

Stratigraphic Study of the Mesozoic in Southeast Saskatchewan for the IEA Weyburn CO₂ Monitoring and Storage Project

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ABSTRACT

As part of the IEA Weyburn CO₂ Monitoring and Storage project, correlation and mapping of the Mesozoic lithostratigraphic units were undertaken to understand the regional distribution of aquifers and aquitards above the Weyburn pool. The study area is located in the contiguous region of southeastern Saskatchewan, northwestern North Dakota and northeastern Montana. Based on the examination of over 3000 geophysical logs, it was found that the Mesozoic strata thicken from 675m in the northeast of the study area to 2300m in the south. The predominantly shale and sandstone sequences were subdivided into 38 units. Four significant unconformities are identified: the Sub Mesozoic, the Sub Cretaceous, the Late Cretaceous sub-Pierre and the Mid Tertiary. Major changes in basin configuration occur above each unconformity.

There are also gross morphological sedimentary packages. The lowest (Triassic to Upper Jurassic) is dominated by red beds (Lower Watrous) evaporites (Upper Watrous), dolomites (Gravelbourg), limestones (Lower Shaunavon) and calcareous sandstones and shales (Upper Shaunavon, Rierdon and Masefield).

The second package (upper Jurassic to Lower Cretaceous) is defined by a predominance of sandstones and overlies the Sub Cretaceous unconformity under which lies a peneplain and dissected topography. This unconformity is itself dissected by the Sub Cantuar deep erosional surface that is infilled by the fluvial and estuarine sediments of the Cantuar formation. The latter is overlain by the marine shales and sandstones of the Pense, Joli Fou and Newcastle Formations; the last which represents a major sandstone aquifer.

With respect to thickness and distribution, the shales, silty shales and argillaceous sandstones of the third sedimentary package (Lower Cretaceous to Upper Cretaceous) dominate the Mesozoic section. The Westgate, Fish scales and Belle Fourche dark grey shales are capped with the calcareous shale and

argillaceous limestone of the Second White Specks (Greenhorn) Formation, whereas the Carlile and early Niobrara are dominated by bituminous black shales. The Middle and late Niobrara and the Alderson (Milk River) are more marine medium to light grey cyclic shales and muddy siltstones. The Sub Pierre unconformity, which is traceable from as far south as Nebraska and Wyoming and eastwards into Manitoba, separates the underlying Niobrara in the east and the Alderson in the western portion of the study area from the overlying Lea Park shales and Belly River sandy mudstones. Marine Bearpaw lithosome of clays and mudstones and sand round out this package. The late Cretaceous marine to non-marine transitions represented by cemented sandstones and siltstones of the Eastend Whitemud and Frenchman Formations completes the package.

The silty clay-dominant bentonitic Bearpaw Formation underlies the Pleistocene drift. Deformation of the bentonitic Bearpaw units and to a lesser extent, the Belly River and Lea Park by static and dynamic stress associated with glacial ice loading, high water content and by lubrication afforded the bentonites are recognized. Beds are apparently displaced southward and westward, presumably, as thrust slices.

Assessment of the hydrocarbon potential of the Mesozoic in southeastern Saskatchewan is limited to date. Recognition of potential source beds such as the Carlile and Govenlock Member of the Niobrara may aid in a decision to re-examine the shallow hydrocarbon prospects of southeast Saskatchewan.