The suites of techniques being employed in geothermal exploration are different from those in either mineral or petroleum exploration.

Geologic reconnaissance techniques involve the mapping of hot springs, fumaroles, and volcanoes. Plate margins typically delineate the broader zones in which economic geothermal reservoirs may occur. Empirical correlation exists between the rate, the angle of subduction, and the spatial occurrence of active volcanoes providing a general guide for exploration. Andesites are more commonly associated with productive geothermal fields than are the more basic rocks.

Geochemical thermometry, coupled with hydrogeologic studies, provides useful clues as to the probable last equilibrium temperature of geothermal reservoirs. However, dilution and continuous rock-water interaction often obfuscates the true reservoir temperature.

Geophysical techniques have become indispensable in narrowing down the targets to be tested by drilling. Foremost among the geophysical techniques is the electrical resistivity method and all of its variants, including deep electromagnetic soundings, tellurics, magnetotellurics, and audio-magnetotellurics. Microearthquake activity has been shown to have empirical correlation with the more productive parts of geothermal fields. Temperature gradient and conductive heat-flow measurements are important tools in detailed exploration, but oversimplified interpretation of the data therefrom can result in grievous disappointment.

Gravimetry may be employed in both direct, as well as indirect exploration for geothermal steam, depending upon the specific circumstances. Magnetometry may be useful in identifying very high temperature zones (greater than about 500°C) by virtue of loss of magnetism beyond the Curie Point.

Other techniques which are employed occasionally include ground noise mapping, SP, seismic refraction and reflection, and radioactivity mapping.

Each of the above listed techniques has certain merits and weaknesses. A proper combination of techniques, which must be individually tailored for the given region under investigation, could result in success, as shown by examples from a number of localities. Overly simplistic interpretation or overinterpretation of limited data have resulted in exploration failures, as documented in other cases.

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Comparative Geology of Inner Solar System

No abstract available.

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Solubility of Petroleum in Water and Its Significance to Petroleum Migration

The aqueous solubilities of individual hydrocarbons, petroleum, and petroleum fractions increase with temperature, the rate of increase being gradual to 100°C and drastic thereafter; eventually cosolubility will be reached at high temperatures. Mass-balance calculations show that the formation of petroleum deposits can be accounted for by a molecular-solution primary-migration mechanism at temperatures greater than 180°C. Temperature decrease and salinity increase cause drastic exsolution of hydrocarbons from the aqueous phase. Thus the pronounced decrease in solubility of petroleum at higher salinities and lower temperatures present at shallow basin depths releases dissolved hydrocarbons during upward movement of deep-basinal waters. Faults provide the main pathway for this vertical movement. Eventually the fluids are collected into shallower sandstones when the fault becomes impermeable to further vertical fluid movement.

The model is supported by geochemical-geologic evidence. At depths of 14,000-18,000 ft (4.27-5.49 km), 15-20 percent water remains in clastic sediments, which is more than sufficient to carry the required volumes of petroleum. Experimental and field evidence has shown the almost total conversion of "kerogen" to extractable organic matter in fine-grained rocks at temperatures greater than 300°C. On the other hand, studies in Tertiary-Mesozoic basins have shown that, at depths shallower than where these temperatures are present the "kerogen" has not thermally degraded at all, and the extractable organic matter in shales is immature and unlike crude oil. Microspore and pollen particles in crude oils are derived from sediments much deeper in the section than where the oils are found. Thermodynamic equilibrium temperatures calculated for crude oils are much higher than reservoir temperatures and are in the range predicted by this model.

The model predicts specific geologic and geographic controls on petroleum occurrence. Examination of petroleum deposits and basins confirms the predictions and indicates that this model can be used as a powerful tool in petroleum exploration. The model's essence is a search for the first trap off a major fault into the area of greatest sediment thickness. The model can be used for exploration in Tertiary depocenters (Gulf Coast, Niger delta), wrench basins (Los Angeles), upthrust basins (Rocky Mountains), thrust basin (Western Canada), and shelf plays (Western Canada; Mid-Continent).

Another implication of the model is the possible existence of a huge new energy resource—crude oil dissolved in hot deep waters of petroleum basins. The possibility exists of tapping these geothermal waters for heat as well as dissolved crude oil. Minimum estimates by mass-balance calculations put the reserves of this resource in range of the trillions of barrels.

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Geology of Northern Greenland

Most of extreme northern Greenland is formed by rocks deposited in the North Greenland geosyncline, an extension of the better known Franklinian Geosyncline of the Canadian Arctic. Across the northeastern corner of Greenland, outliers of beds of late Paleozoic to Tertiary age are present and provide evidence for the existence of a basin of that age off the eastern coast of the island.

The Paleozoic beds of northern Greenland were apparently deposited in two basins that retained their separate identities from Late Proterozoic to late Silurian times. This is well demonstrated by the lithologies of the beds in the two basins. The Cambrian in the western basin is formed dominantly of carbonates; in the eastern basin, a black shale and sandstone sequence is conspicuous. The Ordovician in the west contains a thick bed of anhydrite which is absent or unrecognizable in the east. Thick reefs dominate the Silurian of the west but do not crop out in the east where a thick siltstone sequence lies above the carbonates. To account for the variations in lithology, which do not appear to be gradational, it is postulated that a north-trending crystalline basement "high" separated the two areas throughout sedimentation. Evidence for the presence of this feature can be obtained in the field and from geophysics.

Following a phase of folding in post-Silurian time, sedimentation commenced in a basin toward the east from the present northeastern coast of Greenland. Rocks of all eras have been recognized, but much work remains to be done in this area. It is exceptionally remote.

Analyzing the area in terms of plate tectonics can provide interesting data.