Faults, Joints and Anisotropy Dominate Sonic, Resistivity Log Responses in a Geopressured Wabamun Limestone Gas Reservoir at Resthaven

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A prolific gas well drilled on a dipping seismic reflector at a Resthaven prospect in the Smoky sub-basin of the Western Canadian Sedimentary Basin penetrated a thrust fault and shear zone in the Wabamun limestone formation. The geological setting allows for a fault to ramp up section through the Wabamun at the location. High porosity observed in the otherwise tight limestone might be attributed to secondary porosity as suggested from analysis of cuttings samples from adjacent rock. Samples from the fault/shear zone were not available due to lost drilling fluid circulation and related operational circumstances.

The thrust zone and shear zone can be described on array induction and dipole shear log data. Sonic and resistivity log data are oriented measurements that can be pressed into service to describe oriented physical properties such as formation stress and cracks. Ultimately these data infer important reservoir parameters: volumetrics (porosity) and connectivity (permeability) of the fault and joint system. Fluid identification remains problematic.

Thrusting and a pinchout in the underlying shale led to detachment of, and shear zones in the stronger mechanical unit, the Wabamun. Furthermore, porosity reduction by stress in the Wabamun increases pore fluid pressure (reducing effective stress) and facilitates catastrophic fracture failure and overpressure. Stress phenomena illustrated by structure in the log data include: elastic moduli response anomalies, induction log polarisation horn and conductivity anomalies, sonic waveform refraction and birefringence, and Stonely acoustic wave velocity and attenuation anomalies.

The reservoir at this location is a 5 meter thick interval of limestone rubble with an inferred porosity over 25% sandwiched between 20 meter thick intervals of subhorizontally fractured and leached rock having an average porosity of ~2%. The faulted and jointed leached limestone rock modelled as such at this well location can potentially be extended in the geological model.