

Isotopic geochemistry of hot springs in south Jiangxi Province, China

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Introduction

The study area is located in the southern part of Jiangxi Province, SE-China. 14 samples were collected from cold springs, hot springs and surface waters in the area to determine their hydrochemistry, gas components and isotopic composition of hydrogen, oxygen, carbon and helium. The origin and evolution of geothermal waters and gases are discussed.

Hydrochemistry

For the hot springs in the area, the hydrochemical type are $\text{HCO}_3\text{-Na}$, the pH values range from 6.6 to 7.5, the total dissolved solids is greater than 1.5 g/L, and silica and fluorine concentrations vary from 43 to 135 mg/L and from 1.59 to 3.6 mg/L respectively. Oxygen and hydrogen isotopic composition of hot springs in the area suggest that the geothermal waters are mainly derived from local precipitation with recharge altitude of 350-700 meters^[1].

Gas composition and isotopes

The most hot springs in the area have gas manifestations and their major gas components are CO_2 which takes from 97.7 % to 99.8 % of the total gases. The concentration of noble gas helium in the hot spring gases is from 0.0047 % to 0.0137 %.

The gas isotopes of hot springs are measured and reported in the table below.

Sample No.	$f^{13}\text{C}/\text{‰}$ (PDB)		$^3\text{He}/^4\text{He} / 10^{-6}$	R/R _a
	CH ₄	CO ₂		
2	27.69	4.96	1.90±0.06	1.36
3	34.86	4.43	2.74±0.06	1.96
9	59.31	5.50	2.95±0.06	2.11
11	45.30	5.06	2.30±0.08	1.64

Note: $R = (^3\text{He}/^4\text{He})_{\text{sample}}$, and $R_a = (^3\text{He}/^4\text{He})_{\text{air}} = 1.4 \cdot 10^{-6}$

Conclusions

The isotopic and hydrochemical compositions of hot springs in the area indicate that the geothermal waters are of meteoric origin and are formed by deep circulation of local precipitation along faults and fractures. Gas isotopic evidence shows that the carbon dioxide could come from high-temperature decomposition of carbonates at depth, and helium might originate from the mixing of meteoric and mantle source.

References

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High molecular weight polynuclear aromatic hydrocarbons as indicators for high temperature alteration of reseroired oil

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It is widely accepted that petroleum decomposition with increasing temperature due to reseroired burial in geological conditions is governed by kinetics, the thermodynamically stable end products being methane and almost pure carbon. However, processes involved in the destruction of petroleum in hot reservoirs still remain mystery. Being able to understand and predict such processes becomes economically important because it is essential for accurately evaluating the preservation of crude oils in deep petroleum accumulations.

In present study, we show an example that the thermal alteration stage of petroleum corresponds to the formation of pyrobitumen which can be identified in reservoir. The oils from this reservoir contain unusually high molecular weight polynuclear aromatic hydrocarbons (PAH) as a distinguishing characteristic compared to conventional reservoir petroleum. The major suite of high molecular weight PAHs identified in samples are nonalkylated, pericondensed (i.e., fused six-membered ring aromatic structures) PAHs. Some of them are higher molecular weights than coronene (M.W. 300) which have not been reported to occur in natural petroleum except in hydrothermal petroleum (Kvenvolden and Simoneit, 1990). These PAHs are believed to be formed by ring condensation during progressive maturation, and this was supported by the data from laboratory simulation through a close-pressurized system pyrolysis of oils under heating rate of 20°C/hr in the temperature range of 250 to 650°C. The presence of the high molecular weight PAHs in both natural petroleum system and laboratory simulation indicates that the crude oils in reservoir must be subjected to high temperature pyrosynthesis. The result suggests that high molecular weight polynuclear aromatic hydrocarbons can be acted as potential indicators for high temperature alteration of reseroired oil. It is hoped that this study will creat more opportunities for geochemical applications of these compounds in petroleum exploration, especially in determining the levels of, 1) thermal alteration stage of reservoir petroleum, 2) reliable estimates of the extent of oil cracking.

References

Kvenvolden K A and Simoneit B R T (1990), *AAPG Bulletin* 74, 223-237