New insights into the evolution of a stagnant magma chamber- magma loss and liquid evolution in the Upper Zone of the Bushveld Complex

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The Upper Zone (UZ) of the Bushveld Complex is the final magma chamber to be emplaced and crystallised during the evolution of the mafic portion of Bushveld magmatism. Though isotopic evidence indicates that no magma was added to the UZ during its crystallisation history, numerous studies have postulated the loss of large volumes of magma (20-40% of the original volume[1,2]) from the magma chamber. These estimates are problematic in that volcanic material related to the Upper Zone has never been identified. This new study utilises Zr and K bulk rock data to argue that the Upper Zone has experienced little or no magma loss. Previous estimates of Zr abundance have been too low, as researchers have assumed that Zr was incompatible in the UZ; in fact, zircon is a cumulus phase in the UZ, and is especially abundant in the magnetitite and nelsonite layers in the sequence. The new estimate of <5% magma missing from the original magma is conformable with global studies on intrusion/extrusion rates for mafic magmas[3], and has consequences for the evolution of the liquid line of descent (LLD) for the UZ. A new multi-part LLD for the UZ was constructed and tested using MELTS. The modelled liquid and the actual sequence of minerals present in the UZ is extremely close, indicating that the UZ separated into a number of separate magma packets which then crystallised independently of one another. It is noted that despite the good correlation between the model and the actual rocks, the high Fe, low Si bulk liquid calculated for the UZ is unlikely to occur in nature, and that a portion of the UZ magmatic sequence is likely to be hidden underneath the roof rocks of the Bushveld Complex.

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Distinguishing between advection and source changes recorded by Nd isotopes in the NE Atlantic

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Nd isotopes, measured on authigenic sediment phases, are a powerful tracer of past changes in ocean circulation [1]. Recent method developments have shown that planktonic foraminifera, which have not been chemically cleaned, preserve the Nd isotope signature of bottom water, and thus are an alternative phase to sediment leachates, avoiding possible contamination by volcanic phases [2, 3]. However, interpretation of downcore changes in Nd isotope records, in terms of past changes in water mass proportion, relies on the accurate reconstruction of the endmember composition of water mass source. Records from Fe-Mn crusts [4] and corals [5] from the NW Atlantic, and a sediment leachate record measured on core ODP 980 in the NE Atlantic [6] suggest the Nd isotope composition of the northern source endmember remained constant between the last glacial and the Holocene. However, a recent study comparing sediment leachate and uncleaned foraminifera Nd isotopes from a core close to ODP 980 indicates that sediment leachate data from this region are not reliable [7], thereby calling into question the invariant nature of the northern source endmember composition.

We present Nd isotope records, measured on unclean planktonic foraminifera, from a depth transect of cores in the northern NE Atlantic, which today are bathed by a mixture of overflow waters and Labrador Sea water. Our records sample Nd isotope composition from 1 – 4 km depth, and from 0 - 30ka. We compare our Nd isotope records with previously published benthic $\delta^{13}C$ and B/Ca records, measured on the same cores, and used to infer past changes in ocean circulation [8]. We use the observed decoupling between these three proxies to distingish between endmember source changes in the Nd isotope composition and circulation controlled changes, with implications for interpreting changes in the Nd isotope sigatures recorded elsewhere in the N Atlantic.

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