The Spatial and Temporal Significance of Alteration Associated with Gold-Bearing Structures in the Greater Revenge Area, St. Ives, Western Australia

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A significant effort has been made to document and interpret patterns of alteration within orogenic gold systems. Many previous studies have only considered the spatial context of various alteration assemblages and not how they may be temporally related to an evolving host structural environment. This approach implicitly assumes that all significant observed alteration in the volume surrounding the deposit formed coeval with one major gold mineralization event. A failure to integrate the spatial distribution of alteration with the structural evolution can result in misinterpretation of the data because structures that host gold deposits are commonly multiply reactivated over their history. For example, the presence of two contrasting alteration assemblages may be incorrectly identified as evidence of fluid mixing rather than two separate overprinting events.

This study focused on the Revenge deposit of the St. Ives gold camp in Western Australia, with the specific goal of documenting the temporal evolution of the observed alteration assemblages and their relationship to the evolving structural framework. Importantly, this study focused only on alteration hosted by a single lithological unit, the Devon Consols Basalt, to control for any effects of lithological variability on alteration assemblages. The work completed included paragenetic mapping, lithogeochemistry, and hyperspectral analysis. The spatial distribution of internal lithological variations within the Devon Consols Basalt and each observed alteration assemblage were systematically mapped out. This work used previous structural interpretations of the area to provide context and a link to previous research.

In total, five key alteration minerals have been identified surrounding the major mineralized structures in the study area: epidote, chlorite, biotite, albite, and roscoelite. Epidote, biotite, and roscoelite overprint all previous stages of alteration. Chlorite and albite assemblages are observed to be coeval with epidote and biotite, respectively. Pyrite is present in all assemblages except epidote. All five key alteration minerals occurred during the D_4 main gold event.

Documentation of the alteration paragenesis related to mineralization indicates three distinct phases of gold mineralization. The first phase overprints early pre-ore alteration, is associated with low-grade gold along a WNW-trending Transfer fault zone, and is interpreted to be syn-D_3 late basin formation. The second phase comprises albite alteration and is associated with the main mineralizing event (D_4). The third and final stage is a late pervasive bleaching or vein event that overprints all previous alteration during D_5 late brittle faulting. During each phase, hematite alteration was present, indicating that three distinct hematite alteration events are related to gold mineralization.

We conclude that the observed alteration assemblages represent a sequence of separate alteration events rather than the products of the mixing of two or more fluids in a single event, as previously proposed. Deposit-scale targeting concepts based on the latter hypothesis therefore need to be revised. Furthermore, this study shows that using alteration patterns to target within an ore environment critically requires a detailed understanding of structural evolution and related alteration history.