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Historical Seismicity of Texas—A Summary

A survey of the historical seismicity of Texas revealed more than 100 earthquakes of magnitude 3 or greater from February 1847 to December 1984. Of these, 82 earthquakes are known to have been felt, and 24 events are associated with reports of damage. The largest earthquake (magnitude = 5.9) occurred on August 16, 1931, near the town of Valentine in west Texas. Many buildings were damaged in the epicentral area, and the total felt area exceeded 1 million km². Earthquakes in the Valentine area, as well as other events farther west near El Paso, are probably related to the Rio Grande rift system. Several large events in the Texas Panhandle may be associated with a zone of crustal weakness that follows the trend of the Amarillo uplift. Earthquakes in eastern Texas are associated with several fault systems in the Gulf coastal plain. A large earthquake on October 22, 1882, had previously been located in northeast Texas near the town of Paris; however, a reevaluation of the intensities suggests the epicenter was probably farther north in Oklahoma. Several other events in previous catalogs have been discarded or relocated.

More recent Texas earthquakes may have been induced by oil field operations. Seismic activity in west Texas near the towns of Kermit and Snyder are probably caused by waterflooding projects. Several recent earthquakes in the Gulf coastal plain may be associated with fluid withdrawal from oil and gas fields in up-to-the-coast normal faults.

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Structural Investigation and Tectonic History of East-Central Párras Basin, Coahuila, Mexico

Detailed field mapping and imagery analysis (Landsat, SIR-A radar, and black-and-white air photos) facilitate a structural and tectonic interpretation of the Párras basin. Párras basin is the erosional remnant of a Maestrichtian-Paleocene foreland basin with over 4,000 m of interfingered deltaic and marine deposits that accumulated during the early development of the Sierra Madre Oriental. The deformation sequence in Párras basin began with a main phase of north-northwest-directed thrusting accompanied by layer-parallel shortening, producing a weak solution cleavage. Thrusting was followed by formation of east-northeast-trending, symmetric to slightly asymmetric, north-northwest-verging, gently west-plunging, parallel folds with minor limb thrusting and thinning. The early cleavage was rotated in the limbs of the folds and a moderate axial surface-parallel solution cleavage was formed in the hinge zones. A well-defined 20-km wide zone of north-northwest-trending high-angle strike-slip and normal faults cuts all previously developed structures. Mesoscopic folds, slickenfibers, syntectonic vein fibers, and striae document a dominant north-northwest transport direction and a poorly developed secondary west-northwest transport direction. Párras basin rocks and structures reflect Laramide orogenic activity and the development of the Sierra Madre Oriental. Early thrusting of the thick Mesozoic carbonate sequence and flexure of the foreland generated an asymmetric, longitudinal depression parallel with the advancing sheet. The thickest accumulations of detritus shed from the rising hinterland are preserved along the Sierra Madre Oriental structural front. Continued northward migration of this front along a basal decollement culminated with local overthrusting and the incorporation of the Párras basin rocks in the fold-thrust belt. The present transverse and salient geometry of the fold-thrust belt reflects the influence of irregular basement structures related to the late Paleozoic configuration of northeastern Mexico.

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Depositional Environments of Wilcox Lignites in Choctaw and Winston Counties, Mississippi

Fourteen lignite outcrops from the Wilcox (lower Eocene) Group in Winston and Choctaw Counties in east-central Mississippi were studied by proximate and petrographic measurements. An inverse relationship

was found between the ash content and seam thickness; in 12 of 14 seams investigated, the ash content decreased as the seam thickness increased. Increased ash content is apparently related to the type of lignite-forming environment (freshwater) and the proximity of nearby fluvial systems.

Lignitized tree trunk remains found in several seams were identified as belonging to the taxodiaceous (cypress) groups. In addition, a small amount of dicotyledonous woody material was found. This further points to an "upland" freshwater fluvial swamp environment.

Comparison of the cellular humic material (textinite and ulminite) versus the macerated humic material (humodetrinite) may indicate the physical and botanical environment present during the period of humic accumulation. The data identify two types of plant communities and corresponding physical environments that might enhance humic accumulation from a particular plant community. The two types of marsh or swamp plant communities, based on maceral identifications, are: (1) cellulose-rich/lignin-poor plants (reeds and angiosperms) associated with macerated humic material (humodetrinite), and (2) cellulose-poor/lignin-rich plants (Taxodium) associated with cellular humic material (textinite and ulminite).

Eight of 11 seams petrographically investigated contain a preponderance of humodetrinite (cellulose-rich/lignin-poor) material, implying that most of the lignite seams were formed from a reed-dominated plant community.

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Geologic Effects of Hurricane Alicia on Upper Texas Coast

Hurricane Alicia made landfall on August 18, 1983, on the eastern end of Follets Island just west of San Luis Pass and Galveston Island. The maximum winds (198 km/hour), storm surge (390 cm), and wave energy were concentrated just east of landfall, along the western half of Galveston Island and the easternmost tip of Follets Island. In this area, the mean high waterline typically eroded 30-50 m (100-165 ft), whereas the vegetation line typically eroded 20-30 m (65-130 ft). Maximum erosion of the mean high waterline (up to 300 m) and the vegetation line (up to 100 m) occurred adjacent to San Luis Pass. A narrow band of washover sands, typically extending 20 m (60 ft) inland, was deposited along the nondeveloped portions of west Galveston Island. Because of the modification of the foredune system, these washover sediments typically extended 60-80 m (200-250 ft) inland along the developed portions of the shoreline. Erosion of the shoreline along the eastern part of Galveston Island was minor, although some washover channels formed where beach access roads cut through the dunes.

In contrast, the area west of landfall on Follett's Island experienced little shoreline erosion and virtually no washovers. This area was dominated by offshore-directed winds during the passage of the hurricane; thus, the main effect was numerous storm-surge ebb channels formed by the draining of West Bay. These channels are, on the average, 20 m (65 ft) wide, 55 m (180 ft) long, and up to 3 m (10 ft) deep; the largest channel is 40 m (130 ft) wide and 110 m (360 ft) long. These channels were initiated along low spots in the dunes (typically beach access roads) and grew landward by headward erosion until they encountered the highway, where they were partially deflected.

Much of the sand transported offshore during the storm returned to the beach within the following 6 months by progressive welding of swash bars to the foreshore to form a broad, flat berm. Since then, the patterns of shoreline accretion and erosion appear to reflect seasonal rather than long-term changes. The vegetation line had not shown any significant recovery 20 months after the storm, and complete recovery of the beach to its prehurricane position seems unlikely.

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Depositional Systems and Distribution of Cotton Valley Blanket Sandstones in Northern Louisiana

In northern Louisiana, the Terryville Sandstone of the Cotton Valley Group is composed of four regressive, massive sandstone members. These sandstones lie stratigraphically between the underlying marine shales of the Bossier Formation and the overlying Knowles Limestone. Extending updip from the two youngest sandstone members of the Terryville are at least 14 distinct sandstone tongues, or blanket sandstones.

These blanket sandstones thin progressively updip and eventually pinch out into the time-equivalent Hico Shale.

The sandstones can be divided into two groups based on thickness and extent. Sandstones of group I are generally less than 70 ft (21 m) thick and extend across most of northern Louisiana. In group II, sandstones are rarely greater than 30 ft (9 m) thick and are far less extensive, commonly occurring in isolated pods. Sandstones of both types are stacked vertically and are distributed across northern Louisiana in an elongate, arcuate belt.

The Terryville sediments were delivered to a slowly subsiding shelf by two major marine-dominated delta systems. Marine processes spread the sediments across the shelf, forming massive sandstones. The blanket sandstones were produced when minor marine transgressions—resulting from eustatic sea level rise, deltaic subsidence, or both—caused the transportation of sediments northward from the area of massive sand accumulation. Local topographic relief on the shelf apparently had little effect on the distribution of the blanket sandstones, although overall deposition of the Cotton Valley Group was influenced by several local structures.

Cross sections and isopach maps produced in this study define precisely the distribution of the blanket sandstones and demonstrate the repetitive nature of the Cotton Valley sandstones.

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Geomorphology and Morphologic Development of Ebb-Dominated Tidal Inlet on Microtidal, Wave-Dominated Texas Coast

Few geologic studies have been made of tidal inlets on the Texas coast, and the total picture of inlet dynamics in that region remains poorly understood. Generalizations of inlet geomorphology characterize Texas inlets as wave-dominated with large, well-developed, flood-tidal deltas and small, poorly developed, ebb-tidal deltas. However, in this study, that geomorphology appears not to be the case.

The geomorphology of Bolivar Roads Inlet, located between Galveston Island and Bolivar Peninsula on the Texas coast, was studied through the examination and comparison of aerial photographs, historic maps and charts, and written accounts of historic changes, as well as the analysis of hydraulic, bathymetric, and meteorological data compiled by various sources. Depositional environments and process-morphologic response relationships were determined and compared to models presented for East Coast and Gulf Coast tidal inlets. In addition, examination of the historical development of the inlet between 1721 and 1876 determined long-term changes and trends in tidal inlet hydrodynamics and morphology.

In its natural state (pre-1890), Bolivar Roads Inlet was geometrically stable and behaved like present-day mesotidal, mixed-energy (tide-dominated) tidal inlets, even though it was (and is) in a microtidal, wave-dominated environment. An atypical, large, well-developed ebb-tidal delta was maintained by (a) wind tides and ebb flow enhancement associated with "northers," (b) a large sediment supply, and (c) an ebb dominance and time-velocity asymmetry of tidal currents resulting from a diurnal inequality of the tides and tidal phase lags in Galveston Bay.

Historical documentation of the inlet indicates that the asymmetric flood-tidal delta migrated in a southerly direction, apparently because of norther-generated wave and tidal current action. Major changes in the ebb-tidal delta were associated with repetitive cycles of "channel abandonment bypassing" similar to that documented on the South Carolina coast. The present-day morphology of Bolivar Roads Inlet is the result of a complex interaction between tidal currents, wind waves, and longshore currents, all of which have been disrupted as a result of extensive modification of the inlet.

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Alluvial Architecture of Channel Belt Margins of Mississippi River, False River Region, Louisiana

The term "alluvial architecture" refers to the spatial arrangement and stratigraphic relationships between fixed channel belts (shoestring sands) and finer grained intervening flood-basin deposits. Overbank subenvironments associated with an active channel belt of the Mississippi River, including the levee, crevasses, and splay deposits, the upper point bar, and the abandoned channels, were cored using a standard vibracorer and Gid-

dings Rig Soil probe. This study proposes that two end-member types of transition zones exist between channel belts and flood basins at an instant in time for a simple, sine-wave-shaped stream meandering in a fixed channel belt: (1) a levee to backswamp transition zone (type A), and (2) an upper point bar to backswamp transition zone (type B). Type A transition zones, which consist of interstratified crevasse channel-fills, crevasse splay sheet sands, and fine-grained material of the natural levee, have greater potential for preservation than do type B transitions because crevasse splay deposits may extend for kilometers out into flood basins (type A) whereas preexisting point-bar deposits are destroyed during channel migration within the channel belt (type B). In type B transition zones, a sharp, erosional contact between the backswamp and upper point-bar subenvironments exists because of lateral migration of the point bar through preexisting facies within the fixed channel belt.

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Improving Interpretation of SAR Imagery for Hydrocarbon Exploration and Development in Gulf Coast by Modifying Data Acquisition Conditions: Three Case Histories

A comparison of synthetic aperture radar (SAR) parameters that are characteristic of airborne and orbital systems (e.g., SEASAT and SIR-A) indicates that the major advantage of airborne SAR is its inherent flexibility in matching image acquisition flight paths and altitudes to enhance the geologic "grain" of the terrain and the prevalent relief. The latter factor is particularly significant in low-relief areas, such as the Texas Gulf Coast. There, extensive SAR image coverage was acquired by flying the airborne system at a relatively low altitude, with the radar antenna tilted at a shallow angle. The combination of low altitude and antenna positioning provided a grazing illumination that highlighted, by shadowing, the otherwise subtle relief features in the resulting imagery. A comparison of the SAR with Landsat imagery in a key area demonstrates how "featureless" the terrain appears when illuminated with an energy source in a higher position.

The illumination geometry-enhanced SAR imagery has been used to evaluate three areas in the Gulf coastal plain of Texas. These are, from east to west, an area of salt domes near Houston, an area of strong fractural control near Matagorda, and an area of serpentine plugs near Luling-Austin.

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Depositional Environments of Sunniland Formation and Diagenetic Characteristics of Productive Facies, Lehigh Park Field, Florida

The Sunniland formation in the subsurface of Lehigh Park field, south Florida, consists of 11 carbonate facies deposited during a transgressive and regressive cycle in five major depositional systems: shallow-water shelf, shoal-water carbonate complex, restricted and open lagoon, tidal flat, and sabkha.

The shallow-water shelf facies consists of northwest-southeast-trending caprinid-chondrodontid patch reefs that overlie chondrodontid mounds. Caprinid-chondrodontid rudstones, grainstones, and packstones form a talus debris apron surrounding the patch reefs with abundant carbonate mud in more protected areas. Mollusk, gastropod, peloidal packstones and/or grainstones flank the shallow areas adjacent to the patch reefs. Sea grass probably grew in a mud-rich, protected, back-reef lagoon. In protected shallow-water areas between and behind the patch reefs, chondrodontid and requeniid wackestones and mudstones were deposited. *Orbitolina*(?) sp. and *Coskinolina sunnilandensis* are found in the higher energy shallow-water shelf deposits with miliolids prevalent in the more protected areas. The productive shoal-water complex overlies the shallow-water shelf facies and consists of porous mollusk, echinoid, intraclast, orbitolinid packstones, and grainstones.

Impermeable lagoonal deposits of low-energy, burrowed, miliolid mudstone or wackestone and nodular anhydrite in dolomitic mud provided the trap rock for the productive shoal-water sequence. Requeniid, miliolid wackestones accumulated in the shallow-water protected lagoon on the lee side of the shoals. Broad colonies of chondrodontids inhabited the transitional lagoon-tidal flat areas. Oolitic-coated grainstones com-