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# Petrological investigation of Merensky Reef Unit lithologies at Two Rivers Platinum Mine and comparison to stratigraphically similar rocks north of the Steelpoort fault, eastern Bushveld Complex, South Africa


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## ABSTRACT


**This research study focuses on the enigmatic occurrence of noritic lenses (termed "brown sugar norite" by mine geologists, here after referred to as BSN), within the feldspathic pyroxenite of the Merensky Reef (MR) at Two Rivers Platinum Mine which is situated on the southern sector of the eastern limb of the Bushveld Complex. The cumulate rocks associated with the MR unit are characterised by the use of geochemistry and mineralogy and compared to stratigraphically similar rock types north of the Steelpoort fault at Eerste Geluk.**

**The BSN are fine-grained and appear to only occur where the upper chromite stringer of the MR unit is present. Orthopyroxene is the dominant cumulate phase in both the BSN and feldspathic pyroxenite followed by interstitial plagioclase. Clinopyroxene occurs mostly as exsolved lamellae phase within orthopyroxene and intermittent rims around orthopyroxene which could be attributed to a decrease in temperature and compositional change of the melt. Textural features of the different rock types suggest recrystallization of minerals and disequilibrium of magma. At Eerste Geluk BSN is absent, minerals of the Merensky lithologies display more alteration or deformation and a higher concentration of hydrous minerals. Eerste Geluk's close proximity to the Steelpoort fault makes it plausible for dynamic magmatic processes to have been active (Cawthorn et al., 2002) resulting in the alteration of minerals. Strontium isotope analyses of five representative samples of the Merensky interval at TRP yielded $^{87}Sr/^{86}Sr$ typical of Critical Zone Magma. The BSN has a lower $^{87}Sr/^{86}Sr$ ratio relative to pyroxenite. PGMs occur associated with base metal sulphides (BMS), silicates and chromite (Kinloch, 1982). Results show that pentlandite contains a higher concentration of PGEs relative to pyrrhotite and chalcopyrite. Pd is the most dominant PGE present in BMS analysed with concentrations ranging between 0.5 to 428 ppm.**


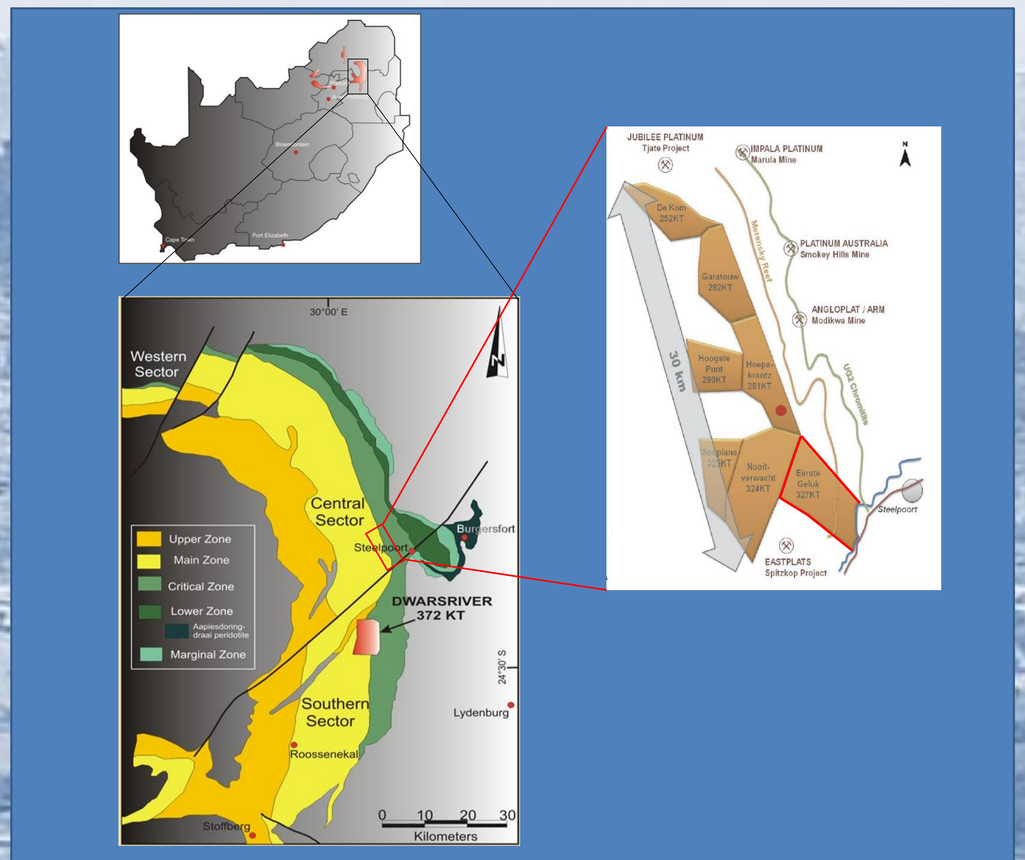


Figure 1: a) Generalised geological map of the Eastern limb of the Bushveld Igneous Complex showing the approximate location of the farm Dwarsriver 372 KT. (Modified by J. Giebel after Cameron & Abendroth, 1957; Sharpe & Chadwick, 1982; Clarke, et al., 2005). b) Illustrates NKWE properties north of the Steelpoort Fault highlighting Eerste Geluk in close proximity to the fault.

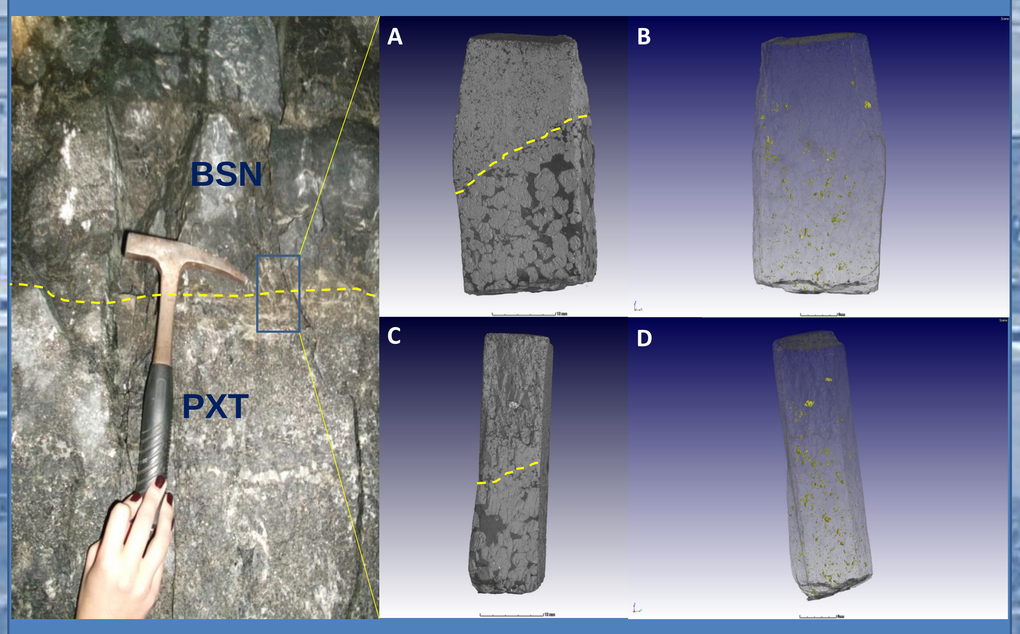


Figure 2 a) illustrates the Merensky reef where BSN lense is intersected. Figures 2 a) and c) shows the contact between the Merensky pyroxenite and BSN in 3D (front view and side view respectively) by the use of X-Ray Computed Tomography. Figures 2b) and c) shows the distribution sulphides in the BSN and pyroxenite. It can be seen that the minerals in the BSN are finer grained and contain relatively less sulphides. This method also make sit possible to determine to view defects such as pores/cracks visible in the rock.

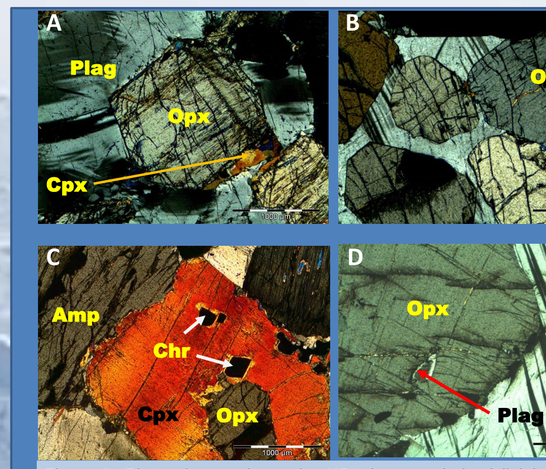


Figure 3: Photomicrographs under XPL (cross polarised light): A and B illustrates main petrographic features of Merensky Pyroxenite (cumulus opx and intercumulus plag). C and D illustrates main features of pegmatoidal pyroxenite (note coarser grained)

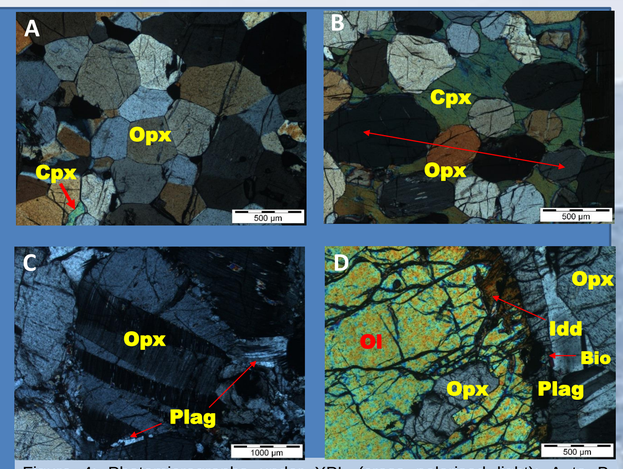


Figure 4: Photomicrographs under XPL (cross polarised light): A to B illustrates main petrographic features of the BSN'. (Note cumulus opx with cpx oikocrysts, relatively less interstitial plag). C: Photomicrographs under XPL of orthopyroxene with "kinks" and curved orientations indicating possible deformation of grains. D: olivine with Iddingsite alteration and orthopyroxene inclusion under XPL. Minor muscovite also present.

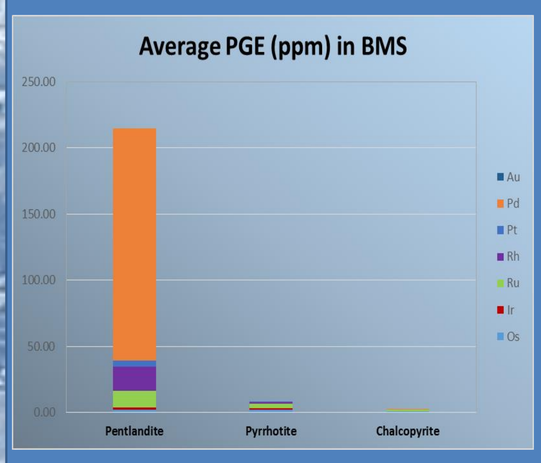


Figure 5: Average PGE concentrations in BMS from the EST drill core sample and TRP underground exposure samples.

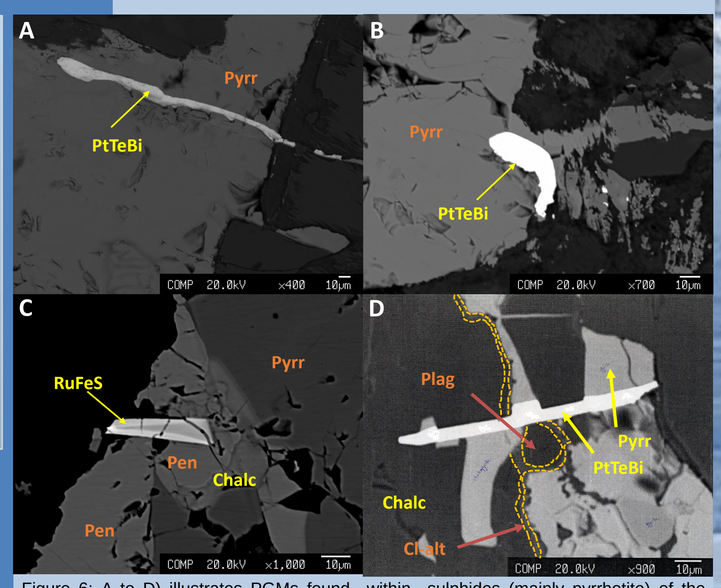


Figure 6: A to D) illustrates PGMs found within sulphides (mainly pyrrhotite) of the pyroxenite found close to the bottom chromitite stringer. A) shows a PtTeBi PGM (moncheite) which have flowed/intruded into the pyrrhotite. B) PtTeBi (moncheite) appearing near the edge of pyrrhotite. C) depicts RuFeS PGM found at the edge or within pentlandite. Note the zonation of the PGM. D) PGM (moncheite) cutting through pyrrhotite. It may be that the sulphides got displaced. Note the chlorite alteration along plagioclase-BMS-PGM boundaries.

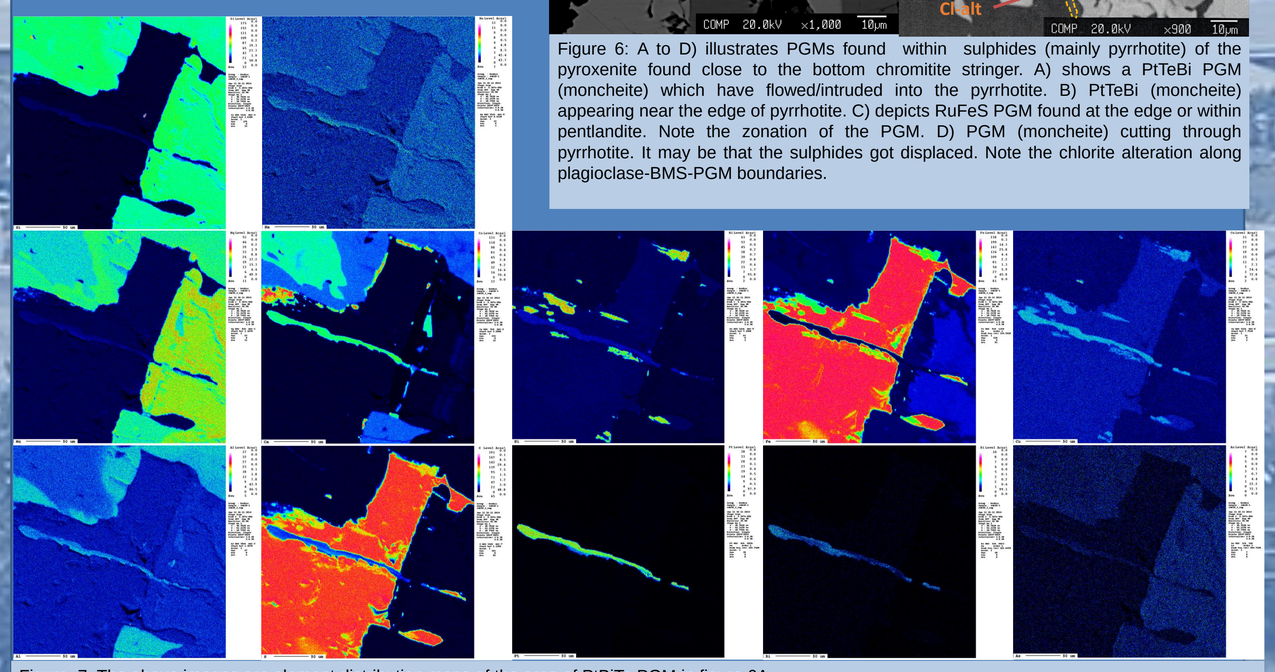

Figure 7: The above images are element distribution maps of the area of PtBiTe PGM in figure 6A.

## CONCLUSION

- Textural features along with complementary mineral chemistry of minerals in the various rock types, Sr analyses of plagioclase separates and whole rock geochemistry associated with the Merensky interval indicate multiple magma injections, fractionation and disequilibrium of the magma.
- Dynamic magma processes such as hydrothermal fluid activity were involved in the formation of rocks from the MR profile at Eerste Geluk (hence greater alteration of minerals and higher hydrous minerals are present) due to its close proximity to the Steelpoort Fault which is believed to may have been the feeder. Olivine accompanied by Iddingsite occurs at Eerste Geluk but not at TRP.
- $^{87}Sr/^{86}Sr$ ratios of representative rocks of TRP are typical of Critical Zone magma.
- PGE mineralisation in the rocks of this study are possibly formed by a various processes. Redistribution and recrystallization of PGMs by late magmatic processes such as hydrothermal fluids are possible.
- Enigmatic BSN lenses within pyroxenite may be due to change in magmatic controls such as rate of cooling resulting in a finer grained texture, possibly formed in a sub chamber and later introduced into the pyroxenite.


*References: *Cameron, E. N., & Abendroth, H. E. (1957). Structure of Lopoliths: Discussion. Bulletin of the Geological Society of South Africa., 79, 3-12. *Cawthorn, R. G., Merkle, R. K., & Viljoen, M. J. (2002). Platinum-group element geochemistry, mineralogy and mineral beneficiation of platinum-group elements. (Vol. 54, pp. 389–429). Can Inst Min Metall Spec. *Clarke, B. M., Uken, R., Watkeys, M. K., & Reinhardt, J. (2005). Folding of the Rustenburg layered suite adjacent to the Steelpoort pericline: implications for syn-Bushveld emplacement of the eastern Bushveld Complex. South African Journal of Geology., 108, 397–412.*Kinloch, E.D (1982). Regional trends in the platinum-group mineralogy of the critical zone of the Bushveld Complex, South Africa. Economic Geology. (77) 1328-1347. *Sharpe, M. R., & Chadwick, B. (1982). Structures in Transvaal Sequence rocks within and adjacent to the eastern Bushveld Complex. Geological Society of South Africa Transactions, 85, 29-41.*



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