Abstracts

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Geothermal Fields and Plate Tectonics in Circum-Pacific Area

A number of geothermal fields explored so far in the Circum-Pacific area occur along spreading ridges and subduction zones in areas of young tectonism and volcanism. A preliminary analysis by pattern recognition techniques, however, suggests that these geothermal fields are not situated along entire segments of plate boundaries but only at certain locations. These locations are (1) near the ends of plate boundary segments or (2) near sharp bends in the trench systems or (3) in transverse zones which divide plates into several blocks 62 to 620 mi (100 to 1,000 km) long. The locations of geothermal fields, therefore, appear to be influenced by plate geometry and correspond to lateral breaks in the continuity of the underthrusting plate. Shear heating in these transverse zones, which separate different blocks in a plate boundary, may explain the excess heat flow which allows the development of geothermal fields in these zones. In divergent zones, the geothermal fields are situated near where the spreading systems are offset by transform faults. Exploration for geothermal fields is on a haphazard basis at present, guided primarily by the presence of hot springs and fumeroles. This study will help in the development of geothermal energy by identifying broad zones in which exploration should be carried out and by providing a hypothesis for their occurrence.

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Geochemistry of Manganese Deposits of Nicoya Ophiolite Complex in Costa Rica

Numerous small Mn deposits have been reported from the Nicoya ophiolite complex in Costa Rica. These deposits are primarily of two types: (1) deposits occurring in radiolarites consisting of laminar units of alternating radiolarite and Mn-oxide and overlying Mn-crusts which grade into nodular concretions, and (2) deposits occurring as stockworks of veins of Mn-oxides within silica lenses (up to 16 × 328 ft, 5 × 100 m) in basalt. The two types occur in different nappe units of Lower and Upper Cretaceous ages.

Geochemical and X-ray analyses of the deposits indicate the following: (a) they show low Ni, Co, and Cu (total <0.5%) and low Fe/Mn ratio (<0.1) like the Mid-Atlantic Ridge deposits; (b) Fe/Mn in a few basaltic deposits ranges from 0.1 to 0.9; (c) concentrations of rare earth elements (REE) and the shale normalized REE patterns of the deposits are similar to those found in tholeiitic basalt; (d) absence of Ce enrichment is commonly observed in manganese nodules; (e) higher REE and Cu and lower Si occur in nodular concretions than in other radiolarian deposits; and (f) braunite and pyrolusite as predominant minerals.

These facts, along with other geologic evidence, suggest that the Mn deposits are hydrothermal precipitations and are related to sea-floor spreading processes during Cretaceous time. The laminar units were formed as the fractionated Mn-rich hydrothermal solutions passed through the radiolarian oozes. The crust was formed directly above the main emanation centers and the nodular concretions possibly grew away from the source. Basaltic deposits were formed at various stages of fractionation of the hydrothermal solutions, resulting in deposits of varying chemistry.

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Compressed Air Energy Storage for Electricity Generation

Electric utilities attempt to meet fluctuating demands for power at lowest cost and with least consumption of premium fuel. Base-load coal and nuclear plants are designed to supply about 50% of maximum load. The remaining load is supplied by less efficient cycling generators which burn natural gas, petroleum, or coal.

The compressed air energy storage (CAES) method reversibly converts electrical energy to mechanical energy. Air compressed with excess base-load capacity during off-peak periods is stored within an excavated geologic cavern or water-bearing porous rock formation. During peak-load periods, compressed air is released, mixed with fuel, burned, and expanded through turbines to generate power. CAES reduces conventional peaking plan consumption of petroleum by over 60%. Advanced conceptual plants could eliminate petroleum consumption by either (1) storing the heat of compression to reheat the compressed air, or (2) passing the compressed air through a pressurized fluidized coal-bed combustion chamber. CAES provides flexibility, frequency control, rapid start-up, and smaller impact on the environment than cycling plants.

In California, potentially favorable geologic sites for CAES exist in depleted gas fields, depleted oil fields, saline aquifers, and hard rock formations. Economic benefit was evaluated using sensitivity analysis to identify how various parameters affect the bus-bar cost of electricity. Feasibility also depends upon the power generation cycle, experimental proof of operations in aquifer reservoirs, and institutional and legal clearances. The future potential for CAES is discussed with respect to the geology and population distributions of the Circum-Pacific region.

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Worldwide Applications of Ground-Coupled Heat Pumps, Conventional and Solar Assisted

The use of the ground as an energy source, sink or storage element for coupling to a heat pump has attracted renewed interest in recent years. Several system options have been developed, some of which use additional solar-derived energy. In applying ground coupling in a given situation, three major decisions must be made. First, it must be decided whether to use solar energy in the ground-coupled system, and if so, whether to design for long- or short-term energy storage. Second, the type of in-