In-situ Sr isotope of plagioclase and its implication in the study of mafic layered intrusions

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Plagioclase has high Sr contents and extremely low Rb/Sr ratios, ideal for in-situ Sr isotope analyses by LA-MC-ICP-MS. We have applied this method to mafic layered intrusions to constrain the isotope composition of magma.

The in-situ data of plagioclase grains from the Upper Critical Zone (UCZ) of Bushveld is broadly consistent with whole rock data, but in some samples, is systematically higher than whole rock result. This could be explained by over age-correction for whole rock analyses, due to elevated Rb/Sr ratios in later stage alteration. We have found disequilibrium of initial $^{87}Sr/^{86}Sr$ ratios (Sr_i) isotopic compositions between cores and rims of plagioclase grains, and between cores of different cumulus plagioclase grains within thin sections. One potential contribution to the heterogeneity is from alteration effect of plagioclase. For example, the Kemi intrusion experienced relatively high alteration, which may have disturbed the Rb-Sr isotope system of plagioclase evidenced by the general negative correlation between Rb/Sr ratios and calculated Sr_i. This could be interpreted by variable elevation of Rb in plagioclase by later fluid. This correlation could potentially be a criteria to evaluate whether later alteration has affected the determination of Sr_i. In contrast, the lack of a negative correlation between Rb/Sr ratio and Sr_i in the Bushveld samples indicates that the primary isotopic signature of plagioclase has been preserved, possibly reflecting the involvement of magmas with different isotope composition. This is consistent with other later studies, showing that the degree of heterogeneity of Sr_i in the intrusions is correlated with the degree of crustal contamination.

In future study, in-situ trace element, Sr isotope analyses of plagioclase, and textural analyses of cumulate rocks should be combined to constrain the magma composition.