and igneous rocks are cut by granitic plutons of Cretaceous and Tertiary age.

The central and eastern parts of the upland are underlain by a metamorphic complex with rocks that range from lower greenschist to amphibolite facies. Fossils date the parent sediments of some green-schist facies rocks as Paleozoic. Radiometric dates from several localities in the metamorphic complex indicate that Precambrian, Ordovician, and Jurassic-Cretaceous thermal events are recorded in the metamorphic history. Mesozoic granodiorite and quartz monzonite batholiths and smaller granitic plutons of Mesozoic and Tertiary ages intrude the crystalline schists. Locally, unmetamorphosed Cretaceous and/or Tertiary sedimentary rocks are in unconformable or fault contact with the older rocks. Tertiary volcanic rocks which range in composition from rhyolite to basalt overlie the older rocks in small but significant parts of the eastern upland. Ultramafic intrusions, mostly small and serpentinized, also are present.

Work has progressed to the point where the sedimentary rocks in the upland can be correlated reasonably well with those in other parts of Alaska, but interregional correlation of the metamorphic terranes must await additional clarification of structural and petrologic relations.

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DEVONIAN ROCKS OF GREENLAND AND SVALBARD

In Greenland and Arctic Scandinavia, Devonian sedimentary rocks crop out in only two areas: (1) east Greenland between lat. 71½°N and 74½°N; and (2) Svalbard, between lat. 76½°N and 80°N in Vestspitsbergen. These strata are nonmarine clastics. Aggregate thicknesses are large, up to 7,000 m in Greenland and 5,000–6,500 m in Vestspitsbergen. In both areas, the successions are unconformable on deformed pre-Devonian, Caledonian rocks. Both areas are well known for their fossil vertebrates, on which the following age determinations depend.

In Greenland the successions can be assigned to 5 major units, each with a maximum thickness of 1,000–3,000 m: (1) A unit that includes the Vilddal Group, of red and gray siltstone, conglomerate, sandstone, volcanic rock, and granite intrusions; (2) a unit of conglomerates, and red and gray-green sandstone; (3) the Kap Kolthoff Formation of gray-green sandstone; (4) Kap Graah Group of red sandstone, siltstone, and volcanic rock; and (5) the Mt. Celsius Supergroup of red and gray-green siltstone with some sandstone. Units (1) and (2) are dated as Givetian (late Middle Devonian), and units (4) and (5) are dated as Famennian (late Upper Devonian). Unconformities between and within these units occur, particularly in the northeast part of the area, and the rocks were folded again before deposition of the nonmarine Carboniferous.

In Svalbard, the succession consists of 4 major units, each with a maximum thickness of 1,000–3,000 m: (1) the Siktefjellet Group of conglomerate and sandstone beds; (2) the Red Bay Group of conglomerates and sandstone beds; (3) the Wood Bay Formation of sandstone and red siltstone; and (4) a supergroup (Grey Hoek and Wijde Bay Formations, Mimer Valley Group) of gray conglomerate, sandstone, and siltstone. There is no fossil evidence for the date of (1) which was strongly folded before the deposition of (2). Unit (2) is dated as Gedinnian (early Lower Devonian), and the succession is continuous through (3) to (4), which ranges up to Givetian (late Middle Devonian) in age. These units were folded strongly before the deposition of Carboniferous sediments.

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AIRBORNE AND GROUND ELECTRICAL RESISTIVITY STUDIES ALONG PROPOSED TRANS-ALASKA PIPELINE SYSTEM (TAPS) ROUTE

Experimental surveys were made in two test areas using a recently developed airborne technique by which several parameters, including wave tilt, of very-low-frequency (VLF) radio waves from distant transmitters are measured. Ground measurements were made using direct-current resistivity sounding and horizontal profiling methods, the slingram method, and an electromagnetic depth sounding method in which variations in the coupling between 2 horizontal loops is measured as a function of frequency. In each test area—one near Glennallen in the Copper River basin and the other near the Yukon River—at least 1 ice-free locality was located using the airborne VLF data and was corroborated by resistivity measurements. The airborne data appear to reflect the presence of gravel deposits near some of the large rivers near Glennallen, but the data are complicated by topographic effects. In the Yukon River test area the airborne data indicate differences in resistivity between deeply weathered and relatively fresh bedrock.

Good quality resistivity depth soundings, which are not seriously affected by lateral effects, were obtained in both areas. Near Glennallen typical resistivities for fine-grained sediments are 40–80 ohm-meters in the active layer, greater than 2,000 ohm-meters in the frozen layer, and 150 ohm-meters in the underlying sediments except in localities where the presence of saline water reduces the resistivity to 10–20 ohm-meters. Resistivities of wet unfrozen gravel are about 200–500 ohm-meters. The depth to the top of the frozen layer can be determined quite accurately; determination of the depth to the bottom cannot be determined as closely. Similar resistivity data were obtained in the Yukon River test area except that the resistivity of the unfrozen material was found to be more variable. Where bedrock is near the surface, the resistivity appears to be inversely proportional to the degree of weathering. The electromagnetic depth soundings substantiate the resistivity results and for some geoelectric sections the electromagnetic data add supplementary information.

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CALEDONIAN GEOLOGY OF ARCTIC NORWAY

(No abstract submitted)

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INUVIK TEST LOOP—AN ARCTIC PROTOTYPE INVESTIGATION

In June of 1969, Mackenzie Valley Pipeline Research Ltd. retained Canadian Bechtel Ltd. to assist in researching the practicability of constructing a large-diameter crude oil pipeline from the North Slope of Alaska to Edmonton, Alberta. Part of the research

program was to design, construct, and operate an experimental test loop at Inuvik, Northwest Territories. Inuvik is on the Mackenzie River, midway between the Arctic Circle and the Beaufort Sea.

The test loop was constructed in the fall of 1969 and placed in operation in early 1970. Continuous operation is scheduled at least through the summer of 1971.

Information is being compiled daily and indications to date are confirming the wisdom of constructing the Arctic test facility.

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EVOLUTIONARY STAGES OF FAUNAS IN STRUCTURE OF STRATIGRAPHIC SCALES OF PALEOGENE AND NEOGENE OF NORTHERN PACIFIC AREA

According to many micropaleontologists, worldwide correlation of Tertiary successions in tropical and subtropical areas can be based on planktonic foraminiferal zones (chronozones). The taxonomic assemblages of such zones correspond to evolution stages of foraminifers. Current studies show that many of these zones can be traced in Japan and, to a certain extent, in Sakhalin, Kamchatka, and North America. For the first time, the stratigraphic scales of the north Pacific area can be tied rather confidently to the general world scale. Studies of nannoplankton, mammals (hipparions and Desmostyliidae in particular), isotopic age dating, paleomagnetism, and paleoclimatology have helped make worldwide correlations more reliable.

Unfortunately, the planktonic fauna is very sparse in the Tertiary rocks of the northern Pacific region. Therefore, the establishment of regional scales must be based mainly on benthonic faunas.

A change of systematic composition of some mollusk genera (*Yoldia*, Arcidae, Pectenidae, Turritellidae, and *Acila*) and the general number of species and newly appearing species in certain periods of their development are reflections of their evolution stages. These stages may be used to subdivide the sections into several zones and to correlate them. To distinguish such zones independently of the facies composition of the rocks, and to correlate them with the planktonic zones are the bases for applying the international scale in the boreal Pacific area. Seven such zones have been proposed for the Neogene of the USSR based on *Yoldia* and other groups; many of the zones have analogues in adjacent areas.

Establishment of faunal succession relative to evolution is of great importance because the composition of each faunal complex in any particular section depends on stratigraphic facies; underestimating this circumstance in the past resulted in significant stratigraphic mistakes. To make the provincial schemes more exact, one naturally may use data on other faunal groups, floral successions, paleoclimatology, *etc*. The establishment of *evolutionary stages of ancient basins*, the changes of fauna and lithology dependent on these stages, and the study of faunal assemblages of unlike and similar facies of contemporaneous and successive levels are of great importance to work out regional stratigraphic scales.

Distinguishing local subdivisions (suites, members, layers) that are related to facies peculiarities of the sequences, should be based on this framework of zones that was established according to evolution stages of faunas. Paleoecologic and paleogeographic methods also play a leading role in these studies.

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PERMIAN-TRIASSIC METALLIFEROUS PROVINCES OF NORTH-CENTRAL SIBERIA

In the Arctic part of the Yenisey-Lena River region of Siberia, a large area is present which was stabilized during the late Paleozoic. This area shows evidence of tectonic reactivization accompanied by the emplacement of a mafic igneous complex and related endogenic mineralization.

1. Tholeiitic basalt is the predominant rock type of the mafic complex; associated trachybasalt, olivine basalt, and basic to ultrabasic units are subordinate. Tholeiitic basalt is both effusive and intrusive. The effusive facies consists of saturated and undersaturated rocks; the intrusive facies consists of oversaturated material. The olivine basalt formation has the most complex and variable composition. Nepheline basalt-trachyte lavas and nepheline picrite-mugerite intrusive series are typical. Basic to ultrabasic rocks are represented by flows of picrite basalts and by their intrusive equivalents that have isotropic and anisotropic structures (massifs of Norilsk-Talnakh type). The alkaline ultrabasic rocks are composed of volcanic rocks of the central type (Gulin massif).

2. Spatial distribution of the basic complexes is determined by structures formed as a result of tectonic reactivization, with faulting taking the leading role. There exists a genetic range of structures of block-fold origin, from linear synforms (grabens) through sublinear troughs to flat synclines. The relations between the structural features and the outcrops of definite types of basic formations permits the delineation of a Taimyr tholeiitic trachybasalt province, a Norilsk-Olenek basic-hyperbasic province with trachybasalts, and a Kotuy-Maymecha alkaline ultrabasic province.

3. These magmatic provinces correspond to the concept of a metalliferous province because there is a close spatial and genetic connection between the endogenic mineralization of the Permian-Triassic metallogenic stage and the specialized rock suites. The increase in metal content toward later magmatic phases is clearly recognized. The Taimyr province is characterized by non-economic copper and zinc sulfide ore occurrences; in northern Tunguska, there are noneconomic ore and sulfide deposits. In the Norilsk-Olenek and Kotuy-Maymecha provinces, large economic copper, nickel, rare metals, apatite, and other deposits have been found.

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GEOLOGIC PRECONDITIONS FOR OIL AND GAS POSSIBILITIES IN SOVIET ARCTIC

The Soviet Arctic, including the continental shelf, occupies an area of about a third of the entire Soviet Union. Within this area, major platform structures with a thick sedimentary mantle are developed. These are the West Siberian and Pechora plates and the Siberian, Barents-Kara, and Hyperborean platforms. All of the discovered oil and gas areas and the most prospective territories and shelves are related to these platforms. Areas favorable for petroleum exploration comprise more than 60–70% of this area.

The largest of these is the West Siberian oil and gas basin, east of the Urals. In the Arctic part of the West