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AUTHORITY
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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.
TECHNICAL REPORT NO. 3-630

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EMENTAL MAPS AND TABULATIONS

Physiography

Physiography: Descriptions and Photographs

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

RAIN FACTOR AND ANALOG MAPS
YUMA PROVING GROUND
(GROSS PLAN-PROFILE: SL.1)

CHARACTERISTIC PLAN-PROFILE:

The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either rectangular or triangular. The characterizes plan-profile is based on random sampling with 100% of the area. Local relief of less than 10 ft is not considered. The gross plan-profile is based on random sampling with circles 34 miles in diameter. Relief of less than 100 ft is not considered. The values are in each a plan-profile are normal component heights, the intervening hatch is component lows.

---

<table>
<thead>
<tr>
<th>Height Group</th>
<th>Schematic Plan</th>
<th>Layer and Bottom</th>
<th>Layer and Bottom</th>
<th>Layer and Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10% of area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-50% of area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;50% of area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

LEGEND
ANALOGS OF YUMA TERRAIN
IN THE MIDDLE EAST DESERT

CHARACTERISTIC PLAN-PROFILE

PLATE 1
YUMA PROVING GROUND

(GROSS OCCURRENCE OF COMPONENT HIGHS: 1)

OCCURRENCE OF SLOPES GREATER THAN 10 PER CENT

Ocurrence may be either continuous or gross. A recurve occurrence of gross indicates a net range of slopes greater than 10 percent along trends containing the maximum number of such slopes. Relief of less than 10 feet is not considered. A gross occurrence indicates the longest distance between component highs or component lows. Relief of less than 100 feet is not considered.

1. The number of slopes steeper than 10 per cent or less than 1 per 100 miles as areas, less than 20 miles in maximum dimension, where such slopes are lacking.
2. The number of slopes steeper than 10 per cent and ranges from 1 to 3 per 100 miles.
3. The number of slopes steeper than 10 per cent and ranges from 4 to 10 per 100 miles.
4. The number of slopes steeper than 10 per cent and ranges from 11 to 20 per 100 miles.
5. The number of slopes steeper than 10 per cent and ranges from 21 to 30 per 100 miles.
6. The number of slopes steeper than 10 per cent and exceeds 300 per 100 miles.

OCCURRENCE COMPLEXES: Shown only where plan-parallel complexes are mapped. All complexes combined in areas where the major, greatly restricted occurrence of gross, or both of the restrictive types, are mapped.
OCCURRENCE OF SLOPES GREATER THAN 50 PER CENT

Occurrence may be either continuous or sparse. A restrictive occurrence class indicates a potential range of slopes greater than 50 per cent found along the slope margin. A sparse occurrence class indicates slopes greater than 50 per cent in isolated areas. Relief of less than 10 ft is not considered. A great occurrence indicates the modal distance between component highs of component blocs. 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 10 per 10 miles.
4. The number of slopes steeper than 50 per cent ranges from 10 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-rose complex are mapped.

Slope Complexes: Combined to areas where non-matrix, actually reduced occurrence units, both of the restrictive type, are mapped.

1. Great occurrence of planarly prominent forms.
2. Great occurrence of actually prominent slopes.
3. Great occurrence of actually prominent forms.
4. Great occurrence of actually significant forms.

Great-component Complexes: Mapped only where great-component planar-rose complex are mapped.

1. Great occurrence of component highs.
2. Great occurrence of component highs.
3. Great occurrence of component highs.

Analogos of Yuma Terrain

In the

Middle East Desert

OCCURRENCE OF SLOPES GREATER THAN 50 PERCENT
CHARACTERISTIC SLOPE WITHIN COMPONENT HILLS

Map: Characteristic slope between 0 and 2 degrees exaggeration 1:1,445

Legend:
- Between 0 and 2 degrees exaggeration 1:1,445
- Between 2 and 7 degrees exaggeration 1:550
- Gentle: Characteristic slope between 2 and 4 degrees exaggeration 1:550
- Moderate: Characteristic slope between 4 and 12 degrees exaggeration 1:550
- Steep: Characteristic slope between 12 and 26.5 degrees exaggeration 1:550
- Precipitous: Characteristic slope greater than 26.5 degrees exaggeration 1:550

SLOPE CLASSIFIED: Shaded only where plan grids can be matched.

Scale: 1:55,000

NORTH

YUMA PROVING GROUND

CHARACTERISTIC SLOPE WITHIN COMPONENT HILLS
CHARACTERISTIC SLOPE

Slope is defined as a surface inclined or designated in terms of its deviation from the horizontal. Characteristic slope is defined as a narrow range of slopes which predominates in an area or region. Geographical or distinctive setting, arrangement, or pattern of contour lines mapped with a 1:2,000,000 scale interval.

**Flat** Characteristic slope between 0 and 2 degrees (approxe 0 - 1.5%).

**Steep** Characteristic slope between 25 and 35 degrees (approxe 10 - 15%).

**Very Steep** Characteristic slope greater than 35 degrees (approxe 15 - 90%).

**Precipitous** Characteristic slope greater than 90 degrees (approxe 90+%).

**Slope Complex:** Shown only where planar scarp complexes are mapped.

**Areal Complex:** Shown as areas where two slopes, or relief features, slope types are mapped.

---

**ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT**

**CHARACTERISTIC SLOPE**
YUMA PROVING GROUND
(GROSS RELIEF OF COMPONENT HIGHS: 7)

CHARACTERISTIC RELIEF

1. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES APPROX., 10 PER CENT

Characteristic relief may be called low, where in gross measurement the sheer fall is less than 6 degrees on any measurable part of the ground.

2. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES APPROX., 10 PER CENT

Relief is defined as the vertical difference in elevation per square mile. In areas where drainage lines are poorly developed or lacking, this method may be applied.

RELIEF COMPLEXES

Mapped only where plan-view complexes are mapped:

- Characteristic relief between 6 and 30 degrees
- Characteristic relief between 30 and 60 degrees
- Characteristic relief between 60 and 90 degrees
- Characteristic relief greater than 90 degrees

- Gross proportional complexes mapped only where gross component plan-view complexes are mapped
- Gross relief of component lines
- Gross relief of component lines
**CHARACTERISTIC RELIEF**

Characteristic relief may be related to elevation or grade. Depression refers to land below the contour. Depression elevation per unit area is indicated below. The area is divided into three types: (1) normal, (2) hilly, and (3) flat. Each type is described in terms of component relief, which is the maximum height of components above the area.

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 10 PER CENT

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Characteristic relief below 0 and 10 feet</td>
</tr>
<tr>
<td>2</td>
<td>Characteristic relief between 10 and 50 feet</td>
</tr>
<tr>
<td>3</td>
<td>Characteristic relief between 50 and 200 feet</td>
</tr>
</tbody>
</table>

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 10 PER CENT

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Characteristic relief between 0 and 50 feet</td>
</tr>
<tr>
<td>5</td>
<td>Characteristic relief between 50 and 200 feet</td>
</tr>
<tr>
<td>6</td>
<td>Characteristic relief between 200 and 500 feet</td>
</tr>
<tr>
<td>7</td>
<td>Characteristic relief greater than 500 feet</td>
</tr>
</tbody>
</table>

RELIEF COMPLEXES: Marked areas where post-gravity complexes are mapped.

 Reese Complexes: Marked areas where post-gravity complexes are mapped.

**ANALOGS OF YUMA TERRAIN**

**IN THE**

**MIDDLE EAST DESERT**

**CHARACTERISTIC RELIEF**

PLATE 4
**Yuma Proving Ground**

**Gross Landscape**

<table>
<thead>
<tr>
<th>Mountain Group</th>
<th>Type</th>
<th>Landform</th>
<th>FF</th>
<th>FF to CER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Generalized Landscape**

<table>
<thead>
<tr>
<th>FF 1</th>
<th>FF to CER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Map Details

- **Gulf of Oman**
- **Yuma Proving Ground**
- **Hills**

The map includes various symbols and colors to represent different landscape features and types.
ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT
SOIL TYPE

I. SOIL-Rock ASSOCIATIONS

A. Snow-covered area

B. Area characterized by a mass of bare rock and

C. Area that has been mapped

D. Area that has been mapped

E. Area that has been mapped

F. Area that has been mapped

G. Area that has been mapped

H. Area that has been mapped

II. SOIL ASSOCIATIONS

A. barren area

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

III. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

IV. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

V. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

VI. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

VII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

VIII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

IX. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

X. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XI. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XIII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XIV. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XV. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XVI. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XVII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XVIII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XIX. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XX. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXI. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXIII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXIV. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXV. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXVI. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXVII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXVIII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXIX. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXX. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXXI. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

XXXII. SOIL COMPLEXES

A. bare rock

B. bare rock

C. bare rock

D. bare rock

E. bare rock

F. bare rock

G. bare rock

H. bare rock

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

SOIL TYPE

PLATE 6
SOIL CONSISTENCY

SOIL CONSISTENCY

1. Homogeneous Consistencies - soils of essentially unaltered materials less than 12 inches in thickness.
2. Layered Consistencies - soils composed of more than one layer, with a minimum thickness of 12 inches.
3. Consistency Complexes - consistencies that are complex due to the presence of different materials or layers.

ANALOGS OF YUMA TERRAIN

IN THE MIDDLE EAST DESERT

SOIL CONSISTENCY

PLATE 7
YUMA PROVING GROUND

SURFACE ROCK
Mapping in regions where rock is exposed and at usable depths to 10 ft. throughout the remainder of the area. In effect this procedure equates the mapping of surface rock areas mapped on 1:2, 4, or 8
scale. Inc. Type

1. IGNEOUS ROCKS: Known for their consolidation - i.e., solidification of melted rock surface

2. Intrusive: Intrusive rocks which form by cooling below the surface of the earth. Granite, syenite. diorite, etc.

3. Extrusive: Intrusive rocks which have been by cooling at the surface of the earth.

4. METAMORPHIC ROCKS: Forms formed from original igneous or sedimentary rocks through alteration produced by pressure, heat, or the injection of other material at depth within the earth's crust. Gneiss, schist, etc.

5. SEDIMENTARY ROCKS: Includes rocks formed from material laid down by wind or water, or from fully defined source, as sediments, through the agency of water, wind, or glaciers.

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


8. shale: A sedimentary rock in which the mineral particles are predominantly of clay size.

9. Conglomerate: A sedimentary rock whose texture is largely due to impregnation and subsequent precipitation of silt from water. Grains, pebbles, and rock salt are the only components of some importance.

10. ROCK COMPLEXES: Each complex is mapped where it is only predominant (50 percent or more) rock type occurs. In such instances, the two most commonly occurring rock types are mapped, the predominance as shown by the number of the dominant rock, the fractional pattern.

It should be noted that the scale of mapping preceding delineates, especially in continental regions, of some allowed known where the thickness of sand or clay is much greater than 10 feet.

GENERALIZED ROCK PROPERTIES

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Absorption</th>
<th>Energy Conversion</th>
<th>Permeability</th>
<th>Stability of Retained Water</th>
<th>Bond Strength at Failure</th>
<th>Load Carrying Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEDIMENTS</td>
<td>A B C D E</td>
<td>F G H I</td>
<td>J K L</td>
<td>M N</td>
<td>O</td>
<td>P</td>
</tr>
<tr>
<td>SEDIMENTARY ROCKS</td>
<td>A B C D E</td>
<td>F G H I</td>
<td>J K L</td>
<td>M N</td>
<td>O</td>
<td>P</td>
</tr>
<tr>
<td>SEDIMENTARY ROCKS</td>
<td>A B C D E</td>
<td>F G H I</td>
<td>J K L</td>
<td>M N</td>
<td>O</td>
<td>P</td>
</tr>
<tr>
<td>SEDIMENTARY ROCKS</td>
<td>A B C D E</td>
<td>F G H I</td>
<td>J K L</td>
<td>M N</td>
<td>O</td>
<td>P</td>
</tr>
<tr>
<td>SEDIMENTARY ROCKS</td>
<td>A B C D E</td>
<td>F G H I</td>
<td>J K L</td>
<td>M N</td>
<td>O</td>
<td>P</td>
</tr>
</tbody>
</table>

HILLS

GULF OF OMAN

MESA
**ANALOGS OF YUMA TERRAIN**

**IN THE**

**MIDDLE EAST DESERT**

**SURFACE ROCK**
YUMA PROVING GROUND

TEGATION

Arable predominant (70 percent or more, vegetation type mapped.

Vegetation

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Barren</td>
</tr>
<tr>
<td>2</td>
<td>Sparse shrub &amp; grass</td>
</tr>
<tr>
<td>3</td>
<td>Scattered shrub &amp; grass</td>
</tr>
<tr>
<td>4</td>
<td>Scattered shrub and/or scrubby trees</td>
</tr>
<tr>
<td>5</td>
<td>Barren shrub and/or scrubby trees</td>
</tr>
<tr>
<td>6</td>
<td>Barren shrub and/or scrubby trees</td>
</tr>
<tr>
<td>7</td>
<td>Orchard trees with grass-herb cultivation</td>
</tr>
<tr>
<td>8</td>
<td>Palate with or without grass-herb cultivation</td>
</tr>
<tr>
<td>9</td>
<td>Barber</td>
</tr>
<tr>
<td>10</td>
<td>Barren</td>
</tr>
<tr>
<td>11</td>
<td>Vegetation complexes</td>
</tr>
<tr>
<td>12</td>
<td>Palate</td>
</tr>
</tbody>
</table>

Vegetation complexes are mapped where an arable 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 understorey, the interseeding as the denomination of the fractional pattern.
**VEGETATION**

ANALOGS OF YUMA TERRAIN
IN THE MIDDLE EAST DESERT

VEGETATION

![Vegetation Map Image]

**VEGETATION**

Analogously predominant (79 percent or more) vegetation type mapped.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Barren</td>
</tr>
<tr>
<td>2</td>
<td>Sparse shrub &amp; grass</td>
</tr>
<tr>
<td>3</td>
<td>Scattered shrub &amp; grass</td>
</tr>
<tr>
<td>4</td>
<td>Scattered shrub and/or scrubby trees</td>
</tr>
<tr>
<td>5</td>
<td>Dense shrub and/or scrubby trees</td>
</tr>
<tr>
<td>6</td>
<td>With scattered 1-story trees</td>
</tr>
<tr>
<td>7</td>
<td>With grass-herb vegetation</td>
</tr>
<tr>
<td>8</td>
<td>Grassy vegetation</td>
</tr>
<tr>
<td>9</td>
<td>Grass-herb vegetation</td>
</tr>
<tr>
<td>10</td>
<td>March</td>
</tr>
</tbody>
</table>

**VEGETATION COMPLEXES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Palms</td>
</tr>
</tbody>
</table>

**Plate 9**

Additional Vegetation (Supplementary Data)

<table>
<thead>
<tr>
<th>Cost</th>
<th>Canopy Cover</th>
<th>Diameter</th>
<th>Height</th>
<th>Trunk Base</th>
<th>Crown Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Barren</td>
<td>&lt;1</td>
<td>1-5</td>
<td>4-10</td>
<td>6-10</td>
<td>2-3</td>
</tr>
<tr>
<td>2. Sparse shrub &amp; grass</td>
<td>1-5</td>
<td>2-5</td>
<td>4-10</td>
<td>6-10</td>
<td>2-3</td>
</tr>
<tr>
<td>3. Scattered shrub &amp; grass</td>
<td>5-25</td>
<td>5-10</td>
<td>6-15</td>
<td>6-20</td>
<td>2-3</td>
</tr>
<tr>
<td>4. Scattered shrub and/or scrubby trees</td>
<td>50-70</td>
<td>10-20</td>
<td>6-15</td>
<td>6-20</td>
<td>2-3</td>
</tr>
<tr>
<td>5. Dense shrub and/or scrubby trees</td>
<td>100-150</td>
<td>20-30</td>
<td>6-25</td>
<td>6-30</td>
<td>2-3</td>
</tr>
<tr>
<td>6. With scattered 1-story trees</td>
<td>150-200</td>
<td>25-30</td>
<td>6-30</td>
<td>6-35</td>
<td>2-3</td>
</tr>
<tr>
<td>7. With grass-herb vegetation</td>
<td>200-250</td>
<td>30-40</td>
<td>6-40</td>
<td>6-45</td>
<td>2-3</td>
</tr>
<tr>
<td>8. Grassy vegetation</td>
<td>250-300</td>
<td>35-45</td>
<td>6-50</td>
<td>6-55</td>
<td>2-3</td>
</tr>
<tr>
<td>9. Grass-herb vegetation</td>
<td>300-350</td>
<td>40-50</td>
<td>6-60</td>
<td>6-65</td>
<td>2-3</td>
</tr>
<tr>
<td>10. March</td>
<td>350-400</td>
<td>45-60</td>
<td>6-70</td>
<td>6-75</td>
<td>2-3</td>
</tr>
</tbody>
</table>

Vegetation categories are mapped where the analogically predominant (79 percent or more) vegetation type occurs. In such instances, the two most common recurring types are mapped, the predominant in heavy or as the numerator, the subordinate as the denominator in the fractional pattern.
YUMA PROVING GROUND
(GROSS LANDSCAPE: SL/1. 1. 5. 7)

LEGEND

Each color type is symbolized by a square or an array of four squares indicat- ing mapping units of PLAN PROFILE (1), SLOPE (1), and RELIEF (1). Mapping units of these four factors are always designated in that order.

1. Landscapes in the Middle East are always compared with Yuma landscapes and not vice versa. The array of squares in the Middle East is shown in light and "weak" type to indicate the relative degree of analogy with Yuma, the analogy increasing as the number of light squares increases. Urns shown in "strong" type are not found in Yuma in combination with the remaining units of the array. "Weak" type indicates the maximum number of units found in the closest corresponding array on the Yuma map.

2. Areas Compared. The second predominant landscape is the same as the one shown in the "strong" type, the subordinate the "weak" type.

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

<table>
<thead>
<tr>
<th>0</th>
<th>Highly Analogous</th>
<th>The identical landscape as found at Yuma.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moderately Analogous</td>
<td>Two units of the array are found in an array occurring at Yuma.</td>
</tr>
<tr>
<td>1.5</td>
<td>Signs Analogous</td>
<td>One or two units of the array are found in an array at Yuma.</td>
</tr>
<tr>
<td>2</td>
<td>Not Analogous</td>
<td>No units of the array are found at Yuma.</td>
</tr>
</tbody>
</table>
ANALOGS OF YUMA IN THE MIDDLE EAST DE 
GEOMETRY AN.
GEOMETRY OR ZONAL ANALOGS

LEGEND

- Each landscape type is symbolized by a letter or an array of letter symbols below using mapping units of PLANE-PERCENTAGE, UOC, LEVEE 1%, SLOPE 1%, and RELIEF 1%. Mapping units of these four letters are always arranged in this order.

In the Middle East, each landscape type is compared with Yuma landscapes and not vice versa. The four areas of symbols in the Middle East are shown in light and boldface type to indicate the maximum degree of analogy with Yuma; the analogous occurrence is the number of lighter and darkness. Yuma shown in a landscape type are not found in Yuma in combination with the remaining units of the area. Yuma in landscape type indicates the maximum number of areas found in the corresponding area on the Yuma map.

AREA COMPARISON: Yuma landscape as the numerator of the coordinates, the denominator the denominator.

LANDSCAPE COMPLEX:

This indicates the degree of analogy of the overall landscape type.

This indicates the degree of analogy of the subordinate landscape type.

This indicates the degree of analogy of the subordinate landscape type.

This indicates the degree of analogy of the subordinate landscape type.

This indicates the degree of analogy of the subordinate landscape type.

In a particular area, it may be possible to show different sets of lighter- and darkface units to indicate the maximum degree of analogy. In such instances, units are compared in the order given in the legend. For example, the Middle East area, 1650, was compared with the Yuma area, 1650, rather than with Yuma, 1650. A discrepancy with the letter would have resulted in the combination, 1650.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

GEOMETRY ANALOGS
YUMA PROVING GROUND

Legend:
- Numbers designate mapping units of soil type and surface rock or soil conditions, 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 condition; mapping unit. In the example given, e.g., 1.7 the first digit is one type, the second, surface rock.
- Ground features in the Middle East are shown on three maps: ground features, and not once, array, if both digits are alike, the units are called; combination as shown. 5 one, of right, and the other, features, and combinations are shown, combining the right side. If both digits are alike, the unit is found in the maps.
- Ground features in the Middle East are shown on three maps: ground features, and not once, array, if both digits are alike, the units are called; combination as shown. 5 one, of right, and the other, features, and combinations are shown, combining the right side. If both digits are alike, the unit is found in the maps.
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

VEGETATION ANALOGS
ANALOGS OF YUMA TERRAIN
IN THE MIDDLE EAST DESERT

TERRAIN-TYPE ANALOGS
ANALOGS OF YUMA TERRAIN IN
SECTION II: SUPPLEMENTAL M
IN THE MIDDLE EAST DESERT

AL MAPS AND TABULATIONS
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

PHYSIOGRAPHY

PLATE 14
Mountains: Mountains are masses of land massive in size and scattered to the base dimensions and which differ from the surrounding terrain. Areas so marked are called mountains, major and minor mountain ranges, and the plains on which they occur. The mountains of the Middle East are extremely rugged and the area is dotted with scattered woodlands and vegetation. Within the mountains, approximately 15 percent of the area is covered with vegetation. The mountains of the western part of the Middle East generally have steep elevations and abrupt breaks in the southern portion of the western end of the range of the Qalamoun Mountains extend.

M-1. Northwest face of Jabal Idriss from Al Murrah in the Wadi Tihna in the mountains of western Aden. At 19°45' N, 44°41' E.

M-4. Wadi Basah where it enters the coastal plain from the Hajar Mountains in western Arabia. At 17°30' N, 43°45' E.

M-5. Jebel Sannin rising to 9422 ft in the Lebanon Mountains in western Syria. Note terraced side slopes. At 35°50' N, 36°45' E.
be summit areas that are small some heights of more than 10,000 ft. above lowly be entirely mountainous, such as they may be plain-mountain component of the total area. The mountains, with slopes ranging from moderate to steep, are typical. A wide variety of mountainous areas, sparse, scrubby, and isolated areas are typical. Mountains in the desert. Ranges of massive ridges of the Arabian Peninsula extending from the mountains. These rugged crystalline mountains from 6000 to 9000 ft.; however, ranges are known to exceed 11,000 ft. In the eastern side of the Rift Valley, as three roughly parallel ridges of sedimentary rock. In northeastern Iraq, roughly parallel, discontinuous ridges of sedimentary rock separated by extensive intermontane plains form a basin and a region which marks the transition from the western steppes to the high mountains of Kurdistan. In eastern Iraq the Zagros Mountains extend into a series of parallel ridge mountains. Geologically, the Zagros are part of the ancient mountain mass of the Kūhdū folk to the north. In the extreme eastern portion of the Arabian Peninsula lies a crescentic band of mountains flanked by the great steppes and deserts to the south and west. These mountains of Oman, an extremely rugged range of igneous and sedimentary rocks trending 400 miles to the northwest, parallel to the coast along the southern shore of Arabia lie a thin strip of parallel ridge mountains. These are structurally part of the Hadramaut Plateau, but the processes at the eastern side of the Hadramaut Plateau, but the processes have created a series of sharp-peaked, rugged parallel, sedimentary several thousand feet in elevation.
three roughly parallel ridges of folded sedimentary rock, roughly parallel, discontinuous ridges of younger Mesozoic rocks, form a basin and range area, from the western slopes to the high, rugged Zagros Mountains extend into the area. Geologically the Zagros are part of the Tethys ranges to the north. In the extreme southwestern area, a crescentic bend of massive mountainous desert is on the south and west. These are the rugged range of igneous and sedimentary mountains, the smartphones, but the processes of erosion created densely parallel, sedimentary ridges.

M-1. View from eastern edge of the top of Jabal Hajar, 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 Muscat, at approximately 22°10' N.
M-1. Northwest face of Jabal Jihaf from Al Marsah in the Wadi Tiban in the mountains of western Aden. At 15°45' N, 44°41' E.

M-4. Wadi Basset where it enters the coastal plain from the Hejaz Mountains in western Arabia. At approximately 17°25' N, 42°30' E.

M-5. Jabal Sannin rising to 8622 ft in the Leban western Syria. Note terraced lower slopes. At mately 34°00' N, 43°15' E.

M-9. Jabal Keir in mountains 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.

Reference numbers refer to similarly numbered entries in the bibliography at the end of volume.
M-2. View southward toward Manbar from the Naim Ibaa pass, elevation 2600 ft, in the mountains of southern Yemen. At 14°46' N, 46°20' E.

M-5. Upper fold and nappe zone in the Qassim and Haraz region of northeastern Iraq. At approximately 35°10' N, 46°20' E.

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

M-11. Dissected limestone country of Rum al Jabal looking southwest from Khasab on the Masandam Peninsula. At 26°11' N, 94°15' E.

M-12. Foothills of the Omani mountains from the Wadi Jiza in the Masandam Peninsula. At approximately 26°28' N, 94°15' E.
M-1. View from eastern edge of the top of Jabal Harr, elevation 7760 ft., in the southwestern mountains of Arabia. At 15°26' N, 46°43' E.

M-7. Mountains along the Iranian border, looking southwest from Kahr-1-Darzurg. At 33°20' N, 46°20' E.

M-8. Oman mountains north of Suraimi. At approximately 12°30' N, 59°20' E.

M-12. Panthills of the Oman Mountains as seen from the Wadi Jina in the Basrah coastal plain. At approximately 30°20' N, 46°35' E.

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 promontories that rise to heights of less than 1000 ft above the base of lower land, consisting of hill masses or ridges and valleys; they occupy as much as 75 percent of the total area. The position of hill lands vary widely. They may consist of igneous, metamorphic, and sedimentary rocks; some are composed of lava flows and others of a wide variety of types by erosion. Slopes are steep, and relief ranges from 10 to 700 ft. The most characteristic feature of a hill land is a broad, rugged, barren area of vegetation, whereas the support a sparse vegetative cover. Hill lands cover the Middle East desert. Random hills of crystalline rocks are surrounded by the great central tableland of Arabia, which flanks the slopes and slopes gently toward the Persian Gulf. In these hill lands are composed predominantly of...
immediately adjacent to the western mountains they are interrupted by volcanic barras, i.e., vast fields of basaltic lava surmounted by groups of cinder cones. The barras extend in a broken line from the Aedea 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 160,000 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 bed dunes, project in a northwesterly direction and terminate in the An Najd -- the northern desert of Arabia. Smaller dune areas are found scattered throughout the peninsula, the most notable of which are the Najd Dali in central Arabia, the Rukbat Sabateyn in southern Arabia, and the Hafar 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.
Mountains they are interrupted by volcanic surmounted by groups of cinder cones. The Aden Peninsula in the south to the
ranges 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
sand and terminate in the An Nafud •
the areas are found scattered throughout
the Nafud Dali in central Arabia, the
the Haa plain in eastern Arabia. Par-
areas, a small zone flanking the reach-
and a hilly area to the west of Jerusalem.
Surface expression of folding in sedi-

N-9. Bush weathered crystalline hill in the
Haa Valley in southwestern Arabia. At
15°18' N, 44°55' E.

H-10. A deep depression in the An Nafud in
southern Arabia. At approximately 25°19' N, 61°50' E.
H-1. Craters and lava-flows north of Jabal Kohl in western Arabia. At 19°47' N, 44°80' E.

H-2. Muzzle dissected hill land in western Transjordan near Aqaba, masses projecting from vast areas of sand. At 29°35' N, 35°25' E.

H-3. A crystalline hill in the Jabal Aja Range near Yumari in central Arabia. At 27°44' N, 41°36' E.

H-4. Weathered crystalline hill in north central Arabia. At 25°44' N, 37°36' E.

H-5. A typical Masa'ar in the Aqabat Mountains. At approximately 26°17' N, 56°30' E.

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

H-7. Weathered crystalline hill in north central Arabia. At 25°44' N, 37°36' E.

H-8. A typical Masa'ar in the Aqabat Mountains. At approximately 26°17' N, 56°30' E.

H-9. Gobustan sand dune, typical of the Red Sea Khali. At approximately 19°95' N, 56°30' E.

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I of this...
1. A granite boulder seen from the Wadi Arrib in the hill lands of southwestern Arabia.

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

II-13. Wind-blown sand encroaching on the date gardens of ġailīf in the Haa. At 26°32' N, 50°00' E.

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

II-14. Fossil dune at 'Marzaliyat in the Haa Plain of eastern Arabia. At 26°34' N, 50°07' E.

H-15. Active dune on a plain in western Arabia. 43°08' E.
H-5. Badly weathered crystalline hill in the Iisma Valley in southwestern Arabia. At 19°15' N, 44°30' 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. Dome patterns created by a variable wind regime on a peneplain in southern Rub al Khali. At 19°45' N, 53°56' E.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT PHYSIOGRAPHY DESCRIPTIONS AND PHOTOGRAPHS

PLATE 15A
Plateaus:

Plateaus are elevated masses of land characterized by flat-topped summit areas bounded on one or more sides by cliffs, cliffs, or lower slopes. Dissected plateaus have been defined as areas where the original surface remains. Approximately 60 percent of the earth's plateaus are dissected plateaus. The average slope of a dissected plateau is less than 1 degree; however, some summits have slopes ranging up to 6 degrees. Dissected plateaus may range up to 10 ft, whereas the rolling plateau ranges from 10 to 50 ft. Depth of dissected plateaus along the major axes of the earth may exceed 1000 ft. The plateaus were formed in areas of sedimentary rock, which sandstone and limestone types. In general, dissected plateaus lie beneath plateaus of the Middle East may be conveniently described as Southern Plateaus, Central Plateaus, and northern section of the Hadramaut, as it is an impressive plateau region of the world. Deep 1000 ft deep and several miles across, cut the

References

P-1. Weh 'Amud at Hureidha in the Hadramaut, Southern Arabia.

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

P-3. Plateau surface above Tarim in the Hadramaut. At approximately 15°S°N.

P-4. Typical plateau surface south of the Weh Hadramaut. At approximately 15°E°N.
of tableland. The Liadhrumau has a steep seaward-facing escarp and slopes gently
to the north where it grades without a distinct break into the Rub' al Khali Desert.
The central region consists of a series of roughly concentric bands of plateau
separated by thin strips of sand desert. They reach the greatest elevations
in the west and grade gently eastward until they dip beneath the plains bordering the
Persian Gulf. The westernmost of these plateaus, Jabil Fawaj, is intensively dissected,
and travel through this area is restricted to the beds of a few deep wadis. The
area for plates extends as relatively undeveloped flat-lying areas of bed-
rock often covered with a thin veneer of semi-polished gravel. The northern pla-
teaus occupy much of the northwest portion of the study area. They are bounded on
the north by the Gela-Ram Ranges and the Euphrates River and extend in a souther-
est direction until they merge with the central plateau to the south. In the east
the plateaus gradually grade into desert plains. In general, they have their great-
est 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 south
east through Syria, Transjordan, and into northern Saudi Arabia. The Al Wadiya Plateau, immediately to the east of these lava fields, is dissected by numerous
shallow wadis.
Seaward-facing scarp and slopes gently

distinct break into the Rub' al Khali, Desert.

of roughly concentric bands of plateau

They reach their greatest elevations in

they dip beneath the plain bordering the

plateaus. Jabal Turayq, is intensely dis-

stricted to the beds of a few deep wadis,

very unaltered flat-lying areas of bed-

wind-polished gravel. The northern pla-

of the study area. They are bounded on

the Euphrates River and extend in a south-

central plateau to the south. to the east

plains. In general, they have their great-

component of this area is separated from

extends from Damascus to the north-

northern Saudi Arabia. The Al Wadyan

lave fields, is dissected by innumerable


P-9. Salt inflow, Jebel Druze, Syria. At

33°25'N, 36°50'E.

P-10. Intensely dissected edge of

the plateau bordering the Wadi Arbeia

in southern Palestine. At 30°00' N,

P-11. Looking up the Wadi Zarga

in the Jordan Plateau north of

the Red Sea. At approximately

P-12. Salt inflow of Jordan Plateau


P-1. Wadi 'Amd at Hurudha in the Hadramaut, 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 Hadramaut. At approximately 15°05' N, 48°50' E.

P-7. Typical plateau surface south of the Wadi Hadramaut. At approximately 15°05' N, 49°00' E.

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

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

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report.
P-1. View eastward from the Deir Plateau region in Jordan, near Petra. Exact location unknown.

P-4. Crater of Jebel Sebaa, Jebel Druze volcanic plateau region, Syria. At 33°25′N, 36°50′E.

P-8. Aerial view of the dissected Hadramawt plateau showing the entrenched drainage and the characteristic denudation. At approximately 16°15′N, 49°36′E.

P-9. The Sebaa Pass in Jabal Tomaiq in central Arabia. At 34°30′N, 46°25′E.

P-10. Intensely dissected plateau borders in southern Palestine 35°05′E.

P-12. Remains of old plateau surface in the Upper Wadiya Province, southwestern Iraq. The Wadi Shuran traverses the area shown in the photo, flowing from left to right. At approximately 31°30′N, 41°40′E.

P-15. Jointing in well-bedded Cretaceous limestone on the north side of Wadi Shuran in southwestern Iraq. At approximately 33°40′N, 42°00′E.
P-5. Safa lava flood, Jebel Druze, Syria. At 33°25'N, 36°50'E.

P-9. Crater of Jebel Suya, Jebel Druze volcanic region, Syria. At 33°25'N, 16°50'E.

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

P-11. Looking up the Wadi Zerqa in the Jordan Plateau north of the Dead Sea. At approximately 32°10'N, 35°30'E.

P-16. Erosional remnants in the Gurni depression, southwestern Iraq. At approximately 33°30'N, 46°15'E.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT PHYSIOGRAPHY DESCRITIONS 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 20 percent of the Middle East desert is occupied by plains. Plains may be subdivided on the basis of origin or physiographic relation. Flood- plains, 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...

PL-1. The town of Muhalla on the narrow coastal plain of southern Arabia. At 14°33' N, 49°01' E.

PL-2. Intermontane plain in the Hijaz of western Arabia. Village and fields in the foreground are backed by volcanic cones. At 19°03' N, 49°...
and plateaus they are highly dissected. Along the Hula 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 northeastern 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 Arabian large number of intermittent lakes upon the level of the rivers. Uplift and erosion with differences in elevation near the northern part of the Sudan's, the Mediterranean mountains, Iraq and south along the Persian Gulf to southeast: (1) the Al Jadra, the desert plains (2) Al Hazara, the alluvial plain (3) the Dib dibba, a flat, shallow Kuwait, and northeastern Arabia parallels the Persian Gulf and may Arabia a number of large sand in southern Arabia flanks the marks the transition between the


PL. 4. Jabal Mashta and Sahmali, a salt knob on the Dibibba Dome in eastern Arabia. Typical sabkha in the foreground. At 26°41' 56°03' E.

PL. 5. Site of the Ain Waj, an oasis in the Lower Wasit Province of southern Iraq. At 35°01' N, 42°08' E.
or the escarpment of the Arabian tableland. Most of the plain is characterized by a large number of intermittent freshwater lakes which vary greatly in size 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 Hajar, the stony plain of southern Iraq south of the Euphrates River, and (4) the Dibibba, a flat, relatively undisturbed desert plain in southeastern Iraq, Kuwait, and northeastern Arabia. In east central Arabia the sandy Hosa 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 marks the Hadramaut Plateaus and the Oman Mountains and marks the transition between these highlands and the Rub' al Khali Desert.
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 sand seas of western Arabia. Vast fields in the foreground are beds of volcanic cones. At 18°03' N.

PL-3. Saudi Arabian Mining Syndicate road passing through high lava plateau strewn with broken lava. At approximately 22°05' N, 49°28' E.

PL-4. Outcrop of gypsum on the surface of the Al Jazer plateau of the Al Jazer, a vast plain between the Tigris and Euphrates approximately 34°30' N, 45° E.

PL-5. Fortified town of Dura Europos in the desert plain bordering the lower Euphrates in Iraq. Exact location unknown.

PL-6. The flat plains of southern Iraq as viewed from the top of the Al Jazer plateau at 30°05' N, 47°04' E.

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume 1.
the Hijaz Moonlage and cultivated backed by a number N, 43°12' E.

PL-1. North slope of the Faişat Sa atullah Depression south of Salum in southern Iraq. Possibly caused by solution. At 30°23' N, 44°25' E.

PL-2. Jabal Madhra' ash Shamali butte on the Daunman Dome in east Typical sabha in the foreground. 50°95' E.

PL-6. Sinkhole near Ain Wiza in the Lower Wadyan Province of southern Iraq. At 33°06' N, 42°00' E.

PL-10. Al Oumeinman 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-16. The vast flood plain of the Tigris south of Baghdad. At approximately 3, 44°35' E.

of this report
PL-4. Jabal Madhra' ash Shamali, an isolated butte on the Damman Dome in eastern Arabia. Typical sabkha in the foreground. At 26°16' N, 50°05' E.

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

PL-9. Ain Agis, an oasis in the Lower Wadyen 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°30' N, 48°00' E.

PL-14. The vast flood plain of the Tigris River south of Baghdad. At approximately 33°10' N, 43°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

by PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

PLATE 15C
HYPSOMETRY
MIDDLE EAST DESERT
IN THE
ANALOGS OF YUMA TERRAIN
ALANOC OF TUNA TERRAIN IN THE MIDDLE EAST DESERT RAINS LANDFORT MAP PLATE 17
## Analogies of Yuma Terrain in the Middle East Desert

### Selected Landforms and Surface Conditions

**PLATE 18**

<table>
<thead>
<tr>
<th>Landform</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancient channels</td>
<td></td>
</tr>
<tr>
<td>Alluvial fans</td>
<td></td>
</tr>
<tr>
<td>Barren, arid sands</td>
<td></td>
</tr>
<tr>
<td>Basaltic scarps</td>
<td></td>
</tr>
<tr>
<td>Calderas</td>
<td></td>
</tr>
<tr>
<td>Canyons</td>
<td></td>
</tr>
<tr>
<td>Caprock</td>
<td></td>
</tr>
<tr>
<td>Casitas and ravines</td>
<td></td>
</tr>
<tr>
<td>Cliffs and cliffs</td>
<td></td>
</tr>
<tr>
<td>Closed basins</td>
<td></td>
</tr>
<tr>
<td>Closed basins</td>
<td></td>
</tr>
<tr>
<td>Corrugated</td>
<td></td>
</tr>
<tr>
<td>Desert pavement</td>
<td></td>
</tr>
<tr>
<td>Deserts</td>
<td></td>
</tr>
<tr>
<td>Dry riverbeds</td>
<td></td>
</tr>
<tr>
<td>Dry valleys</td>
<td></td>
</tr>
<tr>
<td>Erosional features</td>
<td></td>
</tr>
<tr>
<td>Fault scarps</td>
<td></td>
</tr>
<tr>
<td>Fluvial terraces</td>
<td></td>
</tr>
<tr>
<td>Fossilized</td>
<td></td>
</tr>
<tr>
<td>Gullies</td>
<td></td>
</tr>
<tr>
<td>Hardened mud</td>
<td></td>
</tr>
<tr>
<td>High stand valleys</td>
<td></td>
</tr>
<tr>
<td>Lake beds</td>
<td></td>
</tr>
<tr>
<td>Lake beds</td>
<td></td>
</tr>
<tr>
<td>Lava beds</td>
<td></td>
</tr>
<tr>
<td>Migmatites</td>
<td></td>
</tr>
<tr>
<td>Mountain ranges</td>
<td></td>
</tr>
<tr>
<td>Mountains</td>
<td></td>
</tr>
<tr>
<td>Nancon</td>
<td></td>
</tr>
<tr>
<td>Nancon</td>
<td></td>
</tr>
<tr>
<td>Oases</td>
<td></td>
</tr>
<tr>
<td>Offshore bars</td>
<td></td>
</tr>
<tr>
<td>Palm groves</td>
<td></td>
</tr>
<tr>
<td>Pleistocene</td>
<td></td>
</tr>
<tr>
<td>Ravines</td>
<td></td>
</tr>
<tr>
<td>Ravines</td>
<td></td>
</tr>
<tr>
<td>Rock glaciers</td>
<td></td>
</tr>
<tr>
<td>Rounds</td>
<td></td>
</tr>
<tr>
<td>Sediment</td>
<td></td>
</tr>
<tr>
<td>Shells</td>
<td></td>
</tr>
<tr>
<td>Thorns</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td></td>
</tr>
</tbody>
</table>

*This table provides analogies for understanding the geology and landforms found in the Middle East Desert, similar to those observed in Yuma Terrain.*

---

**ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT**

**SELECTED LANDFORMS AND SURFACE CONDITIONS**
<table>
<thead>
<tr>
<th>Photo No.</th>
<th>CLASSIFICATION AND DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. DEPOSITIONAL ALLUVIAL</td>
</tr>
<tr>
<td></td>
<td>Abandoned courses: Abandoned courses are lengthy segments of a river abandoned when the stream migrates to a new course across the floodplain.</td>
</tr>
<tr>
<td>2</td>
<td>Alluvial aprons: Alluvial aprons are created through coalescence of alluvial fans along the base of hills and escarpments. Several fans coalesce to form an alluvial apron.</td>
</tr>
<tr>
<td>3</td>
<td>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 load. Steep slopes near the mountains, slope gently outward with a continually decreasing gradient characterize the external drainage of the fan. Alluvial fans are termed series of sandy ridges and clayey swales resulting, conforming to the curvature of the stream channel.</td>
</tr>
<tr>
<td>4</td>
<td>Bars and swales: Bars and swales are accretion deposits formed on the inside of river bends, wherever the channel migrates. Sandy bar deposits or &quot;ridges&quot; are laid down during the flood stage, as the water subsides, an accretion depression or &quot;swale&quot; often flank the landward side. The swale is modified by subsequent high-stage flow and eventually if the stream continues to migrate. The depression is gradually filled with fine-grained materials. Stages of sandy ridges and clayey swales results, conforming to the curvature of the stream channel.</td>
</tr>
<tr>
<td>5</td>
<td>Boulder-choked wadis: Boulder-choked wadis are relatively narrow and deep, intermittent streams generally in mountainous or plateau regions, where boulders have been amassed in sufficient quantity to retard or prevent vehicular movement.</td>
</tr>
<tr>
<td>6</td>
<td>Deltas: Deltas are alluvial tracts of land, usually triangular in shape, formed at the mouth of a river, where rivers are incised or where the river is otherwise terminated. Several terraces often form larger floodplains.</td>
</tr>
<tr>
<td>7</td>
<td>Floodplains: Floodplains are relatively smooth, flat lands bordering a stream. They are built of fine-grained deposits by the stream and inundated by floodwaters.</td>
</tr>
<tr>
<td>8</td>
<td>River terraces: River terraces are flat strips of land bordering river floodplains. They are channeled by a sharp descent toward the river and by more elevated land on the opposite side. A zigzag arrangement of terraces often forms larger floodplains.</td>
</tr>
<tr>
<td>9</td>
<td>Intermittent freshwater lakes: Intermittent freshwater lakes are standing bodies of inland fresh water which become dry during certain periods of the year.</td>
</tr>
<tr>
<td>10</td>
<td>Intermontane basins: Basins of intermontane drainage between mountain ranges composed of fine-grained deposits by streams issuing from the adjacent mountains.</td>
</tr>
<tr>
<td>11</td>
<td>Levee-flank depressions: Levee-flank depressions are irregular to rectilinear low areas, usually ponds or lakes, paralleling and flanking natural levee ridges. They are best developed in regions near the mouth of a river.</td>
</tr>
<tr>
<td>12</td>
<td>Marsh: Marsh is a tract of low (in reference to surrounding terrain), wet ground, usually near a river or stream, with a rich grass and sedge vegetation and confined to freshwater areas.</td>
</tr>
<tr>
<td>13</td>
<td>Natural levees: Natural levees are long, relatively narrow alluvial ridges, higher near the river and slope away from it. They are built up on either side of a stream by overbank floods, and the drainage patterns range from fan to basin (in major valleys). Usually built on the outside of meander loops.</td>
</tr>
<tr>
<td>14</td>
<td>Ox-bow lakes: Ox-bow lakes are crescent-shaped lakes formed when rivers are shortened by the migration of meander loops.</td>
</tr>
<tr>
<td>Plan-Profile Units</td>
<td>Slope Occurrence Units</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>Number of slopes greater than 50% per 10 miles</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>*NA</td>
<td>NA</td>
</tr>
<tr>
<td>1L. 7</td>
<td>To 0</td>
</tr>
<tr>
<td>1, 1L. 7</td>
<td>To 0</td>
</tr>
<tr>
<td>1. 1L, 7</td>
<td></td>
</tr>
<tr>
<td>1L</td>
<td></td>
</tr>
<tr>
<td>1. 1L</td>
<td></td>
</tr>
<tr>
<td>1. 1L</td>
<td></td>
</tr>
</tbody>
</table>

This phenomenon is classified as a surface condition and considered in terms of surface roughness or micro-rolling in nature, with the crest of the bars ranging from 2 to 10 feet above the adjacent swale.
PHOTOGRAPHS

TYPICAL GEOMETRY FACTOR RANGES

<table>
<thead>
<tr>
<th>Units</th>
<th>Slope Units</th>
<th>Relief Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Degrees</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>50% per 10 miles</td>
<td>10 50 100 500 1000</td>
<td></td>
</tr>
<tr>
<td>100 200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Range in Middle East Desert
- World-wide Range

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

over the adjacent swale.
<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>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 opposite sides. The arrangement of several terraces often flanks larger floodplains.</td>
</tr>
<tr>
<td>8</td>
<td>Intermittent freshwater lakes. Intermittent freshwater lakes are standing bodies of water that become dry during certain periods of the year.</td>
</tr>
<tr>
<td>9</td>
<td>Intermontane plains. Basins of interior drainage between mountain ranges composed of fluvial deposits issued from the adjacent mountains.</td>
</tr>
<tr>
<td>10</td>
<td>Levee-flank depressions. Levee-flank depressions are irregular to rectilinear ponds or lakes, parallel and flanking natural levee ridges. They are regions.</td>
</tr>
<tr>
<td>11</td>
<td>Marsh. Marsh is a tract of low (in reference to surrounding terrain), wet ground, with rank growths and sedges vegetation and confined to freshwater areas.</td>
</tr>
<tr>
<td>12</td>
<td>Natural levees. Natural levees are long, relatively narrow alluvial ridges, usually sloping away from the river, 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.</td>
</tr>
<tr>
<td>14</td>
<td>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 meander.</td>
</tr>
</tbody>
</table>

* Not applicable.  
** Raised numbers refer to similarly numbered entries in the bibliography at the end of the text.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>7</th>
<th>Lacking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steplike</td>
<td></td>
<td>To 5E</td>
</tr>
<tr>
<td>Fresh water</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fine-grained alluvium</td>
<td>1. IL</td>
<td>To 0E</td>
</tr>
<tr>
<td>Usually containing sloped in deltaic</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Mires and covered</td>
<td>This phenomenon is classed as a surface condition and considered in terms of surface roughness</td>
<td></td>
</tr>
<tr>
<td>River and grad-</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Shrink flow. Surface</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Found at right</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D by the coalescence</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

1. Photograph of levee-foreshore
2. Photograph of levee-foreshore
3. Photograph of levee-foreshore
4. Vertical photograph of bar and scale topography. The bars are the light areas, the swales the intervening dark, vegetated areas
5. Boulder-choked wadi
6. Present distributary system of the Mississippi River

7. Photograph of levee-foreshore
8. Photograph of levee-foreshore
9. Photograph of levee-foreshore
10. A vertical photograph of levees - Fales River, Louisiana
11. Photograph of levee-foreshore
12. Marsh
13. Cultivation on natural levees
14. Photograph of levee-foreshore
Terms of surface roughness or microrelief rather than geometry factor ranges. Marshes are

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

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

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS
DESCRIPTIONS AND PHOTOGRAPHS

PLATE 10
**LANDFOR**

<table>
<thead>
<tr>
<th>Photo No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLASSIFICATION AND DESCRIPTION</strong></td>
</tr>
<tr>
<td>1. DEPOSITIONAL (CONT.)</td>
</tr>
<tr>
<td><strong>A. LUUVIAL</strong></td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td><strong>COLLUVIAL</strong></td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td><strong>EOLIAN</strong></td>
</tr>
<tr>
<td>Accumulations near barriers</td>
</tr>
<tr>
<td>Large extensive obstacles</td>
</tr>
<tr>
<td>17</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td><strong>Sand dunes</strong></td>
</tr>
<tr>
<td>21</td>
</tr>
<tr>
<td>22</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>24</td>
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<td>25</td>
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<tr>
<td>26</td>
</tr>
<tr>
<td>27</td>
</tr>
<tr>
<td>28</td>
</tr>
</tbody>
</table>
Photographs

**Typical Geometry Factor Ranges**

<table>
<thead>
<tr>
<th>Range in Middle East Desert</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
</tr>
<tr>
<td>South Africa</td>
</tr>
<tr>
<td>Europe</td>
</tr>
<tr>
<td>Middle East</td>
</tr>
<tr>
<td>South East</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geometry Factor (GF)</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>South Africa</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Europe</td>
<td>NA</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Middle East</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
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</tr>
<tr>
<td>South East</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Note: GF values are approximate and may vary based on specific conditions.*

*GF values are calculated in terms of surface roughness or microrelief rather than geometry factor ranges.*

*Inches per foot.*

*In feet.*

*Values NA (Not Applicable) where applicable.*
Barchans. Barchans are dunes having a crescentic 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.

Complex dunes. Complex dunes are irregular masses of sand not readily classified.

Peak and fuli. These occur where the tips or horns of a fast-moving barchan join the side of another barchan, thus forming a circular or horseshoe-shaped hollow crest of the barchan slipface which flanks the full is referred to as the peak.

Transverse dunes. Transverse dunes are strongly asymmetric ridges extending transverse to the dominant sand-moving winds. The leeward slope is steep; the windward side.

Dome-shaped dunes. Dome-shaped dunes, formed as a result of highly varying wind directions giving broad circular upwarps. Barchan dunes often constitute the secondary surficial dome-shaped dunes.

Dune massifs. Dune massifs are massive, roughly conical or pyramidal dunes characterized by small hollows and terraces which dimple their steep sides. The massifs are longitudinal dunes, but are quite unmistakable as they rise far above the general topography.

Longitudinal dunes. Longitudinal dunes usually consist of a single continuous ridge with regular intervals to form a chain of summits connected by a continuous wadi. They are asymmetric with one side exhibiting a moderate slope, the other, a steeper slope. Longitudinal dunes are aligned parallel to dominant sand-moving winds.

Waves and billows. Waves and billows are undulating to rolling areas of sand which press unlike the waves of a rough sea.

[Images of dune types and descriptions]
ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

LANDFORMS - SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS
# LANDFORMS

## CLASSIFICATION AND DESCRIPTION

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>CLASSIFICATION AND DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>DEPOSITIONAL (CONT.)</strong></td>
</tr>
<tr>
<td>29</td>
<td><strong>LACUSTRINE</strong></td>
</tr>
<tr>
<td>29</td>
<td>Lacustrine terraces: Terraces which mark the shore lines of ancient lakes, or earlier high-water stage existing lakes. They have nearly horizontal surfaces with relatively steep slopes facing the portion of the lake.</td>
</tr>
<tr>
<td>30</td>
<td><strong>MARINE</strong></td>
</tr>
<tr>
<td>30</td>
<td>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.</td>
</tr>
<tr>
<td>31</td>
<td>Mangrove swamps: Salt or brackish swamps along the coast where there are abundant mangrove trees.</td>
</tr>
<tr>
<td>32</td>
<td>Tidal mud flats: Marshy or muddy lands covered and uncovered by the rise and fall of the tide.</td>
</tr>
<tr>
<td>33</td>
<td><strong>ORGANIC-CHEMICAL</strong></td>
</tr>
<tr>
<td>33</td>
<td>Caliche: Caliche is a calcareous deposit occurring at or near the surface which has accumulated from calcium charged groundwater moving upward and evaporating.</td>
</tr>
<tr>
<td>34</td>
<td>Playas: Playas are nearly flat areas of salt or salty fine-grained soils occupying basins where water and evaporates after moderate or torrential rains.</td>
</tr>
<tr>
<td>34</td>
<td>Dry: Dry playas are characterized by very hard, smooth, flat surfaces of fine-grained soil.</td>
</tr>
<tr>
<td>34</td>
<td>Moist: Moist playas are characterized by irregular, puffy surfaces with a thin friable surface crust underlain by soft, spongy ground.</td>
</tr>
<tr>
<td>35</td>
<td>Clay-en crusted: Clay-en crusted playas are moist playas with a surface crust of clay.</td>
</tr>
<tr>
<td>36</td>
<td>Salt-en crusted: Salt-en crusted playas are moist playas with a surface crust of salt.</td>
</tr>
<tr>
<td>37</td>
<td>Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces are so near level of the mean high tide that they are covered by the majority of high tides.</td>
</tr>
<tr>
<td>38</td>
<td><strong>EROSIONAL</strong></td>
</tr>
<tr>
<td>38</td>
<td><strong>GROUNDWATER</strong></td>
</tr>
<tr>
<td>38</td>
<td>Caves and caverns: Caves or caverns are natural cavities or chambers beneath the surface. In limestone areas they are often connected by underground solution channels formed by subterranean water.</td>
</tr>
<tr>
<td>39</td>
<td>Chimneys: Chimneys are vertical shafts, with a variety of plan shapes, connecting underground caves or caverns. They are typically formed by solution in limestone areas.</td>
</tr>
<tr>
<td>40</td>
<td>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 numerous and depressions of all sizes interspersed with abrupt ridges and irregular pseudomorphs rocks.</td>
</tr>
<tr>
<td>41</td>
<td>Sinks: Sinks are circular or elongate depressions of varying size formed by solution and collapse in a limestone or evaporite rock.</td>
</tr>
</tbody>
</table>

* Not applicable

** Raised numbers refer to similarly numbered entries in the bibliography at the end of volume 1 of this report. **
<table>
<thead>
<tr>
<th>Plan-Profile Units</th>
<th>Range at Yuma</th>
<th>Range in Mi</th>
<th>Slope Occurrence Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number of slopes greater than 50% per 10 miles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>for high-water stages of slopes facing the central</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>based on that part which</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at mangrove trees.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of the tide.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>accumulated from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rains where water collects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mined soil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stable surface crust which</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of clay.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>salt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>surfaces are so near the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface. In limestone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NA</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>underground caves with the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NA</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the action of ground and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>weathered by numerous sinks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NA</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and collapse in areas of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NA</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This phenomenon is classified as a surface condition and considered in terms of surface roughness, low tide, are impermeable tangles of roots and knees, overgrown by high mangrove trees.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, relatively smooth surfaces of low bearing capacity and are indented by numerous shallow indentations.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, most desert areas within plains of gentle slope. It may occur as deposits of calcium carbonate diameters up to several inches.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, playas are characterized by desiccation polygons whose edges may warp upward from a few inches to 5 cm.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, characterized by slightly rolling and spongy surfaces.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, playas are characterized by soft, puffy mounds or pinacles of salt a few inches to 5 cm.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, characterized by slightly rolling and spongy surfaces.

This phenomenon is classified as a surface condition and considered in terms of surface roughness, playas are characterized by soft, puffy mounds or pinacles of salt a few inches to 5 cm.

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This phenomenon is classified as a surface condition and considered in terms of surface roughness, playas are characterized by soft, puffy mounds or pinacles of salt a few inches to 5 cm.
### TYPICAL GEOMETRY FACTOR RANGES

<table>
<thead>
<tr>
<th>Face Units</th>
<th>Slope Units</th>
<th>Relief Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Range in Middle East Desert

- 100
- 200

#### World-wide Range

- 10
- 50
- 100
- 600
- 1000

<table>
<thead>
<tr>
<th>Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
</tbody>
</table>

- 0 to 5
- 6 to 5

**Terms of surface roughness or microrelief rather than geometry factor ranges.**

- These swamps, at high mangrove trees.
- These flats have numerous shallow tidal channels.
- Caliche occurs in units of calcium carbonate or as angular, calcium carbonate-cemented fragments of rock with
- Surfaces of these are upward from a fraction of an inch to several inches.
- These playas are
- Surfaces of these few inches to 5 or 10 feet in height.
<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Clay-encrusted: Clay-encrusted playas are moist playas with a surface crust of clay.</td>
</tr>
<tr>
<td>36</td>
<td>Salt-encrusted: Salt-encrusted playas are moist playas with a surface crust of salt.</td>
</tr>
<tr>
<td>37</td>
<td>Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces are level of the mean high tide that they are covered by the majority of high tides.</td>
</tr>
</tbody>
</table>

**II. EROSIONAL GROUNDWATER**

<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>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 subterranean surface waters.</td>
</tr>
<tr>
<td>39</td>
<td>Chimneys: Chimneys are vertical shafts, with a variety of plan shapes, connecting underground surface. They are typically formed by solution in limestone areas.</td>
</tr>
<tr>
<td>40</td>
<td>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 depressions of all sizes interspersed with abrupt ridges and irregular protuberances.</td>
</tr>
<tr>
<td>41</td>
<td>Sinks: Sinks are circular or elongate depressions of varying size formed by solution and collapse in limestone or evaporite rock.</td>
</tr>
</tbody>
</table>

*Not applicable*

†† Raised numbers refer to similarly numbered entries in the bibliography at the end of Volume I of the text.
This phenomenon is classified 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 |
| 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 playas

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

41. A salt pan viewed from the rim
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT
LANDFORMS-SURFACE CONDITIONS
DESCRIPTIONS AND PHOTOGRAPHS
PLATE 198
## II. EROSIONAL (CONT.)

### MARINE

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Classification and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Wave-cut cliffs: Steep cliffs of bare rock, or occasionally undurated materials, marking the seaward limit of the coast.</td>
</tr>
<tr>
<td>43</td>
<td>Wave-cut terraces: Steep, narrow strips of land adjacent to or near the sea, marking the waves and current. Each terrace records a landward advance of littoral drift.</td>
</tr>
</tbody>
</table>

### SURFACE WATER

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Classification and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Amphitheatres: Amphitheatres are semicircular erosion bays, formed at the head of valleys, often scallop plateaus scarps in arid regions.</td>
</tr>
<tr>
<td>45</td>
<td>Aquas: Aquas are gaps in asymmetrical ridges which connect basins of different heights between the ridges.</td>
</tr>
<tr>
<td>46</td>
<td>Badlands: Regions nearly devoid of vegetation where erosion, instead of carving hilly terrain, has cut the land into an intricate maze of narrow ravines, shrubs, and cacti.</td>
</tr>
<tr>
<td>47</td>
<td>Buttes and mesas: Isolated residual promontories with very steep or precipitous sides, remnants of a plateau area. Mesas have distinctively flat tops; buttes have remnants of a plateau area.</td>
</tr>
<tr>
<td>48</td>
<td>Canyon country: Canyon country refers to a plateau dissected by a branching network of valleys.</td>
</tr>
<tr>
<td>49</td>
<td>Flatirons: Triangular remnants of an eroded hogback ridge often occurring in sets.</td>
</tr>
<tr>
<td>50</td>
<td>Foothills: Foothills are lower subsidiary hills at the foot of mountains or higher ridges.</td>
</tr>
<tr>
<td>51</td>
<td>Hogbacks: Hogbacks are sharp-crested ridges produced by unequal erosion in steep streams.</td>
</tr>
<tr>
<td>52</td>
<td>Incised meanders: Incised meanders are deep, sinuous valleys cut by rejuvenated streams having been eroded in a former cycle.</td>
</tr>
<tr>
<td>53</td>
<td>Knife-edged spurs: Sharp-crested rock ridges forming interstream divides which mark masses.</td>
</tr>
<tr>
<td>54</td>
<td>Outliers: Isolated remnants of rock detached from the main mass.</td>
</tr>
<tr>
<td>55</td>
<td>Pediments: Pediments are relatively smooth rock plains gently inclined away from the main mass. They are sometimes partly covered by a thin veneer of alluvium.</td>
</tr>
</tbody>
</table>

* 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 1 of this report
### TYPICAL GEOMETRY AND OCCURRENCE UNITS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Range of Occurrence</th>
<th>Number of slopes greater than 50% per 10 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>To 0.6</td>
<td></td>
</tr>
<tr>
<td>NA</td>
<td>To 0.6</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **NA:** Not Applicable
- **Units:** Range of Occurrence
- **Number of slopes greater than 50% per 10 miles:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6

**Notes:**
- The diagram shows the distribution of slopes across different ranges and their occurrence units.
- Specific values such as percentage and units are indicated.

**Image Description:**
- The diagram contains lines and labels indicating various geometric conditions and occurrence units.
- Specific measurements and notes are present within the grid structure of the image.
<table>
<thead>
<tr>
<th>Relief Classes</th>
<th>Relief Type I</th>
<th>Relief Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

**Typical Geometry Factor Ranges**

- **Range in Middle East Desert**
- **World-wide Range**

<table>
<thead>
<tr>
<th>Unit</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Slope Units**
- **Relief Units**
- **Degrees**
- **Feet**

- **Scale**: 1:20,000
- **Range**: 100 to 1200 feet
- **Units**: 5%, per 10 miles
- **Range in Middle East Desert**
- **World-wide Range**

- **Legend**
  - NA: Not Available
  - 1 to 1.5: Shaded
  - 2: Dotted line
Flatirons  Triangular remnants of an eroded hogback ridge often occurring in series on the flank of a mountain.

Foothills  Foothills are lower subsidiary hills at the foot of mountains or higher hills. They form transition zones between the highlands and the adjacent lower land.

Hogbacks  Hogbacks are sharp-crested ridges produced by unequal erosion in steeply inclined rock.

Incised meanders  Incised meanders are deep, sinuous valleys cut by rejuvenated streams, the meander course having been acquired in a former cycle.

Knife-edged spurs  Sharp-crested rock ridges forming interstream divides which extend outward from mountain masses.

Outliers  Isolated remnants of rock detached from the main mass.

Pediments  Pediments are relatively smooth rock plains gently inclined away from hill or mountain. 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 1 of this report.

49. Flatirons
50. Foothills
51. Hogbacks
52. Hogback formations
53. Knife-edged spurs
54. Outliers
55. Pediments

42. Wave-cut cliffs
43. A wave-cut terrace surmounted by several stacks
44. Two well-developed amphitheaters in the face of an escarpment

50. Foothills
51. Hogbacks
52. The valley of the San Juan River, Utah, incised to a depth of 1200 ft into the plateau
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS - SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

47. Buttes and mesa
48. Canyon country
49. Flatirons
## Classification and Description

### II. EROSIONAL (Cont.)

#### SURFACE WATER

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>Random hills. Randomly oriented masses rising less than 1,000 feet above the level of the surrounding country.</td>
</tr>
<tr>
<td>57</td>
<td>Consolidated random hills. Consist of masses of sedimentary, igneous, or metamorphic rock.</td>
</tr>
<tr>
<td>58</td>
<td>Unconsolidated random hills. Consist of unconsolidated material such as clay, silt, sand, or gravel.</td>
</tr>
<tr>
<td>59</td>
<td>Rock terraces. Rock terraces are relatively narrow benches left when a stream cuts a new valley below the level of the erosional plain which is cut into the bedrock.</td>
</tr>
<tr>
<td>60</td>
<td>Scarp. Scarp is more or less continuous, precipitous slopes exhibiting more than 100 feet of relief.</td>
</tr>
<tr>
<td>61</td>
<td>Steep wadi banks. Steep wadi banks are mapped where a conspicuous number of wadis bordered by precipitous banks occur. Wherever banks are higher than 100 feet they are considered scarp.</td>
</tr>
</tbody>
</table>

#### WIND

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>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.</td>
</tr>
<tr>
<td>62</td>
<td>Flint-streak plains. Flint-streak plains are flat to undulating surfaces developed on weathered limes chalk. They are characterized by scattered pebbles and sharp-edged chips of flint weathered parent rock.</td>
</tr>
<tr>
<td>63</td>
<td>Hamadas. Hamadas are extensive, flat to undulating surfaces of bedrock or bedrock covered by a thin layer of pebbles or rock fragments.</td>
</tr>
<tr>
<td>64</td>
<td>Wind-scored sandstone surfaces. Knobby, knotty surfaces of horizontal sandstone created by the action of sand-laden wind.</td>
</tr>
</tbody>
</table>

### III. MISCELLANEOUS

#### INTRUSIVE

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>Dikes. Wall-like intrusions of igneous rock which cut across the bedding or other layered stratum country rock. On eroding they commonly form narrow, sharp-crested ridges which may run miles across country.</td>
</tr>
<tr>
<td>66</td>
<td>Knobs. Knobs are rounded, isolated hills or small mountains. They usually constitute the surface of weathered plutonic intrusions.</td>
</tr>
</tbody>
</table>

#### METEORIC

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>67</td>
<td>Meteorite craters. Steep-walled, saucer-shaped depressions produced by the impact and accompanying explosion of an object of extraterrestrial origin.</td>
</tr>
</tbody>
</table>

#### RESIDUAL

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>Exfoliated boulders. A term applied to boulders whose surfaces have broken or peeled off as scale or concentric sheets.</td>
</tr>
<tr>
<td>69</td>
<td>Grus. The accumulation of countless discrete particles on the surface sometimes extending to depths greater than 10 feet formed from weathering of the various minerals composing the rock.</td>
</tr>
</tbody>
</table>

* Not applicable.
<table>
<thead>
<tr>
<th>Surface Condition</th>
<th>Plan-Profile Units</th>
<th>Plan-Profile Units</th>
<th>Plan-Profile Units</th>
<th>Plan-Profile Units</th>
<th>Plan-Profile Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. metamorphic rock.</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2. clay, silt, sand, or gravel.</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3. Tum cuts a new valley below the level of the surrounding area.</td>
<td>7.1</td>
<td>7.1</td>
<td>7.1</td>
<td>7.1</td>
<td>7.1</td>
</tr>
<tr>
<td>4. more than 100 feet of relief.</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>5. of wadies bordered by high bedrock. They are considered scarps.</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

- Broken rock fragments usually: **This phenomenon is classed as a surface condition and considered in terms of surf.**
- Laved on weathered limestone or chips of flint weathered from the bedrock. **This phenomenon is classed as a surface condition and considered in terms of surf.**
- Stone created by the abrasive impact and accompanying erosion. **This phenomenon is classed as a surface condition and considered in terms of surf.**

- Other layered structure of the plain which may run for times extending to depths *composing the rocks*. **This phenomenon is classed as a surface condition and considered in terms of surf.**

- Or peeled off as scales, lamellae. **This phenomenon is classed as a surface condition and considered in terms of surf.**
ID PHOTOGRAPHS

TYPICAL GEOMETRY FACTOR RANGES

<table>
<thead>
<tr>
<th>Degree Range</th>
<th>Slope Units</th>
<th>Relief Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° to 3°</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>4° to 6°</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>7° to 9°</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>10° to 12°</td>
<td>400</td>
<td>4</td>
</tr>
<tr>
<td>13° to 15°</td>
<td>1000</td>
<td>5</td>
</tr>
</tbody>
</table>

World-wide Range

- In terms of surface roughness or microrelief rather than geometry factor ranges. Desert pavement on alluvial or residual surfaces. Slopes on the surfaces may vary from flat to gently undulating.

- The angular fragments ranging up to several inches.

- The surface of the pebbles ranging up to several inches in diameter.

- The boulders may be micaceous. The boulders may range in diameter from 3 inches to a few feet.
<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>Hamadas: Hamadas are extensive, flat to undulating surfaces of bedrock or bedrock of pebbles or rock fragments.</td>
</tr>
<tr>
<td>64</td>
<td>Wind-scored sandstone surfaces: Knobby, knotty surfaces of horizontal sandstone action of sand-laden wind.</td>
</tr>
<tr>
<td></td>
<td>III. MISCELLANEOUS</td>
</tr>
<tr>
<td></td>
<td><strong>INTRUSIVE</strong></td>
</tr>
<tr>
<td>65</td>
<td>Dikes: Wall-like intrusions of igneous rock which cut across the bedding or other country rock. On eroding they commonly form narrow, sharp-crested ridges across country.</td>
</tr>
<tr>
<td>66</td>
<td>Knobs: Knobs are rounded, isolated hills or small mountains. They usually consist of weathered plutonic intrusions.</td>
</tr>
<tr>
<td></td>
<td><strong>METEORIC</strong></td>
</tr>
<tr>
<td>67</td>
<td>Meteorite craters: Steep-walled, saucer-shaped depressions produced by the implosion of an object of extraterrestrial origin.</td>
</tr>
<tr>
<td></td>
<td><strong>RESIDUAL</strong></td>
</tr>
<tr>
<td>68</td>
<td>Exfoliated boulders: A term applied to boulders whose surfaces have broken or peeled off in concentric sheets.</td>
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<tr>
<td>69</td>
<td>Grus: The accumulation of countless discrete particles on the surface sometimes greater than 10 feet formed from weathering of the various mineral comp</td>
</tr>
</tbody>
</table>

* Not applicable.

** Raised numbers refer to similarly numbered entries.

46. Rugged, crystalline hills rising above a desert plain
47. Unconsolidated hills near Yuma, Arizona
58. Rock-cut south of Wen
59. Not applicable.

**PHOTOGRAPH AVAILABLE**

64. Wind-scored sandstone surfaces
65. View along a ridge cut by dikes
66. A granite above a desert
<table>
<thead>
<tr>
<th>Description</th>
<th>4. 6. 7</th>
<th>4. 5. 7</th>
<th>Lacking</th>
<th>Lacking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases of horizontal sandstone created by the abrasive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crosses the bedding or other layered structure of the surface</td>
<td>4L.</td>
<td>4L. 5L. 6L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhythms produced by the impact and accompanying expansion</td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Surfaces have broken or peeled off as scales, lamellae,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On the surface sometimes extending to depths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This phenomenon is classed as a surface condition and consists of angular or rounded fragments of igneous, sedimentary, or metamorphic rock constituents. It may be also occur as a result of weathering of granite which may exhibit many typical features of a surface condition. Similarly numbered entries in the bibliography at the end of volume 1 of this report.

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

59. Santa Helena scar at the Grand Canyon do 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.
Landforms

62. A close-up of an isolated boulder showing the typical weathering of desert rock

60. Gran deposit resulting from loose fragments of weathered granite

61. A smooth surface of desert pavement. The tire tracks here penetrate the underlying soil

63. Flint-strewn surface indicating a surface condition and considered in terms of surface roughness or microrelief rather than geometric form or rounded fragments of igneous, sedimentary, or metamorphic rocks. The boulders may range in diameter from 3 inches to several feet.
LANDFORMS—SURFACE CONDITIONS

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

DESCRIPTIONS AND PHOTOGRAPHS
### III. MISCELLANEOUS (CONT.)

#### TECTONIC

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>Basin ranges: Ranges of hills or mountains formed by faulted and tilted blocks of strata (separated)</td>
</tr>
<tr>
<td>71</td>
<td>Domal warps: Domal warps are roughly circular upwarps with beds dipping away from a central point. Surface expression is often that of centrally facing, concentric series of erosional scarps.</td>
</tr>
<tr>
<td>72</td>
<td>Drowned valleys: Drowned valleys are erosional troughs of a dissected land surface inundated by the result of land-margin submergence.</td>
</tr>
<tr>
<td>73</td>
<td>Elongate domes: Elongate domes are elliptical upwarps, the beds dipping away from centrally located areas.</td>
</tr>
<tr>
<td>74</td>
<td>Intramontane valleys: Intramontane valleys are narrow valleys or troughs with exterior drainage by adjacent mountains.</td>
</tr>
<tr>
<td>75</td>
<td>Scarps: Scarps are more or less continuous, precipitous slopes exhibiting more than 100 feet of relief.</td>
</tr>
</tbody>
</table>

#### VOLCANIC

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>Broken lava flows: Flat to undulating lava areas characterised by sharp-edged rocks and boulders.</td>
</tr>
<tr>
<td>77</td>
<td>Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash or cinder around a vent.</td>
</tr>
<tr>
<td>78</td>
<td>Cinder fields: Cinder fields are flat to undulating areas, often miles in extent, composed of volcanic ash that has mantled the pre-existing landscape.</td>
</tr>
<tr>
<td>79</td>
<td>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.</td>
</tr>
<tr>
<td>80</td>
<td>Lava flows: Lava flows are solidified stationary masses of igneous rock which issued from a volcanic fissure.</td>
</tr>
<tr>
<td>81</td>
<td>Mud volcanoes: Small cone-shaped mounds built of clay and ordinarily formed by the eruption of sulfurous mud from a central vent or orifice.</td>
</tr>
<tr>
<td>82</td>
<td>Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by erosion.</td>
</tr>
</tbody>
</table>

---

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

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rather than slope. Which are determined to some extent by the underlying, preexisting landscape. The cinders themselves are an average of 4-12 mm. 

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rather than slope. Surface of these flows varies from flat to gently undulating. Surface irregularities such as fragments of lava and fissures to 10 feet.
Typical Geometry Factor Ranges

<table>
<thead>
<tr>
<th>Units</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>% per 10 miles</td>
<td>100</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Degrees</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>Relief Units</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Relief Type I</td>
<td>Relief Type II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 to 90*</td>
<td>60 to 90*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 2000</td>
<td>To 3000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 4000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Surface roughness or microrelief rather than geometry factor ranges. The slope of the landscape may vary from several inches to several feet.

Cinder fields have a landscape. The cinders themselves are angular and uncremented and have diameters ranging from several inches to several feet.
Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash or fragmental material around a vent.

Cinder fields: Cinder fields are flat to undulating areas, often miles in extent, composed of deposits mantling the pre-existing landscape.

Craters and Calderas: Bowl-or funnel-shaped depressions of volcanic origin which are rimmed by an inward-lowering scarp. Craters are commonly less than a mile in diameter; calderas have diameters several times larger.

Lava flows: Lava flows are solidified stationary masses of igneous rock which issued from fissures.

Mud volcanoes: Small cone-shaped mound of clay and silt formed by the eruption of biogenous mud from a central vent or orifice.

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
Raised numbers refer to similar 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 volcano
73. Cinder field at the northern end of the photograph
74. Mt. Edgecomb, Kruzof Island
75. Lava flow near a previously eroded vent
76. B.C. Sea
77. E. S. Army Map Service
78. E. S. Soil Conservation Service
79. E. S. Soil Conservation Service
80. E. S. Soil Conservation Service
This phenomenon is classed as a surface condition and considered in terms of surface roughness which are determined to some extent by the underlying, preexisting landscape. The slopes between 4 and 32 mm.

<table>
<thead>
<tr>
<th>are more or less circular</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>from a volcanic cone or</td>
</tr>
<tr>
<td>eruption of sulfurous</td>
</tr>
<tr>
<td>ed by erosion</td>
</tr>
</tbody>
</table>

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

74. An intramontane valley

75. Aerial view of Bla

76. Fault scarp formed by south of Mormon, Calif

81. A mud volcano rising above the surrounding terrain

82. Flats towering over a volcanic region
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 un cemented and have diameters ranging...