marine channels. During the depositional growth of the fan, the active channelway shifted periodically, producing abandoned channels. The coarser sediment naturally confined to the channel became covered, after abandonment, by finer grained material. The interchannel deposits, composed chiefly of green hemipelagic muds, are potential petroleum source beds because of their significant carbon content. Thus abandoned channels after sufficient burial and invasion from source beds make excellent stratigraphic traps, especially near the mouth of tributary submarine canyons where the grain size would be larger and the channel width and depth greater.

Off central California, potential stratigraphic traps would be seaward of the mouths of the Arguello, Sur-Partington-Lucia, Monterey-Carmel, Ascension, Pioneer, Farallon, Bodega, and Delgada canyons as shown by subbottom profiling. The proximity of such potential reserves to the United States makes buried channels on large-scale deep-sea fans particularly attractive prospects similar to prospects in turbidite basins of the California borderland.

WINGER, J.

ECONOMICS OF CIRCUM-PACIFIC ENERGY AND MINERAL RESOURCES

No abstract available.

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NICKEL RESOURCES OF AUSTRALIA

Australia has the potential to become a major world source of nickel. Nickel production is currently 43,000 tons a year and projects in the development stage will lift this to 95,000 tons by 1975-1976. The deposits on which this production will be based have all been discovered during the last eight years.

The largest reserves of nickel have been found in Western Australia in the form of sulfide concentrations associated with ultramafic rocks in Archean volcanic belts, and this environment has the potential for further major discoveries. Despite the widespread nickel in these areas it remained undiscovered until 1966 even though exploration in association with gold mining had been active for over 70 years.

Concentrations of lateritic nickel are over ultramafic rocks in Queensland and Western Australia.

The history of the discovery of Australia's nickel resources and consideration of the country's potential as a future source of nickel highlight certain factors fundamental to the development of the mineral resources of any country. The decision must be made to explore and requires belief in the possible existence of certain types of ore and confidence that economic benefits will result if ore is found. It is important for exploration to be concentrated in geologically favorable environments, using effective techniques, and it must be possible to bring discoveries into profitable operation if exploration is to be sustained and development implemented. The limited size of the nickel market is a factor particularly significant in this regard.

The price of nickel in Australian currency and the cost structure in Australia relative to other producing countries are critical factors which will determine the extent to which the Australian nickel resources will be exploited.

WU, P., Dept. of Mines, Ministry of Economic Affairs, Taiwan

COAL RESOURCES OF TAIWAN

The coal in Taiwan is mainly of Tertiary age and all the commercial coal deposits are in Miocene beds. There are 28 Miocene coalfields in Taiwan, three in central Taiwan and the rest in northern Taiwan. Nearly all the producing coalfields are concentrated in northern Taiwan at present. Three Miocene coal-bearing formations are recognized, represented by littoral sediments probably deposited in a tidal-flat, lagoonal to deltaic environment. These shelf-type sediments are in rhythmic alternation with basin-type marine sediments in the Tertiary geosyncline of western Taiwan. These coal-bearing formations gradually are replaced by, and grade into, marine beds as they are traced southward so that no workable coal deposits are known in southern Taiwan. The Miocene coal beds were formed largely in paralic coal basins. Most of them vary greatly in thickness and lateral extent. They are markedly lenticular and often quite limited in areal distribution. Local pinching and swelling of the coal beds are common. The Upper Coal Measures have a maximum of seven workable coal beds; the Middle Coal Measures, a maximum of five workable coal beds; and the Lower Coal Measures, three workable coal beds. Each individual coal bed ranges in thickness from one meter or more to several millimeters with an average thickness of 30-40 cm. In some leading coalfields of northern Taiwan, only the main coal bed in the Middle Coal Measures attains a persistent thickness of one meter. The structure of the Miocene coalfields is complicated by abundant asymmetric folds and thrust faults of varied magnitude. Steeply dipping coal beds are rather common. The Taiwan coals generally fall into two rank categories: low-rank bituminous and subbituminous. Semianthracitic coals are known only in small limited areas where andesitic intrusions are present. The rank of coal increases slightly with its geologic age. The original coal reserves of Taiwan total 659 million metric tons. The remaining coal reserves as of the end of 1973 total 465 million metric tons of which the estimated recoverable reserves may reach 220 million metric tons.

YACIMIENTOS PETROLIFEROS FISCALES BOLIVIANOS

HYDROCARBON POTENTIAL OF ALTIPLANO, BOLIVIA

No abstract available.

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GROUNDWATER IN ANDESITIC AREAS IN JAPAN

The hydrogeologic and geohydrologic studies of volcanoes and volcanic islands in Japan are carried on by the author and his collaborators by field geologic, geophysical and geochemical exploration survey methods, test drilling, and aquifer tests. The main purpose of these studies is to find groundwater resources at an altitude higher than the spring zone of volcanoes.

Stress is laid on two points: (1) to establish a simulated grid drilling program that deals with the groundwater valley, and (2) to clarify relation between

the occurrence of springs and character of volcanic rock.

YEN, T. P., Geol. Survey of Taiwan

GEOLOGIC CONTROLS OF MINERAL DEPOSITS IN TAIWAN

Geologic controls of mineral deposits can be classified into stratigraphic, magmatic, and structural and each control may be divided into several kinds. Generally the three controls are so closely related to one another in time and space that most of mineral deposits are usually associated with two or three of them.

The economically workable mineral deposits of Taiwan include bedded cupriferous iron sulfide deposits, gold-silver-copper deposits, carbonate deposits, sulfur deposits, and geotherms. The bedded cupriferous iron sulfide deposits were related to stratigraphic (primary-geosynclinal to basinal), magmatic (volcanic-basic), and structural (secondary-macroscopic to microscopic) controls; the gold-silver-copper deposits to stratigraphic (secondary-local), magmatic (volcanic-intermediate), and structural (primary-mesoscopic) controls; the carbonate deposits to stratigraphic (primary-geosynclinal to basinal) and structural (secondary-macroscopic to microscopic) controls; the sulfur deposits and geotherms to magmatic (volcanic-intermediate) and structural (primary-mesoscopic) controls.

The geologic controls of mineral deposits which have been studied in Taiwan may be applicable for locating and prospecting for mineral deposits in other regions of the northwestern Pacific island arcs where geologic features are similar.

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IMPACT OF ECONOMIC DEVELOPMENT ON DEMANDS FOR GROUNDWATER AND WASTE DISPOSAL IN HONOLULU

Hawaii long has been acclaimed as the paradise of the Pacific, but only after discovery by Captain James Cooke in 1778 was her beauty exposed to the outside world. At first a place for replenishing provisions and water for whaling ships, Honolulu has experienced a rapid economic growth which has made her the center of trade in the Pacific region. Her rise to prominence has not been free of problems. Like many large cities, Honolulu, the capitol of the state, is suffering from the strains imposed by an ever increasing population. The relentless demand for an adequate supply of water and an environmentally acceptable sewage disposal system are just two of the many crises facing Honolulu today.

Honolulu—city and county—encompasses the whole island of Oahu and contains about 82% of the state's population. This concentration imposes a heavy burden on the available groundwater supply. The developable water supply has been estimated to be about 525 mgd. With a present groundwater draft of 440 mgd, only 85 mgd is available for future use making alternative sources imperative. Desalting and wastewater recycling and impoundment of surface waters for trade-off with agriculture are possible alternatives.

Waste-disposal systems play a critical role in protecting groundwater supplies. Although sewage systems have not kept pace with the city's development, preventing the widespread indiscriminate disposal of sewage by cesspools, septic tanks, and other similar facilities has not been an easy task. Rules and regulations by governmental agencies have been implemented to control waste-disposal facilities and protect the groundwater supplies. The uncertainty associated with viral detection and destruction is one of the major reasons for the conservative measures applied to waste-disposal facilities.

Despite the problems, we are confident that through research, cooperative effort, constant vigilance, and sound long-range planning, we will overcome the problems brought about by economic developments.

ZARELLA, W. M.

ENVIRONMENTAL CONSTRAINTS OF EXPLORATION, PRODUCTION, AND TRANSPORTATION IN CIRCUM-PACIFIC AREA

No abstract available.

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HYDROCARBON POTENTIAL OF AMAZON BASINS OF COLOMBIA, ECUADOR, AND PERU

The Oriente, Ucayali, and Madre de Dios basins in the Amazon drainage of Colombia, Ecuador, and Peru are members of a series of large asymmetric depressions between the Andean cordillera and the Guiana and Brazilian shields. They are separated from one another by basement arches and have areas of 458,000, of 200,000, and of 95,000 sq km, respectively. The area is topographically low, covered by heavy rain forest, traversed by many huge tributaries of the Amazon and is sparsely populated.

From early Paleozoic time until the Maestrichtian, seas repeatedly invaded the area, depositing a variety of sediments, but mostly calcareous and silicate clastic deposits. At the beginning of the Tertiary, dominantly marine deposition gave way to nonmarine deposition, reflecting the Andean orogeny and topographic development of the Andes Mountains. The depositional cycle of major importance for hydrocarbons took place in the Cretaceous. A complete marine cycle of miogeosynclinal sedimentation is represented with a maximum thickness of 2,500 m, but it thins and becomes sandier toward the east. Although the cycle consists mainly of sands and shales, limestones and sandy limestones are important potential reservoirs. Most prospective structures in the basin are anticlines, generally fault-bounded and steeper on the east. Salt domes and other diapiric structures are also present. Amplitude of structures and intensity of deformation decrease eastward. The formation of structures and the migration and entrapment of hydrocarbons appear to have occurred at various times in the Tertiary.

The state of exploration in the Colombian part of the Oriente basin is well advanced with low-undiscovered potential. In Ecuador, although the peak of exploration activity has been passed, the future potential may be substantial. In Peru exploration drilling in the Oriente basin already has discovered reserves on the order of 400 million bbl of oil. On the basis of these facts and on information from Colombia and Ecuador, the total potential of the Oriente basin is estimated to be 25 to 35 billion bbl.

About 20 wildcats have been drilled in the Ucayali basin with the discovery of two small oil