A Stratigraphic Analysis of the Amsden and Broom Creek Formations (Permo-Carboniferous) in the Williston Basin: a Stratigraphic Model for a Carbon Storage Unit

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Abstract

This is part of a student-led analysis and assessment of the Broom Creek and Amsden Formations in the subsurface of the Williston Basin in west-central North Dakota. The Broom Creek Formation has been selected a potential carbon storage unit because of the porosity and permeability of aeolian and nearshore sand facies commonly occurring in the upper part of the formation (which currently functions as a saline aquifer). The Broom Creek was eventually selected as having a good potential for carbon storage because of the porosity and permeability of certain facies and because of the nature of overlying and underlying formations which have good characteristics to function as seals (siltstones and anhydrite layers). The Broom Creek has never been exploited as a hydrocarbon reservoir, so the characteristics of the formation were largely unknown. To rectify this lack of knowledge and explore the storage potential of this interval, a coring program of the Broom Creek was initiated by the EERC (Energy and Environmental Research Center, UND). The EERC also did the description and analysis of these cores as well as doing a section of 3D Seismic in Mercer and Oliver Counties in North Dakota (near the potential carbon storage field). The analysis of individual cores combined with analysis of the line of 3D seismic was good for a large-scale assessment of the carbon storage potential of the Broom Creek, but it may fail to recognize and characterize key surfaces that separate genetic packages of facies within the formation. Four cores containing the Broom Creek Formation and parts of the overlying Opeche Formation and the underlying Amsden Formation have been examined in Mercer and Oliver Counties in North Dakota. The Broom Creek is overlain unconformably by the red siltstone facies of the Opeche Formation. This horizon is conglomeratic and represents a stratigraphically significant surface. The unconformity with the underlying Amsden Formation is much less obvious and consists of a surface on top of an interval of anhydrite. The Broom Creek consists of an upper and lower part that is distinguished by the succession of facies in meter-scale cycles. The cycles in the lower part grade from peritidal carbonates to anhydrites and are capped by nearshore sands and aeolian sands. Cycles in the upper part of the Broom Creek begin with an erosional surface on top of a marine carbonate (fossiliferous and cherty dolostone) and grade upward to nearshore sand and are capped by aeolian sands. Cycles in the upper part of the Broom Creek are more laterally continuous than cycles in the lower part.