environment offer optimum conditions for photosynthesis and bacterial action, small scale biomass systems should provide adequate renewable food, feed, fuel, fertilizer, and various raw materials for appropriate industries, not only to meet local needs, but also for export in order to buy machinery and equipment for meaningful social and economic development. The technology for such systems already exists, and can easily be transferred to all these islands and rural areas to solve many existing problems of malnutrition, sanitation, pollution, energy, and unemployment, in an inexpensive and self-reliant manner. But more important still, the political and cultural attitudes of the local leaders, the extent of government support for training and extension programs, and the needs of the people to conserve energy and other resources, can contribute considerably to the success of such alternative development.

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Geochemistry of Geothermal Field in Eastern Taiwan, R.O.C.

The eight main hot-spring areas of eastern Taiwan, distributed in a belt 185 mi (300 km) long and 25 mi (40 km) wide, can be classified, according to their geologic and chemical characteristics, into three groups: (1) the Eocene slate, phyllite, and quartzite group, (2) the Miocene sedimentary rocks of the Coastal Range group, and (3) the Miocene argillite, slate, and phyllite group. Most of the springs belong to (3).

The laboratory analyses of the hot water and rock samples from the eight springs, performed for this paper, accompanied by earlier chemistry and temperature reports on water from these springs, reveal that little deviations in their characteristics exist for each spring, although the water temperatures have fluctuated.

The SiO_2 concentration geothermometer of the mixing model (Fournier and Truesdell in 1977) and a modified mixing model, accomplished for this paper, are presumably the best available to estimate the geothermal reservoir temperature. Their application, however, cannot be valid in the greenschist region. This fact should not deteriorate the accentuated exploration of the geothermal energy in eastern Taiwan. Meanwhile, the establishment of an alternative geothermometer for the greenschist region is desired.

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A Simple Geological Model for Geothermal Systems in Central Range of Taiwan

There are about 97 hot-spring areas in Taiwan, 70 of which are located in the Central Range metamorphic terrane. Among these 70 spring areas, 13 have maximum spring temperatures $\geq$85°C $\leq$99°C; the rest have $\geq$36°C $\leq$79°C. The five explored thermal areas in this region indicate maximum subsurface temperatures from 173° to 226°C. The Central Range is approximately 185 mi (300 km) long and 25 to 45 mi (40 to 70 km) wide, comprising more than 100 mountain peaks that are 9,840 to 13,100 ft (3,000 to 3,995 m) above sea level. Topographic relief is high, ranging from 1,640 to 4,900 ft (500 to 1,500 m) (ΔH, elevation difference between a mountain peak and the spring) in 1.25 mi (2 km) (D, horizontal distance between the mountain peak and the spring) to 8,200 to 9,840 ft (2,500 to 3,000 m) in 6.2 to 8.7 mi (10 to 14 km). High topographic relief facilitates deep circulation of meteoric water and upwelling of thermal water from depth, so that thermal springs mostly occur in deep valleys and production wells are all artesian. Analysis of the topographic effect on hydrothermal systems reveals that ΔH's of 2,300 to 7,200 ft (700 to 2,200 m) and D's of 1.25 to 6.2 mi (2 to 10 km) favor occurrence of high temperature thermal areas (max. spr. temp. $\geq$35°C or T_{SiO_2} $\geq$140°C), whereas ΔH's of 2,300 to 5,900 ft (700 to 1,800 m) and D's of 1.25 to 4.4 mi (2 to 7 km) can only form low temperature thermal areas (max. spr. temp. $<$60°C or T_{SiO_2} $<$110°C). A simple model for the hydrothermal system in the Central Range is based on these data.

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Heavy Mineral and Manganese Nodule Distribution in Areas Adjacent to Taiwan

The heavy minerals in the sandy shelf sediments around Taiwan consist mainly of magnetite, ilmenite, amphiboles, pyroxenes, olivine, epidote, garnet, zircon, tourmaline, and monazite. The highest concentration of heavy minerals occurs on the eastern Taiwan shelf where average heavy mineral content is about 8%. This abundance of heavy minerals is closely related to the weathering of pyroxene andesite from the Coastal Range. Amphiboles dominate in the heavy minerals from the shelf of northern Taiwan while zircon and monazite are relatively abundant along the southwestern coast.

The manganese nodules dredged by R/V *Chiu-Lien* from the Philippine Sea consist essentially of akaganeite (β-FeOOH), birnessite, and todorokite, while the nuclei of the nodules contain phillipsite, illite, and feldspar. The average compositions of 18 nodules analyzed are Fe 14.10%, Mn 12.94%, Ca 0.26%, Mg 0.80%, Na 1.53%, K 0.62%, Co 2,588 ppm, Cr 30 ppm, Cu 1,257 ppm, Li 14 ppm, Ni 2,733 ppm, Pb 1,033 ppm, Sr 80 ppm, and Zn 518 ppm. The (Ni + Cu) contents tend to increase with increasing Mn/Fe ratios which vary from 0.6 to 1.1 averaging around 0.9. According to the criteria given by Toth, the Philippine Sea nodules are not related to hydrothermal activity. These nodules may have originated by catalytic oxidation and absorption of Mn, Fe, and other transition elements upon suitable submarine surfaces.

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Hoadley—A Potential Supergiant Gas Field in South-Central Alberta, Canada

The Hoadley gas field is a potential supergiant gas condensate accumulation, discovered in November 1977 by Sundance Oil. The discovery well, Sundance et al Hoadley 6-2, has an AOF of 26 mmcf of gas per day with 60 bbl of natural gas liquids per mcf of gas. The field covers approximately 1,500 mi^2 (3,885 km^2) in south-central Alberta. The producing zone is in the Lower Cretaceous Glauconitic formation consisting of 25 to 80 ft (7.6 to 14.4 m) of sandstone pay. The sand was deposited as a gigantic marine barrier bar with an approximate width of 15 mi (24 km) and a length of more than 130 mi (209 km), trending southwest-northeast across south-central Alberta. The central and southwestern part of the barrier bar (approximately 100 mi [161 km] long) is entirely saturated with gas and natural gas liquids. Of more than 100 Glauconitic gas wells completed within this section of the barrier bar since discovery, none has tested or produced salt water. The field is estimated to contain a potential recoverable reserve of 6 to 7 tcf of gas, and a potential recoverable reserve of 350 to 400 million bbl of natural gas liquids.

The geology of the Hoadley gas field is a classic example of a modern barrier-bar complex. Principal facies recognized in the studied area include marine shale, bay, barrier sand bar, eolian sand ridge, tidal channel, levee, inter-bar lagoon, and back-bar washed sands. A deltaic complex, found immediately to the southeast of the barrier bar, includes deltaic distributary channel and abandoned channel sand facies. Each of these facies can be recognized from diagnostic electric-log characteristics.

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Nonlinear Creep Behavior of Oil Shale

Oil shale resources in the United States are important as an energy source. Knowledge of the mechanical properties, including the creep behavior, is essential to any form of development. The creep behavior of oil shale samples taken from the Parachute Creek Member of the Green River Formation has been studied. A pneumatic-driven testing machine with long-term displacement monitors was used. The set of duplicate test specimens required for creep testing were cut from the same horizon of oil shale using a diamond-impregnated-wire saw to avoid surface damage. Duplicate samples were tested at various stress levels of the ultimate compressive strength. Samples with different organic contents were taken at different depths of the core. A nonlinear rheological model was developed and a multiparametric statistical analysis was performed. It was concluded that the organic content and the stress levels were important parameters. The creep phenomenon can be represented by a nonlinear strain-time equation upon which a nonlinear pseudo 3-D creep model can be built, relating the strains to the stresses.

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Application of On-Site Prime Power Packaged Cogeneration Systems in Pacific Basin

The term cogeneration was coined to define the concept of simultaneous production of two forms of useful energy from one fuel source. The energy produced is typically electrical or mechanical power and thermal power. There are two types of systems, distinguished according to whether the electrical power from the generator is first produced by direct combustion of a fuel or results from the utilization of a thermal energy supply. A new modular design concept allows virtually any commercial or industrial project to incorporate a compact, packaged pre-engineered cogeneration system into their plant or office facilities. In the United States, there are approximately 8,000 Mw (megawatts) of cogeneration and this level is expected to double by 1990. The incentives for installing cogeneration systems arise from tax credits and anticipated availability of natural gas at cost.

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Molten Rock Drilling

The Sandia Magma Energy Project has resulted in the conclusion that it is scientifically feasible to extract energy from magma resources buried within the top 6.2 mi (10 km) of the earth's crust. Supporting that conclusion were the ten holes that have been drilled successfully into the melt zone of Kilauea Iki Lava Lake. One recent hole was drilled and cored through the entire 98 ft (30 m) thick molten zone.

Two novel drilling systems were developed. The first used an insulated drill stem with an uncooled superalloy drag bit. This system was tested successfully in the laboratory at magma temperatures but never used in the field. The second system used standard drill pipe, a modified core barrel, and a water jet-augmented face discharge diamond coring bit. A high rate of water flow was used to cool the drill stem and solidify the molten rock as the bit advanced. This system was laboratory tested and successfully used to drill 5 holes (345 ft, 105 m) in the molten rock zone of Kilauea Iki, where the temperatures were above 1,020°C. Core recovery was 100%.

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Southeast Quadrant Mapping: Circum-Pacific Map Project

The Southeast Quadrant maps on display are the coordinated results of panel members from seven South American countries and from the United States plus the special and active participation of a number of geoscientists and institutions from many parts of the world.

Geographic and Plate-Tectonic maps have already been published. The compilation of the Geologic Map has been completed and it is being processed for publication. Unlike traditional small-scale geologic maps, it emphasizes major tectonostratigraphic units and their facies. These have proved to be the most useful mapping units and they provide the most significant background for the other maps of the Circum-Pacific Map Project series. The completed series will facilitate comprehension and correlation of the stratigraphic development between continents in terms of the sequence and chronology of major tectonic events.

The surface sediment distribution is shown on this map as a 13-category classification, prepared by Floyd McCoy of the Lamont-Doherty Geological Observatory. Land geology was compiled from the latest published maps, as well as unpublished information, and from maps compiled specifically for the Project by scientists from Venezuela (C. Martin, H. Bellizzia, C. A. Galavis, N. Pimentel), Colombia (H. Duque-Caro, J. Cruz), Bolivia (C. Salinas), and Peru (J. Lizarraga).

Preliminary drafts of the Mineral Resources Map and the Tectonic Map are also complete. The former, compiled under the technical direction of Philip Gould of the U.S. Geological Survey, includes special contributions from various South American countries. It shows the geographic distribution of mineral deposits according to type, class, and size, on a simplified geologic-tectonic background. The relevant information for each deposits has been recorded and will be computerized. Suggestions from interested geoscientists are welcomed.

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Geologic Map of Antarctica

With the Antarctic sheet of the Plate-Tectonic Map of the Circum-Pacific Map Project (CPMP) now completed and published, the CPMP Antarctic panel is at work preparing a new 1:10,000,000 Geologic Map of Antarctica. It will build upon earlier geologic maps of that continent at 1:5,000,000 (1972 and 1976) and at 1:10,000,000 (1979). It is intended that all new Antarctic work, published through 1981, be incorporated into the new CPMP geologic map.