

Ad Duwayhi, Saudi Arabia: Geology and Geochronology of a Neoproterozoic Intrusion-Related Gold System in the Arabian Shield

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Abstract

The Ad Duwayhi gold deposit, located in the east-central part of the Arabian shield, is the newest gold discovery in Saudi Arabia. Exploration to date has identified a gold resource of greater than 1 million ounces (oz) with significant potential for expansion. Gold mineralization was closely associated, in time and space, with emplacement of a late- to postorogenic, intracrustal, northwest-oriented granite body (659 ± 7 Ma) and comagmatic square quartz porphyry (646 ± 11 Ma), a hypabyssal and perhaps younger phase of the granite.

Mineralization was largely confined to northeast-striking, southeast-dipping fault zones. Hydrothermal alteration consisted of early biotitic alteration overprinted by sericitic alteration. Sericitic alteration was coincident with gold mineralization and produced a quartz-sericite-carbonate-pyrite-rutile mineral assemblage, found both as vein fill and wall-rock alteration products. Mineralization styles, in the following general paragenetic sequence, include (1) quartz-molybdenite veins in and near the granite stock, (2) low-grade gold-bearing quartz vein breccia in and along the margins of the granite stock, (3) gold-bearing stockwork and sheeted quartz veins, and (4) massive to banded gold-rich tabular quartz veins. The gold-bearing stockwork, sheeted, and tabular veins are generally spatially associated with square quartz porphyry dikes and more distal to the granite stock. Mineralized zones at Ad Duwayhi are characterized by low sulfide and base metal content and gold/silver ratios of approximately 6/1. Gold shows no significant correlation with other metals, except lead, and moderate correlation with silver.

Re-Os dating of molybdenite from a quartz-molybdenite vein and a tabular quartz vein with cogenetic gold produced robust ages of 655.6 ± 2.7 and 649.9 ± 2.3 Ma, respectively, documenting that gold mineralization and crystallization of granite and square quartz porphyry were, within uncertainty, coeval events. This age correlation combined with granite textural features, the presence of unidirectional solidification textures in granite and square quartz porphyry, and the nature and time-space distribution of mineralization styles, all indicate that mineralization evolved in and near the interface between a crystallizing magma and the surrounding rocks and, thus, is consistent with an intrusion-related genesis.

In light of our findings at Ad Duwayhi, a reassessment of similar intrusion-hosted deposits in the Arabian shield is warranted, and areas of late- to postorogenic plutonism, particularly in the Afif composite terrane, should be considered prospective for intrusion-related gold systems.

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