and extrusive rocks. It is assumed that the intrusives were the origin of the mineral deposits in the volcanic rocks. Some mineralization occurs in Cretaceous limestone by contact metasomatism.

3. The Sierra Madre Oriental province, a 379,000-sq km area, occupies the great Mexican geosynclinal folded belt of Laramide age. Intrusive rocks and some volcanoes establish the metallogenic processes, which are mostly by contact metasomatism and vein filling. Metallogenesis appears to be of late Tertiary age.

4. The Sierra Madre del Sur area extends for 114,000 sq km from the State of Michoacan ESE toward the State of Oaxaca. Geologically it is very similar to the Sierra Madre Occidental province, but seems to constitute a different block of generally lower topography and with more sedimentary Cretaceous limestone. Limestone remnants overlie extensive intrusive rocks. Some are mineralized. Large areas of metamorphic rocks seem to carry mineralization of Precambrian or pre-Paleozoic age. Mineralization in the volcanic and sedimentary rocks seems to be of late Tertiary age.

5. The Mesa Central province extends over an area of 105,000 sq km from the northern edge of the volcanic axis on the south to northern Zacatecas and to part of the Durango on the Central Plateau. The geology is made up of very vast flows of andesite in the southern part, and predominantly rhyolite in the northern part. The thick sequence of volcanic rocks shows low-temperature and pressure mineralization. This is specially noticeable where intrusives, as in Guanajuato and Pachuca, affect the extrusive rocks. Mercury and fluorite deposits are abundant.

6. Eje Neo-Volcanico, a 190,000-sq km volcanic zone or volcanic chain crosses the continent from Bahia Banderas, in the vicinity of Puerto Vallarta, on the Pacific coast, to the Sierra of San Andres Tuxtla on the Gulf of Mexico.

Some authors have postulated the thesis that a large transverse fault crosses the continent, as a continental expression of the Clarion fault. The author's recent paper on ERTS-1 image interpretation does not show evidence of this effect.

The famous "Taxco," "Pachuca," "Angangueo," "El Oro and Tlalpujagua" silver deposits are along this volcanic belt. Much more research on their origin is needed, and the Metallogenic Chart of Mexico will enhance this research.

SCHOLL, D. W., and M. S. MARLOW, U.S. Geol. Survey, Menlo Park, Calif., and E. C. BUFFINGTON, Marine Geology Branch, Naval Undersea Center, San Diego, Calif.

CENOZOIC AND MESOZOIC PETROLEUM PROSPECTS, ALEUTIAN-BERING SEA REGION

Petroleum prospects of the extensive Aleutian-Bering Sea region include: (1) thick sections (basins) of Cenozoic and, in some areas, Cretaceous strata underlying broad areas of the Bering shelf; (2) deformed Mesozoic rocks unconformably underlying these basins; (3) domal and diapiric structures associated with the more deeply submerged (water depth of 2,000 m) Umnak plateau area; (4) thick masses of Neogene beds in summit basins along the crestal region of the Aleutian Ridge; and (5), in very deep water (4,000 m), thick wedges of slightly to moderately deformed beds flanking its northern and southern sides.

The most promising prospects are the thick (2-6 km) accumulations of early Tertiary through Holocene beds that underlie the shallow submerged floor of the Bering shelf. For example, Norton, Anadyr, and Bristol basins are large inner-shelf basins of little-deformed coastal plain and neritic beds that underlie the shelf's major bays and gulfs. Pribilof, St. George, Zhemchug, Navarin, and other associated but unnamed basins, are elongate outer-shelf basins of broadly deformed and faulted marine deposits. These basins parallel the northwest trend of the adjacent continental slope; several of them are more than 200 km long. Whereas the inner-shelf basins are large structural sags, many of the outer-shelf basins appear to be fault-controlled grabens or half-grabens. Some of the shelf basins (*e.g.*, Anadyr and probably Navarin) may include a basal sequence of Late Cretaceous strata. However, many of the outer-shelf basins are underlain by folded Cretaceous and Jurassic(?) beds, stratigraphic units that are not only prospects in themselves but may have supplied hydrocarbons to overlying Cenozoic structures.

Other promising prospects are the fairly large (as much as 30 x 80 km) summit basins of the 2,200-km-long Aleutian Ridge. Roughly rectangular in shape, these structures are physiographic as well as geologic basins. The floors of two of them, neighboring Amukta (171.7°W) and Amlia (173°W) basins, are overlain by about 1,000 m of water; they are underlain by a 3-4-km-thick section of sedimentary beds, chiefly of late Miocene and younger age. These basins, elongate parallel with the ridge, are bordered by major normal faults. The infilling section is broadly folded and disrupted along high-angle growth faults.

SEKINE, Y., Geol. Survey Dept., Metal Mining Agency of Japan

NATIONAL EXPLORATION PROGRAM FOR BASE-METAL DEPOSITS IN JAPAN

In Japan considerable discrepancy exists between annual demand and domestic supply of base metals which are indispensable raw materials for industrial development. This gap has been filled with an importation of raw metals and ores. Recent trends of demand and supply and the changeable economic conditions have been exerting a serious influence on the metal-mining industry of Japan. The domestic resources of base metals, though their production ratios to demand are fairly low, have been and will be quite a stable source of supply.

Beside a long-continued subsidy policy for minor-scale mines, the national exploration program for domestic base-metal deposits was set up by the government, and put into operation in 1963 by the Metal Mining Agency of Japan under the auspices of the Ministry of International Trade and Industry. The program consists of three kinds of projects: regional geologic survey, detailed geologic exploration, and financial aid for direct exploration by companies. The principle of these projects is to promote prospecting for, and efficiently to discover, new ore deposits of copper, lead, and zinc in the districts which cover potential ore-bearing areas.

The regional geologic survey project has been and is now being carried out in the planned 48 districts where there are expected high potential resources of Kuroko, pyrometasomatic, cupriferous pyritic deposits, and ore veins of different geologic terranes. The geologic field survey, in combination with airborne magnetic survey, ground geophysical and geochemical explorations, and deep structural core drillings, is conducted by using a 1:10,000 topographic base map. The detailed geologic

project is carried out in the target areas selected by the preceding survey in each district. Principal field work is exploratory core drilling spaced more or less regularly. Where necessary for geologic structures, ground and/or borehole geophysical prospecting and exploratory tunneling are integrated with drillings.

Geologic information and ore showings obtained by these projects are useful for interpretation and location of final target areas for advanced prospecting work of mining companies to which the government exploration fund is loaned.

During 10 years of operation of the national program, nearly 100 million tons of domestic new-ore reserves have been acquired, and operation of the program has contributed much to the progress in exploration methods and the concepts of explorationists.

SHILO, N. A., Northeast USSR Scientific Research Inst., Magadan, USSR

GEOLOGIC FRAMEWORK OF METALLIC MINERAL DEPOSITS OF NORTHEAST USSR

The structure of northeast USSR is composed of the following: the Yana-Kolyma and Chukotsk miogeosynclinal system and the Oloysk-Alazeysk eugeosynclinal system of the Mesozoides, median and residual massifs of pre-late Precambrian age (Omolon, Okhotsk) and Paleozoic age (Yablonsk, Yeropolsk), the Anadyr'-Koryak and Olutor-Kamchatka geosynclinal system of Cenozoic age, and the Okhotsk-Chukotsk volcanogenic belt.

Widespread deposits of gold, silver, tin, tungsten, and mercury are controlled by the structure and igneous activity.

Gold-bearing quartz veins of plutonic origin form the Yana-Kolyma gold belt with its alluvial and bedrock deposits. The analogous deposits of the Chukotsk system form a less consistent gold belt. The gold here is associated closely with tin and tungsten mineralizations.

The Okhotsk-Chukotsk volcanogenic belt is a province of volcanic gold-silver deposits, sometimes associated with tin and mercury mineralization.

Tin deposits of different types (sulfide, quartz, silicate, skarn, and pegmatite) are less abundant in the Yana-Kolyma system but are well developed in the Chukotsk system.

Commercial deposits of mercury are present in the Mesozoides, in the region of Cenozoic folding, and within the Okhotsk-Chukotsk volcanogenic belt. The deposits form linear zones either in carbonate rocks rimming the Yana-Kolyma system or in terrigenous rocks of widely differing age. Mercury also is present in volcanic rocks of the Cenozoic age as well as in the Okhotsk-Chukotsk belt. Conditions for the formation of copper, lead, zinc, and other minerals in the region have not been studied adequately. According to available data, they are related to the structures of the massifs of ancient consolidation, to the Oloysk-Alazeysk eugeosynclinal system, and to the Okhotsk-Chukotsk volcanogenic belt. Platinum and chromium are located within ultramafic belts of the Olutor-Kamchatka and Anadyr'-Koryak systems.

The major stage of endogenic ore deposition in northeast USSR is at the end of the Jurassic and in the Cretaceous. In the Anadyr'-Kamchatka system and in Kamchatka its main phase extends upward into the Paleogene, Neogene, and Quaternary. The most intensive period of placer deposition was in Pliocene-Pleistocene and recent times. The placers are connected to relief-forming processes connected with new tectonic activity. The sources of ore material for the placers were the Mesozoic-Cenozoic mineralized zones. In many regions oxide-weathering products also were formed as the result of the development of a semiplatform surface.

SHIMOYAMA, T., Mitsui Mining Co., Ltd., Tokyo, Japan, and A. IIJIMA, Geol. Inst., Univ. of Tokyo, Japan

INFLUENCE OF TEMPERATURE ON COALIFICATION OF TERTIARY COAL IN JAPAN

The main coal deposits of Japan are of Paleogene age. The coals are high-volatile bituminous to subbituminous rank. Their range of carbon-oxygen ratio (O/C) is below and above 0.120, respectively, with a range of carbon-hydrogen ratio (H/C) from 0.650 to 0.900. The Paleogene formations in coalfields consist of marine and nonmarine sedimentary rocks and their thickness varies in different fields. They are developed fully in central Hokkaido and northern Kyushu where their maximum thickness is 4,000 and 2,000 m, respectively.

The deformation of the coal measures is much stronger in central Hokkaido than in northern Kyushu, though coals in both regions are high-volatile bituminous. The deformations in northern Kyushu and Joban-Kushiro are similar, but coal of the latter is subbituminous. These facts strongly suggest that the degree of coalification apparently is not controlled only by depth of burial and tectonic deformation.

Various authigenic zeolites are present in altered silicic vitric tuffs interbedded with coal-bearing formations. Clinoptilolite and mordenite are associated with the host formations of subbituminous coal as in Joban-Kushiro, whereas analcime, heulandite, and laumontite are present with bituminous coal in central Hokkaido and northern Kyushu. These specific assemblages of zeolites and coal ranks are recognized throughout the Japanese coalfields. The zeolites are distributed in a vertically zonal arrangement which is, with depth, clinoptilolite-mordenite, analcime-heulandite, analcime-laumontite, and albite zones. This zonation is well established in the Japanese Neogene oil and gas fields. It is controlled mainly by depth of burial and geothermal gradient, *i.e.*, by temperature. The stability field of each of the zeolite species was estimated by using deep-well data.

Comparison with zeolite occurrence in the oil and gas fields suggests that the degree of coalification is controlled mainly by temperature, and that the temperature range of coalification of bituminous rank is estimated to be from 85 to 125°C.

SIMANJUNTAK, M., (no initials) WURJANDI, and S. U. WIJAYA, Indonesian State Enterprise for Coal Mining

COAL RESOURCES OF INDONESIA

Coal reserves in Indonesia are estimated to be about 445 million tons, of which probable reserves from unexplored areas are estimated to be 365 million tons. The coal ranks from subbituminous to bituminous coal of which about one third may be considered recoverable. Reserves of brown coal and lignites are estimated to be several billion tons.

The amount of total reserves is based on exploration carried out during three periods, *i.e.*, prewar