These holes showed a promising geothermal potential and a first program of seven to ten production drill holes was undertaken to obtain enough steam to install a geothermal power plant with an initial capacity of 25 or 50 M.W. The possibility of freshwater production from this field also has been considered.

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COAL RESOURCES OF CANADIAN CORDILLERA

The Canadian cordillera is estimated to contain 87 billion tons of coal categorized as measured, indicated, and inferred and all ranks of coal are represented. The most important coal deposits are within a narrow belt, not exceeding 35 mi in width, that extends along the extreme eastern edge of the cordillera from lat. 49°00′ northwestward for 600 mi to approximately lat. 56°00′.

The coal-bearing formations are Late Jurassic-Early Cretaceous in age and have been subjected to severe tectonism so that the seams are inclined at all angles, folded, contorted, and displaced by faults, some of which involve lateral movements of up to 30 mi. Much of the coal in this belt is a high-quality metallurgical type and currently some 8 million tons of this type of coal are produced and shipped annually to Japan.

Other coal deposits are in widely distributed areas throughout the cordillera. They generally are confined to small areas, the more accessible of which mainly are mined out and the remainder have undergone little or no exploration. The coals range in age from Late Jurassic to Tertiary and vary in rank from lignitic to anthracitic but none are known to be of metallurgic quality. The more important of these deposits appear to be the Hat Creek coalfield of south-central British Columbia and the Groundhog coalfield of north-central British Columbia. The Hat Creek deposit is of Tertiary age and contains at least five lignitic seams having a total aggregate thickness in excess of 2,000 ft. The Groundhog coalfield contains low-volatile bituminous and anthracitic coal of Late Jurassic-Early Cretaceous age. Limited exploration of the southern part has shown it to be structurally complex and the coal is generally high in ash. The northern part is believed to be disturbed and seems to offer better opportunity for exploration of which there is none to date. No significant coal deposits are known in the immediate coastal area of the cordillera.

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OCCURRENCE AND DEVELOPMENT OF SEDIMENTARY MANGANESE ORE, GROOTE EYLANDT, NORTHERN AUSTRALIA

One of the world's major deposits of high-grade sedimentary manganese ore is on Groote Eylandt in the western section of the Gulf of Carpentaria in northern Australia.

Production and marketing of the ore commenced in 1966 after establishment of mining and treatment equipment together with ancillary facilities such as housing, roads, port facilities, water, and power supply. Subsequently further detailed exploration, development, and metallurgical work resulted in the construction of a comprehensive ore-treatment and beneficiation plant and additional handling facilities.

Current production capacity is of the order of 1.25 million tons of manganese ore per annum, of which 80% is exported. A new expansion program will provide for a production capacity of the order of 2 million tons per annum by the end of 1975, and bring the total capital expenditure on the developments to approximately $65 million.

The manganese ore is a tabular bed approximately of 13 sq mi. It crops out adjacent to the western coastline of Groote Eylandt, and is covered by soft Tertiary and recent sediments.

The ore exhibits varied physical characteristics ranging from fine loose powdery material to unconsolidated oolites and pisolites and to massive laterite and cemented boulders of pisolites. It ranges in thickness from 0.5 to over 15 m, and is present over a 45-m stratigraphic interval of sediments.

Marine arenaceous Foraminifera of Early Cretaceous age have been identified from within the ore zone and no apparent tectonic deformation of the zone has occurred.

The deposit has the appearance of having been formed under shallow-water conditions, being associated with typical shallow-water sediments including unconsolidated clays and sands containing typical shallow-marine (inner sublittoral) faunal assemblages.

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IRON ORE DEPOSITS OF WESTERN AUSTRALIA—GEOLOGY AND DEVELOPMENT

Although iron ore deposits were recorded in Western Australia as early as 1888, not until 1960 were the economic and political conditions conducive to assessment of their potential. Since that time, regional geologic mapping and intensive local evaluation have increased the total reserves from 275 to 24,000 million tons of ore containing 55% or more iron. This ore is of three main types: hematite enrichment, pisolitic limonite, and sedimentary ores. These contribute to production in the approximate porportions 20:2:1, whereas the equivalent proportions for reserves are 200:70:1.

Hematite enrichment ore formed by selective replacement by hematite, probably during Proterozoic time, of a banded iron-formation (BIF) host. Although such ore bodies are widespread in Archean (>2,500 m.y.) BIFs of the Yilgarn and Pilbara blocks, the largest ore bodies, exceeding 1 billion tons, are in the lower Proterozoic (*c.*2,000 m.y.) BIFs of the Hamersley iron province. Ore bodies of this type show stratigraphic and structural control. The ore is hematite with a variable admixture of late goethite. Pisolitic limonite ore, which forms sheets capping elongate sinuous mesas along rivers draining the Hamersley iron province, was formed during the Tertiary in the flat beds of a sluggish paleodrainage system which is closely paralleled by present drainage lines. Sedimentary iron ore is represented by concentrations of supposedly clastic hematite within folded Proterozoic (1,800 m.y.) sediments of the Yampi Sound area.

With a good overseas market available in Japan, export of ore commenced in 1966 and has risen rapidly to 73 million tons in 1973. In the earlier years of export, growth was rapid and profitable, but more recently has been affected adversely by reevaluation of currencies, industrial troubles, and developing competition for markets from Brazil, South Africa, and India.

The future will have to contend with the problems mentioned, also with the threat of a fuel crisis affecting shipping and, in the long term, the high phosphorus content of some of the ore. With huge reserves available, the demand for this iron ore will continue and some of the present problems will be solved.

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DEVELOPING BASALTIC ISLAND WATER SUPPLY—DIKE COMPLEX AND BASAL LENS

Rainfall, the primary source of water resources of basaltic islands such as Hawaii, is distributed contrastingly between low and elevated areas. Typically, in mountain areas rainfall averages 200 to 300 in. a year, whereas in coastal areas rainfall averages only 20 to 30 in. a year. In spite of the prolific rainfall in mountain areas, direct runoff in some watersheds amounts to as little as 20% of rainfall. A permeable basaltic rock terrane accounts for the great absorption of rainfall and the consequent creation of large bodies of groundwater in basaltic rocks. High-level groundwater bodies, present at elevations of as much as 1,000 ft in volcanic-dike complexes of wet mountain areas, are called dike water. Unseen below the surface, groundwater presumably moves from these high-level bodies into even greater and more extensive bodies of groundwater standing basally a few feet to several tens of feet above sea level as buoyant bodies of fresh water on salt water. Salt water saturates the island at depth. The problems of developing dike-complex water supplies relate primarily to hydrologic yield and utilization of natural storage, but the problems of developing basal-lens supplies involve the added constraint of the quality of water produced under pumping conditions. Infiltration tunnels, Maui-type shafts, and drilled wells are utilized in developing dike-complex and basal-lens water supplies. The method of development chosen depends upon the hydrology of the area, water supply design requirements, and economics.

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IRON ORES, COAL, AND STEEL PRODUCTION IN NEW ZEALAND

The present status of knowledge of iron ore and coal deposits in New Zealand is discussed with emphasis on titaniferous iron-sand ore and subbituminous coal. Development of steel production, first from scrap steel and subsequently from titaniferous iron sand, is described in relation to local logistic factors, market requirements, and development of production technology to suit local raw material characteristics. Possible future trends in production, marketing, and technology, and possible applications of the technology in other Pacific countries are mentioned briefly.

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KAPUNI AND MAUI GAS-CONDENSATE FIELDS OF NEW ZEALAND

The onshore Kapuni and offshore Maui gas-condensate fields containing New Zealand's only hydrocarbon reserves are in the Taranaki basin in the west of the North Island. Kapuni, discovered in 1959, first produced in May 1970. Maui, discovered in 1969 in 360 ft of water 25 mi offshore, is not due to produce until October 1978. Production from both fields is from Eocene sandstone reservoirs within the Kapuni Formation which was deposited between Late Cretaceous and Early Oligocene time in a widespread coastal plain and fluviomarine environment.

The original recoverable reserves of the 4-well Kapuni field, which produces from below 11,300 ft, are estimated at 460 million million BTU of dry gas (630 Bcf at 730 BTU/cu ft) and 34 million bbl of condensate. Production averaged 46.3 MMCFGD (carbon dioxide content 43%) and 3,500 b/d of condensate in 1973.

With the additional wells to be drilled in 1974, the maximum deliverability reserves will increase to 260 MMCFGD and 18,000 b/d of condensate so that 108.7 million million BTU (about 24% of the original reserves and two thirds of the production) can be supplied as raw gas, with its original carbon dioxide content, to the New Plymouth power station during 1975-1978.

The reserves of the Maui field are estimated at 5,730 million million BTU of dry gas (5,590 Bcf at 1,025 BTU/cu ft) with 161 million bbl of condensate and 41 million bbl of recoverable LPG. Two platforms will be constructed 23 and 33 mi offshore. Processing facilities will handle a throughput of 750 MMCFGD and 20,000 b/d of condensate. The gas will fuel over 3,000 megawatts of generating capacity in North Island power stations.

Kapuni raw gas, without condensate, is sold at the field by Shell, BP, and Todd for NZ 17.5 cents/million BTU. The Natural Gas Corp. will remove carbon dioxide and distribute in the North Island. Maui gas will be sold at NZ 37 cents/million BTU delivered at the power stations. Development of the Maui field and associated processing and distribution facilities will be undertaken jointly by the New Zealand Government (50%) and Shell, BP, and Todd.

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PETROLIFEROUS TAIWAN BASIN IN TECTONIC FRAMEWORK OF WESTERN PACIFIC OCEAN

In the western Pacific, the Ryukyu fold belt extends southward, parallel with the Taiwan Sinzi fold zone, across the downwarped Okinawa trough, and, at the north end of Taiwan, they merge into the Taiwan Central Range complex. From the Miocene to the late Pleistocene, orogeny in Taiwan was increasingly more intense, pushing westward and northward to fold and thrust the sediments in the Neogene basin toward the west. However, the tectonic influence was limited only to the onshore sediments of the island.

Within the Taiwan Sinzi fold zone along the edge of the continental shelf of the East China Sea, the Taiwan basin covers the Taiwan Strait, the western coastal