Oil Families and Their Sources in Williston Basin

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Compositionally distinctive families of oils initially identified in Canadian Williston Basin can be extended into the United States. Most oils in Ordovician pools and the Silurian pools of the Cedar Creek anticline are identical with previously identified Family A oils. Kukersites, marine Type I source rocks, in Middle and Upper Ordovician formations are the source of this oil family, which is characterized by diagnostic saturate fraction gas chromatograms (SFGC) and terpane compositions. Marine Type II sources in Middle Devonian Winnipegosis Formation, but possibly also occurring in younger Devonian carbonate formations, are the source of Family D oils. Family D oils occur in Silurian to Mississippian strata. Their terpane compositional characteristics are like Family A oils, but they are distinguished by other characteristics. These oils are subdivided into subfamilies D1, D2, and D3. Family D1 oils occur throughout the Devonian and may have a number of sources, of similar composition, in the Middle and Upper Devonian carbonate succession. Family D2 oils are characteristic of Winnipegosis reefs and have sources in basinal Upper Winnipegosis Formation bituminous limestones. The presence of undersaturated n-alkenes in Family D3 oils suggests peculiarities in their generation, possibly attributable to intrusive bodies.

Oil in uppermost Devonian, Mississippian and Mesozoic strata are now divided into three families with different sources. Sources in uppermost Devonian-Mississippian Bakken Formation shale members source Family B oils predominantly in Bakken Formation reservoirs, both in the middle member and the "horizontal" shale play of central and eastern Williston Basin. Family E oil pools in western Williston Basin occur primarily in the middle Bakken sandstone subcrop play and in nearby Mannville Formation in west-central Saskatchewan. Family E oil composition and

stratigraphic occurrence suggests it has Exshaw/Bakken Formation sources in the Alberta/Montana Trough, outside the Williston Basin proper. Mississippian Lodgepole Formation sources most oils (Family C) in Mississippian Madison Group and Mesozoic strata throughout the basin. At low maturities the compositional differences among Family B, C and E oils are shown by biological marker compounds, but at higher maturities or advanced stages of biodegradation compositions are altered. Although biomarker differences persist throughout biodegradation, they are destroyed by cracking at high thermal maturities. Fortunately, significant gross compositional differences persist even at high maturity to allow the different families to be distinguished.

There are six additional oil families in the Williston Basin. The largest is Family F oil, with pools in Lower Cretaceous Viking Formation reservoirs of west-central Saskatchewan, having Cretaceous Colorado Group sources. Although now entrapped in the western part of the Williston Basin, Family F oils were expelled from parts of the Alberta/Montana Trough lying west of Calgary. Other compositionally distinctive oil families have only a few or single pools. These include two additional families in Cambro-Ordovician strata, Families G and J, the former of which probably has a Winnipeg shale source, but the latter of which has an undetermined source that supplies oils to the Newporte structure. Tyler oils, Family H, are the only oils with characteristics of a non-marine source in the Williston Basin. Minnelusa, Family I, oils also have distinctive compositions, but the position of their source is as yet undetermined.