Rare earth element geochemical constraints on the genesis of the Woxi W-Sb-Au deposit, South China

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Introduction

The Proterozoic turbidite-hosted, laminated, stratiform W-Sb-Au ores of the Woxi deposit in South China have been the subject of continued debate in regard to the timing of mineralization. Early workers considered the ores to be a distal portion of magmatic systems, while later researchers have argued for a synmetamorphic replacement origin.

Mineralization at Woxi occurs predominantly (>70 %) as stratiform ore layers and subordinately as stockwork veinlets. The former consists of rhythmically interbedded, well-laminated stibnite, scheelite, quartz, pyrite and silty clays, whereas the latter occurs immediately beneath the stratiform ores and is characterized by numerous quartz + pyrite + gold + scheelite stringer veinlets subvertical to the overlying ore layers (Gu et al., 2002).

Rare earth element geochemistry is used here to demonstrate that a synsedimentary exhalative (sedex) origin is likely for the Woxi deposit.

Results and discussion

Stratiform ores, individual quartz bands and clay bands exhibit a wide range of ΣREE (4-200 ppm), Eu/Eu* (0.6-1.1), and ΣLREE/ΣHREE (3.6-14.2). However, their REE-patterns are comparable overall with the host rocks.

Fluid inclusions in banded quartz have a uniform REE-pattern, with low but variable ΣREE (3-116 ppm), LREE enrichment (ΣLREE/ΣHREE = 6-16), and insignificant Eu-anomalies (Eu/Eu* = 0.9-1.2). In contrast, fluid inclusions in stringer quartz display a marked HREE enrichment (ΣLREE/ΣHREE = 0.18). Except for no negative Eu anomaly, the general pattern for the average fluid is similar in the shape to those of the average banded ore in the deposit, the banded tourmaline-rich exhalative rocks at Sullivan, the stratiform sedimentary exhalites of the Dachang Sn-polymetallic ore deposit in Guangxi, and seawater.

Conclusions

The rare earth element geochemistry provides strong evidence for a synsedimentay exhalative model whereby the stratiform ores formed from metalliferous basinal brines episodically released along diffuse feeder zones.

References

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Thorium and protactinium sorption on silica and carbonate

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Thorium (Th-234, Th-230, and Th-228) and protactinium (Pa-231) are naturally occurring radionuclides in the U/Th decay series. Due to their particle-reactive nature, these isotopes have long been used as tracers in geochemical and oceanographic investigations, such as organic carbon export fluxes, ocean circulation, boundary scavenging, and paleoproductivity. However, the interactions of Th(IV) and Pa (IV, V) with marine particles and their scavenging pathways in the ocean are not well understood. Whether the adsorption or removal process is a non-selective or selective reaction and whether there is fractionation on Pa/Th ratio due to different particle types or chemical composition are important questions needed to be addressed for better use Th and Pa as geochemical tracers.

Radiotracers, Th-234 and Pa-233, were used in batch experiments to examine the adsorption processes of Th(IV) and Pa(IV, V) on amorphous silica and calcium carbonate in artificial seawater. Aliquots of the suspensions were filtered (0.4µm polycarbonate filter, Millipore), and Th-234 and Pa-233 activities were measured in the filter-retained particles and in the filtrate. Systematic experiments were performed to evaluate the effects of kinetic and pH on sorption processes.

The sorption kinetic of Pa-233 on silica was faster than that of Th-234, while the sorption on carbonate was faster for Th-234 than for Pa-233. While there was a fractionation of Pa/Th on silica surfaces, fractionation of Th/Pa on carbonate was much significant. In other words, Th(IV) seems preferentially sorb on carbonate surfaces and silica had higher affinity for Pa. Results on the effect of pH showed that, for the same solid phase, optimal sorption occurred at lower pH, with a sorption edge at lower pH for Th than for Pa. However, the maximum adsorption for both Th and Pa are all at pH > 7 on both silica and carbonate. These results suggest that the nature of sorbent, and adsorption time could affect the distribution of Th and Pa, whereas in the natural seawater pH range, the pH effects on Th and Pa sorption were minor.