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Apatite in the Upper Zone of the Bushveld (Western Limb)- evidence for a rejuvenated magma at the height of Layer 21?

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The occurrence of apatite and its trace element geochemistry in a borehole core through the Upper Zone from the Western Limb of the Bushveld is reported here (BK1). Apatite displays cyclic behaviour in the upper portion of the Upper Zone, appearing and disappearing several times. Two “spikes” of apatite, where apatite appears in abundance and then disappears suddenly, occur below the magnetitite layer noted as Layer 21, and are marked by a pronounced negative Eu anomaly in the apatite REE profile. The apatite intervals above Layer 21 are marked by sudden appearance and gradual disappearance, and have no Eu anomaly. Previous studies on the UZ in the Eastern Limb have noted this difference in REE profiles and have explained it either as a consequence of the trapped liquid shift, or as an indication of massive liquid immiscibility in the chamber at the level of Layer 21. We propose an alternative solution, in which a rejuvenated magma is injected into the magma chamber at or just below the level of Layer 21. This new rejuvenated magma is likely genetically related to the previous magma but is much higher in Fe and depleted in V compared to the previous magma, and is responsible for the formation of Layer 21 (8m thick), a layer considerably thicker than any other magnetitite layer, including the Main Magnetite Layer. The influx of a new magma is clear in the largest compositional shifts in the Upper Zone across layer 21, shown in the compositions of orthopyroxene (Mg#=25 below; Mg#=49 above), plagioclase (An#=47 below; #An=58 above), and olivine (Mg#=20 below; Mg#=40 below), as well as in the occurrence of liquid immiscibility only in the magma above Layer 21. In this model, the Eu anomaly created by plagioclase fractionation in the apatite below Layer 21 has been diluted by the addition of new magma which has not experienced prolonged fractionation of plagioclase.