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.

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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.

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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.

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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

period (1890-1941), rehabilitation period (1950-1965), and the five-year development plan period (1969 to present).

The objectives of exploration of coal in the prewar period were to gather data for the development of the coal mines and their future expansion. During 1950 to 1965 these activities were influenced by a possible development of an iron and steel project.

Since 1969 coal exploration was conducted within the framework of the five-year development plan of the government. Studies were being made to utilize the coal from two major mines in Sumatra as fuel in electric power plants and in industry.

The pattern of the Indonesian coal market in the prewar period was for export and the use as fuel in industries, railroad, and shipping. Since 1950 these markets have been gradually declining because petroleum was considered to be more suitable as fuel than coal. The decline of these markets affects seriously the coal industry in Indonesia.

At present the coal industry will be revived due to the government policy to utilize coal as effectively as possible in any uses previously fueled by petroleum, mainly electric-generating power plants.

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RING MEGA-STRUCTURES OF PACIFIC

No abstract available.

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METALLIC MINERALS IN CANADIAN CORDILLERA

The Canadian cordillera, consisting principally of British Columbia and Yukon, is rich in minable deposits of copper, zinc, lead, and molybdenum, and has nickel, tungsten, gold, silver, mercury, and iron deposits.

The cordillera shows a pronounced regional zoning of metals in background abundances in rocks and an associated zoning in class of deposits and contained metals. Sequential changes occur across the strike of the five subparallel tectonic belts.

The mineral industry has expanded rapidly in the last decade. The total value of metal production in 1973 was $839 million in contrast to $189 million in 1963. Production of major metals for the whole terrane in 1973 was copper, 730 million lb; zinc, 553 million lb; lead, 431.5 million lb; and molybdenum, 25 million lb.

For copper, the 1973 production represented about 8% in international trade. Production and reserves have greatly increased in this decade. For British Columbia geologic reserves at present rates of extraction are estimated to be sufficient for copper and molybdenum for 100 years, for zinc about 60 years, and lead about 35 years.

Mode of discovery has changed radically. Classical prospecting is still the most important method although it shares with more technical methods the revelation of actual significance. Of some 60 major mines and prospects discovered in the last 15 years, the primary discovery credit may be attributed as follows: classical prospecting, 50%; geologic deduction, 21%; geochemistry, 20%; geophysics, 9%.

Factors other than discovery, development, and markets are becoming increasingly important. The industry currently is based significantly on low-grade porphyry deposits most of which have no enriched zones. The profitability of such mines is marginal during periods of low metal prices. To survive, operations have had to become highly efficient. The task becomes more difficult in the face of new legislation in British Columbia and proposed legislation in Yukon. More stringent reclamation and environmental regulations and royalties and increased taxes are being applied. There is a hiatus in mine development awaiting clarification of the impact of the new laws, but exploration and discovery continue at a high level.

SUTOWO, IBNU, President-Director of Pertamina

CIRCUM-PACIFIC CONFERENCE, LUNCHEON ADDRESS

No abstract available.

THIGPEN, J.

EXPLORATION FOR GEOTHERMAL ENERGY IN NICARAGUA

No abstract available.

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HYPOTHESIS FOR PETROLEUM GENERATION AT CONVERGENT PLATE BOUNDARIES

Plate tectonics, the hypothesis of multiple crustal plates floating on a viscous layer called the asthenosphere, provides rationale for viewing the earth's outer shell as a system of shifting continents and growing ocean basins. The idea of diverging plates (or sea-floor spreading) implies that plates converge elsewhere at compatible rates. Estimated convergence rates range up to 4 in. per year, or 140 mi in the 2 m.y. since the beginning of Pleistocene time.

Convergence between oceanic crust and continental crust may result in thermal generation of oil and gas in sediments as young as Pleistocene age because of rapid deep burial associated with subduction. Mountainous source areas for sediment and steep continental slopes favor rapid burial of organic material with turbidites. Rapid subduction of oceanic crust under continental margins may carry sediments to depths which provide requisite thermal environments for generation of oil and gas from organic matter disseminated in the sediment. Continued subduction of oceanic crust under continental slopes may cause reverse faulting such that oil and gas accumulations are uplifted toward the ocean bottom.

Core samples obtained adjacent to the Aleutian Trench in the western Gulf of Alaska apparently show effects of subduction and reverse-fault uplift on a section of Pleistocene sediment. Although this Pleistocene sediment is only a few hundred feet below the ocean bottom, organic matter carbonization suggests previous burial of at least 8,500 ft and late pregeneration stage of organic carbonization. In contrast, noncommercial oil production from uplifted deep-water sediment of early Tertiary age at Katalla, Alaska, suggests formerly significant accumulations have been dissipated by faulting, uplift, and erosion. Late Tertiary rocks beneath outer continental shelves and/or upper continental slopes at convergent margins may be in the