Quantitative identification of reservoir fluid properties and boundary shifts by laser-induced fluorescence

JIN SU[1,2], SHUICHANG ZHANG[1,2], GUANYOU ZHU[1,2], BIN ZHANG[1,2] AND XIAOMEI WANG[1,2]

[1]Research Institute of Petroleum Exploration and Development, PetroChina, Beijing 100083, China

[2]State Key Lab of Oil Recovery Elevation, Research Institute of Petroleum Exploration and Development, PetroChina, Beijing 100083, China

In an oil-gas reservoir with multi-stage structural movement, both hydrocarbons and reservoir bitumen may have suffered from multi-stage mixture, alteration and deconstruction, which results in difficulties to reconstruct migration and adjustment histories of hydrocarbons due to many factors that affect the reconstruction. However, direct evidence for different phases of hydrocarbon migration, variations in oil-gas properties and shifts of oil-water boundaries could be obtained from fluid inclusions of oil-gas reservoirs, which can record primary components and temperature-pressure conditions of hydrocarbon migration and charge. Thus, the present study uses quantitative assessment parameters, such as fluorescence strength and maximum emission waves of organic fluid inclusions, to characterize variations related with oils, gases and water in reservoirs so as to reconstruct adjustment processes of hydrocarbon reservoirs.

The Tarim Basin in China has experienced multi-cycle structural activities, and several developed petroleum systems are vertically superimposed or horizontally distributed in the basin. the present research quantitatively investigates fluorescence characteristics of reservoir sandstones, delineates the difference in fluorescence characteristics for oil-bearing or condensate-bearing reservoirs using λmax (maximum radiofluorescence wave length) and $\triangle\lambda$ (a wave length between 2/1 I_{max}), quantitatively analyzes the relationship between the primary oil-water boundary when hydrocarbon charge occurred and the present-day boundary, deduces reasons resulting in the elevation of oil-water boundaries based on structural evolution, and particularly, distinguishes dominant migrating pathways from all the oil-bearing reservoir beds according with the comparison of I_{max} (maximum radiofluorescence intensity) between present-day and old reservoirs. Therefore, the laser-induced fluorescence quantitative analysis can also play a significant role in investigating variations in paleo-oil-water boundaries, determining paleo-oil-column height, demonstrating oil saturation and wettability of reservoirs, and simulating displacement pressure of reservoirs as well.

Biodegradation of petroleum hydrocarbon in shallow groundwater from carbon and sulfur isotope evidence

SU XIAO-SI, LV HANG* AND ZHANG WEN-JING

Jilin University, Changchun, China, 130021
(*correspondence: lvhangmail@163.com)

Biodegradation is one of main natural attenuation processes in petroleum hydrocarbons contaminated groundwater [1]. Carbon and sulfur isotopes may have been markedly kinetic-fractionated during biodegradation process [2], which provides a powerful tool to reveal mechanism of petroleum hydrocarbons biodegradation. In an oilfield area in Northeast China, oil-bearing saline water moves upward and infiltrates into the shallow groundwater resulting from the accident and the area of groundwater-contaminated plume is about 8000m^2. Concentration of Total Petroleum Hydrocarbons (TPHs), dissolved Inorganic Carbon (DIC) and dominant terminal electron accepters or donators, $\delta^{13}C_{DIC}$ and $\delta^{34}S_{SO42-}$ have been analyzed.

Analytical results show that the spreading direction of contaminated plume is controlled by groundwater flow. And the concentrations of SO_4^{2-} and pH increase along groundwater flow in the central line of the plume while TPH and DIC decrease. The $\delta^{13}C_{DIC}$ values of the uncontaminated groundwater range between -9.5 and 8.0‰$_{PDB}$, while the contaminated is characterized by a significant depletion of ^{13}C with $\delta^{13}C_{DIC}$ of -18.3~-18.5‰$_{PDB}$. Furthermore, the concentration of DIC is negatively correlated with the value of $^{13}C_{DIC}$. It is deduced that the increase of DIC results from the biodegradation of petroleum hydrocarbon in groundwater. Meanwhile, the ^{34}S in the contaminated groundwater with the $\delta^{34}S_{SO42-}$ of 25.0‰ ~ 48.1‰$_{CDT}$ is depleted to the uncontaminated groundwater with the $\delta^{34}S_{SO42-}$ of 19.2‰ ~13.9‰$_{CDT}$. The Rayleigh model calculation [3] shows that the biodegradation of petroleum hydrocarbon with the bacterial sulfate reduction has occurred in the contaminated aquifers.

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