Explanations for the occurrence of heavy oil accumulations in the Grand Banks area of offshore eastern Canada

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We present a multidisciplinary study that seeks to explain the reasons for the occurrences of heavy oil in the Grand Banks area of offshore eastern Canada. If heavy oil is defined as having an API gravity of less than 25°, then it is encountered at several locations in the Jeanne d'Arc Basin and in one well in the South Whale Basin in the southern Grand Banks. The latter is the heavy oil encountered within the Upper Cretaceous Petrel Limestone at Heron H-73 which is only 7°API but is not biodegraded. The high density of this oil is related to its high sulphur content which is probably inherited from a source rock deposited in an unusual carbonate environment. This source interval has yet to be identified.

Biodegradation is the major process responsible for most of the heavy oils in the Jeanne d'Arc Basin. The exception are some marginally heavy oils (~ 24°API) at Hibernia O-35 that are of very low maturity. There are two types of biodegraded oils in the Jeanne d'Arc Basin. Plots of oil saturation versus permeability suggest that the biodegradation of both types took place in the reservoir after secondary migration. The first type are those containing just one phase of biodegraded oil. These occur mainly in shallow reservoirs (<1600 m) with reservoir temperatures of less than 60°C on the eastern flanks of the basin (e.g. North Trinity H-71, South Brook N-30). The second type contain a mixture of lower maturity biodegraded oil and higher maturity unbiodegraded oil and tend to occur in reservoirs in the central parts of the basin (e.g. Hebron I-13, Mara M-54). Both pulses of oil are mostly sourced from the same Kimmeridgian source rocks. A combination of geochemical, paragenetic and fluid inclusion (including microthermometry and fluorescence micro-spectrometry) studies supported by burial history and migration modelling, suggest the following scenario for their occurrence. An initial hydrocarbon generation and migration phase during the Late Cretaceous-Early Tertiary followed by uplift and erosion on the flanks of the basin which allowed the meteoric waters to penetrate deeper into the subsurface thus breaching the recently charged reservoirs and altering the oils. Subsidence resumed during Late Eocene resulting in a second expulsion/migration phase of more mature hydrocarbons that migrated either into previously charged reservoirs containing biodegraded oil, or into newly formed traps.

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