Pristine metasomatic melt preserved in mantle rocks of the Bohemian Massif

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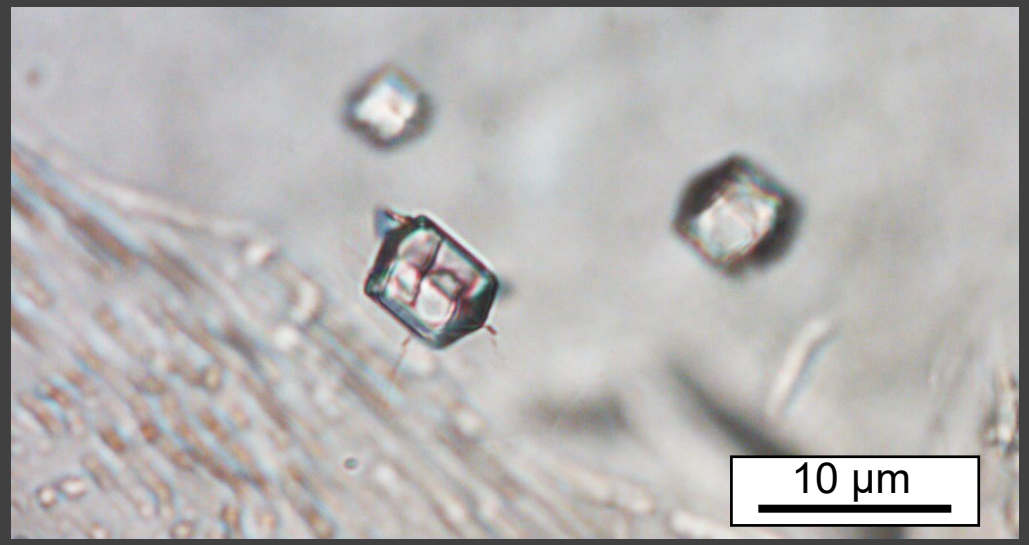

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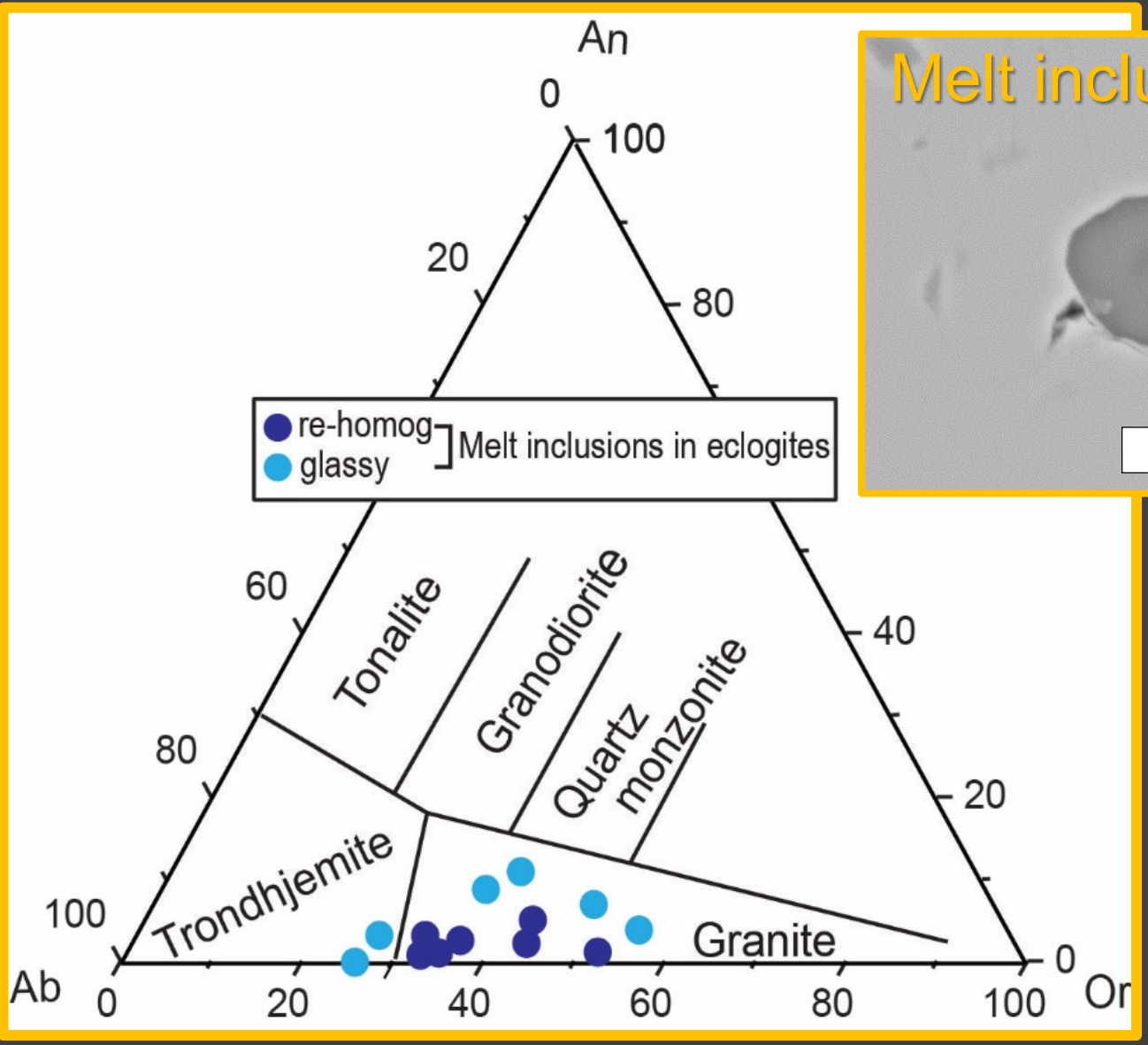
Borghini et al., 2020. Cryptic metasomatic agent measured in situ in Variscan mantle rocks: Melt inclusions in garnet of eclogite, Granulitgebirge, Germany. JMG 38, 207-234, https://doi.org/10.1111/jmg.12519.

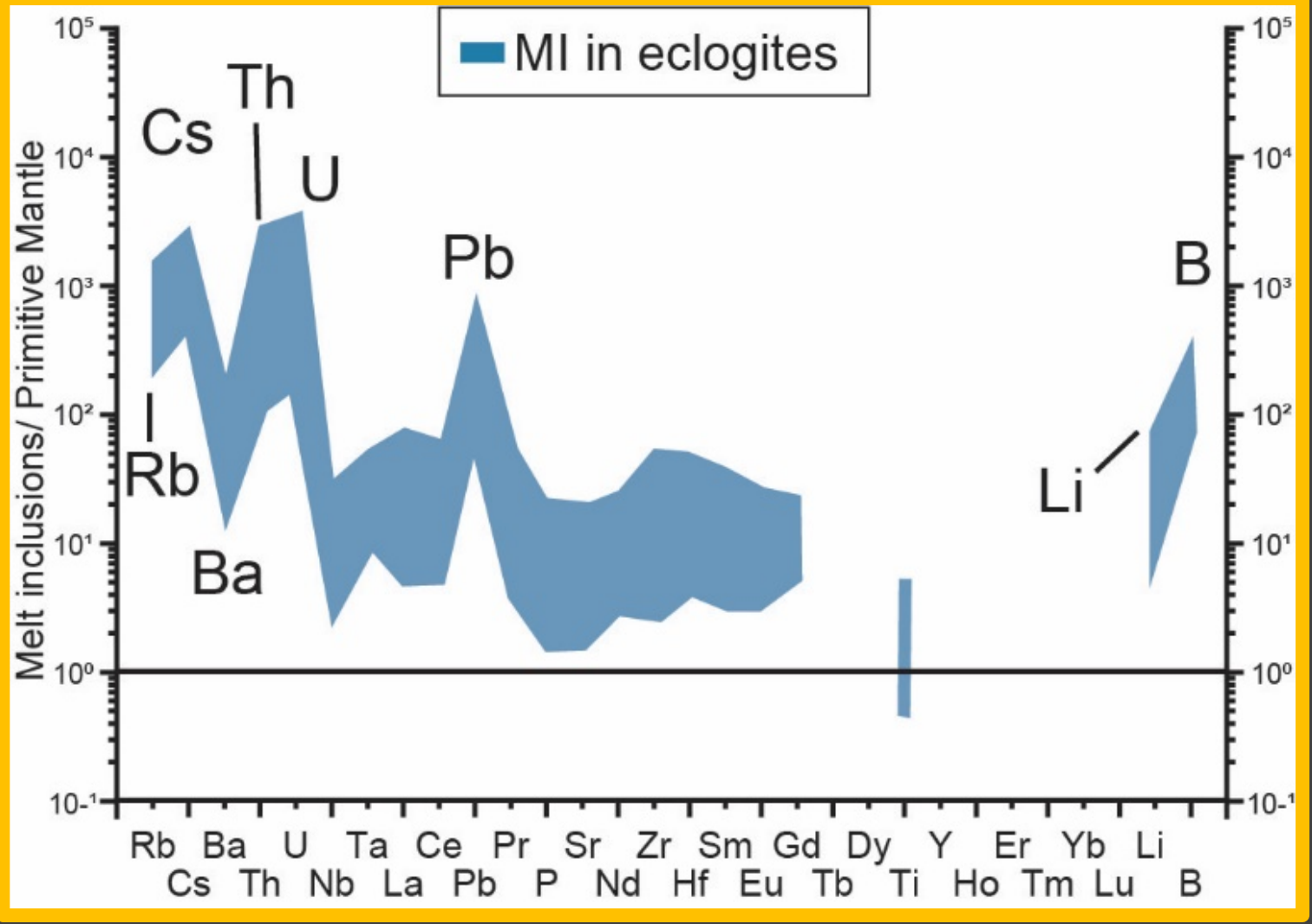
PROBLEM: Granitic melt in garnet of mantle eclogites



The melt is granitic, hydrous, high in alkalis (~9 wt%) and mildly peraluminous (~1.10).

Melting of ultramafic and mafic rocks generally produce respectively basaltic and tonalitic, trondhjemitic or dacitic melts.

PROBLEM: Continental crust signature in melt



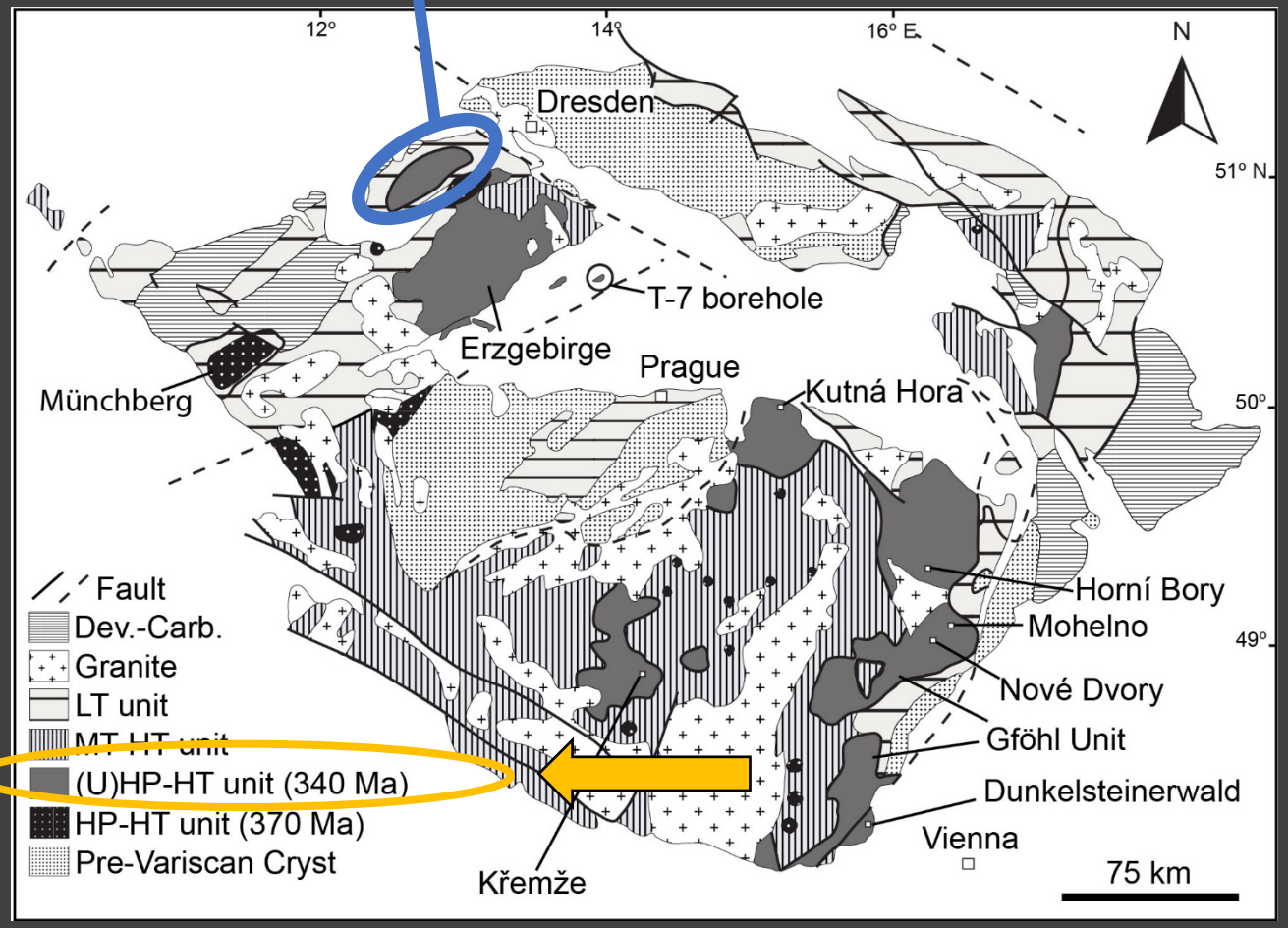
Melt enriched in LILE (Cs in particular), Th, U, Pb, Li and B

Enrichment in LILE, Pb and depletion in Ti and negative anomaly of Nb typical of the continental crust signature (Hartmann & Wedepohl, 1993)

How a granitic melt with a continental crust signature is trapped in mantle rocks?

WHERE: Bohemian Massif

Granulitgebirge



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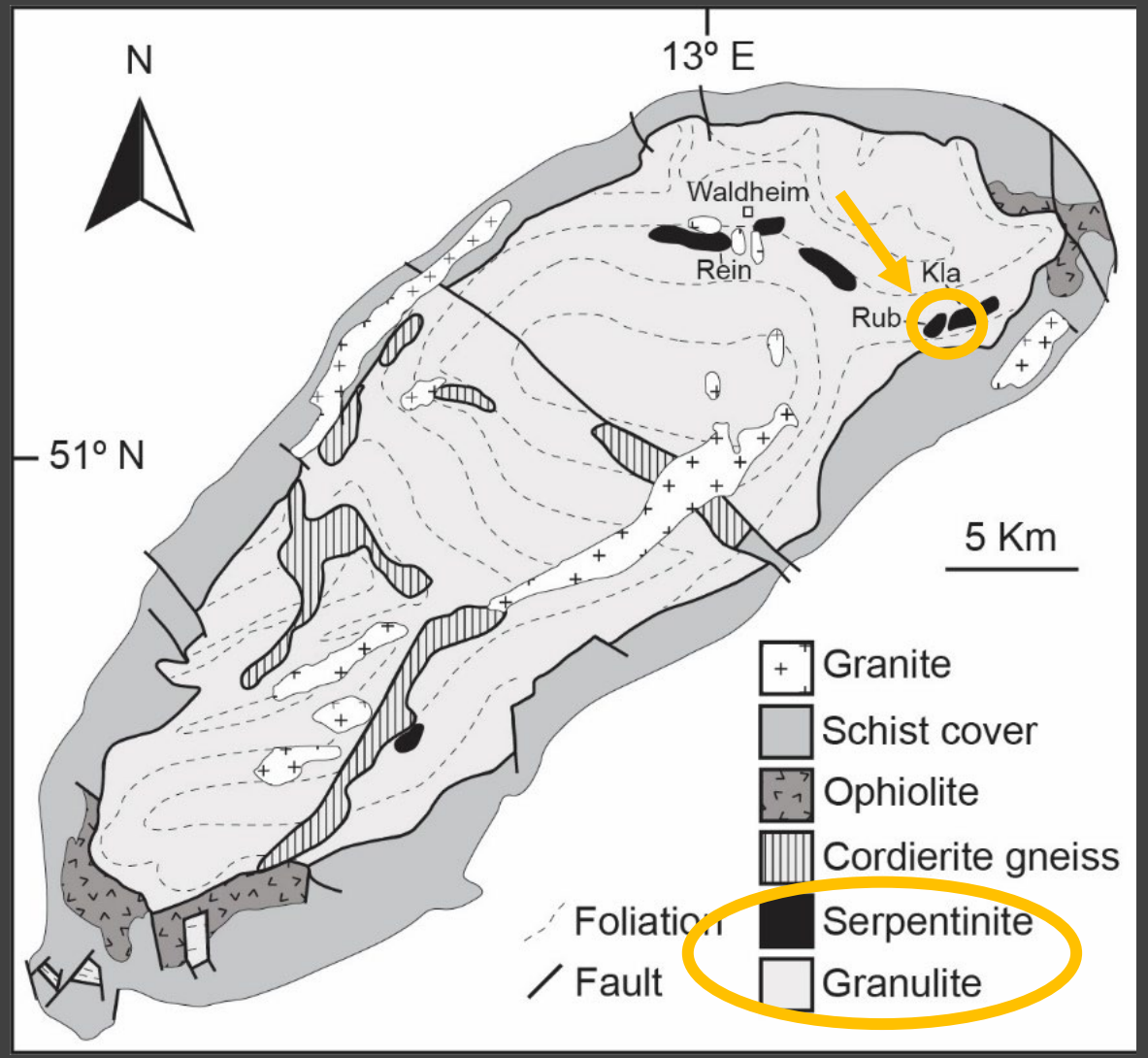
Two stages of formation (O'Brien, 2000):

a. Early oceanic subduction

b. Continental deep subduction (ca. 340 Ma) and exhumation with production of nappe complexes: different types of mantle peridotites with enclosed pyroxenites and eclogites surrounded by HT-HP felsic granulites

Granulitgebirge eclogites in peridotites



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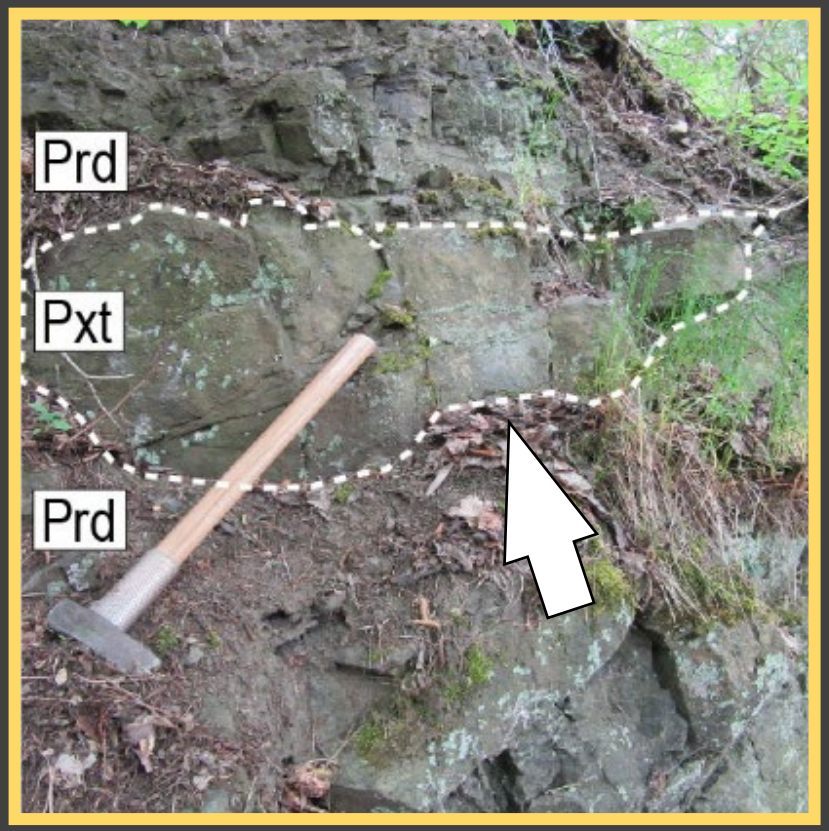
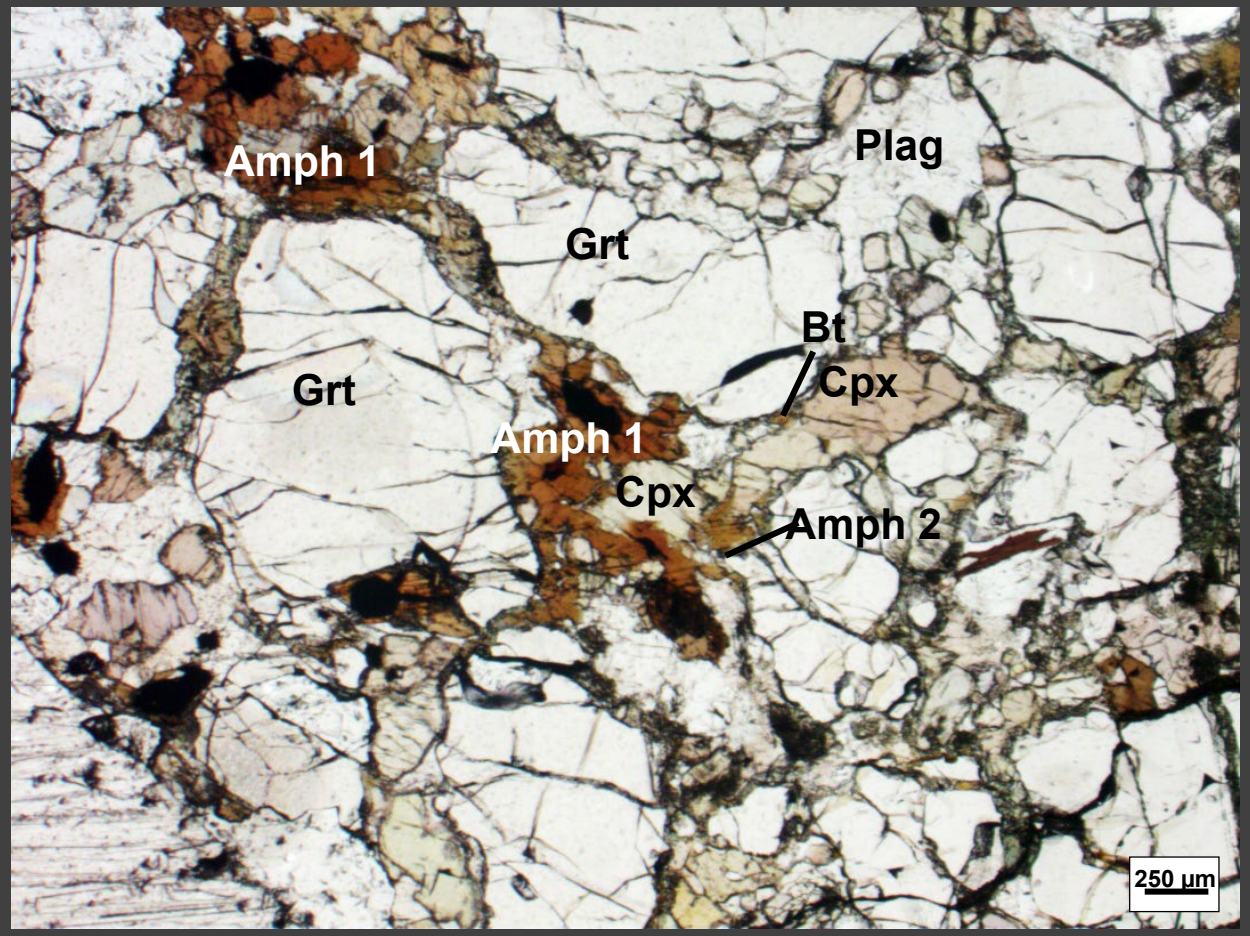
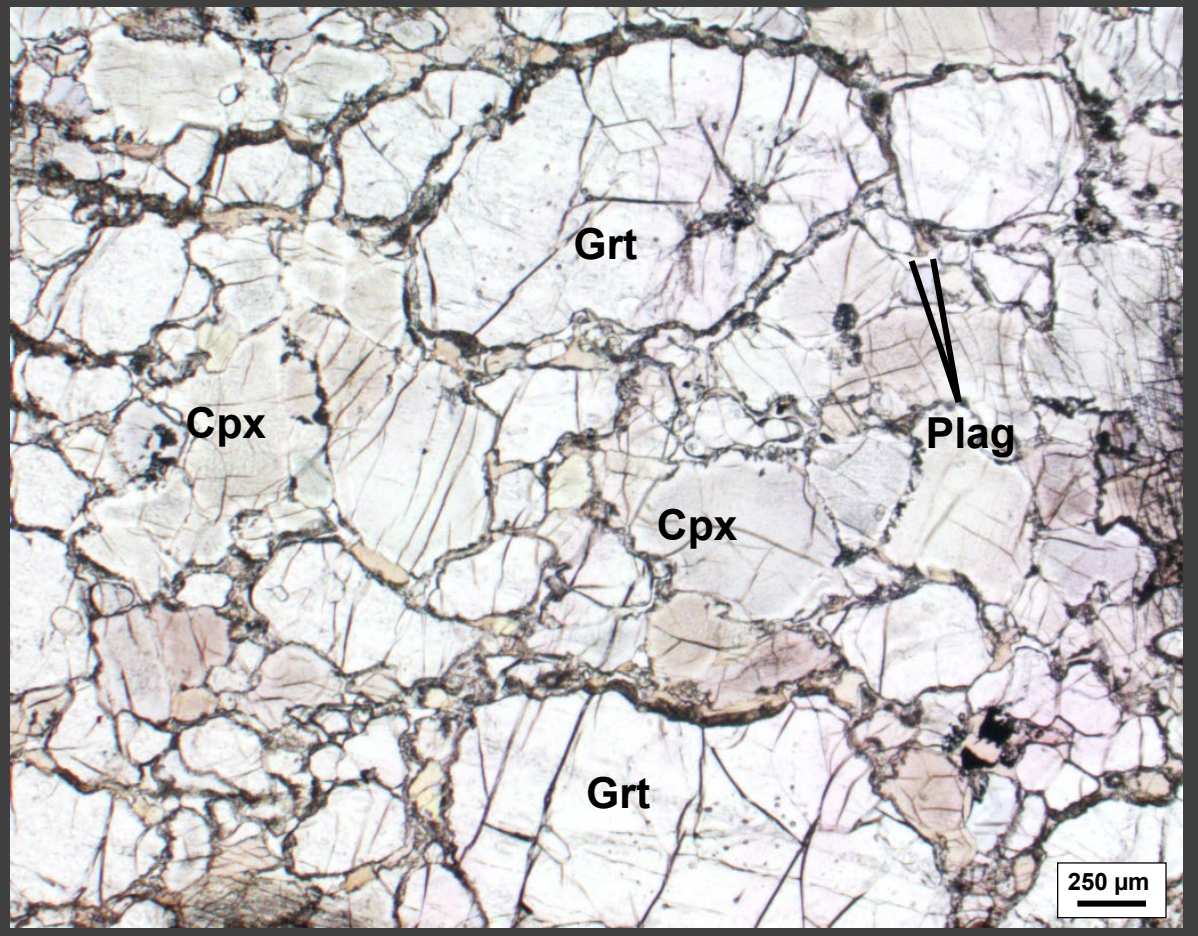


Eclogite occurs as one single lens in serpentinized garnet peridotites, hosted in felsic HP granulites.

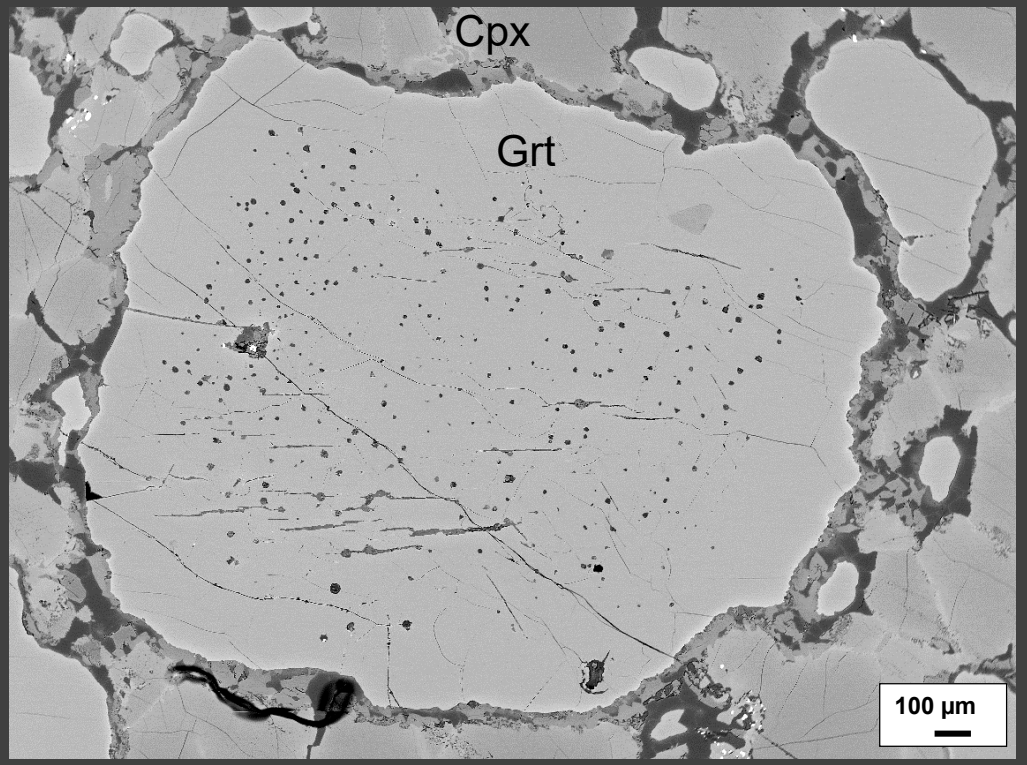
SAMPLES: HP eclogites



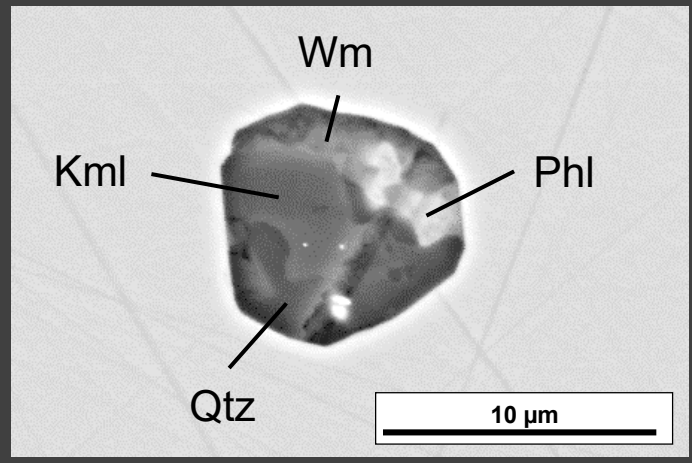


Garnet and clinopyroxene + secondary plagioclase, amphibole and biotite

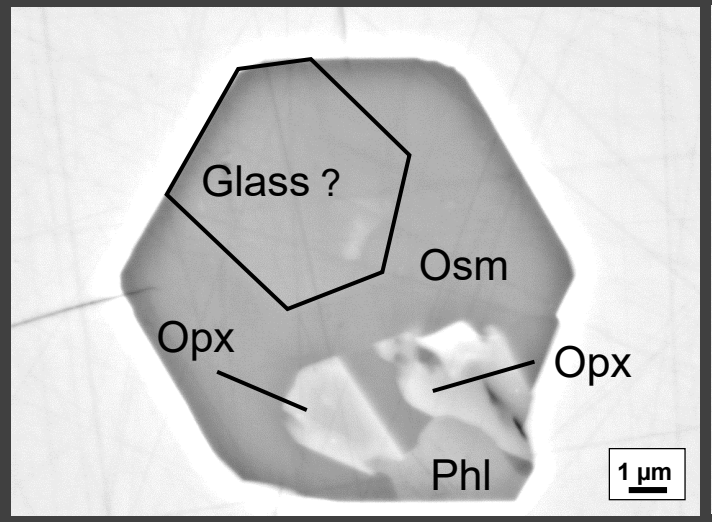
TOOLS: Nanogranitoids

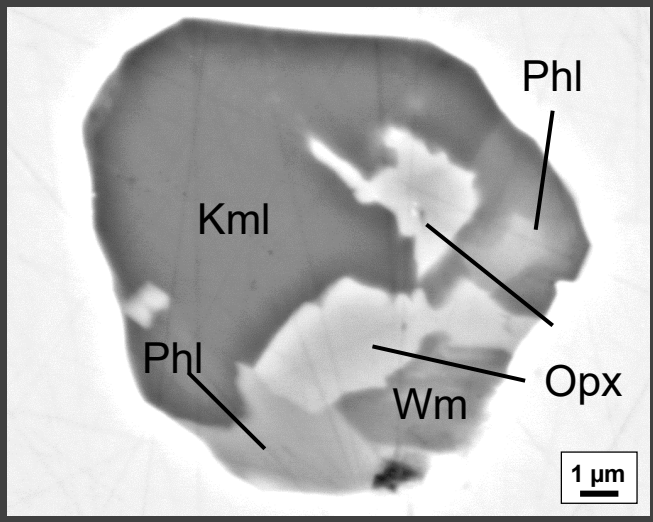


Primary melt inclusions both nanogranitoids (polycrystalline) and glassy randomly distributed in the inner part of the garnet.

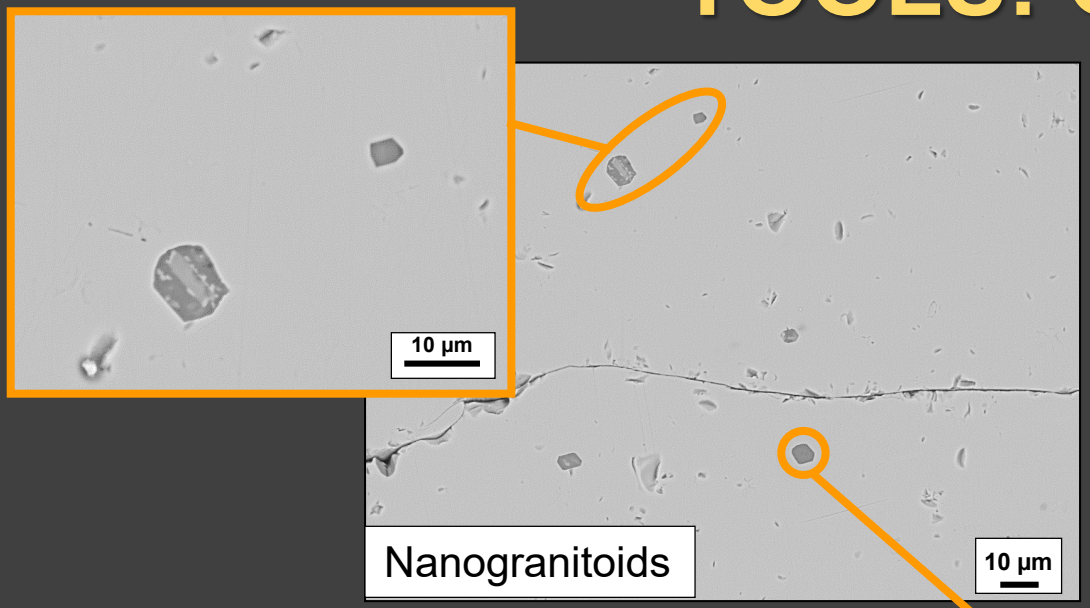


Main mineral assemblage in nanogranitoids: kumdykolite or albite, phlogopite, osumilite, kokchetavite; ± quartz, white mica, orthopyroxene and carbonate.

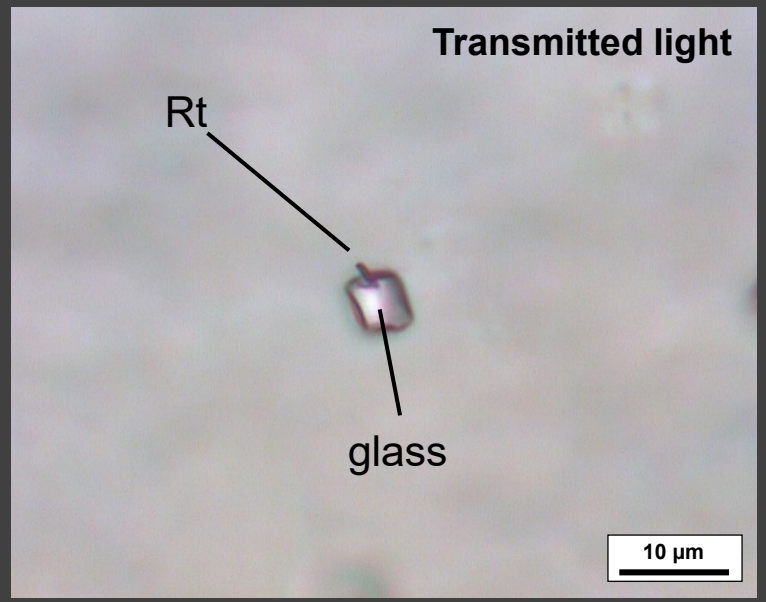


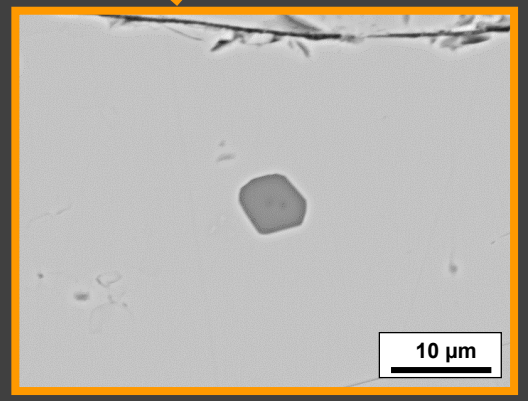


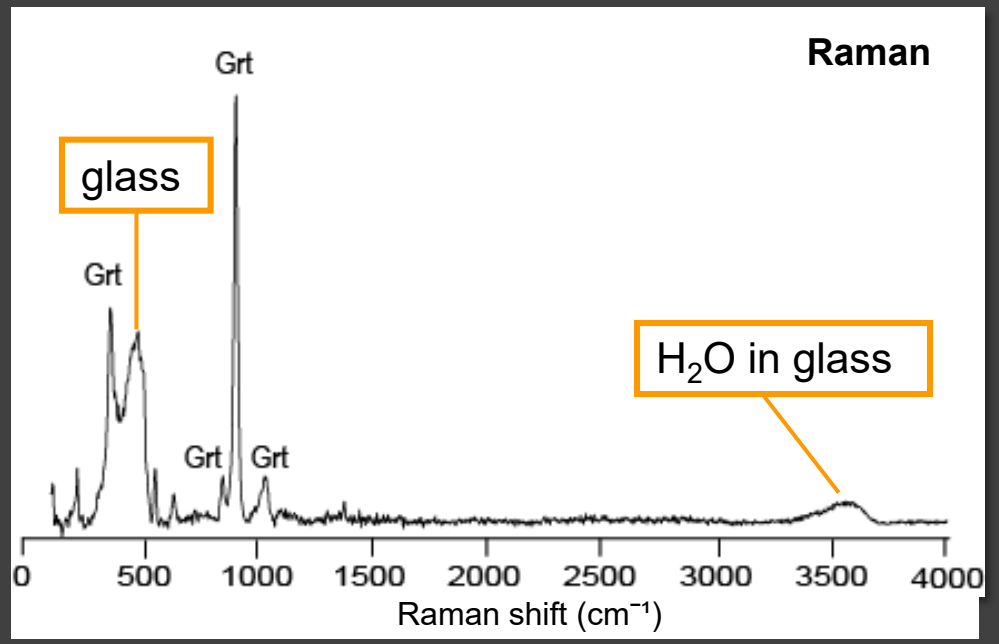
TOOLS: Glassy inclusions



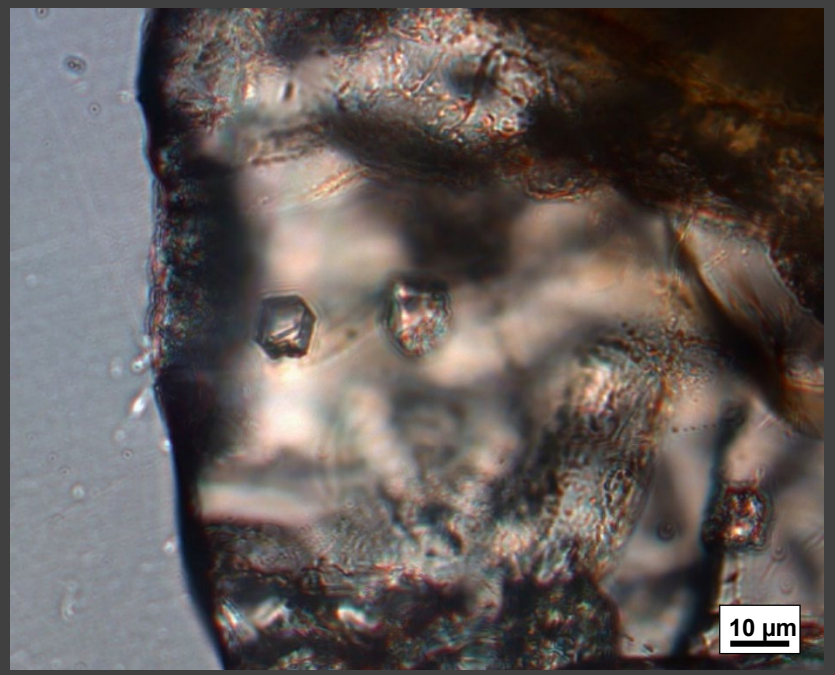
Glassy inclusions occur in the same cluster with the nanogranitoids.
They can be directly measured in order to obtain the melt composition.

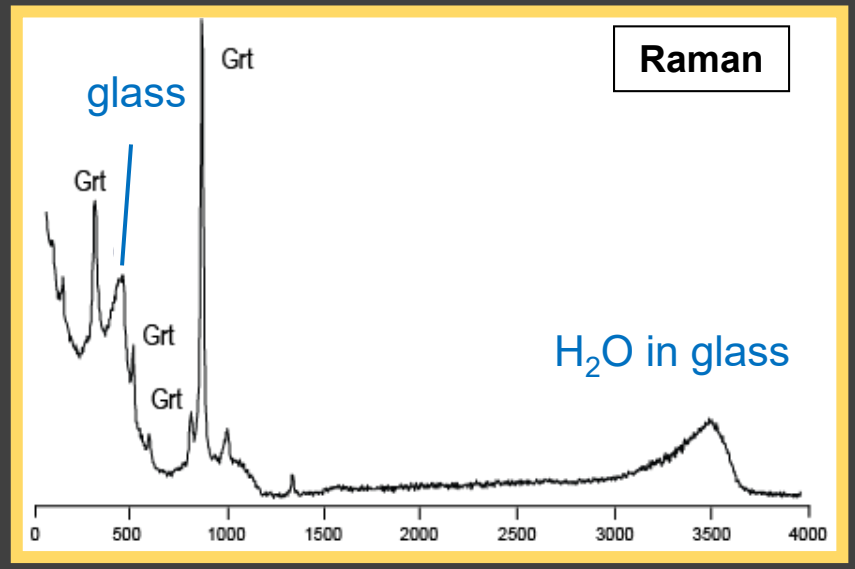






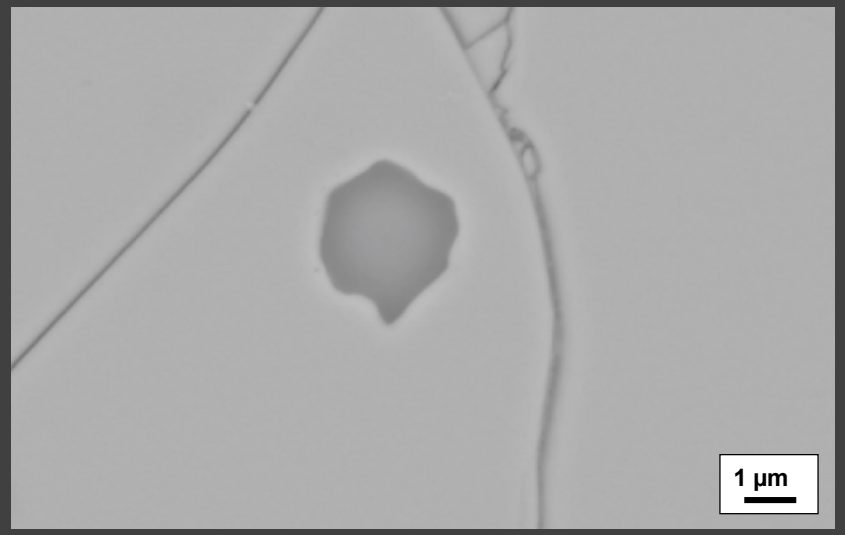
TOOLS: Re-homogenization experiments

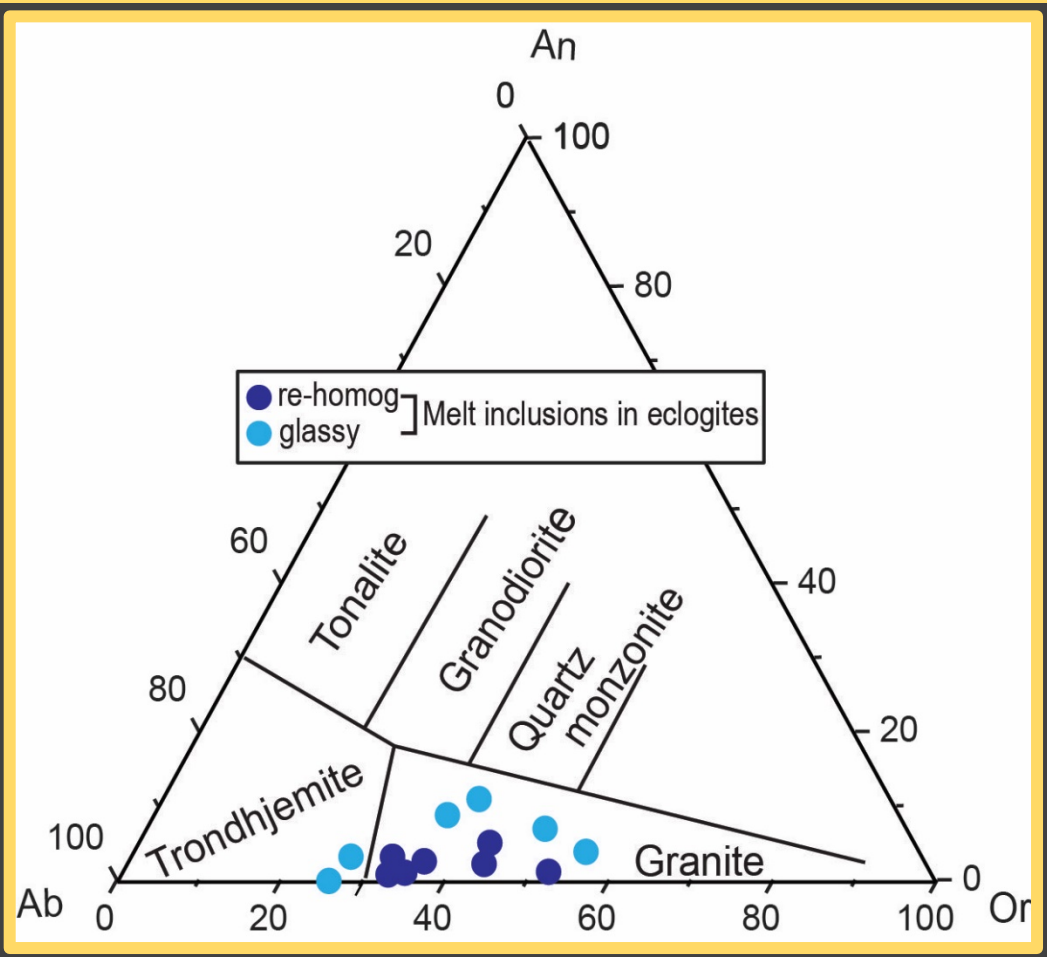


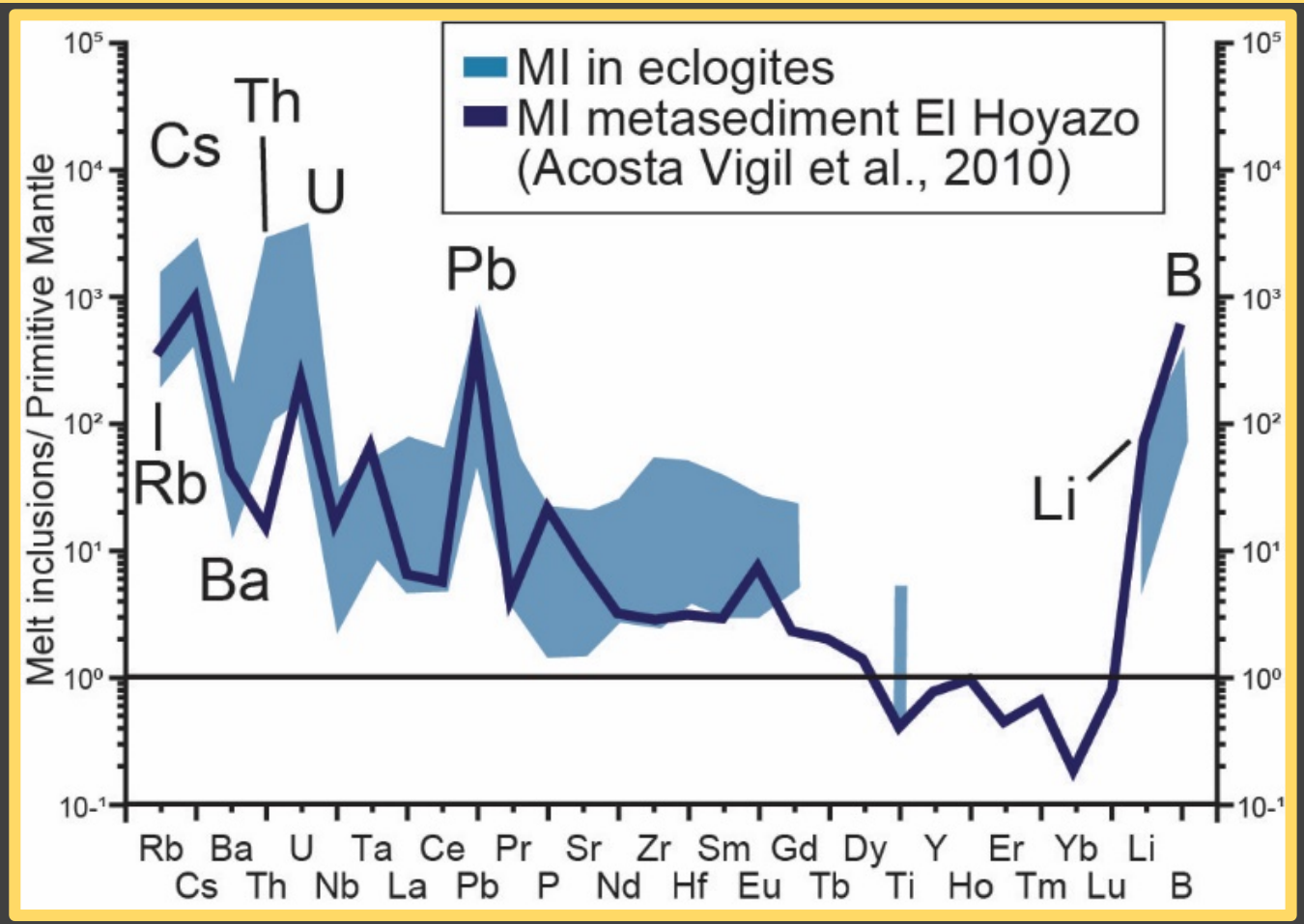


Nanogranitoids

re-homogenized in a piston cylinder apparatus at 1000-1050 °C, 1.5-2.2 GPa to a hydrous glass that can be analyzed (P-T conditions used are expected for the formation of the garnet, Borghini et al., 2018)







Granitic composition and enrichment in LILE (Cs in particular), Pb, Li and B

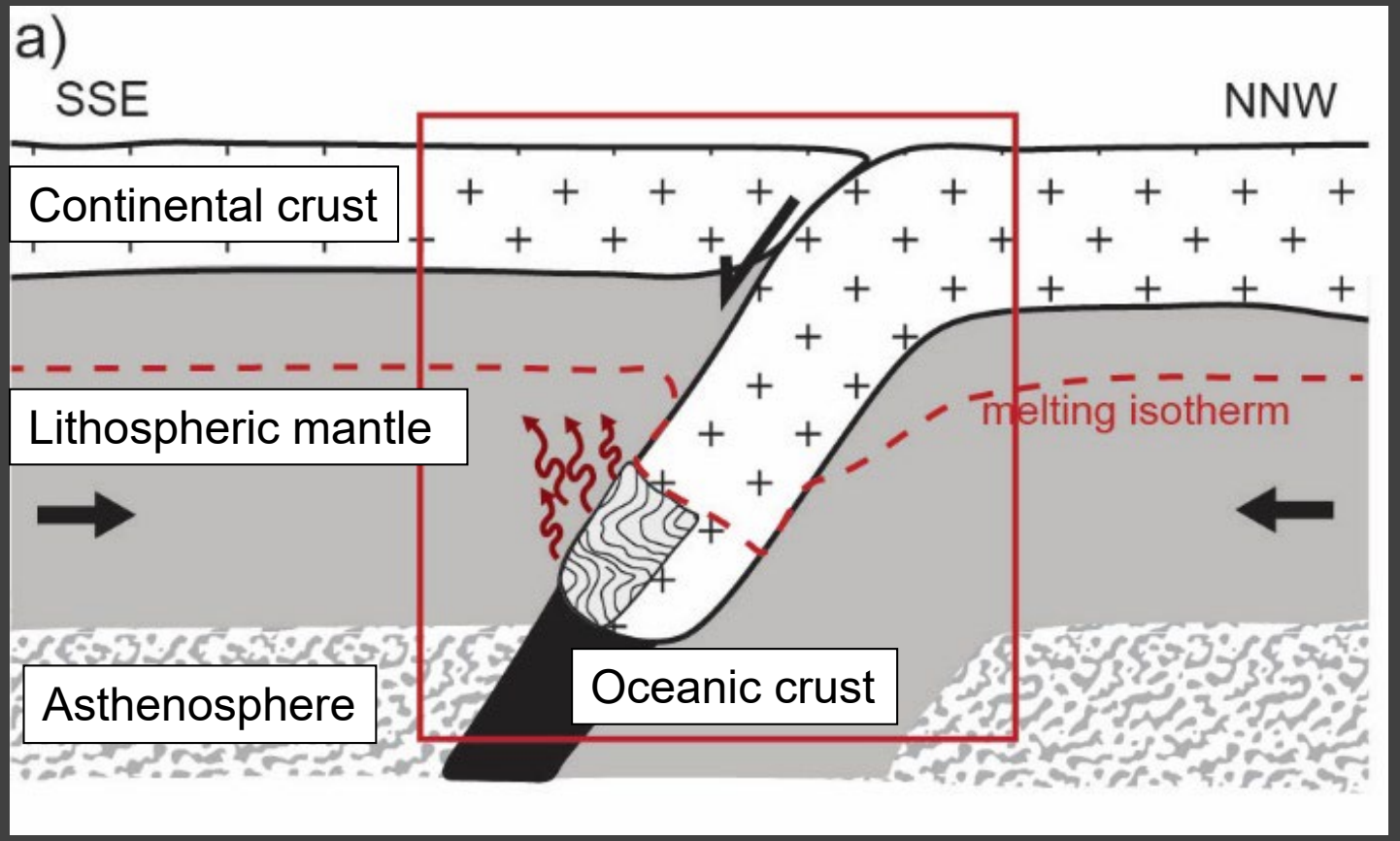
→ involvement of crustal component: phengite (Acosta-Vigil et al., 2010)

Th and U= suggest involvement of a fluid in the subduction zone (Bali et al., 2011)

HOW a granitic melt with a continental crust signature is trapped in mantle rocks?

Metasomatism: the melt is the metasomatic agent infiltrating the peridotites and responsible for the eclogite genesis

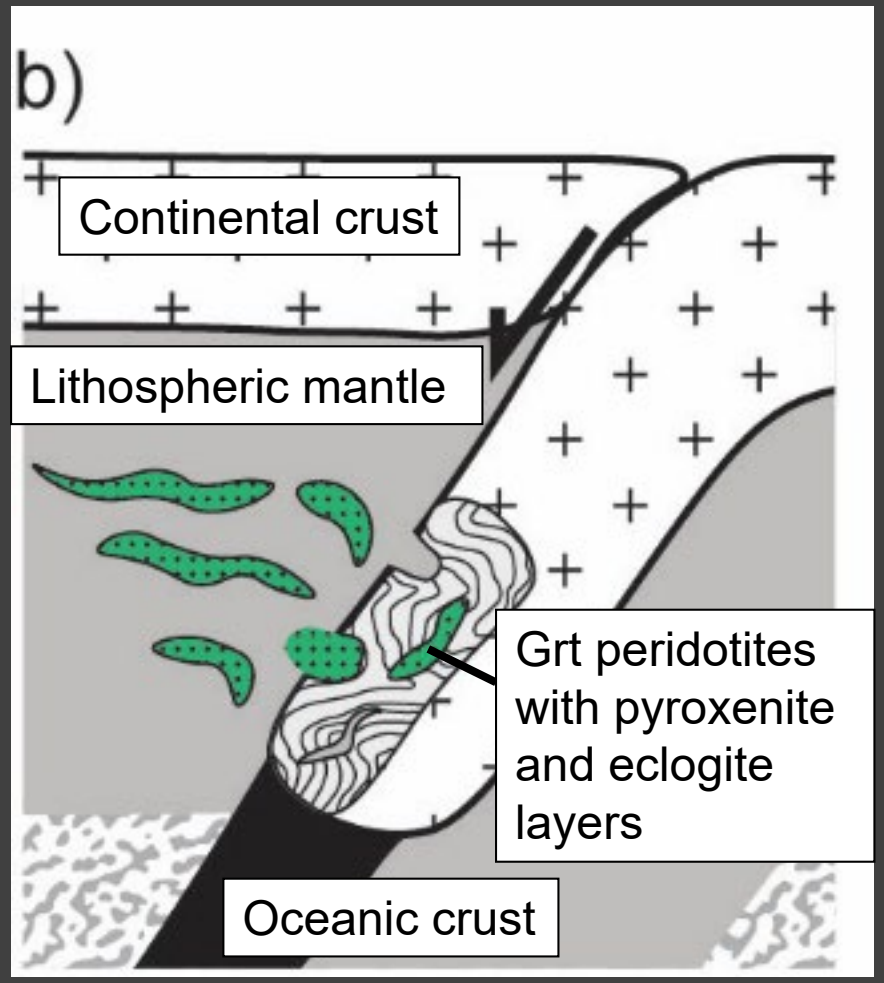
Metasomatism and genesis of Granulitgebirge eclogites



modified after Borghini et al., 2020

a) Melt produced via melting of phengite-bearing felsic rocks migrates to the mantle wedge and infiltrates already inhomogeneous peridotites

Metasomatism and genesis of Granulitgebirge eclogites



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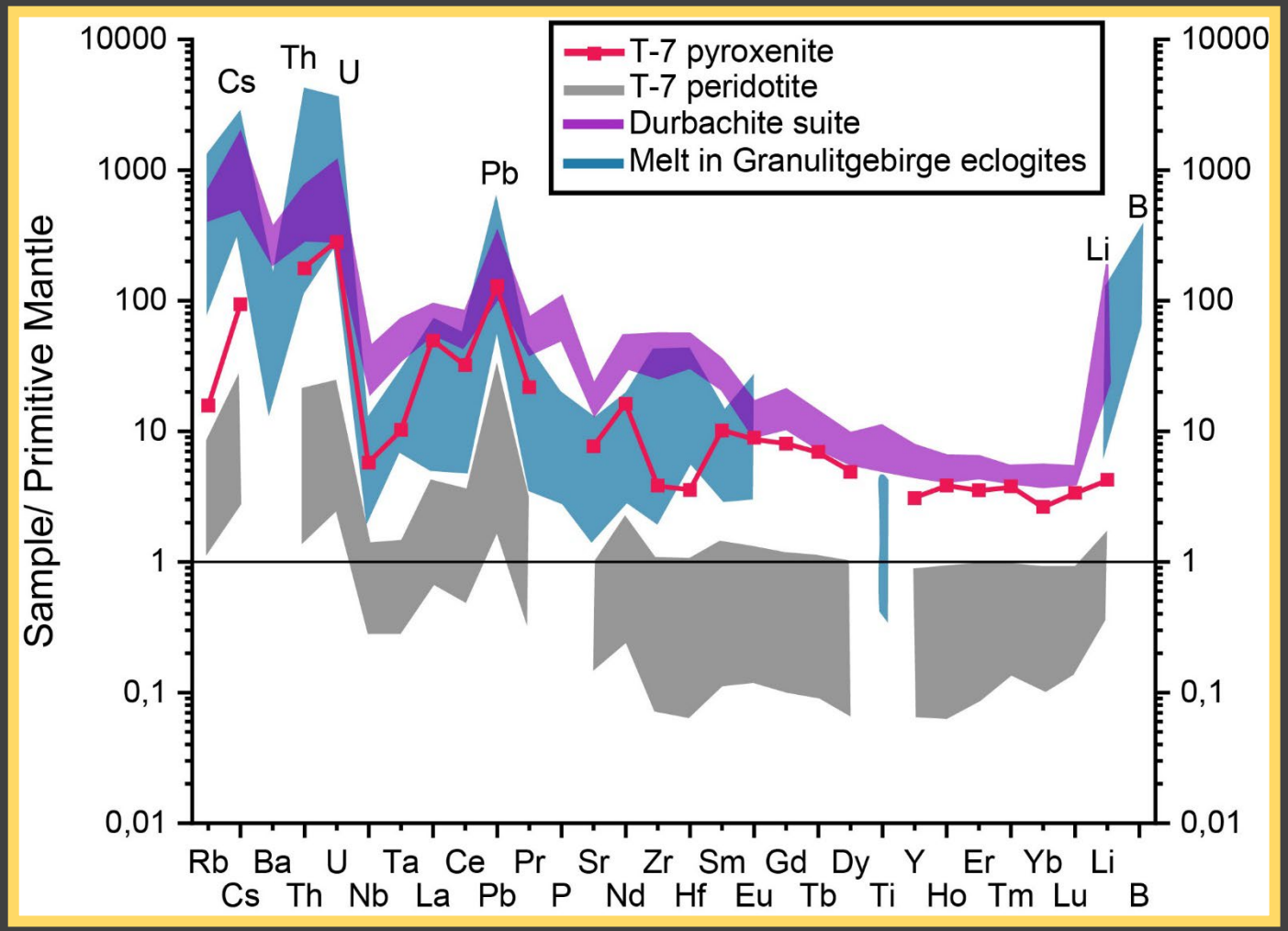
b) Metasomatism of mafic layers already present in the peridotites results in genesis of the Granulitgebirge eclogites.
Portions of metasomatized mantle wedge are incorporated in the continental crust as bodies and exhumed with it.

Metasomatism in the Bohemian Massif



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Similar patterns to the melt in the Granulitgebirge eclogites can be observed in metasomatized peridotites and pyroxenites of the T-7 borehole and in the durbachite suite (ultrapotassic melanosyenites)

TAKE HOME MESSAGE

- Melts from the continental crust, e.g. from Ti Phe-bearing felsic rocks, metasomatizing mafic/ultramafic rocks during garnet growth
- These metasomatic agents are now preserved as nanogranitoids in garnet
- This is the first direct measurement of the metasomatic agent present at mantle depth during the Variscan orogeny
- Mantle contaminated by melts from deeply subducted continental crust is widespread beneath the Bohemian Massif