Geochemical features of the Hishikari epithermal gold deposit based on simultaneous multi-element analysis

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The Hishikari gold deposit, located in the northern part of Kagoshima prefecture, Japan, is known as one of the highest-grade gold deposits in the world. The origin of this low-sulfidation vein-type deposit has been extensively investigated since its discovery in the early 1980s. For example, Ishihara et al. (1986) suggested a magmatic source for gold (Au) and sulfur (S) based on sulfur isotope compositions of pyrites [1]. More recently, Morishita et al. (2018) demonstrated a positive correlation between Au and arsenic (As) in pyrites of the Hishikari veins and discussed their genetic relationship [2].

Understanding the mineralization process of the Hishikari deposit can provide key insights into an exploration strategy for new and high-grade gold deposits. To this end, identifying elements that show behaviors closely associated with Au can be one of the effective approaches. In this study, therefore, major and trace element geochemistry of the Hishikari ore samples have been investigated in order to obtain a new constraint on the Au mineralization processes. We determined multi-elemental composition (including Au) of the host rocks and vein samples by inductively coupled plasma mass spectrometry (ICP-MS).

Previous studies suggested that adularia content is closely related to the Au content of the ore [3]. In the present study, however, we found no correlation between Au and adularia contents in the vein samples. The results of X-ray diffraction (XRD) analysis indicated that the samples with high Au mostly consist of quartz. The Au mineralization thus seems to have occurred concurrently with the quartz mineralization that followed the adularia mineralization.

Among the 49 elements measured in this study, silver (Ag) content was positively correlated with Au content, which is consistent with the fact that electrum is the main host of Au in the Hishikari deposit. Arsenic (As) content had no correlation with Au, although it is well known for a coupling behavior with Au. Most notably, bismuth (Bi) content had clear correlation with Ag ($r = 0.88$) and Au ($r = 0.91$) contents, whereas it had no clear correlation with cobalt (Co), copper (Cu), iron (Fe), zinc (Zn), lead (Pb), or As contents. Bi is known to be enriched in high-sulfidation gold deposits where the common host of Bi is sulfide minerals (e.g. [4]), and closely associated with Au in these deposits. However, elemental behavior of Bi in low-sulfidation gold deposits has so far been poorly understood. Our results imply that Bi in the Hishikari deposit is likely to be involved not in sulfide but in electrum. This in turn suggests that Bi could be an important tracer for Au mineralization in low-sulfidation deposits such as the Hishikari deposit.

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