

CHENG Wenbin, GU Xuexiang, ZHANG Yu, ZHONG Kanghui and ZHANG Gangyang, 2014. Element Geochemical Characteristics of Lower Jurassic Ritang Formation from the Zhaxikang Sb-Pb-Zn-Ag Polymetallic Ore-Concentrated Area in South Tibet. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 896-897.

## Element Geochemical Characteristics of Lower Jurassic Ritang Formation from the Zhaxikang Sb-Pb-Zn-Ag Polymetallic Ore-Concentrated Area in South Tibet

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### 1 Introduction

The Lower Jurassic Ritang Formation is an important ore-hosting horizon and ore-source bed in the North Himalayan Metallogenic Belt (Li, 2010; Zhang, 2012). However, the initial enrichment mechanism of ore-forming elements (such as Sb, As and Ag) in this Formation has not been well studied. In this study, based on detailed geological investigation, the initial enrichment mechanism for ore-forming elements in the Zhaxikang ore-concentrated area is discussed through element geochemical method.

### 2 Samples and Methodology

In this study, all the samples were collected from the drill cores from the Zhaxikang ore-concentrated area. For these samples, major-oxide analyses were performed using X-ray fluorescence spectrometry (XRF). The abundance of Au and Ag were determined by Atomic Absorption Spectroscopy (AAS), and As, Sb, Hg were determined by Atomic Fluorescence Spectrometry (AFS). The abundances of rare earth elements and the other selected trace elements were analyzed by Inductively coupled plasma-mass spectrometry (ICP-MS).

Elemental values were normalised to Al in order to account for dilution effects by potential biogenic components such as carbonates, silica, and phosphorites. Concentrations are compared to the average shale values (AS) of Wedepohl (1991) and expressed as enrichments factors ( $EF_{\text{element}}$ ) relative to AS (Hu et al., 2012). Enrichment factors were calculated using:

$$EF_{\text{Element}} = (\text{element}/\text{Al})_{\text{Sample}} \div (\text{element}/\text{Al})_{\text{AS}}$$

### 3 Result

The samples from the Ritang Formation are characterized by high concentration of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$  and  $\text{TFe}_2\text{O}_3$ , while other major elements are present in low concentrations. The Al-normalised data show that most major elements are close to AS values, with the exception of Ca ( $EF_{\text{Ca}} > 1$ ) and Ti ( $EF_{\text{Ti}} < 1$ ). On the contrary,  $\text{TFe}_2\text{O}_3$  contents in various rocks were different, the FeO were higher than  $\text{Fe}_2\text{O}_3$  on content, with  $\text{Fe}^{3+}/\text{TFe}$  ratios of less than 0.5.

Trace elements show that, the enrichments factors of detrital-input-sensitive elements (i.e., Rb, Zr) are closed to AS, and that of redox-sensitive elements, such as U, Co, Cr, Ni and V, are less than 5. The productivity proxy element, Ba, is characterized by low concentration with EF values less than 1. For the ore-forming elements, Sb, As and Ag, are present in high concentrations with EFs of more than 5, but Pb and Zn are present in low concentrations relatively with EF values varying from 1 to 5.

The  $\Sigma\text{REE}$  values in the analyzed samples vary from 68.87ppm to 293.91ppm. After the REE concentration data are normalized to those of the post-Archean Australian sedimentary rocks (PAAS; McLennan, 1989), some samples show positive  $\delta\text{Eu}$  anomalies while all samples have no obvious negative  $\delta\text{Ce}$  anomaly.

### 4 Discussion and Conclusion

Geochemical results show that, common conservative lithogenic elements in various rocks from the Ritang Formation (i.e.,  $\text{SiO}_2$ ,  $\text{TFe}_2\text{O}_3$ ,  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ ) generally

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have good correlation coefficients when plotted against  $\text{Al}_2\text{O}_3$ , and the enrichment factors of  $\text{SiO}_2$ ,  $\text{MgO}$ ,  $\text{Rb}$  and  $\text{Zr}$  are close to 1 relative to AS, indicating that this “background” detrital sedimentation is relatively close to AS in bulk composition (Turgeon and Brumsack, 2006). Thus, continental input can be preclude as a major factor for the enrichment of ore-forming elements (i.e.,  $\text{Sb}$ ,  $\text{As}$  and  $\text{Ag}$ ).

For these rocks,  $\text{Fe}^{3+}/\text{TFe}$  values are less than 0.5, while the EF values of  $\text{U}$ ,  $\text{V}$ ,  $\text{Cr}$ ,  $\text{Co}$  and  $\text{Ni}$  are less than 5, and  $\delta\text{Ce}$  has no obvious negative anomaly, reflecting they were deposited under oxic-suboxic conditions close to the sediment-water interface (Tribovillard et al., 2006). Therefore, ore-forming elements cannot be concentrated by authigenous mineral under the condition of anoxic-sulfurized bottom water.

For productivity proxies  $\text{P}$  and  $\text{Ba}$ , their EF values are less than 1, indicating that these rocks were deposited under low-normal productivity condition (Tribovillard et al., 2006), and that these ore-forming elements are not the products of biological enrichment under high productivity condition.

After analyzing the enrichment features of  $\text{As}$ ,  $\text{Sb}$  and  $\text{Ag}$  elements, positive  $\text{Eu}$  anomalies existed in some rocks, as well as the geological fact of the interlayers between altered andesite and siliceous rock stratum (formed by hydrothermal sedimentation) occurred in Ritang Formation on regional scale, it's speculated that seafloor hydrothermal activity is likely to be the main reason for the enrichment of ore-forming elements in Ritang Formation of the Zhaxikang ore-concentrated area.

## Acknowledgements

This research was supported by Research Fund for the Doctoral Program of Higher Education of China (grant no. 20125122120013), National Natural Science Foundation of China (grant no. 41302066; 41372093) and Program for Innovative Research Team in Local University of Sichuan Province (13TD0008).

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