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

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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.

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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.

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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 within the belt are of different size, age, and relief. Some contain oil and gas and account for almost one third of world oil production. These basins contain thick sedimentary sequences which form lens-like bodies. Sedimentary basins in which the sediments are more than 3-3.5 km thick generally contain oil and gas.

Tectogenesis is the leading process in the origin and formation of sedimentary basins and their transformation to oil and gas basins. Therefore, when classifying them, one should be guided by the tectonic setting of basins.

All basins in the Circum-Pacific belt can be divided into five groups. The first group includes basins at the junction of the Circum-Pacific belt with ancient platforms. Such basins are composed of thick Mesozoic, Cenozoic, and some Paleozoic sequences and contain oil and gas.

The second group is connected with intermountain areas. These basins usually are on continental-type crust and contain Mesozoic and Cenozoic sequences 3-5 or more km thick. This is the most numerous group including more than 70 basins.

The third group includes pericontinental folded basins at the junction of folded continental structures and oceanic floor. They are mainly along the American Pacific Coast and contain great thicknesses of predominantly Cenozoic deposits.

The fourth group includes perioceanic basins connected with island arcs. These basins may be between an island-arc uplift and an oceanic floor or in a deep-sea depression.

The fifth group includes intraplatform basins, which are rare and are chiefly within the East Australian Paleozoic folded belt.

The main criterion for oil and gas content is the thickness of sedimentary rocks. The function of the thickness is the degree of katagenetic transformation of dispersed organic matter in the subaqueous part of the sedimentary section. All sedimentary basins more than 3.5 km thick contain oil and gas fields, irrespective of their hypsometric position.

The thicknesses of the rock sequences, rather than faults, control oil and gas content. No distinct relation has been observed between oil and gas accumulation and the position of lithospheric plates defined by "the new global tectonics" concept.

BYKOVSKAIA, E. V.

MAIN FEATURES OF SOVIET FAR EAST ACID VOLCANISM

No abstract available.

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PORPHYRY COPPER DEPOSITS OF SOUTHWEST PACIFIC—DISCOVERY AND DEVELOPMENT

In the Southwest Pacific, extending from the Philippines south, economic porphyry copper deposits are known in the Philippines, Sabah, Irian Jaya, Papua, and Bougainville. Other deposits, either uneconomic under present conditions or not yet proved to be economic, are known in Sulawesi, New Guinea highlands, New Britain, New Ireland, Manus, Guadalcanal, Fiji, eastern Queensland and New South Wales, and New Zealand.

The economic deposits are associated with Tertiary to late Quaternary intrusives of the western rim of the Circum-Pacific mobile belts, including the major west-northwest offset trending through the Solomons and New Guinea to Sulawesi.

The first significant mining opportunity was recognized in the Philippines in the mid 1950s. Since the early 1960s the rate of discovery and development of these deposits has increased rapidly as a result of a deliberate search in favorable geologic environments.

Favorable conditions of terrain and rainfall, and the size of the deposits have made geochemical stream-sediment sampling an ideal technique for exploration and delineation of porphyry coppers.

To varying extents in different parts of the region, remoteness, rugged terrain, high rainfall, shortage of skilled workers, shortage of local capital, and rapidly evolving political institutions have influenced the evaluation and development of these deposits.

Because of the large scale of the projects, their location, and the generally low-grade ore, economic evaluation has been expensive and has been carried out with great care. Porphyry copper projects are capital intensive and therefore investors require confidence in the political future.

Such projects can produce quick economic benefits to a developing country, such as capital inflow, export income, government revenue, and improved opportunities for employment and training. They can lead also to economic distortions such as local inflation and drawing away of the few skilled workers from other parts of the country.

The social and political impact of establishing a porphyry copper project in an underdeveloped community can be immense because of the requirement for access roads, the highly technical nature of the operations, introduction of expatriate workers, requirement for significant land areas, and extraction of natural resources.

The long-term success of any project will depend on the understanding with which such problems are handled by both the operating company and the host government.

CHUDOLEY, K. M., M. A. RZONSNICKAJA, O. I. NIKIFOROVA, *et al.*

PALEOBIOGEOGRAPHIC ATLAS OF PACIFIC MOBILE BELT AND PACIFIC OCEAN

No abstract available.

CLARK, A. L.

CIRCUM-PACIFIC MAP PROJECT

No abstract available.

CLEVELAND, H., President, Univ. of Hawaii, Honolulu, Hawaii

TRANS-PACIFIC CONSULTATION CRISIS

The discovery and technical development of hydrocarbons, minerals, geothermal energy, hydrogeology, and coal in the Pacific will be a technical challenge of great complexity. The total-systems consideration which will be faced in the development of any of these resources may match in complexity such things as the advance systems in weaponry and in space. These complexities, however, are far more manageable than the complexities of the institutions which must