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Metasomatic effects in Critical Zone norite adjacent to a calc-silicate xenolith in the western Bushveld Complex, South Africa: implications for chromite-spinel chemistry

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A 2.5 x 3 m calc-silicate xenolith and its immediate environs, exposed during mining operations in the upper Critical Zone of the Rustenburg Layered Suite at Rowland Shaft, Lonmin Platinum (Marikana), is the first reported occurrence of a calc-silicate xenolith in the western Bushveld Complex. A suite of samples were collected from the xenolith and its margins, including material from the centre of the xenolith, a 2-cm-thick spinel-rich layer identified as the xenolith margin, and a hybridized zone within which patches of uvarovitic garnet and calc-silicate fragments up to 10 cm in size occur. Petrographic and EMP analysis indicate that the xenolith is dominated by coarsely crystalline monticellite + forsterite + spinel, indicating peak T in excess of 700°C. Evidence of retrograde metamorphism is provided by

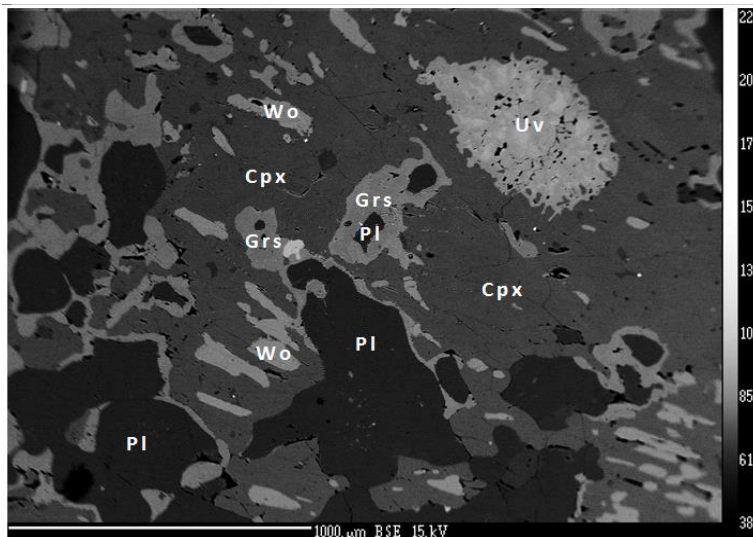


Figure 1: Back-scatter electron image of a sample from the hybridized zone depicting grossularite reaction coronas between plagioclase and clinopyroxene, clinopyroxene with wollastonite inclusions which show a consistent orientation (NW-SE) and the occurrence of two compositionally variable garnets (grossularite and uvarovite) in close proximity to each other. Abbreviations: Cpx = clinopyroxene, Grs = grossularite, Pl = plagioclase, Uv = uvarovite and Wo = wollastonite.

reaction coronas in the hybridized zone, including: (1) garnet + vesuvianite symplectites that indicate hydrous fluid infiltration at T ~600°C; and (2) grossularite reaction coronas occurring between plagioclase and clinopyroxene that display a pseudo-ophitic igneous texture (Figure 1). Evidence interpreted as high-T, Ca metasomatism includes plagioclase and clinopyroxene that show atypical, extremely calcic, compositions (An >96; diopside with wollastonite inclusions; Figure 1). Spinel is found in all samples, but it shows highly variable composition both between samples and via internal zoning and exsolution textures. Spinel cores and grains in samples distal to the xenolith are Cr-rich, comparable with UG2 chromite compositions; rims and grains in proximal samples are more aluminous. Cr is also found in both uvarovitic garnet and Cr-diopside, which occur in clusters, suggesting nucleation around Cr-rich spinel or

chromite grains. Our analysis documents a zone of physical and chemical mixing in which the

decarbonizing calc-silicate xenolith contaminated the enclosing magma. Subsequent hydrous fluid infiltration during cooling between 700 and 400 °C may reflect metamorphic fluid ingress from contact metamorphism of Transvaal Supergroup sediments in the RLS footwall.

