Ni- and PGE-ENRICHED QUARTZ NORITE IN THE LATEST JURASSIC MOROKWENG IMPACT STRUCTURE, SOUTH AFRICA. M. A. G. Andreoli[1,2], R. J. Hart[2], L. D. Ashwal[3] and M. Tredoux[4]
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The 145 ± 0.8 Ma Morokweng impact structure (diameter ~350 km) is among the largest on Earth [1,2,3]. Borehole data [3] show that the center of the structure is represented by a texturally complex, sheet-like igneous body (diam ~30 km; thickness ≥170 m), interpreted as an impact melt [1,3]. These igneous rocks consist of a variety of pyroxene-bearing lithologies, the most predominant of which is a homogeneous, medium-grained quartz norite. The melt sheet has a chilled basal contact with underlying basement granitoids, which are intensely affected by shock and thermal metamorphism. In places, veins and dykes of heterogeneous and/or finer-grained quartz norite, pyroxene-bearing granitoids or pegmatoids, and granophyres crosscut the impact melt sheet.

Constituent minerals in the impact melt rocks include plagioclase (An_{22-51}), orthopyroxene (En_{55}), minor subophitic augite (En_{38-42}, Wo_{40-46}) and granophyric quartz-K-feldspar intergrowths. The opaque minerals occur either as finely disseminated grains (mainly magnetite and ilmenite), or as occasional sulfide-rich blebs and tapering veinlets (up to 3 cm wide) in contact with pyroxenes and quartz. The mineralogy of these veins consists of Ni- and Cu- sulfides (Co-bearing millerite, bornite, chalcopyrite, chalcocite), Ni-rich oxides (bunsenite, Ni-rich ilmenite, trevorite), Ni-rich silicates (liebenbergite, willemseite) and traces of native platinum [3].

The quartz norites are marked by intermediate to acid bulk chemistry (SiO_2 = 59-66 wt%, MgO = 2.4-4.9 wt%). They show poorly fractionated REE and striking enrichments in siderophile elements (avg Ir = 3.8 ppb, Au = 9 ppb, Ni = 480 ppm, Cr = 360 ppm). These are equivalent to or above siderophile abundances in mantle-derived rocks from the Barberton greenstone belt (Fig. 1), possibly indicating an origin as impact-generated crustal melts with appreciable meteoritic contamination [3]. However, Morokweng differs from most other impacts, with the possible exception of Sudbury, as its impact melts show some degree of differentiation between earlier, medium-grained quartz norite and the cross-cutting, finer-grained varieties. There is also evidence of enrichment processes affecting the PGE and Au in the millerite-trevorite veins, which show non-chondritic PGE patterns (avg Os = 9.5 ppm, Ir = 7.8 ppm, Ru = 9.9 ppm, Pt = 2.7 ppm, Pd = 23 ppm, Au = 0.9 ppm; Fig. 1). The Ni-rich mineral assemblages are unique, although reminiscent of an enigmatic 3.5 Ga nickel deposit from the Barberton greenstone belt [4].

References: [1] Andreoli M.A.G. et al. (1995) Abstr. Centennial Congr. Geol. Soc. S. Afr, 1, 541-544. [2] Corner B. et al. (1997) Earth Planet. Sci. Lett., 146, 351-364. [3] Hart R.J. et al. (1997) Earth Planet. Sci. Lett., 147, 25-35. [4] Tredoux M. et al. (1989) JGR, 94, 795-813. [5] Tredoux M. & McDonald I. (1996) Geostandards Newsletter, 20, 267-276.

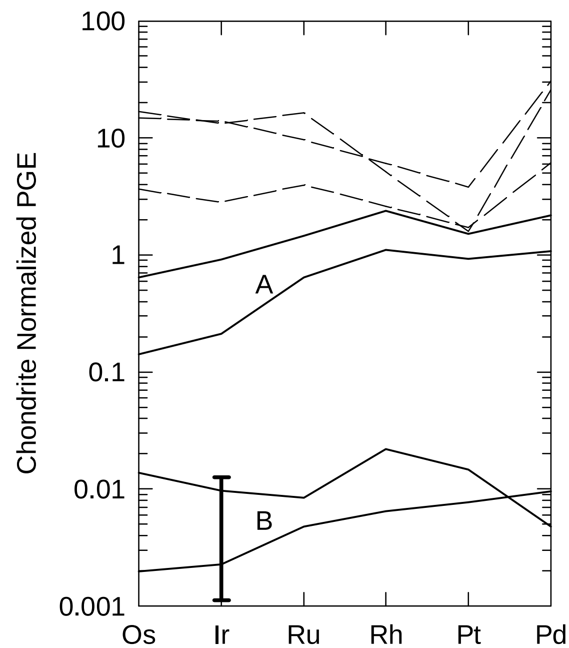

Fig. 1. Chondrite-normalized Ir concentrations of quartz norites (vertical bar) and PGE concentrations of millerite-trevorite veins (broken lines) from the Morokweng impact structure, compared to materials from the Barberton greenstone belt: trevorite-rich Ni ore (field A) and coarse-grained dunite and komatiite (field B). Data from refs [4] and [5].