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TECHNICAL REPORT
71-27-ES

AN ANNOTATED BIBLIOGRAPHY AND EVALUATION OF REMOTE SENSING PUBLICATIONS RELATING TO MILITARY GEOGRAPHY OF ARID LANDS

by
W. G. Mc Ginnies

Office of Arid Lands Studies
University of Arizona

Contract No. DAAG17-67-C-0199

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UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

Earth Sciences Laboratory
ES-61

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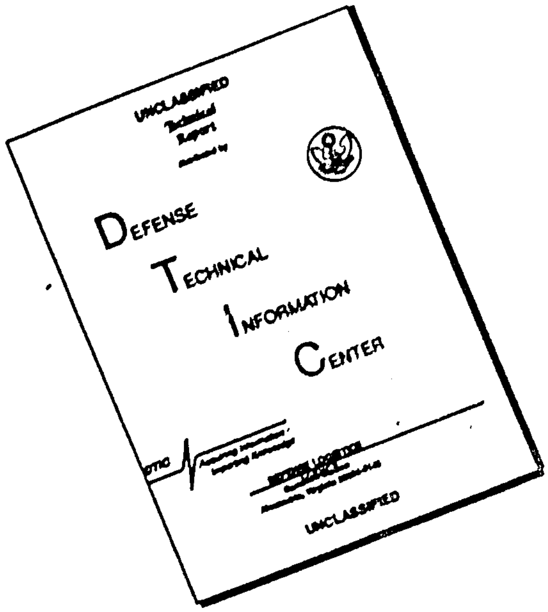

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AN ANNOTATED BIBLIOGRAPHY AND EVALUATION OF REMOTE SENSING PUBLICATIONS RELATING TO MILITARY GEOGRAPHY OF ARID LANDS

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FOREWORD

In 1969 the Earth Sciences Laboratory initiated Task 04 (Military Geography) of Project 1T061102B52A, Research in Military Aspects of Terrestrial Sciences, under which basic research in the earth sciences is conducted by the Army Materiel Command. One of the work items established under this task was a study of new methodologies in desert research, to determine how they might be used to further the mission of the Earth Sciences Laboratory. As a first step in this study, the Office of Arid Lands Studies, University of Arizona, was asked to compile a bibliography of references on remote sensing as applied to the study of desert environments and to evaluate the usefulness of the various items listed. That compilation is presented in the present report.

CONTENTS

ABSTRACT

A comprehensive review has been made of remote sensing publications relating to military geography of arid lands. These have been abstracted or annotated and arranged in tables relating devices and processes to geographic features including terrain, groundwater, surface materials, cultural features, flora, fauna, weather and climate, coastal zones, and general geography. The devices and processes include black and white, color, and infrared photography and devices utilizing longer wave lengths such as radar. Vehicles include conventional airplanes and spacecraft. Each reference is rated as especially useful, useful, or of little value.

AN ANNOTATED BIBLIOGRAPHY AND EVALUATION
OF
REMOTE SENSING PUBLICATIONS RELATING TO MILITARY GEOGRAPHY OF ARID LANDS

Under a previous contract (DA49-092-ARO-71), inventories of arid lands publications related to military geography were furnished to the Earth Sciences Laboratory, U. S. Army Natick Laboratories. Most of the material had to do with ground observations, and almost no attention was given to the rapidly developing fields for obtaining information through remotely situated devices. The present contract included a review of literature under the general heading of methodologies and techniques for the identification and evaluation of features related to military geography. It soon became apparent that the principal devices and methodologies are those utilizing the electromagnetic spectrum, and that the devices may be supported by various aerial platforms such as airplanes and orbiting spacecraft. Hence our reviews are largely concentrated on remote sensing.

Our effort has been centered on a search to determine the nature and extent of information together with an evaluation of the various publications as they may relate to the use of remotely situated devices for military geography in arid regions. Two general categories have been covered: (1) literature related to the basic science and art, and (2) literature of specific application in arid environments. Under the first category the object was to obtain an evaluation of various devices and processes, and under the second to provide references relating specifically to arid environments.

An abstract or annotation was prepared for each of the appropriate publications and these make up the bulk of this report. In addition, tables were prepared to provide a cross reference between devices and geographic features.

A large number of references were checked and those believed to be of value to military geography in arid regions were annotated and classified. Many were eliminated because they did not tie in with arid lands or were of little reference value. Those retained were given a rating as to their value based on the opinion of the present author. Although this subjective rating may be biased, it is hoped that it may save the reader considerable time by the elimination of articles of little or limited value. It should be stressed that the rating is based on the usefulness for readers seeking knowledge of remote sensing, and hence may be considered elementary to scientists with a great deal of knowledge and experience in this field.

In approaching the problems of military geography in arid environments, we first established what we considered the important items to be covered and then searched for appropriate reference material.

In the previous contract (An Inventory of Geographical Research on Desert Environments, DA49-092-ARO-71)* specifications were listed for coverage as follows:

> Emphasis will be placed upon those aspects which have military significance because of their bearing on movement, communications, visibility, concealment, cover, fields of fire, deterioration, durability, storage, construction, food supply, water supply, fuel, disease or other military considerations. These are:
>
> 1. Physical features including:
>   a. Surface configuration - landform types.
>   b. Drainage features - perennial and intermittent streams, bodies of standing water, irrigation canals and ditches.
>   c. Groundwater - aquifers, water tables, springs, wells.
>   d. Surface materials - soils and other unconsolidated materials, rocks.
> 2. Flora and Fauna - distribution and characteristics of flora and fauna.
> 3. Weather and Climate.
> 4. Coastal Zones - nearshore bottom characteristics and coastal structures.

For purposes of the present literature review these were grouped into nine categories as follows:

1. Terrain (TERR) - including surface configuration and drainage
2. Groundwater (GRW)
3. Surface Materials (SOILS)
4. Cultural Features (CUL) - physical works of man
5. Flora (FL)
6. Fauna (FA)
7. Weather and Climate (W & C)
8. Coastal Zones (CO)
9. General Geography (GG)

Surface configuration and drainage features were combined under the heading of "terrain" because of the large overlap of these two features in the literature. The other categories are essentially those listed in the inventory except that the heading "general geography" has been added to cover situations where several different features were discussed in the same article. In some cases where the emphasis warranted it, specific features were marked in addition to general geography.

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* Published as Deserts of the World, an Appraisal of Research into their Physical and Biological Environments. Edited by William G. McGinnies, Bram J. Goldman, and Patricia Paylore. University of Arizona Press, Tucson. 788 p. $15.00.

Devices and processes have been developed to obtain significant amounts of information on various aspects of the environment, but so far these have not been integrated into a comprehensive methodology for obtaining all desired information on the environment at a specific time and place. Existing devices will probably undergo additional developments before comprehensive methodology is possible. Basically there is a sufficient variety of devices available to furnish most of the information needed, but the techniques of using these devices to best advantage and their integration to provide for most efficient use are in an early development stage.

According to Colwell 1968d, the five most important imaging devices are: (1) the converted aerial camera, (2) the panoramic camera, (3) the multiband camera, (4) the optical mechanical scanner, and (5) the side-looking airborne radar device (SLAR). The term process as used here relates to the recording on film or other sensitized material of information obtained through the use of aerial cameras or other sensing devices operated at some distance from the geographic area that is being investigated. As the literature review developed we found it convenient to list literature under a combination of devices and processes:

1. Black-and-white aerial photography (B)
2. Black-and-white infrared aerial photography (BIR)
3. Color aerial photography (C)
4. Color infrared aerial photography (CIR)
5. Infrared emissions (IR)
6. Multiband and multiple sensing (M)
7. Side-looking airborne radar (and other types of radar (S)
8. Space photography (SP)
9. Other, including general discussion and basic references (O)

The references are listed in tables 1 through 9 covering the nine geographical features. Each table includes the author's name in the first column on the left and the date of publication in the next column. Together these two items provide easy reference to the reviewed articles included in this report.

Column 3, "Use," shows our evaluation of these references as they apply to military geography of desert environments. The references were coded as follows:

1. Especially useful
2. Useful
3. Of little value

The remaining columns are checked to show the principal devices and processes discussed in the publication reviewed.

The frequency that a device is checked in the tables gives some indication of its remote sensing value for that feature. But this numerical tendency may not be relied upon as more than an indication, since the various devices and processes are not in the same stage of development. For example, the large number of black-and-white photograph entries might appear to show that this approach is superior to others, but it must be remembered that black-and-white aerial photography has been in practice for a much longer period than the other techniques. Also, even though satisfactory results were obtained with black-and-white aerial photography, more recently developed devices and processes may be superior in bringing out information impossible to obtain without the newer technique; hence the newer technique offers more promise and may eventually be used more. Infrared and radar sensing, for instance, have recently received a great amount of attention, and the literature shows that they can provide information that cannot be obtained readily, if at all, by orthodox aerial photography. This is especially true for terrain features. The larger number of entries under M (multiband and multiple sensing) shows that the use of more than one approach is desirable. An examination of the literature strongly supports this thesis.

It is not the purpose of this report to summarize the extensive literature on remote sensing as applied to arid lands military geography, but a few examples may serve to show how various devices and processes can be used to get information.

Aerial photography using black-and-white has been, over the years, the basic technique for landscape studies. Development in the art and science has led to a very sophisticated and comprehensive delineation of landscapes including all the principal natural and cultural features. Soil surveys, accurate topographic maps made directly from aerial photographs, and timber surveys in which the kinds and amount of timber can be determined with little ground check, are examples of the things that can be done with basic black-and-white photography.

The identification of individual plant species under desert conditions poses many difficulties. Where species have a range related to edaphic conditions, they may be identified through interpretation of topographic and soil conditions. Thus areas dominated by sagebrush (*Artemisia*) and salt bush (*Atriplex*) can be delineated on the basis of soils, so color photography and color infrared photography can be repeated at different seasons. Also, because of the different transpiration characteristics of plants, thermal infrared images may prove valuable, especially where both daytime and nighttime photography is possible.

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Near-infrared black-and-white photography is particularly useful to show the boundaries of water, as these relatively long wavelengths do not penetrate water and hence shorelines are distinctly demonstrated. On the other hand, color films without filters are sensitive in short wavelengths and can depict underwater conditions at considerable depths.

Side-looking aerial radar (SLAR) may be of limited value for continental deserts, but because of its ability to penetrate fogs it should be of great value in coastal deserts such as the Atacama and the Namib. It is of limited value in areas of large topographic range, according to Colwell (1968d), but because of the sharp shadow effects it is of great value in depicting minor topographic differences. SLAR also has the advantage that shadows are the same at all times of the day, whereas aerial photographs taken at midday on the desert are noticeably lacking in detail.

Trafficability appears to be one of the most difficult features to evaluate. The general trafficability conditions in regions of low rainfall and hence generally dry soils may remain fairly constant for long periods, but during and following rains, they may vary greatly. Sandy soils may actually improve in trafficability whereas soils with a high clay content may become a serious handicap to the movement of men and equipment. A playa in dry weather may serve as a landing field for light aircraft, but following rains, and depending upon pH and salt content of the surface, the playa may have entirely different and often unsatisfactory characteristics. Washes that may be traversed easily when dry sometimes become torrential watercourses following rains, and as such they may be hazards or impediments to men and equipment.

Photography from satellites has brought a new dimension to the use of remotely situated devices; although it loses in identification of details, it gains in broader perspective. Physiographic provinces can be seen in their entirety, and the relation of one landscape feature to another is more clearly shown than on smaller-scale photos. The amount of detail that can be recognized with the aid of "ground-truth" control and supplementary information obtained by low-level flights is surprising.

The following acronyms occur throughout the Bibliography following. Some of them refer to the abstracting tools that were helpful in the location of these citations (where fuller abstracts may be found if the user wishes to consult them), others to agencies responsible for research in this field, and still others to devices or techniques used in remote sensing. Any not found here are fully explained in citations using these abbreviations or in the accompanying abstracts.

AAAS	American Association for the Advancement of Science
AFCRL	U. S. Air Force Cambridge Research Laboratories
ANAG	Abstracts of North American Geology
AVCS	Advanced Vidicon Camera System
BA	Biological Abstracts
BIGENA	Bibliography of Geology Exclusive of North America
CFSTI	Clearinghouse for Federal Scientific and Technical Information; since October 1970 called National Technical Information Service (NTIS)
CRES	Center for Research in Engineering Science, University of Kansas
CSIRO	Commonwealth Scientific and Industrial Research Organization, Canberra
FSTC	U. S. Army Foreign Science and Technology Center
IAA	International Aerospace Abstracts
JPRS	Joint Publications Research Service
MGA	Meteorological and Geoastrophysical Abstracts
NASA	National Aeronautics and Space Administration
NTIS	National Technical Information Service
SLAR	Side-looking Airborne Radar
STAR	Scientific and Technical Aerospace Reports
SWRA	Selected Water Resources Abstracts
USDA	U. S. Department of Agriculture

SUMMARY TABLES

1. TERRAIN *

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	C	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	C
Alexander	1965	3								X		Dellwig, Kirk & Walters	1966	3							X		
Anson	1965	1	X		X	X						Dellwig, MacDonald & Kirk	1968	3							X		
Badgley, Childs & Vest	1967	1						X		X		Dellwig & Moore	1966	2							X		
Badgley, Fischer & Lyon	1965	3						X		X		Denny et al.	1968	1	X								
Barringer	1963	2					X		X		X	Ellermeier, Simonett & Dellwig	1967	2							X		
Beccasio & Simons	1965	3							X			Estes	1966a	2					X				
Belcher et al.	1951	2									X	Feder	1960	1							X		
Bertran	1965	2	X									Feder	1963	3						X			
												Fischer	1958	2			X						
Cantrell	1964	1					X					Fischer	1962a	2							X		
Carneggie & Lauer	1956	1						X				Fischer	1962b	1			X						
Clos-Arceduc	1966	2	X									Fischer	1966	1						X			
Colwell	1960	2	X	X		X						Fischer	1967	2								X	
Colwell	1961	2						X				Fischer & Ray	1957	2	X		X						
Colwell	1968b	1						X		X		Gawarecki	1968	2					X				
Crandall	1963	3							X			Ghose, Pandey & Singh	1966	2	X								
Davis, C K & Neal	1963	2	X									Grabau	1967	2									X
Davis, J M	1966	2	X									Hackman	1967	2							X		
DeLancie, Steen & Fippen	1957	2	X									Hannah et al.	1964	2						X			
Dellwig	1968	2							X			Hemphill	1938	2	X								

* See page 4 for meaning of column headings.

TERRAIN (p. 2)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Hemphill	1963	3									X
Hemphill & Danilchik	1968	2			X					X	
Holmes	1968	3	X								
Jennings	1968	2									X
Kent	1957	1			X						
Kharin, Nurberdyev & Serkhanov	1969	3	X								
Leestma	1965	2								X	
Leighty	1968	1							X		
Lewis	1957	2	X								
Llaverias	1968	1						X			
Lowman	1965	2								X	
Lyon & Burns	1963	3					X				
Lyon & Patterson	1966	2					X				
MacDonald, Brennan & Dellwig	1967	2	X						X		
MacKallor	1968b	1								X	
Matalucci & Abel-Hady	1968	1					X				
McCoy	1968	2							X		
McLerran	1967	3					X				
McLerran	1968	3					X				

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Meer & Nefetov	1969	2	X								
Mendez	1968	2								X	
Merifield & Rammelkamp	1966	2								X	
Merifield et al.	1969	3								X	
Molineux	1965a	2						X			
Molineux	1965b	2						X			
Moore, R K	1968	2							X		
National Academy of Sciences	1966	3								X	
Neal	1965	1	X								
Neal	1968	3								X	
Needleman & Molineux	1969	1									X
Newberry	1960	2							X		
Nordberg & Samuelson	1965	3					X				
Ory	1965	2									X
Parker	1968	2						X			
Petrov	1969	1	X								
Poquet	1968a	3								X	
Poquet	1968b	3					X				

TERRAIN (p. 3)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Pratt	1968	2					X				
Ray & Fischer	1960	3	X								
Richter	1967	1	X								
Robinove & Skibitzke	1967	2									X
Romanova	1968	2									X
Rouse, Waite & Walters	1966	2							X	X	
Rydstrom	1966	2							X		
Rydstrom	1967	2							X		
Sabins	1967	2					X				
Sabins	1968	1					X				
Sabins	1969	1					X				
Schaber	1968	2					X		X		
Schwieder	1968	2									X
Sen	1966	2	X								
Shvyryaeva	1969	2	X								
Simonett	1966b	1							X		
Simonett	1968a	3							X		
Simons	1965	2							X		
Smith, H T U	1963	1	X								
Smith, H T U	1969	1	X								

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Souto Crasto	1966	1	X								
Stone	1956	1	X								
Strandberg	1967	2	X								
Strangway & Holmer	1965	2					X				
Titley	1968	2								X	
Tolchelnikov	1969	3	X								
Unesco	1968	1	X								
U S NASA Sci & Tech Div	1967	1								X	
VanLopik	1968	2					X				
Vinogradov	1969	3	X								
Waldo & Ireland	1955	2	X								
Wallace & Moxham	1967	1					X				
Wellman	1966	2	X								
Williams & Ory	1967	2					X				
Wobber	1967	3								X	
Wolfe	1968	2					X				

2. GROUND WATER

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Artsybashev	1969	2					X																
Barringer	1966	3						X															
Colwell	1966	1						X															
Estes	1966	2					X																
Holmes	1968	3	X																				
Howe	1958	3	X																				
Howe	1960	3	X																				
Kuznetsov	1969	2	X																				
Llaverias	1968	1						X															
Meer & Nefetov	1969	2	X																				
Robinove	1965	3					X																
Robinove	1967	2						X															
Robinove	1968	2						X															
Robinove & Anderson	1969	2						X															
Robinove & Skibitzke	1967	2									X												
Shvyryaeva	1969	2	X																				
Strandberg	1966	2	X																				
Strandberg	1967	2	X																				
Van Lopik	1968	2					X																

3. SOILS

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Anson	1966	1	X		X	X					
Anson	1968a	2			X	X					
Artsybashev	1969	2					X				
Becking	1959	2			X						
Belcher	1948	2	X								
Cantrell	1964	1					X				
Carneggie	1968c	2						X			
Carneggie & Colwell	1966	2						X			
Colwell	1968b	1						X		X	
Cooper	1965	2						X			
Coulson	1966	3									X
Curtis	1962	3	X								
Davis & Neal	1963	2	X								
Edgerton	1968	2									X
Fischer	1962b	1			[illegible]						
Holmes, D A	1968	3	X								
Holmes, R F	1967	3							X		
Kern	1963	3					X			X	

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Kuznetsov	1969	2	X								
Molineux	1965a	2						X			
Molineux	1965b	2						X			
Morain & Simonett	1966	1							X		
Morrison	1958	2								X	
Myers *et al.*	1966	3					X	X			
Neal	1965	1	X								
Richter	1967	1	X								
Rivera Márquez	1966	2	X								
Romanova	1968	2									X
Shockley *et al*	1963	1					X				
Shvyryaeva	1969	2	X								
Simakova	1964	2	X		X						
Simakova	1966	2	X								
Simonett	1968a	3							X		
Simons	1965	2							X		
Stone	1956	1	X								
Tolchelnikov	1969	3	X								
Unesco	1968	1	X								
U S Dept of Ag	1966	1	X								
Vinogradov	1958	2	X								

SOILS (p. 2)

AUTHOR	DATE	USE	B	HIR	C	CIR	IR	M	S	SP	O
Wallace & Moxham	1967	1					X				
Williamson	1966	3									X

4. CULTURAL FEATURES

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Alexander	1965	3								X	
Alexander et al	1968	3						X			
Anson	1966	1	X		X	X					
Badgley, Childs & Vest	196[illegible]	1						X			
Bawden	1967	3	X								
Blythe & Kurath	1967	3					X				
Bowden	1968	1				X		X			
Carneggie, Lent & Colwell	1967	2						X			
Colwell	1965b	2	X	X							
Colwell	1968b	1						X		X	
Davis, J M	1966	2	X								
Dmitrenko et al.	1967	2			X						
Doverspike, Flyn & Heller	1965	2			X						
Frey	1967	2						X		X	
Ghose & Singh	1965	2	X								
Gimbarzevsky	1966	3	X								
Hawkins & Munsey	1963	3	X								
Hoffer, Holmes & Shay	1966	2						X			

AUTHOR	DATE	USE	B	PIR	C	CIR	IR	M	S	SP	O
Honea & Prentice	1968	1						X			
Ionesco & Selod	1967	3	X								
Larson, Kuyper & Latham	1969	2			X	X					
Lowe	1968a	3						X			
MacKallor	1968b	1								X	
Moore, E G & Wellar	1968	2						X			
Moore, R K	1968	2							X		
Moore, R K & Simonett	1967	3							X		
Myers et al.	1966	3					X	X			
National Academy of Sciences, Nat Research Council	1966	3								X	
Newberry	1960	2							X		
Olson	1967	3					X				
Parker	1968	2						X			
Pryor	1964	3	X								
Richter	1967	1	X								
Schaber	1968	2					X		X		
Schwartz & Zeidner	1961	3	X								

CULTURAL FEATURES (p. 2)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Simonett	1968b	3							X														
Simonett	1968c	3							X	X													
Steiner	1965	2	X	X	X																		
Stone	1956	1	X																				
Strandberg	1964	3	X																				
Swanson	1964	2	X		X																		
Unesco	1968	1	X																				
Vidal	1967	2	X																				

5. FLORA

AUTHOR	DATE	USE	B	BIR	C	TR	IR	M	S	SP	O
Anson	1966	1	X		X	X					
Artsybashev	1969	2					X				
Avery	1966	2	X								
Avery	1968b	2	X					X			
Becking	1959	2			X						
Belcher	1948	2	X								
Blythe & Kurath	1967	3					X				
Bowden	1968	1				X		X			
Cain	1966	3									X
Carneggie	1967	2			X			X			
Carneggie	1968a	1						X			
Carneggie	1968b	2						X			
Carneggie	1968c	2						X			
Carneggie & Lauer	1966	1						X			
Carneggie, Lent & Colwell	1967	2						X			
Carneggie, et al.	1967	2						X			
Cochrane	1968	3			X	X					
Colwell	1960	2	X	X		X					
Colwell	1965b	2	X	X							
Colwell	1968b	1						X		X	

AUTHOR	DATE	USE	P	BIR	C	CIR	IR	M	S	SP	O
Colwell & Olson	1965	2					X				
Cooper	1965	2						X			
Coulson	1966	3									X
Draeger	1966	2						X			
Ellermeier, Simonett & Dellwig	1967	2							X		
Francis	1970	2			X	X					
Frey	1967	2						X		X	
Gates et al.	1965	1									X
Hoffer, Holmes & Shay	1966	2						X			
Ionesco & Selod	1967	3	X								
Kharin, Murberdyev & Serkhanov	1969	3	X								
Kornfield et al.	1967	1								X	X
Lauer	1967	3						X			
Lauer	1968	3						X		X	
Llaverias	1966	1						X			
Lyons	1967	3						X			
Molineux	1965b	2						X			
Moore, R K	1968	2							X		
Moore, R K & Simonett	1967	3							X		

FLORA (p. 2)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Morain & Simonett	1966	1							X		
Morain & Simonett	1967	2							X		
Myers, V I *et al.*	1966	3					X	X			
National Academy of Sciences	1966	3								X	
National Academy of Sciences	1969a	3								X	
Olson & Good	1962	2									X
Olson & Ward	1968	3			X	X					
O'Neill	1953	3	X								
Peterson *et al.*	1969	2						X			
Poulton	1968	3								X	
Rose & Thomas	1968	2					X				
Rouse, Waite & Walters	1966	2							X	X	
Simonett	1968a	3							X		
Simonett	1968b	3							X		
Stone	1956	1	X								
Unesco	1968	1	X								
Vinogradov	1958	2	X								

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Vinogradov	1966	1	X								
Vinogradov	1969	3	X								
Wallace & Moxham	1967	1					X				
Wickens	1966	1	X								
Wilson	1967	3								X	

6. FAUNA

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Cain	1966	3									X												
Carneggie	1967	2						X															
Carneggie, Rob-erts & Colwell	1966	2						X															

7. WEATHER & CLIMATE

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Allied Research Associates	1967a	2					X			X													
Allied Research Associates	1967b	2					X			X													
Barrett	1967	2						X		X													
Belesky	1968	2							X														
Colwell	1966b	1						X															
International Council of Scientific Unions	1967	2								X													
Jacobs-Haupt	1963	3								X													
Konoski	1964	3					X																
Kornfield et al.	1967	1								X	X												
Korzov & Krasil'shchikov	1967	3		X																			
Moeller	1967	2								X													
Popham & Baliles, eds.	1966-1967	2								X													
Rubin	1968	2					X																
Spitz	1968	3									X												
Warnecke	1967	2								X													
Weiss	1967	3					X																
Winston & Taylor	1967	3								X													

8. COASTAL ZONES

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	CP	O
Badgley, Childs & Vest	1967	1						X		X	
Colwell	1961	2						X			
Dietz	1947	2						X			
Fischer	1962b	1			X						
Geary	1968	2			X						
Lepley	1968	2			X					X	
Lowman	1965	2								X	
Shepard	1950	2	X								
Smith, J T, Jr	1963	2			X						
Sonu	1964	2	X								
Stevenson & Nelson	1968	2								X	
Swanson	1964	2	X		X						
Tewinkle	1963	2	X		X						
Theurer	1959	2						X			
U S NASA Sci & Tech Div	1967	1								X	

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	CP	O

9. GENERAL GEOGRAPHY

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Alexander	1964	2						X		X		Bowden	1968	1				X		X			
Alexander	1967	3						X		X		Brandenberger	1967	3	X								
Amer Soc of Photogrammetry	1960	1						X				Buettner & Kern	1963	3					X				
Amer Soc of Photogrammetry	1965	3								X		Carneggie & Lauer	1966	1						X			
Amer Soc of Photogrammetry	1966	3						X				Carneggie, Lent & Colwell	1967	2						X			
Amer Soc of Photogrammetry	1968	1			X	X						Colwell	1961	2						X			
Anschutz & Stallard	1967	3	X									Colwell	1965a	2						X			X
Anson	1968b	2	X		X	X						Colwell	1966a	3						X			
Avery	1968a	2	X									Colwell	1966b	1						X			
Badgley, Childs & Vest	1967	1						X		X		Colwell	1968a	1								X	
Badgley & Vest	1966	2								X		Colwell	1968c	2						X	X		
Berkowitz	1965	2							X			Colwell	1968d	2						X			
Bird & Morrison	1964	2								X		Colwell	1968e	1						X			X
Bird, Morrison & Chown	1964	1								X		Corriher & Byron	1965	1							X		
Bomback	1964	2			X							Cortright	1968	1								X	
Bomback	1965	2			X							Coulson	1966	3									X
Borchert	1958	3						X				Current	1967	3			X						
												Davis, A & Viezee	1964	3					X				

GENERAL GEOGRAPHY (p. 2)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Davis, J M	1966	2	X								
Dellwig, MacDonald & Kirk	1968	3							X		
Dill	1967	2								X	
Drayson	1969	2					X				
Duddek	1967	3			X						
Entres	1969	2								X	
Enzmann	1966	3								X	
Esten	1964	2	X								
Estes	1966b	2					X				
Fiore	1967	2							X		
Fischer	1968	2								X	
Frey	1967	2						X		X	
Fritz	1967	1				X					
Fry & Mohrhardt	1963	1								X	
Futran	1967	2					X				
Galneder	1967	1	X								
Garrison	1965	2						X			X
Gates	1965	1					X	X			
Ga[illegible]arecki, Lyon & Nordberg	1965	3					X			X	
Gerlach	196[illegible]	3						X			

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SF	O
Ghose & Singh	1965	2	X								
Gillis & Leestma	196[illegible]	2								X	
Grabau	1967	2									X
Hammond	1967	2	X								
Hodgin	196[illegible]	2									X
Hogan & Townsend	1967	3								X	
Holter, M R	1967	3					X				
Holter, M R *et al.*	196[illegible]	2					X				
Honea & Prentice	196[illegible]	1						X			
Innes	1968	1							X		
Jones	1966	1						X			
Korzov & Krasil'shchikov	1967	3		X							
Kover	196[illegible]	3							X		
Laing & Pardoe	1969	3						X		X	
Lancaster, & Feder	1966	3						X			
Lancaster	1968	2						X			
Larson, Kuyper & Latham	1969	2			X	X					
Latham	1963	2						X			X

GENERAL GEOGRAPHY (p. 3)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Latham	1966	3									X	Merriam	1966	3						X			
Latham	1967	3						X				Mintzer	1968	3	X					X			
Latham	1970	2						X				Molineux	1962	3									X
Latham & Witmer	1967	2						X				Momsen	1968	1	X								
Leestma	1966	2						X		X		Moore, E G & Wellar	1968	2						X			
Leestma	1967	2									X	Moore, R K	1966	3							X		
Leonardo	1963	2							X			Morgan	1962	2					X				
Leonardo	1964	3						X				Morrison & Bird	1965	2								X	
Levine et al.	1966	1							X			Morrison & Chown	1964	2								X	
Llaverias	1969	1						X				National Academy of Sciences	1969a	3								X	
Lowe	1968b	2					X					National Academy of Sciences	1969b	3								X	
Lowman	1965	2								X		Newell	1968	3								X	
Lueder	1959	1	X									Nikolaev & Ryabtseva	1969	3	X								
MacKallor	1968a	2								X		Norton	1968	1			X	X					
Malila	1968	2						X				Nunnally	1968	2							X		
Martin	1966	3					X					Ockert	1960	3								X	
Matalucci & Abel-Hady	1968	1					X					Olson	1970	2									X
McAnerney	1966	2							X			Olson	1963	3	X								
McDaniel	1959	2			X							Pardoe	1969	3								X	
Merifield et al.	1969	3								X													

GENERAL GEOGRAPHY (p. 4)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Parker	1962	2									X
Parker	1968	3						X			
Parker & Wolff	1965	3						X			
Pecora	1967	3								X	
Peltier & Pearcy	1966	2									X
Petrov	1969	1	X								
Popham & Baliles	1966-1967	2								X	
Poulton, Schrumpf & Garcia-Moya	1968	2								X	
Prentice	1967	2						X			
Rall	1966	3									X
Raytheon Company	1965	1							X		
Resta	1965	2								X	
Rib	1968	2						X			
Richter	1967	1	X								
Rouse, Waite & Walters	1966	2							X		
Schaber & Gummerman	1969	3					X				
Schwarz & Caspall	1968	2							X		
Sherman	1963	3									X

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Simonett	1966a	3									X
Skolnik	1962	3							X		
Smith, N	1962	2							X		
Sorem	1967	1			X						
Stanford University	1968	2							X		
Steiner	1963	2	X								
Stone	1956	1	X								
Stone	1964	1	X								
Strandberg	1967	2	X								
Strees	1961	3								X	
Stroud	1960	3								X	
Suits	1960	1					X				
Swanson	1964	2	X		X						
Symposium on Photo Interpretation	1962	1						X			
Tarkington & Sorem	1963	2			X	X					
Tata, Palmer & Witmer	1967	3									X
Titley	1968	2								X	
U S Dept of the Army	1967	1						X			

<u>GENERAL GEOGRAPHY</u> (p. 5)

AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O	AUTHOR	DATE	USE	B	BIR	C	CIR	IR	M	S	SP	O
Van Lopik	1962	1									X												
Van Lopik & Yarbrough	1966	3						X															
Viktorov	1969	3	X																				
Vinogradov	1966	1	X																				
Vinogradov	1968	3	X																				
Walters	1968	1							X														
Wear	1960	1			X																		
Weaver	1969	2						X															
Welch	1968	2						X			X												
Williams	1950	2			X																		
Williams	1967	3								X													
Winterburg & Wulfeck	1961	1			X																		
Wolfe	1965	1					X																
Yost & Wenderoth	1967	1			X																		

AN ANNOTATED BIBLIOGRAPHY AND EVALUATION
OF REMOTE SENSING PUBLICATIONS RELATING TO
MILITARY GEOGRAPHY OF ARID LANDS

26

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The particular format of the following citations has been determined by the computer program developed at the University of Arizona for automated retrieval of the world desert reference information bank in the Office of Arid Lands Studies. The use of asterisks herein indicates to the computer a new element in each citation, and has no meaning whatsoever to the user of this bibliography, nor should it affect his use of the information in this form.

data obtained for each day (UT). Daytime data for June 24, 1966, are included for comparison purposes. A transparent overlay for general orientation with the latitude and longitude of the data is included. Nimbus II users' guide is referred to for background information and a description of the experiment.

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43. *Cantrell, J. L.
*1964 *Infrared geology. *Photogrammetric Engineering 30(6): 916-941.

*Infrared imagery can indicate even slight differences in soil and soil moisture capable of influencing vegetative growth; surface materials (sandstone or limestone) can be distinguished. The method is especially good for studying surface water conditions. Some examples on edge or arid zone.

44. *Carneggie, D. M.
*1967 *The use of high altitude, color and spectrozonal imagery for the inventory of wildlife resources. v. 1 (of 3). *University of California, Berkeley, Timber Resources Forestry Remote Sensing Laboratory, for NASA.

45. *--- ---
*1968a *Remote sensing applications for the inventory of range resources. In *Earth Resources Aircraft Program Status Review, II: Agriculture, Forestry and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 39-1 to 39-27. Tables.
*Article includes a table showing relation of various sensors, and ground resolutions in relation to identification of range features and conditions. These relationships are also brought out in color illustrations. Orbital sensing is chiefly valuable for synoptic view. Low altitude sensing is essential for detailed studies. Color films, Ektachrome and Ektachrome IR are best for single lens sensors. 3-band color additive films are excellent.

46. *--- ---
*1968b *Remote sensing applications in forestry; analysis of remote sensing data for range resource management. Annual Progress Report, 30 September 1968. *University of California, Berkeley, Forestry Remote Sensing Laboratory/ NASA-CR-100894. STAR 7(13)N69-25632. 76 p.
*Various remote sensing devices, including photographic systems, optical mechanical scanners and thermal infrared scanners obtained remote sensing data at different seasons and scales. Portions of the electromagnetic spectrum in which remote sensing was accomplished ranged from the ultraviolet, through the visible and near infrared to the thermal infrared. Analysis of the data showed that the season when imagery is obtained is critical in determining the amount of useful information obtainable from remote sensing imagery. For the most part high image resolution is desirable, although broad vetetation and soil typing can be accomplished using lower resolution imagery. The level of detail required is partially determined by the intensity of management that is to be practiced.

47. *--- ---
*1968c *Applying remote sensing technology for improving range resource inventories. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 373-385. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.

*Various sensors are described and their usefulness for identifying range characteristics are discussed. Ektachrome and Ektachrome infrared were consistently best for vegetation and soil mapping, but were only slightly better in arid environments. Infrared and SLAR have their place and multispectral imagery offers great possibilities, but interpretation is complicated.

48. *Carneggie, D. M./Colwell, R. N.
*1966 *The soil, water and wildlife and recreation resources. v. 3 (of 3). *University of California, Berkeley, Timber Resources Forestry Remote Sensing Laboratory, for NASA.

49. *Carneggie, D. M./Lauer, D. T.
*1966 *Uses of multisensor remote sensing in forest and range inventory. *Photogrammetria 21(4):115-141.
*This article considers kinds of information that can be obtained by using thermal infrared and radar imagery in conjunction with conventional aerial photography. Each type of imagery is analyzed in terms of inventory of vegetation classes, timber types (height, age and density), species composition, terrain features, watershed boundaries and human activity.

50. *Carneggie, D. M./Lent, J. D./Colwell, R. N.
*1967 *The feasibility of determining rangeland and cropland conditions by means of multispectral aerial photography. *University of California, Berkeley, School of Forestry. USDA Contract No. 12-18-04-1-559.

51. *Carneggie, D. M./Roberts, E. H./Colwell, R. N.
*1966 *The range resource. v. 2 (of 3). *University of California, Berkeley, Timber Resources Forestry Remote Sensing Laboratory, for NASA.

52. Carneggie, D. M./Poulton, C. E./ Roberts, D. H., eds.
*1967 *The evaluation of rangeland resources by means of multispectral imagery. NASA, Office of Space Sciences and Applications, Annual Report for Earth Resources Program. 76 p.

53. *Clos-Arceduc, A.
*1966 *Le rôle déterminant des ondes aériennes stationnaires dans la structure des ergs sahariens et les formes d'érosion avoisinantes. (The determining role of stationary aerial waves in the structure of Saharan ergs and neighboring forms of erosion). *Académie des Sciences, Paris, Comptes Rendus, sér. D, 262(26):2673-2676. GA 18.7-450.
*The stability and the forms of vertical wind erosion noted on aerial photographs are evidence of the remarkable stability of the local atmospheric oscillatory state. It is suggested that these erosion forms could provide information about the climatic evolution during the Quaternary.

54. *Cochrane, G. R.
*1968 *False color film fails in practice. *Photogrammetric Engineering 34(11):1142-1146.
*In Australia color infrared does not show up insect and disease conditions better than color film. Leaves with heavy cuticle have greater reflectance than mesic types.

55. *Colwell, R. N.
*1960 *Some uses of infrared aerial photography in the management of wildland areas. *Photogrammetric Engineering 26:774-785.
*Simultaneous aerial photographs of wildland areas on infrared and panchromatic aerial negative films are compared and discussed. In general, since subject and atmospheric conditions vary so widely, exposures on both types of films furnish a more adequate basis for the interpretation. Two films for infrared aerial photography and their uses (including suitable filters) are briefly discussed: (1) Kodak Infrared Aerographic Film, a black-and-white negative material, and (2) Kodak Ektachrome Aero Film (Camouflage Detection), a reversal tripack color film.

56. *--- ---
*1961 *Some practical applications of multiband spectral reconnaissance. *American Scientist 49:9-36.
*The applications of the techniques used are described. For example, multiband spectral reconnaissance may be used to distinguish between different terrestrial surfaces and types of terrain; for observing celestial phenomena and events related to them; for studying crop diseases; and for recording the underwater features of coastal areas, etc. Techniques mentioned include diffraction analysis, fluorescent microscopy, autoradiography and integration of several color photographic images.

57. *--- ---
*1965a *The extraction of data from aerial photography by human and mechanical means. *Photogrammetria 20:211-228.
*Machinery can be devised for all photo-image characteristics (size, shape, shadow, tone, texture, pattern and location) but identification of objects and judging of significance are better solved by human photo interpreters.

58. *--- ---
*1965b *Spectrometric considerations involved in making rural land use studies with aerial photography. *Photogrammetria 20:15-33.
*Although not concerned with arid lands, the paper gives some practical suggestions for film-filter combinations to bring out various landscape features.

59. *Colwell, R. N.

*1966a *Aerial photography of the Earth's surface; its procurement and use. *Applied Optics 5(6):883-892.

*The stated purpose of this article is to (1) highlight the ways in which applied optics prints aerial photography of suitable image quality to be obtained and (2) summarize the kinds of highly useful information relative to the Earth's surface that can be obtained from such imagery. Applications are briefly and broadly discussed for cartography, geology, soil science, forestry, range management, wildlife management, agriculture, hydrology and engineering.

60. *--- ---

*1966b *Uses and limitations of multispectral remote sensing. In Symposium on Remote Sensing of Environment. 4th, 1966, Proceedings p. 71-100. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.

*A comprehensive discussion of multispectral remote sensing, beginning with a brief historical account. An analysis follows each of the major factors governing the ability to obtain information through multispectral remote sensing. The paper concludes with several examples to illustrate the uses and limitations of multispectral imagery. It is concluded that multispectral remote sensing is a potentially valuable means of solving inventory requirements.

61. *--- ---

*1968a *Determining the usefulness of space photography of natural resource inventory. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 249-289. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.

*A distinguished authority takes the reader step by step through space photography and tells how to use it to obtain the greatest efficiency in interpretation as a basis for natural resource inventory.

62. *--- ---

*1968b *Aerial and space photographs as aids to land evaluation. p. 324-341. In G. A. Stewart, ed., Land evaluation, Papers of a CSIRO symposium (organized in cooperation with) UNESCO 26-31 August 1968. *Macmillan of Australia.

*If an accurate evaluation of land is to be made, an accurate inventory of its resources must first be obtained. (Photography of the land surface, when taken from aircraft and spacecraft, and used in conjunction with small amounts of direct on-the-ground observation, usually provides the best means of making such an inventory. To be of maximum usefulness, however, this photography must have been taken to proper specifications in terms of photographic film, filter, scale resolution, time of day and season of year.) In some instances more than one kind of photography is needed in order to make an adequate inventory of the land's many resources as quickly and economically as possible. Aerial or space photography, suitably annotated and supported with only a limited amount of tabular and textual data, commonly provides the best means for presenting such an integrated picture to the land evaluator.

63. *Colwell, R. N.
*1968c *Remote sensing of natural resources. *Scientific American 218(1):54-69.
*A review of devices now available for remote sensing of natural resources. Techniques range through the spectrum from the very short wavelengths to the comparatively long wavelengths at which radar operates. Information is given on remote sensing equipment. Those which show the most promise for the inventory of natural resources are the conventional aerial camera, the panoramic camera, the multiband camera, the optical-mechanical scanner, sidelooking air-borne radar and the gamma-ray spectrometer. Following description of the sensing equipment and analytical techniques, consideration is given to some of the ways in which remote sensing can contribute to the management of natural resources. The prospect is that techniques will evolve into a highly automatic operation, in which an unmanned satellite orbiting the Earth will carry multiband sensing equipment together with a computer.

64. *--- ---
*1968e *Photographic studies and applications of the NASA Earth Resources Survey Program. In *Earth Resources Aircraft Program Status Review, II: Agriculture, Forestry and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 28/1-28/35. Tables.
*A rather general introductory-type discussion, but including tables covering the feasibility of identifying natural resource features based on studies in California and Arizona. The various aspects are well illustrated.

65. *Colwell, R. N., ed.
*1968d *Remote sensing of earth resources: special extension course, September 25-27, 1968. *University of California, Berkeley. Various paging.
*An outline of a general brief extension course on remote sensing, with some papers (including Colwell's introduction) in their entirety, others in outline form with illustrations.

66. *Colwell, R. N./Olson, D. L.
*1965 *Thermal infrared imagery and its use in vegetation analysis by remote aerial reconnaissance. In Symposium on Remote Sensing of Environment, 3rd, 1964, Proceedings p. 607-621. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-614 032.

*A simplified discussion of the use of thermal infrared imagery for obtaining information from military and civilian standpoints. Examples include some semi-arid conditions.

67. *Cooper, C. F.
*1965 *Potential applications of remote sensing to ecological research. In Symposium on Remote Sensing of Environment, 3rd, 1964, Proceedings p. 601-606. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-614 032.
*A summary of general state of knowledge. Important properties potentially measurable by remote sensing techniques include leaf area, volume, weight and chlorophyll content of vegetation; water content of soils and vegetation; depth and density of snow. Multiband sensors are essential.

68. *Corriher, H. A./Byron, B. O.
*1965 *A bibliography of articles on radar reflectivity and related subjects; 1957-1964. *Institute of Electrical and Electronics Engineers, Proceedings 53:1025-1064.
*1420 references for the time period 1957-1964. Includes an author index.

69. *Cortright, E. M., ed.
*1968 *Exploring with a camera. *U. S. National Aeronautics and Space Administration, Washington, D. C., NASA SP-168. 214 p.
*A review of flights and hardware up to Apollo. Excellent photos of arid regions show possibilities of satellite photography where cloud cover is low. Arid regions offer greatest possibilities for studies of landscape features.

70. *Coulson, K. L.
*1966 *Effects of reflection properties of natural surfaces in aerial reconnaissance. *Applied Optics 5(1):905-917.
*Basic information on reflectance of soils and vegetation including desert soils and sand. Gives evidence of the possibility of using reflectance to distinquish landscape features.

71. *Crandall, C. J.
*1963 *Advanced radar map compilation equipment. *Photogrammetric Engineering 29(6):947-955.
*Studies have been completed showing the feasibility of mapping from radar photographs.

72. *Current, I. B.
*1967 *Sensitometry in color aerial photography. *Photogrammetric Engineering 33(10):1143-1150.
*Sensitometry is useful for the practical determination of film speed and setting correct exposure, control of processing conditions,

adjustment of color balance and control of printing.

73. *Curtis, L. F.
*1962 *Soil classification and photo interpretation. In *Symposium on Photo Interpretation, Delft, 1962, Transactions p. 153-158/International Archives of Photogrammetry, 14.
*Soil classification in use in 1962 will have to be changed for best results from aerial surveys.

74. *Davis, A./Viezee, W.
*1964 *A model for computing infrared transmission through atmospheric water vapor and carbon dioxide. *Journal of Geophysical Research 69:3785-3794.
*Too far removed from operational activities and hence of little direct value in military geography.

75. *Davis, C. K./Neal, J. T.
*1963 *Descriptions and airphoto characteristics of desert landforms. *Photogrammetric Engineering 29(4):621-631.
*A good brief discussion of desert landforms and their characteristic appearance on aerial photographs. Landforms include (1) river floodplains through flowing streams, (2) structural plains, (3) playas, (4) desert flat, (5) alluvial fans and bajadas, (6) pediments, (7) desert domes, (8) desert mountains, (9) dunes and (10) drainage. All are illustrated - information discernible from standard black-and-white photograph at scales of 1:20,000 and 1:40,000 is discussed.

76. *Davis, J. M.
*1966 *Uses of airphotos for rural and urban planning. *U. S. Department of Agriculture, Agriculture Handbook 315. 39 p.
*This handbook describes ways in which air photos can be used to obtain information of value to planners and others interested in terrain and culture features. It also provides information on the availability of air photos in the U. S. and how to obtain them.

77. *DeLancie, R./Steen, W. W./Pippen, R. E.
*1957 *Quantitative evaluation of photo interpretation keys. *Photogrammetric Engineering 23(5):858-864.
*The use of dichotomous and selective keys, if well organized, gives approximately the same results for aerial photography, and are independent of the experience of the observer.

78. *Dellwig, L. F.
*1968 *Pluses and minuses of radar in geological exploration. In *Earth Resources Aircraft Program Status Review, I: Geology, Geography and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 14-1 to 14-17; appendix, p. A1-A25.
*The most unique contribution of radar will be at a maximum in remote and poorly mapped areas of the world where regional rather than a detailed picture is desired, and where climatic conditions are all adverse to ground and aerial photographic investigation.

79. *Dellwig, L. F./Kirk, J. N./Walters, R. L.
*1966 *The potential of low resolution radar imagery in regional geologic studies. *Journal of Geophysical Research 71(20): 4995-4998.
*The value of low-resolution radar imagery for regional geologic studies lies in its lack of detail which allows the geologist to establish regional relationships. Example is in the Arkansas Ozarks.

80. *Dellwig, L. F./MacDonald, H. C./Kirk, J. N.
*1968 *The potential of radar in geological exploration. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 747-763. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-676 327.
*Radar has its greatest potential in regional studies where terrain or climatic conditions are adverse to either ground or aerial photographic investigations.

81. *Dellwig, L. F./Moore, R. K.
*1966 *The geological value of simultaneously produced like- and cross-polarized radar imagery. *Journal of Geophysical Research 71(14):3597-3601.
*Remote sensing of Pisgah Crater area in California shows the value of simultaneously produced like- and cross-polarized imagery, providing the geologist with information not attainable from only like-polarized radar imagery.

82. *Denny, C. S./et al.
*1968 *A descriptive catalog of selected aerial photographs of geologic features in the United States. *U. S. Geological Survey, Professional Paper 590. 79 p.
*This catalog lists and describes 317 sets of aerial photographs (9- by 9-inch contact prints) available for purchase from the U. S. Geological Survey. Most sets are of vertical photographs and provide stereoscopic coverage. The features shown are listed in an index. Information given for each set includes location, scale and date of photography, a brief description of the features illustrated and reference to a geologic report and topographic map of the area.

83. *Dietz, R. S.
*1947 *Aerial photographs in the geological study of shore features. *Photogrammetric Engineering 13(4):537-545.
*Under proper conditions photos may penetrate 10 to 40 feet in coastal water and 40 to 100 feet in oceanic water. Submerged features show up well from the air. Film sensitive to short wave lengths should be used.

84. *Dill, H. W.
*1967 *World-wide use of airphotos in agriculture. USDA Agriculture Handbook 344. 23 p.
*This bulletin was prepared for NASA as part of an overall study to appraise potential benefits from obtaining land-use and other agricultural data from Earth-orbiting satellites. Arid areas included are Australia, Chile, India, Kenya, Mexico, Morocco, Peru, South Africa, Sudan, UAR, and US.

85. *Dmitrenko, V. P./et al.
*1967 *K metodike aerovizual'nykh agrometeorologicheskikh nabliudenii (Methods of visual agrometeorological observations from the air). *Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy 68:74-86.
*Description of principal crops and of stages of their development and a method of evaluating conditions of plants by color, density and spottiness.

86. *Doverspike, G. E./Flyn, F. M./Heller, R. C.
*1965 *Microdensitometer applied to land use classifications. *Photogrammetric Engineering 31:294-306.
*Color density alone does not seem to offer a solution to differentiate land use. Microdensitometer can be helpful but more research is needed. Results of comprehensive color photo studies outside of arid region are reported.

87. *Draeger, W. C.
*1968 *Wildland resource inventories under the NASA Earth Resources Survey Program. In *Earth Resources Aircraft Program Status Review, II: Agriculture, Forestry and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 35/1-35/10.
*Test site out of arid region, but some of the results have applicability to arid areas. Emphasis is on multispectral black and white photography for color-enhanced imagery by projecting black and white negatives of several spectral bands through filters of various colors on a translucent viewing screen. The composite color image thus formed is photographed in color from behind the screen and reproduced in color print form.

88. *Drayson, S. R.
*1969 *Investigation of atmospheric absorption for remote

sensing applications. *University of Michigan, College of Engineering, Contract ESSA-E71-68(N), Final Report, 26 p. PB-184 239.

*The report discusses the need for an understanding of atmospheric absorption processes in the interpretation of remote radiance measurements. Specifically included are absorption by the 15 micrometers m carbon dioxide bands, the 14 micrometers m ozone band and the oxygen A-band.

89. *Duddek, M.
*1967 *Practical experience with aerial color photography. *Photogrammetric Engineering 33(10):1117-1125.
*Discussion of "Wild" cameras and various lenses and films.

90. *Edgerton, A. T.
*1968 *Engineering applications of microwave radiometry. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 711-724. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 237.
*Studies with ground-based unit demonstrate that a definite relation exists between the radiometric brightness, temperature and moisture content of soils. This relationship can be used for qualitative estimates of the bearing strength of cohesive soils.

91. *Ellermeier, R. D./Simonett, D. S./Dellwig, L. F.
*1967 *Use of multi-parameter radar imagery for the discrimination of terrain characteristics. *Institute of Electrical and Electronics Engineers, International Convention Record 15(2):127-135. NASA Contract NSR 17-004-003. CRES Report 61-19.
*Horsefly Mountain, Oregon, is part of study on the use of radar image combination and enhancement techniques for the discrimination of terrain characteristics using multiple polarization radar images.

92. *Entres, S. L.
*1969 *Earth resources satellites. *Royal Aircraft Establishment, Farnborough, England, Report RAE-TR-69219. 88 p. Available as AD-703 297.
*Operational and technical aspects of earth resources satellite projects are discussed. Attention is concentrated on problems of orbital sensing of electromagnetic earth radiance in the visual, infrared and microwave regions. A list of organizations engaged in relevant branches of science and technology together with bibliographic references are appended.

93. *Enzmann, R. D., ed.
*1966 *Planetology and space mission planning. New York Academy of Sciences, Annals 140(1):1-683. Maps.
*Forty-nine contributions by various authors to a conference on Planetology and Space Planning, November 3-4, sponsored by New York Academy of Sciences. Contents: Section I: Environments; II: Signatures; III: Technology; IV: Mission Planning. Mostly concerned with space. The article by Paul D. Lowman, entitled "Photography from Space - Geological Applications", p. 99-106, discuss Mercury and Gemini photographs.

94. *Esten, R. D.
*1964 *Automatic photogrammetric instruments. *Photogrammetric Engineering 30(4):544-558.
*Developments in automatic instruments are discussed and illustrated.

95. *Estes, J. E.
*1966a *Some applications of aerial infrared imagery. *Association of American Geographers, Annals 56(4):673-682.
*The applications of infrared imagery are discussed including geological features, hydrographic features and vegetation. Illustrations include arid areas.

96. *--- ---
*1966b *Some geographic applications of aerial infared imagery. In Symposium on Remote Sensing of Environment, 4th, 1968, Proceedings p. 173-181. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-632 919.
*This article briefly discusses in simple language infrared imagery as a tool to aid geographers and others to obtain information on climatology, hydrology, physiography, vegetation resource development, urban and rural land use. A good article to provide a general view of the subject for the nontechnical reader.

97. *Feder, A. M.
*1960 *Interpreting natural terrain from radar displays. *Photogrammetric Engineering 26(4):618-630.
*A good discussion of the capabilities of radar, including the following seven: (1) composition and conditions below visual rock and soil surface of terrain can be read. (2) Vegetation can be penetrated and subsurface information obtained. (3) Terrain - surface materials can be determined down to small gravel-size and finer materials can be inferred. (4) Moisture content of terrain can be determined when temperature data are available. (5) Temperature can be determined when moisture content is known. (6) Metallic content of surface and near surface materials can be determined. (7) The properties of a snow cover can be read, or the terrain beneath the snow.

98. *Feder, A. M.
*1963 *Programs in remote sensing of terrain. In Symposium on Remote Sensing of Environment, 2nd, 1962, Proceedings p. 51-63. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-299 841.
*A review of programs with little specific application.

99. *Fiore, C.
*1967 *Side-looking radar restitution. *Photogrammetric Engineering 33(2):215-220.
*Basic discussion of an engineering model for correction of geometric distortion involving two data collecting flights and special processing techniques.

100. *Fischer, W. A.
*1958 *Color aerial photography in photogeologic interpretation. *Photogrammetric Engineering 24:545-549.
*The U.S.Geological Survey is conducting continuing investigations of the geologic uses of color aerial photography, including study of color photographs of Torrance Station SE quadrangle, located approximately 100 miles southeast of Albuquerque, New Mexico. Some geologic features are recognizable locally on conventional black- and white photographs but cannot be traced with assurance. These same features show more continuity on black-and-white prints made from the Aero Ektachrome film, and evidence much more continuity and clarity on full color photographs. New developments in films, lenses, and color measurement devices make the future applications of color aerial photography to geologic study even more promising than they are now.

101. *--- ---
*1962a *An application of radar to geological interpretation. In Symposium on Remote Sensing of Environment, 1st, 1962, Proceedings p. 112-114. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-274 155.
*An example showing possibilities of geological interpretations of radar imagery.

102. *--- ---
*1962b *Color aerial photography in geologic investigations: some results of recent studies. *Photogrammetric Engineering 28(1):133-139.
*Color aerial photography has many geologic applications, particularly in the study of: 1) areas having relatively heavy tree cover in which ground detail is illuminated by the scattered blue light not normally recorded on black-and-white photographs; 2) areas underlain by different colored rocks that would generally photograph with similar gray tones; 3) underwater features, because of the penetration of water by blue light and resultant illumination of features at depths

as great as 80 feet; 4) surficial features, such as gravels of slightly different colors and ages; and 5) other areas where color differences or shadow illumination is important.

103. *Fischer, W. A.
*1966 *Geologic applications of remote sensors. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 13-19. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-638 919.
*A statement of major problems in the application of remote sensors to geology includes a chart showing anticipated geologic applications of remote sensors.

104. *--- ---
*1967 *Satellite detection of natural resources. *Advances in the Astronautical Sciences 21:399-409. SWRA 1(7)R202906 67A. International Aerospace Abstracts 19(30)A67 356 55.
*Analyses of Gemini and Nimbus photographs have demonstrated that some features known to be associated with mineral deposits are visible from orbital altitudes. The benefits resulting from programs of orbital observation include: 1) significant improvement in the precision of natural resource inventories by increasing the knowledge of the size of sedimentary basins and the thickness of strata and the character of the structures within them; and 2) fundamental advances in knowledge of the Earth's crust, its shape, mass distribution, and magnetic qualities.

105. *--- ---
*1968 *EROS, viewing the Earth from space. *GeoScience News 1(3):16-19. ANAG 68-00352.
*From the Gemini and Mercury program came images of the Earth that can aid in regional classification of landforms and recognition of large subtle anomalies. They show that dynamic phenomena are observable from space, and that small scale images have value in resources planning. A photoimage map was compiled of a third of a million square miles in Peru, Boliva, and Chile, and the features shown are discussed. An observation satellite in orbit will allow study of the effects of earthquakes and volcanoes.

106. *Fischer, W.A./Ray, R.G.
*1957 *Geology from the air. *Science 126:725-735.
*Methods and equipment available for aerial surveying and photography are discussed. High-altitude (30,000 feet) photography has been developed so that areas of 50 to 100 square miles in extent can be covered. All details detected on aerial photographs can be measured, the accuracy of measurement being dependent upon the scale of photography selected. Study of stream patterns shown on the photographs reveal underlying structures. Color aerial photographs also often reveal features not visible on black-and-white pictures of the same terrain.

107. *Francis, R. E.
*1970 *Ground markers aid in procurement and interpretation of large-scale 70 mm aerial photography. *Journal of Range Management 23(1):66-68.
*Butcher paper, surveyor stakes, lath strips, plastic letter number codes, paper plates, and drop-panel markers were tested and found useful for photography at 1:600 to 1:2,400.

108. *Frey, H. T.
*1967 *Agricultural application of remote sensing: the potential from space platforms. *U.S.Department of Agriculture, Economic Research Service, Agricultural Information Bulletin 328.
*A discussion of the state of the art as applied to agriculture. Includes information on the feasibility of various sensing activities for various agricultural features and conditions.

109. *Fritz, N. J.
*1967 *Optimum methods for using infrared-sensitive color films. *Photogrammetric Engineering 33(10):1128-1138.
*Kodak Ektachrome Infrared Aero Film, Type 8443, is discussed as a remote sensor for applications as diverse as aerial reconnaissance and the detection of disease and pests in agricultural crops. Descriptions are given of the film and scene characteristics, along with methods of keeping, exposing, and processing to produce photographs with the highest information content.

110. *Fry, B.M./Mohrhardt, R. E., eds.
*1963 *A guide to information sources in space science and technology, v. 1. *Interscience Publishers, New York. 579 p.
*Designed to give scientists, research managers, administrators, engineers, information specialists, librarians, students, and the informed public up-to-date and comprehensive coverage of all significant sources of information, published and unpublished, of domestic and foreign origin on space science and technology. This is an excellent source book covering specialized information centers and services, references, and all phases of technology.

111. *Futran, S.
*1967 *Evaporograph: thermal mapping in color. *Optical Spectra 1(3):61-63. MGA 19.6-96.
*A discussion of methods of obtaining radiation imagery.

112. *Galneder, M.
*1967 *Aerial photographs: the first hundred years. *Special Libraries Association, Geography and Map Division, Bulletin 69:17-25.
*A good summary of historical development of aerial photography.

113. *Garrison, W. L./Alexander, R./Bailey, W./Dacey, M. F./Marble, D. F.
*1965 *Data systems requirements for geographic research. In Goddard Memorial Symposium, 3rd: Scientific Experiments for Manned Orbital Flight, Proceedings p. 139-151. *Northwestern University, Department of Geography, Technical Report 1:139-151. ONR Task No. 389-142, NONR 1228-35.
*This is a methodological paper on the use of remote sensing equipment and the systems involved for geographic data gathering.

114. *Gates, D. M.
*1965 *Characteristics of soil and vegetated surfaces to reflected and emitted radiation. In Symposium on Remote Sensing of the Environment, 3rd, 1964, Proceedings p. 573-600. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-614 032.
*A good discussion of the imagery characteristics of reflected and emitted radiation, with emphasis on energy exchange and energy budgets basic to the interpretation of aerial photos of vegetated surfaces.

115. *Gates, D. M./Keegan, H. J./Schleter, J. C./Weidner, V. R.
*1965 *Spectral properties of plants. *Applied Optics 4(1):11-20.
*A basic discussion of the spectral properties of plant leaves and stems for ultraviolet, visible and infrared frequencies. The spectral reflectance, transmission, and absorptance for certain plants, including desert plants, are listed.

116. *Gawarecki, S. J.
*1968 *Infrared survey of the Pisgah Crater area, San Bernardino County, California: a geologic interpretation. In *Earth Resources Aircraft Program Status Review, I: Geology, Geography, and Sensor Studies. Presented at NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 10/1-10/38.
*Infrared imagery in 8 micron-14 micron band provided useful information to complement data obtained from ground studies and from aerial photography. Best information obtained from flights after sunset. Infrared sensing brings out features not readily apparent in the visible spectrum, and many valid conclusions can be reached with a minimum of field verification.

117. *Gawarecki, S. J./Lyon, R. J. P./Nordberg, W.
*1965 *Infrared spectral returns and imagery of the earth from space and their application to geologic problems. In P. C. Badgley, ed., Goddard Memorial Symposium, 3rd, Washington, D. C., 1965, Proceedings. *American Astronautical Society, Science and Technology Series 4:13-33.
*Remarks on results obtained from a High Resolution Infrared Radiometer (HRIR) on Nimbus I and discussion of potential capabilities of satellite infrared sensing.

118. *Geary, E. L.
*1968 *Coastal hydrography. *Photogrammetric Engineering 34(1): 44-50.
*Color photography will provide a means for more rapid acquisition of nearshore areas. Satellite photography in particular can provide acquisition of information for remote areas.

119. *Gerlach, A. C.
*1968 *Advances in geographic and thematic mapping applications of remote sensor data. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 191-196. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-676 327.
*A discussion of what is being done at various institutions, with little specific information.

120. *Ghose, B./Pandey, S./Singh, S.
*1966 *Studies in photogrammetry: geomorphic studies of Sojat from aerial photographs to delineate land forms. *Indian Society of Soil Science, Journal 14(1):9-12. BIGENA E68-04348.
*Land form units demarcated are flat-topped hills of sedimentary formations, piedmont fringe, nearly level older alluvial plains, flood plains, and river bed.

121. *Ghose, B./Singh, S.
*1965 *Observations on geomorphology and land use of Kitnod village (Rajasthan): aerial photo interpretation and analysis of land. *Geographical Review of India 27(3):145-156. Maps.

122. *Gillis, J.E./Leestma, R.A.
*1965 *Research for the development of an earth atlas based on viewing the Earth from space with various remote sensors and the applications for global planning. In P. C. Badgley, ed., Goddard Memorial Symposium, 3rd, Washington, D. C., 1965, Proceedings. *American Astronautical Society, Science and Technology Series 4:235-244.
*A discussion of the potential of satellite sensing for preparation of synoptical maps and atlases. Includes a brief review of the state of the art.

123. *Gimbarzevsky, P.
*1966 *Land inventory interpretation. *Photogrammetric Engineering 32(6):967-976.
*Canadian study not directly applicable to arid lands.

124. *Grabau, W. E.
*1967 *Terrain analysis for military geography intelligence. *Army Research and Development 8(11):18-20.
*A general methodological statement of what is necessary for terrain analysis for military geographic intelligence. A diagram showing the flow of information through an ideal terrain evaluation system is provided.

125. *Hackman, R. J.
*1967 *Geologic evaluation of radar imagery in southern Utah. *U.S.Geological Survey, Professional Paper 575-D:135-142. Also cited as *U.S.Geological Survey, Technical Letter NASA-58, 1966, 18 p. AMAG(1968)04383.
*Radar imagery has some advantages over conventional aerial photography: 1) it shows a view of a larger area than a single aerial photo; 2) surface areas cov[illegible]ed by clouds can be recorded; 3) it shows greater topographic [illegible]il because of shadow enhancement; 4) it is not restricted on [illegible]n of shadows as the direction of flight controls the dire[illegible]f shadow enhancement; 5) it depicts some geologic faults not visible on aerial photos; 6) it provides some rock signatures; and 7) it makes some Quaternary alluvial deposits more discernible than on aerial photos; however, it does not differentiate between surficial windblown sand and sandstone.

126. *Hammond, R.
*1967 *Air survey in economic development. *American Elsevier, New York. 246 p., maps.
*Contains chapters on the scope, techniques, and instruments for air survey, as well as on the cameras and plotting equipment and aircraft. Based on black and white photography.

127. *Hannah, L. D. et al.
*1964 *The experimental evaluation multisensor intelligence systems. Final report. *American Institute for Research, Pittsburgh, under Contract AF 30(602)-3223. RADC-TDR-64-160. 129 p. Available CFSTI as AD-602 837. STAR N64-26167.
*A series of experiments designed to investigate critical problem areas in the presentation of multisensor intelligence imagery, was designed and is presented here. The group of sensors considered includes a panoramic camera, an image-forming side looking radar system, and an image-forming infrared sensing system. The individual problems were studied in the context of the complete multisensor intelligence collecting and evaluation system.

128. *Hawkins, J.K./Munsey, C.J.
*1963 *Automatic photo reading. *Photogrammetric Engineering 29(4):632-640.
*An optical system combined with the use of photographic film in a multiple stage nonlinear decision process is described. The image resolution attainable with photography is largely retained, while the complex logical decisions possible with electronics are readily performed.

129. *Hemphill, W. R.
*1958 *Small-scale photographs in photogeologic interpretation. *Photogrammetric Engineering 24:562-567.
*The advantage of small scale 1:50,000 or smaller for some geologic features is pointed out. The main feature is the larger area covered permitting greater continuity of observation.

130. *Hemphill, W. R.
*1968 *Application of ultraviolet reflectance and stimulated luminescence to the remote detection of natural materials. In *Earth Resources Aircraft Program Status Review, I: Geology, Geography and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 19/1-19/22.
*Carbonate rocks and evaporite deposits, water, snow, concrete, and metallic objects, especially aluminum, are strongly imaged on ultraviolet imagery, but outdoor methods of measuring reflectance have not developed to the point of dependability.

131. *Hemphill, W. R./Danilchik, W.
*1968 *Geologic interpretation of Gemini photo. *Photogrammetric Engineering 34(2):150-154.
*Geologic features are discernible on a color photo taken with hand held Hasselblad camera of a 7,000 sq. mi. semi-arid area in West Pakistan. Author thinks better results would be obtained with color infrared.

132. *Hodgin, D. M.
*1966 *The characteristics of microwave radiometry in remote sensing of environment. In American Society for Photogrammetry, Selected papers on remote sensing of environment, p. 157-166.
*A brief statement of the state of the art and an outline of potential applications.

133. *Hoffer, R. M./Holmes, R. A./Shay, J. R.
*1966 *Vegetative, soil, and photographic factors affecting tone in agricultural remote multispectral sensing. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 115-134. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-638 919.
*Although studies were conducted in a non-desert area (Indiana), they bring out the multispectral sensing possibilities of distinquishing vegetation that might be applied to desert conditions.

134. *Hogan, G. D./Townsend, M. R.
*1967 *Interrogation, recording and location system. *World Meteorological Organization, Technical Note 82:315-328. MGA 19.5-112.
*This article is a description and discussion of a satellite for simultaneous position fixing and data collection known as Interrogation, Recording and Location System (IRLS), which is being developed by the Goddard Space Flight Center of NASA to be launched early in 1968.

135. *Holmes, D. A.
*1968 *The recent history of the Indus. *Geographical Journal 134(3):367-382. Maps.
*This paper outlines the probable courses of the River Indus through the former province of Sind, West Pakistan, over the past 2000 years, using the evidence obtained from aerial photographs.

136. *Holmes, R. F.
*1967 *Engineering materials and side-looking radar. *Photogrammetric Engineering 33(7):767-770.
*An interpretation of conventional and radar imagery taken simultaneously has shown that the recognition of diagnostic patterns of vegetation, geology, drainage, land use, and landforms will enable an experienced soil scientist to make a reasonable asessment of regional engineering surficial material conditions.

137. *Holter, M. R.
*1967 *Infrared and multispectral sensing. *Bioscience 17(6): 376-383.
*A brief introduction to infrared pictorial sensing for biologists.

138. *Holter, M. R./Nudelman, S./Suits, G. H./Wolfe, W. L./Zissis, G. J.
*1962 *Fundamentals of infrared technology. *Macmillan, New York. 442 p.
*This book contains 4 major sections: (1) basic radiation concepts, sources and the nature of the radiation processes, radiation measurements, and transmission through various media, with particular emphasis on the Earth's atmosphere. (2) optics, optional materials and optical instruments. (3) appropriate solid-state physics. (4) applications and design procedures applied to typical problems. Infrared photography is not included. There is an extensive bibliography, and information sources are listed in an appendix.

139. *Honea, R. B./Prentice, V. L.
*1968 *Selected bibliography of remote sensing. *U. S. Geological Survey, Technical Letter NASA-129. 36 p. NASA-CR-101458. STAR N69-28377. Available CFSTI.
*A selective bibliography of publications pertaining to geographic applications of remote sensing techniques with special reference to land use classification and analysis. Includes list of publications of introductory nature, technical publications, land use investigations using remote sensing techniques, and a bibliography of literature pertaining to data handling and automatic data processing techniques.

140. *Howe, R. H. L.
*1958 *Procedure of applying air photo interpretation in the location of ground water. *Photogrammetric Engineering 24(1):35-49.

*Methodology based on examples outside the arid zone.

141. *Howe, R. H. L.
*1960 *The application of aerial photographic interpretation to the investigation of hydrologic problems. *Photogrammetric Engineering 26(1):85-95.
*A rather general discussion covering everything from water quality, ground water, water bearing patterns and drainage systems to evaluation of the water potential of an area. The examples are outside of the arid zone. (Indiana)

142. *Innes, R. B.
*1968 *An interpreter's perspective on modern airborne-radar imagery. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 107-122. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.
*An excellent discussion of radar, what it can do, and the mechanics of radar imagery in a very readable presentation for those who have little knowledge of radar.

143. *International Council of Scientific Unions. Committee on Space Research (COSPAR), Working Group VI.
*1967 *Status report on the application of space technology to the World Weather Watch, June 1967. Submitted to COSPAR X, London. 144 p. Note: This is bound in: Study Conference on Global Atmospheric Research Programme (GARP), Stockholm, June 28-July 11, 1967, Report of the Conference, Sponsored by ICSU/IUGG - Committee on Atmospheric Sciences, COSPAR, and the World Meteorological Organization. Issued 1967. MGA 19.8-37.
*Reports of 3 panels on: 1) Data requirements for global weather observation and prediction experiments; 2) Remote sensing of meteorological parameters with satellites, and 3) Data collection from atmospheric and surface platforms via a satellite.

144. *Ionesco, T./Selod, Y.
*1967 *L'utilisation des photographies aériennes pour la cartographie de la végétation du Maroc (The use of aerial photographs in establishing vegetation maps of Morocco). *Al Awamia 18:89-102. BA 49(4)-16802.
*An elementary discussion of aerial surveys and establishing of different vegetation maps: land cover, vegetation types, climates, pastures etc. Considering the scale, time of origin, quality and other data about existing photographs, as well as the range covered,

the scope of interpretation is rather limited. The present possibilities of interpreting aerial photographs are indicated.

145. *Jacobs-Haupt, I.
*1963 *Tiros observations over the Mediterranean and North Africa. In H. Wexler and J. E. Caskey, Jr., eds., International Symposium on Rocket and Satellite Meteorology, 1st, Washington, D. C., 1962, Proceedings p. 323-332. *John Wiley and Sons, New York.
*The results indicate that observations from satellites may contribute to making more detailed information available in regions where conventional observations are sparse.

146. *Jennings, J. N.
*1968 *Revised map of the desert dunes of Australia. *Australian Geographer 10(5):408-409. Map.

147. *Jones, N. E.
*1966 *Bibliography of remote sensing of resources. Prepared for Earth Resources Survey Program, Space Applications Program, NASA, by *U. S. Army Corps of Engineers, Ft. Belvoir, Virginia. 40 p.
*A compilation of references that have appeared between January 1960 and June 1966 in the open literature, excluding geophysics, meteorology, and the technical aspects of electromagnetic sensing.

148. *Kent, B. A.
*1957 *Experiment in the use of color aerial photographs for geologic study. *Photogrammetric Engineering 23:365-868.
*Primarily concerns field evaluation studies of aerial photographs for three test areas in arid parts of California and Nevada. Identification of various geologic features is discussed. Results showed promise for this approach.

149. *Kern, C. D.
*1963 *Desert soil temperatures and infrared radiation received by Tiros III. *Journal of the Atmospheric Sciences 20(2): 175-178.
*Theoretical discussions not of direct value to military geography.

150. *Kharin, N. G./Nurberdyev, K./Serkhanov, E.
*1969 *Aerial methods of studying and mapping sands. Translation

of 1969 article in Selskokhozyaistvennoi Nauki (USSR) 14(6): 74-80, available CFSTI as JPRS-48626.
*In regions of widespread erosion, aerial photography makes it possible to map sand features, sand types, and degree of stabilization by plant cover.

151. *Konoski, C. F.
*1964 *Water and cloud temperatures measured from U-2 aircraft. *American Meteorological Society, Bulletin 45(9):581-586.
*Tests of lake and cloud temperatures with an infrared radiation thermometer installed in a U-2 aircraft.

152. *Kornfield, J./Hasler, A. F./Hanson, K. J./Suomi, V. E.
*1967 *Photographic cloud climatology from ESSA III and V computer produced mosaics. *American Meteorological Society, Bulletin 48(12):878-883. MGA 19.5-114.
*A simple photographic averaging technique using multiple exposures is applied to ESSA III and V computer produced mosaics. Several examples showing the distribution of clouds, snow, ice and vegetation cover for typical half month periods are presented and discussed. Large scale cloud bands about equatorial dry regions as well as preferred storm tracks are revealed.

153. *Korzov, V. I./Krasil'shchikov, L. R.
*1967 *Samoletnye izmereniia indikatris iarkosti podstilaiushchei poverkhnosti (Aircraft measurements of the brightness indices of the underlying surface). *Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy 203:70-87. MGA 19.1-208.
*The methodology and results of measurements of spatial distribution of the Earth's surface and cloud brightness, made from an aircraft in the visual and IR regions of the spectrum, are described. The optical diagram of the receiver of the photometer-indicatometer used in the measurements is shown. The results of statistical analysis of oscillograms lead to the conclusion that the reflection of all measured surfaces (Kara-Kum Desert, Kara-Bogaz-Gol, Caspian Sea, and the Volga Delta) is quite anisotropic. The reflection indices in the visual and near IR regions of the spectrum can differ considerably.

154. *Kover, A. N.
*1968 *Side-looking radar imagery. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 781-785. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-676 327.
*A discussion of coverage in 45 states.

155. *Kuznetsov, V. V.
*1969 *Use of the properties of the soil cover in the interpretation of ground water on aerial photographs. Translation

of 1962 publication, available CFSTI as AD-692 627.
*In addition to the ground water information, this report is of value for identification of soil types and soil-vegetation relationships. The aerial photographs were taken in different landscape areas in the Northern Caspian Lowland and Turkmenia.

156. *Laing, R. W./Pardoe, G. K.
*1969 *A review of remote earth observation technology. Presented at the *NATO/British Interplanetary Society, International Summer School on Earth Observation Satellites, Cambridge, England, July 14-25, 1969. 23 p. STAR N70-11275. Available CFSTI.
*A brief review of the historical background is followed by descriptions of the various possible instruments and techniques which range from sensors and infrared devices to radar imagery and photography. A summary of achievements with different satellite orbits at various heights is given.

157. *Lancaster, C. W./Feder, A. M.
*1966 *The multisensor mission. *Photogrammetric Engineering 32(3):484-494.
*Paper in two parts. I, planning and data aquisition and II, processing and interpretation. The multisensor airborne reconnaissance mission is a complex undertaking whose sucess depends on concise planning and timely execution. Laboratory procedures must emphasize processing control which includes data produced by ground truth teams.

158. *Lancaster, J.
*1968 *Geographers and remote sensing. *Journal of Geography 67(5):301-310.
*A good general review article with extensive references, especially suitable for readers with little background in remote sensing. It also stresses the application of remote sensing to geography, including items of importance for military geography.

159. *Larson, D. C./Kuyper, W. H./Latham, J. P.
*1969 *Interpretation of colors by a television scanning and waveform system applied to geographic analysis of multisensor imagery. *Florida Atlantic University, Boca Raton, Department of Geography, Technical Report 8 for/Office of Naval Research, Geography Branch, NONR-4761(00). 29 p. Available CFSTI as AD-694 064.
*The purpose of this experiment was to determine if a black and white television system can be used to differentiate and identify colors from the various signal levels which the camera generates

to produce graytones in television imagery. The system can pick up and qualify density values that have interpretive significance, but complete color identification is beyond the capability of the system.

160. *Latham, J. P.
*1963 *Geographic analysis and remote sensing capability. In Symposium on Remote Sensing of Environment, 2nd, 1962, Proceedings p. 65-79. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-299 841.
*A good discussion of the advantages of combining the techniques of the science of geography and remote sensing. Geography offers methodology for optimum returns from remote sensing techniques.

161. *--- ---
*1966 *Remote sensing of environment. *Geographical Review 56(2):288-291.
*Status of the technology as related to geography. Too general to be of much use.

162. *--- ---
*1967 *Remote sensing papers at the American Association for the Advancement of Science: impact and implications. *Florida Atlantic University, Department of Geography, Technical Report 2 for/Office of Naval Research, Geography Branch, NONR-4761(00).
*This report covers role of instrumentation in geographic research, geographic integration of imagery patterns, and a resume of the special session on remote sensing held at the 1965 AAAS meeting.

163. *--- ---
*1970 *Electronic quantification and comparison of geographic patterns recorded by various remote sensors, and an evaluation of their contributions to geographic research and methodology. *Florida Atlantic University, Boca Raton, Department of Geography, Contract NONR-4761(00), Final Report, January 1, 1965 - January 31, 1970. 12 p. AD-700 947.
*A summary of the basic research program focused upon electronic quantification and comparison of geographic patterns recorded by various remote sensors, and their contributions to goegraphic research and methodology. It includes eight techical reports cited with abstracts covering five years of experimentation analyzing photographic, radar, and thermal IR images via means of an instrumented system using television scanning, waveform analysis, and computer processing to establish feasibility of machine categorizing of geographic patterns from integrating data in images from one or more sensors.

164. *Latham, J. P./Witmer, R. E.
*1967 *Comparative waveform analysis of multisensor imagery. *Photogrammetric Engineering 33(7):779-786.
*An introduction to a research methodology for quantitative comparative analysis of multisensor imagery and to relate transmitted signals containing geographic information to the actually occuring geographic pattern.

165. *Lauer, D. T.
*1967 *The feasibility of identifying forest species and delineating major timber types in California by means of high-altitude multispectral imagery. Annual Progress Report to NASA on Remote Sensing Applications in Forestry. 113 p. NASA-CR-93185. *STAR N68-17494. Available CFSTI CSCL 20F.
*A systematic analysis was made of the factors affecting image tone or color, image detail, and stereoscopic parallax in order to improve the quality of remote sensing imagery. The optimum combination of factors was determined for identifying the major tree species and timber types in selected parts of the world, using imagery taken from earth orbit.

166. *--- ---
*1968 *The identification of western forest species by means of remote sensing. In Earth Resources Aircraft Program Status Review, II: Agriculture, Forestry, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 38/1-38/16.
*Primary objective of research was to analyze factors governing the interpretability of tree species on high-altitude small-scale imagery. Photographic results of various film and filter combinations are shown.

167. *Leestma, R. A.
*1966 *Applications of air and spaceborne sensor imagery for the study of natural resources. In Sympsoium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 111-113. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.
*Manned orbiting satellites equipped with multisensor systems will offer an opportunity to measure and sense the total land, ice and water surfaces of the earth. The information can be organized under a topical geographic methodology to include: atmosphere, biosphere, hydrosphere, lithosphere, and culturesphere.

168. *--- ---
*1967 *A methodology for military geographic analysis. *U. S. Army Engineer Topographic Laboratories, Ft. Belvoir, Virginia, Technical Report 36-TR.
*This is a methodological report that describes a matrix system adaptable for either manual or machine use in making a military

geographic analysis. This is presented as a direction for further research.

169. *Leighty, R. D.
*1968 *Remote sensing for engineering investigation of terrain-radar systems. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 669-685. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.
*An excellent review of radar and its potential for investigations of terrain. The article covers: radar uses, radar systems, radar theory and empirical measurements, qualitative analysis of radar imagery and miscellaneous radar techniques. There is a bibliography of 26 titles.

170. *Leonardo, E. S.
*1963 *Comparison of imaging geometry for radar and camera photography. *Photogrammetric Engineering 29(2):287-293.
*A discussion of the problems of interpreting radar imagery. An understanding of the differences between photographic and radar images is essential for interpreting radar photographs, especially for smaller objects.

171. *--- ---
*1964 *Capabilities and limitations of remote sensors. *Photogrammetric Engineering 30(6):1005-1010.
*State of science and art in 1964. Includes all major sensors.

172. *Lepley, L. K.
*1968 *Coastal water clarity from space photographs. *Photogrammetric Engineering 34(7):667-674.
*On a yearly average 85 percent of the world's coastal water is sufficiently clear for the use of an airborne laser fathometer for mapping sea floor topography from shore out to at least 20 meters depth. 35 percent is clear enough for mapping by color photogrammetry to at least 20 meters depth and laser sounding to 40 meters. 44 references.

173. *Levine, D., ed.
*1966 *Combinations of photogrammetric and radargrammetric techniques. In Manual of Photogrammetry, Published by American Society of Photogrammetry (3rd edition), George Banta Publishing Company, p. 1003-1048.
*This is the bible for radargrammetry, covering everything from theory to specific techniques and devices. A bibliography of 64 references is included.

174. *Lewis, G. K.
*1957 *The concept of analogous area photointerpretation keys. *Photogrammetric Engineering 23(5):874-878.
*Analogous area keys are based on studies of known areas thought to be similar to inaccessible areas.

175. *Llaverias, R. K.
*1968 *Bibliography of remote sensing of earth resources for hydrological applications. *U. S. Geological Survey, Open-file Report, September 1968. 73 p. NASA-TM-X-61717.
*This preliminary bibliography was prepared to acquaint hydrologists with the basic literature involved in this field. Some of the references concern specific hydrological topics or specific remote sensing methods. Other references on vegetation mapping and geology were included so that the reader can find information on the selection, processing, and use of remote sensing data in these cognate fields. A number of meteorological references were included because in many remote sensing applications, especially from earth orbital satellites, atmospheric effects must be taken into account in interpreting the views of the earth.

176. *Lowe, D. S.
*1968a *Infrared studies. In *Earth Resources Aircraft Program Status Review, I: Geology, Geography, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1969, p. 51/1-51/17.
*The title is somewhat misleading as most of the discussion has to do with the operation of multispectral scanners.

177. *--- ---
*1968b *Line scan devices and why use them. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 77-101. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.
*This technical paper summarizes the technological development of scanners, shows the relationship between scanner performance and component specifications, and discusses some modification for converting the conventional scanner into quantitative research tool.

178. *Lowman, P. D., Jr.
*1965 *Space photography, a review. *Photogrammetric Engineering 31(1):76-86.
*A review of the history, present status and capabilities of space photography. Advantages are wider perspective, potential worldwide coverage, greater speed, and rapid repetition coverage. Applications are in geologic and topographic mapping, oceanography and other fields. A chart of space flights from V-2 to Mercury 9 is included. Illustrations include arid lands.

179. *Lueder, D. R.
*1959 *Aerial photographic interpretation, principles and applications. *McGraw-Hill Book Company, Inc., New York. 462 p.
*An important handbook for everyone interested in aerial photography.

180. *Lyon, R. J. P./Burns, E. A.
*1963 *Analysis of rocks and minerals by reflected infrared radiation. *Economic Geology 58(2):274-284.
*Aimed at the moon - of little direct value.

181. *Lyon, R. J. P./Patterson, J. W.
*1966 *Infrared spectral signatures: a field geological tool. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 215-230. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.
*Field geology can be performed by using spectral signatures from rocks and soils in the 8 to 13 micron wavelength region. Developments of equipment are discussed as well as applications to terrestrial and lunar problems.

182. *Lyons, E. H.
*1967 *Forest sampling with 70mm fixed air-base photography from helicopters. *Photogrammetria 22(6):213-231.
*Study conducted in British Columbia. Results indicate that same techniques could be used in arid regions, but the cost might be excessive.

183. *MacDonald, H. C./Brennan, P. A./Dellwig, L. F.
*1967 *Geologic evaluation by radar of NASA sedimentary test site. *Institute of Electrical and Electronics Engineers, Transactions/Geoscience Electronics GE-5(3):72-78. ANAG(1968) 05304.
*This paper presents research in which the investigators studied similarities and contrasts between panchromatic aerial photography and radar imagery from the Cane Springs area, Arizona, for which precise surface geologic data are available. Lithologic and structural information is available on the radar imagery which is not as apparent on the air photography; however, the converse is also true. Interpretations also reveal the fundamental advantage of multisensor reconnaissance.

184. *MacKallor, J. A.
*1968a *A Gemini mosaic along the thirty second degree of latitude from Baja California to Central Texas. *U. S. Geological Survey, Washington, D. C. 15 p. NASA Order R-09-020-013. Also available CFSTI as NASA-CR-95478. STAR N68-28636.
*A series of 39 overlapping photographs of the southwestern United States and adjacent areas of Mexico was obtained as part of an ex-

periment of the Gemini 4 mission. A 1:1,000,000-scale, black and white, semi-controlled mosaic was constructed covering about 150, 000-square miles extending along the 32d parallel of north latitude from the Pacific Ocean to the 100th meridian in west-central Texas, and averages about 150 miles in width. Many of the individual rectified photographs can be enlarged to a scale of 1:250,000 with little or no loss of resolution; such enlargements will be of great value to earth resources studies. If the angle of tilt is more than 35 degrees, some detail in the background of the photograph is lost.

185. *MacKallor, J. A.
*1968b *A photomosaic of western Peru from Gemini photography. *U. S. Geological Survey, Professional Paper 600-C:169-173. BIGENA 32(10) E68-12485.
*A 1:1,000,000-scale mosaic, prepared from photographs taken during the Gemini IX mission, shows the area from the Sechura desert in northern Peru to northern Chile and from the Pacific Ocean to the headwaters of the Amazon. A wide variety of geological features as well as landslides, roads, snowfields, irrigated lands, jungle agricultural sites, archeological sites, and smoke (brush burning) have been identified on the mosaic.

186. *Malila, W. A.
*1968 *Multi-spectral techniques for image enhancement and discrimination. *Photogrammetric Engineering 34(6):566-575.
*The use of multispectral techniques can produce increased image contrasts. They also have possibilities: automatic recognition of objects through processing and computational techniques.

187. *Martin, A. E.
*1966 *Infrared instrumentation and techniques. *Elsevier Publishing Company, New York. 180 p.
*Chapter headings include: modern infrared spectrometers, interferometric spectrometers, miscellaneous instruments, and accessories.

188. *Matalucci, R. V./Abel-Hady, M.
*1968 *Infrared aerial surveys in environmental engineering. *American Society of Civil Engineers, Sanitary Engineering Division, Journal 94(6277):1071-1084. SWRA 2(10):W69-03744.
*An illustrated review is given of the basic principles related to the nature of IR radiation and the problems associated with its atmospheric attenuation. Some of the differences between IR photography and imagery are analyzed, and illustrations are used to demonstrate techniques for locating thermal water pollution by IR sensing. Stream valleys and subsurface drainage patterns are distinctly shown by IR imagery, which can also be used for locating buried conduits and utility systems.

189. *McAnerney, J. M.

*1966 *Terrain interpretation from radar imagery. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 731-750. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.

*Imagery from high-resolution side-looking radar is a useful tool in the remote sensing of environment; although resolution and definition are not as good as that obtained with visual aerial photography, it has the advantage over the latter in that the image is equally good in daylight and darkness, and can be obtained under all weather conditions except heavy rain clouds. Trained observers can describe physiography, geology, soil and cultural features on the basis of side-looking radar imagery alone.

190. *McCoy, R. M.

*1968 *Application of radar imagery to drainage analysis. In *Earth Resources Aircraft Program Status Review, III: Hydrology, Oceanography, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 27/1-27/18.

*Radar imagery offers several advantages: (1) side-looking imaging radars obtain greater ground cover than vertical mapping cameras carried at the same altitude; (2) radar systems present more geomorphic detail relative to their scale; (3) there is a consistent relationship between the quantitative data derived from radar and the data from large-scale topographic maps (1:24,000). The use of spacecraft makes possible topographic information from areas inaccessible to other mapping methods.

191. *McDaniel, J. F.

*1959 *Aerial color-film in military photo interpretation. *Photogrammetric Engineering 25:529-533.

*In recent years, color-film has been and is being used in sharply increased quantities for non-military purposes. This paper is essentially a review of the factors associated with the use of color-film by the armed forces. It also describes developments which may affect its role in future intelligence-reconnaissance operations.

192. *McLerran, J. H.

*1967 *Infrared thermal sensing. *Photogrammetric Engineering 33(5):507-512.

*Includes one example from Yuma, Arizona, but is mostly concerned with Yellowstone Park and cold regions.

193. *--- ---

*1968 *Infrared sensing of soils and rocks. *Materials Research and Standards 8(2):17-21.

*The author concludes that there must be considerably more study of the factors that influence the radiation properties of terrain features before infrared sensing can be used for surveys.

194. *Meer, G. Y./Nefetov, K. E.
*1969 *Interpretation of ground water of typical landscapes in Turkmenia on aerial photographs. *Army Foreign Science and Technology Center, Washington, D. C., Report FSTC-HT-23 498-68. 39 p. Translation of 1962 publication available CFSTI as AD-691 566.
*The report gives a geographical description of the natural landscapes existing in Turkmenia and the individual landscape elements in that Soviet Republic: topography, climate, hydrography, soils, and culture features. Particular attention in this article is given to the relationship between ground water and relief, vegetation and soils, and a description of what features serve as indicators of ground water and how these indicators appear on aerial photographs. Mountains, sandy areas, and techniques are discussed among other geomorphological features.

195. *Mendez, R.
*1968 *Angular dependence of reflected radiation from Sahara measured by Tiros 7 in a torquing maneuver. *University of Chicago, Department of the Geophysical Sciences, Satellite and Mesometeorology Research Project, Research Paper 73. 17 p. Grant NsG-333; NASA-CR-95361. STAR 6(15)N68-28002; MGA 20.1-256.
*Statistical analyses were made using observations of backscattered radiation recorded by Channel 3 (0.2 to 6.0 microns) of the Tiros 7 radiometer, as it passed over the Sahara Desert. Three orbits were selected for this study. In order that the results be consistent the areas involved were classified and labeled according to the terrain. A composite map of the area was then constructed from Gemini II pictures and Nimbus I AVCS pictures. Both closed mode scanning and alternating mode scanning have been used in order to obtain reflectance values from the ground at different angles of view.

196. *Merifield, P. M./Cronin, J./Foshee, L. L./Gawarecki, S. J./Neal, J. T.
*1969 *Satellite imagery of the earth. *Photogrammetric Engineering 35(7):654-668. Available CFSTI as AD-699 620 and AFCRL 70.
*A general review of satellite imagery as related to atmospheric and Earth sciences. Gemini and Apollo photographs have furnished information on sea surface roughness, areas of potential upwelling and oceanic current systems. Regional geologic structures and geomorphologic features are also recorded in orbital photographs. Infrared satellite imagery provides meteorological and hydrological data and is potentially useful for locating fresh water springs along coastal areas, sources of geothermal power and volcanic activity.

197. *Merifield, P. M./Rammelkamp, J.
*1966 *Terrain as seen from Tiros. *Photogrammetric Engineering 32(1):44-54.

Tiros pictures have some possibilities of showing physiographic and geologic features in arid regions, but their use is limited.

198. *Merriam, D. F., ed.
*1966 *Computer applications in the earth sciences: Coloquium on classification procedures. Computer contribution 7. *University of Kansas, Lawrence, State Geological Survey.
*Includes 13 papers of which about half have some relation to handling of remote sensing data.

199. *Mintzer, O. W.
*1968 *Remote sensing for engineering investigation of terrain-photographic systems. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 687-699. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.
*A review of photo interpretation for engineering purposes, followed by a discussion of potential value of multispectral, radar and infrared imagery. Bibliography has 28 references.

200. *Moeller, F.
*1967 *Eine Karte der Strahlungsbilanz des Systems Erde-Atmosphäre für einen 14 tägigen Zeitraum (Radiation balance chart of the Earth-atmosphere system for 14-day period). *Meteorologische Rundschau 20(4):97-98.
*Extraterrestial radiation balance during a two week period from July 2-15, 1966, was plotted from measurements, obtained by NASA, of reflected solar radiation in the range of 0.2-4 microns and the long wave thermal radiation transmitted by Nimbus 2, launched into a polar orbit. Desert areas exhibited high albedos.

201. *Molineux, C. E.
*1962 *Air Force remote sensing programs. In Symposium on Remote Sensing of Environment, 1st, 1962, Proceedings p. 93-98. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-274 155.
*A general discussion of limited value to arid lands problems.

202. *--- ---
*1965a *Aerial reconnaissance of surface features with multi-band spectral system. In Symposium on Remote Sensing of Environment, 3rd, 1964, Proceedings p. 399-421. *University of Michigan, Insitute of Science and Technology, Ann Arbor. Also available as AD-614 032.
*Surface effects of moisture content, vegetation conditions, subsidence, deposition of dust can be detected. Multi-band photography can detect more subtle changes than single sensors.

203. *--- ---
*1965b *Multiband spectral system for reconnaissance. *Photogrammetric Engineering 31(1):131-143.

*This system including camera and data reduction equipment was designed especially for detecting manifestations of underground nuclear test activity. The use of this system can also provide much information to enhance the photointerpretation of vegetation, soil and geologic conditions. The airborne system consists of a nine-lens multiband camera, associated color reference cameras, a dual spectrometer system, cartographic camera, and skylight recording camera, flown in a C-130 aircraft.

204. *Momsen, R. P., Jr.
*1968 *The orthophoto map-geographic tool of the future. *Professional Geographer 20(3):177-180.
*Orthophoto maps have planimetric accuracy combined with the imagery of the photo-mosaic. The method of preparation and uses are discussed.

205. *Moore, E. G./Wellar, B. S.
*1968 *Experimental applications of multiband photography in urban research. *Illinois State Academy of Science, Transactions 61(1):80-88.
*A good example of the use of multiband photography for geography. Examples include identification of housing characteristics and four different road surfaces. Includes a discussion of automated data retrieval from a set of multiband photographs.

206. *Moore, R. K.
*1966 *Radar scatterometry--an active remote sensing tool. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 339-373. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.
*A basic discussion of radar scatterometry. Various systems are described and the range-angle system is outlined in detail. So far, land applications are speculative.

207. *--- ---
*1968 *Radar progress in the NASA earth resources aircraft program. In *Earth Resources Aircraft Program Status Review, I: Geology, Geography, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 50/1-50/51.
*This report is concerned first with the scatterometer and then with imaging radar. Enough measurements have been made to show that scatterometry can be a useful tool for land geoscience. Evidence is at hand to show that radar will be useful in discriminating both cultivated and natural vegetation. The values of multifrequency and polychromatic imagery are predicted.

208. *Moore, R. K./Simonett, D. S.
*1967 *Radar remote sensing in biology. Bioscience 17(6):384-390.

Potential application of radar in agricultural surveys, in mapping natural vegetation and in forest surveys.

209. *Morain, S. A./Simonett, D. S.
*1966 *Vegetation analysis with radar imagery. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 605-622. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.
*Radar imagery, combined with interpretation techniques, may serve as a reliable tool for intermediate scale mapping of already recognized vegetation zones in the semi-arid part of the United States and thus may be of significant value for ecologists, botanists and range managers interested in knowing actual distribution of grassland, shrub land and grazing density of stands.

210. *--- ---
*1967 *K-band radar in vegetation mapping. *Photogrammetric Engineering 33(7):730-740. Also available as Kansas University CRES Report 61-23.
*K-band imagery of Horsefly Mountain, Oregon, shows the possibilities of discrimination patterns of vegetation. Techniques for improving ability to discriminate include: use of tri-color image combinations; the generation of probability; density functions to quantify variations in gray-scale level between types; and the employment of a space sensor to help distinquish between vegetation types, although examples only extend into semiarid conditions, the techniques should apply to arid environments.

211. *Morgan, J. O.
*1962 *Infrared technology. In Symposium on Remote Sensing of Environment, 1st, 1962, Proceedings p. 61-80. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-274 155.
*Theory and processes. In summary it is stated that remote sensing techniques are available which permit the measurements of radiation fluctuations corresponding to temperature fluctuations of 0.01°C, and that resolution is equal to mediocre aerial photography.

212. *Morrison, A./Bird, J. B.
*1965 *Photography of the earth from space and its non-meteorological applications. In Symposium on Remote Sensing of Environment, 3rd, 1964, Proceedings p. 357-376. *University of Michigan, Insitute of Science and Technology, Ann Arbor. Also available as AD-614 032.
*The principal advantages of space photography are the wide geographical coverage and provisions for repeat coverage. Space photography can assist in mapping geology, landforms, vegetation, generalized land use, forest fire burns and temporary lakes and streams.

213. *Morrison, A./Chown, M. C.

*1964 *Photography of the western Sahara desert from the Mercury MA-4 spacecraft. NASA Contract No. NA Sr-140. *McGill University. 125 p. STAR 3(3):N65-12811.

*Sequence of high oblique color photographs taken by the automatic camera in the MA-4 spacecraft over the western Sahara in 1961. The larger geological and landform patterns of the area as well as vegetation boundaries on the southern edge of the Sahara can be mapped from the photographs. One photograph illustrated the potentiality of space photography for small-scale land-use mapping. Observations and calculations show that the smallest ground features that can be seen stereoscopically on these photos are of the order of 1000 feet high.

214. *Morrison, R. B.

*1968 *Preliminary soil classification map of southwestern U.S. and Mexico from Space Photography. *National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. 16 p. NASA-TM-X 61709, NASA-111, NASA Order R-146. STAR 7(15)N69-28395.

*The soil classification map was compiled from a mosaic of rectified black-and-white reproductions of space photographs from the Gemini IV and V missions. Unrectified color prints were used to determine soils colors as protrayed by the photographs, and their distribution; rectified black-and-white prints were used to plot detailed information on topographic base maps at the same scale. This information was then transferred to the small scale mosaic.

215. *Myers, V. I./Wiegand, C. L./Heilman, M. D./Thomas, J. R.

*1966 *Remote sensing in soil and water conservation research. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 801-813. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.

*Spectrophotometry as applied to agricultural and desert vegetation is discussed. Through the use of pictorial and thermal infrared sensing, it is possible to determine relative subsurface salinity and moisture conditions affecting crop production.

216. *National Academy of Sciences/National Research Council

*1966 *Spacecraft in geographic research. Report of a Conference on the Use of Orbiting Spacecraft in Geographic Research, held at the NASA Manned Spacecraft Center, Houston, Texas, January 28-30, 1965, by the Committee on Geography, advisory to the Office of Naval Research, Division of Earth Sciences, NAS/NRC. *NAS/NRC Publication 1353. 107 p.

*Largely a review of desirable studies for spacecraft programs.

217. *National Academy of Sciences/National Research Council

*1969a *Useful applications of earth-oriented satellites--forestry, agriculture, geography. *National Academy of Sciences/National Research Council, Forestry, Agriculture, Geography 1. 76 p. NASA-CR-101410, Contract NSR-09-012-909. Available CFSTI. STAR 7(15)N69-27962.

*The report contains estimates of the value satellite reporting systems might have to the agriculture and forest industry, United States and world-wide. The intangible effects on increasing the efficiency of farming and forestry through new satellite technology are potentially significant. Remote sensing is now technically feasible for: (1) inventory and productivity evaluation of the world's food, fiber, and other natural resources; (2) assessment of environmental conditions and of man-environment interactions.

218. *--- ---

*1969b *Useful applications of earth-oriented satellites: hydrology. *National Academy of Sciences/National Research Council, Hydrology: 3. Contract NSR-09-012-909. NASA-CR-101405. 81 p. Available CFSTI.

*The findings and recommendations of a technical study group on the applications of space technology to hydrologic problems are presented. Four hydrologic objectives are identified: basic studies of the hydrologic cycle and large scale hydrological systems; snow and ice mapping; surveys of coastal hydrologic features and large inland lakes, and real-time communications of ground based hydrologic data. The benefits to be derived from a collection of more and better hydrologic data and improved weather forecasting are evaluated and a cost estimate on a hydrology satellite system is also included.

219. *Neal, J. T.

*1965 *Airphoto characteristics of playas. In Geology, Mineralogy, and hydrology of U. S. playas. *U. S. Air Force Cambridge Research Laboratories, Environmental Research Paper 96:149-176. AD-616 243.

*Major types of playa surfaces can be recognized on the basis of the amount of light reflection. Geomorphic features that can be observed include sheet wash stains, giant contraction polygons, giant contraction stripes, salt pressure polygons, phreatophytes, hot and cold springs, and surface drainage forms.

220. *--- ---

*1968 *Satellite monitoring of lakebed surfaces. In Playa Surface Morphology: Miscellaneous Investigations, p. 131-150. *U. S. Air Force Cambridge Research Laboratories, Terrestrial Sciences Laboratory. STAR(1968)N68-27357.

*Playas are useful as emergency aircraft landing sites and as indicators of the hydrologic environment. A factor that has limited their use is the inability to intermittently monitor surface changes that occur as result of rain. Reflectance changes that indicate soil moisture or compositional variations (which in turn affect trafficability) have been observed on Gemini color photographs and Nimbus AVCS (Advanced Vidicon Camera System) imagery. The best data currently available is the Gemini color photography. The use of infrared and false-color films provide advantages in discriminating moisture as well as improving low-visibility conditions.

221. *Needleman, S. M./Molineux, C. E.
*1969 *Earth science applied to military use of natural terrain. *Air Force Cambridge Research Laboratories, Report AFCRL-AFSIG-211, AFCRL-69-0364. 209 p. Available CFSTI as AD-704 140.
*A comprehensive survey of the state-of-the-art in the evaluation of natural terrain by earth-science techniques and measurement systems. It includes an evaluation for relevant military applications such as unimproved landing areas, trafficability, site-selection for operational facilities, terrain reconnaissance and surveillance, and target detection within a masked terrain complex. The status of research and development, specifying the gaps in technology, is summarized with accompanying conclusions. Information pertaining to the classification of terrain data, field devices to measure bearing strength, and a visualized optimum remote sensing system is also given in the appendix. A glossary and a comprehensive bibliography are included.

222. *Newberry, L. E.
*1960 *Terrain radar reflectance study. *Photogrammetric Engineering 26(4):630-637.
*From the study - much of it in Arizona - it was concluded that water, arid desert, sand, broken desert, heavy vegetation and residential-commercial terrain types can be distinquished.

223. *Newell, H. E.
*1968 *Current program and considerations of the future for earth resources survey. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 69-75. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.
*An appraisal by an associate administrator of NASA, but with little specific information.

224. *Nikolaev, V. A./Ryabtseva, Z. G.
*1969 *Aerial photography as a method for the complex study of the landscape of semi-arid deserts and dry steppes. *Army Foreign Science and Technology Center, Washington, D. C. 26 p. Report No. FSTC-23-507-68. Translation of 1961 publication. Available as AD-695 723.

*The article offers nothing new in methodology and the examples used give little information on semi-deserts and dry steppes of the USSR as a whole.

225. *Nordberg, W./Samuelson, R. E.
*1965 *Terrestial features observed by the high resolution infrared radiometer. p. 37-46. In Observations from the Nimbus I Meteorological Satellite. NASA SP-89.
*A variety of different geophysical and atmospheric facts can be inferred from the observation of temperature variations over the earth's surface by the High Resolution Infrared Radiometer.

226. *Norton, C. L.
*1968 *Aerial cameras for color. *Photogrammetric Engineering 34(1):36-42.
*A basic discussion of the lens and automatic exposure control system (AEC) needed for balanced col... d infrared photography.

227. *Nunnally, N. R.
*1968 *A comparison of microdensitometry and TV waveform analysis as expressions of observed landscape patterns on radar. *Florida Atlantic University, Boca Raton, Department of Geography, Report TR-6. 15 p. NONR Contract 4761(00). Also available as AD-672 561.
*Identification of landscape regions with radar is largely dependent upon recognition of variations in texture patterns on the radar image. Comparison of microdensitometer traces with television waveform reveals that, for similar resolution systems, essentially the same tonal information can be obtained from either system. The advantages of lower cost, faster speed, and the ability to simultaneously see the location of the scan line being analyzed favor the use of waveform analysis.

228. *Ockert, D. L.
*1960 *Satellite photography with strip and frame cameras. *Photogrammetric Engineering 26(4):592-596.
*The advantages and disadvantages of strip and frame cameras are discussed. Although both have good and bad points, the author thinks the frame camera will be most useful.

229. *Olson, C. E., Jr.
*1960 *Elements of photographic interpretation common to several sensors. *Photogrammetric Engineering 26(4):651-656.
*Nine basic elements for interpretation are outlined and illustrated. They are: shape, size, tone, shadow, pattern, texture, site, association and resolution.

230. *--- ---
*1963 *Photographic interpretation in the earth sciences. *Photogrammetric Engineering 29(6):968-978.
*A report of the Photo Interpretation Committee covering status of photo interpretation and needs for additional research. Includes a comprehensive bibliography.

231. *--- ---
*1967 *Accuracy of land-use interpretation from infrared imagery in the 4.5 to 5.5 micron band. *Association of American Geographers, Annals 57(2):382-388.
*Study in Michigan brought out differences in agricultural land use. Best results in mid-day and early afternoon.

232. *Olson, C. E., Jr./Good, R. E.
*1962 *Seasonal changes in light reflectance from forest vegetation. *Photogrammetric Engineering 28:107-114.
*Study in Illinois, with G. E. recording spectrophotometer showed greater light reflectance from hardwoods. Difference between hardwood species was measurable, but difference between pine species was very small.

233. *Olson, C. E., Jr./Ward, J. M.
*1968 *Remote sensing changes in morphology and physiology of trees under stress. *Forestry Remote Sensing Laboratories, Berkeley, California. Annual Progress Report. 41 p. NASA Order R-09-038-002. NASA-CR-99183: APR-2. Available CFSTI. STAR N69-15856.
*Greenhouse studies with tree seedlings exposed to varying concentrations of NaCl and $CaCl_2$ indicate that oak species tested are more resistant to salt injury than aspen, tulip poplar, maple, or willow; and that salt tolerances of these species decreases in the order listed. No consistent differences in foliar reflectance or moisture tension between salt-treated and control plants are observed until leaf mortality occurred. Drought conditions in sugar maple seedlings were accompanied by increasing foliar reflectance of the stressed plants at all wavelengths from 0.5 to 2.5 micrometers.

Previsual detection of drought or salt-stress was not achieved using color or infrared-color photography in the laboratory. Girdled oaks were sucessfully detected in daytime imagery obtained from altitudes up to 4,000 feet above mean terrain. Detection was unsucessful from any altitude at night.

234. *O'Neill, H. T.
*1953 *Keys for interpreting vegetation from air photographs. *Photogrammetric Engineering 19(3):422-424.
*Too general to be of much value.

235. *Ory, T. R.
*1965 *Line-scanning reconnaissance systems in land utilization and terrain studies. In Symposium on Remote Sensing of Environment, 3rd, 1965, Proceedings p. 393-398. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-614 032.
*Advantages of line-scanning are discussed. Can be used with spectral range from ultraviolet to the far infrared. Terrain features stand out from backgrounds.

236. *Pardoe, G. K. C.
*1969 *Earth Resources Satellites. *Hawker Siddeley Dynamics Ltd., Hatfield, England. Science Journal 5(6):58-67. 10 p.
*Advantages of satellite surveying include a continuous and regularly repeatable broad synoptic view of total earth cover over a long period, and low cost per unit of data collected. Sensors operating different bands of the electromagnetic spectrum can cover a wide range of natural features including geologic, geographic, agricultural, and oceanographic. The equipment carried by satellites, handling of data, and administrative problems are discussed. Earth resource satellite programs in the U. S., the United Kingdon, and Europe are reviewed.

237. *Parker, D. C.
*1962 *Some basic considerations related to the problem of remote sensing. In Symposium on Remote Sensing of Environment, 1st, 1962, Proceedings p. 7-23. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-274 155.
*A discussion of theory, process and systems as related to remote sensing. Some basic concepts.

238. --- ---
*1968 *Developments in remote sensing applicable to airborne engineering surveys of soils and rocks. *Materials Research and Standards 8(2):22-30.
*Uses of various airborne sensors in engineering surveys of soils and rocks are discussed. The sensors include cameras, infrared and passive microwave mappers, radar, spectrometers, laser, radiofrequency, and induction devices. Applications include identifying and delimiting soil and rock units and locating information about surface and subsurface conditions that would affect ease of excavation, slope stability, and suitability for subgrade, foundation, or fill materials.

239. *Parker, D. C./Wolff, M. F.
*1965 *Remote sensing. *International Science and Technology 43:20-31, 73. Reprinted in American Society of Photogrammetry. Selected Papers on Remote Sensing of Environment. Washington, D.C. 1966.

240. *Pecora, W. T.
*1967 *Surveying the Earth's resources from space. *Surveying and Mapping 27(4):639-643. ANAG (1968) 05211.
*Experiments have demonstrated our ability to study and

assess natural resources from remote-sensored data. Examples discussed are: mapping, geographical research, hydrogeology, such as salt-water intrusion and pollution, mineral and fuel discoveries, and engineering geology. Some examples are given of the use of infrared imagery in Nevada, Yellowstone Park, and Scranton, Pa., where underground coal beds are burning. Radar has located faults in a mining area in Nevada. Although this data can help with conservation of public lands and forests, and in oceanography, it is too general to be of much use for specific arid lands problems.

241. *Peltier, L. C./Pearcy, G. E.
*1966 *Military geography. *Van Nostrand, Princeton, New Jersey. 176 p.
*A basic text on military geography.

242. *Peterson, R.M./Cochrane, G.R./Morain, S.A./Simonett, D.S.
*1969 *A multi-sensor study of plant communities at Horsefly Mountain, Oregon. *Kansas University, Lawrence Center for Research in Engineering Science. 33 p. Rept. no. CRES-Reprint-133-6. Contract DAAK02-68-C-0089. AD-698 098.
*The Horsefly Mountain region is a complex of upland pine and fir forests and of near-flat, stony basins supporting grass or sage. The diverse plant communities occur with a wide range of sharply to diffusely-defined boundaries and with a wide range of densities within communities. The region thus lends itself well to the testing of image-combining devices now being used in vegetation studies. The IDECS system, which is an Image Discrimination, Enhancement, Combination, and Sampling device used, produces color images by combining data from up to six black-and-white multi-sensor images.

243. *Petrov, M.F.
*1969 *Utilization of aerial photography for the geographic study of the deserts of central asia. *Army Foreign Science and Technology Center, Washington, D. C. Translation of 1961 pub. Report no. FSTC-HT-23-500-68. AD-693 147.
*A very useful discussion of black-and-white aerial photography covering work in the deserts of East Central Asia, in comparison with the deserts in West Central Asia. The methods of Soviet scientists to utilize aerial photography in the geographic studies on the desert territories of the Soviet Union are projected for East Central Asia. The various desert types are discussed in relation to their appearance on aerial photographs.

244. *Popham, R. W./Baliles, M., eds.
*1966- 1967 *Tiros cloud free atlas. 3 vols. *U.S. National Environmental Satellite Center. MGA 19.1-23.
*Highly reflective terrestial features seen in TV photographs from weather satellites have the same apparent brightness as many cloud features. In order to properly identify such features one must learn to recognize their shape, appearance, and general characteristics. The 3 atlases of the U.S. and contigous areas of Canada and Mexico have been compiled by the Applications Group of the National Environmental Satellite Center, ESSA, primarily for use as a guide in training meteorological personnel to recognize features which might otherwise be interpreted as clouds.

245. *Poulton, C. E.
*1968 *The feasibility of inventorying native vegetation and related resources from space photography. In *Earth Resources Aircraft Program Status Review, II: Agriculture, Forestry, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, Sept. 16-18, 1968, p. 40-1 to 40-24.
*A progress report with little in the way of useable results. The objectives of the study were: (1) to determine potentialities and limitations of mapping and interpreting characteristics of native vegetation areas from space photography. (2) to compare vegetation maps from this photography with other available vegetation-resource maps and (3) identify problems and limitations in the practical use of space photography in earth resources applications. The area covered was that from Gemini, Apollo photographs in southwestern U.S.

246. *Poulton, C. E./Schrumpf, B. J./Garcia-Moya, E.
*1968 *The feasibility of inventorying native vegetation and related resources from space photography. *NASA-CR-99249. STAR 7(6):N69-16390.
*Space photographs taken during Gemini IV overflight of southern Arizona are being studied to assess the appropriateness of this system of remote sensing for inventorying native vegetation and related resources. Close examination and experience in relating images to their vegetation and soil subjects indicate that a meaningful inventory of these resources can be accomplished through the use of space photographs. An inventory can be obtained through strict adherence to specific mapping concepts and ecological principles as they apply to several steps in the flow chart.

247. *Pouquet, J.

*1968a *Remote detection of terrain features from Nimbus 1 high resolution infrared radiometer nighttime measurements. *National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. 12 p. NASA-TN-D-4603. Contract 160-44-03-35-51. CFSTI, STAR N68-28872.

*Brightness temperature analyses were made from nighttime Nimbus high resolution infrared data in the 3.5 - 4.2 micron region. Data for the northeast Sahara Desert and the Nile delta regions, obtained during September 1964, were selected. The brightness temperatures detect: (1) the widespread humidity in the upper soil horizons, and (2) the heat storage capacity in various rock formations such as sands and alluvial deposits.

248. *--- ---

*1968b *An approach to the remote detection of earth resources in sub-arid lands. *National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. Presented at the International Congress of Geology, sect 13, Prague, 21 August 1968. 24 p. NASA-TM-X-63268; X-622-68-245. Available CFSTI. STAR N68-29082.

*Efforts were undertaken to find a better geological tool utilizing the nighttime infrared radiations emitted by the ground, and thereby obtain a better knowledge of the agricultural possibilities of arid and sub-arid lands. From this preliminary study certain predominant features emerged and were used as a basis for the interpretation of data.

249. *Pratt, W. P.

*1968 *Infrared imagery of Lordsburg-Silver City area, New Mexico. *Prepared for NASA by U. S. Geological Survey. NASA Order R-146. NASA-TM-X-61711: NASA-71. Available CFSTI. 17 p.

*Nighttime infrared imagery of the area between Lordsburg and Silver City, New Mexico, indicates numerous applications for studies of geology and hydrology of desert regions. Tertiary volcanic rocks consisting of flows and welded tuffs show good tonal contrasts within themselves. Precambrian granites and gneisses appear mottled. Water courses appear as dark streaks, cold water springs as dark patches, and water standing in ponds and reservoirs is bright in contrast to the darker (cooler) surrounding materials.

250. *Prentice, V. L.

*1967 *Remote sensing of environment: progress report, August 1, 1965 through December 31, 1966. *University of Michigan, Institute of Science and Technology, Willow Run Laboratories, Infrared Physics Laboratories, 22 p. Contract Nonr-1224 (44) NR 387-028. 4864-12 P. Contracted for the Office of Naval Research, Geography Branch.

*This document reports investigation of progress in the unclassified areas in the technology of remote sensing of environment. It includes a synopsis of progress in the field as reported at the Fourth Symposium on Remote Sensing of Environment, a discussion of the existence and availability of unclassified imagery, and a summary of related activities. It includes an extensive bibliography.

251. *Pryor, W.T.
*1964 *Evaluation of aerial photography and mapping in highway development. *Photogrammetric Engineering 30(1):111-123.
*A general discussion bringing out the value of aerial photography in the early sixties. The many advances since then reduce the value of the article materially.

252. *Rall, L.L.
*1966 *Geographic data processing. *Photogrammetric Engineering 32(6):978-986.
*A discussion of the design of equipment to collect, reduce and interpret geographic data by such means as a change-detection scheme for map revision; automatic image extraction; learning devices; an optical computer; automatic mapping; and high capacity information storage and manipulation.

253. *Ray, R.C./Fischer, W.A.
*1960 *Quantative photography--a geologic research tool. *Photogrammetric Engineering 26(1): 143-150.
*Height and distance determinations may be augmented by colorimeter and densitometer measurements.

254. *Raytheon Company, Autometric Operation
*1965 *I: Geoscience potentials of side-looking radar. II: Geoscience potentials of side-looking radar imagery and overlays. *Contract DA-44-009-AMC-1040 (X). Also available CFSTI as AD-650 498 and AD-650 499.
*An excellent review of the state of art and evaluation of the SLAR system's utility in geoscientific investigation. Volume 2 contains photographs of radar images from airborne side-looking radar. The figures illustrate volume 1. Items covered include: drainage, culture, vegetation, surface materials, physiography and geology.

255. *Resta, P.E.
*1965 *Image interpretation in a space environment. *Photogrammetric Engineering 31(6):1010-1017.
*Potential problems of image interpretation in manned space systems include physiological, psychological, display, and information-processing variables. Anticipated training and interpretation requirements are discussed.

256. *Rib, H.T.
*1968 *Remote sensing applications to highway engineering. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 725-736. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676-327.
*Remote sensing, with its potential for providing information previously unobtainable ushers in a new era in highway engineering. The types of information that can be obtained and applied to highway engineering are discussed.

257. *Richter, D.M.
*1967 *An airphoto index to physical and cultural features in the western United States. *Photogrammetric Engineering 33(12):1402-1419.
*Examples of physical and cultural features in the western United States. Contact prints of the indexed features are available from USDA photo laboratories at Salt Lake City and Asheville. Related USGS topographic map coverage is also given. 254 selected physical and cultural features are listed.

258. *Rivera Márquez, J.
*1966 *Clasificación de suelos, empleando fotografías aéreas (Classification of soils by the use of aerial photography). *Ingeniería Hidráulica en México 20(4):49-87.
*Accompanied by English summary on inserted loose sheets.

259. *Robinove, C.J.
*1965 *Infrared photography and imagery in water resources research. *American Water Works Association, Journal 57(7):834-840.
*Essentially same material as in his 1966 publication.

260. *--- ---
*1966 *Remote sensor applications in hydrology. In Symposium on Remote Sensing Environment, 4th, 1966, Proceedings p. 25-32. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.
*A review of present and projected applications of remote sensing in hydrology. Devices in use are valuable in studies of water temperature, ground-water discharge pollution, lake classification, evaporation and transpiration. As hydrology is linked with other scientific and technical disciplines, it is vital that research be directed at problems of the interfaces between the disciplines as well as the basic hydrologic problems.

261. *--- ---
*1968 *The status of remote sensing in hydrology. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings p. 827-831. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available CFSTI as AD-676 327.
*Progress in remote-sensor use in hydrology and promising avenues of research are outlined. A general review with some specific examples of what has been done and areas where research might provide effective measures.

262. *Robinove, C. J./Anderson, D. G.
*1969 *Some guidelines for remote sensing in hydrology. *Water Resources Bulletin 5(2):10-19.
*A discussion of remote sensing in the field of hydrology is given to guide the hydrologist to a better understanding of how he may collect, synthesize, and interpret remote sensing data. The techniques discussed include color aerial photography, infrared aerial photography, infrared imagery and photogrammetry. Data reduction methods and equipment are briefly outlined.

263. *Robinove, C. J./Skibitzke, H. E.
*1967 *An airborne multispectral television system. *Geological Survey Research 1967. U. S. Geological Survey, Professional Paper 575-D: 143-146.
*Airborne multispectral television images in visible and near-infrared region of the spectrum have lower spatial resolution than aerial photographs, but have the advantage of instant reproduction and are especially useful for vast coverage of dynamic events such as floods.

264. *Romanova, M. A.
*1968 *Spectral luminance of sand deposits as a tool in land evaluation. p. 342-348. In G. A. Stewart, ed., Land evaluation, Papers of a CSIRO symposium organized in cooperation with UNESCO 26-31 August 1968. *Macmillan of Australia.
*An investigation was made to determine if the spectral luminance of sands in Karakum desert could be registered by remote sensing apparatus, and it was shown that the spectral luminance of the sands does indeed reflect the origin of the deposits. Desert sands are suited to this method because their diffuse reflection of light gives similar luminance values over a range of angles of illumination.

265. *Rose, C. W./Thomas, D. A.
*1968 *Remote sensing of land surface temperature and some applications in land evaluation. In G. A. Stewart, ed., Land evaluation, Papers of a CSIRO symposium organized in cooperation with UNESCO 26-31 August 1968. *Macmillan of Australia. p. 367-375.
*The problems involved in measuring land surface temperature from remote radiometric measurements, made in the 8-13 micrometre atmospheric "window" are discussed. Two possible applications of using land surface temperature in land evaluation are examined: 1)the assessment of the extent and density of vegetation over large areas and 2)the relative assessment of water storage in bare soil.

266. *Rouse, J. W., Jr./Waite, W. P./Walters, R. L.
*1966 *Use of orbital radars for geoscience investigations. *University of Kansas, Lawrence, Center for Research in Engineering Science. Technical report 61-8. 31 p. Maps. STAR 10(22)N66-36512.
*Radar in the fields of scatterometry, altimetry, imagery, and penetration is described. Scatterometry, dealing with the scattering coefficients of terrain targets, is discussed. The effect of surface texture or roughness on the magnitude of the scattering coefficient is discussed. Several radar images are examined which contain information applicable to geology, agriculture, and sea-ice studies. Vegetation penetration is described as the best use for the penetrating capability of radar. Applications of radar altimetry for determining sea slope, height of tides and storm surges, orbit calculations, and in glaciology are evaluated.

267. *Rubin, L.
*1968 *Operational processing of low resolution infrared (LRIR) data from ESSA satellites. *U. S. Environmental Science Services Administration, Technical Report NESC-42. 37 p.
*The advent of weather satellites has made possible the realistic examination of large scale atmospheric phenomena essential to a more thorough understanding of man's environment. The purpose of this report is to provide a key to the operational data processing of the LRIR (low resolution infrared) data. Hardware and technique are discussed relevant to the data recovery problem, and appropriate references are furnished for detailed study.

268. *Rydstrom, H. O.
*1966 *Interpreting local geology from radar imagery. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings, p. 193-201. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-638 919.
*From study of the radar imagery of earth features and application of radar imaging principles to their analysis, it is concluded that high resolution side-looking radar in the existing state of the art can be useful in local geologic interpretation. The intensity of radar return energy, as modified by the factors of radar illumination, surface roughness, and the geometry of objects, is discussed. The principles involved are described and applied to analyses of local geology in the southwestern United States. Local geologic interpretations of radar imagery are applicable to military terrain intelligence, natural resources exploration, and planetary exploration.

269. *Rydstrom, H. O.
*1967 *Interpreting local geology from radar imagery. *Geological Society of America, Bulletin 78: 429-436.

*The intensity of radar return energy, which is dependent on the manner of radar illumination, surface roughness, and geometry of the object, is discussed as applicable to the interpretation of local geology. The principles of radar interpretation of local geology and the use of radar principles in conjunction with knowledge of geomorphic principles to obtain a maximum of information are discussed. These are illustrated with radar images and photographs of areas in the southwestern U. S. Applications of radar imagery to military terrain intelligence, natural resources exploration, and planetary exploration are examined.

270. *Sabins, F. F., Jr.
*1967 *Infrared imagery and geologic aspects. *Photogrammetric Engineering 33(7):743-750.
*Infrared imagery in the Indio Hills of southern California provides basis for identification of alluvial valleys that are cooler than the older deformed sedimentary rocks of the hills. A concealed trace of the San Andreas fault is revealed by a cold anomaly apparently related to blockage of ground water. Other faults and folds are also evident. An excellent discussion of infrared imagery bringing out formations.

271. --- ---
*1968 *Thermal infrared imagery for geologists. *Chevron Oil Field Research Company, La Habra, California, Paper. 21 p. SWRA 2(12):63.
*See Sabins (1969)

272. --- ---
*1969 *Thermal infrared imagery and its application to structural mapping in southern California. *Geological Society of America, Bulletin 80: 397-404.
*An excellent discussion showing how thermal infrared imagery can be used to show terrain features and to bring out features hardly if at all noticeable in aerial photos.

273. *Schaber, G. G.
*1968 *Radar and infrared in geological studies of northern Arizona. In *Earth Resources Aircraft Program Status Review, I: Geology, Geography, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, Sep. 16-18, 1968, p. 13-1 to 13-29.
*The radar imagery furnished data useful in the interpretations of tectonics, surface moisture and overlapping sequence of lava flows. The IR scanner data served to show location of prehistorical Indian agriculture sites and to discriminate between recent and older volcanic ash deposits.

274. *Schaber, G. G./Gumerman, G. J.
*1969 *Infrared scanning images: an archaeological application. *Science 164(3880):712-713.
*Aerial infrared scanner images of an area near the Little Colorado River in north-central Arizona disclosed the existence of scattered clusters of parallel linear features in the ashfall area of Sunset Crater. Soil

and pollen analyses reveal that they are prehistoric agricultural plots. The features are not obvious in conventional aerial photographs, and only one cluster could be recognized on the ground.

275. *Schwartz, A. L./Zeidner, J.
*1961 *Comparison of photo interpretation under stereo and non-stereo viewing conditions *Photogrammetric Engineering 27(5):720 .
*The major objective of this study was to determine whether or not stereo viewing helps in the identification of militarily significant targets in aerial photographs. It was concluded that there was no significant difference.

276. *Schwarz, D. E./Caspall, F.
*1968 *The use of radar in the discrimination and identification of agricultural land use. In Symposium on Remote Sensing of Environment, 5th, 1968, Proceedings, p. 233-247. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available as AD-676 327.
*Discrimination by crop type is feasible with varying probability of identification. Information at more than one time in the growing season enhances the probability for correct crop identification.

277. *Schwieder, W. H.
*1968 *Laser terrain profiler. *Photogrammetric Engineering 34(7):658-664.
*Tests indicate that the laser terrain profiler is acceptable for the acquisition of vertical control for photo mapping.

278. *Sen, A. K.
*1966 *Photo-interpretation to study arid zone geomorphology. In Symposium International de Photo-Interprētation, II, Groupe IV.1. *Institut Français du Pétrole, Revue 21(12): 1903-1906. BIGENA 31(9)E67-07636.
*A photo-interpretation of the structures and textures in the desert region of Baloo (Africa) provides a key for the understanding of aerial photography of all desert regions. The relationship of wind cycles to dune morphology and similarities in the arid zones of India are discussed.

279. *Shepard, F. P.
*1950 *Photography related to investigation of shore processes. *Photogrammetric Engineering 16(5):756-769.

*Various shore processes are illustrated and discussed, mostly from surface photographs, but the author does point out the greater value of aerial photos.

280. *Sherman, J. C.
*1963 *Accumulation of geographic data through remote sensing techniques. In Symposium on Remote Sensing of Environment, 2nd, 1962, Proceedings p. 427-429. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-299 841.
*Too general to be of much value.

281. *Shockley, W. G./Knight, S. J./Lipscomb, E. B.
*1963 *Identifying soil parameters with an infrared spectrophotometer. In Symposium on Remote Sensing of Environment, 2nd, 1962, Proceedings p. 267-288. *University of Michigan, Institute of Science and Technology, Ann Arbor. Also available CFSTI as AD-299 841.
*Object of laboratory tests was to establish feasibility of using infrared spectrometer in determining trafficability characteristic of soils. Results showed that surface moisture, grain size and soil type could be identified. Since reflected infrared radiation is influenced only by surface conditions, internal conditions could not be measured.

282. *Shvyryaeva, A. M.
*1969 *Utilization of the results of geobotanical interpretations of aerial photographs in landscape investigations of the northern Caspian Sea region. Translation available CFSTI as AD-691 973.
*Describes the application of the geobotanical interpretation of aerial photographs of the regions to the north of the Caspian Sea to the determination of the geological landscape of this area. The plant associations growing under specific conditions delineate distinctly the location of various soils and hydrological conditions and hence, the geological origin, age, and topography.

283. *Simakova, M. S.
*1964 *Soil mapping by color aerial photography. *Davey & Co., Inc., New York. 81 p.
*A review of soil surveys based on aerial photography in Caspian lowlands. Title is somewhat misleading as much of the discussion is based on black-and-white photography. Methods and equipment parallel those of the USA.

284. *Simakova, M. S.
*1966 *Field and laboratory interpretation of aerial photographs in compiling soil maps. *Soviet Soil Science 1966(2):131-136. Maps.
*A preliminary soil map can be compiled before going into the field. Field and laboratory work are alternated for best results.

285. *Simonett, D. S.
*1966a *Future and present needs of remote sensing in geography. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 37-47. *University of Michigan, Institute of Science and Technology, Ann Arbor. STAR N66-37521. Available CFSTI as AD-638 919.
*A general discussion of little specific value, but includes a 2-page bibliography.

286. --- ---
*1966b *Application of color-combined multiple polarization radar images to geoscience problems. In D. F. Merriam, ed., Computer applications in the earth sciences, Colloquium on classification procedures. *Kansas Geological Survey, University of Kansas, Lawrence, Computer Contribution 7:19-23.
*This paper describes the operation of a system used to analyze multiple radar images by producing color combined radar images on a color television set and producing differentiated and other modes of image enhancement, and in deriving probability density functions from the images.

287. --- ---
*1968a *Potential of radar remote sensors as tools in reconnaissance geomorphic, vegetation, and soil mapping. *International Congress of Soil Science, 9th, Adelaide, 1968, Transactions 4:271-280.
*Studies using non-photographic remote sensors, particularly infrared and radar have shown that these systems, used in concert with photography, may add materially to the information available and thereby improve the efficiency of ground reconnaissance. This report focuses attention on side-looking radar as a tool for such reconnaissance. Since radar imagery may be obtained in swaths up to 40 miles wide, largely independent of the weather, its usefulness for reconnaissance-mapping needs careful evaluation. A review is given of recent studies with radar on 1) mapping of lineaments and lithologic units and its use as a surrogate for 1:24,000 scale maps in hydrologic analysis; 2) mapping of vegetation types, especially in relation to structure; and 3) its successes and shortcomings as an adjunct to photographs in soil reconnaissance surveys.

288. *Simonett, D. C.
*1968b *Radar as a sensor in agriculture. In *Earth resources aircraft program status review, II: Agriculture, forestry, and sensor studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 34-1 to 34-27.

*Radar results together with summaries of results from other sensing devices. Differences in crop phenology bring out the need for many channels of information, one of which may be radar because of the constraints of obtaining timely data under various weather conditions. Natural vegetation features can often be identified by radar

289. --- ---
*1968c *Thematic land-use mapping with spacecraft photography and radar. In *Earth resources aircraft program status review, I: Geology, geography, and sensor studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 8-1 to 8-20.

*Preliminary studies are reported in a discussion of 1) whether existing thematic land-use maps could be constructed with space data, 2) problems of constructing thematic land-use maps using space data, 3) information on Gemini photographs and in aircraft radar images, and 4) some aspects of the roles of photography and radar as complementary and supplementary sensors.

290. *Simons, J. H.
*1965 *Some applications of side-looking airborne radar. In Symposium on Remote Sensing of Environment, 3rd, 1964, Proceedings p. 563-571. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-614 032.

*Air radars are all-weather systems independent of natural illumination. They are especially useful in showing geological and geomorphologic features, including soil characteristics and trafficability.

291. *Skolnik, M. I.
*1962 *Introduction to radar systems. *McGraw-Hill Book Co., New York. 648 p.

*A basic text covering the engineering aspects of radar. Background information for those interested in remote sensing, although there is no mention of remote sensing in the book. Extensive bibliographies are included with each of the 14 chapters.

292. *Smith, H. T. U.
*1963 *Eolian geomorphology, wind direction, and climatic change in North Africa. Final Report. *U. S. Air Force Cambridge Research Laboratories AFCRL 63-443. Contract AF 19(628)-298. 48 p. Available CFSTI as AD-405 144.
*An excellent discussion covering a large segment of the North African desert belt. Photos used in this study were of the Tri-Metrogon type dating back to World War II.

293. --- ---
*1969 *Photo-interpretation studies of desert basins in northern Africa. Final Report, pt. 1. *U. S. Air Force Cambridge Research Laboratories AFCRL 68-0590. Contract AF 19(628)-2486. 106 p. Available CFSTI as AD-689 408.
*This report is directed toward appraising the feasibility of photogeologic methods for studying characteristics of desert basin floors in the Saharan region, using medium scale Tri-Metrogon photography. General features of basins are satisfactorily delineated, but more specific characteristics are dealt with less conclusively. Supplementary data from remote sensing techniques and from orbital photography or imagery would be most helpful. Playa-type depressions are not common and are recognized only in the western part of the region.

294. *Smith, J. T., Jr.
*1963 *Color, a new dimension in photogrammetry. *Photogrammetric Engineering 29(6):999-1013.
*The paper discusses the use of color aerial photography by the U. S. Coast and Geodetic Survey. Beautifully illustrated with color photographs.

295. *Smith, N.
*1962 *Radar technology and remote sensing. In Symposium on Remote Sensing of Environment, 1st, 1962, Proceedings p. 33-42. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-274 155.
*A discussion of theory and processes of radar as applied to remote sensing.

296. *Sonu, C. J.
*1964 *Study of shore processes with aid of aerial Photogrammetry. *Photogrammetric Engineering 30(6):932-941.
*Problems involved in the use of aerial photography for coastal morphological study resemble more or less those of terrain photography and offer great promise of shore process factors.

297. *Sorem, A. L.
*1967 *Principles of aerial color photography. *Photogrammetric Engineering 33(9):1008-1018.
*A basic discussion of aerial color photography covering films, filters, and processes. Advantages of color over black-and-white are pointed out.

298. *Souto Crasto, T. de
*1966 *A importância do critério de drenagem na interpretação de fotografias aéreas. *Revista Brasileira de Geografia 28(4):380-396.
*A well-illustrated article on the development of drainage maps from aerial photographs.

299. *Spitz, A. L.
*1968 *A method for plotting all sky camera data in geomagnetic coordinates. *Arctic Institute of North America, Washington, D. C., AINA-RP-43. 53 p. NSF Grant No. GA-383. Available CFSTI as PB-179 075.
*Canadian model DA-3 all-sky camera optical system is readily adaptable to any other system by making pertinent changes to one of the mathematical subroutines.

300. *Stanford University, School of Engineering
*1968 *Demeter, an earth resources satellite system. Final report. *Stanford University, School of Engineering. 526 p. Available CFSTI as PB-183 089.
*The Demeter satellite system would observe the earth in the optical, near infrared, and thermal infrared wavelengths and produce real time multiband pictures approximately every two weeks for distribution to various users. The study presents the economic and political as well as technical point of view. Technical designs cover the scanning sensors, the communication system, the data reduction and distribution, and the satellite configuration.

301. *Steiner, D.
*1963 *Technical aspects of air photo interpretation in the Soviet Union. *Photogrammetric Engineering 29:988-998.
*Reviews some technical aspects of air photography and air photo interpretation in the Soviet Union, taken from the Russian literature concerned with the subject and published after World War II. Properties of equipment used in air photography, such as cameras, lenses, films, and filters and their suitability for different surveying and interpretation purposes are dealt with in detail.

302. *Steiner, D.
*1965 *Use of air photographs for interpreting and mapping rural land use in the United States. *Photogrammetria 20:55-80.
*General discussion reviewing equipment and techniques used for various land use surveys. Color and infrared are briefly noted.

303. *Stevenson, R. E./Nelson, R. M.
*1968 *An index of ocean features photographed from Gemini spacecraft. *U. S. National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. 348 p.

304. *Stone, K. H.
*1956 *Air photo interpretation procedures. *Photogrammetric Engineering 22(1):123-132.
*An excellent procedural outline for interpretation of aerial photos. Interpretations should be from general items to specific and from known to unknown, using scales of 1:70,000-1:30,000 for general features; 1:30,000-1:10,000 for intermediate; and larger than 1:10,000 for details. Outlines of features to observe are included.

305. --- ---
*1964 *A guide to the interpretation and analysis of aerial photos. *Association of American Geographers, Annals 54(3):318-328.
*A detailed guide is offered for photo interpretation proceeding from general to specific and known to unknown. 139 steps are outlined.

306. *Strandberg, C. H.
*1964 *An aerial water quality reconnaissance system. *Photogrammetric Engineering 39(1):46-54.
*Aerial reconnaissance systems that can augment ground studies are especially valuable to reach areas of limited or total inaccessibility. Many pollutants can be detected from aerial photos.

307. --- ---
*1966 *Aerial photographic-interpretation techniques for water quality analysis. *Photogrammetric Engineering 32(2):234-248.
*Many water pollution conditions are evident through remote sensing. The article discusses types of pollution and their detection through standard remote sensing techniques.

308. --- ---
*1967 *Aerial discovery manual. *Wiley, New York. 249 p.
*A manual for the beginner or for classroom use. Covers aerial photographic interpretation, photogeology, and photohydrology.

309. *Strangway, D. W./Holmer, R. C.
*1965 *Infrared geology. In Symposium on Remote Sensing of Environment, 3rd, 1964, Proceedings p. 293-319. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-614 032.
*Tests in southern Arizona and New Mexico show microclimatological effects are important. Faults and some other geologic structures were identified.

310. *Strees, L. V.
*1961 *A satellite's view of the earth. *Photogrammetric Engineering 27(1):37-41.
*Atmospheric distortions are discussed and remedial measures proposed.

311. *Stroud, W. G.
*1960 *Our earth as a satellite sees it. *National Geographic Magazine 118(Aug.):292-302.

312. *Suits, G. H.
*1960 *The nature of infrared radiation and ways to photograph it. *Photogrammetric Engineering 26(5):763-772.
*A basic discussion of infrared radiation and recording systems.

313. *Swanson, L. W.
*1964 *Aerial photography and photogrammetry in the coast and geodetic survey. *Photogrammetric Engineering 30(5):699-726.
*The U.S.Coast and Geodetic Survey uses photogrammetry as one of its principal surveying systems in support of major programs such as aeronautical and nautical charting, oceanography, and satellite triangulation. Equipment, facilities, and methodologies are described and illustrated by excellent color photos.

314. *Symposium on Photo Interpretation, 1st, Delft, 1962
*1962 *Transactions. Edited by Commission VII, International Society for Photogrammetry. *Uitgeverij Waltman, Delft. (Archives Internationales de Photogrammetrie, 14). 533 p.
*Pertinent papers are covered individually.

315. *Symposium on Remote Sensing of Environment
*1962-1968 *Proceedings, 1st-5th. *University of Michigan, Institute of Science and Technology, Infrared Laboratory, Ann Arbor. 5 vols. Sponsored by Office of Naval Research, Geography Branch, and other Government agencies. Available CFSTI as AD-274 155, AD-299 841, AD-614 032, AD-638 919 AD-676 327 respectively.
*Pertinent papers are covered individually.

316. *Tarkington, R. W./Sorem, A.L.
*1963 *Colour and false colour films for aerial photography. *Photogrammetric Engineering 29(1):88-95.

*Two scientists from Eastman Kodak Co. discuss and illustrate improvements in color and color infrared films. Color reproduction by the photographic process using three primary colors is discussed, and the use of these photographic and optical principles for false-color reproduction is explained. The characteristics of two new aerial films -- Kodak Ektachrome Aero Film (Process E-3) and a false-color type, Kodak Ektachrome Infrared Aero Film (Process E-3) -- are compared with those of the older products they replace.

317. *Tata, R.J./Palmer, C.E./Witmer, R.E.
*1969 *Review of new geographic methods and techniques. Final technical report (Appendix C). *Florida Atlantic University, Department of Geography. 97 p. Contract DAAK02-68-C-0219. Available CFSTI as AD-700 176.

*The first part of this review summarizes the results of a questionnaire survey of geographers active in researching methodological topics; the second deals with the geographer's role in studies of water resource planning and management; the final study comprises a report and bibliography on new systems of remote sensing techniques.

318. *Tewinkel, G.D.
*1963 *Water depths from aerial photographs. *Photogrammetric Engineering 29(5):1037-1042.

*Objects submerged in water can be measured from vertical aerial photos. In clear water depths to 90 feet, contours have been traced to a depth of 60 feet. Depth of water observed needs to be multiplied by a factor of 1.4 to 1.5.

319. *Theurer, C.
*1959 *Color and infrared experimental photography for coastal mapping. *Photogrammetric Engineering 25(4):565-569.

*Color, infrared and panchromatic aerial photography of shoal areas have been obtained for comparative studies for applications to coastal mapping. One application of color photography is to determine relative depths, not isolating shallow areas which may require a dense hydrographic study. Special devices and techniques are discussed, including the problem of obtaining aerial photographs at a specific stage of the tide, and the possible adaptation of stereoscopic instruments.

320. *Titley, S.R.
*1968 *Southern Arizona, the view from Gemini. In Southern Arizona Guidebook 3:2-6. *Arizona Geological Scoiety, Tucson.
*Examples of the ways in which high-altitude color transparencies, taken from Gemini flight, can be used in geological interpretation are given. The broad range of red colors, so typical of desert landscapes, is clearly evident. Colors of soils, especially on the pediments and bajadas, are very distinct. Limestones, with few exceptions, do not breed red soils; most of the red comes from volcanic rock soil. Landforms are especially clear in such high-altitude photos. Other structural features are pointed out also.

321. *Tolchelnikov, Y.S.
*1969 *The role of soils in the interpretation of Arid-Zone landscapes from aerial photographs. *Translation available CFSTI as AD-692 656.
*A rather general discussion based on black-and-white aerial photography. It is pointed out that the characteristics of soil cover are closely related with all components of the landscape, refracting the specifics of the geologic and geomorphologic structure of the territory, hydrological conditions, migration of chemical compounds, composition of vegetative cover, etc. Examples of interpretation of aerial photographs are given.

322. *Unesco
*1968 *Aerial surveys and integrated studies, proceedings of the Toulouse Conference, 1964. *Unesco, Paris. Natural Resources Research 6. 575 p.
*Part 1 (p.13-286) includes fairly long reviews of research on the application of aerial photographic interpretation to the investigation of natural resources. These are very informative and the more appropriate areas are cited separately by author. This part of the book could well serve as an introduction to aerial surveys and their applications to the inventory of natural resources as a basis for land use. The emphasis is on standard aerial survey procedures. Extensive bibliographies are appended. Part 2 (p. 289-370) includes shorter reports on various aerial surveys and their application to a variety of land use problems. Part 3 (p. 373-530) includes very brief reports on various aspects of aerial photography and its applications. Part 4 (p. 533-570) is a report on a panel discussion of survey principles.

323. *U. S. Department of Agriculture, Soil Survey Staff
*1966 *Aerial photo interpretation in classifying and mapping soils. *USDA Agriculture Handbook 294. 89 p.

*A complete manual of value not only to the soil surveyor but also to anyone using soil survey maps. Soil surveys have been based on aerial photos since 1930. Unfortunately examples are mostly from humid areas.

324. *U. S. Department of the Army
*1967 *Image interpretation handbook, Vol. 1. Technical Manual 30-245, NAVAIR 10-35-685, AFM 200-50. *U.S. Government Printing Office, Washington, D.C. 358 p.
*The purpose of this handboo is to provide military image interpreters with current ference material basic to all types of image interpretat . It provides detailed information on various kinds of imagery and their application to interpretation. The value and limitation of various sensors is included together with detailed information on equipment and processes. It is a text of major importance for all technicians seriously interested in remote sensing.

325. *U. S. National Aeronautics and Space Administration, Scientific and Technical Information Division.
*1967 *Earth photographs from Gemini III, IV, and V. *Special Publication SP-129. 266 p.
*Gemini IV and V carried Synoptic Terrain Photography and Synoptic Weather Photograph experiments. Gemini IV photographed areas of east Africa, the Arabian Peninsula, Mexico and the southwestern U.S.: Gemini V, selected land and near-shore areas of oceanographic interest. The 244 photographs include 39 near-vertical views of the Pacific coast of Mexico to central Texas which show such details as contact between Quaternary alluvium and bedrock, fault zones, tectonic provinces in Sonora and sediment distribution in the Colorado River delta, deposition patterns, and some North African sand dunes.

326. *VanLopik, J. R.
*1962 *Optimum utilization of airborne sensors in military geography. *Photogrammetric Engineering 28(5):733-778.
*A discussion of what sensors should provide.

327. *--- ---
*1968 *Infrared mapping, basic technology and geoscience applications. *GeoScience News 1(3): 4-7, 24-31, 36. ANAG (1968)00351.
*Topics discussed under infrared imagery are: atmospheric effects, basic physics, infrared sensing systems, and applications. Under the last, the geothermal gradient, internal heat and its conductivity, soil mapping by radiometric temperatures and reflectance levels, and surveys for hydrographic purposes are examined.

328. *VanLopik, J.R./Yarbrough, L.A.
*1966 *Comments on remote sensing needs in geoscience engineering and exploration. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 49-54. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-638 919.
*A statement of problems w'th little specific suggestions for solution.

329. *Vidal, R.S.
*1957 *Land use mapping in Chile. *Photogrammetria 22(5):153-159.
*Development and status of the use of air photographs in Chile.

330. *Viktorov, S.V.
*1969 *Use of aerial methods in landscape studies. 409 p. *Translation available CFSTI as AD-698 170.
*The collection of articles covers a wide range of problems: the use of aerial methods in the tundra, taiga, stepps, and sandy deserts; the possibilities of aerial methods for the study of regional characteristics of landscapes; and the applications of aerial photography for large-scale mapping.

331. *Vinogradov, B.V.
*1958 *O svyazi rastitel'nosti s gruntovymi vodami v stepnykh landshaftakh Severnogo Kazakhstana i ispol'zovanii rastitel'nosti v kachestve indikatora pri gidrologicheskom deshifrirovanii aerofoto-snimkov (On the correlation of vegetation and water table in the Northern Kazakhstan steppe landscapes and on the use of vegetation as an indicator for the decoding of aerial photographs for hydrological purposes). *Akademiia Nauk SSR, Izvestiya, Seriya Geologicheskaya 1966(1): 121-128. Referativnyi Zhurnal, Biologiya, 1959, no. 38713. BA(48)58013.
*In this area of abundant springs, lenses of underground water occur under depressions. The distribution of vegetation and soils in the 3 main vegetation types occuring in depressions: Sedge-reed, Sedge-willow and meadows are described. The close dependence of soil distribution and vegetation on hydrogeological conditions is stressed.

332. *--- ---
*1966 *Aerial analysis of vegetation in arid zones (translated title). *No source. Translation available CFSTI as AD-698 850.

*This excellent report is a complete survey of the application of aerial photography to the analysis of vegetation in arid zones. Techniques for photographing, identifying, analyzing, and interpreting vegetation at all photographic scales from 1:3,000 and larger to 1:50,000 and smaller are discussed. The technique which receives primary emphasis for the photographic interpretation of vegetation over wide areas is the selection of key sites, the preparation of aerial photographic interpretation standards and the extrapolation of these standards from the key sites over the entire area. Almost 400 different plants are mentioned by name, and important ecological plant societies, terrain features, and soils are discussed. Areas covered are primarily within the bounds of the Soviet Union, with some references to Africa and the Near East.

333. *Vinogradov, B.V.
*1968 *Experience in large-scale landscape interpretation and mapping of key sectors in the arid and sub-arid zones of Central Asia and Kazakhstan. *Translation available CFSTI as AD-692 374.
*The paper dealing largely with semiarid conditions, is a presentation of some results in an experiment with large-scale landscape mapping based on the interpretation of aerial photographs taken in western Turkmenia and in Northern and Western Kazakhstan in 1952-1958. The author deals with all the basic problems involved in landscape mapping, such as scales and accuracy. In the text a number of aerial photographs are accompanied by landscape maps compiled on the basis of these photographs. It offers little that is new to geographers and foresters in the United States.

334. *--- ---
*1969 *Geographic correlations in distant extrapolation of interpretation characteristics of landscape analogs. 58 p. *Translation available CFSTI as AD-696 915.
*Philosophical discussion of nearby and distant landscape analogs. Includes a good description of the Algerian Sahara which is compared to Asiatic deserts.

335. *Waldo, C.E./Ireland, R.P.
*1955 *Construction of landform keys. *Photogrammetric Engineering 21(4):603-606.
*A landform key is a combination of textual and pictorial material so arranged that it will aid in rapid identification of landforms. Their development and application are discussed.

336. *Wallace, R.E./Moxham, R.M.
*1967 *Use of infrared imagery in study of the San Andreas Fault system, California. *U.S. Geological Survey, Professional paper 575-D: 147-156. Map.
*Infrared imagery shows variation in soil moisture, vegetation, and microtopography observed in tracing the fault over a distance of 200 miles.

337. *Walters, R.L.
*1968 *Radar bibliography for geoscientists. *University of Kansas, Center for Research, CRES Report 61-30. 28 p. NASA-CR-101707. Contracts NSR-17-004-003, NAS9-7175. STAR N69-30303.
*The purpose of this bibliography is to provide a comprehensive source of background information emphasizing geological, agricultural, geographical and related interpretations of modern high resolution, Side-looking Airborne Radar (SLAR) imagery. 266 refs. cited and indexed, covering a broad spectrum of subjects ranging from applied imagery analyses and interpretations to selected theoretical studies.

338. *Warnecke, G.
*1967 *Satelliten und Meteorologie (Satellites and Meteorology). *Annalen der Meteorologie n.s., 3:13-31. MGA 19.6-67.
*An introduction into the meteorological applications of artificial Earth satellites.

339. *Wear, J.F.
*1960 *Interpretation methods and field use of aerial color photographs. *Photogrammetric Engineering 26:805-808.
*Wide acceptance of aerial color photography for special survey purposes has been hampered by lack of suitable office and field interpretation methods. New interpretation techniques have been devised and portable stereo viewing equipment has been developed to solve basic problems in using color transparancies. Color-interpretation techniques, film-handling procedures, and a description of the new light table are presented with appropriate illustrations.

340. *Weaver, K.F.
*1969 *Remote sensing: new eyes to see the world. *National Geographic Magazine 135(1):46-73.
*A popular, but factual discussion aimed toward readers with little knowledge of the subject.

341. *Weiss, M.
*1967 *Infrared in meteorology. *Weatherwise, 20(4): 156-161. MGA 19.2-90.
*Discusses the use of infrared in meteorology. It provides capabilities that are not otherwise obtainable.

342. *Welch, R.
*1968 *Film transparencies versus paper prints. *Photogrammetric Engineering 34(5):490-501.
*Film transparencies are more desireable for photointerpretation.

343. *Wellman, H.W.
*1966 *Active wrench faults of Iran, Afghanistan and Pakistan. *Geologische Rundschau 55(3):716-735. Maps.
*Air photo mosaics, available for nearly the entire area of Iran, Afghanistan, and West Pakistan, were examined carefully for topographic offsets and other evidence of active faults. The degree and direction of movement were ascertained from photo pairs, and the results transferred to base maps at 1:1,000,000 and 1:2,500,000. Agreement with published geologic maps is said to be good. The course, extent, and displacement of nine of the more important faults are described.

344. *Wickens, G.E.
*1966 *The practical application of aerial photography for ecological surveys in the savannah regions of Africa. *Photogrammetria 21(2):33-41. Map.
*A brief but useful discussion of the use of aerial photography, including when and how to make photos, material to use, and interpretation of photos.

345. *Williams, F.C.
*1950 *Objectives and methods of density measurement in sensitometry of color films. *Optical Society of America, Journal 40(2):104-112.
*Density measurements used in the sensitometry of color films can be divided into two broad classes: Integral densitometry, which provides a description of the multilayer image as a whole in terms of its absorptions; and analytical densitometry, which gives a description of the image in terms of its components by determining their individual density values. Terms and units are defined for each class and subclass. The field of usefulness and methods of measurement are briefly discussed.

346. *Williams, O.W.
*1967 *Surveying the Earth by satellite. *Science Journal 3(1):68-73. MGA 19.5-537.
*Satellites can be used in geodetic research in 2 ways. In one the position of the satellite can be determined accurately from 2 tracking stations and the exact position of other tracking stations determined. In the other the height of the satellite can be compared with its expected height, assuming that the Earth were a sphere, and gravitational anomalies can be plotted.

347. *Williams, R.S./Ory, T.R.
*1967 *Infrared imagery mosaics for geological investigations. *Photogrammetric Engineering 33(12): 1377-1380.
*One of the drawbacks of infrared imagery for mapping and areal interpretation has been the "strip" format of the imagery. Through careful planning and execution of infrared surveys, it is possible to assemble uncontrolled infrared imagery mosaics that provide broad areal coverage, resulting in better interpretation and mapping capability.

348. *Williamson, A.N.
*1966 *Laboratory investigations of the gamma-ray spectral region for remote determination of soil trafficability conditions. In Symposium on Remote Sensing of Environment, 4th, 1966, Proceedings p. 623-633. *University of Michigan, Institute of Science and Technology, Ann Arbor. Available CFSTI as AD-638 919.
*Results largely negative.

349. *Wilson, R.C.
*1967 *Space photography for forestry. *Photogrammetric Engineering 33(5):483-490.
*Subject matter outside arid zone, but same principles may apply. Basically space photography provides synoptic overviews of large regions superior to conventional aerial mosaics.

350. *Winston, J.S./Taylor, V.R.
*1967 *Atlas of world maps of long-wave radiation and albedo for seasons and months based on measurements from Tiros IV and Tiros VII. *U.S. Environmental Science Services Administration, Technical Report NESC 43, 32 p. MGA 19.4-247.
*Monthly and seasonal global charts of long wave radiation and albedo are presented for the periods Feb.-June 1962 (Tiros 4) and July 1963-May 1964 (Tiros 7).

351. *Winterburg, R.P./Wulfeck, J.W.
*1961 *Additive color photography and projection for military photo interpretation. *Photogrammetric Engineering 27:250-60.
*In order to assess the value of additive color photography for photo reconnaissance, the colorvision system was analyzed in terms of its inherent capability for projecting black-and-white, full-color, and color-separation records. full color permits increased target detection but shows no apparent increase in detail resolved on simulated panchromatic records.

352. *Wobber, F.J.
*1967 *Space photography: a new analytical tool for the sedimentologist. *Sedimentology 9(4):265-317.
*Orbital remote sensing can provide synoptic environmental data for geoscientists. Color space photographs obtained incident to the Gemini Program provide tools for analyzing sedimentary environments and processes. The principal advantages of orbital geoscience data collection include frequency of coverage leading to environmental analysis within the full spectrum of seasonal contrasts, and opportunities for environmental syntheses by synoptic observations. Gemini space photography is an available source of semi-quantitative data concerning changing environmental phenomena and mechanisms of sediment distribution. It also enables the survey and inventory of global sedimentary landforms.

353. *Wolfe, E.W.
*1968 *Geologic evaluation of thermal infrared imagery, Caliente and Temblor Ranges, Southern California. In Earth Resources Aircraft Program Status Review, I: Geology, Geography, and Sensor Studies. Presented at the NASA Manned Spacecraft Center, Houston, Texas, September 16-18, 1968, p. 12/1 to 12/27. *U.S. Geological Survey, Technical Letter NASA-113. 43 p. STAR N69-25018.
*Thermal infrared (8 to 13 micron) imagery was obtained in the Caliente and Temblor Ranges and Carrizo Plain, southern California, in predawn and post-sunrise hours. Field observations: measurements of moisture and specific gravity of the regolith, and radiation temperatures; and comparison with geologic maps and aerial photographs lead to the following conclusions: (1) The specific gravities of surficial materials (usually not bedrock) influence tonal densities in the pre-dawn imagery. (2) Geologic interpretation of tonal density patterns is complicated by topographic, atmospheric,

and vegetative effects on pre-dawn radiation. (3) Geologic features such as outcrop patterns and some faults are recognizable in the infrared imagery as well as in aerial photographs. (4)Local radiative anomalies, previously suggested to be caused by the occurrence of ground water at shallow depths may be caused by night-time entrapment of cold air in poorly drained, topographically low areas.

354. *Wolfe, W.L., ed.
*1965 *Handbook of military infrared technology.
*U.S. Department of the Navy, Office of Naval Research, Washington, D.C. 905 p.
*As the name indicates, this is a handbook on infrared technology, covering the entire field from basic laws to equipment. It is primarily aimed toward answering specific questions. The complete index, including references and cross references should be of great help in finding useful information, data equations, concepts, and techniques.

355. *Yost, E.F./Wenderoth, S.
*1967 *Multispectral color aerial photography. *Photogrammetric Engineering 33(9):1020-1033.
*A basic discussion of multispectral additive color processes for photo interpretation.

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13. ABSTRACT

A comprehensive review has been made of remote sensing publications relating to military geography of arid lands. These have been abstracted or annotated and arranged in tables relating devices and processes to geographic features including terrain, groundwater, surface materials, cultural features, flora, fauna, weather and climate, coastal zones, and general geography. The devices and processes include black and white, color, and infrared photography and devices utilizing longer wave lengths such as radar. Vehicles include conventional airplanes and spacecraft. Each reference is rated as especially useful, useful, or of little value.

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