A DESCRIPTIVE CATALOG OF SELECTED AERIAL PHOTOGRAPHS OF GEOLOGIC FEATURES IN THE UNITED STATES

U. S. DEPARTMENT OF THE INTERIOR
March 3, 1849

GEOLOGICAL SURVEY
PROFESSIONAL PAPER 590

A Descriptive Catalog of Selected Aerial Photographs Of Geologic Features In the United States

By CHARLES S. DENNY, CHARLES R. WARREN, DONALD H. DOW, *and* WILLIAM J. DALE

GEOLOGICAL SURVEY PROFESSIONAL PAPER 590

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1968

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

Library of Congress catalog-card No. GS 67-292

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

A DESCRIPTIVE CATALOG OF SELECTED AERIAL PHOTOGRAPHS OF GEOLOGIC FEATURES IN THE UNITED STATES

Assembled by CHARLES S. DENNY, CHARLES R. WARREN, DONALD H. DOW, and WILLIAM J. DALE

INTRODUCTION

The U.S. Geological Survey has selected and assembled sets of photographs that illustrate numerous types of geologic features in the United States. This catalog lists these special sets of photographs that are available for purchase and describes the features illustrated. One reduced photograph from each set is shown on the back pages of this catalog to assist the purchaser in his selection.

Full-sized 9- by 9-inch contact prints may be inspected at the Map Information Office of the Geological Survey in Room 1214 of the General Services Administration building, F Street between 18th and 19th Streets, NW., Washington, D.C.

The 857 photographs in these sets were selected from those submitted by Survey geologists and from other sources; they are grouped into 317 sets, each consisting of from 1 to 6 contact prints. All the photographs are vertical and provide stereoscopic coverage except one in Hawaii and one in Alaska, which are oblique. Each set described in this catalog is arranged on a geographic basis, and information includes the location, scale of the photography, a brief description of the features illustrated, and reference to a geologic report or a topographic map of the area. The stratigraphic nomenclature used in the catalog is that of the references cited and does not necessarily follow the nomenclature of the U.S. Geological Survey. Various geologic features shown on the photographs are listed in a subject index which is included.

The sets are listed alphabetically by State as well as by the number within each State. The location of each set is shown on an accompanying map (pl. 1).

This collection could not have been assembled without the generous cooperation of the Army Map Service, which prepared the negatives, and of the following agencies, which supplied many of the original photographs:

Agricultural Stabilization and Conservation Service
Soil Conservation Service
U.S. Air Force
U.S. Coast and Geodetic Survey
U.S. Forest Service
U.S. Navy

Numerous individuals and institutions outside the Federal government also contributed to this project. We wish to acknowledge the assistance of the following: Prof. H. R. Wanless and Mr. M. T. El-Ashry, University of Illinois; Prof. H. T. U. Smith, University of Massachusetts; Mr. Frederick Johnson, R. S. Peabody Foundation for Archeology; Dr. Philip Phillips, Peabody Museum, Harvard University; Prof. C. B. Hunt, The Johns Hopkins University; and Dr. J. L. Snyder, American Geological Institute.

HOW TO ORDER PHOTOGRAPHS

The photographs listed in this catalog can be ordered from the Map Information Office, U.S. Geological Survey, General Services Administration Building, Washington, D.C. 20242. Each order should include the name of the State and the number of the set. No further identification is necessary. An order blank, form 9–1622, is included in the pocket of this publication. Also included in the pocket is form 9–1641, which is to be used in ordering any Geological Survey produced geologic or topographic maps referred to in this publication. Prepayment is required and the amount of remittance, made by check or money order payable to the U.S. Geological Survey, will depend upon the number of prints ordered. The prices are subject to change; however, prices of each 9- by 9-inch contact print in the following quantities will serve as a guide to the purchaser: 1 to 5, \$1; 6 to 100, 90¢; more than 100, 70¢.

INDEX TO GEOLOGIC FEATURES

DETAILED DESCRIPTIONS OF SETS OF AERIAL PHOTOGRAPHS

Ala. 1. Ripley cuesta

County: Sumter.
Lat 32°37′ N.; long 88°08′ W.
Number of photographs: 3.
Photograph scale: 1:69,000.
Focal length: 5.2 in.
Date flown: Mar. 19, 1952.
Map reference: U.S. Geol. Survey Epes 15-min quadrangle, scale 1:62,500.
Geology reference: Monroe, W. H., and Hunt, J. L., 1958, Geology of the Epes quadrangle, Alabama: U.S. Geol. Survey Geol. Quad. Map GQ-113.

Features illustrated (set nos. Ala. 1 A–C in southeast corner of photographs).—The bedrock in this part of the Gulf Coastal Plain is of Late Cretaceous age. It is composed of gently southwest-dipping beds of chalk and some interbedded sand. In the northern two-thirds of photograph 1 C are gently rolling plains with large areas of bare white chalk—the southern edge of the Black Prairie Belt—bordered on the east by a wooded flood plain of the meandering Tombigbee River. Extending northwestward from the southeast corner of photograph 1 B, a steep northeast-facing scarp with a gentle back slope 4–5 miles long forms a belt of wooded hills. The hills are composed largely of sand (Ripley Formation) and are most conspicuous in the southeast quadrant of this photograph. The sandy beds are cut by closely spaced northwest-trending high-angle faults of small displacement. The faults control a network of closely spaced gullies and small valleys. Southwest of the cuesta (southwest quadrant of photograph 1 A) are densely wooded lowlands, the Flatwoods, underlain by Quaternary sand and gravel that overlies clay of Eocene age.

Ala. 2. Elevated marine bars on west side of Mobile Bay

County: Mobile.
Lat 30°25′ N.; long 88°12′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Mar. 16, 1953.
Map reference: U.S. Geol. Survey Coden 7½-min quadrangle, scale 1:24,000.
Geology reference: Carlston, C. W., 1950, Pleistocene history of coastal Alabama: Geol. Soc. America Bull., v. 61, p. 1119–1130; geol. map (pl. 1), scale 1:250,000.

Features illustrated (set nos. Ala. 2 A–C in northeast corner of photographs).—Parallel ridges, about 30 feet above sea level, trend eastward just north of center of photograph 2 B and rise a few feet above a wooded swamp to north and south. To the west, the ridges abut against cultivated uplands as much as 90 feet in altitude. Carlston interprets these ridges as marine bars and the edge of the upland as a marine scarp, both of Pamlico age.

Alaska 1. Ice-wedge polygons near Point Barrow

Lat 71°14′ N.; long 156°45′W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Map reference: U.S. Geol. Survey Barrow sheet, scale 1:250,000.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol. Survey Prof. Paper 264–F, p. 113–146, pl. 38.

Features illustrated (set nos. Alaska 1 A–B in northeast corner of photographs).—Thaw lakes and ice-wedge polygons are in stratified silt and sand on the Arctic coastal plain in the continuous permafrost zone. Thaw lakes, both frozen and unfrozen, are commonly elongated in a north-northwest direction and occupy the central parts of old lake basins whose outer parts show conspicuous patterns of low-center polygons (ridges separating pools of water). In higher areas outside the old lake basins, the polygons are smaller and less conspicuous and have high centers separated by troughs. On gentle slopes, polygonal patterns are replaced by stripes. Plate 38 in Professional Paper 264–F is an annotated copy of photograph 1 B.

Alaska 2. Polygonal ground on flood plain of Kogosukruk River

Lat 69°48′ N.; long 151°36′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: July 9, 1948.
Map reference: U.S. Geol. Survey Umiat sheet, scale 1:250,000.
Geology reference: Ray, R. G., 1960, Aerial photographs in geologic interpretation and mapping: U.S. Geol. Survey Prof. Paper 373, 230 p.

Features illustrated (set nos. Alaska 2 A–B in southwest corner of photographs).—Bands of ice-wedge polygons outline meander scars on the river flood plain. Serrated edge of oxbow lake and of terrace rims mark the location of thawed ice wedges. Permafrost is not present in the well-drained river terrace in the center of photograph 2 B between Kogosukruk River to the west and Colville River to the east. These two photographs are reproduced in figure 109 of Ray's paper.

Alaska 3. Pingo on arctic coastal plain

Lat 69°49′ N.; long 151°05′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: July 9, 1948.
Map reference: U.S. Geol. Survey Umiat sheet, scale 1:250,000.
Geology reference: Ray, R. G., 1960, Aerial photographs in geologic interpretation and mapping: U.S. Geol. Survey Prof. Paper 373, 230 p.

Features illustrated (*set nos. Alaska 3 A–B in southwest corner of photographs*).—Pingo is in northeast quadrant of photograph 3 A. Partly drained lake basins show abandoned shorelines and extensive areas of patterned ground. Modern lakes with serrated margins are partly covered by floating ice. These two photographs are reproduced as figure 110 in Ray's paper.

Alaska 4. Ice-wedge polygons and thaw lakes, Seward Peninsula

County: Second Judicial Division.
Lat 66°06′ N.; long 165°32′ W.
Number of photographs: 3.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: July 27, 1949.
Map reference: U.S. Geol. Survey Shishmaref sheet, scale 1:250,000.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol. Survey Prof. Paper 264–F, p. 113–146, pl. 37.

Features illustrated (*set nos. Alaska 4 A–C in northwest corner of photographs*).—Coastal plain near Shishmaref Inlet (northwest corner of photograph 4 A) in the continuous-permafrost zone. Entire area is underlain by silt and peat. Permafrost present at a depth of 1½–3 feet everywhere except beneath rivers and lakes. Presence of permafrost is indicated by thaw lakes and basins of drained thaw lakes, beaded drainage, low- and high-center ice-wedge polygons. Scalloped margins of lakes and steep banks suggest active thawing. Plate 37 in Professional Paper 264–F is an annotated copy of photograph 4 B.

Alaska 5. Permafrost indicators, northern Seward Peninsula

County: Second Judicial Division.
Lat 65°20′ N.; long 164°24′ W.
Number of photographs: 3.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: June 20, 1950.
Map reference: U.S. Geol. Survey Bendeleben (B–5) quadrangle, scale 1:63,360.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol. Survey Prof. Paper 264–F, p. 113–146, pl. 41.

Features illustrated (*set nos. Alaska 5 A–C in southeast corner of photographs*).—Northern three-quarters of photograph 5 B is underlain by 20–25 feet of peat and silt, southern quarter by fluvial and glaciofluvial sand and gravel mantled by only a few feet of peat and silt. Permafrost lies 1½–2 feet beneath the surface except beneath rivers and lakes. Permafrost is indicated by thaw lakes, modification of oxbow lakes by thawing, pingos, beaded drainage, low- and high-center ice-wedge polygons and vegetation stripes on slopes. Point bars are conspicuous along Kuzitrin River. Plate 41 in Professional Paper 264–F is an annotated copy of photograph 5 B.

Alaska 6. Flood-plain icing, northern Seward Peninsula

County: Second Judicial Division.
Lat 65°38′ N.; long 163°33′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Date flown: Oct. 2, 1946.
Map reference: U.S. Geol. Survey Bendeleben (C–4) quadrangle, scale 1:63,360.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol Survey Prof. Paper 264–F, p. 113–146, pl. 43.

Features illustrated (*set nos. Alaska 6 A–B in northwest corner of photographs*).—White areas along streams in north half of photograph 6 A are new ice that had just begun to accumulate when photographs were taken. Ice on stream in southeast quadrant is perennial. (See Alaska 8.) Beaded drainage (thaw lakes) is conspicuous along streams in north half of photograph 6 B. Valley bottoms are underlain by silt, sand, and gravel as much as 10 feet thick, slopes by silt, as much as 20 feet thick, resting on basalt. Permafrost underlies the slopes at depth of 1½–3 feet and probably underlies flood plains at a depth of less than 10 feet. Area is 15 miles west of Imuruk Lake. Plate 43 *B* in Professional Paper 264–F is an annotated copy of photograph 6 A.

Alaska 7. Discontinuous permafrost, northern Seward Peninsula

County: Second Judicial Division.
Lat 65°35′ N.; long 163°20′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Date flown: Oct. 2, 1946.
Map reference: U.S. Geol. Survey Bendeleben (C–3) quadrangle, scale 1:63,360.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol. Survey Prof. Paper 264–F, p. 113–146, pl. 31.

Features illustrated (*set nos. Alaska 7 A–B in northwest corner of photographs*).—Extensive permafrost is indicated by high-center ice-wedge polygons (northeast quadrant of photograph 7 A) and by the scalloped shore of Imuruk Lake (east edge of photograph 7 B). Presence of local unfrozen galleries and layers is shown by spring-fed streams that empty into closed basins. Except in the escarpment, the area is underlain by 5–20 feet of silt which rests on basaltic lava flows interbedded with thin layers of gravel; the escarpment is the front of a lava flow. Area is 35 miles south of Deering. Plate 31 in Professional Paper 264–F is an annotated copy of photograph 7 A.

Alaska 8. Perennial icing below hot springs, Seward Peninsula

County: Second Judicial Division.
Lat 65°35′ N.; long 163°30′ W.
Number of photographs: 1.
Date flown: Oct. 2, 1946.
Map reference: U.S. Geol. Survey Bendeleben sheet, scale 1:250,000.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol. Survey Prof. Paper 264–F, p. 113–146, pl. 43*C*.

Features illustrated (*Oblique view eastward*).—Hot springs, marked by dense growth of tall willows are below center of photograph, near northwest base of volcanic cone. Winter flow of river, maintained by the springs, produces thick perennial ice (conspicuous white band). Growth of tall willows on flood plain downstream from the icing is shown also in Alaska 6. Imuruk Lake, in middle distance at left, is about half frozen. The dark area at right center is basaltic lava. Plate 43*C* in Professional Paper 264–F is an annotated copy of a part of this photograph.

Alaska 9. Microrelief due to thawing of ice-wedge polygons

Lat 64°52′ N.; long 147°50′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Date flown: Mar. 24, 1948.
Map reference: U.S. Geol. Survey Fairbanks (D–2) quadrangle, scale 1:63,360.
Geology reference: Hopkins, D. M., Karlstrom, T. N. V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geol. Survey Prof. Paper 264–F, p. 113–146, pl. 42.

Features illustrated (*set nos. Alaska 9 A–B in northeast corner of photographs*).—Microrelief of shallow trenches, deep gullies, or closely spaced mounds formed in cleared fields when ground has thawed and ice wedges have melted down. View is of U.S. Department of Agriculture Experimental Farm near Fairbanks. Entire area is underlain by muck and silt that are permanently frozen and contain ice-wedge polygons. Polygons cannot be recognized where the forest is undisturbed. Plate 42 in Professional Paper 264–F is annotated copy of photograph 9 A.

Alaska 10. Stabilized sand dunes on plains northwest of Mount McKinley

Lat 63°39′ N.; long 152°42′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Aug. 27, 1952.
Map reference: U.S. Geol. Survey Mount McKinley sheet, scale 1:250,000.
Geology reference: Reed, J. C., Jr., 1961, Geology of the Mount McKinley quadrangle, Alaska: U.S. Geol. Survey Bull. 1108–A, p. A1–A36; geol. map (pl. 1), scale 1:250,000. Ray, R. G., 1960, Aerial photographs in geologic interpretation and mapping: U.S. Geol. Survey Prof. Paper 373, 230 p.

Features illustrated (*set nos. Alaska 10 A–B in southwest corner of photographs*).—Linear and parabolic sand dunes, 50–150 feet high, that have a northeast trend. The dunes are now stabilized and support a growth of birch, aspen, and white spruce in contrast to the stunted black spruce and muskeg of the interdune areas. Figure 56 in Ray's report shows annotated copies of these photographs.

Alaska 11. Arcuate moraines northwest of Mount McKinley

County: Fourth Judicial Division.
Lat 63°12′ N.; long 151°49′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Aug. 27, 1952.
Map reference: U.S. Geol. Survey Mount McKinley (A–4) quadrangle, scale 1:63,360.
Geology reference: Reed, J. C., Jr., 1961, Geology of the Mount McKinley quadrangle, Alaska: U.S. Geol. Survey Bull. 1108–A, p. A1–A36; geol. map (pl. 1), scale 1:250,000. Ray, R. G., 1960, Aerial photographs in geologic interpretation and mapping: U.S. Geol. Survey Prof. Paper 373, 230 p.

Features illustrated (*set nos. Alaska 11 A–B in southwest corner of photographs*).—Three moraines of two of Reed's older series on the plain northwest of Mount McKinley. Two of the arcuate moraines show almost unmodified topography that has innumerable small ponds; the third shows well-integrated drainage; all are of Pleistocene age. Figure 57 in Ray's report includes annotated copies of parts of these photographs.

Alaska 12. Stagnated terminus of Peters Glacier

Lat 63°15′ N.; long 151°00′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: July 21, 1952.
Map reference: U.S. Geol. Survey Mount McKinley sheet, scale 1:250,000.
Geology reference: Reed, J. C., Jr., 1961, Geology of the Mount McKinley quadrangle, Alaska: U.S. Geol. Survey Bull. 1108–A, p. A1–A36; geol. map (pl. 1), scale 1:250,000.

Features illustrated (*set nos. Alaska 12 A–B in southwest corner of photographs*).—Terminal lobe of Peters Glacier (ends at head of outwash stream, opposite fiducial mark on northeast edge of photograph 12 A); lobe consists of dead ice veneered with drift. A partly buried stream channel, its course marked by circular ponds, traverses the terminal lobe. Streams in tributary valleys have been blocked and diverted by at least two stages of lateral moraines. The terminus is surrounded by moraines of Recent age; the outermost, reaching a point about 2 miles from the present terminus, shows that the glacier formerly bifurcated.

Alaska 13. Ablation moraine, Muldrow Glacier

Lat 63°16′ N.; long 150°29′ W.
Number of photographs: 2.
Photograph scale: 1:47,700.
Focal length: 6 in.
Date flown: July 11, 1951.
Map reference: U.S. Geol. Survey Mount McKinley sheet, scale 1:250,000.

Features illustrated (*set nos. Alaska 13 A–B in southwest corner of photographs*).—Photographs show debris-mantled glacier in deep northeast-trending U-shaped valley about 12 miles above terminus. Highly contorted debris-covered bands alternate with bands of clear ice. Moraines are pockmarked with innumerable melting pits. Talus cones and avalanche chutes on steep valley walls. Large debris-covered tributary glaciers join south side of main ice stream to continue down glacier as debris-covered bands. Small glaciers are in headwaters of valleys draining northward from narrow bedrock divide (arêtes, horns) on north side of Muldrow Glacier (A. T. Fernald, written commun., 1964).

Alaska 14. Debris-covered terminus of Muldrow Glacier

Lat 63°24′ N.; long 150°33′ W.
Number of photographs: 3.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Aug. 17, 1952.
Map reference: U.S. Geol. Survey Mount McKinley sheet, scale 1:250,000.

Features illustrated (*set nos. Alaska 14 A–C in southeast corner of photographs*).—These photographs taken in mid-August show melt-water ponds and streams on pitted ablation moraine. One stream is ice marginal; another follows a narrow flood plain within the area of debris-covered ice. A moraine parallels the north edge of the terminal lobe, and a valley train with conspicuous braided channels extends west from the terminus (A. T. Fernald, written commun., 1964). The bluff on the north side of the ice-marginal stream is loess, probably blown from the surface of the adjacent outwash plain.

Alaska 15. Rapid advance of Susitna Glacier, 1952–53

Lat 63°27′ N.; long 147°08′ W.
Number of photographs: 4.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Sept. 9, 1949; July 3, 1954.
Map reference: U.S. Geol. Survey Healy B–1 and C–1 quadrangles, scale 1:63,360.
Geology reference: Post, A.S., 1960, The exceptional advances of the Muldrow, Black Rapids, and Susitna Glaciers: Jour. Geophys. Research, v. 65, no. 11, p. 3703–3712. Harrison, A. E., 1964, Ice surges on the Muldrow Glacier, Alaska: Jour. Glaciology, v. 5, no. 39, p. 365–368.

Features illustrated.—The 1949 photographs (*set nos. Alaska 15 C–D in northeast corner*) show collapsed terminal segment of glacier ending in a broad outwash plain. The surface is debris covered and has many conspicuous circular ponds. Patches of bare ice appear about 4 miles back from the terminus. There is a conspicuous trimline on the valley sides. The 1954 photographs (*set nos. Alaska 15 A–B in southeast corner*) show that the surface features in the active (bare) part of the glacier have been displaced down valley more than 2 miles. Part of the stagnant terminal area was not overwhelmed, and some of the circular ponds showed little change during this interval. The surge probably occurred in 1952 or 1953. The surface of the upper part of the glacier, east of area shown in these photographs, is covered by a similar "before and after" set. (See Alaska 16.)

Alaska 16. Lowering of surface of Susitna Glacier, 1952–53

Lat 63°28′ N.; long 146°40′ W.
Number of photographs: 4.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Aug. 29, 1949; July 3, 1954.
Map reference: U.S. Geol. Survey Mount Hayes B–6 and C–6 quadrangles, scale 1:63,360.
Geology reference: Post, A. S., 1960, The exceptional advances of the Muldrow, Black Rapids, and Susitna Glaciers: Jour. Geophys. Research, v. 65, no. 11, p. 3703–3712.

Features illustrated.—The 1949 photographs (*set nos. Alaska 16 A–B in northeast corner*) show snow-covered smooth surface of upper part of Susitna Glacier. The area shown is about 15 miles from terminus and includes several ice streams and many nunataks. The main trunk of Susitna Glacier leaves the area shown in northwest quadrant of photograph 16 A. The 1954 photographs (*set nos. Alaska 16 C–D in southeast corner; photograph 16 C covers most of area shown in photograph 16 A*) show that the surface of the glacier has been lowered about 200 feet and is intensely crevassed. This lowering probably occurred in 1952 or 1953 in association with the surge of the ice near the terminus. (See Alaska 15.)

Alaska 17. Yukon-Tanana pingos

Lat 63°29′ N.; long 141°57′ W.
Number of photographs: 2.
Photograph scale: 1:43,000.
Focal length: 6 in.
Date flown: Sept. 14, 1948.
Map reference: U.S. Geol. Survey Tanacross B-2, B-3, C-2, and C-3 quadrangles, scale 1:63,360.
Geology reference: Holmes, G. W., Hopkins, D. M., and Foster, H. L., 1967, Distribution and age of pingos of interior Alaska: Natl. Acad. Sci. Internat. Conf. Permafrost, Proc., Purdue Univ., November 1963.

Features illustrated (*set nos. Alaska 17 A–B in southeast corner of photographs*).—These pingos in the Yukon-Tanana upland are on the lower valley wall and valley floor of tributaries to Dennison Fork. The mounds are roughly circular in plan. Some are undisturbed and some partly slumped; one has a round pond in the center. These pingos are shown in figure 7 of the paper referred to above.

Alaska 18. Glaciers within and adjacent to Katmai Caldera

Lat 58°16′ N.; long 154°58′ W.
Number of photographs: 5.
Photograph scale: 1:42,400.
Focal length: 6 in.
Date flown: Aug. 23, 1951.
Map reference: U.S. Geol. Survey Mount Katmai A-3, A-4, B-3, and B-4 quadrangles, scale 1:63,360.
Geology reference: Muller, E. H., and Coulter, H. W., 1957a, Incipient glacier development within Katmai caldera, Alaska: Jour. Glaciology, v. 3, no. 21, p. 13–17. 1957b, The Knife Creek glaciers of Katmai National Monument, Alaska: Jour. Glaciology, v. 3, no. 22, p. 116–122.

Features illustrated (*set nos. Alaska 18 A–E in northwest corner of photographs*).—Crater Lake in Katmai Caldera (east half of photograph 18 B), formed during the 1912 eruption of Mount Katmai, contains small post-1912 glaciers on the north and south rims. The Knife Creek glaciers (west of lake) appear to be static. The terminus of Fourth Glacier (southwest corner of photograph 18 A) has not moved since 1912, and upper part of glacier near caldera rim has thinned. The glacier was beheaded by the eruption and lost its source area. The ice tongues on the south slope of Mount Katmai (photograph 18 D) end in small valleys that descend steeply to the alluvial plain of Katmai River.

Alaska 19. Outwash plain of Tustumena Glacier

Lat 60°04′ N.; long 150°35′ W.
Number of photographs: 3.
Photograph scale: 1:39,000.
Date flown: July 17, 1950.
Map reference: U.S. Geol. Survey Kenai (A-2) quadrangle, scale 1:63,360.
Geology reference: Karlstrom, T. N. V., 1964, Quaternary geology of the Kenai lowland and glacial history of the Cook Inlet region, Alaska: U.S. Geol. Survey Prof. Paper 443, 69 p.; see fig. 9.

Features illustrated (*set nos. Alaska 19 A–C in southeast corner of photographs*).—Bare surface of the glacier ice has complex patterns of crevasses. The glacier diverts a small stream across a former interfluve. A compound moraine can be seen just beyond the glacier terminus, and a third moraine closely parallels a part of the shore of Tustumena Lake. The braided channels of the outwash plain are conspicuous. The bedrock is graywacke, argillite, and similar rocks of Cretaceous age and is highly folded and fractured. A small rock-basin lake lies about a mile north of the glacier (southeast quadrant of photograph 19 C).

Alaska 20. Worthington Glacier northeast of Valdez

Lat 61°10′ N.; long 145°45′ W.
Number of photographs: 4.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Aug. 12, 1950.
Map reference: U.S. Geol. Survey Valdez (A-5) quadrangle, scale 1:63,360. American Geographical Society, 1960, Worthington Glacier, Alaska, sheet 5 of nine glacier maps, northwestern North America: Am. Geog. Soc., Spec. Pub. 34, scale, 1:10,000.
Geology reference: Coulter, H. W., and Coulter, E. B., 1961, Geology of the Valdez (A-5) quadrangle, Alaska: U.S. Geol. Survey Geol. Quad. Map GQ-142.

Features illustrated (*set nos. Alaska 20 A–D in southeast corner of photographs*).—Worthington Glacier, approximately 4 miles long, descends eastward from a broad névé field to a bifurcated terminus (near center of photograph 20 B). Morainal deposits extend about 1,500 feet beyond the terminus. The largest spruce tree on the outer loop of this moraine has 65 annual rings. The small cirque glaciers on the surrounding mountains and the large glacier about 3 miles to the north (southwest quadrant of photograph 20 D) show conspicuous bare moraines apparently formed during the current retreat. Arêtes and horns are conspicuous. Bedrock is phyllitic graywacke that shows a conspicuous east-west grain.

Alaska 21. Marine terraces on Middleton Island

County: Third Judicial Division.
Lat 59°26′ N.; long 146°20′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Sept. 14, 1955.
Map reference: U.S. Geol. Survey Middleton Island (B-7) quadrangle, scale 1:63,360.

Geology reference: Miller, D. J., 1953, Late Cenozoic marine glacial sediments and marine terraces of Middleton Island, Alaska: Jour. Geology, v. 61, no. 1, p. 17–40; geol. map (fig. 2), scale 1:40,000.

Features illustrated (*set nos. Alaska 21 A–B in northwest corner of photographs*).—Five terrace levels 10–105 feet above present sea level are clearly shown. Intervening raised sea cliffs are precipitous. The bedrock is a Pliocene or Pleistocene sequence of slightly to moderately indurated marine clastic sediments that dip about 25° NW.

Alaska 22. Delta and grooved drift near stagnant margin of Malaspina Glacier

Lat 59°58′ N.; long 141°15′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: June 30, 1948.
Map reference: U.S. Geol. Survey Icy Bay sheet, scale 1:250,000.
Geology reference: Plafker, George, and Miller, D. J., 1958, Glacial features and surficial deposits of the Malaspina district, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–271, scale 1:25,000.

Features illustrated (*set nos. Alaska 22 A–B in northwest corner of photographs*).—A subglacial stream (Yahtse River) emerges from Malaspina Glacier (near center of photograph 22 A) and flows westward to empty into Icy Bay where it has built a small delta. North and south of the river are ridges of drift that rise above the outwash plain. Southeast-trending grooves across these ridges show that they have been overridden by southeastward-moving ice—probably an advance of the Guyot Glacier between 1700 and 1791 A.D. The south-trending band of braided channels and the scattered trees and shrubs along the vegetation-covered west margin of the glacier (near southwest edge of photograph 22 A) is the abandoned channel of Yahtse River. The river used this channel when Icy Bay was blocked by Guyot Glacier. Stagnant crevassed ice and ablation-moraine-covered pitted ice are shown in east half of photograph 22 A. Near southwest edge of exposure, the ablation moraine is partly covered by vegetation.

Alaska 23. Deformed moraines of Malaspina Glacier

Lat 60°06′ N.; long 140°35′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: June 30, 1948.
Map reference: U.S. Geol. Survey Mount St. Elias sheet, scale 1:250,000.
Geology reference: Plafker, George, and Miller, D. J., 1958, Glacial features and surficial deposits of the Malaspina district, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–271, scale 1:125,000. Sharp, R. P., 1958, Malaspina Glacier, Alaska: Geol. Soc. America Bull., v. 69, p. 617–646.

Features illustrated (*set nos. Alaska 23 A–B in northwest corner of photographs*).—Moraine bands on the surface of Malaspina Glacier just west of its junction with Seward Glacier (east corner of photograph 23 A) which supplies more than two-thirds of the ice in this great piedmont glacier. Oily Lake and associated ponds (see Map I–271) lie along the contact of the ice and the south slope of Samovar Hills.

Alaska 24. Outwash apron and forested margin of Malaspina Glacier

Lat 59°43′ N.; long 140°24′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: June 20, 1948.
Map reference: U.S. Geol. Survey Yakutat sheet, scale 1:250,000.
Geology reference: Plafker, George, and Miller, D. J., 1958, Glacial features and surficial deposits of the Malaspina district, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–271, scale 1:25,000.

Features illustrated (*set nos. Alaska 24 A–B in northwest corner of photographs*).—A banded surface of bare glacier ice (northwest part of photograph 24 B, not in stereo) is separated from an outwash apron fronting the Gulf of Alaska by a belt of forest-covered glacier ice nearly a mile wide. Active outwash streams have conspicuous braided channels and are bare. Recently abandoned outwash aprons, between active streams, are largely brush covered. Ancient beach ridges behind the present-day shore support trees and shrubs. Stereoscopic area is adjacent to Alder Stream west of Point Manby.

Alaska 25. Moraines and floating terminus of Lituya Glacier

Lat 58°42′ N.; long 137°32′ W.
Number of photographs: 3.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Aug. 11, 1959.
Map reference: U.S. Geol. Survey Mount Fairweather sheet, scale 1:250,000.
Geology reference: Miller, D. J., 1960, Giant waves in Lituya Bay, Alaska: U.S. Geol. Survey Prof. Paper 354–C, p. 51–86.

Features illustrated (*set nos. Alaska 25 A–C in northeast corner of photographs*).—Lituya Glacier, which has prominent medial and lateral moraines, flows down the southwest slope of the Fairweather Range and then turns southeast into Lituya Bay. The terminal part of the ice is floating—a tidal glacier—and has a crevasse pattern different from that upstream. Material has slid down the steep valley walls and out onto the ice. Perhaps the discontinuous medial moraine on the inside of the bend in the glacier originated from such a landslide. On the steep walls of the bay just beyond the glacier terminus is the trimline or upper limit of destruction of forest by a giant wave caused by a landslide (east of glacier terminus) during the 1958 earthquake.

Alaska 26. Crillon Glacier: Calving terminus of North Crillon Glacier

Lat 58°40′ N.; long 137°28′ W.
Number of photographs: 3.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Aug. 11, 1959.
Map reference: U.S. Geol. Survey Mount Fairweather sheet, scale 1:250,000.
Geology reference: Miller, D. J., 1960, Giant waves in Lituya Bay, Alaska: U.S. Geol. Survey Prof. Paper 354–C, p. 51–86.

Features illustrated (set nos. Alaska 26 A–C in northeast corner of photographs).—A stream emerging from beneath the glacier is building a delta into Lituya Bay, a fiord. A part of the terminus is grounded on the delta. The remainder, where the ice is floating, forms a reentrant, and the glacier is calving. Fractures in the ice curve around the reentrant. Adjacent to the delta, the ice is largely concealed beneath an ablation moraine. Beyond the terminus can be seen the trimline or upper limit of destruction of trees by a giant wave caused by a landslide into the bay during the 1958 earthquake. (Sets Alaska 26–28—Crillon Glacier—form a continuous series.)

Alaska 27. Crillon Glacier: Moraines at junction of North and South Crillon Glaciers

Lat 58°38′ N.; long 137°27′ W.
Number of photographs: 2.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Aug. 11, 1959.
Map reference: U.S. Geol. Survey Mount Fairweather sheet, scale 1:250,000.
Geology reference: Miller, D. J., 1960, Giant waves in Lituya Bay, Alaska: U.S. Geol. Survey Prof. Paper 354–C, p. 51–86.

Features illustrated (set nos. Alaska 27 A–B in northeast corner of photographs).—South Crillon Glacier (southeast half of photograph 27 A) flows west down the southwest slope of Fairweather Range. At the foot of the slope it divides; part flows southeast to Crillon Lake and part northwest to Lituya Bay. The northwest fork is joined by North Crillon Glacier; below the junction a medial moraine has formed. The lower part of the combined glacier is largely covered with debris (ablation moraine). (Sets Alaska 26–28—Crillon Glacier—form a continuous series.)

Alaska 28. Crillon Glacier: Fairweather fault and terminus of South Crillon Glacier

Lat 58°36′ N.; long 137°25′ W.
Number of photographs: 3.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Aug. 11, 1959.
Map reference: U.S. Geol. Survey Mount Fairweather sheet, scale 1:250,000.
Geology reference: Miller, D. J., 1960, Giant waves in Lituya Bay, Alaska: U.S. Geol. Survey Prof. Paper 354–C, p. 51–86.

Features illustrated (set nos. Alaska 28 A–C in northeast corner of photographs).—Terminus of South Crillon Glacier in ice-damned Crillon Lake. Northeast of the lake the trace of the Fairweather fault is clearly visible except where the fault crosses a small alluvial fan. This fresh scarp records fault movement on July 9, 1958, about a year before this photograph was taken. Two small glaciers lie northeast of the lake. The western one is completely covered by ablation moraine and appears to be cut off from its former ice source. The eastern one is deeply crevassed and is fed by an icefall. (Sets Alaska 26–28—Crillon Glacier—form a continous series.)

Alaska 29. Partly stagnant terminus of La Perouse Glacier

County: First Judicial Division.
Lat 58°28′ N.; long 137°09′ W.
Number of photographs: 3.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Aug. 11, 1959.
Map reference: U.S Geol. Survey Mount Fairweather sheet, scale 1:250,000.

Features illustrated (set nos. Alaska 29 A–C in northeast corner of photographs).—A narrow ice tongue descends the southwest slope of Fairweather Range (north quadrant of photograph 29 B) and spreads out as a small piedmont glacier having four or five small tongues. Parts of the tongues are covered with ablation moraine; the southeasternmost one is forested. The tongues are surrounded by wooded morainal ridges that have a conspicuous trimline and that dam small lakes. (H. W. Coulter, written commun., 1964.)

Alaska 30. Nunataks in icefield near Castle Mountain

Lat 56°57′ N.; long 132°22′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: July 5, 1948.
Map reference: U.S. Geol. Survey Petersburg sheet, scale 1:250,000.

Features illustrated (set nos. Alaska 30 A–B in southeast corner of photographs).—Nunataks are steep-sided peaks rising as much as 1,000 feet above the surface of the glacier, which is here flat to gently sloping. The ice is largely snow covered except on the lower slopes of the peaks where belts of crevasses are conspicuous. Geographic coordinates given above are approximate.

Ariz. 1. Merrick Butte and The Mittens, Monument Valley

County: Navajo.
Lat 36°59′ N.; long 110°05′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Sept. 15, 1951.
Map reference: U.S. Geol. Survey Agathla Peak 15-min quadrangle, scale 1:62,500.
Geology reference: Witkind, I. J., and Thaden, R. E., 1963, Geology and uranium-vanadium deposits of the Monument Valley area, Apache and Navajo Counties, Arizona: U.S. Geol. Survey Bull. 1103, 171 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (*set nos. Ariz. 1 A–B in southeast corner of photographs*).—These three "monuments"—small buttes more than 1,000 feet high—are the erosional remnants of a once-continuous cover of sedimentary rocks. The most resistant unit in the stratigraphic sequence is a light-gray conglomeratic sandstone, the Shinarump Member of the Chinle Formation; a small cap of the Shinarump is still preserved on the flat top of Merrick Butte (southwest quadrant of photograph 1 A). The Shinarump is underlain by soft easily eroded reddish-brown shaly siltstone, the Moenkopi Formation, which forms slopes. The vertical walls of the monuments are the light-brown De Chelly Sandstone Member of the Cutler Formation. The broad flaring aprons around the bases of the monuments are underlain by the easily eroded Organ Rock Tongue of the Cutler Formation.

Ariz. 2. Agathla Peak, a volcanic neck

County: Navajo.
Lat 36°50′ N.; long 110°14′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Sept. 15, 1951.
Map reference: U.S. Geol. Survey Agathla Peak 15-min quad rangle, scale 1:62,500.
Geology reference: Witkind, I. J., and Thaden, R. E., 1963, Geology and uranium-vanadium deposits of the Monument Valley area, Apache and Navajo Counties, Arizona: U.S. Geol. Survey Bull. 1103, 171 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (*set nos. Ariz. 2 A–B in southeast corner of photographs*).—This volcanic plug, about 1,400 feet high, is the igneous rock that once filled the conduit (throat) of a volcano when the land surface was far above the present one. The sedimentary rocks that originally enclosed the plug were weaker than the igneous rock and have been eroded away. The desert surrounding Agathla Peak is underlain by lenticular sandstone and conglomerate of the Monitor Butte Member of the Chinle Formation. Owl Rock, a 500-foot needle of siltstone and sandstone with a small cap of Wingate Sandstone, rises from the surface of a prominent cuesta near west edge of the photographs.

Ariz. 3. Dunes at base of Comb Ridge

County: Navajo.
Lat 36°51′ N.; long 110°01′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Sept. 16, 1951.
Map reference: U.S. Geol. Survey Agathla Peak and Dinnehotso 15-min quadrangles, scale 1:62,500.
Geology reference: Witkind, I. J., and Thaden, R. E., 1963, Geology and uranium-vanadium deposits of the Monument Valley area, Apache and Navajo Counties, Arizona: U.S. Geol. Survey Bull. 1103, 171 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (*set nos. Ariz. 3 A–C in southeast corner of photographs*).—Comb Ridge is a north-facing cliff, capped by Navajo Sandstone, that dips southeast off the Agathla anticline. To the north, Little Capitan Valley separates the ridge from a dip slope on the De Chelly Sandstone Member of the Cutler Formation. The valley is floored with eolian sand that forms transverse dunes and barchans and buries the mouths of washes that drain into the valley from the north, such as the wash in Double Arch Canyon (northwest quadrant of photograph 3 C). Small ephemeral lakes occur among the dunes. South of Comb Ridge the Navajo Sandstone is concealed beneath a sheet of eolian sand which forms longitudinal dune ridges.

Ariz. 4. Lava flows and cones at Vulcans Throne, Grand Canyon

County: Coconino and Mohave.
Lat 36°13′ N.; long 113°07′ W.
Number of photographs: 3.
Photograph scale: 1:63,360.
Focal length: 6 in.
Date flown: June 2, 1953.
Map reference: U.S. Geol. Survey Grand Canyon sheet, scale 1:250,000.
Geology reference: Gregory, H. E., 1932, Colorado Plateau region: Internat. Geol. Cong., 16th, Washington, 1932, Guidebook 18, Excursions C–1 and C–2, 38 p.

Features illustrated (*set nos. Ariz. 4 A–C in southeast corner of photographs*).—The Aubrey Cliffs, capped by flat-lying Kaibab Limestone (Permian), border the east side of Prospect Valley (southeast quadrant of photograph 4 B), south of the Colorado River. Fault scarps cut alluvial fans along the west base of cliffs. Lava flows, chiefly north of the river on the edge of Tuweep Valley, spilled down the sides of the inner gorge to the river. Cinder cones both north and south of the river are alined with a fault scarp to the south.

Ariz. 5. Grand Canyon at Bright Angel Creek

County: Coconino.
Lat 36°06′ N.; long 112°06′ W.
Number of photographs: 3.
Photograph scale: 1:36,000.
Focal length: 6 in.
Date flown: Aug. 19, 1960.
Map reference: U.S. Geol. Survey Bright Angel 15-min quadrangle, scale 1:62,500.
Geology reference: Maxson, J. H., 1961, Geologic map of the Bright Angel quadrangle, Grand Canyon National Park, Arizona: Grand Canyon Nat. History Assoc. Text on back of map.

Features illustrated (*set nos. Ariz. 5 A–C in northeast corner of photographs*).—The Granite Gorge, the Tonto Plateau, and the lower part of the walls of the main canyon are shown in this triplet at whose center is the suspension bridge across the Colorado River just above the mouth of Bright Angel Creek. In the Granite Gorge near the southeast edge of photograph 5 B, the Zoroaster Granite can be seen adjacent to the Brahma Schist. In the west quadrant of the same photograph, the mesa on the north side of the gorge is capped by Tapeats Sandstone. To the north, Cheops Pyramid, capped by Redwall Limestone, is surrounded by gentle slopes underlain by Algonkian sedimentary rocks that rest unconformably on the Brahma Schist and are themselves overlain unconformably by the Tapeats Sandstone or Bright Angel Formation of Cambrian age.

Ariz. 6. Mouth of the Little Colorado River

County: Coconino.
Lat 36°10′ N.; long 111°47′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Oct. 11, 1955.
Map reference: U.S. Geol. Survey Grand Canyon National Park, east half, scale 1:48,000.
Geology reference: Gregory, H. E., 1932, Colorado Plateau region: Internat. Geol. Cong., 16th, Washington, 1933, Guidebook 18, Excursions C-1 and C-2, 38 p.; geol. map (fig. 1), scale 1:734,000.

Features illustrated (*set nos. Ariz. 6 A–C in northeast corner of photographs*).—The narrow and steep-sided canyon of the Little Colorado River (southeast quadrant of photograph 6 B) is incised below a broad plateau of flat-lying Kaibab Limestone. Along the Colorado River north of the junction, the Redwall Limestone forms a narrow inner gorge close to the river. A high-angle fault that parallels the Colorado about 2 miles to the west separates Paleozoic rocks (Kaibab Limestone to Tonto group) on the east from Precambrian sedimentary rocks (Grand Canyon Series) on the west.

Ariz. 7. Dunes on Kaibito Plateau north of Moenkopi

County: Coconino.
Lat 36°15′ N.; long 111°11′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Oct. 9, 1952.
Map reference: U.S. Geol. Survey Marble Canyon sheet, scale 1:250,000.
Geology reference: Hack, J. T., 1941, Dunes of the western Navajo Country: Geog. Rev., v. 31, no. 2, p. 240–263; see fig. 2. Gregory, H. E., 1917, Geology of the Navajo Country: U.S. Geol. Survey Prof. Paper 93, 161 p.; see p. 136–138.

Features illustrated (*set nos. Ariz. 7 A–C in southeast corner of photographs*).—Thin mantle of dune sand on Kaibito Plateau north of Moenkopi. Navajo Sandstone of Jurassic and Triassic(?) age is exposed in many places. Dune forms include active and fixed parabolic dunes, transverse dunes, and barchans. A stream valley partly filled with dune sand is visible near the east margin of photographs 7 B and 7 C.

Ariz. 8. Dunes on Moenkopi Plateau

County: Coconino.
Lat 35°52′ N.; long 111°10′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Oct. 10, 1952.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Hack, J. T., 1941, Dunes of the western Navajo Country: Geog. Rev., v. 31, no. 2, p. 240–263; see fig. 18.

Features illustrated (*set nos. Ariz. 8 A–B in southeast corner of photographs*).—Longitudinal and parabolic dunes near the edge of the plateau. Source of the sand is the sandstone at the plateau edge which has been eroded by running water and by sapping. The escarpment overlooks the edge of the Painted Desert in the southwest corner of photograph 8 A.

Ariz. 9. Sand dunes and floodwater farming, Jeddito Valley

County: Navajo.
Lat 35°43′ N.; long 110°17′ W.
Number of photographs: 3.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Feb. 20, 1954.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Hack, J. T., 1941, Dunes of the western Navajo Country: Geog. Rev., v. 31, no. 2, p. 240–263; see fig. 21. Hack, J. T., 1942, The changing physical environment of the Hopi Indians of Arizona: Harvard Univ., Peabody Mus. Papers, v. 35, no. 1, 85 p.

Features illustrated (*set nos. Ariz. 9 A–C in northeast corner of photographs*).—Antelope Mesa (northeast

269-086 O - 68 - 2

quadrant of photograph 9 B) is underlain by Mesaverde Sandstone and covered by a veneer of dune sand. Southwest winds predominate and parabolic dunes, open in that direction, cover much of the mesa. These dunes have vegetation on them and many are inactive. Active parabolic dunes occur on the mesa just south of the head of Tallahogan Wash (the light-colored area just to east of center of photograph 9 B). The source of this sand is the alluvium in the valley to the northwest. Peach orchards and irrigated gardens are on the south slope of Tallahogan Wash. Jeddito Valley, south of Antelope Mesa, is eroded in Mancos Shale but contains a thick fill of sandy alluvium. Many cornfields are at the ends of southward-draining arroyos and are watered by floods that spread over them during occasional summer rains.

Ariz. 10. Sunset Crater

County: Coconino.
Lat 35°22′ N.; long 111°30′ W.
Number of photographs: 2.
Photograph scale: 1:16,000.
Focal length: 8.25 in.
Date flown: May 28, 1960.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Cosher, O. J., 1962, Ground water in the Wupatki and Sunset Crater National Monuments, Coconino County, Arizona: U.S. Geol. Survey Water-Supply Paper 1475–J, p. 357–374; geol. map (pl. 20), scale 1:63,360.

Features illustrated (set nos. Ariz. 10 A–B in southeast corner of photographs).—Cinder cone of late Pleistocene or Recent age surrounded by a plain largely mantled by cinders but including some outcrops of basalt. Northwest of the cone is the head of the Bonito lava flow which issued from near the base of the cone. The rim of the cone is light colored because of oxidation by late fumarole activity.

Ariz. 11. Longitudinal, parabolic, and transverse dunes on Garces Mesa

County: Coconino.
Lat 35°39′ N.; long 110°55′ W.
Number of photographs: 3.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Feb. 19, 1954.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Hack, J. T., 1941, Dunes of the western Navajo Country: Geog. Rev., v. 31, no. 2, p. 240–263.

Features illustrated (set nos. Ariz. 11 A–C in northeast corner of photographs).—A broad plateau rises 100–200 feet above the adjacent wide valleys traversed by meandering arroyos. Most of the area is covered by a thin sheet of dune sand whose source is partly alluvium transported in the arroyos and partly the erosion and sapping of the sandstone that caps the mesa edges. The Sand Springs dune area shown in figure 16 of Hack's paper is the plateau whose edges are partly buried by climbing dunes in the southeast quadrant of photograph 11 C. Hack believes that the transverse dunes form where the greatest amount of sand is in motion, for example just to the lee (northeast) of the climbing dunes. Parabolic dunes form where there is somewhat less actively moving sand, and longitudinal dunes form where the rate of sand transport is least. The transverse dunes have no vegetation except in the troughs between them. The parabolic and longitudinal dunes have a sparse vegetative cover. Little sand is in motion in the darker gray areas between the dunes.

Ariz. 12. Diatremes near Bidahochi

County: Navajo.
Lat 35°29′ N.; long 110°05′ W.
Number of photographs: 3.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Feb. 24, 1954.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Hack, J. T., 1942, Sedimentation and volcanism in the Hopi Buttes, Arizona: Geol. Soc. America Bull., v. 53, p. 335–372; see fig. 8.

Features illustrated (set nos. Ariz. 12 A–C in northeast corner of photographs).—Photograph 12 B shows many buttes and mesas. In general, the darker colored ones are basalt and the lighter colored ones are diatremes, such as the light-colored butte in the northwest corner of this exposure. A second diatreme, Hack's 2, is at the west end of a small basalt mesa (about 1 in. south-southwest of center of north edge of same exposure). This diatreme is about 300 feet in diameter. Its walls flare widely and the beds dip inward. The filling is mostly well stratified basalt tuff. Hack's diatreme 4 is at the south end of a basalt mesa about due east of the center of photograph 12 B.

Ariz. 13. Colorado Plateau and Canyon Diablo near Meteor Crater

County: Coconino.
Lat 35°04′ N.; long 111°02′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Sept. 20, 1948.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Shoemaker, E. M., 1960, Penetration mechanics of high velocity meteorites, illustrated by Meteor Crater, Arizona: Internat. Geol. Cong., 21st, Copenhagen, 1960, Rept., pt. 18, p. 418–434; geol. map (fig. 1), scale 1:284,000.

Features illustrated (set nos. Ariz. 13 A–B in southeast corner of photographs).—Canyon Diablo (west part of photographs) is carved in the nearly horizontal Kaibab Limestone (Permian), which also underlies wide areas in the northeast third of photograph 13 B. The Moenkopi Formation, which is siltstone and sandstone of Triassic age overlying the Kaibab, forms the darker toned, nearly level surface of the Colorado Plateau around Meteor Crater and extends to within a mile or less of Canyon Diablo. Two sets of vertical joints, trending northeast and northwest, affect the drainage pattern in areas of Kaibab Limestone. Shoemaker ascribes the square, somewhat octagonal shape of Meteor Crater to control by joints; the joint systems that exert the strongest influence on the drainage appear to have been of only secondary importance in the cratering process. Arizona 14 shows the crater at a larger scale.

Ariz. 14. Meteor Crater

County: Coconino.
Lat 35°02′ N.; long 111°01′ W.
Number of photographs: 2.
Photograph scale: 1:15,000.
Focal length: 6 in.
Date flown: Aug. 29, 1963.
Map reference: U.S. Geol. Survey Flagstaff sheet, scale 1:250,000.
Geology reference: Shoemaker, E. M., 1960, Penetration mechanics of high velocity meteorites, illustrated by Meteor Crater, Arizona: Internat. Geol. Cong., 21st, Copenhagen, 1960, Rept., pt. 18, p. 418–434; geol. map (fig. 2), scale 1:24,000.

Features illustrated (set nos. Ariz. 14 A–B in southeast corner of photographs).—Meteor Crater is about 600 feet deep and three-quarters of a mile in diameter. At the large scale of these photographs, the rim, which rises 100–200 feet above the surrounding plain, is seen to have a hummocky surface with scattered large ejecta blocks. The area mantled by debris thrown from the crater can be distinguished from the alluvial surface of the surrounding plain. There is a borrow pit in the rim near the southwest corner of the crater. Beds exposed in the crater walls dip outward away from the crater, roughly parallel with the surface. The talus slopes below the outcrops show centripetal drainage. The central part of the floor is flat and is underlain by playa beds. Arizona 13 shows the crater and adjacent Canyon Diablo at a smaller scale.

Ariz. 15. Braided channels on Sacaton Mountain piedmont

County: Pinal.
Lat 33°01′ N.; long 111°53′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Dec. 21, 1957.
Map reference: U.S. Geol. Survey Sacaton Butte and Gila Butte, SE 7½-min quadrangles, scale 1:24,000.
Geology reference: Bryan, Kirk, 1922, Erosion and sedimentation in the Papago country, Arizona: U.S. Geol. Survey Bull. 730, p. 19–90. Tuan, Yi-Fu, 1959, Pediments in southeastern Arizona: California Univ. Pubs. in Geography, v. 13, 163 p.

Features illustrated (set nos. Ariz. 15 A–C in southeast corner of photographs).—These photographs show the piedmont slope on the northwest side of the Sacaton Mountains. Dry braided channels outlined by desert shrubs are conspicuous. The channels curve around small bedrock hills. The form of this piedmont is well shown by comparing these excellent photographs with the detailed topographic maps, mentioned above, that have a 10-foot contour interval. Most of the piedmont is mantled by alluvium. It is not possible to determine on the photographs whether or not the small bedrock hills are surrounded by a narrow pediment.

Ariz. 16. Sacaton Mountains, an inselberge

County: Pinal.
Lat 33°02′ N.; long 111°50′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Apr. 29, 1953.
Map reference: U.S. Geol. Survey Gila Butte, Casa Grande, Sacaton, and Signal Peak 15-min quadrangles, scale 1:62,500.
Geology reference: Bryan, Kirk, 1922, Erosion and sedimentation in the Papago country, Arizona: U.S. Geol. Survey Bull. 730, p. 19–90. Tuan, Yi-Fu, 1959, Pediments in southeastern Arizona: California Univ. Pubs. in Geography, v. 13, 163 p.

Features illustrated (set nos. Ariz. 16 A–C in northeast corner of photographs).—Since Kirk Bryan first applied the term "mountain pediment" to the piedmont that surrounds the Sacaton Mountains, the origin of this and similar features has been widely discussed. These small-scale photographs show the north half of the mountains and the adjacent piedmont from Santa Cruz wash on the west to the flood plain of Little Gila River at Sacaton. The entire piedmont is traversed by closely spaced stream channels.

Ark. 1. Choctaw anticline

County: Scott.
Lat 34°55′ N.; long 94°12′ W.
Number of photographs: 3.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Nov. 9, 1957.
Map reference: U.S. Geol. Survey Waldron 15-min quadrangle, scale 1:62,500.
Geology reference: Reinemund, J. A., and Danilchik, Walter, 1957, Preliminary geologic map of the Waldron quadrangle and adjacent areas, Scott County, Arkansas: U.S. Geol. Survey Oil and Gas Inv. Map OM–192, scale 1:48,000.

Features illustrated (set nos. Ark. 1 A–C in southwest corner of photographs).—The concentric ridges in the south half of photograph 1 A are largely siltstone and sandstone separated by narrow valleys carved in claystone (Atoka Formation of Pennsylvanian age). The rocks are a part of the east-plunging Choctaw anticline. In the south half of photograph 1 C a small syncline is superposed on the south limb of the anticline. The flood plain of Poteau River (north half of photographs) is hemmed in by sandstone ridges.

Ark. 2. Athens plateau and Novaculite uplift

County: Polk and Howard.
Lat 34°22′ N.; long 94°01′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Feb. 17, 1955.
Map reference: U.S. Geol. Survey Umpire 15-min quadrangle, scale 1:62,500.
Geology reference: Miser, H. D., and Purdue, A. H., 1929, Geology of the De Queen and Caddo Gap quadrangles, Arkansas: U.S. Geol. Survey Bull. 808, 195 p.; geol. map (pl. 3), scale 1:125,000.

Features illustrated (set nos. Ark. 2 A–C in southeast corner of photographs).—Closely folded Stanley Shale of Mississippian age forms a piedmont plateau (photograph 2 A) that has a pronounced east-trending grain and is dissected to a depth of about 100 feet. To the north, west-plunging anticlines of closely folded Arkansas Novaculite of Devonian age form east-trending ridges as much as 500 feet high. The ridges mark the southern limit of the Novaculite uplift. The Blaylock Sandstone of Silurian age is exposed in some of the anticlinal ridges in the north part of photograph 2 C.

Ark. 3. Plunging anticline at Hot Springs

County: Garland.
Lat 34°31′ N.; long 93°06′ W.
Number of photographs: 3.
Photograph scale: 1:18,000.
Focal length: 6 in.
Date flown: Apr. 9, 1965.
Map reference: U.S. Geol. Survey Hot Springs and vicinity 15-min quadrangle, scale 1:62,500.
Geology reference: Purdue, A. H., and Miser, H. D., 1923, Description of the Hot Springs district, Arkansas: U.S. Geol. Survey Geol. Atlas, Folio 215, geol. map, scale 1:62,500. (Out of print.)

Features illustrated (set nos. Ark. 3 A–C in northeast corner of photographs).—Sugarloaf Mountain (north half of photograph 3 A) and West Mountain (south half of same photograph) are held up by Arkansas Novaculite (Devonian) on the limbs of a southwest-plunging anticline. The novaculite on the nose of the fold passes beneath the body of water in the southwest corner of photograph 3 B. Stanley Shale (Mississippian) forms the lowlands surrounding the mountains, and Bigfork Chert (Ordovician) forms the intermontane valley. The two ridges of Sugarloaf Mountain northeast of the road that crosses it owe their existence to a minor fold on the north limb of the anticline.

Ark. 4. Quarries and strip mines in the Arkansas bauxite region

County: Pulaski.
Lat: 34°41′ N.; long 92°16′ W.
Number of photographs: 4.
Photograph scale: 1:18,000.
Focal length: 6 in.
Date flown: Mar. 2, 1960.
Map reference: U.S. Geol. Survey Little Rock 7½-min quadrangle, scale 1:24,000.
Geology reference: Gordon, MacKenzie, Jr., Tracey, J. I., Jr., and Ellis, M. W., 1958, Geology of the Arkansas bauxite region: U.S. Geol. Survey Prof. Paper 299, 268 p.; geol. map (pl. 1), scale 1:31,680.

Features illustrated (set nos. Ark. 4 A–D in northeast corner of photographs).—Smooth wooded hills of nepheline syenite and related igneous rocks are overlain and surrounded by lower Tertiary sand and clay. The bauxite occurs as discontinuous blanketlike deposits on the weathered surface of the nepheline syenite and nearby in the rocks of the Coastal Plain province. A large quarry in syenite is visible in the northwest quadrant of photograph 4 B. Bauxite strip mines are conspicuous in the east half of photograph 4 C.

Calif. 1. Mudflow levees on Shastina

County: Siskiyou.
Lat 41°25′ N.; long 122°14′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 23, 1944.
Map reference: U.S. Geol. Survey Shasta 15-min quadrangle, scale 1:62,500.
Geology reference: Williams, Howel, 1932, Mount Shasta, a Cascade volcano: Jour. Geology, v. 40, no. 5, p. 417–429.

Features illustrated (set nos. Calif. 1 A–B in southeast corner of photographs).—These mudflow levees on the northwest slope of Shastina, the cone just west of Mount Shasta, extend from the bare debris-covered slope down into the forest. Some levees are forested in their lower courses and are ancient; others are bare and mark channels down which debris has moved in recent years.

Calif. 2. Summit cone of Mount Shasta

County: Siskiyou.
Lat 41°25′ N.; long 122°12′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 23, 1944.
Map reference: U.S. Geol. Survey Shasta 15-min quadrangle, scale 1:62,500.
Geology reference: Williams, Howel, 1932, Mount Shasta, a Cascade volcano: Jour. Geology, v. 40, no. 5, p. 417–429.

Features illustrated (set nos. Calif. 2 A–D in southeast corner of photographs).—The summit, altitude 14,162 feet, includes several rocky crags above a central platform. The adjacent rubble-mantled slopes of the volcano are at an angle of about 35°, and the angle decreases gradually downward to the heads of the glaciers that are most extensive on the north and east sides of the cone. Bergschrunds and other crevasses are conspicuous.

Calif. 3. Little Glass Mountain dome

County: Siskiyou.
Lat 41°34′ N.; long 121°41′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 25, 1955.
Map reference: U.S. Geol. Survey Medicine Lake 15-min quadrangle, scale 1:62,500.
Geology reference: Anderson, C. A., 1941, Volcanoes of the Medicine Lake Highland, California: California Univ. Pubs. Geol. Sci., v. 25, no. 7, p. 347–422; map, scale 1:30,000.

Features illustrated (set nos. Calif. 3 A–C in southeast corner of photographs).—The rhyolite obsidian flows of Little Glass Mountain present a wrinkled appearance pocked here and there by small depressions presumably formed by small steam explosions. The source of the lava is well marked by an upward bulge of the last extruded material, too viscous to flow outward. The edge of the dome is a steep talus-covered wall more than 100 feet high. The surrounding lowlands are forest covered.

Calif. 4. Glass Mountain obsidian flows and domes

County: Siskiyou.
Lat 41°36′ N.; long 121°30′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 31, 1955.
Map reference: U.S. Geol. Survey Medicine Lake and Timber Mountain 15-min quadrangles, scale 1:62,500.
Geology reference: Anderson, C. A., 1941, Volcanoes of the Medicine Lake Highland, California: California Univ. Pubs. Geol. Sci., v. 25, no. 7, p. 347–422; map, scale 1:30,000. See plates 5b and 6.

Features illustrated (set nos. Calif. 4 A–D in southeast corner of photographs).—These spectacular photographs show that Glass Mountain (photograph 4 B) consists of two obsidian flows, the younger of which runs northeast from a summit dome. Flow structure and steep margins of flows are well shown. The older Hoffman flow lies to the west and supports a moderate growth of pines. Its vent, Mount Hoffman, is outside the area of the photograph. The white patches on the Hoffman flow are pumice that has filled depressions on the flow surface. A line of small domes trends N. 30° W. from Glass Mountain. The flows are probably less than 1,000 years old.

Calif. 5. Domes and mudflows at Lassen Peak

County: Shasta.
Lat 40°30′ N.; long 121°30′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Sept. 30, 1953.
Map reference: U.S. Geol. Survey Lassen Volcanic National Park and vicinity, scale 1:62,500.
Geology reference: Williams, Howel, 1932, Geology of the Lassen Volcanic National Park, California: California Univ. Dept. Geol. Sci. Bull., v. 21, no. 8, p. 195–385; geol. map, scale 1:48,000.

Features illustrated (set nos. Calif. 5 A–C in northeast corner of photographs).—Lassen Peak is described by Williams as an elevated crater filling or plugdome surrounded by great banks of talus. Crescent Crater, about a mile northeast of the peak, is a parasitic vent. Chaos Crags, about 2 miles north-northwest of the peak, are cylindrical bodies of viscous dacite from whose northwest side came a great avalanche known as Chaos Jumbles (northwest corner of photograph 5 B). In 1915, Lassen Peak erupted a small mass of lava and generated several large mudflows on its northeast flank that devastated a broad area for a distance of about 3 miles from the peak.

Calif. 6. Yosemite Valley: Domes and glacial features in Little Yosemite Valley

County: Mariposa.
Lat 37°44′ N.; long 119°31′ W.
Number of photographs: 3.
Photograph scale: 1:47,000.
Focal length: 6 in.
Date flown: Aug. 26, 1955.
Map reference: U.S. Geol. Survey Hetch Hetchy Reservoir, Yosemite, Tuolumne Meadows, and Merced Peak 15-min quadrangles, scale 1 62,500.
Geology reference: Matthes, F. E., 1930, Geologic history of the Yosemite Valley: U.S. Geol. Survey Prof. Paper 160, 137 p. Glacial features shown on pl. 29, bedrock geology on pl. 51.

Features illustrated (set nos. Calif. 6 A–C in northeast corner of photographs).—Joints in the massive granitic bedrock (Half Dome Quartz Monzonite) are widely spaced. Exfoliation (suggested by arches near northwest corner of photograph 6 C) has produced many domes. The shape of Half Dome (northwest of center photograph 6 B) has been attributed to glacier ice in Tanaya Creek valley that sliced away its northwest part. Nevada Fall of Merced River (2 in. southwest of center of east edge of photograph 6 A and south of Liberty Cap, a small dome) and Vernal Fall (nearly an inch farther west on photograph) are parts of Matthes' "glacial stairway." Lateral moraines on the north side of Little Yosemite Valley (northeast quadrant of photograph 6 B) that divert Sunrise Creek westward were deposited when the terminus of the glacier was far west down Yosemite Valley. Loop moraines on the valley floor (just southeast of center of photograph 6 B) were left during retreat of the ice front. (Calif. 6 and 7 are continuous.)

Calif. 7. Yosemite Valley: Lower valley and Merced Gorge

County: Mariposa.
Lat 37°44′ N.; long 119°38′ W.
Number of photographs: 2.
Photograph scale: 1:47,000.
Focal length: 6 in.
Date flown: Aug. 26, 1955.
Map reference: U.S. Geol. Survey Hetch Hetchy Reservoir and Yosemite 15-min quadrangles, scale 1:62,500.
Geology reference: Matthes, F. E., 1930, Geologic history of the Yosemite Valley: U.S. Geol. Survey Prof. Paper 160, 137 p. Glacial features shown on pl. 29, bedrock geology on pl. 51.

Features illustrated (set nos. Calif. 7 A–B in northeast corner of photographs).—El Capitan (2 in. west of center of east edge of photograph 7 A), a sheer cliff nearly 3,000 feet high (difficult to see in stereo), and Cathedral Rocks face each other across nearly flat Yosemite Valley; here the Merced River flows in a U-shaped glaciated valley. At the west edge of the photograph, the valley is narrow, and in Merced Gorge (southwest quadrant of photograph 7 A, not in stereo) the stream fills the bottom of a V-shaped canyon untouched by ice. Upper Yosemite Fall (just west of Yosemite Point, center of northeast quadrant of photograph 7 B; for stereo, see Calif. 6) is dry in late August. Bedrock is Half Dome Quartz Monzonite; vegetation patterns on ice-scoured bedrock upland show that joints are widely spaced. Wawona Tunnel, on Wawona Road south of Merced River (only east portal seen in stereo), is 0.8 mile long. (Calif. 6 and 7 are continuous.)

Calif. 8. Mono Craters

County: Mono.
Lat 37°53′ N.; long 119°01′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Aug. 10, 1951.
Map reference: U.S. Geol. Survey Mono Craters 15-min quadrangle, scale 1:62,500.
Geology reference: Putnam, W. C., 1949, Quaternary geology of the June Lake district, California: Geol. Soc. America Bull., v. 60, p. 1281–1302.

Features illustrated (set nos. Calif. 8 A–B in northeast corner of photographs).—These photographs show a chain of rhyolitic obsidian domes and flows. Putnam describes them as citadellike structural features whose nearly vertical walls are girdled with a continuous mantle of blocky talus and surmounted by a rampart of obsidian pinnacles. Tahoe moraines are conspicuous in the southwest quadrant of photograph 8 B (not in stereo).

Calif. 9. Rock glaciers along Sherwin Creek

County: Mono.
Lat 37°35′ N.; long 118°56′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 24, 1944.
Map reference: U.S. Geol. Survey Mount Morrison 15-min quadrangle, scale 1:62,500.
Geology reference: Rinehart, C. D., and Ross, D. C., 1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 385, p. 74–75, fig. 37; geol. map (pl. 1), scale 1:62,500.

Features illustrated (set nos. Calif. 9 A–B in southeast corner of photographs).—Large inactive rock glacier in northwest quadrant of photograph 9 A. This rock glacier is markedly concave in transverse profile and supports an open forest. Smaller rock glaciers in the southwest quadrant are bare. The bedrock is granodiorite, except in the northeast quadrant where dark-colored beds of hornfels that have a northwest strike are conspicuous.

Calif. 10. Rock glaciers near Mammoth Crest

County: Mono and Fresno.
Lat 37°35′ N.; long 118°58′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 23, 1944.
Map reference: U.S. Geol. Survey Mount Morrison 15-min quadrangle, scale 1:62,500.
Geology reference: Rinehart, C. D., and Ross, D. C., 1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 385, p. 74–75; geol. map (pl. 1), scale 1:62,500..

Features illustrated (set nos. Calif. 10 A–B in southeast corner of photographs).—A small rock glacier and several talus aprons are visible in the northwest quadrant of photograph 10 B. The bedrock is steeply dipping Mesozoic volcanic rock that imparts a northwest-trending topographic grain to Mammoth Creek valley in contrast to that of Sherwin Creek in the northeast quadrant where the bedrock is granodiorite. Mammoth Crest passes through the center of this photograph.

Calif. 11. Intersecting moraines near Convict Lake

County: Mono.
Lat 37°37′ N.; long 118°52′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.

Focal length: 6 in.
Date flown: Aug. 10, 1951.
Map reference: U.S. Geol. Survey Mount Morrison 15-min quadrangle, scale 1:62,500.
Geology reference: Rinehart, C. D., and Ross, D. C., 1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 385, p. 68–70, fig. 34 and pl. 1.

Features illustrated (set nos. Calif. 11 A–B in northeast corner of photographs).—The older moraine consists of a massive embankment whose northeast end is near the center of photograph 11 B. The embankment is elongated east-northeastward parallel with the long axis of Convict Lake (southwest quadrant of same photograph). A sharply defined ridge nested within a more poorly preserved one of about the same height marks the north side of an eastward-moving ice tongue on whose south side next to McGee Mountain only two small remnants remain. The younger moraines (north of Convict Lake) were deposited by glaciers that moved northward across the older more massive moraine. This movement suggests a 90° shift near the terminus in the direction of ice movement of the younger glaciers. The hills in the northwest quadrant of photograph 11 B are composed of rhyolite of Pliocene(?) age. The moraines north of the lake are shown at a larger scale in Calif. 12.

Calif. 12. Moraines north of Convict Lake

County: Mono.
Lat 37°37′ N.; long 118°52′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 24, 1944.
Map reference: U.S. Geol. Survey Mount Morrison 15-min quadrangle, scale 1:62,500.
Geology reference: Rinehart, C. D., and Ross. D. C., 1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 385, p. 68–70, fig. 34.

Features illustrated (set nos. Calif. 12 A–C in southeast corner of photographs).—These photographs show moraines of two glaciations. The younger moraines (northeast quadrant of photograph 12 B) include three groups. The farthest line of advance is marked by a double-crested end moraine, just south of which is a slightly lower recessional moraine. The third group includes smaller nested morainal ridges that begin at a point about halfway between the north end of the lake and the point of maximum advance. A similar sequence is well shown east of the lake. The older moraines consist of a massive embankment east-northeast of the north end of the lake, where the ridges are more rounded and discontinuous than those of the younger glaciation. (See also Calif. 11.)

Calif. 13. McGee Creek moraine offset along Hilton Creek fault

County: Mono.
Lat 37°34′ N.; long 118°47′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Aug. 10, 1951.
Map reference: U.S. Geol. Survey Mount Morrison 15-min quadrangle, scale 1:62,500.
Geology reference: Rinehart, C. D., and Ross. D. C., 1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 385, p. 70, fig. 35, and pl. 1.

Features illustrated (set nos. Calif. 13 A–B in northeast corner of photographs).—Two moraines loop across McGee Creek at a point about a mile beyond the mountain front (northeast quadrant of photograph 13 B). Remnants of the inner and younger moraine occur also along the valley walls in the foothills. The scarp formed by recent movement along the range-front fault is clearly visible crossing both moraines at the mountain front and can be traced to the north and south. A related scarp parallels the highway west of the creek, which has built a small delta in Lake Crowley. The bedrock along the lower part of McGee Creek is largely Paleozoic metamorphic rock and chiefly granodiorite near the headwaters. (Calif. 13 and 14 are continuous.)

Calif. 14. Moraines near Rock Creek and Owens River gorge

County: Mono.
Lat 37°33′ N.; long 118°42′ W.
Number of photographs: 3.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Aug. 10, 1951.
Map reference: U.S. Geol. Survey Casa Diablo Mountain 15-min quadrangle, scale 1:62,500.
Geology reference: Rinehart, C. D., and Ross, D. C., 1957, Geology of the Casa Diablo Mountain quadrangle, California: U.S. Geol. Survey Geol. Quad. Map GQ–99. Putnam, W. C., 1960, Origin of Rock Creek and Owens River gorges, Mono County, California: California Univ. Pubs. Geol. Sci., v. 34, no. 5, p. 221–280.

Features illustrated (set nos. Calif. 14 A–C in northeast corner of photographs).—Drifts of three glaciations occur along Rock Creek that enters the area at the southwest corner of photograph 14 B. Tioga moraines cross the creek south of the center of photograph 14 C, and the conspicuous moraines near the mouth of the creek are of Tahoe age. A broad area on either side of Rock Creek near the center of the photograph contains patches of Sherwin till, which is older than the Bishop Tuff that forms the wooded tableland in the north half of the photograph. Putnam believes that the headward growth of Owens River (north half of photograph 14 B) captured the drainage from a lake in Long Valley (northwest corner of photograph 14 B). This capture caused the river to carve a deep gorge. Rock Creek that formerly flowed north to Long Valley was captured at a somewhat later date by headward growth of a stream roughly parallel to Owens River, forming a barbed junction. (Calif. 13 and 14 are continuous.)

Calif. 15. Moraines in Mono Creek Valley

County: Fresno.
Lat 37°23′ N.; long 119°00′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Aug. 25, 1951.
Map reference: U.S. Geol. Survey Kaiser Peak and Mount Abbot 15-min quadrangles, scale 1:62,500.
Geology reference: Birman, J. H., 1964, Glacial geology across the crest of the Sierra Nevada, California: Geol. Soc. America Spec. Paper 75, 80 p.; pl. 1 (map of glacial geology), scale 1:62,500.

Features illustrated (*set nos. Calif. 15 A–B in northeast corner of photographs*).—Moraines of three Wisconsin advances are present on the west side of the crest of the Sierra Nevada. In photograph 15 A, taken before Edison Dam was built, Tioga moraines surround the west end of the valley just east of the center of the photograph. Tahoe moraines are conspicuous on the uplands north of the valley.

Devils Bathtub, on the north edge of the photograph, and Graveyard Meadows, in the northeast corner, are surrounded by moraines of three Wisconsin Glaciations (Tioga, Tenaya, and Tahoe).

Calif. 16. Inverted topography at Table Mountain

County: Fresno and Madera.
Lat 37°01′ N.; long 119°36′ W.
Number of photographs: 3.
Photograph scale: 1:34,680.
Focal length: 6 in.
Date flown: Nov. 14, 1940.
Map reference: U.S. Geol. Survey Millerton Lake and Clovis 15-min quadrangles, scale 1:62,500.
Geology reference: Macdonald, G. A., 1941, Geology of the western Sierra Nevada between the Kings and San Joaquin Rivers, California: California Univ. Dept. Geol. Sci. Bull., v. 26, no. 2, p. 215–286; geol. map, scale 1:62,500.

Features illustrated (*set nos. Calif. 16 A–C in northeast corner of photographs*).—Table Mountain (center of photograph 16 B) and the adjacent flat-topped hills are erosional remnants of a basalt flow that filled an ancient river channel. The topography is inverted. These remnants exhibit a meanderlike pattern that may be a reflection of meanders of the Pliocene(?) course of San Joaquin River. The bedrock is largely Jurassic crystalline rocks. The present canyon of the river is incised as much as 1,500 feet below the surface of the flows.

Calif. 17. Sierra Nevada and adajcent piedmont near Lone Pine

County: Inyo.
Lat 36°42′ N.; long 118°14′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Sept. 10, 1955.
Map reference: U.S. Geol. Survey Lone Pine and Mount Whitney 15-min quadrangles, scale 1:62,500.
Geology reference: Knopf, Adolph, 1918, A geologic reconnaissance of the Inyo Mountains and the eastern slope of the southern Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 110, 130 p.; geol. map (pl. 2), scale 1:125,000.

Features illustrated (*set nos. Calif. 17 A–B in southeast corner of photographs*).—Granitic rocks form the east face of the Sierra Nevada fault block that has triangular facets between the canyons emerging from the mountains. A discontinuous fault scarp that cuts unconsolidated materials more or less parallels the mountain front. East of the mountain front, a bajada of coalescing alluvial fans slopes northeast to Owens Valley and is crossed by perennial streams.

Calif. 18. Dikes in granitic rocks, Inyo Mountains

County: Inyo.
Lat 36°58′ N.; long 118°12′ W.
Number of photographs: 2.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: July 17, 1947.
Map reference: U.S. Geol. Survey Independence 15-min quadrangle, scale 1:62,500.
Geology reference: Ross, D. C., 1962, Preliminary geologic map of the Independence quadrangle, Inyo County, California: U.S. Geol. Survey Misc. Geol. Inv. Map MF–254.

Features illustrated (*set nos. Calif. 18 A–B in southeast corner of photographs*).—Mafic and felsic dikes in granitic rocks of the Inyo Mountains (dark lines in east half of photograph 18 B). White streaks in the granitic terrane are shear zones. The north-northwest-trending fault trace in Owens Valley is marked by dry sag ponds. The dark canal is the Los Angeles aqueduct; the diversion dam shifting the water from the Owens River to the aqueduct is seen in the north part of photograph 18 A.

Calif. 19. Faults in granite and in alluvium along Owens River

County: Inyo.
Lat 36°54′ N.; long 118°09′ W.
Number of photographs: 3.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: July 17, 1947.
Map reference: U.S. Geol. Survey Independence 15-min quadrangle, scale 1:62,500.

Geology reference: Ross, D. C., 1962, Preliminary geologic map of the Independence quadrangle, Inyo County, California: U.S. Geol. Survey Misc. Geol. Inv. Map MF–254.

Features illustrated (set nos. Calif. 19 A–C in southeast corner of photographs).—Northwest-trending faults in a granitic body near the west base of the Inyo Mountains. The prominent lines marking the faults are in part sheared granitic rock that appears light colored on photographs and are in part bands of sagebrush that appear dark in the photographs. This fault zone is virtually parallel to another fault marked by sag ponds in the alluvium on the floor of Owens Valley. There is no obvious faultline along the base of the range. Dark patches are Pennsylvanian carbonate hornfels inclusions or small roof pendants in the granitic rock. Conspicuous abandoned meanders and oxbow lakes are visible on the dry bed of the Owens River.

Calif. 20. Granitic rocks intruded in metasediments near Mazourka Canyon

County: Inyo.
Lat 36°53′ N.; long 118°04′ W.
Number of photographs: 2.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: July 16, 1947.
Map reference: U.S. Geol. Survey Independence 15-min quadrangle, scale 1:62,500.
Geology reference: Ross, D. C., 1962, Preliminary geologic map of the Independence quadrangle, Inyo County, California: U.S. Geol. Survey Misc. Geol. Inv. Map MF–254.

Features illustrated (set nos. Calif. 20 A–B in southeast corner of photographs).—The contact between the granitic rocks and the metamorphosed sedimentary rocks they intrude is well exposed west of Mazourka Canyon (west half of photographs). Granitic rock is also present in the southeast quadrant of photograph 20 B. The sedimentary rocks of Cambrian, Ordovician, Silurian, and Mississippian age strike parallel to Mazourka Canyon and dip steeply. A few mine workings are visible.

Calif. 21. Scarps of Owens Valley earthquake, 1872

County: Inyo.
Lat 36°34′ N.; long 118°03′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Sept. 10, 1955.
Map reference: U.S. Geol. Survey Lone Pine and New York Butte 15-min quadrangles, scale 1:62,500.
Geology reference: Bateman, P. C., 1961, Willard D. Johnson and the strike-slip component of fault movement in the Owens Valley, California, earthquake of 1872: Seismol. Soc. America Bull., v. 51, no. 4, p. 483–493.

Features illustrated (set nos. Calif. 21 A–B in southeast corner of photographs).—Scarps formed during the Owens Valley earthquake of 1872 along the east side of Alabama Hills at Lone Pine, Calif. A small graben south of the town encloses Diaz Lake (southwest quadrant of photograph 21 A). There is a conspicuous joint pattern in the granitic rocks of Alabama Hills southwest of Lone Pine. Dark soft slopes of Alabama Hills west of Lone Pine (not in stereo) are Mesozoic metavolcanic rocks contrasting with bouldery outcrops of granitic rocks to the southwest. Beach ridges on the north side of the dry bed of Owens Lake are in the southeast quadrant of photograph 21 A.

Calif. 22. Desiccation cracks on dry bed of Owens Lake

County: Inyo.
Lat 36°27′ N.; long 117°59′ W.
Number of photographs: 2.
Photograph scale: 1:38,000.
Focal length: 6 in.
Date flown: July 16, 1947.
Map reference: U.S. Geol. Survey Keeler and Olancha 15-min quadrangles, scale 1:62,500.

Features illustrated (set nos. Calif. 22 A–B in southeast corner of photographs).—The patterns formed by these cracks are irregular in plan and varied in size. One large polygon may enclose many smaller ones. Some of the larger, generally rectangular polygons are more than 1,000 feet in longest dimension. Smaller ones, commonly 150–300 feet in diameter, are more nearly equidimensional and many sided.

Calif. 23. East face of Panamint Range near Aguereberry Point

County: Inyo.
Lat 36°22′ N.; long 117°00′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Oct. 11, 1952.
Map reference: U.S. Geol. Survey Emigrant Canyon and Furnace Creek 15-min quadrangles, scale 1:62,500.
Geology reference: Hunt, C. B., and Mabey, D. R., 1966, Stratigraphy and structure, Death Valley, California: U.S. Geol. Survey Prof. Paper 494–A, 162 p.; geol. map (pl. 1), scale 1:96,000.

Features illustrated (set nos. Calif 23 A–C in southeast corner of photographs).—East face of Panamint Range from Aguereberry Point (altitude 6,433 ft, near center of west edge of photograph 23 B) to the floor of Death Valley. Trail Canyon (southwest quadrant of photograph 23 B) cuts through a thick sequence of generally east-dipping sedimentary rocks of Cambrian age to emerge on a broad fan whose toe is outside the area shown. Dark areas on fans are desert pavement. The salt-crusted playa (northeast quadrant) in this area is largely rock salt. Near the playa, the two black hills and the white formation at south end of one hill are Tertiary volcanic rocks faulted against the Paleozoic rocks.

Calif. 24. Death Valley saltpan and Panamint Range

County: Inyo.
Lat 36°15′ N.; long 116°55′ W.
Number of photographs: 2.
Photograph scale: 1:48,000.
Focal length: 6 in.
Date flown: Dec. 2, 1948.
Map reference: U.S. Geol. Survey Bennetts Well and Furnace Creek 15-min quadrangles, scale 1:62,500.
Geology reference: Hunt, C. B., and Mabey, D. R., 1966, Stratigraphy and structure, Death Valley, California: U.S. Geol. Survey Prof. Paper 494–A, 162 p.; geol. map (pl. 1), scale 1:96,000.

Features illustrated (set nos. Calif. 24 A–B in southeast corner of photographs).—Apex of Panamint Range fan at the mouth of Death Valley Canyon is at the center point of the western edge of photograph 24 B. Fan segments of at least three different ages are visible: (1) Deeply dissected fan-head mesas north and south of Death Valley Canyon wash, (2) areas of desert pavement (dark colored) on fan segments that are only slightly dissected, and (3) the light-colored modern washes that carry the very occasional floods of the present day. In the saltpan (east half of the photographs) can be seen the chloride, sulfate, and carbonate zones. Phreatophytes are in the carbonate zone, in a spring zone along the edge of the saltpan. The sulfate zone is a narrow discontinuous belt on the panward side of the desert shrubs. Most of the saltpan is rock salt with salt-crusted surfaces that are subject to flooding.

Calif. 25. Badwater, Death Valley

County: Inyo.
Lat 36°15′ N.; long 116°45′ W.
Number of photographs: 2.
Photograph scale: 1:48,000.
Focal length: 6 in.
Date flown: Nov. 27, 1948.
Map reference: U.S. Geol. Survey Furnace Creek, Bennetts Well, Ryan, and Funeral Peak 15-min quadrangles, scale 1:62,500.
Geology reference: Drewes, Harald, 1963, Geology of the Funeral Peak quadrangle, California, on the east flank of Death Valley: U.S. Geol. Survey Prof. Paper 413, 78 p.; geol. map, scale 1:62,500. Hunt, C. B., Robinson, T. W., Bowles, W. A., and Washburn, A. L., 1966, Hydrologic basin, Death Valley, California: U.S. Geol. Survey Prof. Paper 494–B, 138 p.; geol. map (pl. 1), scale 1:96,000.

Features illustrated (set nos. Calif. 25 A–B in southeast corner of photographs).—Badwater, almost the lowest point in the United States, is a spring fed sulfate marsh in the reentrant on the north side of the fan in the center of photograph 25 B. The broad white area west of Badwater is subject to flooding and is crusted with rock salt. North of this area, extending to the foot of the gravel fan, is massive rock salt; to the south is rock salt that has been smoothed by flooding (C. B. Hunt, written commun., March 1964). At right is the faulted front of the Black Mountains; the Badwater Turtleback—metasedimentary rocks of Precambrian age—is overlapped at the north by volcanic rocks of Tertiary age.

Calif. 26. Death Valley saltpan and Black Mountain front

County: Inyo.
Lat 36°07′ N.; long 116°45′ W.
Number of photographs: 2.
Photograph scale: 1:48,000.
Focal length: 6 in.
Date flown: Nov. 27, 1948.
Map reference: U.S. Geol. Survey Funeral Peak and Bennetts Well 15-min quadrangles, scale 1:62,500.
Geology reference: Drewes, Harald, 1963, Geology of the Funeral Peak quadrangle, California, on the east flank of Death Valley: U.S. Geol. Survey Prof. Paper 413, 78 p.; geol. map, scale 1:62,500.

Features illustrated (set nos. Calif. 26 A–B in southeast corner of photographs).—Precipitous fault scarps with gullied surfaces form prominent triangular facets. Copper Canyon in the southeast quadrant of photograph 26 A cuts through Tertiary clastic sediments, downfaulted in Precambrian metamorphic rocks, to emerge on a symmetrical alluvial fan. Coffin Canyon empties onto a small fan near the center of the same photograph. White beds in the northeast quadrant of photograph 26 B are siltstone and evaporates that include a dark band of volcanic rocks. Silt and evaporates on the valley floor are traversed by anastomosing channels, distributaries of the Amargosa River.

Calif. 27. Landslides on Bat Mountain piedmont

County: Inyo.
Lat 36°20′ N.; long 116°29′ W.
Number of photographs: 2.
Photograph scale: 1:48,000.
Focal length: 6 in.
Date flown: Dec. 2, 1948.
Map reference: U.S. Geol. Survey Ash Meadows and Ryan 15-min quadrangles, scale 1:62,500.
Geology reference: Denny, C. S., 1961, Landslides east of Funeral Mountains, near Death Valley Junction, California, *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424–D, p. D85–D89.

Features illustrated (set nos. Calif. 27 A–B in southeast corner of photographs).—East-dipping Paleozoic sedimentary rocks and Tertiary arid-basin sediments form a fault-block mountain surrounded by a piedmont of coalescing alluvial fans. Abandoned segments of fans are capped by desert pavement that in most places appears darker than the surrounding piedmont owing to presence of desert varnish on the individual stones. Pavements are dissected by meandering washes that head on piedmont. Several landslides east of the center of photograph 27 B form light-colored digitiform ridges on piedmont. The snout of a conspicuous landslide about 3 inches south of the center of photograph 27 B extends eastward beyond the mountain front. Landslide debris is in part rubble and in part megabreccia and rests either on Tertiary rocks or on Quaternary alluvial deposits.

Calif. 28. Piracy on Shadow Mountain fan

County: Inyo.
Lat 36°17′ N.; long 116°17′ W.
Number of photographs: 2.
Photograph scale: 1:48,000.
Focal length: 6 in.
Date flown: Nov. 25, 1948.
Map reference: U.S. Geol. Survey Ash Meadows 15-min quadrangle, scale 1:62,500.
Geology reference: Denny, C. S., 1965, Alluvial fans in the Death Valley region, California and Nevada: U.S. Geol. Survey Prof. Paper 466, 62 p.; map (pl. 1), scale 1:24,000. Denny, C. S., and Drewes, Harald, 1965, Geology of Ash Meadows quadrangle, Nevada-California: U.S. Geol. Survey Bull. 1181–L, p. L1–L56; geol. map (pl. 1), scale 1:62,500.

Features illustrated (set nos. Calif. 28 A–B in southeast corner of photographs).—The fan heads in a reentrant on the northwest side of Shadow Mountain (near center of photograph 28 A) and slopes first to the northwest and then westward. Down-fan it merges with adjacent fans to form a complex piedmont (near the northeast-trending Old Traction Road).

Floods from the mountain follow broad anastomosing channels separated by abandoned segments of the fan that are mantled by dark-colored desert pavement and dissected by meandering washes that head on the piedmont. Piracy has taken place, the point of diversion being about 3 inches north-northwest of the center of the south edge of photograph 28 B. Dissection of the piedmont caused a northwest-flowing wash heading in the mountains east of the fan to be diverted, only a short time ago, into the headwaters of a west-southwest-trending meandering wash that is incised about 20 feet below surface of adjacent pavement.

Calif. 29. A thrust-faulted anticline in the Orchard Peak area

County: Kern.
Lat 35°43′ N.; long 120°06′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Apr. 11, 1950.
Map reference: U.S. Geol. Survey Sawtooth Ridge 7½-min quadrangle, scale 1:24,000.
Geology reference: Marsh, O. T., 1960, Geology of the Orchard Peak area, California: California Div. Mines Spec. Rept. 62, 42 p.; geol. map (pl. 1), scale 1:35,800.

Features illustrated (set nos. Calif. 29 A–C in southeast corner of photographs).—The Avenal Ridge piercement anticline trends west-northwest across the northeast quadrant of photograph 29 C. Its core of white bentonite and tuffaceous shale (Jurassic?) contrasts with the surrounding darker Cretaceous rocks. The axis of a conspicuous syncline extends east-southeast through the center of the same photograph. The dark rocks forming the ridge on the north limb of the anticline (Bluestone Ridge) are the upper plate of the south-moving Hex thrust, the trace of which turns northward near the center of photograph 29 B. The traces of other thrust faults, of normal faults, and a klippe can also be seen by reference to Marsh's map.

Calif. 30. Horizontal movement on San Andreas fault

County: San Luis Obispo.
Lat 35°16′ N.; long 119°50′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 22, 1957.
Map reference: U.S. Geol. Survey McKittrick Summit and Painted Rock 7½-min quadrangles, scale 1:24,000.
Geology reference: Hackel, Otto, and others, 1962, Geology of Carrizo Plains and San Andreas fault: San Joaquin Geol. Soc. Guidebook, 52 p., Stop 5, fig. 2; geol. map (pl. 1), scale 1:125,000.

Features illustrated (set nos. Calif. 30 A–B in southeast corner of photographs).—Photographs show offset drainage, well-defined scarps, and trenches in Quaternary deposits along the trace of San Andreas fault and subsidiary faults. The area slopes gently to the southwest to the Carrizo Plain and is crossed by parallel intermittent streams that locally meander. The streams are incised northeast of the trace of the fault.

Calif. 31. Elkhorn Scarp, San Andreas fault

County: San Luis Obispo.
Lat 35°07′ N.; long 119°40′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 2, 1957.
Map reference: U.S. Geol. Survey Wells Ranch and Panorama Hills 7½-min quadrangles, scale 1:24,000.
Geology reference: Hackel, Otto, and others, 1962, Geology of the Carrizo Plains and San Andreas fault: San Joaquin Geol. Soc. Guidebook, 52 p.; geol. map (pl. 1), scale 1:125,000. Hill, M. L., and Dibblee, T. W., Jr., 1953, San Andreas, Garlock, and Big Pine faults, California: Geol. Soc. America Bull., v. 64, no. 4, p. 443–458; see fig. 1.

Features illustrated (set nos. Calif. 31 A–C in southeast corner of photographs).—Right lateral offset of drainage lines by the San Andreas fault on the southwest side of Temblor Range where a maximum of 3,000 feet of displacement has occurred through recent movements on the fault.

Calif. 32. Shorelines and fault scarps at Searles Lake

County: San Bernardino.
Lat 35°45′ N.; long 117°14′ W.
Number of photographs: 2.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: July 14, 1947.
Map reference: U.S. Geol. Survey Searles Lake, Trona, Wingate Pass, and Manly Peak 15-min quadrangles, scale 1:62,500.
Geology reference: Jennings, C. W., Burnett, J. L., and Troxel, B. W., 1962, Geologic map of California, Trona sheet: California Div. Mines and Geology.

Features illustrated (*set nos. Calif. 32 A–B in southeast corner of photographs*).—Photographs show differences in expression of shorelines of late Pleistocene Searles Lake between areas where waves worked on bedrock and where lake abutted against unconsolidated upper Cenozoic gravels. In the northwest quadrant of photograph 32 A, the conspicuous strandlines are on the alluvial fans, whereas on bedrock only faint topographic features are visible.

Several low 10- to 20-foot-high fault scarps are visible in the southern half of photograph 32 A just west of the mountain front. The scarps cut all but the most recent gravels in the alluvial washes and in stereoscopic view can be seen to trend diagonally up the slope (northward) in contrast to the shorelines which contour the slope (G. I. Smith, written commun., March 1964).

Calif. 33. Cima Dome, Mojave Desert

County: San Bernardino.
Lat 35°17′ N.; long 115°35′ W.
Number of photographs: 2.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: Apr. 14, 1953.
Map reference: U.S. Geol. Survey Mescal Range and Kelso 15-min quadrangles, scale 1:62,500.
Geology reference: Sharp, R. P., 1957, Geomorphology of Cima Dome, Mojave Desert, California: Geol. Soc. America Bull., v. 68, no. 3, p. 273–290.

Features illustrated (*set nos. Calif. 33 A–B in southeast corner of photographs*).—This remarkably smooth symmetrical alluvium-fringed rock dome is the prototype of W. M. Davis' granitic desert dome. Numerous outcrops of quartz monzonite can be seen on the dome. Teutonia Peak lies just to the northeast of the summit. The slopes of the dome are traversed by many shallow and closely spaced anastomosing channels. (Calif. 34 overlaps photograph 33 A.)

Calif. 34. Granitic dome and cinder cones near Rainbow Wells

County: San Bernardino.
Lat 35°15′ N.; long 115°40′ W.
Number of photographs: 3.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Mar. 7, 1954.
Map reference: U.S. Geol. Survey Mescal Range and Kelso 15-min quadrangles, scale 1:62,500.
Geology reference: Sharp, R. P., 1957, Geomorphology of Cima Dome, Mojave Desert, California: Geol. Soc. America Bull., v. 68, no. 3, p. 273–290.

Features illustrated (*set nos. Calif. 34 A–C in northeast corner of photographs*).—A small granitic dome about 2 miles in diameter (southwest quadrant of photograph 34 A) has virtually straight slopes mantled by a thin layer of detrital gruss. Remnants of Quaternary basalt flows and cinder cones lie on the western flanks of the dome. The slopes of the dome and that of the larger one to the northeast (Cima Dome) are traversed by shallow and closely spaced anastomosing channels. (Calif. 33 overlaps photograph 34 A.)

Calif. 35. Stabilization of sand dunes, San Miguel Island

County: Santa Barbara.
Lat 34°02′ N.; long 120°23′ W.
Number of photographs: 2.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Apr. 1, 1960.
Map reference: U.S. Geol. Survey San Miguel Island East and San Miguel Island West 7½-min quadrangles, scale 1:24,000.
Geology reference: Bremner, C. St. J., 1933, Geology of San Miguel Island, Santa Barbara County, California: Santa Barbara Mus. Nat. History, Occasional Papers 2, 23 p.; see pl. 1.

Features illustrated (*set nos. Calif. 35 A–B in southwest corner of photographs*).—San Miguel Island has a striking set of longitudinal dunes formed by the prevailing northwest winds. Some of the dunes extend clear across the island, a distance ranging from 2 to 4 miles. The island was originally covered by a dense growth of brush, but about 1880, cattle and sheep began to graze and much of the vegetation was destroyed. When Bremner studied the area (see his photomosaic, pl. 1, made from photographs taken in 1929), most of the island was covered by actively moving sand. This stereoscopic pair, taken in 1960, suggests partial stabilization of the dunes since 1929. The island is underlain largely by northeast-dipping Eocene sedimentary rocks that form a rolling upland 400–500 feet above sea level.

Calif. 36. Erosion and deposition near Point Mugu

County: Ventura.
Lat 34°05′ N.; long 119°03′ W.
Number of photographs: 2.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: Aug. 20, 1947.
Map reference: U.S. Geol. Survey Point Mugu 7½-min quadrangle, scale 1:24,000.
Geology reference: Inman, D. L., 1954, Beach and shore processes along the southern California coast, *in* Jahns, R. H., ed., Geology of southern California: California Div. Mines

Bull. 170, chap. 5, p. 29–34, fig. 1. [Bedrock geology shown on map sheet 8.]

Features illustrated (*set nos. Calif. 36 A–B in northeast corner of photographs*).—Point Mugu at the west end of the Santa Monica Mountains forms a natural obstruction which interrupts the littoral drift of sand eastward and thus causes accretion. A wide beach or baymouth bar has formed west of the point on the upcurrent side, and cliff erosion and the building of a few pocket beaches has taken place down current where the supply of sand is diminished. The eastward drift of sediment offshore can be seen east of Point Mugu (southeast quadrant of photograph 36 B). Northward-dipping Miocene shale and conglomerate intruded by diabase form the mountains.

Calif. 37. Dissected marine terraces at Point Dume

County: Los Angeles.
Lat 34°01′ N.; long 118°48′ W.
Number of photographs: 2.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: Aug. 21, 1947.
Map reference: U.S. Geol. Survey Point Dume 7½-min quadrangle, scale 1:24,000.
Geology reference: Putnam, W. C., 1954, Marine terraces of the Ventura region and the Santa Monica Mountains, California, *in* Jahns, R. H., ed., Geology of southern California: California Div. Mines Bull. 170, chap. 5, p. 45–48, fig. 1.

Features illustrated (*set nos. Calif. 37 A–B in northeast corner of photographs*).—Point Dume, an ancient stack, is on a marine terrace more than 100 feet above sea level. Several other narrow terraces can be seen. The treads are conspicuous, but the risers are gently sloping; any sea cliffs that were initially present have been obscured by seaward-sloping blankets of alluvial-fan gravels. In many places the gravels make a continuously sloping surface from one terrace down to a level three or four treads lower, and thus completely obscure intervening terraces.

Calif. 38. Marine terraces of the Palos Verdes Hills

County: Los Angeles.
Lat 33°46′ N.; long 118°25′ W
Number of photographs: 2.
Photograph scale: 1:30,000.
Focal length: 6 in.
Date flown: Feb. 28, 1963.
Map reference: U.S. Geol. Survey Redondo Beach 7½-min quadrangle, scale 1:24,000.
Geology reference: Woodring, W. P., Bramlette, M. N., and Kew, W. S. W., 1946, Geology and paleontology of Palos Verdes Hills, California: U.S. Geol. Survey Prof. Paper 207, 145 p.; see pls. 22–26.

Features illustrated (*set nos. Calif. 38 A–B in northeast corner of photographs*).—Ten marine terraces ranging in altitude from approximately 100 to 1,000 feet have been mapped by Woodring and others within the area shown in these photographs; at least four are easily seen. On this west-facing windward coast the prevailing bedrock is hard Miocene cherty shale (part of the Monterey Shale) which forms open folds. The apparent merging of the terraces both in plan and in profile is due to the cover of nonmarine debris that has accumulated on the platforms following emergence.

Calif. 39. Barchan dunes west of Salton Sea

County: Imperial.
Lat 33°11′ N.; long 115°52′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Nov. 10, 1959.
Map reference: U.S. Geol. Survey Kane Spring NE. and Kane Spring NW. 7½-min quadrangles, scale 1:24,000.
Geology reference: Long, J. T., and Sharp, R. P., 1964, Barchan-dune movement in Imperial Valley, California: Geol. Soc. America Bull., v. 75, no. 2, p. 149–156.

Features illustrated (*set nos. Calif. 39 A–B in southeast corner of photographs*).—These dunes, open to the east, range in size horn to horn from about 150 to 800 feet and in height from about 10 to 30 feet. The dunes rest on a smooth gently sloping plain that descends to the Salton Sea. The ground between the dunes has a patchy residual armor of stones. These excellent photographs cover most of the barchan dunes south of the landing strip shown in figure 1 of Long and Sharp's paper. Movement of these dunes ranged from 325 to 925 feet over a 7-year period from 1956 to 1963.

Calif. 40. Marine terraces, San Clemente Island

County: Los Angeles.
Lat 32°53′ N.; long 118°30′ W.
Number of photographs: 2.
Photograph scale: 1:63,000.
Focal length: 6 in.
Date flown: Feb. 3, 1955.
Map reference: U.S. Geol. Survey San Clemente Island Central and San Clemente Island South 7½-min quadrangles, scale 1:24,000.
Geology reference: Olmsted, F. H., 1958, Geologic reconnaissance of San Clemente Island, California: U.S. Geol. Survey Bull. 1071–B, p. 55–68; geol. map (pl. 1), scale 1:31,680.

Features illustrated (*set nos. Calif. 40 A–B in south corner of photographs*).—A sequence of very gently dipping Miocene volcanics forms this long and narrow island—length about 21 miles, width as much as 4 miles—that rises almost 2,000 feet above sea level. The northeast slope is steep, but on the gentler southwest slope is a spectacular flight of marine terraces of Pleistocene age. The northwest-trending axial drainage divide of the island is close to the northeast coast. The terraces on the southwest slope are notched by steep-sided gullies and canyons, the latter as much as 500 feet deep. The rocky shore is in many places a cliff. A segment of the terraced southwest slope near Eel Point is shown in Calif. 41.

Calif. 41. Marine terraces near Eel Point, San Clemente Island

County: Los Angeles.
Lat 32°56′ N.; long 118°31′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Feb. 19, 1954.
Map reference: U.S. Geol. Survey San Clemente Island Central 7½-min quadrangle, scale 1:24,000.
Geology reference: Olmsted, F. H., 1958, Geologic reconnaissance of San Clemente Island, California: U.S. Geol. Survey Bull. 1071–B, p. 55–68; geol. map (pl. 1), scale 1:31,680.

Features illustrated (*set nos. Calif. 41 A–B in east corner of photographs*).—These photographs show the marine terraces on the southwest slope of the island near the airfield. The terraces are discontinuous. The risers are steep or clifflike, commonly 20–100 feet high. The treads are gently sloping; some are narrow, others as much as 1,000 feet wide. All the treads are more or less mantled by younger alluvial and colluvial material. Calif. 40 shows most of the island.

Colo. 1. Piracy at the Lindenmeier archaeologic site

County: Weld.
Lat 40°58′ N.; long 105°06′ W.
Number of photographs: 2.
Photograph scale: 1:27,700.
Focal length: 5.2 in.
Date flown: June 16, 1947.
Map reference: U.S. Geol. Survey Greeley sheet, scale 1:250,000.
Geology reference: Bryan, Kirk, and Ray, L. L., 1940, Geologic antiquity of the Lindenmeier site in Colorado: Smithsonian Misc. Colln., v. 99, no. 2, 76 p. Wormington, H. M., 1957, Ancient man in North America: Denver Mus. Nat. History Pop. Ser. 4, p. 31–39.

Features illustrated (*set nos. Colo. 1 A–B in southeast corner of photographs*).—A south-facing escarpment formed in Oligocene clay passes through the center of photograph 1 B. The Lindenmeier site is along an east-draining gully just north of the escarpment, about 0.6 inch east of the center of photograph 1 B. When Folsom man lived here nearly 11,000 years ago, the small east-trending valley at the site was drained eastward past the cultivated field near the southeast corner of photograph 1 A. The ancestral stream was later beheaded by a south-flowing stream working headward (northward) through the escarpment (at a point about midway between center and west edge of photograph 1 B). North of the escarpment, gravel-capped interfluves are remnants of the Spottlewood pediment of probable early Pleistocene age, a part of the High Plains. The area south of the escarpment is near the northwest corner of the Colorado piedmont.

Colo. 2. Cirques and glaciers in Rocky Mountain National Park

County: Larimer.
Lat 40°20′ N.; long 105°38′ W.
Number of photographs: 5.
Photograph scale: 1:46,000.
Focal length: 6 in.
Date flown: September 1953.
Map reference: U.S. Geol. Survey Trail Ridge, Estes Park, McHenrys Peak, and Longs Peak 7½-min quadrangles, scale 1:24,000.
Geology reference: Richmond, G. M., 1960, Glaciation of the east slope of Rocky Mountain National Park, Colorado: Geol. Soc. America Bull., v. 71, no. 9, p. 1371–1382.

Features illustrated (*set nos. Colo. 2 A–E in southeast corner of photographs*).—Cirques containing small glaciers just east of the Continental Divide, Rocky Mountain National Park. Taylor, Andrews, Tyndall, and several unnamed glaciers are visible in the northwest quadrant of photograph 2 B, and Longs Peak is in southeast quadrant. The Pinedale moraines surrounding Glacier Basin are in the southeast quadrant of photograph 2 D, and those in Moraine Park are conspicuous due east of the center. Horseshoe Park and Trail Ridge Road are in the north half of photograph 2 E.

Colo. 3. Hogbacks along Rocky Mountain front near Golden

County: Jefferson.
Lat 39°50′ N.; long 105°15′ W.
Number of photographs: 3.
Photograph scale: 1:63,360.
Focal length: 6 in.
Date flown: Sept. 21, 1953.
Map reference: U.S. Geol. Survey Ralston Buttes, Golden, Eldorado Springs, and Louisville 7½-min quadrangles, scale 1:24,000.
Geology reference: Van Horn, Richard, 1957, Bedrock geology of the Golden quadrangle, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ–103. Sheridan, D. M., Maxwell, C. H., Albee, A. L., and Van Horn Richard, 1958, Preliminary map of bedrock geology of the Ralston Buttes quadrangle, Jefferson County, Colorado: U.S. Geol. Survey Mineral Inv. Field Studies Map MF–179.

Features illustrated (*set nos. Colo. 3 A–C in southeast corner of photographs*).—Sandstone hogbacks are locally folded and faulted. These upper Paleozoic and Mesozoic rocks rest unconformably on Precambrian schist and gneiss. The ridge inclosing Upper Long Lake just east of the center of photograph 3 B is a monzonite dike. The hogback northeast of the dam is partly truncated by a pediment in the northeast quadrant of the same photograph. The butte northeast of Golden (southeast quadrant photograph 3 B) is capped by latite lavas; small monzonite intrusions form hills between it and the monzonite dike. Water in Ralston Reservoir (near center of photograph 3 B) is muddy.

Colo. 4. Imminent stream capture near Red Rock Canyon

County: Montrose.
Lat 38°34′ N.; long 107°47′ W.
Number of photographs: 2.
Photograph scale: 1:28,400.
Focal length: 6 in.
Date flown: Aug. 1, 1950.
Map reference: U.S. Geol. Survey Red Rock Canyon 7½-min quadrangle, scale 1:24,000.

Features illustrated (set nos. Colo. 4 A–B in northeast corner of photographs).—A cultivated valley drains northwestward to center of photograph 4 B where it crosses a major faultline and enters the head of Red Rock Canyon which empties into the Black Canyon of the Gunnison in the northwest quadrant. The northern half of photograph 4 B is underlain by Precambrian rocks that north of the Gunnison River show a vertical foliation and in the northwest quadrant are overlain unconformably by the Entrada Sandstone. The cultivated valley in the southeast quadrant is being encroached on by gullies eroding headward (northeastward) from the badlands developed on semiconsolidated Mancos Shale in the southwest quadrant. Stream capture is imminent at several points (W. R. Hansen, written commun., February 1964).

Colo. 5. Rock glaciers in Sawatch Range

County: Chaffee and Gunnison.
Lat 38°55′ N.; long 106°28′ W.
Number of photographs: 2.
Photograph scale: 1:18,400.
Date flown: Sept. 24, 1956.
Map reference: U.S. Geol. Survey Mount Harvard 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Colo. 5 A–B in northeast corner of photographs).—Rock glaciers in cirques on the north side of the Continental Divide show both longitudinal and transverse ridges and furrows. The glaciers are inactive. Some cirques contain rock-basin lakes or tarns. The bedrock is granodiorite (Fred Barker and M. R. Brock, written commun., February 1964).

Colo. 6. Linear scarps on the Sage Plain

County: Dolores.
Lat 37°48′ N.; long 108°59′ W.
Number of photographs: 2.
Photograph scale: 1:27,230.
Focal length: 5.2 in.
Date flown: Sept. 15, 1947.
Map reference: U.S. Geol. Survey Cortez sheet, scale 1:250,000.
Geology reference: Shawe, D. R., 1963, Possible wind-erosion origin of linear scarps of the Sage Plain, southwestern Colorado, *in* Short papers in geology and hydrology: U.S. Geol. Survey Prof. Paper 475–C, p. C138–C141, fig. 95.2.

Features illustrated (set nos. Colo. 6 A–B in southeast corner of photographs).—Low straight subparallel scarps in Pleistocene loess bound elongate flat areas oriented about N. 25° E. Swales between the flats are probably the result of deflation by the prevailing southwesterly winds.

Colo. 7. Canyons at Mesa Verde

County: Montezuma.
Lat 37°15′ N.; long 108°25′ W.
Number of photographs: 5.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Nov. 9, 1954.
Map reference: U.S. Geol. Survey topographic map of Mesa Verde National Park, Montezuma County, Colo., scale 1:31,250.
Geology reference: Wanek, A. A., 1959, Geology and fuel resources of the Mesa Verde area, Montezuma and La Plata Counties, Colorado: U.S. Geol. Survey Bull. 1072–M, p. 667–721; geol. map (pl. 49), scale 1:63,360.

Features illustrated (set nos. Colo. 7 A–E in southeast corner of photographs).—Mesa Verde is capped by massive sandstone that rests on less resistant sandstone, shale, and coal beds. The strata dip gently to the south and are of Late Cretaceous age. The great alcoves at the heads and along the sides of the canyons are sites of ancient cliff dwellings, none of which can actually be seen in these photographs. The canyons shallow northward and are cut off by a prominent north-facing escarpment that leads down to a broad valley along Dry Arroyo (northwest quadrant of photograph 7 D). The badlands south of the arroyo are carved in shale; the low wooded hills adjacent to the arroyo are sandstone that underlies the shale.

Colo. 8. Rock glaciers in Silver and Pierson Basins

County: Ouray and San Miguel.
Lat 37°58′ N.; long 107°43′ W.
Number of photographs: 3.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: Sept. 9, 1951.
Map reference: U.S. Geol. Survey Ironton, Telluride, Montrose, and Ouray 7½-min quadrangles, scale 1:24,000.
Geology reference: Burbank, W. S., and Luedke, R. G., 1964, Geology of the Ironton quadrangle: U.S. Geol. Survey Geol. Quad. Map GQ–291. Howe, Ernest, 1909, Landslides in the San Juan Mountains, Colorado: U.S. Geol. Survey Prof. Paper 67, 58 p.

Features illustrated (set nos. Colo. 8 A–C in northeast corner of photographs).—Many rock glaciers occur in the high cirques of the western San Juan Mountains. Those in Pierson Basin and in Silver Basin (southwest quadrant of photograph 8 C) adjacent to Sneffels Creek near Ouray were mapped and photographed many years ago by Howe who called them "rock streams." (See Howe, 1909, p. 31–34, fig. 2, and pls. 10–13). These lobate masses of rock debris are characterized by steep sides and deeply furrowed top with crescentic furrows roughly parallel to the outline of the mass. Some rock glaciers are known to have ice cores. The country rock is bedded volcanic flows, tuffs, and breccias intruded by numerous igneous dikes and irregularly shaped plutons and cut by many faults and mineralized fissures.

Colo. 9. Slumgullion earthflow

County: Hinsdale.
Lat 37°59′ N.; long 107°16′ W.
Number of photographs: 2.
Photograph scale: 1:40,000.
Focal length: 8.25 in.
Date flown: Sept. 27, 1951.
Map reference: U.S. Geol. Survey Durango sheet, scale 1:250,000.
Geology reference: Howe, Ernest, 1909, Landslides in the San Juan Mountains, Colorado: U.S. Geol. Survey Prof. Paper 67, p. 40–41, pl. 20*B*. Crandell, D. R., and Varnes, D. J., 1960, Slumgullion earthflow and earth slide near Lake City, Colorado [abs.]: Geol. Soc. America Bull., v. 71, no. 12, pt. 2, p. 1846.

Features illustrated (*set nos. Colo. 9 A–B in northeast corner of photographs*).—This prehistoric earthflow descended the east slope of the valley of Lake Fork Gunnison River and dammed this north-flowing river to form Lake San Cristobal. The lower downstream third of the earthflow is stable and contains wood that has a radiocarbon age of about 700 years. The upper two-thirds is being overridden by an active earthslide (northeast quadrant of photograph 9 A, largely outside area visible in stereo). The oldest tree found on the active part is 330 years old (1960).

Colo. 10. Great Sand Dunes, San Luis Valley

County: Saguache and Alamosa.
Lat 37°47′ N.; long 105°33′ W.
Number of photographs: 3.
Photograph scale: 1:53,000.
Focal length: 6 in.
Date flown: Oct. 5, 1953.
Map reference: U.S. Geol. Survey Trinidad sheet, scale 1:250,000.
Geology reference: Merk, G. P., 1960, Great Sand Dunes of Colorado, *in* Weimer, R. J., and Haun, J. D., eds., Guide to the geology of Colorado: Geol. Soc. America, Rocky Mtn. Assoc. Geologists, Colorado Sci. Soc., p. 127–129.

Features illustrated (*set nos. Colo. 10 A–C in southeast corner of photographs*).—The Great Sand Dunes lie near the east side of the broad San Luis Valley, separated from the west base of the Sangre de Cristo Mountains only by Medano Creek. The dunes cover approximately 40 square miles and rise as much as 700 feet above the valley floor. These photographs show the east part of the dune field and the lower slopes of the adjacent mountains. The sharp individual dune crests, and the many directions of their trends suggest variable winds.

Colo. 11. Radiating dikes on flanks of Silver Mountain

County: Huerfano.
Lat 37°37′ N.; long 105°04′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Date flown: Sept. 9, 1938.
Map reference: U.S. Geol. Survey Trinidad sheet, scale 1:250,000.
Geology reference: Johnson, R. B., 1961, Patterns and origin of radial dike swarms associated with West Spanish Peak and Dike Mountain, south-central Colorado: Geol. Soc. America Bull., v. 72, no. 4, p. 579–590; see fig. 3.

Features illustrated (*set nos. Colo. 11 A–B in southeast corner of photographs*).—Radial dike swarm on the northeast flank of Silver Mountain (Dike Mountain of Johnson; southwest corner of photograph 11 A). Trend of dikes ranges from east to west along the southern edge of area shown in photographs and from north to south along its western border. Dikes are discontinuous and form prominent ridges.

Colo. 12. intersecting dikes northeast of Spanish Peaks

County: Huerfano.
Lat 37°30′ N.; long 104°51′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 17, 1938.
Map reference: U.S. Geol. Survey Trinidad sheet, scale 1:250,000.
Geology reference: Johnson, R. B., 1961, Patterns and origin of radial dike swarms associated with West Spanish Peak and Dike Mountain, south-central Colorado: Geol. Soc. America Bull., v. 72, no. 4, p. 579–590.

Features illustrated (*set nos. Colo. 12 A–B in southeast corner of photographs*).—A large east-trending dike (northern half of photograph 12 B) cuts across older radial dikes that trend in a southwesterly direction. The bedrock is mostly competent sedimentary rocks of late Paleozoic and Mesozoic ages. Dikes form prominent ridges that control the drainage pattern.

Conn. 1. Triassic basalt ridges and border fault near Middletown

County: Middlesex.
Lat 41°33′ N.; long 72°40′ W.
Number of photographs: 4.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Oct. 29, 1959.
Map reference: U.S. Geol. Survey Meriden, Middletown, and Middle Haddam 7½-min quadrangles, scale 1:24,000.
Geology reference: Lehmann, E. P., 1959, The bedrock geology of the Middletown quadrangle: Connecticut Geol. and Nat. History Survey, Quad. Rept. 8, 40 p.; geol. map, scale 1:24,000.

Features illustrated (set nos. Conn. 1 A–D in northeast corner of photographs).—East-dipping Triassic basalt flows form wooded hills (eastern third of photograph 1 D) and are overlain by sedimentary rocks and minor basalt that extend east to a line about 2 miles east of Middletown on Connecticut River (east edge of photograph 1 C). The flooded building-stone quarries on the east bank of the river just north of the bridge are in arkose; they provided much of the brownstone used in New York City in the late 19th century. A conspicuous topographic break trending slightly east of north (west half of photograph 1 A) marks the trace of the fault between the Triassic rocks and the older gneisses and schists of the eastern highlands. Pegmatite quarries just east of the border fault show as white spots about 1½ inches southwest of the northeast corner of photograph 1 B. A drift-filled abandoned course of the Connecticut River, marked by a large kettle lake, trends north-northwest from the center of photograph 1 A.

Del. 1. Shoreline changes at Cape Henlopen

County: Sussex.
Lat 38°47′ N.; long 75°06′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Aug. 14, 1954, Mar. 15, 1962.
Map reference: U.S. Geol. Survey Cape Henlopen 7½-min quadrangle, scale 1:24,000.

Features illustrated (set nos. Del. 1 A–B in southeast corner of 1954 photographs and set nos. Del. 1 C–D in northwest corner of 1962 photographs).—Cape Henlopen spit, at the mouth of Delaware Bay opposite Cape May, N.J., has grown northward more than a mile since the area was first surveyed about 200 years ago. During this interval, the shore west of the cape moved northward perhaps a quarter of a mile, and the Atlantic shore was cut back about the same amount. During the more than 7-year interval between the 1954 and the 1962 photographs, the tip of the spit grew northward about 500 feet and the sand dunes on the Atlantic shore have advanced westward across the adjacent roads and trails. The photographs provide only partial stereoscopic coverage (D. W. Moody, written commun., 1964).

Fla. 1. Beach ridges, St. Vincent Island

County: Franklin.
Lat 29°40′ N.; long 85°10′ W.
Number of photographs: 2.
Photograph scale: 1:43,100.
Focal length: 5.2 in.
Date flown: Nov. 1, 1942.
Map reference: U.S. Geol. Survey Indian Pass and West Pass 7½-min quadrangles, scale 1:24,000.

Features illustrated (set nos. Fla. 1 A–B in northeast corner of photographs).—The island is made up entirely of beach ridges and intervening marsh. It has grown southward about 4 miles, during the present sea-level stand. The pattern of ridges suggests that three erosional intervals interrupted the process of island growth (C. A. Kaye, written commun., 1961).

Fla. 2. Tidal marsh and cypress swamp at mouth of Suwannee River

County: Dixie and Levy.
Lat 29°18′ N.; long 83°09′ W.
Number of photographs: 3.
Photograph scale: 1:32,800.
Focal length: 5.2 in.
Date flown: Mar. 26, 1951.
Map reference: U.S. Geol. Survey Suwannee and East Pass 7½-min quadrangles, scale 1:24,000.

Features illustrated (set nos. Fla. 2 A–C in northeast corner of photographs).—The Suwannee River empties into the sea through several distributaries. The land along the shore is a tidal marsh that is generally 1–2 miles wide and is traversed by intricately meandering tidal estuaries. Slightly higher and drier ground is cypress swamp. Similar cypress swamp, bordered to seaward by tidal marsh, forms a belt 5–10 miles wide along the coast of northwest Florida. Altitudes are generally not more than 6 feet (C. A. Kaye, written commun., 1961).

Fla. 3. Shoreline changes at Lacosta Island, 1944–60

County: Lee.
Lat 26°41′ N.; long 82°16′ W.
Number of photographs: 4.
Photograph scale: 1:20,000, 1944; 1:28,000, 1951, 1960; 1:62,000, 1950.
Date flown: 1944, 1950, 1951, 1960.
Map reference: U.S. Geol. Survey Port Boca Grande and Bokeelia 7½-min quadrangles, scale 1:24,000.

Features illustrated (set nos. Fla. 1 A, 1 C, and 1 D in southeast corner of photographs; set no. Fla. 1 B in northeast corner of photograph).—The island (1950 photograph) consists of several sets of beach ridges with small areas of mangrove swamp on its east side. In 1960, sediment was carried out through a gap in the barrier islands (Boca Grande, northwest quadrant of same photograph) and built a curved bar west of the island on Big Shoal. Comparison of the 1944 and 1951 photographs shows that during this 7-year interval the cuspate foreland on the gulf side of the island was prograded and the bar on Big Shoal was modified. The 1960 photograph, taken 2 months after hurricane Donna hit the coast, shows that part of the bar had moved considerably nearer to the island. The cuspate foreland had been eroded and curves northward. This erosion suggests the movement of sediment in that direction during the hurricane (M. T. El-Ashry, written commun., 1963).

269-086 O - 68 - 3

Ga. 1. Stone Mountain, a granitic dome

County: De Kalb.
Lat 33°48′ N.; long 84°09′ W.
Number of photographs: 2.
Photograph scale: 1:29,000.
Focal length: 6 in.
Date flown: Mar 9, 1955.
Map reference: U.S. Geol. Survey Stone Mountain 7½-min quadrangle, scale 1:24,000.
Geology reference: Hopson, C. A., 1958, Exfoliation and weathering at Stone Mountain, Georgia, and their bearing on disfiguration of the Confederate monument: Georgia Mineral Newsletter, v. 11, no. 3, p. 65–79.

Features illustrated (set ncs. Ga. 1 A–B in southeast corner of photographs).—This prominent granitic dome (muscovite-quartz monzonite) rises nearly 800 feet above the rolling Georgia piedmont. The dome is largely bare rock and no joints are visible. The rock has been quarried at the base of its south and east slopes. The Confederate Memorial on its north side is in shadow. The fact that the sheeting in the quartz monzonite, which cannot be seen in these photographs, conforms closely to the topography indicates that sheeting is caused by relief of primary confining pressure during unloading because of erosion.

Hawaii 1. Topographic contrasts on Kohala Mountain

County: Hawaii.
Lat 20°05′ N.; long 155°43′ W.
Number of photographs: 6.
Photograph scale: 1:45,000.
Focal length: 6 in.
Date flown: Oct. 14, 1944.
Map reference: U.S. Geol. Survey Honokane and Kamuela 7½-min quadrangles, scale 1:24,000.
Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1), scale 1:125,000.

Features illustrated (set nos. Hawaii 1 A–F in northwest corner of photographs).—This strip of six photographs extends from the wet northeast slope of Kohala Mountain, a 6,000-foot volcano, to its dry southwest slope. Just northeast of the summit on the windward side, the rainfall exceeds 400 inches a year, the slopes are heavily forested, and deep precipitous canyons extend to the coast. On the lee side of the crest the rainfall drops abruptly to less than 100 inches per year and decreases to less than 50 inches farther down the southwestern slope where the forest is absent and the small ephemeral streams are only slightly incised. Cinder cones mark the mountain crest.

Hawaii 2. Lava terrain on dry west coast of Island of Hawaii

County: Hawaii.
Lat 19°48′ N.; long 156°00′ W.
Number of photographs: 3.
Photograph scale: 1:42,000.
Focal length: 6 in.
Date flown: Oct. 1, 1954.
Map reference: U.S. Geol. Survey Makalawena and Kiholo 7½-min quadrangles, scale 1:24,000.
Geology reference: Wentworth, C. K., and Macdonald, G. A., 1953, Structures and forms of basaltic rocks in Hawaii: U.S. Geol. Survey Bull. 994, 98 p.

Features illustrated (set nos. Hawaii 2 A–C in southeast corner of photographs).—Flowing basaltic lava is usually concentrated into one or two main streams. Under certain conditions, fluid lava beneath the crusted surface may drain away and convert the channel into a tube. The course of such a tube in the southeast quadrant of photograph 2 B is marked by a line of holes through the roof. Aa lava, such as the Kaupulehu flow of 1801, is rough and rubbly, and it photographs dark. The surface of pahoehoe lava is continuous, though perhaps hummocky; it photographs light, although the rock itself is the same color as that in the aa flow.

The older flows support more vegetation than the younger flows in the same climatic zone. A single flow may be bare of vegetation in zones of low rainfall and densely covered in zones of high rainfall (southeast quadrant of photograph 2 A).

A sea cliff is cut on the 1801 flow as well as on older prehistoric flows.

Hawaii 3. East slope of Mauna Kea north of Wailuku River

County: Hawaii.
Lat 19°46′ N.; long 155°13′ W.
Number of photographs: 2.
Photograph scale: 1:44,200.
Focal length: 6 in.
Date flown: Oct. 14, 1954.
Map reference: U.S. Geol. Survey Piihonua 7½-min quadrangle, scale 1:24,000, and Honomu 15-min quadrangle, scale 1:62,500.
Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1), scale 1:125,000.

Features illustrated (set nos. Hawaii 3 A–B in northwest corner of photographs).—The eastern slope of Mauna Kea at altitudes from about 2,500 to 3,000 feet where rainfall ranges from 250 to 300 inches a year. The slope of the volcano has a well-integrated drainage system developed in Pahala Ash overlying basalt lava.

Hawaii 4. Coastal margin of Mauna Kea north of Hilo

County: Hawaii.
Lat 19°46′ N.; long 155°06′ W.
Number of photographs: 2.
Photograph scale: 1:45,000.
Focal length: 6 in.
Date flown: Oct. 14, 1954.
Map reference: U.S. Geol. Survey Hilo and Piihonua 7½-min quadrangles, scale 1:24,000, and Honomu 15-min quadrangle, scale 1:62,500.

Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1,) scale 1:125,000.

Features illustrated (set nos. Hawaii 4 A–B in northwest corner of photographs).—The eastern slope of Mauna Kea along the coast where rainfall ranges from 150 to 200 inches a year. Near the coast are many deep and steep-sided meandering canyons and a sea cliff, both carved in the Pahala Ash that overlies basalt. The sea cliff is about 100 feet high.

Hawaii 5. The undissected east slope of Mauna Loa near terminus of 1942 flow

County: Hawaii.
Lat 19°38′ N.; long 155°13′ W.
Number of photographs: 2.
Photograph scale: 1:44,200.
Focal length: 6 in.
Date flown: Oct. 14, 1954.
Map reference: U.S. Geol. Survey Piihonua and Puu Makaala 7½-min quadrangles, scale 1:24,000
Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1), scale 1:125,000.

Features illustrated (set nos. Hawaii 5 A–B in northwest corner of photographs).—The northeast slope of Mauna Loa at an altitude of 2,500–3,000 feet where rainfall ranges from 250 to 300 inches a year. The slope is mainly undissected. The rock is basalt. The terminus of the 1942 lava flow and of an older 1852 flow to the north are in the northwest quadrant of photograph 5 A.

Hawaii 6. Coastal margin of Mauna Loa south of Hilo

County: Hawaii.
Lat 19°41′ N.; long 155°01′ W.
Number of photographs: 2.
Photograph scale: 1:43,000.
Focal length: 6 in.
Date flown: Nov. 12, 1954.
Map reference: U.S. Geol. Survey Hilo and Keaau Ranch 7½-min quadrangles, scale 1:24,000.
Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1), scale 1:125,000.

Features illustrated (set nos. Hawaii 6 A–B in northwest corner of photographs).—The east slope of Mauna Loa near the coast where rainfall ranges from 150 to 200 inches a year. The east slope of the volcano lacks stream channels, and the coastline is smooth. The rock is basalt lava.

Hawaii 7. Fissure eruptions from southwest rift zone, Mauna Loa

County: Hawaii.
Lat 19°18′ N.; long 155°43′ W.
Number of photographs: 3.
Photograph scale: 1:41,200.
Focal length: 6 in.
Date flown: Oct. 1, 1954.
Map reference: U.S. Geol. Survey Mauna Loa and Honaunau 15-min quadrangles, scale 1:62,500.
Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1), scale 1:125,000. Finch, R. H., and Macdonald, G. A., 1953, Hawaiian volcanoes during 1950: U.S. Geol. Survey Bull. 996–B, 89 p.; geol. map (pl. 1), scale 1:190,000.

Features illustrated (set nos. Hawaii 7 A–C in southeast corner of photographs).—Hawaiian eruptions of basaltic lava commence with copious emission of gas-charged lava from long fissures or rifts. Several undated rift eruptions and parts of several historic eruptions came from the southwest rift zone of Mauna Loa that passes through the center of photograph 7 B. In the southwest quadrant, a row of 1919 cinder cones are west of the main rift zone and south of a line of pits (black dots in white area) that marks a lava tube. A line of black spatter cones on the main rift zone south of the 1919 cones marks the 1926 rift and associated lavas. The 1950 rift (black line in northeast quadrant) produced lava rivers that flowed westward. The 1950 flows are not shown on the topographic map which was surveyed in 1926. It is difficult to identify the ages of all the flows shown in these photographs without reference to plate 1 of Stearns and Macdonald and plate 1 of Finch and Macdonald.

Hawaii 8. Kilauea Caldera

County: Hawaii.
Lat 19°25′ N.; long 155°17′ W.
Number of photographs: 3.
Photograph scale: 1:35,000.
Focal length: 6 in.
Date flown: Oct. 14, Nov. 1, 1954.
Map reference: U.S. Geol. Survey Kilauea 15-min quadrangle, scale 1:62,500.
Geology reference: Macdonald, G. A., and Eaton, J. P., 1957, Hawaiian volcanoes during 1954: U.S. Geol. Survey Bull. 1061–B, p. 17–72; pl. 1, scale 1:24,000. Macdonald, G. A., and Hubbard, D. H., 1961, Volcanoes of the national parks in Hawaii [2d ed.]: Hawaii Nat. History Assoc., 41 p.; fig. 4, scale 1:62,500.

Features illustrated (set nos. Hawaii 8 A–C in southeast corner of photographs).—The summit caldera of Kilauea Volcano is bordered by fault scarps and floored by lava flows erupted within the last century. Along the western and northern edges are step faults. Near the southwest edge of the caldera floor is the "Fire Pit" Halemaumau, a crater about 500-feet deep that is the focus of Kilauea's eruptive activity. In these photographs the spatter cone of the 1952 eruption stands above the floor of Halemaumau, which is covered with lava formed in 1952 and 1954. A fissure that extends east-northeast from the northeast side of the crater fed the 1954 lava flow, whose dark color on the aerial photographs contrasts with the surrounding lighter colored weathered flows. Open fissures that extend southwest from Halemaumau are the surface expression of the north end of the southwest rift of Kilauea. Oblique view is northward; Mauna Kea is in the background.

Hawaii 9. Pit craters and lava lakes on flank of Kilauea Volcano

County: Hawaii.
Lat 19°22′ N.; long 155°09′ W.
Number of photographs: 2.
Photograph scale: 1:44,000.
Focal length: 6 in.
Date flown: Oct. 14, 1954.
Map reference: U.S. Geol. Survey Puna 15-min quadrangle, scale 1:62,500.
Geology reference: Stearns, H. T., and Macdonald, G. A., 1946, Geology and ground-water resources of the Island of Hawaii: Hawaii Div. Hydrography Bull. 9, 363 p.; geol. map (pl. 1), scale 1:125,000.

Features illustrated (*set nos. Hawaii 9 A–B in southeast corner of photographs.*)—The features visible on the photographs are as follows, listed from oldest to youngest: Flow of lava from forest-covered dome; summit of crater, Kane Nuio Hamo, near the center of northwest quadrant of photograph 9 A. Collapse of earliest Makaopuhi pit crater just south of dome. Lava from fissures forming an east-west-trending flow just north of pit craters; now covered by a dense single-species forest. Collapse of Napau pit crater (northeast quadrant of photograph 9 A). Another flow from fissures and into the Napau crater to form a lava lake now partly forested. Flow from area to the west covers the west edge of photograph 9 A and ends along the curved forest border that passes around the west edge of Makaopuhi pit crater; this flow also formed a lava lake in this pit that has since collapsed.

Hawaii 10. Flank eruptions near Kapoho, 1955 and 1960

County: Hawaii.
Lat 19°30′ N.; long 154°51′ W.
Number of photographs: 4.
Photograph scale: 1:43,000, 1954; 1:40,000, 1961.
Focal length: 6 in.
Date flown: Nov. 12, 1954, Feb. 4, 1961.
Map reference: U.S. Geol. Survey Makuu and Kalapana 15-min quadrangles, scale 1:62,500.
Geology reference: Macdonald, G. A., and Eaton, J. P., 1964, Hawaiian volcanoes during 1955: U.S. Geol. Survey Bull. 1171, 170 p.; map (pl. 1), scale 1:62,500. Richter, D. H., and Eaton, J. P., 1960, The 1959–60 eruption of Kilauea Volcano: New Scientist, v. 7, p. 994–997. Macdonald, G. A., 1962, The 1959–60 eruption of Kilauea Volcano, Hawaii, and the construction of walls to restrict the spread of lava flows: Bull. Volcanol. v. 24, p. 249–294; map (fig. 2).

Features illustrated (*set nos. Hawaii 10 A–B in northwest corner*).—The 1954 photographs show that the Kapoho-Cape Kumukahi region is an area of sugarcane fields and forest land. The town of Kapoho nestles on the north side of the prehistoric cone Kapoho on the edge of a shallow northeast-trending graben.

The 1961 photographs (*set nos. Hawaii 10 C–D in southeast corner*) show the same area ravaged by two flank eruptions of Kilauea Volcano. Between March 1 and 6, 1955, 36 million cubic yards of lava and cinders were erupted from vents west of the Kapoho cone (near center of west edge of photograph 10 D). This lava forms the Kii flow which covered 1,100 acres south of Kapoho (the dark area that extends east-west just south of cone). Between January 13 and February 20, 1960, 156 million cubic yards of lava were extruded from vents north and east of Kapoho; the lava covered 2,000 acres of land (in northeast quadrant of same photograph) and formed 500 acres of new land beyond the former coastline.

Idaho 1. Sand dunes on floor of Eagle Cove south of Snake River

County: Owyhee.
Lat 42°53′ N.; long 115°42′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 24, 1957.
Map reference: U.S. Geol. Survey Sand Dunes 7½-min quadrangle, scale 1:24,000.
Geology reference: Malde, H. E., Powers, H. A., and Marshall, C. H., 1963, Reconnaissance geologic map of west-central Snake River Plain, Idaho: U.S. Geol. Survey Misc. Geol. Inv. Map I–373.

Features illustrated (*set nos. Idaho 1 A–B in southeast corner of photographs*).—The most prominent feature of this small dune field is an irregular hill of bare sand, more than 450 feet high and about a mile long. The dunes rest on the flat floor of the cove, which is 2–3 miles across and is an embayment in the cliffs on the south side of the Snake River between Hammett and Bruneau. The sand comes from the flat upland surface west of the cove and about 350 feet above its floor.

Idaho 2. Patterns of mounds and stripes near Glenns Ferry

County: Elmore.
Lat 43°03′ N.; long 115°11′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 22, 1950.
Map reference: U.S. Geol. Survey King Hill 15-min quadrangle, scale 1:62,500.
Geology reference: Malde, H. E., 1964, Patterned ground in the western Snake River Plain, Idaho, and its possible cold-climate origin: Geol. Soc. America Bull., v. 75, p. 191–208; see pl. 1, fig. 1. Malde, H. E., Powers, H. A., and Marshall, C. H.,

1963, Reconnaissance geologic map of west-central Snake River Plain, Idaho: U.S. Geol. Survey Misc. Geol. Inv. Map I-373.

Features illustrated (set nos. Idaho 2 A–B in southeast corner of photographs).—A plateau of weathered basalt, smoothed by mass wasting, is marked by closely packed circular mounds of silt about 50 feet in diameter. These mounds are surrounded by a dark pavement of basalt rubble. An apron of basaltic colluvium along the southeast margin of the plateau is also marked with mounds, but these lie along downhill stripes of soil that alternate with stripes of rubble. The pattern of mounds, pavement, and stripes probably is a relict of a former periglacial climate. (Idaho 2 and 3 overlap.)

Idaho 3. Earthflow near King Hill

County: Elmore.
Lat 43°02′ N.; long 115°14′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 22, 1950.
Map reference: U.S. Geol. Survey King Hill 15-min quadrangle, scale 1:62,500.
Geology reference: Malde, H. E., Powers, H. A., and Marshall, C. H., 1963, Reconnaissance geologic map of west-central Snake River Plain, Idaho: U.S. Geol. Survey Misc. Geol. Inv. Map I-373.

Features illustrated (set nos. Idaho 3 A–C in southeast corner of photographs).—An earthflow covering about 2 square miles lies immediately north of King Hill in the southwest quadrant of photograph 3 B. It descended 1,000 feet to King Hill Creek, a tributary of the Snake River, and came to rest on unconsolidated sand and gravel that had been previously deposited by catastrophic outflow from Pleistocene Lake Bonneville. Well-defined slump blocks, still capped by basalt, are conspicuous features in the upper part of this landslide. Patterned ground is visible on top of the basalt mesa. (Idaho 2 and 3 overlap.)

Idaho. 4. Gravel bars and scabland near King Hill

County: Elmore.
Lat 42°58′ N.; long 115°11′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 22, 1950.
Map reference: U.S. Geol. Survey Pasadena Valley 7½-min quadrangle, scale 1:24,000.
Geology reference: Malde, H. E., Powers, H. A., and Marshall, C. H., 1963, Reconnaissance geologic map of west-central Snake River Plain, Idaho: U.S. Geol. Survey Misc. Geol. Inv. Map I-373. Malde, H. E., 1960, Evidence in the Snake River Plain, Idaho, of a catastrophic flood from Pleistocene Lake Bonneville, *in* Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper 400-B, p. B295-B297.

Features illustrated (set nos. Idaho 4 A–C in southeast corner of photographs).—The surface of a basalt flow between Snake River and the railroad (east part of photograph 4 B) has potholes and other scour features caused by passage of a gigantic flood when Pleistocene Lake Bonneville overflowed into Snake River near Preston. Farther downstream (The Pasture, northeast quadrant of same photograph), streamlined bars of basaltic gravel overlie the basalt. West of the river, in the southern part of photograph 4 B, enormous bars of boulder gravel form a high bench separated from the west wall of the canyon by a marginal channel—Pasadena Valley—floored with fine-grained deposits.

Idaho 5. Rift zone, Craters of the Moon

County: Butte.
Lat 43°27′ N.; long 113°34′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 23, 1959.
Map reference: U.S. Geol. Survey Craters of the Moon National Monument, Idaho, scale 1:31,680.
Geology reference: Stearns, H. T., Crandall, Lynn, and Steward, W. G., 1938, Geology and ground-water resources of the Snake River Plain in southeastern Idaho: U.S. Geol. Survey Water-Supply Paper 774, 268 p.; geol. map (pl. 13), scale 1:47,500.

Features illustrated (set nos. Idaho 5 A–C in southeast corner of photographs).—Basaltic cinder cones, many of which are alined along a northwest-trending rift zone, have conspicuous craters of various sizes. In places the rift zone is marked by a line of small spatter cones (near center of photograph 5 B). The craters are surrounded by dark-toned basalt flows that issued from the rift zone. Older basalt flows, in part covered by vegetation, are in the north half of photograph 5 A.

Idaho 6. Patterned alluvial fans near Mackay

County: Custer and Butte.
Lat 43°47′ N.; long 113°29′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 1, 1946.
Map reference: U.S. Geol. Survey Idaho Falls sheet, scale 1:250,000.
Geology reference: Malde, H. E., 1964, Patterned ground in the western Snake River Plain, Idaho: Geol. Soc. America Bull., v. 75, no. 3, p. 191-208.

Features illustrated (set nos. Idaho 6 A–B in southeast corner of photographs).—Dissected gravel fans that border the Big Lost River valley near Mackay are marked with a distinct pattern of silt mounds that may represent the effects of a former periglacial climate. Similar features are described by Malde (1964).

Idaho 7. Menan Buttes

County: Madison.
Lat 43°47′ N.; long 111°58′ W.
Number of photographs: 3.
Photograph scale: 1:25,000.
Focal length: 6 in.
Date flown: Oct. 8, 1950.
Map reference: U.S. Geol. Survey Menan Buttes 7½-min quadrangle, scale 1:24,000.
Geology reference: Hamilton, Warren, and Myers, W. B., 1963, Menan Buttes, cones of glassy basalt tuff in the Snake River Plain, Idaho, *in* Short papers in geology, hydrology, and topography: U.S. Geol. Survey Prof. Paper 450–E, p. E114–E118.

Features illustrated (*set nos. Idaho 7 A–C in southeast corner of photographs*).—The Menan Buttes are two cones of basalt tuff that rise from a surface of Recent basalt flows on the Snake River Plain 20 miles north of Idaho Falls. Asymmetry of the Menan Buttes demonstrates northeastward drift of pyroclastic ejecta parallel to the prevailing winds. The cones were built by small fragments of solid glass that were erupted explosively within the craters and then fell to form the inner walls of the craters as well as the outer slopes of the cones. The meandering channel of Snake River and its wooded flood plain are also well shown on these photographs.

Ill. 1. Hicks Dome

County: Hardin.
Lat 37°32′ N.; long 88°23′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 12, 1952.
Map reference: U.S. Geol. Survey Karbers Ridge and Herod 7½-min quadrangles, scale 1:24,000.
Geology reference: Snyder, F. G., and Gerdemann, P. E., 1965, Explosive igneous activity along an Illinois-Missouri-Kansas axis: Am. Jour. Sci., v. 263, p. 465–493; geol. map (fig. 2), scale 1:186,500.

Features illustrated (*set nos. Ill. 1 A–B in southeast corner of photographs*).—Hicks Dome, a low wooded limestone hill, is surrounded by an oval-shaped shale valley about 2 miles in longest diameter. These Devonian limestones include several explosion breccias or diatremes (not visible on photographs). A collar of wooded hills carved in outward-dipping Pennsylvanian sedimentary rocks surrounds the valley.

Ind. 1. Indiana sand dunes

County: Porter.
Lat 41°39′ N.; long 87°04′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 8, 1954.
Map reference: U.S. Geol. Survey Dune Acres 7½-min quadrangle, scale 1:24,000.
Geology reference: Cressey, G. B., 1928, The Indiana sand dunes and shorelines of the Lake Michigan basin: Geog. Soc. Chicago Bull. 8, 80 p.

Features illustrated (*set nos. Ind. 1 A–B in southeast corner of photographs*).—A belt of dunes about half a mile wide lies along the shore of Lake Michigan, between the beach and the marsh that separates the dunes from an older beach and dune ridge that is closely followed by highway and railroad. The dunes rise as much as 180 feet above the lake; in places a foredune—a discontinuous ridge—is adjacent to and parallel with the beach. The dunes on the shore are forested except for blowouts or great tongues of bare sand that project inland.

Ind. 2. Point bar on Ohio River flood plain near Henderson

County: Vanderburgh and Henderson.
Lat 37°52′ N.; long 87°38′ W.
Number of photographs: 4.
Photograph scale: 1:28,400.
Focal length: 6 in.
Date flown: Apr. 16, 1950.
Map reference: U.S. Geol. Survey Wilson, Henderson, West Franklin, and Evansville 7½-min quadrangles, scale 1:24,000.

Features illustrated (*set nos. Ind. 2 A–D in northeast corner of photographs*).—In the photographs, the meandering Ohio River flows from right to left. The entire area is covered by river alluvium except for loess-mantled hills in the northeast corner of photograph 2 D and except for dune sand along the river under the city of Henderson. The flood plain on the right bank of the river is a large point bar with two distinct patterns of low swell and swale topography. Configuration of the swells and swales in the central and east part of the point bar indicates a lateral southward movement of the river. Bedrock at Henderson has now deflected the river, and lateral cutting and building of the point bar, which have been concentrated on the southwest side, have formed a series of swells and swales at variance with the earlier ones. (L. L. Ray, written commun., 1965).

Iowa 1. Topographic discontinuities of the Des Moines lobe

County: Buena Vista.
Lat 42°38′ N.; long 95°12′ W.
Number of photographs: 3.
Photograph scale: 1:70,000.
Focal length: 6 in.
Date flown: Sept. 23, 1950.
Map reference: U.S. Geol. Survey Fort Dodge sheet, scale 1:250,000.
Geology reference: Ruhe, R. V., 1952, Topographic discontinuities of the Des Moines lobe: Am. Jour. Sci., v. 250, p. 46–56, fig. 2.

Features illustrated (*set nos. Iowa 1 A–C in northeast corner of photographs*).—Cultivated fields on poorly drained Cary drift (north half of photograph 1 B) have a mottled appearance that is lacking on the better drained Tazewell drift (south half of photograph 1 A) where the individual fields appear sharp and clear. The contact between the two drifts closely follows the railroad that runs northward from the south edge of the photographs to encircle Storm Lake and continue on in a northwest direction. There is also a difference in degree of integration of drainage between the area mantled by Tazewell drift and that mantled by Cary drift. The Tazewell surface has a high drainage density compared with that of the Cary drift. This contrast is, however, not obvious on these photographs.

Iowa 2. Paha in Benton County

County: Benton.
Lat 42°11′ N.; long 92°14′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 14, 1963.
Map reference: U.S. Geol. Survey Waterloo sheet, scale 1:250,000.
Geology reference: Scholtes, W. H., 1955, Properties and classification of the paha loess-derived soils in northeastern Iowa: Iowa State Coll. Jour. Sci., v. 30, no. 2, p. 163–209.

Features illustrated (set nos. Iowa 2 A–B in southeast corner of photographs).—According to Scholtes (see his fig. 6), two northwest-trending ridges, or paha, are in the southeast quadrant of photograph 2 A. The wooded area is an irregularly shaped paha, and a second cultivated ridge is just north of the woods, largely between the railroad and the section-line road that almost exactly bisects the north and south halves of the same photograph. The northern paha is covered with loess except for two small outcrops of Kansan till. The plain around the paha is Iowan drift with patches of loess.

Iowa 3. Paha near Vinton

County: Benton.
Lat 42°11′ N.; long 92°10′ W.
Number of photographs: 3.
Photograph scale: 1:70,000.
Focal length: 6 in.
Date flown: Oct. 18, 1950.
Map reference: U.S. Geol. Survey Waterloo sheet, scale 1:250,000.
Geology reference: Scholtes, W. H., 1955, Properties and classification of the paha loess-derived soils in northeastern Iowa: Iowa State Coll. Jour. Sci., v. 30, no. 2, p. 163–209; see fig. 3.

Features illustrated (set nos. Iowa 3 A–C in northeast corner of photographs).—A group of loess-covered ridges that have a pronounced northwest trend, are on the Iowan drift plain just west of Vinton on Cedar River (near the center of photograph 3 C) and are shown in figure 3 of Scholtes' paper. (Iowa 2 covers area in southwest quadrant of Iowa 3 A.)

Kans. 1. Changes in channel of Cimarron River near Rolla, 1936–60

County: Morton.
Lat 37°13′ N.; long 101°38′ W.
Number of photographs: 6.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 23, 1936, and June 29, 1960.
Map reference: U.S. Geol. Survey Dodge City sheet, scale 1:250,000.
Geology reference: Schumm, S. A., and Lichty, R. W., 1963, Channel widening and flood-plain construction along Cimarron River in southwestern Kansas: U.S. Geol. Survey Prof. Paper 352–D, p. 71–88, fig. 48A.

Features illustrated (set nos. Kans. 1 A–F in southeast corner of photographs).—These two triplets show a narrowing of the channel and a growth of vegetation on the flood plain along the Cimarron River north of Rolla, Kans., that took place between 1936 and 1960. West of the bridge along State Route 51, the channel had an average width of about 2,500 feet in 1936 and of about 800 feet in 1960. This change occurred during a period of above-average annual precipitation and floods of low to moderate peak discharge. Vegetation became established in the wide sandy channel and aided deposition and flood-plain formation.

Kans. 2. Flat-lying limestone and shale in the Flint Hills

County: Pottawatomie.
Lat 39°17′ N.; long 96°33′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 18, 1937.
Map reference: U.S. Geol. Survey Manhattan sheet, scale 1:250,000.
Geology reference: Scott, G. R., Foster, F. W., Crumpton, C. F., 1959, Geology and constructional material resources of Pottawatomie County, Kansas: U.S. Geol. Survey Bull. 1060–C, p. 97–178; geol. map (pl. 2), scale 1:62,500.

Features illustrated (set nos. Kans. 2 A–B in southeast corner of photographs).—Flat-lying cherty limestone and shale of Permian age in northeast Kansas. The white bands are outcrops of limestone; the wider gray bands are intervening beds of shale. Area is prairie; trees grow only in valleys on the banks of Cedar Creek and its tributaries that are incised below the Flint Hills Upland.

Ky. 1. Sand Ridge at Flaherty

County: Meade and Hardin.
Lat 37°49′ N.; long 86°04′ W.
Number of photographs: 3
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: Jan. 25, 1960.
Map reference: U.S. Geol. Survey Flaherty 7½-min quadrangle, scale 1:24,000.

Geology reference: Swadley, W. C., 1963, Geology of the Flaherty quadrangle, Kentucky: U.S. Geol. Survey Geol. Quad. Map. GQ–229.

Features illustrated (set nos. Ky. 1 A–C in southeast corner of photographs).—The sandstone member of the Mooretown Formation (Mississippian) was deposited in a large channel cut deeply into the underlying Ste. Genevieve Limestone and St. Louis Limestone. Erosion has transformed the sandstone member into Sand Ridge, which south of Flaherty is largely wooded. East of the town, the ridge is less prominent and largely bare of trees. The low rolling hills and flats with numerous broad shallow sinkholes west of the longitude of Flaherty are on the Ste. Genevieve Limestone. East of the line, the underlying St. Louis Limestone is marked by many small and deep sinks, except for a very broad sink (or valley) floored with alluvium near the center of photograph 1 A.

Ky. 2. Sinkholes in cherty limestone near Bristow

County: Warren.
Lat 37°02′ N.; long 86°16′ W.
Number of photographs: 2.
Photograph scale: 1:18,000.
Focal length: 6 in.
Date flown: Feb. 12, 1954.
Map reference: U.S. Geol. Survey Bristow 7½-min quadrangle, scale 1:24,000.
Geology reference: Gildersleeve, Benjamin, 1963, Geology of the Bristow quadrangle, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–216.

Features illustrated (set nos. Ky. 2 A–B in northeast corner of photographs).—Broad and shallow sinkholes in the north half of photograph 2 A have been formed in the Ste. Genevieve Limestone. The smaller deeper more steep sided and more abundant sinkholes in the southern half of the exposure are in St. Louis Limestone. Outcrops are scarce. The Ste. Genevieve Limestone, largely concealed beneath a weathered residuum containing chert blocks as much as 2 feet in maximum diameter, is a thick-bedded and oolitic limestone interbedded with nonoolitic lithographic to coarse-grained limestone. The St. Louis Limestone, covered in most places by a thick residuum of clay containing abundant chert nodules, is a cherty lithographic to coarse-grained thin- to medium-bedded limestone.

Ky. 3. Cedar Sink

County: Edmonson.
Lat 37°10′ N.; long 86°10′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Mar. 19, 1953.
Map reference: U.S. Geol. Survey Rhoda 7½-min quadrangle, scale 1:24,000.
Geology reference: Klemic, Harry, 1963, Geology of the Rhoda quadrangle, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–219.

Features illustrated (set nos. Ky. 3 A–C in northeast corner of photographs).—The narrow flood plain of the meandering Green River is carved in virtually flat-lying Upper Mississippian limestones (Girkin Formation and Ste. Genevieve Limestone). The upper walls of Green River valley are composed of thick beds of sandstone with interbedded limestone. A stream heading in the southwest corner of photograph 3 B flows northeastward for about 2 miles to end in a sinkhole about half a mile from Green River and at about the same altitude. In the southeast quadrant of the same photograph, another large valley with gently sloping sides (Smith Valley) and no surface drainage contains a small steep-sided deep sinkhole (Cedar Sink) whose floor is also at about the same altitude as Green River.

Ky. 4. Karst near Park City

County: Edmonson and Barren.
Lat 37°06′ N.; long 86°05′ W.
Number of photographs: 2.
Photograph scale: 1:18,000.
Focal length: 6 in.
Date flown: Feb. 22, 1954.
Map reference: U.S. Geol. Survey Park City 7½-min quadrangle, scale 1:24,000.
Geology reference: Haynes, D. D., 1962, Geology of the Park City quadrangle, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–183.

Features illustrated (set nos. Ky. 4 A–B in northeast corner of photographs).—In the southern half of the photographs, the St. Louis Limestone underlies a well-developed karst area consisting of abundant small closely spaced and deep sinkholes. The larger shallower and less abundant sinks to the north are in the overlying Ste. Genevieve Limestone. The wooded hills have sandstone caps (Big Clifty Sandstone Member of Golconda Formation).

La. 1. Poverty Point archaeologic site on terrace along Bayou Macon

County: West Carroll and East Carroll Parishes.
Lat 32°38′ N.; long 91°24′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Nov. 11, 1960.
Map reference: U.S. Geol. Survey Mitchiner 15-min quadrangle, scale 1:62,500.
Geology reference: Fisk, H. N., 1944, Geological investigations of the alluvial valley of the lower Mississippi River: Vicksburg, Miss., Mississippi River Comm., 78 p.; see pl. 15, sheet 3, scale 1:250,000. Ford, J. A., and Webb, C. H., 1956, Poverty Point, a late Archaic site in Louisiana: Am. Mus. Nat. History Anthropol. Papers, v. 46, pt. 1, 136 p.

Features illustrated (set nos. La. 1 A–C in southeast corner of photographs).—The Poverty Point archaeologic site is on a flat terrace separated by a 15-foot bluff from Bayou Macon to the east. The most prominent topographic feature at the site is an artificial mound more than 50 feet high, but the most conspicuous pattern on these photographs are six concentric artificial earth ridges that form about half of a large octagon (northwest quadrant of photograph 1 B. The site lies on the edge of a flat plain that is a remnant of an alluvial fan of the Arkansas River (Fisk's stage A–1). The plain east of the bayou about 15 feet below the fan's surface is the remnant of a younger flood plain cut by the Arkansas River (Fisk's stage H). Joes Bayou (east edge of photographs 1 B and 1 C) is the trace of a still younger, meandering channel of the river (Fisk's stage 1). The archaeologists believe that the bluff along Bayou Macon was cut after the earthworks were constructed. This cut erased half of what may have once been a complete octagonal figure. Thus the earthworks were made prior to stage H. Fisk estimated the age of stage H as from 2,000 to 3,000 years. Radiocarbon age determinations suggest that the cultural levels at the Poverty Point site are from 2,550 to 2,750 years old.

La. 2. Point bars and natural levees along Walnut Bayou

County: Madison Parish.
Lat 32°20′ N.; long 91°06′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: May 17, 1956.
Map reference: U.S. Geol. Survey Talla Bena 15-min quadrangle, scale 1:62,500.
Geology reference: Fisk, H. N., 1944, Geological investigations of the alluvial valley of the lower Mississippi River: Vicksburg, Miss., Mississippi River Comm., 78 p.; see pl. 22, sheet 11, scale 1:62,500.

Features illustrated (set nos. La. 2 A–C in southeast corner of photographs).—Walnut Bayou, bordered by natural levees, runs northwest across northeast quadrant of photograph 2 B and is a segment of an ancient meandering channel or point bar of the Mississippi River (stage 11 of Fisk). Scrolls related to slightly older channels are visible northeast of the bayou (stages 9 and 10). Faint scrolls of still older channels (stages 5–7) trend north-northeast in northwest quadrant of photograph 2 B.

The wooded Indian mounds in fields just southwest of the bayou (east of center of photograph 2 B) are the Fitzhugh archaeologic site; this site must be younger than Fisk's stage 11, which he estimates at perhaps not more than 1,000 years old.

La. 3. Chenier plain and Calcasieu Pass at Cameron

County: Cameron Parish.
Lat 29°47′ N.; long 93°20′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Apr. 5, 1957.
Map reference: U.S. Geol. Survey Cameron 7½-min quadrangle, scale 1:24,000.
Geology reference: Byrne, T. V., LeRoy, D. O., Riley, C. M., 1959, The Chenier Plain and its stratigraphy, southwestern Louisiana: Gulf Coast Assoc. Geol. Soc. Trans., v. 9, p. 237–260. Gould, H. R., and McFarlan, E., Jr., 1959, Geologic history of the Chenier Plain, southwestern Louisiana: Gulf Coast Assoc. Geol. Soc. Trans., v. 9, p. 261–270.

Features illustrated (set nos. La. 3 A–C in southeast corner of photographs).—These curving beach ridges or cheniers record progressive changes in the configuration of the shoreline as it advanced seaward during the last 3,000 years. The cheniers are lenticular sand and shell bodies, averaging about 300 feet across, as much as 7 feet thick, and as much as 30 miles long, that rest on finer sediment and are overlapped by marsh deposits. They rise from a few inches to 10 feet above the marsh. Radiocarbon dating indicates that the wide beach ridge in the northeast corner of photograph 3 A was part of the shoreline 2,100–2,200 years ago and that the cheniers become progressively younger seaward. The prominent one just back of the modern beach and adjacent mudflat is dated at 600–800 years before present.

La. 4. Mississippi delta: Levees and abandoned distributaries

County: Plaquemines Parish.
Lat 29°43′ N.; long 89°59′ W
Number of photographs: 1.
Photograph scale: 1:30,000.
Focal length: 6 in.
Date flown: Feb. 22, 1956.
Map reference: U.S. Geol. Survey Pointe a la Hache 15-min quadrangle, scale 1:62,500.
Geology reference: Welder, F. A., 1959, Processes of deltaic sedimentation in the lower Mississippi River: Louisiana State Univ., Coastal Studies Inst., Tech. Rept. 12, 90 p.; see fig. 5.

Features illustrated (set no. La. 4 in southeast corner of photograph).—Levee west of river attains a width of about 1 mile and stands about 5 feet above the river. Except where cleared by man, the levee is wooded. East of the river are several abandoned distributaries, such as River Aux Chenes in the northeast quadrant of the photograph.

La. 5. Mississippi delta: Dry Cypress Bayou, an inactive distributary

County: Plaquemines Parish.
Lat 29°15′ N.; long 89°31′ W.
Number of photographs: 1.
Photograph scale: 1:30,000.

Focal length: 6 in.
Date flown: Mar. 25, 1956.
Map reference: U.S. Geol. Survey Empire and Venice 15-min quadrangles, scale 1:62,500.
Geology reference: Welder, F. A., 1959, Processes of deltaic sedimentation in the lower Mississippi River: Louisiana State Univ., Coastal Studies Inst., Tech. Rept. 12, 90 p.; see fig. 7.

Features illustrated (set no. La. 5 in southeast corner of photograph).—This bayou, the last (southernmost) major abandoned distributary branching from the right bank of the Mississippi, flowed almost due south to the coast. Its mouth has been entirely closed, although a tidal channel connects it to Bay Coquette (southeast quadrant). This photograph shows only the last 4 miles of the bayou.

La. 6. Mississippi delta: Mangrove swamp and tidal estuaries near Grand Bay

County: Plaquemines Parish.
Lat 29°23′ N.; long 89°23′ W.
Number of photographs: 1.
Photograph scale: 1:30,000.
Focal length: 6 in.
Date flown: Mar. 25, 1956.
Map reference: U.S. Geol. Survey Venice 15-min quadrangle, scale 1:62,500.
Geology reference: Welder, F. A., 1959, Processes of deltaic sedimentation in the lower Mississippi River: Louisiana State Univ., Coastal Studies Inst., Tech. Rept. 12, 90 p.; see fig. 9.

Features illustrated (set no. La. 6 in southeast corner of photograph).—Mangrove swamp (dark areas) along the shore, tidal marsh cut by meandering estuaries, and straight artificial channels. The area is subsiding. Incipient beaches on part of coast. Grand Bay is in southeast quadrant.

La. 7. Mississippi delta: Cubits Gap

County: Plaquemines Parish.
Lat 29°12′ N.; long 89°14′ W.
Number of photographs: 1.
Photograph scale: 1:30,000.
Focal length: 6 in.
Date flown: Mar. 25, 1956.
Map reference: U.S. Geol. Survey West Delta and East Delta 15-min quadrangles, scale 1:62,500.
Geology reference: Welder, F. A., 1959, Processes of deltaic sedimentation in the lower Mississippi River: Louisiana State Univ., Coastal Studies Inst., Tech. Rept. 12, p. 25–38.

Features illustrated (set no. La. 7 in northwest corner of photograph).—Pilottown (southwest quadrant) stands on the natural levee on the left (east) bank of the Mississippi River. A crevasse that opened in this levee about a century ago, northwest of Pilottown and about 3 miles upstream from Head of Passes (south edge of photograph), is now Cubits Gap (northwest quadrant). Three distributaries diverge from Cubits Gap: Main Pass which runs north from the main channel, Octave Pass which trends northeast, and Raphael Pass which flows east. Mississippi sediment carried by these distributaries has converted more than 100 square miles of the Gulf of Mexico into land and fresh-water lakes. The mouths of several distributaries fed by Octave Pass are shown in La. 8.

La. 8. Mississippi delta: Mouth of Dead Women Pass

County: Plaquemines Parish.
Lat 29°14′ N.; long 89°08′ W.
Number of photographs: 1.
Photograph scale: 1:30,000.
Focal length: 6 in.
Date flown: Feb. 23, 1956.
Map reference: U.S. Geol. Survey East Delta and Breton Island 15-min quadrangles, scale 1:62,500.
Geology reference: Welder, F. A., 1959, Processes of deltaic sedimentation in the lower Mississippi River: Louisiana State Univ., Coastal Studies Inst., Tech. Rept. 12, 90 p.

Features illustrated (set no. La. 8 in southeast corner of photograph).—Area of active sedimentation near mouth of Dead Women Pass (northeast quadrant). Beaches are virtually absent. Area is a network of large and small distributaries bordered by marsh, which encloses many fresh-water ponds. These passes discharge part of the water that flows through Cubits Gap shown in La. 7. Most of the land shown in this photograph has been built since about 1900.

La. 9. Mississippi delta: Southwest Pass

County: Plaquemines Parish.
Lat 28°57′ N.; long 89°23′ W.
Number of photographs: 2.
Photograph scale: 1:30,000.
Focal length: 6 in.
Date flown: Mar. 25, 1956.
Map reference: U.S. Geol. Survey Southwest Pass 15-min quadrangle, scale 1:62,500.
Geology reference: Welder, F. A., 1959, Processes of deltaic sedimentation in the lower Mississippi River: Louisiana State Univ., Coastal Studies Inst., Tech. Report. 12, 90 p.

Features illustrated (set nos. La. 9 A–B in southeast corner of photographs).—These two photographs show the lower 7 miles of the pass but do not provide stereoscopic coverage. The land areas are largely marsh. Jetties extend from the mouth of the pass for nearly 2 miles beyond limit of the marsh.

Maine 1. Cirques on Mount Katahdin

County: Piscataquis.
Lat 45°55′ N.; long 68°55′ W.
Number of photographs: 3.
Photograph scale: 1:63,000.
Focal length: 6 in.
Date flown: June 30, 1952.
Map reference: U.S. Geol. Survey Katahdin, Harrington Lake, Telos Lake, and Traveler Mountain 15-min quadrangles, scale 1:62,500.

Geology reference: Caldwell, D. W., 1960, The geology of Baxter State Park and Mount Katahdin: Maine Geol. Survey State Park Geol. Ser. 2, 54 p.; map, scale 1:284,000.

Features illustrated (set nos. Maine 1 A–C in southeast corner of photographs).—Mount Katahdin rises 2,000–4,000 feet above the surrounding lowlands. The mountain, made of granite, has a broad gently sloping summit upland that is cut into by prominent glacial cirques (southeast quadrant of photograph 1 B). Some of the cirque headwalls form arêtes or knife-edge ridges. Small north-trending moraines dam four small ponds about 2 miles northeast of the highest peaks. Landslides scar the slopes of the mountains on west side of photograph 1 B (Mount Coe and South Brother). In the western part of the same photograph, the light-colored curving bands on the slopes in forested areas are blown-down trees attributed to the 1938 hurricane. It is not clear why the areas of blown-down trees occur in bands.

Maine 2. The Horseback along Sunkhaze Stream

County: Hancock.
Lat 44°57′ N.; long 68°25′ W.
Number of photographs: 3.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: May 1, 1956.
Map reference: U.S. Geol. Survey Great Pond 15-min quadrangle, scale 1:62,500.
Geology reference: Stone, G. H., 1899, The glacial gravels of Maine: U.S. Geol. Survey Mon. 34, p. 108 and pl. 42. Leavitt, H. W., and Perkins, E. H., 1935, Glacial geology of Maine: Maine Tech. Expt. Sta. Bull. 30, v. 2. Mon. 34, out of print.

Features illustrated (set nos. Maine 2 A–C in northeast corner of photographs).—This gravel ridge—an ice-channel filling or esker—crosses the area from northwest to southeast. It is virtually continuous, as much as 70 feet high, and is bordered by swamps and, locally, by kames. The adjacent rounded hills are of granitic rock.

Maine 3. Somes Sound and Sargent Mountain, Mount Desert Island

County: Hancock.
Lat 44°20′ N.; long 68°17′ W.
Number of photographs: 3.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: May 7, 1956.
Map reference: U.S. Geol. Survey Mount Desert and Bar Harbor 15-min quadrangles, scale 1:62,500.
Geology reference: Chapman, C. A., 1962, The geology of Mount Desert Island, Maine, with explanation and descriptive field guide: Ann Arbor, Mich., Edwards Bros., 52 p. Chapman, C. A., and Rioux, R. L., 1958, Statistical study of topography, sheeting, and jointing in granite, Acadia National Park, Maine: Am. Jour. Sci., v. 256, p. 111–127.

Features illustrated (set nos. Maine 3 A–C in northeast corner of photographs).—This island, largely of granitic rock, is cut by through-going U-shaped glacial valleys containing many small rock-basin lakes. These photographs include a segment of the more rugged part of the island. Sargent Mountain (northeast quadrant of photograph 3 B) rises more than 1,300 feet above Somes Sound, a small fiord (west edge of same exposure). Preglacial valleys trending just east of north were scoured and reshaped by glaciers moving across the island from the northwest, so the dominant trend of valley and ridge is now slightly west of north. Many ridges are asymmetric and have steeper slopes on their east side (Norumbega Mountain, southwest quadrant of photograph 3 B).

Md. 1. Falls of the Potomac

County: Montgomery and Fairfax.
Lat 39°00′ N.; long 77°15′ W.
Number of photographs: 4.
Photograph scale: 1:19,000.
Focal length: 6 in.
Date flown: Mar. 18, 1963.
Map reference: U.S. Geol. Survey Seneca, Rockville, Vienna, and Falls Church 7½-min quadrangles, scale 1:24,000.
Geology reference: Reed, J. C., Jr., and Jolly, Janice, 1963, Crystalline rocks of the Potomac River gorge near Washington, D.C.: U.S. Geol. Survey Prof. Paper 414–H, p. H1–H15; geol. map (pl. 2), scale 1:12,000.

Features illustrated (set nos. Md. 1 A–D in southeast corner of photographs).—The photographs show Great Falls (white water in northeast quadrant of photograph 1 B) and a narrow gorge downstream. Bear Island, a narrow rocky belt, lies east of the gorge between it and the Chesapeake and Ohio Canal. West of the river is an abandoned channel. The rock is a bedded sequence of mica schist and quartzite that has interlayered amphibolite exposed in a series of nearly isoclinal folds. The gorge of the Potomac River that marks the Fall Zone begins at Great Falls in the Piedmont province and extends southeastward for about 10 miles to the inner edge of the coastal plain near Washington. The flow of the river on the date the photographs were taken was about 43,500 cubic feet per second, 4 feet below flood stage.

Md. 2. Scientists Cliffs

County: Calvert.
Lat 38°31′ N.; long 76°31′ W.
Number of photographs: 3.
Photograph scale: 1:28,400.
Focal length: 6 in.
Date flown: Dec. 17, 1953.
Map reference: U.S. Geol. Survey Prince Frederick 7½-min quadrangle, scale 1:24,000.
Geology reference: Clark, W. B., Shattuck, G. B., and Dall, W. H., 1904, The Miocene deposits of Maryland, *in* Miocene [volume]: Maryland Geol. Survey, p. xxi–xciv. Singewald,

J. T., Jr., and Slaughter, T. H., 1949, Shore erosion in Tidewater Maryland: Maryland Dept. Geology, Mines, and Water Resources Bull. 6, p. 19–118.

Features illustrated (set nos. Md. 2 A–C in southeast corner of photographs).—These cliffs on the west shore of Chesapeake Bay cut off along an almost straight line the intricately dissected upland of southern Maryland carved in flat-lying beds of sandy clay, sand, and clay (Choptank and Calvert Formations of Miocene age). There is a narrow sand beach at the base of the cliffs. During the last 100 years, most of the cliffs have retreated; the total distance ranges from about 250 to 480 feet. From the beach, the floor of the bay declines very gently eastward and is marked by as many as eight submerged bars within not more than 1,000 feet offshore.

Mass. 1. Dunes and beaches at Provincetown

County: Barnstable.
Lat 42°04′ N.; long 70°12′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: May 6, 1960.
Map reference: U.S. Geol. Survey Provincetown 7½-min quadrangle, scale 1:24,000.
Geology reference: Davis, W. M., 1957, Geographical essays; chap. 25, The outline of Cape Cod: New York, Dover Publications, Inc., p. 690–724. Smith, H. T. U., and Messinger, Curtis, 1959, Geomorphic studies of the Provincetown dunes, Cape Cod, Massachusetts: U.S. Office of Naval Research, Geog. Branch, Tech. Rept. 1, 62 p.

Features illustrated (set nos. Mass. 1 A–C in northeast corner of photographs).—Sand dunes cover the tip of Cape Cod. Those dunes in the northern half of Cape Cod are active and largely bare; those to the south are stabilized by vegetation. A considerable part of the end of the Cape, perhaps all of it, was built by marine processes. Longshore transport from the east extended the point northward and northwestward, whereas the west end of the cape was eroded to build the east-curving spit on the south side that protects Provincetown Harbor. Submerged sandbars are visible offshore. Those on the north side parallel the shore; those to the south in Provincetown Harbor trend roughly at right angles to the shore.

Mass. 2. Meandering tidal creeks in salt marsh near Barnstable

County: Barnstable.
Lat 41°44′ N.; long 70°21′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 13, 1952.
Map reference: U.S. Geol. Survey Hyannis 7½-min quadrangle, scale 1:24,000.
Geology reference: Redfield, A. C., 1965, Ontogeny of a salt marsh estuary: Science, v. 174, p. 50–55.

Features illustrated (set nos. Mass. 2 A–C in southeast corner of photographs).—Carbon-14 dating of peat samples from various positions and depths have enabled Redfield to reconstruct the history of the marsh. He believes that as sea level has risen relative to the land during the last 4,000 years, the salt marsh has been built out into the bay protected by the eastward growth of the sandspit (Sandy Neck, north half of photograph 2 B). The presence of meandering channels in sand on the edge of the bay (southeast quadrant of photograph 2 B) suggests that the intricate meander patterns of the tidal streams in the marsh originated from such meanders. During the gradual filling of the bay, the marsh extends to the margins of these meandering channels. The creeks are now in quasi-equilibrium with the hydraulic forces that arise from the quantity of water that they must carry in response to the rhythm of the tide. Sand dunes with conspicuous blowouts mantle Sandy Neck.

Mich. 1. Shore features of Glacial Lake Duluth

County: Ontonagon.
Lat 46°42′ N.; long 89°30′ W.
Number of photographs: 5.
Photograph scale: 1:27,500.
Focal length: 6 in.
Date flown: Apr. 28, 1944.
Map reference: U.S. Geol. Survey Bergland NE. and Matchwood NW. 7½-min quadrangles, scale 1:24,000.
Geology reference: Leverett, Frank, 1928, Moraines and shorelines of the Lake Superior basin: U.S. Geol. Survey Prof. Paper 154–A, p. 1–73. Hack, J. T., 1965, Postglacial drainage evolution and stream geometry in the Ontonagon area, Michigan: U.S. Geol. Survey Prof. Paper 504–B, p. B1–B40.

Features illustrated (set nos. Mich. 1 A–E in northeast corner of photographs).—The plain in the north half of the photographs has a thin mantle of till overlying interbedded till and lake deposits and in photograph 1 B shows glacial fluting by ice that moved southward beyond the limits of the area shown in these photographs. Hills in the southern part of the area are volcanic rocks of Precambrian age. Beach and wave-cut cliff can be seen in the southern half of photograph 1 B, together with a sand and gravel bar across the middle part of bay (southwest quadrant of photograph 1 C). Tombolos are present in the northwest and southeast quadrants of photograph 1 E; the one in the southeast quadrant is outside the area of overlap. The faint curved trace of the younger and lower shoreline of Lake Duluth is seen in the north center of photograph 1 A.

Mich. 2. Postglacial drainage controlled by glacial flutings

County: Ontonagon.
Lat 46°48′ N.; long 89°25′ W.
Number of photographs: 2.
Photograph scale: 1:27,500.

Focal length: 6 in.
Date flown: Oct. 19, 1943.
Map reference: U.S. Geol. Survey Ontonagon 15-min quadrangle, scale 1:62,500.
Geology reference: Leverett, Frank, 1928, Moraines and shorelines of the Lake Superior basin: U.S. Geol. Survey Prof. Paper 154-A, p. 1-73. Hack, J. T., 1965, Postglacial drainage evolution and stream geometry in the Ontonagon area, Michigan: U.S. Geol. Survey Prof. Paper 504-B, p. B1-B40.

Features illustrated (set nos. Mich. 2 A-B in northeast corner of photographs).—A till plain veneered with very thin lake sediments and crossed by glacial grooves or flutings which have controlled the postglacial drainage pattern. Cranberry River in the east part of photograph 2 B is entrenched 40-80 feet in glacial till and bedrock. The wavelength of meanders of Cranberry River changes abruptly near the corner of the road. The riverbed is in till and alluvium north of this point and in shale and sandstone bedrock south of it. Beaver ponds in glacial grooves in south part of photograph 2 A.

Mich. 3. Bedrock and coastal features on Keweenaw Peninsula

County: Keweenaw.
Lat 47°26′ N.; long 88°12′ W.
Number of photographs: 2.
Photograph scale: 1:27,200.
Focal length: 6 in.
Date flown: Oct. 8, 1943.
Map reference: U.S. Geol. Survey Eagle Harbor 7½-min quadrangle, scale 1:24,000.
Geology reference: Cornwall, H. R., and Wright, J. C., 1954, Bedrock geology of the Eagle Harbor quadrangle, Michigan: U.S. Geol. Survey Geol. Quad. Map GQ-36.

Features illustrated (set nos. Mich. 3 A-B in northeast corner of photographs).—Northward-dipping basalt and andesite flows and conglomerates of Keweenawan age form cuestas parallel to the south shore of Lake Superior. Conspicuous lineaments trending a little west and a little east of north, some of which are stream valleys, are caused by faults of small displacement. Throughout most of the area, the bedrock is concealed beneath glacial drift. Prominent dunes are behind the present curving beach. The shoreline east of the dunes is controlled by an outcrop of lava flow behind which are numerous abandoned beach ridges. The gray area at the foot of the bedrock slope a mile east of the dunes is mine tailings.

Mich. 4. Cuestas and strandlines on Keweenaw Peninsula

County: Keweenaw.
Lat 47°27′ N.; long 88°03′ W.
Number of photographs: 4.
Photograph scale: 1:27,200.
Focal length: 6 in.
Date flown: Oct. 8, 1943.
Map reference: U.S. Geol. Survey Delaware 7½-min quadrangle, scale 1:24,000.
Geology reference: Cornwall, H. R., 1954, Bedrock geology of the Delaware quadrangle, Michigan: U.S. Geol. Survey Geol. Quad. Map GQ-51.

Features illustrated (set nos. Mich. 4 A-D in northeast corner of photographs).—Northward-dipping conglomerates and lava flows of Precambrian age form cuestas parallel to the south shore of Lake Superior and submerged reefs offshore. Lineaments striking N. 10°-15° W. across the conglomerate ridge in the center of photographs 4 C mark the trend of minor faults of a type that locally contains native copper veins in the lava series to the south. An esker in the center of photograph 4 A trends northward through a fault-controlled gap in the lava ridge to merge with a delta(?) graded to the highest level of Lake Algonquin. The supposed delta is dissected by a stream that flows north through a gap in a conglomerate ridge and that has built a fan or possibly a delta graded to a lower glacial lake level.

Mich. 5. Esker near Black Lake

County: Cheboygan.
Lat 45°23′ N.; long 84°25′ W.
Number of photographs: 2.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: May 5, 1953.
Map reference: U.S. Geol. Survey Tower 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Mich. 5 A-B in northeast corner of photographs).—A narrow steep-sided esker about 30-60 feet high crosses these photographs from northwest to southeast. The ridge is bordered by swamp and in places by much larger masses of drift, probably kames.

Mich. 6. Beach ridges at Hammond Bay

County: Presque Isle.
Lat 45°31′ N.; long 84°07′ W.
Number of photographs: 2.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: Apr. 25, 1954.
Map reference: U.S. Geol. Survey Grace and Onaway 15-min quadrangles, scale 1:62,500.

Features illustrated (set nos. Mich. 6 A-B in northeast corner of photographs).—These regular curving parallel beach ridges, about 40 in number, form a mile-wide belt parallel to the shore at the west end of Lake Huron. The beaches and intervening swales form a platform that rises from the lakeshore to a height of about 40 feet at the inner edge of the beach-ridge belt.

Minn. 1. Attenuated drumlins east of Hewitt

County: Todd.
Lat 46°20′ N.; long 95°03′ W.

Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 21, 1963.
Map reference: U.S. Geol. Survey Brainerd sheet, scale 1:250,000.
Geology reference: Wright, H. E., 1957, Stone orientation in Wadena drumlin field, Minnesota: Geog. Annaler, v. 39, no. 1, p. 19–31; see fig. 3.

Features illustrated (set nos. Minn. 1 A–B in northeast corner of photographs).—These long ridges, largely cultivated land, range from 15 to 30 feet in height and are symmetrical in cross section and in profile. Side slopes are less than 3°. The ice that molded the drumlins moved south-southwest. The ridges consist largely of a yellowish-brown sandy calcareous till. Streams occupy shallow valleys between and parallel to the drumlins. (Compare with Mont. 5.)

Minn. 2. Ice-channel filling east of Grand Rapids

County: Itasca.
Lat 47°17′ N.; long 93°18′ W.
Number of photographs: 2.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: May 2, 1947.
Map reference: U.S. Geol. Survey Calumet 7½-min quadrangle, scale 1:24,000.
Geology reference: Cotter, R. D., Young, H. L., and Winter, T. C., 1964, Preliminary surficial geologic map of the Mesabi-Vermilion Iron Range area, northeastern Minnesota: U.S. Geol. Survey Misc. Geol. Inv. Map I–403, scale 1:125,000.

Features illustrated (set nos. Minn. 2 A–B in northeast corner of photographs).—A prominent northwest-trending ridge indented and bordered by kettle lakes extends diagonally across the photographs. In the northwest quadrant of photograph 2 B the ridge is narrow and steep sided, but to the southeast it becomes a flat-topped ridge as much as a quarter of a mile wide. The ridge is probably an ice-channel filling. It is bordered by a rolling till-covered plain dotted by lakes and swamps. Swan River follows a winding course across the plain.

Miss. 1. Ancient meanders near Grace archaeologic site

County: Issaquena.
Lat 32°59′ N.; long 90°58′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Nov. 30, 1949.
Map reference: U.S. Geol. Survey Lorenzen 15-min quadrangle, scale 1:62,500.
Geology reference: Fisk, H. N., 1944, Geological investigations of the alluvial valley of the lower Mississippi River: Vicksburg, Miss., Mississippi River Comm., 78 p.; see pl. 15, sheet 3, and pl. 22, sheet 9.

Features illustrated (set nos. Miss. 1 A–B in southeast corner of photographs).—The broad forest and swamp-covered meander (Lafayette Lake; part of Fisk's stage 10) bisects an older meander, largely cultivated land (stage 9) in the northeast quadrant of photograph 1 B. The area south and east of these two meanders (southeast quadrant of photograph 1 A) lacks a scroll pattern and is a remnant of a depositional segment of the Mississippi River flood plain that is considerably older (stage B3) than the two ages of meanders. The Indian mounds southeast of the junction of the two meanders (just northeast of center of photograph 1 A and west of road) are the Grace archaeologic site.

Miss. 2. Meander scrolls on flood plain near Tippo

County: Tallahatchie.
Lat 33°53′ N.; long 90°13′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 21, 1962.
Map reference: U.S. Geol. Survey Philipp 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Miss. 2 A–C in southeast corner of photographs).—Meander scrolls, oxbow lakes, and sloughs on alluvial plain of Yazoo Basin about 50 miles northeast of Greenville. One set of meander scrolls covers most of photograph 2 A, except where intersected by younger scrolls in the southwest corner of the photograph. Much of the area is cleared; only the larger depressions of the meander scrolls are tree covered. The local relief ranges from less than 5 to nearly 10 feet.

Mo. 1. Precambrian core of Saint Francois Mountains

County: Iron.
Lat 37°37′ N.; long 90°38′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 18, 1954.
Map reference: U.S. Geol. Survey Ironton 15-min quadrangle, scale 1:62,500.
Geology reference: McCracken, M. H., compiler, 1961, Geologic map of Missouri: Missouri Geol. Survey and Water Resources Div., scale 1:500,000.

Features illustrated (set nos. Mo. 1 A–C in southeast corner of photographs).—Rounded hills of Precambrian crystalline rocks stand above the lowlands underlain by sedimentary rocks of Cambrian age in the center of the Saint Francois Mountains.

Mo. 2. Salem Plateau along Crooked Creek

County: Dent.
Lat 37°50′ N.; long 91°24′ W.
Number of photographs: 4.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: July 8, 1959.

Map reference: U.S. Geol. Survey Steelville 15-min quadrangle, scale 1:62,500.
Geology reference: Snyder, F. G., and Gerdemann, P. E., 1965, Explosive igneous activity along an Illinois-Missouri-Kansas axis: Am. Jour. Sci., v. 263, no. 6, p. 465–493.

Features illustrated (set nos. Mo. 2 A–D in southwest corner of photographs).—These photographs show a part of the Salem Plateau section of the Ozark Plateaus on the northwest side of the Saint Francois Mountains. Essentially flatlying dolomite beds, largely of Ordovican age, form wooded hills that rise 100–200 feet above narrow cultivated valleys. Crooked Creek, a tributary of the Meramec River, flows northward across the northeast quadrant of photograph 2 C. The cultivated uplands west of the river include the central part of the Crooked Creek disturbance, a complex ring structure 3–4 miles in diameter bounded by high-angle faults. None of the detailed structural features of this disturbance can be seen in the photographs.

Mo. 3. Subterranean stream piracy near Jefferson City

County: Cole.
Lat 38°33′ N.; long 92°04′ W.
Number of photographs: 4.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: Apr. 7, 1965.
Map reference: U.S. Geol. Survey Jefferson City 15-min quadrangle, scale 1:62,500.
Geology reference: Bretz, J H., 1965, Geomorphic history of the Ozarks of Missouri: Missouri Geol. Survey and Water Resources Div., 2d ser., v. 41, p. 111.

Features illustrated (set nos. Mo. 3 A–D in northeast corner of photographs).—Bluffs on the south side of the narrow flood plain of the Missouri River expose flatlying beds of cherty dolomite that to the south form steep-sided hills 150–300 feet high. The meandering Moreau River (west edge of photograph 3 B) enters the Missouri by way of a gorge through a narrow peninsula of rock. A recently abandoned course of the Moreau River extends eastward just south of the Missouri trench to join the Osage River less than a mile from where the latter joins the Missouri. The modern Moreau River gorge may be an example of subterranean stream piracy.

Mont. 1. Lewis overthrust near Chief Mountain, Glacier National Park

County: Glacier.
Lat 48°56′ N.; long 113°37′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Aug. 25, 1958.
Map reference: U.S. Geol. Survey Chief Mountain 30-min quadrangle, scale 1:125,000.
Geology reference: Dyson, J. L., 1960, The geologic story of Glacier National Park: Glacier Nat. History Assoc. Spec. Bull. 3 [rev.], 24 p.

Features illustrated (set nos. Mont. 1 A–C in southeast corner of photographs).—Chief Mountain, a steep-sided block of resistant argillite of the Belt Series of Precambrian age (just south of center of photograph 1 C), rests on a broad ridge of Cretaceous shale. Chief Mountain is an outlier of the Lewis overthrust, as are the small hills southwest of the mountain. Elsewhere the virtually flat-lying rocks of the Belt Series above the thrust plane form curving and branching mountain ridges (light-colored areas in most of photograph 1 B) with steep slopes or cliffs that are commonly the headwalls of cirques and are partly mantled by talus deposits. The Precambrian rocks were thrust eastward over the Cretaceous strata. The trace of the overthrust zigzags back and forth, more or less following the base of the light-colored cliffs in photograph 1 A.

Mont. 2. Blackfoot Glacier, Glacier National Park

County: Glacier.
Lat 48°36′ N.; long 113°40′ W.
Number of photographs: 4.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Aug. 25, 1958.
Map reference: U.S. Geol. Survey Chief Mountain 30-min quadrangle, scale 1:125,000.
Geology reference: Dyson, J. L., 1952, Glaciers and glaciation in Glacier National Park: Glacier Nat. History Assoc. Spec. Bull. 2 [rev.], 24 p.

Features illustrated (set nos. Mont. 2 A–D in southeast edge of photographs).—This glacier hangs on the headwall of a north-facing cirque (southwest quadrant of photograph 2 B) carved in more or less flat-lying rocks of the Belt Series. The cirques contain bare moraines of Recent age. Arêtes and horns are conspicuous. The major valleys are U-shaped and contain conspicuous steps or glacial stairways.

Mont. 3. Moraines and gravel benches near Deep Creek

County: Teton.
Lat 47°43′ N.; long 112°32′ W.
Number of photographs: 3.
Photograph scale: 1:37,200.
Focal length: 6 in.
Date flown: July 13, 1955.
Map reference: U.S. Geol. Survey Lake Theboe and Split Rock Lake 7½-min quadrangles, scale 1:24,000.
Geology reference: Alden, W. C., 1932, Physiography and glacial geology of eastern Montana and adjacent areas: U.S. Geol. Survey Prof. Paper 174, p. 46, 120, and pl. 1. Stebinger, Eugene, 1919, Oil and gas geology of the Birch Creek-Sun River area, northwestern Montana: U.S. Geol. Survey Bull. 691, p. 149–184.

Features illustrated (set nos. Mont. 3 A–C in southeast corner of photographs).—Deep Creek (north edge of photograph 3 A) is incised about 200 feet below an eastward sloping gravel bench that to the west partly buries low hills composed of closely folded Cretaceous sandstone and shale (northwest quadrant of photograph 3 B). The creek may have originated as an ice-marginal stream because it follows the north edge of Alden's Sun River glacier which flowed eastward onto the plains. South of Deep Creek are several east-trending lateral moraines and many small ponds and swamps.

Mont. 4. Dikes and domes in Bearpaw Mountains

County: Blaine.
Lat 48°12′ N.; long 109°10′ W.
Number of photographs: 3.
Photograph scale: 1:63,360.
Focal length: 6 in.
Date flown: Oct. 25, 1952.
Map reference: U.S. Geol. Survey Rattlesnake 15-min quadrangle, scale 1:62,500.
Geology reference: Hearn, B. C., Jr., Pecora, W. T., and Swadley, W. C., 1965, Geology of the Rattlesnake quadrangle, Blaine County, Montana: U.S. Geol. Survey Bull. 1181–B; geol. map (pl. 1), scale 1:31,680.

Features illustrated (set nos. Mont. 4 A–C in northeast section of photographs).—Domes, dikes, and other Eocene intrusive rocks arranged in radial pattern. Several domes, 1–2 miles in diameter, on the outer edge of the hills in the southwest quadrant of photograph 4 B are outlined by outward-dipping Cretaceous sedimentary rocks. The slightly elongate dome about 2 miles southeast of the center of the west edge of the photograph, has a core of igneous rock. An east-west dike is visible about half a mile to the north. The drainage is radial. To the west and to the southeast the bedrock is mantled by gravel deposits at several different levels.

Mont. 5. Ice-fluted till plain east of Havre

County: Phillips.
Lat 48°23′ N.; long 108°23′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 12, 1953.
Map reference: U.S. Geol. Survey Havre sheet, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1961, Glacial map of Montana east of Rocky Mountains: U.S. Geol. Survey Misc. Geol. Inv. Map I–327, scale 1:500,000.

Features illustrated (set nos. Mont. 5 A–B in northeast corner of photographs).—Till plain fluted by ice advancing from the northwest; the ridges are mainly elongated drumlins. Postglacial drainage forms a trellis pattern controlled by the flutes.

Mont. 6. Drift border near Martin Lake

County: Phillips.
Lat 48°49′ N.; long 107°55′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 20, 1954.
Map reference: U.S. Geol. Survey Glasgow sheet, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1961, Glacial map of Montana east of the Rocky Mountains: U.S. Geol. Survey Misc. Geol. Inv. Map I–327, scale 1:500,000.

Features illustrated (set nos. Mont. 6 A–B in northeast corner of photographs).—The linear ridge across the northern third of these photographs is part of a terminal moraine built by south-moving ice. The moraine separates an area of knob and kettle topography to the north from a well-drained and moderately dissected plain (outwash plain?) to the south. The conspicuous north-south valley that cuts across the entire area and the broad valley near the south edge of the photographs, which contains Martin Lake, are melt-water channels; the latter valley predates the moraine.

Mont. 7. Volcanic rocks and Cretaceous sediments in Bearpaw Mountains

County: Blaine.
Lat 48°02′ N.; long 109°16′ W.
Number of photographs: 2.
Photograph scale: 1:63,360.
Focal length: 6 in.
Date flown: Oct. 20, 1952.
Map reference: U.S. Geol. Survey Maddux and Rattlesnake 15-min quadrangles, scale 1:62,500.
Geology reference: Bryant, Bruce, Schmidt, R. G., Pecora, W. T., 1960, Geology of the Maddox quadrangle, Bearpaw Mountains, Blaine County, Montana: U.S. Geol. Survey Bull. 1081–C, p. 91–116; geol. map (pl. 3), scale 1:31,680.

Features illustrated (set nos. Mont. 7 A–B in northeast corner of photographs).—Tilted middle Eocene flows and pyroclastic rocks (west part of photograph 7 A) are separated by a southeast-trending fault from pre-volcanic Cretaceous and lower Tertiary sedimentary rocks. The beds of volcanic rock are cut off by the fault.

The volcanic rocks form small rugged hills with lower drainage density than the less rugged area to the east carved in the Cretaceous Bearpaw Shale. The area east of the fault includes extensive gravel benches at various levels.

Mont. 8. Diatreme and fault structures south of Bearpaw Mountains

County: Blaine.
Lat 47°50′ N.; long 109°12′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1956.

Map reference: U.S. Geol. Survey Bird Rapids 7½-min quadrangle, scale 1:24,000.
Geology reference: Reeves, Frank, 1924, Geology and possible oil and gas resources of the faulted area south of the Bearpaw Mountains, Montana: U.S. Geol. Survey Bull. 751–C, p. 71–114; geol. map (pl. 13), scale 1:125,000. 1946, Origin and mechanics of thrust faults adjacent to the Bearpaw Mountains, Montana: Geol. Soc. America Bull., v. 57, p. 1033–1047.

Features illustrated (set nos. Mont. 8 A–C in northeast corner of photographs).—On these photographs the dark areas are largely Bearpaw Shale, and the light areas are the underlying Judith River Formation which includes sandstone, siltstone, and shale. The Bearpaw Shale lies flat, but the Judith River Formation is raised up along high-angle faults and gently tilted. These bands or lineaments were thought by Reeves to be due to shallow deformation within a gravity slide sheet, the base of the sheet lying about 1,500 feet below the present valley floors.

The circular diatreme about 1,000 feet in diameter (near center of photograph 8 A) is a volcanic pipe filled with pyroclastic rocks; the light-colored patches near its border are blocks of younger Cretaceous and Tertiary formations, now eroded away, which have been dropped several thousand feet into the pipe (B. C. Hearn, Jr., written commun., 1964).

Mont. 9. Ice-marginal drainage channels east of Little Rocky Mountains

County: Phillips.
Lat 47°49′ N.; long 108°23′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 10, 1953.
Map reference: U.S. Geol. Survey Lewistown sheet, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1961, Glacial map of Montana east of the Rocky Mountains: U.S. Geol. Survey Misc. Geol. Inv. Map I–327, scale 1:500,000.

Features illustrated (set nos. Mont. 9 A–B in northeast corner of photographs).—A group of subparallel channels run southward across the uplands as shown in the center of photograph 9 B. These melt-water channels were cut when southeast-draining valleys from the Little Rocky Mountains were dammed by a tongue of early Wisconsin ice that came from the northeast.

Mont. 10. Desiccation cracks near Beaver Creek

County: Phillips.
Lat 47°51′ N.; long 108°14′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 10, 1953.
Map reference: U.S. Geol. Survey Lewistown sheet, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1961, Glacial map of Montana east of the Rocky Mountains: U.S. Geol. Survey Misc. Geol. Inv. Map I–327, scale 1:500,000.

Features illustrated (set nos. Mont. 10 A–B in northeast corner of photographs).—Giant desiccation cracks on the flat valley floor south of Beaver Creek. Some of the individual polygons are as much as 200 feet across. The valley floor is surrounded by hills of Cretaceous Bearpaw Shale.

Mont. 11. Antelope Sag

County: Sheridan.
Lat 48°41′ N.; long 104°27′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 9, 1949.
Map reference: U.S. Geol. Survey Antelope and Shippe Canyon 7½-min quadrangles, scale 1:24,000.
Geology reference: Witkind, I. J., 1959, Quaternary geology of the Smoke Creek-Medicine Lake, Grenora area, Montana and North Dakota: U.S. Geol. Survey Bull. 1073, p. 27–34, fig. 11.

Features illustrated (set nos. Mont. 11 A–C in northeast corner of photographs).—Antelope Sag is a faint depression across the upland now followed by the highway and the railroad that run north-south through the center of photograph 11 B. The sag marks the approximate location of an ancestral outwash channel now wholly concealed beneath till. Following the cutting of this old channel, the area was overridden by a westward-advancing ice sheet. During the subsequent eastward retreat of the ice front, melt water cut a new horseshoe-shaped channel around the ice margin. When the ice withdrew from the area, the north-trending ancestral valley was filled with till, and Big Muddy Creek drainage used the new channel west of Antelope.

Mont. 12. Dagmar Channel, an outwash channel separating two till sheets

County: Sheridan.
Lat 48°40′ N.; long 104°10′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 30, 1940.
Map reference: U.S. Geol. Survey Wolf Point sheet, scale 1:250,000.
Geology reference: Witkind, I. J., 1959, Quaternary geology of the Smoke Creek-Medicine Lake-Grenora area, Montana and North Dakota: U.S. Geol. Survey Bull. 1073, 80 p.; see geol. map (pl. 1), eastern part, scale 1:62,500.

Features illustrated (set nos. Mont. 12 A–C in northeast corner of photographs).—Dagmar Channel, about 1 mile wide, trends south across the central part of photograph 12 B. The area to the west is a till plain of an early Wisconsin(?) ice sheet, and it has a well-integrated drainage system. Dagmar Channel was cut by melt

269-086 O - 68 - 4

water flowing along the west edge of a younger ice sheet (Mankato age), and it is floored by well-sorted outwash sand and gravel; Clear Lake is a kettle at its eastern edge. East of Dagmar Channel the Mankato till plain retains its original knob-and-kettle topography; no integrated drainage system exists.

Mont. 13. Tilting of ancient courses of Madison River

County: Madison.
Lat 44°48′ N.; long 111°29′ W.
Number of photographs: 3.
Photograph scale: 1:59,000.
Focal length: 6 in.
Date flown: Sept. 6, 1954.
Map reference: U.S. Geol. Survey Cliff Lake and Hebgen Dam 15-min quadrangles, scale 1:62,500.
Geology reference: Myers, W. B., and Hamilton, Warren, 1964, Deformation accompanying the Hebgen Lake earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435–I, p. 55–98; see pl. 2 and figs. 47 and 48.

Features illustrated (*set nos. Mont. 13 A–C in northeast corner of photographs*).—The Madison River leaves its canyon (northeast corner of photograph 13 B) to flow along the north edge of broad Madison Valley. South of the river (largely in northwest quadrant of same photograph) are a flight of river terraces cut on Oligocene(?) rhyolite. The higher terraces, although considerably dissected, rise westward because of a general northeasterly tilting of much of the area shown in this photograph. The successively younger terraces are also tilted, but this tilting is not easy to see. A recent fault scarp bounds the west front of the Madison Range (east edge of photograph 13 B). There was a slight northeast tilt of this part of the Madison Valley during the Hebgen Lake earthquake. The cutting of the trough of Cliff Lake (near center of west edge of photograph 13 B) must postdate the formation of the high terraces east of the lake.

Mont. 14. Hebgen Lake earthquake: Preslide view of Madison River canyon

County: Madison.
Lat 44°49′ N.; long 111°26′ W.
Number of photographs: 3.
Photograph scale: 1:16,000.
Focal length: 8.25 in.
Date flown: Sept. 19, 1956.
Map reference: U.S. Geol. Survey Hebgen Dam 15-min quadrangle, scale 1:62,500.
Geology reference: Hadley, J. B., 1964, Landslides and related phenomena accompanying the Hebgen Lake earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435–K, p. 107–121.

Features illustrated (*set nos. Mont. 14 A–C in northeast corner of photographs*).—Madison River canyon prior to the Madison slide that descended the south wall of the canyon in the southwest quadrant of photograph 14 B. Dolomite buttress can be seen on the thickly wooded south wall of the canyon. The slide extended upriver (to northeast) to a point about at the center of photograph 14 B and downriver to the western edge of fan at mouth of south-draining dry wash; about a 1-mile segment of the canyon floor was buried. Rock Creek camp ground (later largely buried by slide) lies on the northwest side of the river.

Mont. 15. Hebgen Lake earthquake: The Madison slide

County: Madison.
Lat 44°49′ N.; long 111°26′ W.
Number of photographs: 4.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Hebgen Dam 15-min quadrangle, scale 1:62,500.
Geology reference: Hadley, J. B., 1964, Landslides and related phenomena accompanying the Hebgen Lake earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435–K, p. 107–121.

Features illustrated (*set nos. Mont. 15 A–D in north corner of photographs*).—Thirty-seven million cubic yards of broken rock slid into the Madison River canyon and buried a mile of the river and highway to a depth of 100–200 feet and then rode some 400 feet up the opposite canyon wall. These photographs were taken 5 days after the earthquake. The south wall of Madison Canyon is formed by Precambrian schist and gneiss which are deeply weathered and fractured and which dip northward at high angles. These rocks were overlain and held in place by a dolomite buttress, a remnant of which still shows on the northwest side of the slide. Apparently the buttress failed, and the schists and gneisses broke along a curving, concave-upward plane and slid valleyward. Dolomite shows as a sinuous white ridge along the north edge of the slide. Much of the deeper part of the slide, concealed by loose surface material, consists of blocks of bedrock which slid as distinct units. Earthquake Lake, along the east edge of the slide, is filled with debris and as yet is not high enough to submerge all trees.

Mont. 16. Hebgen Lake earthquake: Hebgen fault scarp along northwest arm of Hebgen Lake

County: Gallatin.
Lat 44°52′ N.; long 111°20′ W.
Number of photographs: 3.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Hebgen Dam 15-min quadrangle, scale 1:62,500.
Geology reference: U.S. Geological Survey, 1964, Geology of the Hebgen Lake, Montana, earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435, 242 p.

Features illustrated (*set nos. Mont. 16 A–C in east corner of photographs*).—Hebgen Dam and the northwest part of lake 5 days after the earthquake. Photographs show the submerged north shore and landslides into the lake. Hilgard Lodge, completely destroyed, is near the southeast edge of photograph 16 B. The Hebgen fault scarp, partly concealed by trees northeast of the lake, follows the southwest flank of Hebgen Ridge where the height of the scarp ranges from 1 to 22 feet. Colluvium is the dominant material offset. Locally, small subsidiary scarps parallel or diverge from the main scarp. Northeast of the dam the main scarp curves eastward around a colluvial fan which has slid toward the dam. Earthfill along the downstream side of Hebgen Dam shows erosion channels formed when the dam was crested by the waves of the seiche set up in Hebgen Lake at the time of the earthquake.

Mont. 17. Hebgen Lake earthquake: Highway damage along north shore of Hebgen Lake

County: Gallatin.
Lat 44°51′ N.; long 111°18′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Hebgen Dam 15-min quadrangle, scale 1:62,500.
Geology reference: Witkind, I. J.. 1964, Structural damage in the Hebgen Lake-West Yellowstone area: U.S. Geol. Survey Prof. Paper 435–B, p. 5–11.

Features illustrated (*set nos. Mont. 17 A–B in east corner of photographs*).—Submerged shoreline and highway along the northeast side of Hebgen Lake near Kirkwood Motel. Across the highway from the motel, a curving line of driftwood parallel to the shore marks the limit of one advance of the seiche. Two sand spouts in alluvial fill appear as small white spots just south of the access road which extends to the lake from the highway.

Mont. 18. Hebgen Lake earthquake: Submerged north shore of Hebgen Lake

County: Gallatin.
Lat 44°49′ N.; long 111°16′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Hebgen Dam 15-min quadrangle, scale 1:62,500.
Geology reference: Myers, W. B., and Hamilton, Warren, 1964 Deformation accompanying the Hebgen Lake earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435–I, p. 75–77.

Features illustrated (*set nos. Mont. 18 A–B in east corner of photographs*).—Alluvial fan at the mouth of Dave Johnson Creek (southern quadrant of photograph 18 B) submerged by northward tilting of the lake. Rows of inundated willows mark former shoreline. Small white spots near the southeast corner of the fan are sand spouts. Hebgen fault scarp is visible just behind cabins at head of the fan.

Mont. 19. Hebgen Lake earthquake: Red Canyon fault scarp along south flank of Kirkwood Ridge

County: Gallatin.
Lat 44°52′ N.; long 111°13′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Tepee Creek 15-min quadrangle, scale 1:62,500.
Geology reference: Witkind, I. J., 1964, Reactivated faults north of Hebgen Lake: U.S. Geol. Survey Prof. Paper 435–G, p. 37–50.

Features illustrated (*set nos. Mont. 19 A–B in east corner of photographs*).—In these photographs the new scarps along the Red Canyon fault can be traced for 2 miles on the south flank of Kirkwood Ridge. The ridge is composed of steeply dipping Paleozoic strata; the vertical limestone ribs are part of the Mission Canyon Limestone of the Madison Group (Mississippian), and the dark-gray band immediately northeast is the Amsden Formation. The scarp, 6–15 feet high, displaces colluvium and generally parallels bedding in the exposed rocks higher on the slope.

Mont. 20. Hebgen Lake earthquake: Emerged south shore of Hebgen Lake

County: Gallatin.
Lat 44°45′ N.; long 111°14′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey West Yellowstone, Hebgen Dam, and Tepee Creek 15-min quadrangles, scale 1:62,500.
Geology reference: Myers, W. B., and Hamilton, Warren, 1964, Deformation accompanying the Hebgen Lake earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435–I, p. 70–77.

Features illustrated (*set nos. Mont. 20 A–B in east corner of photographs*).—The south shore of Hebgen Lake has raised beaches, broad mudflats, and piers on dry land that was exposed when the lake was displaced northeastward. The land area on the northeast side of photograph 20 B is Edwards Island, once surrounded by water but now by mudflats that extend to the north shore of the lake, outside the area shown in these photographs.

Mont. 21. Hebgen Lake earthquake: Sediment in streams

County: Gallatin.
Lat 44°47′ N.; long 111°10′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Tepee Creek 15-min quadrangle, scale 1:62,500.
Geology reference: U.S. Geological Survey, 1964, Geology of the Hebgen Lake, Montana, earthquake of August 17, 1959: U.S. Geol. Survey Prof. Paper 435, 242 p.

Features illustrated (*set nos. Mont. 21 A–B in east corner of photographs*).—Grayling Creek (north quadrant) discharges turbid water into Grayling Arm of Hebgen Lake. The white color is a result of reflection of fine-grained sediment. Spring-fed streams in volcanic rocks carried large amounts of very fine volcanic sediment in suspension, and the streams remained murky for several months. By contrast, streams heading in sedimentary rocks were murky for a week to 10 days and then cleared. Apparently, the earth tremors caused grinding of the rocks along fractures, and the fine material so formed was picked up by ground water and discharged into the streams via springs. The northeastern part of the visible shore is submerged a foot or two; the southern part is in the zone of no change in shoreline between the submerged and emerged shorelines.

Mont. 22. Hebgen Lake earthquake: Red Canyon fault scarp cuts across Grayling Creek

County: Gallatin.
Lat 44°48′ N.; long 111°08′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Aug. 22, 1959.
Map reference: U.S. Geol. Survey Tepee Creek 15-min quadrangle, scale 1:62,500.
Geology reference: Witkind, I. J., 1964, Reactivated faults north of Hebgen Lake: U.S. Geol Survey Prof. Paper 435–G, p. 37–50.

Features illustrated (*set nos. Mont. 22 A–B in east corner of photographs.*)—The Red Canyon fault scarp, 5–14 feet high, cuts across Grayling Creek near the center of photograph 22 B. Southeast of the creek the new fault scarp follows precisely an older fault scarp along the edge of a large alluvial fan. A higher, nearly parallel scarp may also have been produced by faulting. The main scarp northwest of the creek passes into many small fractures which continue the westward trend. The U.S. Geological Survey field camp is shown in a clump of aspens on a low hill northeast of the ranch. The white spots are house trailers, cars, and tents; dark areas are cloud shadows.

Nebr. 1. Changes in the channel of Sand Creek, 1939–54

County: Dawes.
Lat 42°47′ N.; long 103°26′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 9, 1939, and Aug. 8, 1954.
Map reference: U.S. Geol. Survey Alliance sheet, scale 1:250,000.
Geology reference: Schumm, S. A., 1961, Effect of sediment characteristics on erosion and deposition in ephemeral stream channels: U.S. Geol. Survey Prof. Paper 352–C, p. 41–49, figs. 23–27.

Features illustrated (*set nos. Nebr. 1 A–D in northeast corner of photographs*).—Historic changes in the Sand Creek channel, in part documented by these photographs, are discussed in detail by Schumm. Between 1939 and 1954, parts of the channel of Sand Creek have been completely filled by aggradation, and deposition has taken place on the adjacent flood plain. Elsewhere a trenched channel formed during this 15-year interval. There is also a noticeable difference in the growth of vegetation on surfaces of recent deposition.

Nebr. 2. Domical sand hills and saline lakes

County: Sheridan.
Lat 42°12′ N.; long 102°35′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 23, 1954.
Map reference: U.S. Geol. Survey Antioch 15-min quadrangle, scale 1:62,500.
Geology reference: Thorp, James, and Smith, H. T. U., 1952, Pleistocene eolian deposits of the United States, Alaska, and parts of Canada: Geol. Soc. America, map, scale 1:2,500,000. Smith, H. T. U., 1965, Dune morphology and chronology in central and western Nebraska: Jour. Geology, v. 73, p. 557–578.

Features illustrated (*set nos. Nebr. 2 A–C in northeast corner of photographs*).—Dome-shaped sandhills, largely stabilized by vegetation, have shallow northwest-trending grooves on their surfaces. Hills range from ½ to 1 mile in diameter and are surrounded by ephemeral saline lakes comparable in area to the sandhills.

Nebr. 3. Longitudinal sand ridges near Ashby

County: Grant.
Lat 42°01′ N.; long 101°57′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 16, 1955.
Map reference: U.S. Geol. Survey Ashby 15-min quadrangle, scale 1:62,500.
Geology reference: Thorp, James, and Smith, H. T. U., 1952, Pleistocene eolian deposits of the United States, Alaska, and parts of Canada: Geol. Soc. America, map, scale 1:2,500,000. Smith, H. T. U., 1965, Dune morphology and chronology in central and western Nebraska: Jour. Geology, v. 73, p. 557–578.

Features illustrated (*set nos. Nebr. 3 A–B in northeast corner of photographs*).—East-west trending sandhills rise from 150 to 200 feet above adjacent flat-floored valleys. On the crest of the ridges are many closed depressions and on the sides are small gullies. The surface is largely covered with turf except for a few gullies, at the mouths of which are small alluvial fans. Ashby is near the eastern edge of photograph 3 A.

Nebr. 4. Changes in channel of North Platte River, 1939–60

County: Garden.
Lat 41°24′ N.; long 102°26′ W.
Number of photographs: 6.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 12, 1939, and June 20, 1960.
Map reference: U.S. Geol. Survey Scottsbluff sheet, scale 1:250,000.

Features illustrated (*set nos. Nebr. 4 A–E in northeast corner of photographs*).—The flood plain of the river is about a mile wide and consists of many braided channels, some bare and some partly covered by low vegetation. A comparison of the flood plain as it was in 1939 with its picture in 1960 shows that during this 21-year interval some channels have been abandoned and a few new ones have formed. In general the main channels have not changed position, but they are narrower and islands have formed in them. In 1939 some of the small meandering gullies south of the river had conspicuous bare channels and bare alluvial fans on the edge of the main flood plain (for example in the southeast quadrant of photograph 4 D). In 1960 these same channels and fans appear to be narrower and in part covered by vegetation (S. A. Schumm, written commun., 1964).

Nebr. 5. Longitudinal dunes near Lone Valley

County: Logan.
Lat 41°37′ N.; long 100°38′ W.
Numerb of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 3, 1955.
Map reference: U.S. Geol. Survey Cody Lake 15-min quadrangle, scale 1:62,500.
Geology reference: Thorp, James, and Smith, H. T. U., 1952, Pleistocene eolian deposits of the United States, Alaska, and parts of Canada: Geol. Soc. America, map, scale 1:2,500,000. Smith, H. T. U., 1965, Dune morphology and chronology in central and western Nebraska: Jour. Geology, v. 73, p. 557–578.

Features illustrated (*set nos. Nebr. 5 A–B in northeast corner of photographs*).—Long narrow steep-sided and closely spaced sand ridges, commonly about 50 feet high are shown. These longitudinal dunes, largely stabilized by vegetation, are parallel or subparallel and, locally, branching. There are many small blowouts. The ridges appear to be superimposed on older, more or less stabilized, sandhills.

Nebr. 6. Longitudinal dunes on the north side of North Loup River

County: Loup.
Lat 41°45′ N.; long 99°18′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 10, 1954.
Map reference: U.S. Geol. Survey Taylor SE. and Sargent East 7½-min quadranges, scale 1:24,000.
Geology reference: Thorp, James, and Smith, H. T. U., 1952, Pleistocene eolian deposits of the United States, Alaska, and parts of Canada: Geol. Soc. America, map, scale 1:2,500,000. Smith, H. T. U., 1965, Dune morphology and chronology in central and western Nebraska: Jour. Geology, v. 73, p. 557–578.

Features illustrated (*set nos. Nebr. 6 A–B in northeast corner of photographs*).—The flood plain of North Loup River ranges from ½ to 1 mile wide; it is bordered on the north by large area of northwest-trending longitudinal dunes. Sandbars partly choke stream channels and cause incipient braided patterns. Dunes, largely stabilized by vegetation, are long, narrow, and steep sided and as much as 50 feet high. Dissected plains to the south of the river are mantled by a thick covering of loess.

Nev. 1. Lake Lahontan: Compound spit south of Bunejug Mountains

County: Churchill.
Lat 39°18′ N.; long 118°36′ W.
Number of photographs: 2.
Photograph scale: 1:43,200.
Focal length: 5.2 in.
Date flown: Dec. 18, 1947.
Map reference: U.S. Geol. Survey Carson Lake 15-min quadrangle, scale 1:62,500.
Geology reference: Morrison, R. B., 1964, Lake Lahontan: Geology of the southern Carson Desert, Nevada: U.S. Geol. Survey Prof. Paper 401, 156 p.; geol. map (pl. 3), scale 1:31,680. See figs. 11 and 25.

Features illustrated (*set nos. Nev. 1 A–B in southeast corner of photographs*).—Northeast of the alkali flat in the southwest quadrant of photograph 1 A (Bass Flats) is a spit nearly 2 miles long. The spit extends southeast from the southwest corner of the Bunejug Mountains which are circled by many higher Lahontan shorelines. The spit, mapped as part of the Pleistocene Sehoo Formation, is compound and has hooks graded to several successively lower lake levels. Recent eolian sand (Fallon Formation) extends across the southeast quadrant of photograph 1 B from the east edge of the alkali flat across Simpson Pass to Eightmile Flat.

Nev. 2. Lake Lahontan: Shorelines in southern Dead Camel Mountains

County: Churchill.
Lat 39°17′ N.; long 118°53′ W.
Number of photographs: 3.
Photograph scale: 1:43,200.
Focal length: 5.2 in.
Date flown: Dec. 18, 1947.
Map reference: U.S. Geol. Survey Fallon and Weber Reservoir 15-min quadrangles, scale 1:62,500.
Geology reference: Morrison, R. B., 1964, Lake Lahontan: Geology of the southern Carson Desert, Nevada: U.S. Geol. Survey Prof. Paper 401, 156 p.

Features illustrated (set nos. Nev. 2 A–C in southeast corner of photographs).—Isolated hills of volcanic rock in the southeast and west parts of photograph 2 B are fringed on their northeast sides by prominent shorelines of Pleistocene Lake Lahontan. Several conspicuous spits curve southward from the southeast corner of a hill near the center of the northwest quadrant of this photograph. (See Morrison, fig. 11A.) The coarse-grained sediments (gravel and sand) below the highest strand line have a smooth surface, whereas the fine-grained sediments (clay, silt, and some sand) are gullied. The curving line in the northeast quadrant is the trace of a possible fault. The adjacent light-colored material is lake sediment of Recent age.

Nev. 3. Lake Lahontan: Beaches at Sehoo Mountain

County: Churchill.
Lat 39°25′ N.; long 118°36′ W.
Number of photographs: 2.
Photograph scale: 1:43,200.
Focal length: 5.2 in.
Date flown: Dec. 18, 1947.
Map reference: U.S. Geol. Survey Carson Lake 15-min quadrangle, scale 1:62,500.
Geology reference: Morrison, R. B., 1964, Lake Lahontan: Geology of the southern Carson Desert, Nevada: U.S. Geol. Survey Prof. Paper 401, 156 p.; geol. map (pl. 3), scale 1:31,680. See fig. 10.

Features illustrated (set nos. Nev. 3 A–B in southeast corner of photographs).—The Pliocene basaltic rocks of Sehoo Mountain (southeast quadrant of photograph 3 B) are largely concealed beneath lacustrine and alluvial sediments of later Quaternary age. There is a marked contrast in minor topographic features above and below the highest shoreline (Lahontan beach) which lies about 450 feet above the lake plain to the west. More than 10 easily discernible shorelines are marked by wave-cut and depositional shore terraces, spits, bars, and tombolos. The shore features are contrasted with the multitude of large and small stream channels on the desert floor.

Nev. 4. Sand dunes near Fourmile Flat

County: Churchill.
Lat 39°16′ N.; long 118°28′ W.
Number of photographs: 2.
Photograph scale: 1:50,000.
Focal length: 6 in.
Date flown: Nov. 20, 1956.
Map reference: U.S. Geol. Survey Reno sheet, scale 1:250,000.
Geology reference: Morrison, R. B., 1964, Lake Lahontan: Geology of the southern Carson Desert, Nevada: U.S. Geol. Survey Prof. Paper 401, 156 p.; see pl. 1 and fig. 12A.

Features illustrated (set nos. Nev. 4 A–B in northeast corner of photographs).—Complex sandhills in the saddle at the south end of Stillwater Range northwest of the Sand Mountains. Sand appears to have come from the playa of Fourmile Flat to the southwest. The dunes extend northeastward to the divide. Small valleys choked by sand have now been partly re-excavated.

N.H. 1. Landslides in Franconia Notch

County: Grafton.
Lat 44°09′ N.; long 71°41′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 11, 1955.
Map reference: U.S. Geol. Survey Franconia 15-min quadrangle, scale 1:62,500.
Geology reference: Goldthwait, J. W., Goldthwait, Lawrence, and Goldthwait, R. P., 1951, The geology of New Hampshire; pt. 1, Surficial geology: New Hampshire State Plan. and Devel. Comm., p. 18, 54–55. Williams, C. R., and Billings, M. P., 1938, Petrology and structure of the Franconia quadrangle, New Hampshire: Geol. Soc. America Bull., v. 49, p. 1011–1044.

Features illustrated (set nos. N.H. 1 A–B in southeast corner of photographs).—This glacially scoured U-shaped drainage divide is carved in the Conway Granite. In 1948 a great landslide—debris avalanche—from Mount Lafayette (northeast quadrant of photograph 1 A) blocked the highway. Ancient forest-covered landslide scars are also visible. The "Old Man of the Mountain" (The Profile) is at the north end of the cliffs southwest of Profile Lake. Numerous ski trails in northwest quadrant of photograph 1 A are on Cannon (Profile) Mountain.

N.H. 2. Mount Pawtuckaway, a ring dike

County: Rockingham.
Lat 43°07′ N.; long 71°11′ W.
Number of photographs: 2.
Photograph scale: 1:34,000.
Focal length: 6 in.
Date flown: Apr. 30, 1951.
Map reference: U.S. Geol. Survey Mount Pawtuckaway 15-min quadrangle, scale 1:62,500.
Geology reference: Freedman, Jacob, 1950, Stratigraphy and structure of the Mount Pawtuckaway quadrangle, southeastern New Hampshire: Geol. Soc. America Bull., v. 61, p. 449–492.

Features illustrated (set nos. N.H. 2 A–B in northeast corner of photographs).—The Pawtuckaway mountains are a roughly circular group of hills about 2 miles in diameter that rise 300–500 feet above the surrounding lowlands. The mountains are composed dominantly of a core of dioritic rocks that underlie valleys surrounded by a ring dike of coarse-grained monzonite that forms the highest hills. The adjacent lowlands are underlain by quartz monzonite. The southwestern segment of the mountains is low because the ring dike is cut off along a northwest-trending high-angle fault.

N.J. 1. Outlier of Cohansey Sand

County: Burlington.
Lat 40°01′ N.; long 74°41′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Nov. 11, 1956.
Map reference: U.S. Geol. Survey Columbus 7½-min quadrangle, scale 1:24,000.
Geology reference: Owens, J. P., and Minard, J. P., 1962, Pre-Quaternary geology of the Columbus quadrangle, New Jersey: U.S. Geol. Survey Geol. Quad. Map GQ–160.

Features illustrated (set nos. N.J. 1 A–C in southeast corner of photographs).—Partly indurated rocks of late Tertiary age (Kirkwood Formation and Cohansey Sand) form steep-sided wooded hills that rise about 100 feet above a gently undulating cultivated plain formed on unconsolidated rocks of Late Cretaceous and early Tertiary age. The hills are outliers of clean quartz sand that forms well-drained soils. The plains are underlain by less well drained clayey glauconitic quartz sand.

N.J. 2. Shoreline changes at Little Egg Inlet, 1940–63

County: Atlantic.
Lat 39°29′ N.; long 74°19′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: 1940, 1957, 1963.
Map reference: U.S. Geol. Survey Atlantic City 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. N.J. 2 A–C in southeast corner of photographs).—These three photographs taken in 1940, 1957, and 1963 show changes in Island Beach south of the inlet but do not provide stereoscopic coverage. The tidal channels in the salt marsh serve as reference marks for comparison of shoreline changes from year to year. In 1940, a long narrow north-trending beach and spit separated the marsh from the ocean. By 1957, the north-trending beach and spit had been replaced by a northwest-trending beach and spit, shorter and slightly west of those of 1940. In addition a new northwest-curving spit about a quarter of a mile wide had been built east of the position of the 1940 spit and extending northward for about a mile. By 1963, the curving spit had grown northwestward an additional 1,000 feet and changed shape to some extent.

N. Mex. 1. Sandstone cuestas near Ship Rock

County: San Juan.
Lat 36°41′ N.; long 108°50′ W.
Number of photographs: 4.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Feb. 5, 1954.
Map reference: U.S. Geol. Survey Ship Rock 15-min quadrangle, scale 1:62,500.
Geology reference: O'Sullivan, R. B., and Beikman, H. M., 1963, Geology, structure, and uranium deposits of the Ship Rock quadrangle, New Mexico and Arizona: U.S. Geol. Survey Misc. Geol. Inv. Map I–345 (sheet 1, Geology).

Features illustrated (set nos. N. Mex. 1 A–D in northeast corner of photographs).—This impressive volcanic neck, more than 1,500 feet high, and its radiating dikes stand on a pedestal of virtually flat-lying Mancos Shale. A small dark-colored apron of waste surrounds the neck; farther away the shale of the pedestal is scored by many small closely spaced radial stream channels (high drainage density). The large north-draining wash in the eastern half of photograph 1 A (Little Ship Rock Wash) follows a strike valley in Mancos Shale. The cuesta just east of the wash is the Gallup Sandstone, which here occurs within the Mancos Shale. West of the wash is a group of discontinuous cuestas and hills that are eastward-dipping beds of sandstone separated by shale and siltstone (Dakota Sandstone and Morrison Formation).

N. Mex. 2. Landslides from Black Mesa near Lyden

County: Rio Arriba.
Lat 36°09′ N.; long 106°01′ W.
Number of photographs: 2.
Photograph scale: 1:21,000.
Focal length: 6 in.
Date flown: Dec. 2, 1949.
Map reference: U.S. Geol. Survey Lyden and Velarde 7½-min quadrangles, scale 1:24,000.
Geology reference: Miller, J. P., Montgomery, Arthur, and Sutherland, P. K., 1963, Geology of part of the southern Sangre de Cristo Mountains, New Mexico: New Mexico Bur. Mines and Mineral Resources Mem. 11, 106 p.

Features illustrated (set nos. N. Mex. 2 A–B in northeast corner of photographs).—The lava flows of Black Mesa rest on semiconsolidated sediments of late Cenozoic age. Semicircular and rectangular landslide blocks mantle the southeast side of the mesa. The caprock near the edge of the mesa is broken by conspicuous cracks that parallel the top of the scarp. The landsliding is related to the removal of material by the lateral swing of the Rio Grande across its flood plain, here as much as three-quarters of a mile wide. Southeast of the river the edge of a dissected pediment is outlined by an irrigation ditch.

N. Mex. 3. Landslides in Rio Grande Canyon near Embudo

County: Rio Arriba and Taos.
Lat 36°13′ N.; long 105°55′ W.
Number of photographs: 2.
Photograph scale: 1:37,600.
Focal length: 6 in.
Date flown: July 23, 1958.
Map reference: U.S. Geol. Survey Velarde and Taos Junction 7½-min quadrangles, scale 1:24,000.
Geology reference: Miller, J. P., Montgomery, Arthur, and Sutherland, P. K., 1963, Geology of part of the southern Sangre de Cristo Mountains, New Mexico: New Mexico Bur. Mines and Mineral Resources Mem. 11, 106 p.; geol. map (pl. 1), scale 1:63,360.

Features illustrated (set nos. N. Mex. 3 A–B in northeast corner of photographs).—Semiconsolidated sediments of later Cenozoic age (silt, sand, gravel, and a little ash, clay, and breccia) capped by basalt flows (north half of photograph 3 A) have been dissected to depths of about 1,000 feet. Tilted landslide blocks of the caprock mantle the canyon walls. On the north side of the river (northwest quadrant of photograph 3 B), landsliding has removed all the caprock from a part of the top of the canyon wall near Chorreras. This loss of caprock has exposed the light-colored sedimentary rocks and left only slump blocks of lava on the walls below. There is no evidence that any large-scale movement has taken place for a long time.

N. Mex. 4. Lava flows and intrusives near Philmont Scout Ranch

County: Colfax.
Lat 36°27′ N.; long 104°59′ W.
Number of photographs: 3.
Photograph scale: 1:28,400.
Focal length: 6 in.
Date flown: Sept. 18, 1954.
Map reference: U.S. Geol. Survey Miami and Tooth of Time 15-min quadrangles, scale 1:62,500.
Geology reference: Robinson, G. D., Wanek, A. A., Hays, W. H., and McCallum, M. E., 1964, Philmont Country: The rocks and landscape of a famous New Mexico Ranch: U.S. Geol. Survey Prof. Paper 505, 152 p.; geol. map (pl. 3), scale 1:48,000.

Features illustrated (set nos. N. Mex. 4 A–C in southeast corner of photographs).—The creek that flows in a northeasterly direction across photograph 4 B (Urraca Creek) is bordered in the northeast quadrant by lowlands floored with shale thinly veneered by alluvium. Philmont Scout Ranch is in the northeast corner of this photograph. A gravel terrace about 150 feet high (northeast corner of photograph 4 A) is a remnant of an ancient flood plain of Urraca Creek. The steep-sided ridge of dacite porphyry northwest of the creek is part of a laccolith intruded in the adjacent shale of Cretaceous age. The lower contact of the intrusive body is largely concealed by colluvium, except near the west edge of the photograph where the base of the the laccolith is marked by a sharp break in slope. The slopes of the basalt-capped mesa in the southwest corner of this same exposure (Urraca Mesa) are mantled by landslide deposits, except near the east edge of the photograph where the underlying Cretaceous shale is exposed in gullies (tributary to Chicoso Creek).

N. Mex. 5. Mount Capulin, a scoria cone

County: Union.
Lat 36°46′ N.; long 103°58′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: July 27, 1956.
Map reference: U.S. Geol. Survey Dalhart sheet, scale 1:250,000.
Geology reference: Collins, R. F., 1949, Volcanic rocks of northeastern New Mexico: Geol. Soc. America Bull., v. 60, no. 6, p. 1017–1040.

Features illustrated (set nos. N. Mex. 5 A–B in southeast corner of photographs).—An almost undissected scoria volcano about 1,000 feet high which has an unbreached crater about 100 feet deep. The cone is surrounded by older weathered basalt flows that still retain much of their initial surface form. The cone is a National Monument. Drainage is radial.

N. Mex. 6. Rhyolite lava dome and flows in Valles Caldera

County: Sandoval.
Lat 35°50′ N.; long 106°31′ W.
Number of photographs: 3.
Photograph scale: 1:32,680.
Date flown: 1935.
Map reference: U.S. Geol. Survey Jemez Springs and Frijoles 15-min quadrangles, scale 1:62,500.
Geology reference: Smith, R. L., Bailey, R. A., and Ross, C. S., 1961, Structural evolution of the Valles Caldera, New Mexico, and its bearing on the emplacement of ring dikes, *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424–D, p. D145–D149; geol. map (fig. 340.1), scale 1:139,000.

Features illustrated (set nos. N. Mex. 6 A–C in southeast corner of photographs).—The broad elongate mountain near the center of photograph 6 B is one of 10 similar rhyolite dome-flows that form a discontinuous ring within the Valles Caldera in the Jemez Mountains. The conspicuous arcuate ridges on the south side of the mountain are ribs of vertically flow-banded rhyolite which have been accentuated by erosion of intervening zones of less resistant flow breccia. These semiconcentric ridges are part of a thick rhyolite flow that forms the base of the dome-flow complex and extends 8 miles to the west (beyond the limits of the photograph). Capping this basal flow is another dome-flow which originates at the grass-covered crest and extends 2 miles to the northeast; this uppermost flow also displays conspicuous concentric flow ridges. The small tree-covered knoll immediately northeast of the dome-flow complex is a small isolated rhyolite dome.

N. Mex. 7. Fine-textured topography on upper Tertiary sediments

County: Santa Fe and Los Alamos.
Lat 35°47′ N.; long 106°07′ W.
Number of photographs: 2.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: May 27, 1954.
Map reference: U.S. Geol. Survey Espanola 15-min quadrangle, scale 1:62,500.
Geology reference: Griggs, R. L., 1964, Geology and groundwater resources of Los Alamos area, New Mexico: U.S. Geol. Survey Water-Supply Paper 1753, 107 p.

Features illustrated (set nos. N. Mex. 7 A–B in northeast corner of photographs).—Fine-textured topography with high drainage density formed on the semiconsolidated upper Tertiary rocks (sandstone, conglomerate, siltstone, and clay of the Santa Fe Group). The drainage pattern is largely dendritic, except for the parallel or pinnate pattern in the northeast quadrant of photograph 7 B. Mesas near the west edge of the same photograph are capped by basaltic rocks of late Tertiary or Quaternary age. Buckman is near the northwest corner of photograph 7 B.

N. Mex. 8. Normal faults cutting basalt mesa

County: Sandoval.
Lat 35°26′ N.; long 106°32′ W.
Number of photographs: 4.
Photograph scale: 1:31,680.
Date flown: 1935.
Map reference: U.S. Geol. Survey Santa Ana Pueblo 7½-min quadrangle, scale 1:24,000.
Geology reference: Kelley, V. C., 1954, Tectonic map of a part of the upper Rio Grande area, New Mexico: U.S. Geol. Survey Oil and Gas Inv. Map OM–157, scale 1:190,080.

Features illustrated (set nos. N. Mex. 8 A–D in southeast corner of photographs).—The photographs show the eastern half of the Santa Ana mesa near the confluence of Jemez River and Rio Grande (photograph 8 A). The basalt flows issued from a north-south-trending string of vents, some of which are visible on the west edge of photographs 8 C and 8 D, and also from a similar line of vents outside the area shown to the east. Numerous north-south-trending faults displace the basalts from a few to 150 feet. The blocks are tilted eastward, and along any one fault the eastern block has risen relative to the one to the west. The drainage of the mesa has a trellis pattern.

N. Mex. 9. Fault border of Rio Grande depression along Arroyo Tonque

County: Sandoval.
Lat 35°22′ N.; long 106°22′ W.
Number of photographs: 3.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Feb. 28, 1954.
Map reference: U.S. Geol. Survey San Felipe Pueblo 15-min quadrangle, scale 1:62,500.
Geology reference: Stearns, C. E., 1953, Tertiary geology of the Galisteo-Tonque area, New Mexico: Geol. Soc. America Bull., v. 64, p. 459–508; geol. map (pl. 1), scale 1:125,000.

Features illustrated (set nos. N. Mex. 9 A–C in northeast corner of photographs).—Unconsolidated or weakly cemented alluvial-fan deposits of late Tertiary age (western part of photograph 9 B) are downfaulted against the east-dipping Paleozoic to early Tertiary strata. A dendritic drainage pattern and a high drainage density characterize the areas underlain by late Tertiary rocks. Hogbacks of pre-Tertiary rock are offset along high-angle faults and are broken by crosscutting dikes (southeast quadrant of photograph 9 B). Small flat surfaces now dissected are remnants of gravel deposits resting unconformably on the underlying deformed rocks. These unconformities are largely small pediment surfaces. Several of the formations in, and structures of, the older rocks, mapped by Stearns (pl. 1), can be traced on these photographs.

N. Mex. 10. Flows, dikes, and unconformities in the Galisteo area

County: Santa Fe and Sandoval.
Lat 35°31′ N., long 106°12′ W.
Number of photographs: 3.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Feb. 28, 1954.
Map reference: U.S. Geol. Survey Agua Fria, Santo Domingo Pueblo, and San Felipe Pueblo 15-min quadrangles, scale 1:62,500.
Geology reference: Stearns, C. E., 1953, Tertiary geology of the Galisteo-Tonque area, New Mexico: Geol. Soc. America Bull., v. 64, p. 459–508; see pl. 1.

Features illustrated (set nos. N. Mex. 10 A–C in northeast corner of photographs).—The Pleistocene(?) lava flows and cinder cone of the Mesita de Juana Lopez (northeast quadrant of photograph 10 B) rest on slightly deformed upper Tertiary sediments and volcanics (northwest quadrant) and on eastward-dipping upper Paleozoic and Mesozoic sedimentary rocks (near the center of same photograph). The Tertiary rocks are downfaulted against the older sedimentary rocks. Crosscutting dikes are conspicuous in the pre-Tertiary rocks (southeast quadrant of photograph 10 B). Stippled and linear patterns of dots which are conspicuous on Mesita de Juana Lopez resemble those found on basalt in the Snake River Plains and are attributed to Pleistocene frost action.

N. Mex. 11. Patterned ground on basalt mesas near Laguna

County: Valencia.
Lat 35°03′ N.; long 107°27′ W.
Number of photographs: 2.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: May 29, 1955.
Map reference: U.S. Geol. Survey Laguna 7½-min quadrangle, scale 1:24,000.
Geology reference: Malde, H. E., 1964, Patterned ground in the western Snake River Plain, Idaho, and its possible cold climate origin: Geol. Soc. America Bull., v. 75, p. 191–208. Moench, R. H., 1963, Geologic map of the Laguna quadrangle, New Mexico: U.S. Geol. Survey Geol. Quad. Map GQ–208.

Features illustrated (*set nos. N. Mex. 11 A–B in northeast corner of photographs*).—Basalt-capped mesas (northeast quadrant of photograph 11 A), standing about 700 feet above the Rio San Jose to the south, show stippled and linear patterns of silt mounds that are possibly of cold-climate origin. (See Idaho 2 and 3.) These lower Pleistocene(?) basalt flows came from Wheat Mountain just north of the area shown in the photographs.

Talus and landslide deposits, largely basalt rubble, mantle the slopes of the mesas where the basalt rests on Mancos Shale overlying Dakota Sandstone and Morrison Formation.

N. Mex. 12. Travertine mesa along Comanche thrust fault

County: Valencia and Socorro.
Lat 34°35′ N.; long 107°12′ W.
Number of photographs: 3.
Photograph scale: 1:28,400.
Focal length: 6 in.
Date flown: Oct. 12, 1951.
Map reference: U.S. Geol. Survey Mesa Aparejo 15-min quadrangle, scale 1:62,500.
Geology reference: Kelley, V. C., and Wood, G. H., 1946, Geologic map of the Lucero uplift, Valencia, Socorro, and Bernalillo Counties, New Mexico: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 47.

Features illustrated (*set nos. N. Mex. 12 A–C in southeast corner of photographs*).—Plains near the western edge of the valley of the Rio Puerco (eastern part of photograph 12 B), formed largely of gravel on pediment surfaces, adjoin a cuesta formed of westward-dipping Pennsylvanian limestones brought up along the westward-dipping Comanche thrust fault. Travertine deposited from springs along the thrust fault forms a low dissected mesa (light-colored area on photograph), through which Arroyo Pato has cut a gorge (northeast quadrant of same photograph). The springs are now largely inactive, and the travertine is concealed beneath open woodlands (piñon and juniper).

N.Y. 1. Niagara cuesta at Lewiston

County: Niagara.
Lat 43°10′ N.; long 79°03′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 25, 1938.
Map reference: U.S. Geol. Survey Lewiston 7½-min quadrangle, scale 1:24,000 (N.Y. only), Toronto sheet, scale 1:250,000.
Geology reference: Johnston, R. H., 1964, Ground water in the Niagara Falls area, New York, with emphasis on the water-bearing characteristics of the bedrock: New York Water Resources Comm. Bull. GW–53, 93 p.

Features illustrated (*set nos. N.Y. 1 A–B in southeast corner of photographs*).—The Niagara River emerges from a narrow gorge cut about 250 feet into a flat upland and enters a broad flat lowland where its channel is wide and its banks are low. The north-facing escarpment separating the upland from the lowland is the Niagara cuesta, across which the ancestral Niagara River flowed in late-glacial time as a waterfall that has now retreated southward about 6½ miles. The upper part of the escarpment is the massive Lockport Dolomite, underlain by the Rochester Shale and older rocks that erode by sapping. This sapping causes the dolomite cap to be undermined. The lowland north of the escarpment is underlain by Queenston Shale.

N.Y. 2. Niagara Falls

County: Niagara.
Lat 43°05′ N.; long 79°04′ W.
Number of photographs: 2.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: May 7, 1963.
Map reference: U.S. Geol. Survey Niagara Falls 7½-min quadrangle, scale 1:24,000.
Geology reference: Johnston, R. H., 1964, Ground water in the Niagara Falls area, New York, with emphasis on the water-bearing characteristics of the bedrock: New York Water Resources Comm. Bull. GW–53, 93 p.

Features illustrated (*set nos. N.Y. 2 A–B in southeast corner of photographs*).—Horseshoe Falls and American Falls separated by Goat Island. The falls are about 160 feet high. At the time these photographs were taken, there was considerable ice in the rapids both above and below the falls. The massive Lockport Dolomite forms the lip of the falls and the upper part of the walls of the gorge. Below is the Rochester Shale.

N.Y. 3. Drumlins near Palmyra

County: Wayne.
Lat 43°08′ N.; long 77°14′ W.
Number of photographs: 2.

Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: May 6, 1960.
Map reference: U.S. Geol. Survey Palmyra and Macedon 15-min quadrangles, scale 1:62,500; Ontario, Williamson, Macedon, and Palmyra 7½-min quadrangles, scale 1:24,000.
Geology reference: Fairchild, H. L., 1929, New York drumlins: Rochester Acad. Sci. Proc., v. 7, 37 p.

Features illustrated (set nos. N.Y. 3 A–B in northeast corner of photographs).—Ice moving southward from the Ontario basin formed a large drumlin field on the Ontario plain north of the Finger Lakes. The bedrock, concealed beneath drift, is in large part gently dipping shale and dolomite of Silurian age. The drumlins are oval in plan and range in length from less than a quarter of a mile to more than 2 miles. They are commonly three to five times longer than they are wide. The flat-floored valleys between the drumlins are underlain in part by lake deposits and in part by glacial outwash.

N.Y. 4. Potsdam outliers near Hammond

County: St. Lawrence and Jefferson.
Lat 44°22′ N.; long 75°46′ W.
Number of photographs: 3.
Photograph scale: 1:19,000.
Focal length: 6 in.
Date flown: May 4, 1960.
Map reference: U.S. Geol. Survey Muskellunge Lake, Hammond, Redwood, and Chippewa Bay 7½-min quadrangles, scale 1:24,000.
Geology reference: New York State Museum and Science Service, Geological Survey, 1962, Geologic map of New York, 1961. Adirondack sheet: New York State Mus. and Sci. Service Geol. Survey Map and Chart Ser. 5, scale 1:250,000.

Features illustrated (set nos. N.Y. 4 A–C in northeast corner of photographs).—Broad tables of flat-lying Potsdam Sandstone of Late Cambrian age rise above lowlands underlain by metasedimentary rocks of Precambrian age. The mantle of glacial drift is thin and patchy, and the grain of the metamorphic rocks is clearly expressed by the irregular shapes of the small hills east of Black Creek.

N.Y. 5. Hickory Lake phacolith

County: St. Lawrence.
Lat 44°26′ N.; long 75°35′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: May 4, 1960.
Map reference: U.S. Geol. Survey Pope Mills 7½-min quadrangle, scale 1:24,000.
Geology reference: Buddington, A. F., 1934, Geology and mineral resources of the Hammond, Antwerp, and Lowville quadrangles: New York State Mus. Bull. 296, 251 p.; geol. map, scale 1:62,500.

Features illustrated (set nos. N.Y. 5 A–B in northeast corner of photographs).—The oval-shaped area of numerous small roughly concentric ridges in the southern half of photograph 5 B is one of Buddington's granite phacoliths. Although the area has been glaciated, the drift is thin and discontinuous. The lowland that surrounds the phacolith (along Birch Creek) is mantled by fine-grained lake sediments of Quaternary age. The surrounding area of more irregular hills is underlain by quartzite, marble, gneiss, and related rocks of the Grenville Series.

N.Y. 6. Deltas of Ausable River

County: Clinton and Essex.
Lat 44°34′ N.; long 73°27′ W.
Number of photographs: 5.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: June 28, 1962.
Map reference: U.S. Geol. Survey Plattsburgh 15-min quadrangle, scale 1:62,500.
Geology reference: Chapman, D. H., 1937, Late-glacial and postglacial history of the Champlain Valley: Am. Jour. Sci., 5th ser., v. 34, no. 200, p. 89–124.

Features illustrated (set nos. N.Y. 6 A–E in southeast corner of photographs).—Beaches, spits, and underwater features near the mouths of two distributaries of the Ausable River delta in Lake Champlain (photograph 6 D) show both north and south transport of sediment along the lakeshore. Remnants of ancient Ausable River deltas occur nearby. The south edge of a high delta is south of the curving east-west road just north of the center of photograph 6 A. At a somewhat lower level, the Ausable River followed a curving channel similar to those on the modern delta that can be seen in the southwest quadrant of photograph 6 D between the river and the main north-south highway. Another channel follows the curving north edge of the high delta from the main highway (in northwest quadrant of photograph 6 B) southeastward through the center of photograph where the channel turns northeastward into the swamp that empties into the lake. Bedrock is exposed in places on the north side of this channel which appears to have discharged into the lake at or below present lake level. Ausable Chasm is just visible on the west edge of photograph 6 B.

N.C. 1. Changes in Hatteras Inlet caused by Hurricane Helene, September 1958

County: Hyde and Dare.
Lat 35°12′ N.; long 75°45′ W.
Number of photographs: 6.
Photograph scale: 1:20,000, 1955; 1:24,000, 1959.
Date flown: Mar. 29, 1955, Aug. 16, 1959.
Map reference: U.S. Geol. Survey Green Island and Hatteras 7½-min quadrangles, scale 1:24,000.

Features illustrated (set nos. N.C. 1 A–F in southwest corner of photographs).—On the east side of Hatteras

Inlet (east of center of photograph 1 B), the 1955 photographs show a curved spit (Inlet Peninsula) separated from the west end of Hatteras Island (west edge of same photograph) by a sand flat. Near the center of the inlet is Pelican Shoal (just north of center of same photograph). The barrier beach on the west side of the inlet (Ocracoke Island) is bisected by a narrow channel just east of the Coast Guard station (near center of photograph 1 A). The 1959 photographs, taken nearly a year after the hurricane, show that the narrow channel just east of the site of the station has been greatly enlarged, the station is gone, and Pelican Shoal is connected to a remnant of the east end of Ocracoke Island. The tidal delta on the north (lagoon) side of the inlet is well shown in the 1959 photographs. Deposition on the south (ocean) side of the inlet is shown by underwater bars and by curved spits on the south side of Pelican Shoal and the isolated tip of Ocracoke Island (M. T. El-Ashry, written commun., 1963).

N.C. 2. Shoreline changes at Cape Hatteras, 1945–62

County: Dare.
Lat 35°14′ N.; long 75°32′ W.
Number of photographs: 4.
Photograph scale: 1:21,000, 1945, 1953; 1:24,000, 1959, 1962.
Date flown: 1945, 1953, 1959, 1962.
Map reference: U.S. Geol. Survey Cape Hatteras 7½-min quadrangle, scale 1:24,000.
Geology reference: Athearn, W. D., and Ronne, Claude, 1953, Shoreline changes at Cape Hatteras: Naval Research Rev., v. 16, no. 6, p. 17–24.

Features illustrated.—These photographs do not provide stereoscopic coverage. On the 1945 photograph (*set no. N.C. 2 A in the southeast corner*) a dirt road (white line) runs north from the Cape to the center point on the north edge. A point common to all the photographs is the small light-colored area of bare sand about 0.1 of an inch long that lies just west of the road and about 1.5 inches north of the shore.

The 1953 photograph (*set no. N.C. 2 B in the northwest corner*) shows that the erosion of the beach southwest of the reference point (*set no. N.C. 2 C in the southwest corner*) amounted to about 1,500 feet during an 8-year period. The 1959 photograph shows further erosion from 1953 to 1959, but the 1962 photograph (*set no. N.C. 2 D in the southeast corner*) suggests very little change from 1959 to 1962.

The spit at the tip of the Cape has changed markedly during this 17-year period. In 1945 there was almost no spit, in 1953 a prominent spit pointed eastward, and in 1959 no spit was visible.

M. T. El-Ashry suggests (written commun., 1963) that the southwest-trending spit in the 1962 photograph was formed during an extratropical cyclone that passed over the area a few days before the photograph was taken. A similar spit formed during Hurricane Helene in 1958 but had disappeared by the time the 1959 photograph was taken.

N. Dak. 1. Fluted drift near Long Lake Creek

County: Emmons.
Lat 46°28′ N.; long 100°01′ W.
Number of photographs: 2.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: July 28, 1952.
Map reference: U.S. Geol. Survey Jamestown and Bismarck sheets, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1963, Preliminary glacial map of North Dakota: U.S. Geol. Survey Misc. Geol. Inv. Map I–331. Fisher, S. P., Jr., 1952, The geology of Emmons County, North Dakota: North Dakota Geol. Survey Bull. 26, 47 p.

Features illustrated (set nos. N. Dak. 1 A–B in northeast corner of photographs).—Plains are mantled by ground moraine. On the west side of Long Lake Creek (west half of photograph 1 A), the ground surface was molded by south-southwest-moving ice into linear ridges and swales that give a fluted appearance to the surface.

N. Dak. 2. End moraines in Kidder County

County: Kidder.
Lat 47°15′ N.; long 99°35′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: July 31, 1952.
Map reference: U.S. Geol. Survey New Rockford sheet, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1963, Preliminary glacial map of North Dakota: U.S. Geol. Survey Misc. Geol. Inv. Map I–331. Laird, W. M., Lemke, R. W., and Hansen, Miller, 1958, Guidebook, Midwestern Friends of the Pleistocene, 9th Annual Field Conference, 1958: North Dakota Geol. Survey Misc. Ser. 10, 114 p.

Features illustrated (set nos. N. Dak. 2 A–C in northeast corner of photographs).—A broad area of collapse or "dead ice" ground moraine is characterized by many large and small lakes. There is no conspicuous linear trend to the topography. A prominent belt of end moraine (north half of photograph 2 B) formed by southward-moving ice shows many small subparallel linear ridges and swales with a few small ponds. A part of an older belt of more lobate end moraine also built by southward-moving ice occurs in the southern part of the photographs. These moraines are the northward extension of the Streeter moraine that Lemke and Colton believe marks the drift border of an ice advance that is younger than the Cary maximum.

N. Dak. 3. Streeter moraine near Alkaline Lake

County: Kidder, Stutsman, and Logan.
Lat 46°38′ N.; long 99°25′ W.
Number of photographs: 2.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: July 28, 1952.
Map reference: U.S. Geol. Survey Jamestown sheet, scale 1:250,000.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1963, Preliminary glacial map of North Dakota: U.S. Geol. Survey Misc. Inv. Map I–331. Paulson, G. F., 1952, Geology and occurrence of ground water in the Streeter area, Stutsman, Logan, and Kidder Counties, North Dakota: North Dakota Geol. Survey Ground-Water Studies 20, 73 p.

Features illustrated (*set nos. N. Dak. 3 A–B in northeast corner of photographs*).—The massive Streeter moraine with many prominent arcuate ridges (southwest quadrant of photograph 3 B) was built by southwest-moving glacier ice. In front of it is an outwash plain. Behind the moraine to the northeast is a broad area of collapse moraine deposits with some large lakes and multitudes of small irregularly shaped ponds and swamps.

N. Dak. 4. Lake Agassiz: Beaches and dissected lake floor near Larimore

County: Grand Forks.
Lat 47°56′ N.; long 97°36′ W.
Number of photographs: 2.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Sept. 10, 1952.
Map reference: U.S. Geol. Survey Larimore 15-min quadrangle, scale 1:62,500.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1963, Preliminary glacial map of North Dakota: U.S. Geol. Survey Misc. Geol. Inv. Map I–331. Laird, W. M., Lemke, R. W., and Hansen, Miller, 1958, Guidebook, Midwestern Friends of the Pleistocene, 9th Annual Field Conference, 1958: North Dakota Geol. Survey Misc. Ser. 10, 114 p.

Features illustrated (*set nos. N. Dak. 4 A–B in northeast corner of photographs*).—Prominent beaches (Campbell, McCauleyville, Hillsboro) cross the northeast-sloping floor of the lake basin. The meandering Turtle River has carved a narrow valley about 50 feet below the lake floor. It flows in part parallel to the beach ridges and in part at right angles to them.

N. Dak. 5. Lake Agassiz: Herman Beach on west edge of lake basin near Kempton

County: Grand Forks.
Lat 47°52′ N.; long 97°40′ W.
Number of photographs: 2.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Aug. 1, 1952.
Map reference: U.S. Geol. Survey Larimore 15-min quadrangle, scale 1:62,500.
Geology reference: Colton, R. B., Lemke, R. W., and Lindvall, R. M., 1963, Preliminary glacial map of North Dakota: U.S. Geol. Survey Misc. Geol. Inv. Map I–331. Upham, Warren, 1895, The Glacial Lake Agassiz: U.S. Geol. Survey Mon. 25, p. 332–333. (Out of print.)

Features illustrated (*set nos. N. Dak. 5 A–B in northeast corner of photographs*).—Herman beach, which marks the western limit of Lake Agassiz, separates the smooth lake plain on the east from an area of ground moraine to the west. In the southeast quadrant of photograph 5 B, the Herman beach is a ridge of sand and gravel with undrained depressions to the west as much as 15 feet deep. The ridge is virtually continuous except where crossed by Little Goose River. In areas farther north, the local drainage from the till plain to the west is deflected north or south by the beach ridge.

N. Dak. 6. Lake Agassiz: Beaches and wave-cut scarp near Arvilla

County: Grand Forks.
Lat 47°53′ N.; long 97°27′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: June 24, 1962.
Map reference: U.S. Geol. Survey Emerado 15-min quadrangle, scale 1:62,500.
Geology reference: Upham, Warren, 1895, The Glacial Lake Agassiz: U.S. Geol. Survey Mon. 25, p. 418, 436, pl. 29 and fig. 25.

Features illustrated (*set nos. N. Dak. 6 A–C in northeast corner of photographs*).—Prominent northwest-trending gravelly beach ridges as much as 1,000 feet wide are locally the sites of borrow pits. On the lake (east) side, the beaches are about 20 feet high; on the landward (west) side they are as much as 10 feet high. The McCauleyville beach passes through the center of photograph 6 C, and the Campbell beach is just to the west. West of the latter beach is a low wave-cut(?) scarp. The trellised drainage pattern is controlled by the ridges.

Ohio 1. Pleistocene lake beaches east of Elyria

County: Lorain.
Lat 41°25′ N.; long 82°03′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: May 16, 1960.
Map reference: U.S. Geol. Survey Avon and North Olmsted 7½-min quadrangles, scale 1:24,000. Toledo sheet, scale 1:250,000.
Geology reference: Goldthwait, R. P., White, G. W., and Forsyth, J. L., 1961, Glacial map of Ohio: U.S. Geol. Survey Misc. Geol. Inv. Map. I–316.

Features illustrated (*set nos. Ohio 1 A–C in northeast corner of photographs*).—On the lacustrine plain south of Lake Erie the main highways follow sandy and gravelly beach ridges of Wisconsin age. A major highway (State Route 254) enters the west edge of photograph 1 B just north of center and follows the gently curving beaches of Lake Warren northeast to Avon (about 1 in. south of center of north edge of photograph) and thence east beyond the limits of this exposure. Another main road (U.S. Route 20) enters the west edge of photograph 1 B about 3 inches south of the center point, and follows the Lake Whittlesey beach to the northeast, under the Ohio Turnpike, through North Ridgeville, and on the northwest side of an area of woodland (due east of center of photograph).

Okla. 1. Cuesta and strip mine near Lehigh

County: Coal.
Lat 34°26′ N.; long 96°12′ W.
Number of photographs: 3.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: Mar. 4, 1956.
Map reference: U.S. Geol. Survey Lehigh 7½-min quadrangle, scale 1:24,000.
Geology reference: Knechtel, M. M., 1937, Geology and fuel resources of the southern part of the Oklahoma coal field; pt. 2, The Lehigh district, Coal, Atoka, and Pittsburg Counties: U.S. Geol. Survey Bull. 874–B, p. 91–149; geol. map (pl. 11), scale 1:63,360.

Features illustrated (set nos. Okla. 1 A–C in northeast corner of photographs).—A sequence of shale, sandstone, and coal of Pennsylvanian age dips gently northeast at about 400 feet to the mile. A sandstone cuesta from 40 to 80 feet high faces southwest. The dip slope to the northeast is wooded. The strip mine on the cultivated plain west of the cuesta has been opened along the Lehigh coal bed of the McAlester Shale.

Okla. 2. Sigmoid fold in Black Knob Ridge

County: Atoka.
Lat 34°24′ N.; long 96°05′ W.
Number of photographs: 3.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: Feb. 29, 1956.
Map reference: U.S. Geol. Survey Stringtown 7½-min quadrangle, scale 1:24,000.
Geology reference: Hendricks, T. A., 1947, Geology of the western part of the Ouachita Mountains in Oklahoma: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 66, sheet 1, scale 1:42,240.

Features illustrated (set nos. Okla. 2 A–C in northeast corner of photographs).—An S-shaped line of hills rises about 100–160 feet above the surrounding shale lowland. The hills are divisible into two ridges. The western one is the higher of the two and is held up by the Bigfork Chert; the eastern one is composed of Arkansas Novaculite. Shale units (Polk Creek Shale and Missouri Mountain Shale) separate the two ridges. The rocks are tightly folded. The pond is on the axis of a northeast-plunging syncline; to the southeast is an anticline plunging in the same direction. These ridges are part of a narrow structural block bounded by thrust faults that are not visible in these photographs.

Okla. 3. Pine Mountain syncline

County: Le Flore.
Lat 34°55′ N.; long 94°40′ W.
Number of photographs: 4.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Feb. 9, 1955.
Map reference: U.S. Geol. Survey Heavener 15-min quadrangle, scale 1:62,500.
Geology reference: Miser, H. D., 1954, Geologic map of Oklahoma: U.S. Geol. Survey, scale 1:500,000.

Features illustrated (set nos. Okla. 3 A–D in northeast corner of photographs).—These photographs show a folded sequence of Pennsylvanian sedimentary rocks. Narrow sandstone ridges are separated by broad lowlands underlain by shale. The locality is near Heavener, about on the boundary between the Ouachita Mountains and the Arkansas Valley. Pine Mountain syncline (south half of photograph 3 B), held up by the Hartshorne Sandstone, plunges eastward and is bordered on the south by the meandering Poteau River. To the north, sandstone ridges outline an east-plunging anticline (center of photograph 3 C). Strip mines have been opened in the rocks of Pine Mountain, and the same rocks form a narrow ridge north of the anticline (northwest quadrant of photograph 3 D).

Okla. 4. Rich Mountain syncline

County: Le Flore.
Lat 34°41′ N.; long 94°34′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Feb. 12, 1955.
Map reference: U.S. Geol. Survey Page 15-min quadrangle, scale 1:62,500.
Geology reference: Seely, D. R., 1963, Structure and stratigraphy of the Rich Mountain area, Oklahoma and Arkansas: Oklahoma Geol. Survey Bull. 101, 173 p.; geol. map (pl. 1), scale 1:41,600.

Features illustrated (set nos. Okla. 4 A–C in northeast corner of photographs).—Thick sandstone beds separated by thin shale units (Game Refuge Formation of Mississippian age) form the Wilton Mountain, an east-plunging syncline (east half of photograph 4 B). The surrounding lowlands are underlain largely by shale (Wesley, Markham Mill, and Prairie Mountain Formations). Rich Mountain to the north (center of photograph 4 B) is held up by massive sandstone (Wildhorse

Mountain Formation) on the north limb of the syncline. Small bare masses of scree lie on the south slope of Rich Mountain. The gullied lower slopes on the north side of the mountain are mantled by bouldery colluvuim.

Oreg. 1. Dunes near Cape Lookout

County: Tillamook.
Lat 45°18′ N.; long 123°57′ W.
Number of photographs: 3.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: Aug. 10, 1953.
Map reference: U.S. Geol. Survey Tillamook 15-min quadrangle, scale 1:62,500.
Geology reference: Cooper, W. S., 1958, Coastal sand dunes of Oregon and Washington: Geol. Soc. America Mem. 72, p. 77–78, pls. 2 and 16.

Features illustrated (*set nos. Oreg. 1 A–C in northeast corner of photographs*).—An enormous parabolic-shaped dune, about 3.5 miles long, has its long axis orientated about N. 30° E.; it lies to the northwest of Sand Lake, a broad tidal flat. The seaward side of the sand ridge has been sliced away by the sea on a north-south line. Along the shore near Chamberlain Lake the truncated sand body is about 80 feet high. The main part of the dune is stabilized and densely forested; its outer margins are steep-sided ridges. A strip of bare mobile sand lies along the axis of the parabola from the shore to its northeast tip, including four units, each with an active slip face. Cape Lookout is a narrow rocky headland, bordered by 400-foot cliffs that jut out about 1½ miles into the Pacific Ocean. The Cape and adjacent highlands are composed of Miocene basalt that overlies sandstone and shale, also of Tertiary age and forms the lower hills in the east part of photograph 1 B.

Oreg. 2. Stabilized and active dunes near Siuslaw River

County: Lane.
Lat 44°01′ N.; long 124°07′ W.
Number of photographs: 3.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: Sept. 29, 1954.
Map reference: U.S. Geol. Survey Heceta Head and Siltcoos Lake 15-min quadrangles, scale 1:62,500.
Geology reference: Cooper, W. S., 1958, Coastal sand dunes of Oregon and Washington: Geol. Soc. America Mem. 72, p. 88–93, pls. 3, 7, 14, 15, and 17.

Features illustrated (*set nos. Oreg. 2 A–C in southeast corner of photographs*).—North of the river (photograph 2 B), the dune complex is more than 3 miles wide. A north-south highway follows a flat densely forested plain where sand is completely stabilized. To the east and west are areas of active sand, elongate north-south. The lakes near the north edge of the same exposure are streams ponded by dune sand. The longshore (northward) transport of suspended sediment is indicated both by turbidity patterns in the sea and by the northward shift of the mouth of Siuslaw River, a distance of about 3 miles.

Oreg. 3. Coastal dunes near Siltcoos River

County: Douglas and Lane.
Lat 43°53′ N.; long 124°09′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 14, 1952.
Map reference: U.S. Geol. Survey Siltcoos Lake 15-min quadrangle, scale 1:62,500.
Geology reference: Cooper, W. S., 1958, Coastal sand dunes of Oregon and Washington: Geol. Soc. America Mem. 72, p. 104–110, pls. 3, 19, and 20.

Features illustrated (*set nos. Oreg. 3 A–C in southeast corner of photographs*).—North of the river (north half of photograph 3 B) the dune belt, about 1¾ miles wide, is largely bare sand broken by a few small forested areas. The bare sand has a pattern of northeast-trending ridges transverse to the prevailing winds; near the east edge of the area this pattern is superposed on larger northwest-trending sand ridges. South of the river the dune belt is less than a mile wide between mountains and beach. Between beach and dunes is a strip of small hillocks, in part grassed, which Cooper calls a "marram-grass foredune."

Oreg. 4. Crater Lake

County: Klamath.
Lat 42°56′ N.; long 122°06′ W.
Number of photographs: 5.
Photograph scale: 1:54,000.
Focal length: 6 in.
Date flown: Aug. 9, 1953.
Map reference: U.S. Geol. Survey Medford sheet, scale 1:250,000.
Geology reference: Williams, Howel, 1941, Crater Lake, the story of its origin: Berkeley, California Univ. Press, 97 p.

Features illustrated (*set nos. Oreg. 4 A–E in northeastern corner of photographs*).—These photographs show the lake and a part of the eastern and western slopes of Mount Mazama. The U-shaped valleys on the slopes of the volcano are cut off by the walls of the crater. These valleys were carved by alpine glaciers that mantled the upper slopes of the volcano at the time of the violent eruptions that led to the disappearance of the top of Mount Mazama and the formation of Crater Lake and Wizard Island, a cinder cone.

Oreg. 5. Patterned ground south of Owyhee Reservoir

County: Malheur.
Lat 43°14′ N.; long 117°25′ W.
Number of photographs: 2.
Photograph scale: 1:27,700.
Focal length: 5.2 in.
Date flown: Sept. 14, 1946.

Map reference: U.S. Geol. Survey Boise sheet, scale 1:250,000.
Geology reference: Malde, H. E., 1964, Patterned ground in the western Snake River Plain, Idaho: Geol. Soc. America Bull., v. 75, no. 3, p. 191–208.

Features illustrated (set nos. Oreg. 5 A–B in northeast corner of photographs).—Mounds of silt surrounded by rock rubble form a distinctive spotted pattern on weathered upland basalt and rhyolite. The pattern is characteristic of extensive basaltic terranes in the Columbia Plateau and the Snake River Plain; it is presumably a periglacial landform.

Pa. 1. Nippenose Valley anticline

County: Lycoming and Clinton.
Lat 41°10′ N.; long 77°12′ W.
Number of photographs: 4.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Oct. 25, 1956.
Map reference: U.S. Geol. Survey Williamsport 15-min quadrangle, scale 1:62,500.
Geology reference: Gray, Carlyle, and others, 1960, Geologic map of Pennsylvania: Pennsylvania Geol. Survey, 4th ser., scale 1:250,000.

Features illustrated (set nos. Pa. 1 A–D in southwest corner of photographs).—Ordovician limestones on the crest of a northeast-trending anticline floor Nippenose Valley (south half of photograph 1 C) where there are many sinkholes. The valley is completely surrounded by ridges of outward-dipping quartzitic sandstone of the Juniata and Tuscarora Formations. The surface drainage of the valley is by way of Antes Creek that flows northward through a gorge into the broad valley of the West Branch Susquehanna River near Jersey Shore. This valley is underlain in large part by shale of Silurian and Devonian age. On the south edge of the flood plain of the West Branch, Antes Creek has built an alluvial fan.

Pa. 2. Strip mines in anthracite coal near Mount Pleasant

County: Schuylkill.
Lat 40°42′ N.; long 76°20′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 29, 1958.
Map reference: U.S. Geol. Survey Minersville 7½-min quadrangle, scale 1:24,000.
Geology reference: Wood, G. H., Jr., Trexler, J. P., Yelenosky, Andy, and Soren, Julian, 1958, Geology of the northern half of the Minersville quadrangle and a part of the northern half of the Tremont quadrangle, Schuylkill County, Pennsylvania: U.S. Geol. Survey Coal Inv. Map C–43, scale 1:12,000.

Features illustrated (set nos. Pa. 2 A–C in southeast corner of photographs).—The coal beds occur in closely folded synclines; so, in general, the mines outline synclines and the wooded areas anticlines. In the central part of photograph 2 B, for example, the east-northeast-trending belt of strip mines just north of the center of the photograph is along a syncline. The adjacent anticline to the south is marked by a strip of woods that passes through the center of the photograph, and the next syncline passes under the large flat-topped heap of coal-mine debris (gray areas east of center of same exposure).

Near the west edge of the photograph the northern syncline is replaced by several minor folds whose axes rise westward. Rocks stratigraphically below the coal beds are brought to the ground surface. The traces of several thrust faults cross the photographs but are not readily apparent.

Pa. 3. Hickory Run boulder field, Pocono Plateau

County: Carbon.
Lat 41°03′ N.; long 75°39′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: June 8, 1959.
Map reference: U.S. Geol. Survey Stoddartsville 15-min quadrangle, scale 1:62,500.
Geology reference: Smith, H. T. U., 1953, The Hickory Run boulder field, Carbon County, Pennsylvania: Am. Jour. Sci., v. 251, no. 9, p. 625–642.

Features illustrated (set nos. Pa. 3 A–B in southeast corner of photographs).—The boulder field (northeast quadrant of photograph 3 A) is a bare expanse of boulders of locally derived quartzitic sandstone and conglomerate as much as 20 feet long. The field slopes about 1°. Smith believes that the boulder field was formed when the Wisconsin ice sheet was close by. The terminal moraine lies just north of the field outside the area of overlap.

Pa. 4. Ice-marginal delta near Saylorsburg

County: Monroe.
Lat 40°56′ N.; long 75°18′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Apr. 24, 1957.
Map reference: U.S. Geol. Survey Saylorsburg 7½-min quadrangle, scale 1:24,000.

Features illustrated (set nos. Pa. 4 A–C in northeast corner of photographs).—Flat-topped grassy hill in center of photograph 4 B is a delta; borrow pit on its east edge (at west end of bedrock ridge) exposes gravel and sand. The delta was built by a melt-water stream emerging from ice that covered much of the northeast quadrant of the photograph and which dammed the northeast drainage (McMichael Creek) tributary to Delaware River. The discontinuous ridge north of the delta is probably an esker formed by the delta-building stream. Depressions, chiefly at the northeast edge of the delta, are kettles. Lacustrine silt and clay underlie lowlands east, south, and west of delta. The hills in the southwest corner of the photograph were not glaciated in Wisconsin time (J. B. Epstein, written commun., 1964).

Pa. 5. Terminal moraine at Bangor

County: Northampton and Monroe.
Lat 40°53′ N.; long 75°13′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Apr. 24, 1951.
Map reference: U.S. Geol. Survey Stroudsburg, Saylorsburg, Wind Gap, and Bangor 7½-min quadrangles, scale 1:24,000.
Geology reference: Leverett, Frank, 1934, Glacial deposits outside the Wisconsin terminal moraine in Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. G 7.

Features illustrated (set nos. Pa. 5 A–C in northeast corner of photographs).—Wisconsin terminal moraine on the southeast slope of Blue Mountain near Bangor. A belt of hummocky topography with many small ponds and swamps and as much as half a mile wide extends north and south in the eastern half of photograph 5 B. In Blue Mountain (northwest quadrant of photograph 5 C), the quartzite and conglomerate of the Shawangunk Conglomerate overlie the Martinsburg Shale and form a southwestward-plunging syncline. The numerous slate quarries in the Martinsburg near Bangor are now largely inactive.

Pa. 6. Delaware Water Gap

County: Monroe and Northampton, Pa., and Warren, N.J.
Lat 40°58′ N.; long 75°07′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: May 6, 1959.
Map reference: U.S. Geol. Survey Stroudsburg and Portland 7½-min quadrangles, scale 1:24,000; Delaware Water Gap 15-min quadrangle, scale 1:62,500.
Geology reference: Epstein, J. B., 1966, Structural control of wind gaps and water gaps and of stream capture in the Stroudsburg area, Pennsylvania and New Jersey: *in* Geological Survey research 1966, U.S. Geol. Survey Prof. Paper 550-B, p. B80–B86.

Features illustrated (set nos. Pa. 6 A–C in southeast corner of photographs).—Delaware Water Gap is one of the classic water gaps in the Appalachian Highlands, about 1,200 feet deep and less than a mile wide at the top. The nearly flat top of Kittatinny Mountain at the gap was believed by W. M. Davis to be a remnant of his Schooley peneplain preserved on top of the resistant quartzite that can be seen dipping steeply to the northwest. The course of the river through the ridge has been variously attributed to superposition or to structural control related to joints, faults, or plunging folds.

P.R. 1. Doline or sinkhole karst topography

County: Municipio de Camuy.
Lat 18°24′ N.; long 66°51′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Feb. 12, 1963.
Map reference: U.S. Geol. Survey Camuy 7½-min quadrangle, scale 1:20,000.
Geology reference: Monroe, W. H., 1963, Geology of the Camuy quadrangle, Puerto Rico: U.S. Geol. Survey Geol. Quad. Map GQ–197.

Features illustrated (set nos. P.R. 1 A–B in northeast corner of photographs).—Intricate karst topography formed in lower Miocene limestone which dips 3°–5° N. Sinkholes are as deep as 60 meters and towers as high as 40 meters. Apparently bare southern and eastern slopes in the southern part of the area are covered by a mat of ferns in contrast to the densely wooded northern and western slopes. Near the southeast corner of photograph 1 B a stream appears at the head of an alluviated valley, flows north and then east and disappears in a cave (in woods), flows underground to the north, reappears in another alluviated valley, flows through a small gorge, and finally disappears in a cave that is near the east edge of photograph 1 B.

P.R. 2. Tower karst and haystack hills

County: Municipios de Camuy and Hatillo.
Lat 18°26′ N.; long 66°49′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Feb. 8, 1963.
Map reference: U.S. Geol. Survey Camuy 7½-min quadrangle, scale 1:20,000.
Geology reference: Monroe, W. H., 1963, Geology of the Camuy quadrangle, Puerto Rico: U.S. Geol. Survey Geol. Quad. Map GQ–197.

Features illustrated (set nos. P.R. 2 A–C in northeast corner of photographs).—Parallel valleys, apparently joint controlled, are in tower karst on both sides of the canyon of Rio Camuy. The rock is nearly horizontal, very pure compact chalk, cemented on surface to very compact dense limestone. Many mogotes or haystack hills, projecting through a mantle of alluvial clayey sand, appear in photograph 2 C.

P.R. 3. Observatory sinkhole and exhumed buried hill

County: Municipios de Arecibo and Utuado.
Lat 18°21′ N.; long 66°45′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.

Focal length: 6 in.
Date flown: Mar. 21, 1963.
Map reference: U.S. Geol. Survey Bayaney and Utuado 7½-min quadrangles, scale 1:20,000.
Geology reference: Zapp, A. D., Bergquist, H. R., and Thomas, C. R., 1948, Tertiary geology of the coastal plains of Puerto Rico: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 85.

Features illustrated (set nos. P.R. 3 A–C in northeast corner of photographs).—An exceptionally large sinkhole, 400 meters in diameter and 70 meters deep, is the site of the Arecibo Ionospheric Observatory. The entrance of the underground course of Rio Tanamá is just to the south of sinkhole. Mixed doline and tower karst topography are well shown in all three photographs. Smooth topography in the southeast quadrant of photograph 3 B is an inlier of weathered volcanic rocks—an exhumed buried hill. A small tower of limestone just west of the crest is a hum, or residual karst hill.

P.R. 4. Canyon of Rio Grande de Arecibo

County: Municipio de Arecibo.
Lat 18°23′ N.; long 66°41′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Feb. 22, 1963.
Map reference: U.S. Geol. Survey Arecibo and Utuado 7½-min quadrangles, scale 1:20,000.
Geology reference: Zapp, A. D., Bergquist, H. R., and Thomas, C. R., 1948, Tertiary geology of the coastal plains of Puerto Rico: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 85.

Features illustrated (set nos. P.R. 4 A–B in northeast corner of photographs).—The valley of the Rio Grande de Arecibo has an alluvial floor about 1 kilometer wide and almost vertical walls as much as 180 meters high. The surrounding uplands have a well-formed sinkhole karst topography in gently north-dipping Aguada Limestone (northern part of area) and Montebello Member of the Cibao Formation (southern part of area). In the valley near the south edge of the photographs is an area of small tower karst formed in the Lares Limestone.

P.R. 5. Eolianite ridges and sea cliffs on north coast

County: Municipio de Manati.
Lat 18°28′ N.; long 66°29′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Feb. 8, 1963.
Map reference: U.S. Geol. Survey Manati and Barceloneta 7½-min quadrangles, scale 1:20,000.
Geology reference: Monroe, W. H., 1962, Geology of the Manati quadrangle, Puerto Rico: U.S. Geol. Survey Misc. Geol. Inv. Map I–334. 1960, Sinkholes and towers in the karst area of north-central Puerto Rico, *in* Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper 400–B, p. B356–B360.

Features illustrated (set nos. P.R. 5 A–B in northeast corner of photographs).—A ridge of eolianite (calcareous dune sand cemented by action of underground water) forms Punta Marchiquita (center of photograph 5 B). To the west of the area behind (south of) the eolianite ridge are sand flats alternating with marshes; just west of Punta Marchiquita is a small reverberation bay whose beach has the form of the wave front of the refracted waves that enter the narrow mouth of the bay. To the south, a higher ridge of eolianite forms a sea cliff, in part now abandoned. Inland, ridges made up of haystack hills (mogotes) rise above a plain mantled by alluvial sand.

P.R. 6. Joint-controlled solution trenches (zanjones)

County: Municipios de Morovis and Ciales.
Lat 18°22′ N.; long 66°27′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Jan. 16, 1964.
Map reference: U.S. Geol. Survey Ciales 7½-min quadrangle, scale 1:20,000.
Geology reference: Monroe, W. H., 1964, The zanjón, a solution feature of karst topography in Puerto Rico, *in* Geological Survey research 1964: U.S. Geol. Survey Prof. Paper 501–B, p. B126–B129; see fig. 4.

Features illustrated (set nos. P.R. 6 A–C in northeast corner of photographs).—The southeast quadrant of photograph 6 B shows compound or multiple zanjones—enlarged solution joints that form parallel valleys in thin-bedded limestone. In the southwest quadrant of the same exposure there is a lateral facies change to massive limestone and well-formed tower karst. In the north half of the same exposure the massive limestone is overlain by calcareous clay. A steep south-facing escarpment at the extreme north edge of the same photograph is a cuesta capped by a thick bed of hard limestone.

P.R. 7. Tower karst

County: Municipios de Vega Baja and Manati.
Lat 18°24′ N.; long 66°26′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Feb. 12, 1963.
Map reference: U.S. Geol. Survey Manati 7½-min quadrangle, scale 1:20,000.
Geology reference: Monroe, W. H., 1962, Geology of the Manati quadrangle, Puerto Rico: U.S. Geol. Survey Misc. Geol. Inv. Map I–334. Monroe, W. H., 1960, Sinkholes and towers in the karst area of north-central Puerto Rico, *in* Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper 400–B, p. B356–B360.

Features illustrated (set nos. P.R. 7 A–B in northeast corner of photographs).—Mogotes or haystack hills surrounded by alluvial "blanket" sand. Many mogotes are steeper on their west-facing slopes than on their east-facing slopes; shelter caves and cliffs are common on the west-facing slopes but rare on other slopes.

P.R. 8. Landslides near Corozal

County: Municipios de Corozal and Vega Alta.
Lat 18°21′ N.; long 66°21′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Jan. 16, 1964.
Map reference: U.S. Geol. Survey Corozal 7½-min quadrangle, scale 1:20,000.
Geology reference: Monroe, W. H., 1964, Large retrogressive landslides in northern Puerto Rico, *in* Geological Survey research 1964: U.S. Geol. Survey Prof. Paper 501–B, p. B123–B125.

Features illustrated (*set nos. P.R. 8 A–B in northeast corner of photographs*).—The triangular-shaped lowland, largely in the northwest quadrant of photograph 8 A, is bounded on the north and southwest by limestone cliffs. To the south and southeast are low hills of volcanic and intrusive rocks. The lowland is covered by landslide debris whose surface is irregular and hummocky in contrast to the fine-scale dissection of the igneous rocks to the south and the tower karst on the limestone to the east and west. As the Río Cibuco, that skirts the north edge of the lowland, cut down through the limestone, blocks of the limestone broke off the adjacent cliffs and slid on the clay that underlies the massive beds. By these processes the lowland has been widened and mantled by bouldery deposits.

R.I. 1. Charlestown ablation moraine

County: Washington.
Lat 41°24′ N.; long 71°36′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Nov. 12, 1951.
Map reference: U.S. Geol. Survey Kingston and Carolina 7½-min quadrangles, scale 1:24,000.
Geology reference: Kaye, C. A., 1960, Surficial geology of the Kingston quadrangle, Rhode Island: U.S. Geol. Survey Bull. 1071–I, p. 341–396.

Features illustrated (*set nos. R.I. 1 A–D in southeast corner of photographs*).—A segment of the Charlestown moraine (north half of photograph 1 B) and its outwash plain (south half of same photograph). The ridges on the moraine represent superglacial debris that slid into crevasses in the wasting ice; the mound-shaped hills are similar fillings of large depressions in the ice. The material is till and some sand and gravel. The ridges fronting the moraine on the north and south are colluvial ramparts. Stratified sand and gravel form the outwash plain that slopes gently southward from the moraine and is drowned at its southern edge where ponds are formed by building of beaches between headlands.

S.C. 1. Cottonpatch Bay

County: Horry.
Lat 33°47′ N.; long 78°57′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Feb. 23, 1958.
Map reference: U.S. Geol. Survey Nixonville and Myrtle Beach 15-min quadrangles, scale 1:62,500.
Geology reference: Prouty, W. F., 1952, Carolina Bays and their origin: Geol. Soc. America Bull., v. 63, p. 167–224.

Features illustrated (*set nos. S.C. 1 A–C in southeast corner of photographs*).—Cottonpatch Bay (north half of photograph 1 B), an elliptical-shaped swamp about three-quarters of a mile in diameter, is surrounded by a nearly continuous low sandy ridge. The Carolina "bays" are particularly abundant on the Carolina coastal plain and have been the subject of controversy since they first became readily discernible with the advent of aerial photography.

These bays transect many narrow closely spaced parallel sandy ridges and swamps, apparently ancient shore features.

S. Dak. 1. Cuestas near Hot Springs on southeast flank of Black Hills

County: Fall River and Custer.
Lat 43°27′ N.; long 103°25′ W.
Number of photographs: 5.
Photograph scale: 1:68,800.
Focal length: 6 in.
Date flown: Aug. 25, 1953.
Map reference: U.S. Geol. Survey Hot Springs, Minnekahta NE., and Buffalo Gap 7½-min quadrangles, scale 1:24,000.
Geology reference: Darton, N. H., 1902, Description of the Oelrichs quadrangle [South Dakota]: U.S. Geol. Survey Geol. Atlas, Folio 85. (Out of print.)

Features illustrated (*set nos. S. Dak. 1 A–E in northeast corner of photographs*).—Carboniferous, Jurassic, and Cretaceous sedimentary rocks dip southeast off the Black Hills uplift. Carboniferous limestone forms hills just west of Hot Springs (southwest quadrant of photograph 1 D). The city is in a shale lowland (Spearfish) bounded to the east by hills of Jurassic and Cretaceous rocks, capped by Dakota Sandstone (southwest and northeast quadrants of photograph 1 C). The Dakota forms a conspicuous dip slope on west side of broad shale valley (southeast quadrant of same photograph) that contains a low but prominent limestone cuesta. Gravel terraces border the meandering Cheyenne River (southeast quadrant of photograph 1 B).

S. Dak. 2. Sheep Mountain Table, Badlands National Monument

County: Shannon and Pennington.
Lat 43°41′ N.; long 102°34′ W.
Number of photographs: 3.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: Oct. 13, 1948.
Map reference: U.S. Geol. Survey Sheep Mountain Table 7½-min quadrangle, scale 1:24,000.
Geology reference: Smith, K. G., 1958, Erosional processes and land forms in Badlands National Monument, South Dakota: Geol. Soc. America Bull., v. 69, no. 8, p. 975–1008.

Features illustrated (set nos. S. Dak. 2 A–C in northeast corner of photographs).—This flat mesa is surrounded by badlands carved in essentially flat-lying beds of clay, lenticular sandstone, conglomerate, and volcanic ash of Oligocene age. The edge of the mesa is frayed by many small gullies that have a dendritic pattern. The floors of the badland washes on either side of the mesa are 300–400 feet below the mesa top.

S. Dak. 3. Clastic dikes in badlands at head of Conata Basin

County: Pennington.
Lat 43°51′ N.; long 102°15′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 21, 1938.
Map reference: U.S. Geol. Survey Quinn Table SE. and Wall SW. 7½-min quadrangles, scale 1:24,000.
Geology reference: Smith, K. G., 1958, Erosional processes and landforms in Badlands National Monument, South Dakota: Geol. Soc. America Bull., v. 69, no. 8, p. 975–1008.

Features illustrated (set nos. S. Dak. 3 A–B in southeast corner of photographs).—Flat-lying beds of clay, lenticular sandstone, conglomerate, and volcanic ash are eroded into badlands. Those in the north half of photograph 3 B form a divide—the Wall—between washes draining southward to White River and those that empty into the Cheyenne River to the northwest. The plain south of the Wall has a sod cover, and at its upper end is about 200 feet below the headwaters of the tributaries of the Cheyenne River. Sandstone dikes are conspicuous in the Oligocene sedimentary rocks of the Wall.

Tenn. 1. Sequence of abandoned meanders near Reelfoot Lake

County: Lake and Obion (Tenn.), Fulton (Ky.), and New Madrid (Mo.).
Lat 36°27′ N.; long 89°22′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Oct. 23, 1952.
Map reference: U.S. Geol. Survey Tiptonville and Samburg 7½-min quadrangles, scale 1:24,000.
Geology reference: Fisk, H. N., 1944, Geological investigations of the alluvial valley of the lower Mississippi River: Vicksburg, Miss., Mississippi River Comm., 78 p.; see pl. 22, sheet 2, scale 1:62,500.

Features illustrated (set nos. Tenn. 1 A–C in southeast corner of photographs).—The conspicuous meandering channel in the east half of photograph 1 B contains a 2-mile-long pond (Fisk's stage 5). The low curving ridges (scrolls) on either side of the conspicuous channel (south half of the same photograph) are slightly older channels (Fisk's stages 1–4). The scrolls adjacent and nearly parallel to the Mississippi River are younger than the channel (Fisk's stages 12–16 and 19). The channel (stage 5) makes an almost complete oval. In the north half of photograph 1 C it curves west and southwest, and in the north half of photograph 1 A it enters the photograph just east of the center of the north edge; it makes a 180° turn near the center of the photograph and leaves just west of the center of the north edge. The east-west-trending scrolls within the oval are traces of the oldest channels shown (Fisk's stages E–J).

Reelfoot Lake in the south half of photograph 1 A (not in stereo) was formed about 1813 during the New Madrid earthquake.

Tenn. 2. Avalanche chutes on Mount Le Conte, Great Smoky Mountains

County: Sevier and Swain.
Lat 35°39′ N.; long 83°26′ W.
Number of photographs: 3.
Photograph scale: 1:28,000.
Focal length: 6 in.
Date flown: Mar. 30, 1963.
Map reference: U.S. Geol. Survey Great Smoky Mountains National Park, Tennessee and North Carolina (east half), scale 1:62,500.
Geology reference: Hadley, J. B., and Goldsmith, Richard, 1963, Geology of the eastern Great Smoky Mountains, North Carolina and Tennessee: U.S. Geol. Survey Prof. Paper 349–B, 118 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (set nos. Tenn. 2 A–C in northeast corner of photographs).—The higher parts of the mountains consist of steep-sided ridges (slopes 20° or more) with narrow crests that range in altitude from about 5,500 to 6,500 feet. Forests cover the entire area except for a few heath balds on higher crests. The first-order hollows or ravines are closely spaced; the drainage density is high. The average annual rainfall is probably more than 60 inches. Avalanche scars on the south slope of Mount Le Conte (narrow white bands in north-central part of photograph 2 B) were formed during a summer thunderstorm in 1951. In the area of the avalanches the bedrock is largely slate and phyllite; elsewhere the rock is chiefly metamorphosed sandstone with interbedded slate, phyllite, and schist. All the rocks are variously folded, faulted, and metamorphosed.

The strike of the foliation commonly trends in a northeasterly direction.

Tex. 1. Strongly folded Paleozoic rocks of the Marathon Basin

County: Brewster.
Lat 30°08′ N.; long 103°08′ W.
Number of photographs: 3.
Photograph scale: 1:63,360.
Focal length: 5.2 in.
Date flown: May 15, 1954.
Map reference: U.S. Geol. Survey Marathon 15-min quadrangle, scale 1:62,500.
Geology reference: King, P. B., 1937, Geology of the Marathon region, Texas: U.S. Geol. Survey Prof. Paper 187, 148 p.; geol. map (pl. 24), scale 1:62,500.

Features illustrated (*set nos. Tex. 1 A–C in southwest corner of photographs*).—A part of the Marathon Basin, an area of low country where the surrounding Cretaceous rocks have been stripped off to expose strongly folded Paleozoic rocks. The prominent narrow zigzag ridges are composed of novaculite and of limestone; the lowlands are underlain by sandstone, shale, and limestone. The Paleozoic rocks form close folds. The folds trend northeast and are overturned to the northwest. The folds are broken by thrust faults and locally by many cross faults. The regional structure is beautifully shown on these photographs that are at approximately the same scale as King's geologic map.

Tex. 2. Sierra Diablo, a tilted and faulted plateau

County: Hudspeth and Culberson.
Lat. 31°17′ N.; long. 104°54′ W.
Number of photographs: 3.
Photograph scale: 1:43,150.
Focal length: 5.2 in.
Date flown: Feb. 13, 1948.
Map reference: U.S. Geol. Survey Van Horn sheet, scale 1:250,000.
Geology reference: King, P. B., 1965, Geology of Sierra Diablo region, Texas: U.S. Geol. Survey Prof. Paper 480, 185 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (*set nos. Tex. 2 A–C in southeast corner of photographs*).—The Sierra Diablo or Diablo Plateau lies on the west side of Salt Basin, a prominent down-faulted block in the Sacramento section of the Basin and Range province. These photographs show a part of the southern end of the plateau about 15 miles north of Van Horn. Drainage on the plateau is westward from the more than 1,000-foot escarpment that overlooks Salt Basin. Carboniferous or Permian limestone unconformably overlies Precambrian sandstone. The limestone dips very gently northeastward and is cut by northwest-trending normal faults. Both fault and bedding planes can be seen in these photographs.

Tex. 3. Sinkholes on the southern High Plains

County: Ector and Crane.
Lat. 31°40′ N.; long. 102°25′ W.
Number of photographs: 2.
Photograph scale: 1:63,360.
Focal length: 5.2 in.
Date flown: May 3, 1954.
Map reference: U.S. Geol. Survey Pecos sheet, scale 1:250,000.
Geology reference: Hoots, H. W., 1926, Geology of a part of western Texas and southeastern New Mexico, with special reference to salt and potash: U.S. Geol. Survey Bull. 780, p. 33–126; geol. map, (pl. 10), scale 1:1,000,000.

Features illustrated (*set nos. Tex. 3 A–B in southwest corner of photographs*).—The slightly dissected eastern edge of the southern High Plains or Llano Estacado is dotted with shallow sinkholes. The plains are mantled by upper Cenozoic alluvial and eolian deposits cemented near the surface by caliche (includes the Ogallala and younger formations). The underlying indurated bedrock is limestone and sandstone of Cretaceous age. These rocks are largely concealed. The rock benches on the sides of shallow valleys in the southeast quadrant of photograph 3 A are sandstone.

Tex. 4. High Plains escarpment east of Lubbock

County: Crosby.
Lat 33°35′ N.; long 101°13′ W.
Number of photographs: 2.
Photograph scale: 1:63,360.
Focal length: 5.2 in.
Date flown: Jan. 23, 1954.
Map reference: U.S. Geol. Survey Lubbock sheet, scale 1:250,000.
Geology reference: Frye, J. C., and Leonard, A. B., 1957, Studies of Cenozoic geology along the eastern margin of the Texas High Plains, Armstrong to Howard Counties: Texas Univ. Bur. Econ. Geology Rept. Inv. 32, 62 p.

Features illustrated (*set nos. Tex. 4 A–B in northeast corner of photographs*).—Escarpment on the west side of White River (east half of photograph 4 A), a tributary of Brazos River. Massive beds of sand cemented by caliche cap the plains and in many places rest directly on sand and gravel (Ogallala Formation of Pliocene age). Triassic sedimentary rocks crop out near White River. Badlands east of the escarpment have a high drainage density compared with the virtually undissected plains to the west where numerous large shallow depressions are as much as half a mile in diameter.

Tex. 5. Dissected plateaus carved in flat-lying well-bedded limestone

County: Val Verde.
Lat 29°56′ N.; long 101°12′ W.
Number of photographs: 2.
Photograph scale: 1:46,000.
Focal length: 6 in.
Date flown: Apr. 24, 1950.
Map reference: U.S. Geol. Survey Bakers Crossing 15-min quadrangle, scale 1:62,500.
Geology reference: Freeman, V. L., 1965, Geologic map of the

Bakers Crossing quadrangle, Val Verde County, Texas: U.S. Geol. Survey Misc. Geol. Inv. Map I-434, scale 1:62,500.

Features illustrated (set nos. Tex. 5 A–B in northeast corner of photographs).—In the southern part of the Edwards Plateau, flat-lying Upper Cretaceous limestones show finely banded outcrop patterns. The small gray-toned plateau tops in the southwest quadrant of photograph 5 A are capped by a thin-bedded flaggy limestones (Boquillas Flags). Surrounding these flats are lighter toned gentle slopes that extend down to a conspicuous light band. These slopes are bare outcrops of thin- to thick-bedded limestone (Buda Limestone). The lower and steeper slopes, down to floors of narrow valleys tributary to Devils River (northeast quadrant of photograph 5 A), are underlain by thin- to thick-bedded gray limestone (Georgetown Limestone). Total relief is about 300 feet.

Tex. 6. Paleozoic and Cretaceous rocks along the Pedernales River

County: Gillespie and Blanco.
Lat 30°14′ N.; long 98°36′ W.
Number of photographs: 4.
Photograph scale: 1:19,000.
Focal length: 6 in.
Date flown: Mar. 8, 1958.
Map reference: U.S. Geol. Survey Cave Creek School, Rocky Creek, Stonewall, and Hye 7½-min quadrangles, scale 1:24,000.
Geology references: Barnes, V. E. [1952], Geologic map of the Gold quadrangle, Gillespie County, Texas: Texas Univ. Bur. Econ. Geology Geol. Quad. Map [No. 9], scale 1:31,680. [1952], Geologic map of the Stonewall quadrangle, Gillespie and Kendall Counties, Texas: Texas Univ. Bur. Econ. Geology Geol. Quad. Map [No. 14], scale 1:31,680. [1952], Geologic map of tbe North Grape Creek quadrangle, Blanco and Gillespie Counties, Texas: Texas Univ. Bur. Econ. Geology Geol. Quad. Map [No. 10], scale 1:31,680.

Features illustrated (set nos. Tex. 6 A–D in northeast corner of photographs).—The Pedernales River separates Cretaceous limestones of the Edwards Plateau to the south from Precambrian and Paleozoic rocks of the Central Mineral district to the north. Near the north edge of photograph 6 D, granite crops out on the crest of a west-trending anticline. Steeply dipping beds of sandstone and limestone (Cambrian) on the south limb of the anticline cross the northeast-flowing Pedernales River. Further upriver and in the beds of small tributary streams, flat-lying beds of limestone and dolomite are visible in many places. The adjacent lowlands have a thin covering of virtually flat-lying Lower Cretaceous sand, silt, and clay, including beds of limestone in the upper part. The Paleozoic rocks commonly form wooded hills and project above the adjacent lowlands of Cretaceous rocks.

Utah 1. Open pit at Bingham

County: Salt Lake.
Lat 40°32′ N.; long 112°08′ W.
Number of photographs: 3.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: June 20, 1950.
Map reference: U.S. Geol. Survey Bingham Canyon and Lark 7½-min quadrangles, scale 1:24,000.
Geology reference: Hunt, R. N., 1933, Bingham mining district: Internat. Geol. Cong., 16th, Washington, 1933, Guidebook 17, Excursion 2, p. 45–56.

Features illustrated (set nos. Utah 1 A–C in southeast corner of photographs).—This great open pit is nearly 1,500 feet deep and 2 miles in diameter. The ore is disseminated pyrite and lesser amounts of copper sulfides in monzonite, quartzite, and limestone.

Utah 2. Faulted moraines at mouth of Little Cottonwood Canyon

County: Salt Lake.
Lat 40°34′ N.; long 111°48′ W.
Number of photographs: 3.
Photograph scale: 1:28,000.
Focal length: 6 in.
Date flown: Aug. 2, 1962.
Map reference: U.S. Geol. Survey Draper 7½-min quadrangle, scale 1:24,000.
Geology reference: Richmond, G. M., 1964, Glaciation of Little Cottonwood and Bells Canyons, Wasatch Mountains, Utah: U.S. Geol. Survey Prof. Paper 454-D, p. D1–D41; geol. map (pl. 1), scale 1:24,000.

Features illustrated (set nos. Utah 2 A–C in southeast corner of photographs).—Moraines of Bull Lake Glaciation form ridges on the south side of the mouth of Little Cottonwood Canyon (larger canyon in northeast quadrant of photograph 2 B) and on either side of the next canyon to the south—Bells Canyon—where the ridge fills the canyon's mouth and encloses a small reservoir. The inner part of Bells Canyon morainic loop is believed by Richmond to belong to the younger Pinedale glaciation. Fault scarps cut the Bull Lake moraines north and south of Bells Canyon reservoir. These moraines merge westward with gravelly deltaic deposits of Pleistocene Lake Bonneville that underlie a westward-sloping plain. South of Bells Canyon are prominent fault scarps and triangular facets on the mountain front.

Utah 3. Glaciation of Little Cottonwood Canyon, Wasatch Mountains

County: Salt Lake.
Lat 40°33′ N.; long 111°42′ W.
Number of photographs: 3.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: June 30, 1950.
Map reference: U.S. Geol. Survey Dromedary Peak 7½-min quadrangle, scale 1:24,000.
Geology reference: Richmond, G. M., 1964, Glaciation of Little Cottonwood and Bells Canyons, Wasatch Mountains,

Utah: U.S. Geol. Survey Prof. Paper 454–D, D1–D41; geol. map (pl. 1), scale 1:24,000.

Features illustrated (*set nos. Utah 3 A–C in southeast corner of photographs*).—The north side of this west-draining canyon has short and steep-sided tributary valleys in contrast to the prominent cirques at the heads of long glacial troughs that drain northward to the main canyon. Small loop moraines of the Pinedale Glaciation cross Little Cottonwood Creek south of the center of the north edge of photograph 3 B. The cirques contain rock glaciers, extensive talus mantles, and small lakes. Arêtes and horns are conspicuous.

Utah 4. Landslides on Thousand Lake Mountain

County: Wayne.
Lat 38°25′ N.; long 111°30′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 17, 1952.
Map reference: U.S. Geol. Survey Torrey and Loa 15-min quadrangles, scale 1:62,500.
Geology reference: Smith, J. F., Huff, L. C., Hinrichs, E. N., and Luedke, R. G., 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U.S. Geol. Survey Prof. Paper 363, 102 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (*set nos. Utah 4 A–D in southeast corner of photographs*).—The mountain is composed of Cretaceous shale and sandstone capped by lava flows. Its upper slopes are mantled by landslide debris. The elongate ridges west of the scarp surrounding the flat treeless summit (photograph 4 D) are tilted, and in places jumbled blocks of lava have slid only short distances. Farther down the slope to the west (southwest quadrant of photograph 4 A), younger landslide deposits have long ridges that parallel the direction of movement of the material downslope between projecting hills of bedrock.

Utah 5. Landslide on north slope of Boulder Mountain

County: Wayne.
Lat 38°16′ N.; long 111°29′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 29, 1950.
Map reference: U.S. Geol. Survey Torrey and Grover 15-min quadrangles, scale 1:62,500.
Geology reference: Flint, R. F., and Denny, C. S., 1958, Quaternary geology of Boulder Mountain, Aquarius Plateau, Utah: U.S. Geol. Survey Bull. 1061–D, p. 103–164; geol. map (pl. 6), scale 1:63,360. See fig. 29. Smith, J. F., Jr., Huff, L. C., Hinrichs, E. N., and Luedke, R. G., 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U.S. Geol. Survey Prof. Paper 363, 102 p.; geol. map (pl. 1), scale 1:62,500.

Features illustrated (*set nos. Utah 5 A–B in southeast corner of photographs*).—Lower part of a complex landslide (west half of photograph 5 B) on the north slope of Boulder Mountain. The terminal part of the slide (northwest quadrant of same photograph) is a lobate earthflow that fills an older valley and has well-defined margins. The toe is convex downstream. Upstream and parallel to it are several arcuate ridges. The central part of the slide (southwest quadrant of photograph 5 B) consists of boulders and finer debris arranged in discontinuous irregular ridges parallel with the margin of the slide. This landslide is the Coleman slide of Flint and Denny. The mountain summit and upper slopes are shown in Utah 6.

Utah 6. Drift lobe and rock glaciers on Boulder Mountain

County: Wayne.
Lat 38°13′ N.; long 111°29′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 29, 1950.
Map reference: U.S. Geol. Survey Grover 15-min quadrangle, scale 1:62,500.
Geology reference: Flint, R. F., and Denny, C. S., 1958, Quaternary geology of Boulder Mountain, Aquarius Plateau, Utah: U.S. Geol. Survey Bull. 1061–D, p. 103–164, fig. 25; geol. map, scale 1:63,360. Smith, J. F., Jr., Huff, L. C., Hinrichs, E. N., and Luedke, R. G., 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U.S. Geol. Survey Prof. Paper 363, 102 p., fig. 19; geol. map, scale 1:62,500.

Features illustrated (*set nos. Utah 6 A–C in southeast corner of photographs*).—An icecap on the flat top of Boulder Mountain (south part of photograph 6 C) spilled northward over the summit cliff and flowed northeast for a distance of about 3 miles from the cliff (northeast corner of photograph 6 B). The surface of the drift deposited by this ice lobe is irregular and hummocky, with many undrained depressions, some of which contain lakes. At a later time, rock glaciers formed along the base of the cliff. These bulbous masses of bouldery material show concentric ridges, particularly near the terminal margins. Boulder Mountain, a part of the Aquarius Plateau, is underlain by almost flat-lying Tertiary volcanic rocks. The plateau top is at an altitude of about 11,000 feet.

Utah 7. Fracture patterns in Navajo Sandstone of Capitol Reef

County: Wayne.
Lat 38°18′ N.; long 111°14′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Oct. 29, 1950.
Map reference: U.S. Geol. Survey Fruita 15-min quadrangle, scale 1:62,500.
Geology reference: Smith, J. F., Jr., Huff, L. C., Hinrichs, E. N., and Luedke, R. G., 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U.S. Geol. Survey Prof. Paper 363, 102 p.; geol. map, scale 1:62,500.

Features illustrated (*set nos. Utah 7 A–B in southeast corner of photographs*).—North-trending fractures in thick beds of Navajo Sandstone forming crest of Capitol Reef control a conspicuous pattern of gullies and ravines which have almost vertical walls as much as several hundred feet high. The beds dip very gently to the east and are overlain (in northeast quadrant photograph 7 A) by a sequence of even-bedded siltstone, claystone, sandstone, and gypsum (Carmel Formation) that lack conspicuous joints. Some of the southeast-trending lineaments are along faults. The village of Fruita (southwest corner of photograph 7 A) is at the point where Fremont River enters the Reef. A high gravel terrace lies just to the west of the village.

Utah 8. Capitol Reef, a monocline, near Pleasant Creek

County: Wayne.
Lat 38°12′ N.; long 111°11′ W.
Number of photographs: 2.
Photograph scale: 1:31,680.
Focal length: 6 in.
Date flown: July 17, 1938.
Map reference: U.S. Geol. Survey Notom 15-min quadrangle, scale 1:62,500.
Geology reference: Hunt, C. B., Averitt, Paul, and Miller, R. L., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, 234 p., fig. 94; geol. map, scale 1:125,000. Smith, J. F., Jr., Huff, L. C., Hinrichs, E. N., and Luedke, R. G., 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U.S. Geol. Survey Prof. Paper 363, 102 p.; geol. map, scale 1:62,500.

Features illustrated (*set nos. Utah 8 A–B in southeast corner of photographs*).—Capitol Reef is the boundary between the High Plateaus of Utah and the Canyon Lands sections of the Colorado Plateaus province. Eastward-dipping Triassic and Jurassic sedimentary rocks form an impressive monocline more than 1,000 feet high, locally known as a reef. The prominent cliff west of the center of the photographs is the Wingate Sandstone; west of it are Triassic shale, siltstone, sandstone, and limestone that near the west edge of the photographs underlie a dip slope. The ledge above the Wingate cliff is the Kayenta Formation.

The white sandstone knobs and domes (east half of photographs) are the Navajo Sandstone. Some of the domes resemble in form the dome of the Capitol in Washington, D.C., from which feature the reef takes its name. Conspicuous joints parallel the strike of the Navajo Sandstone and can be seen to pass under the overlying and unjointed Carmel Formation.

Utah 9. Badlands near South Caineville mesa

County: Wayne.
Lat 38°18′ N.; long 110°57′ W.
Number of photographs: 2.
Photograph scale: 1:31,680.
Date flown: July 12, 1939.
Map reference: U.S. Geol. Survey Factory Butte 15-min quadrangle, scale 1:62,500.
Geology reference: Hunt, C. B., Averitt, Paul, and Miller, R. L., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, 234 p., fig. 99; geol. map, scale 1:125,000.

Features illustrated (*set nos. Utah 9 A–B in northeast corner of photographs*).—The mesa is capped by the Emery Sandstone Member of the Mancos Shale; the badlands surrounding it are underlain by the Blue Gate Shale Member of the Mancos. Pediments have been formed between the foot of the badlands and the alluvium along Sweetwater Creek (southeast quadrant of photograph 9 B).

Utah 10. Gravel benches on the west side of Mount Ellen

County: Wayne and Garfield.
Lat 38°09′ N.; long 110°53′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Oct. 13, 1955.
Map reference: U.S. Geol. Survey Salina sheet, scale 1:250,000.
Geology reference: Hunt, C. B., Averitt, Paul, and Miller, R. L., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, p. 192, pls. 18 and 19, figs. 103 and 104.

Features illustrated (*set nos. Utah 10 A–C in southeast corner of photographs*).—Hunt has mapped gravel deposits of five different ages on the piedmont west of the Henry Mountains. In the northeast corner of photograph 10 C is circular Table Mountain, a diorite porphyry bysmalith, and the boulder-covered summit ridge of Mount Ellen is in the southeast quadrant of the same photograph. (See Hunt's pl. 18.) The Cedar Creek Benches are near the center of photograph 10 C, and those along Dugout Creek are in the southwest quadrant of the same photograph. Several recently completed or imminent stream diversions are shown. The place where Birch Creek is in imminent danger of being diverted, shown in Utah 11, is in the southeast corner of photograph 10 A.

Utah 11. Imminent stream diversion on north side of Mount Ellen

County: Wayne and Garfield.
Lat 38°13′ N.; long 110°46′ W.
Number of photographs: 3.
Photograph scale: 1:40,000.
Focal length: 6 in.
Date flown: Sept. 6, 1961.
Map reference: U.S. Geol. Survey Salina sheet, 1:250,000.
Geology reference: Hunt, C. B., Averitt, Paul, and Miller, R. L., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, p. 192–195, pls. 18 and 20, figs. 103A and 105.

Features illustrated (*set nos. Utah 11 A–C in southeast corner of photographs*).—Where streams emerge from the Henry Mountains onto the surrounding piedmont, they have steeper gradients and coarser grained bedloads than their tributaries that rise on the piedmont and are cutting largely in shale and thin-bedded sandstone. Stream piracies have occurred and others are imminent. In the central part of the north half of photograph 11 A are the Birch Creek Benches. (See Hunt's pl. 18.) The benches are underlain by gravel deposited by Birch Creek that rises on the north slope of Mount Ellen (southwest quadrant of photograph 11 A) and now flows along the west edge of the benches on the east rim of the headwaters of a deep valley (Jet Basin, northwest quadrant of same photograph). The head (south end) of this valley is north of and several hundred feet lower than Birch Creek where it leaves the mountains. Diversion of Birch Creek northwestward into Jet Basin at a point near the mountain front will require only the breaching of a narrow divide that is 20 feet high.

Utah 12. Sand dunes in Green River Desert

County: Emery.
Lat 38°32′ N.; long 110°35′ W.
Number of photographs: 3.
Photograph scale: 1:31,680.
Focal length: 6 in.
Date flown: Oct. 20, 1938.
Map reference: U.S. Geol. Survey Temple Mountain 15-min quadrangle, scale 1:62,500.
Geology reference: Hunt, C. B., Averitt, Paul, and Miller, R. L., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, p. 175–177, fig. 93.

Features illustrated (*set nos. Utah 12 A–C in southeast corner of photographs*).—Individual sand hills are barchans, concave in plan to leeward (northeast). The barchans are clustered in crescentic arcs that are concave to windward (southwest). Nearly straight ridges of sand extend southwestward from the tips of each crescentic arc. The sand can be seen to bury an area of badlands to west of the north-south road. The bedrock is flat-lying Entrada Sandstone. Gibson Butte in the northwest corner of photograph 12 B is an outlier of the overlying sandstone of the Curtis Formation.

Utah 13. Upheaval Dome

County: San Juan.
Lat 38°26′ N.; long 109°56′ W.
Number of photographs: 4.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Sept. 21, 1951.
Map reference: U.S. Geol. Survey Upheaval Dome 15-min quadrangle, scale 1:62,500.
Geology reference: McKnight, E. T., 1940, Geology of area between Green and Colorado Rivers, Grand and San Juan Counties, Utah: U.S. Geol. Survey Bull. 908, 147 p.; geol. map, pl. 1, scale 1:62,500.

Features illustrated (*set nos. Utah 13 A–D in southeast corner of photographs*).—This symmetrical structure is clearly shown on these excellent photographs. The dome is expressed topographically as a circular lowland, about a mile in diameter, surrounded by a high rim breached at one point by Upheaval Canyon. Shale, mudstone, and sandstone form small irregular hills in the center of the dome surrounded by a lowland (Moenkopi and Chinle Formations). The rim includes an inner and an outer ring of massive sandstone separated by more shaly and thin-bedded rocks (Wingate Sandstone, Kayenta Sandstone, and Navajo Sandstone). Steer Mesa and Holeman Spring are on the south side of Upheaval Dome.

Utah 14. Cliffs and domes in Navajo Sandstone, Zion National Park

County: Washington and Kane.
Lat 37°13′ N.; long 112°55′ W.
Number of photographs: 3.
Photograph scale: 1:63,360.
Focal length: 6 in.
Date flown: June 16, 1953.
Map reference: U.S. Geol. Survey Zion National Park, Zion Canyon Section, scale 1:31,680.
Geology reference: Gregory, H. E., 1950, Geology and geography of the Zion Park region, Utah and Arizona: U.S. Geol. Survey Prof. Paper 220, 200 p.; geol. map (pl. 2), scale 1:125,000.

Features illustrated (*set nos. Utah 14 A–C in southeast corner of photographs*).—Flat-lying massive Jurassic sandstones enclose Zion Canyon (northwest quadrant of photograph 14 B) and Parunuweap Canyon (south edge of same photograph). Both these narrow canyons are floored with Chinle Shale. The Navajo Sandstone forms the canyon rim and shows conspicuous north-south jointing. The smoother upland away from the canyons is underlain by shales of the Carmel Formation. The Great White Throne, a monolith of Navajo Sandstone, stands just south of the horseshoe bend (Big Bend) in Zion Canyon (northwest quadrant of photgraph 14 B). Some of the smaller streams that flow in Navajo Sandstone have meanders that appear to be joint controlled, for example, the stream just southwest of the center of photograph 14 B and in the upper part of Parunuweap Canyon (in southeast quadrant).

Utah 15. Glen Canyon Colorado River below Hite

County: Garfield and San Juan.
Lat 37°46′ N.; long 110°28′ W.
Number of photographs: 3.
Photograph scale: 1:31,680.

Focal length: 6 in.
Date flown: July 23, 1938.
Map reference: U.S. Geol. Survey Hite 15-min quadrangle, scale 1:62,500.
Geology reference: Hunt, C. B., Averitt, Paul, and Miller, R. E., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, 234 p., fig. 87; geol. map, scale 1:125,000.

Features illustrated (set nos. Utah 15 A–C in south corner of photographs).—A U-shaped bend of the river, The Horn (east quadrant of photograph 15 B), is about 6 miles downstream from Hite (north corner of photograph). In the center of the southwest edge of the photograph there is a mesa capped by dark shale of the Carmel Formation (Jurassic). The mesa is about 2,000 feet above the river. The white knobby Navajo Sandstone, below the Carmel, shows conspicuous north-south joints. The still older Kayenta Formation makes smooth slopes and ledges above prominent cliffs of Wingate Sandstone; three benches of Wingate Sandstone between The Horn and Hite show joints in as many different directions. A lower bench just above the river is held up by the Shinarump Conglomerate of Triassic age. Sand bars are in the river at mouths of tributaries.

Vt. 1. Topographic grain related to structural complexity and glacial scour

County: Rutland.
Lat 43°45′ N.; long 73°09′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 27, 1942.
Map reference: U.S. Geol. Survey Bomoseen, Proctor, Brandon, and Sudbury 7½-min quadrangles, scale 1:24,000.
Geology reference: Zen, E-an, 1961, Stratigraphy and structure at the north end of the Taconic Range in west-central Vermont: Geol. Soc. America Bull., v. 72, no. 2, p. 293–338; geol. map (pl. 1), scale 1:48,000.

Features illustrated (set nos. Vt. 1 A–C in southeast corner of photographs).—A series of east-west ridges or cuestas wind across these photographs and display a conspicious north-south topographic grain. These features are related to the interaction of three factors: (1) a tendency for the planar or linear structures in these complexly folded lower Paleozoic rocks to dip or plunge to the south or southeast; (2) a second period of folding along a north-south axis which gives the east-west trending formations their sinuosity; and (3) glacial scour by southward-moving ice. The northernmost cuesta—just south of High Pond (northwest quadrant of photograph 1 B)—is held up by resistant arkose and graywacke; a second—Ganson Hill (west of center of same exposure)—by compact cherty slate; a less conspicuous one—just north of curving road (south half of same exposure)—by arkose and graywacke; and a fourth—Sargent Hill (south of curving road)—by quartzite. The open valley followed by the curving round is underlain by weak, chloritoid-bearing slate and phyllite.

Va. 1. Beech Grove cutoff, a hanging entrenched meander

County: Lee.
Lat 36°37′ N.; long 83°16′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Mar. 19, 1953.
Map reference: U.S. Geol. Survey Back Valley and Rose Hill 7½-min quadrangles, scale 1:24,000.
Geology reference: Miller, R. L., and Brosgé, W. P., 1954, Geology and oil resources of the Jonesville district, Lee County, Virginia: U.S. Geol. Survey Bull. 990, p. 144–150; geol. map, scale 1:24,000.

Features illustrated (set nos. Va. 1 A–C in southeast corner of photographs).—The entrenched meanders of Powell River are bordered by slip-off slopes and lie in a belt parallel to the strike of generally southward-dipping Ordovician limestones. The floor of an abandoned cut-off meander (northeast quadrant of photograph 1 A that encircles Beech Grove School hangs about 30 feet above the river. The meanders are in the noncherty Hurricane Bridge Limestone where outcrops are abundant, and the area is largely woodland. North of the river, the fields are largely in the cherty Martin Creek Limestone that is rarely seen in outcrop. Wallen Ridge (southeast corner of photograph 1 B) has a cap of Clinch Sandstone overlying shale and siltstone that form a steep gullied slope.

Va. 2. Debris avalanches formed during cloudburst

County: Augusta.
Lat 38°25′ N.; long 79°13′ W.
Number of photographs: 2.
Photograph scale: 1:10,000.
Focal length: 8.25 in.
Date flown: Mar. 13, 1955.
Map reference: U.S. Geol. Survey Parnassus 15-min quadrangle, scale 1:62,500.
Geology reference: Hack, J. T., and Goodlett, J. C., 1960, Geomorphology and forest ecology of a mountain region in the central Appalachians: U.S. Geol. Survey Prof. Paper 347, 66 p.; map, scale 1:31,680. See pl. 4.

Features illustrated (set nos. Va. 2 A–B in east corner of photographs).—A violent cloudburst in June 1949, with more than 9 inches of rain in a few hours, caused many small debris avalanches that swept away the forest cover. The accompanying floods enlarged most channelways and in places removed the forest from the entire valley floor and left bare ground. The area is one of steep-sided narrow valleys where the total relief is more than 1,500 feet. Bedrock is gently dipping Devonian and Mississippian sandstone and shale.

Va. 3. Residual manganese deposits in a synclinal valley

County: Augusta.
Lat 37°56′ N.; long 79°07′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Nov. 10, 1951.
Map reference: U.S. Geol. Survey Vesuvius 15-min quadrangle, scale 1:62,500.
Geology reference: Knechtel, M. M., 1943, Manganese deposits of the Lyndhurst-Vesuvius district, Augusta and Rockbridge Counties, Virginia: U.S. Geol. Survey Bull. 940–F, p. 190–194, pl. 29.

Features illustrated (set nos. Va. 3 A–B in southeast corner of photographs).—The west-southwest-flowing St. Mary's River near the center of photograph 3 B follows a deep synclinal trough at the top of the Antietam Quartzite of Early Cambrian age. Beds of quartzite can be seen to have steeper dips on the south limb of the syncline than on the north limb. The Tomstown (Shady) Dolomite of Cambrian age overlies the quartzite along the axis of the trough just south of the river. Because the dolomite itself is mostly weathered, only clayey residuum remains. Manganese oxides have been concentrated in the residuum. Two mine workings can be seen at east and west sides of the photographs.

Va. 4. Imminent stream capture near Mount Solon

County: Augusta.
Lat 38°22′ N.; long 79°06′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Nov. 10, 1951.
Map reference: U.S. Geol. Survey Parnassus 15-min quadrangle, scale 1:62,500.
Geology reference: Hack, J. T., 1960, Interpretation of erosional topography in humid temperate regions: Am. Jour. Sci., v. 258–A, p. 91–92. 1965, Geomorphology of the Shenandoah Valley, Virginia, and West Virginia, and origin of the residual ore deposits: U.S. Geol. Survey Prof. Paper 484, 84 p.

Features illustrated (set nos. Va. 4 A–B in southeast corner of photographs).—North River (northwest quadrant of photograph 4 A) has a broad flood plain underlain by sandstone cobbles and gravel that came from the mountains to the west (outside of area shown in photographs). Mossy Creek which drains northeast past Mount Solon (town surrounding the pond in northeast quadrant of photograph 4 A) flows on and heads in limestone bedrock and its gradient is less than North River. Near Mount Solon, the valley of Mossy Creek lies about 60 feet below that of North River. During a flood in 1949, North River spilled through the gap northwest of Mount Solon and flowed down into Mossy Creek. A permanent diversion into such a course can be predicted in the near geologic future.

Va. 5. Entrenched meanders of the North Fork Shenandoah River

County: Shenandoah.
Lat 38°54′ N.; long 78°28′ W.
Number of photographs: 3.
Photograph scale: 1:27,200.
Focal length: 5.2 in.
Date flown: Mar. 9, 1945.
Map reference: U.S. Geol. Survey Strasburg and Edinburg 15-min quadrangles, scale 1:62,500.
Geology reference: Hack, J. T., and Young, R. S., 1959, Entrenched meanders of the North Fork of the Shenandoah River, Virginia: U.S. Geol. Survey Prof. Paper 354–A, 10 p.

Features illustrated (set nos. Va. 5 A–C in northeast corner of photographs).—These meanders near Woodstock are incised 100–150 feet below the adjoining shale uplands. The sinuosity (distance along stream divided by distance down valley) attains the high value of 3.2. The meander belt is 1–2½ miles wide and is localized within the outcrop area of the Martinsburg Shale. The two parallel ridges in the southeast quadrant of photograph 5 B, which are of quartzite, form a syncline whose axis follows the valley between the ridges. Hack and Young believe that the meanders are caused by strong planar and prismatic structures in the Martinsburg Shale that favor northwest-southeast differential erosion.

Va. 6. Deposition and erosion at Jamestown Island

County: James City.
Lat 37°13′ N.; long 76°47′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Dec. 3, 1953.
Map reference: U.S. Geol. Survey Surry 7½-min quadrangle, scale 1:24,000.
Geology reference: Cotter, J. L., 1958, Archeological excavations at Jamestown, Colonial National Historical Park and Jamestown National Historic Site, Virginia: U.S. Natl. Park Service, Archaeol. Research Ser. 4, 299 p.

Features illustrated (set nos. Va. 6 A–B in southeast corner of photographs).—The site of the first permanent English settlement in North America (1607) is near the docks south of the center of photograph 6 B. A bridge connects the site with the mainland (northeast quadrant of photograph 6 B). The site is on a platform of wooded sandy ridges separated by tidal marsh and is adjacent to a deep channel of the tidal James River. The sandy ridges were deposited by the river on its east side, perhaps during a late-glacial high stand of the sea. When the first settlement was built, Jamestown Island was part of the mainland, and Powhatan Creek that flows southwestward from northeast corner of photograph 6 B did not reach James River. The creek turned eastward to flow past the townsite and off the photographs to the east, via what is now Back River (the stream crossed by the bridge that joins island to mainland). Erosion of the east bank of the James River, west of the bridge, during the last 300 years has cut off the townsite from the mainland.

Va. 7. Dismal Swamp and Suffolk Scarp

County: Norfolk, Nansemond, Gates, and Camden.
Lat 36°35′ N.; long 76°30′ W.
Number of photographs: 3.
Photograph scale: 1:60,000.
Focal length: 6 in.
Date flown: Dec. 8, 1959.
Map reference: U.S. Geol. Survey Lake Drummond and Suffolk 15-min quadrangles, scale 1:62,500.
Geology reference: Oaks, R. Q., Jr., and Coch, N. K., 1963, Pleistocene sea levels, southeastern Virginia: Science, v. 140, p. 979–983.

Features illustrated (set nos. Va. 7 A–C in southwest corner of photographs).—Lake Drummond is surrounded by Dismal Swamp that is underlain by 5–10 feet of fresh-water peat of Recent age. The peat rests on a complex of older Pleistocene sediments of fluvial, eolian, and marine origin. The east-facing Suffolk Scarp (west half of photograph 7 B), 10–30 feet high, was fashioned by the sea in the early Pleistocene and has been considerably dissected since that time.

Wash. 1. Mount Olympus and its glaciers

County: Jefferson.
Lat 47°48′ N.; long 123°42′ W.
Number of photographs: 5.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: Oct. 3, 1952.
Map reference: U.S. Geol. Survey Mount Olympus and Mount Tom 15-min quadrangles, scale 1:62,500.
Geology reference: Danner, W. R., 1955, Geology of Olympic National Park: Seattle, Washington Univ. Press, 68 p. Allen, C. R., Kamb, W. B., Meire, M. F., and Sharp, R. P., 1960, Structure of the lower Blue glacier, Washington: Jour. Geology, v. 68, no. 6, p. 601–625.

Features illustrated (set nos. Wash. 1 A–E in northeast corner of photographs).—Mount Olympus (near center of photograph 1 C) and adjacent peaks support alpine glaciers; the longest are on the north side of the peaks. Blue Glacier, one of the most thoroughly investigated glaciers in the conterminous United States, heads on the northeast slope of Mount Olympus and follows a northward-curving path. Medial morainic bands, crevasses, ice falls, and the approximate firn limit on Blue Glacier can be seen in these photographs taken in early October. Young nonforested moraines and older forest-covered morainal ridges are conspicuous down valley from some of the glaciers.

Wash. 2. Alpine glaciers on Glacier Peak

County: Snohomish.
Lat 48°07′ N.; long 121°07′ W.
Number of photographs: 3.
Photograph scale: 1:27,700.
Focal length: 5.2 in.
Date flown: Oct. 7, 1944.
Map reference: U.S. Geol. Survey Glacier Peak 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Wash. 2 A–C in northeast corner of photographs).—This Pleistocene to Recent andesitic volcano (altitude 10,541 ft) rises about 6,000 feet above the tops of the adjacent mountains. Glaciers largely conceal the upper slopes of the peak except on its southwest side. The individual glaciers are separated by small arêtes and flow in shallow U-shaped valleys. The glacial dissection of the volcano, although only moderate, is noticeably more advanced than on Mount St. Helens. (See Wash. 7.) Adjacent photographs from this same flight strip, showing the east slope of Glacier Peak, constitute Wash. 3. (A. B. Ford, written commun., 1964).

Wash. 3. Mudflows and glacial features on east side of Glacier Peak

County: Snohomish.
Lat 48°07′ N.; long 121°02′ W.
Number of photographs: 3.
Photograph scale: 1:27,700.
Focal length: 5.2 in.
Date flown: Oct. 7, 1964.
Map reference: U.S. Geol. Survey Glacier Peak 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Wash. 3 A–C in northeast corner of photographs).—Along the east base of Glacier Peak, Suiattle River (northeast quadrant of photograph 3 B) follows an earlier U-shaped glacial valley that has truncated spurs and hanging tributaries and that was partly buried by a large volcanic debris fan. The toe of this fan follows the west bank of the river. The fan heads on the east slope of the volcano near the tree line (northwest quadrant of same photograph). The fan is now dissected to depths of 500–1,000 feet by Suiattle River and its tributaries. Immense exposures of the material in the debris fan along the creek on south side of the fan near its apex (Chocolate Creek, northwest quadrant of photograph 3 B) suggest the presence of easterly dipping beds, more or less parallel to the fan surface. Adjacent photographs from this same flight strip, showing the summit of Glacier Peak, constitute Wash. 2 (A. B. Ford, written commun., 1964).

Wash. 4. Soil mounds on Mima Prairie

County: Thurston.
Lat 46°53′ N.; long 123°03′ W.
Number of photographs: 2.
Photograph scale: 1:37, 400.
Focal length: 6 in.
Date flown: July 23, 1951.

Map reference: U.S. Geol. Survey Rochester 15-min quadrangle, scale 1:62,500.
Geology reference: Ritchie, A. M., 1953, The erosional origin of the Mima Mounds of southwest Washington: Jour. Geology, v. 61, no. 1, p. 41–50; see pl. 3B.

Features illustrated (set nos. Wash. 4 A–B in southeast corner of photographs).—This nearly level plain about 3 miles long and 2 miles wide is one of several prairies covered by conspicuous soil mounds or Mima Mounds. The mounds range from 10 to 70 feet in diameter and from a few inches to 7 feet high. They are rounded or oval in plan, in cross section commonly resemble a segment of a circle, and are composed of pebbly sand and silt. Ritchie attributes them to the erosion of partially thawed ice-wedge polygons.

Wash. 5. Channeled scabland: Cataract in Moses Coulee

County: Douglass and Grant.
Lat 47°30′ N.; long 119°45′ W.
Number of photographs: 4.
Photograph scale: 1:73,800.
Focal length: 6 in.
Date flown: Sept. 22, 1952.
Map reference: U.S. Geol. Survey Ritzville sheet, scale 1:250,000.
Geology reference: Bretz, J H., 1959, Washington's channeled scabland: Washington Div. Mines and Geology Bull. no. 45, 57 p.

Features illustrated (set nos. Wash. 5 A–D in southeast corner of photographs).—This great compound cataract (west of center of photograph 5 C) includes three recessional gorges that reach back upstream into a broad scabland tract. The cataract to the east started as a double cataract whose members united to leave an island in the gorge below the dry falls. Bretz believes that all three gorges and their cataracts were contemporaneous. To the north the main coulee is a gorge nearly 400 feet deep (northeast quadrant of photograph 5 B).

Wash. 6. Sand dunes near Moses Lake

County: Grant.
Lat 47°04′ N.; long 119°22′ W.
Number of photographs: 3.
Photograph scale: 1:20,000.
Focal length: 6 in.
Date flown: Aug. 11, 1954.
Map reference: U.S. Geol. Survey Moses Lake 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Wash. 6 A–C in southeast corner of photographs).—Part of dune field damming Moses Lake. The dunes include both transverse and longitudinal forms. The sand is largely bare and is moving eastward up a low scarp and across a broad terrace. In the southern part of the area the depressions between dunes are flooded.

Wash. 7. Debris flows on Mount St. Helens, a Recent volcano

County: Skamania.
Lat 46°12′ N.; long 122°11′ W.
Number of photographs: 3.
Photograph scale: 1:47,200.
Focal length: 6 in.
Date flown: July 28, 1952.
Map reference: U.S. Geol. Survey Mount St. Helens and Spirit Lake 15-min quadrangles, scale 1:62,500.
Geology reference: Verhoogen, Jean, 1937, Mount St. Helens; a Recent Cascade volcano: California Univ., Dept. Geol. Sci. Bull., v. 24, p. 263–302. Mullineaux, D. R., and Crandell, D. R., 1962, Recent lahars from Mount St. Helens, Washington: Geol. Soc. America Bull., v. 73, p. 855–870.

Features illustrated (set nos. Wash. 7 A–C in southeast corner of photographs).—This symmetric volcano rises about 6,000 feet above the surrounding hills on the west flank of the Cascade Range. The present cone may have been built during the last thousand years, and the small glaciers on its steep slopes have not yet cut deep broad valleys. The areas of sparse vegetation on the lower slopes of the volcano have been devastated by debris flows or lahars within the past century.

Wash. 8. Channeled scabland: Giant current ripple marks

County: Adams.
Lat 47°03′ N.; long 118°04′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 28, 1950.
Map reference: U.S. Geol. Survey Ritzville sheet, scale 1:250,000.
Geology reference: Bretz, J H., Smith, H. T. U., and Neef, G. E., 1956, Channeled scabland of Washington: New data and interpretations: Geol. Soc. America Bull., v. 67, p. 1030 and pl. 16, fig. 2.

Features illustrated (set nos. Wash. 8 A–B in southeast corner of photographs).—A scabland channel with small rock basins in basalt between two small smooth cultivated loess-covered hills (north half of photograph 8 A). In the south half of the same exposure are what Bretz describes as current ripples that have a wavelength of perhaps 200 feet.

Wash. 9. Channeled scabland: Staircase Rapids bar

County: Adams.
Lat 46°47′ N.; long 118°17′ N.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 29, 1950.
Map reference: U.S. Geol. Survey Washtucna 15-min quadrangle, scale 1:62,500.
Geology reference: Bretz, J H., 1959, Washington's channeled scabland: Washington Div. Mines and Geology Bull. 45, 57 p., fig. 27.

Features illustrated (set nos. Wash. 9 A–B in southeast corner of photographs).—On the terrace near the center of photograph 9 B are east-west-trending parallel ridges and swales spaced 175–350 feet apart. Bretz believes that these ridges are giant current ripple marks on a bar built by a south-flowing river, a part of his "Spokane flood." To the east and west are loess-covered "Palouse" hills.

Wash. 10. Channeled scabland: Palouse River canyon

County: Adams, Franklin, and Whitman.
Lat 46°43′ N.; long 118°14′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Aug. 28, 1950.
Map reference: U.S. Geol. Survey Starbuck, Benge, Washtucna, and Haas 15-min quadrangles, scale 1:62,500.
Geology reference: Bretz, J H., Smith, H. T. U., and Neff, G. E., 1956, Channeled scabland of Washington: New data and interpretations: Geol. Soc. America Bull., v. 67, p. 1015–1020.

Features illustrated (set nos. Wash. 10 A–B in southeast corner of photographs).—Palouse River in the north half of photograph 10 B flows westward in a broad open valley—Washtucna Coulee—but near the west edge of the photograph it makes a sharp bend and flows south in a narrow canyon toward the Snake River. Bretz believes that Washtucna Coulee follows the preglacial course of Palouse River. Glacial floodwaters overtopped the bedrock divide south of the Coulee (the area shown in photograph 10 A) and at least 350 feet above the preglacial Palouse Valley. The divide area is now scabland in which the Palouse River has carved a 400-foot deep canyon. The paper cited above includes references to other interpretations of these features.

Wash. 11. Channeled scabland: Giant ripple marks along Union Flat Creek

County: Whitman.
Lat 46°50′ N.; long 117°56′ W.
Number of photographs: 2.
Photograph scale: 1:20,000.
Focal length: 8.25 in.
Date flown: Sept. 21, 1950.
Map reference: U.S. Geol. Survey La Crosse 15-min quadrangle, scale 1:62,500.
Geology reference: Bretz, J H., 1959, Washington's channeled scabland: Washington Div. Mines and Geology Bull., no. 45, 57 p.

Features illustrated (set nos. Wash. 11 A–B in southeast corner of photographs).—Giant ripple marks on terraces along Union Flat Creek near its junction with Palouse River (northwest corner of photograph 11 B). Scabland on basalt forms the surrounding uplands.

W. Va. 1. Strip mines in the Appalachian Plateaus

County: Mingo and Pike.
Lat 37°39′ N.; long 82°11′ W.
Number of photographs: 3.
Photograph scale: 1:31,000.
Focal length: 6 in.
Date flown: Mar. 16, 1957.
Map reference: U.S. Geol. Survey Matewan 7½-min quadrangle, scale 1:24,000.
Geology reference: Stose, G. W., and Ljungstedt, O. A., 1932, Geologic map of West Virginia: West Virginia Geol. Survey, scale 1:500,000.

Features illustrated (set nos. W. Va. 1 A–C in southeast corner of photographs).—This area of steep-sided wooded hills with a maximum relief of about 1,200 feet is underlain by virtually flat-lying coal-bearing shale and sandstone of Pennsylvanian age. The region borders on Tug Fork, which flows in a narrow meandering valley and forms the Kentucky-West Virginia boundary. Some of the coal beds have been extensively worked; strip mines contour the slopes of hills near Tug Fork.

W. Va. 2. Chestnut Ridge anticline near Coopers Rock

County: Monongalia.
Lat 39°38′ N.; long 79°49′ W.
Number of photographs: 3.
Photograph scale: 1:31,000.
Focal length: 6 in.
Date flown: Apr. 12, 1956.
Map reference: U.S. Geol. Survey Lake Lynn and Masontown 7½-min quadrangles, scale 1:24,000.
Geology reference: Hare, C. E., 1957, Geology of Coopers Rock State Forest and Mont Chateau State Park: West Virginia Geol. and Econ. Survey, State Park Series Bull. 5, 26 p.

Features illustrated (set nos. W. Va. 2 A–C in southeast corner of photograph).—Cheat River cuts through Chestnut Ridge in a 1,200-foot-deep gorge that runs northwest diagonally across photograph 2 B. In part of its course the river is known as Lake Lynn, being dammed a few miles downstream (just north of northwest corner of photograph 2 A). Chestnut Ridge is an anticline. In the walls of the gorge the resistant sandstone beds (Pottsville Series) that make the ridge can be seen to rise southeastward. The lower cultivated land to the northwest is on younger beds of shale, sandstone, limestone, and coal (Conemaugh Series).

W. Va. 3. Potomac River gorge near Harpers Ferry

County: Jefferson, Loudoun, Washington, and Frederick.
Lat 39°19′ N.; long 77°43′ W.
Number of photographs: 4.
Photograph scale: 1:24,000.
Focal length: 6 in.
Date flown: Mar. 28, 1965.
Map reference: U.S. Geol. Survey Charles Town and Harpers Ferry 7½-min quadrangles, scale 1:24,000.
Geology reference: Nickelsen, R. P., 1956, Geology of the Blue Ridge near Harpers Ferry, West Virginia: Geol. Soc. America Bull., v. 67, p. 239–270; geol. map (pl. 1), scale 1:25,000.

Features illustrated (set nos. W. Va. 3 A–D in northeast corner of photographs).—The Shenandoah River joins the Potomac River at Harpers Ferry to flow eastward through the mountains by way of two water gaps, each about 900 feet deep. Rapids can be seen where resistant strata crop out on the river's bed. Blue Ridge (south of the junction of two rivers) and Short Ridge (southwest quadrant of photograph 3 D) are Weverton Quartzite (Cambrian); they form recumbent folds overturned to the northwest. Some of the individual quartzite beds can be seen in cliffs along the river. Meta-igneous and metasedimentary rocks of Precambrian age underlie the lowlands between the two quartzite mountains.

Wis. 1. Drumlins and moraines of Green Bay glacier near Fond du Lac

County: Fond du Lac.
Lat 43°50′ N.; long 88°20′ W.
Number of photographs: 4.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Apr. 24, 1952.
Map reference: U.S. Geol. Survey Fond du Lac 15-min quadrangle, scale 1:62,500.
Geology reference: Alden, W. C., 1918, The Quaternary geology of southeastern Wisconsin: U.S. Geol. Survey Prof. Paper 106, p. 250–256, pls. 3 and 28.

Features illustrated (set nos. Wis. 1 A–D in northeast corner of photographs).—Roughly the north half of photograph 1 B is moraine of Green Bay glacier and the south half is a drumlin field. The drumlins are small, almost circular, and commonly less than half a mile long. Some of the larger drumlins trend southwest and have small south-trending knolls on their crests. The material is a compact calcareous clayey till. The stones in the drift are about 91 percent local limestone and 9 percent Precambrian crystalline rocks.

Wis. 2. The great Kettle Moraine near Campbellsport

County: Fond du Lac and Sheboygan.
Lat 43°36′ N.; long 88°11′ W.
Number of photographs: 4.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Apr. 30, 1952.
Map reference: U.S. Geol. Survey Kewaskum 15-min quadrangle, scale 1:62,500.
Geology reference: Alden, W. C., 1918, The Quaternary geology of southeastern Wisconsin: U.S. Geol. Survey Prof. Paper 106, 356 p.; geol. map (pl. 3), scale 1:250,000.

Features illustrated (set nos. Wis. 2 A–D in northeast corner of photographs).—These photographs show a 7-mile strip across the Kettle Moraine. East of the moraine lies a kettled outwash plain (east half of photograph 2 A). To the west is a 2-mile-wide belt of rough kettle moraine (west half of same exposure). East Branch Milwaukee River meanders on the floor of a broad north-south trench (center of photograph 2 C) that to the north is floored with outwash and to the south with swamp deposits. The moraine extends westward from the trench for several miles (photograph 2 D) and includes some narrow ridges that may be ice-channel fillings.

Wis. 3. The great Kettle Moraine east of Whitewater

County: Jefferson and Walworth.
Lat 42°50′ N.; long 88°37′ W.
Number of photographs: 4.
Photograph scale: 1:17,000.
Focal length: 6 in.
Date flown: Apr. 8, 1955.
Map reference: U.S. Geol. Survey Whitewater 15-min quadrangle, scale 1:62,500.
Geology reference: Alden, W. C., 1918, The Quaternary geology of southeastern Wisconsin: U.S. Geol. Survey Prof. Paper 106, 356 p.; geol. map (pl. 3), scale 1:250,000.

Features illustrated (set nos. Wis. 3 A–D in northeast corner of photographs).—This massive interlobate moraine was formed between the Lake Michigan lobe and the Green Bay lobe of the Wisconsin ice sheet. The gently rolling poorly drained drift plain of the Green Bay lobe (photograph 3 A) is bordered on the east by a belt of small wooded hills 50–150 feet high that mark the west edge of the Kettle Moraine (east edge of photograph 3 B). The moraine has a gently undulating surface pitted by iceblock holes 50–80 feet deep (east half of photograph 3 C). Much of the surface of the moraine is only slightly above that of the drift plain to the west. Most of the material in the moraine is probably gravel, sand, and clay, especially in its eastern part (photograph 3 D).

Wyo. 1. Beartooth fault and landslide lake

County: Park.
Lat 44°54′ N.; long 109°20′ W.
Number of photographs: 4.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: July 7, 1948.
Map reference: U.S. Geol. Survey Deep Lake 15-min quadrangle, scale 1:62,500.

Features illustrated (set nos. Wyo. 1 A–D in northeast corner of photographs).—Deep Lake (photograph 1 B), in a canyon carved in Precambrian granite gneiss at the south end of the Beartooth Mountains, is dammed by a landslide that is younger than the glacier that built the conspicuous moraines at the canyon's mouth (east edge of photograph 1 C). The landslide debris that moved down the north wall of the canyon left a reentrant at the top of the slope.

The Beartooth fault, a high-angle reverse fault, forms the east front of the mountains (east half of photograph 1 C). Precambrian rocks to the west are in contact with upturned and broken Paleozoic sedimentary rocks to the east. Another landslide mantles the mountain front just south of the moraines (W. G. Pierce, written commun., 1964).

Wyo. 2. Cody terrace, Shoshone River

County: Park.
Lat 44°31′ N.; long 109°03′ W.
Number of photographs: 2.
Photograph scale: 1:37,400.
Focal length: 6 in.
Date flown: July 7, 1948.
Map reference: U.S. Geol. Survey Cody 15-min quadrangle, scale 1:62,500.
Geology reference: Mackin, J. H., 1937, Erosional history of the Big Horn Basin, Wyoming: Geol. Soc. America Bull., v. 48, no. 6, p. 813–893. Moss, J. H., and Bonini, W. E., 1961, Seismic evidence supporting a new interpretation of the Cody Terrace near Cody, Wyoming: Geol. Soc. America Bull., v. 72, p. 547–556. Pierce, W. G., and Andrews, D. A., 1941, Geology and oil and coal resources of the region south of Cody, Park County, Wyoming: U.S. Geol. Survey Bull. 921–B, p. 99–180; geol. map (pl. 11), scale 1:63,360.

Features illustrated (set nos. Wyo. 2 A–B in northeast corner of photographs).—Cody is on a gravel terrace or flight of steps ranging from 120 to 190 feet above the river (Cody terrace); another broad plain lies about 80 feet above the Cody level (Powell terrace). Mackin holds that these are rock-cut terraces, whereas Moss and Bonini postulate an alluvial origin. The hogbacks south of the terraces are thin sandstone beds separated by thick shale units on the northeast limb of an anticline whose axis trends northwestward across the southwest quadrant of photograph 2 B. The prominent hogback that ends at the center of the west side of photograph 2 A is sandstone of the Cloverly Formation of Cretaceous age. The Permian and Triassic Chugwater Formation is exposed in the center of the anticline.

Wyo. 3. Piracy of Greybull River near Burlington

County: Big Horn.
Lat 44°27′ N.; long 108°27′ W.
Number of photographs: 2.
Photograph scale: 1:57,900.
Focal length: 6 in.
Date flown: Aug. 23, 1954.
Map reference: U.S. Geol. Survey YU Bench NE. and Burlington 7½-min quadrangles, scale 1:24,000.
Geology reference: Mackin, J. H., 1936, The capture of the Greybull River: Am. Jour. Sci., 5th ser., v. 31, p. 373–385. Robinove, C. J., and Langford, R. H., 1963, Geology and ground-water resources of the Greybull River-Dry Creek area, Wyoming: U.S. Geol. Survey Water-Supply Paper 1596, 88 p.; see pl. 1 and figs. 6 and 7.

Features illustrated (set nos. Wyo. 3 A–B in northeast corner of photographs).—The flood plain of the Greybull River (south half of photograph 3 B) slopes eastward on the south side of Table Mountain (east-central part of same photograph). The broad mesa (Emblem Bench) that slopes gently northeast through the center of photograph 3 A is the remnant of an ancient flood plain of Greybull River that lay on the north side of Table Mountain. While the river flowed north of the mountain, a small stream worked headward (west) in soft rocks at a lower elevation south of the mountain. Greybull River abandoned its gravel-covered flood plain to the north—Emblem Bench—and was diverted southward into the lower channel south of the mountain. A part of the bench and of the Greybull River flood plain are shown at a larger scale in Wyo. 4.

Wyo. 4. Emblem Bench and Greybull River flood plain

County: Big Horn.
Lat 44°28′ N.; long 108°29′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Aug. 6, 1948.
Map reference: U.S. Geol. Survey YU Bench NE. and Burlington 7½-min quadrangles, scale 1:24,000.
Geology reference: Mackin, J. H., 1936, The capture of the Greybull River: Am. Jour. Sci., 5th ser., v. 31, p. 373–385. Robinove, C. J., and Langford, R. H., 1963, Geology and ground-water resources of the Greybull River-Dry Creek area, Wyoming: U.S. Geol. Survey Water-Supply Paper 1596, 88 p.; see pl. 1.

Features illustrated (set nos. Wyo. 4 A–C in northeast corner of photographs).—This gravel-covered bench between Dry Creek and the flood plain of Greybull River includes at least two levels; its eastern part is irrigated. The surface of the bench, which marks an abandoned course of Greybull River, is smooth compared with the surface of the younger terraces. The flood plain of the river shows abandoned channels and meander scars. These photographs show in more detail a part of the area that is included in Wyo. 3.

Wyo. 5. Devils Tower and Belle Fourche River

County: Crook.
Lat 44°35′ N.; long 104°43′ W.
Number of photographs: 2.
Photograph scale: 1:28,400.
Focal length: 6 in.
Date flown: Sept. 15, 1953.
Map reference: U.S. Geol. Survey Devils Tower and Oshoto 15-min quadrangles, scale 1:62,500.
Geology reference: Robinson, C. S., 1956, Geology of Devils Tower National Monument, Wyoming: U.S. Geol. Survey Bull. 1021–I, p. 289–302; geol. map (pl. 30), scale 1:4,800.

Features illustrated (set nos. Wyo. 5 A–B in northeast corner of photographs).—Devils Tower is a steep-sided shaft of igneous rock that has vertical columnar jointing and that rises about 700 feet above the surrounding hills. At the base of the Tower is an apron of talus and landslide material that rests on flat-lying beds of sandstone, shale, and gypsum of Jurassic age. The Belle Fourche River meanders across a half-mile-wide flood plain. The flood plain itself also has a meandering course and is incised about 200 feet below the adjacent hilltops.

Wyo. 6. Circle Ridge Dome

County: Fremont.
Lat 43°32′ N.; long 109°04′ W.
Number of photographs: 3.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Oct. 22, 1948.
Map reference: U.S. Geol. Survey Thermopolis sheet, scale 1:250,000.
Geology reference: Andrews, D. A., 1944, Geologic and structure contour map of the Maverick Springs area, Fremont County, Wyoming: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 13.

Features illustrated (set nos. Wyo. 6 A–C in southeast corner of photographs).—This asymmetrical dome (photograph 6 B), which has nearly vertical beds on its southwest flank and gentler dips on its northeast side, has a central lowland underlain by Triassic shale and sandstone (Chugwater Formation) surrounded by outward-dipping sandstone ridges separated by shale units, largely of Jurassic age (Morrison and Sundance Formations). The beds of the northwest-plunging terminus of the dome are faulted. Most of the streams draining the dome follow strike valleys around the central lowland and flow outward across the resistant beds only near the south end of the anticline.

Wyo. 7. Little Dome

County: Fremont.
Lat 43°25′ N.; long 108°52′ W.
Number of photographs: 2.
Photograph scale: 1:23,600.
Focal length: 6 in.
Date flown: Oct. 20, 1948.
Map reference: U.S. Geol. Survey Thermopolis sheet, scale 1:250,000.
Geology reference: Andrews, D. A., 1944, Geologic and structure contour map of the Maverick Springs area, Fremont County, Wyoming: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 13.

Features illustrated (set nos. Wyo. 7 A–B in southeast corner of photographs).—A small area of Jurassic rocks is exposed in the center of this elongate dome that is largely outward-dipping Cretaceous beds composed of shale and some sandstone. The beds are tightly folded along the southeast-plunging anticlinal axis. The lowlands around the dome are underlain by Cody Shale that is largely concealed by alluvium and terrace deposits.

Wyo. 8. Pinedale moraines around Boulder Lake

County: Sublette.
Lat 42°50′ N.; long 109°40′ W.
Number of photographs: 4.
Photograph scale: 1:60,300.
Focal length: 6 in.
Date flown: June 21, 1954.
Map reference: U.S. Geol. Survey Lander sheet, scale 1:250,000.
Geology reference: Holmes, G. W., and Moss, J. H., 1955, Pleistocene geology of the southwestern Wind River Mountains, Wyoming: Geol. Soc. America Bull., v. 66, p. 629–654; see pls. 2 and 3.

Features illustrated (set nos. Wyo. 8 A–D in northeast corner of photographs).—A spectacular display of moraines surrounds Boulder Lake. The moraines terminate in a broad outwash apron. They lie on and are derived in large part from weak clay and sand of Tertiary age. The moraines end abruptly where they pass onto the Precambrian igneous and metamorphic rocks of the southwestern part of the Wind River Mountains.

Wyo. 9. Anticlines near Little Medicine Bow River

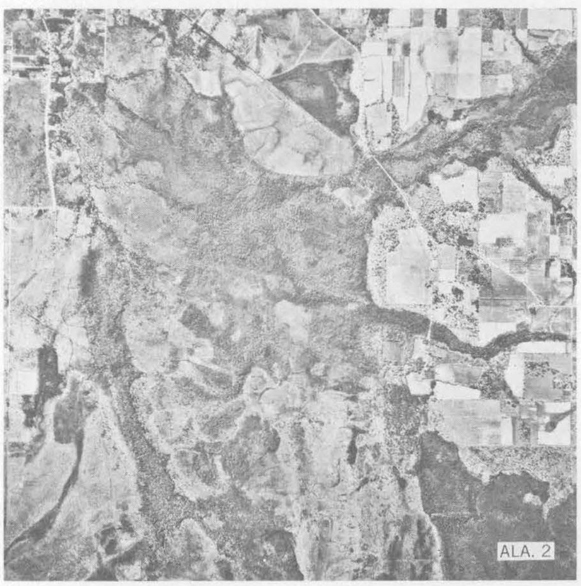
County: Carbon.
Lat 41°58′ N.; long 106°16′ W.
Number of photographs: 3.
Photograph scale: 1:27,700.
Focal length: 5.1 in.
Date flown: June 14, 1947.
Map reference: U.S. Geol. Survey Saddleback Hills and Como Ridge 15-min quadrangles, scale 1:62,500.
Geology reference: Dobbin, C. E., Bowen, C. F., and Hoots, H. W., 1929, Geology and coal and oil resources of the Hanna and Carbon basins, Carbon County, Wyoming: U.S. Geol. Survey Bull. 804, 88 p.; geol. map (pl. 27), scale 1:62,500.

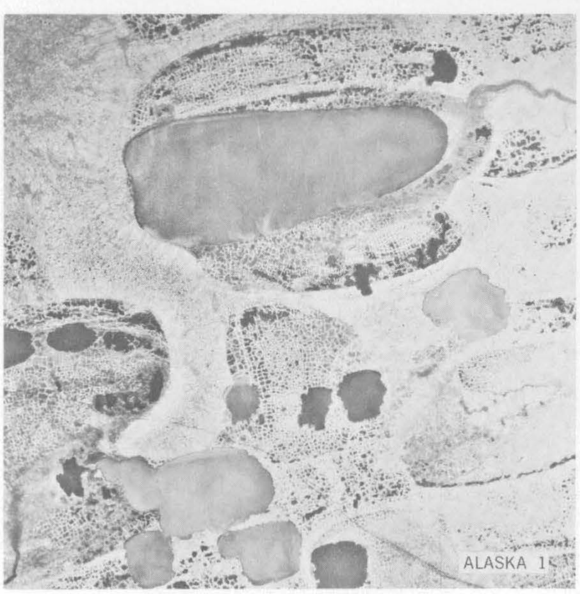
Features illustrated (set nos. Wyo. 9 A–C in southeast corner of photographs).—The long narrow doubly plunging anticline (near center of photograph 9 C) has a sandstone core surrounded by shale formations. Most of photograph 9 B is a westward-plunging anticline with a core of Precambrian crystalline rocks surrounded by outward-dipping sandstone cuestas separated by shale units. Just west of the Precambrian core (Pine Butte) the sedimentary rocks are locally broken by faults. Many of the individual cuestas show distinctive patterns of gullies and are offset by small cross faults. The large valleys are in shale, and rivers have meandering courses except where streams pass through or close to sandstone beds.

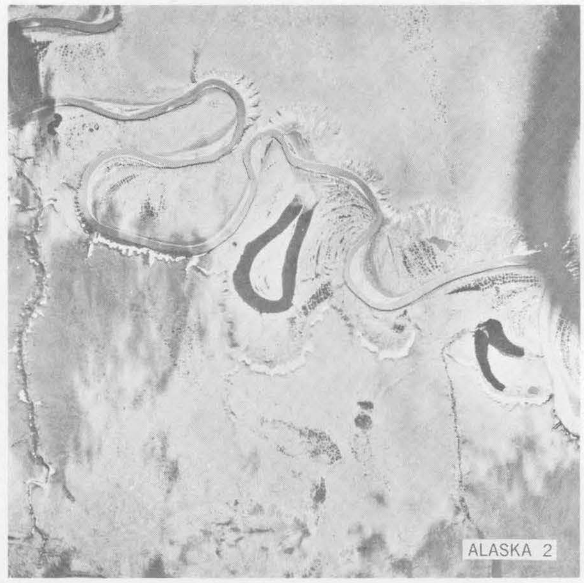
269-086 O - 68 - 6

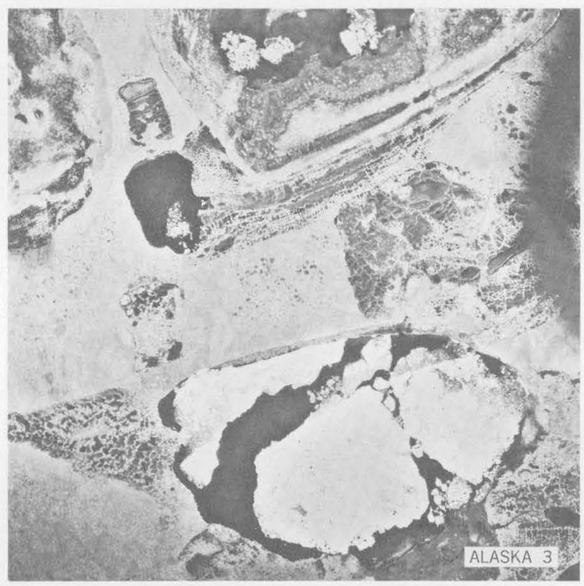
REPRESENTATIVE AERIAL PHOTOGRAPHS

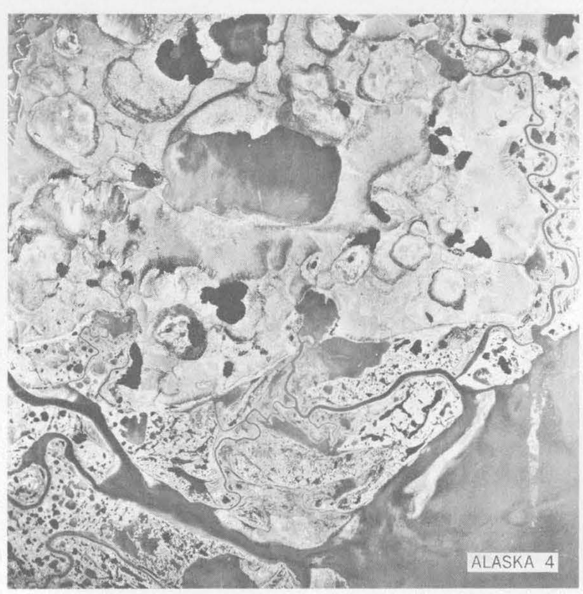

ALA. 1

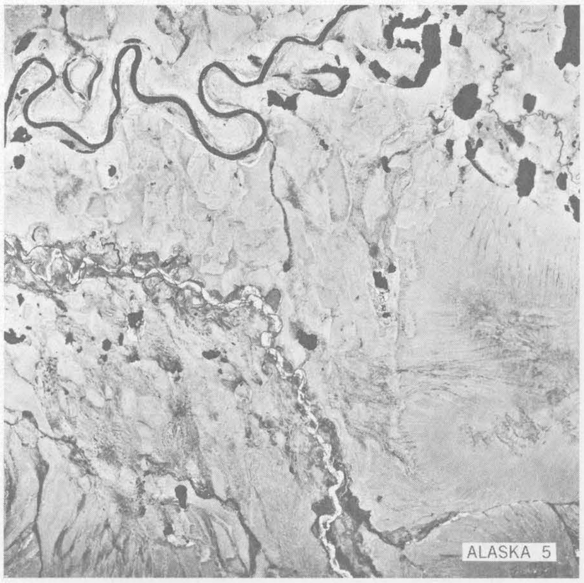

ALA. 2


ALASKA 1

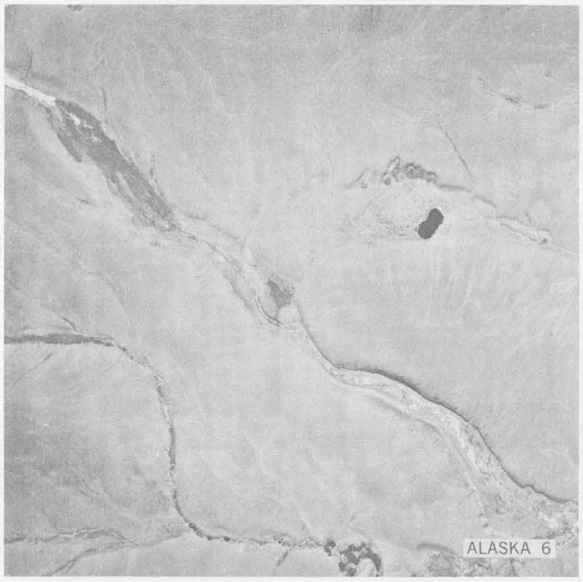

ALASKA 2


ALASKA 3


ALASKA 4

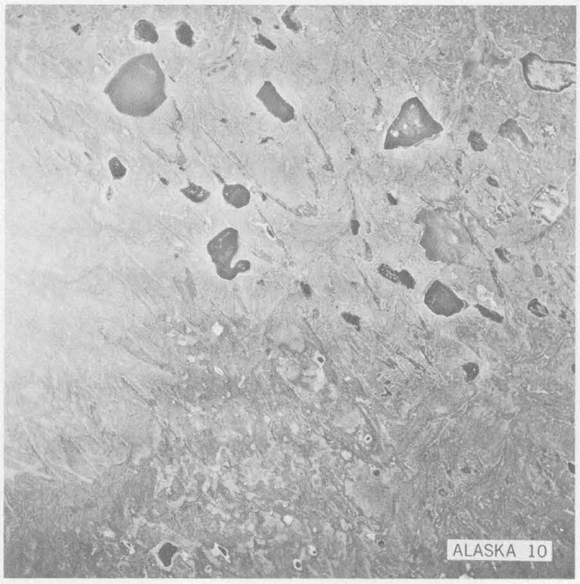

ALASKA 5

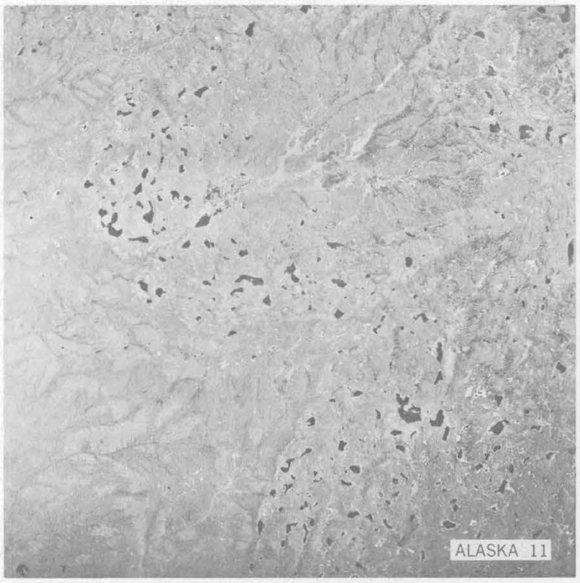

ALASKA 8

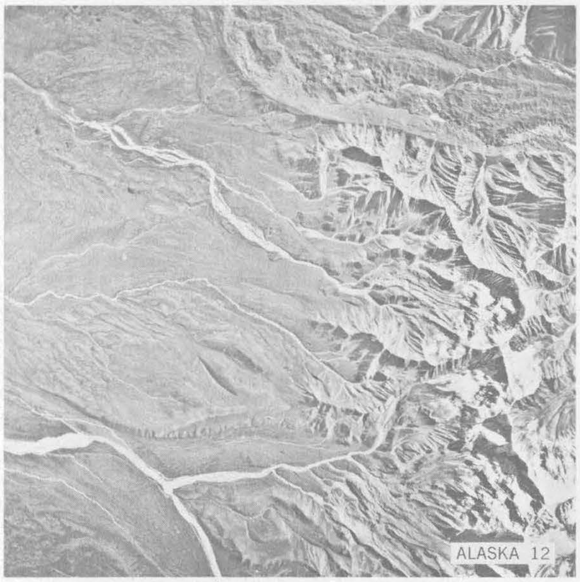

ALASKA 6

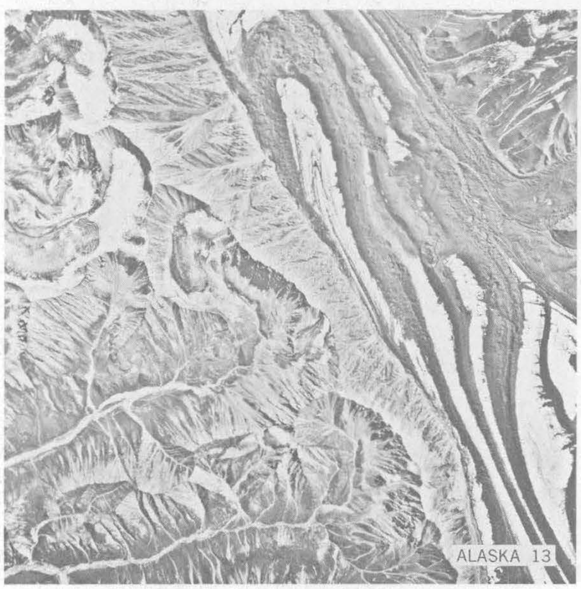

ALASKA 9


ALASKA 7


ALASKA 10

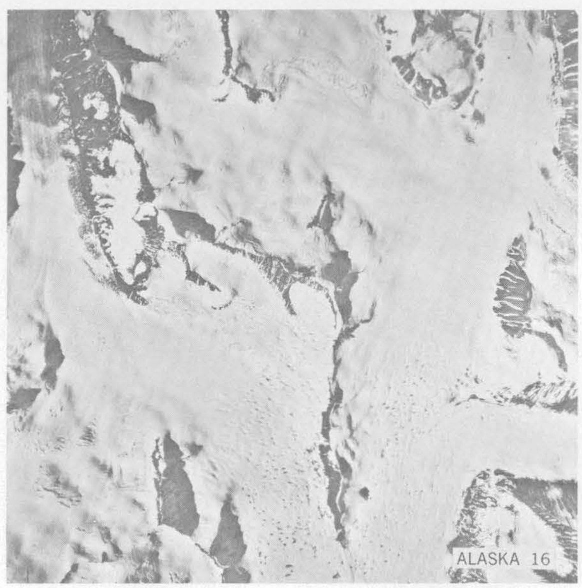

ALASKA 11

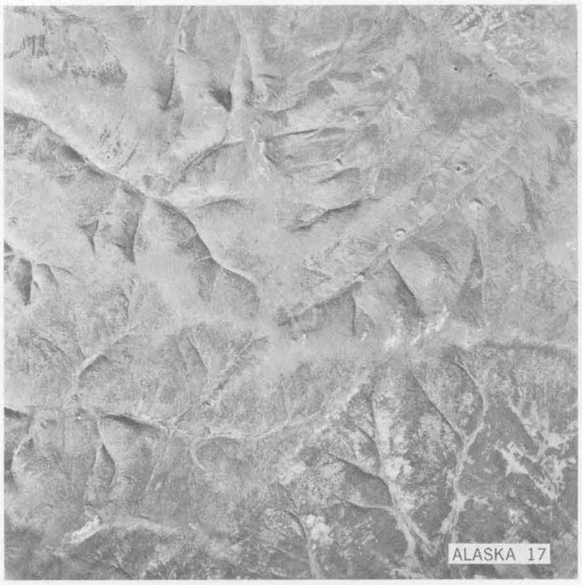

ALASKA 12


ALASKA 13

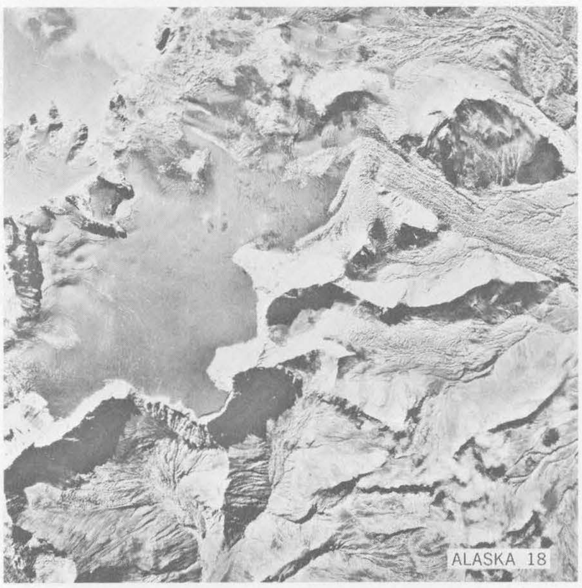

ALASKA 14


ALASKA 15

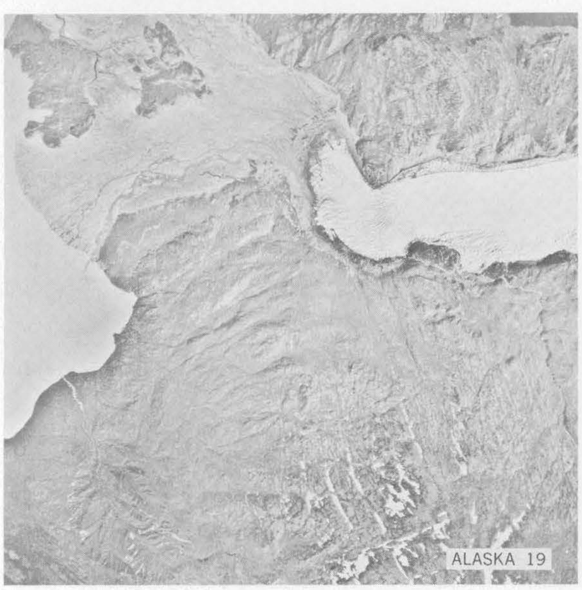

ALASKA 16



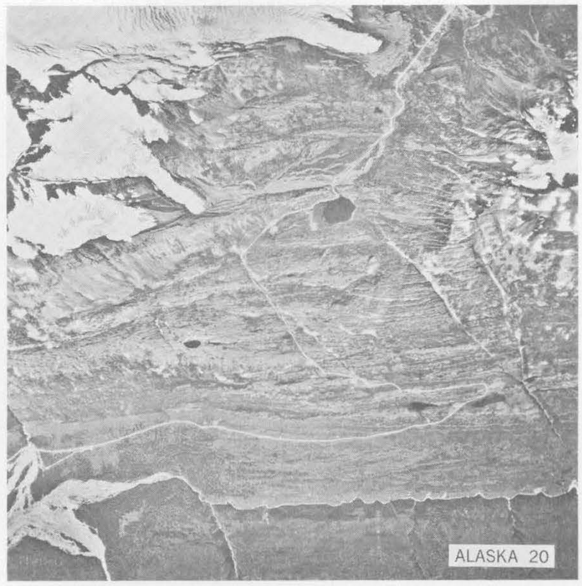
ALASKA 17



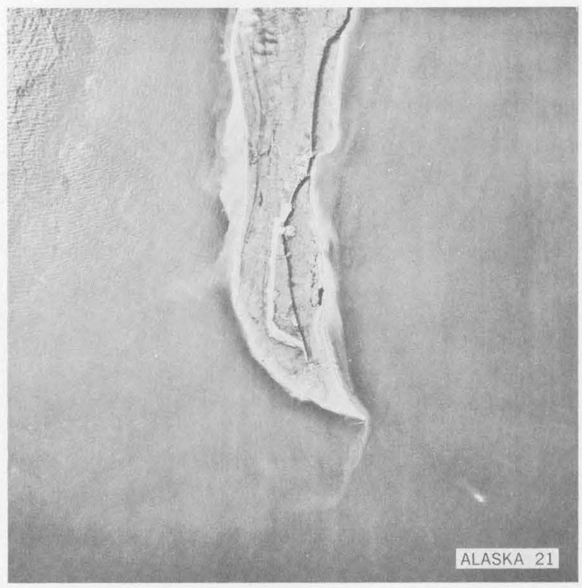
ALASKA 18



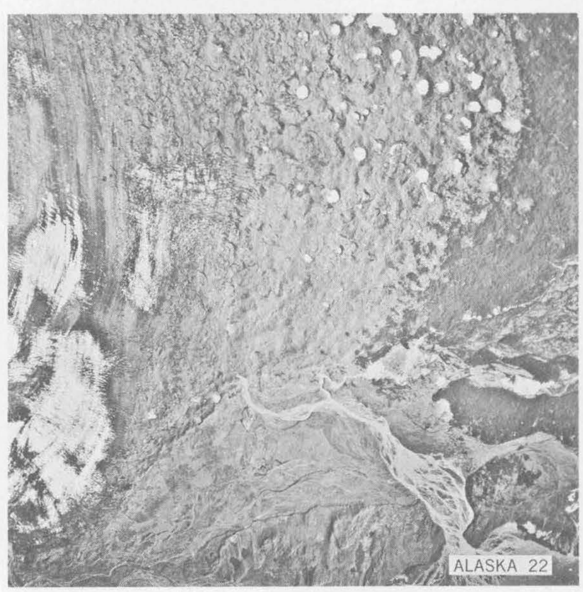
ALASKA 19



ALASKA 20



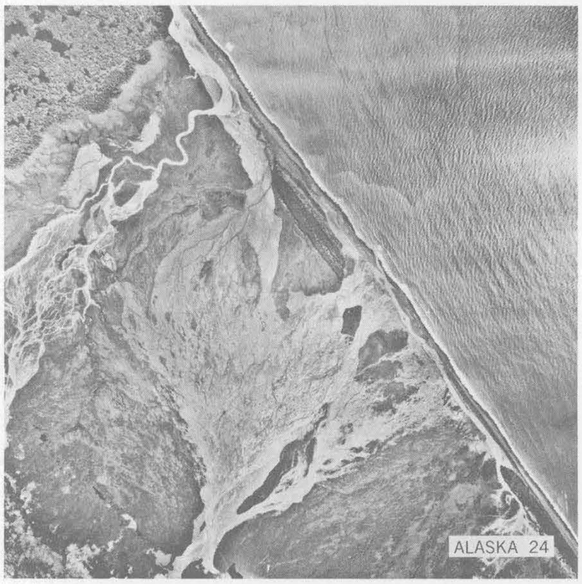
ALASKA 21



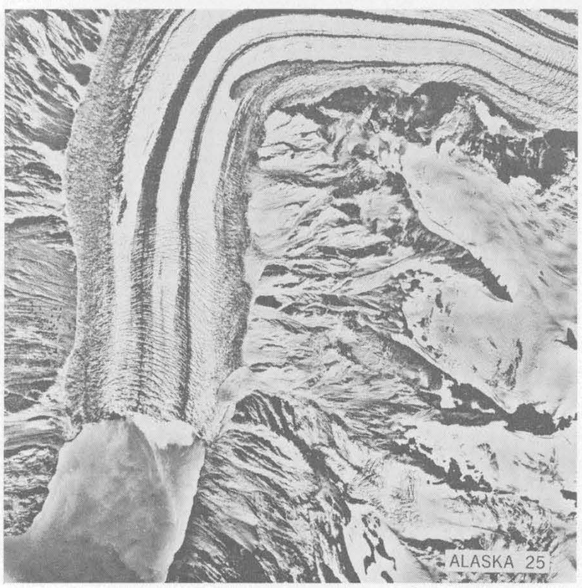
ALASKA 22

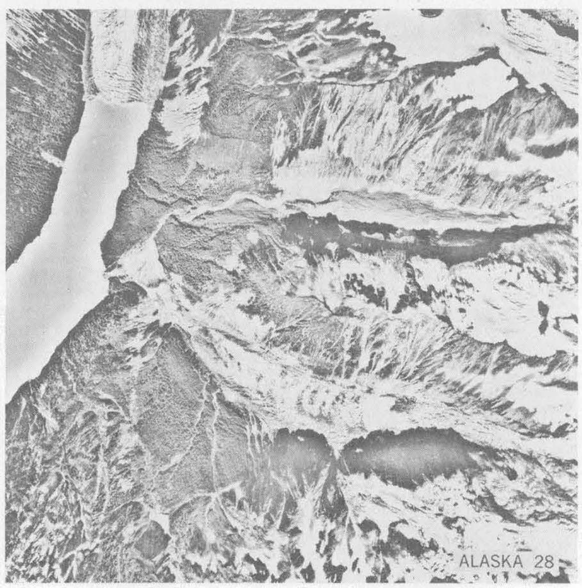

ALASKA 23


ALASKA 26

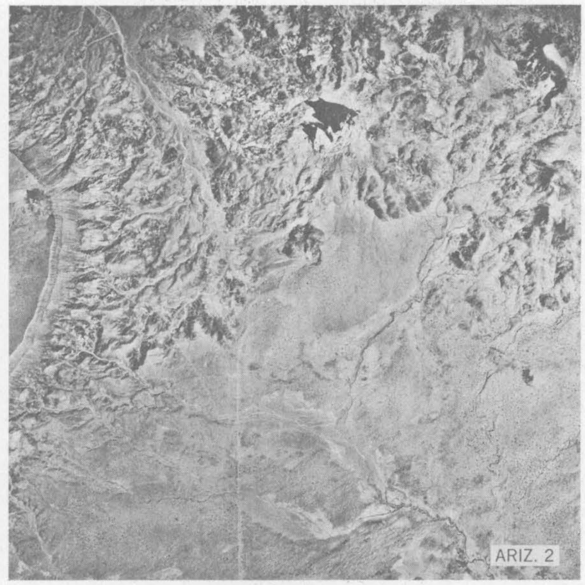

ALASKA 24

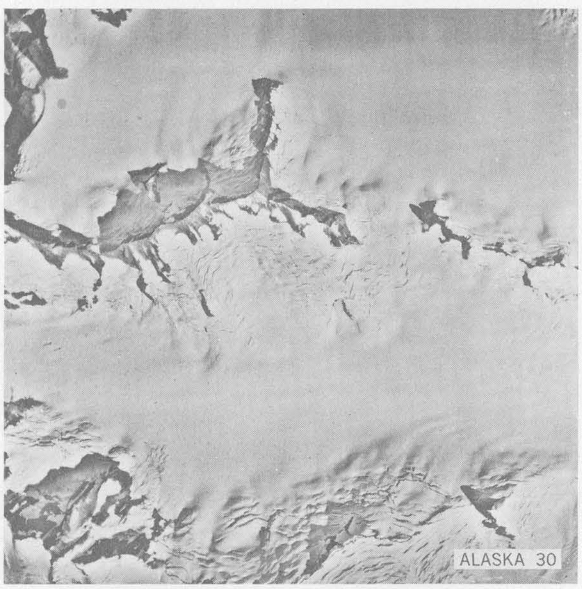

ALASKA 27

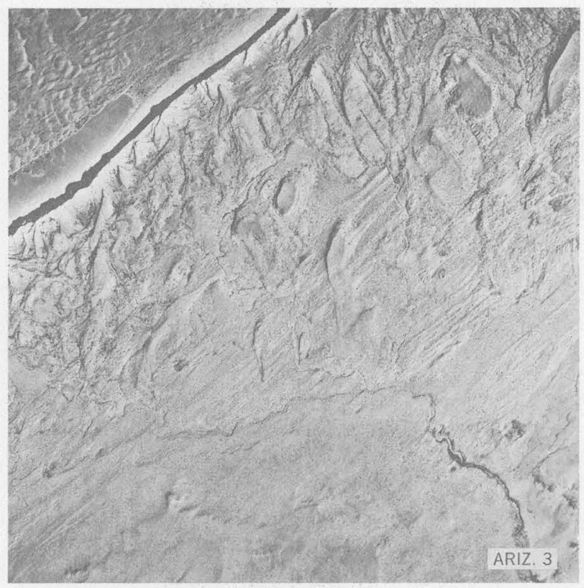

ALASKA 25

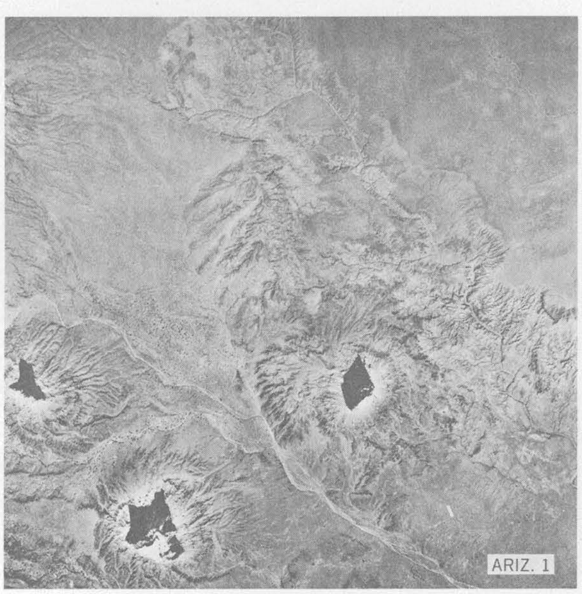

ALASKA 28

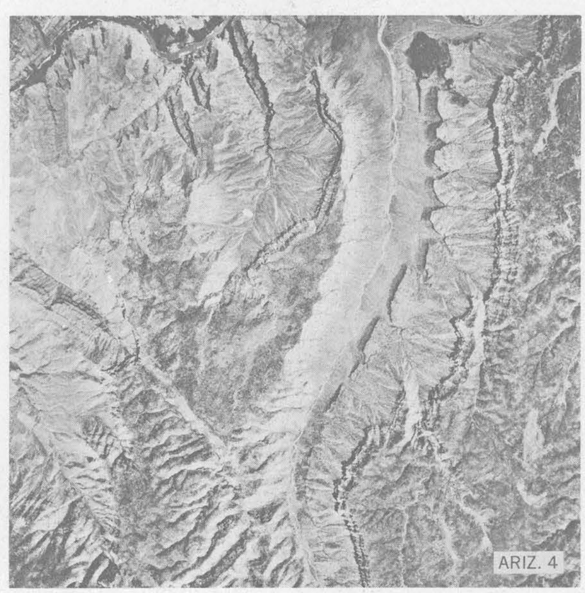

ALASKA 29


ARIZ. 2


ALASKA 30

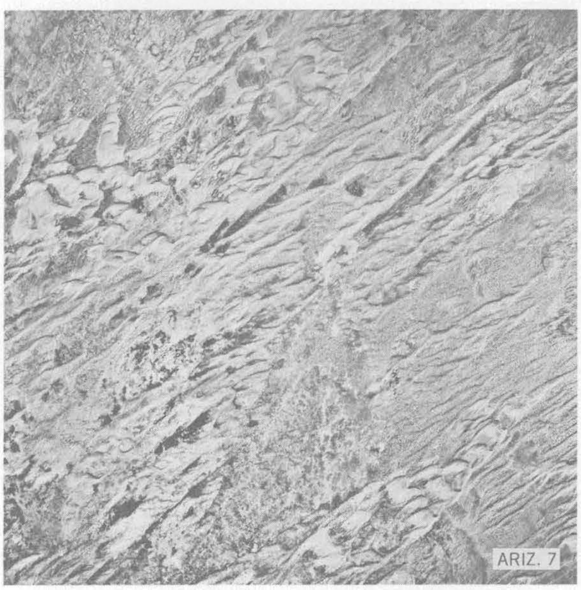

ARIZ. 3


ARIZ. 1

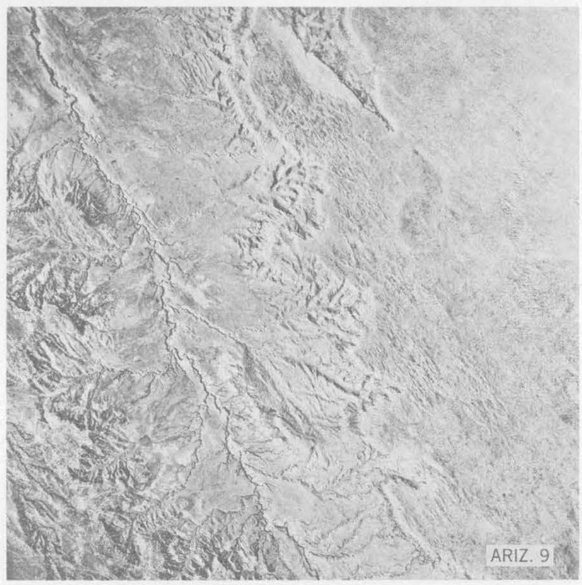

ARIZ. 4

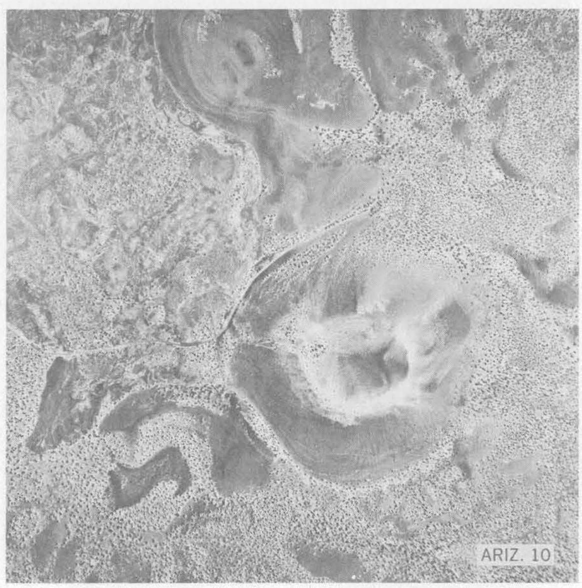

ARIZ. 5

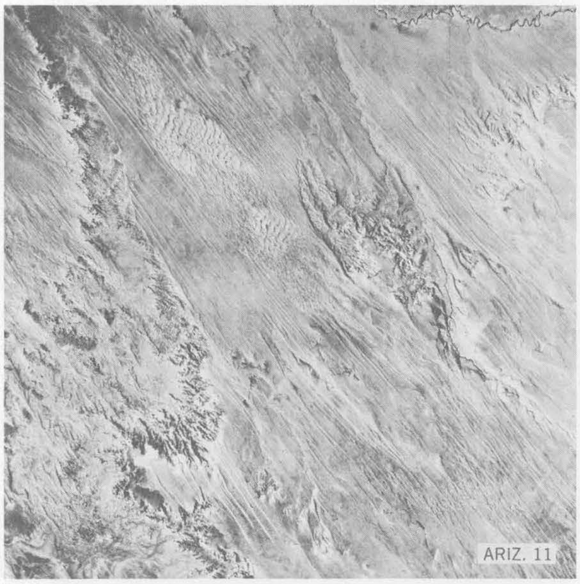

ARIZ. 6

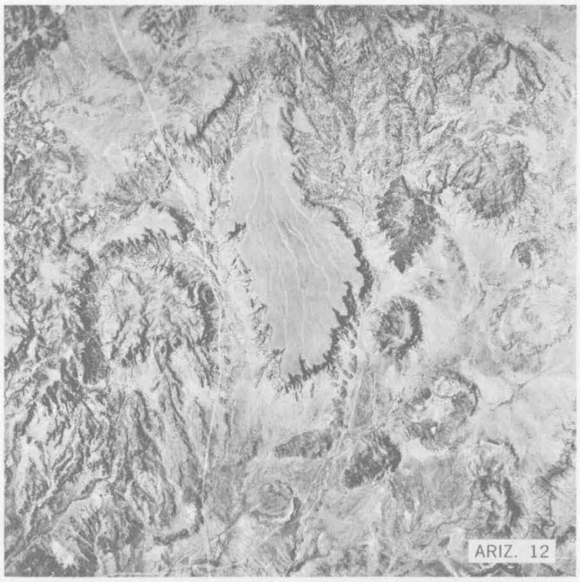

ARIZ. 7

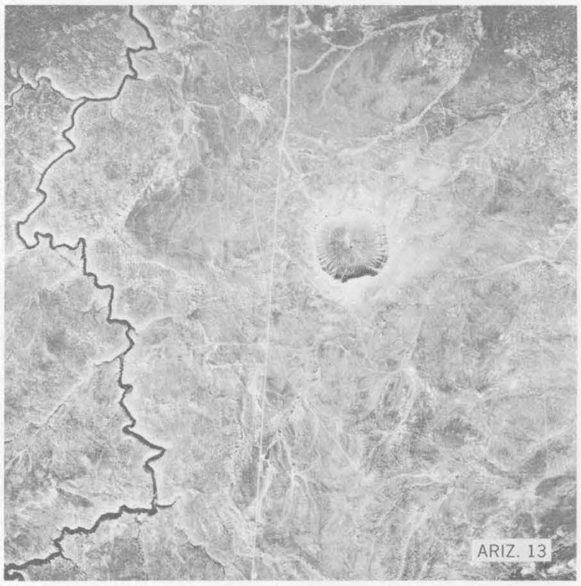

ARIZ. 8


ARIZ. 9

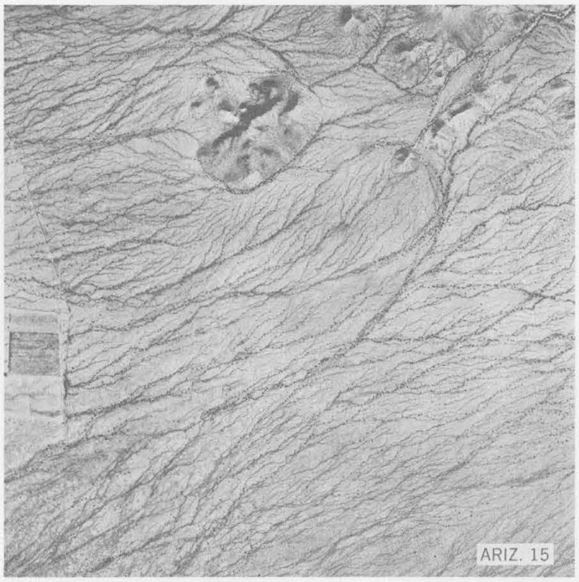

ARIZ. 10

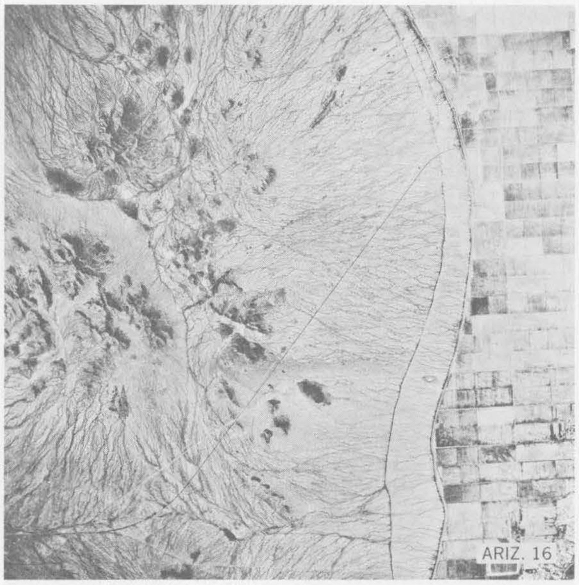

ARIZ. 11


ARIZ. 12


ARIZ. 13


ARIZ. 14


ARIZ. 15


ARIZ. 16

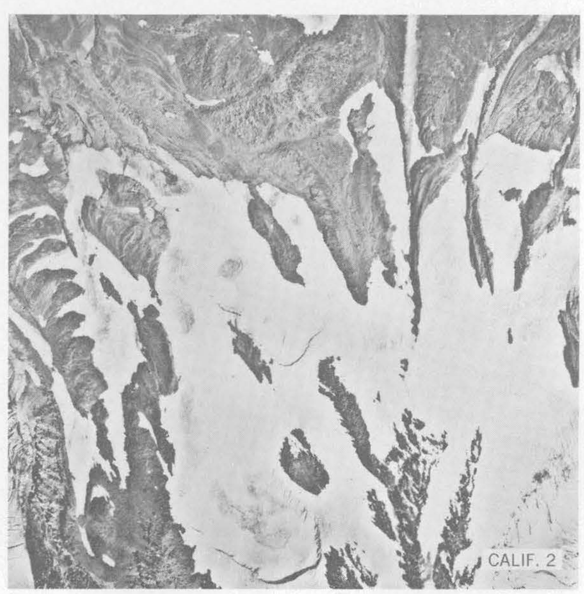

ARK. 1

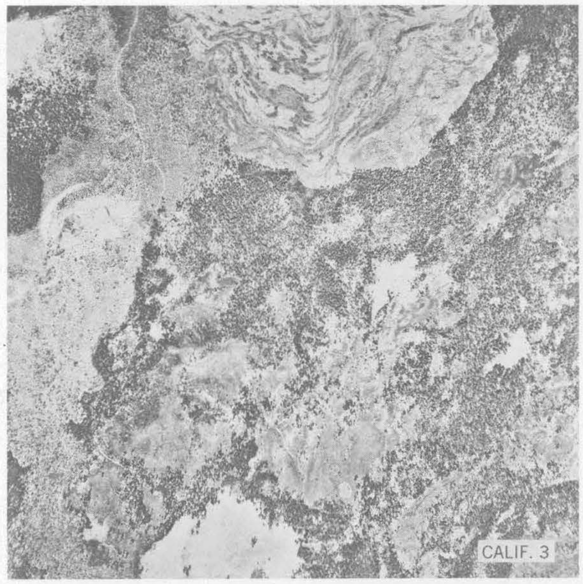

ARK. 2


ARK. 3

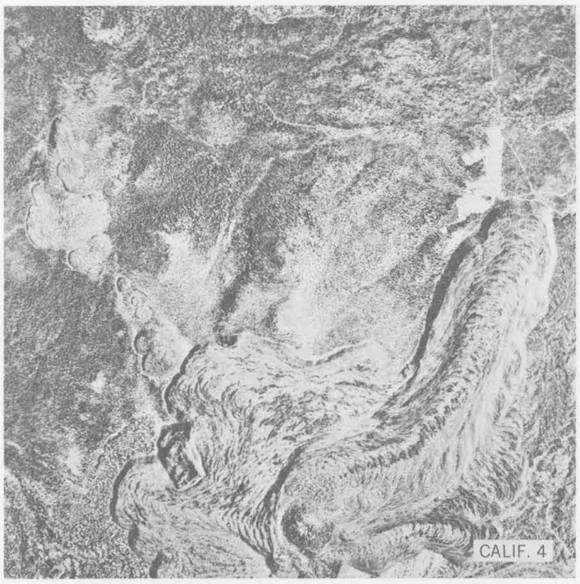

ARK. 4


CALIF. 1

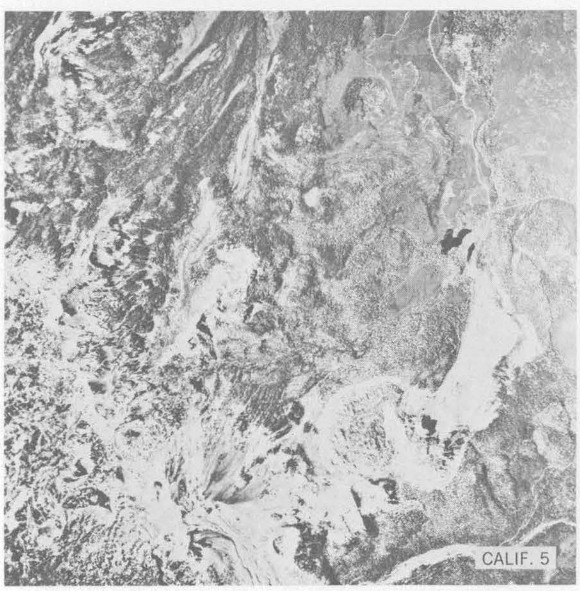

CALIF. 2



CALIF. 3



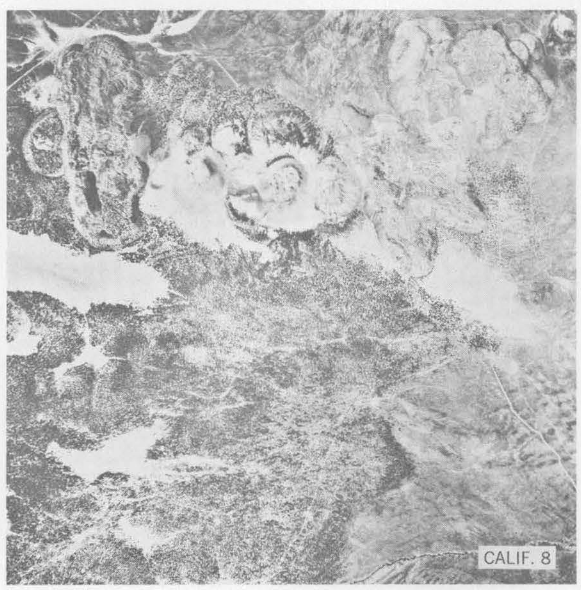
CALIF. 4



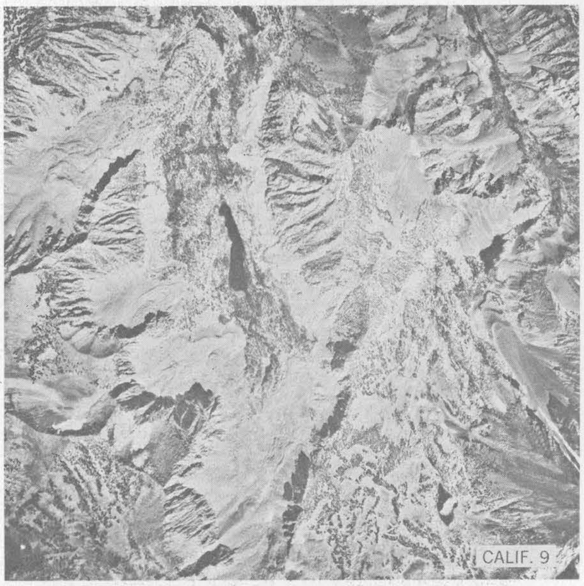
CALIF. 5

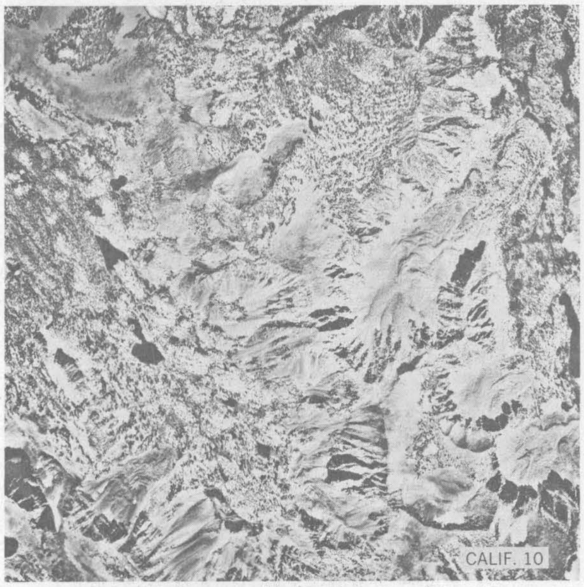
CALIF. 6

CALIF. 7



CALIF. 8


CALIF. 9


CALIF. 10

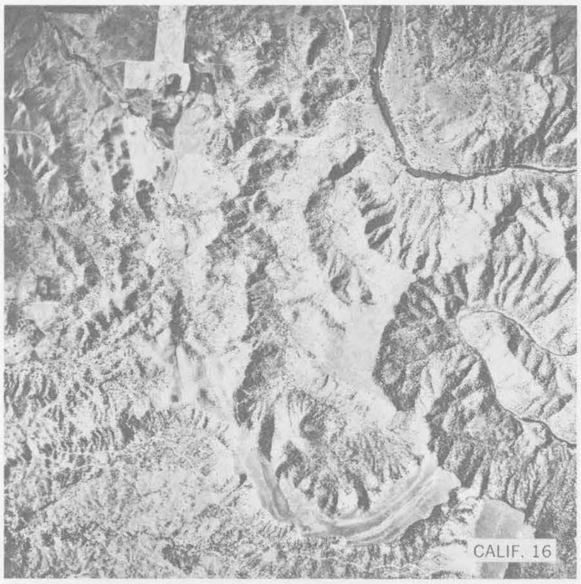

CALIF. 11


CALIF. 12

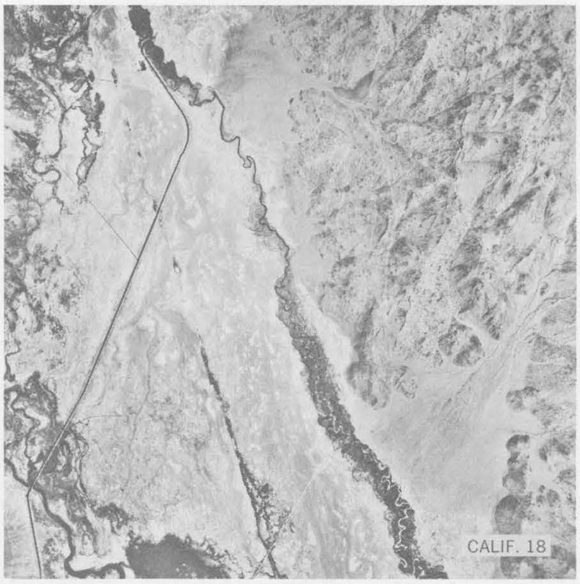

CALIF. 13


CALIF. 14


CALIF. 15

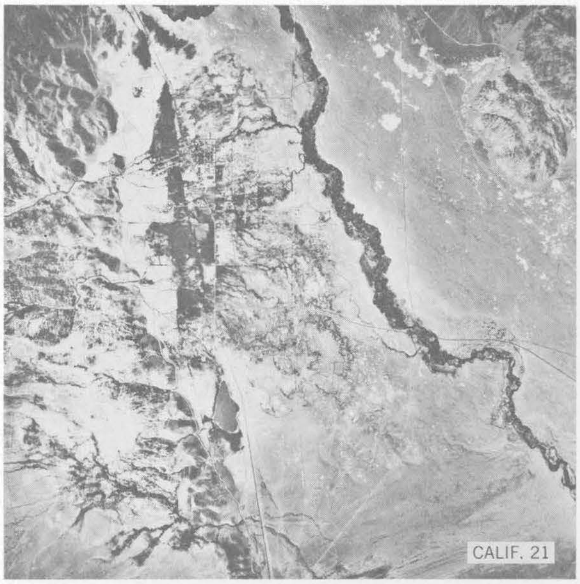

CALIF. 16


CALIF. 17

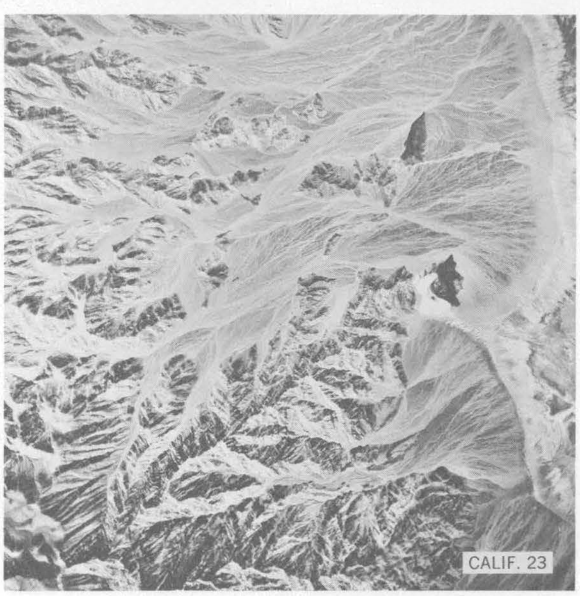

CALIF. 18

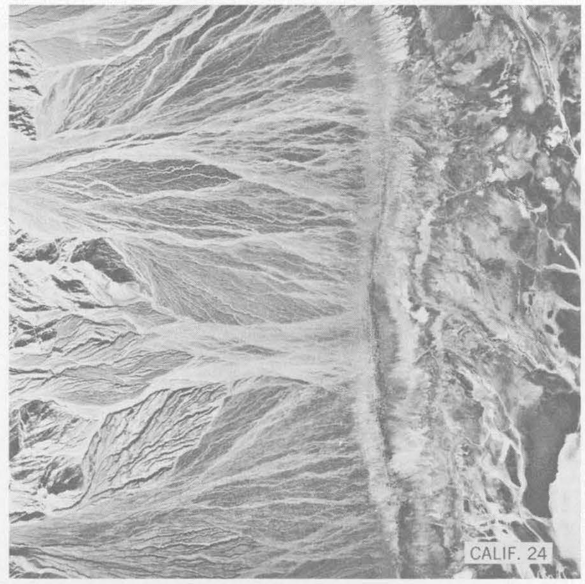

CALIF. 19


CALIF. 20

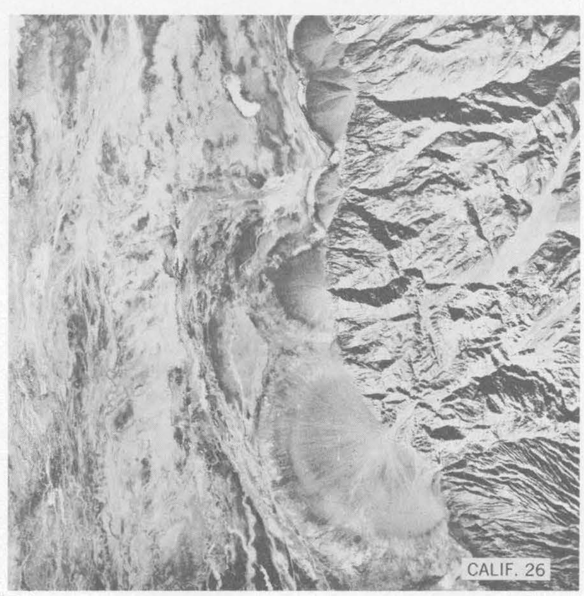

CALIF. 21


CALIF. 22

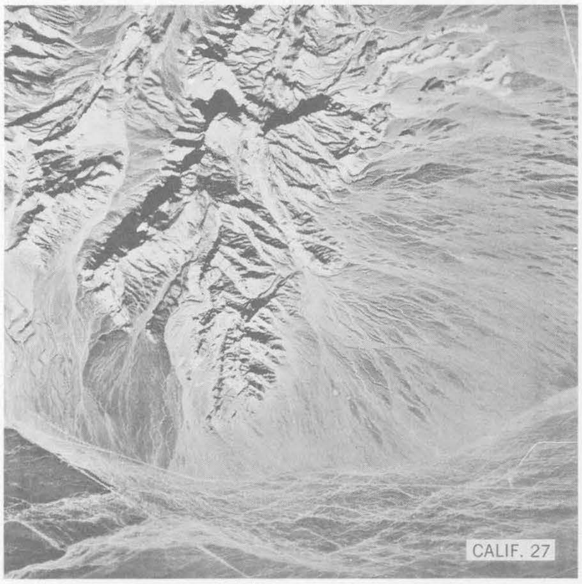

CALIF. 23


CALIF. 24

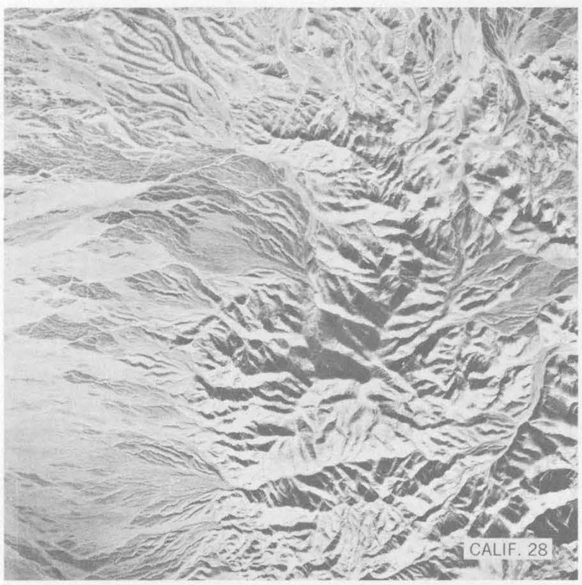

CALIF. 25


CALIF. 26

269-086 O - 68 - 7

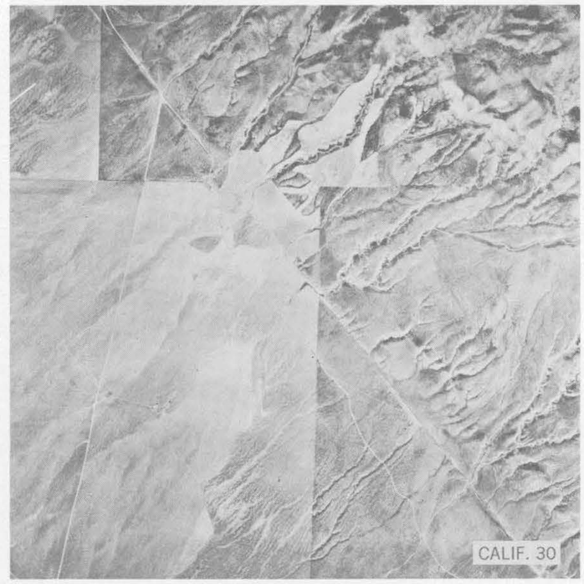


CALIF. 27



CALIF. 28

CALIF. 29

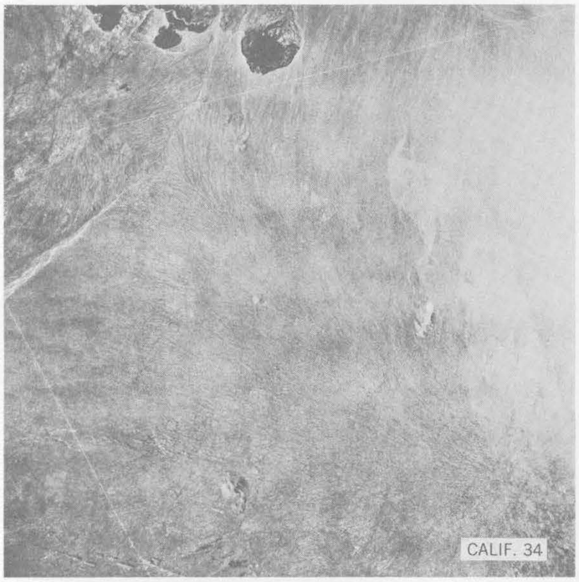


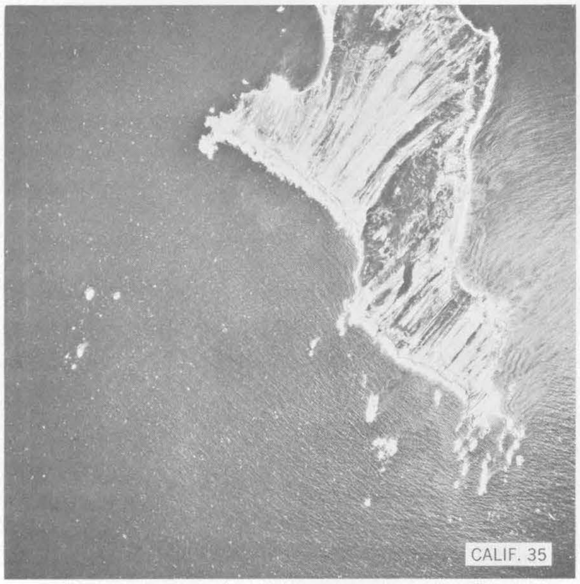
CALIF. 30

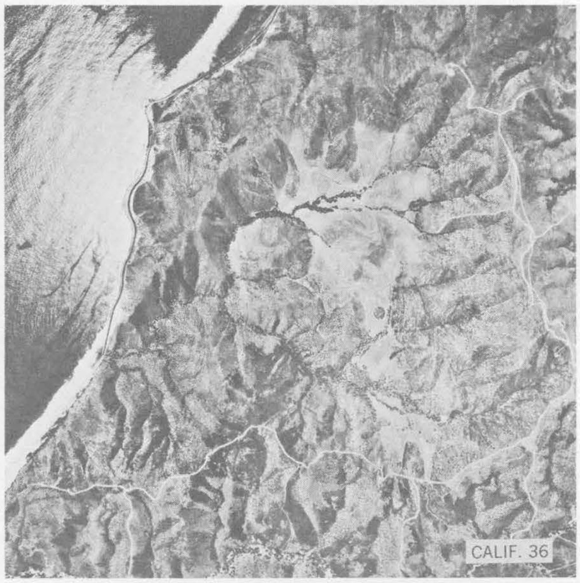
CALIF. 31

CALIF. 32

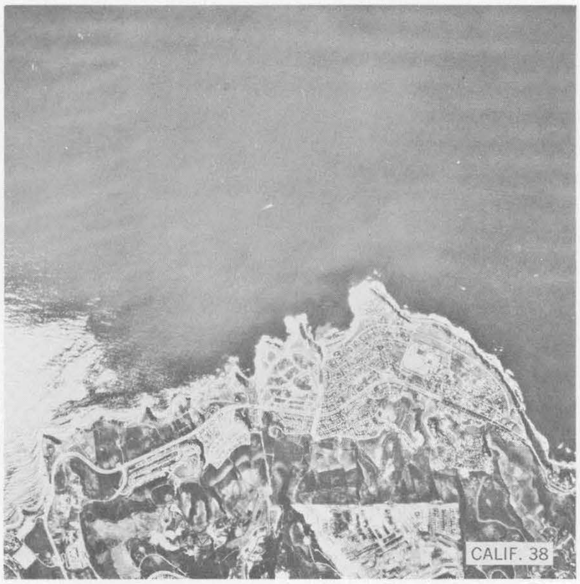

CALIF. 33


CALIF. 34

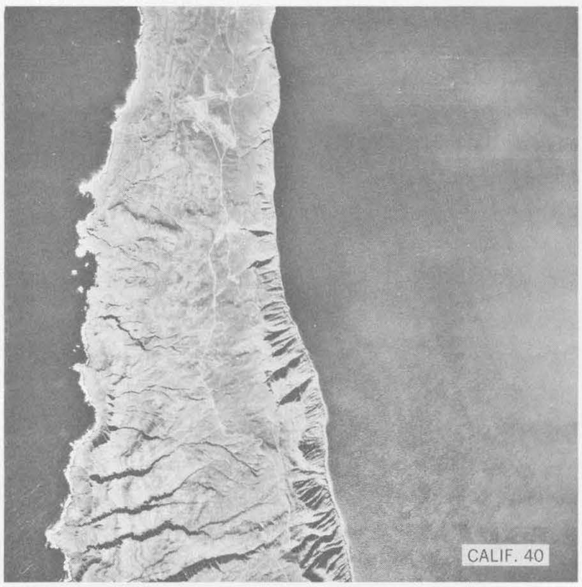

CALIF. 35

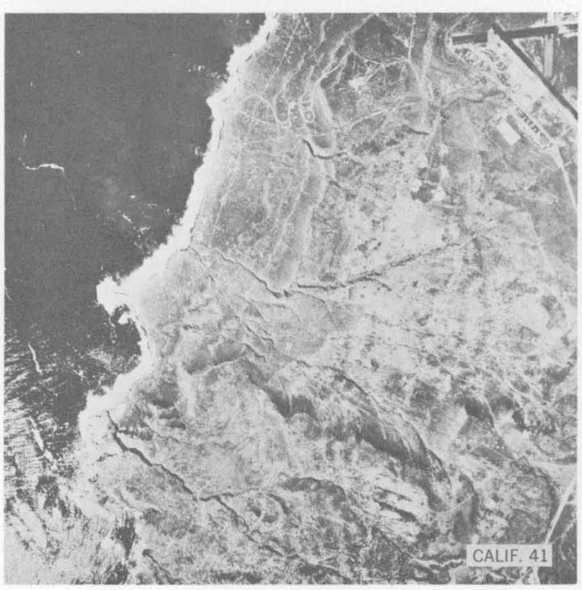

CALIF. 36


CALIF. 37

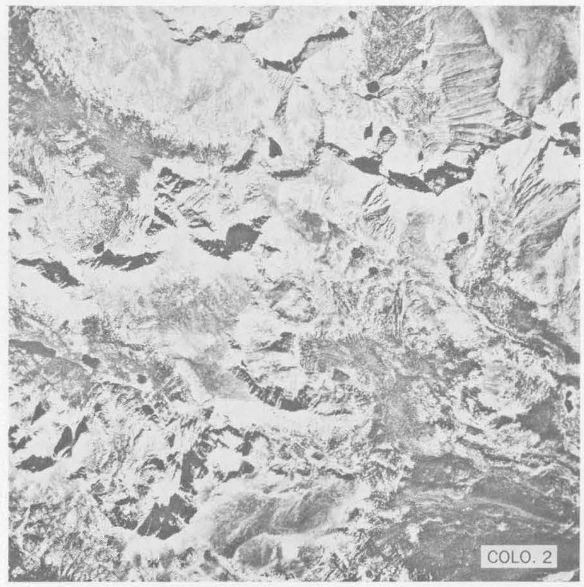

CALIF. 38


CALIF. 39


CALIF. 40

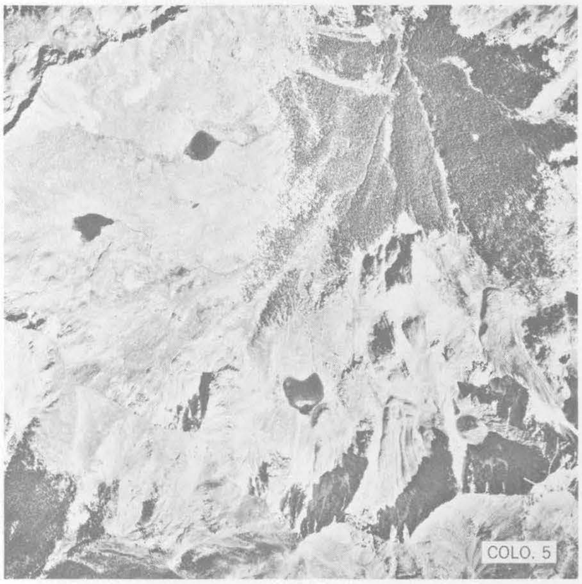

CALIF. 41


COLO. 1


COLO. 2

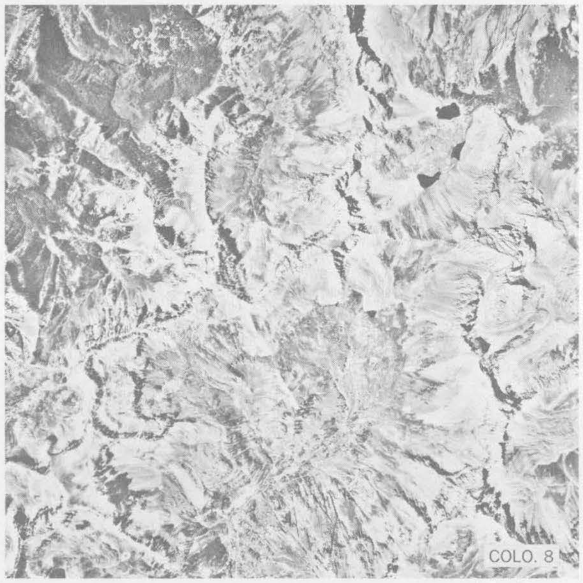

COLO. 3


COLO. 4

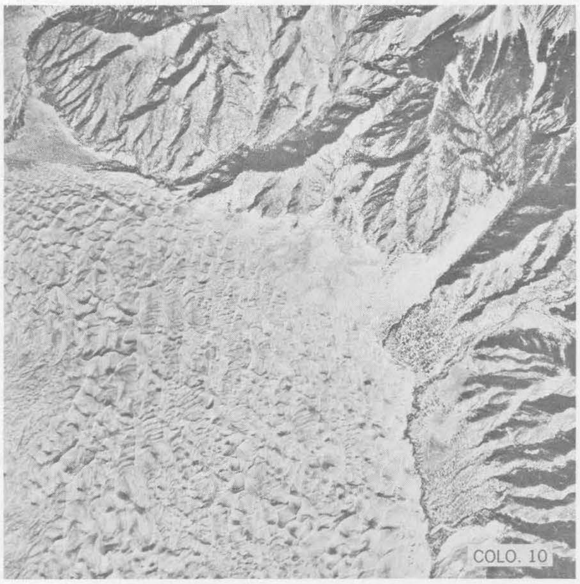

COLO. 5


COLO.6

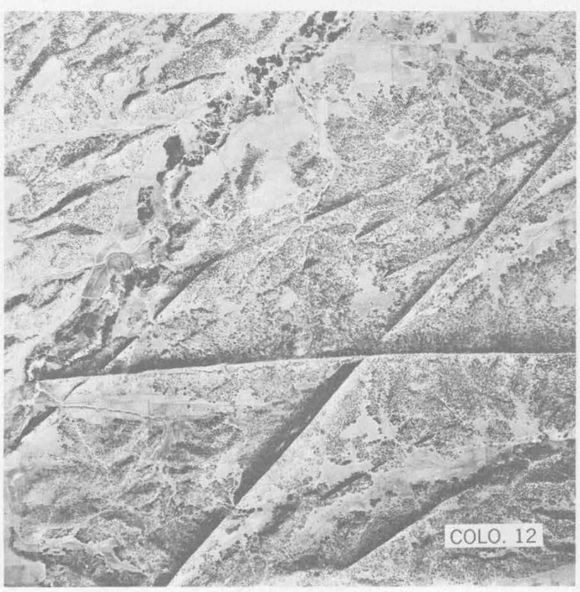

COLO. 7


COLO. 8

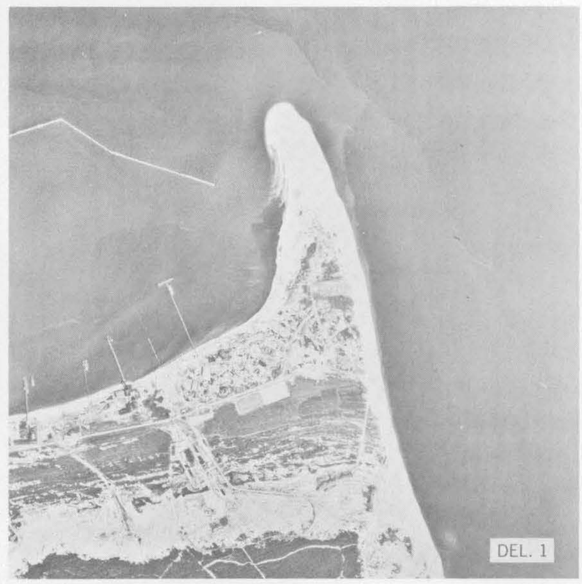

COLO. 9

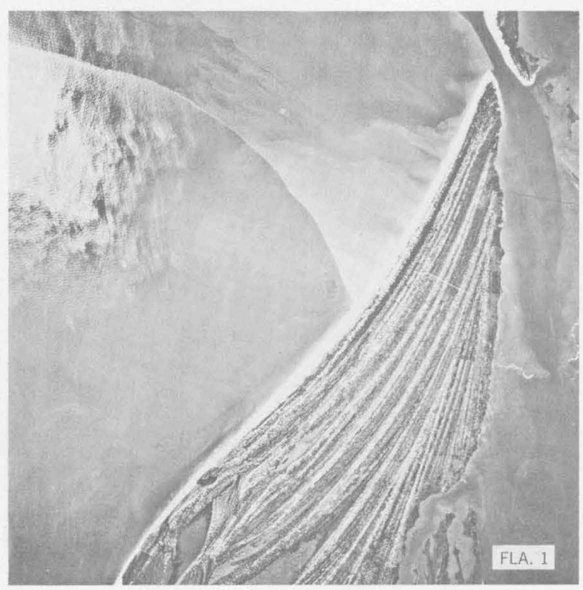

COLO. 10

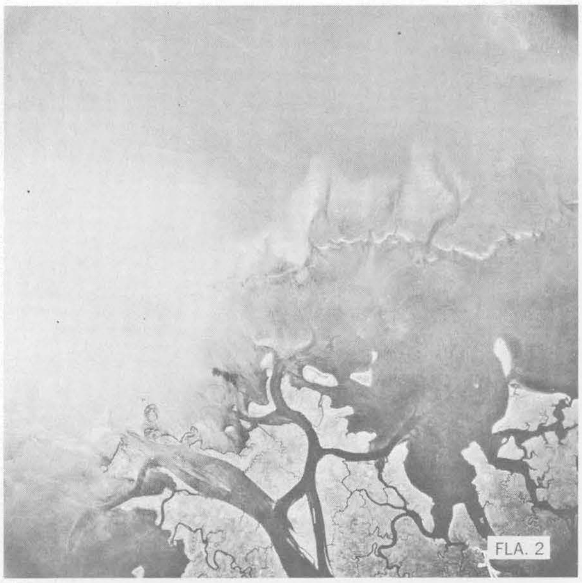

COLO. 11


COLO. 12

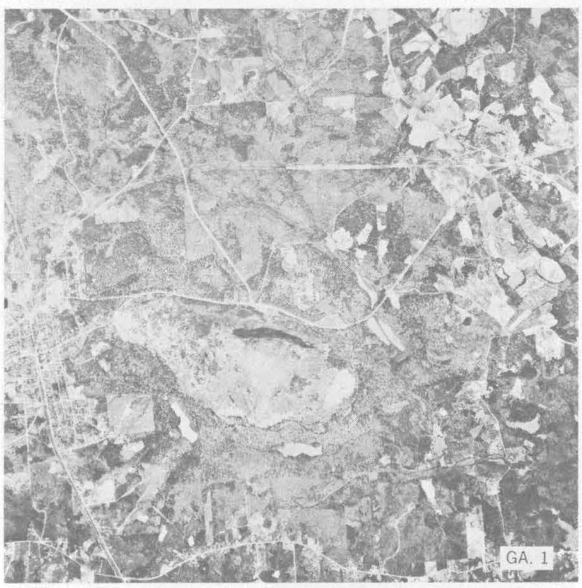

CONN. 1

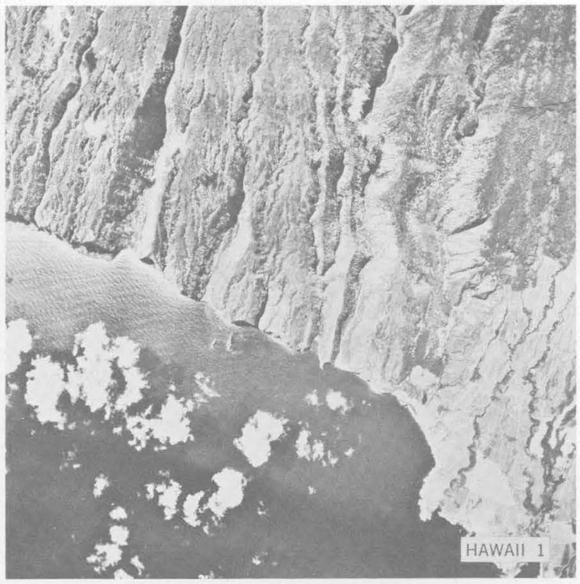

DEL. 1

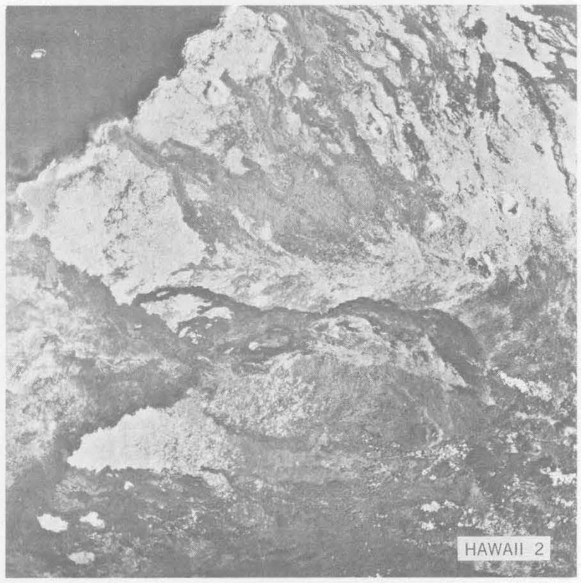

FLA. 1

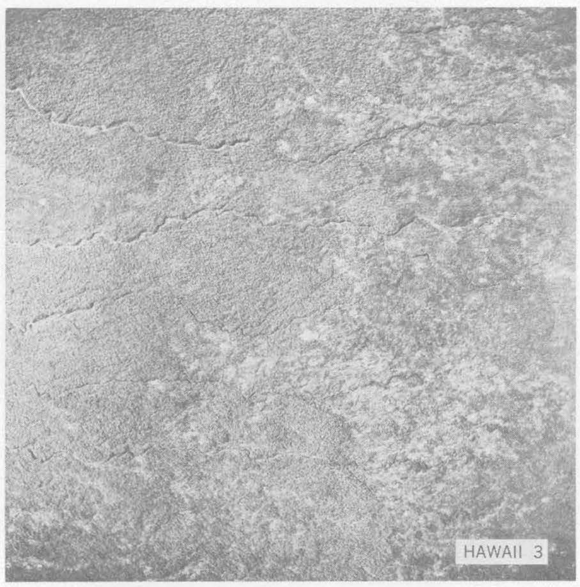

FLA. 2

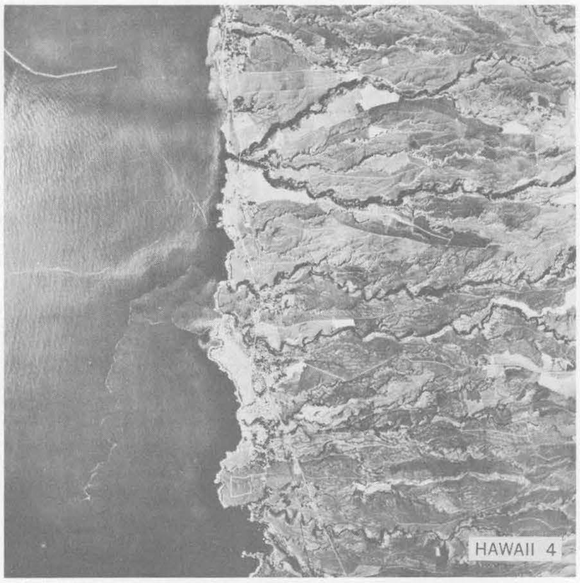

FLA. 3

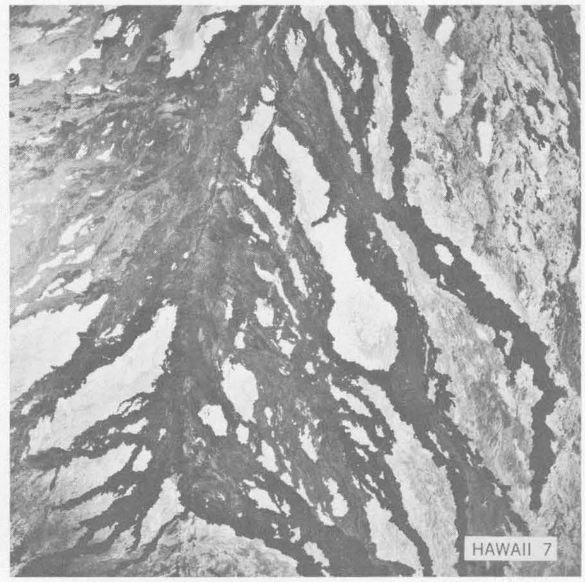

GA. 1

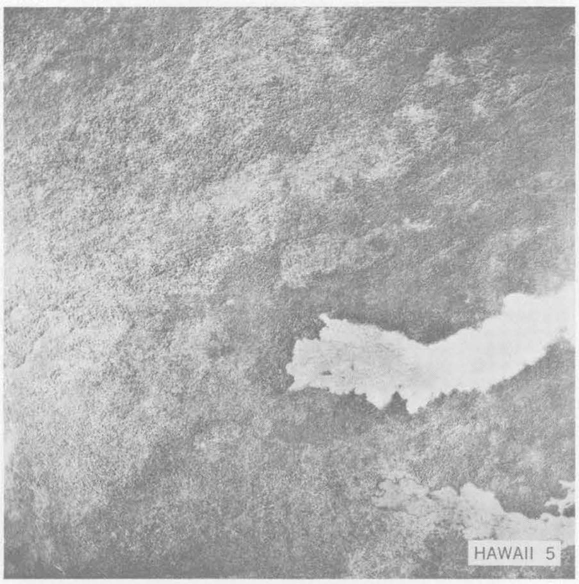

HAWAII 1


HAWAII 2

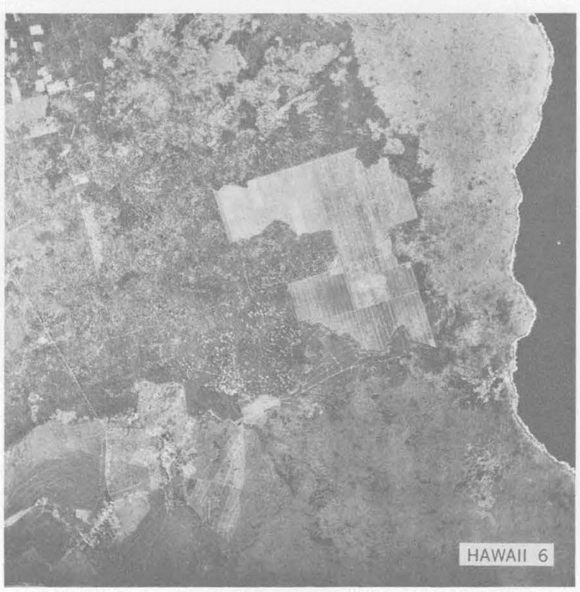

HAWAII 3

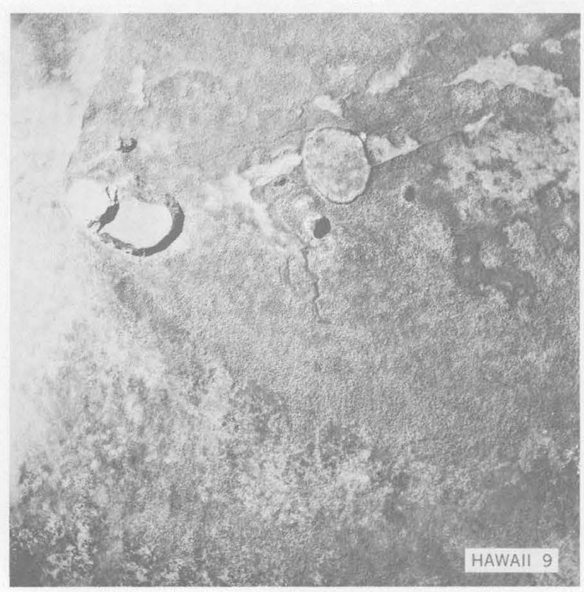

HAWAII 4

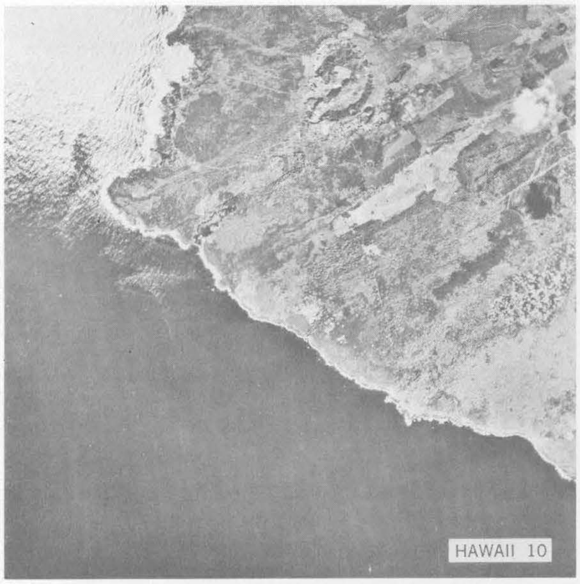

HAWAII 7


HAWAII 5


HAWAII 8


HAWAII 6


HAWAII 9


HAWAII 10


IDAHO 3


IDAHO 1


IDAHO 4

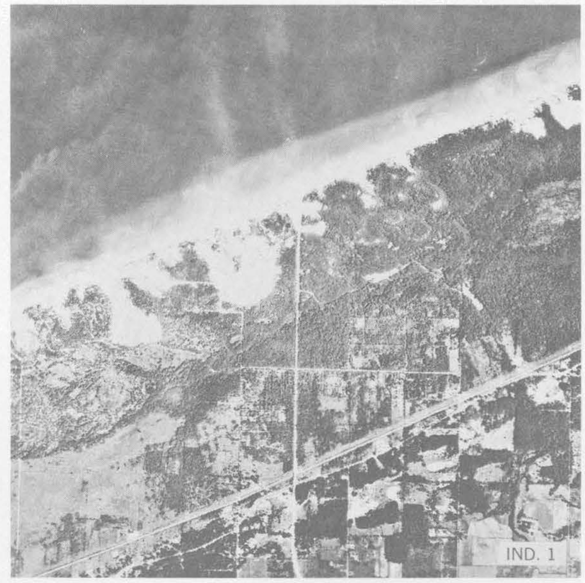

IDAHO 2


IDAHO 5

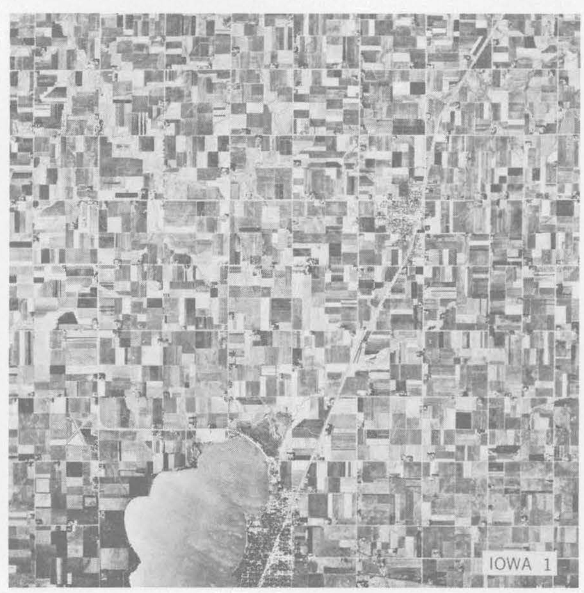

IDAHO 6


IDAHO 7

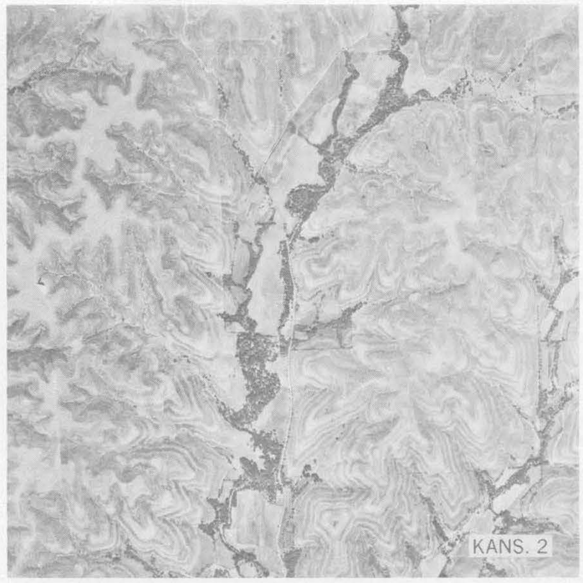

ILL. 1

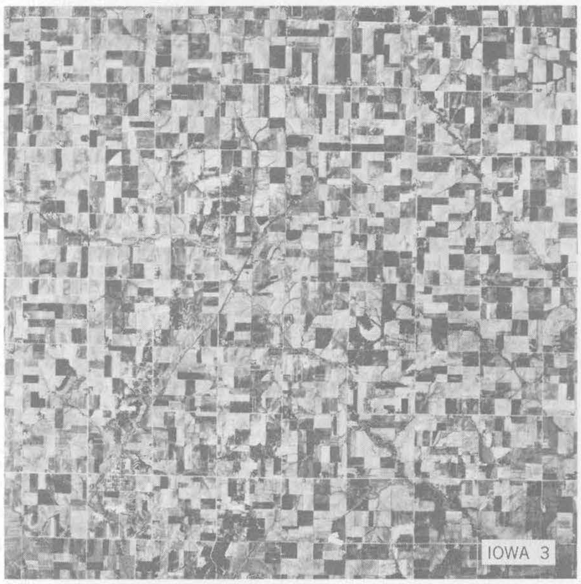

IND. 1

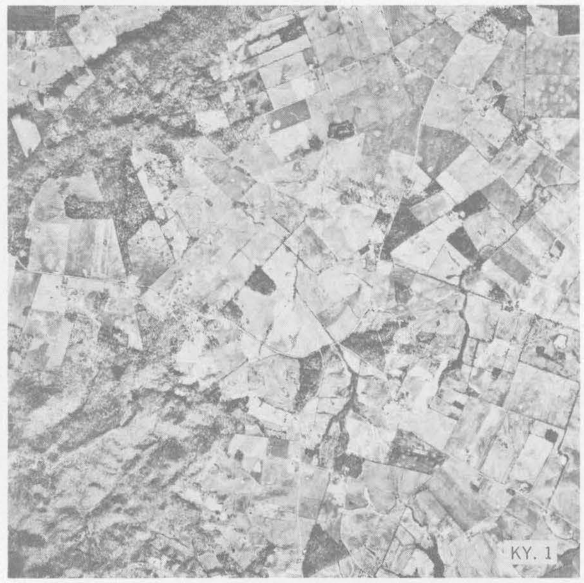

IND. 2

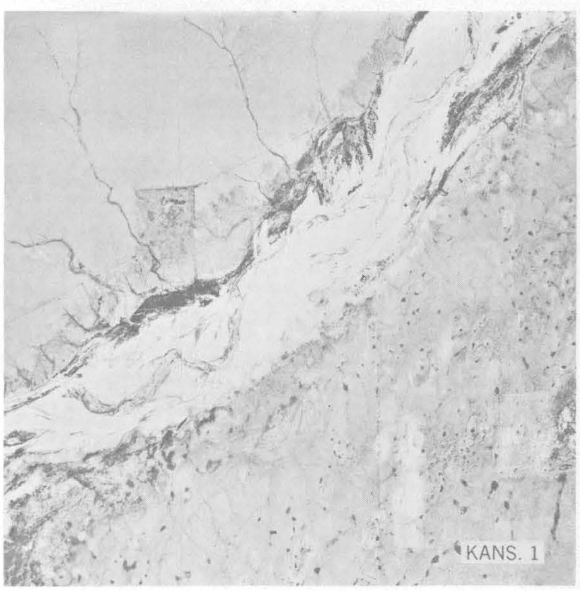

IOWA 1

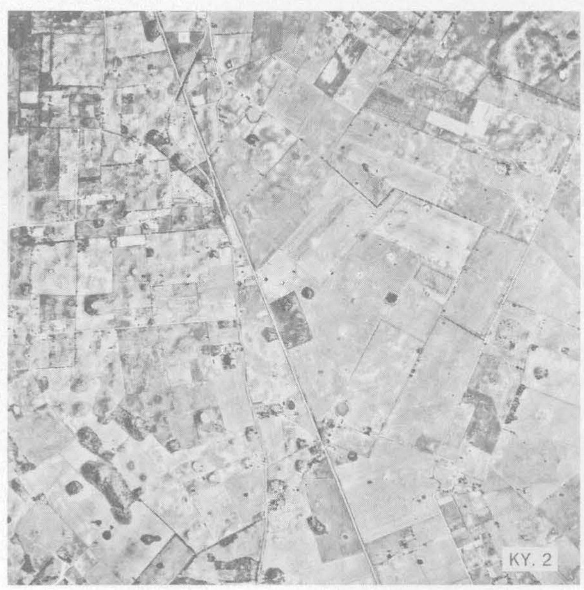

IOWA 2


KANS. 2

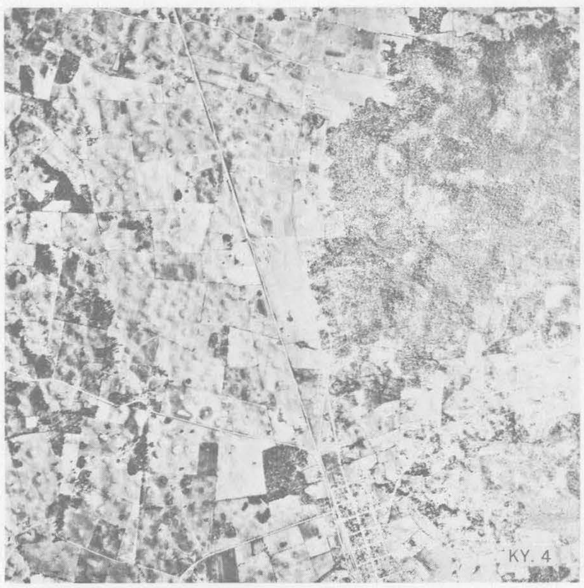

IOWA 3


KY. 1


KANS. 1

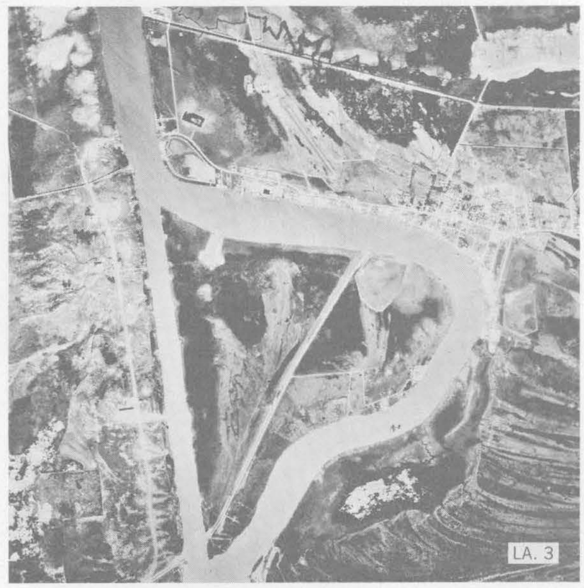

KY. 2


KY. 3


KY. 4

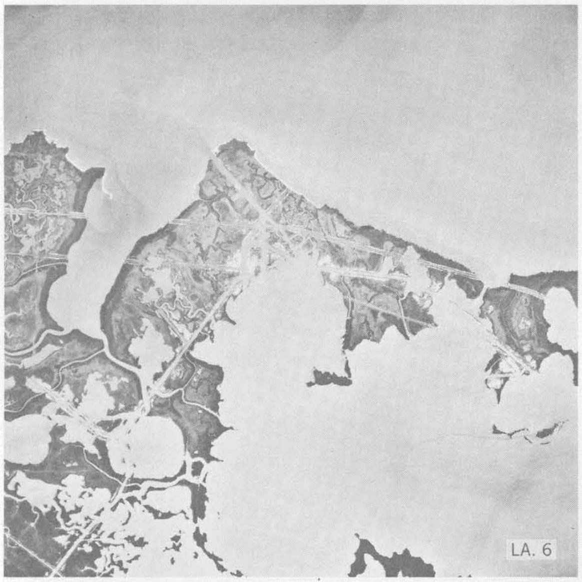

LA. 1

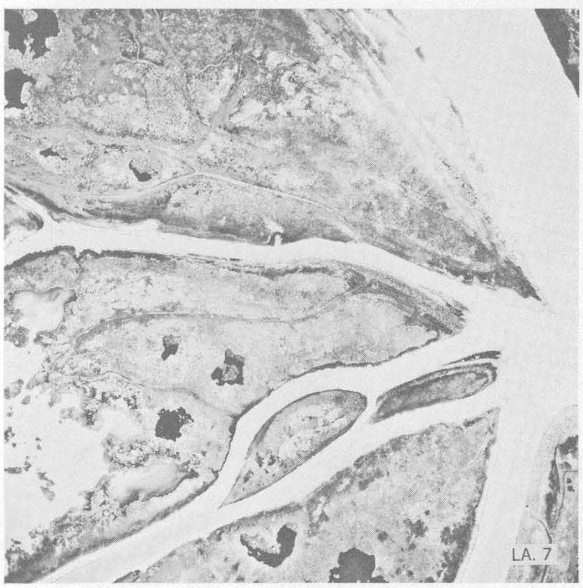

LA. 2

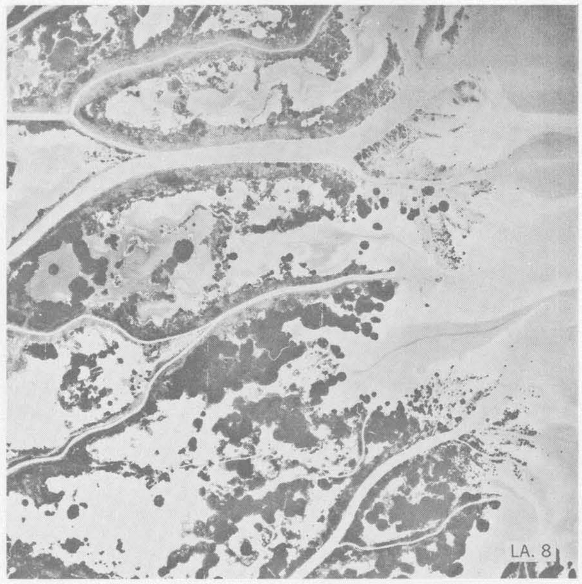

LA. 3

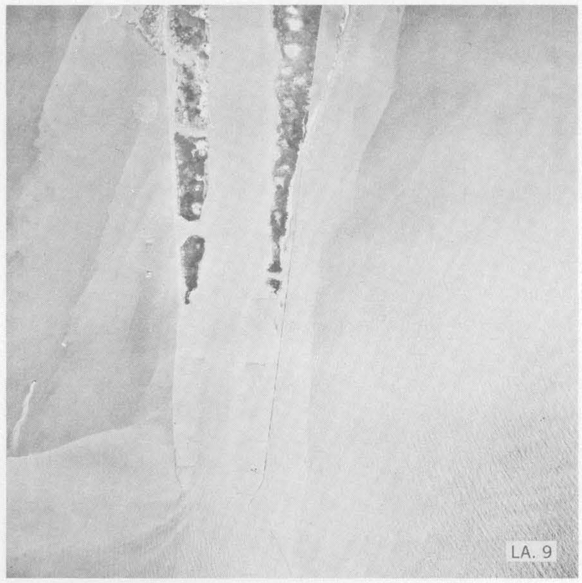

LA. 4


LA. 5

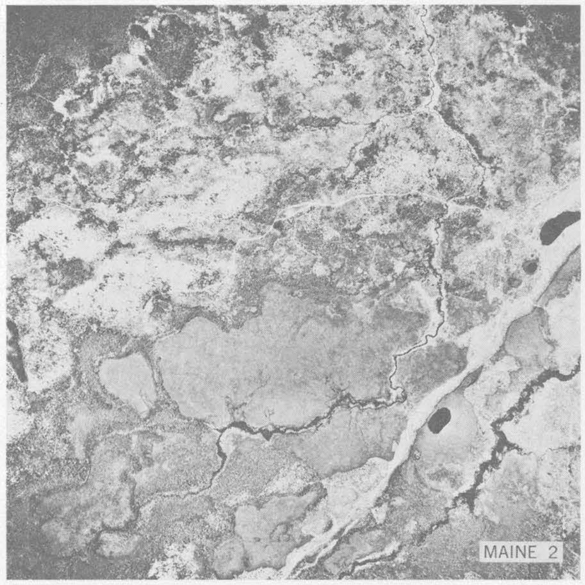

LA. 6

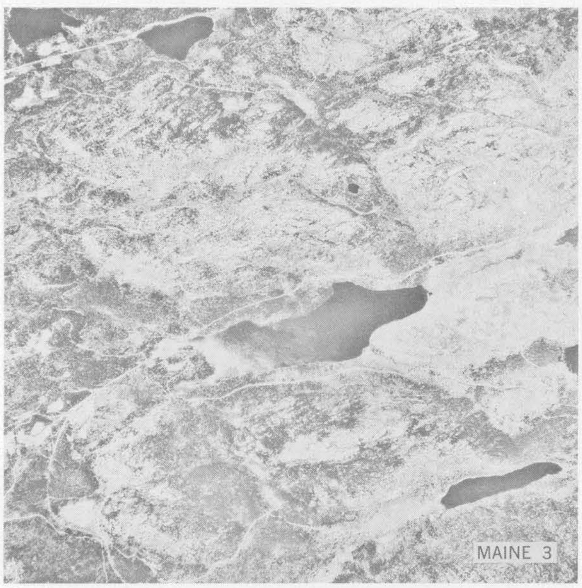

LA. 7


LA. 8

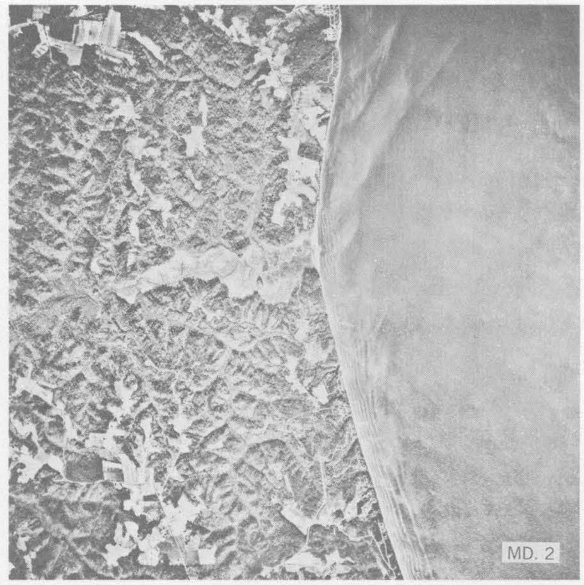

LA. 9


MAINE 1


MAINE 2

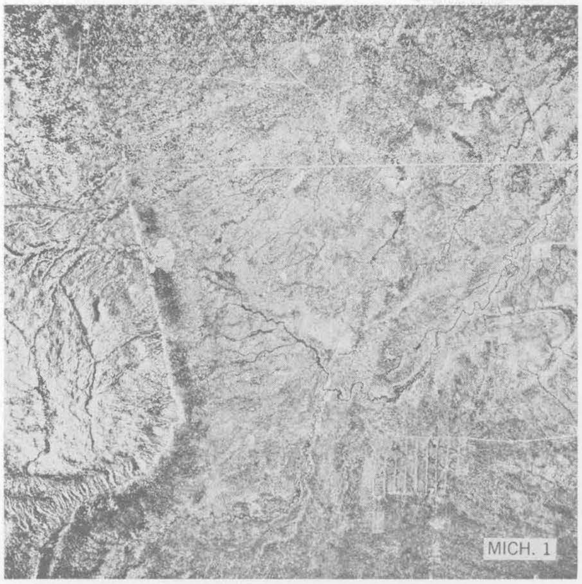

MAINE 3

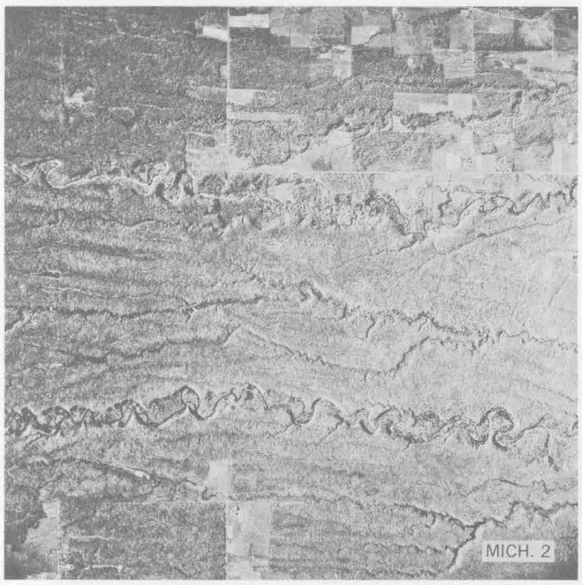

MD. 1

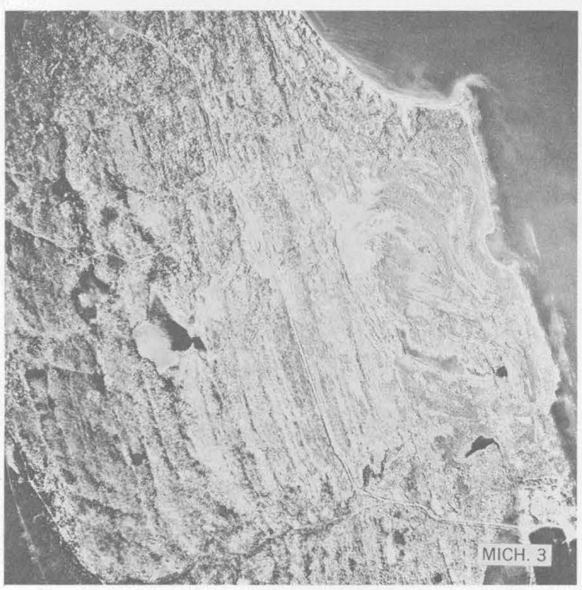

MD. 2


MASS. 1

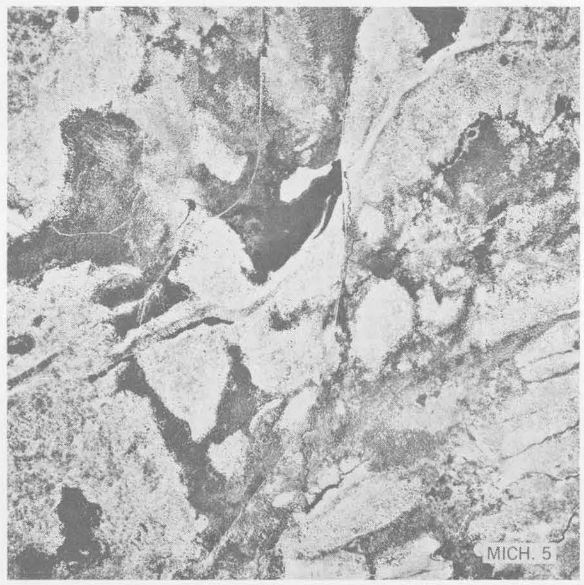

MASS. 2

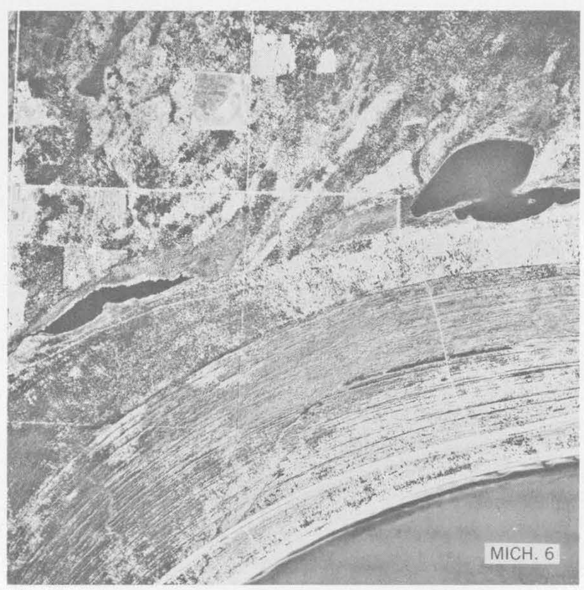

MICH. 1

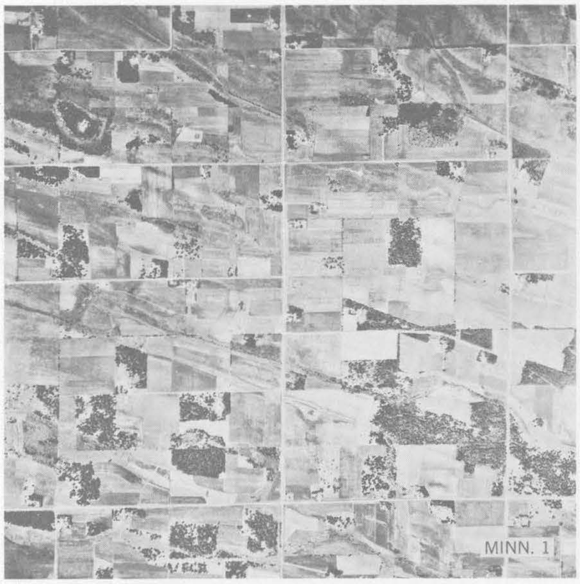

MICH. 2

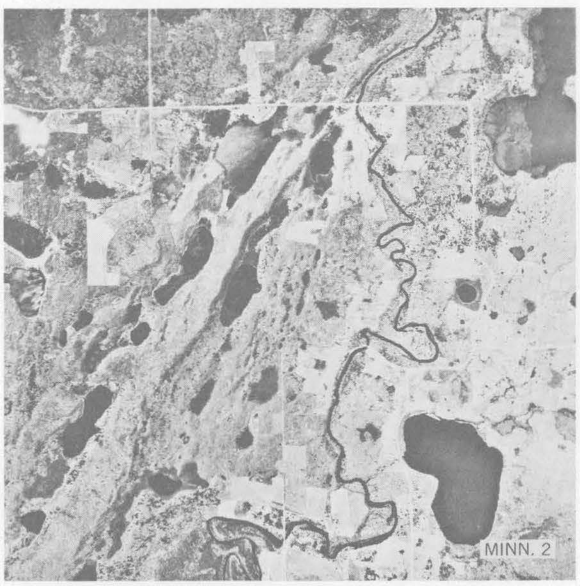

MICH. 3


MICH. 4

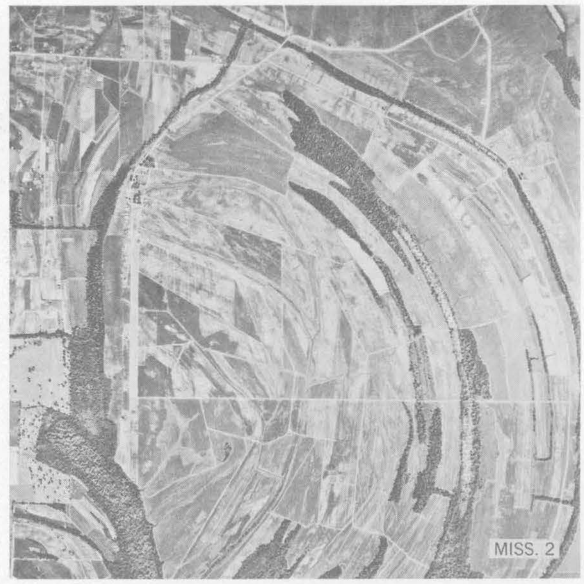

MICH. 5


MICH. 6

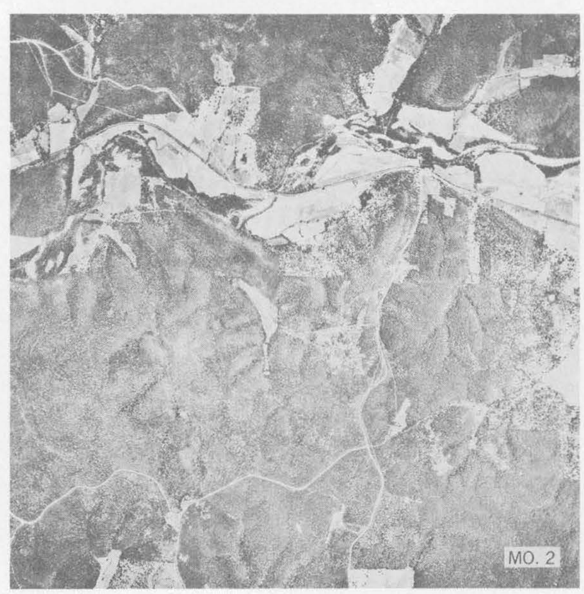

MINN. 1

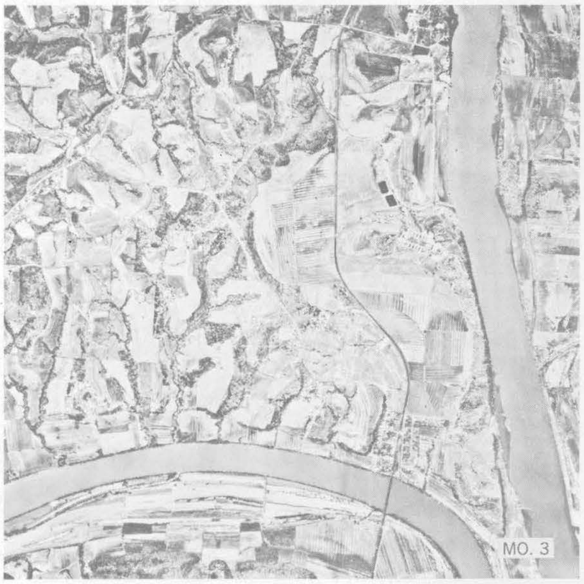

MINN. 2

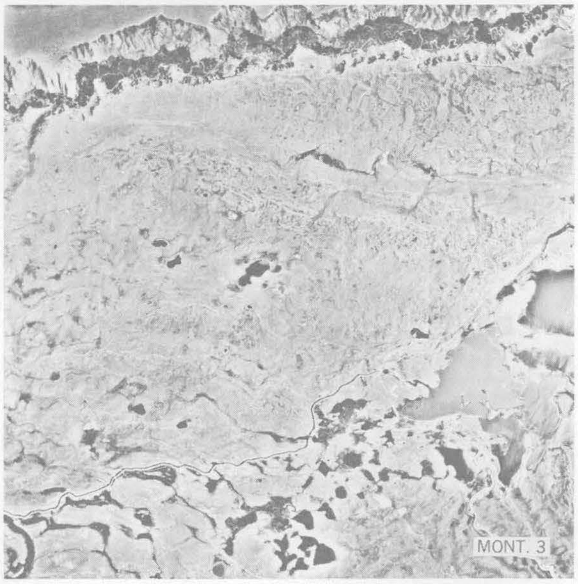

MISS. 1

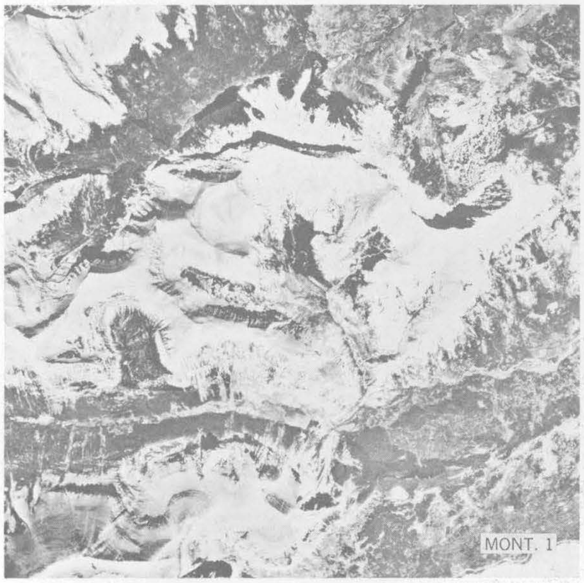

MISS. 2


MO. 1

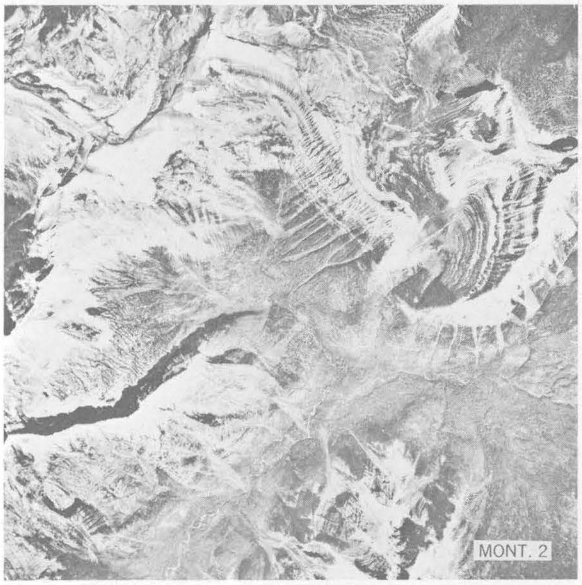

MO. 2

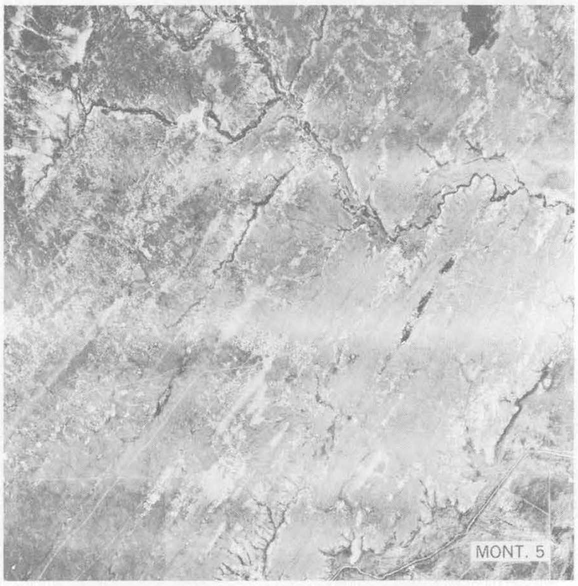

MO. 3

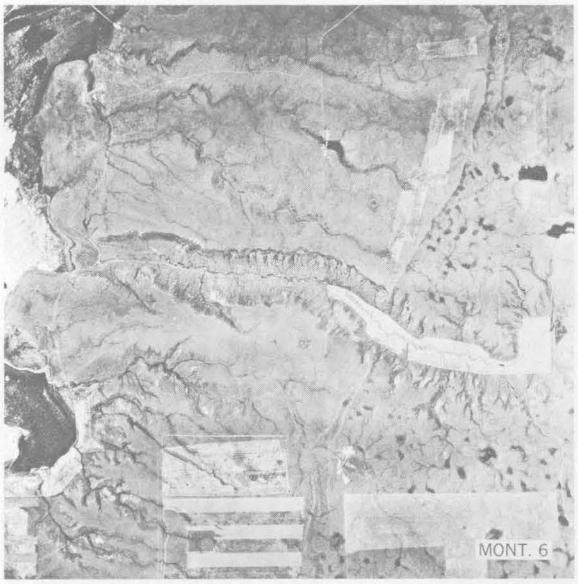

MONT. 3


MONT. 1


MONT. 4

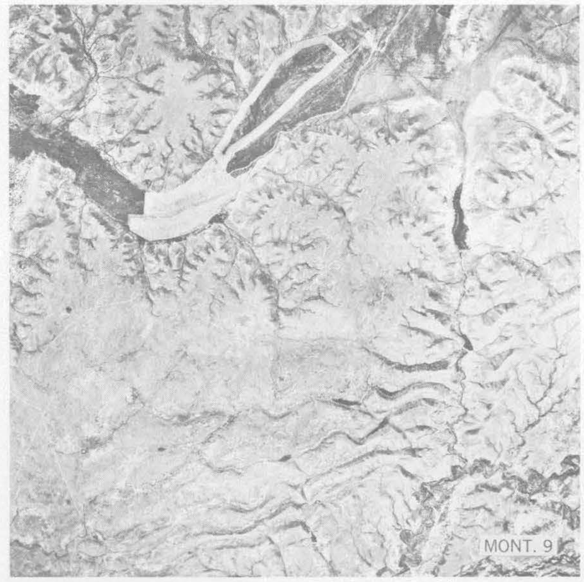

MONT. 2

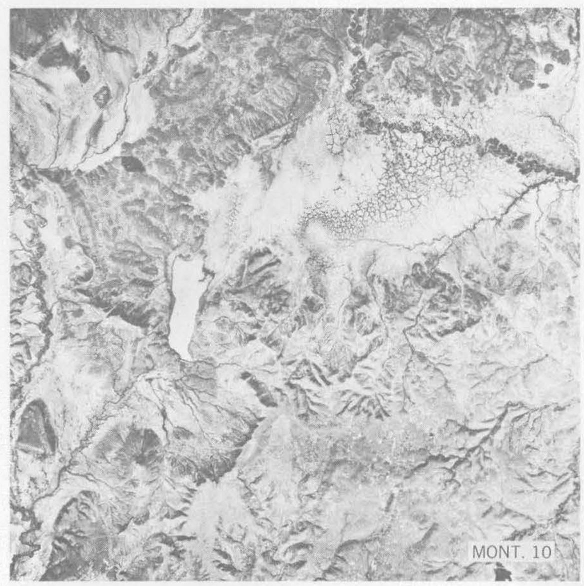

MONT. 5


MONT. 6

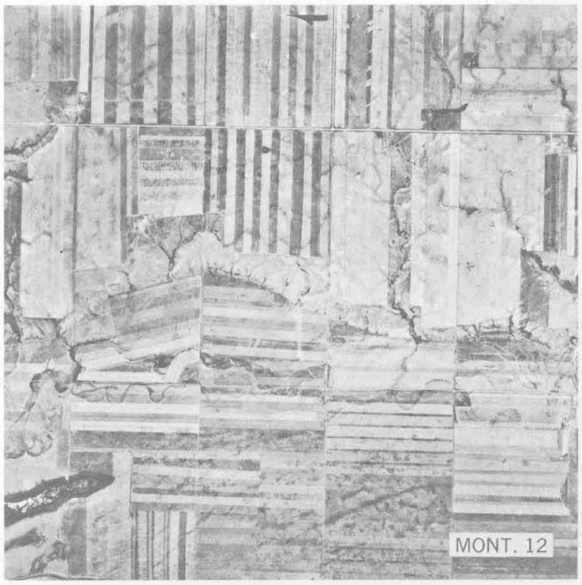

MONT. 7

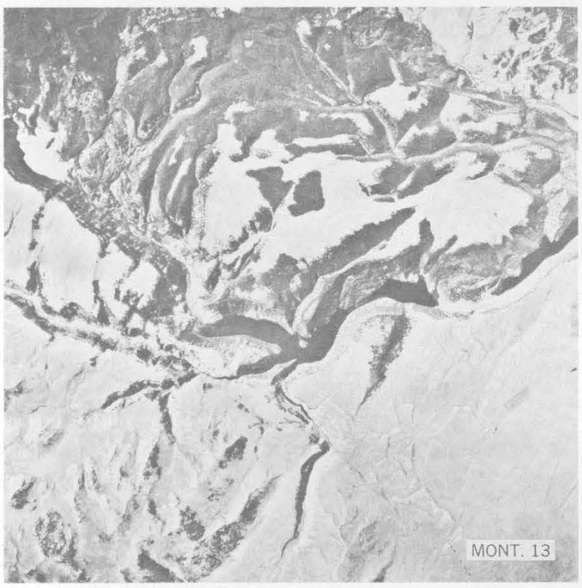

MONT. 8


MONT. 9

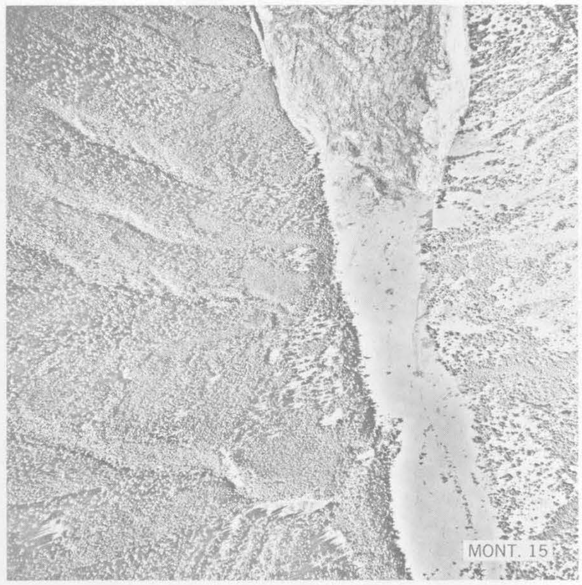

MONT. 10


MONT. 11

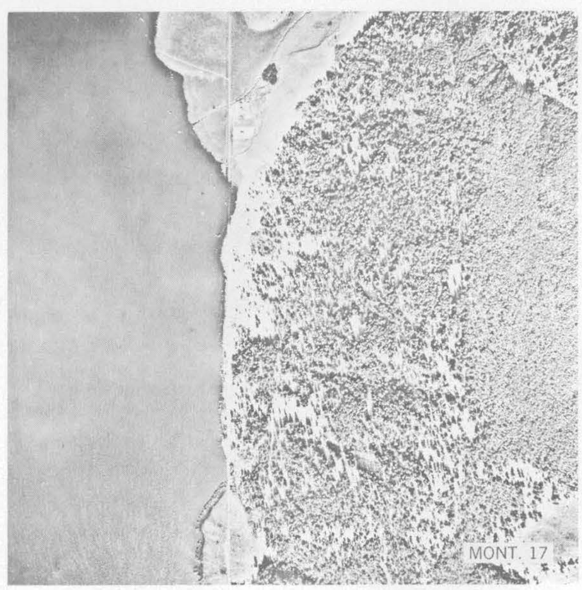

MONT. 12

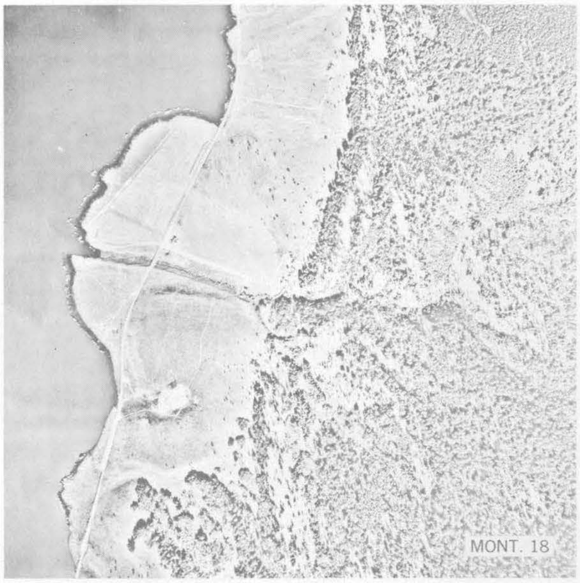

MONT. 13

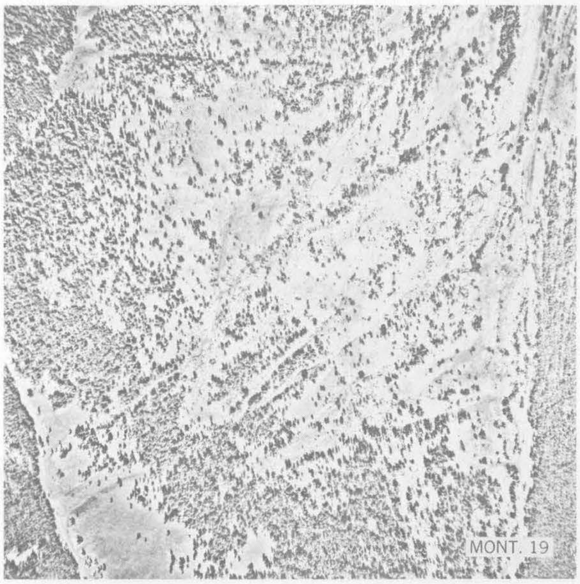

MONT. 14

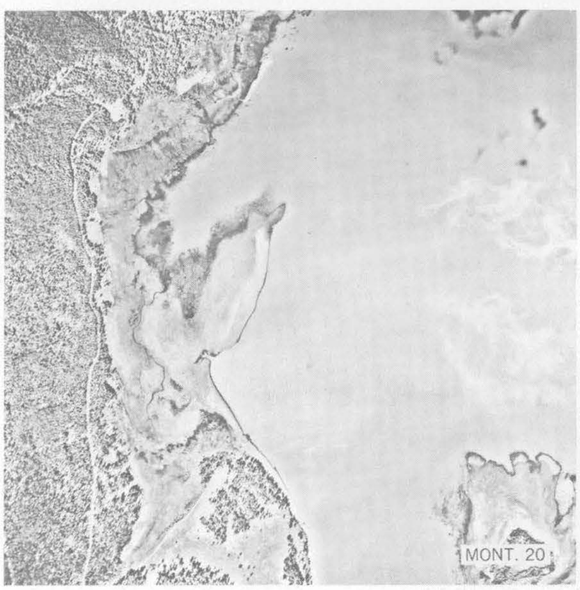

MONT. 15

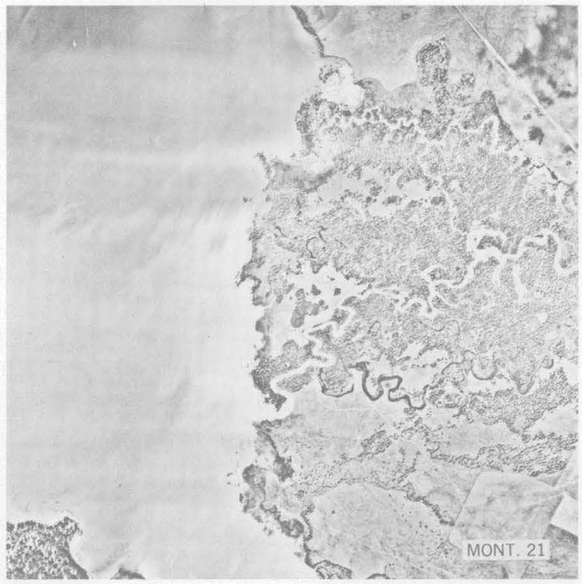

MONT. 16

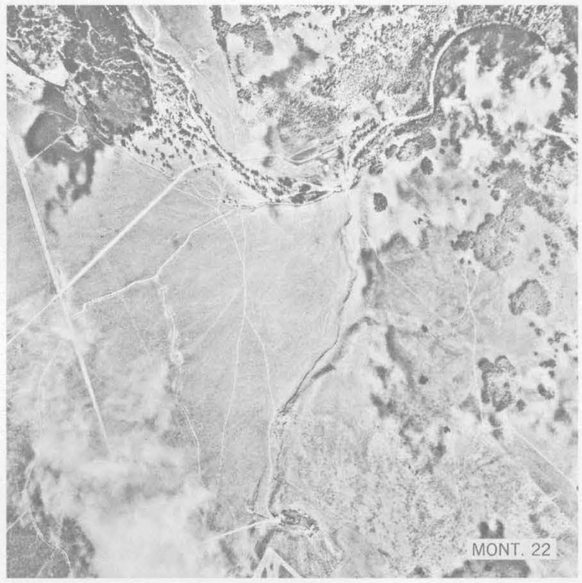

MONT. 17


MONT. 18

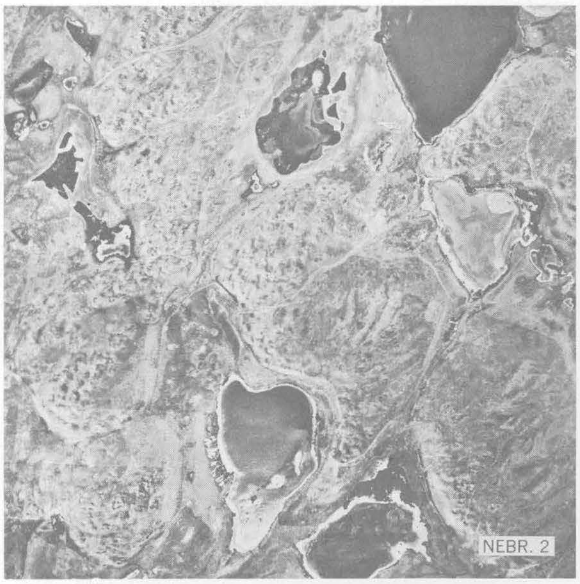

MONT. 19

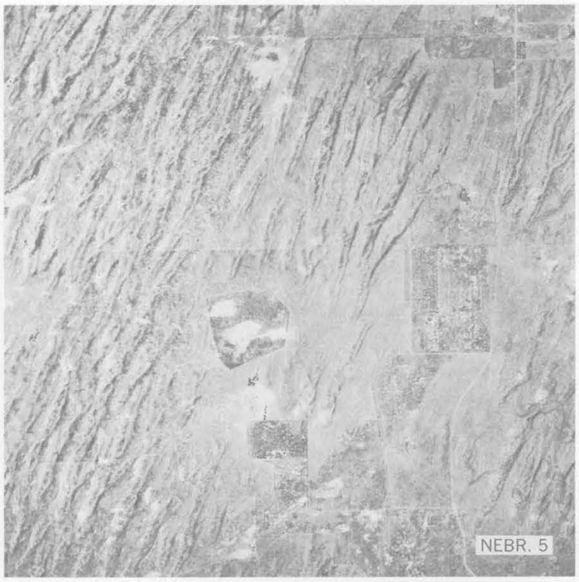

MONT. 20


MONT. 21


MONT. 22

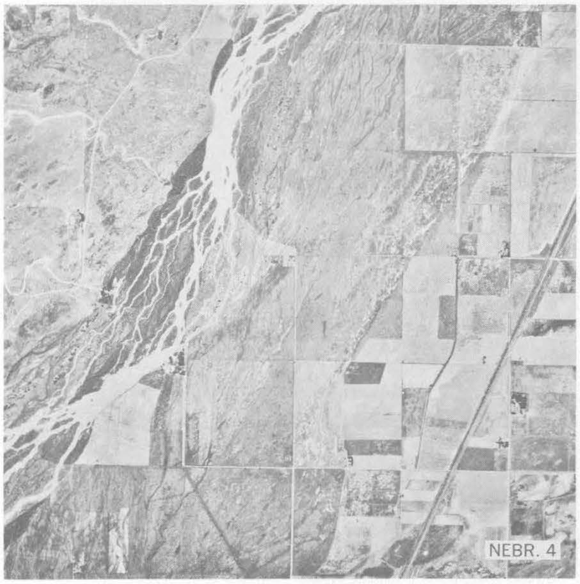

NEBR. 1

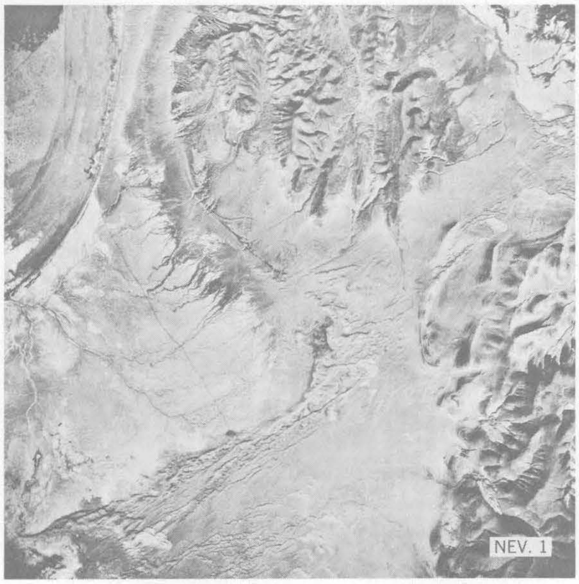

NEBR. 2

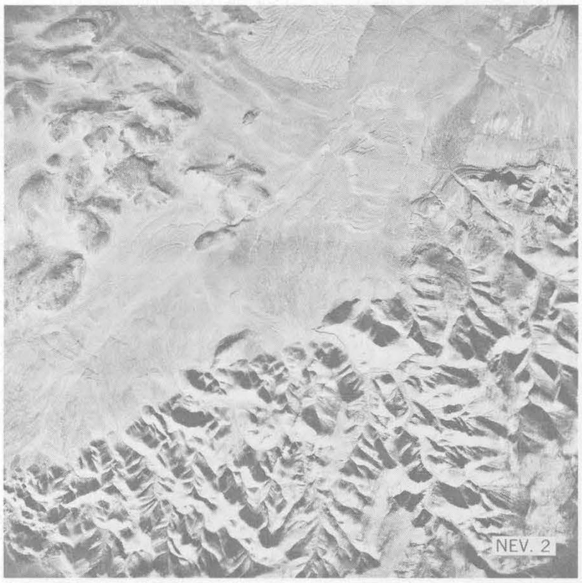

NEBR. 5


NEBR. 3

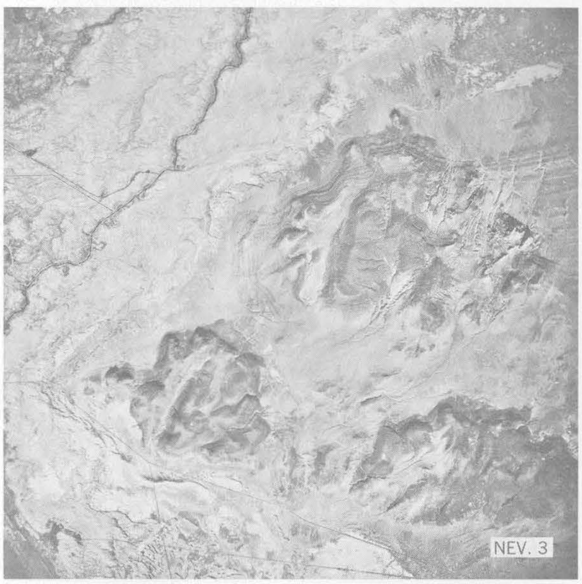

NEBR. 6

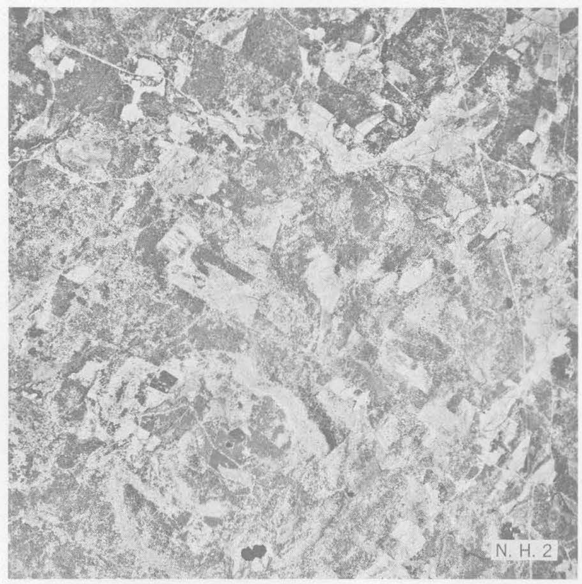

NEBR. 4


NEV. 1


NEV. 2

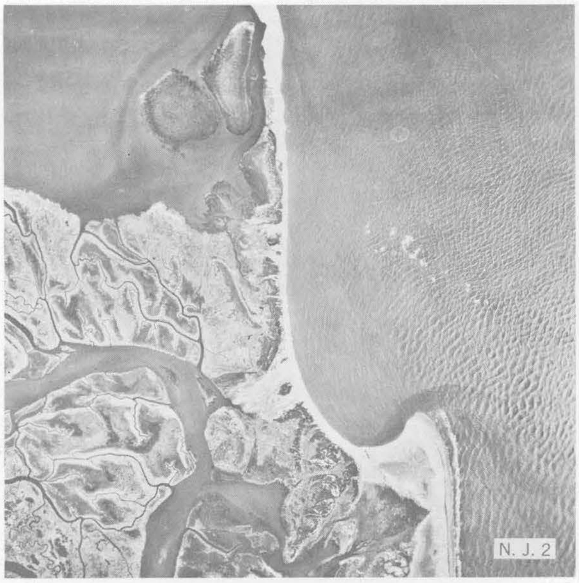

N. H. 1


NEV. 3

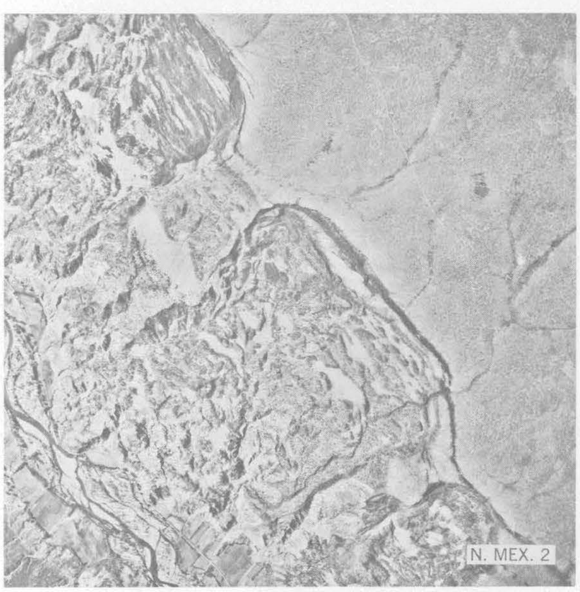

N. H. 2

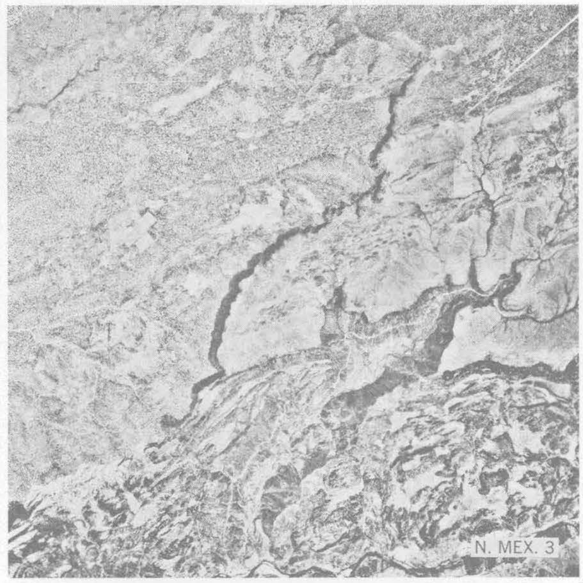

NEV. 4


N. J. 1

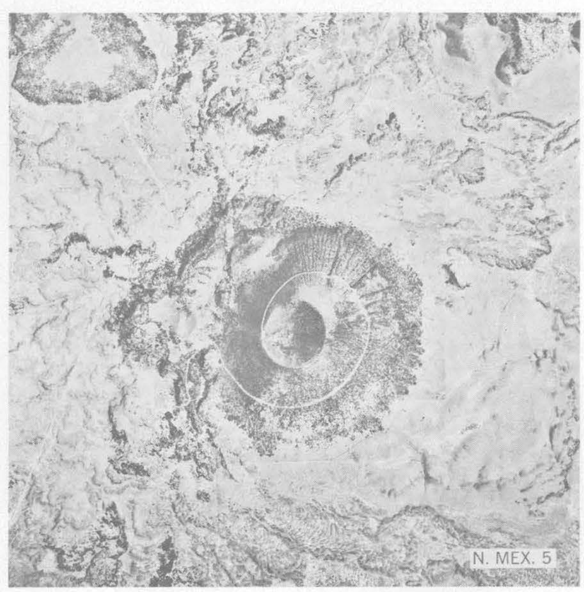

N. J. 2

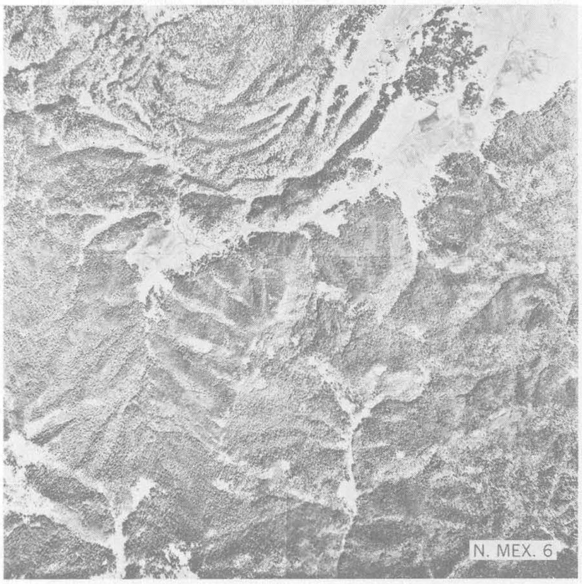

N. MEX. 1


N. MEX. 2


N. MEX. 3

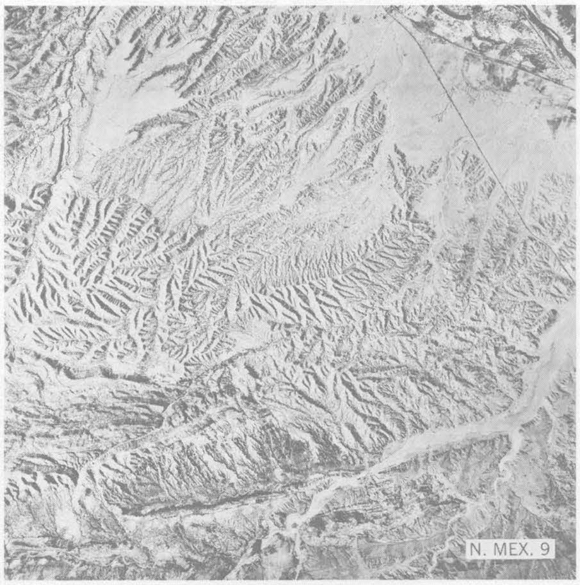

N. MEX. 4

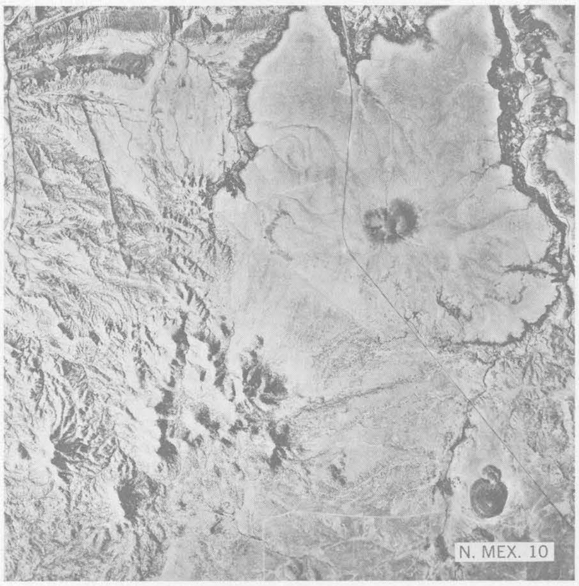

N. MEX. 5

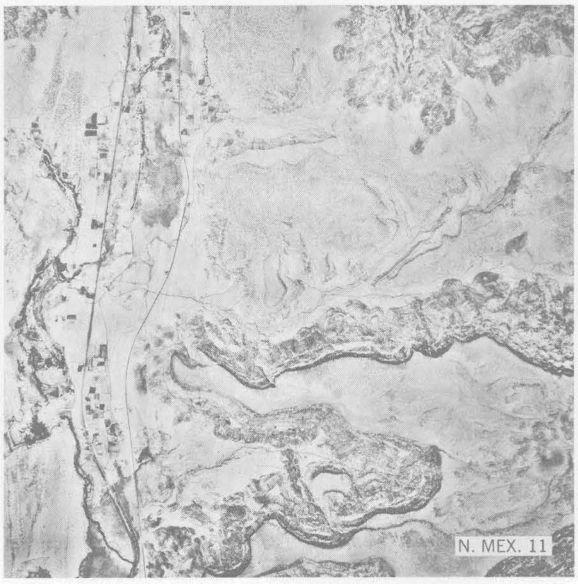

N. MEX. 6


N. MEX. 7

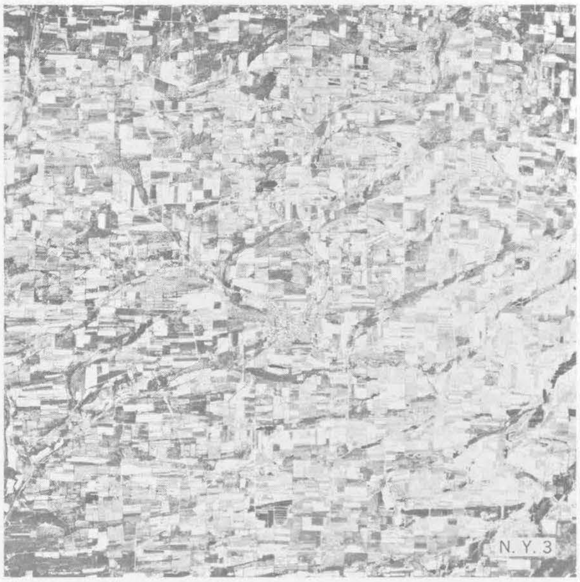

N. MEX. 8


N. MEX. 9


N. MEX. 10


N. MEX. 11

N. MEX. 12

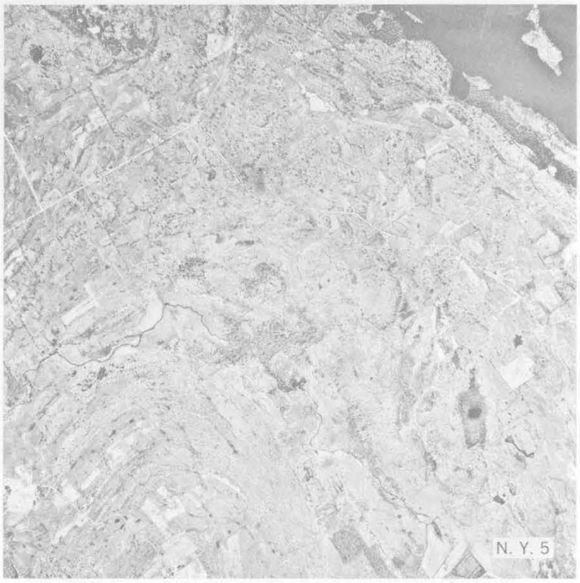


N. Y. 3

N. Y. 1

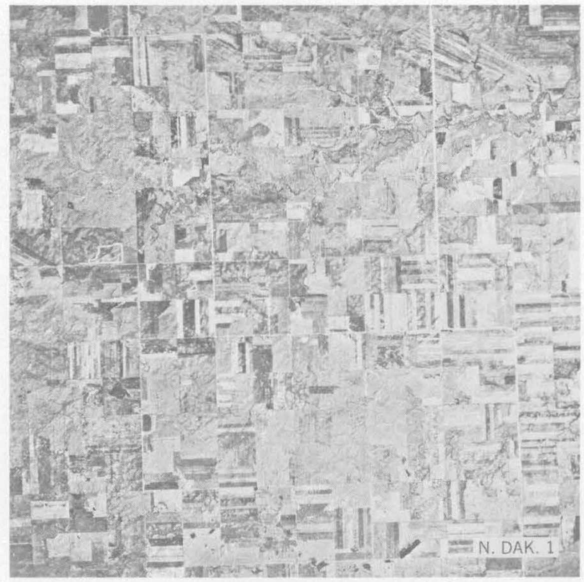
N. Y. 4

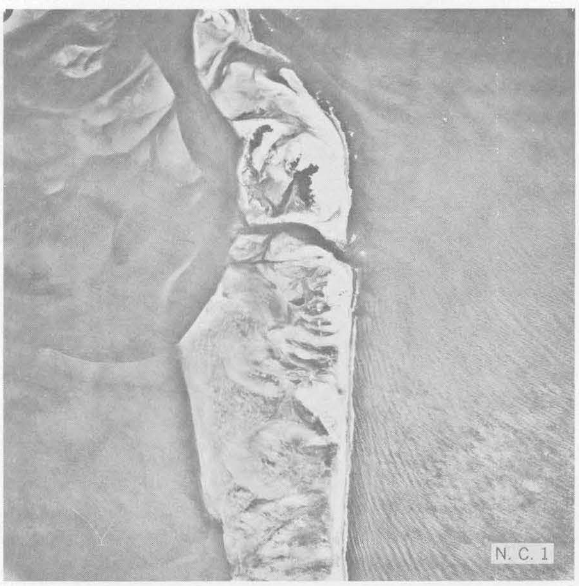
N. Y. 2



N. Y. 5


N. Y. 6


N. DAK. 1

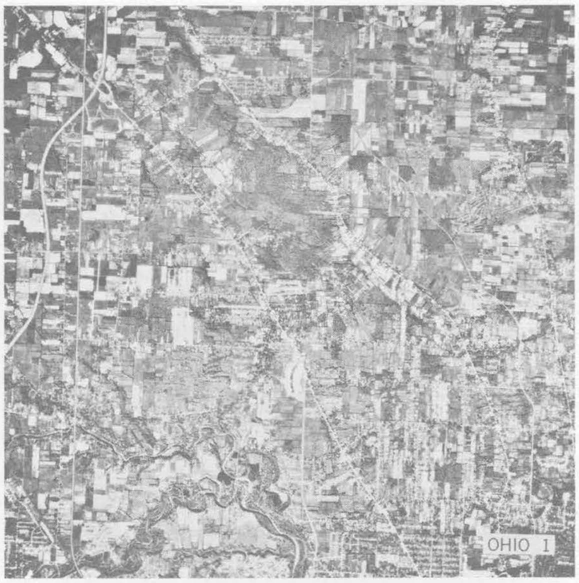

N. C. 1

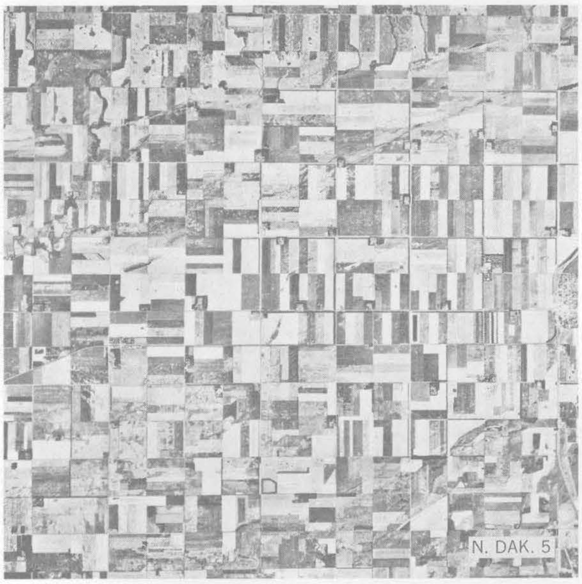

N. DAK. 2


N. C. 2


N. DAK. 3

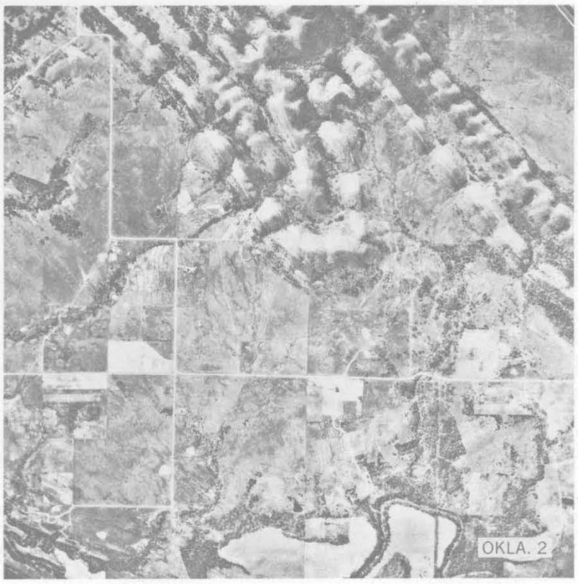

N. DAK. 4


OHIO 1

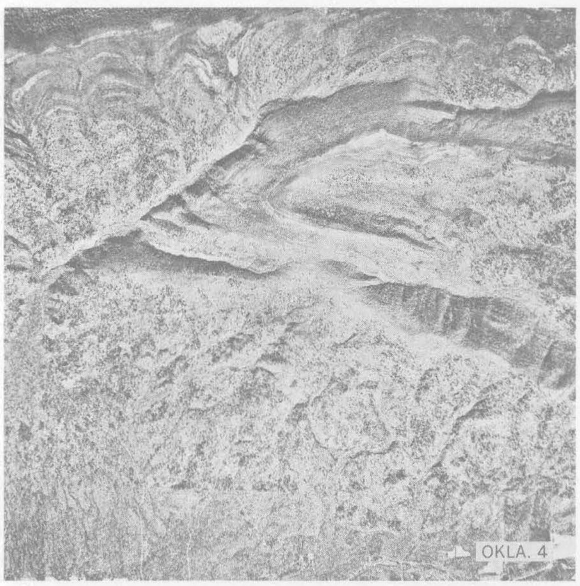

N. DAK. 5


OKLA. 1

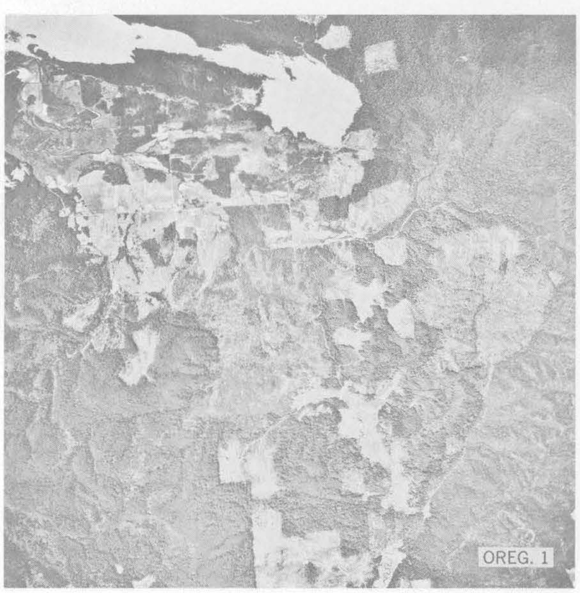

N. DAK. 6


OKLA. 2

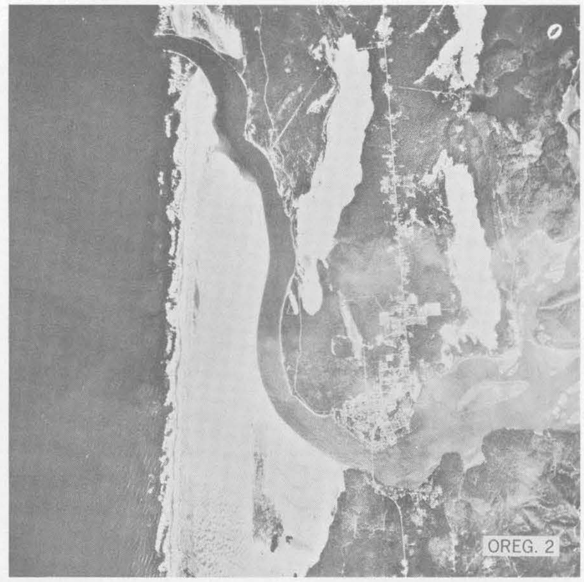
OKLA. 3



OKLA. 4

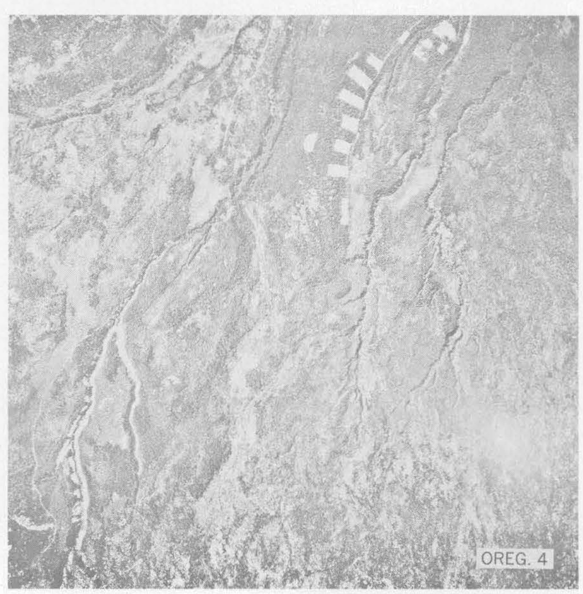


OREG. 1



OREG. 2

OREG. 3

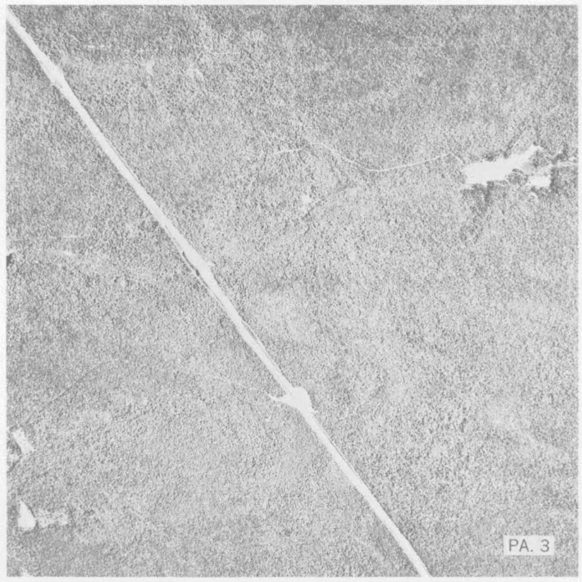


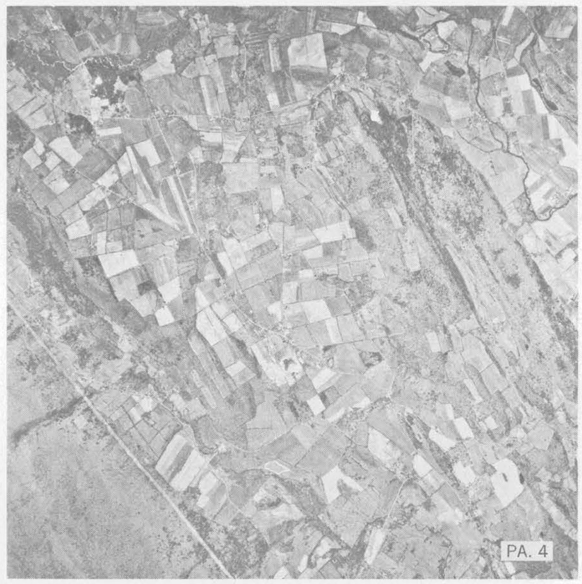
OREG. 4


OREG. 5


PA. 1


PA. 2

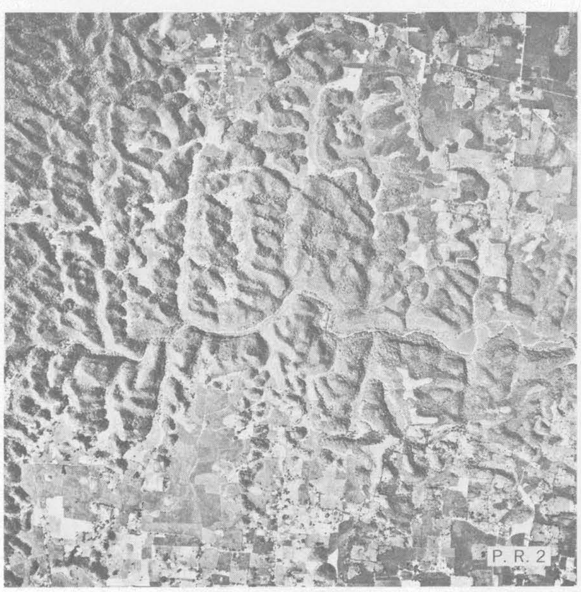

PA. 3

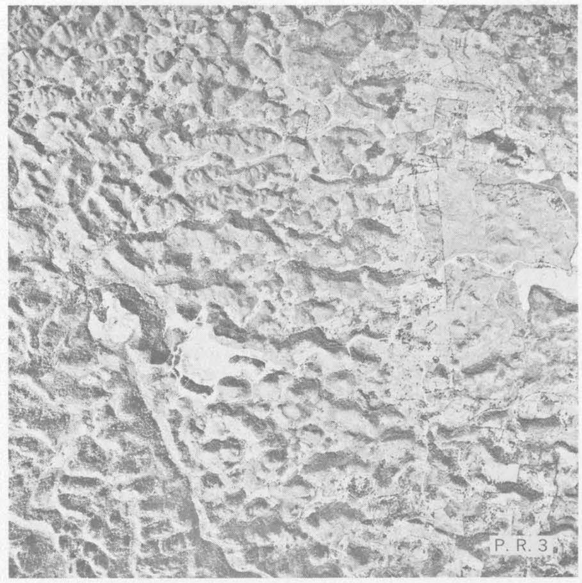

PA. 4

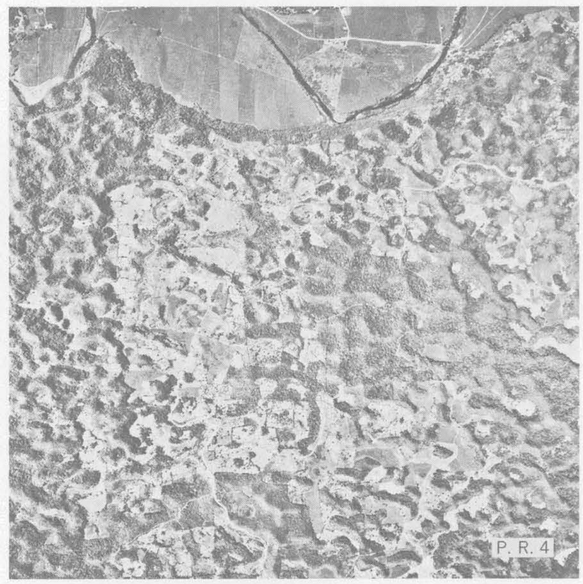

PA. 5


PA. 6

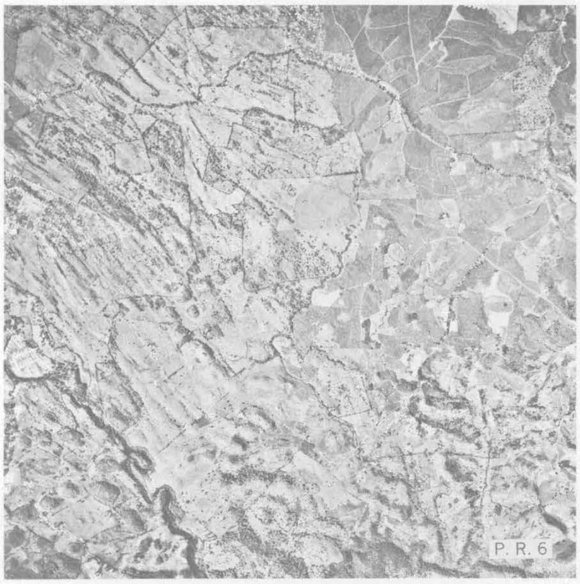

P. R. 1

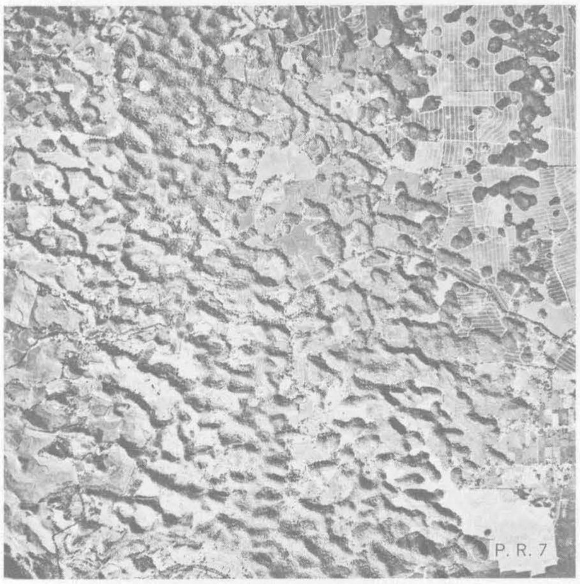

P. R. 2

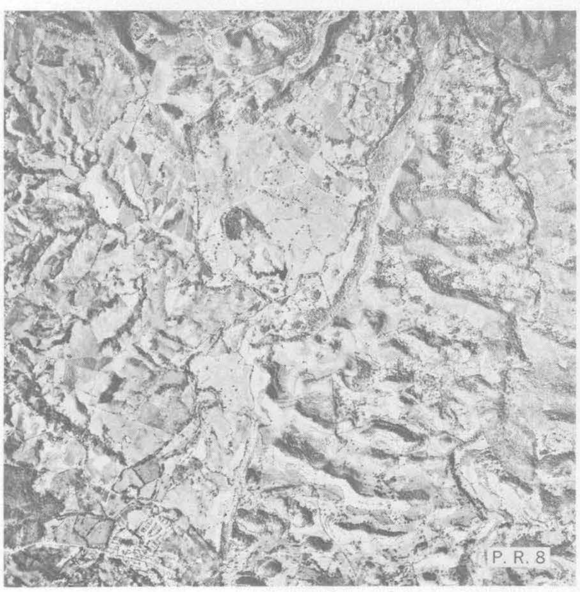

P. R. 3


P. R. 4


P. R. 5


P. R. 6

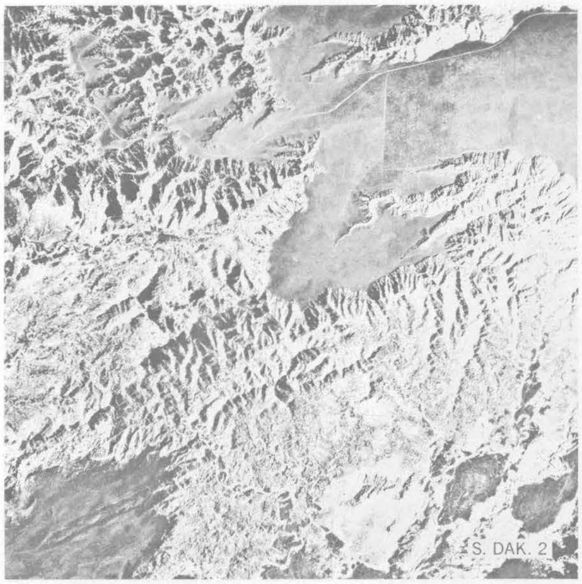

P. R. 7

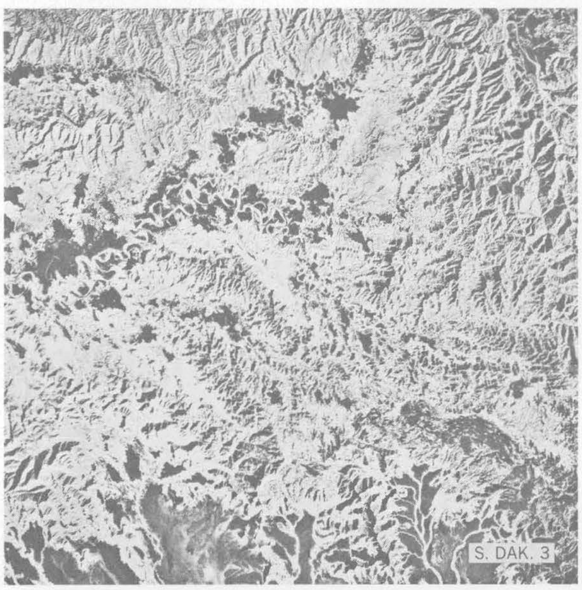

P. R. 8


R. I. 1

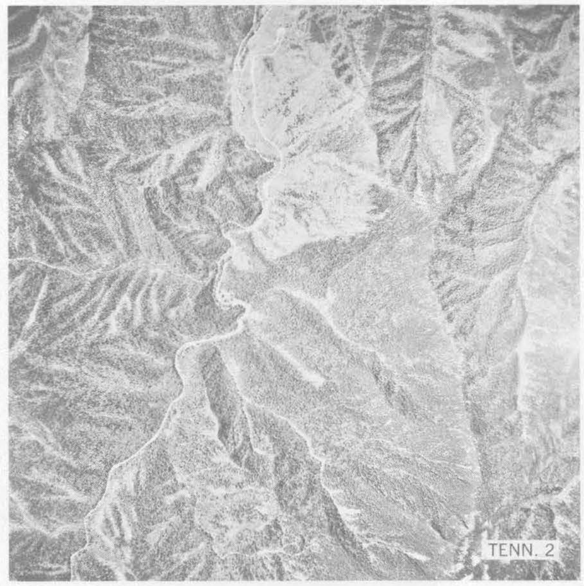

S. C. 1

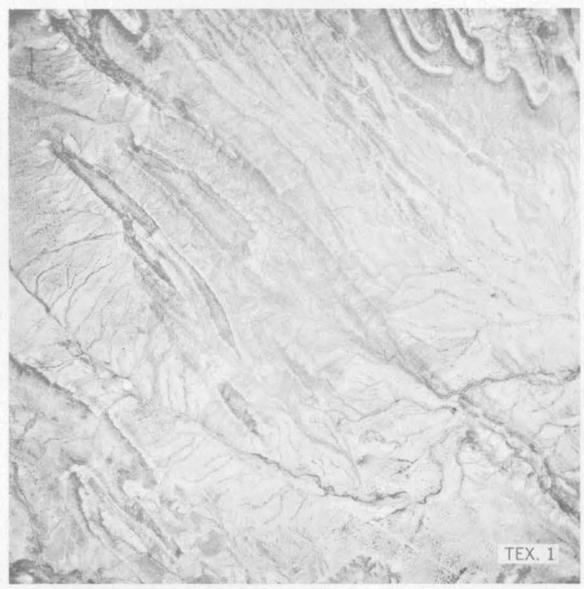

S. DAK. 1

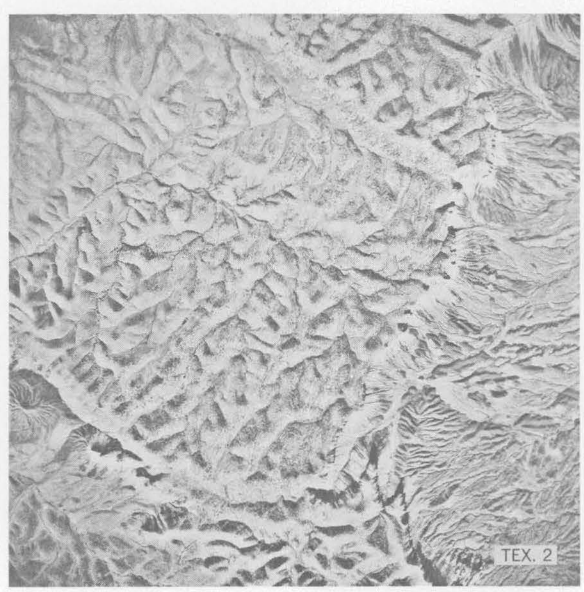

S. DAK. 2

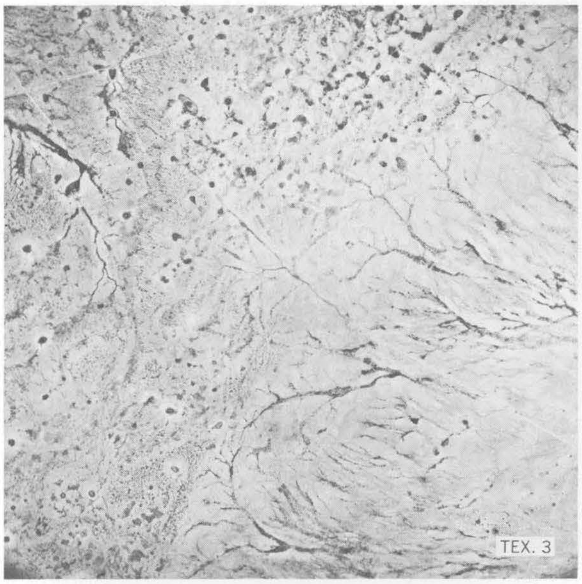

S. DAK. 3

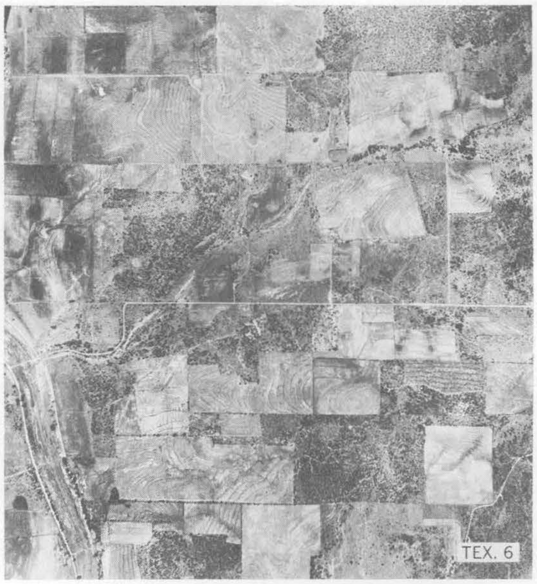

TENN. 1

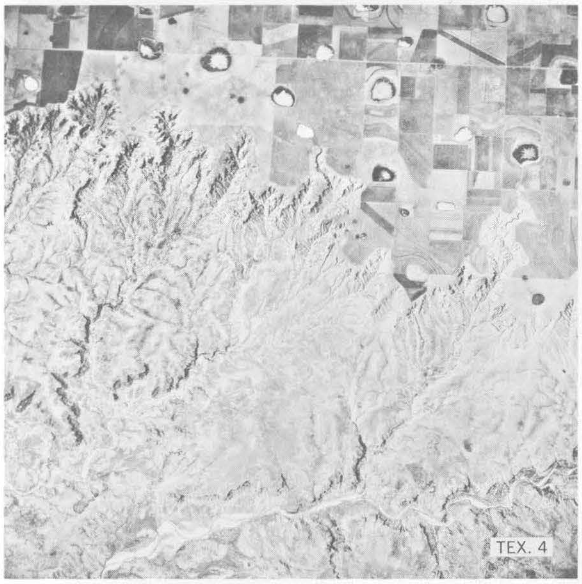

TENN. 2

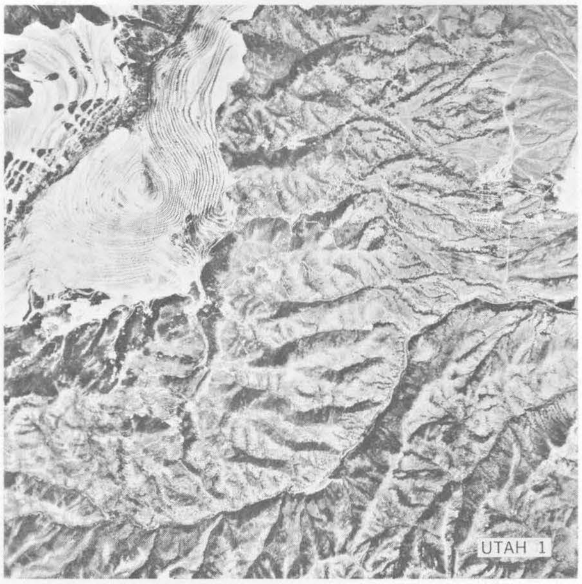

TEX. 1

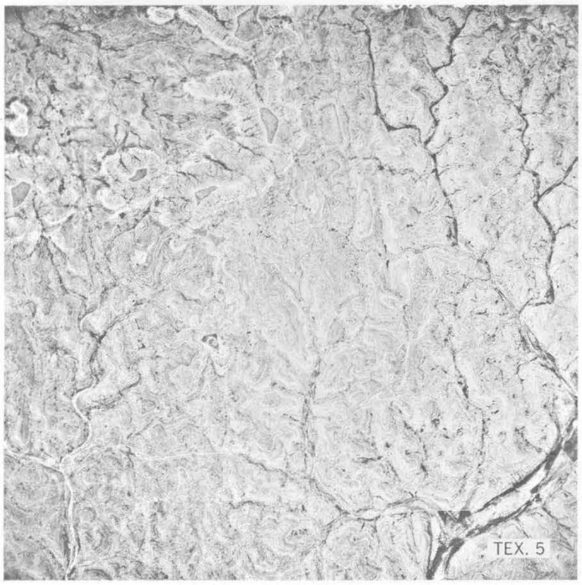

TEX. 2

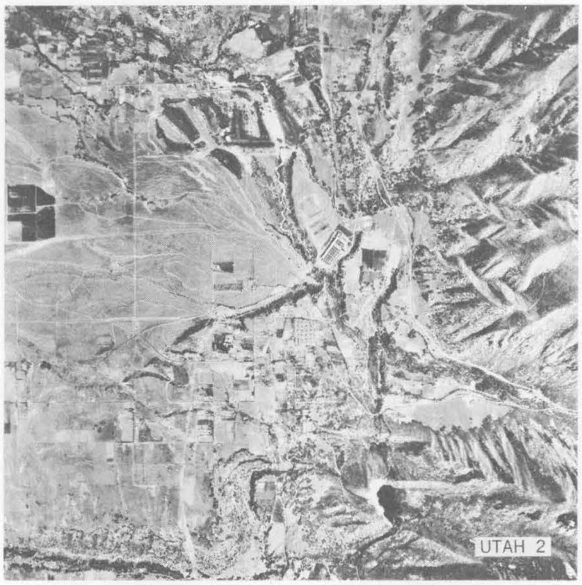




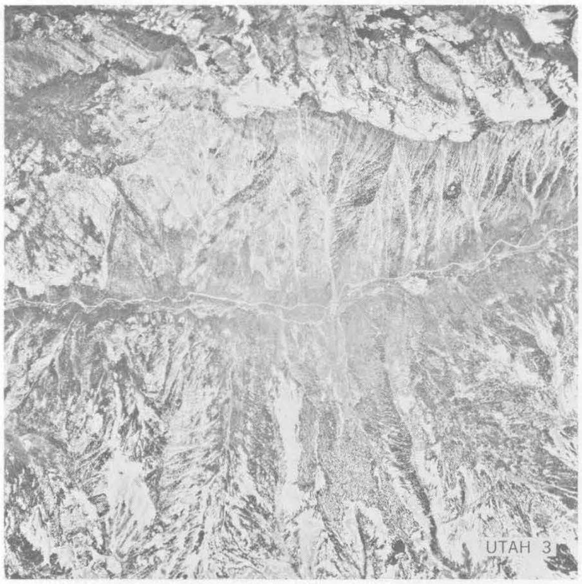


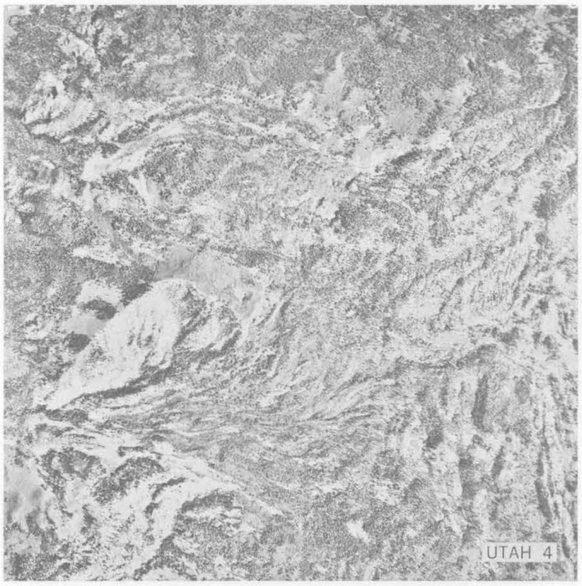


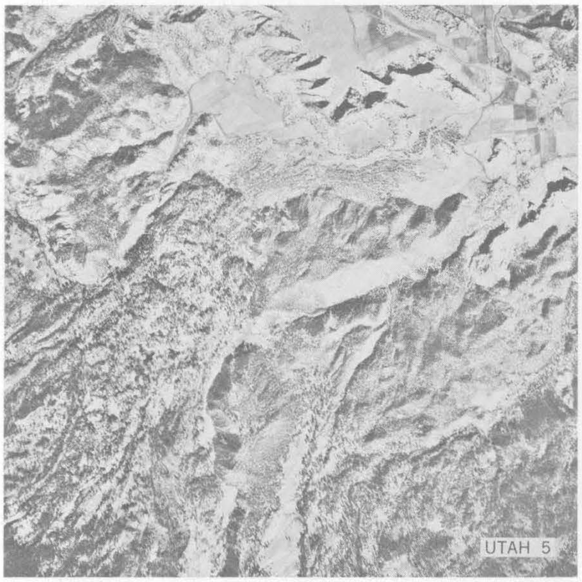


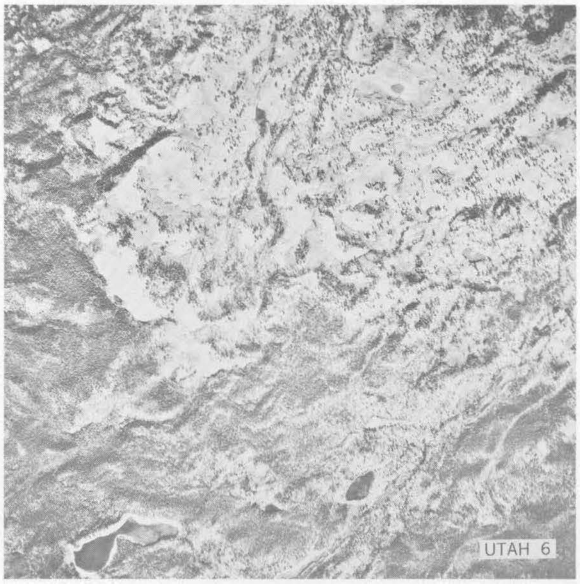


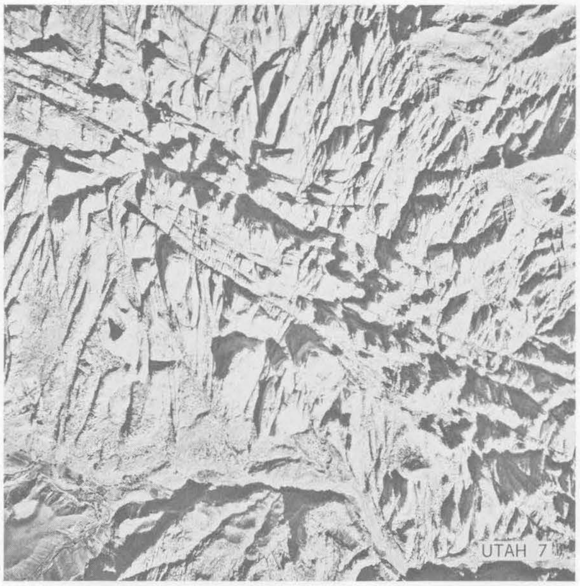
269-086 O - 68 - 9

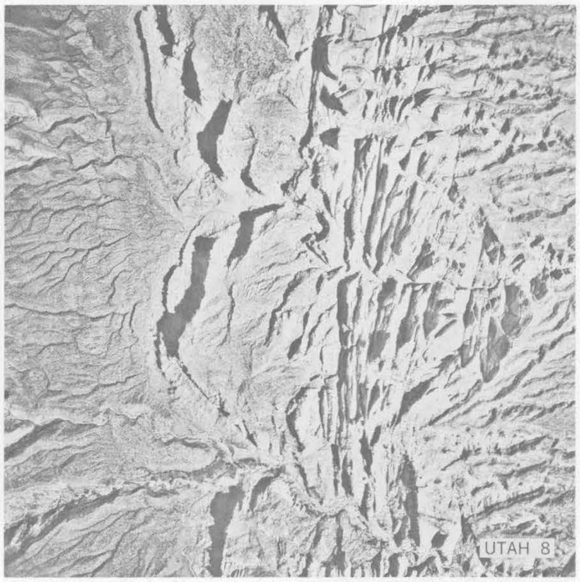

UTAH 3


UTAH 4


UTAH 5

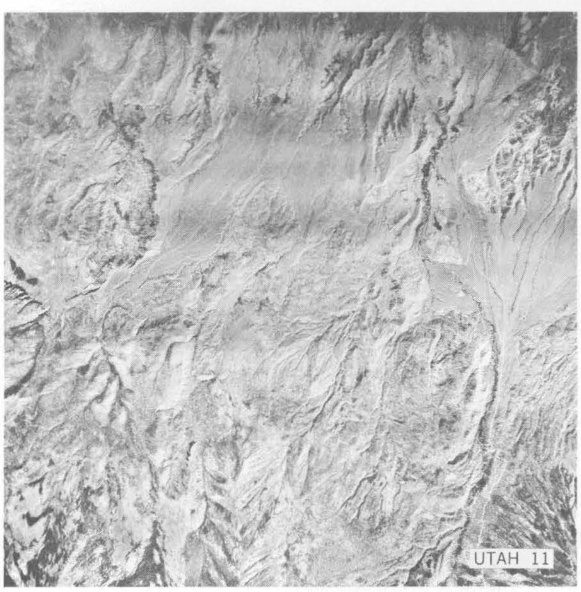

UTAH 6


UTAH 7


UTAH 8

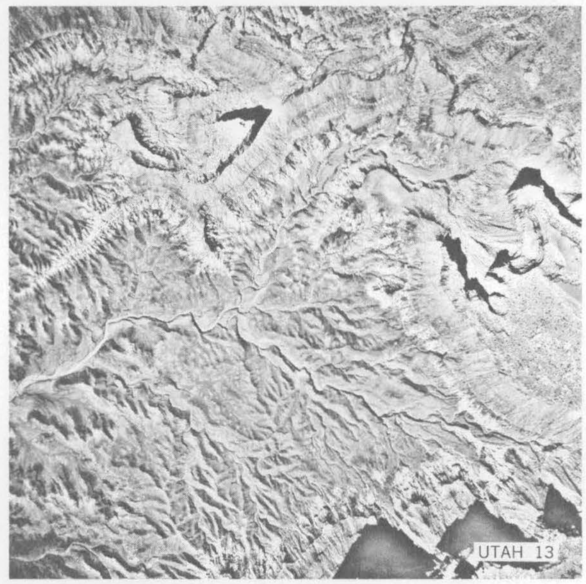
UTAH 9

UTAH 10



UTAH 11

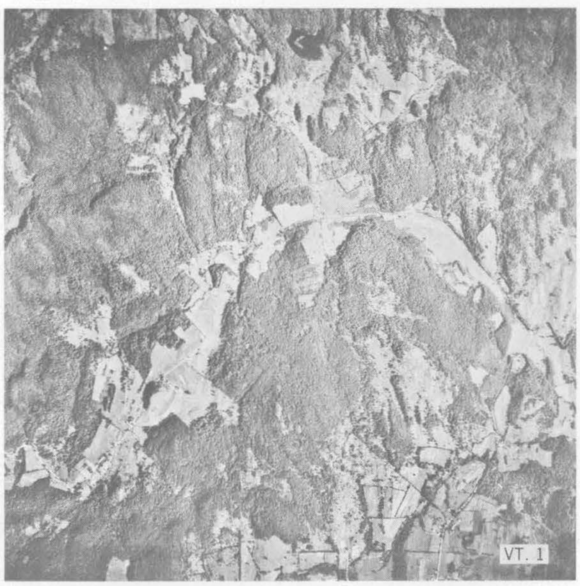
UTAH 12



UTAH 13

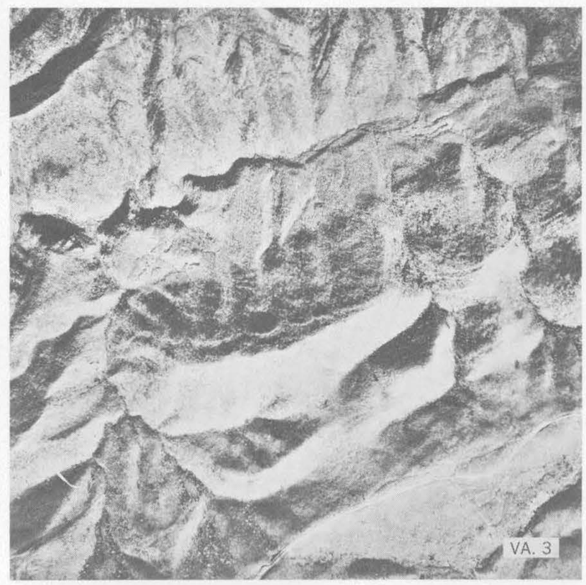
UTAH 14


UTAH 15

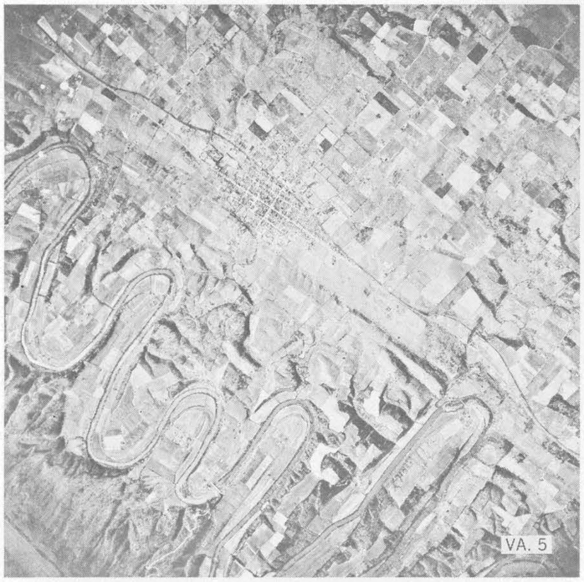

VT. 1

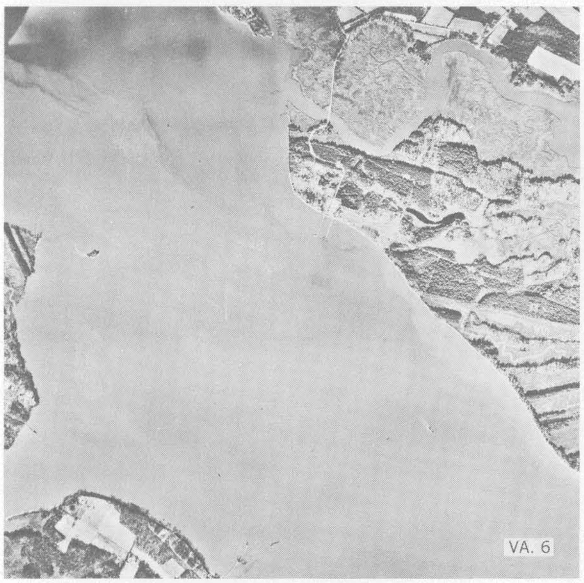

VA. 1

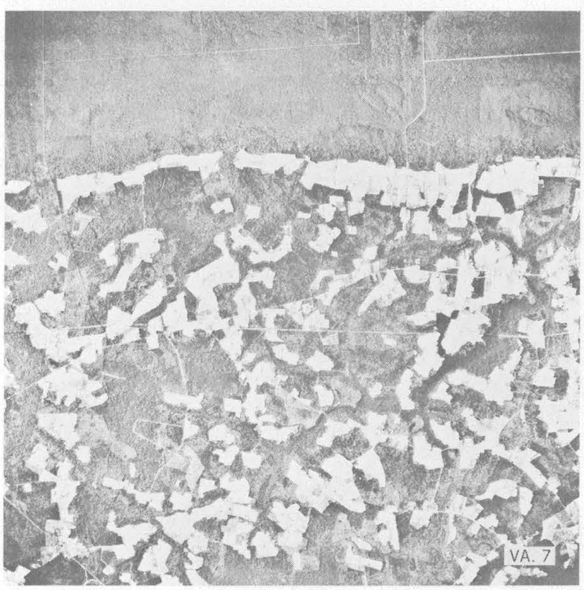

VA. 2

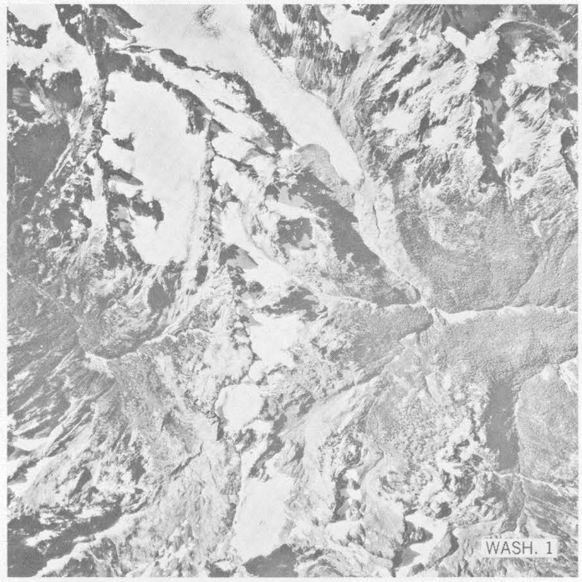

VA. 3

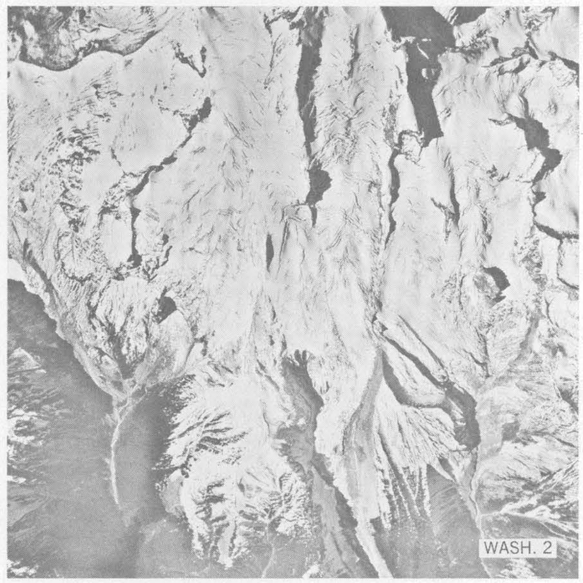

VA. 4


VA. 5

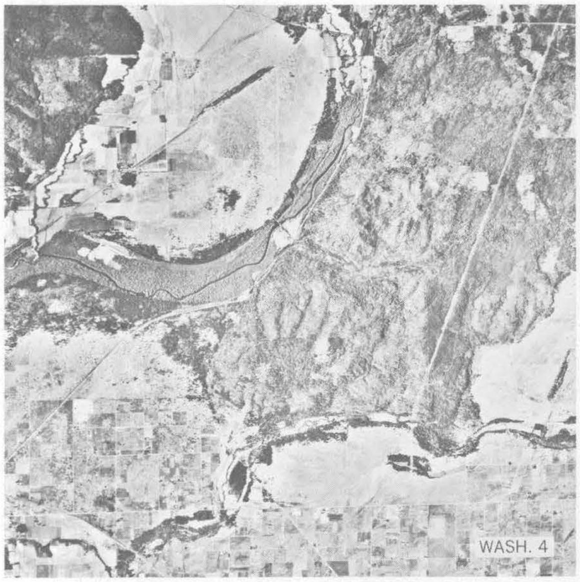

VA. 6


VA. 7


WASH. 1

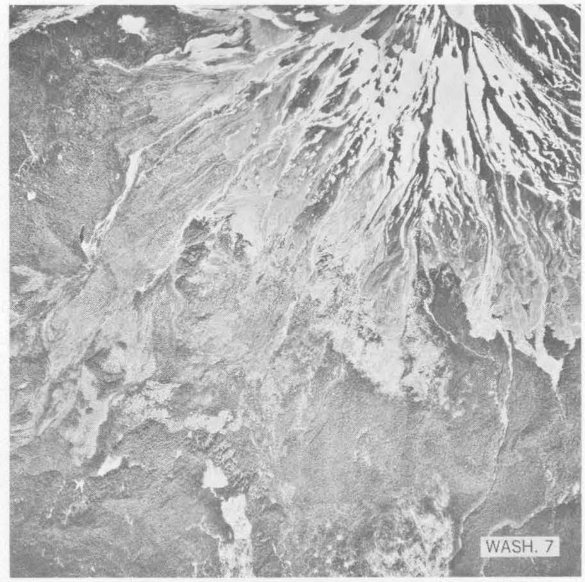

WASH. 2

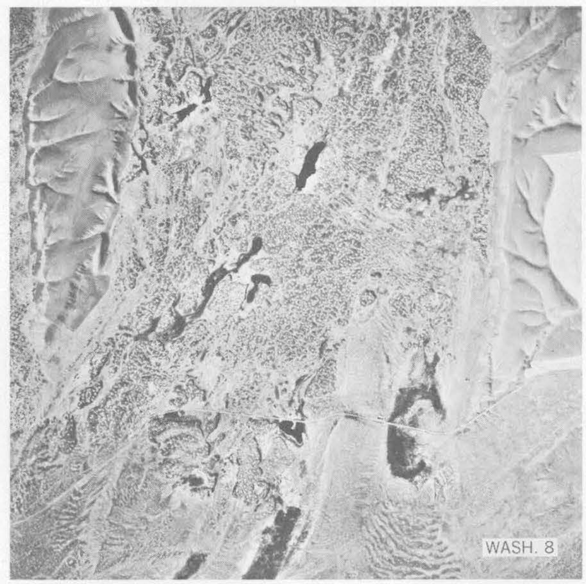

WASH. 3

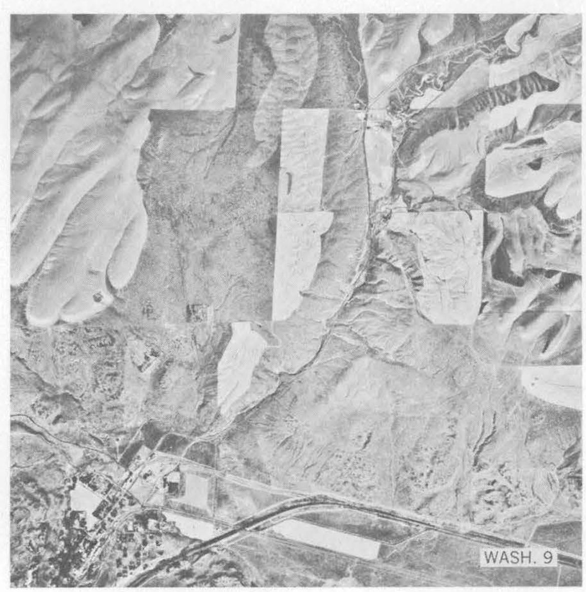

WASH. 4

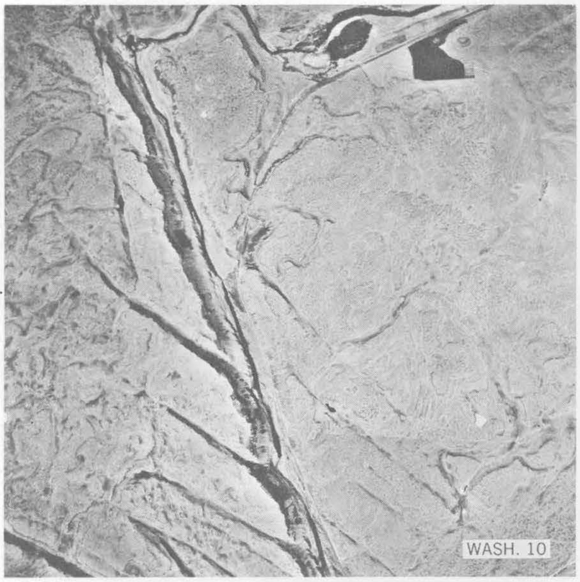

WASH. 5

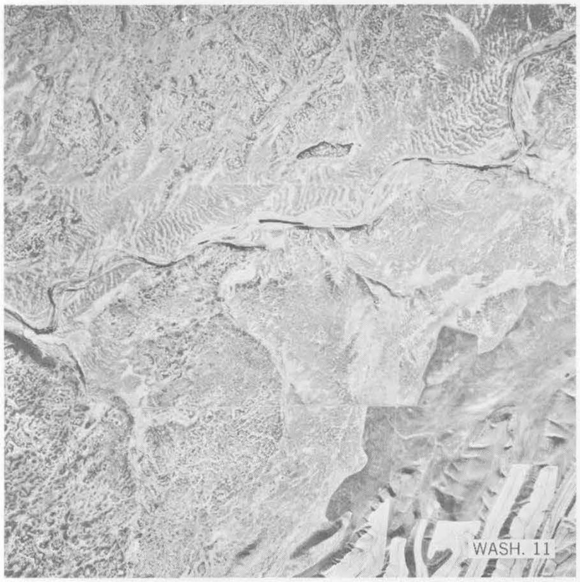

WASH. 6


WASH. 7

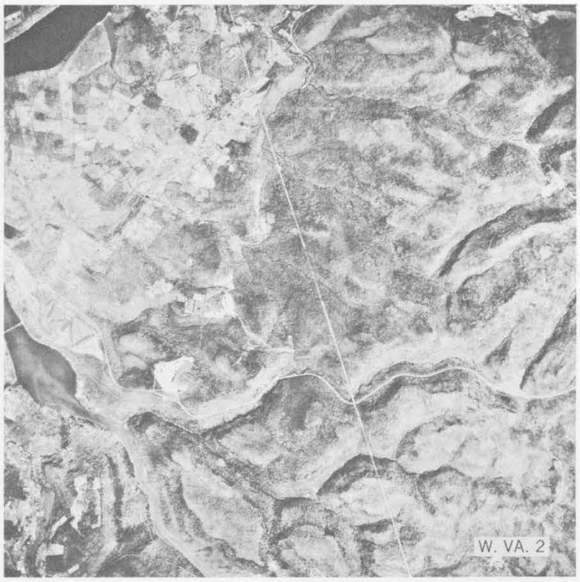

WASH. 8


WASH. 9


WASH. 10


WASH. 11

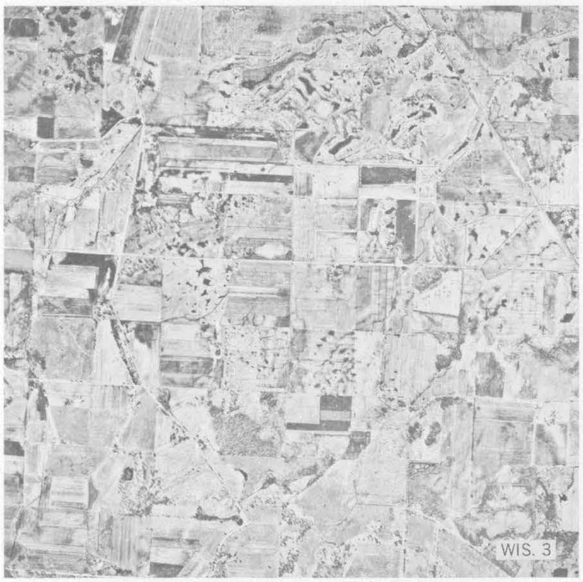

W. VA. 1


W. VA. 2

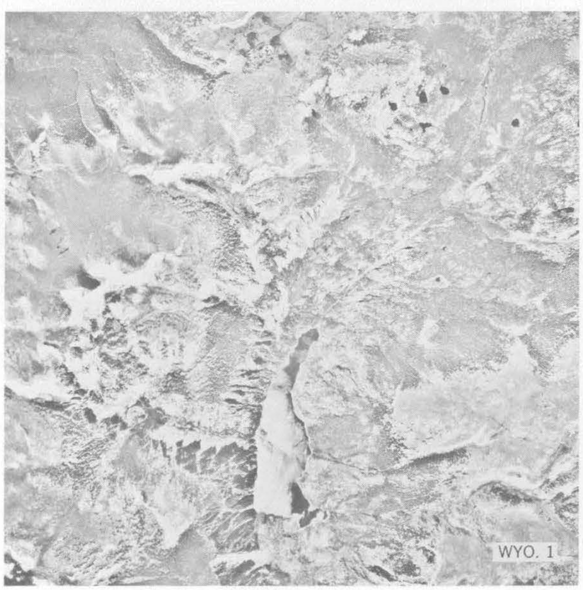

W. VA. 3


WIS. 1

WIS. 2



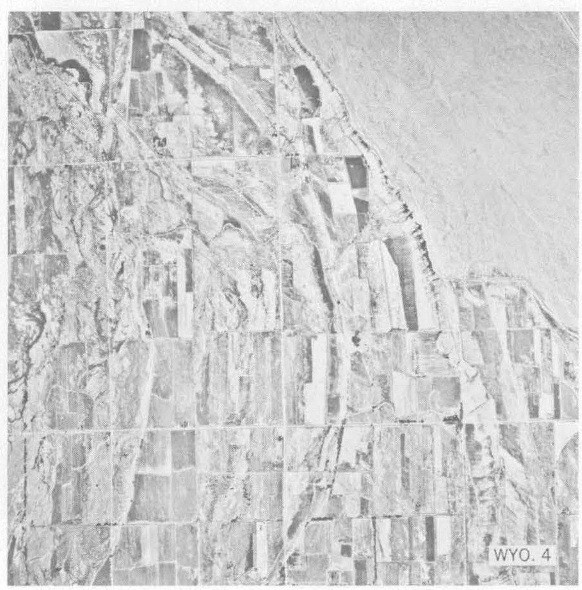
WIS. 3



WYO. 1

WYO. 2

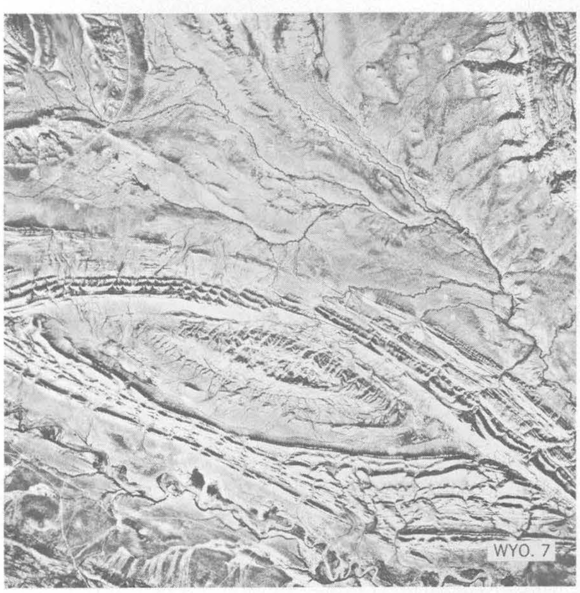
WYO. 3

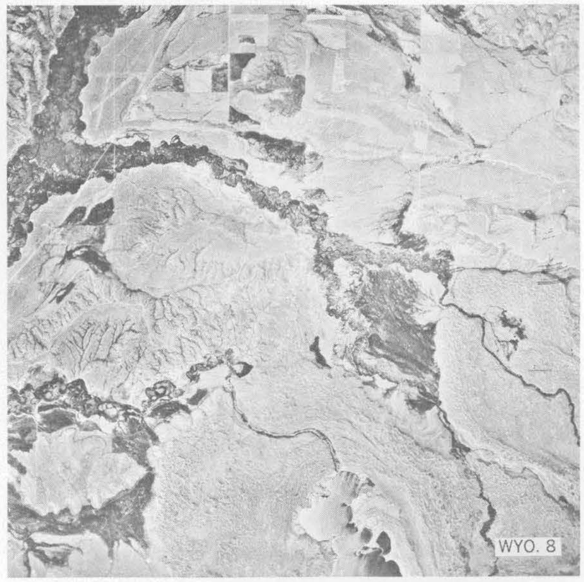


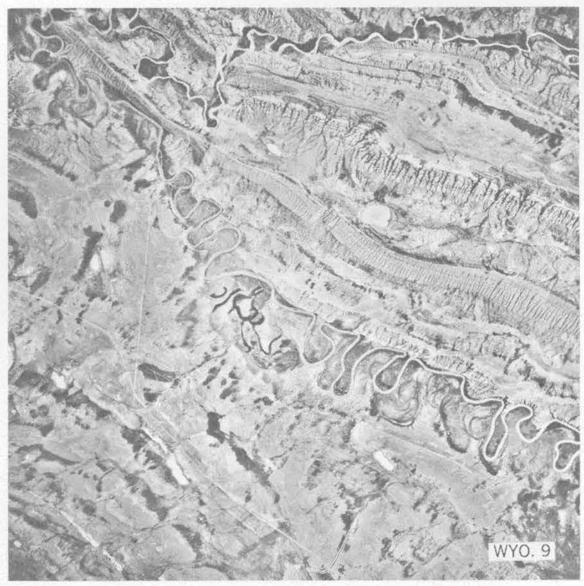
WYO. 4


WYO. 5


WYO. 6


WYO. 7


WYO. 8


WYO. 9

U. S. GOVERNMENT PRINTING OFFICE : 1968 O - 269-086