VREDEFORT GRANOPHYRE GENESIS: CLUES FROM RE-OS ISOTOPE DATA

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Introduction: The long controversial genesis of the Vredefort impact melt rock (Vredefort Granophyre) from the central uplift (Vredefort Dome) of the world's largest and oldest known impact structure, Vredefort in (South Africa) [1], has been subject to a new investigation over the last few years with new field geological, chemical and isotopic approaches. Here, we discuss a much expanded Re-Os isotopic record for this enigmatic lithology and various country rock types.

Background: Vredefort Granophyre has long been regarded a chemically homogeneous lithology, with only local occurrence of a more mafic phase due to local assimilation of mafic wall rock [2]. However, [3] described two locations of allegedly zoned Granophyre in the NW of the Vredefort Dome, composed of clast-poor mafic marginal and clast-rich felsic central portions. They proposed "assimilation of host rock at the base of the superheated impact melt sheet and differentiation of the sheet and emplacement of the dike in a *two-stage* scenario" [*p.179*]. To test this allegation, we have studied a major part of this dike on Kopjeskraal with special attention to litho-zonation, variations in texture, clast populations, wall rock compositions, and chemical/isotopic compositions of Granophyre phases and country rocks. Results were presented in 2015 [4] and were strongly in favor of a *one-stage* emplacement *cum* local assimilation scenario.

New work: Here, we discuss new Re-Os isotope analyses for a host of Granophyre samples of both the felsic and mafic types, epidiorite and Dominion Group Lava (DLG), in conjunction with older data by [5] for Granophyre, Ventersdorp lava, and Witwatersrand shale. Additional data for mid-crustal mafic granulites of the Vredefort Dome were presented by [6], but this level did not feature in Granophyre genesis. Koeberl et al. [5] had shown that the felsic Granophyre contains a small but significant component of extraterrestrial material, thereby bringing to conclusion the lengthy debate about whether or not the Vredefort Structure was of impact origin or not.

Results: Compared to the previous results for Granophyre samples by [5], our new felsic and mafic Granophyre data are much reduced in Os content and extend the ^{188}Re/^{187}Os isotope ratios further from the meteorite data field. Clearly the new samples from Kopjeskraal contain much less meteoritic component than the former suite of samples. This could be due to heterogeneous admixture of meteoritic component or due to dilution with a crustal component (shale or Ventersdorp lava). The two mafic country rocks – Dominion Group Lava and epidiorite – have distinctly different isotopic characteristics, with the DLG sample plotting into the Granophyre field of [5] and the epidiorite plotting with comparatively high ^{188}Os/^{187}Os and ^{188}Re/^{187}Os ratios. A Ventersdorp lava sample [5] plots distinctly different from epidiorite, considering that it had long been thought that epidiorite in the Vredefort collar could represent a feeder dike system for the regional Ventersdorp extrusion. If ^{188}Os/^{187}Os ratios are plotted versus Os abundance or versus 1/Os, a complex, multi-component mixing situation is revealed – consistent with the proven clast population for Vredefort Granophyre. Supercrustals, here represented by Witwatersrand shale, upper crustal basement in the form of Archean granitoids, and Ventersdorp lava/epidiorite all contributed to the impact melt. However, the fact that there is a nice mixing relationship between felsic Granophyre, mafic Granophyre, and epidiorite lends further strong support to the conclusion of [4] that such mixing caused the generation of the mafic impact melt phase on Kopjeskraal – thus further opposing the idea of [4,5] that successive pulses of differentiated impact melt had caused the formation of composite Granophyre occurrences.

References: [1] Gibson, R.L. & Reimold, W.U., 2008, The Geology of the Vredefort Impact Structure. Memoir 97, CGS, Pretoria, 181pp. [2] Reimold, W.U. & Gibson, R., 2006, Chemie d.Erde, 66, 1-35. [3] Lieger, D. & Riller, U. 2012. ICARUS 219, 168–180. [4] Reimold, W.U. et al., 2015, Bridging the Gap III, abstr. #1035, LPI, Houston. [5] Koeberl, C. et al., 1996, Geology 24, 913-916; [6] Hart, R.J. et al., S. Afr. J. Geol. 107, 173-184.