age of the rocks overlying both unconformities seems to indicate slow transgressive marine overlap in the two basins.

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GEOTHERMAL AND GEOPRESSURE RELATIONS AS TOOL FOR PETROLEUM EXPLORATION

The Uinta basin represents a timely model for the study of many interesting geologic and geochemical problems that are pertinent to current exploration research investigations and to technical problems concerning petroleum production which face the petroleum industry, particularly in light of the present energy crisis. The primary areas of investigation in this reported study on the Uinta basin concern the complexities in the exploration of ultraparaffinic crudes from fresh- and brackish-water lacustrine sedimentary deposits.

An investigative study of the subsurface temperature and pressure distribution patterns within the potentially productive section of the Wasatch Formation (Eocene) has produced highly favorable results as an exploration tool in predicting the recent successful exploratory trends within the Uinta basin. A direct relation has been documented between the occurrence of productive hydrocarbons within the Wasatch Formation and the simultaneous occurrences of high geotemperatures, abnormally high pressures, and the presence of an organic-rich shale facies. These relations currently are being investigated as a potential tool for the exploration of stratigraphic traps in Tertiary basins.

In addition, this study illustrates an application of computer techniques to geologic evaluations on a regional basis: rapid data-processing methods, data banks, computer-contoured maps, and statistical analysis of geologic data.

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TEXTURAL PARAMETERS OF ROCKS FROM BOREHOLD MEASUREMENTS AND THEIR APPLICATIONS IN DETERMINING DEPOSITIONAL ENVIRONMENTS

No abstract available.

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DISCRIMINATION AMONG GRAIN-SIZE DISTRIBUTIONS BY CANONICAL ANALYSIS AS AID TO ENVIRONMENTAL INTERPRETATION

Grain-size analyses of sediments and sedimentary rocks have been made fot many purposes. During the last 10 to 15 years, grain-size analyses have been made of sands and sandstones as a means of determining their depositional environments. Most of the published work on discrimination of depositional environments has been based on modern sands which contain little fine material. The results of this work generally cannot be applied to sandstones because of the presence of considerable amounts of diagenetic silt- and clay-sized material that often is present in sandstones. In the present study, sandstones were used rather than sands.

A problem that always occurs when using grain-size analyses, regardless of whether they are of sands or sandstones, is that of comparing the size distributions. Canonical analysis is a statistical method of comparing grain-size distributions. The primary aim of canonical analysis is to determine numerical characteristics that best separate size distributions or determine the characteristics they have in common. In using canonical analysis, a typical or model size distribution is selected against which all the size distributions are compared. If physical theory can be applied to the choice of a reference distribution or weight function, then the results may be interpreted more easily in a physical sense. Two sets of numerical values are calculated for each size distribution. The discriminate functions show which variable or variables, size classes in this case, are important for discrimination; and the discriminate moments show how the size distributions are related so they may be sorted and classified. A set of characteristic roots or eigenvalues also are calculated. These eigenvalues, arranged in decreasing numerical order, show the proportion of variation among the distributions. Generally, two to three characteristic roots, each having a set of discriminate functions and moments, account for most of the variation among the size distributions.

Canonical analysis techniques were applied to grain-size distributions of samples from known depositional environments to see if discrimination could be achieved. Outcrop samples from the Gallup Sandstone of the San Juan basin, and Brushy Canyon Formation of the Delaware basin, and core samples from the "J" formation of the Denver basin were used. Even though the samples contained considerable amounts (greater than 20%) of silt- and clay-sized material, consistent grouping of similar types of size distributions were obtained. It was not possible to assign, from the grain-size data alone, groups of sandstone samples to specific depositional environments. The numbers generated by canonical analysis are not unique to a particular environment.

However, by using the canonical analysis techniques with grain-size data combined with a knowledge of sedimentary structures of the same samples, a geologist can obtain more information about transportation mechanisms and depositional environments than could be obtained by the use of either approach separately.

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EARLY CAMPANIAN (CRETACEOUS) DELTA-FRONT SEDIMENTATION, SOUTH FLANK OF WIND RIVER BASIN, WYOMING

Upper Cretaceous rocks of the Mesaverde Formation, exposed between Hudson and Muskrat Creek on the south flank of the Wind River basin, accumulated in an ascending succession of delta-front, tidal-flat, and delta-plain environments. Rocks of the lower two environments grade east and northeast into strata deposited in an offshore marine environment, whereas rocks of the youngest environment grade east into deposits of a delta-front platform. During early Campanian time, the delta-front facies accumulated across a 14-km-wide belt near Alkali Butte. Repeated fluctuations of strand position produced interbedded units of siltstone and sandstone in the facies, and intermittent development of low-relief bars permitted accumulation of estuarine or swamp sediments across subjacent deposits of the delta front.

Sandstone units of the delta-front facies show an upward gradation from siltstone and sandy siltstone beds to silty sandstone and fine sandstone beds characterized by slump and massflow structures. Slumping was triggered by instability of sediments on the delta-front slope and by recurrent tectonic movements along the trend of the ancestral Alkali Butte anticline. Succeeding the slump-dominated sandstone in each unit is well-sorted sandstone, deposited in a variety of littoral marine, beach dune, and estuarine channel environments. Depositional strike of the delta-front sediments, determined from primary sedimentary structures, ranged from N8°W to N30°E, and the slope declined east-southeast.

Sandstone units of the delta-front facies are saturated with oil near Alkali Butte. Variations of porosity and permeability of the units along depositional strike in the subsurface, or an association of the units with reversals of dip along faults in the south-central part of the Wind River basin may form traps for petroleum, and make the units worthwhile exploration objectives.

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GENESIS AND DISTRIBUTION OF DESMOINES (PENNSYLVANIAN) SANDSTONE RESERVOIR AT SLEEPY HOLLOW FIELD, RED WILLOW COUNTY, NEBRASKA

Sleepy Hollow field, Red Willow County, Nebraska, discovered in 1960, has produced more than 28 MMBO from a "basal" Pennsylvanian sandstone. The trap for this substantial oil accumulation is complex, related to sandstone characteristics and distribution, low-relief late Paleozoic tectonism, and very subtle post-Paleozoic folding.

Examination of reservoir core samples from 23 field wells reveals the following sedimentologic characteristics.

1. Despite some difficulty of grain-size measurement resulting from erratic sorting, sand grains are consistently coarser at the top and finer at the base of producing sandstone intervals.

2. Sandstone in the producing interval is rarely cemented, and often disaggregates completely when cored or drilled. Core samples of the reservoir sandstone that have been preserved are usually consolidated with an oil residue, and crumble when handled. Uncommon interlaminated, less permeable sandstone beds have argillaceous (kaolinitic?) cement.

3. Mineralogy of the producing sandstone is quite simple; essentially pure quartz with very scarce clasts and cobbles of lime mudstone, weathered feldspar, and chert.

4. Coarse quartz grains in the sandstone are nearly spherical, and commonly frosted and pitted; fine quartz grains are usually subangular.

5. When sedimentary structures can be observed (in the scarce argillaceous beds), subplanar lamination and low-angle cross-lamination can be observed. No moderate or high-angle cross-lamination has been found.

The aforementioned characteristics, when combined with observations of the stratigraphic sequences adjacent to the subject sandstone, suggest the following sequence of sedimentary events governing the distribution of this reservoir rock. First, the Precambrian surface that had been exposed since Early Pennsylvanian time (and perhaps before) was incised by fluvial channels which were choked with granite detritus (quartz, and feldspar in various stages of weathering decay). During mid-Pennsylvanian marine transgression of the crystalline surface, quartz fragments derived from the (channel) granite wash were reworked by westward longshore drift in the shallow sea, but rarely transported more than a mile or two from the drainage system from which they were derived. Accumulation of relatively pure quartz sand is presumed to have been accomplished by final oxidation and destruction of decayed feldspar and then removal through winnowing by marine currents of the clay minerals thus generated. Because of low inclination of the transgressed Precambrian surface (less than 10 ft per mi), subtle eustatic sea-level changes had a profound effect on strand movement and position. Therefore, sand accumulation occurred in an erratic pattern when compared to modern shoreline sand deposits. After three episodes of shoreline and shallow-marine sand deposition and accompanying clay-winnowing, the lobate sand bodies coalesced to form present reservoir distribution. Sand deposition did not occur north and south of Sleepy Hollow because of absence of a near-shore high-energy clastic environment. Sand deposition did not occur east of Sleepy Hollow because of the relative position of the fluvial channel and the direction of longshore drift.

The Desmoines oil accumulation at Sleepy Hollow field is controlled by sandstone reservoir distribution as described above, and by two increments of gentle tectonic uplift, modified by subtle differential compaction of overlying shales.

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EARLY PALEOZOIC TRILOBITES, SEDIMENTARY FACIES, LITHOSPHERIC PLATES, AND OCEAN CURRENTS

In examining the known occurrence of Cambrian and particularly Ordovician trilobites it has been found that:

1. Faunas of continents and platforms that have remained in a single latitudinal zone, particularly in a warm climate, show most strongly the effects of local environment. Concentric geographic changes in faunal composition and diversity result, as in North America.

2. Faunas of continents that passed rapidly through inclement climatic zones bear the print of climatic rather than local environmental variants. Faunas may be arranged in broad latitudinal bands and apparent standing diversities may change stratigraphically within each continental shelf area, as in western Gondwana (Andean area).

3. Inferred patterns of warm oceanic currents relative to changing continental obstructions are compatible with distribution of pelagic trilobites.

4. Tethyan trilobite distribution during the Ordovician shows reversals in migration related to (a) movement of Moroccan and Algerian Gondwana into warmer climate, (b) removal of Antarctic and Australian Gondwana from its obstructing position across the equatorial current, (c) westward movement of Baltoscandia, and (d) eastward movement of North America.

Most oil reserves are in areas that have been in warm climates (horse latitudes) at some time in their geologic history. Lands that have spent the longest geologic time in such zones may have the greatest potential for petroleum production, provided that there is adequate stratigraphic cover and satisfactory geologic structure to retain the oil.