GEOLOGICAL SURVEY CIRCULAR 683

United States Geological Survey Alaska Program, 1973

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Washington 1973

United States Department of the Interior

ROGERS C. B. MORTON, *Secretary*

Geological Survey

V. E. McKelvey, *Director*

Free on application to the U.S. Geological Survey, Washington, D.C. 20244

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UNITED STATES GEOLOGICAL SURVEY
ALASKA PROGRAM, 1973

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 1973. 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 1973; (4) cooperative programs with the State of Alaska; (5) summary of important results of geological and geophysical research in 1972, and (6) reports published by Survey authors in 1972.

SERVICES OF THE UNITED STATES GEOLOGICAL SURVEY

INTRODUCTION

This report on the 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 acounts of recent results and summaries of plans for the summer of 1973. 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 is 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 services of the Geological Survey are discussed. The second section presents organization charts of the Survey. A third section is a comprehensive listing of Alaskan summer field activities for 1973. The fourth section summarizes projects undertaken in cooperation with the State of Alaska. The fifth section, a summary of the more important results of that year's geological and geophysical research, complements the sixth section, a list of reports published by Survey authors in 1972.

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. 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:

Distribution Section
U.S. Geological Survey
Federal Center
Denver, Colo. 80225

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

U.S. Geological Survey
445 Federal Building
209 West Ninth Street
Juneau, Alaska 99801

Books and maps may also be purchased from the U.S. Geological Survey Public Information Office, 108 Skyline Building, 508 Second Avenue, Anchorage, Alaska 99501.

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 Nenana 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., 1972, Placer deposits of Alaska: U.S. Geol. Survey open-file rept.

Available from: Alaskan Technical Data, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025.

A catalog 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 sea-floor spreading and continental drift. The study is scholarly and has attracted the wide interest of research geologists.

Reference: Anchorage A–8 quadrangle, Alaska, 1:63,360, series 1952, U.S. Geological Survey.

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 outline 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, Reconnaissance 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, Washington, D.C. 20244; copies are distributed free of charge while the supply lasts.

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.

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

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

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 several interdivisional programs, committees, and working groups. These are briefly described in the following section.

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 minimum acceptable bids 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 strengthens operating regulations and procedures for the prevention of pollution incidents, surface damage resulting from mining 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, Washington, D.C. 20244. 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, Alaska-Pacific Area Hydraulic Engineer, is located at 2800 Cottage Way, Sacramento, Calif. 95825, and the Alaska waterpower evaluation 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. 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 studies; aeromagnetic and gravity surveys and interpretation; engineering geology studies in urban areas; 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 Branch of Crustal Studies, and the Office of Marine Geology at the Pacific Coast Field Center, 345 Middlefield Road, Menlo Park, Calif. 94025; the Branches of Regional Geophysics, Exploration Research, Rocky Mountain Mineral Resources, and Engineering Geology at the Rocky Mountain Field Center, Denver, Colo. 80225; and the Branches of Paleontology and Stratigraphy and of Isotope Geology, Washington, D.C. 20244. 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. Mr. L. H. Borgerding is Acting Chief.

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, Colorado 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 (A/C 907–277–0569).

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	122	88
Sediment	0	73
Chemical	1	4
Biological	3	3
Temperature	30	180
Ground-water observation wells	11	10

The Geological Survey's water resources investigations are under the direction of E. L. Hendricks, Chief Hydrologist, Water Resources Division, Washington, D.C. 20244. 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, assisted by Donald A. Morris. The District Office is in the Skyline Building, 218 E Street, Anchorage, Alaska 99501 (A/C 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 Barnwell. It is located at 1209 Orca Street, Anchorage, Alaska 99501 (A/C 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 (A/C 907–586–7217). The Fairbanks Subdistrict Office is responsible for operations in northern Alaska and is under the supervision of Jim Meckel. It is located at 310 First Avenue, Fairbanks, Alaska 99701 (A/C 907–452–1951, ext. 176). The Water Resources Division QW Lab, which is responsible for chemical, biological, and physical quality and sediment analysis for the entire State of Alaska, is under the supervision of Robert Madison and is located at 1209 Orca Street, Anchorage, Alaska 99501 (A/C 907–277–2644).

PUBLICATIONS DIVISION

Information on the publications of the Geological Survey and Geological Survey maps and map-related publications on Alaska are available at three locations in Alaska.

The Alaska Distribution Section is located at 310 First Avenue, Fairbanks, Alaska 99701 (A/C 907–452–1951, ext. 174) and is supervised by William J. Olvey. Maps and map-related publications are distributed by mail as well as over-the-counter. Maps are sold (schedule of prices and discounts available on request) to the public, to 20 commercial dealers in Alaska, and to federal and state agencies. Maps are also available for sale in Juneau at the Subdistrict Office of the Water Resources Division, 441 Federal Building, 710 West Ninth Street, Juneau, Alaska 99801. During fiscal year 1972 the Alaska Distribution Section dispensed over 107,000 items.

A Public Inquiries Office is located at 108 Skyline Building, 508 Second Avenue, Anchor-

age, Alaska 99501 (A/C 907–277–0577). The office is supervised by Margaret L. Erwin. It serves as a public contact point for information on Survey activities in Alaska and maintains a sales stock of Alaskan topographic and geologic maps and book reports. This office is a depository for open-file reports on Alaska and has a complete library of all Survey publications. During the calendar year 1972, the Anchorage Public Inquiries Office had more than 22,000 public contacts.

ADMINISTRATIVE DIVISION

The Alaska Field Office of the Administrative Division is located at 204 Skyline Building, 218 E Street, Anchorage, Alaska 99501 (A/C 907–277–0569). The office is supervised by Mrs. 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 through the Alaska Field Office in Anchorage. Notice in advance is necessary.

The Anchorage Warehouse is under the supervision of Ralph Chapman and is located at 5500 Oilwell Road, about 5 miles east of downtown Anchorage, just inside the boundary of Elmendorf Air Force Base (A/C 907–753–2119). Field equipment and samples may be shipped to the warehouse for storage. The warehouse for the Fairbanks area is located at Ft. Wainwright but will be supervised only if warranted by the level of field activity. The telephone number at Ft. Wainwright is A/C 907–353–3139.

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. The EROS Program is managed by the U.S. Geological Survey, and participated in by ten 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 imagery at nominal cost to users throughout the world. To order data, write the U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota 57198 (A/C 605–339–2270). Alaskan imagery is available for inspection at the Public Inquiries Office, 218 E Street, 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 (A/C 415–323–8111, ext. 2348).

ALASKA SURVEY COMMITTEE

Discussion and coordination of Alaska activities is provided by the Alaska Survey Committee, a forum in which each of the Divisions of the Geological Survey are represented. Thomas J. O'Brien, Topographic Division, is Chairman for 1973; other members are Harry Pulsing, Water Resources; Florence R. Weber, Geologic; Alexander A. Wanek, Conservation; Margaret I. Erwin, Publications; and Betty J. McIntire, Administrative.

RADIO NETWORK

The Radio Officer for Alaska, Florence Weber, Geologic Division, College, Alaska 99701 (A/C 907–479–7245), is charged with the responsibility of implementing the U.S. Geological Survey's radio network. Two frequencies, 5381.5 KHz and 3212.5 KHz (both upper SSB), are the official frequencies for

USGS personnel. For emergency purposes, 5167.5 KHz (Alaska public fixed) is used and installed on field radios. Base stations using commercial radio service facilities will be established in Fairbanks or Anchorage prior to the beginning of the field season.

EMERGENCY SEARCH AND RESCUE

In cases of emergency in the field, contact the Air Rescue Coordination Center in Anchorage during the day (A/C 907–752–0227 or A/C 907–752–1106); at night (A/C 907–272–5398 or A/C 907–277–7266), or through the nearest FAA Flight Service Station, military installation, or state trooper. After the emergency message is received, search and rescue operations will start within one-half hour during the day and one hour during the night. To the extent possible, specify the crash, time of the accident, number of people involved, and the nature of possible injuries.

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 Washington, D.C.

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 includes seven operating offices (Mineral Resources, Environmental Geology, Geochemistry and Geophysics, Energy Resources, Earthquake Research, International Geology, and Marine Geology) supported by an Office of Scientific Publications. The headquarters of the offices are located in Washington, D.C., except for the National Center for Earthquake Research, which is located in Menlo Park, Calif.

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 Conservative 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, midcontinent, Rocky Mountain, and western) under the supervision of the Chief of the Topographic Division.

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 1973. 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; A/C 907–272–8228.

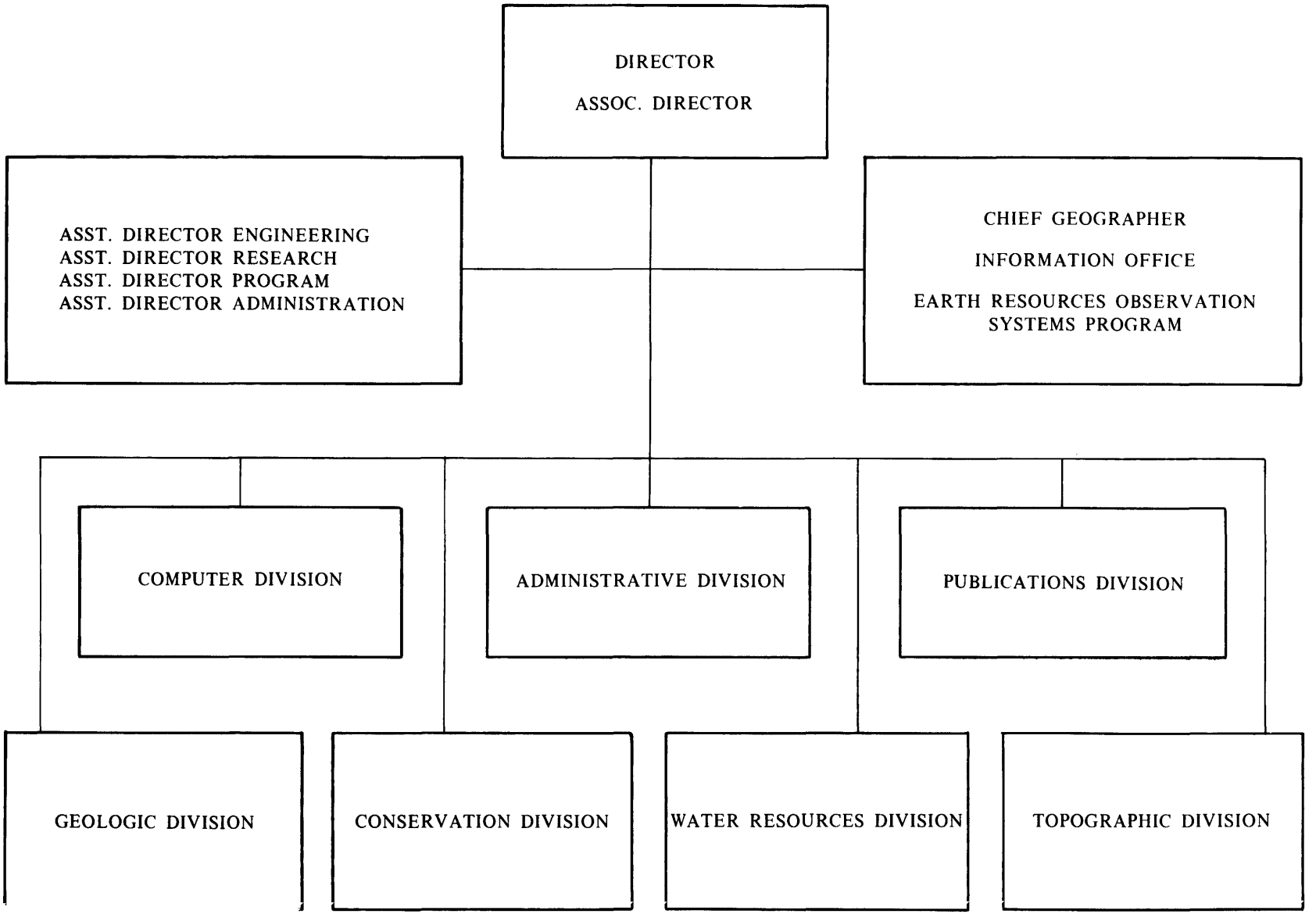


FIGURE 1.—Organization of the U.S. Geological Survey

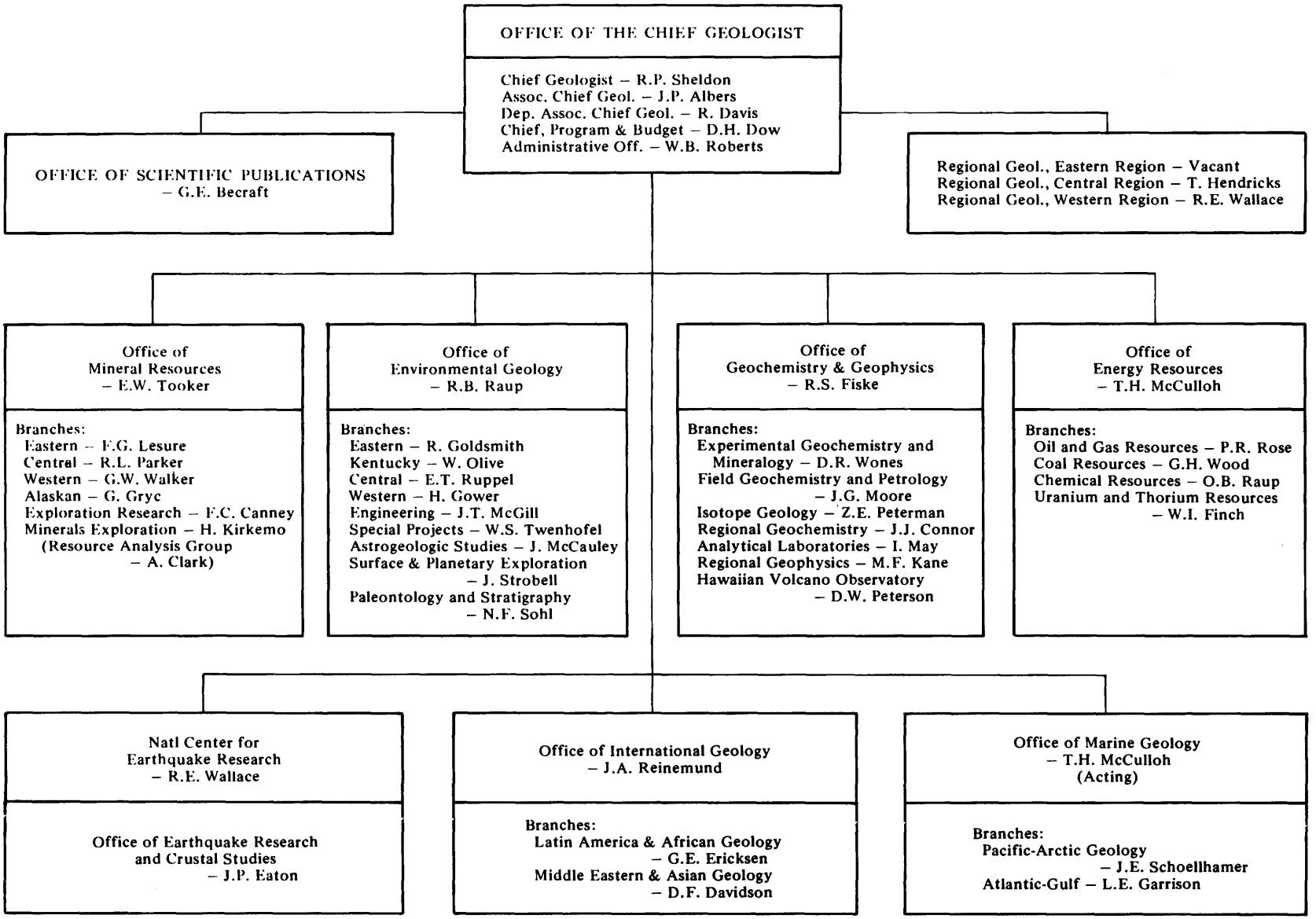


FIGURE 2.—Organization of the Geologic Division.

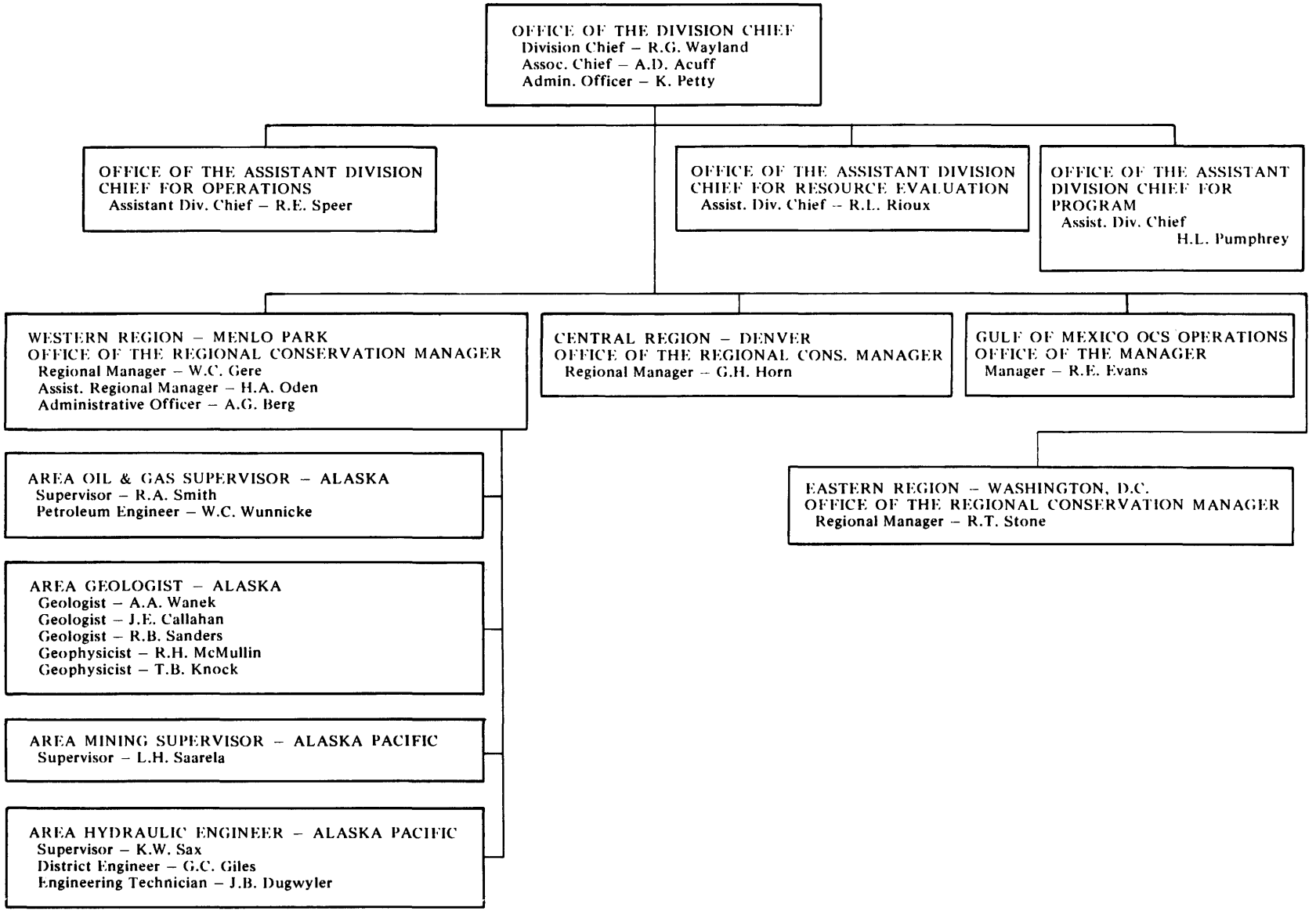


FIGURE 3.—Organization of the Conservation Division.

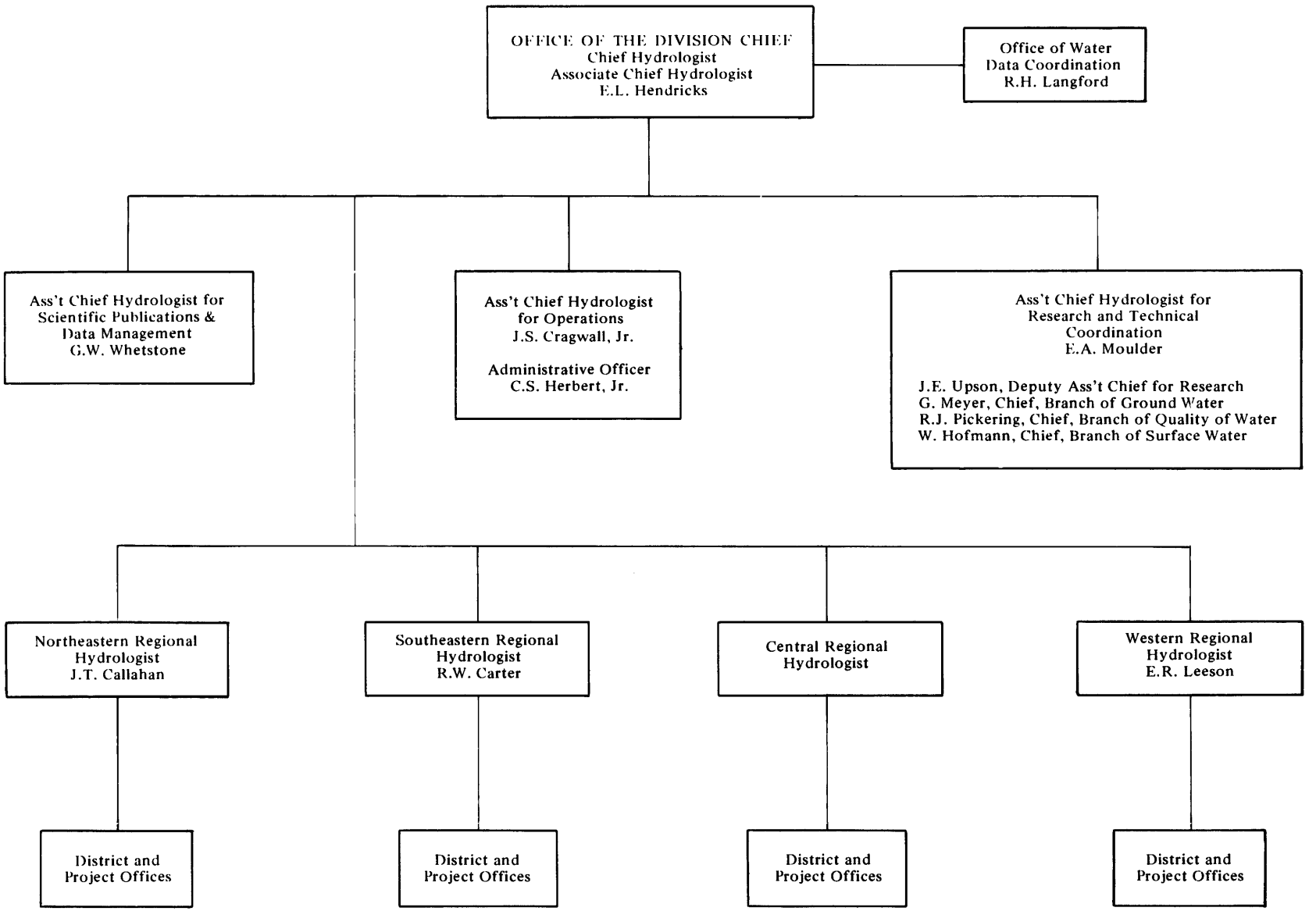


FIGURE 4.—Organization of the Water Resources Division.

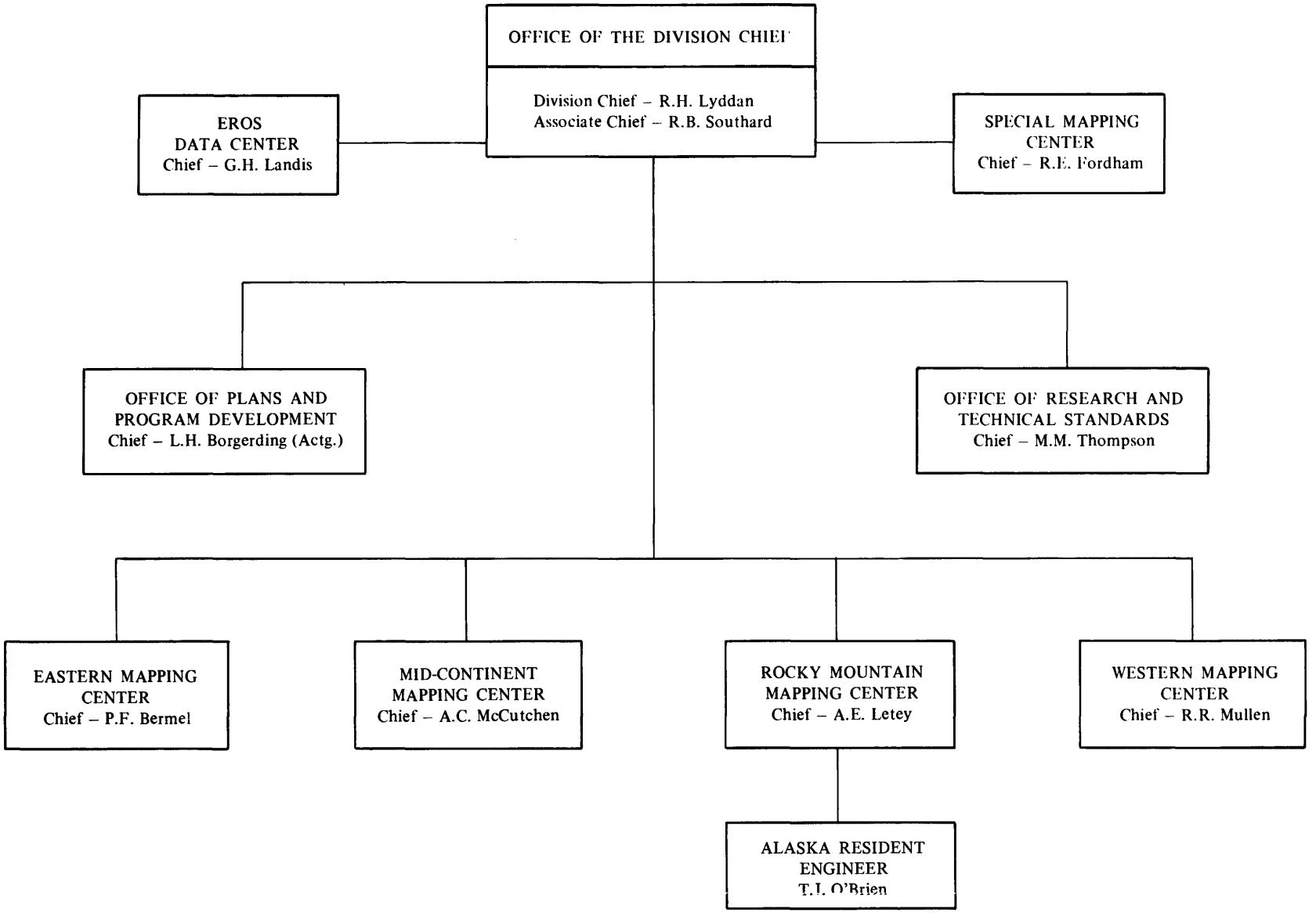


FIGURE 5.—Organization of the Topographic Division.

Project plans: Plans for the 1973 field season include a helicopter-supported program of geologic and geochemical mapping of volcanic rocks and associated hot springs in Alaskan Peninsula (2–3 weeks) and Wrangell Mountains (3–4 weeks) beginning in late June and continuing into early August, and 5–7-day helicopter traverse to sample hot springs in western Alaska in either mid-June or early August. The party will consist of Thomas P. Miller and Ivan Barnes; in the Wrangell Mountains they will be working with Donald H. Richter, E. M. MacKevett, and R. L. Smith. Field headquarters in the Alaskan Peninsula will be at Pilot Point, Port Heiden, and Port Moller; headquarters in the Wrangell Mountains will be chiefly at Devils Mountain Lodge, Nabesna.

Project: Engineering geology of the proposed trans-Alaska pipeline route.

Region: Statewide.

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

Project chiefs: Oscar J. Ferrians, Jr., Reuben Kachadoorian, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025, A/C 415–323–8111, ext. 2247 or 2262.

Project plans: Oscar J. Ferrians, Jr., Reuben Kachadoorian, and possibly other members of the Branch of Alaskan Geology will participate in meetings in Anchorage to review the engineering-geologic elements of the final design of various segments of the Trans-Alaskan Pipeline System. When circumstances require it, Ferrians and Kachadoorian also will make enginering-geologic investigations of special problem areas along the proposed pipeline route. Mail address: U.S. Geological Survey, 218 E Street, Anchorage, Alaska 99501.

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

Region: Statewide (see fig. 6).

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

Project chiefs: George Gryc, Ernest H. Lathram, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2231 and 2348.

Project plans: This project is evaluating the usefulness of ERTS in identifying geologic structures and lithologic elements of regional extent in Alaska and in interpreting their significance as keys 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 being identified by their linear expression as reflected in vegetation, topography, and the disruption of rock units, their identity verified where local geology has been mapped on the ground, and their existence extended beyond present knowledge by interpretation of ERTS data. 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; identification of like or contrasting sequences not previously recognized should be possible because of the large area covered by a single ERTS image with one tonal range. The significance of these structures and lithologic elements as sources of minerals, pathways for their transportation, favored sites for deposition, or as blocks to deposition is being interpreted in the light of known mineral deposits, providing keys to possible location of similar undiscovered deposits, and on a regional scale providing keys to the delineation of mineral provinces—large areas in which one or another suite of minerals or type of deposit typically occurs. In addition, the observed interrelations of these structures and elements will be analyzed to determine whether significant data are provided to assist in unraveling the geologic history of Alaska. These studies, under the general coordination of George Gryc and direction 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.

FIGURE 6.—Nimbus 4 image of Alaska and adjacent parts of Canada, March 29, 1971.

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

Project plans: The Alaska State maps being updated using 1:250,000-scale maps as source material are: (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 1973 regional projects, data on the location, staffing, and plans are presented. The location of each project is also shown on the accompanying map (fig. 7).

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 Circular on "Summary of Important Results, 1972." 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: Arctic coastal and shelf processes and the environment of the Beaufort Sea.

Region and map key: Northern Alaska (1).

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

Project chiefs: Erk Reimnitz, P. W. Barnes, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2695 or 2114.

Project plans: Plans this year call for a two-part effort to define further the sedimentation processes associated with the initial river flow over and under the sea ice and to outline the sedimentary framework of the continental shelf off central-northern Alaska. Our first field effort will be a two-week study of the Colville River breakup during the end of May and early June. Peter Barnes and Erk Reimnitz will install current meters and use salinity, temperature, and turbidity sensors to monitor the flow of river water away from the delta. After the initial breakup, two current meters will be placed close to the bottom on the inner shelf to record the current regime from the time of complete ice cover through the open season. We will be supported by NARL light aircraft but generally work with a snow machine out of the Oliktok DEW site. As time allows, we will also study the ice-sediment contact in the vicinity of the shore and delta.

The second part of our field effort will be during August, using the Coast Guard icebreaker ***Glacier***, but mainly the USGS R/V *Loon*, operating out of Prudhoe Bay as a resupply base. These studies, using high resolution seismic profiling gear, side-scan sonar, and bottom sampling equipment along with diving, will extend from the Barter Island region to Barrow and essentially from the coast to the shelf break. In this operation emphasis will be placed on monitoring the rate at which ice disrupts bottom sediments in several specific test sites. Further attempts will be made to measure bottom temperature gradients by thermoprobe and to obtain shallow cores. If the summer schedule permits, the R/V *Loon* will be used for a short time as a mobile camp to study Quaternary sediments exposed in coastal bluffs of the Beaufort Sea; Dave Hopkins of the U.S.G.S. will also participate.

Project: Seward Peninsula-Bering Sea.

Region and map key: Northern and west-central Alaska (2) (10).

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

Project chief: D. M. Hopkins, U.S. Geological Survey, 345 Middlefield Road, Menlo, Park, Calif. 94025; A/C 415–323–8111, ext. 2659.

Project plans: From June 20 to June 26 Dave Hopkins will work along the lower Colville River, in cooperation with Prof. H. J. Walker of Louisiana State University. The primary purpose is to examine the richly fossiliferous exposure of Pliocene marine gravel at Ocean Point and to examine exposures discovered by Walker containing vertebrate fossils in wood-bearing alluvium of middle Wisconsin age.

From June 27 to July 31 Hopkins will take part in a cooperative study with C. L. Hummel and W. W. Patton, assisted by Robert Nelson, in a study of the geology of southwestern Seward Peninsula. Special emphasis will be placed on study of the extent of the older glacial deposits south and southeast of the Kigluaik Mountains and on the detailed chronology of the youngest or Wisconsin glacial deposits near and in the Kigluaik Mountains.

From August 1 to August 10 Hopkins and Robert Rowland have tentative plans to join

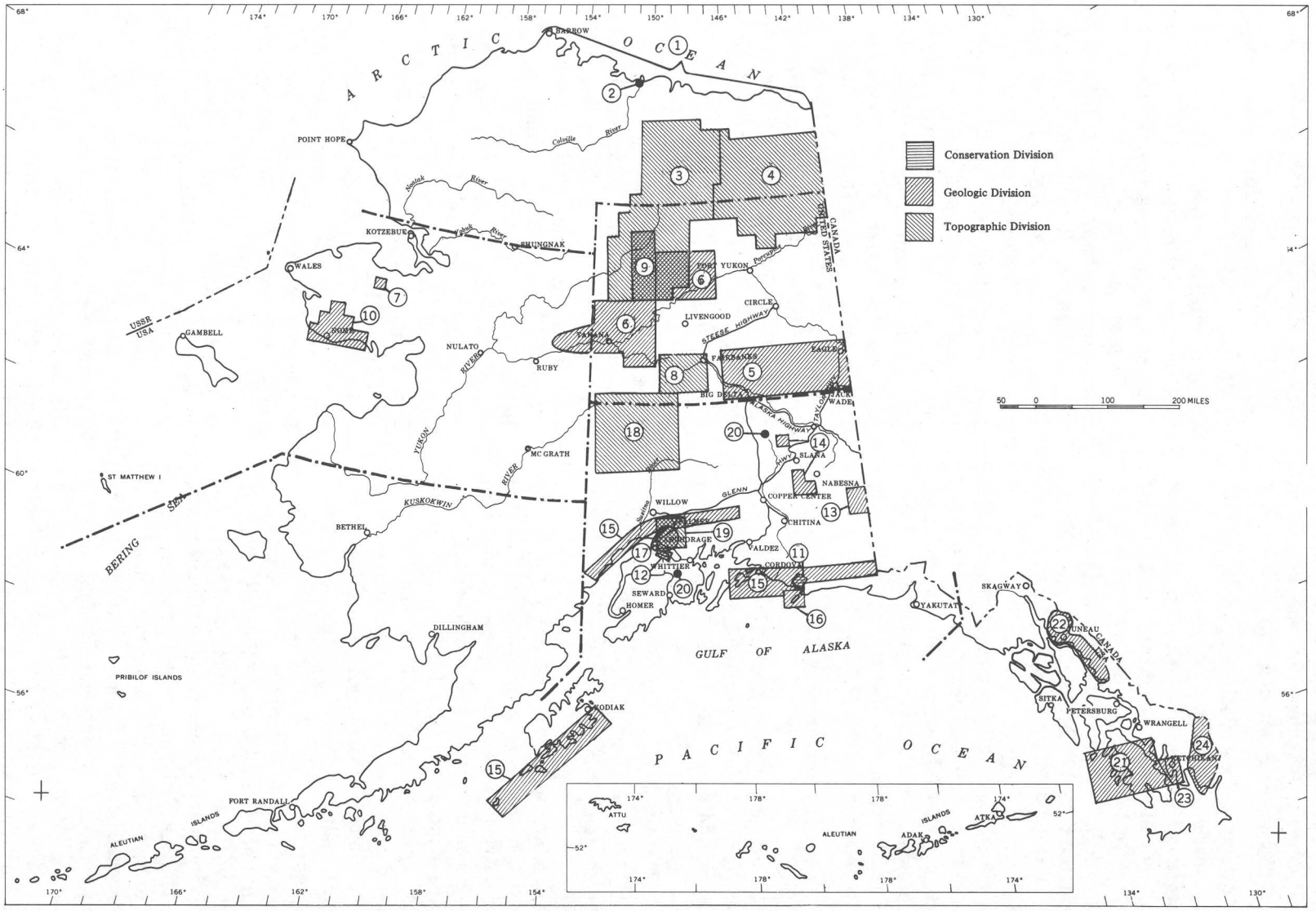


FIGURE 7.—Map showing locations of 1973 field projects of the U.S. Geological Survey. The circled numbers key to project discussions in the text.

Erk Reimnitz and Peter Barnes aboard the R/V *Loon* in order to examine the Tertiary and Quaternary geology of the shores of Beaufort Sea near Camden Bay.

Project: Compilations of Alaskan geology.
Region: Northern Alaska.
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; A/C 415–323–8111, ext. 2348.
Project plans: Completion of recompilation and updating of 1:1,000,000 scale Preliminary Geologic Map of Northern Alaska (released to open-file, 1965) preparation for multicolor publication. Completed map will cover Alaska north of lat. 67° N.

Project: Arctic Lowlands landmarks investigations.
Region: Northern Alaska-Arctic Slope.
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: Robert L. Detterman, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2244.
Project plans: The purpose of this project is to investigate geologic and geomorphic features in the Arctic Lowlands region in order to make recommendations to the National Park Service of potential sites for inclusion in the Registry of Natural Landmarks. Primary areas of interest will be surficial materials and permafrost features on the Arctic Coastal Plains. Selected sites will be studied between about July 23 and August 5, using a helicopter and working out of Arctic Research Lab facilities near Cape Thompson, Barrow, Umiat, Lake Peters, and also, out of Deadhorse and Point Hope. Arthur Grantz, Chukchi Sea Program, will accompany project to investigate bedrock areas along the west coast. John Koranda, Tundra Biome Group, U.S. International Biological Program, will also accompany the project along the north coast to study the ecological theme sites for the National Park Service Landmarks Program. Field headquarters will be: U.S. Geological Survey, c/o Bill Olvey, 310 First Avenue, Fairbanks, Alaska 99701.

Project: Chukchi-Beaufort Sea Continental Shelf.
Region: Northern Alaska.
Organizational designation: Geologic Division, Office of Energy Resources, Branch of Pacific-Arctic Marine Geology.
Project chief: Arthur Grantz, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2259.
Project plans: Seismic reflection magnetic and gravity profiling, and sonobuoy refraction studies of the continental shelf, slope, and rise in the Beaufort Sea between Barrow and the Alaska-Canadian line will be conducted in the late summer of 1973 if Coast Guard icebreaker support is again available in 1973. These studies will conclude the geophysical data acquisition phase of a reconnaissance study of the geology and mineral resource potential of the Alaskan continental shelf and slope north of Bering Strait. Mail address: c/o NARL, Barrow, Alaska.

Project: Central Brooks Range.
Region and map key: Northern, east-central, and west-central Alaska, parts of Sagavanirktok, Chandler Lake, Phillip Smith Mountain, Wiseman, Chandalar, Bettles, Beaver quadrangles (3).
Organizational designation: Topographic Division, Rocky Mountain Mapping Center.
Project Chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225; A/C 303–234–2351.
Project plans: This project area, consisting of 158 1:63,360-scale quadrangles along the proposed trans-Alaska pipeline route was begun in 1970, with fieldwork being performed in 1970 and 1971. All map compilation has now been completed and 41 quadrangles are currently being published. The remaining 117 quadrangles should be published in 1974.

Project: Eastern Brooks Range.
Region and map key: Northern and east-central Alaska, parts of Coleen, Demarcation Point, Table Mountain, Christian, Arctic, Mt. Michelson quadrangles (4).

FIGURE 8.—Engineering geology of the proposed pipeline route: helicopters facilitate geologic studies on the North Slope

Organizational designation: Topographic Division, Rocky Mountain Mapping Center.

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

Project plans: This project consists of 74 1:63,360-scale quadrangles along the possible gas-pipeline route to Canada. Field control was obtained for 51 quadrangles during the 1972 field season. Map compilation is presently underway for 23 quadrangles. No fieldwork is planned for the 1973 season.

EAST-CENTRAL ALASKA

Project: Yukon-Tanana.

Region and map key: East-central Alaska, includes Tanacross, Eagle, Big Delta, and Circle quadrangles (5).

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; A/C 415–323–8111, ext. 2331.

Project plans: The principal objectives of this project are reconnaissance geologic mapping, geochemical sampling, special geologic studies, and mineral resource evaluation of the eastern part of the Yukon-Tanana Upland. Helen L. Foster and Florence R. Weber are the principal investigators. In the 1973 field season Foster will concentrate work in the Eagle quadrangle, and Weber in the Big Delta quadrangle.

Access in the Eagle quadrangle will be by boat and fixed-wing airplane. In the Big Delta quadrangle, localities that can be reached from roads and from the Salcha River will be mapped and studied.

Fieldwork will begin on the 5th of June and continue to the middle of September. During the field season, Foster and Weber may be contacted through the College office: U.S. Geological Survey, P.O. Box 80586, College, Alaska 99701; A/C 907–479–7245.

Project: Tanana-Beaver quadrangles.

Region and map key: East-central Alaska, parts of the Tanana quadrangle and adjacent

FIGURE 9.—Yukon-Tanana project: luxurious field camp.

northern part 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; A/C 415–323–8111, ext. 2670.

Project plans: Fieldwork will be begun in August 1973 to complete the geologic mapping of the Tanana quadrangle. Robert M. Chapman and William P. Brosgé will base at Manley Hot Springs for about 10 days, with helicopter support to cover areas in the southeastern part of the Tanana quadrangle and in part of the adjacent northern part of the Kantishna River quadrangle. As a result of the mapping in parts of the 1970-72 field seasons, several structural and stratigraphic problems, critical to an interpretation of the geologic setting in this region of Alaska, have been brought into focus, and the additional fieldwork will be directed toward securing more detailed information in selected key areas.

Project: Fairbanks revision.

Region: East-central Alaska, Fairbanks quadrangle.

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 checking is planned.

Project: Southwestern Alaska.

Region and map key: West-central Alaska (7).

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; A/C 415–323–8111, ext. 2372.

Project plans: No fieldwork is planned in the Southwestern Alaska project during the 1973 field season. Tentative plans are being made to sample the basalts on Cape Espenberg and

in the vicinity of Imuruk Lake in west-central Alaska as part of an on-going study of the late Cenozoic basalts. J. M. Hoare hopes to establish a base camp and fuel supply on Imuruk Lake. The volcanic areas contain many lakes that make most of the rocks accessible by use of a small float plane. This work is scheduled for July.

WEST-CENTRAL ALASKA

Project: Hughes-Shungnak.

Region and map key: West-central and east-central Alaska, includes all of the Selawik, Shungnak, Hughes, Bettles and Melozitna quadrangles and parts of the Baird Mountains, Ambler River and Wiseman quadrangles (9).

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; A/C 415–323–8111, ext. 2248.

Project plans: This project has as its overall objective the regional mapping (1:250,000 scale) and resource evaluation of the northern part of Yukon-Koyukuk province. To date, maps have been completed and published for the Selawik, Shungnak, Hughes, and Bettles quadrangles and for parts of the Baird Mountains, Ambler River, and Wiseman quadrangles.

Efforts during the summer of 1973 will be focused on the proposed trans-Alaska pipeline route in the eastern part of the Bettles quadrangle and southeastern part of the Wiseman quadrangle. Of particular interest in this area are: (1) east- and northeast-trending faults and lineaments along the Kobuk fault zone and (2) the stratigraphic and structural relationships of the ophiolite assemblage exposed along the Caribou Mountain-Melozitna ultramafic belt.

Fieldwork will be carried out by helicopter from the Alyeska Pipeline Service Company camp at Prospect Creek during August.

Project: Nome project.

Region and map key: West-central Alaska (10).

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

Project chief: Chuck Hummel, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2606.

Project plans: Chuck Hummel will be engaged in fieldwork throughout much of western Seward Peninsula, to be done in three stages. During July he will be working in helicopter-based operations, first with Bill Patton and Tom Dutro on stratigraphic and structural problems in the York Mountains, and then with Dave Hopkins on collaborative investigations of the bedrock and surficial geology of the southwest and south-central part of the peninsula.

SOUTHERN ALASKA

Project: Bering River coal field.

Region and map key: Southern Alaska, parts of Cordova and Bering Glacier quadrangles (11).

Organizational designation: Conservation Division, Alaska Area Office, Mineral Evaluation.

Project chief: A. A. Wanek, U.S. Geological Survey, Box 259, Anchorage, Alaska 99510; A/C 907–277–0570.

Project plans: A field party consisting of Bob Sanders, a field assistant, and a cook-camphand plan to establish a field camp near Carbon Creek on Kushtaka Ridge. Logistic support will be in the form of light aircraft and helicopter. The Carbon Creek coal area and surrounding areas on Kushtaka Ridge will be mapped at a scale of 1:12,000; Cunningham and Carbon Ridges will be mapped at 1:24,000 scale. Fly camps are planned in the Carbon Mountain area for the purpose of measuring stratigraphic sections and collecting microfossils.

Project: Alaskan coastal environments.

Region and map key: Southern Alaska (12).

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; A/C 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

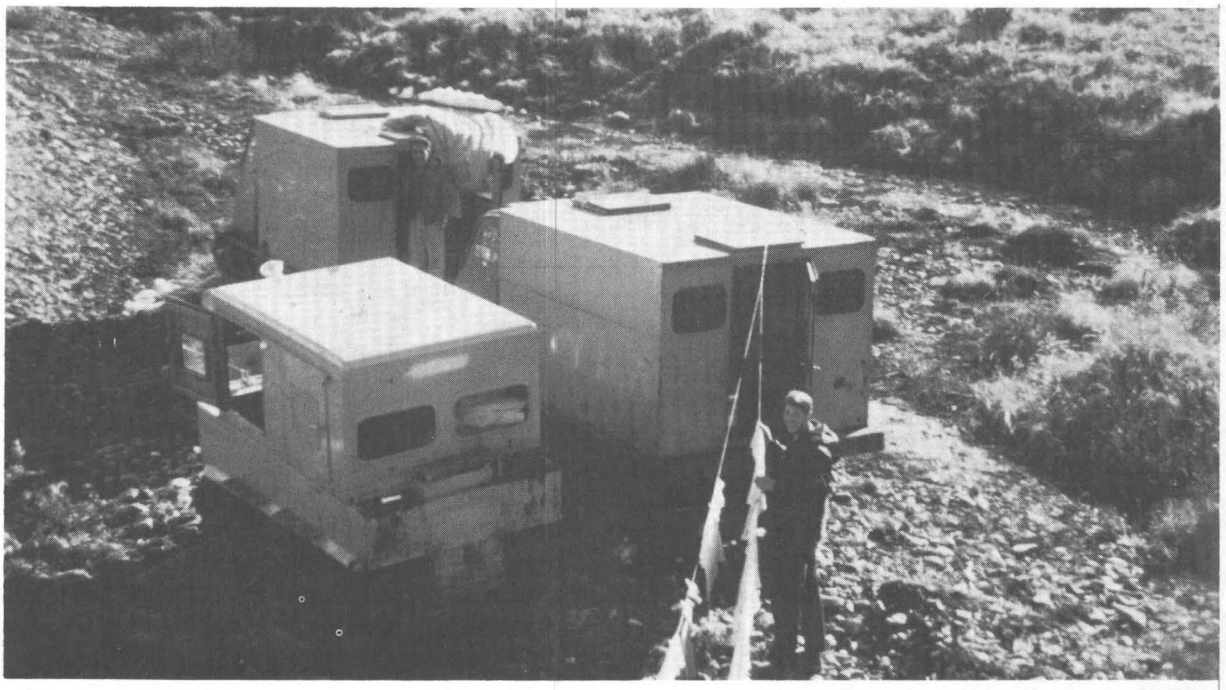


FIGURE 10.—Seward Peninsula: all-terrain vehicles used in mapping and mineral resource evaluation.

Turnagain Arm area near Anchorage, Alaska. Field studies on three scales are planned for the period July 1–September 1, 1973: (1) reconnaissance-scale sampling of the entire arm for texture, minor element geochemistry, bedform and internal sedimentary structures; (2) intermediate-scale facies delineation and mapping in the Portage area; (3) detailed-scale process-response studies of small plots.

A. T. Ovenshine and Nairn Albert (USGS) and Dan Lawson (University of Illinois) will headquarter in the Girdwood area, with mail contact through Betty McIntire's office in Anchorage.

Project: Wrangell Mountains.

Region and map key: Southern Alaska, McCarthy 1° quadrangle (13).

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; A/C 415–323–8111, ext. 2216.

Project plans: The Wrangell Mountains project will focus on geologic mapping and related investigations in the McCarthy quadrangle. The detailed mapping phase of the project, which included mapping eight 1:63,360 quadrangles, has ben completed, and current and future work stresses completion of the reconnaissance geologic mapping for the entire quadrangle that was started on a small scale in 1971. The principal aims of the project are to provide modern multi-purpose geologic maps that should be fundamental in land-use planning, land classification, construction, mineral resource evaluation and exploration, and similar endeavors; to appraise the quadrangle's mineral resources and mineral resource potential; and to provide geologic data of interest to scientists as well as laymen. Contemplated 1973 fieldwork includes 2 weeks of helicopter-supported investigations in the northeastern part of the quadrangle (White River drainage) during late July or early August in cooperation with Don Richter.

Project: Eastern Alaska Range.

Region and map key: Southern Alaska, Nabesna quadrangle and parts of the McCarthy, Mt. Hayes and Gulkana quadrangles (14).

Organizational designation: Geologic Division,

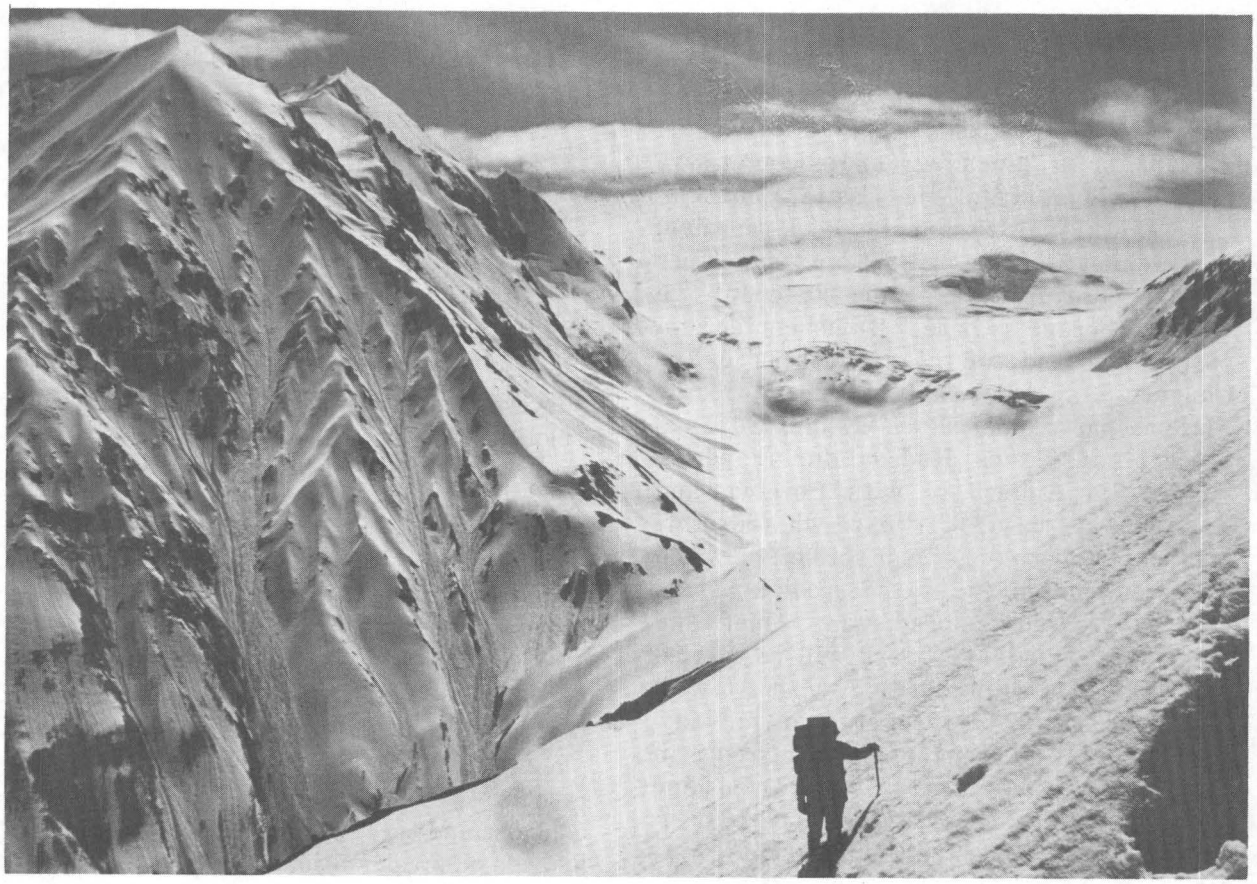


FIGURE 11.—Wrangell Mountains project: a "tough go."

Office of Mineral Resources, Branch of Alaskan Geology.

Project chief: D. H. Richter U.S. Geological Survey, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–272–8228.

Project plans: Detailed mapping and biostratigraphic studies of the Permian-Pennsylvanian in the Mt. Hayes A–1 quadrangle (1:63,360 scale) will begin in late June. The work will be carried out by Don Richter and J. T. Dutro, Jr., with helicopter support. Field headquarters will be at Mankomen Lake.

In early July Don Richter and E. M. MacKevett will begin reconnaissance mapping of the northeast corner of the McCarthy quadrangle (1:250,000 scale). Helicopter support will be provided, and the base camp will be situated on the White River.

In late July, Don Richter, R. L. Smith, and T. P. Miller, with helicopter support, will carry out detailed mapping of the Wrangell volcanic field in the Nabesna A–5, A–6, and B–6 quadrangles (1:63,360 scale). Field headquarters will be at Devils Mountain Lodge, Nabesna.

Detailed studies along the Denali fault in the Mt. Hayes A–1 quadrangle (1:63,360 scale) will commence in August. Tracked vehicles will be used, and the field camp will be located on the upper Slana River.

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; A/C 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 1973 include: (1) Helicopter-supported field study of the Castle Mountain-Lake Clark fault system by R. Detterman, party chief, George Plafker, and one other geologist during period June 20 to July 20 with Anchorage as base; (2) helicopter-supported field study of the western end of the Chugach-Saint Elias fault system by George Plafker, party chief, Russ Tysdal, Ed MacKevett, and Travis Hudson during period July 20 to August 20 with Cordova and Yakataga as base; (3) fixed-wing-aircraft and boat-supported study of active faults and displaced shorelines in the Kodiak Island area by Warren Coonrad, party chief, and one or two assistants (work will be carried out from about June 20 to August 31 with Kodiak as base); (4) field study of liquefaction potential and earthquake recurrence in the Turnagain Arm area by A. T. Ovenshine and Reuben Kachadoorian as part of Ovenshine's Alaskan Coastal Environments project.

Project: Gulf of Alaska Tertiary.

Region and map key: Parts of Mt. Fairweather, Skagway, Yakutat, Mount St. Elias, Icy Bay, Bering Glacier, and Cordova quadrangles (16).

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; A/C 415–323–8111, ext. 2201.

Project plans: The overall objective of the project in 1973 is to complete geologic map coverage of Tertiary basin and adjacent older terrain, with detailed mapping and biostratigraphic studies in selected key areas.

In 1973 approximately 1 week will be spent completing detailed geologic mapping and biostratigraphic study of Kayak and Wingham Islands. Personnel in the party will be George Plafker, Russ Tysdal, Ed MacKevett, and Travis Hudson. Work will be carried out in the period from July 20 to August 20, during which time the party will be based in Cordova and Yakataga with a helicopter for logistic support.

Project: Greater Anchorage Area Borough, Alaska.

Region and map key: Southern Alaska, Greater Anchorage Area Borough (17).

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

Project chief: E. Dobrovolny, U.S. Geological Survey, Denver Federal Center, Lakewood, Colo. 80225; A/C 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, such as slope, stability, construction materials, and foundation and excavation conditions, are being prepared from the geologic maps for use by planners and developers. A generalized geologic map and a slope map of Anchorage and vicinity recently have been published, and several interpretive maps are in process.

Assigned personnel: E. Dobrovolny and H. R. Schmoll.

Project: Alaskan seismic studies.

Region: Southern Alaska.

Organizational designation: Geologic Division, Office of Earthquake Research and Crustal Studies.

Project chief: Robert A. Page, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2461.

Project plans: This project investigates seismicity, tectonic processes, and earth structure in southern Alaska. Earthquakes in the Cook Inlet-Kenai Peninsula-Prince William Sound-

Chugach Mountains region are recorded by a network of 23 seismic stations. 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 will be published in the form of maps of epicenters, catalogs of earthquakes, and scientific reports and articles.

Betwen July and September 1973, existing stations will be serviced, and as many as seven additional stations may be added to the network. The fieldwork will be headquartered in Anchorage and will be carried out by four to six people under the supervision of Edward Criley and Robert Page.

Project: Mt. McKinley National Park map.
Region and map key: Southern Alaska, Mt. McKinley (18).
Organizational designation: Topographic Division, Rocky Mountain Mapping Center.
Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225; A/C 303–234–2351.
Project plans: A new map of Mt. McKinley Park is being prepared at the 1:250,000 scale, using 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: Anchorage project.
Region and map key; Southern Alaska (19).
Organizational designation: Topographic Division, Rocky Mountain Mapping Center.
Project chief: A. E. Letey, Chief, Rocky Mountain Mapping Center, Denver, Colo. 80225; A/C 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. During the 1973 season, Topographic Division field parties will perform vertical and horizontal control operations as well as obtain advance field information. Thomas J. O'Brien, Resident Engineer, will be in charge of the project. Five field engineers under the direction of Mr. Robert Foley, Project Supervisor, will perform the field operations. Helicopter support will be used in the mountainous areas.

Project: Glaciology studies.
Region and map key: Southern Alaska (20).
Organizational designation: Water Resources Division, Alaska District Office.
Project staff: L. R. Mayo, Project Chief, D. R. Scully, Hydrologist, U.S. Geological Survey, Water Resources Division Field Office, 310 First Avenue, Fairbanks, Alaska 99701; A/C 907–452–1951, ext. 176 or 177.
Project plans:
Objective: To collect data on the climate, on changes in ice storage, and on the water balance in order to answer basic questions about the effect of climatic variation on ice storage at basins dominated by glaciers. Two glaciers in Alaska are under study at the present time—Gulkana Glacier on the south flank of the Alaska Range and Wolverine Glacier in south-central Alaska. Wolverine Glacier is strongly affected by the North Pacific maritime climate, and Gulkana Glacier is located in the northern continental climate of central Alaska.
Approach: The climatic items measured include air temperature at different altitudes and precipitation rate. The ice storage study will include mapping the growth and melting of the seasonal snowpack and glacial ice mass. The difference between precipitation and stream-discharge data provides a check on the snow and ice balance data.
Progress: Both Gulkana and Wolverine Glaciers are instrumented in the same way, including recording precipitation gage, recording stream gage, seven storage precipitation gages, two recording air temperature gages, network of snow and ice balance stakes and snow density/temperature test pits, and periodic air photography to map hydrologic pattern data. The network of gages and detailed mapping of snow accumulation in these basins show that annual precipitation increases markedly with altitude in the Alaska Range.

Reports completed:

Meier, M. F., Tangborn, W. V., Mayo, L. R., and Post, Austin, 1971, Combined ice and water balances of Gulkana and Wolverine Glaciers, Alaska, and South Cascade Glacier, Washington, 1965 and 1966 hydrologic years: U.S. Geol. Survey Prof. Paper 715–A.

Post, Austin, Mayo, L. R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geol. Survey Hydrol. Inv. Atlas HA–455.

Mayo, L. R., 1972, Self-mixing antifreeze solution for precipitation gages. Jour. Applied Meteorology, v. 11, no. 2, p. 400–404.

Mayo, L. R., Meier, M. F., and Tangborn, W. V., 1972, A system to combine stratigraphic and annual mass-balance systems; a contribution to the International Hydrological Decade: Jour. Glaciology, v. 11, no. 61, p. 3–14.

SOUTHEASTERN ALASKA

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, Lakewood, Colo. 80225; A/C 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 preparation and planned for completion and release in open files in 1973. Assigned personnel: L. A. Yehle.

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, Lakewood, Colo. 80225; A/C 303–234–3546.

Project plans: Main objective of the project is to evaluate, by reconnaissance field studies, 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. Work during the remainder of the year will be directed toward completing open-file reports for the remaining communities. Assigned personnel: R. W. Lemke.

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

Region: Southeastern Alaska, parts of Juneau A–2, B–2, and B–3 quadrangles, 1:63,360.

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

Project chief: R. D. Miller, U.S. Geological Survey, Denver Federal Center, Lakewood, Colo. 80225; A/C 303–234–2960.

Project plans: Fieldwork has been completed. Report and map "Surficial geology of the Juneau urban area and vicinity, Alaska, with emphasis on earthquake and other geologic hazards" was open-filed in May 1972. Geologic map with accompanying tabular text is in preparation for publication in the miscellaneous geologic investigations map series. Several short scientific papers on various aspects of the geology of the Juneau area are in preparation for publication. Assigned personnel: R. D. Miller.

Project: Craig quadrangle.

Region and map key: Southeastern Alaska (21).

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

Project chiefs: G. D. Eberlein and M. Churkin, Jr., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2210 or 2256.

Project plans: Field plans for 1973 include work

along the west coast of Prince of Wales Island using R/V *Don J. Miller* from May 4 to August 28 for support. Systematic geologic mapping of hitherto unmapped (i.e., since the 1916–17 reconnaissance published in U.S. Geological Survey Bulletin 800) parts of Craig A–5, B–5, and B–6 1:63,360 quadrangles. This work will be done by Eberlein and Churkin with the assistance of Nairn Albert and another Geological Survey field assistant. Besides this work to complete the Craig 1:250,000 quadrangle, Churkin will work from June 28, 1973, until about August 1, 1973, in the Craig C–3, D–3, and D–4 quadrangles doing inland traverses along the extensive network of logging roads. His base camp will be at Thorne Bay.

Project: Juneau, Alaska, regional mapping and related geologic investigations.

Region and map key: Southeastern Alaska, Juneau and Taku River 1:250,000 map areas (22).

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; A/C 415–323–8111, ext. 2178.

Project plans: During the months of June and July, geologists D. A. Brew and A. B. Ford, accompanied by S. W. Nelson and one other assistant, will be engaged in field studies of the granitic and metamorphic rocks in the northernmost part of the Juneau Icefield. The studies are part of the continuing effort to complete the geologic mapping and mineral-resource survey of the Juneau and Taku River 1:250,000 map areas.

The field party will operate from tent camps on the glaciers and from the permanent camps of the Juneau Icefield Research Program using skis, snowmobiles, and Nansen sledges. The party will be placed in the icefield by helicopter. Radio contact will be through Livingston Copters, Juneau (A/C 907–586–2030). The mailing address will be: c/o General Delivery, Juneau, Alaska 99801.

Project: Annette-Gravina area.

Region and map key: Southeastern Alaska, Ketchikan quadrangle (23).

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

Project chief: H. C. Berg, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2266.

Project plans: Fieldwork in the Annette-Gravina (Islands) area, which includes nearby parts of Revillagigedo Island and Cleveland Peninsula, was recessed in 1972 owing to temporary reassignment of the project chief but will resume in August with geologic mapping and mineral-resource evaluation of southwestern Revillagigedo Island.

Because upper Mesozoic strata identical to those on Annette and Gravina Islands are thought to extend the length of southeastern Alaska, this summer's plans also include a brief reconnaissance to confirm their presence near Haines at the opposite end of the panhandle.

The work on Revillagigedo Island will be supported by small boat, four-wheel-drive Survey vehicle, and fixed-wing aircraft; the work near Haines will be carried out mainly by four-wheel-drive Survey vehicle.

Project personnel include H. C. Berg, party chief, and R. L. Elliott, geologist. Mail address: Box 1618, Ketchikan, Alaska 99901.

Project: Geochronology of the Coast Range plutonic-metamorphic complex.

Region and map key: Southeastern Alaska, Ketchikan and Juneau quadrangles (24).

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

Project chief: James G. Smith, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2484.

Project plans: This is a new project; its members will work in close cooperation with personnel of the Granite Fiords and Tracy Arm Wilderness Study Area projects. The purpose of this project is to apply K/Ar-dating techniques to help unravel the geochronology and thermal history of the Coast Range plutonic-metamorphic complex. Logistic support will be from the R/V *Don J. Miller* as part of the Granite Fiords and Tracy Arm projects. Members of those two projects will do some of the sample collecting.

FIGURE 12.—Granite Fiords Wilderness project: turbine helicopter landing on R/V *Don J. Miller II*, Hyder, southeastern Alaska.

Project: Hyder, Alaska.
Region: Southeastern Alaska, Ketchikan D–1 and Bradfield Canal A–1 quadrangles.
Organizational designation: Geologic Division, Office of Mineral Resources, Branch of Alaskan Geology.
Project chief: James G. Smith, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2484.
Project plans: Fieldwork in the project area is complete, and none is planned in the summer of 1973. A report is in preparation.

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. 13).

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

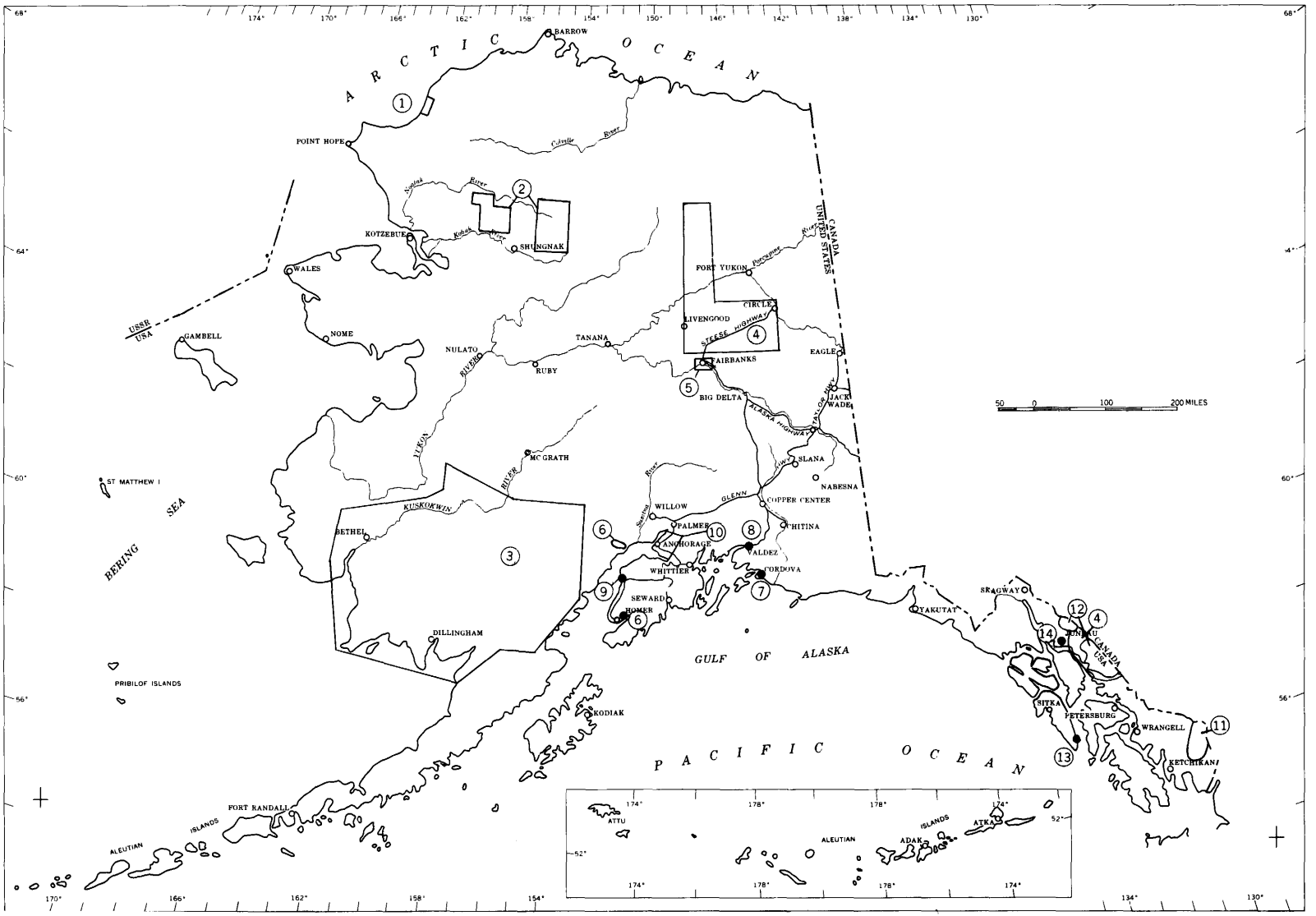


FIGURE 13.—Map showing locations of 1973 fields projects of the U.S. Geological Survey and cooperating agencies. The circled numbers key to project discussions in text.

Survey, Chemistry and Sedimentology Laboratories, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–277–2644 or 2645.

Project plans:

Objective: To provide a national bank of water-quality data for broad Federal planning and action programs and to provide data for Federal management of interstate and international waters.

Approach: Operation of a network of water-quality stations to provide average chemical concentrations, loads, and time trends as required by planning and management agencies.

Cooperating agencies: Alaska Power Administration, U.S. Army Corps of Engineers, and U.S. Forest Service.

Reports completed:

U.S. Geological Survey, 1957, Compilation of records of quantity and quality of surface waters of Alaska through September 1950: U.S. Geol. Survey Water-Supply Paper 1372.

——— 1950–63, Quantity and quality of surface waters of Alaska: U.S. Geol. Survey Water-Supply Papers 1466, 1486, 1500, 1570, 1640, 1720, and 1953.

——— 1964, Water quality records in Alaska, U.S. Geol. Survey basic-data release.

——— 1965–69, Water resources data for Alaska, Part 2. Water-quality records: U.S. Geol. Survey basic-data releases.

——— 1970–71, Water resources data for Alaska, Part 1. Surface water records; Part 2. Water-quality records: U.S. Geol. Survey basic-data releases.

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; A/C 907–277–5526.

Project plans:

Objectives: A. To collect water-level data sufficient to provide a minimum long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known and potential problems can be defined early enough to allow proper planning and management.

B. To provide a data base against which the short-term records acquired in areal studies can be analyzed. This analysis must (1) provide an assessment of the ground-water resource, (2) allow prediction of future conditions, (3) detect and define pollution and supply problems, and (4) provide the data base necessary for management of the resource.

Approach: Evaluation of regional geology allows broad, general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of the stress on the system in time and space and the hydrologic properties of the aquifers, a subjective decision can be made on the most advantageous locations for observation of long-term system behavior. This subjective network can be refined as records become available and detailed areal studies of the ground-water system more closely define the aquifers, their properties, and the stresses to which they are subjected.

Cooperating agencies: State of Alaska, Department of Natural Resources: U.S. Air Force, U.S. Army Corps of Engineers.

Reports completed:

U.S. Geological Survey, 1963, Ground-water levels in the United States 1955–60, Northwestern States: U.S. Geol. Survey Water-Supply Paper 1760, p. 3–12.

——— 1968, Ground-water levels in the United States 1961–65, Northwestern States: U.S. Geol. Survey Water-Supply Paper 1845, p. 3–8.

——— 1972, Ground-water levels in the United States 1966–70, Northwestern States: U.S. Geol. Survey Water-Supply Paper 1980, p. 4–15.

Project: Surface-water stations.

Region: Statewide.

Organizational 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; A/C 907–277–5526.

Project plans:

Objectives: A. To collect surface-water data sufficient to satisfy needs for current purposes and uses, such as (1) assessment of water resources, (2) operation of reservoirs or industries, (3) forecasting, (4) disposal of wastes and pollution controls, (5) discharge data to accompany water-quality measurements, (6) compact and legal requirements, and (7) research or special studies.

B. To collect data necessary for analytical studies to define for any location the statistical properties of, and trends in, the occurrence of water in streams, lakes, estuaries, and other sources, for use in planning and design.

Approach: Standard methods of data collection will be used as described in the series, "Techniques of Water Resources Investigations of the United States Geological Survey." Partial-record gaging will be used instead of complete-record gaging where it serves the required purpose.

Cooperating agencies: Alaska Power Administration; National Marine Fisheries Service; U.S. Air Force; U.S. Army Corps of Engineers; U.S. Forest Service; U.S. Public Health Service. State of Alaska, Department of Fish and Game; State of Alaska, Department of Highways; State of Alaska, Department of Natural Resources.

Reports completed:

Childers, J. M., 1970, Flood frequency in Alaska: U.S. Geol. Survey open-file rept.

——— 1970, A proposed streamflow data program in Alaska: U.S. Geol. Survey open-file rept.

U.S. Geological Survey, 1957, Compilation of records of quantity and quality of surface waters of Alaska through September 1950: U.S. Geol. Survey Water-Supply Paper 1372.

——— 1964, Compilation of records of surface waters of Alaska, October 1950 to September 1960: U.S. Geol. Survey Water-Supply Paper 1740.

——— 1961–63, Surface water records of Alaska: U.S. Geol. Survey basic-data releases.

——— 1964–69, Water resources data for Alaska, Part 1. Surface water records: U.S. Geol. Survey basic-data releases.

——— 1970–71, Water resources data for Alaska, Part 1. Surface water records: Part 2. Water quality records: U.S. Geol. Survey basic-data releases.

Project: Sediment stations.

Region: Statewide.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: V. W. Norman, U.S. Geological Survey, Water Resources Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–279–1563.

Project plans:

Objectives: To provide a national bank of sediment data for use in broad Federal and State planning and action programs and to provide data for Federal management of interstate and international waters.

Approach: Establish and operate a network of sediment stations to provide spatial and temporal averages and trends of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

Cooperating agencies: Alaska Power Administration: U.S. Army Corps of Engineers; U.S. Forest Service.

Reports completed:

U.S. Geological Survey, 1950–63, Quantity and quality of surface waters of Alaska: U.S. Geol. Survey Water-Supply Papers 1466, 1486, 1500, 1570, 1640, 1720, and 1953.

——— 1964, Water quality records in Alaska: U.S. Geol. Survey basic-data release.

——— 1965–69, Water resources data for Alaska, Part 2. Water quality records: U.S. Geol. Survey basic-data releases.

——— 1970–71, Water resources data for Alaska, Part 1. Surface water records; Part 2. Water quality records: U.S. Geol. Survey basic-data releases.

Project: Corrosion and encrustation studies for Alaskan Air Command.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: H. L. Heyward, U.S. Geological Survey, Chemistry and Sedimentology Laboratories, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–277–2644 or 2645.
Project plans:
Objective: To assess the corrosive and encrustation characteristics of water at selected Air Force sites throughout Alaska.
Approaches: (1) Make corrosion rate measurement of raw water using Magna Corp. Model 1170 Corrator and probe of mild steel; (2) make field measurements of chemical properties such as Eh, pH, and alkalinity; (3) collect and identify encrusting materials as they become available; (4) make periodic chemical analysis of water in the laboratory; and (5) evaluate the chemistry of the water in relation to corrosion.
Progress: Raw and treated water from 16 Air Force sites have been tested for corrosive and encrustation properties. The data gathered suggest four types of water: (1) soft water containing high dissolved oxygen corrosive to mild steel; (2) soft water that is moderately mineralized, containing no dissolved oxygen and noncorrosive to mild steel; (3) hard water containing no dissolved oxygen or neutral salts and noncorrosive to mild steel; (4) hard water containing no dissolved oxygen but significant concentrations of neutral salts and corrosive to mild steel.
Cooperating agency: Alaskan Air Command.
Reports completed:
Heyward, H. L., 1969, Corrosion and encrustation at selected Air Force sites in Alaska: U.S. Geol. Survey adm. rept.
——— 1971, A study of corrosive properties of selected Alaskan ground water: Univ. of Alaska, Proc. of Symposium on Cold Regions Eng., College, Alaska, v. 2, p. 602–620, March.

Project: Scour research.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project chief: V. W. Norman, U.S. Geological Survey, Water Resources Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–279–1563.
Project plans:
Objective: At a network of bridge sites, observe and record the magnitude of those factors believed to be significantly related to scour, such as (a) channel contraction, in the case of general scour, (b) depth and velocity of flow approaching locations of local scour, and (c) size distribution of bed material in and around the area of scour.
Approach: Observe and record the magnitude of scour, both general and local, during significant floods at selected bridges. Analyze recorded scour and scour-related data. Analysis should verify or help to modify presently available analytic techniques for evaluating probable scour at bridge crossings.
Progress: Scour-related data have been collected during floods of mean annual peak discharge or greater at nine different bridge sites. At those sites where general scour occurred owing to width contraction, computed values of general scour were in fair agreement with measured values. Minimum bed elevations at bridge openings tended to remain at a given level but were observed to shift laterally, in some places many tens of feet. Computed values of local scour at piers in gravel and cobble-bed streams were up to five times greater than the measured values.
Cooperationg agency: State of Alaska, Department of Highways.
Reports completed:
Leveen, L. S., 1966, Investigation of scour at selected bridge crossings in Alaska: U.S. Geol. Survey adm. rept.
——— 1967, Investigation of scour at selected bridge crossings in Alaska: U.S. Geol. Survey adm. rept.

Project: Quality of water analysis.
Region: Statewide.
Organizational designation: Water Resources Division, Alaska District Office.
Project staff: R. J. Madison, project chief, H. L. Heyward, chemist, U.S. Geological Survey, Chemistry and Sedimentology Labo-

ratories, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–277–2644 or 2645.

Project plans:

Objective: To provide chemical analyses of selected samples of water as collected by representatives of the State, Federal, and military agencies.

Approach: Quality of water analysis for Alaska Department of Environmental Conservation, Bureau of Indian Affairs, Public Health Service, Air Force, and U.S. Army will be provided as needed. This data will be added to our general files of basic data.

Progress: During 1973 fiscal year, analyses for approximately 600 samples of water were provided.

Plans for next fiscal year: The U.S. Air Force and U.S. Army will be dealing directly with the Salt Lake City Central Laboratory for chemical analyses. It is estimated that the other cooperating agencies will submit approximately 200 samples for analyses next year.

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; A/C 907–277–5526.

Project plans:

Objective: To assist the approximately 270 indian villages and numerous other small villages and towns in the State in the development of water supplies for domestic use. The program is set up on a continuing basis whereby a few villages are assisted each year until the need is satisfied.

Approach: The work involves primarily rapid geohydrologic reconnaissance of the areas in question. This involves an appraisal of the surface and ground water available and its quality. After the brief reconnaissance and collection of miscellaneous basic data, a report will be written giving conclusions and recommendations for future development.

Progress: During the 1973 fiscal year, reports are being prepared on Kotzebue, Pelican, Seldovia, and Skagway, largely on the basis of existing data supplemented by minimum field reconnaissance. Some preliminary work has also been done on Seward.

Plans for next fiscal year: Work will continue as required to provide assistance to small villages on demand.

Cooperating agency: State of Alaska, Department of Natural Resources.

Reports completed:

Feulner, A. J., 1970, Water-resources reconnaissance of the Kwiguk (Emmonak) area, Alaska: U.S. Geol. Survey open-file rept.

Weeks, J. B., 1960, Water-resources reconnaissance of the Old Harbor area, Kodiak Island, Alaska: U.S. Geol. Survey open-file rept.

——— 1970, Water-resources reconnaissance of the Golovin area, Alaska: U.S. Geol. Survey open-file rept.

Project: Hydrologic environment of the Trans-Alaska Pipeline System (TAPS), Alaska.

Region: Statewide, east-central 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, Chester Zenone, hydrologist, U.S. Geological Survey, Alaska District Office, 218 E Street, Anchorage, Alaska 99501; A/C 907–277–5526.

Project plans:

Objective: To provide and assure maintenance of environmental quality, especially as related to the safe design and construction of a pipeline corridor. To deploy a group of competent specialists to collect and interpret facts of a timely and useful nature. To collaborate closely with other Federal and State agencies and institutes to assure a coordinated input of effort. To collect basic hydrologic data and to establish a system to monitor and evalu-

ate appropriate aspects of the hydrology and related sciences within the pipeline corridor.

Approach: To evaluate specific environmental problems, including (1) floods, (2) icings, (3) scour and fill, (4) erosion and deposition, (5) water quality, (6) water supply, (7) waste disposal, and (8) glaciers. Assess the impact of construction and operation of a pipeline and appurtenant facilities on hydrologic and geomorphic environments along the pipeline corridor. Study of any special problems that may arise, such as avalanches and mudflows. Continuous monitoring of the water environment to assess the inception of irreversible undesirable changes.

Progress: The project is now 3 years old. Work has continued on providing specific assessment of anticipated hazards and impacts on water resources of the proposed trans-Alaska pipeline. General studies of arctic hydrology are also in progress. Field work includes (1) establishing and operating 10 stream-gaging and water-quality stations and 11 aquatic biology stations, (2) channel surveys of flood and erosion characteristics at 24 sites, (3) annual surveillance of icings, glacier advance, and glacier-dammed lakes, (4) surge-glacier profile survey, and (5) reconnaissance of 11 arctic springs. Preconstruction aquatic biological data collection is completed. Office work includes analysis of data and analytical studies leading to technical reports.

Plans for next fiscal year: The work is planned to continue, with emphasis on data analysis and report preparation. A more intensive study of Black Rapids Glacier surge characteristics using aerial photogrammetry is planned, as is a detailed study of channel scour characteristics at selected sites.

Reports completed:

Alaska District Staff, 1969, Hydrological observations, Fairbanks Prudhoe Bay and other Arctic Slope areas: U.S. Geol. Survey open-file rept.

Brice, J. C., 1971, Measurement of lateral erosion at proposed river crossing sites of the Alaska pipeline: U.S. Geol. Survey open-file rept.

Childers, J. M., 1970, Flood frequency in Alaska: U.S. Geol. Survey open-file rept.

——— 1972, Channel erosion surveys along proposed TAPS route, Alaska, July 1971: U.S. Geol. Surveys open-file rept.

——— 1972, Flood surveys along proposed TAPS route, Alaska, July 1971: U.S. Geol. Survey open-file rept.

Childers, J. M., Sloan, C. E., and Meckel, J. P., 1973, Hydrologic reconnaissance of streams and springs in eastern Brooks Range, Alaska, July 1972: U.S. Geol. Survey open–file rept.

Emmett, W. W., 1972, The hydraulic geometry of some Alaskan streams south of the Yukon River: U.S. Geol. Survey open-file rept.

Interagency Task Force, 1972, Final environmental impact statement, proposed trans-Alaska pipeline: U.S. Dept. of Interior, Federal Task Force on Alaskan Oil Devel., v. 1–9.

——— 1972, Stipulations for the proposed trans-Alaska pipeline: U.S. Dept. of Interior, Federal Task Force on Alaskan Oil Devel.

Post, Austin, and Mayo, L. R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geol. Survey Hydrol. Inv. Atlas HA–455.

Sloan, C. E., and Bredehoeft, J. D., 1972, Some effects of a heated pipeline on ground-water flow in Alaska: U.S. Geol. Survey open-file rept.

NORTHERN ALASKA

Project: Cape Beaufort-Corwin Bluff coal investigation.

Region and map key: Northern Alaska (1), parts of Point Lay and De Long Mountains quadrangles.

Organizational designation: Conservation Division, Alaska Area Office, Mineral Evaluation.

Project chief: A. A. Wanek, U.S. Geological Survey, Box 259, Anchorage, Alaska 99501; A/C 907–277–0570.

Project plans: This summer a continuation of a 1:24,000-scale reconnaissance mapping program will be carried out in anticipation of resumption of the U.S. Bureau of Mines-Geological Survey drilling program initiated

in 1972 field season. Owing to very sparse outcrops, this work will consist of mapping and interpreting surface indications of coal (for example, bloom and rubble) and structural relationships in associated sandstones for the purpose of locating favorable drill sites. Efforts will be concentrated in the Deadfall Syncline area north of Cape Beaufort. The field party will consist of J. E. Callahan and one field assistant and possibly someone from the U.S. Bureau of Mines. A Rolligon belonging to the Bureau will be used to transport a "roving" field camp that will resupply from the abandoned D.E.W. site at Cape Beaufort.

Cooperating agency: U.S. Bureau of Mines.

Project: Ipewik-Kukpuk.

Region and map key: Northern Alaska (2).

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, California 94025; A/C 415–323–8111, ext. 2254 and G. H. Pessel, Alaska Division of Geological and Geophysical Surveys, 3001 Porcupine Drive, Anchorage, Alaska 99501; A/C 907–279–1433.

Project plans: In this cooperative investigation geologists from both the Alaska and Federal surveys are joining in fieldwork in a remote part of northern Alaska. State personnel are G. H. Pessel (leader), R. E. Garland, geologist, J. M. Zdepski, assistant, and Mary Moran, camphand; U.S.G.S. personnel are geologists W. P. Brosgé and I. L. Tailleur. R. Forbes, D. Turner, and J. Mowatt (University of Alaska) will join the project at times. Fieldwork will be supported by helicopter and will start May 31 from a camp at Walker Lake and move later in the season to camps at Lake Omelaktavik on the upper Noatak and near the Jade Mountains. Mailing address: c/o Alaska Geological Survey, College, Alaska 99501.

Cooperating agency: State of Alaska, Division of Geological and Geophysical Surveys.

EAST-CENTRAL ALASKA

Project: Alaskan aeromagnetic surveys.

Region and map key: East-central Alaska (4), Circle quadrangle, plus parts of Chandalar, Beaver, Livengood quadrangles; southeastern Alaska (4), parts of Sumdum and Taku River quadrangles.

Organizational designation: Geologic Division, Office of Geochemistry and Geophysics, Branch of Regional Geophysics.

Project chief: John Henderson, Regional Geophysics Branch, U.S. Geological Survey, Federal Center, Denver, Colo.; A/C 303–234–2623.

Project plans: Under a cooperative agreement, the State of Alaska Division of Geological and Geophysical Surveys and the U.S. Geological Survey are both contracting for aeromagnetic surveys to prepare an aeromagnetic map of the State. The Federal effort is funded as one part of a broader program to prepare a national aeromagnetic map. For the coming summer a contract has been awarded to Geometrics Inc. of Palo Alto, Calif., to survey all of the Circle 1:250,000-scale quadrangle and also to cover the unsurveyed halves of the Chandalar, Beaver, and Livengood quadrangles. The contractor plans to operate out of Fairbanks from early June until mid-July and can probably be contacted through the U.S. Geological Survey office at 310 First Avenue, Fairbanks, Alaska (A/C 907–452–1949). The contract will also include aeromagnetic coverage of about 2,000 square miles in parts of the Taku River and Sumdum quads in southeastern Alaska. This survey will be part of the geologic evaluation of the proposed Tracy Arms-Ford's Terror Wilderness Area.

Cooperating agency: State of Alaska, Division of Geological and Geophysical Surveys.

Project: Reconstruction base line biological water quality of the Chena and Little Chena Rivers.

Region and map key: East-central Alaska (5).

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: G. A. McCoy, U.S. Geological Survey, Chemistry and Sedimentology Laboratories, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–277–2644 or 2645.

Project plans:

Objective: To determine the present biological conditions for the Chena and Little

Chena Rivers downstream from the proposed dam sites and above the upper limit of the reservoir pool on the Chena River.

Approach: To collect quantitative and qualitative data on the stream biota eight times per year to determine species composition, relative abundance, and diversity. Benthic invertebrates, periphyton, and phytoplankton will be collected and described using the following twofold approach: (1) Three fixed stations will be sampled at predetermined intervals; and (2) synoptic reconnaissance sampling to determine longitudinal variation in biological composition will be carried out early in the summer and before freezeup. Synoptic reconnaissance sampling sites will represent various environments at varying distances upstream and downstream from the proposed dam sites. Physical and chemical data from other CBR projects will be coordinated with the biological data.

Progress: During fiscal year 1973, biological samples on the Chena River were collected on six occasions. In June an extensive reconnaissance sampling at 12 sites was conducted. Laboratory analysis of these biological samples is approximately 70 percent complete.

Plans for next fiscal year: A report will be prepared covering biological water quality of the Chena and Little Chena Rivers. Analysis of samples collected in fiscal year 1973 will be completed. Samples will be collected five times, and 80 percent of the analysis of these samples will be completed in fiscal year 1974.

Cooperating agency: U.S. Army Corps of Engineers.

SOUTHWESTERN ALASKA

Project: Alaskan gravity surveys.

Region and map key: Southwestern Alaska (3), Lime Hills, Russian Mission, Goodnews, Iliamna, and intermediate quadrangles.

Organizational designation: Geologic Division, Office of Geochemistry and Geophysics, Branch of Regional Geophysics.

Project chief: David F. Barnes, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2249.

Project plans: A 10-year U.S. Geological Survey program to prepare a gravity map of Alaska is being completed under a 3-year cooperative agreement with the State of Alaska Division of Geological and Geophysical Surveys. This year, as in most of the previous 9 years, the major effort will be to obtain data by small-boat traverses along rivers and shorelines. The 1973 field season will complete these traverses and will be concentrated on the Nushuagak, Mulchatna and Lower Kuskokwim River drainages and lake shorelines on the upper Peninsula. A four- or five-man party will begin these traverses with air support from Anchorage in late June and will then work out of successive operating bases—Sleetmute, Aniak, Bethel, Dillingham, and Iliamna. Personnel will probably include D. F. Barnes, K. D. Folden, R. L. Morin, S. L. Robbins, and one other. Mailing address will be: c/o Administrative Officer, U.S. Geological Survey, 218 E Street, Anchorage, Alaska 99501.

Cooperating agency: State of Alaska, Division of Geological and Geophysical Surveys.

SOUTHERN ALASKA

Project: Petroleum geology of Cook Inlet basin.

Region and map key: Southern Alaska (6), parts of Tyonek, Anchorage, Kenai, and Seldovia quadrangles.

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, California 94025; A/C 415–323–8111, ext. 2116 or 2117.

Project plans: The objectives of this project are fivefold: to prepare comprehensive bibliographies for petroleum provinces in Alaska, such as Cook Inlet Basin, North Slope, Southeast Alaska, and Nushagak; to establish a regional stratigraphic framework and nomenclature for Cook Inlet Basin by means of interlocking cross sections utilizing samples, paleontology, and electrical logs; to determine facies, depositional environment, source areas, and spatial relationships of Tertiary and possibly some Mesozoic rocks; to analyze the factors involved in the origin, migration, and accumulation of petroleum; and finally, to evaluate the potential of relatively unexplored areas of Cook Inlet and adjacent areas of the continental shelf with particular em-

phasis on providing data and interpretations suitable for extrapolation to the outer continental shelf (Shelikof Strait) subject to nominations for bidding and leasing by the oil industry.

Fieldwork in 1973 will be in southern Alaska. From June 1 to July 15, plans are to finish describing and sampling Tertiary outcrops about 12-20 miles northeast of Homer. From July 15 to August 15 emphasis will be on describing and sampling Tertiary rocks south of Capps Glacier, about 60 miles west of Anchorage. Fieldwork will be done by W. L. Adkison and John Kelley of the Branch of Oil and Gas Resources, and E. R. Landis and Kevin Biddle of the Coal Resources Branch. They plan to use four-wheel-drive vehicle, all-terrain vehicle, and helicopter. Field headquarters from about June 1 to July 15 will be at Homer, Alaska, and from July 15 at Nikiski, Alaska.

Cooperating agency: State of Alaska, Division of Geological and Geophysical Surveys.

Project: Hydrology of the Cordova area, Alaska.

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

Organization designation: Water Resources Division, Alaska District Office.

Project chief: G. S. Anderson, U.S. Geological Survey, Alaska Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–279–1563.

Project plans:

Objective: To assist the city of Cordova in its current drilling and testing program and, working closely with its consultants, to evaluate the geohydrology of the area. This work will also require water sampling of appropriate intervals in some wells and exhaustive aquifer testing involving the individual wells or the entire well field as the drilling program proceeds. Discharge measurements on selected streams will be made.

Approach: To follow the test-drilling program closely and to collect water samples and make geophysical logs as appropriate to evaluate the water-bearing characteristics of the aquifers supplying ground water and to determine the quantity and quality of water available. As each new well is completed and developed, to make pump tests to determine the specific capacity of the well and the transmissivity of the aquifer and thereby provide data necessary for the optimum design of the well field and for the development of a coordinated pumping schedule. It is planned that a water-level stages recorder will be used to monitor and analyze pumping effects during testing. Low-flow measurements will be made on Heney Creek.

Progress: Data from previous aquifer tests have been reevaluated, and additional tests have been performed. A water-level stage recorder has been installed to monitor the effects of pumping. Winter low-flow measurements have been made in Heney Creek, which is Cordova's principal water source during the summer.

Plans for next fiscal year: Additional water-resources data are needed in the Cordova area. This requires continuation of the basic-data collection and testing program and expansion of the scope of the program to provide a comprehensive report on the alternatives available to water managers in the area.

Cooperating agency: City of Cordova.

Project: Water resources investigations of the Valdez-Copper Center area, south-central Alaska.

Region and map key: Southern Alaska (8), Valdez area.

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; A/C 907–277–5526.

Project plans:

Objective: To make a hydrologic appraisal of water availability and quality as related to the industrialization and urbanization activities in and along the Alaska pipeline corridor from Valdez to Copper Center.

Approach: To include an inventory of present development, delineation of principal aquifers, definition of stream low-flow characteristics, and base-line data on water quality including sediment load, quality,

characteristics of rivers, lakes, springs, and ground water.

Progress: Two field trips this fiscal year have been made to inventory existing water supplies, to obtain basic data on streamflow, and to collect water samples to determine the quality of both surface and ground water. Other fieldwork is planned to supplement the data already acquired.

Plans for next fiscal year: Plans for next fiscal year involve the compilation and analysis of the basic data and completion of a basic-data report on the first segment of the corridor from Valdez to Copper Center, Alaska. At the completion of this report, additional segments along the corridor will be studied.

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

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

Region and may key: Southern Alaska (9), 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, Alaska Subdistrict Office, 1209 Orca Street, Anchorage, Alaska 99501; A/C 907–279–1563.

Project plans:

Objectives: 1, To locate and evaluate the availability and quality of municipal and industrial water supplies. 2, To evaluate the effects of industrial pumpage in the North Kenai area. 3, To develop an inventory of hydrologic data to aid in the current and future water-resources development of the area and to provide the necessary information to assist in management decisions.

Approach: Investigation of surface and subsurface sources involving streamflow measurements, test drilling, geophysical logging, aquifer testing, record of ground-water level changes, and analysis of water quality. Evaluation of hydrologic data for estimates of variability of streamflow, potentially available ground water, regional variability of surface- and ground-water quality, causes of ground-water and lake storage changes, and effects of ground-water development.

Progress: A report on the water resources of the Kenai-Soldotna area has been completed and is being published. A basic-data program for collecting streamflow, ground-water, and lake-level data is continuing. Plans have also been made for additional aquifer testing in the Beaver Creek valley near Kenai this fiscal year.

Plans for next fiscal year: Future plans include the continuation of the basic-data monitoring program that involves 1 stream-gaging station, 13 ground-water observation wells, and 10 annual lake-level surveys.

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

Reports completed:

Anderson, G. S., 1971, Ground-water exploration, Beaver Creek valley near Kenai, Alaska: U.S. Geol. Survey open-file rept.

——— 1972, Aquifer test, Soldotna, Alaska: U.S. Geol. Survey open-file rept.

Anderson, G. S., and Jones, S. H., 1971, Hydrologic data of the Kenai-Soldotna area, Alaska: U.S. Geol. Survey open-file rept.

——— 1971, Lake-level fluctuations in the Kenai-Soldotna area, Alaska, 1967–71: U.S. Geol. Survey open-file rept.

——— 1972, Water resources of the Kenai-Soldotna area, Alaska: U.S. Geol. Survey open-file rept.

Project: Geohydrology of the Anchorage, area, Alaska.

Region and map key: Southern Alaska (10), 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, Alaska Subdistrict Office, 1209 Orca

Street, Anchorage, Alaska 99501; A/C 907–279–1563.

Project plans:

Objective: A continuing study of the geohydrology of the Anchorage area has been undertaken to provide interpretive and basic data for the orderly development of its water resources. The study will define surface and subsurface flow of water into and out of the area, with consideration of changes in chemical quality resulting from use. The effects of urbanization are being assessed, and the feasibility of artificial recharge to the ground-water reservoir is being investigated. The analog model constructed of the area is being used to study the alternatives available for effective management of the water resources of the area.

Approach: This investigation includes inventory of hydrologic data, test drilling, areal geophysical studies including seismic and resistivity surveys, geophysical logging, remote sensing studies, and a study of the quality of surface and ground water. It also includes study of the relationship of surface and ground water to inflow, outflow, and storage. In addition to these emphasis will be placed on the possibility of ground-water recharge, the effects of urbanization on hydrology, and the use of the analog model to provide data needed in management decisions.

Progress: The results of project work during the period 1966–70 have been compiled into a report describing water availability and the effects of urban development on the hydrology. An electric-analog model of the Anchorage hydrologic system has been constructed and is revised periodically to allow its use in water management studies.

Plans for next fiscal year: The hydrologic work may be separated into three categories. These include: (1) A basic-data collection and monitoring program designed to measure the impact of man's activities on the water resources of the area, (2) water availability studies designed to keep pace with the community's increasing water-supply requirements, and (3) urban hydrology studies intended to provide information that will aid in minimizing and evaluating the impact of urbanization on the natural environment.

Cooperating agencies: City of Anchorage and the Greater Anchorage Area Borough.

Reports completed:

Barnwell, W. W., and George, R. S., Progress report 1966–67; Water study—Greater Anchorage area, Alaska: U.S. Geol. Survey open-file rept.

Barnwell, W. W., George, R. S., Dearborn, L. L., Weeks, J. B., and Zenone, Chester, 1972,Water for Anchorage: U.S. Geol. Survey open-file rept.

Weeks, J. B., 1969, The relationship between surface water and ground water in Ship Creek near Anchorage, Alaska: U.S. Geol. Survey Prof. Paper 700–B, p. B224–B226.

SOUTHEASTERN ALASKA

Project: Granite Fjords Wilderness Study Area.

Region and map key: Southeastern Alaska (11), Ketchikan quadrangle.

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

Project chief: George Gryc, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif. 94025; A/C 415–323–8111, ext. 2266.

Project plans: On June 28, a joint U.S.G.S.–U.S.B.M. research team will complete a 2-year program of geologic mapping and mineral resource evaluation of the Granite Fjords Wilderness Study Area, a 1,000-square-mile area of rugged mountains and glaciers about 65 miles northeast of Ketchikan. This year's fieldwork is expected to end by July 31.

The investigation is being carried out under the provisions of the Wilderness Act of 1964, which require that the Survey and Bureau of Mines carry out mineral surveys of lands proposed for wilderness preservation.

The 13-man field party will be based on the 117-foot Geological Survey Research Vessel *Don J. Miller II,* and will be supported by a jet helicopter under contract from Temsco Helicopters, Inc., Ketchikan.

Survey personnel include geologists H. C. Berg (party chief) and R. L. Elliott, assisted

by P. A. Frame and Mike Rymer. Bureau of Mines personnel are T. L. Pittman and A. Kimball, mining engineers, and two assistants. Other members of the party include the three-man crew of the *Miller:* Capt. R. D. Stacey, E. C. Magalhaes, engineer, and E. M. Keuhn, cook-deckhand; and a helicopter pilot and mechanic. Mail address: Box 1618, Ketchikan, Alaska 99901; Radiotelephone via Ketchikan Marine Operator on call letters WZ 2103, or via Temsco Helicopters, Inc., or Todd's Air Service in Ketchikan.

Cooperating agency: U.S. Bureau of Mines.

Project: Tracy Arm-Fords Terror Wilderness Study Area.

Region and map key: Southeastern Alaska (12), Taku River and Sumdum 1:250,000 map areas.

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; A/C 415–323–8111, ext. 2178.

Project plans: The joint Geological Survey-Bureau of Mines mineral-resource-potential study of this area will start on August 1 and continue into early September of this season. Two more field seasons of study will be required to complete the evaluation of the 1,400-square-mile study area for the U.S. Forest Service. The project personnel will be D. A. Brew, A. B. Ford, D. A. Grybeck, and one other geologist, and S. W. Nelson, P. A. Frame, and one other assistant. They will be accompanied by T. L. Pittman and A. L. Kimball, mining engineers, and two assistants from the Bureau of Mines.

The field party will be based on the U.S. Geological Survey Research Vessel, the *Don J. Miller II,* and will be supported by a jet helicopter under contract. Other members of the party will include the helicopter pilot and mechanic and the crew of the *Miller:* Capt. R. D. Stacey, E. C. Megalhaes, engineer, and E. C. Keuhn, cook-deckhand. Radio telephone contact will be to the *Miller* (call letters WZ 2103). Mailing address: c/o General Delivery, Juneau, Alaska 99801.

Cooperating Agency: U.S. Bureau of Mines.

Project: Precipitation stations.

Region and map key: Southeastern Alaska (13), Sashin Lake.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: V. K. Berwick, U.S. Geological Survey, Alaska Subdistrict Office, 441 Federal Building, Juneau, Alaska; A/C 907–586–7216.

Project plans:

Objective: To collect daily precipitation data at the head of Sashin Lake for the National Marine Fisheries.

Approach: To design, install, and maintain a precipitation station measuring accumulative rainfall at the head of Sashin Lake.

Progress: The precipitation station was installed in August and was serviced in November. Another trip is planned for maintenance in May.

Plans for next fiscal year: Plans are to continue this station next fiscal year. Its location, however, may be changed to a higher point in the Sashin Lake watershed.

Cooperating agency: National Marine Fisheries.

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

Region and map key: Southeastern Alaska (14), Juneau, Alaska.

Organizational designation: Water Resources Division, Alaska District Office.

Project chief: G. O. Balding, U.S. Geological Survey, Alaska Subdistrict Office, 441 Federal Building, 710 West 9th Street, Juneau, Alaska; A/C 907–586–7216.

Project plans:

Objective: The objectives of the project are to evaluate the availability of water in the City and Borough of Juneau and to determine the effects of development on water quality. Of particular interest is the amount of potable water available in Mendenhall Valley and in the Salmon Creek Reservoir.

Approach: The approach for this fiscal year is to monitor ground-water availability and quality in Mendenhall Valley and to determine the storage, water quality, and runoff of surface water in the Salmon

Creek Reservoir. The discharge of Salmon Creek below the dam will also be measured.

Progress: Inventory of new wells in the Mendenhall Valley has been completed and miscellaneous water samples taken. Groundwater levels have been monitored continuously at one well in the upper part of the valley. The maximum volume of the Salmon Creek Reservoir has been determined and chemical quality parameters have been measured. Miscellaneous measurements have been made on Salmon Creek below the dam, and runoff relationships have been used in determining historic runoff at the dam.

Plans for next fiscal year: Plans involve the continued monitoring of water availability and quality in Mendenhall Valley with increased emphasis on the effects of urbanization on water levels and water quality in the area.

Cooperating agencies: City and Borough of Juneau, Alaska.

Reports completed:

McConaghy, J. A., 1969, Hydrologic data of the Juneau Borough, Alaska: U.S. Geol. Survey open-file rept.

McConaghy, J. A., and Bowman, W. N., 1971, Water resources of the City and Borough of Juneau, Alaska: U.S. Geol. Survey open-file rept.

SUMMARY OF IMPORTANT RESULTS, 1972

The Geological Survey prepares annual summaries of the outstanding 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 Geologic Division's 1972 summary of outstanding results in Alaska is reproduced in this section in the form prepared for publication in the Professional Paper series. It is important to emphasize, however, that not all results of Geological Survey work are summarized in this section. Important investigations by the Water Resources Division, for example, are compiled and published separately by the Alaska District Office. Requests for information concerning the results of Alaskan water resources investigations and reports in progress should be directed to Mr. Harry Hulsing, District Chief, Skyline Building, 218 E Street, Anchorage, Alaska 99501 (A/C 907–277–5526).

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. Outlines of the regions and locations of the study areas are shown in the accompanying index map of Alaska (fig. 14).

Paleozoic corals widely distributed in Alaska

Paleozoic coral faunas in Alaska occur almost exclusively in structurally complex limestone and dolomite deposits of Ordovician through Permian age that are scattered widely through most of the geological provinces of the state, according to Michael Churkin, Jr.

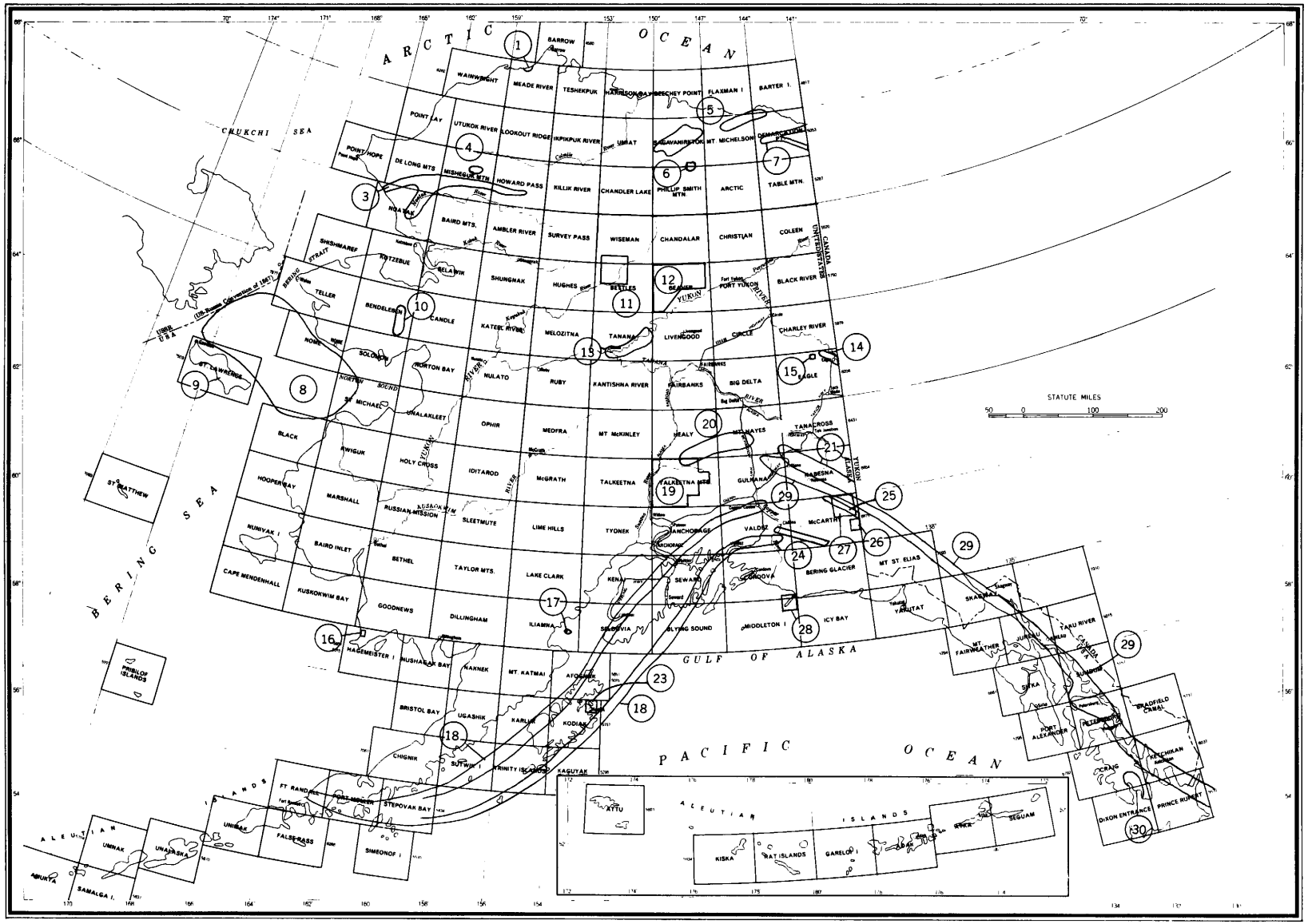
Ordovician corals are uncommon. According to W. A. Oliver, Jr., they occur in interior Alaska in the Porcupine River and Jones Ridge sections and in the Lake Minchumina area. In the Seward Peninsula, a sequence of coral faunas is of probable Middle and Late Ordovician age.

Silurian corals are known from the Seward Peninsula, the Fairbanks-Rampart area of central Alaska, and the eastern Brooks Range (Oliver) but are especially abundant in thick limestones of southeastern Alaska (C. W. Merriam).

Corals of Devonian age have been most commonly reported from Alaska. They are widely distributed in the Brooks Range, in the Porcupine River and Nation River areas of east-central Alaska, and in the Fairbanks-Rampart area, smaller assemblages are known from southwestern Alaska to the eastern Alaska Range (Oliver). In southeastern Alaska a succession of corals is known of Early, Middle, and Late Devonian age (Merriam).

Mississippian corals are common in the Brooks Range, in southeastern Alaska, and on St. Lawrence Island, according to A. K. Armstrong.

Pennsylvanian corals are known from the Brooks Range and probably occur also in the Alaska Range (Armstrong).



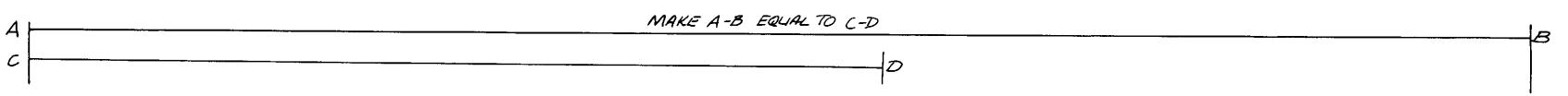


FIGURE 14.—Map showing locations of studies discussed in the summary of outstanding results, 1972. The circled numbers key to project discussions in text.

Permian corals are rare in northern Alaska but are abundant in the limestone sections interlayered with basaltic lavas in the Alaska Range and southeastern Alaska, according to C. L. Rowett (Texas Christian Univ.). In the Alaska Range a sequence of coral zones extends through 6,000 feet of strata. Permian corals also occur in east-central and southeastern Alaska.

Coral reefs and reef breccia deposits are known in the Silurian, Devonian, and Carboniferous. Paleozoic corals of Alaska have their closest affinities to corals of Asia and provide clues to the former marine connections and paleoclimatic conditions in the Pacific Ocean and Arctic Ocean regions.

Modern tectonic analogs to the Cordilleran geosyncline

Similarities between lithology and stratigraphic sequence of Paleozoic rocks of Alaska and modern deposits studied by Michael Churkin, Jr., on Deep Sea Drilling Project, Leg 21 (Fiji to Australia), indicate that the volcanic arc–marginal ocean basin tectonic system provides the best modern analog for the Cordilleran geosyncline in Alaska (Churkin, 1972). Detailed comparisons between these two regions, now underway, will help us understand the geologic history of Alaska and will point to specific areas most favorable for economic development.

NORTHERN ALASKA

Informal Russian-American cooperation yields new geologic data on Beringia

Cooperation between scientists of the U.S. Geological Survey and the Geological Institute of the Academy of Science, U.S.S.R., in dealing with problems of the Quaternary geology of Beringia (Alaska, northeastern Siberia, and the intervening seas) has begun to produce concrete results. Exchanges of visits, rock and fossil specimens, and publications had already heightened ability to correlate stratigraphic units and to establish models of ancient climates, landscapes, and ocean circulation systems in the region. Recently, knowledge has been enlarged still further as a result of studies by Soviet paleontologists of materials collected in Alaska.

Mollusk-bearing Pleistocene marine sand and gravel beds at Skull Cliff, about 55 km southwest of Point Barrow (loc. 1, fig. 14), were examined last summer by D. M. Hopkins (USGS) and O. M. Petrov (U.S.S.R.), and a large fossil collection was made. After returning to Moscow, Dr. Petrov determined the fauna and provided a list of about 35 taxa—a tremendous increase over the 13 species listed for this locality in publications by C. E. Meek and F. S. MacNeil. The locality had been considered to be of early Pleistocene age, on the basis of the presence of extinct *Neptunea leffingwelli* and *Astarte leffingwelli,* but it is now clear that both species are Arctic endemic species that persisted later than previously thought. *N. leffingwelli* is found in middle Pleistocene beds penetrated in boreholes offshore at Nome, and Petrov collected *A. leffingwelli* in beds that are radiocarbon-dated as middle Wisconsin age near Point Barrow. Two other mollusk species present as fossils at Skull Cliff no longer live north of Bering Strait. Although the age of the Skull Cliff fauna cannot be firmly established, it seems more likely to be middle than early Pleistocene in age, and it may even be late Pleistocene (Sangamon) in age.

A large contribution to understanding of paleoenvironments in Beringia was provided by pollen counts by Dr. R. E. Giterman of the Geological Institute on seven species collected in northwestern Alaska by Hopkins and Petrov. Five significant specimens were collected at various stratigraphic levels in the deposits of the middle Pleistocene Kotzebuan marine transgression on the shores of Kotzebue Sound near the Arctic Circle. Mollusks in these beds indicate extremely low water temperatures, and some features of the enclosing beds suggest that large glaciers may have been present on nearby land areas. Conversely, rich pollen floras indicate that when sea level was rising, the adjacent land area supported shrub tundra rich in alder and dwarf birch and that when sea level was at its maximum, spruce forest was present on the adjacent mainland. In other words, the fact that vegetation on land was generally similar to the modern vegetation seems incompatible with encroaching glaciation.

Late Early Permian rocks discovered in northeastern Alaska

Fieldwork in 1972 planned as a summary and

concluding study of the Sadlerochit Formation led to the discovery by R. L. Detterman of the oldest Permian rocks yet known in northeastern Alaska. The late Early Permian age of the lower part of the Sadlerochit Formation is substantiated by a brachiopod fauna including *Attenuatella* sp. and *Anidanthus* sp. found on Flood Creek in the Sagavanirktok quadrangle (loc. 6). These rocks probably extend at least to the Canadian border and the south flank of the British Mountains (Joe Creek).

Age of carbonate unit in Demarcation Point quadrangle revised

A relatively thin gray-weathering limestone, locally characterized by coarse-grained quartzitic beds, crops out over a wide area of the central and eastern Demarcation Point quadrangle (loc. 7). Detailed mapping in 1972 by W. P. Brosgé and H. N. Reiser shows that these rocks are in normal depositional contact over volcanic graywackes of probable Late Ordovician age. This is significant, as previous knowledge did not preclude a Precambrian age interpretation for these carbonate rocks.

WEST-CENTRAL ALASKA

Benthic fauna of the Bering Sea

A study of the species composition, community structure, and ecological relationships of the benthic fauna of the Bering Sea (loc. 8) by R. W. Rowland defines five distinctive communities. Previous authors have doubted the existence of a shallow intertidal fauna in the subarctic and arctic because of the traumatic effects of winter sea ice. Rowland finds that although the intertidal zone on open coasts is barren, the lagoons have a distinctive intertidal community that includes taxa tolerant of brackish water. The other communities are in deeper water. Their distribution is mainly governed by substrate and is independent of depth, salinity, and temperature. The paleoecology of fossil assemblages of mollusks, brachiopods, echinoids, and barnacles can be interpreted on the basis of this exceptionally detailed study of the modern fauna, and the effects of environmental disturbance owing to underwater mining can be predicted.

Evidence of oroclinal bending between Alaska and Siberia

Recent mapping on St. Lawrence Island by W. W. Patton, Jr., and Béla Csejtey, Jr., provides evidence that the Cordilleran fold belt is buckled into a tight southward-looping oroclinal bend between Alaska and Siberia. Pre-Cretaceous miogeosynclinal rocks of the Brooks Range seem to swing in an arc southward across the Seward Peninsula to St. Lawrence Island and then northward into the Chukotsk Peninsula. The Paleozoic and early Mesozoic stratigraphic sequence exposed on eastern St. Lawrence Island (loc. 9) is nearly identical with that found in the western Brooks Range, 250 miles to the north, and also has counterparts on the Seward Peninsula and on the northern part of the Chukotsk Peninsula. The oroclinal bend is also reflected in the trends of upper Paleozoic and lower Mesozoic ophiolites and Cretaceous granitic rocks. The ophiolites seem traceable from the southern edge of the Brooks Range southward across the Seward Peninsula to St. Lawrence Island and then northward into the Chukotsk Peninsula. The Cretaceous granitic rocks likewise seem to be deflected southward in an arcuate belt stretching from west-central Alaska to St. Lawrence Island and then northward into the Chukotsk Peninsula. The oroclinal bending of Paleozoic and Mesozoic Cordilleran trends in the Bering Strait region is believed to be a consequence of east-west compression between North America and Eurasia in Late Cretaceous or Tertiary time.

Age of plutonic rocks and grade of metamorphic rocks in eastern Seward Peninsula

Laboratory studies of samples collected from the numerous large plutons of the eastern Seward Peninsula (loc. 10), together with geologic mapping completed the previous year by T. P. Miller and Donald Grybeck, allow the delineation of separate intrusive suites of various ages. A wide variety of plutonic rock types have been identified. They range in composition from quartz monzonite to nepheline syenite and in age from 100 m.y. to 80 m.y.

Petrographic studies also confirm an abrupt change in metamorphic grade along a north-south line west of the Darby Mountains. West of this line, the metamorphic rocks belong to the quartz-albite-muscovite-chlorite subfacies of the greenschist facies of regional metamor-

phism. East of the line, the rocks belong to the middle and upper almandine amphibolite facies.

EAST-CENTRAL ALASKA

ERTS–1 imagery provides clue to direction of movement on Kobuk fault zone

The Kobuk fault zone has been traced along the southern edge of the Brooks Range for 300 miles from the Kobuk River delta on the west to the Yukon Flats on the east. The fault zone, locally as much as 20 miles wide, is made up of numerous, nearly-vertical, east-trending fractures. Major structural discontinuities in the bedrock along the fault zone suggest strike-slip movement, but until recently no evidence had been found to indicate the direction of movement. However, according to W. W. Patton, Jr., recently acquired ERTS–1 satellite imagery may provide a clue. An ERTS–1 image covering the Bettles region of central Alaska (loc. 11) clearly shows that the bedrock lying within the fault zone is sliced by closely spaced north-northeast-trending fractures. These cross-fractures had not been recognized previously either on the ground or in aerial photographs. If they are tension joints, left-lateral offset on the Kobuk fault zone is suggested. However, if they are shear fractures, right-lateral offset is indicated. The fact that they do not appear to offset the east-west trends in the bedrock suggests that they are probably tension joints, but further fieldwork is needed to verify this.

Hodzana highland similar to southernmost Brooks Range

Rapid reconnaissance geologic mapping of the Beaver quadrangle by W. P. Brosgé, H. N. Reiser, and W. E. Yeend shows that the bedrock sequence on the southeast flank of the Hodzana highland (loc. 12) is similar to that on the south and southeast flanks of the Brooks Range. Quartz-mica schist and Cretaceous granite form the core of the highland and are flanked by successive belts of phyllite and lithic graywacke. Thin limestone beds that contain Paleozoic corals of probable Silurian or Devonian age occur in the phyllite and strike toward a zone of marble beds in the schist, a fact suggesting that the phyllite and schist are of the same age. The youngest extensive rock unit is an assemblage of mafic volcanic rocks, eclogite, and chert that strikes southwest toward the mafic rocks of the Rampart Group and northeast toward the Jurassic mafic complex in the Christian quadrangle.

Kaltag fault inferred in Yukon River valley between Tanana and Rampart

The Kaltag fault may be inferred to extend northeastward along the Yukon River valley between Tanana and Rampart (loc. 13) in the Tanana quadrangle on the basis of recent geologic mapping by R. M. Chapman, W. P. Brosgé, H. N. Reiser, and W. E. Yeend. The fault has been traced eastward between Norton Sound and Tanana, a distance of 275 miles, by W. W. Patton, Jr., and J. M. Hoare (1968), and they suggest that it probably extends northeastward from Tanana. Right-lateral offset of 40 to 80 miles since Cretaceous time is postulated.

In the 60 miles between Tanana and Rampart, a major fault zone has not been identified in outcrops or as a positive trace in surficial deposits. However, it is probable that the northeast-trending belt of Tertiary sedimentary rocks was deposited in the fault trench and obscures the fault zone or zones. The southwesterly course of the Yukon River, along the north side of this belt is probably controlled by the trend of the fault zone. The granitic pluton on the Yukon River at The Rapids and a belt of Tertiary(?) tuffs and rhyolitic rocks, southwest of Rampart, have a marked northeast elongation and are regarded as fault controlled. Known or inferred fault and shear zones that also trend northeast have been recognized in the area to the south as far as the Tanana River.

Right-lateral offset of 40 to 80 miles along the Yukon River valley is compatible with reconstructions based on recent mapping. A unit in the Rampart Group (Permian?) lying southwest of Rampart and a carbonate-bearing unit of metamorphic rocks (probably middle Paleozoic) south of the Yukon River appear to have been offset right laterally by at least 30 to 40 miles from more extensive units of similar rocks on the north side of the Yukon River valley.

Tintina fault zone relocated in part of Eagle quadrangle

Investigations along the Tintina fault zone in the Eagle quadrangle, eastern Yukon-

Tanana Upland, by H. L. Foster have led to a change in the mapping of the fault zone in part of the quadrangle (loc. 14). The discovery of a breccia zone, along with topographic evidence and information from new mapping on the north side of the Seventymile River, suggest that the main fault zone may lie to the west of the trend as shown on map MF–358 (1972). Also, several semiparallel faults were mapped as possible splays of the Tintina system. A mass of marble containing echinodermal debris was found north of the fault zone where metamorphic rocks have not previously been found. Also, unmetamorphosed Permian rocks were found south of the fault. These finds suggest that the pattern of faulting may resemble that in the Tintina fault zone in the Ross River area of Canada.

First Permian rocks found south of Tintina fault zone in Yukon-Tanana Upland

The first occurrence of definite Permian rocks south of the Tintina fault zone in the eastern Yukon-Tanana Upland was found in 1972 in the Eagle D–3 quadrangle by H. L. Foster. Brachiopod molds and casts were collected from a quartzite on the ridge west of Sutter Creek about 3 miles south of the Seventymile River (loc. 15). According to J. T. Dutro, Jr., the collection contained the genera *Megousia, Yakovlevia, Anemonaria, Spiriferella, Neospirifer,* and *Tityrophora*? and a punctate spiriferoid. The brachiopods indicate a Permian age, probably about the same age as the Early Permian Tahkandit Limestone and Permian Step Conglomerate, which occur north of the Tintina fault zone.

The zone of quartzite, argillite, and other slightly metamorphosed sedimentary rocks in which the fosils were found is believed to extend about 12 miles northwestward from Bryant Creek in a narrow discontinuous band until it is cut off by faulting and an ultramafic intrusion near Flume Creek. The fossiliferous rocks are bordered on the northeast primarily by gneisses and schists of amphibolite facies and on the southwest by silicic to ultramafic intrusive and extrusive rocks and greenschist facies metamorphic rocks. Most contacts are probably fault contacts.

SOUTHWESTERN ALASKA

Platinum group metals in Red Mountain complex

The Red Mountain ultramafic complex (loc. 16), located near Goodnews Bay, is the source of the platinum group metals recovered in the placer mining operation of the Goodnews Bay Mining Company. Detailed mapping of the complex by A. L. Clark and Donald Grybeck has shown that it has a distinct border zone composed of dunite that grades successively through peridotite, pyroxenite, and hornblendite to the margin. Locally, the surrounding greenstone and greenschist country rocks are metasomatically converted to amphibolite. The border zone of the complex varies in thickness, ranging from 15 to 300 feet, and locally is absent.

Detailed sampling on the southern flank of the Red Mountain ultramafic complex has shown the local occurrence of areas having a high concentration of chromite. The chromite is in discontinuous stringers or pods (locally up to 1 ft in diameter) or is disseminated throughout the dunite to perioditite host rock. Analytical results show that the highest concentrations of platinum group metals (5 ppm) are associated with the high chromite concentrations within the complex. In addition, the highest analytical values for platinum group metals and the corresponding associated chromite concentrations occur near the headwaters of the richest placer streams.

Continuing studies will provide more data on the occurrence and distribution of platinum group metals within a known platiniferous ultramafic complex. The results of these studies can be applied as guides to exploration for platinum group metals in the numerous ultramafic complexes of southern and southeastern Alaska.

Late Mesozoic fossils discovered on Augustine Island

The first discovery of late Mesozoic fossils on Augustine Island was made on the south flank of Augustine Volcano (loc. 17) by R. L. Detterman and R. W. Imlay. *Diplomoceras notabile* and *Inoceramus* ex. gr. *I. subundatus* of Late Cretaceous age and *Buchia concentrica, B. rugosa,* and *B. piochii* of Late Jurassic age were found in a section of sedimentary rocks, a few hundred feet thick, that underlies recent

volcanic rubble and pumice flows. Previously, only late Tertiary rocks had been found on this island.

Gravity anomalies along south coast of Alaska

Gravity surveys by D. F. Barnes and others (1966) have revealed very long belts of gravity anomalies that almost parallel the southern coast of Alaska (loc. 18). Gravity surveys during 1972 now provide more data concerning the extent of the eastern and western ends of these belts. Data from the southwestern end of the Alaska Peninsula suggest that in this area two belts of gravity highs merge into the gravity high associated with the Aleutian volcanic arc, but the gravity high associated with the continental margin crosses the peninsula between Port Moller and Cold Bay and trends northward along the edge of the Bering Sea continental shelf. Thus, the Aleutian arc gravity feature seems to have been superimposed on a continental-shelf gravity feature. At the northeast end of the gravity belts, the new data suggest that the belts may not exend long distances east of the Copper River. The Prince William Sound gravity high definitely crosses the Copper River but was not detected in surveys along the upper Bremner River. Similarly, a very extensive belt of highs that extends from the Semidi Islands along the north shore of Kodiak and to the south edges of Cook Inlet and the Copper River basin may not penetrate far into the Chitina Valley before it is lost in the gravity minimum associated with the Wrangell Mountains.

SOUTHERN ALASKA

Paleozoic island arc in Talkeetna Mountains

Reconnaissance investigations by Béla Csejtey, Jr., provisionally indicate that the Talkeetna Mountains (loc. 19) are underlain by two geologically dissimilar terranes of different ages and depositional environments. The two terranes are separated by a northeast-trending mesozonal batholithic complex of dominantly quartz monzonite, ranging in age from Jurassic to Cretaceous.

Rocks southeast of the batholith have been previously mapped as complexly deformed sedimentary and volcanic rocks of Early Jurassic to Tertiary age. Northwest of the batholith a thick, tightly folded sequence of low-grade metavolcanic and metavolcaniclastic rocks is dominant along with a few interbeds of recrystallized cherty limestone. Lacking any fossil evidence, previous workers correlated this sequence with the Mesozoic rocks southeast of the batholith. The presence of poorly preserved crinoid columnals, corals, and bryozoans from a newly discovered limestone locality strongly suggests a late Paleozoic age for the sequence, according to A. K. Armstrong. On the basis of correlation with similar rocks in the eastern and west-central Alaska Range, this metavolcanic sequence in the northern Talkeetna Mountains is interpreted to represent a late Paleozoic volcanic island arc that was subsequently welded onto older continental crust.

Newly defined metamorphic belt in south-central Alaska

Recent studies by T. E. Smith (Alaska Div. Geol. and Geophys. Surveys, and USGS) demonstrate the continuity of a zonational metamorphic belt between the Alaska Range near the Delta River and the northern Talkeetna Mountains (loc. 20). This terrane, defined by mapping during the last 4 years and referred to informally as the "Maclaren metamorphic belt," extends northeastward over 80 miles from the Talkeetna Mountains near Tyusana Lake through the Clearwater Mountains into the Alaska Range, where it is apparently truncated by the Denali fault system (Stout, 1972).

Bedrock along the belt consists mainly of pelitic sediments deposited in Jurassic time and regionally metamorphosed in Late Cretaceous or early Tertiary time. A three-dimensional view of pressure-temperature conditions during progressive metamorphism is preserved in the lateral variation of index mineral assemblages along its length. Near the Delta River in the northeast, the aluminosilicate pair andalusite-sillimanite is present in presumably stable equilibrium, whereas farther southwest in the Clearwater Mountains, kyanite and sillimanite coexist. The lateral transition between these mineral pairs may be interpreted as a pressure transition across the Al_2SiO_5 triplepoint, and the deeper or higher pressure segment of the metamorphic belt is exposed at the southwest end.

A remarkably complete zonation between deformed metasedimentary rocks of the pumpellyite-prehnite-quartz metamorphic facies and pelitic gneisses of the uppermost amphibolite facies is exposed in the Clearwater Mountains; there, metamorphic grade increases transversely across the belt to the northwest. Dynamothermal components of the metamorphic event have produced a textural gradation across the belt as well as a zonation of index minerals. Mildly metamorphosed pelitic rocks having primary sedimentary features grade through slates and phyllites to schists and gneisses having abundant rotational microtextures.

Plutonic rocks of the metamorphic belt include an intermediate magmatic series of Late Cretaceous age, which comprises most of the larger intrusive bodies, a small alkali gabbro stock of Late Jurassic age, and minor felsic bodies of mid-Tertiary age near the Delta River. Field and textural relations as well as K-Ar dates determined for the study suggest that many bodies of the Late Cretaceous intermediate series were emplaced during the metamorphic event and were probably derived by anatectic melting of the pelitic sediments. Many of these plutons, though discordantly intruded into metamorphic host rocks, retain contorted compositional layering suggestive of a paragneiss origin. These parts of the metamorphic terrane were apparently very near the igneous-metamorphic boundary and display facets of both, along with attendant autoinjection of near-molten material into slightly less mobile areas. K-Ar ages presently known from metamorphic and plutonic rocks near the Delta River appear to have been reset by post-Cretaceous thermal or tectonic events. Isotope studies and mapping programs in that region demonstrate an angular truncation of the metamorphic belt at the Denali fault.

The Denali fault offset problem

K-Ar age determinations by D. L. Turner (Univ. of Alaska and USGS) on samples collected by T. E. Smith (Alaska Div. Geol. and Geophys. Surveys and USGS), J. H. Stout (Univ. of Minnesota) (1965), Turner, and F. R. Weber (USGS) from the "Maclaren metamorphic belt" (loc. 20), described by Smith in the preceding article, indicate that synkinematic metamorphism occurred between 65 and 75 m.y. ago. The "Maclaren belt" is cut by the McKinley strand of the Denali fault. To the north, a crescent-shaped block bounded by the McKinley and Hines Creek strands of the Denali fault contains slightly metamorphosed (greenschist facies) Devonian sedimentary rocks, which have been intruded by a small granitic pluton dated at 90 m.y. The relatively young synkinematic age and compressed isograds of the "Maclaren metamorphic belt" (Smith and Lanphere, 1971) do not correlate with the regional greenschist facies terrane that characterizes the so-called Birch Creek Schist north of the Denali fault or with the muscovite K-Ar ages between 112 and 115 m.y., determined for quartz-mica schists north of the fault near Canwell Glacier.

R. B. Forbes, (Univ. of Alaska and USGS), Turner, and Stout (Stout and others, 1972) have been searching for the offset segment of the Maclaren metamorphic belt, on the north block of the Denali fault. Synkinematic metamorphism of the Maclaren belt appears synchronous with development of the metamorphic belt on the west flank of the Coast Range in southeastern Alaska (Forbes, 1959; Forbes and Engels, 1970). K-Ar dates, lithologies, and regional outcrop patterns indicate that the Ruby Range metamorphic belt east of Kluane Lake, Yukon Territory, Canada, may have originally been a contiguous northwestern extension of the Coast Range metamorphic belt. The Ruby Range batholith and its adjacent metamorphic belt are truncated by the Denali fault along the Shakwak lineament. The Maclaren, Ruby Range, and Coast Range belts each include Barrovian metamorphic terranes, migmatite zones, late- and post-kinematic granodiorite and quartz monzonite plutons, and similar structural styles.

A Kluane offset of the Maclaren belt would imply a right-lateral offset of 250 miles along the Denali fault since latest Cretaceous time.

Aeromagnetic surveys and geological interpretation in eastern Alaska Range

Aeromagnetic surveys of parts of Alaska, made by the State of Alaska in collaboration with the U.S. Geological Survey, help to illustrate many of the geologic features delineated

by the Survey's reconnaissance field-mapping programs. The aeromagnetic maps provide a valuable additional dimension for interpretive structural studies and have further beneficial applications in preliminary land-use planning and mineral-resources exploration.

D. H. Richter reports that three distinct magnetic terranes are recognized in the eastern Alaska Range (loc. 21), each corresponding to a major unit of lithologically similar rock. North of the Denali fault the sequence of low-grade metamorphic rocks of Devonian and older age is characterized by moderate anomalies having a magnetic relief of generally less than 500 gammas. The anomalies are conspicuously elongate and subparallel to the pronounced structural trend of the metamorphic terrane. Immediately south of the Denali fault, a broad magnetic low, almost entirely devoid of local anomalies and having a maximum relief of less than a few hundred gammas, coincides with a clastic wedge of Jurassic and Cretaceous sedimentary rocks. South of the clastic wedge and over Pennsylvanian to Triassic volcanic and volcaniclastic rocks and limestone, the magnetic field increases; strong and extremely irregular anomalies are commonly greater than 2,000 gammas.

Many of the local anomalies on either side of the Denali fault are apparently caused by Mesozoic granitic plutons. However, the magnetic expression of plutonic bodies north of the fault is much subdued compared to that south of the fault.

Late Cretaceous age established for extensive slate and graywacke belt

A thick sequence of highly deformed flysch-like metasandstone, slate, and argillite crops out in a belt extending at least 650 miles from northeast of Anchorage southwestward to the Shumagin Islands. Investigations in the Chugach and Kenai Mountains and on Kodiak Island (loc. 23) by D. L. Jones and S. H. B. Clark (1973) have shown that although fossils are rare, the same types are present at widely scattered localities throughout this sequence of deep-water marine deposits that includes the Valdez(?) Group and the Kodiak and Shumagin Formations. These poorly fossiliferous rocks have long been considered Cretaceous in age because of scattered occurrences of fragmentary shells of *Inoceramus* sp. Mainly on the basis of new fossil collections by Jones and Clark, the age of some of these rocks can now be firmly established as Late Cretaceous (Maestrichtian), and the critical fossil is *Inoceramus kusiroensis* Nagao and Matsumoto. No evidence for other ages has been found in this extensive and thick rock sequence.

Inoceramus kusiroensis Nagao and Matsumoto also occurs in the much more fossiliferous and only slightly deformed Matanuska Formation, which forms a parallel belt north of the Chugach Mountains. Based on faunal, lithologic, and bedding characteristics, this formation is the shelf equivalent of the deep-water trench, or continental-rise deposits of the Chugach and Kenai Mountains and islands to the southwest.

Major fault identified in Chugach Mountains

A 248-km-long segment of the Border Ranges fault (MacKevett and Plafker, 1973), a major fault that can be traced for more than 1,000 km along the Pacific border of Alaska, was mapped in the Chugach Mountains by E. M. MacKevett Jr. and George Plafker. In the McCarthy and Valdez quadrangles (loc. 24), the fault separates the Valdez Group, a thick Mesozoic flysch sequence, from diverse upper Paleozoic rocks to the north. The upper Paleozoic rocks include metamorphosed volcanic and sedimentary rocks, subordinate gabbro and diorite, and rare ultramafic rocks and constitute the regional basement for much of south-central Alaska between the Denali and Border Ranges faults. They are interpreted as remnants of a late Paleozoic island arc and oceanic crust.

For most of its mapped length, the Border Ranges fault is a northward-dipping thrust characterized by dips between 20° and 60° and the local development of nappes and klippen in the Paleozoic rocks of the upper plate. In its eastern part, throughout most of the McCarthy quadrangle, the fault is characterized by steep northward or vertical dips. The fault marks a plate boundary that developed during the late Mesozoic or early Tertiary.

Totschunda fault mapped in McCarthy quadrangle

During 1972 fieldwork, E. M. MacKevett, Jr., D. H. Richter, and D. L., Jones traced the

Totschunda fault, a major fault described in the Nabesna quadrangle by Richter and N. A. Matson, Jr., across the northeastern part of the McCarthy quadrangle from the Nabesna quadrangle to the Canadian border. Throughout most of its extent in the McCarthy quadrangle (loc. 25), the fault dips nearly vertically and is characterized by a discrete lineament. In its southeastern part the fault splays into subsidiary steep faults and thrusts that dip northward. The fault cuts rocks as young as the Wrangell Lava (Tertiary and Quaternary). The style of faulting exemplified by the Totschunda in the McCarthy quadrangle is an aid to tectonic interpretations in the region.

Devonian(?) marble in McCarthy quadrangle

A thick, dominantly marble sequence has been recognized in the McCarthy B-1 quadrangle south of the Klutlan Glacier (loc. 26) as a result of reconnaissance mapping by E. M. MacKevett, Jr., D. H. Richter, and D. L. Jones. This sequence lies south of the Totschunda fault and is separated from the Wrangell Lava (Tertiary and Quaternary) on the northeast by a fault that probably is a strand of the Totschunda. In places the marble is unconformably overlain by Wrangell Lava or cut by monzonitic plutons, but most of its contacts are masked by snow and and ice. The sequence is unlike any other lithologic assemblage in the McCarthy quadrangle. Although no fossils were found, the marble is lithologically similar to parts of the Kaskuwalsh Group in nearby areas of Canada that have yielded Devonian fossils. The marble is inferred to represent the northwesternmost known extent of the Kaskuwalsh Group, which correlates with parts of the Alexander terrane of southeastern Alaska. The recognition of Devonian(?) marble provides additional data for geologic interpretations of a region of great significance in regional tectonics. Of critical importance is the as yet unresolved relationship between the Devonian(?) rocks and the upper Paleozoic sequence that constitutes much of the regional basement between the Denali and Border Ranges faults.

Permian fossils and Middle Triassic rocks found in northeastern McCarthy quadrangle

Reconnaissance geologic mapping in the northeastern part of the McCarthy quadrangle by E. M. MacKevett, Jr., D. H. Richter, and D. L. Jones has revealed faunules that are different from those previously collected in Permian rocks of the region and more widely distributed remnants of Middle Triassic strata than have been known (loc. 27). Both elements are atypical when compared to previously mapped parts of the quadrangle. In the northeastern part of the quadrangle, many of the Permian rocks contain abundant fusilinids and large rugose corals of the genus *Caninophyllum*. The Middle Triassic rocks consist chiefly of dark shale and siltstone, and they contain abundant remnants of the pelecypod *Daonella*.

Guides to interpretation of petroleum potential found in Kayak-Wingham Islands area

Detailed stratigraphic and structural studies by George Plafker in the Kayak-Wingham Islands area near Katalla (loc. 28) provide data critical to interpretation of the offshore petroleum potential in adjacent areas of the continental shelf. Bedded clastic sedimentary and pyroclastic rocks on the islands have a composite thickness of about 15,000 feet and range in age from late Eocene to early or middle Miocene. Much of the late Oligocene part of the sequence appears to have good source rock characteristics. Potential reservoir beds include sandstones in the upper Eocene and lower Oligocene section as well as sandstones and conglomerates in the lower and middle Miocene rocks. The major problem for hydrocarbon accumulation appears to be the extreme deformation that has affected the entire sequence. All strata dip steeply or are overturned as a result of tight folding accompanied by imbrication on at least five major steeply dipping reverse faults with the northwest blocks relatively upthrown. Comparable structural complexity, if present beneath the continental shelf, would undoubtedly appear as acoustic basement on seismic profiles.

SOUTHEASTERN ALASKA

Gravina-Nutzotin belt—new key to upper Mesozoic tectonics of southern and southeastern Alaska

Stratigraphic and structural studies originally based on work in the Annette-Gravina area near Ketchikan (Berg 1972a, b; 1973) have

led to an entirely new concept of southern and southeastern Alaska geology. This concept, which offers a unified hypothesis of the late Mesozoic tectonic history of the region, was formulated and published by H. C. Berg, D. L. Jones, and D. H. Richter (1972). It is based on the recognition and documentation of the Gravina-Nutzotin belt, a sequence of upper Mesozoic flysch and volcanic deposits in southern and southeastern Alaska. The belt crops out nearly continuously from southeastern Alaska through the St. Elias Range and into the eastern Alaska Range (loc. 29) and thus is the first documented link between the geology of these regions.

The definition of the Gravina-Nutzotin belt and an analysis of other rock sequences led to the new interpretations. One is that the upper Mesozoic rocks in the belt are remnants of a magmatic arc that can be traced almost continuously for more than 700 miles from the eastern Alaska Range to the southern tip of southeastern Alaska. The belt, together with two coeval shallow-marine and deep-marine assemblages in southern and southeastern Alaska, satisfy many of the criteria for an ancient tripartite arc-trench system. The other interpretation is that southeastern Alaska's myriad Paleozoic and Mesozoic rock units actually comprise only four or five main tectonic elements that are either crustal plates, fragments of plates, or terranes formed by the interaction of plates.

New evidence bearing on age of Wales Group

In its type area on southern Prince of Wales Island, the Wales Group comprises a thick heterogeneous, mainly volcanogenic, assemblage of low-grade (greenschist and semischist) polymetamorphic rocks. Locally, marble is interstratified with the schists in units ranging in thickness from less than 100 feet to 1,000 feet or more. The age of the group has been asigned by various workers to the range "possibly pre-Ordovician to Devonian" and even Carboniferous, largely on the basis of lithologic analogy and gross, poorly understood field relations. So far the Wales Group has failed to yield any diagnostic fossils, despite considerable diligent searching at numerous places where lithologic characteristics favor their occurrence and preservation.

Detailed mapping by G. D. Eberlein and Michael Churkin, Jr., along the southwest coast of Prince of Wales Island (loc. 30) has demonstrated the existence of an angular unconformity, probably folded, between the Wales Group and overlying unmetamorphosed marine sedimentary rocks of late Early or possibly early Middle Devonian age. From this and other field relations it is evident that the Wales Group was deposited, metamorphosed, locally intruded by trondhjemite, and exposed to erosional processes before Devonian time. Furthermore, the discovery of Zone 9–10 (Middle Ordovician) graptolites in unmetamorphosed beds in Klakas Inlet that appear to be at least 20,000 feet stratigraphically above the Wales Group strongly supports a pre-Middle Ordovician age asignment. Inferentially, the presence of such a thick section of unmetamorphosed, thin-bedded, rhythmically layered, graded siliceous siltstone and fine-grained sandstone, sedimentary breccia and conglomerate beneath the horizon represented by the Middle Ordovician fossil locality suggests that the Wales Group may be at least as old as Cambrian, and probably pre-Cambrian.

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