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Playing Battleship in the Powder River Basin - exploring for isolated, shelf sandstone bodies and associated halo plays of the Wall Creek and upper Turner Sandstone

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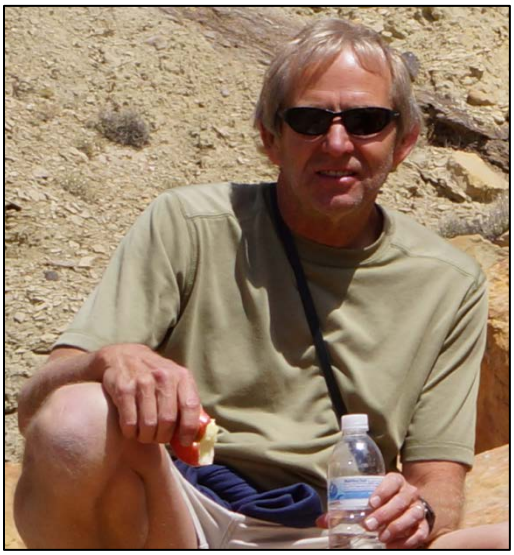

ABSTRACT: The Powder River Basin has yielded 3,000 MMBO and 1,825 BCFG from conventional structural and stratigraphic traps. The USGS estimates 630 MMBO and 650 BCFG remain in conventional reservoirs and 1050 MMBO and 15,000 MCFG remain in unconventional, continuous reservoirs, making the Powder River Basin one of the more prospective oil and gas basins in the Rocky Mountain region. This paper presents the work flow and preliminary results of a stratigraphic evaluation of the Wall Creek Member of the Frontier Formation and upper Turner Sandstone Member of the Carlile Shale, just two of several stacked pay and resource play opportunities in the Powder River Basin.

Based on an outcrop- and core-facies analysis, the Wall Creek and upper Turner sandstones in the Powder River Basin are interpreted to have been deposited in a shallow marine shelf environment, not attached to a shoreline as a delta or shoreface deposit. Most conventional reservoirs of the Wall Creek and upper Turner sandstones produce from cross stratified sandstone facies that accumulated in elongated, isolated sand bodies or sand ridges. The emerging unconventional Wall Creek and upper Turner sandstone play has focused on the low resistivity, low permeability, pervasively bioturbated, shaly sandstone that was deposited on the bar fringes. Facies architecture and paleocurrent analyses of nearby outcrops indicate that these sand ridges migrated from north-northwest to south-southeast by storm-generated shelf currents. Large storms occasionally reworked the tops of sand ridges, but HCS is rare.

Using gamma ray and resistivity cut-offs is not very useful for generating isolith maps because Wall Creek and upper Turner sandstone facies contain abundant clay in the form of intraformational mudstone clasts, clay drapes, biogenically introduced clay, and authigenic clays. However, using a combination of gamma ray and porosity cut-offs, "clean" sandstone isolith maps (GR < 60 API and porosity > 8%) can be used to identify sand ridge sizes, shapes and trends. Also, shaly sandstone isolith maps (GR between 60 and 80 API and porosity > 8%) can be used to identify broad areas of hydrocarbon-saturated bar fringe deposits.

The Powder River Basin contains hundreds of square miles of "white space" without Wall Creek or upper Turner sandstone penetrations. Finding undiscovered shelf sandstone ridges is much like playing the game Battleship. The isolated sandstone reservoirs are the ships and the more economic discoveries are the battleships and aircraft carriers. The clean sandstone and shaly sandstone isolith maps give us information about the azimuth, thickness, width and length of "already discovered" ships. However, knowledge about the size, shape and azimuth of the ships doesn't guarantee you'll win the game because, when you are drilling vertical wells, you're still lobbing one bomb at a time over the wall. The game changer in the Powder River Basin was introducing submarines equipped with steel-penetrating torpedoes and geosteering capability. In addition to prospecting for battleships, submarines can exploit the bioturbated shaly sandstone (the "halo" play) adjacent to known battleships, as well as stumble upon the occasional frigate or oiler in the convoy.

Speaker Biography: Edmund R. "Gus" Gustason is a senior geologist and geoscience advisor with Enerplus Resources (USA) Corporation in Denver, Colorado. Gus received his BS Geology from Humboldt State University and his MS Geology from Northern Arizona University. He moved to Boulder, Colorado in 1981 to join Dr. Erle Kauffman's Cretaceous Attack Team (CATs) at the University of Colorado. Gus worked as a geologist for RPI International during the 80s while he conducted research on the Dakota Formation of southern Utah; eventually receiving his PhD from CU Boulder in 1989. He then worked for BP Alaska, Schlumberger Reservoir Technologies, EnCana, El Paso and, for the past 5 years, for Enerplus.

Gus is particularly interested in core- and outcrop-based facies analyses and sequence stratigraphic evaluations of oil- and gas-producing formations. He has thirty-three years of experience in the petroleum industry. He also teaches a graduate-level course on core facies analysis at CU Boulder. Gus is a long-time member of AAPG, SEPM, GSA, and IAS. He and his wife, Leslie, live in Boulder, Colorado and spend much of their free time skiing, biking, hiking, backpacking, climbing mountains, and walking around the Colorado Plateau and the Rocky Mountains with eyes wide open.