The Application of Geochemical and Isotope Tracers for the Identification of Source Contributors to Mineral (Scale) Precipitation in Petroleum Reservoirs

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Mineral (scale) precipitation can significantly hinder production in petroleum reservoirs. This includes steam assisted gravity drainage (SAGD) operations used for bitumen recovery in the Athabasca oil sands region of north-eastern Alberta, Canada. Variations in scale compositions and their formation conditions have been observed throughout SAGD facilities and often require costly and laborious mechanical and/or chemical treatment efforts. Hence, we investigate methods to prevent or at least minimize scale formation by applying select geochemical and isotopic tracers to identify source contributors to mineral precipitation. Pore water, bottom formation water, and steam condensate and returned emulsions (produced bitumen and water) were sampled from a SAGD reservoir in Alberta and analysed for geochemical and isotope parameters. Results indicate distinct concentrations of dissolved Na and Cl and $\delta^{18}O$ and $\delta^{2}H$ values for the three fluid sources. Significant differences in $\delta^{13}C_{DIC}$, $\delta^{11}B$, $\delta^{34}S$ values and $^{87}Sr/^{86}Sr$ ratios were also observed between bottom formation water and steam condensate and returned water samples, and hence constitute excellent tracers for bottom water influx. Scale sampled from multiple steam injector and production wells has been analysed for $\delta^{18}O$, $^{13}C_{DIC}$, $\delta^{34}S$, $\delta^{11}B$, $^{87}Sr/^{86}Sr$ and trace elements and results are assessed to determine the fluid sources and reservoir dynamics that contributed to its formation.