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Seismic Models of Fifteen Stratigraphically Controlled Oil and Gas Fields with Sandstone Reservoirs, Rocky Mountain Basins

Two-dimensional seismic models, derived from both normal-incidence ray-theory and wave-theory solutions, were generated for 15 stratigraphically trapped oil and gas accumulations in the Rocky Mountain province. The investigation is a feasibility study to determine the seismic character of moderate-sized (6 to 30 m thick), lenticular sandstone reservoirs in Rocky Mountains basins. The models are noise free and do not include all the complexities of the seismic phenomena, but they do provide a reasonable indication of the anomaly to be expected for a specific problem and the quality of seismic data required to solve it. The fields chosen for the model studies represent four major classes of stratigraphic traps and the reservoirs range in age from Late Pennsylvanian to Late Cretaceous. The fields include Bell Creek, Dillinger Ranch, Pine Lodge, Raven Creek, Red Bird, Rozet, South Glenrock, Well Draw, and West Salt Creek from the Powder River basin; Adena, Holster-Third Creek, and Peoria from the Denver basin; Desert Springs and Patrick Draw from the greater Green River basin; and Horseshoe Canyon from the San Juan basin.

Each seismic model was constructed from a detailed geologic cross section and typically consists of 30 layers and several hundred velocity and density values. No estimates of the effects of inelastic attenuation, interbed multiples, or hydrocarbon saturation are included; however, the latter parameter should be partly accounted for in the acoustic and density-log values. Final synthetic seismic sections are displayed with 80-, 60-, and 40-Hz symmetrical Ricker wavelets.

Our study indicates that the trap-reservoir interface of all 15 examples may be detected using the 40-Hz Ricker wavelet and thus would have a reasonable chance of being recognized on a conventional seismic section. Several of the documented anomalies are very subtle. The seismic anomalies are generally manifested as amplitude increases owing to either marked acoustic contrasts at the boundaries of a stratigraphic unit or to the constructive interference of waveforms interacting with numerous stratigraphic horizons (i.e., tuning).

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Depositional Setting of Coals in Upper Cretaceous Ferron Sandstone Member, Central Utah

Superb exposures of the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in southern Castle Valley, Utah, have been utilized in a detailed study of the stratigraphic and paleoenvironmental setting of the major coal beds of the Emery coalfield. Strata of the Ferron Sandstone Member accumulated in a suite of deltaic environments along the western margin of the Interior Cretaceous seaway during late Turonian time. Prodelta, delta-front, delta-plain, distributary-channel, and alluvial facies are recognized. The Ferron consists of five major cycles of deposition. Each cycle

records rapid northeast progradation of a high-constructive delta followed by phases of abandonment and destruction. With the exception of the first delta cycle, only the seaward part of which is exposed, each of the cycles contains one thick bed of coal. Thick, laterally continuous coals are present only in the delta-plain facies and are generally associated with brackish-water claystones and siltstones. Peat accumulation appears to have occurred primarily during phases of delta progradation, though two areas have been identified in the Emery coalfield where peat-producing swamps continued to exist through phases of delta destruction into the following phases of progradation. The thickest part of each of the major coal beds of the Ferron occurs in a position just landward (southwestward) of the pinchout of its associated delta-front sandstone. This genetic relation forms the basis of a predictive model that can be used to guide coal exploration programs in Cretaceous coal-bearing rocks of the Western Interior.

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Hydrocarbon Shows—Proximity Indicators for Stratigraphic Traps

Stratigraphic traps may consist of three distinct zones: (1) downdip oil-water transition zone, (2) economic oil productive zone, and (3) updip waste zone (Dunham). As only one of these zones is economic, exploration efforts for stratigraphic traps should be geared toward determining if any show in a wildcat well is in one of these three zones of a trapped accumulation. If a well is thought to have drilled into the transition zone, calculations can be made as to how far structurally updip a well should be drilled to locate economic oil-water ratios. If a well is drilled in the economic zone of a trap, calculations can be made from the first wildcat well to estimate the downdip limits of the field. If a well is drilled in the updip waste zone of a trapped accumulation, calculations can be made to estimate the distance downdip to the oil-water contact.

Cored wells updip from three economic stratigraphic traps were studied to determine if they were in the waste zone of the accumulation and to test the hypothesis that calculations to determine the oil-water contact in a field can be made from shows in updip waste-zone wells. Two oil-waste zones and one gas-waste zone were studied. Results of the calculations based on available data agree closely with documented oil columns in the fields studied. These results suggest that the concept is valid and can be used both qualitatively and quantitatively as an exploration tool in exploring for oil or gas as an exploitation tool in developing fields.

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Evolution and Response of Fluvial System—Sedimentologic Implications

A fluvial system ideally has three main components: (1) a drainage basin or sediment- and water-source areas, (2) a river or conduit for the waste of the drainage basin, and (3) a site of sediment deposition in the pied-

mont or coastal zone.

The nature and quantity of sediment produced from the source area determine the morphologic character of the river, and a river can be classified into five patterns dependent on type of sediment load. The (1) straight and the (2) sinuous-thalweg patterns reflect relatively low values of sediment transport, of bed-load to total-load ratio, and of stream power. The (3) meandering pattern reflects relatively low to moderate values of sediment transport, of bed-load to total-load ratio, and of stream power. The (4) meandering-braided transitional pattern and the (5) braided pattern reflect relatively high values of sediment transport, of bed-load to total-load ratio, and of stream power.

Throughout geologic time fluvial systems have had complex erosional and sediment-production histories as a result of external and internal influences. The external variables that most significantly affect the fluvial system are tectonic, eustatic, and climatic. The response of the fluvial system to changes in these controls is not necessarily simple; rather a complex response involving both erosion and deposition will ensue and the morphologic character of a river will change as the character of the sediment delivered from the source area changes. The exceeding of intrinsic geomorphic thresholds also produces episodes of high sediment movement.

The character of sedimentary deposits (piedmont, deltaic, or nearshore) will reflect the geology, morphology, and erosional history of the source area as well as the type of river transporting the sediment. Abrupt changes in amount and type of sediment reflect not only the complexity of the erosional evolution of the area, but also the dynamics of the sediment-producing and transport zones of the fluvial system.

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Oil and Gas in China

No abstract available.

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Hydrogeologic Significance of Ogallala Fluvial Environments

A "spring line" separates areas of flowing and non-flowing artesian wells completed in alluvial-fan deposits of the Ogallala Formation southwest of Cheyenne, Wyoming. Electric and lithologic logs from water well test holes in the area permit the distinction of depositional subenvironments within and near the ancient fan. West of the "spring line," the Ogallala coarsens upward through an aquifer unit of interbedded sand and gravel approximately 35 m thick, representing low-sinuosity fluvial-channel deposits. East of the "spring line," the same unit becomes markedly finer and is characterized by fining-upward subunits 10 to 15 m thick, representing deposits of fluvial channels with higher sinuities. Water wells completed in the proximal-fan deposits on the west commonly produce a few hundred gallons per minute; in contrast, wells in the distal fan and in interbedded fan and lacustrine deposits on the east pro-

duce only several tens of gallons per minute or less. Identifying the location of the distal margin of the low-sinuosity deposits, and thus the "spring line," through interpretations of depositional environments from outcrops and logs, helped locate rapidly one industrial water supply in the area.

Contrasting fan geometries illustrate varying rates of progradation with respect to the adjacent aggrading flood basins, whereas cyclicity within fan bodies reflects lobe shifting and/or basin-floor subsidence. General contrasts in fan thickness, size, and facies on opposite basin margins allow reconstruction of the basin geometry and provide clues to the likely types of bounding faults.

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Paleosols as Environmental Indicators in Nonmarine Sedimentary Rocks—Example from Brule Formation

Although there has been considerable study of Pleistocene and post-Pleistocene soils as stratigraphic markers and environmental indicators, much less attention has been given to older paleosols. In nonmarine sedimentary beds, periods of nondeposition or erosion can be characterized as intermittent, areally extensive, and of variable duration. Under favorable conditions of weathering, soils may develop on exposed rocks and subsequently be preserved by deposition and burial.

The Brule Formation (Oligocene) in northwest Nebraska consists predominantly of fluvial and eolian rocks. Based on paleontologic evaluations, several stratigraphic levels have been suggested as being soils or soil complexes. Of these, two stratigraphic zones were studied as possible paleosols. One of these, the lower ash bed of the Whitney Member, Brule Formation, has physical characteristics similar to those of a soil formed in a semiarid climate.

The lower ash bed is indicated to be a paleosol on the basis of trends in organic matter, particle-size distribution, and calcium carbonate content. The vertical profile shows a zone of higher organic matter in the upper part, a zone of high clay content below, and high calcium carbonate content in the subsoil. The White marker bed of the Whitney Member of the Brule Formation was also studied. The amounts of organic matter, clay, and calcium carbonate do not indicate a simple paleosol origin for the White marker bed.

Comparison of the lower ash paleosol to modern soils provides a basis for additional interpretations. Depth and thickness of zones of accumulation suggest that the paleosol was developed under a grassland cover and are characteristic of Chestnut-type soil. The climatic conditions that typically produce these characteristics include an average annual precipitation of 30 to 45 cm.

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Geology and Hydrocarbon Accumulation in Mississippian Midale Beds, Benson Oil Field, Southeastern Saskatchewan