Ridge. Previous geologic investigations of the terrestrial Tertiary basalts of the Davis Strait area have shown however, that the lavas are similar enough in chemical composition to be petrogenetically related.

The planned 1970 field work, consisting of sea magnetometer, gravity, bathymetry, seismic reflection profiling, seismic refraction measurements, and dredging, should enable the seaward extent and possible chemical evolution of the "aseismic ridge" of Davis Strait and the crustal type, structure, and sedimentary thickness of Baffin Bay to be determined. The analysis of these data may enable more substantial comment to be given on the pattern of sea-floor spreading between Greenland and Canada.

McGAW, RICHARD W., DUWAYNE M. ANDERSON, JERRY BROWN, RICHARD K. HAUGEN, and ALLEN R. TICE, Earth Sci. Branch, U.S. Army Cold Regions Research and Engineering Lab., Hanover, N.H.

Bentonitic Debris Flows near Umiat, Alaska

Mudflows and bentonitic debris flows are found at numerous locations around the globe. Those that occur in arctic regions or at high elevations are unique in that the base material normally will remain frozen during periods of flow activity. The influence of a frozen base on flow morphology and frequency of activity was investigated for large-scale bentonitic debris flows along the Colville River near Umiat on the North Slope. These features originate in bentonitic detritus slumping from bluffs 150–200 m high. When the material becomes sufficiently hydrated it flows downslope leaving slickensided, fluted channels ranging in depth from 0.5 to 2 m and from 2 to 12 m wide. During July and August flow velocities up to 6 m/minute were observed.

Data were obtained that yielded relations among precipitation, water content, flow rate and frequency, thaw depth, and channel morphology. Flow was observed as initiating in the upper, steeper parts of the bluffs along an initial slip zone at the upper boundary of the permafrost. However, snow meltwater and thawing of the active layer were not sufficient to bring about the critical relationship between water content and slope angle required to initiate flow. As with mud- and debris-flows in warmer regions, frequency of flow was found to be closely related to the occurrence of precipitation.

MEYERHOFF, A. A., Am. Assoc. Petroleum Geologists, Tulsa, Okla.

High-Latitude Evaporite Deposits and Geologic History of Arctic and North Atlantic Oceans

High-latitude evaporites—late Proterozoic through Early Permian—are widespread in Canada, Siberia, and Europe. Their distribution patterns show that they precipitated from marine waters entering the continents from the Eurasian-Arctic basin, *not* from the Canadian-Arctic basin, which is separated from the former by the Proterozoic Lomonosov sill, and from the North Pacific by the 1,350-km-wide, Archean, Bering-Chukotsk shelf. Late Proterozoic through Devonian evaporites which precipitated from Arctic waters do not extend (except locally) west of the Rocky Mountains or east of the Chukotsk-Koryak Ranges. Marine connections between the high-latitude evaporite basins and those of the Tethys seas were minimal. After Devonian time, evaporite depocenters shifted systematically Atlanticward with the progressive formation of the Franz Josef and Faeroes-Greenland sills. High-latitude evaporite deposits are scarce after formation of the Faeroes-Greenland sill.

Thus the requisite temperature and salinity for late Proterozoic-Paleozoic evaporite deposition in high latitudes during evaporite-maximum periods can be attributed only to the existence, and persistence, of the Gulf Stream–North Atlantic Drift system since middle Proterozoic time. No proposed mechanism of continental drift or polar wandering accounts for the high-latitude evaporite-deposition pattern, or for the consistent and progressive Atlanticward shift of evaporite depocenters through time. Continental drift and polar wandering in the Arctic and North Atlantic Ocean areas, if either ever took place, are pre-late Proterozoic events.

MEYERHOFF, A. A., Am. Assoc. Petroleum Geologists, Tulsa, Okla., ILYA A. MAMANTOV, Southern Methodist Univ., Dallas, Tex., and THEODORE SHABAD, Am. Geog. Soc., New York., N. Y.

Russian Arctic Petroleum Provinces

Major hydrocarbon reserves have been discovered and developed during the last 20 years in the Russian Arctic. Productive basins include the West Siberian. Pechora, and Vilyuy. Gas discoveries in the Anadyr basin are too new to be evaluated. Untested basins include the following: (1) *onshore:* Anabar, Lena delta, Indigirka, and Kolyma; and (2) *offshore:* Barents and Pechora Seas, Kara Sea, Laptev Sea, East Siberian Sea, Bering Sea, and Sea of Okhotsk.

In the West Siberian basin, as of January 1, 1970, more than 40 oil fields and 50 gas fields had been found. Production is from Cretaceous and Jurassic paralic to nonmarine strata. At least 9 oil fields had reserves greater than 500 million bbl; 20 gas fields had reserves greater than 3.5 Tcf. Samotlor is the largest oil field with 15.1 billion bbl; Urengoy, the world's largest gas field, had 210 Tcf. Deepest production was from about 10,500 ft, but most production was shallower than 8,150 ft.

The Pechora basin contained about 62 oil and gas fields productive from Devonian through Permian marine strata. Of these, 1 oil field contained more than 500 million bbl and 2 gas fields, more than 3.5 Tcf. Deepest production was from about 11,155 ft.

The Yenesey-Khatanga trough contained several fields, but is relatively undeveloped.

The Vilyuy basin contained about 41 gas fields, of which 2 gas fields contained more than 3.5 Tcf each in Triassic and Jurassic paralic strata. Deepest production was from about 9,840 ft.

More than 200 structures remain to be tested in the 4 basins. Although deformed basement has been penetrated in several areas, particularly near basin margins, the basin centers have not been explored thoroughly. In most of the West Siberian basin, for example, 2,000–8,000 ft of section below the deepest producing zones has not been tested.

In the West Siberian basin alone, proved plus probable oil reserves exceed 35 billion bbl, and proved plus potential gas reserves exceed 400 Tcf. If the results from the West Siberian, Vilyuy, and Pechora basins are indicative of Russian Arctic potential, a bright future could be in store for the Russian petroleum industry.

Despite the high costs and enormous logistics problems involved in development of these remote permafrost areas, the Russians are well on their way in developing the West Siberian fields. The first pipeline of 40-in. diameter was completed to the Omsk refinery in 1967, and a second pipeline, of 48-in. diameter, is under construction. Siberia already has achieved self-sufficiency and the flow of crude oil in the Trans-Siberian pipeline was reversed west of Omsk in the summer of 1970 so that surplus West Siberian crude now moves westward to European Russia instead of the previous eastward flow of Volga-Urals crude to Siberia. In the Pechora basin, development of the largest potential producer, the Usa field, was underway in 1970 and construction of a pipeline to the Yaroslavl refinery in central Russia was started. The gas of the Vilyuy basin at present is used only locally, in the city of Yakutsk. No specific plans for long-distance transmission have been announced.

MIGLIACCIO, RALPH R., and JAMES W. ROONEY, R & M Engineering & Geol. Consultants, Fairbanks, Alaska

ENGINEERING GEOLOGIC AND SUBSURFACE SOIL INVESTIGATIONS FOR TRANS-ALASKA PIPELINE SYSTEM

Since early 1968, the Trans-Alaska Pipeline System has been involved in surface and subsurface investigations for a pipeline originating at Prudhoe Bay and terminating at Valdez, Alaska. This route, which is slightly less than 800 mi long, crosses numerous geologic provinces, each with its own set of engineering and geologic problems.

Since work was begun, field studies have increased in scope and have advanced from preliminary route studies to more detailed surface and subsurface work. Presently, 12 drilling units are operating in the field and over 800 borings have been accomplished south of the Yukon River. Over 300 pipeline route borings have been put down north of the Yukon River and approximately 800 additional borings are planned. Drilling equipment being used is capable of being moved in rough terrain and of obtaining undisturbed frozen cores of different sizes to depths of 50 ft or more.

Many problems have been and are still being studied to further insure integrity and optimum security of the proposed pipeline. Some of the soil related problems receiving attention are (1) extent and character of permafrost; (2) solifluction; (3) landslides and avalanches; (4) stream and river scour; (5) erosion potential; (6) soil types and physical properties; and (7) seismicity.

Many techniques other than drilling have been, and are being, used or studied. Included are both infrared color and black and white aerial photography and other remote sensing techniques including thermal scanning and sidelooking radar. These techniques have been used to compile geologic maps of the entire route. In addition, seismic and acoustical sounding equipment is being evaluated.

As rapidly as information becomes available, it is utilized to finalize design parameters and determine construction requirements and controls. Because of the highly variable and complex soil and related conditions along the route, evaluation of all geologic and engineering data is a time consuming but extremely necessary process. It is anticipated that careful studies and the design now in progress will continue throughout the preconstruction and construction phases of the project. These studies, together with continued review of all data, will combine to insure a safe, pipeline system.

MILLER, THOMAS P., U.S. Geol. Survey, Menlo Park, Calif.

PRELIMINARY CORRELATION OF MESOZOIC PLUTONIC ROCKS IN BERING SEA REGION

Most of the plutonic rocks of the Bering Sea region are of Cretaceous age and were emplaced in 3 main episodes dated by K/Ar methods at 98–108 m.y., about 90 m.y., and 75–82 m.y. The two younger suites consist of rather typical calc-alkaline granodiorite and quartz monzonite. In the 98–108 m.y.-old suite, quartz monzonite is closely associated with silica-saturated syenite and with strongly potassic subsilicic rocks. Plutons of this suite appear to be aligned along the boundary between the Paleozoic and Precambrian metamorphic and sedimentary rocks of the Seward Peninsula and the adjacent Mesozoic volcanogenic province. Rocks of the 90 m.y.-old suite also occur near this boundary; however, not enough data are available to indicate that rocks of this age are confined to this area. The 75–82 m.y.-old plutonic rocks are present throughout both geologic provinces and are not restricted to the boundary area.

MOKSHANTSEV, K. B., and G. S. GUSEV, Inst. Geol. Yakut Branch of Siberian Dept. USSR Acad. Sci., USSR

TECTONICS OF ARCTIC REGION OF YAKUT ASSR

The Arctic sector of Yakut ASSR includes the ancient Siberian platform, the late Hercynian Taimyr fold belt, the Mesozoic Verkhoyansk-Chukotsk fold ranges, and shelf seas that represent the recent Laptev-East Siberian Seas paraliageosynclinal region.

The Taimyr fold structures are cut off at the continental slope. Fold systems in the Verkhoyansk-Chukotsk region are divided by median masses, and are traced within the shelf seas. The Verkhoyansk-Kolyma system is divided by the Shelon, Kular, and Laptev buried massifs into 3 branches; one of these, in the northwest, abuts the Hercynides of Taimyr and the others extend northward toward the continental slope. The Novosibirsk-Chukotsk fold system, confined on the north by the Novosibirsk and De-Longa massifs, is traceable northwest to the continental slope; on the southeast it is subdivided into 2 branches. One branch terminates with Mesozoides of the Anyuy zone, and another extends toward Wrangel Island.

Outliers of fold structures of Mesozoides are exposed on islands of the shelf seas. Parts of median massifs represent uplifts of the basement of the recent paraliageosynclinal region. Within the latter there are northern and southern trough systems. The northern eugeosynclinal(?) system includes foreshelf and marginal-shelf troughs and uplifts, separated by systems of deep faults which probably have large associated intrusions of mafic magmatic rocks. The southern system consists of the miogeosynclinal sublatitudinal troughs that are separated by the Lyakhov uplift. Upper Mesozoic and Cenozoic strata of the troughs may reach thicknesses of 10–12 km.

The cut-off by shelf seas and the continental slope of the Mesozoides, Hercynides, and median massif structures; features associated with the building of the Arctic Ocean crust; the nearby presence of mid-ocean and other submarine ridges, which are nearly perpendicular to the continental margins and which commonly are extensions of the continental fold structures of different age; and the formation of a juvenile paraliageosynclinal region within marginal areas of the ocean are