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The significance of trace element composition of Fe-Ti oxides on deciphering the PGE fractionation in layered mafic intrusions: an example from the Dufek Intrusion, Antarctica

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Fe-oxides and their trace element characteristics are increasingly evaluated to develop indicator minerals for exploration of ore deposits and to better understand their petrogenesis. The world's most important carriers of Ni-Cu-PGE sulphide and Cr-V-Fe oxide deposits are mafic-ultramafic intrusions. One of the largest of these magmatic bodies is the poorly examined Dufek layered mafic intrusion in Antarctica. It is characterised by enrichment of platinum-group elements (PGE) in the evolved upper part of the 8 – 9 km thick intrusion, where Fe-Ti oxide-bearing gabbroic cumulates, thin Fe-Ti oxide layers and anorthosites alternate. The PGE enrichment is most prominent with up to ~ 800 ppb in the oxide-rich gabbros and in the thin oxide layers in the lower 300 m of the upper third of the intrusion. However, the PGE enrichment is highly variable even in samples of similar mineralogy; elevated PGE concentrations are not evident macroscopically since sulphides are very rare or absent.

To improve our understanding of PGE fractionation in the Dufek Intrusion, which seems to be related to the late-stage formation of oxide-rich cumulates, we investigated the trace element composition of Fe-Ti oxides from cumulates of the upper third of the intrusion. The results of our electron microprobe study of Ti-magnetite so far indicate positive correlations among V, Cr, Ni, Mg and Al that mainly follow fractionation trends with decreasing element abundances up sequence, whereas Mn and Zn increase. An obvious reversal in Ti-magnetite composition occurs at about 1000 m below the top of the intrusion. It correlates approximately with reversals shown by the variation trends of the associated pyroxenes. Above this reversal, a further peak of PGE enrichment (~ 340 ppb) is indicated.

The obtained general variation trends in Ti-magnetite composition indicate that changes in magma composition and related redox conditions due to extensive crystallisation of oxide minerals, as well as repeated magma influx into the crustal Dufek magma reservoir occurred. These processes need to be considered as major processes governing PGE fractionation within this initially sulphur-undersaturated intrusion.

Deviations from the general variation trends exhibited by Fe-Ti-oxides of individual cumulates from the cyclic succession of anorthosites, gabbros, and magnetitites with the highest PGE contents of the intrusion so far, as well as striking differences observed for Ti-magnetite from thin oxide layers and their hosting gabbros have to be further evaluated by more detailed data. Furthermore, it is unclear, why some but not all oxide-rich cumulates are enriched in PGE. We intend to shed light on these issues by presenting the first laser ablation ICP-MS data on further trace elements of Fe-Ti oxides from the Dufek Intrusion.