Polycyclic aromatic compounds in petroleum inferring secondary alteration processes in reservoir

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Abundant solid reservoir bitumen has been found in the Upper Ediacaran and Lower Cambrian carbonate reservoirs of the Anyue gas field in the central Sichuan Basin, SW China. Selected reservoir core samples were powdered and extracted thoroughly and the aromatic hydrocarbon fractions of the obtained extracted bitumen were investigated by using gas chromatography–mass spectrometry (GC-MS). The solid bitumen was believed to be formed by thermal cracking of early-charged oils in these reservoirs (Chen et al., 2017). Distributions of phenanthrenes and aromatic steroids, which are frequently used to evaluate petroleum thermal maturity at highly mature stages, are in agreement with severe maturation experienced by the host reservoirs. Organic sulfur compounds including alkylthiolanes, dibenzothiophenes (DBTs), and benzo[b]naphthathiophenes (BNTs) were identified. Previous studies have observed the alkylthiolanes in oils altered by thermochemical sulfate reduction (TSR) and proposed that they are generated by the TSR-H_2S incorporation into labile compounds which were generated under high temperatures (Cai et al., 2009). In addition, several compounds including fluoranthene (Fl), pyrene (Py), benzo[a]anthracene (BaA), chrysene (Chy), benzofluoranthenes (BFl), and benzopyrenes (BPy) are found to have enhanced concentrations in several samples. Abnormally high values of the Fl/(Fl + Py), BaA/(BaA + Chy), and BFl/(BFl + BPy) ratios are also observed. Moreover, they have parent aromatic compounds that are considerably more abundant than their alkyl homologues. These features have been attributed to abnormal heating caused by igneous intrusion and/or hydrothermal activity (Kawka and Simoneit, 1990; Huang et al., 2015). To sum it up, distributions of these aromatic compounds suggest that oils in the reservoir have been altered by secondary alteration processes including TSR and abnormal heating, leading to formation of the solid bitumen. Cai et al., 2009. Chem. Geol. 268, 197–210. Chen et al., 2017. Precambrian Res. 296, 1–19. Huang et al., 2015. Energy Fuels 29, 5578–5586. Kawka, O.E. and Simoneit, B.R.T., 1990. Appl. Geochem. 5, 17–27. This work has been supported by the National Natural Science Foundation of China (Grants No. 41702140).