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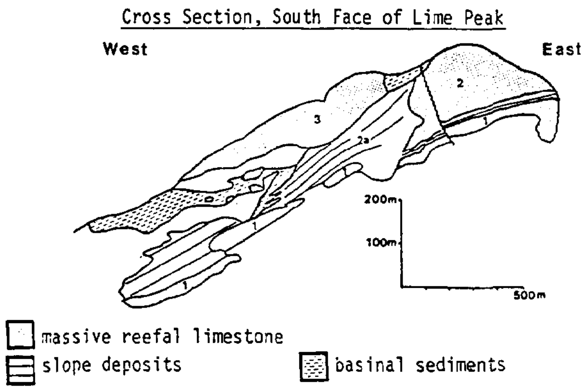
Lime Peak—An Upper Triassic Reef Complex in Yukon

Upper Triassic carbonates in the Whitehorse trough, Yukon, are lenticular bodies surrounded by Triassic graywacke and volcanic-clast conglomerate derived from an arc to the west. The carbonates at Lime Peak are unusually well exposed. They show multiple stages of reef growth and a complete facies zonation from massive reefal limestone to offlapping slope and basin.

The massive reefal limestones have variable lithology from peloidal mudstones to organic framestones containing spongiomorphs, tabulozoans, and calcareous sponges, with lesser contributions from corals, brachiopods, mollusks, algae, and echinoderms.



Slope deposits are alternations of thick beds of reef-derived debris with thinner beds containing attached spongiomorphs, thick-shelled pelecypods, large gastropods, and corals which colonized the debris beds.

Basinal sediments include thin-bedded limestones and shales consisting of muddy layers rich in sponge spicules and organic matter and graded packstones containing thin-shelled bivalves and skeletal debris.

The stages of growth were (1) initial development of lensoid masses each about 25 m thick (1 on sketch), (2) growth of a much larger reefal mass about 150 m thick (2 on sketch) which shed an apron of debris to the west (2a on sketch), and (3) development of a second thick buildup (3 on sketch) on the underlying forereef debris (2a) as the whole system prograded to the west.

The Lime Peak reef complex is not typical of other Triassic buildups in North America which are generally low-relief, thin accumulations (less than 10 m thick) dominated by corals and spongiomorphs. The buildups at Lime Peak are much thicker, and tabuloazons and sponges are more important builders than corals.

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Sedimentologic and Stratigraphic Interpretation of Sand Bodies in a Tidal Embayment

A depositional model for intertidal sand bodies indicative of tidal embayments was developed from 20 vibracores and 25 can cores taken at St. Helena Sound, South Carolina. This V-shaped embayment located 35 km south of Charleston, South Carolina, has a tidal range of 2.0 to 2.8 m.

The intertidal shoals are formed and reworked by opposing tidal currents. Ebb currents usually exceed 100 cm/sec in the deep adjacent channels and produce the long linear features on the shoals. Flood currents rarely exceed 75 cm/sec and are dominant across the broad seaward sand flats.

The range of sedimentary features gradually changes from a dominance of physical sedimentary structures on the exposed seaward sand flats to a dominance of biogenic sedimentary structures on the protected sand flats. The distribution of each feature is controlled by their relative position on the sand flats to maximum wave energy. Where biogenic sedimentary structures are abundant, protection from wave energy is afforded by the shoal crest. Laterally the shoals grade into ebb channels or lower subtidal mixed sand and mud flats.

The shoals display a coarsening-upward sequence of wavy-bedded to flaser-bedded clays and sands overlain by clean well-sorted, cross-bedded to burrowed sands. The sands are composed of fine to very fine subangular quartz grains.

The depositional history of the intertidal sand bodies indicates a vertical buildup of sediments and subsequent lateral accretion. Subtidal sand bodies were first deposited on preexisting bay-fill muds. With a decline in sea-level rise, an increase in vertical deposition occurred, producing incipient intertidal bars. As the bars became fully emergent, increasing wave energy and tidal currents reworked the shoals into their present shape. Continued sand deposition occurred as lateral accretion and infilled adjacent channels.

The shoals are up to 10 m thick and cover an area of 1 to 4 km^2. They extend 3 to 5 km seaward and are as much as 1 to 2 km in width. Because most of the shoals are subtidal to intertidal, preservation potential is high. As the embayment fills, prograding salt marshes will eventually cap the sand bodies.

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Niobrara Formation (Upper Cretaceous), Eastern North Dakota

The Niobrara Formation (Upper Cretaceous) has recently gained attention as a shallow, low-permeability reservoir for natural gas. Understanding its distribution and the conditions under which it was deposited will contribute to its evaluation as a source of hydrocarbons in this region.

On the basis of outcrop sections and cores in northeastern North Dakota, the Niobrara Formation is approximately 64 m thick and can be divided into two subequal units. The lower 31-m unit is medium dark gray and medium olive-gray, laminated calcareous shale with "white specks" (fecal pellets), comminuted fish remains, *Lingula,* and thin fine-grained sand stringers near the base. The upper 33-m unit is light-gray to light olive-gray, shaly chalk containing abundant "white specks", with a thin (5 m) very light gray, bioturbated chalk at its base. Sediments are bioturbated at the top of the lower unit and the base of the upper unit.

The main controls of sediment character are rates of calcareous plankton productivity and aerobic versus anaerobic bottom conditions. The Niobrara represents, from bottom to top, the following sequence of environments: (1) low productivity anaerobic conditions; (2) low productivity aerobic conditions; (3) high productivity aerobic conditions; and (4) high productivity anaerobic conditions.

Over the eastern half of North Dakota, the Niobrara ranges in thickness from less than 17 m to greater than 75 m. Alternating thinning and thickening bands trend northwest-southeast and suggest structural control of deposition.

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Biogenic and Nonbiogenic Ore-Forming Processes in South Texas Uranium District, Panna Maria Deposit

Geochemical and petrographic studies of core samples from the Panna Maria uranium deposit, a roll-type orebody in the Jackson Group (Eocene) in Karnes County, Texas, yield important constraints on the origin of the deposit. Organic carbon content averages about 0.42 wt. % in reduced rock and correlates positively with sulfur content. Pyrite is the dominant iron disulfide (FeS_2) mineral in most of the ore zone and throughout a surrounding zone of reduced barren ground and is commonly associated with organic debris. Marcasite is sparse except in ore adjacent to the altered tongue in one core and locally in mineralized lignite. Sulfur isotopic compositions ($\delta^{34}S$) of FeS_2 minerals range broadly from -1 to -34 per mil; the lightest $\delta^{34}S$ values (less than -20 per mil) were measured in samples from mineralized lignite and from the nose of the ore roll. Petrographic and geochemical characteristics of the Panna Maria deposit contrast greatly with those of three other south Texas roll-type uranium deposits (the Benavides, Felder, and Lamprecht deposits), which are devoid of organic carbon and which contain more sulfide than does the Panna Maria. These three deposits are characterized by abundant isotopically light ore-stage marcasite and by isotopically heavy pre-ore (in the Benavides) or post-ore (in the Felder and Lamprecht) pyrite. We concluded in earlier reports that sulfide-bearing fault-leaked solutions from underlying hydrocarbon accumulations were important in the formation of the Benavides, Felder, and Lamprecht deposits. Although the Panna Maria deposit shows an apparent alignment along a fault zone, and although underlying formations in the Karnes County area contain sour gas $\delta^{34}S) \simeq +14$ per mil) and produce oil, the deposit lacks characteristics indicating that its formation and/or preservation involved extrinsically derived reductants such as fault-leaked hydrogen sulfide. Mineralization of the Panna Maria, rather, appears to have been controlled by intrinsically derived reductants related either directly or indirectly to the presence of organic matter.

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Structure and Salt Tectonics of Northwest Gulf of Mexico Banks

Members of the Oceanography Department at Texas A&M University have conducted extensive geologic and geophysical surveys across the shelf-edge banks off Texas and Louisiana in the northern Gulf of Mexico. These prominent topographic features are the surface expression of isolated salt diapiric structures, in places capped by carbonate sediments and reefal communities. There is great variability in the details of their physiography and structure. However, analysis of the geophysical data indicates that the banks may be classified into three main structural types: (1) rectangular, fault-controlled, uplifted blocks of sedimentary strata; (2) circular domes modified by faulting more or less parallel with the shelf edge; and (3) circular domes with radial and/or annular fault patterns. The majority of the banks, particularly types two and three, show some evidence of collapse, probably a result of dissolution of salt. Based on the variety and regional setting of the observed structures, evolutionary models have been developed. Ubiquitous local topographic trends associated with the banks occur along the shelf edge and upper slope. They strike roughly northwest-southeast and may reflect structures formed during the early tectonic history of the Gulf of Mexico.

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Interactive Color Display and Analysis—Added Dimension to Seismic Interpretation

Interactive color video display systems provide a new dimension to the analysis of seismic data. Subtle concurrent changes in multiple seismic parameters such as reflection strength, velocity, frequency, and structure can be assimilated more effectively with the aid of interactive color technology. We examine here two typical interpretation problems—bright spots and 3-D data—and illustrate the use of interactive color display and analysis in formulating a solution. The successful analysis of hydrocarbon indicators relies on both the ability to measure the auxiliary effects that hydrocarbon indicators have on seismic data and to display these effects in a form that is visible to the interpreter. If the interpreter can view an optimum combination of subtle changes in these parameters, his ability to predict both the lateral extent of the reservoir and the amount of gas saturation can be substantially improved.

One way to display simultaneous variation in several seismic parameters is through the use of an interactive color imaging system. After digital displays of the seismic reflection data variables are input, color assignments are made interactively among the seismic variables and the primary colors. This process can vary from a simple assignment of a primary color for each variable to a more complex analysis technique that dynamically assigns proportions of the seismic variables to all colors. Unlike some approaches that "color" a single parameter to better illustrate its dynamic range, the methods described here use color to illustrate the simultaneous changes in all variables. These video imagery systems provide flexible, high-resolution displays that can cope visually with large volumes of data that are typical for 3-D surveys. It allows the interpreter to perform a variety of instant, on-the-spot enhancement techniques. Thus, the technology significantly minimizes some of the problems in dealing with 3-D data. Typical vertical sections or horizontal time-slice displays from a cube of 3-D data can be shown in a variable intensity mode. The horizontal Seiscut displays can be viewed in a flexible and easily controlled movie fashion or overlaid in color to enhance delineation of structural features. When the multiple parameter technique is employed on the Seiscut display, it produces an "instant geologic map." Each lithologic unit boundary can be distinguished by its unique color pattern.

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Tectonic Control on Deposition of Frontier Formation (Upper Cretaceous), Northeastern Uinta Basin

Vertical block tectonics significantly affected the deposition of the Frontier Formation of Late Cretaceous age. This syntectonic relationship was identified by detailed facies mapping which recognized seven major lithofacies on the basis of lithology, sedimentary structures, sandstone geometries, fossils, and trace fossils. Each lithofacies is a process-controlled genetic unit and can be related to a depositional environment within a wave-dominated deltaic system. The ascending sequence of environments and lithofacies is: (1) prodelta shales and siltstones; (2) hummocky-stratified, distal delta-front sandstones; (3) low-angle trough to tabular-stratified, delta-front and mouth-bar sandstones; (4) lenticular, medium to coarse-grained, distributary-channel sandstones; (5) lagoonal and delta-plain carbonaceous shales and coals; (6) medium-grained fluvial sandstones; and (7) bioturbated, offshore and shelf sandstones and shales.

These lithofacies change laterally across two east-west-trending basement faults. Delta-front and distributary-channel deposits thicken between the faults, indicating a topographic low or graben at the time of deposition. Within the graben, sandstone