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CRACKING THE CRETACEOUS CODE

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Impacts of the Keg River Reef and Devonian Structural Controls on McMurray Formation Geomorphology and SAGD Reservoir Architecture at Sunrise Oil Sands

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ABSTRACT

The Sunrise field, located approximately 60 km northeast of Fort McMurray (TWP 94–95 RGE 7 W4), is the northernmost in-situ thermal play in Cenovus Energy's oil sands portfolio. The partially developed field exploits the bituminous sand of the McMurray Formation and yields approximately 60,000 bpd of SAGD oil production. The northern portion of the Sunrise asset falls within the AER shallow area (defined as reservoir depths <150 m TVD). The developed reservoir is approximately 200 m TVD and deepens to the south, along regional structural dip. The Sunrise reservoir comprises amalgamated and cross-cutting fluvial, estuarine, and tidal-channel deposits of the lower, middle, and upper McMurray Formation.

The architecture of the underlying Keg River Formation carbonates and the later impacts of epigenetic and hypogenetic karsting play a key role in the fluvial geomorphology and resulting reservoir structure of the McMurray Formation. This is due to pre-, syn-, and post-depositional structural effects and associated accommodation in Early Cretaceous time. The Keg River Formation includes a series of reefs developed on Precambrian highs in and around the margins of the La Crete basin in northeastern Alberta during the deposition of the upper Elk Point Group strata. At Sunrise, the Keg River reefs have coalesced on Precambrian highs to form a continuous Keg River Bank which is oriented NE/SW. Off-lease to the north, the Bitumont sub basin lies in an area of Precambrian lows and associated graben-like structures. Within the Sunrise lease to the east is a comparably smaller-scale intra-reef basin, herein referred to as the Sunrise sub-basin. The Keg River reefs and sub-basins were filled with and overlain by halite and anhydrites of the Prairie Evaporite Formation. These salts were later dissolved resulting in varying degrees of karsting and collapse in the overlying strata. Structural accommodations resulting from karsting vary in scale and timing and, in addition to the effects on McMurray sedimentation, also appear to affect the fluid distributions (oil, gas, water) within the reservoir.

The Sunrise asset is situated at the confluence of the Assiniboia and Firebag paleovalleys, which complicates resource mapping due to the dynamic depositional setting and resulting preservation conditions of the area. The near-complete removal of upper McMurray parasequences, which are typically leveraged to differentiate between adjacent valley systems, makes it challenging to establish boundary conditions for resource mapping and SAGD pad planning. The uppermost regional McMurray unit (A1) is the only apparent regional unit preserved across Sunrise, and in some areas it is removed by contemporaneous tidal channels. All other underlying upper McMurray (A2, B1, B2) and possibly middle McMurray (C) parasequences appear to be completely eroded and replaced by stacked and amalgamated remnants of incised-valley fills. The uppermost portion of the Sunrise reservoir, informally referred to as the McMurray Unit 3 (MU3), comprises at least two post-A2 incisions. The youngest of these incisions falls roughly within the Sunrise sub-basin area and is also overlain by overthickened Wabiskaw D tidal deposits. This demonstrates sustained dissolution and subsidence, resulting in increased accommodation throughout McMurray time and into Clearwater time in the off-reef area.

Legacy pads are positioned on-reef, and in recent years Cenovus has begun to develop the Sunrise sub-basin to the east. Looking to the future, prospective development appraisal and planning require an understanding of the Devonian impacts on accommodation during McMurray time, coupled with identifying areas of thick uncompartimentalized reservoir sand and high oil saturations, which do not necessarily coincide with each other.