

KNIGHT, MICHAEL T., JOHN G. MCPHERSON, and DONALD F. REASER, Univ. Texas at Arlington, Arlington, TX

Deltaic Sedimentation in Nacatoch Formation (Late Cretaceous), Northeast Texas

The terrigenous clastics of the Nacatoch Formation are a record of short-lived progradational phases within the major Late Cretaceous transgression in the East Texas embayment. Progradation was achieved by deltaic out-building from three fluvial feeder systems along the north and northwest margins of the basin. It is probable that additional sediment was derived from a major "sediment dispersal system" east of the Nacatoch deltas.

The deltaic package of the Nacatoch (131 m, 430 ft) is composed of roughly equal proportions of sandstones and mudstones, with the sandstones ranging from very fine-grained, poorly sorted, and mud-rich, to fine-grained and well-sorted. The sandstones have a feldspathic litharenite and subfeldspathic litharenite composition with increasing compositional maturity in the well-sorted examples. Some of the muddy sandstones are highly bioturbated and carbonaceous.

Vertical and lateral lithofacies changes in the Nacatoch deltas were determined by means of electric-log (resistivity) interpretation and well core data, with support from limited outcrop studies. Dip- and strike-oriented cross sections delineated three major coarsening-upward sandstone units which could be correlated in a shore-parallel direction for 42 km (25 mi). Each sandstone shows evidence of reworking by wave-induced processes and redistribution by longshore currents. The lower two sandstones are separated by a thick mudstone interval interpreted as a minor transgressive event. The highly bioturbated, carbonaceous, mud-rich intervals between the other sandstone units are interdistributary bay fills.

The Nacatoch deltas are lobate and developed in response to moderate sediment input, moderate to low wave-energy flux, and significant longshore current action.

Southwest longshore sediment transport from the Nacatoch deltas gave rise to extensive shelf sands in the western margin of the East Texas basin. These well-sorted sandstones are petroleum reservoirs at shallow depths. The similar well-sorted sandstones of the Nacatoch deltas have the same potential as petroleum reservoirs, given the same structural influence.

KOCHEL, R. CRAIG, and JACOB H. KAHN, Univ. Virginia, Charlottesville, VA

Washover Fan and Terrace Dynamics—A Stormy Year on Assateague Island, Virginia and Maryland

Five surveys of painted sand plugs were made between 1982 and 1983 at 7 washover sites on Assateague Island to observe sedimentologic and geomorphologic changes during overwash. The stormy 1982-83 period included a large extratropical storm in October 1982 that produced waves exceeded only by the March 1982 Ash Wednesday storm, 7 northeasters of moderate intensity, and a significant tropical storm.

Our surveys suggest that eolian and washover processes are equally important in net sediment dynamics and morphology of washover fans. Strong storm winds caused erosion of fan surfaces and adjacent dunes. Eolian activity sealed the throats of 2 fans early in the October storm, preventing subsequent washover. Erosion dominated the early phases of washover events and was followed by accretion. For all storms studied, the net effect was accretion.

The occurrence of storms of various magnitudes and frequency permits a comparison of their relative effectiveness in transporting sediment and causing geomorphologic change. The October storm deposited between 20 and 40 cm (8 and 16 in.) of horizontally bedded coarse sand and shell fragments on fans located along northeasterly trending shorelines. Fans along easterly trending shorelines were shielded from direct wave attack and experienced little change. The net effect of 7 subsequent northeasters of moderate intensity also resulted in net accretion, but their total sediment movement averaged less than the amount deposited by the October storm. Surfaces of recently overwashed fans exhibited upper flow regime bedforms and lacked relief. Eolian processes altered fan surfaces between washover events and established partially vegetated dunes on their surfaces in less than 6 months.

KOLLA, V., Superior Oil Co., Houston, TX, F. COUMES, Elf Aquitaine, Pau, France, and A. LOWRIE, U.S. Naval Oceanographic Office, NSTL Station, MS

Morphology, Internal Structure, and Sedimentation in Indus Fan as Revealed by Seismic Investigations and Piston Core Studies

The sea floor of the upper Indus fan is characterized by gradients less than 1/500, channels with levees approximately 100 m (330 ft) high, distinct echos with several continuous subbottom reflectors on 3.5-kHz records, and generally fine-grained sediments (Tc-e sequences) except in channels where coarse-grained sediments (Ta-e) are present. On multi-channel and sparker seismic lines, the levee complexes are characterized by overlapping wedge-shaped reflection packages, and channel axes by high amplitude discontinuous reflections. Since the Oligocene and Miocene, several major episodes of extensive migration of the channels on the upper fan (with sediments more than 3 km, or 10,000 ft, thick) and of the feeder canyons on the Pakistan-India shelf are recognized. During the latest episode (Plio-Pleistocene), 3 distinct regions, each with numerous channel-levee complexes fed by the sediments of both the Indus and the now-extinct Hakra-Nara rivers on the Pakistan-India shelf, are identified.

The middle fan has gradients of 1/500 to 1/1,000, numerous channels with levees approximately 20 m (66-ft) high, and convex morphology due to extensive channel-levee buildup. Gradients less than 1/1,000, channels with levees 8–20 m (26–66 ft) high, prolonged echos with few or no subbottom reflectors on 3.5-kHz records, smooth continuous reflections on seismic records, and the highest sand content in the sediments (Ta-e) of any fan region characterize the lower fan. Although unchannelized sheet-flow turbidite deposition was the dominant mode, channelized and overbank deposition also played a significant role in the sedimentation of the lower fan. On a gross scale, 2 extensive Quaternary sand-rich deposits (lobes), primarily laid down by sheet flows, are mapped on the lower fan.

KOSTER, EMLYN H., Alberta Geol. Survey, Edmonton, Alberta, Canada

Sedimentology of Paleochannels on Foreland Coastal Plain, Judith River Formation (Upper Cretaceous), Southeast Alberta

The upper 90 m (295 ft) of the sub-Bearpaw Judith River Formation, continuously exposed in the badlands along the Red Deer River 185 km (115 mi) east of Calgary, is famous for the unrivaled assemblage of dinosaur fossils. Dinosaur Provincial Park presents a rare opportunity to view the architecture of a foreland coastal-plain sequence as well as to clarify the origin and distribution of subbituminous coal zones and gas reservoirs associated with this formation across southeast Alberta.

The distal reaches of paleodrainage from the developing Cordillera to the Western Interior seaway are being examined by north-south traverses across the badlands. Sharp-based paleochannel units, enclosed by rooted, olive-gray mudstone sequences that are commonly 4–6 m (13–20 ft) thick, vary between 2 end members. The first contains laterally accreted sand-mud couplets with abundant macrofloral debris, and represents cyclical, low-energy growth of point bars, possibly with an estuarine influence. The second, mainly comprising cosets of large trough cross-beds with mudstone intraclasts, was formed by episodic aggradation of high-energy systems. An intermediate composite type displays evidence for an energy increase as channel sinuosity decreased. This variation in paleochannel type is attributed to alternating alluviation/rejuvenation associated with an unstable base level. Coal zones and potential reservoirs appear to be associated with the transgressive and regressive phases, respectively, of the Bearpaw coast. Amalgamation of paleochannels—marked by laterally extensive horizons of bone fragments, lithic and intraclastic gravel—is more common seaward over the axial region of the Sweetgrass arch.

KOSTERS, ELISABETH C., Louisiana Geol. Survey, Baton Rouge, LA, and ALAN BAILEY, Univ. Southwestern Louisiana, Lafayette, LA

Mississippi Delta Peats—Their Relationship to Deltaic Lignites and Coals

Deltaic peats accumulate on abandoned deltaic platforms, in interdistributary basins, in abandoned channels, and as detrital bay deposits.

Within these depositional settings, several parameters determine the potential for extensive peat formation: (1) botanical parent material, (2) climate, (3) frequency of delta-lobe switching, (4) subsidence, (5) detrital influx, and (6) marine inundation. Each factor controls the variability in ash content and mineralogical composition of the peats.

Five areas were cored. Analysis of more than 2,000 samples shows that the average ash content of true peats (less than 25% ash) in the Mississippi delta is 18.3%, and that 5–15% of all sediment in the upper 4.5 m (15 ft) consists of true peat. It appears then that parameters 1 and 3 inhibit extensive peat accumulation, parameter 2 is favorable, whereas 4, 5 and 6 vary depending on the depositional setting.

When studying peats as precursors for coal, one should consider quality as well as quantity of the ash. Examination of ashes indicates that major components are water-soluble salts and silica. Leaching ashes with distilled water result in loss of salts and reduction of ash weights up to 77%. Scanning electron microscopy shows that abundant silica is biogenic and in a state of dissolution. Decrease of the amount of ash by natural dissolution of salts and silica during early diagenesis may result in better quality peats and more true peat overall.

Organic-rich deposits in the Mississippi delta may provide examples of modern coal-forming environments if conditions are properly considered. An understanding of the processes in peats will help in deciphering the rock record with respect to deltaic lignites and coals.

KREISA, R. D., and R. J. MOIOLA, Mobil Research & Development Corp., Dallas, TX

Sigmoidal Bundles and Other Tidal Features, Curtis Formation (Jurassic), Utah

Recently, a new suite of tide-generated sedimentary structures has been described, principally from sandy shoals and large excavations associated with flood-control structures in tidal estuaries of the Dutch coast. These sedimentary structures can be less ambiguous than criteria previously used to recognize tidalites. Structures and sequences of structures like those recognized in the North Sea can be applied to the rock record, in this case the Curtis Formation (Jurassic), San Rafael swell, Utah, to significantly enhance our ability to interpret tidal facies.

Our discussion centers on the recognition of tidal bundles, the lateral succession of cross-strata generated by the migration of a large-scale bed-form during one dominant tidal episode. Tidal bundles in the Curtis consist of two gently dipping sigmoid-shaped pause planes which enclose avalanche foresets. They are up to 80 cm (30 in.) thick and 11 m (36 ft) long. Pause planes may be accentuated by erosion of the megaripple by the subordinate tide, by generation of ripples or small megaripples with opposed inclinations, and/or by a drape of fine sediment which settles during slack water. Systematic variability that occurs within bundles is due to increasing then waning current velocity during a tidal episode. Systematic variability among tidal bundles results from regular fluctuations of tidal current velocities during a lunar month (neap/spring cycles). These include changes in bundle thickness, dip of foresets, internal geometry, and lateral extent. Recognition of these features in the Curtis leads to an uncontested interpretation of its tidal origin.

KRUGER, J. M., Marathon Oil Co., Casper, WY, and G. R. KELLER, Univ. Texas, El Paso, TX

Regional Gravity and Tectonic Study of the Ouachita System

A regional study of the Ouachita system has been undertaken using gravity and deep-drilling data. An integrated analysis of gravity maps, computer models, and geologic data suggests that the crust beneath the Gulf coastal plain is variably attenuated continental crust. The transition zone between this crust and the craton, which is marked by a steep gravity gradient that lies along the trend of the Ouachita system, may have been created by Mesozoic reactivation of a crustal zone of weakness inherited from a plate collision during the late Paleozoic Ouachita orogeny. Gravity minima along the frontal zone of the Ouachita system are due to a thick sedimentary rock pile in conjunction with a gulfward dipping intracrustal or crust/mantle boundary in some areas. The arcuate Ouachita gravity maximum is the result of denser (metamorphic) rocks of the interior zone,

with uplifts and upper crustal mafic intrusions making contributions in some areas. Gravity anomalies in the Gulf coastal plain are a combined effect of variable crustal attenuation, subsidence, and densification of the upper crust. Maxima in the southern Oklahoma aulacogen area are the result of uplifts and upper crustal mafic intrusions and/or lower crustal upwarps.

KRUTAK, PAUL R., ARCO Exploration Co., Lafayette, LA, and RAUL GIO-ARGAEZ, Instituto de Geologia, Mexico City, Mexico

Ostracodes as Indicators of Low-Energy Versus High-Energy Marine Carbonates, Northeastern Yucatan Shelf, Mexico

Carbonate sediments on the inner Yucatan Shelf occur as textural belts paralleling the shoreline. Nearshore, high-energy, oolitically coated grains occur in the strait between Isla Mujeres and the mainland. Nichupte Lagoon, on the lee side of the tombolo connecting Punta Cancun and Cancun, contains fine-grained, low-energy, magnesium-calcite rich mud.

Five widely spaced quantitative (total = live + dead) benthic reconnaissance samples were collected from each of these radically different depositional settings. Ostracodes (approximately 300/sample) isolated from each sample were speciated, and ternary plots of the first 3 dominant species generated.

Plots from the low-energy Nichupte Lagoon indicate: (1) *Cyprideis* sp. is the first-order dominant in 80% of these samples, (2) second-order dominants are usually *Xestoleberis* sp., with some *Paranesidea* "frilled" and others, (3) other *Paranesidea* ("frilled" and "arched") occur as third-order dominants, and (4) the percentage spread among the 5 samples of the first-order dominants is approximately 52%, whereas it is only 24% among the second- and third-order dominants.

Ternary diagrams of the first three dominants in high-energy strait sediments reveal: (1) *Paranesidea* "arched" is the first-order dominant in 60% of these samples, (2) second-order dominants are almost equally divided between *P.* "arched" and *P.* "elongate," (3) third-order dominants are almost equally divided between *P.* "elongate" and *Neonesidea longisetosa*, and (4) the percentage spread among the 5 samples of the first-order dominants is approximately 32%, whereas it is only about 16% among the second- and third-order dominants.

The smaller spread (32%, 16%) of the high-energy grainstones of the carbonate strait separates these sediments from the greater spread (52%, 24%) of the low-energy lagoonal sediments of Nichupte Lagoon.

KUMAR, NARESH, ARCO Exploration Co., Dallas, TX

Charting Exploration Strategy in a Mature Producing Area, Northwest Shelf of Delaware Basin, New Mexico

In formulating strategy for mature areas, management has to consider chance factor for success, as well as the chance of finding sizeable reserves. As a case history, we describe an investigation of the Northwest Shelf of Delaware basin carried out in 1979 to locate areas having the best potential of finding new reserves. In 1983, we tabulated the activity since 1980 to compare our predictions against the drilling results.

The 1979 study had shown that out of a total of almost 200 wildcats drilled during 1974-79, the largest number (63) had been drilled for San Andres (Permian) objective with a success ratio of 33%. Forty-six wells had been drilled for various Pennsylvanian objectives with a success ratio of 40%, and 25 wells had been drilled for Siluro-Devonian targets with a success ratio of 16%. However, based on wildcat success ratios and cumulative-frequency plots of field sizes, the probability of a wildcat discovering reserves larger than 1 million bbl was only 6% in San Andres, 19% in Pennsylvanian, and 7% in Siluro-Devonian.

The 1979 study allowed us to "high-grade" three blocks representing 5% of the total 5.25 million acres. These blocks were considered to have the best potential for San Andres and Siluro-Devonian objectives. Subsequent analysis of 1980-83 drilling results shows that these blocks contain 55% of the 20 new successful San Andres tests and the only new discovery in the Siluro-Devonian. However, as predicted, all of these have been small discoveries. Such studies allow management to develop a course of action for mature areas.