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GEOLOGICAL SURVEY CIRCULAR 700

United States Geological Survey Alaska Program, 1974

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Claire Carter, Editor

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1974

United States Department of the Interior
ROGERS C. B. MORTON, *Secretary*

Geological Survey
V. E. McKelvey, *Director*

Free on application to U.S. Geological Survey, National Center, Reston, Va 22092

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ILLUSTRATIONS

UNITED STATES GEOLOGICAL SURVEY ALASKA PROGRAM, 1974

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ABSTRACT

This report on the Alaskan activities of the U.S. Geological Survey contains up-to-date accounts of recent results and summaries of plans for the summer of 1974. It is organized in six parts: (1) responsibilities and services of the Geological Survey; (2) organization of the U.S. Geological Survey; (3) Alaskan field activities for 1974; (4) cooperative programs with state and federal agencies; (5) summary of important results of geological and geophysical research in 1973, and (6) reports published by Survey authors in 1973.

SERVICES OF THE UNITED STATES GEOLOGICAL SURVEY

INTRODUCTION

This report on Alaskan activities of the United States Geological Survey is for the many people and groups deeply interested in Alaska. For the professional geologist, hydrologist or topographer, for example, it contains up-to-date accounts of recent results and summaries of plans for the summer of 1974. For various private groups, the business community, and other Federal and State agencies, there is news of investigations that are intended to assist them in their separate and important tasks. And for the citizen of Alaska, whose pleasure and livelihood are linked to the natural surroundings, the report is an introduction to our studies of the land and water of his incomparable State.

To reach such a complex audience, this circular is organized into six parts. In this introductory section the responsibilities and organization of the Geological Survey are discussed. The second section presents organizational segments of the Survey serving Alaska. A third section is a comprehensive listing of Alaskan summer field activities for 1974. The fourth section summarizes projects undertaken in cooperation with the State of Alaska. The fifth section, a summary of the more important results of last year's geological and geophysical research, complements the sixth section, a list of reports published by Survey authors in 1973.

RESPONSIBILITIES OF THE GEOLOGICAL SURVEY

The U.S. Geological Survey serves the needs of the citizens and their government for information on the land and water of the United States. This information is obtained and analyzed by scientists and engineers and is distributed to the public in the form of maps and reports. Most maps and reports are published by the government and current publications are announced by means of monthly notices, "New Publications of the Geological Survey," which are free on application to the Geological Survey, Reston, Va. 22092. Book publications may be ordered from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Maps may be ordered from the following places:

Branch of Distribution, Central Region
U.S. Geological Survey
Federal Center
Denver, Colo. 80225

Alaska Distribution Section
U.S. Geological Survey
310 First Avenue
Fairbanks, Alaska 99701.

Maps may also be purchased over the counter from the U.S. Geological Survey, Water Resources Division, 441 Federal Bldg., 710 West Ninth St., Juneau, Alaska 99801 and the U.S. Geological Survey, Public Inquiries Office, 108 Skyline Bldg., 508 Second Ave., Anchorage, Alaska 99501. Book publications on Alaska are also available from the Public Inquiries Office in Anchorage.

Some studies, especially those of high scientific merit, are published in professional journals; these are available at college and industrial libraries.

The scope of Alaskan studies is broad and is probably best illustrated by example. Thus the list that follows contains a selection of recent Geological Survey maps and reports accompanied by a brief explanation of what they disclose, why they are needed and how they may be used.

Reference: Childers, Joseph M., and Meckel, James P., 1967, Flood of August, 1967, at Fairbanks, Alaska: U.S. Geol. Survey Hydrologic Investigations Atlas HA–294.
Available from: Denver Distribution Section, U.S. Geological Survey, Federal Center, Denver, Colo. 80225; $1.00.

The map shows the parts of the greater Fairbanks area that were submerged in the disastrous flood of the Chena River in August 1967. It can be used by homeowners and city planners to determine which areas might be subject to flooding in the future.

Reference: Cobb, Edward H., 1973, Placer deposits of Alaska: U.S. Geol. Survey Bulletin 1374.
Available from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402; $3.10.

A catalogue of the gold placers of Alaska including data on when they were prospected or mined and the amount of gold produced. An invaluable aid for prospectors, land planners, historians, and economic geologists.

Reference: Berg, H. C., Jones, D. L., and Richter, D. H., 1972, Gravina-Nutzotin belt—Tectonic significance of an upper Mesozoic sedimentary and volcanic sequence in southern and southeastern Alaska, *in* Geological Survey research 1972: U.S. Geol. Survey Prof. Paper 800–D, p. D1–D24.
Available from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402; $4.50 (volume 800–D includes many other studies).

This explanation of the earth history of the "panhandle" during the last several hundred million years applies new concepts of seafloor spreading and continental drift. The study is scholarly and has attracted the wide interest of research geologists.

Reference: U.S. Geological Survey, 1952, Anchorage A–8 quadrangle, Alaska: U.S. Geol. Survey, Topog. Ser., scale 1:63,360.
Available from: Denver Distribution Section, U.S. Geological Survey, Federal Center, Denver, Colo. 80225; $0.75.

A standard detailed topographic map at a scale of 1 inch equals 1 mile. In addition to the outlines of land and sea, the map shows streams, most of Anchorage, major roads, and the elevation of the land above sea level. Topographic maps are widely used by sportsmen and planning engineers.

Reference: Foster, Helen L., 1970, Reconnassiance geologic map of the Tanacross quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–593.
Available from: Denver Distribution Section, U.S. Geological Survey, Federal Center, Denver, Colo. 80225; $1.00.

By colors and symbols, the map shows the age, rock type, and geologic structure of a large part of the Yukon-Tanana Upland. By interpreting geologic maps, prospectors and mining companies can locate the areas where mineral deposits are most likely to occur.

Reference: Lachenbruch, Arthur H., 1970, Some estimates of the thermal effects of a heated pipeline in permafrost: U.S. Geol. Survey Circular 632.
Available from: U.S. Geological Survey, Reston, Va. 22092; copies are distributed free of charge.

This report uses computers and the laws of heat physics to estimate the melting of permafrost by a buried hot-oil pipeline. It has been used by government and industry in the planning and design for the trans-Alaska pipeline.

References: Scholl, D. W., and Hopkins, D. M., 1968, Bering Sea shelf seismic reflection records, 1967 (R/V *Thomas G. Thompson*): U.S. Geol. Survey open-file report.

Scholl, D. W., and Marlow, M. S., 1970, Bering Sea seismic reflection profiles, 1969: U.S. Geol. Survey open-file report.

Available from: Alaskan Technical Data, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; Scholl and Hopkins: $21.00; Scholl and Marlow: $26.00.

Acoustic profiling is a technique used to determine the rocks and geologic structures that are beneath the sea floor. The method is often the first stage in the search for offshore deposits of petroleum and gas.

In addition to its responsibility for obtaining and analyzing land and water resources data, the Geological Survey supervises the production of valuable mineral commodities from many types of federal lands, including the offshore outer continental shelf.

The Alaskan activities of the Geological Survey are conducted by all of its four main operating divisions, and by a number of interdivisional programs, committees,and working groups. These are briefly described in the following sections.

ORGANIZATION OF THE U.S. GEOLOGICAL SURVEY

The organization of the Geological Survey and its four main operating divisions is portrayed in figures 1 through 5.

The main structure of the Geological Survey (fig. 1) consists of four operating divisions (Geologic, Conservation, Water and Topographic) and three support divisions (Computer, Administrative, and Publications). Headquarters for all divisions are in Reston, Va.

Investigations of the geology of the United States and certain other countries are mainly conducted in the Geologic Division under the direction of Richard P. Sheldon, Chief Geologist. The Geologic Division (fig. 2) includes six operating offices (Mineral Resources, Environmental Geology, Geochemistry and Geophysics, Energy Resources and Marine Geology, Earthquake Studies, and International Geology) supported by an Office of Scientific Publications. The headquarters of the offices are located in Reston, Va.

The Conservation Division supervises oil, gas, and other mineral extraction activities on certain federal lands. The regional responsibilities of the Division are vested in four operational offices: Eastern, Central, and Western Regions and Gulf of Mexico Outer Continental Shelf. The Alaskan activities of the Conservation Division, which are especially emphasized in figure 3, are supervised by the Western Region Office in Menlo Park, Calif.

The organization of the Water Resources Division of the Geological Survey is shown in figure 4. The main operating units are located under four regional subdivisions (northeastern, southeastern, central and western) supported by Assistant Chief Hydrologist Offices for Scientific Publications and Data Management, Operations and Research, and Technical Coordination.

The preparation of topographic and other special-purpose geographic maps is accomplished by the Topographic Division (fig. 5). The principal work responsibilities are met by the regional mapping centers (eastern, mid-continent, Rocky Mountain and western) under the supervision of the Chief of the Topographic Division.

ORGANIZATIONAL SEGMENTS SERVING ALASKA

All four operational Divisions of the Geological Survey—Conservation, Geologic, Topographic, and Water Resources—function in Alaska and are supported by the Administrative, Publications and Computer Divisions.

CONSERVATION DIVISION

The Conservation Division examines and classifies federal lands as to their mineral character and waterpower and water-storage values; determines estimated resource values for onshore and offshore competitive lease sales; supervises exploration and development in leases on federal, Indian, and certain Naval petroleum reserve land, and the offshore outer continental shelf; and maintains accounts and collects rentals and royalties from related mineral production.

Consistent with the national concern for environmental protection, the Division reviews and continually strengthens operating regulations and procedures for the prevention of pollution incidents, surface damage resulting from mining, geothermal, and petroleum operations, and adverse effects to public health and safety resulting from mineral operations conducted under leases and prospecting permits.

This work is under the general direction of Russell G. Wayland, Chief, Conservation Division, National Center, Mail Stop 650, 12201 Sunrise Valley Drive, Reston, Va. 22092. The Alaskan activities are supervised by W. C. Gere, Regional Conservation Manager, 345 Middlefield Road, Menlo Park, Calif. 94025. The office of the Alaska-Pacific Mining Supervisor, Leo H. Saarela, is also located at the Menlo Park address.

K. W. Sax, Western Area Hydraulic Engineer, is located at 2800 Cottage Way, Sacramento, Calif. 95825, and the Alaska waterpower evaluation

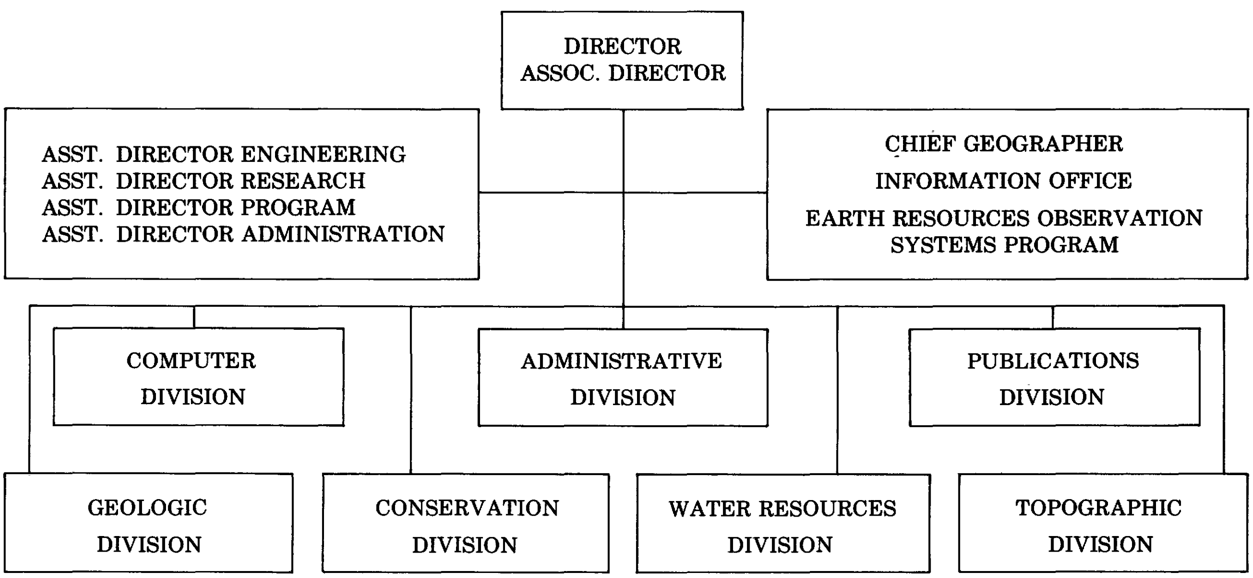

FIGURE 1.—Organization of the U.S. Geological Survey.

Office of the Chief Geologist

Chief Geologist—R. P. Sheldon
Dep. Chief Geol.—R. E. Davis
Dep. Chief Geol. for
Program and Budget—D. H. Dow
Administrative Off.—W. E. Fichtner

Office of Scientific Publications
—G. E. Becraft

Regional Geol., Eastern Region—E. H. Roseboom, Jr.
Regional Geol., Central Region—R. P. Erickson
Regional Geol., Western Region—D. L. Jones

Office of Mineral Resources
—E. W. Tooker

Branches:
- Eastern—C. E. Brown
- Central—R. L. Parker
- Western—G. W. Walker
- Alaskan—G. Gryc
- Exploration Research —P. K. Theobald
- Office of Resource Analysis —A. L. Clark

Office of Environmental Geology
—J. C. Reed, Jr.

Branches:
- Eastern—N. L. Hatch, Jr.
- Kentucky—W. W. Olive
- Central—E. T. Ruppel
- Western—M. C. Blake, Jr.
- Engineering—J. T. McGill
- Special Projects—W. W. Twenhofel
- Astrogeologic Studies —J. F. McCauley
- Paleontology and Stratigraphy —J. E. Hazel
- Environmental Impact Analysis —vacant

Office of Geochemistry & Geophysics
—R. S. Fiske

Branches:
- Experimental Geochemistry and Mineralogy—D. R. Wones
- Field Geochemistry and Petrology —W. E. Hall
- Isotope Geology—Z. E. Peterman
- Regional Geochemistry —J. J. Connor
- Analytical Laboratories—I. May
- Theoretical and Applied Geophysics —M. F. Kane
- Hawaiian Volcano Observatory —D. W. Peterson

Office of Energy Resources and Marine Geology —C. D. Masters

Branches:
- Oil and Gas Resources—P. R. Rose
- Coal Resources—G. H. Wood
- Chemical Resources—O. B. Raup
- Uranium and Thorium Resources —W. I. Finch
- Pacific-Arctic Geology —J. E. Schoellhamer
- Atlantic-Gulf—J. C. Behrendt

Office of Earthquake Studies
—R. M. Hamilton

Branches:
- Seismic Engineering—R. Matthiesen
- Seismicity and Risk Analysis —T. Algermissen
- Seismology—J. P. Eaton
- Earthquake Tectonics—C. B. Raleigh

Office of International Geology
—J. A. Reinemund

Branches:
- Latin American and African Geology —G. E. Ericksen
- Middle Eastern and Asian Geology —D. F. Davidson

FIGURE 2.—Organization of the Geologic Division.

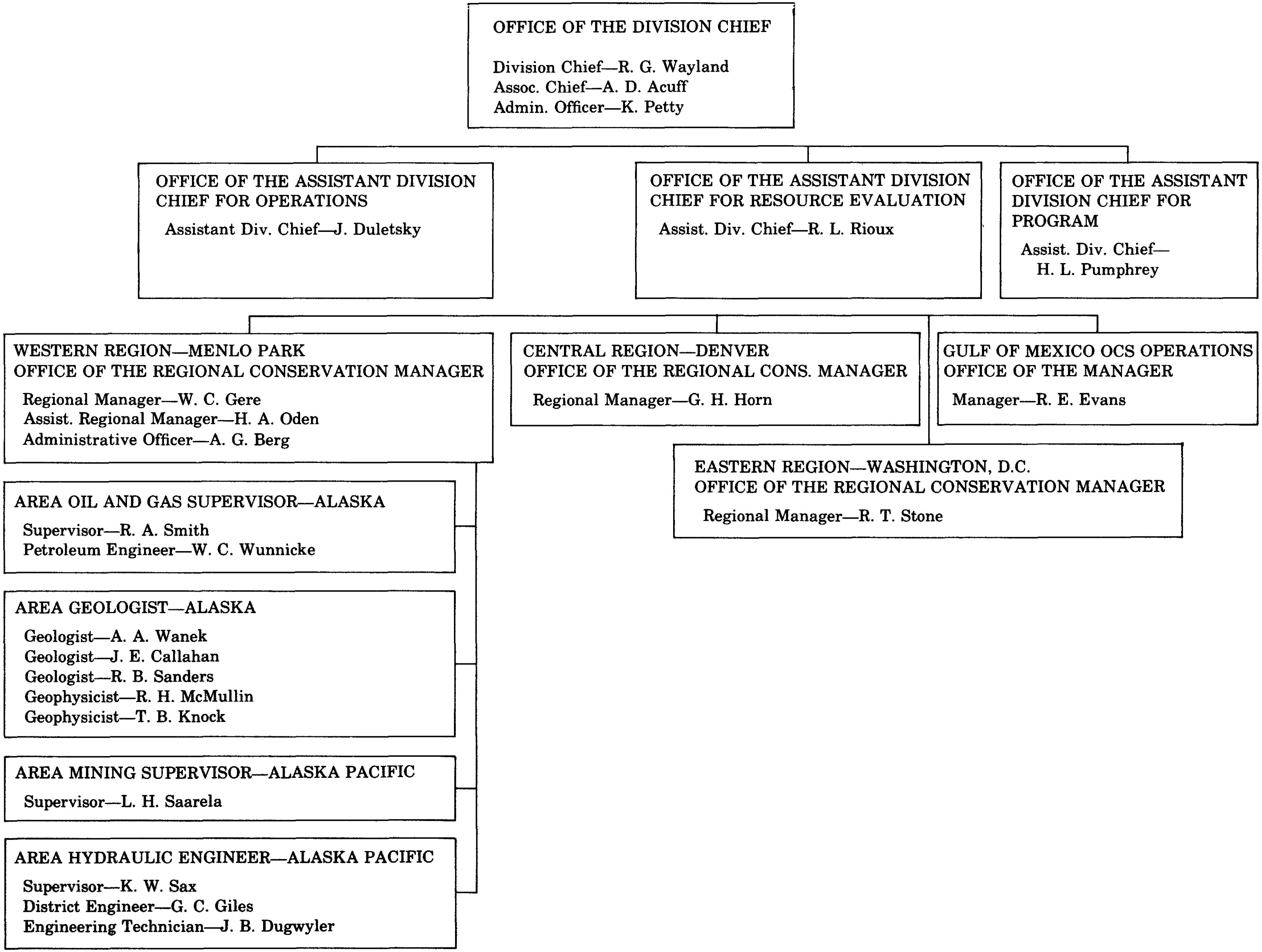

FIGURE 3.—Organization of the Conservation Division.

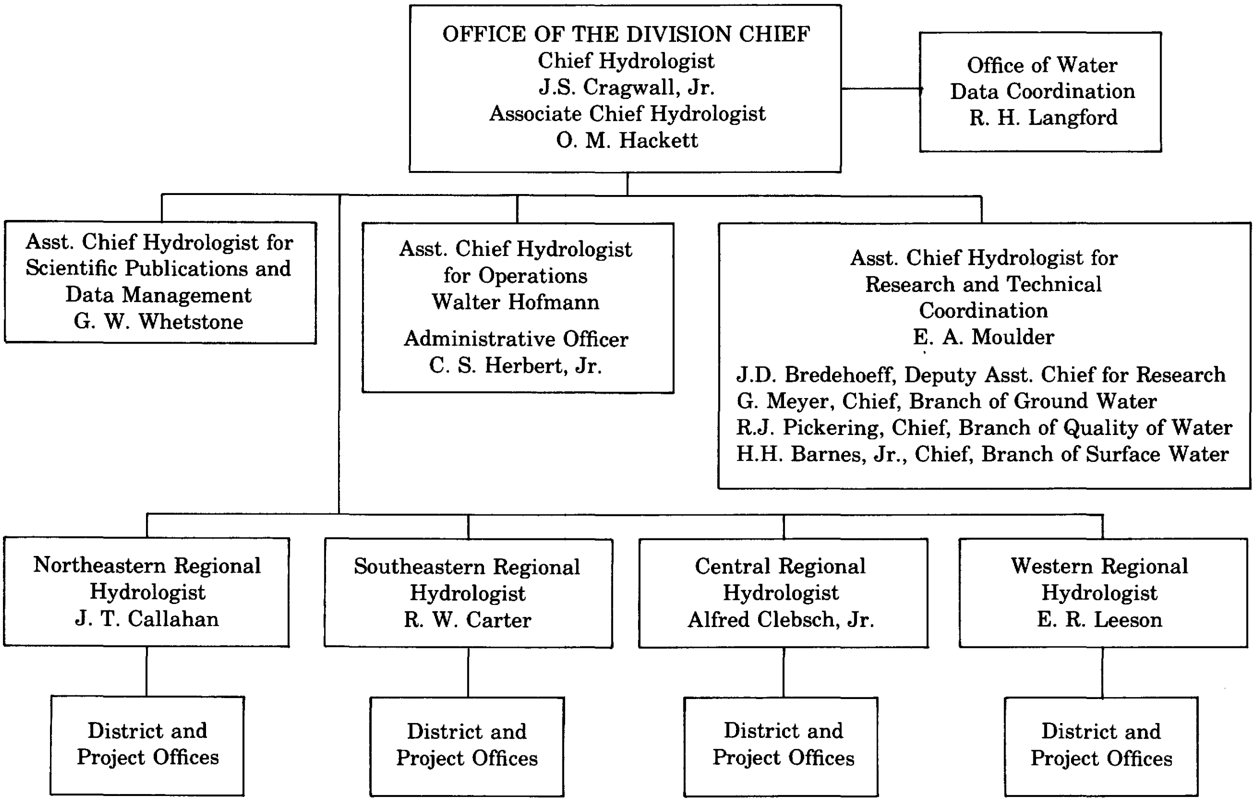

FIGURE 4.—Organization of the Water Resources Division.

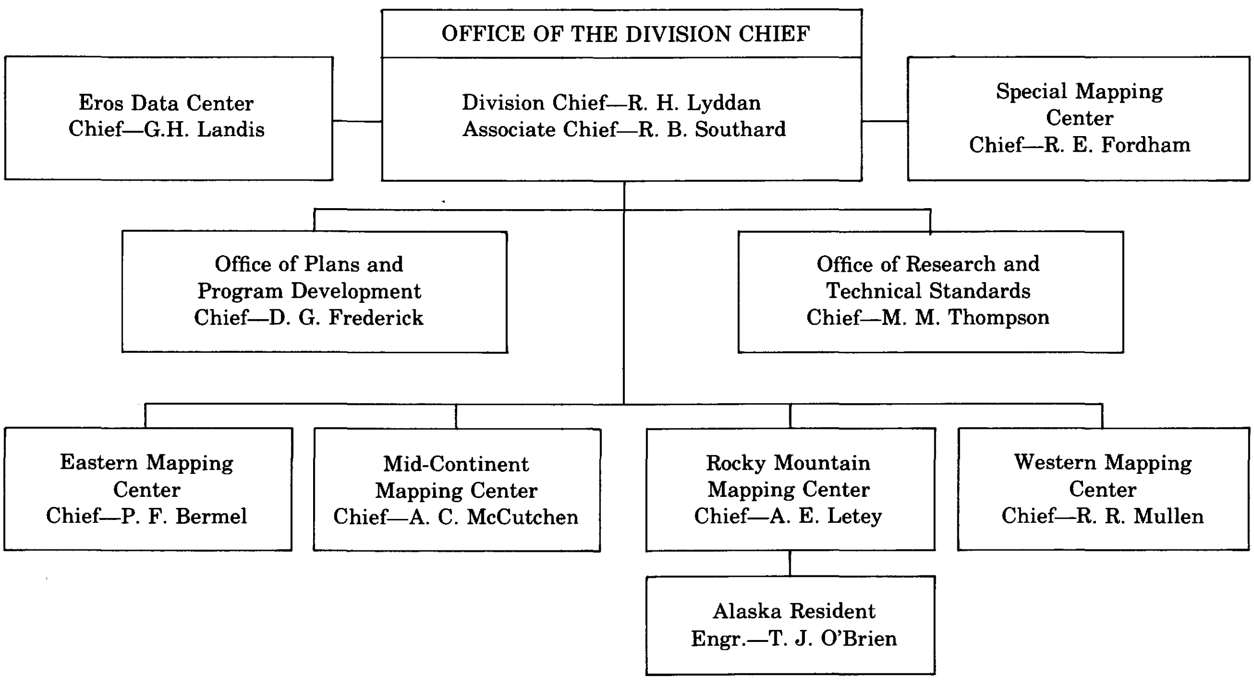

FIGURE 5.—Organization of the Topographic Division.

program is under the Tacoma District Office, P.O. Box 1152, Tacoma, Wash. 98401, Gordon C. Giles, District Hydraulic Engineer. Alexander A. Wanek is the Alaska Area Geologist, assisted by J. E. Callahan and R. B. Sanders, geologists, and R. H. McMullin and T. B. Knock, geophysicists. The Alaska Area Oil and Gas Supervisor is Rodney A. Smith, assisted by W. C. Wunnicke, petroleum engineer, and R. E. Zettlemoyer, administrative assistant and accounting officer. The office is in the Skyline Building, 218 E Street, Anchorage, Alaska 99510.

GEOLOGIC DIVISION

The current scientific investigations of the Geologic Division in Alaska include geologic mapping and mineral resource evaluation, principally at scales of 1:250,000 and 1:63,360; mineral district mapping and evaluation; mineral reconnaissance; geochemical studies and sampling, particularly related to mineral deposit studies; aeromagnetic and gravity surveys and interpretation; engineering geology studies in urban areas and transportation routes; isotope age determinations and interpretation; heat flow; and submarine sampling, subbottom profiling, and other geophysical studies of the ocean floor.

The Survey's program of geologic research is under the direction of Richard P. Sheldon, Chief Geologist. Activities in Alaska are the responsibility of several groups within the Geologic Division: the Branch of Alaskan Geology, the Office of Earthquake Studies, and the Office of Energy Resources and Marine Geology at the Pacific Coast Field Center, 345 Middlefield Road, Menlo Park, Calif. 94025; the Branches of Theoretical and Applied Geophysics, Exploration Research, and Engineering Geology at the Rocky Mountain Field Center, Denver, Colo. 80225; and the Branches of Paleontology and Stratigraphy and of Isotope Geology at the National Center, Reston, Va. 22092. Several other branches of the Geologic Division provide services or conduct research in cooperation with these units.

In its study of Alaskan geology, the Survey supports and cooperates with several universities and other public agencies, including the State of Alaska's Geological and Geophysical Survey.

TOPOGRAPHIC DIVISION

The Topographic Division's main task is the preparation of the National Topographic Map Series, which includes all of the quadrangle maps covering the 50 states of the nation. The topographic mapping program of the Geological Survey is under the direction of Robert H. Lyddan, Chief, Topographic Division. The Office of Plans and Program Development is responsible for initiating and controlling the work of the Division. The chief of this office is D. G. Frederick.

Mapping operations in Alaska are the responsibility of A. E. Letey, Chief, Rocky Mountain Mapping Center, who directs the operational functions of the mapping center, including all field and office operations. He may be consulted at the Federal Center, Denver, Colo. 80225.

The resident engineer in Alaska is Thomas J. O'Brien. He directs the Division's field operations in Alaska. He may be contacted about the Alaska program at his office in the Skyline Building, 218 E Street, Anchorage, Alaska 99501, [907] 279–5812.

WATER RESOURCES DIVISION

The Alaskan water resources program includes the collection, analysis, and interpretation of data on the availability and quality of surface and ground water and includes special studies and research that seek to evaluate and increase the effective use of water resources data in the State. This basic water data provides a broad base to support the proper management and protection of the State's water and related land resources.

The network of data collection sites maintained includes:

	Daily sites	Intermittent or partial record sites
Streamflow	107	88
Sediment	0	40
Chemical	1	6
Biological	10	4
Temperature	32	163
Ground-water observation wells	11	10

The Geological Survey's water resources investigations are under the direction of the Chief Hydrologist, Water Resources Division, Reston, Va. 22092. The investigations in Alaska are under the jurisdiction of the Western Region Office and are the responsibility of Elwood R. Leeson, Regional Hydrologist, Western Region Field Center, 345 Middlefield Road, Menlo Park, Calif. 94025. The water resources program in Alaska is headquartered on a year-round basis at Anchorage, Alaska, and is under the supervision of Harry Hulsing, District Chief. The District Office is in the Skyline Building, 218 E Street, Anchorage, Alaska 99501 ([907] 277–5526).

The field activities of the Alaska District are headquartered at Anchorage, Fairbanks, and Juneau. The Anchorage Subdistrict Office is responsible for operations in south-central and western Alaska and is under the supervision of William W. Barnwell. It is located at 1209 Orca Street, Anchorage, Alaska 99501 ([907] 279–1563). The Juneau Subdistrict Office, which is responsible for operations in southeastern Alaska, is under the supervision of Vern Berwick and is located at 441 Federal Building, P.O. Box 1568, Juneau, Alaska 99801 ([907] 586–7217). The Fairbanks Subdistrict Office is responsible for operations in northern Alaska and is under the supervision of James P. Meckel. It is located at 310 First Avenue, Fairbanks, Alaska 99701 ([907] 452–1951, ext. 176).

PUBLICATIONS DIVISION

The Publications Division edits scientific and technical manuscripts; prepares technical illustrations and maps, except topographic; reproduces topographic, geologic, and other maps; prepares exhibits and visual aids; disseminates general Survey program and publications information and distributes maps to the public. These activities are under the direction of Harry D. Wilson, Jr., Chief, Publications Division, National Center, Reston, Va.

The Division maintains two offices in Alaska for the customers' convenience in obtaining maps, book reports, and other material prepared by the U.S. Geological Survey.

The Alaska Distribution Section at 310 First Avenue, Fairbanks, Alaska 99701 ([907] 452–1951, ext. 174) is supervised by Natalie A. Cornforth under the direction of the Publications Division, Western Region, Menlo Park, Calif. It distributes maps and map-related publications by mail and over the counter to the public, to 25 commerical dealers in Alaska, and to Federal and State agencies. A schedule of map prices and discounts is available on request. During calendar year 1973 the Alaska Distribution Section dispensed more than 112,000 items.

A Public Inquiries Office at 108 Skyline Building, 508 Second Avenue, Anchorage, Alaska 99501 ([907] 277–0577) is supervised by Margaret I. Erwin under the direction of the Office of Public Inquiries, Publications Division, National Center, Reston, Va. It maintains a stock of Alaska topographic and geologic maps for over-the-counter sale, and as an agent of the Superintendent of Documents sells Geological Survey book reports on Alaska. It serves as a public contact point for Survey activities in the State and has a complete library of all Survey publications. The office is a depository for Alaska open-file reports and maintains a browse file containing microfilms of ERTS satellite images. During the calendar year 1973 the Anchorage office had more than 25,000 public contacts.

EROS PROGRAM

The EROS (Earth Resources Observation Systems) Program was established by the U.S. Department of the Interior in 1966 because of the wealth of practical benefits to be obtained from high-altitude photographs and other remote-sensing data acquired by aircraft and spacecraft, particularly that acquired by the Earth Resources Technology Satellite (ERTS–1). The EROS Program is managed by the U.S. Geological Survey, and participated in by 10 other Bureaus of the Department of the Interior. Cooperating in the EROS Program are NASA, Department of Agriculture, Department of Commerce, Office of Naval Research, Naval Oceanographic Office, Department of Defense (Inter-American Geodetic Survey), numerous universities, state and local governments, and private industry.

The research of the EROS Program is in five areas: (1) cartographic applications and mapping requirements; (2) geology, mineral and land resources; (3) water resources; (4) marine resources; and (5) geography, human and cultural resources. EROS research is concerned with the distribution of ice, snow, water, vegetation, and the works of man; the identification of land-use categories; the measurement of the quantity and quality of ground water; the distribution of distinctive biological communities such as forest and tundra; and the determination of changes in the land surface.

The Department of the Interior distributes ERTS and other imagery at nominal cost to users throughout the world. To order data, write the U.S. Geological Survey, EROS Data Center, Sioux Falls, S. Dak. 57198 ([605] 594–6511). Alaskan imagery is available for inspection at the Public Inquiries Office, 508 Second Avenue, Anchorage, Alaska. For technical assistance contact Ernest H. Lathram, EROS Program Representative, Pacific

Coast-Alaska, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025. ([415] 323–8111, ext. 2348).

ALASKA SURVEY COMMITTEE

Discussion and coordination of Alaska activities are provided by the Alaska Survey Committee, a forum in which each of the Divisions of the Geological Survey is represented. Alexander A. Wanek, Conservation Division, is Chairman for 1974; other members are Harry Hulsing, Water Resources; Florence R. Weber, Geologic; Thomas J. O'Brien, Topographic; Margaret I. Erwin, Publications; and Betty J. McIntire, Administrative.

ADMINISTRATIVE DIVISION

The Alaska Field Office of the Administrative Division is located at 204 Skyline Building, 218 E Street, Anchorage, Alaska 99501 ([907] 277–0569). The office is supervised by Betty J. McIntire and provides service and supply support to U.S. Geological Survey offices and personnel in Alaska.

Arrangements for U.S. Geological Survey personnel to stay at the Alyeska Pipeline Service Company camps, and reservations for transportation to the camps, are made by Mrs. McIntire in Anchorage. Notice in advance is necessary.

The Anchorage Warehouse is under the supervision of Clarence (Buck) Buchanan and is located about 5 miles east of downtown Anchorage, just inside the boundary of Elmendorf Air Force Base ([907] 753–2119). Field equipment and samples may be shipped to the warehouse for storage. The address is: 5500 Oilwell Road, Elmendorf Air Force Base, Anchorage, Alaska 99506. The warehouse for the Fairbanks area is located at Ft. Wainwright but will be staffed only if warranted by the level of field activity. The telephone number at Ft. Wainwright is [907] 353–3139.

EMERGENCY SEARCH AND RESCUE

In cases of emergency in the field, contact the Air Rescue Coordination Center in Anchorage at [907] 277–2131, 752–0227, 752–1106 at any time during the day or night, or through the nearest FAA Flight Service Station, military installation, or the State Troopers. To the extent possible, specify the location of the crash, time of the accident, number of people involved, and the nature of possible injuries.

If possible, the Administrative Division in Anchorage should also be contacted for the purpose of notifying headquarters and family. At any time contact Betty J. McIntire (work: [907] 277–0569, home: [907] 272–5398) or Ralph Chapman (work: [907] 277–0569, home: [907] 277–7266).

RADIO NETWORK

The Radio Officer for Alaska, Florence Weber, Geologic Division, College, Alaska 99701 ([907] 479–7245), is charged with the responsibility of implementing the U.S. Geological Survey's radio network at such times as the necessity demands. Two frequencies, 5380 KHz and 3211 KHz (both upper SSB), are the official frequencies for USGS personnel. During the 1973 field season, Survey activities in Alaska were not extensive enough to warrant a separate USGS network, but good communications were maintained on 5167.5 KHz (Alaska public fixed) and on some VHF frequencies using commerical radio service facilities in Fairbanks and Anchorage. It is anticipated a similar system will be used in 1974.

BRANCH OF EXPLORATION RESEARCH

Field Services Section will have a five- or six-man Spectrographic and Wet-Chemistry Laboratory operating adjacent to Elmdorf Air Force Base at 5500 Oilwell Road, Anchorage. The laboratory will accept samples from any of the Survey field teams in Alaska. The facilities include semiquantitative spectroscopy and wet-chemistry-atomic absorption analyses. The laboratory is under the direction of Richard O'Leary; Carl Forn is in charge of the spectrographic laboratory, and Richard O'Leary is in charge of wet chemistry laboratory. The laboratory will be open from approximately June 17 through September 20, or whenever the weather closes down the Alaska field season.

Samples may be sent to: Field Services Section, 5500 Oilwell Road, Elmendorf Air Force Base, Alaska 99506; or the laboratory can be reached by phone ([907] 753–2119).

ALASKAN PROJECTS OF THE U.S. GEOLOGICAL SURVEY

Much of the work of the Geological Survey is organized and accomplished by projects in which the investigations of one or more scientists, engineers and technicians are directed by a project chief. Some of the projects are statewide in scope, but most focus on one or more aspects of topography, geology, or hydrology in particular parts of Alaska. Summarized in this section are the statewide and regional Survey projects planned for the field season of 1974. Summarized in a subsequent section are the projects undertaken in cooperation with various agencies of the State of Alaska.

STATEWIDE PROJECTS

Project: Alaska geothermal.

Region: Statewide.

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: Thomas P. Miller, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501; [907] 272–8228.

Project plans: Approximately 1 month will be spent doing helicopter-supported geologic mapping and sampling of young volcanic rocks, fumaroles, and hot springs of the lower Alaska Peninsula. About half of the time will be spent completing reconnaissance mapping of the recent volcanic centers of Peulik, Chiginigak, Aniakchak caldera, Black Peak, Veniaminof, and Kupreanof volcanoes. The remainder of the time will be spent in reconnaissance of the Pavlof and Frosty Peak volcanic centers and the Fisher caldera further down the Peninsula. If money becomes available from the Navy, 1–2 weeks work will be done in the vicinity of Adak in the Aleutian Islands. Approximately 10 days will be spent in the western Wrangell Mountains completing the geologic mapping of the Wrangel volcanic pile with D. H. Richter and perhaps R. Smith. Some geochemical sampling of hot springs in southeastern Alaska may be done by personnel under the direction of Ivan Barnes of Water Resources Division. This work will depend upon the availability of the U.S.G.S. research vessel *Don J. Miller* and will be done in cooperation with other Branch of Alaskan Geology projects in this part of Alaska. Detailed geologic mapping, core sampling, geochemical studies, and consultation may be done at a site to be selected in either western Alaska or the Aleutian Islands in cooperation with, and funded by, the AEC as part of its proposed "Remote Village Geothermal Project." This work is unlikely to begin, assuming it is approved, before fall of 1974.

Project: ERTS–1 investigation SR 180, Identification of geostructures of continental crust.

Region: Statewide.

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: Ernest H. Lathram, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; [415] 323–8111, ext. 2231 and 2348.

Project plans: This project is applying ERTS imagery in identifying geologic structures and lithologic elements of regional extent in Alaska and in interpreting their significance as guides to the emplacement of known mineral resources, the possible location of unknown mineral resources, and the mechanism and history of formation and deformation of the continental crust in Alaska. Geologic structures, such as folds, faults, and fracture systems are identified, their identity verified where local geology has been mapped on the ground, and their existence extended beyond present knowledge; and geologic elements, such as bodies of extrusive and intrusive igneous rocks and sequences of strata having common origin and identified by tonal character, boundary relations with other elements, vegetal cover, and fracture pattern are identified to improve geologic mapping. These studies, under the general coordination of E. H. Lathram, involve all geologists of the Alaskan Branch.

Project: Alaska state base maps.

Region: Statewide.

Organizational designation: Topographic Division, Rocky Mountain Mapping Center.

Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225; [303] 234–2351.

Project plans: The following Alaska state maps are being updated using 1:250,000-scale maps as source material: (1) Map B—1:1,584,000 scale—base and contour editions, and (2) Map E—1:2,500,000 scale—base and shaded relief editions.

PROJECTS WITH REGIONAL EMPHASIS

The major part of the Geological Survey's Alaskan program consists of projects of less than statewide scope. In this summary of 1974 regional projects, data on the location, staffing, and plans are presented. The location of each project is also shown by number on the accompanying map (fig. 6).

Many projects are intensive investigations that require several years to complete. As with most technical studies, final formulation and publication of results are accomplished at the end of the investigation. For some Geologic Division projects, however, interim results and findings are compiled and presented in the section of this report on "Summary of Important Results, 1973." Interim accounts of the continuing hydrological investigations are prepared and separately published by the Water Resources Division. Inquiries on the status of the various projects should be directed to the project chief at the address listed in the project summary.

NORTHERN ALASKA

Project: Kukpowruk River Coal Field.
Region and map key: Northern Alaska, Pt. Lay Quadrangle (1).
Organizational designation: Conservation Division, Office of the Area Geologist, Alaska Area.
Project chief: J. E. Callahan, U.S. Geological Survey, P. O. Box 259, Anchorage, Alaska, 99510; [907] 277–0570.
Project plans: Surface mapping and limited drilling and trenching along the Kukpowruk River have, to date, resulted in basically a single north-south section across the Howard syncline, with extrapolation of known coal beds a short distance east and west based on rubble traces and animal burrows. By use of a Rolligon-mounted light auger, it is hoped to determine the lateral extent of the major (20 feet) coal bed exposed on the river. In addition to this primary objective, other thick beds will be traced as far east and west as possible, and geologic mapping in other synclinal basins downstream (north) will be done.

Project: Beaufort-Chukchi Sea Continental Shelf.
Region: Northern Alaska.
Organizational designation: Geologic Division, Office of Energy Resources and Marine Geology, Pacific-Arctic Branch.
Project chief: Arthur Grantz, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2259).
Project plans: Dredging and dart coring of outcrops on the Continental Shelf and Slope in the Chukchi and Beaufort Seas will be conducted from the U.S. Coast Guard icebreaker *Burton Island* during August, 1974. In addition, measurements of

Northern Alaska

Name of project	Personnel	Type of work	Area(s)
Kukpowruk River Coal Field	J. E. Callahan	Geologic mapping, drilling	Kukpowruk River
Beaufort-Chukchi Sea Continental Shelf	Arthur Grantz	Dredging and dart coring, heat flow and gravity measurements, arcer profiling	Chukchi and Beaufort Seas
Northern Bering Seafloor	Hans Nelson	Side-scan sonar analysis, seismic profiling	Southern Bering Straits, offshore of Yukon subdelta
Central Brooks Range (TAPS route)	A. E. Letey and Topographic Division	Topographic mapping	Parts of Sagavanirktok, Chandler Lake, Phillip Smith Mt., Wiseman, Chandalar, Bettles, and Beaver quadrangles
Eastern Brooks Range	A. E. Letey and Topographic Division	Topographic mapping	Parts of Coleen, Demarcation Point, Table Mountain, Christian, Arctic, and Mt. Michelson quadrangles

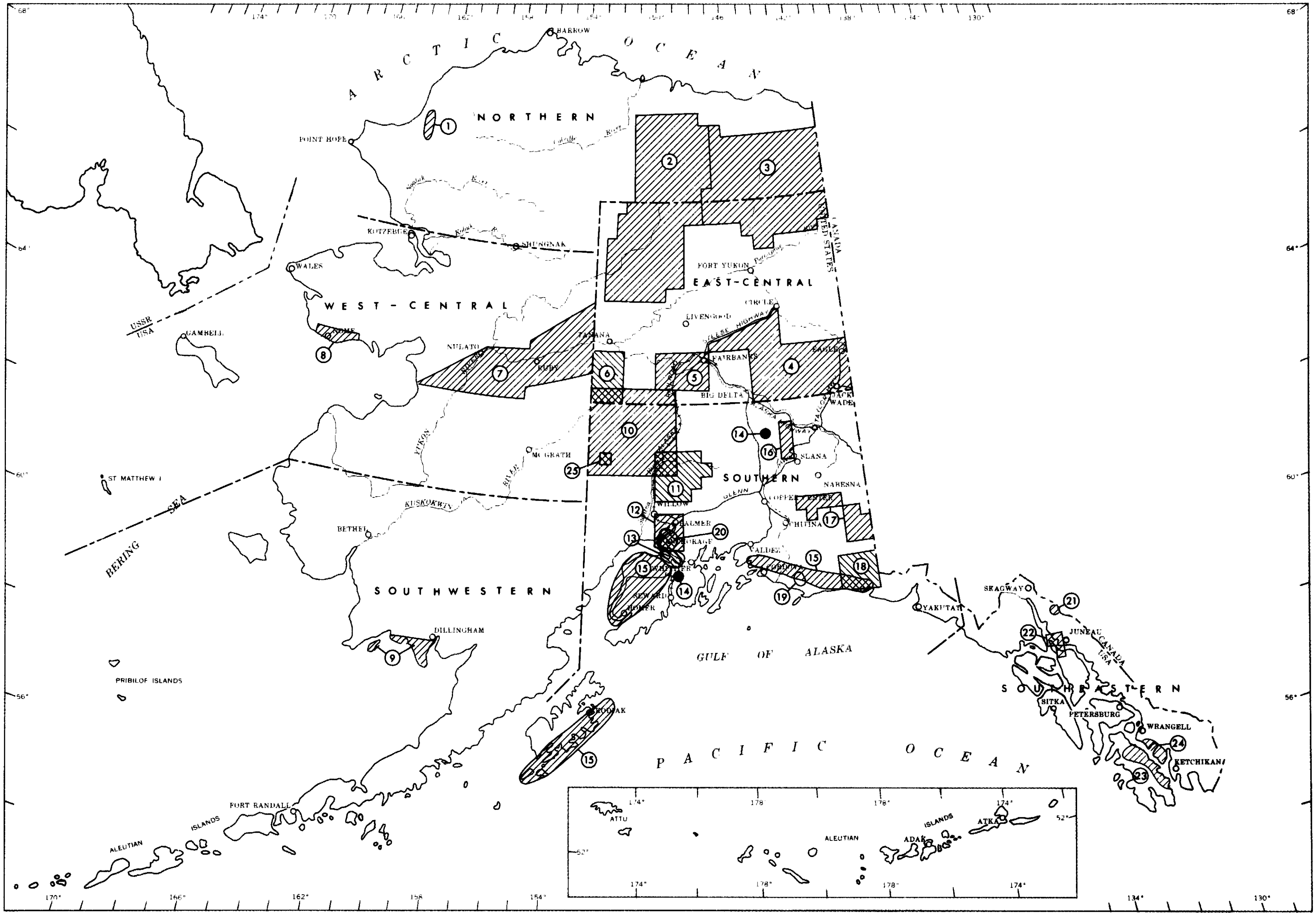

FIGURE 6.—Map showing locations of 1974 field projects of the U.S. Geological Survey. The circled numbers key to project discussions in the text.

heat flow and gravity will be made, and 30 KJ and high-resolution arcer profiles will be obtained between sample stations. Benthic invertebrates, particularly those with shells, benthic foraminifers, and modern sediments will also be collected. The bedrock samples will be used to help assign ages and lithologies to geophysically defined geologic units mapped in the Chukchi and Beaufort Seas in 1969–1973. Mail address: c/o NARL, Barrow, Alaska, 99723.

Project: Northern Bering Seafloor.
Region: Northern Alaska.
Organizational designation: Geologic Division, Office of Energy Resources and Marine Geology, Pacific-Arctic Branch.
Project chief: Hans Nelson, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2603).
Project plans: If transit time is available on the newly acquired R/V *Lee* when it travels from Beaufort to Bering Sea, the following research will be attempted: (1) side-scan sonar analysis of the southern area of the Bering Straits, and (2) continuous high resolution seismic profiling of the offshore region adjacent to the modern Yukon subdelta.

Project: Central Brooks Range (area of trans-Alaska oil pipeline route).
Region and map key: Northern, East-Central, and West-Central Alaska. Parts of Sagavanirktok, Chandler Lake, Phillip Smith Mtn., Wiseman, Chandalar, Bettles, Beaver (2).
Organizational designation: Topographic Division, Rocky Mountain Mapping Center.
Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225 ([303] 234–2351).
Project plans: This project area, consisting of 118 1:63,360-scale quadrangles, was begun in 1970 with fieldwork being performed in 1970 and 1971. Map finishing operations remain for 14 quadrangles. The remaining quadrangles have been or are being published.

Project: Eastern Brooks Range (area of proposed gas pipeline to Canada).
Region and map key: Northern and East-Central Alaska. Parts of Coleen, Demarcation Point, Table Mountain, Christian, Arctic, Mt. Michelson (3).
Organizational designation: Topographic Division, Rocky Mountain Mapping Center.
Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225 ([303] 234–2351).
Project plans: This project consists of 74 1:63,360-scale quadrangles. Field control was obtained for 51 quadrangles during the 1972 field season. Map compilation has been completed for 23 quadrangles. Remaining quadrangles are delayed for lack of aerial photography. No field operations are scheduled for the 1974 season.

EAST-CENTRAL ALASKA

Project: Yukon-Tanana Upland (fig. 7).
Region and map key: East-Central Alaska (4).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: Helen L. Foster, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2331).
Project plans: Reconnaissance geologic mapping and geochemical sampling will be carried on with helicopter support by Helen L. Foster, project chief, Florence R. Weber, and a field assistant in the eastern part of the Big Delta quadrangle. Geologic traverses will also be made in the Circle quadrangle from the Steese Highway, and some specific collecting and checking will be done by Helen Foster in the Eagle quadrangle. Fieldwork will begin about June 1 and continue through mid-September. While working with helicopter the field party will be headquartered at Dot Lake on the Alaska Highway. At other times the party can be contacted through the U.S. Geological Survey office at College.

Project: Fairbanks revision.
Region and map key: East-Central Alaska (5).
Organizational designation: Topographic Division, Special Mapping Center.
Project chief: Roy E. Fordham, Chief, Special Mapping Center, Reston, Va.
Project plans: The Fairbanks 1:250,000-scale map and 16 1:63,360-scale quadrangles in the Fairbanks area are being photorevised. (No field check.)

Project: Kantishna River quadrangle (Tanana-Beaver quad area).

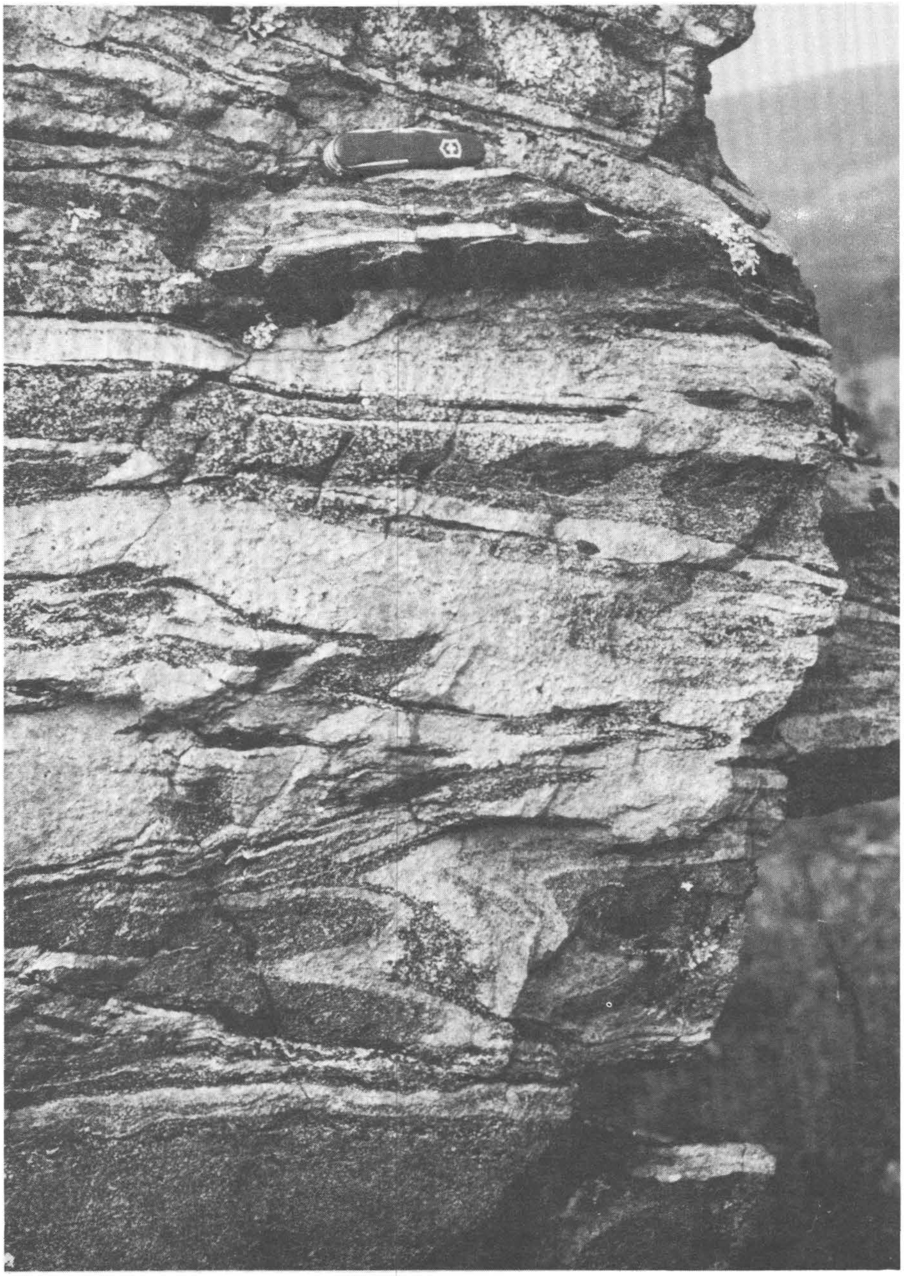

FIGURE 7.—Dark-greenish-gray hornblende gneiss with light-colored quartz-feldspar bands crops out in the south-central part of the Eagle A-1 quadrangle in terrane of amphibolite facies.

Region and map key: East-central Alaska, chiefly western half of Kantishna River quadrangle (6).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: Robert M. Chapman, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2670).

Project plans: Fieldwork will be done in the western half of the Kantishna River quadrangle from July 21 to July 31 by Robert M. Chapman, William W. Patton, Jr., and one other geologist. The party will base at Tanana and have helicopter support. Investigations will be focused on reconnaissance mapping of the bedrock units and unconsolidated deposits that presently are poorly known and partly unmapped in this area, on gathering structural and stratigraphic data that will aid in identifying regional structural trends and major fault zones, and on collecting reconnaissance geochemical samples of bedrock units and stream sediments. Attention will be given to establishing correlations between the rock units and major structures in this area and those that have been mapped in recent years in the Tanana and Livengood quadrangles.

This project will be coordinated with subsequent work farther west along the Yukon River by Patton and Chapman to expand geologic knowledge of the Ruby geanticline, one of the major structural elements of interior Alaska.

WEST-CENTRAL ALASKA

Project: TAPS, Hughes-Shungnak.

Region and map key: West-central Alaska, Melozitna, Ruby, Nulato, and Norton Bay quadrangles (7).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: William W. Patton, Jr., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111 ext. 2248).

Project plans: Investigations of the Kaltag fault will be carried out in west-central Alaska by William W. Patton, Jr., George Plafker, and Robert M. Chapman from operating bases at Tanana and Galena during the month of August. The Kaltag fault has been traced for 443 km (275 mi.) across west-central Alaska from Norton Sound to near the mouth of the Tanana River. Reconnaissance geologic mapping along the fault suggests that between 64 and 130 km (40 and 80 mi.) of right-lateral offset have occurred since the Cretaceous, and aerial photographs provide evidence of Holocene activity with as much as 2.4 km (1.5 mi.) of local drainage offset. Investigations this summer will be concentrated primarily on Holocene displacements in an effort to determine the amount, direction, and timing of recent movements.

In addition to the fault investigations, approximately 10 days will be spent by Patton and Chapman in reconnaissance mapping and mineral investigations in the Kaiyuh Mountains and Kokrines Hills as part of a broad regional study of the Ruby geanticline.

Project: Nome.

Region and map key: West-Central Alaska (8).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: C. L. Hummel, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2606).

Project plans: C. L. Hummel will conclude his semireconnaissance geological and geochemical investigations of the bedrock and mineral deposits of the Nome gold fields during the current field season.

SOUTHWESTERN ALASKA

Project: Southwestern Alaska.

Region and map key: Southwest Alaska. Taylor Mountains, Dillingham, Nushagak Bay 1:250,000 quads (9).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: J. M. Hoare, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2372).

Project plans: Tentative plans are being made to conduct field investigations on Hagemeister Island and on the mainland north of Bristol Bay from the mouth of Togiak River eastward to, and including, the Nushagak Peninsula. The purpose of the work is to upgrade basic geologic knowledge in parts of the Hagemeister Island and Goodnews Bay 1:250,000 quadrangles and to complete the geologic mapping of the Nushagak Bay quadrangle. Specific objectives include: (1) sampling a shaly sequence on Hagemeister Island for its possible pollen content, (2) sampling sediments of probable Tertiary age that crop out on the mainland coast for pollen, (3) paleomagnetic study of the young volcanic rocks, and (4) sampling of the young volcanic rocks and a variety of siliceous and mafic intrusives for radiometric dating and chemical analyses.

Fieldwork will start the first week in June and continue for about 15 days. The work will be accomplished by means of a helicopter based at Dillingham. Personnel include J. M. Hoare, R. Detterman, and one or two others.

Project: Aleutian-Bering Sea.

Region: Southwestern Alaska.

Organizational designation: Geologic Division, Office of Energy Resources and Marine Geology, Pacific-Arctic Branch.

Project chief: David W. Scholl, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2617).

Project plans: Plans are being formulated to return to the Bering Sea during the summer months of 1974. Geophysical field checking with multichannel seismic reflection techniques will be the primary aim of the limited work being planned. Only the deep Bering Sea and the Bering shelf will be investigated. The work itself will be conducted from research vessel *S.P. Lee.*

A research program has been initiated to study the geological factors associated with the formation of the BSR (bottom-simulating reflector). This acoustic phenomenon is poorly understood, but it appears to be related to the diagenetic transformation of muddy diatom ooze to mudstone. The studies will involve geochemical and mineralogical investigations of drill cores collected at a number of DSDP drilling sites.

Assigned personnel: David W. Scholl, Michael S. Marlow, and Alan Cooper.

SOUTHERN ALASKA

Project: Mt. McKinley National Park Map.

Region and map key: Southern Alaska (10).

Organizational designation: Topographic Division, Rocky Mountain Mapping Center.

Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225 ([303] 234–2351).

Project plans: A new map of the park is being prepared at the 1:250,000 scale using the existing maps of this scale. The new map covers a larger area than the 1952 map to include areas that may be encompassed by proposed boundary changes.

Project: Talkeetna Mountains (fig. 8).

Region and map key: South-central Alaska, Talkeetna Mountains quadrangle (11).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: Béla Csejtey, Jr., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2277).

Project plans: Contemplated 1974 fieldwork includes 2 weeks of helicopter supported reconnaissance investigations in the central and western Talkeetna Mountains. In addition, some time will be spent with a field party of the Alaska Division of Geological and Geophysical Surveys investigating batholithic rocks in the southern Talkeetnas.

Project: Anchorage project.

Region and map key: Southern Alaska, Anchorage quadrangle (12).

Organizational designation: Topographic Division, Rocky Mountain Mapping Center.

Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225([303] 234–2351).

Project plans: The Anchorage project consists of 31 quadrangles of topographic mapping at a scale of 1:25,000 with contour intervals of 5, 10, and 20 meters. The project area includes the City of Anchorage and extends north to the towns of Willow, Palmer, and Jonesville. Sixteen of these quadrangles are standard line maps that should be compiled by July 1974, after which advance compilation prints will be available. The remaining 15 quadrangles are scheduled for orthophotomaps, and compilation has not started. Field operations were completed during 1973, and none are scheduled for the 1974 season.

Project: Alaskan seismic studies.

Region: Southern Alaska.

Organizational designation: Geologic Division, Office of Earthquake Studies.

Project chief: Robert A. Page, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323-8111, ext. 2461).

Project plans: This project investigates seismicity, tectonic processes, and earth structure in southern Alaska. Earthquakes are recorded by a network of 32 seismograph stations extending from Katmai National Monument north and east through Cook Inlet, the Kenai Peninsula, Northern Prince William Sound, the Chugach Mountains to Yakutat (fig. 9). The data are recorded at the Palmer Seismological Observatory of the National Oceanic and Atmospheric Administration under a cooperative earthquake-recording program. Information and results from this project are published in the form of maps of epicenters, catalogs of earthquakes, and scientific reports and articles.

Southern Alaska

Name of Project	Personnel	Type of work	Area(s)
Mt. McKinley National Park Map	A. E. Letey and Topographic Division	Topographic mapping	Mt. McKinley National Park
Talkeetna Mountains	Béla Csejtey, Jr.	Reconnaissance geologic mapping	Central and western Talkeetna Mountains
Anchorage project	A. E. Letey and Topographic Division	Topographic mapping	Anchorage quadrangle
Alaskan seismic studies	Robert A. Page, Edward Criley, Michael Blackford	Servicing and adding to the network of seismograph stations	From Katmai National Monument north and east through Cook Inlet, Kenai Peninsula, northern Prince William Sound, Chugach Mtns. to Yakutat
Alaskan coastal environments	A. Thomas Ovenshine, Susan Bartsch	Sedimentological reconnaissance, facies analysis, core drilling	Turnagain Arm
Glaciology studies	L. R. Mayo, D.C. Trabant, Austin Post	Instrument monitoring, theodolite-laser ranger surveying	Wolverine Glacier, Gulkana Glacier
Alaska earthquake hazards	George Plafker, W. L. Coonrad, R. G. Tysdal	Strip mapping, trenching, drilling, seismic hazard zonation studies, reconnaissance of fault systems, marine terrace studies	Castle Mtn. fault, Bruin Bay fault, Lake Clark fault, various faults in Chugach Mtns., Copper River to Icy Bay area, Kodiak Islands area, Cook Inlet-Kenai area
Eastern Alaska Range	D. H. Richter, J. T. Dutro, Jr., T. P. Miller, R. L. Smith, W. N. Sharp	Detailed geologic mapping	Mt. Hayes A-1, B-1 and Gulkana D-1 quadrangles, Wrangell volcanic pile, Denali fault
Wrangell Mountains	E. M. MacKevett, Jr.	Reconnaissance geologic mapping, copper deposit studies, geochemical sampling	Southeastern and northwestern McCarthy 1° quadrangle, Nebesna quadrangle
Bering Glacier	A. E. Letey and Topographic Division	Topographic mapping	Bering Glacier quadrangle
Bering River Coal Field	R. B. Sanders	Measuring stratigraphic section, mapping coal fields	Trout Creek and Clear Creek basins, upper Carbon Creek
Greater Anchorage Area Borough, Alaska	E. Dobrovolny, H. R. Schmoll	Map and report preparation	Greater Anchorage Area Borough
Southern Alaska Range	Bruce Reed	Geologic mapping, geochemical investigations, economic studies	Talkeetna D-5 quadrangle

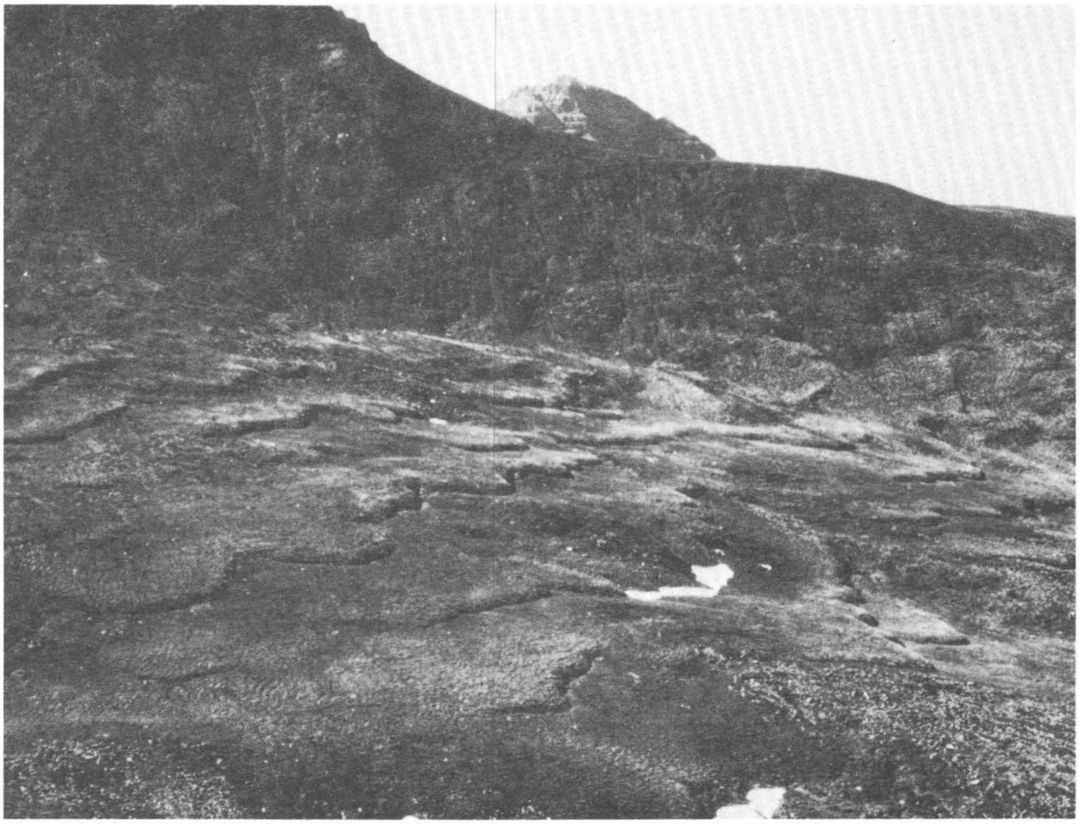

FIGURE 8.—Solifluction lobes developed on a southeastern-facing slope, southeastern Talkeetna Mountains.

Between June and September 1974, existing stations will be serviced, and as many as 11 additional stations may be added to the network. The work will be headquartered in Anchorage and will be carried out by four to six people under the supervision of Edward Criley, Michael Blackford, and Robert Page.

Project: Alaskan Coastal Environments.
Region and map key: Southern Alaska (13).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: A. Thomas Ovenshine, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2463).
Project plans: The purpose of this project is to study contemporary and Holocene intertidal, supratidal and subtidal sedimentation in the Turnagain Arm area near Anchorage, Alaska. There are four objectives to the 1974 field studies: (1) facies model formulation for the Girdwood Bar, (2) sedimentological reconnaissance of mid-arm bars between Bird Point and Portage, (3) facies analysis of newly formed intertidal sediment in the Portage area, and (4) core drilling to identify ancient paleosols at Portage. Fieldwork on the first three objectives will be undertaken during the period June 15–August 1; core drilling will be attempted during the last 2 weeks in September.

Field headquarters for A. Thomas Ovenshine, Susan Bartsch, and a field assistant will be Girdwood with mail contact through Betty J. McIntire's office in Anchorage.

Project: Glaciology studies.
Region and map key: Southern Alaska (14).
Organizational designation: Water Division, Alaska District Office.
Project chief: L. R. Mayo, project chief, D. C. Trabant, hydrologist, U.S. Geological Survey, Water Resources Division Subdistrict Office, 310 First Avenue, Fairbanks, Alaska 99701 ([907] 452–1951, ext. 176 or 177.
Project plans: Wolverine Glacier.—Kenai Mountains—Part of the instrumentation used during the International Hydrological Decade

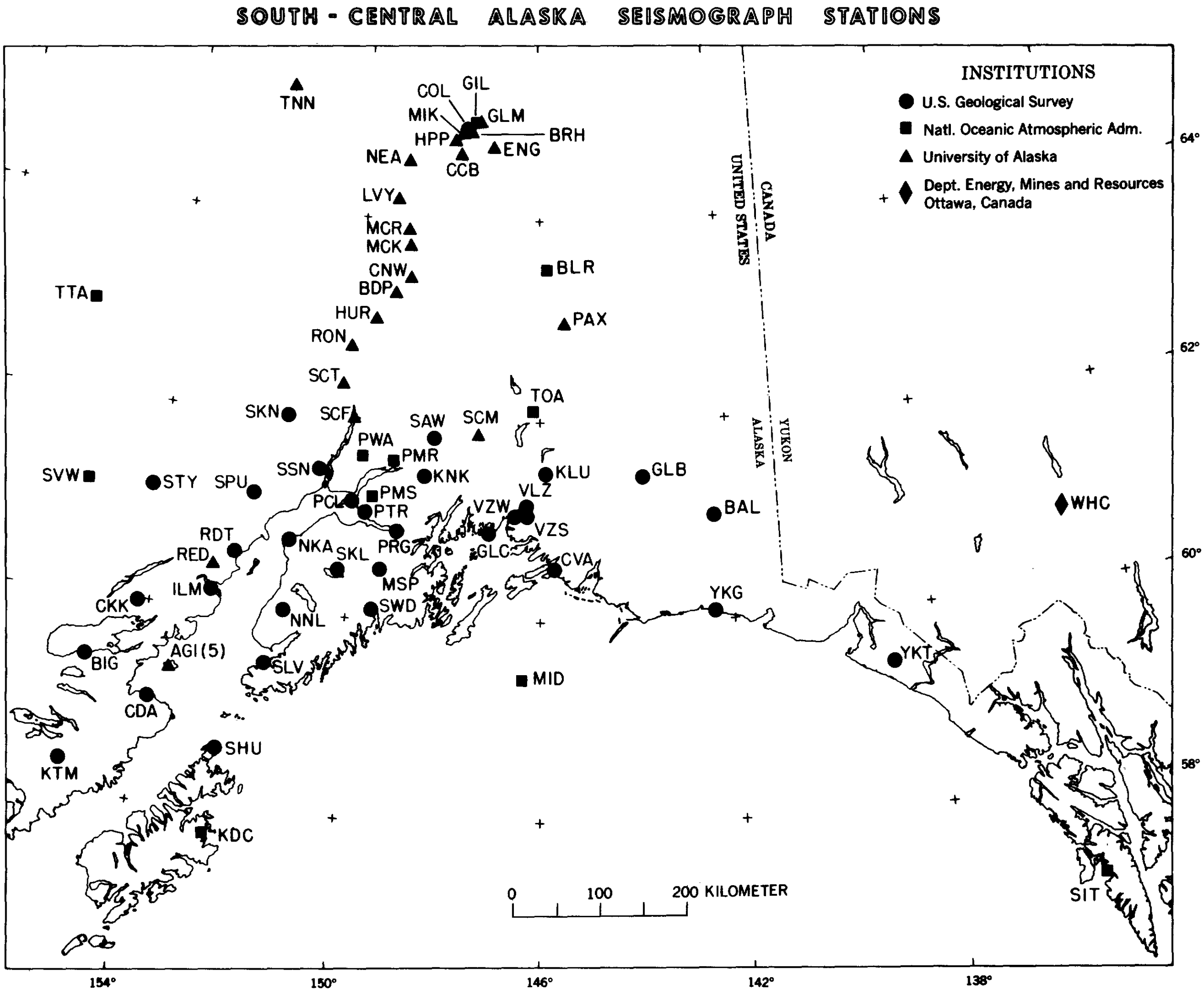

FIGURE 9.—Map showing location of seismograph stations in south-central Alaska.

(IHD) will be removed from the basin and the remainder (balance index stations, stream gage, air temperature gage, and recording precipitation gage) will be operated as long-term data-collection stations. The longitudinal profile and three transverse profiles will be surveyed by theodolite-laser ranger techniques. Ranger markers will be installed to measure ice motion at three points. Gulkana Glacier.—Alaska Range—The IHD program was shifted to the long-term monitoring program in 1973. Monitoring will be continued. Air Photo Glacier Inventory.—Regional-Glacier inventory data by aerial photography will be continued as a joint effort with Austin Post, U.S. Geological Survey, Tacoma.

Project: Alaska earthquake hazards.

Region and map key: Southern Alaska (15).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: George Plafker, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2201).

Project plans: The overall objective of this project is to study and evaluate risk in Alaska from tectonic displacement, seismic shaking, and secondary geologic effects. A more general goal is to gain insight into tectonic processes within the seismically active zones of Alaska with special emphasis on south-central Alaska.

Plans for 1974 include:

1. Strip mapping, trenching, and drilling to delineate western extent of the active Castle Mtn. fault and to obtain additional data on the age of its last displacement.

2. Strip mapping in Chugach Mtns. along the Ragged Mtn., Chugach-St. Elias, Border Ranges, Chitina, Kosakuts, Hope Creek, Miller, and Sullivan faults to determine nature of slip and state of activity.

3. Marine terrace studies between the Copper River and Icy Bay to determine uplift rates and recurrence intervals for major tectonic events involving shoreline uplift.

4. Seismic hazard zonation study of the Kodiak Islands area.

5. Seismic hazard zonation study of the Cook Inlet-Kenai area.

6. Reconnaissance of major active fault systems of interior Alaska.

7. Support A. T. Ovenshine's studies of sedimentation in Turnagain Arm related to the 1964 earthquake and previous comparable seismic events.

8. Reconnaissance study and strip mapping of Bruin Bay and Lake Clark faults on the Alaska Peninsula.

Project: Eastern Alaska Range.
Region and map key: Southern Alaska, Nabesna quadrangle and parts of the McCarthy, Mt. Hayes and Gulkana quadrangles (16).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Mineral Resources, Branch of Alaskan Geology.
Project chief: D. H. Richter, U.S. Geological Survey, 1209 Orca St., Anchorage, Alaska 99501 ([907] 272–8228).
Project plans: Geologic mapping at scales of 1:63,360 and 1:250,000 in the Mt. Hayes A-1, B-1 and Gulkana D-1 quadrangles will be completed in cooperation with J. T. Dutro, Jr. More detailed mapping in the Wrangell volcanic pile will possibly be undertaken with T. P. Miller and R. L. Smith. Also planned is some detailed mapping and sampling of the ultramafic bodies along the Denali fault in cooperation with W. N. Sharp.

Project: Wrangell Mountains.
Region and map key: Southern Alaska (17).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: E. M. MacKevett, Jr., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2216).
Project plans: This summer's plans for the Wrangell Mountains project include: (1) reconnaissance geologic mapping of unmapped or partly mapped 15′ quadrangles within the McCarthy 1° quadrangle—these are mainly in the southeastern and northwestern parts of the 1° quadrangle; (2) completing detailed mapping of the McCarthy C-7 quadrangle; and (3) (possibly under the aegis of mineral resource investigations) additional studies of copper deposits in the McCarthy and Nebesna quadrangles along with reconnaissance and, locally, detailed geochemical sampling. Probably some geophysical investigations will be carried out in the McCarthy quadrangle.

The project is in the terminal stages of field investigations, and its main objectives have been largely or partly achieved. These objectives include: (1) providing modern multipurpose geologic maps for a variety of users; (2) deriving a current mineral resource appraisal of the McCarthy quadrangle and, concomitantly, sound geologic knowledge of the region's mineral deposits; (3) enhancing the general geologic knowledge of Alaska and, particularly, the relevance of the region's geology in terms of modern geotectonic concepts; and (4) providing a realistic basis for judicious land use decisions.

A 6-week helicopter-supported field season, mainly operating from a base at McCarthy, is contemplated. At present, assignments of project personnel are not definite.

Project: Bering Glacier.
Region and map key: Southern Alaska, Bering Glacier quadrangle (18).
Organizational designation: Topographic Division, Rocky Mountain Mapping Center.
Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225 ([303] 234–2351).
Project plans: This project consists of 12 1:63, 360-scale quandrangles. These quadrangles are being compiled using Air Force aerial photography and utilizing existing control. No additional fieldwork is planned.

Project: Bering River Coal Field.
Region and map key: Southern Alaska, parts of the Cordova and Bering Glacier quadrangles (19).
Organizational designation: Conservation Division, Office of the Area Geologist, Alaska area.
Project chief: R. B. Sanders, U.S. Geological Survey, P.O. Box 259, Anchorage, Alaska 99510 ([907] 277–0570).
Project plans: The Trout Creek and Clear Creek basins will be studied from a camp on the shore of Kushtaka Lake. If snow conditions permit, the upper parts of the Carbon Creek area that were snow covered in 1973 will be examined. The top-priority project will be the measuring of a good stratigraphic section(s).

Project: Greater Anchorage Area Borough, Alaska.
Region and map key: Southern Alaska, Greater Anchorage Area Borough (20).
Organizational designation: Geologic Division, Office of Environmental Geology, Branch of Engineering Geology.
Project chief: E. Dobrovolny, U.S. Geological Survey, Denver Federal Center, Denver, Colo. 80225 ([303] 234–3471).
Project plans: The project involves detailed geologic mapping of the Anchorage and vicinity area, at a scale of 1:24,000, and reconnaissance geologic mapping of the remainder of the Greater Anchorage Area Borough, at a scale of 1:63,360, with emphasis on Quaternary deposits. The objective is to provide geologic information needed for citywide and boroughwide land-use planning. The studies were undertaken in response to requests from local government officials and are closely coordinated with hydrologic investigations by the USGS Water Resources Division. Fieldwork has been completed, and maps and reports are in preparation. Special-purpose maps are being prepared from the geologic maps for use by planners and developers. Several interpretive maps have been released in open-file, and others are in the process of being completed. Assigned personnel: E. Dobrovolny and H. R. Schmoll.

Project: Southern Alaska Range.
Region and map key: Southern Alaska (25).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: Bruce Reed, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 272–8228).
Project plans: Continuation of geologic mapping, geochemical investigations and economic studies of a tin granite and an associated cassiterite/sulfide deposit in the Alaska Range (Talkeetna D-5 quadrangle) is planned. If helicopter support is available, geologic mapping and geochemical investigations will be extended east and west of the tin granite and along the Denali fault. If helicopter support is not available, work will be concentrated on detailed (1:31,000) mapping of the granite and metamorphic rocks near the tin deposit.

SOUTHEASTERN ALASKA

Project: Engineering geology reconnaissance studies of coastal communities, Alaska.
Region: Southeastern Alaska, selected coastal communities in the several coastal regions of Alaska.
Organizational designation: Geologic Division, Office of Environmental Geology, Branch of Engineering Geology.
Project chief: R. W. Lemke, U.S. Geological Survey, Denver Federal Center, Denver, Colo. 80225 ([303] 234–3546).
Project plans: Main objective of the project is to evaluate, by reconnaissance field studies, the earthquake and other geologic hazards of several Alaska coastal communities not already studied for this purpose. Fieldwork has been completed. Open-file reports have been completed and released for the towns of Haines and Skagway as well as a general report on southeastern Alaska. Also a report for the town of Wrangell has been completed and is being processed for open-file release. Work during the remainder of the year will be directed toward completing open-file reports for the remaining communities. Assigned personnel: R. W. Lemke (W.A.E.).

Project: Juneau, Alaska, regional mapping and related geologic investigations.
Region and map key: Southeastern Alaska,

Southeastern Alaska

Name of project	Personnel	Type of work	Area(s)
Engineering geology reconnaissance studies of coastal communities, Alaska	R. W. Lemke	Report preparation	Southeastern Alaska coastal communities
Juneau, Alaska, regional mapping and related geologic investigations	D. A. Brew, A. B. Ford	Geologic mapping	Northeastern Juneau Icefield
Surficial geology of the Juneau urban area and vicinity, Alaska	R. D. Miller	Report preparation	Parts of Juneau A-2, B-2, and B-3 quadrangles
Reconnaissance engineering geology of the Sitka area, Alaska	J. T. McGill, L. A. Yehle	Report preparation	Sitka urban area
Craig quadrangle	G. D. Eberlein, Michael Churkin, Jr., N. M. Savage	Geologic mapping, paleontological studies	Prince of Wales Island
Geology and mineral resources of the Ketchikan quadrangle	H. C. Berg, R. L. Elliot, C. J. Nutt	Geologic mapping	Cleveland Peninsula, Etolin Island

Juneau and Taku River 1:250,000 map areas (21).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: D. A. Brew, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2178).

Project plans: During the month of June geologists D. A. Brew and A. B. Ford, accompanied by two assistants, will be engaged in field studies of the granitic and metamorphic rocks in the northern extension of the Juneau Icefield near Mounts Nesselrode and Bressler on the International Boundary. These studies are part of the continuing effort to complete the geologic mapping and mineral resource survey of this part of the Coast Range.

The field party will operate from a tent camp on the upper Bucher Glacier, using skis. The party will be placed in the field by helicopter. Radio contact will be through Livingston Copters, Juneau ([907] 586–2030). The mailing address will be ℅ General Delivery, Juneau, Alaska 99801.

Project: Surficial geology of the Juneau urban area and vicinity, Alaska.

Region and map key: Southeastern Alaska, parts of Juneau A-2, B-2, and B-3 quadrangles, 1:63,360 (22).

Organizational designation: Geologic Division, Office of Environmental Geology, Branch of Engineering Geology.

Project chief: R. D. Miller, U.S. Geological Survey, Denver Federal Center, Denver, Colo. 80225 ([303] 234–2960).

Project plans: Fieldwork has been completed. Reports describing results are being prepared. Two articles, one in the Journal of Research, U.S. Geological Survey, v. 1, no. 3, clarifying the meaning of a published radiocarbon date, and the other as Bulletin 1394–C, describing glaciomarine deposits and their origins, were published in 1973. A geologic map has been transmitted for publication in the Miscellaneous Geologic Investigations Map series, and preparation will start this calendar year on the final report, to be published as a U.S. Geological Survey Professional Paper. Assigned personnel: R. D. Miller.

Project: Reconnaissance engineering geology of the Sitka area, Alaska.

Region: Southeastern Alaska.

Organizational designation: Geologic Division, Office of Environmental Geology, Branch of Engineering Geology.
Project chief: J. T. McGill, U.S. Geological Survey, Denver Federal Center, Denver, Colo. 80225 ([303] 234–3721).
Project plans: The main objective of the project is to evaluate, by reconnaissance field studies, earthquake and other geologic hazards of the Sitka urban area. Limited physical properties tests have been performed in the laboratory. Fieldwork has been completed. Report and map are in final review and planned for open-file release in 1974. Preparation of similar report concerning the Metlakatla area, Alaska, has begun and submittal of report planned for 1974; collection of field data completed previously. Assigned personnel: L. A. Yehle.

Project: Craig quadrangle (fig. 10).
Region and map key: Southeastern Alaska (23).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: G. D. Eberlein and M. Churkin, Jr.; U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2210 or 2256.
Project plans: Field plans from July 1 to September 1 include systematic shoreline and nearshore mapping by Eberlein and Churkin and two field assistants. Eberlein will establish a base camp in the Cholmondeley Sound-Skowl Arm area and work north using a 28-foot boat. Churkin will have a base camp at or near Thorne Bay and work southward using a 21-foot boat. The geologic mapping will cover parts of the Craig A-1, A-2, B-1, C-2, and D-2 quads and include field checking the 1942–44 mapping of Kasaan Peninsula by E. N. Goddard and others to evaluate the extent to which it can be integrated with the present mapping effort. To the extent that time permits, exposures along the rather extensive U.S. Forest Service logging

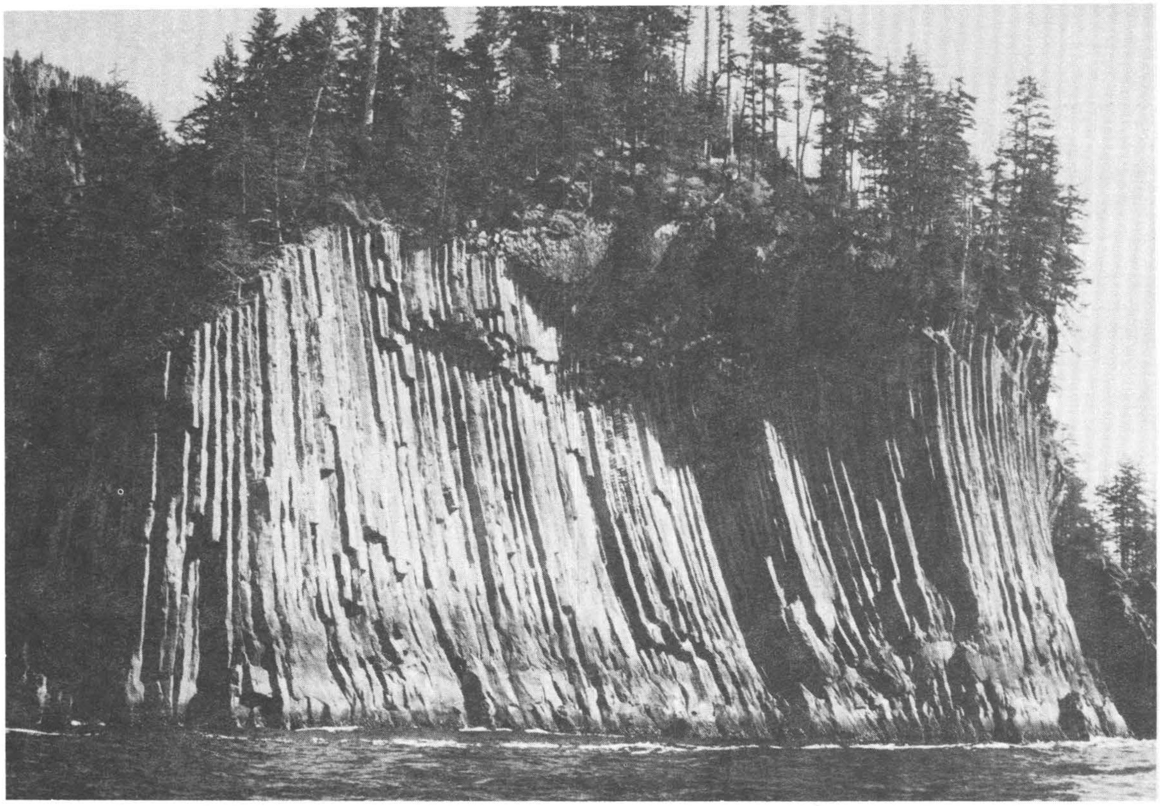

FIGURE 10.—Columnar structure in Tertiary or Quaternary dacite exposed at Cape Felix, Suemez Island, southeastern Alaska.

road network on interior of Prince of Wales Island will also be examined. H. C. Berg, assisted by Ray Elliott and two field assistants, using the R/V *Don J. Miller II* from May 15 to June 30, will extend previously completed mapping of the Annette-Gravina Islands belt into the Cleveland Peninsula-Etolin Islands area to provide needed geologic coverage in the Craig C-1, D-1, and D-2 quads. Finally, arrangements are planned that will permit Dr. N. M. Savage (University of Oregon) to initiate detailed field and office studies of Silurian and Early Devonian conodonts and brachiopod species present in several coeval formations.

Project: Geology and mineral resources of the Ketchikan quadrangle.
Region and map key: Southeastern Alaska, Craig and Ketchikan quadrangles (24).
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: Henry C. Berg, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2266).
Project plans: From about May 15 to June 30, H. C. Berg and R. L. Elliott, accompanied by C. J. Nutt and one other assistant, will map the geology of the outer Ernest Sound area, about 96 km (60 mi.) northwest of Ketchikan. The area to be mapped consists of western Cleveland Peninsula and southern Etolin Island and includes parts of the Craig and Ketchikan 1:125,000-scale quadrangles.

The study is part of the continuing effort to complete a geologic map and mineral resource survey of the Craig area and also will contribute significantly to a similar understanding of the Ketchikan region.

Fieldwork will consist of coastal traverses in outboard skiffs, and helicopter- and fixed-wing aircraft-supported foot traverses of inland areas. The field party will be based on the 37-m-(120 ft) long U.S. Geological Survey R/V *Don J. Miller II.*

COOPERATIVE PROJECTS WITH OTHER AGENCIES

Certain projects of the Geological Survey are undertaken to meet the specific needs of city or state governments or to provide scientific and technical data required by other federal agencies. These projects are funded jointly and are termed cooperative projects. In one project, in addition to joint funding, there is combined participation in the scientific work by geologists of the Alaska Division of Geological and Geophysical Surveys and the Branch of Alaskan Geology, U.S. Geological Survey.

Listed in this section are the cooperative projects of the U.S. Geological Survey. Most cooperative projects concern the hydrology of Alaska and are statewide in scope. Other cooperative projects in geology, hydrology, and geophysics have a particular regional focus; the locations of these are shown on the accompanying map (fig. 11).

STATEWIDE PROJECTS

Project: Quality-of-water stations.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: R. J. Madison, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 277–2644 or 2645).
Project plans: To provide information on chemical and physical properties of water by (1) determining mineral composition of water to evaluate its use for domestic, municipal, and industrial water supply; and (2) determining the mineralogical and biological composition of water to establish a base line under natural conditions from which the changes caused by man's activities can be evaluated. This will be accomplished by operation of a network of water-quality stations.
Cooperating agencies: U.S. Army Corps of Engineers; U.S. Forest Service.

Project: Ground-water stations.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: D. A. Morris, U.S. Geological Survey, Water Resources District Office, 218 E Street, Anchorage, Alaska 99501 ([907] 277–5526).
Project plans: To provide information on water levels throughout Alaska, indicating ground water in storage or in transit and the availability of supplies, showing changes in ground-water storage, estimating base flow of streams, identifying areas of rising or declining water levels, providing long-term records for basin or

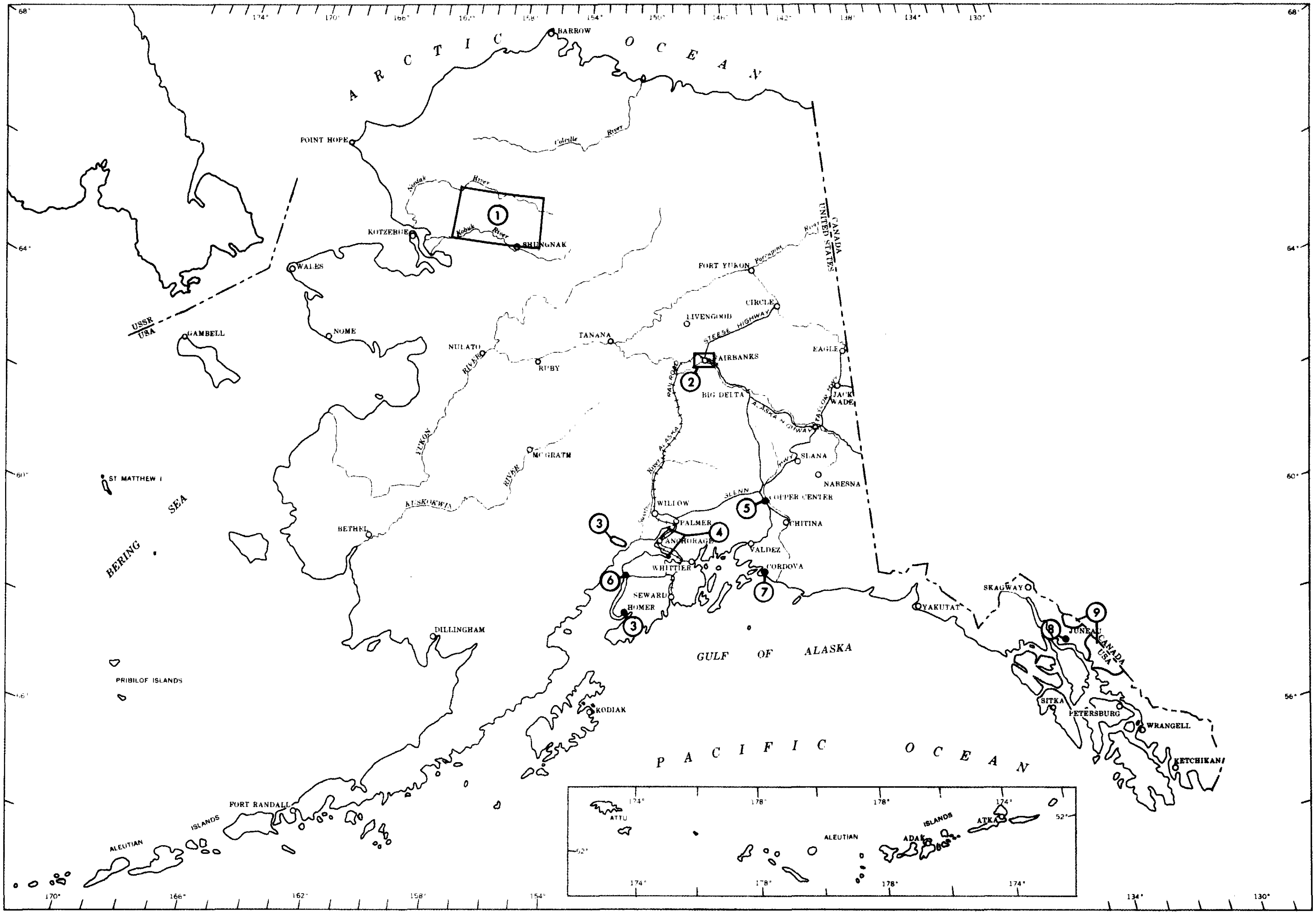

Figure 11.—Map showing location of 1974 field projects of the U.S. Geological Survey and cooperating agencies. The circled numbers key to project discussions in text.

Statewide projects

Name of project	Personnel	Type of work	Area(s)	Cooperating agencies
Quality-of-water stations	R. J. Madison	Monitoring a network of water-quality stations	Statewide	U.S. Army Corps of Engineers, U.S. Forest Service
Ground-water stations	D. A. Morris	Monitoring a network of ground-water observation wells	Statewide	U.S. Air Force
Surface-water stations	Harry Hulsing	Monitoring a network of stream, lake, and estuary gaging stations	Statewide	Alaska Power Administration, National Marine Fisheries Service, U.S. Air Force, U.S. Army Corps of Engineers, U.S. Forest Service, State of Alaska Dept. of Fish and Game, State of Alaska Dept. of Highways, State of Alaska Dept. of Natural Resources
Sediment stations	P. J. Still	Monitoring a network of sediment stations on streams, lakes, and estuaries	Statewide	U.S. Forest Service
Quality-of-water analysis	R. J. Madison	Chemical analysis of water	Statewide	Bureau of Indian Affairs, U.S. Air Force, U.S. Army, U.S. Public Health Service, State of Alaska Dept. of Environmental Conservation
Municipal water-supply investigation	D. A. Morris	Streamflow measurements	Barbara Creek near Seldovia, Bridge Creek near Homer, Monashka Creek near Kodiak	State of Alaska, Department of Natural Resources
Hydrologic environment of the trans-Alaska Pipeline System (TAPS), Alaska	J. M. Childers, J. W. Nauman, C. E. Sloan, L. R. Mayo	Channel surveys, establishment of a periphyton monitoring system, glacier studies	Trans-Alaska Pipeline System route, Prudhoe Bay to Valdez	
Hydrological studies for Alaskan Air Command	R. J. Madison	Water temperature studies, miscellaneous hydrologic studies	Ship Creek	Alaskan Air Command

Name of project	Personnel	Type of work	Area(s)	Cooperating agencies
Water-resources investigations (salmon-rearing sites)	G. A. McCoy	Chemical and biologic sampling	Redoubt Lake, Klawak Lake, Salmon Lake, Kathleen Lake, Hasselborg Lake	State of Alaska, Department of Fish and Game

watershed studies, and providing long-term records by means of which shorter records can be correlated. This will be accomplished by the operation of a network of ground-water observation wells.
Cooperating agencies: U.S. Air Force.

Project: Surface-water stations.
Region: Statewide.
Organization designation: Water Resources Division, Alaska District Office.
Project chief: Harry Hulsing, U.S. Geological Survey, Water Resources District Office, 218 E Street, Anchorage, Alaska 99501; ([907] 277–5526).
Project plans: To provide historic and current year data on (1) streamflow, (2) lake stage and contents, and (3) estuary flow conditions for use in planning and design of water supply and waste disposal systems and in assessing the resulting environmental impacts. A network of complete- and partial-record stations is operated for these purposes.
Cooperating agencies: Alaska Power Administration; National Marine Fisheries Service; U.S. Air Force; U.S. Army Corps of Engineers; U.S. Forest Service; State of Alaska, Department of Fish and Game; State of Alaska, Department of Highways; State of Alaska, Department of Natural Resources.

Project: Sediment stations.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: P. J. Still, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501; ([907] 277–2644 or 2645).
Project plans: To provide information on sediment in streams, lakes, and estuaries by determining (1) summer and winter normal concentrations and the particle size distribution of suspended sediments; (2) sediment-discharge transport curves to assist in evaluating sediment yields; (3) particle-size distribution of bed and bank material; (4) bedload transport; (5) characteristics of glacial sediments; and (6) ranges in turbidity. The information will be obtained from operation of a network of sediment stations.
Cooperating agency: U.S. Forest Service.

Project: Quality-of-water analysis.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: R. J. Madison, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501; ([907] 277–2644 or 2645).
Project plans: Plans include the periodic chemical analysis of water collected at Indian villages, Air Force sites, and at other public water supplies as required to assess the quality of water and changes in the quality that occur with time.
Cooperating agencies: Bureau of Indian Affairs; U.S. Air Force; U.S. Army; U.S. Public Health Service; State of Alaska, Department of Environmental Conservation.

Project: Municipal water-supply investigations.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: D. A. Morris, U.S. Geological Survey, Water Resources District Office, 218 E. Street, Anchorage, Alaska 99501 ([907] 277–5526).
Project plans: Fieldwork during the summer of 1974 will include the continuation of streamflow measurements at Barbara Creek near Seldovia, Bridge Creek near Homer, and Monashka Creek near Kodiak.
Cooperating agency: State of Alaska, Department of Natural Resources.

Project: Hydrologic environment of the Trans-Alaska Pipeline System (TAPS), Alaska.
Region: Statewide, transportation corridor, east-

ern Alaska, Arctic Ocean (Prudhoe Bay) to Pacific Ocean (Valdez).

Organizational designation: Water Resources Division, Alaska District Office.

Project staff: J. M. Childers, project chief, J. W. Nauman, oceanographer, C. E. Sloan, research hydrologist, L. R. Mayo, research hydrologist, U.S. Geological Survey, Alaska District Office, 218 E Street, Anchorage, Alaska 99501 ([907] 277–5526).

Project plans: J. M. Childers will extend his channel geometry studies to small streams in order to establish flood risk zones and evaluate erosion potential. C. E. Sloan will continue the reconnaissance of icings along the pipeline route and attempt to use ERTS imagery and other remote sensing to inventory the larger icings. J. W. Nauman will establish a periphyton monitoring system in the northern half of the pipeline route. L. R. Mayo will continue to monitor glacier-dammed lakes near the pipeline route and will continue research into the surge mechanics of Black Rapids Glacier. Aerial photographic techniques will be continued in order to monitor glacier activity along the pipeline corridor.

Project: Hydrological studies for Alaskan Air Command.

Region: Statewide.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: R. J. Madison, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 277–2644 or 2645).

Project plans: Continuing cooperative work with Alaskan Air Command will include temperature studies of the water in Ship Creek near the power plant and miscellaneous hydrologic studies as required.

Cooperating agency: Alaskan Air Command.

Project: Water-resources investigations (salmon-rearing sites).

Region: Statewide.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: G. A. McCoy, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 277–2644 or 2645).

Project plans: Field plans call for continued lake reconnaissance work in south-central and southeastern Alaska. Two trips are currently being planned to study Redoubt Lake near Sitka, Klawak Lake near Klawock village, Salmon Lake on Prince of Wales Island, and Kathleen and Hasselborg Lakes on Admiralty Island where chemical and biological sampling will be undertaken.

Cooperating agency: State of Alaska, Department of Fish and Game.

NORTHERN ALASKA

Project: Ipewik-Kukpuk; Brooks Range.

Region and map key: Northern Alaska (1).

Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.

Project chiefs: I. L. Tailleur, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2254), and G. H. Pessel, Alaska Division of Geological and Geophysical Surveys, 3001 Porcupine Drive, Anchorage, Alaska 99501 ([907] 279–1433).

Project plans: Shared Alaska and Federal investigations of the metamorphic and mineralized rocks in the southwestern Brooks Range will continue westward from the 1973 limit of fieldwork in the Baird Mountains. Mapping & sampling objectives are: (1) extensions, from southwestern Ambler River into eastern Baird Mountains quadrangles, of most rock units and possibly of the assemblage that bounds the rich copper concentrations to the east; (2) a sharp southward deflection of structural grain that includes the Klery Creek placer-gold district and mineral shows along the Salmon River; and (3) adjoining part of a broad, presumably allochthonous, terrane of mid-Paleozoic carbonate that is mineralized locally. Plans include study of rock properties by geophysical methods. Unfortunately, fieldwork will be resumed without a desirable synthesis of last year's results, which has been precluded by other demands during the office season.

State personnel are G. H. Pessel and an assistant; Geological Survey personnel are W. P. Brosgé, I. L. Tailleur, and an assistant; Tailleur will serve his turn as field party chief. A jet helicopter under State contract will be operated out of Kiana from the first week in June to the first week in August. As in 1973, R. B. Forbes, D. L. Turner, and J. R. Cardin from the University of Alaska will be supported in detailed studies along transects of the metamorphic belts. To help with special aspects and in anticipation of future work in the province, visits by Michael Churkin, Jr., Warren Hamilton, and P. K. Theobald of the Geological Survey have been tentatively scheduled. Mailing address: c/o U.S. Geological Survey, Kiana, Alaska 99749 until August 1; thereafter c/o Alaska Geological and Geophysical Surveys, 3001 Porcupine Drive, Anchorage, Alaska 99501.

EAST-CENTRAL ALASKA

Project: Preconstruction base line biological water quality of the Chena and Little Chena Rivers.
Region and map key: East-central Alaska(2).
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: G. A. McCoy, U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 277–2644 or 2645).
Project plans: Tentative plans are to continue operation of stream-gaging stations on the Little Chena River near Fairbanks and the Chena River near North Pole (fig. 12). In addition, water-surface profiles will be determined, at prescribed flows, for a 2-mile reach encompassing the proposed dam site. Sediment samples will be collected monthly, and some measurements of bedload transport also will be obtained. Water samples will be collected for chemical analysis. Water levels in shallow observation wells along the proposed dam axis, in the Tanana levee, and in drains or borrow areas will be measured at least monthly. A report on baseline biological water quality of the Chena and Little Chena Rivers, now in review, will be completed.
Cooperating agency: U.S. Army Corps of Engineers.

SOUTHERN ALASKA

Project: Petroleum geology of Cook Inlet basin.
Region and map key: Southern Alaska (3), parts of Tyonek, Anchorage, Kenai, and Seldovia quadrangle.
Organizational designation: Geologic Division, Office of Energy Resources, Branch of Oil and Gas Resources.
Project chief: John C. Maher, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2116 or 2117).
Project plans: This project may be recessed June 30, 1974. No fieldwork is planned for 1974.
Cooperating agency: State of Alaska, Division of Geological and Geophysical Surveys.

Project: Geohydrology of the Anchorage area, Alaska.
Region and map key: Southern Alaska (4), Anchorage, Alaska, the Greater Anchorage area extending from Cook Inlet on the west to the crest of the Chugach Mountains and Lake George on the east and from Turnagain Arm on the south to Knik Arm on the north, 1,800 sq. mi.
Organizational designation: Water Resources Division, Alaska District Office.
Project staff: R. S. George, project chief, G. S. Anderson, hydrologist, Chester Zenone, hydrologist, L. L. Dearborn, hydrologist, and D. E. Donaldson, chemist, U.S. Geological Survey, Anchorage Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 279–1563).
Project plans: The continuing study of the geohydrology of the Anchorage areas has two main objectives: (1) monitor natural hydrologic characteristics and measure the impact of man's activities on the water resources of the area, and (2) provide basic information necessary for the economical and orderly development of additional water supplies.

To accomplish this, hydrologic studies currently include test drilling preparatory to drilling several production wells in the Anchorage area, continuing study of the feasibility of artificial recharge using infiltration ponds or wells, continued collection of basic data on surface and ground water, continued study of the quality of water underlying sanitary landfill sites, and updating and utilization of the analog model of the Anchorage hydrologic system.
Cooperating agencies: City of Anchorage and the Greater Anchorage Area Borough.

Project: Water-resources investigations of the Copper Center-Summit Lake area, south-central Alaska.
Region and map key: Southern Alaska (5).
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: C. E. Sloan, U.S. Geological Survey, Alaska District Office, 218 E Street, Anchorage, Alaska 99501 ([907] 277–5526).
Project plans: Plans for this project include a hydrologic appraisal of water availability and

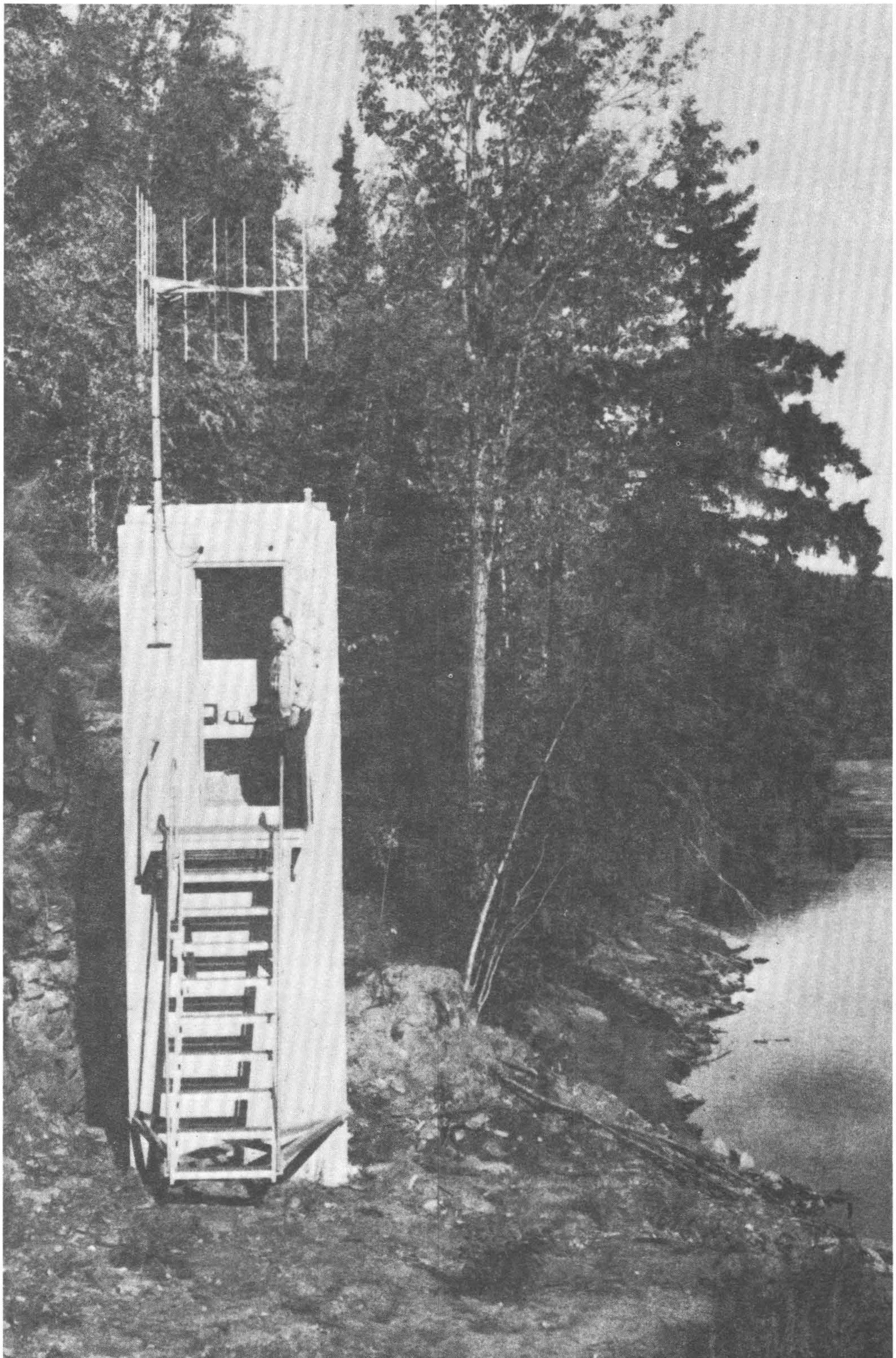
FIGURE 12.—Telemetering water stage station in the Fairbanks flood warning network, Chena River.

Southern Alaska

Name of project	Personnel	Type of work	Area(s)	Cooperating agencies
Petroleum geology of Cook Inlet basin	J. C. Maher	Project may be recessed	Parts of Tyonek, Anchorage, Kenai and Seldovia quadrangles	State of Alaska, Division of Geological and Geophysical Surveys
Geohydrology of the Anchorage area, Alaska	R. S. George, G. S. Anderson, C. Zenone, L. L. Dearborn, D. E. Donaldson	Test drilling, various hydrologic studies	Anchorage area	City of Anchorage and the Greater Anchorage Area Borough
Water-resources investigations of the Copper Center-Summit Lake area, south-central Alaska	C. E. Sloan	Water-quality sampling, ground-water inventorying	Copper Center area	State of Alaska, Department of Environmental Conservation
Water-resources investigations of the Kenai Peninsula Borough area, Alaska	G. S. Anderson, D. R. Scully	Monitoring observation wells, stream-gaging stations, and lakes	Kenai Peninsula Borough	City of Kenai and the Kenai Peninsula Borough
Hydrology of the Cordova area, Alaska	G. S. Anderson	Water-quality studies	Cordova, Eyak Lake	City of Cordova

quality as related to the industrialization and urbanization activities in and along the trans-Alaska pipeline corridor. During the 1974 field season, trips will be made in late winter and midsummer to sample the quality of streams and Pippin and Summit Lakes. An inventory of sources and quality of ground water will also be conducted.

Cooperating agency: State of Alaska, Department of Environmental Conservation.

Project: Water-resources investigations of the Kenai Peninsula Borough area, Alaska

Region and map key: Southern Alaska (6), the Kenai Peninsula Borough.

Organizational designation: Water Resources Division, Alaska District Office.

Project staff: G. S. Anderson, project chief, and D. R. Scully, hydrologist, U.S. Geological Survey, Anchorage Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 279–1563).

Project plans: The investigation will continue with emphasis on monitoring the long-term effects of ground-water development. This includes measurements at 10 observation wells, 1 stream-gaging station, and 9 lakes. It also requires continuing inventory of major industrial and municipal ground-water withdrawals.

In addition, the U.S. Geological Survey will cooperate in the continuing test-drilling program to define further the extent of the Beaver Creek aquifer.

Cooperating agencies: City of Kenai and the Kenai Peninsula Borough.

Project: Hydrology of the Cordova area, Alaska.

Region and map key: Southern Alaska (7), Cordova area.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: G. S. Anderson, U.S. Geological Survey, Anchorage Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501 ([907] 279-1563).

Project plans: Continuing work at Cordova includes the initiation of water-quality studies of Eyak Lake and the construction of an analog model of the Cordova water-supply well field. The model will be based on aquifer testing data to be acquired.

Cooperating agency: City of Cordova.

SOUTHEASTERN ALASKA

Project: Water resources of the City and Borough of Juneau, Alaska.

Region and map key: Southeastern Alaska (8), Juneau, Alaska.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: G. O. Balding, U.S. Geological Survey, Juneau Subdistrict Office, 441 Federal Building, 710 West 9th Street, Juneau, Alaska 99801 ([907] 586–7216).

Project plans: The Water Resources Division in cooperation with the Juneau City-Borough plans to continue its water-resources study of Mendenhall Valley, particularly the eastern part. As part of this program, the City-Borough has scheduled during late spring or early summer the test drilling of an 8-inch well in this area to assess the reported high potential of obtaining an adequate supply of ground water. This assessment involves a thorough testing of the well, water sampling, and hydrologic evaluation preparatory to development.

Cooperating agencies: City and Borough of Juneau, Alaska.

Project: Tracy Arm-Fords Terror Wilderness Study Area.

Region and map key: Southeastern Alaska, Taku River and Sumdum 1:250,000 map-areas (9).

Organizational designation: Geologic Division, Office of Mineral Resources, Wilderness Study Program and Branch of Alaskan Geology.

Project chief: D. A. Brew, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025 ([415] 323–8111, ext. 2178).

Project plans: During the months of July and August, a joint Geological Survey–Bureau of Mines team will continue the mineral resource potential evaluation started last season in the 1,500-square-mile study area. The evaluation includes reconnaissance geologic mapping, intensive geochemical sampling of bedrock and stream sediments, mapping and sampling of known prospects, aeromagnetic mapping, analysis of the results of these efforts, and preparation of a report of the findings. The evaluation is part of the U.S. Forest Service study of the suitability of the project area for classification in the National Wilderness System established by the Wilderness Act of 1964.

The team will include D. A. Brew, A. B. Ford, D. A. Grybeck, and one other geologist, together with assistants C. J. Nutt and C. Carlson from the Geological Survey and J. Still and A. L. Kimball, mining engineers, and assistants M. A. Parke and F. Smith from the Bureau of Mines. The work will be based on the U.S.G.S. R/V *Don J. Miller II* and will be supported by contract helicopter.

Radio contact will be through Juneau Marine radiotelephone operator to the *Don J. Miller,* call letters WZ 2103. The mailing address will be: U.S. Geological Survey, c/o Channel Flying, Inc., R.R. 3, Box 3577, Juneau, Alaska 99801.

Cooperating agency: U.S. Bureau of Mines.

SUMMARY OF IMPORTANT RESULTS, 1973

The Geological Survey prepares annual summaries of the principal technical results of its investigations, and about a year after preparation these summaries are published in the Professional Paper series under the title, "Geological Survey Research." The 1973 summary of important results in Alaska is reproduced in this section in the form prepared for publication in the Professional Paper series.

Significant new scientific and economic geologic information has resulted from many field and topical investigations in Alaska during the past year. Discussions of the findings are grouped under seven subdivisions corresponding to six major geographic regions and a general, statewide, category. Locations of the study areas are shown in the accompanying index map of Alaska (fig. 13).

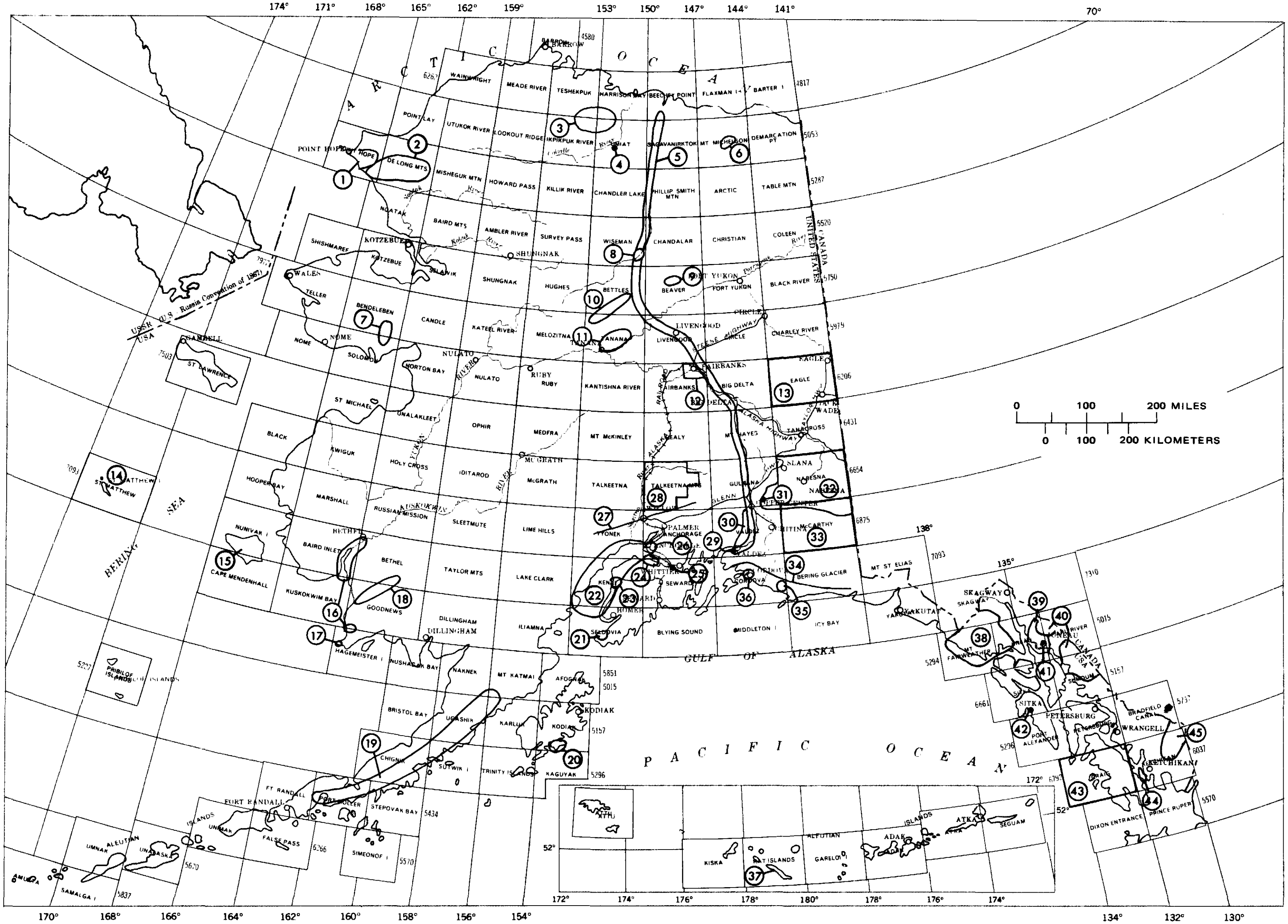

FIGURE 13.—Map showing locations of studies discussed in the summary of important results, 1973. The circled numbers key to project discussions in text.

Progress toward a metamorphic facies map of Alaska
By David A. Brew

A Branch of Alaskan Geology Committee (D. A. Brew, B. Csejtey, A. B. Ford, H. L. Foster, T. P. Miller, and H. N. Reiser) is compiling a 1:2,500,000-scale metamorphic facies map of Alaska from existing information and from current Alaskan Branch field studies. Metamorphic mineral locality information is being collected in machine-processable form and will be available for retrieval according to several criteria. The map is intended as a contribution to (1) a Map of the Metamorphic Belts of the Word sponsored by the Commission for the Geological Map of the World of the International Geological Congress and the International Union of Geological Sciences, and to (2) the joint U.S. Geological Survey–State of Alaska Geological Survey publication on the Geology of Alaska. The map shows metamorphic facies, facies groups, facies series, selected isograds, and granitic rock bodies in the style of the IUGS suggested metamorphic facies map explanation (1967). Preliminary compilation of regional metamorphic facies maps at 1:1,000,000 scale for all the state is now nearly complete, as is coding of background metamorphic mineral locality information.

New Alaskan mineral exploration rationale
By Ernest H. Lathram

Studies of Nimbus and ERTS imagery by E. H. Lathram resulted in the formulation and strengthening of an hypothesis that mineralized areas in Alaska may be spatially related to a regional set of northeast- and northwest-trending linears—many previously unrecognized—that possibly reflect crustal fractures (Lathram and Gryc, 1973; Lathram and others, 1973 fig. 14). Linears representative of this set are clearly apparent on an ERTS mosaic of the Yukon-Tanana Upland east of Fairbanks.

According to the conventional metallogenic hypothesis, areas deemed favorable for occurrence of various types of ore deposits are assumed to describe arcuate belts through southern and central Alaska, consonant with the arcuate distribution pattern of stratigraphic, orogenic, and orographic features. The new hypothesis postulates that favorable areas would form belts parallel to major northwest- and northeast-trending fractures, and deposits would be more abundant where such fractures crossed. For example, using the conventional concept one would expect to find copper-molybdenum porphyry deposits in an arcuate belt south of the Denali fault, whereas according to the new hypothesis such deposits could be found in two northeast-trending belts that could extend northeast of the Denali fault (see fig. 14).

Additional information substantiating the new hypothesis has now been received (E. R. Chipp, written commun., 1973). In 1970 and 1971, independent mineral exploration utilizing northeast and northwest fracture systems as a guide resulted in the discovery of a number of copper-molybdenum deposits in the Tanacross quadrangle in the Yukon-Tanana Upland, two of which are currently being explored by drilling. These deposits lie northeast of the Denali fault.

Although these deposits were not found directly by use of ERTS imagery, their discovery in an area and in a geologic setting predictable by the new hypothesis developed solely through use of space imagery leads to two important conclusions:

1. The new hypothesis can be profitably used as an additional exploration rationale by the mineral resource industry.
2. ERTS imagery can be employed effectively to improve existing concepts of mineral resource potential and develop new ones.

Hydrological studies for Alaskan Air Command
By R. J. Madison

The continuing cooperative program with the Alaskan Air Command has resulted in a report by the Regional Geophysics Branch of the U.S. Geological Survey on the Cape Newenham Air Force Station, southwestern Alaska (loc. 17, fig. 13). In this study, geophysical techniques including magnetic, seismic, and resistivity were used in the investigation of the occurrence of ground water. According to Hans D. Ackermann, the coincidence of a fractured bedrock zone (seismic interpretation) and a zone of maximum bedrock weathering (electrical resistivity interpretation) suggests a site favorable for ground-water exploration through test drilling.

Another study has been begun to determine the effect of the disposition of heated power-plant effluent water on Ship Creek in Anchorage. This study is continuing with the collection of continuous records of flow and temperature of the thermal discharge. Evaluation studies are also being made of an ERTS data-relay system installed at the site.

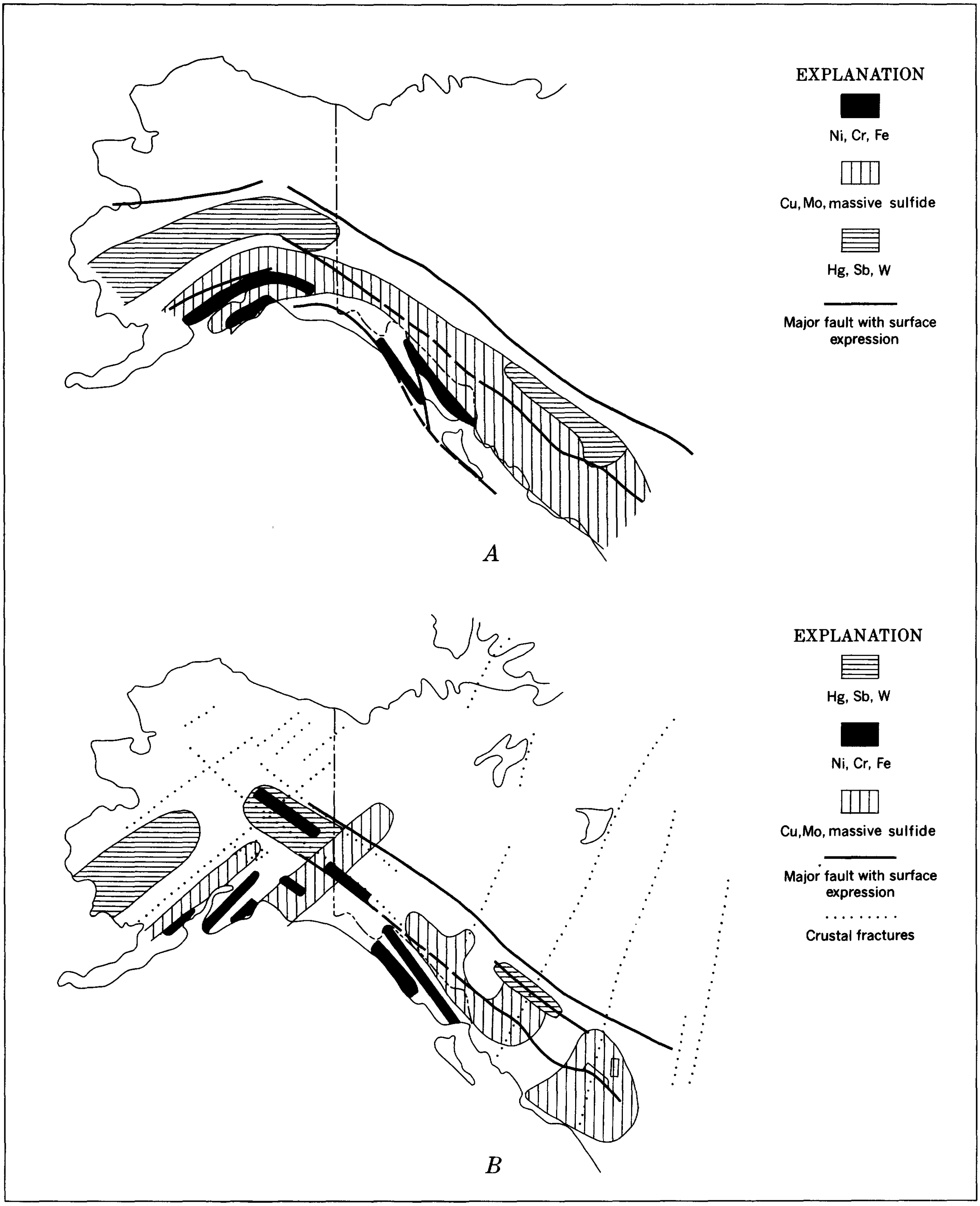

FIGURE 14.—Areas of Alaska and western Canada considered favorable for location of deposits of selected metals based on extrapolation of geologic conditions at known occurrences. *A*, Conventional concept guided by north-convex arcuate distribution of lithologic belts. *B*, Postulated alternative, assuming that linears seen on Nimbus IV image are crustal fractures and have influenced mineralization.

A final report (in preparation) on corrosion properties of water supplies at Air Force sites throughout Alaska by H. H. Heyward has related corrosion to four types of water.

Hydrologic environment of the Trans-Alaska Pipeline System (TAPS) Alaska
By J. M. Childers.

Channel surveys at nine sites in south-central Alaska were used to compute bankfull discharge and maximum evident flood discharge. The results were compared with flood-discharge characteristics estimated from gaging-station records and regional multiple regression equations. Bankfull discharge was found to be a fair estimate of the 50-year flood (average recurrence interval of 50 years).

Hydrologic environment of the Trans-Alaska Pipeline System (TAPS) Alaska (Aquatic biological monitoring along the trans-Alaska pipeline corridor).
By J. W. Nauman

A determination of preconstruction water-quality characteristics and benthic invertebrates at selected lake and stream sites along the Alaska pipeline corridor (loc. 5) using artificial substrate samplers was made by J. W. Nauman and D. R. Kernodle. Three kinds of substrates (multiplates and unlined and lined rock-filled baskets) were used at 41 sites. Lined rock-filled baskets and multiplate samplers collected six and two times as many organisms as unlined baskets, respectively. Lined rock-filled baskets also collected on the average two more taxa per sample than unlined rock-filled baskets. Other observations at Jackson Point at Port Valdez (a marine site) using the same sampling procedures indicate that each sampler type collected approximately the same major groups of organisms (Mollusca, Crustacea, and immature insects). At Jackson Point, lined rock-filled baskets and multiplate samplers collected on the average nine and two times as many organisms as unlined baskets, respectively. Lined rock-filled baskets also collected on the average four more taxa per sample than the other two types. Collectively the three different types of samplers showed that Mollusca (Pelecypoda and Gastropoda) were more abundant during summer and fall while Crustacea (Copepoda) were more abundant during winter and spring. Laboratory analysis for unlined and lined rock-filled baskets require two to three times more time than multiplate samplers.

Water-resources investigations (salmon-rearing sites)
By G. A. McCoy

In fiscal year 1974 a program to collect hydrologic data in south-central Alaska and provide information on the quantity and quality of ground and surface water was started in cooperation with the State of Alaska, Department of Fish and Game. Stream-gaging and water-temperature recording stations were established at Tutka Lagoon Creek near Homer, East Creek near Dillingham, Snake River near Dillingham, and Humpback Creek near Cordova. A number of miscellaneous measurements were also made during winter ice cover to determine low winter flow and water temperature at these stations. In addition, discharge measurements to determine low flows were made at the following sites: Meadow Creek at Anchorage-Fairbanks Highway, Meadow Creek at Beaver Lake Road, near Big Lake, Fish Creek at Big Lake outlet, Fish Creek at Goose Bay Road, Crooked Creek at Old Sterling Road, Hidden Lake outlet at Skilak Lake Road, and Jean Lake outlet at Skilak Lake Road.

Alaska geothermal study
By Thomas P. Miller

Completion of preliminary field and lab studies on the thermal springs of central and western Alaska by T. P. Miller and Ivan Barnes indicates that these springs which occur chiefly along the contacts of granitic plutons are the result of deeply circulating meteoric water. They are likely to have relatively low reservoir temperatures and recharge characteristics as compared to geothermal systems presently being exploited but may have potential for small-scale and local production of electricity and heat.

Reconnaissance studies were begun on the Quaternary volcanic centers between Pavlof Volcano and Becharof Lake on the Alaska Peninsula (loc. 19). Thick dacitic ash flow units were mapped at several calderas and preliminary geologic maps of several of the centers are being prepared. Mapping in the western Wrangell Mountains in cooperation with D. H. Richter and R. L. Smith resulted in an increased knowledge of the recent volcanic history of the large Wrangell volcanic pile. Mt. Drum (loc. 31), a dome-ringed stratovolcano, in particular may have significant geothermal potential. The site of the volcanic eruption that deposited 8 km^3 of rhyodacite ash over eastern Alaska and northwestern Canada approximately

1,400 years ago was visited and sampled on the Klutlan Glacier in the eastern Wrangell Mountains.

New approach to computer-assisted field methods
By Travis Hudson, Gerald Askevold, and George Plafker

A new system for recording, storing, retrieving, and updating field data was developed and extensively tested in 1973 by personnel of the Alaskan geologic earthquake hazards project. Procedures for recording field notes were designed with the following key factors taken into consideration: (1) project needs must take precedence over computer technology; (2) transitions made by project geologists from previous notetaking techniques must be as effortless as possible; and (3) the flexibility of traditional notetaking procedures must be preserved. The resulting notetaking scheme combines a dual system of (a) standardized entries for general and recurring information such as station number, location, subject, and samples, combined with (b) traditional free-text entry for information of a more qualitative or descriptive nature.

Field data collected using this method during regional studies in the eastern Chugach Mountains, Alaska, provided a data base for testing several flexible computer retrieval systems that allow the geologist to create and use data files. Aspects of these systems that were evaluated include: (1) mechanisms for creating complete files of field data; (2) data retrieval procedures for utilization of such files; and (3) updating capabilities necessary to the maintenance of a useful and dynamic information system.

Test results show that computer systems that support random access retrieval combined with interactive ("conversational") text editing can greatly facilitate use of geologic data. It is essential that the user-geologist be involved in the design or selection of these systems to guarantee their maximum usefulness. Because storage and retrieval systems are now becoming inexpensive, easy to use, and require no previous experience on the part of the geologist, they should find increasing acceptance for many geologic applications.

Gravity lows suggest small Tertiary basins along Interior River systems
By David F. Barnes

Fieldwork during the summer of 1973 completed a 10-year program of river traverses that provide a skeletal network of detailed gravity traverses now covering most of the state. The primary objective of these traverses was the preparation of a state gravity map, but the data were also expected to indicate the presence or absence of any sedimentary basins beneath the large alluvial flats that cover a significant proportion of the Alaskan interior. The results in the past year seem to emphasize many of the results of the previous 10 years. Although the gravity lows suggesting such basins seldom have areal extents comparable to the topographic basins which they occupy, the abundance, similar magnitudes, and scattered locations of the anomalies are interesting.

Gravity maps of data from the Medfra and McGrath quadrangles were released during the past summer (Barnes, 1973), and reveal a pair of small gravity lows with magnitudes of about 35 milligals which together extend about 40 km (25 mi.) southwest of the village of Medfra. An unconfirmed report of an outcrop of Tertiary sedimentary rocks near the center of the northern low suggests small sedimentary basins as probable causes of the lows. Further downstream on the Kuskokwim the summer fieldwork revealed a similar gravity low occupying the alluvial flats southeast of Aniak and near an outcrop of gravels reported by Cady, Wallace, Hoare, and Webber (1955) to have a probable Tertiary age. These gravity lows in the Kuskokwim River drainage resemble both in size and magnitude many other small gravity lows that have previously been discovered in other Alaskan drainage basins.

The first of these lows was reported by Barnes (1961) and occupies part of the Tanana River drainage near the village of Minto. Later exploration of the anomaly included a test hole that revealed less than 1 km of sediments or considerably less than suggested by the initial gravity data. This result may indicate that many of the sediments within these basins have very low densities, but the test hole is also believed to have been drilled on a local high within the main gravity low. A partial list of other gravity lows suggesting similar sedimentary basins might include the following: three fairly large lows in the Yukon Flats (Barnes, 1971), a long narrow low along the Yukon River between Tanana and Ruby, another small low in the alluvial flats south of Galena (Barnes, 1969), two lows in the Selawik-Kobuk drainage, a poorly defined low in the Fish River flats of the Seward Peninsula (Barnes, 1971), and an anomaly that forms part of an extraordinary gravity feature in the Noatak Flats. Almost all of these features show gravity relief of 35 to 50 milligals, and most appear to have at least one faulted boundary. Their similar magnitudes in widely scattered parts of Alaska suggest similarity in the magnitudes and processes of past Tertiary structural warping in the Alaskan interior.

NORTHERN ALASKA

Northern Alaskan-Canadian boundary reconnaissance
By H. N. Reiser

During July 1 to July 5, 1973, a geologic reconnaissance both east and west of the most northern portion of the Canadian-Alaskan boundary was completed by D. K. Norris of the Canadian Geological Survey and H. N. Reiser of the U.S. Geological Survey. This work resulted in the recognition of the extension into Canada of the major fault separating the belt of mafic volcanic and carbonate rocks of Cambrian age from the underlying rocks to the north. Previously along its eastern part this contact was regarded as an unconformity. On-site comparisons of the Triassic, Jurassic, and Lower and Upper Cretaceous sections over a distance in excess of 300 km (186 mi.) were made. These confirmed the legitimacy of carrying the formation names of Shublik and Kingak to at least portions of these respective Triassic and Jurassic sections in Canada. Coarse Upper Cretaceous conglomerates (Moose Channel Formation equivalent) mapped on lower Trial River in Canada are lithologically very similar to an exotic thick sequence of unfossiliferous rocks occuring 80 km (50 mi.) west of the boundary on the Jago River. However, here these rocks are regarded as Lower Cretaceous, so the problem remains to be resolved.

Chukchi-Beaufort Sea Continental Shelf
By Arthur Grantz

The 1973 field season saw completion of reconnaissance geophysical profiling of the Alaskan continental shelf north of Bering Strait. About 450,000 km^2, from the Siberian coast to the MacKenzie delta and from the Alaskan coast to the 74th parallel, were surveyed since the project began in 1969. During the 1973 field season, working from the U.S. Coast Guard icebreaker *Burton Island,* the Project recorded 4,500 km (2,796 mi.) of single channel seismic reflection, magnetic and gravity profiles, and seven sonobuoy refraction profiles.

The 1973 work found that the continental shelf east of Point Barrow is constructional and, in its upper part, consists of thick Cretaceous and Tertiary sedimentary rocks on the north flank of the Barrow arch. From Point Barrow to about 145° W. these beds dip gently, and in general uniformly, seaward with a local flattening or arching under the outer shelf. East of 146° W. long., the shelf structure is dominated by large amplitude folds in Tertiary rocks. These folds are parallel to the north-northeast-striking Marsh anticline of the North Slope. Locally they extend to the continental slope, where further investigation was blocked by pack ice.

C. J. Yorath of the Geological Survey of Canada joined Arthur Grantz, Tor Nilsen, Byron Ruppel, and Graig McHendrie on the *Burton Island* for the 1973 field season and will participate in report preparation. They were assisted by Jeff Phillips, Chris Cramer, Jack Lee, Jim Nicholson, Steve Wallace, Gene Foord, and George White.

ERTS images improve geologic mapping
By E. H. Lathram

ERTS images are being used to complete a revised 1:1,000,000-scale map of northern Alaska by E. H. Lathram. For example, in the earlier compilation (Lathram, 1965), the lowland area of the Ipewik and Kukpuk Rivers (loc. 1) is largely devoid of structural data. Despite several seasons of exploration by private companies, and by the U.S. Geological Survey, the ubiquitous tundra cover and paucity of outcrops along the shallow streams and rivers prevented recognition of the distribution of structural elements in this area. Interpretation of conventional aerial photographs revealed little additional data. ERTS images, however, display a startlingly clear and detailed representation of the area (Lathram and others, 1973, fig. 2). The new map compilation of this area shows clearly the complexity of structure revealed by the ERTS image and the pronounced difference between the structural pattern in this area and that pattern in the area of strata of comparable age to the north and east. This change in structural complexity may be due to oroclinal bending around an axis trending northeast through the lowlands (Tailleur and Brosgé, 1970) or, more probably, to the superimposition of a western and younger belt of east-directed thrust faults upon an eastern and older belt of north-directed thrust faults (Grantz and others, 1970). Recognition of the structural complexity and determination of its cause are critically important in determining the potential for petroleum accumulations at depth in the area.

Enlargements of ERTS images to a scale of 1:250,000 are also being used in medium-scale geologic mapping. In the Kukpuk-Ipewik Rivers area of northern Alaska, compilation of known geology on the ERTS images has permitted extrapolation of data into unmapped areas and has resulted in the recognition of structural and stratigraphic anomalies that suggests new interpretations of the geology (Tailleur, in Gryc and Lathram, 1973). In field mapping in 1973, W. P. Brosgé, I. L. Tailleur, and others successfully used ERTS images to determine the location of lithologic contacts between successive field stations (Tailleur, oral commun. 1973). G. Plafker, R. L. Detterman, and others employed ERTS images in field studies of the location and continuity of major faults in southern Alaska, as a part of the U.S. Geological Survey's Earthquake Hazards Reduction Program. The images were particularly useful in mapping in the snowfield areas bordering the Gulf of Alaska. Not only is the location of field observations more easy and accurate in the ERTS image than on the most recent topographic map, but the distribution of perennial snow is more true on the near real-time image than on the more than 10-year-old map (G. Plafker, oral commun., 1973).

Western Brooks Range
By I. L. Tailleur

Even though no organized fieldwork in the western De Long Mountains (loc. 2) has been possible since 1968, continued cooperation with private exploration adds to public knowledge. Field-checking by helicopter, provided by Standard Oil Company of California, afforded three important observations in 1973.

I. L. Tailleur sampled two facies of the Mississippian Lisburne Group, from grossly superposed tectonic units, in which A. K. Armstrong identified diagnostic fossils. One facies forms a thin layer of grainstone and wackestone carbonate sporadically exposed at the base of a folded broad allocthonous sheet on Cretaceous and older subthrust units. Although the limestone areally underlies the detritus-rich Utukok Formation, it lithogenetically resembles the Kogruk Formation gradationally above the Utukok. One sample locality lies at the foot of a ridge from which Armstrong described (1970) an 1,800-foot thick section (62C–15) of the Kogruk. Corals, foraminifers, and algae suggest a Meramecian age, possibly representing Mamet's endothyroid zones 14–15. Although the Kogruk has not been thoroughly zoned locally, the fossils seem no older than others from that formation. The thin layer would thus represent another broad thrust sheet instead of development of the Kogruk depositional environment before deposition of the Utukok Formation.

The other samples with diagnostic fossils represent the so-called "black facies" that makes up the structurally lowest exposures of the Lisburne Group in the region. Dark-colored packstone interbedded subordinately with lime mudstone contains foraminifera and algae indicative of a Late Mississippian, zone 11–13 age. They are the first faunal evidence for the age of the facies across the headwaters of the Wulik River and they suggest a more precise biostratigraphic age than unreported fossils collected from the facies along the upper Kukpuk River in 1963. In the latter area, black mudstone above dark-colored carbonate mudstone yielded crushed bellerophontid gastropods that E. L. Yochelson thought might represent a Late Mississippian to Early Pennsylvanian age, and a concretion from clay shale contained a cephalopod identified by MacKenzie Gordon, Jr., as apparently the first record of *Phacoceras* sp. in this hemisphere and which, in Europe, occurs across an interval that includes equivalents to the Meramecian-Chesterian (Late Mississippian) boundary. A Late Mississippian age for these low-energy, possibly northernmost deposits may constrain the oil and gas potential of the Lisburne Group in the subsurface to the north.

Further investigation of remnant mafic and ultramafic ophiolitelike complexes in the western Brooks Range (U.S. Geol. Survey, 1973, p. 64–65) was limited to a single landing near the apices of the large gravity and magnetic anomalies east of the lower Noatak River (Barnes and Tailleur, 1970). In addition to the serpentinite that had been observed in the vicinity in 1966, rubble consists of gabbroic and more mafic phases as well as fragments of a very coarse grained black-amphibole and white-feldspar pegmatitic phase. These lithologies confirm Barnes' inference that the anomalies reflect rocks denser than the shallow-seated mafic rocks dominant in previous observations of the belt of igneous rocks across the west plunge of the Baird Mountains.

A chromite claim in the vicinity, recorded in 1954, and the presence of similar rock types in ultramafic layers or sheets synformally upon terrane of the shallow-seated phases in the Iyikrok Mountain, Avan River, Misheguk Mountain, and Siniktanneyak Mountain complexes in the southern De Long Mountains to the west, north, and east suggest that bodies producing the anomalies could be ultramafic rock.

Possible new Alaskan oil target
By E. H. Lathram

Examination of ERTS image 1004–21395 by W. A. Fischer and E. H. Lathram revealed hitherto unrecognized lineations in Coastal Plain lakes north of Umiat, Alaska (loc. 3). Comparison of the trend of these lineations with available geologic, magnetic, and gravity data suggests that concealed structures exist in this area that may be favorable for concentrations of gas in shallow strata and of oil in deeper strata at or near basement (Fischer and Lathram, 1973).

Study of ERTS images of northern Alaska acquired in 1973 not only substantiates observations made of the Umiat area but also shows that the east-trending lineation is prominent throughout the Coastal Plain to the east, extending as far as the Canning River (Lathram, 1974b). This area includes Prudhoe Bay and other recently discovered oil fields.

The newly observed lineation is prominent only in the area east of the Ikpikpuk River. This restriction in the area characterized by the east-trending lineation lends support to the conclusion that it reflects buried geologic structure. In addition, the recognition of the lineation in the Coastal Plain between the Colville and Canning Rivers substantially increases the area in which the lineation may provide an additional guide to the exploration of oil.

Identification of vehicular scars on Arctic tundra
By E. H. Lathram

Study of ERTS images by E. H. Lathram (1974a) resulted in identification of severe vehicular scars formed in the tundra near Umiat, Alaska (loc. 4), during the 1945–52 period of exploration. This suggests that, if such scars are of an intensity or have spread to a dimension such that they can be resolved by ERTS sensors (>20 meters), they can be identified and their state monitored by the use of ERTS images. Field review of the state of these vehicular scars in the Umiat area by R. L. Detterman and John Koranda (Lawrence Livermore Laboratory) indicates that all are revegetating at varying rates and are approaching a stable state.

The extent of scarring depends on the season of occurrence, substrate (particularly with respect to water content, that is, ice-wedge occurrence), degree of vegetation removal, and slope. Trails made by small tracked vehicles such as weasels and bombardiers have left little trace. LVT trails are most intensely scarred. "Cat-tracks", with little or no blading and used only in winter, do not cause extensive scars. The scars presently visible from the air will remain visible from the air for a few years after the physical effects of the disturbance have been healed. The principal indicator of trails is the presence of grasses in the tracks that are not present in surrounding terranes, giving the tracks a greener appearance. Old trails are difficult to see on the ground at present and in 5 to 10 years will probably not be visible on the ground. The most striking example of scarring occurs on the ridge north of Umiat. Here a heavily used "cat" trail, bladed bare of vegetation, leads up a 10° slope to the site of several drill holes. Not only was the trail bladed, but it was also used summer and winter during the 1945 to 1952 period and crosses the exposed area of a bentonitic shale formation. The trail has spread to a depression on the slope about 150 feet wide and up to 15 feet deep. This scar was noted on Band 5 ERTS images. Revegetation is proceeding, with felt-leaf willow, equisetum, and a grass (stipa) not noted elsewhere, indicating the onset of healing, although much more slowly than elsewhere.

Study of images of the area to the south and east of Umiat, where exploration activity has occurred since 1960, indicates that younger scars may be more apparent on ERTS images than the older scars in the Umiat area. To date these studies have all been visual inspection of imagery. No attempt has been made yet to employ computer enhancement techniques to identify less severe scars or changes in scars.

Ostracodes from Northern Alaska
By I. G. Sohn

A study of Mississippian ostracodes from northern Alaska is currently underway. One group, the Paraparchitacea, has been monographed and published (Sohn, 1971), and about 75 percent of the remaining groups have been photographed. The ostracode assemblages from northern Alaska appear to be more closely related to those described from Russia than to those known from western Europe and the conterminous United States.

Late Triassic marine ostracodes in samples from a section of the Shublik Formation on Fire Creek, Mount Michelson quadrangle (loc. 6), that was measured by R. L. Detterman, are also being studied. Preliminary picking yielded a well-preserved assemblage that includes species of *Bairdia, Hungarella,* and as yet undetermined taxa.

Pennsylvanian beds in Lisburne Group; south-central Brooks Range
By W. P. Brosgé, H. N. Reiser, and I. L. Tailleur

The southernmost exposures of the Lisburne Group in the central part of the Brooks Range are in a section about 1,000 feet thick on the North Fork of the Koyukuk River in the Wiseman quadrangle (loc. 8). These exposures are about 48 km (30 mi.) south of the Lisburne's type area on the Anaktuvuk River, where the Lisburne is about 3,000 feet thick and comprises two formations, the Wachsmuth Limestone (Osagean and Meramecian, Lower and Upper Mississippian) and the Alapah Limestone (Meramecian and Chesterian, Upper Mississippian). Foraminifera recently collected by W. P. Brosgé, H. N. Reiser, and I. L. Tailleur from the upper 135 feet of the Lisburne on the North Fork have been identified by A. K. Armstrong and B. L. Mamet (Université de Montréal) as Lower Pennsylvanian (Morrowan; Mamet Zone 20). The upper Lisburne on the North Fork is therefore younger than the Alapah Limestone of the type area and is correlative with the Pennsylvanian (Morrowan and Atokan) Wahoo Limestone so far found only in the upper Lisburne of the northeast Brooks Range.

Foraminifera from 35 feet above the base of the Lisburne on the North Fork are Upper Mississippian (Meramecian; Mamet zones 12 or 13) according to Armstrong. Therefore the base of the Lisburne on the North Fork is also probably younger than that of the type area and is about the same age as the basal Lisburne on the Marsh Fork of the Canning River in the northeast Brooks Range. As in the northeast Brooks Range, the Lower Mississippian Kayak Shale beneath the Lisburne on the North Fork of the Koyukuk rests unconformably on lower Paleozoic rocks.

The Lisburne on the North Fork is overlain locally by gray partly calcareous siltstone from which brachiopods of Early(?) Permian age have been identified by J. T. Dutro, Jr., succeeded by carbonaceous shale, siltstone, and limestone of the Shublik Formation from which Upper and possibly Middle Triassic pelecypods have been identified by N. J. Silberling. A north-dipping thrust fault along the valley of the North Fork separates this Mississippian to Triassic sequence from the typical central Brooks Range sequence of the Upper Devonian to Upper Mississippian Endicott and Lisburne Groups to the north.

WEST-CENTRAL ALASKA

Southeastern Seward Peninsula
By Thomas P. Miller

Preliminary studies by T. P. Miller on the Darby pluton (loc. 7) in southeastern Seward Peninsula suggest an above-average content of uranium and thorium. Three samples of quartz monzonite, selected as representing the range in composition of the pluton based on 35 modal analyses, were analyzed by Carl Bunker using gamma ray spectrometric methods and showed a range of 9 to 15 ppm (parts per million) uranium and 49 to 65 ppm thorium. These values are similar to published averages of 15 ppm uranium and 56 ppm thorium for the uranium- and thorium-rich Conway Granite of New Hampshire. Studies are continuing on the distribution of uranium and thorium in the Darby pluton and adjoining bodies using a larger sample size to check this possible high U-Th background.

Reconnaissance geology of St. Matthew and Hall Islands
By W. W. Patton, Jr.

Reconnaissance investigations on St. Matthew and Hall Islands (loc. 14) by W. W. Patton, Jr., T. P. Miller, H. C. Berg, G. Gryc, J. M. Hoare, and A. T. Ovenshine show that these two central Bering Sea islands are made up almost entirely of calc-alkaline volcanic rocks that range in composition from rhyolite to high-alumina basalt. Along the northeast coast of St. Matthew the volcanic rocks are locally intruded and thermally altered by small bodies of granodiorite. The volcanic rocks are flat lying to mildly deformed and are broken by north- and northeast-trending high-angle faults. Marine geophysical data and onshore mapping suggest that these volcanic rocks belong to a Late Cretaceous to early Tertiary arc that extends across the Bering Sea shelf from Anadyr Gulf in northeastern Siberia to the Yukon delta of southwestern Alaska.

EAST-CENTRAL ALASKA

Pitka ultramafic complex may be a klippe
By W. P. Brosgé, H. N. Reiser, and M. A. Lanphere

As a result of rapid reconnaissance of the Beaver quadrangle in 1971–72 a unit designated "eclogite and amphibolite" crops out in an area of 25 Km^2 (10 $mi.^2$) on the Pitka Fork (loc. 9) mapped by W. P. Brosgé, H. N. Reiser, and Warren Yeend (1973). Two days examination of the area by Brosgé, Reiser, and M. A. Lanphere in 1973 revealed that the Pitka ultramafic complex consists largely of banded garnet-amphibolite, foliated dunite, and harzburgite with pronounced cleavage, gneissic leucogabbro, and only minor eclogite. These rocks are interlayered in a crude synform; most of the amphibolite is near the base, and most of the gneissic leucogabbro is at the axis. Massive nonfoliated gabbro cuts across the foliation of the ultramafic rocks. The synform lies within a large area of mafic volcanic rocks. The layers in the synform strike northwest, discordant with the contact with the volcanic rocks and with the apparent regional northeast strike of the volcanic terrane. At the only exposed contact that was found, the amphibolite rests on about 100 meters of fine-grained pelitic and mafic schist of the amphibolite facies, which in turn rests on the unmetamorphosed volcanic rocks. Therefore, the Pitka ultramafic complex may be a klippe.

Kanuti ultramafic belt
By W. W. Patton, Jr.

The recently mapped (Patton and Miller, 1973; Patton, 1973) Kanuti ultramafic belt (loc. 10) could provide valuable insight into the complex and as yet poorly understood tectonic history of western Alaska. This 125–km-long belt lies along the contact of two sharply contrasting geologic assemblages: on the northwest the Cretaceous and Tertiary volcanogenic deposits of the Yukon-Koyukuk provinces and on the southeast the Precambrian(?) and Paleozoic platform deposits of the Ruby geanticline. Reconnaissance investigations and mapping of this 125 km (78 mi.) long belt were carried out in 1970 by W. W. Patton, Jr., and T. P. Miller and again in 1973 by Patton, M. A. Lanphere, and W. P. Brosgé in an effort to determine the age, structural setting, and mode of emplacement of the ultramafic-mafic complexes. The reconnaissance studies have served to outline six major ultramafic-mafic complexes ranging in size from less than 2 km^2 to 60 km^2 (1.2 mi^2 to 23 $mi.^2$) with a combined total area of about 150 km^2 (58 $mi.^2$). The complexes occur as tabular masses as much as 1,000 m thick composed of partially serpentinized dunite-harzburgite in the lower part and gabbro in the upper part. They dip 10° to 60° northwestward beneath the Cretaceous and Tertiary volcanic and sedimentary deposits of the Yukon-Koyukuk province and at the base are thrust faulted onto mafic volcanic rocks of probable late Paleozoic age and pelitic schist and carbonate rocks of Precambrian(?) and early Paleozoic age. At present the complexes cannot be dated more closely than post-Devonian to pre-late Early Cretaceous. However, amphibole-bearing samples recently collected from hornblendite dikes cutting the upper part of the ultramafic-mafic succession and from garnet amphibolite at the base are now being processed for K-Ar isotope dating and offer possibilities for obtaining a more refined age.

Metamorphic rock sequence between Rampart and Tanana dated
By Robert M. Chapman

The first fossils to be discovered in a 1,300 Km^2-(502 $mi.^2$) area of low-grade metamorphic rocks on the north side of the Yukon River between the villages of Rampart and Tanana (loc. 11) were collected in 1972 by R. M. Chapman. Colonial rugose corals were found in a thin limestone interbedded with schist and phyllite on Raven Ridge, about 37 Km (23 mi.) southwest of Rampart.

The corals are not well preserved, and the critical features are obscure in thin section. However, W. A. Oliver, Jr., C. W. Merriam, and A. K. Armstrong agree that the corals are post-Ordovician, could be Silurian to Permian, and have some resemblance to Devonian and Carboniferous genera.

Mapping in 1971 by Chapman, W. E. Yeend, and W. P. Brosgé in this area of schist, quartzite, slate, phyllite, chert, greenstone, limestone, and dolomite north of the Yukon River and in similar areas north and west of the Tozitna River yielded no direct age data. These rocks were formerly identified as Paleozoic, Devonian, and pre-Devonian, possibly including some Precambrian, by H. M. Eakin (1913) who mapped a small part of this area in 1911.

Prominent carbonate rock units are common in what is believed to be the upper part of the highly deformed section in this terrane. The total section is generally similar to the lower Paleozoic sections in the Livengood quadrangle to the east and in the Tanana quadrangle south of the Yukon River. In view of the age range given for the corals and an interpreted relationship between the bedrock sections in this and adjacent areas in east-central Alaska, Silurian and (or) Devonian is the most reasonable age for the carbonate-bearing upper part of the section in this area north of the Yukon River. The underlying rock units, chiefly noncarbonate, are believed to be lower Paleozoic.

Environmental geology and land utilization of the Fairbanks area, Alaska
By Troy L. Péwé

New geologic maps and derivative environmental maps for land use planning on the scale of 1:24,000 were essentially completed for the Fairbanks area (loc. 12) in 1973. Field data obtained in 1972, plus information from earlier surveys, were compiled and interpreted by Troy L. Péwé and John W. Bell to produce geology, permafrost, construction materials, foundation conditions, and ground water maps of the Fairbanks D2–SW, D2–NW, D2–SE, D2–NE and D1–SW quadrangles covering the Fairbanks area, a total of 25 maps. Robert B. Forbes and Florence R. Weber revised pre-Cenozoic geology on the D2 geologic maps.

The presentation of the pre-Cenozoic rocks has been greatly modified. The formal name "Birch Creek Schist" was abandoned by Foster, Weber, Forbes, and Brabb (1973) because its definition was too inclusive. In the Fairbanks area, the complex metamorphic sequence was subdivided into various types of schist, quartzite, slate, and marble. These rocks have long been believed to be Precambrian, but now the schist is known to have been recrystallized in Jurassic and Cretaceous time. The Cenozoic geology map units were refined from an earlier, smaller scale map and given formal stratigraphic names. Formations range from the auriferous Cripple Gravel of Pliocene and Pleistocene age to the Chena Alluvium of Pleistocene (Illinoian?) and Holocene age.

The distribution of permafrost and bore hole data indicating frozen ground thicknesses are given on the five quadrangle maps devoted to this subject. Each of the eight map units outlined indicates a different permafrost unit based on the amount of ground ice and the resulting susceptibility to subsidence of the surface upon disruption of the natural cover. Hilltops and south slopes have little or no permafrost. The Chena-Tanana River flood plain has sporadic permafrost with low ice content. The creek valley bottoms in the uplands contain permafrost with high ice content.

Three major ground-water units are defined: Chena-Tanana flood plain with abundant, generally poor-quality water produced both below and above permafrost; upland hills with low yield but good-quality water; and the creek valley bottoms with moderate quantities of poor-quality water produced from below permafrost.

Maps showing construction materials indicate location and quality of sand, gravel, aggregate, material for crushed rock, decorative rock, riprap, peat, and agricultural soil.

Not only do conventional foundation and construction problems occur, but unique permafrost and seasonal frost action problems complicate the otherwise normal land utilization in the Fairbanks area. Five maps indicate the different foundation conditions present in the nine different "foundation map units" based on presence and type of materials, mechanical properties of the material, and engineering properties when frozen and thawed. Details of hundreds of well and drill logs are presented along with geological and engineering analyses of the material.

Preconstruction base line biological water quality of the Chena and Little Chena Rivers, or water quality of a subarctic stream system
By G. A. McCoy

Chemical and biological data were collected on the Chena and Little Chena Rivers (loc. 12) by G. A. McCoy to determine the water quality of these rivers prior to construction of the Moose Creek and Little Chena Dams by the U.S. Army Corps of Engineers. Chemical quality parameters measured include conductivity, alkalinity, pH, dissolved oxygen, nitrogen, and phosphorous species, dissolved iron, BOD, and COD. Biological data included a quantitative and qualitative assessment of benthic invertebrates, periphyton, and phytoplankton. The results indicate a typical clean-water subarctic stream with excellent water-quality characteristics. The chemical and biological water-quality parameters in this reach of the Chena River are relatively uniform. The biological data show that productivity is low. The flora and fauna are diverse and are characteristic of cold-water streams high in dissolved oxygen and low in productivity. The construction and operation of Moose Creek Dam probably will not appreciably alter the present water conditions, except for possible temporary effects.

Metamorphic rocks of the Fairbanks area
By Florence R. Weber

Examination of new exposures, produced largely as the result of urban development, of the metamorphic rocks of the Fairbanks area (loc. 12) in connection with the preparation of new geologic maps for the Fairbanks D–1 and D–2 1:24,000 quadrangle series by Florence R. Weber and Robert B. Forbes resulted in a better understanding of the stratigraphy and structure of the area. Several units of the metamorphic complex were delineated, probably from older to younger: lower amphibolite facies—pelitic schists, quartzite, amphibolite, marble and paragneiss; upper greenschist facies—pelitic schist, quartzite, greenschist and calc-mica schist; and lower greenschist facies—metasiltstone, quartzite, phyllite, calc phyllite and calc mica schist. Synclinal and anticlinal axes in these metamorphic rocks were mapped.

Recent potassium-argon age determinations have shown that the schists were recrystallized in Jurassic time. Discordant K^{40}/Ar^{40} biotite and hornblende ages indicate that a thermal disturbance occurred in the Cretaceous which was associated with the onset of an episode of Cretaceous and early Tertiary granitic plutonism.

Ultramafic rocks and the Tintina fault in the Yukon-Tanana upland
By Helen L. Foster

Study of the mineralogy and field relations of more than 100 ultramafic bodies in the Eagle quadrangle (loc. 13), east-central Alaska, indicates that they can be divided into three groups on the basis of degree of serpentinization. The rocks of group I are completely serpentinized; those of group II partially serpentinized, and those of group III not serpentinized.

The rocks of group I and II are considered to be alpine-type peridotites and may be part of a dismembered ophiolite. They include the Mount Sorenson and American Creek ultramafic bodies.

Many of the ultramafic bodies occur in a zone along the Tintina fault and its splays. Extensive zones of breccia and gouge were found in the summer of 1973 along what is now believed to be the principal zone of the fault. The faulting has crushed and shattered both Paleozoic(?) metamorphic rocks and Tertiary(?) sedimentary rocks. Previously it was supposed that the fault zone lay beneath the Tertiary(?) rocks, but it is now clear that Tertiary(?) rocks have been involved in fault movement and breccia and gouge from Tertiary(?) conglomerate and sandstone form prominent cliffs near the mouth of Barney Creek.

Blueschist was found for the first time in the Yukon-Tanana Upland and occurs, associated with a small mass of serpentine, near a splay of the Tintina fault.

More than 80 samples from ultramafic bodies of all three types were analyzed for platinum group minerals. One sample, a biotite pyroxenite from the Eagle C–3 quadrangle, contained 0.3 ppm platinum and 0.2 ppm palladium. An age determination by Don Turner, Potassium Argon Laboratory of the University of Alaska, on biotite and hornblende from intrusive rocks possibly associated with the platinum-bearing group III ultramafic rocks gave the age of 170.5 m.y. (million years) on hornblende and 180.9 m.y. on biotite.

SOUTHWESTERN ALASKA

Less depleted(?) xenoliths in olivine tholeiite, Nunivak Island
By J. M. Hoare

Lherzolite and augitite xenoliths, which were found by J. M. Hoare and W. H. Condon in olivine tholeiite at Nanwaksjiak Crater, Nunivak Island, Alaska (loc. 15), appear to be less depleted than similar types of xenoliths that occur in the highly alkalic basalts on the island. The xenoliths are considered to be fragments of deformed mantle rock because olivine and orthopyroxene crystals exhibit strong deformation lamellae (kinkbands) and cleavage planes in the augitite xenoliths are curved. No chemical analyses have yet been made of these xenoliths, but by comparing them in thin section with other analysed xenoliths one may infer that they are less depleted than "normal" xenoliths. Most of the xenoliths in olivine tholeiite contain far more liquid and gas CO_2 inclusions and much more exsolved aluminous spinel than do similar types of xenoliths in the highly alkalic basalts.

Lherzolite xenoliths are generally considered to be the refractory residue of partial melting because they are strongly deficient in the more fusible elements Al_2O_3, Na_2O, K_2O, and P_2O_5. Thin sections of typical depleted lherzolite xenoliths from Nunivak Island reveal that they contain few CO_2 inclusions and no exsolved spinel that can be recognized by ordinary petrographic means. Most or all of the spinel that has exsolved in lherzolite at Nanwaksjiak Crater is in chrome diopside. The spinel is colorless or pale green and considered to be pleonaste. Small yellow and reddish-brown spinels also occur in orthopyroxene but probably are primary rather than exsolved. Some diopside contains little or no recognizable spinel. In other crystals spinel is moderately abundant. It exsolved as small blades and irregular blebs along cleavage planes. In one augitite xenolith, pale-green spinel constitutes at least 25 percent of some of the augite crystals.

The presence of highly aluminous spinel in these xenoliths implies that they are abnormally rich in Al_2O_3. This, in turn, suggests that they probably are enriched in Na_2O because R. W. White's pyroxene analyses show that Al_2O_3 and Na_2O increase coherently in clinopyroxenes.

CO_2 inclusions are very abundant in most of the xenoliths in olivine tholeiite at Nanwaksjiak Crater. They range in size from submicroscopic to ~0.1 mm. They are characteristically most abundant in diopside crystals, and, except locally, are less abundant in orthopyroxene and olivine. They are common to abundant in the augitite xenoliths. Most diopside crystals are brown due to their content of CO_2 inclusions. Relatively few CO_2 inclusions have been identified in the augitite xenoliths.

The highly alkalic basalts on Nunivak are nepheline and analcime basanites and olivine nephelinites. Basalts such as these are commonly thought to come from deep in the mantle and to represent only a small amount of partial melting, whereas olivine tholeiites represent more extensive melting higher in the mantle. It is therefore difficult to explain the less depleted nature of the xenoliths in olivine tholeiite at Nanwaksjiak Crater.

Mercury dispersal from natural lode deposits into Kuskokwim River and bay sediments

By Hans Nelson

Analysis of bulk sediments from nearly 500 sediment, suspended sediment, and water samples in the Kuskokwim River, estuary, and bay system, the Goodnews Bay area (loc. 16), and along southern Seward Peninsula suggests that sediments near mercury lode deposits contain extremely high mercury contents in hundreds of parts per million. Downstream dilution, however, occurs very rapidly, and sediment values return to normal within a few tens of miles of the natural deposits. As a result, the estuary, shoreline, and bay content of mercury in sediments is normal for the Kuskokwim River. Preliminary analysis indicates that water content in these mercury-rich areas also is normal. Thus, in natural systems, dispersal of mercury through the sediment dispersal system may be most important, and even then, extensive dispersal may take place only through suspended sediment transport.

Late Holocene sediment dispersal in northeastern Bering Sea

By Hans Nelson

The Yukon and Kuskokwim Rivers annually discharge more than 100 million tons of sediment into the eastern Bering Sea. Some silt is deposited in mudflats. ERTS photos and suspended-sediment data suggest that much of the Kuskokwim River discharge of about 4 million tons per year is dispersed southward; the remainder is transported westward and northward mainly along the delta complex. Most of the large input of Yukon sediment is carried eastward and northward by counterclockwise current gyre in Norton Sound. Apparently, a significant part of the Yukon sediment, 30 to 60 million tons per year, eventually bypasses the relict sediment flooring the northern Bering Sea and is flushed out of the Bering Sea. This is suggested by the general thinness (0.25–1.0 m) of deposits of Yukon sediment in Norton Sound, the lack of modern Yukon silt and sand on the northern Bering Sea floor, and the accumulation of Holocene Yukon sediment in the Chukchi Sea. Thin sand rhythmically interbedded with Yukon sandy silt of Norton Sound indicates that storm waves and currents over this shallow modern depositional area intermittently resuspend much of the accumulated bottom sediment, leaving thin lag layers of sand. The strong northerly currents of the Alaska coastal water carry the suspended sediment northward to the Chukchi Sea.

Precambrian rocks in southwest Alaska
By J. M. Hoare, R. B. Forbes, D. L. Turner

The Precambrian age of a group of crystalline schists and gneisses in southwest Alaska was recently confirmed by radiometric dating. These metamorphic rocks crop out discontinuously in a narrow belt (loc. 18) about 150 km (90 miles) long that trends northeastward from Jacksmith Bay on the Bering Sea coast across the northwest corner of the Goodnews Bay 1:250,000-scale quadrangle. The belt extends to a point about 5 km (3 miles) south of the Kisaralik River in the Bethel 1:250,000 quadrangle. The northern part of the metamorphic belt is widely overlain by sedimentary rocks of Cretaceous age and glacial deposits.

The rocks in the belt apparently consist of interbedded sedimentary and volcanic rocks, as well as some mafic and granitic intrusive rocks that have been metamorphosed to the upper greenschist and lower almandine amphibolite facies. Characteristic rock types include biotite-hornblende gneiss, hornblendite, garnet-amphibolite, orthoclase gneiss, feldspathic quartzite, garnet-epidote-muscovite schist, biotite-clinozoisite schist, and marble. White quartz veins 10–25 cm thick occur locally.

Three age determinations have been made on small hand specimens that were collected in the course of reconnaissance mapping in the Goodnews Bay quadrangle between the Arolic and Kannektok Rivers. The age determinations were done in the laboratories of the Geophysical Institute at the University of Alaska. Two hornblende ages of 1072 $\pm$32 m.y. and 533 $\pm$16 m.y. and a biotite age of 437 $\pm$13 m.y. have been obtained. These data suggest that the metamorphic complex is of Precambrian age and that it has been subjected in part to thermal overprinting during an Ordovician or later thermal event.

The overall significance of this old terrane is not known but it was clearly an important factor in the sedimentary and tectonic history. Thick conglomerates of Early Cretaceous age are widely exposed along the eastern edge of the old terrane. Small isolated patches of conglomerate also lie on top of the old metamorphic rocks. The conglomerate consists largely of gneiss, schist, and white quartz from the metamorphic terrane. The clasts in the conglomerate are a mixture of well-rounded resistant rock and angular fragments of schist and other less resistant rocks. Locally the conglomerate contains large angular sandstone clasts. The soft angular clasts are probably first-cycle detritus; whereas the well-rounded hard clasts are probably recycled detritus derived from older conglomeratic rocks. The thick conglomerates wedge out and grade into finer grained clastic rocks a few kilometers southeast of the metamorphic terrane.

In post-Early Cretaceous time the old metamorphic terrane acted as a resistant buffer to southeast compression. The patches of conglomerate on top of the metamorphic rocks show little or no evidence of deformation. But similar conglomerate and associated sandstones and shales as well as older rocks of Paleozoic and early Mesozoic ages are strongly folded southeast of the metamorphic belt. The folds trend parallel to the old metamorphic terrane and are overturned toward it. The intensity of deformation decreases southeastward, but in the Goodnews Bay quadrangle rocks that are at best 35 km (22 mi.) distant are overturned 15°–10° toward the old metamorphic belt.

Aleutian Islands-Bering Sea region
By David W. Scholl

Offshore studies in the Aleutian Islands-Bering Sea region were, during 1973, confined to data analyses and report writing. This work was divided into three parts, southern Bering shelf, deep Bering Sea, and the Aleutian Ridge. Bering shelf investigations were aimed chiefly at preparing a regional isopach map of Cenozoic deposits. Two exceptionally large basins and a number of smaller ones were outlined. The two large basins, Navarin and St. George, are several hundred kilometers long and are underlain by Cenozoic deposits as much as 6,000 m (19,685 ft.) thick. Upper Cretaceous beds may form the lower part of these sections. All of the basins are gently deformed, and those beneath the outer part of the shelf are bordered by major normal faults. Basement rocks appear to be folded eugeosynclinal beds of Jurassic and Cretaceous age. The sedimentary sequences of these basins are important prospects for energy resources.

Investigations in the area of the deep Bering Sea, especially the Aleutian Basin, were carried out to determine the thickness of the Mesozoic and

Cenozoic deposits underlying its floor, and the origin and geologic significance of the magnetic anomalies of this region. Geophysical data collected from many sources indicate that the thickness of sedimentary deposits is, in certain areas, as much as 10,000 m (32,808 ft.), although the typical section is closer to 4,000 m (13,123 ft.). These beds rest on what appears to be normal oceanic crust, a crust associated with north-south magnetic lineations that may represent anomalies produced at a spreading center. During the course of these investigations a number of acoustic "bright spots" were discovered on seismic reflection records. These bright spots are associated structurally with the crestal areas of domes, which are probably linked with deep-seated diapiric cores. These structures are attractive petroleum and gas prospects.

Geologic studies of the Aleutian Ridge were very diverse, but they concentrated chiefly on resolving the structural evolution and sedimentary filling of a number of large (<1,000 km^2) summit basins. These basins, for example, Amlia and Amukta Basins and Pratt Depression, are geomorphologic as well as structural basins. They occur along the north edge of the generally flat crestal area of the Aleutian Ridge, and are aligned with the ridge's chain of late Cenozoic volcanic centers. Geophysical information reveals that the floors of these basins are underlain by about 4,000 m (13,123 ft) of gently deformed beds. Regional geological correlations suggest that the infilling beds are late Miocene and younger. The basins themselves are grabens or half-grabens that began to form in the late Miocene in conjunction with the outbreak of late Cenozoic volcanism. Folding and faulting of the late Cenozoic beds took place consanguineously with sedimentation. These summit basins may be important petroleum prospects.

Geologic hisotry of Amchitka Island, Aleutians Islands
By Leonard M. Gard, Jr.

Earth-science studies on Amchitka Island (loc. 37) by the Branch of Special Projects were undertaken primarily to assure containment of underground nuclear tests recently conducted there by the Atomic Energy Commission; however, an additional result of these studies was a better understanding of the geologic history of Amchitka.

Amchitka Island, about 65 km (40 mi.) long and 5–8 km (3–5 mi.) wide, is one of the most southerly islands in the Aleutian Island Arc. Its general geologic history is probably representative of most of the Aleutian Islands.

Three volcanic episodes have been recognized and dated by fossil evidence and by radiometric dating (Carr and others, 1970; Carr and others, 1971). The oldest of these episodes is early Tertiary, probably Eocene, and is represented by altered basic submarine lavas and volcanic debris. Next, coarse turbidites and other sediments of basaltic debris shed from nearby volcanoes were deposited on the sea floor during late Eocene or early Oligocene time. This was followed by a mid-Tertiary period of uplift, tilting, faulting, erosion, and invasion by two small dioritic plutons. The older of these plutons is dated at 15.8 m.y. A subsequent subaerial andesitic volcanic complex, probably centered near the western end of the island, was constructed during the Miocene. Lavas from the upper part of this volcanic pile have K-Ar dates ranging from 12.4–14.1 m.y. An undated epizonal diorite porphyry on western Amchitka and on eastern Rat Island is closely related to these volcanics petrographically and temporally. During the Miocene the island probably stood higher above sea level than at present, and trees were common. During Pliocene time, 2–7 or 2–5 (see attachment) m.y. ago, minor shallow basaltic and hornblende andesitic intrusions were emplaced.

Early Pleistocene lake beds, tilted, faulted, and overlain by two interglacial marine deposits, have been preserved in a graben at South Bight. During the early Pleistocene, trees grew on this currently treeless Aleutian island, and a pollen assemblage collected from the lake beds suggests that the average July temperature was several degrees warmer than at present (E. B. Leopold, written commun., 1970). The two marine deposits, also tilted and faulted, were laid down during high-level stands of the sea, here called the South Bight I and South Bight II marine transgressions. These transgressions carved two broad terraces at 37–49 m (121–161 ft) and 67–76 m (220–249 ft) above present sea level on Amchitka Island. The older South Bight I transgression cannot be dated at this time; it contains only siliceous marine sponge spicules that are not diagnostic of age (R. M. Finks, Queens College, written commun., 1972). The overlying fossiliferous beach deposit of the South Bight II transgression contains the only remains of Steller's Sea Cow found in place in Pleistocene deposits (Gard and others, 1972). The South Bight II deposit, previously dated by the uranium series method at about 130,000 years (Gard and Szabo, 1971), is now recalculated by Szabo to be 117,000±5,000 years old (B. J. Szabo, written commun., 1973).

Evidence for two distinct episodes of glaciation is found on Amchitka. The earlier glaciation, represented by only a small outcrop of well-indurated diamictite, appears to have occurred prior to the South Bight I marine transgression. The later glaciation, which is younger than the South Bight II transgression, is represented by local deposits of outwash and thin diamicton, and by a few isolated erratics and striated bedrock surfaces. Ice probably covered the island in late Wisconsinan time as soils and peat older than about 10,000 years have not been found, either on Amchitka or on any of the islands between Kiska and Tanaga Islands. There is good evidence to believe that, during the Wisconsinan, there was more than one ice center on the island, perhaps existing simultaneously. The mountainous western end of the island displays glacial erosion and scattered drift from an ice cap probably centered there. Large, distinctive erratic boulders are found 15 km (9.3 mi.) west of the eastern end of the island and at least 8 km (5 mi.) west of their source area. In addition, striated bedrock and thin diamicton found near these erratics indicate that ice, probably centered near the low eastern end of the island, carried these erratics to their present location. The apparent source area for this ice is now less than 75 m (246 ft) above sea level.

Fault movement continued into Wisconsinan time yet the island appears to have been stable for the past 2,000–4,000 years (Morris and Bucknam, 1972).

SOUTHERN ALASKA

Kodiak Island faults inactive

By Gary W. Greene and Warren L. Coonrad

A reconnaissance high-resolution (Uniboom) seismic reflection survey was made around Sitkalidak Island (loc. 20) to determine the activity of faulting in the Kodiak Island region as part of the Alaskan geologic earthquake hazards project. Sitkalidak Island is located along the southeastern coast of Kodiak Island and is separated from the main island by narrow, shallow fiords.

Several faults trend northeastward along the length of Kodiak Island. Many of these faults are recognizable on land by their prominent topographic expression. After the 1964 Alaska earthquake local people reported the presence of newly formed cracks and scarps in the vicinity of these faults, which, together with reconnaissance marine data and the aftershock distribution, suggested to some that the faults may be active. Along the southeastern side of Kodiak Island and around Sitkalidak Island the fiords cut across the faults at right angles. Approximately 100 km (62 mi.) of seismic profiles collected in the fiords around Sitkalidak Island did not show any evidence of active faulting. No sea floor displacement or topographic relief was observed in the profiles across the trace of the faults, and no offset could be detected in the late Pleistocene glacial stratigraphy in the shallow subsurface immediately above the faults. In several seismic profiles the highly sculptured bedrock surface was shown to be vertically offset along a fault, and one fault appeared to have cut early Pleistocene(?) glacial material. The Pleistocene glacial stratigraphy is well defined in the profiles, and moraines, outwash, and till are easily distinguishable.

Municipal water-supply investigations

By D. A. Morris

Work accomplished on the continuing cooperative program with the State of Alaska, Department of Natural Resources included an administrative report on Seldovia, Alaska (loc. 21). In this report, G. S. Anderson and D. R. Scully concluded that several sources of surface water are available for development and that their potential is probably more than adequate for the future needs. Ground water has not been developed but may be available in limited quantities. Development of ground water in conjunction with surface water would provide the most dependable supply because the addition of warmer ground water would reduce the probability of freezing in the distribution system during the winter months.

Spatial distribution of earthquakes in the Cook Inlet-Prince William Sound region

By Robert A. Page and John C. Lahr

Recently acquired data from the U.S. Geological Survey network of seismographs in southern Alaska has led to a better definition of the spatial distribution of earthquakes in the Cook Inlet region (loc. 22) and in the vicinity of Valdez (loc. 29) (Lahr and others, 1974; Lahr and Page, 1972).

Focal depths of earthquakes typically are less than 30 km (19 mi.) in Prince William Sound, in the vicinity of Valdez, and 40 km (25 mi.) in the Chugach Mountains northwest of Valdez and range from near the surface to 75 km (47 mi.) beneath the western Kenai Peninsula and the northern end of Cook Inlet, from 50 to 100 km (31 to 62 mi.) beneath central Cook Inlet, and from 100 to 130 km (62 to 81 mi.) beneath the axis of active volcanos west of Cook Inlet. West of the volcanic axis the maximum focal depths are 150 to 160 km (93 to 99 mi.). In the Cook Inlet region, the foci at depths greater than 50 km (31 mi.) define a thin west-northwest-dipping zone that is locally only 5 km (3 mi.) thick. The strike of the dipping seismic zone parallels the trend of the active volcanos —Augustine, Iliamna, Redoubt, and Spurr. The depth of seismic zone beneath the volcanos is 110 to 115 km (68 to 71 mi.).

Water-resources investigations of the Kenai Peninsula Borough area, Alaska
By G. S. Anderson

The tentative conclusions of the continuing monitoring program in the Kenai-Soldotna area (loc. 23) are that the effects of major ground-water withdrawal are observed only near pumping centers. Elsewhere throughout the area most water-level fluctuations are correlated with climatic conditions.

Twenty million cubic meters of silt
By A. T. Ovenshine

Before the March 27, 1964 Alaska earthquake, Portage was a small roadside settlement at the head of Turnagain Arm (loc. 24), about 80 kilometers (50 mi.) southeast of Anchorage. Portage was abandoned after the earthquake because land subsidence amounting to at least 2.1 meters (6.9 ft) occurred over an area of more than 18 km^2 (7 $mi.^2$).

The earthquake dropped Portage into the intertidal zone of Turnagain Arm, a 72-Km-(45 mi.) long estuary nearly filled with sediment and subject to the second highest tides (10 m) in North America. Rapid sedimentation ensued. A. T. Ovenshine, Daniel E. Lawson, and Susan Bartsch (1974) estimate that 20 million cubic meters of silt have been swept into the Portage area since 1964. The new and still-forming tidal deposit is arborescent in plan because of the access to the depositional areas provided by the five streams that meet at tidewater in the Portage area. The thickness pattern of the deposit reflects the effects both of proximity to the source—the intertidal bars in Turnagain Arm—and the constraint on the flood tide of a highway embankment that follows the shoreline. Seaward of the highway the deposit averages 1.5 m thick; landward the deposit averages 0.9 m.

The environmental consequences of inundation and sedimentation in the Portage area are more lasting, and perhaps more serious, than the direct effects of the earthquake. Habitations and businesses, most of which were only damaged by the earthquake, have been abandoned and partly buried, and a large area of beautiful forest and meadow was killed and covered by thick deposits of "quicksilt" that present the most severe foundation problems and may have taken the life of at least one unwary person.

Glaciology of Portage Glacier, Alaska
By L. R. Mayo

A study of Portage Glacier (loc. 25) was made by L. R. Mayo, Chester Zenone, and D. C. Trabant. Since 1880 the glacier has receded 4 kilometers (2.5 mi.), leaving 190 m deep Portage Lake in the glacially scoured valley. The mass-balance study revealed that the spectacular calving from the glacier terminus is caused primarily by thinning and retreat of the glacier; the current weather conditions are not producing sufficient snowfall to halt the recession. Thus, Portage Glacier will probably continue to retreat an estimated 1.5 km (0.9 mi.) unless a relatively large and unlikely climatic change alters this prediction.

Geohydrology of the Anchorage area, Alaska
By R. S. George

Ongoing urban hydrology studies in the Anchorage area (loc. 26) have defined the hydrology of the marshes, swamps, and associated lakes in the western part of the area and addressed drainage and pollution problems in the Hillside area southeast of Anchorage.

Continuing studies of water availability include compilation and analysis of pumpage and water consumption data and its comparison with projected demands. To meet these demands, exploration for water has been extended to the Eagle River valley and to six promising sites in the Anchorage area. One test hole in the Eagle River valley has been drilled to a depth of 136 m (445 ft). Two potential aquifers were found.

Feasibility studies of artificial recharge by surface-water spreading are continuing. Current infiltration studies at a recently excavated 10-acre pit indicated a rate of 0.3 m per day, with a total of 15,100 m³/day. The potentiometric head in the vicinity of the pit rose 5.5 m (18 ft) during the 2-month test.

In monitoring two active sanitary landfill sites in the Anchorage area, the effects of waste disposal on the water resources have been studied. Where the water table is near the land surface, leachate components were detected in ground water within and beneath the landfill site.

Late Holocene displacement of Castle Mountain fault
By R. L. Detterman, George Plafker, Travis Hudson, and R. G. Tysdal

The Castle Mountain fault (loc. 27), one of the many large linear surface faults in Alaska, is of special importance for earthquake hazard studies because it is located near Anchorage, the major center of population and growth in the State. Detailed strip mapping along the fault, which was carried out during the 1973 field season, indicates that the 40-km (25 mi.) long segment of the fault that crosses the Susitna Lowland is a reverse fault that has been active in late Holocene time. The most recent displacement along the fault has produced a scarp that averages slightly more than 2 m high. Tree ring counts indicate that the offset occurred more than 225 years ago and the maximum age of the scarps indicated by radiocarbon dating of organic material from an offset soil horizon is 1,860±250 years before present (W–2930). The amount of horizontal offset related to this event is not known although there is local evidence that there was a horizontal slip component. The Castle Mountain fault does not show any evidence of recent activity where it is exposed in the outcrop along the front of the Talkeetna Mountains to the east of the Susitna Lowland.

Isotopic age determinations of a batholithic complex in the Talkeetna Mountains, Alaska
By Béla Csejtey, Jr. and Marvin A. Lanphere

Reconnaissance investigation of a batholithic complex (loc. 28), approximately 6,500 km² (about 2,500 mi.²) in area, in the Talkeetna Mountains, south-central Alaska, suggest that the bulk of the complex is made up by rocks of Late Cretaceous and early Tertiary age instead of Jurassic rocks as postulated by many earlier workers. The batholithic complex consists dominantly of tonalite and granodiorite. Jurassic ages, determined by the K-Ar and Pb-α methods, were obtained by Grantz, Thomas, Stern, and Sheffey (1963) for the Kosina pluton, forming the easternmost part of the complex. In contrast, K-Ar age determinations on hornblende and biotite mineral pair samples from three separate localities within the western two-thirds of the batholithic complex yielded Late Cretaceous and early Tertiary ages. As most mineral deposits in southern Alaska are associated with plutons of Late Cretaceous and early Tertiary age (Reed and Lanphere, 1969), the new age determinations make the western two-thirds of the largely unexplored Talkeetna Mountains batholithic complex an attractive target area for mineral exploration.

Water-resources investigations of the Valdez-Copper Center area, south-central Alaska
By C. E. Sloan

Surface and ground water of excellent quality is generally abundant in the relatively undeveloped area between Valdez and Copper Center, Alaska (loc. 30). Some natural variations in both quality and quantity may, nevertheless, impose some temporal and spatial limitations on use. Water quality in glacial lakes and streams is affected during peak summer flow periods by high turbidity. Low to moderate concentrations of bacteria occur in most surface water during late spring and early summer, but the concentration decreases during winter flow periods. Dissolved-oxygen concentrations are near saturation in surface water except in shallow lakes, such as Pippin and Willow, and approach zero under winter ice cover. Although dissolved-solids concentration in ground water is generally quite low throughout the area, some high concentrations limit its use in some areas such as Copper Center.

Plutonism and metamorphism, eastern Alaska Range
By D. H. Richter and M. A. Lanphere

Regional mapping by D. H. Richter and radiometric dating by M. A. Lanphere on plutonic and metamorphic rocks indicate three principal plutonic events and two episodes of complex plutonic metamorphic activity in the eastern Alaska Range (loc. 32). The plutonic rocks, largely granodiorite and quartz monzonite in composition, were emplaced in Late Pennsylvanian time (282–285 m.y.) and during two distinct intervals in

Cretaceous time (105–117 m.y. and 89–94 m.y.). Development of a large plutonic-metamorphic complex, consisting of diorite and quartz diorite intimately associated with amphibolite-grade banded gneisses and other metamorphic rocks, apparently occurred during Late Triassic to Middle Jurassic time (163–199 m.y.). A smaller plutonic-metamorphic complex is Miocene in age (17 m.y.).

The younger Cretaceous plutons are recognized only in the regionally metamorphosed Devonian and older terrane north of the Denali fault. The older Cretaceous and Pennsylvanian plutons are restricted to Pennsylvanian and younger terrane south of the Denali fault and are associated with coeval volcanic rock assemblages. The major plutonic-metamorphic complex, also restricted to the terrane south of the Denali fault, may relate to collapse of a late Paleozoic volcanic arc in Triassic time followed by syntectonic magmatism in the Jurassic. The smaller plutonic-metamorphic complex occurs within the Denali fault zone; its Miocene age probably reflects the time of initial movement along the fault.

Relationship between the Taku-Skolai and Alexander terranes in the McCarthy quadrangle

By E. M. MacKevett, Jr., Travis Hudson, and Russell G. Tysdal

Fieldwork in the McCarthy quadrangle provided additional data on the enigmatic relationship between the Kaskawulsh Group of Kindle (1952), a widespread unit in the Yukon Territory (Muller, 1967), and the Skolai Group, which forms the basement for most of the McCarthy quadrangle (loc. 33). The Devonian(?) Kaskawulsh is part of the Alexander terrane (Berg and others, 1973), which has been interpreted to represent continental crust. The upper Paleozoic Skolai Group represents the basal unit of the Taku-Skolai terrane (Berg and others, 1973) in the region and is interpreted as vestiges of an island arc that formed directly on oceanic crust. The Kaskawulsh extends into the eastern part of the McCarthy quadrangle where, except for a local fault contact with Cenozoic volcanic rocks, it is separated from the Skolai by intervening granitic masses. The granitic rocks constitute a complex that contains some syenite and monzonite and also more silica-rich intrusive rocks in its western parts. Plutons related to this complex locally cut older rock of the Skolai Group.

A syenite from the granitic complex has been radiometrically dated by James G. Smith as 295±8 million years on the basis of K-Ar determinations on hornblende. The prevalent concept to account for the juxtaposition of the dissimilar Alexander and Taku-Skolai terranes invokes large-scale lateral transport by faulting, but our work does not provide evidence for the inferred faulting and suggests, that if such faults exist, they are now largely obscured by the granitic masses. Additional investigations are required to complete mapping of the peripheral contacts of the Kaskawulsh and clarify details about the granitic complex, including relations and ages of its discrete phases.

Preliminary results of investigations in the southeastern McCarthy quadrangle

By E. M. MacKevett, Jr., Travis Hudson, and Russell G. Tysdal

Field investigations in the southeastern part of the McCarthy quadrangle (loc. 33) provide additional data on the structure, stratigraphy, and mineral deposits of the region.

Structure.–A major zone of south to north thrusting extends along the northern flank of the Chugach Mountains in the southeastern part of the quadrangle and southeastward into the Bering Glacier quadrangle and more distally into Canada. This zone relates to a similar zone in previously mapped quadrangles to the west, but continuity of the two zones is partly obscured by surficial deposits of the Chitina Valley. In the southeastern McCarthy quadrangle the zone is characterized by locally imbricated south-dipping thrusts that separate upper-plate upper Paleozoic rocks from lower plate Triassic rocks.

Stratigraphy.–An infaulted sliver of siltstone, sandstone, and shale that was found in the McCarthy A–4 quadrangle in the northern part of the Chugach Mountains is lithologically similar to fossiliferous Lower Cretaceous (Neocomian) rocks discovered in nearby parts of the Bering Glacier quadrangle by George Plafker. These rocks enlarge the known extent of the Wrangell-Matanuska type Cretaceous to the south and also are older than other rocks that are known in the eastern part of the Wrangell-Matanuska Cretaceous terrane.

Mineral deposits.–Jurassic and Cretaceous quartz diorite and granodiorite along the northern flank of the Chugach Mountains locally contain chalcopyrite and secondary copper minerals that are associated with pyrite in quartz veinlets. More detailed work is desirable to delineate the extent and grade of these occurrences and to evaluate their significance.

Float of granitic rocks that contains copper minerals and molybdenite and is suggestive of porphyry type mineralization was found on moraines of Hawkins and Barnard Glaciers.

Age of the Bagley fault
By George Plafker and Marvin A. Lanphere

The Bagley fault (loc. 34) forms a major structural boundary in the Chugach Mountains that for most of its length separates the late Mesozoic Valdez Group on the north from interbedded sedimentary and volcanic rocks of the early Tertiary Orca group on the south. For more than 250 km (155 mi.) in the area east of the Copper River the fault is marked by spectacular linear trenches that are occupied by the Bagley Icefield and the Miles, Columbus, and Seward Glaciers. The linearity of the fault has prompted speculation that it is the western continuation of the active dextral-slip Fairweather fault. In the Miles Glacier area a granodiorite stock that has been intruded across the fault zone has not undergone any detectable postemplacement offset. Two new samples taken from the pluton north and south of the fault have potassium-argon ages of 49.3 and 49.2 m.y., respectively. The dates indicate that the Bagley fault in the Miles Glacier area has not undergone significant displacement since early Eocene time and that it cannot be related to present movement on the Fairweather fault.

Bering River coal field, southern Alaska
By R. B. Sanders

In the Carbon Creek area (loc. 35), coal is found at apparently several horizons in the Kushtaka Formation (Eocene and Ologocene). Most exposed coal consists of augenlike diastrophic lenses or wedges of crushed and slickensided coal. Analyses indicate the coal to be at the low-volatile bituminous-semianthracite boundary. Sulfur and ash contents are low. Samples collected from near the surface in 1973 lacked coking properties. Indicated reserves of 1.02 million tons and hypothetical resources of 13 million tons are calculated for the area to the south of Carbon Creek on Kushtaka Mountain to a depth of about 75 m. Coal:waste ratio in this zone is approximately 1:6.

Hydrology of the Cordova area, Alaska
By G. S. Anderson

Water-resources studies still in progress indicate that the source of water for the Cordova area (loc. 36) is either from small streams or from ground water. Streams provide an adequate supply during the summer; however, discharge measurements made during the winter have indicated the supply is inadequate. It is supplemented at this time by using ground water. Results of recent aquifer tests point out that additional ground water can be obtained. However, any large increase in ground-water development will depend on inducing recharge from Eyak Lake.

Sedimentary and volcanic features of the Orca Group
By Gary R. Winkler and George Plafker

Recent fieldwork in the vicinity of Cordova, Alaska (loc. 36), and subsequent laboratory studies have added considerable new information about the sedimentary and volcanic features of the Orca Group, a thick highly deformed stratified sequence of early Tertiary age.

Collectively, the sedimentary rocks may be characterized as a flysch facies and include thin pelitic intervals with pelagic foraminifera. In a few places coarse pebbly sandstone and conglomerate is interbedded with the more typical sandstone-siltstone turbidites. Paleocurrent measurements demonstrate general east-to-west sediment transport but are dispersed in a radial pattern. Probably the Orca sediments near Cordova were deposited on a complex westward-sloping deep-sea fan.

The Orca sandstones are subquartzose—chiefly feldspathic or lithofeldspathic. Composition of lithic grains is widely variable, but volcanic and sedimentary clasts predominate. Pyriboles, epidote, and mica are the dominant heavy-mineral grains; polycrystalline quartz comprises about 10 percent of total quartz. Orca detritus apparently was derived from a nearby "tectonized" terrane of sedimentary, metasedimentary, volcanic, and metavolcanic rocks.

Thick and thin tabular bodies of greenstone are concordant on a large scale with the Orca's sedimentary rocks. They constitute about 15 percent of the outcrop area of Hinchinbrook Island. The greenstones consist of pillowed and nonpillowed altered tholeiitic basalt flows, breccias, and tuffs, with subordinate interbedded sandstone and siltstone. Thin lenticular bioclastic limestone, chert, and red and green shale mantle upper surfaces of the volcanic rocks in many places and are supplanted upward by normal thick flyschoid sequences. Mafic volcanism during Orca time thus was active near enough to the continental margin for the effusives to be intercalated within the rapidly forming prism of terrigenous sediment.

Spotty microfaunal evidence on Hinchinbrook Island suggests a middle or late Paleocene age for the Orca Group. The rocks were pervasively folded and faulted, generally along trends parallel to the continental margin, and were regionally metamorphosed to the laumontite and prehnite-pumpellyite facies prior to, or concurrent with, intrusion of early Eocene granitic plutons.

Radiometrically dated plutons cutting the Orca Group
By George Plafker and Marvin A. Lanphere

The Orca Group is a thick, complexly deformed and sparsely fossiliferous stratified sequence of predominantly eugeosynclinal clastic and volcanic rocks that crops out over an area of roughly 15,500 Km^2 (6,000 $mi.^2$) of the Prince William Sound region and the Chugach Mountains. The Orca probably also underlies large parts of the Gulf of Alaska Tertiary Province to the south of the outcrop belt and may extend southwestward at least as far as the Kodiak Archipelago.

Six new potassium-argon dates from four granodiorite and quartz monzonite plutons intrusive into the Orca Group give closely concordant ages ranging from 49.2 to 52.2 m.y. These dates indicate that the Orca Group was deposited and deformed before emplacement of the plutons in early Eocene time, and they are compatible with meager paleontological data suggestive of a middle or late Paleocene age for the Orca Group.

Summary of recent studies in Glacier Bay National Monument, Alaska
By David A. Brew and A. Thomas Ovenshine

The initial objective of the studies in Glacier Bay was to appraise the mineral resources and potential of Glacier Bay National Monument (loc. 38) for use in considering the creation of Glacier Bay National Park. This appraisal has been completed, and still underway are the longer range objectives of (1) completing the reconnaissance geologic mapping to provide multipurpose geologic data pertinent to regional geologic and mineral resource studies, (2) preparing a short "popular-type" report on the bedrock geology and glacial history for Monument visitors, and (3) preparing reports on specialized topical problems.

The monument is underlain by Silurian through Permian(?) graywacke, shale, limestone, and volcanic rocks in the eastern part; metamorphosed equivalents of those units in the central part; Mesozoic graywacke, shale, volcanic rocks and their metamorphosed equivalents in the western part; and Tertiary sandstone, shale, and volcanic rocks in a narrow strip next to the Pacific Ocean. Almost all of these units except the last named are cut by Jurassic(?) through middle Teritary gabbroic and granitic intrusive rocks.

The monument contains potentially important deposits of copper, molybdenum, nickel, gold, silver, titanium, and iron. The most important potentially minable deposits are the Nunatak molybdenum deposit and the Brady Glacier nickel-copper deposits. Other deposits of potential significance are the Alaska Chief and Margerie copper prospects, deposits associated with the layered gabbroic intrusive complexes of the Fairweather Range, beach placers near Lituya Bay, gold lodes near Reid Inlet and at the Sandy Cove prospect, a copper-molybdenum deposit in the Bruce Hills, and several base metal deposits. The geochemical sampling program found five areas with significant anomalous metal contents in stream sediments and several areas with smaller anomalies and also provided information about background concentration of elements in geologically different terranes in the monument (MacKevett and others, 1971).

The reconnaissance geologic mapping provides bedrock terrane compositional information that was critical to the interpretation of the geochemical data and also added greatly to the knowledge of regional geology in this part of Alaska. In particular, new fossil finds, structural information, and lithic data elucidate the understanding of the Silurian through Middle Devonian or younger graywacke, shale, limestone, and volcanic rocks in the eastern part of the monument and aid in correlating those rocks with their more metamorphosed equivalents in the central part. Similarly, new data on the probable Mesozoic rocks in the Fairweather Range allow better correlation with units outside the monument to the south.

Structural studies show that the dominant north-northwest trends in the monument are locally interrupted by important east-west fault and fold systems that may be related to the configurations of granitic intrusions. Also of importance is the west-northwest-directed high-angle reverse faulting that has brought Middle Devonian or younger strata over Silurian(?) in the east-central part of the monument.

Analysis of the types and distributions of intrusive bodies in the monument results in a gross threefold classification that reflects the age and habit of the bodies. The oldest bodies are late Early Cretaceous in age on the basis of K-Ar dates and are well-foliated diorites to granodiorites that make up the major belts, one trending northward through the west-central part of the monument to join the other, which trends west-northwest across the northeastern part. There is some evidence regarding the age relations of the other groups of intrusions, one of which is the layered gabbroic complexes confined to a north-northwest-trending belt in the Fairweather Range and the other of which consists of leucocratic and locally porphyritic adamellites and granodiorites that occur in a north-trending belt along the east side of the Fairweather Range and also are scattered within the two belts of Cretaceous intrusives. The leucocratic granitic bodies were emplaced during two middle Tertiary events (on the basis of K-Ar dates).

Bathymetric studies show that Glacier Bay proper includes at least nine enclosed submarine basins with depths ranging from 181 to 1,261 feet. The basins are canoe shaped, and their long axes are parallel to the fiord trends. The basin floors are level and have almost negligible slopes. Sedimentation rates range from 0.4 to 4.2 feet per year based on comparison of the 1966 soundings with soundings made in 1936 and 1940.

Studies of the provenance of glacial erratics in Glacier Bay indicate that the lower part of the bay was filled almost entirely by ice derived from the Fairweather Range to the west and northwest thereby blocking off the glacier coming from Muir Inlet to the northeast (Ovenshine, 1970).

Geology of the Juneau Icefield and adjacent areas
By David A. Brew and Arthur B. Ford

Detailed geologic mapping and study have provided new data regarding the local stratigraphic sequence, structure, metamorphic zones, origin of the gneissic and granitic rocks in the Coast Range batholithic complex, and the metallic mineral potential of the project area (loc. 39), which consists of a wide transect across the Coast Range. Highly folded low metamorphic-grade greenstones, greenschists, phyllites, graywacke semischists, and slates on the southwest are succeeded northeastward by slightly higher metamorphic grade greenschists, slates, and phyllites and by complexly deformed high metamorphic-grade schists, marble, and gneiss immediately adjacent to the large gneissic and granitic bodies which, together with scattered schist screens, make up the core of the batholithic complex. At the International Boundary to the northeast, these core granitic rocks intrude and metamorphose moderately deformed metavolcanic rocks. Most of the country rocks on both sides of the complex are Mesozoic in age, and the gneisses and granitic rocks are of late Mesozoic or Cenozoic age.

Scanty fossil evidence suggests that some of the low-grade metavolcanic rocks southwest of the batholithic complex are permian in age and therefore older than the slate and phyllite of Late Triassic age that borders them on the northeast. Lithically similar rocks across Gastineau Channel on the southwest side of the so-called Gastineau Volcanic Group are probably Cretaceous in age. As noted below, these and all other metamorphic rocks in the project area are involved in complicated folds, and reconstruction of the original stratigraphic section is difficult. The difficulties are increased by apparent facies changes in the units.

Study of the geometry of the fold elements and mapping of individual lithic units indicate that the well-developed isoclinal fold system southwest of the Coast Range complex is characterized by steeply to moderately northeast-dipping axial planes and by shallow to moderately plunging axes. The plunges vary from dominant southeasterly to northwesterly attitudes. Mapping has also revealed the presence of a very large northwest-plunging fold that appears to be abruptly refolded about a steep north-plunging axis immediately adjacent to the main gneiss unit which forms the southwest edge of the Coast Range composite batholith. The structure may be a model for what occurs in less obvious form all along the batholith.

Mineral assemblages in the progressively metamorphosed rocks southwest of the Coast Range batholithic complex indicate a Barrovian metamorphic facies series gradation from greenschist facies to amphibolite facies toward the complex. The isograds are truncated by gneissic units of the complex (Ford and Brew, 1973). Mineral assemblages in the rocks on the northeast side of the complex indicate albite-epidote hornfels to hornblende hornfels facies metamorphism.

The Coast Range complex contains several types of gneiss. The most common heterogeneous and migmatitic gneisses are probably derived in part from the Mesozoic metavolcanic and metadetrital clastic rocks and in part from sills or dikes of granitic to gabbroic rocks. The less common homogeneous granitic gneisses occur within the heterogeneous and migmatitic gneiss as do screens of schist. The homogeneous granitic gneisses may be derived from relatively large granitic bodies that predate the final metamorphic event. Although the available evidence is not conclusive, the relationships of these diverse gneiss bodies to (1) the Mesozoic low-grade metavolcanic and metadetrital clastic rocks southwest of the Coast Range crystalline complex, (2) the Tertiary crosscutting granitic body known in the central and northeastern parts of the complex, and (3) the unmetamorphosed Tertiary volcanic rocks reported on the northeast side of the complex suggest that the high-grade metamorphic and intrusive events may have occurred in a relatively short period between Late(?) Cretaceous and middle Tertiary time.

Detailed mapping of the relations of structures and isograds in the schists near Juneau to a large sheetlike body of homogeneous quartz dioritic gneiss (presumably orthogneiss) that is strongly discordant to the schists shows that foliation within the gneiss body closely parallels that of the country-rock schists, is at high angle to the contacts of schist and gneiss, and thus demonstrates its tectonic origin. Establishment of the orthogneiss origin for this body carries important implications for the origin of many gneissic units along the west margin of the batholith where the relations are more obscure.

The Tertiary crosscutting granitic body referred to above underlies over 1,650 km^2 (640 mi.^{2}) in the Juneau Icefield. It is composite and consists of generally poorly foliated leucocratic hornblende-biotite granodiorite and adamellite, minor biotite-hornblende tonalite, and complex intrusive breccias. A deeper level of the batholithic complex intrusive breccias. A deeper level of the batholithic complex is exposed to the southwest and a higher level to the northeast as shown by the variations within the granodiorite-adamellite and by the relation of the intrusive rocks to the country rocks to the southwest, where the contacts with both metamorphic screens and the main country rock mass are steep, and to the northeast where varied relations are present, including some isolated remnants of the roof over the intrusive rocks. A deeper level of erosion to the southwest is also suggested by the structural and metamorphic character of the rocks on either side of the complex.

Four important fault zones have been mapped in the project area. They are the Mt. Olds, Silverbow, Fish Creek, and Gastineau Channel zones. Apparently none are of major tectonic significance but metamorphic isograds appear to be offset along the westward extension of the Mt. Olds fault.

Gold is the most important commodity that has been produced in the project area. Deposits of copper, lead, zinc, and iron occur elsewhere in the Juneau Gold Belt, and it is possible that such deposits also occur within the study area. Economic results of the present investigations consist of new geochemical data for the distribution of metallic elements in stream sediment and bedrock, some ideas regarding the localization of the Alaska-Juneau and other gold deposits, and new bedrock data for previously totally unknown parts of the Juneau Icefield proper.

Stream sediment samples from up to 15 miles to the northwest and southeast of the Alaska-Juneau deposit give little indication that any similar but undiscovered deposits may be present. Large volumes of altered greenschist and phyllite containing disseminated sulfides occur on southeastern Douglas Island, southeast of the Treadwell group of mines. The metal content is great enough to cause significant anomalies in stream sediments, but analyses of the schists show that the metal content is generally too low to be economically significant (Brew and Ford, 1969a).

The main Alaska-Juneau and Perseverance gold ore bodies occur in well-fractured dark slate in the core of an antiform. The gold-bearing quartz stringers follow the dominant fracture set, which is parallel to the axial plane of the fold. A relatively less fractured quartz-muscovite schist and phyllite unit is structurally above the ore-bearing dark slate and phyllite; this suggests that the ore fluids may have been confined by the schist and phyllite. This possible structural control should be considered in the search for similar ore bodies elsewhere in the Juneau Gold Belt. Another possible control is the apparently consistent spatial relation of the ore bodies to the contact of a persistent metavolcanic unit with a black slate or phyllite unit.

The northeasternmost part of the Tertiary granodiorite-adamellite complex that forms the core of the Coast Range has abundant iron-stained zones within it and near it. Spectrographic analysis of samples from several of these zones shows that most are not economically significiant, but one such zone in an intensely iron-stained aplitic dike phase of the main intrusive complex contains anomalously high amounts of molybdenum, silver, and copper (Brew and Ford, 1969b). Iron-stained zones are less abundant in and near the west-central part of the complex.

SOUTHEASTERN ALASKA

Preliminary results of studies in the Tracy Arm-Fords Terror Wilderness Study Area
By David A. Brew

The study area (loc. 40) is on the west flank of the Coast Range batholithic complex about 64 km (40 mi.) southeast of Juneau. It is underlain in the western part by greenschist through amphibolite facies metamorphosed volcanic and detrital clastic rocks of original Mesozoic and late Paleozoic age that adjoin a complex of gneisses and granitic intrusive rocks of late Mesozoic(?) and Tertiary(?) age that extends eastward to the International Boundary. The complex includes large screens and pendants of amphibolite facies metamorphic rocks. The area is known to contain deposits of copper, lead, silver, zinc, and gold.

Reconnaissance geologic mapping and intensive geochemical sampling in the project area have been concentrated to date on a transect along the southwestern and southern boundaries. The low-grade metamorphic rocks in the western part contain complex structures and are locally altered and bleached. Higher grade metavolcanic rocks that are cut by the prominent Coast Range "megalinear" separate that terrane from the gneiss, schist, and Tertiary(?) granitic intrusion complex of the high part of the Coast Range. The studies indicate a varied petrogenetic history for the gneisses and also suggest a much greater volume of Tertiary(?) granitic rocks than hitherto suspected.

Marine till in the Juneau area redefined
By Robert D. Miller

As a result of several seasons of fieldwork in the Juneau, Alaska, area (loc. 41), deposits previously considered by others to be till or marine till have been grouped into three facies of stony diamictons, all of which contain marine fossils, as the Gastineau Channel Formation (Miller, 1973). The first facies, generally the oldest, is a hard, firm, stone-rich, and till-like diamicton containing clasts in a matrix of silt and sand. The second facies is a hard and dense gravelly diamicton, and the third is a sand-rich diamicton. Although this latter facies contains occasional fragments 0.6–2.4 m in diameter, overall the diamicton is the finest grained and least dense deposit in the formation. Radiocarbon dates obtained from shell material in the diamicton indicate a range of from at least 12,000 years B.P. to about 9,500 years B.P. This range overlaps ages obtained from basal muskegs by Heusser (1960, p. 96–97) in mountain valleys tributary to Gastineau Channel that he thought had not been covered by glacial ice for at least the last 10,000 years. All the radiocarbon dates obtained from shells in the diamicton of the Gastineau Channel Formation were collected from sites at altitudes lower than those of Heusser's 10,000-year dates, sites that should have been ice free even earlier. Thus, the similarities of radiocarbon dates of the glaciomarine deposits to those of the mountain muskegs have led me to interpret that the Gastineau Channel fiord was free of valley-filling glaciers during deposition of the Gastineau Channel Formation. Deltas now lying at heights of from 76 m to as high as 152 m above sea level along the fiord walls also support this interpretation; shells from the delta deposits are dated at from 10,000 to 12,000 years B.P.

The coarse clasts in the formation are explained as having been derived from both local and distant sources and as having been transported by bergs from glaciers that reached tidal waters outside the immediate Juneau area or by seasonal ice that developed along the shores. When such types of ice melted, the debris was dropped and became incorporated into the softer material then accumulating on the bottom of the fiord.

Deposition of the Gastineau Channel Formation started in late Fraser (late Pleistocene) time and extended into the early Holocene. The lower part is tentatively correlated with the glaciomarine deposits of Everson age in the Puget Sound lowland and the Fraser River area of Washington and British Columbia (Easterbrook, 1963; Armstrong, 1957). Similar stony shell-rich glaciomarine deposits extending northward throughout the fiord areas of coastal British Columbia and southeastern Alaska, such as the Forest Creek Formation of Haselton (1966), are probably correlative in time with the lower part of the Gastineau Channel Formation.

Reconnaissance engineering geology of the Sitka area, Alaska
By L. A. Yehle

Fieldwork and geologic interpretation indicate that most of Sitka, Alaska (loc. 42), is underlain at relatively shallow depth by hard graywacke bedrock, or by firm surficial deposits including glacial till and fine gravel of a large emerged beach ridge at an altitude of 10 m; locally, thick muskeg (known maximum, 23 m) or loose fill is present. Evaluation of earthquake and other geologic hazards indicates that ground shaking during anticipated major earthquakes may be locally severe in areas underlain by thick muskeg or loose fill, particularly reworked volcanic ash. Elsewhere in the city, only moderate shaking is anticipated. Extensive liquefaction and landsliding are not expected. High water waves, most of them caused by earthquakes, occasionally will damage harbor and other low-lying areas. Further study is recommended of the hazard to Sitka from renewed volcanic eruptions on nearby Kruzof Island.

Paleozoic stratigraphy of the Craig quadrangle
By G. D. Eberlein and Michael Churkin, Jr.

Detailed geologic mapping and numerous fossil discoveries have resulted in the following important changes in knowledge of the geology of the Craig quadrangle (loc. 43) and its Paleozoic stratigraphy:

The sedimentary rocks of Baker and St. Ignace Islands, heretofore considered to be of Devonian age, are now known to range in age from early Middle Ordovician to Early Silurian on the basis of several new graptolite localities. The rocks are therefore largely correlative with the Descon Formation, of Early Ordovician through Early Silurian age. Graptolite and coral collections from southwestern and southern Noyes Island indicate a Silurian rather than Devonian age for the interbedded volcanic and volcaniclastic rocks and limestone, as previously assigned. Thus, they too are partly correlative with the Descon and Heceta Formations. Several new graptolite collections from southern Lulu and San Fernando Islands range from Early Ordovician through Early Silurian. The Veta Bay region of western Baker Island is underlain by a folded sequence of interbedded calcareous shale, siltstone, sandstone, and both thick and thin bedded limestone that is believed to occupy the same stratigraphic position relative to the Descon Formation as does the Heceta Limestone and possibly the basal part of the Karheen Formation in the Sea Otter Sound region about 48 Km (30 mi.) to the north.

Vertebrate fossil discovered on Gravina Island
By H. C. Berg

The first pre-Tertiary vertebrate fossil in southeastern Alaska has been discovered on the northern coast of Gravina Island (loc. 44), about 16 km (10 mi.) from Ketchikan. The fossil, a reptile tentatively identified by C. A. Repenning as a mixosaurid ichthyosaur, is embedded in recrystallized Upper Triassic silty limestone. It consists of an approximately 38-cm-long segment of vertebral column, plus indefinite structures that might be ribs (see fig. 15). In addition to the vertebrate remains, the enclosing bed also contain specimens of the Upper Triassic pelecypod *Halobia.*

A photograph of the vertebrate, which is too fragile to remove from the outcrop, was submitted to C. McGowan of the Vertebrate Paleontology Department of the Royal Ontario Museum, Toronto. McGowan confirmed that the fossil is a mixosaurian, but the absence of forefins or skull precluded further identification. The locality information, however, will be useful in compiling data on global distribution of ichthyosaurs.

Geology and mineral resources of Granite Fiords Wilderness Study Area
By H. C. Berg

A 2-year, joint U.S. Geological Survey–U.S. Bureau of Mines resource evaluation of Granite Fiords Wilderness Study Area, Alaska (loc. 45), was completed during the summer of 1973. Geological Survey scientists included H. C. Berg, R. L. Elliott, J. G. Smith, and A. Griscom; Bureau

FIGURE 15.—Vertebral column and ribs(?) of a mixosaurid ichthyosaur embedded in Upper Triassic silty limestone, Gravina Island, southeastern Alaska.

of Mines engineers included T. L. Pittman and A. L. Kimball. The 2,600-km^2-(1,000 mi.^{2}) area is in the remote and unpopulated Coast Mountains, about 60 km northeast of Ketchikan. It is a starkly beautiful land dominated by deep fiords and rugged mountains dotted with spectacular icefields and valley glaciers.

Field studies consisted of reconnaissance geologic mapping, intensive geochemical sampling, an airborne magnetic survey, and detailed investigations of previously known and newly discovered mineral occurrences. The nine-man field party lived aboard the 34-m-long U.S.G.S. R/V *Don J. Miller II,* and used a jet helicopter to reach the otherwise inaccessible interior of the study area.

Granite Fiords Wilderness Study Area is underlain mainly by an assemblage of Mesozoic and Cenozoic plutonic and metamorphic rocks collectively known by the informal name Coast Range batholithic complex. The plutonic rocks include quartz diorite, granodiorite, and quartz monzonite that are progressively younger, less foliated, and less mafic northeastward across the complex. Exceptions to this regional pattern include a small stock of massive, homogeneous gabbro that crops out just beyond the southernmost boundary of the study area, and the western margin of the Texas Creek Granodiorite, a batholith at the northeastern boundary. Geologic relations suggest that at least some of the most highly foliated plutons were formed by anatexis during high-grade regional metamorphism in late Mesozoic or Cenozoic time. Preliminary isotopic (K-Ar) dating studies show that several of the least foliated plutons are about 45–50 m.y. old, the gabbro about 23 m.y. old, and the Texas Creek Granodiorite about 200 m.y. old.

The metamorphic rocks include amphibolite (sillimanite)-grade paragneiss that underlies the western half of the study area, and up to hornblende-hornfels-grade recrystallized sedimentary and volcanic rocks that crop out near the northeastern boundary. The regional metamorphism probably took place in late Mesozoic or Cenozoic time; the thermal metamorphism in mid-Cenozoic time. The premetamorphic age of the paragneiss is uncertain, but might be no greater than late Paleozoic; that of the recrystallized bedded rocks is mainly mid-Mesozoic.

The youngest bedded rocks in the study area are Quaternary (post-glacial) basaltic lava flows, which crop out in three small widely separated areas.

Last year's studies led to the discovery of a zone of postulated large-scale overthrust faulting in northeastern Granite Fiords. The fault is the first of its kind to be mapped in the region and is important because it offsets rock units that contain the most significant mineral deposits in the study area.

The southeast Alaska earthquakes of July, 1973
By Robert A. Page and William H. Gawthrop

In early July, 1973, two magnitude 6 earthquakes occurred about 60 km (37 mi.) off the coast of southeast Alaska, about 150 km (93 mi.) northwest of Sitka; the first (MS=6.7) on July 1 and the second (MS=6.0) on July 3 (Gawthrop and others, 1973). Both earthquakes were followed by numerous aftershocks, of which 13 were large enough to be located from teleseismic P-wave arrivals. Precise relative epicenters for these events define a zone about 60 km (37 mi.) long and 15 km (9 mi.) wide that trends west-northwest parallel to the bathymetric contours along the continental slope west-southwest of Cross Sound (about 58° N., 138°

W.). This zone is inferred to be the surface projection of the fault segment that ruptured in the earthquakes. The trend and dimensions of the aftershock zone are substantiated by epicenters determined for 118 small (mostly magnitude 3 or smaller) aftershocks recorded by temporary land and ocean seismographs operated in the field between July 5 and 12. The focal depths of the shocks are less than 15 km (9 mi.).

Focal mechanism solutions for the two magnitude 6 shocks are identical and indicate predominantly thrust faulting beneath the continental slope. One P-wave nodal plane of the focal mechanism solution remains undetermined until the worldwide S-wave data for the events become available. This earthquake sequence is inferred to mark the southeast end of the active coastal thrust belt in southern Alaska.

The 1973 earthquake sequence occurred about 40 km (27 mi.) southwest of the Fairweather fault and about 75 km (47 mi.) northwest of the northern end of the segment of the Fairweather fault that ruptured in the 1972 Sitka earthquake sequence (Page and Gawthrop, 1973). The 1972 and 1973 earthquake sequences reflect different styles of tectonic deformation: dextral strike-slip on the Fairweather fault at the edge of the continental slope west of Sitka in the 1972 sequence, and predominantly reverse slip along the continental slope southwest of Cross Sound in the 1973 sequence.

Water resources of the City and Borough of Juneau, Alaska By G. O. Balding

In response to a need for an expanded water system, Salmon Creek Reservoir was evaluated as a potential source of water. G. O. Balding concluded that an adequate amount of water (storage capacity of 21,700,000 m^3) was available and that the supply was of excellent quality. However, at the present time, it is not economical for the City and Borough to develop this supply. As a result, attention has been directed to drilling a 60 m test well in the glacial deposits in the northeastern part of Mendenhall Valley. These water-bearing deposits have been penetrated only by shallow domestic wells but are believed capable at greater depth of producing high yields.

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———1973, Beaver C-5 topographic map, 1:63,360 scale.

———1973, Beaver C-6 topographic map, 1:63,360 scale.

———1973, Beaver D-4 topographic map, 1:63,360 scale.

———1973, Beaver D-5 topographic map, 1:63,360 scale.

———1973, Beaver D-6 topographic map, 1:63,360 scale.

———1973, Bettles A-1 topographic map, 1:63,360 scale.

———1973, Bettles A-2 topographic map, 1:63,360 scale.

———1973, Bettles A-3 topographic map, 1:63,360 scale.

———1973, Bettles A-4 topographic map, 1:63,360 scale.

———1973, Bettles A-5 topographic map, 1:63,360 scale.

———1973, Bettles A-6 topographic map, 1:63,360 scale.

———1973, Bettles B-1 topographic map, 1:63,360 scale.

———1973, Bettles B-2 topographic map, 1:63,360 scale.

———1973, Bettles B-3 topographic map, 1:63,360 scale.

———1973, Bettles B-4 topographic map, 1:63,360 scale.

———1973, Bettles B-5 topographic map, 1:63,360 scale.

———1973, Bettles B-6 topographic map, 1:63,360 scale.

———1973, Bettles C-1 topographic map, 1:63,360 scale.

———1973, Bettles C-2 topographic map, 1:63,360 scale.

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———1973, Bettles C-4 topographic map, 1:63,360 scale.
———1973, Bettles C-5 topographic map, 1:63,360 scale.
———1973, Bettles C-6 topographic map, 1:63,360 scale.
———1973, Bettles D-1 topographic map, 1:63,360 scale.
———1973, Bettles D-2 topographic map, 1:63,360 scale.
———1973, Bettles D-3 topographic map, 1:63,360 scale.
———1973, Bettles D-4 topographic map, 1:63,360 scale.
———1973, Bettles D-5 topographic map, 1:63,360 scale.
———1973, Bettles D-6 topographic map, 1:63,360 scale.
———1973, Chandalar A-4 topographic map, 1:63,360 scale.
———1973, Chandalar A-5 topographic map, 1:63,360 scale.
———1973, Chandalar A-6 topographic map, 1:63,360 scale.
———1973, Chandalar B-4 topographic map, 1:63,360 scale.
———1973, Chandalar C-4 topographic map, 1:63,360 scale.
———1973, Chandalar C-5 topographic map, 1:63,360 scale.
———1973, Chandalar C-6 topographic map, 1:63,360 scale.
———1973, Chandalar D-5 topographic map, 1:63,360 scale.
———1973, Chandalar D-6 topographic map, 1:63,360 scale.
———1973, Chandler Lake A-1 topographic map, 1:63,360 scale.
———1973, Chandler Lake A-4 topographic map, 1:63,360 scale.
———1973, Chandler Lake C-1 topographic map, 1:63,360 scale.
———1973, Chandler Lake C-2 topographic map, 1:63,360 scale.
———1973, Chandler Lake D-2 topographic map, 1:63,360 scale.
———1973, Mt. Michelson A-5 topographic map, 1:63,360 scale.
———1973, Mt. Michelson B-5 topographic map, 1:63,360 scale.
———1973, Phillip Smith Mountains A-5 topographic map, 1:63,360 scale.
———1973, Phillip Smith Mountains C-1 topographic map, 1:63,360 scale.
———1973, Phillip Smith Mountains C-3 topographic map, 1:63,360 scale.
———1973, Phillip Smith Mountains C-4 topographic map, 1:63,360 scale.
———1973, Phillip Smith Mountains D-2 topographic map, 1:63,360 scale.
———1973, Phillip Smith Mountains D-3 topographic map, 1:63,360 scale.
———1973, Sagavanirktok A-1 topographic map, 1:63,360 scale.
———1973, Sagavanirktok A-2 topographic map, 1:63,360 scale.
———1973, Sagavanirktok A-3 topographic map, 1:63,360 scale.
———1973, Sagavanirktok A-5 topographic map, 1:63,360 scale.
———1973, Sagavanirktok B-3 topographic map, 1:63,360 scale.
———1973, Sagavanirktok B-4 topographic map, 1:63,360 scale.
———1973, Sagavanirktok B-5 topographic map, 1:63,360 scale.
———1973, Sagavanirktok C-2 topographic map, 1:63,360 scale.
———1973, Umiat C-1 topographic map, 1:63,360 scale.
———1973, Wiseman A-1 topographic map, 1:63,360 scale.
———1973, Wiseman A-2 topographic map, 1:63,360 scale.
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