Proterozoic and lower Paleozoic strata in the cordillera comprise an assemblage of clastic and carbonate with minor volcanic rocks that appears to represent a continental-terrace wedge built along the margin of an earlier Precambrian continent. All units show a distinct polarity of facies distribution and thickness relative to the source area. This assemblage contains most of the known stratiform mineral deposits of gypsum, iron, copper, zinc, and lead in the cordillera.

The distinctive elements of a Late Devonian and Early Mississippian assemblage suggest, at least in the northern cordillera, the presence of a foredeep and related source areas in the west and northwest. In the southern and eastern parts of the cordillera, however, the rocks reflect a continuing shelf-platform environment linked to the craton. The mineral potential of these rocks has been considered low but needs further study in view of an important zinc-lead deposit in eastern Selwyn basin.

Distinctive rocks of oceanic character ranging in age from Mississippian to Middle Triassic underlie parts of the cordilleran intermontane belt. The important mineral deposits in these rocks include asbestos deposits in ultramafic rocks in the northern cordillera. Generally, however, mineral discoveries, other than those in ultramafic rocks have been few. In the eastern cordillera a shelf environment prevailed.

The association of copper with volcanic rocks of Late Triassic and Early Jurassic ages is well known. The volcanic rocks, together with spatially and temporally associated plutons, are thought to outline a system of evolving island arcs probably roughly coincident with the mapped distribution of these rocks. Between the arcs and the craton, strata were deposited in a marginal basin with little or no evidence of the volcanism that occurred farther west.

The remaining stratigraphic units, ranging in age from Early Jurassic to the Cenozoic, are described as successor-basin and foredeep assemblages whose distribution and lithology reflect a close relation to bounding uplifts of metamorphic and plutonic terrains. Because they are a late-stage phenomenon in the evolution of the cordillera these assemblages have potential for a variety of placer deposits. They also contain all of the known coal reserves of the region.

GANESHIN, G. S., *et al.*

CLASSIFICATION OF SHELVES AROUND PACIFIC

No abstract available.

GLASBY, G. P., New Zealand Oceanog. Inst., Dept. of Scientific and Industrial Research, Wellington, New Zealand

EXPLOITATION OF MANGANESE NODULES IN SOUTH PACIFIC

Manganese nodules in the South Pacific are mainly in the following regions: an elongate belt approximately 1,000 km wide beneath the Antarctic Circumpolar Current; the Southwest Pacific basin; the Peru basin; the Chile basin; and the mountain region bounded by the Cook Islands and Tuamotu Islands. Metalliferous sediments are present dominantly along the crest of the East Pacific Rise where nodules are largely absent. The distribution patterns suggest that the formations of manganese nodules and metalliferous sediments are mutually exclusive. Modes of origin of the nodules are suggested and the possibility of economic exploitation of the nodules discussed.

GROVER, J. C., Consultant, Australia

BACKGROUND TO PRESENT MINERAL SEARCH IN BRITISH SOLOMON ISLANDS AND FIJI

The effects of earlier mining policy have inhibited exploration. In both countries government geological surveys were established amid hopes that geologists might supplant prospecting activity by private enterprise, a view that matured over the years in the face of reality. Long-range ground exploration, with continued support and technical collaboration from London, produced geologic maps. Modest finances demanded a basic philosophy differing from the advice from the private sector, but outstanding results were produced which even better complemented and supported the role of private enterprise in resources development.

In the Solomons, the situation demanded the evolution of a dynamic role for government. Unprecedented support, from many sources, and international collaboration in a series of ventures led to a buildup in fundamental exploration which deployed scientists, engineers, army personnel, research vessels, and ships of the Royal Navy. Nickel and other minerals were found and drilled. Activity culminated in a regional preinvestment airborne geophysical survey with shipborne and ground follow-up teams of competent indigenous staff and bearers, each team led by a scientist, and involving an expenditure in excess of a million dollars. There were successes and shortcomings. Copper and bauxite were the main discoveries. The knowledge was applied later to Fiji where a different approach was needed.

Fiji's mapping progress and observations suggested the need for complementary activity by the private sector. Copper mineralization suggesting porphyry-type potential was described in an official letter to more than 80 major mining companies of the world and was supported by press advertisements. The mining companies were not interested. Three replies were received in 11 months. The government decision led to the discovery of anomalies and large deposits now being test drilled. Other mineral occurrences are also mentioned.

The remaining 5,000 sq mi of the main Fiji Islands was the subject of a decision in the same year. Within well-informed mining policy guidelines, aggrement was reached with a highly skilled research group for the expenditure of $2,000,000. The methods and the outcome are described.

Hopes of financial independence now are held where there had been none. The need for a well-informed governmental role in resources development is emphasized as a means to national self realization. Mention also is made of the adjoining New Hebrides and the unusual petroleum potential of the Kingdom of Tonga.

HADIKUSUMO, D., and L. PARDYANTO, Geol. Survey of Indonesia, Bandung

GEOTHERMAL POTENTIALS IN INDONESIA

Since 1969, beginning with the first year of the First Five-Year Development Program, prospecting for geothermal resources has been carried out by the Geo-

logical Survey of Indonesia (GSI) throughout the entire Indonesian territory. At the end of 1973 55% of the area has been explored in a preliminary way; the work covered mainly the vast volcanic region.

Data on geothermal indications or visible surface phenomena, such as hot springs, hot water, hot mud pools, solfataras, and fumaroles, are indicated on topographic maps, and data on temperature, pH, estimated discharge, and chemical analyses are included.

From these data, the potential energy has been calculated. The local geologic features should be studied in more detail to enable us to interpret the existence of geothermal potential and to guide future exploration. This will be carried out during the Second Five-Year Development Program in the framework of the national demand for electric power outside the "conventional electrically supplied" areas.

Results of prefeasibility studies on geothermal resources in Indonesia were evaluated and two localities in volcanic areas, the Dieng Highlands and Kawah Kamojang, were recommended for further exploration. Exploration drilling has been started in Dieng, but unfortunately it was stopped because of technical difficulties before any results were obtained. Exploration drilling in Kawah Kamojang is scheduled for February 1974.

HAYAKAWA, M., Tokai University, Japan, and K. BABA, Geological Survey of Japan

GEOTHERMAL RESOURCES AND ENERGY IN JAPAN ESTIMATED FROM GEOPHYSICAL DATA

At present, we are using heat in the form of volcanic steam from dormant volcanoes in Japan for electric power generation.

However, in due time it will be possible to make use of the heat, itself, from present volcanoes. For this, necessary techniques must be developed. Heat from the Cenozoic granitic rocks also may be utilized.

At the beginning of the Miocene, Japan seems to have entered into a new geologic evolution. Depression, violent volcanism, and some igneous intrusion took place rather abruptly on the land, and the Miocene sea began to transgress and finally covered almost all of Japan. The deep depression of Fossa Magna formed and separated northeast Japan from southwest Japan. In the Pleistocene, the sea largely regressed, but volcanism continued until the present, and has constructed many volcanic cones and lava plateaus.

The writers are calculating the heat generated by each stage of the igneous activity. Ages and heat of subterranean heat sources can be learned from analysis of heat-flow-profile data utilizing the method of differences of running-mean-values, which acts as a kind of filter for different wavelengths. The long wavelength corresponds to a large-scale source of heat, probably started during very ancient time, whereas the middle wavelength corresponds to a middle-scale source, probably started later than the first one, and very short wavelength expresses the heat flow caused by a smaller, very young heat source.

The method has been applied in a preliminary manner to the present study, and some significant correlation with past igneous activity can be demonstrated. Finally, the geothermal energy, which will be available now for use in Japan, is being calculated.

HEALY, J., Dept. of Scientific and Industrial Research, Rotorua, New Zealand

GEOTHERMAL STEAM PROSPECTS AROUND PACIFIC

Geothermal energy is normally dissipated at the surface. Hot water and steam extracted from drilled wells so far have constituted the main economic sources of geothermal energy. Geothermal areas have been developed or explored in several countries around the Pacific margin.

The geothermal areas are commonly in regions of Quaternary volcanism, though hydrogen and oxygen isotopic studies of the waters fail to reveal the presence of magmatic water. The waters are of meteoric origin. Geothermal systems are of two main types—hot-water systems and vapor systems. Hot-water systems are numerically dominant and are typically located in discharge areas at low levels. Evidence suggests that their locations are affected by, or related to, regional groundwater flow in which there may be a strong horizontal component. Temperature controls include rainfall, rock permeabilities and local heat flux. Vapor systems are usually in elevated recharge areas where groundwater movement normally would be downward and outward; temperatures and pressures are controlled by the thermodynamic properties.

The fluids in hot-water systems are mineralized to varied extents. The energy available from hot-water systems is limited by the amount of steam that can be extracted, and disposal of the remaining effluent can constitute a pollution problem. A vapor system yields relatively more energy and no pollution problem.

In the Pacific region a close relation exists among the distribution of thermal springs, known geothermal fields, and Quaternary volcanism. No specific relation exists between hydrothermal areas and active volcanoes. Rather, all tend to be located above subduction zones or on spreading ridges. This suggests the presence of a large common heat source.

The known geothermal potential in the region is limited, but the ultimate potential is unknown. Future expansion may be in two main directions. The first involves testing the ultimate production capacity of selected known fields, seeking additional zones where no superficial indications exist, and investigating regional hydrology in selected geothermal areas. Geologic, geophysical, and geochemical explorations are required in combination with exploratory drilling. The second promising direction is toward the use of low-boiling-point fluids in equipment and methods for increasing permeability of the rocks.

HEALY, J., and R. JAMES, Dept. of Scientific and Industrial Research, Rotorua, New Zealand

REVIEW OF GEOTHERMAL ENERGY IN NEW ZEALAND

Generation of electric power in New Zealand from geothermal steam at the present time amounts to 148 MW at the Electricity Department's station at Wairakei, and <10 MW at the Tasman Pulp and Paper Company's mill at Kawerau. Exploration commenced in 1950, and in association with geologic, geophysical, and geochemical surveys, wells were drilled at Waiotapu,