ALTERATION AND GOLD MINERALIZATION, HOG MOUNTAIN PLUTON, NORTHERN ALABAMA PIEDMONT

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ABSTRACT

The Hog Mountain pluton is a syn-kinematic tonalite sill that intrudes metasediments of the Wedowee Group in the Tallapoosa block of the Northern Alabama Piedmont. It is transgressed by a series of bifurcating, barren white quartz veins (type I), auriferous grey quartz-sulfide veins (type II), and associated alteration zones. Multiple generations of type I veins are present in the metasedimentary country rocks, but type II veins appear to be restricted to the intrusion, oriented en echelon, oblique to the long axis of the intrusion and to the foliation in the country rocks. They were emplaced into tensional zones in the tonalite during regional metamorphism and the second of several stages of regional deformation. Gold is invisible in unweathered veins and is associated exclusively with sulfides.

Least-altered tonalites are characterized by abundant quartz, oscillatory-normal zoned plagioclase, and biotite; minor muscovite, corroded garnet, and ilmenite; and accessory apatite, zircon, pyrrhotite, and chalcopyrite. Plagioclase is incipiently altered to sericite ± clinozoisite, and biotite is intergrown with chlorite ± muscovite. K-feldspar is rare; hornblende is absent. With increasing degrees of alteration, plagioclase is altered to albite ± clinozoisite and ultimately replaced by muscovite + quartz, biotite becomes more magnesian and is ultimately replaced by sericite + pyrrhotite, and ilmenite is replaced by rutile/sphene + pyrrhotite. Altered tonalites are strongly enriched in Au, S, K, Rb, Ba, Fe, Co, and W (up to 26 ppm); and strongly depleted in Na, Ca, Sr, Mn, Zn, and Eu. Some altered rocks are slightly enriched in trivalent rare-earth elements and other immobile, high field-strength elements (e.g. Y, Zr, U, Th, Hf, and Ta) relative to least-altered tonalites, suggesting volume losses up to 10 percent during shearing and alteration.

Plagioclase-muscovite geothermometry of alteration zones indicates mineralization temperatures of 315-340°C at an estimated 4-6 kb. Stable isotopic data for strongly altered granitoids range +9.6 to +10.5 per mil δ34S (CDT), -75 to -50 per mil δD (SMOW), and +9.8 to +11.4 per mil δ18O (SMOW), compared to least-altered granitoids which range +10.2 to +11.3 per mil δ34S (CDT), -82 to -78 per mil δD (SMOW), and +9.7 to +11.2 per mil δ18O (SMOW). Based on experimentally-determined quartz-water and muscovite-water isotopic fractionation, and the above temperature estimate, the isotopic composition of the fluid is calculated at -10 to -25 per mil δD and +3.6 to +4.9 per mil δ18O.

Gold is interpreted to have been transported as a bisulfide complex in a metamorphically-derived hydrothermal fluid and to have precipitated in response to a decrease in pH and a decrease in S activity through fluid-wall rock interaction.

INTRODUCTION

Gold was first discovered in the Northern Alabama Piedmont in 1830. For two decades, more than 20,000 people participated in intensive prospecting for the precious metal. Mining activity declined rapidly after the discovery of gold at Sutter's Mill in 1849 resulted in a mass exodus of miners from eastern Alabama to the California gold fields. Reactivation of the Alabama gold-mining districts was attempted between 1874 and 1880, 1888 and 1916, and 1929 and 1936 (Simpson and Neathery, 1980), but there has been little activity since.

The distribution of gold deposits in the Northern Alabama Piedmont has been reviewed by Adams (1930), Pardee and Park (1948), Spaine (1969), Gustavson and Neathery (1976), and Simpson and Neathery (1980). Three principal types of gold deposits have been identified: alluvial placers, eluvial deposits, and lodes. The first two are formed from the latter by weathering processes. Gold has been mined from nine major districts (Figure 1): the Arbacochee (1) and Chulafinee (2) districts along the Hollins Line fault; the Idaho district (5) in the Coosa Block; the Cragford (6) and