Applying Field Work to De-Risk Exploration: The Inner Foothills Thrust Carbonate Play, Central Brooks Range, Alaska

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Our perception of technical risk for the Lisburne thrust play in Alaska has matured significantly since 2002 with the reduction in exploration risk factors of trap, seal, reservoir and source attributable to careful field investigation of extensive backlimb exposures. In contrast with the highly developed oil fields in NPRA (i.e. Prudhoe Bay), data coverage in the Inner Foothills of the Brooks Range is sparse. Five seasons of field mapping, measuring sections and sample collection have vastly improved our subsurface mapping and prospect inventory, while advancing our geologic understanding from the regional to the local (intrawell) scale. Exploration geoscientists can easily be dazzled by high-tech methodologies and approaches to de-risking but at least in this case, the application of traditional field techniques was the key factor in delineating a very attractive gas opportunity trend.

The Brooks Range orogen of northern Alaska is an east-west trending thrust belt created by crustal shortening of the Arctic Alaska microplate and is commonly viewed as the arctic extension of the Rocky Mountains. Stratigraphy entrained in the fold and thrust sheets spans the Lower Paleozoic to Middle Mesozoic with reservoir potential limited to the Mississippian-aged ramp carbonates of the Lisburne Formation. Multiple imbricate thrusts of Lisburne reservoir quality dolomite exposed in outcrop continue northward into the subsurface and can be imaged on seismic beneath the foothills of the associated Colville (foreland) Basin. The untapped exploration potential of this trend as well as the striking geological similarity between this play and producing Mississippian gas reservoirs in Western Canada where Petro-Canada had years of experience were the key drivers to our company (now Suncor) entering into Alaska.

Trap: A clear tie was needed between reflector character and lithology in order to map out the thrust structures on seismic and balance structural interpretations. Deciphering the 2D seismic data is complicated by surface noise associated with the rugged terrain, the ductile behaviour of overlying clastics and the limited applicability of well ties due to regional stratigraphic variability. Careful structural observations and field mapping have allowed us to differentiate tectonic zones across the thrust belt including areas of “thin skin” vs. basement-involved detachments which impact the potential for thrust imbrication of the reservoir. By modeling the acoustic impedance between basal Lisburne dolomite and the underlying Kayak Formation shale which acts a fault propagation horizon, a correlative “trough-peak-trough” reflector package could be traced on seismic to delineate fault cutoffs and reservoir presence.

Reservoir: Key risks associated with the Lisburne reservoir included: 1) the presence of sufficient porous dolomite, 2) regional distribution patterns. Early in the project, correlation of outcrop descriptions and conodont biostratigraphy suggested the distribution of dolomite to be quite variable between sections and diffuse over a single vertical thickness of Lisburne Formation. In subsequent seasons, infill sections have afforded additional correlation control which when combined with collected porosity-permeability data and high resolution biostratigraphy, showed a concentration of porous dolomite in the Lower Lisburne. Palinspastic mapping of the outcrops and their reservoir quality further supports the consistency of net porous dolomite observed throughout our target area.

Seal: The lithologies potentially forming top, lateral and base seals for the Lisburne thrust play had not previously been evaluated for seal capacity. The only positive indicator of seal viability was a single drill-stem test from the Lisburne Test #1 well which penetrated 6 thrust repeats of moderate quality reservoir and flowed gas in minor amounts. To improve our knowledge of seal risk, field samples were analyzed using petrographic and mercury injection techniques to determine pore throat characteristics and seal capacity. Based on the calculated gas column heights each seal sample could constrain in the subsurface, our confidence in an effective trap seal was greatly increased.

Source: Potential source rocks for the Lisburne reservoir are postulated as organic-rich shale ("Kuna facies") deposited as the distal equivalents of the prospective ramp facies and can be observed in outcrop in the Western Brooks Range. Alternatively, a "top-down" or "bottom-up" source contribution from the overlying Triassic Shublik Formation (similar deep-water carbonates and shale) is plausible and this stratigraphy is typically transported along with allochthonous Lisburne in imbricate sheets. Geochemical and analytical techniques (TAI, TOC, Ro, CAI) were applied to outcrop samples and cuttings to investigate source rock potential and thermal maturity for the play. Integration of these results with USGS geochemical data, well tests, shows and petrographic evidence have encouraged our partnership that fair to good gas potential exists for mapped prospects.

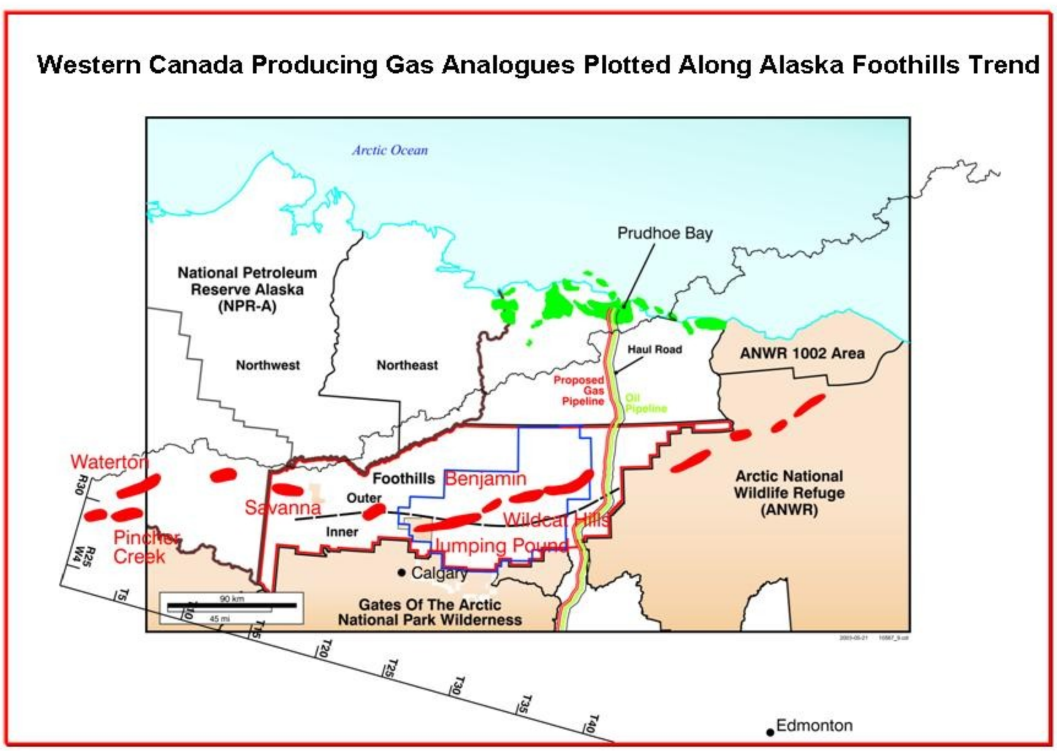

Figure 1. Scale Comparison: Alaska Inner Foothills vs. Western Canada Gas Pool (Foothills) Trend