CHAPTER 7

Potential Petroleum Reservoirs on Deep-Sea Fans off Central California

Pat Wilde, William R. Normark, T. E. Chase, and Christina E. Gutmacher

Abstract

Evaluation of the petroleum potential of the Monterey and Delgada submarine fans based on single-channel seismic reflection profiles and surficial sediment data indicates two high, six good, and four moderate prospects. Sediment thicknesses in a northwest-southeast basement trough at the base of the continental slope generally exceed 1 km; within internal depressions thicknesses can reach 2 to 3 km. Organic carbon contents up to 1.3 weight percent occur on the upper fan. An average heat flow of 2 HFU suggests the occurrence of a thermal gradient sufficient to exceed catagenic conditions within the trough if potential source beds are old enough.

Introduction

There is increasing interest in the possibility of petroleum accumulation along continental margins and, in particular, in submarine fans [1–7]. The hydrocarbon potential of specific deep-sea areas has been investigated in the Gulf of Mexico [1,8,9], the Nile Cone [10], and the U.S. Atlantic continental rise [11].

The pioneer work on central California submarine fans [12–15] was extended to incorporate localized detailed survey data [16–18]. The bathymetry presented in this report (Fig. 1) is our revision of earlier charts [19–20]. In a previous study [21], we discussed the petroleum potential of the deep continental margin off central California, primarily on the Monterey submarine fan. Since 1976, geophysical and sample data from six U.S. Geological Survey cruises (Fig. 1) have been made available to augment and modify the earlier discussion of the petroleum potential in the central California margin. These new data give a more detailed view of the Monterey Fan and provide a reconnaissance seismic survey on the similarly sized Delgada Fan to the north. The study area (Fig. 1) extends from latitude 34° to 40° N. and from the base of the continental slope westward to longitude 127° W., and encompasses approximately 1.8 x 10^5 km^2. Even with the seismic coverage from these new cruises, large areas of the fans are crossed by only a few single-channel seismic profiles taken with sparker and air-gun sound sources.

We do not imply that direct evidence exists for significant petroleum reserves on these or other modern submarine fans. This can be determined only by drilling. High energy costs, however, accompanied by the extension of drilling and production capabilities for deeper water areas indicate that deep-water environments of continental margins may be exploratory targets in the near future. Particularly attractive are areas off coasts with both high marine biogenic productivity and extensive sedimentary wedges or basins.

Conditions for Petroleum Accumulation

The basic requirements for the accumulation of petroleum in submarine fans are the same as for nearshore continental sedimentary basins. These are: 1) source beds brought to the appropriate thermal-maturation conditions for petroleum generation; 2) these source beds are adjacent or linked to reservoir rocks that have sufficient porosity and permeability to allow the migration and collection of hydrocarbons; and 3) stratigraphic or structural traps involving reservoir rocks favorable for the accumulation of hydrocarbons [22].
Source Beds

The central California continental rise is potentially a favorable area for the formation of hydrocarbon source beds as a result of the seasonal upwelling and high organic productivity that occurs there [22,23]. Analyses for organic carbon in sediments from recently collected piston cores from the middle and upper parts of the Monterey and Delgada Fans shows values about double those reported for Deep Sea Drilling Project (DSDP) Sites 32, 33, and 34 on the more distal part of the Delgada Fan [24]. The total organic carbon content in the DSDP samples resembles that