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The Application of Microchemical Analysis of Alluvial Gold Grains to the Understanding of Complex Local and Regional Gold Mineralization: A Case Study in the Irish and Scottish Caledonides

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Abstract

Terranes of the Appalachian-Caledonian orogen north of the Iapetus suture host gold mineralization in North America, Scotland, and Ireland. To date, commercial exploitation has been confined to the Appalachian terrane of Canada. In Scotland and Ireland, regional analysis of the types of gold mineralization has been handicapped by the relatively small number of bedrock gold occurrences available for study. However, there are a large number of alluvial gold localities. A technique of microchemical characterization of gold grains has been applied to facilitate the classification of alluvial gold localities in terms of the style or styles of source mineralization, thereby permitting a more complete interpretation of regional gold mineralization.

The technique of microchemical characterization used in this study classifies populations of gold grains from each locality in terms of the assemblage of opaque mineral inclusions enclosed within the gold grains and the concentration of minor alloying elements in the gold. A total of 2,400 gold grains collected from 44 sites in Ireland and Scotland have been studied. The microchemical signatures of populations of gold grains extracted from bedrock samples correlate closely with those from adjacent alluvial populations, and furthermore, our data are compatible with the descriptions of the vein mineralogy of bedrock mineralization reported by other workers. This result has facilitated informed speculation on the type of source mineralization of other alluvial occurrences where the bedrock source remains undiscovered.

Populations of alluvial gold from individual localities have been grouped into larger regional data sets on the basis of similarities in microchemical signature. The signatures of these data sets were analyzed using the same criteria, and 10 classes of gold were identified. Regional analysis of the distribution of the gold classes showed that the occurrence of the four major classes correlates strongly with host terrane, irrespective of geographical location. Gold from the Southern Uplands terrane is characterized by inclusions of base metal sulfides and sulfarsenides, with the silver content of the gold being less than 15 percent. In contrast, populations of alluvial gold from the Grampian and Highland terranes commonly exhibit median silver contents of over 20 percent and frequently contain silver telluride and bismuth telluride inclusions, which are extremely rare in gold from the Southern Uplands terrane. However, in other cases, the style of mineralization is controlled

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by specific host or source rocks and is independent of the terrane. Two examples are gold mineralization within porphyry systems and gold associated with red-bed sediments.

The study has confirmed the value of the technique of gold grain characterization, using information from both concentrations of alloying elements and inclusion assemblages as a powerful tool in interpreting complex local and regional gold mineralization.