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Offshore World Petroleum Frontiers

The potential to find the large oil and gas fields of the future lies in the offshore frontiers. Exploration for petroleum in the coming decades must be concentrated on discovering commercial supplies of the hydrocarbons that lie untapped in these areas. New and better uses of geology, geophysics, petroleum engineering, and technology must be employed in all aspects of exploration, development, and production. Vital to accomplishing these tasks is an in-depth knowledge of the characteristics of basin areas and offshore frontier regions. New exploration strategies must be formulated for exploration in both moderate and harsh offshore areas. New technology for drilling and producing oil and gas, especially in Arctic regions and at greater depths globally than heretofore considered feasible, must also be advanced rapidly. As part of a unified exploration effort, each specialized discipline—whether geology, geophysics, or petroleum engineering—has to provide the bold and innovative thinking that will lead to the offshore discoveries of the oil and gas the world needs for future energy survival. This paper illustrates with slides the location of these promising offshore areas and the basins involved.

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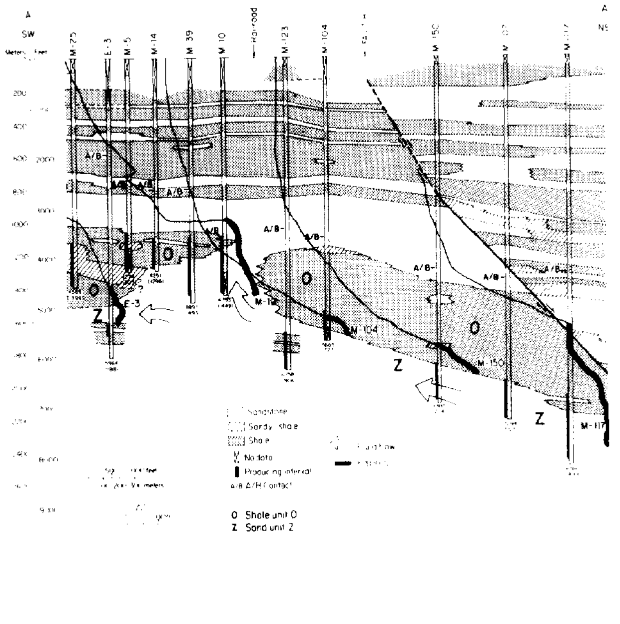
Geologic and Geothermal Fluid Flow Models of Cerro Prieto Field

A detailed hydrogeologic model of the liquid-dominated Cerro Prieto geothermal field in Mexico (located in Baja California about 35 km [22 mi] south of the U.S. border) has been developed to identify subsurface geothermal fluid flow paths. This was accomplished by integrating downhole temperature profiles and depth of production intervals with a geologic model derived from the interpretation of geophysical and lithologic well logs.

Two different methods were used to define the geologic model of the Cerro Prieto field. In the first, the lithology was divided into seven different formations based on correlatable groups of beds having distinct lithologic, structural, and fluid production characteristics. In the second method, the lithology was classified into three basic types of lithofacies: shales, sandy shales, and sands. Faults identified by the first method were incorporated into lithofacies sections.



Geothermal fluid flow paths were identified by integrating well temperature profiles and the depths of geothermal well production intervals with the lithofacies cross sections. Hot fluids are believed to enter the field at depths greater than 3,000 m (10,000 ft) from the east through a thick, porous sand unit, called Sand Unit Z, which dips gently to the east. This unit underlies a 450 to 600 m (1,500 to 2,000 ft) thick low porosity shale unit, named Shale Unit O, which acts as a local caprock. The fluids flow westward until they encounter a normal fault, Fault H, with downthrow to the southeast. The fluids then move up along this fault until they again encounter Sand Unit Z along the upthrown side of Fault H. Whereas most of the fluids continue to flow westward through Sand Unit Z, a small portion rise along Fault H, as evidenced by high temperatures found at shallow depths in the faulted region. The westward flow continues until it reaches a gap in the overlying Shale Unit O. There, some of the flow rises up and into the western Shale Unit O, which is sandier in this region, while the rest continues to flow westward through Sand Unit Z. Eventually, some of the geothermal fluids leak to the surface, whereas the rest mix with colder waters that surround the geothermal system. A number of cross sections detailing the subsurface movement of the geothermal fluids are shown.

This hydrogeologic model is consistent with other geologic, geophysical, geochemical, and reservoir engineering studies carried out at this field.

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Computer-Aided Exploration for Small Companies

Recent advances in computer hardware technology have created a trend of lower prices and higher performance. Today, both individuals and small companies can afford computer equipment for geoscience applications. The question is often asked, "What is necessary to initiate the use of computer technology to assist in the exploration process?" This paper reviews the hardware, software, and techniques involved in computer-aided exploration.

Basic hardware requirements for geoscience applications are a digitizing tablet for data capture, a processor and peripherals for data analysis, and a plotter for displaying results. Software is available for common applications such as digitizing, log analysis, and mapping. Nortex has purchased a digitizer and plotter and shares part of a computer with the business group.

Nortex has both purchased application programs and hired programmers to develop applications internally and maintain the present software. Applications include log digitizing and analysis, seismic data digitizing, mapping and retrieval from WHCS data, and trend surface and residual analysis.

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Larger Foraminifera as Depth Indicators in Carbonate Depositional Environments

Studies of living larger foraminifera have provided several breakthroughs pertinent to the use of their ancient analog in paleoenvironmental interpretation. The first of these insights is that modern larger foraminifera are nutritionally dependent upon algal symbionts and are morphologically adapted to house those symbionts. The second is that algal symbiosis is energetically highly advantageous under nutrient-deficient conditions such as those prevalent in well-developed modern coral reef environments. In addition, experimental evidence demonstrates that the availability of light and water turbulence in the environment