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Leo Depositional Environments, Southeastern Powder River Basin

The informal middle member of the Minnelusa Formation, commonly known as Leo, consists of a spectrum of sediments including sandstone, dolomite, anhydrite, bedded chert, limestone, and radioactive carbonaceous shale. Deposition within the upper Paleozoic Alliance basin of the present day tri-state area of South Dakota, Wyoming, and Nebraska occurred in sabkha, tidal flat, and shallow subtidal environments. Major and minor cycles of eustatic sea level changes are manifest by the Leo section. Eolian sands, organic "black shales", supratidal to subtidal carbonates, and evaporites are intercalated in close vertical and lateral proximity.

Early Desmoinesian (lowermost Leo) sediments are open marine, upper subtidal limestone interbedded with restricted marine upper subtidal dolomite, anhydrite, and radioactive organic-rich dolomite. During the upper Desmoinesian and lower Missourian, most of the Alliance basin was a restricted carbonate tidal flat. Throughout the remainder of the Pennsylvanian, the prevalent environment was a restricted coastal to inland sabkha with episodic inundations intercalating intertidal dolomite and lagoonal "black shale" with the sabkha sediments. Prolonged periods of exposure allowed migration of eolian dunes across the region. The broad sabkha surface was an area of eolian bypass with only isolated patches of dunes being trapped by rare topographic relief. The bulk of the migrating sand was transported south

and west into the sand seas of the Tensleep, Weber, and Casper Formations. Sand was supplied from the north probably by eroded Tyler and older Paleozoic sandstones. In the present-day Hartville uplift area, an Upper Pennsylvanian trough known as the Lusk embayment modified Leo sedimentation. This trough introduced open marine waters into the southwestern corner of the Leo region, resulting in deposition of crinoidal limestone (in lieu of evaporites and carbonaceous shale) interbedded with eolian dunes.

Isolated eolian sandstones provide excellent stratigraphic traps for hydrocarbons generated in the organic-rich shales. The current flurry of Leo drilling that began in 1978, has affirmed the inherent potential of this play. Definition of paleodepositional trends and seismic recognition of isolated dunes are the keys to Leo exploration success.