CHANGES IN GOLD COMPOSITION AND GOLD-ASSOCIATED MINERALOGY WITH TIME AND TEMPERATURE AT THE FORT KNOX GOLD DEPOSIT, ALASKA

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The Fort Knox gold deposit, located 30 km NNE of Fairbanks, will ultimately produce more than 5 million ounces of gold. Nevertheless, little is known concerning the composition and mineralogical associations of the gold. This is largely due to the extremely low Au grade (typically about 750 parts per billion) and small size (typically less than 100 microns) of the gold. Consequently, most polished thin sections of ore contain no visible gold. To get around this problem, we examined gold grains sampled from the gravity concentrate at Fork Knox combined with a small number of very high grade veins via reflected light and electron microprobe analyses.

The earliest deposition of gold at Fort Knox is associated with feldspar-rich quartz veins. In the gravity concentrate such gold is recognized by rare intergrown feldspar grains. This gold is of two types: extremely fine-grained, myrmekitic intergrowths of Bi^o and Au^o that likely formed by unmixing of Maldonite (Au_2Bi) and rare grains of Maldonite. Both types are commonly surrounded by or associated with grains of Bi^o. The myrmekitic gold is essentially pure, with fineness (1000x Au/(Au+Ag)) of 995-999, and distinctively bright yellow. Although Maldonite is unstable below ~100°C and should unmix, the intergrowths present are far too coarse to represent unmixing at 100C. We do not know why most Maldonite has experienced unmixing and some hasn't.

Myrmekitic Au^o-Bi^o grains occur in the gravity concentrates both as isolated grains and as composites with Bi^o (most commonly) or composites with lower-fineness gold. In the latter cases the fineness of the surrounding gold is typically zoned, with finess as high as 980 adjacent to the myrmekitic intergrowths and as low as 870 30-50 microns away. Such grains show visible changes in color from the bright yellow of nearly pure gold to more subdued pale yellow of silver-bearing gold. Gold grains that are not associated with Au-Bi myrmekite, do not, in general, display compositional zoning but are invariably associated with Bi-S $\pm$ Te minerals and rarely with molybdenite (MoS_2). Dozen of Bi-Te-S minerals are known; so far we have identified mostly non-stoichiometric minerals with compositions of Bi(Te,S), $Bi_3(Te,S)_2$, $Bi(S,Te)_2$, and $Bi_8(S,Te)_5$. These probably correspond to ingodite, tetradymite (high and low S versions), and joseite. Where gold is rimmed or otherwise associated with Bi+BiTeS, the fineness is 960-980. In contrast, where gold is rimmed or otherwise associated with Bismuthenite (Bi_2S_3), the fineness varies from 960 to 870. Rare calcite associated with Bi_2S_3 indicates that this and low fineness gold were at relatively low temperature.

These mineralogical variations suggest that gold—initially deposited as Au_2Bi—was remobilized at successively lower temperatures and higher f_{S2} to gradually produce 'gold' with high silver contents and Bi_2S_3. Although the Au and Bi change mineralogical forms over time, they stay associated. This explains the very strong Bi-Au assay correlations seen at Fort Knox (average ~ 20:1) and the weaker Au-Te and Au-Mo correlations.