Controlling mechanism of thermochemical sulfate reduction

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Thermochemical sulfate reduction (TSR) is the reaction to form H_2S, which not only can critically affect the economic value of hydrocarbon gas, but is highly toxic and corrosive for production equipment. However, the exact nature and reaction mechanisms which influence the TSR are not known. In present study elemental sulfur and different sulfates are applied to investigate hydrocarbon reduction in different aqueous. Our result suggests that the nature of the aqueous is critical for TSR reactions and products. Aqueous with elemental sulfur can trigger the reaction quickly and complete the reaction within short time, but gas products dominated by H_2S and CO_2 with minor amount of hydrocarbon gas (<5%) clearly contradict those natural gases from most TSR areas. Acid salt aqueous phase formed by strong acid and weak base (Ca, Mg) seems facilitate TSR, and produces gases dominated by hydrocarbons with well situated amount of H_2S (0~25%). However, aqueous with alkali metal (Na, K) sulfate is hard to trigger TSR reaction because of the neutral pH of salt aqueous phase by strong acid and strong base. Therefore, slightly acidic medium with abundance SO_4^{2-} should be the prerequisite for initiating TSR at carbonate reservoirs. Therefore, the likelihood and intensity of TSR can be predicted on the base of concentrations of four type of anions (Cl^-, SO_4^{2-}, CO_3^{2-}, HCO_3^-) and two type of cations (alkali metal ions such as Na^+, K^+ and alkaline earth metal ions such Ca^{2+}, Mg^{2+}) in formation water. This result is compatible with our case study in the Sichuan Basin where the aqueous within TSR occurrence area contains high concentration of SO_4^{2-} ion and alkaline earth metal ions (Ca^{2+}, Mg^{2+}) with low concentration of CO_3^{2-} and HCO_3^- ions.

References

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Mantle metasomatism in the peridotite xenolith from Panshishan, Jiangsu Province, China

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Panshishan alkaline basalt is located in the joint area of Jiangsu and Anhui Provinces. It is a Cenozoic volcanic cluster (N_1^3) of Luhe-Yizheng in the SE seaboard of China. The alkaline basalt contains a lot of spinel lherzolite xenoliths. Detailed electron-microprobe study revealed that substantial mantle metasomatism taken placed, and many metasomatic mineral phases related to mantel melt/fluid occur in the intergranular spaces of primary ones.

Detailed observation revealed that the course-grained metasomatic Cr-diopsides develop between the primary olivine grains, and a primary Cr-spinel is found in it. A lot of fine-grained Cr- spinels develop in the Cr-diopside, which exsoluted from the Cr-diopside. At the joint position of the Cr-spinel and Cr-diopside a kind of silicate glasses develops, rich in Si, Al and K and poor in Fe and Mg, which are believed to be derivatives of the metasomatic process of mantle fluid. And between the Cr-diopside and the primary olivine a spong-rim develop, which consists of feldspar + silicate glasses (Fe-,Mg-rich, Si-,Al-,K-poor and volatile-rich) + olivine + apatite + Cr-spinel. It is suggested that the upper mantle rock could have been at least undergone two periods of mantle metasomatism in the area. First period of metasomatism formed the mineral assemble of feldspar + olivine + apatite + Cr-spinel + Cr-diopside, which could be related to a melt/liquid with higher viscidity; And the second period of metasomatism formed the silicate glasses rich in Fe and Mg and depleted in Si and Al, which might indicate a melt/liquid with lower viscidity. The Metasomatic phenomenon can account well for that the mantle source of the alkaline basalt had been undergone enrichment process during Neocene.

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