The slide was along the bedding plane in the eastern two thirds of the area. In the western third of the area the arcuate leading edge cut up section along the western and southwestern flank of Coyanosa and continued along the sea floor to just beyond Rojo Caballos. Rapid emplacement is implicit from the westerly thinning wedge of detritus which was churned up by the toe of the slide as it traversed the sea floor.

Alternate interpretations to submarine sliding require almost inexplicable faulting and erosion to account for the observed phenomena.

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RATIONALE FOR DELIBERATE PURSUIT OF STRATIGRAPHIC AND PALEOGEOMORPHIC TRAPS

It is obvious that the results of exploratory onshore efforts in the last decade—which have been directed toward structural anomalies—have not been generally successful. Yet, the industry continues to neglect the purposeful search for stratigraphic and paleogeomorphic traps even though some of the largest oil and gas fields in the world are in such reservoirs. As explorationists it is our responsibility to originate new ideas, new methods, and arrive at a decisive "breakthrough" of some kind to discover these so-called subtle traps. Because these traps occur in a great variety of possible geologic environments—such as relic shorelines, channels, deltas, lagoons, river and stream beds, buried overlaps and onlaps, and in other ancient topography—ranging in size from inconsequential to supergiant—the industry is shirking its duty to the nation if it does not embark immediately on an extensive and concentrated effort to focus all of its exploration know-how toward searching for and finding the large petroleum reserves which surely exist in these subtle traps.

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GEOLOGY AND ENVIRONMENTAL FACTORS AFFECTING GIANT FIELDS

At least 187 giant oil fields and 79 giant gas fields are known in the world today. Giant fields are those that contain 500 million bbl or more of recoverable oil, or 3.5 Tcf or more of recoverable gas, or an equivalent combination of gas and liquids which has a calorific value equivalent to 500 million bbl of oil. Altogether these fields contain an estimated, minimum ultimate recoverable reserve of 638.77 billion bbl of oil and 1,180 Tcf of gas or *approximately* 30–40% of the total known world recoverable gas. Most giant fields (190 = 71%) are in the Eastern Hemisphere; only 76 (29%) are in the Western Hemisphere; 81% of those in the Eastern Hemisphere (58% of the world's total) are in a U-shaped belt 10,000 km long and 750–1,300 km wide that extends from Algeria to the Arctic Ocean at the longitude of the Polar Urals.

Giant accumulations show a distinct preference for certain geologic environments. Platform, semiplatform (parageosyncline), and platform-margin areas contain 83% (221 fields) of all giants; only 17% (45 fields) are in other geologic environments (*e.g.*, fold belts, actively subsiding grabens, *etc.*). The numerous giant fields in platform-related areas suggests that giant fields are more likely to be preserved in tectonically stable environments.

Of the reserves in giant oil fields, 58% are in sandstone and 42% are in carbonate reservoirs (an unusually large percentage of carbonate reservoirs are in the Middle East); of the reserves in giant gas fields 75% are in sandstone and only 25% in carbonate reservoirs. A total of 29% of the oil and 10% of the gas are in Tertiary strata; 63% of the oil and 65% of the gas are in Mesozoic beds; and 8% of the oil and 25% of the gas are in Paleozoic reservoirs. The abrupt increase in the number of giant fields in Mississippian and younger beds very possibly reflects the sudden proliferation during Late Devonian and Mississippian times of plant life in the terrestrial and, particularly, in marine environments. However, giant accumulations are not restricted to marine sediments. Of the 266 giant fields 6% (5 oil fields, 10 gas fields) are in rocks of nonmarine origin and 15% contain major oil and/or gas reserves of probable nonmarine origin.

Giant hydrocarbon accumulations require (1) abundant organic source materials; (2) depositional and postdepositional environments suitable for accumulating, preserving, and converting the organic materials into mobile hydrocarbons; (3) efficient carrier beds; (4) voluminous and/or high-quality reservoir rocks; and (5) a giant trap, ideally syndepositional. Unconformities, though important in some fields, are not important in most. Geothermal gradient can be of importance in controlling the types of hydrocarbons present and their degree of mobility during migration.

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GEOLOGIC HISTORY OF OCEANS: INTRODUCTION

Only a few years have passed since the concepts of the permanence of continents and ocean basins and the stability of the oceans were widely accepted, and the notion of continental drift was regarded as heresy. Since inception of the programs of deep ocean coring, however, a major new body of data has appeared. Many of the new observations are in conflict with traditional ideas. It has become evident that the oceans have a fascinating and complex history, and the history of ocean chemistry appears to be inextricably interwoven with the development of oceanic organisms. It had been tacitly assumed by many geologists that the oceans constituted a massive buffer system, stabilizing climate and affecting geochemical processes on the surface of the earth and in its atmosphere. Now deep-sea sediments are known to bear a record of dramatic changes, some local, some of worldwide significance. It is the purpose of this symposium to explore new ideas which are being generated, and to provide a synthesis of the present state of knowledge concerning the history of the oceans.

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HISTORY OF BIOGENIC SILICA IN DEEP SEA

The primary components of biogenic silica in deep-sea sediments are the tests of diatoms and radiolarians. Their distribution and concentration in open ocean deep-sea sediments are strongly influenced by the productivity of the overlying water masses. In general, in deep-sea sediments far from land where masking by continental detritus is not an important factor, sediments rich in opaline silica underlie regions of strong vertical mixing and consequent high productivity. Therefore, the presence and fluctuation of the concentration of opaline silica in deep-sea sediments can be an important indicator of paleo-oceanographic conditions. Upward changes from sediments low in opaline silica to sediments high in opaline silica about 2 m. y. ago in the Antarctic region and about 4.5 m. y. ago in the North Pacific suggest an increase of vertical mixing at these times in these areas.

The widespread occurrence of middle Eocene cherts in the Atlantic indicates a strikingly different circulation pattern for Eocene time than exists today. A modified Eocene circulation pattern is suggested on the basis of the probable shape of the Eocene Atlantic.

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THIN-SECTION EXAMINATION OF OIL SOURCE-ROCK SAMPLES

Thin sections of 388 fine-grained rocks, which had been chemically analyzed for hydrocarbon content, were examined for details of lithology and paleontology. Three general types of thin-section observations were found to correlate with source-rock quality as determined chemically: (1) abundant visible organic matter, (2) dark-brown thin-section color, and (3) microlaminations (bedding <1 mm thick). Of the clastic potential oil source rocks (>500 ppm heavy hydrocarbon extractable) used in this study, 75% contain all 3 criteria. None of the nonoil-source rocks (<150 ppm HC) have all 3 criteria. The "typical" potential oil source rock is described as *"dark-brown, abundantly organic, microlaminated shale."* This "typical" rock is commonly barren of fossils, but it may contain a sparse benthonic fauna and (or) abundant pelagic microfossils concentrated in microlaminae. One set of depositional conditions able to produce this rock is a stable basin setting of relatively slow sedimentation, far from a major coarse clastic source, with no appreciable bottom currents, and with a low oxygen content at the sediment-water interface.

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DISSOLVED SILICA AND ITS RELATION TO DEEP-SEA SEDIMENTS

Neither the concentration nor distribution of dissolved silica in the ocean is controlled by equilibria with solid silica or silicates. Rather, the observed pattern results from horizontal and vertical movements of oceanic water masses interacting with the formation, sedimentation, and dissolution of opaline tests of diatoms and radiolarians. Because the forces controlling this dynamic system are complex and in many cases poorly understood, it is difficult to construct a quantitative model of the present distribution pattern, or to deduce the distribution of silica in ancient oceans.

The residence time of silica in seawater, a few thousand years, is short from a geologic point of view. Consequently, the ocean can have little buffering effect on the dissolved-silica cycle. The rate of supply from continental weathering, submarine weathering, or volcanism, and upward diffusion of interstitial waters must therefore be balanced by the depositional removal of opal. Because there is little evidence for dramatic changes in the rate of supply of dissolved silica to the oceans during the Cenozoic, changes in the locus of sedimentation, rather than variations in the global budget of dissolved silica, probably were responsible for variations in the nondetrital silica content of Tertiary deep-sea sediments.

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MORPHOLOGIC VARIATION IN RECENT PLANKTONIC FORAMINIFERA

Intraspecific variation of *Globigerinoides ruber* and *Globigerinoides trilobus-Globigerinoides sacculifer* was investigated in 20 core top samples from the Atlantic Ocean and Gulf of Mexico. Such samples come from the top centimeter of cores and represent about 1,000 years accumulation. The average number of specimens measured for each sample was 50 and the size of the specimens was coarser than 250μ. Specimens are largest in the Gulf of Mexico and Caribbean Sea, smaller in the equatorial Atlantic, and smallest in the North Atlantic. Between 15 and 25°C, specimen size is correlated with mean sea surface temperature. Above 25°C large size variations occur within a narrow temperature range. Expansion rates, as measured by the relative increase in chamber diameters in both species, are correlative with available nutrients. The highest expansion rates occur in the Atlantic Undercurrent (0–5°N), and in the North Atlantic north of 30°N. Between 5 and 30°N in the Sargasso Sea, expansion rates are lower than in the equatorial or North Atlantic. Thus, for both species temperature and nutrient availability affect maximum size attained and rate of chamber growth.

Comparison of size and expansion rates for *G. trilobus* and *G. sacculifer* distinguished by the presence or absence of a saclike final chamber show the 2 phenotypes to be statistically similar. Within populations of *G. ruber*, the width/height ratio of the test, and of the primary aperture show a general trend of increasing values with increasing latitude. Variations in aperture size are linearly correlated with mean sea surface temperatures.

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TRANSPORT AND DEPOSITION OF COARSE CLASTICS IN TURBIDITE BASIN IN FRENCH ALPS

Marine breccias of Jurassic to Early Cretaceous ages are present in the Breccia Nappe of the French Prealps. Breccia types Ia and Ib are restricted to the lower part of the sequence in the Lower Shale, Lower Breccia, and Upper Shale formations. Type Ia breccias occur in beds from a few centimeters to tens of meters thick. They contain clasts up to more than 1 m in diameter, and are sometimes graded. Sole markings occur but are not common. Tops of some beds have large scale cross-stratification or parallel bedding, usually in granule-pebble grade material. Individual beds are of limited lateral extent—of the order of 1–2 km along the depositional strike and in places up to 7–8 km across it. The breccias have a clast framework and interstitial material is usually pebble or granule size. There is a continuous spectrum, with change in relative proportions of gravel and sand, from the breccias to pebbly turbidite sandstones.

Type Ib is much less common than Ia. It has clasts of the same composition and size but it is character-