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Geochemical characterization of P1, P2, P3 and P4 units at the Akanani prospect area, Bushveld Complex, South Africa: Combination of R-Cluster, R-Factor and Discriminant analysis approach

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The Platreef is located in the northern limb of the Bushveld Igneous Complex (BIC) and is comprised of a 10- to 400-m thick package of pyroxenitic lithologies, which host platinum-group element (PGE) and base metal sulphide (BMS) mineralization at various heights above the floor rocks. The pyroxenites are overlain by norites and gabbronorites, generally assigned to the Main Zone of the BIC.

The greatest challenge facing mining personnel is differentiating between mineralized pyroxenites and those barren off mineralization and also finding a definitive criteria for characterizing the four lithological units. Exploration geologists at the Akanani prospect area have classified the pyroxenitic units into P1, P2, P3 and P4 units in their order of succession with depth based on their textures, color and mineralogy. The geochemical attributes which distinguish them still remains unresolved.

Fifty-three pyroxenite samples were therefore taken from 6 boreholes at the Akanani Prospect area for geochemical and petrographic studies. The samples were analyzed for over 40 elements by X-ray Fluorescence (XRF) and Inductively Coupled Mass spectrometry (ICP-MS). The geochemical data were evaluated using combination of three multivariate statistical techniques, these being: cluster, factor and discriminant analysis using SPSS 20. The present study was initiated to determine the distinctive geochemical characteristics that can be used to identify each layer and in so doing determine geochemical elements characterizing each of these pyroxenite layers.

The discriminant accuracies for the four groups resulted in a 100% recognition rate, indicating that the percentage of accurate analysis is high for discriminating between the four Platreef units. Results identifies P1 unit as high in Cr, Fe₂O₃, and TiO₂, higher MgO and LOI characterize the highly serpentinized P2 unit which corroborates with the high olivine and orthopyroxene contents associated with this unit. The P3 unit shows SiO₂, Al₂O₃, K₂O and Na₂O in line with a pronounced feldspathic composition for this unit, while a higher CaO and P₂O₅ is associated with the P4 unit.

The stratigraphic subdivision presented here conflicts widely with the A-B-C reef terminology as well as the most recent PU1, PU2 and PU3 subdivision of the Platreef at Akanani.

The results presented here underline the effectiveness of the combination of R-mode cluster, R-mode factor and discriminant analysis in distinguishing between various rock types as well as exploring various relationships amongst data sets. The correlation between the geochemical and petrographic results shows the effectiveness of this technique especially in areas where the identification of the unit is unclear, uncertain or unknown or in areas where the stratigraphy is unclear due to processes like structural deformity, assimilation and metasomatism. The results presented here provide a new guide to the exploration of PGE-BMS mineralization in the Platreef at Akanani.

KEYWORDS: Bushveld Complex, Platreef, Multivariate statistics, cluster analysis, factor analysis, discriminant analysis

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