WEI Jia, CHEN Youliang, CHANG Dan, HE Zhongyang and HU Xugang, 2014. Significance and Geochemical Characteristics of Trace Elements of Siliceous Rocks in the Zoige Uranium Ore Field in Sichuan Province, China. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 1395-1396.

Significance and Geochemical Characteristics of Trace Elements of Siliceous Rocks in the Zoige Uranium Ore Field in Sichuan Province, China

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1 The Introduction

The Zoige uranium ore field, located in Sichuan province, is one of the well-known carbonate-siliceous-pelitic uranium deposits in China region. With a large scale,a rich grade and intensive distribution, the uranium deposit accompanied with a variety of metal elements for comprehensive utilization, it has attracted a lot of geological workers (CHEN You-liang, 2004). The host rocks mainly consist of siliceous rocks and silicified limestone. The research on geochemical characteristics of the trace elements of siliceous rocks will contribute to elucidate the ore-forming geological environment of the uranium deposit and provide important evidences for the study of the genesis of ore deposit.

2 Samples and Experimental Method

In this paper, the samples are taken from the distributions in and outside of the uranium deposit in the Zoige uranium ore field, namely 510-3 mine, the ditch standard stratigraphic section in 510-1 mine, 512-1 mine and 511mine.

The trace elements of samples were analyzed by Beijing Research Institute of Uranium Geology Test Center by the means of DZ/T00223-2001 inductively coupled plasma mass spectrometry (ICP-MS). The instrument model is HR-ICP-MS Element Ⅰ which is produced by Finnigan company, and the relative error is less than 10%.

3 Results and Conclusion

The siliceous rocks of ore-bearing rock series in the Zoige uranium ore field and mineral or mineralized samples have similar composition of trace elements, the tendencies of their primitive mantle-normalized spider diagrams of trace elements are almost the same, explaining that metallogenic material and siliceous rocks have similar origins. According to figure 1 and figure 2, it can be seen clearly U positive anomaly and Th negative anomaly, the contents of V、Co、Cu、Zn and Ba are several times higher than Clark value of sedimentary rocks, these elements with high contents are exactly the characteristic elements of hot-water sedimentation. In particular, the average content of Ba is 249.471×10^{-6}, that is significantly higher than the average content of Ba in carbonate rocks (table 1), it is one of the important parameters in distinguishing hot-water sedimentation and siliceous rocks of other origins (JIANG Qi-gang, 1992). Meanwhile, the low ratios of Th/U and Rb/Sr also provide a further proof of deep source and hot water injection, reflecting the siliceous rocks deposited with rich mafic minerals, indicating that there was a strong expansion cracking (LI Qing, 2010). The variety scope of the ratio of Sr/Ba is between 0.024×10^{-6} and 0.408×10^{-6}, and the average value is 0.186×10^{-6}, which is less than 1, showing

Table 1 The comparison of trace elements of siliceous rocks in Zoige and carbonate rocks ($\times10^{-6}$)

The types of sedimentary rocks	V	Co	Cu	Zn	Ba
The average values of trace elements of siliceous rocks in Zoige	209.776	1.612	71.141	42.258	249.471
The average values of trace elements in carbonate rocks	20	0.1	4	20	10

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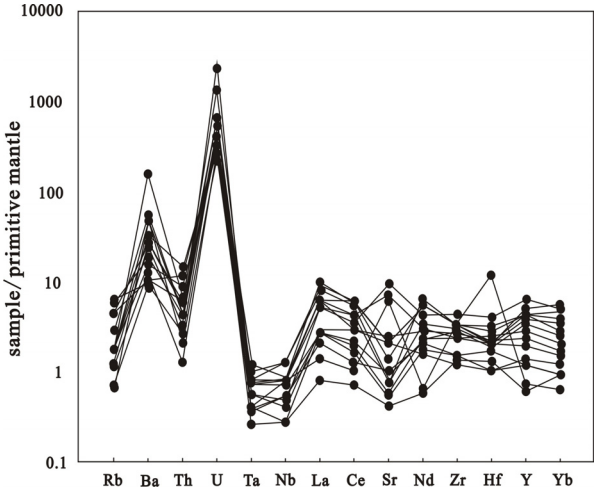

Fig.1. The primitive mantle-normalized spider diagram of trace elements in Zoige.

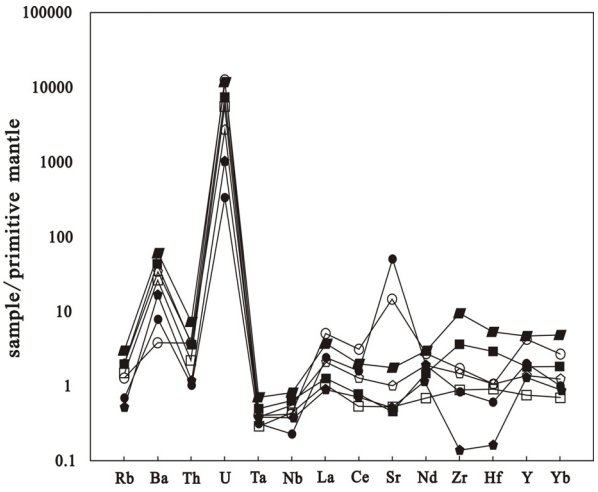

Fig.2. The primitive mantle-normalized spider diagram of trace elements of mineral or mineralization in Zoige.

the intensive hot-water deposition. Similarly, in the diagram of Cr and Zr, the 17 samples of siliceous rocks in Zoige are all in the area of modern hot-water sediments. The value of Ni ranges from 4.100×10^{-6} to 44.500×10^{-6}, the average value is 11.996×10^{-6}, the value of Cu varies from 12.200×10^{-6} to 123.000×10^{-6}, the average value is 71.141×10^{-6}, these parameters have explained the mid-ocean ridge (ocean basin) sedimentary environment (Murray R W, 1994).

The ∑REE of siliceous rocks in Zoige range from 5.230×10^{-6} to 45.472×10^{-6}, after normalizing by NASC, the average value of δCe is 0.604×10^{-6}, the average value of δEu is 1.218×10^{-6}, and the average ratio of La/Yb is 0.507×10^{-6}, these characteristic parameters exactly match the characteristic of siliceous rocks of hot-water sedimentation in typical area while they are different from the siliceous rocks of biological sedimentation.

In summary, the siliceous rocks in the Zoige uranium ore field and mineral or mineralized samples have similar composition of trace elements, the primitive mantle-normalized spider diagrams of trace elements are also similar, indicating that metallogenic material and siliceous rocks have similar origins. Microelements of V, Co, Cu, Zn and Ba with high contents and the characteristic parameters of REE of siliceous rocks also point the hot-water sedimentation, as well as the mid-ocean ridge (ocean basin) sedimentary environment.

The siliceous rocks formed by hot-water sedimentation in Zoige have high content of U and low content of Th, the average value of U is 10.960×10^{-6}, and the average value of Th is 0.530×10^{-6}, but the average ratio of Th/U is only 0.06, belonging to the sedimentation with rich uranium. Usually, the content of Th is higher than that of U in most sedimentary rocks (Th/U>1), and U has great similarities with Th in geochemical behavior, they are often exist as isomorphic impurities that will limit the activity of U. The extremely low ratio of Th/U of siliceous rocks in this area may provide an indication of the active uranium in rocks. Therefore, these parameter values are very advantageous to the uranium ore forming process, the siliceous rock series formed by hydrothermal sedimentation have established favorable material basis for uranium mineralization in later period.

Acknowledgements

This study was supported by the National Science Foundation of China Project(41072064). We are grateful to Prof. YL Chen for his constructive comments and suggestions on earlier version of this manuscript.

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