temperature anomalies occur over fields which are contained in stratigraphic traps.

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Geothermics of Landau Field by Corrected Temperature Measurements

One of the most striking geothermal anomalies within the Rhine graben is in the Landau/Pfalz oil field. The temperature at 1,000 m depth is about 100°C in the center of the anomaly. Temperature logs in the oil field are generally disturbed, owing to the former production or injection of fluids. A mathematical model is presented, describing the distribution with depth of the temperature disturbance in a flowing borehole. Based on this, the process of cooling after a period of flowing can be calculated. It is then possible to check whether a borehole is in thermal equilibrium. If favorable conditions prevail (high flow rates and/or small depth of the reservoir) the presented model can be used to estimate the temperature in the reservoir from the surface temperature of the fluid.

The geothermal anomaly is probably associated with deep reaching faults, in which thermal water can rise up from a depth of several thousand meters. The water originates near the crystalline basement and flows into the sedimentary fill, transmitting its heat content to the surrounding rocks.

A numerical model shows that the required water flux to match the observed temperature distribution is very small, and that an anomaly as found in Landau can be created within a time period of about 100,000 years.

The same conditions as in Landau exist in other zones of the Rhine graben, and similar convective systems can account for other temperature anomalies.

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Organic Geochemistry and Petroleum Exploration—Problems?

Results of organic-geochemical studies of deep well bores contradict current concepts on the generation, maturation, and thermal destruction of hydrocarbons. Main-phase hydrocarbon generation (high bitumen coefficients) apparently occurs between 190 and 250°C in Lower Cretaceous to Devonian rocks in five separate well bores. In these same rocks, the kerogen still retains high values of pyrolyzable hydrocarbons normalized to organic carbon. All five well bores have had higher than 250°C paleotemperatures. These results indicate that much higher temperatures than those commonly accepted are required for the complete generation and thermal destruction of hydrocarbons. Other results from these studies contradict the following accepted organic-geochemical trends versus depth: (1) maturation of saturated hydrocarbons; (2) the $S_1/S_1 + S_2$ ratio (S_1 = extractable bitumens and S_2 = pyrolyzable hydrocarbons per thermal analysis); (3) the temperature at the maximum of the S_2 peak; (4) the thermal phaseout of C_{15} + hydrocarbons; and (5) correlation of elemental kerogen composition and vitrinite reflectance with extractable and pyrolyzable hydrocarbons. Laboratory duplication of generation-maturation reactions in closed, pressurized, water-wet systems shows that the controlling parameters of these reactions are not as described in the accepted mathematical formulas modeling these reactions. Concepts concerning the generation and thermal destruction of hydrocarbons apparently have been greatly oversimplified.

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Hydrothermal Approach to Petroleum Exploration

In sedimentary basins the accumulation of raw materials to form oil and gas deposits is in many ways similar to the accumulation of materials to form mineral (ore) deposits. Logic suggests that in either case the job can hardly be done without an active water system, functioning as both solvent and vehicle for the raw materials. Members of the mining community have no problem with this concept. A majority of the petroleum people (especially in the Western Hemisphere), however, seem to have a chronic aversion to water.

The mining and the petroleum people are both working in the same environment of water-wet sedimentary material. It can be shown that some similarities of petroleum and mineral accumulations are not just coincidence. They are essential functions common to both systems.

An important similarity of petroleum and mineral accumulations, and the main topic of this paper, is the hydrothermal regime. In both systems, hydrothermal conditions are supported by field and laboratory evidence. Such evidence has been used effectively in mineral exploration for many years. There is good reason to believe it can be used in petroleum exploration. If moving waters carry raw materials for oil and gas deposits, and temperatures can be used to track those waters, then the temperatures may also point toward possible oil and gas deposits. As with mineral deposits, places of interest could be where depressuring and cooling associated with upward movements of enriched waters are likely to cause hydrocarbon fall-out.

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Present Thermal Conditions in Baltimore Canyon and Georges Bank Basins in Relation to Extensional Models

We examine the thermal evolution of the Baltimore Canyon and Georges Bank basins to derive their present temperature structure. Our models are based on the hypothesis that these basins have formed over continental crust which was thinned by extension during the opening of the Atlantic Ocean. The cooling and subsidence history are simulated using two-dimensional finite difference techniques. The results of this work demonstrate that the extensional model is consistent with seismic, gravity, and heat-flow observations in the two basins. Since the model reliably predicts the observed features of the basins, we believe that its predictions for the temperature structure of the basins are also reliable.

The thermal gradient, heat flow, and temperature at depth in the two basins are expected to vary laterally because of variations in the amount of crustal thinning, sediment distribution, and basement depth. The Baltimore Canyon basin is characterized by one large sediment depocenter, while the Georges Bank basin has several smaller depocenters. This difference is character may be attributed to the oblique, rather than normal, orientation of rifting in the Georges Bank area. The modeling technique used predicts what effects these types of features will have on the present temperatures and temperature history of these parts of the continental margin.

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