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TECHNICAL REPORT NO. 3-630

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

Report 4

by

C. R. Kolb

W. K. Dornbusch, Jr.

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Volume II

June 1966

Sponsored by

U. S. Army Materiel Command

Project No. 1-V-0-25001-A-131

Conducted by

U. S. Army Engineer Waterways Experiment Station

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Vicksburg, Mississippi

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Hypsometry

Raisz's Landform Map

Selected Landforms and Surface Conditions

Landforms-Surface Conditions: Descriptions and Photographs

ANALOGS OF YUMA TERRAIN IN

SECTION I: BASIC TERRAIN F

RAIN IN THE MIDDLE EAST DESERT

AIN FACTOR AND ANALOG MAPS

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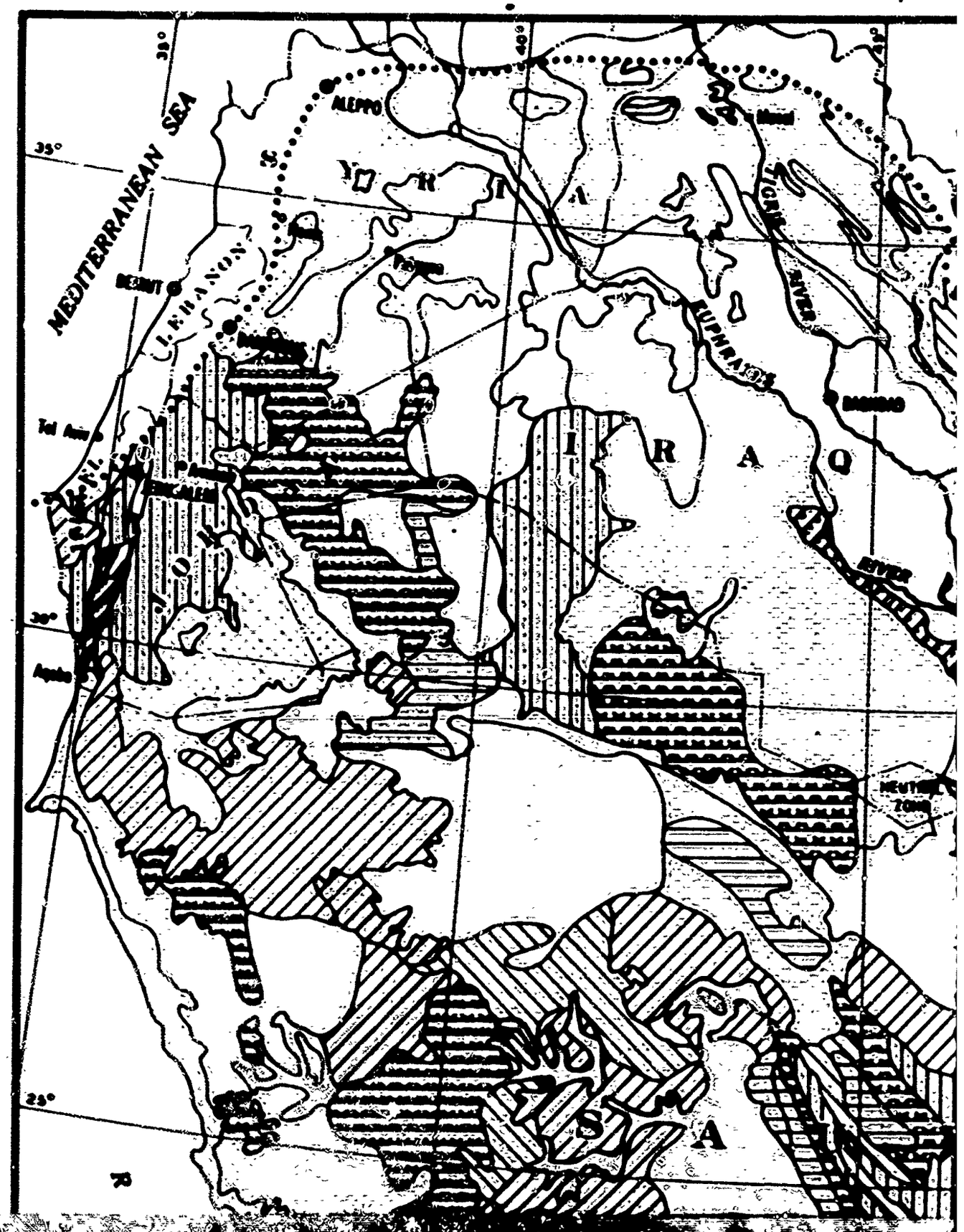
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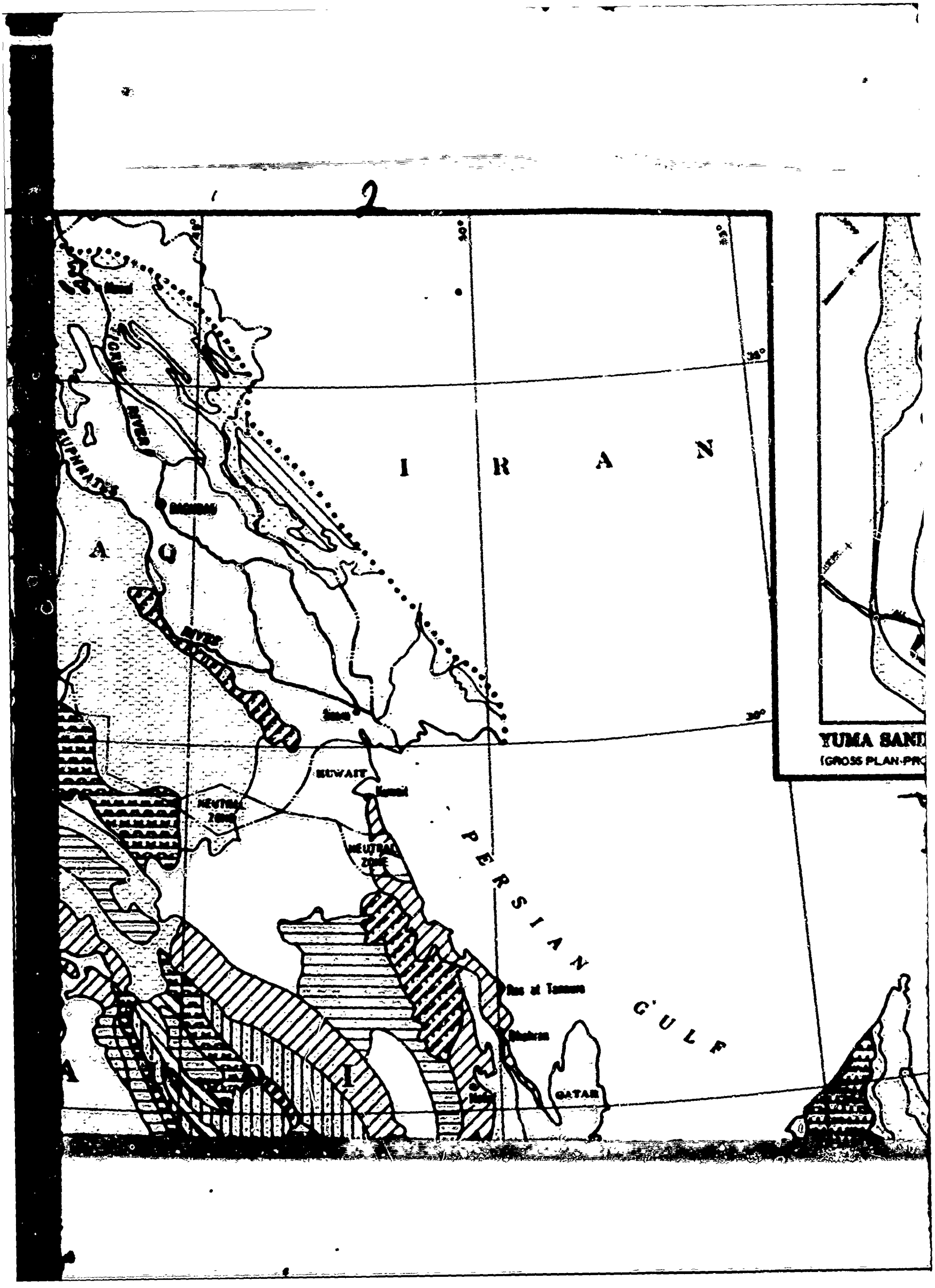
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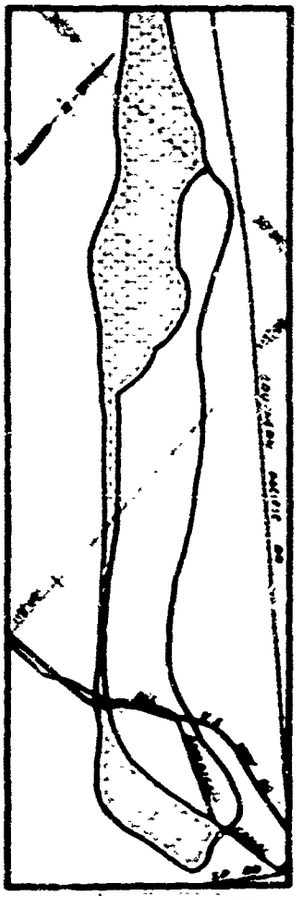
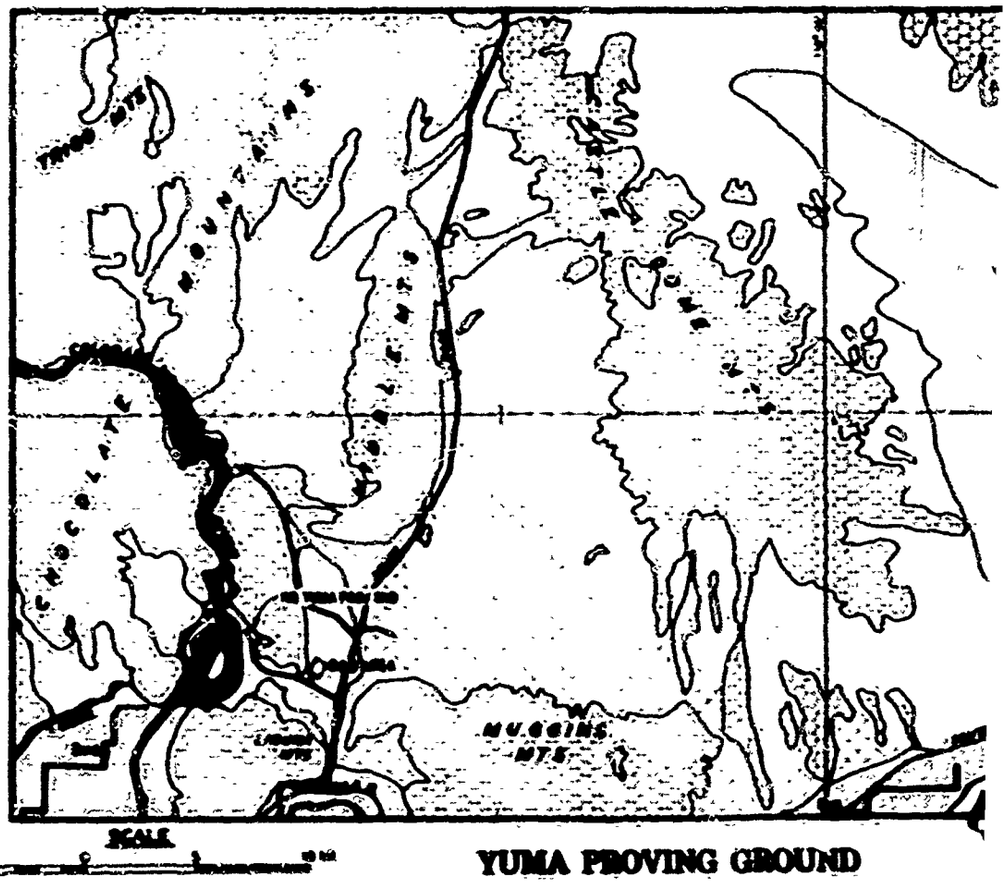
NEUTRAL ZONE
PERSIAN GULF
QATAR
YUMA SAND
(GROSS PLAN-PRO

3



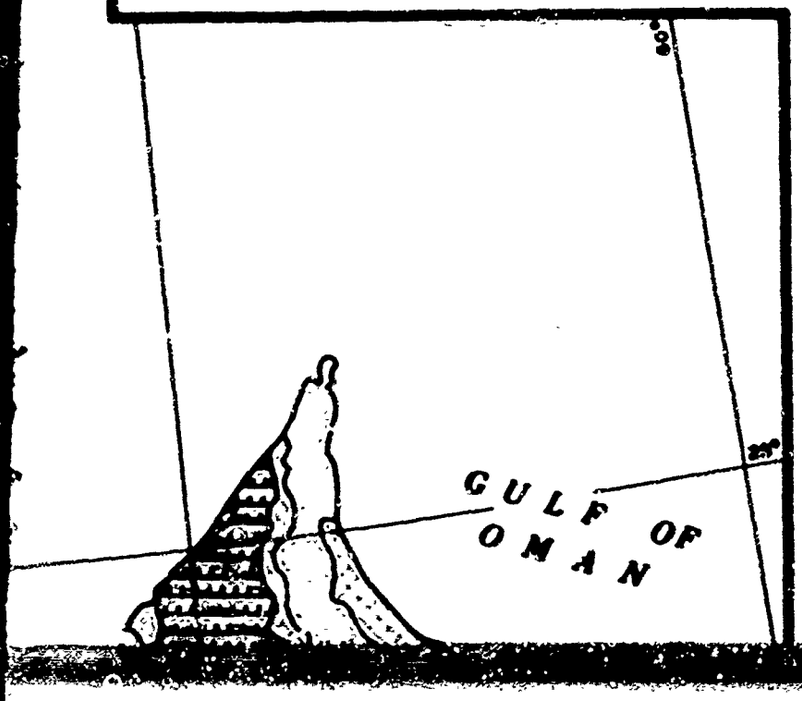
YUMA SAND HILLS

(GROSS PLAN-PROFILE: 6L)



YUMA PROVING GROUND

(GROSS PLAN-PROFILE: 5L///)

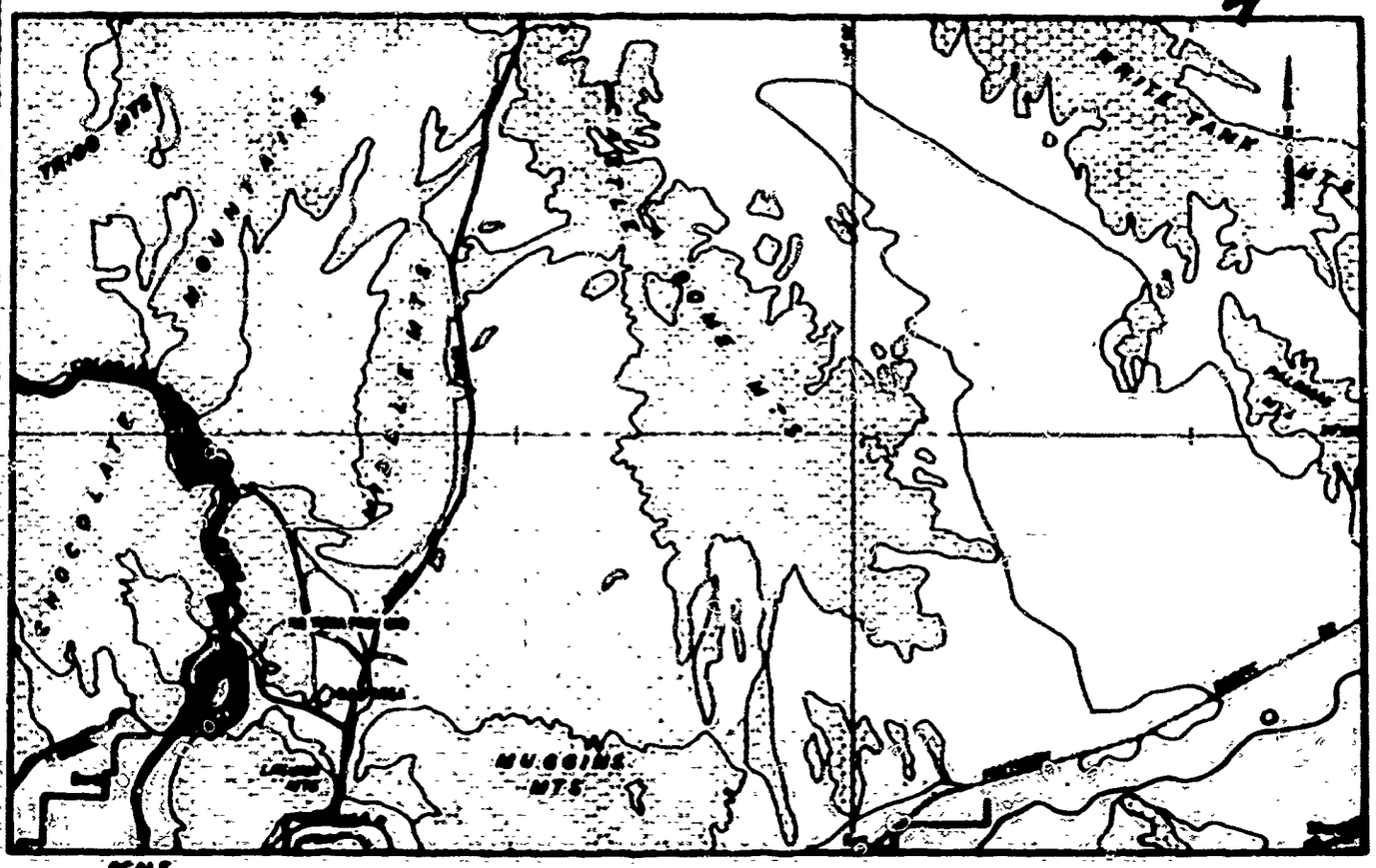


CHARACTERISTIC PLAN-PROFILE

The characteristic plan-profile is the most commonly found plan-prof[illegible] may be either restrictive or gross. The restrictive plan-profile is based [illegible] with circles 1 mile in diameter). Local relief of less than 10 ft is not con[illegible] plan-profile is based on random sampling with circles 35 miles in diame[illegible] 500 ft is not considered. The permutations in such a plan-profile are tove[illegible] intervening lowland component here.

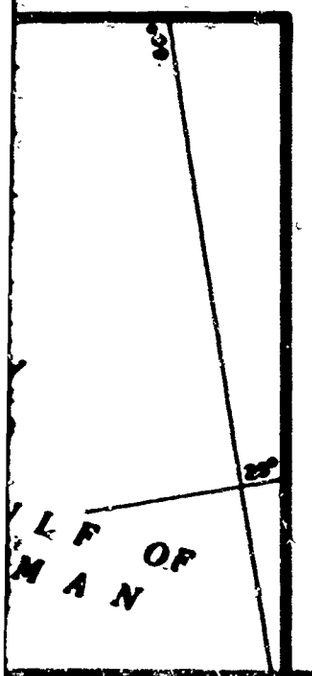
LEGEND

Higher Occupy.	Higher are → / Schematic Plan / Schematic Profile	Restrictive and Random	Lower and Random	[illegible]
>60% of area	Flat-topped	1	1L	
40-60% of area		2	2L	
<40% of area		3	3L	



YUMA PROVING GROUND

(GROSS PLAN-PROFILE: 5L//)

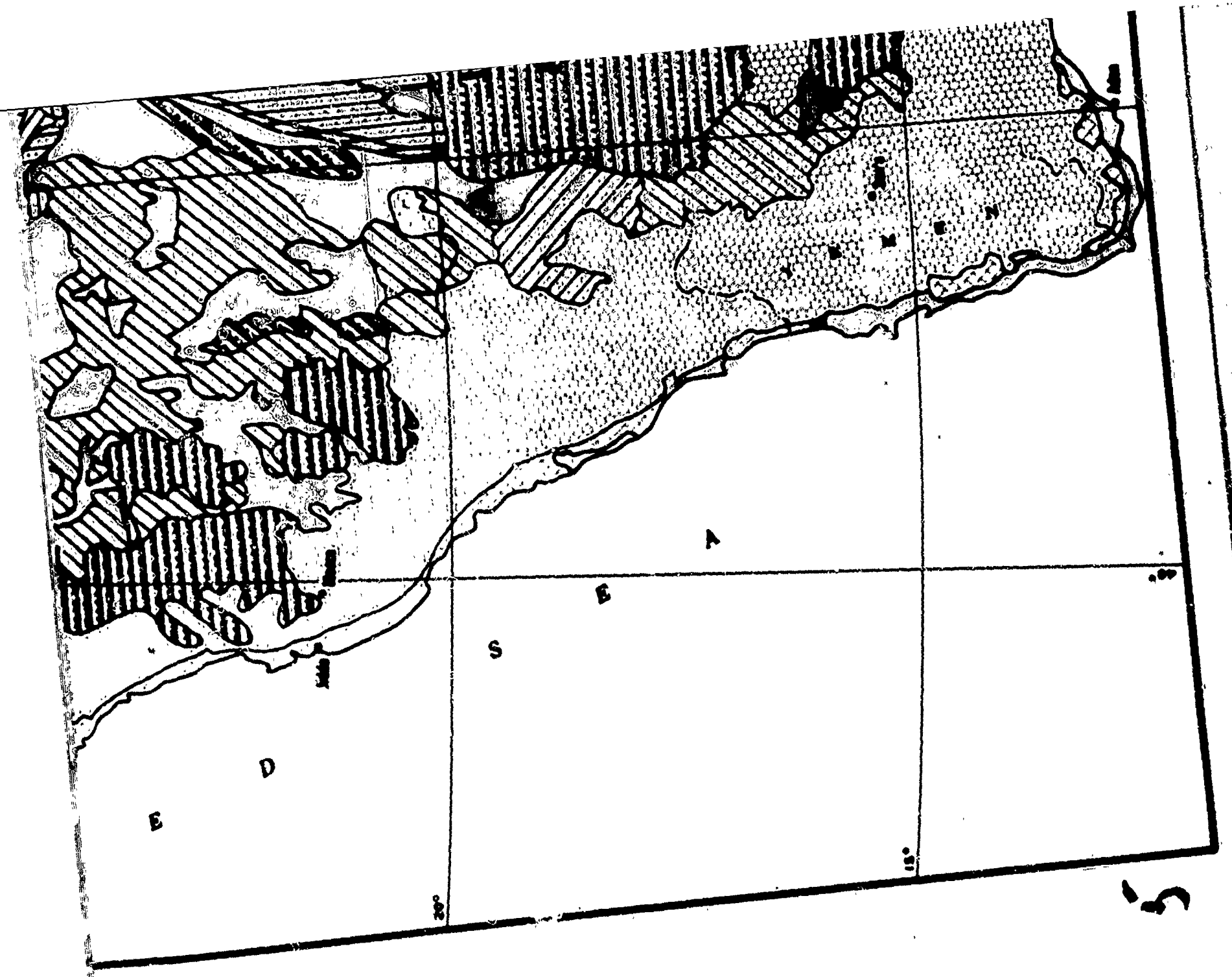


CHARACTERISTIC PLAN-PROFILE:

The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either restrictive or gross. The restrictive plan-profile is based on random sampling with circles 1 mile in diameter. Local relief of less than 10 ft is not considered. The gross plan-profile is based on random sampling with circles 35 miles in diameter. Relief of less than 100 ft is not considered. The prominences in each plan-profile are termed component highs, the intervening lowlands component lows.

LEGEND

Highs Occupy:	Highs are →	Smoothest and Random	Lumpy and Random	Smoothest and Parallel	Lumpy and Parallel
	Schematic Plan / Schematic Profile				
>60% of area	Flat-topped	1	1L	1H	1L,H
30-60% of area		2	2L	2H	2L,H
<30% of area		3	3L	3H	3L,H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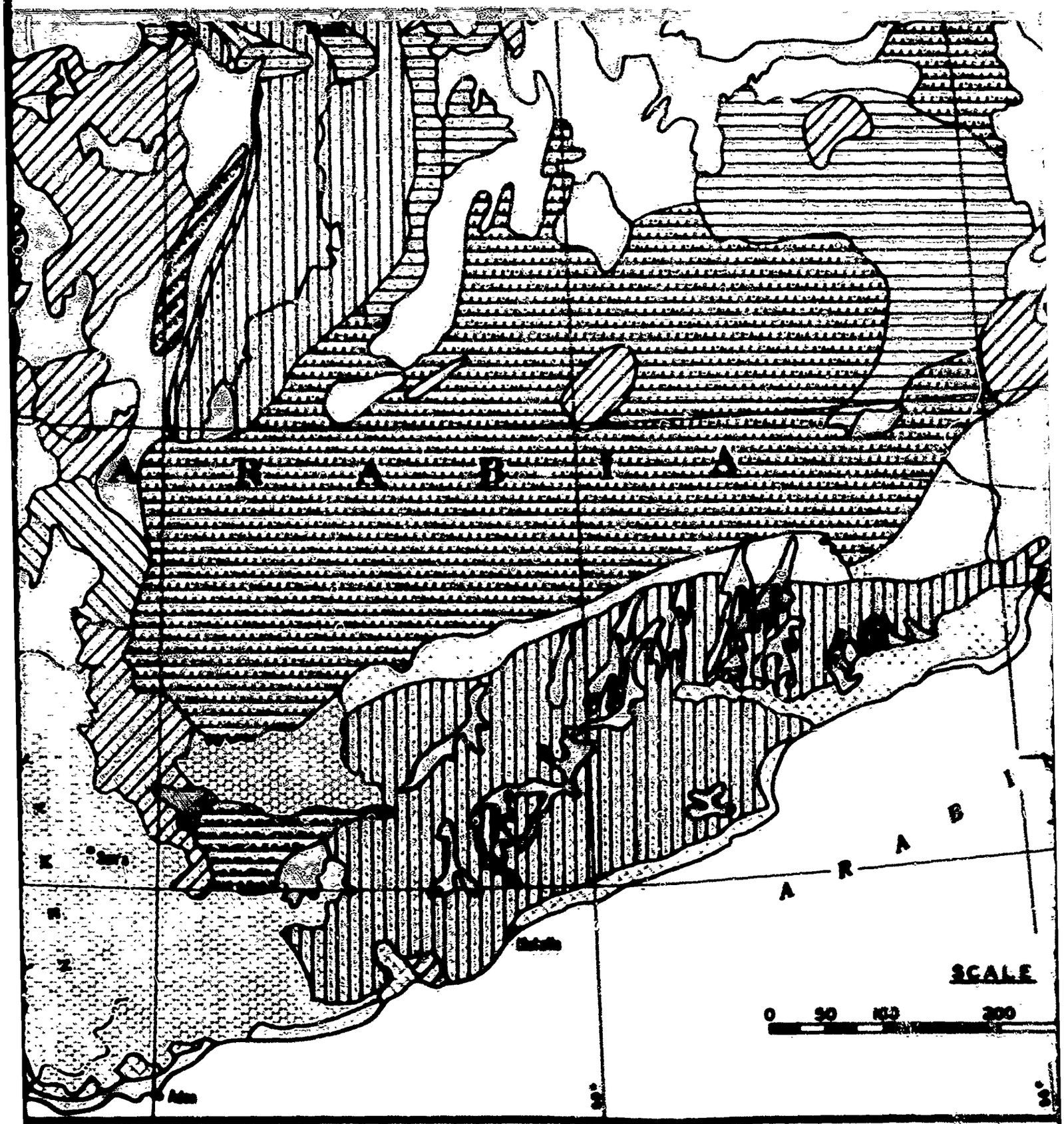

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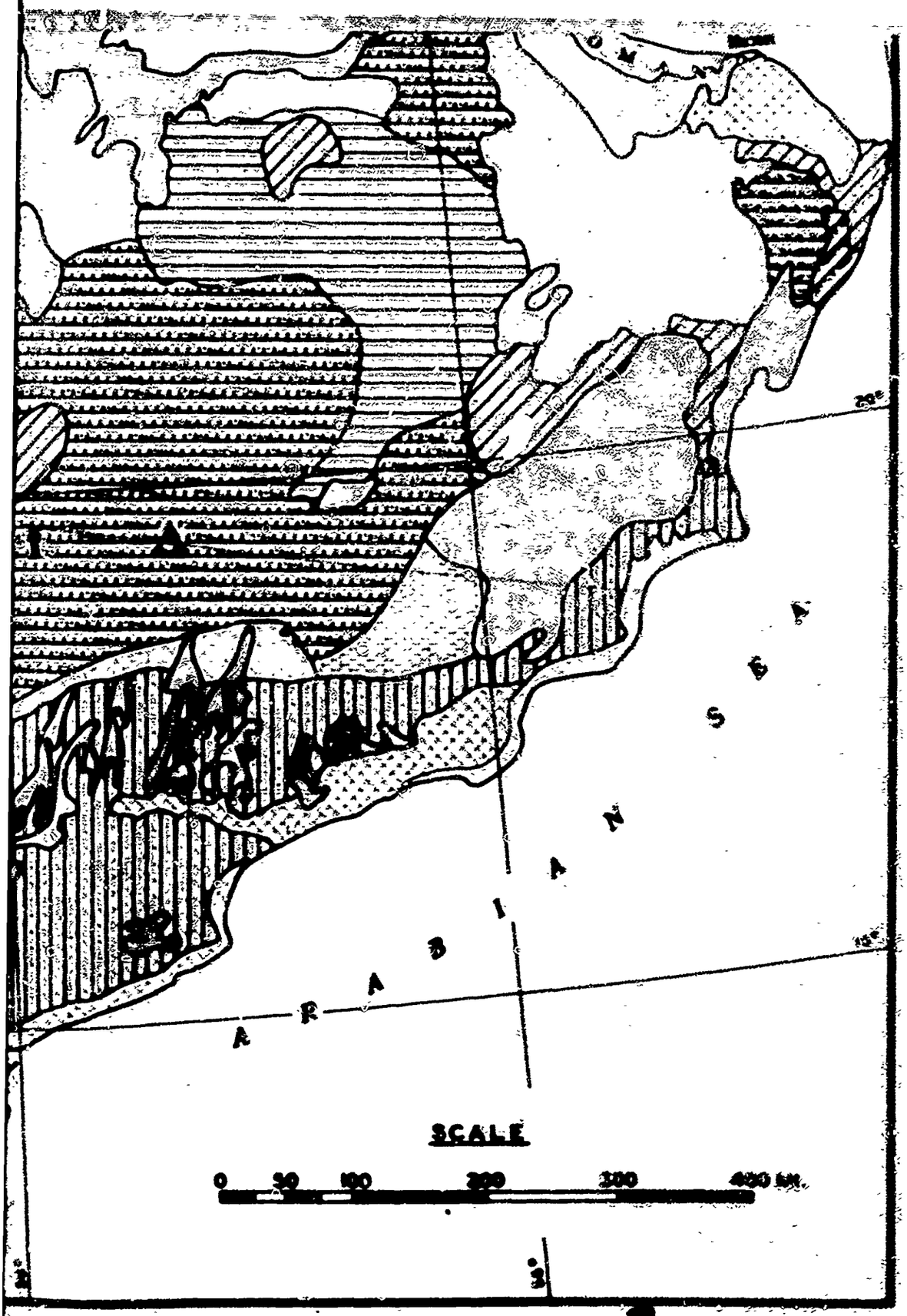

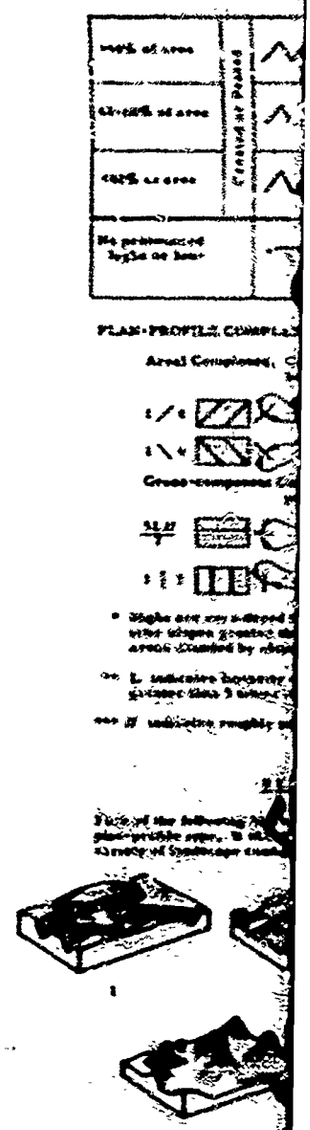

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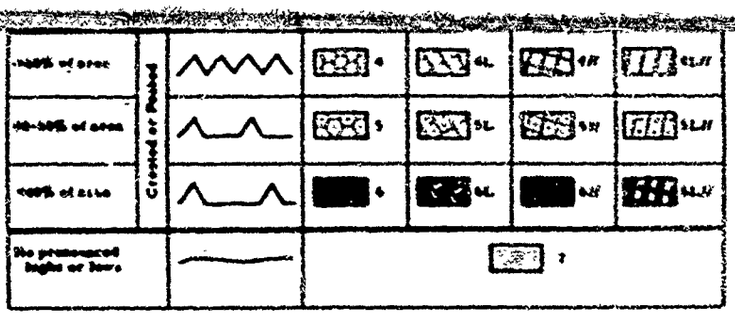


PLAN-PROFILE COMPLEXES:

Areal Complexes: Confined to areas where two major, areally restricted plan-profiles, both of the restrictive type, are mapped.

1 / 4 — Plan-profile of the areally predominant lows. Plan-profile of the areally subordinate highs.

1 \ 4 — Plan-profile of the areally predominant highs. Plan-profile of the areally subordinate lows.

Gross-component Complexes: Confined to areas where a gross and a restrictive plan-profile of either a component high or a component low are mapped.

1/4 — Gross plan-profile. Restrictive plan-profile of component lows.

1 | 4 — Gross plan-profile. Restrictive plan-profile of component highs.

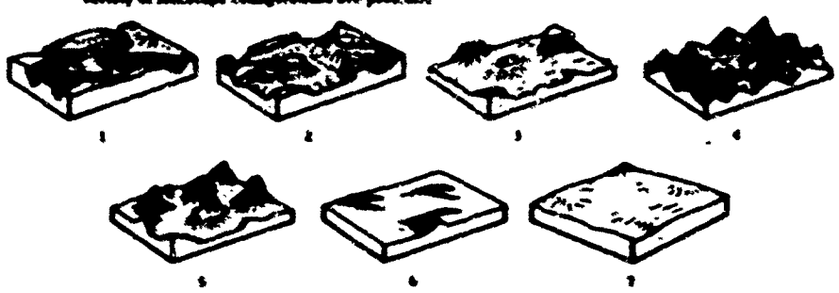
* Highs are considered to be (1) positive or crested permanences which exhibit characteristic slopes greater than 6 degrees or (2) fairly flat-topped permanences or high-level areas bounded by slopes in excess of 16 degrees.

** L indicates linearity of highs. A high is considered to be linear when its length is greater than 3 times its width.

*** H indicates roughly parallel arrangement of highs or aligned highs.

REPRESENTATIVE PLAN-PROFILES

Each of the following block diagrams illustrates a landscape representative of a specific plan-profile type. It should be emphasized that, within the defined limits of each type, a wide variety of landscape configurations are possible.



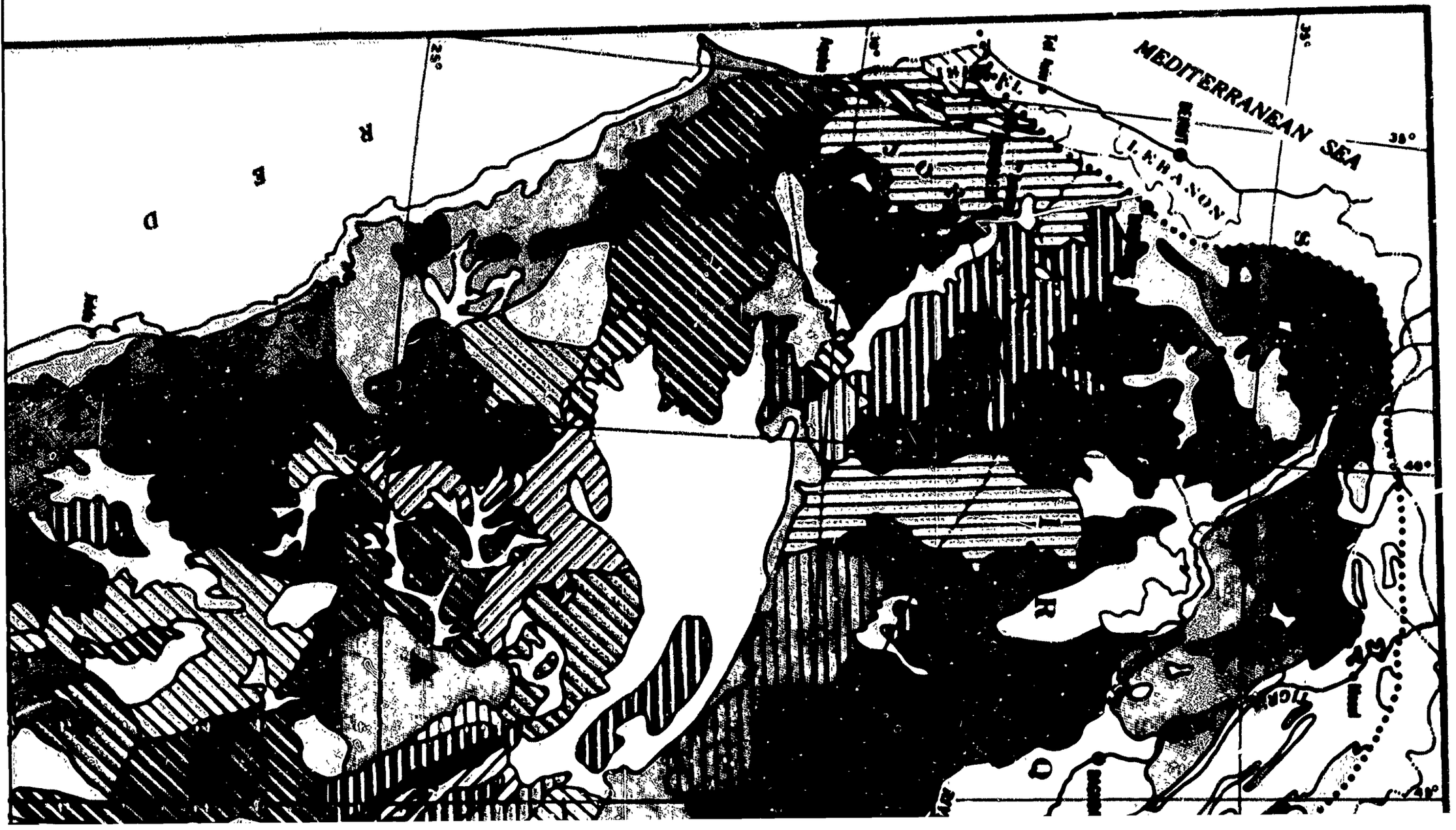
ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

CHARACTERISTIC PLAN-PROFILE

PLATE 1


MEDITERRANEAN SEA
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40°
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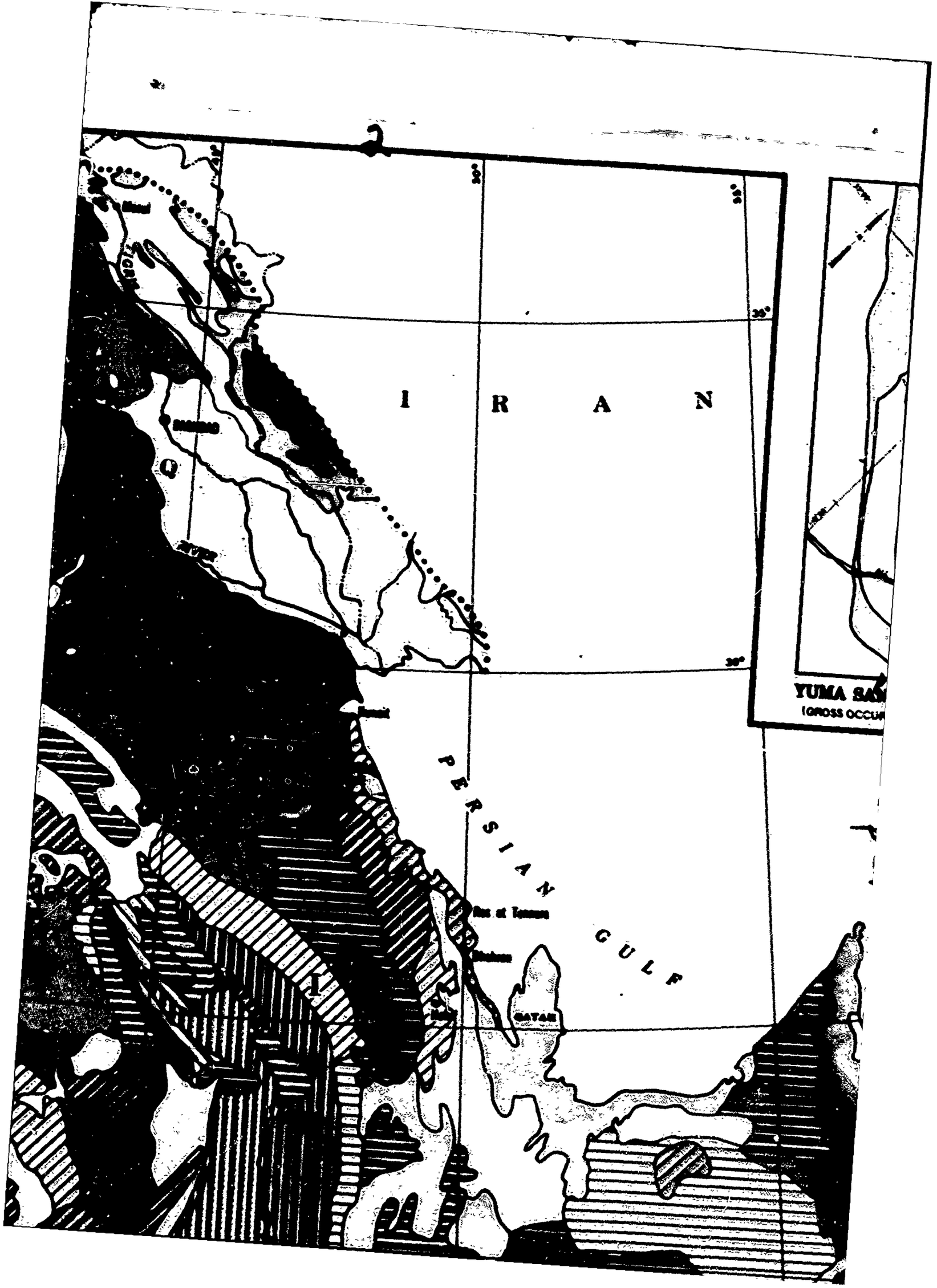
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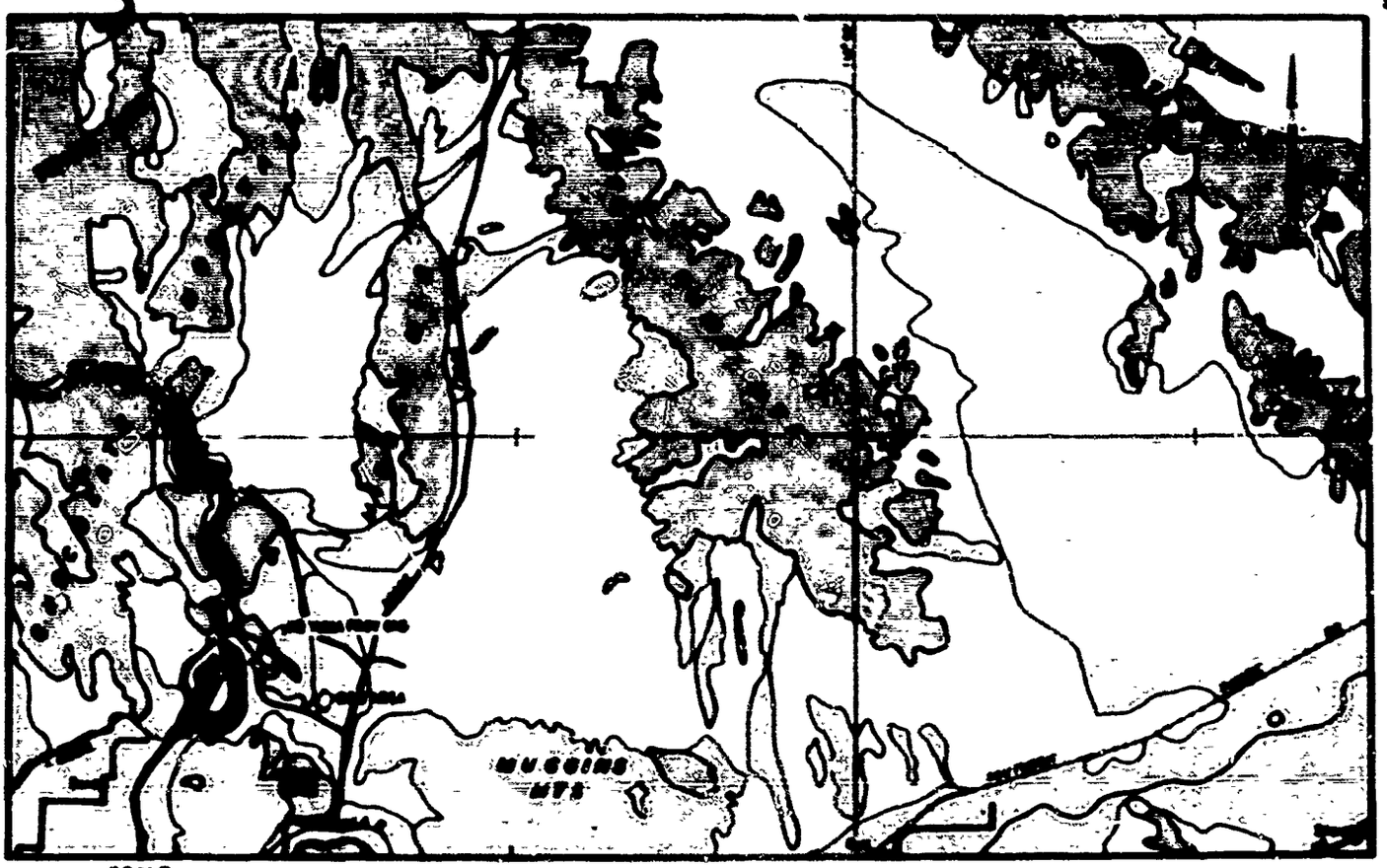


YUMA PROVING GROUND

(GROSS OCCURRENCE OF COMPONENT HIGHS: 1)

OCCURRENCE OF SLOPES GREATER THAN 50 PER CENT

Occurrence may be either restrictive or gross. A restrictive occurrence class indicates a modal range of slopes greater than 50 per cent found along traverses containing the maximum number of such slopes. Relief of less than 10 ft is not considered. A gross occurrence indicates the modal distance between component highs or component lows. Relief of less than 100 ft is not considered.

1 The number of slopes steeper than 50 per cent is less than 1 per 10 miles or in areas, less than 10 miles in maximum dimension, where such slopes are lacking.

2 The number of slopes steeper than 50 per cent ranges from 1 to 5 per 10 miles.

3 The number of slopes steeper than 50 per cent ranges from 5 to 30 per 10 miles.

4 The number of slopes steeper than 50 per cent ranges from 30 to 100 per 10 miles.

5 The number of slopes steeper than 50 per cent ranges from 100 to 200 per 10 miles.

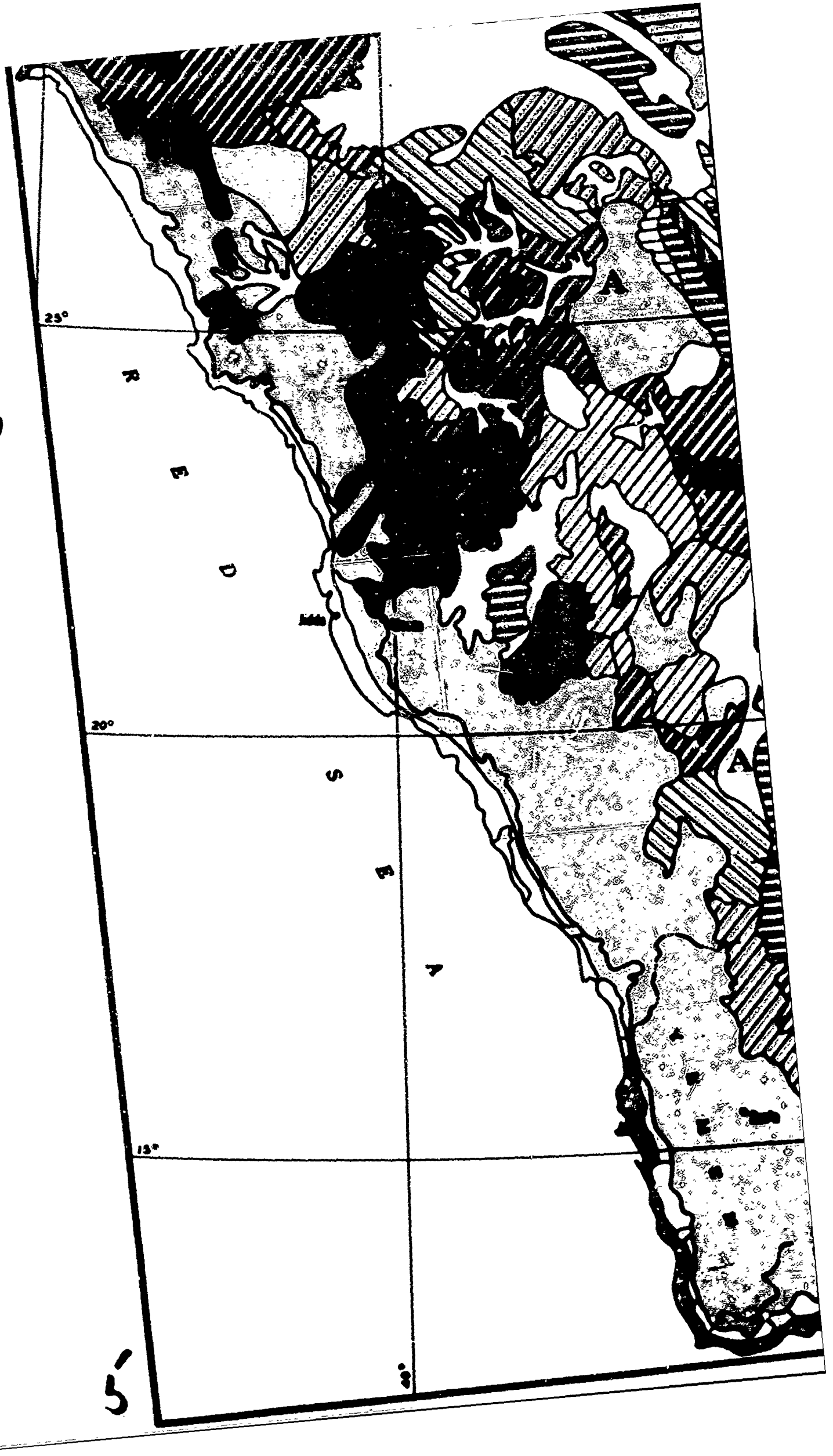
6 The number of slopes steeper than 50 per cent exceeds 200 per 10 miles.

OCCURRENCE COMPLEXES: (Mapped only where plan-profile complexes are mapped.)

Areal Complexes: Confined to areas where two major, areally contrasted occurrence cells, both of the restrictive type, are mapped.

1/3 Slope occurrence of areally predominant lows.
Slope occurrence of areally subordinate highs.

2/3 Slope occurrence of areally predominant highs.
Slope occurrence of areally subordinate lows.



5

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A R A B
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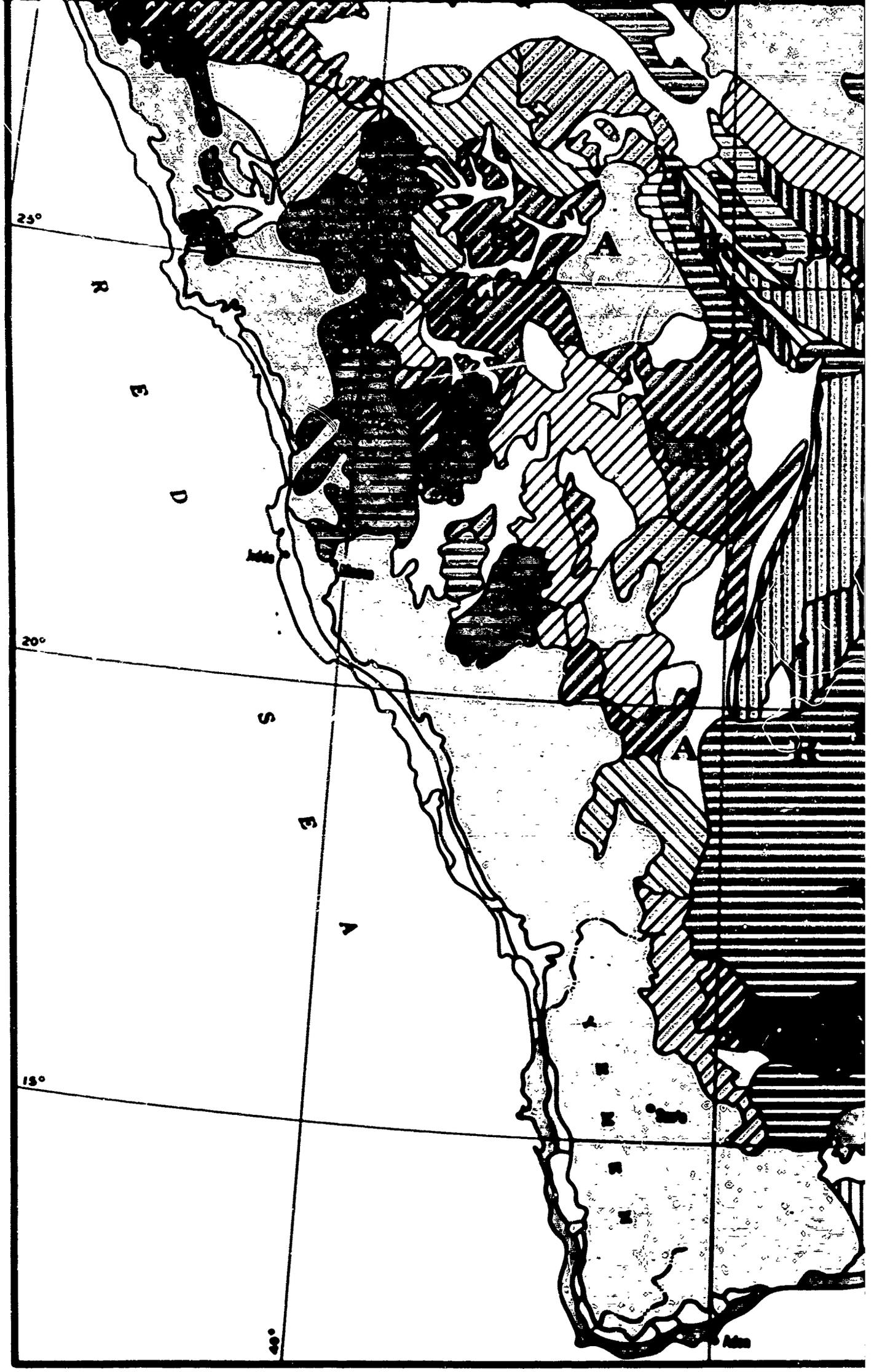

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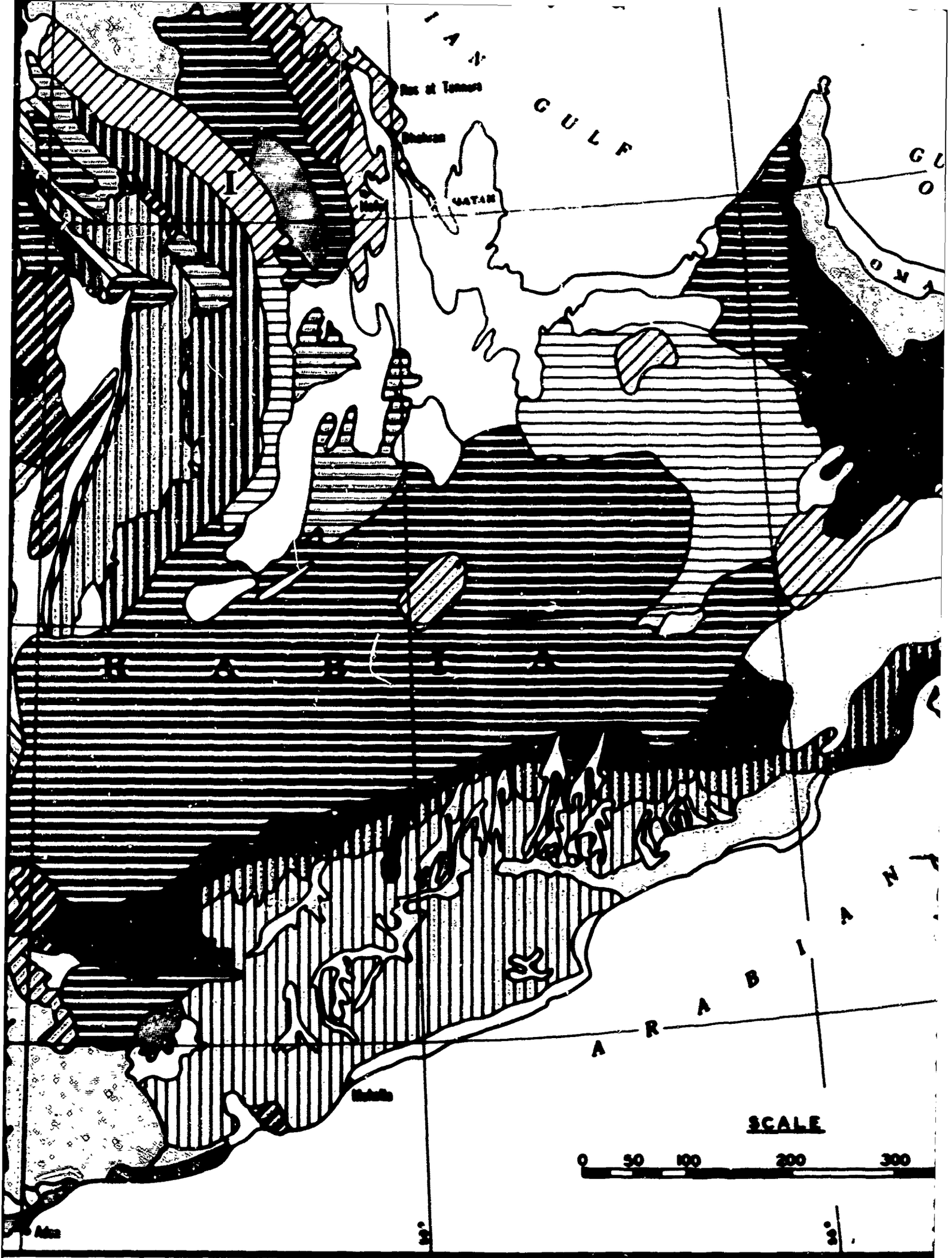
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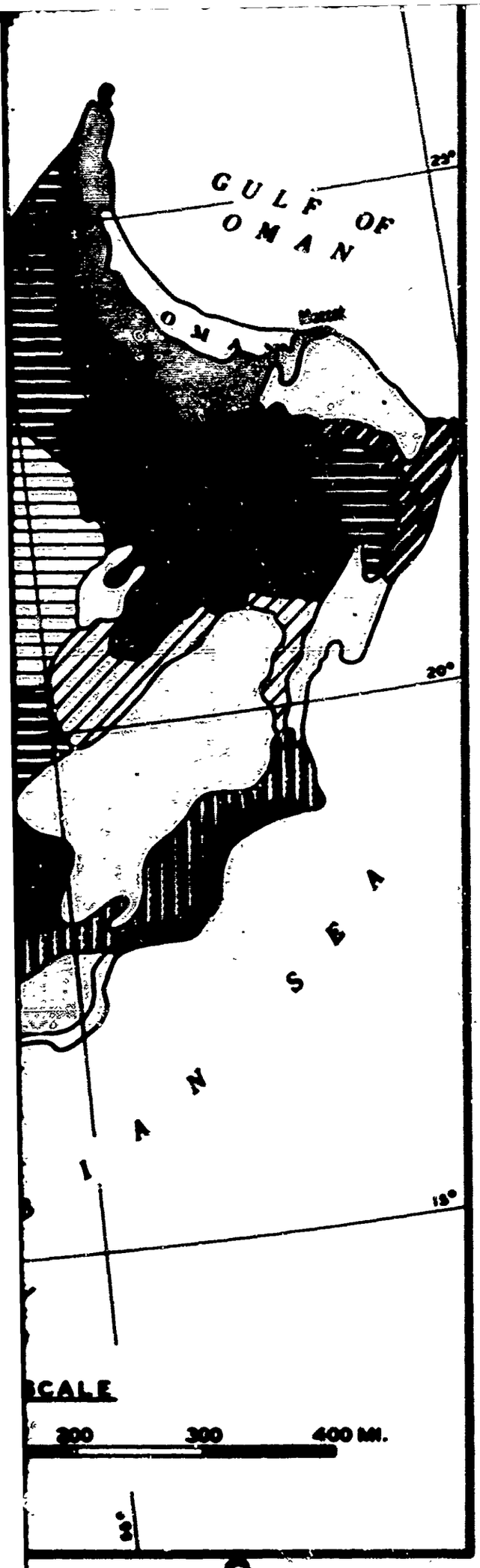


OCCURRENCE OF SLOPES GREATER THAN 50 PER CENT

Occurrence may be either restrictive or gross. A restrictive occurrence class indicates a modal range of slopes greater than 50 per cent found along traverses containing the maximum number of such slopes. Relief of less than 10 ft is not considered. A gross occurrence indicates the modal distance between component highs or component lows. Relief of less than 100 ft is not considered.

1 The number of slopes steeper than 50 per cent is less than 1 per 10 miles or in areas, less than 10 miles in maximum dimensions, where such slopes are lacking.

2 The number of slopes steeper than 50 per cent ranges from 1 to 5 per 10 miles.

3 The number of slopes steeper than 50 per cent ranges from 5 to 20 per 10 miles.

4 The number of slopes steeper than 50 per cent ranges from 20 to 100 per 10 miles.

5 The number of slopes steeper than 50 per cent ranges from 100 to 200 per 10 miles.

6 The number of slopes steeper than 50 per cent exceeds 200 per 10 miles.

OCCURRENCE COMPLEXES: (Mapped only where plan-profile complexes are mapped.)

Areal Complexes. Confined to areas where two major, areally restricted occurrence units, both of the restrictive type, are mapped.

1/4 Slope occurrence of areally predominant lows.
Slope occurrence of areally subordinate highs.

2/3 Slope occurrence of areally predominant highs.
Slope occurrence of areally subordinate lows.

Gross-component Complexes: Mapped only where gross-component plan-profile complexes are mapped.

Gross occurrence of component highs.
Restrictive occurrence within component lows.

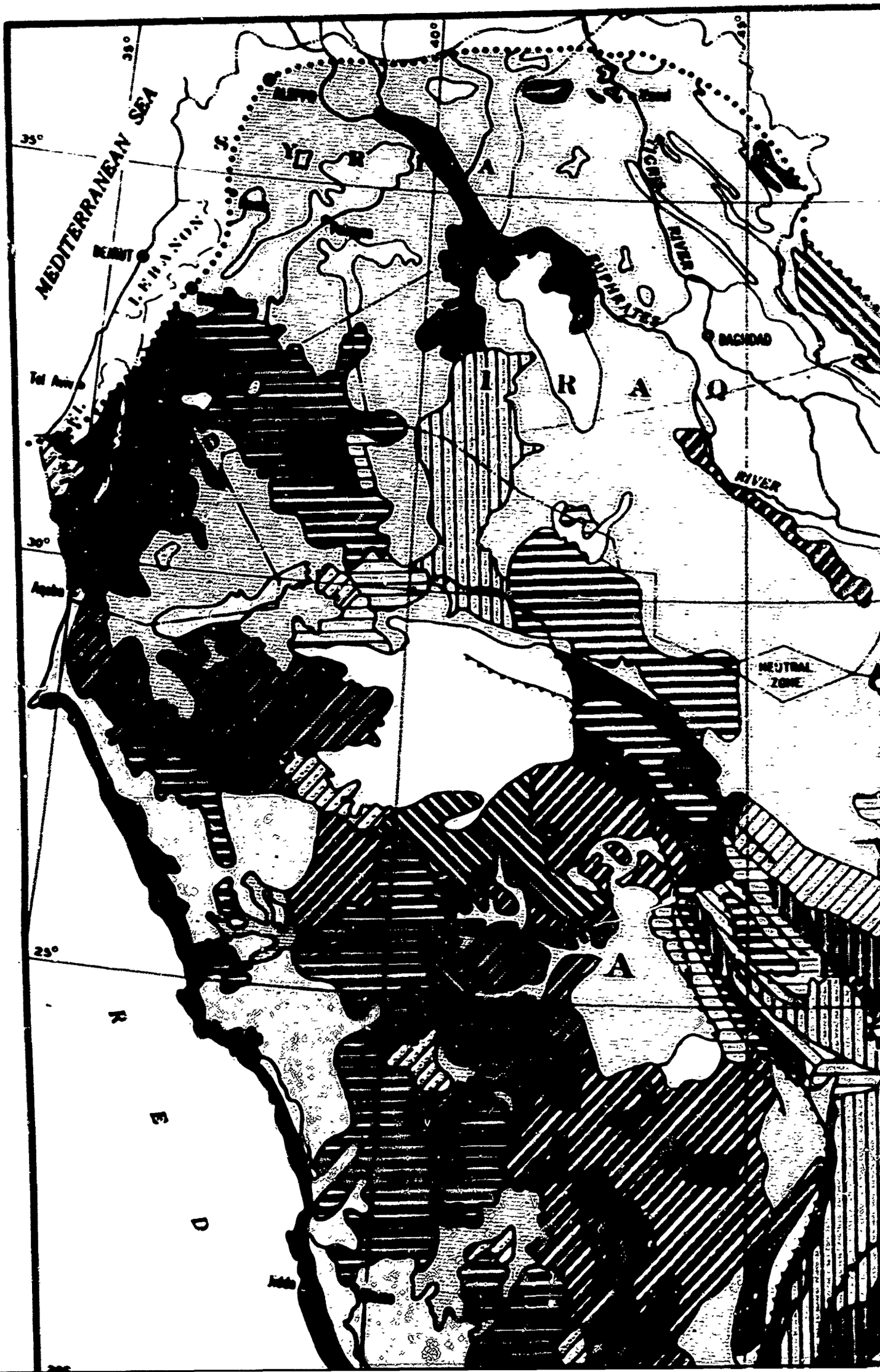
Gross occurrence of component lows.
Restrictive occurrence within component highs.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

OCCURRENCE OF SLOPES GREATER THAN 50 PERCE

7

1


MEDITERRANEAN SEA
BEIRUT
LEBANON
Tel Aviv
Aqaba
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SEA
SYRIA
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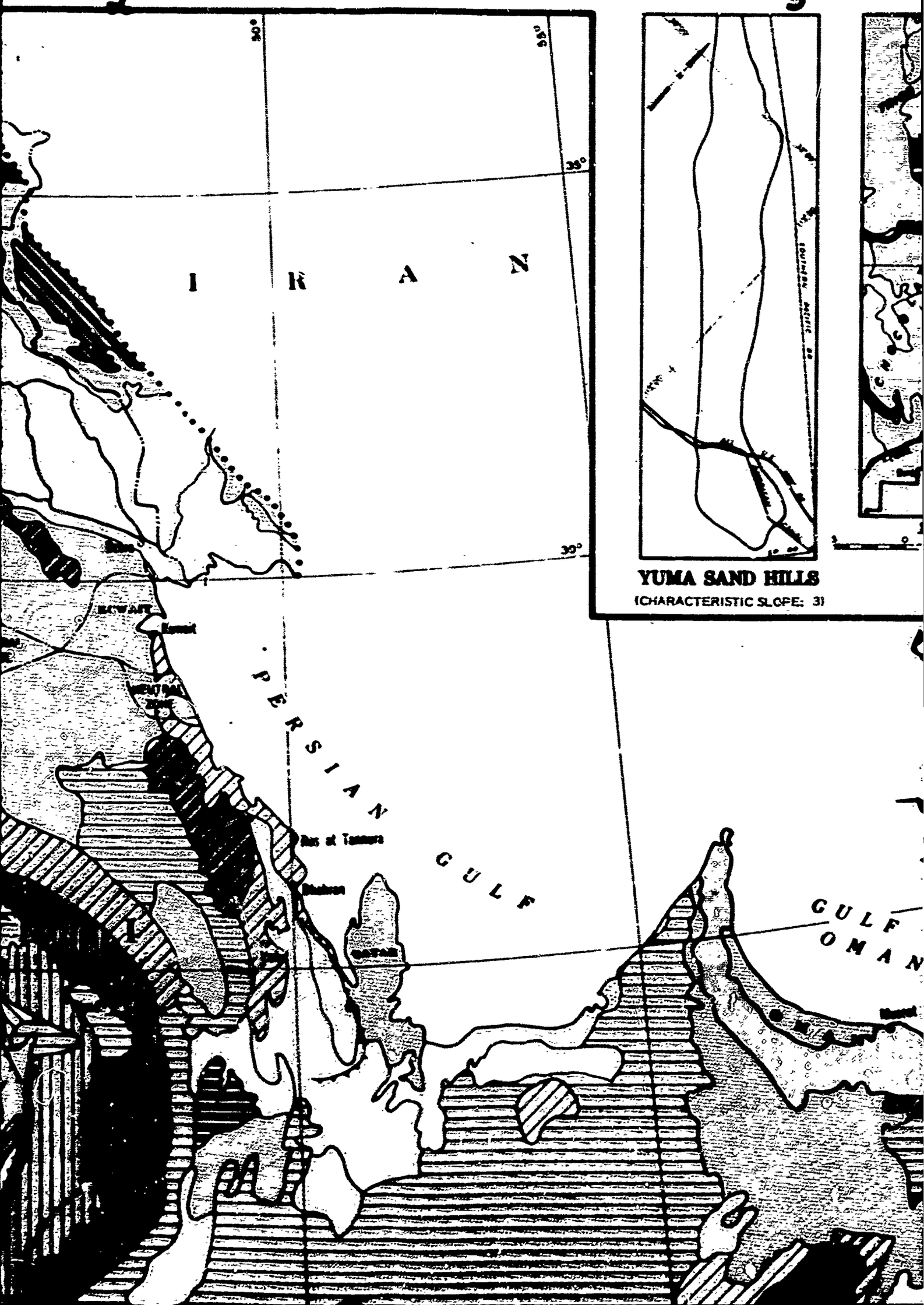
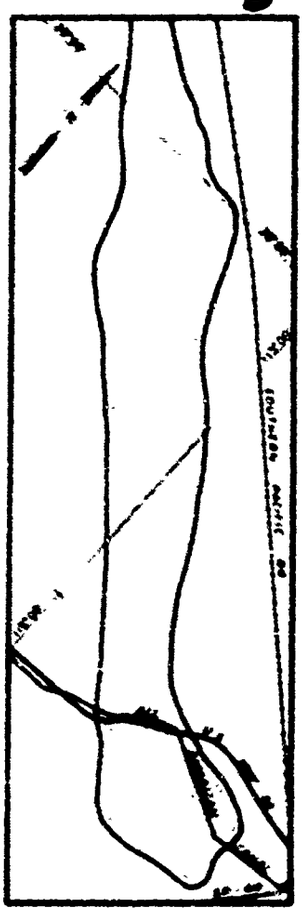
2

3


I R A N
PERSIAN GULF
GULF OMAN
Ras al Tanura
Bahrain
Kuwait
YUMA SAND HILLS
(CHARACTERISTIC SLOPE: 3)

3



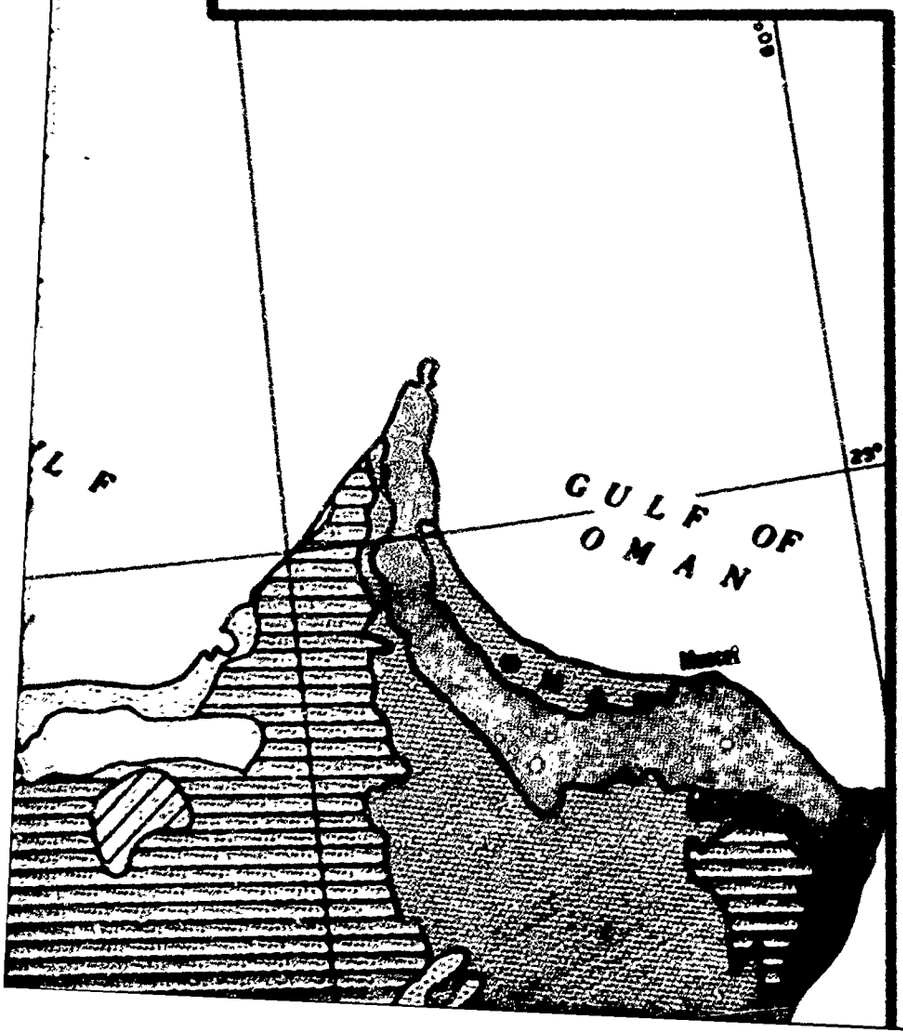
YUMA SAND HILLS

(CHARACTERISTIC SLOPE: 3)

SCALE

YUMA PROVING GROUND

(CHARACTERISTIC SLOPE WITHIN COMPONENT HIGH



CHARACTERISTIC SLOPE

Slope is defined as a surface identifiable deviation from the horizontal. Characteristic range of slopes which predominates or is in ipsencessing a distinctive spacing, arrangement mapped with a 10-ft contour interval.

Flat: Characteristic slope between 0 and 0 - 1.5%).

1a Between 0 and 1/2 degree (0%)

1b Between 1/2 and 2 degrees (0

2 Gentle: Characteristic slope between 2 1.5 - 10%).

3 Moderate: Characteristic slope between 10 - 25%)

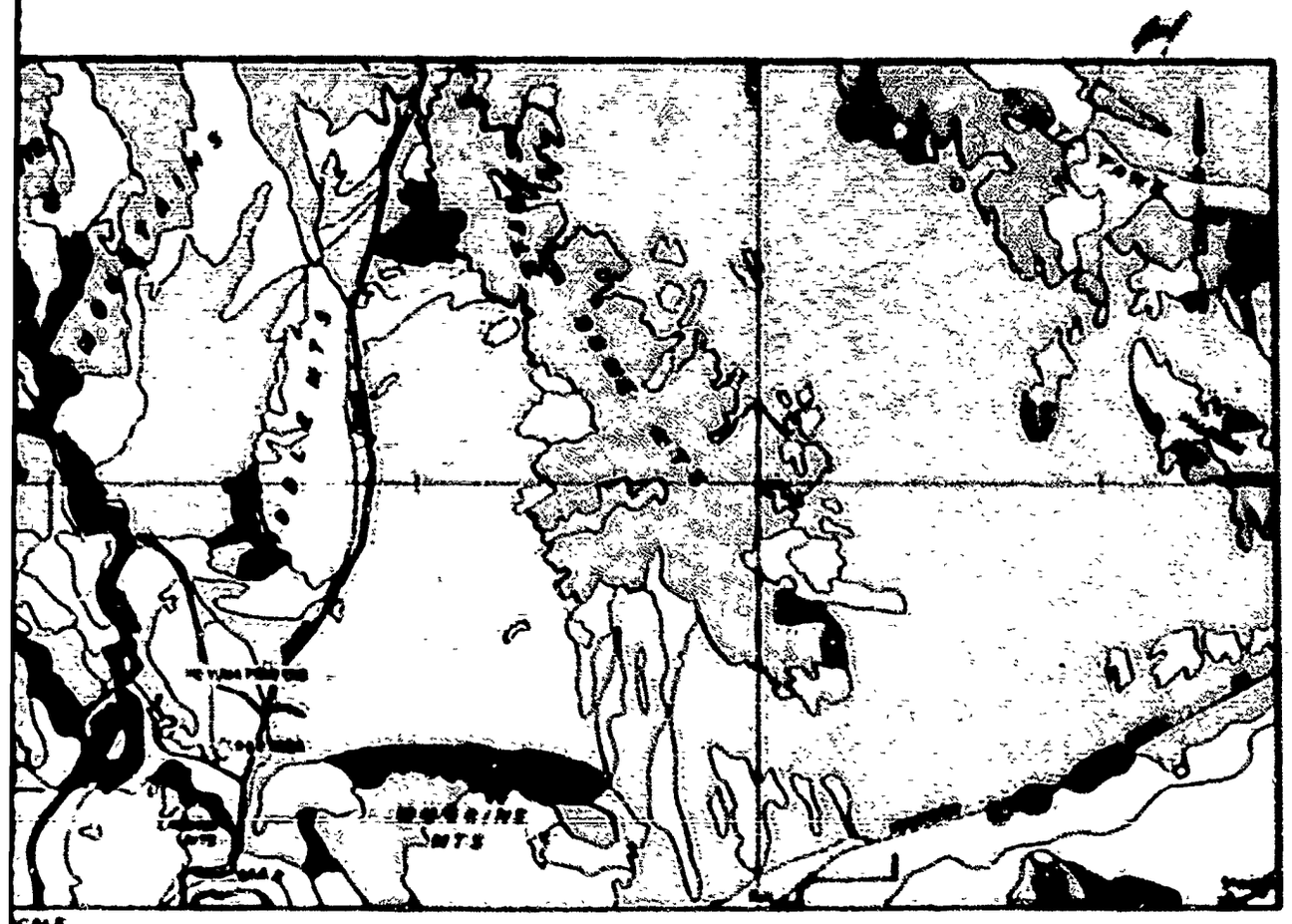
4 Rectrenuous: Characteristic slope betwe 25 - 50%).

5 Steep: Characteristic slope between 50 - 100%).

6 Precipitous: Characteristic slope gre than 100%).

SLOPE COMPLEXES: (Shaper) only where plan Areal Complexes: Confined to areas o slope types are mapped.

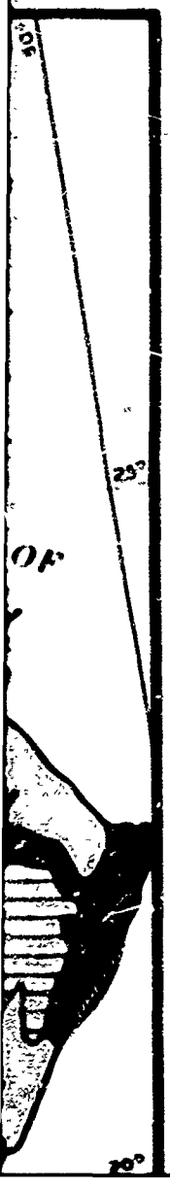
Characteristic slope of actually pr



SCALE

YUMA PROVING GROUND

CHARACTERISTIC SLOPE WITHIN COMPONENT HIGHS



CHARACTERISTIC SLOPE

Slope is defined as a surface of uniform or designated gradient in terms of its deviation from the horizontal. Characteristic slope is defined as a narrow range of slopes which predominates or is most common within a region possessing a distinctive spacing, arrangement, or pattern of landform (level mapped with a 10 ft contour interval)

Flat: Characteristic slope between 0 and 2 degrees (approx. 0 - 3.5%)

Between 2 and 3.7 degrees (approx. 0 - >5%)

Between 1/2 and 2 degrees (approx. 1 - 3.5%)

Gentle: Characteristic slope between 2 and 6 degrees (approx. 3.5 - 10.5%)

Moderate: Characteristic slope between 6 and 18 degrees (approx. 10 - 35%)

Definitely: Characteristic slope between 18 and 26.5 degrees (approx. 35 - 50%)

Steep: Characteristic slope between 26.5 and 65 degrees (approx. 50 - 100%)

Precipitous: Characteristic slope greater than 65 degrees (approx. more than 100%)

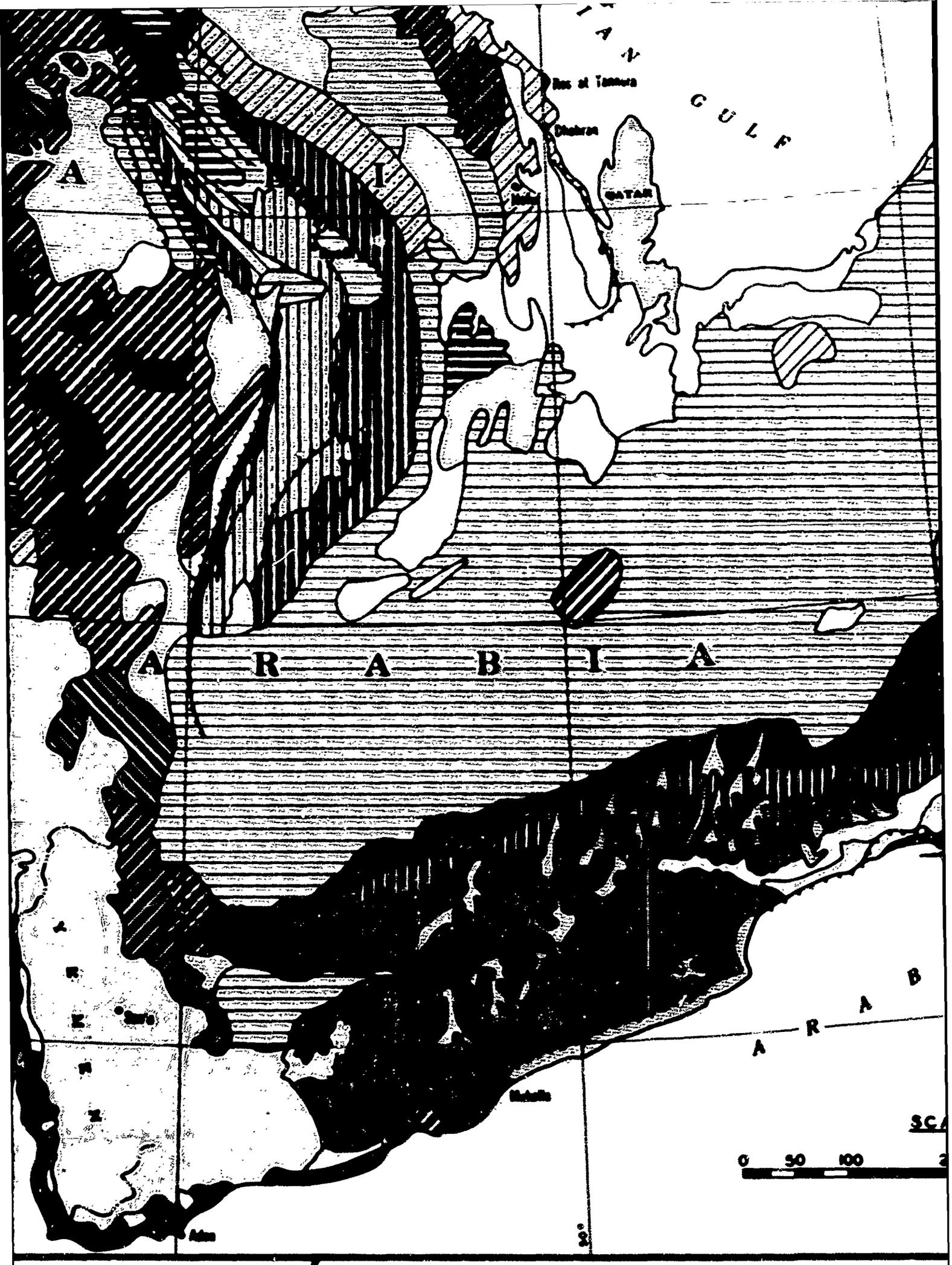
SLOPE COMPONENTS (Mapped only where plan profile complexity are mapped)

Areal Complexes: Confined to areas where two major slopes predominant slope types are mapped

Characteristic slope of areally predominant lows
Characteristic slope of areally subordinate highs

Characteristic slope of areally predominant highs
Characteristic slope of areally subordinate lows

5



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CHARACTERISTIC SLOPE

Slope is defined as a surface identified or designated in terms of its deviation from the horizontal. Characteristic slope is defined as a narrow range of slopes which predominates or is most common within a region (possessing a distinctive spacing, arrangement, or pattern of contour lines) mapped with a 10-ft contour interval.

Flat: Characteristic slope between 0 and 2 degrees (approx. 0 - 3.5%).

3a — Between 0 and 1/2 degree (approx. 0 - 1%).

3b — Between 1/2 and 2 degrees (approx. 1 - 3.5%).

2 — Gentle: Characteristic slope between 2 and 6 degrees (approx. 3.5 - 10.5%).

3 — Moderate: Characteristic slope between 6 and 16 degrees (approx. 10 - 29%).

4 — Dissected: Characteristic slope between 16 and 26.5 degrees (approx. 29 - 50%).

5 — Steep: Characteristic slope between 26.5 and 65 degrees (approx. 50 - 100%).

6 — Precipitous: Characteristic slope greater than 65 degrees (greater than 100%).

SLOPE COMPLEXES: (Mapped only where plan-profile complexes are mapped)

Areal Complexes: Confined to areas where two (major), areally restricted slope types are mapped.

2/4 — Characteristic slope of areally predominant base. Characteristic slope of areally subordinate height.

4/2 — Characteristic slope of areally predominant height. Characteristic slope of areally subordinate base.

Gross-component Complexes: Mapped only where gross-component plan-profile complexes are mapped. The symbols to the complex are arranged vertically or horizontally depending on the plan-profile.

3/16 — Characteristic slope within component height.* Characteristic slope within component base.

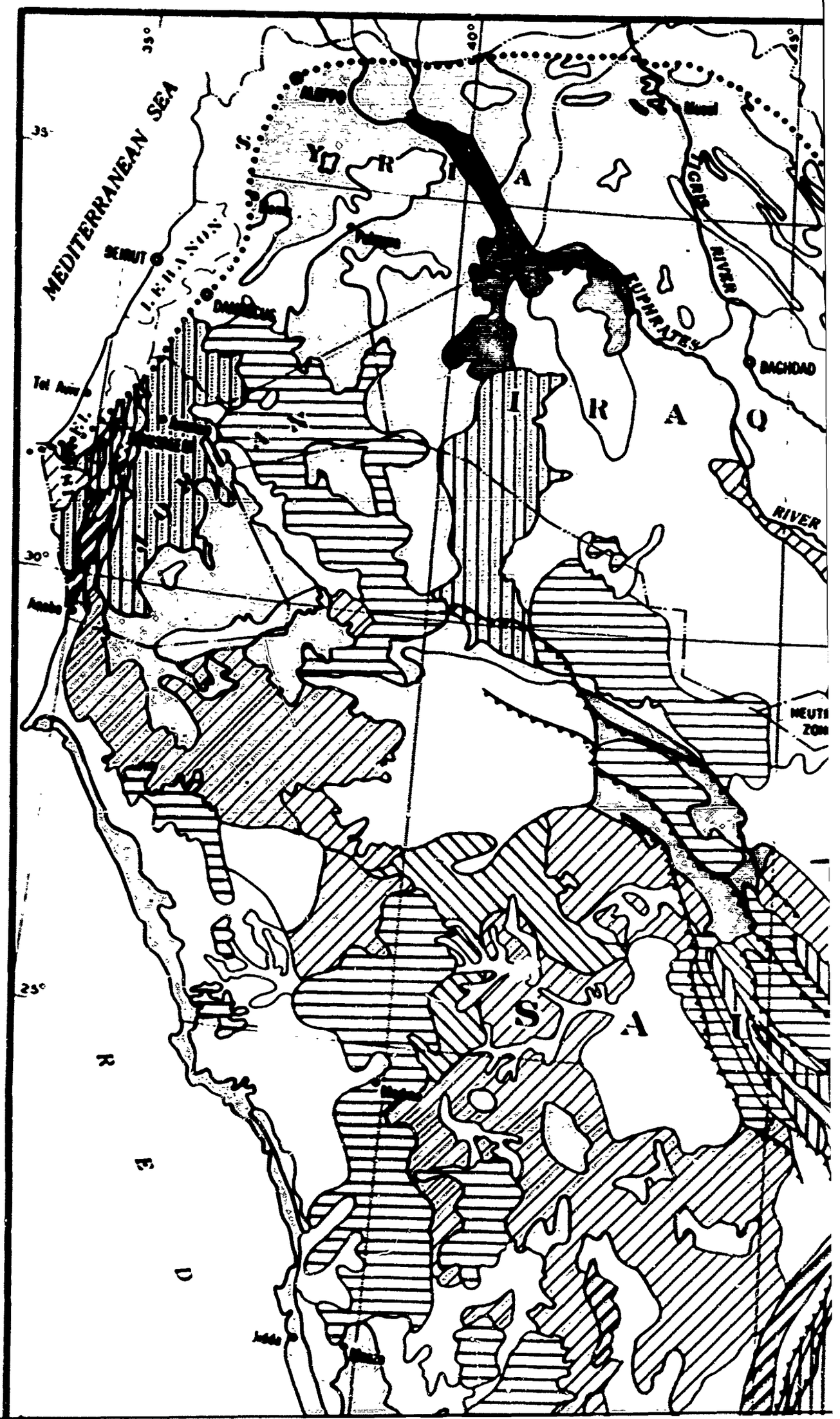
5/2 — Characteristic slope within component base.* Characteristic slope within component height.

Important Scarps: An important scarp is defined as a more or less continuous precipitous slope exhibiting more than 100 feet of relief. Only the better known scarps which extend for considerable distances have been mapped. Scarp height is indicated where known.

* In cases where the gross plan-profile is flat-topped or flat-bottomed the characteristic slope is considered to be the modal slope of the bounding surface.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

CHARACTERISTIC SLOPE


MEDITERRANEAN SEA
BEIRUT
LEBANON
DAMASCUS
Tel Aviv
Amman
Aqaba
Jeddah
Mecca
Medina
Mosul
TIGRIS
RIVER
EUPHRATES
BAGHDAD
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I R A Q
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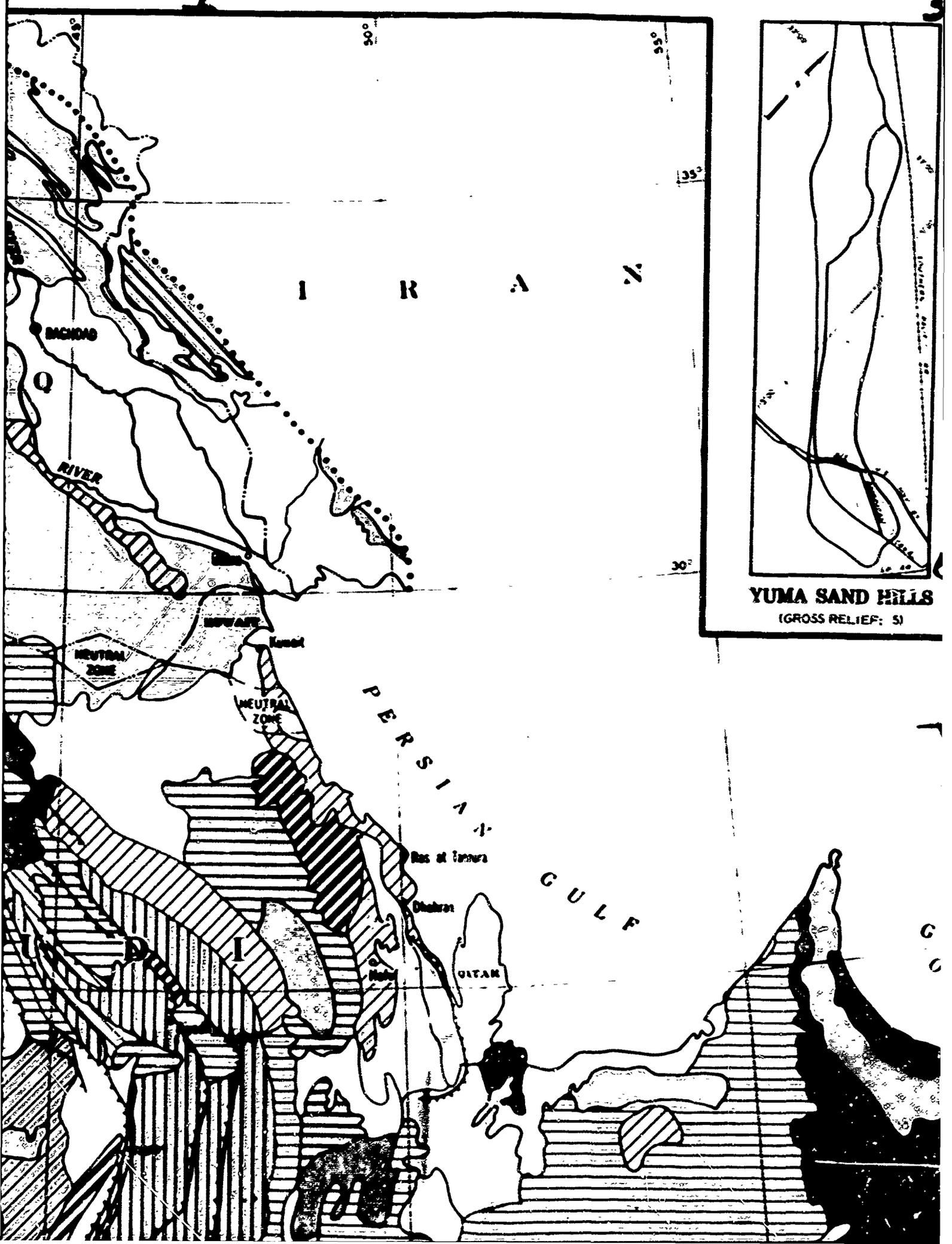
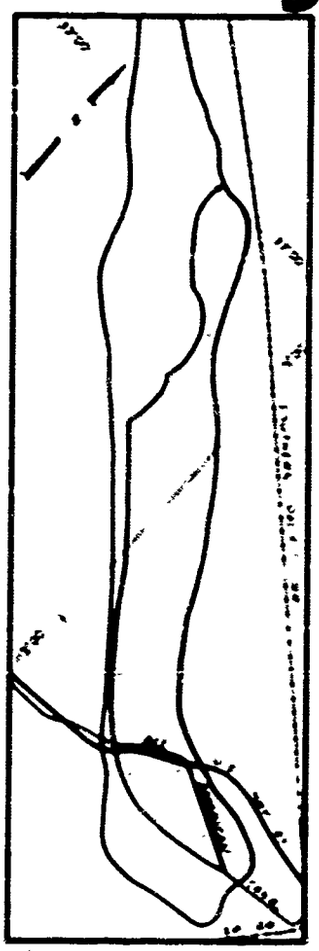
30°
25°
40°
45°


I R A N
BAGHDAD
Q
RIVER
NEUTRAL ZONE
NEUTRAL ZONE
PERSIAN GULF
Ras al Tanura
Dhahran
OMAN
YUMA SAND HILLS
(GROSS RELIEF: 5)

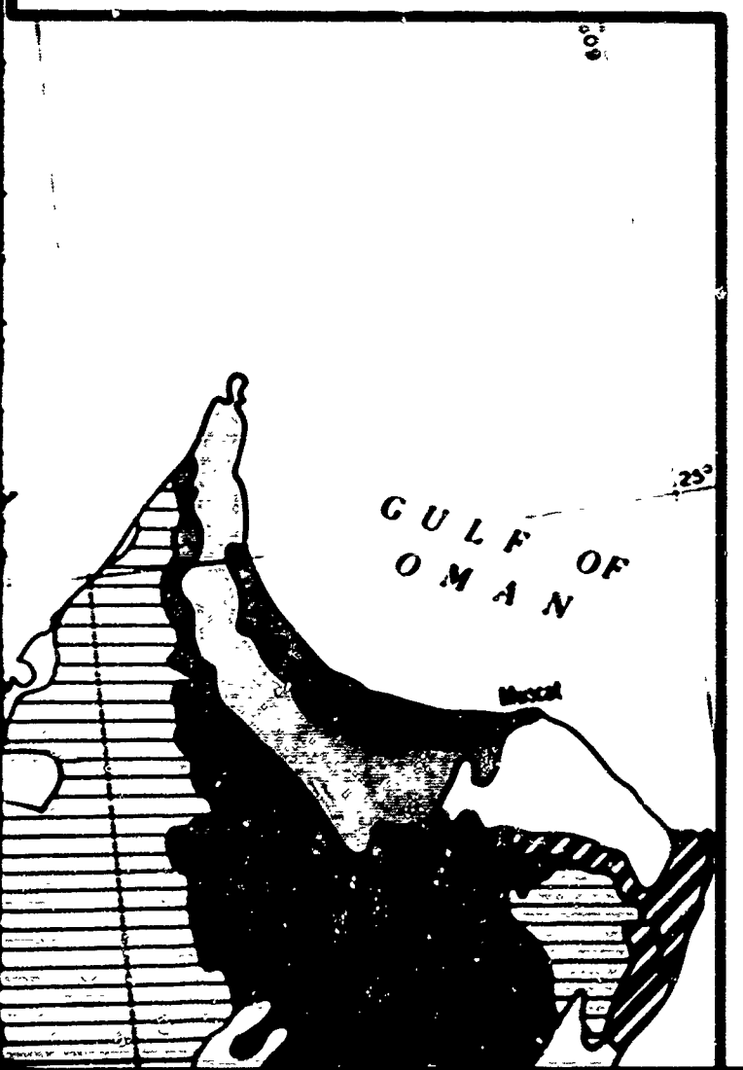


YUMA SAND HILLS

(GROSS RELIEF: 5)

YUMA PROVING GROUND

(GROSS RELIEF OF COMPONENT HIGHS: 7)



CHARACTERISTIC RELIEF

Characteristic relief may be either regional or local in origin. Regional relief is based on model heights of stream depth, corrected differentials per unit area of phenomenon height. This is further defined under type I and type II as shown below. Gross relief indicates the model heights of component highs or the model depth of component lows.

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the model vertical distance from the highest point to the immediately adjacent flow line of an area where drainage [illegible] possible development or landing.* Slope measured to adjacent lows.

1. Characteristic relief between 0 and 10 feet
2. Characteristic relief between 10 and 50 feet
3. Characteristic relief > 50 feet

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the model maximum differences in elevation per square mile, or in areas where drainage [illegible] possible development or landing.* Slope measured to adjacent lows.

* A mobile reinforced to avoid damage [illegible] maximum height of flows in [illegible] where known.

4. Characteristic relief between [illegible] and 250 feet
5. Characteristic relief between 250 and 500 feet
6. Characteristic relief between 500 and [illegible] feet

YUMA PROVING GROUND

(GROSS RELIEF OF COMPONENT HIGHS: 7)

CHARACTERISTIC RELIEF

Characteristic relief may be either residual or gross. Residual relief is based on media classes of stream depth, elevation differential per unit area, or [illegible] height. The [illegible] defined under type I and type II relief, below. Gross relief indicates the median height [illegible] of the modal depth of component lows.

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the median elevation difference to the nearest [illegible] in the immediately adjacent flat [illegible] areas where drainage lines are poorly developed or lacking.* Gross contrast to adjacent lows

1. Characteristic relief between 0 and 25 feet
2. Characteristic relief between 25 and 50 feet
3. Characteristic relief > 50 feet

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the median maximum difference in elevation per square mile, or in areas where drainage lines are poorly developed or lacking.* Gross contrast to adjacent lows

* Usually restricted to small dune areas; measurement height of dunes is defined above lows.

4. Characteristic relief between 0 and 100 feet
5. Characteristic relief between 100 and 500 feet
6. Characteristic relief between 500 and 1,000 feet
7. Characteristic relief greater than 1,000 feet

RELIEF COMPLEXES (Mapped only where plan-profile complexes are mapped.)

Areal Complexes. Confined to areas where two mapped areal's represented relief units, both of the continuous type, are mapped.

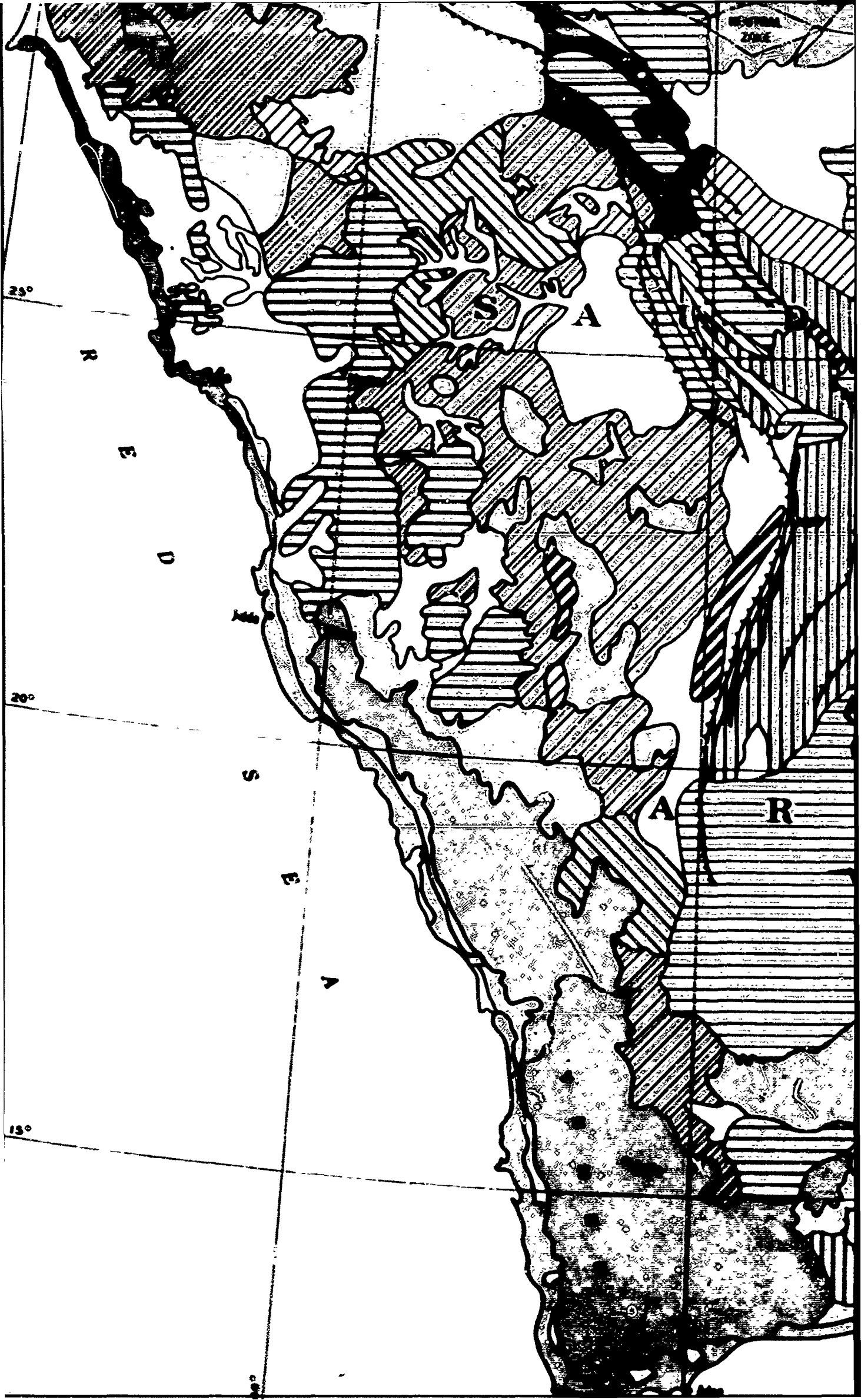
Relief of areally predominant lows
Relief of areally subordinate highs

Relief of areally predominant highs
Relief of areally subordinate lows

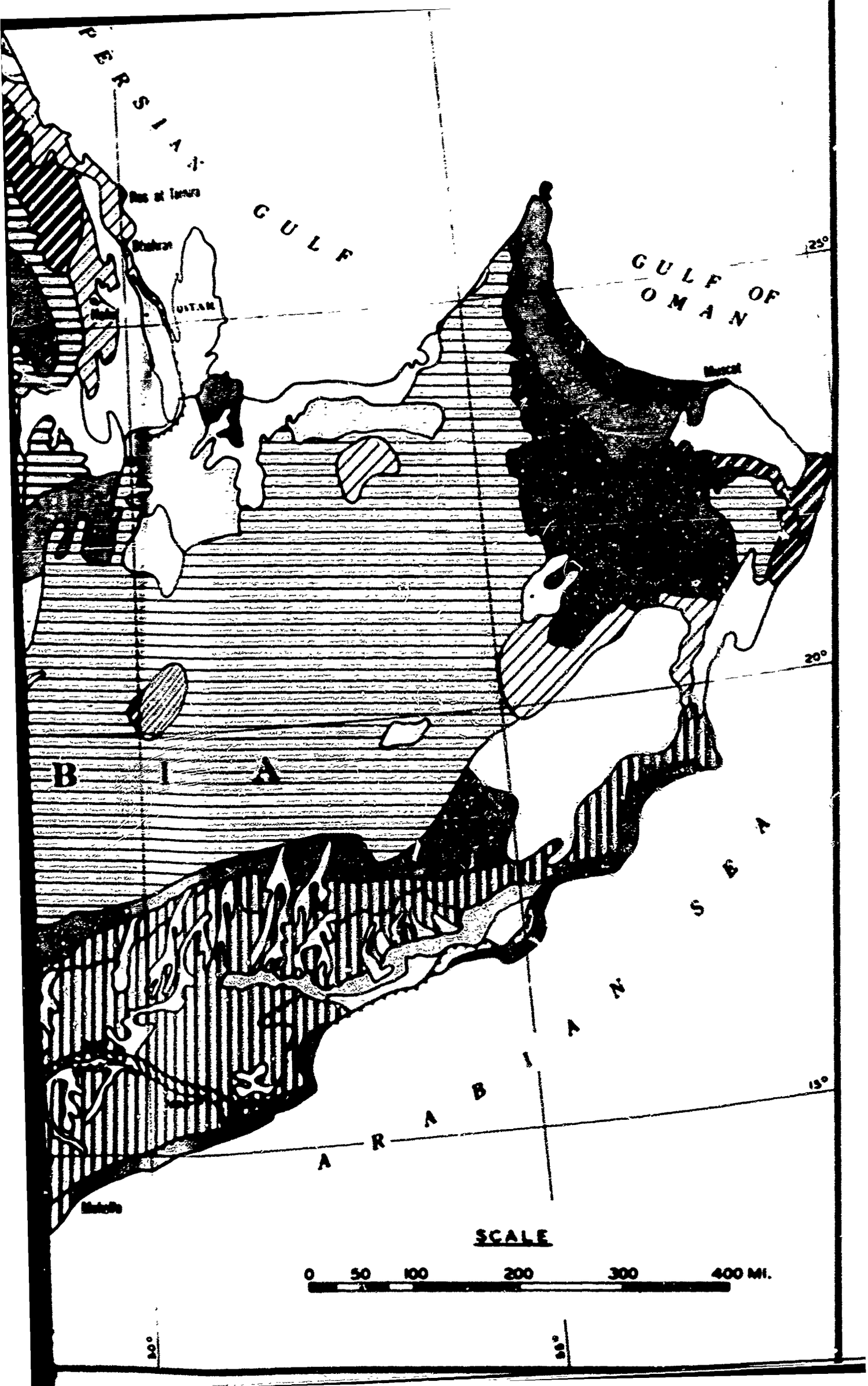
Gross-component Complexes. Mapped only where gross component plan-profile complexes are mapped

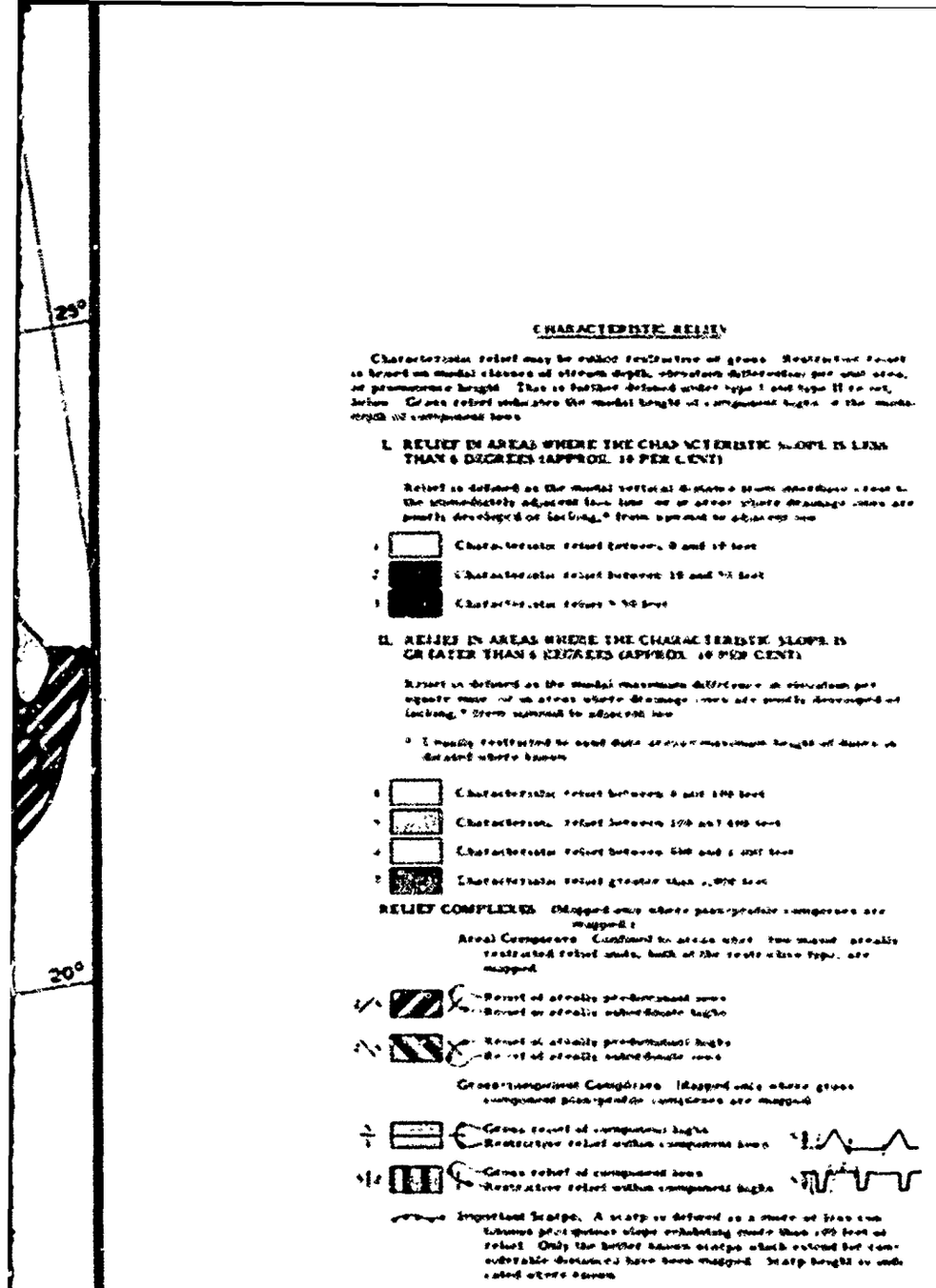
Gross relief of component highs
Residual relief within component lows

Gross relief of component lows


NEUTRAL ZONE
25°
20°
15°
R E D S E A
S A
A R

NEUTRAL ZONE
PERSIAN
GULF
Ras al Tanura
Dhahran
QATAR
I
R A B I A
A R A B I A N
SCALE
0 50 100 200 300


PERSIAN GULF
GULF OF OMAN
Ras al Jamira
Bushire
Muscat
Mukalla
B I A
ARABIAN SEA
25°
20°
15°
SCALE
0 50 100 200 300 400 MI.
50°
55°



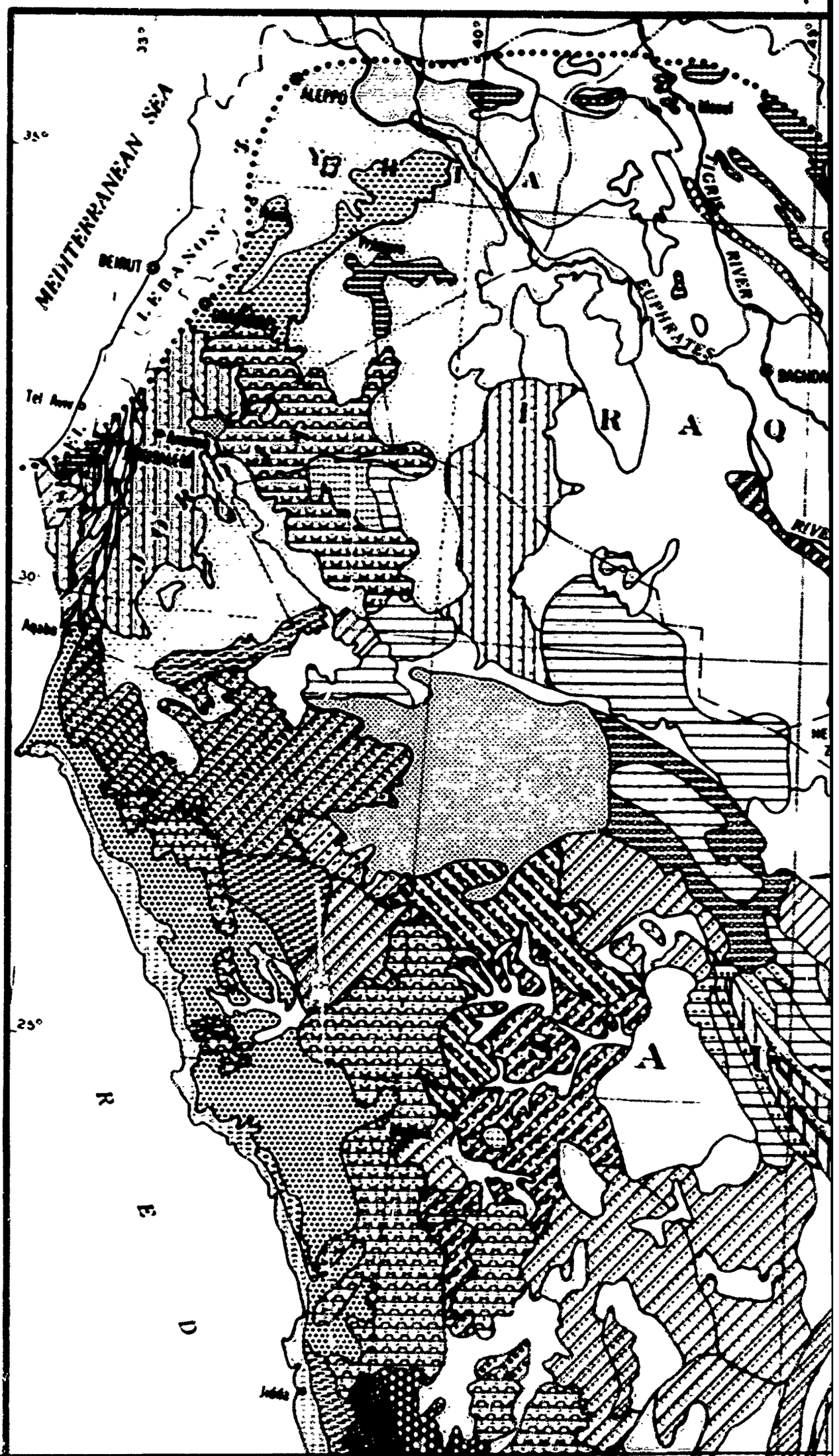
ANALOGS OF YUMA TERRAIN

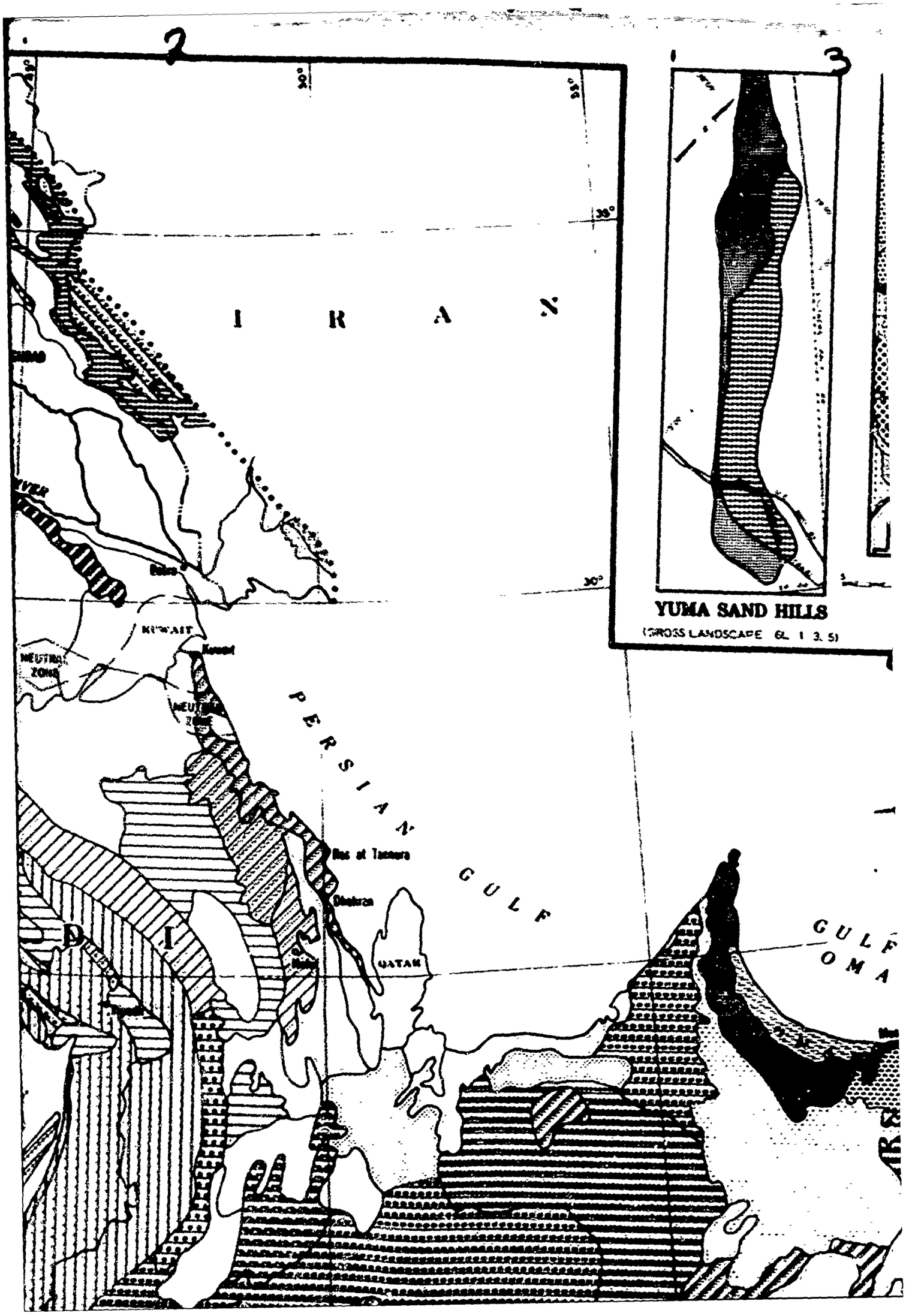
IN THE

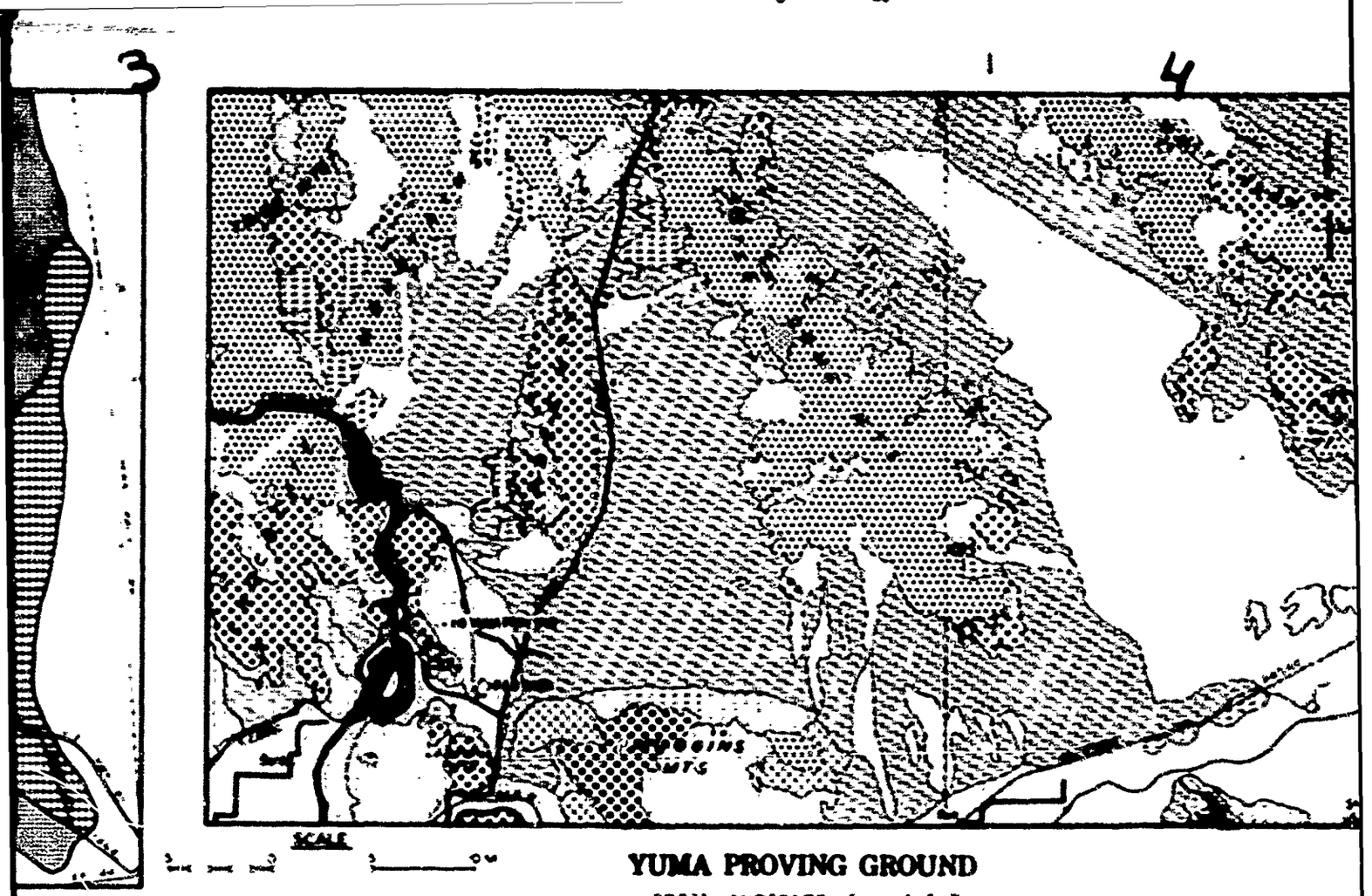
MIDDLE EAST DESERT

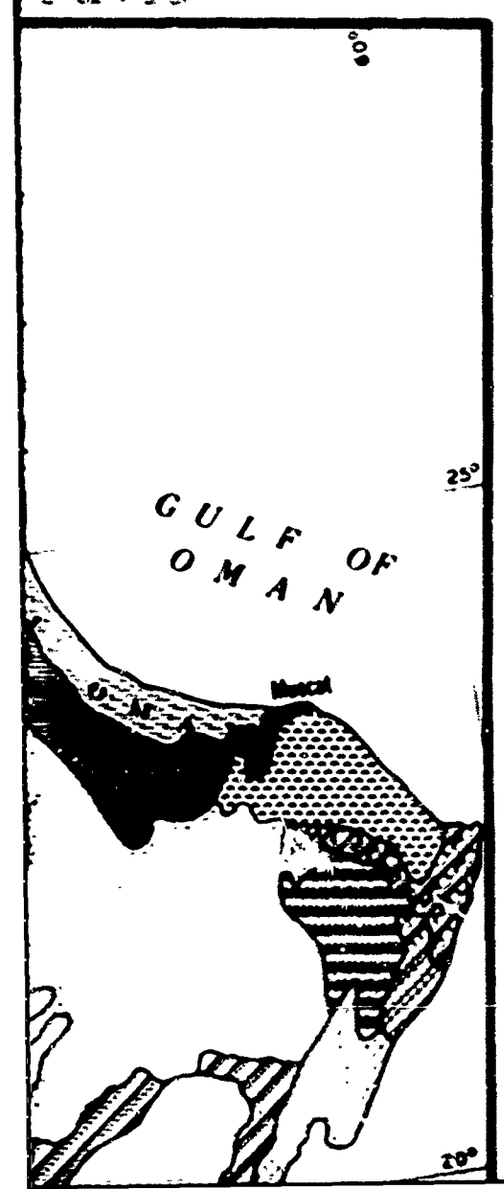
CHARACTERISTIC RELIEF

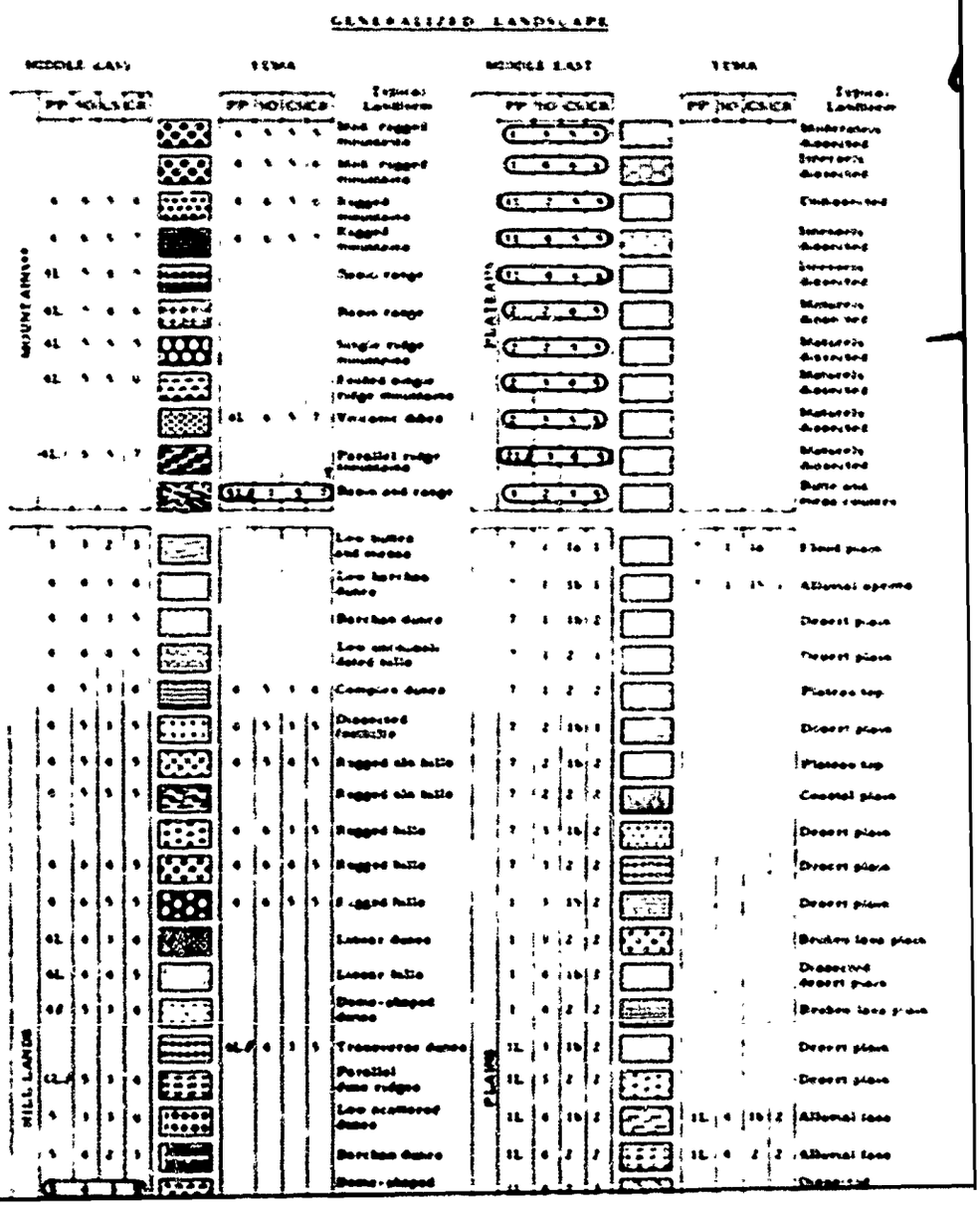
PLATE 4

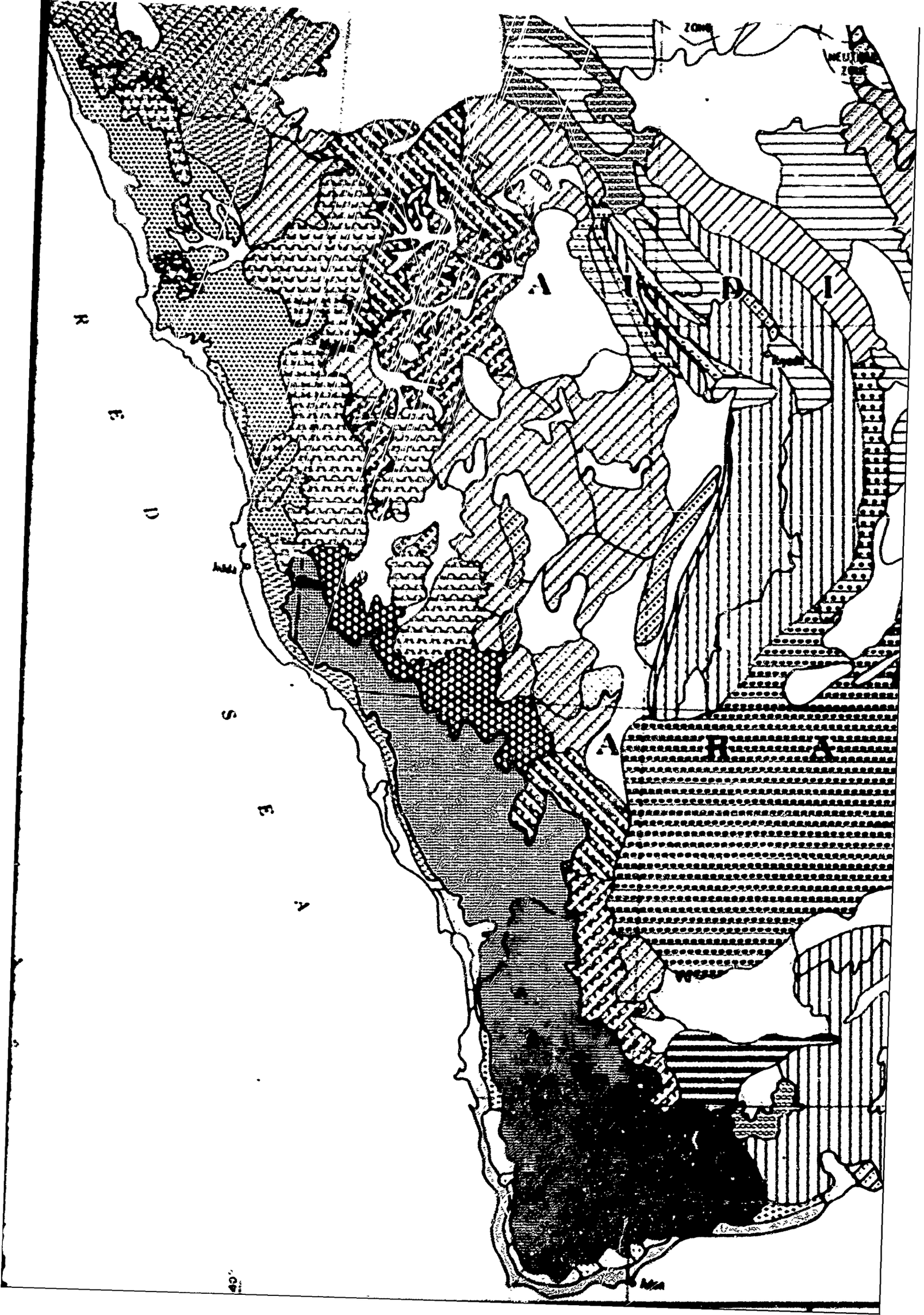

MEDITERRANEAN SEA
ALEPPO
BEIRUT
LEBANON
Tel Aviv
Aqaba
Jeddah
TIGRIS
RIVER
EUPHRATES
BAGHDAD
R A Q
A
R E D
35°
30°
25°
40°

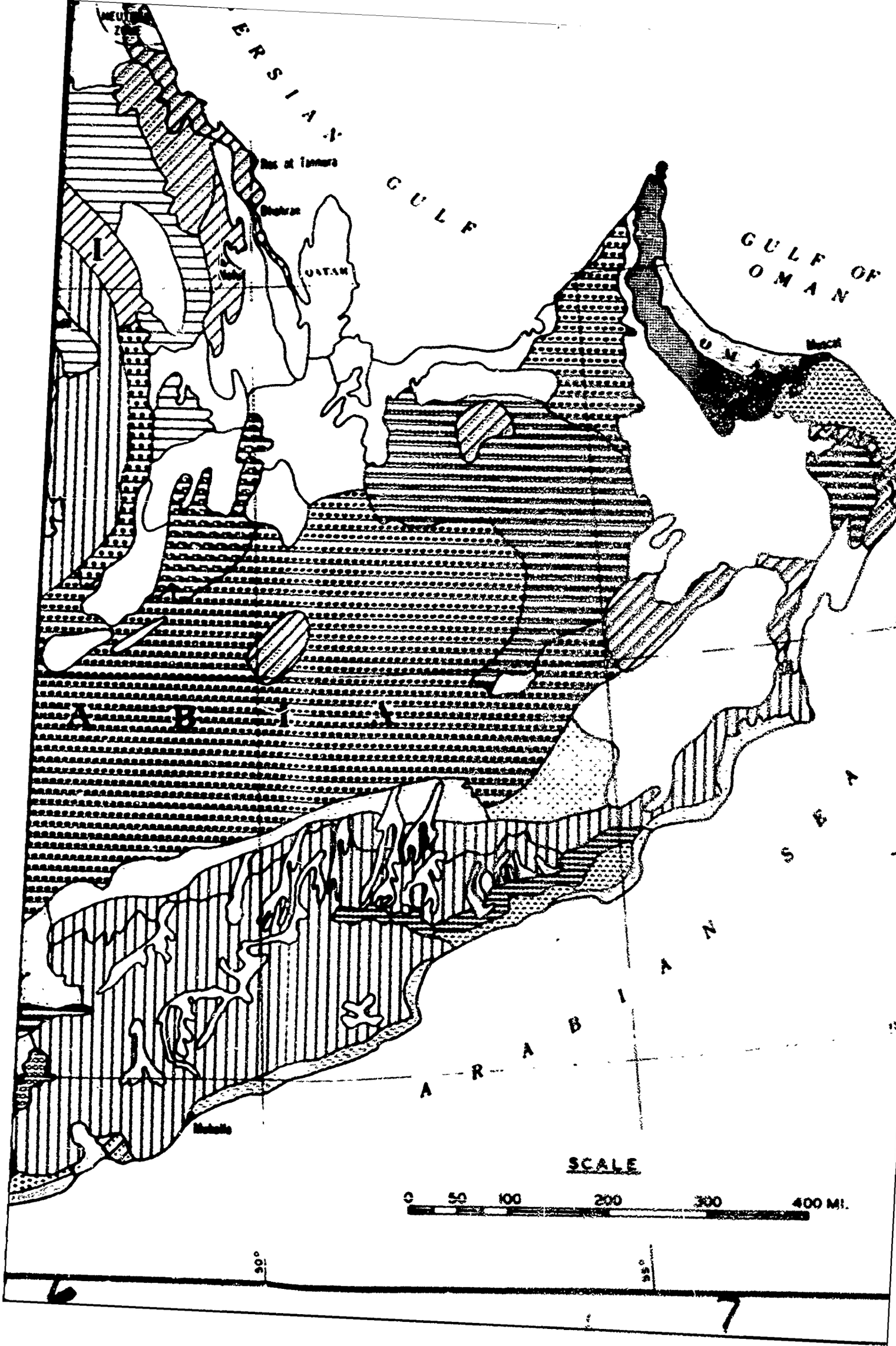

2
3
I R A N
KUWAIT
NEUTRAL ZONE
PERSIAN GULF
Ras at Tanura
Dhahran
QATAR
GULF OMA
YUMA SAND HILLS
(CROSS LANDSCAPE GL 1 3, 5)

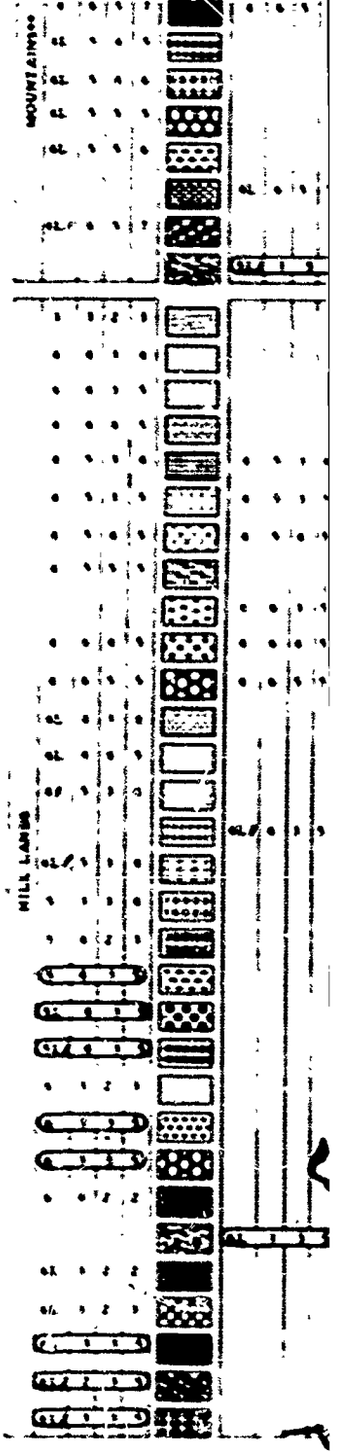

3
4
SCALE
YUMA PROVING GROUND
GROSS LANDSCAPE


GULF OF OMAN
Muscat
25°
20°


GENERALIZED LANDSCAPE
MIDDLE EAST
YUMA
MOUNTAINS
PLATEAUS
HILL LANDS
PLAINS


ZONE
NEUTRAL
ZONE
A
D
I
A
R
A
R
E
U
S
E
A

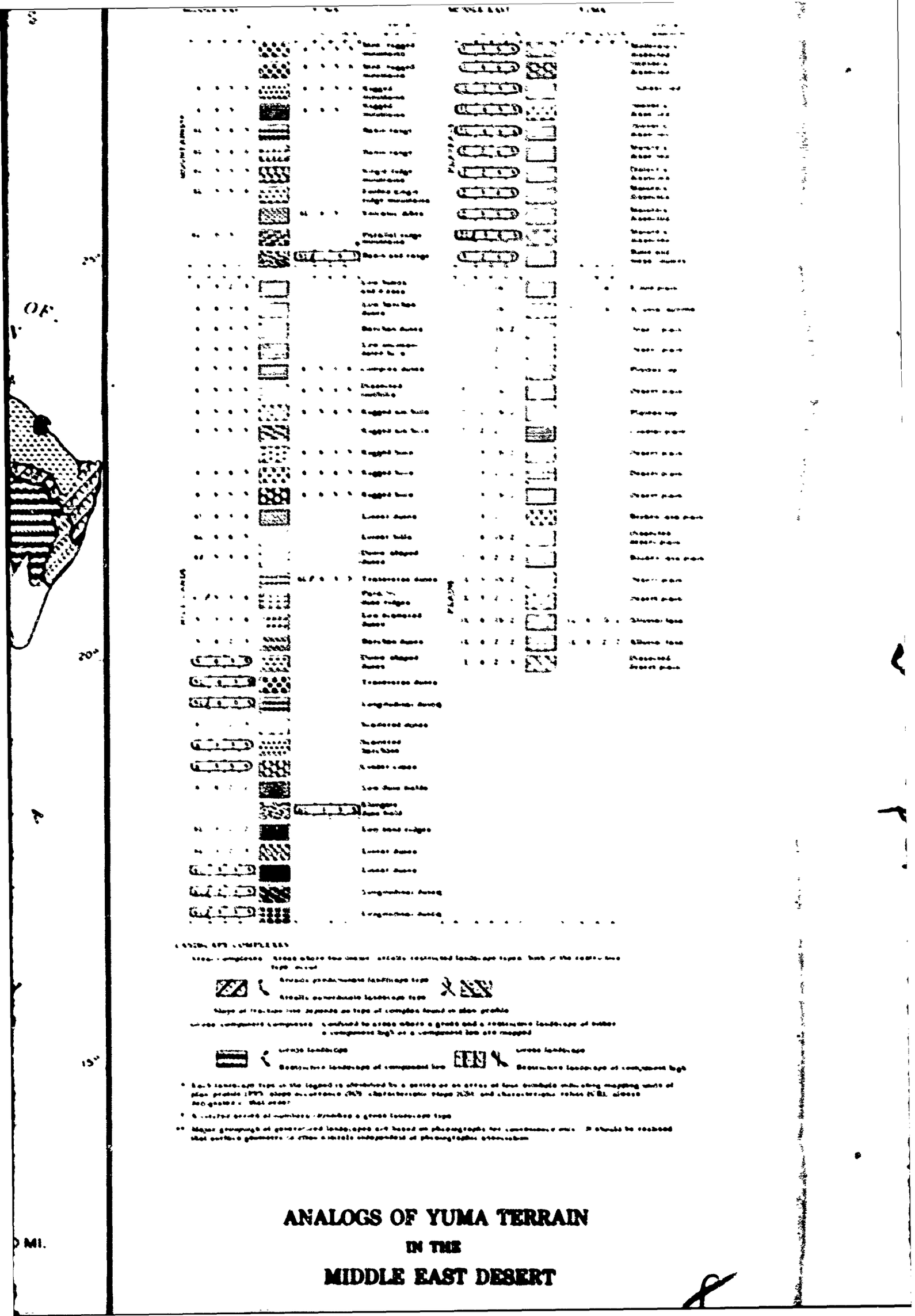

PERSIAN GULF
GULF OF OMAN
Ras al Ismara
Bushehr
QATAR
Muscat
OMAN
I
A
B
ARABIAN SEA
Mukalla
SCALE
0 50 100 200 300 400 MI.



ANALO

MID

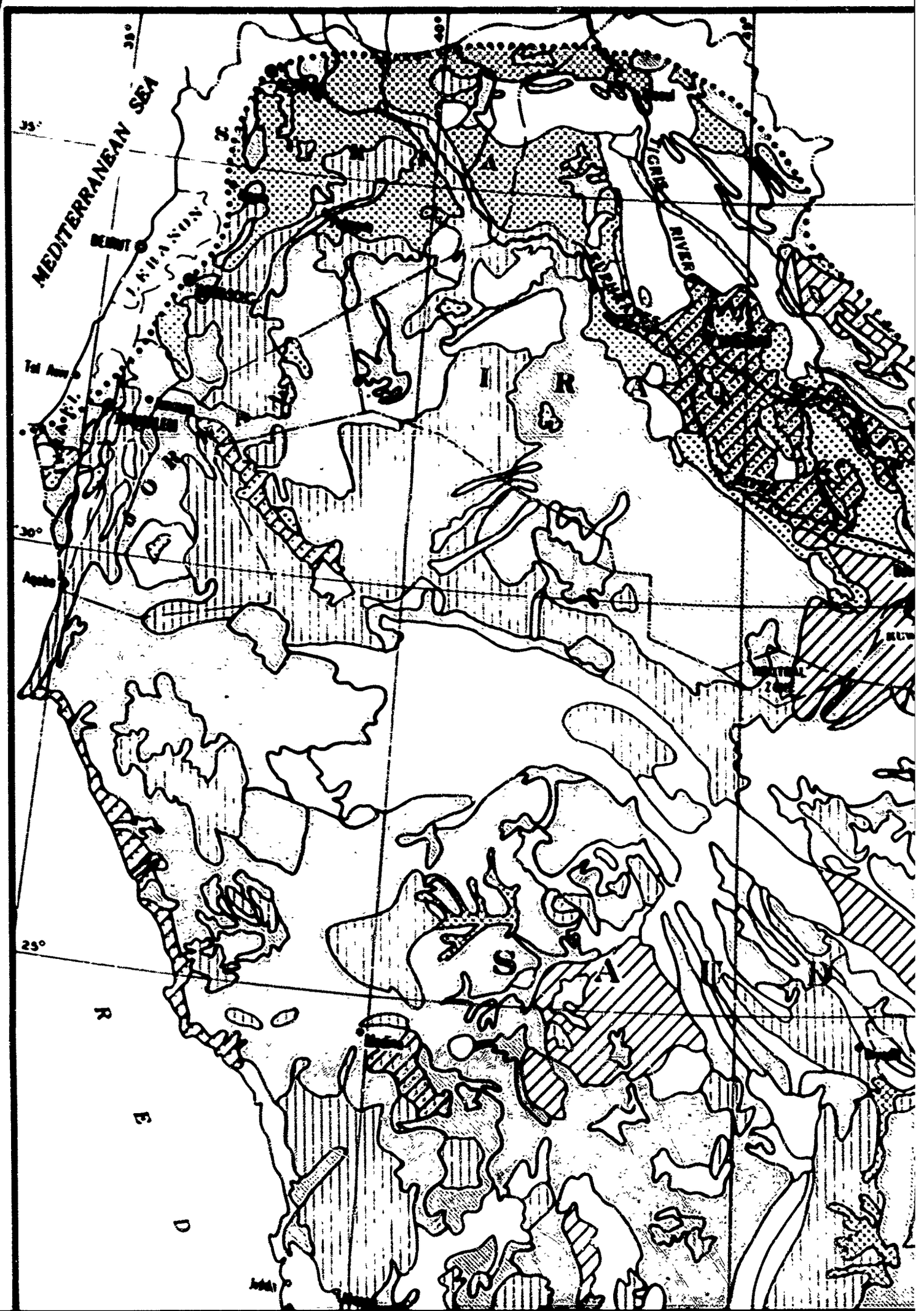
GENERA

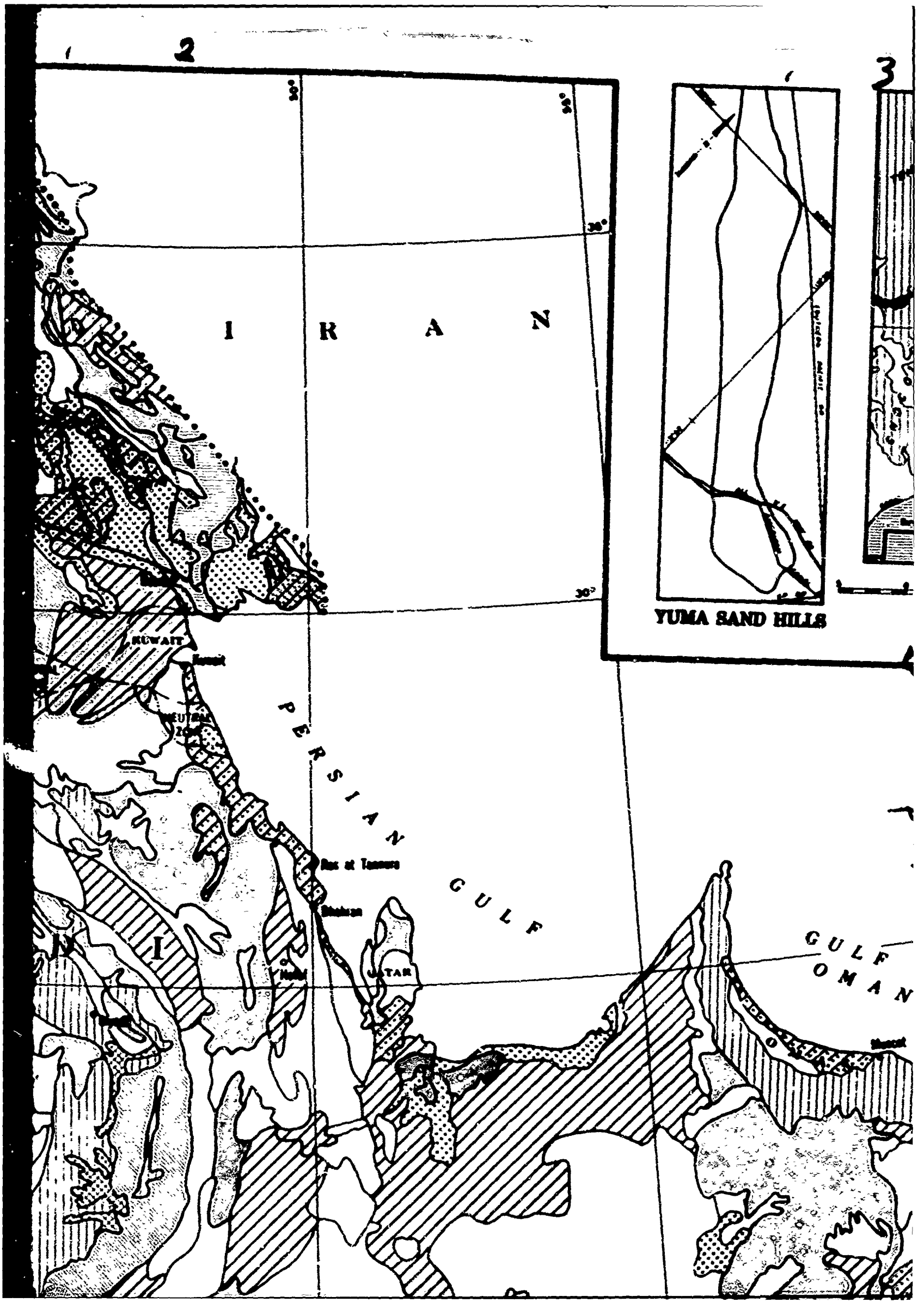


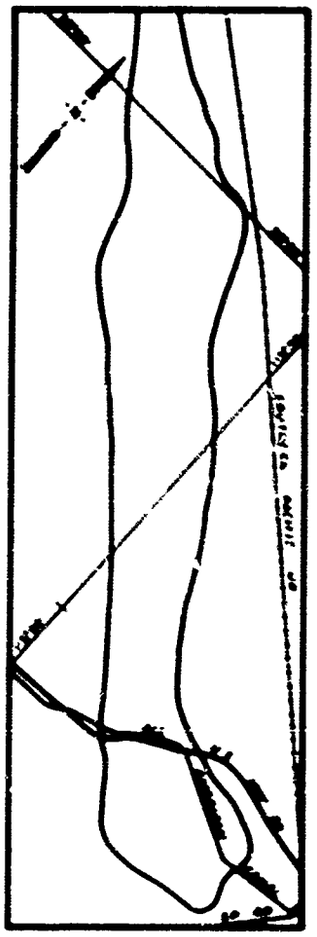
ANALOGS OF YUMA TERRAIN

IN THE

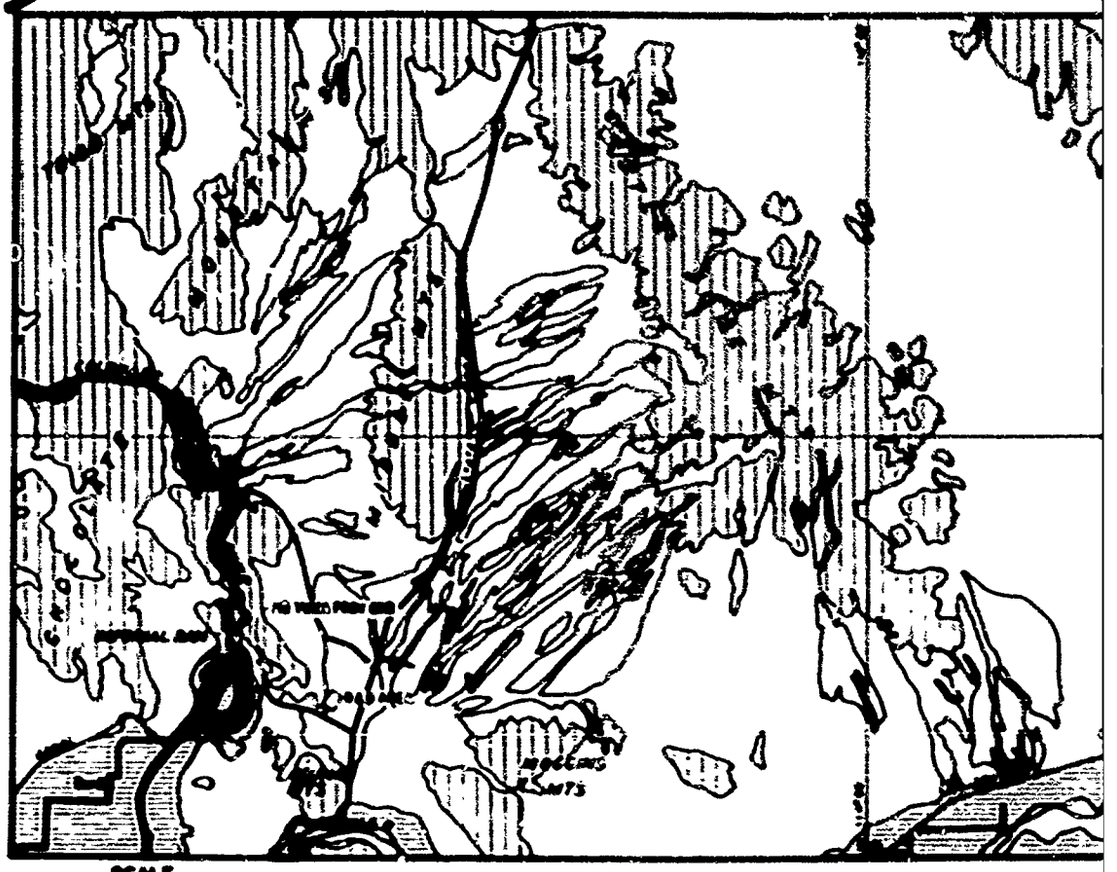
MIDDLE EAST DESERT


MEDITERRANEAN SEA
BEIRUT
LEBANON
Tel Aviv
Aqaba
TIGRIS
RIVER
I R A Q
S A U D I
R E D
35°
30°
29°

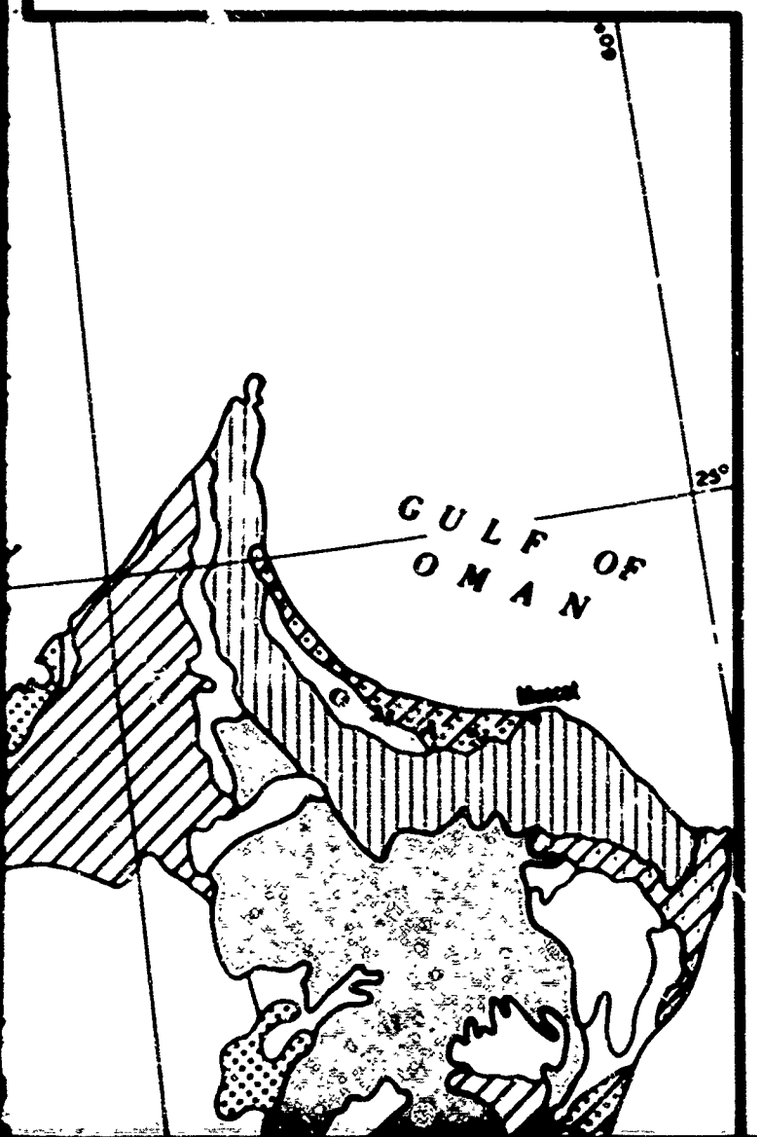

2
3
I R A N
PERSIAN GULF
GULF OMAN
KUWAIT
Kuwait
Ras al Tanura
Dhahran
QATAR
Doha
Muscat
YUMA SAND HILLS



YUMA SAND HILLS



YUMA PROVING GROUND



SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1. Areas characterized by a mosaic of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 90 per cent of the area mapped.

2. Areas characterized by a mosaic of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 to 90 per cent of the area mapped.

3. Areas characterized by a mosaic of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 10 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of volcanic ash or cyrtia.

*Stony soils: More than 75 per cent of a typical sample consists of material coarser than gravel. Coarse-grained soils: More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils: More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS*

Areally predominant (70 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils.

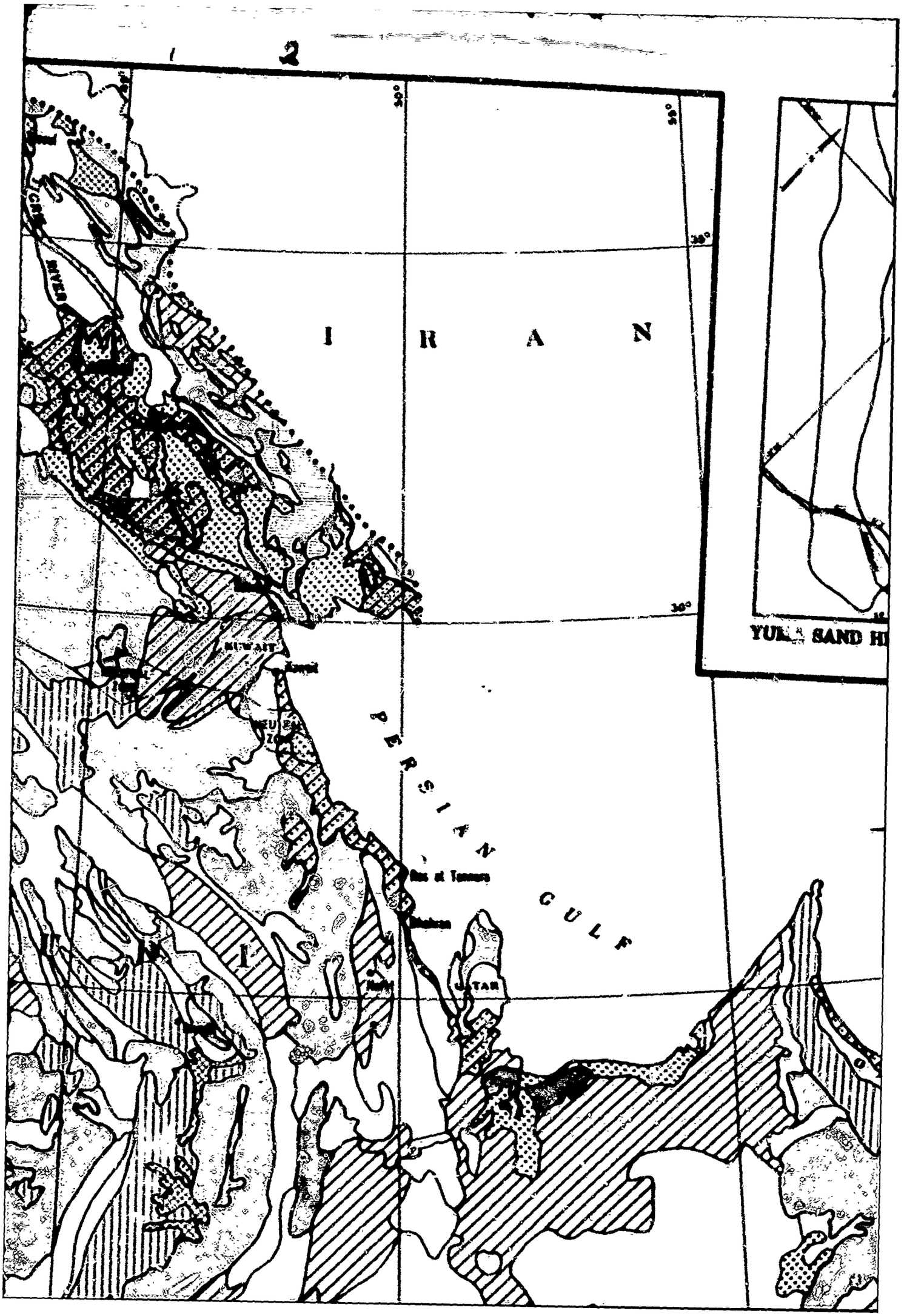
COARSE-GRAINED SOILS

4. Gravel: More than 50 per cent of a typical sample consists of gravel.

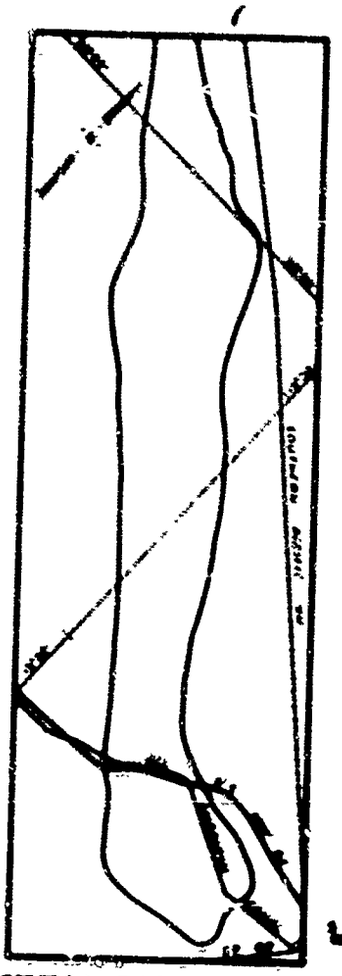
5. Sand: More than 50 per cent of a typical sample consists of sand.

6. Sand and gravel mixed with minor amounts of finer materials: More than 50 per cent of a typi-

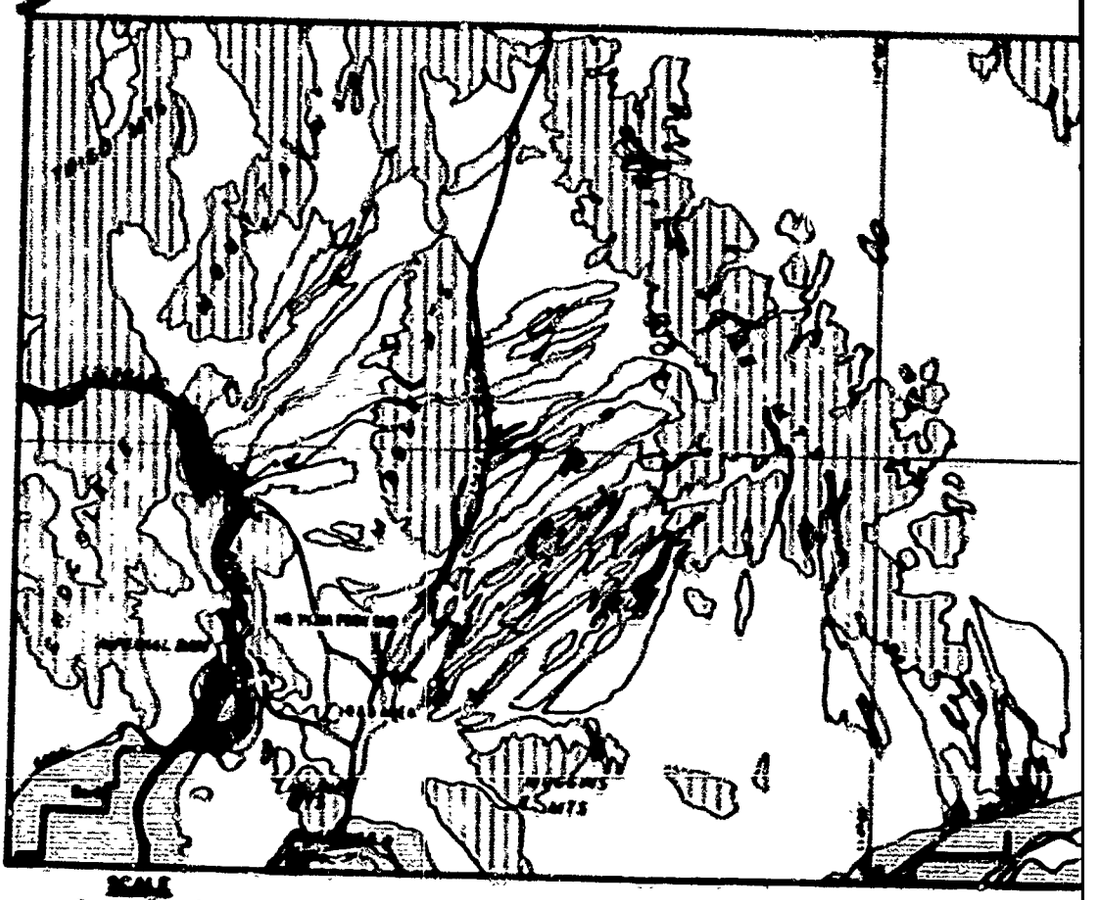
MEDITERRANEAN SEA
BEIRUT
LEBANON
Tel Aviv
Aqaba
TIGRIS
RIVER
I R
S A
R E D
35°
30°
25°


2
IRAN
PERSIAN GULF
KUWAIT
Ras al Tanura
Bahrain
QATAR
YUMA SAND HI

3



YUMA SAND HILLS



YUMA PROVING GROUND

SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1 Areas characterized by a mixture of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 50 per cent of the area mapped.

2 Areas characterized by a mixture of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 to 90 per cent of the area mapped.

3 Areas characterized by a mixture of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 20 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of soil and/or rocks.

*Stony soils. More than 75 per cent of a typical sample consists of material coarser than gravel. Coarse-grained soils. More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils. More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS

Actually predominant (70 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils.

COARSE-GRAINED SOILS

4 Gravel. More than 90 per cent of a typical sample consists of gravel.

5 Sand. More than 90 per cent of a typical sample consists of sand.

6 Sand and gravel mixed with minor amounts of fine material. More than 50 per cent of a typical sample consists of sand and/or gravel.

YUMA PROVING GROUND

SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1. Areas characterized by a mixture of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 50 per cent of the area mapped.

2. Areas characterized by a mixture of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 to 50 per cent of the area mapped.

3. Areas characterized by a mixture of coarse- and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 25 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of relatively soft or sparse.

*Stony soils. More than 25 per cent of a typical sample consists of material coarser than gravel. Coarse-grained soils. More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils. More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS

Actually predominant (50 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils.

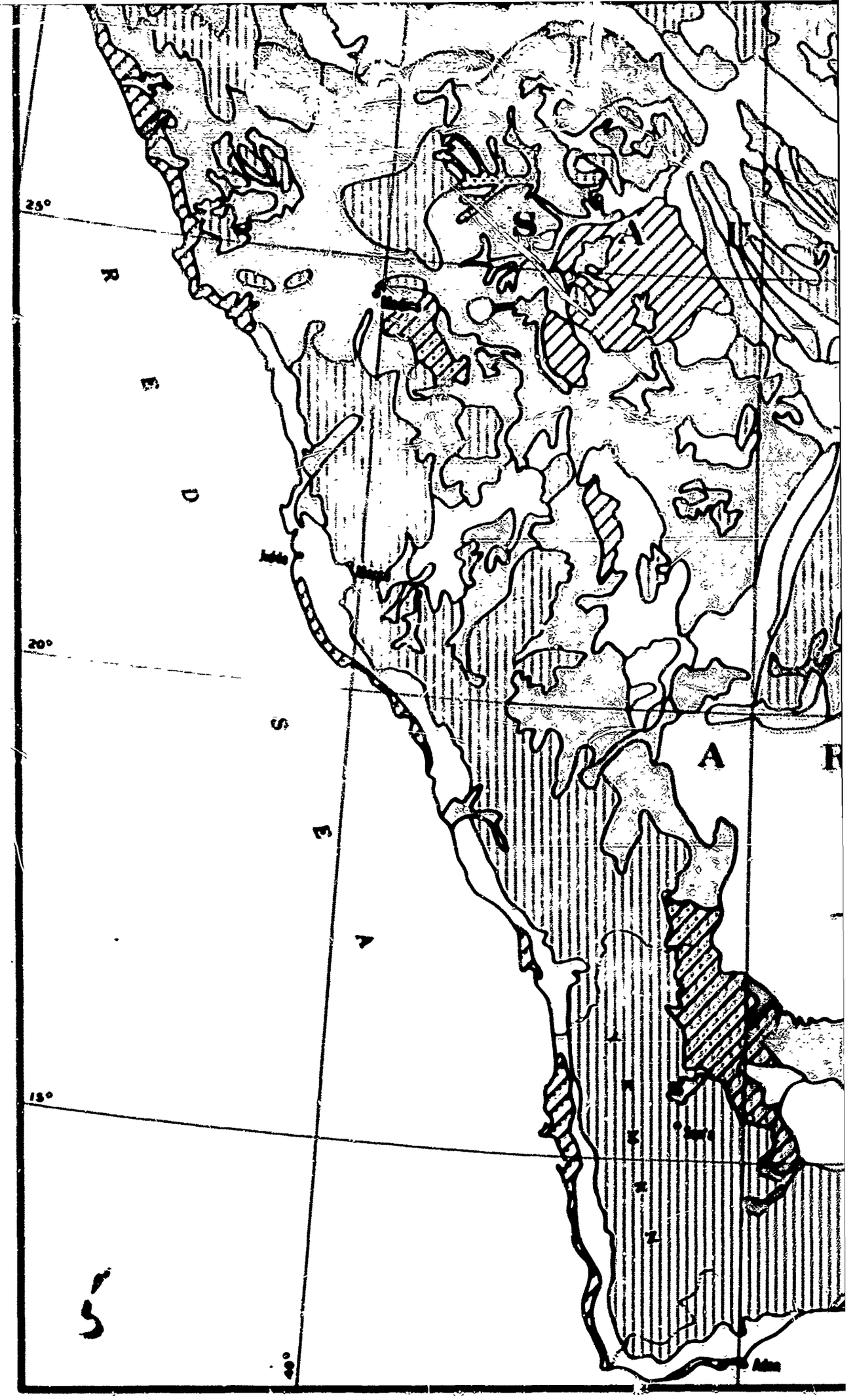
COARSE-GRAINED SOILS

4. Gravel. More than 50 per cent of a typical sample consists of gravel.

5. Sand. More than 50 per cent of a typical sample consists of sand.

6. Sand and gravel mixed with minor amounts of finer material. More than 50 per cent of a typical sample consists of sand and/or gravel.

7. [illegible]



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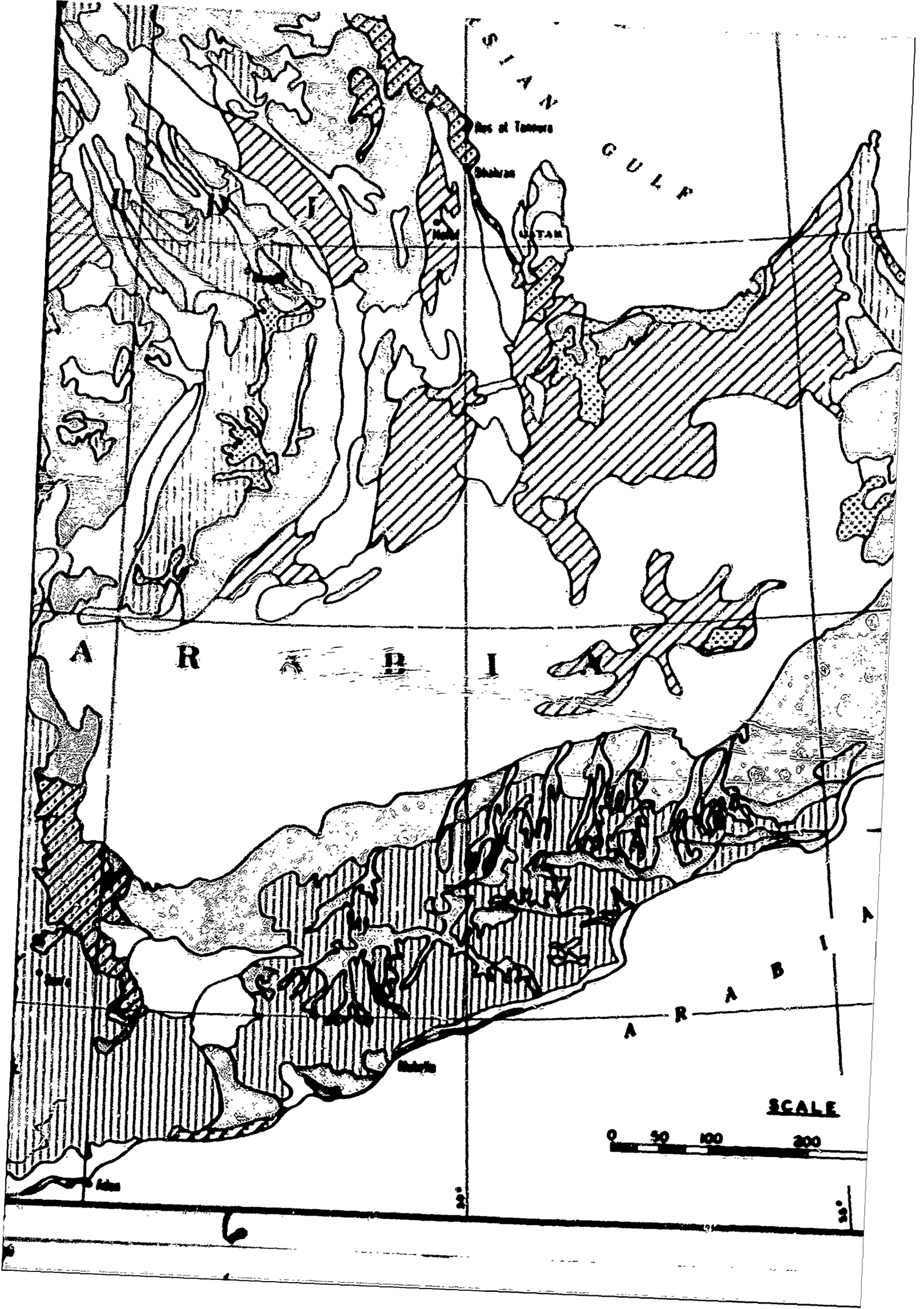
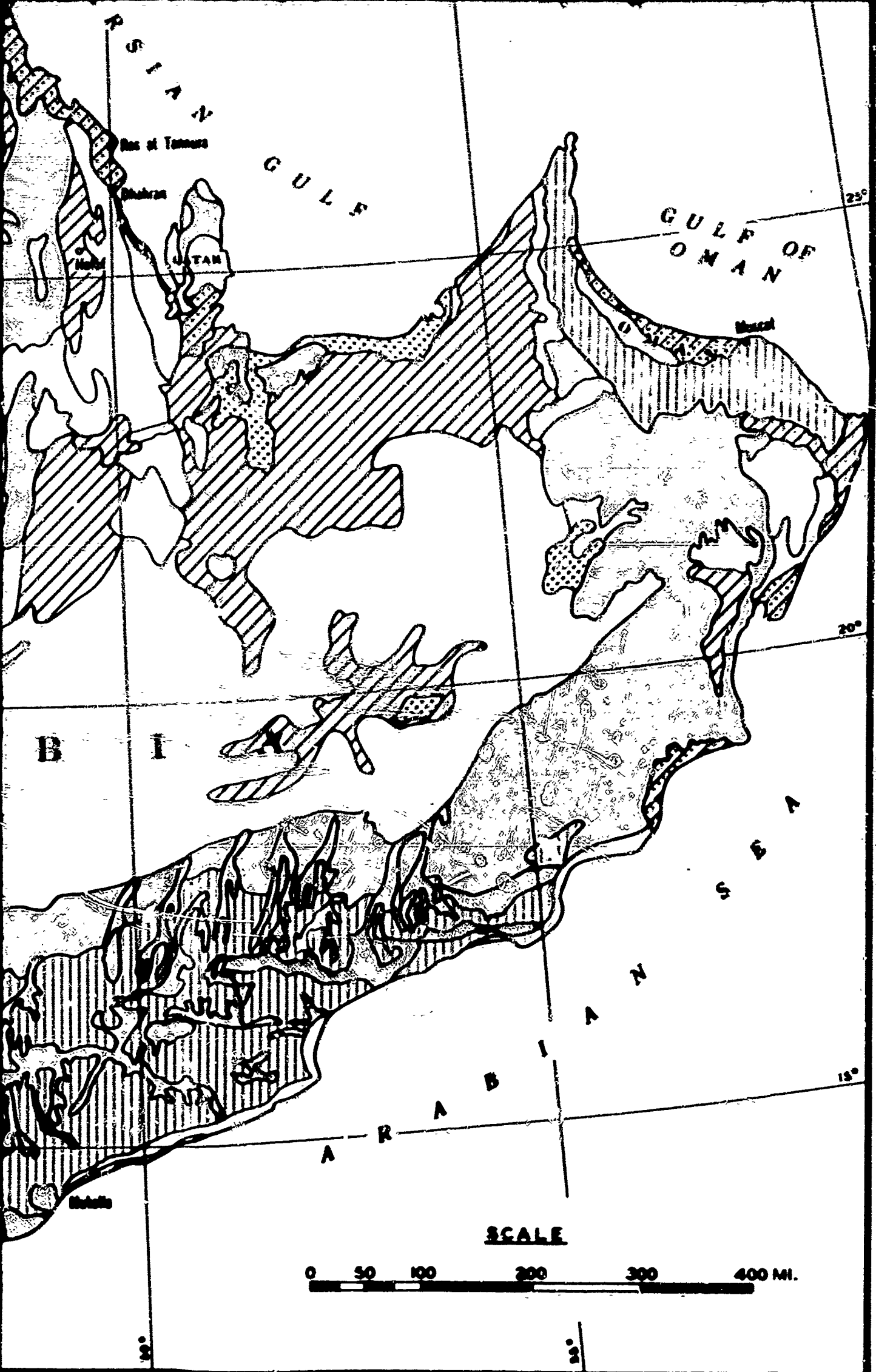
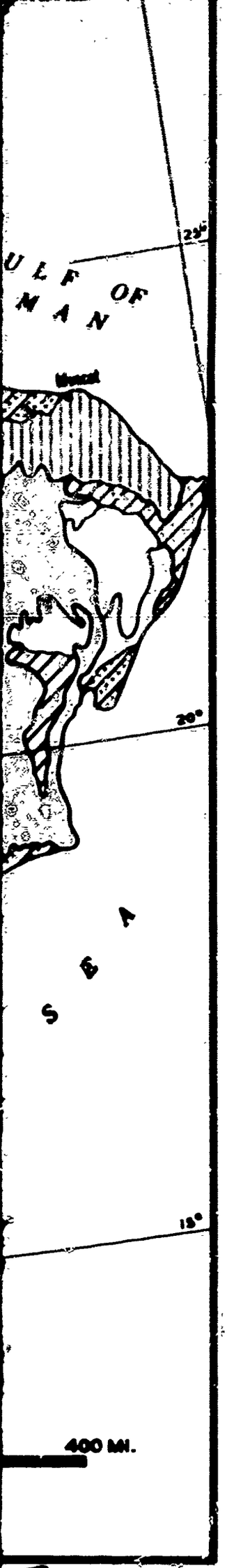

SIAN
GULF
Ras al Tanura
Shahran
Hofuf
QATAR
A R A B I A
A R A B I A
Muscat
Aden
SCALE
0 50 100 200


PERSIAN GULF
Ras al Tanura
Bahrain
Hofuf
QATAR
GULF OF OMAN
OMAN
Muscat
25°
20°
15°
B I A
ARABIAN SEA
Mukalla
SCALE
0 50 100 200 300 400 MI.



SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

3 Areas characterized by a mosaic of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 75 per cent of the area mapped.

4 Areas characterized by a mosaic of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 to 75 per cent of the area mapped.

5 Areas characterized by a mosaic of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 25 to 50 per cent of the area mapped.

Areas thinly patched with coarse or fine-textured deposits of volcanic ash or pumice.

*Stony soils. More than 35 per cent of a typical sample consists of material coarser than gravel. Coarse-grained soils. More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils. More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS*

Areally predominant (75 per cent or more) soil type mapped. Area mapped never includes more than 25 per cent bare rock and stony soils.

COARSE-GRAINED SOILS

1 Gravel. More than 70 per cent of a typical sample consists of gravel.

2 Sand. More than 50 per cent of a typical sample consists of sand.

3 Sand and gravel mixed with minor amounts of finer material. More than 50 per cent of a typical sample consists of sand and/or gravel.

FINE-GRAINED SOILS

7 Silt and clay with minor amounts of coarser material. More than 50 per cent of a typical sample consists of silt and/or clay.

8 Silt. More than 75 per cent of a typical sample consists of silt.

9 Clay. More than 75 per cent of a typical sample consists of clay.

10 Saline. A typical soil sample has a salt content of more than 25 per cent—usually associated with silt and clay.

5/5 SOIL COMPLEXES: Soil complexes are mapped where no areally predominant (70 per cent or more) soil type occurs. In such instances, the two most commonly occurring soil types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

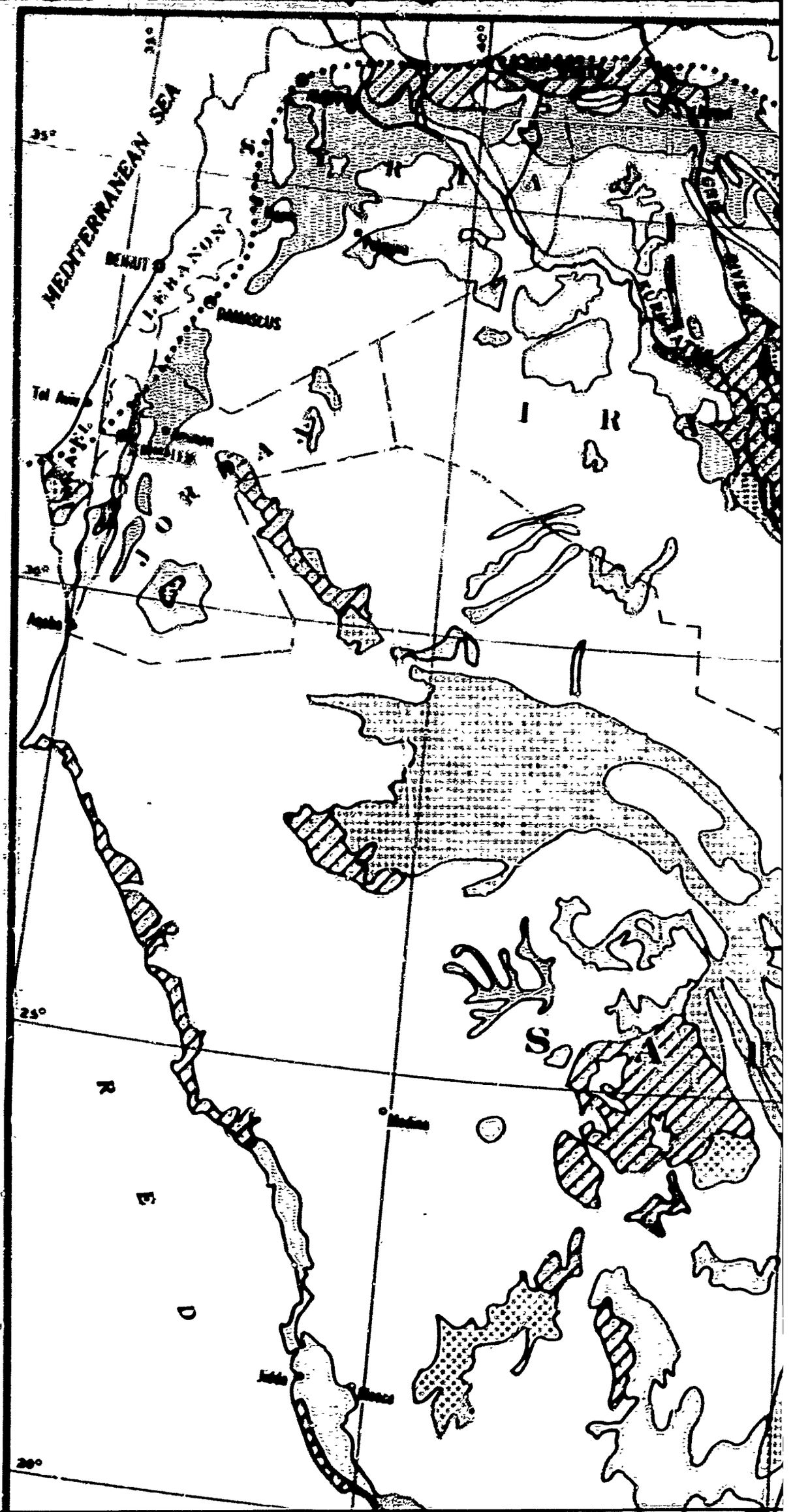
* In general soil associations exhibit soil thickness greater than 10 feet.

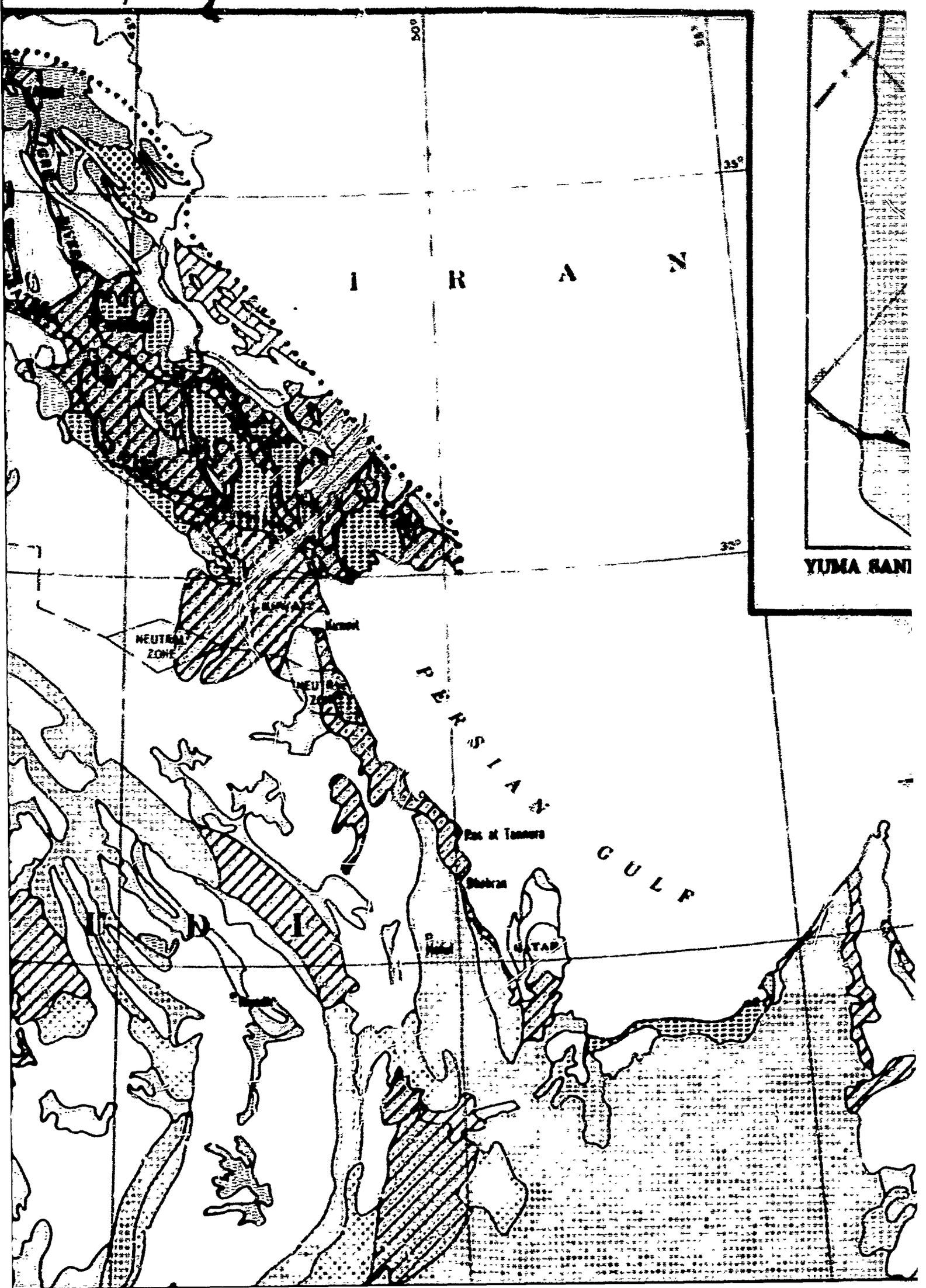
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT
SOIL TYPE

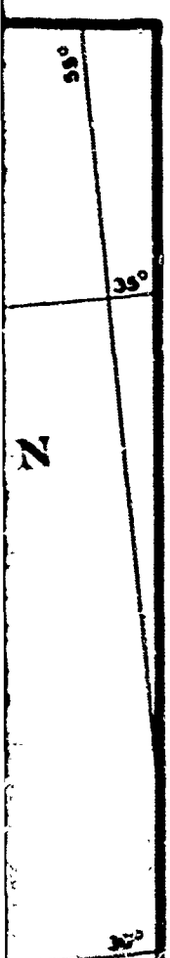
8

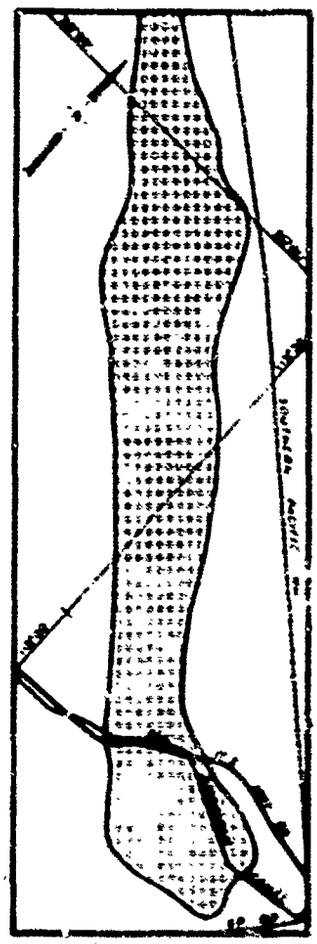
7

PLATE 6

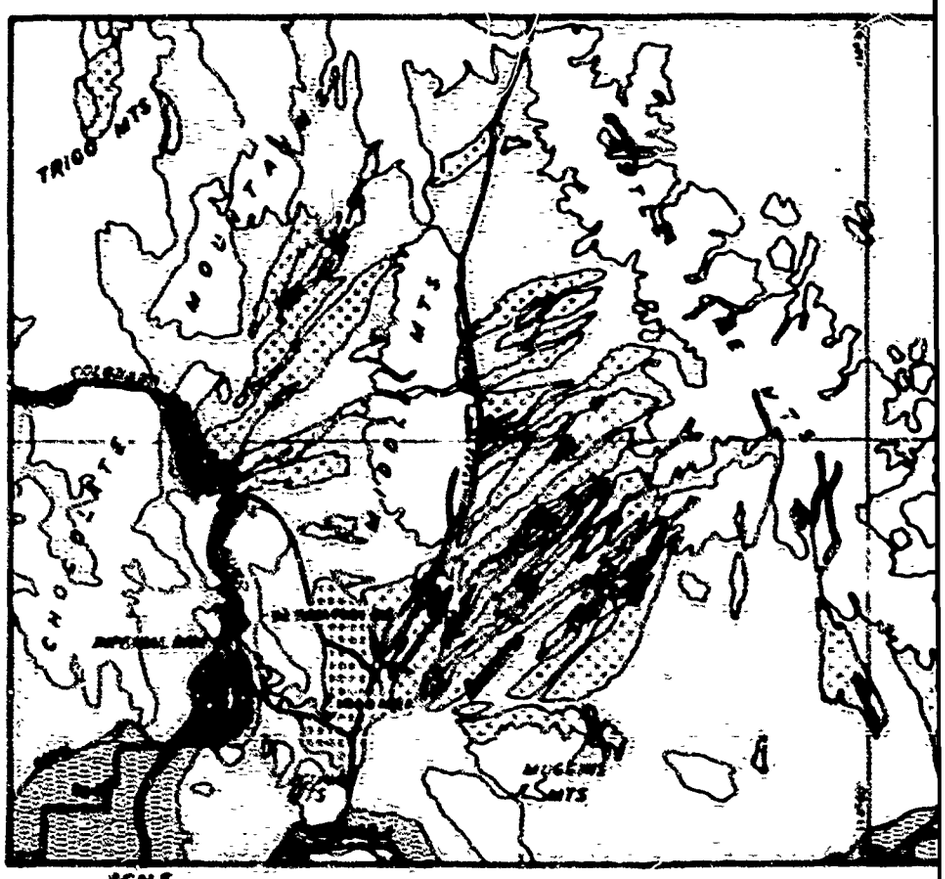

MEDITERRANEAN SEA
BEIRUT
LEBANON
DAMASCUS
Tel Aviv
Amman
Aqaba
Medina
Jeddah
RED
SEA
35°
30°
25°
20°


IRAN
PERSIAN GULF
NEUTRAL ZONE
Ras al Tanura
Bahrain
QATAR
YUMA SAN

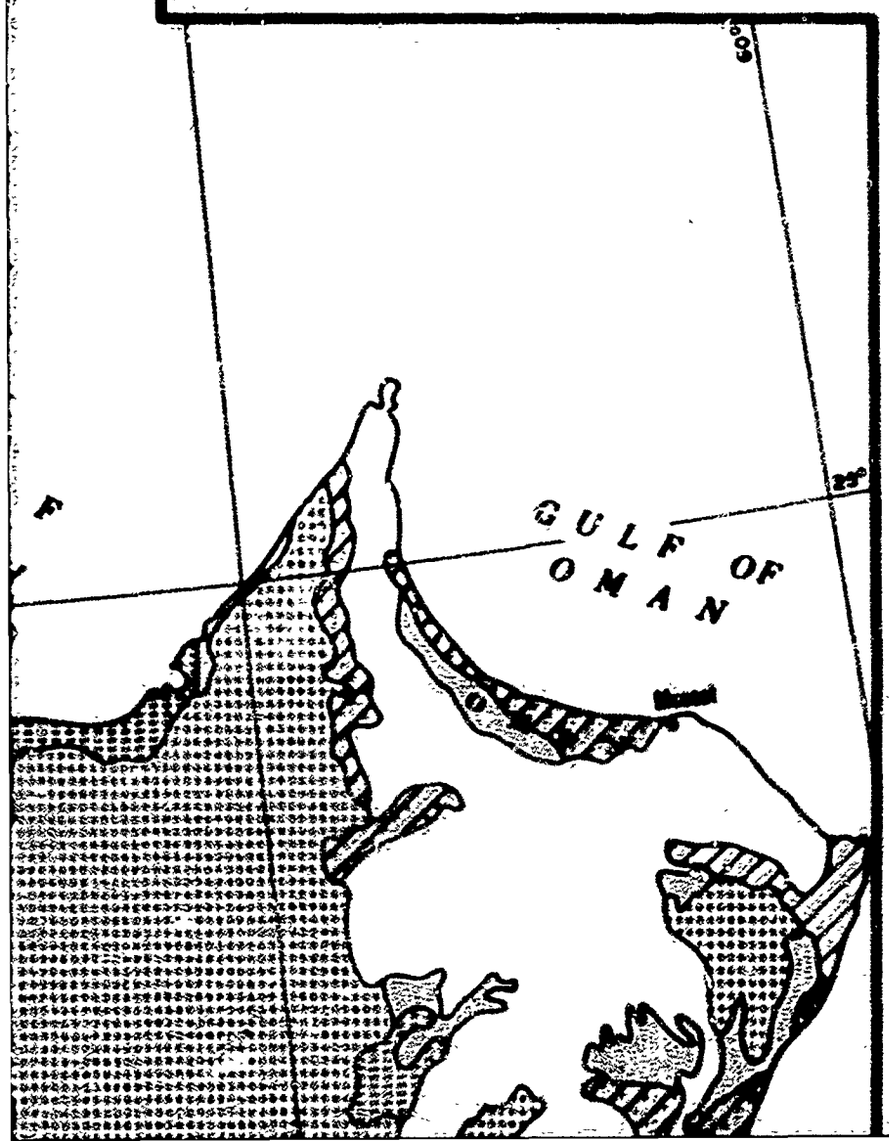




YUMA SAND HILLS



YUMA PROVING GROUND



SOIL CONSISTENCY

Soil consistencies are mapped only where c
Actually predominant (70 per cent or more) soil con

I. HOMOGENEOUS CONSISTENCIES: Soil
changed consistencies to depth greater t

A. Noncohesive: Materials in which the
do not adhere to each other.

1 Loose: The ratio of voids to so
close to a naturally occurring
grains are loosely packed.

2 Dense: The ratio of voids to so
close to a naturally occurring
grains are closely packed.

B. Cohesive: Materials in which the
adhere to each other, either because
of the particles themselves, or bec
a cementing material.

3 Soft (usually permeability and
capacity.

4 Firm: Moderate bearing capac

5 Hard: High bearing capacity.

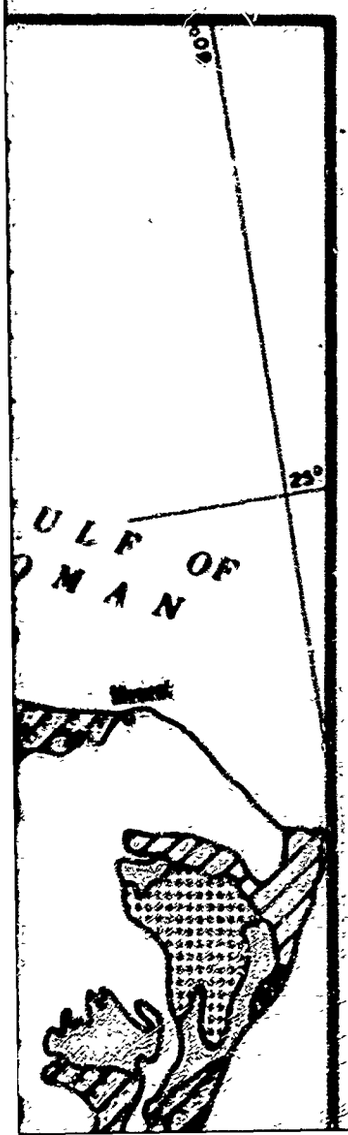
II. LAYERED CONSISTENCIES: Soils pos
relatively distinct layers within 12 inch

A. Crusted Surfaces: Surface crust ma
cohesive.

6 Hard thin crust (commonly of c
overlying soft noncohesive materi
cement, etc.).

7 Hard crust (commonly of cemen
lying noncohesive material (com
soil).

YUMA PROVING GROUND



SOIL CONSISTENCY

Soil consistencies are mapped only where soil associations occur. Areally predominant (33 per cent or more) soil consistency mapped.

I. HOMOGENEOUS CONSISTENCIES: Soils of essentially unchanged consistencies to depth greater than 12 inches.

A. Noncohesive: Materials in which the constituent particles do not adhere to each other.

1 Loose: The ratio of voids to constituent grains is close to a naturally occurring maximum, i.e., the grains are loosely packed.

2 Dense: The ratio of voids to constituent particles is close to a naturally occurring minimum, i.e., the grains are closely packed.

B. Cohesive: Materials in which the constituent particles adhere to each other, either because of mutual attraction of the particles themselves, or because of the presence of a cementing material.

3 Soft (usually permanently wet): Little or no bearing capacity.

4 Firm: Moderate bearing capacity.

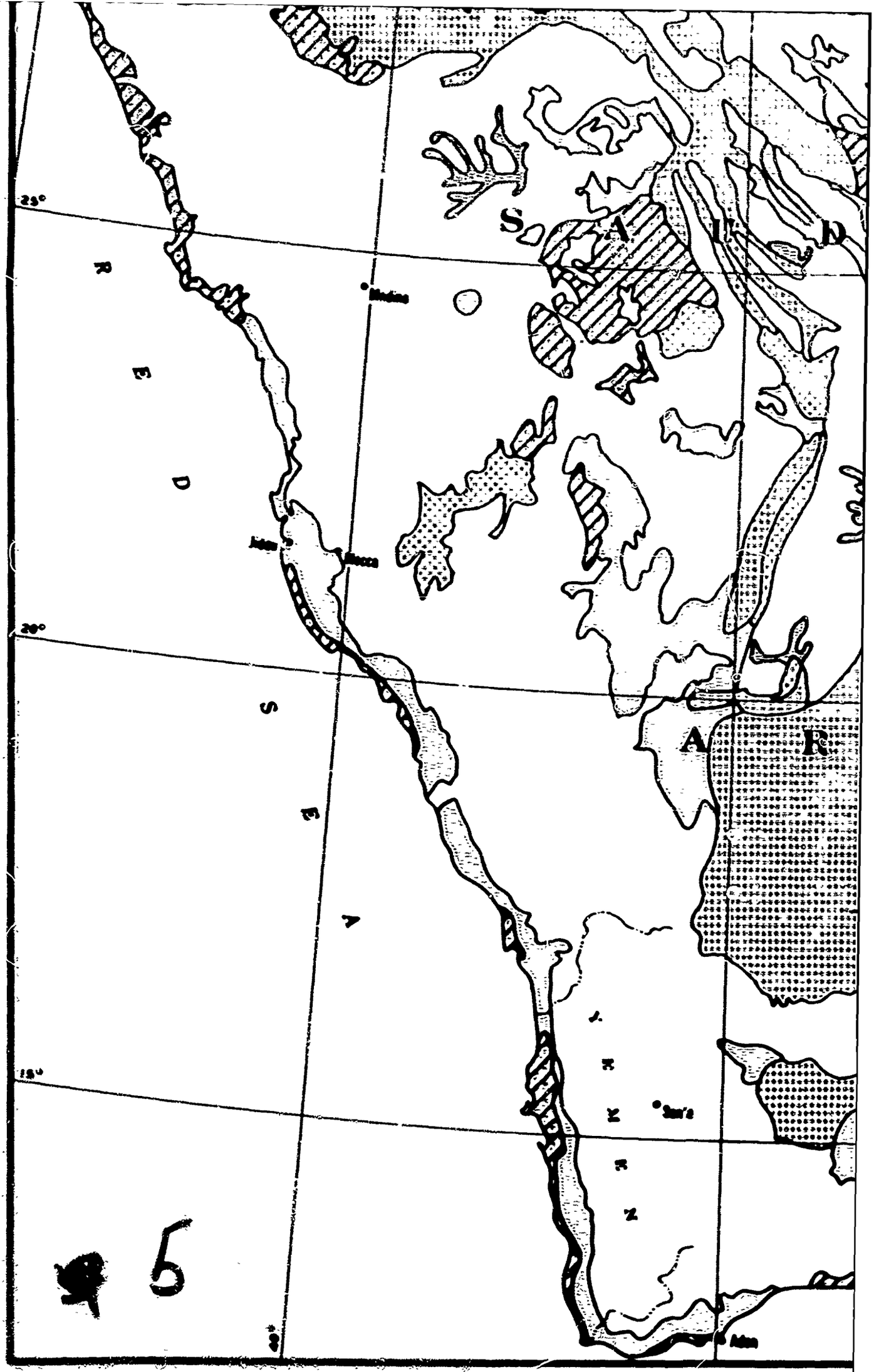
5 Hard: High bearing capacity.

II. LAYERED CONSISTENCIES: Soils possessing two or more relatively distinct layers within 12 inches of the surface.

A. Crusted Surfaces: Surface crust may be either cohesive or noncohesive.

6 Hard thin crust (commonly of cemented material) overlying soft material (commonly moist, wet, or saturated silt).

7 Hard crust (commonly of cemented material) overlying noncohesive material (commonly sand or silt).



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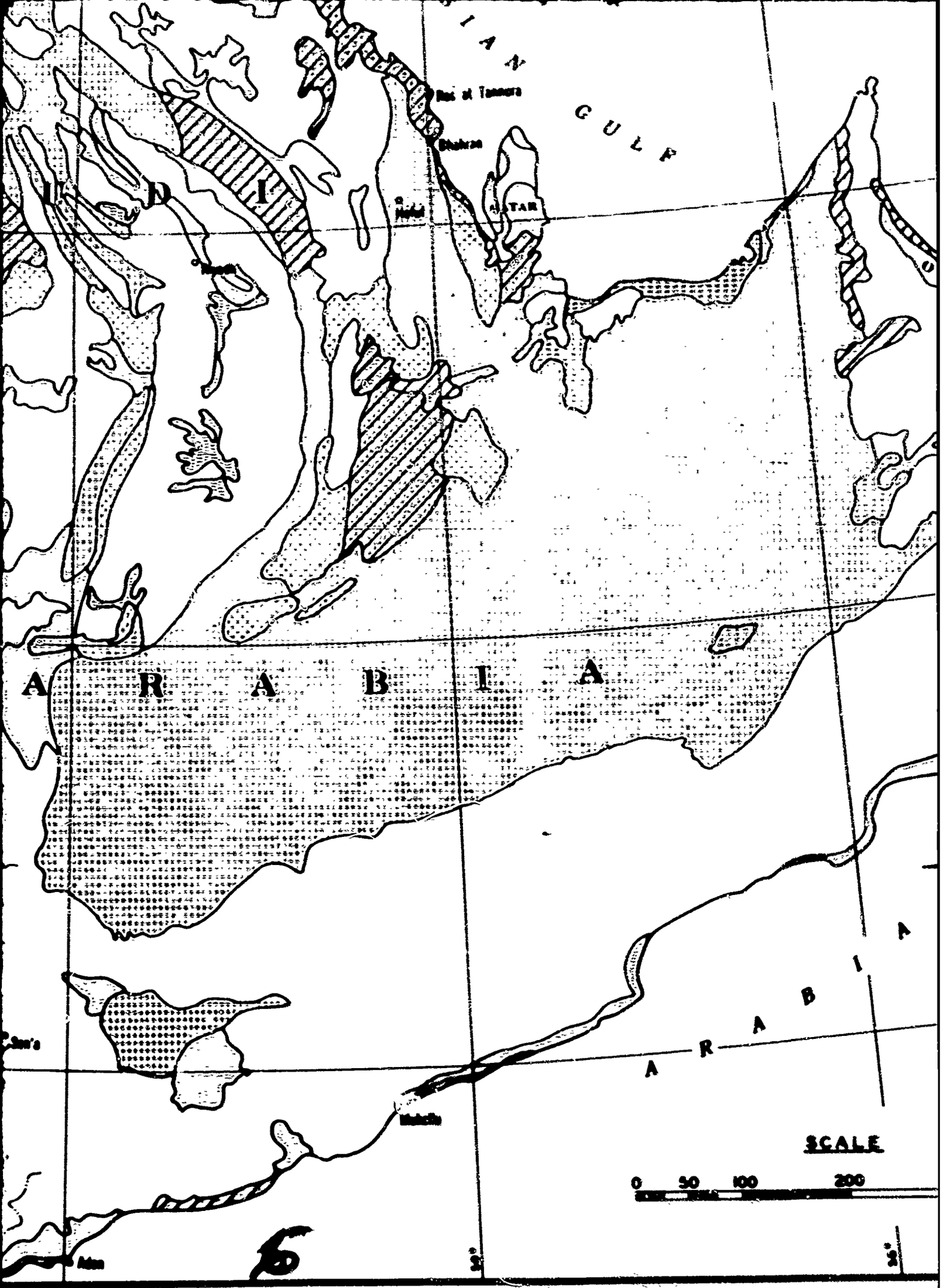

I A N
G U L F
Ras al Tanura
Bahrain
Hofuf
QATAR
I N D I A
A R A B I A
A R A B I A
Muscat
Aden
SCALE
0 50 100 200

SOIL CONSISTENCY

Soil consistences are mapped only where soil consistence [illegible] Areally predominant (75 per cent or more) soil consistency mapp[illegible]

I. HOMOGENEOUS CONSISTENCIES: Soils of essentially changed consistence to depth greater than 12 inches.

A. Noncoherent: Materials in which the constituent p[illegible] do not adhere to each other.

1 Loose: The ratio of voids to constituent grain[illegible] closer to a naturally occurring minimum, i.e., grains are loosely packed.

2 Dense: The ratio of voids to constituent parti[illegible] closer to a naturally occurring minimum, i.e., grains are closely packed.

B. Coherent: Materials in which the constituent parti[illegible] adhere to each other, either because of mutual attr[illegible] of the particles themselves, or because of the pres[illegible] a cementing material.

3 Soft (usually permanently wet). Little or no bea[illegible] capacity.

4 Firm: Moderate bearing capacity.

5 Hard. High bearing capacity.

II. LAYERED CONSISTENCIES: Soils possessing two or m[illegible] essentially distinct layers within 12 inches of the surfac[illegible]

A. Crusted Surfaces: Surface crust may be either coh[illegible] noncoherent.

6 Hard thin crust (commonly of cemented materi[illegible] overlying soft materials (commonly much, ver[illegible] saturated silts).

7 Hard crust (commonly of cemented materials) [illegible] lying noncoherent material (commonly sand or [illegible] silts).

8 Thin zone of firm materials over noncoherent [illegible] rials. (Most common development on areas of [illegible] dunes, with more or less continuous vegetation [illegible] cover.)

9 Surface of closely-fitted noncoherent pebbles o[illegible] gravel overlying noncoherent materials (comm[illegible] sand or silt). (Both "desert pavements" also [illegible] over bedrock or materials of firm consistence [illegible] than is less common.)

B. Noncoherent surface layer less than 12 inches thick.

10 Dense layer within 12 inches of the surface.

20 Hard layer within 12 inches of the surface (usu[illegible] not always cemented).

6/3 CONSISTENCY COMPLEXES: Consistency com[illegible] are mapped where no areally predominant (75 p[illegible] cent or more) consistency occurs. In such [illegible] the two most commonly occurring consistencies [illegible] mapped, the predominant is shown as the [illegible] the subordinate as the denominator in the fract[illegible] pattern.

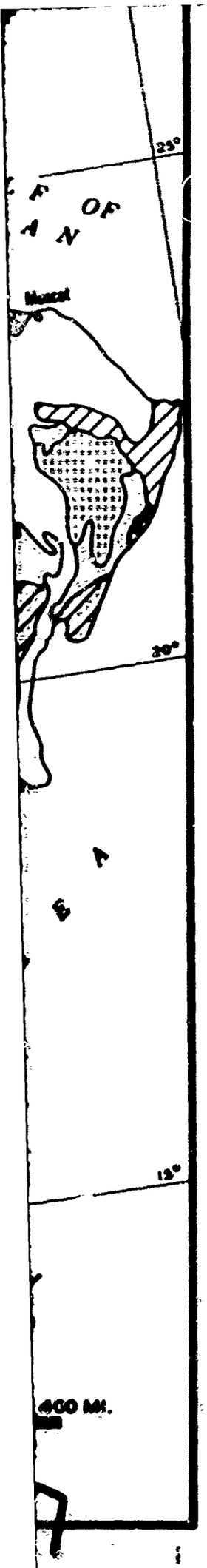
In complexes (e.g., 3/6) the first digit always refers to the areally dominant unit.

ANALOGS OF YUMA TERRA[illegible]

IN THE

MIDDLE EAST DESERT

SOIL CONSISTENCY



SOIL CONSISTENCY

Soil consistencies are mapped only where soil associations occur (really predominant (70 per cent or more) soil consistency mapped.

I. **NONHOMOGENEOUS CONSISTENCIES.** Soils of essentially unchanged consistencies to depth greater than 12 inches.

A. **Noncohesive:** Materials in which the constituent particles do not adhere to each other.

1 **Loose.** The ratio of voids to constituent grains is close to a naturally occurring maximum, i.e., the grains are loosely packed.

2 **Dense.** The ratio of voids to constituent particles is close to a naturally occurring minimum, i.e., the grains are closely packed.

B. **Cohesive.** Materials in which the constituent particles adhere to each other, either because of mutual attraction of the particles themselves, or because of the presence of a cementing material.

3 Soft (usually permanently wet). Little or no bearing capacity.

4 Firm. Moderate bearing capacity.

5 Hard. High bearing capacity.

II. **LAYERED CONSISTENCIES.** Soils possessing two or more relatively distinct layers within 12 inches of the surface.

A. **Crusted Surface.** Surface crust may be either cohesive or noncohesive.

6 Hard thin crust (commonly of cemented materials) overlying soft materials (commonly much, ooze, or saturated silts).

7 Hard crust (commonly of cemented materials) overlying noncohesive material (commonly sand or silt).

8 Thin zone of firm materials over noncohesive materials. (Most common development on areas of fixed dunes, with more or less continuous vegetation cover.)

9 Surface of closely-fitted noncohesive pebbles or gravel overlying noncohesive materials (commonly sand or silt). Such "desert pavements" also occur over bedrock or materials of firm consistencies, but this is less common.)

B. Noncohesive surface layer less than 12 inches thick.

10 Dense layer within 12 inches of the surface.

11 Hard layer within 12 inches of the surface locally but not always exposed.

4/3 **CONSISTENCY COMPLEXES.** Consistency complexes are mapped where no really predominant (70 per cent or more) consistency occurs. In such instances, the two most commonly occurring consistencies are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

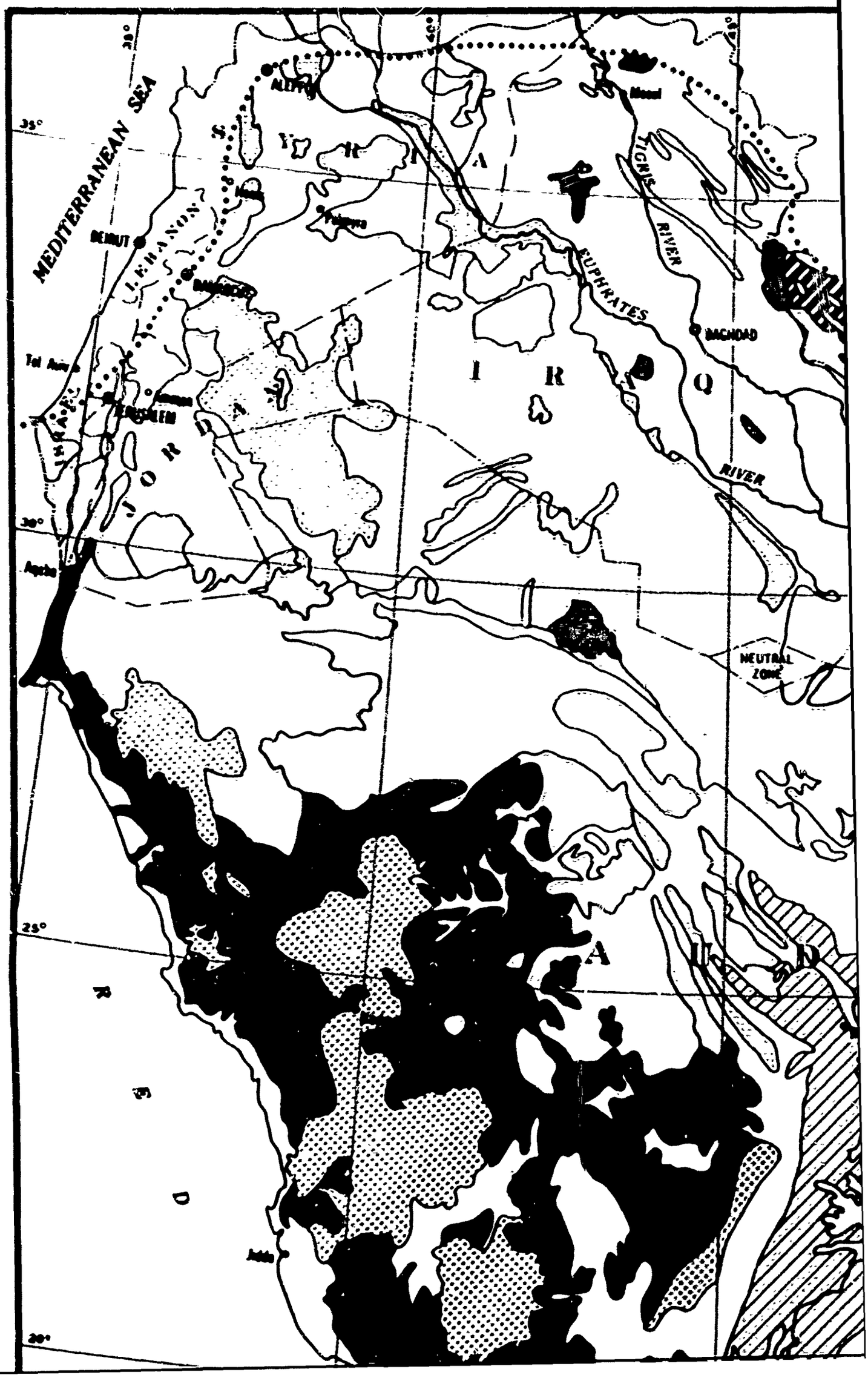
In complexes (e.g., 5/6) the first digit always refers to the really predominant unit.

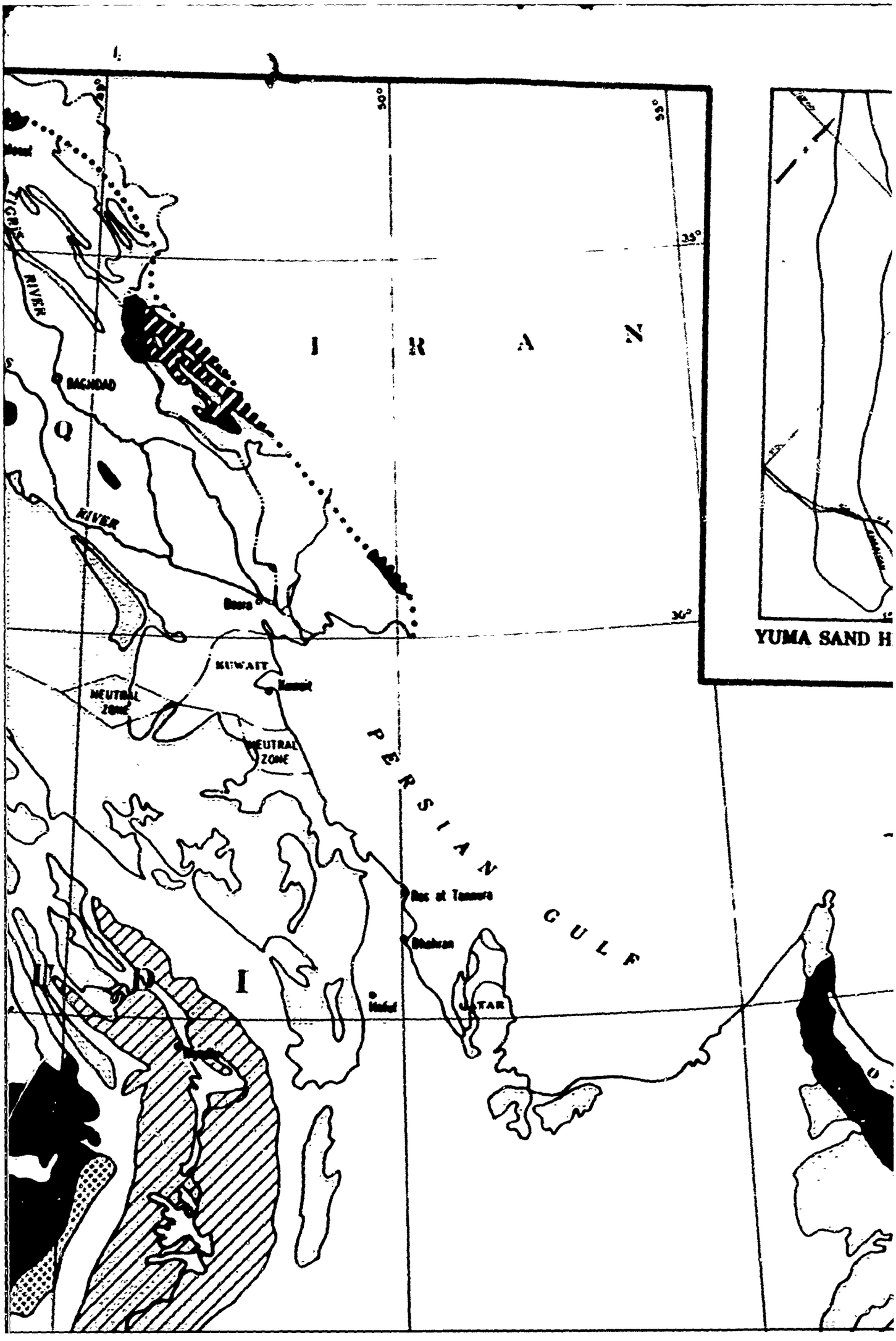
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

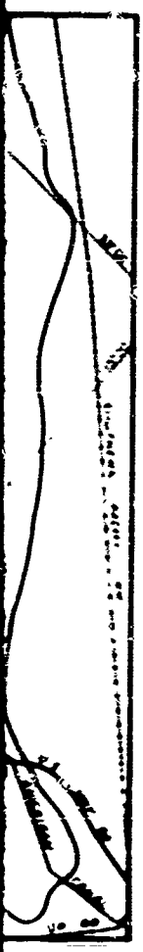
8

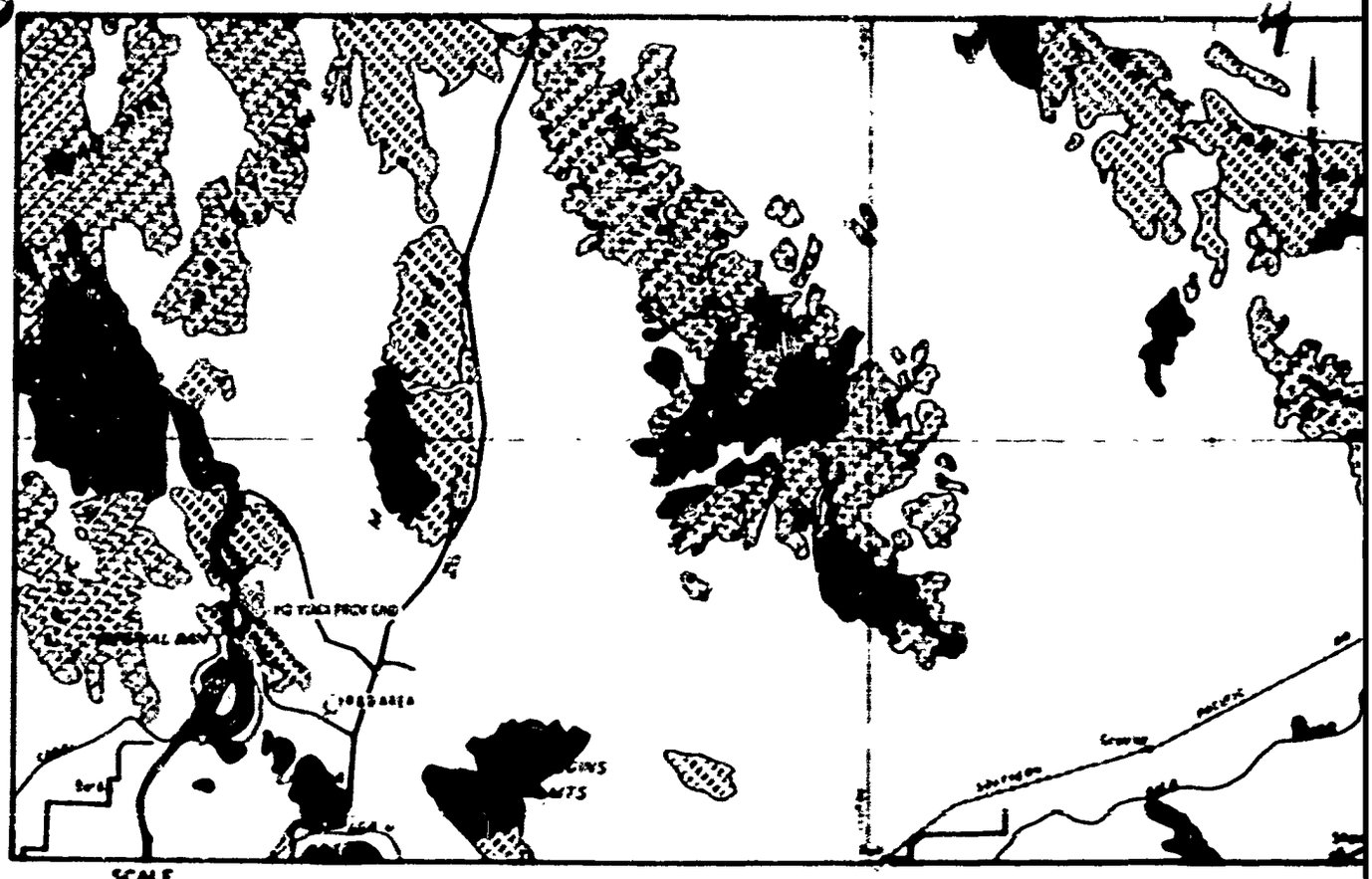
SOIL CONSISTENCY

PLATE 7

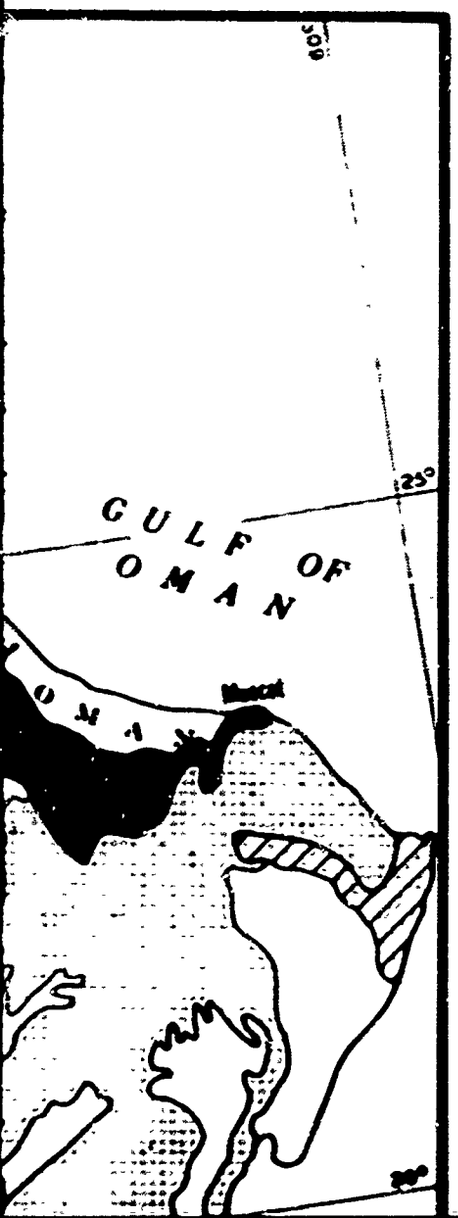

MEDITERRANEAN SEA
BEIRUT
LEBANON
Tel Aviv
ISRAEL
JERUSALEM
JORDAN
Aqaba
SYRIA
Mosul
TIGRIS
RIVER
EUPHRATES
BAGHDAD
IRAQ
RIVER
NEUTRAL ZONE
ARABIA
RED SEA
Jeddah
35°
30°
25°
20°


TIGRIS
RIVER
BAGHDAD
Q
RIVER
I R A N
KUWAIT
NEUTRAL ZONE
NEUTRAL ZONE
PERSIAN GULF
Ras at Tanura
Bahrain
I
QATAR
YUMA SAND H





D HILLS



SEDIMENTARY ROCKS

Mapped in regions where rock is exposed and at shallow depths (i.e. 5-10 feet) throughout the remainder of the area. In other this procedure restricts the mapping of surface rock to areas mapped as 1, 2, or 3 under Sec. Type.

Areas predominant (70 percent or more) rock type mapped.

1. IGNEOUS (UNDIFFERENTIATED): Rocks formed by crystallization of a molten solution. A hot liquid state.

2. Intrusive: Igneous rocks, typically crystalline, which have formed by cooling below the surface of the earth (granite, syenite, diorite, etc.)

3. Extrusive (undifferentiated): Igneous rocks which have formed by cooling at the surface of the earth.

3a. Some extrusive rocks formed by solidification of molten material that poured out on the surface of the earth (e.g. basalt, dacite, etc.)

3b. Rocks formed by secondary consolidation of loose deposits of volcanic ejecta (e.g. tuff, agglomerate, etc.)

4. METAMORPHIC (UNDIFFERENTIATED): Rocks formed from original igneous or sedimentary rocks through alteration produced by pressure, heat, or the infiltration of other materials at depths where the surface zones of weathering and cementation. The alterations are sufficiently complete throughout the body of the rock to produce a well-ordered new type (gneiss, schist, slate, etc.)

5. SEDIMENTARY (UNDIFFERENTIATED): Rocks formed from material laid down as a loose or less finely divided state, as sediment, through the agency of water, wind, or glaciers.

6. Sandstone: A sedimentary rock predominantly composed of sand grains cemented together

7. Limestone: A sedimentary rock consisting essentially of calcium carbonate.

8. Shale: A sedimentary rock in which the constituent particles are predominantly of clay size

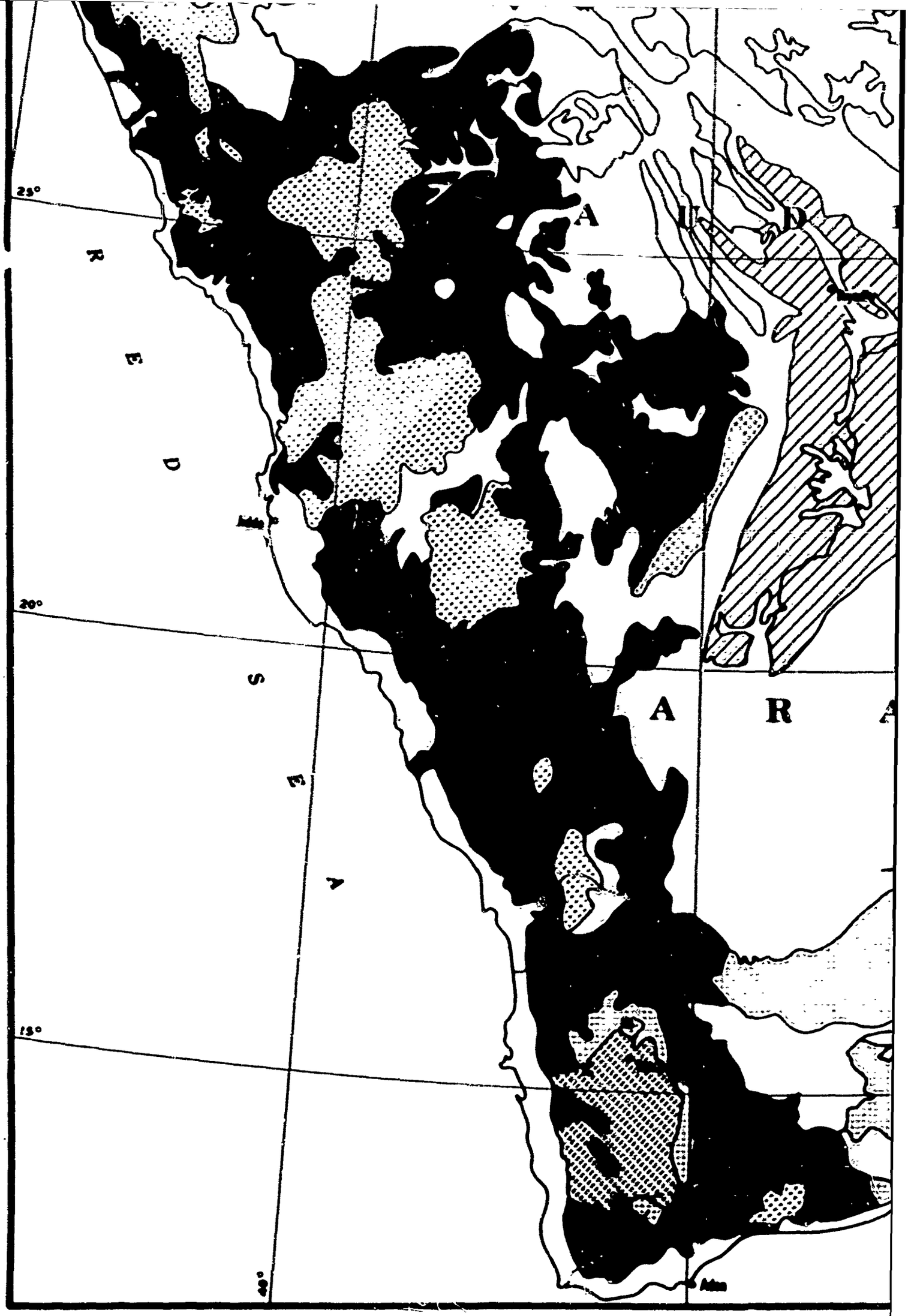
9. Evaporite: A sedimentary rock whose origin is largely due to evaporation and subsequent precipitation of salt from water. (Gypsum, anhydrite, and rock salt are the only evaporites of quantitative importance.)

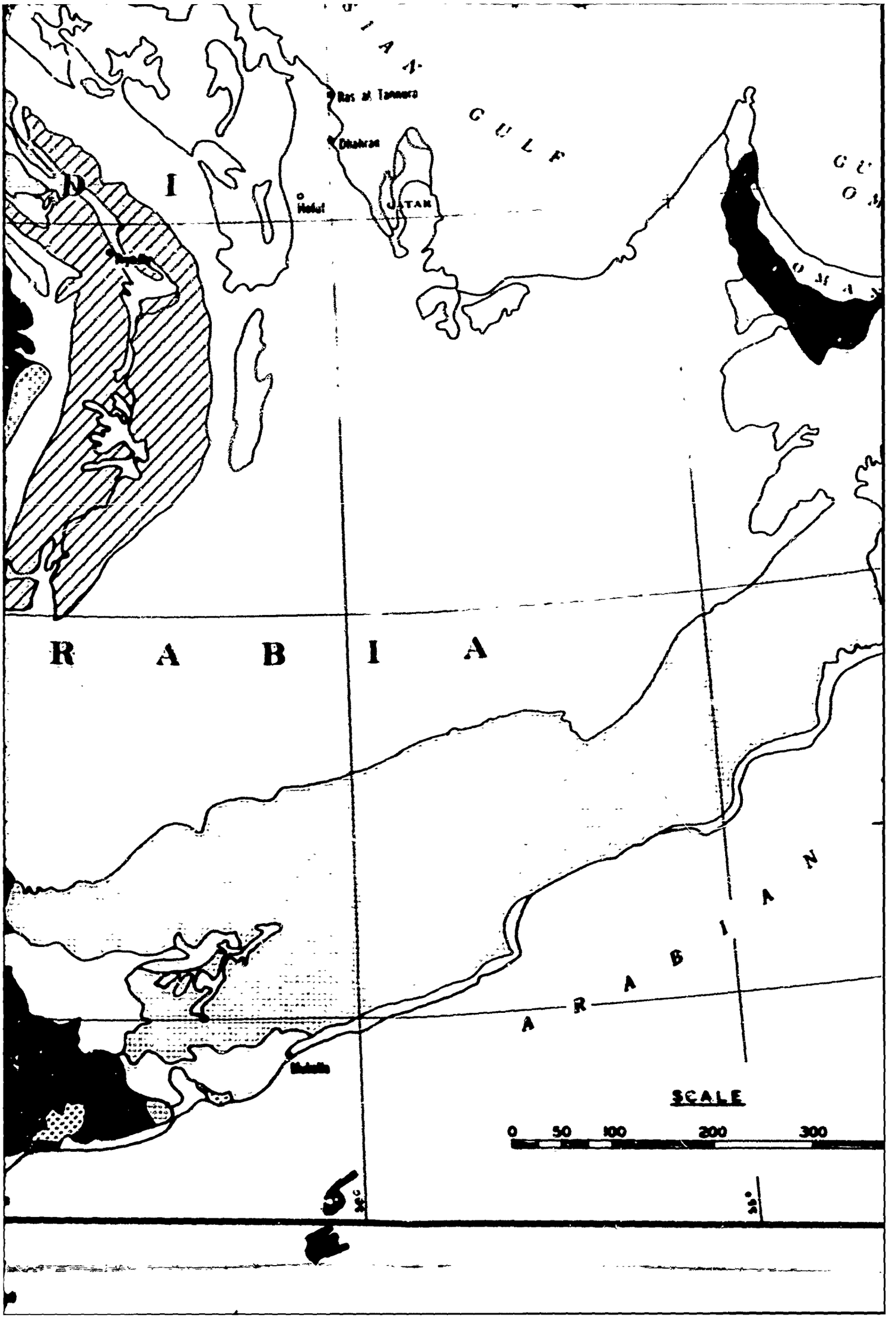
5a/9b. ROCK COMPLEXES: Rock complexes are mapped where no areally predominant (70 percent or more) rock type occurs. In such instances, the two most commonly occurring rock types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

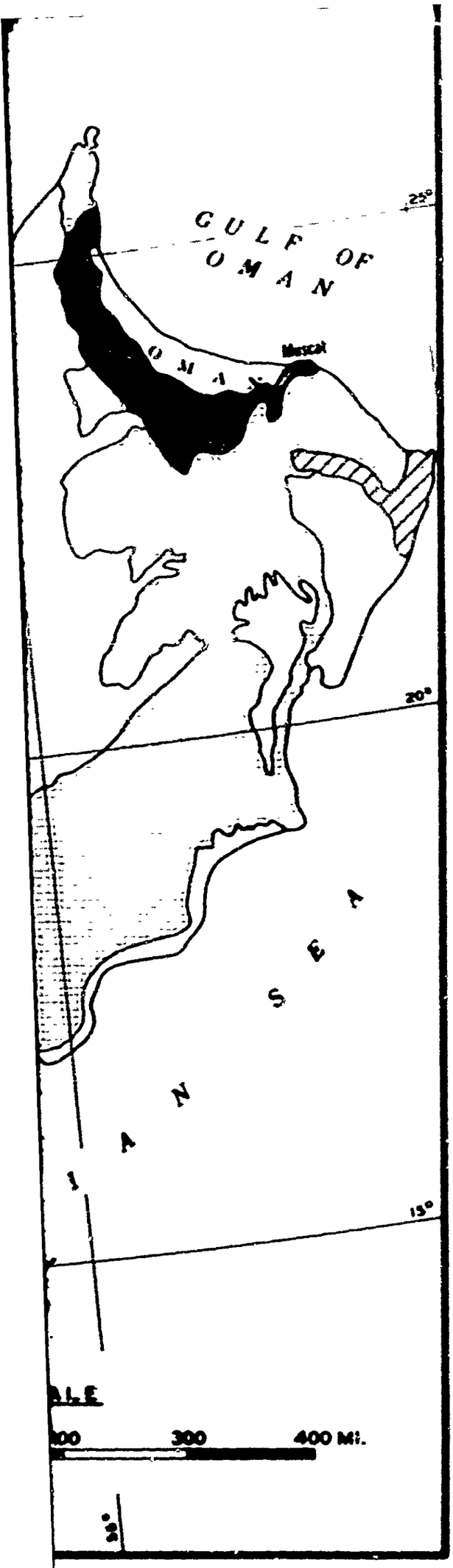
* It should be recognized that the scale of mapping precludes delineation, especially in mountainous regions, of many alluvial basins where the thickness of soil cover is much greater than 10 feet.

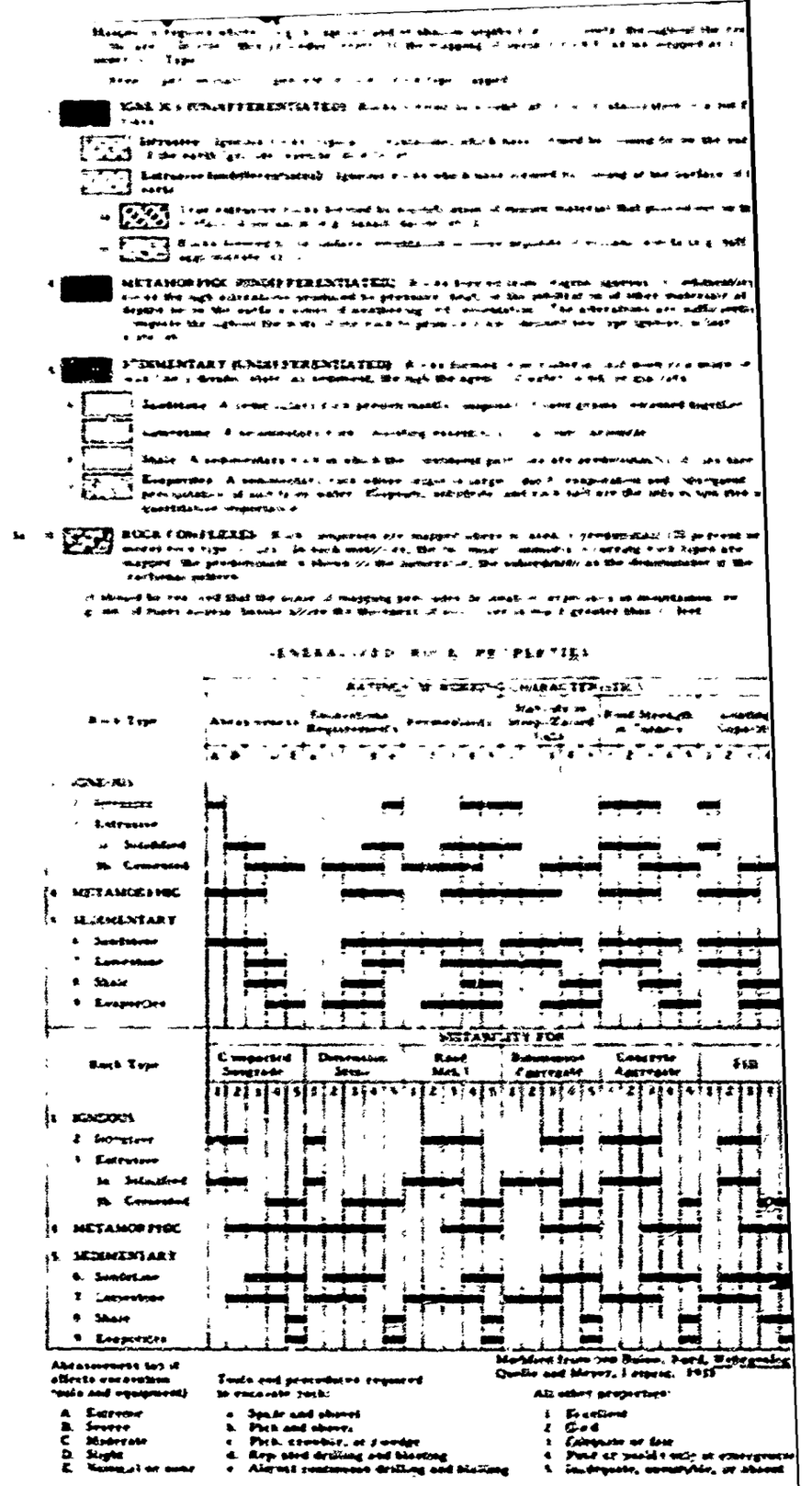
GENERALIZED ROCK PROPERTIES

| Rock Type | RATINGS OF WORKING CHARACTERISTICS | | |


25°
20°
15°
40°
A
D
R
E
D
S
E
A
A
R
A


Ras al Tanura
Dhahran
Hofuf
QATAR
GULF
OMAN
D I
R A B I A
A R A B I A N
SCALE
0 50 100 200 300



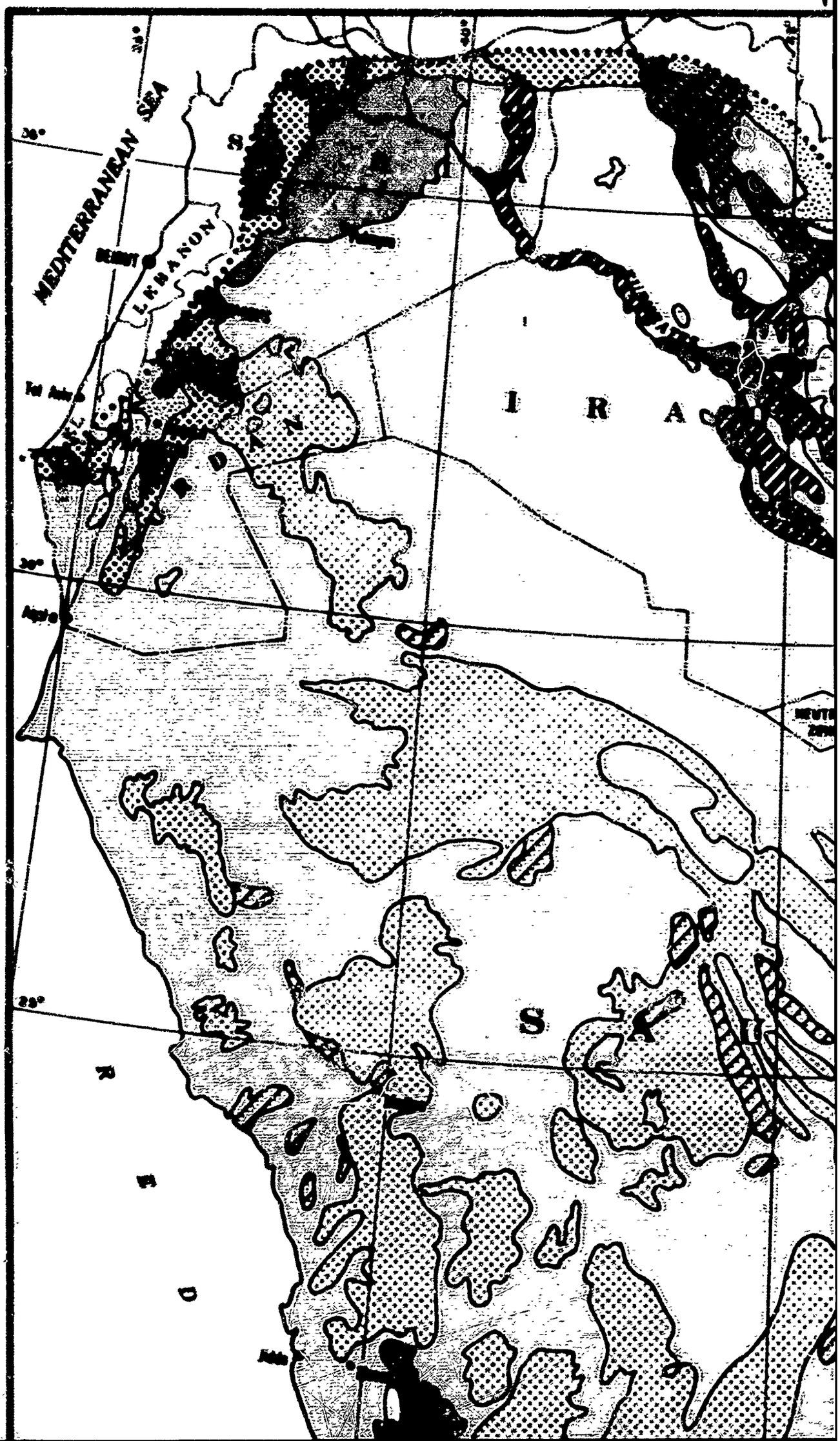


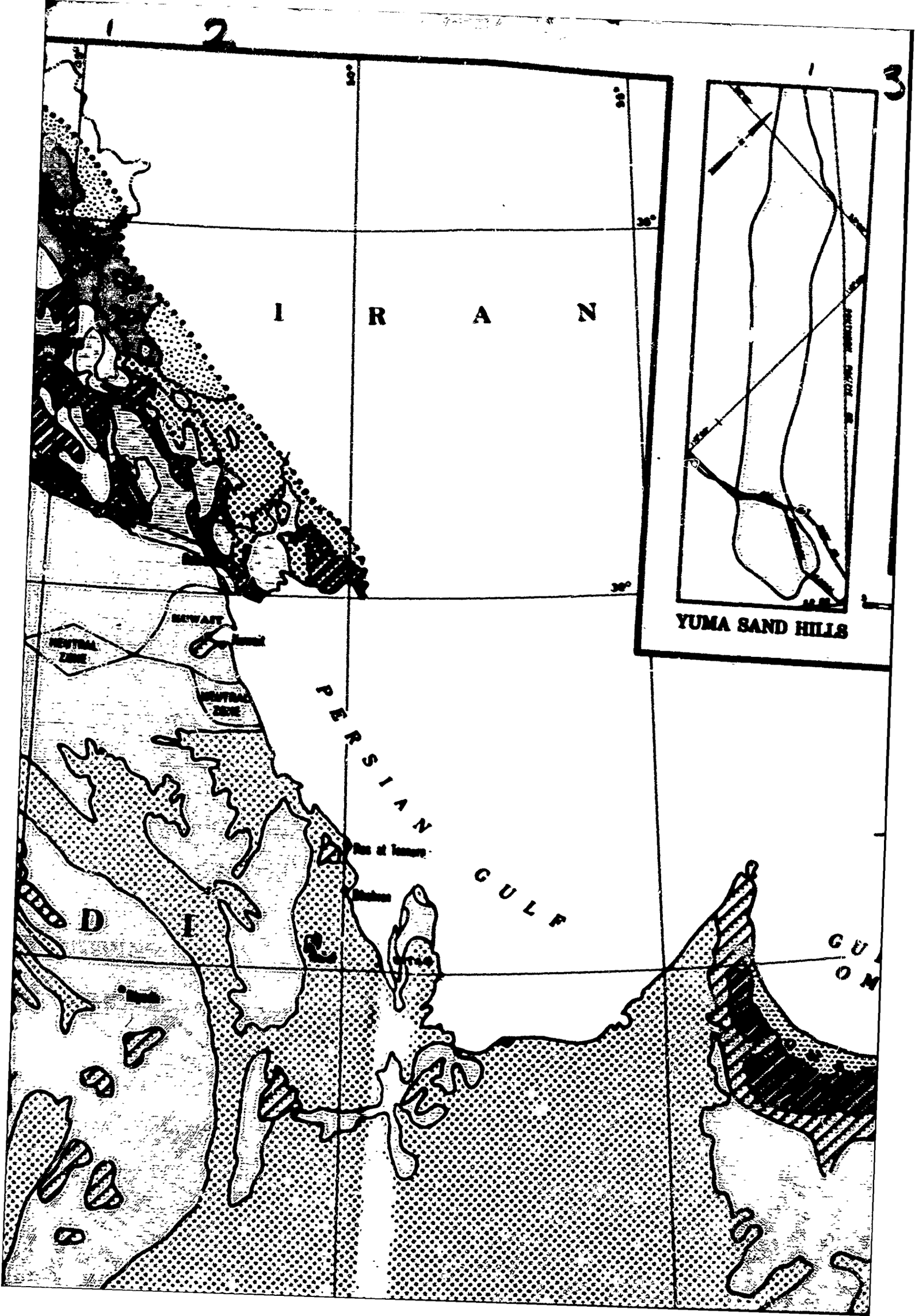
ANALOGS OF YUMA TERRAIN

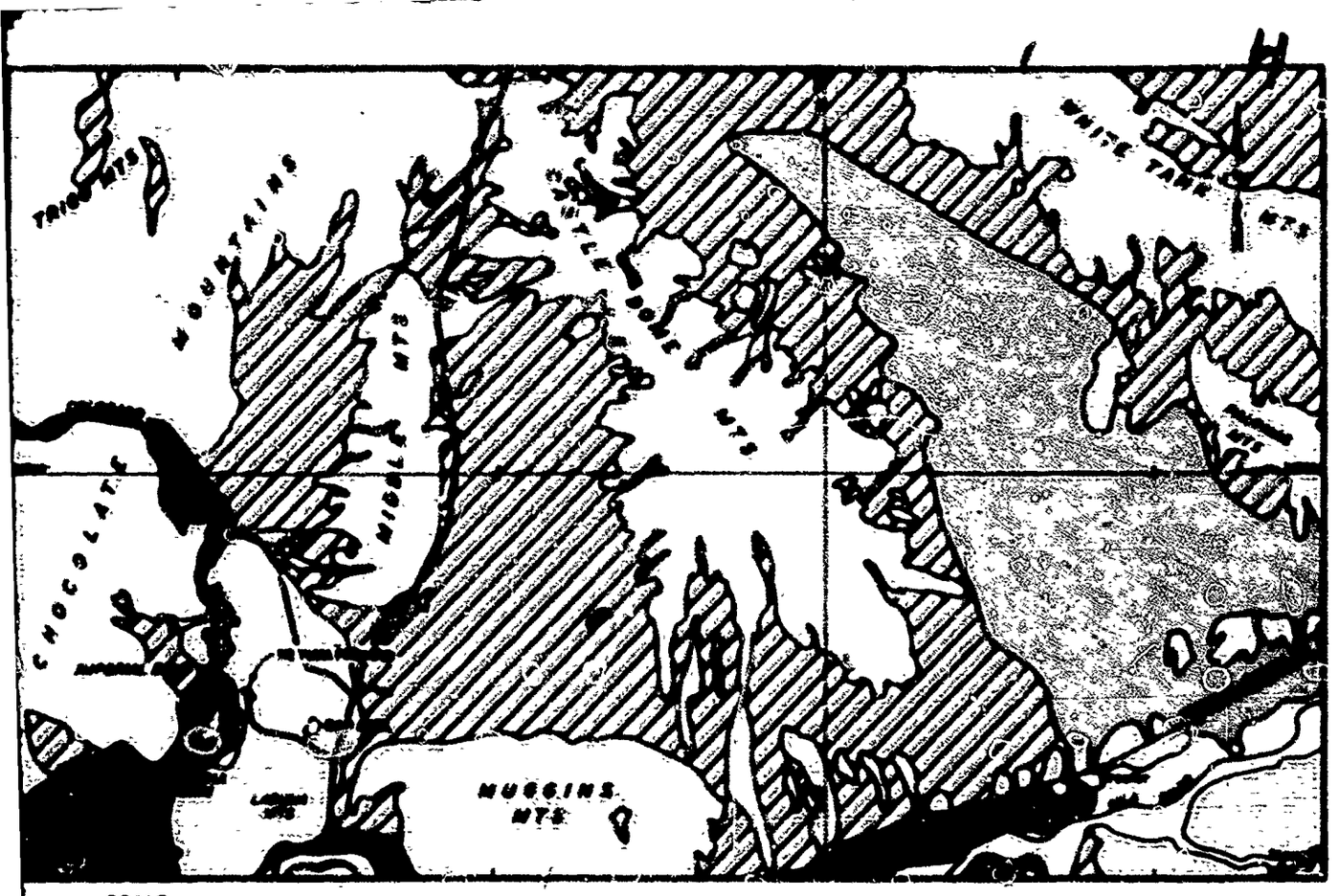
IN THE

MIDDLE EAST DESERT

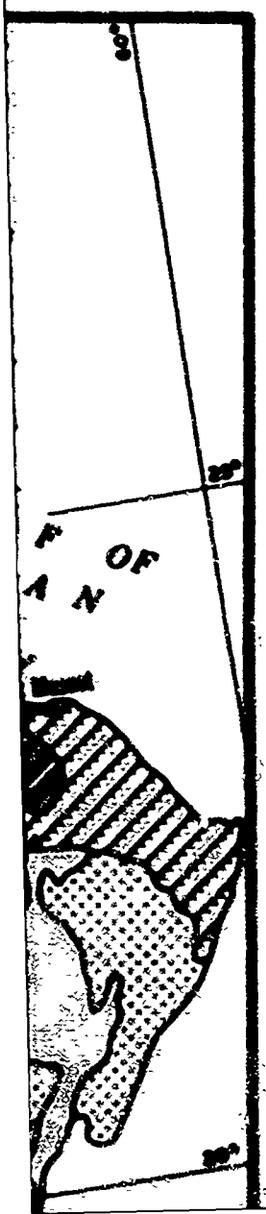
SURFACE ROCK


MEDITERRANEAN SEA
LEBANON
Beirut
Tel Aviv
Aqaba
I R A
S
D


I R A N
PERSIAN GULF
D I
KUWAIT
NEUTRAL ZONE
NEUTRAL ZONE
YUMA SAND HILLS



YUMA PROVING GROUND



VEGETATION

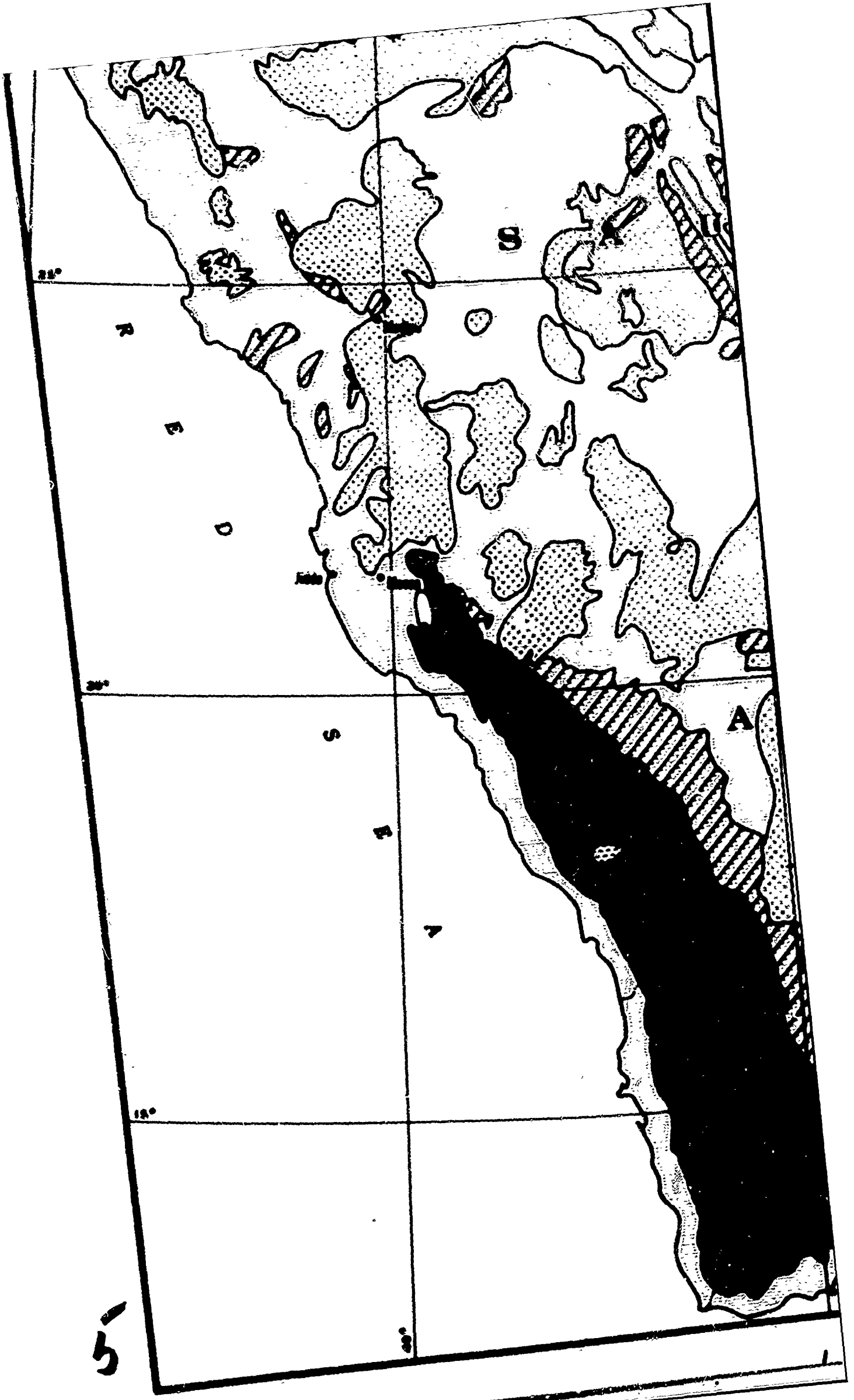
Areally predominant (70 percent or more) vegetation type mapped.

	Unit	Description
1	Barren	Devoid or nearly devoid of vegetation.
2	Sparse shrub & grass	Widely spaced thorny shrubs, bushes, low scrubby trees, herbs, or clumps and open stands of coarse grass. (Also includes cacti in the U. S.)
3	Scattered shrub & grass	Moderate spacing of forms mentioned under unit 2.
4	Scattered shrub and/or scrubby trees	Thin stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
4a	a. With scattered 2nd-story trees	----------
5	Dense shrub and/or scrubby trees	Dense stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
5a	a. With scattered 2nd-story trees	----------
5b	b. With grass-herb cultivation	Orchard trees with grass-herb cultivation forming the 1st story.
6	Palms with or without grass-herb cultivation	Dense palm groves, 1st-story grass-herb cultivation may or may not be present.
7	Steppe	Low grass cover, may or may not include scattered low scrubby trees and shrubs. Height of grass ranges from a few in. to 2 ft.
8	Steppe-savanna	High continuous grass cover, includes scattered scrubby trees and shrubs. Height of grass averages 2-5 ft.
9	Grass-herb cultivation	Cultivated plots of grains, vegetables, etc.
10	Marsh	Dense growth of grasses, sedges, etc.
5/6	VEGETATION COMPLEXES	Vegetation complexes are mapped where no areally predominant (70 percent or more) vegetation type occurs. In such instances, the two most commonly occurring types are mapped; the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.
	palms	

VEGETATION

Supplementary Data

Unit	Ground Cover %	Canopy Cover		Species		Shrub		Trees Dom		Crown Dom	
		Sub%	Sub	Sub	Sub	Sub	Sub	Sub	Sub	Sub	Sub



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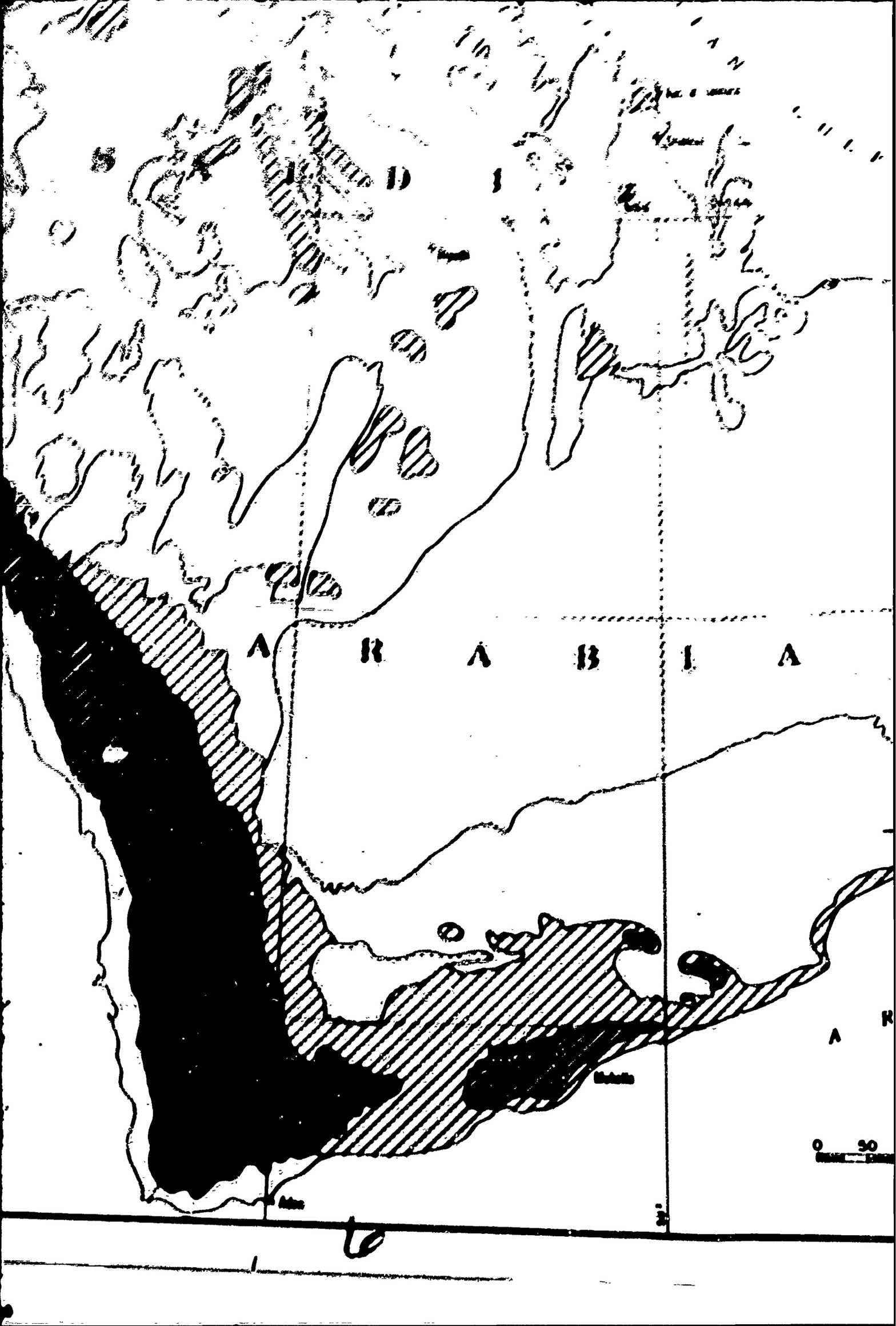
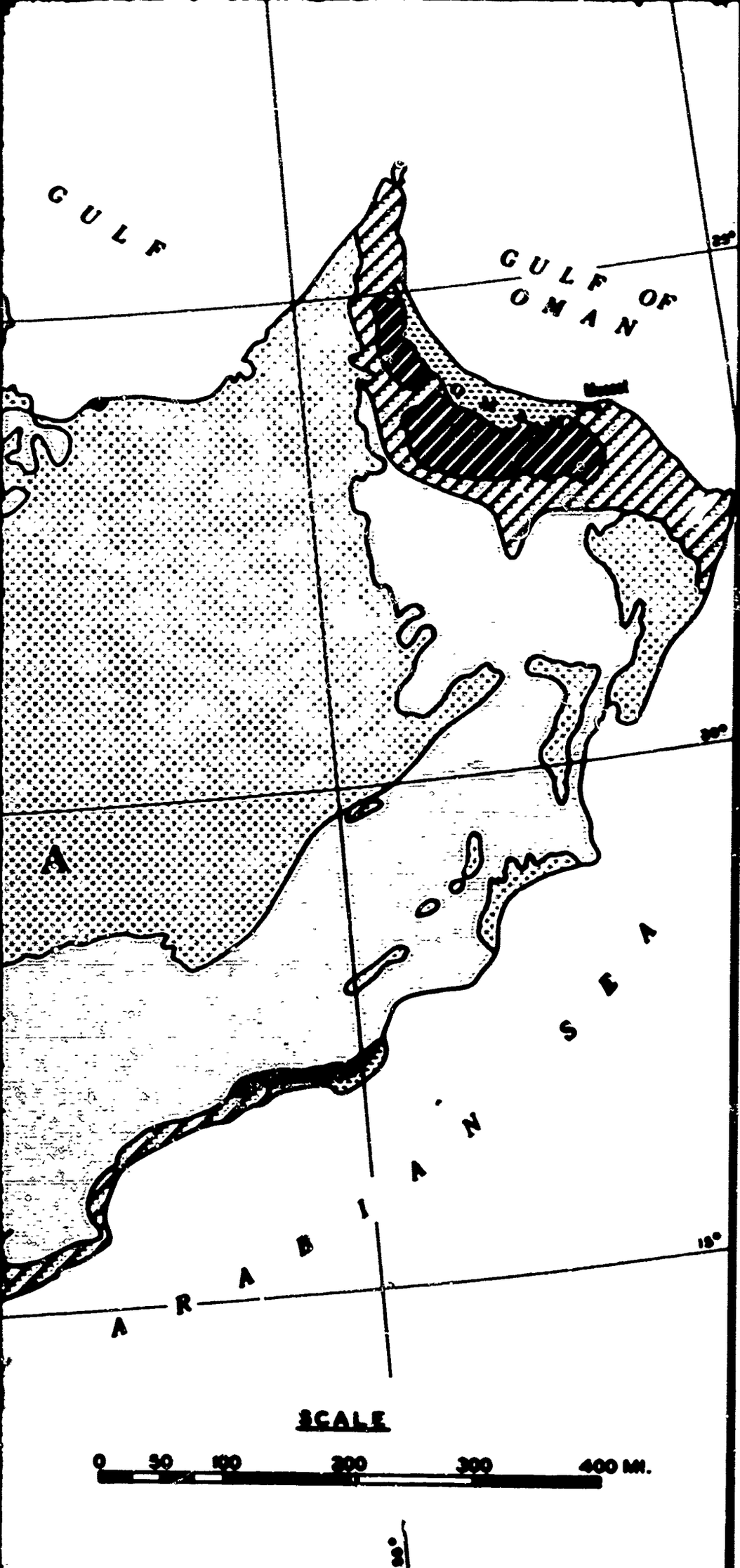

S A U D I
A R A B I A
A R
0 50



Areally predominant (70 p

Unit	
1	Barren
2	Sparse shrub & grass
3	Scattered shrub & grass
4	Scattered shrub and/or scrubby trees
4a	a. With scattered 3rd-story trees
5	Dense shrub and/or scrubby trees
5a	a. With scattered 3rd-story trees
5b	b. With grain-herb cultivation
6	Palms with or without grain-herb cultivation
7	Steppe
8	Steppe-savanna
9	Grain-herb cultivation
10	Marsh
1/6	VEGETATION COMPLEXES
	Palms

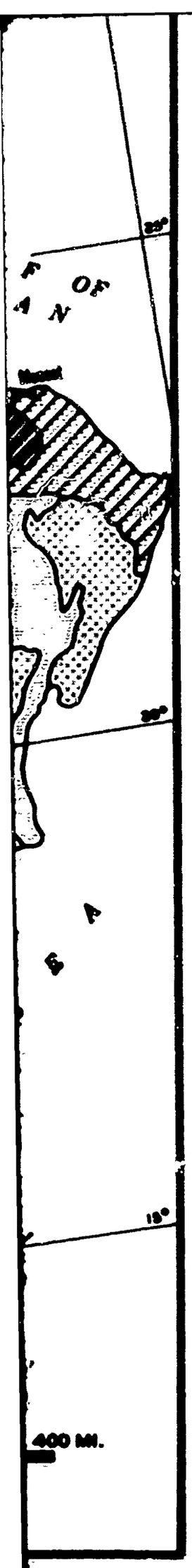
Unit	Ground Cover %	Canopy Cover 2nd* Story %
1. Barren	<1	?
2. Sparse shrub & grass	1-5	?
3. Scattered shrub & grass	5-25	0-5
4. Scattered shrub and/or scrubby trees	50-90	<50
With scattered 3rd-story trees	50-90	<05
5. Dense shrub and/or scrubby trees	80-100	>50
a. With scattered 3rd-story trees	80-100	>50
b. With grain-herb cultivation	90-130	>50
6. Palms with or without grain-herb cultivation	75-100	?
7. Steppe	50-100	?
8. Steppe-savanna	90-130	5-13
9. Grain-herb cultivation	90-100	?
10. Marsh	80-100	?

* Vegetation stories are distinguished on the basis of height
6 to 25 ft. 3rd story, from 25 to 70 ft.
? Indicates factor is unimportant or not applicable within th

ANALOGS O

MIDDLE

VEG



VEGETATION

Actually predominant (50 percent or more) vegetation type mapped.

Unit		Description
1	Barren	Ground or areas devoid of vegetation.
2	Sparse shrub & grass	Widely spaced thorny shrubs, bushes, low scrubby trees, herbs, or clumps and open stands of coarse grass. (Also includes cacti in the U. S.)
3	Scattered shrub & grass	Moderate spacing of forms mentioned under unit 2.
4	Scattered shrub and/or scrubby trees	Thin stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
4a	a. With scattered 3rd-story trees	----------
5	Dense shrub and/or scrubby trees	Dense stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
5a	a. With scattered 3rd-story trees	----------
5b	b. With grass-herb cultivation	Orchard areas with grass-herb cultivation forming the 1st story.
6	Palms with or without grass-herb cultivation	Dense palm groves, 1st-story grass-herb cultivation may or may not be present.
7	Steppe	Low grass cover, may or may not include scattered low scrubby trees and shrubs. Height of grass ranges from a few in. to 2 ft.
8	Steppe-savanna	High continuous grass cover, includes scattered scrubby trees and shrubs. Height of grass averages 3-5 ft.
9	Grass-herb cultivation	Cultivated plots of grasses, vegetables, etc.
10	Marsh	Dense growth of grasses, sedges, etc.
5/6	VEGETATION COMPLEXES	Vegetation complexes are mapped where no actually predominant (50 percent or more) vegetation type occurs. In such instances, the two most commonly occurring types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.
	Palms	

VEGETATION

(Supplementary Data)

Unit	Ground Cover %	Canopy Cover 2nd* Story %	Canopy Cover 3rd Story %	Spacing 2nd Story ft	Spacing 3rd Story ft	Height 2nd Story ft	Height 3rd Story ft	Trunk Diam 2nd Story in.	Trunk Diam 3rd Story in.	Crown Diam 2nd Story ft	Crown Diam 3rd Story ft
1. Barren	<1	†	†	†	†	†	†	†	†	†	†
2. Sparse shrub & grass	1-5	†	†	†	†	†	†	†	†	†	†
3. Scattered shrub & grass	5-25	0-5	†	much >12	†	6-10	†	2-5	†	5-10	†
4. Scattered shrub and/or scrubby trees	50-90	<50	†	>12	†	6-25	†	2-12	†	5-25	†
With scattered 3rd-story trees	50-90	<05	5-25	>12	>12	6-25	25-50	2-12	12-20	5-25	25-60
5. Dense shrub and/or scrubby trees	80-100	>50	†	<12	†	6-25	†	2-12	†	5-25	†
a. With scattered 3rd-story trees	80-100	>50	5-25	<12	>12	6-25	25-50	2-12	12-20	5-25	25-60
b. With grass-herb cultivation	90-100	>50	†	>12	†	10-20	†	5-10	†	10-20	†
6. Palms with or without grass-herb cultivation	75-100	†	50-75	†	>12	†	60-60	†	12-20	†	20-30
7. Steppe	50-100	†	†	†	†	†	†	†	†	†	†
8. Steppe-savanna	90-100	5-50	†	much >12	†	15-25	†	7-12	†	15-25	†
9. Grass-herb cultivation	90-100	†	†	†	†	†	†	†	†	†	†
10. Marsh	80-100	†	†	†	†	†	†	†	†	†	†

* Vegetation stories are distinguished on the basis of height: 1st-story vegetation ranges from 0 to 6 ft in height. 2nd story, from 6 to 25 ft; 3rd story, from 25 to 70 ft.

† Indicates factor is unimportant or not applicable within the vegetation unit.

ANALOGS OF YUMA TERRAIN

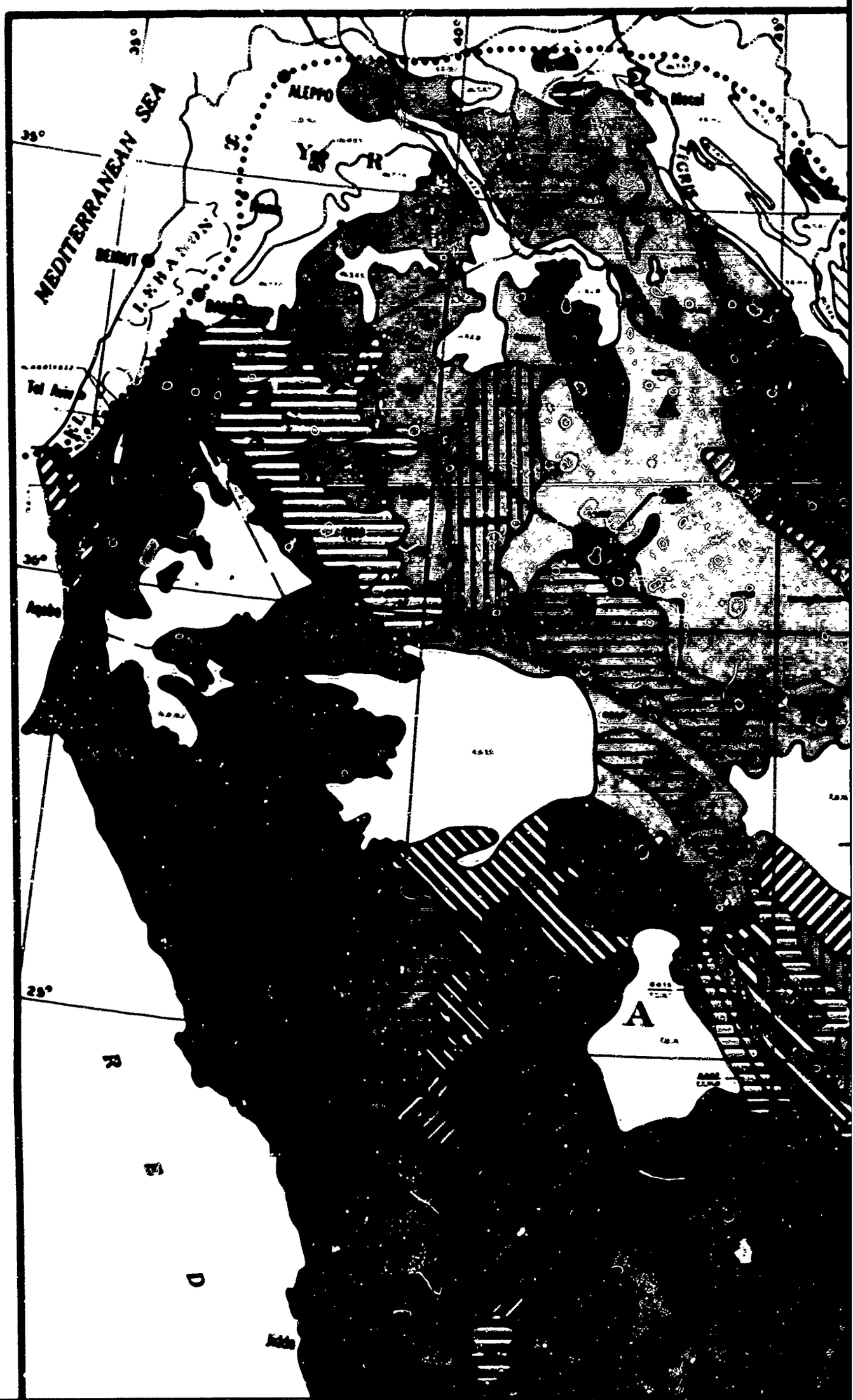
IN THE

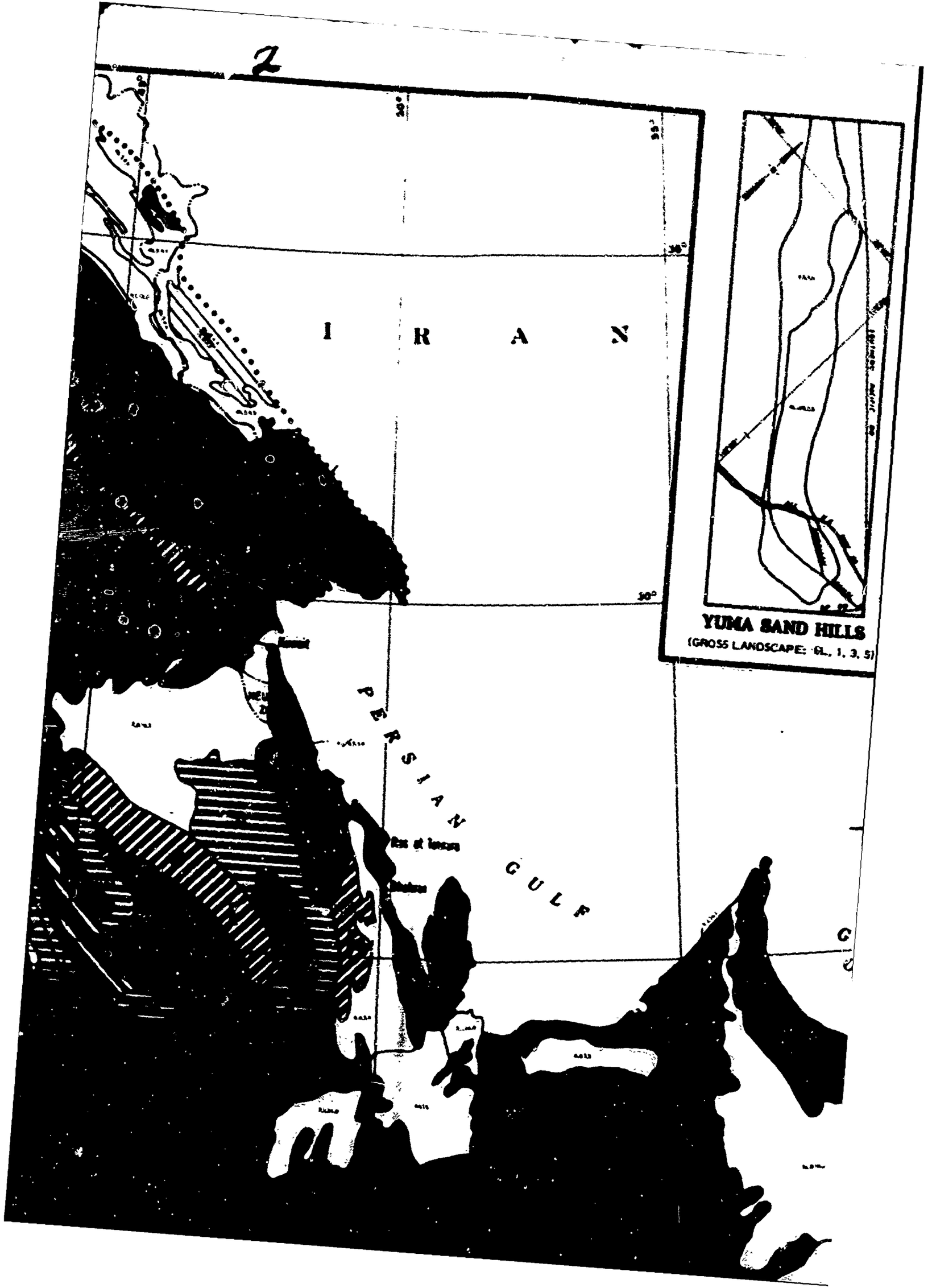
MIDDLE EAST DESERT

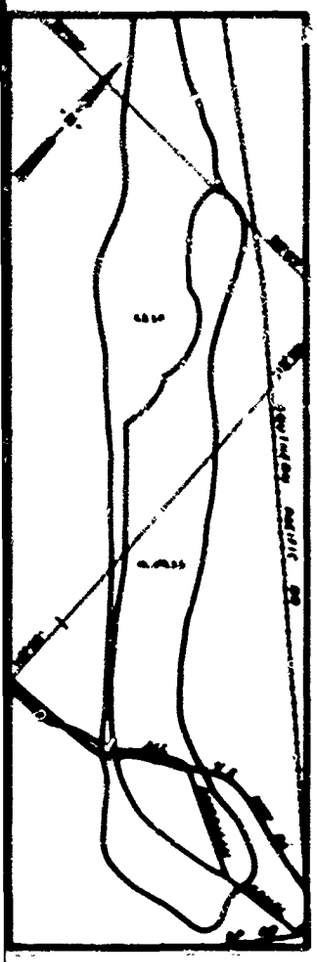
8

VEGETATION

PLATE 9

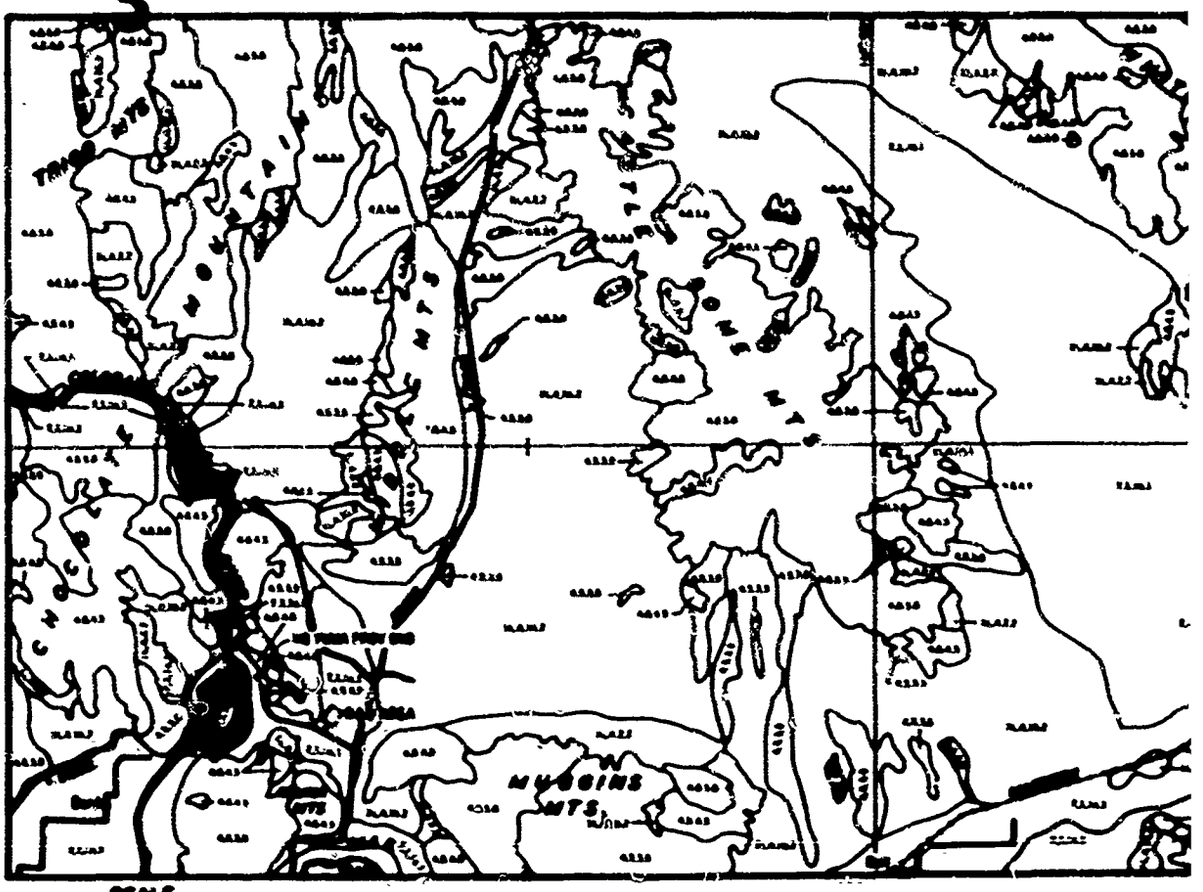

MEDITERRANEAN SEA
ALEPPO
BEIRUT
LEBANON
Tel Aviv
Aqaba
Mosul
TIGRIS
35°
36°
29°
40°
A


2
I R A N
PERSIAN GULF
YUMA SAND HILLS
(GROSS LANDSCAPE: 6L, 1, 3, 5)



YUMA SAND HILLS

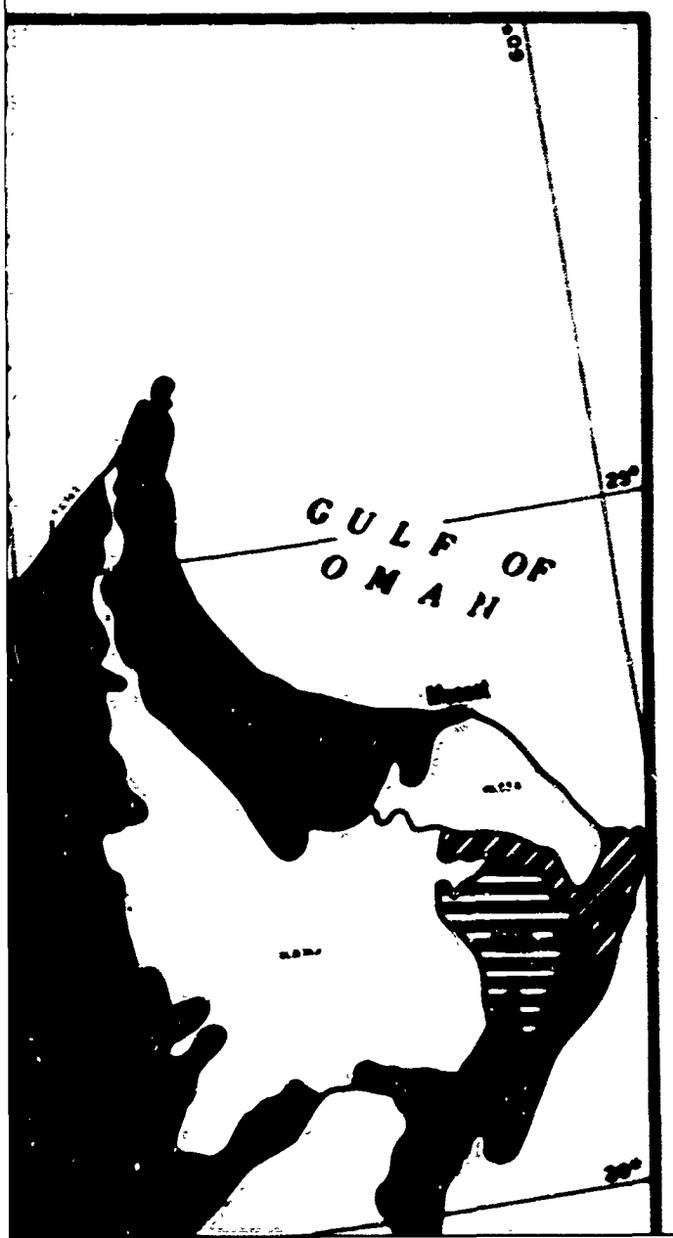
ROSS LANDSCAPE: 6L, 1, 3, 5)



SCALE

YUMA PROVING GROUND

(GROSS LANDSCAPE: 5L //, 1, 5, 7)



GEOMETRY OR FORM ANALOGS

LEGEND

Each landscape type is described by a series or an array of four symbols underlying mapping units of PLAN-PROFILE (6), SLOPE OCCURRENCE (5), SLOPE (3), and RELIEF (1). Mapping units of these four factors are always designated in this order.

Landscapes in the Middle East are always compared with Yuma landscapes and not vice versa. The array of symbols in the Middle East is shown in light- and boldface type to indicate the maximum degree of analogy with Yuma, the analogy increasing as the number of lightface units increases. Units shown in boldface type are not found at Yuma in combination with the remaining units of the array. Units in lightface type indicate the maximum number of units found in the closest corresponding array on the Yuma map.*

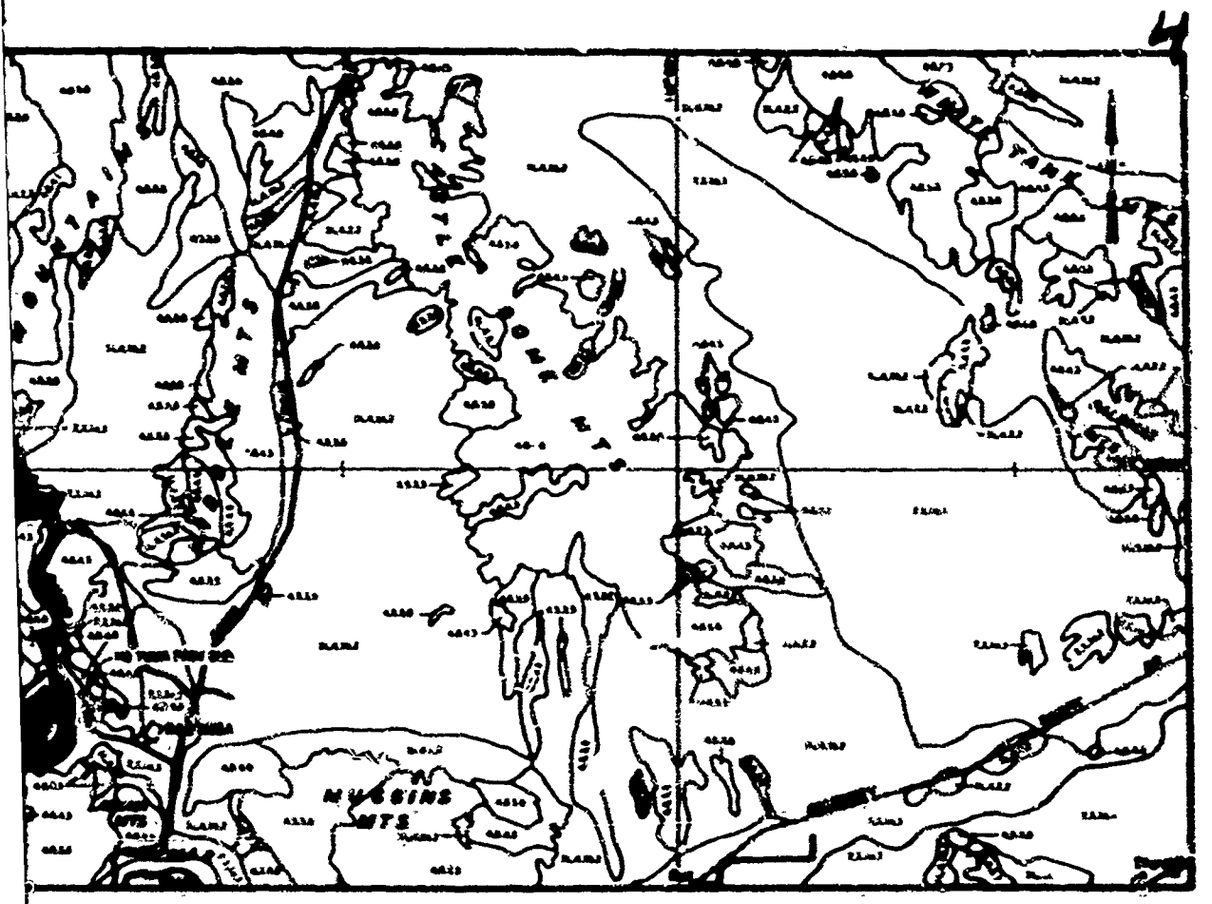
Areal Complex. The areally predominant landscape is the numerator of the complex, the subordinate the denominator.

Gross-Component Complex. The gross landscape is compared only with other gross landscapes.

4	Highly Analogous	The identical landscape is found at Yuma.
3	Moderately Analogous	Three units of the array are found in an array occurring at Yuma.
1,5	Slightly Analogous	One or two units of the array are found in an array at Yuma.
0	Not Analogous	No unit of the array is found at Yuma.

LANDSCAPE COMPLEXES

Indicates the degree of analogy of the areally predominant landscape type.



YUMA PROVING GROUND

(GROSS LANDSCAPE: SL //. 1. 5. 7)

GEOMETRIC OR FORM ANALOGS

LEGEND

Each landscape type is identified by a series or an array of four symbols indicating mapping units of PLAN-PROFILE (1), SLOPE OCCURRENCE (2), SLOPE (3), and RELIEF (4). Mapping units of these four factors are always designated in this order.

Landscapes in the Middle East are always compared with Yuma landscapes and not vice versa. The array of symbols in the Middle East is shown in lighter and heavier type to indicate the maximum degree of analogy with Yuma, the analogy increasing as the number of lighter units increases. Units shown in heavier type are not found in Yuma in combination with the remaining units of the array. Units in lighter type indicate the maximum number of units found in the closest corresponding array on the Yuma map.*

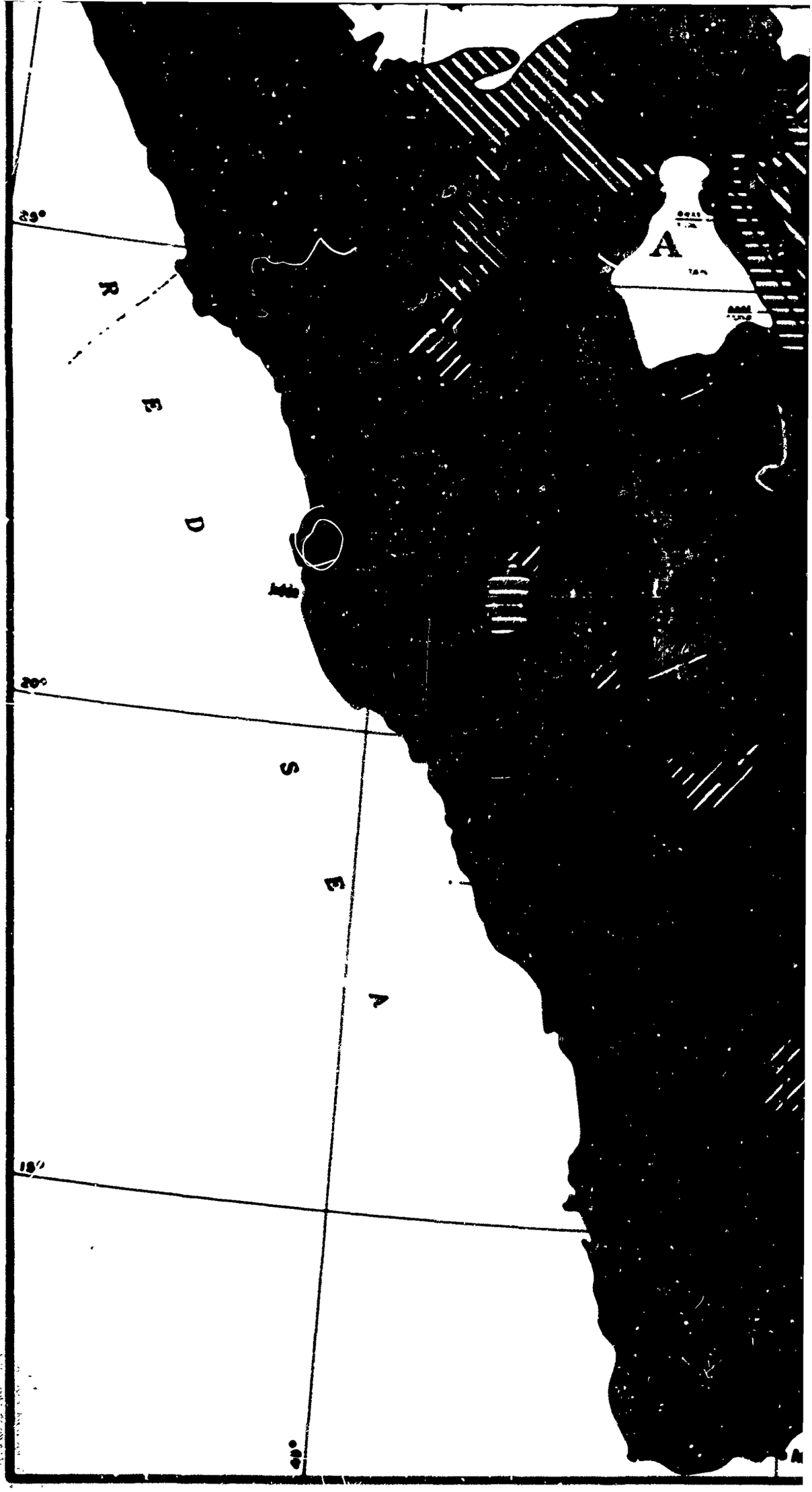
Areal Complex. The areally predominant landscape is the numerator of the complex, the subordinate the denominator.

Gross-Component Complex. The gross landscape is compared only with other gross landscapes.

1	Highly Analogous	The identical landscape is found at Yuma.
1	Moderately Analogous	Three units of the array are found in an array occurring at Yuma.
1.5	Slightly Analogous	One or two units of the array are found in an array at Yuma.
0	Not Analogous	No unit of the array is found at Yuma.

LANDSCAPE COMPLEXES

Indicating the degree of analogy of the areally predominant



5

N
Ras al Tanura
Dhahran
GULF
A
A R A
Muscat
0 50 100
Aden
50°

GEOMETRY OF FORM

LEGEND

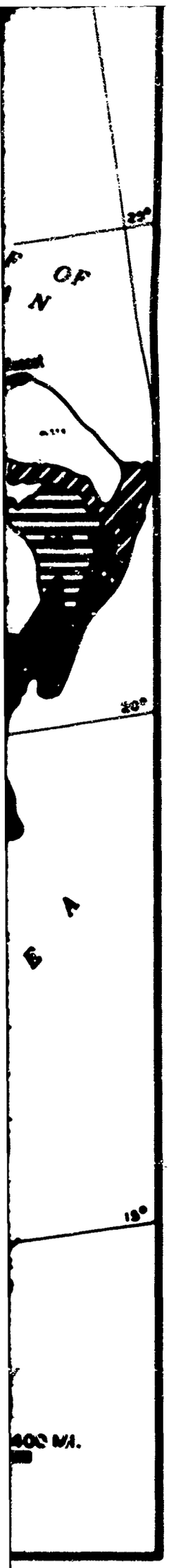
LANDSCAPE COMPLEXES

ANALOGS OF YUMA

IN THE

MIDDLE EAST DE

GEOMETRY AN



GEOMETRY OF TERRAIN ANALOGS

LEGEND

[illegible] Each landscape type is identified by a series or an array of four symbols indicating mapping units of PLAN-PROFILE (1), SLOPE OCCURRENCE (2), SLOPE (3), and RELIEF (4). Mapping units of these four factors are always designated in the order.

[illegible] Landscapes in the Middle East are always compared with Yuma landscapes and not vice versa. The array of symbols in the Middle East is shown in light- and boldface type to indicate the maximum degree of analogy with Yuma, the analogy increasing as the number of lightface units increases. Units shown in boldface type are not found at Yuma in combination with the remaining units of the array. Units in lightface type indicate the maximum number of units found in the closest corresponding array on the Yuma map.*

Areal Complex. The areally predominant landscape is the numerator of the complex, the subordinate the denominator.

Green-Component Complex. The green landscape is compared only with other green landscapes.

4	Highly Analogous	The identical landscape is found at Yuma.
3	Moderately Analogous	Three units of the array are found in an array resembling at Yuma.
1-2	Slightly Analogous	One or two units of the array are found in an array at Yuma.
0	Not Analogous	No unit of the array is found at Yuma.

LANDSCAPE COMPLEXES

Indicates the degree of analogy of the areally predominant landscape type.

Indicates the degree of analogy of the areally subordinate landscape type.

Indicates the degree of analogy of the green landscape.

Indicates the degree of analogy of the restrictive landscape of component hues.

Indicates the degree of analogy of the green landscape.

Indicates the degree of analogy of the restrictive landscape of component hues.

* In a particular array it may be possible to change different sets of light- or boldface units to indicate the maximum degree of analogy. In such instances units are compared in the order given in the array. For example, the Middle East array [illegible] was compared with the Yuma array [illegible] rather than with Yuma [illegible]. A comparison with the latter would have resulted in the symbolization [illegible]

ANALOGS OF YUMA TERRAIN

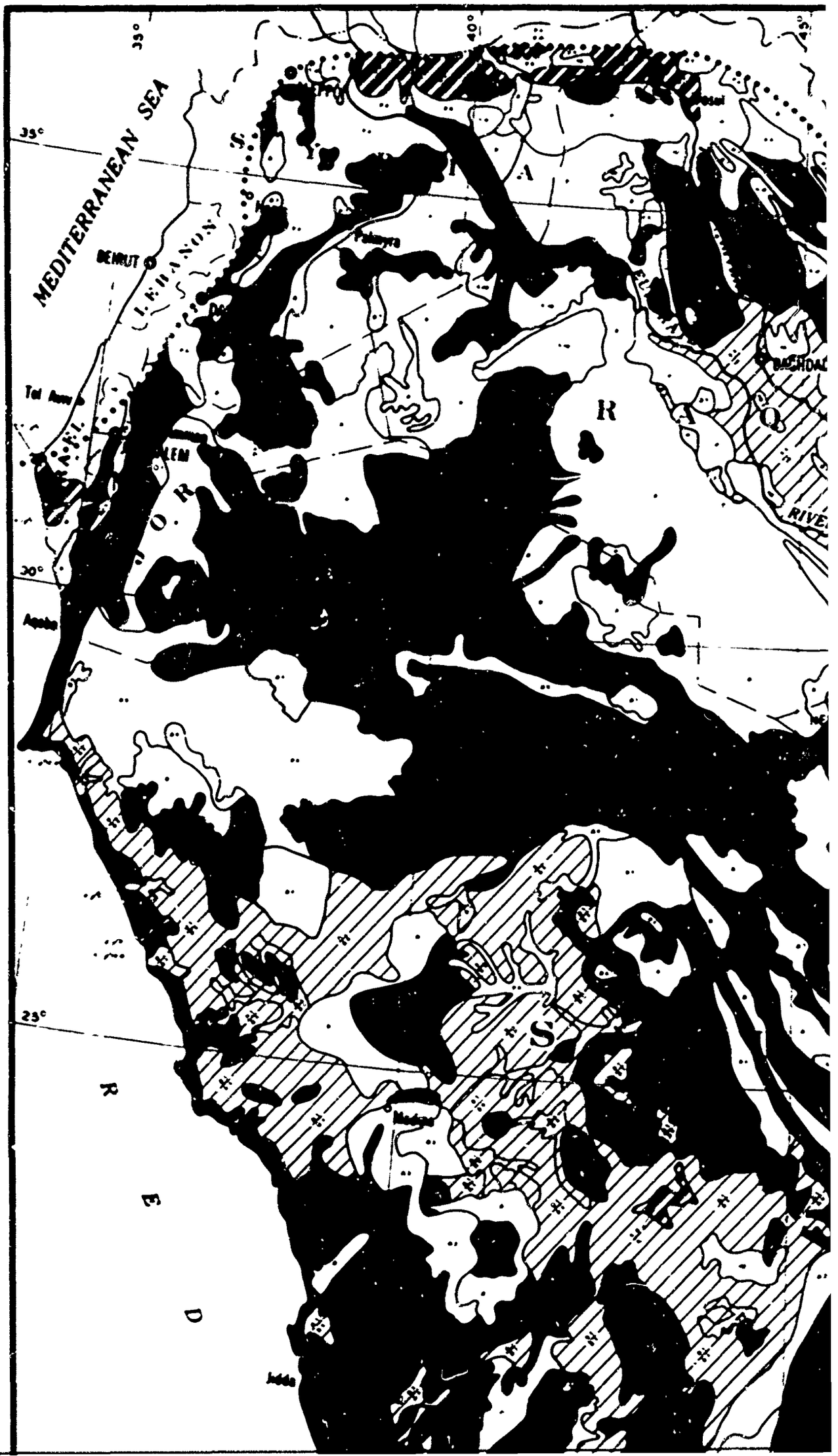
IN THE

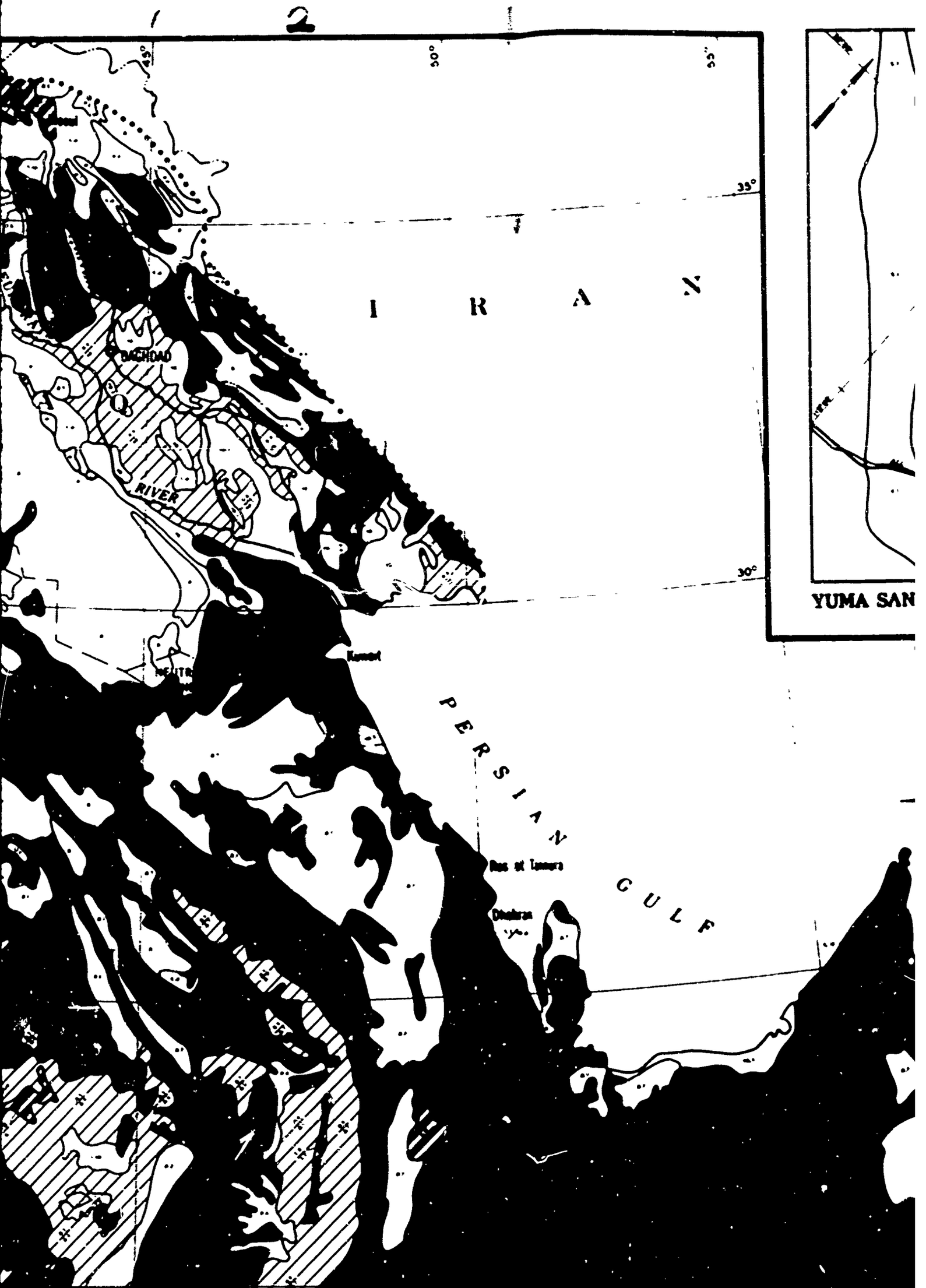
MIDDLE EAST DESERT

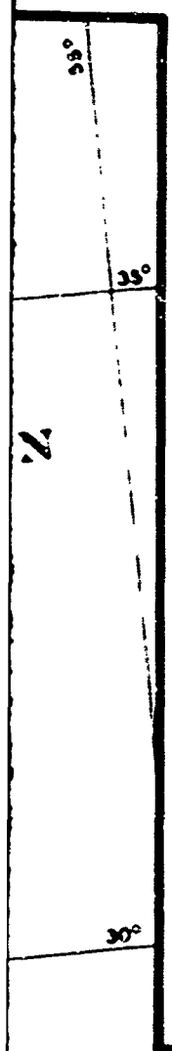
GEOMETRY ANALOGS

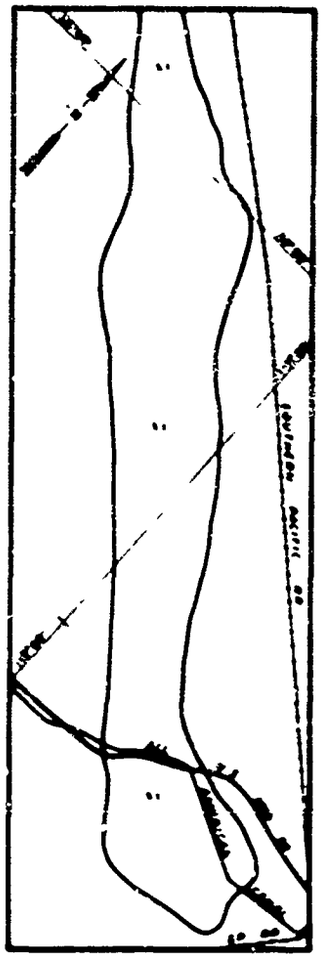
8

PLATE 10

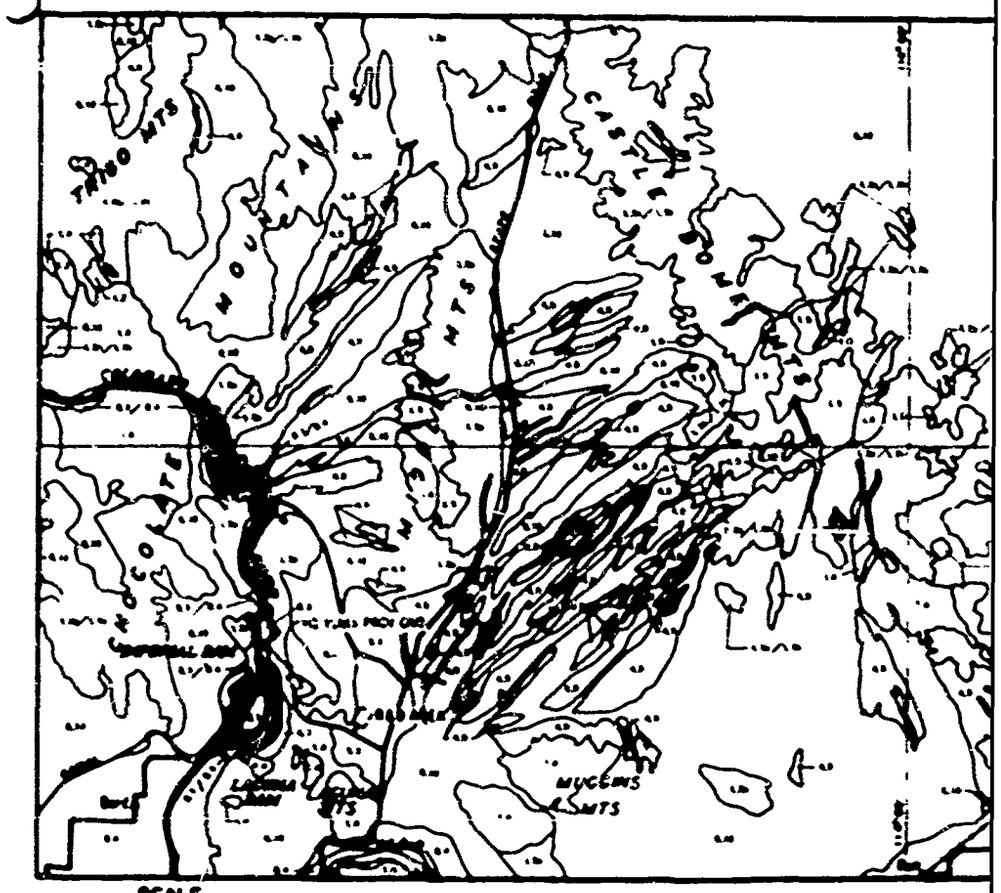

MEDITERRANEAN SEA
BEIRUT
LEBANON
Tel Aviv
Aqaba
Palmyra
BAGHDAD
RIVER
Medina
Jedda
35°
30°
25°
40°
45°


45°
50°
55°
35°
30°
I R A N
BAGHDAD
RIVER
Kuwait
P E R S I A N
G U L F
Ras al Tanura
Dhahran
YUMA SAN

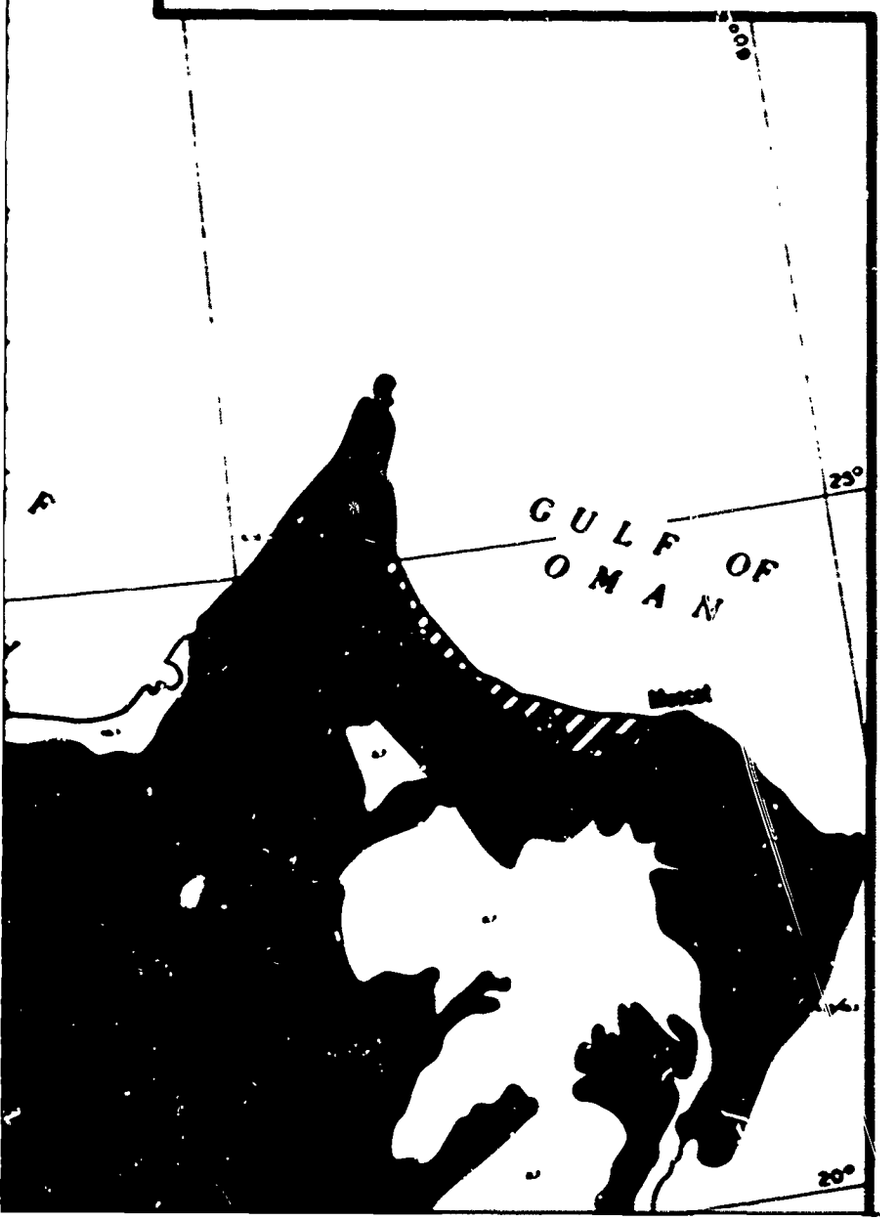




YUMA SAND HILLS



YUMA PROVING GROUND



GROUND ANALOGS

LEGEND

Numbers designate mapping units of soil type combinations (respectively). If the soil type (the second digit) designates a surface rock or (first number) is 6 or higher, the second digit combinations mapping units. In the example given type the second, surface rock.

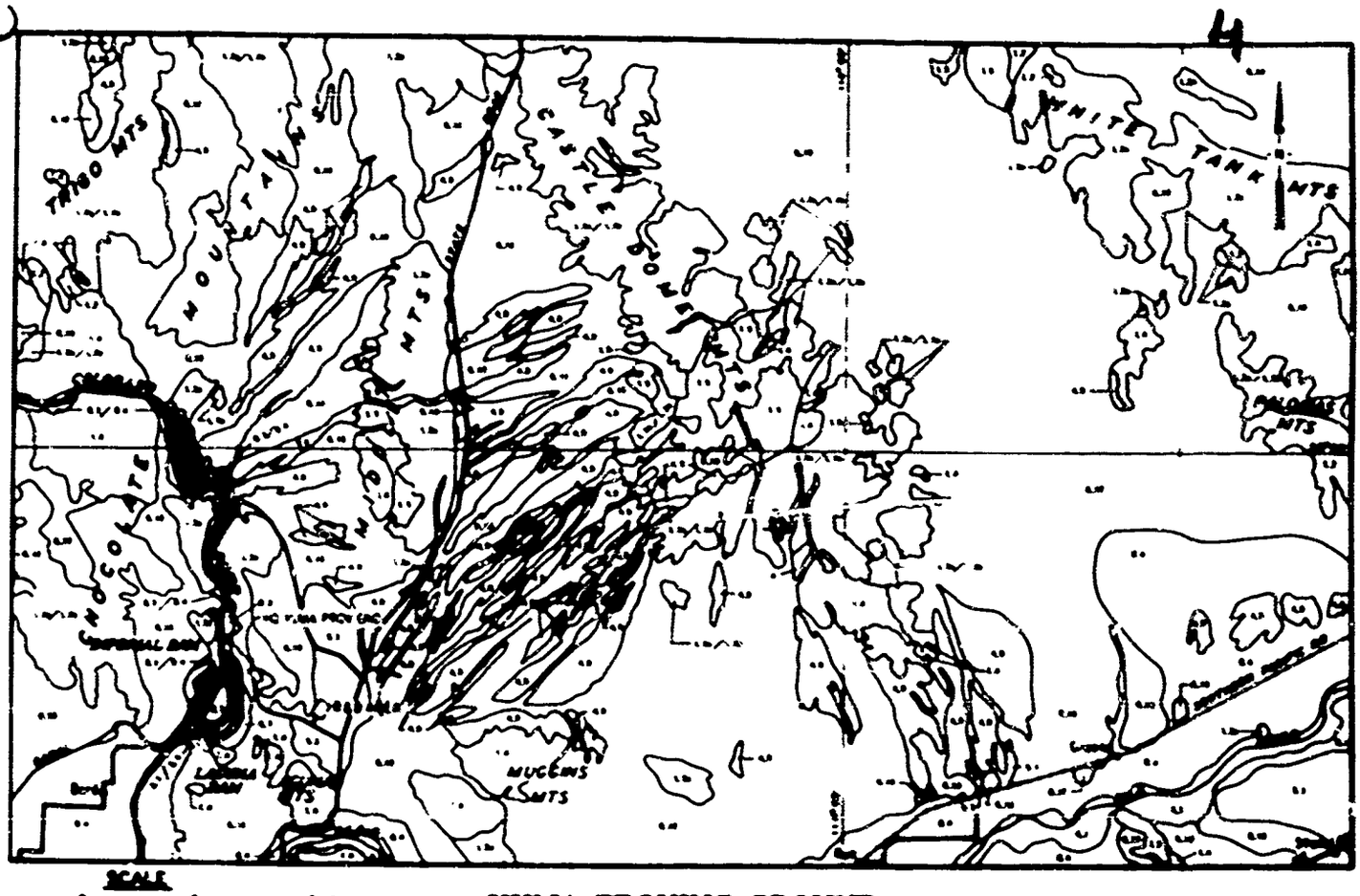
Ground features in the Middle East are almost ground features and not rock types. Both the designated are found in combinations of Yuma other landform combinations exists at Yuma also. If both digits are landform number and

Indicates area of ground compare. Two detail or soil combinations are present provided derivations. The circuits provide in total of the compare.

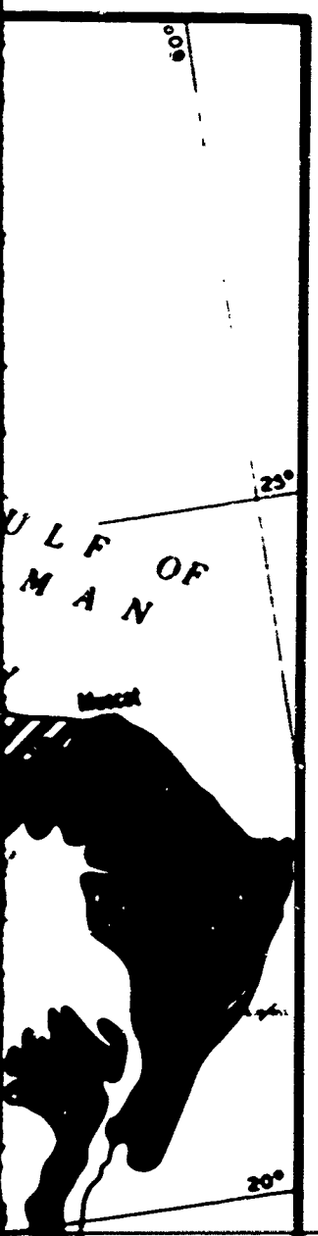
Highly Analogous — combinations found

Partially Analogous — One of the two units

Not Analogous — None of the units



YUMA PROVING GROUND



GROUND ANALOGS

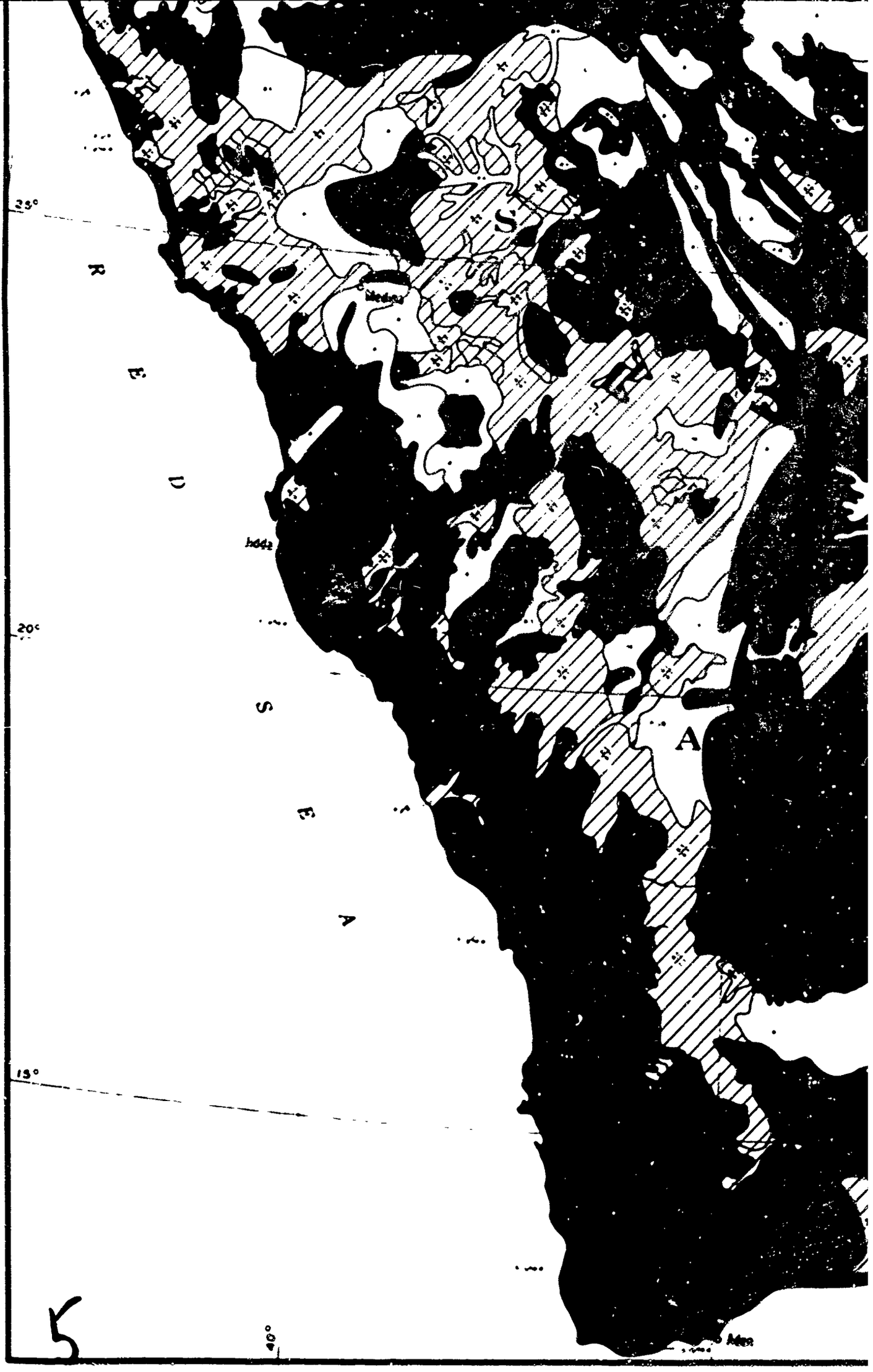
LEGEND

* Numbers designate mapping units of soil type and surface rock or soil consistence, respectively. If the soil type (first number) is 1, 2, or 3, the second digit designates a surface-rock mapping unit; if the soil type (first number) is 4 or higher, the second number designates a soil consistence mapping unit. In the example given, e.g. 3 7, the first digit is soil type, the second, surface rock.

** Ground factors in the Middle East are always compared with Yuma ground factors and not vice versa. If both digits are nighties, the units designated are found in combination at Yuma. If one is nighty and the other baddies, a combination exists at Yuma containing the nighties unit. If both digits are baddies, neither unit is found at Yuma.

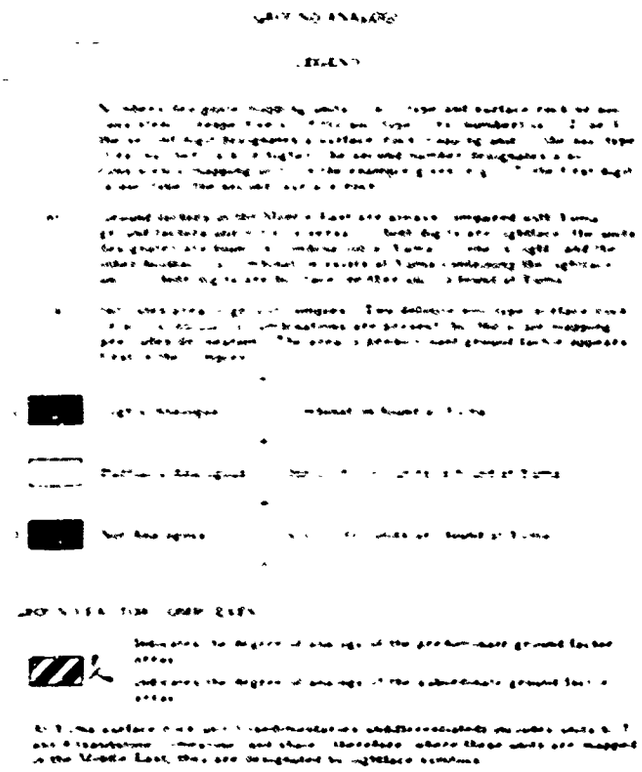
*** Indicates area of ground compare. Two defunits soil type-surface rock or soil consistence combinations are present, but the scale mapping precludes delineation. The area is predominant ground factor appears first in the compare.

2	Nighties Analogues	combinations found at Yuma
1	Partially Analogues	One of the two units is found at Yuma
0	Not Analogues	None of the units are found at Yuma



5

GULF
GULF OF OMAN
Muscat
ARABIAN SEA
Mukalla
SCALE
0 50 100 200 300 400 MI.



ANALOGS OF YUMA TERRAIN

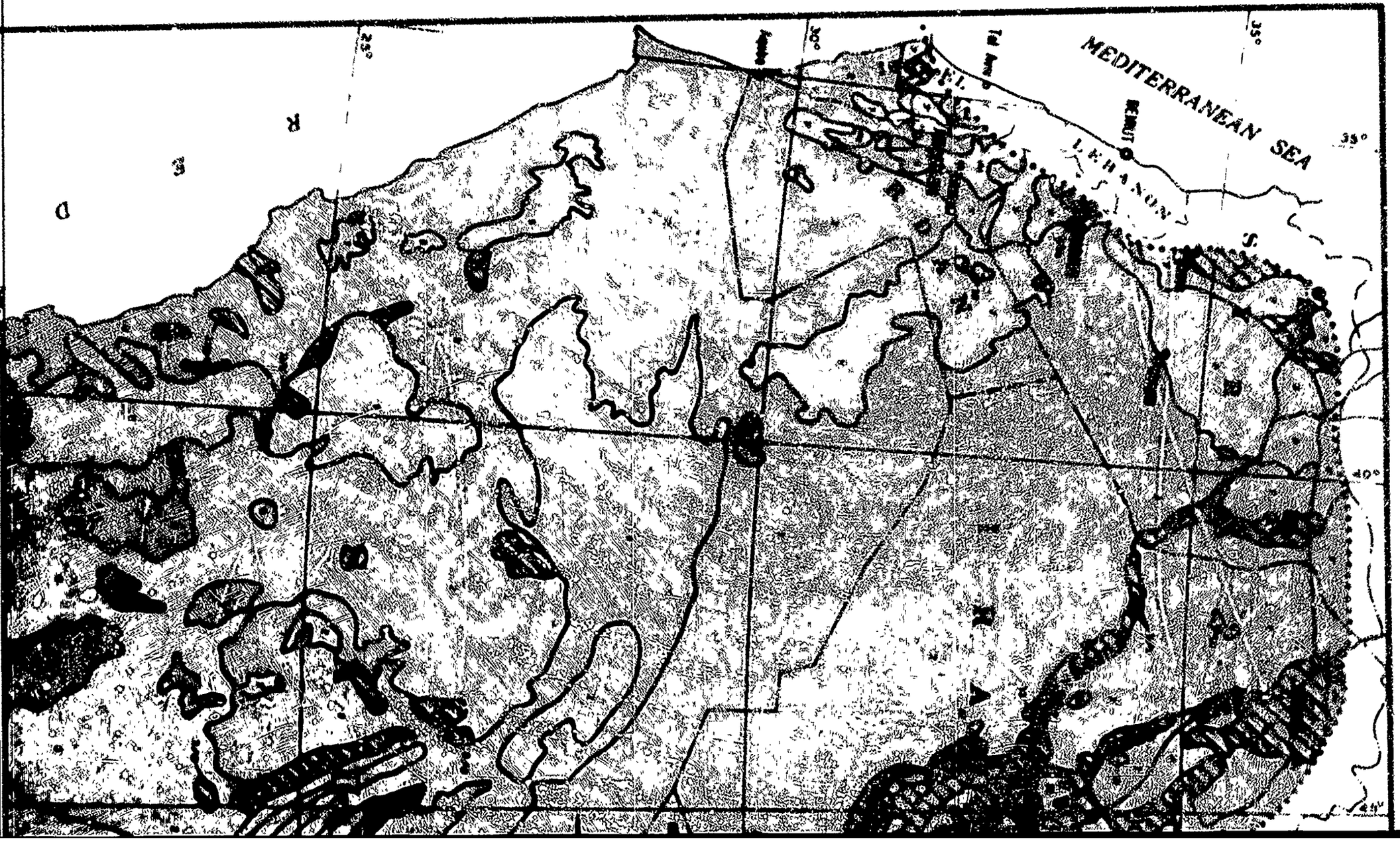
IN THE

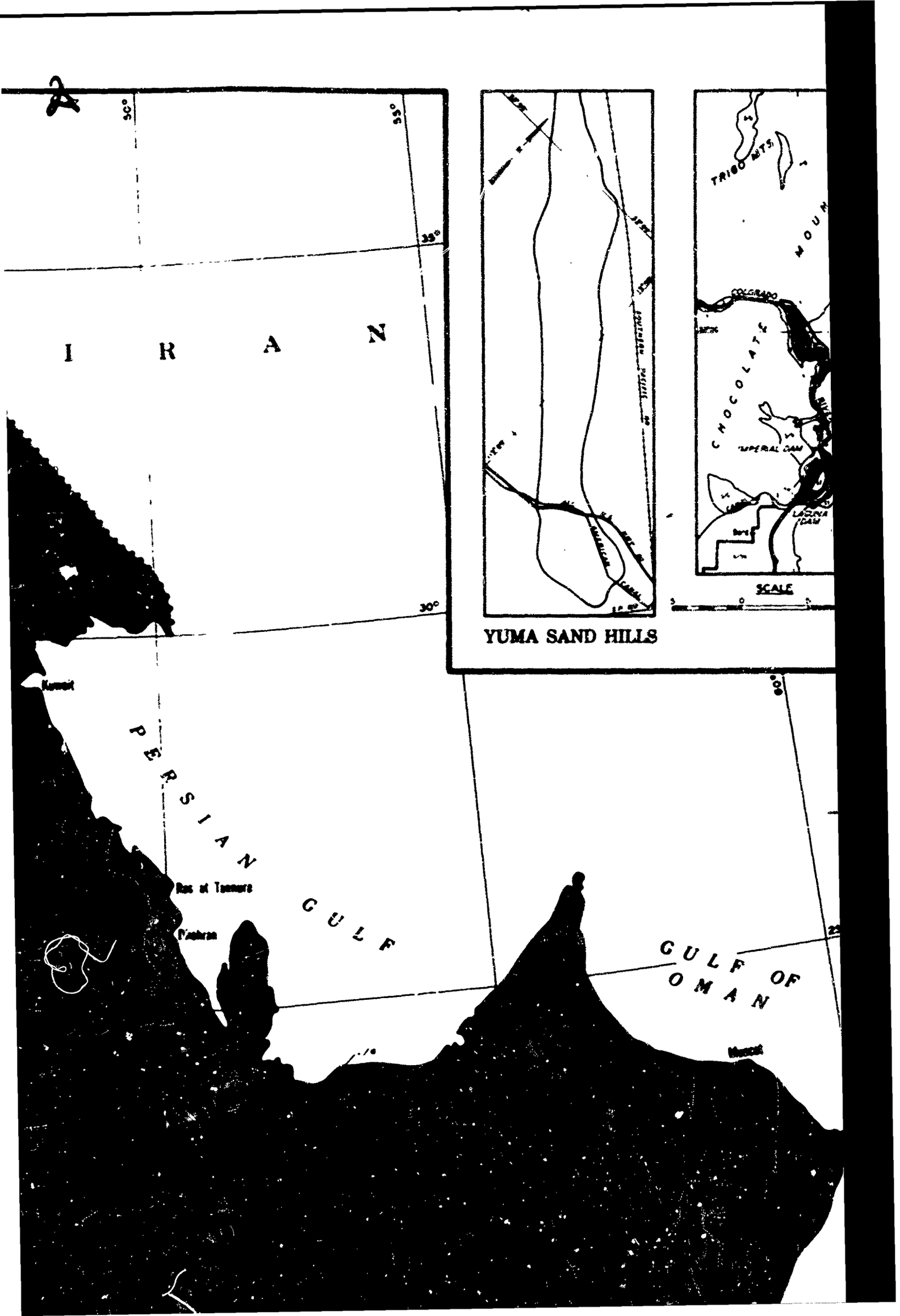
MIDDLE EAST DESERT

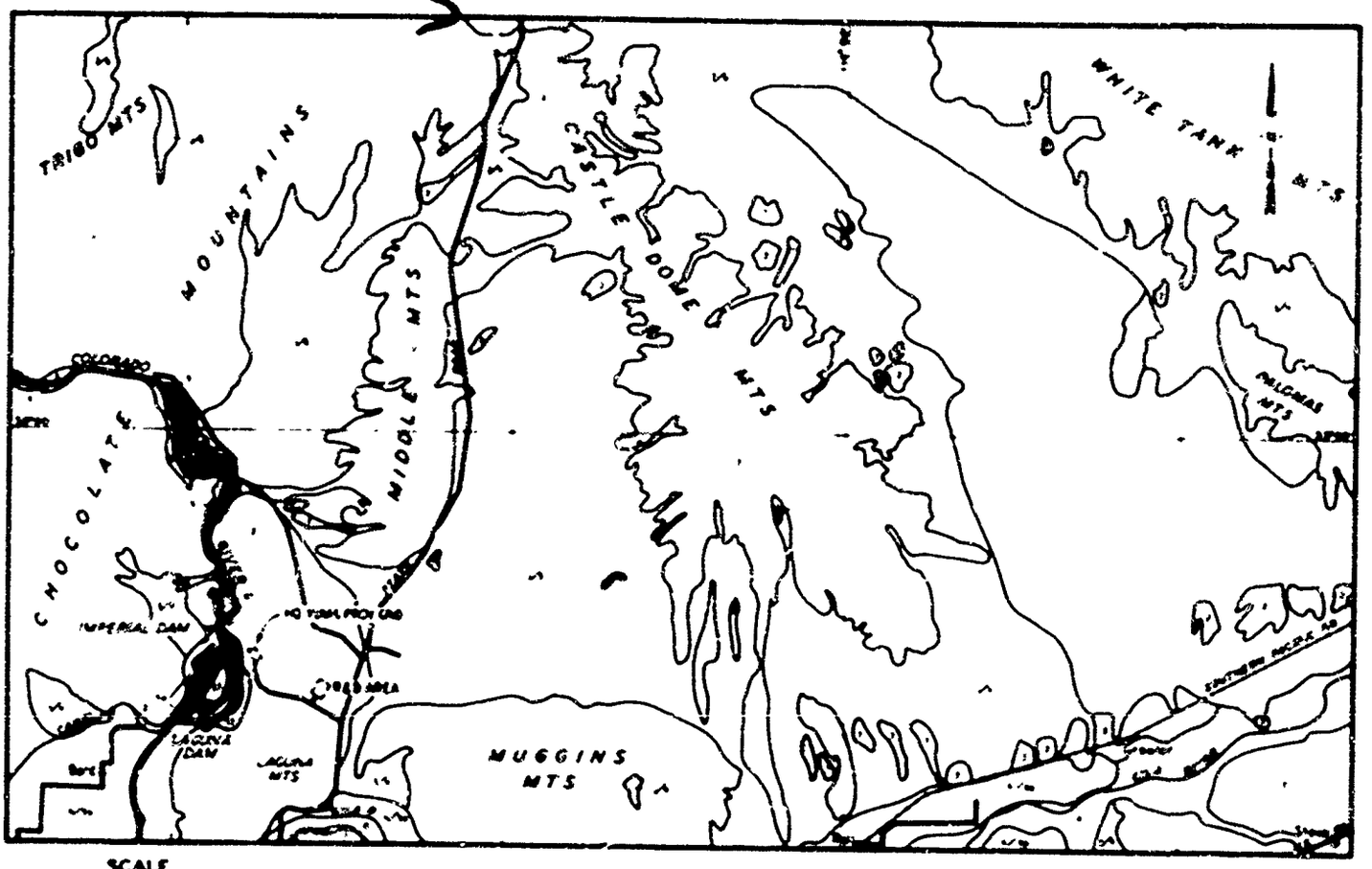
GROUND ANALOGS

8

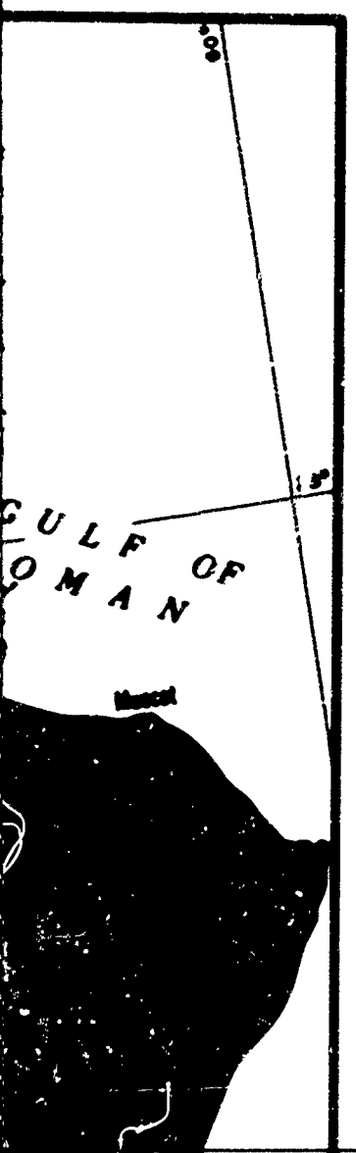
PLATE 11

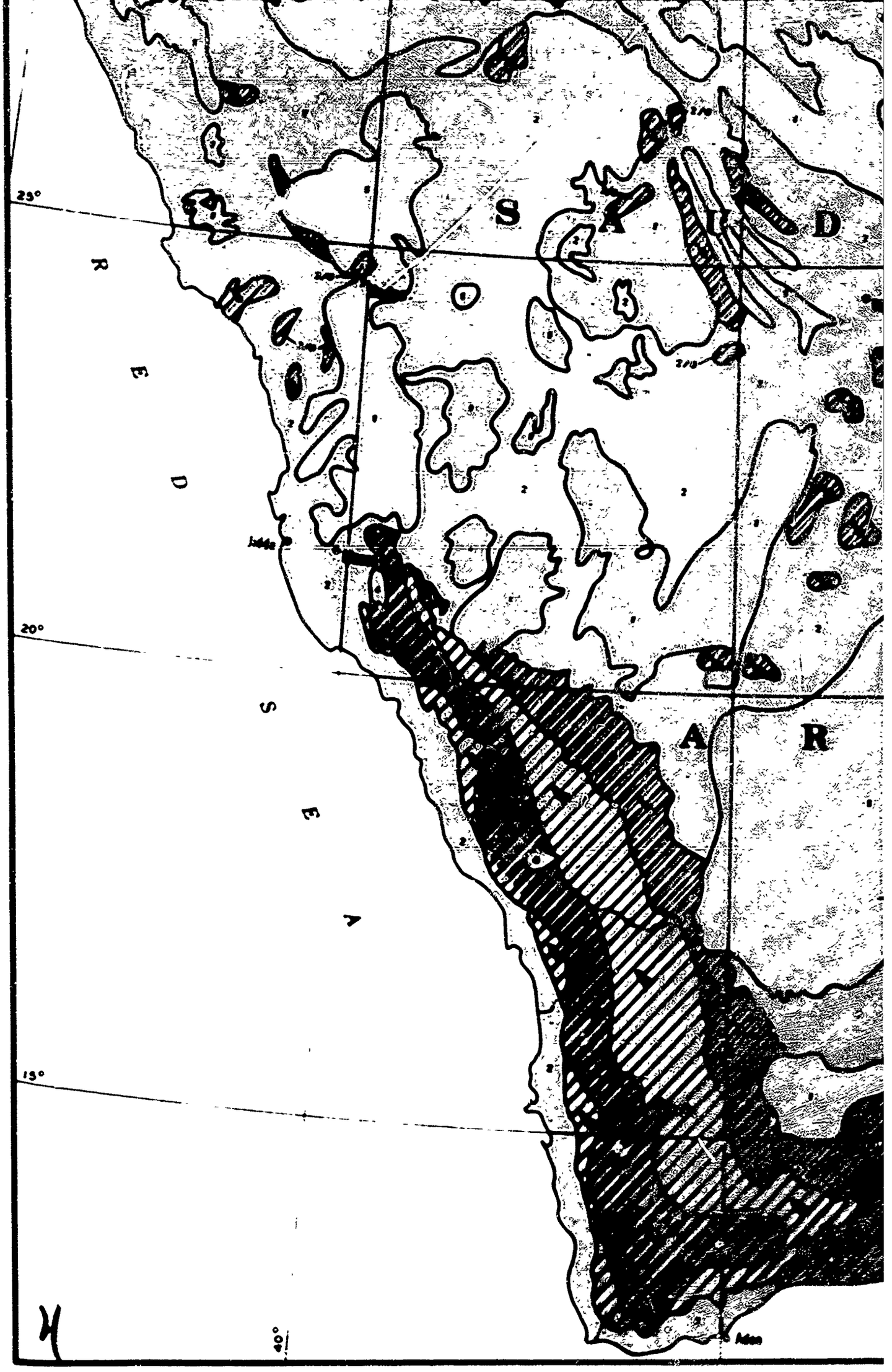

MEDITERRANEAN SEA
LEBANON
35°
40°

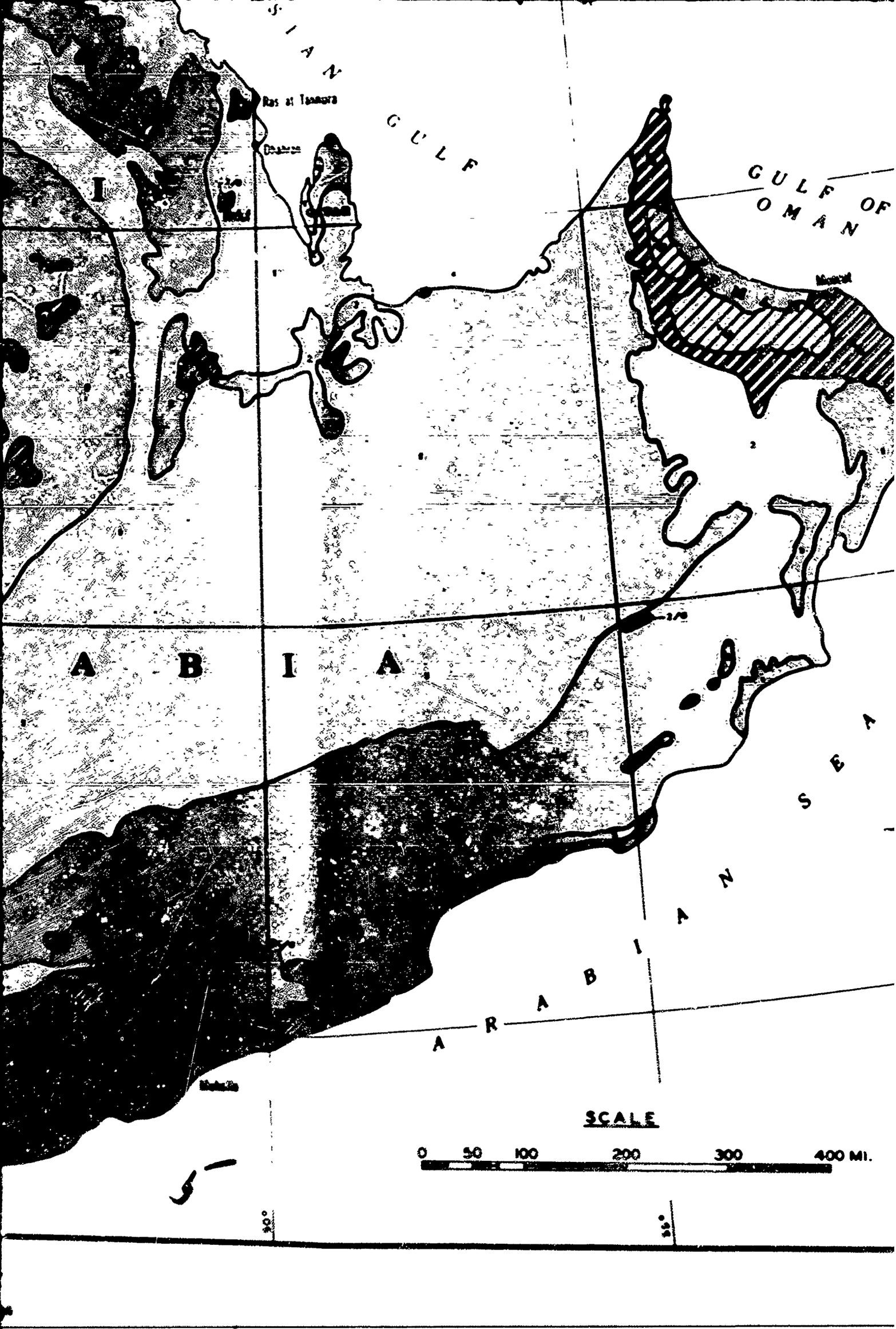

IRAN
PERSIAN GULF
GULF OF OMAN
Kuwait
Ras al Tanura
Tehran
Muscat
50°
55°
35°
30°
60°
YUMA SAND HILLS
TRIBO MTS.
COLORADO
CHOCOLATE
IMPERIAL DAM
LAGUNA DAM
SCALE

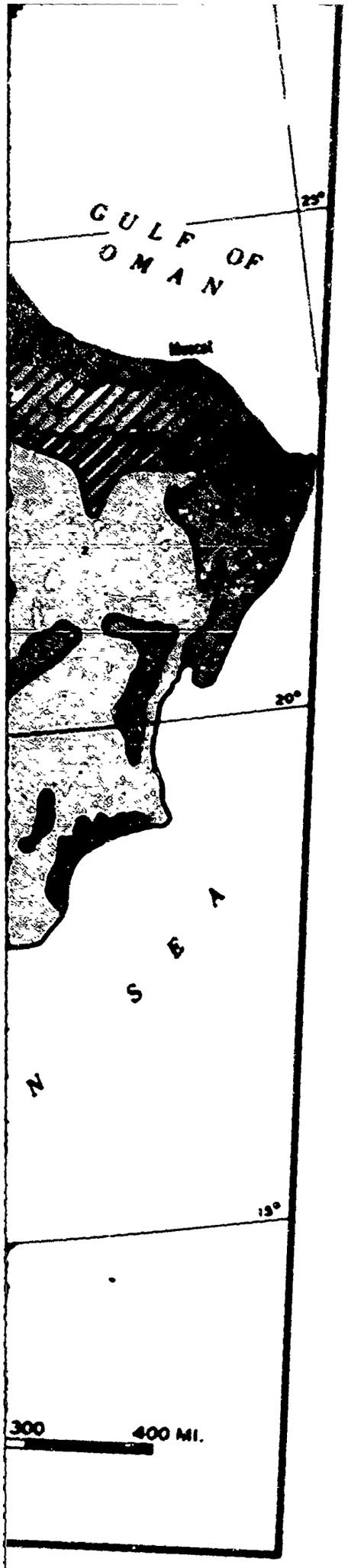


YUMA PROVING GROUND




S A U D
A R
R E D
S E A
25°
20°
15°
40°

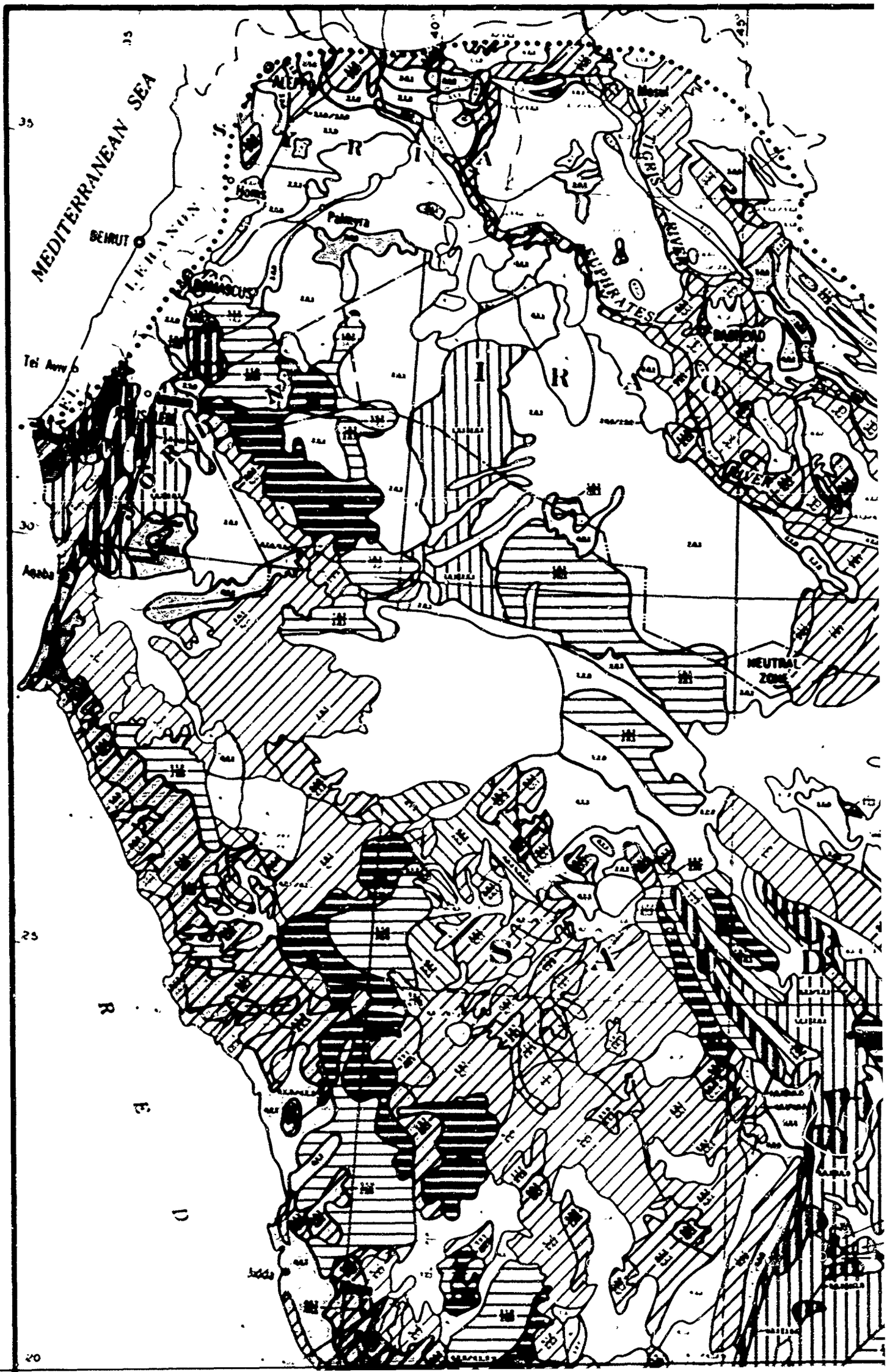

GULF
GULF OF OMAN
A B I A
A R A B I A N S E A
SCALE
0 50 100 200 300 400 MI.

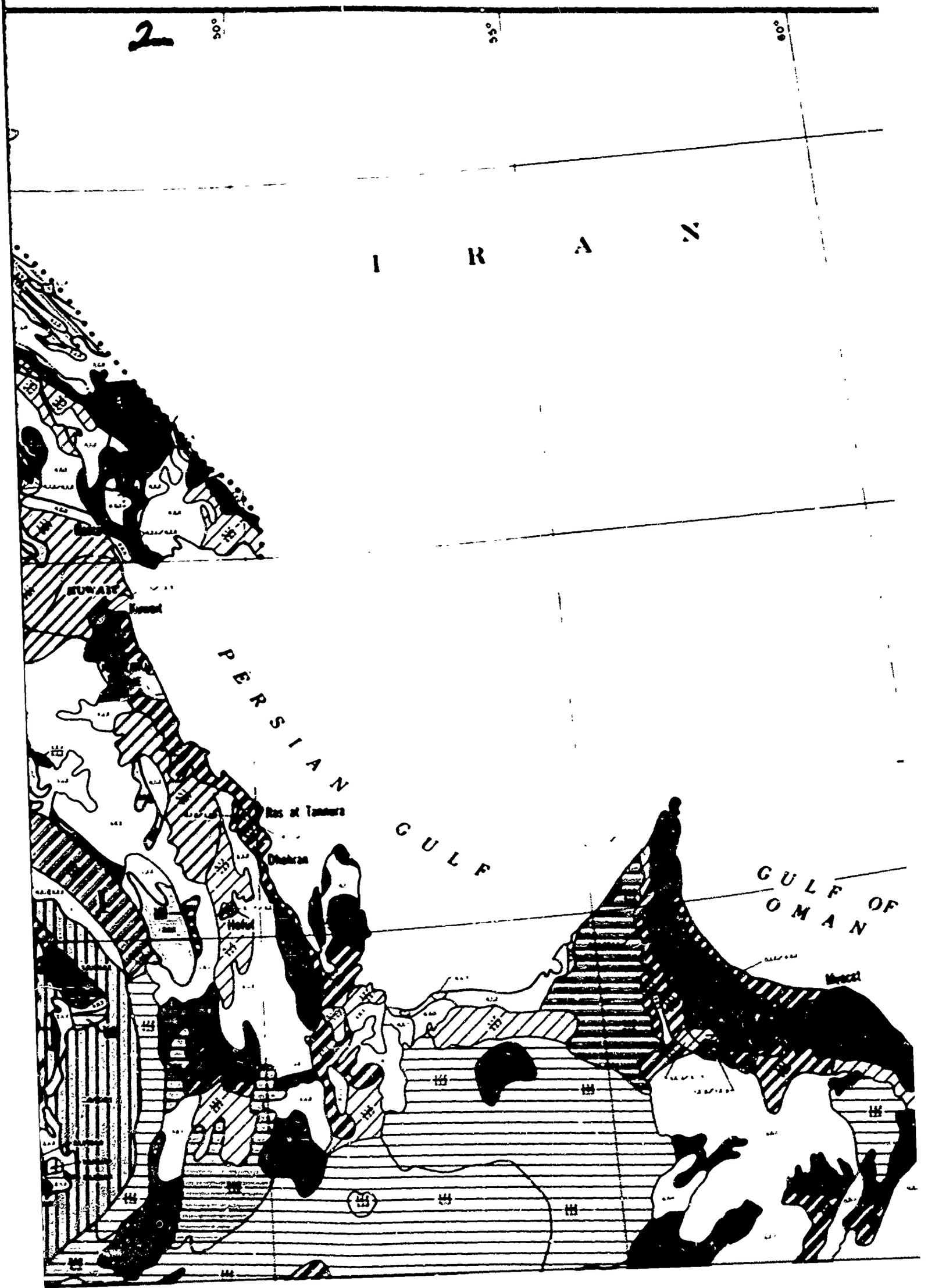


ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

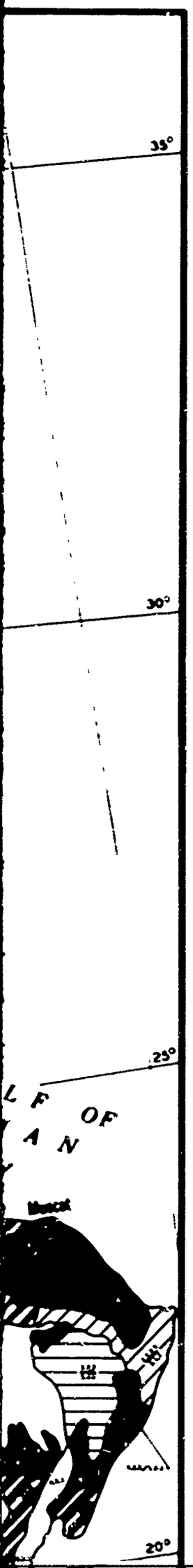
6 VEGETATION ANALOGS

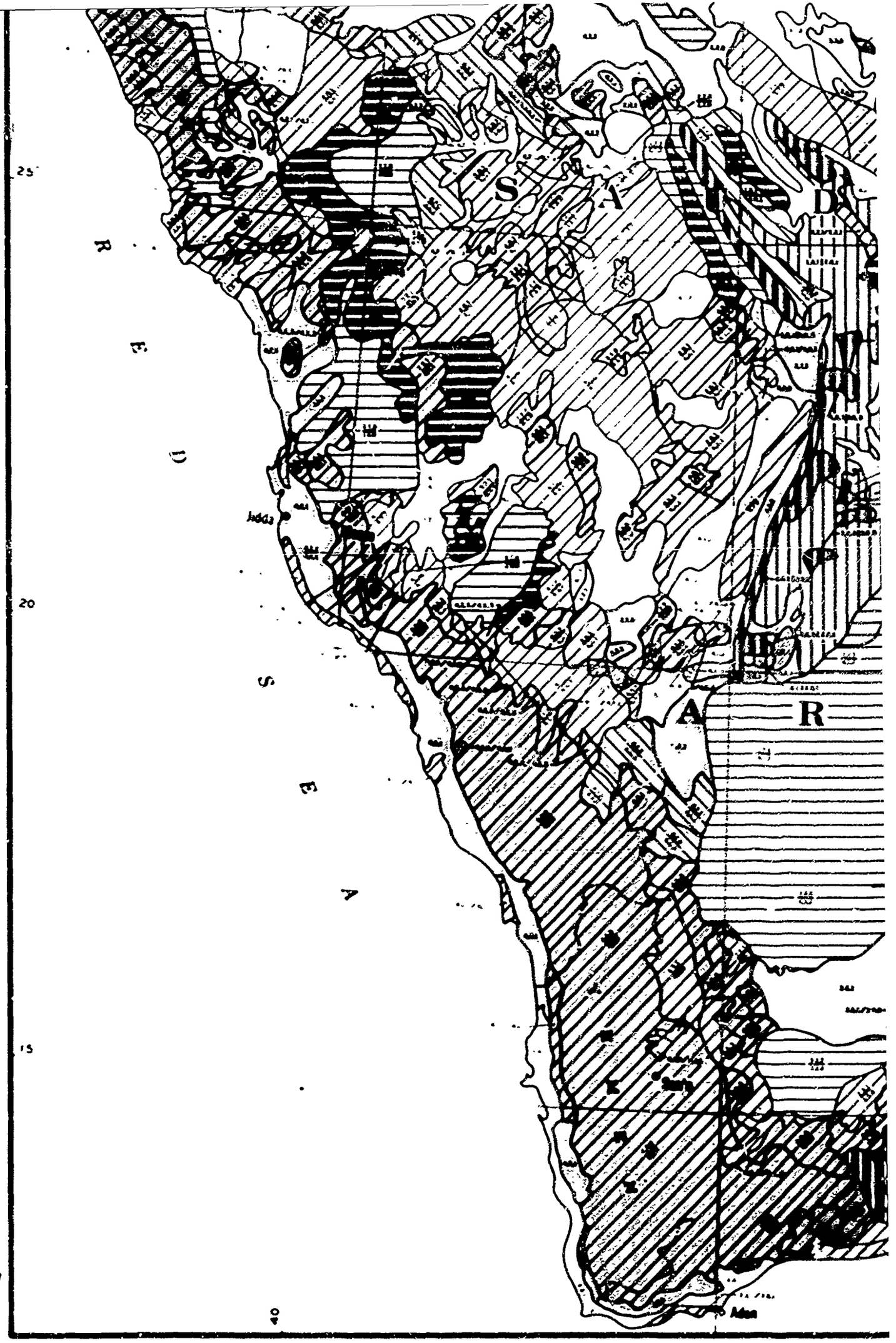
PLATE 12

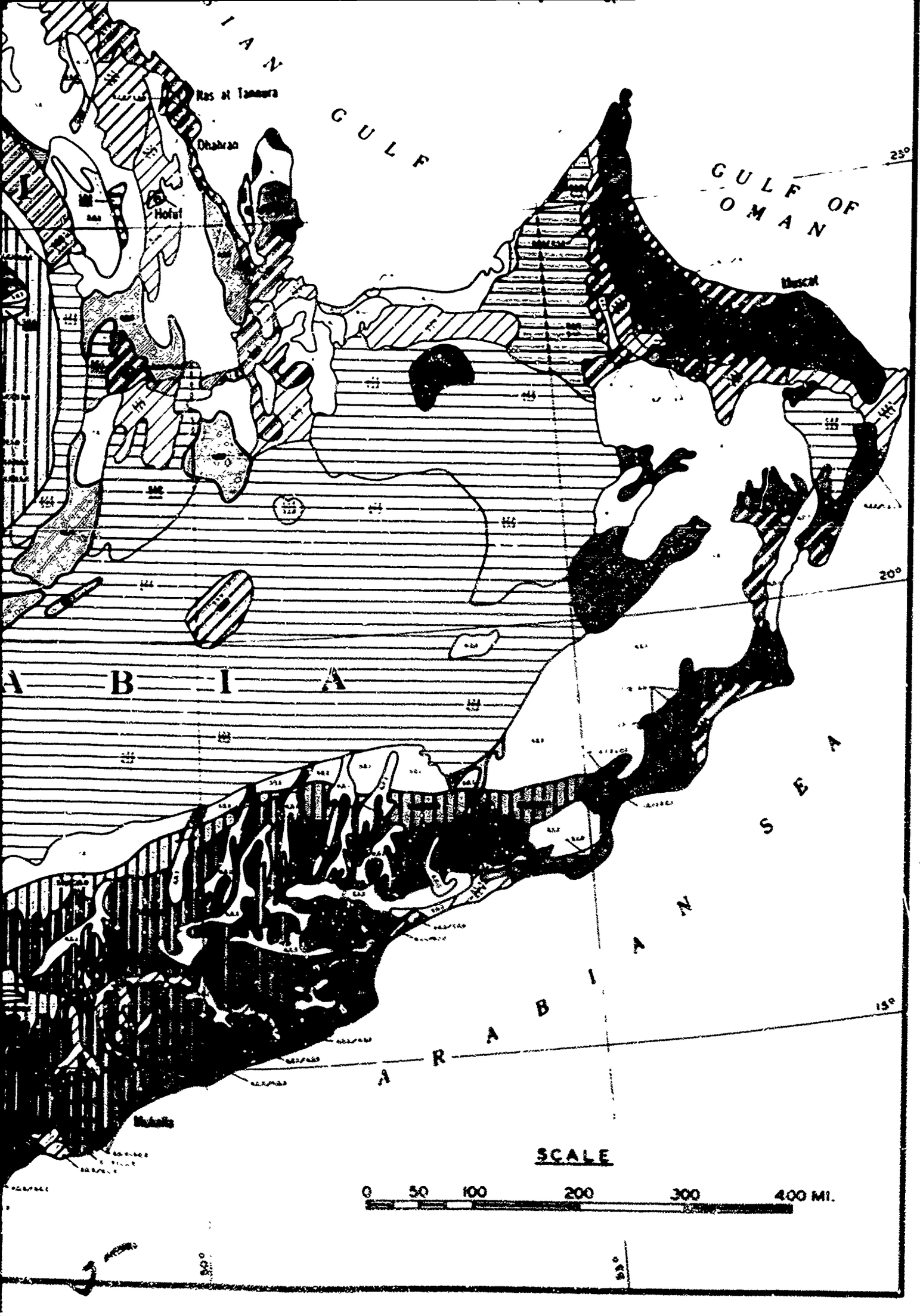

MEDITERRANEAN SEA
BEIRUT
LEBANON
DAMASCUS
Tel Aviv
Aqaba
Palmyra
Mosul
TIGRIS RIVER
EUPHRATES RIVER
BAGHDAD
NEUTRAL ZONE
35
30
25
20

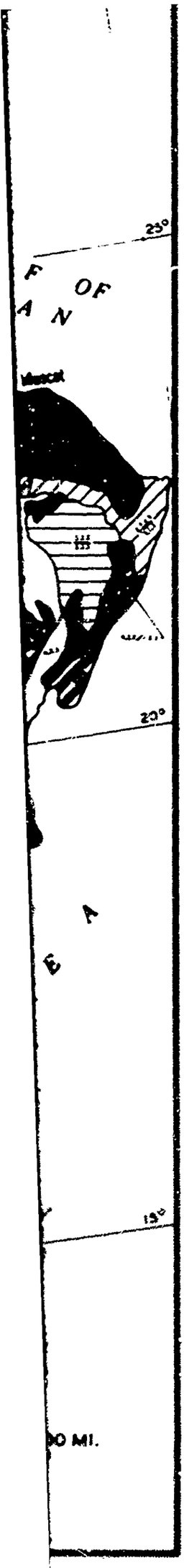

2
I R A N
SUWAIT
Kuwait
PERSIAN GULF
Ras at Tanura
Dhahran
Hofuf
GULF OF OMAN
Muscat

3




25
20
15
10
R E D S E A
S A U D I A R A B I A
Jidda
Aden


Ras al Tanura
Dhahran
Hofuf
GULF
GULF OF OMAN
Muscat
25°
20°
15°
A B I A
A R A B I A N S E A
Mukalla
SCALE
0 50 100 200 300 400 MI.



ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

6

TERRAIN-TYPE ANALOGS

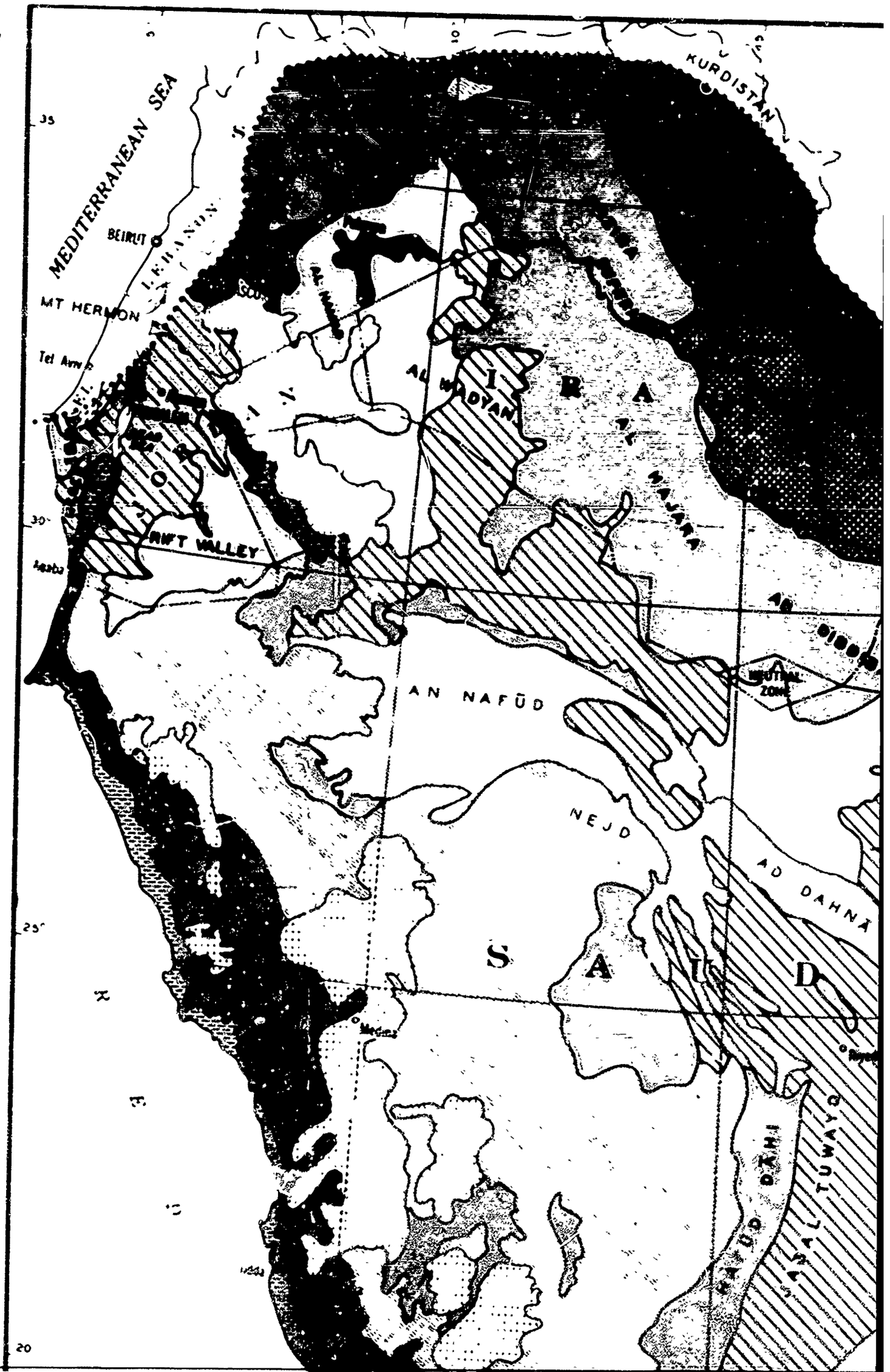
ANALOGS OF YUMA TERRAIN IN

SECTION II: SUPPLEMENTAL M

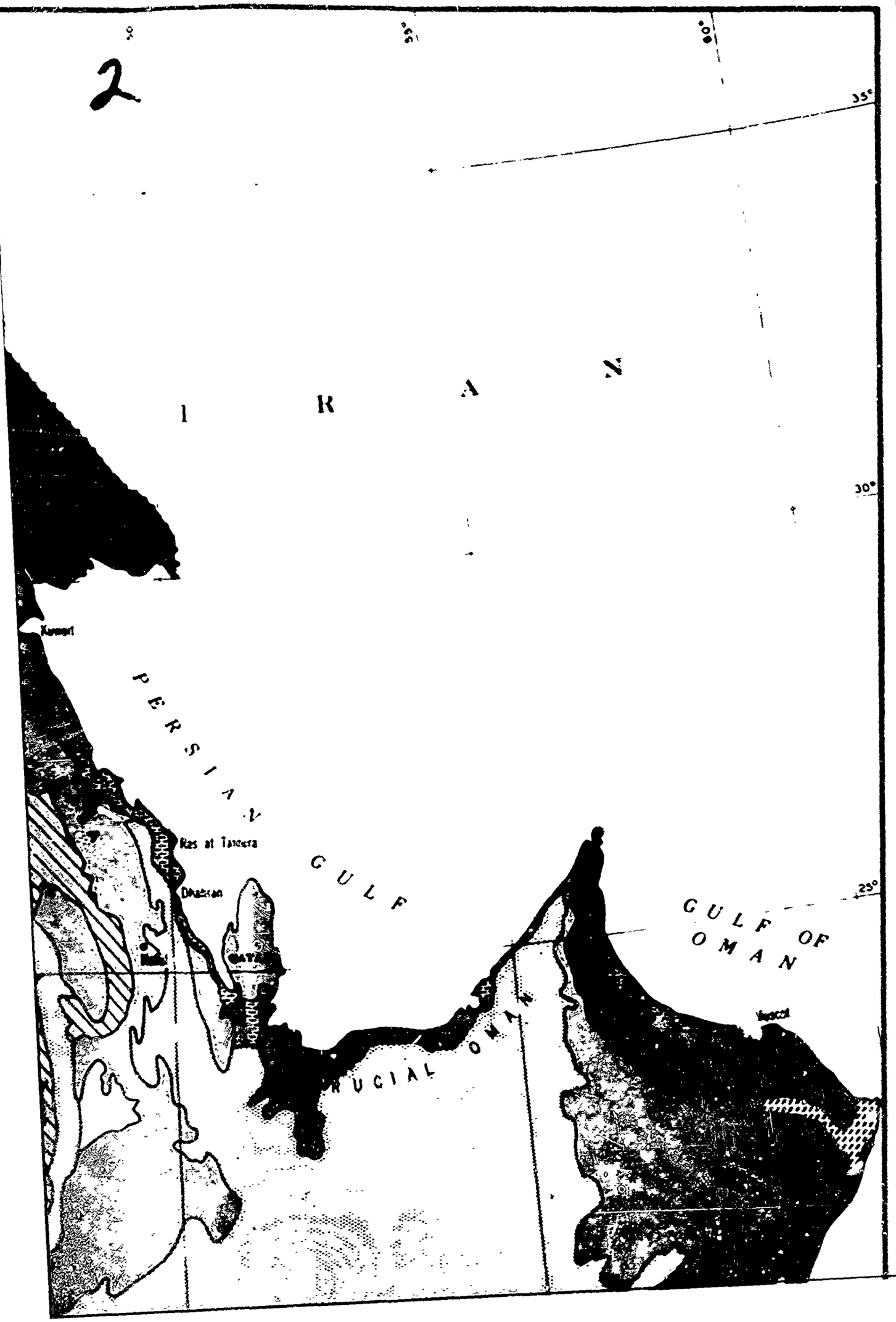
AIN IN THE MIDDLE EAST DESERT

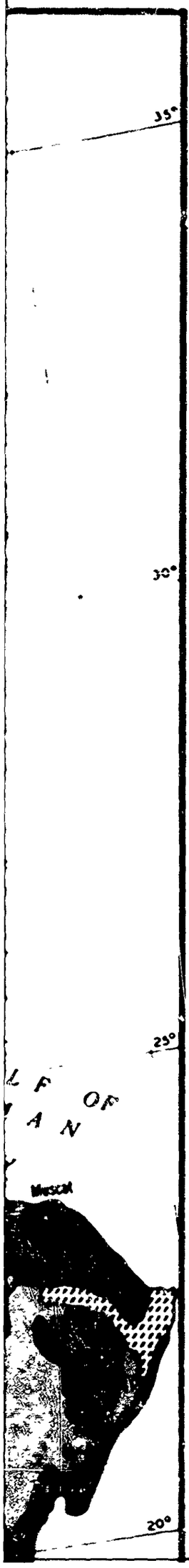
AL MAPS AND TABULATIONS

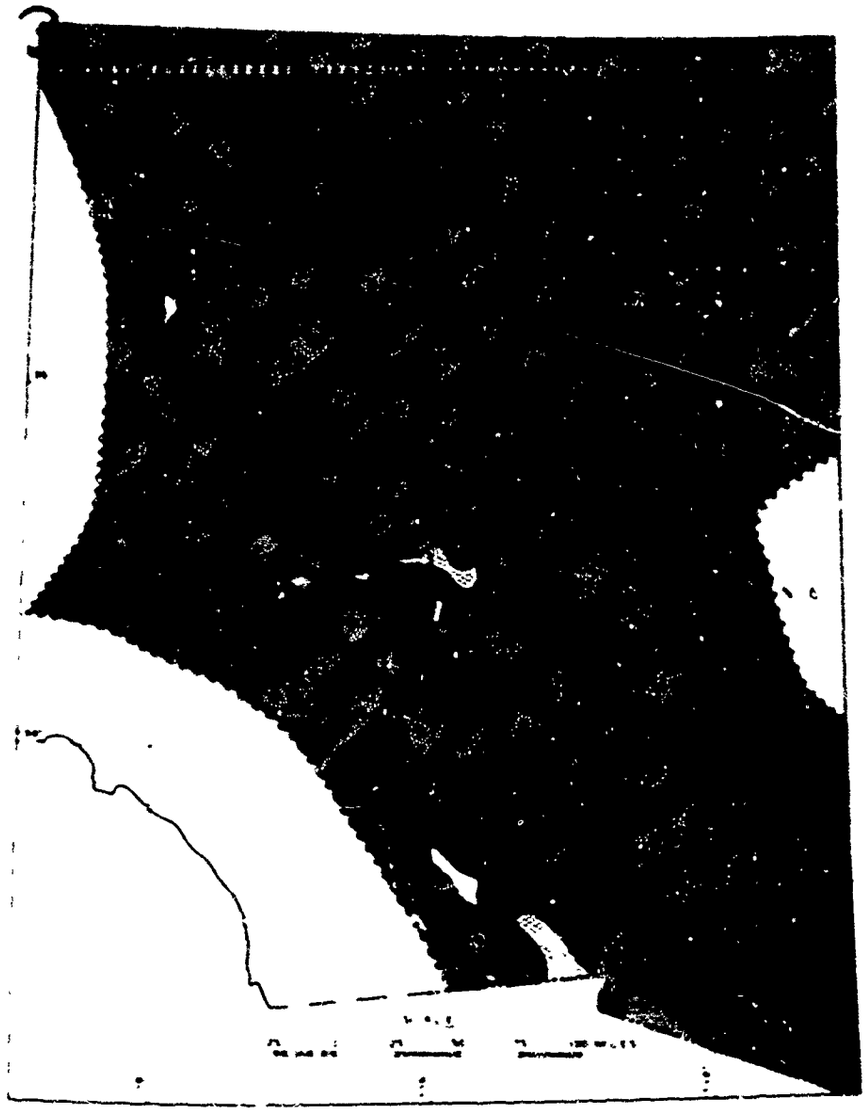
2


MEDITERRANEAN SEA
KURDISTAN
BEIRUT
LEBANON
MT HERMON
Tel Aviv
AL WADYAN
I R A
RIFT VALLEY
Aqaba
NEUTRAL ZONE
AN NAFŪD
NEJD
AD DAHNĀ
S A U D
HAUD DAHI
HALTUMA
35
30
25
20

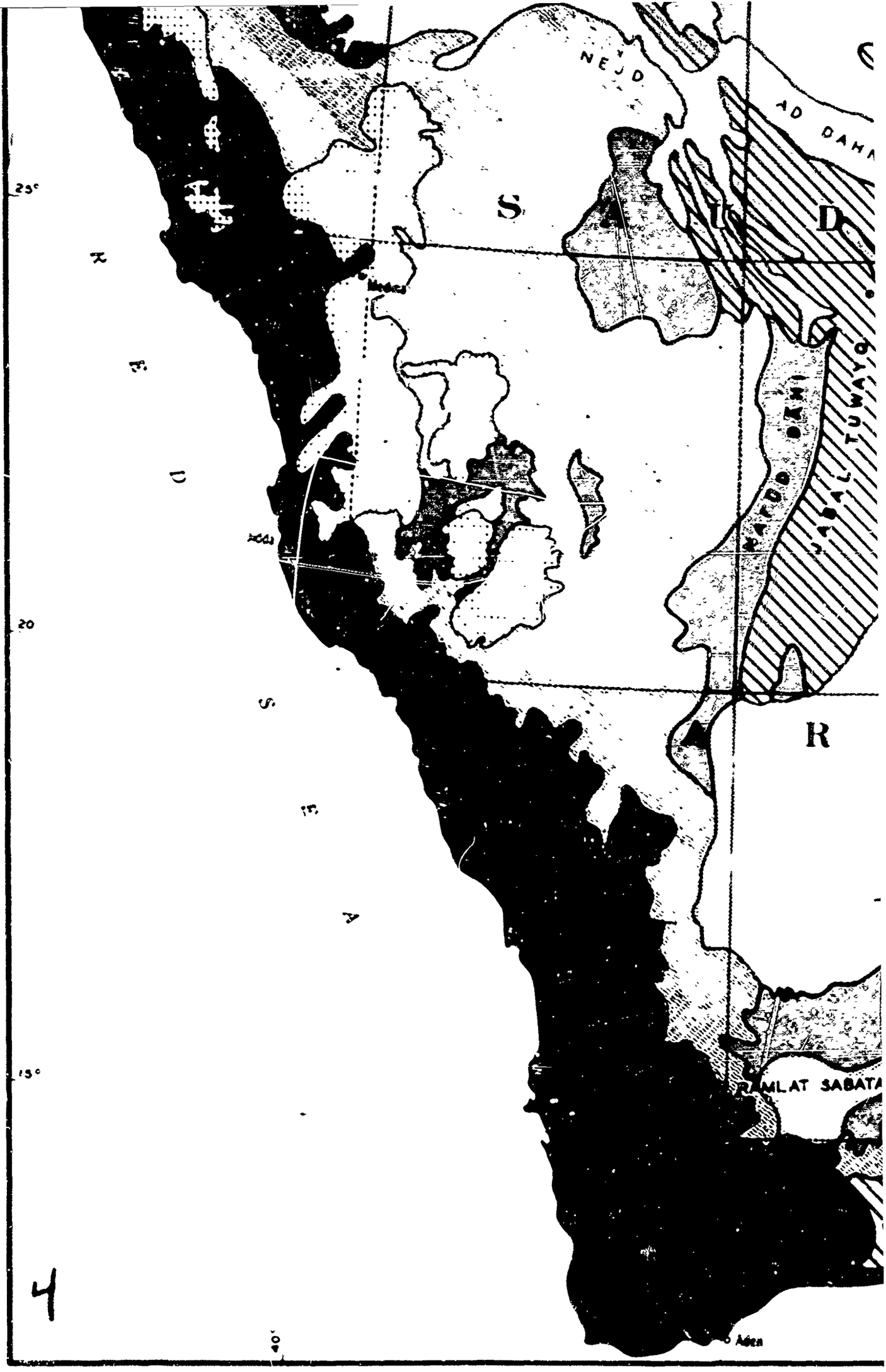
2


35°
30°
25°
I R A N
Kuwait
PERSIAN GULF
Ras al Tanura
Dhahran
QATAR
TRUCIAL OMAN
GULF OF OMAN
Muscat

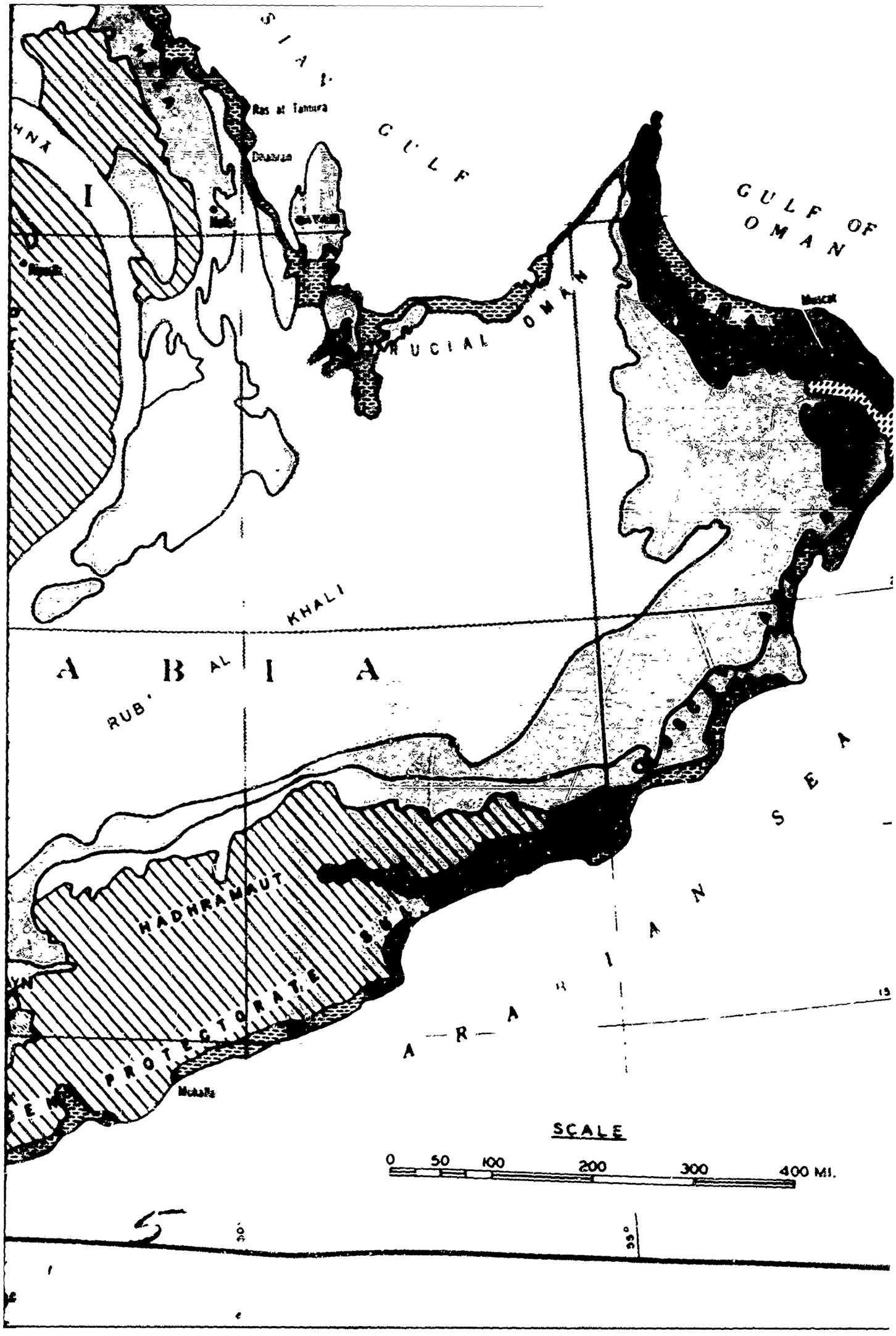




SOUTHWESTERN UNITED STATES


NEJD
AD DAHN
S
D
R
JABAL TUWAYQ
RUB AL KHALI
RAMLAT SABATA
Medina
Jeddah
Aden
25°
20
15°

4


GULF
GULF OF OMAN
Ras al Tanura
Dhahran
Muscat
TRUCIAL OMAN
KHALI
RUB' AL
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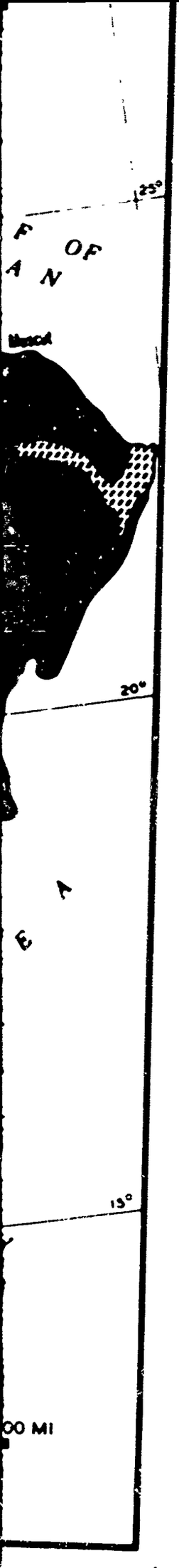
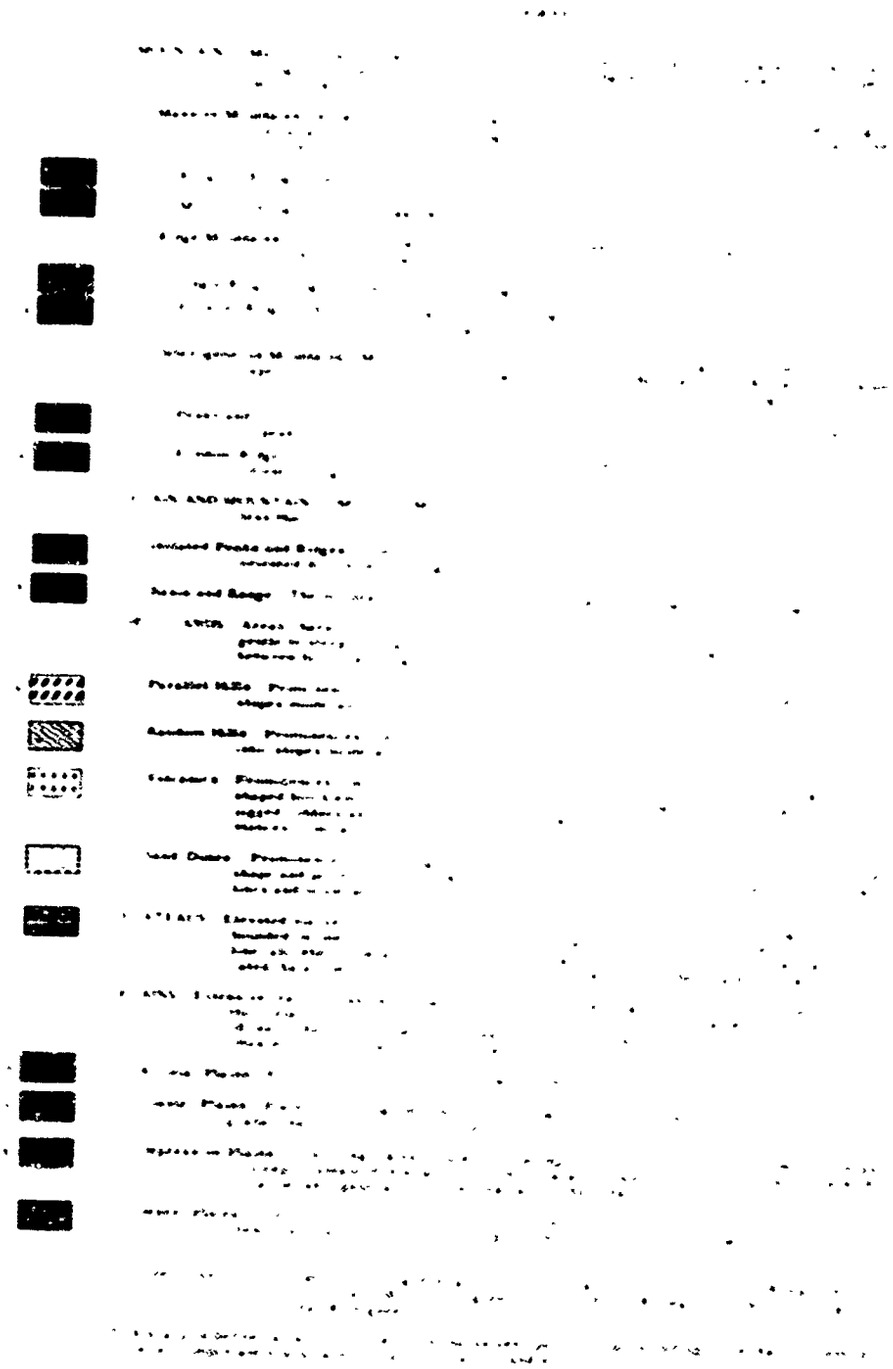
HADHRAMAUT
PROTECTORATE
Mukalla
ARABIAN SEA
SCALE
0 50 100 200 300 400 MI.





ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

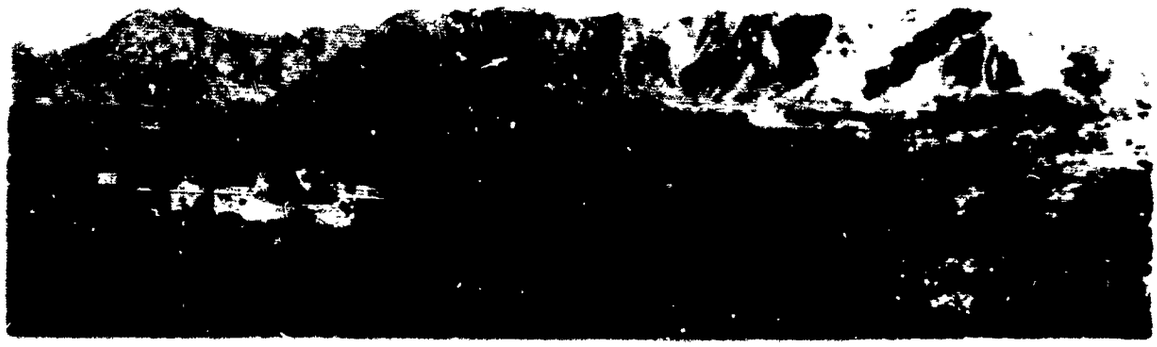
PHYSIOGRAPHY

PLATE 14

PHY

MOUNTAINS:

Mountains are masses of land whi
pared to the basal dimensions and which r
the surrounding terrain. Areas so mapp
massive, ridge, and heterogeneous mounta
places in which the plains occupy more tha
tains of the Middle East are extremely ru
to steep and relief ranging from 50 to
vegetative types has been mapped within t
areas spotted with scattered woodlands a
comprise approximately 13 percent of the
mountains form the entire western rim
Aden in the south to the port of Aqaba in t
tains generally have crest elevations ran
crous peaks in the southern portion of th
western Syria the Qalamoun Mountains ext



M-1. Northwest face of Jabal Jihaf from Al Muriah in the Wadi Tiban in the mountains of western Aden. At 13°45' N, 44°41' E.

M-4. Wadi Baish where it enters the coastal plain from the Hejaz Mountains in western Arabia. At

M-5. Jabel Sannin rising to 8622 ft in the Leba
western Syria. Note terraced lower slopes. A
mately 34°30'N, 35°45'E.

OGRAPHY: 2 DESCRIPTIONS AND PHOTOGRAPHS

r summit areas that are small com-
heights of more than 1[illegible] ft above
y be entirely mountainous, such as
or they may be plain-mountain com-
percent of the total area. The moun-
, with slopes ranging from moderate
al thousand feet. A wide variety of
mountainous areas. Sparse, scrubby
tivated zones are typical. Mountains
dle East desert. Ranges of massive
e Arabian Peninsula extending from
rth. These rugged crystalline moun-
from 6000 to 9000 ft; however, num-
ge are known to exceed 11,000 ft. In
northeast from Mount Hermon, on the
eastern side of the Rift Valley, as three roughly parallel ridges of [illegible]
mentary rock. In northeast Iraq roughly parallel, discontinuous ridges
mentary rock separated by extensive intermontane plains form a basin an
region which marks the transition from the western steppes to the high
mountains of Kurdistan. In eastern Iraq the Zagros Mountains extend into
as a series of parallel ridge mountains. Genetically the Zagros are par
same mountain mass as the Kurdish ranges to the north. In the extreme
eastern portion of the Arabian Peninsula lies a crescentic band of massiv
tains flanked by the great steppes and deserts to the south and west. These
mountains of Oman, an extremely rugged range of igneous and sedimentar
tains trending some 400 miles to the northwest, paralleling the coast o
Along the southern shore of Arabia lies a thin strip of parallel ridge mo
These are structurally part of the Hadhramaut Plateaus, but the processes
sion have created a series of sharp-crested, roughly parallel, sedimentar
several thousand feet in elevation.

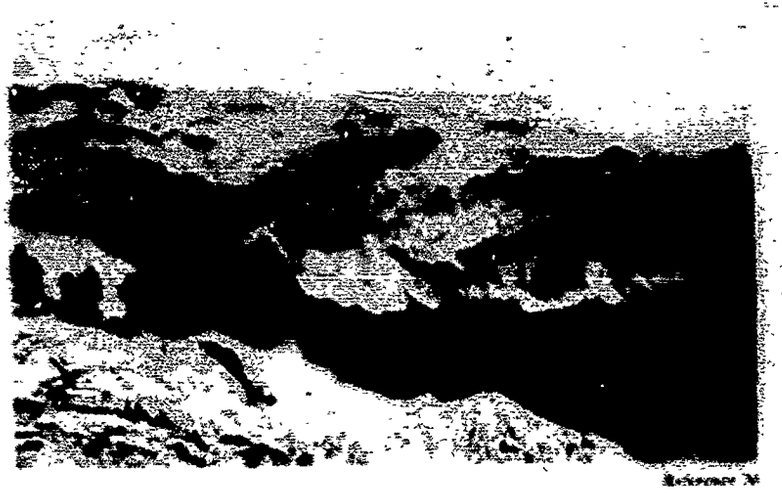
M-2. View southward toward Ma'bar from the Naqil isla pass, elevation 9600 ft, in the mountains of southern Yemen. At 14°46' N, 44°20' E.

M-6. Upper fold and nappe zone in the Basin and Range region of northeastern Iraq. At ap-

M-7. Mountains along the Iranian bor
looking southwest from Kaluh-i-Bazr

three roughly parallel ridges of folded sedi-
roughly parallel, discontinuous ridges of sedi-
the intermontane plains form a basin and range
from the western steppes to the high, rugged
Iraq the Zagros Mountains extend into the area
Geologically the Zagros are part of the
ranges to the north. In the extreme south-
land lies a crescentic band of massive moun-
and deserts to the south and west. These are the
rugged range of igneous and sedimentary moun-
the northwest, paralleling the coast of Oman.
is like a thin strip of parallel ridge mountains.
Mountains, but the processes of stre-
erected, roughly parallel, sedimentary ridges

, elevation 9600 ft.

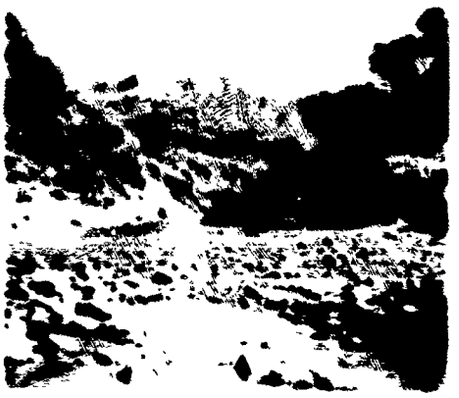


M-3. View from eastern edge of the top of Jabel Harir, elevation 7700 ft, in the southwestern mountains of Arabia. At 13°46' N, 44°52' E.

M-7. Mountains along the Iranian border.

M-8. Oman Mountains north of Buraimi, at approximately 22°10' N.

M-1. Northwest face of Jabal Jihaf from Al Marich in the Wadi Tibaq in the mountains of western Aden. At 13°45' N, 44°41' E.



M-4. Wadi Baish where it enters the coastal plain from the Hejaz Mountains in western Arabia. At approximately 17°23' N, 42°30' E.

M-5. Jabel Sanain rising to 8622 ft in the Lebanon western Syria. Note terraced lower slopes. At mately 34°00'N, 35°15'E.

M-9. Jabal Kaur in mountainous Oman as seen from the west. At approximately 22°57' N, 56°53' E.

M-10. Drowned valley near Ras the northern tip of Oman. At app 26°20' N, 56°30' E.

4

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume

M-2. View southward toward Ma'ber from the Naqb Isla pass, elevation 5600 ft, in the Mountains of southern Yemen. At 14°46' N, 44°20' E.

...ehanian range. ... At approxi-

M-6. Upper fold and nappe zone in the Basin and Range region of northeastern Iraq. At approximately 35°30' N, 45°20' E.

M-7. Mountains along the Iran... looking southwest from Kaish... At 33°20' N, 46°20' E.

...Ras Musandam on ...t approximately

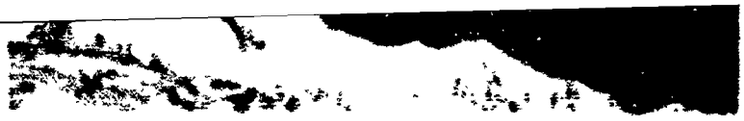
M-11. Dissected limestone country of Ruus al Jibal looking southeast from Khasab on the Musandam Peninsula. At 26°11' N, 56°15' E.

M-12. Foothills of the O... from the Wadi Jizi in the ... At approximately 26°25' ...

...sue I of this report

Reference 70

, elevation 9600 ft.



Reference 70

M-5. View from eastern edge of the top of Jabel Harir, elevation 7[illegible] ft., in the southwestern mountains of Arabia. At 1[illegible]° N, 46°52' E.

By [illegible]

M-7. Mountains along the Iranian border, looking southwest from Kalak-i-Buzurg. At 33°30' N, 46°20' E.

Reference 72

M-8. Oman Mountains north of Buraimi. At approximately 24°30' N, 56°00' E.

Reference 45

M-12. Foothills of the Oman Mountains as seen from the Wadi Jizu in the Batina coastal plain. At approximately 24°25' N, 56°39' E.

Reference 23

M-13. Western end of the Aden peninsula seen eastwards from the air.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

PHYSIOGRAPHY

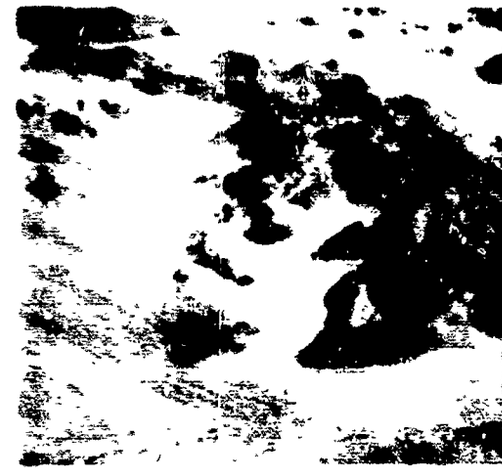
DESCRIPTIONS AND PHOTOGRAPHS

HILL LANDS:

Hill lands are areas characterized by prom
that rise to heights of less than 1000 ft above the
mapped may consist of hill masses or of hills a
occupy as much as 75 percent of the total area.
position of hill lands vary widely. They may co
composed of igneous, metamorphic, and sediment
materials; volcanic hills, composed of lava or a
into a wide variety of types by the wind. Slopes v
to steep, and relief ranges from 10 to 700 ft. Th
characteristically barren of vegetation, whereas
support a sparse vegetative cover. Hill lands com
the Middle East desert. Random hills of crystalli
the great central tableland of Arabia which flanks
and slopes gently toward the Persian Gulf to the e
these hill lands are composed predominantly of

Reference 20

H-1. Crateve and lava-flows north of Jabal Kahi in western Arabia. At 19°17' N, 44°04' E.



Landlike and Aer

H-2. Maturely dissected hill lands in western Transjordan near Aqaba. Gr masses projecting from vast areas of and sand. At 29°39' N, 35°25' E.

Reference 24

H-6. Crystalline hill in the Jabal Aja Range near Tonaiye in central Arabia. At 27°44' N, 41°36' E.

Reference 20

H-7 Weathered crystalline hill in north central Arabia. At 29°44' N, 37°36' E.

H-8. A typi approximate

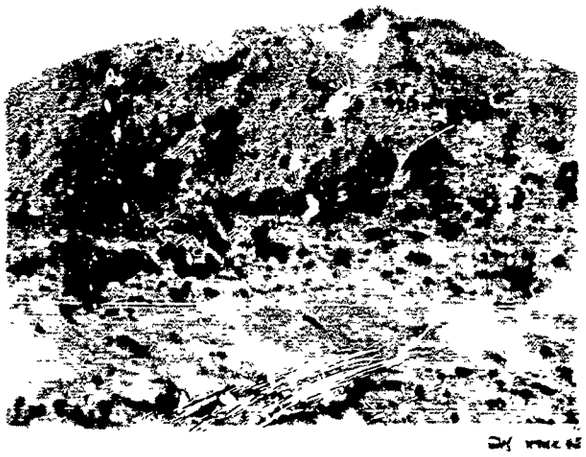
2

RAPHY: DESCRIPTIONS AND PHOTOGRAPHS

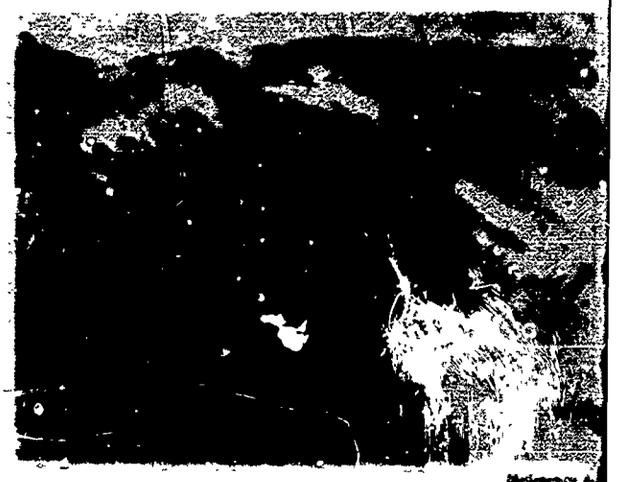
[illegible], or small [illegible] area, surrounding terrain. Areas so [illegible]rated by plains [illegible] may [illegible]. The characteristics of some [illegible]st of parallel or [illegible] hills [illegible]y rock or [illegible] consolidated [illegible]ers; or sand [illegible], sculptured [illegible] in hill lands range [illegible] gentle [illegible]nes and the [illegible] hills are [illegible] parallel and [illegible] hills may [illegible]se approximately [illegible] percent of [illegible] rock form the [illegible] part of [illegible] great western [illegible] main range [illegible]. In their northern extremity, [illegible] sedimentary rocks. However, immediately adjacent to the western mountains they are interrupted by volcanic harras, i.e. vast fields of basaltic lava surmounted by groups of cinder cones. The harras extend in a broken line from the Aden Peninsula in the south to the Hauran district of southern Syria. Sand dunes occupy much of southern Arabia with the greatest concentration being in the Rub' al Khali, a sand dune area of 150,000 square miles and second only to the Sahara in size. From the northern part of this vast sea of longitudinal dunes, thin strips of sand desert, composed of low dunes, project in a northwesterly direction and terminate in the An Nafud -- the northern desert of Arabia. Smaller dune areas are found scattered throughout the peninsula, the most notable of which are the Nafud Dahi in central Arabia, the Ramlat Sabatayn in southern Arabia, and the Hasa plain in eastern Arabia. Parallel hills have been mapped in two small areas, a small zone flanking the southeastern extremity of the Oman Mountains and a hilly area to the west of Jerusalem. The gross topography of both areas is the surface expression of folding in sedimentary rocks.

[illegible]

[illegible]uth-
[illegible] rock
[illegible]cres

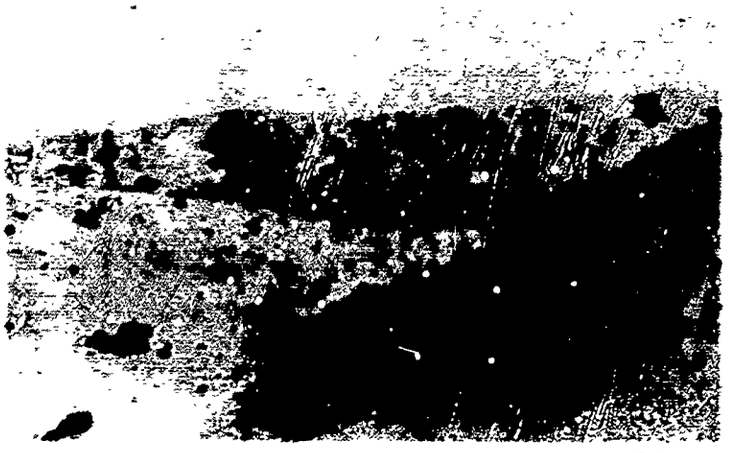


H-1. A granite boss as seen from the Wadi Tayib in the hill lands of southwestern Arabia.



H-4. Interior of Harah volcanic crater in the hill lands of southwestern Arabia. At 18°25' N, 46°45' E.

[illegible]l longitudinal dune in the Rub al Khali. At [illegible] 22°30' N, 52°30' E.



H-9. Dune massifs in southern Liwa in northeastern Rub al Khali. At approximately 23°00' N, 55°10' E.

3

PHS

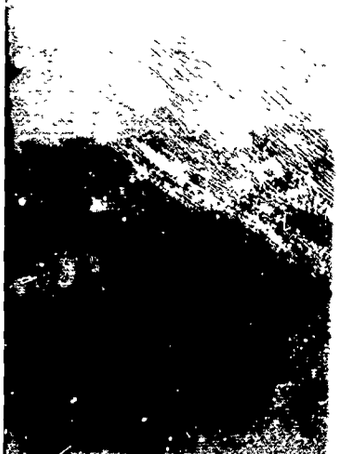
ntains they are interrupted by volcanic
surmounted by groups of cinder cones.
the Aden Peninsula in the south to the
dunes occupy much of southern Arabia
the Rub' al Khali, a sand dune area of
the Sahara in size. From the northern
thin strips of sand desert, composed of
ction and terminate in the An Nafud --
ne areas are found scattered throughout
re the Nafud Dahi in central Arabia, the
the Hasa plain in eastern Arabia. Par-
areas, a small zone flanking the south-
nd a hilly area to the west of Jerusalem.
surface expression of folding in sedi-

Reference 61

erior of Karah volcanic crater in the
n of southwestern Arabia. At 14°26' N,
E.

Reference 61

H-9. Badly weathered crystalline hill in the Hima Valley in southwestern Arabia. At 18°15' N, 44°30' E.



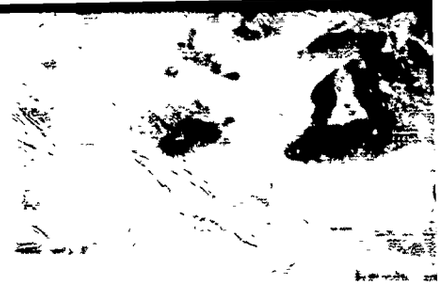
Reference 61

Lava in northeastern Rub al
N, 53°10' E.

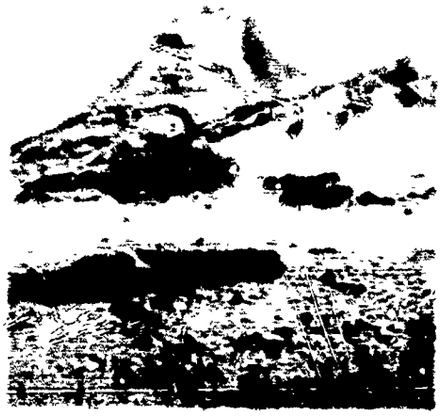
Reference 4

H-10. A deep horseshoe depression in the An Nafud in northern Arabia. At approximately 28°30' N, 41°30' E.

H-1. Craters and lava-flows north of Jabal Kohl in western Arabia. At 19°47' N, 44°04' E.



H-2. Maturely dissected hill land western Transjordan near Aqaba. masses projecting from vast area and sand. At 29°35' N, 35°25' E.



H-6. Crystalline hill in the Jabal Aja Range near Yuwaiya in central Arabia. At 27°44' N, 41°36' E.

H-7. Weathered crystalline hill in north central Arabia. At 27°44' N, 37°36' E.

H-8. A t approxim

H-11. Isolated barchan dunes between Dammam Dome and the northern Jafura desert in eastern Arabia. At approximately 26°17' N, 50°00' E.

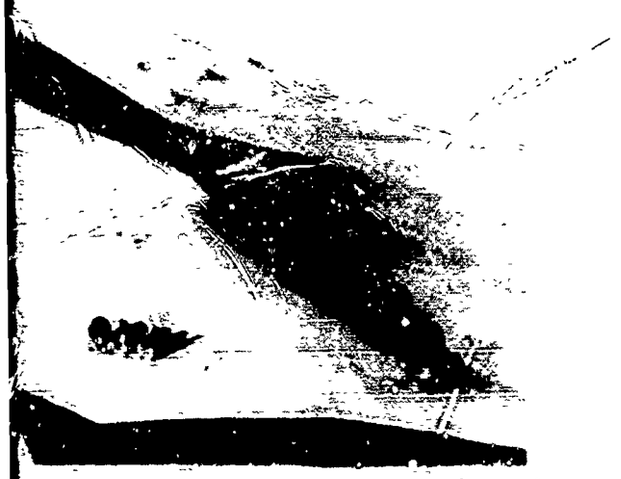
H-12. Gebunim sand dune, typical of the Rub' al Khali. At approximately 19°55' N, 54°30' E.

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I of this

outh-
nt rock
scree

d-3. A granite boss as seen from the Wadi
arib in the hill lands of southwestern Arabia.

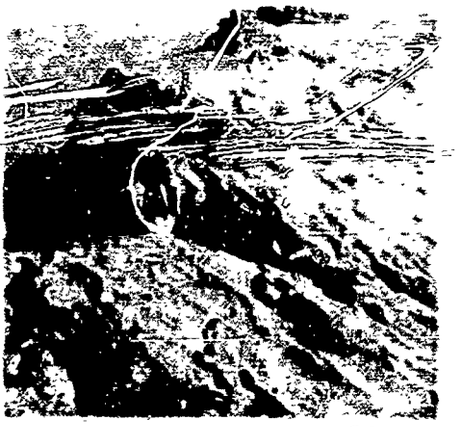
H-4. Interior of Karsh volcanic crater in the hill lands of southwestern Arabia. At 14°35' N, 46°45' E.



l longitudinal dune in the Rub al Khali. At
22°30' N, 52°30' E.

H-9. Dune massifs in southern Liwa in northeastern Rub al Khali. At approximately 23°00' N, 53°10' E.

H-13. Wind-blown sand encroaching on the date gardens of Qatif in the Hasa. At 26°32' N, 50°00' E.



H-14. Fossil dune at Suraimiyat in the Hasa Plain of eastern Arabia. At 26°24' N, 50°07' E.

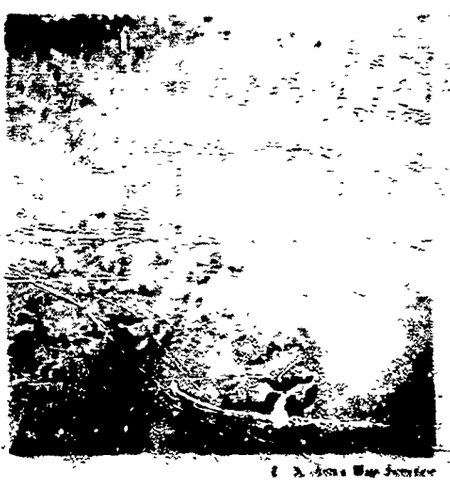
H-15. Active dunes on a
plain in western Arabia.
43°05' E.

or of Karsh volcanic crater in the
southwestern Arabia. At 14°35' N,

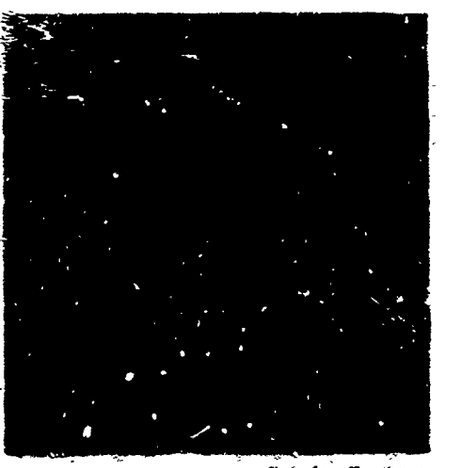
H-5. Badly weathered crystalline hill in the Iiima Valley in southwestern Arabia. At 18°15' N, 44°50' E.

in northeastern Rub al
3°10' E.

H-10. A deep horseshoe depression in the An Nafud in northern Arabia. At approximately 28°30' N, 41°30' E.



H-15. Active dunes on an old peneplain in western Arabia. At 21°00' N, 43°05' E.



H-16. Dune patterns created by a variable wind regime on a peneplain in southern Rub al Khali. At 18°45' N, 52°50' E.

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

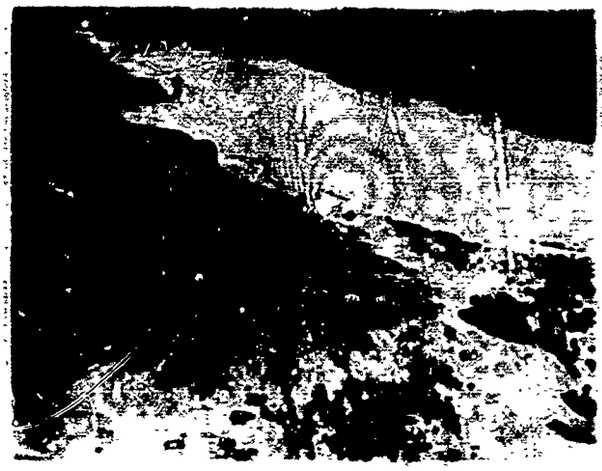
PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

PHYSIO

PLATEAUS:

Plateaus are elevated masses of land cha
less flat-lying summit areas bounded on one or
100 ft in height. Dissected plateaus have been
of the original surface remains. Approximate
desert consists of plateaus, some 80 percent of
sected plateaus. The average slope of a plateau
than 1 degree; however, some summits have sur
rolling and exhibit slopes ranging up to 6 degree
may range up to 10 ft, whereas the rolling plate
10 to 50 ft. Depth of dissection along the major d
ceed 1000 ft. The plateaus were formed in area
mentary rock of which sandstone and limestone
types. In general, plateau summits lie between e
plateaus of the Middle East may be conveniently
Southern Plateaus, (2) the Central Plateaus, an
southern section of the Hadhramaut, as it is ca
impressive plateau regions of the world. Deep
1000 ft deep and several miles across, cut the



Reference 22

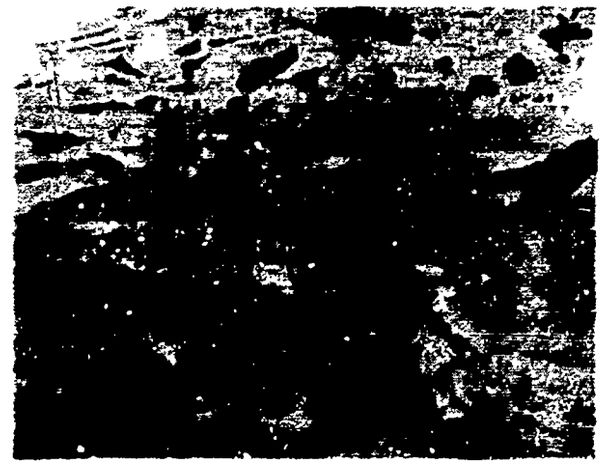
P-1. Wadi 'Amd at Hureidha in the Hadhramaut, Southern Arabia.

By courtesy of the British Ministry of Defence (Navy Department)

P-2. The Jordan Plateaus between Jerusalem and Jericho as seen from the air. Exact location unknown.

Reference 12

P-6. Plateau surface above Tarim in the Hadhramaut. At approximately 16°05' N, 48°00' E



Reference 17

P-7. Typical plateau surface south of the Wadi Hadhramaut. At approximately 15°45' N, 48°00' E

GRAPHY: DESCRIPTIONS AND PHOTOGRAPHS

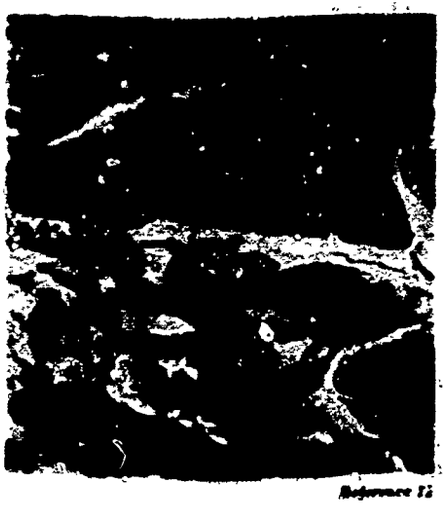
cterized by extensive, more or
rge sides by scarps greater than
pped where less than [illegible] percent
21 percent of the Middle East
hich have been mapped as dis-
mmit is characteristically less
es which are more undulating or
Relief on the flat-lying summits
scarps have relief ranging from
inageways may occasionally ex-
f bedded horizontal-lying sedi-
the most commonly occurring
vations of 1000 and [illegible] ft. The
ided into three sections: (1) the
(3) the Northern Plateaus. The
d, is certainly one of the most
inding wadis, often as much as
untry into great isolated blocks
of tableland. The Hadhramaut has a steep seaward-facing scarp and slopes gently to the north where it grades without a distinct break into the Rub' al Khali Desert. The central section consists of a series of roughly concentric basins of plateau separated by thin strips of sand desert. They reach their greatest elevations in the west and grade gently eastward until they dip beneath the plain bordering the Persian Gulf. The westernmost of these plateaus, Jabal Tuwayq, is intensely dissected, and travel through this area is restricted to the beds of a few deep wadis. To the east the plateaus occur as relatively undissected flat-lying areas of bedrock often covered with a thin veneer of wind-polished gravel. The northern plateaus occupy much of the northwest portion of the study area. They are bounded on the north by the Galaaa Ranges and the Euphrates River and extend in a southeast direction until they merge with the central plateaus to the south. To the east the plateaus gradually grade into desert plains. In general, they have their greatest dissection in the west. The western component of this area is separated from the eastern by the large volcanic area that extends from Damascus to the southeast through Syria, Transjordan, and into northern Saudi Arabia. The Al Wadyan Plateau, immediately to the east of these lava fields, is dissected by innumerable shallow wadis.

By courtesy of the British Ministry of Defence (Navy Department)

P-3. View eastward from the Deir Plateau region in Jordan, near Petra. Exact location unknown.

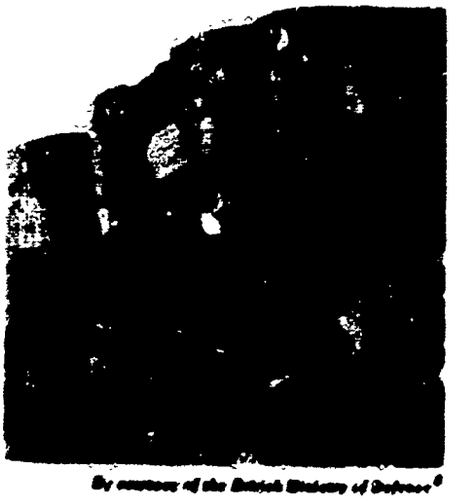
By courtesy of the British Ministry of Defence (Navy Department)

P-4. Crater of Jabal Seys, Jabal Druse volcanic plateau region, Syria. At 33°25'N, 36°50'E.



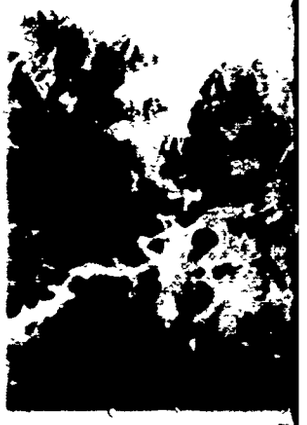
Reference 12

P-8. Aerial view of the dissected Hadhramaut plateaus showing the [illegible] trenched plateaus and the char-



By courtesy of the British Ministry of Defence

P-9. The Sagta Pass in Jabal Tuwaiq in central Arabia. At 24°30' N, 46°25' E.



P-10. Intensely dissected the plateau bordering the

3

ep seaward-facing scarp and slopes gently
stinct break into the Rub' al Khal, Desert.
s of roughly concentric bands of plateau
They reach their greatest elevations in
they dip beneath the plain bordering th
plateaus, Jabal Tuwayq, is intensely dis-
estricted to the beds of a few deep wadis,
vely unbisected flat-lying areas of bed-
wind-polished gravel. The northern pla-
gn of the study area. They are bounded on
e Euphrates River and extend in a south-
central plateaus to the south. to the east
plains. In general, they have their great-
component of this area is separated from
at extends from Damascus to the south
o northern Saudi Arabia. The Al Wadyan
e lava fields, is dissected by innumerable

er of Jebel Seys, Jebel Druse volcanic
gion, Syria. At 33°25'N, 36°50'E.

By courtesy of the British Ministry of Defence (Navy Department)

P-5. Safa lava flood, Jebel Druse, Syria. At 33°25'N, 36°50'E.

U. S. Army Map Service

P-10. Intensely dissected edge of the plateau bordering the Wadi Arabe in southern Palestine. At 30°09' N,

Bulletin of the Amer. Assoc. of Petroleum Geologists

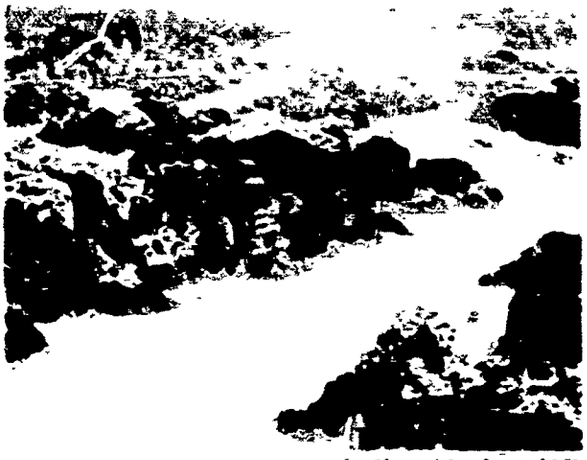
P-11. Looking up the Wadi Zerqa in the Jordan Plateau north of the Dead Sea. At approximately

P-1. Wadi 'Amd at Hureidha in the Hadhramaut, Southern Arabia.

P-2. The Jordan Plateaus between Jerusalem and Jericho as seen from the air. Exact location unknown.

P-6. Plateau surface above Tarim in the Hadhramaut. At approximately 16°05' N, 48°58' E.

P-7. Typical plateau surface south of the Wadi Hadhramaut. At approximately 15°45' N, 49°00' E.



P-12. Intensely dissected plateau region near Jabel Ram in southwestern Transjordan. At 29°35' N, 35°25' E.

P-13. A line of rugged peaks rising sharply from the margins of the Wadi Araba south of the Dead Sea. At 29°55' N, 35°05' E.

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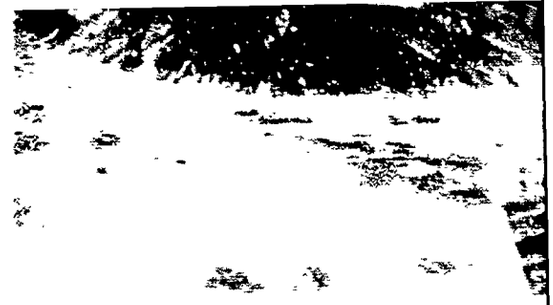
* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I of this rep

P-3. View eastward from the Deir Plateau region in Jordan, near Petra. Exact location unknown.



P-4. Crater of Jebel Seyo, Jebel Druse volc plateau region, Syria. At 33°25'N, 36°50'E.

Reference 12

P-8. Aerial view of the dissected Hadhramaut plateaus showing the entrenched drainage and the characteristic denudation. At approximately 16°15' N, 49°30' E.

By courtesy of the British Ministry of Defence

P-9. The Seqta Pass in Jabal Tuwaiq in central Arabia. At 24°30' N, 46°25' E.

P-10. Intensely di the plateau borderi in southern Palest 35°05' E.

Dr. James G. Holcomb

P-14. Remnant of old plateau surface in the Upper Wadyan Province, southwestern Iraq. The Wadi Hauran traverses the area shown in the photo, flowing from left to right. At approximately 33°30' N, 41°40' E.

Dr. James G. Holcomb

P-15. Jointing in well-bedded Cretaceous limestone on the north side of Wadi Hauran in southwestern Iraq. At approximately 33°40' N 42°00' E.

5

rater of Jebel Syys, Jebel Druse volcanic region, Syria. At 33°25'N, 36°50'E.

P-5. Safa lava flood, Jebel Druse, Syria At 33°25'N, 36°50'E.

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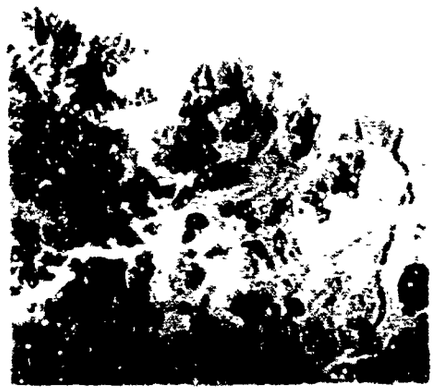
At



P-10. Intensely dissected edge of the plateau bordering the Wadi Araba in southern Palestine. At 30°00' N, 35°05' E.

P-11. Looking up the Wadi Zerga in the Jordan Plateau north of the Dead Sea. At approximately 32°10' N, 35°50' E.

Dr. James C. Ridgeway

inting in well-bedded Cretaceous on the north side of Wadi Hauran in ern Iraq. At approximately 33°40' N,

Dr. James C. Ridgeway

P-16. Erosional remnants in the Gaara Depression, southwestern Iraq. At approximately 33°30' N, 40°15' E.

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

PLAINS:

Plains are extensive tracts of land characterized by flat to gentle slopes. Hills may be found within plain regions but occupy less than 25 percent of the total area. Approximately 28 percent of the Middle East desert is occupied by plains. Plains may be subdivided on the basis of origin or physiographic relation. Floodplains, deltas, and terraces of major rivers are termed alluvial plains; plains bordering the sea, coastal plains; low-lying plains bounded on two or more sides by scarps, depression plains; and interior plains not readily classifiable into the other types, desert plains. Undissected plains exhibit relief ranging from approximately 0 to 10 ft. Relief within dissected plains would characteristically be between 10 and 50 ft and occasionally up to 100 ft. The composition of the plains of the Middle East desert varies widely. In the interior, vast plains of sedimentary and crystalline rocks are found. However, the majority of the plains are composed of unconsolidated material of which sand, gravel, silt, and salt are the most common. Most of the plains lie between the elevations of 0 and 1000 ft. A narrow coastal plain fringes the entire Arabian Peninsula. The plain ranges from several miles to as much as 40 miles in width and is occasionally interrupted where the adjacent highlands extend to the sea. Where the coastal plains lie in close proximity to the mountains

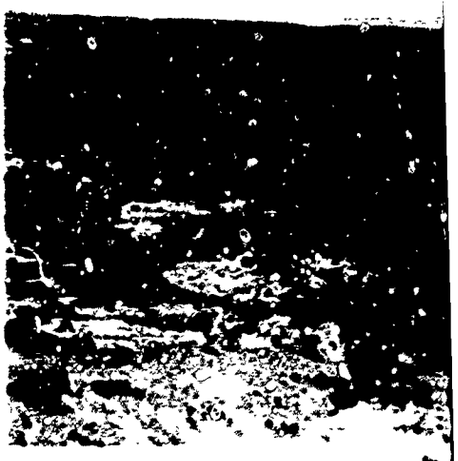
Reference 72

PL-1. The town of Mukalla on the narrow coastal plain of southern Arabia. At 14°33' N, 49°07' E.

PL-2. Intermontane plain in the Hi[illegible] tains of western Arabia. Village an[illegible] fields in the foreground are backed [illegible] of volcanic cones. At 18°83' N, 43°[illegible]

Reference 42

PL-6. Saudi Arabian Mining Syndicate road passing through high lava plateau strewn with broken lava. At approximately 22°05' N, 40°20' E.



PL-7. Outcrop of gypsum exposed [illegible] face of the Al Jezire, a vast desert [illegible] between the Tigris and Euphrates R[illegible] approximately 34°30' N, 41°30' E.

2

OGRAPHY: DESCRIPTIONS AND PHOTOGRAPHS

and plateaus they are highly dissected. Along the Hasa plain in eastern Arabia and in the southeast part of the peninsula, relatively undissected plains grade into interior plains which extend inland for great distances. Two depression plains are found in the Middle East desert: (1) the Dead Sea Trough which marks the eastern boundary of Palestine, and (2) the Wadi Sirhan in northwestern Arabia. Of the two the Wadi Sirhan is the larger, being some 200 miles in length and averaging some 20 miles in width. The Dead Sea Trough is approximately half this size. Characteristics of the two plains, however, are strikingly similar. Both are bounded on either side by high, steep scarps flanked by numerous alluvial fans and talus slopes. The floors of the depressions are generally sandy with numerous salt playas and patches of gravel. Both contain large areas of salt marsh. The Dead Sea Trough north of the Dead Sea is crossed by the Jordan River and bears little resemblance to the portion of the depression lying south of the sea. Only one alluvial plain has been mapped in the Middle East desert, that of the Tigris and Euphrates Rivers. The plain extends from north of Baghdad to the head of the Persian Gulf. The eastern limit of the floodplain is the break with the mountains of Iran. To the west the plain gradually rises until it merges with the dunes of the bordering desert plains

or the escarpment of the Ara
large number of intermittent f
upon the level of the rivers. T
vial origin characterize the pla
with differences in elevation ne
of the northern part of the stud
ders the Mediterranean mount
Iraq and south along the Pers
northwest to southeast: (1) th
(2) the Al Jazira, the desert pla
(3) Al Hajara, the st plain
(4) the Dibdibba, a flat, relati
Kuwait, and northeastern Arab
allels the Persian Gulf and me
Arabia a number of large sand
in southern Arabia flanks the
marks the transition between t

Reference 20

a Mean-
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y a number
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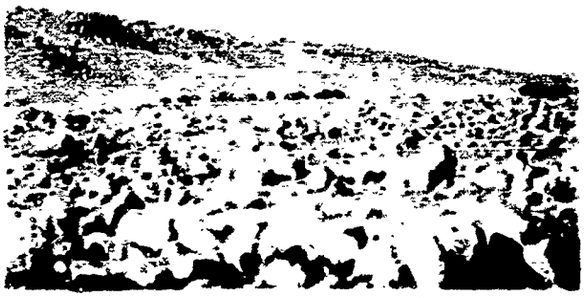


Dr. James G. Ibbeson

PL-3. North slope of the Faidhat Sa'ftullah Depression south of Salum in southern Iraq. Possibly caused by solution. At 30°25' N, 44°25' E.

Ref

PL-4. Jabal Madhra' ash Shamali, an isol butte on the Dammam Dome in eastern Ara Typical sabkha in the foreground. At 26°1 50°05' E.

James G. Ibbeson

n the sur-
dain lying
pers. At

Dr. James G. Ibbeson

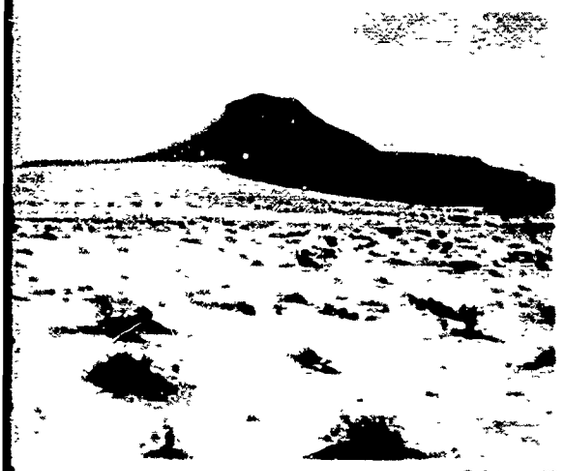
PL-8. Sinkhole near Ain Wisa in the Lower Euphrates Province of southern Iraq. At 33°06' N, 43°40' E.

Dr. James G. Ib

PL-9. Ain Aqis, an oasis in the Lower Wad Province of southern Iraq. The trees surrounding the spring are date palms. At app

3

or the escarpment of the Arabian tableland. Most of the plain is sw[illegible] a large number of intermittent freshwater lakes which vary greatly in s[illegible] depending upon the level of the rivers. Unconsolidated deposits of silt, sand, and clay of alluvial origin characterize the plain. The relief throughout the entire plain is very low with differences in elevation never exceeding a few feet. Desert plains occupy much of the northern part of the study area. Beginning with the Syrian Steppe, which borders the Mediterranean mountains to the west, the plains extend to the east across Iraq and south along the Persian Gulf in Arabia. The northern plains are, from northwest to southeast: (1) the Syrian Steppe, lying west of the Euphrates River, (2) the Al Jazira, the desert plain lying between the Tigris and the Euphrates Rivers, (3) Al Hajara, the stony plain of southern Iraq south of the Euphrates River, and (4) the Dibdibba, a flat, relatively undissected desert plain in southeastern Iraq, Kuwait, and northeastern Arabia. In east central Arabia the sandy Hasa plain parallels the Persian Gulf and merges with the central plateaus to the west. In central Arabia a number of large sand and gravel plains occur. A long, rolling desert plain in southern Arabia flanks the Hadhramaut Plateaus and the Oman Mountains and marks the transition between these highlands and the Rub' al Khali Desert.



Reference 30

-4. Jabal Madhra' ash Shamali, an isolated [illegible]te on the Dammam Dome in eastern Arabia. [illegible]ical sabkha in the foreground. At 26°18' N, [illegible]05' E.

Dr. James G. Holcomb

PL-5. Stony surface typical of the Al Hajara Plateau Province in southern Iraq. At 30°40' N, 43°45' E.

Dr. James G. Holcomb

-9. Ain Aqis, an oasis in the Lower Wadyan [illegible] of southern Iran. The trees are-

Dr. James G. Holcomb

PL-10. The surface of the Al Hamad Plain in southeastern Iran. At approximately 33°20' N,

PL-1. The town of Mukalla on the narrow coastal plain of southern Arabia. At 14°33' N, 49°07' E.

PL-2. Intermontane plain in
tains of western Arabia. Vill
fields in the foreground are h
of volcanic cones. At 18°03'

PL-6. Saudi Arabian Mining Syndicate road passing through high lava plateau strewn with broken lava. At approximately 22°05' N, 40°20' E.

PL-7. Outcrop of gypsum ex
face of the Al Jezira, a vast
between the Tigris and Euph
approximately 36°30' N, 43°

PL-11. Fortified town of Dura-Europus in the desert plains bordering the lower Euphrates in Iraq. Exact location unknown.

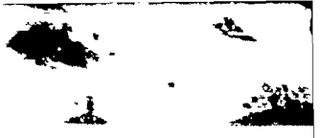
PL-12. The flat plains of
southern Iraq as viewed f
Sassan. At 30°25' N, 47°4

4

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I

the Hijaz Moun-
lage and cultivated
backed by a number
N, 43°12' E.

PL-3. North slope of the Fa'ilat Sa'atullah Depression south of Salum in southern Iraq. Possibly caused by solution. At 30°25' N, 44°25' E.



PL-4. Jabal Madhra' ash Shamali butte on the Dammam Dome in eas
Typical sabkha in the foreground.
50°95' E.

xposed on the sur-
desert plain lying
rates Rivers. At
30' E.

PL-8. Sinkhole near Ain Wiza in the Lower Wadyan Province of southern Iraq. At 33°06' N, 42°40' E.

PL-9. Ain Aqis, an oasis in the Lo
Province of southern Iraq. The tre
rounding the spring are date palms
imately 33°20' N, 43°00' E.

Ad Dibdibba in
rom the top of Jabal
5' E.

PL-13. Al Umchaimin Depression in southwestern Iraq, the crater is approximately 2 miles in diameter and is, supposedly, of meteoric origin. At 32°35' N, 39°25' E.

PL-14. The vast flood plain of the Ti
south of Baghdad. At approximately 3
44°35' E.

of this report

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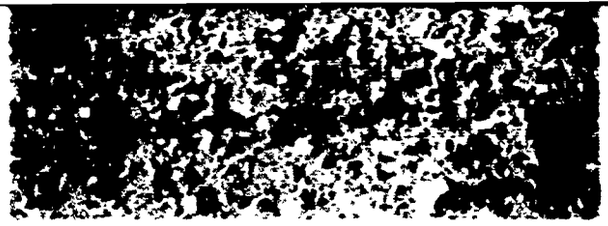
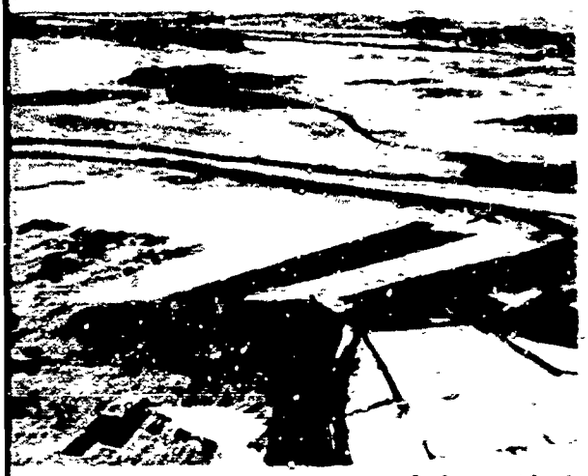
PL-4. Jabal Madhra' ash Shamali, an isolated butte on the Dammam Dome in eastern Arabia. Typical sabkha in the foreground. At 26°18' N, 50°05' E.



PL-5. Stony surface typical of the Al Hajara Plateau Province in southern Iraq. At 30°40' N, 43°45' E.

PL-9. Ain Aqis, an oasis in the Lower Wadyan Province of southern Iraq. The trees surrounding the spring are date palms. At approximately 33°20' N, 43°00' E.

PL-10. The surface of the Al Hamad Plain in southwestern Iraq. At approximately 33°20' N, 40°00' E.



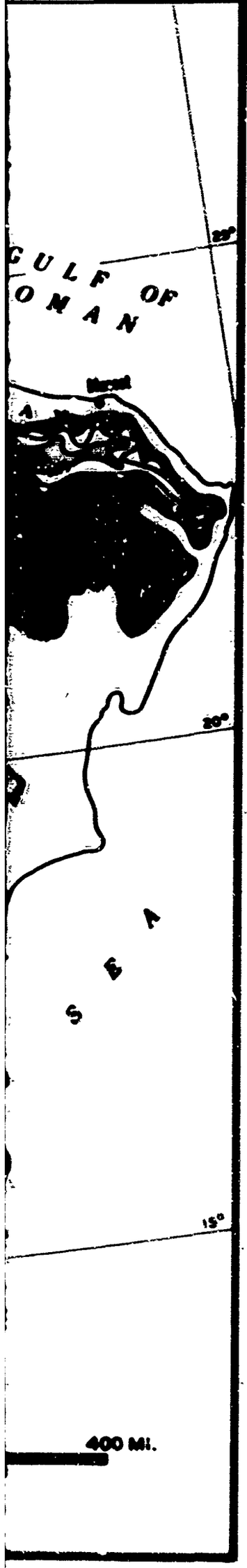
L-14. The vast flood plain of the Tigris River uth of Baghdad. At approximately 33°10' N, 0°35' E.

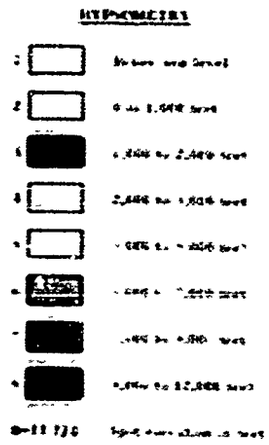
PL-15. Marsh in the southern part of the Tigris-Euphrates Delta Plain. At approximately 30°50' N, 47°30' E.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

4 PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS



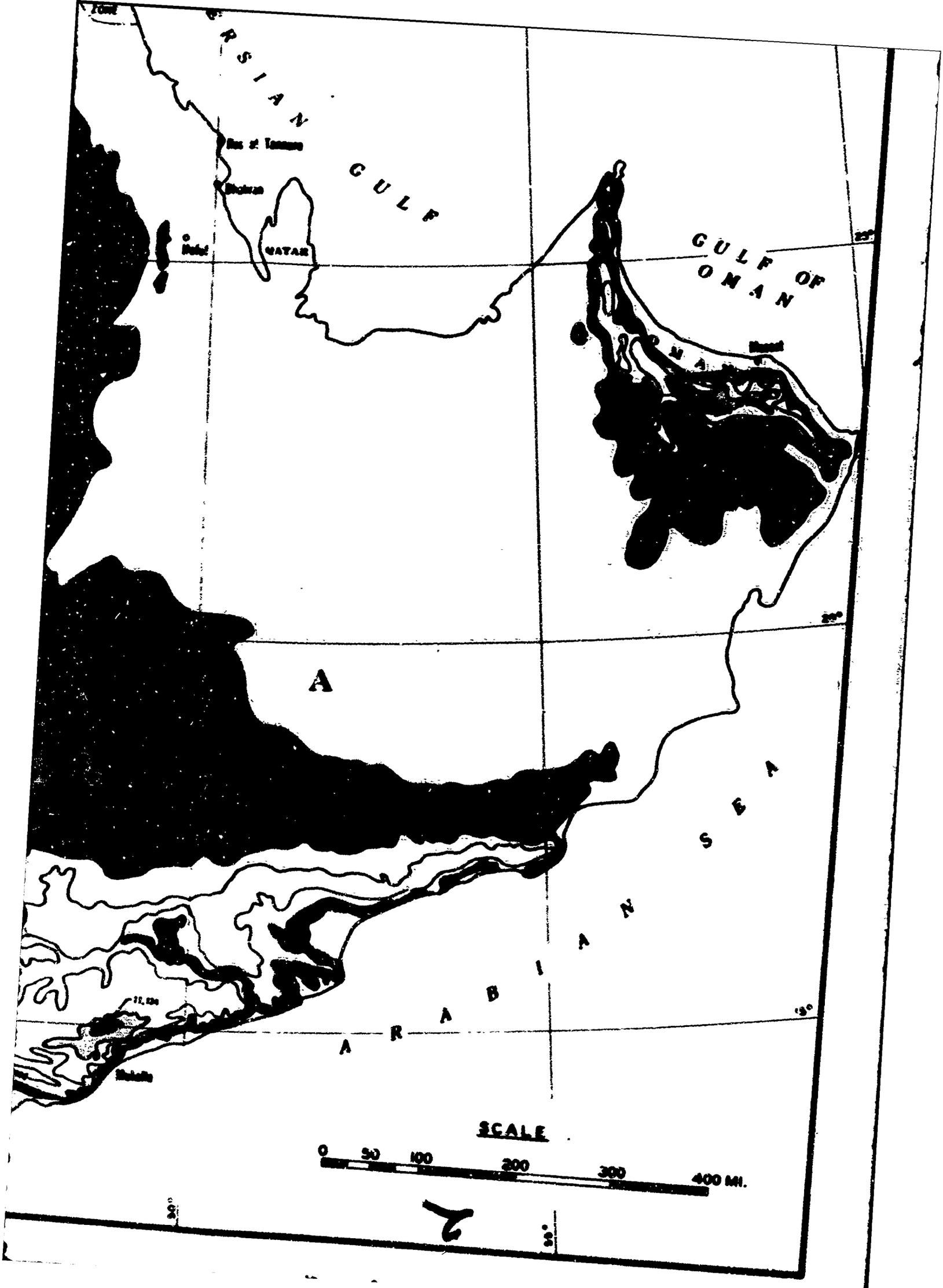


ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

HYPSOMETRY


PERSIAN GULF
Ras al Tanura
Dhahran
Bahrain
QATAR
GULF OF OMAN
Muscat
OMAN
A
ARABIAN SEA
Mukalla
SCALE
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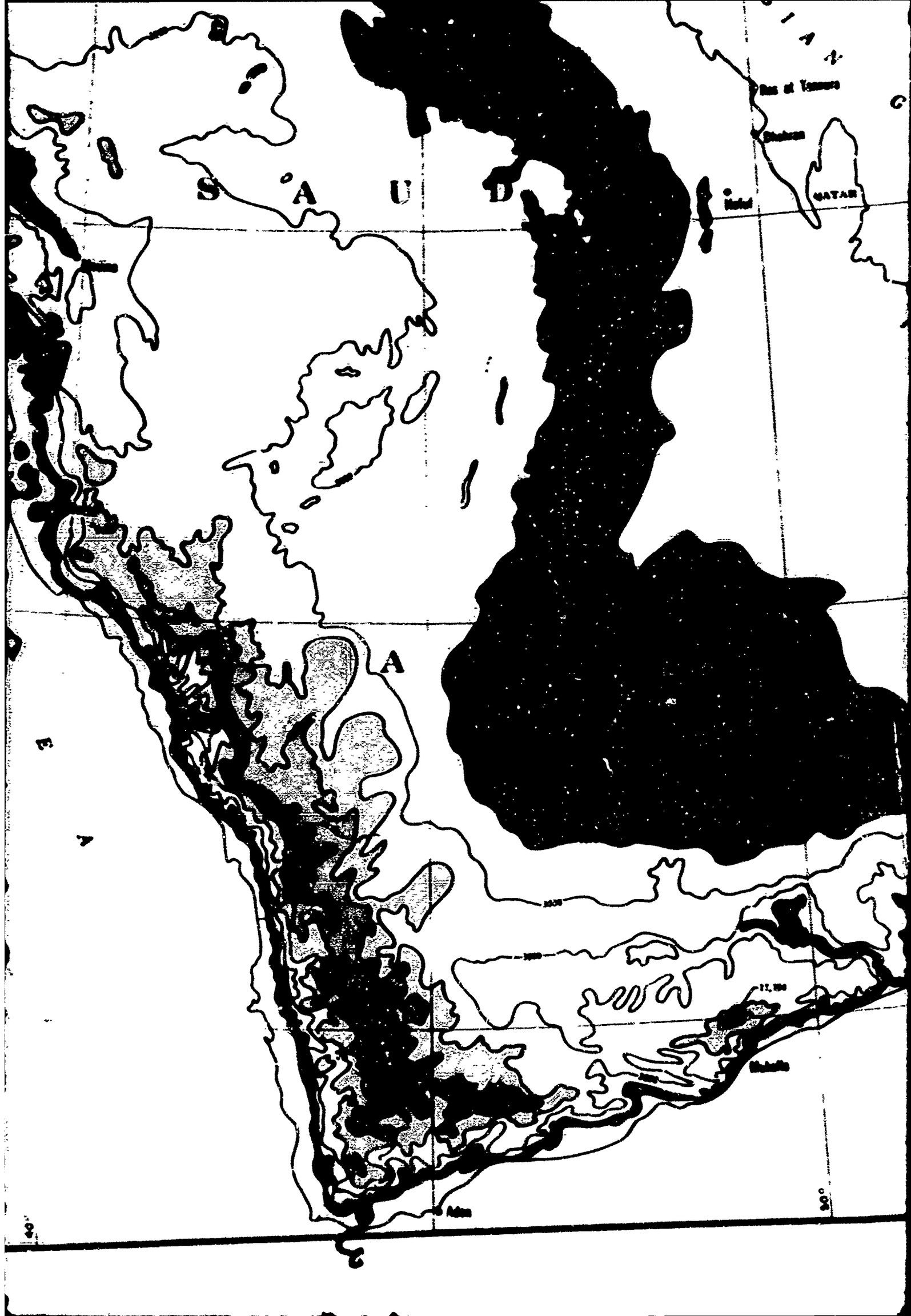
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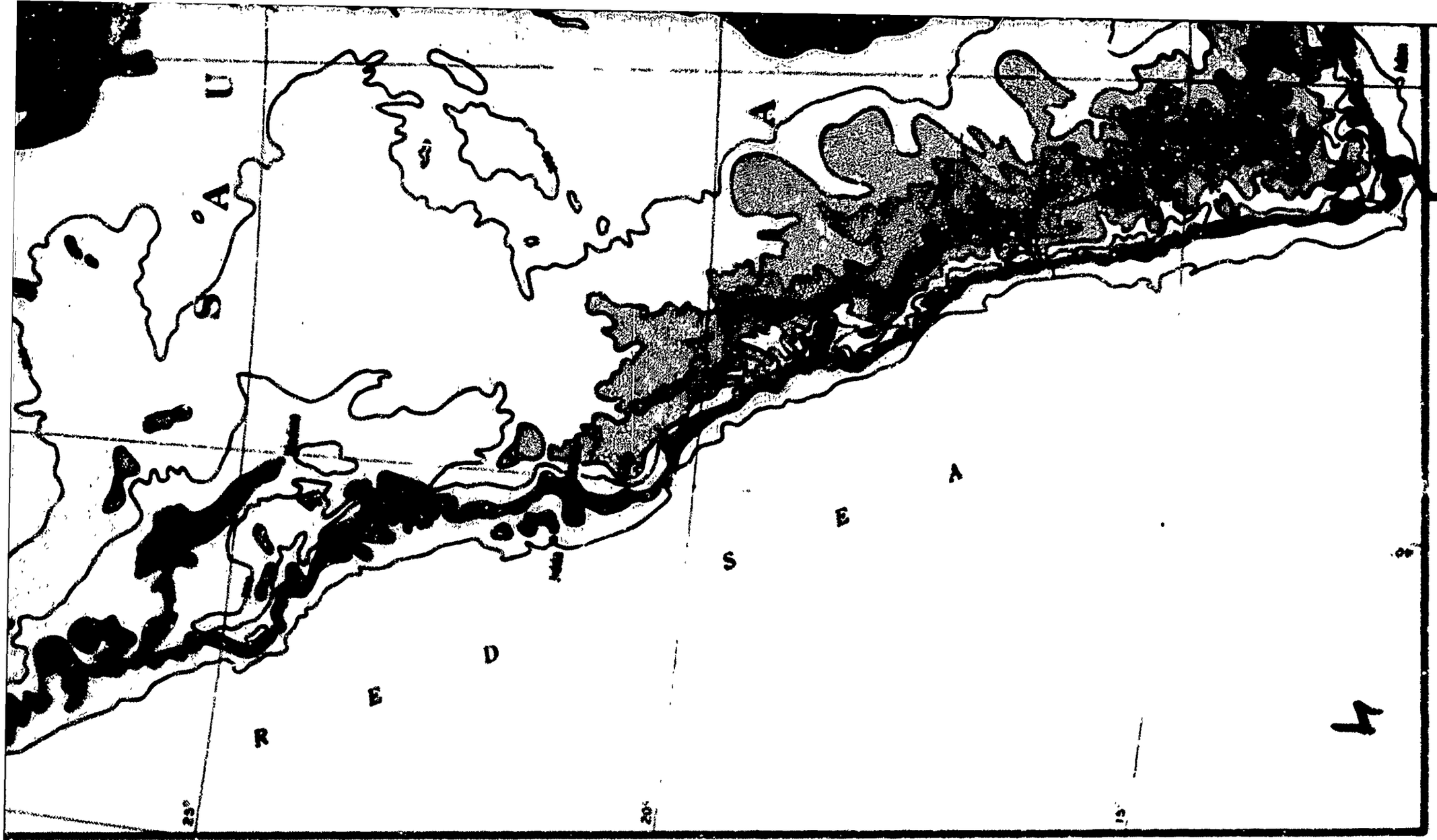
Salalah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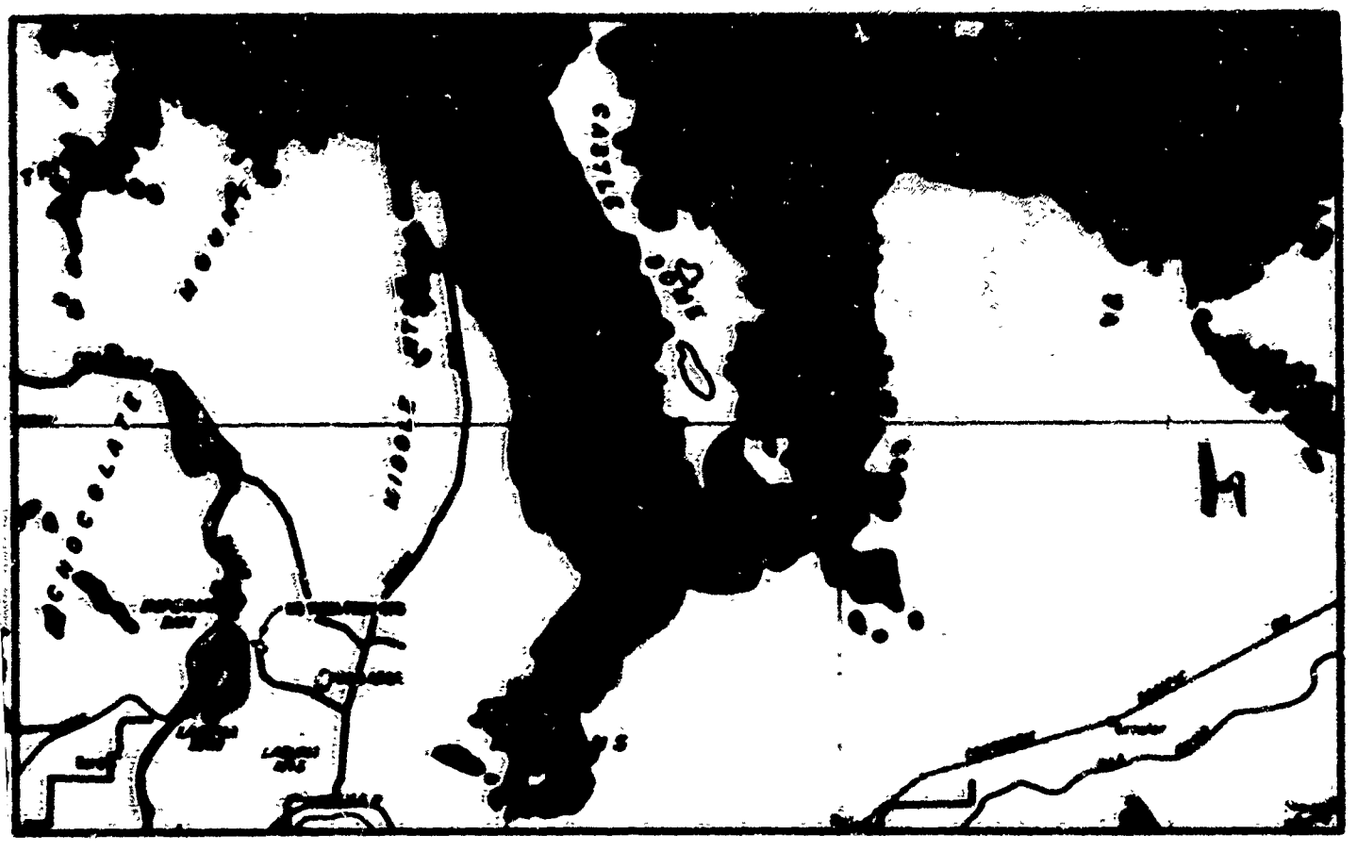
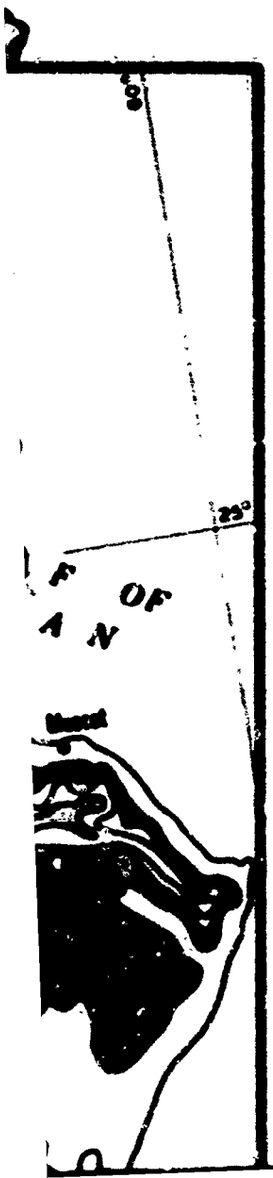
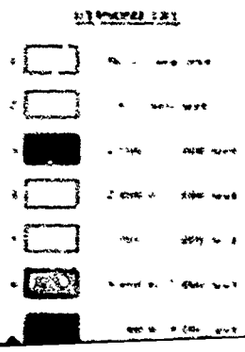
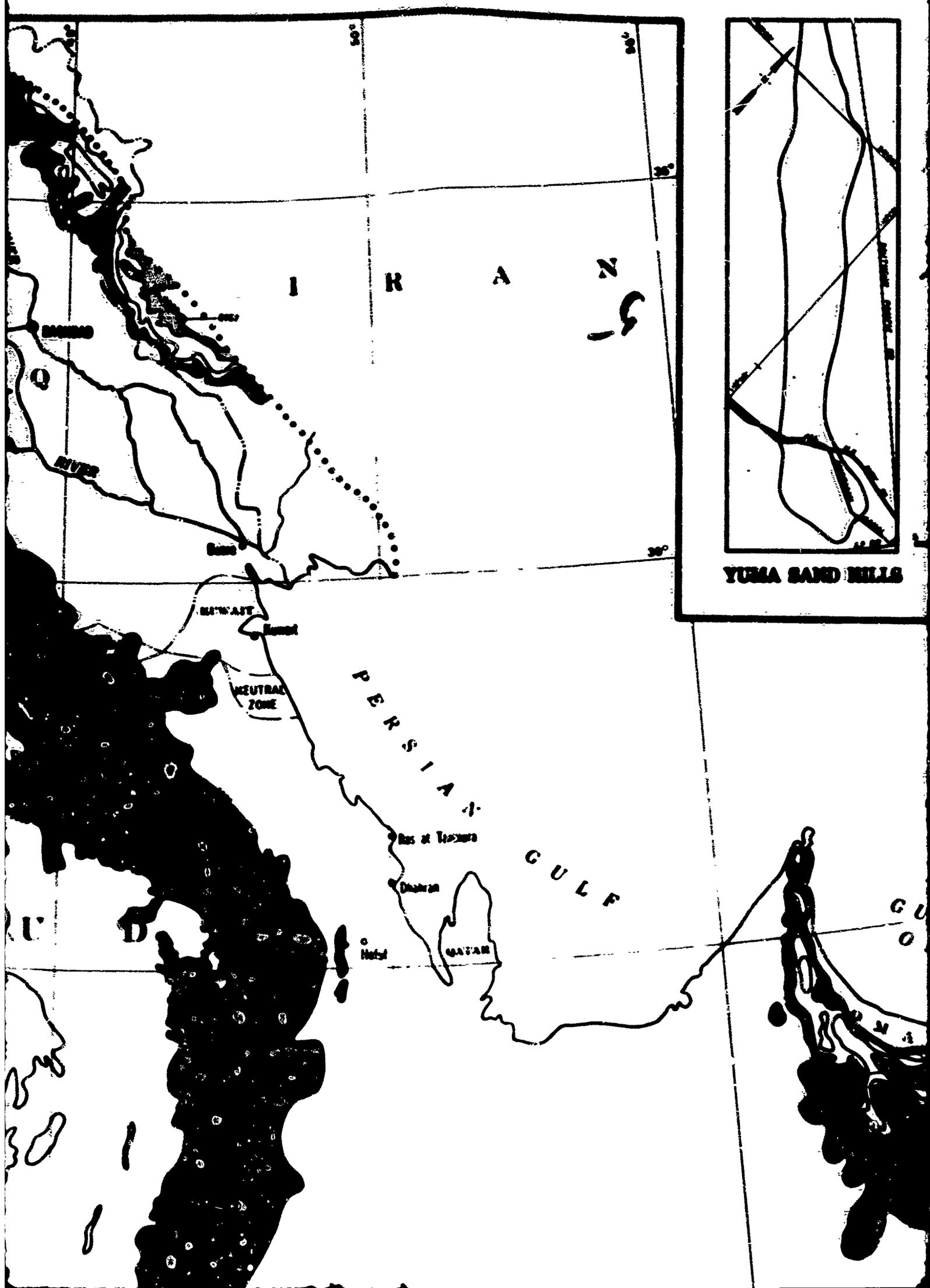
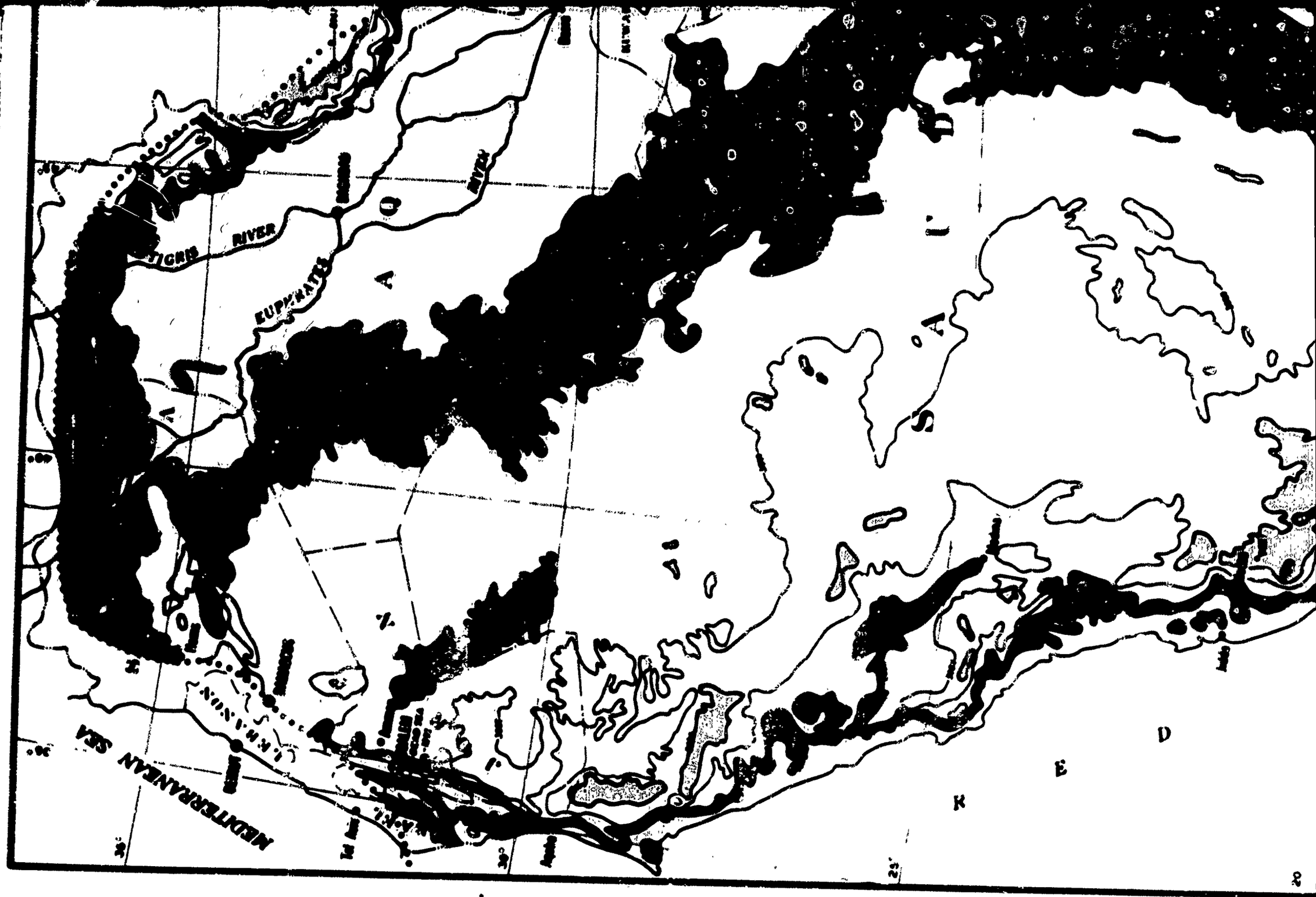


YUMA PROVING GROUND

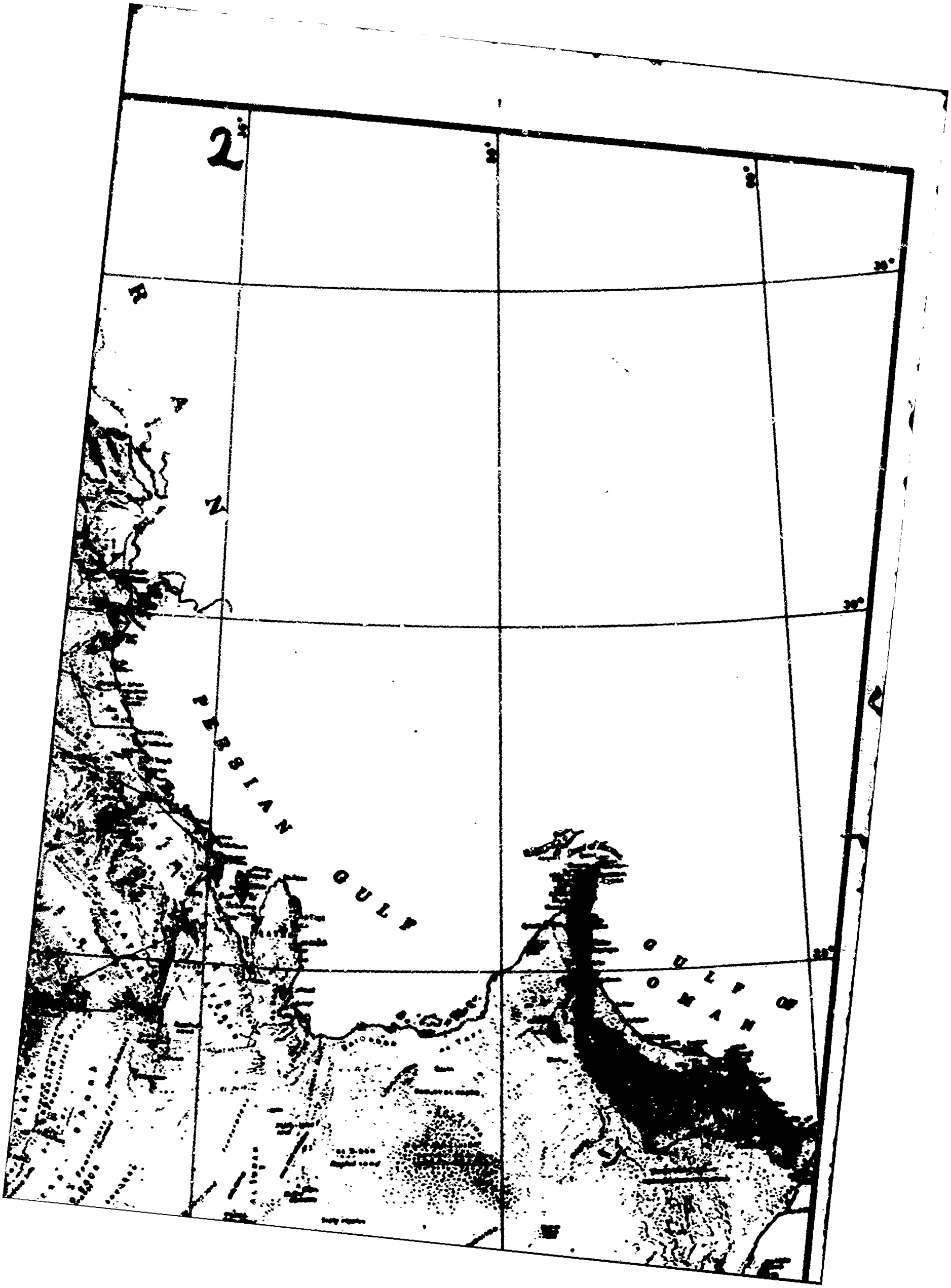


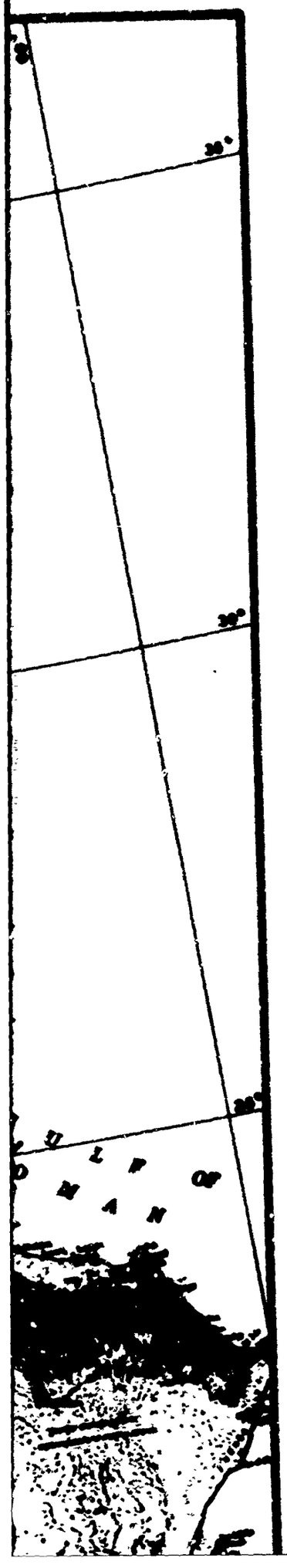



I R A N
PERSIAN GULF
NEUTRAL ZONE
Dhahran
QATAR
Hofuf
YUMA SAND HILLS


TIGRIS RIVER
EUPHRATES
RIVER
MEDITERRANEAN SEA
A
S
E
D
R

MEDITERRANEAN
SEA
30°
35°
40°
25°

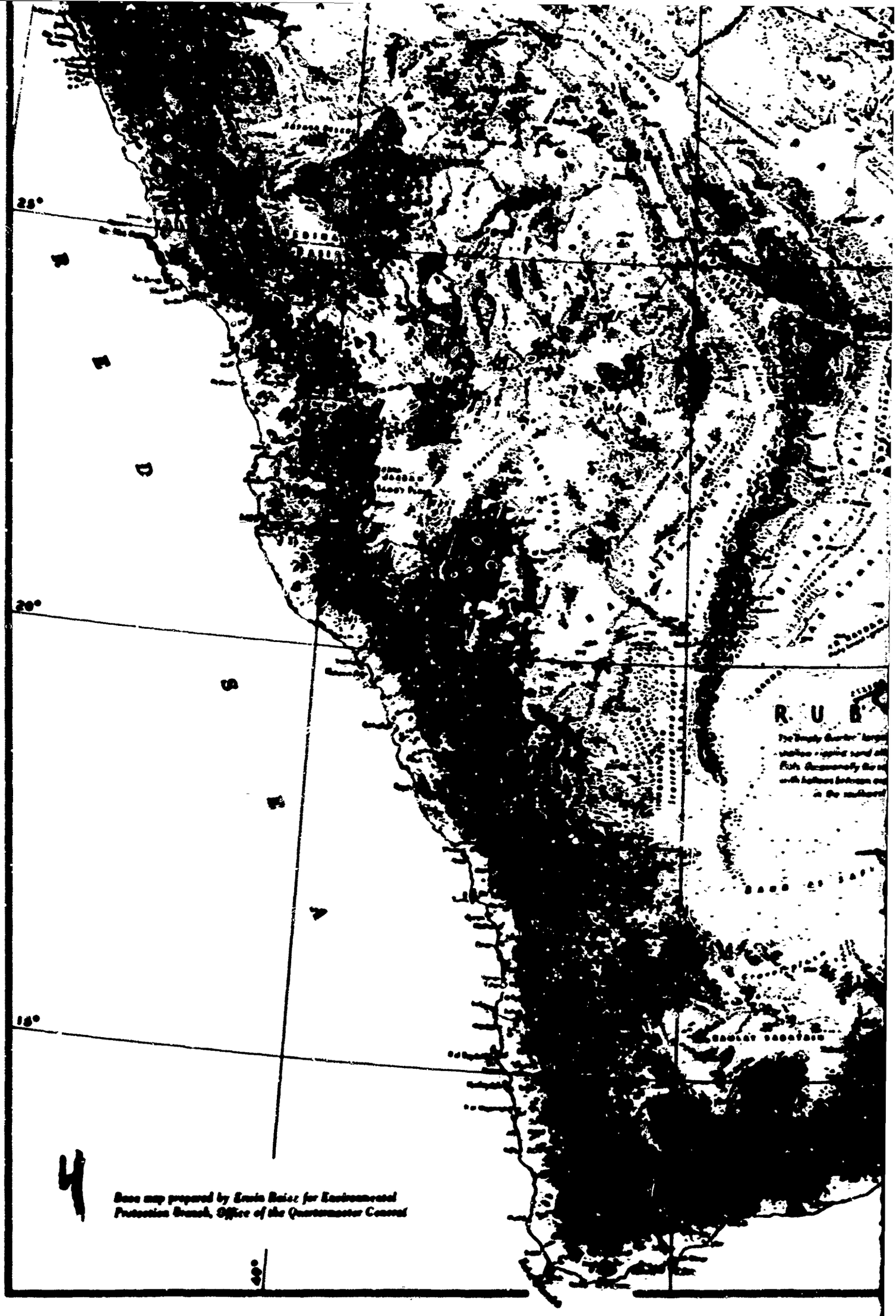

2
PERSIAN GULF
GULF OF OMAN

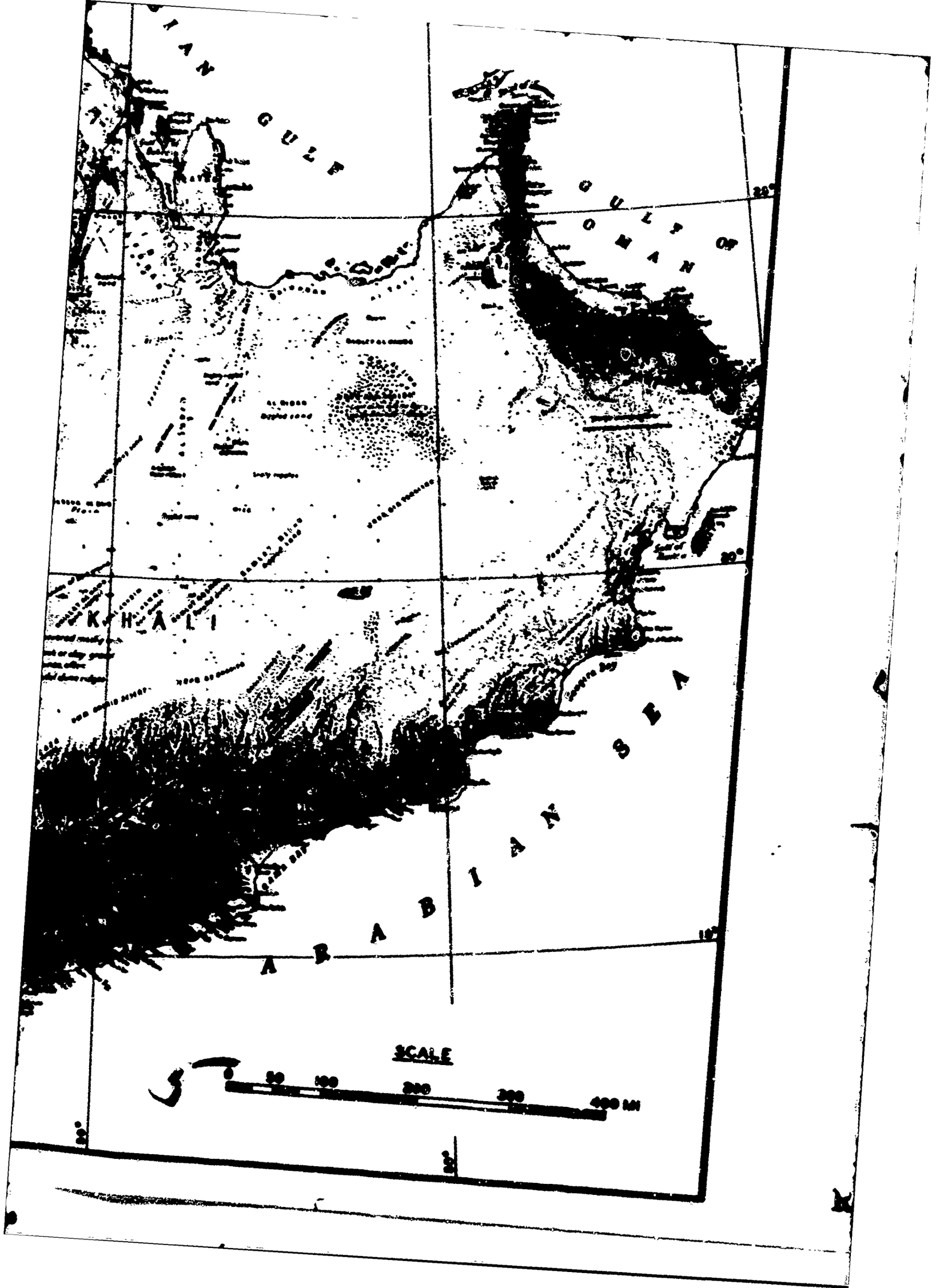


3

SOUTHWESTERN UNITED STATES

Reproduced from Map of the Landforms of the United States by Permission of Ernest Heinz and Hinz & Co.


25°
20°
15°
R U B
4
Base map prepared by Ervin Raisz for Environmental
Protection Branch, Office of the Quartermaster General


GULF
GULF OF OMAN
KHALI
ARABIAN SEA
SCALE
50
100
200
300
400 MI

Shown by Permission of Erwin Raisz and Ginn & Co.

ANALOGS OF YUMA TERRAIN

IN THE

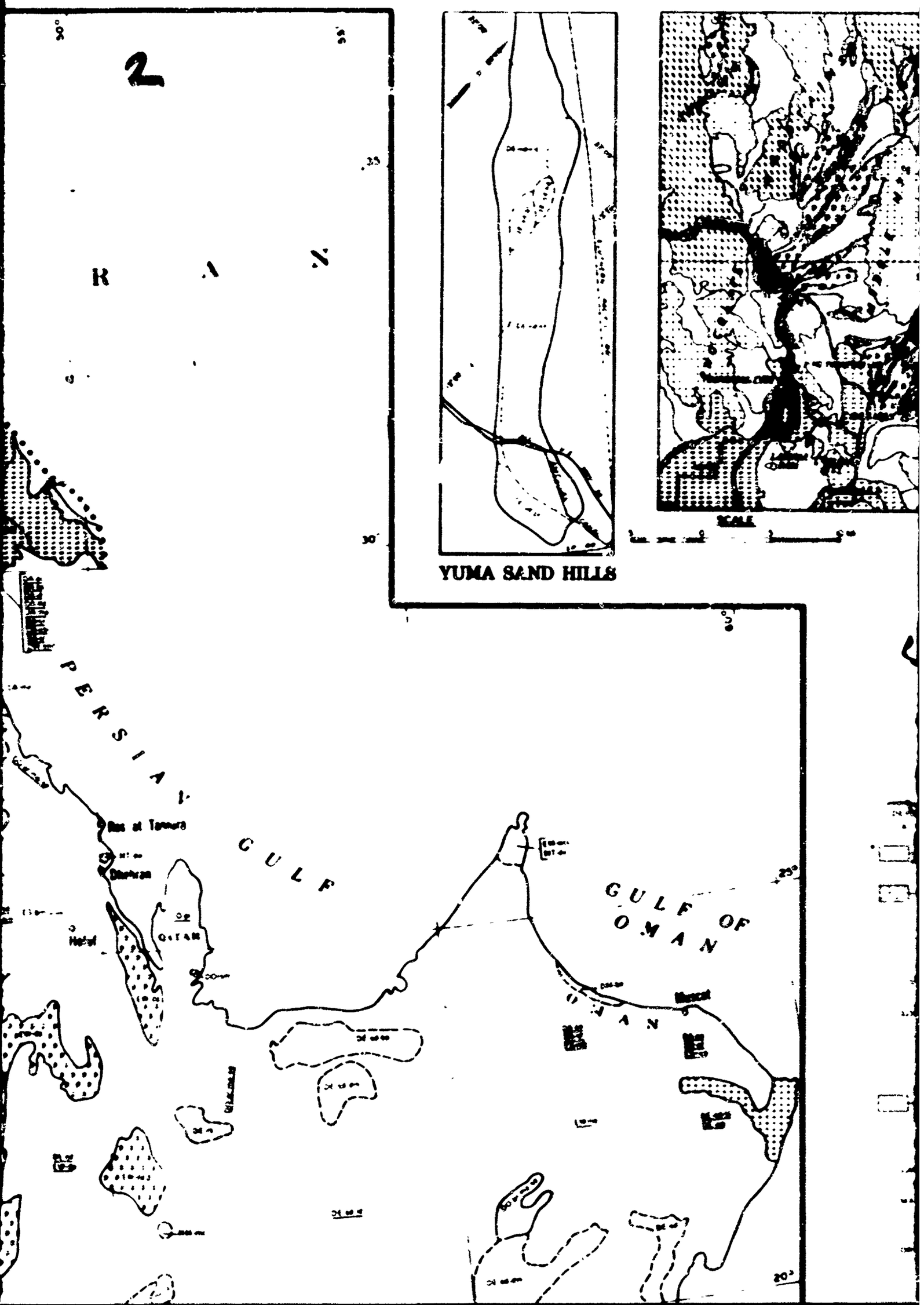
MIDDLE EAST DESERT

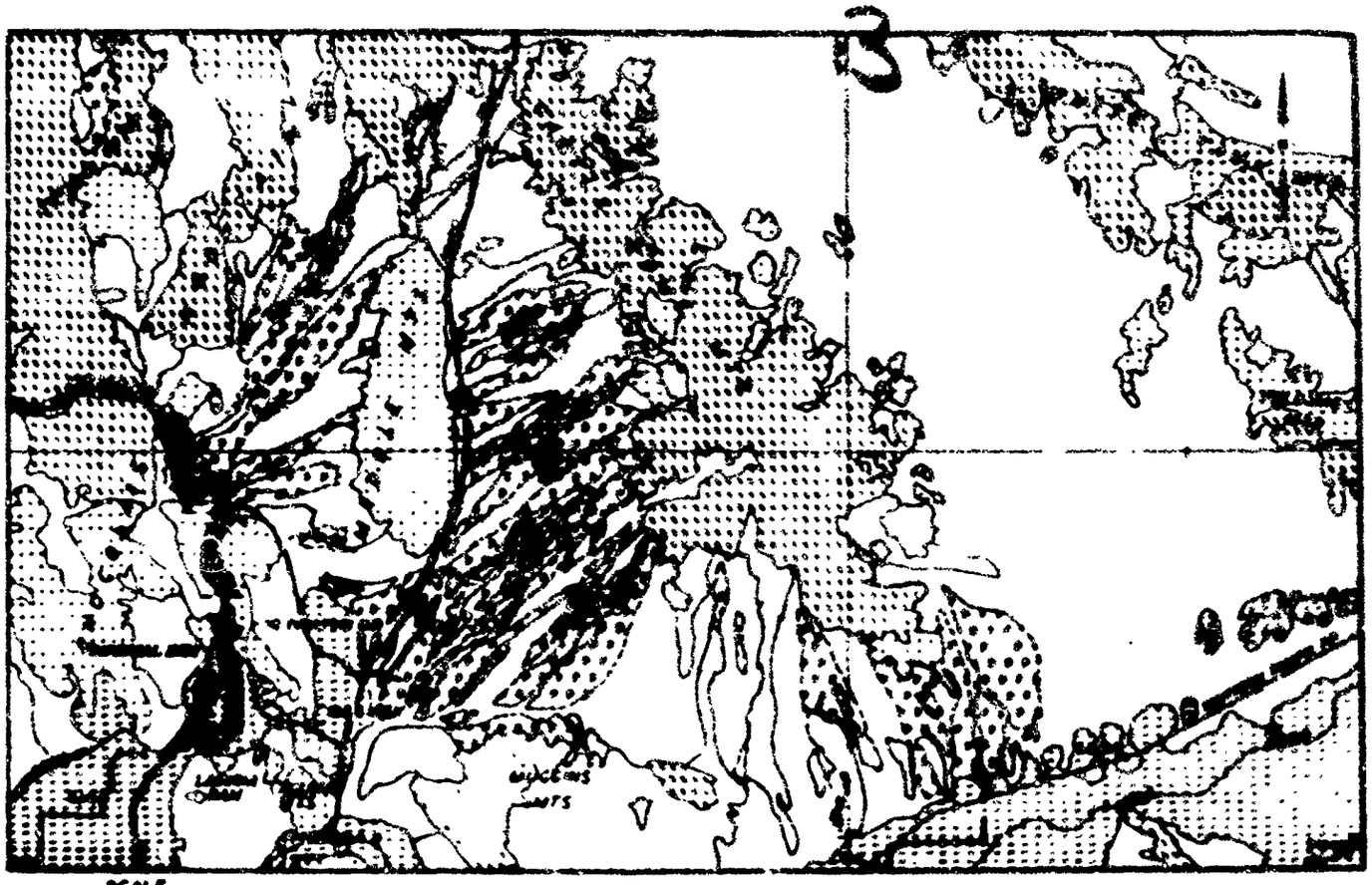
RAISZ'S LANDFORM MAP

PLATE 17

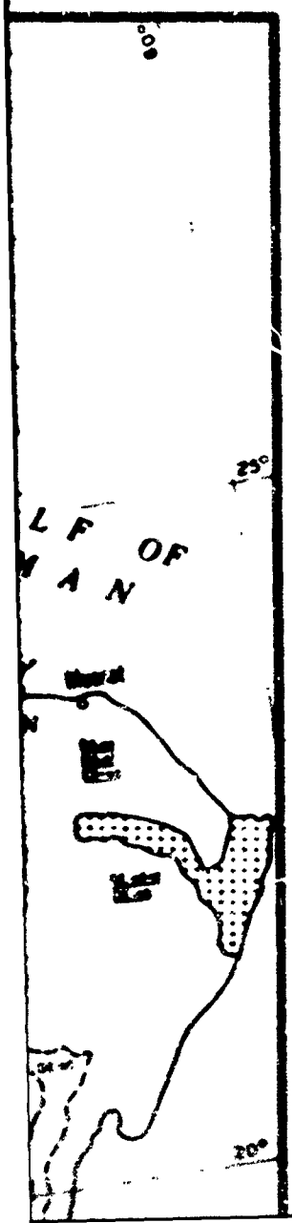
MEDITERRANEAN SEA
ALEPPO
S Y R I A
Homs
Palmyra
BEIRUT
LEBANON
DAMASCUS
Tel Aviv
Amman
JERUSALEM
ISRAEL
JORDAN
Aqaba
EUPHRATES
TIGRIS
RIVER
T R
G
NEUTRAL ZONE
S A U D I
R E D
Medina
Jeddah
Mecca
35
30°
29°

2


YUMA SAND HILLS
SCALE
PERSIAN GULF
GULF OF OMAN
QATAR
OMAN
Ras al Tanura
Dhahran
Hofuf
Muscat



YUMA PROVING GROUND



SELECTED LANDFORMS AND SURFACE CONDITIONS

[illegible]

COLLUVIAL

[illegible]

EOLIAN

[illegible]

LACUSTRINE

[illegible]

MARINE

[illegible]

[illegible]

[illegible]

MARINE

[illegible]

[illegible]

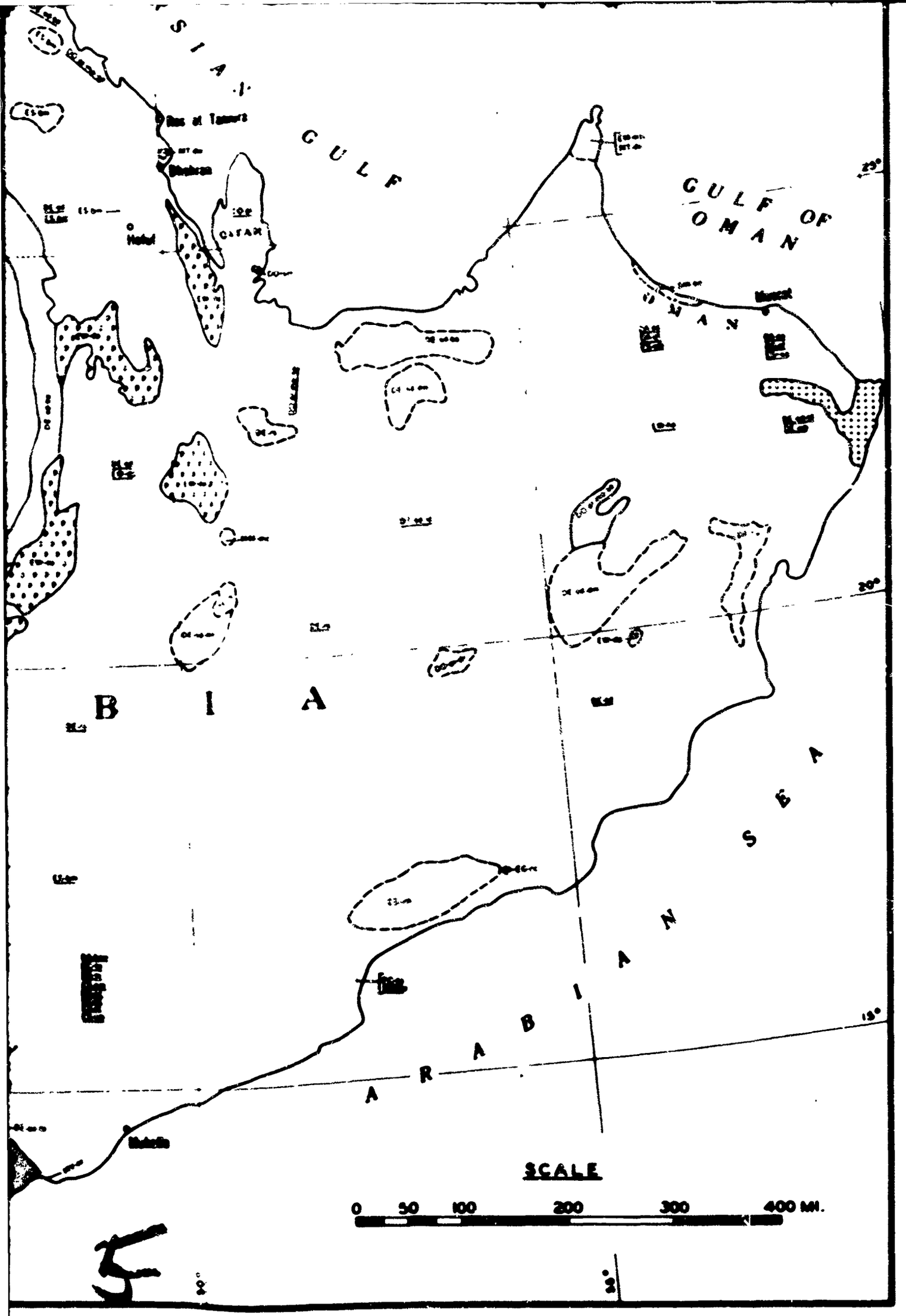
WIND

[illegible]

[illegible]

[illegible]

4


GULF
GULF OF OMAN
QATAR
B I A
ARABIAN SEA
SCALE
0 50 100 200 300 400 MI.

SELECTED LANDFORMS AND SURFACE CONDITIONS

I. DEPOSITIONAL

ALLUVIA

Abandoned courses
Alluvial fans
Playa and swales
Sandy dissected areas
Terraces
Intermittent freshwater lakes
Intermittent streams
Marsh
Natural levees
Oxbow lakes
Salt lakes

COLLUVIAL

Talus

EOLIAN

Accumulations near barriers
Large extensive obstacles
Climbing sand drifts
Falling sand drifts
Rippled surfaces
Sand dissected areas
Sand sheet tumbleff
Barchans
Sinuous dunes
Star and fan
Transverse dunes
Dune-changed dunes
Dune masses
Longitudinal dunes
Dunes and hummocks

LACUSTRINE

Intermittent lakes

MARINE

Beaches
Mangrove swamps
Tidal mud flats

ORGANIC-CHEMICAL

Coral
Marine limestone
Dry
Marsh
Intermittent
Salt marsh

II. EROSIONAL

GROUNDWATER

Caves and caverns
Chimneys
Karst topography
Sinks

II. EROSIONAL (continued)

MARINE

Wave-cut cliffs
Wave-cut terraces

SURFACE WATER

Angular drainage
Badlands
Bedrock
Pebbles and gravels
Flat-lying
Fluvial
Gullies
Highly dissected
Inclined monoclines
Rounded-edged mesas
Outcrops
Pediments
Rounded hills
Dissected
Undissected
Rock terraces
Scarps
Steep-sided basins

WIND

Desert pavement (reliff)
Flat-topped plains
Hamadas
Wind-dissected mesas

III. MISCELLANEOUS

INTRUSIVE

Dikes
Sills

METEORIC

Meteor craters

BIOTIC

Fossiliferous limestone
Coral

CULTURE

Bomb craters
Human scarps
Unpaved roads
Irrigation ditches
Miscellaneous roads
Scarps

VOLCANO

Pressure ridges
Cones
Craters
Lava flows
Lava domes
Lava tubes
Sills and dikes

*The colors used on the maps have been restricted to the most common landforms which occur at Yuma. Areas as delineated in the Middle East indicate regions within which the particular landform predominates. Landform types DA-ob, DA-fbrs, DC-ob, ES-ob, ES-ob, DA-ac, and DA-ma occur at Yuma but are of relatively minor areal extent and have not been mapped.

(DA-ob) or DA-ob — Indicates the general area in which a particular landform or surface condition is known to exist.

ES-ob — Indicates that this feature is continuous or widespread through the photographic area within which the designation lies.

ES-ob — Indicates a particular location of a landform.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

SELECTED LANDFORMS AND SURFACE CONDITIONS

PLATE 18

LANDFORMS

Photo No.	CLASSIFICATION AND DESCRIPTION
	I. DEPOSITIONAL **ALLUVIAL**
1	**Abandoned courses:** Abandoned courses are lengthy segments of a river abandoned when the stre a new course across the floodplain.
2	**Alluvial aprons.** Alluvial aprons are created through coalescence of alluvial fans along the base or plateau escarpments. Several fans coalesce to form an alluvial apron.
3	**Alluvial fans** Alluvial fans are cone-shaped features occurring at the base of mountains, hills, etc., where streams experience a sufficient reduction in gradient to deposit their loads. steepest near the mountains, slope gently outward with a continually decreasing gradient characterized by braided stream channels which score their surfaces.
4	**Bars and swales:** Bars and swales are accretion deposits formed on the insides of river bends, wherever the channel migrates. Sandy bar deposits or "ridges" are laid down during the river and, as the water subsides, an accurate depression or "swale" often flanks th landward side. The swale is modified by subsequent high-stage flow and eventually is river continues to migrate. The depression is gradually filled with fine-grained mater ternating series of sandy ridges and clayey swales results, conforming to the curvature grating channel.
5	**Boulder-choked wadies:** Boulder-choked wadies are relatively narrow and deep, intermittent str generally in mountainous or plateau regions, where boulders have been amassed in num cient to retard or prevent vehicular movement.
6	**Deltas.** Deltas are alluvial tracts of land, usually triangular in shape, formed at the mouth of a r boundaries of deltas often, but not invariably, coincide with the farthest upstream distrit of a river.
7	**Floodplains:** Floodplains are relatively smooth, flat lands bordering a stream. They are built o deposited by the stream and inundated by floodwaters.
8	**River terraces:** River terraces are flat stripe of land bordering river floodplains. They are ch by a sharp descent toward the river and by more elevated land on the opposite side. A arrangement of several terraces often flanks larger floodplains.
9	**Intermittent freshwater lakes:** Intermittent freshwater lakes are standing bodies of inland fresh which become dry during certain periods of the year.
10	**Intermontane plains:** Basins of interior drainage between mountain ranges composed of fine-gra deposited by streams issuing from the adjacent mountains.
11	**Levee-flank depressions:** Levee-flank depressions are irregular to rectilinear low areas, usual ponds or lakes, paralleling and flanking natural levee ridges. They are best developed regions.
12	**Marsh:** Marsh is a tract of low (in reference to surrounding terrain), wet ground, usually dairy with rank grass and sedge vegetation and confined to freshwater areas.
13	**Natural levees:** Natural levees are long, relatively narrow alluvial ridges, higher near the river ually sloping away from it, which are built up on either side of a stream by overbank flo drainage patterns range from minute drainageways to major crevasses, commonly foun angles to the direction of levee elongation.
14	**Ox-bow lakes:** Ox-bow lakes are crescent-shaped lakes formed when rivers are shortened by th of migrating river bends at the upstream and downstream arms of meander loops.

* Not applicable.

** [illegible]

RFACE CONDITIONS: DESCRIPTIONS AND PHOTOGRAPHS

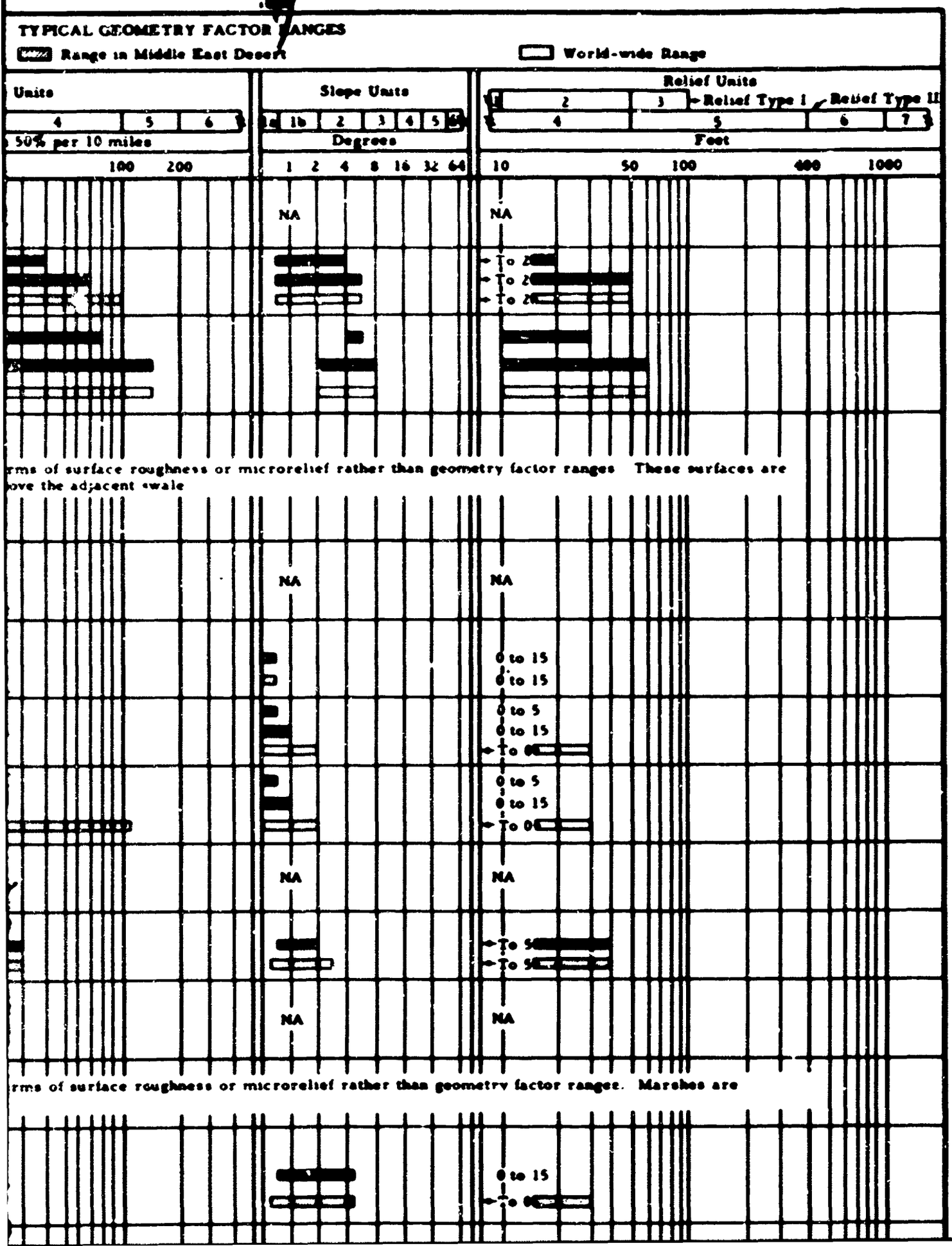
TYPICAL GEOMETRY FACTOR RA

Range at Yuma

Range in Middle East Desert

	Plan-Profile Units	Slope Occurrence Units (Number of slopes greater than 50% per 10 miles: 1, 5, 20, 100, 200)
oses	•NA	NA
tains	1L, 7 1, 1L, 7 1, 1L, 7	→To 0 →To 0
ems, fans, e	1L 1, 1L 1, 1L	
ges of on the as the an al- mi-	This phenomenon is classed as a surface condition and considered in terms of surface roughness or microre rolling in nature, with the crest of the bars ranging from 2 to 10 feet above the adjacent swale.	
ds, ffi-	NA	NA
inland s	7 7	Lacking Lacking
ents	7 7 7, 1, 1L	Lacking →To 0 →To 0
ized	7 7, 1 7, 1	Lacking →To 0 →To 0
	NA	NA
ligenum	7, 1, 1L 7, 1, 1L	→To 0 →To 0
tanung aic	NA	NA
vered	This phenomenon is classed as a surface condition and considered in terms of surface roughness or micro characteristically featureless.	
grad- urface ight	NA NA	NA NA
lescence	NA	NA

PHOTOGRAPHS



7	deposited by the stream and inundated by floodwaters
8	River terraces. River terraces are flat strips of land bordering river floodplains by a sharp descent toward the river and by more elevated land on the opp arrangement of several terraces often flanks larger floodplains.
9	Intermittent freshwater lakes Intermittent freshwater lakes are standing bodies which become dry during certain periods of the year
10	Intermontane plains Basins of interior drainage between mountain ranges compo deposited by streams issuing from the adjacent mountains.
11	Levee-flank depressions. Levee-flank depressions are irregular to rectilinear id ponds or lakes, paralleling and flanking natural levee ridges. They are regions.
12	Marsh Marsh is a tract of low (in reference to surrounding terrain), wet ground with rank grass and sedge vegetation and confined to freshwater areas
13	Natural levees Natural levees are long, relatively narrow alluvial ridges, higher ually sloping away from it, which are built up on either side of a stream drainage patterns range from minute drainageways to major crevasses, angles to the direction of levee elongation.
14	Ox-bow lakes. Ox-bow lakes are crescent-shaped lakes formed when rivers are of migrating river bends at the upstream and downstream arms of mea

* Not applicable.

†† Raised numbers refer to similarly numbered entries in the bibliography at the end o

1. A vertical photograph showing the now heavily vegetated meander of an abandoned course in the lower left quarter of the photograph

2. An alluvial apron forming a narrow, continuous band between the background mountains and the basin in the lower half of the photograph

3. A ver an alluvi

9 Intermittent freshwater lakes

10. Intermontane plain as viewed from adjacent mountains

11. Wa depress

4

e characteristic . A steplike	7 7, 1	Lacking To 0E
fresh water	NA	NA
-grained alluvium	1, 1L 1, 1L	To 0E To 0E
usually containing loped in deltaic	NA	NA
mary and covered	This phenomenon is classed as a surface condition and considered in terms of surface roughness characteristically featureless	
river and grad- nk flow. Surface found at right	NA NA	NA NA
by the coalescence .	NA	NA

of this report

tograph of

4. Vertical photograph of bar and swale topography. The bars are the light arcuate areas, the swales the intervening dark, vegetated areas

5. Boulder-choked wadis

6. Present distributary sy the Mississippi River Del

levee-flank

12. Marsh

13. Cultivation on natural levees

14. A vertical photograph low lake -- False River C Louisiana.

		0 to 5	
		0 to 15	
		To 0	
	NA	NA	
		To 5	
		To 5	
	NA	NA	

rms of surface roughness or microrelief rather than geometry factor ranges. Marshes are

		0 to 15	
		To 0	
	NA	NA	

U. S. Army Engineer District, New Orleans

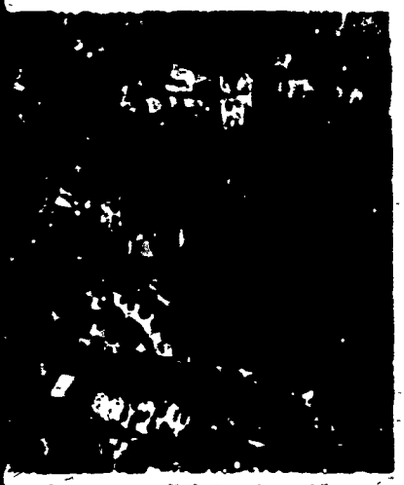
Present distributary system of Mississippi River Delta

Reference 66

7. Floodplain of the Colorado River, looking southward from Laguna Dam, Arizona

H. E. Gregory, USGS[93]

8. Valley of Sevier River near Hatch, Utah, showing meanders and terraces



U. S. Army Corps of Engineers

A vertical photograph of an oxbow -- False River Cutoff, Louisiana.

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	I. DEPOSITIONAL (CONT.)
	ALLUVIAL
15	Salt lakes Salt lakes are permanent or intermittent bodies of saline water, generally of Surface evaporation of water exceeds inflow, thus creating saline conditions.
	COLLUVIAL
16	Talus. Talus is an unconsolidated, sloping heap of fairly large rock fragments or debris an escarpment or steep slope through gravitational accumulation.
	EOLIAN
	Accumulations near barriers
	Large extensive obstacles
17	Climbing sand drifts: These are massive accumulations of windblown sand which for extensive obstacles such as plateau scarps, hills, and mountains.
18	Falling sand drifts: Falling sand drifts are massive accumulations of windblown san ward of extensive obstacles such as plateau scarps, hills, and mountains.
19	Rippled surfaces: Washboard-like surfaces caused by the heaping of sand by wind actio found on the gentler slopes of dunes or in flat, sandy areas.
20	Sand-choked wadis Sand-choked wadis are intermittent streambeds generally within plai areas which have been almost completely or partially filled with windblown sand
	Sand dunes: Mobile heaps of windblown sand independent of fixed objects or underlying top
21	Barchans: Barchans are dunes having a crescentric ground plan with the convex side f extending leeward. The profile is asymmetric with the gentler slope on the steeper slope on the concave or leeward face.
22	Complex dunes Complex dunes are irregular masses of sand not readily classifiable i
23	Peak and fuji: These occur where the tips or horns of a fast-moving barchan join or i side of another barchan, thus forming a circular or horseshoe-shaped hollow crest of the barchan slipface which flanks the fuji is referred to as the peak.
24	Transverse dunes: Transverse dunes are strongly asymmetric ridges extending transv dominant sand-moving winds. The leeward slope is steep; the windward, comp
25	Dome-shaped dunes: Dome-shaped dunes, formed as a result of highly varying wind di broad circular upwarps. Barchan dunes often constitute the secondary surface dome-shaped dunes.
26	Dune massifs: Dune massifs are massive, roughly conical or pyramidal dunes characte Small hollows and terraces often dimple their steep sides. The massifs are u longitudinal dunes, but are quite unmistakable as they rise far above the gener
27	Longitudinal dunes Longitudinal dunes usually consist of a single continuous ridge whic at regular intervals to form a chain of summits connected by a continuous wavy is asymmetric with one side exhibiting a moderate slope, the other, a steep or nal dunes are aligned parallel to dominant sand-moving winds
28	Waves and billows Waves and billows are undulating to rolling areas of sand which presen unlike the waves of a rough sea.

MS—SURFACE CONDITIONS: DESCRIPTIONS AND PHOTOGRA

2

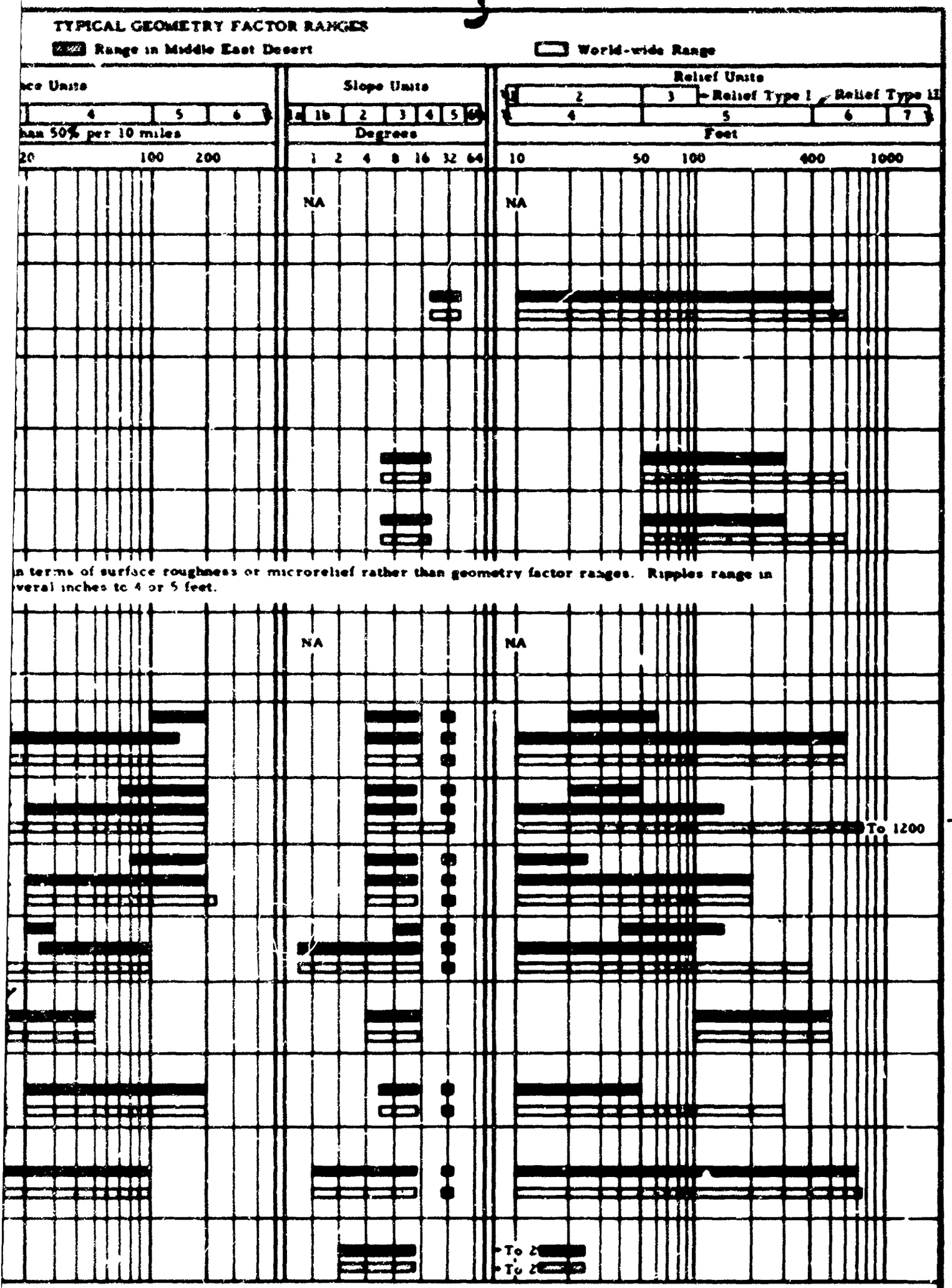
Range at Yuma

TYPICAL GEOMETR

Range in Middl

	Plan-Profile Units	Slope Occurrence Units (Number of slopes greater than 50% per 10 miles)
		1 (1–5) / 2 (5–20) / 3 / 4 (20–100) / 5 (100–2
onsiderable size	•NA	NA
formed at the base of	NA NA	NA NA
orm to the windward of	7 7	Lacking Lacking
nd which form to the lee-	7 7	Lacking Lacking
n. They are normally	This phenomenon is classed as a surface condition and considered in terms of surface rou height from 1 or 2 inches to 3 feet and are spaced at intervals of several inches to 4 or 5 fe	
ain or plateau nd.	NA	NA
topography.		
facing the wind and horns convex side and the	4 4, 5, 6 4, 5, 6	
e into types.	4 4 4, 4L, 5, 5L, 5, 5L, 6, 6L, 6, 6L	
intersect the windward w known as a fulji. The k.	4 4 4	
averse to the direction of mparatively gentle.	4L 4L, 4L, 5L, 5L 4L, 4L, 5L, 5L, 6L, 6L	
direction, are shaped like face expression on broad	4, 4, 5, 5, 6, 6 4, 4, 5, 5, 6, 6	
acterized by curved slopes, e usually associated with neral crest level.	4 4	
which swells and rises eavy crest. The profile or slipface. Longitudi-	5L, 6L 4, 4L, 5L, 5L, 6L, 6L	
sent a surface not		

PHOTOGRAPHS



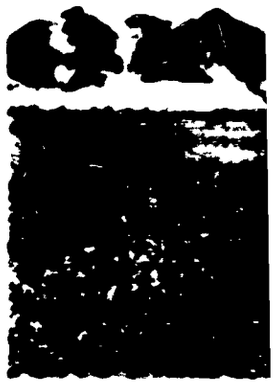
21	**Barchans.** Barchans are dunes having a crescentric ground plan with the convex side extending leeward. The profile is asymmetric with the gentler slope on the steeper slope on the concave or leeward face.
22	**Complex dunes** Complex dunes are irregular masses of sand not readily classifiable
23	**Peak and fulji:** These occur where the tips or horns of a fast-moving barchan join or side of another barchan, thus forming a circular or horseshoe-shaped hollo crest of the barchan slipface which flanks the fulji is referred to as the pea
24	**Transverse dunes:** Transverse dunes are strongly asymmetric ridges extending tran dominant sand-moving winds. The leeward slope is steep; the windward, co
25	**Dome-shaped dunes:** Dome-shaped dunes, formed as a result of highly varying wind broad circular upwarps. Barchan dunes often constitute the secondary surf dome-shaped dunes.
26	**Dune massifs.** Dune massifs are massive, roughly conical or pyramidal dunes chara Small hollows and terraces often dimple their steep sides. The massifs are longitudinal dunes, but are quite unmistakable as they rise far above the ger
27	**Longitudinal dunes.** Longitudinal dunes usually consist of a single continuous ridge w at regular intervals to form a chain of summits connected by a continuous w is asymmetric with one side exhibiting a moderate slope, the other, a steep nal dunes are aligned parallel to dominant sand-moving winds.
28	**Waves and billows** Waves and billows are undulating to roll g areas of sand which pres unlike the waves of a rough sea.

Not applicable
Circled plan-profile designations indicate gross landscapes

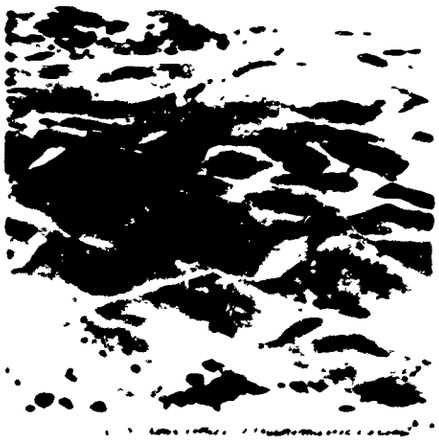
* Underlined plan
** Raised numbers

15. A salt lake fringed by white, crystalline salt

16. Steeply sloping talus cone flanking a plateau escarpment



17. A large climbing encroaching on a



23. Peak and fulji topography in the Yuma Sand Hills, Arizona

24. Transverse dunes in the vicinity of Delta, Utah

25. A vertical photo dome-shaped dunes light, roughly circular

	4, 5, 6	
to types.	4 4 4, 4L, 5, 5L, 5, 5L, 6, 6L, 6, 6L	
ersect the windward nown as a fulji. The	4 4 4	
rse to the direction of ratively gentle.	4L 4L, 4L, 5L, 5L 4L, 4L, 5L, 5L, 6L, 6L	
ction, are shaped like expression on broad	4, 4, 5, 5, 6, 6 4, 4, 5, 5, 6, 6	
ized by curved slopes. ally associated with l crest level.	4 4	
swells and rises crest. The profile ipface. Longitudi-	5L, 6L 4, 4L, 5L, 5L, 6L, 6L	
a surface not	7, 4 7, 4	Lacking Lacking

file designations indicate that the [illegible] in both gross and restrictive landscapes
er to similarly numbered entries [illegible] bibliography at the end of volume I of this report

d drift
n front

18. Cliffs covered b falling sand drift east of Point Ar uevo, Calif.

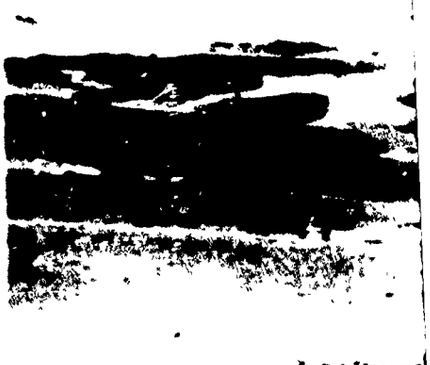
19. Rippled surfaces

20. Sand-choked wadis appear as white bands which weave through the highly dissected plateau

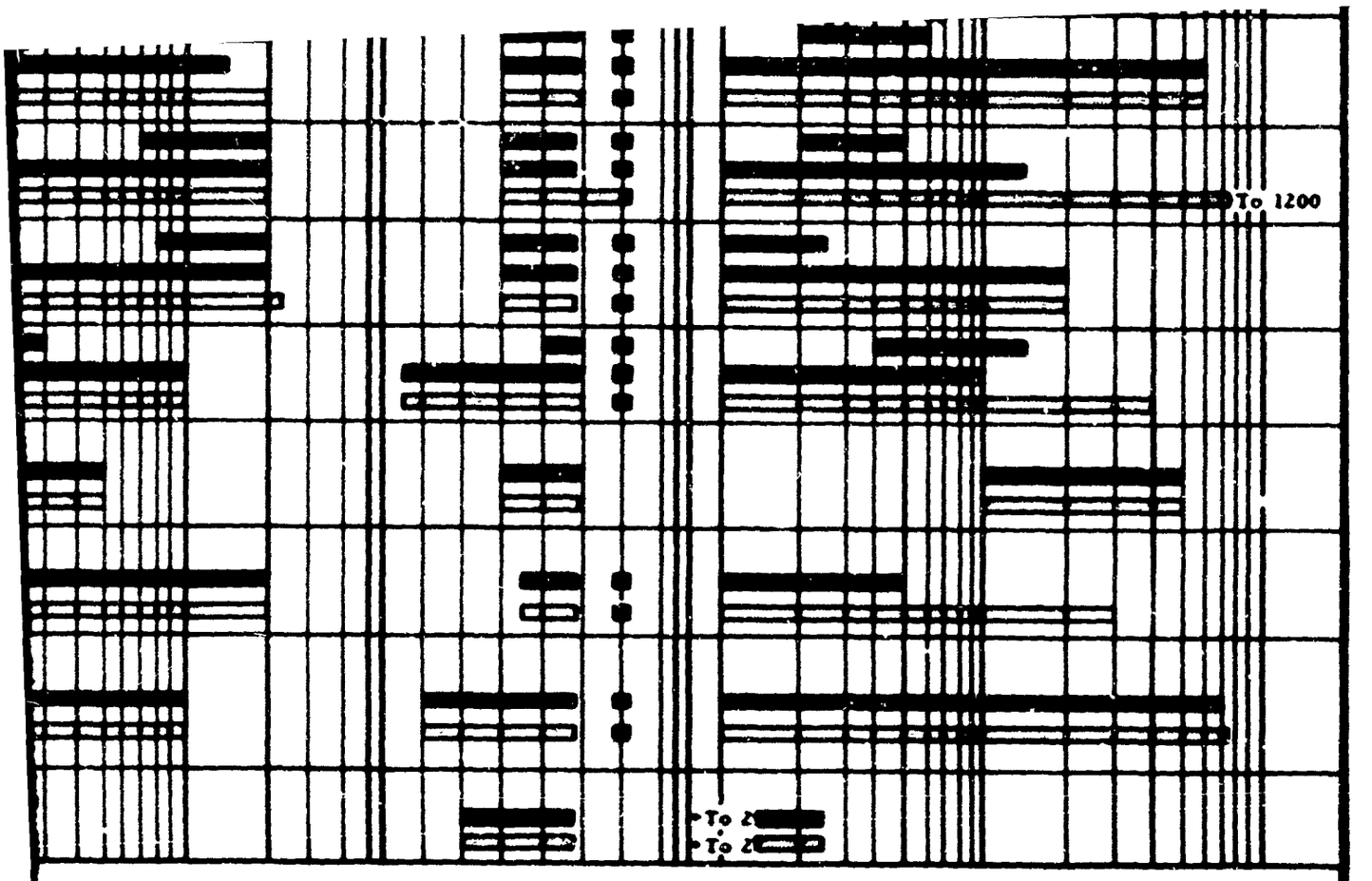
ith
g as the

26. Dune massi rated by sandy plains

27. The sinuous crest line of a longitudinal dune



28. Sand waves and hollows rising above a sandy plain



[illegible] Nevada Nuclear Test Site

[illegible] wadis appear as [illegible] which weave through the [illegible] dissected plateau

Reference 21

21. A field of barchan dunes [illegible] north of Magdalena Bay, Mexico

[illegible] Air Service

22. A vertical photograph of a complex dune field in Algeria

Wilhelm Dominguez

[illegible] waves and billows rising [illegible] sandy plain

6

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	I. DEPOSITIONAL (CONT.)
	LACUSTRINE
29	Lacustrine terraces: Terraces which mark the shore lines of ancient lakes, or earlier high-water sta existing lakes. They have nearly horizontal surfaces with relatively steep slopes facing the c portion of the lake.
	MARINE
30	Beaches: Beaches are gently sloping strips of land bordering the sea, usually recognized as that part lies between high- and low-water marks and formed by the action of the sea.
31	Mangrove swamps: Salt or brackish swamps along the coast where there are abundant mangrove trees
32	Tidal mud flats: Marshy or muddy lands covered and uncovered by the rise and fall of the tide.
	ORGANIC-CHEMICAL
33	Caliche: Caliche is a calcareous deposit occurring at or near the surface which has accumulated from calcium charged groundwater moving upward and evaporating.
	Playas: Playas are nearly flat areas of salt or salty fine-grained soils occupying basins where water and evaporates after moderate or torrential rains.
34	Dry: Dry playas are characterized by very hard, smooth, flat surfaces of fine-grained soil.
	Moist: Moist playas are characterized by irregular, puffy surfaces with a thin friable surface crus is underlain by soft, spongy ground.
35	Clay-encrusted: Clay-encrusted playas are moist playas with a surface crust of clay.
36	Salt-encrusted: Salt-encrusted playas are moist playas with a surface crust of salt.
37	Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces are so ne level of the mean high tide that they are covered by the majority of high tides.
	II. EROSIONAL
	GROUNDWATER
38	Caves and caverns: Caves or caverns are natural cavities or chambers beneath the surface. In lime areas they are often connected by underground solution channels formed by subterranean wa
39	Chimneys: Chimneys are vertical shafts, with a variety of plan shapes, connecting underground caves surface. They are typically formed by solution in limestone areas.
40	Karst topography: Karst topography is developed in limestone regions by the solution action of ground surface waters. In advanced stages, the topography is irregular and characterized by numer and depressions of all sizes interspersed with abrupt ridges and irregular protuberant rocks
41	Sinks: Sinks are circular or elongate depressions of varying size formed by solution and collapse in limestone or evaporite rock.

* Not applicable

†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume 3 of this rep

ORMS—SURFACE CONDITIONS: DESCRIPTIONS AND PHOTOG

2

TYPICAL GEOM

Range at Yuma — Range in Mi

Slope Occurrence Units

1 | 2 | 3 | 4 | 5

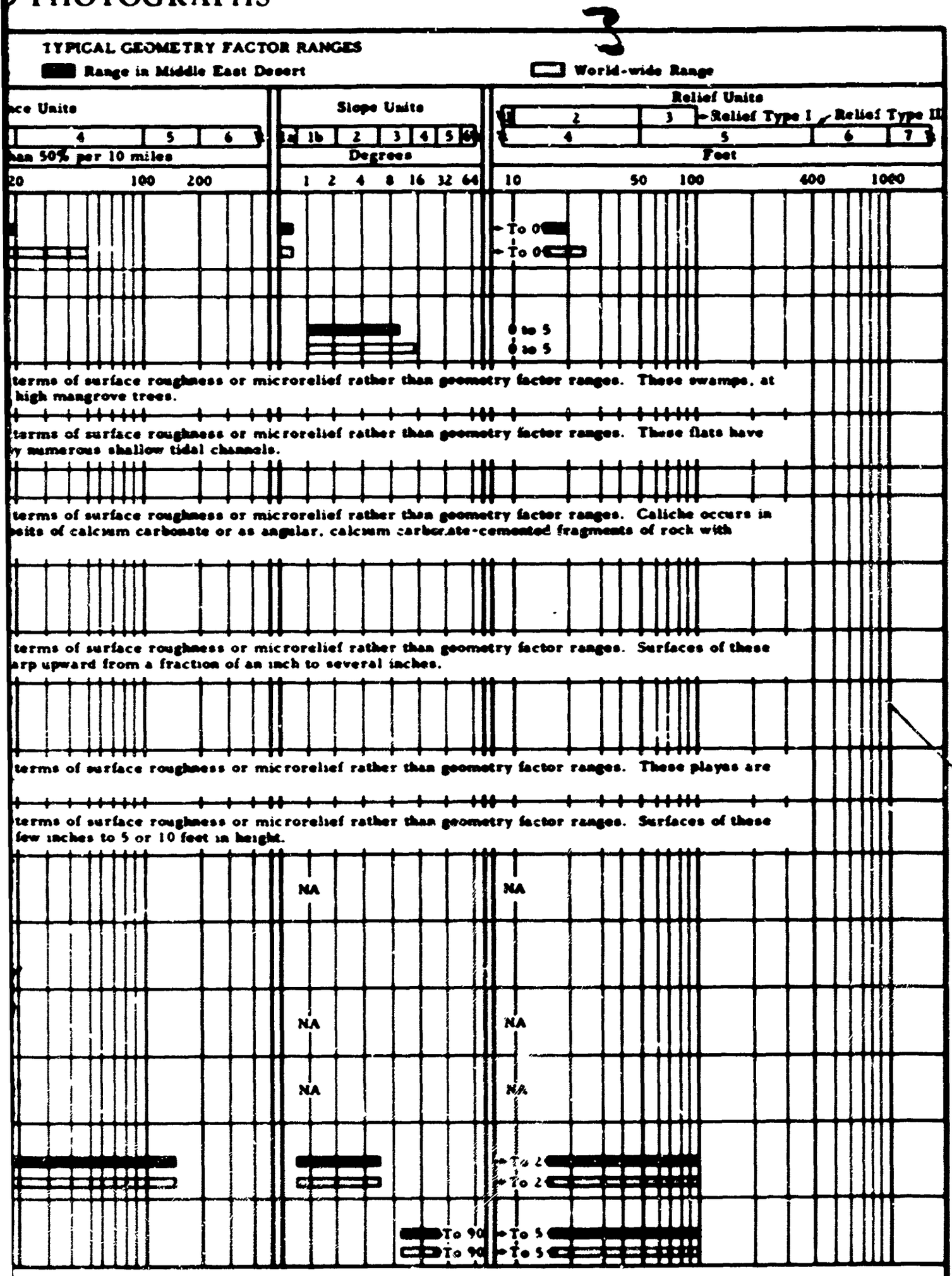
Number of slopes greater than 50% per 10 miles

1 | 5 | 20 | 100

	Plan-Profile Units	
er high-water stages of lopes facing the central	7 7, 3	→ To 0 → To 0
ised as that part which	7 7	Lacking Lacking
t mangrove trees.	This phenomenon is classed as a surface condition and considered in terms of surface rou low tide, are impenetrable tangles of roots and knees, surmounted by high mangrove trees.	
of the tide.	This phenomenon is classed as a surface condition and considered in terms of surface rou relatively smooth surfaces of low bearing capacity and are indented by numerous shallow	
accumulated from	This phenomenon is classed as a surface condition and considered in terms of surface rou most desert areas within plains of gentle slope. It may occur as deposits of calcium carb diameters up to several inches.	
sins where water collects		
ained soil.	This phenomenon is classed as a surface condition and considered in terms of surface rou playas are characterized by dessication polygons whose edges may warp upward from a	
able surface crust which		
f clay.	This phenomenon is classed as a surface condition and considered in terms of surface rou characterized by slightly rolling and spongy surfaces.	
salt.	This phenomenon is classed as a surface condition and considered in terms of surface rou playas are characterized by soft, puffy mounds or pinnacles of salt a few inches to 5 or	
riaces are so near the e.	*NA	NA
surface. In limestone subterranean water.	NA	NA
nderground caves with the	NA	NA
e action of ground and terized by numerous sicke protuberant rocks.	1 1	
and collapse in areas of	NA NA	NA NA

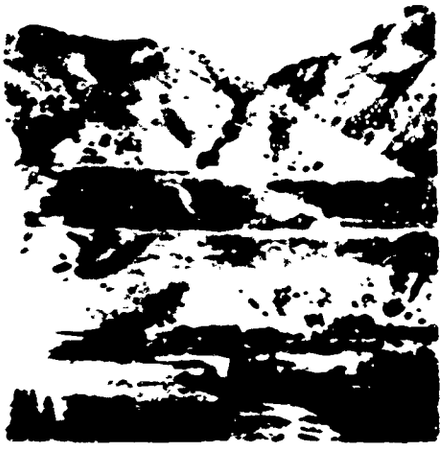
ume I of this report

PHOTOGRAPHS

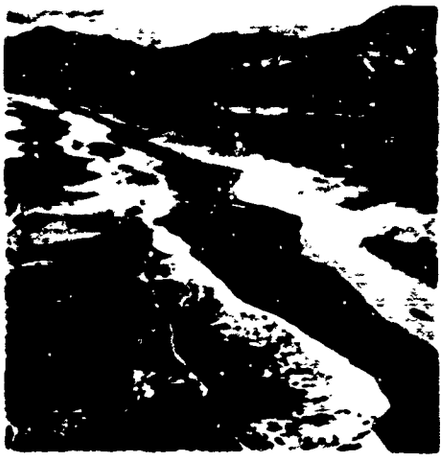


35	Clay-encrusted: Clay-encrusted playas are moist playas with a surface crust of clay.
36	Salt-encrusted: Salt-encrusted playas are moist playas with a surface crust of salt.
37	Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces ar level of the mean high tide that they are covered by the majority of high tides.
	II. EROSIONAL GROUNDWATER
38	Caves and caverns: Caves or caverns are natural cavities or chambers beneath the surface. areas they are often connected by underground solution channels formed by subterrar
39	Chimneys: Chimneys are vertical shafts, with a variety of plan shapes, connecting undergroun surface. They are typically formed by solution in limestone areas.
40	Karst topography: Karst topography is developed in limestone regions by the solution action of surface waters. In advanced stages, the topography is irregular and characterized by and depressions of all sizes interspersed with abrupt ridges and irregular protuberan
41	Sinks: Sinks are circular or elongate depressions of varying size formed by solution and colla limestone or evaporite rock.

- Not applicable
†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of t

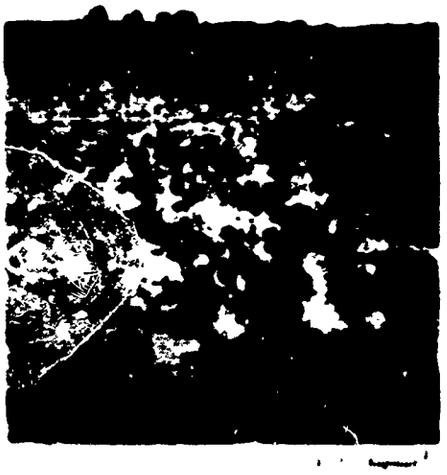


29. Several flat-topped, steep-fronted lacustrine terraces flanking a mountain range in Utah



30. A narrow beach bounded by the vegetated coastal plain and the sea

31. Mangrove swamps bo the Gulf of Siam in southe insula, Thailand



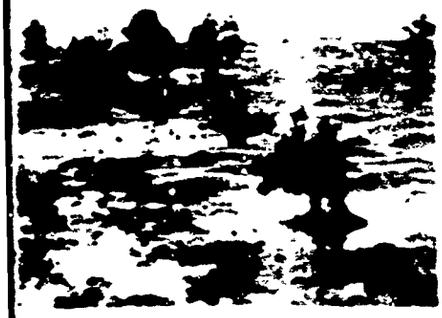
37. Salt marsh

38. Entrance to Carlsbad Caverns in southeastern New Mexico

NO PHOTOGRAPH AVAILABLE

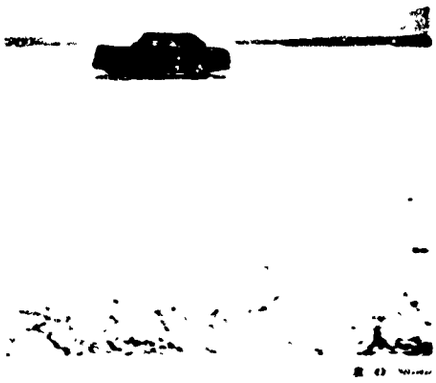
39. Chimneys

	characterized by slightly rolling and spongy surfaces.		
	This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief playas are characterized by soft, puffy mounds or pinnacles of salt a few inches to 5 or 10 feet in height.		
	NA	NA	NA
	NA	NA	NA
he	NA	NA	NA
ker			
f	NA NA	NA NA	



32. Tidal mud flat at the mouth of the Chao Phraya River, coastal Thailand

33. The light-colored caliche is overlain by a dark sandy clay layer



34. Desiccation cracks on the surface of a dry playa

35. clay-

40. A vertical photograph of Karst topography in a limestone plateau area

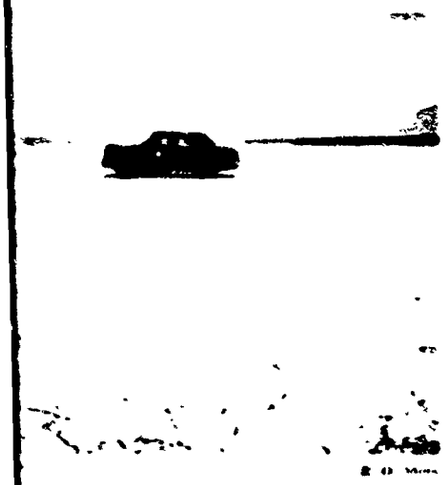
41. A sink as viewed from the rim

LA

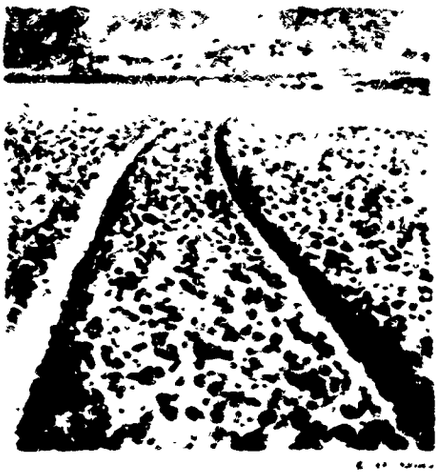
in terms of surface roughness or microrelief rather than geometry factor ranges. These playas are

in terms of surface roughness or microrelief rather than geometry factor ranges. Surfaces of these
a few inches to 5 or 10 feet in height.

	NA		NA
	NA		NA
	NA		NA
			To 2
			To 2
		To 90	To 5
		To 90	To 5



34. Desiccation cracks on the surface of a dry playa



35. Soft and spongy surface of a clay-encrusted playa

36. Rough surface of a salt-encrusted playa

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	II. EROSIONAL (CONT.)
	MARINE
42	Wave-cut cliffs: Steep cliffs of bare rock, or occasionally unindurated materials, marking the seaward limit of the coast.
43	Wave-cut terraces: Steplike, narrow strips of land adjacent to or near the sea wh the waves and current. Each terrace records a landward advance of litto
	SURFACE WATER
44	Amphitheatres: Amphitheatres are semicircular erosion bays, formed at the head often scallop plateau scarps in arid regions.
45	Aqabas: Aqabas are gaps in asymmetrical ridges which connect basins of different between the ridges.
46	Badlands: Regions nearly devoid of vegetation where erosion, instead of carving hi dinary type, has cut the land into an intricate maze of narrow ravines, sha
47	Buttes and mesas: Isolated residual prominences with very steep or precipitous sl remnants of a plateau area. Mesas have distinctively flat tops; buttes have small flat tops or peaks remain.
48	Canyon country: Canyon country refers to a plateau dissected by a branching netwo valleys.
49	Flatirons: Triangular remnants of an eroded hogback ridge often occurring in seri mountain.
50	Foothills: Foothills are lower subsidiary hills at the foot of mountains or higher zones between the highlands and the adjacent lower land.
51	Hogbacks: Hogbacks are sharp-crested ridges produced by unequal erosion in stee
52	Incised meanders: Incised meanders are deep, sinuous valleys cut by rejuvenated course having been acquired in a former cycle.
53	Knife-edged spurs Sharp-crested rock ridges forming interstream divides which tain masses.
54	Outliers: Isolated remnants of rock detached from the main mass.
55	Pediments: Pediments are relatively smooth rock plains gently inclined away from They are sometimes partly covered by a thin veneer of alluvium.

* Not applicable
** Circled plan-profile designations indicate gross landscapes
† Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes
†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report

URFACE CONDITIONS: DESCRIPTIONS AND PHOTOGRAPHS

2

TYPICAL GEOMETRY FACTOR RA

Range at Yuma

Range in Middle East Desert

Slope Occurrence Units

1 | 2 | 3 | 4 | 5 | 6

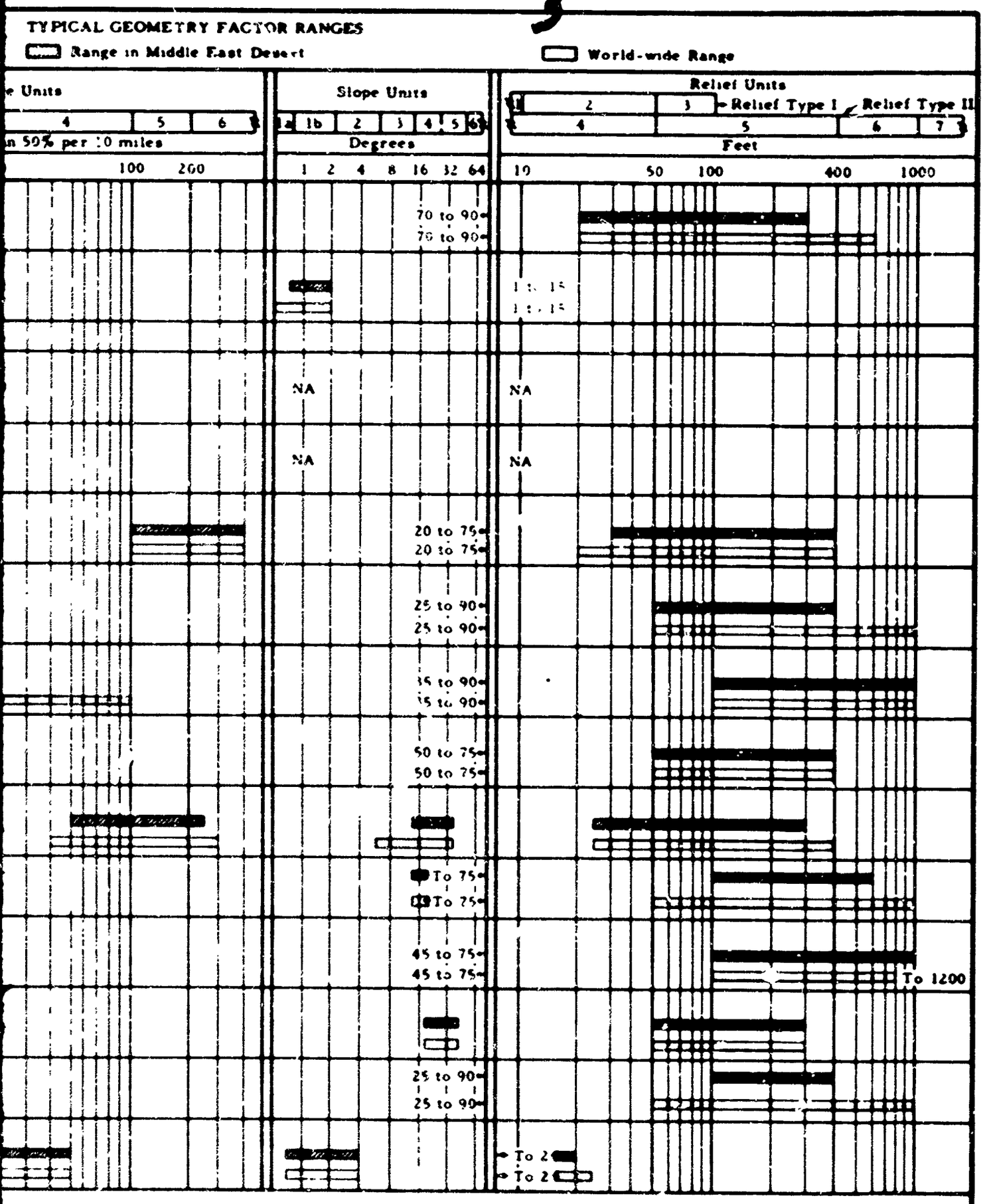
Number of slopes greater than 50% per 10 miles

1 | 5 | 20 | 100 | 200

	Plan-Profile Units	
erosion	*NA NA	NA NA
red by	7, 1 7, 1	→ To 0 → To 0
hich	NA	NA
r	NA	NA
o-- cles.	4 4	
l only	[illegible] [illegible]	
alled	[illegible] [illegible]	
	7 7	Lacking Lacking
sitional	4, 4L 4, 4L	
	4L, 5L, 6L 4L, 4L, 5L, 6L	
ring	NA NA	NA NA
moun-	4L, 4L, 5L, 5L//, 6L, 6L// 4L, 4L, 5L, 5L//, 6L, 6L//	→ To 0
	1, 1L, 6, 6L 1, 1L, 6, 6L	
sses.	1, 1L 1, 1L	

NA | NA

PHOTOGRAPHS



49	**Flatirons** Triangular remnants of an eroded hogback ridge often occurring in series on the flank of a mountain.
50	**Foothills** Foothills are lower subsidiary hills at the foot of mountains or higher hills. They form tran zones between the highlands and the adjacent lower land.
51	**Hogbacks** Hogbacks are sharp-crested ridges produced by unequal erosion in steeply inclined rock.
52	**Incised meanders** Incised meanders are deep, sinuous valleys cut by rejuvenated streams, the meande course having been acquired in a former cycle.
53	**Knife-edged spurs** Sharp-crested rock ridges forming interstream divides which extend outward from tain masses.
54	**Outliers** Isolated remnants of rock detached from the main mass.
55	**Pediments** Pediments are relatively smooth rock plains gently inclined away from hill or mountain m They are sometimes partly covered by a thin veneer of alluvium.

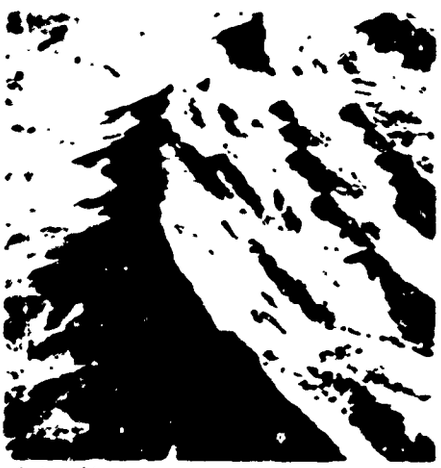
Not applicable
Circled plan-profile designations indicate gross landscapes
* Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes
** Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report

42. Wave-cut cliffs

41. A wave-cut terrace surmounted by several stacks

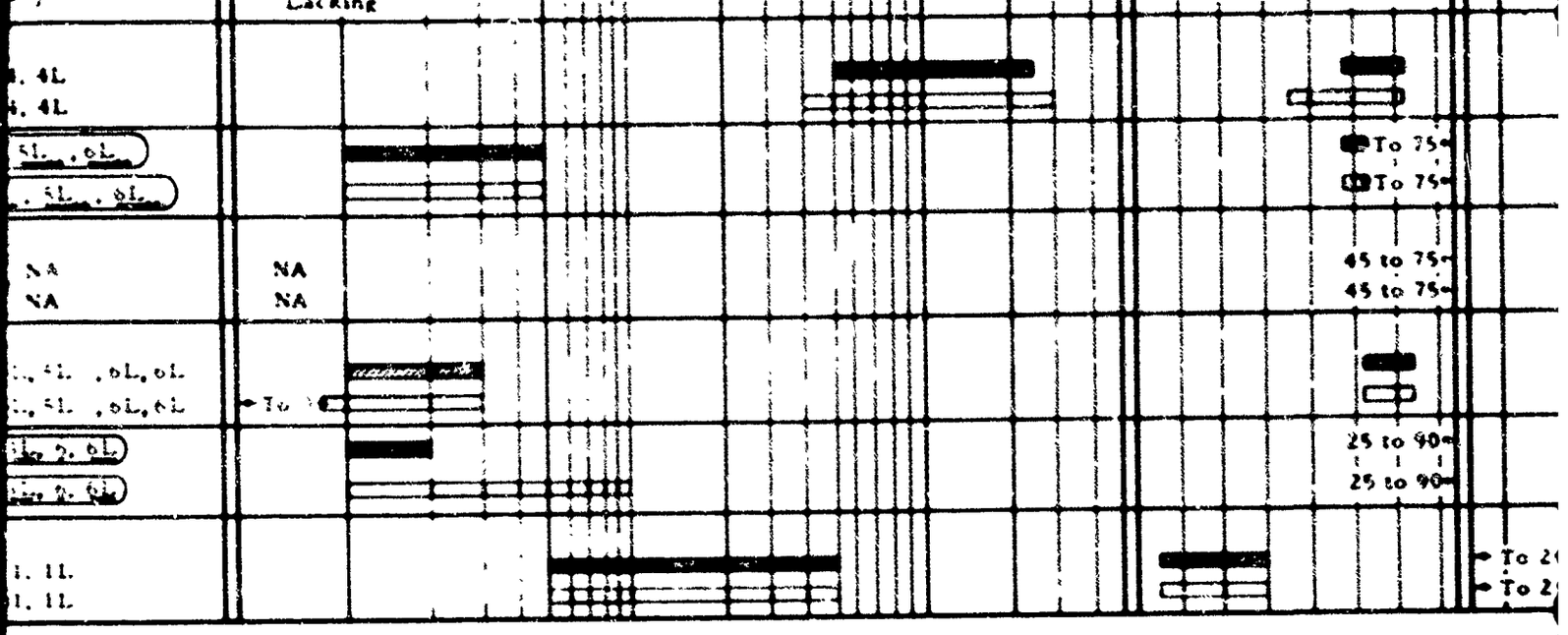
44. Two well-developed amphith atres in the face of an escarpmen

50. Foothills



51. Hogbacks

52. The valley of the San Juan River, Utah, incised to a depth o 1200 ft into the plateau



ing through

46. Badlands

47. Buttes and mesas

48. Canyon country

along west
, northeast

54. Outliers

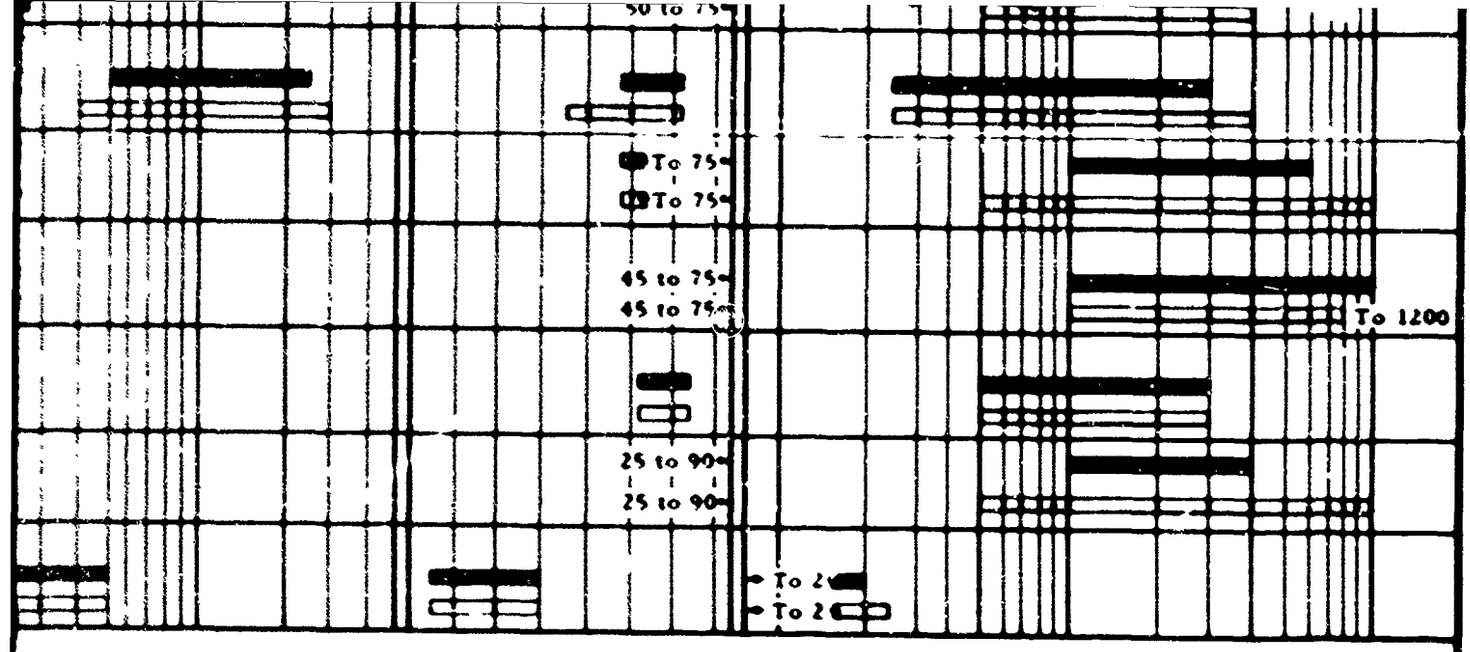
55. A gently sloping pediment flanking the Grand Atlas Mountain in southern Morocco

ANALOG

MIDI

LANDFORMS-

DESCRIPTIO



47 Buttes and mesas

48. Canyon country

49. Flatirons

gently sloping pediment flank-
e Grand Atlas Mountain in
err Morocco

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	II. EROSIONAL (CONT.)
	SURFACE WATER
	Random hills. Randomly oriented masses rising less than 1,000 feet above the level of the surrounding country.
56	Consolidated random hills: Consist of masses of sedimentary, igneous, or metamorphic rock.
57	Unconsolidated random hills Consist of unconsolidated material such as clay, silt, sand, or grav
58	Rock terraces Rock terraces are relatively narrow benches left when a stream cuts a new valley be level of the erosional plain which is cut into the bedrock.
59	Scarps. Scarps are more or less continuous, precipitous slopes exhibiting more than 100 feet of rel
60	Steep wadi banks Steep wadi banks are mapped where a conspicuous number of wadies bordered by precipitous banks occur. Wherever banks are higher than 100 feet they are considered sca
	WIND
61	Desert pavement Desert pavement is a mosaic of closely packed pebbles and broken rock fragment coated with a stain or crust of manganese or iron oxide.
62	Flint-strewn plains Flint-strewn plains are flat to undulating surfaces developed on weathered lim chalk. They are characterized by scattered pebbles and sharp-edged chips of flint weath parent rock.
63	Hamadas Hamadas are extensive, flat to undulating surfaces of bedrock or bedrock covered by a th of pebbles or rock fragments.
64	Wind-scored sandstone surfaces Knobby, knotty surfaces of horizontal sandstone created by the ab action of sand-laden wind
	III. MISCELLANEOUS
	INTRUSIVE
65	Dikes Wall-like intrusions of igneous rock which cut across the bedding or other layered structur country rock On eroding they commonly form narrow, sharp-crested ridges which may ru miles across country
66	Knobs Knobs are rounded, isolated hills or small mountains. They usually constitute the surface of weathered plutonic intrusions.
	METEORIC
67	Meteorite craters Steep-walled, saucer-shaped depressions produced by the impact and accompan plosion of an object of extraterrestrial origin.
	RESIDUAL
68	Exfoliated boulders A term applied to boulders whose surfaces have broken or peeled off as scale or concentric sheets
69	Grus The accumulation of countless discrete particles on the surface sometimes extending to dep greater than 10 feet formed from weathering of the various minerals composing the roc

• Not applicable.

NDFORMS – SURFACE CONDITIONS: DESCRIPTIONS AND PHOT

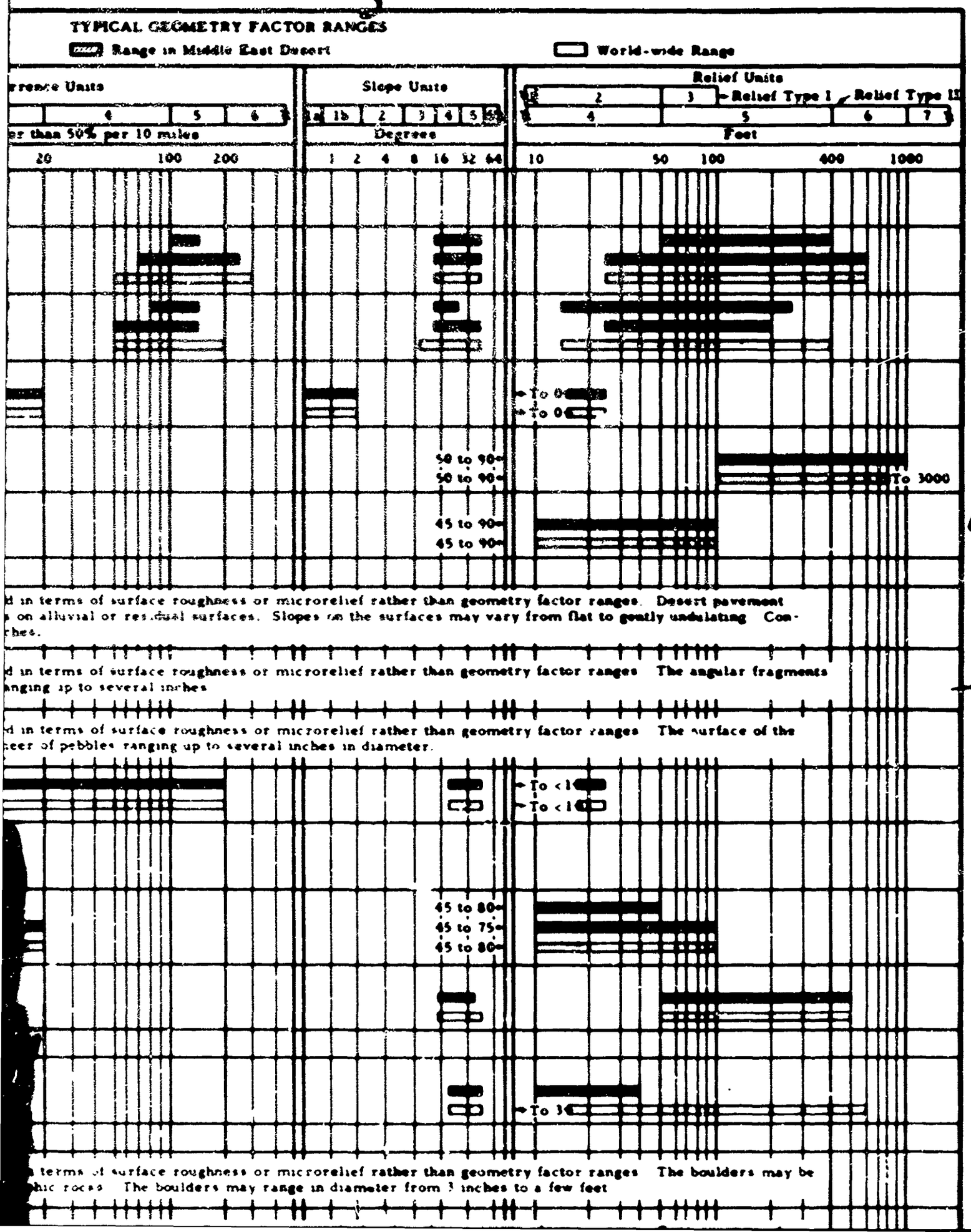
1

Range at Yuma — TYPICAL Ran

	Plan-Profile Units	Slope Occurrence Units (Number of slopes greater than 50% per 1; 1 – 5 – 20)
e level of the surrounding		
metamorphic rock.	4 4, 4L 4, 4L	
clay, silt, sand, or gravel.	4 4, 4L 4, 4L	
ram cuts a new valley below the	7, 1 7, 1	To 0 To 0
ore than 100 feet of relief.	•NA NA	NA NA
of wadies bordered by high hey are considered scarps.	NA NA	NA NA
d broken rock fragments usually	This phenomenon is classed as a surface condition and considered in terms of surf occurs as a thin veneer of closely fitted gravel or rock fragments on alluvial or re stitutent particles may exhibit maximum diameters of several inches.	
loped on weathered limestone or d chips of flint weathered from the	This phenomenon is classed as a surface condition and considered in terms of surf and chips of flint which cover these plains may have diameters ranging up to sever	
bedrock covered by a thin veneer	This phenomenon is classed as a surface condition and considered in terms of surf hamada is flat to gently undulating and may be covered with a veneer of pebbles ra	
stone created by the abrasive	4, 5, 7 4, 5, 7	Lacking Lacking
ther layered structure of the ed ridges which may run fo-	4L 4L, 5L, 6L 4L, 5L, 6L	
constitute the surface expression	4, 5, 6 4, 5, 6	
e impact and accompanying ex-	NA NA	NA NA
or peeled off as scales, lamellae,	This phenomenon is classed as a surface condition and considered in terms of surf angular or rounded fragments of igneous, sedimentary, or metamorphic rocks. Th	
times extending to depths s composing the rock	This phenomenon is classed as a surface condition and considered in terms of surf angular fragments of weathered granite which may exhibit maximum diameters of	

ND PHOTOGRAPHS

3



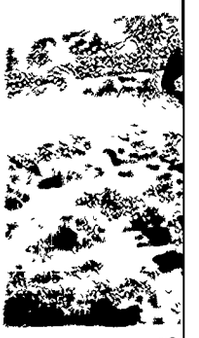
63	**Hamadas:** Hamadas are extensive, flat to undulating surfaces of bedrock or bedroc of pebbles or rock fragments.
64	**Wind-scored sandstone surfaces:** Knobby, knotty surfaces of horizontal sandstone action of sand-laden wind.
	III. MISCELLANEOUS
	INTRUSIVE
65	**Dikes:** Wall-like intrusions of igneous rock which cut across the bedding or other country rock. On eroding they commonly form narrow, sharp-crested rid miles across country.
66	**Knobs:** Knobs are rounded, isolated hills or small mountains. They usually consti of weathered plutonic intrusions.
	METEORIC
67	**Meteorite craters:** Steep-walled, saucer-shaped depressions produced by the impa plosion of an object of extraterrestrial origin.
	RESIDUAL
68	**Exfoliated boulders:** A term applied to boulders whose surfaces have broken or pe or concentric sheets.
69	**Grus:** The accumulation of countless discrete particles on the surface sometimes greater than 10 feet formed from weathering of the various mineralic comp

* Not applicable.

†† Raised numbers refer to similarly numbered entries

56. Rugged, crystalline hills rising above a desert plain

57. Unconsolidated hills near Yuma, Arizona



58. Rock-cu south of Wen

NO PHOTOGRAPH AVAILABLE

64. Wind-scored sandstone surfaces

65. View along a ridge cut by dikes

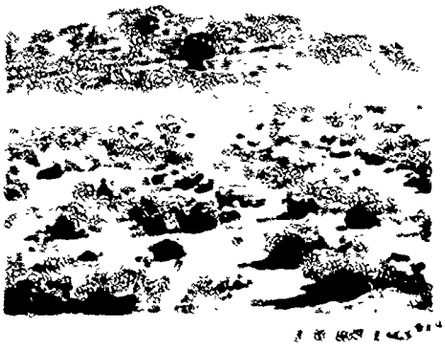
66. A granite above a desert

4

25

		This phenomenon is classed as a surface condition and consi hamada is flat to gently undulating and may be covered with
ces of horizontal sandstone created by the abrasive	4, 5, 7 4, 5, 7	Lacking Lacking
across the bedding or other layered structure of the narrow, sharp-crested ridges which may run for	4L 4L, 5L, 6L 4L, 5L, 6L	
ntains. They usually constitute the surface expression	4, 5, 6 4, 5, 6	
sions produced by the impact and accompanying ex-	NA NA	NA NA
surfaces have broken or peeled off as scales, lamellae,	This phenomenon is classed as a surface condition and consid angular or rounded fragments of igneous, sedimentary, or me	
on the surface sometimes extending to depths the various minerals composing the rock.	This phenomenon is classed as a surface condition and consid angular fragments of weathered granite which may exhibit ma	

umbered entries in the bibliography at the end of volume I of this report

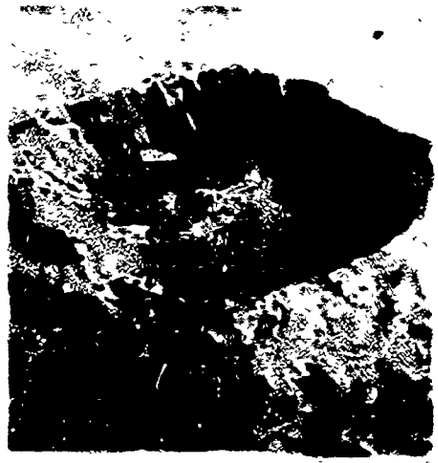


58. Rock-cut terraces 10 miles south of Wendover, Nevada

59. Santa Helena scarp of the Grand Canyon de Santa Helena, Brewster County, Texas

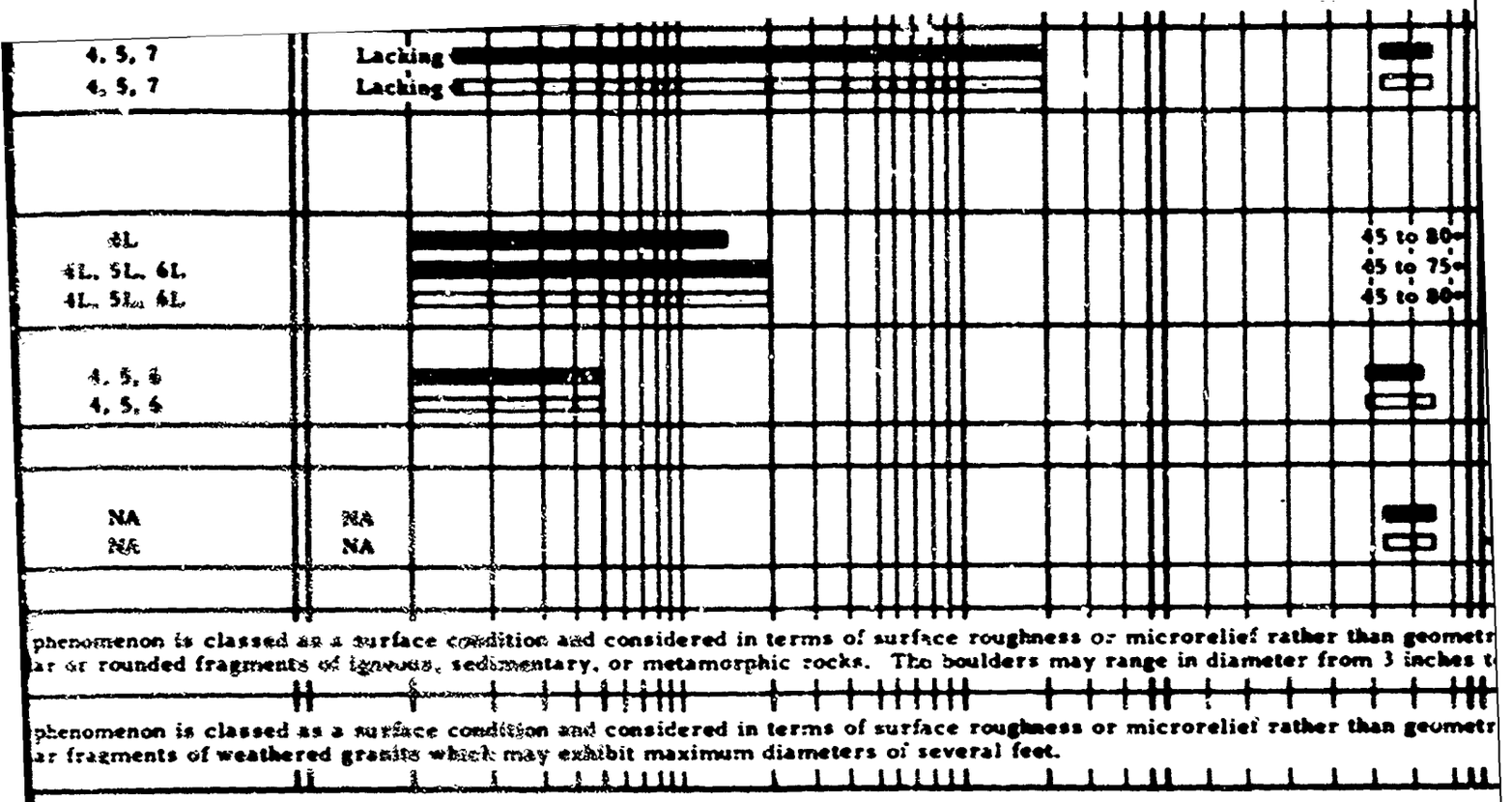
60. Steep wadi banks

66. A granite knob rising abruptly above a desert plain



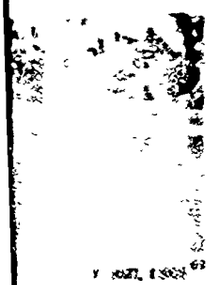
67. The famous Arizona meteor crater

68. A close-up of an exfoliated boulder showing the typical spalling action



phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rather than geometr
ar or rounded fragments of igneous, sedimentary, or metamorphic rocks. The boulders may range in diameter from 3 inches t

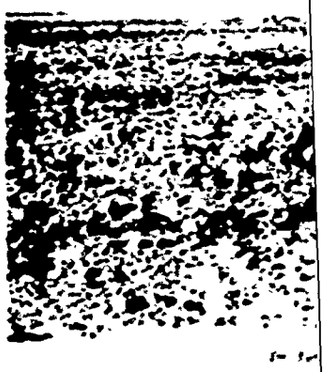
phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rather than geometr
ar fragments of weathered granite which may exhibit maximum diameters of several feet.



...the Grand
...Brewster

60. Steep wadi banks

61. A smooth surface of desert pavement. The tire tracks have penetrated the underlying silt



62. Flint-strewn pla

...meteor

68. A close-up of an exfoliated boulder showing the typical spalling action

69. Grus deposit resulting from weathering of igneous rock

ANAL

MI

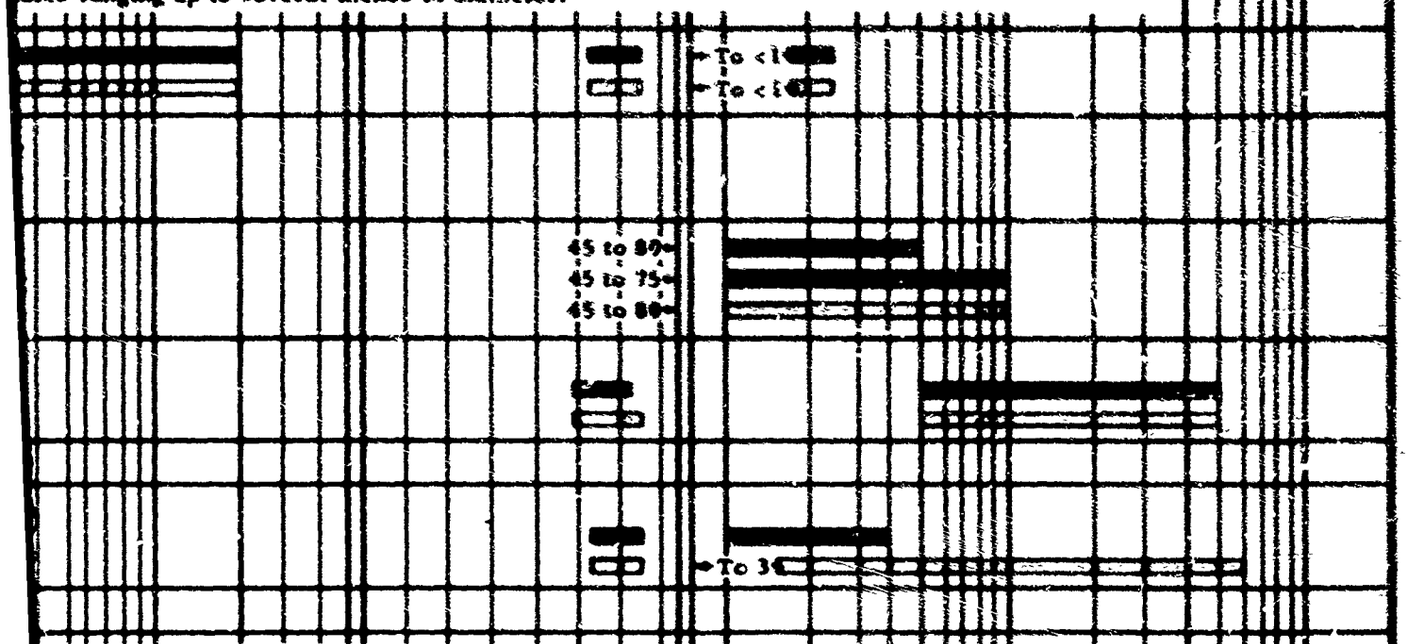
LANDFORMS

DESCRIPT

6

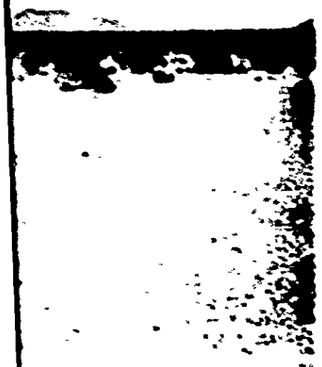
of surface roughness or microrelief rather than geometry factor ranges. The angular fragments
o several inches.

of surface roughness or microrelief rather than geometry factor ranges. The surface of the
bles ranging up to several inches in diameter.



f surface roughness or microrelief rather than geometry factor ranges. The boulders may be
s. The boulders may range in diameter from 3 inches to a few feet.

f surface roughness or microrelief rather than geometry factor ranges. Grus consists of
rs of several feet.



ooth surface of desert
. The tire tracks have
d the underlying silt

62. Flint-strewn plains

63. The rocky surface of a hamada

eposit resulting from
of igneous rock

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

6

Photo No.	CLASSIFICATION AND DESCRIPTION
	III. MISCELLANEOUS (CONT.)
	TECTONIC
70	Basin ranges: Ranges of hills or mountains formed by faulted and tilted blocks of strata (separated
71	Domal warps: Domal warps are roughly circular upwarps with beds dipping away from a central poi surface expression is often that of centrally facing, concentric series of erosional scarps.
72	Drowned valleys: Drowned valleys are erosional troughs of a dissected land surface inundated by the result of land-margin submergence.
73	Elongate domes: Elongate domes are elliptical upfolds, the beds dipping away from centrally located
74	Intramontane valleys: Intramontane valleys are narrow valleys or troughs with exterior drainage by mountains.
75	Scarps: Scarps are more or less continuous, precipitous slopes exhibiting more than 100 feet of reli
	VOLCANIC
76	Broken lava flows: Flat to undulating lava areas characterized by sharp-edged rocks and boulders.
77	Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash or clinker-rial around a vent.
78	Cinder fields: Cinder fields are flat to undulating areas, often miles in extent, composed of volcanic that has mantled the pre-existing landscape.
79	Craters and Calderas: Bowl- or funnel-shaped depressions of volcanic origin which are more or less in plan and rimmed by an infacing scarp. Craters are commonly less than a mile in diameter calderas have diameters several times larger.
80	Lava flows: Lava flows are solidified stationary masses of igneous rock which issued from a volcanic fissure.
81	Mud volcanoes: Small cone-shaped mounds built of clay and ordinarily formed by the eruption of sulf bituminous mud from a central vent or orifice.
82	Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by erosion.

* Not applicable
** Circled plan-profile designations indicate gross landscapes
† Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes
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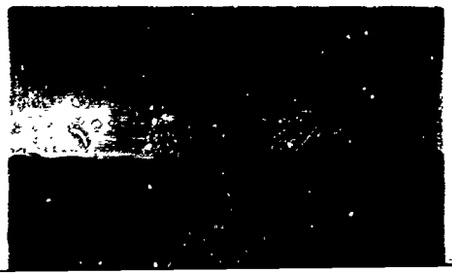


CE CONDITIONS: DESCRIPTIONS AND PHOTOGRAPHS

2

TYPICAL GEOMETRY FACTOR RANGES

Range at Yuma

Range in Middle East Desert

Plan-Profile Units	Slope Occurrence Units: Number of slopes greater than 50% per 10 miles (1, 5, 20, 100, 200)	Slope [illegible] Degr[illegible] (1, 2, 4)
4 4, 4L (5L, 5L//, 6L, 6L//)**†		
6 4, 4L		
•NA	NA	NA
4, 4L 4, 4L		
1, 1L 1, 1L		
NA NA	NA NA	

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rathe flow is composed of large, angular blocks of lava having diameters ranging up to several feet.

4, 4//, (5, 5//, 6, 6//) 4, 4//, (5, 5//, 6, 6//)	

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rathe slopes which are determined to some extent by the underlying, preexisting landscape. The cinders themselves are an between 4 and 32 mm.

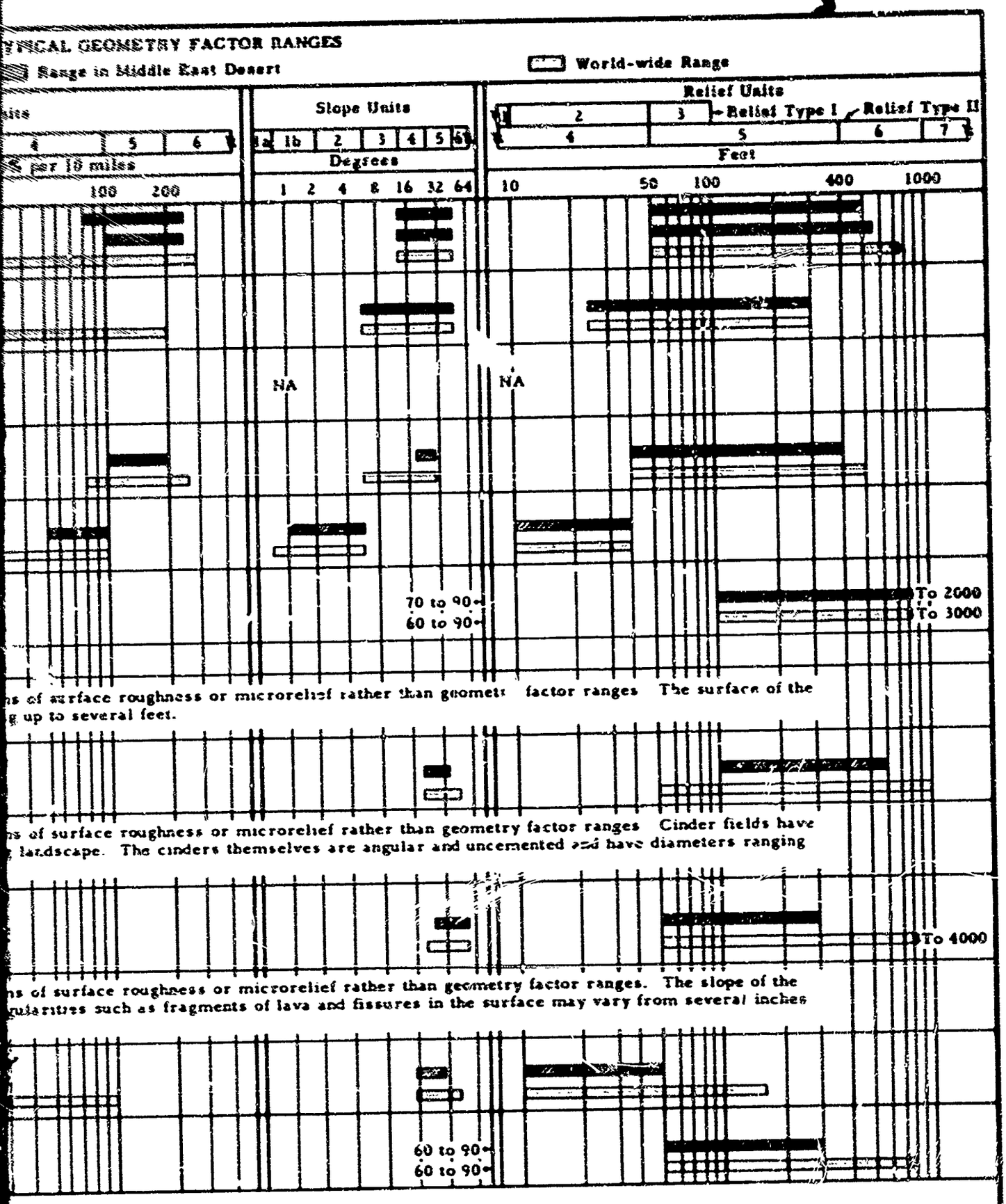
NA NA	NA NA

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rathe surface of these flows varies from flat to gently undulating. Surface irregularities such as fragments of lava and fiss to 10 feet.

4, 4// 4, 4//, (5, 5//, 6, 6//)	
4 4, 4//	

HOTOGRAPHS

3



ns of surface roughness or microrelief rather than geometr factor ranges The surface of the
g up to several feet.

ns of surface roughness or microrelief rather than geometry factor ranges Cinder fields have
landscape. The cinders themselves are angular and uncemented and have diameters ranging

ns of surface roughness or microrelief rather than geometry factor ranges. The slope of the
gularities such as fragments of lava and fissures in the surface may vary from several inches

76	[illegible] ating lava areas characterized by sharp-edged rocks and b
77	Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash o rial around a vent.
78	Cinder fields: Cinder fields are flat to undulating areas, often miles in extent, composed o that has mantled the pre-existing landscape.
79	Craters and Calderas: Bowl- or funnel-shaped depressions of volcanic origin which are m in plan and rimmed by an infacing scarp. Craters are commonly less than a mile calderas have diameters several times larger.
80	Lava flows: Lava flows are solidified stationary masses of igneous rock which issued from fissure.
81	Mud volcanoes: Small cone-shaped mounds built of clay and ordinarily formed by the erup bituminous mud from a central vent or orifice.
82	Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by

Not applicable

* Circled plan-profile designations indicate gross landscapes

† Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes

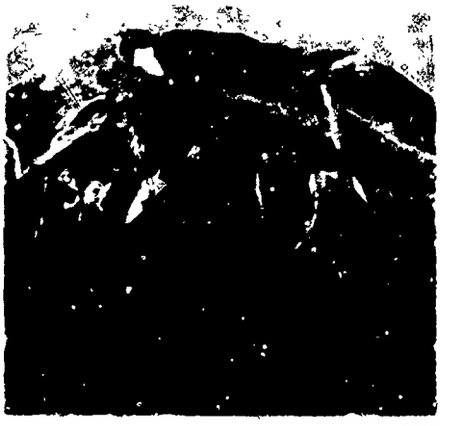
†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report

70. Basin ranges in the center and background of the photograph separated by alluvial aprons

71. An eroded domal warp forming a topographic basin

72. Drowned v

78. Cinder field at the northern



79. Mt. Edgecomb, Kruzof Island,

80. Lava flow

	5, 5//, 6, 6//	
based of volcanic ejecta	This phenomenon is classed as a surface condition and considered in terms of surface rou slopes which are determined to some extent by the underlying, preexisting landscape. The between 4 and 32 mm.	
are more or less circular mile in diameter, while	NA NA	NA NA
d from a volcanic cone or	This phenomenon is classed as a surface condition and considered in terms of surface rou surface of these flows varies from flat to gently undulating. Surface irregularities such a to 10 feet.	
eruption of sulfurous and	4, 4/ 5, 5//, 6, 6//	
ed by erosion,	4 4, 4//	

Walk[22]

ed valleys

Samuel Greeno - [illegible] National, Forest[32]

73. Vertical photograph of a breached elongate dome with inward dendritic drainage

R. Cross, 1965[31]

74. An intramontane valley

75. Aerial view of Bla fault scarp furrowed by south of Mormon, Calif

[illegible] Department of Agriculture

with cinder
ower left

J. T. Hickson[30]

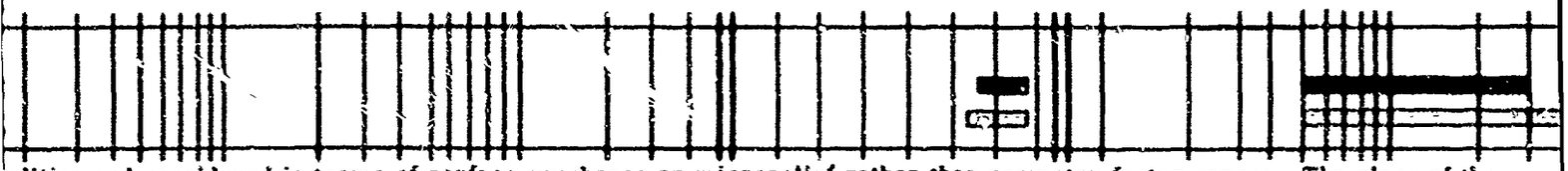
81. A mud volcano rising above the surrounding terrain

Photograph by O.F.A.L.A.C., courtesy P. Sinclair[11]

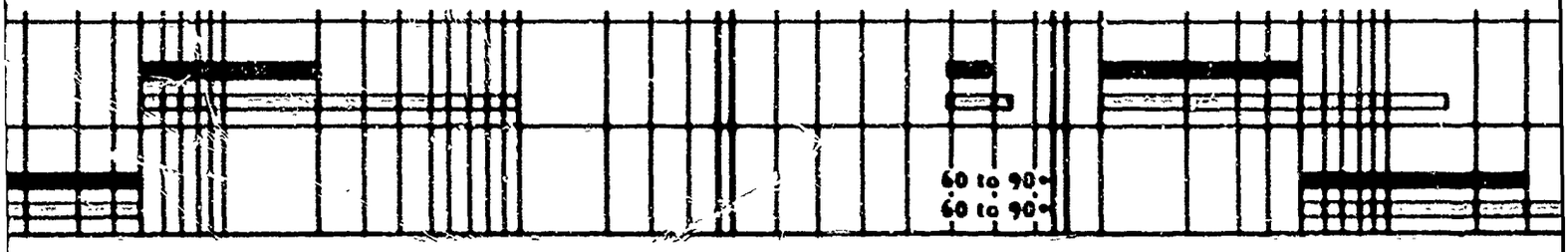
82. Plugs towering over a volcanic region

5

dition and considered in terms of surface roughness or microrelief rather than geometry factor ranges Cinder fields have by the underlying, preexisting landscape The cinders themselves are angular and uncemented and have diameters ranging



dition and considered in terms of surface roughness or microrelief rather than geometry factor ranges. The slope of the ntly undulating. Surface irregularities such as fragments of lava and fissures in the surface may vary from several inches



ontane valley

75. Aerial view of Black Mountain fault scarp furrowed by gorges south of Mormon, California

76. A broken [illegible] partially [illegible] sand

77. Cinder con

ring over a
n

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDIT

DESCRIPTIONS AND PHOTOGRAPH

END

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