Tangkubanparahu. The Nganjuk-Kertosono area is an intermontane basin filled with volcaniclastic rocks that have been washed away from the volcanoes Wilis, Anjasmoro, Pandan, and Kelut.

Artesian conditions are not distinct at Yogyakarta, but potential artesian basins underlie both the Bandung and the Nganjuk-Kertosono areas. In the latter a clay layer of lacustrine-paludal origin acts as a confining bed. Specific capacities at Yogyakarta average between 0.5 and 5 l/second/m of drawdown. Water-bearing parts in the lower breccias and lavas at Bandung have a specific capacity between 0.5 and 1 l/second/m of drawdown, whereas the specific capacity of the aquifers in the overlying lahars range between 1 and 5 l. A piezometric surface about 10 m above the ground is measured at wells drilled to the upper zone. Specific capacities in the Nganjuk-Kertosono area vary considerably depending upon the material which was derived from several sources.

Groundwater is expected to be used increasingly in the three areas for domestic purposes, for irrigation, and by industry.

PURBO-HADIWIDJOYO, M. M., and R. SUKARDI, Geol. Survey of Indonesia, Bandung, Java, Indonesia

GROUNDWATER POTENTIAL OF LIMESTONE TERRANES—EXAMPLES FROM INDONESIA

The groundwater potentials of the areas of Gunung Kidul, central Java, and Lenteng on Madura Island are typical of limestone terranes in Indonesia.

In the Gunung Kidul area, southward dipping middle Miocene limestone, about 200 m thick, is deeply dissected by solution channels which probably follow fractures. The whole area exhibits a typical karst morphology. Baron spring on the south coast of Java has a dry- and rainy-season discharge that fluctuates between 6 and 20 cu m per second. This spring is thought to be the main outlet through which the area is drained.

Two groups of aquifers are present in the Lenteng area, one between 8 and 70 m below ground surface and the second below 228 m. In the proximity of Lenteng Village the groundwater potential of the upper group is 0.33 cu m per second.

Both areas have a relatively dense population (about 400 persons per sq km), but the groundwater potential at present is practically untapped.

PUSHCHAROVSKY, YU. M., P. L. BEZRUKOV, YU. K. BURLIN, L. I. KRASNY, and B. A. SOKOLOV, U.S.S.R.

GEOLOGIC STRUCTURAL SYNTHESIS OF PACIFIC AREA AS BASIS FOR ESTABLISHING REGULARITIES OF DISTRIBUTION OF MINERAL RESOURCES

Geologic studies of the Pacific Ocean and its margins have advanced in the Soviet Union. Some of the results are presented on the unique published maps. (a) Tectonic Map of Eurasia, scale 1:5,000,000 (1966); (b) Geological Map of the Pacific Mobile Belt and the Pacific, scale 1:10,000,000 (1973); and (c) Tectonic Map of the Pacific Segment of the Earth, scale 1:10,000,000 (1970). Moreover, many maps and books have been published which deal with the geology and mineral resources of the northwestern segment of the Pacific including the eastern USSR.

A geologic map synthesizes the data on stratigraphy, age, and composition of sedimentary, volcanic, and intrusive rocks on the Pacific continental margins, in the island arcs, and on the Pacific Ocean floor. The arrangement of geologic complexes of different age and character reflects various styles of tectonic systems on the inner structure: ancient platform—perioceanic belt—ocean. A regular rejuvenation of geologic complexes from continental nuclei toward the ocean is indicated. The map also shows that the distribution of sediment types on the Pacific floor is determined by such factors as climatic zonation, position of zones of upwelling and subsidence of waters, and depth of the ocean; whereas, in the perioceanic zones, a tectonic factor influencing intensity of supply of terrigenous and volcanic material is especially important.

The tectonic map presents the structural formation of the Pacific area which is divided into four principal categories: folding zones of the ocean margins, recent geosynclinal zones, thalassogenes (large parts of the oceanic floor), and the East Pacific mobile belt. The structural analysis, on the whole, shows that plate tectonics fails to explain the constitution of the Pacific area. This hypothesis does not conform to the concept of the Circum-Pacific belt as the earth's structural zone of planetary importance. However, horizontal movements of rather large blocks and sheets of the Earth's crust are real.

The geologic-structural synthesis creates the basis for general metallogenic constructions. Further studies on concentric zonation in the arrangement of ore deposits around the Pacific Ocean appear promising. The zone adjacent to the ocean is rich in gold and copper; the next continentward zone is characterized by rich deposits of tin and tungsten (in addition to gold) in Asia, and lead and zinc in North America. The ophiolitic belts are characterized by peculiar complexes of metals. Study of morphologic and geodynamic properties of ore-controlling faults poses a special problem.

The ocean floor is characterized by extensive accummulations of manganese-polymetallic ores and locally by metasomatic phosphorites.

The geologic-structural synthesis is important for prediction of oil and gas prospects. About 140 actual and possible gas and oil basins have been recorded in the Pacific margins. Most of them are associated with depressions and basins within folded zones and oceanic depressions. The basins in the perioceanic sector are composed mostly of Cenozoic deposits; the main productive strata are Miocene to Pliocene in age. Oil and gas already have been detected in about half of the basins.

RIVAS, S., Mineral Corporation of Bolivia (COMIBOL), La Paz, Bolivia

DEPOSITS OF BOLIVIAN TIN BELT

It is surprising that the Bolivian tin belt does not cross the national frontiers either north into Peru or south into Argentina. Lithologic and tectonic controls can explain this anomaly. The length of the belt is about 1,000 km.

Three metallogenetic cycles of different age can be distinguished. The oldest is in the northern part of the High Cordillera and is related to pegmatites and pneumatolytic veins in granitic batholiths of Triassic-Jurassic age. South of the latitude of La Paz is the Miocene metallogenetic cycle with its abundant tin and wolframite veins, from the vicinity of Viloco to Colquiri. South

of Oruro, the lode deposits are related to small stocks and dikes of dacite and rhyolite of Pliocene age. The belt widens (100 km) and forms the famous polymetallic province, unique in the world because of the rare associations of tin, silver, and other minerals such as teallite, franckeite, aramayoite, andorite, argirodite, *etc.* (Chocaya).

Inexplicably the deposits are of shallow depth; in most cases their root zones are in the lower part of the hills and the vertical difference in elevation of the zones is not more than 1,000 m (Chorolque).

There is zonal arrangement from tin, wolframite, bismuth to lead, silver and zinc, to the outer zone of quartz and stibnite. In the southern province, the zonal arrangement is more local (Tasna).

There are approximately 750 tin mines, 2,000 lead mines, 250 antimony mines, and about 30 mines for bismuth, most of them are small and shallow. The wealth of some of these mines is extraordinary. The production of Llallagua (Catavi) is estimated as 600,000 tons of tin. There remains one million tons of proven and indicated reserves, 75 percent of which belongs to Corporacion Minera de Bolivia (COMIBOL).

The tin veins are exploited by selective underground methods despite high mining costs. The grade averages of the deposits have declined to limits which now can be considered marginal.

ROBERTSON, G. A., D. E. POWELL, and G. M. EDMOND, B.O.C. of Australia Ltd., Perth

AUSTRALIAN NORTHWEST CONTINENTAL SHELF: RESULTS OF 10 YEARS' EXPLORATION

Exploration during the past 10 years on the Northwest Shelf of Australia provides an excellent example of the use of modern technology to evaluate the hydrocarbon potential of a large offshore region.

The area under concession consists of about 140,000 sq mi and comprises the greater part of five separate sedimentary basins or subbasins. Water depths range from 20 mi to more than 1,500 m, and are greater than 175 m in over half the total concession area.

Exploration commenced in 1964 with seismic surveys which have continued every year to the present. The first drilling commenced in 1967, and to the end of 1973 a total of 36 exploration wells has been drilled. Of these, nine can be classed as hydrocarbon discoveries, with several being potentially commercial fields despite relatively deep water and long distances from shore. In addition, nine successful appraisal wells have been completed.

The utilization of both drilling and seismic data has enabled a meaningful geologic interpretation of this previously unexplored area.

The Paleozoic history of the offshore area is largely unknown. During the early Mesozoic, rifting on a continental scale resulted in the development of a typical pull-apart tectonic regime. Extensive Triassic to Middle Jurassic fluviodeltaic sedimentation was terminated in Late Jurassic time by major faulting followed by a widespread marine transgression. Upper Jurassic and Lower Cretaceous sedimentary rocks are mainly marine clastic, passing upward to predominantly carbonate sedimentation.

Tertiary sediments are thick and widespread, showing a transition from sands in the nearshore areas to carbonates farther out on the shelf.

The main hydrocarbon accumulations have been found in reservoirs ranging in age from Late Triassic to Late Cretaceous. These discoveries can be attributed largely to the successful application of geologic models produced as a result of close cooperation between geologists and geophysicists.

RONA, P. A., NOAA, Atlantic Oceanographic and Meteorological Laboratories, Miami, Fla., and L. D. NEUMAN, Office for Ocean Economics and Technology, United Nations, New York, N.Y.

PLATE TECTONICS AND MINERAL RESOURCES OF PACIFIC

Maps have been compiled of the geologic framework of the Pacific Ocean basin and surrounding continents including lithospheric plate boundaries, volcanic activity, geologic age provinces, geothermal sites and heat flow, gravity, and sediment thickness. On a common base also have been compiled maps of Pacific energy resources (oil, gas, coal, lignite, uranium, hydroelectric, geothermal) and material resources (iron and ferro-alloy metals, base metals, light metals, rare metals, precious metals, chemical and fertilizer minerals, metal-bearing mud, and manganese nodules and crusts).

Analysis reveals patterns of distribution of the different Pacific resources. Many of the patterns may be related to lithospheric-plate boundaries and associated processes.

ROTMAN, V. K.

MEIMECHITE OF KAMCHATKA AND KIMBERLITE PROBLEMS OF PACIFIC MOBILE BELT

No abstract available.

ROTMAN, V. K.

OUTLINE OF KURILE-KAMCHATKA ARC

No abstract available.

SALAS, G. P., Council of Nonrenewable Natural Resources, Mexico City, Mexico

METALLOGENIC PROVINCES IN MEXICO

The first Metallogenic Chart of Mexico has been prepared in compliance with the Metallogenic Chart of the World Project and in keeping with the North America Subcommittee commitments.

It portrays the location of mines and/or mineral districts, and through special symbols and colors from an ample and explicit legend, shows the type of ore deposits, their age, and depositional environment, *etc.*

Thus, on the basis of mineral-deposit environment, the author tentatively proposes to divide the Mexican territory into six metallogenic provinces. (These later may be subdivided into subprovinces and smaller units.)

1. The Baja California province, on the north, with an approximate surface area of 92,000 sq km, is made up of one or more very large granodioritic batholiths, vast areas of metamorphic rocks of undetermined age, and restricted volcanic-neck areas. The southern part shows extensive andesitic and ignimbrite flows as well as silicic and mafic intrusive rocks.

2. The Sierra Madre Occidental province is a 266,000-sq km area of volcanic rock intruded by granites and granodiorites and subordinate mafic rocks. Mineral deposits are present as veins in the intrusive