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# Hondo Evaporites in the Grosmont Heavy Oil Carbonate Reservoir

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## Summary

The Hondo Formation is an evaporitic unit within the Devonian Grosmont shelf complex, which is the world's largest heavy oil deposit hosted in carbonates, with an estimated 400-450 billion barrels of bitumen in place. At present, the Grosmont reservoir is not under production but under consideration for several in-situ thermal recovery schemes. Reservoir evaluation includes constraining the nature of deposition of the evaporites (marine-lagoonal, lacustrine, sabkha, etc.), and their spatial distribution on a regional scale.

## Introduction

The Grosmont reservoir is located in east-central Alberta at depths of 200m to about 1200m near the updip limit of the Alberta Basin (Figure 1). The Grosmont shelf complex represents a shallow marine carbonate platform (Machel and Hunter, 1994), and is subdivided into four shallowing-upward cycles: Lower Grosmont (LGM), Upper Grosmont1 (UGM1), Upper Grosmont2 (UGM2), and Upper Grosmont3 (UGM3). These units are separated by shale breaks named consecutively SB1, SB2, and SB3, which can be identified on well logs (Dembicki and Machel, 1996). The Hondo Formation is an evaporitic sub-unit within the Grosmont and replaces part of the four cycles in some areas of the complex, especially at the top of the UGM3. Diagenetic processes, such as dolomitization, karstification and dissolution, have affected the succession especially in the upper stratigraphic units (Huebscher, 1996). Also, brecciation takes place mainly in the eastern part of the complex, near the pre-Cretaceous erosional edge.

Several studies regarding characterization of the reservoir properties have been conducted in the complex, mainly in the central and eastern parts of the platform (Machel and Hawlader, 1990; Dembicki and Machel, 1996; Huebscher, 1996). However, the Hondo Formation received only sparse attention (Cutler, 1983 studied the Hondo evaporites in the south part) probably because it has been found in only four cores. As a result, its depositional nature and areal distribution are enigmatic.

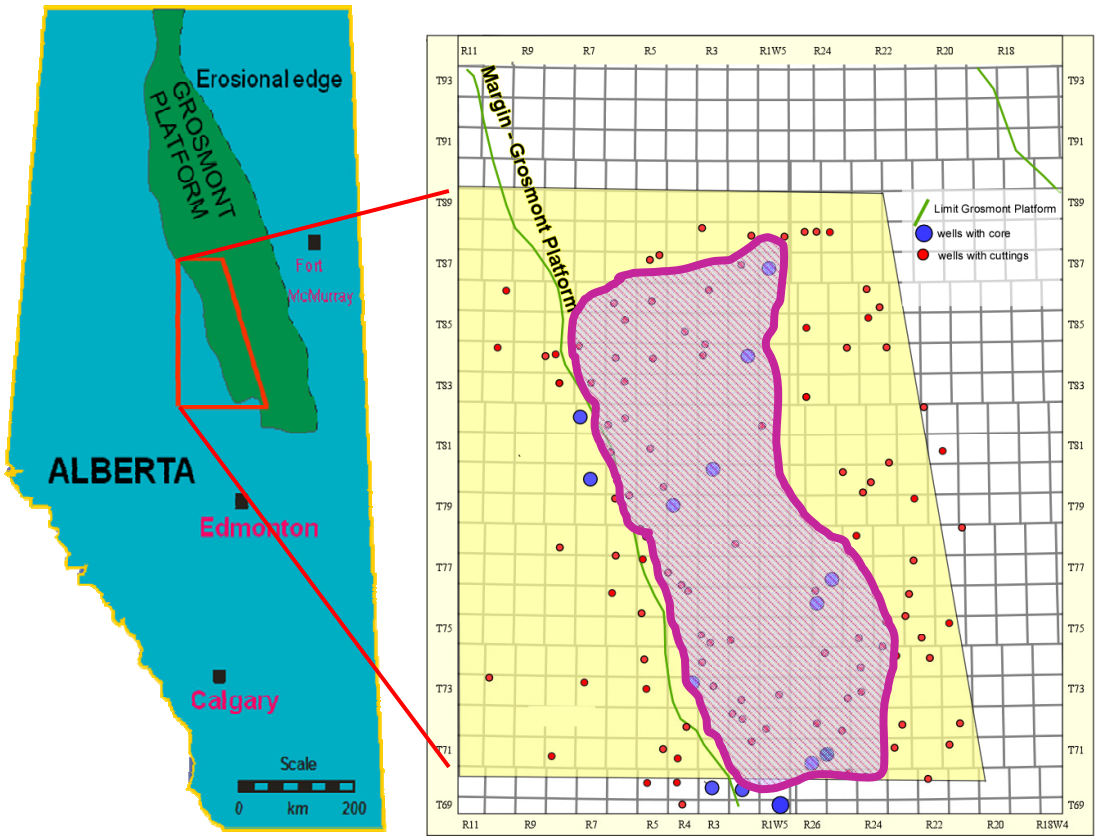


Figure 1: Location of the study Area and wells used for this study.

## Data base and Methods

This study involves core examination; facies description; Sr, S, C, and O isotope analysis; and log interpretation. Detailed petrographic analyses of 19 cores, and cuttings from 75 wells reveal that 'primary' evaporites are present in 4 cores, and evaporites occur in cuttings of 22 additional wells. The thickest continuous evaporite core section is 25m long and contains five lithofacies: (1) laminated anhydrite in dolomudstone, (2) mosaic anhydrite with algal mats, (3) enterolithic anhydrite, (4) nodular to distorted anhydrite, and (5) synsedimentary breccias with green argillaceous matrix (Figure 2). Most of these lithofacies appear to be marine-subaqueous 'primary'deposits, and many of the microtextures suggest original formation as gypsum. Additionally, diagenetic 'secondary' anhydrite fills fractures and molds, both within the Hondo and in the adjacent strata. Halite is conspicuously absent today, but halite must have been deposited in at least parts of the region, as suggested by isolated molds of halite hoppers and questionable syndepositional breccias.

The composition of the brines that formed the 'primary' sulfates is interpreted using isotope analyses. Most $^{87}Sr/^{86}Sr$ values of anhydrite vary between the range of 0.70806 and 0.70833 ($n$ = 9), which are within the known range of Frasnian seawater. Three samples have higher values, interpreted to represent diagenetic alteration. Moreover, data from $\delta^{34}S$ vary from 23.7 to 27.9 permil CDT and $\delta^{18}O$ from 14.3 to 16.6 permil SMOW, supporting that the saline brines were of Late Devonian marine parentage.

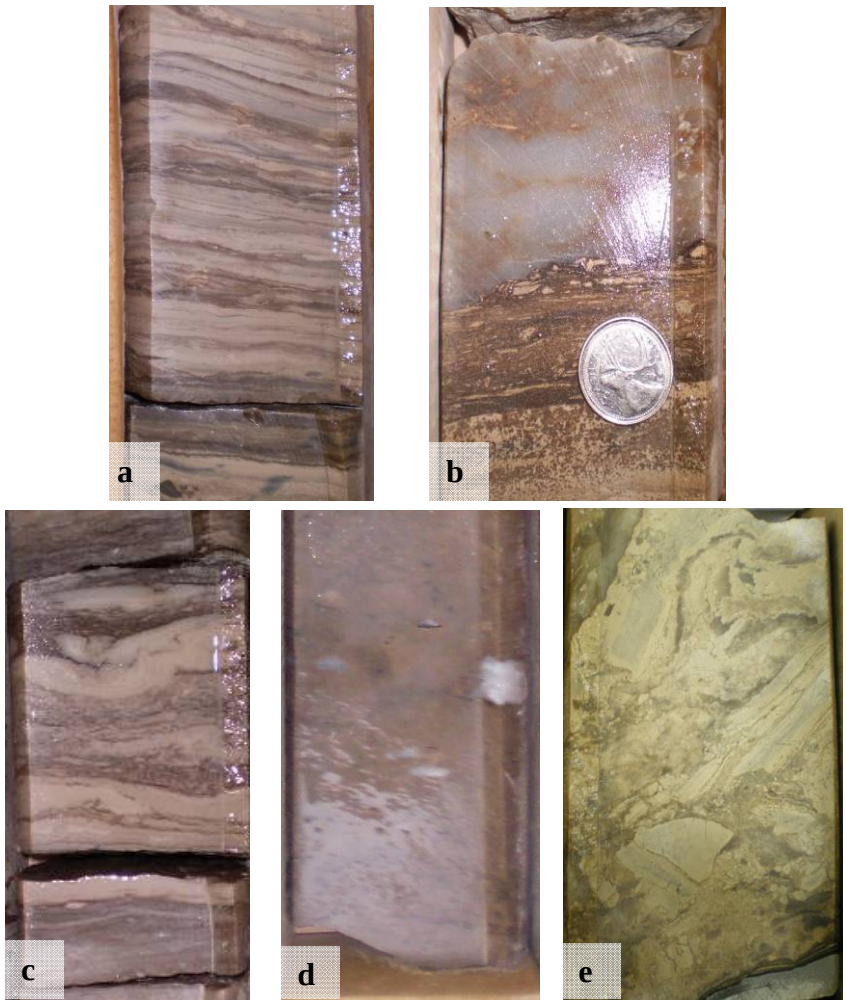


Figure 2: Hondo Lithofacies. a) Laminated anhydrite in dolomudstone,b) Mosaic anhydrite with algal mats, c) Enterolithic anhydrite, d) Nodular to distorted anhydrite, e) synsedimentary breccias with green argillaceous matrix.

## Spatial Distribution

The spatial distribution of the Hondo evaporites has been reconstructed based on cores and cuttings, as well as on electrical, density and sonic logs interpretation. It appears that the Hondo evaporites were deposited in an oblong area that measured about 40 x 150 km, similar in size to some other known evaporite units in the world. It is not clear, however, whether this area was one large 'salina', or whether it envelopes a series of relatively small (10 x 10-20 km) brine ponds on the much larger Grosmont shelf (about 150 x 500 km) (see Figure 1). These brine ponds may have formed following the paleotopography of the sea floor during the Late Devonian. In the eastern part of the study area, the Hondo appears to be dissolved and replaced by solution-collapse breccias. The significance of these findings for heavy-oil trapping and reservoir exploitation are under further investigation.

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