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Initial insights into reservoir development of gas and oil bearing shales of the Devonian Duvernay Formation, Alberta

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Geological controls on permeability, porosity and hydrocarbon distribution of the Devonian Duvernay Formation in Alberta is being investigated. Porosity and pore size distribution, matrix permeability and hydrocarbon saturation vary significantly stratigraphically and areally in response to variations in lithology, digenesis and thermal maturation. The Formation is mature in a 200km arcuate band in western Alberta stretching from the West Shale Basin northward and is immature and overmature to the east and west respectively. The Formation is thickest to the northeast, averaging 250m where it is truncated by the sub-Cretaceous unconformity and thins to the west and south, averaging 60m in the West Shale Basin. The lithologies are characterized by finely laminated dark brown to black calcareous shale and laminated carbonate mudstone, with compositions ranging from 15-40% illite, 15-75% calcite, and 5-25% quartz, with lesser amounts of ankerite and chlorite. Analyses of preserved core to date show absolute matrix permeability that ranges from $1.0E^{-3}$ to $1.0E^{-7}$ mD. Higher permeability samples contain equal proportions of mesopores to macropores, whereas low permeability samples indicate generally a higher proportion of mesopores as compared to macropores. The relative permeability (on preserved core) is at least an order of magnitude less than absolute permeability. Permeability is markedly anisotropic with permeability perpendicular to bedding being at least an order of magnitude lower than horizontal permeability and varies with fabric and mineralogy. Matrix permeability is strongly stress sensitive, varying with the rock moduli which is in turn a product of mineralogy and fabric. Effective porosity to hydrocarbons varies from about 2% to 6% and is intergranular and in part maybe related to organic matter shrinkage during diagenesis. Preliminary data indicate the variation in gas and oil saturations through the basin is a product of maturity, kerogen type and capillary pressure.