The Grosmont: A Complex Dolomitized, Fractured and Karstified Heavy Oil Reservoir in a Devonian Carbonate-Evaporite Platform

Hans G. Machel[1], Mary Luz Borrero[2], Eugene Dembicki[3], Harald Huebscher[4], Luo Ping[5], and Yi Zhao[2]
[1]*University of Alberta, Edmonton, AB, Canada*
[2]*Husky Energy, Calgary, AB, Canada*
[3]*Athabasca Oil Sands Corp., Calgary, AB, Canada*
[4]*Shell Canada, Calgary, AB, Canada*
[5]*PetroChina, Beijing, China*

Abstract

The Upper Devonian Grosmont platform in Alberta, Canada, is the world's largest heavy oil reservoir hosted in carbonates, with 400-500 billion barrels of IOIP at an average depth of about 250 – 400 m. Our study, which aims to aid in thermal recovery of this reservoir, shows that the current reservoir characteristics were created by the succession of five major factors and/or processes: sedimentary stratigraphy, dolomitization, polyphase and polygenetic fracturing, polyphase and polygenetic karstification, and biodegradation. Most of the present porosity and permeability is due to fracturing and karstification.

The sedimentary stratigraphy of the Grosmont reservoir consists of 6 stacked carbonate units interbedded with marls and some evaporites. The latter two originally acted as aquitards during diagenesis but are breached or missing in parts of the area today. Dolomitization by density-driven reflux was the first pervasive diagenetic process. Most dolostones are fine-crystalline and tight, however, and the only notable porosity caused by and/or related to dolomitization is scattered molds and vugs. A dense fracture network was created in three or four phases. Most fractures probably originated from collapse following subsurface salt dissolution and/or from Laramide tectonics far to the west, whereby pulsed crustal loading in the fold-and-thrust belt created a dynamic forebulge in the Grosmont region via multiple pulses of basin-wide crustal flexing, each followed by relaxation. The fracture network probably was reactivated and/or expanded by glacial loading and post-glacial isostatic rebound in the Pleistocene and Holocene, respectively.

The region experienced three or four prolonged periods of epigene (top-down) karstification, although there is tangible evidence for only two of them in the Grosmont platform. The first of these episodes was a 'warm epigene karstification' during the Jurassic - Cretaceous, and the second was/is a 'cold epigene karstification' that started sometime in the Cenozoic and is continuing to this day, as is biodegradation. In addition, there is circumstantial evidence for hypogene (bottom-up) 'karstification' (= dissolution) throughout much of the geologic history of the Grosmont since the Late Devonian, with two possible maxima around the time of hydrocarbon emplacement, i.e., Early-Middle Cretaceous and Early Tertiary, respectively.