In situ Sr isotope data evidences mineral mingling in the UG2 unit of the Bushveld complex (South Africa)

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Chromite formation in layered mafic intrusions is not yet well understood and two endmember models are debated. The in situ cumulate model is based on the fact that mixing of silicate melts into a hybrid melt can result in chromite as sole cumulus phase. However, the total amount of observed chromite cannot be explained by this model as silicate melts can only host up to 2-3 wt% Cr_2O_3. In contrast, the intrusive model proposes an intrusive origin of already crystallised chromite and circumvents the "missing silicate" problem through formation of chromite in structural traps and subsequent intrusion as crystal mush. Both approaches propose mixing of melts either in or below the main magma chamber, which would demand a homogenous mineral chemistry of the accompanying cumulus plagioclase.

We studied a drill core from the Eastern Lobe through the UG2 unit, which is made up of five melanoritic layers and two chromitite seams.

Anorthite contents of cumulus plagioclase grains show values between 70 and 80 mol%, which is typical for the upper Critical Zone. Plagioclase grains hosted in the upper melanoritic layers show evidence for later hydrothermal alteration with highly variable anorthite contents (55 to 90 mol%). Interestingly, initial $^{87}Sr/^{86}Sr$ ratios show typical upper Critical Zone signatures of ca. 0.7065 for all but one unit and are unrelated to anorthite contents. The uppermost melanoritic layer shows significantly more radiogenic initial Sr isotopic signatures of 0.7075. This value is considered typical for the Main Zone [1]. Close to the contact between Upper Critical and Main Zone mineral mingling has already been proposed based on Sr isotope signatures of plagioclase in contrast to mixing of melts [1]. We speculate here that at least one melanoritic unit is originally derived from Main Zone magmas and, thus, evidences mineral mingling over larger scales than has been previously shown.

[1] Seabrook et al (2005) Econ. Geol. 100:1191-1206