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# Tectonics and Sedimentation Along Antler Orogenic Belt of Central Nevada

The Antler orogenic belt of central Nevada is a zone of tectonic activity which profoundly affected sedimentation patterns during the late Paleozoic. Lower Paleozoic through Middle Devonian strata indicate deposition in miogeosynclinal to eugeosynclinal environments with deposition of carbonate rocks on the east and shale, chert, and volcanic rocks on the west. In Late Devonian time, the depositional sequence was interrupted by eastward thrusting of the Roberts Mountains system which carried siliceous eugeosynclinal sediments onto miogeosynclinal carbonate rocks in the Antler belt. Debris eroded and transported eastward from this thrust system overwhelmed carbonate deposition during latest Devonian and earliest Mississippian time. Early Mississippian through Early Pennsylvanian tectonism with a strong vertical component provided a source terrane which again shed coarse to fine detritus eastward. These synorogenic sediments are herein interpreted as having been deposited in a shallow-marine and marginal-marine environment although carbonate rocks were at times deposited. This interpretation differs significantly from others that interpret the rocks as deep-water flysch deposits. As tectonism slowed, carbonate deposition recurred in central Nevada and the Antler belt was overlapped by Lower Permian sediments. With the overlap, shelf-to-basin sedimentation similar to that of the early Paleozoic was resumed. Antler tectonism is thus interpreted as having interrupted a well-established depositional system which persisted in a fragmentary manner throughout the time of deformation, and which finally was reestablished across the deformed zone.

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# Evaluation of Organic Matter and Subsurface Temperature and Pressure with Regard to Gas Generation in Low-Permeability Upper Cretaceous and Lower Tertiary Sandstones in Pacific Creek Area, Sublette County, Wyoming

Investigations of Upper Cretaceous and lower Tertiary rocks in the Pacific Creek area of the northeastern Green River basin show that studies of organic matter content, type, maturity, subsurface temperature, and reservoir pressure will help define prospective gas-saturated intervals and delineate areas of maximum gas-resource potential not included in previous U.S. Geological Survey resource estimates.

The onset of overpressuring occurs at about 11,600 ft (3,500 m), near the base of the Upper Cretaceous Lance Formation. Drill-stem test data indicate that at about 12,800 ft (3,900 m) the pressure gradient is as high as 0.84 psi/ft (19.0 kPa/m). Current data indicate that the active generation of large amounts of wet gas is important to the development of this overpressuring. A reversal of the spontaneous potential curve is nearly coincident with the top of overpressuring and is probably caused by a reduction of formation-water salinity. Very

small amounts of water produced during thermochemical decomposition of organic matter and the dehydration of clays may provide enough low-salinity water to dilute effectively the original formation water, so that the resistivity of the formation water ( $R_w$ ) is greater than that of the mud filtrate ( $R_{mf}$ ).

Humic-type kerogen dominates the organic matter. Total organic carbon contents range from 0.25 to 7.84 wt. %, averaging 1%. The top of overpressuring and beginning of important wet-gas generation occur at vitrinite reflectance values of 0.76 to 0.84 and color alteration values of about 2.8 on a scale of 1 to 5. The present minimum temperature at the top of overpressuring is 190°F (88°C; determined from uncorrected bottom-hole temperatures). The preservation of abnormally high pressures is probably due to presently active generation of gas in a thick interval of discontinuous, very low-permeability shales, siltstones, and sandstones.

The U.S. Geological Survey is studying gas-bearing intervals in the very few wildcat penetrations of deep tight sandstone intervals in Rocky Mountain basins to better define a possible major gas resource.

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# Opal-Cristobalite-Cemented Sands in Catahoula Formation—Implications on Source of Silica Cementation of Quartzose Sandstones

Channel sands and sand lenses in the Catahoula Formation, an Oligocene-Miocene fluvial unit of the Gulf Coast, are in places cemented by an opaline material. Petrographic, X-ray diffraction, and electron microscopy studies indicate that the cement (1) shows poorly developed banding of varying birefringence (or degree of crystallinity); (2) has shrinkage cracks apparently resulting from ordering and dehydration; and (3) consists of opal and crypto- to micro-crystalline cristobalite which occurs as lephospheres about 2  $\mu$ m in diameter. The cement develops in sands that are encased in tuffaceous silty mudstones. The development is apparently restricted to outcrops and near-surface zones of high permeability and appears to be pedogenic in origin.

Pervasive alteration of the rhyolitic tuffaceous mudstones to clay minerals gives rise to excessive free silica, which is carried by groundwater to the permeable sandy zones. The silica was initially precipitated in sand interstices as a silica gel. Subsequent dehydration and ordering produces the opal-cristobalite observed. Further crystallization of opal-cristobalite during burial diagenesis may result in chalcedony or quartz cements.

Calculations show that for a rhyolite ash to alter completely to 2:1 layer clay minerals (smectites), as much as 35 wt. % of the ash may be released as hydrogen silicate. This suggests that ash beds are significant sources of silica cement in sandstones.

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# Application of Conodont and Palynomorph Color Alteration Studies to Thermal Maturation History, Southern Ontario