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The Vergenoeg Strato-Volcano – IOCG-like Mineralization Associated with Felsic Magmatism in the Bushveld Magmatic Province, South Africa

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The Vergenoeg Igneous Complex (VIC) defines a strato-volcano that erupted as the terminal phase of the bimodal Rooiberg Group (RG), the latter representing the extrusive component of the 2057-2054 Ma Bushveld Magmatic Province. The RG was extruded immediately prior to emplacement of both the mafic (Rustenburg Layered Suite - RLS) and felsic (Lebowa Granite Suite - LGS) intrusive phases of the Complex. The lowermost portion of the RG comprises the basaltic-to-andesitic Dullstroom Formation, much of which occurs beneath the RLS and therefore predates the main layered mafic intrusion. The upper portions of the RG, including the VIC, comprise the dacitic-to-rhyolitic, Damwal, Kwaggasnek, and Schrikkloof Formations, which are closer in composition to the highly fractionated A-type granites of the LGS. The VIC hosts world-class fluorite mines associated with a Fe-F-(Cu-REE) mineralization style that has marked IOCG affinities.

Numerous polymetallic, magmatic-hydrothermal mineral deposits occur throughout the various felsic phases of the Bushveld Magmatic Province, and these are typically represented by a three-stage paragenetic sequence: early magmatic Sn-W-Mo-F ores (600° > T > 400°C), followed by a Cu-Pb-Zn-As-Ag-Au paragenesis (400° > T > 200°C) and then late-stage Fe-F-U mineralisation (<200°C). Borehole core from mineralized intervals of the VIC reveals a sharp, erosional contact (~35°) between the uppermost RG volcanics (i.e., the Schrikkloof Formation) and pyroclastic rocks of the VIC, suggesting that the latter postdates the RG and may be synchronous with subjacent LGS emplacement. A well-defined vent occurs in the centre of the complex and is also the site of the world-class F-Fe-REE deposit of the Vergeneog Mine. The vent preserves a coarse volcaniclastic breccia comprising mainly hematite (goethite/siderite)-fluorite-magnetite-fayalite—minor minerals include apatite, cassiterite, monazite, titanite, and REE-carbonate phases. It is zoned vertically and records a complex interplay between volcanic eruptive processes, magmatic-hydrothermal remobilization of ore constituents, and later supergene overprinting. Prominent sulphide mineralization occurs in the form of pyrite and chalcopyrite with lesser arsenopyrite and sphalerite. Away from the vent, subaerially-deposited volcaniclastic material defines a strato-volcano (ca. 10 x 5 km in extent) comprising two distinct units, becoming finer grained with increasing distance from the vent. The lower portion of the VIC is built of siliceous ignimbrite with a minor rhyolitic component. This is overlain by volcanic hematite-fluorite breccia intercalated with laminated, locally reworked, fan-delta sediments, all deposited in a maar-like structure. The recently developed Nokeng fluorite mine is hosted in these bedded VIC volcaniclastic sediments, distal to the vent.

Genesis of the polymetallic mineralization in the VIC, and other felsic phases of the Bushveld Complex, remains poorly understood. The association between intrusive and extrusive pulses of felsic magmatism, together with evidence for widespread magmatic-hydrothermal Fe-F-(Cu-REE) mineralization processes, define a Bushveld metallotect that has similarities to other iron-oxide-copper-gold (IOCG) provinces in, for example, Brazil and Sweden. An IOCG footprint in the felsic phases of the Bushveld event would render them more prospective than previously thought.