Jurassic Sea-Level Changes From Seismic Stratigraphy

Two areas from the northern North Sea, the inner Moray Firth and the north Viking graben, contain sequences defined by seismic stratigraphic techniques which are indicative of Jurassic fluctuations in sea level. The seismic sequences involve Upper Triassic, Jurassic, and Lower Cretaceous strata. Ten sequences have been identified and their geologic ages are: (1) Rhaetian-Hettangian (198-189 Ma); (2) Sinemurian–early Pliensbachian (189-182 Ma); (3) late Pliensbachian-Toarcian (182-174 Ma); (4) Aalenian-Bajocian (174-165 Ma); (5) Bathonian (165-156 Ma); (6) Callovian (156-149 Ma); (7) Oxfordian-Kimmeridgian (149-141 Ma); (8) Tithonian–early Berriasian (141-133 Ma); (9) late Berriasian (133-131 Ma); and (10) Valanginian (131-126 Ma).

High stands of sea level are represented by the Rhaetian-Hettangian, Bathonian, Oxfordian-Kimmeridgian, and Tithonian–lower Berriasian sequences. Distinctive low stands are indicated by the lower Sinemurian, lower Callovian, upper Berriasian, and Valanginian sequences. The remaining sequences are defined by sea-level fluctuations of intermediate magnitude.

The sea-level fluctuations observed in the North Sea have been partly modified by structural activity. Their chronostratigraphic positioning, however, is thought to be caused by sea-level changes on a global scale. Charts of relative changes of sea level generated for the inner Moray Firth and the north Viking graben in the North Sea compare closely with similar charts from northwest Africa, the Gulf of Mexico, and other areas.

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Characterization of Regularly Interstratified Chlorite/Smectite Mixed-Layered Clay Using Combined Scanning Electron Microscopy/X-Ray Diffraction Techniques

Regularly interstratified chlorite/smectite (corrensite) is rarely found in hydrocarbon-bearing reservoir rocks as a dominant constituent of the clay mineral suite. However, several sandstone core samples, when subject to X-ray diffraction (XRD) analysis, were found to contain 46-100% of this mixed-layered clay mineral. The samples containing 100% corrensite permitted characterization of crystal morphology and mode of occurrence by use of scanning electron microscopy (SEM).

Corrensite was identified by XRD analysis because its characteristic basal reflections as the mixed-layered clay mineral responded to glycolation and heating treatment. This mineral consists of a 14A chlorite in a 1:1 relation with a 15A expandable smectite layer, yielding a total thickness of 29A. Glycolation expands the swelling smectite layer to 32.7A (001), 16.0A (002), 7.97A (003), and 5.91A (004).

The identification of corrensite as the dominant clay mineral of this reservoir rock is significant in that it has permitted: (1) characterization of the crystal morphology of this mixed-layered clay mineral by SEM; (2) the definition of a part of the pore-lining clays in a sandstone reservoir rock as water-sensitive due to the expandable smectite layers; (3) identification of chlorite within this mixed-layered clay so that proper completion fluids could be added to chelate the iron released if hydrocloric acid was used to stimulate the formation; and (4) differentiation of this type of corrensite from chlorite-swelling chlorite and chlorite-vermiculite, and other mixed-layered minerals to insure proper reservoir exploitation.

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Evolution and Stress History of Low-Permeability Upper Cretaceous Gas Reservoirs, Rocky Mountains

The physical properties of the Mesaverde gas reservoirs in Wyoming, Utah, Colorado, and New Mexico are the result of stress-induced changes that modified the sediment's original properties. Consideration of the stress history aids in interpretation of well log data and in understanding the reservoir performance that is controlled by natural or artificial fractures.

The poorly sorted and discontinuous reservoir sands were formed in a shifting nearshore environment in a region of nascent tectonic compression. Rapid sedimentation induced compaction and diagenesis, and later Tertiary burial continued compression and promoted some thermal stress. Laramide wrench-faulting could cause early shear fractures; a later uplift-reburial-uplift sequence, together with episodes of extensional tectonics, could promote tensional fracturing and a re-orientation of fractures and other structures in the well-indurated sediments.

Reservoir style is a result of several aspects of basin history, e.g., the depth of Tertiary burial in the Green River versus the San Juan basin. The regions considered are now generally inactive seismically, and there has been very little igenous activity since Cretaceous time, as contrasted to most nearby areas in the Rocky Mountains.

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Applied Petrophysics—Case History

Although the term "petrophysics" was defined by G. E. Archie in 1949, application of petrophysical approaches and techniques to exploration projects has been minimal during the past 30 years. This paper documents the application of varied petrophysical techniques to a field study and illustrates the integration of data to form a detailed interpretation of the reservoir.

Cut Bank field is a giant oil and gas field located on the west flank of the Sweetgrass arch in north-central Montana. Production is from the Lower Cretaceous Cut Bank Sandstone, which was deposited in a braided fluvial system.

Porosity versus permeability cross-plots of core data indicate a wide range of different rock types within the Cut Bank Sandstone interval. Capillary pressure curves, X-ray diffraction analyses, scanning electron micrographs, and thin section evaluation further define the rock types and document pore geometry differences. An Sw versus height-above-sea-level plot indicates field-wide pressure communication with a common water-oil