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Looking at the Cardium Formation from Top to Bottom – Understanding the Self-Sourcing Nature of the Cardium and the Implications of this to Resource Estimates

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The Cardium Formation of the Western Canada Sedimentary Basin has been producing oil and liquids rich gas since the early 1950's and remains one of the largest conventional light oil reservoirs in the country. Historically, hydrocarbon production within the Cardium was mainly through vertical wells drilled into relatively thinner sandstone and conglomerate intervals. Since the rise of unconventional plays around 2008 and the introduction of horizontal, multistage frac programs, there has been a revival of activity in the Cardium. Instead of targeting the traditional conventional zones, much of the attention has been around adding resource found in the lower quality portions of the play, either laterally adjacent to conventional pools and/or stratigraphically below the main Cardium sand package.

Intensely bioturbated to laminated, siltstones/shales that interbed and gradationally bound the Cardium sandstones, have largely been overlooked until recently. This misunderstanding comes primarily from conventional 'quick pass log analysis' which indicates little or even negative porosity using the bulk density in the shaly/bioturbated zones. While other curves such as the gamma ray, neutron porosity, and deep resistivity, all show positive indications of section being hydrocarbon-filled; the density porosity log however, does not. The low-density porosity readings are due to the presence of pyrite and siderite, both of which are commonly associated with the presence of organic material. Once this mineralogy effect is accounted for and log data is calibrated back to core data, the true porosity and water saturations are evident (Figure 1).

The organic potential of these interbedded and bioturbated facies are poorly understood. Recent geochemical analyses and FIB-SEM analytics reveal that these 'unconventional' or 'tight' zones within the Cardium are organic-rich and thermally mature, and may in part be the source of the conventional Cardium hydrocarbons. Moreover, the FIB-SEM images reveal organic nano-porosity within the organics, leading us to believe that the conventional reported core porosities may be under estimated (Figure 1).

The Cardium Formation should now be considered a true hybrid play, containing a significant self-sourcing component. These organic-rich siltstones/shales comprise approx. 80% of the total Cardium package and can be found in both interbedded and bioturbated strata. The addition of this unconventional facies not only adds to the total thickness of the reservoir but also the addition to resource estimates. Through detailed and selective core analysis and a correctly calibrated petrophysical workflow, the true potential of the entire Cardium section, both conventional and unconventional can be quantified.

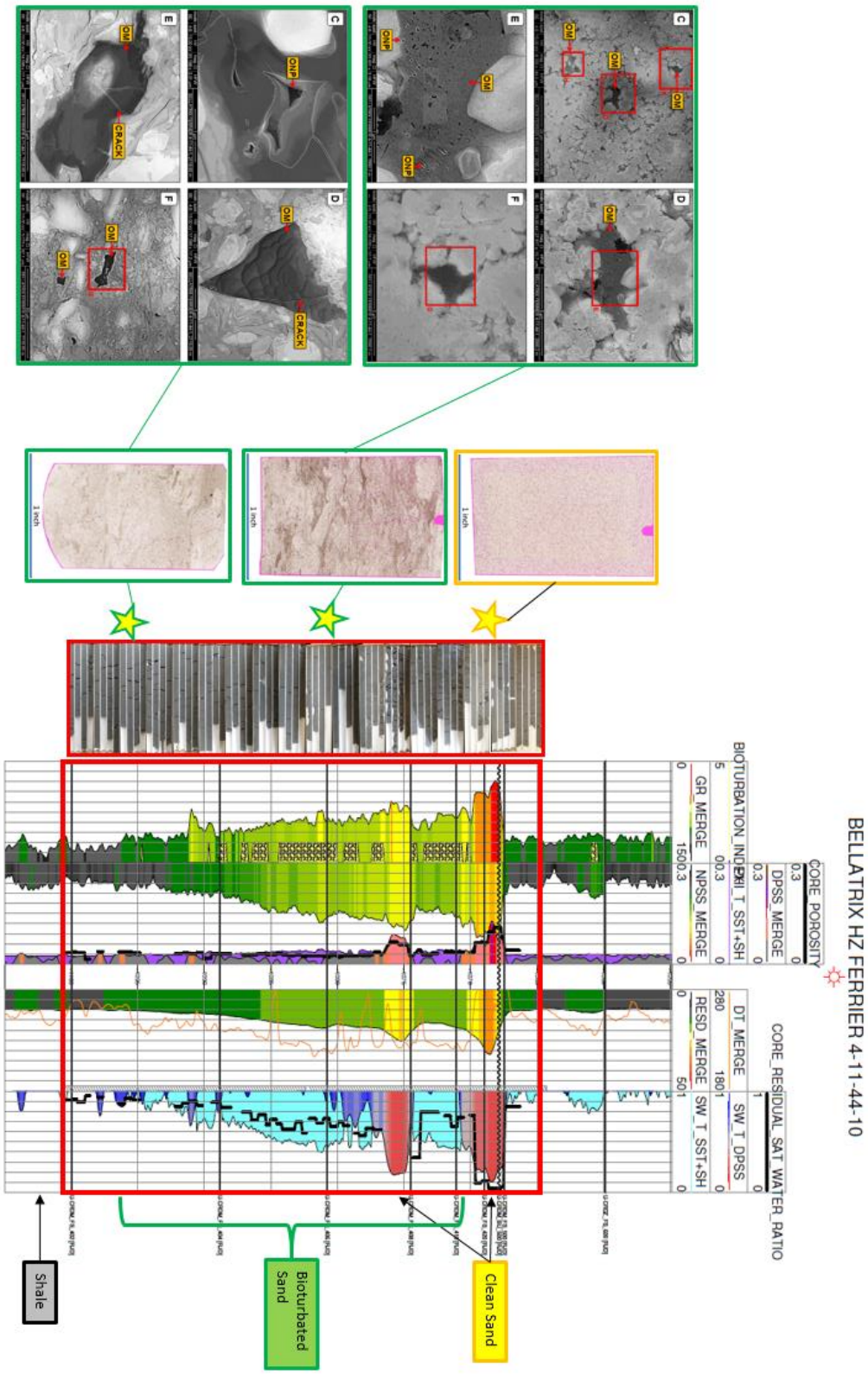

Figure 1: Cardium Corrected Logs with associated core photos, thin section and FIB-SEM images