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The spinel lherzolite at Lherz: a result of mantle refertilization?

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The Lherz Massif, in the French Pyrenees, is the type locality for 'lherzolite', which is the predominant rock type in the lower part of the peridotite body (to the NW). The lherzolites are equilibrated in the spinel peridotite facies. They are strongly deformed and interlayered with thin, boudinaged websterite layers. In the upper part of the massif (to the SE), however, the lherzolites are intermingled with numerous bodies of highly refractory harzburgites which are the predominant rock type. In this area, the lherzolites show a strong websterite-peridotite compositional layering but they are only weakly deformed. In such, they differ markedly from the associated harzburgites, which are strongly and homogeneously deformed.

The spinel lherzolites have a depleted Nd-Sr isotopic signature comparable to that of the MORB-type asthenospheric mantle. In contrast, the harzburgites have enriched isotopic signatures indicating their derivation from LREE- and LILE-enriched refractory mantle isolated in the subcontinental lithosphere for at least 1 by - a feature which is further corroborated by Os isotopes. The two different units recognized in the massif are separated by a narrow ($<$ 10 m) but extremely convoluted boundary. In map, the complicated shape of the contact results in the isolation of rounded bodies and lenses of harzburgites within anastomosed bands of the spinel lherzolite /websterite suite. However, the parallelism of the harzburgite fabric between individual bodies suggests that they are connected to the main harzburgite unit in 3D. Websterite layering in the spinel lherzolite/websterite suite tends to parallel the contact and is clearly oblique on the pervasive and homogeneously oriented foliation of the harzburgites.

Structural observations and geochemical data indicate that the spinel lherzolite/websterite suite was developed at the expense of the harzburgites via a near-solidus refertilization reaction involving precipitation of pyroxene, spinel and minor amphibole at the expense of olivine and infiltrated melt. The boundary between the spinel lherzolite/websterite and harzburgite units is therefore considered as a reaction front that would also trace the upper limit of silicate melt infiltration in the lithospheric mantle. Geochemical evidence for the refertilization reaction include nearly constant concentration of moderately incompatible elements in the lherzolite minerals (e.g., Ti in Cpx) and transient (chromatographic), convex-upward normalized REE patterns in Cpx at the harzburgite-lherzolite transition.

Based on these new structural and geochemical findings, we consider that the fertile spinel lherzolites of the Lherz Massif represent refertilized mantle rather than 'pristine' mantle that would have preserved most of the primitive mantle composition. The most likely episode to place the refertilization event at Lherz is the late-Variscan, post-collisional thermal event responsible for granulitic metamorphism in the Pyrenees.