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Regional folding, low-angle thrusting and permeability networks: Structural controls of gold mineralization in the Hope reef at Fairview Mine, Barberton Greenstone Belt, South Africa

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ABSTRACT

The Hope reef forms part of a number of high-grade mineralized, but hitherto undocumented auriferous shear zones at Fairview Mine in the Barberton Greenstone Belt in South Africa, collectively referred to as the hanging-wall reefs. The reefs are hosted by steeply-dipping greywacke units of the Fig Tree Group on the western limb of the regional-scale Ulundi syncline. The currently mined shallow Hope reef represents a top-to-the northwest, low-angle thrust that formed as a secondary accommodation structure during continued NW subhorizontal shortening after the lock up of the Ulundi syncline. Northwest shortening strains correspond to the main phase of upright regional folding ($D_{2/3}$) in the greenstone belt.

The formation of shear and extensional vein sets documents fault-valve behaviour along the low-angle thrust, driven by close-to-lithostatic fluid pressures and under very low differential stresses (< 5 Mpa). High-grade ore shoots in the plane of the shallow reef delineate lithologically and structurally controlled interconnected fault-fracture meshes. Bedding planes in Fig Tree greywacke units have provided suitably orientated anisotropies that promoted the development of a wider, anastomosing shear-zone system. The shear zones envelop lithons of relatively competent greywacke units. Slip transfer from shears into the competent lithons induced extensional and shear fractures and the formation of an interconnected fracture network in and between lithons recording a net dilation of up to 50-60 vol%. Individual lithons show extents of 20–25 m^2, but ore shoots defined by imbricated lithons cover areas of several hundred square metres. Mutually cross-cutting extensional veins sets and local domains of normal slip point to transient stress switches related to periods of post-slip relaxation and rapid fluid pressure build up prior to the restoration of horizontal stresses and reverse slip along the shallowly dipping reef.

The hanging-wall reefs at Fairview Mine underline the formation of mineralized reefs in the Barberton gold district with vastly different orientations, structural and lithological controls, either in sequence or broadly contemporaneous, but during the late-stage shortening of the greenstone belt. The absolute timing of this deformation and associated hydrothermal events remain unclear.

1. Introduction

The bulk of the > 350 of gold produced from the Mesoarchean Barberton Greenstone Belt (BGB) in South Africa comes from the northwestern margin of the belt and, for over 130 years, gold production has centred around the Fairview, Sheba and New Consort mines, a number of smaller deposits and countless prospects (Anhaeusser, 1976a) (Fig. 1a and b). The concentration of gold mines in this part of the BGB suggests some unifying controls of the mineralization unique to this part of the belt. Gold mineralization is closely associated with quartz- and quartz-sulphide veins and vein networks either along faults, or lithological contacts or both, that testify to the structurally controlled discharge of large amounts of fluids. Despite this, studies of individual deposits suggest diverse structural and lithological controls of auriferous reefs, substantially different P-T conditions of ore formation, and different timing and tectonic settings for the mineralization, either during late-stage shortening of the BGB or regional extension (e.g., Anhaeusser, 1976a,b; Wiggett et al., 1986; De Ronde et al., 1991, 1992; Robertson et al., 1994; Otto et al., 2007; Dziggel et al., 2010, Munyai et al., 2011; Dirks et al., 2009, 2013). The only agreement is on the relatively late-stage introduction of the gold mineralization with respect to the tectonometamorphic evolution the BGB. This, in turn, raises

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