Gold mineralisation associated with low temperature basinal brines in Connemara, western Ireland

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ABSTRACT: Fluids inclusion studies suggest that the gold mineralisation occurring in a silica-rich fault zone in Silurian rocks at Bohaun in Connemara, western Ireland is associated with low temperature, moderate–high salinity fluids more consistent with a basinal brine than an orogenic gold lineage. This contrasts with other gold deposits in western Ireland that are typically orogenic in mineralisation style. Remobilisation of pre-existing gold mineralisation by low-temperature, high-salinity brines is recognized in a number of gold deposits worldwide. However, at Bohaun there is no evidence for earlier mineralisation suggesting that low-temperature fluids can transport gold and potentially form gold deposits independent of other fluids.
KEYWORDS: gold, Connemara, Ireland, fluid inclusions

1 INTRODUCTION

Significant shear-hosted vein gold deposits are known from western Ireland including the occurrences at Lecanvey and Cregganbaun in Co. Mayo (Figure 1). The principal controls on mineralisation are major crustal structures and the style of mineralisation is typical of orogenic gold deposits (Aherne et al. 1992; Wilkinson and Johnston 1996). Additional gold occurrences are recorded from the Silurian and Dalradian rocks of eastern Connemara. This paper describes the Bohaun gold mineralisation in eastern Connemara and discusses the nature and origin of possible fluid sources.

The Bohaun mineralisation was discovered in the late 1980s during a commercial regional geochemical sampling programme. The mineralisation is located on Bohaun mountain, south of the western end of Lough Kilbride, in Co. Galway (Figure 1). Elevated gold values were identified in rocks associated with a north–south trending brecciated and silicified zone hosted within Silurian rocks. Limited exploration was carried out, including the drilling of three shallow boreholes. Drilling intersected quartz-silica breccia containing limonite, chlorite, calcite, pyrite, chalcopyrite and visible gold to a minimum depth of 45 m (Ovoca Gold Exploration plc, unpublished data 1990).

2 GEOLOGICAL SETTING

The South Mayo Trough represents an arc-continent collision zone (Draut et al. 2002) consisting of a thick succession of Ordovician volcanic and sedimentary rocks (Clift & Ryan 1994) (Figure 1). Silurian sediments of the Croagh Patrick Succession unconformably overlie the Ordovician sequence to the north (Aherne et al. 1992). To the south Silurian strata extend inland east-south-east from south of Killary Harbour to the area around Lough Kilbride, before disappearing under the Carboniferous rocks of Lough Mask (Graham et al. 1989). The Killary Harbour-Joyces Country Succession rests unconformably on the Dalradian to the south and Ordovician rocks of the South Mayo Trough to the north (Morris et al. 1995). The main deformation in the South Mayo Trough occurred during the late Silurian to early Devonian. Folding was accompanied by large-scale thrusting in the area immediately south of Clew Bay, with other thrusts developed within the Silurian succession to the south (Aherne et al. 1992).

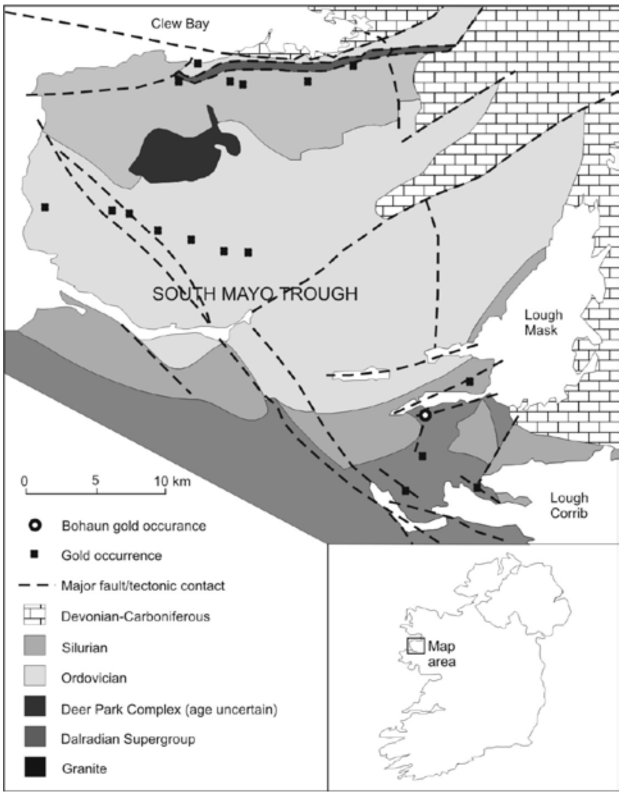

Figure 1. Location of Bohaun and other gold occurrences in relation to the regional geology of South Mayo and Connemara (adapted from Aherne et al. 1992).

3 LOCAL GEOLOGY

The Bohaun mineralisation is hosted by Silurian sediments of the Killary Harbour-Joyces Country Succession of Llandovery to Wenlock age. These unconformably overlie the Ben Levy Formation of possible Dalradian age. The mineralised area consists of a 1.5 km long north-south trending silicified fault zone. The Silurian succession, comprising sandstones and shales, is folded into a synform which has been subsequently faulted.

4 MINERALISATION AND ALTERATION

The mineralisation consists of a series of anastomosing quartz veins cementing a major fault zone. A central area of intense silicification, in which discrete veins are hard to define, passes outwards into a stockwork of varying intensity. Mineralisation has exploited the fault zone but is not confined to the main fracture. The veins display little deformation and there is no brecciation of pre-existing quartz suggesting mineralisation post-dates fault development.

Quartz dominates all the veins and commonly displays multiple growth stages as resolved by cathodoluminescene and a variety of textures. Saccharoidal quartz is most common and gold enrichment is preferentially associated with this textural variant. Crustiform and comb textures, weakly developed colloform banding, vuggy quartz and euhedral, acicular crystals within open fractures are locally common. Fresh sulphides are extremely rare in outcrop, although significant remnant sulphide occurs in the quartz. Visible gold is observed in white to grey saccharoidal quartz which shows an intimate association with hematitic staining and/or a green-grey chloritic clay material. Rare occurrences of late-stage, well-developed dolomite and barite are found within vugs and cavities in the quartz. On an outcrop scale, visible gold shows a close association with bleached wall-rock suggesting this may be significant.

4.1 *Ore petrography*

A strong association is observed between gold and relatively late sericite veinlets both cutting the banded quartz and orientated subparallel to the quartz banding. Gold grains within these veinlets are relatively large, up to 890 μm. These late-stage veinlets are not the only gold repository; smaller gold grains up to 15 μm occur independently of discreet sericite veinlets surrounded by fine-grained, anhedral quartz with interstitial sericite. Specular hematite and/or hematitic quartz is closely associated with the gold, either occurring in zones roughly parallel to the edge of sericite veinlets or forming halos around isolated gold grains. Fine-grained chalcopyrite is associated with the specular hematite.

4.2 *Gold grain chemistry*

Electron microprobe analysis indicates that both Ag-rich and Ag-poor gold occur adjacent to one another in grains of similar morphology. Ag values vary from 16 to 21 wt. % and 39 to 42 wt. % defining a bimodal distribution. No systematic pattern in Ag variations is evident within the gold grains. However, some grains show a zonation from a relatively Ag-rich rim to Ag-poor core suggesting some form of Ag enrichment has variably affected the gold.

4.3 *Geochemistry*

Recent geochemical sampling by Alba Mineral Resources returned gold values up to 587 ppm in mineralised float samples (Alba Mineral Resources, Regulatory News Service 14th Feb. 2006). Reconnaissance sampling undertaken along the silicified zone at intervals identified elevated gold values throughout the strike length of the structure. Assays from the area returned a number of high-grade gold values including 51.1 ppm and 19.9 ppm Au, with associated silver values of 10.9 ppm and 1.4 ppm Ag respectively (Alba Mineral Resources, Regulatory News Service 14th Feb. 2006). Ag is the only element that correlates with Au, consistent with the presence of electrum.

5 FLUID INCLUSION STUDY

Preliminary fluid inclusion data (Figure 2) from gold-bearing samples indicate two distinct fluids. Fluid I is sodic with mass % NaCl equiv. ranging from 0.8 to 4.9. Fluid II is calcic (first melting temperatures in the region of –50ºC) and has distinctly higher salinities (10.0–20.3 mass % NaCl equiv.) with NaCl/(NaCl + $CaCl_2$) mass ratios between 0.74 and 0.90. Homogenisation temperatures of both fluids are in the range of 141 to 180ºC. No evidence for the presence of carbon dioxide was recorded in any sample.

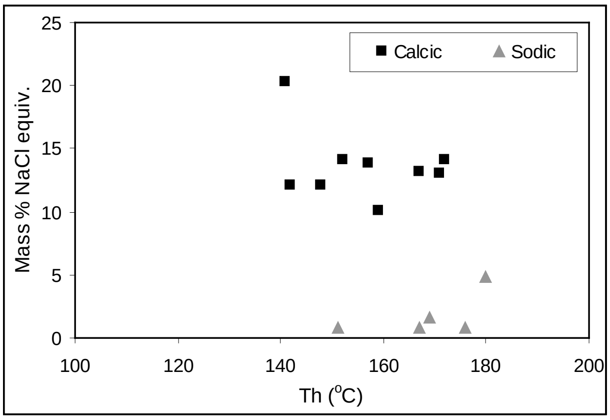

Figure 2. Homogenisation temperature against salinity, illustrating the two separate fluids.

6 DISCUSSION

The fluids at Bohaun are atypical for orogenic gold (e.g. Groves et al. 2003) and volcanogenic epithermal-style mineralisation (Cooke & Simmons, 2000). The lack of deformation and quartz textures suggestive of open space growth are more characteristic of epithermal environments. In the British Isles, calcic brines are a widely recognised fluid type associated with Carboniferous and later Pb–Zn mineralisation (Wilkinson et al. 1995; Gleeson et al. 1999; O'Reilly et al. 1997). Late-stage, low-temperature, high-salinity fluids are reported from orogenic gold deposits worldwide (Guha and Kanwar 1987). Indeed, it is recognised that late-stage NaCl-$CaCl_2$ fluids are responsible for remobilising orogenic-style gold mineralisation at Curraghinalt in Northern Ireland (Wilkinson et al. 1999). These late-stage fluids show some similarities to those identified at Bohaun. It has not been possible at Curraghinalt to determine whether the late-stage fluid introduced additional gold or just remobilised pre-existing mineralisation (Wilkinson et al. 1999). There is no evidence at Bohaun for pre-existing mineralisation from which gold could have been remobilised.

However, it is interesting to note that the fluids identified at Bohaun are similar in terms of their microthermometric data, to those found in red-bed style Au-Pd mineralisation at a number of localities throughout Europe (Shepherd et al. 2005). Although there is an association of gold with hematite at Bohaun, the corresponding Pd and Se mineral assemblages noted by Shepherd et al. 2005 are absent.

A number of fluid sources can be envisaged. The underlying Dalradian is a possible source of basement brines. The Carboniferous Midlands Basin to the east could potentially yield low-T_h, high salinity fluids containing sulphate, consistent with the mineralogy at Bohaun.

7 CONCLUSIONS

The origin of the gold at Bohaun remains enigmatic. However, links to low-temperature basinal brines similar to those seen in red-bed

Au-Pd mineralisation or base metal deposits seem stronger than an orogenic gold lineage. Bohaun also provides further evidence that low-temperature brines can transport gold and potentially form gold deposits independent of other fluids.

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