Stratigraphic and Structural Setting of Selected Gold and Base Metal Deposits in the Natal Thrust Front, South Africa

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ABSTRACT

The Namaqua-Natal Metamorphic Province is a Mesoproterozoic mobile belt formed by plate collision against the southern margin of the Archean Kaapvaal Craton. The Natal Metamorphic Province is regionally metamorphosed and incorporates obducted ophiolites, marginal bimodal metasedimentary/metavolcanic sequences, accreted island arcs and para-autochthonous granite-gneiss basement. The leading deformation edge, a 2-12 km wide south- dipping imbricate complex of low-grade high-pressure metamorphic rocks, comprises the Ntingwe and Mfongosi Groups transposed along the basal Mfongosi Thrust. The northernmost Ntingwe Group directly overlying the Kaapvaal Craton Margin comprises metamorphosed dolomite, limestone, shale, mudstone, conglomerate and breccia while the overlying Mfongosi Group consists of phyllitic quartzite, quartz-chlorite schist, carbonate-rich quartz-chlorite schist, epidote-actinolite schist, and garnet-staurolite-mica schist representing interlayered schistose meta-argillites and metalavas. Assemblages occur in the chlorite-garnet zone (upper greenschist), to high- pressure, intermediate facies (500-550°C at 12-16 Kb) with epidote, chlorite and albite being prevalent. East- trending tight isoclinal folds with south-dipping axial planes, disrupted by northward-verging overthrusting, are ubiquitous.

The westernmost portion of the Mfongosi Group, the "Ngubevu" Area, hosts enigmatic quartzofeldspathic blows (large-scale augen structures) and stringers containing Au and base-metal sulfide mineralization. It comprises two main lithological groups: a) positively-weathering, volumetrically dominant epidote - actinolite - quartz - talc ± calcite and chloritic schist/ metabasites and b) negatively-weathering banded units, essentially crenulated graphite - sericite - quartz - albite - tourmaline ± analcite ± chlorite ± calcite schist, classified as metapelites to metacalcsilicates. Mineralized quartzofeldspathic blows and intrafolial stringers are products of a complex interaction between deformation and pressure solution. Two constants of mineralization apply: a) blows and stringers occur exclusively in competent metabasites containing minor metapelitic/metacalcsilicate layers; and b) major mineralized blows formed in early- to syn-tectonic times. The dominant planar foliation (S_{01}) is oriented at 090°/60°S, parallel to the craton margin. S_{01} exhibits cylindrical and non-cylindrical folding, with axes trending between 110°→39° and 133°→48°. Quartz/calcite tension gash formation parallelling σ_1 (hinterland or para-autochthonous nappe zone origin) accompanied folding and transpressional left-lateral movement with finite strain ratios (R_f) of up to 15. Poles to late-tectonic tension veins parallel the long axes of antitaxial quartz crystals on vein margins (contoured maxima of 192°→66°) implying orthogonal vein dilation. Mineralization appears spatially non-systematic but is explained by intense and repeated deformation of the intersections between early - syn-tectonic 190°-trending tension gashes and fine metapelite / metacalsilicate layers, in which deposition of Au, pyrite and chalcopyrite occurred. Mineralized blows are the thickened limbs of ptygmatically- or fish-hook-folded early- syn-tectonic tension gashes, while stringers are residual, thinned limbs of these folds. High strain rates and superimposed pure and simple shear destroyed continuity between mineralized blows and stringers, resulting in complex, yet resolvable, mineralization patterns.

INTRODUCTION - REGIONAL GEOLOGY

The Namaqua-Natal Metamorphic Province (NNMP) is a Mesoproterozoic mobile belt formed by the collision between the southern margin of the Archean Kaapvaal Craton and a southern plate or sub-plate (Du Toit, 1931; Matthews, 1959, 1981 a, b). Its extent beneath Paleozoic and Phanerozoic cover from the southeastern coast of South Africa to the west coast is inferred (Fig. 1; Barkhuizen and Matthews, 1990). The mobile belt may be divided into two main parts: the western portion consisting of the Namaqua Metamorphic Province and the Natal Metamorphic Province (NMP) in the east (Fig. 1).

Outcrops of the NMP, the northernmost portions of which contain the Natal Thrust Front, are restricted to a narrow 220 km long erosional inlier parallel to the coast (Matthews, 1981 b) in Kwazulu-Natal. The NMP is a regionally metamorphosed mobile belt incorporating possible obducted ophiolites and ocean floor material, accreted island arcs and para-autochthonous granite-gneiss basement (Du Toit, 1931; Matthews, 1959, 1972, 1981 a, b; Cain, 1975; Thomas, 1989 a, b). The NMP may be readily subdivided into four zones, based on tectonostratigraphic and metamorphic variations across the inlier (Figs. 1 and 2). From north to south these four zones are: the Natal Thrust Front; the Natal Nappe Zone; the Mzumbe Terrane; and the Margate Terrane (Matthews, 1959, 1972; Cain, 1975; Thomas, 1989 b). The Nappe Zone consists chiefly of obducted ophiolite with syn-tectonic granitoids; the Mzumbe and Margate Terranes incorporate two complete island arcs (Thomas, 1989 b). The stable Kaapvaal Craton to the north of the Natal Thrust Front consists primarily of granite-gneiss basement unaffected by a major regional metamorphic event for at least 2600 Ma (Matthews, 1972). The Kaapvaal Craton contains infolded greenschists and amphibolites of the Nondweni Greenstone Belt and is overlain by the 6000 m thick Archean Pongola Supergroup (e.g. Tankard *et al.*, 1982).