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#### Hydrothermal Resources of Makushin Volcano Region of Unalaska Island, Alaska

Eight fumarole fields have been located in the Makushin Volcano region of Unalaska Island. Large vapor-dominated hydrothermal reservoirs are suspected to exist in the region of the fumarole fields located on the southeast flank of Makushin Volcano. The driving heat sources for some of these reservoirs might be at vertical depths of several kms and located laterally to the west, northwest, and north. The other fumarole fields are suspected to have driving heat sources near the surface, where these fumarole fields are in or near centers of Quaternary volcanic activity. The locations of the southeast-flanking fumarole fields are controlled by plutonic-metavolcanic contact boundaries and corresponding fractures, as well as by large northwest-trending fracture systems that are believed to have been caused by tectonic stresses.

There is a need for deep exploratory drilling within this geothermal resource area in order to define the potential of any hydrothermal reservoirs. Further exploration is planned.

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#### Circum-Pacific Map Project: Framework for International Resources Assessment

The Circum-Pacific Map Project is an innovative approach to the compilation and presentation of geological and geophysical data related to the genesis and distribution of energy and mineral resources. Some of the innovations already developed by this cooperative international mapping program are in respect to: (1) techniques for cooperation between geoscientists and resource specialists in industry, academia, and government; (2) depiction of new categories and sources of data; and (3) the presentation of geologic and geophysical data such as sea-floor sediment distribution, bottom photography of manganese nodules, representation of active geologic phenomena, and the representation of plate motion.

The seven series of geologic, tectonic, and geophysical maps provide an integrated regional framework to illustrate the relationship of significant mineral and energy resources to the geological environment. Especially important are those deposits that are related to subduction phenomena, rifting, and sedimentation.

Future Map Project activities that offer opportunities for new or expanded areas of international cooperation include: the standardization of data systems, the comparative modeling of mineral deposits, the classification of continental margins in relationship to mineral genesis or deposition, and factors affecting the distribution of resources.

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#### Experimental Results and Potential for Hot Dry Rock Geothermal Resources

Development of hydrothermal geothermal resources associated with volcanic fields of the Circum-Pacific region is

progressing at an accelerating pace. This valuable energy resource base can be greatly expanded by forming artificial reservoirs in rock that is hot but contains insufficient permeability and fluid for hydrothermal development. The formation of significant in-situ heat transfer systems and subsequent testing of these man-made geothermal reservoirs have indicated the technical and economic feasibility of the hot dry rock (HDR) geothermal concept. Extended production history and heat-extraction data obtained during the period of 1978-1980 have confirmed heat transfer, chemical, water loss, and thermal drawdown models of the systems. Closed-loop heat extraction operations during a 9-month test, during which  $15 \times 10^6$  kwh of thermal energy were produced, have demonstrated growth of the reservoir's effective heat-transfer area and volume due to secondary fracturing caused by thermal contraction and sustained pressurization. Drilling, fracturing, and testing of a larger reservoir system, are underway, which will demonstrate a HDR geothermal reservoir of commercial size. HDR projects within the Circum-Pacific area include the Los Alamos experiments supported by the U.S. Department Energy and of the governments of Japan and Federal Republic of Germany. A small-scale field test has been carried out at Yakedake, Japan, since 1979. This project will be continued until 1983 and a candidate site chosen for the construction of a several megawatt pilot plant.

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#### Recent Development in Pacific Metallogenic Provinces of Mexico

Mexico conducts continuous regional explorations and detailed evaluations of its Pacific metallogenic provinces. Efforts of the past few years have resulted in 300,000 mi<sup>2</sup> (775,900 km<sup>2</sup>) of Landsat imagery coverage, photogeology, surface and subsurface geology, surface and aerial magnetometry, geochemistry and diamond drilling, plus underground mining methods of exploration. Isotope geochronologic determinations were performed on 719 rock samples, mostly from the Sierras of the Pacific provinces.

Economic geologic investigations resulted in the discovery of 183 polymetallic deposits, many of which are already in operation. La Minita, eastern State of Michoacan (Ag, Ba, Zn, Pb; 2000 t/d), is a notable example. Fourteen important nonmetallic orebodies were also found, some of which are already in production. One of these is Teliztlahuaca in the State of Oaxaca, where reserves of crystalline graphite, estimated at more than 2 MMt, assay at 4.25% and are processed by a 600 t/d plant.

The total reserves of in-situ metallics amount to 124 MMt, with a value of US\$8,680 MM. They include Au, Ag, Cu, Pb, Zn, As, Bi, W, Fe, etc. The total volume of in-situ nonmetallics is 78 MMt, valued at US\$3,600 MM. The most important of these are barite, borates, gypsum, marble, anthracite, and magnesite. Geologic and geophysical maps show the locations of outstanding deposits.

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#### Geology and Production History of Offshore Northwest Palawan, Philippines

The area of study is the continental shelf and rise off northwest Palawan and part of the southeastern margin of the South

China Sea spreading center. A pre-Tertiary continental basement complex is separated from the accreted oceanic crust, outcropping on southern Palawan, by the Ulugan Bay fault, which is one of several north-south-trending strike-slip fault zones recognized in the area.

A geologic section consisting, in the lower part, of limestones, volcanics and fine-grained clastics, ranging in age from pre-Tertiary to lower Oligocene, is encountered off northwest Palawan. This is unconformably overlain by the Nido Limestone and deep-marine shales of the Pagasa Formation (upper Oligocene to middle Miocene). The contact with the coarse clastic Matinloc Formation is an unconformity recognized on a regional scale and related to collision of the drifting margin with the remainder of the Philippine archipelago. The sequence is topped by the Carcar Limestone, described from many areas in the Philippines.

A total of 30 wells have been drilled so far: 12 were dry, 10 were discoveries, 7 of which have been declared commercial, and 7 were delineation wells. Occurrence of hydrocarbons had been restricted to reef-related reservoirs of the Nido Limestone, until the recent discovery of oil in sandstone reservoirs in Galoc 1 heralded a new chapter in the Philippines search for hydrocarbons.

Evaluation of the production performance from these reefs and analysis of the behavior of fractured limestones as reservoirs serves as a guide for future operations in the area. The future prospects of the northwest Palawan shelf and rise can be assessed from the current discovery success ratio in the exploration for reefs and from initial discoveries in turbidites.

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Tectonic Map of Circum-Pacific Southwest Quadrant—A Draft Presentation

(No abstract)

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Preliminary Results of Geophysical and Geological Studies to Assess Resource Potential and Geologic Evolution of Central Tonga Ridge and Summit Platform (21-24° Latitude)

In April 1982, the R/V *S. P. Lee*, operated by the USGS, supported geological and geophysical studies over the central area of the Tonga Ridge immediately south of Tongatapu. The cruise plan calls for the collection of approximately 1,250 mi (2,000 km) of multichannel (24) seismic reflection data and several dredge stations to sample submarine outcrops. The bulk (70%) of this work will be concentrated over the summit platform of the ridge, in water depths less than about 5,000 ft (1,500 m). One or more seismic lines will be extended eastward to and slightly seaward of the Tonga Trench, and westward of the ridge's present volcanic axis toward the Lau Basin, in order to resolve the regional rock and structural framework of the ridge. Several multichannel lines will cross the fore-arc basin that lies

between the summit platform and the trench. Sonobuoy refraction and wide-angle reflection data will be gathered routinely as well as gravity and magnetic data and high-resolution subbottom seismic records (3.5 kHz and multiplate Uniboom sources). Navigation will be controlled by satellite fixes and computer-generated dead-reckoning positions, based on ship's heading and speed, and doppler-sonar inputs.

The results of the shipboard examination of dredged samples, seismic monitor records, and possibly several hundred km of brute-stacked processed multichannel records will be presented at the CPEMRC III. The implications of this sketchy and roughly assembled data base relative to the mineral and petroleum resource potential of the sedimentary sections underlying the ridge's summit platform and the adjacent fore-arc basin will be discussed. Comments on the geologic and tectonic history of the Tonga Ridge implied by the incompletely analyzed field data will be offered for discussion and consideration.

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Wind Applications in Pacific

Hawaii shares with many other isolated areas and island communities of the Pacific a near-total dependence for energy on imported oil—a supply source which during the past decade has become increasingly expensive and less secure. Hawaii also shares with many of these areas which are deficient in conventional energy supplies, a variety of renewable energy resources which can serve as substitutes, or alternatives to seaborne petroleum. A case study showing what has been accomplished in Hawaii in moving one of these resources—wind energy—closer to commercialization is based on the limited amount of known information on the potential of wind energy in the Pacific region and studies which are underway to expand the knowledge on the extent of the wind resource throughout this region.

The Hawaii Natural Energy Institute (HNEI) and the Department of Meteorology of the University of Hawaii have developed over the past 6 years an inventory of the wind resource in Hawaii. This effort involved an extensive system of 18 long-term wind data stations located on the five major islands, supplemented by a series of mobile, short-term stations and a loan program of wind measurement devices for specific site measurements. The Hawaii Wind Data Bank provides information both to wind researchers and to those who are seeking optimum sites for installing wind energy conversion systems (WECS). HNEI also is engaged in a WECS reliability verification program and is conducting research on various wind energy applications, including storage and nitrogen generation.

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Formation, Evolution, and Hydrocarbon Prospects of Makassar Basin, Indonesia

The occurrence of hydrocarbons in back-arc basins of Indonesia has been known since the beginning of this century, but its relation to the formation and evolution of sedimentary basins is rather poorly understood. This can be resolved by explaining the origin of a basin in terms of extensional tectonics. This approach has been applied to the Makassar basin. Data provided by well records and multichannel seismic reflection profiling indicate that the observed subsidence can be explained by the thinning of continental crust by a factor of between 2 and 2.9. Stret-