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GEOLOGICAL EVOLUTION OF THE PIETERSBURG GREENSTONE BELT, SOUTH AFRICA, AND ASSOCIATED GOLD MINERALIZATION;

M.G. Jones, Department of Geology, Imperial College, London and M.J. de Wit, Lunar and Planetary Institute, Houston, Texas.

This poster presents current thoughts based on preliminary field work carried out as part of a Ph.D. project, the aim of which is to integrate the polyphase history of gold mineralization seen in the area with the geochemical and tectonic evolution of the greenstone belt as a whole.

Gold mineralization is found in four distinct regional geological settings;

1. A first phase of gold mineralization was associated with early low grade metamorphism and metasomatism of a 'greenstone basement' sequence of serpentinites (metaperidotites). These are generally intrusive into a series of BIF units, ferruginous shales and cherts. There are also associated extrusive tholeiitic metabasalts and ocellular-bearing komatiitic basalts. The regional hydration which characterizes this early metamorphism resulted in major chemical alteration of the basement and large scale fluid movement, with migration of Fe, and Mg ions, SiO_2 and possibly gold. Early shear zones (possibly represented by a now flat-lying carbonate-fuchsite-gneiss horizon) may have facilitated this fluid movement.

2. The basement sequence is unconformably overlain by a 'cover' of coarse clastic sandstones and conglomerates which contain basement-derived detritus. The conglomerates are often well sorted and graded and may represent coarse turbidites. Placer-type pyrite and BIF clasts, both containing minor gold values, are present in these cover rocks and hence a second period of gold mineralization (reworking) is envisaged.

3. The older rock sequences and gold mineralization above were all affected by a regional deformation event and it is the associated structural traps which contain the most significant gold occurrences seen in this greenstone belt. A well developed upright cleavage with a predominantly NE-SW strike and three major composite shear zones (each containing a number of tectonic breaks) are the main manifestations of this deformation. Strain analysis in the shear zones has been carried out using ocelli from the pillowed komatiitic basalts. The measurements indicate that close to or within the shear zones the finite strain ellipsoid results from a minimum of 50-70% flattening across the cleavage and 100 - 180% extension along the main stretching lineation seam.

Antitaxial and composite extension veins have been recognized. The veins contain fibrous crystals of quartz and calcite which plunge parallel to the stretching lineation (as defined by stretched conglomerate and breccia clasts lying in the cleavage plane). The veins are thus syn-kinematic with this main deformation event. The orientation of the quartz fibres is parallel to the incremental extension growth direction of the dilational veins and so the stretching lineation is parallel to the kinematic movemnt direction (approx. NW-SE when rotated to the horizontal). The veins are formed by the crack-seal fibrous growth mechanism and semi-quantitative strain analysis indicates clearly that the incremental strain ellipse (in the X-Y plane) did not change orientation significantly during the deformation event.

Field evidence indicates that the shear zones were thrusts (SE over NW) with both vertical and lateral components of movement. One of the shear zones, the Synmansdrift shear zone is marked by an unusual chaotic breccia which consists of white and brown-red banded chert and BIF clasts, identical to the BIF from the basement, set in a red ferruginous shale-like matrix. The clast content and size vary abruptly both across and along strike and there is no well-defined bedding. The lithology can be traced for 7km along strike and may be upto 100m in thickness but its upper (southern) boundary is ill-defined as it grades over tens of metres into conformably overlying but often highly deformed red shales and sandstones. Hence the upper contact appears to be sedimentary although this has yet to be confirmed by lithogeochemistry. The lower contact is clearly tectonic and an L-S tectonite fabric is well-developed. As well as small clasts, the lower half of the breccia also contains extremely large (upto 100m long x 20m wide) BIF inclusions which themselves are 'clasts' within the lithology. These larger inclusions can be clearly seen to be tectonically ground-up by a 'spalding-off' process which produces the smaller, often euhedral, breccia clasts.

As a whole the unit constitutes a tectono-sedimentary melange which is envisaged to have formed as a sedimentary wedge above a low dipping shear zone (thrust) during horizontal shortening across the region. Large scale movement of Fe ions, SiO_2 ± Au occurred.

Gold mineralization is found in quartz ± tourmaline veins associated with various structural traps e.g. fold hinges and minor shear planes including ultracataclasites. In the vicinity of these traps pressure solution and metamorphic segregation features are common which indicate fluid movement and possible gold mobility from the deformed sediments (and possibly the basement rocks) into the traps. This fluid migration may have occurred early with respect to the deformation with the resultant veins being subsequently slightly deformed and tectonically displaced probably later but within the same deformational event.

4. A later porphyroblastic overprint of gold-bearing arsenopyrite is seen locally within the shear zones as well as porphyroblasts of ephesite (a lithium-bearing brittle mica) and andalusite. These features seem to indicate a later period of gold mineralization and 'static' metamorphism probably related to granitic and pyroxenitic intrusions which provided a heat source (and possibly fluids) for element mobility and mineralization within the already deformed volcano-sedimentary pile.