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.

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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.

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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.

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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,

Reporoa, Broadlands, Tauhara, Orakei Korako, and Te Kopia in the central volcanic region of the North Island, and at Ngawha in Northland. At Broadlands the production potential of wells already drilled is about 130 MW, and other wells are being drilled.

Technical studies carried out in New Zealand indicate that capital costs per kW for small geothermal power plants are at least as cheap as those for large plants, making the former attractive for developing countries and isolated districts. Estimates of power-life of geothermal systems are not yet possible, but studies of the effect of draw-off rate show that a maximum power-life is obtained if wellhead pressure is allowed to fall to 75 p.s.i.g. over the life of a field. From a hot-water geothermal reservoir power output can be increased for the same rate of production if the steam-water mixture is conveyed to the powerhouse in a single pipeline and separated in two stages.

More than 500 shallow wells have been drilled in Rotorua and a few in Taupo to tap hot water and steam used in conjunction with heat exchangers to provide space heating and hot-water supplies for domestic and commercial users, for drying of timber lucerne, growing of mushrooms and fruit, and hydrotherapy in the treatment of patients.

Permission has been given to a Japanese group to make a feasibility survey, based on a study of the Broadlands field, of the possibility of using geothermal energy in the production of heavy water.

Hot spring discharges at localities in both islands have been augmented by drilled wells to extend facilities at swimming pools for public use. A recent development in the Bay of Plenty near Tauranga has been the drilling of wells to obtain warm water for public and private swimming pools in areas where the subsurface gradient is 1.5-4 times normal.

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MINERAL TRADE IN CIRCUM-PACIFIC REGION

Few nations are endowed with all the mineral resources needed to maintain a vigorous economy. Domestic resources must be augmented for foreign supplies.

The Circum-Pacific region, with its rich mineral endowment and relative proximity to many mineral importing centers, accounts for a large segment of international mineral trade. In 1971, the value of all mineral commodities exported and imported by Circum-Pacific countries totaled $24.0 and $25.4 billion respectively. These totals amounted to approximately 32% of total world mineral exports and 34% of imports. Much of this mineral trade remained within the region. In 1971, the value of trade between Circum-Pacific partners amounted to approximately $12.2 billion.

The impact of the Circum-Pacific countries on mineral trade is further illustrated by trade in selected metallic ores, concentrates, and metals. The region traditionally has produced and exported large quantities of copper and tin. In 1971, the region accounted for about 46% of world copper exports and supplied about 85% of world tin exports. Indonesia, Malaysia, Thailand, and Bolivia accounted for almost all of this total. Nickel also has been a traditional export commodity of the region. Canada and New Caledonia are the leading world producers of nickel and Canada is the largest exporter. More recently, increased demand, particularly from Japan, has resulted in large exports of bauxite and alumina, and iron ore and concentrates from Australia.

The industrialized nations of the world not only have been the primary contributors to the demand for Circum-Pacific mineral resources, but also have been prominent in financing its mineral development. The types of foreign participation vary considerably within the region, including direct investment, long-term purchasing contract, and debt underwriting.

The investment climate throughout much of the region generally has been favorable. This is illustrated by the rapid development of mineral deposits in Australia and Canada. However, the possibility of a less favorable investment climate within the region and increased competition between mineral importers may raise the cost of regional investment. This could result in a shift of mineral activity to other areas of the world.

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SOLAR DISTILLATION—PUERTO PENASCO EXPERIENCE

Since the late 1800s, there have been numerous attempts to develop economical systems for solar distillation. Initially these were simple single-effect, glass-covered stills. During the 1950s, as a result of support from the Office of Saline Water of the U.S. Department of the Interior, many efforts to develop a multiple-effect solar still were undertaken.

The University of Arizona developed a multiple-effect, humidification-cycle, solar-powered distillation unit that was installed in Puerto Penasco, Sonora, Mexico, in 1962. This unit operated successfully until 1965, when it was converted from solar energy to waste-thermal energy from a diesel-electric set. At the time of the discontinuation of its operation, it was the premise of the University of Arizona that the major obstacle to the development of an economical solar distillation system was inadequate low-cost materials that would provide a reasonable service life in a solar-energy application.

With the current renaissance of interest now in solar energy, it is hoped that the necessary long-term development programs will be established to improve the probability of successful solar-energy applications in the future. The paper presents some thoughts as to the direction in which future research should go.

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STRUCTURAL STYLE AND HYDROCARBONS OF BASS, GIPPSLAND, AND OTWAY BASINS

The Bass, Gippsland, and Otway basins lie mainly offshore southeast of Australia. Offshore fields in the Gippsland basin contain recoverable reserves of approximately 8.0 Tcf of gas and 1.7 billion bbl of oil and currently supply two thirds of Australia's oil requirements. No commercial hydrocarbons have been discovered in the adjacent Bass and Otway basins.

The basins were created during the Jurassic to mid-Cretaceous continental breakup of Antarctica, Australia, and New Zealand. Their initial tectonic framework was primarily tensional with basining achieved by normal faulting.