Rare earth elements, Ir and Au from pallasite olivines

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Introduction

Pallasite consists of metal and olivine. As most pallasites are finds, they have more or less suffered contamination after their falls. Since olivine and metal are adjacent to each other, siderophile contents in olivine tend to be influenced by the neighboring metal phase. Incompatible elements like rare earth elements (REEs) in olivines are extremely low in their contents and, hence, may be increased by terrestrial contamination. Thus, initial contents of REEs and siderophile elements are hard to be accurately determined for pallasite olivines. In this study, rare earth elements (REEs), Ir and Au in olivine separates were determined by radioactive neutron activation analysis (RNAA) for four main-group pallasites (Brenham, Dora, Imilac, Esquel).

Results and discussion

Figure 1 shows CI chondrite-normalized REE abundances in pallasite olivines. V-shaped patterns were observed for HCl-leachates whereas the residual olivines show light-REEs depleted patterns. REE abundance patterns for the HCl-residue are similar to the partition coefficients of REEs in olivines but their inclination is more steeper than the partition coefficient pattern.

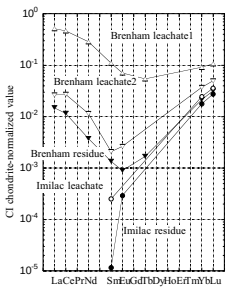

Fig. 1.
REE from pallasite olivines

Ir and Au contents (1-20 ppt and 2-25 ppt, repectively) in the least weathered pallasite olivines are lower than those in weathered olivines (Fig.2) and are assumed to primordial values when pallasite olivines formed in their parent body. These Ir and Au contents coupled with Ir and Au contents in metal are consistent with the equilibrium partitioning of Ir and Au between liquid metal (core) and silicate mantle. Our results of REEs and siderophile elements (Ir and Au) suggest a cumulative origin of pallasite olivines.

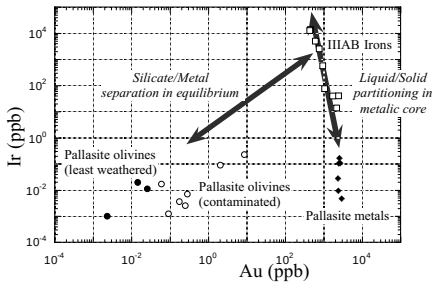

Fig.2 Ir vs. Au diagram for pallasite olivines and metals

Experimental study of gold, silver and water behaviour in endogenic processes at high temperature and pressure

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Water and gold behaviour at interaction of water-bearing melts of main and acid compositions with crystalline phases (T=900-1200°C and P=1 kbar) and fluid - solid phase (T=200-500°C and P=1 kbar) has been studied by use of hydrogen (^{3}H) and gold (^{195}Au) radioisotope autoradiography. Gold and silver (^{110}Ag) behaviour at leaching volcanites of main to acid compositions by hyrothermal solutions (T=200-500°C and P=200-1000 bar) has been investigated as well. A similiarity in behaviour of water and gold has been revealed that is expressed by their higher contents on contact of the melt and solid phase, and their enrichment in hybrid formations when mixing the melts of main and acid compositions. A dependence of metal leaching on composition of silicate vein-stuff, P-T conditions and O_2 regime has been found.

The effect of water (fluid) concentration at the boundary of water-bearing basalt melt and plagioclase crystals as well as acid melt with host rocks has been established due to the use of tritium ß-radiography in the T-water experiments. The effect results from water (fluid) influx to the front of melting (from melt) and can be employed in explaining the mechanism of magma replacement.

Higher contents of water as well as gold, iron and alkalis are also determined in the zone of water-bearing acid granite and basalt melt mixture. The effect of gold enrichment in the melt of mixed composition is elucidated by an increasing role of depolymerization factors in the mixed zone, particularly, such as H_2O and FeO due to their high activity in comparison with other elements-modificators.

The experimental data obtained allow to explain close association of gold deposits with magmatic rocks that underwent complex interaction of basalt and granite magmas or their contamination by wall rocks. Thus, “andesite maximum” is revealed both for water and gold and it mostly causes the peculiarities of gold geochemistry during magmatic and hydrothermal processes.

The experiments on hydrothermal water-rock interaction show that metal leaching occurs from volcanites with the clark amounts of gold and silver (195 Au and 110 Ag). Rate and extent of leaching depend on T, P and P_{O2}. In favourable conditions, up to 50% Au and about 100% Ag of the initial contents in rock can be leached. The rocks that contain these metals at clark level can be source of ore matter for gold and silver hydrothermal deposits.

The work has been carried out with financial support of Russian Foundation for Basic Research (grant 98-05-65110).