zation genetically related to granitic igneous rocks. Regional geologic structure and the lithology of country rocks are the most important factors controlling localization and deposition of fluorite.

In some replacement fluorite deposits, both the fluorite and the country rocks have very similar visual characteristics. Microscopic study of thin sections can be of assistance in solving the problems of identification, quality control, and beneficiation of crude fluorite.

Experiments using geophysical methods for locating fluorite deposits have been introduced into exploration work. Gravimeter and magnetometer studies have been applied to the deposits, but they have been found useful only in broadly outlining local structures. Unfortunately, fluorite cannot be detected directly by these methods.

Until now, only easily worked surface fluorite has been mined at the several known deposits. Intensive exploration, underground mining, and sophisticated beneficiation facilities are needed to maintain high-production levels.

Estimated potential reserves of metallurgical-grade fluorite in Thailand are thought to exceed 11,500,000 metric tons.

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ANTARCTICA: UNPROSPECTED AND UNEXPLOITED CONTINENT

Antarctica is a storehouse of mineral wealth. All other continents are. There is no reason to believe that Antarctica is unique in this respect. The continent was discovered about 150 years ago. Because of the unfavorable environment and high costs, exploration proceeded slowly and intermittently for a century. Since 1957 multi-nation efforts have revealed a fairly complete knowledge of the geomorphology, structure, and general geology of the continent. A program of detailed geologic surveying and prospecting is needed. In the not too distant future the natural resources of Antarctica will be in demand.

Antarctica is a difficult continent to explore. Over 90% of it is located within the Antarctic Circle. Approximately 95% of the continent is buried beneath ice sheets some of which exceed 3,000 m in thickness. The climate is severe and the field and shipping seasons are short. All supplies and equipment must be shipped in; the continent provides nothing.

East Antarctica is an ancient shield composed of a Precambrian basement under locally thick deposits of Devonian-Jurassic terrestrial sedimentary rocks. West Antarctica is an archipelago composed of segments of deformed Precambrian and Paleozoic continental crust. The late Mesozoic Circum-Pacific orogeny resulted in the emplacement of granitic plutons in coastal West Antarctica. Volcanism has occurred along the Pacific margin since the middle Tertiary.

Deposits of minerals containing such metals as chromium, cobalt, copper, gold, iron, lead, manganese, molybdenum, nickel, silver, tin, uranium, vanadium, and zinc have been noted. Nonmetallic deposits include beryl, micas, and coal. Offshore deposits of petroleum and natural gas are possibilities.

Under a treaty signed by 16 nations, operations in Antarctica are restricted to exploration and research. There are political aspects to be considered, but surely they can be resolved and the program of exploration and prospecting can proceed at an accelerated rate.

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COAL IN ALASKA

Estimates indicate that Alaska contains 130 billion tons of coal of different rank and age distributed over approximately 33 million acres. Commercial coal production began in Alaska in 1916, but peaked after World War II, and today less than a million tons are produced annually. Only the Nenana coalfield is currently active.

The northern coal province includes several coalfields of Cretaceous age with a reserve potential of 120 billion tons of high-volatile B and C bituminous and subbituminous coals. In central Alaska, 7 billion tons of subbituminous coal and lignite are estimated in the Nenana coalfield and in associated Tertiary coal basins. The Broad Pass, Susitna, Matanuska, and Kenai coalfields of south-central Alaska may contain 3 billion tons of high-volatile B bituminous and lesser rank coal.

Subbituminous coal and lignite of Late Cretaceous and Tertiary age are present at Hereenden Bay, Chignik, and Unga Island on the Alaska Peninsula, along the Yukon River, and on the Seward Peninsula, but their extents are poorly known. Low-volatile, high-rank bituminous coal is present in the Bering River coalfield, southeast Alaska, but is highly deformed and no reliable resource estimates exist. Coal deposits of Paleozoic age are local in northwest Alaska and on the upper Yukon River. Some of the coals of the Bering River coalfield and of the northwest part of the northern coal province may have coking potential; all Alaska coals are low in sulfur.

Development of the Alaskan coals has been restricted because of land-status problems, hostile environment, inaccessibility, and high costs of exploration and production. Probably only strip mining can be competitive with other energy sources.

Future planning should include investigation of potential coking coals, large-scale strip and underground mining, in situ gasification and development of chemical industries utilizing low-rank coal.

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PETROLEUM POTENTIAL ON CONTINENTAL RISE OFF CENTRAL CALIFORNIA

The JOIDES program has demonstrated the technical feasibility of drilling in the deep ocean. However, except for petroleum shows in the Sigsbee Knolls in the Gulf of Mexico, there is no firm evidence of petroleum reservoirs in the deep ocean beyond the limits of the continental slope to require economic use of such technology.

Emery suggested the possibility of vast petroleum resources in deep water adjacent to the continents in areas of hemipelagic sedimentation. One such area adjacent to the United States is the continental rise off California between Point Conception and Cape Mendocino, which covers 200,000 sq km and consists of three major submarine fans, the Arguello, Monterey, and Delgada, at depths of about 3,000 m to 4,500 m.

The fans are composed of continental debris carried down submarine canyons and deposited on the fan through a system of branching and meandering submarine 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.

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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