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Effects of Arkosic Sandstone Diagenesis on Reservoir Rock Properties

Upper Miocene channel turbidite sandstones of Yowlumne and Rio Viejo fields, southern San Joaquin Valley, California, are clean arkoses buried to depths of 11,000 ft (3,550 m) or more. Petrographic analyses of cored intervals from seven wells show that these medium-grained sandstones have no detrital constituents other than quartz and feldspars (at an approximately 2:1 ratio). The relative abundance of K-feldspar to plagioclase, however, varies among the intervals studied. This variation has given rise to different paths in clay authigenesis, which then control reservoir-rock properties. Nearly all clays, which constitute from a few percent to more than 20% of the rocks, are derived from feldspar alteration.

Sandstones with high K-feldspar relative to plagioclase yield clay assemblages dominated by kaolinite, with minor amounts of illite and vermiculite. Those with high plagioclase content yield abundant expandable clays. Chlorite is practically absent in all intervals studied. Besides detrital composition, abundance and mineralogy of the clays are also affected by depth of burial of the rock.

Feldspar alteration has resulted in porosities in the range of 14 to 20% and permeabilities up to 200 md at depths of 11,000 to 15,000 ft (3,550 to 4,570 m). In contrast, other reservoirs of different composition in the same area have greatly reduced reservoir properties at the same depths. Knowledge of sandstone composition and diagenesis, therefore, is important to exploration.

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Geology of University Waddell Devonian Field, Crane County, Texas

The primary production in the University Waddell field in Crane County, Texas, is obtained from Devonian siliceous carbonates. Since its discovery in 1948, the field has produced 42 million bbl of oil through primary and secondary production.

The field's structure is an asymmetric anticline created by the upthrown side of a reverse fault. The anticline dips steeply into the fault on the west side of the crest and dips gently away from it on the east. The seal and source rock for the field is the Woodford Shale (Devonian), a black pelagic shale. Updip migration from the Woodford provided the source for the three productive zones in the reservoir rock. Production is directly related to fracture porosity (7 to 12%) in beds with abundant replacement chert. Permeability through the productive zones is discontinuous and generally low (less than 5 md). The fractures in the Devonian siliceous limestones developed as a response to Pennsylvanian compression that created the reservoir structure.

The siliceous lithologies make up 60% of the Devonian sequence. The cherts are black, white, or gray and occur in brecciated or massive beds. Associated limestones are light-gray bioclastic packstones.

The chert is thought to be of secondary origin. The silica was derived from in-situ spiculites, locally reprecipitated as chert. A basinal environment is interpreted for the Devonian siliceous limestone and carbonate units. The Devonian carbonates deposited after the Silurian pelagic shales indicate a period of shallowing in the basin.

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Geometry of Tertiary Coal Seams as a Response to Changes in Structural Framework

Diminished subsidence of the Williston basin at the end of the Cretaceous was followed by accumulation of thick lignite seams in the Ravenscrag Formation (Paleocene). The formation of seven coal fields in southern Saskatchewan was also influenced by contemporaneous subsidence structures that originated as collapse of overlying strata above areas of salt leaching from the buried Devonian Elk Point evaporite basin. Lignite seams, up to 10 m thick, accumulated in successively younger coal fields that prograded to the southeast across southern Saskatchewan toward the cratonic depocenter in western North Dakota. The shape of the older coal basins conformed to the areas of salt solution activity and both the coal fields and component beds accumulated as circular forms. Salt-solution collapse effects diminished upsection with more pronounced cratonic influence that originated with intermittent movements between Precambrian crustal blocks forming the Williston basin. The thicker areas of coal seams in the middle of the 300-m coal-bearing section accumulated parallel with the cratonic lineaments but oblique to the coal-basin forms that retained a geometric relation to the salt solution. The uppermost coal basins were almost completely dominated by cratonic influence with thick coal bed areas parallel with cratonic lineaments and dispersed in a reticulate pattern. Younger coal fields distant from the cratonic depocenter were elongated parallel with lineaments oriented toward the cratonic depocenter, whereas coal fields next to the center of the Williston basin accumulated as arcuate forms along the strike of the basin. The activity of salt-solution subsidence structures during the formation of the uppermost coal fields was sufficiently weak to favor greater regional bed thickness but not affect lateral basin form.

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Breccias, Mudflows, Turbidites, Fossil Soils, or Transposition Structures? A Case Study from Eocene Green River Formation, Wyoming

Sedimentary structures in carbonate micrite sediments of the Green River Formation (Eocene) have been interpreted as breccias, mudflows, turbidites, or fossil soils. After careful study of these sediments and their vertical and lateral associations, they are actually seen to be transposition structures that result from intrastratal viscous or hydroplastic flow.

Some of the features that are associated with the soft-sediment deformation include microfaults, microfolding, flair structures, ball-and-pillow type structures, lense- and tear-shaped intraclasts, lineated intraclasts, unusually shaped intraclasts, "roof-pendant" intraclasts, and "fluidized" sediment.

When deformed units are traced laterally for even small distances (< 1 m) they may grade into undeformed units. Many units form boudinage structures and completely disappear laterally for short distances. Discontinuous "breccias" can be traced laterally or vertically in many instances to intact, undisturbed sedimentary units. Vertical associations are large-scale arcuate or fold structures (wavelengths 3 to 4 m), soft-sediment injection features, and mudcracks up to 2 m deep.

This case study points out the necessity of caution when interpreting carbonate micrite sediments that contain intraclasts that may at first appear diagnostic of primary breccias, mudflows, turbidites, or fossil soils.

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