

Constraints on the Genesis of the Orbicular Rocks and Sulphide Mineralization in the Koperberg Suite, Namaqualand Metamorphic Complex, South Africa

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The 1020-1060 Ma Koperberg Suite (KS) rocks contain zones with orbicular textures, thought to form by magmatic, metasomatic, or metamorphic processes. Some orbicular zones are also associated with Cu mineralization, suggesting a possible link between orbicule formation and metallogenesis. This study documents a selection of orbicular localities from the KS to understand their genesis using petrography, in-situ mineral chemistry, and isotopic data. Four different orbicule localities are described including Orbicule Koppie (OK), Henderson North (HN), Henderson South (HS), and Hoogskraal Lease (HL).

Orbicules occur in a spectrum of lithologies of the KS, ranging from granite to diorite. The orbicules are characterized by coarse-grained (2-6 mm) felsic cores. Sharp contacts mark the transition from cores to the fine-grained (0.2-1 mm) shells that exhibit polygonal textures. Sharp boundaries mark the transition from core to shells and coarse-grained matrices. Some of the orbicule localities contain deformed orbicules trending parallel to steep structures. Plagioclase in the HN (An₄₇₋₆₅) and HS (An₅₂₋₆₂) orbicules are more calcic than plagioclase at HL (An₃₅₋₅₂) and OK (An₄₁₋₅₇). Biotite in the HN (x = Mg#77) and the OK (x = Mg#75) orbicules are more magnesian than those at HS (x = Mg#62) and HL (x = Mg#68) orbicules. Plagioclase in the HN orbicules are characterized by elevated initial ⁸⁷Sr/⁸⁶Sr ratios (I_{Sr}) (0.709675-0.723517) relative to other orbicular localities (0.705608-0.724905).

A variety of textural and geochemical constraints rules out a metasomatic origin. These include chemical similarity between orbicules and the magmatic matrices, as well as a variety of synmagmatic textures. This, along with isotopic data, indicate that distinct pulses of orbicular-forming magmas make up the KS, where variable amounts of magma mixing, mingling, and assimilation occurred. These differentiation processes possibly took place during magma ascent and emplacement, possibly triggering the ideal conditions for orbicular rock and sulphide formation.