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Geochemical characteristics of olivine from Karoo picrites with a primitive mantle affinity

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1. Introduction

1) Continental flood basalts (CFB) in the Karoo large igneous province have been divided into the **North and South Karoo groups**

2) **Picrites from Luenha river, Mozambique, represent a primitive mantle-like end-member** required to explain the **higher ΔNb of North Karoo** compared to South Karoo.

3) Luenha picrites have **narrow range of bulk-rock εNd_i (-2.0 to +1.4)** but a **wide range of $^{87}Sr/^{86}Sr_i$ (0.704096-0.71061)** across bulk-rock, plagioclase and groundmass.

AIM: To use olivine to characterize the mantle source of the picrites and elucidate the geological processes that produced their geochemical and petrographic variability.

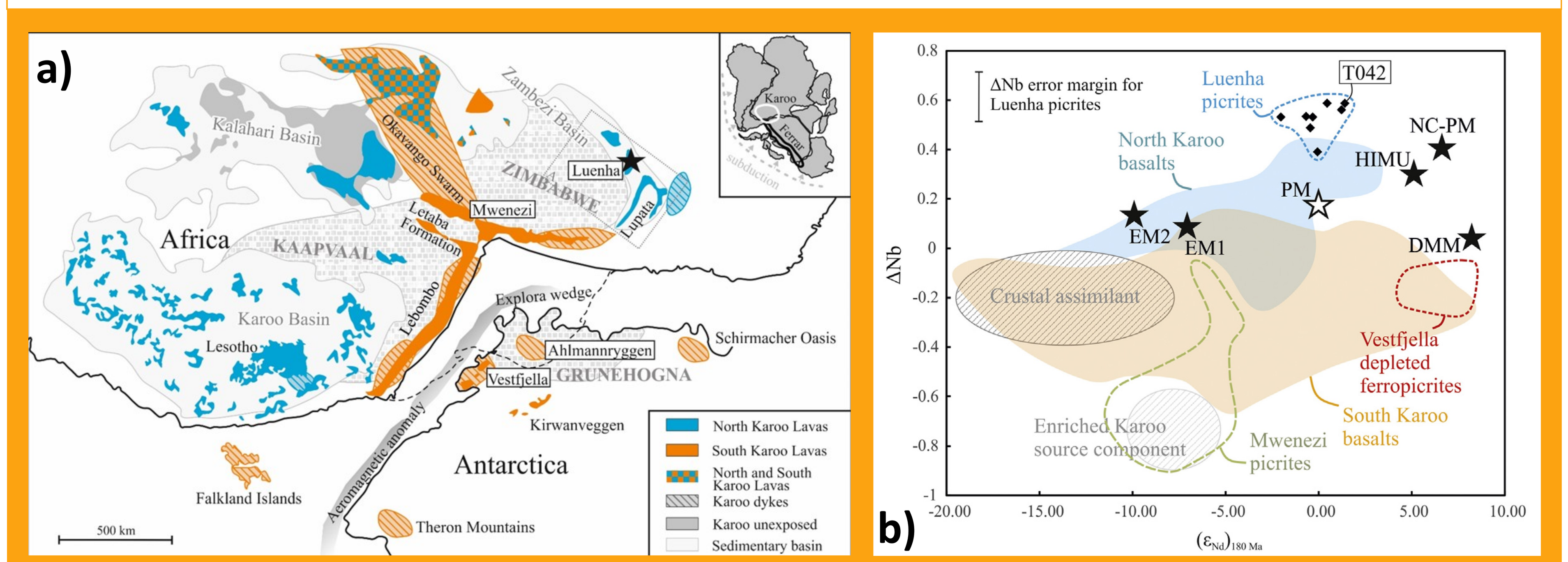

Figure 1. a) Map of the Karoo large igneous province, showing the location of the Luenha river sampling locality. Inset map shows the Karoo and Ferrar provinces in a reconstruction of Gondwana. **b)** CFBs and picrites from Karoo in ΔNb-εNd space, showing the compositional contrast between North and South Karoo basalts, and the positions of three picrite suites (including Luenha) and crustal contaminants as end-members of the compositional variation. Note the similarities between the Luenha picrites and primitive mantle (PM) and non-chondritic primitive mantle (NC-PM). From Turunen *et al.* (2019).

2. Analytical Methods

Two samples with contrasting compositions: **T042**, the most primitive sample, with low $^{87}Sr/^{86}Sr_i$, and **T026F**, with high $^{87}Sr/^{86}Sr_i$. **Trace element data were acquired for olivines** *in situ* from petrographic thick sections of both samples via laser ablation inductively-coupled plasma mass spectrometry (**LA-ICPMS**) at the **Department of Geosciences and Geography, University of Helsinki**. **Preliminary O isotope data for olivines** from **T026F** were acquired via **ion microprobe** at the **NordSIM** facility of the Swedish Natural History Museum.

3. Olivine Compositions

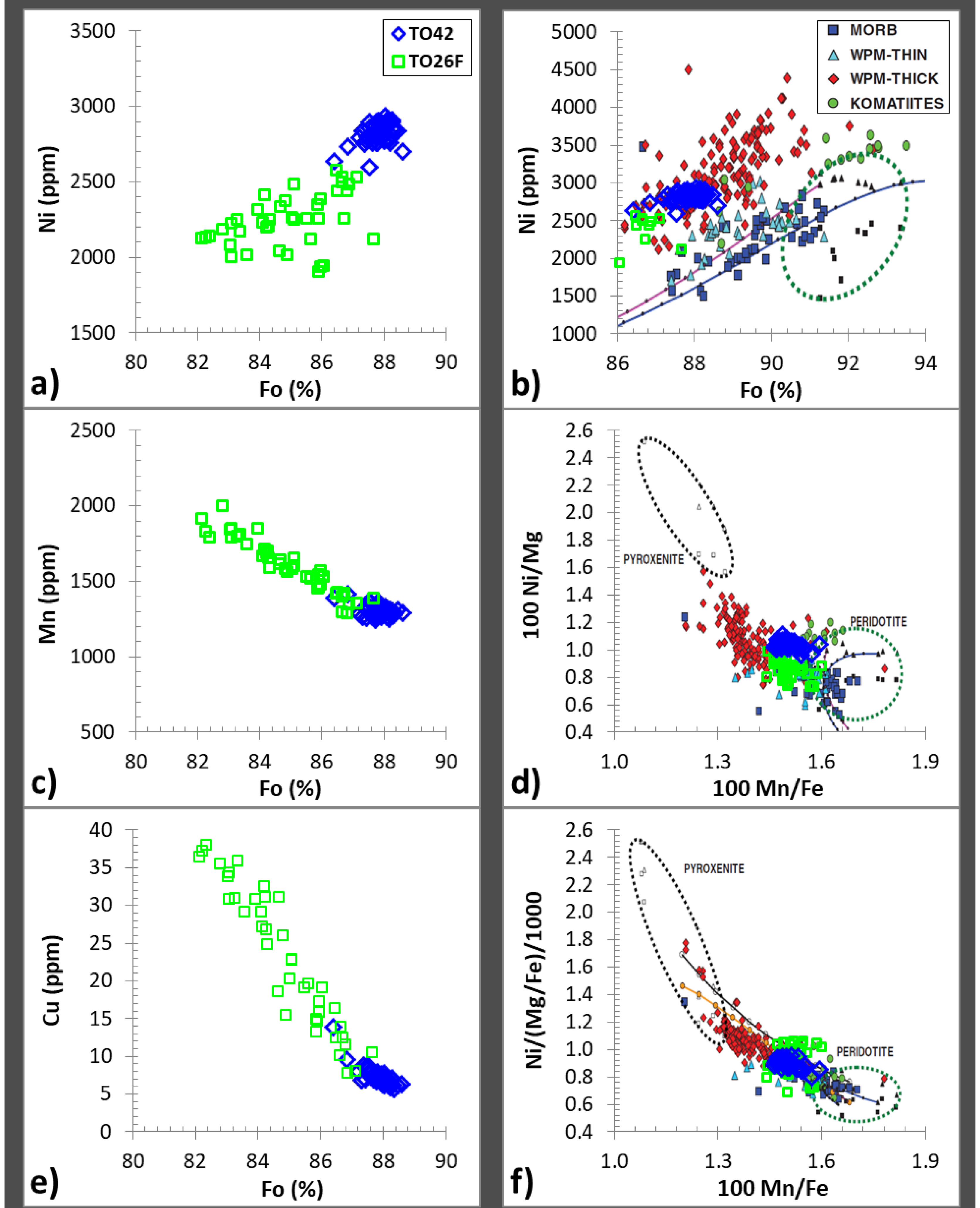

Figure 2. a), c) & e) Trace element concentrations plotted against the Fo content of olivines. The data show minor overlap and coherency of geochemical trends between the two samples. **b), d) & f)** Olivine data shown on Ni vs Fo and Ni-Mg-Fe-Mn element ratio plots used by Sobolev *et al.* (2007) to show the influence of peridotite versus pyroxenite in the mantle source regions of basalts. Although the Ni contents are high, the data show closer affinity to peridotite-derived MORB and within-plate-thin-lithosphere (WPM-THIN) than to the pyroxenite field in **d) & f)**.

4. Preliminary O Isotope Data

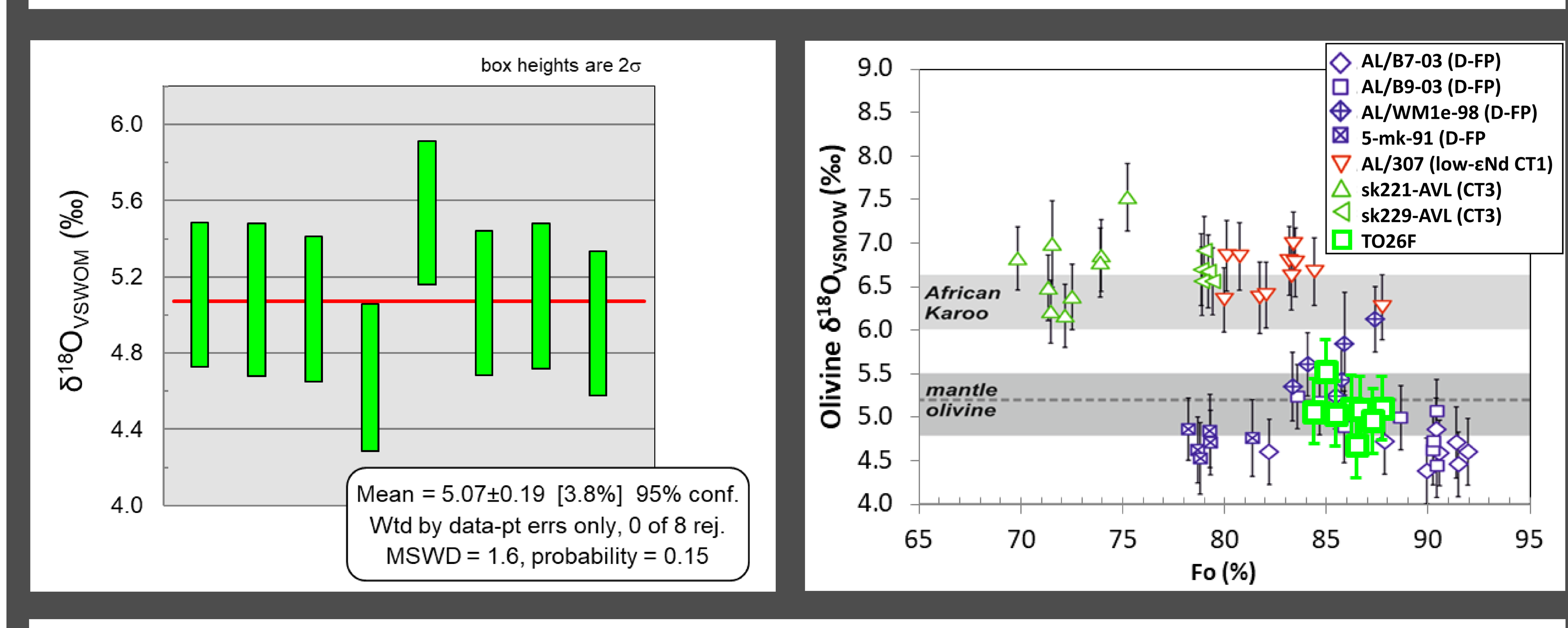

Figure 3. Preliminary O isotope data. **a)** Individual analyses and the average composition of olivine from sample TO26F. **b)** Comparison of TO26F with olivine from Antartica on the plot of Heinonen *et al.* (2018). The "African Karoo" field is based upon the data of Harris *et al.* (2015), and the "mantle olivine" range and average are from Matey *et al.* (1994) and Eiler (2001), respectively. The weighted mean composition is within uncertainty of the oxygen isotope composition of mantle-derived olivine. Although the $^{87}Sr/^{86}Sr$ of 0.707124 for sample TO26F is relatively high, these O isotope data suggest little to no crustal contamination in the sample. The data, although limited to n = 8, show little isotopic heterogeneity, which suggests mixing of isotopically distinct sources in not involved.

5. Findings and Future Work

- **Coherent trends** for olivine Fo content versus trace elements suggests olivine **compositions are related via fractional crystallisation.**
  - Within-sample diversity shows that the bulk-rocks sample a range of the crystallisation history
- Olivine trace element data support at most a **minor contribution from pyroxenite** in the mantle source region—source is likely **peridotite-dominated.**
  - Consistent with **peridotite origin inferred from bulk-rock Zn/Fe-Mn/Fe** data and the **primitive mantle affinity** suggested by bulk-rock **ΔNb, εNd_i and trace element patterns** (Turunen *et al.* 2018).
- Preliminary **O isotope data show typical mantle values**, without suggestion of crustal contamination or involvement of recycled crust in mantle source region, thus the evolved Sr isotope compositions may reflect late-stage, higher level magmatic contamination.
- **Larger dataset of olivine O isotope data to be acquired for 4 samples** will allow more clear assessment of magma or source contamination and the cause of Sr isotopic variability.
  - These data will be paired with major element data to trace magmatic processes
- In parallel, a detailed petrographic and mineral chemistry study will aid interpretation of trace element and O isotope data.