

Archean cratons on Mars?: Evidence from trace elements, isotopes and oxidation states of SNC magmas

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Recent studies of the basaltic shergottites indicate that their source in the Martian mantle was highly reduced (~IW), but that some of these shergottite parent magmas incorporated a highly oxidized (\geq -QFM) "crust-like" component (Wadhwa, 2001; Herd et al., 2001). In this work, we estimated the oxidation state of the parent magmas of the nakhlites. Combining redox constraints for the shergottites and nakhlites with their isotopic systematics (particularly Rb-Sr, ^{147,146}Sm-^{143,142}Nd and ¹⁸²Hf-¹⁸²W; McSween, 2002 and references therein) allows us to infer their source characteristics and the nature of the oxidized component in some of these rocks.

Using Eu/Gd ratios in augites (Wadhwa and Crozaz, 1995) and REE augite/melt partitioning values (Oe et al., 2002), we estimate that the nakhlite parent magmas were at least as oxidized as Shergotty. However, unlike Shergotty (initial ϵ Nd ~-8 at 180 Ma; high initial ⁸⁷Sr/⁸⁶Sr; no ¹⁴²Nd or ¹⁸²W anomalies), the nakhlites are characterized by positive initial ϵ Nd (~+16 at 1.3 Ga in Nakhla), relatively low initial ⁸⁷Sr/⁸⁶Sr, and excesses in ¹⁴²Nd and ¹⁸²W. Clearly, the isotopic systematics in the nakhlites suggest a depleted mantle source isolated early in Mars' history (similar, although not identical, to the source inferred for QUE 94201, the most reduced of the basaltic shergottites). However, this is complicated by the fact that the nakhlite parent melt was LREE-enriched (Wadhwa and Crozaz, 1995) and oxidized. We propose here that the range of trace element-isotopic compositions and oxidation states in the basaltic shergottites and nakhlites could be explained by the formation of distinct mantle reservoirs early in the differentiation history of Mars: (1) depleted reservoirs in the deep mantle that degassed early and became reduced through loss of volatiles such as H₂O and CO₂ and (2) ancient cratonic reservoirs that were stabilized in the shallow mantle and were subsequently variably metasomatized and oxidized by the melts and degassed volatiles from the deep mantle.

References

- Herd C. D. K. et al. (2001) *American Mineral.* **86**, 1015-1024.
 McSween H. Y., Jr. (2002) *Meteoritics Planet. Sci.* **37**, 7-25.
 Oe K. et al. (2002) *Lunar Planet. Sci. XXXII*, #2065.
 Wadhwa M. (2001) *Science* **291**, 1527-1530.
 Wadhwa M. and Crozaz G. (1995) *Geochim. Cosmochim. Acta* **59**, 3629-3645.

Inferences about magma reservoir dynamics from zoned clinopyroxenes of an alkaline suite in North Morocco

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Introduction

The degree to which shallow-level processes affect the geochemical characteristics of the mantle sources can now be best approached with in situ microanalysis. We present here the results of a major and trace element investigation of clinopyroxenes from alkaline rocks of North Morocco, known to be isotopically different and related to an open-system evolution [1].

Results and discussion

Clinopyroxenes are Al-rich diopside and salite enriched in incompatible elements. Frequently present in a same rock, they exhibit a complex zoning, with resorbed cores. Al content shows that cores and rims follow a trend of low-pressure origin; the cores have thus been introduced into the magma reservoir through magma mixing.

Compositional profiles from core to rim show abrupt chemical variations suggesting repeated mixing episodes. Some crystals have recorded up to four cycles of crystallization interrupted by episodes of mixing between \pm evolved melts. The decoupling between major and trace elements resembles that resulting from fractional crystallization in periodically refilled magma chambers [2]. The volatile-rich lamprophyric magmas may likely have enhanced a turbulent regime which disrupt any compositional and thermal gradient.

References

- [1] Wagner et al. (2002, submitted to *J. Petrol.*).
 [2] Neumann et al. (1999) *J. Petrol.* **40**, 1089-1123.