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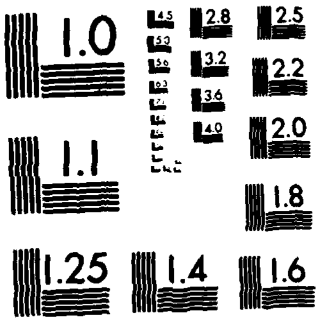

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BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA

Geologic and Seismologic Investigation

AD-A172 511

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Black Butte Dam	quaternary geology	morphostratigraphic surface
Glenn County, California	thrust faulting	
Tehama County, California	quaternary faulting	
Earthquake hazard	maximim credible event	
Black Butte Fault	Coast Range thrust	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Black Butte Dam is located within a zone of expected major earthquake damage. In 1903 and 1906, the site was shaken moderately by the Willows event and the St. Andreas event. Faults shown on present day maps resulted from early reports on California geology. Prior to this study there was no consensus on detail or activity concerning the Black Butte Fault. Substantial investigations of others were divided in opinion about its existence. The present study consists of extensive fieldwork and analysis of surface geology, subsurface geology, and geophysical data about the subsurface. Our evaluation of ~~all~~ this data has led to

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) the conclusion that the Black Butte Fault and Willows Fault system as proposed do not exist within 10 miles around the dam. Small distinct and separate faults might exist further away.

BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA

GEOLOGIC AND SEISMOLOGIC INVESTIGATION

January 1986

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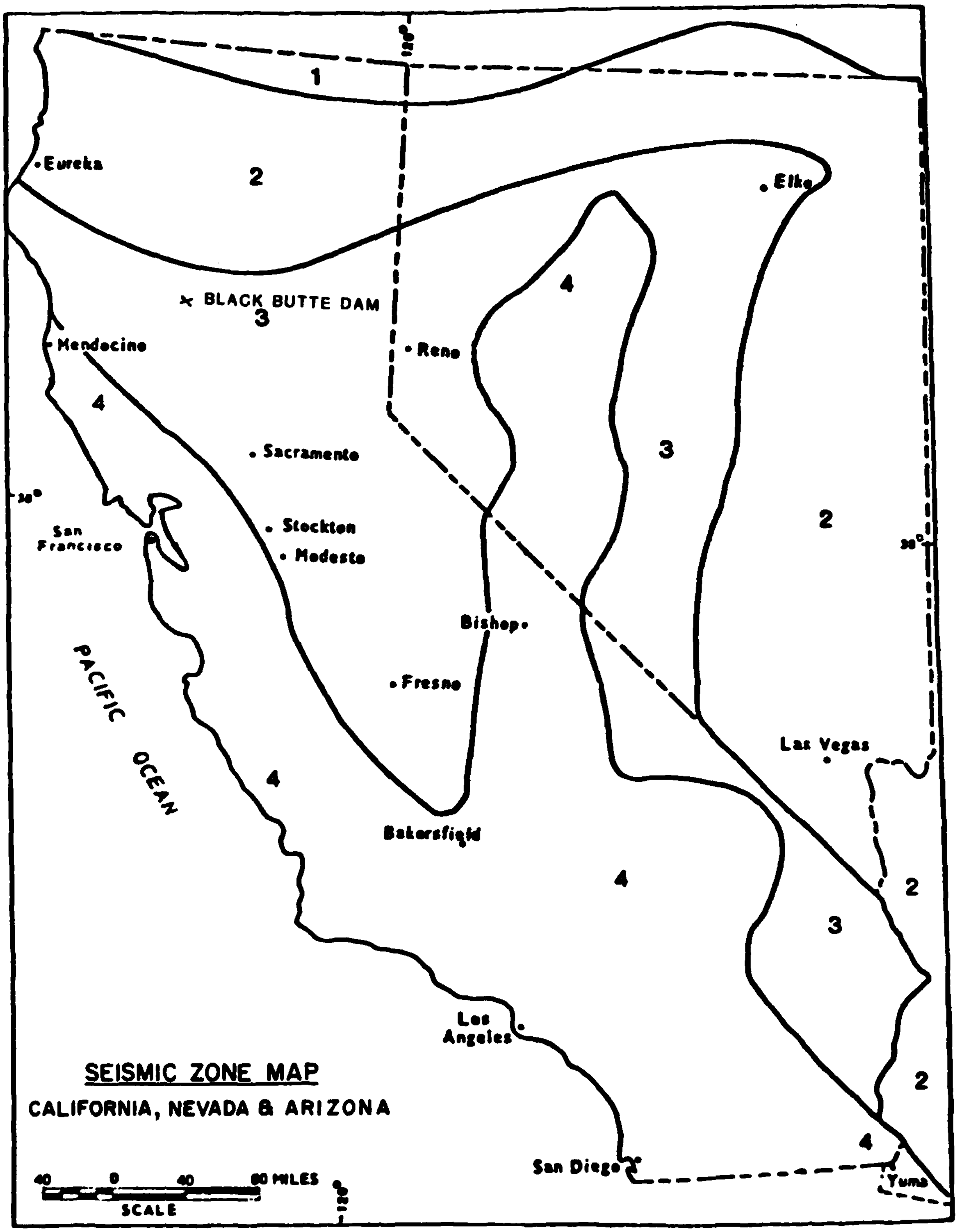
EXECUTIVE SUMMARY

Black Butte Dam is located on Stony Creek, a tributary of the Sacramento River, about 9 miles northwest of Orland, California. The Corps of Engineers completed construction of Black Butte Dam in 1963. In accordance with ER 1110-2-1806, "Earthquake Design and Analysis for Corps of Engineers Dams," dated 30 April 1977, an earthquake stability analysis was performed on the dam in 1983. The seismic loading for this analysis was obtained from a geological and seismological study estimating a design earthquake and ground response occurring on a nearby fault 2 to 6 kilometers (km) from the dam. The authors of that study, Drs. Bolt and Seed of the University of California, recommended a site acceleration of 0.45 gravity from a source tectonic structure like the Black Butte Fault or Willows Fault system as defined in literature and on maps of California geology.

Using a dynamic method of analysis it was concluded that the dam may experience significant movements under the given earthquake loadings, resulting in the possibility of slumping in the upstream portion of the dam. The large available freeboard of the dam would, however, retain the reservoir. Because of this slumping, due to this design event, Seattle District, Corps of Engineers, was asked by the Sacramento District, Corps of Engineers, to locate and extensively study nearby faults and determine their capability to produce the design event. The ongoing study was authorized under the Federal Dam Safety Assurance Program.

Black Butte Dam is located within Seismic Zone 3 (see accompanying figure), a zone of expected major earthquake damage. As shown on geologic maps of California, the dam is located approximately 15 miles from the Coast Range Thrust, 14 miles from the Stony Creek Fault, 12 miles from the Paskenta Fault zone, 1 mile from the mapped position of the contested Black Butte Fault, and 15 miles from the northernmost end of the Willows Fault. The contested Willows Fault system is a multibranched fault system extending from the north end of the Willows Fault. A tectonic wedge, with thrust detachments at depth, has also been proposed as existing within the near field area around the dam.

Underlying the dam are folded sediments of the Mesozoic age Great Valley Sequence. Through the interactions of plate tectonics they were folded into a synclinal trough which emerged from marine to subaerial environment. During folding, crustal shortening took place with the development of several deeper level detachments. Formative tectonic stress stopped in the interior valley of California about 3.2 million years ago. The present stress regime is considered an extension, similar to that occurring in the Basin and Range Province to the east, but modified by compression caused by plate interaction between the Pacific and North American plates along the San Andreas Fault zone. The interior valley is marked by a relative seismic quietness when contrasted with the very active western Coast Ranges margin and less active Sierra Nevada eastern border.



EXECUTIVE SUMMARY FIGURE

In past historic time, the site area has been shaken moderately by two earthquakes. The 1903 Willows event (estimated epicentral Maximum Mercalli (MM) intensity of VII) most probably was not on the nearby Willows Fault but miles to the east of the fault. Historic location for this event is in the central part of the valley, but early settlement diaries indicate that the event was not felt along the North Fork of Stony Creek. The 1906 San Andreas event (epicentral MM intensity of XI) was on the distant San Andreas system. In the site area, this event had an estimated felt intensity of MM V or less.

Faults shown on present day maps resulted from early reports on California geology. For instance, the Black Butte Fault was accepted by the Corps of Engineers (1963) during site investigations for the dam and reservoir based on 1931 vintage reconnaissance work. Prior to this study there was no consensus on detail or activity concerning the Black Butte Fault; substantial investigations of others were divided in opinion about its existence. In addition, numerous faults mapped as short segments were lumped together and proposed to represent a multibranched fault system called the Willows Fault system.

The present study consists of extensive fieldwork and analysis of surface geology, subsurface geology, and geophysical data about the subsurface. Our evaluation of all this data has led to the conclusion that the Black Butte Fault and Willows Fault system as proposed do not exist within 10 miles around the dam. Small distinct and separate faults might exist further away.

With elimination of the Black Butte Fault and Willows Fault system near the site, other sources were looked into. The tectonic capability of doubly plunging anticlinal folds in the subsurface near the midvalley axis was assessed. Possibly these folds are evidence for tectonic wedging and thrust faulting at depth, but this evidence is hidden from view. No subsurface evidence of faulting was found to account for a drag folding origin of the anticlines, and they have no seismogenic history.

Based on minor offsets along a few young Holocene terraces on a Stony Creek Fault segment near Thomes Creek, 27 km from the dam, magnitude 6.5 was chosen as the maximum (credible) event. The source is on the youngest segment of the fault, as this is judged to be the only capable segment.

Because of the few number of earthquakes experienced and the limited historic earthquake record in Glenn and Tehama Counties, calculating the exceedance chance for the maximum event during the project life span becomes an academic exercise, as does estimating earthquake recurrence levels. Instead, historic experience in northern California, as a whole, indicates a local magnitude of 5-3/4 as the maximum event in areas away from the San Andreas Fault zone during any 100-year period. Therefore, this level of magnitude is recommended to be a substitute for a statistical event and to serve as the 100-year probable earthquake. The source for this event is either near the Coast Ranges-Great Valley contact or east of the Willows Fault that lies southeast of the dam.

Guidance, opinion, and onsite review of the study were supplied by professional peers Dr. Roy Shlemon and Mr. Alan L. O'Neill. Conclusions arrived at in this study have their concurrence. Based on the surface geology, including two extensive undeformed Holocene terrace sequences and the subsurface stratigraphy, capable faults were not found to exist near the dam. We recommend exclusion of the Black Butte Fault and Willows Fault system from all future design considerations.

SECTION 1. INTRODUCTION

1.1 Authority. General earthquake risk and seismic hazard studies are authorized under ER 1110-2-1806, dated 16 May 1983. The Sacramento District, Corps of Engineers, requested this study by Memorandum of Understanding between Seattle and Sacramento Districts dated 1 May 1984. This report was prepared by Seattle District, Corps of Engineers, following guidelines of ER 1110-2-1806.

1.2 Purpose. All dams constructed by Federal agencies are reviewed for their performance based on current state-of-the-art civil engineering design. This review includes the reaction of the dam to seismic loading. The purpose of this report is to document the results of evaluation of suspected faults capable of generating earthquakes close to Black Butte Dam. The effects of close "capable" faults on the dam are reported in terms of seismic loading, stated as maximum magnitude and distance between the source and the dam.

1.3 Previous Studies. The Sacramento District performed various earthquake hazard and engineering studies for Black Butte Dam during 1982. These studies and preliminary results from a dynamic analysis of Black Butte Dam are reported in a series of in-house documents released in October 1983. Emerging from those studies was a single design event with maximum magnitude of $M_L = 6.0$. At the time of the study there was no clear consensus concerning activity on nearby faults, thereby generating the prudent procedure of accepting the moderate level earthquake on the closest fault and awaiting further confirmation on that fault's existence. This magnitude 6.0 event was localized on the contested Black Butte Fault producing a site acceleration of 0.45g.

1.4 Scope. This study assesses the capability of close faults, those known to the Corps of Engineers as well as those implied by others. The study included a review and summary of seismic history and a data catalogue. It includes the results of a lineament analysis employing a study of remote sensing and photogeologic imagery. It contains a regional structural analysis and fault evaluation. This study relied heavily on relative age of morphostratigraphic units and landforms to evaluate Quaternary faulting near Black Butte Dam (see Harwood and Helley, 1980; Harwood, 1983; Wentworth and Others, 1984a). It includes a reconstruction of Quaternary tectonic history using field analysis of geomorphic-stratigraphic landforms and units. Existing geologic literature and mapping was compiled and reviewed for a study area within a 50-mile radius, centered on the dam.

1.5 Investigation and Performance. Field geologic study was accomplished during May through November 1984. This represents a 23-week, two man-day field season. Field mapping of structure, stratigraphy, and morphostratigraphic units was performed at a scale of 1:24,000 (1 inch = 2,000 feet) on six United States Geological Survey (USGS) topographic quadrangle maps of the 7-1/2 minute series. When possible, we employed field review and discussion with geologic authorities. The study of geology and seismology around Black Butte Dam was assisted by the following contracted services:

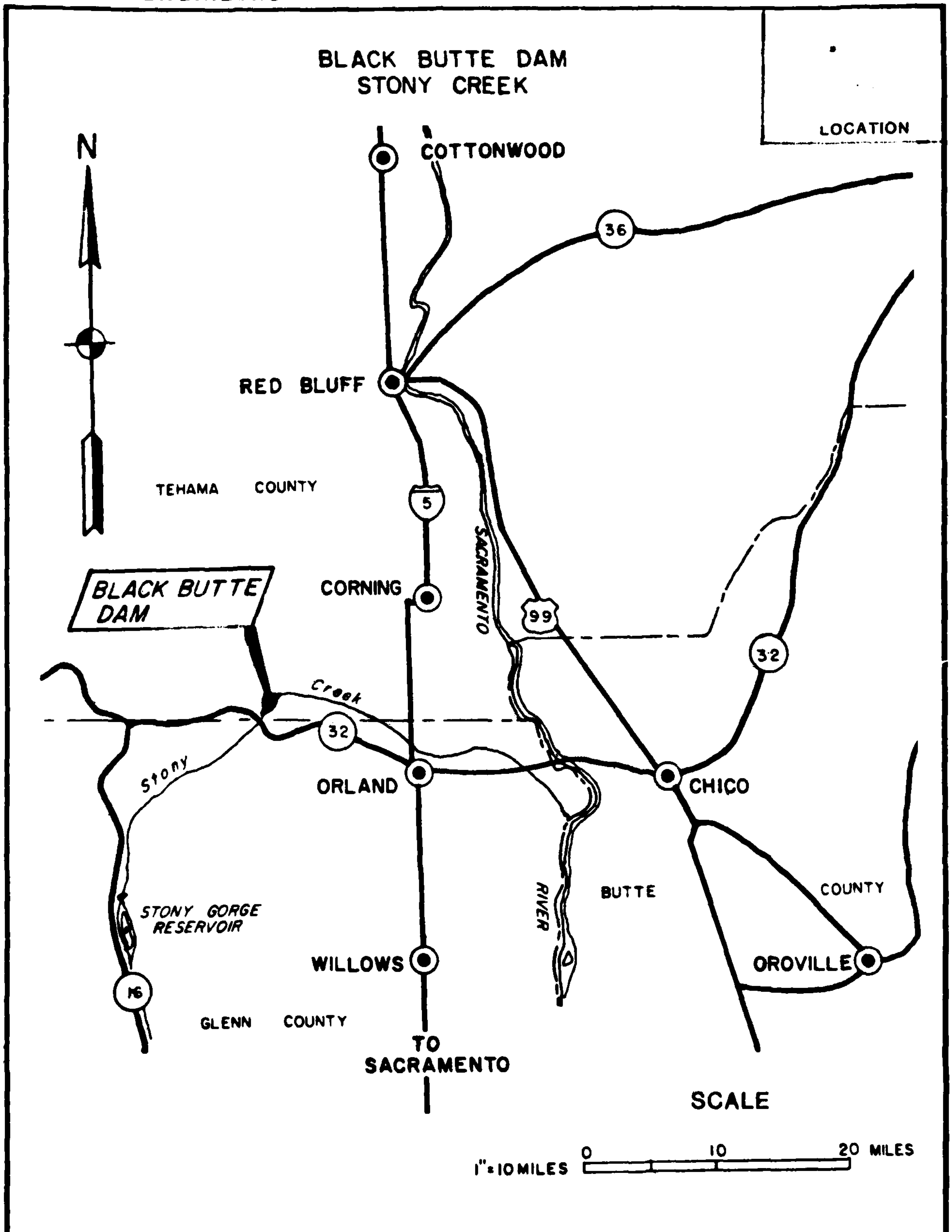
o Northwest Geophysical Associates, Inc., 1984, Magnetic Modeling of Black Butte Dam Report and supplemental letter, DACW-67-84-M-1591, NCA.

o Endacott and Associates, 1984, Discussion and Results of Shallow Seismic Reflection Surveys at Black Butte Dam - Technical letter with time sections, DACW-76-84-M-1417.

o Harlan Miller Tait, 1984, Imagery and Photogeologic Analysis of Major Faults, Black Butte Dam, Orland, California Report, DACW-677-84-0048, HMT.

Guidance, opinion, and onsite review of the study problems were supplied by professional peers Dr. Roy J. Shlemon and Mr. Alan L. O'Neill. We gratefully acknowledge their contribution to the study. Shell Exploration Limited and other oil exploration concerns supplied valuable information and conversation about the acoustical subsurface character in the study area.

1.6 Project Description (see location and vicinity map on figure 1-1). Black Butte Dam, a flood control and water conservation structure, is located on Stony Creek about 9 miles northwest of Orland, California. The project has a gross pool capacity of 160,000 acre-feet, and was completed in 1963. This dam is a zoned earthfill structure with a crest length of 2,970 feet, a crown width of 20 feet, and a maximum height above streambed of 140 feet. The embankment volume is approximately 2.6 million cubic yards (c.y.) and serves as a closure to a water gap in Orland Buttes. Main project features are shown on figure 1-2. The embankment consists of a central impervious core, transition sections, pervious sections, and random rockfill sections. The embankment spans across streambed alluvium to rock abutments. The core is founded on rock through alluvium. Six earthfill dikes are located at various places around the lake to contain the high pool. The outlet works are founded on and through rock. The spillway is a broad-crested, unlined channel cut into rock.



LOCATION AND VICINITY MAP FIG. 1-1

CORPS OF ENGINEERS U.S. ARMY

BLACK BUTTE DAM AND APPURTENANCES | **FIG. 1-2**

SECTION 2. GEOLOGY

2.1 Geologic Setting. Northern California is divisible into geologic provinces that are clearly marked by differences in morphology, geologic structure, and stratigraphy (see figure 2-1). The project is located in the northern Sacramento Valley portion of the Great Valley (GV) Province. Mountain provinces surround the Black Butte study area. To the north are the Klamath Mountains, to the west and southwest are the Coast Ranges, to the north and east is the Cascade Range, and to the east is the Sierra Nevada Range.

a. Sacramento Valley. The Sacramento Valley is in the northern part of the Great Valley of California; a nearly flat alluvial plain extending south some 450 miles from the Klamath Mountains on the north. The valley width of 50 miles is seldom broken in its featureless profile. The only elevations of prominence on the valley floor are Marysville (Sutter) Buttes, a Pliocene volcanic plug, and the Dunnigan Hills, a Pliocene sedimentary heap. The Cenozoic sediments and volcanics rests atop the Great Valley Sequence. The subsurface of the valley is a geosynclinal east-west-trending warp with a north-south-trending deep fold axis along the western valley edge.

b. Coast Ranges. West of the Great Valley are many mountain masses juxtaposed by northwest-trending strike-slip faults. Two principal core complexes are present in these mountains: Jurassic-Cretaceous eugeosynclinal assemblages (Franciscan) and Early Cretaceous granitic and metamorphic rocks. The two are not related. The Coast Ranges are structurally complicated, owing their existence to plate collision and transform movement throughout their history.

c. Klamath Mountains. The Klamath Mountains consist predominantly of marine arc-related volcanic and sedimentary rocks of Paleozoic and Mesozoic ages. Ultramafic and ophiolitic rocks are also important rock types. Many areas of the Klamath Mountains are intruded by Jurassic granitic plutons. Rocks of the Klamath Mountains are not exposed in the project area; however, they were a source of detritus for the Great Valley Sequence.

d. Cascade Range. In the northeasternmost part of California and extending into Oregon and Washington is the Cascade Range (including the Modoc Plateau). The dominance of Pleistocene/Holocene constructional volcanic landforms and block faulted basins characterizes this region.

e. Sierra Nevada. Along the eastern edge of California's Great Valley is a huge batholithic landmass and thick sequence of Upper Paleozoic volcanic strata. Old island arcs thrust onto a Paleozoic continental margin were heavily intruded and plutonized through a Mesozoic Era plate collision. The Sierra Nevada core resulted as an elongate block of crust. Later this block broke free along its eastern edge and rose upwards thousands of feet tilting westward and forming this dominant mountain range on California's landscape.

0 —— 50
Scale in miles

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California Division of
Mines and Geology,
Sacramento, Ca.
1962

RELIEF MAP OF NORTHERN CALIFORNIA SHOWING THE NATURAL PROVINCES	FIG. 2-1

f. San Andreas Fault. In California, faults are numerous, but their hazard varies according to location. With the exception of the Great Valley and the San Andreas (SA) fault zone, provinces surrounding Black Butte Dam have no overwhelming influence on seismic hazard at Black Butte Dam.

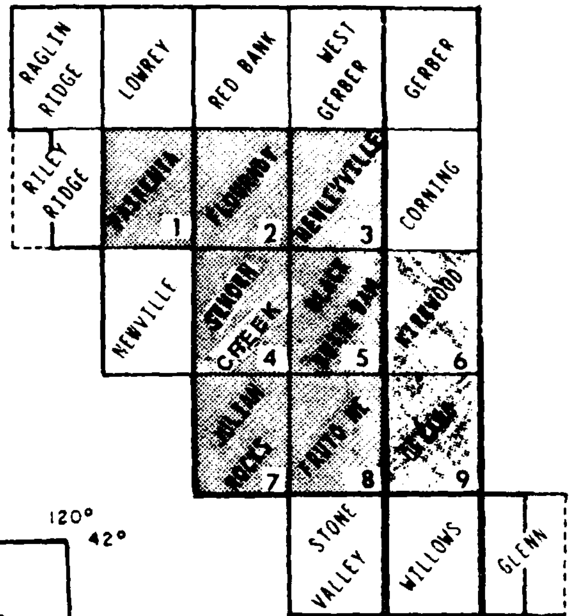
The San Andreas Fault is California's most spectacular and best known plate border. The San Andreas Fault zone has had a series of large recurring earthquakes. This fault strikes N35^o W along the western flank of the Coast Ranges in nearly a straight line. Extending southward from Cape Mendocino, it has 650 miles of continuous length. The main San Andreas Fault lies within 125 miles of the dam. Inland from the fault is a zone of sympathetic shearing and faulting that mimics the San Andreas trend. The sympathetic faults of the San Andreas lie as close as 57 miles west of Black Butte Dam.

2.2 Regional Geology. Quaternary geology and lineaments were compiled on a 1:100,000 scale base map shown as plate 1. The stratigraphy, morphology, and structure within 50 miles of Black Butte Dam were compiled on portions of three State of California 1:250,000 scale geologic maps. Figure 2-2 serves as an index to geologic maps on plates 2, 3, and 4. Figure 2-2 also provides a key to nine maps in the pocket showing more detailed geologic mapping.

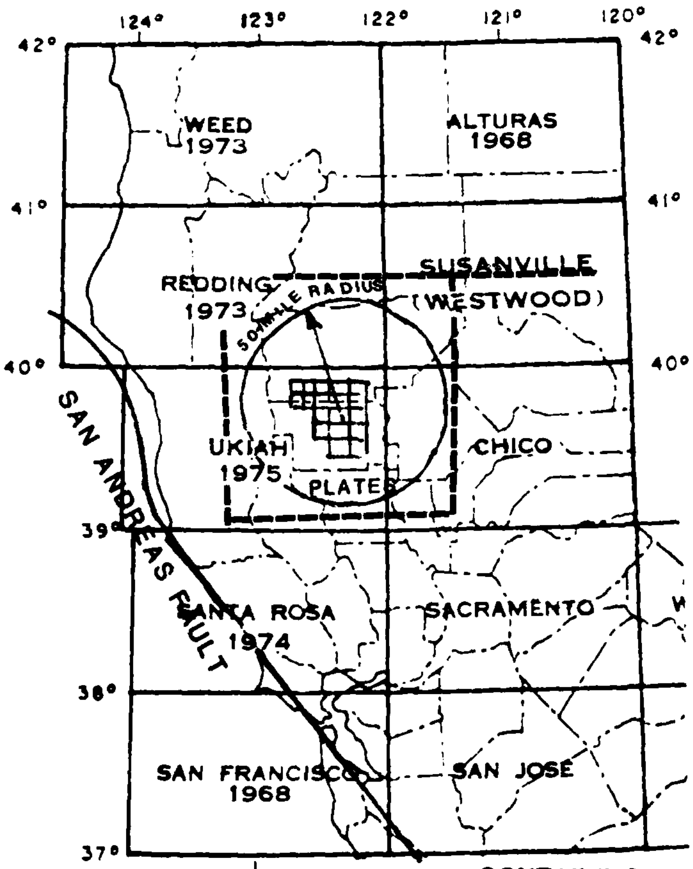
2.2.1 Pre-Quaternary Stratigraphy. Figure 2-3 accompanies this discussion of stratigraphy. Also refer to plates 2 through 6. Pre-Quaternary stratigraphy is extensively discussed in appendix B, and should be consulted for a better understanding of the stratigraphic section and stratigraphy identified on the figures and plates. Northern Sacramento Valley stratigraphy represents deposition on an emerging crystalline continental margin. Successions of turbidites, shelf deposits, shallow marine, and subaerial deposits are present throughout the valley. Sedimentary deposits overlie a basement consisting of down-thrusted Franciscan Complex and ophiolites in the west and Sierran granodiorites and Paleozoic metasedimentary strata in the east.

a. The rocks overlying the basement are thick units known as the Great Valley Sequence (up to 24,000 feet thick). Generally the Great Valley Sequence is divided into three series: Knoxville series (Jurassic), Shasta series (Lower Cretaceous), and Chico series (Upper Cretaceous). Each series has several formations. In the project area the depth to basement is unknown. The project and lake are located on top of exposures of the Chico series. Formations present at the damsite include: Forbes mudstone, Dobbins shale, and Guinda sandstone. On the lake shore Funks, Sites, Yolo, Venado, and Boxer (Julian Rocks conglomerate and Clark Valley mudstone) Formations are present in outcrop. Further east along Stony Creek the Lodoga Formation is present (Shasta series).

b. A major erosional unconformity marks the boundary between the Cretaceous formations and overlying Tertiary deposits. This unconformity represents a period of time in which a huge submarine valley (lower Princeton Submarine Valley) was eroded into the Cretaceous units in the area of the present Sacramento Valley (see figure 2-4).



MAP SHEETS IN POCKET
MAP SHEET INDEX SHOWN ABOVE
INDEX AREA LOCATED IN RELATIONSHIP TO STUDY AREA SHOWN ON LEFT



AREA CONTAINING 50-MILE RADIUS IN FIGURE ABOVE SERVES TO LOCATE MAP PLATE 1 AND PLATE 2

GEOLOGIC MAPS

FIG. 2-2

QUATERNARY				Alluvium/Colluvium/Terrace Sequences
TERTIARY	NEOGENE			TEHAMA FM. / NOMLAKI TUFF
				NEROLY FM.
				UPPER PRINCETON VALLEY
				LOVEJOY BASALT
	PALEOGENE			BLACK BUTTE FM.
				MARKLEY FM.
				NORTONVILLE FM.
				DOMENGINE FM.
				IONE FM.
				CAPAY FM. (LOWER PRINCETON VALLEY)
CRETACEOUS	UPPER	GREAT VALLEY SEQUENCE	CHICO SERIES	KIONE FM.
				FORBES FM.
				DOBBINS SHALE
				GUINDA FM.
				FUNKS FM.
				SITES FM.
				YOLO FM.
				VENADO FM.
				BOXER FM. (JULIAN ROCKS) (CLARK VALLEY MUDSTONE)
	LOWER		SHASTA SERIES	LODOGA FM.
JURASSIC	UPPER		KNOXVILLE SERIES	STONY CREEK FM.

STRATIGRAPHY OF THE WEST-CENTRAL SACRAMENTO VALLEY

FIG. 2-3

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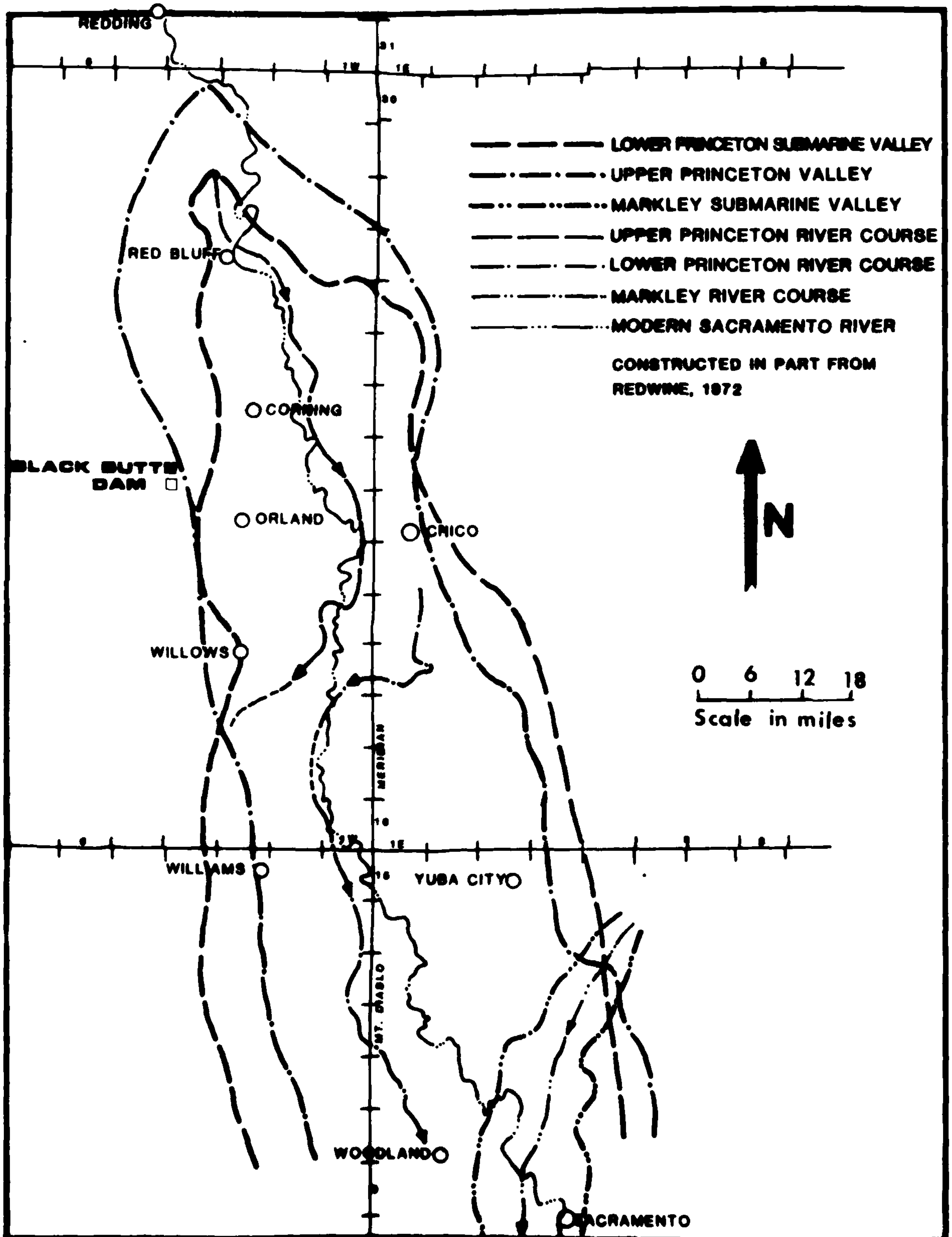


GENERALIZED BOUNDARIES OF THE
EOCENE VALLEYS OF NORTHERN CALIFORNIA

FIG. 2-4

c. Next group in overlying succession is the nonmarine group. An important stratigraphy is the one which makes up the formidable buttes that the dam closes at Stony Creek gap. This strata is a locally occurring series of volcanic sandstone, mudstone, and conglomerate capped with basalt. The Black Butte Formation, as it is found at the buttes in Stony Creek gap, became host to a thin basalt flow or canyon flow about 15 million years ago. The Lovejoy basalt occurs sporadically throughout the valley in wells, presenting in section a sinuous canyon-like nature to its occurrence.

d. Next in succession is the oldest alluvium, representing a flood of clastic material occurring during the Pliocene that descended from the rising western mountain masses.

Tehama Formation. In the greater project area, the Tehama Formation consists of greenish gray, occasionally pale yellowish gray, sandy, tuffaceous siltstone, lenticular channelized interbeds of conglomerate and sandstone, and locally abundant conglomerate beds. Where near the surface, the conglomerate commonly takes on a bright red-brown color presumably due to weathering on the surface of clasts and the matrix. Where the weathering is incomplete, the conglomerate takes on a mottled appearance. This bright red-brown coloration was also observed locally in conglomerate beds exposed at depth by larger creeks west of the damsite and may represent buried geosoils (see glossary). The Tehama Formation is moderately consolidated and usually uncemented. It lies unconformably on all older formations and was deposited in a fluvial environment of an ancestral (and similar) Sacramento Valley of low relief. The Tehama deposits, derived from the Coast Ranges and Klamath Mountains, were deposited along the west and north sides of this ancestral valley. The Tuscan Formation deposits, derived from the Sierra Nevadas, are coeval with the Tehama, and the two interfinger in the central area of the present Sacramento Valley where they reach a thickness of over 2,000 feet. The Tehama Formation in the general project area takes on the appearance of a large fan from ancestral Stony Creek. The north toe of the fan lies near Black Butte Dam 20-25 miles to the south, the south toe lies about 1 mile east of Willows, and the remnant apex lies aproximately 1 mile southeast of Julian Rocks. The Tehama Formation is late Pliocene in age, bracketed by age dates of 3.4 million years (Evernden and others, 1964) and 1.5 million years (Lydon, 1968) based on fossil contents. The Tehama Formation is relatively thin west of the damsite but thickens rapidly to the east.

Nomlaki Tuff Member. The Nomlaki Tuff Member is 10 to 50 feet thick and found near the base of the Tehama Formation over a large area of the northwestern Sacramento Valley. It is a dacite tuff, locally white, salmon pink, or light gray, massive, and coarse grained. Age dates indicate this tuff is 3.4 million years old. It is exposed consistently near the western margin of the valley and throughout the mapped area of the Tehama Formation. In the course of this study, presumably reworked Nomlaki Tuff was noted in wave cut exposures of the Tehama Formation at Orland Buttes Recreation Area. An additional exposure is noted in the Black Butte Foundation Report (Corps of Engineers, 1983) between the North and South Forks of Stony Creek (sec. 21, T. 22 N, R. 5 E.). These occurrences verify the relatively thin cover of Tehama Formation and the shallow depth to Cretaceous rocks in this area.

2.2.2 Quaternary Stratigraphy and Geomorphology.

a. General. The cycle of uplift, erosion, downwarping, and reestablishment of ancient Sacramento River fluvial deposition, responsible for the deposition of the Neroly and Tehama Formations, was operative at least twice in the Quaternary. The Red Bluff Formation represents a Quaternary cycle and the modern alluvium of the Sacramento River another. Erosion of Tehama and older formations has been occurring along valley margins since early Quaternary time. Through various base level adjustments, numerous morphostratigraphic surfaces have developed along the Quaternary drainages. Modern stream locations are similar in nature to paleo-drainages from the highland areas west of the project. The last major sedimentary cycle (Tehama aggradation) has built an extensive coalescing alluvial fan outward from the Coast Ranges. Erosion is presently moving material down a slope of transportation. About 1.25 million years ago, fluvial deposition ceased, perhaps resulting from a Pleistocene orogeny west of the study area (Earth Sciences Associates (ESA), 1980; Steele, 1979, 1980; Harlan Miller Tait, 1983, 1984). Between about 1.25 million and 0.5 million years ago, extensive "high terraces" were cut across and into the Tehama Formation by ancestral drainages of Stony and Thomes Creeks and the precursor of other east flowing streams.

b. Red Bluff Formation. The Red Bluff Formation consists of deposits very similar to the Tehama Formation; however, the Red Bluff Formation is generally of uniform deep brick-red color, much coarser, and contains less rounded clasts. These features can usually be used to differentiate the formations where both exist. The principal occurrence of the Red Bluff deposits is north and northeast of the Black Butte Dam area. It reportedly attains a thickness of 100 feet in the vicinity of Redding but rapidly thins to less than 50 feet to the south (Anderson and Russell, 1939). South of the general area of Sehorn Creek only remnant patches of Red Bluff deposits remain, and they become mappably indistinguishable from similarly colored gravels of the Tehama Formation. The Red Bluff deposits unconformably overlie the Tehama Formation and the Cretaceous rocks where the Tehama is absent. The Red Bluff was deposited on an erosional surface in an alluvial environment very similar to that of the Tehama and Neroly Formations.

c. River Fluvial Terrace Systems. Between about 1.25 and 0.5 million years ago and continuing to the present, an extensive terrace system has been formed along major valley drainages. This system is composed of nested terrace levels which are of regional extent and are mappable. Terrace levels were developed in response to episodic base level lowering resulting mainly from climatic changes (ESA, 1980; Huston, 1973; Steele, 1979; Harlan Miller Tait, 1984; and Shlemon, 1967a, 1984, Per. com.). Terrace levels, either cut or fill surface, and extensive "high" surfaces are correlated along the Sacramento Valley. They have been dated by association with major climatic changes during the Quaternary. Terrace levels are distinguished by morphology and are calibrated by soil stratigraphy to distinct time periods. These morphostratigraphic surfaces provide the best means of evaluating the history of folds and faults mapped across these units. Maps 1 through 10 (in the pocket) indicate that neither faults presently mapped or inferred by others, nor folds, or lineaments in the study area, have disturbed the units of age Q6 or less (350,000 years before the present).

Morphostratigraphic Units. Ten years ago few engineering geologists understood terms such as morphostratigraphic units, geosoils, or soil-stratigraphic nomenclature; however, these terms have become the geologist's "clue kit" to aid him in solving recent fault history and defining displacement when faults lie across or underneath morphostratigraphic units. These terms are described in the accompanying glossary. Morphostratigraphic units in the Black Butte area are nested terrace levels continuous to downstream channel deposits developed in the youngest prominent fan heads (Steele, 1980; Huston, 1973; Shlemon, 1980; Shlemon and Begg, 1972).

Along the eastern foothills of the northern Coast Ranges the basic geomorphic process has been the development of a slope of transportation by dissection and lowering of the Tehama surface, resulting in the exhumation of underlying folded sedimentary rock. Resurrected strike valleys and thrust zones are exposed in the area of a once existing alluvial plain (i.e., maximum aggradation of Tehama fans) lapping onto the mountain front. On this slope, pedological profiles formed in the last 0.5 million years when given a stable land surface, climate, and vegetation. Where there has been geomorphic stability through time, distinct soil horizons have developed that can be measured and described as stages of profile development. Along Stony Creek, zonal soils develop genetic horizons (such as the argillic horizon) that allow excellent resolution of chronological sequence. Parent material and relief influence zonal soil formation, however, through time past, in California in general, and in this study area, zonal soil formation processes have mostly been dominated by climate and biological forces.

In the foothill region, parent material is of mixed mineralogy and has been inplace for a long time. Materials from the original Coast Ranges source are sedimentary, metasedimentary, and basic volcanic in origin. The oldest materials above bedrock are mixed texture alluvium and gravel channels present as oldest alluvial fans. Remnants of channels are now exposed on high benches, ridge lines, and side-hill terraces as caps (fragipan) containing gravel and cobblestone. These near-level surfaces can be mistaken as "high terraces" suggestive of braided channels on the oldest upland plain. In some instances, as at sec 28, T. 24 N., R. 4 W., these channels are exposed in cuts as exhumed gravel channels of the Tehama. These channels have been weathered long enough in time to develop an abrupt duripan.

Very often, recently exposed nonweathered Tehama materials contain gravel channels that also have duricrust (calcrete and silcrete). Old coarse-textured overwash fans form at the base of secondary drainages dissecting the upland surfaces. The largest ones are seen in poorly sorted material exposed through incision of Thomes and Stony Creeks. Moderately old gravelly alluvium has been deposited on alluvial fans by local intermittent streams draining the old alluvium of the foothills. There, surfaces are moderately to deeply weathered. Moderately old sedimentary alluvium has been deposited from intermittent streams draining the exhumed strike valley and older, fine-grained fan materials. Younger alluvium (but older than recent flood plain) has been deposited by Stony Creek as flood plain and coarse fan head gravel channels due to changing base levels because of shifting basins in the lower reaches. Recent alluvium is varied-texture channel sand and gravel and recent flood plain sediments laid down by Stony and Thomes Creeks.

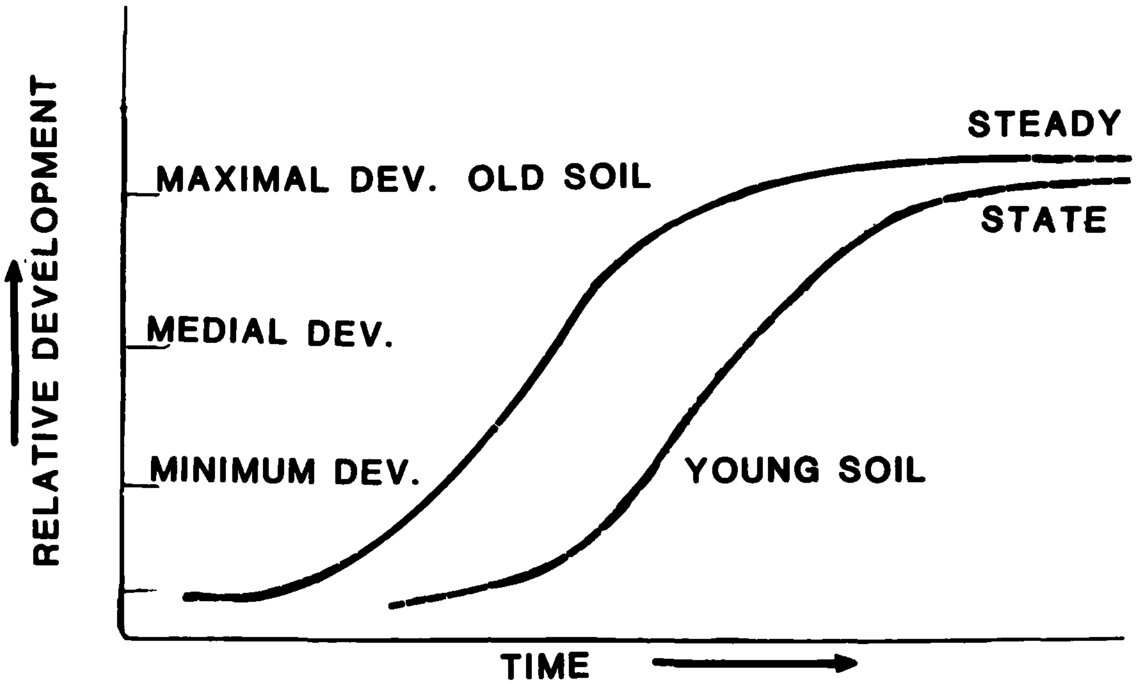
Soil Stratigraphy. Fine tuned division of the Quaternary is most often related to worldwide climatic change and the accompanying alternation of vegetation, sedimentation, and hydraulic regime. These are, in turn, related to interglacial and interstadial epochs. Most fluvial sediments in the Central Valley were laid down during glacial/pluvial time, and most soil formation occurred during preceding and following interglacial and interstadial epochs. On any stable geomorphic surface, exemplified by terraces flanking Stony and Thomes Creeks, soil profile began to form. With the passage of time, distinct horizons slowly formed and, based on physical and chemical characteristics, can be qualitatively distinguished by relative degree of soil profile development: (1) minimal (slight), (2) medial (moderate), and (3) maximal (strong) (Begg 1968, Gowan, 1967). Relative soil profile development can be calibrated to epochs of Quaternary climatic change by association with oxygen isotope chronology. Figure 2-5 shows relative soil profile; schematically mapped soil series particularly applicable to the study area are shown on table 2-1. They are distinguished mainly by relative development of the B2t (argillic) horizon and are divisible into subcategories by differences in parent material and texture.

Units. In this study, the major "intermediate" and "low" terrace levels are designated from younger to older as morphostratigraphic units Q1 through Q6. The use and application of the concept of morphostratigraphic units follows the approach discussed in detail in Harlan Miller Tait (1983, pages 37 to 43). The lowermost four or five terraces are correlative to the Modesto and Riverbank Formations of the northeastern San Joaquin Valley (Davis and others, 1959). These formations were extended to the southeastern Sacramento Valley (Shlemon, 1967b; 1972), and later to the western and northern Sacramento Valley (Harwood and others, 1980; Helley and others, 1981; Helley and Jaworowski, 1985). Steele similarly recognized terraces in the study area, naming them after soils series forming on them, e.g., Orland, Yolo, Arbuckle, Perking terraces (Steele, 1980, p. 18).

Many minor discontinuous intermediate units are also preserved in the study area but have been identified only locally by observation in the areas. Detailed field checking of morphostratigraphic units was conducted on Stony Creek and Walker Creek. Reconnaissance checking was performed on Thomes Creek.

Channels. Units Q1 through Q5 have equivalent age channels associated with Stony Creek, downstream from Black Butte Dam. These channels were field mapped in this study using prior mapping by Shlemon, et al. (1976). The channels reflect the migration of Stony Creek across its fan. Soils developed on morphostratigraphic units Q1 through Q5 are of the same pedological development as those developed on equivalent-age channels C1 through C5.

RELATIVE SOIL PROFILE DEVELOPMENT



Typical development of soil groups and profiles in the study area

SUBGROUP	PROFILE	DEVELOPMENT
Typic Xerofluvents	Ap-C1-2C2	Minimal
Typic Xerothent	C1-C1OIIC3	Minimal
Typic Haploxeralfs	Ap-A12-B1t-B2t	Minimal
Typic Haploxeralfs	Ap-B1t-B21t-B22t-B3tca-C1ca	Medial
Typic Palexeralfs	O1-A1-A3-B21t-B22t-B3t-C1	Maximal
Typic Palexeralfs	Ap-A1-A3-B1t-B2t-B31t-B3..	Maximal
Abruptic Durixeralfs	A1-A3-B21t-B22qm-Cm1-Cm2	Maximal

Subordinate Distinctions

a-accumulation of carbonates
q-accumulation of silica
t-accumulation of silicate clay
x-fragipan character
p-plowed
m-Cementation or induration

Classification after Begg (1968) and Gowans (1967).

SOIL DEVELOPMENT IN STUDY AREA FIG. 2-5

TABLE 2-1

SOILS OF THE SACRAMENTO VALLEY APPLICABLE TO BLACK BUTTE DAM STUDY AREA

Soil (1) Texture	Soil Series	Parent Material	Argillic Development	Pan	Suborder	Youngest (2) State Age
Coarse Textured Soils	Cortina	Coarse Textured Recent Alluvium	Minimal	None	Typic Xerofluvents	Modern
	Arbuckle	Gravelly or Cobbley Alluvium	Minimal	None	Typic Haploxeralfs	10,000
	Perkins	Gravelly or Cobbley Alluvium	Medial	None to Clay	Mollic Haploxeralfs	125,000
	Corning	Gravelly or Cobbley Alluvium Old Terrace	Maximal	Clay	Typic Palexeralfs	125,000
Medium Textures Soils	Orland	Flood Plain Outwash from Sedimentary Rocks	Minimal	None	Typic Xerorthents	Modern
	Wyo	Sedimentary Alluvium	Minimal	None	Mollic Haploxeralfs	10,000
	Tehama	Old Alluvial Fans	Medial	None	Typic Haploxeralfs	10,000
	Hillgate	Old Fans and Low Terraces	Maximal	None to Clay Pan	Typic Haploxeralfs	125,000
Fine Textured Soils	Yolo	Recent Alluvium of Sandstone	Minimal	None	Mollic Haploxeralfs	10,000
	Zamora	Mixed Alluvium on Alluvial Fans	Minimal	None	Typic Haploxeralfs	10,000
	Kimball	Terraces	Maximal	None	Mollic Haploxeralfs	125,000
Cemented Soils	Moda	Fine Grained Alluvium	Maximal	Iron-Silica	Abruptic Durixeralfs	125,000
	Redding	Gravelly or Cobbley Alluvium	Maximal	Iron-Silica	Abruptic Durixeralfs	250,000
	Red Bluff	Old Fans	Maximal	Iron-Silica	Abruptic Durixeralfs	250,000

(1) Soil series after Begg (1968) and Gowans (1967).
(2) Estimated minimal ages after ESA (1980); Harlan Miller Tait (1984); Shlemon and Begg (1972); and Steele (1979).

Q1 - This unit consists of the youngest topographically low fill deposit, probably less than 10,000 to 12,000 years old, associated with all the larger drainages in the study area. It includes the active channel and flood plain, the first emergent terrace, which is probably alluvial land and of essentially modern soils, including Orland, Yolo and Cortina.

Q2 - This unit consists of the first preserved "low" terrace remnants above the active channel and flood plain. It is discontinuous but locally present along most major drainages and locally is more extensive than Q3. Unit Q2 is generally used for row-crop agriculture and is characterized by soils less than 10,000 years old, including Zamora, Wyo, and Cortina.

Q3 - This unit consists generally of the most extensive "low" terrace remnants present along most major drainages. It is best preserved on the north side of Thomes Creek. It is locally covered by a thin veneer of young alluvial fan deposits from adjacent sidestreams graded to its surface. Q3 is generally used for row-crop agriculture, but where uncleared is sparsely tree covered. It is characterized by minimally to medially developed soils, approximately 35,000 to 50,000 years old, including Arbuckle, Tehama, and Pleasanton soils.

Q4 - This is locally the most prominent unit in the study area associated with the present drainage system, although it is less prominent in this area than in the northernmost Sacramento Valley. It is generally the most continuous and widest unit, and extends up larger tributary drainages. It may have a distinct hummocky micro-relief, but in the study area it seldom displays this character. It is best preserved on the north side of Thomes Creek. It is locally covered by a thin veneer of young alluvial fan deposits from adjacent sidestreams graded to its surface.

Unit Q4 has moderate relief and is slightly dissected. It characteristically has more minor, discontinuous, intermediate levels than others, particularly on the outside of Q4 age meanders, and locally preserves remnants of now abandoned drainage networks related to its formation. Intermediate levels in these areas include some slightly higher and older and some slightly lower and younger than Q4. Q4 is generally used for pasture, crops, and range, and where uncleared is sparsely to moderately tree covered. It is characterized by medially developed soils approximately 80,000 to 125,000 years old, including the Hillgate, Arbuckle, Tehama, Perkins, and young Kimball soils in the study area.

Q5 - This unit consists of remnants of the first "intermediate" terrace level preserved in the study area. It is generally moderately dissected with moderate relief and is generally narrower and less continuous than Q4. Q5 remnants usually have a distinct hummocky micro-relief on Corning soils; otherwise micro-relief is seldom seen on Q5 in the study area.

Unit Q5 is generally used for pasture and range, with vegetation consisting of annual grasses and forbs and scattered to locally abundant trees. It is characterized by maximally developed soils or equivalent surfaces approximately 200,000 to 250,000 years old developed on sediments greater than 250,000 to 300,000 years old. Commonly associated soils include the Perkins, Red Bluff, Kimball, and Corning in the study area.

Q6 - This unit consists of remnants of a second, topographically higher "intermediate" terrace. It generally is moderately dissected with undisturbed remnants typified by distinct hummocky micro-relief and is somewhat narrower and less continuous than Q5. However, it is readily differentiated from Q5 and occurs along most major drainages in the study area.

Unit Q6 is generally used for pasture and range, with vegetation consisting of annual grasses and forbs with scattered to locally abundant trees. It is characterized by maximally developed soils or equivalent surfaces approximately 300,000 to 350,000 years old. Commonly associated soils are the Redding-Newville and Corning in the area of study.

Red Bluff Pediment/Redding High Flood Plain. The term "Redding High Flood Plain" was coined by Steele (1979) to designate the highest continuous, generally gently eastward-sloping surface preserved in the northern Sacramento Valley west of the Sacramento River. The name "Redding" was derived from the extensive soils series of that name mapped on several high-level geomorphic surfaces in Glenn, Tehama, and Shasta Counties (Begg, 1968; Gowans, 1967; Klassen and Ellison, 1974). These surfaces were inferred by Steele to represent a once continuous, regionally extensive high erosion surface, or pediment, cut across the Plio-Pleistocene Tehama and Pleistocene Red Bluff Formations. Helley and others (1981) included the "Redding High Flood Plain" in the Red Bluff Formation, which they interpreted as a large, dissected alluvial fan which truncated the Tehama Formation as a pediment. More recently, Helley and Jaworowski (1985) referred to the surface as "Red Bluff Pediment".

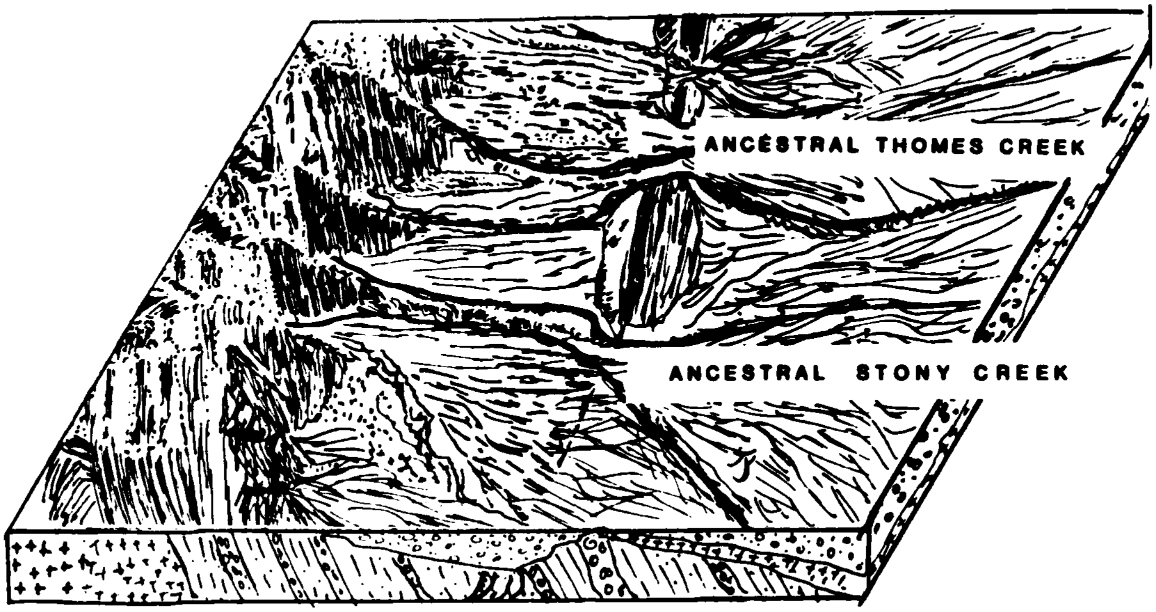
Prior to Steele (1980), Begg (1968) postulated that the oldest fans in the study area were uplifted by tectonic action and subsequently dissected by Stony Creek leaving many disconnected terrace remnants. Steele (1980) attempted to reconstruct the predissected surface of the "Redding High Flood Plain" by drawing generalized contours connecting points of equal elevation on surface remnants. The resultant contour pattern displayed several localized deflections which were postulated by Steele to reflect tectonics within the last 1.25 million years. Helley and Jaworowski produced a Red Bluff age contour map in the study area just south and east of Black Butte Dam (Fruto N.E. quadrangle map) that shows a small east-west-trending dome in the area between Wilson Creek on the south and South Fork Walker Creek on the north. This small structure is one of several east-west-trending folds that their contour mapping suggests along the west side of the valley.

The concept that a once continuous, regionally extensive high erosion surface existed throughout much of the study area and entire Sacramento Valley is intriguing and, if true, would provide one method to evaluate recent tectonics. However, detailed photointerpretation, field mapping, and geomorphic interpretation of published soil surveys conducted as part of the Cottonwood Creek project study (Harlan Miller Tait, 1983) and this study indicate that the highest surfaces preserved in the study area are not remnants of a once continuous, regionally extensive "flood plain" or pediment. Flood plain may be an incorrect usage of the term, as is pediment, for anything other than a constructional slope. Begg (1968) used alluvial plain; although the Tehama Formation might have fit this concept once, perhaps coalescing in a large semiunified "surface", individual fan surfaces in the formation were probably never regionally continuous. In fact, present remnants of the many high surfaces are representative of distinct fan levels localized by gaps in folded sedimentary bench land. Terraces were cut across and into the Tehama Formation in early Quaternary time between about 1.25 and 0.5 million years ago by ancestral drainages of Thomes Creek and Stony Creek and by precursors of many other east flowing streams in the northwestern Sacramento Valley. They became regionally graded to the ancestral Sacramento River. Figure 2-6 illustrates the maximum aggradation of Tehama fans and the onset of dissection by ancestral Stony and Thomes Creeks.

A further examination of the pediment concept is warranted. A pediment is a gently inclined plane (typically 1 percent in the southwestern United States) at the foot of a mountain front. It is formed by degradation and retreat of the mountain front, the headward source of sediments. The upper erosion surface is thinly veneered with alluvium while at the toe a greatly thickening wedge of clastic is graded to a closed basin or a through-going stream. The outermost zone of aggradation encroaches on the thin veneer or pediment by building of alluvium (Easterbrook, 1969). Pediments are dissected by changes in base levels. The Black Butte area does not fit the description of an undissected pediment as illustrated by figure 2-7.

North of Stony Creek (off of figure 2-7) the Tehama and Red Bluff overlie the bedrock wholly as a zone of aggradation. Thin wedges exist at Table Mountain, elevation 1,100 feet, where the Tehama is presumably the thinnest, but the wedge thickens rapidly eastward to more than 600 feet and persists for 3 miles west. (Table Mountain, sec. 25, T. 26 N., R. 5 W., to Occidental Petroleum Harris 9811 No. 1., sec. 23, T. 26 N., R. 5 W.).

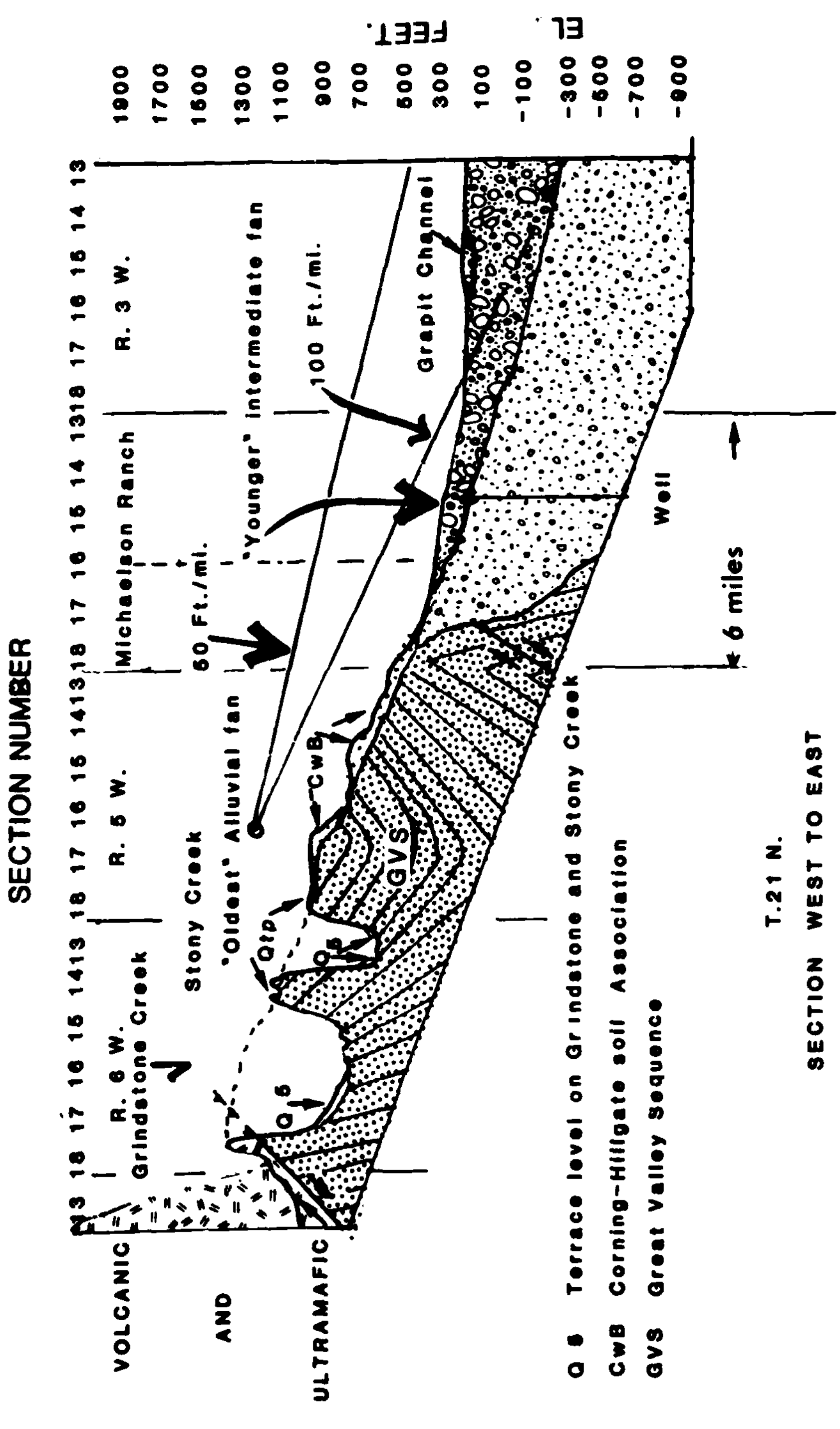
The section sketch in figure 2-7 is south of Stony Creek across T. 21 N., R. 6 to 3 W. down the regional slope. For the section shown, the upper slope is greater than 100 feet per mile; somewhat more than 50 feet per mile is typical of southwest pediments. Since the Tehama dips at 2 degrees (250 feet/mile), this is not the original constructional slope but rather an adjusted slope reflecting degradation and/or slight regional tilting. Field evidence suggests that in places more than 80 feet of thick clastic wedges of Tehama exist on the higher slope areas, not suggestive of a veneer. Many areas in the Fruto and Stone Valley quadrangles contain outcrop and subcrop of Nomlaki Tuff, suggesting that the Tehama has been eroded to near the base of the formation. The lower fan area has intact Q5 and younger units as do the upper fan heads and subsequent valleys, suggesting that this is a 100- to 250-million-year-old surface at the oldest. We found no "high" terraces on Worthington Ranch (Fruto N.E. northern half). The Tehama is 600 feet thick at Worthington Oil Well (sec. 33, T. 24 N., R. 4 W.) indicating that this area could have been a consequent breach in the bedrock bench land probably serving to localize the



Maximum aggradation of Tehama fans are depicted. Resistant folded sedimentary rock forms ridgelines. Breached by erosion during an older cycle, ridgelines form benches that stand topographically higher than fan surfaces.

As presently occurring near Sheep Mountain, Wyoming, breached ridgelines serve to localize new fan heads. Toe areas of the fans tend to coalesce into a semiunified alluvial plain.

AGGRADATION OF TEHAMA FAN SURFACE FIG. 2-6



DISSECTION OF TEHAMA FAN SURFACE FIG. 2-7

Tehama fan at the gap during its beginning. For at least the last 0.5 million years there have been adjustments in slope profile to a new base level of the Sacramento River. No evidence of the former regional alluvial plain exists. The remnant "high" surfaces mapped by Steele (1980) and Helley and Jaworowski (1985) include morphostratigraphic units Q5, Q6, and older than Q6. Because the remnant highest surfaces in the study area represent at least several distinct terraces formed at differing times and at different elevations, the surfaces cannot be meaningfully contoured. Localized deflections in any resultant contour pattern cannot, therefore, be necessarily inferred to reflect late Quaternary tectonism.

d. Recent Deposits. Alluvial deposits in the study area, present in nearly all stream valleys, consist principally of material ranging from silt to gravel. Clay and boulders are rare. These materials have been derived locally from the Great Valley Sequence rocks, the Tehama Formation, and the Franciscan Complex. Thickness of the alluvium is quite variable but probably does not exceed 40 feet. Exposure of bedrock in creek bottoms is not common, while thickness of alluvium at the damsite is approximately 20 feet. Colluvial slopewash commonly interfingers with alluvium at the base of slopes and frequently is found as a wedge of material onlapping the morphostratigraphic surfaces. Minor alluvial fans typically are found where small intermittent creeks discharge onto the morphostratigraphic surfaces. Landslides in the study area are prominent on the west side of Orland Buttes as earth flows in the talus and underlying residuum below the steep basalt cliffs. Very few landslides were noted in the Great Valley Sequence rocks, and those were minor.

2.2.3 Structure. The geologic structure of the region is dominated by north- to northwest-trending folds and faults resulting from synclinal collapse of the Great Valley in Late Cretaceous time. Development of northeast, northwest, and east-west structures continued throughout Tertiary time. The dominant north-northwest-trending Willows Fault system proposed by Harwood and Helley (1982) is not supported by convincing evidence. Moreover, the absence of such a system is supported by data developed during this study.

a. General. In the area studied, structures are grouped as to their form (faults or folds). Just after or during the time of accretion of the volcanic arc and forearc basin to the continent, the Coast Range Complex thrust eastward under the Great Valley sequence. Thereafter, additional crustal shortening occurred.

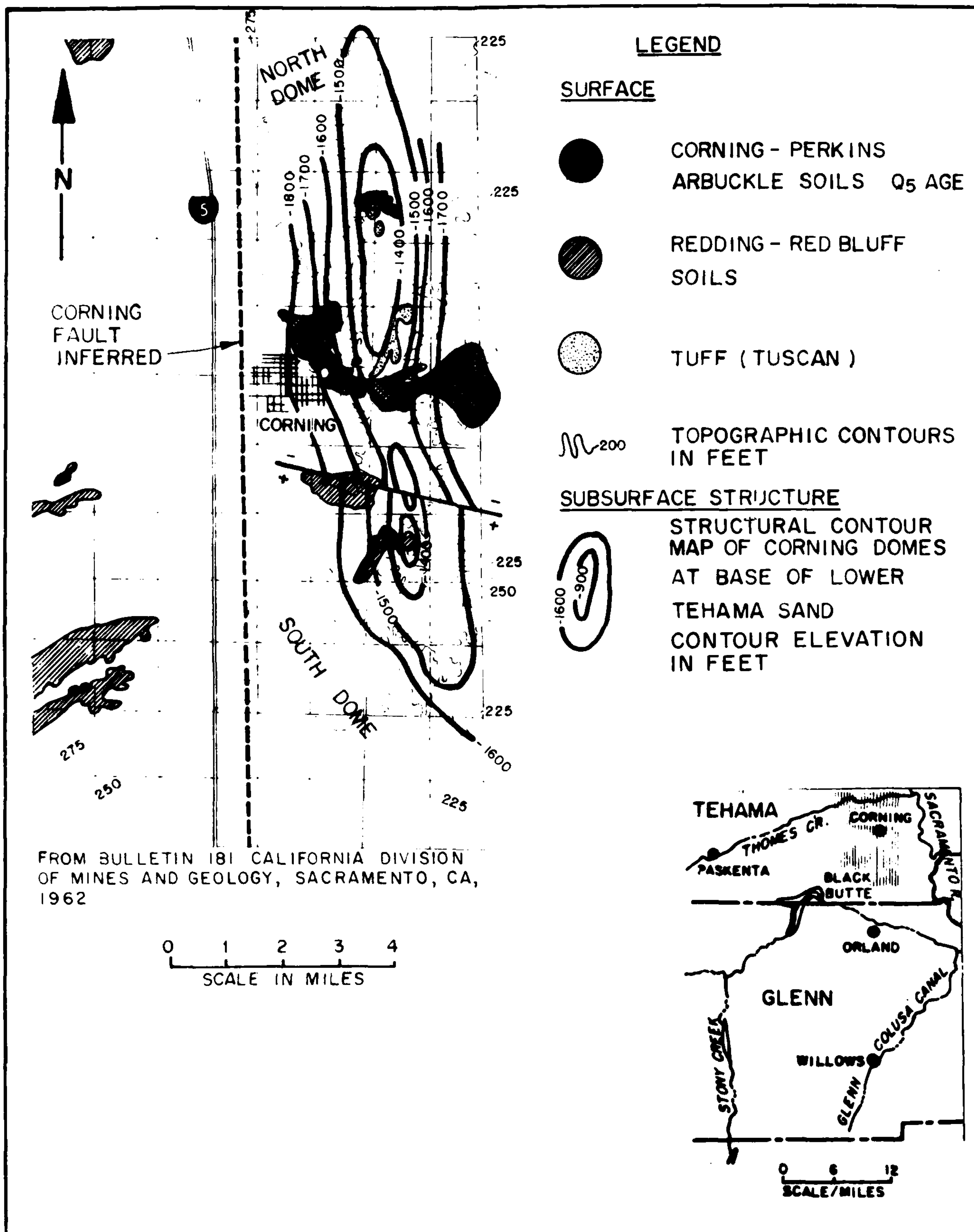
Folds and faults resulting from crustal shortening and the synclinal collapse of the Great Valley are the largest dominant structures. Later northwest, northeast, and east-west oriented faults occurred resulting from the change in stress field during the end of continental accretion and synclinal collapse, approximately 3 million years ago. There is no convincing evidence for a large branching northwest fault system in the area.

b. Folds, Domes, and Arches (Plate 3).

Red Bluff Arch. This structural feature is a northeast-trending anticline located midway between Cottonwood Creek and the town of Red Bluff. The Red Bluff arch lies about 40 miles northeast of Black Butte Dam. The fold has been the subject of several studies; the most recent by Harlan Miller Tait (1983, 1984). This arch is underlain by the Tehama Formation and is capped by the Red Bluff Formation. Several levels of Q5 terrace on the arch flanks appear to be tilted and the region is believed to have undergone some tectonic instability about 250,000 to 300,000 years ago.

Corning Domes. Corning North and South Domes and Corning Dome are located in Tehama County along a north-south trend 1-mile east of Corning. They are north-trending anticlinal features defined in the subsurface. Prominent hills lie on the crest and western flank of the buried structure on an otherwise flat plain. This topographic and geomorphic expression drew initial geologic investigation to the area for exploration of gas deposits. After gas discovery, the anticlines became better defined and remain as longtime recognized structural features. Some over steepened stream gradients are present over the general area of the anticlines. Additional evidence from Plio-Pleistocene gas stratigraphic markers suggest early Cenozoic tectonic folding. Some investigators suggest that the presence of Red Bluff gravel on the flanks and Tehama-Tuscan Formation at the crest of the topographic hills indicates post-Red Bluff folding (within the last 0.5 million years, Harwood and Helley, 1982). However, the distribution of these deposits does not correspond with the location of the subsurface structural axial fold plane (see figure 2-8). Stratigraphic closure within the Tehama gas sand (unit 3) ranges from 300 feet in the north to 50 feet in the south (California Division Mines and Geological Bulletin 181). This sand is about 200 feet above the Upper Cretaceous Forbes contact with the Kione Formation. The north dome is separated from the south dome by a high angle, northwest-trending fault. Harwood and Helley (1982) cite well log data, earthquake pattern recognized by Marks and Lindh (1978), surficial mapping, and seismic reflection work by Seisdata as evidence that the Corning Dome (and Greenwood anticline, see paragraph below) was formed by east side up drag on a north-trending fault. Based on studies reported in the geophysics section (paragraph 2.4), the evidence cited for drag folding through faulting is far from conclusive. Well location on the domes/folds is orderly and spacially distributed with even density. In the area of the suspected fault, no wells exist. Closest wells are 3 miles west of the dome. The earthquake pattern shown by Marks and Lindh (1978) is 10 miles east of Willows (near Glenn) and considerably south of structures discussed. The Seisdata lines examined by this study had considerable data dropout along the Interstate (I) 5 corridor, and very poor geophone coverage adjacent to structures. We were not able to confidently define structure along the I-5 corridor. This area is believed to correspond to the map location of Harwood and Helley's (1982) Corning Fault.

Multiple oil company proprietary seismic lines examined during this study, private discussion with oil companies, and discussions of others' work indicate



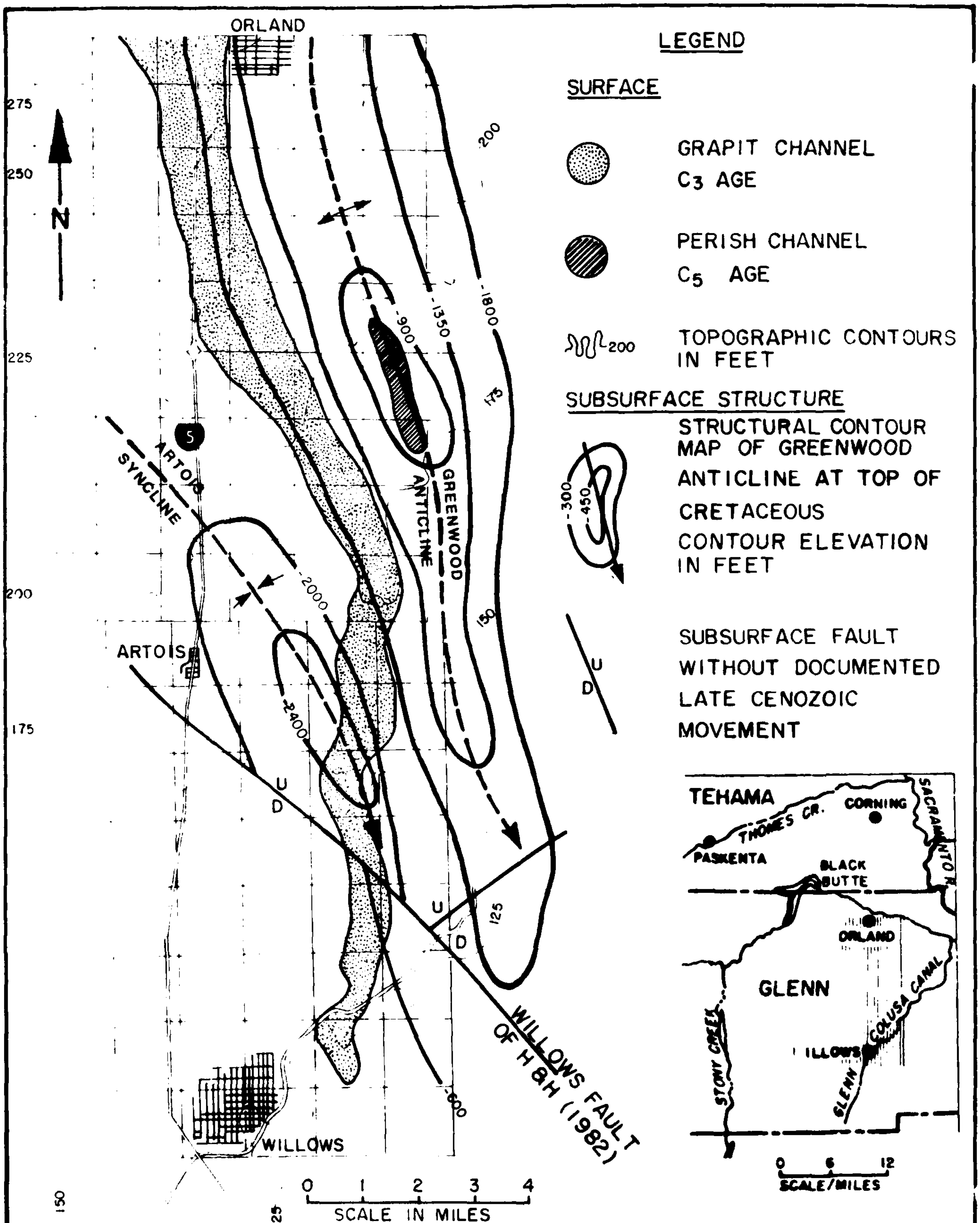
CORNING DOMES

FIG. 2-8

faulting along the flanks of folds is equally northeast as well as northwest in trends. North-south trends are generally minor. State of California Bulletin 181 and other oil and gas journals also indicate similar faulting in published maps of the gas fields. Furthermore, faults indicated on time sections are not spacially alined to indicate through-going trends. At best we can speculate on an anastomosing subsurface pattern.

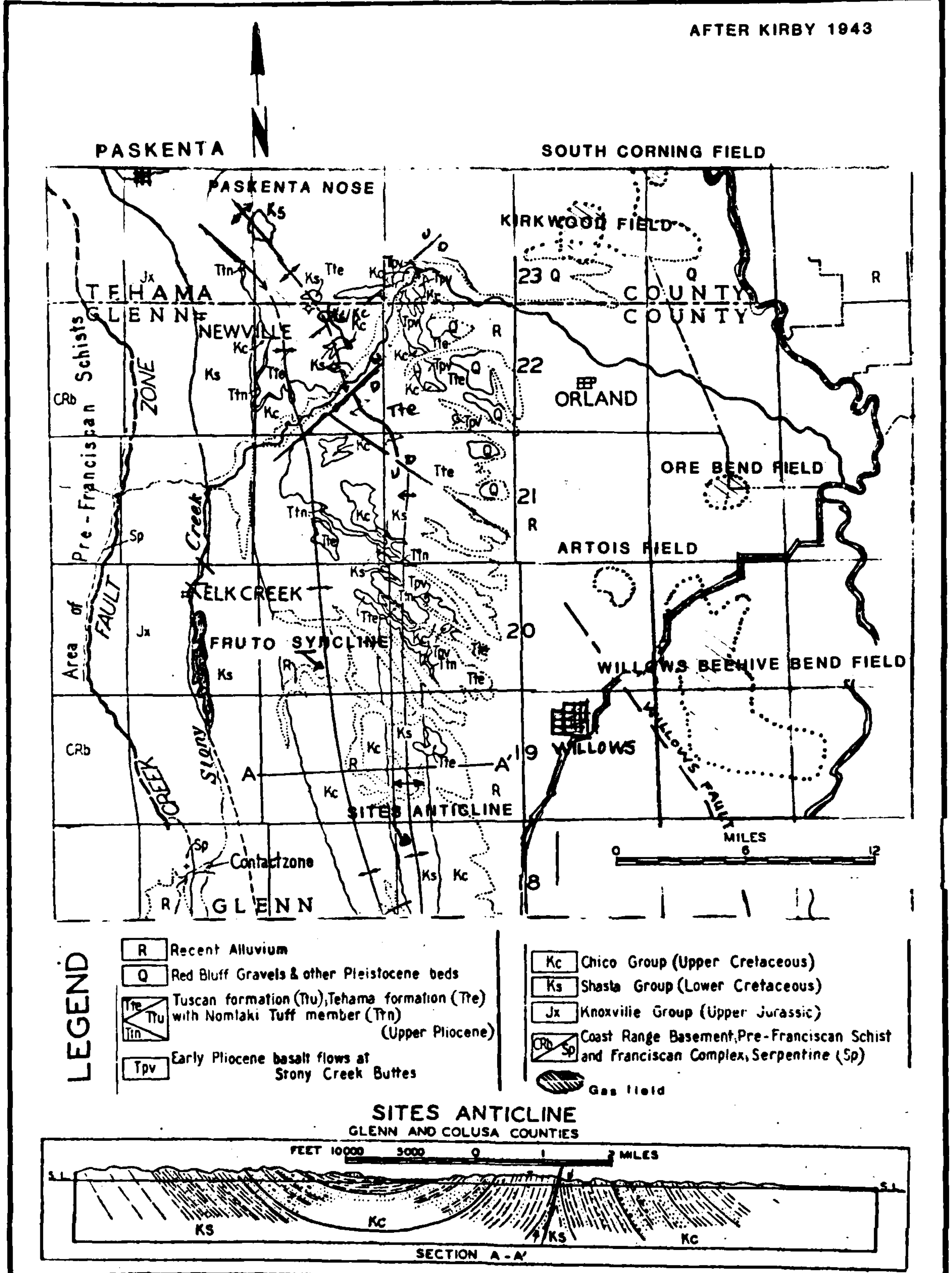
Greenwood and Willows Anticlines. The Greenwood anticline is a minor north-trending fold (Harwood and Helley, 1982). The fold area is shown in figure 2-9. We interpret the fold to be a northwest continuation of the adjacent Willows-Beehive Bend anticline lying to the south and east. The western flank of the Willows anticline is truncated by the Willows Fault. Alkire (1968) suggests this fault terminates at Artois and is one of many cutting the general Willows anticline, both along northwest and northeast trends. Harwood and Helley (1982) do not indicate these faults on their illustrations; however, they continue the Willows Fault beyond Artois and suggest a genetic relationship between the folds and the fault. Stratigraphic producers in the Willows, Artois, and Ore Bend fields are within the Kione or Forbes Formation. A lack of Tehama production is noted because of either the absence of the Tehama gas sand or no deformation in the Tehama. We believe that seismic lines indicate the Tehama to be undeformed throughout most of its section. As shown on figure 2-9, C3 and C5 channels lie across the suspected fault and fold trends in the Greenwood anticline (see also map 9). Both channels are undisturbed in topographic profile across the fold. Thus there has been no deformation in this section for the last 250,000 years.

Sites Anticline. The Great Valley sedimentary bedrock forms a broad synclinal structure with large folds superimposed on the west limb. The Sites anticline and Fruto syncline are two such folds (figure 2-10). The Sites anticline is a flexure named by Kirby (1943). The 35-mile-long fold is a tight, near vertical isoclinal fold structure about 3 miles east of the Fruto syncline. There is evidence to suggest that the Sites anticline is a decollement fold detached from a subregional basement structure by the Sites thrust fault. The section on geophysics (paragraph 2.4) develops the Sites thrust in more detail. The anticline is asymmetric with a steep axial plane, and the east limb is slightly overturned. The west limb rapidly flattens into the Fruto syncline. The axial plane of the fold dips steeply east and generally corresponds with a reverse fault, east side down. This fault appears at depth to be a listric surface that roots into a sole thrust at a depth of about 12,000 feet. This is easily seen in cross sections developed and presented in the geophysics section (2.4). The anticline strikes with excellent exposure up the west side of the valley foothills from Sites for over 10 miles to the vicinity of White Cabin Creek and French Camp (Fruto N.E. quadrangle) where the bedrock disappears beneath the Tehama Formation. Kirby (1943) surmises that either the anticline bent westward to blend into the Paskenta nose or continued north toward the reservoir area of Black Butte. Several seismic reflection lines crossing the north reservoir area and Walker Creek area do not reveal the continuation of the Sites Anticline northward along axial strike. Chuber (1961) mapped multiple southeast-trending, high angle faults that parallel the dominant northwest trend to drainage of creeks in the Fruto N.E. area. These faults sometimes



GREENWOOD ANTICLINE & ARTOIS SYNCLINE

FIG. 2-9



SITES ANTICLINE AND FRUTO SYNCLINE

FIG.2-10

offset the axial plane of the fold. Limited exposure of beds at the head of White Cabin Creek are warped westward and suggest that the Paskenta nose is a continuation of the Sites anticline, possibly offset eastward by high angle, lateral slip faulting.

Fruto Syncline. The Fruto Syncline is a double plunging fold with a locally steeper west limb. The syncline axis is 3 miles west of the Sites Anticline axis. The fold is approximately 30 miles long. The syncline has several shallow, minor northwest-trending faults disrupting the east limb. High angle northeast and northwest faults are present in individual formation members on the west limb.

Chico Monocline. Along the eastern foothills a remarkable northwest-trending linear feature defines the valley edge. This feature is the Chico Monocline. The structure is a west-dipping monoclinal fold in the Pliocene Tuscan Formation and underlying the Great Valley Sequence. Harwood and Helley (1982) interpret the structure as indicating that beneath the monocline exists a steeply east dipping reverse fault in the basement. Magnetic data, interpreted by Griscom (1973) through modeling, indicate that the fault separates ophiolite from Sierran basement at depth. The existence of earthquake epicenters coinciding with the trace of ground expression suggests a near vertical or slightly west dipping fault (Marks and Lindh, 1978). It appears that the Chico Monocline has been active during the last 1 million years.

c. Faults.

Coast Range Thrust. The Coast Range Thrust has been described as a prominent thrust of considerable magnitude. In regional expression the Coast Range Thrust is a sinuous contact between the Great Valley Sequence and the ophiolitic and Franciscan rocks or the sporadic ultramafic sheet that lies between. Bailey and others (1970) considered the thrust to be separate allochthonous tectonic blocks carrying the Great Valley Sequence over the Franciscan assemblage. Maxwell (1974), Raney (1976), and Suppe (1979) have argued that the Coast Range Thrust separates paraautochthons, preferring to have the foreland of Franciscan Complex rocks dive or wedge under the Great Valley Sequence in subduction-like response to a compressional collision. In the present environment of north/south compression, past compressional structures which are presently nonsynchronous with contemporary stress have little bearing for neotectonic response. Harlan Miller Tait (1983) and ESA (1980) reports deal thoroughly with the Coast Range Thrust. Trenching by ESA (1980) indicated no activity along this fault since the Pliocene.

Stony Creek Fault. The Stony Creek Fault is treated in this study as the Great Valley/Ophiolite contact located in the western part of the study area. It extends from the Coastal Range Thrust in the vicinity of the Elder Creek fault zone on the north, southward beyond Glenn and Colusa counties. Multiple studies of this fault have been conducted.1/ They have considered the

1/Irwin (1966); Kirby (1943); Jennings and Strand (1960); Strand (1962); Chuber (1961); Brown (1964); Fritz (1975); Raney (1976).

contact as being (1) normal depositional in nature, (2) depositional but faulted, or (3) wholly faulted, a large spectrum for any structure. ESA (1980) examined the Stony Creek Fault contact through its extent during a study for the Glenn Reservoir Complex. They concluded that the configuration of the Stony Creek Fault can be characterized as high angle, exhibiting both normal and reverse motion locally, with the west side (ophiolite) moving up to produce the present configuration of the mountain front. The fault represents shearing along a preexisting depositional contact and is composed of multiple segments. ESA and the State of California Department of Water Resources (DWR) investigated terrace deposits located along Stony Creek Fault, although the latter agency's study was more of a review of the former's work. Taken in totality, Quaternary terrace sequences indicate vertical movements on a segment of the Stony Creek Fault near Thomes Creek occurred between 30,000 and 130,000 years ago (ESA, 1980). Southern areas of the fault seem to have been inactive for 250,000 years. DWR does not support younger movement at Thomes Creek.

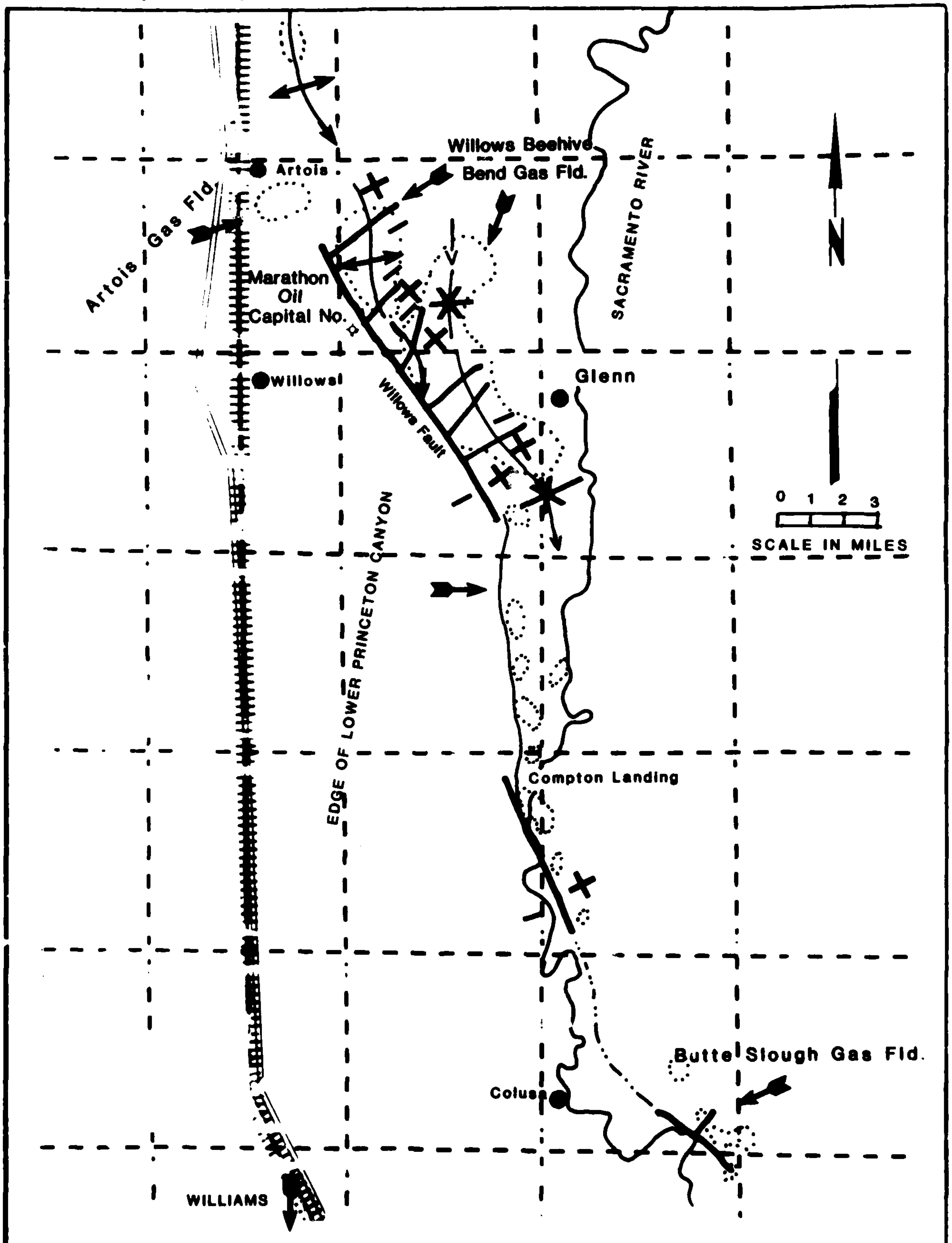
Battle Creek Fault. This fault has been the subject of analysis by Harlan Miller Tait (1983) for Corps of Engineers, and information is drawn from that study and from Helley, et al. (1980). The Battle Creek Fault zone is the name given by Harwood and others (1980) to the approximately N. 70° E. to east-trending fault zone on the northwest side of Battle Creek. The fault zone extends from east of the Sacramento River near Balls Ferry Bridge northeast toward Lassen Peak for a distance of 35 kilometers (km). It is projected west of the Sacramento River as a lineament. East of the Sacramento River, the Battle Creek Fault is roughly coincident with Battle Creek and forms a prominent escarpment. Vertical offsets progress from 200-foot offsets in broken Quaternary alluvial fans near the Sacramento River to 1,400-foot offsets in Cascade volcanic units. These volcanic units are approximately 0.5 million years old. The Battle Creek Fault is less well defined in the younger sediments of the northern Sacramento Valley west of the Sacramento River. The fault is questionably extended towards Sulphur Springs near the Coast Ranges/Klamath province on the basis of weak expression by gravity and magnetics. Surface lineaments and some disturbance in Upper Cretaceous basement contours reinforce the fault extension. Harlan Miller Tait (1983) feels there has not been measurable faulting younger than morphostratigraphic unit Q6 southwest of the Sacramento River. This is in conflict with Harwood et al. (1983) who speculate movement more recent than 130,000 years. Seismic reflection data confirms the existence of the Battle Creek Fault zone in the subsurface at least at one point (see Harlan Miller Tait, 1984, page 12). The sense of movement on this line is down to the south as indicated on the records published in the above-cited report. Harlan Miller Tait (1984) believe a 0.5-million-year age for last fault movement is correct because the fault does not penetrate strata 0.5 million years old.

Red Bluff Fault. The Red Bluff Fault is the southernmost of a series of east-northeast alined faults in the northeastern corner of the Sacramento Valley. The Red Bluff Fault is a buried feature corresponding to the linear magnetic gradient that terminates the north end of the Great Valley magnetic high. Jennings (1977) and Steele (1979), each citing Madsen and Johnson (1960), show movement on the Red Bluff Fault as south-down. Because of the similarity of its relationship to the Great Valley magnetic and gravity high with that shown by the Midland and Willows Faults, it is suggested by the above authors that the Red Bluff Fault may correspond to a basement fault along the east flank of the west side trough of the Great Valley syncline.

Jennings (1975) shows the Red Bluff Fault as a queried feature extending along trend across the west side of the Sacramento Valley to aline with a fault shown offsetting the south end of the Elder Creek Fault. Peppard and Associates (1981) show a fault of similar extent at the horizon of the Dobbins Shale within the Great Valley Sequence. No specific field study of the Red Bluff Fault was made in this study.

Willows Fault. (See figure 2-11) This fault is a north-to-northwest-trending, steeply dipping reverse fault with some slip components (Redwine, 1972, Alkire, 1968). The Willows structure has a suspected length of about 38 miles starting west of Artois and extending southward to a point about 14 miles east of Williams. Harwood and Helley, 1982, extend the Willows Fault south to the area of the Stockton Fault along the eastern side of the Sacramento Valley from the Colusa Dome at Colusa. Their extension is apparently based on a steepening of the crystalline basement west of the -1,500 meter depth contour. However, no clear offset of the subsurface, such as that demonstrated by Redwine, 1972, along the trend of the Willows Fault, north of Colusa, is documented along this trend of Harwood and Helley. Its length and orientation bisects the Willows-Beehive anticline, localizing gas productivity on the east or up-thrown block. Cross faults oriented northeastward also cut the anticline and are mostly truncated by the northwest portion of the Willows Fault. The cross faults cut the anticline into a series of down-to-the-north blocks. These and other faults, as well as the fold, were first defined in seismic reflection and refraction work (Alkire, 1968). Bruce (1958) mapped an unnamed fault west of Compton Landing gas field in Colusa County. In addition, an arcuate northwest-trending fault was mapped southwest of Butte Slough gas field in 1960. Redwine (1972) connected these faults based on the complementary trend of his contours outlining the Princeton submarine valley, the subject of his study. He believed that in this locality the course of the valley was determined by the Willows Fault. This work extended the Alkire (1968) trace of the Willows Fault to the southeast into sec. 1, T. 15N., R. 1 E. Redwine (1972), examining the Marathon Oil Capital-Capital No. 1 well (sec. 30, T.20N., R.2W.) and other wells, concluded the Willows Fault to have an offset of 850 feet at the top of the Neroly Formation with the offset extending into the Tehama Formation.

From Redwine's structural contouring it appears that most of the movement along the Willows Fault has been dip-slip, northeast-side-up relative to the southwest. In the Artois-Willows area a C3 and C5 age channel deposit crosses the fault without any evidence of disturbance in the channel topographic profile. Even though historic seismicity in the Willows area might be attributed to the Willows Fault, there is no evidence for measurable ground surface deformation since about 120,000 years ago.



WILLOWS FAULT

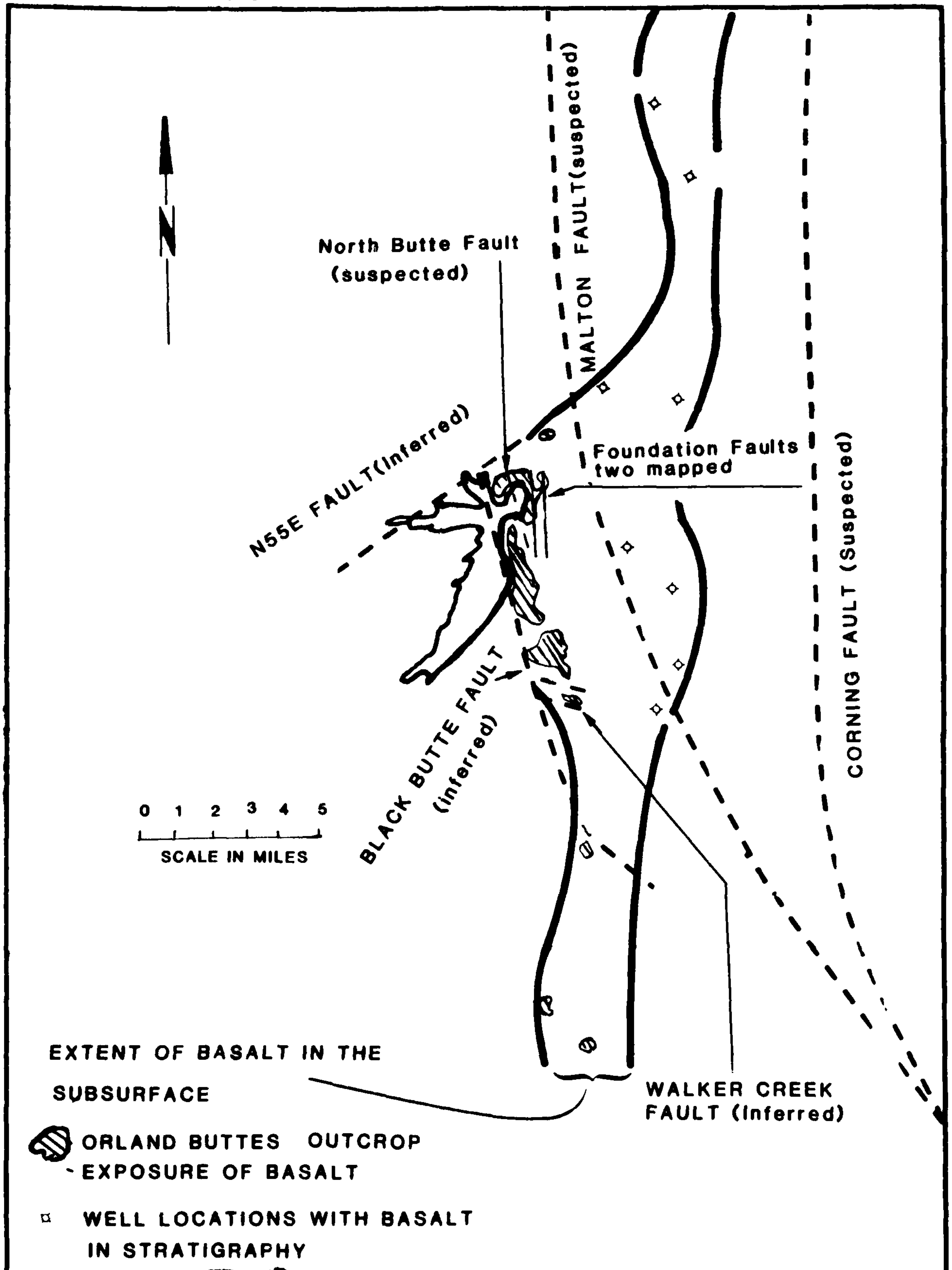
FIG. 2-11

Corning Fault. The Corning Fault is envisioned to extend from Kirkwood on the south to nearby Red Bluff on the north (Harlan Miller Tait 1982). In USGS OF 82-737 of Harwood and Helley, speculation on the faults existence is based on unpublished analysis of several seismic lines crossing the fault area. Seismic reflection profiles used are interpreted to show some steep, east-dipping reverse faults with increasing offset with depth. Deformation in the Red Bluff gravel is also used to indicate faulting. In addition, observing the regional slope defined by the bottom of the Cretaceous along the east side of the valley (or top of basement), there appears a possibility of an offset of several hundred meters along the valley medial line which coincides with the Corning fault. Other authors have constructed sections in the area of the fault and have failed to identify fault structures such as the Corning trend described by Harwood and Helley (see Redwine, 1972; Safonov, 1962; Sacramento Petroleum Association, 1962; Calif. Div. of Oil and Gas Vol. 30 No. 2 1944). In this study (see section on Geophysical Study, paragraph 2.4.4), cross section and topographic profiles indicate the existence of a dome but not the continuous fault shown by Harwood and Helley.

Malton Fault. Harwood and Helley (1982) project the Malton Fault as lying east of Orland Buttes along a north-striking, high angle fault trend. This is based on their interpretation of seismic reflection records and map patterns of Quaternary units. They give the fault a length of 20 miles. The sense of relative movement is similar to the Corning and Willows Faults; that is, the east side is up, and doming of subsurface structure on the east block is due to drag folding. There is, however, no evidence of near surface folding as indicated by a shallow seismic reflection investigation performed during this study and by extensive remnants of Q5 and Q6 terraces which cross fault locations in Thomes Creek and Stony Creek (at Lemon Home Colony). The results of the geophysical survey crossing the fault and ground topographic profiling are reported in the Geophysical Study section (2.4). Extensive analysis of wells containing the Lovejoy Basalt indicates that the flow is essentially unfaulted across the supposed trace of the Malton Fault (figure 2-12).

Black Butte Fault. (See figure 2-12)

(1) Previous Observations. The Black Butte Fault as shown by Jennings and Strand (1960) has a map length of 9 miles and trends N. 10° to 20° W. The fault is thought to exhibit west-side-down displacement relative to the east. Russell (1931) was first to show a fault in this position to explain the presence of topographic, high buttes of basalt capping Cretaceous bedrock. He correctly reasoned Orland Butte basalt (referred to as Stony Creek Butte) was the same as basalt present in valley wells beneath the Tehama Formation. Russell evoked the fault mechanism to explain the absence of Tehama materials on top of the Buttes by stripping the uprising block. Later Durrell (1959) and Creely (1954) suggested the origin of the basalt was a Miocene flow that spread into the valley as channel flows from the Honey Lake escarpment. Orland Buttes and Table Mountain were suggested as coeval. Relief on the basalt surface was caused mostly by erosional relief of the underlying sedimentary rocks, the basalt acting as a cast. The basalt on the valley edge was uplifted by continued folding of the valley syncline. However, in the western valley,



FAULTS INFERRED OR SUSPECTED NEAR BLACK BUTTE DAM

FIG. 2-12

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Van den Berge (1968) saw tectonic movements caused by folding and uplift as mainly responsible for the relief in structural position of the basalt, with principal tectonic movement occurring at the end of Pliocene time.

The Black Butte Fault was added to the California State Geologic Map by Jennings and Strand (1960). Older versions were first published in Bulletin 181 of the State of California and 1936 vintage maps. Present day map configuration resulted from reports by the Corps of Engineers, Sacramento District. The Black Butte Fault was accepted by the Corps of Engineers (1963) during site investigations for Black Butte Dam and Reservoir based on published maps. In addition to the main Black Butte Fault, four subsidiary faults were mapped during design and construction of the dam. Two north-trending, high angle normal faults with steep easterly dips are present in the right abutment of Black Butte Dam. Both these faults have reported displacements of less than 50 feet (15m) with the east side down-dropped. A third fault trends N. 20° W. and was shown 3/4 mile (1.2 km) west of Black Butte Dam. The presence of this fault is based on an east side-down step in the basalt capped ridge north of Stony Creek. The mapped trace of this fault extends to the southeast about 1-1/2 miles (2-1/2 km) from this basalt capped ridge. The fourth fault has a trend of N. 55° E. and is mapped as displacing the Tehama Formation.

During subsequent work by the California DWR, two additional splay faults were mapped south of Orland Buttes near Walker Creek. These two faults trend N. 60° to 70° W. and extend to the southeast from the main Black Butte Fault. These faults were mapped based on photolineaments and brief field examination; they are shown as offsetting deposits of the Tehama Formation.

Redwine (1972) examined subsurface oil well data, and suggested that the Willows Fault, to the south, projects into the Black Butte Fault. This combined Black Butte-Willows Fault would have a total fault length of 55 to 60 miles (88 to 96 km).

(2) Evidence Developed During this Investigation. Field mapping, lineament analysis, stratigraphic reconstruction, gravity and magnetic data analysis, shallow seismic reflection traverses, deep seismic reflection traverses, and trenching developed as part of this investigation leads to the conclusion that the Black Butte Fault does not exist; rather the Buttes are a topographic escarpment and that Orland Buttes was a hogback prior to Tehama deposition. The evidence for this conclusion is summarized as follows:

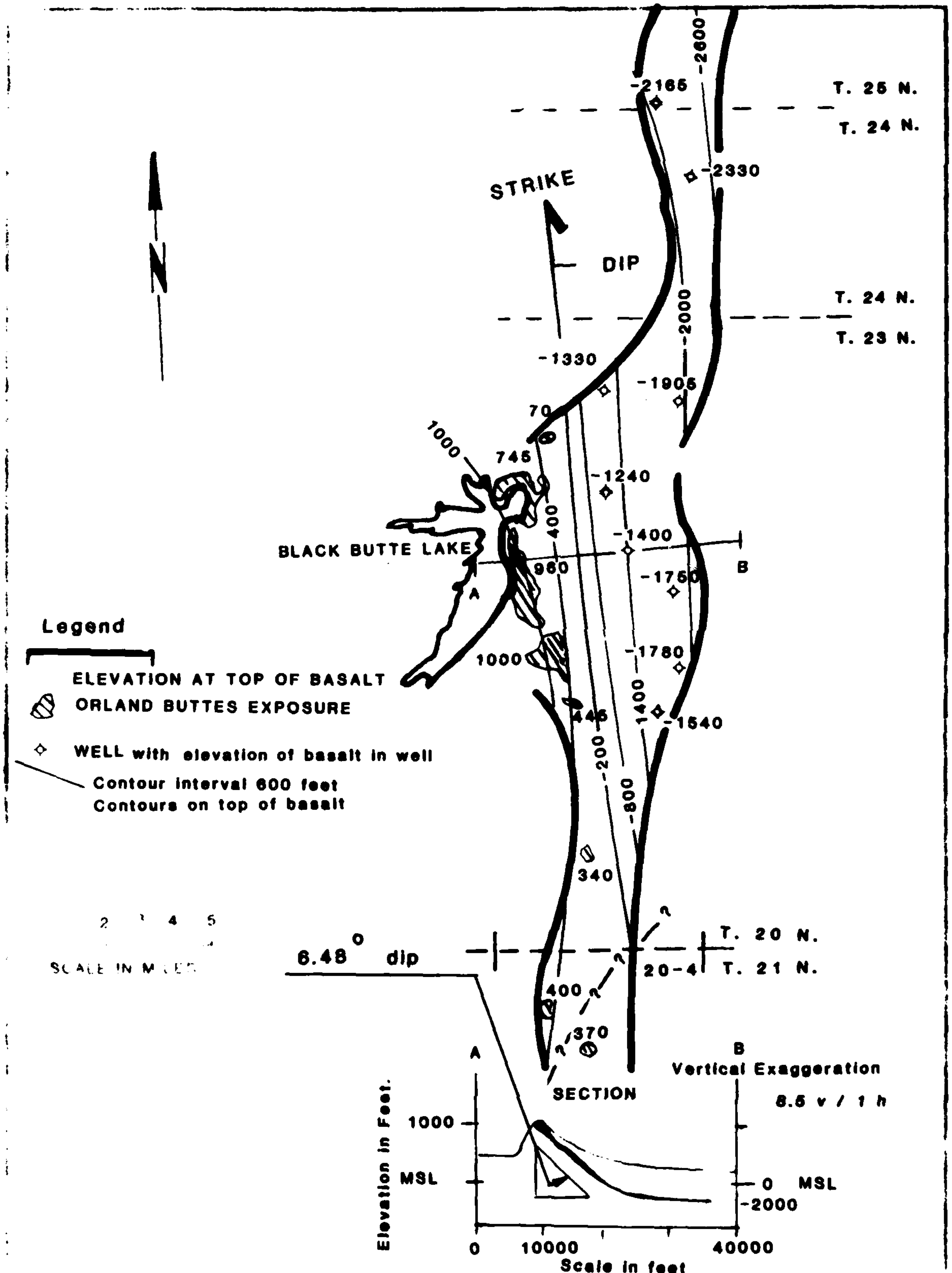
o Field mapping of the Black Butte area reveals that Orland Buttes are a topographic expression of an erosion escarpment and that an unfaulted stratigraphic column lies across the inferred location of the fault. Field maps for the area of the inferred fault are Black Butte Dam, Fruto N.E., and Sehorn Creek sheets. Greater understanding of this discussion can be gained by examining figures 2-12 and 2-13. Orland Buttes are capped with up to 80 feet of basalt that strikes in outcrop an average N. 17° W., and dips 4 degrees east-northeast. Underlying the basalt is Upper Cretaceous Great Valley Sequence that strikes N. 21° W. and dips 20 to 30 degrees east-northeast; hence, the linear nature of the Buttes. The Tehama Formation was deposited to an elevation of 600 feet on the basalt eastern slope and on the Great Valley Sequence's western slope. The Tehama contact with underlying material is an erosional unconformity in nature; thus the formation draped around the ridge line as it was deposited. The pre-Tehama topography, a hogback consisting of basalt and Great Valley strata, is the original escarpment that was partially buried during Tehama deposition and presently undergoing exhumation.

o The stratigraphic section of Cretaceous rock at Orland Buttes along the Tehama-Glenn County line was presented in prior paragraphs. As noted in plate 5, the section is not faulted and continuous to the west in normal succession. Gravel benches present at elevation 900 feet on the middle Butte are a pre-Pliocene channel of a west-southwest flowing stream which transported Sierran granite materials as evidenced by granite present in the cobbles. Redwine (1972) suggests, and we agree, that the Lovejoy Basalt marks the rimrock of the lower Princeton gorge. The presence of granite bearing stream gravels yields added evidence to this hypothesis and does not indicate uplifted Tehama formation on the western slope of the escarpment.

o Lovejoy Basalt lies as a single unfaulted flow on the top and eastern side of the Buttes. Outcrop pattern on the Buttes and subcrop elevations in wells east of the Buttes suggest the basalt is a narrowly confined flow controlled by the existing Great Valley topography at time of deposition. Figure 2-12 shows the limits of the flow. The flow subsequent to deposition appears elevated through continued folding of the valley edge and is tilted eastward. The axis of tilt strikes nearly due north as does the valley axis. As seen in well logs, the flow tilts eastward at 111 feet per 1,000 feet, or approximately 6-1/2 degrees. This is in good agreement with outcrop information and three-point solutions using flow tops. Solutions indicate the average strike of N. 17 W. and 4-1/2 to 6-1/2 degrees eastward dip. Predicted by strike and dip, the strong repetitive presence of basalt at subsurface elevations in wells to the east of the Buttes indicates little if any faulting in the basalt. The geometry of the data presented in figure 2-13 indicates the possibility of only minor faults in the area of T. 21 N. and T. 20 N., R. 4 W. offsetting basalt with less than 200 feet total vectoral displacement.

o Lineations in the Great Valley Sequence along western slope of the Buttes are not faults but linear side slope benches emerging through the cover of basalt colluvium and Tehama material. The projection of the inferred fault based on photolineament trend south of Orland Buttes, crosses South Fork Walker Creek, and strikes towards an unnamed drainage. The suspected main branch of the lineament crosses Q3 and Q4 (?) terraces on Hambright Creek and Walker Creek without apparent disruption or offset. A cut bank across this lineament on the north side of Walker Creek was cleaned and logged. No Tehama age material is faulted in this exposure (see log of trench on plate 6).

o The stratigraphic section of Cretaceous rock at Black Butte, along the Tehama-Glenn County line, was presented earlier in this study. No evidence of faulting is revealed in the stratigraphy.



STRIKE AND DIP OF LOVEJOY BASALT

FIG. 2-13

o Gravity and magnetic data were analyzed. Several microgravity traverses were conducted. The Geophysical Study section (2.4) presents the results of the Bouguer gravity profile analysis and Bott 2D analysis. Gravity observations do not support the presence of the Black Butte Fault. Magnetic data in the area indicate that the Lovejoy Basalt is a continuous flow dipping to the east. It is not detected west of Orland Buttes and pinches out to the east. No fault of any magnitude can be modeled using the available magnetic base and traverses made by this study (NGA, 1984).

o A shallow seismic reflection survey was run crossing the suspected Black Butte Fault at two locations. No trace of the fault exists in the 1/2-second records (see plates 11 and 12.)

o Deep seismic reflection records were obtained on three crossings of the fault. No faulting of any significance can be found to correspond with the west side of Orland Buttes (see Geophysical Study section, 2.4).

Two north-trending, high angle faults with steep easterly dips (east down) are present in the right abutment. We analyze these to be block slides in the Butte due to erosion at the toe of the basalt (see Site Geologic Conditions section (2.3)).

The north-trending fault mapped in the basalt cap on North Butte is an apparent step in the flow geometry. Mapping an individual flow across the Butte shows this ridge is not faulted. Plane table mapping of Great Valley Sequence rocks exposed at the base of North Butte and at Eagle Pass did not reveal any offset of strata (communication obtained from Chico State College Geology Department, 1984; see Black Butte map sheet).

The N. 55° E. trending fault mapped on the north side of Black Butte does not appear in the stratigraphy at or above the level of Lovejoy Basalt. A three-point solution to Lovejoy Basalt elevations using North Butte elevation mark 782, Humble-Hall #1 well (sec. 21, T. 23 N., R. 4 W.), and the Grace Petroleum well indicates attitude in good agreement with the north-trending channel of basalt as a whole (strike solution N. 10° W., 4.28 degree dip east). However, this area is southeast of the implied fault and on the indicated up-thrown block. To the north the projection of basalt shows that an outcrop should occur at Butte Mountain-Long Hollow Road, map 5 (elevation 500 feet). Field checking in that area did not reveal any basalt; nor did shallow wells or seismic reflection survey indicate basalt in the subsurface.

We conclude that faulting cannot be confirmed on the basalt occurrence northeast of the supposed fault. Using wells in T. 24 N. and T. 25 N., three-point solutions indicate the basalt flow is unfaulted. The Tehama Formation does not appear faulted in field examination and is so mapped on the Black Butte sheet at Buckhorn area north of the dam. A northeast-trending fault exists in the subsurface Upper Cretaceous stratigraphy. Up to 200 feet of offset exists, with the northwest side up. The fault does not penetrate the upper 1,000 feet of strata. This fault is present only in the subsurface, and the only evidence for its existence is that the fault appears in the Long Hollow-Ham seismic section (see in Geophysical Study section, 2.4).

The Walker Creek Faults identified by ESA (1980) through their lineament analysis do not indicate faulting in the Lovejoy Basalt. A basalt knob lies between the faults (sec. 34, T. 22 N., R. 4 W.). Again, a three-point solution using the basalt contact on Orland Buttes (sec. 21, T. 22 N., R. 4 W.), Worthington Knob, and Franklin Well (S.E. 1/4 sec. 24, T. 22 N., R. 4 W.) basalt at -1,508 feet mean sea level gives a N. 5^{o} W. strike and 4.05 degree dip. This is in excellent agreement with the regional strike and dip on basalt as an unfaulted flow. Field mapping indicates the Tehama is not faulted (Fruto N.E. sheet) in the area of Walker Creek. On individual creeks, Q4 terrace elevations match on each side of the banks that straddle the fault projections. In sum, the Walker Creek Faults have no field evidence to support their existence.

Paskenta Fault Zone. The Paskenta Fault was studied in detail by ESA (1980). That study concluded that the fault zone had no expression in four terrace levels along Thomes Creek (probably Q4, Q5 and Q6 equivalent strata terraces) and had ceased movement by the beginning of Tehama deposition, 3.4 million years ago. Prior to ESA, Jones, et al. (1968, 1969), show the fault zone on a generalized Buchia zone map as 1/2-mile wide, northwest-trending, and curving gently northward to merge with the Stony Creek Fault (Buchia Crassicollis is a prominent faunal marker in Lower Cretaceous rocks.) They conclude that large differences in Buchia zones indicate many miles of stratigraphic separation occurred on the fault and that the apparent 4-1/2 to 6 miles of left-lateral surface offset took place during pre-Tertiary time. The movement probably occurred when the beds were more horizontal. Mapping from Jones and Bailey on the Paskenta 15-minute quadrangle and included in the ESA report (1980) indicates the fault zone to be an anastomizing series of shears that branch toward the south and cannot be followed into the Tehama Formation that caps the fault southeast of Paskenta. Page (1966) sees the Paskenta zone as part of the Sierran/Franciscan boundary where the tear fault becomes a tectonic contact (Stony Creek Fault) between the Franciscan Complex and the Great Valley Sequence.

Kirby (1943) first termed an area of structural disturbance, traceable southward from Paskenta in scarce river and creek bottom outcrops, the Paskenta nose. This synchronous fold/fault zone is mapped northwest of the north arm of Stony Creek trending towards Paskenta (see Sehorn Creek and Newville sheets). The trend disappears beneath the Tehama Formation north of the north branch of Stony Creek along a trend that follows the northwest trend of Kendrick Creek towards Paskenta. The immediate suggestion is that it is related to the Paskenta Fault zone. This study believes the Paskenta nose as that area where the Paskenta tear fault passes into the listric fault associated with the Sites anticline. Geophysical seismic sections developed across the Paskenta nose indicate the nose originates at depth along the same detachment as the Sites thrust fault. (Sections indicating this are shown in the Geophysical Study section 2.4.)

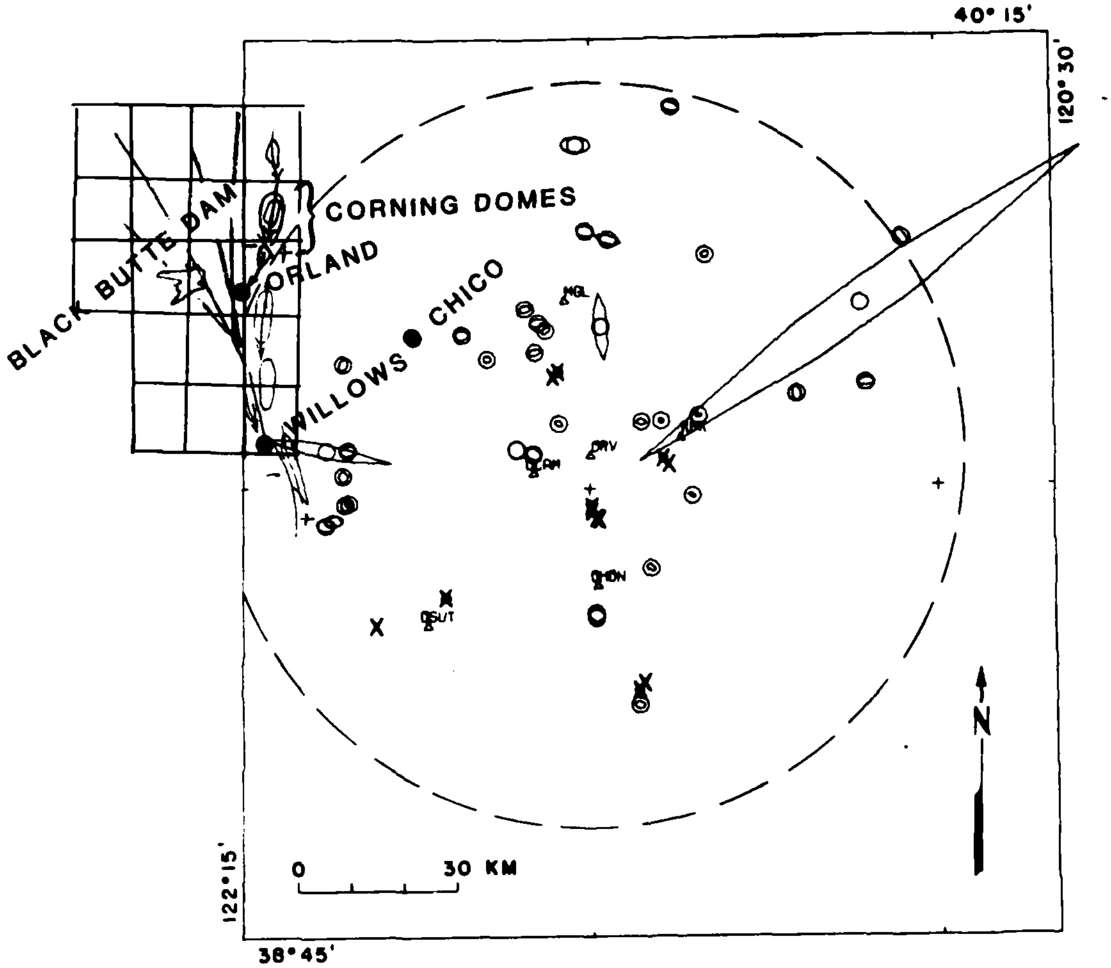
Willows Fault System. The Willows Fault system was defined by Harwood and Helley (1982) based on contouring of stratigraphic units obtained from analysis of well log data, some seismic reflection, and other assumptions. Their concept of the Willows system is shown on plate 6. As mentioned, the Willows Fault system is reported in USGS Open File 82-737. A large part of our study was devoted to examining the field evidence for the existence of this fault system. We conclude that the Willows Fault system, as so defined, does not exist. Appendix C contains a detailed examination of the assumptions and evidence for the existence of the system presented by Harwood and Helley, including findings of this study that are contrary to statements of evidence given by Harwood and Helley in their text. The existence of the fault system described is controversial and suspect in any hazard analysis for Black Butte Dam. In sum, we do not feel there is any evidence supporting the items in the following list. Quite the contrary, this study presents cogency of evidence against the existence of the items noted below and, therefore, continuity of the fault system proposed:

- The fault at Orland Buttes.
- Association and trend of seismic events (shown by Marks and Lindh, 1978, see figure 2-14).
- Corning Domes and Greenwood anticline as evidence for drag faulting.
- Citing the Muculloch Sunray Anchordogry No. 1 well and Occidental Petroleum Harris No. 1 well as evidence for existence of the Malton Fault.
- The interpretation of Harwood and Helley concerning the Seisdata lines.
- The Willows Fault in the Willows gas field and the Paskenta and Elder Creek Faults at three respective zones appear to be well supported. However, the evidence for connecting faults between these zones is unwarranted and contrary to data developed during this investigation.

2.2.4 Lineaments.

a. General. Recent offset expressed in fault-scarp morphology can often be documented through analysis of low-sun-shadow enhancement of aerial photography (Slemmons, 1977). If the fault has been recently active, segments of known faults are sometimes reflected in disturbance of drainageway and other topographic features. Active or growing fold structure sometimes disrupts drainage patterns, such as producing centripetal drainage nets. Several types of imagery were used to analyze the area (indicated by shaded squares in figure 2-2) for lineaments. The imagery list includes the following:

- Landsat 1:250,000 scale images, 30x30-inch enlargements, 28 Sept 1979 scene, bands 4, 5 and 6 and a false color composite of bands 4, 5 and 6.
- Skylab: Three 1:250,000 scale color infrared (CIR) stereophoto enlargements, June 1973 scene of Sacramento Valley.
- Stereoscopic, Panchromatic, quad-centered 9x9-inch photographs: 1:80,000 scale, 1983 flight, Ames RB47-7 flight lines.



Projected 67 per cent confidence-error ellipsoids for each located event

SEISMICITY REPORTED BY MARKS AND LINDH
IN BSSA 1978, Vol. 68n no. 4, pg1107

RELATIONSHIP OF SEISMICITY REPORTED BY MARKS AND LINDH TO THE CORNING STRUCTURES	FIG. 2-14

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o Monoscopic Panchromatic low-sun-angle photographs: 1:12,000 scale; 10 flight lines.

Results of independent photographic analysis teams composed of Photographic Interpretation Corporation (PIC) personnel was reported in Harlan Miller Tait (1984). Photoanalysis and ground truth was carried out by Seattle District personnel, the results of which are shown on plate 1.

b. Interpretation of the Final Lineament Maps. The lineaments plotted on the final map are not necessarily faults in bedrock but may represent zones of bedrock structure (joints, fractures, bedding, or faulting) which are expressed as linear features upon the aerial photo or satellite imagery. Those lineaments shown as solid lines merited further investigation. The results of the investigation are given in table 2-2. Table 2-2 is cross referenced to plate 1.

It is difficult to compare lineaments mapped from satellite imagery to those mapped from relatively large scale aerial photographs. Two studies listed on plate 1 demonstrate this difficulty. The difference in scale necessitates that each analysis be based on differing criteria. At the satellite scale, entire river valley systems extending for many miles may aline themselves into one linear element, while at the 1:80,000 or 1:12,000 scale, only straight segments of a river channel within a valley system would be mapped as lineaments. A lineament drawn on a small-scale satellite image will span a width of hundreds of feet, and can be symbolized by a single, straight line on the satellite image. Each image, whether small-scale satellite or large-scale airphoto, provides differing levels of detail and care must be taken in comparing one scale image to another.

In the area of study, careful inspection of the drainage overlays generated as part of the PIC lineament analysis did not reveal obvious deflections in drainage patterns of the present day systems. Thus, no doming or upwarping is suggested. Harlan Miller Tait (1984) does not see any obvious evidence of upwarps associated with the surface projections of major mapped subsurface faults suspected in the Sacramento Valley (particularly those listed by Harwood and Helley, 1982). These faults include the Willows, Corning, Malton, Paskenta, and Black Butte. Drainage associated with the South Fork of Walker Creek makes a large boat-hook bend (see sheet 9, Fruto NE quadrangle map) to the south of Orland Buttes, probably because of the presence of the south basalt butte. Drainage between S. Walker and Wilson Creek north of Michaelson Ranch contains minor deviations from the dominant northwest trend and underlying silt-type dendritic character. In general, there is no obvious disturbance to the drainage net in this area, yet a peculiar pattern does exist and a strong lineament runs between the creeks alined towards the back side of Orland Buttes. This and several other lineaments of sufficient length and closeness to the dam warranted ground investigation. Further details on the above referenced lineaments are in the Geophysical Study section (2.4). Generally few lineaments found to date represent expressions of faults, and the ground investigation revealed that not one fault-lineament correspondence indicated faulting with Quaternary slip.

TABLE 2-2

IMAGERY AND PHOTOGEOLOGIC ANALYSIS

Group Letter	Number	Location	Type	Youngest Surface	Photo No.	Comments
A	1 thru 8	Lower Wilson Crk. North-west of Willows	Drainage	600,000 ybp	5484017	Photogeologic lineaments related to parallel drainage patterns developed in Tehama silts and areas of consequent fan slope. Do not offset Sites anticline.
	a 1	White Cabin Crk.	Fabric	450,000 ybp	10-1, 11A-1 11A-2, 12-1	*Side slopes develop linear, slope percent abrupt* change, banks cut in linear fashion but does not cross pock-mark ground. Dendritic deviation to Trellis pattern. Strong ground truth expression.
	a 2	Sheep Coral	Drainage	450,000 ybp	10-1, 11A-1, 12-1	Consequent drainage pattern in silt.
	a 3	Stone Valley	Drainage	Tehama	9-2	Consequent drainage pattern in silt.
	a 4	Salt Gulch	Drainage	450,000 ybp	94-96 HAP	*Consequent drainage pattern in silt.*
	a 5	North Hayes Hollow	Drainage	Tehama	94-96 HAP	Consequent drainage pattern in silt.
	a 6	South Hayes Hollow	Drainage	Tehama	94-96 HAP	Does not offset Nomlaki Tuff.
	a 7	Hoodo Creek	Drainage	Tehama	94-96 HAP	Does not offset Nomlaki Tuff.
	a 8	Nye Creek	Drainage	Cretaceous		*Corresponds to nearby Cretaceous fault.*
B	1 thru 9	Strike-Vale topography	Fabric	10,000 ybp	HAP 83 Strip 39 & 40	Resistant hogback ridges in strike-vale topography of Cretaceous outcrop belt. Trends do not disturb Quaternary surfaces.
	b 1					Siltstone-conglomerate contact in Ku-hogback with subsequent drainage.
	b 2					Julian Rocks conglomerate hogback and Kl.
	b 3					Congolmerate in lower Lodoga Formation (Fm.).
	b 4					Contact between Stony Creek Fm. and Lodoga Fm. Conglomerate.
	b 5					Bedford Creek at Masterson Bridge sandstone-also congolmerate near Buris Creek (hogback).
	b 6					Jurassic-Cretaceous contact (Crassicolis zone).
	b 7					Rocky Ridge conglomerate.
	b 8					Scribner Ranch concretionary mudstone w/resist. Sandstone ridges.
	b 9					Conglomerate ridge unit and pebbly mudstone.
	b 10					Contact between mudstone and basic volcanic units of Coast Ranges.

TABLE 2-2 (continued)

Group Letter	Number	Location	Type	Youngest Surface	Photo No.	Comments
C	1	West Marg. of Great Valley	Fabric	125,000 ybp	HAP 83 Strip 402211	Coast Range Thrust.
D	1 thru 15	Foothill Belt	Tone	10,000 ybp	HAP 83-Strip 40213 and 54017	North-trending *lineaments at front of foothill* belt on western side of Great Valley.
d	1	West Michaelson Ranch	Tone	10,000 ybp	12-3, 2,1	No ground trace, possibly mislocated d_3 - d_2.
d	2	Wilson Creek	Fabric	10,000 ybp	11-A5	Trenched at Boathook Bend Walker Creek - no expression.
d	3	Orland Buttes	Drainage	10,000 ybp	11A-1/B-1	Corresponds to west side Orland Buttes and strike of Cretaceous bedrock.
d	4	Buckhorn Crk.	Drainage	13×10^6 ybp	12-10,9,8	Linear drainage in Tehama/no expression in Q4 or 5-45 @ 240' RB not disturbed. (Red Bluff (RB)).
d	5	Brannin Crk.	Drainage	3×10^6 ybp	11B-1	Tehama silt, R.B. cap not cut by linear.
d	6	Sourgrass Rd.	Drainage	600,000 ybp	9-15, 14, 8-14,13	Tehama silt, does not cut Corning age surface or Redding gravel.
d	7	Elmore Cem.	Drainage			See d 4 - continuation of trend.
d	8	Squaw Hollow	Drainage	600,000 ybp	11B-1, 9, 8	Combination of drainage and roading system.
d	9	Boundary Line	Tone	10,000 ybp	HAP 83 39218	Boggs Chapline Road & Rreservation Boundary eastside land use.
d	10	Table Mountain	Tone	10,000 ybp	HAP 83 402213	West Reservation boundary & Table Mountain land use.
d	11	Reservation	Drainage	10,000 ybp	HAP 83 402213	Linear drainage in calcrete silt, corresponds to joints seen in Mill Crk.
d	12	Crumbine Rd.	Tone	3×10^6 ybp	11B-4	Old road system.
dd	1	So. Fork Walker	Drainage	10,000 ybp	401710-5	Does not offset basalt at Worthington Knob with Orland Butte strike and dip.
dd	2	Stony Creek	Drainage	10,000 ybp	40179-11/ 8-11	Does not disrupt or offset Q1-Q5 drainage channels
dd	3	Sehorn Creek	Drainage	Present	392214 HAP 83	Sehorn Creek drainage not anomalous.
dd	4	Jewett Creek	Drainage	10,000 ybp	40179-21/ 8-22	Linear drainage off Jewett Creek - joint and fault trends in Cretaceous.

TABLE 2-2 (continued)

Group Letter	Number	Location	Type	Youngest Surface	Photo No.	Comments
E	e 1	Hambright Crk.	Drainage	125,000 ybp	401713-5	Straight segment in Hambright trellis pattern. No offset in Cretaceous beds at head of lineament.
	e 2	Masterson Hollow	Drainage	$13x10^6$ ybp	392213 HAP 83	Straight pattern in Masterson Hollow drainage.
	e 3	N. Elmore Crk.	Drainage	$13x10^6$ ybp	399212 HAP 83	Cretaceous is not faulted when exposed at bedrock outcrop. Several ridgelines and creeks north of Elmore. Drainage pattern, Nomlaki Tuff in subsurface.
	g 1	Ranch	Fabric	Cretaceous	3992212 HAP 83	Fault in Cretaceous, not investigated.
F						Not investigated.
G	g 1	Eagle Ford.	Fabric	125,000 y.b.p.		Reconnaissance did not identify linear on ground.
	g 2	Henleville Rd.	Fabric	125,000 y.b.p.		North side limit of Red Bluff gravel pile.
	g 3	Red Bluff Ranch	Fabric		402212 Hap 88	Air Reconnaissance failed to identify lineament. Not investigated.
	g 4		Fabric			Not investigated, related to Cold Creek fault.
	g 5		Fabric		402213 Hap 83	Not investigated, related to Cold Creek fault.
	g 6		Fabric			Not investigated, related to Cold Creek fault.
H	h 1	Table Mtn. one	Fabric		402212 Hap 83	Projects from northeast faults in Cretaceous, Tehama drapes over bedrock fault.
	h 2	Table Mtn. two	Fabric		402212 Hap 83	Projects from northeast faults in Cretaceous, Tehama drapes over bedrock fault.
	h 3	McCarty Creek	Drainage		392219 Hap 83	Old terrace break (Strath)

c. Lineament Summary. The photogeologic study and field examination concluded that lineaments in the Black Butte study area are related to drainage character and/or rock fabric. Strongly expressed lineaments in the study area are interpreted as reflecting the megascopic skeletal bedrock fabric, including the following:

- North 5 to 25 degree strike of Cretaceous bedding.

- Regional eastward dip of Cretaceous bedrock.

- A regional hinge line running from sec 28, T. 23 N., R. 5 W., through sec 23, T. 23 N., R. 4 W., towards sec 3, T. 19 N., R. 4W.

- High angle shear faults along N. 60° E, east-west, and N. 45° W. trends.

- A subdued zone of secondary folding between strike valleys and hinge line.

2.3 Site Geologic Conditions. Black Butte Dam was built in a bedrock channel incised through and 420 feet below the upper surface of the sandstone and basalt ridge forming Orland Buttes. Black Butte forms the north abutment while Orland Buttes form the south abutment. Stony Creek passes over Great Valley Sequence rocks with a relatively thin cover of Tehama Formation to the Quaternary alluvium on the floor of the modern Sacramento River flood plain, which is underlain by hundreds of feet of Tehama Formation.

2.3.1 Stratigraphy. The stratigraphy at the damsite is somewhat less complex than that for the greater study area and is portrayed on plate 5. The oldest exposed rock is shale of the Cretaceous Great Valley Sequence (Forbes Formation) which dips 20 to 30 degrees to the east and the top of which is marked by an angular unconformity. The volcaniclastic Black Butte Formation overlies the Great Valley Sequence rocks, and in the area of the dam it thickens eastward. Field exploration along the west side of the Buttes indicated that the Black Butte Formation must be thin (less than 20 feet) if it exists at all (see Foundation Report, Black Butte Dam, 1963). Up to 90 feet of Black Butte Formation lies beneath the basalt at the dam abutments and up to 50 feet occurs beneath the main dam embankment. The Lovejoy Basalt unconformably overlies the Black Butte Formation. The basalt varies locally in thickness due to prebasalt topography, being approximately 70 feet thick at the damsite but elsewhere is often about 40 feet thick. The basalt dips 4 degrees to the east. The Tehama Formation laps around the buttes, lying upon and against the Lovejoy Basalt and Great Valley Sequence rocks. Up to 20 feet of recent alluvium underlies the bed of Stony Creek at the dam.

2.3.2 Dam Foundation Geology. The channel of Stony Creek has cut through the basalt caprock and into the underlying mudstone, sandstone, and conglomerate of the Black Butte Formation, and in one area it has reached the shale of the Forbes Formation. Plates 7, 8, and 9 depict the foundation geology of the dam and appurtenant structures. The impervious core is founded entirely on the

Black Butte siltstone and sandstone, except from stations 30+50 to 31+20 which is founded on conglomerate and stations 20+10 to 21+40 which is founded on Forbes Shale. The upstream and downstream shells of the dam embankment are founded on recent alluvium of Stony Creek, which is typically 10 to 15 feet thick overlying bedrock. On the left abutment, the main embankment was placed against deposits of the Black Butte Formation up to approximately elevation 415 feet and on Lovejoy Basalt above that elevation. The right abutment was placed against the same materials as the left abutment with the change in rock type at approximately elevation 395 feet. The spillway channel was cut through the Lovejoy Basalt and, in the lower part of the upstream end, siltstone and sandstone of the Black Butte Formation. The concrete structures of the outlet works upstream of the tunnel are founded on Lovejoy Basalt, mudstone and sandstone of the Black Butte Formation, and the Forbes shale. The intake control tower is founded entirely on shale of the Forbes Formation. The intake tower bridge abutment is founded on Lovejoy Basalt. Bridge pier No. 1 is founded on mudstone, and bridge pier No. 3 on conglomerate. The upstream end of the tunnel starts in shale of the Forbes Formation and conglomerate of the Black Butte Formation, and as a result of the downstream dip of the formations, penetrates the shale, conglomerate, mudstone, and lower portion the Lovejoy Basalt. A fault with 25 feet of east side-down displacement was encountered in the tunnel at station 8+02.5 and is discussed in the following section. Concrete structures of the outlet works downstream of the tunnel are founded on Lovejoy Basalt, except for a portion of the north stilling basin wing wall which is founded on Tehama Formation deposits of clay, silty sand, and gravel.

2.3.3. Dam Foundation Structure. Structural features of the foundation and attitudes, jointing, and faulting are treated below.

o Attitudes. As noted above, the rocks of the Great Valley Sequence dip 20 to 30 degrees to the east, a consequence of being part of the limb of the valley syncline. Three-point problem resolution of the upper surfaces of the basalt capped Buttes, projection to subsurface occurrences to the east, and magnetic modeling show the Lovejoy Basalt dipping at 4+ degrees to the east. No bedding was evident in the Black Butte Formation, hence its attitude is unknown. The Tehama Formation generally lacks measurable bedding planes but regional occurrence suggests it dips at less than 2 degrees to the east.

o Jointing. Two prominent and normal joint systems are present in the basalt at the damsite, and on the right abutment area they extend into the underlying sandstone. They strike N. 40° to 55° W. and N. 0° to 60° E. and both have vertical dips. A less prominent joint set dips gently eastward and was probably horizontal prior to the tilting of the flow. Overall, the joint system defines roughly rectangular blocks whose dimensions average 15 to 20 feet. Additional fracturing in the mudstone and sandstone of the Black Butte Formation is confined to the right abutment area, particularly in the upstream tunnel portal area and the tunnel from stations 10+30 to 11+00 where they are open and closely spaced, with heavily stained surfaces. Conglomerate of the Black Butte Formation does not exhibit jointing. Of the two joint systems in the Forbes Formation, one follows the bedding planes and the other trends slightly east to west of north and has steep dips.

o Faults. Two faults of minor displacement, revealed at the damsite during construction of the outlet tunnel and now inaccessible, were discussed in the foundation report as follows (C.O.E., 1963):

> "(Two)...faults are present in the right abutment, one cutting the outlet tunnel at Sta. 8+00 and the other cutting through the tunnel conduit section at Sta. 13+00 Both trend north and dip east at high angles. They are normal faults in which the east blocks have been dropped in relation to the west blocks. Although they have displacements of less than 50 feet, their effects on the rock have been extremely detrimental and almost totally unexpected. ...Multiple gouge zones up to 40 feet in width were uncovered in the basalt of the tunnel conduit section, stilling basin and irrigation diversion channel. These zones cut the basalt mostly at high angles and consist of intensely altered basalt fragments in a matrix of brown, gray or tan clay. ...In the outlet tunnel from Sta. 7+50 to Sta. 9+35 an almost continuous zone of shearing was penetrated. Spacing of the individual shear planes ranged from 3 feet to less than one inch. ...Not infrequently the mudstone has been thoroughly pulverized into a loose, dry silty clay. The individual zones of extreme shearing ranged in width from a few inches to 5 feet or more. These zones, as well as the individual shear planes with sufficient continuity to determine attitude, almost always had strikes in the range of N10°E to N10°W and dips from 75° to vertical. Minor shearing was also noted in the stream channel section of the core trench and in the left abutment upstream from the core trench. ...However, faulting has probably been at least partly responsible for the development in the basalt of a system of near vertical joints in both abutments along which extreme weathering has taken place."

These faults, shown on plates 7 and 9, were considered in the foundation report to be branches of the "Black Butte Fault." However, this report shows that fault to be nonexistent. The basalt apparently flowed across a surface that was fairly level or tilted slightly to the west. Since its deposition, it has been tilted 4+ degrees to the east and possibly more. In addition, after emplacement of the basalt, down cutting of the upper Princeton Valley removed much of the basalt, creating a rimrock topography for the upper Princeton Valley fill, where detached blocks spalled off the valley walls. Such relationships are observed at the terminal end of the spillway where the basalt is in various stages of block detachment and moving downslope over terrain devoid of basalt. Also, underlying the basalt at the crest of the spillway cut where the basalt lies in a normal depositional relationship are "slick" clayey sandstone and mudstones. These factors, taken together, suggest that these two faults are related to gravity sliding and adjustment of blocks of basalt overlying an east-tilted "slick" clay formation.

2.4 Geophysical Study. Plate 6 is a map showing the nature and location of various geophysical studies. Figure 2-15 shows the results of gravity and magnetic modeling.

2.4.1 Gravity Study. Several gravity lines were surveyed along east-west trends perpendicular to regional structure. The lines were read to microgal accuracy and program corrections were made for tides and drift. Free-air, simple Bouguer, terrain, and regional gradient corrections were removed. A mass balance model using modified Bott 2-D routine was calculated (Bott, 1960).

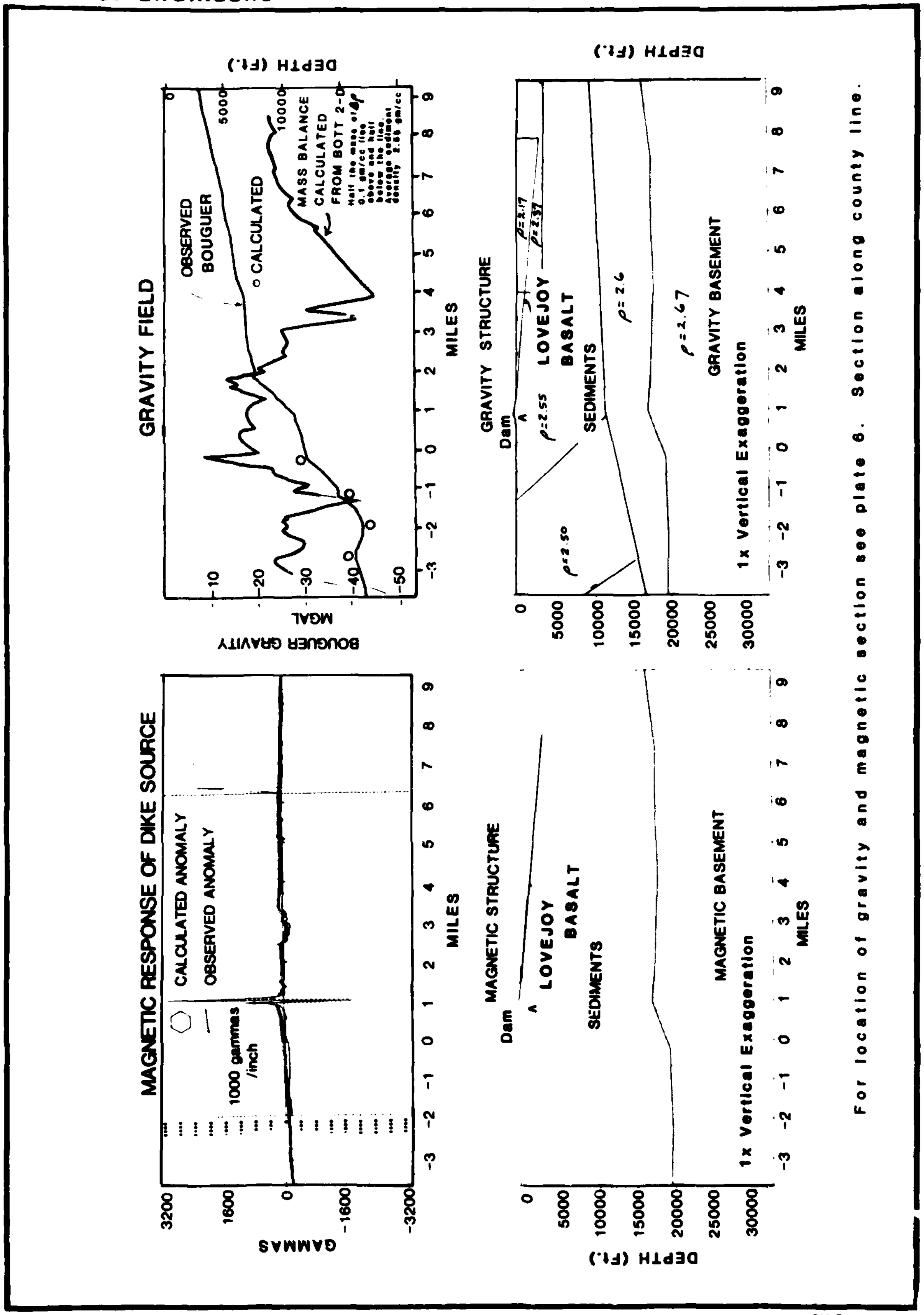
Based on the results indicated for $\Delta\rho$ 1/ = 0.1 gm./cc., a two-dimensional section gravity model was attempted. Limited points were calculated and compared to observe Bouguer gravity. Results of this modeling indicate the lack of steep north-trending faults in the study area. Neither the suspected Black Butte nor Malton Fault could be confirmed. Gravity analysis indicates that the principal structure present is at subbasement level in the dam area, about 20,000 feet deep, and is parallel to the regional geologic trend expressed on the surface by visible structure. The gravity model suggests a wedge of less dense material is emplaced at depth near the mapped position of the Paskenta nose. Also, a block of higher density (possibly Franciscan or mafic volcanic) material is piled at depth beneath the dam in section 17 at a depth below 17,500 feet. No high angle faulting is associated with these boundary conditions, but rather the profiles suggest thrust slivers and doming.

2.4.2 Magnetic Survey. Several ground magnetic lines were surveyed along east-west trends perpendicular to the regional topography. The purpose of this work was to determine the most likely geologic structure of the Lovejoy Basalt flows in the area. The geologic structure was obtained by modeling surface magnetic data, using comparisons between observed and calculated magnetic anomalies to refine geologic sections developed from surface and borehole geology. The modeling results were further constrained by geomagnetic and paleomagnetic data. A complete report of modeling is contained in NGA, 1984. The favored computed magnetic model presents the Lovejoy Basalt as a continuous flow dipping to the east at 4.25 degrees. The basalt was not detected west of Orland Buttes nor is there any noticeable displacement in the basalt other than east dip. The only indication of structure other than unfaulted basalt flow is the character of the magnetic basement (as shown in figure 2-15).

There is a noticeable increase in the slope of the basement slightly west of Orland Buttes with the west side down. The inclination of the slope and the offset at depth indicated is dependent upon the magnetic parameters that are used for the basement. While these parameters may vary, the presence of some basement structure is required to model the regional magnetic anomaly. A minor anomaly near the crest of Middle Butte on the east flank corresponds to either the onset of superposition of two flows or a minor fault. Two flows can be mapped on the Butte at some locations. This anomaly does not appear in the South Butte.

2.4.3 Paleomagnetic Analysis and Age. Six sites on Black Butte and one Upper Chico Canyon site were sampled for age and paleomagnetic study. The location

1/ $\Delta\rho$ (Change in density or contrast between density of rock.)



GRAVITY AND MAGNETIC MODEL OF SECTION BENEATH BLACK BUTTE DAM FIG. 2-15 and results of this study are reported in detail in NGA (1984). The Chico Canyon basalt is correlative with the Table Mountain basalt on the east side of the Sacramento Valley. The results of K-Ar radiometric age dates from opposite sides of the valley indicated mid-Miocene age between 13.6 and 15.2 million years ago for the basalts. The Lovejoy Basalt was formed during a reversed magnetic epoch. Some slight variation in declination and inclination exists, possibly due to small relative motion of basalt along Orland Buttes during uplift. However no large scale block rotation at the sample sites is indicated. The paleomagnetic property of the basalt suggests the direction of the flow is from the north in the immediate area.1/

2.4.4 Shallow Reflection Survey. Four shallow seismic reflection survey lines were made across suspected surface locations of fault structures identified by other investigators. The shallow seismic reflection survey, using common offset reflection profiles, was conducted under Corps of Engineers direction by Endacott and Associates. Complete results of the reflection survey are contained in their report (Endacott and Associates, 1984). The interpreted profiles are shown on plates 10 through 13. Results are as follows:

Line 1 (Plate 10). This line was shot across the Paskenta nose and morphostratigraphic unit Q4. This line shows two geological features. The anticlinal fold at 160-foot depth is Cretaceous bedrock configured as the Paskenta nose. The high-angle fault associated with the Sites-Paskenta feature is confined to the Cretaceous strata and does not propagate through the Tehama Formation or the Q4 terrace overlying Tehama.

Line 2 (Plate 11). This line was shot across the inferred Black Butte Fault at Hambright Creek. The predominant geologic feature seen on this profile is a wavy rise on the time section on reflector R3. This corresponds to the location of buried Cretaceous topography. The east curvature of the reflector is a dip-slope of Cretaceous beds and the west curvature is an eroded slope exposing bed section as a reflector. No fault is present at station 15+00, the inferred position of the fault. Reflectors R4 and R2 are different materials as are R5 and R3. This interpretation is not unique and could also be interpreted to indicate a buried dike or fault. The dike is eliminated through magnetic modeling and no fault is indicated in deeper seismic records. No structure propagates into upper terrace cover (Q3).

Line 3 (Plate 12). This line was shot across the projected Black Butte lineament at Walker Creek. Geologic interpretation of this line indicates very shallow Cretaceous bedrock at the east end where it appears to be a buried topography mimicking monoclinal beds. The presence of the R5 (?) reflector

1/Magnetic grain indicates a general northern channel source. Ultimate source believed to be Honey Lake escarpment.

(diffraction) suggests a fault. A deep seismic record of the same area indicates no faulting of underlying beds. Deep reflection work tends to discount a shallow fault interpretation. A trench dug in the overlying Tehama material shows no evidence of disruption (a bank log of the trench is included on plate 19).

Line 4 (Plate 13). Line four was shot across the inferred position of the Malton Fault. Interpretation of this line indicates a fairly uniform and flat lying geological section of Tertiary sediments. No faulting of the Q5 terrace can be seen. Underlying Tertiary reflectors are continuous without fault interruption. A remnant of Lovejoy Basalt (indicated in well data) is possibly in the subsurface at 345 feet below the surface; however, if this is so, the high speed basalt causes velocity pull ups and makes depth uncertain. Diffraction near the K3 reflector can be the result of a pull up.

2.4.5 Deep Seismic Reflection Work. Four seismic reflection profiles were obtained and examined in detail and were correlated with wells, ground geology, and gravity lines. The results of this analysis are shown on four geologic-seismic sections illustrated on plates 14 through 17. The sections are of the general areas listed below.

Long Hollow Seismic Section (Plate 14). This section is along an east-west line from R. 5 W. to R. 2 W. in the general area of the northern border of T. 23 N. The line crosses the inferred position of Black Butte, Malton, and Corning Faults. The section shows the beginning of the Kirkwood-South Corning dome.

Basement is about 1.4 seconds (about 12,000 feet) in this area. Lying above basement, a series of detachment planes initiate within the Chico Series. The detachments rise in section and cut across east-dipping strata. Within the Chico Series, an orderly, persistent reflector group, characterizing Dobbins-Guinda-Sites Formation, are undisturbed beneath the trace of the Black Butte and Malton Faults. Disrupting this group is a high angle, west dipping fault labeled the Burris Creek Fault with approximately an 800-foot throw. This fault is repeated on strike in section shown on plate 15. In the eastern portion of the record, block and shallow trust faults ramp off the basement detachment below the Corning Dome.

Ham Bridge to Black Butte Seismic Section (Plate 15). This section is along an east-northeast oriented line paralleling the general area of the north shore of Black Butte Lake and the North Fork of Stony Creek. This seismic section crosses the Paskenta nose and the inferred position of the Black Butte Fault.

Basement (not shown) is deeper than 3 seconds (greater than 15,000 feet) in this area. In the section plane, the basement dips sharply off to the west. The dip is estimated to be greater than 20 degrees. Approximately 3,000 feet of Shasta Series lies below the Horsetown group of reflectors.[1] The seismic-geologic data interpreted in this section shows the Paskenta nose rooted in a detachment plane lying above basement. The detachment rises in section with the thrust refolding the recumbent upper plate and dragging the lower plate. Originally, the upper plate fold was probably a nontectonic collapse structure. The nose subsequently became part of the synclinal folding of the valley edge, thrusted in continued crustal shortening and sheared along the Paskenta wrench fault trend. Strong reflectors within the Julian Rocks Formation correlate with higher acoustic impedance material found in wells and outcrop. The contact between the Venado Formation and Horsetown group reflectors is shown. It occurs in records as a dominant, coherent reflector. Very clearly multiple reflectors in section and principal reflectors noted are not offset or disturbed under the inferred position of the Black Butte Fault. The Burris Creek Fault is present in section.

Stubin Bridge to Walker Creek Seismic Section (Plate 16). This section lies along an east-west oriented line running along the southern sections of T. 22 N. from R. 6 W. to R. 2 W. The line crosses the Sites anticline/ Paskenta nose, and the inferred positions of the Black Butte and the Malton Faults.

Basement (not shown) is deeper than 3 seconds in this area (greater than 15,000 feet). The contact between the Upper Cretaceous and the Lower Cretaceous Shasta Series lies in the lower portions of the record and is distinguished in well and reflector data by the distinctive conglomerate unit of Julian Rocks. Again, the geologic-seismic data interpreted in this section shows the Paskenta nose rooted in a detachment plane lying above basement. The detachment illustrated as a thrust fault is folded, as is the recumbent fold in the Aspilche shale (member of the Lodoga Formation). The syncline in the west part of the record is the beginning of the Fruto Syncline. An unnamed fault confined to bedrock exists east of Julian Rocks. Strong, coherent reflectors in the Upper Cretaceous strata are not disrupted at the inferred position of the Black Butte or Malton Faults.

Hayes-Burnell Seismic Section (Plate 17). This east-west line shows the seismic section from Fruto to the Glenn-Colusa canal north of Willows. The section crosses the Fruto Syncline, Sites Anticline, and the inferred position of the Willows and Malton Fault at bifurcation. The section continues on figure 2-16 and shows the onset of the Greenwood Anticline.

Basement varies from 8,500-foot depth in the eastern portion of the record to about 15,000 feet at midsection (basement not shown). Basement appears to dip off to the west. This line is of interest because it crossed the mapped position of the Sites Anticline. The section is considerably south of the dam near the limits of this study area. The Paskenta nose has apparently turned into and merged with the Sites tectonic structure as shown in this seismic-

1/Horsetown group includes Clark Valley mudstone and Julian Rocks congomerate.

geologic section. The Sites tectonic structure is interpreted as a slightly recumbent, anticlinal fold cut by a thrust fault rooted at depth. The thrust has a lystric surface originating from a basement detachment. Upper Cretaceous Chico Series have no faults disturbing reflectors corresponding with the inferred map position at depth of the Willows, Malton, or Corning Faults.

Sections were oriented approximately east-west and nearly perpendicular to the structural grain. Several additional northeast oriented seismic reflection profiles were also examined. Profiles were generally 4 to 15 miles long and had good resolution to acoustic basement, generally at 3.0 seconds. They were shot by oil exploration or geophysical service companies. Four major tectonic themes are indicated by the profiles and sections.

2.4.6 Analysis of Geophysical Data.

a. The western edge of the Great Valley Sequence near Black Butte Dam displays several folded overthrusts which are rooted in the Upper Cretaceous bedrock just above the acoustical basement (plates 14, 15, 16, and 17). The largest overthrust in the study area appears to be associated with the Sites anticline as an attendant listric fault (plate 17). This relationship apparently persists south of the Black Butte study area also (Richard Willingham, Ogle Oil Company and Carl Wentworth, USGS; personal communication January 1985). In the study area, the overthrust block has traveled over the Lower Cretaceous strata in excess of 1 mile. The primary zone of detachment is not observed on the records. The Sites listric thrust does not continue north to the reservoir but merges with the Paskenta structure. The Sites thrust is absent from the Long Hollow section (plates 14 and 15).

b. Northeast and northwest-trending, high angle, normal and reverse faults cut the folded Cretaceous bedrock near the valley edge but do not cut the Lovejoy Basalt. The overlying Tehama Formation copies bedrock structure as a draping pattern where the Tehama has a thin cover over the Cretaceous bedrock. Northeast-trending faults are visible on the Ham Bridge and Hayes-Burnell Geophysical Sections (plates 15 and 17).

c. A line of subsurface doubly plunging anticlines appears to mark the western half of the north-central valley. The domes are gas traps, have maximum closure in the Upper Cretaceous strata, and sometimes, but not always, work upward into the base of the Tehama Formation (figure 2-10). The positioning of the domes has been discussed in the general literature and speculated to be linked to the deep seated structure identified by Oliver and Griscom (1980) as the Great Valley Gravity High. Oliver and Griscom explain the gravity high as possibly a tectonically emplaced fragment of oceanic crust. However, they do not discuss the domes. Others have expanded the concept using the proximity of domes near the gravity high to yield evidence for a high angle reverse fault that steps out of the tectonic basement. Using this fault mechanism, the folds result from drag on the reverse slip of the east block. Two other possible causes for the domes are explained below.

(1) Primary Folding with Secondary Reverse Faulting Model. This model of deformation is developed as the primary response of thin-skin layered competent rock to general compression. As shown on figure 2-16, the folding may have been facilitated by localized or shallow detachment within the suprabasement. In this model, dipping reverse faults that flank the fold were formed during the late stages of fold development and are secondary to the fold structure. Sections shown in the domes on the Long Hollow and Hayes Burnell lines indicate this mechanism to be the most probable cause of the domes and faults (plate 14 and figure 2-16).

(2) Primary Reverse Faulting and Secondary Folding Model. The spatial distribution and geometry of the same folds can also be used to infer the presence of major reverse faults that are the controlling structures in fold development. Bentley (1977) proposed that the Yakima folds in the State of Washington are faulted monoclines that are localized above zones of high-angle faults that extend from the basement. He terms this phenomenon "basement jacking." Laubscher (1977) suggests that such folds are narrow structures developed on broader warps. From this, he infers the presence of multiple decollements in the deeper basement and suggests that the broad warps were localized by thrust ramps rising from a deep (approximately 20 km) regional decollement and that the narrow folds formed above a shallow (1- to 3-km deep) decollement. A geometric analysis of Greenwood and Corning anticlines, based on a fault ramp-flexure model (Bruhn, 1979), suggests that the presence of fault ramps below the study area folds would extend to decollements at preferred depths of 10 to 12 km. The presence of crest, fan, and hinge set faults indicate the possibility of basement jacking as the underlying cause of these folds. However, deep decollement planes cannot be seen on the records.

No major concealed north-trending, high angle reverse faults can be interpreted from our analysis of the deep seismic records. In the records examined, the pattern of doming does not suggest drag folding. As shown on figure 2-16, an adequate explanation is found in horizontal shortening already visible in the area. Instead of an overthrust block rooted in the lower infrastructure, the domes are a result of detachment jacking of the shallow basement. An explanation of folding due to transpressive fold-thrust welt development need not be considered due to lack of a major northeast wrench zone (see transpression in glossary).

d. The Paskenta Fault trend is interpreted through profiles and section to continue into the Black Butte area and merge with the Sites anticline. In Cretaceous strata, fold deformation becomes more dramatic in the area of Kirby's Paskenta nose. The causitive mechanism suggested for this is a tear in the overthrust block connecting the Sites decollement with the Paskenta translational fault zone. Profiles on plates 15 and 16 show the squeezed nature of the Paskenta nose. This is a three-dimensional fold with left-lateral slip accounting for horizontal drag to folding as demonstrated on map on plate 15.

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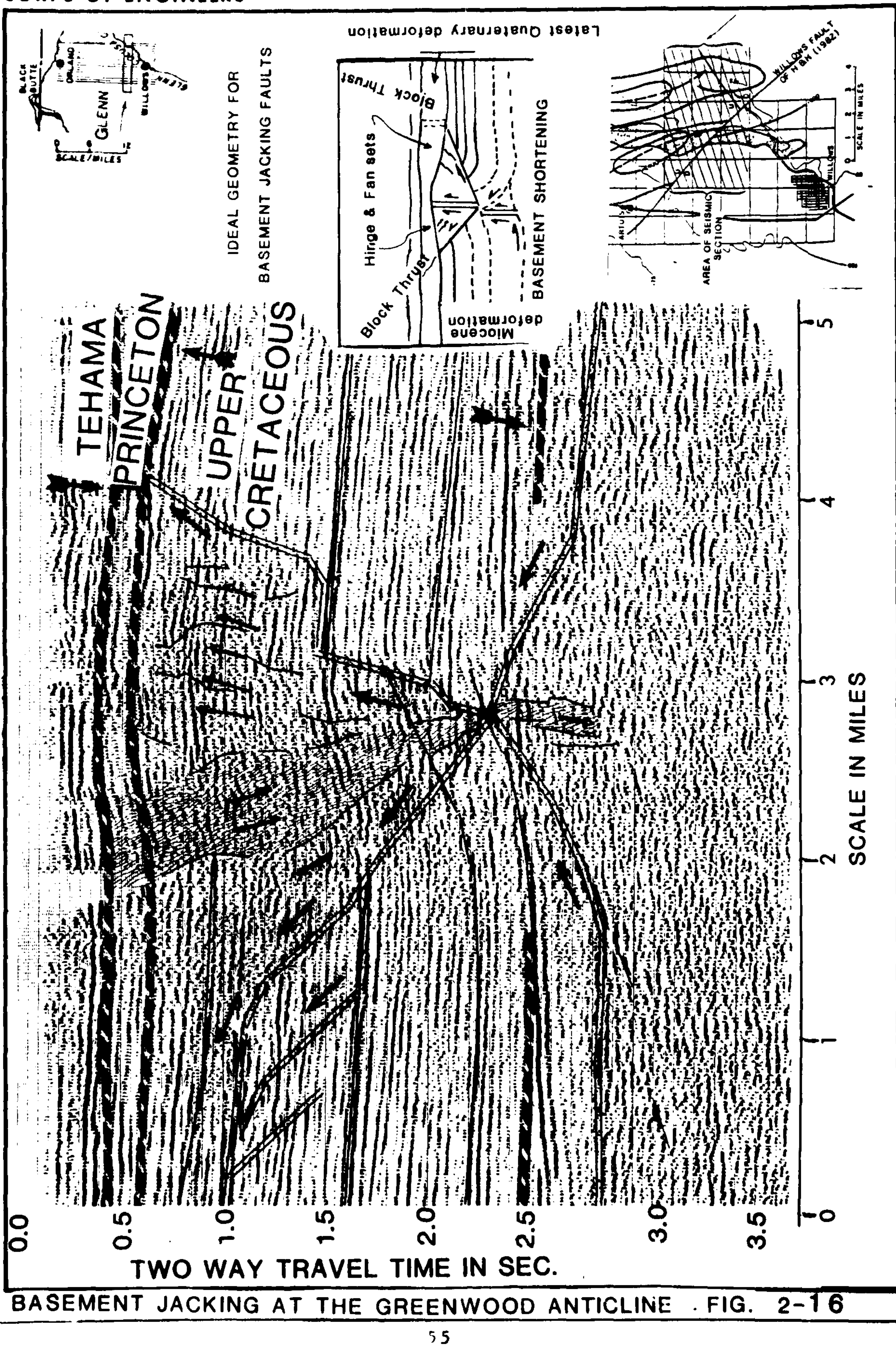


BASEMENT JACKING AT THE GREENWOOD ANTICLINE . FIG. 2-16

e. The suspected Black Butte Fault cannot be found in the two reflection sections that cross its suspected position at Black Butte Dam. Little evidence for the Malton or Corning Fault exists that supports them as major concealed features. No northwest continuation of the Willows Fault was found and no major tectonic structure was found to cut the Sites decollement. Topographic profiles shown on plate 18 lie across the suspected location of the Malton and Corning Faults. As indicated by broken elevation profile on this plate, the Corning Fault area has indications of possibly reversed or oversteepened drainage.

2.5 Summary of Structural Relationships. Analysis and study of Black Butte regional geology and structure indicates the upturned western edge of the northern Sacramento Valley resulted from past crustal shortening. Within the study area listric faulting is responsible for thickening the Upper Cretaceous (Chico) section lying east of Julian Rocks between Nye Canyon and the North Fork of Stony Creek. The high-angle thrust daylighting along the axis of the Sites Anticline is the expression of one such listric surface. Thickening of the Chico seems to be limited along the north by the Paskenta nose structure of Kirby. As such, the Paskenta nose marks a continuation of the upper plate tear identified as the Paskenta fault zone at the Stony Creek fault junction. We believe that this zone dies as it merges into the Sites anticlinal structure much as a bedding fault dies.

All Cretaceous strata are strongly folded; however, there is much less folding in Tertiary strata. The Lovejoy Basalt has only a slight eastern dip and the Tehama Formation is essentially flat-lying. Northwest and northeast-trending, high angle normal faulting began along the western edge of the valley sometime during the time of the Lower Princeton Valley. This faulting was short lived because it does not seem to invade Lovejoy Basalt or Tehama Formation strata. No evidence to support the existence of a north or northwest-branching fault system was found. Faulting is present at Willows along and throughout the Willows Anticline.

The existence of the Black Butte Fault cannot be supported. No surface or subsurface geologic relationships support the proposed fault. A Quaternary stream terrace system dissecting the surface of the Tehama Formation serves to define morphostratigraphic units that lie across all existing and suspected faults. No evidence that these units were disrupted or disturbed could be found. With the exception of the Corning Anticline that indicates some recent doming, the present land surface is not deformed by any suspected or known faults. The existence of the Malton and Corning Faults could not be confirmed by surface or subsurface exploration. Rather, in the case of the Corning Fault, this study concludes the subsurface and near surface disruption of the strata is probably better explained by anastomising fan sets; minor faults resulted from primary folding of the Greenwood and Corning domes with development of secondary reverse faulting. No through-going regional structure cuts across the Sites-Paskenta trend.

Post-Tehama time has been marked by relative geologic stability. An excellent set of Quaternary terraces, 0.5 million years old or younger, lie across all of the above principal tectonic expressions. No evidence for continuing fault activity can be found in the Black Butte area more recent than 0.5 million years ago.

SECTION 3. TECTONICS

3.1 Tectonic Setting and History. A summary of the regional setting through Mesozoic and Cenozoic evolution follows. Each of the five informal provinces that are discussed in the regional setting of the project area has a different tectonic history. The major structural features in three of the provinces, the Klamath Mountains, Great Valley, and Sierra Nevada, were largely developed by the end of Mesozoic time some 70 million years ago, and have changed relatively little since then. Many of the Cenozoic features of the Great Valley and Sierra Nevada provinces appear to represent relatively small scale adjustments to changing stress fields that have been localized along major Mesozoic structures and have propagated upward into the overlying late Cenozoic section in increasingly smaller increments. The Cascade province has been largely developed in late Cenozoic time through a combination of basinand range-type extensional tectonism and Cascade volcanism. The northern Coast Ranges province has developed through nearly continuous periods of activity since mid-Mesozoic time. This activity is associated with the evolution of the continental margin.

In terms of the contemporary plate tectonics setting, the northern Sacramento Valley lies considerably inland of, but opposite, the northermost part of the San Andreas transform boundary between the Pacific, Gorda, and North American crustal plates. This is the Mendocino triple junction. The region immediately inland from the sharp westward bend in the San Andreas Fault is an area of concentrated stress marked by frequent earthquakes. Despite the westward turn of the San Andreas Fault some of the regime of right-lateral shear that exists in the northern Coast Ranges continues along trend as the Lake Mountain-Mad River Fault zone. This active zone intersects the coastline in the vicinity of Trinidad Head, north of Eureka, and continues for some distance offshore. As suggested by Herd (1978), it continues toward the alined and similarly oriented Blanco fracture zone.

North of the Mendocino triple junction the offshore Gorda Plate underthrusts the North American Plate beneath the present continental margin. The underthrust plate dips shallowly eastward beneath the present continental shelf and the coastal region north of Cape Mendocino. A highly seismic zone that exists between about 15 and 30 km in depth, beneath the lower Eel River Valley, is thought to be localized within the Gorda Plate. The south edge of the plate is interpreted from gravity evidence as extending beneath the northern Coast Ranges along a southeasterly trend from the vicinity of Cape Mendocino, approximately toward Lake Pillsbury. Two zones of active tectonism exist within the provinces bordering the northern Great Valley. One of these is the zone of right-lateral shear within the northern Coast Ranges that lies adjacent to the San Andreas Fault. This zone represents a wide mobile belt of continuing deformation along the transform boundary between the North American and Pacific crustal plates. The Maacama Fault is one such member. The second zone is the region of generally east-west crustal extension corresponding to the Basin and Range province and overlapping the southern Cascade Range province.

The present structural form of the northern Sacramento Valley is that of an asymmetric synclinorium, with a deep keel of Lower Cretaceous and Jurassic rocks beneath its western margin. Under the central part of the valley an overlapping section of Upper Cretaceous strata extends eastward from the core of the trough of older rocks directly across a platform of crystalline basement, probably oceanic crust. The overlap seems to wedge out northward over the Klamath Mountains and eastward over Sierran rocks. The strike of bedding in the unwarped Great Valley Sequence rocks generally parallels the valley margin. Thus, the Upper Cretaceous rocks define a shallow south-plunging basin underlying the northern valley area. The configuration of the subsurface of the deep keel of Lower Cretaceous strata beneath the west side of the valley was ascertained by geophysical analysis. The east flank of the west side trough has geophysical expression as the steep, linear magnetic and gravity gradients that extend up the axis of the Sacramento Valley, forming the west flank of the Great Valley magnetic and gravity highs. The gradient reflects a basement dicontinuity resulting from juxtapositioning of crust of contrasting magnetic character and density. There are two contrasting interpretations.

One view is that the east flank of the west side trough is faulted against the basement providing the existence of a series of east-up faults extending upward through the Upper Cretaceous section in a zone that closely matches the center of the magnetic and gravity gradient (Harwood and Helley, 1982).

Another view sees a continuous basement surface dipping southwestward about 40 degrees to a depth of 15 km under the Coast Ranges. An eastward thinning wedge of Franciscan rock is defined between the basement and the overlying Great Valley sequence. Farther east the Great Valley Sequence is placed directly on the same mafic basement. Thus the Franciscan was emplaced in wedgelike fashion by assemblage thrusting northeastward beneath the Great Valley (Wentworth, Walter, Bartow, and Zoback, 1984). This view has gained widespread interest since 1983 and the Coalinga earthquakes. Postulated tectonic mechanism for Coalinga indicates wedge thrusting is active in the southern Great Valley.

Finally, several centers of persistent seismic activity that occur at unusually great depths for central California (15 to 40 km) exist in locations that would be down dip along the inferred zone of basement underthrusting (subduction), thrusting (wedge theory), or faulting (reverse faulting theory).

The Great Valley magnetic and gravity high terminates northward rather abruptly at about the latitude of the town of Red Bluff, and the matching west side magnetic and gravity low turns sharply east across the valley trend. Griscom (1973) interprets the alinement of the magnetic gradient that terminates the valley highs as representing a basement fault (possibly corresponding with the Red Bluff fault shown on proprietary seismic reflection data (HMT, 1982, 1983). Concepts such as the Sierran-Klamath block of Page (1966), connecting lower Paleozoic oceanic assemblages between the Klamath-Trinity central metamorphic belt and ultramafic sheet and the Sierran equivalents (Shoofly Formation) or the trench-rift-transform triple junction of Blake and Jones (1981) would define the magnetic trend as well. (See discussions of Blake and Jones or Schweickert and Snyder in Ruby Volume, 1981.)

In the Great Valley, from the vicinity of Corning southward, the topography and stratigraphy from the Pliocene nonmarine to the oldest Jurassic marine sediments, show the valley as being in a condition of long-term structural depression. It has been only since the Tuscan-Tehama deposition (3.5 million years ago) that the valley has changed posture. Small compressional features still exist from late-Cenozoic time, such as the doubly-plunging, dome-like folds and the Chico Monocline. However, these features can be traced from active tectonics diminishing between 15.6 (Lovejoy) to 3.2 million years ago (Tehama). Valley-down tectonics (east-west extension?) is displayed on ENE-alined faults on the northern margin, along the west valley margin at Stony Creek, and some small breaks along the Chico Monocline. Structural deformation continued in this mode until 2.3 million years ago. Since that time, only minor tectonics are documented by structures such as the Red Bluff arch or Corning Domes, which are the youngest structural features in the valley, indicating upwarping at 250,000 years ago or later (Harlan Miller Tate, 1983). Some indications of valley margin deformation at Stony Creek between 125,000 to about 30,000 years ago (ESA, 1980) exist also, and tectonic movement is indicated by the 1975 Oroville earthquake along the Cleveland Hill fault. This geology and seismology on the whole seems to indicate north-south compression, east-west extension.

3.2 Contemporary Tectonic Model.

3.2.1 General. No consensus exists on the specific geotectonic forces affecting the Great Valley. Prior sections describe geologic evidence regarding state of stress and plate-tectonic setting. Figure 3-1 is a tectonic model which best fits the observations of this study in the Black Butte area.

3.2.2 Regional Stress Patterns. Earthquake focal mechanism and in-situ stress measurements provide a useful check on geologic observations. Well constrained fault-plane solutions and stress measurements are available in a publication by Zoback and Zoback (1980) for the western United States. Less well constrained data is sparsely available for the Great Valley and northern California in the fragmented references. Table 3-1 below summarizes contemporary stress.

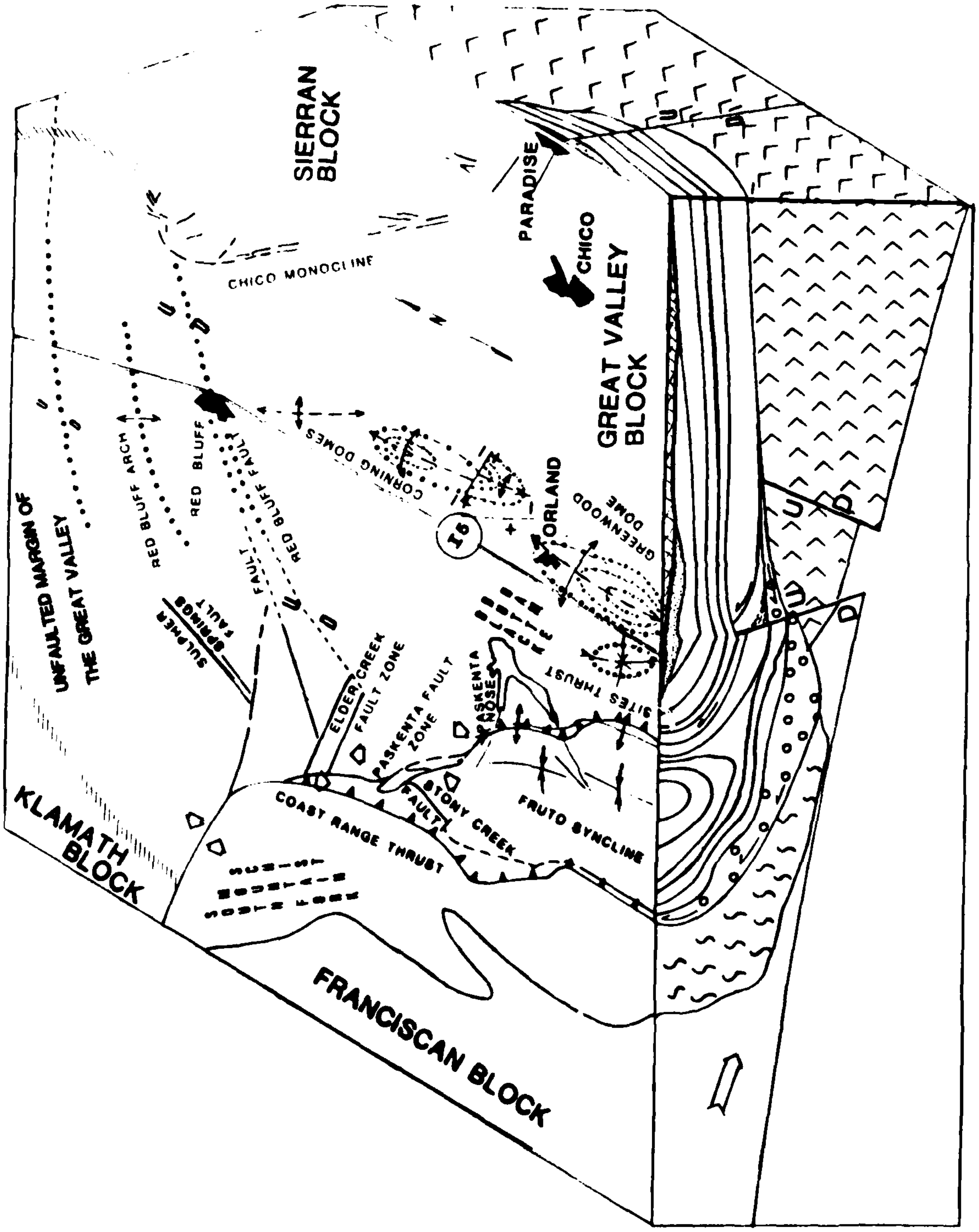
Focal mechanisms of earthquakes associated with both the 1975 Oroville events east of the valley and 1978 Alder Springs events west of the valley show normal displacements along north-northwest oriented faults. Therefore, general stress in the valley is interpreted to be general north-south compression and east-west extension.

TABLE 3-1

SUMMARY OF CONTEMPORARY STRESS

Province	Maximum Stress Axis	Intermediate Stress Axis	Minimum	Data	Source
San Andreas	N/NNE	Vertical	W/WNW	Strong Seismologic	Z&Z* (1980)
Coast Ranges	N/NNE	Vertical	W/WNW	Seismologic	Bolt (1967) ESA (1980)
Sierra Nevada	NNE	Vertical	WNW	Geologic	Z&Z* (1980)
Basin and Range	Vertical	NNE	WNW	Strong Geologic Seismologic	Z&Z* (1980)
Cascade	Vertical	NNE	WNW	Geologic	Harlan
Miller Tate (1982)					
Great Valley	NNE	NNW	Vertical	Weak Seismologic	Lomnitz & Bolt (1967)
Margin	N75E	N15W	Vertical	Geologic	Bolt et al (1968)
Interior	NNE	NNW	Vertical	Geologic Seismologic	ESA (1980)

*Zoback and Zoback



TECTONIC MODEL | FIG. 3-1

SECTION 4. SEISMOLOGY

4.1 Seismologic Setting. The northern Coast Ranges have a history of active faults and earthquakes. The Great Valley and Sierra Nevada is marked by relative quiescence. The distribution of epicenters is shown on plate 4. Macroseismicity (events greater than magnitude 3.5) is presented on figure 4-1. A lack of seismicity near the project is apparent; the nearest event is approximately 21 km distant. Plate 4 shows the distribution of all earthquakes listed in appendix A and the distribution of only those earthquakes which are believed to have occurred at depths greater than 12 km. A very low level of microseismicity is noted near the project.

A catalog of earthquakes for the region bounded by north latitudes 39°00' and 40°45' and by west longitudes 121°15' and 123°30' is presented as appendix A. The catalog, compiled from three sources, has had obvious duplication removed and has been scrutinized for accuracy only for events greater than magnitude 3.5. The following sources were used:

- Corps of Engineers Pacific Northwest Catalog. This is a multisource based catalog for the period 1853 through 1980, north of latitude 37°00'.

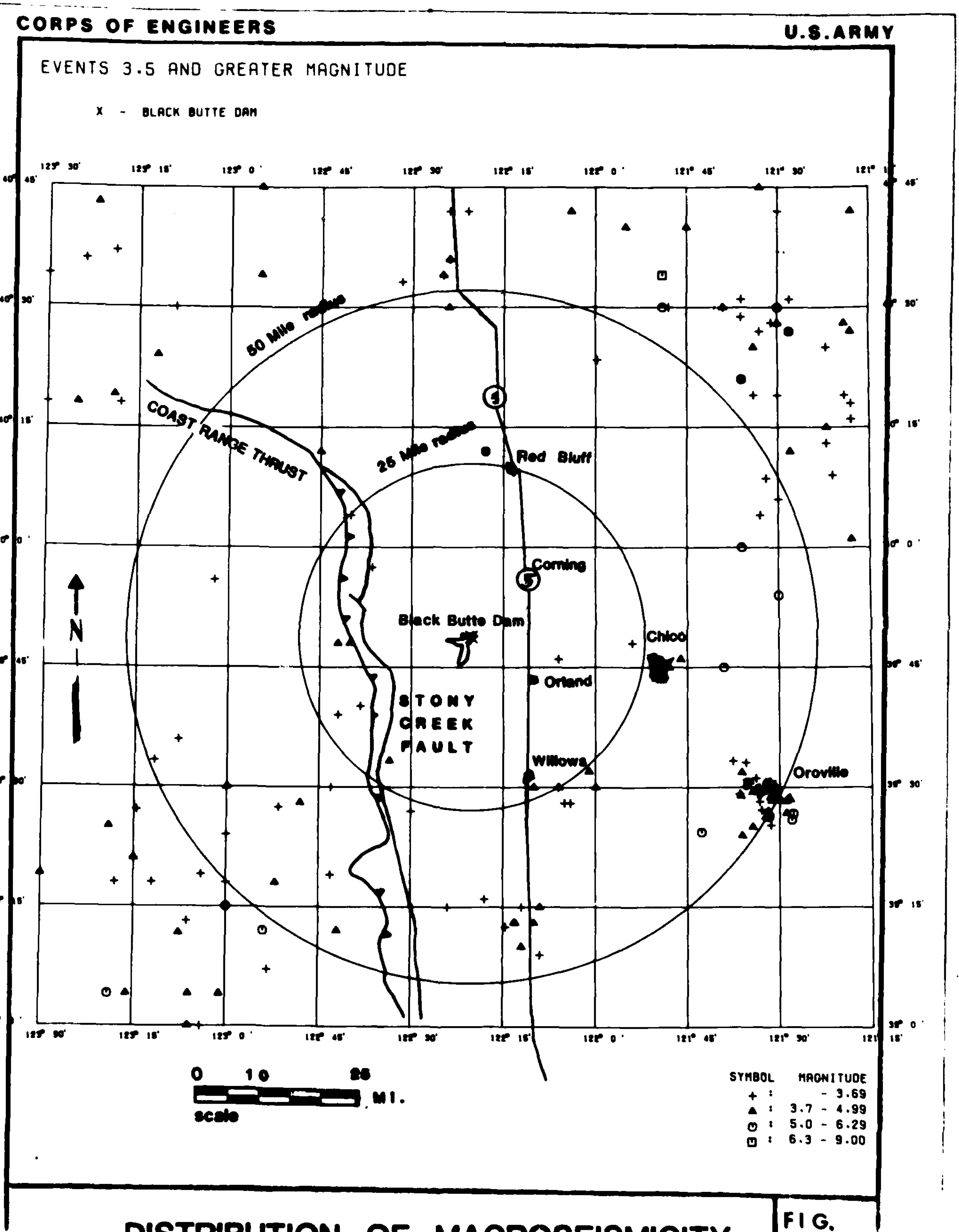
- California Department of Water Resources. This is a catalog of events recorded by that agency since 1975 from an extensive instrument array. This includes an eight-instrument array installed around Glenn County during the period June 1981 through February 1985. Also contained in this catalog are a limited number of relocated (University of California, Berkeley) events covering the period 1903 through 1973.

- National Oceanic and Atmospheric Administration. A catalog of macroseismicity covering the period 1877 through early 1983.

Large events have occurred in the regional history. The largest events to affect the site of the dam are the 1903 Willows event at intensity (MM) VI and the 1906 San Andreas event at felt intensity (MM) V. The accuracy and locations of the reported earthquake effects vary according to the population density in the felt area and the historic period pre-1900, preinstrumental period (1901 to 1949), and instrumental data base. Structural features, as understood, presently mirror patterns of microseismicity and some isolated macroseismic trends. However, close examination of the uncertainty in seismic location and depth, net bias, and lack of tectonic understanding weaken correspondence between seismicity, structure, and location as constituting cause. The one exception is the San Andreas fault.

4.2 Microzonation.

4.2.1 Northern Coast Ranges. Seismic activity in the northeastern part of this province defines two northwest-trending alinements, which correspond generally to the Maacama and Mad River-Lake Mountain fault trends, and a north-northwest-trending alinement that includes the Alder Springs earthquake



DISTRIBUTION OF MACROSEISMICITY

FIG. 4-1

sequence of 1978. A fourth, north-northeast trend, parallels and is nearly coincident with the Coast Range Thrust-Stony Creek Fault boundary.

Both the surface expression of faulting along the Maacama and the Mad River Lake Mountain trends and the few focal mechanisms that have been determined for earthquakes along them are suggestive of right-lateral, strike-slip faulting. Nearly all events along these trends are shallow, with focal depths typically being 6 km or less. The largest earthquakes recorded from this region are the 5.6- and 5.7-magnitude main shocks of the 1969 Santa Rosa earthquake sequence and, probably, the 1898 Mare Island earthquake, estimated to have been of about 6 magnitude (Toppozada and others, 1981). ESA (1982) has previously estimated a maximum credible earthquake (MCE) value of 6-3/4 for the Maacama fault zone. Instrumental earthquake lists show that the adjacent region along the eastern foothills of the Coast Ranges is one of low seismicity but earthquakes occur on a regular basis (Bolt, 1982).

The north-northwest trend of epicenters that is centered at about 39°40'N., 122°45'W., includes the Alder Springs sequence studied by ESA in 1980. This trend, although also involving shallow events, differs from the two described above in not being associated with any extensive fault trend thus far recognized. First motion solutions determined by S.W. Smith for the 1980 ESA (stated in Harlan Miller Tate, 1983) study indicated normal movement along northwest-alined faults for the source mechanism. The largest events recorded from this area are in the 3.5- to 4.0-magnitude range.

West of the region, the northern Coast Ranges are bordered on the west by the San Andreas fault, having recognized capability for generating an earthquake of 8.3 magnitude.

4.2.2 Klamath Mountains. The level of seismicity in the southern Klamath Mountains is generally low. Magnitudes seldom exceed 5.

4.2.3 Northern Sierra Nevada. The seismicity of the interior Sierra Nevada province, occurring mainly in proximity to the northerly part of the Melones Fault and the Magalia-Cohossett Ridge Fault, might be due to instrumental and recent historic bias. A diffuse seismicity probably occurs across the Sierras. Magnitudes of 3.0 to 4.0 (Ml) are scattered through the Sierran foothills. Larger magnitudes (6-1/2) occur to the north; however, they are far from the study area and only as close as the northern Sierran boundary.

4.2.4 Sacramento Valley.

a. Western Margin of the Northern Sacramento Valley. This section is the area near the Coast Range Thrust and the area approximately parallel to the Stony Creek Fault.

Two earthquakes of about 4.5 magnitude have occurred near the Coast Range Thrust-Stony Creek Fault during the past 80 years, and a seemingly well defined alinement of epicenters of small, shallow earthquakes occurs paralleling and lying a few kilometers west of these fault trends. Since the Coast Range

Thrust has a moderate eastward dip and is probably cut off at depth by the younger Stony Creek Fault, it is unlikely that these earthquakes originate on the thrust.

One sequence of shallow earthquakes, ranging up to nearly magnitude 5, was recorded by the USGS at a location somewhat east of the Stony Creek Fault and directly on the trace of the Elder Creek Fault. The Elder Creek Fault has not otherwise been identified as active. Alternatively, the sequence may have been centered on the Stony Creek Fault near its intersection with the zones of fracturing along the Elder Creek and Paskenta Faults. The Paskenta Fault zone appears free of seismicity.

b. Eastern Margin of the Northern Sacramento Valley. Four centers of seismic activity exist between the vicinities of Oroville and Red Bluff, along the eastern margin of the northern Sacramento Valley. The Oroville earthquake sequence began on August 1, 1975, with shocks up to 5.7 magnitude. Since then activity has diminished with decreasing frequency. It is the southernmost such center. Earthquakes of this sequence were accompanied by cracking and a few centimeters of differential movement at the surface along the trace of the Cleveland Hill Fault, a seemingly minor structural feature that had hardly been recognized prior to the earthquakes. Marks and Lindh (1978) showed that the foci of shocks of this sequence defined a plane striking north-northwest and dipping 60 degrees west. The shocks originated at depths ranging from the surface down to about 18 kilometers, and exhibited first motions indicating a west-down normal fault mechanism. Activity in this area now extends over a distance of about 25 km, centered approximately at Lake Oroville (Marks and Lindh, 1978; Lester, et al., 1975).

A second center of seismic activity is located near Chico, a few kilometers south of the southernmost surface expression of the Chico Monocline. Two earthquakes of magnitude 4+ were recorded in this area prior to 1981, and the plot for 1981-1982 shows 10 small shocks there. The latter events occurred at depths between 2 and 25 km and were mostly below 17 km. The distribution of hypocenters is suggestive of a moderately west-dipping fault as a source structure with a zone of activity extending about 20 km along a north-northwesterly strike (Bolt, 1968).

The third zone of seismic activity is defined by a scattering of small earthquakes along the trend of the Chico Monocline. Although there is one shallow-focus shock in this series, most of the events occurred between depths of about 20 and 25 km. The proximity of the epicenters of these events to the surface trace of the Chico Monocline suggests that they originated along the underlying fault in the basement, and further, that the fault is essentially vertical and extends deep into the crust.

A fourth area of seismic activity exists northeast of Red Bluff, and is mostly between the northeast end of the Red Bluff Fault and the Battle Creek Fault. This seismicity is represented by seven small shocks in the 1981-1982 USGS data set and by a 4.3 magnitude event that occurred in 1968. Focal depths range from shallow to more than 20 km.

c. Interior of the Northern Sacramento Valley. Seismicity within the interior of the northern Sacramento Valley is represented by a few scattered small events and by two well-defined, persistent clusters of activity. The epicenter clusters are located near the settlements of Hamilton City and Glenn. The northerly cluster at Hamilton City area is several miles southeast of the south end of the Corning domes as it is defined by the Upper Cretaceous in the subsurface, and the southerly one near Glenn is east of the northern part of the Willows fault. Most of the events in both groups have focal depths between 17 and 35 km, although a few shallow focus events are included with the southerly cluster.

ESA studied the Willows earthquake of 1903 and earthquakes near Glenn during their 1980 study for Glenn Reservoir Complex. For a series of five earthquakes of magnitude 3.0 to 3.9, reported as occurring along a northwest alinement a few miles east of the town of Willows, and two magnitude 4.0 to 4.9 shocks about 10 miles east of Willows, upon resolution and relocation of the events ESA found the northwest trend near Glenn to be unfounded. Although the northwest alinement is not confirmed by ESA relocation of the events, new locations remain very close to the Willows Fault trace as known in the subsurface.

4.2.5 Depth Distribution. A few scattered earthquakes in the region, generally between the northwest margin of the Sacramento Valley and Cape Mendocino, have focal depths in the range of 40 to 50 km. These events may be associated with the southerly part of the underthrust Gorda plate. North of Cape Mendocino and beneath the Eel River basin, a well defined, gently east-dipping zone of seismic activity that exists between depths of about 18 and 30 km is interpreted as occurring along conjugate sets of steeply inclined fractures within this lithospheric plate (Smith, 1978). The scattered deep events located farther east and southeast of this region may result from isolated failures within the same plate at a greater depth beneath the overriding North American plate. The shallow events occurring at depth of 17 to 35 km in the interior valley are very often discussed in conjunction with down-dip expressions of suspected faults (referred to in prior paragraphs). As a whole, this study concludes that the seismic reflection data in the interior valley does not support the existence of east-dipping, reverse high angle faults in the basement nor do they favor reverse faults ramping from deepest basement structures. Scattered seismicity of the interior valley remains unexplained.

4.3 Recurrence Intervals. The recurrence level of different magnitudes in a given time span and area is useful to engineering design. The design project life is about 100 years. Bolt (1982) feels, and we concur, that it is an academic exercise of little value to attempt an assessment of earthquake frequency distribution for the 100-year historic record in Glenn County. Nonetheless an estimate can be made based on the historic record for northern California. One or more San Andreas events should be experienced per 100 years as a source outside the project area. Similarly, based on observations in areas of known faulting away from the San Andreas, "earthquakes with M_L = 5-1/2 are perhaps the largest probable in 50- to 100-year periods for northern California." (Bolt, 1982)

If the Willows earthquake of 1903 is representative of such a magnitude and recurrence, then magnitude 5.5 is appropriate for the project life taken at any seismogenic source near the project. So the maximum probable earthquake for the Willows or Stony Creek Faults would be $M_L = 5\text{-}1/2$ or for the Oroville margin about $M_L = 5\text{-}3/4$ (small incremental addition due to increased activity in the foothills).

SECTION 5. SELECTION OF THE SOURCE AREAS

5.1 Earthquake Potential. Prior to this study, the Sacramento District was provided a report on earthquake potential (Bolt, 1982). The earthquake sources of the region are essentially unchanged from those reported by Bolt (1982) except in minor detail. With exception of that detail, the following summarizes Bolt's report. The San Andreas 1906 event and the Willows 1903 event are the two chief historic earthquakes to affect the site. All faults near the Black Butte study area are pre-Quaternary in age. Various independently authored studies of various exposures along the Coast Range Thrust disclose no evidence of recent tectonic activity since Pliocene time. Bolt (1982) left open the question of activity on faults near the dam for a conservative approach. This study closes that question by showing that the Black Butte Fault and the continuity of the reported Willows Fault system does not exist.

The uncertainties regarding unmapped, north-trending faults branching from the Willows Fault south of the study area have now been sufficiently investigated to clarify and resolve the question. Three major studies, California Water Resources (1982), Harlan Miller Tate (1983, 1984b) and the present study conclude that there is insufficient evidence to support the concept of Harwood and Helley in Open File Report 82-737 proposing the Willows Fault system. The Willows Fault and faulted anticlines do exist in the interior valley; however, they are not connected. The question of age of deformation exists. Mid-Tehama deformation is demonstrable in seismic reflection data (2 million years ago) on the midvalley anticlines, yet the nature and extent of the 0.5-million-year-old deformed Red Bluff material on the Corning dome is questionable. Using Marks and Lindh (1980) or any other plot of earthquakes to associate micro or macroseismicity with these structures would be trifling if not misleading.

In light of the most probable structural connection to the Sites anticline, the Paskenta Fault zone and Paskenta nose are striking structural features. The Paskenta nose can be followed 10 miles from where it emerges from the Sites detachment to Tehama Formation cover. On trend, the Paskenta Fault zone can be followed 10 miles on the ground until it merges into the Stony Creek Fault. The Paskenta Fault is capped in many places by pre-Pliocene sediments, pre-Miocene pyroclastics and the Tehama Formation. Some clustering of microseismicity exists near Paskenta, but Bolt (1982) concludes the evidence is not sufficient to indicate capability. The Paskenta nose and the Sites anticline/fault do not disturb the Tehama Formation or the extensive Quaternary terrace system across it.

For the Stony Creek Fault, ESA (1980) concluded that the lack of Holocene displacement makes that fault an unlikely source of significant earthquakes. Nonetheless, the last major reactivation at 200,000 to 300,000 years ago and a minor episode 30,000 years ago is documented with minor offset in terrace strata. Although unlikely, it is considered a close, capable structure.

Finally, as Bolt states, "two faults to the west of the Coast Range Thrust must be considered since there is no question that either could be the focus of major earthquakes." The first is the Maacama fault located about 95 km to the west of Black Butte Dam. This fault has been identified recently by Bolt as a major strike-slip feature with a length of approximately 120 km. Field study of displacements along the Maacama Fault has established its activity in Holocene time and studies of regional strain and seismicity suggest that a significant earthquake might occur on this fault in the lifetime of a modern engineering project nearby. Further to the west, the San Andreas fault is encountered at a distance of 140 km from Black Butte Dam. Bolt feels it is necessary therefore to consider the possibility of a repetition of the 1906 earthquake on the San Andreas fault so far as shaking at Black Butte Dam is concerned.

Bolt's report, circa 1982, if written in 1985, possibly would be different. One new development that might be addressed is the impact of the Coalinga 1983 and Kettleman Hills 1985 events on how geotectonics are viewed in the Great Valley. The presence of a magnitude 6.7 (Coalinga) event some 35 km away from the San Andreas has caused some to rethink GV tectonics. Appendix D contains in greater detail the position this study has adopted regarding the impact of the Coalinga and Kettleman Hills events on valley edge tectonics. The following summarizes appendix D. Although tectonic wedges might reasonably exist in some fashion along northern California valley edge areas, as they seem to do in southern California near Coalinga, they are not presently proved to exist nor is there reason to believe that crustal strain existing at Coalinga exists at Black Butte. On the whole, the major structures present at Coalinga and Kettleman Hills that complement the mechanism for the earthquakes are as follows:

a. Fold belts in proximity to the San Andreas fault.

b. Folds that have orientation sympathetic to shear transfer from the SA.

c. Folds that show en echelon segmentation and have regional extent.

d. Deformation related to folds on young geomorphic surfaces.

e. Subsurface northeastward-directed thrust that invades eastward-directed wedges and end in roof structure such as folds.

f. Reverse faults emanating from basement that are associated with growing folds and localize position of overthrust plate.

g. Seismogenic activity in the fold area.

The table below compares this list of what is found at Coalinga with what is present at Black Butte (see appendix D for detail).

TABLE 5-1

FOLD BELT COMPARISON

Structure/Mechanics	Coalinga Area	Black Butte Area
Fold belt proximity to San Andreas	35 km	140 km
Fold orientation compared to San Andreas (N40^{o}W)	N60^{o}W	North-South
En echelon folds? – regional extent	Yes 100 km	Possibly yes 60 km
Youngest surface deformed related to folds	2,000 y.b.p.	500,000 y.b.p.
Eastward directed thrust invading eastward directed wedges	Present	Absent
Reverse faults associated with folds and emanating from basement	Present	Questionable
Seismogenic activity	Present	Absent

In Coalinga there are 2,000-year-old stream terraces undergoing deformation. At Black Butte, major stream terrace systems extending throughout the 40-km study radius (centered on the dam) were examined in detail and found to show no tectonic deformation for the last 200,000 years. The only deformation found is at least 500,000 years old and lies 20 or more km away from the dam. Very strong confidence can be had in the resolution of the three-dimensional subsurface within a 10-km radius of the dam. No capable structure was found within this zone. Nonetheless, two seismogenic sources, one at Stony Creek Fault and one at Corning Dome, will be considered, and these sources can be visualized as related to wedge tectonics if desired.

Bolt (1982) feels there should be mention of possible earthquakes generated because of crustal loading by water impounded in the reservoir. However, he concludes "the amount of elastic energy added to the system by the reservoir loading is insignificant for earthquakes of engineering consequence." Experience with crustal loading from small lakes (such as Black Butte) vindicate this stand.

Finally, there has been no evidence whatsoever of induced earthquakes associated with Black Butte reservoir during its life since 1963. Especially significant is the fact that the California DWR monitoring for the past 4 years (1978 through 1982) has shown no microearthquakes in the reservoir area. By comparison with various case histories, a dam height of 140 feet is grouped with dams of low significance for induced seismicity.

5.2 <u>Effective Seismic Sources</u>. Table 5-2 below is the result of the study identifying major faults and structure that could possibly be seismogenic.

TABLE 5-2

SEISMIC SOURCES FOR BLACK BUTTE DAM

Name	Distance to Dam	Structural Mechanism	Length	Activity During Project Life?	Recurrence of Faulting
Stony Creek fault	27 km	Dip-slip	100 km	No	30,000 years ago
Willows fault	25 km	Dip-slip	60 km	Yes	Assume Holocene
Maacama fault	95 km	Strike-slip	120 km	Yes	Holocene
San Andreas fault	140 km	Strike-slip	1000 km	Yes	Holocene
Great Valley anticlines	20 km	Thrust	60 km	No	500,000 years ago
Cleveland Hill fault	63 km	Normal-slip	3 km	Yes	Holocene

5.3 Tectonic Blocks. Based on the tectonic model developed in prior sections and figures, we assign the magnitude of events to zones described in table 5-3 below.

TABLE 5-3

MAGNITUDES BY ZONES

Block	Distance to Dam	Magnitude
Sierra Nevada	40 km	6.0
Eastern Coast Ranges	20 km	6.0
Western Coast Ranges	140 km	8.3
Northern Sacramento Valley	20 km	5.5

5.4 Earthquake Source Area. For purposes of design, we follow the technique that the event and source must be localized on a candidate structure. For the western Coast Ranges the overwhelming choice is the San Andreas Fault. For the northern Sacramento Valley and Black Butte Dam, the matter becomes more obscure. The magnitude of the event can be empirically linked to the length of rupture along a candidate fault or the area of fault plane and stress drop. Empirical approaches such as Slemmons' (1977) curves and/or Randall (1973), Kanamori, et al. (1975), and Gibowicz (1973) are useful for estimation. Another obscurity is the matter of tectonic folds existing without a clear, causative fault. Here our magnitude is based on tabulation of limited data and our recent experience. Our premise is that the size of the fold, as indicated by dimensions, wave length, and maximum closure can be useful in identifying magnitude potential. We believe, in this case, that magnitude potential as indicated by strain/stress accumulation is proportional to elastic energy stored in the deforming plane fold body underlying.

Table 5-4 below, while not exhaustive, serves to suggest credible limits in competent, layered, folded rock by comparing the Corning-Greenwood area with the two other known areas of folded structure that have earthquake history.

Two magnitudes are listed under "Mechanism" on table 5-4. For reverse faulting secondary to folding (2), the maximum stress plane down-dip width is probably no greater than the width of the fold (or wave length). Small surface areas result for the plane of stress accumulation and, if it is seismogenic, only moderate magnitudes are possible. If folding is secondary to faulting (1), then deeper reverse fault planes are involved. The down-dip fault length may vary from 7 km (the immediate basement level) to 14 km (the depth of focus for some deeper interior valley events). Fault length in both cases will be limited to the surface length of fold segments (along axis of complete closure). The deepest events in the interior valley are very few and are most probably related to plate tectonics. In summary, a magnitude 6.3 is the maximum conservative, credible event possible on the Greenwood or Corning anticlines. This is based on the upper uncertainty added to the calculated value for mechanism (1) of table 5-4.

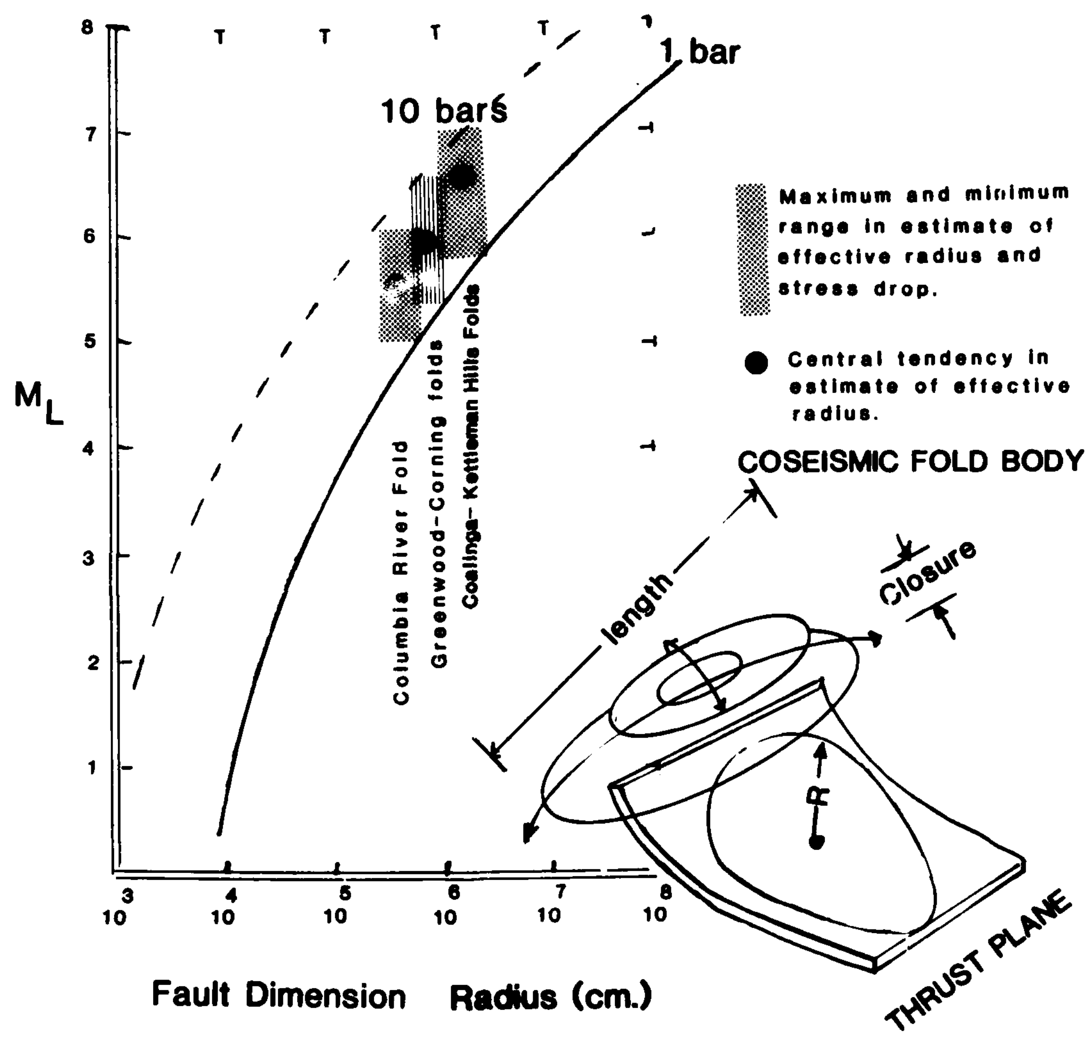
TABLE 5-4

EARTHQUAKE POTENTIAL FROM FOLDS

	Historic Maximum	Segmented Length	Length of Closure	(1) Mechanism*	(2)
Columbia River Basalts-Umtanum/ Gable Mtn	5.3	20 km	850 m	M_L = 5.5 ($\pm$.5)	M_L = 5.1 ($\pm$.6)
Kettleman Hills/ Coalinga Anticline	6.7	35 km	1980 m	M_L = 6.7 ($\pm$.3)	M_L = 5.4 ($\pm$.4)
Corning-Greenwood Dome	None	21 km	300 m	M_L = 5.8 ($\pm$.5)	M_L = 5.4 ($\pm$.6)

*Mechanism is either (1) primary reverse faulting with secondary folding or (2) primary folding with secondary reverse faulting. M_L is obtained by Randall's relationship for 1-10 bar stress drop on a plane area representing the zone of accumulation of stress underlying the folding strata. Randall's (1973) relationship converts effective radius of the stressed plate to M_L at a given stress drop of 10 bars. Figure 5-1 shows this relationship.

After Randall, 1973, BSSA vol. 63, pp. 1133-1144



Stressed plane VS. local magnitude.

RANDALL'S RELATIONSHIP	FIG. 5-1

SECTION 6. MAXIMUM EARTHQUAKE

Finally we are in a position to recommend the selection of a maximum earthquake and a source for it. Table 6-1 below shows the candidate structures and gives estimates of their maximum magnitude and distance to the dam from the source.

TABLE 6-1

MAXIMUM EARTHQUAKE MAGNITUDES
FOR BLACK BUTTE DAM

Structure	Distance Source Site	Maximum Earthquake (ML)	Province	Source of Estimate
Stony Creek Fault 1/	27 km	6.5	Border Coast Ranges/ Interior Valley	Bolt, 1982
Willows Fault	25 km	6.25	Interior Valley	Bolt, 1982
Great Valley Anticlines	20 km	6.3	Interior Valley	This report
Maacama Fault	95 km	7.0	Coast Ranges	Bolt, 1982
San Andreas Fault	140 km	8.3	San Andreas	Bolt, 1982
Cleveland Hill Fault	63 km	6.5	Sierra Nevada	USBR Auburn Dam Studies

1/As shown on the table, Stony Creek Fault poses the most significant hazard to the dam.

The data presented in table 6-1 results from a very conservative approach during the preceding steps. For example, the offset morphostratigraphic surface at Stony Creek Fault has questionable elements, and has 30,000 to 35,000 years age. It is at the limit of guidance governing capability (ETL 1110-2-301 dated 26 August 1983). The distance of the active fault segment from the dam is 27 to 30 km, a distance that is at the border of the near/far field limits for strong ground motion. Other sources are similar in situation. Source to site distance and hypocentral depth of 14 km leads to assigning the maximum event to far field conditions. The recommended MM intensity is VIII for such a maximum event. Using an approach such as referenced in Krinitzsky and Marcuson (1983) gives site acceleration at or below 0.35g as appropriate.

SECTION 7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions. Through the Dam Safety Assurance Program, Black Butte Dam was subjected to dynamic analysis studies in a prior investigation. This analysis indicates distress would result in the upstream shell of the embankment. For the dynamic analysis, seismic loading was obtained by contracting the focus of geological and seimological analysis from regional view to near-site view and existing conditions. By applying a conservative approach to resulting open questions regarding activity on nearby inferred faults, an estimate of design acceleration was obtained.

This study answers many, if not all, the open questions left by a prior study by focusing on inferred nearby faults and establishing their existence, non-existence, and capability. The present study consists of extensive fieldwork and analysis of surface geology, subsurface geology, and geophysical subsurface data. Our evaluation of all data involved has subsequently led to the conclusion that the Black Butte Fault and Willows Fault system as proposed do not exist within 10 miles around the dam. With the near-field elimination of the Black Butte Fault and Willows Fault system as being a concern, other sources were investigated. The tectonic capability of doubly plunging anticlinal folds in the subsurface near the midvalley axis was assessed. There is no visual evidence that these folds are the result of tectonic wedging and thrust faulting at depth. No subsurface evidence of faulting was found to account for a drag folding origin of the anticlines and they have no seismogenic history. Based on minor offsets along a few young Holocene terraces on a Stony Creek Fault segment near Thomes Creek, 27 km from the dam, the maximum (credible) event was chosen as a magnitude 6.5 event. The source is on the youngest segment of the fault as this is judged to be the only capable segment.

Because of the few number of earthquakes experienced and the limited historic earthquake record in Glenn and Tehama Counties, calculating the exceedance chance for the maximum event during the project life span becomes an academic exercise as does existing earthquake recurrence intervals. Instead, historic experience in northern California, as a whole, indicates a local magnitude of 5-3/4 as the maximum event in areas away from the San Andreas Fault zone during any 100-year period.

Based on present results, we find that prior estimates of seismic loading derived by establishing the maximum event on close-in faults like the inferred Black Butte Fault have been overly conservative. A reduction in design acceleration level is justified as no viable seismic source is closer than 27 km to Black Butte Dam.

7.2 Recommendations. The following recommendations are made as a result of this study:

a. The previously inferred Black Butte Fault does not exist, and should be deleted from geologic maps and given no further consideration.

b. The MCE for seismic safety analysis of Black Butte Dam is a magnitude 6.5 crustal event on the Stony Creek Fault with a source distance of 27 km.

c. The inferred Willows Fault system of Harwood and Helley (1982) need not be considered in evaluating seismic sources in the northern Sacramento Valley.

d. A local magnitude of 5-3/4 as the maximum event, based on historic experience, is recommended to be a substitute for a statistical event and to serve as the 100-year probable earthquake. The source for this event is either near the Coast Ranges-Great Valley contact or east of the Willows Fault that lies southeast of the dam.

[redacted]

GLOSSARY

- Soil stratigraphy is used as a technique to define stratigraphic markers in Quaternary deposits and land forms.

- Geosoil is a weathering profile that formed at or immediately beneath and essentially parallel with the land surface. It has physical characteristics, and stratigraphic relationships that permit its consistent recognition and mapping and whose stratigraphic interval or relationship to immediately older and younger deposits is known quite definitely (Morrison, 1967).

- Morphostratigraphic unit is a distinct stratigraphic unit as a body that is identified primarily from the surface form it displays; it may or may not have distinct lithologic character, and it may or may not be time transgressive in extent.

- Soil stratigraphy is used as stated in Begg (1968) for Glenn County and in Gowan (1967) for Tehama County. Alluvial soils (Xerothents and Xerofluvents) are used as young stratigraphic markers. (They have undeveloped to slightly developed soil profile.) Zonal soils (Haploxeralfs, Durixeralfs, and Palexeralfs) are used as local geosoils and are correlated to stage chronology division (relative time) of the Quaternary by Shlemon (1980), and others in the western Sacramento Valley.

- Transpression is crustal deformation as an intermediate stage between compression and strike-slip motion. It occurs in zones with oblique compression and wrench faulting.

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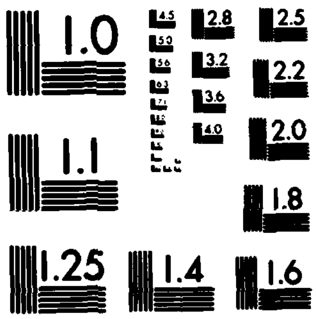

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3048 EARTHQUAKES

AREA OF CONCERN: 39.000 TO 40.750 NORTH LATITUDE
121.250 TO 123.500 WEST LONGITUDE

MINIMUM RICHTER MAGNITUDE= -1.0
HYPOCENTER DEPTH LIMITS= 0 TO 999 KM

LOCATION OF BLACK BUTTE DAM
39.813 NORTH LATITUDE, 122.336 WEST LONGITUDE

EXPLANATION OF EARTHQUAKE CATALOG HEADINGS:

EQ #	UNIQUE EARTHQUAKE NUMBER ASSIGNED TO EACH EARTHQUAKE IN THE U.S. ARMY CORP OF ENGINEERS MASTER EARTHQUAKE FILE.
DATE YEAR MO-DY	DATE IS IN GREENWICH MEAN TIME UNLESS OTHERWISE NOTED IN THE COMMENT COLUMN.
TIME HRMN;SECS	TIME IS GREENWICH MEAN TIME UNLESS OTHERWISE NOTED IN THE COMMENT COLUMN.
LAT.	LATITUDE IN DECIMAL DEGREES NORTH OF THE EQUATOR.
LON.	LONGITUDE IN DECIMAL DEGREES WEST OF THE PRIME MERIDIAN.
DIST	DISTANCE FROM EPICENTER TO SITE IN MILES (MI) AND KILOMETERS (KM)
DPTH	HYPOCENTER DEPTH IN KILOMETERS. A "*" AFTER THE DEPTH INDICATES THAT IT WAS DETERMINED BY THE USER RATHER THAN OBSERVED.
MMI	MAXIMUM MODIFIED MERCALLI INTENSITY.
CRM	CALCULATED RICHTER MAGNITUDE. MAGNITUDE OF EVENT AS: 1. OBSERVED, 2. CALCULATED FROM INTENSITY (USUALLY CRM=2/3(MMI)+1), OR 3. GENERATED BY THE USER (USING A PROJABILITY TECHNIQUE). (SEE "CD" BELOW)
CD	MAGNITUDE DETERMINATION CODE. (SEE "CRM"ABOVE) 1. BLANK IMPLIES MAGNITUDE WAS OBSERVED, 2. "I" IMPLIES MAGNITUDE WAS CALCULATED FROM INTENSITY, 3. "G" IMPLIES MAGNITUDE WAS GENERATED BY THE USER.
REF	SEISMIC DATA REFERENCE (SEE DOCUMENTATION FOR U.S. ARMY CORPS OF ENGINEERS MASTER EARTHQUAKE FILE).

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1877 11-24	1430: 0.0	40.200	122.300	27	43	0		0.00		NOAA	
1877 11-24	1450: 0.0	40.200	122.300	27	43	0		0.00		NOAA	
1878 12- 9	2320: 0.0	40.200	122.300	27	43	0	IV	3.67	I	NOAA	
1879 5-27	440: 0.0	39.400	122.000	34	54	0		0.00		NOAA	
1881 1- 2	255: 0.0	40.200	122.300	27	43	0		0.00		NOAA	
1881 1- 7	225: 0.0	40.200	122.300	27	43	0		0.00		NOAA	
1884 6- 6	900: 0.0	40.200	122.300	27	43	0	VI	5.00	I	NOAA	
1885 7-17	615: 0.0	39.800	121.800	29	46	0	III	3.00	I	NOAA	
1892 4-21	1610: 0.0	40.200	122.300	27	43	0		0.00		NOAA	
1899 12-12	0: 0.0	39.800	121.800	29	46	0		0.00		NOAA	
1899 12-13	0: 0.0	39.800	121.800	29	46	0		0.00		NOAA	
1899 12-19	0: 0.0	39.800	121.800	29	46	0		0.00		NOAA	
1899 12-20	0: 0.0	39.800	121.800	29	46	0		0.00		NOAA	
1901 11-14	300: 0.0	39.800	121.800	29	46	0	II	2.33	I	NOAA	
1903 7-24	2026: 0.0	39.500	122.000	28	45	0	VII	4.50		CDMG	WILLOWS AREA, GLEN
1904 4-16	920: 0.0	40.500	122.400	47	76	0	VI	4.50		CDMG	REDDING AREA
1904 10-29	0: 0.0	39.500	121.500	50	80	0		0.00		NOAA	
1906 5- 7	410: 0.0	39.200	122.900	52	84	0	VII	5.67	I	CDMG	UPPER LAKE AND UKI
1906 5- 8	30: 0.0	39.200	122.700	47	75	0		0.00		NOAA	
1906 6-16	552: 0.0	39.900	122.300	6	10	0	I	1.67	I	NOAA	
1906 7-24	700: 0.0	39.500	122.500	23	37	0		0.00		NOAA	
1909 1- 7	1240: 0.0	39.500	122.200	23	37	0		0.00		NOAA	
1909 11-23	715: 0.0	39.500	122.200	23	37	0		0.00		NOAA	
1910 3-19	130: 0.0	39.167	122.917	54	87	0		0.00		BRK	
1910 10-15	2044: 0.0	39.167	122.917	54	87	0		0.00		BRK	
1913 3- 8	1200: 0.0	40.200	121.900	35	57	0		0.00		NOAA	
1913 8-20	1530: 0.0	39.317	123.250	60	96	0		0.00		BRK	
1914 5-31	0: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1914 10-23	1430: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1914 11- 7	325: 0.0	39.920	122.080	16	25	0	III	3.00	I	NOAA	BERK COORD.
1915 1-23	1640: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1915 1-23	1700: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1915 2-22	0: 0.0	40.567	121.817	59	95	0	VIII	6.33	I	CDMG	TWIN VALLEY, SHAST
1915 5-22	0: 0.0	40.750	121.500	78	126	0		0.00		BRK	
1915 7-15	1800: 0.0	40.417	121.567	58	94	0		0.00		BRK	
1915 7-22	0: 0.0	40.417	121.567	58	94	0		0.00		BRK	
1915 7-22	1100: 0.0	40.317	121.567	53	86	0		0.00		BRK	
1915 8- 5	1630: 0.0	40.417	121.567	58	94	0	V	4.33	I	CDMG	DRAKESBAD
1915 8- 6	1840: 0.0	40.317	121.567	53	86	0		0.00		BRK	
1915 10-30	0: 0.0	40.750	121.500	78	126	0		0.00		BRK	
1916 8- 2	44: 0.0	39.750	123.250	49	79	0		0.00		BRK	
1918 10-12	1230: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1919 1- 4	2300: 0.0	40.567	121.817	59	95	0	VIII	6.33	I	CDMG	SHASTA COUNTY, POS
1919 5- 2	830: 0.0	40.567	122.917	60	97	0	V	4.33	I	CDMG	SHASTA COUNTY
1919 5- 2	838: 0.0	40.567	122.917	60	97	0		0.00		BRK	
1920 6- 3	555: 0.0	40.567	122.917	60	97	0		0.00		BRK	
1920 6-10	1053: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1920 7-23	355: 0.0	40.500	121.817	55	88	0	VII	5.67	I	CDMG	SHASTA COUNTY
1920 7-23	1400: 0.0	40.500	121.817	55	88	0		0.00		BRK	
1920 7-23	1600: 0.0	40.500	121.817	55	88	0		0.00		BRK	
1920 7-23	2000: 0.0	40.500	121.817	55	88	0		0.00		BRK	
1920 9-17	620: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1920 12-29	959: 0.0	39.500	122.167	24	38	0	V	4.33	I	CDMG	GLENN COUNTY
1921 1-13	1030: 0.0	39.500	122.167	24	38	0	V	4.33	I	CDMG	WILLOWS

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1921 12- 4	1657: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1922 12- 4	1657: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1923 10-24	1430: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1923 10-27	1847: 0.0	39.000	122.917	64	103	0		0.00		BRK	
1925 12-18	905: 0.0	40.567	122.917	60	97	0		0.00		BRK	
1926 10-13	1940: 0.0	40.750	122.917	71	115	0		0.00		BRK	
1927 3- 1	1500: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1927 3- 1	2226: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1928 4-15	2157:15.0	39.800	122.667	17	28	0	VIII	4.50		CDMG	GLENN COUNTY
1928 4-16	800: 0.0	40.500	121.500	65	104	0		0.00		BRK	
1928 6- 4	530: 0.0	40.750	122.917	71	115	0	VII	4.50		CDMG	WEAVERVILLE AREA
1929 6-14	2300: 0.0	40.417	122.817	49	79	0		0.00		BRK	
1929 11- 4	1750: 0.0	39.417	123.317	59	95	0		0.00		BRK	
1929 12- 5	645: 0.0	39.417	123.317	59	95	0		0.00		BRK	
1930 1-19	543: 0.0	39.917	121.317	55	88	0		0.00		BRK	
1930 3-10	600: 0.0	40.300	122.300	34	54	0		0.00		NOAA	
1930 4-20	0: 0.0	40.667	121.917	63	101	0		0.00		BRK	
1930 4-29	2013: 0.0	40.567	122.917	60	97	0		4.00		CDMG	REDDING AREA
1930 10-29	1030: 0.0	40.567	122.417	52	84	0		0.00		BRK	
1930 10-29	1130: 0.0	40.567	122.417	52	84	0		0.00		BRK	
1930 10-29	1237: 0.0	40.667	121.917	63	101	0	VI	4.50		CDMG	WHITEMORE AREA
1930 10-29	1928: 0.0	40.500	122.067	50	80	0		0.00		BRK	
1930 10-29	1950: 0.0	40.567	122.417	52	84	0	V	4.00		CDMG	REDDING AREA
1930 10-30	429: 0.0	40.317	121.567	53	86	0		0.00		BRK	
1930 11- 1	0: 0.0	40.567	122.417	52	84	0		0.00		BRK	
1930 11-11	855: 0.0	40.317	123.317	63	101	0	V	4.33	I	CDMG	FOREST GLEN
1930 11-17	1743: 0.0	40.317	123.317	63	101	0		0.00		BRK	
1930 12- 8	2200: 0.0	39.317	123.250	60	96	0		0.00		BRK	
1930 12-12	1000: 0.0	39.317	123.250	60	96	0		0.00		BRK	
1930 12-12	2200: 0.0	39.317	123.250	60	96	0		0.00		BRK	
1930 12-30	1337: 0.0	40.567	122.417	52	84	0		0.00		BRK	
1931 1-20	1030: 0.0	39.417	123.317	59	95	0	V	4.00		CDMG	WILLITS AREA
1931 1-24	721: 0.0	39.750	121.800	29	46	0	IV	4.00		CDMG	ORLAND AREA
1931 9-10	1330: 0.0	39.750	121.817	28	45	0		0.00		BRK	
1931 10- 9	1330: 0.0	40.317	123.417	67	108	0		0.00		BRK	
1931 11-11	1105: 0.0	39.417	123.317	59	95	0		0.00		BRK	
1931 11-22	1052: 0.0	39.250	123.250	62	100	0		0.00		BRK	
1931 11-22	1130: 0.0	39.167	122.917	54	87	0		0.00		BRK	
1932 1-14	1410: 0.0	39.317	123.067	52	84	0	IV	3.67	I	CDMG	
1932 6-21	900: 0.0	39.500	122.000	28	45	0		0.00		NOAA	
1932 7-11	1300: 0.0	40.500	123.150	64	103	0	IV	3.67	I	CDMG	
1932 7-22	114: 0.0	39.317	123.250	60	96	0		0.00		CDMG	
1932 10-31	1500: 0.0	39.000	123.067	68	110	0	IV	3.67	I	CDMG	
1933 3-27	1046: 0.0	40.567	122.417	52	84	0	IV	3.67	I	CDMG	
1933 6-12	1500: 0.0	40.317	121.567	53	86	0	IV	3.67	I	CDMG	
1933 7- 4	0: 0.0	40.500	121.500	65	104	0		0.00		CDMG	
1934 6- 5	2215: 0.0	40.500	122.000	50	81	0	IV	3.67	I	CDMG	
1935 6-21	1717: 0.0	40.500	121.500	65	104	0		0.00		CDMG	
1935 6-21	1740: 0.0	40.500	121.500	65	104	0		0.00		CDMG	
1936 5- 9	744: 0.0	40.500	121.550	63	102	0		0.00		CDMG	
1936 5- 9	812: 0.0	40.500	121.550	63	102	0		0.00		CDMG	
1936 5- 9	940: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1936 5- 9	1104: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1936 5- 9	1230: 0.0	40.350	121.600	54	87	0		0.00		CDMG	

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1936 5- 9	1841: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1936 5- 9	2021: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 5-10	218: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 5-14	1115: 0.0	40.500	121.650	60	96	0		0.00		CDMG	
1936 5-15	704: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 5-27	718: 0.0	40.350	121.600	54	87	0	IV	3.67	I	CDMG	
1936 6- 2	1430: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 6-14	2226: 0.0	40.500	121.550	63	102	0		0.00		CDMG	
1936 6-29	1245: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 6-29	1505: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 6-29	1952: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 6-30	630: 0.0	40.350	121.600	54	87	0	V	4.33	I	CDMG	
1936 6-30	1027: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 6-30	1247: 0.0	40.500	121.650	60	96	0	IV	3.67	I	CDMG	
1936 6-30	2036: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 6-30	2350: 0.0	40.500	121.650	60	96	0	IV	3.67	I	CDMG	
1936 7- 1	1150: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7- 1	1243: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7- 1	1550: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1936 7- 2	720: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7- 2	1738: 0.0	40.350	121.600	54	87	0	VI	5.00	I	CDMG	
1936 7- 6	1016: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7- 6	1111: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7- 6	1541: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7- 6	1735: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 7-13	1043: 0.0	40.450	121.300	70	113	0	V	4.33	I	CDMG	
1936 9-23	1714: 0.0	40.500	121.650	60	96	0		0.00		CDMG	
1936 12-25	1605: 0.0	40.500	121.500	65	104	0	V	4.33	I	CDMG	
1938 1-11	25: 0.0	39.000	123.100	70	112	0	V	4.33	I	CDMG	
1938 1-11	1804: 0.0	39.000	123.100	70	112	0		0.00		CDMG	
1938 9- 2	2039: 0.0	39.250	123.000	53	85	0		0.00		CDMG	
1938 11-15	1348: 0.0	39.250	123.000	53	85	0	VI	5.00	I	CDMG	
1938 11-15	1348:42.0	39.100	123.000	61	98	0		0.00		CGS	
1939 6-23	1728: 0.0	40.500	121.500	65	104	0	V	4.33	I	CDMG	
1939 8-25	407: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1939 11-19	1237: 0.0	40.000	121.500	46	74	0		0.00		CDMG	
1940 2- 8	805:59.0	40.000	121.600	41	66	0	VII	5.70		CDMG	
1941 7- 6	847: 0.0	39.317	123.250	60	96	0		0.00		CDMG	
1941 10-25	708: 0.0	39.500	122.167	24	38	0		0.00		CDMG	
1942 3- 6	1100: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1942 7- 9	1223: 0.0	39.150	122.150	47	75	0		0.00		CDMG	
1942 7-13	512: 0.0	39.150	122.150	47	75	0		0.00		CDMG	
1942 7-14	1642: 0.0	39.150	122.100	47	76	0		0.00		CDMG	
1942 8-11	530: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1942 9-28	837: 0.0	39.150	122.150	47	75	0	IV	3.67	I	CDMG	
1942 9-29	829: 0.0	39.250	122.150	40	65	0	V	4.33	I	CDMG	
1942 11-18	2020: 0.0	39.900	121.500	45	72	0	VI	5.00	I	CDMG	
1942 11-18	2035: 0.0	39.900	121.500	45	72	0	VI	5.00	I	CDMG	
1943 10-14	550:15.0	39.250	122.400	39	63	0*		3.60		BERK	
1943 10-14	2226:25.0	39.267	122.300	38	61	0	V	3.70		CDMG	
1943 10-26	1158:57.0	39.200	122.700	47	75	0	IV	3.80		CDMG	
1943 11-14	1829: 0.0	39.250	122.200	40	64	0		0.00		CDMG	
1943 11-14	2203: 0.0	39.500	122.150	24	38	0		0.00		CDMG	
1943 11-15	536:28.0	39.217	122.217	42	67	0	V	4.00		CDMG	

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1943 11-15	659: 0.0	39.250	122.200	40	64	0		0.00		CDMG	
1943 11-16	615:24.0	39.217	122.167	42	68	0	V	3.80		CDMG	
1943 11-16	1125: 0.0	39.250	122.200	40	64	0		0.00		CDMG	
1943 11-16	1812: 0.0	39.250	122.200	40	64	0	IV	3.67	I	CDMG	
1943 11-17	712: 0.0	39.250	122.200	40	64	0		0.00		CDMG	
1943 12- 4	2013:43.0	39.167	122.200	45	73	0	IV	4.00		CDMG	
1944 1-10	1439: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1944 1-11	455: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1944 1-11	552: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1944 1-17	1423: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1944 6- 2	627:53.0	40.600	122.400	55	88	0		0.00		CDMG	
1944 7-30	342: 0.0	40.750	122.900	71	115	0		0.00		CDMG	
1944 8-29	1852:10.0	40.300	121.300	65	104	0	II	3.30		CDMG	
1944 8-30	632:28.0	40.300	121.300	65	104	0		3.60		CDMG	
1944 8-30	652: 0.0	40.600	122.400	55	88	0		0.00		CDMG	
1944 8-30	657: 0.0	40.600	122.400	55	88	0		0.00		CDMG	
1944 9- 1	529: 0.0	40.600	122.400	55	88	0		0.00		CDMG	
1944 9- 9	1015: 0.0	39.350	121.700	47	75	0		0.00		CDMG	
1944 10- 1	1518: 0.0	39.350	123.100	52	83	0		0.00		CDMG	
1944 12-30	1816:43.0	40.350	121.600	54	87	0		0.00		CDMG	
1945 4-20	536:10.0	39.750	121.650	37	59	0	VI	5.00	I	CDMG	
1945 8-29	430: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1945 8-29	445: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1945 9- 8	1120: 0.0	40.500	121.400	68	110	0		0.00		CDMG	
1945 9- 8	1130: 0.0	40.500	121.400	68	110	0		0.00		CDMG	
1945 9-30	430: 0.0	40.350	121.550	56	90	0		0.00		CDMG	
1945 10-16	511: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1945 10-19	507: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1945 10-25	1645: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1945 12- 4	2107: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1946 4-19	2100: 0.0	39.700	123.500	63	101	0		0.00		CDMG	
1946 4-[illegible]3	0: 0.0	40.400	121.600	56	90	0		0.00		CDMG	
1946 6-14	656: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1946 6-24	525: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1946 7- 7	655:15.0	40.500	121.500	65	104	0	VI	5.00		CDMG	
1946 7- 8	1204: 0.0	40.350	121.600	54	87	0		0.00		CDMG	
1947 10- 1	1211: 0.0	40.600	122.400	55	88	0		0.00		CDMG	
1947 11- 7	650: 0.0	39.750	121.650	37	59	0		0.00		CDMG	
1947 11-10	649:21.0	39.800	122.700	19	31	0	IV	3.90		CDMG	
1948 1-31	2342:12.0	40.700	122.350	61	98	0	IV	3.67	I	CDMG	
1948 2- 9	2342:27.0	40.600	122.400	55	88	0		0.00		CDMG	
1948 6-18	1035: 0.0	39.067	123.267	71	115	0	VI	3.80		CDMG	
1948 6-19	540: 0.0	39.000	122.900	64	103	0		0.00		CDMG	
1948 7- 5	1014: 0.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1948 7- 8	115: 0.0	39.000	122.900	64	103	0		0.00		CDMG	
1948 7-13	1102:48.0	40.600	122.400	55	88	0	IV	3.67	I	CDMG	
1948 11-14	1030: 0.0	39.750	121.850	26	42	0		0.00		CDMG	
1949 1- 1	1330:42.0	40.500	121.500	65	104	0		0.00		CGS	
1949 2- 1	1330:42.0	40.500	121.500	65	104	0		0.00		CGS	
1949 3- 3	323: 0.0	39.250	121.500	59	95	0		0.00		CDMG	
1949 4- 5	436: 0.0	40.600	122.400	55	88	0	V	4.33	I	CDMG	
1949 11- 1	2307:34.0	39.917	121.717	34	54	0		2.00		CDMG	
1949 11-16	801: 0.0	40.517	121.567	63	102	0		2.60		CDMG	
1949 11-16	804:20.0	40.517	121.567	63	102	0		3.20		CDMG	

EARTHQUAKE CATALOG

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1950	1- 1	2339: 9.0	40.500	121.500	65	104	0	IV	3.10		CDMG	
1950	1-16	1921:25.0	40.250	121.367	60	96	0	V	3.80		CDMG	
1950	3-13	1717:39.0	39.500	122.100	25	40	0	III	3.00	I	NOAA	
1950	3-20	1446: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-20	1522:17.0	40.450	121.467	63	102	0	V	5.50		CDMG	
1950	3-20	1716: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-20	1718: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950	3-20	1800: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-20	1819: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-20	1903: 0.0	40.450	121.467	63	102	0		3.40		CDMG	
1950	3-20	1925: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-20	2027: 0.0	40.467	121.500	63	102	0		2.30		CDMG	
1950	3-20	2029: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-20	2243: 0.0	40.450	121.467	63	102	0		3.60		CDMG	
1950	3-21	1: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-21	33: 0.0	40.450	121.467	63	102	0		3.10		CDMG	
1950	3-21	101: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-21	227: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-21	435: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950	3-21	905: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-21	1039: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-21	1224: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-21	1448: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950	3-21	1533: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-21	2028: 0.0	40.450	121.467	63	102	0		3.00		CDMG	
1950	3-22	0: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-23	212: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-23	222: 0.0	40.467	121.500	63	102	0		2.90		CDMG	
1950	3-23	302: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-23	335: 0.0	40.450	121.467	63	102	0		3.00		CDMG	
1950	3-23	417: 0.0	40.450	121.467	63	102	0		3.80		CDMG	
1950	3-23	537: 0.0	40.450	121.467	63	102	0		3.50		CDMG	
1950	3-23	547: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-23	603: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-23	801: 0.0	40.450	121.467	63	102	0		3.40		CDMG	
1950	3-23	833: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-23	955: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-23	1045: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950	3-23	1104: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950	3-23	1108: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-23	1712: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-23	1804: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-23	2146: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-24	31: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-24	42: 0.0	40.450	121.467	63	102	0		3.50		CDMG	
1950	3-24	306: 0.0	40.467	121.500	63	102	0		2.90		CDMG	
1950	3-24	451: 0.0	40.467	121.500	63	102	0		2.50		CDMG	
1950	3-24	546: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950	3-24	732: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-24	1259: 0.0	40.467	121.500	63	102	0		2.70		CDMG	
1950	3-24	2208: 0.0	40.450	121.467	63	102	0		3.00		CDMG	
1950	3-24	2214: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950	3-24	2222: 0.0	40.450	121.467	63	102	0		3.50		CDMG	
1950	3-24	2228: 0.0	40.450	121.467	63	102	0		3.10		CDMG	

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1950 3-24	2232: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950 3-25	49: 0.0	40.450	121.467	63	102	0		3.00		CDMG	
1950 3-25	213: 0.0	40.450	121.467	63	102	0		3.40		CDMG	
1950 3-25	233: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950 3-26	425:34.0	40.500	121.500	65	104	0		0.00		CGS	
1950 4-13	1746:41.0	40.417	121.367	66	106	0		3.50		CDMG	
1950 7-22	637: 0.0	39.750	121.850	26	42	0	IV	3.67	I	CDMG	
1950 10- 7	547: 0.0	40.700	122.400	62	99	0	IV	3.67	I	CDMG	
1950 10- 7	1911:47.0	39.517	123.067	44	71	0		3.30		CDMG	
1950 11-14	140: [illegible]	40.467	121.500	63	102	0		3.40		CDMG	
1950 11-14	149: [illegible]	40.467	121.500	63	102	0		2.60		CDMG	
1950 11-14	204:40.0	40.467	121.500	63	102	0		4.10		CDMG	
1950 11-14	235:50.0	40.467	121.500	63	102	0	V	4.60		CDMG	
1950 11-14	246: 0.0	40.467	121.500	63	102	0		3.80		CDMG	
1950 11-14	250: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950 11-14	301: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950 11-14	307: 0.0	40.467	121.500	63	102	0		2.40		CDMG	
1950 11-14	319: 0.0	40.467	121.500	63	102	0		3.00		CDMG	
1950 11-14	356: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950 11-14	415: 0.0	40.467	121.500	63	102	0		3.20		CDMG	
1950 11-14	444: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950 11-14	535: 0.0	40.467	121.500	63	102	0		3.60		CDMG	
1950 11-14	634:32.0	40.467	121.500	63	102	0		4.50		CDMG	
1950 11-14	736: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950 11-14	826: 0.0	40.467	121.500	63	102	0		3.50		CDMG	
1950 11-14	831: 0.0	40.467	121.500	63	102	0		2.90		CDMG	
1950 11-14	906: 0.0	40.467	121.500	63	102	0		2.90		CDMG	
1950 11-14	939: 0.0	40.467	121.500	63	102	0		2.80		CDMG	
1950 11-14	945: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950 11-14	954: 0.0	40.467	121.500	63	102	0		2.60		CDMG	
1950 11-14	1519: 0.0	40.467	121.500	63	102	0		2.40		CDMG	
1950 11-14	1600: 0.0	40.467	121.500	63	102	0		3.80		CDMG	
1950 11-15	322:42.0	40.467	121.500	63	102	0		4.10		CDMG	
1950 11-15	935: 0.0	40.467	121.500	63	102	0		2.90		CDMG	
1950 11-16	854: 0.0	40.467	121.500	63	102	0		3.30		CDMG	
1950 11-20	951:43.0	40.100	121.300	58	94	0		3.00		CDMG	
1951 2-21	1252:17.0	39.000	122.500	57	91	0		2.90		CDMG	
1951 4-26	1521:26.0	40.100	121.500	48	78	0		3.60		CDMG	
1951 6- 5	854:43.0	40.500	121.400	68	110	0		3.40		CDMG	
1952 3- 7	0: 0.0	40.600	122.400	55	88	0	IV	3.67	I	CDMG	
1952 3-23	1336:13.0	40.500	121.650	60	96	0	V	4.33	I	CDMG	
1952 5- 5	1301:49.0	39.300	122.900	47	75	0	V	3.10		CDMG	
1952 7-10	952:52.0	40.500	121.300	73	117	0		2.80		CDMG	
1952 8-14	647: 7.0	39.300	122.867	45	73	0	V	4.00		CDMG	
1952 10-17	1134:39.0	40.667	121.750	66	107	0		4.00		CDMG	
1952 11-15	2256:50.0	40.467	121.317	70	113	0		3.80		CDMG	
1952 11-16	703:56.0	40.467	121.317	70	113	0		3.80		CDMG	
1953 1- 2	308:36.0	40.500	121.400	68	110	0		2.00		CDMG	
1953 1- 2	1905: 2.0	40.500	121.600	62	99	0		3.20		CDMG	
1953 1-24	959:50.0	39.500	123.000	42	67	0		3.90		BERK	
1953 2- 6	2212: 0.0	40.500	121.600	62	99	0		2.80		CDMG	
1953 2-25	844:43.0	40.667	121.617	70	113	0		3.40		CDMG	
1953 2-27	1655: 1.0	40.667	121.567	71	115	0		3.30		CDMG	
1953 3- 2	2100:22.0	40.700	121.600	73	117	0		2.90		CDMG	

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1953 3- 9	17: 0.0	40.600	123.500	82	132	0		2.40		CDMG	
1953 4- 2	2256:12.0	40.700	121.600	73	117	0		3.20		CDMG	
1953 4-30	1400:48.0	40.600	121.600	67	108	0		2.90		CDMG	
1953 5- 1	335:38.0	40.600	121.600	67	108	0		2.10		CDMG	
1953 5- 6	400:24.0	40.467	121.550	62	99	0		2.50		CDMG	
1953 5-25	407:59.0	39.300	123.300	63	101	0	VI	3.20		CDMG	
1953 6-29	1108:24.0	39.717	122.367	7	11	0	V	3.10		CDMG	
1953 6-29	1324: 3.0	40.667	121.917	63	101	0		3.00		CDMG	
1953 8- 1	1719:13.0	40.600	121.417	73	117	0		3.00		CDMG	
1953 8-23	1221:58.0	40.467	121.717	56	90	0	V	3.30		CDMG	
1953 10-18	1019:58.0	40.500	121.600	62	99	0		2.80		CDMG	
1953 12-21	637:39.0	39.400	123.100	50	80	0	IV	3.10		CDMG	
1953 12-24	717:39.0	40.750	121.550	77	124	0		4.00		CDMG	
1953 12-28	644: 8.0	39.400	122.700	34	55	0		3.10		CDMG	
1954 1- 1	1330: 0.0	39.000	123.200	73	117	0	III	3.40		CDMG	
1954 2- 4	55:12.0	40.400	123.500	74	119	0		3.20		CDMG	
1954 2- 4	1112:18.0	40.517	121.500	66	106	0		3.40		CDMG	
1954 6-16	1603:26.0	40.480	121.600	60	97	0*		3.60		BERK	
1954 8-19	2146:32.0	39.450	123.467	65	105	0	III	3.20		CDMG	
1954 11-10	1807:21.0	39.067	123.017	63	101	0	VI	4.40		CDMG	
1954 11-25	1106:15.0	40.700	121.300	82	132	0		3.80		CDMG	
1954 12-10	1713: 0.0	40.550	121.367	72	116	0		3.30		CDMG	
1955 8-24	2037:29.0	40.300	123.500	70	113	0		3.60		CDMG	
1955 11-11	1218: 0.0	40.500	121.567	63	101	0		3.20		CDMG	
1955 11-14	715:59.0	40.467	121.567	61	98	0	IV	3.20		CDMG	
1955 11-14	1312:58.0	40.467	121.600	60	96	0	V	3.10		CDMG	
1955 12- 1	601:38.0	40.467	121.550	62	99	0	IV	2.90		CDMG	
1955 12- 1	603:38.0	40.467	121.550	62	99	0	IV	2.90		CDMG	
1955 12- 1	626:54.0	40.467	121.550	62	99	0		2.20		CDMG	
1955 12- 5	650: 0.0	40.450	121.550	60	97	0	IV	3.67	I	CDMG	
1955 12- 8	2155:27.0	40.417	121.450	63	101	0		3.00		CDMG	
1956 1- 4	523: 0.0	39.350	123.250	58	94	0	V	4.33	I	CDMG	
1956 2-10	745:34.0	40.100	122.500	22	35	0		3.00		CDMG	
1956 2-14	2102:11.0	40.500	121.567	63	101	0		3.30		CDMG	
1956 3-11	749:18.0	40.467	121.550	62	99	0	IV	2.80		CDMG	
1956 3-18	1017:41.0	40.517	121.600	62	100	0		3.50		CDMG	
1956 3-18	1022: 3.0	40.517	121.600	62	100	0	VI	3.70		CDMG	
1956 4- 1	1049:45.0	40.750	121.667	74	119	0		2.50		CDMG	
1956 4- 2	1453:47.0	39.000	122.500	57	91	0		2.90		CDMG	
1956 4- 5	115:14.0	40.500	121.500	65	104	0	IV	3.00		CDMG	
1956 4-19	545: 5.0	40.500	121.500	65	104	0		2.90		CDMG	
1956 4-20	2026:51.0	40.400	123.000	53	86	0		3.20		CDMG	
1956 5-10	907:56.0	40.500	121.550	63	102	0	V	3.30		CDMG	
1956 5-10	1751: 5.0	40.500	121.800	55	89	0	IV	3.00		CDMG	
1956 5-15	1740:28.0	40.517	121.467	67	108	0		2.60		CDMG	
1956 5-15	1836:48.0	40.517	121.467	67	108	0	IV	3.60		CDMG	
1956 5-15	1850:12.0	40.517	121.467	67	108	0		2.40		CDMG	
1956 5-15	1937:53.0	40.517	121.467	67	108	0	IV	2.80		CDMG	
1956 5-15	1942:44.0	40.517	121.467	67	108	0	IV	3.40		CDMG	
1956 5-15	2116:46.0	40.517	121.467	67	108	0		3.00		CDMG	
1956 5-15	2139:51.0	40.517	121.467	67	108	0		2.90		CDMG	
1956 5-16	354:38.0	40.517	121.467	67	108	0		2.30		CDMG	
1956 5-16	534: 2.0	40.517	121.467	67	108	0		2.70		CDMG	
1956 5-16	553:45.0	40.517	121.467	67	108	0		2.80		CDMG	

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1956 5-16	825:36.0	40.517	121.467	67	108	0		2.70		CDMG	
1956 5-17	2329:23.0	40.517	121.467	67	108	0		3.20		CDMG	
1956 5-18	1030: 0.0	40.517	121.467	67	108	0	IV	3.67	I	CDMG	
1956 5-19	230: 3.0	40.517	121.467	67	108	0		2.60		CDMG	
1956 5-19	626:56.0	40.517	121.467	67	108	0		2.40		CDMG	
1956 5-24	510:56.0	40.500	121.500	65	104	0		3.00		CDMG	
1956 6- 3	2141:36.0	40.200	121.567	48	78	0		2.90		CDMG	
1956 6-28	2157:31.0	40.500	121.600	62	99	0		3.10		CDMG	
1956 6-29	531:21.0	40.467	121.600	60	96	0		2.90		CDMG	
1956 7- 3	150:39.0	40.700	121.600	73	117	0		2.40		CDMG	
1956 7- 3	605:32.0	40.700	121.600	73	117	0		2.40		CDMG	
1956 7- 5	1958: 4.0	40.500	121.617	61	98	0		2.60		CDMG	
1956 7- 6	1616:46.0	40.600	121.600	67	108	0		2.10		CDMG	
1956 7- 6	1747:16.0	40.500	121.500	65	104	0		2.20		CDMG	
1956 7-11	1904:55.0	40.667	121.517	73	118	0		2.90		CDMG	
1956 7-13	2302: 1.0	40.700	121.400	79	127	0		3.30		CDMG	
1956 7-15	444:23.0	40.550	121.350	73	117	0		2.20		CDMG	
1956 8- 3	339:41.0	40.600	121.400	73	118	0	IV	2.90		CDMG	
1956 8- 3	1821:25.0	40.467	121.467	65	104	0	IV	3.20		CDMG	
1956 8- 7	703:29.0	40.500	121.500	65	104	0	V	3.20		CDMG	
1956 9-18	1352: 6.0	40.567	121.567	66	106	0		2.90		CDMG	
1956 10- 4	1011:21.0	40.467	121.467	65	104	0		2.70		CDMG	
1956 10-23	1122:56.0	40.400	121.500	60	97	0		2.90		CDMG	
1956 11-25	841:38.0	40.467	121.517	63	101	0		3.50		CDMG	
1956 11-28	1634:18.0	40.500	121.500	65	104	0		2.80		CDMG	
1956 12-19	510:44.0	40.700	122.067	63	101	0	IV	3.80		CDMG	
1957 1- 7	1239: 0.0	39.250	122.617	42	67	0		3.30		CDMG	
1957 1-22	415:46.0	39.100	122.900	58	93	0	IV	2.90		CDMG	
1957 1-22	1903:10.0	39.100	122.900	58	93	0		2.80		CDMG	
1957 3- 2	1639:52.0	40.000	122.300	13	21	0		3.00		CDMG	
1957 3-28	2237:48.0	40.100	122.300	20	32	0		3.10		CDMG	
1957 9-25	1235:22.0	39.617	123.367	57	91	0		2.70		CDMG	
1957 11-22	2348:33.0	40.200	121.400	57	91	0		2.70		CDMG	
1958 1-18	1148: 2.0	40.600	123.200	71	114	0		3.30		CDMG	
1958 1-26	2005:56.0	40.400	123.500	74	119	0		2.90		CDMG	
1958 1-27	1522: 2.0	39.500	122.050	27	43	0		2.90		CDMG	
1958 1-28	946: 4.0	40.067	121.517	47	75	0		3.20		CDMG	
1958 3-25	258:23.0	39.500	122.300	22	35	0	IV	3.40		CDMG	
1958 9- 1	1009: 1.0	39.467	122.800	34	55	0		2.10		CDMG	
1958 9- 1	1101:52.0	39.467	122.800	34	55	0		3.80		CDMG	
1958 9- 1	1945:48.0	40.200	121.400	57	91	0		2.70		CDMG	
1958 9- 1	2006:49.0	39.500	122.800	33	53	0		2.10		CDMG	
1958 9-23	529:30.0	40.100	121.500	48	78	0		2.60		CDMG	
1958 10-24	259:24.0	40.400	121.600	56	90	0		3.00		CDMG	
1958 11- 3	32:14.0	40.600	122.000	57	92	0		2.50		CDMG	
1958 11-16	1607:35.0	39.067	123.017	63	101	0	III	2.80		CDMG	
1958 11-25	1319:16.0	40.567	123.417	77	124	0		2.90		CDMG	
1958 11-29	1140:54.0	40.400	123.100	57	92	0		3.10		CDMG	
1958 11-30	1030:47.0	40.500	122.000	50	81	0		2.20		CDMG	
1958 12- 2	506:15.0	40.500	121.600	62	99	0		3.10		CDMG	
1958 12- 3	1301:46.0	40.100	123.200	50	80	0		2.60		CDMG	
1958 12- 3	1944:37.0	40.600	122.200	55	88	0		2.30		CDMG	
1959 1- 4	1709:29.0	39.850	121.950	21	33	0		2.40		CDMG	
1959 2-17	1330:56.0	40.067	123.000	39	63	0		3.20		CDMG	

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1959 3- 9	1313:50.0	39.600	122.100	19	31	0	I	1.67	I	NOAA	
1959 3-11	249:49.0	39.767	122.100	13	21	0		3.50		CDMG	
1959 4- 6	608:22.0	39.300	123.200	58	94	0	VI	3.60		CDMG	
1959 4-13	1835:21.0	39.800	122.100	12	20	0		3.20		CDMG	
1959 5- 2	38:14.0	39.400	122.200	29	47	0		3.20		CDMG	
1959 5- 9	1246: 4.0	39.817	123.017	36	58	0		2.70		CDMG	
1959 5-18	404:13.0	39.700	122.917	32	51	0		2.90		CDMG	
1959 6- 3	426:11.0	39.850	122.067	14	23	0		3.00		CDMG	
1959 6-13	1419:59.0	40.600	122.200	55	88	0		2.80		CDMG	
1959 9- 6	24:21.0	39.567	123.000	39	63	0		3.00		CDMG	
1959 9-16	15:47.0	39.300	123.000	50	81	0		3.50		CDMG	
1959 9-24	1702: 9.0	39.400	123.000	45	73	0	VI	3.60		CDMG	
1959 9-27	1503:54.0	40.567	123.467	80	128	0		3.00		CDMG	
1959 9-30	1021:36.0	40.100	121.900	30	49	0		2.50		CDMG	
1959 10- 5	112:20.0	39.100	122.700	53	85	0		2.80		CDMG	
1959 11- 1	1229:18.0	40.100	122.600	24	39	0		2.80		CDMG	
1959 11-11	12: 1.0	39.300	123.300	63	101	0		3.20		CDMG	
1959 11-27	1259: 4.0	39.800	122.100	12	20	0		2.70		CDMG	
1960 2-15	1903:56.0	39.500	123.300	56	90	0		2.90		CDMG	
1960 3- 3	1706:11.0	39.600	123.500	64	103	0		3.00		CDMG	
1960 4- 8	1353: 0.0	40.500	121.400	68	110	0		2.90		CDMG	
1960 4-23	221:39.0	39.800	121.900	23	37	0		3.50		CDMG	
1960 4-27	153:53.0	40.600	123.400	78	126	0		2.60		CDMG	
1960 7-24	1312: 3.0	39.867	121.867	25	41	0		2.40		CDMG	
1960 7-24	1953:47.0	39.200	123.500	75	121	0		2.90		CDMG	
1960 9- 7	2135:27.0	40.500	121.500	65	104	0		3.00		CDMG	
1960 11- 2	402: 6.0	40.300	122.800	42	67	0		3.10		CDMG	
1960 11-22	613:57.0	40.600	121.767	62	100	0		2.80		CDMG	
1960 12- 8	1246:28.0	39.000	123.200	73	117	0	IV	3.10		CDMG	
1961 1-30	842:45.0	39.400	122.300	29	46	0		3.40		CDMG	
1961 3- 3	907:28.0	40.300	123.300	61	98	0		3.60		CDMG	
1961 3-18	513:46.0	40.600	123.400	78	126	0		3.70		CDMG	
1961 7- 9	902:28.0	40.300	123.417	66	107	0		4.00		CDMG	
1961 10-14	646:48.0	39.000	122.700	60	96	0		2.70		CDMG	
1961 10-14	1253: 0.0	39.500	122.717	30	48	0		3.50		CDMG	
1961 10-15	2347:32.0	39.417	121.417	56	90	0		2.70		CDMG	
1961 12-21	1025:48.0	40.150	121.567	47	76	0		2.70		CDMG	
1962 4- 1	52: 2.0	40.567	122.067	54	87	0		3.00		CDMG	
1962 6- 6	1750: 6.2	39.067	123.317	73	118	5	VII	5.20		CDMG	
1962 7- 7	818: 5.2	39.317	123.317	63	101	2		2.80		CDMG	
1962 12- 6	1743:36.3	40.617	122.350	55	89	7		3.10		CDMG	
1963 5- 4	1637:15.0	39.867	122.617	16	25	0		3.20		CDMG	
1963 6- 8	1400:32.0	40.600	122.183	55	88	0		3.10		CDMG	
1963 6-20	228:46.0	40.600	123.383	78	125	0		3.00		CDMG	
1963 7- 8	535:35.5	40.117	121.467	51	82	0	IV	3.20		CDMG	
1963 9- 4	516:46.8	40.317	122.067	37	60	0	IV	3.30		CDMG	
1963 9-13	2243:16.3	40.083	121.650	41	66	0	V	3.40		CDMG	
1963 9-25	416:41.3	39.417	123.467	66	107	0		3.10		CDMG	
1963 12- 7	1517:11.0	39.750	122.250	6	10	0		3.10		CDMG	
1964 1-27	1044:10.0	39.467	123.167	50	81	0		3.00		CDMG	
1964 10-27	32:23.2	40.067	121.550	45	73	0		3.50		CDMG	
1965 8-29	1825:17.0	39.500	122.100	25	40	16		3.60		CDMG	
1965 8-29	2128:50.0	39.500	122.100	25	40	0		3.20		CDMG	
1965 11- 8	330: 1.1	40.000	121.400	52	83	0	III	3.00	I	NOAA	

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1965 12-12	1257:49.8	40.200	121.467	53	86	0		4.00	CDMG	
1965 12-20	1831: 0.0	40.700	121.500	75	121	33		3.60	CDMG	
1965 12-26	329:36.0	40.200	121.300	61	98	16		2.50	CDMG	
1966 5-24	349:55.1	39.767	121.767	30	49	20	VI	4.60	CDMG	
1966 8- 3	226:20.0	39.500	123.200	51	82	0		3.40	CDMG	
1966 9-25	1305:39.9	39.617	122.117	18	29	0		3.00	CDMG	
1967 1- 8	1214:56.3	39.600	122.900	34	54	0		2.90	CDMG	
1967 2- 3	1535: 8.1	39.517	122.150	23	37	0		3.40	CDMG	
1967 2-23	2030:23.0	40.300	123.000	48	78	0		3.40	CDMG	
1967 2-25	1552: 7.5	40.400	123.200	61	98	0	IV	4.10	CDMG	
1967 2-26	1351:57.0	40.100	121.800	35	56	0		3.10	CDMG	
1967 6-26	1515:35.0	39.300	123.300	63	101	2	VI	3.50	CDMG	
1967 9-11	1857:28.5	40.617	123.317	76	122	0		3.50	CDMG	
1967 11-24	1512:13.6	39.450	122.500	27	43	0		3.60	CDMG	
1967 11-29	255: 2.9	40.400	121.950	45	73	0		3.10	CDMG	
1968 4- 7	240:40.0	40.500	121.800	55	89	0		3.50	CDMG	
1968 4-29	21:38.6	39.533	122.017	25	41	0	VI	4.70	CDMG	
1968 6-11	1145:57.8	39.767	123.267	50	80	0		3.10	CDMG	
1968 7- 1	313: 9.9	39.783	123.300	52	83	0	IV	3.20	CDMG	
1968 7-22	105: 2.5	39.817	121.883	24	39	0	V	3.30	CDMG	
1968 7-22	107:12.0	39.817	121.867	25	40	0		3.30	CDMG	
1968 7-27	2357:17.2	40.200	122.033	31	50	0		3.30	CDMG	
1968 8-10	1606:16.0	40.000	123.000	37	60	0		3.40	CDMG	
1969 6- 2	538:55.2	39.350	123.250	58	94	0	V	3.10	CDMG	
1970 3-13	1933:28.0	40.117	123.117	47	75	0		3.30	CDMG	
1970 4-23	526:14.0	40.217	121.367	58	94	0	IV	3.70	CDMG	
1970 7- 1	755:26.0	39.467	122.067	28	45	0	V	3.60	CDMG	
1970 7- 1	1856:59.4	39.467	122.083	27	44	0	IV	3.50	CDMG	
1970 7- 6	1152:29.2	39.367	122.017	35	57	0		3.00	CDMG	
1970 8- 5	410:18.0	39.200	122.617	45	72	0		3.30	CDMG	
1970 8-19	654:25.0	40.200	122.750	35	56	0	IV	4.10	CDMG	
1970 8-19	941:41.0	40.100	122.700	28	45	0		3.30	CDMG	
1970 8-19	943:39.0	40.100	122.600	24	39	0		3.40	CDMG	
1970 9-20	837:21.4	40.267	121.300	63	102	0		3.50	CDMG	
1970 12- 2	1053: 8.0	39.767	122.600	14	23	0		3.10	CDMG	
1970 12- 3	1458:32.5	39.200	122.517	43	70	0		2.80	CDMG	
1970 12- 9	935:48.0	40.150	121.350	57	92	0	V	3.60	CDMG	
1970 12-20	547:28.0	39.517	123.050	43	70	0		3.00	CDMG	
1971 1-14	1443: 1.1	39.800	122.800	25	40	0		3.00	BERK	
1971 2-19	1751:24.0	40.100	122.700	28	45	0		3.00	BERK	
1971 3-26	809:37.3	40.000	121.350	54	87	0		3.00	CDMG	
1971 7- 3	942: 7.0	40.567	123.500	81	130	0		3.50	CDMG	
1971 7-11	1236:34.0	40.067	122.667	25	40	0		3.60	CDMG	
1971 7-26	827:47.0	40.667	121.567	71	115	0		3.20	CDMG	
1971 7-27	546:52.0	40.667	121.667	69	111	0		3.20	CDMG	
1971 8- 6	2229:48.3	39.500	122.100	25	40	0	IV	3.80	CDMG	
1971 8-30	756:21.0	40.150	123.000	42	68	0		3.00	CDMG	
1971 10-28	1124: 6.3	39.400	123.383	63	101	0		3.10	CDMG	
1971 10-30	53:59.4	39.517	123.150	48	77	0		3.10	CDMG	
1971 12- 3	2137:10.0	40.317	121.317	64	103	0		3.50	CDMG	
1971 12-13	1307:38.0	40.317	121.500	57	91	0	IV	3.60	CDMG	
1972 1-12	220: 0.0	39.167	122.567	46	74	0		3.10	CDMG	
1972 2- 5	1922:36.0	40.417	122.917	52	83	0		3.00	CDMG	
1972 3- 5	1510: 2.0	39.317	122.717	40	64	0	III	3.50	CDMG	

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1972 3-21	643:12.0	39.300	122.667	40	64	0		3.00		CDMG	
1972 4-11	1609:22.0	39.500	121.917	31	50	0		3.10		CDMG	
1972 4-11	2227:59.0	40.067	121.317	57	92	0	IV	3.40		CDMG	
1972 4-11	2303:43.0	40.017	121.400	52	83	0		3.10		CDMG	
1972 5-25	300:52.0	40.250	123.000	47	75	0		3.10		CDMG	
1972 5-27	2204:16.0	39.400	122.600	32	51	0		2.70		CDMG	
1972 6- 6	1838:17.0	40.120	121.430	53	85	0		2.80		BERK	
1972 6-30	618:49.0	40.417	121.667	55	88	0		3.40		CDMG	
1972 7-12	1553:31.0	40.050	121.550	45	72	0		3.20		CDMG	
1972 7-16	1442: 9.2	40.017	121.300	57	91	0	V	4.10		CDMG	
1972 8- 9	1558:59.4	39.850	123.200	46	74	0		3.10		CDMG	
1973 2-15	254: 6.9	39.767	122.117	12	19	0		3.00		CDMG	
1973 5-13	1120:22.6	40.233	121.533	52	83	0	V	3.10		CDMG	
1973 7-24	1348:51.2	39.067	123.100	66	106	0	V	3.80		CDMG	
1973 10-13	924:23.7	40.150	123.250	54	87	0		3.10		CDMG	
1973 11-12	339:37.0	39.317	123.500	71	114	0	V	4.40		CDMG	
1973 11-25	507:30.4	39.350	123.250	58	94	0	V	3.50		CDMG	
1974 12-21	1254:57.8	39.350	123.250	58	94	0		3.20		CDMG	
1974 12-27	1212:10.6	40.717	123.367	83	133	0		3.90		CDMG	
1975 1- 5	1354: 4.1	39.605	121.403	52	83	17*		-.50		CDWR	OROVILLE DAM
1975 1-13	2028: 4.2	40.522	121.547	65	104	5*		0.80		CDWR	MANZANITA LAKE SE
1975 1-23	1735:52.6	39.424	122.055	30	49	5*		-.10		CDWR	PRINCETON
1975 1-28	456:54.5	39.494	122.018	28	45	7*		0.10		CDWR	PRINCETON
1975 2-11	118:48.0	39.700	121.723	34	54	5*		-.50		CDWR	HAMLIN CANYON
1975 2-15	1353:24.8	39.776	121.911	23	37	12*		0.40		CDWR	NORD
1975 2-19	215:41.3	39.678	122.102	16	25	4*		0.50		CDWR	HAMILTON CITY
1975 2-19	1621:39.3	39.602	122.067	21	33	4*		0.30		CDWR	GLENN
1975 3- 7	1845:33.2	39.775	121.821	27	44	8*		0.50		CDWR	RICHARDSON SPRINGS
1975 3-19	2059:37.6	39.222	122.478	42	67	6		3.30		USGS	
1975 3-19	2059:38.0	39.233	122.592	42	68	5*		3.40		CDWR	CLEARLAKE OAKS NE
1975 3-20	1506:36.9	39.371	123.059	49	79	1*		3.20		CDWR	POTTER VALLEY
1975 4-10	936:11.4	39.638	121.879	27	44	27*		0.40		CDWR	ORD FERRY
1975 4-18	1632:58.2	39.237	121.826	48	78	5*		2.90		CDWR	SUTTER BUTTES
1975 5-13	1409:19.4	39.788	122.322	2	3	0*		2.90		CDWR	BLACK BUTTE DAM
1975 5-20	1254:27.9	39.658	122.101	16	26	5*		0.50		CDWR	HAMILTON CITY
1975 5-21	1547:14.7	40.008	121.515	45	73	20*		0.30		CDWR	BUTTE MEADOWS SE
1975 5-25	1634:12.4	39.383	123.210	55	89	4*		3.40		CDWR	POTTER VALLEY NW
1975 5-27	2236:29.8	39.973	122.092	17	27	5*		0.70		CDWR	VINA
1975 5-29	1401:42.0	39.392	123.235	56	90	13*		3.40		CDWR	POTTER VALLEY NW
1975 5-31	851:58.9	39.779	121.544	42	68	5*		-.40		CDWR	PARADISE SE
1975 6- 3	810: 9.2	39.539	121.867	31	50	24*		0.10		CDWR	NELSON
1975 6- 3	2308: 5.9	39.980	122.079	18	29	0*		2.30		CDWR	VINA
1975 6- 6	816: 2.8	39.443	122.152	27	44	3*		0.30		CDWR	LOGANDALE
1975 6- 7	1015: 7.0	39.500	121.517	48	78	9*		-.30		CDWR	PALERMO
1975 6- 8	1102:10.8	40.046	121.525	46	74	10*		0.40		CDWR	BUTTE MEADOWS SE
1975 6-13	1639:10.5	39.314	123.015	50	80	1*		3.20		CDWR	POTTER VALLEY
1975 6-25	843:15.6	39.724	121.620	39	62	10*		-.50		CDWR	CHEROKEE
1975 6-28	231:54.7	39.484	121.531	48	78	8*		-.40		CDWR	PALERMO
1975 6-28	419:53.1	39.486	121.609	45	72	6	II	3.60		USGS	
1975 6-28	443:29.6	39.471	121.614	45	73	0*		2.60		CDWR	PALERMO
1975 6-28	504:10.6	39.457	121.523	50	80	6*		-.20		CDWR	PALERMO
1975 6-28	639:41.1	39.508	121.526	48	77	7*		-.10		CDWR	OROVILLE
1975 6-28	1131:24.0	39.469	121.533	49	79	6*		-.70		CDWR	PALERMO
1975 6-28	1416:19.1	39.486	121.605	45	72	3*		2.80		CDWR	PALERMO

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1975 6-28	1821:59.4	39.486	121.531	48	78	8*		-.10		CDWR	PALERMO
1975 6-29	2020:39.9	39.478	121.545	48	77	8*		-.20		CDWR	PALERMO
1975 7- 5	857: 9.9	40.138	122.018	28	45	3*		0.40		CDWR	TUSCAN SPRINGS
1975 7- 5	1819:15.8	39.456	121.535	49	79	7*		-.30		CDWR	PALERMO
1975 7- 6	611: 3.2	39.516	121.504	49	79	6*		-.40		CDWR	OROVILLE
1975 7- 6	1321:60.0	39.513	121.486	50	80	5*		2.80		CDWR	OROVILLE DAM
1975 7- 6	1435:45.9	39.487	121.528	48	78	9*		-.20		CDWR	PALERMO
1975 7- 7	14:35.5	39.478	121.529	49	79	8*		-.20		CDWR	PALERMO
1975 7- 7	1054: 4.7	39.481	121.523	49	79	9*		-.30		CDWR	PALERMO
1975 7- 7	2104:33.6	40.365	121.680	52	83	4*		2.30		CDWR	LASSEN PEAK SW
1975 7- 8	620:20.7	39.398	122.148	30	49	0*		0.90		CDWR	LOGANDALE
1975 7- 8	2119:58.8	39.474	121.534	48	78	8*		-.30		CDWR	PALERMO
1975 7- 9	556:36.4	39.753	121.656	37	59	5*		-.10		CDWR	PARADISE SW
1975 7-10	1258:11.1	40.011	121.490	47	76	8*		0.10		CDWR	JONESVILLE SW
1975 7-14	1949: 0.4	39.474	121.522	49	79	9*		-.50		CDWR	PALERMO
1975 7-16	1551:35.9	39.971	121.460	48	77	1*		2.40		CDWR	PULGA NW
1975 7-20	508:43.1	39.275	123.171	58	93	12*		3.40		CDWR	REDWOOD VALLEY
1975 7-20	928: 9.1	39.448	121.589	47	76	1*		3.20		CDWR	PALERMO
1975 7-20	1038:52.2	39.460	121.550	48	78	9*		-.10		CDWR	PALERMO
1975 7-21	417:37.0	39.464	121.595	46	74	0*		3.10		CDWR	PALERMO
1975 7-21	514:49.1	39.499	121.507	49	79	7*		2.50		CDWR	PALERMO
1975 7-22	1232:55.4	39.603	121.815	31	50	24*		-.40		CDWR	NELSON
1975 7-25	2253:16.4	39.699	122.176	12	19	0*		2.90		CDWR	ORLAND
1975 8- 1	1545:37.8	39.450	121.531	50	80	7		3.80		USGS	
1975 8- 1	1627:17.8	39.438	121.537	50	80	5	V	4.70		USGS	
1975 8- 1	1726:50.1	39.462	121.538	49	79	9		3.00		USGS	
1975 8- 1	2020: 4.8	39.439	121.528	50	81	8		4.50		USGS	
1975 8- 1	2020:12.9	39.439	121.528	50	81	15	VII	5.70		USGS	
1975 8- 1	2025: 0.0	39.438	121.528	50	81	0		4.70			OROVILLE
1975 8- 1	2029: 0.0	39.438	121.528	50	81	0		4.60			OROVILLE
1975 8- 1	2032:39.8	39.445	121.507	51	82	5		3.00		USGS	
1975 8- 1	2046:18.4	39.473	121.500	50	81	6		3.80		USGS	
1975 8- 1	2105:39.8	39.433	121.487	52	84	7		3.00		USGS	
1975 8- 1	2121:50.7	39.442	121.528	50	81	8	IV	4.10		USGS	
1975 8- 1	2125:59.0	39.474	121.518	50	80	7		3.30		USGS	
1975 8- 1	2129:24.1	39.452	121.549	49	79	7		3.60		USGS	
1975 8- 1	2344:41.0	39.486	121.522	49	79	7		3.20		USGS	
1975 8- 2	52:48.5	39.484	121.509	50	80	7		3.80		USGS	
1975 8- 2	631:57.2	39.447	121.484	52	84	6		3.20		USGS	
1975 8- 2	1011:53.7	39.490	121.512	49	79	7		3.10		USGS	
1975 8- 2	1151:50.7	39.473	121.488	51	82	2		3.40		USGS	
1975 8- 2	1724:29.2	39.474	121.471	52	83	6		4.30		USGS	
1975 8- 2	1743:24.1	39.478	121.474	52	83	6		4.00		USGS	
1975 8- 2	1958:36.9	39.448	121.537	50	80	7		3.10		USGS	
1975 8- 2	2022:16.3	39.445	121.463	53	85	0		5.10			OROVILLE
1975 8- 2	2035:48.6	39.471	121.482	52	83	6		3.90		USGS	
1975 8- 2	2059: 0.0	39.432	121.466	53	86	0		5.20			OROVILLE
1975 8- 2	2059: 2.7	39.406	121.711	43	70	5		5.10		USGS	
1975 8- 3	103: 5.8	39.488	121.518	49	79	8		4.60		USGS	
1975 8- 3	247: 8.8	39.478	121.501	50	81	7		4.10		USGS	
1975 8- 4	947:45.0	39.421	121.523	51	82	8		3.50		USGS	
1975 8- 5	2044:24.5	39.415	121.515	52	83	7		3.20		USGS	
1975 8- 6	350:29.9	39.479	121.524	49	79	7	IV	4.70		USGS	
1975 8- 6	1641:52.1	39.497	121.529	48	78	8		3.60		USGS	

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1975	8- 6	2100:33.5	39.440	121.485	52	84	9		3.00		USGS	
1975	8- 7	2031:20.4	39.517	121.533	47	76	9		3.10		USGS	
1975	8- 8	700:50.1	39.502	121.512	49	79	8		4.90		USGS	
1975	8- 8	1337:53.9	39.497	121.490	50	81	6		3.20		USGS	
1975	8-11	611:36.3	39.446	121.481	52	84	4	V	4.30		USGS	
1975	8-11	1559: 5.3	39.470	121.554	48	77	6		3.60		USGS	
1975	8-16	548: 9.4	39.472	121.521	50	80	9		4.00		USGS	
1975	8-21	1407:30.6	39.445	122.043	30	48	0*		0.60		CDWR	PRINCETON
1975	9- 1	2141:46.0	40.121	121.685	40	65	0*		3.20		CDWR	BUTTE MEADOWS SW
1975	9- 3	2120:53.4	39.494	121.542	48	77	3*		2.80		CDWR	PALERMO
1975	9- 4	117: 1.6	39.438	121.635	45	73	7*		3.30		CDWR	BIGGS
1975	9- 4	1539:24.9	39.480	121.590	46	74	0*		2.70		CDWR	PALERMO
1975	9- 4	1603:43.6	39.365	121.511	54	87	1*		2.70		CDWR	HONCUT
1975	9- 5	2101:38.9	39.465	121.618	45	73	7*		3.40		CDWR	PALERMO
1975	9- 6	137: 5.2	39.439	121.599	47	76	7*		3.10		CDWR	PALERMO
1975	9- 6	942:38.1	39.419	121.530	51	82	3*		2.80		CDWR	PALERMO
1975	9- 6	2110:53.8	39.538	121.646	42	67	11*		2.80		CDWR	SHIPPEE
1975	9- 7	31:28.9	39.652	121.625	40	64	5*		2.70		CDWR	HAMLIN CANYON
1975	9- 7	36:11.8	39.456	121.598	47	75	1*		2.70		CDWR	PALERMO
1975	9- 7	1207:10.5	39.421	121.496	52	84	0*		2.70		CDWR	BANGOR
1975	9- 7	1235: 6.7	39.364	121.467	56	90	5*		1.20		CDWR	LOMA RICA
1975	9- 9	329:28.4	39.395	121.568	50	81	0*		2.60		CDWR	PALERMO
1975	9-10	1238:30.3	39.550	121.611	43	69	5*		3.00		CDWR	OROVILLE
1975	9-10	1723:46.0	39.529	121.616	43	69	0*		2.90		CDWR	OROVILLE
1975	9-10	1739: 4.5	39.565	121.626	42	67	4*		3.50		CDWR	SHIPPEE
1975	9-10	1850:39.4	39.545	121.622	42	68	0*		3.10		CDWR	OROVILLE
1975	9-12	200:47.7	39.519	121.564	46	74	0*		3.50		CDWR	OROVILLE
1975	9-13	1827:50.3	39.421	121.544	50	81	0*		2.60		CDWR	PALERMO
1975	9-15	1447:11.1	39.423	121.628	47	75	1*		3.00		CDWR	BIGGS
1975	9-17	1904:30.4	39.798	121.849	26	42	0*		0.30		CDWR	RICHARDSON SPRINGS
1975	9-18	4:23.0	39.793	121.842	26	42	0*		0.40		CDWR	RICHARDSON SPRINGS
1975	9-20	653:14.7	39.520	121.595	44	71	2*		2.80		CDWR	OROVILLE
1975	9-20	836:41.3	39.439	121.542	50	80	6*		2.50		CDWR	PALERMO
1975	9-20	1222:34.4	39.402	121.559	50	81	2*		2.50		CDWR	PALERMO
1975	9-21	1749:58.4	39.436	121.610	47	75	8*		2.80		CDWR	PALERMO
1975	9-22	2125: 9.2	39.450	121.527	50	80	2*		2.70		CDWR	PALERMO
1975	9-23	31:20.8	39.840	121.913	22	36	0*		0.60		CDWR	NORD
1975	9-23	717:45.9	39.485	121.415	54	87	0*		1.80		CDWR	BANGOR
1975	9-25	1346:23.0	39.443	121.552	49	79	6*		2.70		CDWR	PALERMO
1975	9-26	231: 6.8	39.490	121.573	47	75	9	IV	4.00		USGS	
1975	9-26	306:32.4	39.511	121.595	45	72	6*		2.00		CDWR	OROVILLE
1975	9-26	435:52.8	39.440	121.602	47	75	8*		2.90		CDWR	PALERMO
1975	9-26	536:45.0	39.408	121.563	50	80	4*		1.90		CDWR	PALERMO
1975	9-26	815: 8.3	39.436	121.626	46	74	4*		2.30		CDWR	BIGGS
1975	9-26	957:15.2	39.438	121.607	47	75	10	IV	2.90		USGS	
1975	9-26	957:16.1	39.472	121.594	46	74	10*		3.20		CDWR	PALERMO
1975	9-26	1249:31.9	39.455	121.564	48	77	7*		2.30		CDWR	PALERMO
1975	9-26	1255:56.0	39.418	121.550	50	80	5*		1.70		CDWR	PALERMO
1975	9-27	247:10.2	39.416	121.622	47	76	0*		2.50		CDWR	PALERMO
1975	9-27	1305:14.8	39.519	121.591	45	72	1*		2.60		CDWR	OROVILLE
1975	9-27	2234:37.7	39.531	121.602	43	70	6*		3.90		CDWR	OROVILLE
1975	9-27	2234:38.0	39.511	121.536	47	76	0		4.60			OROVILLE
1975	9-27	2240:14.4	39.541	121.610	43	69	4*		3.00		CDWR	OROVILLE
1975	9-27	2248: 7.1	39.404	121.404	57	92	3*		2.40		CDWR	BANGOR

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1975 9-27	2251:12.3	39.600	121.496	47	76	0*		2.00	CDWR	OROVILLE DAM
1975 9-27	2253:46.1	39.595	121.486	48	77	0*		2.10	CDWR	OROVILLE DAM
1975 9-27	2254:27.5	39.596	121.494	47	76	1*		2.50	CDWR	OROVILLE DAM
1975 9-27	2304:30.4	39.518	121.527	48	77	11		3.10	USGS	
1975 9-27	2307:43.3	39.511	121.616	43	70	0*		2.60	CDWR	OROVILLE
1975 9-27	2328: 4.7	39.529	121.544	47	75	10		3.10	USGS	
1975 9-27	2338: 8.0	39.509	121.615	43	70	2*		3.00	CDWR	OROVILLE
1975 9-28	3:49.3	39.513	121.607	44	71	0*		2.50	CDWR	OROVILLE
1975 9-28	34:24.7	39.595	121.486	48	77	0*		2.40	CDWR	OROVILLE DAM
1975 9-28	146:57.0	39.524	121.527	47	76	8*		2.40	CDWR	OROVILLE
1975 9-28	422:14.9	39.550	121.683	39	63	11*		2.50	CDWR	SHIPPEE
1975 9-28	905: 2.1	39.523	121.581	45	72	7*		1.80	CDWR	OROVILLE
1975 9-28	925:37.3	39.427	121.546	50	80	0*		2.60	CDWR	PALERMO
1975 9-28	930:15.0	39.518	121.532	47	76	9*		1.80	CDWR	OROVILLE
1975 9-28	1959:50.9	39.554	121.513	47	76	7*		2.20	CDWR	OROVILLE
1975 9-28	2107:14.3	39.552	121.591	43	70	6*		3.50	CDWR	OROVILLE
1975 9-29	203:36.3	39.478	121.565	47	76	4*		2.70	CDWR	PALERMO
1975 9-29	1009:36.5	39.489	121.597	45	73	0*		2.10	CDWR	PALERMO
1975 9-29	1151:11.5	39.533	121.555	46	74	4*		2.00	CDWR	OROVILLE
1975 9-30	1708:33.9	39.422	121.554	50	80	0*		2.50	CDWR	PALERMO
1975 9-30	2236: 4.3	39.540	121.627	42	68	0*		2.90	CDWR	SHIPPEE
1975 10- 1	255:44.3	39.455	121.575	47	76	2*		2.60	CDWR	PALERMO
1975 10- 1	2345:51.4	39.776	121.800	29	46	0*		0.10	CDWR	RICHARDSON SPRINGS
1975 10- 2	108:21.0	39.566	121.493	48	77	5*		-.40	CDWR	OROVILLE DAM
1975 10- 2	2142:25.7	39.487	121.585	46	74	0*		2.80	CDWR	PALERMO
1975 10- 2	2215: 0.7	39.498	121.524	48	78	5*		3.30	CDWR	PALERMO
1975 10- 2	2238:28.4	39.464	121.484	52	83	0*		2.60	CDWR	BANGOR
1975 10- 3	137:19.8	39.417	121.653	45	73	0*		2.70	CDWR	BIGGS
1975 10- 3	214: 0.7	39.412	121.647	46	74	0*		2.90	CDWR	BIGGS
1975 10- 3	228: 8.9	39.571	121.469	49	79	2*		2.50	CDWR	OROVILLE DAM
1975 10- 3	311:29.0	39.421	121.668	45	72	0*		2.80	CDWR	BIGGS
1975 10- 3	645:18.3	39.490	121.571	47	75	0*		2.50	CDWR	PALERMO
1975 10- 4	19:19.1	39.438	121.543	50	80	7*		3.10	CDWR	PALERMO
1975 10- 4	1228:41.0	39.609	121.635	40	64	4*		2.60	CDWR	SHIPPEE
1975 10- 5	804:26.3	39.724	122.106	14	22	6*		0.20	CDWR	HAMILTON CITY
1975 10- 8	954:41.8	39.394	121.643	47	76	0*		2.10	CDWR	BIGGS
1975 10- 9	717:19.1	39.465	121.463	52	84	4*		-.20	CDWR	BANGOR
1975 10-10	744:47.4	39.469	121.499	50	81	6	IV	3.50	USGS	
1975 10-10	750:18.3	39.626	121.698	37	59	0*		2.50	CDWR	HAMLIN CANYON
1975 10-11	2355: 0.2	39.585	121.481	48	78	0*		2.20	CDWR	OROVILLE DAM
1975 10-12	440:53.4	39.458	121.494	51	82	0*		2.40	CDWR	BANGOR
1975 10-12	1505:35.1	39.518	121.587	45	72	2*		2.10	CDWR	OROVILLE
1975 10-12	2324:17.2	39.422	121.600	48	77	0*		-.20	CDWR	PALERMO
1975 10-13	1456:37.2	39.522	121.537	47	76	3*		3.00	CDWR	OROVILLE
1975 10-13	1606:50.7	39.535	121.572	45	72	10		3.00	USGS	
1975 10-13	1606:51.5	39.518	121.544	47	75	3*		3.20	CDWR	OROVILLE
1975 10-13	2130: 8.4	39.537	121.441	52	83	7*		2.50	CDWR	OROVILLE DAM
1975 10-14	244:59.2	39.586	121.480	48	78	4*		1.90	CDWR	OROVILLE DAM
1975 10-14	901: 6.6	39.489	121.492	50	81	8*		-.50	CDWR	BANGOR
1975 10-14	2132: 6.2	39.625	121.553	43	70	3*		2.00	CDWR	OROVILLE
1975 10-16	320:49.2	39.440	121.506	51	82	4*		2.50	CDWR	PALERMO
1975 10-16	911:27.0	39.594	121.489	48	77	4*		2.20	CDWR	OROVILLE DAM
1975 10-18	1358:15.8	39.256	121.526	58	93	5*		0.50	CDWR	HONCUT
1975 10-18	1359:42.4	39.440	121.513	51	82	10*		-.10	CDWR	PALERMO

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1975 10-19	1008:12.9	39.695	122.012	19	31	7*		0.20	CDWR	HAMILTON CITY
1975 10-19	1322:23.7	40.055	121.974	25	41	7*		0.50	CDWR	PANTHER SPRING SW
1975 10-20	1441: 0.2	39.517	121.618	43	70	0*		2.90	CDWR	OROVILLE
1975 10-21	1326:24.6	39.408	121.530	52	83	0*		-.30	CDWR	PALERMO
1975 10-23	703:24.1	39.468	122.100	27	43	0*		3.10	CDWR	PRINCETON
1975 10-23	2007:43.8	39.476	121.620	45	72	0*		2.50	CDWR	PALERMO
1975 10-27	2102:44.2	39.518	121.524	48	77	6*		3.00	CDWR	OROVILLE
1975 10-28	341:15.0	39.517	121.561	46	74	10	III	3.40	USGS	
1975 10-28	513:46.1	39.542	121.558	45	73	6*		2.50	CDWR	OROVILLE
1975 10-30	1409:20.1	39.524	121.462	51	82	6*		-.50	CDWR	OROVILLE DAM
1975 10-30	1524:40.1	39.581	121.460	49	79	2*		-.50	CDWR	OROVILLE DAM
1975 11- 1	246: 4.3	39.470	121.466	52	84	3*		2.80	CDWR	BANGOR
1975 11- 1	2055: 3.1	39.440	121.541	50	80	1*		-.50	CDWR	PALERMO
1975 11- 3	1000:56.5	39.591	121.481	48	77	0*		2.60	CDWR	OROVILLE DAM
1975 11- 3	1603:37.2	39.424	121.618	47	75	0*		2.90	CDWR	PALERMO
1975 11- 3	2023:36.4	39.682	122.041	18	29	1*		2.90	CDWR	HAMILTON CITY
1975 11- 3	2317:38.3	39.404	121.569	50	80	1*		2.90	CDWR	PALERMO
1975 11- 4	2104:47.3	39.482	121.582	46	74	0*		2.40	CDWR	PALERMO
1975 11- 4	2304:11.9	39.462	121.628	45	72	0*		2.40	CDWR	BIGGS
1975 11- 5	537:45.9	39.401	121.593	49	79	9	II	3.30	USGS	
1975 11- 5	1930:39.6	39.575	121.481	48	78	4*		2.40	CDWR	OROVILLE DAM
1975 11- 5	2318: 6.4	39.441	121.478	52	84	3*		-.30	CDWR	BANGOR
1975 11- 6	103:29.5	39.782	121.793	29	47	0*		0.00	CDWR	RICHARDSON SPRINGS
1975 11- 7	943: 7.1	39.401	121.425	57	91	3*		-.60	CDWR	BANGOR
1975 11- 7	1204:32.0	39.403	121.471	54	87	6*		-.50	CDWR	BANGOR
1975 11- 7	2358:42.4	39.413	121.514	52	83	1*		2.70	CDWR	PALERMO
1975 11- 8	420:56.2	39.761	121.773	30	49	26*		0.50	CDWR	RICHARDSON SPRINGS
1975 11- 8	444: 8.1	39.491	121.471	51	82	1*		2.60	CDWR	BANGOR
1975 11- 9	1105:26.3	39.410	121.473	54	87	0*		-.40	CDWR	BANGOR
1975 11- 9	1815:23.3	39.467	121.533	49	79	6*		-.70	CDWR	PALERMO
1975 11- 9	1909:29.0	39.519	121.530	47	76	10*		-.30	CDWR	OROVILLE
1975 11-10	7:44.5	39.408	121.480	53	86	2*		-.30	CDWR	BANGOR
1975 11-10	800:27.4	39.385	121.467	55	88	0*		-.50	CDWR	BANGOR
1975 11-10	942:52.8	39.523	121.520	48	77	8*		-.60	CDWR	OROVILLE
1975 11-10	1124:46.7	39.402	121.494	53	86	2*		-.70	CDWR	BANGOR
1975 11-10	2028:25.9	39.434	121.513	51	82	4*		-.30	CDWR	PALERMO
1975 11-12	1349:26.2	39.505	121.524	48	78	7*		-.40	CDWR	OROVILLE
1975 11-13	17:49.5	39.795	121.852	25	41	0*		0.50	CDWR	RICHARDSON SPRINGS
1975 11-13	531: 9.8	39.415	121.516	52	83	3*		1.00	CDWR	PALERMO
1975 11-13	1146: 3.0	39.459	121.507	50	81	3*		1.00	CDWR	PALERMO
1975 11-13	2335:53.7	39.415	121.474	53	86	1*		-.20	CDWR	BANGOR
1975 11-14	1129: 9.4	39.399	121.469	55	88	4*		-.50	CDWR	BANGOR
1975 11-14	1138:52.8	39.429	121.506	52	83	1*		-.80	CDWR	PALERMO
1975 11-14	1400:12.5	39.423	121.500	52	84	2*		-.70	CDWR	BANGOR
1975 11-14	1423: 8.6	39.438	121.507	51	82	0*		-.80	CDWR	PALERMO
1975 11-14	1519:49.2	39.422	121.468	53	86	3*		-.50	CDWR	BANGOR
1975 11-14	1619:21.2	39.458	121.525	50	80	6*		-.60	CDWR	PALERMO
1975 11-14	1620: 9.9	39.485	121.536	48	78	2*		-.40	CDWR	PALERMO
1975 11-15	335: 1.6	39.417	121.572	49	79	5	III	4.00	USGS	
1975 11-15	345: 8.3	39.423	121.478	53	85	0*		2.70	CDWR	BANGOR
1975 11-15	422:34.6	39.420	121.440	55	88	0*		-.20	CDWR	BANGOR
1975 11-15	728: 1.7	39.409	121.498	53	85	0*		-.30	CDWR	BANGOR
1975 11-15	1008:44.8	39.423	121.472	53	86	0*		-.30	CDWR	BANGOR
1975 11-15	1301:52.2	39.409	121.485	53	86	1*		-.70	CDWR	BANGOR

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1975 11-15	1341:17.0	39.415	121.502	52	84	0*		0.00		CDWR	PALERMO
1975 11-15	1558:25.7	39.408	121.479	53	86	0*		-.10		CDWR	BANGOR
1975 11-15	2023:27.7	39.404	121.497	53	85	2*		0.00		CDWR	BANGOR
1975 11-15	2329:24.7	39.424	121.510	52	83	3*		-.90		CDWR	PALERMO
1975 11-16	500:35.1	39.506	121.493	50	80	6*		-.70		CDWR	OROVILLE DAM
1975 11-16	1004:28.1	39.437	121.523	50	81	10*		-.50		CDWR	PALERMO
1975 11-16	1415:19.0	39.389	121.470	55	88	1*		-.50		CDWR	BANGOR
1975 11-16	1917:14.7	39.411	121.508	52	84	0*		2.90		CDWR	PALERMO
1975 11-16	1918:56.0	39.404	121.507	52	84	1*		-.30		CDWR	PALERMO
1975 11-17	650:50.0	39.406	121.474	54	87	2*		-.40		CDWR	BANGOR
1975 11-17	1851:28.8	39.484	121.484	51	82	0*		-.30		CDWR	BANGOR
1975 11-18	847: 6.8	39.419	121.475	53	86	0*		-.40		CDWR	BANGOR
1975 11-18	1310:43.0	39.478	121.475	52	83	0*		2.90		CDWR	BANGOR
1975 11-19	4:46.2	39.813	121.846	26	42	0*		0.20		CDWR	RICHARDSON SPRINGS
1975 11-20	1132:14.6	39.495	121.505	50	80	6*		-.40		CDWR	PALERMO
1975 11-20	1236:19.1	39.433	121.477	53	85	1*		-.20		CDWR	BANGOR
1975 11-20	1851:39.1	39.412	121.483	53	86	0*		-.30		CDWR	BANGOR
1975 11-20	2301:59.1	39.435	121.477	53	85	0*		-.20		CDWR	BANGOR
1975 11-21	2037:27.0	39.448	121.436	54	87	4*		-.70		CDWR	BANGOR
1975 11-22	445:19.2	39.416	121.453	55	88	0*		-.10		CDWR	BANGOR
1975 11-22	833:56.0	39.555	123.196	49	79	0*		3.60		CDWR	BRUSHY MTN.
1975 11-22	1704:43.0	39.430	121.484	53	85	0*		-.30		CDWR	BANGOR
1975 11-22	1751:58.9	39.462	121.545	48	78	7*		-.20		CDWR	PALERMO
1975 11-23	438:39.1	39.424	121.474	53	86	0*		-.20		CDWR	BANGOR
1975 11-23	732:53.4	39.416	121.476	53	86	0*		2.70		CDWR	BANGOR
1975 11-23	1345:29.8	40.049	122.158	19	30	5*		0.40		CDWR	GERBER
1975 11-23	2142: 7.1	39.408	121.522	52	83	3*		-.20		CDWR	PALERMO
1975 11-24	714:15.6	39.428	121.481	53	85	0*		-.90		CDWR	BANGOR
1975 11-24	941:40.4	39.428	121.522	51	82	5*		-.40		CDWR	PALERMO
1975 11-24	1111:19.5	39.406	121.503	53	85	4*		-.60		CDWR	PALERMO
1975 11-24	1410:22.1	39.476	121.516	50	80	10*		-.40		CDWR	PALERMO
1975 11-25	2134: 4.9	39.494	121.490	50	81	4*		-.30		CDWR	BANGOR
1975 11-26	2353:43.7	39.793	121.833	27	43	1*		0.10		CDWR	RICHARDSON SPRINGS
1975 11-27	319:38.1	39.388	121.425	57	91	0*		-.20		CDWR	BANGOR
1975 11-27	400: 1.3	39.428	121.510	52	83	5*		-.20		CDWR	PALERMO
1975 11-30	1032:37.0	39.564	121.501	48	77	8*		-.40		CDWR	OROVILLE
1975 12- 1	750:29.2	39.469	121.487	51	82	5*		-.60		CDWR	BANGOR
1975 12- 1	1831:37.0	39.466	121.475	52	83	0*		-.60		CDWR	BANGOR
1975 12- 1	2326:27.3	39.408	121.502	53	85	0*		-.60		CDWR	PALERMO
1975 12- 2	1253:33.9	39.416	121.500	52	84	4*		-.60		CDWR	PALERMO
1975 12- 2	1317:32.2	39.415	121.515	52	83	1*		-.30		CDWR	PALERMO
1975 12- 3	133:11.5	39.400	121.515	52	84	6*		1.10		CDWR	PALERMO
1975 12- 3	450:23.6	39.436	121.479	53	85	0*		-.30		CDWR	BANGOR
1975 12- 3	623:31.3	39.389	121.444	56	90	5*		-.80		CDWR	BANGOR
1975 12- 3	712:13.2	39.433	121.472	53	85	0*		3.00		CDWR	BANGOR
1975 12- 3	1013: 9.6	39.397	121.460	55	88	0*		-.30		CDWR	BANGOR
1975 12- 4	2340:17.8	39.406	121.474	54	87	0*		-.50		CDWR	BANGOR
1975 12- 4	2348:56.6	39.780	121.852	26	42	0*		0.50		CDWR	RICHARDSON SPRINGS
1975 12- 5	1111:58.4	39.387	121.486	54	87	0*		0.00		CDWR	BANGOR
1975 12- 5	1225:43.0	39.428	121.478	53	85	0*		2.70		CDWR	BANGOR
1975 12- 5	2043:40.3	39.477	121.523	49	79	4*		-.60		CDWR	PALERMO
1975 12- 5	2059:22.1	39.439	121.474	53	85	1*		-.50		CDWR	BANGOR
1975 12- 5	2151:41.8	39.412	121.493	53	85	0*		-.30		CDWR	BANGOR
1975 12- 6	1404:53.8	39.506	121.474	50	81	0*		2.20		CDWR	OROVILLE DAM

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1975 12- 7	606:15.4	39.414	121.507	52	84	4*		-.50		CDWR	PALERMO
1975 12- 7	1342: 8.0	39.509	121.509	49	79	7*		-.60		CDWR	OROVILLE
1975 12- 9	2120: 4.9	39.489	121.489	50	81	0*		1.90		CDWR	BANGOR
1975 12-10	519:45.9	39.489	121.494	50	81	6*		-.50		CDWR	BANGOR
1975 12-11	852:32.5	39.459	121.492	51	82	0*		2.50		CDWR	BANGOR
1975 12-11	2341:43.4	39.790	121.851	26	42	0*		0.00		CDWR	RICHARDSON SPRINGS
1975 12-12	1333:14.9	39.548	121.500	48	78	4*		-.50		CDWR	OROVILLE DAM
1975 12-13	254:43.4	39.444	121.467	53	85	0*		2.80		CDWR	BANGOR
1975 12-13	953:22.4	39.417	121.505	52	84	6*		-.20		CDWR	PALERMO
1975 12-13	1321:3).6	39.421	121.463	54	87	3*		-.70		CDWR	BANGOR
1975 12-13	2140:31.7	39.492	121.490	50	81	6*		-.30		CDWR	BANGOR
1975 12-14	2332:38.7	39.395	121.491	53	86	1*		-.30		CDWR	BANGOR
1975 12-14	2337:37.0	39.177	121.713	55	89	5*		0.60		CDWR	SUTTER
1975 12-15	13:53.6	39.925	121.562	42	67	13*		0.60		CDWR	PARADISE NE
1975 12-15	722:27.7	39.401	121.446	55	89	5*		-.90		CDWR	BANGOR
1975 12-15	916: 6.5	39.271	121.790	47	76	5*		-.30		CDWR	PENNINGTON
1975 12-16	454:50.3	3' 495	121.499	50	80	5*		-.50		CDWR	BANGOR
1975 12-16	854:38.6	39.513	121.518	48	78	8*		-.50		CDWR	OROVILLE
1975 12-16	1239:23.1	39.462	121.514	50	81	10*		-.60		CDWR	PALERMO
1975 12-18	428:48.3	39.505	121.499	50	80	7*		-.70		CDWR	OROVILLE DAM
1975 12-18	547:15.3	39.431	121.447	54	87	0*		-.70		CDWR	BANGOR
1975 12-18	1412:53.2	39.417	121.511	52	83	5*		-.50		CDWR	PALERMO
1975 12-19	115:15.5	39.417	121.480	53	86	0*		-.20		CDWR	BANGOR
1975 12-19	646:50.1	39.452	121.510	50	81	0*		2.50		CDWR	PALERMO
1975 12-19	1915: 0.5	39.324	121.485	57	91	14*		-.20		CDWR	LOMA RICA
1975 12-19	2007:33.8	39.427	121.519	51	82	5*		-.50		CDWR	PALERMO
1975 12-20	614:45.5	39.403	121.485	53	86	0*		-.20		CDWR	BANGOR
1975 12-20	738:18.4	39.498	121.592	45	73	0*		2.40		CDWR	PALERMO
1975 12-20	1356:46.7	39.493	121.496	50	80	5*		-.30		CDWR	BANGOR
1975 12-20	1754:44.6	39.285	121.470	59	95	17*		-.20		CDWR	LOMA RICA
1975 12-21	408: 4.5	39.408	121.458	55	88	0*		-.20		CDWR	BANGOR
1975 12-22	43:20.6	39.459	121.522	50	80	9*		-.20		CDWR	PALERMO
1975 12-22	801:44.9	39.410	121.467	54	87	2*		-.60		CDWR	BANGOR
1975 12-22	2341:15.7	39.459	121.476	52	84	0*		-.60		CDWR	BANGOR
1975 12-23	255:19.7	39.518	121.546	47	75	2*		-.40		CDWR	OROVILLE
1975 12-23	704:20.1	39.434	121.471	53	85	1*		-.30		CDWR	BANGOR
1975 12-24	59:15.8	39.381	121.490	54	87	0*		-.80		CDWR	BANGOR
1975 12-24	122: 6.0	39.414	121.476	53	86	2*		-.80		CDWR	BANGOR
1975 12-24	742:10.7	39.516	121.499	49	79	6*		-.60		CDWR	OROVILLE DAM
1975 12-25	2128:15.1	39.411	121.493	53	85	4*		-.40		CDWR	BANGOR
1975 12-26	1322: 8.2	39.415	121.480	53	86	1*		-.30		CDWR	BANGOR
1975 12-26	1931:48.9	39.416	121.482	53	86	0*		-.40		CDWR	BANGOR
1975 12-26	2025:25.6	39.720	121.702	34	55	11*		0.10		CDWR	HAMLIN CANYON
1975 12-27	720:13.1	39.403	121.478	54	87	1*		-.20		CDWR	BANGOR
1975 12-28	306:39.5	39.420	121.47[illegible]	53	86	0*		-.10		CDWR	BANGOR
1975 12-28	1234:45.9	39.421	121.483	53	85	0*		-.70		CDWR	BANGOR
1975 12-29	928: 3.8	39.423	121.459	54	87	3*		-.50		CDWR	BANGOR
1975 12-29	945:10.3	39.408	121.479	53	86	3*		-.80		CDWR	BANGOR
1975 12-29	1524:26.5	39.418	121.500	52	84	3*		-.80		CDWR	PALERMO
1976 0-61	1322:13.2	39.481	121.504	50	80	7*		-.10		CDWR	PALERMO
1976 1- 1	1022:41.5	39.288	121.479	58	94	18*		-.50		CDWR	LOMA RICA
1976 1- 1	1858:39.4	39.424	121.487	53	85	0*		2.70		CDWR	BANGOR
1976 1- 2	522:59.7	39.412	121.478	53	86	1*		-.30		CDWR	BANGOR
1976 1- 2	1022: 9.7	39.453	121.473	52	84	0*		-.40		CDWR	BANGOR

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1976 1- 2	1030:14.6	39.391	121.510	53	85	0*		-.30		CDWR	PALERMO
1976 1- 3	917:24.0	39.421	121.517	52	83	1*		-.40		CDWR	PALERMO
1976 1- 3	1435:38.6	39.435	121.505	52	83	0*		2.40		CDWR	PALERMO
1976 1- 4	309:14.9	39.389	121.523	52	84	0*		-.80		CDWR	PALERMO
1976 1- 4	1048:32.6	39.408	121.469	54	87	0*		0.00		CDWR	BANGOR
1976 1- 4	1313:42.9	39.561	121.514	47	76	5*		-.60		CDWR	OROVILLE
1976 1- 4	1541:38.1	39.502	121.522	48	78	6*		0.70		CDWR	OROVILLE
1976 1- 4	1550: 4.3	39.497	121.501	50	80	12*		0.50		CDWR	PALERMO
1976 1- 5	825:16.7	39.396	121.475	54	87	1*		-.80		CDWR	BANGOR
1976 1- 5	1509:26.6	39.425	121.509	52	83	4*		-.50		CDWR	PALERMO
1976 1- 5	1840:46.4	39.436	121.494	52	84	0*		-.30		CDWR	BANGOR
1976 1- 5	1926:21.9	39.348	121.428	58	94	5*		-.20		CDWR	LOMA RICA
1976 1- 6	1308:32.4	39.399	121.424	57	91	0*		-.60		CDWR	BANGOR
1976 1- 8	1627:21.8	39.857	121.505	44	71	1*		3.00		CDWR	PARADISE SE
1976 1- 8	2158:38.1	39.431	121.490	52	84	0*		-.30		CDWR	BANGOR
1976 1- 9	57:26.3	39.366	121.515	53	86	7*		-.50		CDWR	HONCUT
1976 1- 9	921:58.8	39.403	121.505	53	85	0*		-.50		CDWR	PALERMO
1976 1- 9	1754:26.0	39.493	121.482	50	81	0*		2.70		CDWR	BANGOR
1976 1-10	1449: 3.5	39.486	122.199	24	38	2*		0.90		CDWR	LOGANDALE
1976 1-10	2126:24.6	39.419	121.490	53	85	0*		-.80		CDWR	BANGOR
1976 1-10	2159:33.0	39.410	121.468	54	87	4*		-.80		CDWR	BANGOR
1976 1-11	1125:47.9	39.408	121.484	53	86	5*		-.90		CDWR	BANGOR
1976 1-12	541: 1.5	39.392	121.463	55	88	0*		0.90		CDWR	BANGOR
1976 1-12	1307:47.0	39.407	121.478	53	86	0*		-.50		CDWR	BANGOR
1976 1-13	317:35.1	39.374	121.413	58	93	7*		-.10		CDWR	LOMA RICA
1976 1-13	2054:43.3	39.425	121.476	53	85	0*		-.60		CDWR	BANGOR
1976 1-13	2159:35.2	39.497	121.646	43	69	18*		-.70		CDWR	BIGGS
1976 1-13	2216:51.0	39.390	121.572	50	81	0*		-.50		CDWR	PALERMO
1976 1-14	1412:47.7	39.407	121.455	55	88	0*		-.50		CDWR	BANGOR
1976 1-14	2140:31.7	39.657	122.090	17	27	6*		0.70		CDWR	HAMILTON CITY
1976 1-15	450: 9.7	39.404	121.490	53	86	0*		-.70		CDWR	BANGOR
1976 1-15	2041:18.1	39.414	121.518	52	83	1*		-.40		CDWR	PALERMO
1976 1-16	57:45.9	39.412	121.487	53	85	0*		-.40		CDWR	BANGOR
1976 1-16	454: 8.4	39.414	121.488	53	85	0*		-.30		CDWR	BANGOR
1976 1-16	2105:23.6	39.390	121.466	55	88	0*		2.10		CDWR	BANGOR
1976 1-16	2331:45.2	39.521	121.466	50	81	0*		2.20		CDWR	OROVILLE DAM
1976 1-17	501:29.7	39.442	121.533	50	80	8*		-.70		CDWR	PALERMO
1976 1-17	515:25.5	39.430	121.506	52	83	0*		-.60		CDWR	PALERMO
1976 1-17	715:19.9	39.434	121.515	51	82	4*		3.10		CDWR	PALERMO
1976 1-17	905: 0.3	39.411	121.440	55	89	0*		-.40		CDWR	BANGOR
1976 1-17	1232:48.4	39.405	121.465	54	87	0*		-.50		CDWR	BANGOR
1976 1-18	37:22.9	39.424	121.494	52	84	6*		3.30		CDWR	BANGOR
1976 1-19	1446:47.8	39.417	121.490	53	85	0*		-.30		CDWR	BANGOR
1976 1-19	1516:12.2	39.418	121.479	53	86	4*		-.80		CDWR	BANGOR
1976 1-19	1534: 5.3	39.416	121.504	52	84	0*		1.00		CDWR	PALERMO
1976 1-20	558:23.9	39.434	121.467	53	86	0*		-.20		CDWR	BANGOR
1976 1-21	657:46.3	39.419	121.516	52	83	4*		-.70		CDWR	PALERMO
1976 1-22	745: 1.2	39.426	121.492	52	84	0*		-.30		CDWR	BANGOR
1976 1-22	816:41.8	39.425	121.492	52	84	0*		0.80		CDWR	BANGOR
1976 1-22	817:27.5	39.390	121.445	56	90	10*		-.30		CDWR	BANGOR
1976 1-22	1157:37.8	39.451	121.472	52	84	0*		1.90		CDWR	BANGOR
1976 1-23	1212:33.9	39.424	121.488	53	85	0*		-.40		CDWR	BANGOR
1976 1-23	1313:18.9	39.415	121.486	53	85	0*		2.30		CDWR	BANGOR
1976 1-25	331:22.0	39.410	121.472	54	87	0*		-.20		CDWR	BANGOR

EARTHQUAKE CATALOG

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1976	1-25	801:21.9	39.451	121.491	52	83	0*		-.40		CDWR	BANGOR
1976	1-26	56: 9.1	39.498	121.515	49	79	8*		-.30		CDWR	PALERMO
1976	1-26	201:42.5	39.431	121.497	52	84	4*		2.90		CDWR	BANGOR
1976	1-26	755: 3.7	39.405	121.503	53	85	2*		-.60		CDWR	PALERMO
1976	1-26	848: 7.9	39.414	121.509	52	84	1*		1.00		CDWR	PALERMO
1976	1-26	1159:34.0	39.565	122.091	22	35	8*		3.00		CDWR	GLENN
1976	1-26	1940: 0.0	39.434	121.569	48	78	10		3.30		USGS	
1976	1-26	1940: 0.7	39.428	121.501	52	83	5*		3.30		CDWR	PALERMO
1976	1-26	2108:14.0	39.435	121.457	53	86	0*		1.80		CDWR	BANGOR
1976	1-27	1850: 2.3	39.365	121.387	59	95	4*		-.80		CDWR	LOMA RICA
1976	1-27	2137:52.1	39.404	121.449	55	89	1*		-.10		CDWR	BANGOR
1976	1-28	352:19.5	39.419	121.545	50	81	4*		2.80		CDWR	PALERMO
1976	1-28	742:55.8	39.325	121.540	54	87	24*		-.20		CDWR	HONCUT
1976	1-28	742:57.8	39.367	121.457	56	90	5*		-.40		CDWR	LOMA RICA
1976	1-28	856: 2.6	39.583	121.705	37	60	0*		-.40		CDWR	SHIPPEE
1976	1-28	2002:54.9	39.493	121.493	50	81	4*		-.60		CDWR	BANGOR
1976	1-28	2341:35.1	39.412	121.529	51	82	2*		2.80		CDWR	PALERMO
1976	1-29	315:25.3	39.434	121.537	50	80	1*		-.60		CDWR	PALERMO
1976	1-29	449:23.7	39.399	121.460	55	88	5*		-.70		CDWR	BANGOR
1976	1-29	1223:10.0	39.431	121.470	53	86	1*		-.10		CDWR	BANGOR
1976	1-30	325:27.1	39.508	121.504	49	79	9*		-.50		CDWR	OROVILLE
1976	1-30	600: 6.7	39.455	121.495	51	82	0*		-.20		CDWR	BANGOR
1976	2- 1	15:31.8	39.438	121.463	53	86	0*		-.40		CDWR	BANGOR
1976	2- 1	836:20.7	39.401	121.475	54	87	0*		-.50		CDWR	BANGOR
1976	2- 1	1807:56.2	39.533	121.614	43	69	6*		2.60		CDWR	OROVILLE
1976	2- 2	2144: 0.0	39.528	121.444	52	83	8*		-.50		CDWR	OROVILLE DAM
1976	2- 4	624:24.5	39.465	121.465	52	84	0*		-.50		CDWR	BANGOR
1976	2- 5	811:53.9	39.404	121.472	54	87	4*		-.80		CDWR	BANGOR
1976	2- 5	1257:46.6	39.528	121.524	48	77	10*		1.10		CDWR	OROVILLE
1976	2- 6	945:18.1	39.498	121.478	51	82	3*		-.50		CDWR	BANGOR
1976	2- 7	504:19.8	39.922	121.548	42	68	14*		0.10		CDWR	PARADISE NE
1976	2- 7	1246:27.0	39.482	121.501	50	81	0*		-.70		CDWR	PALERMO
1976	2- 9	139:13.1	39.459	121.460	53	85	0*		-.50		CDWR	BANGOR
1976	2- 9	956:47.7	39.488	121.500	50	80	5*		2.00		CDWR	BANGOR
1976	2- 9	1106:46.6	39.496	121.515	49	79	0*		2.40		CDWR	PALERMO
1976	2- 9	1333: 5.2	39.513	121.621	43	70	1*		3.00		CDWR	OROVILLE
1976	2- 9	1342:39.0	39.490	121.469	52	83	0*		1.50		CDWR	BANGOR
1976	2- 9	1357:48.5	39.506	121.614	44	71	1*		2.30		CDWR	OROVILLE
1976	2- 9	2215:14.2	39.434	121.498	52	83	0*		-.30		CDWR	BANGOR
1976	2-10	426:46.3	39.413	121.479	53	86	0*		-.30		CDWR	BANGOR
1976	2-10	934:16.8	39.412	121.438	55	89	4*		-.40		CDWR	BANGOR
1976	2-10	2052: 6.1	39.421	121.472	53	86	1*		-.50		CDWR	BANGOR
1976	2-12	1226:16.7	39.430	121.480	53	85	0*		-.10		CDWR	BANGOR
1976	2-14	636:27.6	39.408	121.457	55	88	0*		-.30		CDWR	BANGOR
1976	2-14	818:40.0	39.521	121.515	48	78	7*		-.80		CDWR	OROVILLE
1976	2-16	11:54.4	39.413	121.485	53	86	0*		-.90		CDWR	BANGOR
1976	2-16	115:26.5	39.413	121.467	54	87	3*		1.00		CDWR	BANGOR
1976	2-16	1226:36.7	39.617	121.978	24	38	9*		-.20		CDWR	LLANO SECO
1976	2-19	1003: 9.9	39.493	121.497	50	80	6*		0.70		CDWR	BANGOR
1976	2-19	1214:44.7	39.468	121.508	50	81	6*		-.50		CDWR	PALERMO
1976	2-22	1738:35.3	39.465	121.506	50	81	4*		-.60		CDWR	PALERMO
1976	2-23	959:33.4	39.479	121.494	50	81	0*		-.70		CDWR	BANGOR
1976	2-23	1001: 9.6	39.476	121.492	51	82	3*		-.70		CDWR	BANGOR
1976	2-24	1948: 8.9	39.416	121.523	52	83	10*		-.90		CDWR	PALERMO

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1976 2-25	647:56.7	39.465	121.457	53	85	5*		-.70	CDWR	BANGOR
1976 2-25	1803:38.5	39.485	121.453	52	84	0*		-.80	CDWR	BANGOR
1976 2-25	2340: 1.8	39.415	121.478	53	86	1*		1.00	CDWR	BANGOR
1976 2-26	741: 5.0	39.445	121.525	50	81	7*		-.50	CDWR	PALERMO
1976 2-27	1645: 0.7	39.500	121.511	49	79	8*		-.90	CDWR	OROVILLE
1976 2-28	901: 9.2	39.420	121.486	53	85	4*		-.50	CDWR	BANGOR
1976 2-29	18: 4.6	39.525	122.072	24	39	10*		0.00	CDWR	GLENN
1976 2-29	202:48.5	39.494	121.485	50	81	5*		-.90	CDWR	BANGOR
1976 2-29	533:33.2	39.471	121.511	50	80	4*		-.70	CDWR	PALERMO
1976 2-29	1053:14.8	39.507	121.515	48	78	7*		-.80	CDWR	OROVILLE
1976 3- 2	159:27.6	39.462	121.544	48	78	8*		-.80	CDWR	PALERMO
1976 3- 4	615:38.6	39.410	121.483	53	86	3*		-.50	CDWR	BANGOR
1976 3- 4	810: 7.6	39.411	121.515	52	83	5*		-.20	CDWR	PALERMO
1976 3- 4	952:23.9	39.462	121.466	52	84	0*		-.50	CDWR	BANGOR
1976 3- 4	1535:51.2	39.472	121.502	50	81	1*		1.00	CDWR	PALERMO
1976 3- 5	850:33.0	39.428	121.488	52	84	3*		-.50	CDWR	BANGOR
1976 3- 5	2116:32.7	39.782	121.655	36	58	17*		-.10	CDWR	PARADISE SW
1976 3- 8	8: 2.5	39.923	121.494	45	73	10*		0.30	CDWR	PULGA NW
1976 3-10	1207:47.7	39.410	121.468	54	87	2*		-.70	CDWR	BANGOR
1976 3-12	538:26.7	39.477	121.493	50	81	2*		-.80	CDWR	BANGOR
1976 3-12	549:21.5	39.473	121.517	50	80	2*		-.60	CDWR	PALERMO
1976 3-13	7:44.8	39.440	121.518	51	82	6*		-.80	CDWR	PALERMO
1976 3-14	8:33.4	39.515	121.511	48	78	7*		-.80	CDWR	OROVILLE
1976 3-14	908: 5.6	39.507	121.506	49	79	8*		-.60	CDWR	OROVILLE
1976 3-14	2338: 9.8	39.462	121.535	49	79	5*		1.00	CDWR	PALERMO
1976 3-15	605:19.5	39.400	121.479	54	87	3*		0.60	CDWR	BANGOR
1976 3-15	652:31.9	39.464	121.479	52	83	0*		-.70	CDWR	BANGOR
1976 3-15	714:19.6	39.406	121.499	53	85	1*		2.70	CDWR	BANGOR
1976 3-15	716:32.2	39.429	121.444	55	88	0*		0.40	CDWR	BANGOR
1976 3-15	743:22.4	39.400	121.499	53	85	5*		0.20	CDWR	BANGOR
1976 3-15	754:35.7	39.396	121.499	53	86	7*		0.40	CDWR	BANGOR
1976 3-15	1045:37.0	39.396	121.501	53	85	5*		0.60	CDWR	PALERMO
1976 3-16	243:34.8	39.482	121.489	50	81	3*		-.30	CDWR	BANGOR
1976 3-16	323:59.9	40.131	122.304	22	35	1*		0.80	CDWR	RED BLUFF WEST
1976 3-16	350:34.1	40.087	122.074	24	38	8*		1.20	CDWR	LOS MOLINOS
1976 3-16	414:16.2	39.448	121.494	52	83	3*		0.10	CDWR	BANGOR
1976 3-16	1303:25.1	39.426	121.379	58	93	1*		0.00	CDWR	BANGOR
1976 3-17	707:22.2	39.525	121.503	48	78	5*		-.80	CDWR	OROVILLE
1976 3-18	1625: 8.5	39.539	121.507	48	77	7*		-.70	CDWR	OROVILLE
1976 3-19	214:56.2	39.546	121.526	47	76	5*		2.60	CDWR	OROVILLE
1976 3-19	1209:37.9	39.413	121.457	55	88	0*		-.60	CDWR	BANGOR
1976 3-19	1432:26.2	40.066	121.383	53	86	9*		0.00	CDWR	JONESVILLE SW
1976 3-20	843: 0.5	39.401	121.485	53	86	9*		-.70	CDWR	BANGOR
1976 3-20	1157:13.7	39.441	121.475	53	85	2*		-.80	CDWR	BANGOR
1976 3-20	1209:42.2	39.413	121.469	54	87	0*		-.70	CDWR	BANGOR
1976 3-20	2134:57.4	39.400	121.489	53	86	0*		-.30	CDWR	BANGOR
1976 3-20	2314:39.4	39.402	121.412	57	92	5*		0.10	CDWR	BANGOR
1976 3-21	906:11.6	39.582	121.430	51	82	5*		1.00	CDWR	OROVILLE DAM
1976 3-21	1403:26.1	39.395	121.534	52	83	0*		1.00	CDWR	PALERMO
1976 3-22	259:36.6	39.433	121.522	51	82	8*		-.50	CDWR	PALERMO
1976 3-22	1213:43.9	39.474	122.022	29	46	7*		-.10	CDWR	PRINCETON
1976 3-23	2048:28.2	39.412	121.516	52	83	8*		-.80	CDWR	PALERMO
1976 3-25	654:20.3	39.480	122.035	28	45	17*		0.60	CDWR	PRINCETON
1976 3-26	230:29.2	39.396	121.470	55	88	1*		-.60	CDWR	BANGOR

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRN	CD	REF.	COMMENTS
1976 3-27	1551:42.7	39.500	121.476	51	82	0*		2.70		CDWR	OROVILLE DAM
1976 3-28	815:31.6	39.510	121.500	49	79	12*		-.30		CDWR	OROVILLE
1976 3-28	842: 5.4	39.510	121.519	48	78	8*		0.80		CDWR	OROVILLE
1976 3-28	1315:50.6	39.399	121.490	53	86	2*		-.70		CDWR	BANGOR
1976 3-28	1419:30.2	39.417	121.509	52	84	1*		-.60		CDWR	PALERMO
1976 3-28	1744:29.4	39.437	121.489	52	84	2*		-.50		CDWR	BANGOR
1976 3-30	1903: 9.8	39.410	121.484	53	86	5*		0.80		CDWR	BANGOR
1976 3-31	2058:32.3	39.501	121.523	48	78	8*		-.90		CDWR	OROVILLE
1976 4- 1	2303: 9.3	39.415	121.505	52	84	6*		-.40		CDWR	PALERMO
1976 4- 1	2307:56.2	39.599	121.439	50	81	0*		-.50		CDWR	OROVILLE DAM
1976 4- 4	1804:31.8	39.417	121.478	53	86	0*		-.60		CDWR	BANGOR
1976 4- 9	1329:58.0	39.868	121.604	39	63	4*		2.80		CDWR	PARADISE SE
1976 4-11	944:23.0	39.533	121.389	54	87	8*		-.40		CDWR	OROVILLE DAM
1976 4-11	1215:49.9	39.579	122.089	21	34	19*		0.80		CDWR	GLENN
1976 4-12	743: 5.3	39.413	121.423	56	90	0*		-.80		CDWR	BANGOR
1976 4-12	1035:52.2	39.503	121.528	48	77	10*		-.70		CDWR	OROVILLE
1976 4-12	1045:18.1	39.558	121.379	54	87	8*		-.50		CDWR	OROVILLE DAM
1976 4-12	1757:20.4	39.512	121.477	50	81	3*		-.50		CDWR	OROVILLE DAM
1976 4-13	1900:21.4	39.391	121.534	52	83	5*		-.40		CDWR	PALERMO
1976 4-13	2115:21.2	39.405	121.516	52	84	1*		-.20		CDWR	PALERMO
1976 4-14	18:19.0	39.460	121.513	50	81	1*		-.80		CDWR	PALERMO
1976 4-14	833:39.5	39.510	122.029	27	43	8*		-.40		CDWR	GLENN
1976 4-16	625:29.7	39.419	121.476	53	86	0*		-.70		CDWR	BANGOR
1976 4-16	1305:59.5	39.428	121.492	52	84	4*		-.50		CDWR	BANGOR
1976 4-16	1711:47.9	39.632	121.711	35	57	0*		3.00		CDWR	HAMLIN CANYON
1976 4-16	1721:36.9	39.496	121.473	51	82	0*		2.50		CDWR	BANGOR
1976 4-19	825:48.1	39.406	121.452	55	88	1*		1.00		CDWR	BANGOR
1976 4-19	903:38.2	39.513	121.527	48	77	0*		-.60		CDWR	OROVILLE
1976 4-19	1349:51.0	40.146	121.427	53	86	2*		0.20		CDWR	JONESVILLE NW
1976 4-19	1837:43.7	39.412	121.517	52	83	0*		-.60		CDWR	PALERMO
1976 4-19	2240:45.1	39.266	122.600	40	65	5*		1.10		CDWR	GILMORE PEAK
1976 4-20	2131:28.6	40.280	121.684	47	76	5*		0.80		CDWR	LASSEN PEAK SW
1976 4-22	706: 7.7	39.535	121.501	48	78	6*		-.60		CDWR	OROVILLE
1976 4-22	1335:38.7	39.411	121.496	53	85	5*		2.40		CDWR	BANGOR
1976 4-23	251:46.3	39.517	121.520	48	77	10*		-.40		CDWR	OROVILLE
1976 4-23	1135: 4.6	40.006	121.501	47	75	7*		0.30		CDWR	BUTTE MEADOWS SE
1976 4-25	204:43.1	39.413	121.476	53	86	4*		0.10		CDWR	BANGOR
1976 4-26	349:25.3	39.401	121.491	53	86	5*		0.30		CDWR	BANGOR
1976 4-26	2007:48.9	39.478	121.526	49	79	3*		-.10		CDWR	PALERMO
1976 4-27	229:12.0	39.402	121.460	55	88	3*		-.20		CDWR	BANGOR
1976 4-27	925:15.9	39.407	121.479	53	86	0*		-.30		CDWR	BANGOR
1976 4-29	2133:54.3	39.520	121.497	49	79	5*		0.10		CDWR	OROVILLE DAM
1976 4-30	7:24.0	39.529	121.479	50	80	5*		-.30		CDWR	OROVILLE DAM
1976 4-30	705:50.8	39.428	121.461	53	86	3*		-.40		CDWR	BANGOR
1976 4-30	2051:39.2	39.427	121.484	53	85	0*		-.80		CDWR	BANGOR
1976 5- 1	808:53.0	39.414	121.486	53	85	4*		-.60		CDWR	BANGOR
1976 5- 2	5:36.2	39.486	121.505	50	80	1*		-.50		CDWR	PALERMO
1976 5- 2	1902:45.9	39.382	121.540	52	83	0*		-.90		CDWR	PALERMO
1976 5- 3	1216:15.4	39.125	121.444	67	108	11*		0.30		CDWR	BROWNS VALLEY
1976 5- 4	623:16.4	39.485	121.516	49	79	0*		-.40		CDWR	PALERMO
1976 5- 4	1153: 2.0	39.457	121.475	52	84	1*		-.50		CDWR	BANGOR
1976 5- 7	741:43.8	39.464	121.442	53	86	0*		2.40		CDWR	BANGOR
1976 5- 7	1305:49.6	39.474	121.481	51	82	0*		-.60		CDWR	BANGOR
1976 5- 7	1348: 3.2	39.419	121.483	53	85	2*		-.80		CDWR	BANGOR

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1976	5-11	205:32.2	39.507	121.480	50	81	0*		-.90		CDWR	OROVILLE DAM
1976	5-11	1120:43.6	39.416	121.499	52	84	7*		-.30		CDWR	BANGOR
1976	5-11	2138:21.5	39.411	121.469	54	87	2*		1.00		CDWR	BANGOR
1976	5-12	1429:15.3	39.399	121.465	55	88	1*		-.30		CDWR	BANGOR
1976	5-13	2333:42.2	39.533	121.477	50	80	0*		-.80		CDWR	OROVILLE DAM
1976	5-15	1536: 7.5	39.416	121.476	53	86	3*		-.80		CDWR	BANGOR
1976	5-17	1713: 8.0	39.448	121.486	52	83	2*		-.40		CDWR	BANGOR
1976	5-18	946:46.8	39.467	121.465	52	84	0*		1.60		CDWR	BANGOR
1976	5-18	2333:35.0	39.143	121.717	57	91	5*		0.30		CDWR	SUTTER
1976	5-19	110: 3.1	39.514	121.479	50	81	3*		-.40		CDWR	OROVILLE DAM
1976	5-19	1115:43.6	39.390	121.536	52	83	1*		-.90		CDWR	PALERMO
1976	5-19	1127:23.9	39.487	121.488	50	81	2*		1.00		CDWR	BANGOR
1976	5-19	1320: 2.7	39.482	121.502	50	80	0*		-.80		CDWR	PALERMO
1976	5-20	727:34.5	39.486	121.493	50	81	0*		1.30		CDWR	BANGOR
1976	5-21	2321:24.0	39.748	121.739	32	52	1*		-.10		CDWR	HAMLIN CANYON
1976	5-22	2116:32.2	39.409	121.497	53	85	3*		-.50		CDWR	BANGOR
1976	5-23	8:47.0	39.468	121.510	50	81	5*		-.50		CDWR	PALERMO
1976	5-26	355:25.4	39.488	121.527	48	78	5*		2.40		CDWR	PALERMO
1976	5-26	1124:29.7	39.409	121.482	53	86	5*		-.90		CDWR	BANGOR
1976	5-27	1355:38.8	39.399	121.487	53	86	6*		-.60		CDWR	BANGOR
1976	5-29	514:29.9	39.785	122.743	22	35	5*		1.60		CDWR	HALL RIDGE
1976	5-30	51: 0.2	39.400	121.485	53	86	2*		-.30		CDWR	BANGOR
1976	5-30	1826:18.0	39.393	121.479	54	87	7*		-.30		CDWR	BANGOR
1976	5-30	2111:31.3	39.397	121.460	55	88	0*		-.60		CDWR	BANGOR
1976	5-31	236: 1.2	39.503	121.517	48	78	0*		2.50		CDWR	OROVILLE
1976	5-31	355:45.0	39.419	121.466	54	87	4*		-.70		CDWR	BANGOR
1976	5-31	530: 2.5	39.423	121.478	53	85	0*		-.70		CDWR	BANGOR
1976	5-31	831:43.3	39.512	121.522	48	77	4*		2.20		CDWR	OROVILLE
1976	5-31	842:18.5	39.519	121.540	47	76	7*		-.90		CDWR	OROVILLE
1976	5-31	905:38.1	39.609	121.682	37	60	1*		-.90		CDWR	SHIPPEE
1976	5-31	1648:58.3	39.438	121.523	50	81	8*		1.00		CDWR	PALERMO
1976	6- 4	14:55.4	39.426	121.456	54	87	0*		-.50		CDWR	BANGOR
1976	6- 4	956:23.4	39.479	121.505	50	80	3*		-.50		CDWR	PALERMO
1976	6- 4	1152:34.8	39.517	121.629	43	69	36*		-.70		CDWR	SHIPPEE
1976	6- 4	2232:59.7	39.774	121.877	25	40	2*		0.30		CDWR	NORD
1976	6- 5	628:41.7	39.701	122.066	16	26	6*		1.30		CDWR	HAMILTON CITY
1976	6- 5	1239: 7.0	39.508	121.506	49	79	7*		-.60		CDWR	OROVILLE
1976	6- 6	1214:18.7	39.424	121.483	53	85	6*		0.40		CDWR	BANGOR
1976	6- 8	946:40.2	39.454	121.506	51	82	4*		-.80		CDWR	PALERMO
1976	6- 8	1111:30.6	39.467	121.985	30	49	24*		1.70		CDWR	BUTTE CITY
1976	6- 9	352:11.7	39.514	121.560	46	74	2*		0.10		CDWR	OROVILLE
1976	6- 9	705:38.0	39.764	121.595	40	64	19*		-.90		CDWR	PARADISE SE
1976	6- 9	720:29.1	39.512	121.527	48	77	2*		0.10		CDWR	OROVILLE
1976	6- 9	853:58.0	39.413	121.483	53	86	0*		-.20		CDWR	BANGOR
1976	6- 9	1748: 9.7	39.708	121.999	19	31	3*		0.30		CDWR	ORD FERRY
1976	6-12	1338:21.5	39.397	121.465	55	88	0*		0.60		CDWR	BANGOR
1976	6-14	637:28.2	39.471	121.513	50	80	8*		2.50		CDWR	PALERMO
1976	6-14	733:52.4	39.752	121.580	40	65	13*		0.60		CDWR	PARADISE SE
1976	6-14	1836: 6.5	39.527	121.521	48	77	3*		1.90		CDWR	OROVILLE
1976	6-14	1914:36.8	39.521	121.523	48	77	7*		-.40		CDWR	OROVILLE
1976	6-14	2117:35.3	39.390	121.479	54	87	2*		0.20		CDWR	BANGOR
1976	6-14	2330:25.5	39.482	121.605	45	73	11	V	3.80		USGS	
1976	6-14	2351:24.7	39.384	121.435	57	91	1*		0.60		CDWR	BANGOR
1976	6-14	2351:55.0	39.475	121.526	49	79	3*		0.90		CDWR	PALERMO

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1976 6-15	231:18.3	39.397	121.479	54	87	0*		0.40		CDWR	BANGOR
1976 6-15	357: 3.8	39.491	121.540	48	77	0*		-.40		CDWR	PALERMO
1976 6-15	536:15.0	39.546	122.238	19	31	6*		1.20		CDWR	WILLOWS
1976 6-15	1234:46.1	39.498	121.564	47	75	5*		-.10		CDWR	PALERMO
1976 6-16	34:18.5	39.493	121.463	52	83	1*		-.40		CDWR	BANGOR
1976 6-17	2234:41.7	39.805	121.840	26	42	6*		0.00		CDWR	RICHARDSON SPRINGS
1976 6-18	425:26.7	39.463	121.479	52	83	2*		-.70		CDWR	BANGOR
1976 6-18	556:47.4	39.447	121.463	53	85	0*		-.40		CDWR	BANGOR
1976 6-18	955: 4.3	39.462	121.475	52	84	3*		-.80		CDWR	BANGOR
1976 6-18	1141:57.7	39.734	121.708	34	55	17*		-.50		CDWR	HAMLIN CANYON
1976 6-18	1233:19.9	39.433	121.600	47	76	5*		-.50		CDWR	PALERMO
1976 6-18	2301:11.7	39.468	121.487	51	82	0*		0.50		CDWR	BANGOR
1976 6-20	525:30.6	39.399	121.452	55	89	4*		-.10		CDWR	BANGOR
1976 6-21	917:13.5	39.494	121.481	50	81	0*		-.50		CDWR	BANGOR
1976 6-21	2008:26.1	39.409	121.485	53	86	4*		-.50		CDWR	BANGOR
1976 6-24	1201:19.5	39.390	121.494	53	86	2*		-.40		CDWR	BANGOR
1976 6-24	1556:57.9	40.290	122.731	39	63	4*		1.10		CDWR	ONO SW
1976 6-24	2043:19.2	39.418	121.464	54	87	4*		-.90		CDWR	BANGOR
1976 6-25	111:53.2	39.419	121.454	54	87	1*		-.60		CDWR	BANGOR
1976 6-25	152:28.7	39.754	121.976	20	32	5*		0.40		CDWR	NORD
1976 6-25	1912:22.4	39.418	121.466	54	87	0*		1.00		CDWR	BANGOR
1976 6-26	401:53.5	39.707	121.967	21	34	11*		0.20		CDWR	ORD FERRY
1976 6-26	603: 0.7	39.409	121.494	53	85	1*		0.80		CDWR	BANGOR
1976 6-27	200:29.1	39.412	121.479	53	86	4*		-.80		CDWR	BANGOR
1976 6-27	1858:13.1	39.423	121.518	52	83	8*		-.10		CDWR	PALERMO
1976 6-27	1949:59.4	39.403	121.569	50	80	0*		-.20		CDWR	PALERMO
1976 6-28	102: 2.9	39.424	121.489	53	85	0*		-.20		CDWR	BANGOR
1976 6-29	703:58.6	39.536	121.524	47	76	5*		1.90		CDWR	OROVILLE
1976 6-29	838:59.3	39.409	121.478	53	86	4*		-.30		CDWR	BANGOR
1976 6-30	18:12.7	39.406	121.497	53	85	0*		-.40		CDWR	BANGOR
1976 7- 3	2014:28.7	39.441	121.481	52	84	1*		-.60		CDWR	BANGOR
1976 7- 5	1047:18.4	39.477	121.527	49	79	7*		-.30		CDWR	PALERMO
1976 7- 6	355:16.2	39.399	121.601	48	78	5	V	4.10		USGS	
1976 7- 6	759:34.2	39.421	121.513	52	83	3*		0.60		CDWR	PALERMO
1976 7- 7	17: 1.5	39.402	121.536	51	82	5*		-.60		CDWR	PALERMO
1976 7- 7	5?:21.3	39.859	121.643	37	60	0*		0.30		CDWR	PARADISE SW
1976 7- 7	343:48.1	39.542	121.498	48	78	7*		1.60		CDWR	OROVILLE DAM
1976 7- 7	550: 1.5	39.611	122.133	17	28	12*		0.70		CDWR	WILLOWS
1976 7- 8	1024:18.1	39.430	121.380	57	92	0*		0.80		CDWR	BANGOR
1976 7- 9	530:40.5	39.412	121.498	53	85	4*		-.30		CDWR	BANGOR
1976 7- 9	2227:41.0	39.482	121.501	50	81	6*		-.80		CDWR	PALERMO
1976 7-11	2319:20.3	39.408	121.473	54	87	0*		1.50		CDWR	BANGOR
1976 7-11	2320:24.1	39.402	121.491	53	86	1*		0.80		CDWR	BANGOR
1976 7-12	1923:12.7	39.844	121.401	50	80	2*		-.30		CDWR	PULGA SW
1976 7-14	301:57.7	39.411	121.497	53	85	2*		-.30		CDWR	BANGOR
1976 7-14	304:14.9	39.411	121.486	53	86	5*		-.50		CDWR	BANGOR
1976 7-14	2118:44.1	39.496	121.514	49	79	5*		-.70		CDWR	PALERMO
1976 7-15	341:39.3	39.391	121.482	54	87	1*		-.80		CDWR	BANGOR
1976 7-15	440:41.0	39.778	121.862	25	41	0*		-.50		CDWR	RICHARDSON SPRINGS
1976 7-16	1337:12.6	39.409	121.516	52	83	9*		-.90		CDWR	PALERMO
1976 7-17	351:50.6	39.532	121.630	42	68	34*		-.60		CDWR	SHIPPEE
1976 7-17	1959:57.3	39.397	121.470	55	88	1*		-.40		CDWR	BANGOR
1976 7-18	454:33.1	39.392	121.521	52	84	5*		0.00		CDWR	PALERMO
1976 7-18	1341: 6.6	39.402	121.477	54	87	3*		0.10		CDWR	BANGOR

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1976 7-19	1134:42.9	39.508	121.472	51	82	2*		-.90		CDWR	OROVILLE DAM
1976 7-20	747:24.0	39.402	121.473	54	87	2*		-.20		CDWR	BANGOR
1976 7-23	1621:15.7	39.507	121.514	48	78	10*		-.80		CDWR	OROVILLE
1976 7-23	1924: 9.9	39.509	122.006	27	44	9*		-.10		CDWR	GLENN
1976 7-24	215:53.6	39.125	121.797	55	89	11*		0.60		CDWR	SUTTER BUTTES
1976 7-24	1226:43.6	39.409	121.482	53	86	4*		-.70		CDWR	BANGOR
1976 7-24	1257: 1.9	39.488	121.514	49	79	7*		-.60		CDWR	PALERMO
1976 7-24	1906:29.2	39.515	121.513	48	78	10*		-.70		CDWR	OROVILLE
1976 7-25	412:25.0	39.694	122.026	19	30	6*		0.10		CDWR	HAMILTON CITY
1976 7-27	953:49.7	40.169	121.366	57	92	8*		-.10		CDWR	JONESVILLE NE
1976 7-27	1230: 0.2	39.686	121.612	40	64	0*		1.10		CDWR	CHEROKEE
1976 7-28	1436:57.2	39.481	121.481	51	82	0*		-.80		CDWR	BANGOR
1976 7-28	1437: 4.6	39.490	121.471	51	82	1*		-.70		CDWR	BANGOR
1976 7-28	2003:47.8	39.483	121.493	50	81	3*		-.60		CDWR	BANGOR
1976 7-29	533:43.6	39.563	122.083	22	35	0*		-.50		CDWR	GLENN
1976 7-29	1130: 1.2	39.327	121.843	43	69	0*		1.40		CDWR	PENNINGTON
1976 7-29	1200: 1.5	39.421	121.419	56	90	1*		-.50		CDWR	BANGOR
1976 7-30	1727:41.3	39.491	121.523	48	78	11*		1.00		CDWR	PALERMO
1976 7-31	1442:13.1	39.839	121.497	45	72	5*		-.40		CDWR	PULGA SW
1976 8- 1	130:53.0	39.699	122.102	15	24	5*		0.40		CDWR	HAMILTON CITY
1976 8- 1	1240:46.1	39.440	121.428	55	88	0*		-.70		CDWR	BANGOR
1976 8- 3	339:42.0	39.467	121.460	52	84	5*		-.20		CDWR	BANGOR
1976 8- 3	913:23.4	39.534	121.495	49	79	5*		1.00		CDWR	OROVILLE DAM
1976 8- 3	2028:25.6	39.494	121.563	47	75	11*		-.90		CDWR	PALERMO
1976 8- 4	855:49.9	39.400	121.483	53	86	2*		-.70		CDWR	BANGOR
1976 8- 5	1405:44.8	39.533	121.491	49	79	5*		1.00		CDWR	OROVILLE DAM
1976 8- 5	2021:50.8	39.465	121.490	51	82	3*		0.20		CDWR	BANGOR
1976 8- 6	910:49.5	39.421	121.469	53	86	12*		-.90		CDWR	BANGOR
1976 8- 7	739:57.4	39.395	121.448	55	89	0*		-.20		CDWR	BANGOR
1976 8- 8	407:42.5	39.716	121.844	27	44	5*		-.10		CDWR	CHICO
1976 8- 8	1952:45.4	39.487	121.503	50	80	5*		-.70		CDWR	PALERMO
1976 8- 8	1952:57.5	39.492	121.495	50	80	4*		-.60		CDWR	BANGOR
1976 8- 8	1955:22.4	39.493	121.500	50	80	4*		-.60		CDWR	BANGOR
1976 8- 9	1504:21.1	39.405	121.449	55	89	0*		-.80		CDWR	BANGOR
1976 8- 9	1515: 1.1	39.402	121.446	55	89	1*		-.80		CDWR	BANGOR
1976 8- 9	1538:56.7	39.505	121.518	48	78	8*		-.50		CDWR	OROVILLE
1976 8- 9	1746:47.3	39.488	121.493	50	81	4*		-.10		CDWR	BANGOR
1976 8-10	439:15.1	39.654	121.507	45	73	5*		-.60		CDWR	CHEROKEE
1976 8-10	828:29.3	39.441	121.460	53	86	0*		0.10		CDWR	BANGOR
1976 8-10	1113:36.9	39.419	121.461	54	87	3*		-.70		CDWR	BANGOR
1976 8-12	1314:35.2	39.529	121.515	48	77	7*		-.90		CDWR	OROVILLE
1976 8-13	758:36.6	39.426	121.400	57	91	0*		-.40		CDWR	BANGOR
1976 8-14	708:49.6	39.401	121.481	54	87	2*		-.60		CDWR	BANGOR
1976 8-14	1529:50.2	39.403	121.481	53	86	3*		-.60		CDWR	BANGOR
1976 8-15	833: 7.0	39.421	121.459	54	87	1*		-.30		CDWR	BANGOR
1976 8-15	1440:15.9	39.409	121.805	40	64	10*		0.40		CDWR	WEST OF BIGGS
1976 8-16	619:22.4	39.450	121.466	53	85	4*		-.70		CDWR	BANGOR
1976 8-16	1511:58.0	39.422	121.520	51	82	1*		2.70		CDWR	PALERMO
1976 8-16	2313:42.1	39.408	121.508	52	84	0*		3.00		CDWR	PALERMO
1976 8-18	1035:23.8	39.495	121.529	48	78	8*		-.80		CDWR	PALERMO
1976 8-19	543:49.9	39.525	121.478	50	80	3*		0.80		CDWR	OROVILLE DAM
1976 8-19	815: 1.7	39.465	121.475	52	83	2*		-.70		CDWR	BANGOR
1976 8-19	815: 3.6	39.531	121.488	49	79	5		2.90		USGS	
1976 8-19	815: 4.7	39.466	121.475	52	83	1*		3.30		CDWR	BANGOR

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1976 8-19	824:17.5	39.459	121.474	52	84	4*		-.60		CDWR	BANGOR
1976 8-19	1516:21.8	39.422	121.475	53	86	2*		-.50		CDWR	BANGOR
1976 8-20	126:57.8	39.463	121.475	52	84	8*		-.50		CDWR	BANGOR
1976 8-21	2237:13.2	39.482	121.621	45	72	5*		-.70		CDWR	PALERMO
1976 8-24	710:11.2	39.368	121.386	59	95	5*		-.10		CDWR	LOMA RICA
1976 8-24	715:48.5	39.424	121.475	53	86	1*		0.20		CDWR	BANGOR
1976 8-26	962:53.5	39.211	122.483	42	68	0*		2.00		CDWR	WILBUR SPRINGS NW
1976 8-27	1217:13.7	39.427	121.527	51	82	5*		-.30		CDWR	PALERMO
1976 8-30	1455: 2.9	39.402	121.532	52	83	7*		-.30		CDWR	PALERMO
1976 8-31	1929:35.6	39.518	121.536	47	76	6*		2.90		CDWR	OROVILLE
1976 9- 1	927:40.5	39.398	121.492	53	86	6*		-.70		CDWR	BANGOR
1976 9-17	1421:20.1	39.501	121.510	49	79	8*		-.60		CDWR	OROVILLE
1976 9-18	951:36.4	40.267	122.261	32	51	5*		0.40		CDWR	HOOKER
1976 9-19	2230: 1.0	39.414	121.475	53	86	4*		-.80		CDWR	BANGOR
1976 9-27	1012:21.9	39.473	121.538	48	78	9*		-.80		CDWR	PALERMO
1976 9-28	810:11.2	39.403	121.490	53	86	6*		-.30		CDWR	BANGOR
1976 9-28	1639:43.1	39.416	121.482	53	86	9*		-.50		CDWR	BANGOR
1976 10- 1	336:23.5	39.998	121.500	46	74	1*		0.40		CDWR	PULGA NW
1976 10- 4	640:13.6	39.415	121.452	55	88	2*		1.00		CDWR	BANGOR
1976 10- 5	916: 0.1	39.410	121.472	54	87	0*		-.40		CDWR	BANGOR
1976 10- 6	1820: 1.8	39.396	121.502	53	85	4*		-.40		CDWR	PALERMO
1976 10- 6	1905: 7.0	39.412	121.498	53	85	0*		-.40		CDWR	BANGOR
1976 10- 7	1741:57.0	39.351	121.451	57	92	0*		-.90		CDWR	LOMA RICA
1976 10- 8	314:35.8	39.410	121.437	55	89	0*		-.30		CDWR	BANGOR
1976 10- 8	1506:31.1	40.040	121.360	54	87	1*		0.00		CDWR	JONESVILLE SE
1976 10- 8	2331:25.1	39.394	121.502	53	85	5*		-.60		CDWR	PALERMO
1976 10- 9	219:22.2	39.531	121.477	50	80	5*		-.70		CDWR	OROVILLE DAM
1976 10-10	816:15.9	39.387	121.681	45	73	5*		-.40		CDWR	BIGGS
1976 10-11	108: 3.4	39.399	121.493	53	86	1*		-.90		CDWR	BANGOR
1976 10-12	1542:32.2	39.426	121.461	54	87	1*		-.60		CDWR	BANGOR
1976 10-15	530:25.3	39.836	121.582	40	65	6*		-.50		CDWR	PARADISE SE
1976 10-16	121:14.8	39.407	121.483	53	86	0*		-.70		CDWR	BANGOR
1976 10-21	636:12.1	39.403	121.476	54	87	3*		0.80		CDWR	BANGOR
1976 10-22	1254:24.0	39.403	121.470	54	87	5*		-.90		CDWR	BANGOR
1976 10-24	7:31.3	39.404	121.483	53	86	2*		-.30		CDWR	BANGOR
1976 10-24	25: 8.3	39.410	121.477	53	86	1*		-.90		CDWR	BANGOR
1976 10-24	348:21.7	39.405	121.474	54	87	1*		-.40		CDWR	BANGOR
1976 10-24	1014:24.6	39.409	121.458	55	88	0*		-.40		CDWR	BANGOR
1976 10-26	324:22.6	39.404	121.479	53	86	1*		-.60		CDWR	BANGOR
1976 10-27	918:55.8	39.388	121.541	52	83	5*		-.20		CDWR	PALERMO
1976 10-31	1707:12.1	39.412	121.848	38	61	17*		0.30		CDWR	WEST OF BIGGS
1976 11- 4	238:52.0	39.473	121.500	50	81	3*		-.10		CDWR	PALERMO
1976 11- 8	606: 8.6	39.669	121.926	24	39	14*		0.30		CDWR	ORD FERRY
1976 11- 8	2003:50.7	40.030	121.630	40	65	5*		0.50		CDWR	BUTTE MEADOWS SW
1976 11- 8	2315:34.4	39.513	121.497	49	79	7*		-.80		CDWR	OROVILLE DAM
1976 11-10	814:57.2	39.411	121.484	53	86	0*		-.80		CDWR	BANGOR
1976 11-14	907:47.1	39.401	121.535	52	83	5*		0.00		CDWR	PALERMO
1976 11-15	1717:30.6	39.394	121.667	46	74	5*		0.30		CDWR	BIGGS
1976 11-19	38:41.4	39.510	121.493	50	80	5*		-.70		CDWR	OROVILLE DAM
1976 11-22	1852: 9.9	39.454	121.488	52	83	4*		-.60		CDWR	BANGOR
1976 11-23	657: 6.6	39.397	121.476	54	87	0*		-.60		CDWR	BANGOR
1976 11-23	1258: 6.3	39.468	121.479	52	83	1*		0.60		CDWR	BANGOR
1976 12- 8	1246:22.0	39.812	122.613	15	24	19		3.00		USGS	
1977 1- 9	2324:39.5	39.500	121.643	43	69	2	V	3.30		USGS	

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1977 1- 9	2327:43.9	39.493	121.504	50	80	7*		2.30			PALERMO
1977 1-10	628: 1.5	39.419	121.474	53	86	0*		0.30			BANGOR
1977 1-12	330:13.7	39.411	121.488	53	85	0*		2.50			BANGOR
1977 1-13	1925:19.5	39.522	121.515	48	78	8*		0.70			OROVILLE
1977 1-13	2009:58.3	40.553	122.530	52	84	8*		3.70			FRENCH GULCH SE
1977 1-13	2042:40.0	39.493	121.491	50	81	4*		0.10			BANGOR
1977 1-15	732:54.8	39.486	121.482	51	82	0*		0.90			BANGOR
1977 1-16	418: 2.8	39.491	121.493	50	81	4*		0.00			BANGOR
1977 1-16	726:45.7	39.477	121.446	53	85	5*		0.20			BANGOR
1977 1-17	645:41.6	39.412	121.499	53	85	2*		0.50			BANGOR
1977 1-17	1248:33.1	39.479	121.493	50	81	4*		0.30			BANGOR
1977 1-18	1455:57.2	39.408	121.485	53	86	1*		0.30			BANGOR
1977 1-19	421:29.5	39.461	121.481	52	83	4*		0.50			BANGOR
1977 1-19	1323:26.0	39.479	121.487	51	82	1*		0.80			BANGOR
1977 1-23	1037:31.7	39.416	121.490	53	85	2*		0.20			BANGOR
1977 1-23	1102:14.9	39.400	121.479	54	87	1*		1.00			BANGOR
1977 1-24	826:14.0	39.413	121.488	53	85	5*		0.40			BANGOR
1977 1-25	157:52.7	39.405	121.482	53	86	0*		0.50			BANGOR
1977 1-27	1642:17.5	39.600	122.028	22	35	5*		1.00			GLENN
1977 1-28	337: 6.8	39.522	121.511	48	78	7*		0.10			OROVILLE
1977 1-28	1516:32.8	39.404	121.500	53	85	6*		0.00			PALERMO
1977 1-29	439:56.5	39.402	121.486	53	86	0*		0.30			BANGOR
1977 1-29	1736:18.2	39.531	121.530	47	76	8*		-.10			OROVILLE
1977 1-30	635:25.4	39.442	121.495	52	83	0*		2.80			BANGOR
1977 1-30	2259:44.5	39.430	121.481	53	85	2*		-.10			BANGOR
1977 2- 2	631:32.8	39.421	121.479	53	85	0*		0.50			BANGOR
1977 2- 2	2217: 2.3	39.508	121.499	49	79	7*		-.20			OROVILLE DAM
1977 2- 3	20:13.4	39.438	121.460	53	86	2*		0.40			BANGOR
1977 2- 6	1919:58.4	39.483	121.495	50	81	0*		0.00			BANGOR
1977 2- 7	1449: 2.2	39.342	121.394	60	96	6*		-.10			LOMA RICA
1977 2- 7	1632:14.6	39.580	122.035	23	37	6*		1.00			GLENN
1977 2- 8	454:54.9	39.466	121.477	52	83	1*		0.70			BANGOR
1977 2- 9	644:30.9	39.411	121.470	54	87	3*		-.10			BANGOR
1977 2- 9	645: 9.9	39.412	121.475	53	86	2*		0.80			BANGOR
1977 2- 9	750:58.9	39.410	121.476	53	86	2*		0.50			BANGOR
1977 2- 9	1235:13.6	39.404	121.451	55	89	0*		0.00			BANGOR
1977 2-11	31:59.7	39.413	121.470	54	87	4*		0.00			BANGOR
1977 2-11	41:45.0	39.513	121.491	50	80	6*		0.10			OROVILLE DAM
1977 2-11	206:12.2	39.412	121.472	54	87	2*		0.40			BANGOR
1977 2-13	830:24.2	39.405	121.461	55	88	0*		-.10			BANGOR
1977 2-17	152:15.6	39.727	121.999	19	30	5*		0.80			ORD FERRY
1977 2-17	346: 7.5	39.539	121.561	45	73	10*		0.30			OROVILLE
1977 2-18	1435:25.8	39.407	121.481	53	86	4*		0.30			BANGOR
1977 2-21	551:14.7	39.404	121.474	54	87	3*		0.50			BANGOR
1977 2-21	1109:15.0	39.452	123.243	55	88	10*		3.50			POTTER VALLEY NW
1977 2-23	1940: 0.4	40.546	121.502	67	108	5*		2.70			MANZANITA LAKE SE
1977 2-26	312:21.8	39.507	121.493	50	80	5*		0.70			OROVILLE DAM
1977 2-26	553: 2.2	39.420	121.476	53	86	0*		0.60			BANGOR
1977 2-26	1424: 9.8	39.391	121.507	53	85	1*		0.00			PALERMO
1977 2-26	1934: 3.2	39.412	121.465	54	87	1*		0.20			BANGOR
1977 2-27	1313:54.8	39.445	121.481	52	84	0*		0.80			BANGOR
1977 2-28	541: 9.3	39.435	121.497	52	83	4*		0.40			BANGOR
1977 3- 2	1755:32.6	39.411	121.485	53	86	0*		2.80			BANGOR
1977 3- 3	219: 5.7	39.510	121.521	48	78	7*		0.20			OROVILLE

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1977 3- 3	630:31.6	39.395	121.486	54	87	0*		0.00			BANGOR
1977 3- 4	2229:37.4	39.411	121.479	53	86	4*		0.60			BANGOR
1977 3- 9	2155:27.3	39.471	121.518	[illegible]	80	6*		0.80			PALERMO
1977 3-11	2354:11.6	39.437	121.453	54	87	1*		0.10			BANGOR
1977 3-12	46:15.4	39.423	121.481	53	85	3*		1.20			BANGOR
1977 3-12	1020:50.3	39.742	121.704	34	55	2*		1.00			HAMLIN CANYON
1977 3-14	413:26.7	39.487	121.440	53	85	7*		0.20			BANGOR
1977 3-16	1037:15.3	39.430	121.468	53	86	0*		0.40			BANGOR
1977 3-16	2338:39.4	39.498	121.506	49	79	7*		0.10			PALERMO
1977 3-18	626:21.0	39.492	121.485	50	81	2*		-.10			BANGOR
1977 3-19	2237:21.5	39.404	121.445	55	89	0*		2.60			BANGOR
1977 3-20	455: 5.8	39.500	121.497	50	80	8*		0.80			OROVILLE DAM
1977 3-20	1936: 2.6	39.480	121.408	55	88	0*		0.80			BANGOR
1977 3-24	1555: 4.1	39.508	121.497	50	80	8*		0.70			OROVILLE DAM
1977 3-24	1608:54.8	39.508	121.506	49	79	9*		-.30			OROVILLE
1977 3-24	1941:36.8	39.515	121.486	50	80	7*		0.60			OROVILLE DAM
1977 3-28	350:46.2	39.464	121.955	32	51	9*		1.70			BUTTE CITY
1977 3-29	16:12.2	39.512	121.500	49	79	7*		0.30			OROVILLE
1977 3-29	1202:50.4	39.519	121.508	48	78	9*		-.60			OROVILLE
1977 3-29	1836:34.2	39.517	121.499	49	79	8*		-.60			OROVILLE DAM
1977 4- 1	1249:41.8	39.421	121.471	53	86	1*		0.40			BANGOR
1977 4- 2	1728:25.1	39.399	121.454	55	89	0*		-.20			BANGOR
1977 4- 3	1020:44.5	39.706	122.872	29	47	5		3.20		USGS	
1977 4- 5	1750:42.9	39.449	121.520	50	81	10*		-.20			PALERMO
1977 4- 7	334:33.1	39.502	121.443	52	84	5*		0.00			OROVILLE DAM
1977 4- 7	1042:31.9	39.520	121.993	27	44	10*		1.90			LLANO SECO
1977 4- 9	700:25.9	39.454	121.464	53	85	3*		0.20			BANGOR
1977 4- 9	1937:37.1	39.521	121.462	51	82	10*		0.30			OROVILLE DAM
1977 4-10	1329:14.0	39.411	121.454	55	88	0*		-.20			BANGOR
1977 4-11	1819:30.6	39.449	121.485	52	83	0*		0.40			BANGOR
1977 4-15	1139:40.1	39.408	121.484	53	86	3*		1.10			BANGOR
1977 4-15	2257:11.4	39.506	121.485	50	81	5*		-.10			OROVILLE DAM
1977 4-16	517: 3.6	39.463	121.497	51	82	4*		0.30			BANGOR
1977 4-16	1057:58.8	39.463	121.530	49	79	7*		0.80			PALERMO
1977 4-16	2310:14.8	39.480	121.481	51	82	4*		-.20			BANGOR
1977 4-21	1231:23.1	39.487	121.444	53	85	8*		0.90			BANGOR
1977 4-22	15:52.6	39.408	121.477	53	86	0*		0.80			BANGOR
1977 4-22	527:16.0	39.552	121.565	45	72	7*		-.10			OROVILLE
1977 4-23	1324:56.4	39.411	121.482	53	86	1*		0.80			BANGOR
1977 4-24	2314:17.5	39.403	121.460	55	88	3*		0.60			BANGOR
1977 4-26	2225:49.2	39.405	121.486	53	86	1*		0.90			BANGOR
1977 4-27	426:29.2	39.403	121.487	53	86	1*		1.90			BANGOR
1977 4-28	1745:52.2	39.406	121.478	53	86	0*		1.20			BANGOR
1977 5- 4	611:11.4	39.406	121.496	53	85	3*		3.10			BANGOR
1977 5- 4	615:36.4	39.401	121.476	54	87	0*		2.90			BANGOR
1977 5- 4	659:10.3	39.405	121.478	53	86	0*		3.40			BANGOR
1977 5- 4	826:12.3	39.400	121.479	54	87	0*		0.20			BANGOR
1977 5- 4	1342:24.2	39.397	121.485	53	86	0*		-.10			BANGOR
1977 5- 5	1019:40.7	39.397	121.478	54	87	0*		0.10			BANGOR
1977 5- 5	1641:44.3	39.410	121.500	53	85	0*		0.30			PALERMO
1977 5- 6	701:53.1	39.398	121.472	54	87	0*		1.50			BANGOR
1977 5- 6	822:52.2	39.398	121.473	54	87	0*		0.30			BANGOR
1977 5- 6	1343:59.6	39.395	121.476	54	87	0*		0.50			BANGOR
1977 5- 8	30:57.9	39.395	121.488	53	86	4*		0.70			BANGOR

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1977 5-10	229:40.2	39.392	121.482	54	87	0*		0.10			BANGOR
1977 5-10	1104:40.2	39.408	121.465	54	87	2*		0.40			BANGOR
1977 5-11	1:52.0	39.391	121.481	54	87	0*		-.10			BANGOR
1977 5-11	1644: 7.2	39.506	121.479	50	81	0*		2.40			OROVILLE DAM
1977 5-13	359:54.3	39.735	122.013	18	29	9*		0.80			HAMILTON CITY
1977 5-13	2159:40.8	39.508	121.499	49	79	7*		0.30			OROVILLE DAM
1977 5-16	338:11.3	39.478	121.492	50	81	2*		-.10			BANGOR
1977 5-17	1718:29.0	39.402	121.474	54	87	4*		1.00			BANGOR
1977 5-18	1720:22.2	39.461	121.441	53	86	0*		1.70			BANGOR
1977 5-18	1815:55.0	39.401	121.474	54	87	4*		0.30			BANGOR
1977 5-18	2157:41.4	39.578	122.055	22	36	3*		2.30			GLENN
1977 5-18	2349: 7.1	39.785	121.699	34	55	18*		0.50			PARADISE SW
1977 5-19	53:55.5	39.496	121.482	50	81	5*		-.30			BANGOR
1977 5-20	657:51.4	39.401	121.479	54	87	0*		0.50			BANGOR
1977 5-21	518: 4.4	39.399	121.471	54	87	0*		0.70			BANGOR
1977 5-23	804:15.9	39.614	122.097	19	30	6*		1.60			GLENN
1977 5-24	422:24.1	39.524	121.527	47	76	9*		-.10			OROVILLE
1977 5-24	1056:43.9	39.519	121.484	50	80	5*		0.20			OROVILLE DAM
1977 5-25	1018:58.4	39.414	121.467	54	87	1*		1.60			BANGOR
1977 5-26	226:37.3	39.429	121.525	51	82	7*		-.10			PALERMO
1977 6- 2	544:31.8	39.542	121.520	47	76	9*		0.00			OROVILLE
1977 6- 2	846:12.5	39.417	121.494	53	85	4*		0.50			BANGOR
1977 6- 2	1609:55.6	39.390	121.458	55	89	5*		0.40			BANGOR
1977 6- 6	2019: 8.8	39.426	121.468	53	86	1*		0.00			BANGOR
1977 6- 8	527:40.5	39.400	121.478	54	87	0*		0.50			BANGOR
1977 6- 8	1644:43.8	39.383	121.447	56	90	1*		0.80			BANGOR
1977 6- 8	1802:23.8	39.926	121.397	50	81	1*		1.80			PULGA NW
1977 6- 9	1736:26.6	39.401	121.473	54	87	0*		0.90			BANGOR
1977 6-10	1121: 8.8	39.465	121.482	52	83	2*		-.30			BANGOR
1977 6-12	1231:35.1	39.660	122.057	18	29	6*		0.60			HAMILTON CITY
1977 6-13	1320:39.1	39.412	121.455	55	88	0*		0.50			BANGOR
1977 6-17	1339:32.6	39.515	121.535	47	76	8*		-.50			OROVILLE
1977 6-21	1453:13.4	39.416	121.438	55	89	0*		-.70			BANGOR
1977 6-22	1537:59.5	39.412	121.481	53	86	0*		0.80			BANGOR
1977 7- 4	1128:37.6	39.394	121.503	53	85	6*		0.50			PALERMO
1977 7- 5	1235:18.7	39.400	121.485	53	86	1*		-.20			BANGOR
1977 7- 7	430:22.2	39.495	121.626	43	70	5*		1.00			BIGGS
1977 7-10	1554:30.7	39.465	121.525	50	80	6*		0.40			PALERMO
1977 7-11	837:15.8	39.797	121.691	34	55	9*		2.70			PARADISE SW
1977 7-14	39:56.0	39.517	121.517	48	78	8*		2.20			OROVILLE
1977 7-15	423: 8.5	39.394	121.480	54	87	2*		-.2)			BANGOR
1977 7-16	705:47.8	39.539	122.031	25	40	6*		0.60			GLENN
1977 7-16	1953:48.6	39.426	121.526	51	82	6*		0.40			PALERMO
1977 7-18	943:20.6	39.404	121.483	53	86	0*		1.30			BANGOR
1977 7-19	57:23.5	39.419	121.458	54	87	2*		1.40			BANGOR
1977 7-19	117:48.6	39.523	121.951	29	46	0*		2.70			LLANO SECO
1977 7-20	848:16.8	39.426	121.471	53	86	1*		1.40			BANGOR
1977 7-21	1914:49.2	39.435	121.525	50	81	8*		0.40			PALERMO
1977 7-21	1926: 9.8	39.476	121.495	50	81	4*		0.00			BANGOR
1977 7-22	918:40.4	39.374	121.478	55	88	13*		0.80			LOMA RICA
1977 7-28	1927:16.7	39.407	121.464	54	87	0*		0.80			BANGOR
1977 7-29	11:58.4	39.742	122.004	19	30	5*		0.80			HAMILTON CITY
1977 7-29	1421:20.1	39.464	121.525	50	80	4*		0.20			PALERMO
1977 8- 1	744:41.2	40.156	121.420	54	87	0*		2.40			JONESVILLE NW

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1977 8- 1	2257:22.4	39.401	121.452	55	89	1*		0.50			BANGOR
1977 3- 2	608:31.3	39.404	121.465	55	88	0*		0.10			BANGOR
1977 8- 5	831:23.7	39.398	121.472	54	87	3*		-.10			BANGOR
1977 8- 6	406:27.6	39.411	121.550	50	81	5*		0.50			PALERMO
1977 8- 6	1035:28.8	39.423	121.524	51	82	5*		3.00			PALERMO
1977 8- 6	1059:13.2	39.415	121.466	54	87	3*		-.30			BANGOR
1977 8- 7	237:31.6	39.397	121.450	55	89	0*		-.20			BANGOR
1977 8- 7	1931:55.5	39.482	121.488	51	82	1*		0.80			BANGOR
1977 8- 7	2002:24.7	39.473	122.272	24	38	6*		1.90			LOGAN RIDGE
1977 8-13	734:28.3	40.053	121.811	32	52	7*		2.30			PANTHER SPRING SE
1977 8-15	1748:12.8	40.505	121.866	54	87	0*		2.90			WHITMORE SE
1977 8-16	144: 3.9	39.398	121.517	52	84	3*		0.50			PALERMO
1977 8-17	1531:51.6	39.398	121.523	52	84	0*		0.90			PALERMO
1977 8-23	1346:59.9	39.410	121.481	53	86	0*		-.10			BANGOR
1977 8-25	351:13.3	39.772	122.829	26	42	8*		2.70			LOG SPRING
1977 8-25	1629:22.1	39.487	123.059	45	72	0*		1.60			POTTER VALLEY NE
1977 8-28	1839:26.6	39.428	121.494	52	84	5*		0.00			BANGOR
1977 8-29	1233:12.2	39.405	122.917	42	67	0*		2.80			LAKE PILLSBURY
1977 8-30	2257:44.3	39.415	121.527	51	82	8*		1.10			PALERMO
1977 9- 1	1017:49.8	39.423	121.482	53	85	5*		0.00			BANGOR
1977 9- 1	1615:15.7	39.501	122.048	27	43	12*		0.90			GLENN
1977 9- 1	2044:10.4	39.419	121.452	55	88	3*		0.50			BANGOR
1977 9- 1	2219:50.6	39.441	121.482	52	84	2*		0.40			BANGOR
1977 9- 3	1145:23.8	39.252	122.654	42	68	5*		3.00			FOUTS SPRINGS
1977 9- 3	1153:22.6	39.243	122.647	43	69	5*		2.80			CLEARLAKE OAKS NW
1977 9- 3	1824:14.2	39.653	122.019	20	32	4*		0.00			HAMILTON CITY
1977 9- 4	827:31.7	39.432	121.444	54	87	0*		0.70			BANGOR
1977 9- 8	903:49.2	39.470	121.536	49	79	7*		0.00			PALERMO
1977 9- 8	1325:56.9	39.720	121.459	47	76	0*		0.40			BERRY CREEK
1977 9-13	428:28.5	39.402	121.445	55	89	0*		2.50			BANGOR
1977 9-13	639:49.8	39.403	121.448	55	89	0*		2.30			BANGOR
1977 9-13	1034:48.8	39.708	121.930	23	37	9*		1.60			ORD FERRY
1977 9-15	558:17.0	40.286	121.394	60	96	7*		2.50			MT. HARKNESS SW
1977 9-15	853:13.8	40.277	121.372	60	97	3*		1.10			MT. HARKNESS SE
1977 9-17	1241:47.8	39.416	121.456	54	87	0*		-.10			BANGOR
1977 9-18	701:16.4	39.393	121.485	54	87	0*		0.60			BANGOR
1977 9-20	136:11.3	39.404	121.513	52	84	9*		-.20			PALERMO
1977 9-21	1712:52.7	39.426	121.476	53	85	4*		0.30			BANGOR
1977 9-21	2210:14.2	39.407	121.474	54	87	0*		0.30			BANGOR
1977 9-25	1233: 2.9	39.403	121.461	55	88	3*		0.10			BANGOR
1977 9-28	1200:15.0	39.407	121.464	54	87	2*		0.50			BANGOR
1977 9-30	435:34.1	39.486	121.508	50	80	5*		-.40			PALERMO
1977 9-30	2112:19.5	39.395	121.462	55	88	3*		-.20			BANGOR
1977 10- 3	1822:38.2	39.436	121.514	51	82	6*		2.50			PALERMO
1977 10- 8	18:15.7	39.493	121.481	51	82	3*		-.70			BANGOR
1977 10- 8	32:59.1	40.013	122.978	37	59	11		3.10		USGS	
1977 10-11	2328:55.6	39.499	121.491	50	80	5*		0.40			BANGOR
1977 10-16	909:27.6	39.554	121.583	44	71	5*		0.90			OROVILLE
1977 10-16	1036: 9.9	39.562	121.595	43	69	5*		1.10			OROVILLE
1977 10-16	1407:27.3	39.561	121.608	42	68	4*		0.60			OROVILLE
1977 10-18	26:25.3	39.501	121.480	50	81	2*		0.40			OROVILLE DAM
1977 10-18	1333:28.7	39.481	121.449	53	85	0*		-.20			BANGOR
1977 10-18	1446: 2.4	39.408	121.471	54	87	3*		0.10			BANGOR
1977 10-19	1544:41.6	39.406	121.494	53	85	3*		0.90			BANGOR

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1977 10-20	502:59.7	39.508	121.482	50	81	1*		0.00			OROVILLE DAM
1977 10-24	1720:30.2	39.422	121.403	57	91	0*		0.30			BANGOR
1977 10-25	2000: 5.5	39.392	121.501	53	86	6*		0.10			PALERMO
1977 10-30	220:27.2	39.498	121.523	48	78	10*		0.70			PALERMO
1977 10-31	723:28.8	39.388	121.446	56	90	0*		0.30			BANGOR
1977 10-31	1956:14.3	39.503	121.532	48	77	10*		0.30			OROVILLE
1977 11- 1	530:47.0	39.499	121.490	50	81	5*		-.50			BANGOR
1977 11- 3	1036:20.6	39.414	121.498	53	85	0*		0.30			BANGOR
1977 11- 5	855:44.2	39.504	121.535	48	77	9*		-.20			OROVILLE
1977 11- 5	1341: 9.0	39.422	121.475	53	86	0*		0.20			BANGOR
1977 11- 7	1438:34.8	39.394	121.493	53	86	6*		-.50			BANGOR
1977 11-10	846:54.5	39.307	122.700	40	64	2*		3.20			FOUTS SPRINGS
1977 11-10	2024:42.0	39.417	121.482	53	86	0*		3.00			BANGOR
1977 11-11	1720:18.3	39.405	121.470	54	87	0*		0.80			BANGOR
1977 11-12	550:41.7	39.473	121.505	50	81	3*		-.30			PALERMO
1977 11-14	617:21.6	39.423	121.464	53	86	0*		0.30			BANGOR
1977 11-14	724:55.9	39.622	122.075	19	31	5*		0.60			GLENN
1977 11-18	448:54.6	39.411	121.477	53	86	0*		0.60			BANGOR
1977 11-23	828: 2.6	39.396	121.479	54	87	3*		1.20			BANGOR
1977 11-23	1527:19.3	39.598	123.133	45	72	19*		3.70			BRUSHY MTN.
1977 11-27	1058:21.5	39.665	121.914	25	40	5*		0.70			ORD FERRY
1977 11-27	1228:43.1	39.403	121.466	54	87	7*		0.50			BANGOR
1977 11-29	932:49.0	39.410	121.496	53	85	6*		0.30			BANGOR
1977 12- 4	1250:12.1	39.378	121.450	56	90	0*		-.40			BANGOR
1977 12- 6	1414:57.5	39.406	121.470	54	87	0*		2.70			BANGOR
1977 12- 7	953:15.3	39.409	121.483	53	86	4*		0.80			BANGOR
1977 12- 9	403:11.4	39.402	121.506	53	85	2*		1.90			PALERMO
1977 12- 9	939: 7.8	39.400	121.493	53	86	2*		1.90			BANGOR
1977 12- 9	1146:23.8	39.409	121.474	54	87	1*		0.10			BANGOR
1977 12-10	1043:46.4	39.402	121.483	53	86	3*		-.50			BANGOR
1977 12-11	842:41.8	39.410	121.480	53	86	0*		1.00			BANGOR
1977 12-11	953:45.7	39.410	121.474	53	86	0*		0.00			BANGOR
1977 12-11	1437: 8.2	39.516	121.510	48	78	2*		0.70			OROVILLE
1977 12-11	1818: 0.7	39.504	121.506	49	79	6*		-.60			OROVILLE
1977 12-12	458:10.4	39.401	121.463	55	88	0*		-.60			BANGOR
1977 12-13	433:49.7	40.209	121.536	50	81	6*		2.60			BUTTE MEADOWS NE
1977 12-13	935: 8.7	40.238	121.559	50	81	0*		0.70			BUTTE MEADOWS NE
1977 12-14	1408:55.2	39.475	121.544	48	78	5*		0.70			PALERMO
1977 12-19	1207:10.6	39.521	121.896	31	50	5*		0.00			LLANO SECO
1977 12-19	2257:54.6	39.394	121.446	55	89	2*		0.40			BANGOR
1977 12-20	527:56.1	39.391	121.482	54	87	7*		0.60			BANGOR
1977 12-20	849:43.0	39.390	121.436	56	90	0*		0.40			BANGOR
1977 12-21	424:42.3	39.441	123.095	48	77	0*		3.30			POTTER VALLEY NE
1977 12-22	607: 3.8	39.450	121.942	33	53	12*		2.20			BUTTE CITY
1977 12-22	1718:10.9	39.341	121.593	52	83	7*		-.30			HONCUT
1977 12-22	1729:43.9	39.400	121.461	55	88	8*		-.10			BANGOR
1977 12-23	11:58.7	39.426	121.515	52	83	8*		-.30			PALERMO
1977 12-23	1941:15.9	39.410	121.474	53	86	2*		-.10			BANGOR
1977 12-26	1106:36.7	39.523	122.142	22	36	1*		1.10			WILLOWS
1977 12-27	1233: 8.7	39.452	121.387	57	91	1*		1.10			BANGOR
1977 12-28	620:51.9	39.440	121.498	52	83	6*		-.30			BANGOR
1977 12-28	1412:20.6	39.423	122.020	32	51	16*		0.80			PRINCETON
1977 12-28	2042:52.8	39.461	121.485	52	83	2*		0.10			BANGOR
1977 12-29	150:24.4	39.575	122.300	17	27	7*		1.80			STONE VALLEY

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1977 12-29	344: 7.5	39.445	121.542	49	79	1*		0.00			PALERMO
1977 12-30	114: 2.2	40.276	121.672	48	77	5*		1.60			LASSEN PEAK SW
1977 12-30	440:17.8	39.401	121.471	54	87	2*		0.30			BANGOR
1977 12-31	1142: 1.7	39.418	121.502	52	84	8*		0.10			PALERMO
1978 1- 1	2356:51.8	40.124	121.752	38	61	5*		0.90			PANTHER SPRING SE
1978 1- 2	827:22.0	39.404	121.481	53	86	4*		0.20			BANGOR
1978 1- 4	2058:22.7	39.407	121.471	54	87	0*		1.00			BANGOR
1978 1- 6	1042:47.2	39.504	123.012	42	67	9*		2.50			SANHEDRIN MTN.
1978 1- 7	342:10.3	39.409	121.472	54	87	1*		-.10			BANGOR
1978 1- 7	1247:46.7	39.391	121.480	54	87	6*		-.10			BANGOR
1978 1- 9	1158:42.2	39.406	121.489	53	86	0*		-.20			BANGOR
1978 1-10	1451:48.6	39.353	121.806	42	68	23*		0.30			PENNINGTON
1978 1-11	808:37.0	39.383	121.361	60	96	3*		1.20			RACKERBY
1978 1-12	1911:26.8	39.405	121.481	53	86	3*		-.40			BANGOR
1978 1-12	2233:56.7	39.475	121.493	51	82	9*		0.00			BANGOR
1978 1-14	1432: 4.0	39.505	121.415	53	86	2*		0.80			OROVILLE DAM
1978 1-14	1442:18.8	39.578	122.036	23	37	10*		0.90			GLENN
1978 1-15	650:15.7	39.390	121.492	53	86	6*		-.10			BANGOR
1978 1-15	650:55.5	39.386	121.498	53	86	5*		0.30			BANGOR
1978 1-17	2059:18.1	39.254	122.871	48	77	18*		1.90			POTATO HILL
1978 1-18	2337:57.7	39.677	122.249	11	17	9*		1.10			ORLAND
1978 1-21	408:37.3	39.571	122.894	34	55	2*		1.30			HULL MOUNTAIN
1978 1-21	1126: 9.7	40.158	121.421	54	87	5		2.80		GS	36
1978 1-22	1539:23.8	39.428	121.416	56	90	5*		-.10			BANGOR
1978 1-25	2336:55.5	39.530	121.589	44	71	8*		-.60			OROVILLE
1978 1-27	155:54.2	39.445	121.447	54	87	0*		0.20			BANGOR
1978 1-28	1907:48.9	39.628	122.066	19	31	5*		1.10			HAMILTON CITY
1978 1-30	813: 1.1	39.405	122.308	28	45	16*		1.70			LOGAN RIDGE
1978 1-31	1928:29.5	39.390	121.465	55	88	0*		-.60			BANGOR
1978 1-31	2209:57.9	39.518	121.468	50	81	2*		1.00			OROVILLE DAM
1978 2- 1	24:13.2	39.521	121.401	54	87	5*		0.00			OROVILLE DAM
1978 2- 1	1055:34.1	39.407	121.464	54	87	6*		-.10			BANGOR
1978 2- 1	2140:58.2	40.174	122.161	27	43	4*		1.70			RED BLUFF EAST
1978 2- 1	2328:35.4	40.153	122.227	24	39	8*		1.00			RED BLUFF EAST
1978 2- 2	443:32.9	40.077	121.459	50	80	0*		2.90			JONESVILLE SW
1978 2- 2	457: 4.1	40.070	121.466	50	80	0*		1.90			JONESVILLE SW
1978 2- 5	947:55.0	39.424	121.465	53	86	1*		-.50			BANGOR
1978 2- 5	1731:53.4	40.144	122.162	25	40	1*		2.30			RED BLUFF EAST
1978 2- 5	2311:14.3	40.159	122.145	26	42	0*		2.20			RED BLUFF EAST
1978 2- 5	2328:26.4	40.189	122.130	28	45	5*		1.20			RED BLUFF EAST
1978 2- 5	2335:20.0	40.172	122.171	26	42	7*		0.90			RED BLUFF EAST
1978 2- 6	319:24.8	40.174	122.165	27	43	10*		1.10			RED BLUFF EAST
1978 2- 6	1259:58.0	39.478	121.513	50	80	2*		0.10			PALERMO
1978 2- 7	220:48.0	39.416	121.470	53	86	5*		-.20			BANGOR
1978 2- 7	1339:25.9	39.518	122.919	37	60	9*		3.20			HULL MOUNTAIN
1978 2- 8	56: 0.1	39.399	121.484	53	86	5*		-.20			BANGOR
1978 2- 8	1135:17.5	39.413	121.438	55	89	3*		0.80			BANGOR
1978 2- 8	1206: 8.5	39.409	121.434	56	90	5*		0.10			BANGOR
1978 2-11	738:18.8	39.418	121.462	54	87	4*		-.30			BANGOR
1978 2-11	1556:13.3	40.010	121.374	53	85	1*		1.40			JONESVILLE SE
1978 2-13	608:45.7	40.133	122.133	25	40	2		3.30		USGS	
1978 2-13	2354: 7.7	40.146	122.220	24	38	5*		1.10			RED BLUFF EAST
1978 2-14	1450:27.1	40.149	121.426	53	86	8*		2.00			JONESVILLE NW
1978 2-16	1523:36.4	40.330	122.073	39	62	0*		1.50			DALES

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1978 2-17	735:26.9	40.082	121.457	50	81	0*		3.10			JONESVILLE SW
1978 2-17	1339:44.7	40.092	121.457	50	81	8*		2.50			JONESVILLE SW
1978 2-18	222:20.4	39.410	121.516	52	83	1*		0.70			PALERMO
1978 2-22	859:37.5	39.380	121.497	54	87	6*		-.20			BANGOR
1978 2-23	810: 2.8	39.441	121.976	32	52	25*		0.80			BUTTE CITY
1978 2-23	2354:44.5	40.173	122.152	27	43	2*		1.20			RED BLUFF EAST
1978 2-24	551:28.7	40.163	122.141	26	42	2*		1.20			RED BLUFF EAST
1978 2-25	603: 0.0	39.376	122.913	43	69	10*		1.40			LAKE PILLSBURY
1978 2-26	1402:24.4	39.580	121.974	25	40	26*		0.90			LLANO SECO
1978 2-28	645:55.6	39.495	121.511	49	79	0*		0.60			PALERMO
1978 2-28	1007:26.1	39.667	122.697	22	35	5*		1.30			ALDER SPRINGS
1978 2-28	1620:52.8	40.417	121.999	45	73	2		3.00		GS	36
1978 2-28	2123:49.6	39.405	121.488	53	86	0*		0.50			BANGOR
1978 3- 1	1355:14.7	39.453	121.511	50	81	7*		0.00			PALERMO
1978 3- 2	232:18.6	39.534	121.389	54	87	9*		-.30			OROVILLE DAM
1978 3- 4	114:56.3	39.395	121.500	53	85	5*		-.20			PALERMO
1978 3- 6	1659:42.8	39.724	121.923	23	37	5*		0.90			ORD FERRY
1978 3- 7	203:39.5	39.998	121.636	39	63	7*		1.90			PARADISE NW
1978 3- 7	354:35.1	40.061	121.376	54	87	5*		1.50			JONESVILLE SW
1978 3- 8	29:57.3	39.451	121.804	38	61	22*		0.50			WEST OF BIGGS
1978 3- 9	456:18.1	39.544	122.020	25	40	5*		1.60			GLENN
1978 3- 9	547:49.4	39.490	121.949	30	49	9*		1.20			BUTTE CITY
1978 3-11	7:30.0	39.543	121.396	53	86	15*		0.20			OROVILLE DAM
1978 3-12	1552:47.1	39.479	121.513	50	80	11*		-.20			PALERMO
1978 3-12	2012:42.0	39.479	121.468	52	83	0*		0.70			BANGOR
1978 3-13	413:32.0	39.495	121.442	52	84	8*		0.50			BANGOR
1978 3-13	1143:54.2	39.392	121.429	57	91	1*		0.00			BANGOR
1978 3-13	1806: 6.2	39.405	121.472	54	87	2*		-.50			BANGOR
1978 3-15	935:45.2	39.234	121.756	50	81	27*		0.60			SUTTER BUTTES
1978 3-15	1612:31.9	39.508	121.990	28	45	9*		1.10			LLANO SECO
1978 3-17	38:56.4	39.522	121.390	54	87	4*		-.10			OROVILLE DAM
1978 3-17	946:47.0	39.378	121.446	56	90	2*		0.70			BANGOR
1978 3-19	1112:27.6	39.396	121.490	53	86	0*		-.40			BANGOR
1978 3-19	1547:59.3	40.518	121.501	66	106	5*		1.70			MANZANITA LAKE SE
1978 3-20	1208: 7.9	39.374	121.456	56	90	4*		0.10			LOMA RICA
1978 3-20	1813:12.9	39.923	121.527	43	70	7*		1.70			PARADISE NE
1978 3-21	331:51.9	39.698	121.829	28	45	1*		0.50			CHICO
1978 3-22	633:17.5	40.070	122.940	37	59	25		3.20		GS	36
1978 3-22	840:33.4	40.038	122.994	39	62	6*		3.10			YOLLA BOLLY SW
1978 3-22	1049:46.2	40.028	122.969	37	59	8*		3.10			YOLLA BOLLY SW
1978 3-23	17: 5.9	39.582	122.058	22	35	5*		1.40			GLENN
1978 3-24	1645:34.3	40.180	121.419	55	88	8*		1.40			JONESVILLE NW
1978 3-25	2037:42.6	39.479	121.544	48	77	4*		0.10			PALERMO
1978 3-26	27: 5.6	39.194	123.128	60	97	18*		4.30			UKIAH
1978 3-26	34:13.0	39.213	123.005	55	88	3*		3.10			COW MOU TAIN
1978 3-26	119: 9.6	39.219	123.106	58	93	1*		3.60			COW MOU TAIN
1978 3-26	229:17.2	39.166	123.234	65	105	22*		3.40			UKIAH
1978 3-26	428:18.4	39.232	123.128	58	94	1*		3.40			UKIAH
1978 3-26	1620:30.5	39.464	121.467	52	84	1*		0.60			BANGOR
1978 3-27	129:40.4	39.492	121.489	50	81	4*		0.10			BANGOR
1978 3-27	343:37.9	39.499	121.484	50	81	4*		1.30			BANGOR
1978 3-27	740: 1.4	39.489	121.488	50	81	3*		0.50			BANGOR
1978 3-27	1615:33.4	39.200	123.121	60	96	3*		3.30			COW MOUNTAIN
1978 3-28	1343:35.7	39.429	121.477	53	85	5*		1.10			BANGOR

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1978	3-31	614:53.6	39.523	122.228	21	34	7*		1.60			WILLOWS
1978	3-31	950:43.8	39.484	121.464	52	83	0*		0.50			BANGOR
1978	4- 2	1446:53.8	39.417	121.423	56	90	0*		1.50			BANGOR
1978	4- 2	2342:49.1	39.663	121.758	32	52	21*		0.40			CHICO
1978	4- 3	402:37.6	39.412	121.447	55	88	0*		0.70			BANGOR
1978	4- 4	2334:54.8	39.506	121.485	50	81	5*		0.50			OROVILLE DAM
1978	4- 5	251:11.3	39.681	122.117	15	24	5*		1.60			HAMILTON CITY
1978	4- 5	1438: 1.9	39.238	122.962	52	84	5*		1.40			UPPER LAKE
1978	4- 6	1555:38.4	39.203	122.929	53	85	5*		1.70			UPPER LAKE
1978	4- 8	922:18.1	39.163	123.146	62	100	2*		3.30			UKIAH
1978	4-10	912:40.1	39.413	121.481	53	86	5*		0.00			BANGOR
1978	4-11	204:33.1	39.824	122.951	33	53	1*		2.00			MENDOCINO PASS
1978	4-11	214: 6.5	39.665	122.671	21	33	0*		3.10			ALDER SPRINGS
1978	4-12	236:24.1	39.416	121.475	53	86	0*		0.60			BANGOR
1978	4-13	2334:11.3	39.512	121.490	50	80	8*		0.70			OROVILLE DAM
1978	4-15	155:14.7	39.446	121.458	53	86	0*		0.70			BANGOR
1978	4-16	2150:19.0	39.397	121.425	57	91	2*		0.90			BANGOR
1978	4-18	341:19.7	39.657	122.699	22	36	8*		3.40			ALDER SPRINGS
1978	4-18	854:17.3	39.618	122.786	27	44	5		3.00		USGS	
1978	4-18	854:20.1	39.651	122.699	22	36	12*		3.50			ALDER SPRINGS
1978	4-18	1711:40.4	39.662	122.660	20	32	2*		3.20			ALDER SPRINGS
1978	4-18	1723:52.7	39.683	122.607	17	27	0*		3.10			CHROME
1978	4-19	138:18.1	39.669	122.638	19	30	0*		3.50			ALDER SPRINGS
1978	4-19	419:50.8	39.660	122.732	24	38	5		3.20		USGS	
1978	4-19	419:51.9	39.675	122.681	21	33	13*		3.40			ALDER SPRINGS
1978	4-20	42:51.1	39.981	121.988	22	35	1*		1.40			RICHARDSON SPGS NW
1978	4-20	650:44.3	39.552	121.389	53	86	3*		0.50			OROVILLE DAM
1978	4-23	1154:26.6	39.403	121.490	53	86	1*		0.20			BANGOR
1978	4-23	1435:19.0	39.657	122.668	21	33	0*		1.70			ALDER SPRINGS
1978	4-25	132:59.7	39.714	122.637	17	28	5		2.90		USGS	
1978	4-25	133: 0.3	39.696	122.615	17	27	0*		3.30			CHROME
1978	4-25	1334:44.0	39.413	121.474	53	86	1*		0.50			BANGOR
1978	4-27	2017:57.1	39.497	121.398	55	88	0*		1.40			BANGOR
1978	4-28	912:59.2	39.698	122.602	16	26	4*		1.90			CHROME
1978	4-28	1215: 5.6	39.416	121.477	53	86	3*		0.60			BANGOR
1978	4-29	1200:34.0	39.627	122.829	29	47	5*		2.00			PLASKETT MEADOWS
1978	4-30	1454:59.3	39.570	122.880	34	54	1*		1.70			HULL MOUNTAIN
1978	5- 1	37:43.8	39.409	121.475	53	86	0*		1.00			BANGOR
1978	5- 1	558:16.9	39.601	122.037	22	35	9*		1.00			GLENN
1978	5- 2	400:49.8	39.405	121.474	54	87	0*		1.20			BANGOR
1978	5- 3	437: 5.1	39.491	121.484	50	81	4*		0.20			BANGOR
1978	5- 3	1723:23.3	40.174	122.136	27	44	8*		3.20			RED BLUFF EAST
1978	5- 4	2132:51.4	39.257	122.396	39	62	10*		2.10			LODOGA SW
1978	5- 6	1438:13.9	39.441	121.484	52	84	9*		0.70			BANGOR
1978	5- 7	1153:35.4	40.109	122.180	22	35	12*		1.20			GERBER
1978	5- 7	1231:33.4	40.134	122.140	24	39	7*		1.70			RED BLUFF EAST
1978	5- 7	1314:26.2	40.164	121.477	52	83	10*		1.00			JONESVILLE NW
1978	5- 8	129:59.5	39.708	121.798	30	48	11*		1.70			CHICO
1978	5- 8	945:10.4	39.482	121.995	29	47	13*		1.90			BUTTE CITY
1978	5-11	703:50.8	39.702	122.619	17	27	5*		2.80			CHROME
1978	5-11	707:14.4	39.692	122.615	17	27	12*		2.40			CHROME
1978	5-11	1601:10.8	39.693	122.627	17	28	2*		1.70			ALDER SPRINGS
1978	5-13	433:17.6	39.573	121.556	45	72	10*		1.10			OROVILLE
1978	5-13	707:31.6	39.682	122.652	19	31	0*		2.40			ALDER SPRINGS

EARTHQUAKE CATALOG

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1978 5-15	516:14.3	39.435	121.459	53	86	0*		0.80			BANGOR
1978 5-15	654:19.9	39.716	122.678	19	31	0*		1.80			ALDER SPRINGS
1978 5-15	955:13.4	39.395	121.514	52	84	0*		0.20			PALERMO
1978 5-17	2211:53.1	39.484	122.739	31	50	4*		2.40			SAINT JOHN MTN.
1978 5-17	2238:45.6	39.473	122.803	34	55	4*		3.20			CROCKETT PEAK
1978 5-20	1221:40.0	40.481	121.493	64	103	5*		1.70			MT. HARKNESS NW
1978 5-21	240:53.1	39.381	121.499	53	86	0*		0.70			BANGOR
1978 5-22	2232: 2.6	39.398	121.443	55	89	5*		1.00			BANGOR
1978 5-23	1426:18.4	39.446	121.467	53	85	7*		0.10			BANGOR
1978 5-24	1950:22.6	40.026	122.128	19	30	5*		1.80			GERBER
1978 5-25	354:23.2	39.402	121.490	53	86	0*		1.10			BANGOR
1978 5-25	2258:51.5	39.469	121.968	31	50	12*		1.10			BUTTE CITY
1978 5-26	1938:59.0	39.410	121.543	50	81	2*		0.30			PALERMO
1978 5-27	1613: 7.9	40.261	122.033	35	56	0*		1.90			DALES
1978 5-27	1658:48.0	39.458	121.486	52	83	5*		0.20			BANGOR
1978 5-27	2034:59.6	39.440	122.010	31	50	20*		1.30			PRINCETON
1978 5-28	403:22.1	39.541	121.462	50	81	9*		0.40			OROVILLE DAM
1978 5-29	1103:37.1	39.513	121.529	48	77	10*		0.50			OROVILLE
1978 5-29	2027:31.1	39.406	121.492	53	85	1*		2.10			BANGOR
1978 5-30	1205:43.1	39.406	121.466	54	87	1*		0.90			BANGOR
1978 6- 3	537:18.0	39.407	121.497	53	85	0*		0.60			BANGOR
1978 6- 3	2328:42.0	39.409	121.598	48	78	10*		0.40			PALERMO
1978 6- 4	42:31.8	39.398	122.245	29	47	12*		1.70			LOGANDALE
1978 6- 4	2234:14.9	39.449	121.591	47	76	5*		0.60			PALERMO
1978 6- 6	1815:29.1	39.185	121.441	65	104	8*		0.90			BROWNS VALLEY
1978 6- 7	2307:37.1	40.004	121.974	24	38	7*		2.30			PANTHER SPRING SW
1978 6-15	159:49.0	39.709	121.796	30	48	11*		1.10			CHICO
1978 6-17	209:18.8	39.444	121.486	52	84	1*		0.80			BANGOR
1978 6-17	344:52.8	39.407	121.482	53	86	1*		0.70			BANGOR
1978 6-17	1534:27.6	39.329	121.400	60	97	6*		0.60			LOMA RICA
1978 6-19	958: 5.5	39.443	121.417	55	89	0*		0.60			BANGOR
1978 6-21	634:47.0	39.394	121.504	53	85	5*		0.30			PALERMO
1978 6-21	1119:57.6	39.932	123.038	38	61	18*		3.70			LEECH LAKE MTN.
1978 6-22	1125: 8.3	39.466	121.525	50	80	8*		-.30			PALERMO
1978 6-26	213: 8.8	39.563	122.051	23	37	1*		1.00			GLENN
1978 6-27	644:15.2	39.426	121.464	53	86	5*		0.80			BANGOR
1978 6-27	746:29.3	39.775	122.057	15	24	14*		1.30			FOSTER ISLAND
1978 7- 2	1355:30.1	39.400	121.539	51	82	7*		0.10			PALERMO
1978 7- 2	1926:56.9	39.438	121.452	54	87	3*		-.30			BANGOR
1978 7- 5	207:33.4	39.431	121.461	53	86	3*		0.10			BANGOR
1978 7- 5	1010:53.5	39.576	122.008	24	39	11*		0.80			GLENN
1978 7- 7	2054: 2.2	39.395	121.575	50	80	1*		0.60			PALERMO
1978 7- 9	1056:13.7	39.468	121.464	52	84	0*		0.60			BANGOR
1978 7-11	704:22.1	39.413	121.476	53	86	2*		0.30			BANGOR
1978 7-11	718:32.4	39.411	121.471	54	87	0*		2.10			BANGOR
1978 7-11	719:26.3	39.421	121.498	52	84	5*		0.00			BANGOR
1978 7-11	1242:43.9	39.396	121.497	53	86	0*		0.40			BANGOR
1978 7-11	1407:57.6	39.359	121.363	61	98	4*		1.40			OREGON HOUSE
1978 7-12	1007:46.6	39.586	122.061	22	35	5*		1.20			GLENN
1978 7-13	832: 4.1	39.415	121.456	55	88	0*		1.00			BANGOR
1978 7-14	557:21.4	39.392	121.544	52	83	0*		0.50			PALERMO
1978 7-14	1449:28.2	39.477	121.467	52	83	3*		0.20			BANGOR
1978 7-15	554: 4.0	39.417	121.463	54	87	0*		2.80			BANGOR
1978 7-15	838:32.6	40.364	122.066	40	65	5*		1.90			DALES

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1978 7-15	1918:28.0	39.555	122.038	24	38	11*		1.00			GLENN
1978 7-16	40:20.8	39.522	122.035	25	41	9*		0.60			GLENN
1978 7-16	1207: 6.1	39.356	121.503	55	88	0*		-.40			HONCUT
1978 7-18	1342:57.3	39.421	121.448	55	88	9*		0.90			BANGOR
1978 7-20	1447:59.4	39.456	121.510	50	81	6*		1.20			PALERMO
1978 7-20	1846:43.9	40.272	121.419	58	93	6*		1.10			MT. HARKNESS SW
1978 7-22	506:51.0	39.388	121.503	53	86	6*		0.10			PALERMO
1978 7-23	733:36.0	39.405	121.474	54	87	4*		3.30			BANGOR
1978 7-24	539:42.5	39.388	121.440	56	90	0*		0.50			BANGOR
1978 7-28	552:44.6	40.009	122.628	21	33	0*		3.00			RAGLIN RIDGE
1978 7-28	807:24.5	40.009	122.622	21	33	12*		2.10			LOWREY
1978 7-29	833: 8.2	39.497	122.287	22	35	10*		1.60			LOGAN RIDGE
1978 8- 2	534:33.9	39.414	121.442	55	89	0*		0.50			BANGOR
1978 8- 2	1657:41.0	39.401	121.557	50	81	5*		0.60			PALERMO
1978 8- 3	49:42.4	39.289	121.796	46	74	2*		0.20			PENNINGTON
1978 8- 3	134:32.0	39.464	121.519	50	80	5*		0.10			PALERMO
1978 8-10	1232: 8.9	39.424	121.495	52	84	0*		0.80			BANGOR
1978 8-15	2009: 7.0	39.774	121.700	34	55	18*		0.50			PARADISE SW
1978 8-21	1939:27.1	39.416	121.426	56	90	0*		0.50			BANGOR
1978 8-21	2317:33.1	39.994	121.974	23	37	5*		1.50			RICHARDSON SPGS NW
1978 8-22	1945:25.8	39.466	121.469	52	84	0*		1.00			BANGOR
1978 8-25	1515:15.4	39.566	122.735	27	44	0*		1.70			FELKNER HILL
1978 8-25	1814:48.7	39.504	121.456	52	83	10*		0.70			OROVILLE DAM
1978 8-25	1842:52.1	39.670	122.713	22	36	1*		1.60			ALDER SPRINGS
1978 8-25	1844:26.5	39.586	122.813	30	48	1*		1.60			KNEECAP RIDGE
1978 8-26	407:55.6	39.410	121.479	53	86	4*		0.00			BANGOR
1978 8-26	2141:14.3	39.411	121.476	53	86	0*		2.60			BANGOR
1978 8-30	1612:24.3	39.489	121.373	56	90	1*		0.50			RACKERBY
1978 8-30	2008:37.2	39.399	121.445	55	89	0*		0.70			BANGOR
1978 8-30	2103:21.5	39.476	121.462	52	84	4*		0.70			BANGOR
1978 8-31	521:44.1	39.438	121.540	50	80	6*		0.20			PALERMO
1978 9- 1	1042:40.5	39.406	121.509	52	84	7*		0.00			PALERMO
1978 9- 2	825:55.8	39.447	121.487	52	83	1*		0.10			BANGOR
1978 9- 2	1009:30.4	39.407	121.452	55	88	0*		0.40			BANGOR
1978 9- 6	1327:50.6	39.585	122.764	28	45	5*		1.40			KNEECAP RIDGE
1978 9- 8	1006:52.9	39.757	122.192	9	14	6*		1.50			KIRKWOOD
1978 9-10	136:45.4	39.397	121.559	50	81	0*		0.60			PALERMO
1978 9-10	1820:18.7	39.441	121.468	53	85	0*		0.90			BANGOR
1978 9-13	514:36.5	39.543	121.554	45	73	3*		0.70			OROVILLE
1978 9-13	1211:39.7	39.422	121.469	53	86	0*		1.00			BANGOR
1978 9-13	1247:12.1	39.491	121.426	53	86	0*		-.40			BANGOR
1978 9-13	1748:19.2	39.406	121.468	54	87	0*		1.00			BANGOR
1978 9-15	329:31.8	39.423	121.478	53	85	0*		2.20			BANGOR
1978 9-16	2113: 6.9	40.180	121.388	57	91	5*		1.80			JONESVILLE NW
1978 9-17	746:42.7	39.414	121.471	53	86	0*		1.80			BANGOR
1978 9-17	932:57.2	39.407	121.482	53	86	1*		0.80			BANGOR
1978 9-19	259:13.1	40.225	121.363	59	95	15*		1.10			JONESVILLE NE
1978 9-19	1124: 9.7	39.401	121.463	55	88	0*		0.50			BANGOR
1978 9-23	2208:28.4	39.457	121.477	52	84	4*		0.00			BANGOR
1978 9-23	2236:31.8	39.403	121.535	51	82	5*		0.80			PALERMO
1978 9-24	359: 7.2	39.426	121.406	57	91	0*		0.20			BANGOR
1978 9-24	1606:24.8	39.420	121.482	53	85	6*		0.50			BANGOR
1978 9-29	2:20.4	39.831	121.854	25	41	0*		2.20			RICHARDSON SPRINGS
1978 10- 2	2331:32.0	39.432	121.426	55	89	12*		0.20			BANGOR

DATE YEAR-MO-DY	TIME HRMM:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1978 10- 3	522:41.0	39.404	121.456	55	88	3*		0.20			BANGOR
1978 10- 4	2224:17.1	39.473	121.477	52	83	5*		0.30		CDWR	BANGOR
1978 10-10	1944: 2.2	39.411	121.527	52	83	16*		1.00			PALERMO
1978 10-10	2212:45.3	40.005	121.982	23	37	8*		1.60			PANTHER SPRING SW
1978 10-13	929:17.9	39.415	121.484	53	85	4*		1.70			BANGOR
1978 10-13	1435:25.2	39.387	121.479	54	87	0*		0.60			BANGOR
1978 10-17	1325:26.3	39.424	121.484	53	85	4*		1.40			BANGOR
1978 10-18	2120: 4.9	39.695	121.763	32	51	5*		0.50			CHICO
1978 10-21	53:14.2	39.401	121.477	54	87	1*		0.90			BANGOR
1978 10-21	113: 9.6	39.474	121.519	50	80	5*		0.30			PALERMO
1978 10-21	641:28.9	39.502	121.521	48	78	10*		0.20			OROVILLE
1978 10-22	1801:17.6	39.381	121.435	57	91	5*		0.30			BANGOR
1978 10-22	2341:23.8	39.408	121.475	54	87	10*		0.50			BANGOR
1978 10-23	952:19.5	39.403	121.458	55	88	0*		0.20			BANGOR
1978 10-23	1841:44.0	39.685	121.778	31	50	5*		0.80			CHICO
1978 10-26	326:15.6	39.400	121.474	54	87	0*		0.40			BANGOR
1978 10-28	1021: 3.4	39.484	121.428	53	86	4*		1.40			BANGOR
1978 11- 4	1039:37.2	40.040	121.732	35	57	14*		1.60			BUTTE MEADOWS SW
1978 11- 4	1411: 8.8	39.511	122.056	25	41	12*		1.30			GLENN
1978 11- 7	902:13.5	39.395	121.451	55	89	0*		0.00			BANGOR
1978 11- 7	1618:40.4	39.384	121.448	56	90	0*		0.60			BANGOR
1978 11-12	1307:58.3	39.458	122.859	37	60	26*		3.60			CROCKETT PEAK
1978 11-15	857:58.5	39.798	121.645	37	59	20*		0.20			PARADISE SW
1978 11-16	1031:29.0	39.398	121.460	55	88	4*		0.70			BANGOR
1978 11-16	1317:18.6	39.410	121.500	53	85	5*		0.30			PALERMO
1978 11-18	2136:42.8	39.399	121.524	52	84	7*		1.10			PALERMO
1978 11-22	1040:19.1	39.378	121.535	52	84	6*		0.10			PALERMO
1978 11-24	648:40.5	39.711	121.701	35	56	7*		0.40			HAMLIN CANYON
1978 11-24	712:17.1	39.732	121.652	37	59	16*		0.90			HAMLIN CANYON
1978 11-24	1335:34.9	39.411	121.478	53	86	1*		0.50			BANGOR
1978 11-28	302: 5.8	39.452	121.480	52	84	1*		0.20			BANGOR
1978 11-28	2124:23.3	39.714	121.684	35	57	3*		1.10			HAMLIN CANYON
1978 11-29	1238:33.6	39.481	121.502	50	81	9*		1.30			PALERMO
1978 12- 1	1933:51.2	39.653	122.015	21	33	26*		2.50			HAMILTON CITY
1978 12- 2	230:41.5	39.632	121.859	29	46	28*		1.70			CHICO
1978 12- 3	19:52.9	39.715	121.683	35	57	13*		0.10			HAMLIN CANYON
1978 12- 7	1834:22.3	39.814	122.083	14	22	9*		1.80			FOSTER ISLAND
1978 12- 7	1957:26.1	39.407	121.549	50	81	3*		0.60			PALERMO
1978 12-10	505:46.1	39.410	121.463	54	87	0*		0.60			BANGOR
1978 12-10	702:29.8	39.770	121.809	28	45	19*		2.10			RICHARDSON SPRINGS
1978 12-12	422:54.3	39.412	121.469	54	87	0*		0.40			BANGOR
1978 12-13	652:25.5	39.394	121.550	51	82	6*		0.40			PALERMO
1978 12-14	437:24.0	39.548	121.872	31	50	10*		0.90			NELSON
1978 12-14	904:40.2	39.506	121.545	47	76	11*		0.50			OROVILLE
1978 12-15	2024:34.1	39.446	121.461	53	85	3*		0.20			BANGOR
1978 12-19	16:15.0	39.361	121.448	57	91	0*		0.30			LOMA RICA
1978 12-21	141: 6.1	39.413	121.434	56	89	3*		0.70			BANGOR
1978 12-21	917:35.0	39.721	122.082	15	24	6*		1.30			HAMILTON CITY
1978 12-22	708:32.5	40.264	121.430	57	92	7*		1.50			MT. HARKNESS SW
1978 12-22	733:15.6	39.456	121.539	49	79	8*		0.10			PALERMO
1978 12-22	1524:52.0	39.778	121.889	24	38	27*		1.30			NORD
1978 12-27	522:12.9	39.711	121.669	36	58	13*		0.60			HAMLIN CANYON
1978 12-27	1323:13.7	39.474	121.484	51	82	1*		0.50			BANGOR
1978 12-28	452:58.3	39.415	121.506	52	84	7*		0.60			PALERMO

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1979 1- 2	349:37.6	39.517	122.061	25	40	12*		0.70			GLENN
1979 1- 2	1448: 0.7	39.598	121.986	24	38	10*		0.70			LLANO SECO
1979 1- 3	725:53.6	39.445	121.508	51	82	5*		0.40			PALERMO
1979 1- 5	1400:54.5	39.871	121.799	29	46	5*		0.60			RICHARDSON SPRINGS
1979 1- 6	510:51.1	39.694	121.661	37	59	19*		0.40			HAMLIN CANYON
1979 1- 6	1811:20.1	39.427	121.444	55	88	0*		0.10			BANGOR
1979 1- 7	327:52.9	39.388	121.479	54	87	3*		-.40			BANGOR
1979 1- 7	1507:53.4	39.690	122.110	15	24	4*		1.50			HAMILTON CITY
1979 1- 7	2014:29.0	39.407	121.477	53	86	0*		-.40			BANGOR
1979 1-10	238: 6.3	39.389	121.453	55	89	0*		0.80			BANGOR
1979 1-10	652:11.9	39.414	121.450	55	88	3*		0.10			BANGOR
1979 1-10	1905:46.1	39.399	121.515	52	84	12*		1.20			PALERMO
1979 1-12	626: 5.1	39.488	121.467	52	83	1*		0.30			BANGOR
1979 1-13	513:20.9	39.513	121.490	50	80	7*		0.90			OROVILLE DAM
1979 1-13	1322:21.9	39.545	121.514	48	77	9*		0.90			OROVILLE
1979 1-13	1502:35.4	39.553	121.508	48	77	9*		2.60			OROVILLE
1979 1-18	121: 6.9	39.401	121.460	55	88	1*		1.00			BANGOR
1979 1-18	912:38.3	39.672	122.529	14	23	3*		1.80			CHROME
1979 1-21	1024:27.9	39.543	122.011	25	41	11*		0.80			GLENN
1979 1-22	2028:19.4	39.432	122.161	28	45	12*		2.50			LOGANDALE
1979 1-22	2111: 3.6	39.507	121.931	30	49	10*		0.60			LLANO SECO
1979 1-22	2315:21.9	39.537	122.037	25	40	9*		0.90			GLENN
1979 1-24	554:31.5	39.406	121.485	53	86	2*		0.40			BANGOR
1979 1-26	1009:29.5	39.400	122.216	29	47	12*		1.50			LOGANDALE
1979 1-26	2140:12.7	39.163	122.321	45	72	9*		2.40			MANOR SLOUGH
1979 2- 1	631: 1.1	39.824	121.480	45	73	7*		1.20			NO QUAD FOR THIS EI
1979 2- 3	1015:29.0	39.106	121.449	68	109	5*		0.80			WHEATLAND
1979 2- 6	828: 3.9	39.424	122.044	31	50	14*		2.10			PRINCETON
1979 2- 8	406: 4.2	39.386	121.476	55	88	1*		0.00			BANGOR
1979 2- 8	1717:17.4	39.572	121.975	25	41	4*		1.00			NO QUAD FOR THIS EI
1979 2- 9	2247:22.7	39.423	121.496	52	84	7*		1.10			BANGOR
1979 2-10	1854: 1.7	39.469	121.637	44	71	11*		0.80			BIGGS
1979 2-18	830:40.8	39.740	121.840	27	43	8*		1.00			NO QUAD FOR THIS EI
1979 2-19	556:12.8	39.485	121.493	50	81	3*		0.10			BANGOR
1979 2-22	359:36.5	39.451	121.442	54	87	0*		0.70			BANGOR
1979 2-22	802:27.8	39.413	121.471	54	87	1*		0.30			BANGOR
1979 2-24	347:58.3	39.386	121.475	55	88	0*		1.00			BANGOR
1979 2-24	841: 0.8	39.405	121.499	53	85	5*		0.60			BANGOR
1979 2-26	1340:22.2	39.730	121.616	39	62	25*		0.80			NO QUAD FOR THIS EI
1979 3- 1	2015:20.1	39.827	121.879	24	39	21*		0.90			NORD
1979 3- 2	828:20.2	39.449	121.503	51	82	5*		0.20			PALERMO
1979 3- 3	645: 0.2	39.393	121.486	54	87	3*		0.50			BANGOR
1979 3- 3	1944:46.7	39.776	121.920	22	36	5*		1.00			NORD
1979 3- 4	212:40.5	39.393	121.480	54	87	9*		0.40			BANGOR
1979 3- 7	1052:12.4	39.535	121.988	27	43	16*		1.40			LLANO SECO
1979 3- 9	1924:54.0	39.550	122.100	22	36	2*		0.70			GLENN
1979 3-10	1330:22.9	39.268	122.740	43	70	1*		3.10			FOUTS SPRINGS
1979 3-14	1914:18.3	39.472	121.576	47	75	8*		0.10			PALERMO
1979 3-18	2047:16.1	39.399	121.464	55	88	5*		-.40			BANGOR
1979 3-19	1649:38.2	39.408	121.468	54	87	1*		0.10			BANGOR
1979 3-29	501:30.1	39.488	121.777	37	60	7*		0.40			WEST OF BIGGS
1979 3-31	2339: 4.9	39.489	121.490	50	81	4*		1.20			BANGOR
1979 4- 6	1009:14.2	39.498	121.471	51	82	3*		0.50			BANGOR
1979 4- 6	1929:41.6	39.402	121.480	54	87	1*		1.20			BANGOR

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1979 4- 6	2025:51.9	39.398	121.473	54	87	0*		0.70			BANGOR
1979 4- 6	2027:41.5	39.405	121.485	53	86	3*		0.50			BANGOR
1979 4- 6	2339: 1.4	39.659	121.870	27	43	5*		1.70			CHICO
1979 4- 6	2344:22.7	39.489	121.482	51	82	4*		1.10			BANGOR
1979 4- 7	1449:52.7	39.402	121.477	54	87	0*		1.40			BANGOR
1979 4- 8	938:54.5	39.571	122.011	24	39	8*		1.30			GLENN
1979 4- 8	1028:10.5	39.567	121.839	32	51	24*		0.90			NELSON
1979 4-12	1030:14.8	39.707	121.579	41	66	7*		0.40			CHEROKEE
1979 4-13	1101:51.2	39.592	122.019	23	37	9*		0.60			GLENN
1979 4-14	758:17.9	39.618	122.189	16	25	9*		2.80			WILLOWS
1979 4-15	1840: 0.7	39.401	121.491	53	86	4*		0.20			BANGOR
1979 4-20	1035:27.9	39.506	121.509	49	79	1*		0.10			OROVILLE
1979 4-20	1035:29.7	39.506	121.501	49	79	1*		0.10			OROVILLE
1979 4-24	1224:50.0	39.407	121.488	53	86	1*		0.90			BANGOR
1979 4-26	1318:47.6	39.460	121.478	52	83	3*		0.90			BANGOR
1979 4-27	515:20.5	40.015	121.625	40	65	5*		1.40			BUTTE MEADOWS SW
1979 4-27	1352:36.7	39.558	121.916	29	46	11*		0.60			LLANO SECO
1979 4-27	1439:18.7	39.711	121.809	29	47	10*		0.70			CHICO
1979 4-30	505:31.7	39.404	121.481	53	86	0*		0.60			BANGOR
1979 5- 3	621:30.2	39.400	121.481	54	87	0*		0.90			BANGOR
1979 5- 3	1019:50.4	39.466	121.494	51	82	8*		1.00			BANGOR
1979 5- 4	29:18.3	39.708	121.976	21	33	7*		1.30			ORD FERRY
1979 5- 4	1743:13.5	39.537	122.079	24	38	7*		1.50			GLENN
1979 5- 4	2214:54.3	39.403	121.508	52	84	2*		0.50			PALERMO
1979 5-11	220:24.1	39.610	121.386	53	85	17*		0.50			OROVILLE DAM
1979 5-11	231:47.8	39.594	121.365	54	87	15*		-.20			FORBESTOWN
1979 5-15	1926:24.5	39.613	121.392	52	84	17*		-.10			OROVILLE DAM
1979 5-16	22:25.9	39.418	121.506	52	84	9*		0.50			PALERMO
1979 5-16	949:46.4	39.443	121.440	54	87	1*		0.80			BANGOR
1979 5-17	1148:56.2	39.570	121.943	27	43	9*		1.10			LLANO SECO
1979 5-21	1439: 4.5	39.421	121.510	52	83	8*		1.30			PALERMO
1979 5-22	1252:25.9	39.418	121.459	54	87	1*		0.90			BANGOR
1979 5-24	1706:19.0	39.533	121.933	29	46	10*		0.90			LLANO SECO
1979 5-25	1338:28.5	39.433	121.469	53	86	0*		0.40			BANGOR
1979 5-25	1858:32.3	39.722	122.105	14	22	12*		1.70			HAMILTON CITY
1979 5-28	1014:19.6	39.423	121.485	53	85	6*		0.00			BANGOR
1979 6- 2	1358:50.5	39.387	121.490	54	87	0*		0.30			BANGOR
1979 6- 3	455:11.4	39.411	121.545	50	81	2*		1.00			PALERMO
1979 6- 9	650:27.4	39.465	122.009	30	48	28*		1.10			PRINCETON
1979 6-13	2017:33.8	40.548	121.742	60	96	4*		2.60			MANZANITA LAKE SW
1979 6-13	2025:53.2	40.533	121.744	59	95	6*		1.90			MANZANITA LAKE SW
1979 6-15	1111:37.9	39.416	121.499	52	84	6*		0.50			BANGOR
1979 6-19	727:31.0	40.255	122.364	30	49	13*		1.90			HOOKER
1979 6-26	903:10.3	40.079	121.412	52	84	5*		2.90			JONESVILLE SW
1979 6-29	1529: 3.0	39.415	121.481	53	86	0*		0.50			BANGOR
1979 7- 3	1742:21.6	39.505	121.516	48	78	11*		0.60			OROVILLE
1979 7- 6	1457:49.4	39.499	121.504	49	79	7*		2.60			PALERMO
1979 7- 7	408:38.3	39.499	121.498	50	80	8*		1.50			BANGOR
1979 7- 7	416:48.8	39.503	121.499	50	80	7*		0.50			OROVILLE DAM
1979 7-11	416: 9.3	39.515	121.505	49	79	9*		0.70			OROVILLE
1979 7-15	1446: 0.5	39.424	121.468	53	86	5*		2.60			BANGOR
1979 7-15	1517:18.5	39.425	121.475	53	86	8*		2.80			BANGOR
1979 7-15	1645:42.2	39.433	121.489	52	84	8*		0.30			BANGOR
1979 7-15	1702:28.8	39.425	121.486	53	85	7*		0.50			BANGOR

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DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1979 7-15	1729:34.2	39.439	121.475	53	85	5*		0.50			BANGOR
1979 7-18	550: 7.1	39.390	121.478	54	87	0*		0.20			BANGOR
1979 7-19	740:53.6	39.421	121.475	53	86	6*		0.70			BANGOR
1979 7-19	2053:16.7	39.414	121.483	53	86	3*		0.30			BANGOR
1979 7-20	835:10.8	39.820	122.661	17	28	0*		3.10			HALL RIDGE
1979 7-21	2220:11.0	39.528	121.551	46	74	0*		0.50			OROVILLE
1979 7-21	2225:30.0	39.505	121.479	50	81	1*		0.60			OROVILLE DAM
1979 7-22	102:48.7	39.495	121.489	50	81	6*		0.20			BANGOR
1979 7-23	858:57.6	39.736	122.001	19	30	6*		1.50			HAMILTON CITY
1979 7-26	1016: 7.7	39.583	122.053	22	35	7*		1.20			GLENN
1979 7-29	2314:12.6	39.746	121.848	26	42	8*		0.90			CHICO
1979 8- 2	1526: 7.7	39.615	122.368	14	22	9*		2.70			STONE VALLEY
1979 8- 5	712:48.9	39.612	122.206	16	25	8*		1.30			WILLOWS
1979 8- 6	707:39.1	39.429	121.459	54	87	5*		-.20			BANGOR
1979 8- 8	1910:26.0	39.433	121.490	52	84	4*		0.50			BANGOR
1979 8- 9	2306:54.3	39.494	121.499	50	80	7*		0.50			BANGOR
1979 8-11	222: 0.8	39.419	121.503	52	84	5*		3.00			PALERMO
1979 8-11	227: 1.8	39.422	121.478	53	86	0*		1.10			BANGOR
1979 8-11	1220:57.4	39.404	121.503	53	85	7*		0.70			PALERMO
1979 8-11	1628:28.2	39.414	121.493	53	85	5*		0.30			BANGOR
1979 8-12	49:10.2	39.429	121.408	56	90	1*		0.10			BANGOR
1979 8-13	2252:48.0	39.478	121.482	51	82	8*		0.80			BANGOR
1979 8-22	423:21.4	39.382	121.472	55	88	3*		0.20			BANGOR
1979 8-25	1314: 1.7	39.396	121.484	54	87	3*		0.60			BANGOR
1979 9- 4	2334: 7.1	39.412	121.442	55	89	0*		0.70			BANGOR
1979 9- 7	1149:54.8	39.426	121.471	53	86	0*		0.90			BANGOR
1979 9-21	1828: 0.1	39.425	121.542	50	81	0*		0.50			PALERMO
1979 10- 7	617:37.8	39.416	121.540	50	81	1*		0.10			PALERMO
1979 10-13	503:46.0	39.412	121.482	53	86	4*		0.50			BANGOR
1979 10-17	208:39.0	39.390	121.455	55	89	4*		-.10			BANGOR
1979 10-27	2259:36.7	40.385	122.105	41	66	5*		2.50			NO QUAD FOR THIS EF
1979 10-28	622:59.8	39.754	121.881	25	40	17*		1.50			NORD
1979 10-28	1748:54.8	39.414	121.495	53	85	3*		2.90			BANGOR
1979 10-28	1801:37.2	39.403	121.469	54	87	1*		0.80			BANGOR
1979 10-31	17: 4.8	39.636	121.572	42	68	17*		0.50			CHEROKEE
1979 10-31	2006:25.3	39.426	121.516	51	82	6*		3.10			PALERMO
1979 11- 1	1230: 4.1	39.407	121.484	53	86	3*		0.60			BANGOR
1979 11- 2	345:48.8	39.403	121.474	54	87	0*		0.90			BANGOR
1979 11- 2	844:36.9	39.405	121.472	54	87	1*		0.40			BANGOR
1979 11- 3	1317:23.0	39.394	121.446	55	89	0*		-.10			BANGOR
1979 11- 3	1749:53.2	39.416	121.475	53	86	2*		0.90			BANGOR
1979 11- 6	2017:47.0	39.440	121.616	46	74	0*		0.60			PALERMO
1979 11-14	622:16.6	39.391	121.471	55	88	6*		2.70			BANGOR
1979 11-14	751:21.4	39.392	121.476	54	87	1*		0.20			BANGOR
1979 11-21	2335:25.5	40.243	121.377	59	95	8*		2.70			JONESVILLE NW
1979 11-22	655:36.6	39.653	122.987	37	59	19*		2.80			PLASKETT RIDGE
1979 11-24	844:32.1	39.732	121.984	19	31	7*		1.70			ORD FERRY
1979 11-25	732:18.9	39.546	122.005	25	41	9*		1.10			GLENN
1979 11-27	1239:56.2	39.395	121.498	53	86	0*		0.30			BANGOR
1979 11-28	516:51.2	39.419	122.209	28	45	5*		2.50			LOGANDALE
1979 11-28	757:43.2	39.412	121.468	54	87	0*		0.80			BANGOR
1979 11-28	800:21.8	39.403	121.468	54	87	6*		0.40			BANGOR
1979 12- 1	20:22.3	39.526	121.494	49	79	8*		0.50			OROVILLE DAM
1979 12- 1	402:44.6	39.797	122.709	20	32	5*		2.10			HALL RIDGE

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1979 12- 1	1759:44.8	39.751	121.691	35	56	11*		0.90			PARADISE SW
1979 12-12	1026:39.8	39.395	121.484	54	87	0*		1.00			BANGOR
1979 12-15	409:28.1	39.529	122.140	22	36	0*		1.80			WILLOWS
1980 1-10	252:42.6	39.674	122.033	19	30	6*		2.30			HAMILTON CITY
1980 1-10	255: 9.9	39.699	122.122	14	22	9*		1.50			HAMILTON CITY
1980 1-11	547: 7.4	39.403	121.481	53	86	5*		0.50			BANGOR
1980 1-14	855:34.0	39.440	122.949	42	67	0*		2.80			LAKE PILLSBURY
1980 1-24	1531: 2.5	40.140	121.479	51	82	8*		2.70			JONESVILLE NW
1980 1-24	1541:27.8	39.355	121.538	53	85	0*		2.70			HONCUT
1980 1-30	439: 8.5	39.410	121.479	53	86	5*		0.60			BANGOR
1980 2- 4	155:23.5	40.013	121.376	53	85	8*		2.30			JONESVILLE SW
1980 2- 6	2157:38.1	39.531	122.152	22	35	7*		1.50			WILLOWS
1980 3- 4	1613:19.7	39.516	121.503	49	79	3*		2.60			OROVILLE
1980 3-12	707:22.5	39.621	121.981	23	37	5*		2.30			LLANO SECO
1980 3-22	1239:48.9	39.271	122.236	38	61	2*		1.90			MAXWELL
1980 4- 4	2335:30.8	40.349	122.121	39	62	7*		2.60			DALES
1980 4-13	2243:10.6	40.162	121.448	53	85	11*		2.40			JONESVILLE NW
1980 4-24	333:55.0	39.694	122.083	16	25	7*		2.40			HAMILTON CITY
1980 4-25	1118:15.7	39.433	122.916	40	65	9*		2.00			LAKE PILLSBURY
1980 4-28	620: 4.4	39.645	121.907	25	41	9*		1.60			ORD FERRY
1980 4-29	1350:22.6	40.437	123.480	75	120	5		3.00		GS	36
1980 5-12	416: 1.2	39.410	121.473	54	87	0*		1.70			BANGOR
1980 5-12	427:23.1	39.823	122.674	18	29	4*		3.10		CDWR	HALL RIDGE
1980 5-12	1146:49.8	39.398	121.477	54	87	0*		1.00			BANGOR
1980 6- 5	1910:54.1	39.468	121.363	57	92	5*		1.10			RACKERBY
1980 6- 9	229:27.5	39.709	123.073	40	64	2*		3.40			THATCHER RIDGE
1980 6- 9	236:40.0	39.430	121.486	52	84	0*		2.40			BANGOR
1980 6-11	2157:17.5	39.554	122.866	34	54	4*		2.90			KNEECAP RIDGE
1980 6-13	758:12.1	39.108	121.730	58	94	14*		2.70			GILSIZER SLOUGH
1980 7- 4	1612:31.6	39.423	122.825	37	60	4*		2.60		CDWR	CROCKETT PEAK
1980 7- 9	2132:18.0	39.603	121.871	29	46	3*		1.00			NELSON
1980 7-19	1017:38.7	39.411	121.475	53	86	5*		0.30			BANGOR
1980 7-26	209:19.5	39.400	121.474	54	87	0*		1.60			BANGOR
1980 7-28	1008:11.2	39.410	121.489	53	85	3*		0.30			BANGOR
1980 8- 2	932:59.6	39.392	121.479	54	87	0*		0.40			BANGOR
1980 8- 4	633:32.9	39.485	121.517	49	79	0*		2.40			PALERMO
1980 8-10	1710:43.1	39.611	122.846	30	49	8*		1.50			KNEECAP RIDGE
1980 8-15	2011:56.0	39.417	121.468	54	87	0*		2.20			BANGOR
1980 8-17	2131: 5.5	39.484	121.487	51	82	1*		0.50			BANGOR
1980 8-21	1030:33.5	39.463	121.476	52	83	0*		0.50			BANGOR
1980 8-29	1257:47.5	39.402	121.485	53	86	3*		1.40			BANGOR
1980 8-30	701:10.9	39.417	121.483	53	85	2*		1.30			BANGOR
1980 9- 9	1019:41.5	40.236	121.450	55	89	5*		2.10			JONESVILLE NW
1980 9-26	524: 2.0	39.403	121.501	53	85	8*		2.20			PALERMO
1980 9-26	938:52.1	39.374	121.366	60	97	4*		2.10			OREGON HOUSE
1980 10- 3	40:13.9	39.558	121.724	37	60	1*		2.60			SHIPPEE
1980 10- 3	943:10.5	39.149	121.734	56	90	20*		1.10			SUTTER
1980 10-14	1609:27.7	39.543	121.925	29	46	11*		1.80			LLANO SECO
1980 10-16	1355: 7.3	40.123	122.686	29	46	5*		3.20		GS	36
1980 10-16	2337:34.0	39.516	121.514	48	78	9*		0.50			OROVILLE
1980 10-18	347:26.8	39.537	121.974	27	44	11*		0.80			LLANO SECO
1980 10-20	2038: 7.7	39.993	122.208	14	23	12*		2.60			CORNING
1980 11-13	710: 5.1	40.008	122.179	16	25	12*		3.10			GERBER
1980 11-15	53: 4.0	39.588	121.984	24	39	26*		2.30			LLANO SECO

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1980 11-18	1236:53.2	39.427	121.455	54	87	1*		0.40		BANGOR
1980 11-19	456:57.4	39.414	121.482	53	86	8*		0.60		BANGOR
1980 11-19	915: 6.9	39.398	121.440	56	90	0*		0.30		BANGOR
1980 11-19	1300:59.0	39.526	121.544	47	75	6*		2.90		OROVILLE
1980 11-19	1547:57.9	39.407	121.490	53	86	1*		0.00		BANGOR
1980 11-21	702:24.4	39.614	121.633	40	64	5*		1.20		SHIPPEE
1980 11-24	1910:47.9	39.222	122.220	41	66	5		3.30	USGS	
1980 11-24	1910:49.0	39.218	122.220	42	67	15*		3.80		WILLIAMS
1980 11-26	233:16.2	39.226	122.220	41	66	31*		3.10		WILLIAMS
1980 11-28	2102: 7.1	39.214	122.202	42	67	9*		3.00		WILLIAMS
1980 11-29	638:21.7	39.205	122.218	42	68	27*		2.40		WILLIAMS
1980 11-29	1350:14.3	39.403	121.477	54	87	1*		1.50		BANGOR
1980 11-30	1337:33.9	39.809	121.639	37	60	7*		2.30		PARADISE SW
1980 11-30	1916:50.3	40.079	121.668	40	64	9*		2.10		BUTTE MEADOWS SW
1980 12- 1	120:31.1	39.306	122.317	35	56	11*		2.80		SITES
1980 12- 1	1539: 0.6	39.372	121.575	51	82	5		2.80	USGS	
1980 12- 9	2:29.2	39.179	122.956	55	88	5*		1.70		UPPER LAKE
1980 12-10	108:16.8	39.800	122.092	13	21	30*		2.60		FOSTER ISLAND
1980 12-12	709:14.3	39.333	122.132	35	56	20*		2.30		MAXWELL
1980 12-12	709:56.3	39.318	122.132	36	58	11*		2.50		MAXWELL
1980 12-12	912:18.9	39.565	121.974	26	42	10*		2.20		LLANO SECO
1980 12-12	1313:17.5	39.260	122.406	39	62	5		3.40	USGS	
1980 12-12	1313:20.8	39.209	122.244	42	68	15*		3.60		WILLIAMS
1980 12-14	1911:53.3	39.230	122.219	41	66	15*		3.20		WILLIAMS
1980 12-15	1435:40.1	39.400	122.131	30	49	12*		2.90		LOGANDALE
1980 12-20	1101:13.6	39.615	122.027	21	34	11*		2.00		GLENN
1980 12-23	224:17.9	39.824	121.612	39	62	0*		1.30		PARADISE SE
1980 12-25	1338:46.6	39.594	121.807	32	51	6*		0.40		NELSON
1980 12-27	2137:55.2	39.694	122.046	17	28	10*		1.60		HAMILTON CITY
1980 12-31	1:36.8	39.906	123.075	40	64	14*		3.00		LEECH LAKE MTN.
1981 1- 4	1605:33.4	39.417	121.463	54	87	1*		0.30		BANGOR
1981 1- 6	803:16.6	39.554	121.975	26	42	17*		2.60		LLANO SECO
1981 1- 6	813:24.7	39.559	122.011	25	40	11*		2.30		GLENN
1981 1- 6	1305:18.2	39.459	121.505	50	81	7*		0.10		PALERMO
1981 1- 7	2005:28.7	39.573	121.958	26	42	0*		2.20		LLANO SECO
1981 1- 7	2134:46.0	39.244	122.264	39	63	5*		1.10		MANOR SLOUGH
1981 1- 7	2315:39.6	39.734	121.523	43	70	5*		-.10		CHEROKEE
1981 1-10	1406:29.3	39.351	121.373	60	97	0*		0.20		OREGON HOUSE
1981 1-14	1313:28.6	39.540	121.514	48	77	7*		3.40		OROVILLE
1981 1-16	1046:10.7	40.094	122.475	21	33	6*		2.70		RED BANK
1981 1-20	1147:50.5	40.023	121.941	25	41	7*		2.00		PANTHER SPRING SW
1981 1-22	410:33.7	39.390	121.478	54	87	0*		1.70		BANGOR
1981 1-24	1840:54.8	39.633	122.026	21	33	24*		1.50		HAMILTON CITY
1981 1-29	841:33.1	40.143	121.533	48	78	5		3.50	USGS	
1981 2- 2	1424:31.2	39.307	122.087	37	60	4*		1.00		MOULTON WEIR
1981 2- 2	1847:44.8	39.706	121.855	27	43	8*		2.30		CHICO
1981 2- 3	2305: 2.4	39.435	122.885	39	63	5*		3.00		LAKE PILLSBURY
1981 2-15	2245: 9.5	39.374	122.319	30	49	10*		3.00		SITES
1981 2-16	1457:39.5	39.404	121.485	53	86	0*		0.80		BANGOR
1981 2-26	241:23.9	39.718	121.799	29	47	9*		2.00		CHICO
1981 3- 1	1742: 0.7	39.569	121.998	25	40	10*		0.60		LLANO SECO
1981 3-13	457:10.9	39.408	121.499	53	85	8*		1.90		BANGOR
1981 3-13	855:33.8	39.406	121.461	55	88	1*		0.10		BANGOR
1981 3-13	1011:50.4	39.424	121.427	55	89	5*		0.00		BANGOR

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1981 3-14	1850:26.5	40.188	121.362	58	93	8*		2.70			JONESVILLE NE
1981 3-16	1420:35.7	39.411	121.483	53	86	4*		1.60			BANGOR
1981 3-16	2025:44.2	39.689	122.020	19	30	10*		1.80			HAMILTON CITY
1981 3-20	745:58.8	39.474	121.478	52	83	0*		0.80			BANGOR
1981 3-24	834:35.9	39.432	121.482	53	85	0*		0.30			BANGOR
1981 3-24	1747:58.1	39.521	122.043	25	41	21*		2.80			GLENN
1981 3-30	2343:47.6	39.364	121.429	57	92	3*		0.30			LOMA RICA
1981 4- 2	723:22.8	39.711	122.648	18	29	28*		2.70			ALDER SPRINGS
1981 4- 8	1814:47.0	39.376	121.491	54	87	7*		1.60			BANGOR
1981 4-10	253: 9.9	40.437	122.206	43	70	9*		2.20			NO QUAD FOR THIS EP
1981 4-10	448:26.3	39.397	121.475	54	87	1*		1.80			BANGOR
1981 4-12	1009: 4.7	39.226	122.548	42	68	7*		1.70			CLEARLAKE OAKS NE
1981 4-13	2238: 8.4	40.278	121.555	52	84	10*		2.80			LASSEN PEAK SE
1981 4-15	2045: 6.6	39.412	121.489	53	85	0*		0.90			BANGOR
1981 4-21	311:37.8	39.397	121.480	54	87	5*		2.40			BANGOR
1981 4-28	642:11.4	40.079	121.480	49	79	10*		1.10			JONESVILLE SW
1981 4-28	2053:26.0	39.401	121.453	55	89	5*		0.80			BANGOR
1981 5- 3	410:45.9	39.763	121.758	31	50	26*		2.40			RICHARDSON SPRINGS
1981 5- 5	1427: 7.7	39.910	122.755	23	37	0*		0.00			BALL MOUNTAIN
1981 5- 6	853:10.5	39.957	123.244	49	79	1*		0.00			BLUENOSE RIDGE
1981 5- 6	2006:47.8	39.604	122.892	33	53	4*		0.00			HULL MOUNTAIN
1981 5- 6	2015: 4.1	39.633	122.878	32	51	1*		0.00			PLASKETT RIDGE
1981 5- 6	2251:11.7	39.670	122.799	27	43	0*		0.00			PLASKETT MEADOWS
1981 5- 8	1557:36.7	39.523	122.253	21	33	21*		2.50			STONE VALLEY
1981 5-15	2035:55.5	39.365	121.405	58	94	5*		0.40			LOMA RICA
1981 5-17	1710:26.5	40.465	121.553	61	98	4*		2.90			LASSEN PEAK NE
1981 5-18	1755:57.0	39.999	121.926	25	41	11*		1.30			RICHARDSON SPGS NW
1981 5-19	1645:32.0	40.165	122.968	42	67	19*		3.20			YOLLA BOLLY NW
1981 5-23	7:39.7	40.077	123.186	48	78	0*		0.00			BLACK ROCK MTN NE
1981 5-23	1824:51.3	39.475	122.804	34	55	6*		0.00			CROCKETT PEAK
1981 5-23	2007: 0.8	39.441	121.438	54	87	2*		0.10			BANGOR
1981 5-23	2327:44.6	39.859	122.109	12	20	36*		0.00			FOSTER ISLAND
1981 5-24	918:47.1	39.376	122.836	40	65	5*		0.00			CROCKETT PEAK
1981 5-24	1051: 6.0	39.787	122.608	14	23	18*		0.00			NEWVILLE
1981 5-25	136: 7.7	39.593	122.766	27	44	17*		0.00			KNEECAP RIDGE
1981 5-26	110: 5.8	39.622	122.862	31	50	7*		0.00			KNEECAP RIDGE
1981 5-26	2118:26.6	40.003	121.924	25	41	8*		1.40			PANTHER SPRING SW
1981 5-27	1518:53.0	39.899	122.843	27	44	0*		0.00			BALL MOUNTAIN
1981 5-28	1503:51.0	39.929	123.032	38	61	0*		0.00			LEECH LAKE MTN.
1981 5-28	1513:19.0	39.351	123.190	56	90	0*		0.00			REDWOOD VALLEY
1981 5-30	1141:24.0	39.858	122.914	31	50	3*		0.00			MENDOCINO PASS
1981 6- 2	1923:30.2	39.373	121.365	60	97	9*		1.C0			OREGON HOUSE
1981 6- 2	2253:11.9	39.508	123.082	45	72	5*		0.00			SANHEDRIN MTN.
1981 6- 3	1337: 3.1	39.933	123.021	37	60	0*		0.00			LEECH LAKE MTN.
1981 6- 3	2347:40.4	39.906	123.071	40	64	1*		0.00			LEECH LAKE MTN.
1981 6- 4	858:15.7	39.533	123.092	45	72	5*		0.00			SANHEDRIN MTN.
1981 6- 4	1223:15.1	39.383	123.211	55	89	19*		3.40			POTTER VALLEY NW
1981 6- 4	1253:33.2	39.811	122.661	17	28	3*		0.00			HALL RIDGE
1981 6- 4	1854:20.2	39.811	122.663	17	28	0*		0.00			HALL RIDGE
1981 6- 4	2022:53.9	39.593	121.585	43	69	0*		1.40			OROVILLE
1981 6- 6	942:25.6	39.775	122.866	29	46	13*		0.00			LOG SPRING
1981 6- 7	1967:26.9	39.347	121.359	62	99	7*		0.70			OREGON HOUSE
1981 6- 8	121:47.5	39.971	122.987	36	58	0*		0.00			BUCK ROCK
1981 6- 8	135: 5.9	40.090	123.065	43	69	1*		0.00			BLACK ROCK MTN SE

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1981 6- 9	1558: 4.3	39.410	122.649	32	52	0*		0.00			SAINT JOHN MTN.
1981 6- 9	2344:21.9	40.021	121.935	25	41	8*		1.60			PANTHER SPRING SW
1981 6-11	1234:51.0	39.586	121.939	26	42	9*		0.70			LLANO SECO
1981 6-14	1702:26.5	39.786	123.236	48	77	0*		0.00			COVELO EAST
1981 6-14	2204:12.0	39.575	123.145	46	74	0*		0.00			BRUSHY MTN.
1981 6-14	2230: 5.6	39.639	122.936	34	55	0*		0.00			PLASKETT RIDGE
1981 6-15	750:12.0	39.690	122.743	23	37	1*		0.00			ALDER SPRINGS
1981 6-15	1130:50.5	39.677	122.756	24	39	4*		0.00			PLASKETT MEADOWS
1981 6-16	701: 9.8	39.854	123.146	43	69	5*		1.90			COVELO EAST
1981 6-16	839:29.0	39.809	122.694	19	31	5*		0.00			HALL RIDGE
1981 6-17	339:54.7	39.844	122.921	31	50	5*		0.00			MENDOCINO PASS
1981 6-18	1804:29.1	39.896	123.244	48	78	0*		0.00			BLUENOSE RIDGE
1981 6-22	2337:57.1	39.433	121.468	53	86	0*		2.00			BANGOR
1981 6-25	1454:12.2	39.328	121.469	57	92	3*		0.50			LOMA RICA
1981 6-27	244: 6.7	40.112	122.131	24	38	10*		1.60			GERBER
1981 6-27	1133:19.2	39.203	122.749	47	76	1*		1.60			CLEARLAKE OAKS NW
1981 6-29	2204: 6.5	39.939	122.397	9	15	5*		0.00			FLOURNOY
1981 6-30	107:34.8	39.734	122.829	27	43	15*		0.00			PLASKETT MEADOWS
1981 6-30	1155:22.4	39.518	122.890	36	58	0*		0.00			HULL MOUNTAIN
1981 6-30	1456:26.1	39.408	121.481	53	86	0*		2.90			BANGOR
1981 6-30	1850:14.1	39.406	121.468	54	87	2*		1.00			BANGOR
1981 6-30	1926:40.8	39.823	122.662	17	28	10*		0.00			HALL RIDGE
1981 7- 1	446:54.3	39.458	121.539	49	79	4*		0.10			PALERMO
1981 7- 2	128:21.9	39.835	122.659	17	28	10		3.20		USGS	
1981 7- 2	131:35.7	39.854	122.743	22	35	0*		0.00			HALL RIDGE
1981 7- 2	144: 8.5	39.403	121.475	54	87	0*		0.50			BANGOR
1981 7- 2	152:58.9	39.849	122.713	21	33	1*		0.00			HALL RIDGE
1981 7- 2	337:47.2	39.854	122.724	21	34	0*		0.00			HALL RIDGE
1981 7- 2	541:39.9	39.871	122.721	21	34	10*		1.60			HALL RIDGE
1981 7- 2	548:58.0	39.859	122.717	21	33	0*		0.00			HALL RIDGE
1981 7- 2	1120:44.1	39.852	122.726	21	34	0*		0.00			HALL RIDGE
1981 7- 2	1711:28.3	39.904	122.722	22	35	22*		0.00			RILEY RIDGE
1981 7- 2	2350:22.7	39.826	122.731	21	34	1*		0.00			HALL RIDGE
1981 7- 3	112:28.3	39.784	122.733	21	34	0*		0.00			HALL RIDGE
1981 7- 3	127:10.6	39.385	121.441	56	90	0*		0.10			BANGOR
1981 7- 4	244: 2.3	39.796	123.091	40	65	4*		0.00			NEWHOUSE RIDGE
1981 7- 4	320:45.8	39.381	122.588	33	53	12*		1.40			STONYFORD
1981 7- 4	2257:45.5	39.705	121.739	33	53	14*		1.30			HAMLIN CANYON
1981 7- 8	817:30.9	40.397	121.688	53	85	5*		1.90			LASSEN PEAK NW
1981 7- 9	1636:27.9	39.835	122.686	19	30	2*		0.00			HALL RIDGE
1981 7- 9	1707:49.3	39.846	122.732	21	34	3*		0.00			HALL RIDGE
1981 7-10	408:56.3	39.677	122.915	32	52	0*		0.00			PLASKETT RIDGE
1981 7-11	330:47.4	39.873	122.564	13	21	33*		0.00			NEWVILLE
1981 7-11	359:40.2	39.546	122.864	34	54	9*		0.00			KNEECAP RIDGE
1981 7-11	411:52.9	39.490	123.028	43	69	0*		0.00			POTTER VALLEY NE
1981 7-12	200:56.9	39.877	122.652	17	28	2*		0.00			RILEY RIDGE
1981 7-12	822:58.4	39.818	122.668	17	28	6*		0.00			HALL RIDGE
1981 7-13	1108:42.6	39.403	121.477	54	87	0*		0.40			BANGOR
1981 7-13	1115:20.5	39.415	123.242	55	89	0*		0.00			POTTER VALLEY NW
1981 7-13	1527:38.6	39.418	121.483	53	85	1*		0.90		CDWR	BANGOR
1981 7-13	1856:30.5	39.630	122.913	33	53	0*		0.00			PLASKETT RIDGE
1981 7-14	229:21.6	39.577	122.717	26	42	1*		0.00			FELKNER HILL
1981 7-14	454:11.4	39.386	122.976	45	73	2*		0.00			LAKE PILLSBURY
1981 7-14	2130:57.2	39.409	121.475	53	86	0*		1.90			BANGOR

EARTHQUAKE CATALOG

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1981	7-15	2300:20.7	39.657	122.891	32	51	0*		0.00			PLASKETT RIDGE
1981	7-15	2308:43.1	39.332	121.430	58	94	14*		0.80			LOMA RICA
1981	7-16	53:25.9	39.404	121.484	53	86	0*		1.30			BANGOR
1981	7-16	1056:13.5	39.755	121.863	25	41	3*		1.90			RICHARDSON SPRINGS
1981	7-16	1112: 8.7	39.648	122.858	30	48	0*		0.00			PLASKETT MEADOWS
1981	7-17	233:43.1	39.679	122.883	30	49	0*		0.00			PLASKETT RIDGE
1981	7-17	234:13.1	39.668	122.937	34	54	1*		0.00			PLASKETT RIDGE
1981	7-17	423:43.4	39.476	121.441	53	85	5*		0.00			BANGOR
1981	7-17	1343:11.8	39.817	122.676	18	29	2*		0.00			HALL RIDGE
1981	7-18	1307:11.5	39.572	121.588	43	70	0*		1.30			OROVILLE
1981	7-18	2303:12.1	39.573	121.582	43	70	3*		1.90			OROVILLE
1981	7-20	440: 2.6	39.600	121.720	36	58	0*		0.20			SHIPPEE
1981	7-20	909:54.9	40.307	122.058	37	60	12*		2.40			DALES
1981	7-20	1410:10.8	39.784	121.912	22	36	13*		1.20			NORD
1981	7-21	1821:12.5	39.533	123.043	42	68	1*		0.00			SANHEDRIN MTN.
1981	7-23	123:19.5	39.776	122.785	24	39	1*		0.00			LOG SPRING
1981	7-23	1208:37.1	39.717	121.747	32	52	20*		1.80			HAMLIN CANYON
1981	7-23	2355:46.2	39.373	121.403	58	94	3*		0.70			LOMA RICA
1981	7-25	723:27.8	39.529	122.735	29	47	0*		0.00			FELKNER HILL
1981	7-26	724:50.8	39.404	121.466	54	87	0*		0.20			BANGOR
1981	7-26	1008:30.1	39.570	122.997	39	63	0*		0.00			HULL MOUNTAIN
1981	7-28	1105: 2.5	39.328	122.989	48	78	1*		0.00			ELK MOUNTAIN
1981	7-28	1105:15.4	39.338	122.982	48	77	0*		0.00			ELK MOUNTAIN
1981	7-29	540:50.7	39.610	122.967	37	59	0*		0.00			HULL MOUNTAIN
1981	7-29	810:15.2	39.623	122.909	33	53	2*		0.00			HULL MOUNTAIN
1981	7-29	928:11.9	39.623	123.023	39	63	0*		0.00			SANHEDRIN MTN.
1981	7-30	1151:28.4	39.304	123.101	54	87	4*		2.20			POTTER VALLEY
1981	7-30	1733:38.0	40.191	122.551	29	46	5*		0.00			OXBOW BRIDGE
1981	7-31	111:50.7	39.499	123.105	47	75	4*		0.00			POTTER VALLEY NE
1981	7-31	1634:27.2	39.783	122.989	35	56	5*		0.00			MENDOCINO PASS
1981	7-31	2206: 4.4	39.875	122.636	17	27	5*		0.00			RILEY RIDGE
1981	7-31	2212:56.8	39.767	122.951	33	53	5*		0.00			MENDOCINO PASS
1981	8- 1	1626:44.6	39.614	121.842	30	48	29*		0.40			NELSON
1981	8- 2	1623:21.1	40.166	122.786	34	55	0*		0.00			YOLLA BOLLY NE
1981	8- 3	925: 1.1	39.471	123.092	47	75	2*		0.00			POTTER VALLEY NE
1981	8- 3	1048:15.0	39.818	122.785	24	38	2*		0.00			LOG SPRING
1981	8- 3	1522:55.2	39.417	122.799	37	59	0*		0.00			CROCKETT PEAK
1981	8- 4	358:25.2	39.848	122.688	19	30	0*		0.00			HALL RIDGE
1981	8- 4	515: 7.0	39.761	123.050	38	61	3*		0.00			NEWHOUSE RIDGE
1981	8- 4	1035:13.2	39.718	123.216	47	76	0*		0.00			JAMISON RIDGE
1981	8- 5	1836:58.3	39.663	122.728	24	38	4*		0.00			ALDER SPRINGS
1981	8- 6	359:42.8	39.702	122.940	33	53	10*		0.00			PLASKETT RIDGE
1981	8- 6	412:59.2	39.883	122.608	16	25	4*		0.00			PASKENTA
1981	8- 7	1802:42.7	40.014	121.931	25	41	8*		1.30			PANTHER SPRING SW
1981	8-10	423:23.6	39.934	123.123	43	69	9*		0.00			LEECH LAKE MTN.
1981	8-11	627: 2.2	39.918	122.897	30	49	0*		0.00			BUCK ROCK
1981	8-12	1615: 3.7	40.016	122.971	37	59	1*		0.00			YOLLA BOLLY SW
1981	8-14	1447:10.1	39.926	123.042	39	62	1*		0.00			LEECH LAKE MTN.
1981	8-14	1705: 7.1	39.625	122.686	23	37	5*		0.00			ALDER SPRINGS
1981	8-14	2130:12.5	39.993	122.739	25	40	0*		0.00			RILEY RIDGE
1981	8-16	550: 1.7	39.457	123.105	48	77	1*		0.00			POTTER VALLEY NE
1981	8-17	1909:22.2	39.379	121.474	55	88	0*		0.40			BANGOR
1981	8-18	1518:30.5	39.853	122.759	22	36	5*		0.00			LOG SPRING
1981	8-20	1650:57.8	40.163	123.209	52	84	0*		0.00			BLACK ROCK MTN NW

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1981 8-21	321:58.0	39.979	123.132	44	71	0*		0.00			BLUENOSE RIDGE
1981 8-22	202: 1.5	39.863	122.845	27	44	0*		0.00			LOG SPRING
1981 8-23	1418:48.6	39.701	122.566	14	23	0*		0.00			CHROME
1981 8-24	134:33.5	39.602	123.211	49	79	1*		0.00			BRUSHY MTN.
1981 8-26	445: 3.4	39.407	123.146	52	83	1*		0.00			POTTER VALLEY NW
1981 8-26	2140:53.2	39.633	122.780	27	43	0*		0.00			PLASKETT MEADOWS
1981 8-27	2259:33.7	39.869	122.767	23	37	5*		0.00			LOG SPRING
1981 8-30	1517:27.3	39.335	123.203	57	91	1*		0.00			REDWOOD VALLEY
1981 9- 1	1610:27.7	39.724	122.140	12	19	5*		0.00			ORLAND
1981 9- 1	2118:37.0	39.555	123.077	43	70	5*		0.00			SANHEDRIN MTN.
1981 9- 2	2349:59.7	39.706	123.164	45	72	0*		0.00			JAMISON RIDGE
1981 9- 3	2345: 9.9	39.611	121.768	34	54	5*		0.10		CDWR	NELSON
1981 9- 6	1036:19.1	39.763	122.322	4	6	9*		0.00			BLACK BUTTE DAM
1981 9- 7	1135:21.8	39.411	121.476	53	86	0*		1.50			BANGOR
1981 9- 9	1749:33.4	40.205	122.980	43	70	1*		0.00			YOLLA BOLLY NW
1981 9-10	1240:23.2	39.904	122.742	22	36	0*		0.00			RILEY RIDGE
1981 9-12	1544:45.5	39.550	122.738	28	45	10*		0.00			FELKNER HILL
1981 9-12	1646:40.6	39.952	122.824	28	45	0*		0.00			BALL MOUNTAIN
1981 9-13	333:21.2	39.923	122.756	24	38	0*		0.00			BALL MOUNTAIN
1981 9-13	341:26.7	39.913	122.785	25	40	1*		0.00			BALL MOUNTAIN
1981 9-15	1329:35.8	40.090	122.492	21	34	5*		1.70			RED BANK
1981 9-15	2101:17.9	40.335	122.936	48	77	5*		0.00			CHANCHELULLA PEAK S
1981 9-16	1728:52.3	39.259	121.430	62	99	7*		2.90			LOMA RICA
1981 9-23	158: 3.1	39.449	122.020	30	49	30*		1.40			PRINCETON
1981 9-24	817:47.7	39.858	122.768	23	37	0*		0.00			LOG SPRING
1981 9-25	2113:32.0	39.211	123.190	62	99	0*		0.00			UKIAH
1981 9-25	2239:15.8	39.898	122.859	29	46	8*		0.00			BALL MOUNTAIN
1981 9-26	6:31.6	39.497	123.102	47	75	4*		0.00			POTTER VALLEY NE
1981 9-26	21:34.1	39.856	122.780	24	38	0*		0.00			LOG SPRING
1981 9-26	2036: 9.0	39.796	122.921	31	50	0*		0.00			MENDOCINO PASS
1981 9-27	217:58.0	39.377	123.043	48	78	2*		0.00			POTTER VALLEY NE
1981 9-27	2249:10.4	39.729	121.670	36	58	22*		0.90			HAMLIN CANYON
1981 9-28	1946:15.5	39.325	123.029	50	81	4*		0.00			POTTER VALLEY
1981 10- 3	1256:56.6	39.870	123.108	41	66	0*		0.00			NEWHOUSE RIDGE
1981 10- 6	257:37.8	39.824	122.554	12	19	23*		0.00			NEWVILLE
1981 10- 8	1902:35.5	40.171	121.396	56	90	5*		1.10			JONESVILLE NW
1981 10- 9	127:57.0	39.902	122.946	33	53	10*		0.00			BUCK ROCK
1981 10-10	710:48.4	39.685	122.558	15	24	30*		0.00			CHROME
1981 10-10	1213:17.8	40.528	122.137	50	81	0*		3.10			PALO CEDRO
1981 10-11	1421:14.4	39.387	122.616	33	53	5*		0.00			STONYFORD
1981 10-11	1749:39.3	39.789	122.953	33	53	0*		0.00			MENDOCINO PASS
1981 10-12	1:29.5	39.278	122.937	49	79	0*		0.00			ELK MOUNTAIN
1981 10-12	1319:16.7	39.592	121.607	42	67	23*		2.40			OROVILLE
1981 10-12	1359:55.3	39.887	123.118	42	67	5*		0.00			LEECH LAKE MTN.
1981 10-12	1417:53.2	39.715	121.674	36	58	8*		1.60			HAMLIN CANYON
1981 10-14	50:35.9	40.377	122.190	40	64	5*		1.60			NO QUAD FOR THIS E
1981 10-14	1739:49.5	39.834	122.964	34	54	0*		0.00			MENDOCINO PASS
1981 10-15	1804:56.0	39.817	122.674	18	29	0*		0.00			HALL RIDGE
1981 10-15	2217:36.4	39.853	122.383	4	6	5*		0.00			SEHORN CREEK
1981 10-18	1659:15.4	39.689	122.742	23	37	4*		0.00			ALDER SPRINGS
1981 10-18	1847:14.0	39.869	122.766	23	37	5*		0.00			LOG SPRING
1981 10-19	1628:32.7	39.905	122.797	25	41	5*		0.00			BALL MOUNTAIN
1981 10-23	920:36.2	39.939	122.795	26	42	3*		0.00			BALL MOUNTAIN
1981 10-23	1704:20.9	39.657	121.886	26	42	2*		1.40			ORD FERRY

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1981 10-24	234:37.6	39.521	122.979	40	64	0*		0.00			HULL MOUNTAIN
1981 10-24	420: 7.4	39.420	122.346	27	44	10*		0.00			LOGAN RIDGE
1981 10-24	1241:33.0	39.869	123.053	39	62	5*		0.00			NEWHOUSE RIDGE
1981 10-25	458: 4.6	39.836	121.825	27	44	24*		2.50			RICHARDSON SPRINGS
1981 10-25	602:24.1	39.958	122.540	15	24	14*		0.00			PASKENTA
1981 10-26	521:11.8	39.816	123.227	47	76	1*		0.00			COVELO EAST
1981 10-26	1318:31.2	39.777	121.793	29	47	5*		0.60			RICHARDSON SPRINGS
1981 10-26	2047:40.5	39.886	123.142	43	69	0*		0.00			BLUENOSE RIDGE
1981 10-26	2308:28.8	39.846	122.300	3	5	5*		0.00			BLACK BUTTE DAM
1981 10-30	2216:24.2	39.658	122.827	28	45	1*		0.00			PLASKETT MEADOWS
1981 10-31	1806:30.7	39.628	122.878	32	51	3*		0.00			PLASKETT RIDGE
1981 11- 1	1007:56.4	40.025	122.880	32	52	0*		0.00			YOLLA BOLLY SW
1981 11- 2	1916:23.0	39.919	123.050	39	62	1*		0.00			LEECH LAKE MTN.
1981 11- 2	2012: 1.0	39.607	122.901	34	54	6*		0.00			HULL MOUNTAIN
1981 11- 4	2226:54.6	39.647	123.092	42	67	0*		0.00			THATCHER RIDGE
1981 11- 5	1027:28.2	40.161	122.096	27	44	9*		2.50			TUSCAN SPRINGS
1981 11- 5	1451:35.6	39.668	122.910	32	52	0*		0.00			PLASKETT RIDGE
1981 11- 6	1806: 7.0	39.591	122.964	37	59	0*		0.00			HULL MOUNTAIN
1981 11- 7	1102: 2.4	39.622	122.465	15	24	21*		0.00			FRUTO
1981 11- 7	1700: 6.8	39.630	122.912	33	53	10*		0.00			PLASKETT RIDGE
1981 11- 7	2023:26.9	39.656	122.496	14	22	22*		0.00			JULIAN ROCKS
1981 11- 9	1306: 9.1	39.915	122.747	23	37	0*		0.00			RILEY RIDGE
1981 11- 9	1458:11.5	39.918	122.742	23	37	0*		0.00			RILEY RIDGE
1981 11- 9	1503:40.7	39.918	122.742	23	37	0*		0.00			RILEY RIDGE
1981 11- 9	1939:53.7	39.315	121.411	60	97	2*		0.30			LOMA RICA
1981 11-10	217:16.2	39.751	122.009	18	29	8*		1.10			FOSTER ISLAND
1981 11-10	836:19.6	39.848	122.726	21	34	1*		0.00			HALL RIDGE
1981 11-10	1407:42.2	39.752	122.089	14	22	35*		1.10			FOSTER ISLAND
1981 11-10	1947: 9.7	39.917	122.743	23	37	0*		0.00			RILEY RIDGE
1981 11-13	1959:59.3	39.607	122.913	34	55	1*		0.00			HULL MOUNTAIN
1981 11-17	2303:20.3	39.895	122.750	23	37	0*		0.00			BALL MOUNTAIN
1981 11-18	2234:45.4	39.648	122.850	30	48	2*		0.00			PLASKETT MEADOWS
1981 11-20	0:57.1	39.866	122.926	32	51	5*		0.00			MENDOCINO PASS
1981 11-20	542:15.0	39.584	122.868	32	52	0*		0.00			KNEECAP RIDGE
1981 11-22	1855: 0.9	39.217	122.905	51	82	5*		0.00			UPPER LAKE
1981 11-24	2127: 6.4	39.991	122.934	34	55	0*		0.00			BUCK ROCK
1981 11-25	504:37.4	39.529	122.940	38	61	5*		0.00			HULL MOUNTAIN
1981 11-25	1027:25.4	39.585	122.902	34	55	0*		0.00			HULL MOUNTAIN
1981 11-25	2237:50.1	39.554	123.060	42	68	0*		0.00			SANHEDRIN MTN.
1981 11-30	36:29.8	39.997	122.747	25	41	8*		0.00			RILEY RIDGE
1981 11-30	1213:41.4	39.309	123.185	57	92	0*		1.50			REDWOOD VALLEY
1981 12- 1	1340:25.4	39.747	123.227	48	77	0*		0.00			JAMISON RIDGE
1981 12- 2	250:28.5	39.924	122.805	26	42	4*		0.00			BALL MOUNTAIN
1981 12- 2	829:48.6	39.470	121.528	49	79	8*		1.30			PALERMO
1981 12- 3	2031:21.0	39.787	123.041	37	60	0*		0.00			NEWHOUSE RIDGE
1981 12- 4	1931:48.5	39.749	122.963	34	54	4*		0.00			PLASKETT RIDGE
1981 12- 7	1306:33.4	39.881	122.644	17	27	2*		0.00			RILEY RIDGE
1981 12- 7	1312:48.8	39.897	123.019	37	59	0*		0.00			LEECH LAKE MTN.
1981 12- 7	2132:36.7	39.449	123.126	49	79	7*		2.70			POTTER VALLEY NW
1981 12- 8	149:53.2	39.300	123.026	51	82	2*		0.00			POTTER VALLEY
1981 12- 8	507:24.4	39.760	123.208	47	75	0*		0.00			COVELO EAST
1981 12- 8	2332:53.7	40.238	123.083	49	79	1*		1.90			BLACK ROCK MTN NE
1981 12- 9	426:22.2	40.208	122.781	36	58	0*		0.00			YOLLA BOLLY NE
1981 12- 9	436:50.3	40.213	122.626	32	51	5*		0.00			COLD FORK

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1981 12- 9	558:59.1	39.434	122.696	32	52	9*		2.50			SAINT JOHN MTN.
1981 12- 9	611: 0.4	39.454	122.620	29	47	13*		1.50			STONYFORD
1981 12- 9	1032:26.3	39.887	122.696	20	32	6*		0.00			RILEY RIDGE
1981 12-10	2305:57.9	39.762	121.691	35	56	1*		1.50			PARADISE SW
1981 12-12	737:17.7	39.805	122.613	15	24	26*		0.00			NEWVILLE
1981 12-12	1113: 5.2	39.463	121.484	52	83	7*		2.10			BANGOR
1981 12-13	1102:33.6	39.943	122.709	22	35	24*		0.00			RILEY RIDGE
1981 12-14	1037:59.6	39.638	122.979	36	58	0*		0.00			PLASKETT RIDGE
1981 12-15	2237:41.0	39.350	122.782	40	64	5*		2.00			POTATO HILL
1981 12-15	2300:10.4	39.460	122.586	28	45	5*		1.90			STONYFORD
1981 12-16	604:48.6	39.434	122.704	33	53	0*		0.00			SAINT JOHN MTN.
1981 12-20	1825:44.9	40.204	122.215	28	45	9*		0.00			RED BLUFF EAST
1981 12-21	1605:37.6	39.846	122.634	16	26	10*		0.00			HALL RIDGE
1981 12-22	2215:18.8	39.338	123.111	53	85	0*		0.00			POTTER VALLEY
1981 12-23	1537:37.7	39.897	122.755	23	37	3*		0.00			BALL MOUNTAIN
1981 12-24	1219:30.1	40.008	122.861	31	50	9*		0.00			YOLLA BOLLY SE
1982 1- 3	1831:46.3	39.956	123.179	46	74	5		0.80			BLUENOSE RIDGE
1982 1-10	1536:51.4	39.675	122.594	17	27	8		-.30			CHROME
1982 1-14	523:24.2	39.622	122.934	34	55	0		1.00			HULL MOUNTAIN
1982 1-14	1448:24.7	40.249	122.683	35	57	0		1.40			COLD FORK
1982 1-16	1045:52.4	39.266	122.986	52	83	0		1.30			ELK MOUNTAIN
1982 1-18	2118:33.2	39.654	122.937	34	54	1		0.80			PLASKETT RIDGE
1982 1-20	249:44.1	39.642	122.788	27	43	0		0.60			PLASKETT MEADOWS
1982 1-25	1902:48.2	39.921	122.740	23	37	2		0.70			RILEY RIDGE
1982 1-25	1905:52.3	40.018	122.784	28	45	10		0.30			YOLLA BOLLY SE
1982 1-27	1510:11.9	39.921	123.085	40	65	0		0.50			LEECH LAKE MTN.
1982 1-30	1938: 1.9	39.625	122.412	14	22	20		0.10			FRUTO
1982 2- 6	644:11.8	39.381	122.088	32	52	16		1.10			PRINCETON
1982 2- 6	923:28.1	39.544	122.001	25	41	5		0.80			GLENN
1982 2- 6	2030:42.9	39.395	122.042	33	53	25		2.70			PRINCETON
1982 2- 7	552: 5.3	39.415	121.489	53	85	1		1.20			BANGOR
1982 2- 9	15:41.7	40.011	121.644	39	63	10		1.30			BUTTE MEADOWS SW
1982 2- 9	1524:20.1	40.311	123.023	50	81	18		3.30			DUBAKELLA MTN SE
1982 2-12	2352:49.8	39.392	121.466	55	88	0		0.90			BANGOR
1982 2-26	5:55.0	39.452	122.033	30	48	5		1.10			PRINCETON
1982 3- 7	952:13.5	39.412	121.470	54	87	1		1.70			BANGOR
1982 3- 7	953:49.9	39.395	121.480	54	87	1		1.50			BANGOR
1982 3- 7	955: 8.8	39.422	121.465	53	86	7		0.50			BANGOR
1982 3-16	653:17.6	39.600	123.053	41	66	7		1.90			SANHEDRIN MTN.
1982 3-16	1152:46.1	39.657	123.000	37	59	5	IV	3.20		USGS	
1982 3-16	1152:47.3	39.656	122.993	37	59	8		2.90			PLASKETT RIDGE
1982 3-16	1206:10.1	39.649	123.013	38	61	5		2.80		USGS	
1982 3-16	1206:11.6	39.666	122.977	35	57	9		3.20			PLASKETT RIDGE
1982 3-17	1451:10.5	39.881	122.881	29	47	8		1.70			BUCK ROCK
1982 3-22	1210: 2.9	39.880	122.535	12	19	1		3.30		USGS	
1982 3-22	1210: 3.4	39.876	122.600	15	24	8		3.20			PASKENTA
1982 3-23	746:32.5	39.872	122.735	22	35	0		1.40			HALL RIDGE
1982 3-23	746:52.0	39.844	122.711	20	32	0		2.00			HALL RIDGE
1982 4- 4	1558: 1.2	39.849	122.698	19	31	11		1.20			HALL RIDGE
1982 4-10	129: 8.7	39.434	122.042	30	49	16		2.30			PRINCETON
1982 5- 3	1646:56.1	39.677	123.100	42	67	5		0.90			THATCHER RIDGE
1982 5- 4	2350:33.8	39.510	121.523	48	77	12		1.00			OROVILLE
1982 5- 5	947:47.8	39.514	122.054	25	41	20		1.20			GLENN
1982 5- 6	2223:47.3	40.345	122.087	39	63	4		1.50			DALES

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1982 5-10	1015:54.7	39.398	122.880	41	66	0		1.10			LAKE PILLSBURY
1982 5-11	1058:49.3	39.656	121.604	40	65	2		0.90			CHEROKEE
1982 5-12	1714:33.9	39.331	123.084	52	84	0		1.10			POTTER VALLEY
1982 5-13	1250:56.4	39.518	121.486	50	80	8		0.60			OROVILLE DAM
1982 5-15	1318: 1.6	39.413	121.483	53	86	4		1.40			BANGOR
1982 5-15	2226: 0.3	39.862	122.330	3	5	5		1.70			BLACK BUTTE DAM
1982 5-15	2237:38.9	39.755	122.564	13	21	20		-.10			NEWVILLE
1982 5-17	834:30.8	39.429	121.485	53	85	6		1.00			BANGOR
1982 5-17	837:30.6	39.428	121.490	52	84	13		0.40			BANGOR
1982 5-19	15:20.9	39.622	123.011	39	62	5		0.50			SANHEDRIN MTN.
1982 5-19	2016:11.0	40.008	122.617	20	32	8		3.00			LOWREY
1982 5-19	2055:12.2	40.082	122.875	34	55	0		1.00			YOLLA BOLLY SE
1982 5-20	403:39.5	39.896	122.699	20	32	0		0.20			RILEY RIDGE
1982 5-20	405: 1.4	39.906	122.688	20	32	1		0.20			RILEY RIDGE
1982 5-20	1214:25.9	39.960	122.743	24	38	1		0.10			RILEY RIDGE
1982 5-21	1616:58.4	39.593	122.871	32	52	0		0.70			KNEECAP RIDGE
1982 5-30	2112:25.4	40.465	122.177	46	74	8		2.10			NO QUADRANGLE FOUND
1982 6- 3	800:45.0	40.020	122.509	17	27	1		1.50			LOWREY
1982 6- 3	1117:11.8	40.172	121.621	45	73	11		0.70			BUTTE MEADOWS NE
1982 6- 3	1134:42.0	40.007	122.515	16	26	2		1.70			LOWREY
1982 6- 6	700: 8.5	39.482	121.600	45	73	5		2.90		USGS	
1982 6- 6	700: 9.6	39.524	121.534	47	76	5		3.00			OROVILLE
1982 6- 6	702:40.2	39.521	121.536	47	76	5		3.00			OROVILLE
1982 6- 6	926:39.6	39.519	121.519	48	77	10		1.30			OROVILLE
1982 6- 7	317: 7.7	39.466	121.435	53	86	0		0.40			BANGOR
1982 6- 7	1442:27.8	39.525	121.451	51	82	3		0.60			OROVILLE DAM
1982 6-11	1604:27.3	39.611	122.001	22	36	6		2.10			GLENN
1982 6-18	1046: 2.4	39.491	122.900	37	60	12		3.00			LAKE PILLSBURY
1982 6-18	1048: 5.7	39.478	123.030	43	70	1		1.70			POTTER VALLEY NE
1982 6-18	1345: 5.4	39.496	123.002	42	67	1		1.30			POTTER VALLEY NE
1982 6-26	2248:10.6	39.719	121.505	45	72	9		0.60			CHEROKEE
1982 6-26	2343: 7.7	39.711	121.512	45	72	6		0.20			CHEROKEE
1982 7- 5	5:55.6	39.495	121.995	29	46	9		1.50			BUTTE CITY
1982 7-11	1211:25.1	39.518	122.088	24	39	9		1.30			GLENN
1982 7-13	1745:18.8	39.465	123.086	47	75	4		1.70			POTTER VALLEY NE
1982 7-15	827:53.0	40.303	122.115	36	58	3		1.40			DALES
1982 7-16	211:22.0	39.248	121.567	57	91	1		0.50			YUBA CITY
1982 7-18	128:19.1	39.996	122.690	22	36	21		3.10			RILEY RIDGE
1982 7-18	606:55.4	40.019	122.649	22	35	8		1.40			RAGLIN RIDGE
1982 7-18	2232:11.3	39.980	122.655	21	33	12		2.30			RILEY RIDGE
1982 7-18	2245:22.8	39.958	122.607	17	28	10		3.60		USGS	
1982 7-18	2245:24.1	39.992	122.658	21	34	12		3.40			RILEY RIDGE
1982 7-21	242:55.4	39.961	122.797	27	43	8		1.90			BALL MOUNTAIN
1982 8- 1	144:54.2	39.553	122.928	36	58	0		1.10			HULL MOUNTAIN
1982 8- 1	149:12.6	39.534	122.943	38	61	0		1.60			HULL MOUNTAIN
1982 8- 1	206:41.3	39.611	122.805	29	46	6		0.50			KNEECAP RIDGE
1982 8- 1	213: 1.6	39.599	122.865	32	51	4		0.60			KNEECAP RIDGE
1982 8- 1	422:29.3	39.613	122.868	32	51	4		0.70			KNEECAP RIDGE
1982 8- 1	943:42.6	39.636	122.678	22	35	9		3.20			ALDER SPRINGS
1982 8- 1	947:28.5	39.571	122.883	34	54	0		0.80			HULL MOUNTAIN
1982 8- 1	947:56.7	39.605	122.819	29	47	5		0.30			KNEECAP RIDGE
1982 8- 1	1010:52.3	39.588	122.856	32	51	2		0.90			KNEECAP RIDGE
1982 8- 1	1025: 3.5	39.558	122.894	35	56	7		1.10			HULL MOUNTAIN
1982 8- 1	1026:39.3	39.526	122.951	39	62	5		1.80			HULL MOUNTAIN

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1982	8- 2	8:21.0	39.272	122.983	51	82	0		1.30			ELK MOUNTAIN
1982	8- 3	1424:46.1	39.846	122.693	19	31	0		0.60			HALL RIDGE
1982	8- 5	1644:26.4	39.932	122.906	32	51	3		0.40			BUCK ROCK
1982	8- 8	2349:42.7	39.367	123.046	49	79	5		1.50			POTTER VALLEY
1982	8- 9	511:56.8	39.775	122.052	16	25	22		1.30			FOSTER ISLAND
1982	8- 9	1148:35.1	39.922	122.891	30	49	11		1.00			BUCK ROCK
1982	8-12	102:37.0	39.258	121.428	62	99	6		1.10			LOMA RICA
1982	8-17	1036: 4.9	39.503	123.084	45	73	2		0.90			SANHEDRIN MTN.
1982	8-17	2059: 0.1	39.566	122.885	34	54	7		2.30			HULL MOUNTAIN
1982	8-18	1039: 9.9	39.930	122.757	24	38	8		0.50			BALL MOUNTAIN
1982	8-19	125:22.4	39.318	121.398	61	98	12		1.40			LOMA RICA
1982	8-22	134:50.6	39.797	122.969	34	54	1		0.20			MENDOCINO PASS
1982	8-22	525:48.9	39.785	122.893	30	48	0		0.40			MENDOCINO PASS
1982	8-22	720:59.4	39.786	122.904	30	49	6		0.90			MENDOCINO PASS
1982	8-22	1819:48.5	39.784	122.611	15	24	9		0.10			NEWVILLE
1982	8-22	2051:45.0	39.495	123.100	46	74	0		1.10			POTTER VALLEY NE
1982	8-23	1740:37.8	39.939	123.023	37	60	2		1.10			LEECH LAKE MTN.
1982	8-24	1826:57.8	39.577	122.124	20	32	9		1.50			GLENN
1982	8-25	1054:26.9	39.562	123.237	51	82	1		1.10			BRUSHY MTN.
1982	8-25	1101:59.5	39.580	123.137	45	73	4		2.70			BRUSHY MTN.
1982	8-26	148:56.7	39.578	122.708	25	41	10		0.50			FELKNER HILL
1982	8-26	433:18.9	40.124	122.876	36	58	1		0.90			YOLLA BOLLY SW
1982	8-26	1025:48.0	39.639	123.094	42	68	0		0.90			THATCHER RIDGE
1982	8-27	913:23.6	39.743	122.951	33	53	14		0.90			PLASKETT RIDGE
1982	8-27	1153:22.9	40.114	122.825	34	54	0		0.20			YOLLA BOLLY SE
1982	8-27	1520:57.9	39.299	121.414	61	98	5		1.20			LOMA RICA
1982	8-29	1230: 2.2	39.796	122.953	33	53	2		0.30			MENDOCINO PASS
1982	8-31	827: 7.9	39.933	122.662	19	31	16		0.70			RILEY RIDGE
1982	8-31	1835:49.3	39.780	122.618	15	24	16		0.40			NEWVILLE
1982	8-31	2101: 5.3	40.122	122.980	40	65	0		1.50			YOLLA BOLLY SW
1982	9- 1	122:39.7	39.961	122.630	19	30	13*		-.40		CDWR	RILEY RIDGE
1982	9- 1	139:15.4	40.306	122.452	35	56	5*		0.30		CDWR	MITCHELL GULCH
1982	9- 1	140: 1.2	39.946	122.644	19	30	12*		0.40		CDWR	RILEY RIDGE
1982	9- 1	218: 0.9	39.900	122.631	17	27	4*		0.10		CDWR	RILEY RIDGE
1982	9- 1	221: 5.6	40.035	122.604	21	34	14*		-.40		CDWR	LOWREY
1982	9- 1	436:55.1	39.850	122.624	16	25	20*		0.40		CDWR	NEWVILLE
1982	9- 3	1858:23.8	39.555	122.558	21	34	5	III	4.00		USGS	
1982	9- 3	1905:42.7	39.560	122.627	24	38	11*		0.50		CDWR	FELKNER HILL
1982	9- 3	2029:42.7	39.574	122.625	22	36	11*		0.20		CDWR	FELKNER HILL
1982	9- 3	2333:46.4	39.551	122.631	24	39	11*		-.10		CDWR	FELKNER HILL
1982	9- 3	2355:23.9	39.566	122.620	23	37	10*		0.30		CDWR	ELK CREEK
1982	9- 4	100: 6.4	39.616	122.606	20	32	0*		0.20		CDWR	ELK CREEK
1982	9- 4	218:19.9	39.268	122.950	50	80	0*		1.20		CDWR	ELK MOUNTAIN
1982	9- 4	946:31.0	40.041	122.778	28	45	7*		0.50		CDWR	YOLLA BOLLY SE
1982	9- 4	1948:25.9	39.617	122.606	20	32	3*		0.60		CDWR	ELK CREEK
1982	9- 5	17:54.4	39.863	123.032	37	60	3*		1.20		CDWR	NEWHOUSE RIDGE
1982	9- 6	2054:48.6	39.277	122.985	51	82	1*		0.90		CDWR	ELK MOUNTAIN
1982	9- 7	653:28.1	39.721	121.994	19	31	7*		1.20		CDWR	ORD FERRY
1982	9- 7	658: 5.2	39.726	121.990	19	31	7*		0.90		CDWR	ORD FERRY
1982	9- 7	1251:53.1	40.036	123.055	41	66	0*		1.10		CDWR	BLACK ROCK MTN SE
1982	9- 7	1425:42.5	39.620	122.882	32	51	6*		0.90		CDWR	HULL MOUNTAIN
1982	9- 7	1746:29.6	39.620	122.899	33	53	0*		1.30		CDWR	HULL MOUNTAIN
1982	9- 8	907:56.6	39.508	121.512	48	78	10*		1.90		CDWR	OROVILLE
1982	9- 8	1532: 7.7	39.507	121.511	49	79	10*		1.80		CDWR	OROVILLE

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1982 9-10	844: 4.4	39.573	122.578	21	34	13*		0.30		CDWR	ELK CREEK
1982 9-12	651:36.7	40.281	122.599	35	57	2*		3.10		CDWR	ONO SE
1982 9-14	739:40.1	39.961	122.902	32	51	5*		0.60		CDWR	BUCK ROCK
1982 9-16	744: 2.6	39.622	123.134	45	72	3*		1.10		CDWR	BRUSHY MTN.
1982 9-16	746:39.1	39.569	123.160	47	76	1*		0.90		CDWR	BRUSHY MTN.
1982 9-16	748: 4.9	39.159	122.945	56	90	0*		1.10		CDWR	UPPER LAKE
1982 9-16	1500:51.6	39.636	122.594	19	30	0*		0.00		CDWR	CHROME
1982 9-16	1533:55.0	39.582	123.201	48	78	5*		3.30		CDWR	BRUSHY MTN.
1982 9-16	1958:10.3	39.666	122.840	29	46	0*		0.50		CDWR	PLASKETT MEADOWS
1982 9-17	1510: 5.9	39.609	122.735	25	41	2*		-.30		CDWR	FELKNER HILL
1982 9-18	6:10.9	39.874	122.179	9	15	11*		1.00		CDWR	KIRKWOOD
1982 9-18	131:14.9	40.083	121.981	27	43	11*		0.90		CDWR	PANTHER SPRING SW
1982 9-18	135:18.7	39.792	122.076	14	22	31*		1.00		CDWR	FOSTER ISLAND
1982 9-18	530:23.8	39.481	122.599	27	43	10*		-.40		CDWR	STONYFORD
1982 9-18	1128:20.9	39.566	122.009	24	39	16*		1.00		CDWR	GLENN
1982 9-18	1815:26.7	40.045	122.821	30	49	6*		0.60		CDWR	YOLLA BOLLY SE
1982 9-19	204:41.1	39.783	122.869	29	46	6*		0.10		CDWR	LOG SPRING
1982 9-19	342: 7.5	39.679	123.163	45	72	0*		0.20		CDWR	JAMISON RIDGE
1982 9-19	607:15.8	39.352	123.043	49	79	5*		0.60		CDWR	POTTER VALLEY
1982 9-20	801:32.0	39.764	122.037	16	26	30*		2.70		CDWR	FOSTER ISLAND
1982 9-20	1835:31.3	39.271	121.429	61	98	7*		1.10		CDWR	LOMA RICA
1982 9-20	1946:33.3	39.832	122.706	20	32	0*		0.50		CDWR	HALL RIDGE
1982 9-21	29: 7.4	39.307	121.415	60	97	5*		1.00		CDWR	LOMA RICA
1982 9-23	1744:40.4	40.126	122.153	24	38	12*		2.50		CDWR	RED BLUFF EAST
1982 9-24	1219:35.8	39.837	122.027	17	27	27*		1.50		CDWR	FOSTER ISLAND
1982 9-24	2308: 9.1	39.666	123.046	39	63	0*		1.00		CDWR	THATCHER RIDGE
1982 9-24	2314:17.7	39.616	123.188	47	76	0*		1.40		CDWR	BRUSHY MTN.
1982 9-25	35:27.9	39.381	123.232	57	91	4*		1.70		CDWR	POTTER VALLEY NW
1982 9-25	719:59.3	39.794	122.032	16	26	36*		0.90		CDWR	FOSTER ISLAND
1982 9-25	745:32.6	39.621	122.598	19	31	0*		0.00		CDWR	ELK CREEK
1982 10- 1	711:13.0	39.586	122.623	22	35	11*		0.10		CDWR	ELK CREEK
1982 10- 2	126:56.0	40.020	122.002	23	37	8*		1.10		CDWR	LOS MOLINOS
1982 10- 3	737:18.8	40.098	122.743	29	47	9*		0.40		CDWR	RAGLIN RIDGE
1982 10- 4	738:44.9	39.386	121.475	55	88	1*		1.50		CDWR	BANGOR
1982 10- 5	819: 3.7	39.387	122.825	39	63	1*		1.50		CDWR	CROCKETT PEAK
1982 10- 5	1842:32.6	39.858	122.636	16	26	23*		-.80		CDWR	HALL RIDGE
1982 10- 5	2062:17.3	39.591	122.603	21	34	5*		0.40		CDWR	ELK CREEK
1982 10- 6	303:25.6	39.568	122.383	17	27	28*		0.50		CDWR	FRUTO
1982 10- 6	851:24.8	39.858	122.714	21	33	1*		-.10		CDWR	HALL RIDGE
1982 10- 6	1410:30.1	39.621	121.605	41	66	5*		0.50		CDWR	OROVILLE
1982 10- 6	1436: 1.9	39.471	122.674	30	48	17*		0.70		CDWR	SAINT JOHN MTN.
1982 10- 7	216: 1.2	39.549	122.659	25	40	12*		0.00		CDWR	FELKNER HILL
1982 10-10	1712:14.4	39.778	122.034	16	26	28*		1.70		CDWR	FOSTER ISLAND
1982 10-10	2231: 8.1	39.781	122.036	16	26	20*		1.70		CDWR	FOSTER ISLAND
1982 10-12	332:15.6	39.525	122.669	27	43	17*		-.20		CDWR	FELKNER HILL
1982 10-13	307:49.5	39.810	122.784	24	38	3*		0.20		CDWR	LOG SPRING
1982 10-13	1345:55.2	39.482	122.650	29	46	11*		-.50		CDWR	SAINT JOHN MTN.
1982 10-17	944:58.6	39.949	122.932	33	53	0*		0.70		CDWR	BUCK ROCK
1982 10-17	2131: 9.5	39.697	122.529	13	21	35*		0.00		CDWR	CHROME
1982 10-20	1545:59.6	39.559	122.607	23	37	16*		1.90		CDWR	ELK CREEK
1982 10-20	2000:58.9	39.559	123.092	44	71	5*		1.00		CDWR	SANHEDRIN MTN.
1982 10-21	569:47.0	40.254	122.909	43	69	0*		0.90		CDWR	CHANCHELULLA PEAK S
1982 10-26	1202:42.5	40.219	121.654	46	74	5*		2.10		CDWR	BUTTE MEADOWS NW
1982 10-28	917:39.8	39.519	122.675	27	44	16*		-.20		CDWR	FELKNER HILL

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1982 10-28	2342:51.1	39.782	123.036	37	60	0*		1.00		CDWR	NEWHOUSE RIDGE
1982 10-29	1431: 1.0	39.766	121.742	32	51	25*		1.40		CDWR	PARADISE SW
1982 11- 8	356:34.5	40.437	122.861	51	82	5*		1.70		CDWR	CHANCHELULLA PEAK N
1982 11- 8	752:19.9	39.407	121.475	54	87	5*		1.70		CDWR	BANGOR
1982 11- 8	756: 5.0	39.400	121.480	54	87	5*		1.30		CDWR	BANGOR
1982 11- 8	1810:44.6	39.581	122.605	22	35	0*		-.40		CDWR	ELK CREEK
1982 11- 9	10:52.6	39.881	122.737	22	35	0*		0.00		CDWR	RILEY RIDGE
1982 11-10	1041:39.0	39.786	122.962	34	54	0*		0.60		CDWR	MENDOCINO PASS
1982 11-11	241:41.4	39.937	122.048	17	28	8*		1.40		CDWR	VINA
1982 11-14	638:36.6	39.885	122.899	30	49	0*		0.20		CDWR	BUCK ROCK
1982 11-14	1324:59.3	39.674	122.651	19	31	5*		0.00		CDWR	ALDER SPRINGS
1982 11-15	348:40.1	39.774	122.578	13	21	10		3.10		USGS	
1982 11-15	348:42.2	39.785	122.715	21	33	1*		3.30		CDWR	HALL RIDGE
1982 11-15	1025:36.4	39.486	121.984	29	47	12*		1.00		CDWR	BUTTE CITY
1982 11-15	2222:20.4	39.280	122.828	45	73	0*		1.10		CDWR	POTATO HILL
1982 11-19	852:51.9	39.718	122.805	26	42	1*		0.30		CDWR	PLASKETT MEADOWS
1982 11-21	2152:19.3	39.897	122.822	27	43	5*		0.50		CDWR	BALL MOUNTAIN
1982 11-21	2253:51.3	39.477	121.993	30	48	11*		1.80		CDWR	BUTTE CITY
1982 12- 2	1602:43.8	39.167	122.327	45	72	5		3.10		USGS	
1982 12- 2	1602:46.3	39.130	122.183	48	77	9*		3.40		CDWR	WILLIAMS
1982 12- 2	1608:23.8	39.126	122.173	48	78	9*		2.50		CDWR	WILLIAMS
1982 12- 2	1717:52.6	39.125	122.167	48	78	9*		2.60		CDWR	CORTINA CREEK
1982 12- 2	2117:18.4	39.734	123.042	38	61	0*		1.10		CDWR	THATCHER RIDGE
1982 12- 2	2241:14.0	39.741	123.032	37	60	0*		1.20		CDWR	THATCHER RIDGE
1982 12- 2	2312:52.8	39.131	122.180	48	77	8*		2.60		CDWR	WILLIAMS
1982 12- 2	2342:15.3	39.128	122.182	48	77	9*		2.30		CDWR	WILLIAMS
1982 12- 4	1511:25.2	39.130	122.177	48	77	9*		2.80		CDWR	WILLIAMS
1982 12- 5	2234:49.0	39.128	122.174	48	77	9*		3.20		CDWR	WILLIAMS
1982 12- 5	2305:10.3	39.119	122.171	48	78	9*		3.20		CDWR	CORTINA CREEK
1982 12- 7	2041:10.3	39.895	122.812	26	42	10*		1.90		CDWR	BALL MOUNTAIN
1982 12-11	2205:21.3	39.547	122.700	27	43	23*		0.50		CDWR	FELKNER HILL
1982 12-15	1908:29.8	39.879	122.790	25	40	5*		0.40		CDWR	BALL MOUNTAIN
1982 12-19	4:37.2	39.615	122.609	20	32	0*		0.20		CDWR	ELK CREEK
1982 12-19	813: 1.0	39.733	122.491	10	16	1*		1.80		CDWR	JULIAN ROCKS
1982 12-21	230:44.9	39.815	123.039	37	60	0*		0.70		CDWR	NEWHOUSE RIDGE
1982 12-23	1633:26.8	39.565	122.673	25	40	6*		1.10		CDWR	FELKNER HILL
1982 12-23	2048:54.2	39.699	122.913	32	51	1*		0.60		CDWR	PLASKETT RIDGE
1982 12-23	2101:46.0	39.587	122.544	19	31	25*		0.00		CDWR	ELK CREEK
1982 12-28	927:54.0	39.797	122.734	21	34	0*		0.20		CDWR	HALL RIDGE
1982 12-28	1344:27.8	39.712	121.655	37	59	18*		1.40		CDWR	HAMLIN CANYON
1983 1- 2	723:18.1	39.554	123.064	43	69	0*		1.20		CDWR	SANHEDRIN MTN.
1983 1- 2	1827:46.0	39.948	123.122	43	69	0*		1.20		CDWR	LEECH LAKE MTN.
1983 1- 6	1054: 8.9	39.653	123.018	38	61	0*		1.00		CDWR	THATCHER RIDGE
1983 1- 6	1411: 0.8	39.941	122.950	34	54	3*		0.40		CDWR	BUCK ROCK
1983 1- 8	851:27.9	39.846	122.728	21	34	1*		0.20		CDWR	HALL RIDGE
1983 1- 9	1123:57.0	39.818	121.825	27	44	10*		1.50		CDWR	RICHARDSON SPRINGS
1983 1- 9	2339: 5.4	39.928	122.932	33	53	1*		0.30		CDWR	BUCK ROCK
1983 1-12	725: 3.6	39.380	123.087	50	80	4*		1.70		CDWR	POTTER VALLEY NE
1983 1-12	850:14.0	39.525	122.945	38	61	0*		0.80		CDWR	HULL MOUNTAIN
1983 1-13	1513: 4.2	39.619	122.607	20	32	0*		0.00		CDWR	ELK CREEK
1983 1-15	1410:59.6	39.508	123.137	48	77	1*		1.30		CDWR	BRUSHY MTN.
1983 1-15	1436:34.1	39.891	122.891	30	48	5*		-.40		CDWR	BUCK ROCK
1983 1-15	1601: 0.3	39.685	122.042	18	29	35*		1.80		CDWR	HAMILTON CITY
1983 1-16	1927:28.7	39.847	122.722	21	33	5*		0.00		CDWR	HALL RIDGE

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1983 1-20	1832: 7.3	39.705	122.878	30	48	0*		0.40	CDWR	PLASKETT RIDGE
1983 1-24	2000:38.9	39.623	122.600	19	31	1*		0.10	CDWR	ELK CREEK
1983 1-31	526:57.6	39.430	121.991	32	52	26*		1.60	CDWR	BUTTE CITY
1983 2- 6	656:56.4	39.416	121.459	54	87	5*		0.70	CDWR	BANGOR
1983 2-12	824:37.4	40.028	122.754	27	43	5*		0.80	CDWR	YOLLA BOLLY SE
1983 2-17	634:41.1	39.835	122.726	21	33	0*		0.50	CDWR	HALL RIDGE
1983 2-17	929:12.5	39.727	122.873	29	47	0*		0.40	CDWR	PLASKETT MEADOWS
1983 2-17	2205:43.4	39.809	123.208	47	75	0*		1.30	CDWR	COVELO EAST
1983 2-18	1406:51.2	39.384	121.463	55	89	5*		1.00	CDWR	BANGOR
1983 2-19	1213:41.6	39.826	122.500	9	14	30*		3.00	CDWR	SEHORN CREEK
1983 2-22	146:21.9	39.210	123.049	57	91	4*		2.30	CDWR	COW MOUNTAIN
1983 2-26	452:26.8	39.599	122.812	29	47	5*		0.90	CDWR	KNEECAP RIDGE
1983 3- 5	1641:29.1	39.829	122.567	12	20	19*		0.40	CDWR	NEWVILLE
1983 3- 8	1131:14.7	39.920	122.819	27	43	12*		0.20	CDWR	BALL MOUNTAIN
1983 3-17	28:20.5	39.535	122.882	35	56	1*		1.00	CDWR	HULL MOUNTAIN
1983 3-18	550:18.8	40.212	122.105	30	48	9*		2.70	CDWR	TUSCAN SPRINGS
1983 3-19	602:42.2	39.784	122.099	13	21	16*		1.10	CDWR	FOSTER ISLAND
1983 3-20	242:30.6	39.990	123.084	42	67	2*		1.40	CDWR	LEECH LAKE MTN.
1983 3-20	505:53.9	39.535	122.964	39	62	6*		1.30	CDWR	HULL MOUNTAIN
1983 3-21	327:30.2	39.402	122.975	44	71	5*		1.30	CDWR	LAKE PILLSBURY
1983 3-23	129: 3.1	40.230	122.412	29	47	12*		2.20	CDWR	BLOSSOM
1983 3-23	247:51.8	39.500	121.496	50	80	7*		1.40	CDWR	BANGOR
1983 3-23	249:41.7	39.273	122.772	44	71	4*		1.80	CDWR	POTATO HILL
1983 3-26	1551: 3.2	39.935	123.090	41	66	2*		0.60	CDWR	LEECH LAKE MTN.
1983 3-27	1651:30.9	39.520	121.486	50	80	5*		-.60	CDWR	OROVILLE DAM
1983 3-28	46:38.1	39.776	122.698	19	31	0*		-.60	CDWR	HALL RIDGE
1983 3-30	2227:12.3	39.624	122.603	19	31	0*		0.60	CDWR	ELK CREEK
1983 4- 1	537: 7.4	39.410	123.042	47	75	5*		0.80	CDWR	POTTER VALLEY NE
1983 4- 3	355:33.0	39.975	122.842	29	47	5		3.10	USGS	
1983 4- 3	355:33.3	39.961	122.808	27	44	11*		3.10	CDWR	BALL MOUNTAIN
1983 4- 5	1252: 5.4	39.463	122.056	29	46	4*		2.30	CDWR	PRINCETON
1983 4- 7	304:13.0	39.690	123.207	47	76	5*		1.60	CDWR	JAMISON RIDGE
1983 4- 7	735:50.3	39.119	122.887	56	90	15*		3.70	CDWR	LAKEPORT
1983 4- 8	16:24.5	39.598	123.110	44	71	1*		1.30	CDWR	SANHEDRIN MTN.
1983 4-15	408:56.2	39.647	122.583	17	28	0*		0.00	CDWR	CHROME
1983 4-18	19:55.8	39.584	122.774	28	45	0*		0.40	CDWR	KNEECAP RIDGE
1983 4-21	901:58.1	39.342	122.776	40	65	5*		2.70	CDWR	POTATO HILL
1983 4-22	2055:42.6	40.390	121.996	43	70	5		3.50	USGS	
1983 4-22	2055:42.7	40.491	121.942	51	82	23*		3.10	CDWR	MANTON NW
1983 4-25	1015:50.3	39.761	122.057	16	25	14*		1.70	CDWR	FOSTER ISLAND
1983 4-28	716:56.5	39.828	122.032	16	26	35*		1.70	CDWR	FOSTER ISLAND
1983 4-30	2104: 6.5	39.906	122.882	30	48	0*		0.60	CDWR	BUCK ROCK
1983 5- 9	1927: 9.5	39.404	121.469	54	87	4*		1.40	CDWR	BANGOR
1983 5- 9	2115:17.3	39.564	123.250	52	83	0*		1.20	CDWR	BRUSHY MTN.
1983 5-16	250:12.0	39.609	122.861	31	50	1*		0.20	CDWR	KNEECAP RIDGE
1983 5-27	1745:24.7	39.910	122.900	30	49	5*		0.40	CDWR	BUCK ROCK
1983 5-28	1611:20.5	39.811	122.767	23	37	5*		-.40	CDWR	LOG SPRING
1983 5-30	8: 9.9	39.830	121.458	47	75	9*		2.30	CDWR	PULGA SW
1983 6- 1	644:30.4	39.887	121.375	52	83	6*		1.80	CDWR	PULGA NE
1983 6- 1	1800: 3.5	39.954	121.455	48	77	7*		1.90	CDWR	PULGA NW
1983 6-10	331: 1.3	39.676	122.991	36	58	0*		1.10	CDWR	PLASKETT RIDGE
1983 6-10	1357:15.5	40.164	122.763	33	53	26*		2.10	CDWR	YOLLA BOLLY NE
1983 6-10	1357:46.1	40.167	122.751	33	53	27*		2.10	CDWR	YOLLA BOLLY NE
1983 6-11	239: 3.6	39.563	121.984	25	41	9*		2.20	CDWR	LLANO SECO

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1983 6-11	1645:40.8	39.744	121.958	21	33	0*		2.20		CDWR	ORD FERRY
1983 6-15	1138:59.6	40.092	122.783	30	49	5*		0.80		CDWR	YOLLA BOLLY SE
1983 6-21	1612:39.5	39.692	122.871	30	48	0*		0.50		CDWR	PLASKETT MEADOWS
1983 6-23	900:58.6	39.282	122.076	39	63	24*		3.10		CDWR	MOULTON WEIR
1983 6-28	227:45.8	39.918	121.406	50	80	5*		1.30		CDWR	PULGA NW
1983 6-29	126: 0.7	39.939	122.872	30	48	5*		1.70		CDWR	BALL MOUNTAIN
1983 6-30	812:25.7	39.943	122.885	30	49	5*		0.50		CDWR	BUCK ROCK
1983 6-30	1452:14.0	39.568	121.930	27	44	11*		1.80		CDWR	LLANO SECO
1983 7- 2	1731:54.7	39.933	122.730	22	36	1*		0.30		CDWR	RILEY RIDGE
1983 7- 3	46:25.7	39.968	122.945	34	55	0*		1.20		CDWR	BUCK ROCK
1983 7- 3	445: 0.7	40.006	123.213	48	78	5*		1.40		CDWR	BLACK ROCK MTN NE
1983 7- 6	858:36.6	39.493	122.749	31	50	9*		1.00		CDWR	SAINT JOHN MTN.
1983 7- 6	947: 2.9	39.519	122.742	30	48	8*		0.40		CDWR	FELKNER HILL
1983 7- 7	1607:53.2	39.560	121.986	25	41	30*		1.10		CDWR	LLANO SECO
1983 7- 9	2234:51.4	39.409	122.910	42	67	8*		1.60		CDWR	LAKE PILLSBURY
1983 7-10	110:22.6	39.992	122.986	37	59	2*		0.90		CDWR	BUCK ROCK
1983 7-11	209:18.1	39.605	122.577	19	31	5*		0.90		CDWR	ELK CREEK
1983 7-11	1610:38.5	39.685	122.789	25	41	1*		0.10		CDWR	PLASKETT MEADOWS
1983 7-12	1449:56.2	39.674	122.779	25	41	5*		0.50		CDWR	PLASKETT MEADOWS
1983 7-12	1450:32.4	39.674	122.779	25	41	5*		0.70		CDWR	PLASKETT MEADOWS
1983 7-14	1500:47.5	39.432	122.805	36	58	1*		1.10		CDWR	CROCKETT PEAK
1983 7-15	1110:36.0	39.753	122.026	17	27	26*		1.50		CDWR	FOSTER ISLAND
1983 7-16	1722:13.5	39.701	122.867	29	47	0*		0.30		CDWR	PLASKETT MEADOWS
1983 7-18	933:57.9	39.654	122.974	35	57	1*		0.80		CDWR	PLASKETT RIDGE
1983 7-19	2316:51.7	39.874	123.232	48	77	0*		1.10		CDWR	COVELO EAST
1983 7-21	1540:28.0	39.937	122.605	17	27	23*		0.10		CDWR	PASKENTA
1983 7-21	1545:50.9	39.940	122.518	13	21	27*		2.00		CDWR	PASKENTA
1983 7-21	1745:54.1	39.624	122.796	28	45	0*		0.70		CDWR	KNEECAP RIDGE
1983 7-22	2215:57.0	39.993	122.649	21	33	31*		0.00		CDWR	RILEY RIDGE
1983 7-25	2311:48.8	39.301	122.466	36	58	5*		1.10		CDWR	LODOGA SW
1983 7-31	122: 4.6	39.606	122.901	34	54	0*		0.20		CDWR	HULL MOUNTAIN
1983 7-31	536:27.0	39.897	122.613	16	25	34*		1.80		CDWR	PASKENTA
1983 7-31	1156:14.5	39.656	122.803	27	44	6*		0.40		CDWR	PLASKETT MEADOWS
1983 8- 1	1546:19.8	39.518	121.865	32	52	22*		1.40		CDWR	NELSON
1983 8- 4	1416:23.7	39.730	122.070	16	25	28*		1.90		CDWR	HAMILTON CITY
1983 8- 4	2021:47.6	39.727	122.925	32	51	0*		0.70		CDWR	PLASKETT RIDGE
1983 8- 9	1818:49.9	39.629	122.606	19	31	6*		0.50		CDWR	CHROME
1983 8-11	1129:55.9	39.630	122.591	19	30	1*		-.60		CDWR	CHROME
1983 8-14	1314:17.3	39.503	122.946	39	63	0*		1.10		CDWR	HULL MOUNTAIN
1983 8-16	1441:37.0	39.852	121.404	50	80	0*		1.10		CDWR	PULGA SW
1983 8-17	452:38.9	39.689	122.766	24	39	0*		0.30		CDWR	PLASKETT MEADOWS
1983 8-17	624:30.3	40.381	122.114	41	66	9*		1.50		CDWR	NO QUADRANGLE FOUN
1983 8-18	722:28.3	39.406	123.099	50	80	0*		1.20		CDWR	POTTER VALLEY NE
1983 8-21	1950:26.5	40.278	122.902	44	71	0*		1.40		CDWR	CHANCHELULLA PEAK S
1983 8-22	1402:34.0	39.970	122.764	25	41	0*		0.90		CDWR	BALL MOUNTAIN
1983 8-24	1607: 3.4	40.046	123.071	42	68	12*		2.10		CDWR	BLACK ROCK MTN SE
1983 8-26	1815:17.0	39.642	122.070	19	30	19*		0.60		CDWR	HAMILTON CITY
1983 8-28	503:51.3	39.718	121.731	33	53	3*		1.30		CDWR	HAMLIN CANYON
1983 9- 1	339:27.3	39.697	122.808	26	42	1*		0.10		CDWR	PLASKETT MEADOWS
1983 9- 3	1126:45.1	39.855	122.726	21	34	1*		0.20		CDWR	HALL RIDGE
1983 9- 4	155: 4.2	39.694	122.727	22	36	1*		0.20		CDWR	ALDER SPRINGS
1983 9- 6	1920:56.8	39.859	121.883	24	39	6*		1.40		CDWR	NORD
1983 9-11	2042: 3.9	39.611	122.633	21	34	0*		0.50		CDWR	FELKNER HILL
1983 9-14	822:30.5	39.695	122.816	27	43	0*		0.70		CDWR	PLASKETT MEADOWS

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1983 9-14	1013: 0.8	39.751	121.949	21	34	7*		1.30		CDWR	NORD
1983 9-18	703:22.7	39.328	122.981	48	77	2*		1.90		CDWR	ELK MOUNTAIN
1983 9-19	156:28.3	39.697	122.336	8	13	12*		0.80		CDWR	FRUTO NE
1983 9-21	58: 5.5	39.663	122.829	28	45	1*		0.40		CDWR	PLASKETT MEADOWS
1983 9-23	1830:25.3	39.854	122.646	17	27	5*		-.30		CDWR	HALL RIDGE
1983 9-24	1103:54.1	39.928	122.889	30	49	0*		1.30		CDWR	BUCK ROCK
1983 10- 2	1722:38.5	39.660	122.854	30	48	0*		0.60		CDWR	PLASKETT MEADOWS
1983 10- 2	1725:11.8	39.654	122.862	30	48	0*		0.30		CDWR	PLASKETT MEADOWS
1983 10- 2	2142:58.4	39.670	122.748	24	39	0*		0.10		CDWR	ALDER SPRINGS
1983 10- 5	355:13.9	39.399	123.055	48	77	0*		1.40		CDWR	POTTER VALLEY NE
1983 10- 5	2040:14.4	39.429	121.506	52	83	0*		1.70		CDWR	PALERMO
1983 10- 7	1127:26.3	39.628	122.935	34	55	0*		0.90		CDWR	PLASKETT RIDGE
1983 10- 8	1903:51.6	39.779	122.767	23	37	0*		0.30		CDWR	LOG SPRING
1983 10- 8	2348:11.4	39.794	122.404	4	6	10*		0.00		CDWR	SEHORN CREEK
1983 10-12	838:52.7	39.280	123.028	52	84	0*		1.50		CDWR	POTTER VALLEY
1983 10-17	445:17.9	39.489	123.224	52	84	20*		2.30		CDWR	POTTER VALLEY NW
1983 10-19	1356:22.6	39.481	122.977	41	66	0*		1.10		CDWR	LAKE PILLSBURY
1983 10-22	352:11.1	39.554	122.936	37	59	4*		-.10		CDWR	HULL MOUNTAIN
1983 10-23	1455:57.9	39.326	123.003	49	79	0*		1.20		CDWR	POTTER VALLEY
1983 10-26	27:51.9	40.073	122.781	30	48	8*		2.10		CDWR	YOLLA BOLLY SE
1983 10-26	155:21.8	39.945	122.716	22	36	0*		0.30		CDWR	RILEY RIDGE
1983 10-26	1157:47.0	39.443	121.524	50	81	5*		0.80		CDWR	PALERMO
1983 10-28	1511:51.2	40.094	122.934	37	60	0*		1.00		CDWR	YOLLA BOLLY SW
1983 10-31	1628:39.6	39.787	121.521	43	70	4*		0.70		CDWR	PARADISE SE
1983 11- 1	658: 1.1	39.491	121.470	51	82	7*		1.50		CDWR	BANGOR
1983 11- 7	1758:29.8	39.480	121.505	50	80	6*		1.30		CDWR	PALERMO
1983 11- 8	144:49.6	39.274	121.464	60	96	15*		1.60		CDWR	LOMA RICA
1983 11- 8	2236:48.3	40.390	123.170	60	96	5*		2.20		CDWR	DUBAKELLA MTN NW
1983 11-13	2210:25.3	39.960	122.835	29	46	3*		1.50		CDWR	BALL MOUNTAIN
1983 11-17	450: 6.9	39.754	123.109	42	67	4*		2.00		CDWR	NEWHOUSE RIDGE
1983 11-17	2310:49.5	39.929	122.918	32	51	5*		0.90		CDWR	BUCK ROCK
1983 11-18	2337:40.6	39.401	123.045	47	76	4*		1.60		CDWR	POTTER VALLEY NE
1983 12- 6	1153:34.1	39.659	122.698	22	35	5*		0.50		CDWR	ALDER SPRINGS
1983 12-13	802:49.2	39.879	123.249	48	78	5*		1.90		CDWR	BLUENOSE RIDGE
1983 12-15	11:51.7	39.984	121.983	22	36	5*		1.50		CDWR	RICHARDSON SPGS NW
1983 12-21	1543:45.8	39.815	122.894	30	48	5*		0.10		CDWR	MENDOCINO PASS
1983 12-22	101: 7.7	40.428	122.537	43	70	3*		1.00		CDWR	ONO NE
1983 12-22	2205:20.1	39.815	122.800	25	40	0*		-.10		CDWR	LOG SPRING
1984 1-15	2012: 0.4	40.006	122.342	13	21	9*		2.30		CDWR	WEST OF GERBER
1984 1-16	300:27.7	39.701	122.581	15	24	3*		-.20		CDWR	CHROME
1984 1-16	732:41.4	39.919	122.609	16	26	13*		0.10		CDWR	PASKENTA
1984 1-18	514: 2.7	39.818	122.852	27	44	0*		0.50		CDWR	LOG SPRING
1984 1-26	1227:26.5	39.722	122.058	16	26	11*		1.60		CDWR	HAMILTON CITY
1984 1-29	112:35.3	39.740	121.427	48	78	0*		0.40		CDWR	BERRY CREEK
1984 2- 3	2015:58.7	39.715	123.030	37	60	0*		0.90		CDWR	THATCHER RIDGE
1984 2- 3	2136:54.7	39.686	123.232	48	78	0*		1.50		CDWR	JAMISON RIDGE
1984 2- 5	2144: 8.4	39.516	121.485	50	80	11*		0.00		CDWR	OROVILLE DAM
1984 2- 8	843:24.3	39.753	122.832	27	43	5*		0.00		CDWR	LOG SPRING
1984 2-10	1225:44.4	39.926	122.840	28	45	0*		0.30		CDWR	BALL MOUNTAIN
1984 2-10	1440:29.6	39.757	122.697	20	32	12*		1.70		CDWR	HALL RIDGE
1984 2-10	1606:58.5	39.724	122.665	19	30	3*		0.50		CDWR	ALDER SPRINGS
1984 2-10	2124:55.3	39.404	122.754	36	58	0*		1.50		CDWR	CROCKETT PEAK
1984 2-11	518:28.9	39.488	123.185	50	81	1*		1.70		CDWR	POTTER VALLEY NW
1984 2-14	1359:13.6	40.149	122.907	38	61	1*		1.40		CDWR	YOLLA BOLLY NW

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1984 2-18	2150:35.4	40.015	121.933	25	41	5*		1.10		CDWR	PANTHER SPRING SW
1984 2-19	2109: 1.4	39.419	121.468	53	86	0*		0.90		CDWR	BANGOR
1984 2-20	1649: 4.6	39.546	121.990	26	42	11*		1.50		CDWR	LLANO SECO
1984 2-22	1014:26.9	40.185	122.807	36	58	6*		2.70		CDWR	YOLLA BOLLY NE
1984 2-22	2356:42.3	39.730	122.818	26	42	5*		0.20		CDWR	PLASKETT MEADOWS
1984 2-24	554:42.0	39.675	122.621	18	29	2*		-.10		CDWR	CHROME
1984 2-25	2220:52.1	39.717	122.727	22	35	0*		0.50		CDWR	ALDER SPRINGS
1984 2-26	207:36.8	40.447	122.812	50	81	5*		1.50		CDWR	CHANCHELULLA PEAK N
1984 2-26	447:55.5	39.549	121.509	48	77	8*		1.30		CDWR	OROVILLE
1984 2-26	1422:46.5	39.957	121.423	50	80	2*		1.30		CDWR	PULGA NW
1984 2-26	1459:32.7	39.440	122.212	27	43	20*		1.60		CDWR	LOGANDALE
1984 2-26	1923:31.8	39.854	122.706	20	32	0*		0.00		CDWR	HALL RIDGE
1984 2-27	1124:26.0	39.658	122.738	24	39	0*		-.20		CDWR	ALDER SPRINGS
1984 2-28	1750: 1.2	39.607	122.720	25	40	6*		0.70		CDWR	FELKNER HILL
1984 3- 2	59:15.6	39.936	122.873	30	48	2*		0.10		CDWR	BALL MOUNTAIN
1984 3- 2	1619:14.1	40.013	122.892	32	52	2*		1.00		CDWR	YOLLA BOLLY SW
1984 3- 3	841:25.4	40.206	122.209	28	45	9*		1.30		CDWR	RED BLUFF EAST
1984 3- 3	926:40.1	39.836	122.899	30	48	5*		0.90		CDWR	MENDOCINO PASS
1984 3- 4	545:45.1	39.954	123.042	39	62	2*		0.90		CDWR	LEECH LAKE MTN.
1984 3- 9	729:23.4	39.507	123.017	42	68	5*		0.80		CDWR	SANHEDRIN MTN.
1984 3-10	2211:37.4	39.614	121.914	26	42	4*		1.50		CDWR	LLANO SECO
1984 3-11	153:28.3	39.823	122.805	25	40	5*		0.00		CDWR	LOG SPRING
1984 3-18	610: 7.0	40.037	123.224	50	80	0*		0.70		CDWR	BLACK ROCK MTN NE
1984 3-18	1821:46.4	39.725	122.091	14	23	11*		1.10		CDWR	HAMILTON CITY
1984 3-19	211:53.6	40.106	122.663	27	43	5*		1.00		CDWR	RAGLIN RIDGE
1984 3-19	2057: 0.3	39.773	122.582	14	22	15*		0.20		CDWR	NEWVILLE
1984 3-21	1017:21.2	39.458	122.017	30	48	7*		1.70		CDWR	PRINCETON
1984 3-24	2242:28.8	39.302	123.180	57	92	22*		2.90		CDWR	REDWOOD VALLEY
1984 3-31	923: 8.2	39.940	123.063	40	64	1*		1.10		CDWR	LEECH LAKE MTN.
1984 3-31	2217:52.8	39.950	122.948	34	55	4*		1.00		CDWR	BUCK ROCK
1984 4- 2	555:55.3	39.884	122.877	29	47	5*		0.40		CDWR	BUCK ROCK
1984 4- 5	335:55.8	39.521	122.759	30	49	6*		0.30		CDWR	KNEECAP RIDGE
1984 4- 6	153: 2.0	39.702	122.584	16	25	5*		-.20		CDWR	CHROME
1984 4- 9	2205:25.9	39.372	123.066	50	80	15*		2.00		CDWR	POTTER VALLEY
1984 4-16	100:52.0	39.564	122.642	24	38	10*		0.90		CDWR	FELKNER HILL
1984 4-16	920:36.3	39.815	122.724	21	33	0*		0.20		CDWR	HALL RIDGE
1984 4-16	1820:16.6	40.102	123.164	48	78	5*		0.80		CDWR	BLACK ROCK MTN NE
1984 4-16	2049:57.3	40.071	122.818	31	50	2*		0.80		CDWR	YOLLA BOLLY SE
1984 4-18	1005:45.8	39.885	122.638	17	27	5*		0.00		CDWR	RILEY RIDGE
1984 4-20	731:46.4	39.710	122.777	24	39	5*		0.10		CDWR	PLASKETT MEADOWS
1984 4-20	1315:14.8	39.581	122.909	34	55	0*		0.30		CDWR	HULL MOUNTAIN
1984 4-22	726:56.2	40.316	121.652	50	81	4*		3.30		CDWR	LASSEN PEAK SW
1984 4-22	753: 2.4	40.308	121.636	50	81	6*		2.80		CDWR	LASSEN PEAK SW
1984 4-22	1632:34.0	39.407	121.487	53	86	5*		1.30		CDWR	BANGOR
1984 4-26	1119:40.0	39.704	122.038	17	28	6*		1.20		CDWR	HAMILTON CITY
1984 4-30	1813:34.5	39.779	123.115	42	67	0*		1.00		CDWR	NEWHOUSE RIDGE
1984 5- 1	230:52.5	40.484	122.180	47	76	7*		2.60		CDWR	NO QUADRANGLE FOUNI
1984 5- 1	645:14.9	39.352	122.813	41	66	5*		1.30		CDWR	POTATO HILL
1984 5- 6	101:46.7	39.749	122.901	30	49	0*		0.50		CDWR	PLASKETT RIDGE
1984 5- 7	913:13.4	39.677	122.646	19	31	14*		0.10		CDWR	ALDER SPRINGS
1984 5-10	335: 1.4	39.727	122.898	30	49	1*		2.30		CDWR	PLASKETT RIDGE
1984 5-10	351:27.2	39.764	122.946	33	53	0*		0.80		CDWR	MENDOCINO PASS
1984 5-12	2357:42.6	39.748	122.886	30	48	0*		-.10		CDWR	PLASKETT RIDGE
1984 5-13	941:26.5	39.836	122.792	24	39	1*		0.10		CDWR	LOG SPRING

DATE YEAR-MO-DY		TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM CD	REF.	COMMENTS
1984	5-13	1639:55.7	39.519	122.757	30	49	5*		-.10	CDWR	KNEECAP RIDGE
1984	5-13	1748:59.6	39.502	122.785	32	52	3*		0.60	CDWR	KNEECAP RIDGE
1984	5-14	2249:17.0	39.567	122.707	26	42	1*		0.30	CDWR	FELKNER HILL
1984	5-15	2004: 4.8	40.003	122.989	37	60	4*		1.00	CDWR	YOLLA BOLLY SW
1984	5-16	136:20.1	39.515	122.804	32	52	4*		0.40	CDWR	KNEECAP RIDGE
1984	5-16	626:34.7	39.739	122.861	29	46	0*		-.20	CDWR	PLASKETT MEADOWS
1984	5-16	1552:58.8	40.117	122.749	30	49	27*		1.80	CDWR	RAGLIN RIDGE
1984	5-16	2303:19.2	39.972	121.879	27	43	1*		1.40	CDWR	RICHARDSON SPGS NW
1984	5-17	2100:57.3	40.019	121.928	26	42	8*		1.80	CDWR	PANTHER SPRING SW
1984	5-18	900:53.7	39.561	122.908	35	56	4*		0.00	CDWR	HULL MOUNTAIN
1984	5-19	2139: 4.4	39.607	123.102	43	70	5*		1.00	CDWR	SANHEDRIN MTN.
1984	5-20	255:18.3	39.895	123.238	48	78	1*		1.60	CDWR	BLUENOSE RIDGE
1984	5-22	1618:20.2	39.635	122.825	29	46	5*		0.10	CDWR	PLASKETT MEADOWS
1984	5-26	500:55.5	39.493	122.859	35	57	9*		1.60	CDWR	CROCKETT PEAK
1984	5-28	2304:19.0	39.757	122.027	17	27	26*		1.60	CDWR	FOSTER ISLAND
1984	5-28	2318:38.3	39.731	122.024	17	28	12*		1.60	CDWR	HAMILTON CITY
1984	6- 2	2222: 8.4	39.294	122.982	50	80	3*		2.20	CDWR	ELK MOUNTAIN
1984	6- 3	235:21.8	39.668	122.764	25	40	6*		0.30	CDWR	PLASKETT MEADOWS
1984	6- 5	2355:36.7	39.459	121.459	53	85	0*		1.60	CDWR	BANGOR
1984	6- 6	1409:38.0	39.881	121.420	49	79	6*		1.20	CDWR	PULGA NW
1984	6- 8	630:50.0	40.182	122.583	29	46	0*		1.70	CDWR	OXBOW BRIDGE
1984	6-16	1845:55.9	39.445	123.013	44	71	4*		1.90	CDWR	POTTER VALLEY NE
1984	6-16	1915:57.1	39.460	123.093	47	76	5*		1.70	CDWR	POTTER VALLEY NE
1984	6-19	1056: 3.1	39.984	122.972	36	58	5*		1.00	CDWR	BUCK ROCK
1984	6-20	658:30.5	39.514	121.506	49	79	8*		0.70	CDWR	OROVILLE
1984	6-20	1809:38.9	39.196	121.442	64	103	24*		1.80	CDWR	BROWNS VALLEY
1984	6-21	1154:45.5	39.826	122.822	26	42	2*		0.10	CDWR	LOG SPRING
1984	6-24	1938: 2.1	39.783	122.582	13	21	15*		-.20	CDWR	NEWVILLE
1984	6-24	1943:42.6	39.789	122.633	16	26	10*		-.20	CDWR	HALL RIDGE
1984	6-24	2341:39.0	39.565	122.430	18	29	33*		0.90	CDWR	FRUTO
1984	6-25	125:18.6	39.889	122.961	34	54	5*		1.00	CDWR	BUCK ROCK
1984	7- 9	1331:14.0	39.778	122.845	27	44	1*		0.50	CDWR	LOG SPRING
1984	7-15	1348:24.2	40.189	122.079	29	47	9*		1.90	CDWR	TUSCAN SPRINGS
1984	7-20	634:58.5	39.303	122.722	41	66	2*		2.00	CDWR	FOUTS SPRINGS
1984	7-21	1743:13.8	39.649	122.810	28	45	2*		0.40	CDWR	PLASKETT MEADOWS
1984	7-22	1231:59.4	39.661	122.717	23	37	14*		0.90	CDWR	ALDER SPRINGS
1984	7-23	953:25.0	39.999	121.921	25	41	17*		1.60	CDWR	RICHARDSON SPGS NW
1984	7-25	620:30.2	39.563	122.889	34	55	1*		0.50	CDWR	HULL MOUNTAIN
1984	7-26	1733:16.8	40.023	121.925	26	42	9*		1.60	CDWR	PANTHER SPRING SW
1984	7-27	1728:21.2	40.029	121.918	27	43	9*		1.80	CDWR	PANTHER SPRING SW
1984	7-29	2127:25.2	39.630	122.823	29	46	7*		0.50	CDWR	PLASKETT MEADOWS
1984	7-31	956:12.9	39.312	122.792	42	68	5*		1.50	CDWR	POTATO HILL
1984	7-31	1705:58.5	40.180	122.648	30	49	16*		0.90	CDWR	COLD FORK
1984	8- 6	141:36.6	39.420	121.503	52	84	10*		1.80	CDWR	PALERMO
1984	8- 6	653:31.8	39.377	122.892	42	68	5*		1.10	CDWR	LAKE PILLSBURY
1984	8- 9	539:31.2	39.617	122.600	19	31	4*		0.10	CDWR	ELK CREEK
1984	8-10	748:37.3	40.160	122.807	35	56	19*		1.00	CDWR	YOLLA BOLLY NE
1984	8-13	1123:50.0	39.393	122.969	45	72	5*		0.90	CDWR	LAKE PILLSBURY
1984	8-13	1123:57.6	39.272	123.193	59	95	5*		1.50	CDWR	REDWOOD VALLEY
1984	8-18	958:47.1	39.833	122.792	24	39	1*		0.00	CDWR	LOG SPRING
1984	8-20	1659:32.1	39.737	122.036	17	27	37*		1.10	CDWR	HAMILTON CITY
1984	8-23	1141:58.6	39.734	122.705	21	33	5*		-.30	CDWR	ALDER SPRINGS
1984	8-25	1957: 9.0	40.011	122.805	29	46	1*		0.80	CDWR	YOLLA BOLLY SE
1984	8-26	1239:37.7	39.507	122.744	30	49	4*		0.60	CDWR	FELKNER HILL

EARTHQUAKE CATALOG

DATE YEAR-MO-DY	TIME HRMN:SECS	LAT.	LON.	DIST MI	DIST KM	DPTH KM	MMI	CRM	CD	REF.	COMMENTS
1984 8-28	1253: 0.7	39.476	122.792	34	54	2*		2.30		CDWR	CROCKETT PEAK
1984 8-29	618: 2.5	40.016	122.567	19	30	4*		0.30		CDWR	LOWREY
1984 8-30	58: 6.2	39.690	122.938	33	53	0*		0.70		CDWR	PLASKETT RIDGE
1984 8-30	1054:11.6	39.519	122.745	30	48	0*		0.50		CDWR	FELKNER HILL
1984 8-30	1116:57.1	39.994	122.592	19	30	7*		0.90		CDWR	PASKENTA
1984 9- 4	1835:53.8	39.418	121.386	58	93	5*		0.90		CDWR	BANGOR
1984 9- 5	1114: 1.1	40.032	122.631	22	35	5*		1.70		CDWR	RAGLIN RIDGE
1984 9- 5	1131:59.5	40.013	122.798	28	45	1*		0.60		CDWR	YOLLA BOLLY SE
1984 9- 5	1301:10.2	39.978	122.731	24	38	5*		0.00		CDWR	RILEY RIDGE
1984 9- 5	1511:46.2	39.445	123.119	49	79	2*		1.00		CDWR	POTTER VALLEY NE
1984 9- 7	753:17.8	40.209	122.117	30	48	8*		2.10		CDWR	TUSCAN SPRINGS
1984 9- 8	9:15.8	40.208	122.123	29	47	11*		1.90		CDWR	TUSCAN SPRINGS
1984 9- 9	417: 9.7	40.183	122.153	27	44	8*		1.60		CDWR	RED BLUFF EAST
1984 9- 9	603:18.2	39.761	122.702	20	32	0*		0.00		CDWR	HALL RIDGE
1984 9-13	1539:56.0	39.954	122.867	30	48	5*		0.90		CDWR	BALL MOUNTAIN
1984 9-13	2135:35.1	39.997	121.897	27	43	11*		2.60		CDWR	RICHARDSON SPGS NW
1984 9-15	2257:52.7	40.020	121.920	26	42	9*		1.80		CDWR	PANTHER SPRING SW
1984 9-18	305:37.8	39.366	123.084	50	81	1*		1.20		CDWR	POTTER VALLEY
1984 9-19	236:50.3	39.644	123.044	40	64	0*		0.90		CDWR	THATCHER RIDGE
1984 9-21	1217:43.5	39.775	122.903	30	49	5*		0.90		CDWR	MENDOCINO PASS
1984 9-24	125:43.3	40.036	122.078	21	33	36*		2.50		CDWR	LOS MOLINOS
1984 9-25	1713:13.5	40.132	122.308	22	35	25*		2.70		CDWR	RED BLUFF WEST
1984 9-25	2151:46.5	39.665	123.01[illegible]	37	60	0*		0.80		CDWR	THATCHER RIDGE
1984 9-29	318:29.3	39.505	122.057	26	42	15*		0.80		CDWR	GLENN

APPENDIX B

STRATIGRAPHY

APPENDIX B

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STRATIGRAPHY

General Introduction. Stratigraphy in the study area represents deposition on an emerging continental margin. Succession began with deep marine turbidites (Great Valley (GV) Sequence) deposited in an elongated forearc basin lying between a subduction zone and parallel volcanic chain. After synclinal collapse and the accretion of the basin onto the continental margin, marine sedimentation dwindled and subaerial deposition began (Dickinson, 1981; Hackel, 1966). The sequence then is oceanic and continental basement overlain by assemblages of lithologically heterogenous metasedimentary, metavolcanic, and ophiolitic rock (Franciscan Complex) juxtaposed against marine sedimentary rock of simple stratigraphic order (Great Valley Sequence). These suprabasement stratigraphies are in turn overlain by marine shelf and lower submarine canyon fill deposits (Tertiary marine sequence) and upper canyon deposits. These consist of pelites, sandstone, and conglomerates of upper valley mixed load rivers laying down meander belt and flood plain deposits (Tuscan-Tehama and Upper Princeton fill).

Basement Complex. From west to east across northern California the basement rocks consist of the principally metamorphic Franciscan Complex, an ophiolite sequence, the sedimentary marine (turbidites) Great Valley Sequence, and the granitic Sierra Nevada Batholith. For the most part these groups are coeval, representing different terrains collectively formed during Late Mesozoic subduction.

Franciscan Complex. The Franciscan Complex forms the core of the California Coast Ranges west of the project area. These deep marine sediments, mafic marine volcanic, and metamorphic rocks have been tectonically scraped from a subducting plate and dragged downward. This has resulted in a melange of chaotic units represented by graywacke, siltstone, shale, volcanic rocks, radiolarian chert, and serpentinite, much of which has been metamorphosed to blueschist facies by high pressure-low temperature (Bailey and others, 1964). The Franciscan Complex is principally Late Jurassic and Cretaceous in age making it coeval with the Great Valley Sequence. However the Franciscan lies structurally below the Ophiolite and Great Valley Sequence. The Franciscan Complex has been tectronically thrust eastward beneath the Ophiolite Complex and Great Valley Sequence by imbricate thrust faulting (Maxwell, 1974; Raney, 1976; Suppe, 1979).

Ophiolite Complex. The Ophiolite Complex is believed to be Jurassic oceanic crust upon which the Great Valley Sequence was deposited. The rock comprising the Ophiolite Complex is best described as a serpentinite melange. It is a chaotic complex of volcanic breccia, bedded radiolarian chert, pillow basalt, variable sized blocks of basalt commonly altered to greenstone, and highly weathered and sheared serpentinite. The serpentinite is the most abundant rock type, is highly weathered and sheared, and contains mudstone-graywacke blocks (Fritz, 1975). Although the Great Valley Sequence is believed to be deposited directly on the Ophiolite, the contact is nearly everywhere faulted along the Stony Creek fault.

Sierra Nevada Batholith. Most of the Sierra Nevada batholith is composed of numerous plutons of granodioritic composition that were emplaced between Middle Triassic and Middle Cretaceous times into older Paleozoic marine sedimentary strata. These rocks are bordered along the western side of the Sierra by a belt of deformed metamorphic rocks. The Sierra Nevada was the principal source of detritus for the Great Valley Sequence. Batholithic or related rocks of the Sierra Nevada may form much of the crystalline basement at great depth beneath the Sacramento Valley.

Great Valley Sequence. The Mesozoic rocks of the Great Valley Sequence are generally exposed in a long band along the western margin of the Great Valley. The sequence is composed of interbedded and intertonguing mudstone, sandstone, and conglomerate. The sequence is up to 24,000 feet thick in the area of the project. Rocks of the Great Valley Sequence are coeval with, but structurally overlie, those of the Franciscan Complex. In contrast to the Franciscan Complex, the Great Valley Sequence consists of clastic sedimentary rocks that occur in simple stratigraphic order, are folded and faulted locally but not disrupted into a melange, and are affected only by mild metamorphism (Dickinson and others, 1969). The great bulk of material comprising the sequence is believed to be derived from the igneous and metamorphic terrains of the Klamath Mountains and Sierra Nevada to the north and east of the Great Valley, respectively.

The Great Valley Sequence was primarily deposited as deep marine turbidites in a fore-arc basin associated with Late Mesozoic subduction (Dickinson, 1971; Ingersol, 1976). This depositional environment resulted in coarse-grained (sandstone and conglomerate) tongue-shaped lenticular beds set in a continuum of fine-grained material (Ingersol, and others 1977). This lateral variability of the continuity of the coarse-grained units has given rise to many local lithologic names which lack regional continuity and are generally uncorrelatable. The Great Valley Sequence has long been divided into three principal units based on faunal criteria (Anderson, 1933): the Upper Jurassic-Knoxville series, the Lower Cretaceous Shasta series, and the Upper Cretaceous Chico series. More recent work has relied on petrologic criteria of the coarse-grained portions to subdivide the Great Valley Sequence into formations (e.g., Dickinson & Rich, 1972) and to subdivide on texturally mappable criteria. Ingersol and others (1977) combined these methods by broadly subdividing the mapped coarser-grained units, based on internally consistent petrology, to establish five formational units. The lower three of these units were adapted for this study: Stony Creek, Lodoga, and Boxer Formations. The Stony Creek Formation includes all of the Knoxville Series and the lower Shasta Series while the Lodoga Formation comprises the upper Shasta Series. The Boxer Formation forms the lowermost unit of the Chico Series. Nomenclature used here for the remaining exposed portion of the Chico Series is that originally used by Kirby (1943), in ascending order: Venado, Yolo, Sites, Funks, Guinda, and Forbes formations. The uppermost unit of the Chico Series, the Kione Formation, is not exposed in the study area but is identified in the subsurface east of the project (see plate 5).

Throughout most of the immediate project area the Upper Cretaceous Chico series is heavily blanketed by the late Pliocene Tehama Formation and younger alluvial terrace materials. Hence, heavy emphasis was placed on correlating and extrapolating the limited number of outcrops to more extensive and better known exposures adjacent to the project area.

Stony Creek Formation. The Stony Creek Formation consists of dark greenish-gray to black, thinly bedded to laminated siltstone and mudstone containing minor thin to thick beds and lenses of sand and conglomerate (Ingersol, 1977). The lower half of the unit contains a basaltic sandstone member and a variably thick, pebble-cobble conglomerate, while the upper half of the unit is predominately siltstone. The Stony Creek Fault forms the lower contact of the unit. Along Stony Creek the formation is 15,000 to 18,000 feet thick.

Lodoga Formation The Lodoga Formation consists of numerous thin to thick, fine- to medium-grained lenticular sandstone beds, or sets of sandstone-siltstone beds, at closely spaced stratigraphic horizons (Ingersol and others, 1977). In contrast the underlying Stony Creek Formation is predominately mudstone with scattered sandstone beds. Additionally the sandstones of the Lodoga Formation are gray and brown in color. The contact between the two formations is generally sharp or gradational over a vertical distance of 18 to 90 feet. The Lodoga Formation is about 8,000 to 10,000 feet thick.

Boxer Formation. The lower portion of the Boxer Formation consists predominately of medium to dark gray, thin bedded to laminated siltstone and mudstone with a conglomerate unit at the base, while the upper portion has randomly spaced beds, rarely up to 3 feet thick, of fine-grained sandstone (Ingersol and others, 1977). The contact between the conglomerate unit and the Lodoga Formation lies in back of the prominent north-south-trending ridges at Julian Rock where the conglomerate is approximately 280 feet thick. The Boxer Formation has previously been referred to as the Julian Rocks Formation by Chuber (1961). The formation is approximately 5,000 feet thick in the Julian Rocks area. This is the basal unit of the Chico Series. (The Boxer is composed of Julian Rocks and Clark Valley mudstone on some sections presented in this report because of acoustical character and other distinctions.)

Venado Formation. The remaining portion of the Chico Series consists of alternating formations dominated by sandstone (Venado, Sites, and Guinda Formations) or siltstone and shale (Yolo, Funks, and Forbes Formations). Ingersol and others (1977) note that the sandstone units are lenticular along strike and are therefore not everywhere present, leaving no means for differentiating the similar appearing siltstone/shale formations. However, in the project area, each of the individual formations appear represented; hence the terminology of Kirby (1943) was used in this study rather than the more general terminology of Ingersol and others (1977). The Venado Formation consists predominately of sandstone with varying amounts of siltstone and mudstone interbeds. The sandstone is light olive-gray to pale olive, thick bedded to massive, and fine- to medium-grained. The formation tends to form prominent strike ridges in the topography. Faulted thickness in the Stony Creek area is approximately 600 to 900 feet; beneath the dam the strata is up to 2,000 feet thick.

Yolo Formation. The Yolo Formation consists primarily of siltstone and mudstone with numerous thin layers of sandstone. The siltstone and mudstone is medium to dark gray and thin bedded to laminated. The sandstone is fine-grained and tends to be flaggy. In the lowermost part of the section the sandstone and siltstone is rhythmically bedded (Kirby, 1943; Ingersol and others, 1977). The Yolo Formation tends to form low rounded hills with few outcrops. In the Stony Creek area the faulted thickness of the Yolo appears to be 900 feet. Beneath the dam its sectional thickness is about 600 feet.

Sites Formation. The Sites Formation is mostly concretionary sandstone. The sandstone is light olive-gray to pale olive, thin to thick bedded, and fineto medium-grained (Kirby and Ingersol). Interbeds of greenish gray carbonaceous siltstone are common. The Sites Formation is thick to the south (Nye Canyon area) but thins dramatically immediately north of the project area. The Sites formation is about 2,500 feet thick in unfaulted section beneath the dam and thins gradually to the east.

Funks Formation. The Funks Formation consists primarily of greenish gray siltstone and mudstone similar to that of the Yolo Formation. These rocks are interbedded with fine-grained sandstone. The Funks Formation also tends to form low rounded hills with few outcrops. The Funks Formation appears to be 400 feet thick beneath the dam.

Guinda Formation. The Guinda Formation consists mostly of massive to well bedded sandstone alternating with thin bedded siltstones and shales. The sandstone beds weather from gray to buff, are fineto medium-grained, and are laterally persistent over distances of hundreds to thousands of feet. Calcareous concretions are abundant in the upper portion of the formation, commonly reaching 3 feet in diameter and rarely reaching 15 feet in diameter. The siltstone and shales, interbedded with the sandstones, are gray, generally less than 5 cm thick, and strongly laminated. They occasionally contain small concretions and rarely display ripple marks and convoluted bedding (Hoggart and Ward, 1984). The Guinda sandstone is well exposed approximately 1 mile upstream from the dam where wave erosion has exposed it along the shoreline between Orland and Black Buttes. A few small outcrops are also found on the west flank of the buttes where the Guinda Formation is unconformably overlain by the Lovejoy Basalt which caps the buttes. Shadows reveal that the sandstone beds strike parallel to the trend of the buttes (N. 10° W.), indicating the existence of the sandstone along the entire west face of the buttes. At exposed section on the buttes, the Guinda is about 500 feet thick.

Dobbins Shale. The Dobbins Shale is a distinctive mudstone formation lying conformably upon the Guinda Formation. Kirby (1943) identified this lithologic unit as constituting the base of the Forbes Formation. Pessagno (1976) elevated the Dobbins Shale to member status as the basal member of the Forbes Formation. However, others have considered the Dobbins Shale as a unique unit separated from the Forbes Formation by an unconformity. These relationships were not determinable in the area of Black Butte Dam where a limited amount of outcrop is found between the dam and the buttes. The Dobbins Shale is well recognized in the subsurface east of the dam where at 3 miles distance its upper surface is found at the 4,300-foot depth in gas wells. The Dobbins Shale is also readily recognized by its foraminiferal assemblage, and it marks the top of the "G" foraminiferal zone of Goudkoff (1945). This important marker identifies the bottom of the Forbes Formation which is the major gas producing formation. East of the dam the Dobbins shale appears to be 300 feet thick in the subsurface and thickens slightly at the damsite.

Forbes Formation. The Forbes Formation consists mainly of carbonaceous siltstone and shales with occasional thin beds of fairly soft sandstone. The siltstone and shale is generally well bedded to laminated and has a greenish gray to light gray color. The sandstone beds are lenticular and for the most part are fine grained.

The sandstone locally contains pebbles and fragments of rock derived from older Cretaceous beds to the west (Kirby, 1943). The Forbes Formation is approximately 2,700 feet thick in the subsurface east of Black Butte Dam where it is the major gas producing formation in the Black Butte/Malton Gas Field.

In the subsurface, beneath R. 3 W. and eastward, the Forbes Formation is conformably overlain by the Kione Formation while in the area of Black Butte Dam (R. 4 W.) the top of the Forbes Formation is marked by an erosional unconformity and is overlain by Tertiary and Quaternary deposits. At the dam site, the Forbes Formation constitutes the foundation of the control tower, transition section, and a portion of the main dam embankment and tunnel, where it is characteristically massive to thin bedded, gray, soft shale with thin sandstone and limestone interbeds.

Kione Formation. The Kione Formation is not exposed in the project area but is known to exist in the subsurface some 4 miles east of the dam. Early Tertiary erosion has removed it near the dam (see plate 5). The Kione consists of fine- to coarse-grained sandstone interbedded with gray siltstones and shales. Some sand lenses have good lateral development which serve as major gas reservoirs (Barger and Sullivan, 1966). The Kione Formation is the uppermost unit in the Chico Series and thus marks the top of the Cretaceous section. This surface is marked by a major erosional unconformity. The Kione formation thickness is extremely variable in the subsurface sections showing the stratigraphy of the northern Valley (see, for example, California Division of Mines and Geology Bulletin 181).

Paleogene Units. A major erosional unconformity marks the boundary between the Cretaceous formations and the overlying Tertiary deposits. This unconformity marks a period of time (Paleocene) in which a huge submarine valley (lower Princeton Valley) was eroded into the Cretaceous units in the area of the present Sacramento Valley (see figure 2-4). This submarine valley became infilled in the early Eocene and is now occupied in the subsurface by sandstone and siltstone of the Capay Formation. Additional middle to late Eocene formations conformably overlie the Capay Formation and unconformably underlie the Lovejoy Basalt. These formations, Capay, Ione, Domingine, and Nortonville, are all found at depth in the gas wells in the central Sacramento Valley. They are generally marine deposits but locally, and particularly around their periphery, may include nonmarine facies. None of these Eocene formations are exposed in outcrop along the western margin of the valley in the area of Black Butte Dam. While not exposed, these units are discussed here to complete the regional geologic section and history and to present the possible relationship with the Black Butte Formation.

The Black Butte Formation is one additional Paleogene Formation which lies directly beneath the Lovejoy Basalt at the dam site and was exposed extensively during foundation preparation for the dam. The following description of these units relies in part on descriptions presented by Redwine (1979) and Boyd (1956).

Capay Formation. The Capay Formation consists principally of thick to very thick bedded, internally massive claystone, siltstone, and sandstone beds with a chaotic basal conglomerate unit. The pelitic rocks are greenish, the sandstone beds are buff to brown and generally massive, and the conglomerate is dark to very dark gray with a sandstone matrix.

This conglomerate is similar to conglomerates found in the Upper Cretaceous section suggesting that the conglomerate unit was a very large submarine slide or submarine mass flow (Redwine 1972). Overall, the Capay Formation was deposited in the submarine lower Princeton Valley during early Eocene where it reaches a thickness of over 2,000 feet. Typical thickness of the formation beyond the confines of the principal submarine valley is typically 300 feet. (See figure 2-4 for the extent of the Princeton Valley and its relationship to Black Butte Dam.)

Ione Formation. The Ione Formation is apparently absent in the subsurface east of the project area. It consists for the most part of white to yellowish white, highly quartzose kaolinitic sandstone with some claystone interbeds that lie conformably on the Capay Formation. The Ione Formation is mostly early Eocene and partly middle Eocene in age.

Domengine Formation. The Domengine Formation is principally sandstone but occasionally contains interbeds of shale, siltstone, and lignite. The Domengine Formation lies conformably upon the Capay Formation and upon the Ione Formation where that formation exists. The formation is approximately 170 feet thick in the Johnson Unit No. 6 well, 5 miles east of Black Butte Dam. The Domengine Formation is considered to be middle Eocene age.

Nortonville Formation. The Nortonville Formation consists principally of siltstone with minor shale and some carbonaceous material. The siltstone is brown to tan, firm, massive, fine to very fine grained, highly quartzose, and micromicaceous. The Nortonville Formation lies conformably upon the Domengine Formation and is late Eocene in age. The formation represents relatively deep marine sediments and is the youngest marine formation of the last major marine transgression of the Sacramento Valley. It is approximately 100 feet thick in the Johnson Unit No. 6 well, east of Black Butte Dam.

Markley Sandstone Formation. The Markley Sandstone is well documented far south of the study area, in the Mount Diablo area. The Markley Sandstone is not recognized in the subsurface immediately to the east of Black Butte Dam, however similar sandstone is widely recognized in the Sacramento Valley subsurface. This seemingly widespread, previously unnamed, sandstone lying between the Nortonville Formation and the Lovejoy Basalt (Harding and others, 1960) to the east and southeast of the study area was considered by Van den Berge (1966) to be part of his nonmarine Nord Formation. Van den Berge considered the deposits (Black Butte Formation) beneath the basalt at Black Butte Dam to be an outcrop of his Nord Formation. Redwine (1972) correlated and considered most of Van den Berge's Nord Formation to be the Markley Formation; however, in the "Hamilton Nord" No. 1 well, located due east of the study area and near the Sacramento River (sec. 9, T. 22 N., R. 1 W.), Redwine considered it to be part of the Domengine Formation based on correlation to adjacent wells.

The Markley sandstone consists principally of grayish brown to yellowish brown, arkosic sandstone with abundant large muscovite flakes. It rests conformably upon the Nortonville Formation, is thought to be late Eocene in age, and is probably a marine to nonmarine deposit.

Black Butte Formation. The name Black Butte Formation was coined by the Corps of Engineers for a distinctive sequence of rocks found at the damsite underlying the Lovejoy Basalt and overlying the Upper Cretaceous formations. The sequence consists of a basal conglomerate overlain by mudstone and sandstone. The formation was exposed extensively during foundation preparation for the dam and pertinent structures. A somewhat degraded exposure of the sandstone can be seen in the spillway and a good exposure of the mudstone can be seen in the right bank below the intake tower bridge. There are no natural exposures of the conglomerate and those excavated during construction were covered by the structures. The foundation report (Corps of Engineers, 1963) gives a detailed account of the rock types as follows:

> "The deposit is well consolidated and poorly cemented to uncemented although some zones of the sandstone and conglomerate are moderately cemented. The conglomerate consists of rounded particles from fine sand to 6-inch cobbles. In most excavations the matrix consists of fine to coarse sand and the deposit is slightly to moderately pervious. The grading of the constituents and presence of some cementing agent, together with silty zones make the deposit less pervious than would be supposed. In general, the material is fairly well graded from fine sand through 2-1/2-inch gravel with a lesser amount of cobbles up to 6-inch size. The particles are hard and fresh and are composed of quartzite, chert, volcanics, jasper, vein quartz and metamorphics. Despite the multicolored particles, the conglomerate is typically either blue or tan. The deposit varies in thickness from a minimum of 10 feet in the stream channel to a maximum of 75 feet in the left abutment where it interfingers with sandstone... Sandstone and mudstone are grayish green to blue-

gray or tan. The mudstone is composed of clays, silts and fine sand and frequently has a pseudo-granular texture; that is, it has the appearance of fine-grained sandstone but breaks down to a slick, shiny clay when moistened and rubbed. The material is well consolidated and uncemented except in the upper few feet where heat from the basalt flow has baked it into a moderately hard, well indurated rock having much the same appearance as the basalt. In fact, in some localities, particularly the right abutment core trench, the mudstone has a definite columnar structure in the upper 3 or 4 feet of the baked zone. In the outlet tunnel random zones occur where it is a light chocolate brown color, is moderately hard and is assumed to have been thermally altered even though the zones are often completely surrounded by softer mudstone. The unaltered mudstone is typically massive, soft and can usually be crumbled under hand pressure when dry. It tends to air slake badly after exposure for a few weeks. The sandstone is poorly cemented, soft and crumbly to moderately cemented and moderately hard. It is friable even in the moderately cemented zones. Although megascopically blue or bluish gray, examination under a hand lens indicates it is composed of vari-colored metamorphic and volcanic rocks and contains a large percentage of white quartz. The rounded particles are fine to medium grained with occasional zones of coarse particles up to one-quarter inch. Frequently there are silty or clayey zones, some in which the clay has a pseudo-granular texture. It is usually the silty and clayey zones which are least cemented. Where sandstone is in contact with the basalt, it, too, has been well indurated by heat and is black, dark gray or brown. Downward from the basalt contact, it gradually becomes less indurated and grades to the typical bluish color. The sandstone is massive with no indication of bedding."

The Black Butte Formation probably represents a part of one of the Eocene formations or possibly a facies change of one of the Eocene formations with the depositional environment being high on the west margin of the lower Princeton submarine valley. There are several possible correlations.

The only known outcropping of the Black Butte Formation in the project area is at the damsite where it attains a maximum thickness of 100 feet. The position of the Cretaceous rocks and Lovejoy Basalt higher on the buttes limits the thickness of the Black Butte sediments (beneath colluvium) in some areas, to less than 40 feet. Hence, the Black Butte Formation at the dam site may occupy an erosional low in the topography existing at the time of its deposition.

In the existing literature, Van den Berge (1968) has made the only known correlation of deposits at the damsite to another known Eocene Formation, specifically his Nord Formation which he describes as variegated bentonitic clays. While not directly addressing the damsite outcrops, Redwine (1972), suggests that most of the "Nord Formation" belongs to the Markley Formation and locally to the Domengine Formation (see paragraph on Markley Formation). Redwine acknowledged the possible existence of an unnamed post-Markley, pre-Lovejoy Basalt volcaniclastic formation, at least locally, directly beneath the basalt. He represents these deposits as a volcanic episode culminating with the Lovejoy Basalt. Such relationships would correlate the Black Butte Formation with the Domengine, Markley, or a younger volcaniclastic (possibly redefined "Nord") formation.

Descriptions in the literature of the Capay Formation (Boyd, 1956, see Capay section; Redwine, 1972) bear a remarkable resemblance to the Black Butte Formation. Additionally, the Capay Formation , as far as is known, abuts the sides of lower Princeton Valley rather than drapes the sides. No megafossil or microfossil studies were performed in connection with any study and no other field evidence has been found to further establish the age of the Black Butte Formation or its correlation to other formations. This study concludes that the Black Butte Formation is a younger volcaniclastic formation, of Oligocene or early Miocene age, and that both its upper and lower contacts are marked by unconformities. At the dam, the Black Butte Formation unconformably lies upon the Upper Cretaceous rocks and is overlain unconformably by the Lovejoy Basalt.

Neogene Units. After deposition of the Eocene formations a relatively smooth, erosional, subaerial surface developed in the present area of the Sacramento Valley upon which the Lovejoy Basalt spread. The basalt apparently issued in a south and southwesterly direction from the Northern Sierra Nevada. The upper Princeton Valley was then subaerially eroded and then backfilled with the Upper Princeton Valley fill. Major subaerial erosion occurred once again after which the fluvial Neroly Formation was deposited. After another similar cycle the Tehama Formation was deposited.

Lovejoy Basalt. The Lovejoy Basalt is a discontinuous unit found in the subsurface of the Sacramento Valley and in outcrops around its margins. In the subsurface the basalt is found as the rimrock of the upper Princeton Valley (Redwine, 1972). This relationship may also hold for the limited surface exposures of the basalt along the western margin of the Sacramento Valley. The Lovejoy Basalt is the dominant geologic feature at the dam site, capping and leaving near vertical scarps on the flat topped Orland and Black Buttes (which rise to over 1000 feet in elevation), and is conspicuous in the topography of smooth and rounded hills. On the whole the buttes are formed of Cretaceous sandstone beds of the Guinda Formation, capped by 40 to 80 feet of basalt, and dissected by Hambright and Stony Creeks. From the buttes the basalt dips gently eastward at nearly 4 degrees and appears to extend into the subsurface. Magnetic modeling performed as part of this study (see geophysical studies section) suggests the basalt is a continuous flow dipping to the east in the subsurface. Two miles east of the dam, the Lovejoy Basalt is found in gas wells at approximately 1,200 feet below sea level with a thickness of up to 120 feet ("Black Butte" 27-3, Grace Petroleum Co., well). Paleomagnetic analysis performed in connection with magnetic modeling on Lovejoy Basalt samples taken from Orland Buttes concluded: (a) magnetization on the basalt was very strong, (b) the basalt was formed during a reversed magnetic epoch, and (c) the basalt contains slight variations in declination (average 155 degrees) and inclinations (average -52 degrees).

The Black Butte Dam Foundation Report (Corps of Engineers, 1963) offers a good description of the basalt as found in the study area:

"Two separate flows have occurred, and underlying the basalt, in localized areas at least, is a volcanic breccia which reaches a maximum thickness of 16 feet. The lower boundary of the basalt is marked by a thin vesicular zone. The top flow, which averages 45 feet in thickness is characterized by its crude columnar structure and darker color. The columns are mostly 3 to 12 inches in diameter. They are very irregular with nonplanar sides that curve and twist. Other low angle joints divide the columns into blocks that generally range from 3 to 24 inches. The fractures have been tightly healed with zeolites, quartz and lime, and in unweathered rock the columnar structure is not readily apparent. However, with only slight weathering the fracture fillings are removed or their bonding strength is lost. The structure then becomes quite definite, at least in its breaking characteristics. When unweathered, the rock is as apt to break across the healed fractures as along them. When slightly weathered, breakage of the rock is controlled by the cooling fractures with resultant small, crude, roughly equidimensional columnar fragments, the most common size being 3 to 6 inch. The top flow is black, dense, aphanitic, hard, and extremely brittle. The lower flow, averaging about 20 feet in thickness, differs from the upper flow in its lighter (medium to dark gray) color, lack of any columnar structure, blocky fracturing and in being slightly softer and less brittle. Fractures of the lower flow are generally filled with soft, brown to yellow-brown zeolites. Some fracture fillings are as much as 2 or 3 inches wide. The material is usually flaky and has little strength. Fractures are spaced from a few inches to several feet and average about 1.5 to 2 feet. They occur in a blocky or rectangular pattern. The contact between the two flows is not a sharp break. On close inspection it appears to be gradational but from a distance there is a definite change in structure which can be located within a space of one or two feet. Petrographic analysis indicates that 27 percent of the basalt is andesine, 14 percent is augite and the ground mass, which accounts for 59 percent of the volume, consists of a dark opaque volcanic glass. The high percentage of glass accounts for the extreme brittleness and conchoidal fracturing featured by the basalt. The base of the basalt is marked by a layer of breccia which ranges in thickness from 1 to 16 feet where observed in excavations. In the thinner zones it apears only to be a vesicular layer but frequently contains pockets of loose pyroclastics and baked mudstone. In the thicker sections, particularly in the outlet tunnel and left abutment core trench, the flow breccia consists of vesicular basalt boulders of various sizes up to 25 feet surrounded by a mixture of smaller fragments and volcanic ash together with inclusions of mudstone. It is sometimes completely loose but frequently welded together in a fairly stable mass. Weathering has turned the breccia rust-brown but has not been intense. Vesicles and surfaces of the larger fragments are coated with zeolites and calcareous material. The only evidence of flow direction is in the streaking out of some inclusions of mudstone, in an easterly direction."

This study also recognizes sparse megascopic olivine crystals.

Durrell (1959) states the origin of Lovejoy Basalts to be related to the Cohassett Ridge and Big Chico Creek flows. As part of this study, and to aid in correlating the basalt at Orland/Black Buttes, two samples of basalt were radiometrically dated (K-Ar). One sample, taken near the abutment of the intake control tower bridge, yielded an age of 15.2.± 0.2 million years. The other sample, collected from Big Chico Creek (sec. 35, T. 23 N., R. 2 E.) on the eastern margin of the Sacramento Valley, yielded an age of 13.6± 0.2 m.y. Both samples were formed during a single reverse-magnetic polarity episode and have slight diversity in paleomagnetic inclination but similar declamation. Thus, the Orland Buttes basalt indicates coeval age but with tectonic between site deformation. Hence, based on these two dates, the Lovejoy Basalt is believed to be mid-Miocene spanning a 1.5 million-year-old flow episode. This differs from most previously published ages: Dalrymple (1964), early Miocene; Van den Berge (1968), late Oligocene or early Miocene; Durrell (1959), upper Eocene and lower Oligocene. Throughout its occurrence, the Lovejoy Basalt and related underlying volcaniclastic interval rests unconformably upon all older formations, the ancestral Sacramento Valley having been eroded to a fairly level subaerial basin. Along the northeastern margin of the valley as many as 15 separate flows have been identified. Apparently only the largest flows crossed the valley as generally fewer numbers of flows are recognized to the west and south; two at Orland and Black Buttes.

Upper Princeton Valley Fill. The upper Princeton Valley fill typically consists of variegated sandstone with locally varying amounts of interbedded shale and siltstone and occasional conglomerate. While commonly greenish brown to gray, the inclusion of volcaniclastic minerals causes the varying degree of color. The shale and siltstone are also somewhat variable in color, moderately soft, and have a waxy texture. These materials were deposited in the upper Princeton Valley in a subaerial environment principally as channel deposits of an ancestral Sacramento Valley. The age of the fill is post-upper Princeton Valley erosion, which in turn is post-Lovejoy Basalt, and is pre-Neroly Formation. Hence, the fill is considered upper Miocene and possibly lower Pliocene in age. The upper Princeton Valley fill is not identified in the subsurface stratigraphy east of the dam site. However, Redwine (1972) notes the existence of a thin section of the basal part found in the "Altofer" No. 1 well (sec. 14, T. 22 N., R. 4 W.) four miles southeast of Black Butte Dam. A thin section of the fill may be included, possibly locally, with the basal section of the Tehama Formation, as shown in the section on plate 5. As in the lower Princeton Valley, the fill abuts rather than drapes the upper Princeton Valley walls.

Neroly Formation. The Neroly Formation consists of locally variable amounts of interbedded tuffaceous sandstone and tuffaceous shales with occasional conglomerate. These sediments commonly have a bluish color due to montmorillonite coating, but where not tainted are typically greenish gray and dark gray. These predominately volcaniclastic sediments unconformably overlie the upper Princeton Valley fill. The Neroly was deposited on an erosional surface characterized as a nearly level fluvial flood plain. As with the upper Princeton Valley fill, the Neroly Formation is not specifically identified in the subsurface east of the damsite. The deposits belonging to the Neroly Formation may be included, possibly locally, in the basal section of the Tehama Formation. Due to its stratigraphic position between the upper Princeton Valley fill and the Tehama Formation, the Neroly Formation is here considered to be possibly early Pliocene and probably middle Pliocene in age.

APPENDIX C

WILLOWS FAULT SYSTEM

APPENDIX C

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WILLOWS FAULT SYSTEM

Introduction. Willows Fault system was identified by Harwood and Helley (1982) in United States Geological Survey (USGS) Open File Report 82-737. Bolt (1982) relied upon the faults as identified by Harwood and Helley to postulate a "close in" fault source for design earthquake of his report. A large part of our study was devoted to examining the field evidence for the existence of this fault system.

Willows Fault System. The Willows Fault system was defined by Harwood and Helley based on contouring of stratigraphic units obtained from analysis of well log data. Some surface mapping and seismic reflection profiles run by Seisdata Services Inc. added to their confidence. Their concept of the Willows system is shown on plate 6. We conclude that the Willows Fault system, as defined, does not exist. Points we take exception to are noted following each quote from Harwood and Helley's open file text (excerpted below).

> "The main stem of the Willows fault was discovered in the subsurface rocks of the northern Valley when it was penetrated by the Marathon Oil Company (formerly Ohio Oil Company "Capital Company" No. 1 well during development of the Willows-Beehive Bend gas field in the late 1950's (Calif. Div. Oil and Gas, 1960; Alkire, 1962; 1968). From the discovery well, Redwine (1972) traced the Willows fault southeast to Sutter Buttes and he suggested that it extended northwest of the discovery well possibly connecting with the surface fault mapped west of the Orland Buttes (Anderson and Russell, 1939; Jennings and Strand, 1960). Redwine (1972) documented displacement on this 40 km (25 mi) segment of the main stem of the fault and concluded that it dipped 74° or steeper to the east and showed reverse, east-side-up movement that decreased upward in the geologic section. He found that the Princeton submarine channel was localized, in part, by "movement on the fault and that vertical separation in the discovery well varied from about 488 m (1610 ft) on top of the Cretaceous rocks to about 477 m (1575 ft) on the top of the Eocene Capay Formation. At Orland Buttes, the Willows fault offsets the Miocene Lovejoy Basalt and the Pliocene Tehama Formation."

Fault at Orland Buttes. The existence of a fault at Orland Buttes is discussed in the section on Black Butte Fault. A conclusive line of evidence has been developed to refute the existence of a high-angle fault here. Neither the Lovejoy Basalt nor the Tehama Formation are offset. Thus the Willows trend, as shown by Open File Report 82-737, is broken, and this study concludes the Willows Fault extends no farther than Artois (section 20-3) as indicated by Alkire's (1962) analysis.

> "Data from a number of sources indicate that the Willows fault is far more extensive and complex than previously thought. The first clue that the Willows fault branched into a multi-strand fault system was provided by an analysis of seismicity of the northern Valley and

Sierran foothills after the Oroville earthquake. Marks and Lindh (1978) located a number of small-magnitude earthquakes that originated near the discovery well in the Willows-Beehive Bend gas field and extended north for a distance of about 30 km (20 mi) rather than following the known, northwest trend of the Willows fault. The trend of seismic events suggested that a north-trending fault splayed off from the main stem of the Willows fault and passed west of the Corning domes.

Trend of Seismic Events. In our judgment, Marks and Lindh (1978) do not indicate the conclusion stated by Harwood and Helley (1982). Figure 2-14 from their article shows the relationship of Corning domes to the seismicity. Marks and Lindh (1978) do not discuss seismicity in the western valley.

"Analysis of well records in the Corning gas fields by the Sacramento Petroleum Association (1962), however, did not identify a fault west of the Corning domes, but that study did show an anticlinal fold in the area with a 121 m (400 ft) of maximum closure on the base of the Tehama Formation in the north dome and a steeply dipping southeast-trending fault located at the north end of the south Corning dome.

"Recent seismic reflection profiles in the area have identified a major north-trending, steeply east-dipping reverse fault that passes west of the Corning domes and the Greenwood anticline. Displacement of reflecting horizons increases with depth on this north-trending fault indicating progressive deformation through time similar to the pattern of deformation on the main stem of the Willows fault in the Willows-Beehive Bend gas field. From well-log data, the pattern of earthquakes shown by Marks and Lindh (1978), surficial mapping, and the seismic reflection profiles, we conclude that the Corning domes and the Greenwood anticline formed by east-side-up drag on the north-trending Corning fault which splays off from the main stem of the Willows fault."

Corning and Greenwood Folds. We do not interpret the Corning domes and Greenwood anticline as drag folds. There is no data present east of and at the 1-5 corridor to justify the map position shown by Harwood and Helley (1982) for the fault (see the Hayes-Burnell and Long Hollow Seismic Section in the Geophysical Study section of this report, paragraph 2.4).

"The location of this north-trending splay fault north of Red Bluff is unknown, if, in fact, it extends north of the Red Bluff fault.

"The youngest deposits deformed by the Corning fault are gravels of the Pleistocene Red Bluff Formation, the age of which has been bracketed by overlying and underlying volcanic rocks radiometrically dated at 0.45 and 1.09 m.y., respectively (Harwood and others, 1981).

"The location of the Willows fault system north and northwest of Orland Buttes is not closely controlled by direct evidence in either the surface or subsurface rocks. Wells are sparse in this area of the Valley, particularly wells located west of the probable trace of the main stem of the Willows fault, and, for that reason, the structure contours are very generalized and of little value in locating even major structures. Several pieces of evidence, however, point to a pattern of deformation associated with the Corning fault and the main stem of the Willows fault to the south and east.

> "First, the north northwest-trending fault, shown as the Malton fault east of Orland Buttes and extending at least 32 km (20 mi) northward toward Red Bank, was crossed by two seismic lines run by Seisdata Services, Inc. Their profiles show a steeply east-dipping fault with east-side-up displacement that increases with depth. The broad anticlinal dome identified by Redwine (1972, section AA') southeast of Red Bank lies east of the Malton fault and appears to bear the same genetic relationship to that fault as the Corning domes bear to the Corning fault."

Seisdata Lines. At Orland Buttes two proprietary seismic lines (not Seisdata) fail to confirm the Malton or Willows faults as presented. The fault found on the Seisdata line north of Black Butte, identified as the Malton, is in fact a northeast-trending high-angle fault (east side up) identified as Burris Creek fault by this study.

> "The base of the Tehama Formation occurs at an elevation of -17 m (55 ft) in the McCulloch Oil Corporation 'McCulloch Sunray Anchordogry' no. 1 well (sec. 7 T25N R4) east of the Malton Fault and at -297 m (980 ft) in the Occident Petroleum Corporation 'Harris' no. 1 well (sec. 23 T26N R4W) west of the fault. This difference in elevation on the base of the Tehama is due to the combined effects of doming east of and offset on the Malton fault."

Citing these wells for existence of the Malton fault is ambiguous. Occidental Petroleum Harris No. 1 lies north of the map limits shown by the authors on the map plate of Open File Report 82-737. This well is possibly more meaningful to the development of south-side-down movement on the Red Bluff Fault, a position sponsored by both the authors and other investigators (Jennings (1976) and Peppard and Associates (1981)). Redwine (1972) indicates a broad fold, unfaulted in section, with a wave length of 8 miles, not the 2- to 4-mile wave lengths of Greenwood or Corning folds.

> "Relatively extensive deposits of Red Bluff gravels cap the interfluves east of the Malton fault, but only a few scattered patches of Red Bluff gravel occur west of the fault. The western limit of the extensive Red Bluff deposits is generally aligned along the Malton fault trace suggesting that the Red Bluff was stripped from the area west of the Malton fault either by deformation on that fault or by uplift on the Willows fault to the west. The northern extent of the Malton fault is not known."

Red Buff Deposits. It would possibly be more fitting to explain the western limit of the Red Bluff Formation as controlled by source and waning of southward tilting of the Great Valley. East-side-up faulting does not need to be implied. Steele's (1979) mapping of the Red Bluff Formation indicates extensive deposits west of the hypothetical Willows and Malton Faults. The Black Butte and Malton gas fields are two such areas blanketed by Red Bluff gravels.

> "Our projection of the Willows fault into the Cold Fork and Elder Creek faults, and possibly into the Paskenta fault mapped by Jones and others (1969) is based primarily on the outcrop pattern of the Tehama Formation. North of Elder Creek, the Tehama Formation dips gently east and the Nomlaki Tuff Member is at the base of the Tehama or is, at most, a few tens of feet above the base of the Pliocene section. South of Elder Creek, however, the Tehama dips more steeply into the valley and the Nomlaki Tuff is a few hundred feet above the base of the Tehama. This outcrop pattern of the Tehama Formation suggests that the Great Valley Sequence was topographically higher and projected farther east into the Valley north of the Willows fault prior to deposition of the Pliocene rocks. The position of the Nomlaki Tuff relative to the base of the Tehama on opposite sides of the Willows fault indicates that the Tehama filled a topographic low southwest of the fault prior to eruption of the Nomlaki Tuff about 3.4 m.y. ago. We interpret the topographic low, reflected by the thicker basal part of the Tehama, to be the result of east-side-up movement on the Willows fault prior to and possibly during deposition of the early phases of the Tehama Formation.

We believe the position of the basal Tehama deposits was controlled by sedimentary bench-land topography near topographic gaps in the strike valley walls of the Pliocene foothills locating fanheads. Along the flanks of the fan, the Nomlaki Tuff is thin and occurs near Cretaceous bedrock. In the core of the fan it thickens and is up further in the Tehama section. We suggest that there are two different fans north and south of Elder Creek.

> "If this interpretation is correct, Late Cenozoic movement on the Willows-Elder Creek fault system has been significantly different, in style and movement of displacement, from the Cretaceous movement on the Elder Creek-Cold Fork-Paskenta fault system outlined by Jones and Irwin (1971)."

> "Jones and Irwin (1971) inferred at least 96 km (60 miles) of left-lateral displacement of the Early Cretaceous (Valanginian) shoreline along the combined Cold Fork-Elder Creek-Paskenta faults. They concluded that this deformation commenced shortly after deposition of the Valanginian rocks and continued concurrently with deposition until at least mid Late Cretaceous time. Well documented vertical displacement of Late Cretaceous and younger rocks on the Willows fault in the Beehive-Bend gas field is not incompatible with left-lateral displacement on the Elder Creek fault system to the northwest, but it does indicate that the inferred lateral displacement was accompanied

by a major component of east-side-up vertical movement. This vertical movement is consistent with the interpretation that the Elder Creek fault system represents tear faults in the upper plate of the Coast Range Thrust (Jones and Irwin, 1971) along which the Klamath Mountain terrane moved upward and westward over the Coast Range province."

In conclusion of the review of evidence for the Willows Fault system, we wish to address the Seisdata lines referred to in Open File 82-7370. Three out of five lines crossing the map positions of the Willows Fault system have been examined by this study. (See time sections in Geophysical Study section of main report). The existence of faults in two Seisdata time sections and other oil company time sections examined is not denied. However, neither the orientation and position of faults nor the density of line coverage allow us confidently to define through-going faults, or to indicate the presence of a multiple branching fault system.

APPENDIX D

TECTONIC WEDGE THEORY

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TECTONIC WEDGE THEORY

Introduction. This appendix discusses what effect the tectonic wedge theory has on seismic hazard analysis at Black Butte Dam. It should be emphasized that tectonic wedging for the eastern margin of the Coast Ranges is an emerging theory and has not yet been widely accepted as the tectonic mechanism responsible for the structure of the western edge of the Great Valley and eastern Coast Ranges.

Coherent Structural Interpretation. Chief spokesmen of this theory are pursuing a coherent structural interpretation for the entire west side of the Great Valley of California. This interpretation suggests that the Franciscan complex and steeply dipping Great Valley Sequence is underlain by a subhorizontal to west-dipping thrust fault that nowhere reaches the ground surface. Eastward thrusting of the Great Valley Sequence and Franciscan Complex across this surface has produced an east-dipping thrust in the overlying rocks one of which is the Coast Range Thrust (Wentworth letter of 11 October 1985; Wentworth, et. al, 1984; and Wentworth, personal communication). Much of the movement on these thrusts should have occurred in the Cretaceous and early Tertiary time. Within this thrust environment, the Coalinga earthquake of 1983 (magnitude 6.7) occurred. The tectonic wedge theory has two elements of concern to seismic hazard at Black Butte Dam. One element consists of the validity of such a tectonic model in northern California, a distance of 275 miles from where the model seeks substantiation. The second element is the validity of carrying crustal strain, cause of the Coalinga earthquake, into the northern California environment. An examination of each element leads to the conclusion that although tectonic wedges might exist along the northern California western valley edge, there is no reason to believe that the crustal strain existing at Coalinga exists at the wedge nearest Black Butte Dam.

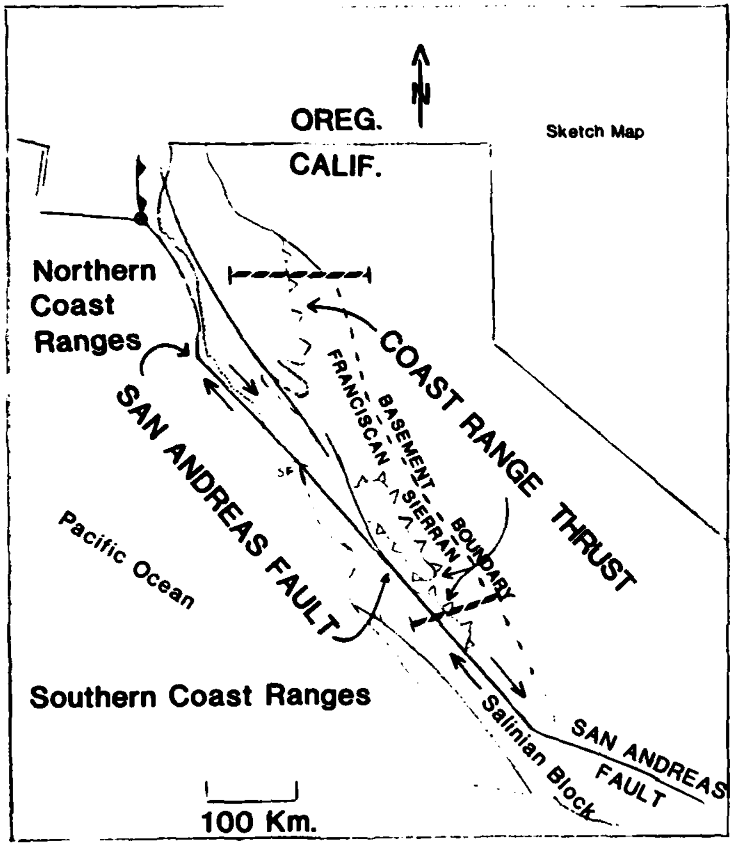
Pervasive Structure. Examination of the first element starts with the pervasive structure along the western edge of the Great Valley and within the Coast Ranges. As shown on the sketch map in figure D-1, this structure consists of the Coast Range Thrust at the eastern range front and the San Andreas zone of transform faulting. The San Andreas is a recent tectonic entity, being created when subduction along the coast was extinguished (arch switch off). The San Andreas lengthened along the California coast margin north and south of the point of contact between the Pacific and North American plate. In the southern ranges this first occurred 25 million years ago (Dickinson and Snyder, 1978). In the northern ranges the event occurred less than 5 million years ago.

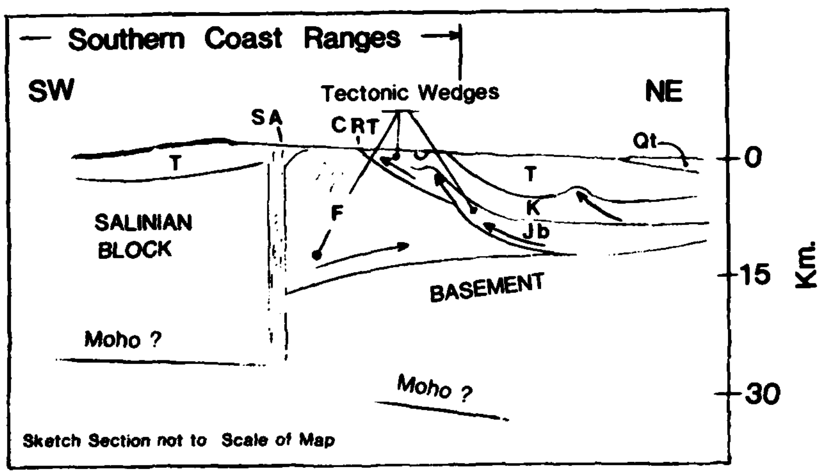
The Coast Range Thrust separates two coeval terrains, the Franciscan Complex (F, see sketch) and Great Valley Sequence (K) along the eastern range front. Ophiolite (Jb) often overlies the thrust. It is generally held that Great Valley Sequence was deposited on ophiolite basement along the Mesozoic continental margin. As indicated in sections illustrated in the figure, the Coast Range Thrust (symbol CRT) can be visualized as defining the upper plate on top of an eastward underthrusting wedge of Franciscan material. The driving mechanism for this wedge, or any wedges in the Great Valley Sequence located further eastward, must come from the west. Eastward thrusting of the Franciscan Complex is responsible for the primary Franciscan wedge (F) and is located in the sketch sections as possibly occurring all along the valley. Faults typically associated with the top of the Coast Range ophiolite (SCF) appear to mark another wedge; thrust faults in the Cretaceous section (ST) mark other wedges. The compressional episode that caused the thrusting was definitely shut off at the onset of transform boundary tectonics. Franciscan thrusting derives from collisional tectonics prior to transform faulting when the subduction zone existed further west (Wentworth, et. al., 1984). Thus, in regional aspect, the state of stress in the crust for thrusting tectonics preceded the state of stress for transform tectonics and they are different. Similarities in geometry of the Coast Range Thrust and the Franciscan Complex-Great Valley Sequence can be followed in sections from the south to the north along the western valley edge.

Stress and Mechanism. We are now led to examine the second element. Can the conditions viewed as explaining the 1983 Coalinga event or the Kettleman Hills earthquake of 1985 be found at/near the tectonics and structure around Black Butte Dam? To answer this it is first necessary to look at the cause and mechanism of the 1983 and 1985 events. Figure D-2 shows sections normal to the Coalinga and Kettleman Hills anticlines. These sections are taken from various publication releases of USGS authors and wedging theory spokesmen. The Coalinga section is taken normal to the anticlinal axis and lies 7 km southeast of the 1983 event. The structure defined is based on interpretation obtained during the USGS Deep Crustal Study, No. 9540-02191; principal investigator, Dr. C. Wentworth. Investigators feel the 1983 Coalinga earthquake occurred at the east margin of the Coast Range beneath the Coalinga anticline and was located some 35 km northeast of the San Andreas Fault. This anticline is the northwest segment of a 100 km long zone of young anticlines associated with the San Andreas zone. Folding northeast of the San Andreas in the Diablo Range and Tremblor Range is indeed young. Harding (1976) suggests a regular progression of late Cenozoic folding away from the San Andreas, the youngest folds outboard of the older folds which lie nearer to the San Andreas. The Kettleman Hills anticline began growing in late Pliocene time and has folded a thick section of Pleistocene alluvial sediments. At the Coalinga nose, the northwest fold trend evident in the Kettleman Hills is superimposed against the existing westerly trend of older San Andreas folding.1/ Study of stream terrace deformation south of the Coalinga nose (King and Stein, 1984) suggests deformation and recent movement beneath the Coalinga anticline. The Coalinga, Kettleman Hills, and Lost Hills anticlinal deformation trend is accepted as being controlled by the San Andreas in movement much like Riedel shear is associated with master fault movement (see figure D-4 - Riedel shear).

As shown on the sketch figure D-2, northeast directed thrusts (named Coalinga Thrusts), terminate beneath the anticline, at a depth of 10 km (point C on figure), in a series of upward-splayed reverse faults above which the anticline

1/See Woodring, Stewart, Richards, 1940, and Dibblee, 1973 and 1971; references in Wentworth, et. al, 1984.

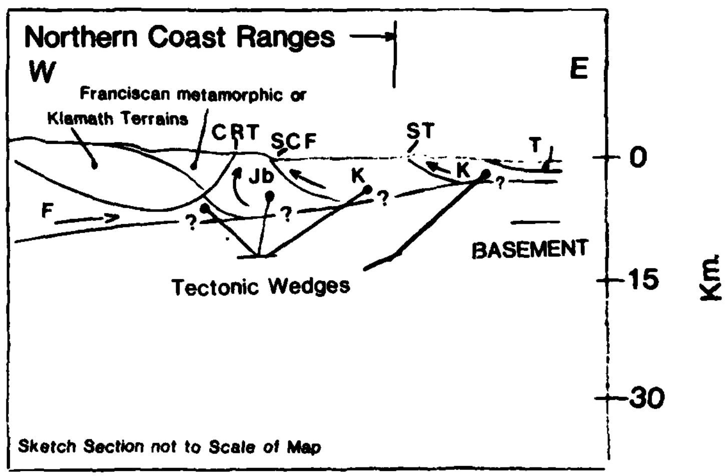




Schematic cross sections across Coast Ranges- Great Valley boundary *in the north adapted from Wentworth et.al., 1984. In the south from Page, 1981.*

Explanation

K- Great Valley sequence
T- Miocene marine sediments and volcanics
Qt- Pleist. and Plio. clastic sediments
Jb- Great Valley Ophiolite
F- Franciscan Complex
CRT- Coast Range Thrust
SCF- Stony Creek Thrust
ST- Sites Thrust
SA- San Andreas Fault



STRUCTURE ALONG COAST RANGE -- GREAT VALLEY CONTACT FIG. D-1

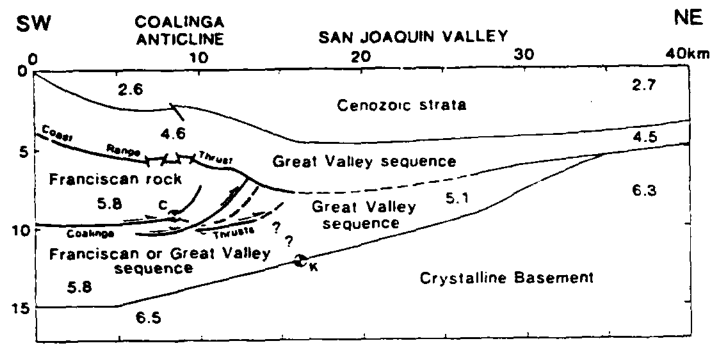
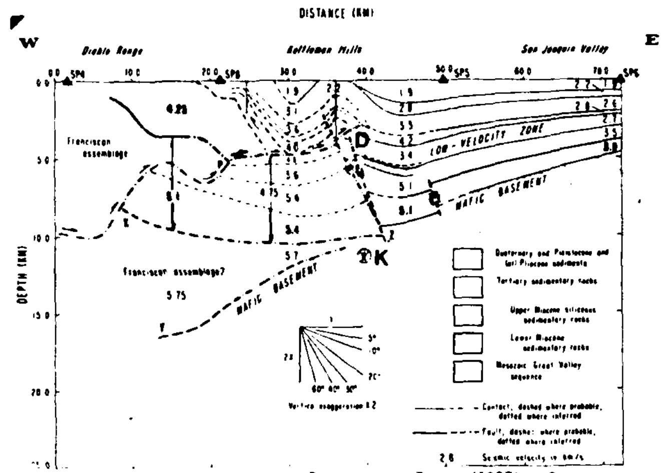
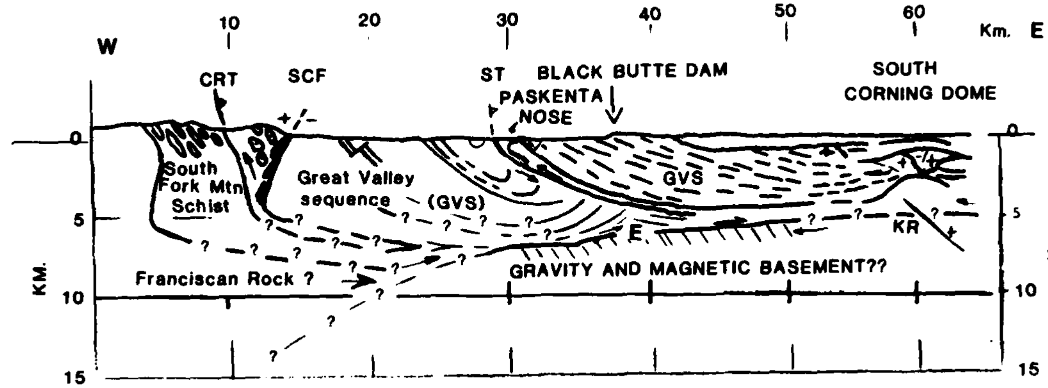


FIGURE SUPPLIED BY WENTWORTH, WRITTEN COMM., 1985. CROSS SECTION NORMAL TO COALINGA ANTICLINE AND 7 KM. SOUTHEAST OF 1983 MAINSHOCK EPICENTER. STRUCTURE IN UPPER 10 KM OF SECTION BASED ON REFLECTION PROFILE, SURFACE OF BASEMENT FROM REFRACTION WORK OF WALTER(1984). LOCATION OF THE COSEISMIC SURFACE DEFORMATION ABOVE THE WESTERNMOST REVERSE FAULT REQUIRES PLACING THE MAINSHOCK HYPOCENTER(EATON 1984) AT THE BASE OF THE EASTERNMOST THRUST(C)APPROXIMATE LOCATION OF THE 1985 KETTLEMAN HILLS EARTHQUAKE IS PROJECTED ON SECTION.(K)



TAKEN FROM WENTWORTH, WALTER, BARTOW, AND ZOBACK(1983). BASEMENT AND FRANCISCAN BASED IN PART ON ASSOCIATED REFRACTION VELOCITY MODEL. TWO FOLD VERTICAL EXAGGERATION. PROJECTED LOCATION OF THE 1985 KETTLEMAN HILLS EARTHQUAKE SHOWN ON SECTION(K)



BASEMENT OBTAINED FROM GEOPHYSICAL SECTION. ?? QUESTIONED LINES ARE PROJECTIONS BASED ON WEDGE THEORY. HYPOTHETICAL REVERSE FAULT PLACED IN EAST SECTION BELOW CORNING DOME HAS NO BASIS IN FACT. REVERSE FAULT PLACED AS EXPLANATION OF DEFORMATION OCCURRING AT CORNING DOME.(KR)

CROSS SECTION WEST TO EAST ACROSS PLATE 1. STRUCTURE FROM COAST RANGE THRUST TO CRETACEOUS GREAT VALLEY SEQUENCE PROJECTED DOWNWARD 1000 FT. FROM SURFACE GEOLOGY. STRUCTURE IN CRETACEOUS GREAT VALLEY BASED ON REFLECTION PROFILE, DRILL HOLES AND GEOLOGY.

TECTONIC WEDGING IN CALIFORNIA

FIG. D-2

has grown. The Coalinga main shock occurred at the base of the reverse fault splay with focal mechanism that closely resembles the strike of the fold and dip of the fault (Eaton, et. al. 1984).

Thrusting of the type responsible for the growth of the Coalinga Anticline probably extends the length of the Coalinga-Kettleman Hills trend. Wentworth sees tear faults in the subsurface as en echelon steps connecting the thrust. At Kettleman Hills the thrust is not rooted and the fold is underlain by a subhorizontal thrust that terminates beneath the east limb of the anticline (point D in figure). The position of the easternmost ramp on the thrust surface was probably controlled by reverse fault deformation of the lower plate (Wentworth, Walter, Bartow, and Zoback, 1984). The driving force for thrusting is believed by Wentworth not to be superficial but deep crusted. His interpretation is a reverse fault penetrating from basement and controlling the location of the thrust ramp and fold. Mechanisms for the Kettleman Hills event suggest high angle reverse faulting (Eaton, personal communication, 1985) at the basement, consistent with shallow east thrusting. Reverse faults are localized where the basement bends to plunge beneath the Diablo Range.

At this point the major structures present in the sections that complement the mechanism reported at the Coalinga and Kettleman Hills events can be listed:

a. Fold belts in proximity to the San Andreas fault.

b. Fold belts that have orientation sympathetic to shear transfer from the San Andreas.

c. Fold belts that have en echelon nature and presumably are of some extent regionally.

d. Young surfaces of deformation that demonstrate recent growth in folds.

e. Northeast directed thrusts invading eastward directing wedges in the subsurface; thrusts that do not penetrate surface but end in roof structure of fold.

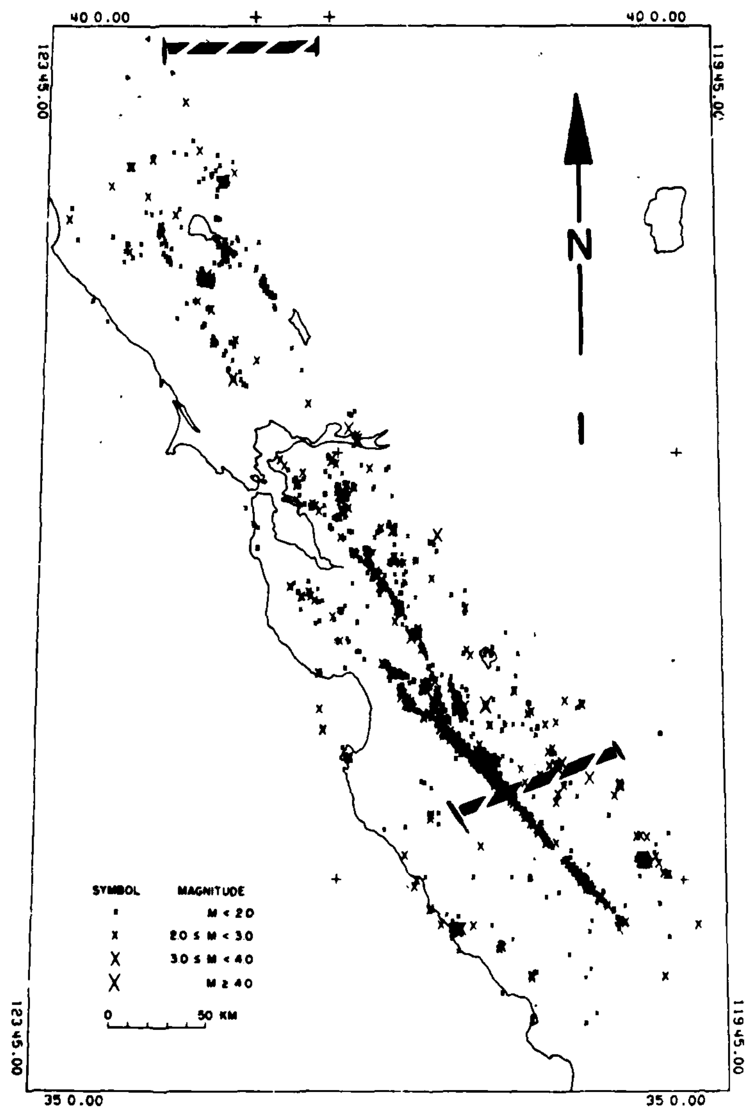
f. Reverse faults emanating from basement that are associated with growing folds and localize position of overthrust plate and fold.

g. Seismogenic activity in fold area (see figure D-3).

Comparison of Structure. The lower section presented in figure D-2 is a west to east section across Black Butte Dam study area shown on map plate 1. The section runs along the Glenn-Tehama County line. The section is supplemented with depth information obtained through the geophysical studies. The quality of subsurface data in the lower section is less than that obtained from the deep crustal studies of the USGS from which the upper sections are drawn. Surface geology is projected to 1,000-foot depth and indicates the Coast Range Thrust (CRT) and Stony Creek fault (SF) are steeply dipping. They are projected in the crust as flattening eastward to conform with wedge theory. The

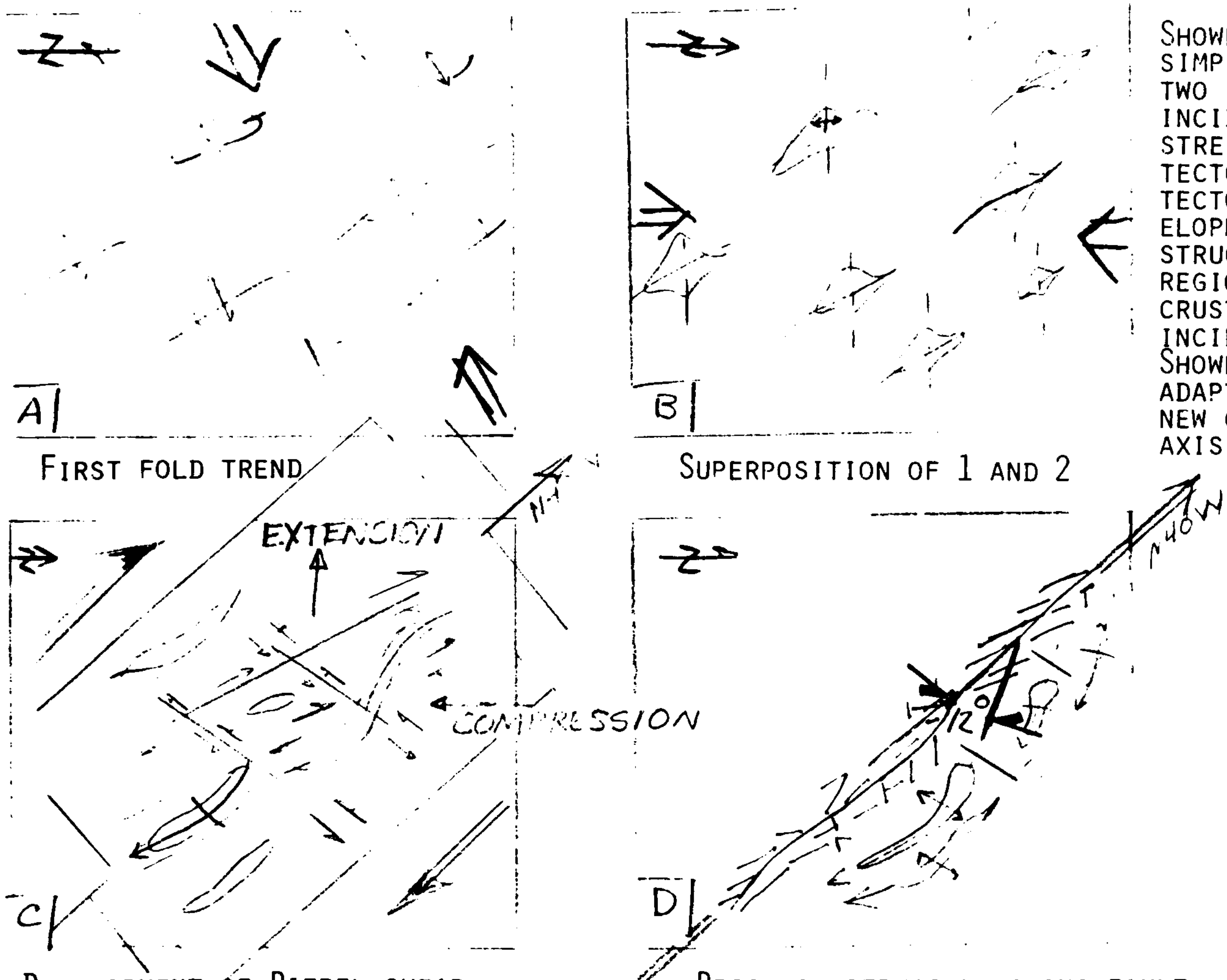
Great Valley Sequence (Jurassic and Lower Cretaceous) is steeply east dipping and compressed against the ophiolite belt that separates the Coast Range Thrust from the Great Valley Sequence. There is no evidence of shallow east directed thrusts or folds in the lower Great Valley Sequence. A west-directed thrust exists near the Sites anticline and Paskenta nose (labelled Sites Thrust-ST). A possible thrust of Franciscan ophiolite or schist, of Great Valley Sequence exists above the basement flexure at point E. Gravity indicates this to be lighter than the overlying material. If this material is thrusted to the position shown, the wedge has not penetrated the overlying Cretaceous Great Valley Sequence. A fold exists to the east that can be included as part of the line of anticlines and domes trending north-south down the medial northern Sacramento Valley. At KR on the section, a high angle reverse fault, positive on the east, is drawn as penetrating from the basement into the upper Cretaceous. This fault has not been seen in any records of seismic reflection data but is shown as an explanation for the fold and is consistent with the wedge theory. The projection of the fault to the surface is the point of flexure on the 0.5-million-year-old Redding topography near Corning.

In summation, the Black Butte section, shown in figure D-2, has general wedge-type elements similar to Coalinga-Kettleman Hills structure but lacks the east-directed subhorizontal thrust with overlaying coseismic folds. The general axis of principal compression in the northern Sacramento Valley is north-south and not east-west. The San Andreas fault is very distant to the existing valley folds and, we believe, too distant to activate the folds/faults through stress transfer on conjugate shear lines.



Epicenters of earthquakes in central California for the year 1976, based on data t.om USGS Central California Network (McHugh and Li ster, 1978). From Eaton (in press).

EARTHQUAKE EPICENTERS IN CENTRAL CALIFORNIA FIG. D-3



FIRST FOLD TREND

SUPERPOSITION OF 1 AND 2

DEVELOPMENT OF RIEDEL SHEAR
ACCOMODATION OF FOLD AXIS.

RESIDUAL STRUCTURE ALONG FAULT

SHOWN IN BOX A AND B ARE SIMPLE SUPERPOSITION OF TWO FOLD DIRECTIONS CO-INCIDENT WITH CHANGES IN STRESS FROM COLLISION TECTONICS TO TRANSFORM TECTONICS. INITIAL DEVELOPMENT OF RIEDEL SHEAR STRUCTURE FOLLOWS IN THE REGION AS PEAK STRENGTH OF CRUST IS APPROACHED ALONG INCIPIENT TRANSFORM FAULT. SHOWN IN BOX C IS THE ADAPTION OF THE FOLDS TO NEW COMPRESSION/EXTENSION AXIS DEVELOPING AS PEAK SHEAR STRENGTH OF THE CRUST IS APPROACHED. RIEDEL ZONE WIDENS WITH TIME UNDER CONTINUOUS SHEAR. SHOWN IN BOX D, THE RIEDEL SHEARS CONNECT INTO RESIDUAL STRUCTURE PATTERN OF SHEAR ALONG THE TRANSFORM FAULT. FOLD AXIS INCLINED 12 DEGREES TO MAIN FAULT TREND.

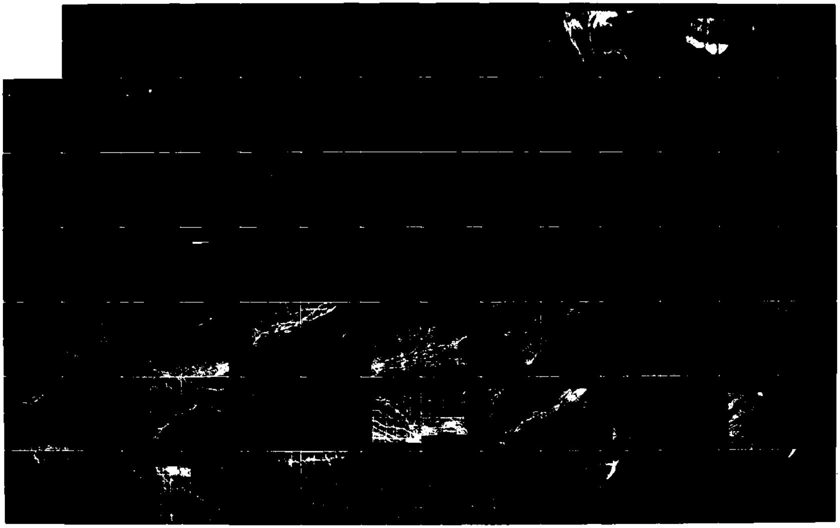
REFERENCE: DE SITTER, 1956;
TCHALENKO, 1970.

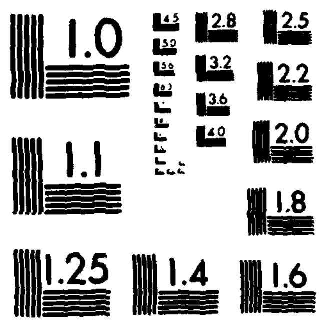
RIEDEL SHEAR - FIG. D-4

SUBJECT INDEX

AD-A172 511 BLACK BUTTE LAKE STONY CREEK CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION(U) CORPS OF ENGINEERS SEATTLE WA SEATTLE DISTRICT W E HANCOCK ET AL. JAN 86 3/4

UNCLASSIFIED F/G 13/2 NL





'CROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SUBJECT INDEX

SUBJECT INDEX (con.)

SUBJECT INDEX (con.)

SUBJECT INDEX (con.)

SUBJECT INDEX (con.)

SUBJECT INDEX (con.)

BLACK
BUTTE
DAM
5 MILE
RADIUS
Lookout
Tower
Hungry Hollow
Radio
Tower
Windmill
BURR VALLEY
D3
D4
D6
D7
D8
D9
D10
D11
DD4
E2
E3
B6
B8
B10

REVISIONS

KEY

PIC STUDY *

LINEAMENT ZONES OF BEDROCK STRUCTURES (JOINTS, FRACTURES, BEDDING OR FAULTING), SOLID LINES INDICATE HIGH CONFIDENCE, DASHED LINES LESSER STRENGTH (HARLAN, MILLER, TAIT: 1984)

U.S.G.S. OPEN FILE REPORT 79-1470 PHOTOLINEAMENTS STUDY

EXPRESSED BY DRAINAGE

EXPRESSED IN PHOTOGRAPHIC TONE

EXPRESSED IN ROCK FABRIC

1 STRONG LINEAMENT
3 POORLY DEFINED

B_3 LINEAMENTS OF RELATED ORIGIN (REF: TABLE 2-1 IN TEXT

MORPHOSTRATIGRAPHIC UNITS AND AGE CORRELATION

SURFACE 10,000 TO 125,000 y.b.p.

SURFACE 125,000 TO 450,000 y.b.p.

SURFACE 450,000 TO 600,000 y.b.p.

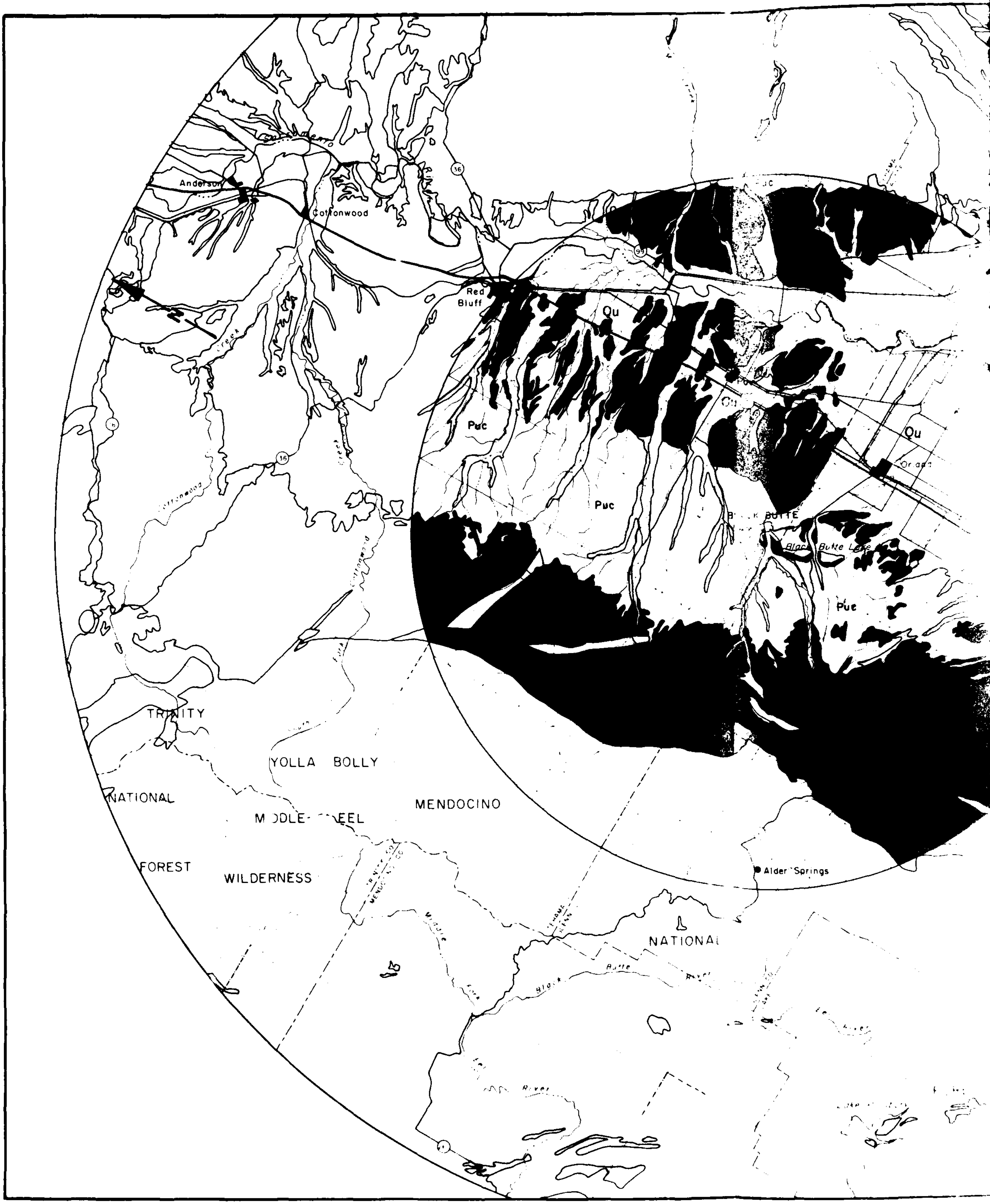
SURFACE 13 X 10^6 y.b.p.

0 10,000 20,000
SCALE IN FEET

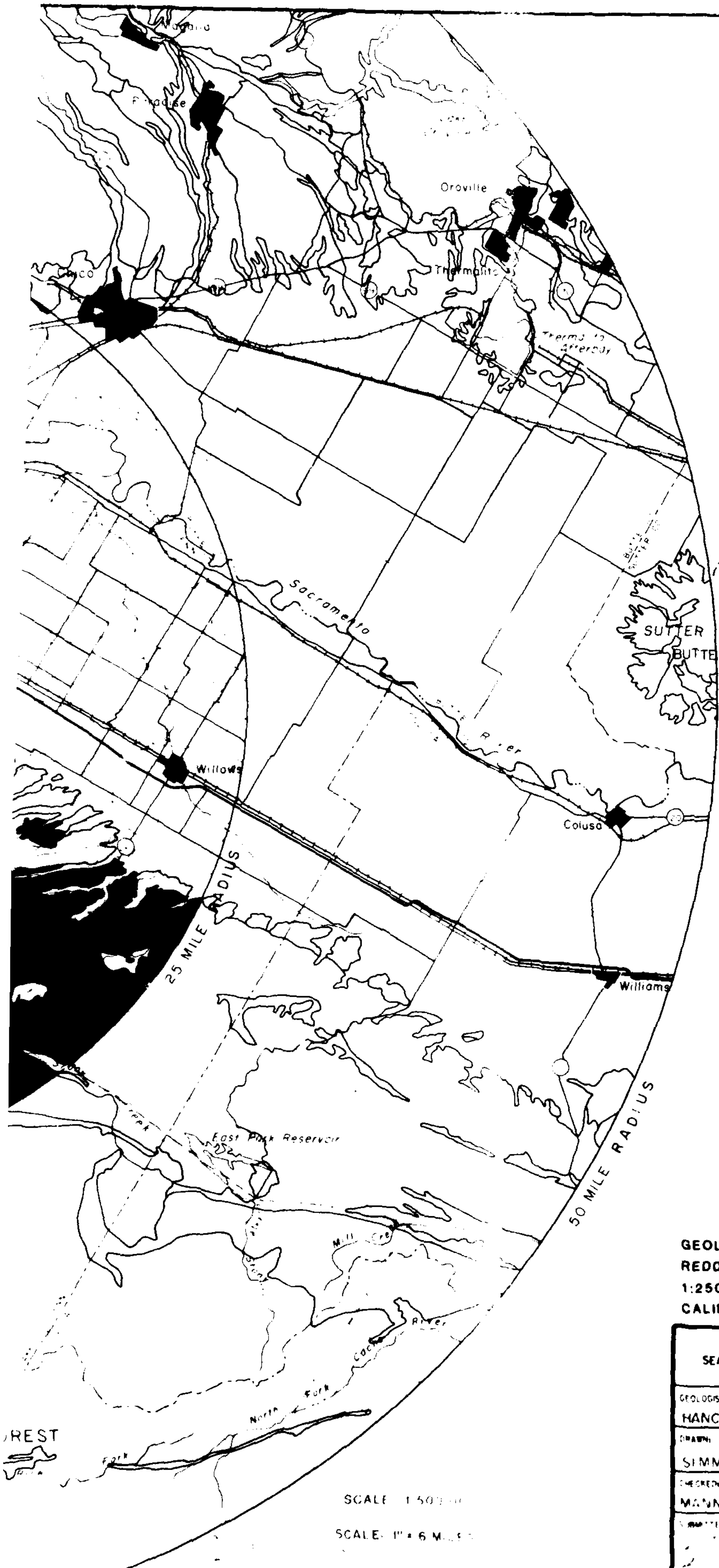
*PIC PHOTOGRAPHIC INTERPRETATION CORPORATION STUDY CONDUCTED FOR HARLAN, MILLER, TAIT; 1984

U. S. ARMY ENGINEER DISTRICT, SEATTLE CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
DESIGNED: HANCOCK DRAWN: HANCOCK CHECKED:	BLACK BUTTE LAKE STONY CREEK CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION IMAGERY AND PHOTOGEOLOGIC ANALYSIS
SUBMITTED: [signature] DATE APPROVED: 31 Dec 85	SCALE: AS SHOWN SPEC. No. SHEET FILE No. SC-1-10-238

PLATE 1



Anderson
Cottonwood
Red Bluff
Qu
Puc
Puc
Puc
Qu
Qu
Orland
BLACK BUTTE
Black Butte Lake
Pue
TRINITY
YOLLA BOLLY
NATIONAL
MENDOCINO
FOREST
WILDERNESS
Alder Springs
NATIONAL



GEOLOGIC LEGEND

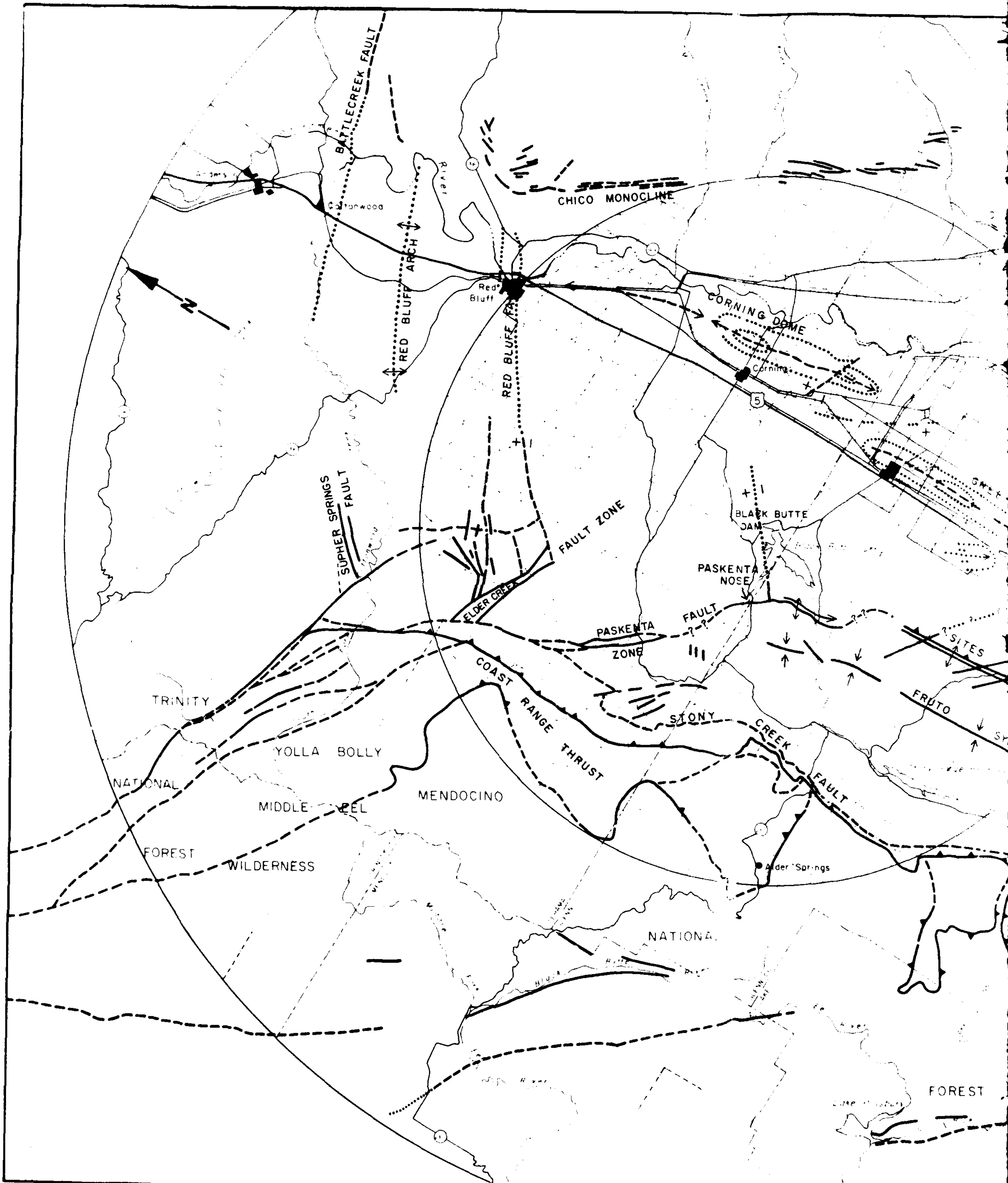
Qu	UNDIFFERENTIATED UPPER AND MIDDLE QUATERNARY DEPOSITS - ALLUVIUM, COLLUVIUM, STREAM CHANNEL, FAN AND BASIN DEPOSITS.
Qc	PLEISTOCENE NONMARINE DEPOSITS, CHIEFLY RED BLUFF FORMATION.
Puc Puv	UPPER-PLIOCENE NONMARINE DEPOSITS WITH VOLCANIC RHYOLITE, CHIEFLY TEHAMA FORMATION AND NOMLAKI TUFF.
Ku	UPPER-CRETACEOUS MARINE SEDIMENTS - CHICO FORMATION.
Kl	LOWER-CRETACEOUS MARINE SEDIMENTS - SHASTA SERIES.
KJ	UPPER-JURASSIC - LOWEST CRETACEOUS MARINE SEDIMENTS - KNOXVILLE FORMATION
ub	MESOZOIC ULTRABASIC INTRUSIVE ROCKS.

GEOLOGY COMPILATION FROM GEOLOGIC MAP OF CALIFORNIA; REDDING, WESTWOOD, UKIAH, AND CHICO SHEETS; 1:250,000 SCALE; DIVISION OF MINES AND GEOLOGY STATE OF CALIFORNIA DEPARTMENT OF NATURAL RESOURCES.

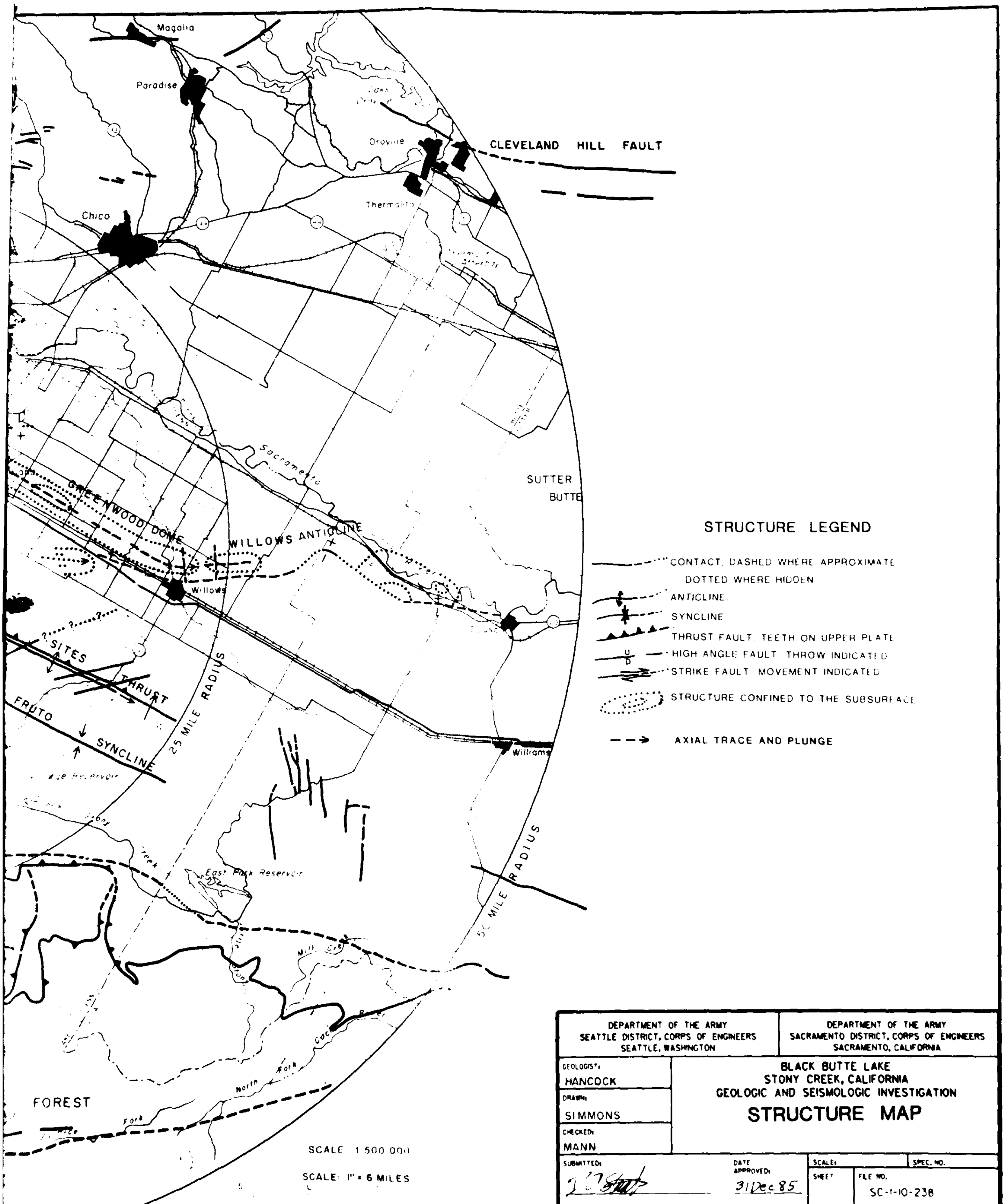
DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: HANCOCK DRAWN: SIMMONS CHECKED: MANN	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **GEOLOGIC MAP**

SUBMITTED | DATE APPROVED | SCALE | SPEC. NO. | SHEET | FILE NO.

PLATE **2**

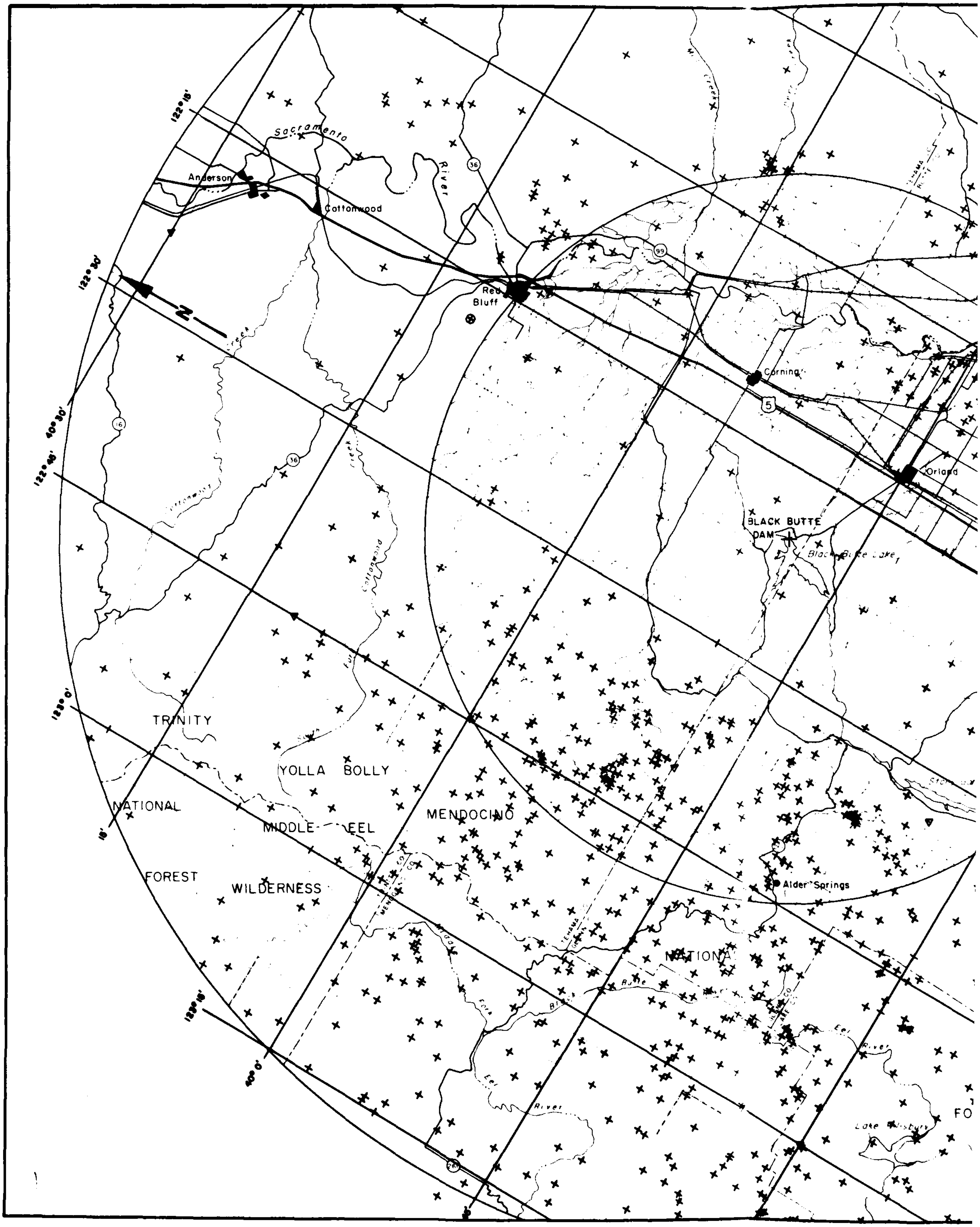


BATTLECREEK FAULT
Cottonwood
River
CHICO MONOCLINE
N
RED BLUFF ARCH
Red Bluff
RED BLUFF FAULT
CORNING DOME
Corning
5
SULPHER SPRINGS FAULT
FAULT ZONE
ELDER CREEK
BLACK BUTTE DAM
PASKENTA NOSE
PASKENTA FAULT ZONE
SITES
FRUTO
COAST RANGE THRUST
STONY CREEK FAULT
TRINITY
YOLLA BOLLY
NATIONAL
MIDDLE EEL
MENDOCINO
FOREST
WILDERNESS
Alder Springs
NATIONAL
FOREST

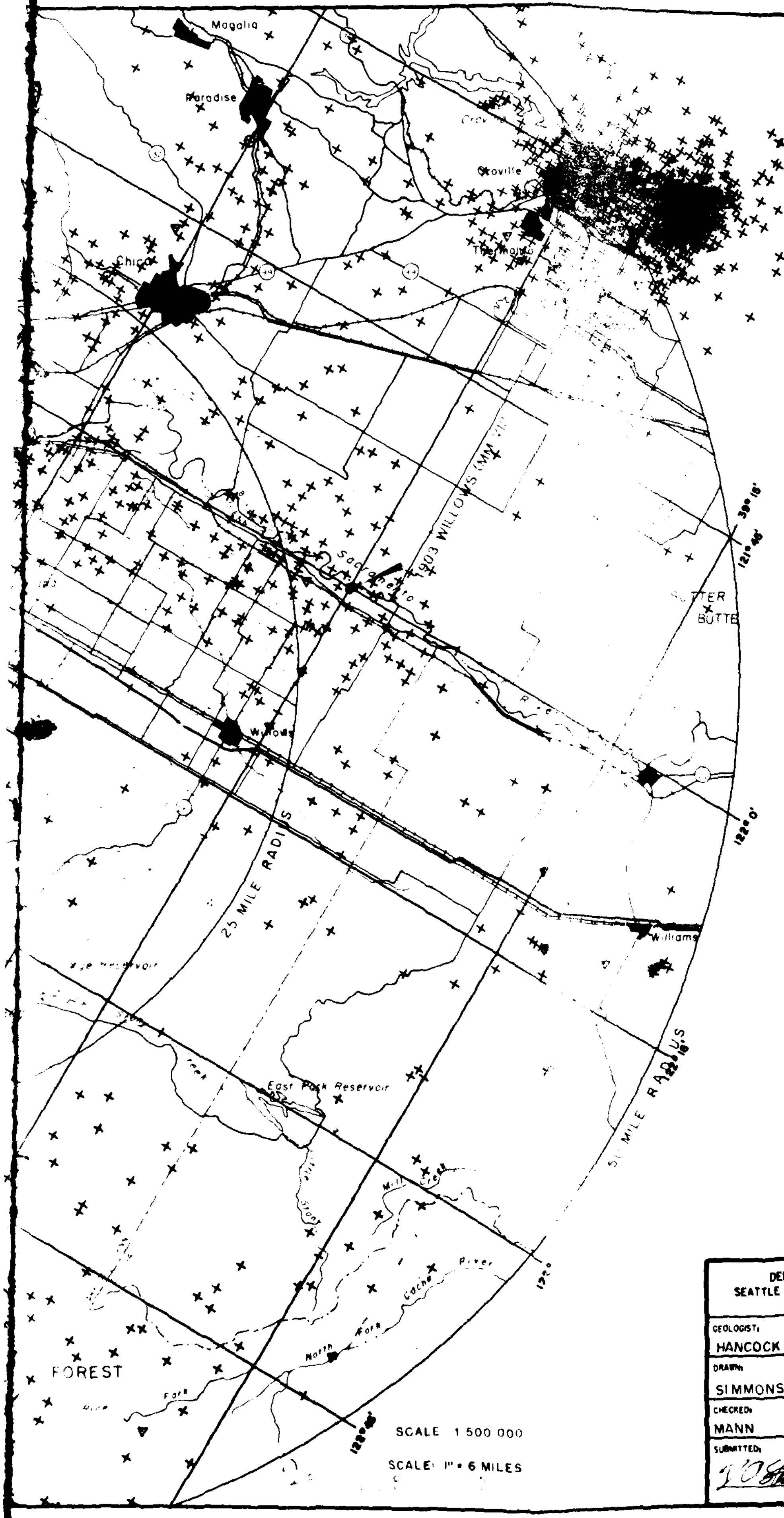


DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: HANCOCK DRAWN: SIMMONS CHECKED: MANN	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **STRUCTURE MAP**
SUBMITTED: [signature] DATE APPROVED: 31 Dec 85	SCALE: SPEC. NO. SHEET FILE NO. SC-1-10-238

PLATE 3



122°15'
122°30'
122°45'
123°0'
123°15'
40°30'
40°0'
15'
N
Sacramento
River
Anderson
Cottonwood
Red Bluff
Corning
Orland
BLACK BUTTE DAM
Black Butte Lake
Alder Springs
TRINITY
YOLLA BOLLY
NATIONAL
MIDDLE EEL
FOREST
WILDERNESS
MENDOCINO
NATIONAL
Eel River
Lake Pillsbury
36
99
16
5



EARTHQUAKE EPICENTER DATA SET
SOURCE: U.S. ARMY CORPS OF ENGINEERS
PACIFIC AND NORTHWEST CATALOGUE
INTERVAL: 1877-1984

SEE PLATE 3 FOR STRUCTURE LEGEND.

ALL EARTHQUAKE EPICENTERS

SYMBOL	MAGNITUDE
+	0.0 - 3.69
▲	3.7 - 4.99
ʘ	5.0 - 6.29
⊡	6.3 - 9.00

EARTHQUAKE EPICENTERS OF EVENTS DEEPER THAN 12 KILOMETERS.

SYMBOL	MAGNITUDE
+	0.0 - 3.69
▲	3.7 - 4.99
ʘ	5.0 - 6.29
⊡	6.3 - 9.00

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
SEATTLE, WASHINGTON

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

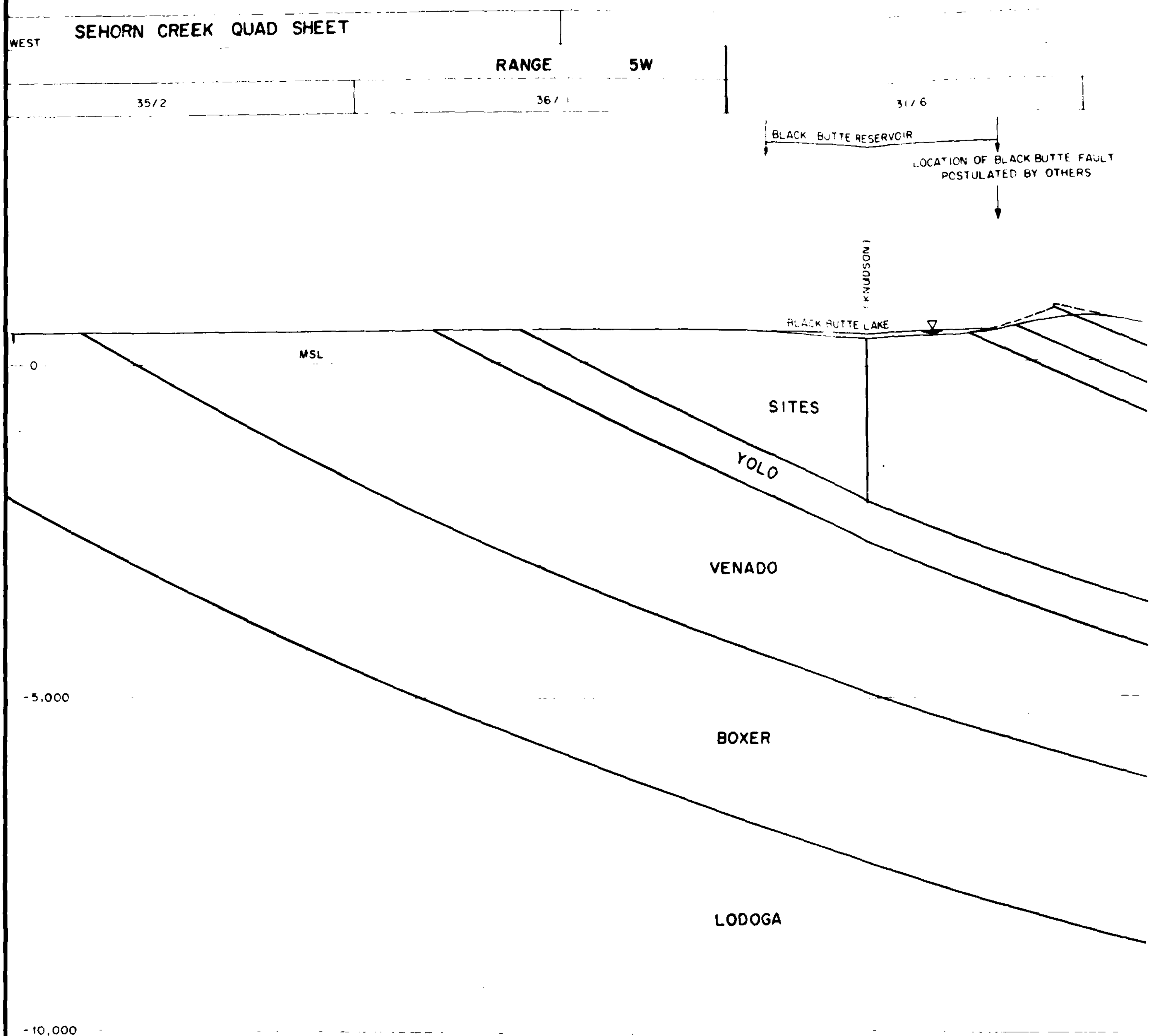
GEOLOGIST: HANCOCK
DRAWN: SIMMONS
CHECKED: MANN

BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA
GEOLOGIC AND SEISMOLOGIC INVESTIGATION

EPICENTER MAP

SUBMITTED: [signature]
DATE APPROVED: 31 Dec 85
SCALE:
SPEC. NO.
SHEET
FILE NO. SC-1-10-238

PLATE 4



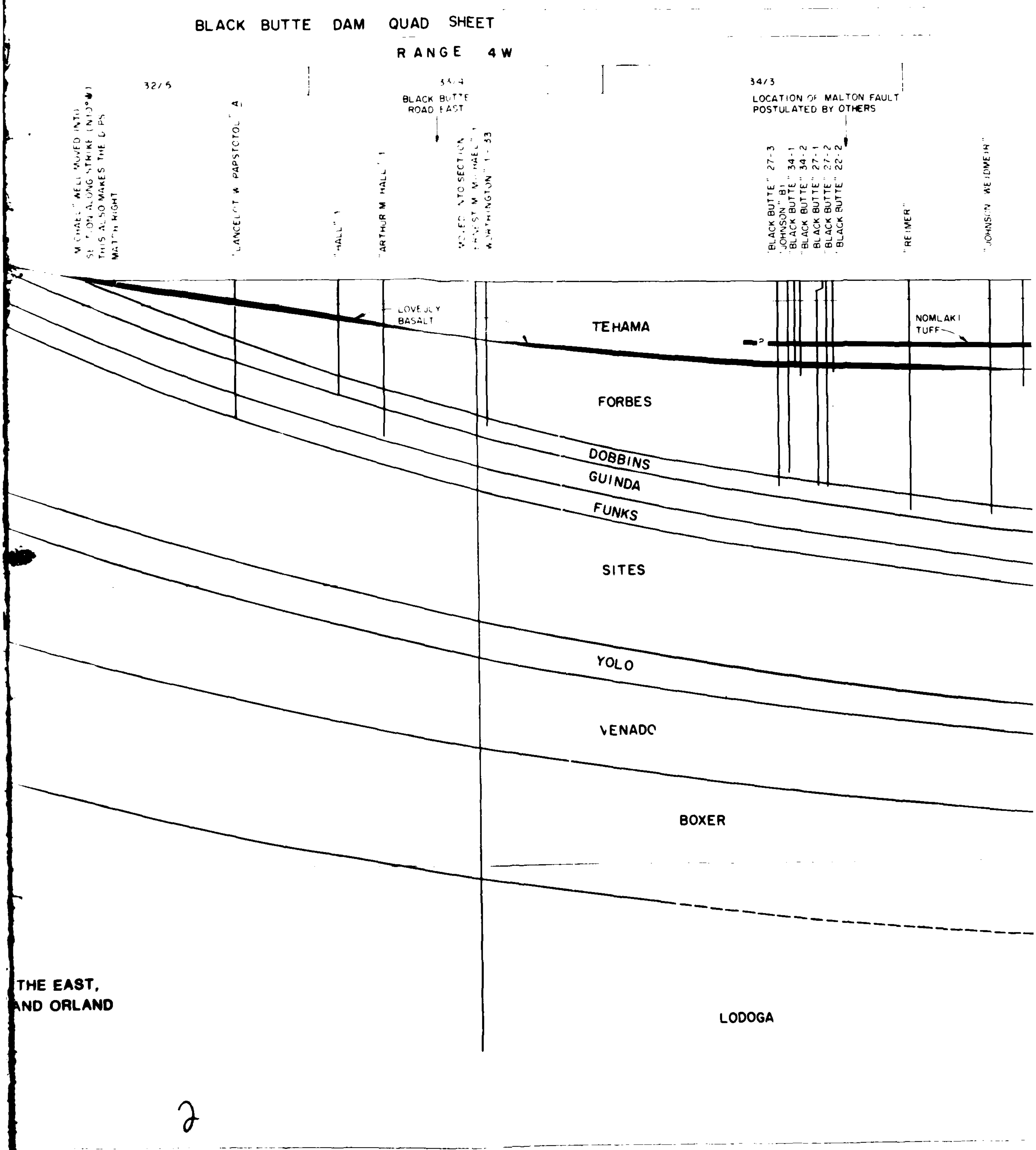
NOTES:

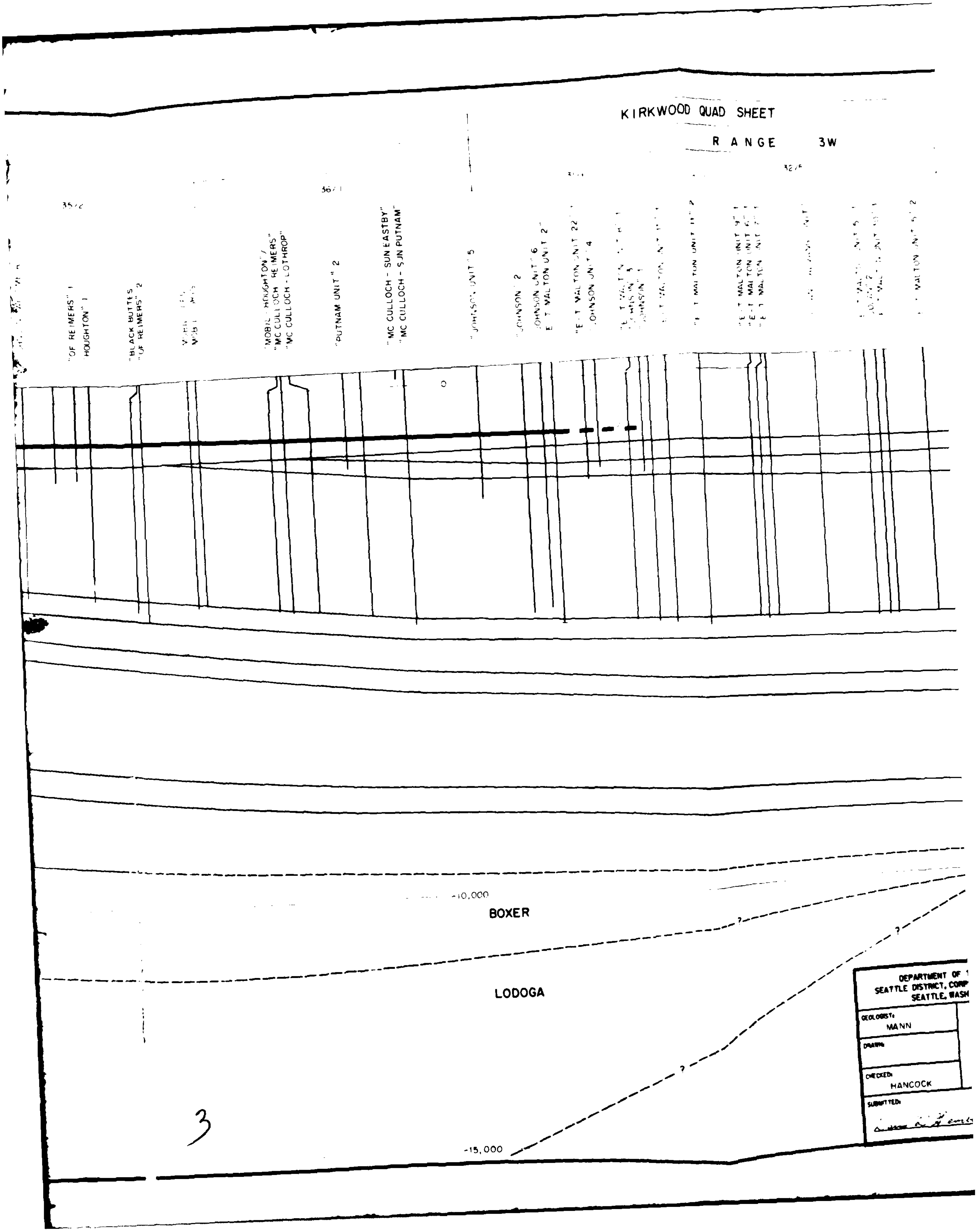
- REFER TO FIGURE 2-6 FOR COMPLETE STATIGRAPHIC SECTION
- REFER TO TEXT FOR DESCRIPTION OF UNITS
- VERTICAL CONTROL OF FUNKS, SITES, YOLO AND VENADO FORMATIONS PROVIDED BY: BUTTES O. & G., "Corning Comm." 9-A WELL, 4 MILES TO THE (sec. 6 T.23N., R.2W., OFF SECTION), MICHAEL 1 (sec. 1, T.22N., R4W.) AND COMM. 2 (SEC. 31, T22N., R2W.)
- * EOCENE FORMATION NOT DIFFERENTIATED

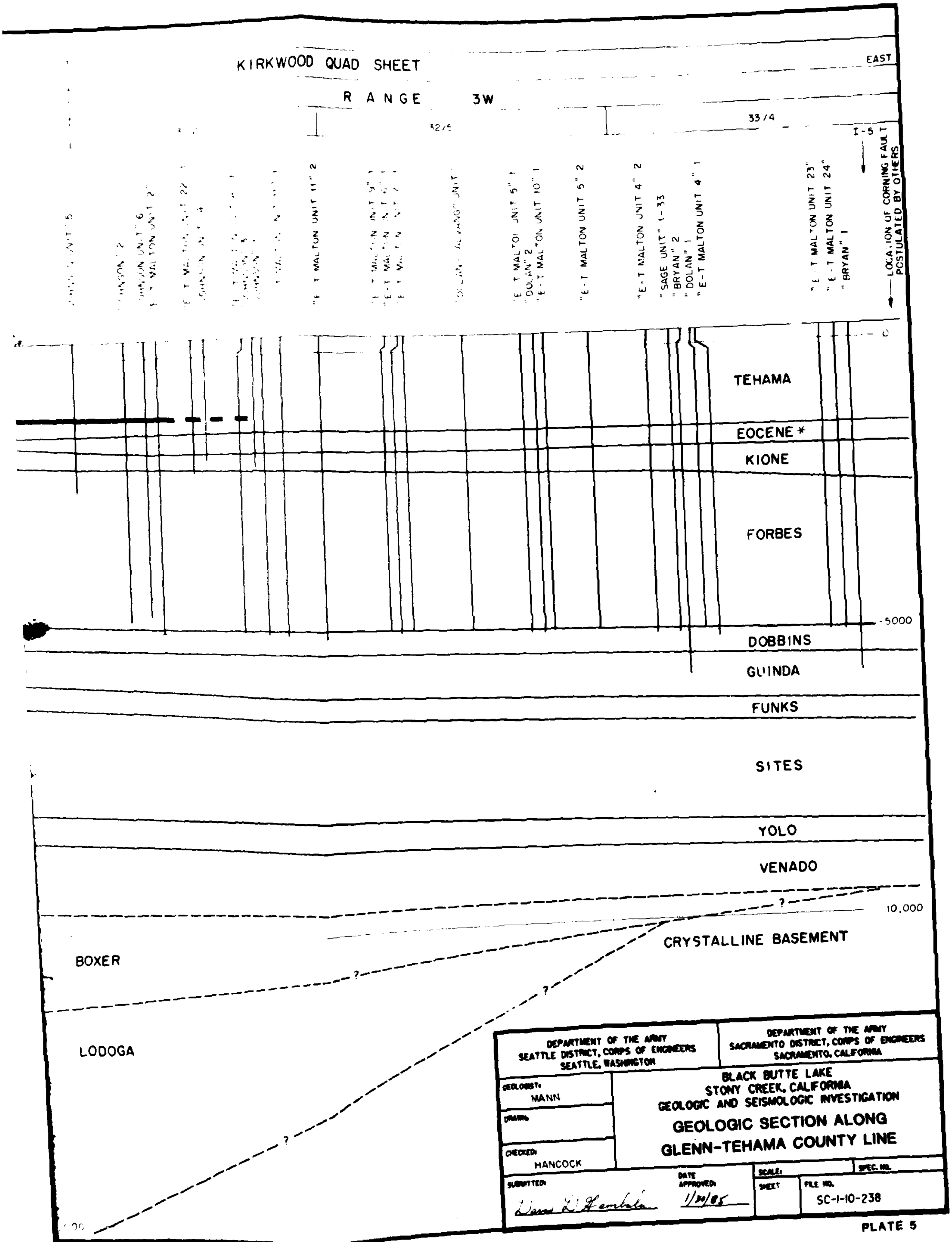
SCALE: 1" = 1000'

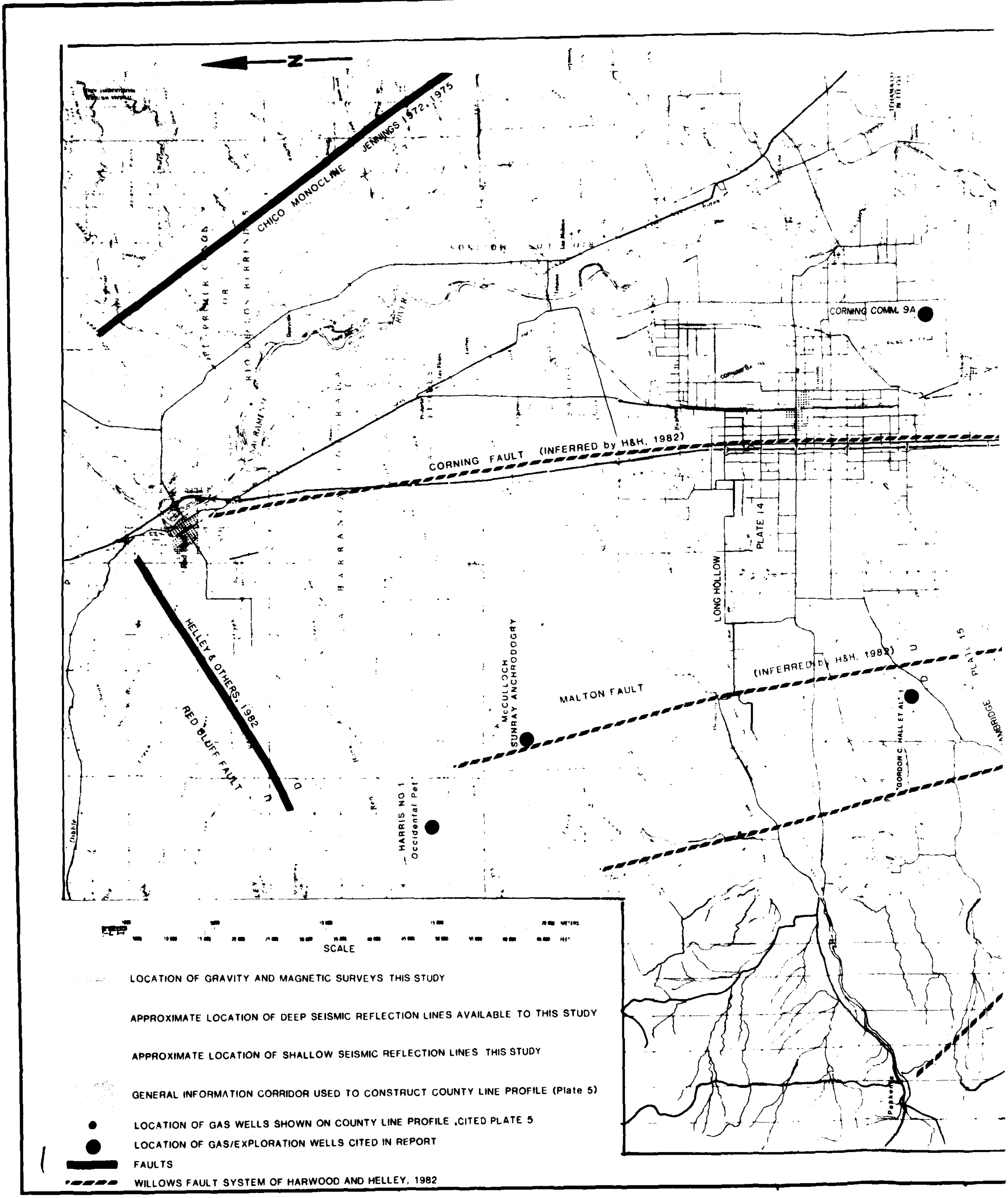
1000' 0 1000' 2000'

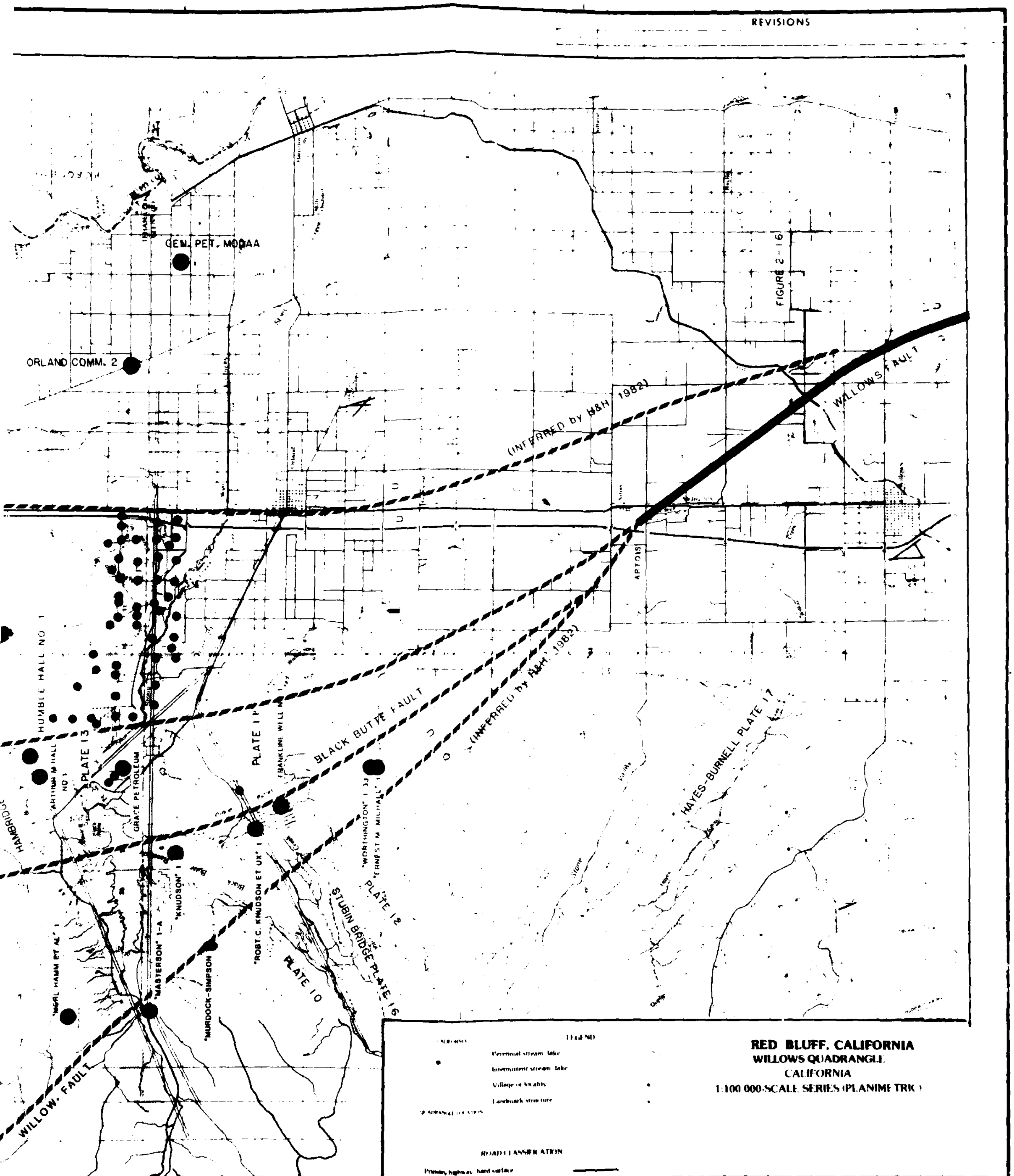
-15,000


BLACK BUTTE DAM QUAD SHEET
RANGE 4W
32/5
34/3
BLACK BUTTE ROAD EAST
LOCATION OF MALTON FAULT POSTULATED BY OTHERS
"LANCELOT W. PAPSTOTOL" A
"HALL" 1
"ARTHUR M HALL" 1
"REIMER"
LOVEJOY BASALT
NOMLAKI TUFF
TEHAMA
FORBES
DOBBINS
GUINDA
FUNKS
SITES
YOLO
VENADO
BOXER
LODOGA
THE EAST,
AND ORLAND
2


KIRKWOOD QUAD SHEET
RANGE 3W
"OF REIMERS" 1
"HOUGHTON" 1
"BLACK BUTTES" 2
"OF REIMERS" 2
"MOBIL-HOUGHTON" 1
"MC CULLOCH-REIMERS"
"MC CULLOCH-LOTHROP"
"PUTNAM UNIT" 2
"MC CULLOCH - SUN EASTBY"
"MC CULLOCH - SUN PUTNAM"
"JOHNSON UNIT" 5
"JOHNSON" 2
"JOHNSON UNIT" 6
"E-T WALTON UNIT" 2
"E-T WALTON UNIT 22"
"JOHNSON UNIT" 4
-10,000
BOXER
LODOGA
-15,000
DEPARTMENT OF
SEATTLE DISTRICT, CORP
SEATTLE, WASH
GEOLOGIST:
MANN
DRAWN:
CHECKED:
HANCOCK
SUBMITTED:
3


KIRKWOOD QUAD SHEET
EAST
RANGE 3W
32/5
33/4
I-5
"E-T MALTON UNIT 11" 2
"E-T MALTON UNIT 5" 1
"DOLAN" 2
"E-T MALTON UNIT 10" 1
"E-T MALTON UNIT 5" 2
"E-T MALTON UNIT 4" 2
"SAGE UNIT" 1-33
"BRYAN" 2
"DOLAN" 1
"E-T MALTON UNIT 4" 1
"E-T MALTON UNIT 23"
"E-T MALTON UNIT 24"
"BRYAN" 1
LOCATION OF CORNING FAULT POSTULATED BY OTHERS
0
TEHAMA
EOCENE *
KIONE
FORBES
-5000
DOBBINS
GUINDA
FUNKS
SITES
YOLO
VENADO
?
10,000
CRYSTALLINE BASEMENT
BOXER
?
?
LODOGA
?
DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
SEATTLE, WASHINGTON
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA
BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA
GEOLOGIC AND SEISMOLOGIC INVESTIGATION
GEOLOGIC SECTION ALONG
GLENN-TEHAMA COUNTY LINE
GEOLOGIST: MANN
DRAWN:
CHECKED: HANCOCK
SUBMITTED:
DATE APPROVED: 1/30/85
SCALE:
SPEC. NO.
SHEET
FILE NO. SC-1-10-238
4
PLATE 5

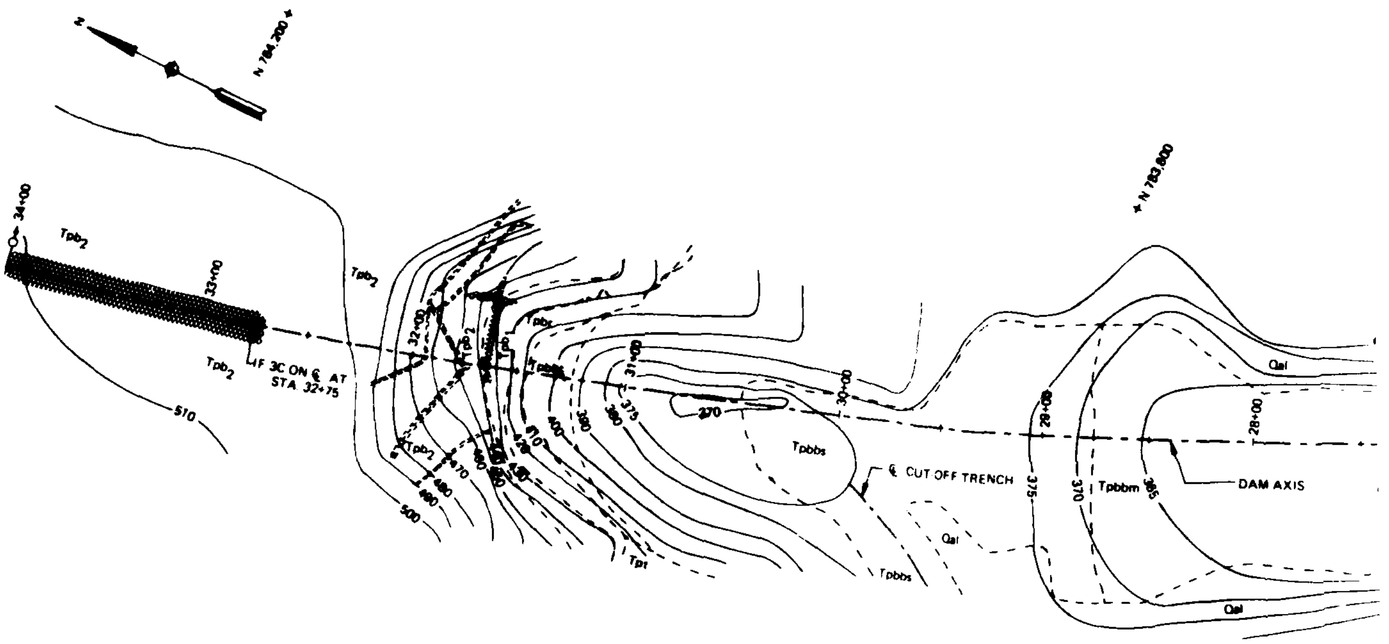

N
CHICO MONOCLINE JENNINGS 1972, 1975
CORNING FAULT (INFERRED by H&H, 1982)
CORNING COMM. 9A
PLATE 14
LONG HOLLOW
HELLEY & OTHERS, 1982
RED BLUFF FAULT
U
D
McCULLOCH SUNRAY ANCHRODOCRY
MALTON FAULT
(INFERRED by H&H, 1982)
PLATE 15
GORDON C. HALL ET AL
HARRIS NO 1 Occidental Pet
SCALE
LOCATION OF GRAVITY AND MAGNETIC SURVEYS THIS STUDY
APPROXIMATE LOCATION OF DEEP SEISMIC REFLECTION LINES AVAILABLE TO THIS STUDY
APPROXIMATE LOCATION OF SHALLOW SEISMIC REFLECTION LINES THIS STUDY
GENERAL INFORMATION CORRIDOR USED TO CONSTRUCT COUNTY LINE PROFILE (Plate 5)
LOCATION OF GAS WELLS SHOWN ON COUNTY LINE PROFILE ,CITED PLATE 5
LOCATION OF GAS/EXPLORATION WELLS CITED IN REPORT
FAULTS
WILLOWS FAULT SYSTEM OF HARWOOD AND HELLEY, 1982



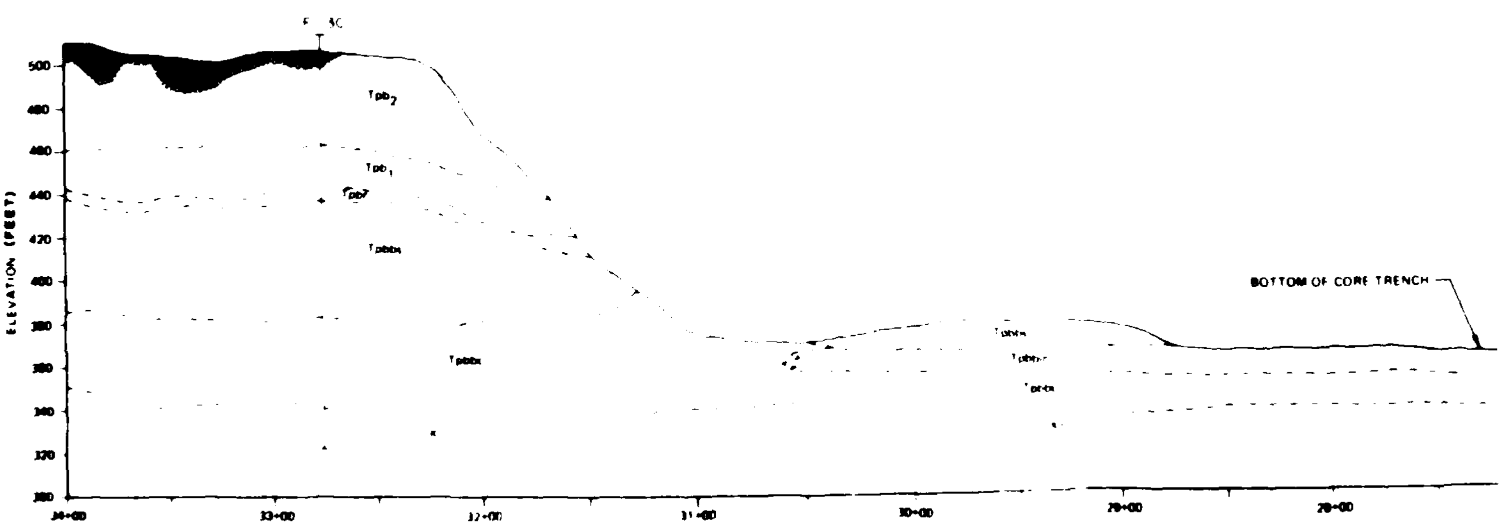
DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: HANCOCK DRAWN: MANN CHECKED: MANN	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION WILLOWS FAULT SYSTEM AND SOURCE OF SUBSURFACE DATA
SUBMITTED: [signature] DATE APPROVED: 1/30/85	SCALE: SPEC. NO. SHEET FILE NO. SC-1-C-238

2

PLATE 6



LEFT ABUTMENT



GEOLOGIC CONTACT OR CHANGE IN ROCK TYPE

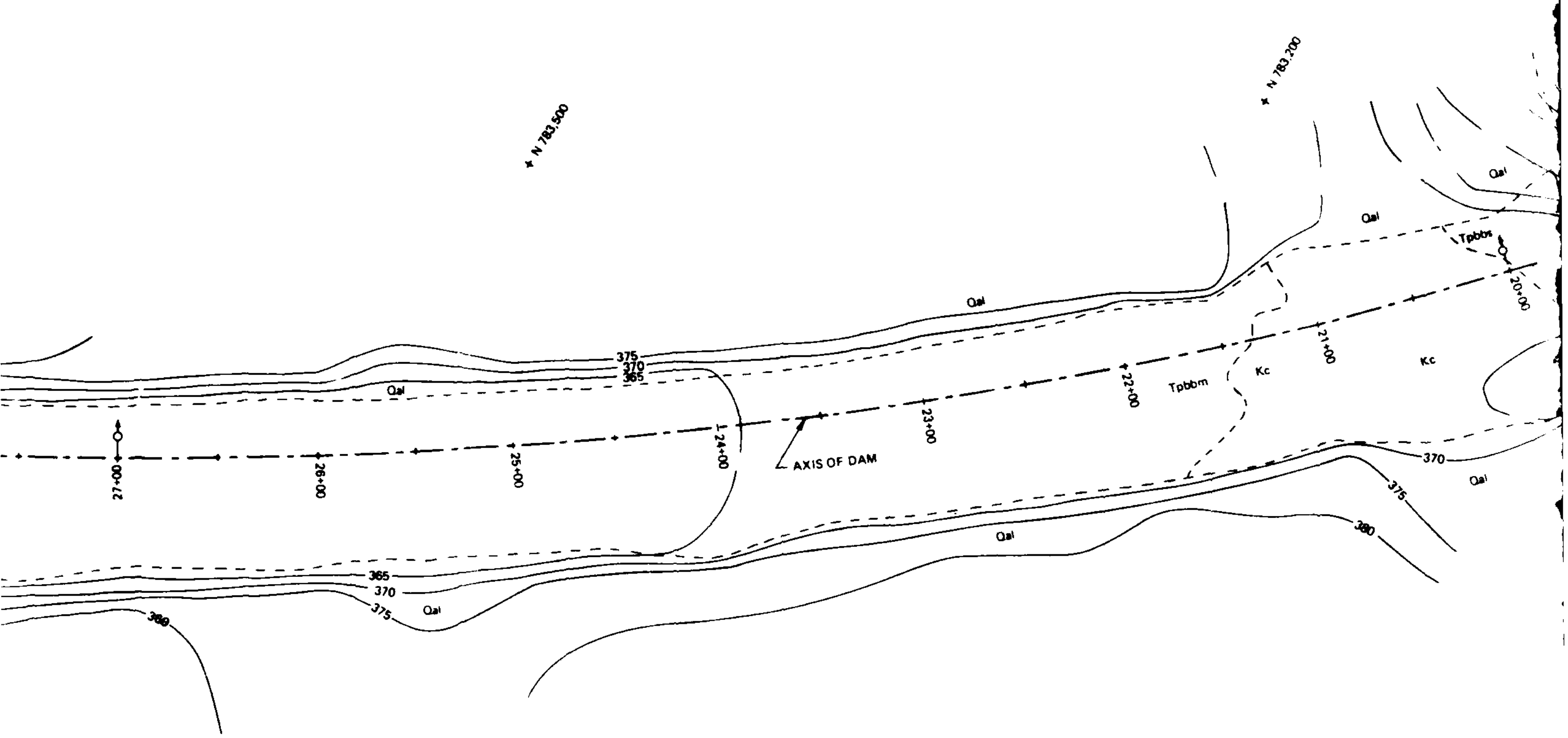
TRACE OF JOINT PLANE

BADLY FRACTURED ROCK NO PREFERRED ORIENTATION OF FRACTURES

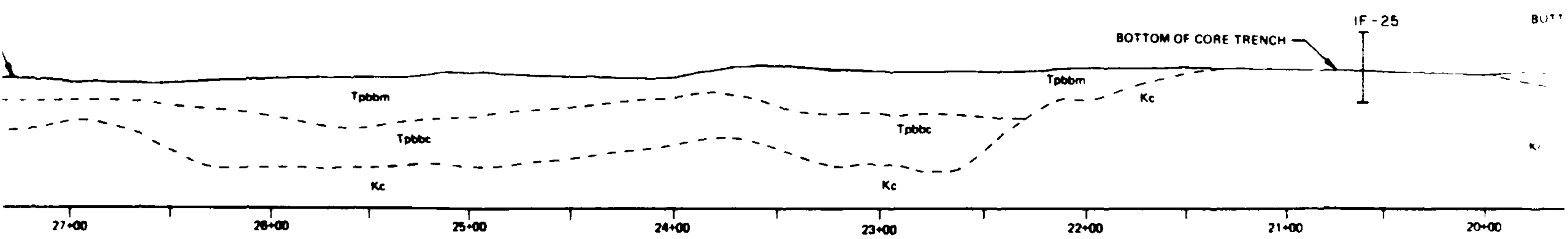
CLAY SEAM WEATHERED FRACTURES OR FRACTURE IN FILLING

Qa OVERBURDEN RECENT ALLUVIUM STREAM CHANNEL AND FLOOD PLAIN DEPOSITS CONSISTING OF SAND GRAVEL AND A FEW COBBLES, FREQUENT POCKETS OR THIN LAYERS OF SILTY SAND DEPOSITS FAIRLY WELL GRADED UP TO ... SIZE PARTICLES HARD, STREAM ROUNDED, COMPOSED OF VOLCANICS, QUARTZITE, JASPER, VEIN QUARTZ AND GRANITIC ROCKS POORLY CONSOLIDATED UNCEMENTED, PERVIOUS

Tpt AN ALLUVIAL DEPOSIT COMPOSED OF LEAN TO FAT CLAY WITH VARYING PROPORTIONS OF FINE TO COARSE SAND, STREAM ROUNDED GRAVELS, AND ANGULAR FRAGMENTS AND BOULDERS OF BASALT, TAN, FIRM, MODERATELY CONSOLIDATED NOT INDURATED



GEOLOGIC PLAN OF CORE TRENCH



GEOLOGIC SECTION ALONG CENTERLINE OF CORE TRENCH

Tpb **BASALT** - DARK GRAY TO BLACK, APHANITIC TO FINE GRAINED, DENSE, HARD WHEN UNWEATHERED, MASSIVE, BRITTLE AND GLASSY. TWO FLOWS PRESENT - Tpb1, LOWER FLOW CHARACTERIZED BY LIGHTER COLOR, COARSER TEXTURE, AND BLOCKY JOINTING; Tpb2, UPPER FLOW DISTINGUISHED BY DARKER COLOR, COLUMNAR STRUCTURE, FINER TEXTURE AND EXTREME BRITTLENESS

Tpbr **VOLCANIC BRECCIA** - BROWN TO GRAY, COMPOSED OF BASALT BOULDERS UP TO 10' OR MORE IN DIAMETER, SOME VESICULAR, IN A MATRIX OF VOLCANIC EJECTA WITH INCLUSIONS OF MUDSTONE. FRAGMENTS ARE GENERALLY WELDED TOGETHER, DEPOSIT IS PERVIOUS AND STAINED THROUGHOUT WITH IRON OXIDE. MATRIX IS SOFT TO MODERATELY HARD. SOME ZONES ARE LOOSE AND CRUMBLY.

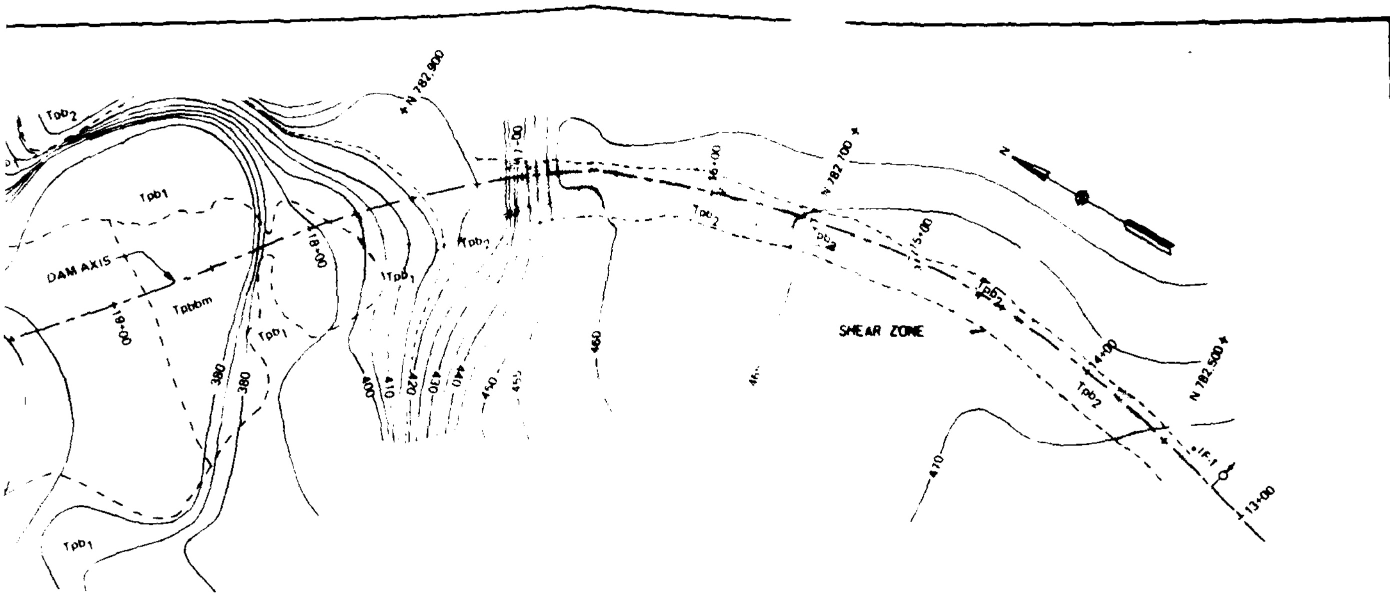
Tpbbm **MUDSTONE** - COMPOSED OF LEAN CLAY, SILT AND FINE SAND, BLUE, GRAY, GRAY-GREEN OR TAN, MASSIVE OR IRREGULARLY BEDDED, SOFT TO MODERATELY HARD - MOST CAN BE SCRATCHED WITH A FINGERNAIL OR CARVED EASILY WITH A KNIFE - MOIST TO DRY, WELL CONSOLIDATED WITH LITTLE OR NO INDURATION

Tpbbs **SANDSTONE** - BLUE, GRAY, GRAY-GREEN, FINE GRAINED, MASSIVE, SOFT, FRIABLE, EASILY CRUSHED, COMPOSED MOSTLY OF ROUNDED QUARTZ PARTICLES, FREQUENTLY CONTAINS A SMALL AMOUNT OF LEAN CLAY OR SILT, WELL CONSOLIDATED, POORLY TO MODERATELY CEMENTED, UNWEATHERED.

Tpbbc **CONGLO**
BLUE
ROUNDE
JASPER
DE

Kc **SHALE**
BROWN
LIME
ZONES
FRACT

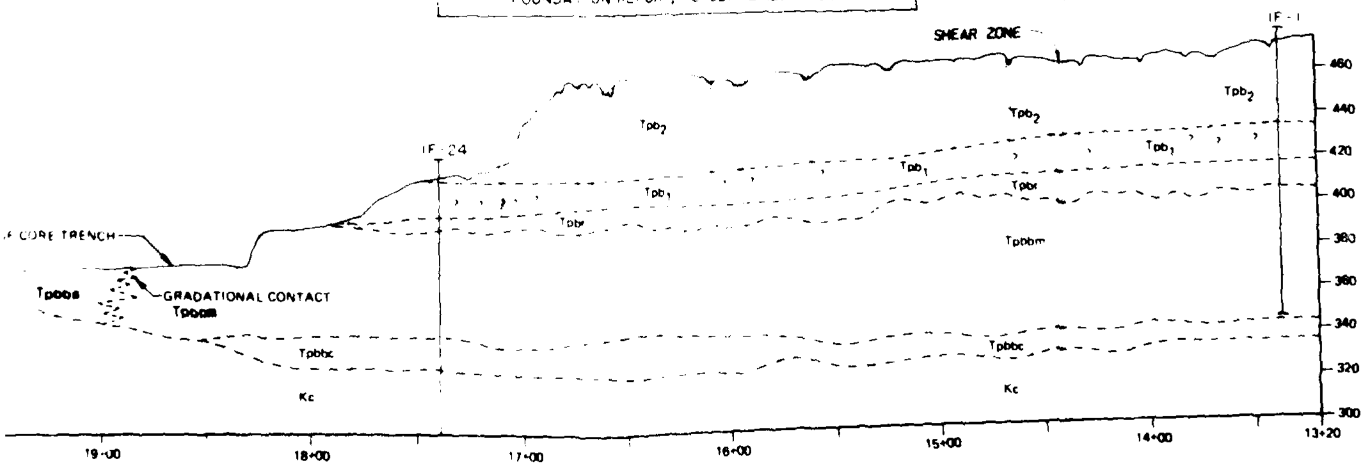
ƛ



Tpt	TEHAMA FORMATION
Tpb1 Tpb2 Tpbr	LOVEJOY BASALT
Tpbbm Tpbbs Tpbbc	BLACK BUTTE FORMATION
Kc	FORBES FORMATION (CHICO SERIES)

NOTE: FORMATION SYMBOLS ON FOUNDATION GEOLOGY PLATES ARE THOSE USED IN ORIGINAL FOUNDATION REPORT AND DO NOT CONFORM TO SYMBOLS USED ELSEWHERE IN THIS REPORT

THIS MAP IS A COMPOSITE OF SHEETS 4, 5 AND 6 CONTAINED IN THE BLACK BUTTE DAM PROJECT, FOUNDATION REPORT, 16 SEPTEMBER 1963



...ATE (POORLY CEMENTED GRAVEL) MULTI COLORED PARTICLES IN A GRAY, GREEN ...N MATRIX OF FINE SAND OR SILTY SAND. GRAVEL PARTICLES ARE HARD, STREAM ...AIRLY WELL GRADED UP TO 3" SIZE, CONSISTING OF VOLCANICS, QUARTZITE, ...ERT, VEIN QUARTZ AND GRANITIC ROCKS. SANDS ARE PREDOMINANTLY QUARTZ ... WELL CONSOLIDATED, POORLY CEMENTED, UNWEATHERED

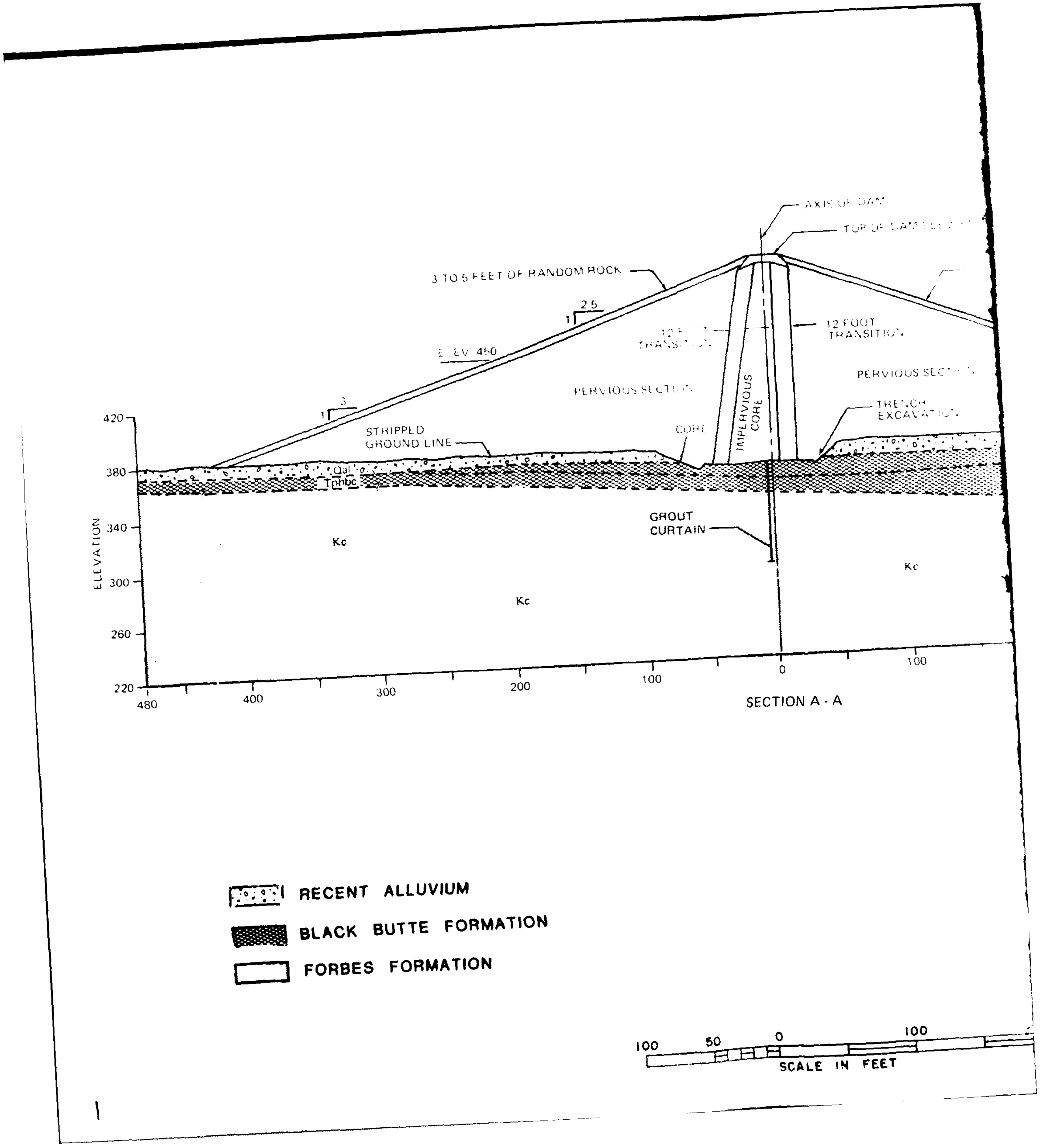
...TH THIN INTERBEDS OF SANDSTONE AND LIMESTONE, DARK GRAY EXCEPT WHITE TO ...ALCAREOUS ZONES, APHANITIC TO FINE GRAINED, SOFT TO HARD DEPENDING ON ...ENT, MASSIVE TO THIN BEDDED. CALCITE FRACTURE FILLINGS AND LIME RICH SANDSTONE OR SANDY SHALE ARE COMMON, UNWEATHERED, MOST IS ONLY SLIGHTLY ...

SCALE IN FEET 50 25 0 25 50 100

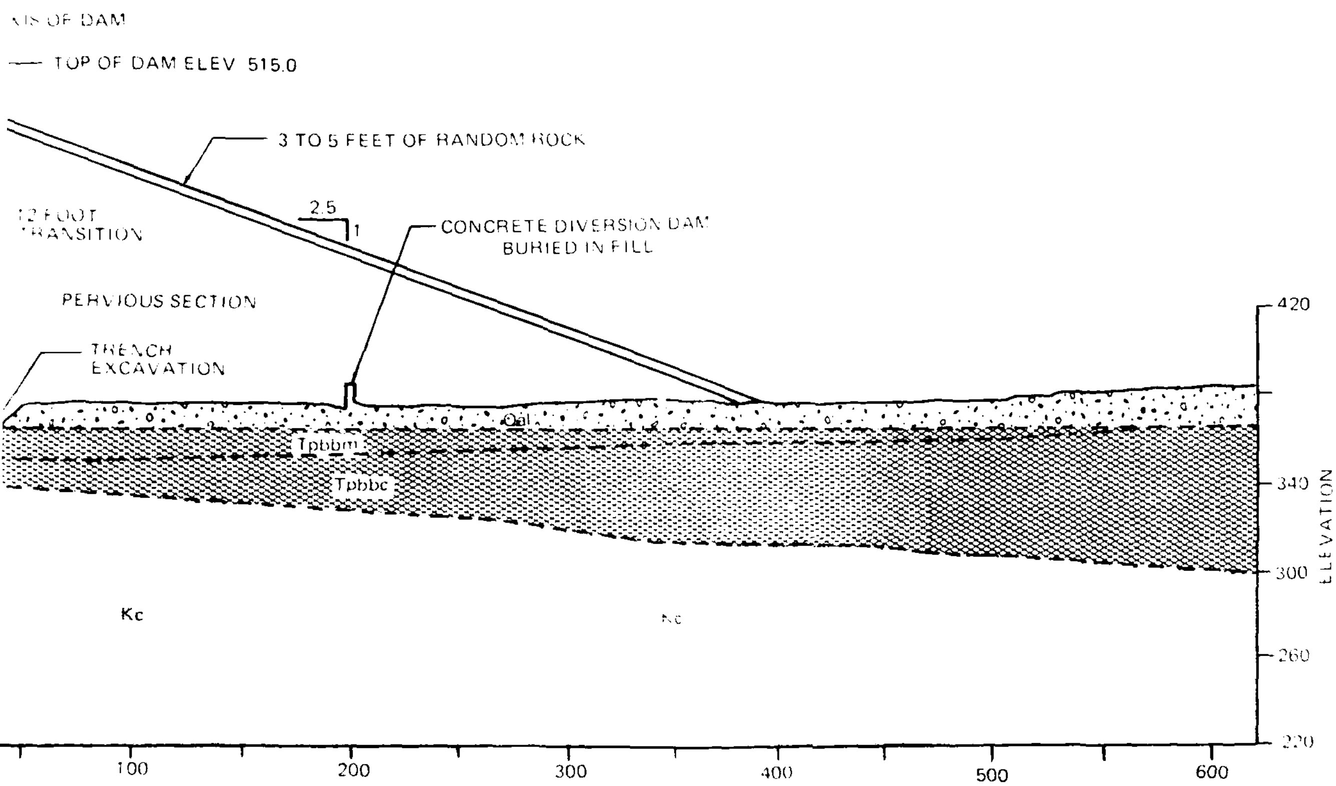
DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: MANN DRAWN: CNT CHECKED: HANCOCK	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **FOUNDATION GEOLOGY OF THE DAM** **CORE TRENCH**
SUBMITTED: [signature] DATE APPROVED: 1/30/85	SCALE: SPEC. NO. SHEET FILE NO. SC-1-10-238

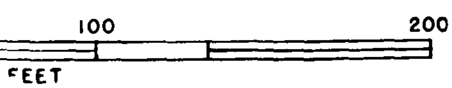
PLATE 7

3



AXIS OF DAM
3 TO 5 FEET OF RANDOM ROCK
2.5
1
12 FOOT TRANSITION
ELEV 450
PERVIOUS SECTION
IMPERVIOUS CORE
3
1
STRIPPED GROUND LINE
CORE
TRENCH EXCAVATION
Qal
Tpbbc
GROUT CURTAIN
Kc
Kc
Kc
ELEVATION
420
380
340
300
260
220
480
400
300
200
100
0
100
SECTION A - A
RECENT ALLUVIUM
BLACK BUTTE FORMATION
FORBES FORMATION
100
50
0
100
SCALE IN FEET





DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
SEATTLE, WASHINGTON

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

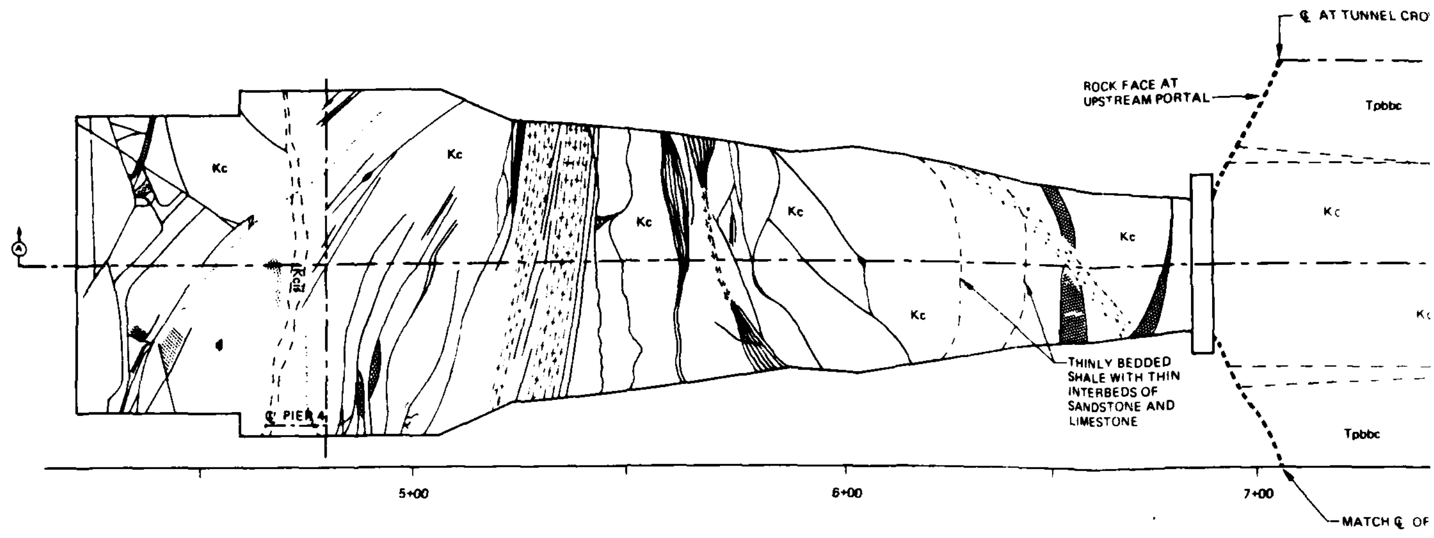
GEOLOGIST: MANN
DRAWN: CNT
CHECKED: HANCOCK

BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA
GEOLOGIC AND SEISMOLOGIC INVESTIGATION

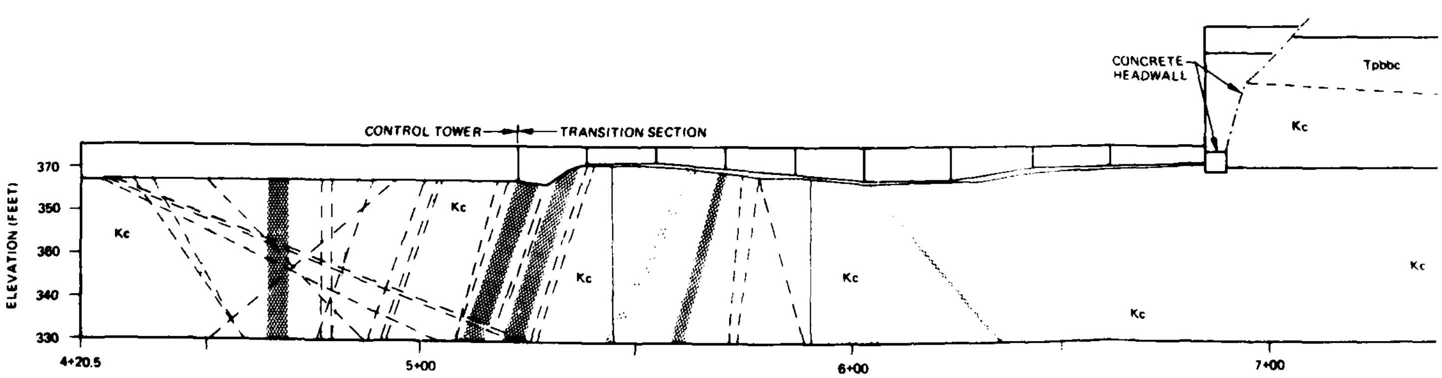
TYPICAL DAM SECTION
STA . 25 + 50

SUBMITTED: David D Kenlak
DATE APPROVED: 1/30/85
SCALE:
SPEC. NO.
SHEET
FILE NO. SC-1-10-238

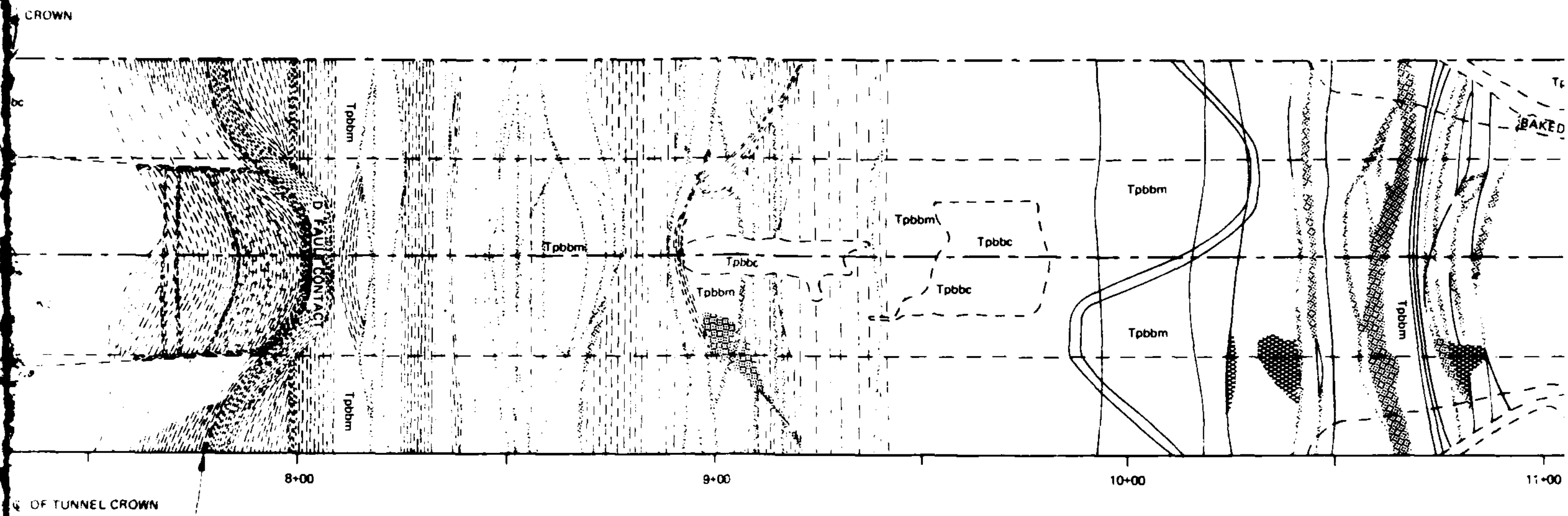
PLATE 8



℄ AT TUNNEL CRO
ROCK FACE AT UPSTREAM PORTAL
Tpbbc
Kc
Ⓐ
℄ PIER 4
THINLY BEDDED SHALE WITH THIN INTERBEDS OF SANDSTONE AND LIMESTONE
5+00
6+00
7+00
MATCH ℄ OF

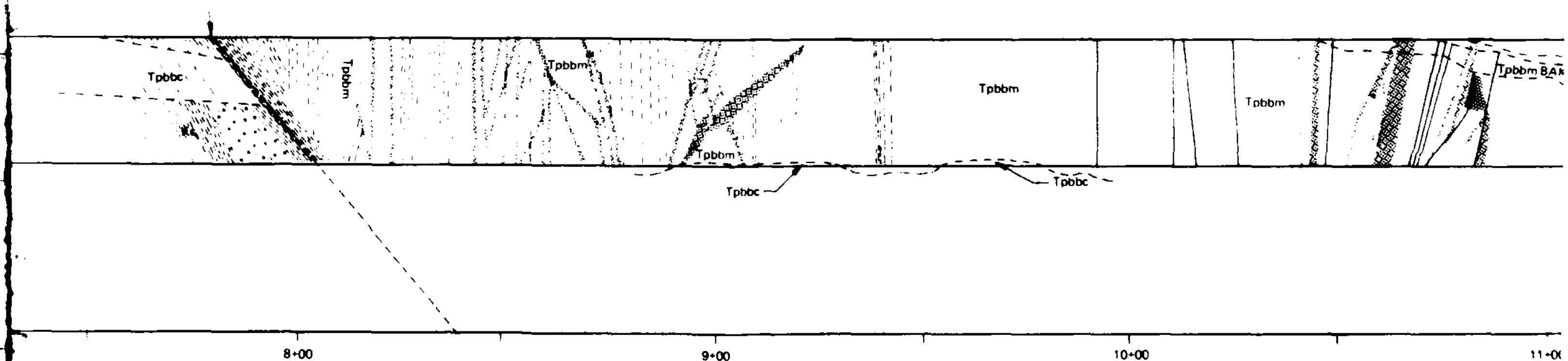


CONCRETE HEADWALL
Tpbbc
Kc
CONTROL TOWER
TRANSITION SECTION
ELEVATION (FEET)
370
350
360
340
330
4+20.5
5+00
6+00
7+00



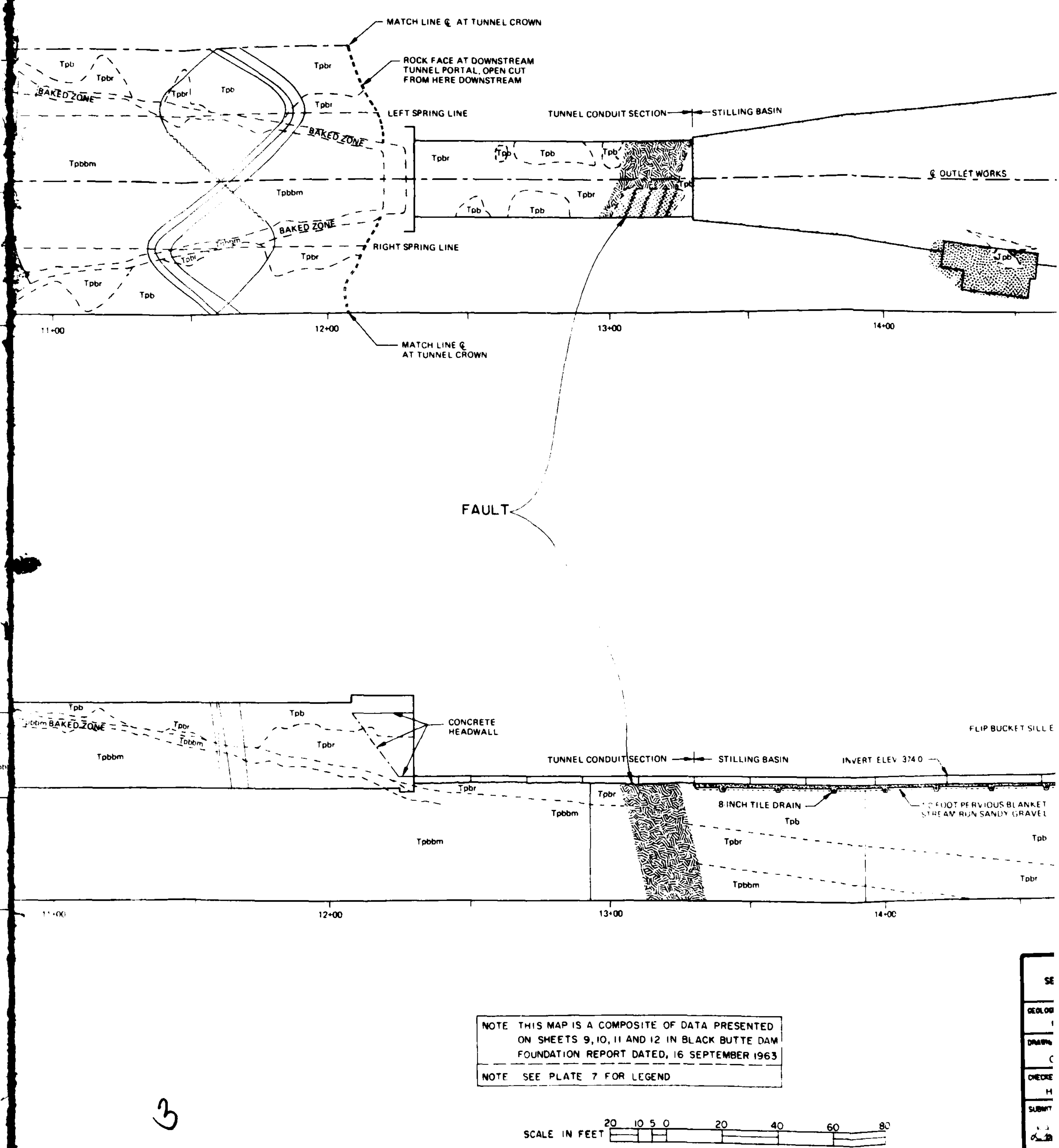
GEOLOGIC PLAN OF OUTLET WORKS

FAULT

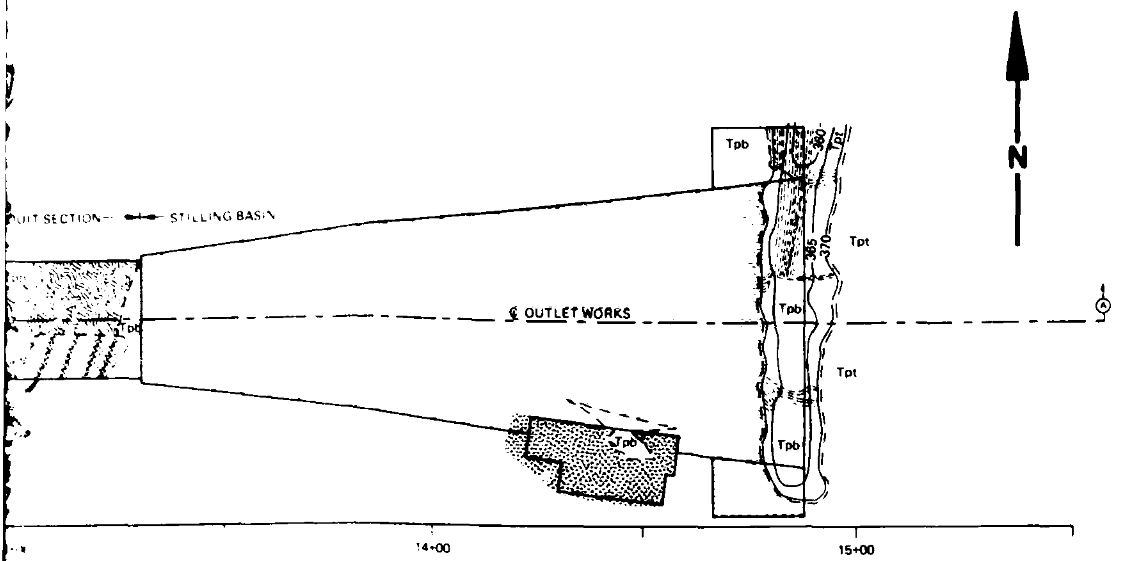


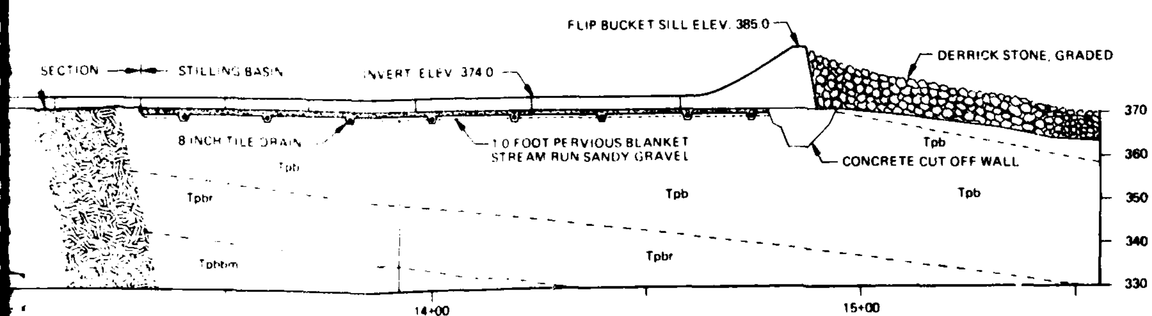
GEOLOGIC SECTION OF OUTLET WORKS

2



MATCH LINE ℄ AT TUNNEL CROWN
ROCK FACE AT DOWNSTREAM TUNNEL PORTAL, OPEN CUT FROM HERE DOWNSTREAM
LEFT SPRING LINE
TUNNEL CONDUIT SECTION
STILLING BASIN
℄ OUTLET WORKS
RIGHT SPRING LINE
BAKED ZONE
Tpb
Tpbr
Tpbbm
11+00
12+00
13+00
14+00
MATCH LINE ℄ AT TUNNEL CROWN
FAULT
CONCRETE HEADWALL
FLIP BUCKET SILL E
TUNNEL CONDUIT SECTION
STILLING BASIN
INVERT ELEV 374.0
8 INCH TILE DRAIN
STREAM RUN SANDY GRAVEL
NOTE THIS MAP IS A COMPOSITE OF DATA PRESENTED ON SHEETS 9, 10, 11 AND 12 IN BLACK BUTTE DAM FOUNDATION REPORT DATED, 16 SEPTEMBER 1963
NOTE SEE PLATE 7 FOR LEGEND
3
SCALE IN FEET
20 10 5 0 20 40 60 80





TE OF DATA PRESENTED
AND 2 IN BLACK BUTTE DAM
DATED, 6 SEPTEMBER 1963

LEGEND

20 40 60 80

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: MANN DRAWN: CNT CHECKED: HANCOCK	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **FOUNDATION GEOLOGY OF OUTLET WORKS**
SUBMITTED: [signature] DATE APPROVED: 1/30/85	SCALE: SPEC. NO. SHEET FILE NO. SC-1-10-238

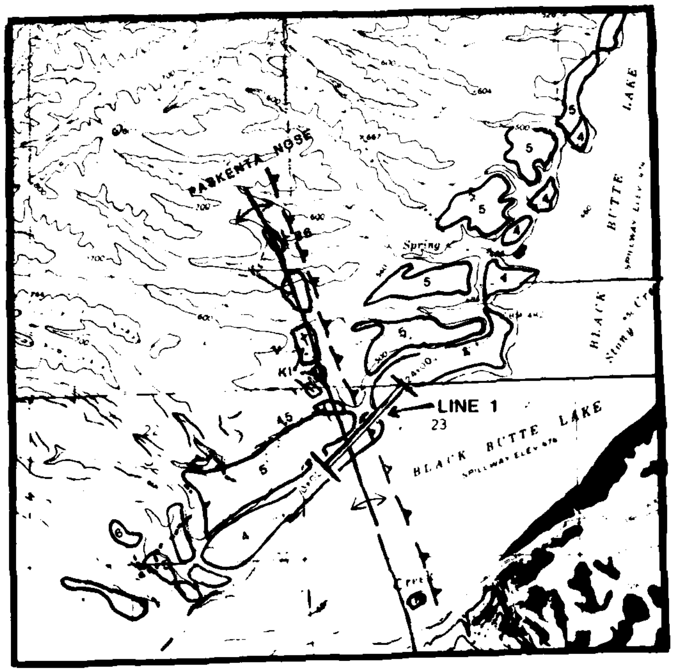
4

PLATE 9

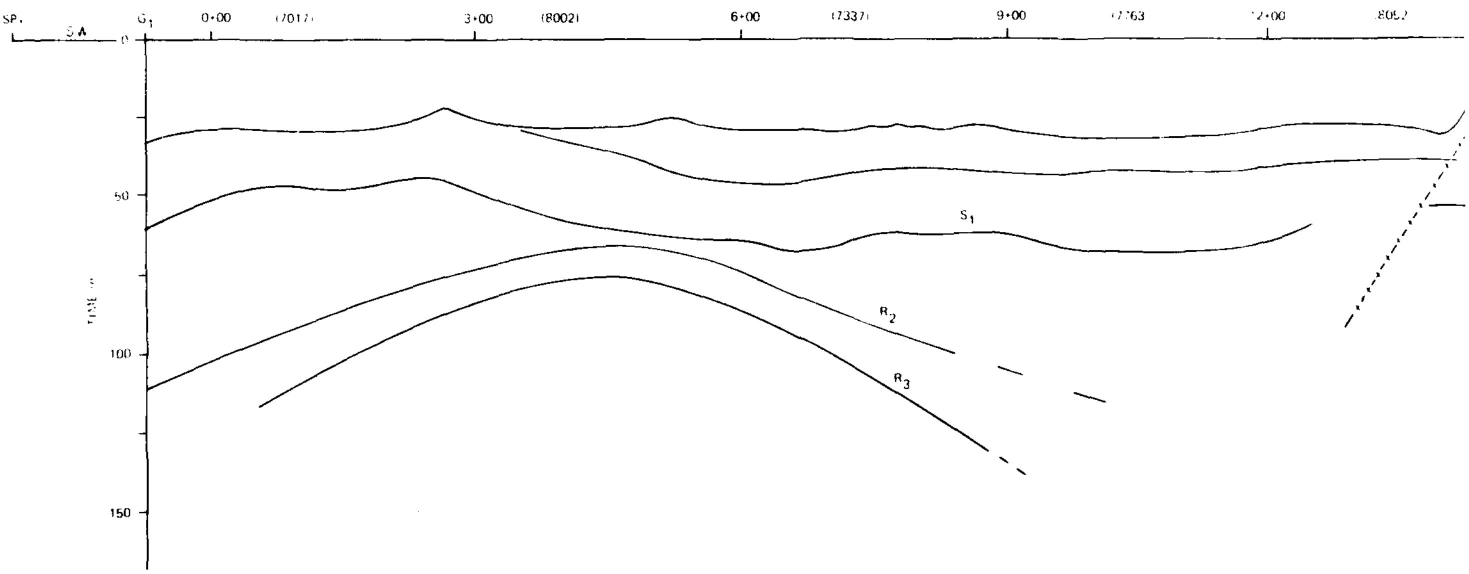
SEISMIC LINE 1 LOCATION

scale feet 4000

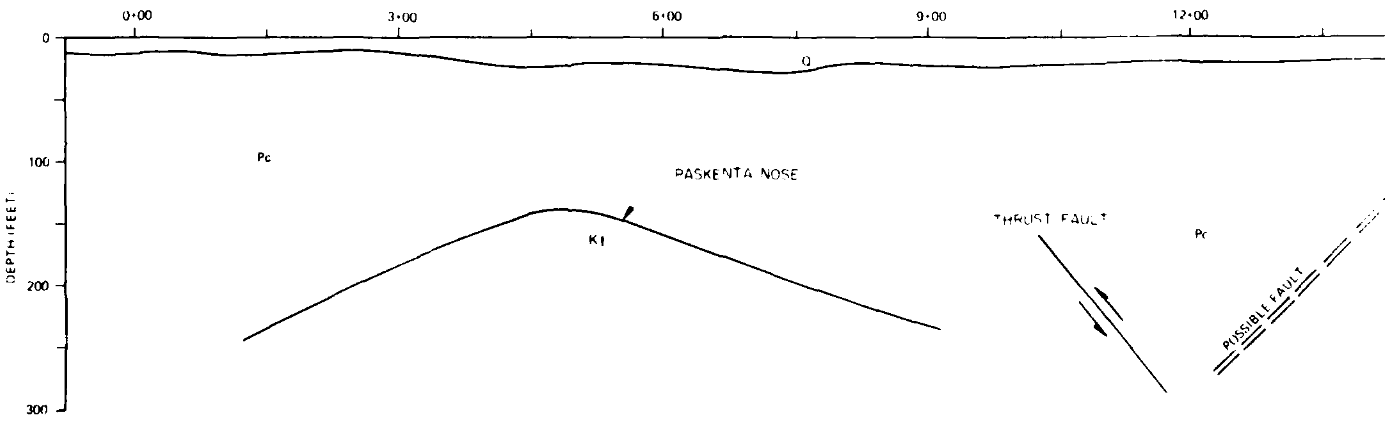
FOR LEGEND SEE MAP SHEET 1



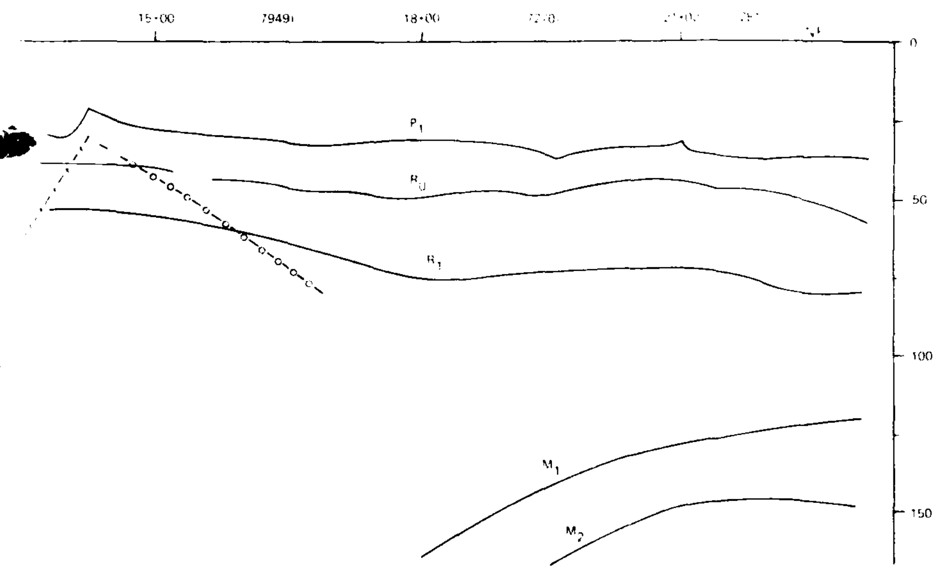
SEISMIC TIME SECTION



GEOLOGIC INTERPRETATION



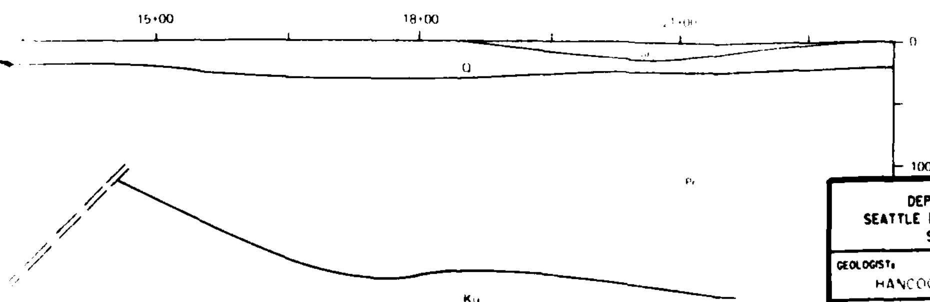
REVISIONS			



SEISMIC REFLECTION PROFILE ACQUIRED BY COMMON OFFSET METHOD

LINE SHOT BY
ENDACOTT & ASSOCIATES

SEISMIC VELOCITY
COMPRESSIONAL WAVE
SHEAR WAVE
RAYLEIGH WAVE
REFLECTED WAVE
o — o — DIFFRACTION
x — x — INFERRED FAULT PLANE



Q ALLUVIUM & COLLUVIUM
Qa ALLUVIAL CHANNEL
Pc TEHAMA FM
Ku CRETACEOUS, upper
Kl - CRETACEOUS, lower

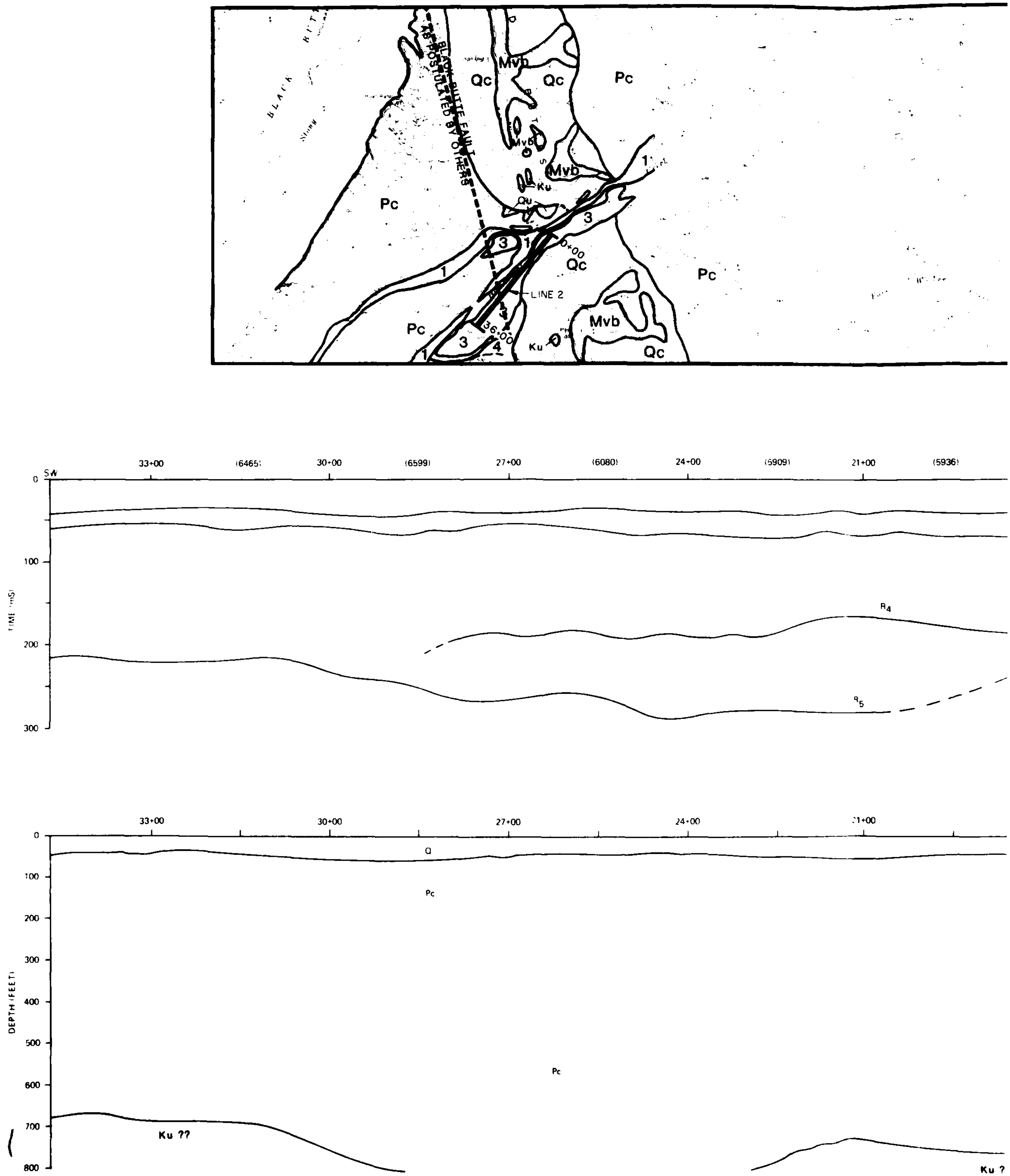
2

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

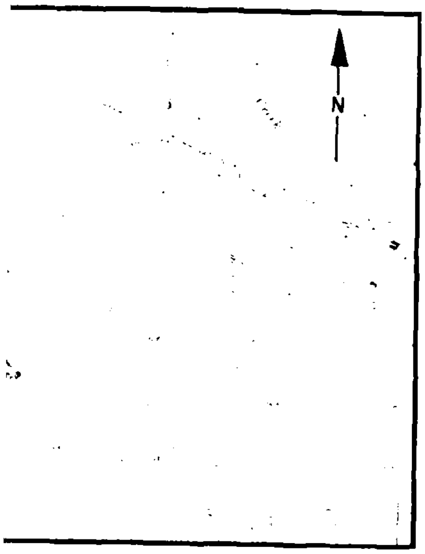
GEOLOGIST: HANCOCK DRAWN: ENDACOTT CHECKED: MANN	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **SHALLOW SEISMIC REFLECTION LINE 1**

SUBMITTED:	DATE APPROVED:	SCALE:	SPEC. NO.
[signature]	4/30/85	SHEET	FILE NO. SC-1-10-238

PLATE 10



BLACK BUTTE FAULT AS POSTULATED BY OTHERS
Qc
Mvb
Pc
Ku
LINE 2
0+00
36+00
SW
33+00
(6465)
30+00
(6599)
27+00
(6080)
24+00
(5909)
21+00
(5936)
TIME (mS)
R4
R5
DEPTH (FEET)
Q
Pc
Ku ??
Ku ?



SEISMIC LINE 2 LOCATION

2000 0 2000 4000

scale feet

FOR LEGEND SEE MAP SHEET 1

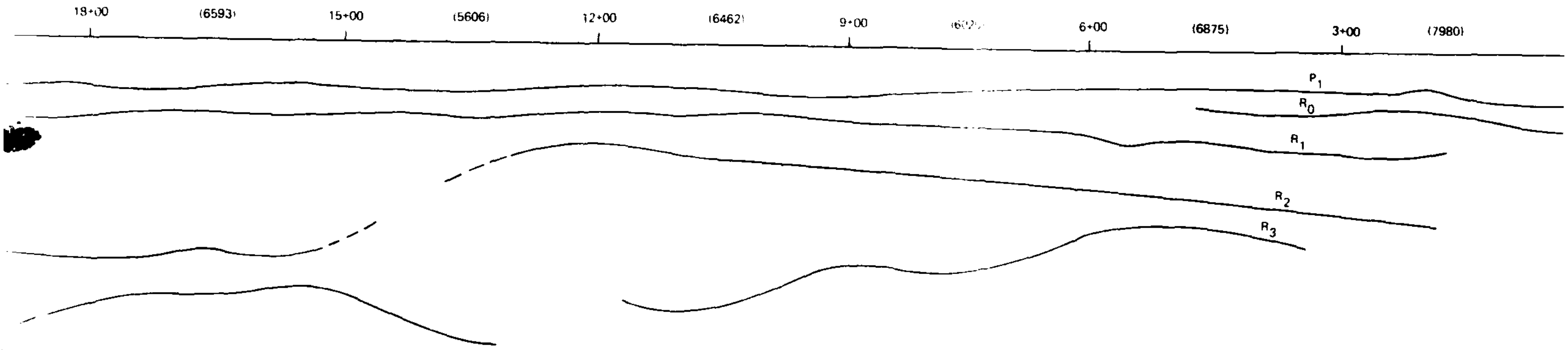
NOTE INFERRED POSITION OF BLACK BUTTE FAULT TAKEN FROM RUSSEL, 1931. SEISMIC LINE SPREADS ACROSS REPORTED POSITIONS BY H&H, 1982, JENNINGS, 1975, ESA, 1980, STEELE, 1979.

SEISMIC REFLECTION PROFILE ACQUIRED BY COMMON OFFSET METHOD.

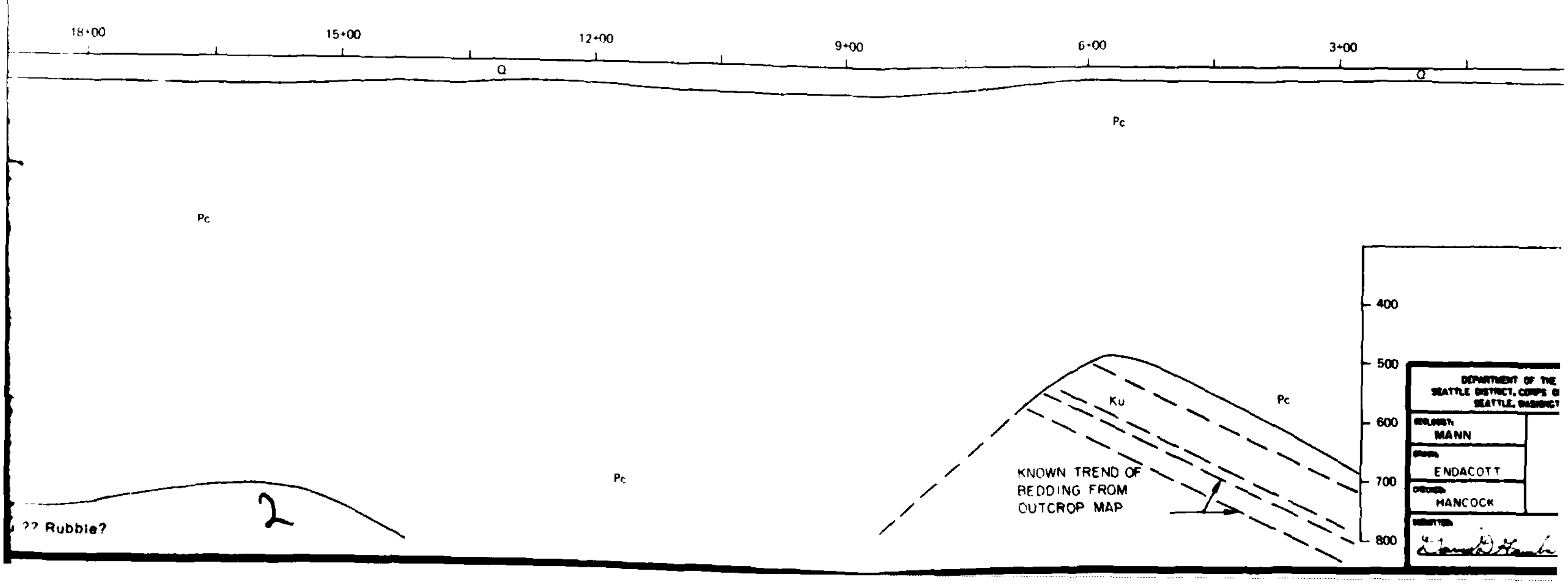
LINE SHOT BY:
ENDACOTT & ASSOCIATES

(7281) SEISMIC V
P_1 COMPRESS
S_1 SHEAR WA
M_1 RAYLEIGH
R_0 REFLECTE
o—o— DIFFRACT
x—x— INFERRED

SEISMIC TIME SECTION



GEOLOGIC INTERPRETATION



DEPARTMENT OF THE ...
SEATTLE DISTRICT, CORPS OF ...
SEATTLE, WASHINGT...

GEOLOGIST: MANN

DRAWN: ENDACOTT

CHECKED: HANCOCK

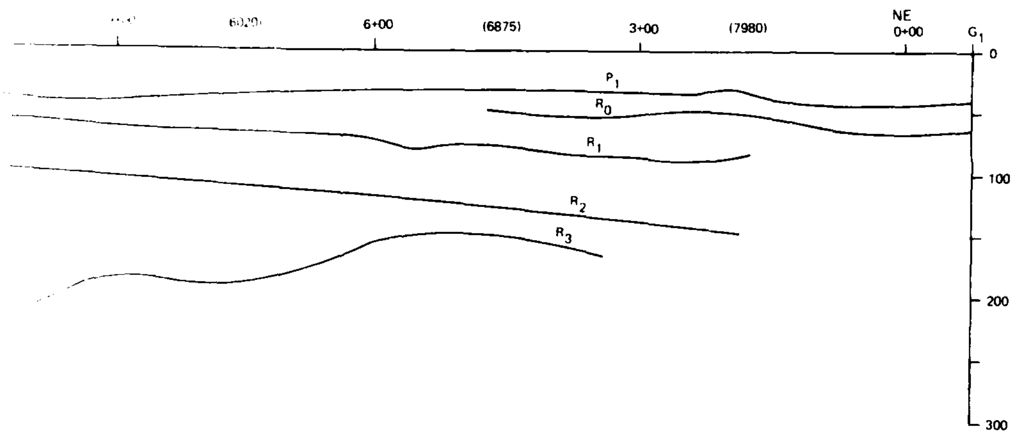
SUBMITTED:

NOTE INFERRED POSITION OF BLACK BUTTE FAULT TAKEN FROM RUSSEL, 1931 SEISMIC LINE SPREADS ACROSS REPORTED POSITIONS BY H&H, 1982, JENNINGS, 1975, ESA, 1980, STEELE, 1979.

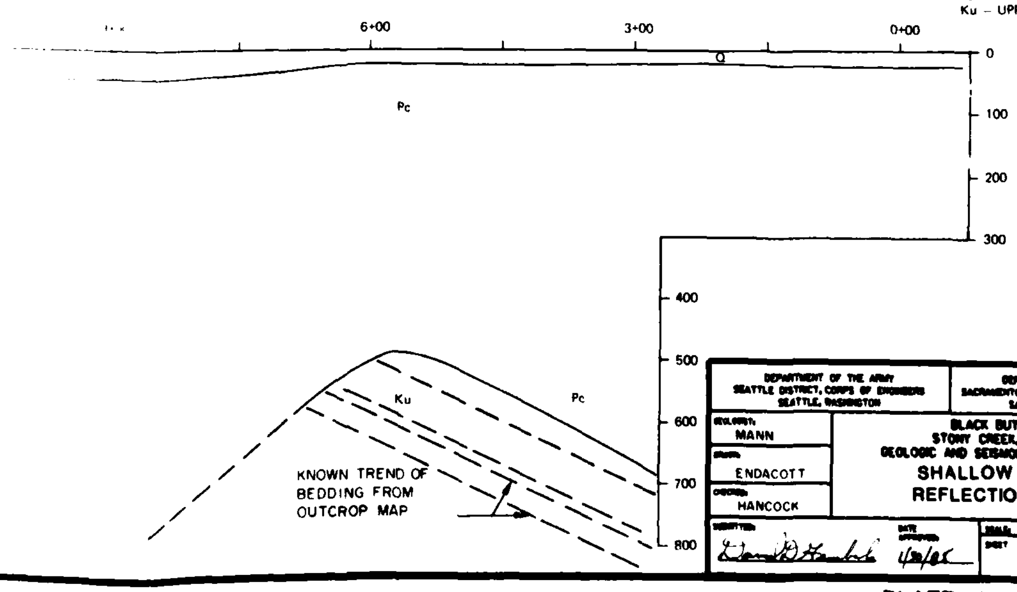
SEISMIC REFLECTION PROFILE ACQUIRED BY COMMON OFFSET METHOD.

LINE SHOT BY: ENDACOTT & ASSOCIATES

(7281)	SEISMIC VELOCITY (fps)
P_1	COMPRESSIONAL WAVE
S_1	SHEAR WAVE
M_1	RAYLEIGH WAVE
R_0	REFLECTED WAVE
o—o—	DIFFRACTION
x—x—	INFERRED FAULT PLANE



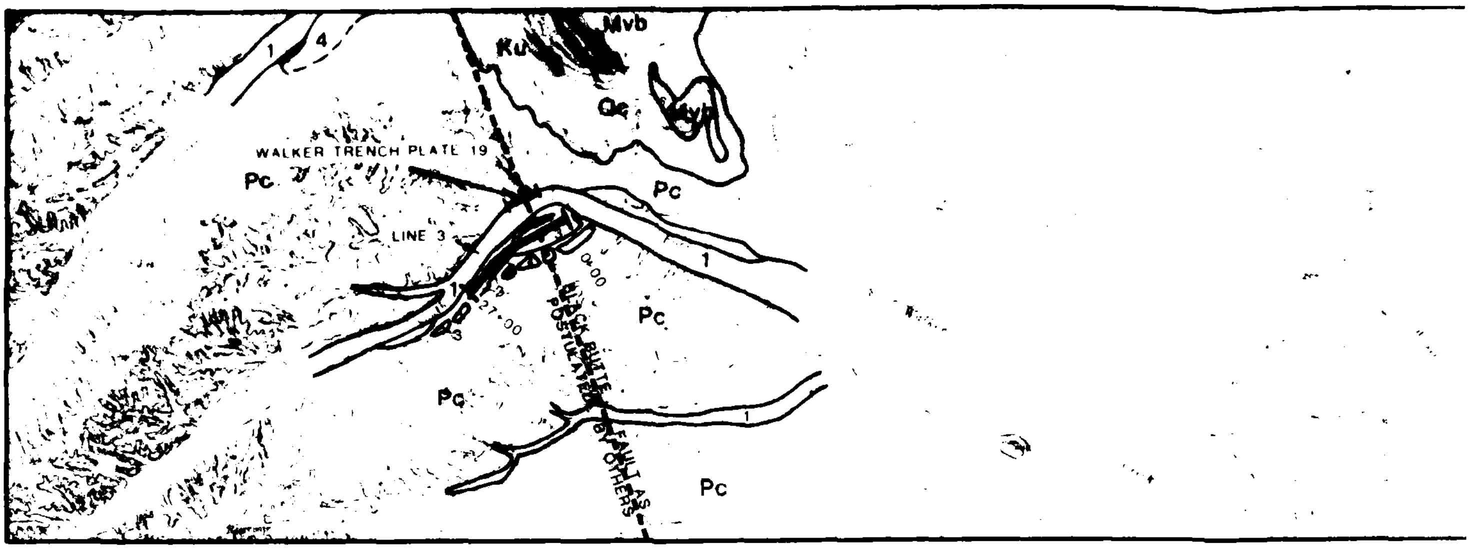
Q – ALLUVIUM & COLLUVIUM
Pc – TEHAMA FM.
Ku – UPPER CRETACEOUS



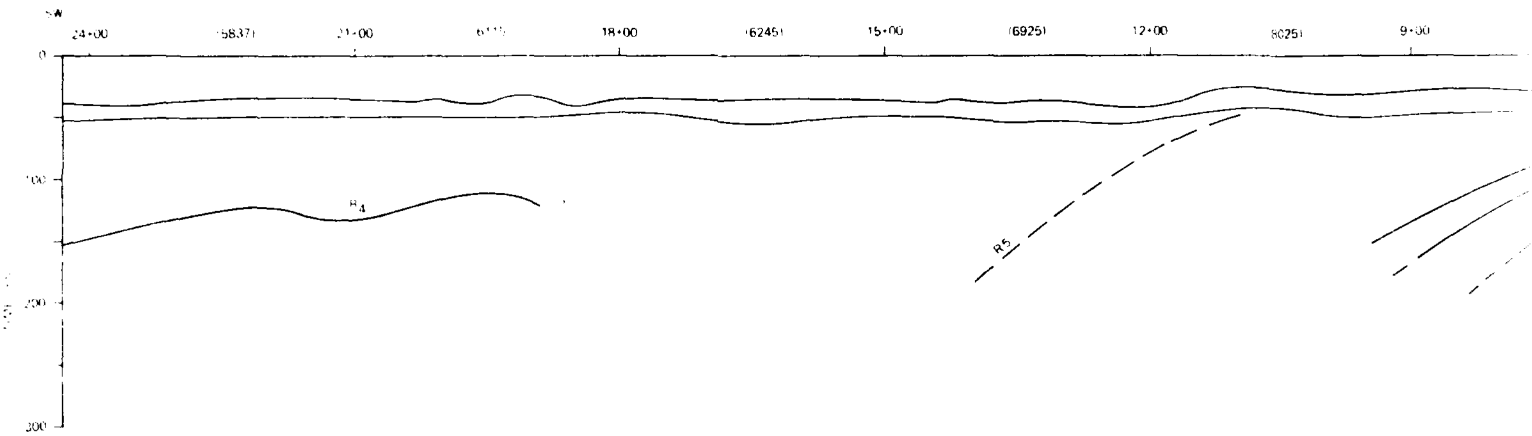
DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: MANN	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION
DRAWN: ENDACOTT	**SHALLOW SEISMIC REFLECTION LINE 2**
CHECKED: HANCOCK	
SUBMITTED: [signature] DATE APPROVED: 4/?/85	SCALE: SPEC. NO.: SHEET: FILE NO. SC-1-10-238

3

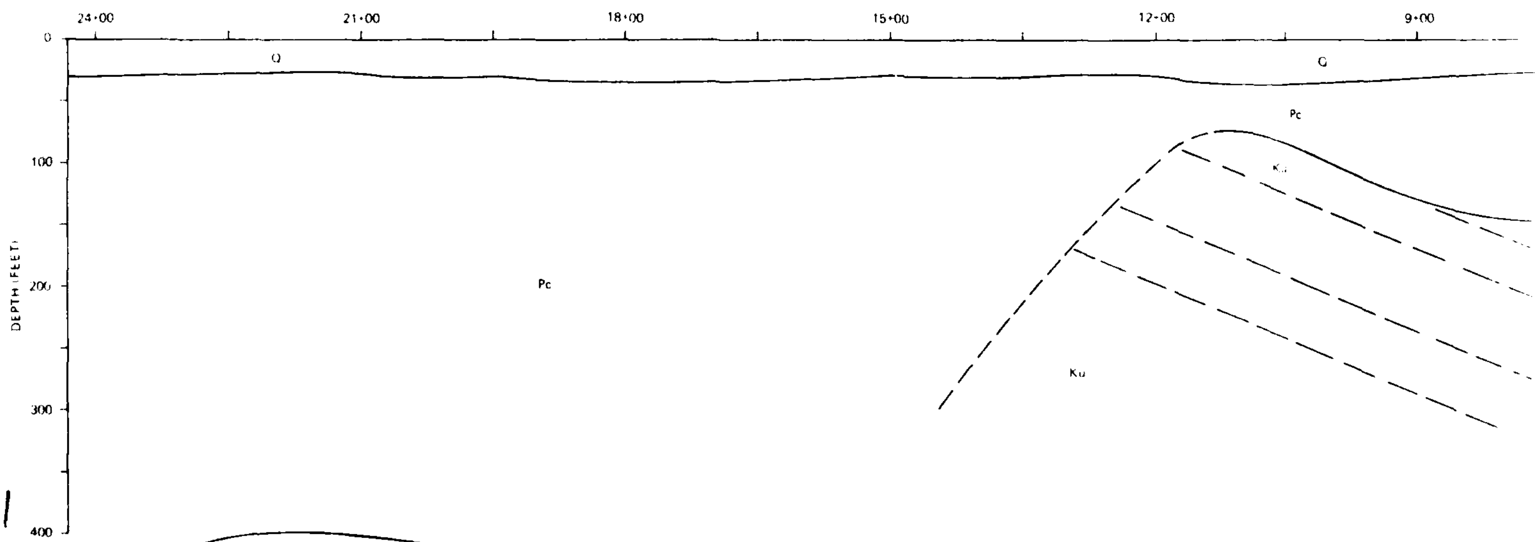
PLATE 11



SEISMIC TIME SECTION



GEOLOGIC INTERPRETATION



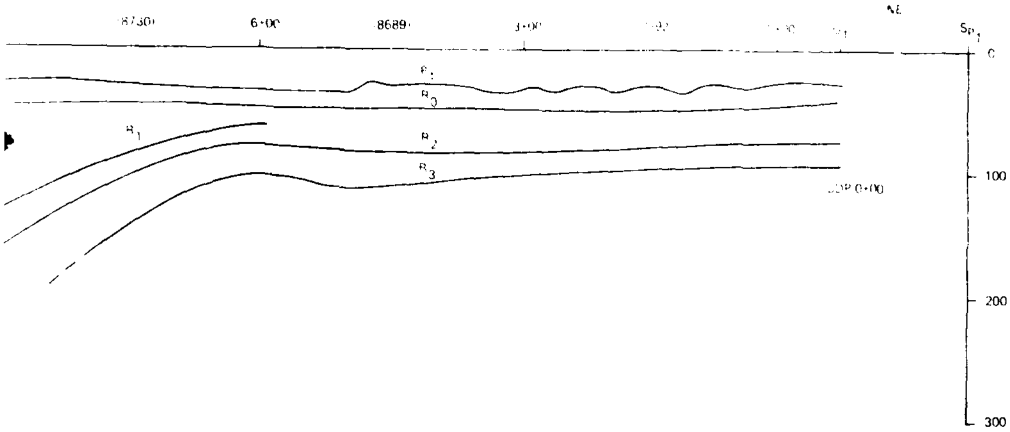
REVISIONS

SEISMIC LINE 3 LOCATION

2000 0 2000 4000

scale feet

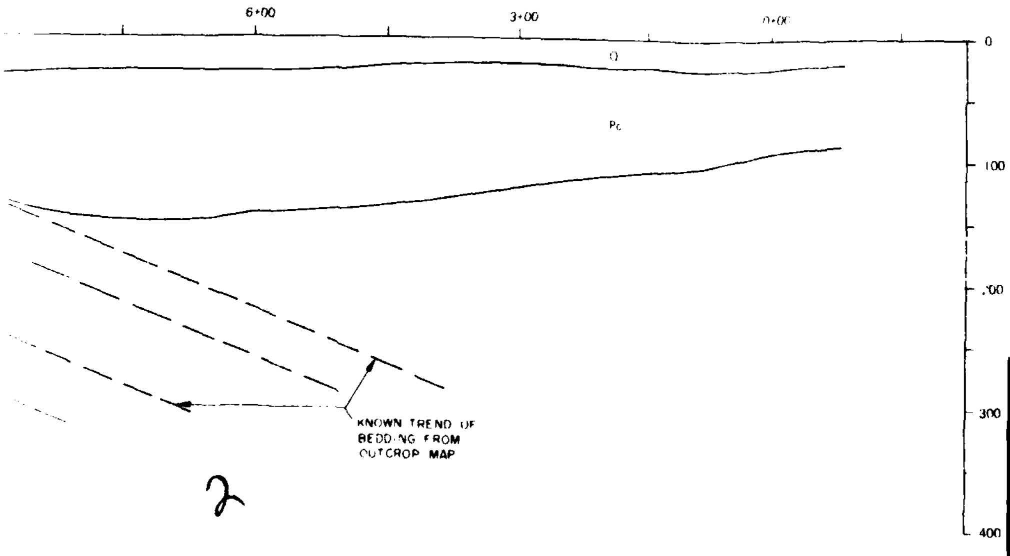
FOR LEGEND SEE MAP SHEET 1
REFER TO PLATE 19
for WALKER TRENCH



SEISMIC REFLECTION PROFILE ACQUIRED USING THE COMMON OFFSET METHOD

LINE SHOT BY
ENDACOTT & ASSOCIATES

(7281)	SEISMIC VELOCITY (fps)
P_1	COMPRESSIONAL WAVE
S_1	SHEAR WAVE
M_1	RAYLEIGH WAVE
R_0	REFLECTED WAVE
— o — o —	DIFFRACTION
x—x—x—	INFERRED FAULT PLANE



Q ALLUVIUM & COLLUVIUM
Pc TEHAMA FM.
Ku UPPER CRETACEOUS

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SEATTLE, WASHINGTON

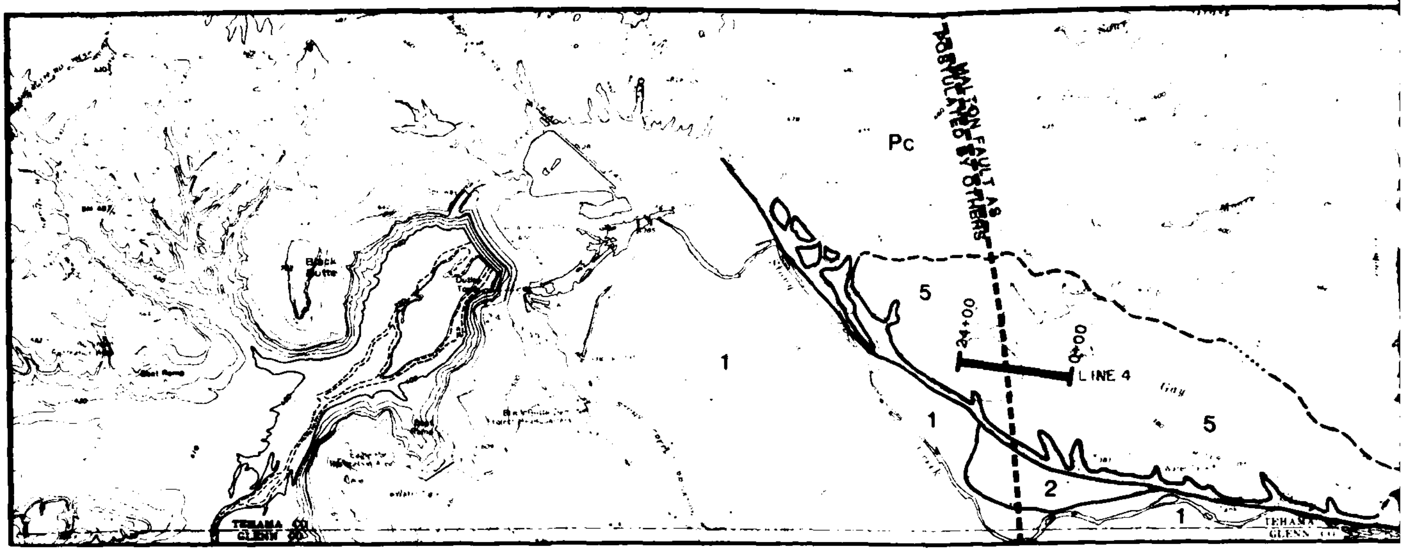
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

GEOLOGIST: MANN
DRAWN: ENDACOTT
CHECKED: HANCOCK

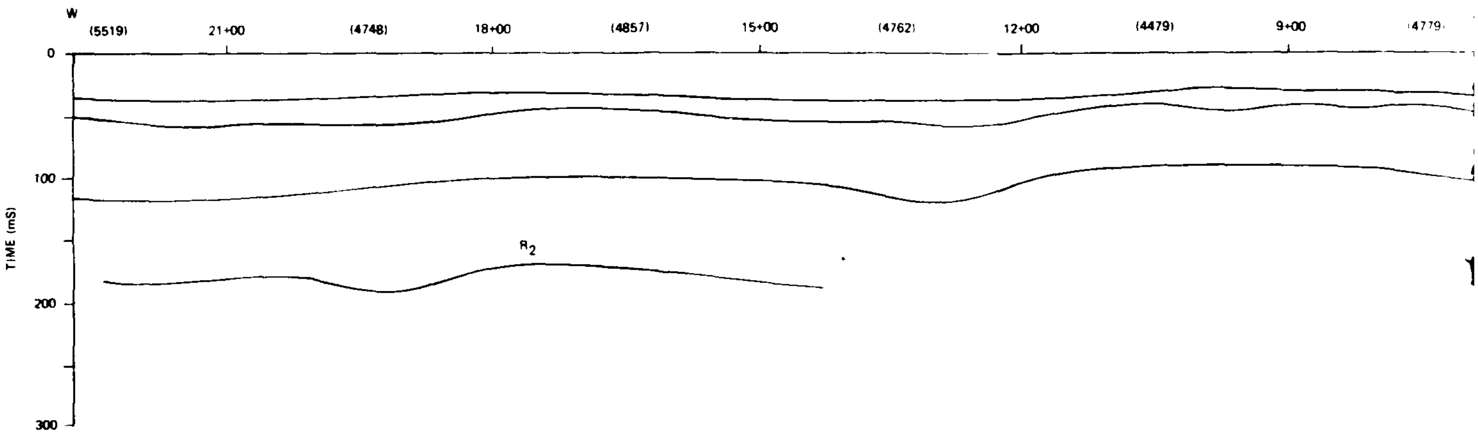
BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA
GEOLOGIC AND SEISMOLOGIC INVESTIGATION
SHALLOW SEISMIC REFLECTION
LINE 3

SUBMITTED: [signature]
DATE APPROVED: 1/30/85
SCALE:
SPEC. NO.
SHEET
FILE NO. SC-1-10-238

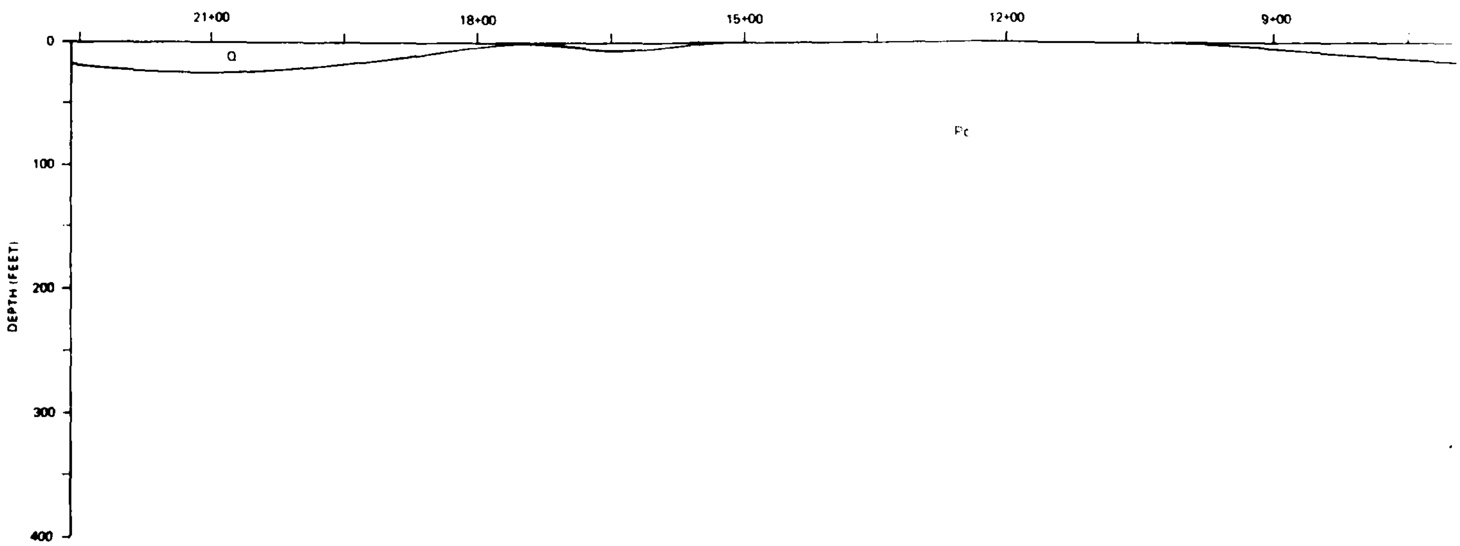
PLATE 12



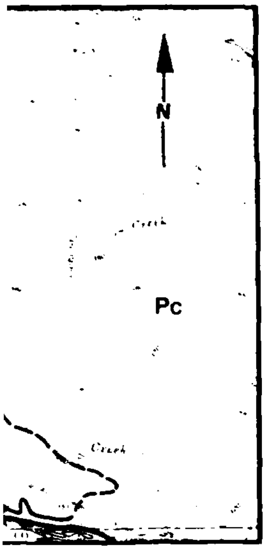
SEISMIC TIME SECTION



GEOLOGIC INTERPRETATION



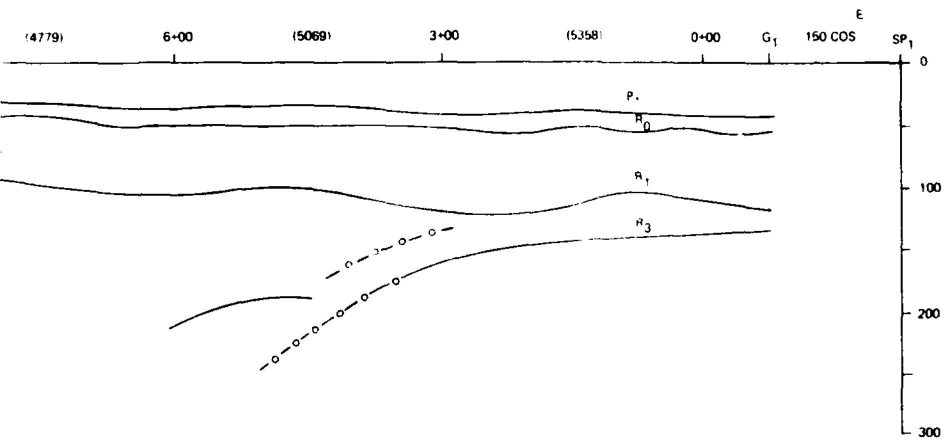
REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



SEISMIC LINE 4 LOCATION

2000 0 2000 4000
scale feet

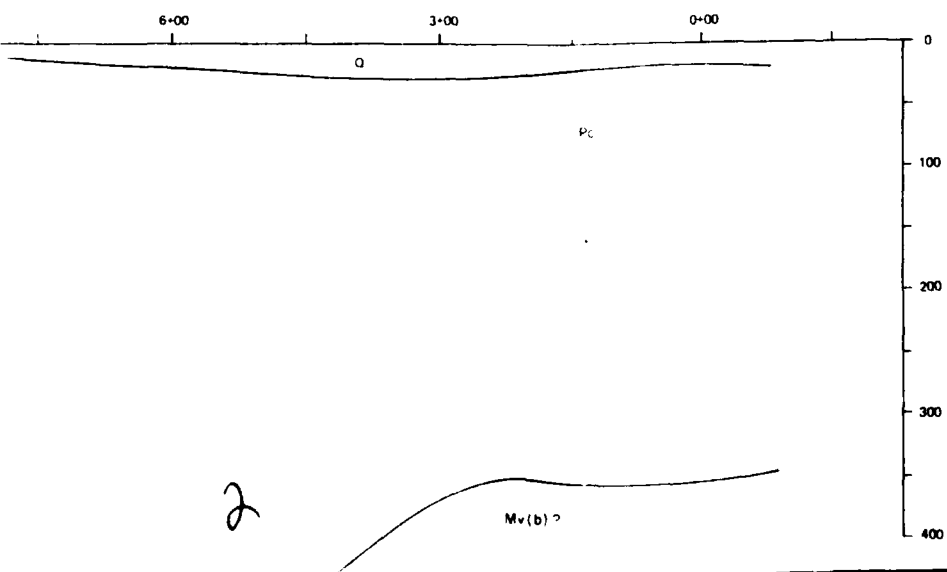
FOR LEGEND SEE MAP SHEET 1



SEISMIC REFLECTION PROFILE ACQUIRED USING THE COMMON OFFSET METHOD

LINE SHOT BY
ENDACOTT & ASSOCIATES

(7281) SEISMIC VELOCITY (fps)
P_1 COMPRESSIONAL WAVE
S_1 SHEAR WAVE
M_1 RAYLEIGH WAVE
R_0 REFLECTED WAVE
o—o—o— DIFFRACTION
x— x— x— INFERRED FAULT PLANE
REFLECTED WAVE



Q - ALLUVIUM & COLLUVIUM
Pc - TEHAMA FM.
Mv(b) - BASALT RUBBLE OVER BLACK BUTTE Fm - (Tpb AND Tpbbm - S OF PLATE 9)

SCALE: AS SHOWN

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SEATTLE, WASHINGTON

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

GEOLOGIST: HANCOCK
DRAWN: ENDACOTT
CHECKED: MANN

BLACK BUTTE LAKE
STONY CREEK, CALIFORNIA
GEOLOGIC AND SEISMOLOGIC INVESTIGATION
SHALLOW SEISMIC REFLECTION
LINE 4

SUBMITTED: [signature] DATE APPROVED: 1/30/85

FILE NO. SC-1-10-238

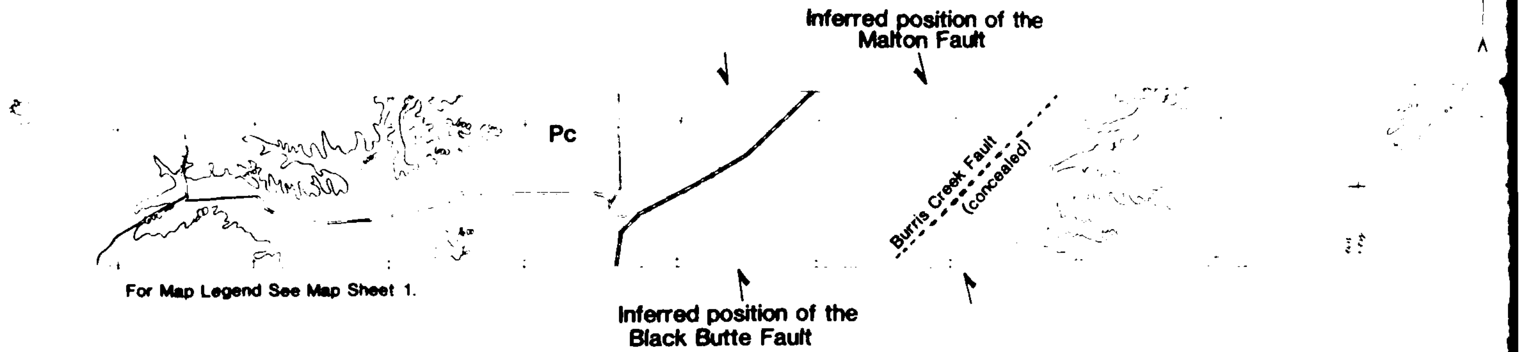
PLATE 13

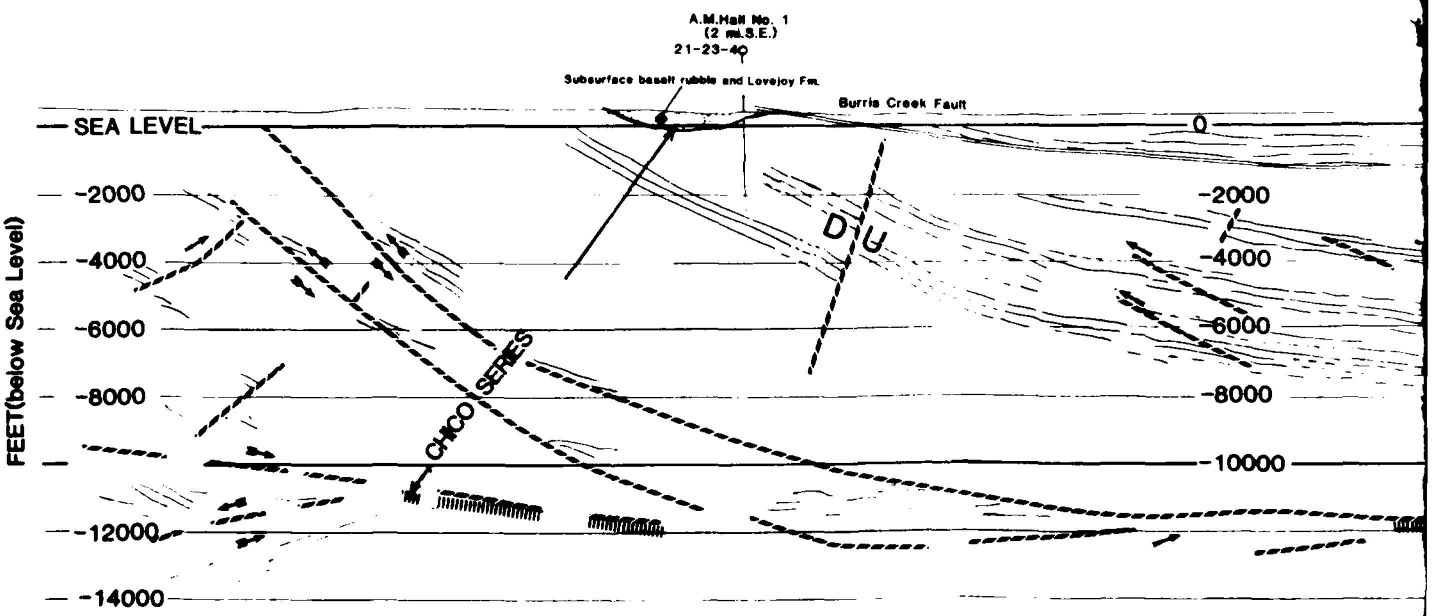
0 2000 4000

Approximate scale in feet.

Contour interval in Feet.

Map strip location shown on Plate 6





Seismic section constructed from geology, well and reflection data located along several mile corridor either side of the center of map shown above.

Exact location of reflection data not shown due to proprietary nature and lending agreements.

Horizontal to vertical scale has 1.2 V. to 1 H. exaggeration.

Section Le

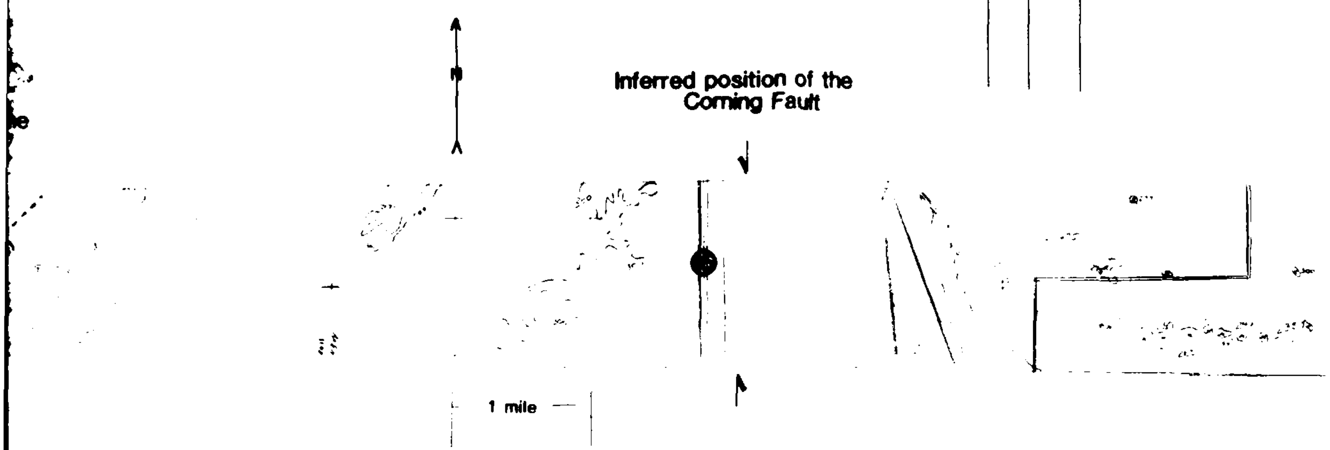
Ac

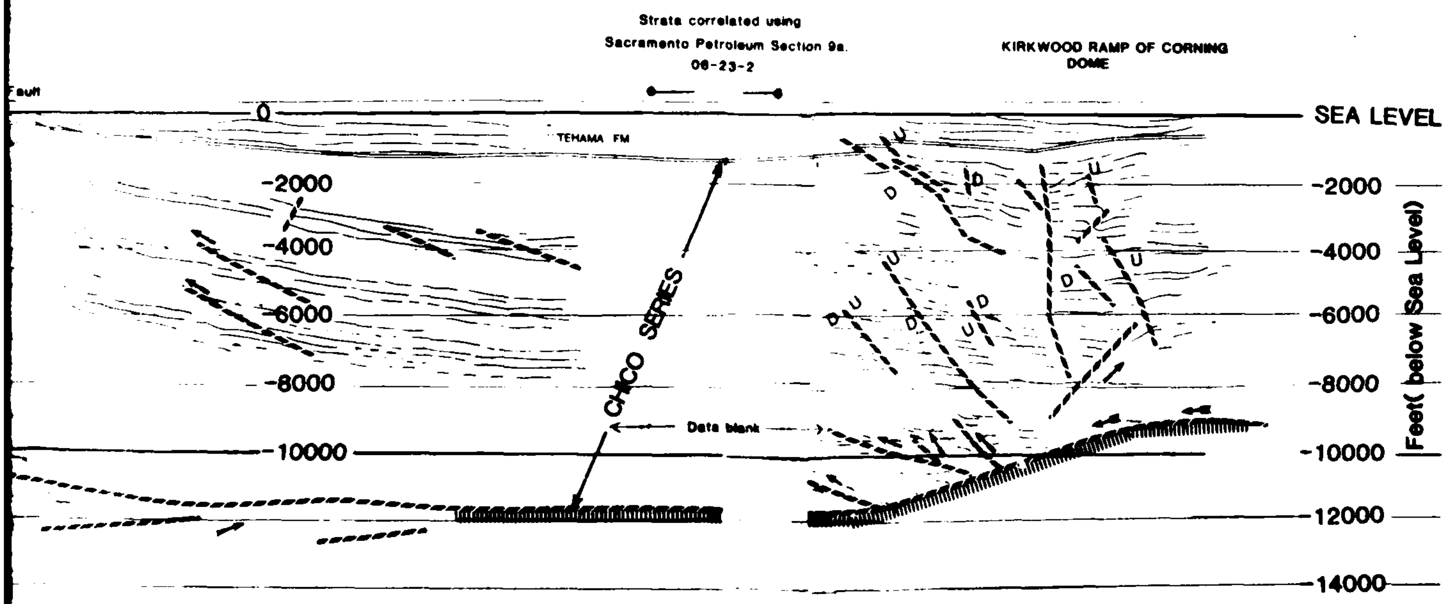
Th

Se

mi

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY





several mile corridor

agreements.

Section Legend

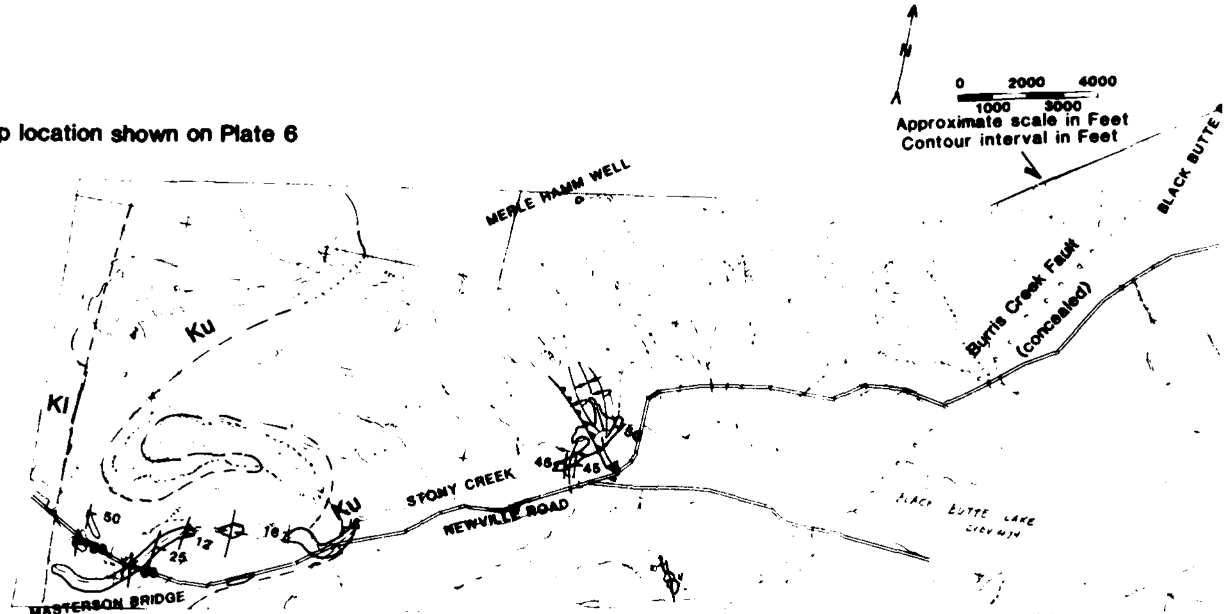
- Acoustical basement
- Thrust detachment or High angle fault
- Sense of movement
- migrated reflector

∂

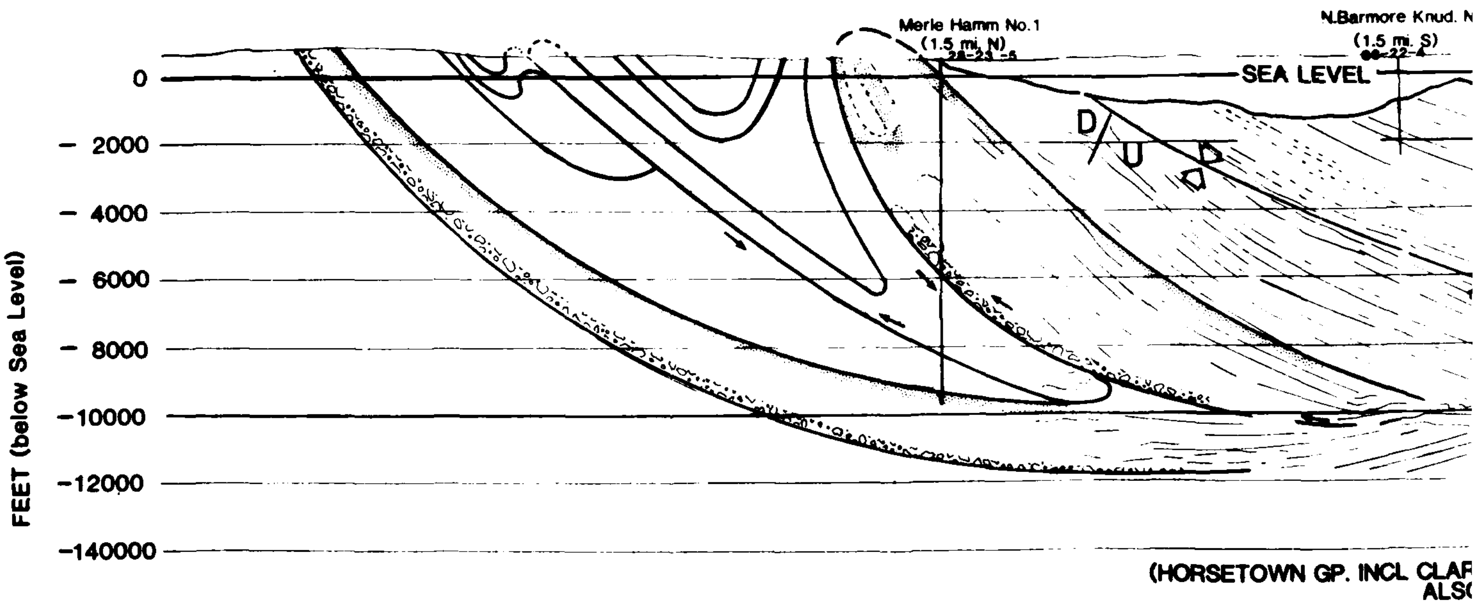
DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: HANCOCK DRAWN: JOHNSTON CHECKED: INTERPRETATIVE	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION LONG HOLLOW SEISMIC-GEOLOGIC SECTION
SUBMITTED: [signature] DATE APPROVED: 11/85	SCALE: SPEC. NO. SHEET FILE NO. SC-I-10-238

PLATE 14

Map strip location shown on Plate 6

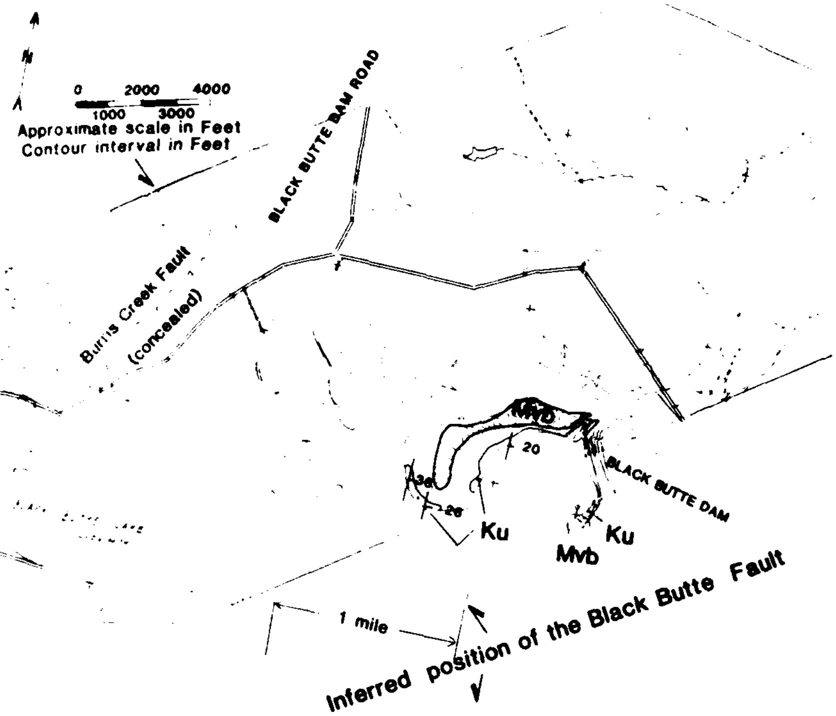


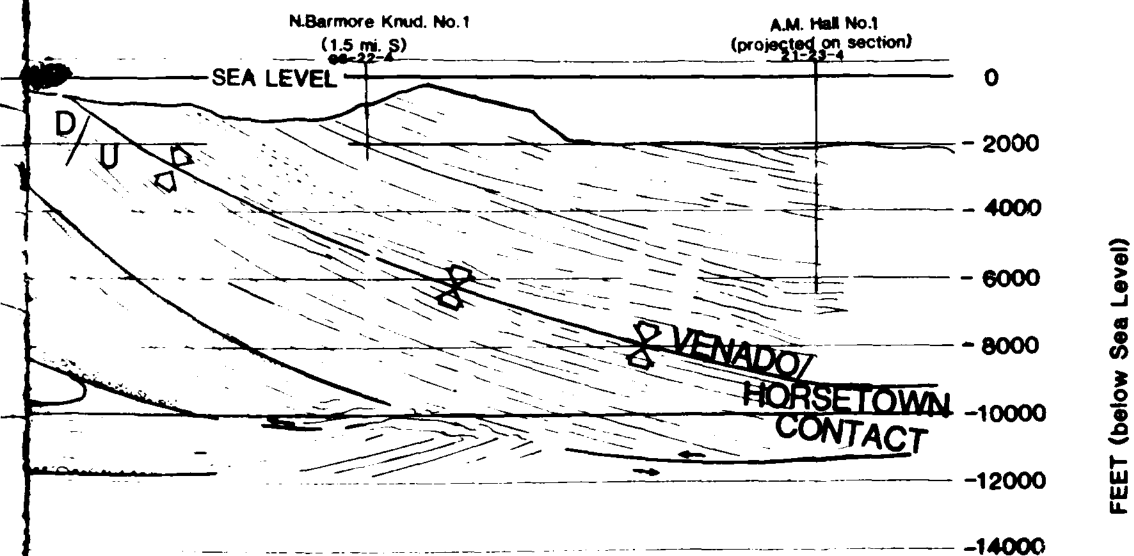
For Map Legend See Map Sheet 1



Seismic section constructed from geology, well and reflection data located along several mile corridor either side of the center of map shown above.
Exact location of reflection data not shown due to proprietary nature and lending agreements.
Horizontal to vertical ratio approx. 1:1

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY





(HORSETOWN GP. INCL CLARKVALLEY MUDSTONE AND JULIAN ROCKS FM.)
ALSO LISTED AS BOXER FORMATION

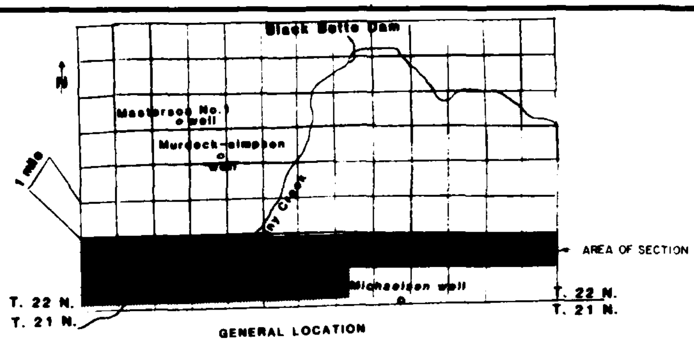
mile corridor
ts.

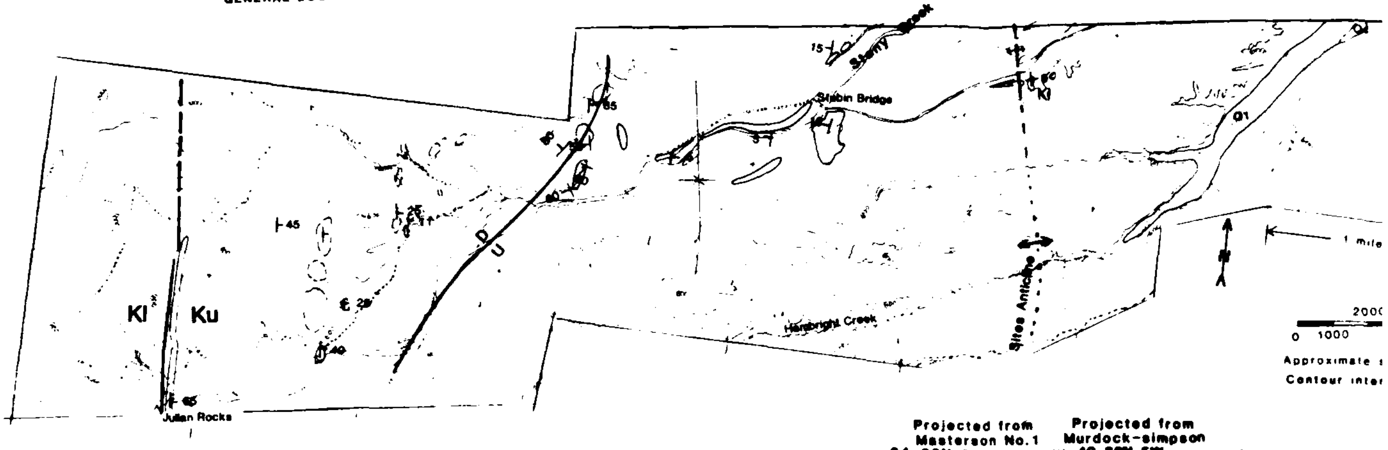
SEE PLATE 4 FOR SECTION LEGEND

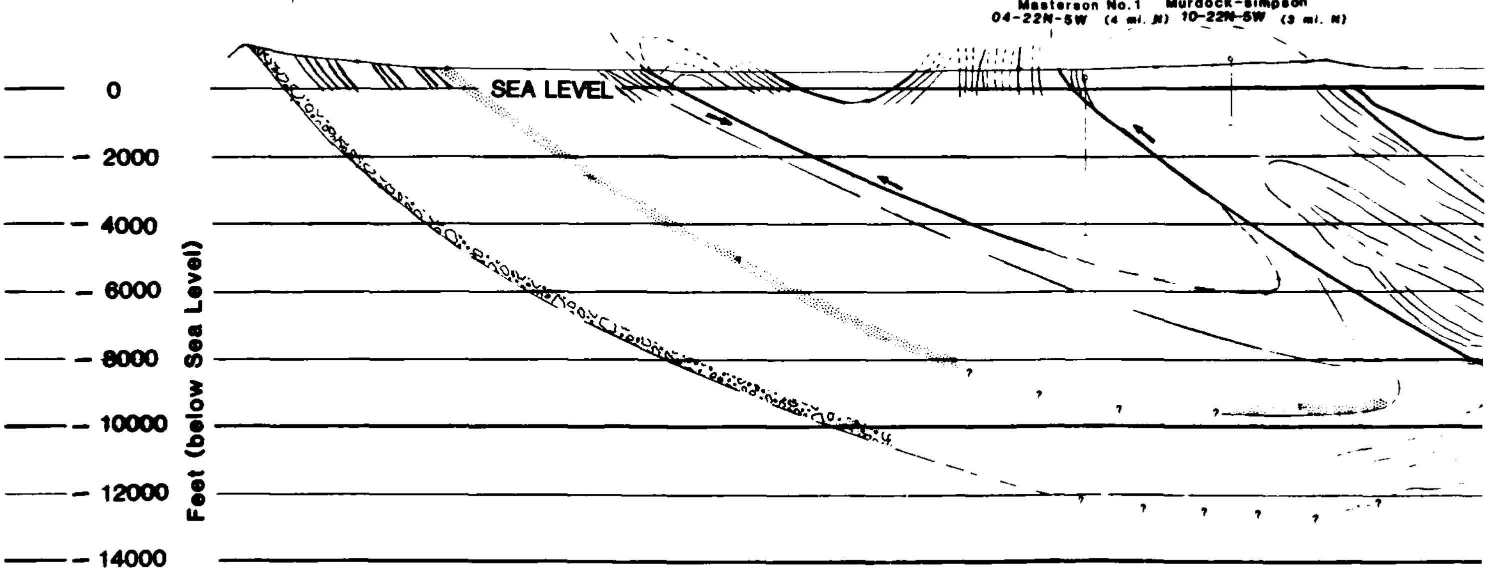
7

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: HANCOCK DRAWN: HANCOCK CHECKED: INTERPRETATIVE	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION HAM BRIDGE TO BLACK BUTTE SEISMIC-GEOLOGIC SECTION
SUBMITTED: [signature] DATE APPROVED: 4/20/85	SCALE: SPEC. NO.: SHEET: FILE NO. SC-1-10-238

PLATE 15

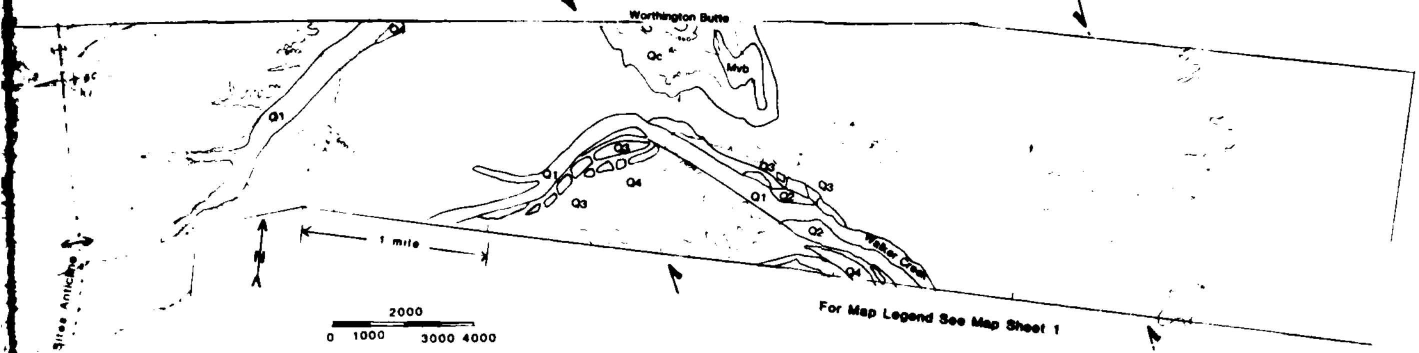


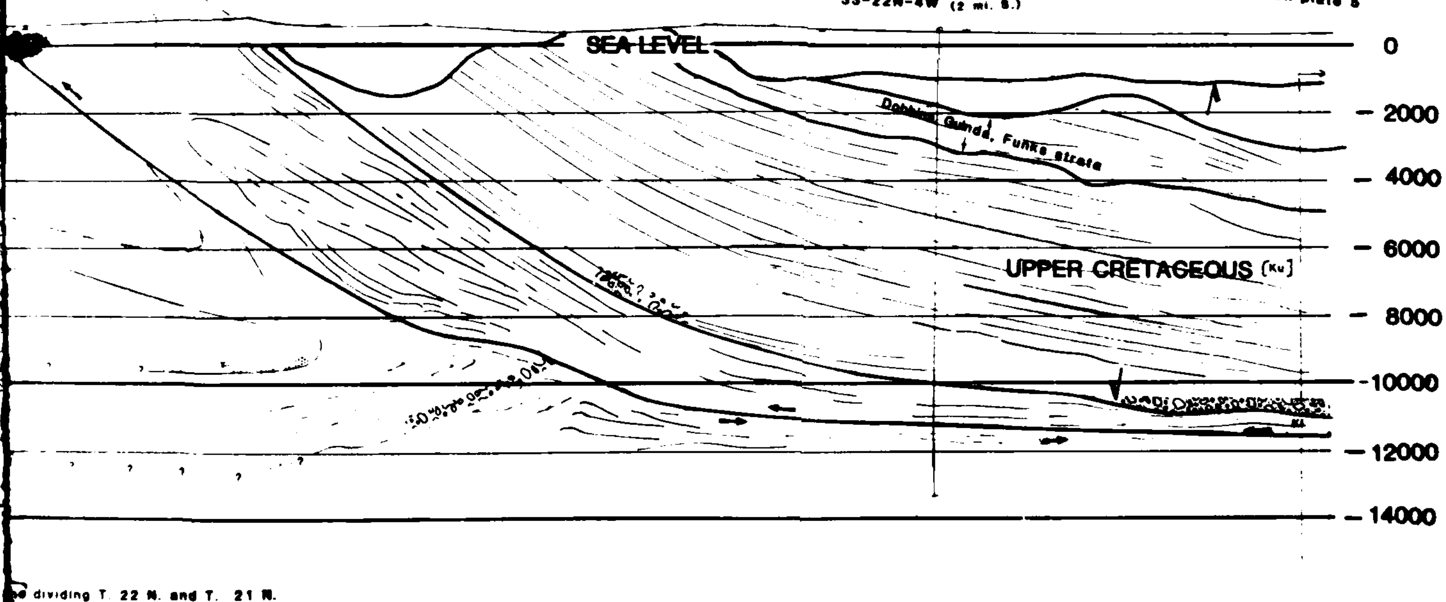




Seismic section constructed from geology, well and reflection data located along a several mile corridor near the range line dividing T. 22 N. and T. 21 N.
Exact location of reflection data not shown due to proprietary nature and lending agreements.
Horizontal to vertical ratio approx. 1:1

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY





dividing T. 22 N. and T. 21 N.

SEE PLATE 14 FOR SECTION LEGEND

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGY: HANCOCK	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION
DRAWN: HANCOCK	STUBIN BRIDGE TO WALKER CREEK SEISMIC-GEOLOGIC SECTION
CHECKED: INTERPRETATIVE	
SUBMITTED: [signature]	DATE APPROVED: 1/20/83 · SHEET · FILE NO. SC-1-10-238

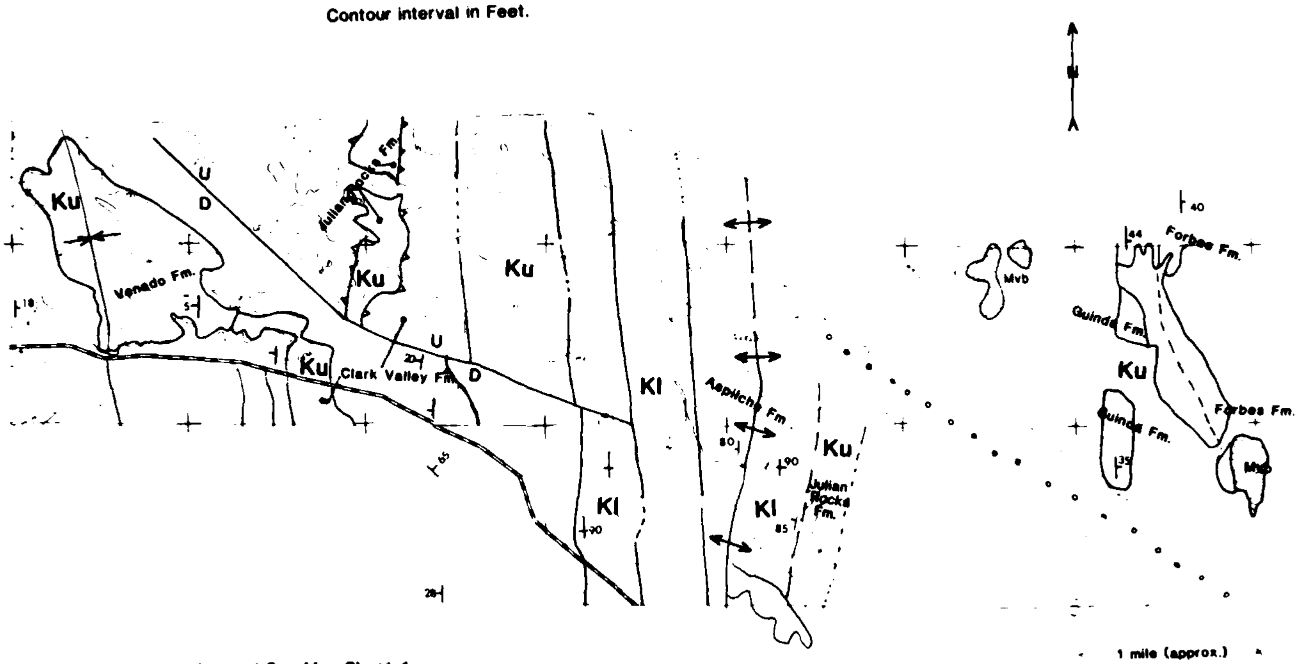
2

PLATE 16

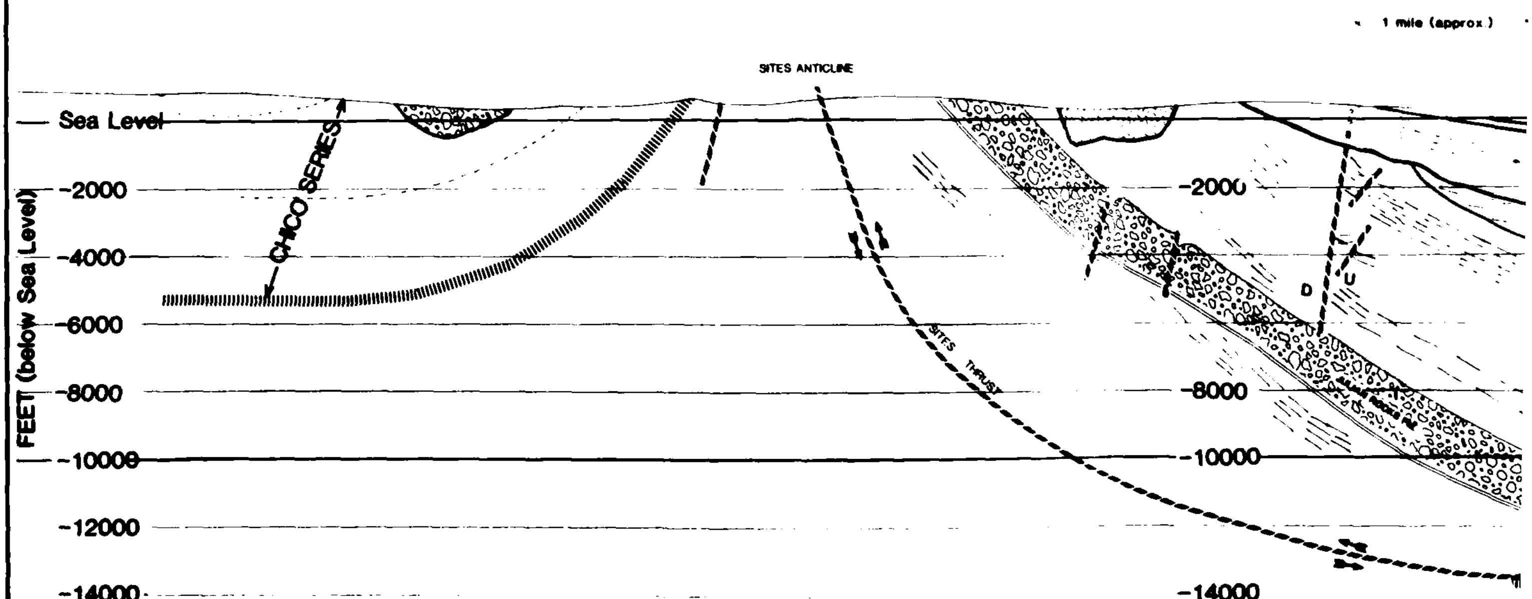
0 2000 4000
1000 3000

Approximate scale in feet varies thru record length.

Contour interval in Feet.

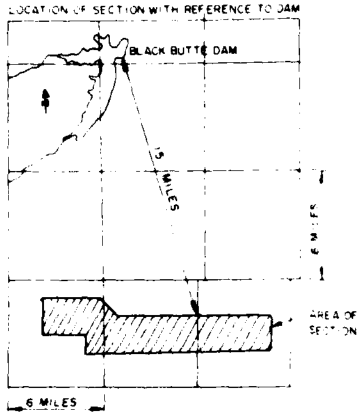


For Map Legend See Map Sheet 1.

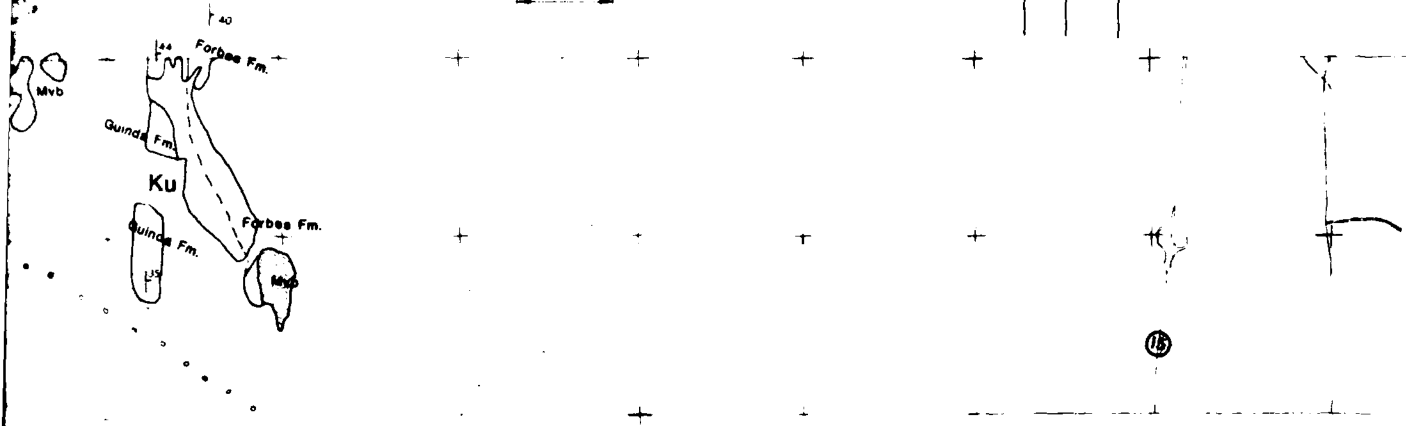


Seismic section constructed from geology, well and reflection data located along several mile corridor either side of the center of map shown above.
Exact location of reflection data not shown due to proprietary nature and lending agreements.
Horizontal to vertical scale approx. 1:1.

LOCATION OF SECTION WITH REFERENCE TO DAM



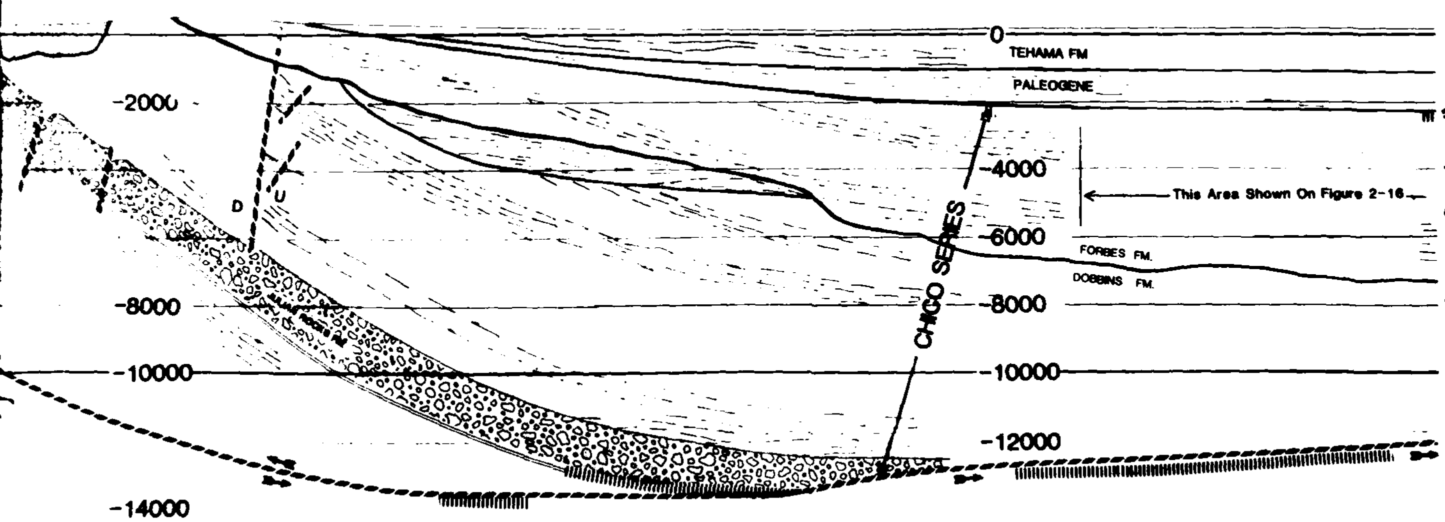
REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



1 mile (approx.) 1 mile (approx.) 1 mile (approx.) 1 mile (approx.)

HORIZONTAL SCALE VARIES ON SECTION

1 mile (approx.) 1 mile (approx.) 1 mile (approx.)

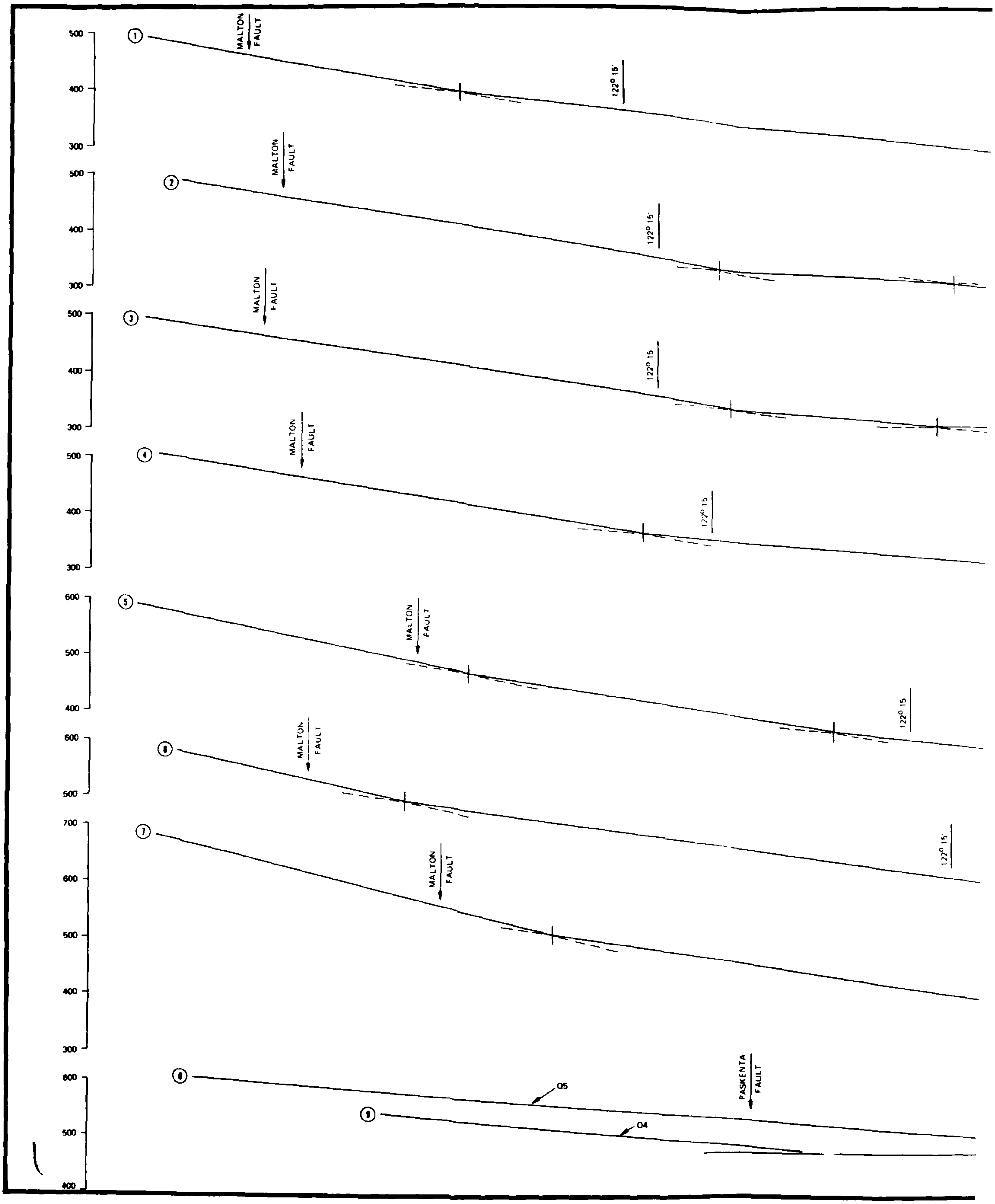


SEE PLATE 14 FOR SECTION LEGEND

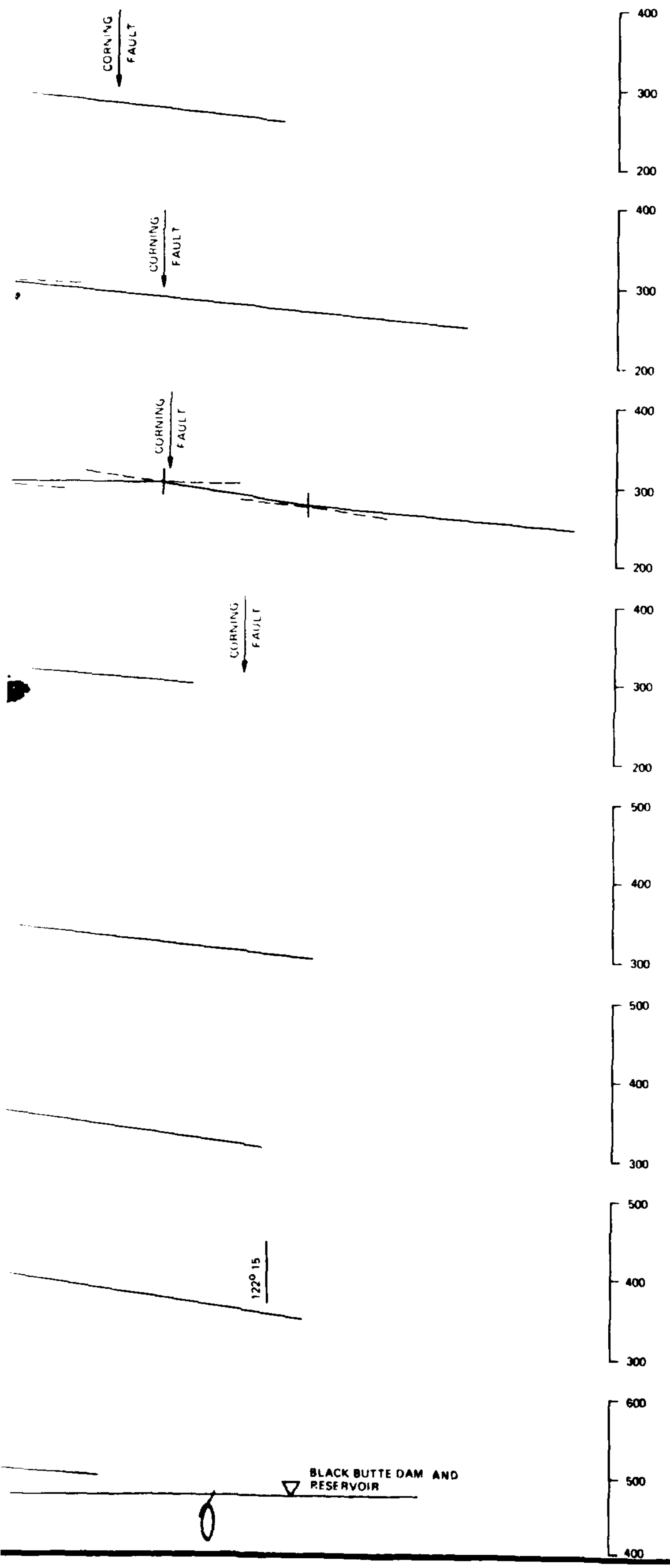
DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: HANCOCK & JOHNSON DRAWN: HANCOCK CHECKED: INTERPRETATIVE	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **HAYES-BURNELL SEISMIC-GEOLOGIC SECTION**
SUBMITTED: [signature] DATE APPROVED: 1/30/85	SCALE: SPEC. NO. SHEET FILE NO. SC-1-10-238

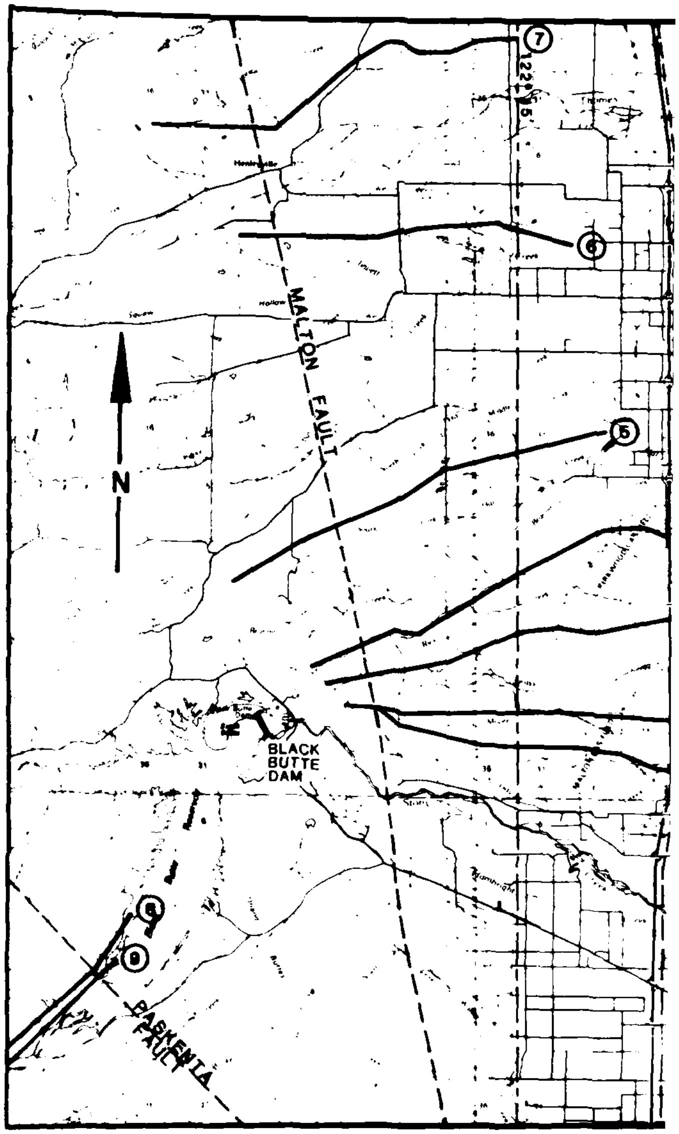
2

PLATE 17



500
400
300
1
MALTON FAULT
122° 15'
500
400
300
2
MALTON FAULT
122° 15'
500
400
300
3
MALTON FAULT
122° 15'
500
400
300
4
MALTON FAULT
122° 15'
600
500
400
5
MALTON FAULT
122° 15'
600
500
6
MALTON FAULT
122° 15'
700
600
500
400
300
7
MALTON FAULT
600
500
400
8
Q5
9
Q4
PASKENTA FAULT





PROFILE LOCATION MAP

SCALE 1:100,000

0 1 2 3 4 5
MILES

NOTES

DATA FOR PROFILES 1 THROUGH 9 WERE TAKEN FROM 1:24,000 QUADRANGLE MAPS

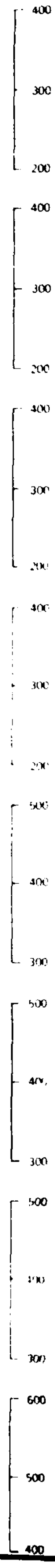
PROFILES 1 THROUGH 7 ARE PLOTTED ON AN EAST WEST SECTION WITH THE DATA PROJECTED INTO THAT SECTION

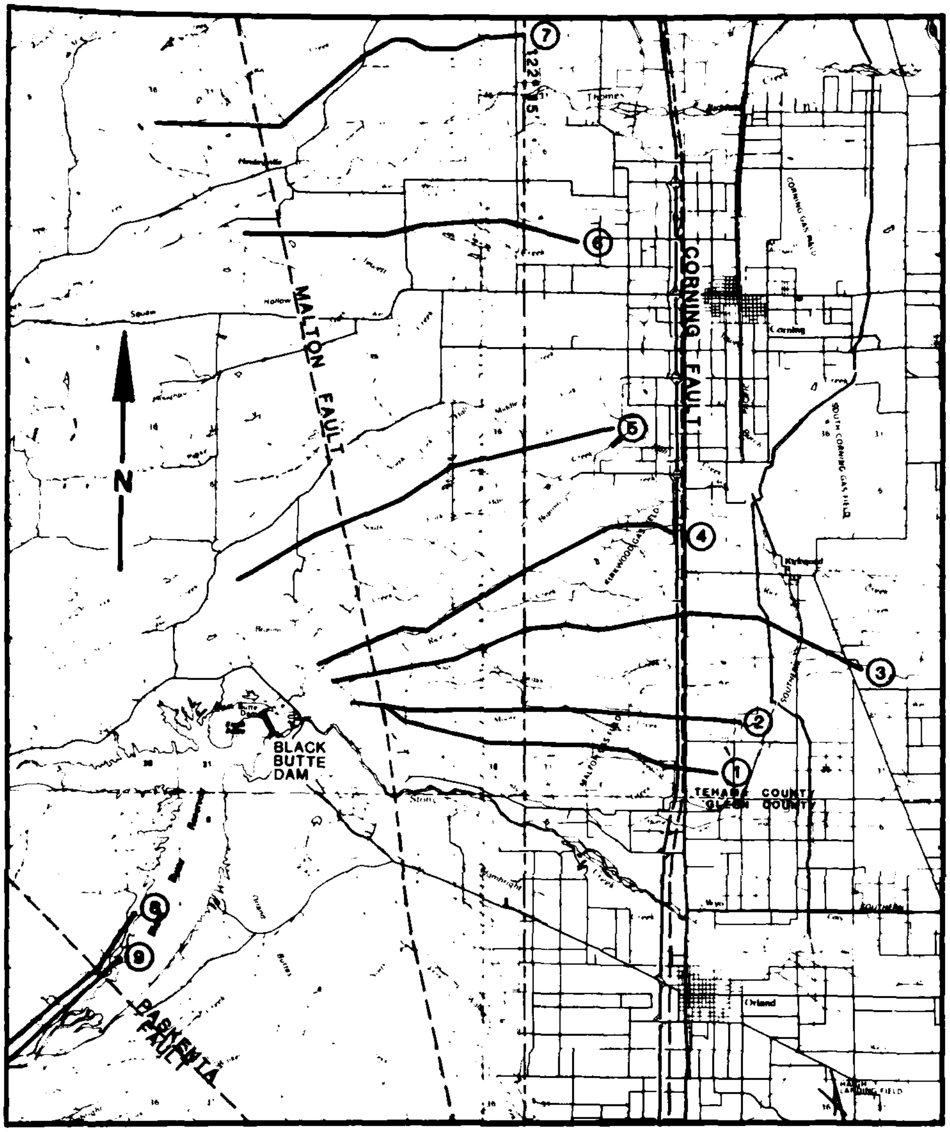
PROFILES 8 AND 9 MADE USING THE HIGH POINTS ON TERRACE SURFACES ONLY

THE FAULTS SHOWN ON MAP ARE THOSE POSTULATED BY PREVIOUS WORKERS

SCALE OF PROFILES 1 : 2000

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEER SEATTLE, WASHINGTON	
GEOLOGIST: MANN	GEOLO
DRAWN: MANN	TERI
CHECKED: HANCOCK	
SUBMITTED: David D. [illegible]	DATE APP





PROFILE LOCATION MAP

SCALE 1:100,000

0 1 2 3 4 5 MILES

NOTES

DATA FOR PROFILES 1 THROUGH 9 WERE TAKEN FROM 1:24,000 QUADRANGLE MAPS
PROFILES 1 THROUGH 7 ARE PLOTTED ON AN EAST WEST SECTION WITH THE DATA PROJECTED INTO THAT SECTION
PROFILES 8 AND 9 MADE USING THE HIGH POINTS ON TERRACE SURFACES ONLY
THE FAULTS SHOWN ON MAP ARE THOSE POSTULATED BY PREVIOUS WORKERS

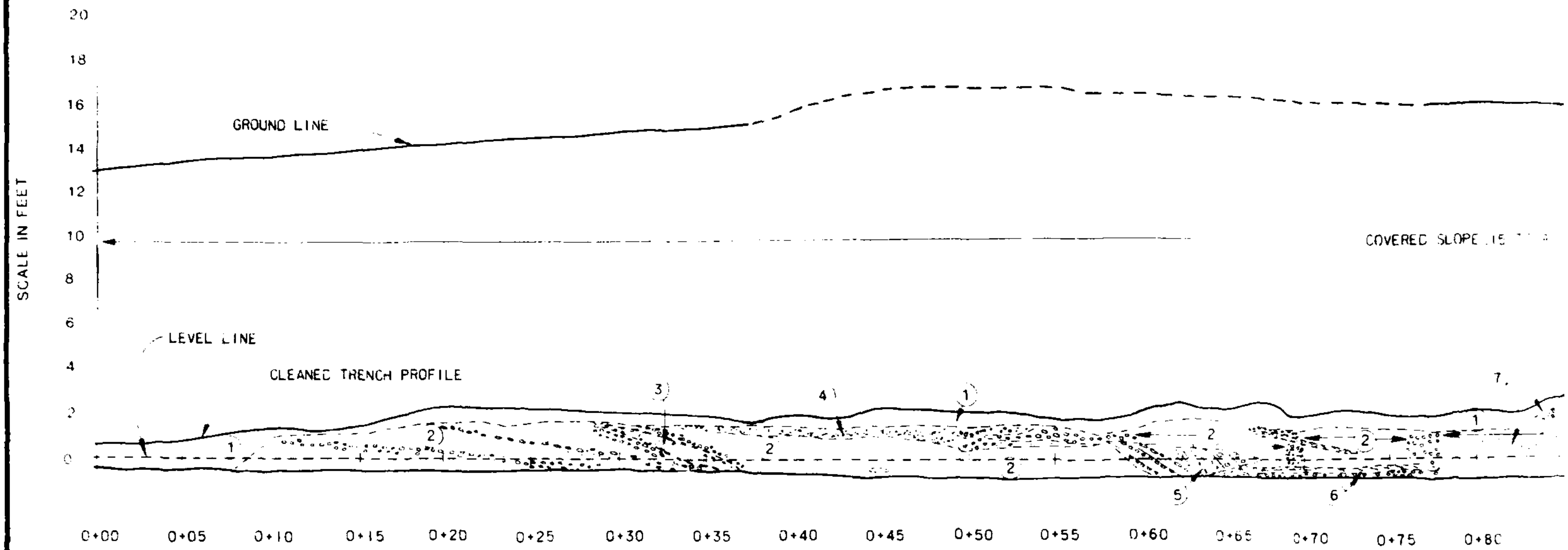
SCALE OF PROFILES 1" = 2000'

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGIST: MANN DRAWN: MANN CHECKED: HANCOCK	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION **TERRACE LEVELING PROFILES**
SUBMITTED: Donald D. Henkel · DATE APPROVED:	SCALE: · SPEC. NO. · SHEET · FILE NO. SC-1-10-238

3

PLATE 18

N 40 E SECTION



1. NwD - NEWVILLE GRAVELLY LOAM. B2t HORIZON OVERLAIN BY SLOPE WASH. GRAYISH- BROWN TO BROWN SLOPE WASH (10YR 5/2) OVER WET BROWN (7.5 YR 5/4) SILTY CLAYEY GRAVEL. 20 TO 80 DEGREE SLOPE ABOVE. B2t IS COARSE PRISMATIC STRUCTURE OCCASIONALLY SUB ANGULAR BLOCKY. WAVY BOUNDARY. SOIL CREEPS DOWN SLOPE AND MIXES LAYERS.

2. SILTY GRAVELLY SAND - PALE YELLOW TO OLIVE (2 5YR 5/4) DRY. HORIZONTALLY STRATIFIED, VERY GRAVELLY. MIXED WITH SANDY CLAY AND SILT. WET COLOR (5Y 6/2). LIGHT OLIVE GRAY - WET COLOR, GRAVEL INCLUDED. ←— 2 —→ INDICATES EXPANSE WHERE UNIT 2 IS CONSISTENT THROUGHOUT.

3. SILTY COARSE SAND, GRAY, GRADES TO GRAVEL ABOVE AND BELOW SAND POD.

4. SILTY SAND, GRAY TO OLIVE. WET COLOR MAKES MASS

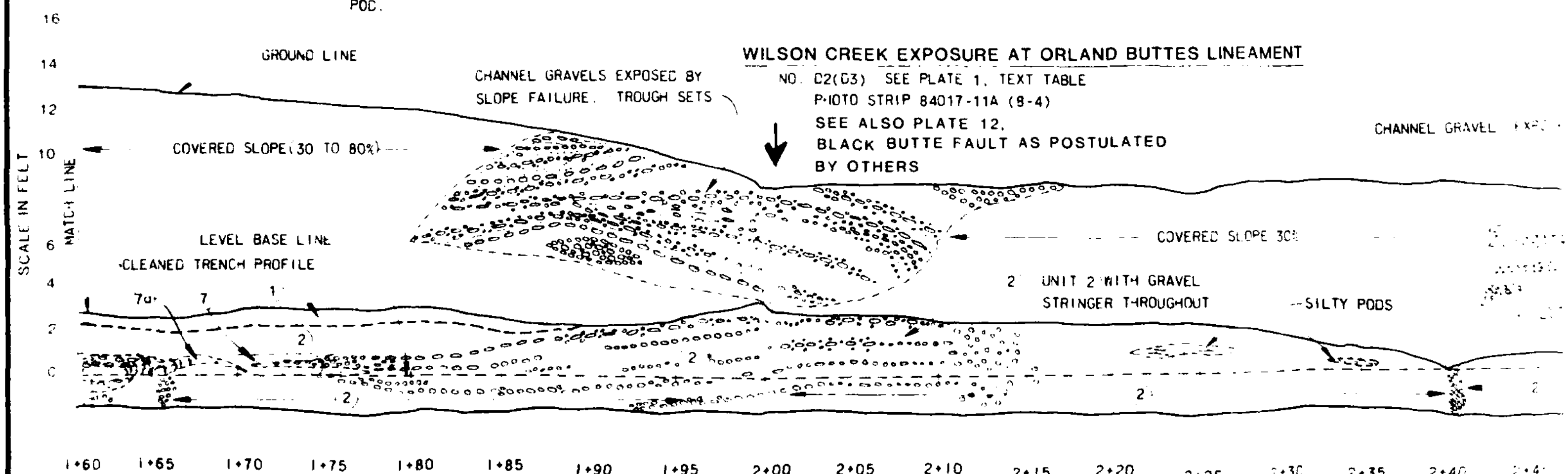
5. PEBBLY SAND, GRAYISH BROWN, FINE TO PEBBLES THROUGHOUT. COARSE SAND AND OXIDIZED. PSEUDO BEDDING DIPS 20 BEDS.

6. SILTY CLAY AND COARSE SAND, LENSE. WET COLOR (5Y 5/3).

7. SILT, CLAY AND SAND, LENSES AND PODS WET (5Y 5/3) COARSE SAND&GRAVEL

WILSON CREEK EXPOSURE AT ORLAND BUTTES LINEAMENT

NO. C2(C3) SEE PLATE 1, TEXT TABLE
PHOTO STRIP 84017-11A (8-4)
SEE ALSO PLATE 12.
BLACK BUTTE FAULT AS POSTULATED BY OTHERS



N 40 E SECTION

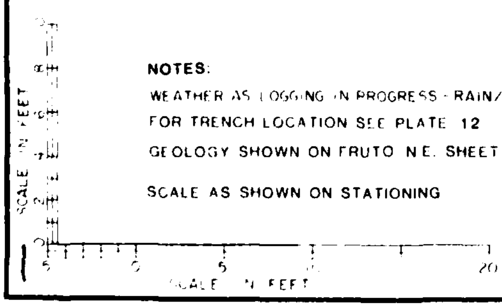
NOTES:

WEATHER AS LOGGING IN PROGRESS - RAIN/CREEK HIGH

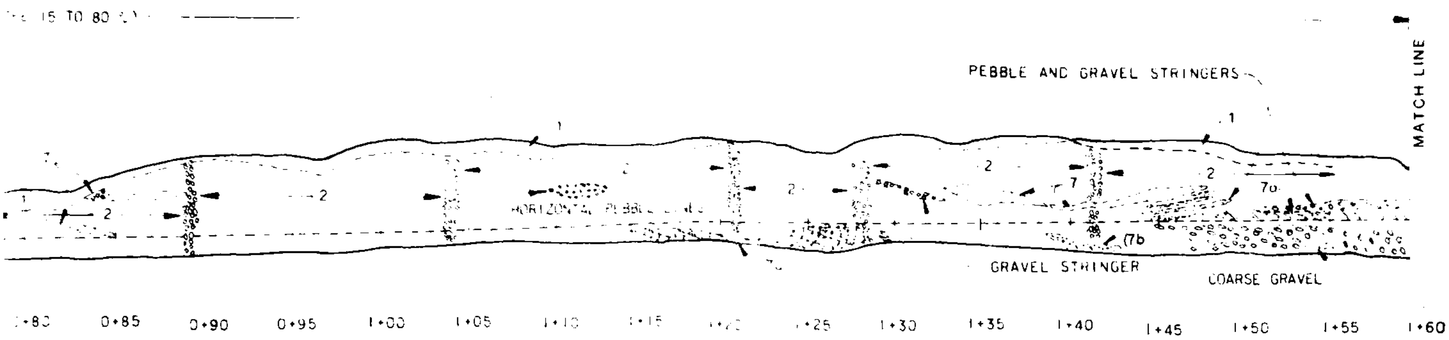
FOR TRENCH LOCATION SEE PLATE 12

GEOLOGY SHOWN ON FRUTO N.E. SHEET

SCALE AS SHOWN ON STATIONING



REVISIONS



COLOR (5Y 4/3). FINE

FINE TO COARSE SAND WITH
AND GRAVEL STRINGERS ARE
20 DEGREES MIMIC FORESET

OLIVE TO GRAYISH BROWN.

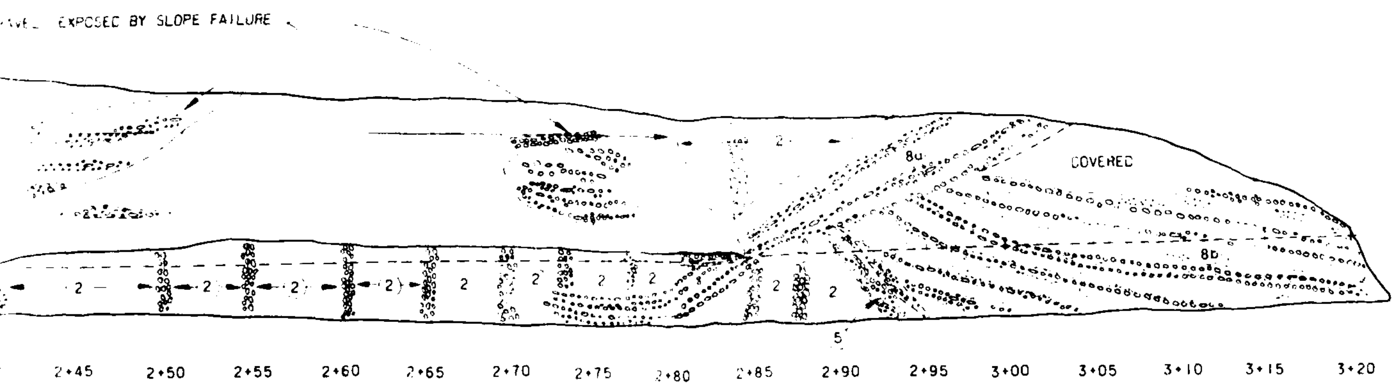
PODS. OLIVE TO GRAY COLOR.
GRAVEL INCLUDED.

7a SILTY FINE SAND, ... OLIVE BROWN TO GRAY COLOR. WET (5Y 5/3). INCLUDES FINE SANDY CROSSBEDS

7b SAND, COARSE GRAIN, MICACEOUS. OLIVE TO GRAY COLOR, WET (5Y 5/3). MASSIVE.

8 ... CROSS - BEDDING IN CHANNEL GRAVEL

8a THICK BEDDED ... TABULAR SETS



2

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
GEOLOGISTS: HANCOCK, B. MANN DRAWN: LOPE CHECKED:	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION SOUTH FORK WALKER CREEK BANK LOG AT BOAT HOOK BEND- MICHAELSON RANCH
SUBMITTED:	DATE APPROVED: 01/03/86
SCALE:	SPEC. NO.
SHEET	FILE NO. SC-1-10-238

PLATE 19

LEGEND

Qc——Colluvium; shown on the slopes of Orland Buttes only.

Q——Quaternary Terrace Sequence; chronologically numbered with I being the youngest. 'Q' omitted for clarity.

Qu——Undifferentiated Quaternary Deposits; principally multiple terrace levels with local side stream fan deposits and fan deposits in the southwest area.

Pc——Tehama Formation; Pliocene alluvial fan deposits.

Pvp——Nomlaki Tuff; found in lower part of Tehama Fan.

Mvb——Basalt; found capping Orland Buttes. Correlates to Lovejoy Formation on east side of Sacramento Valley.

Ku——Upper Cretaceous sedimentary basement; includes Kione, Forbes, Dobbins Shale, Guinda, Funks, Sites, Yolo, Venado, and Boxer (Julian Rocks) Formations. (Chico Series)

Kl——Lower Cretaceous sedimentary basement; includes Lodoga (Horsetown) and the upper part of Stony Creek Formations. (Shasta Series)

KJ——Upper Jurassic lowest Cretaceous sedimentary basement; includes lower part of Stony Creek Formation. (Knoxville Series)

Refer to text for detailed description of units.

Contact; dashed where approximately located.

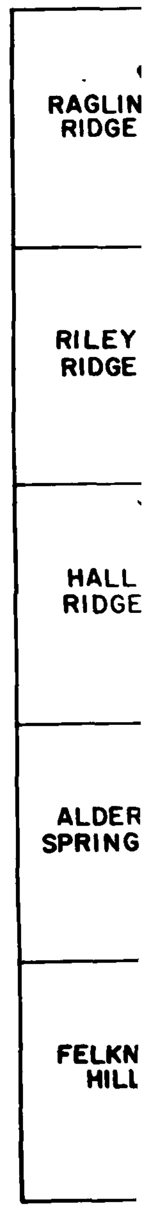
Anticline

Syncline

U

D

Thrust Fault; teeth on upper plate.



only.

ımbered
y.

to
ley.

; Kione,
Venado,

Lodoga
ormations.

sement;
oxville

located.

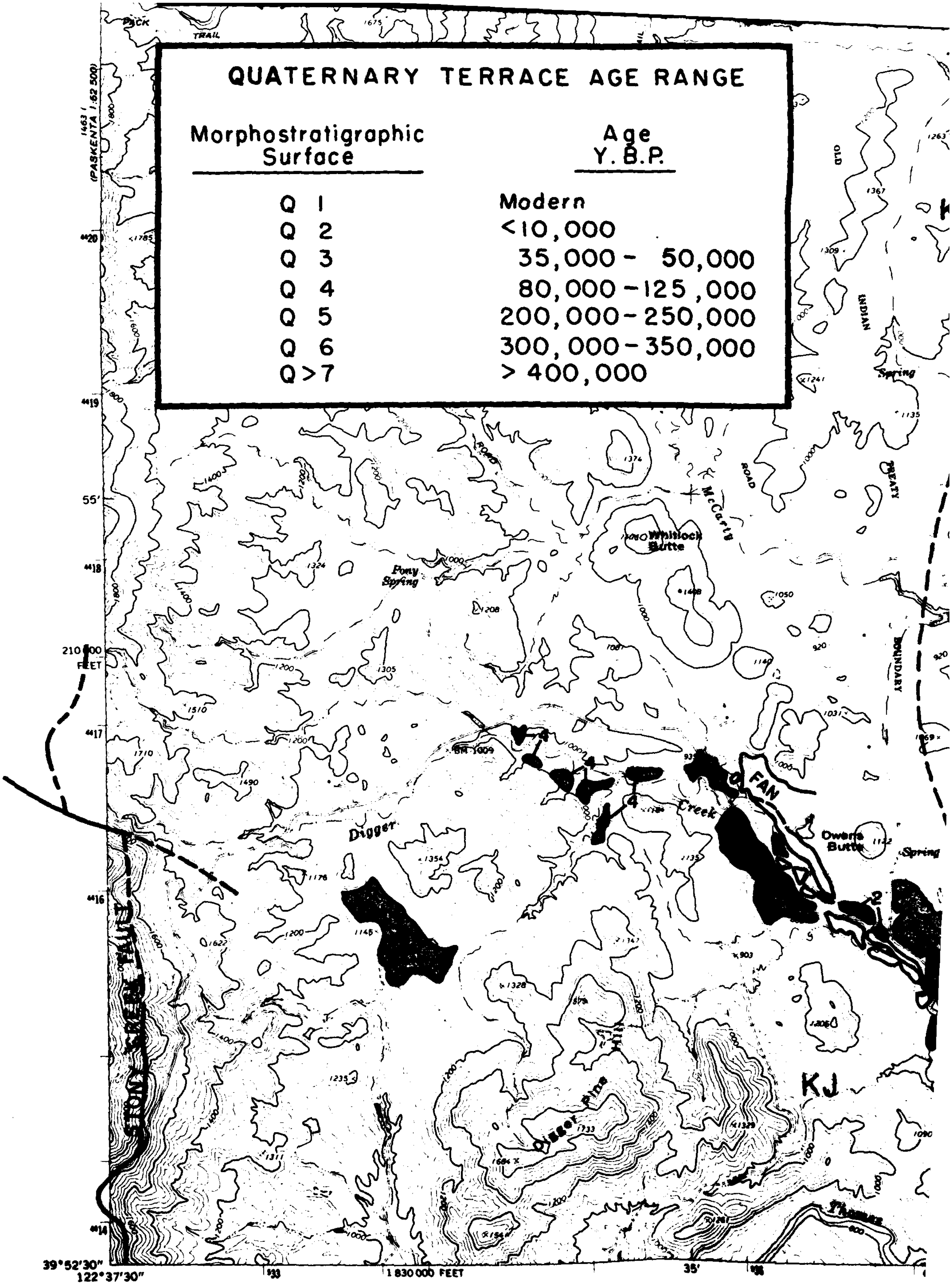
MAP INDEX

7.5 QUADRANGLES

RAGLIN RIDGE	LOWREY	RED BANK	WEST OF GERBER	GERBER	LOS MOLINOS
RILEY RIDGE	SHEET 1 PASKENTA	SHEET 2 FLOURNOY	SHEET 3 HENLEYVILLE	CORNING	VINA
HALL RIDGE	NEWVILLE	SHEET 4 SEHORN CREEK	SHEET 5 BLACK BUTTE DAM	SHEET 6 KIRKWOOD	FOSTER ISLAND
ALDER SPRINGS	CHROME	SHEET 7 JULIAN ROCKS	SHEET 8 FRUTO NE	SHEET 9 ORLAND	HAMILTON CITY
FELKNER HILL	ELK CREEK	FRUTO	STONE VALLEY	WILLOWS	GLENN

QUATERNARY TERRACE AGE RANGE

Morphostratigraphic Surface	Age Y.B.P.
Q 1	Modern
Q 2	<10,000
Q 3	35,000 - 50,000
Q 4	80,000 - 125,000
Q 5	200,000 - 250,000
Q 6	300,000 - 350,000
Q >7	> 400,000



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(PASKENTA 1:62 500)

CONT

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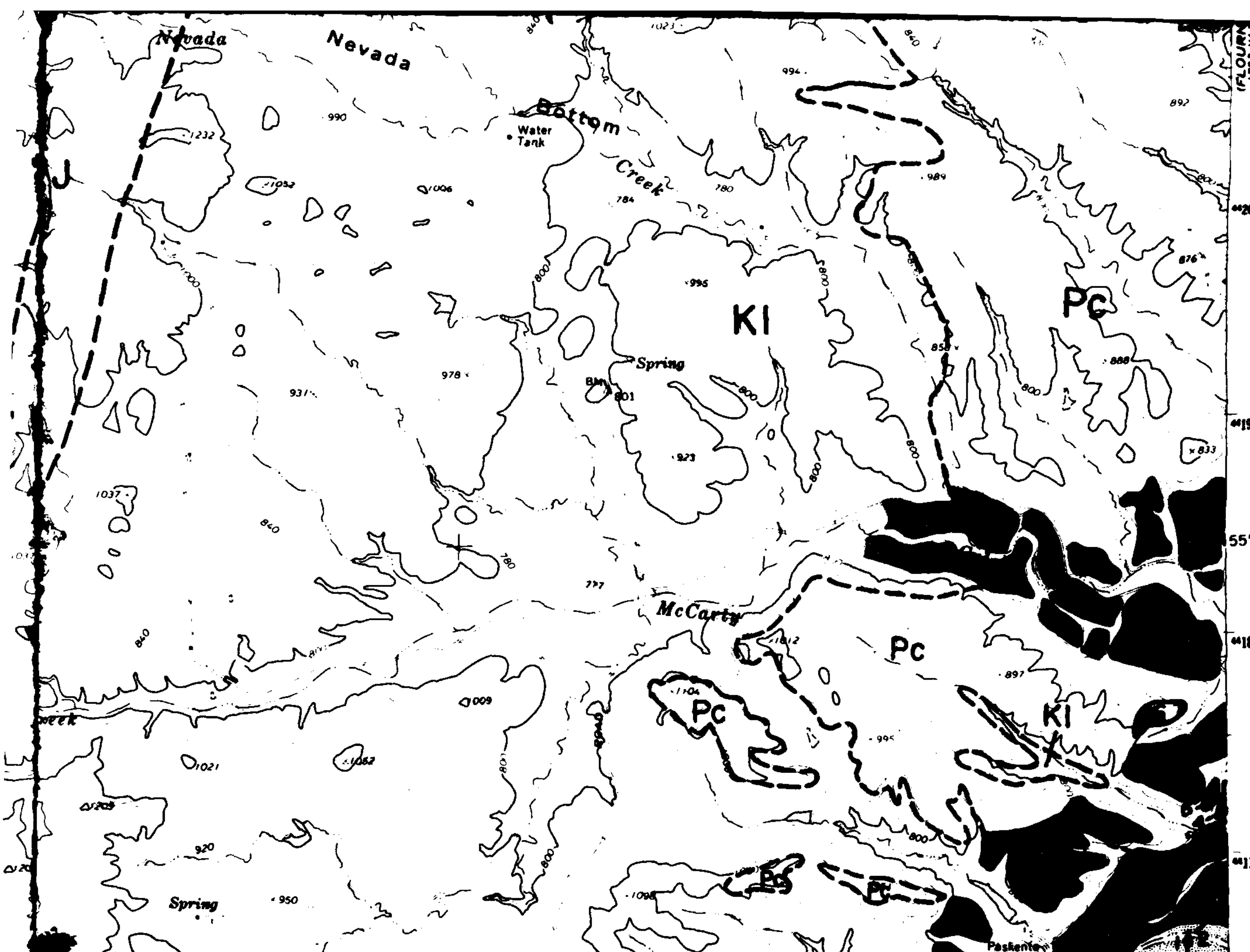


H

2

KENTA 1:62 500I 1463 I

ALE 1:24 000

0 1 MILE

3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

INTERVAL 40 FEET
PRESENT 20-FOOT CONTOURS
S MEAN SEA LEVEL

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

4

CALIF

QUADRANGLE LOCATION

1

PASKENTA, CALIF.

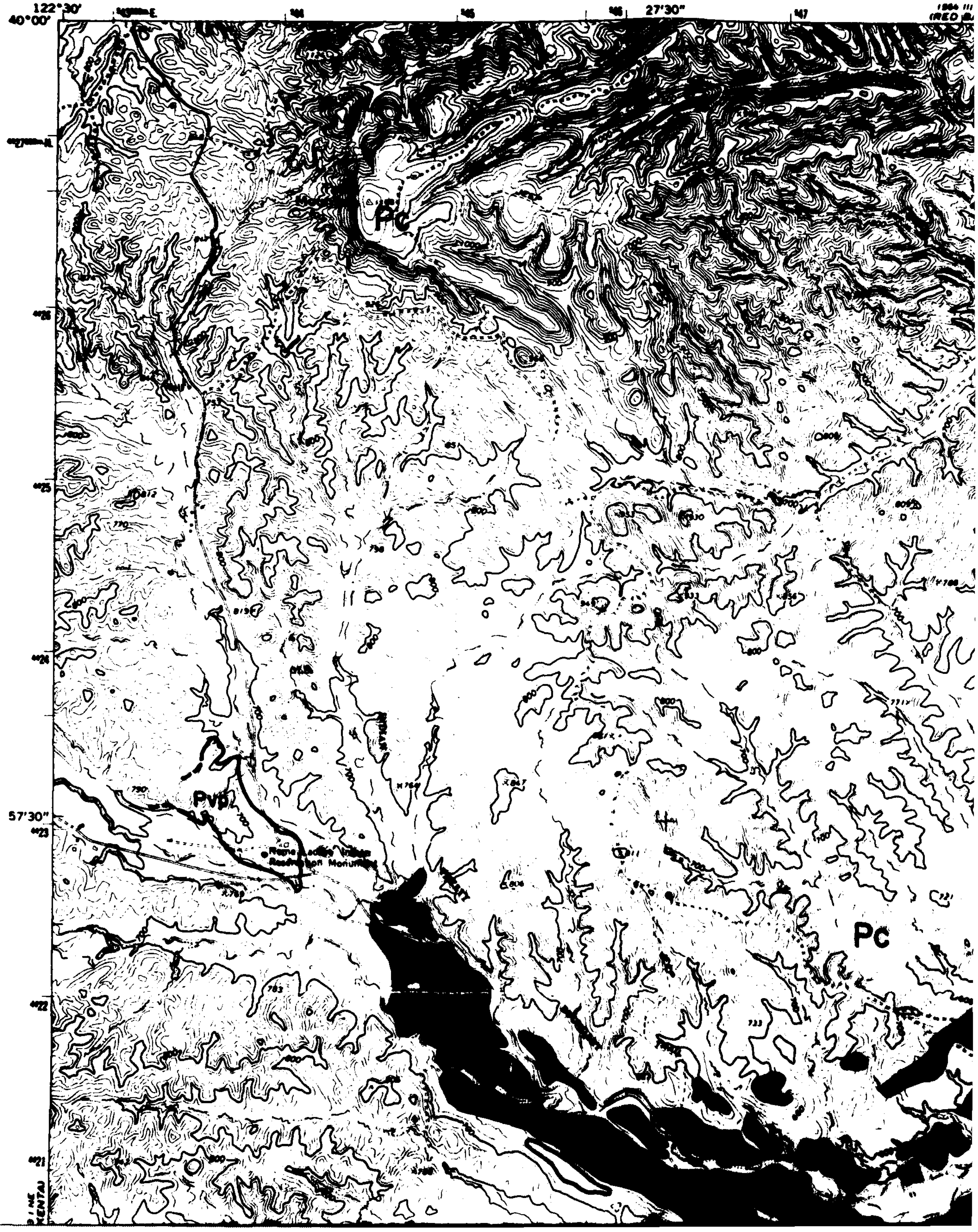
NE/4 PASKENTA 15' QUADRANGLE
N3952.5—W12230/7.5

1967

AMS 1463 I NE—SERIES V895

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF C
DEPARTMENT OF W



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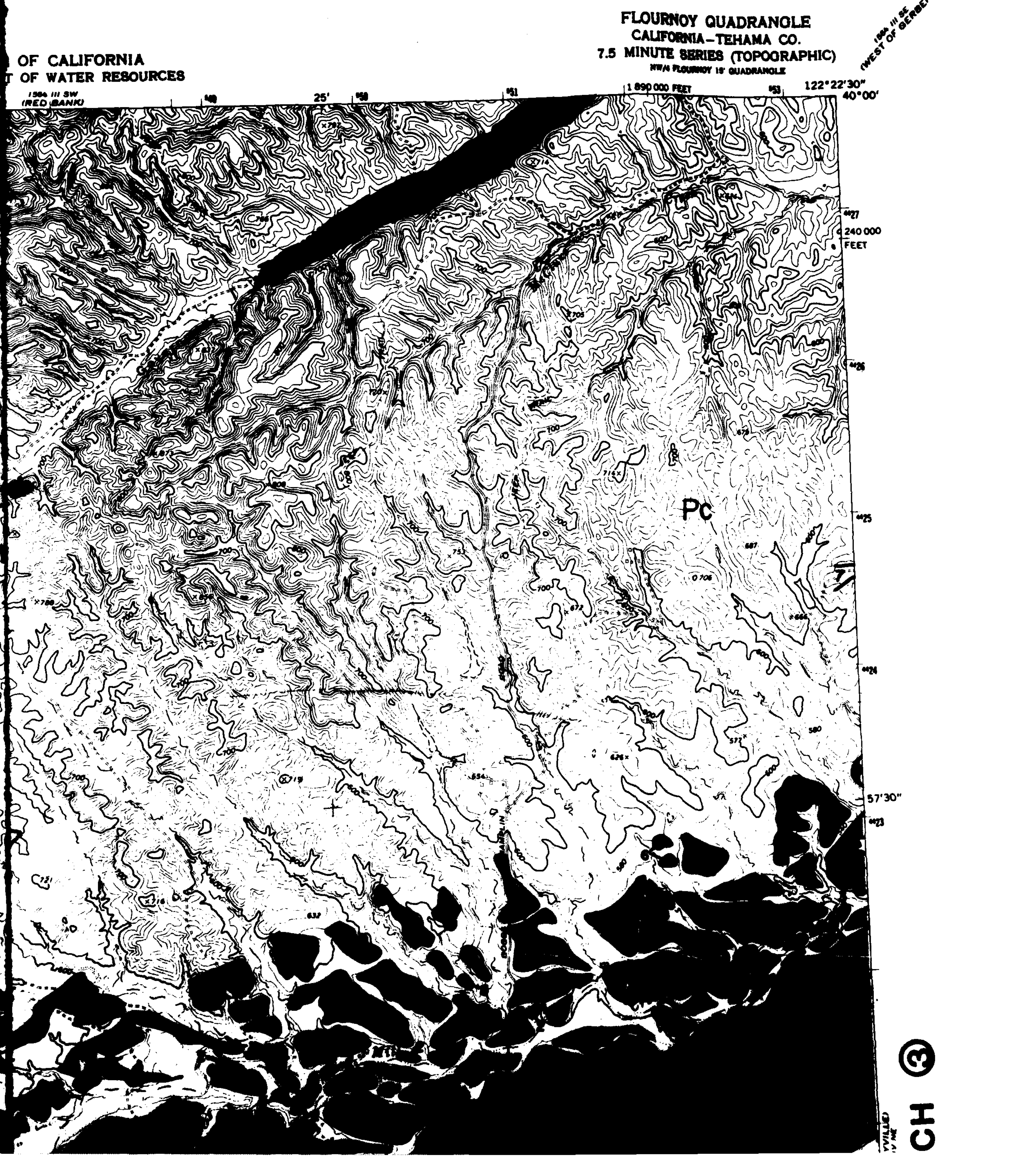
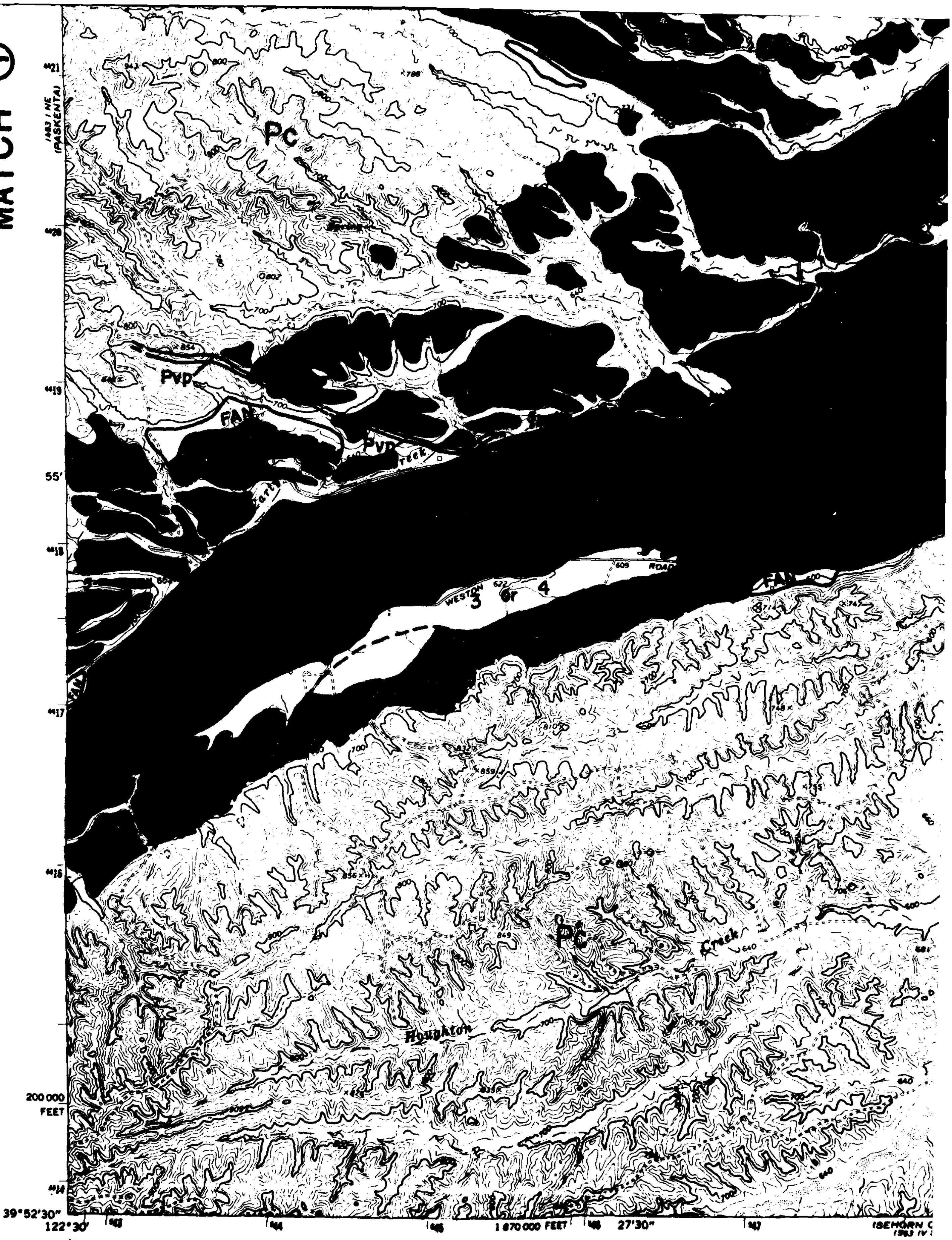

OF CALIFORNIA
T OF WATER RESOURCES
FLOURNOY QUADRANGLE
CALIFORNIA-TEHAMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 FLOURNOY 15' QUADRANGLE
(RED BANK)
(WEST OF GERBER)
25'
1 890 000 FEET
122°22'30"
40°00'
240 000
FEET
57'30"
Pc
700
CH ③

MATCH ①



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Control by USGS and USC&GS

(PASKENTA 1:62 500) 1983 I

3

SCALE 1:

1000 0 1000 2000 3000

CONTOUR INTER

DOTTED LINES REPRESEN

DATUM IS MEAN

MATCI

(…EHORN CREEK)
1563 IV SW

SCALE 1:24 000

1 MILE

3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

4

…R INTERVAL 20 FEET
…REPRESENT 10-FOOT CONTOURS
… IS MEAN SEA LEVEL

…TCH ④

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

(BLACK BUTTE DAM)
1563 IV SE

CALIF.
QUADRANGLE LOCATION

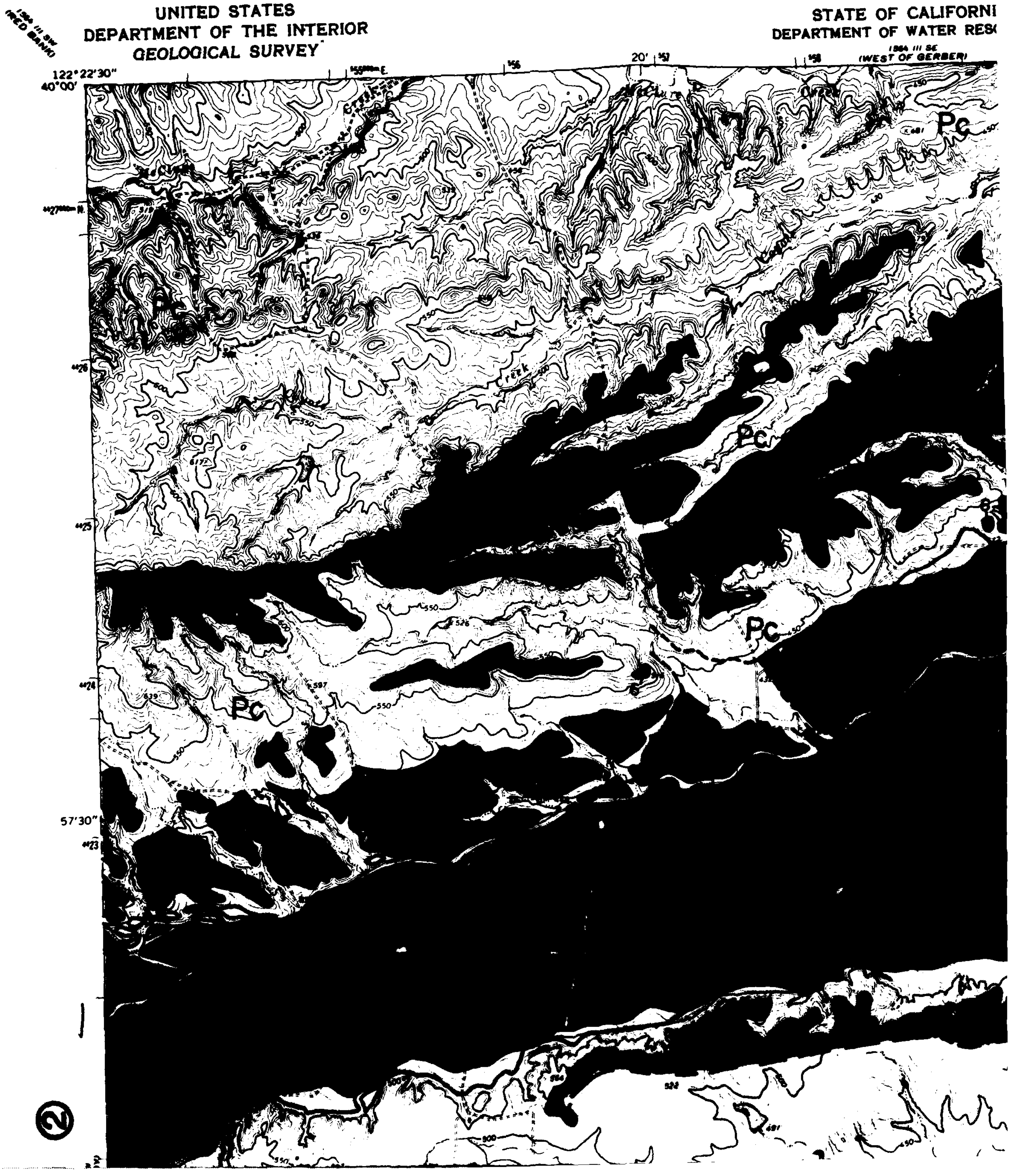
② FLOURNOY, CALIF.
NW/4 FLOURNOY 15' QUADRANGLE
N3952.5—W12222.5/7.5

1967

AMS 1563 IV NW—SERIES V895

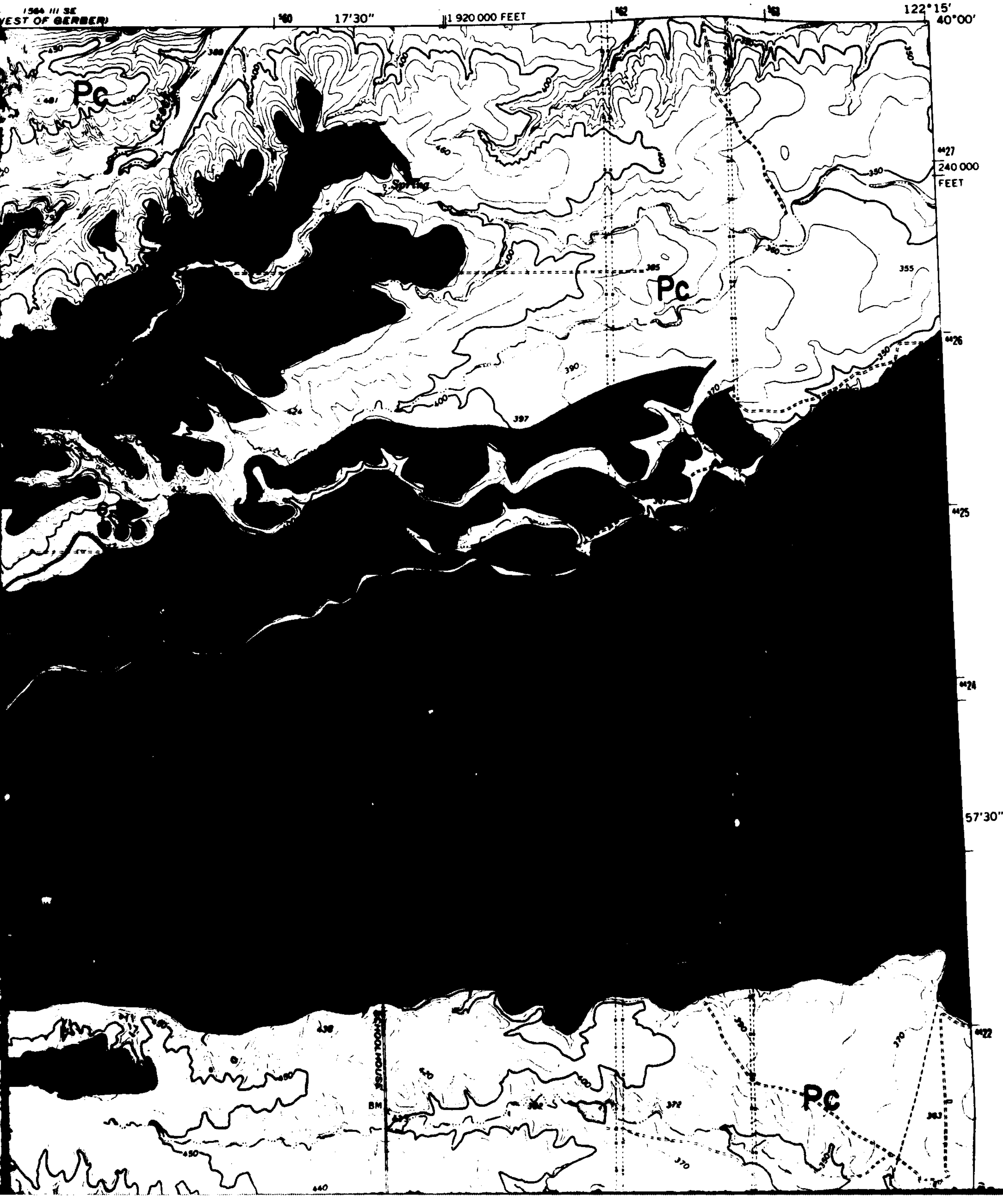
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF CALIFORNI
DEPARTMENT OF WATER RES(



OF CALIFORNIA
T OF WATER RESOURCES

HENLEYVILLE QUADRANGLE
CALIFORNIA–TEHAMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NE/4 FLOURNOY 15' QUADRANGLE



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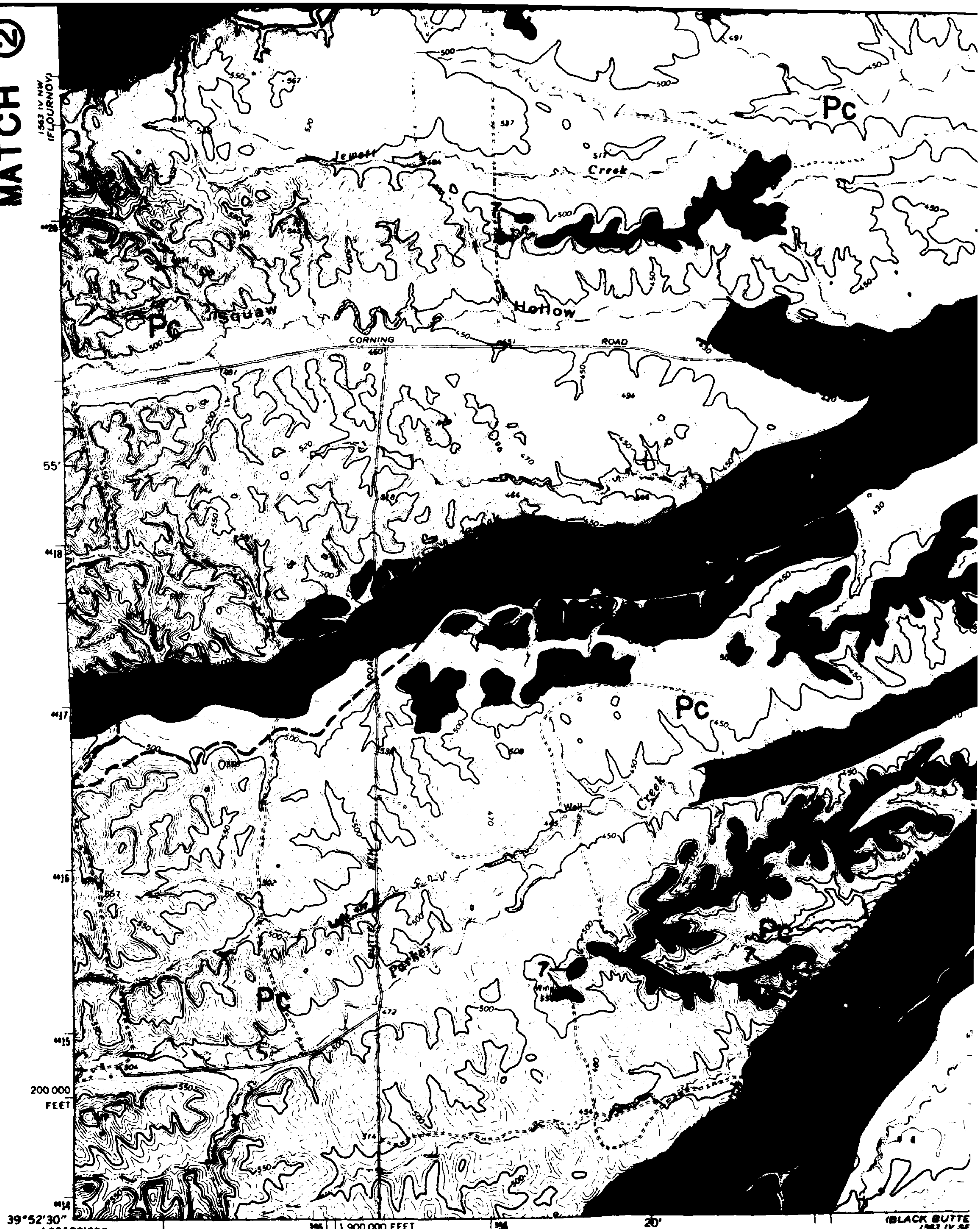
MATCH ②



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(BEHORN CREEK) 1563 IV SW

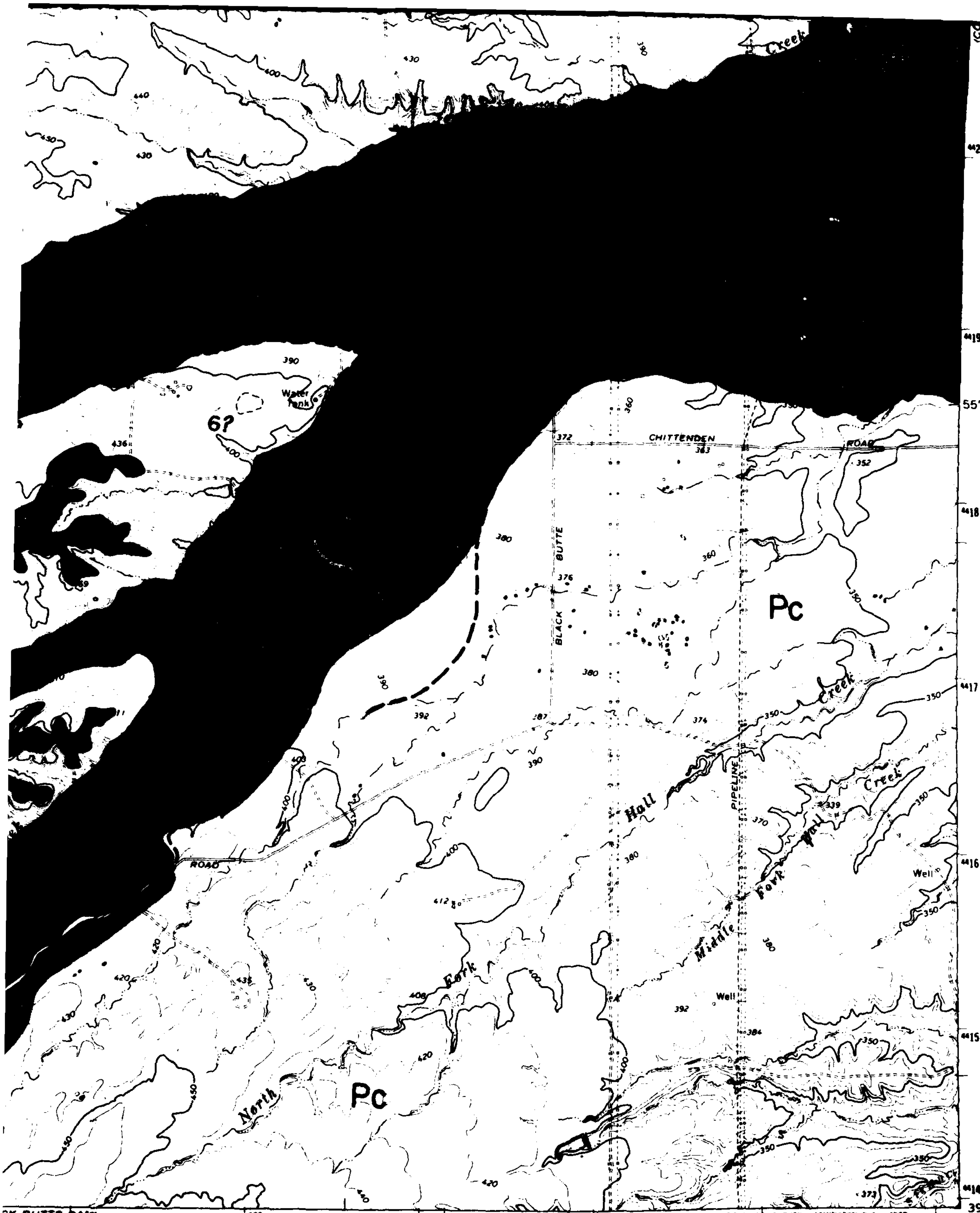
SCALE 1:24

CONTOUR INTERV

DATUM IS MEAN

MATCH

3



CK BUTTE DAM)
1563 IV SE

17'30"

INTERIOR—GEOLOGICAL SURVEY WASHINGTON D C — 1968

39°52'30"
122°15'

(KIRKWOOD)
1563 I SW

ALE 1 24 000

1 MILE

3000 4000 5000 6000 7000 FEET

1 KILOMETER

INTERVAL 10 FEET
IS MEAN SEA LEVEL

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

4

'CH ⑤

CALIF

QUADRANGLE LOCATION

③ HENLEYVILLE, CALIF.

NE/4 FLOURNOY 15' QUADRANGLE

N3952.5—W12215/7.5

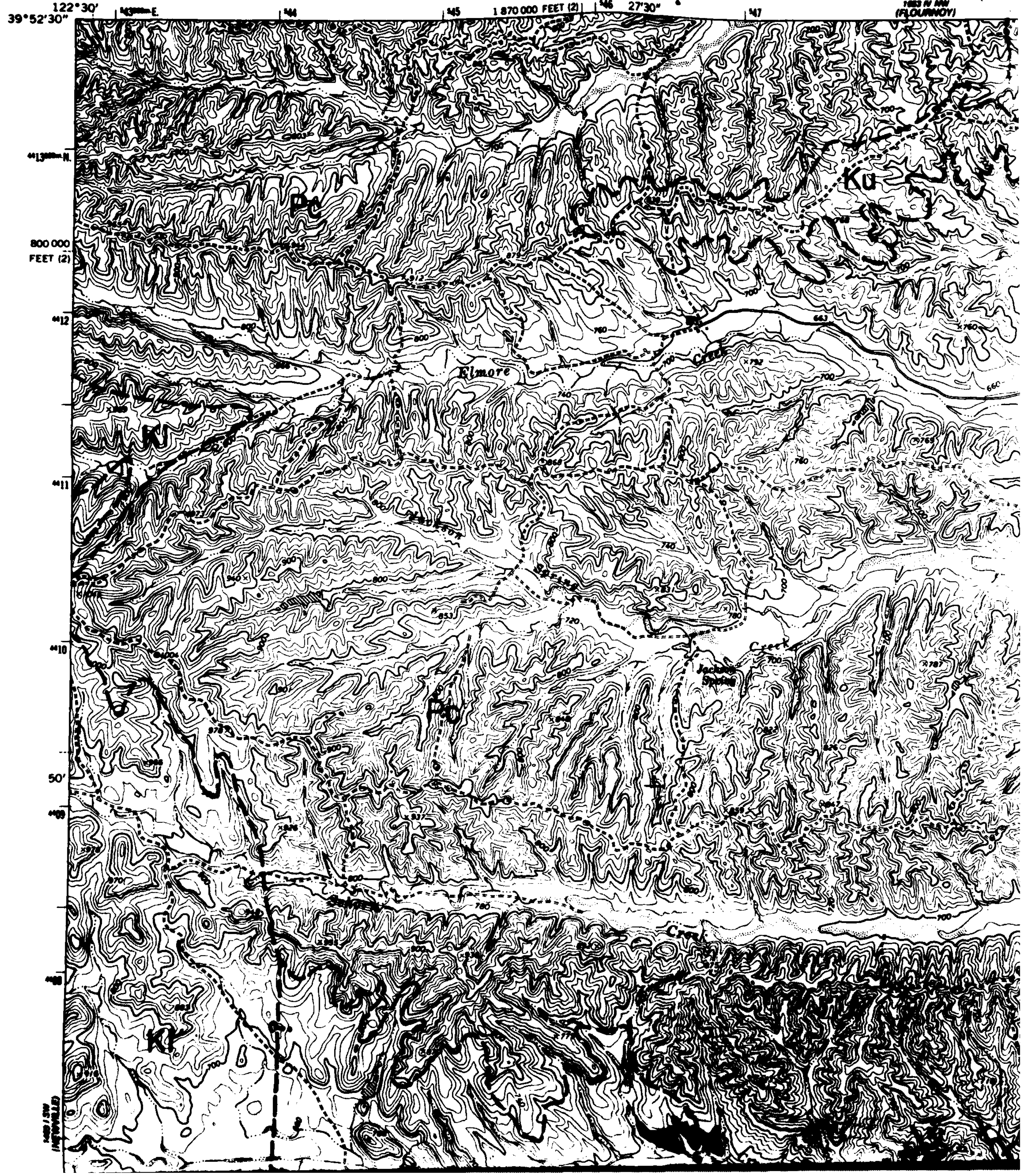
1967

AMS 1563 IV NE—SERIES V895

MATCH ②

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

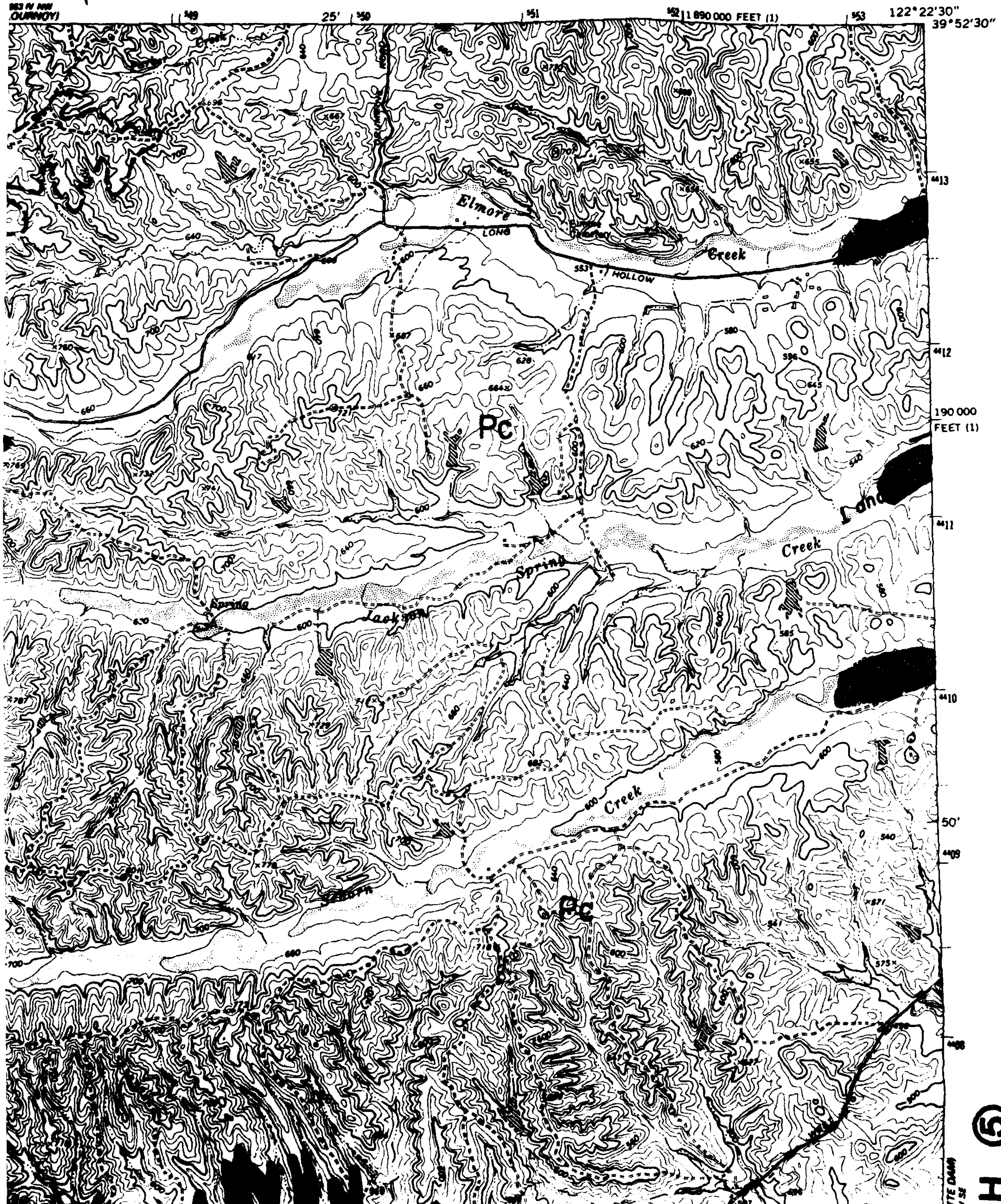
STATE OF CALIFORNI
DEPARTMENT OF WATER RESO



CH ②

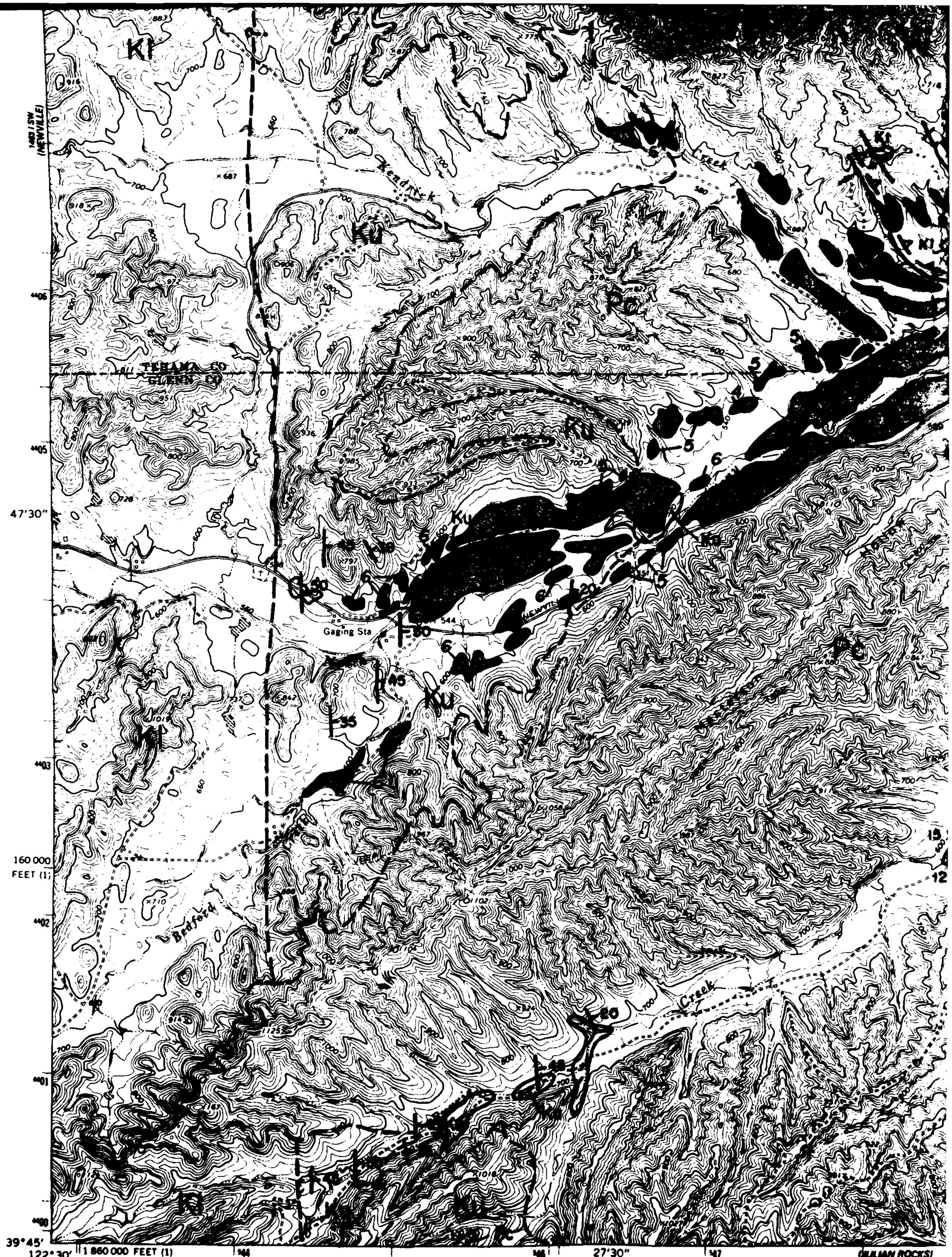
CALIFORNIA
WATER RESOURCES

SEHORN CREEK QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 FLOURNOY 15' QUADRANGLE



2

CH ⑤



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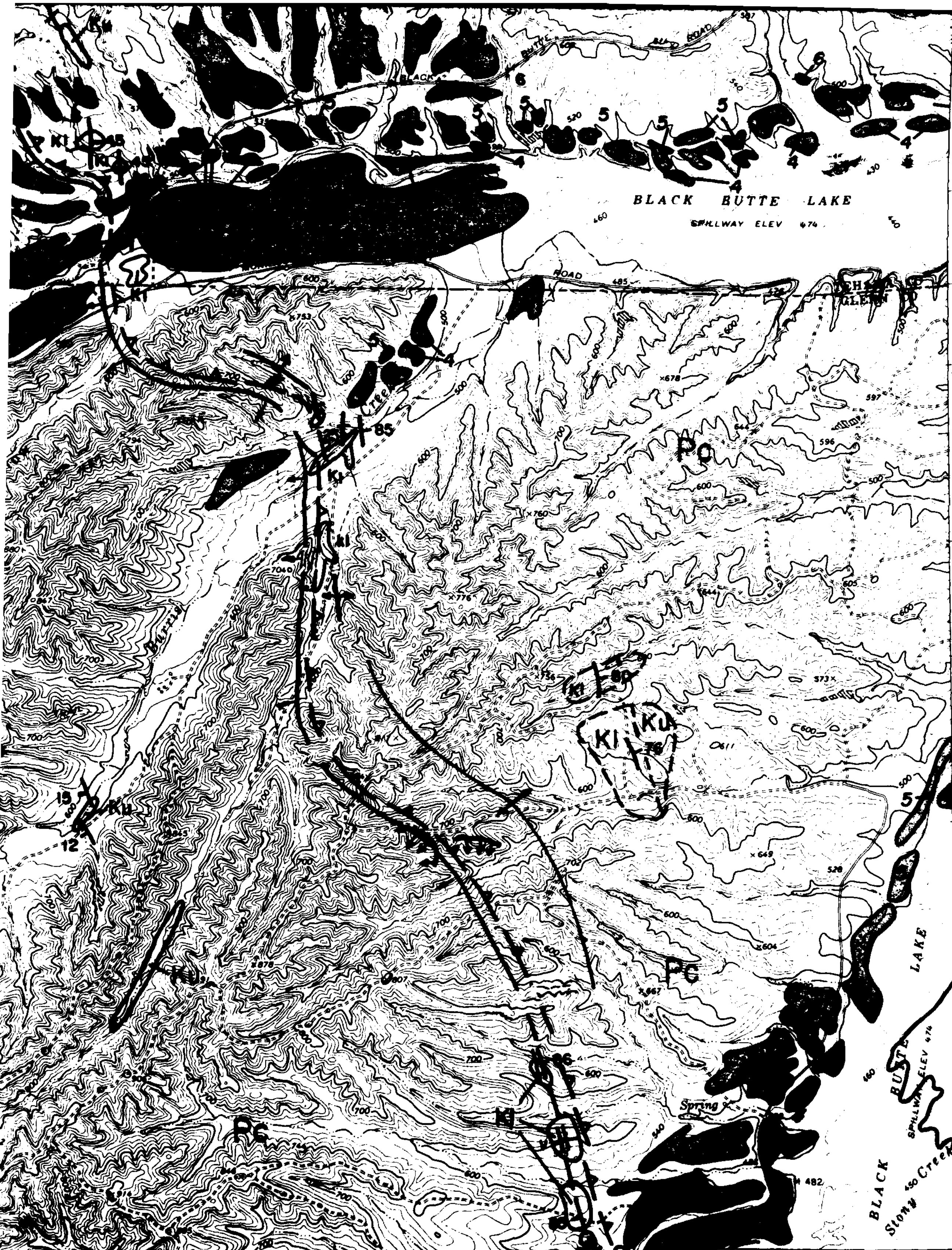
SCALE 1:24 000

CONTOUR INTERVAL 20

DOTTED LINES REPRESENT 10-FO



MATCH

(...LIAN ROCKS)
...1563 III NW

...LE 1:24 000

1 MILE

3000 4000 5000 6000 7000 FEET

1 KILOMETER

...INTERVAL 20 FEET
...RESENT 10-FOOT CONTOURS
...C VERTICAL DATUM OF 1929

...CH ⑦

(BLACK BUTTE ...)
1563 IV S...

(FRUTO NE)
1563 III NE

ROAD CLASSIFICATION

Medium-duty ——— Light-duty ———

Unimproved dirt - - - - - - - -

QUADRANGLE LOCATION

CALIF

④ SEHORN CREEK, CALIF.

SW/4 FLOURNOY 15' QUADRANGLE

N3945—W12222.5/7.5

1967

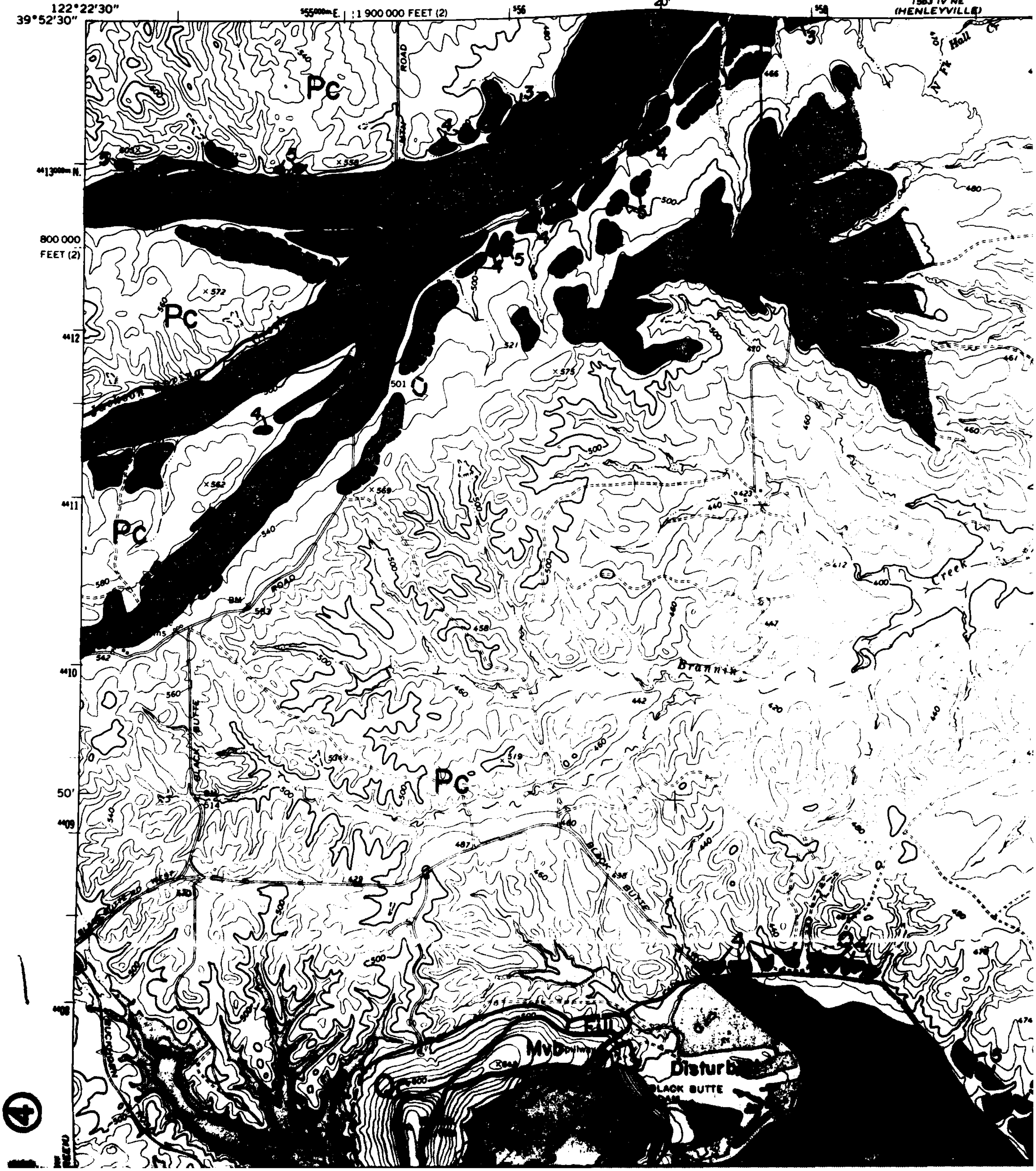
AMS 1563 IV SW—SERIES V895

4

MATCH ③

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF CALIFORNI
DEPARTMENT OF WATER RESC



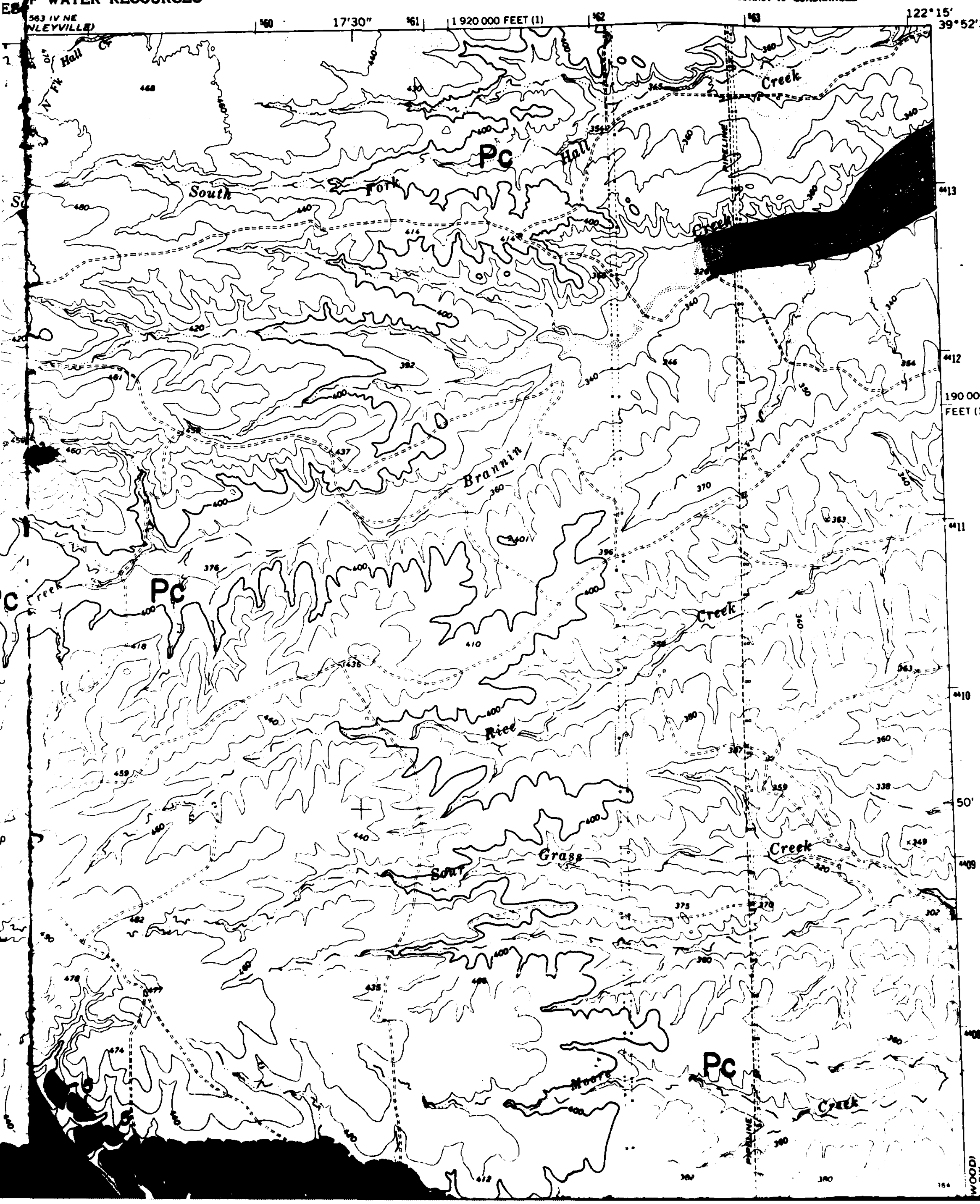
④

CH ③

F CALIFORNIA

F WATER RESOURCES

BLACK BUTTE DAM QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 FLOURNOY 15' QUADRANGLE



CH ⑥

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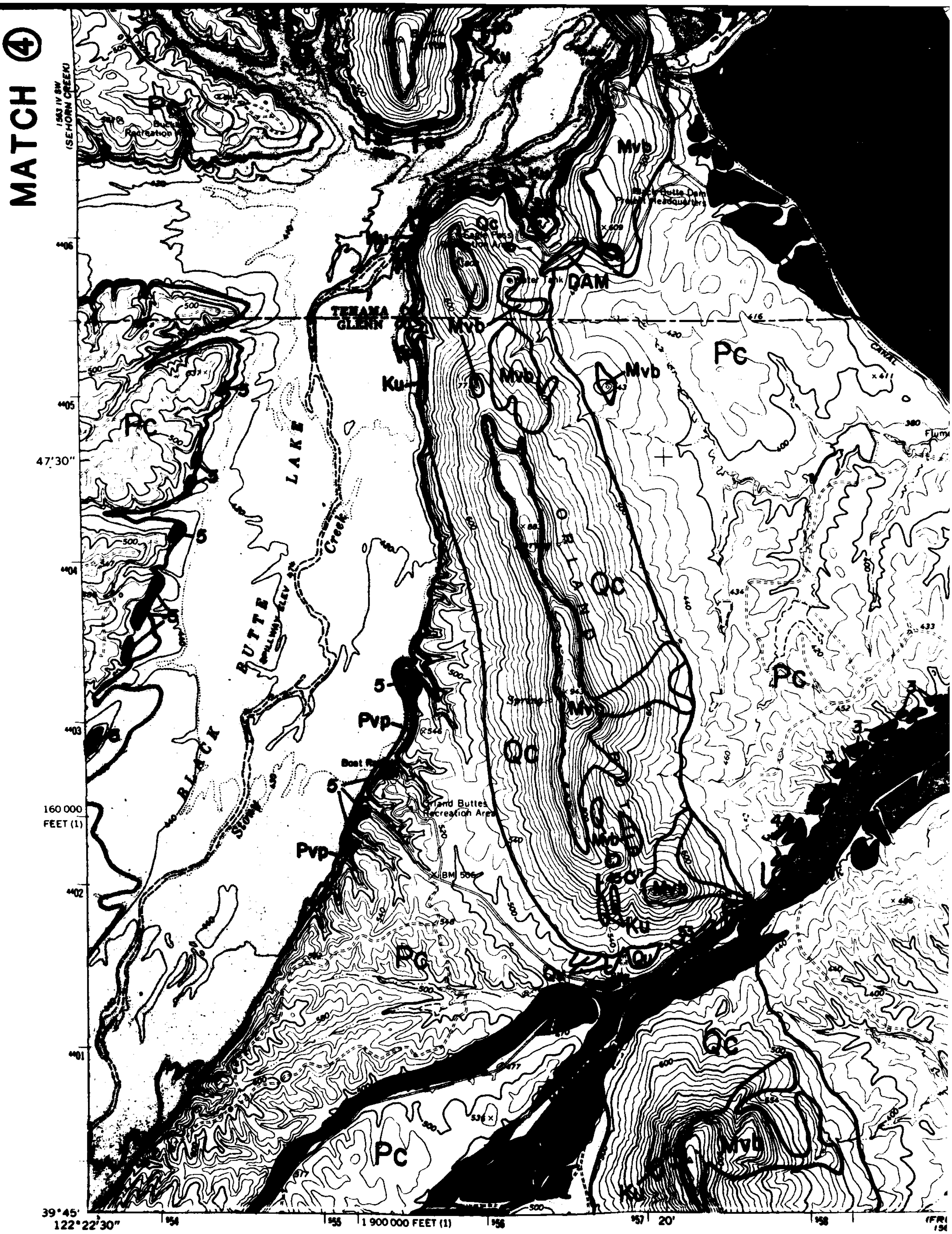

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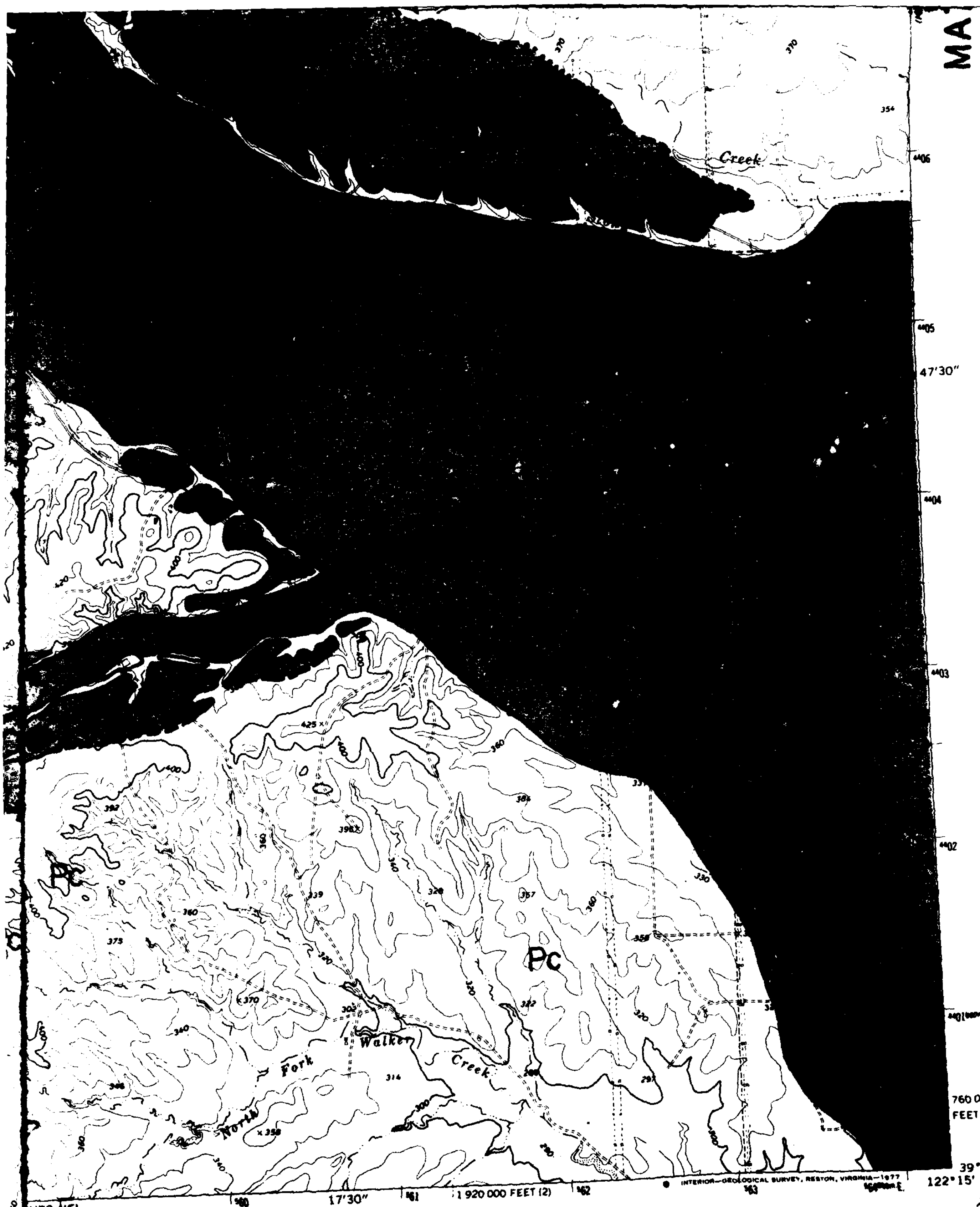
C **Channel numbers distinguished from terrace sequence Q'. See sheets 1 and 6.**

3



UTO NE
63 III NE

E 1:24 000

0 1 MILE

3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

NTERVAL 20 FEET
RESENT 10-FOOT CONTOURS
VERTICAL DATUM OF 1929

H ⑧

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

QUADRANGLE LOCATION

⑤ BLACK BUTTE DAM, CALIF.

SE/4 FLOURNOY 15' QUADRANGLE

N3945—W12215/7.5

1967

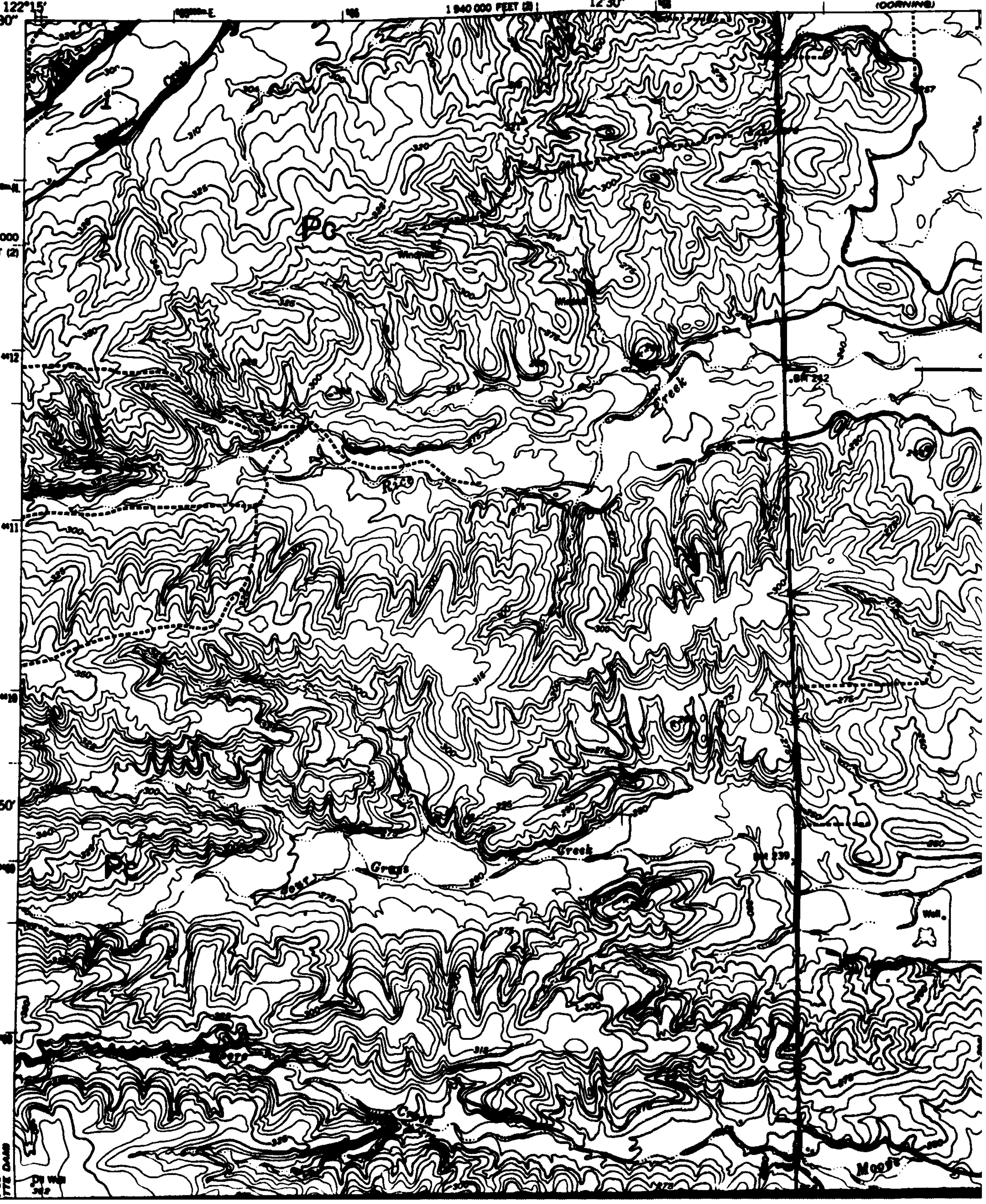
AMS 1563 IV SE—SERIES V895

ORLAND
1963 II NW

4

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

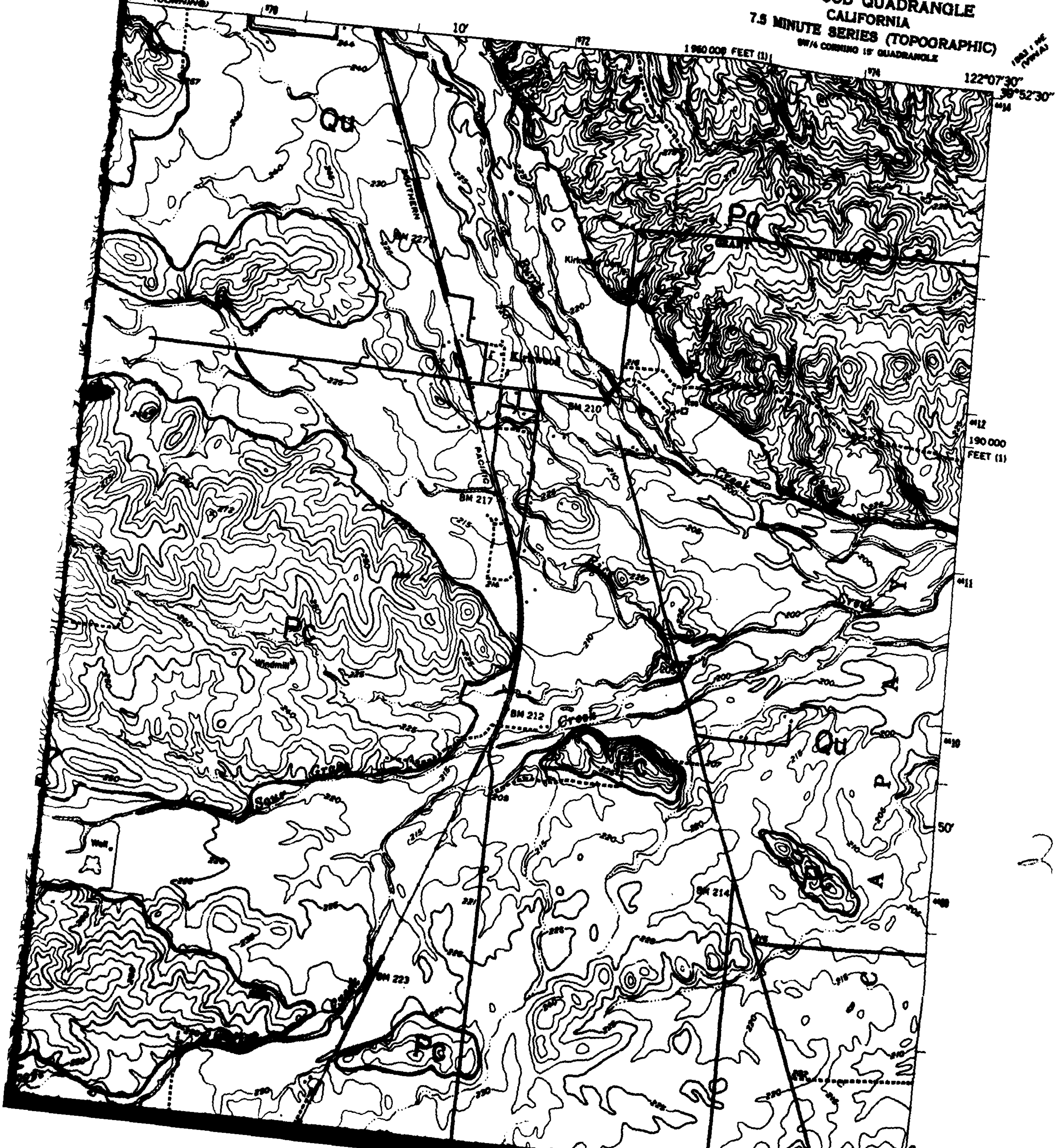
STATE OF CALIFOR
DEPARTMENT OF WATER RE

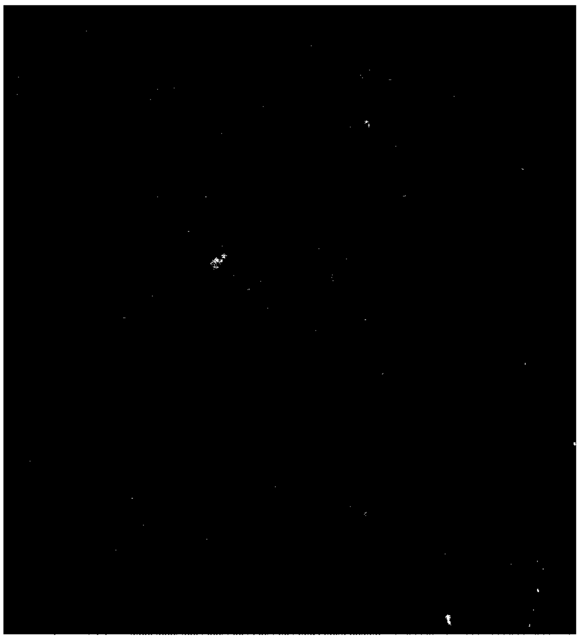


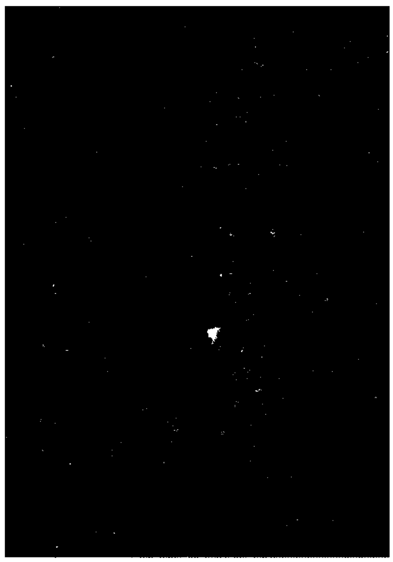
H ⑤

E OF CALIFORNIA
T OF WATER RESOURCES

KIRKWOOD QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



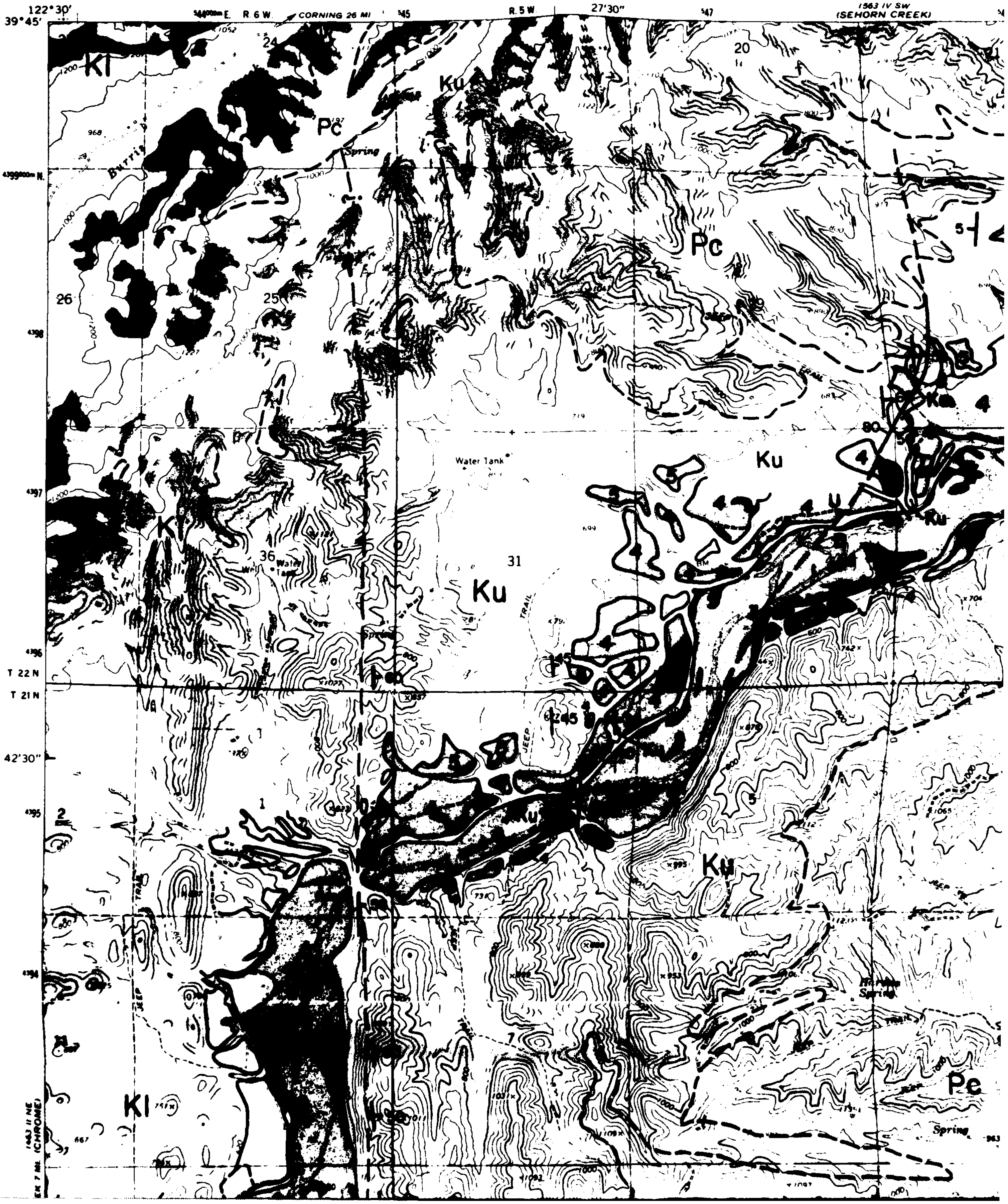




MATCH ④

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURC

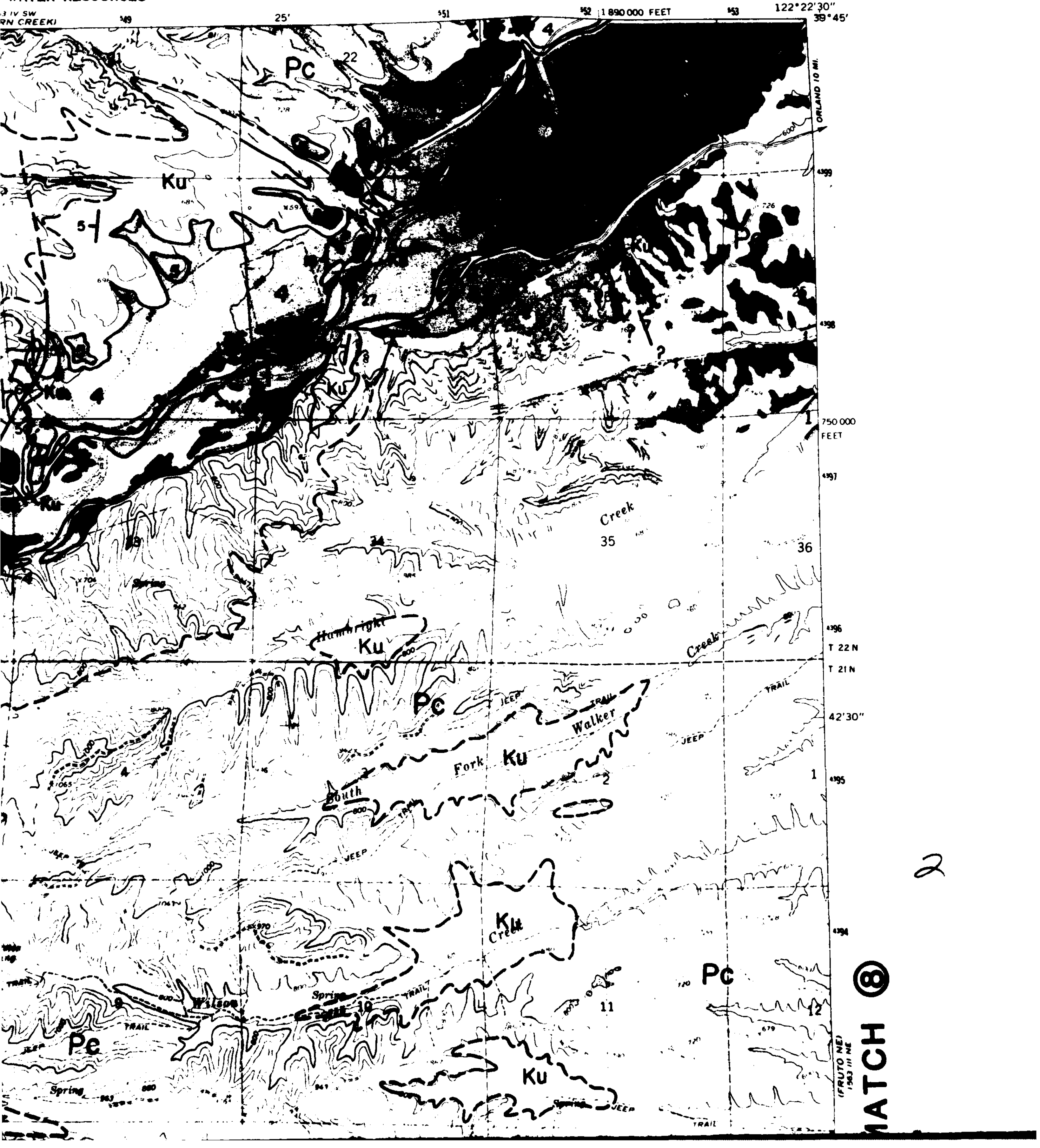


CH ④

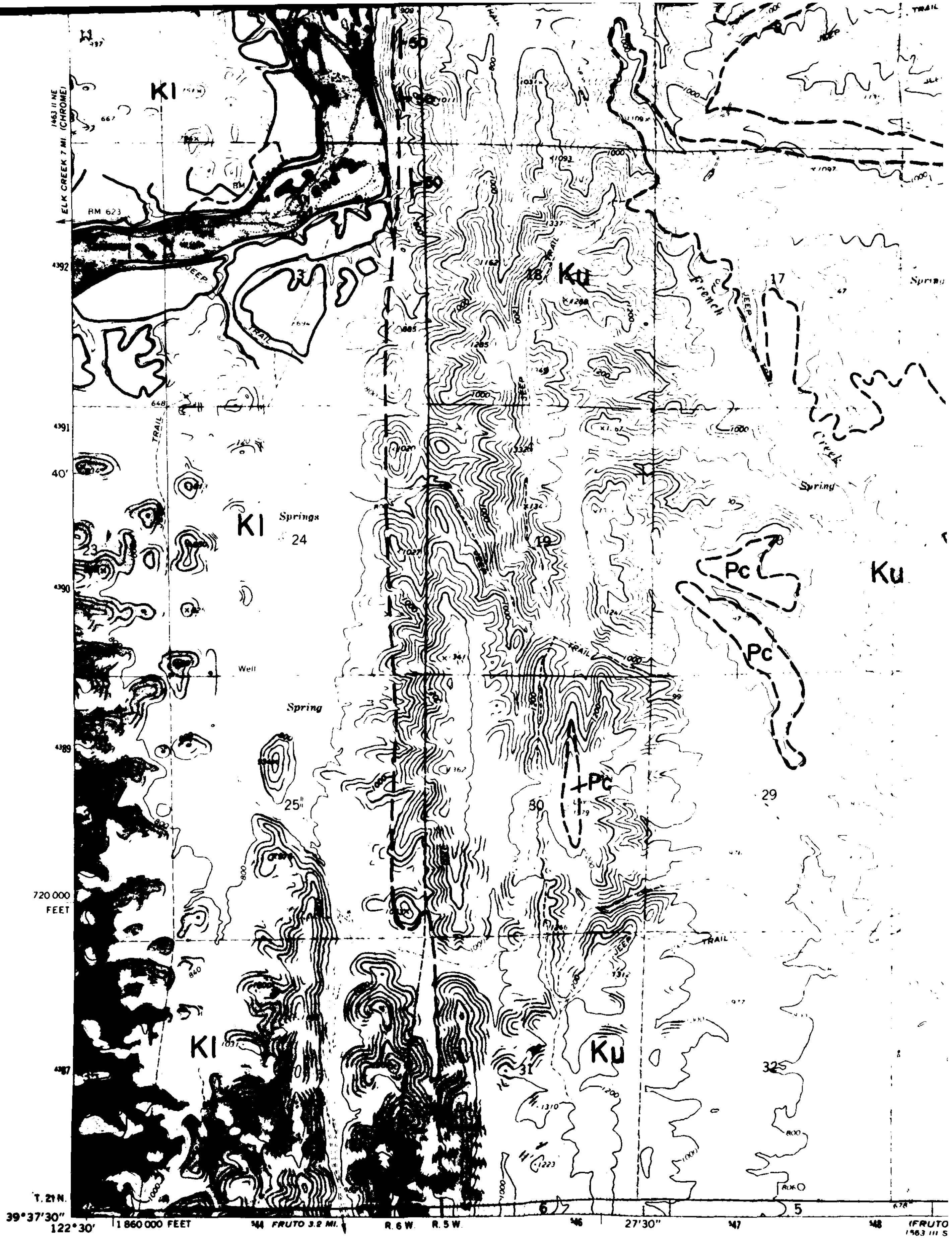
CALIFORNIA

WATER RESOURCES

JULIAN ROCKS QUADRANGLE
CALIFORNIA–GLENN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 FRUTO 15' QUADRANGLE



2



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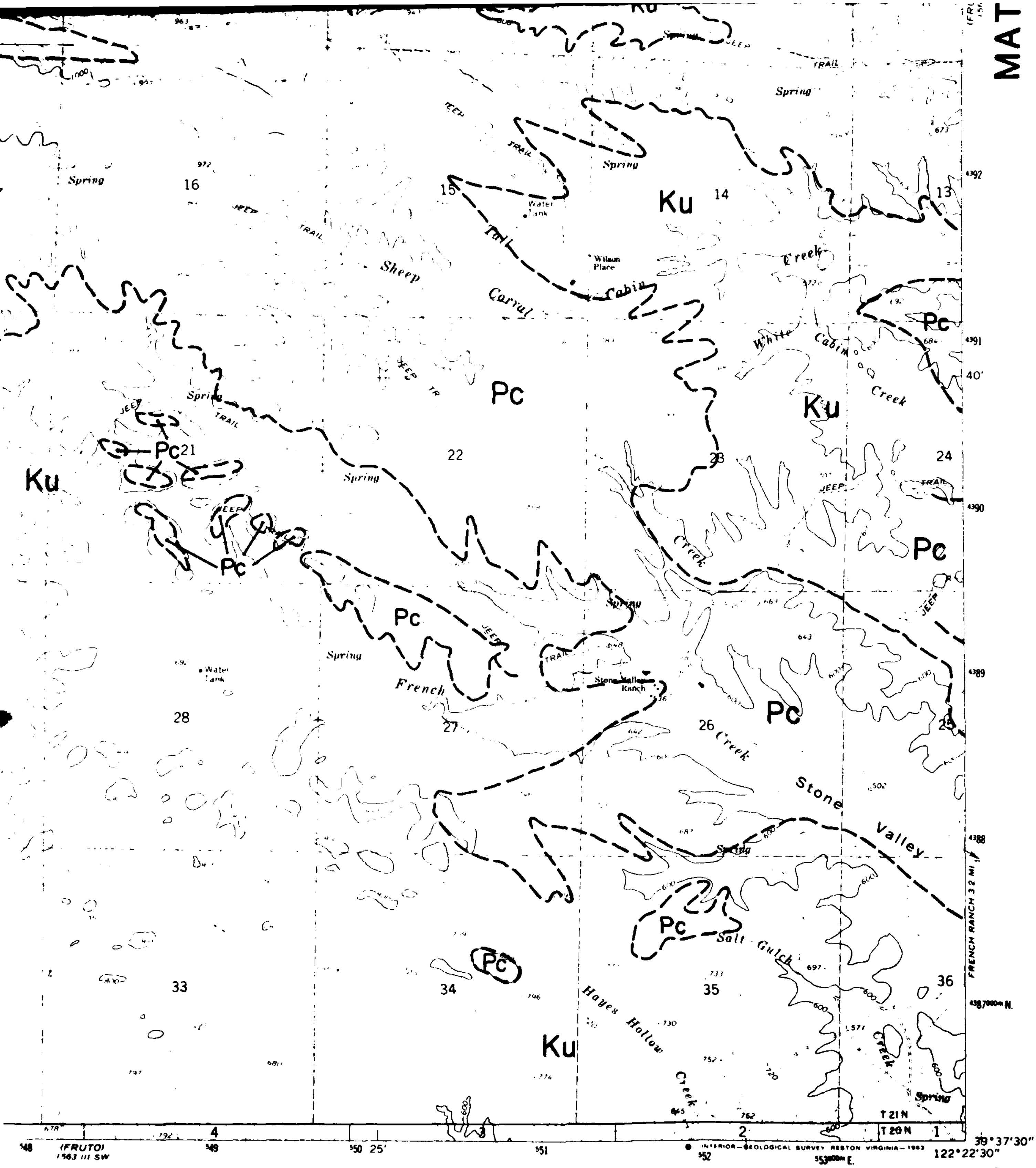
SCALE 1:2

CONTOUR INTERV

DOTTED LINES REPRESENT

NATIONAL GEODETIC VERTI

3



4

SCALE 1:24 000

0 1 MILE

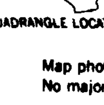
2000 3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

ONTOUR INTERVAL 40 FEET
LINES REPRESENT 20-FOOT CONTOURS
. GEODETIC VERTICAL DATUM OF 1929

ROAD CLASSIFICATION

Light-duty ———— Unimproved dirt - - - - - - - -



QUADRANGLE LOCATION

7

Map photoinspected 1973
No major culture or drainage changes observed

JULIAN ROCKS, CALIF.
NW/4 FRUTO 15' QUADRANGLE
N3937.5—W12222.5/7.5

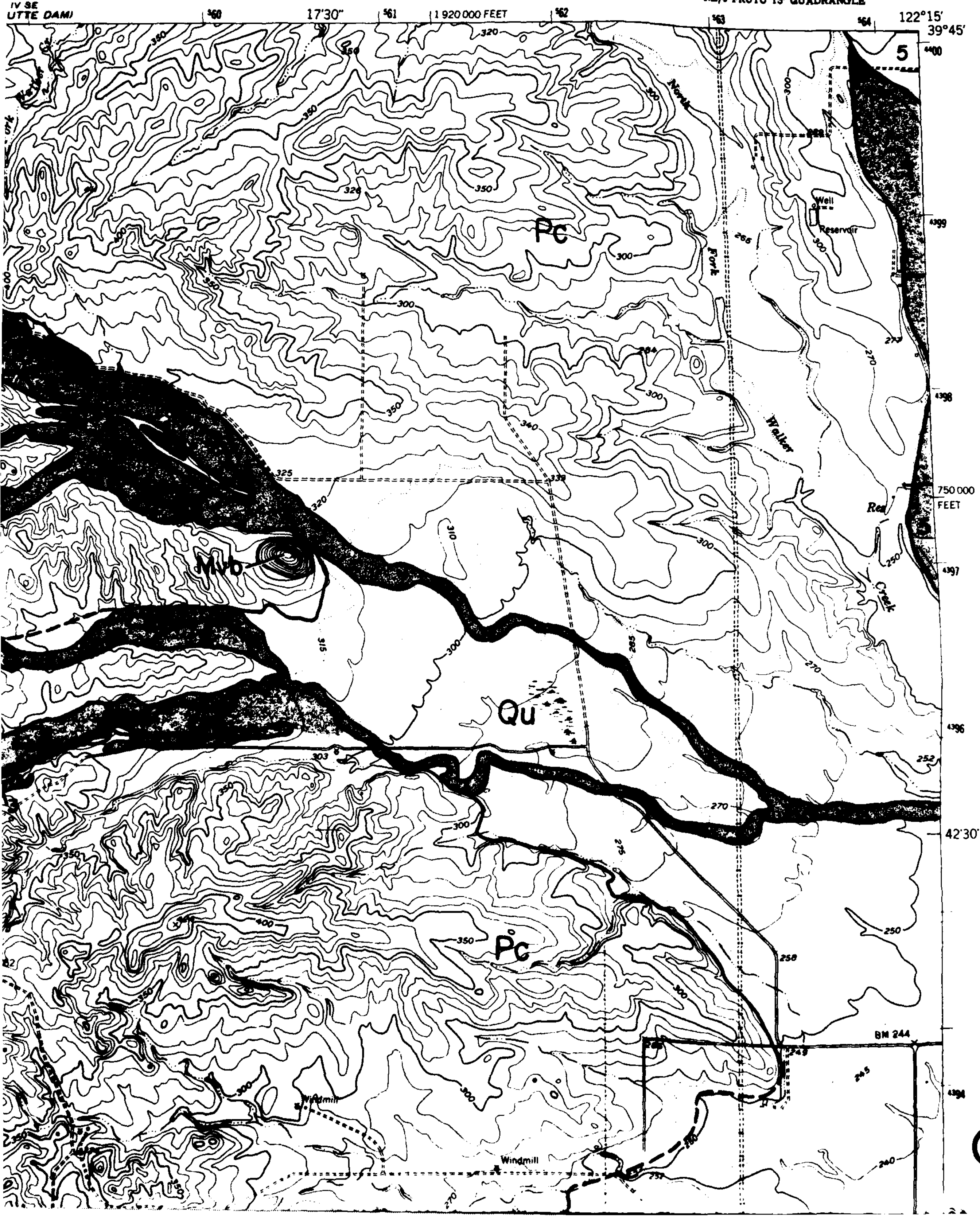
1968
PHOTOINSPECTED 1973
DMA 1563 III NW—SERIES V895


Rc

;H ⑤

CALIFORNIA
WATER RESOURCES

FRUTO NE QUADRANGLE
CALIFORNIA-GLENN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NE/4 FRUTO 15' QUADRANGLE



⑨

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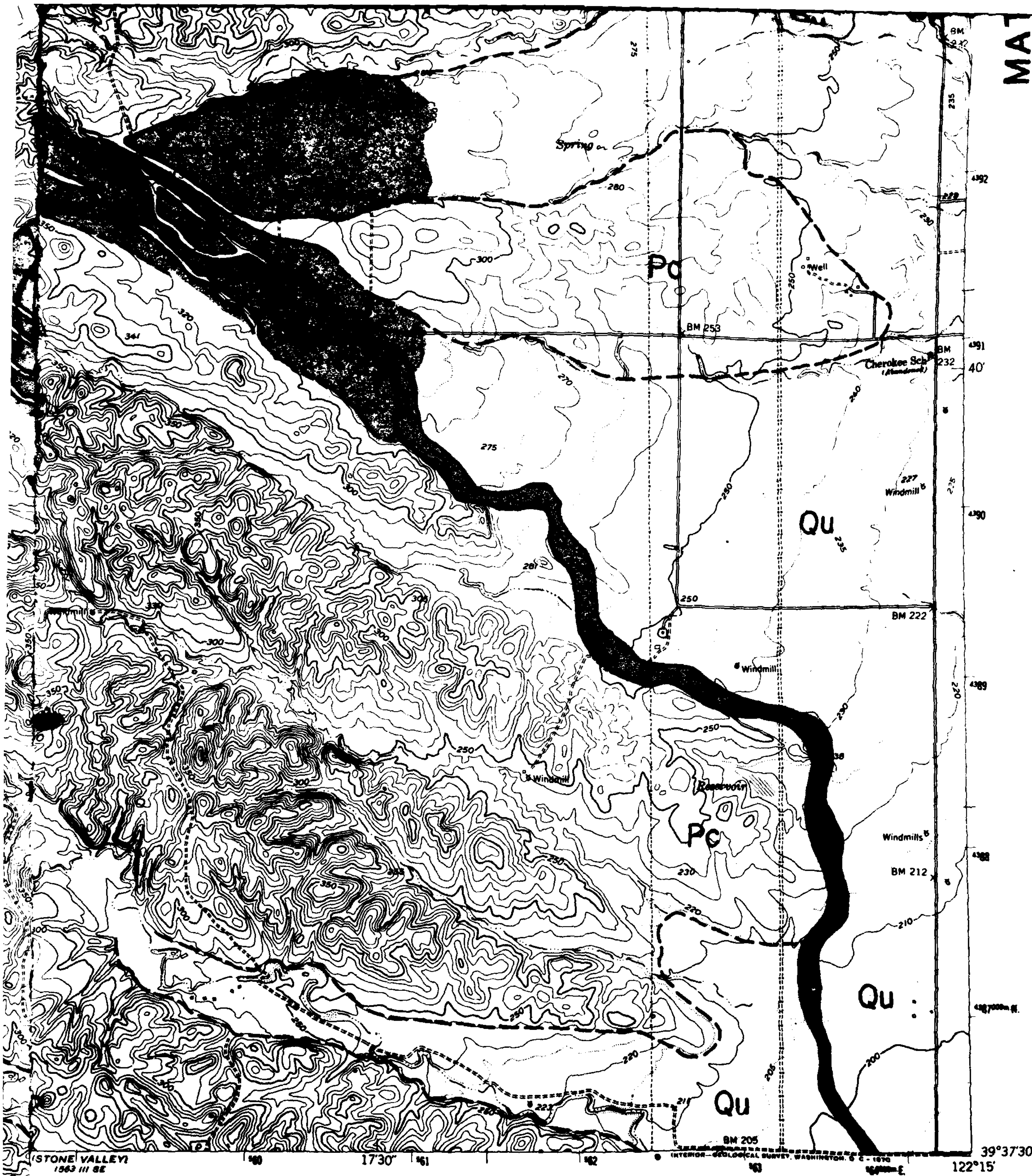
SCALE 1:24 00

1000 0 1000 2000 3000

CONTOUR INTERVAL

DOTTED LINES REPRESENT 5-

DATUM IS MEAN SEA



SCALE 1:24000

1 MILE

3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

...R INTERVAL 10 FEET
...REPRESENT 5-FOOT CONTOURS
...M IS MEAN SEA LEVEL

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt

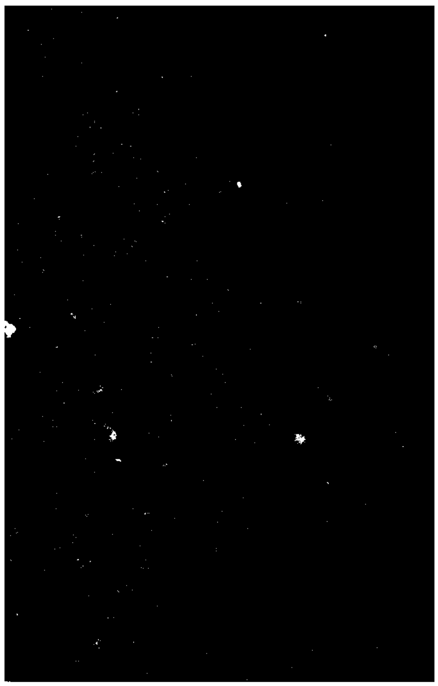
QUADRANGLE LOCATION

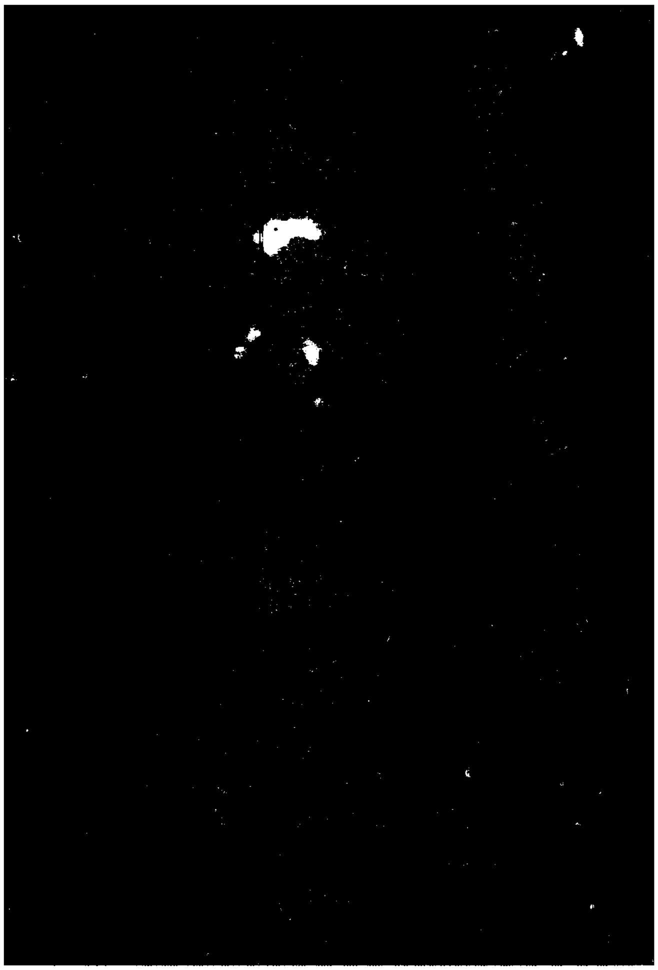
8 FRUTO NE, CALIF.
NE/4 FRUTO 15' QUADRANGLE
N3937.5—W12215/7.5

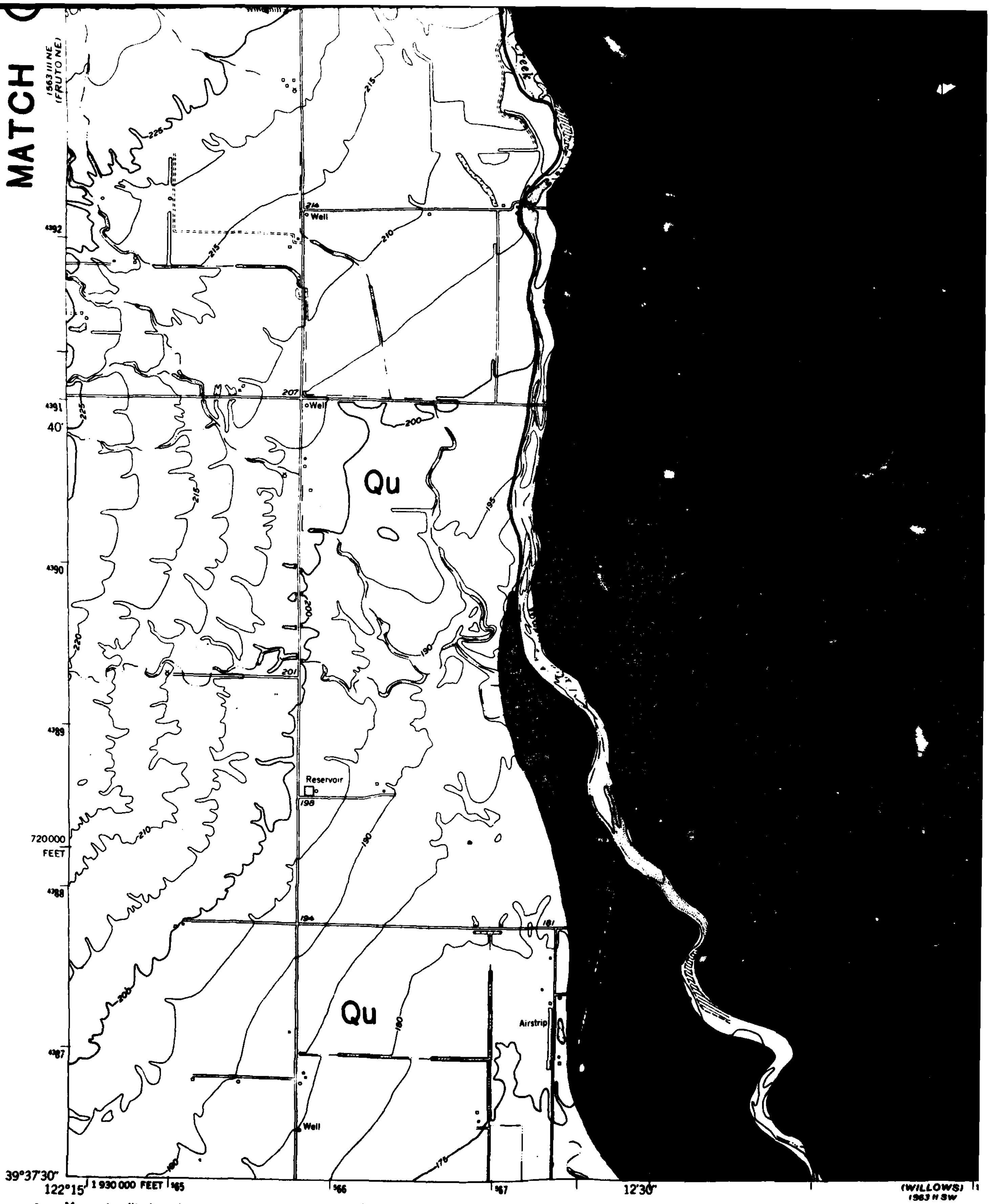
1952

AMS 1563 III NE—SERIES V895

4







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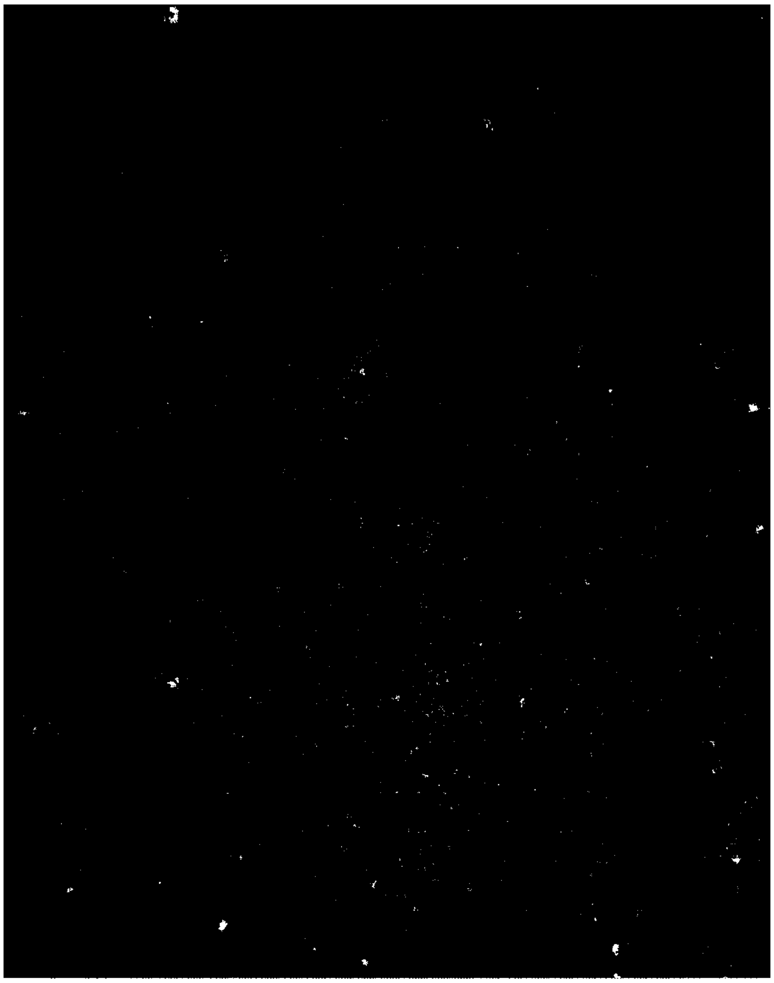
Channel numbers on this sheet indicate channel above modern channel (−1). Letters indicate texture subdivisions (example overbank silts).

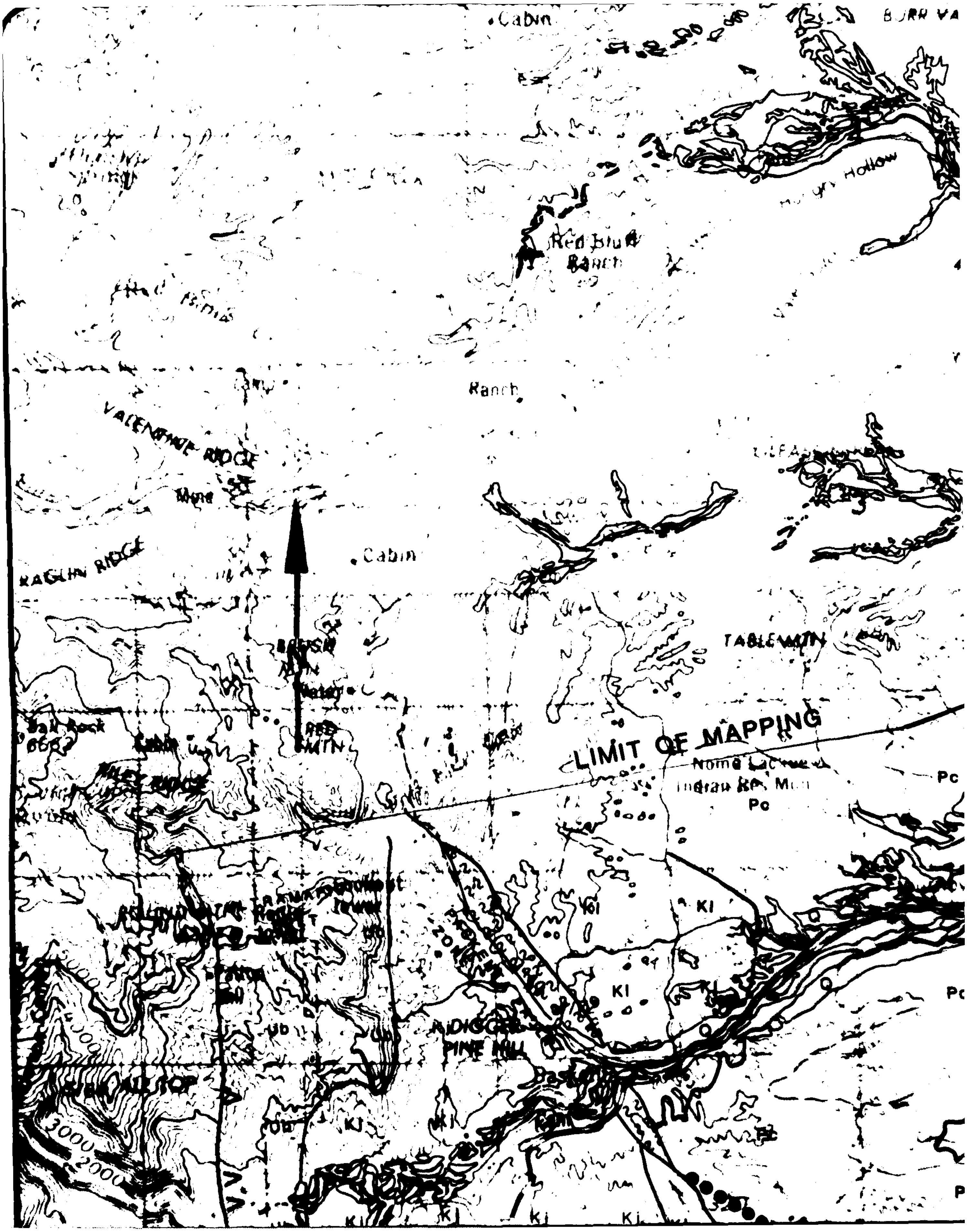
SCALE 1:24 000

CONTOUR INTERVAL 5

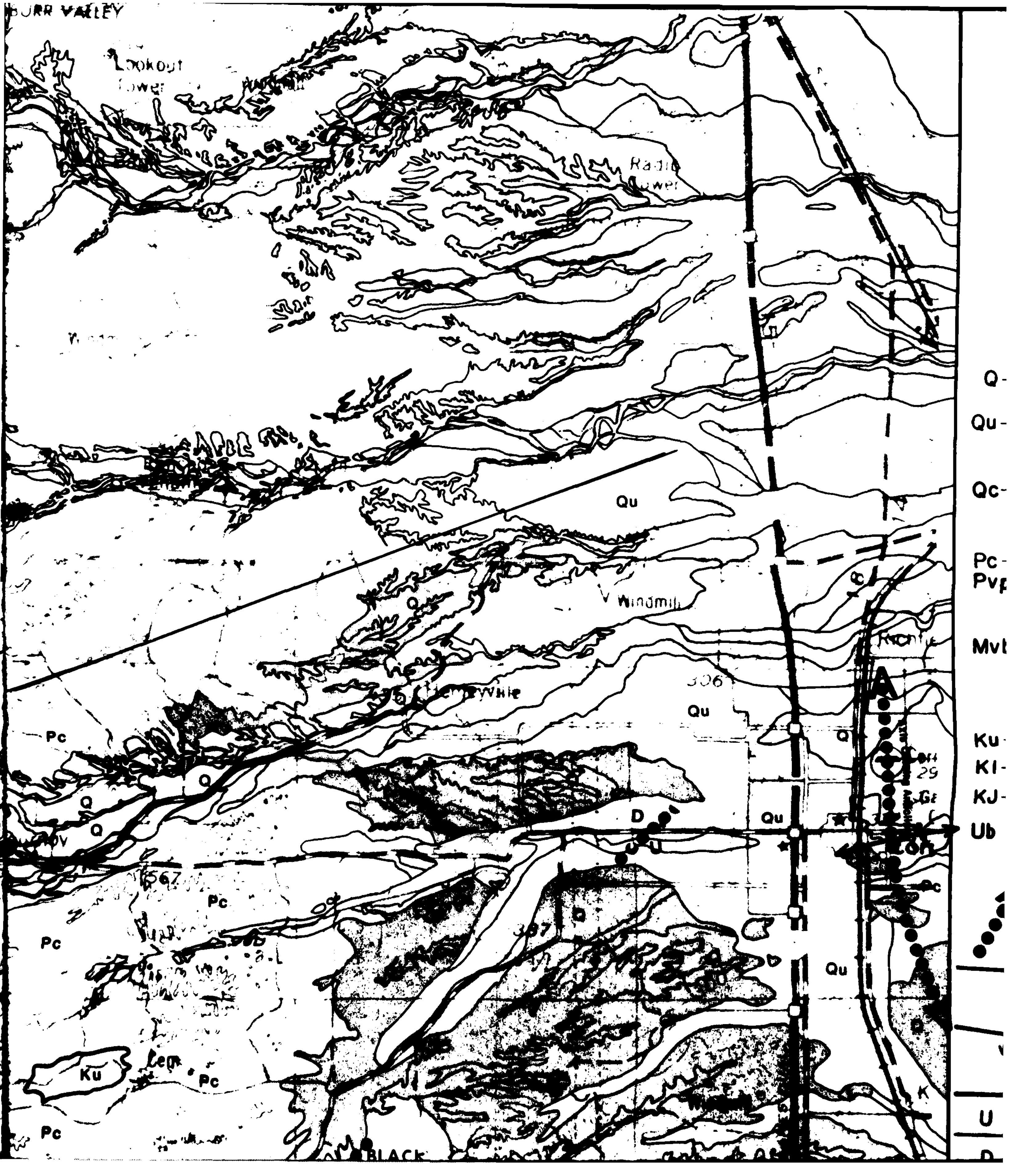
DATUM IS MEAN SEA LE

3

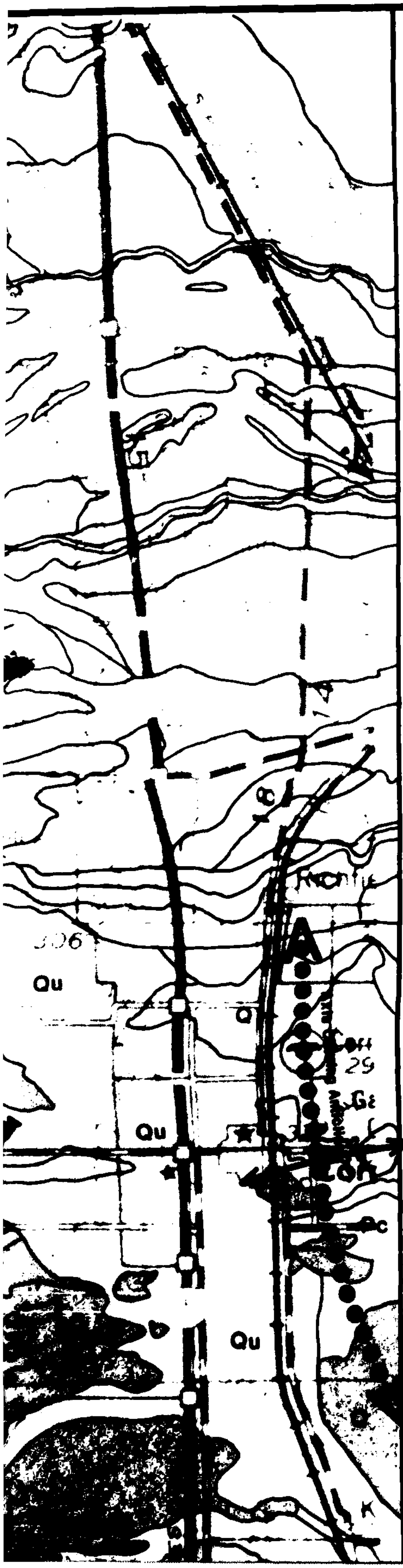




Cabin
Hollow
Red Bluff
Ranch
Ranch
VALENTINE RIDGE
Cabin
TABLE MTN
RED MTN
LIMIT OF MAPPING
Pc
Pc
Kl
Kl
Kl
Kl
Kl
PINE MILL
3000
2000



BURR VALLEY
Lookout
Tower
Radio
Tower
Qu
Windmill
306
Qu
Pc
Q
Q
Q
D
Qu
Qu
Pc
Pc
Pc
Ku
Pc
Pc
Qu
K
BLACK
Q
Qu
Qc
Pc
Pvp
Mvb
Ku
Kl
KJ
Ub
U
D



LEGEND

Q—Quaternary Terrace Sequence; chronologically younger shown as clear, oldest shaded

Qu—Undifferentiated Quaternary Deposits; principally multiple terrace levels with local side stream fan deposits and fan deposits in the southwest area.

Qc—Colluvium; shown on the slopes

Pc—Tehama Formation; Pliocene alluvial fan deposits.

Pvp—Nomlaki Tuff; found in lower part of Tehama Fan.

Mvb—Basalt; found capping Orland Buttes. Correlates to Lovejoy Formation on east side of Sacramento Valley.

Ku— Upper Cretaceous sedimentary basement;

Kl— Lower Cretaceous sedimentary basement;

KJ— Upper Jurassic lowest Cretaceous sedimentary basement;

Ub **Ultrabasic and aphiolite** 3

Refer to text for detailed description of units.

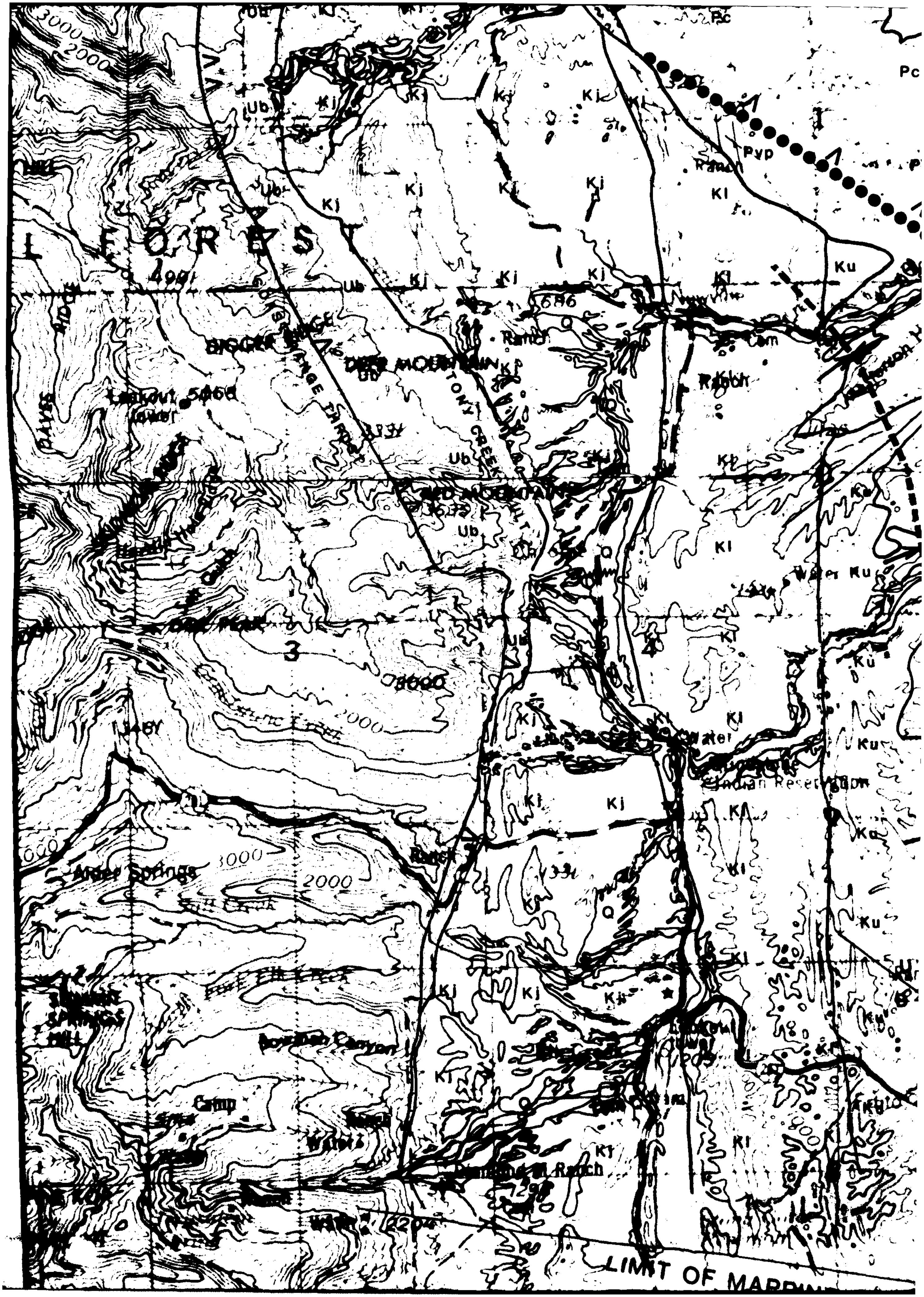
Subsurface structure

Contact; dashed where approximately located

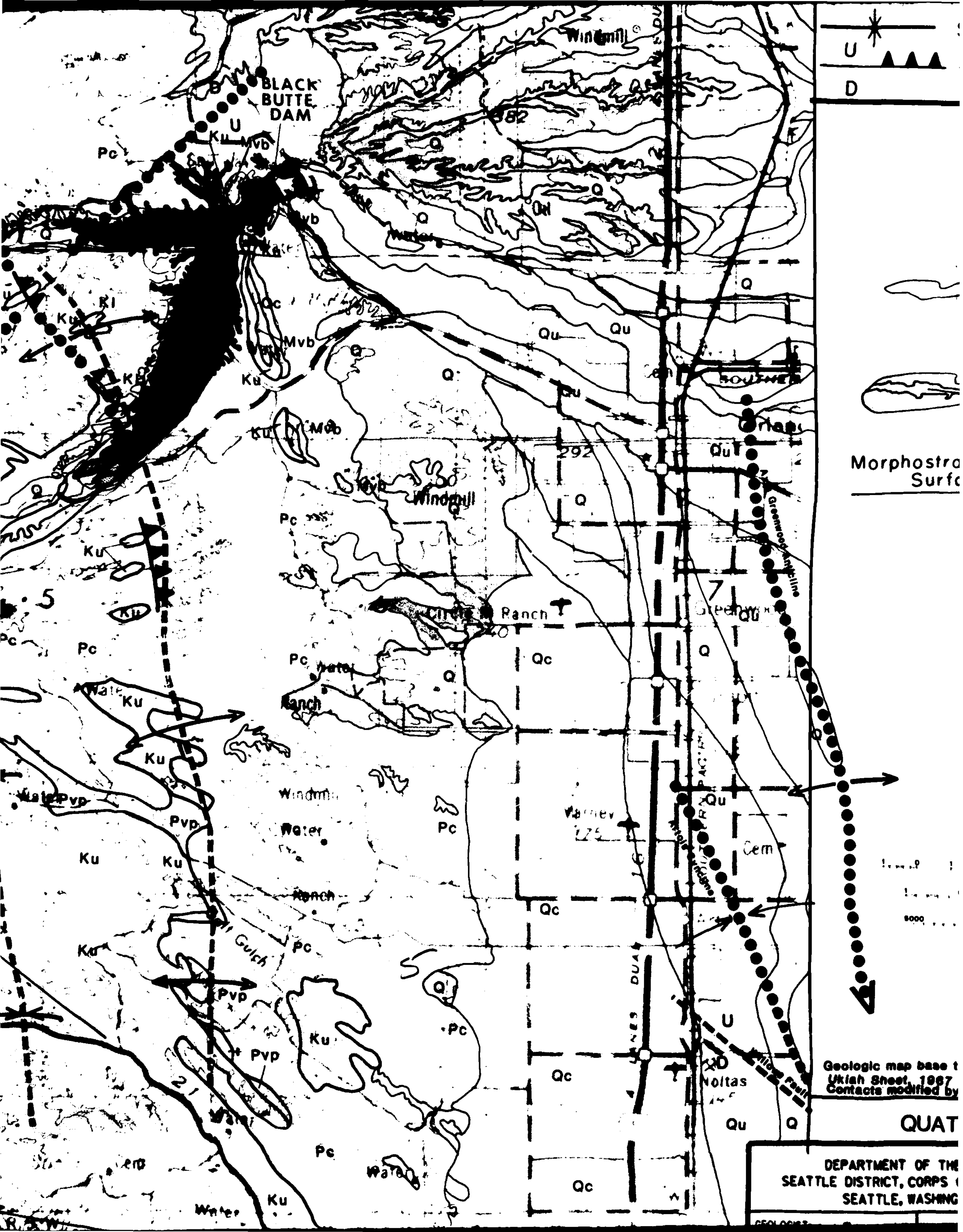
Anticline

Syncline

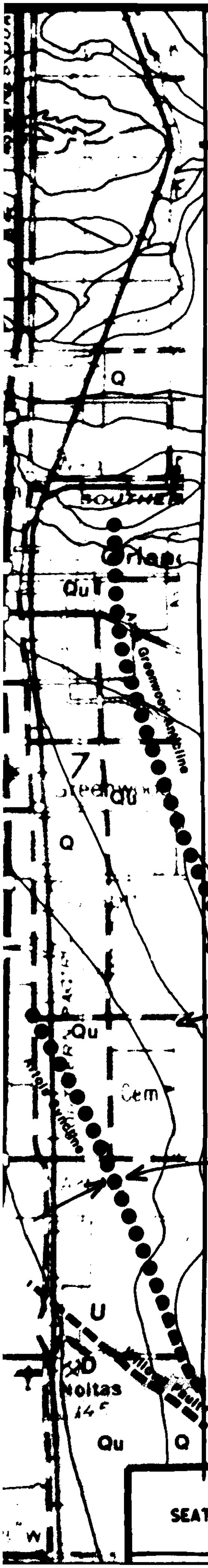
U



F O R E S T
BIGGER RANGE
DEER MOUNTAIN
RED MOUNTAIN
Lookout 5060
Tower
Alder Springs
Bowman Canyon
Camp
Indian Reservation
Ranch
LIMIT OF MAPPING
Kj
Kl
Ku
Ub
Q
Pc
Pyp
3
4
2000
3000



BLACK BUTTE DAM
U
D
Windmill
Circle Ranch
Greenwood
Orland
Morphostro
Surfa
Greenwood anticline
Willows Fault
Noltas
Gulch
Geologic map base t
Ukiah Sheet, 1967
Contacts modified by
QUAT
DEPARTMENT OF THE
SEATTLE DISTRICT, CORPS
SEATTLE, WASHING



U
D

Syncline

Thrust Fault; teeth on upper plate.

Morphostratigraphic Surface

Age Y.B.P.

SCALE 1:100 000

KILOMETERS 10

MILES

FEET 5000 10000 15000 20000 25000

NATIONAL GEODETIC VERTICAL DATUM OF 1929
ELEVATIONS SHOWN IN Feet

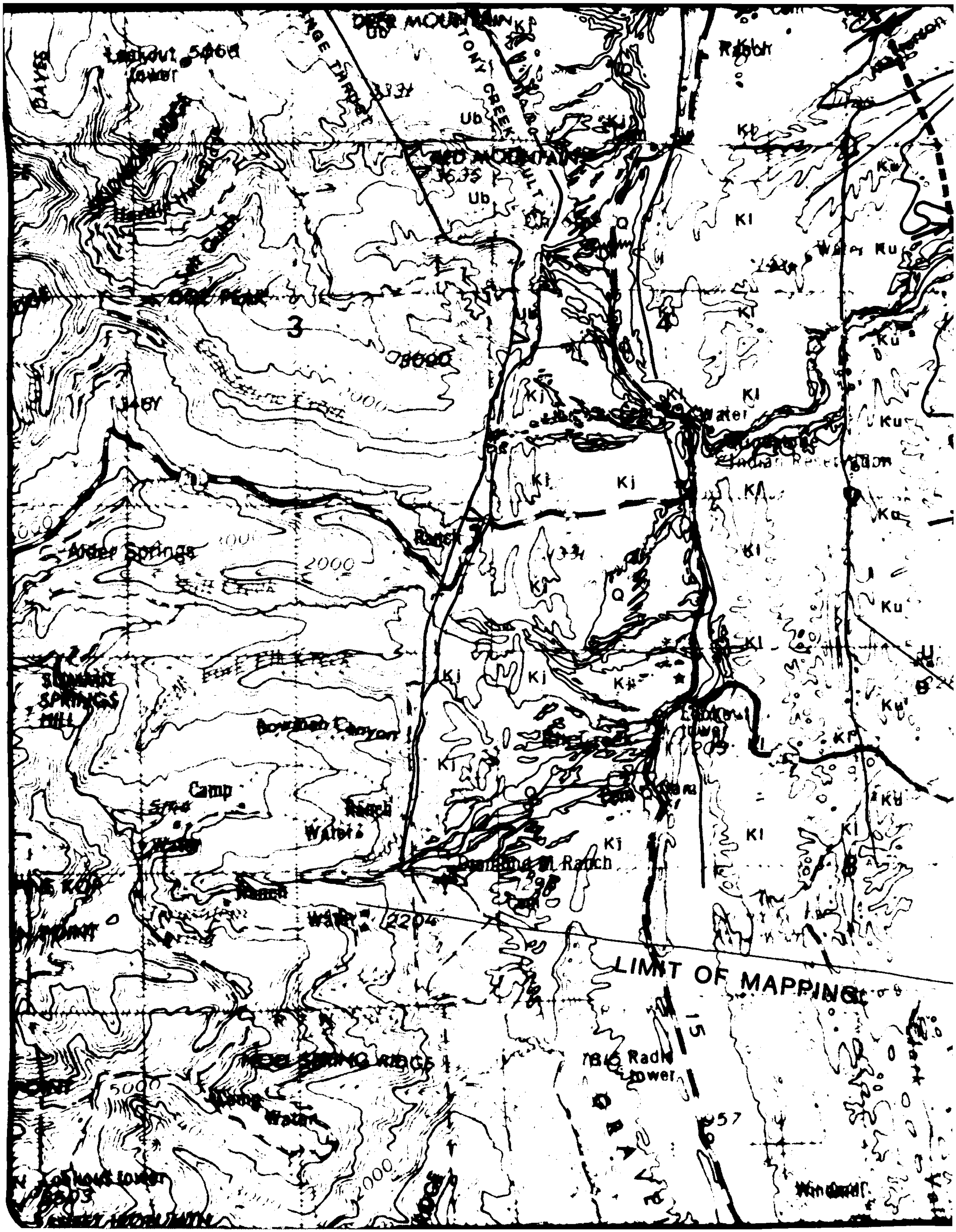
NOTE

1. Compiled from Steele, 1980.

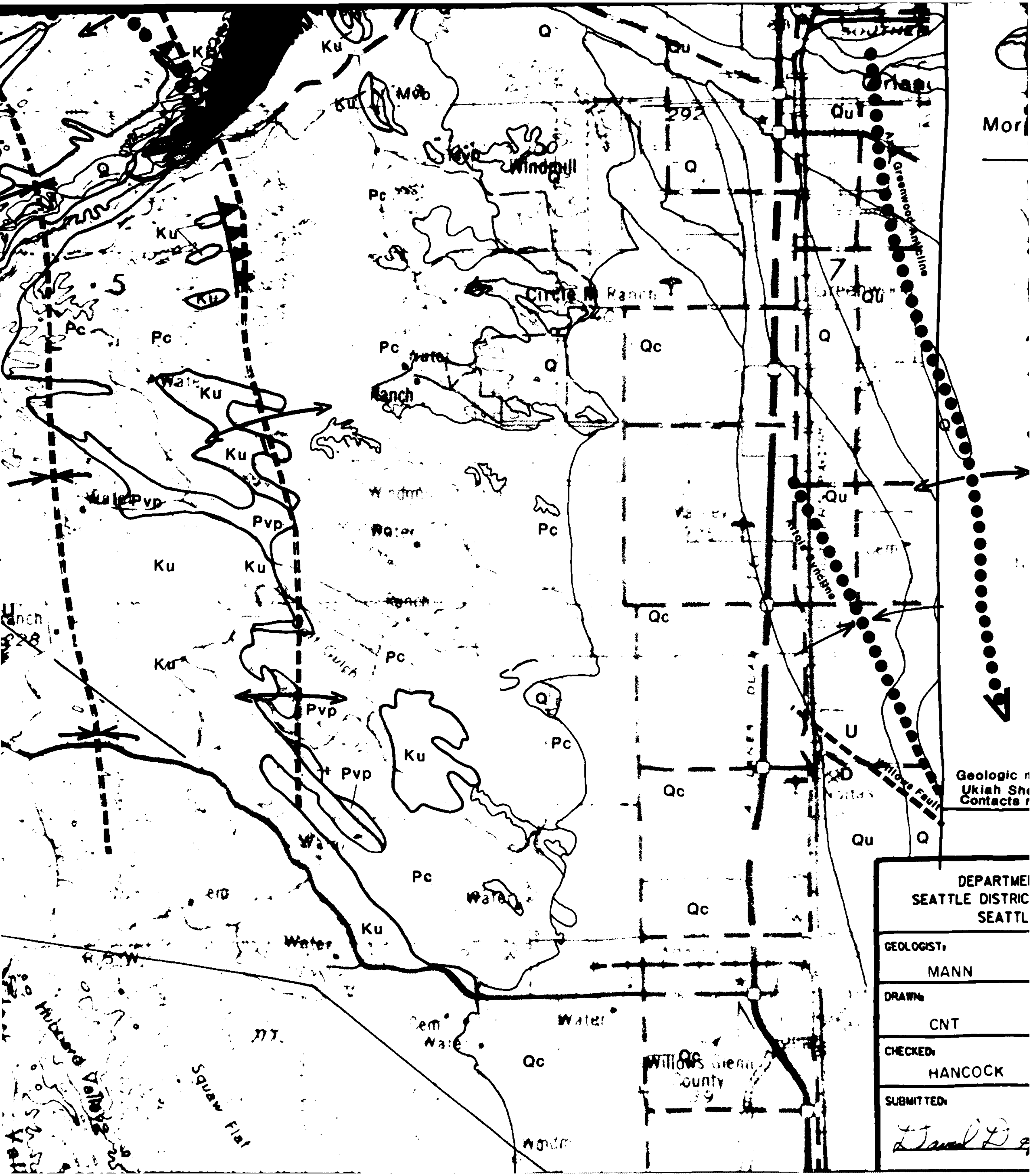
Geologic map base taken from DNR, State of California
Ukiah Sheet, 1967 and Chuber S., 1961.
Contacts modified by this study.

QUATERNARY GEOLOGY MAP[1]

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA



LIMIT OF MAPPING
Alder Springs
Camp
Ranch
Water
Diamond M Ranch
Ub
Kj
Kl
Ku
Q
3
4
15
2000
5000
2204



Q
Ku
Mvb
Qu
292
Windmill
Pc
Ku
5
Circle
Ranch
Qc
7
Greenwood Anticline
Ranch
Pvp
Qc
Q
Pc
U
Willows Fault
Qu
Q
Geologic
Contacts
DEPARTME
SEATTLE DISTRIC
SEATTL
GEOLOGIST:
MANN
DRAWN:
CNT
CHECKED:
HANCOCK
SUBMITTED:
Water
Squaw Flat
Hubbard Valley
Willows Glenn
County

AD-A172 511 BLACK BUTTE LAKE STONY CREEK CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION(U) CORPS OF ENGINEERS SEATTLE WA SEATTLE DISTRICT W E HANCOCK ET AL. JAN 86 4/4

UNCLASSIFIED F/G 13/2 NL

END
DATE
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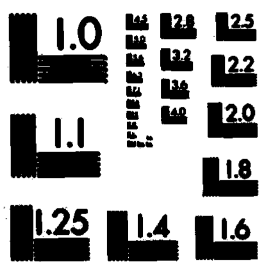
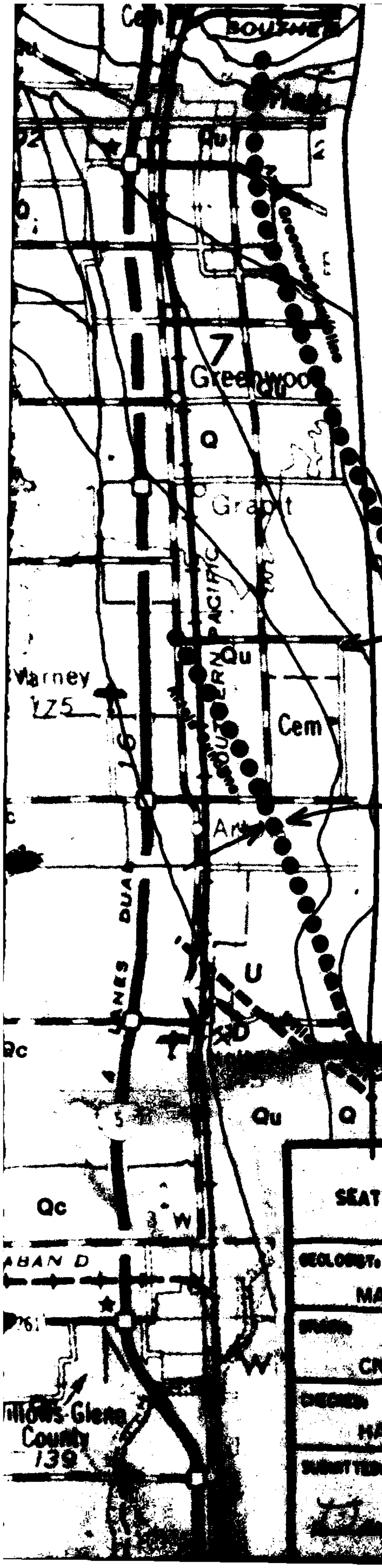


CROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



Morphostratigraphic Surface	Age Y.B.P.

SCALE 1:100 000

KILOMETERS

MILES

FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

ELEVATIONS SHOWN IN Feet

CALIFORNIA

NOTE

1. Compiled from Steele, 1980.

State of California ... 1967 ... 1981.

QUATERNARY GEOLOGY MAP[1]

DEPARTMENT OF THE ARMY SEATTLE DISTRICT, CORPS OF ENGINEERS SEATTLE, WASHINGTON	DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

GEOLOGIST: MANN	BLACK BUTTE LAKE STONY CREEK, CALIFORNIA GEOLOGIC AND SEISMOLOGIC INVESTIGATION BEDROCK GEOLOGY MAP
DRAWN: CNT	
CHECKED: HANCOCK	

SUBMITTED:	DATE APPROVED:	SCALE:	SPEC. NO.
[signature]	[signature]	SHEET	FILE NO. SC-1-10-238

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