

Changes in Paleomagnetic, Rock Magnetic and Geochemical Properties in the Exshaw Formation: Evidence for Permeability Variations?

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Paleomagnetic, rock magnetic and geochemical properties of the lower black shale unit of the Mississippian-Devonian Exshaw Formation in the Tangent Field area of the Western Canada Sedimentary Basin clearly differentiate two subunits. The lower “cohesive” shale zone, within 3 m of the Exshaw-Wabamun contact is characterized by: 1) the presence of a viscous remanence ($D=20.7^\circ$, $I=72.0^\circ$, $k=272.5$, $U_{95}=3.4^\circ$) and a normal characteristic remanence ($D=357.9^\circ$, $I=72.3^\circ$, $k=96.4$, $U_{95}=5.7^\circ$); 2) relatively high total carbon content of 11.6 wt.%; and, 3) depleted dolomite oxygen isotope values averaging -9.43 per mil. Above this depth, in the “fissile” shale zone: 1) the Exshaw Formation characteristic magnetization inclination is much shallower ($I=51.1^\circ \pm 5.2^\circ$, $k=65.6$); 2) total carbon is low, averaging 3.4 wt%; and, 3) dolomite oxygen isotope values are less depleted, averaging -4.13 per mil. The change in paleomagnetic, rock magnetic and geochemical properties is marked by the presence of a grey-green k-bentonite or tuff layer. The differences between the two subunits may reflect the presence of diagenetic fluids that affected only the lower subunit, thereby suggesting that the tuff may have acted as a permeability barrier to fluid flow.