Geochemistry and origin of black shale hosted Ni-Mo-PGE-Au mineralization in south China

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Most of the world's PGE mineralizations are mainly associated with mafic intrusions. There is, however, increasing evidence that economic levels of PGEs can be found in other environments. In this regard, the black shale-hosted PGE deposit has recently become a promising important source of PGE and many other metals in the world.

In the Yangtze Platform of South China occurs a thick sequence of metal-rich black shales of Neoproterozoic to early Cambrian age. An extreme multi-metal enriched sulfide ore bed has been identified in the lowermost strata of the Niutitang Formation in Lower Cambrian. Compared to average upper continental crust value, this multi-metal rich ore layer contains >10,000 times enrichment in Re and Os, and >1,000 times enrichment in Pt, Pd, Ag, and Au. In recent years, we have conducted a detailed geochemical and isotopic invesigation in an attempt to decipher the depositional environments, to trace the source of metals, and to establish a ore genetic model for this special type of mineralization. Our Re-Os and Pb-Pb isotope dating of the black shales and sulfide ores suggested an age of ~530 Ma for deposition of the black shales and Ni-Mo-PGE-Au mineralization. A detailed trace element study shows that both the sulfide ores and their host black shales share similar element distribution patterns with pronounced depletion in Th, Nb, Hf, Zr, Ti, and extreme enrichment in U, Ni, Mo, and V compared to average upper crust. The high field strength elements such as Zr, Hf, Nb, Ta, Sc, Th, rare earth elements, Rb and Ga show significant interelement correlations and may have been derived mainly from terrigenous sources. The redox sensitive elements such as V, Ni, Mo, U, and Mn; base metals such as Cu, Zn, Pb; Sr and Ba may have been derived from mixing of seawater and venting hydrothermal sources. The chondrite-normalized REE patterns, positive Eu and Y anomalies, and high Y/Ho ratios for the Ni-Mo-PGE-Au sulfide ores are suggestive for a submarine hydrothermal-exhalative origin. Hence, we suggest that this type of mineralization is different from the magmatic-hydrothermal or epithermal origins as proposed for some black shale hosted PGE-Au mineralization elsewhere. A modern analogue of such type deposit could be organic-rich sediments of the Bering Sea, which are known to have high PGE concentrations.

Using isotope geochemsity to trace the origin of ore forming materials in the Jiaodong gold province, China

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The Jiaodong gold province is the most important gold concentration area in China and the largest hydrothermal vein gold producing area in the world. For tracing the origin of oreforming materials in this region, we integrated and analyzed the composition of sulfer, lead and strontium isotopes in the major gold ore deposits and the host late Archean Jiaodong Group, Mesozoic Linglong biotitegranite and Guojialing porphyre granodiorite.

The value of $\delta^{34}S$ in the Jaiodong Group is 4.7‰ in average and ranges from 3‰ to10‰. This in the Mesozoic granites is 7.4‰ and 6‰-10‰, respectively. The $\delta^{34}S$ of gold ore ranges from 4.0‰ to 11.8‰, and shows a tower distribution. The value of $^{206}Pb/^{204}Pb$ in the Jiaodong Group, Linglong biotite granite and Guojialing porphyritic Granodiorite ranges from 16.111 to18.025, 17.143 to 17.288 and 16.408 to 17.851, respectively. The value of $^{207}Pb/^{204}Pb$ in the three geologic bodies varies from 15.043 to 15.762, 15.413 to 15.456 and 15.342 to 15.581, respectively. The value of $^{208}Pb/^{204}Pb$ in the three geologic bodies is 36.752-38.824, 37.625-37.855 and 36.645-38.394, respectively. The initial ratio of Sr in the Mesozoic granite, gold ore, altered rocks or minerals and fluid inclusions ranges from 0.706 to 0.711, 0.709 to 0.712, 0.703 to 0.713 and 0.710 to 0.716, respectively.

Similarity exists in isotope components among gold deposits and host rocks. This indicates that the oreforming material is the mixture between crustal and mantle. The gold deposits may be formed in the relative close environment, where had no large scale intrusions entering in continental crust.