Raman spectroscopy applied to enhanced oil recovery research

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Enhanced oil recovery (EOR) is a topic of high interest for the Norwegian government as more than 50 % of hydrocarbons (HC) in existing fields on the Norwegian Continental Shelf (NCS) cannot be produced with current methods. EOR is concerning the mobilization of immobile oil and seawater injection is one of the most common methods used to maintain pore-pressure and displace oil in HC reservoirs at the NCS. Understanding the mineralogical and chemical changes induced by brine injection proves especially important for EOR research. Compaction increases with dissolution of chalk. Formation of secondary minerals will affect rock surface properties, flow pathways for oil and porosity estimations. Textural changes in chalk allow different fluid flow mechanisms to play a role in reservoirs. Two samples of chalk (Liége, Belgium) were flooded with $MgCl_2$ for 1.5 and 3 years at reservoir conditions (130°C, 1 PV/day, 12 MPa effective stress) and studied with Raman spectroscopy to observe mineralogical changes due to fluid injection. When chalk is injected with $MgCl_2$, substitution of Ca^{2+} by Mg^{2+} will take place. If the Mg^{2+} ions bond with CO_3^{2-}, magnesite ($MgCO_3$) will grow as a new mineral phase. Previous research of the 1.5-years-test has shown decreasing chemical alteration in flooding direction and magnesite was identified as the major newly grown mineral phase. Raman spectroscopy could identify a decreasing occurrence of magnesite along the core of the 1.5-years-test. In previous research, magnesite was traced positively up to 3 cm from the injection surface, while in this study magnesite was detected in 4 cm distance, suggesting the alteration front to be located in this area. Raman spectroscopy could confirm very fast that in a similar test over 3 years, nearly the entire core has been changed to magnesite. Other methodologies would have needed far longer research to show the same outcome. The results obtained in this study strengthen the possibility of the application of Raman spectroscopy as a quick, cheap, and effective methodology for the study of mineral compositions and even fine-grained rock material like chalk.