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Multi-stage melt-rock interactions in peridotite xenoliths inferred from micro textural and chemical evidences.

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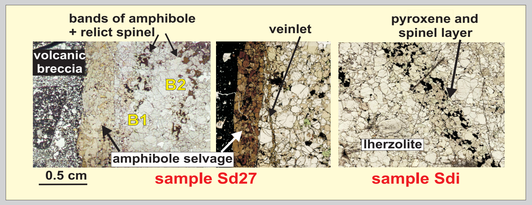
Introduction

♦ The xenoliths are anhydrous and hydrous (amphibole +/- mica) protogranular spinel lherzolites from the French Massif Central (Devès province).

♦ The xenoliths are fresh with no evidence of host magma infiltration.

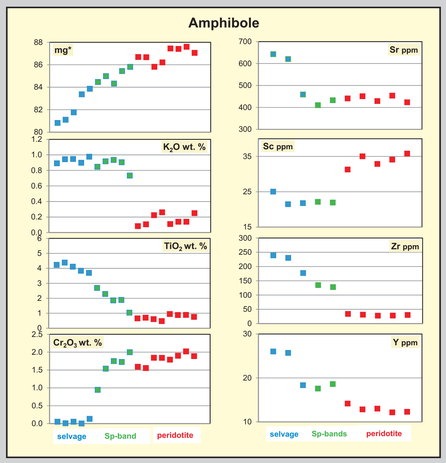
♦ We present a detailed investigation of the amphibole occurrences, compositions and destabilization textures observed in some nodules.

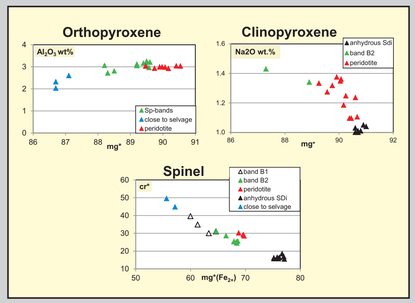
♦ The hydrous samples are composite nodules partially surrounded by a kaersutite (+/- phlogopite) selvage. In the peridotite part, amphibole fills veinlets, forms bands with relict spinels, and occurs as disseminated pargasite crystals.



1- Evidence for migration of a metasomatizing melt

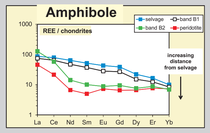
Composition of amphibole and anhydrous phases

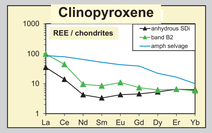




♦Amphibole from the hydrous *SDi nodule* shows compositional gradients in major and trace elements along the veins (*i.e.* along percolation paths) and away from the peridotite / selvage contact:
- decrease in Ti, Fe, K, Sr, Zr, Y
- increase in Cr, Mg, Na, Sc

♦Anhydrous phases show similar variations with distance from the selvage.





♦ Both amphibole and clinopyroxene have similar LREE-enriched patterns.

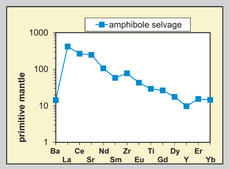
♦ Clinopyroxene from the anhydrous SDi nodule is also LREE-enriched.

The peridotite has been modified adjacent to hydrous selvage and veins by reactions with a metasomatic agent emanating from the selvage forming melt.

These modifications are here evidenced on a cm-scale distance from the zone of initial melt supply.

Metasomatic modifications in anhydrous samples are likely to result from the same metasomatic episode.

Parental melt



♦ The melt pattern calculated from the composition of the selvage amphibole is rich in incompatible elements.

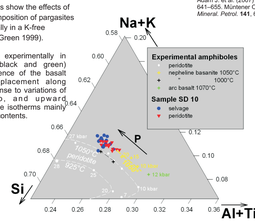
Partition coefficients from Chazot et al. (1995) *Geochim. Cosmochim. Acta*, 60, 423-437, 1996

P-T *vs.* chemical effects on the composition of pargasite

The white isotherms show the effects of T and P on the composition of pargasites grown experimentally in a K-free peridotite (Niida & Green 1999).

Pargasites grown experimentally in basalts (yellow, black and green) illustrate the influence of the basalt composition: displacement along isotherms in response to variations of the Si/Al ratio, and upward displacement of the isotherms mainly due to the K and Ti contents.

Adam J. et al. (2007) *Eur. J. Mineral.* **19**, 641-655. Mcinerney D. et al. (2001) *Contr. Mineral. Petrol.* **141**, 643-658. Niida K. &



♦ Amphiboles from sample SD10 belong to the K-bearing, "alkaline basaltic" type with slight differences between selvage (blue) and peridotite (red, Al-richer and Ti-poorer).

The parental melt is likely to be an alkali basalt magma, as indicated by the calculated trace element composition.

Moreover, the potassic and alkaline nature of the parental melt is further supported by the amphibole composition.

2- Reactional sites

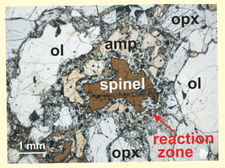
♦ **Reaction zones have only been observed in a few nodules (<10%), either hydrous or anhydrous samples. We present here data from four samples: hydrous, *La25 and Sd10*, and anhydrous *La7 and Mg102*.**

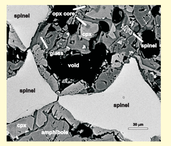
♦ **In all samples, there is no evidence of host magma infiltration, and the reaction zones are not particularly developed near the host lava contact.**

♦ **Three distinct types of reaction zones have been identified around amphibole, orthopyroxene (opx) and spinel, while clinopyroxene (cpx) rarely show reactional rims.**

Petrographic features

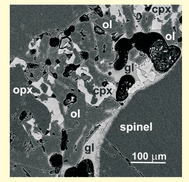
♦ Amphibole reaction zone at the contact with spinel, *sample La25*.





♦ It consists of secondary olivine, cpx, spinel, formerly volatile filled bubbles and patches of fresh glass.

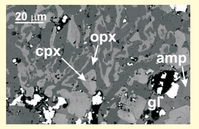
♦ Similar secondary assemblages of olivine, cpx, spinel and glass are observed at the contact between primary spinel and opx in anhydrous nodule (*sample La7*).
- the primary spinel shows destabilized rim.
- relict opx is observed embedded in secondary cpx.



Anhydrous La7

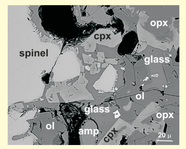
♦ Orthopyroxene reaction zone, *sample La25.*

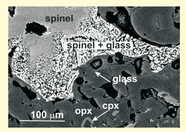
♦ It consists of olivine, cpx, glass, and rare spinel.



♦ Spinel reaction zone, *samples Sd10, Mg102.*

- sieve-textures are developed on spinel rim at contact with glass.
- the width of the reaction zone is variable.



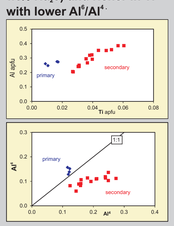


♦ Similar sieve textures have been developed experimentally on spinel by reaction of alkali melts and peridotite
(e.g. Shaw et al., (2008) Contrib. Mineral. Petrol., 155, 199-214).

Secondary phase composition

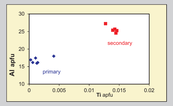
Clinopyroxenes

The are less sodic (0.8 / 1.5 wt% Na_2O) and richer in Ti with lower Al^{iv}/Al^{vi}

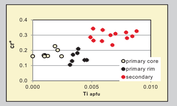


Spinels

They are found in two occurrences:
- **as isolated crystals in the glass or secondary olivine.**
- **in a reactional sieve-texture rim at the glass / primary spinel contact.**



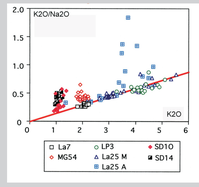
♦ In *sample Sd10*, the detabilized rim shows an inner Al-enriched zone followed by a Cr-enriched zone.



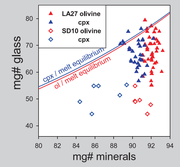
Glasses

♦ **The glass is rich in total alkalis (6-8 wt. %), Al_2O_3 (22-24 wt. %) and contains up to 7 wt. % FeO and up to 3 wt. % TiO_2.**

♦ **The glass composition is variable between different samples and different sites.** *red line: Yémen glasses: in situ melting of* amphibole, *Chazot et al, 1996, Chem. Geol.,134,159-179.*



♦ **The glass is not in equilibrium with the secondary minerals. In the anhydrous *La7 sample*, we observed a trend towards equilibrium.**



♦ **The similarity in nature and composition of the secondary phases observed in the reaction zones in both hydrous and anhydrous nodules, suggests the presence of a former amphibole in the anhydrous nodules.**

♦ **The presence of reaction zones is rare (<10%) among the nodules studied, either hydrous or anhydrous.**

♦ **This suggests that heating and decompression associated with the transport of the xenoliths to the surface is not sufficient to explain the amphibole breakdown.**

♦ **This is further supported and constrained by the composition of the glass from the reaction pockets. Although partly controlled by the amphibole composition, the glass composition evidences the need for an additional component, particularly to account for the alkali budget.**