to obtain geothermal energy. Only one of them has been developed, five more are being studied, and general inventory and sampling are being done throughout the country.

The probable potential in the geothermal zone of Cerro Prieto, Baja California, has been determined and a general estimate of the known geothermal zones and the total potential have been completed.

AOKI, S., Faculty of Science, Niigata Univ., Niigata, Japan

LAND SUBSIDENCE IN JAPAN RESULTING FROM FLUID EXTRACTION

The land-subsidence areas in Japan are in and around big cities, industrial zones, and paddy-field zones on the coastal lowlands where groundwater has been utilized extensively and excessively. In view of the enormous sums of money spent for various countermeasures in the land-subsidence areas, groundwater hardly can be said to be a cheap resource.

From the viewpoint of an unsuccessful example of groundwater-resource development, the characteristics and the future problems of land-subsidence in Japan are summarized briefly.

AVILA, J. L., Council of Nonrenewable Natural Resources, Mexico City, Mexico

PRINCIPAL CHARACTERISTICS OF PORPHYRY COPPER DEPOSITS IN STATE OF SONORA, MEXICO

The State of Sonora, where several porphyry copper deposits are located, is south of Arizona and New Mexico, USA. Sonora and the copper province of the southwestern USA have similar physiography in part, mineralized areas, and geologic conditions, which have been traced southward parallel with the Mexican Pacific Coast.

This paper is a summary of the regional geology of the area as well as of geologic characteristics of the mineralization and alteration of the main deposits such as Cananea, Pilares de Nacozari, and La Caridad.

BACA, M. F., Petroperu, Lima, Peru

LATIN AMERICA'S OUTLOOK TOWARD ENERGY RESOURCES

Latin America countries are alike in many ways, but they differ widely in respect to present and future problems in energy and mineral resources. Rapidly rising demands for energy already have created serious trade-balance problems for some countries. As development rate accelerates, Latin America will be consuming an ever increasing share of its own mineral resources most of which are now exported. As a region, Latin America is rich in energy and mineral resources. For a group bound by history, culture, and language, a logical approach for the future is to make a joint study of the situation, and to propose a unified formulation of a regional development plan which will make most effective use of each country's potential for the mutual benefit of all the Latin American countries.

BASKOV, E. A.

REGULARITIES OBSERVED IN REGIME OF WATER OF CIRCUM-PACIFIC AREA

No abstract available.

BERG, H. C., A. L. CLARK

METALLIFEROUS PROVINCES OF ALASKA

No abstract available.

BERGER, V. I.

EVOLUTIONARY SERIES OF ANTIMONY DEPOSITS OF EASTERN USSR

No abstract available.

BEZRUKOV, P. L., A. S. MONIN

MANGANESE NODULES OF PACIFIC

No abstract available.

BOUCAUT, W. R. P., Geol. Survey of Australia, Adelaide, Australia

SALINE GROUNDWATER INFLOWS TO RIVER MURRAY IN SOUTH AUSTRALIA

The River Murray flows for 650 km of its total length of 2,600 km through South Australia, where it meanders in an incised channel across a floodplain 1 to 10 km wide, and is underlain by 500 m of predominantly Tertiary bryozoal limestone and sand of the Murray basin. Natural groundwater in the basin commonly has a salinity of 30,000 mg/l.

Groundwater gradients are relatively flat (0.25 m/km) and flow is generally toward the river and reflects the recharge from the higher country of the basin margins, about 250,000 sq km in area. The Tertiary sediments form aquifers of moderate transmissivity (200 to 500 cu m/day/m). Some inflows of saline groundwater are present naturally through the river bed but most inflows are the result of man-made structures and practices.

The waters of the River Murray are vitally important to South Australia for domestic supplies and for irrigation of citrus orchards along the river banks. This irrigation has resulted in the buildup of groundwater mounds which are relieved by a tile drainage system. Drainage water, now of increased salinity, is pumped to evaporation basins on the floodplain close to the river. The raised water levels in these basins and also in the river weir system have increased inflows of saline groundwater to the river. In drought years these salt accessions can make the water unsuitable for irrigation.

Piezometers have been established to monitor the regional groundwater regime, the irrigation groundwater mounds, and the effect of raised water levels in storage basins. The mechanisms of leakage from these basins have been studied to determine remedial measures necessary to intercept and remove saline-groundwater underflow. Alternative evaporation basins sited

on impermeable clay have been located away from the river floodplain. Pumping schemes for the transport of drainage water to the basins are proposed.

BOWEN, R. G., Oregon Dept. of Geology and Mineral Industries, Portland, Oregon

ENVIRONMENTAL EFFECTS OF GEOTHERMAL ENERGY DEVELOPMENT

Most of the undesirable effects of energy usage come from the rejection of heat, waste products, and by-products during the steps of production, transportation, processing, and the conversion of chemical energy to thermal energy. Where geothermal energy can be substituted for coal, oil, or nuclear fuels, it will result in a net reduction of such adverse environmental impacts.

Geothermal developments appear to have a major impact when a field such as The Geysers or Wairakei is compared to an electric-power-production facility such as a fossil-fuel or nuclear-power plant. Industrialization, the drilling of wells and the building of pipelines and power plants, constitutes the main impact from geothermal developments. All other impact factors—noise from drilling, possible flashing of steam in separators, release of noncondensable gases, and disposal of spent fluids—can be handled by present technology with minimal investment. Many years of experience at the Larderello field in Italy show that geothermal developments can be compatible with other land uses, as farms, orchards, and vineyards cover much of the productive field with only minimal conflict between the two operations.

To give a true picture of the environmental costs from any power source, all steps from the mine to the final product must be added together. The geothermal-steam cycle has fewer steps, fewer energy inputs, and fewer hidden subsidies than any of the coal, oil, or nuclear processes. This simplicity of the geothermal-steam cycle lowers the net-environmental costs and enhances reliability. Because the geothermal-power cycle is self contained, it needs no outside support to maintain the production of electricity; there are no railroads or mines or complex processing facilities to be put out of service by a strike or natural catastrophe or by political decision in a foreign land.

BREDEHOEFT, J. D., U.S. Geol. Survey, Lakewood, Colo.; C. B. RALEIGH and J. H. HEALY, U.S. Geol. Survey, Menlo Park, Calif.

CONTROL OF EARTHQUAKES AT RANGELY, COLORADO

Following the experience with earthquakes at the Rocky Mountain Arsenal, it was recognized that there might be other places where earthquakes were triggered by fluid injection. In fact, Griggs suggested that it might be possible to control earthquakes by controlling subsurface fluid pressures. A seismic observatory at Vernal, Utah, reported many earthquakes near the Rangely oil field in northwest Colorado. The U.S. Geological Survey observed earthquakes in the field for one month in 1967 and established two active zones, both on the periphery of the field, both areas of waterflooding and high reservoir pressure.

In 1969, the U.S. Geological Survey began a four-year experiment to control earthquakes along one active fault. Through an arrangement with Chevron Oil Company, the operator of the Rangely unit, the U.S. Geological Survey gained operating control of four water-flood injection wells in one of the zones of earthquake activity. The experiment was conducted in three phases: (1) an initial phase of reducing fluid pressure, an attempt to stop the earthquakes; (2) a second phase of reinjection and increased pressure, an attempt to reactivate the fault; and (3) a fluid phase of reducing pressure, an attempt to terminate earthquake activity along the fault. The experiment was completed successfully during the summer, 1973. The results demonstrate conclusively that by controlling the effective stress through the injection and withdrawal of fluids, it was possible to control earthquakes, at least in favorable geologic environments.

BUENO S., R., and C. GOVEA R., Empresa Colombiana de Petroleos, Bogota, Colombia

POTENTIAL FOR EXPLORATION AND DEVELOPMENT OF HYDROCARBONS IN PACIFIC COASTAL BASIN OF COLOMBIA

The Pacific Coastal basin of Colombia is an area of approximately 56,000 sq km between the Pacific Ocean and the Western Cordillera. However, it is one of the least explored potentially petroliferous areas in Colombia. Four wells (2 offshore, 2 inland) have been drilled and one (inland) is being drilled. Reasons for this low exploration effort may be found in the relative inaccessibility and inhospitable climate of the area. Unsuccessful results also may be traced to the lack of a concentrated effort at deciphering the regional geology and geologic history. Surface geology does not always reflect accurately the subsurface picture and in many cases it has masked the true underground structure.

Only after oil was found in the Putumayo (east of the Andes) during the earlier 1960s was interest renewed on the part of several of the major oil companies. This interest is revealed in the large acreage (3,660,000 ha.) and the increase in geologic and geophysical work (4,600 km of profile) recently performed both inland and offshore.

As a result of revised opinions and ideas, the area currently is regarded as one of promising potential for a country that badly needs to find new oil if it is to meet ever rising demands. Such potential appears clear, considering that sedimentary rocks in excess of 20,000 ft thick have accumulated in the basin, and that possible source rocks of both early Tertiary and Late Cretaceous age are present. Furthermore, many oil and gas seeps have been reported and noncommercial wells previously drilled had encouraging oil and gas shows.

BURLIN, Yu. K., Yu. M. PUSHCHAROVSKI, and B. A. SOKOLOV, U.S.S.R.

OIL AND GAS CONTENT OF SEDIMENTARY BASINS IN CIRCUM-PACIFIC BELT

The Circum-Pacific belt, more than 50,000 km long and from 600 to 5,000 km wide, is a complex of crustal structures which were developed at different times since the late Precambrian, have different makeup, and are confined to the common ring zone.

About 40% of all basins known in the world are within the Circum-Pacific belt. The sedimentary basins