time of lower sea stand 12,000 to 14,000 years b.p. Because of higher rates of eustatic sea level rise in the early Holocene and possible subsidence of the main part of the geosyncline, it is possible that greater thicknesses of Holocene coastal sediments may be deposited in the middle and outer continental shelf. On the inner shelf and present coastal area, the upper portions of the Holocene sediments tend to be destroyed by erosion at the shoreface and move to new depositional loci within the transgressing system. An understanding of the lateral and vertical facies relationships as compared with time-depositional planes within this transgressive sequence of coastal stratigraphic units is critical in the formation of modern analogs for interpretation of ancient coastal systems. This study also demonstrates that rates and especially volumes of sediment eroded in the shoreface may play a major role in the economics of human occupation of the coastal zone.

KRONEY, R. H., Johnson and Swanson, Dallas, TX

Selected Common Estate Planning Problems for Oil and Gas Investor in 1983 with Suggested Solutions

No abstract.

KRYSTINIK, LEE F., Reservoirs, Inc., Denver, CO

Turbidite Fans in Upper Cretaceous Pierre Shale, Eagle Basin, Colorado: A New Reservoir Facies

Turbidites have been recognized increasingly in the Cretaceous Interior seaway. Most are described as thin, economically unimportant sandstone beds isolated in prodelta mudstone. This study documents the occurrence of southerly prograding, sand-dominated turbidite fans of sufficient size to be considered economically viable hydrocarbon reservoirs.

Two fans intercalate with the Upper Cretaceous Pierre Shale and form cliffs over more than 10 mi (16 km) of continuous outcrop in the Eagle basin, north of Walcott, Colorado. Both units exhibit progradational sequences typical of turbidite fans. A common vertical succession of sedimentary structures consists of starved ripples, flat-bottomed ripple beds, thin flat beds grading into ripples of climbing ripples, and amalgamated flat beds. Massive to graded beds are rare and occur only in the upper part of each sandstone body. Associated sedimentary features include parting lineation, grooves, prod marks, mud chips, contorted bedding, and flute casts. Broad, low-relief channels occur at the top of the lower, more well-developed sequence.

The sedimentary structures described correlate well with accepted models for turbidite-fan sedimentation. The upward-thickening and coarsening character of the sandstone bodies, the abundance of incomplete Bouma sequences, and the presence of broad low-relief channels are typical of the outer-fan lithofacies associations of E. Mutti and F. Ricci-Lucchi.

Alternative interpretations of these laterally continuous, progradational sandstone bodies might include deposition in a distal shoreface or offshore bar environment. Hummocky cross-stratification and large-scale cross-stratified bed forms are not common in the sequence, as would be expected in a shoreface or marine-bar environment.

Turbidite-fan deposits similar to those studied could be economically significant because of their extreme lateral continuity, updip seals, intercalation with hydrocarbon source rock, and possible overpressuring. In addition, the apparently "distal" nature of these sandstone bodies suggests the possibility of thicker, better developed turbiditic sandstone bodies to the north. The presence of submarine fans within the Cretaceous Western Interior seaway may increase significantly the hydrocarbon potential of previously unexplored, "shaly" portions of the basin.

KURESHY, A. A., Staten Island, NY

Foraminiferal Stratigraphy of Ranikot (Paleocene) of Pakistan

The sedimentary deposits of Pakistan are divided into three distinct basins: the Lower Indus basin, the Upper Indus basin, and the Baluchistan basin. The Lower Indus basin is further divided into two parts; the northern part is the Sulaiman Province, and the southern part is known as Kirthar Province. The tertiary stratigraphy of Kirthar Province is conspicuous for its characteristic lithostratigraphic units. The Paleocene deposits of Kirthar Province are designated as Ranikot Group. The Ranikot Group was divided by Cheema et al in 1977 into three distinct lithostratigraphic units: the Khadro formation (Cardita beaumonti beds), Bara formation (Lower Ranikot), and Lakhra formation (Upper Ranikot).

The Khadro and Lakhra formations are marine, characterized by foraminiferal assemblages. The characteristic planktonic forms are: *Globigerina triloculinoides* Plummer, *Globorotalia pseudobulloides* (Plummer), *G. compressa* (Plummer), *G. velascoensis* (Cushman), and *G. pseudomenardii* Bolli. The diagnostic forms of larger foraminifera are: *Nummulites nuttalli* Davies, *Miscellanea* (d'Archiac & Haime), *Kathina major* Smout, and *Lockhartia conditii* (Nuttall). The planktonic foraminifera were assigned to *Globorotalia trinidadensis, G. pseudomenardii*, and *G. velascoensis* zones of Kureshy in 1977, and larger foraminifera were assigned to *Nummulities nuttalli* zones of Kureshy in 1978. The Bara formation is nonmarine and devoid of foraminifera fauna. On the basis of the larger foraminifera, Lakhra Formation is correlated to the 1927 "Ta" Letter Stage Classification of East Indies of Van der Vlerk and Umbrogrove.

KUYKENDALL, MICHAEL D., Oklahoma State Univ., Stillwater, OK

Correlation of Wireline Logs with a Shaly Sandstone Sequence, Red Fork Sandstone, Payne County, Oklahoma

The optimal use of well logs is to measure properties of rocks in a manner that permits valid and reliable inferences about rock type, porosity, permeability, fluid content, and related characteristics. The success of such an endeavor must be evaluated in terms of the known or fully determinable properties of the rocks that have been logged. Reservoir rocks whose actual physical properties differ significantly from those inferred from wireline logs are common.

At some localities in north-central Oklahoma, logs of Red Fork Sandstone (Desmoinesian, Middle Pennsylvanian) show suppressed spontaceous-potential curves, incomplete bed definition, misleadingly low resistivity, and no consistent, direct quantitative correlation between porosity and permeability. Foot-by-foot evaluation of an enigmatical core of the Red Fork by thin-section analysis, scanning-electron microscopy, and X-ray diffraction explained peculiarities in the gamma-ray and spontaneous-potential curves, and contributed to explanation of uncommonly low resistivity. Diagenetic effects and primary and authigenic clay seem to have had strong effects on log signatures. A large proportion of porosity is secondary.

LAGOE, MARTIN B., ARCO Oil and Gas Co., Dallas, TX,

and KRISTIN MCDOUGALL, U.S. Geol. Survey, Menlo Park, CA

Distribution of Benthic Foraminifers Across a Middle Miocene Basin Margin, Central California: Paleoenvironmental, Tectonic, and Biostratigraphic Implications

The quantitative distribution of Miocene benthic foraminifers within the Cuyama basin, central California, demonstrates the relationship between biofacies, key species, and specific environmental factors. During the Miocene, the Cuyama basin occupied an inboard position along an active, convergent to translational, continental margin resembling the modern continental borderland off southern California. Benthic foraminiferal assemblages delineate shelf, slope, and basin plain biofacies. Migration and replacement of these biofacies with time reflect the depositional subsidence history of this Miocene basin. Initially, biofacies are broad and less structured, reflecting the influx of cosmopolitan species during early basin development. Recognizable biofacies are established quickly after the initial marine transgression and basin subsidence. As the basin fills, the number of biofacies decreases and deeper biofacies are excluded, whereas low oxygen and shelf biofacies expand. Bathymetrically displaced species are common, implying downslope transport by turbidity currents, increased sediment input, and/or tectonic activity.

Benthic foraminiferal species diagnostic of the standard California Miocene stages and zones occur commonly throughout the Cuyama basin. Among the key biostratigraphic events commonly cited for the early and middle Miocene are the "*Valv. cal.* flood" zone (middle Luisian) and the evolutionary succession of valvulinerids and siphogenerinids. Although these events are important stratigraphic markers, some difficulty is encountered in recognizing certain zones and chronostratigraphic sequences are boundaries as presently defined. The bathymetric distribution and biofacies associations for certain key species critically impact on the usefulness of these species for biostratigraphy. Siphogenerinids appear only in slope, lower slope, and basin plain assemblages, and individual species are restricted to specific parts of these areas. Stratigraphic and evolutionary events based on these species are therefore limited to deeper water environments. Valvulinerids are present in shelf-edge environments as in-situ members of assemblages and as transported specimens in deeper environments. The *Valv. cal.* flood is obscured in sections dominated by shelf-edge environments where valvulinerids occur in large numbers throughout the middle Miocene, and is confused in lower slope and basin plain assemblages where they are concentrated as transported specimens.

Early and middle Miocene fauna distributions are complex. Sedimentary, tectonic, and oceanographic conditions strongly effect in-situ and transported occurrences of key species. These factors must be evaluated for individual basins if benthic foraminiferal zonations are to have regional applicability.

LARICCIA, MARILYN PLITNIK, and PAUL R. KRUTAK, Univ. Nebraska, Lincoln, NE

Intertidal Variation in Foraminiferal Species Diversity: Mississippi-Louisiana Salt Marshes

Salt marshes are tide-stressed environments where ecologic variables exert strong selective control upon the distribution, type, and abundance of organisms. Ecologic conditions range from marine to terrestrial; hence gradational and/or abrupt environmental changes across marshes produce similar gradients in communities of organisms and their biotopes. Salt marshes are one of the present-day sites of peat accumulation. They represent a potential milieu for lignite and coal formation. Recognition of microenvironments within such marshes will provide coal explorationists and paleontologists with another tool for predicting the location of subsurface peats, lignites, and coals.

Twenty-eight modern bottom samples were collected for analysis for foraminiferal populations (total = live + dead) in the Hancock County, Mississippi, and Pearl River, Louisiana, marshes during May and June 1981. Fourteen stations of the 28 were sampled twice—once at "peak" high tide and once at "peak" low tide. Three microbiotopes occur among the 14 stations: (1) beach (B)—3 localities, (2) lacustrine (L)—3 localities, and (3) bayou-fluvial (BF)—8 stations. Average salinities (parts/mil) at these biotopes were 10.4 (B), 2.3 (L), and 7.7 (BF). Ranges were 0.2 to 13.5. Average dissolved oxygen (ppm) values were 10.4 (B), 7.9 (L), and 5.4 (BF). Ranges were 2.6 to 12. Temperatures (°C) averaged 29.4 (B), 30.4 (L), and 29.3 (BF). Ranges were 20.9 to 32.7. We are currently studying interbiotope and intrabiotope variability.

After extracting a minimum of 300 specimens/sample, foraminiferal species diversity patterns among the 14 doubly sampled stations were studied. We used S (number of species), H(S) (Shannon-Wiener information function), and E (species equitability). The following ranges and average ($\bar{x}$) exist at high tide: S—2 to 13, $\bar{x}$ = 7.4; H(S)—0.311 to 2.046, $\bar{x}$ = 1.25; E—0.306 to 0.720, $\bar{x}$ = 0.522. Low-tide samples have these ranges and averages: S—2 to 12, $\bar{x}$ = 7.0; H(S)—1.721 to 3.750, $\bar{x}$ = 1.08; E—0.326 to 0.727, $\bar{x}$ = 0.488. High-tide samples have much higher species diversity, slightly lower dominance, and are more equable.

LASEMI, ZAKARIA, and PHILIP A. SANDBERG, Univ. Illinois, Urbana, IL

Recognition of Original Mineralogy in Micrites

Detailed SEM study of selected micrites (<4 μm) and microspars (4 to 12 μm) from all Phanerozoic systems and various geographic localities suggest that textural properties of micrites and microspars are mineralogically controlled. Those micrites and microspars with apparent aragonite-dominated lime mud precursors (ADP) have neomorphic calcite crystals which show pitted surfaces or relic aragonite inclusions in polished, etched sections. The presence of relics in all crystal sizes in ADP micrites and microspars indicates an absence of secondary dissolution-precipitation or aggrading neomorphism. That is, formation of all neomorphic crystal sizes occurred in a single diagenetic event. Micritic limestones with apparent calcite-dominated precursors (CDP), however, are characterized by finely crystalline (<4 μm) textures, lack any inclusions, and have unpitted crystal surfaces.

Strontium content of micrites and microspars studied are bimodally distributed. A similar distribution was recognized by Veizer in 1977 and Veizer and Demovic in 1973 and 1974, who suggested it was the result of original mineralogy. Preliminary results on the micrites and microspars studied show Sr distribution generally well correlated with textural properties. ADP and CDP micrites and microspars possess Sr values which fall, with few exceptions, within the high-Sr and low-Sr groups, respectively, of Veizer and others. Several ADP samples which fall within the low-Sr group are molluscan-rich. Thus, likely aragonite contribution to precursor muds was more probably low-Sr. Low-Sr ADP could also be the result of open-system diagenetic alteration. In such cases, low-Sr ADP micrites and microspars are associated with high Mn content. We have found several low-Sr ADP samples that are high in Mn. High-Sr ADP micrites and microspars are, therefore, interpreted as being originally composed of high-Sr aragonite mineralogy. The Sr content of CDP