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Discordant Bodies within the Critical Zone of the Bushveld Complex, South Africa: Overview and Effect on Mining and Exploration

Scoon, R.N.[1], and Viljoen, M.J.[2]

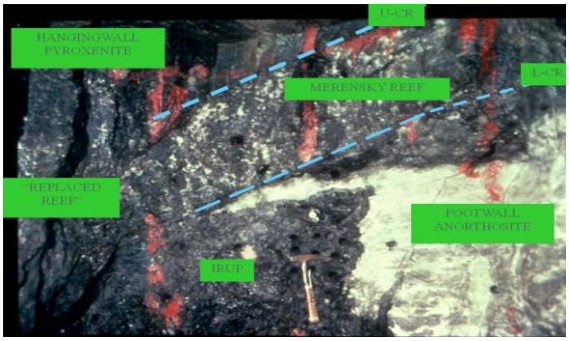
[1]*Department of Geology, Rhodes University, Grahamstown, South Africa (rnscoon@iafrica.com)*

[2]*Bushveld Minerals, Johannesburg*

The 2,055 Ma Bushveld Complex is well known for the occurrence of discordant bodies, some of which transgress the layering perpendicularly. The recognition of discrete types is based on differences in petrology and mineralogy. Some pipes are mineralized. Three platinum-rich pipes were mined between 1924 and 1930, prior to exploitation of layered reefs. Mooihoek the discovery site of economic mineralization, Onverwacht the oldest mine with grades in selected samples of almost 2,000 g/t Pt, and Driekop. The platiniferous pipes are complexly zoned and include components of the two most abundant end-member types of discordant body, dunite and iron-rich ultramafic pegmatite (IRUP). The Kennedy's Vale locality is an example of a zoned body of IRUP in which a core of V-rich Ti-magnetite was mined over many years. The prevalence of discordant bodies in structurally disrupted areas is remarkable and helicopter-borne magnetic surveys are essential in exploration programmes. Dunite pipes are moderately magnetic (serpentinization produces secondary magnetite) and the IRUP are strongly magnetic.

The least well known category of discordant body is the **dunite pipes**. These features are mostly known from the Eastern Limb where they occur as either small, homogenous bodies or large, concentrically zoned pipes with diameters of 300-500 m. The latter are comprised of central stocks of dunite (magnesian olivine) with outer sheaths of wehrlite, harzburgite, or pyroxenite. They are related to intrusions of Lower Zone-lineage magma through vertical conduits causing catastrophic downwarping of primary layering. The Winnaarshoek (Merensky), Driekop (UG2), and Onverwacht (LG6) pips sterilize huge areas of layered reefs.

The IRUP is a collective name proposed by Viljoen and Scoon (1985) for unusual discordant bodies that are characterized by iron-rich olivine, augite, and Fe-Ti oxides (Ti-magnetite and ilmenite). Accessories include amphibole, mica, and base-metal sulphides. The IRUP occur as subvertical discs with diameters up to 1 km as well as pods, dykes, and veins. Sheet-like bodies that mimic primary layering are a well known feature of the IRUP. The IRUP becomes increasingly differentiated with height and grade upward into zoned bodies. The IRUP formed through a process of magmatic replacement. Dissolution of wall rocks was triggered by reactive, immiscible, Fe-Ti oxide-rich melts that drained downward exploiting syn-Bushveld zones of weakness. Melts were derived from iron-rich magmas in the Upper Zone. Interaction between bodies of IRUP and layered reefs is important. IRUP juxtaposed with chromitite layers includes highly unusual, Fe-rich (magnetic) spinels. IRUP affects mining of the UG2 and Merensky Reef and ore resource estimations should include losses in this regard. Typically, where sheet-like bodies have preferentially replaced the anorthositic footwall, as in the attached photograph, **Replaced Reef** can still be exploited, albeit PGE are displaced (and recrystallized) over a vertical height of a few tens of cm. Replaced Reef is very similar to the core-parts of the Mooihoek and Onverwacht pipes. PGE are only found in discordant bodies that have either replaced earlier-formed reef or the internal parts of dunite pipes.



IRUP partially replacing the Merensky Reef and Footwall anorthosite at the Amandelbult mine.

References:

[1] Viljoen M J and Scoon R N (1995) Economic Geology 80: 1109-1128