World Academy of Science, Engineering and Technology
International Journal of Geological and Environmental Engineering
Vol:12, No:11, 2018

The Sr-Nd Isotope Data of the Platreef Rocks from the Northern Limb of the Bushveld Igneous Complex: Evidence of Contrasting Magma Composition and Origin

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Abstract : The Platreef is a platinum group element (PGE) deposit in the northern limb of the Bushveld Igneous Complex (BIC) which was emplaced as a series of mafic and ultramafic sills between the Main Zone (MZ) and the country rocks. The PGE mineralisation in the Platreef is hosted in different rock types, and its distribution and style vary with depth and along strike. This study contributes towards understanding the processes involved in the genesis of the Platreef. Twenty-four Platreef (2 harzburgites, 4 olivine pyroxenites, 17 feldspathic pyroxenites and 1 gabbronorite) and few MZ (1 gabbronorite and 1 leucogabbronorite) quarter core samples were collected from four drill cores (e.g., TN754, TN200, SS339, and OY482) and analysed for whole-rock Sr-Nd isotope data. The results show positive εNd values (+3.53 to +7.51) for harzburgites suggesting their parental magmas derived from the depleted Mantle. The remaining Platreef rocks have negative εNd values (-2.91 to -22.88) and show significant variations in Sr-Nd isotopic compositions. The first group of Platreef samples has relatively high isotopic compositions (εNd= -2.91 to -5.68; $^{87}Sr/^{86}Sri$= 0.709177 - 0.711998). The second group of Platreef samples has Sr ratios ($^{87}Sr/^{86}Sri$= 0.709816-0.712106) overlapping with samples of the first group but slightly lower εNd values (-7.44 to -8.39). Lastly, the third group of Platreef samples has low εNd values (-10.82 to -14.32) and low Sr ratios ($^{87}Sr/^{86}Sri$= 0.707545-0.710042) than those from samples of the two Platreef groups mentioned above. There is, however, a Platreef sample with εNd value (-5.26) in range with the Platreef samples of the first group, but its Sr ratio (0.707281) is the lowest even when compared to samples of the third Platreef group. There are also five other Platreef samples which have either anomalous εNd or Sr ratios which make it difficult to assess their isotopic compositions relative to other samples. These isotopic variations for the Platreef samples indicate both multiple sources and multiple magma chambers where varying crustal contamination styles have operated during the evolution of these magmas prior their emplacements into the Platreef setting as sills. Furthermore, the MZ rocks have different Sr-Nd isotopic compositions (For OY482 gabbronorite [εNd= +0.65; $^{87}Sr/^{86}Sri$= 0.711746]; for TN754 leucogabbronorite [εNd= -7.44; $^{87}Sr/^{86}Sri$= 0.709322]) which do not only indicate different MZ magma chambers, but also different magmas from those of the Platreef. Although the Platreef is still considered a single stratigraphic unit in the northern limb of the BIC, its genesis involved multiple magmatic processes which evolved independently from each other.

Keywords : crustal contamination styles, magma chambers, magma sources, multiple sills emplacement
Conference Title : ICAMG 2018 : International Conference on Applied Mineralogy and Geochemistry
Conference Location : Cape Town, South Africa
Conference Dates : November 15-16, 2018