

Formation of acid volcanic brines through interaction of magmatic gases, seawater and rock within the White Island volcanic-hydrothermal system, New Zealand

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A series of acid volcanic brines were collected at White Island, New Zealand, largely during the period 1974-1977, when the acid brine discharge rate was high. The chemical and isotopic composition of these brines were quantitatively compared with the composition of fumarolic gases, seawater, volcanic rocks and altered rocks in order to determine their origins. The compositions of rock-forming elements in the acid brines are similar with those in the volcanic rocks, supporting the idea of the source rock isochemical dissolution. Detailed examination of the compositions of brines and rocks, however, revealed that there are also some deviations from the composition formed by the isochemical dissolution such as enrichment in Na and depletion in Al, K, Ca and Cu. Since there is no other Na-sources, the enrichment in Na is most likely indicate incorporation of seawater, whereas depletion in Al, K, Ca and Cu is accounted for the formation of altered rocks containing alunite, anhydrite and pyrite, as the results of rock leaching with the acid brines. Manganese and Mg are quantitatively leached from the source rock. Magmatic gas is the major source of B, NH₃, Cl and S in the brines; B and NH₃ are quantitatively transferred from the gases to the brine whereas the magmatic HCl and S are partially absorbed in the brines partially lost with the gas passing through the hydrothermal system. The δD and $\delta^{18}O$ values of acid brines and fumarolic condensates are consistent with the formation of the volcanic-hydrothermal system mainly by seawater-magmatic water mixing. Significant amount of meteoric water is likely incorporated into the brine formation process, but this cannot be quantitatively evaluated because δD and $\delta^{18}O$ compositions of the meteoric water are poorly constrained and close to that of seawater. The detailed examination of the brine compositions resulted in the change of the old themes; 1) incursion of seawater into the White Island hydrothermal system, and 2) non-isochemical dissolution of the source volcanic rocks.

Development of analytical method to study the behavior of platinum group elements in oceanic island basalts

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Platinum group elements (PGEs) in mantle derived rocks have been used as the powerful tracers for discussing core-mantle interaction and genesis of sulfide ore deposits. The behavior of PGEs during magma formation and differentiation processes have been mainly investigated in komatiites which contain an appreciable amounts of PGEs. On the other hand, PGE abundances in basaltic samples have been reported rarely because the concentration of PGEs is extremely low and basaltic melts showing low degree of partial melting are generally considered to be sulfide-saturated. Because of the highly compatible behavior of all PGEs during the differentiation of sulfide saturated melts, the PGE abundances in the original source melt or mantle cannot be readily estimated.

Tatsumi et al. (1999, 2000) compared PGE abundances in the several oceanic island basalts (OIBs). They observed the strong decrease of PGE abundances with the decrease of MgO contents in Mangaia basalts (HIMU) while the opposite trend in Rarotonga ones (EM1). On the other hand, Hawaiian basalts showed almost constant PGE trends in this diagram. Hence, it was suggested that Mangaia melt was sulfide-saturated while Rarotonga was not and PGEs in the Hawaiian basalts were weakly affected by sulfide segregation. To demonstrate the various behaviors of PGEs among OIBs and provide consistent explanation for their systematics, we are developing precise and simple analytical method for trace PGEs in basalt samples.

We first examined double NiS fire assay followed by Te coprecipitation described in Oguri et al (1999) using two geological reference rocks (JP-1, peridotite, GSJ and BHVO-2, Hawaiian basalt, USGS). In three replicate analyses of JP-1, more than 90 % of analytical reproducibilities were obtained except for Au. In contrast, BHVO-2 yielded insufficient precision for Rh, Pd and Au (>10 %) due to large correction of spectral interferences (>30 % on ¹⁰³Rh and ¹⁰⁵Pd) and significant contribution of blank (~10 % for Ru, Pd and Ir; ~100 % for Au) may cause the uncertainties of the results. We concluded that the method was applicable only for the analyses of the samples with relatively higher PGE contents. Therefore, NiS fire assay with isotope dilution (ID) analysis is examined as the next step. Since complete chemical recovery is unnecessary in ID analysis, we can reduce the total amounts of chemical reagents and apply further chemical separation. The chemical separation of Ni, Cu, Zr, Mo, W and Ta has been examined, which may interfere the isotopic analysis of PGEs in quadrupole ICP-MS.