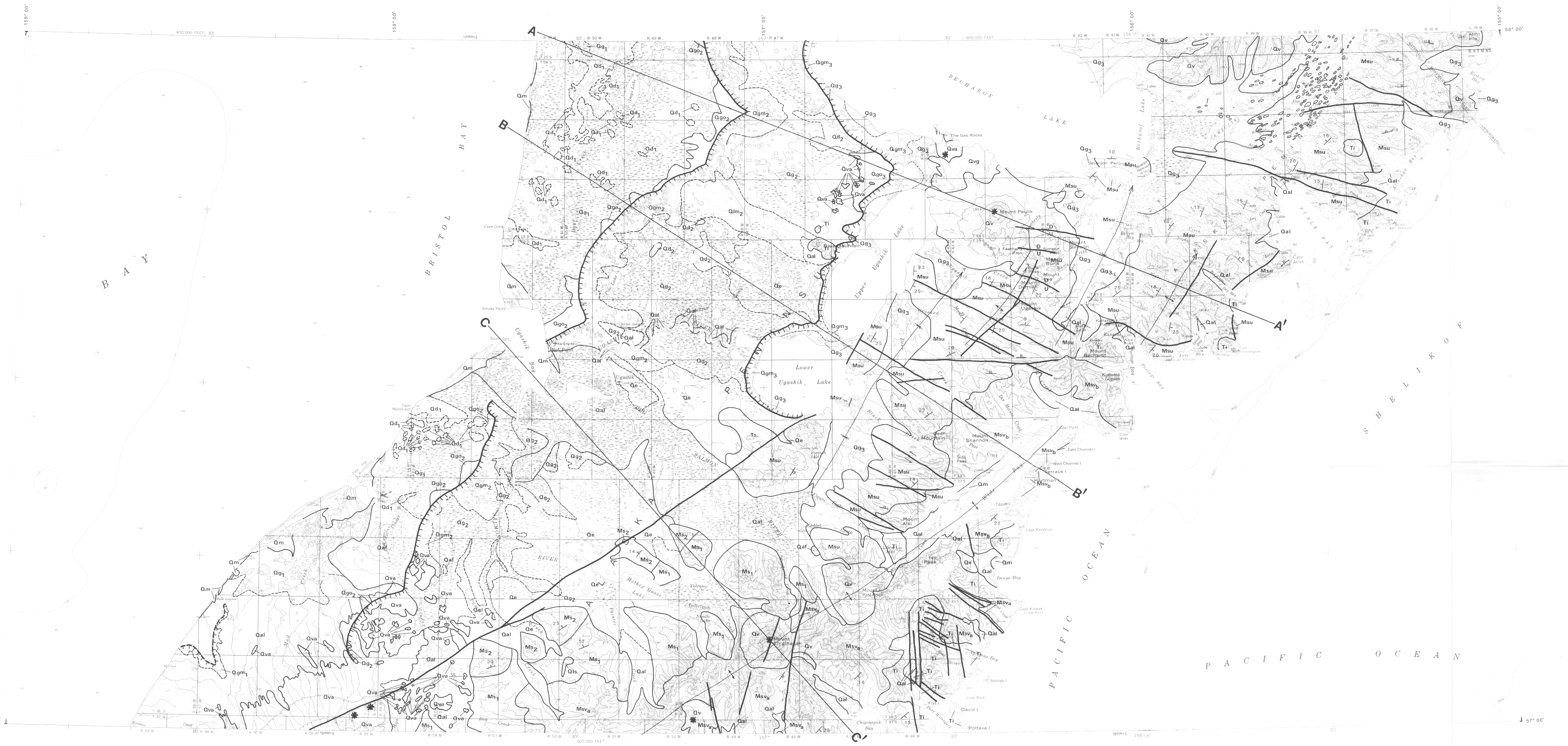
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

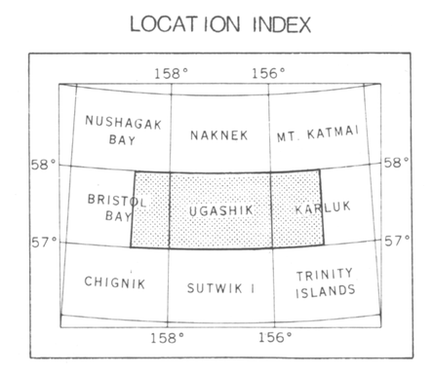
OPEN-FILE REPORT
OF-82-141

SHEET 1 OF 5



Base from U.S. Geological Survey
Bristol Bay, Ugashik 1963; Karluk 1952

LOCATION INDEX



SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

DESCRIPTION OF MAP UNITS

- Qm - Quaternary intertidal and beach deposits.
- Qal - Quaternary alluvial deposits; undivided.
- Qaf - Quaternary alluvial fan deposits.
- Qls - Quaternary landslide deposits.
- Qe - Quaternary aeolian and glaciofluvial deposits; largely dunes on glaciofluvial deposits.
- Qva - Quaternary volcanic pyroclastic deposits; largely volcanic ash to volcanic pebbles.
- Qv - Quaternary volcanic deposits; undivided volcanic flows and pyroclastic deposits.
- Qvg - Quaternary volcanic pyroclastic and contemporaneous(?) glacial deposits. (Description based on field observations.)
- Qgo_3 - Quaternary glacial outwash deposits of Qg_3.
- Qg_3 - Quaternary glaciofluvial and glaciolacustrine(?) deposits; undivided; youngest (3rd) glaciation.
- Qgm_3 - Quaternary glacial terminal moraine deposits; youngest (3rd) glaciation.
- Qgo_2 - Quaternary glacial outwash deposits of Qg_2.
- Qg_2 - Quaternary glaciofluvial deposits; middle (2nd) glaciation.
- Qd_2 - Quaternary glacial drift deposits; similar in composition to moraines; middle (2nd) glaciation.
- Qlm_2 - Quaternary glacial lateral moraine deposits; middle (2nd) glaciation.
- Qgm_2 - Quaternary glacial terminal moraine deposits; middle (2nd) glaciation.
- Qg_1 - Quaternary glaciofluvial deposits; oldest (1st) glaciation.
- Qd_1 - Quaternary glacial drift deposits; similar in composition to moraines; oldest (1st) glaciation.
- Qgm_1 - Quaternary glacial terminal moraine deposits(?); oldest (1st) glaciation.
- Ts - Tertiary(?) sedimentary rocks.
- Ti - Tertiary(?) intrusive rocks.
- Ms_2 - Mesozoic marine(?) sedimentary rocks south of Dog Salmon River; younger.
- Ms_1 - Mesozoic marine(?) sedimentary rocks south of Dog Salmon River; older.
- Msv_a - Mesozoic marine(?) sedimentary and volcanic rocks; numerous occurrences of Cenozoic volcanic rocks also present.
- Msv_b - Mesozoic marine(?) sedimentary and volcanic rocks; volcanic rocks are sporadic; local occurrences of Cenozoic volcanic rocks may be present.
- Msu - Mesozoic marine sedimentary rocks; undivided; largely coarse grained sand to conglomerate (from field observations).

EXPLANATION OF MAP SYMBOLS

- Geologic contact identified on synthetic aperture imagery*
- Geologic contact identified on real aperture imagery*
- Fault identified on synthetic aperture imagery*
- Terminal moraine boundary identified on synthetic aperture imagery*
- Terminal moraine boundary identified on real aperture imagery*
- 15 Bedding determined from synthetic aperture imagery; using "three point" technique
- Bedding determined from synthetic aperture imagery; dip of 10°-25°
- Anticline showing direction of plunge
- Syncline showing direction of plunge
- Cinder cone, fumarole, or maar
- Drumlins

*Does not imply that feature was not visible on other type of imagery.

DISCUSSION

This map was prepared in order to evaluate the extent to which side-looking airborne radar imagery could be used as a tool for preparing reconnaissance geologic maps in Alaska. The Bristol Bay, Ugashik, and Karluk quadrangles study area was selected mainly because of complete, dual-look, stereoscopic coverage by two different radar imaging systems. Ongoing field mapping in the area by an Alaska Mineral Resource Assessment Program (AMRAP) project lead by Robert L. Detterman provided logistic support for field work and a relatively detailed geologic basis by which this experimental map could be checked.

Description of Study Area

The study area includes the Bristol Bay and Ugashik quadrangles and part of the Karluk quadrangle and occupies a land area of approximately 16,000 km^2 in the northern part of the Alaska Peninsula, between 57° and 58° north latitude and 155° and 159° west longitude. Elevations in the area range from sea level to 2,134 m, but much of the area is relatively flat with elevations of less than 150 m. The area is remote and with the exception of tiny settlements at Pilot Point and Ugashik, uninhabited. There are no roads. Although the best access to the area is by aircraft, it is often hampered by high winds and low visibilities.

Description of Imagery

Two contractors supplied imagery to the project, Aero Service, Inc. and MARS Aerial Remote Sensing, Inc., each using a different system of image acquisition. These systems are briefly described below. Detailed discussions of the principles of radar imagery and the differences between the two systems is beyond the scope of this paper. The principles of radar imagery are discussed in detail by Lillesand and Kiefer (1979) and Sabins (1978). Detailed information pertaining specifically to the radar imagery used in this study is given by Moore and others (1981).

The MARS system is a real aperture radar system operating in the 3 cm wavelength (X band) region of the electromagnetic spectrum. The imagery supplied by MARS covering the study area includes individual strips at 1:250,000-scale with 25 km swath widths and 1:250,000-scale mosaics of each quadrangle (sheets 2 and 3). Overlap of the strip images provides stereo coverage of the entire study area. Both the strip images and mosaics have been produced with north and south look directions. Resolution with this system varies from an area of 30 X 79 m in the near range (approximately 10 km) to an area of 30 X 157 m in the far range (approximately 20 km).

The Aero Service system is a synthetic aperture system also operating in the 3 cm wavelength (X band) region of the electromagnetic spectrum. The imagery supplied by Aero Service covering the study area includes individual strips at 1:400,000-scale with 37 km swath widths and 1:250,000-scale mosaics of each quadrangle (sheets 4 and 5). Overlap of the strips also provides stereo coverage of the entire study area. Both the strip images and mosaics are produced with northwest and southeast look directions. Resolution with this system is 10 X 12 m at all distances.

All strip images, mosaics, and photoindex maps used in this study are on file with the U.S.G.S. Alaska Technical Data Unit in Menlo Park. Inquiries regarding the purchase of copies of these materials, however, should be directed to:

Gerald K. Moore
EROS Data Center
Sioux Falls, S.D. 57198

Telephone: (605) 594-6511
FTS: 784-7114

Methods Used

This map was prepared using standard radar imagery interpretation techniques on the SLAR imagery discussed above in an effort to determine the extent to which this kind of imagery can be used in preparing a reconnaissance geologic map. No aerial photography nor other kinds of imagery was used. Prior to preparation of the map, gross geologic characteristics of the area described by Beikman (1980), particularly her Upper Jurassic (uJ) unit, were studied in order to get a general feeling for the geologic setting. The data were augmented by two days of subsequent field observations during the summer of 1981. Except for the ages, which are largely conjectural, and where otherwise noted in the Description of Map Units, all data shown on the map were taken and deduced directly from the SLAR imagery.

Faults and boundaries between photogeologic units were drawn directly on clear plastic overlays on stereo strip images and on image mosaics. The data were then transferred to a clear plastic 1:250,000 scale topographic base map. In general, the real aperture imagery was most useful for discriminating geomorphic features in the relatively flat, lowland areas, while the synthetic aperture imagery was most useful in the mountainous areas, particularly for determining bedding attitudes. Total amount of time involved in preparing the map was approximately 160 man-hours.

Results

Briefly, the data derived from the SLAR imagery show a northeast-trending mountainous area on the east comprised mainly of volcanic and shallow-dipping marine sedimentary rocks that have been gently folded into two sets of northeast-plunging anticlines and synclines (fig. 1). The area has been heavily glaciated and is disrupted in places by a number of volcanoes. The relatively flat plain on the west is covered by extensive glacial, alluvial, and aeolian deposits - in only a few places is bedrock visible.

A simple (albeit somewhat tentative) geologic history can be deduced from the SLAR imagery interpretation map. During Mesozoic(?) time, sedimentary materials were deposited in a marine(?) environment. (Field observations indicate large amounts of terrigenous material, suggesting a relatively near-shore environment.) This was followed by Cenozoic(?) folding, uplift, and emergence, possibly with concurrent volcanic and intrusive activity, of the east part of the study area due to northwest-southeast compressional forces. The west part of the study area may have also been raised during this time to about sea level. Sometime after this folding and uplift period, the northwest-trending faults developed in the area east of the Ugashik Lakes between Becharof Lake and Dog Salmon River as the result of another period of local uplift and northeastward tilting. During the Quaternary, at least three periods of glaciation occurred. Terminal moraine patterns and drumlins suggest that these glaciers advanced from and retreated to a source area somewhere to the east or northeast of the study area. Sometime during or shortly after these periods of glaciations, the flat, northwest part of the study area emerged. Volcanic and intrusive activity continued during this time and the maars near The Gas Rocks and steam activity on Mount Chiginagak attest to ongoing volcanic activity in the area.

The major northeast-trending fault shown in the southern part of the study area is highly speculative. The imagery clearly shows a linear feature here, but field work in the area has failed to provide any evidence for its existence (Robert L. Detterman, oral commun., 1981). Field observations by the author suggests that the linear feature may actually reflect a linear alinement of glacial features. Preliminary aeromagnetic data, however, shows a coincident steepened magnetic gradient on the northwest flank of a belt of volcanic rocks that is permissive for the occurrence of a fault (James E. Case, written commun., 1981).

Field observations by the author have also shown several errors on the map. For example: 1) the maars indicated in the southwest part of the quadrangle do not exist; 2) the "volcanic ash" deposits immediately northwest of Upper Ugashik Lake are actually fine-grained (loess?) glacial deposits; and 3) the "Tertiary intrusive unit" shown at Lone Hill is actually Mesozoic marine sedimentary rocks. Other errors of this sort also exist, but regardless of them and despite the fact that the geology on this map is greatly simplified, it nevertheless corresponds fairly well with the geology of this area as mapped by Burk (1965).

Conclusions

These results indicate that dual-look, stereoscopic SLAR imagery may be useful in preparing preliminary reconnaissance geologic maps by providing early clues as to structure, surficial geology, and more tentatively, gross bedrock geology, thus simplifying and speeding up the mapping process. Because of the relatively low resolution of the SLAR imagery and its inability to effectively differentiate rock types, however, extensive use of aerial photography and field work are nevertheless essential in obtaining accurate geologic data in sufficient detail for preparing high quality reconnaissance geologic maps. These limitations are demonstrated by the fact that no new data, perhaps with the exception of the major northeast-trending "fault", were provided by the SLAR imagery to the nearly completed AMRAP mapping project of the area.

References Cited

Beikman, H. M., 1980, Geologic map of Alaska: U.S. Geological Survey, scale 1:2,500,000, 2 sheets.

Burk, C. A., 1965, Geology of the Alaska Peninsula - island arc and continental margin: Geological Society of America Memoir 99, scale 1:250,000, 3 sheets.

Lillesand, T. M., and Kiefer, R. W., 1979, Remote sensing and image interpretation: New York, John Wiley and Sons, 612 p.

Moore, G. K., and others, 1981, Application of radar imagery for cartographic, geologic, and hydrologic mapping: U.S. Geological Open-File Report 81-1358.

Sabins, F. F., Jr., 1978, Remote sensing principles and interpretation, San Francisco, W. H. Freeman and Company, 426 p.

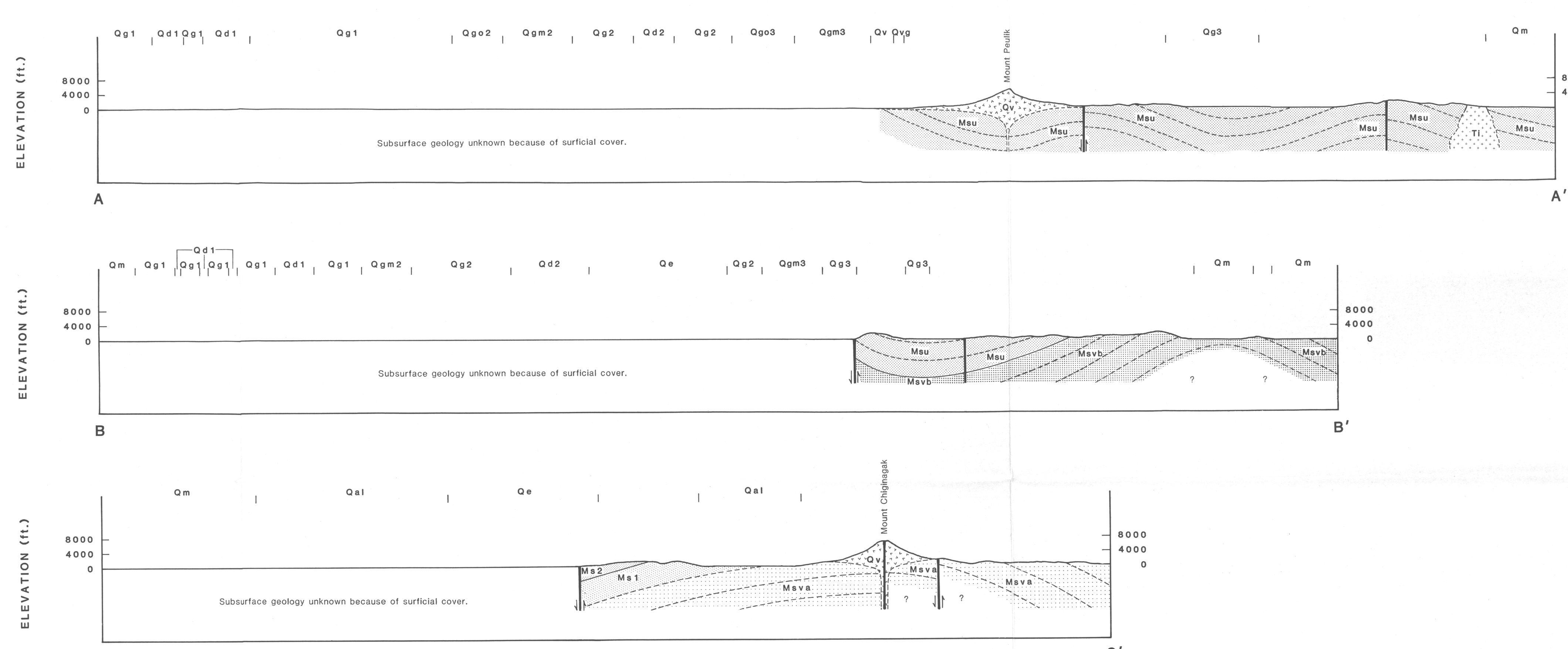


Figure 1. Cross sections of the Bristol Bay, Ugashik, and Karluk quadrangles study area. Scale 1:250,000.

PRELIMINARY MAP SHOWING RECONNAISSANCE PHOTOGEOLOGIC INTERPRETATION OF SLAR IMAGERY OF THE BRISTOL BAY, UGASHIK, AND KARLUK QUADRANGLES, ALASKA

BY

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1982