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Deposit-scale controls of hypozonal gold mineralization in amphibolite facies metaturbidites: 3D modelling of the Twin Hills deposit, Damara Belt, Namibia

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ABSTRACT

The recently discovered Twin Hills deposit is a new resource in the Pan-African Damara Belt of central Namibia, described by a finely dispersed, low-grade and high tonnage disseminated and vein-style gold mineralization. The underlying assumption of the 3D implicit modelling followed in this study is that the integration of gold grades and ore shells with structural and lithological data from oriented core logging reflects the underlying controls of hydrothermal fluid flow and mineralization at Twin Hills. The deposit comprises distinct clusters of economic-grade gold mineralization, measuring several hundred meters along strike, separated by several kilometer-long intervals of only sporadic and sub-economic gold grades. Mineralization is developed on the subvertical southern limb of a regional-scale syncline hosted in highly-strained compositionally heterogeneous, amphibolite facies metaturbidites. Additionally, the stretch of the main mineralization in the central parts of the ~12 km long east-northeast-trending mineralized Twin Hills corridor coincides with the change of the fold vergence direction. We suggest that the steep orientation of the wall-rock strata generated high-permeability fluid conduits for focusing regional fluid flow during flexural-slip folding and associated local dextral strike-slip component of $D_{2/3}$ deformation. Disseminated sulfide mineralization is mostly developed in pelitic units, whereas networks of quartz-sulfide veins and veinlets with subordinate disseminated sulfides are present in rigid psammitic beds in interbedded pelite-psammite horizons. While the wide distribution of finely disseminated sulfides point to the rather pervasive fluid flow along grain-scale permeabilities during recrystallization of mineral fabrics, the formation of fractures and resultant dilatancy in psammitic units created hydraulic gradients and focused fluid flow into the psammite horizons. High-grade ore shoots are controlled by the combination and interplay of two main factors, namely lithological contacts and subtle deflections of bedding of the highly-strained, subvertical metaturbidites. The mineralized corridor of the Twin Hills deposit is largely confined to imbricated and/or tightly folded packages of interbedded pelites-psammites within the otherwise pelite-dominated sequence. It is these units that promoted fracturing, fluid flow and the development of fine-scale vein networks as a result of pronounced strain partitioning between pelitic units (ductile) and interbedded psammites (brittle) during regional deformation. Ore shoots of higher-grade mineralization (>1.5 g/t Au) follow these main lithological contacts, but are laterally confined to subtle (5–15°) clockwise deflections of bedding (dilational jogs) from its regional east-northeast trends. Outside these deflections, gold mineralization is patchy and only sub-economic. The structural and lithological controls of the Twin Hills mineralization closely resemble those of orogenic gold deposits, whereas the fine-grained and dispersed texture of gold and associated sulfide mineralization are more reminiscent of disseminated gold deposits. We suggest that the Twin Hills deposit is an example of a hypozonal orogenic gold deposit formed under peak metamorphic amphibolite conditions.

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