

Kontinentální subdukce a vznik HP-UHP hornin v Českem masivu

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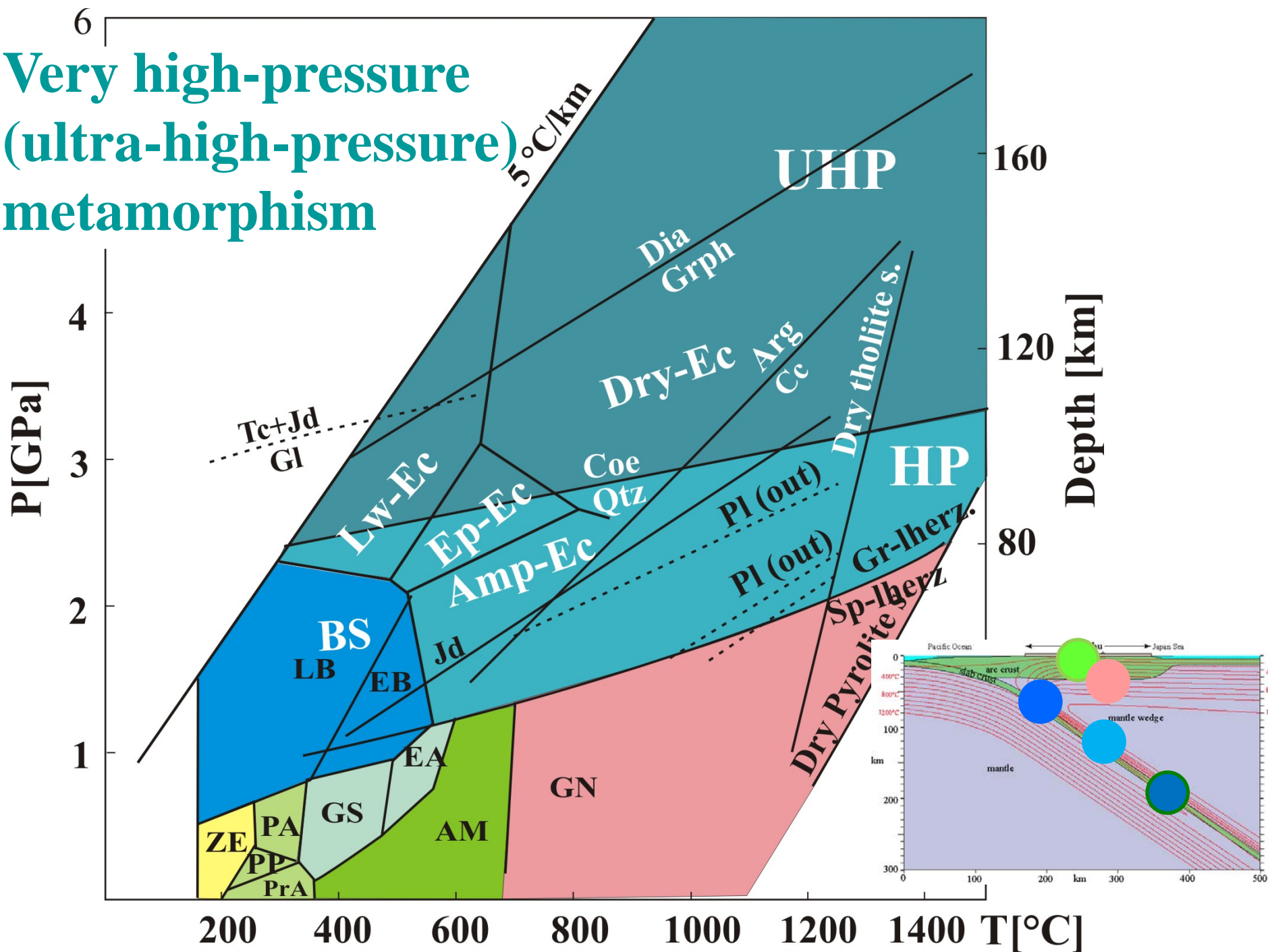
Methods of petrological investigation

PT estimate of the UHPM rocks

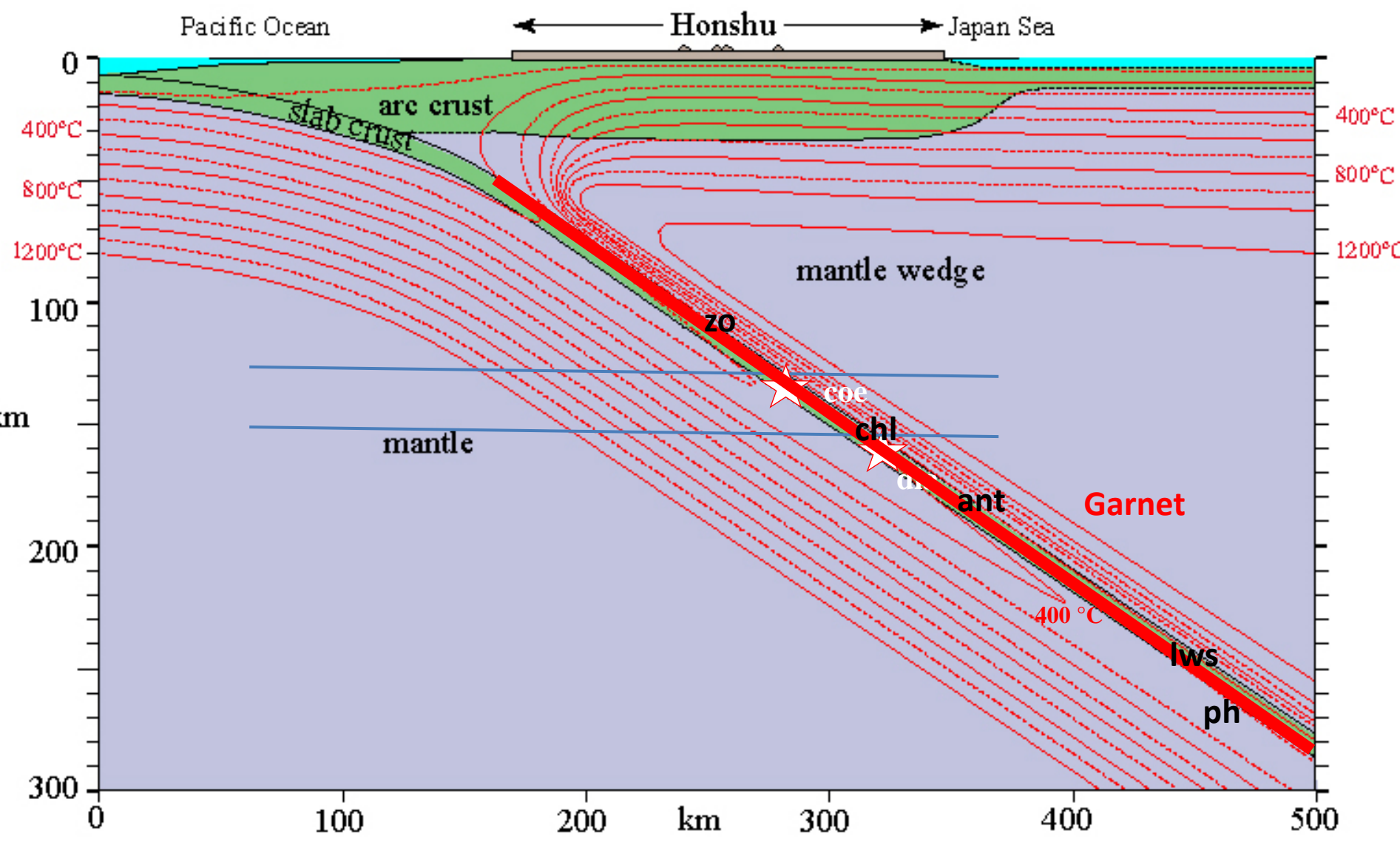
**Inferred geodynamic model for Variscan Orogeny in the
Bohemian Massif**

Behavior of UHP rocks and minerals during exhumation

Very high-pressure (ultra-high-pressure) metamorphism



Indicators of subduction depth



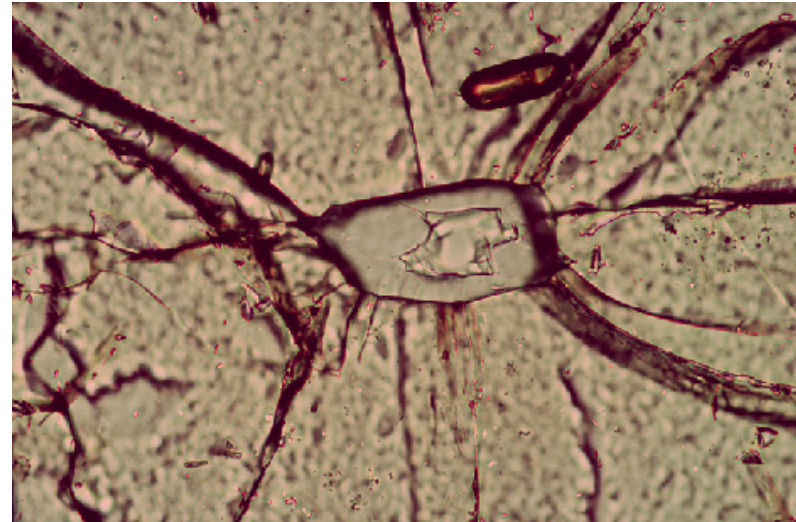
Garnet-granát

Fe₃Al₂Si₃O₁₂ Almandine

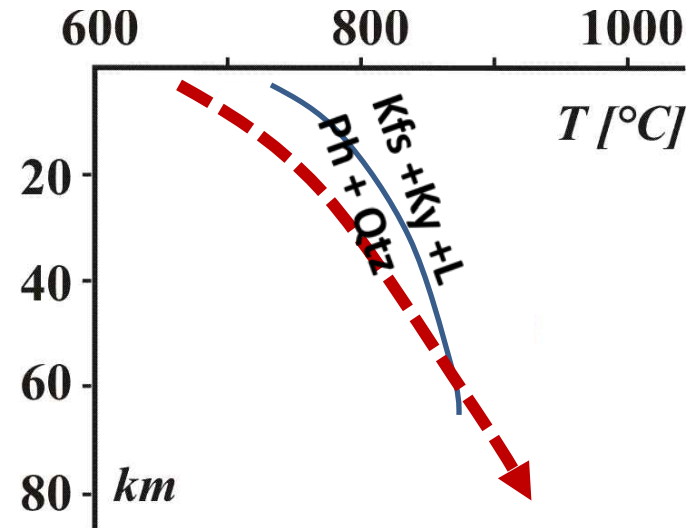
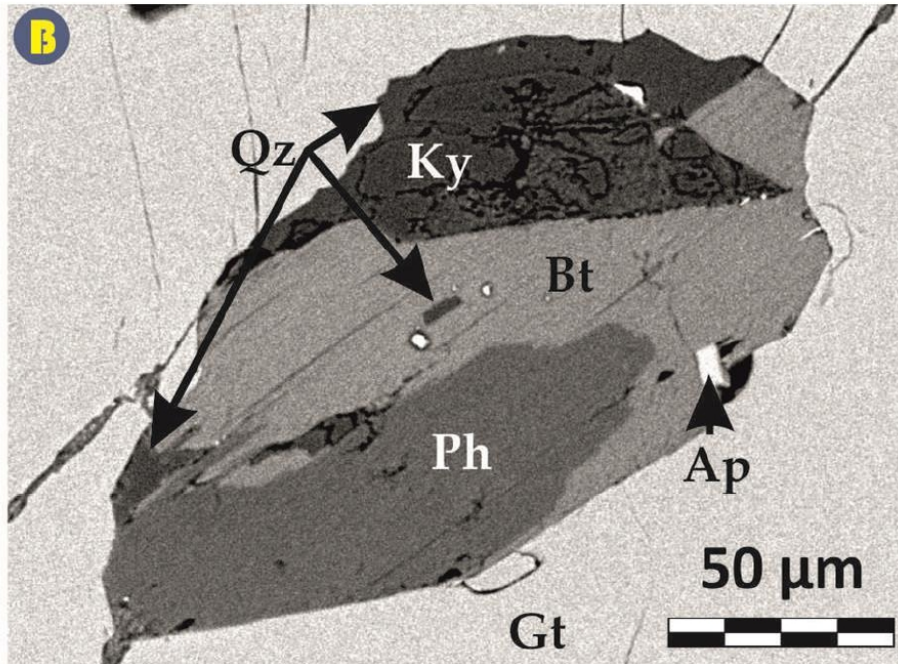
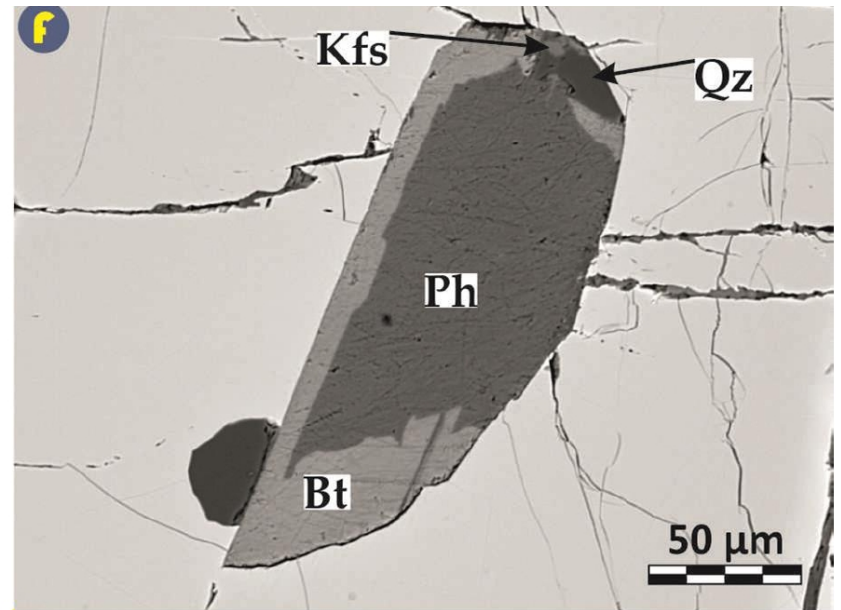
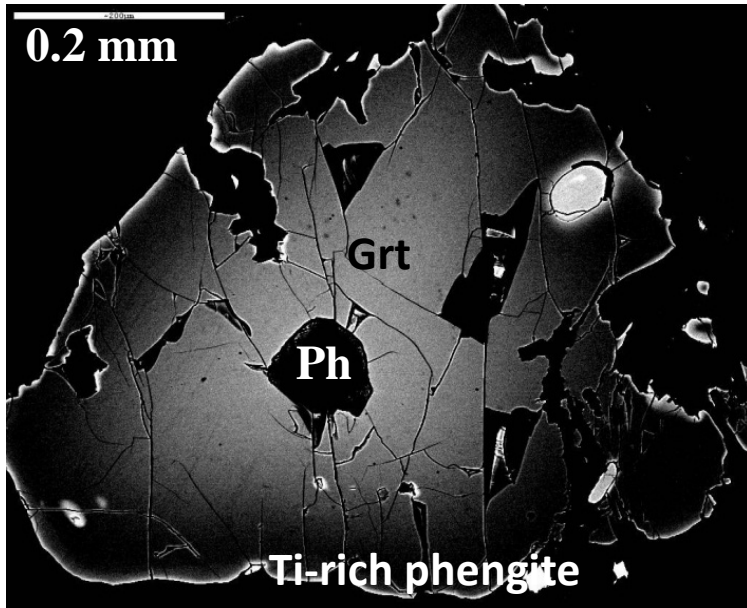
Mg₃Al₂Si₃O₁₂ Pyrope

Ca₃Al₂Si₃O₁₂ Grossular

Mn₃Al₂Si₃O₁₂ Spessartine



Phegite inclusions in garnet (Bohemian Massif)



Compositional zoning in garnet

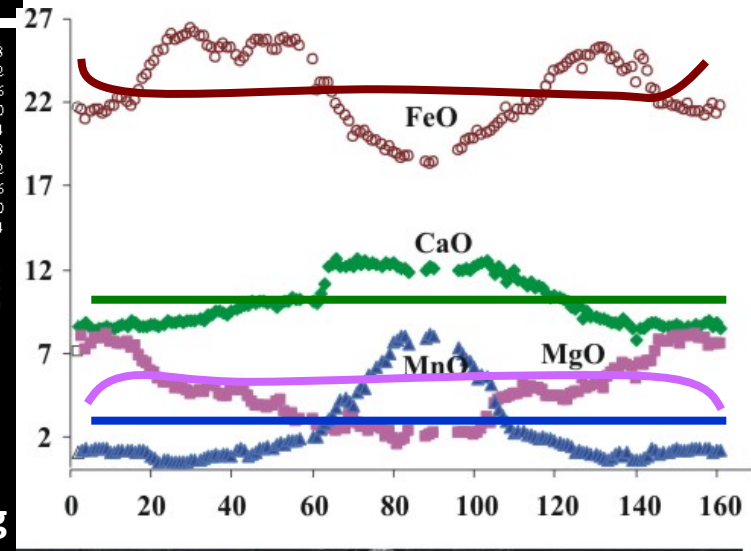
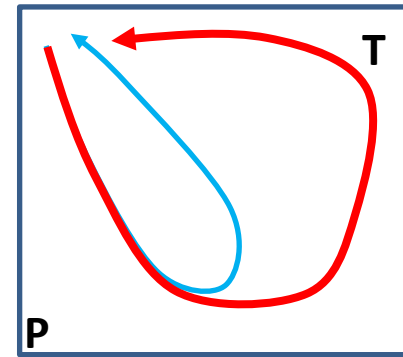
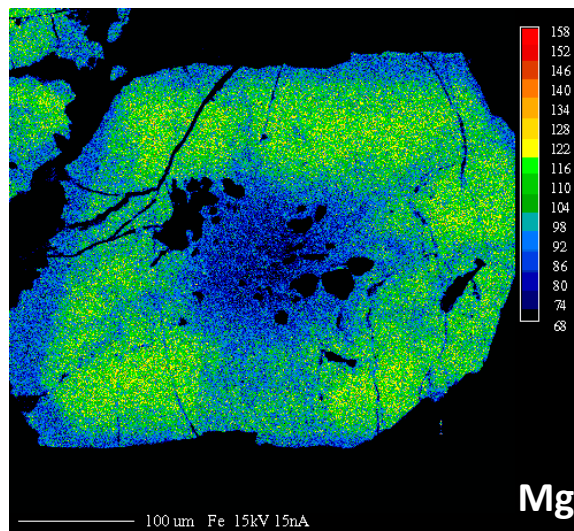
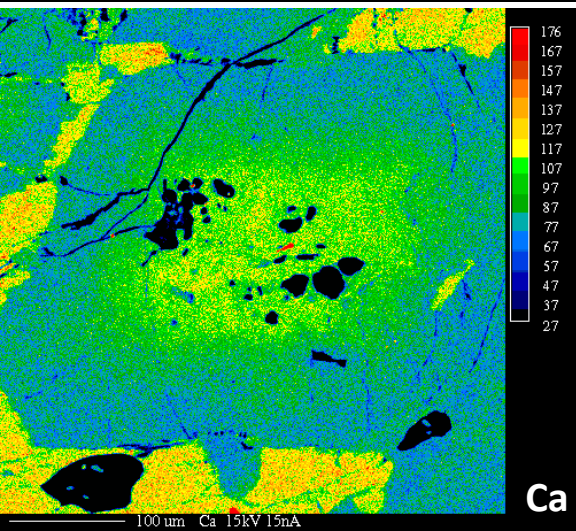
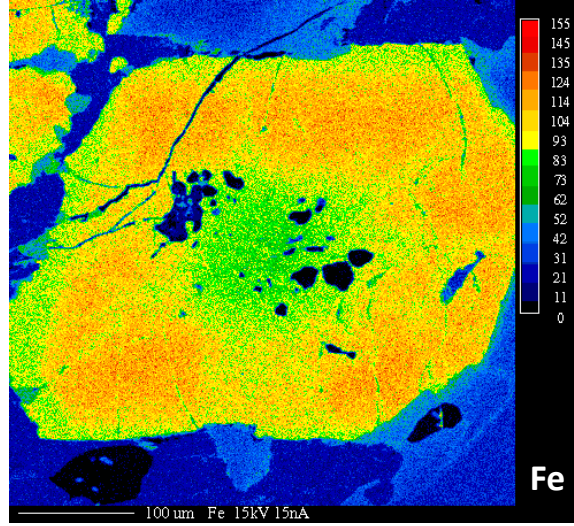
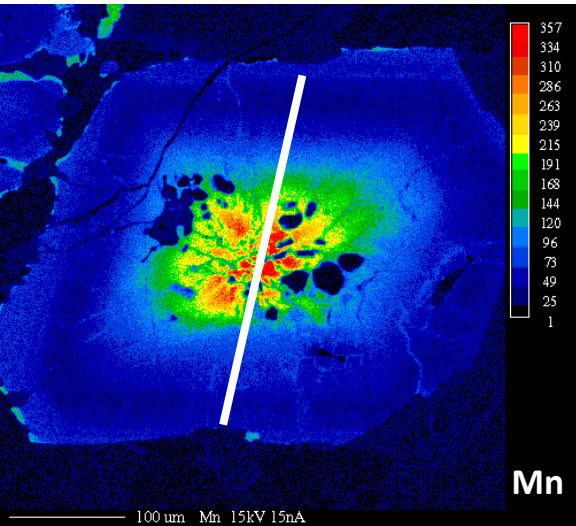
Prograde during metamorphism

Multi component diffusion and homogenization of zoning

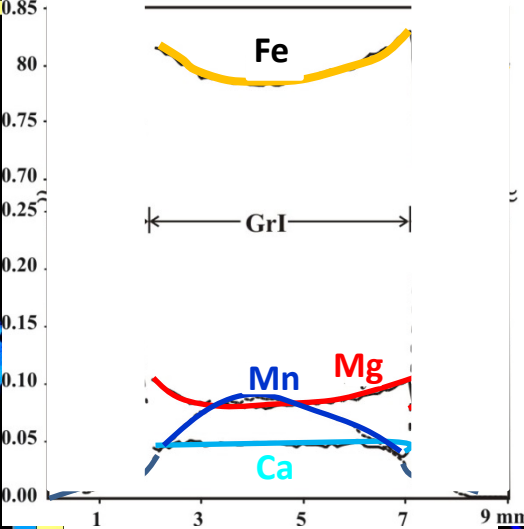
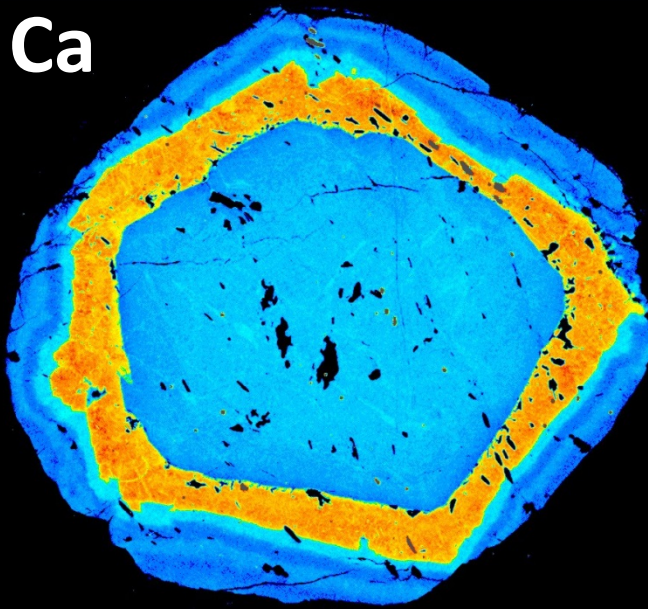
Retrograde zoning in garnet

$\text{Fe}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ Almandine
 $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ Pyrope
 $\text{Ca}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ Grossular
 $\text{Mn}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ Spessartine

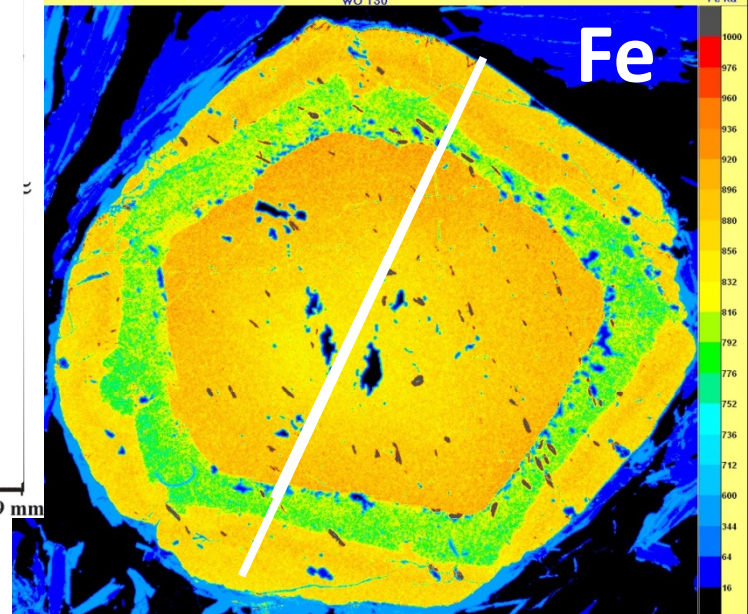
$$D(\tau) = D_o e^{-(Ea/RT)}$$



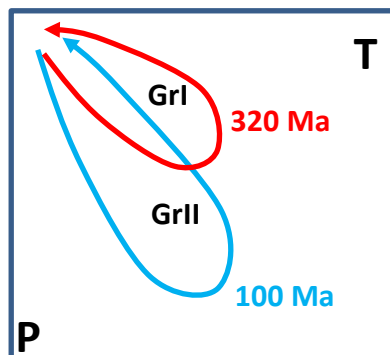
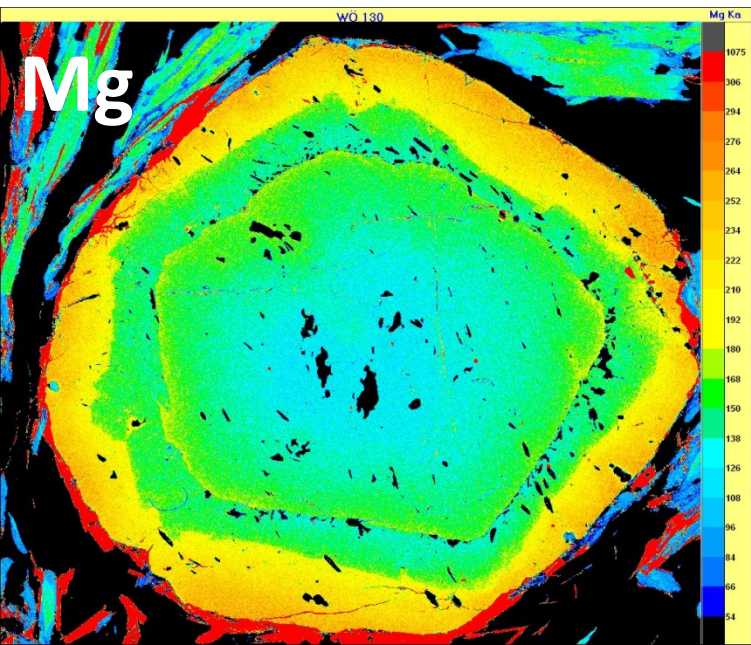
Ca



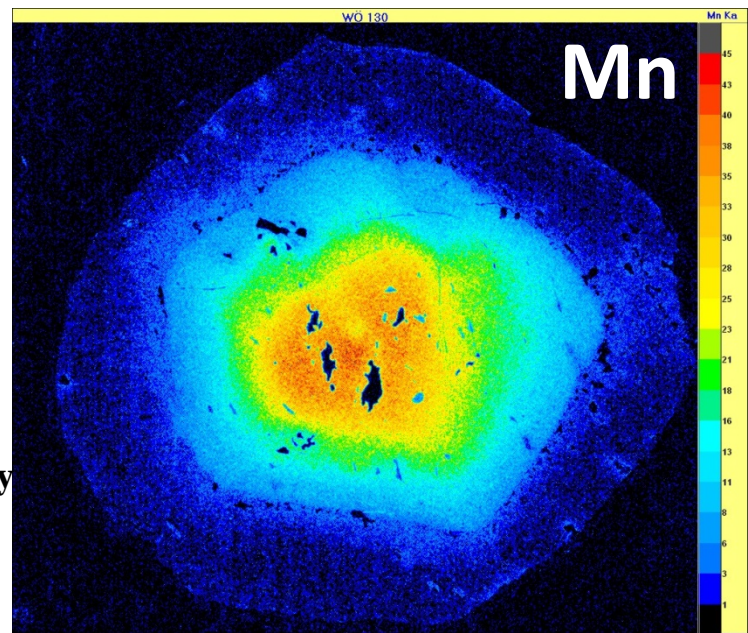
Fe



Compositional zoning in garnet

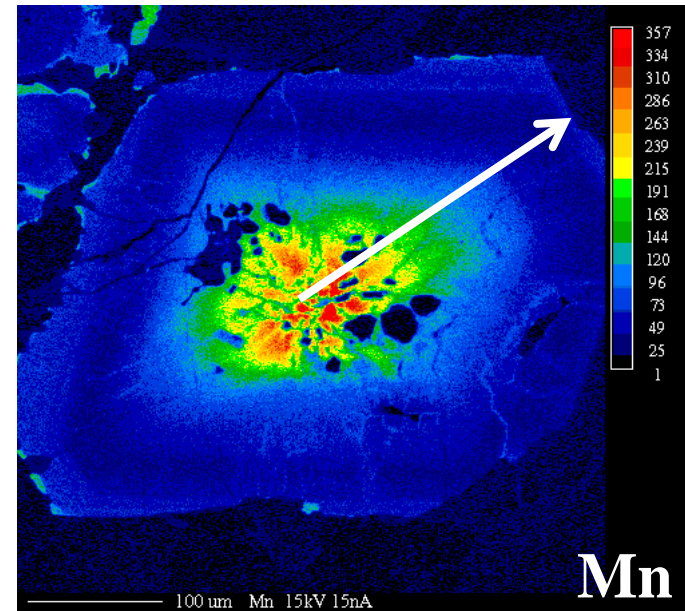
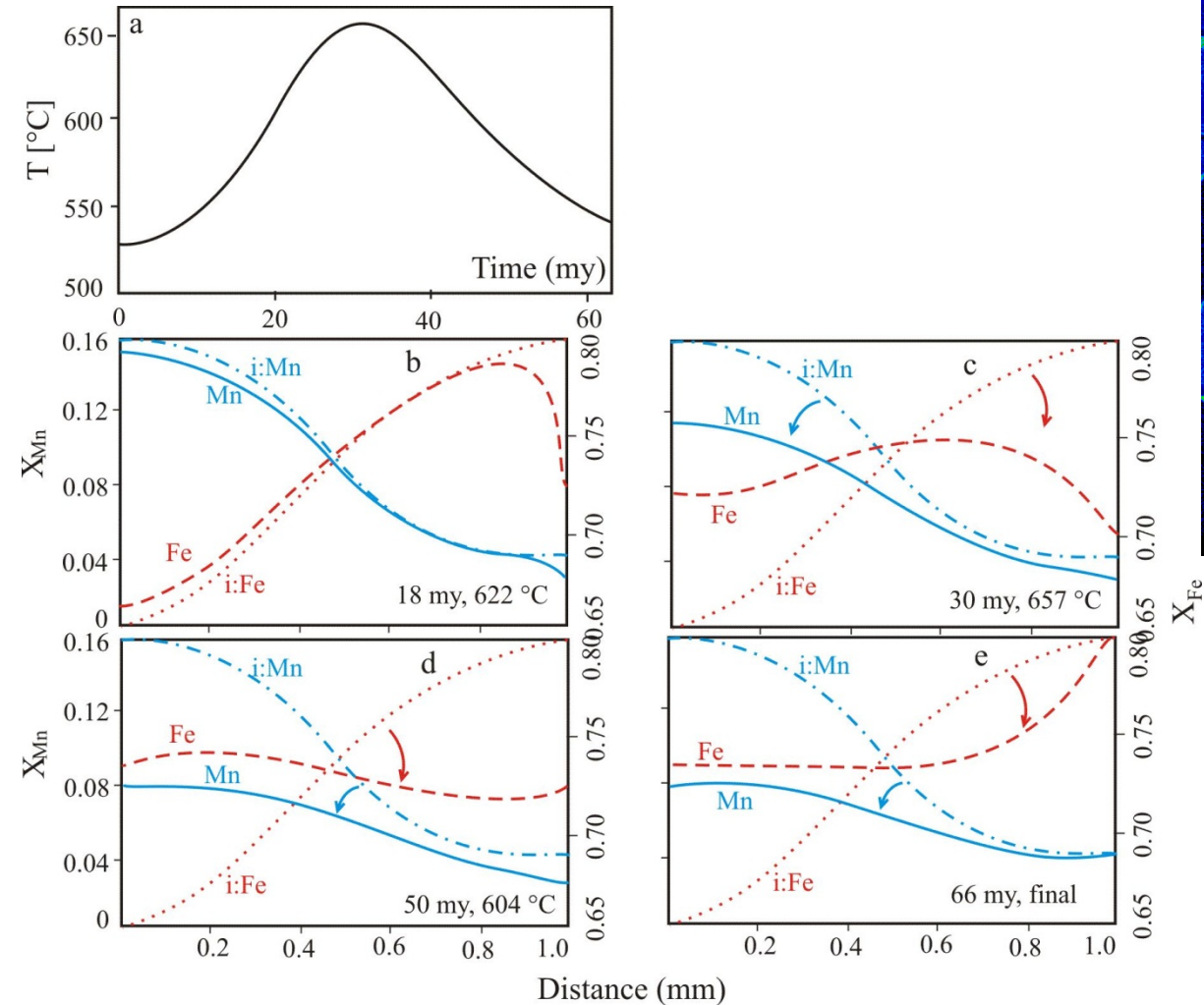


Faryad and Chakraborty (2006), CMP

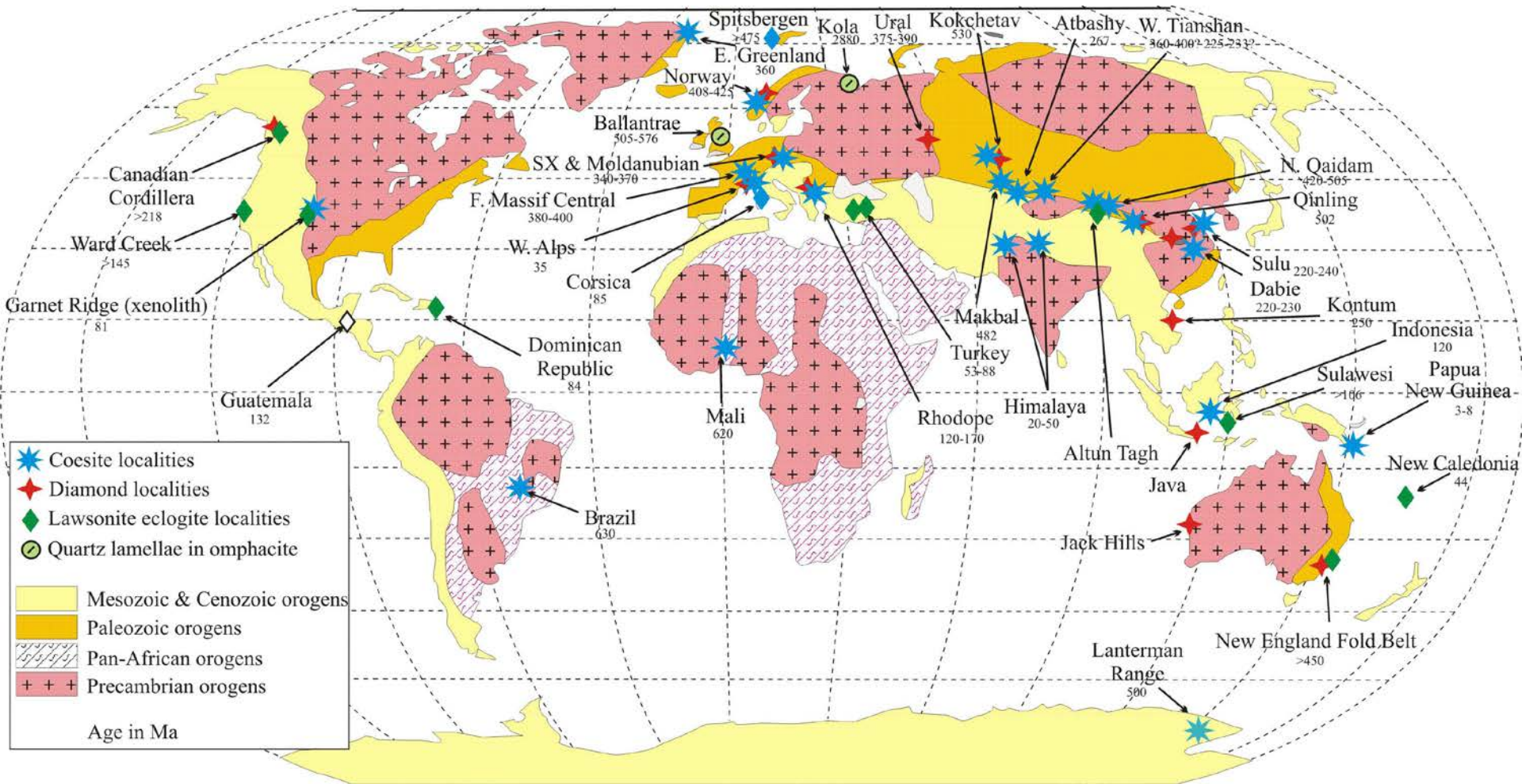


Průchod růstové zonálnosti \Leftrightarrow difuzní zonálnosti

S růstem stupně metamorfózy - změna růstové zonálnosti na difuzní zonálnost, např. srovnání zvoncového tvaru Mn profilu

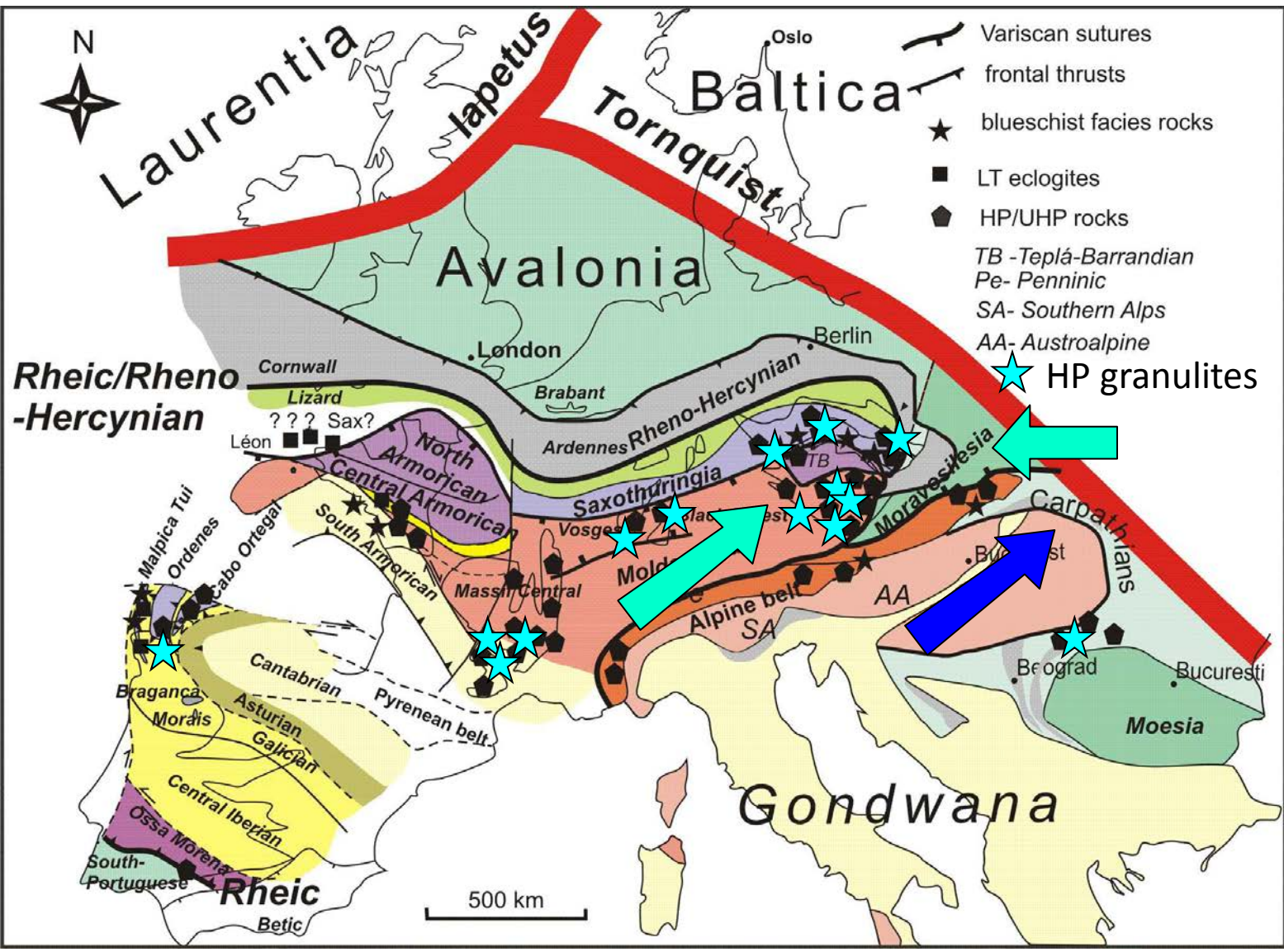


Distribution of UHPM terranes and ages of their metamorphism



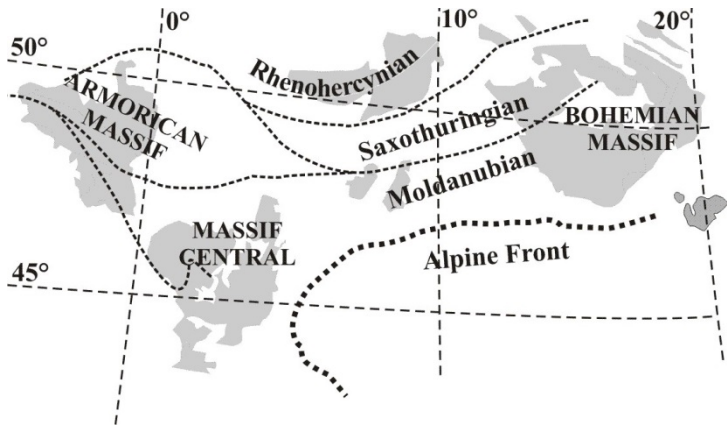
Liou et al., 2009; Dobrzhinetskaya and Faryad, 2011

Distribution of HP-UHP rocks along the European Variscan Belt



Faryad & Kachlík (2013), JMG

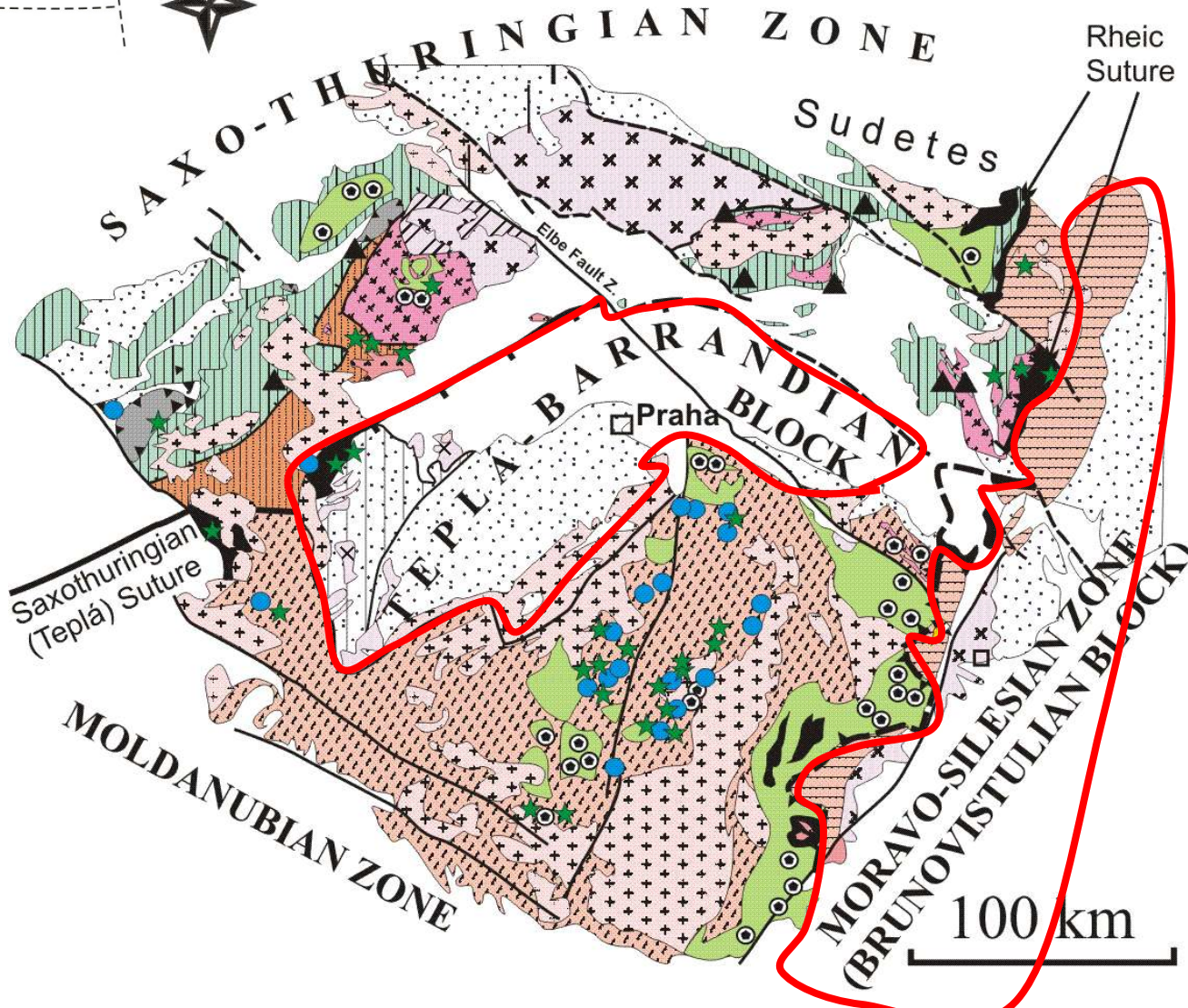
Bohemian Massif and occurrences of HP-UHPM rocks

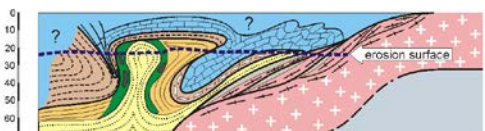
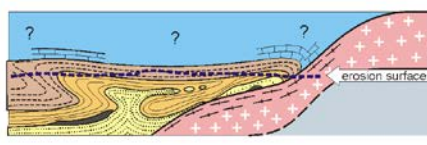
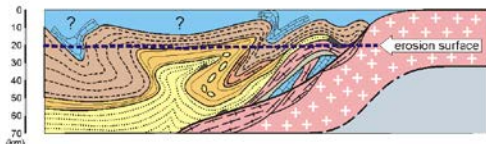
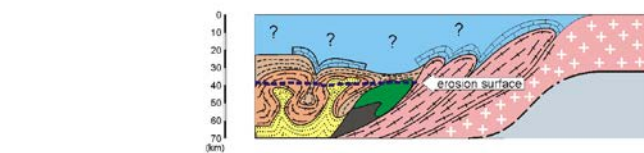
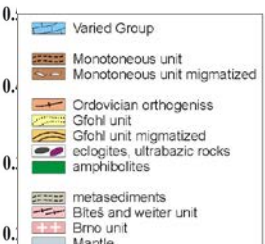
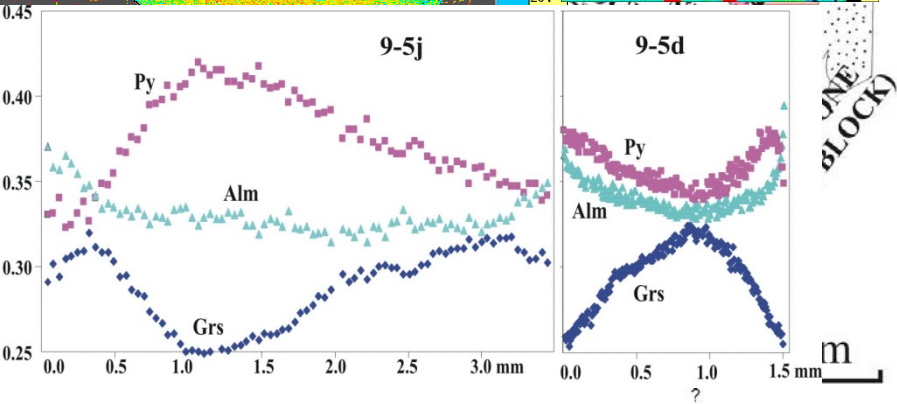
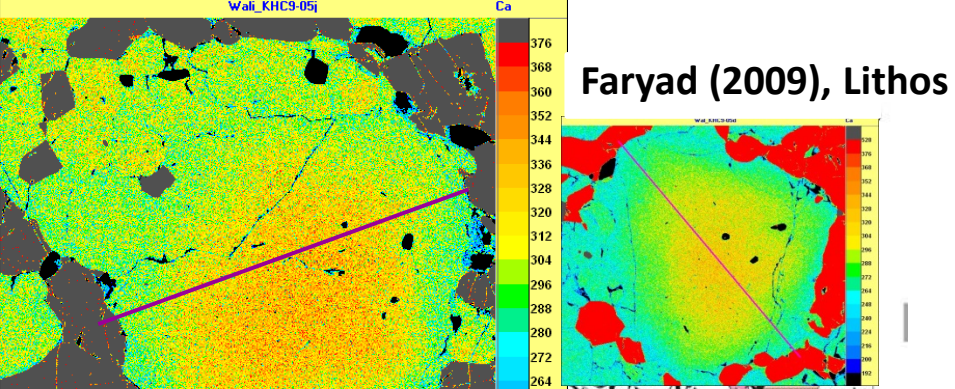


Amphibolite facies units

- eclogite ★
- -serpentinite ●

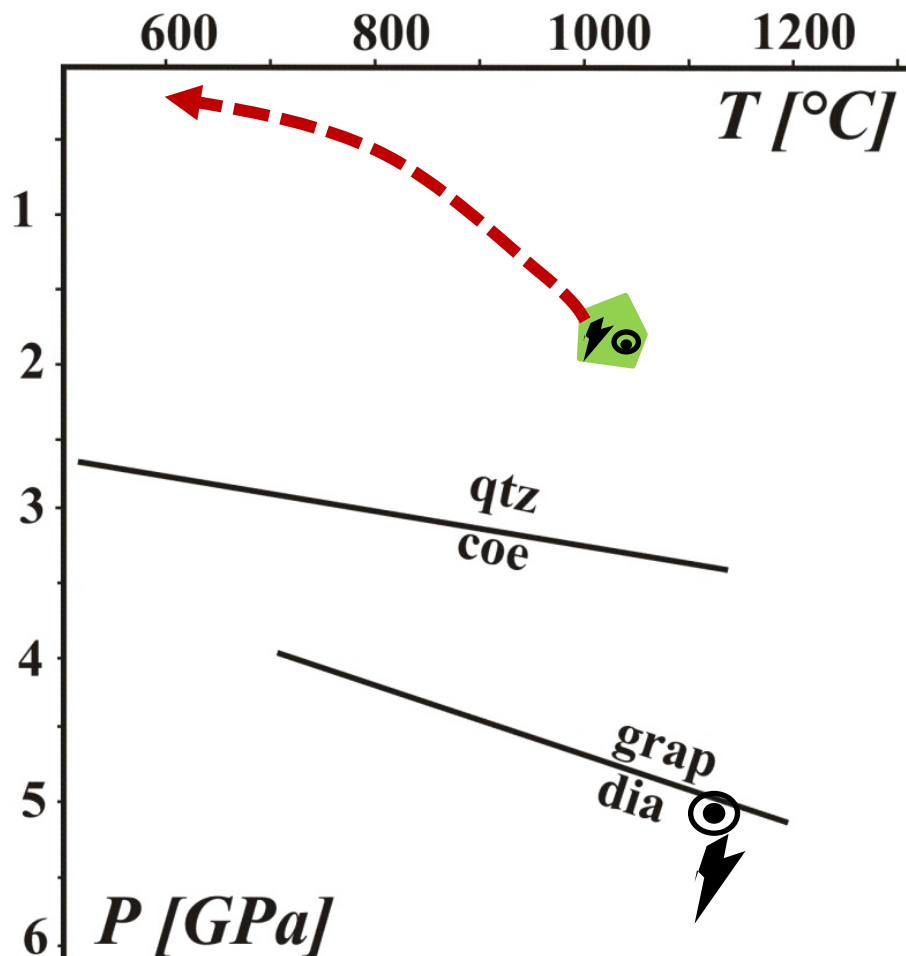
- felsic granulite
- grt peridotite
- eclogite

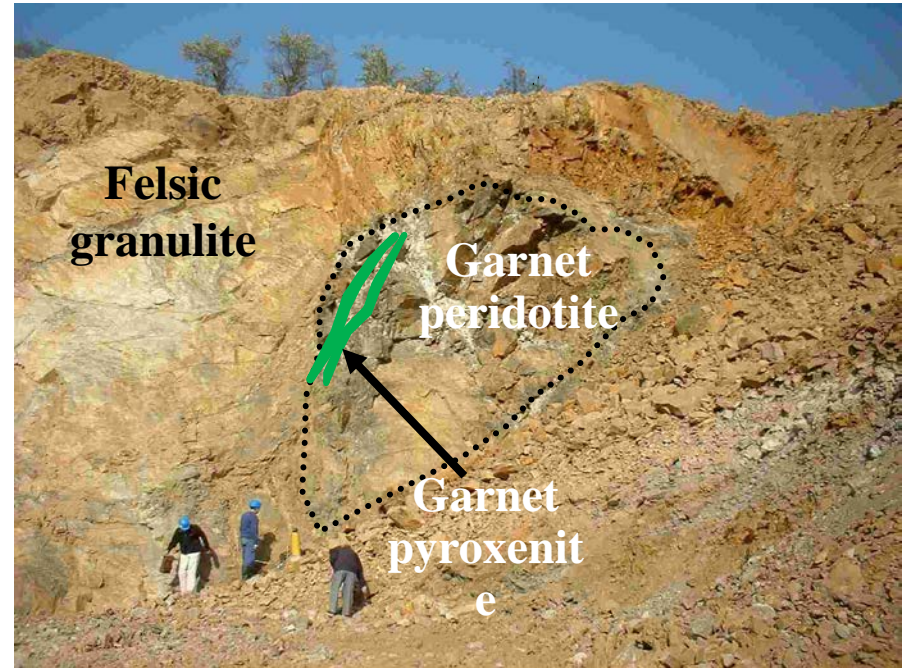
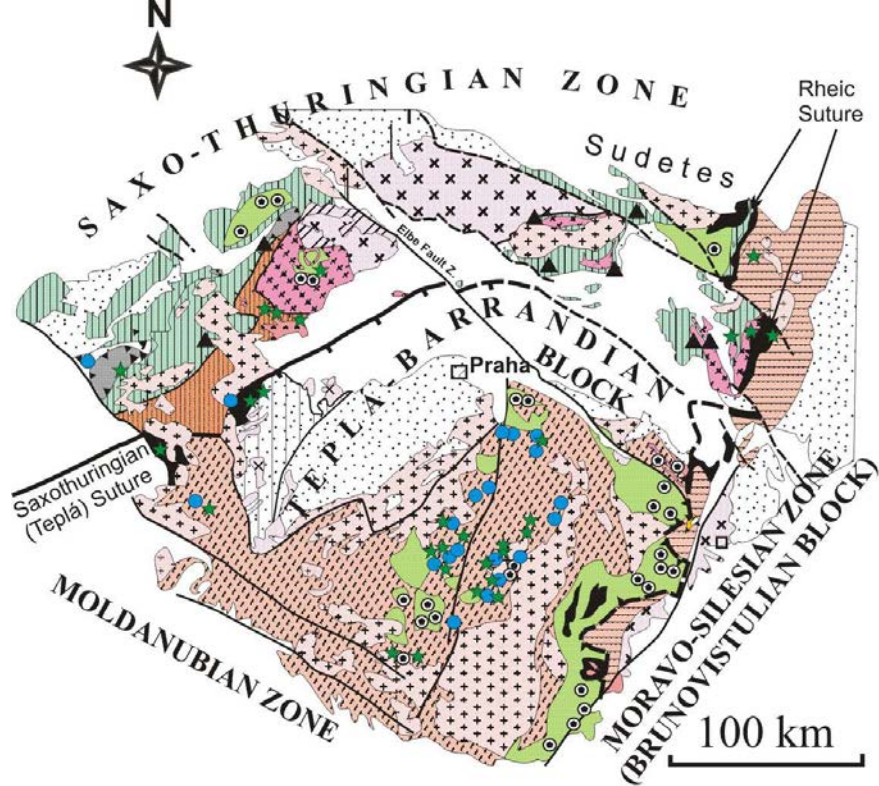




Schulmann et al. (2005), AJS

Research motivation

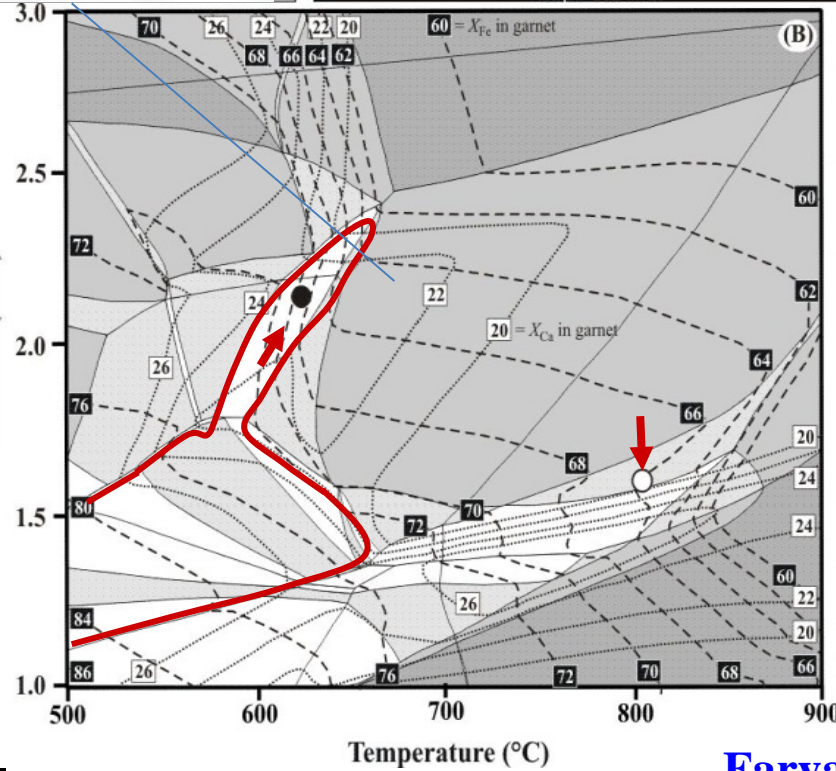
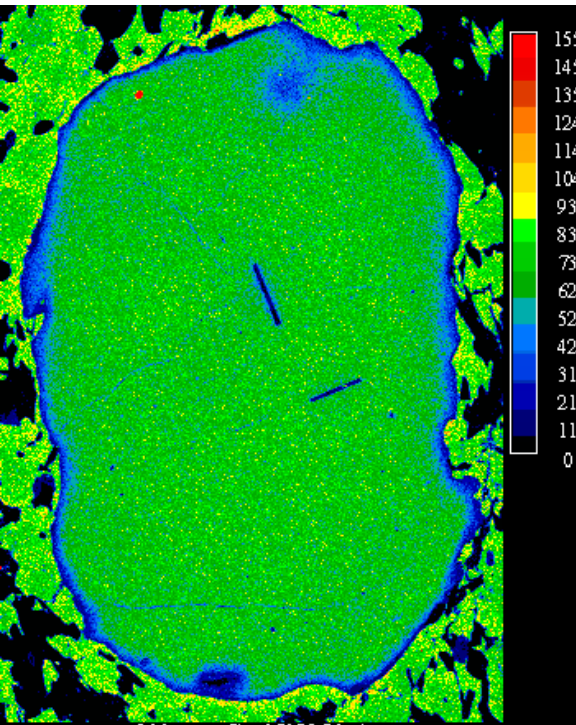
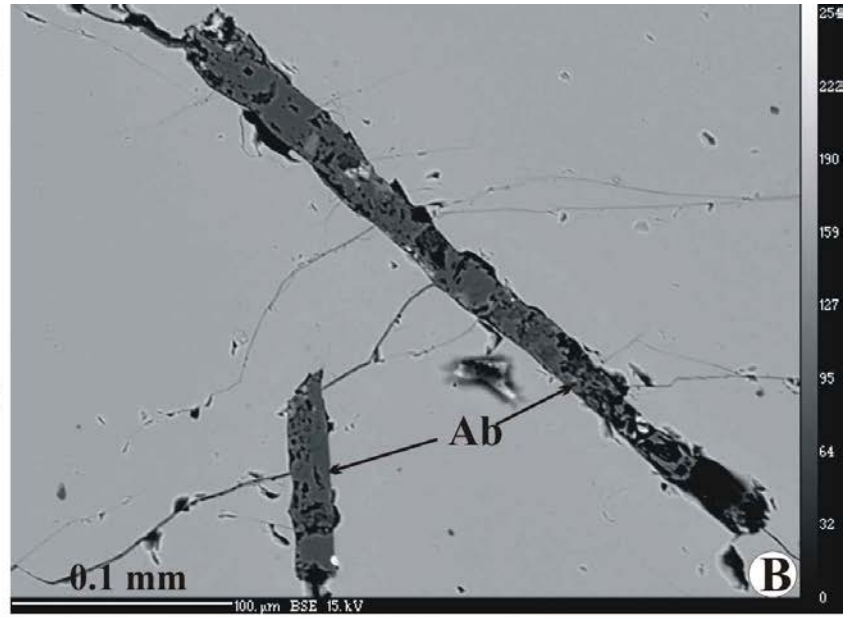




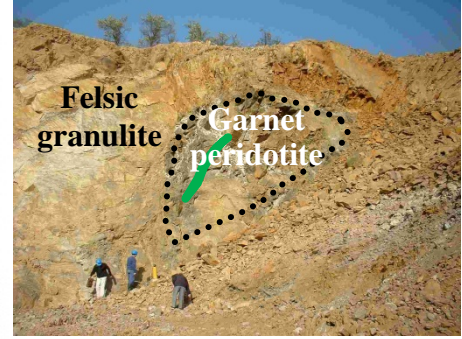
Main goals

1. Pressure-temperature evolution of granulite (crustal rocks)
2. Pressure-temperature evolution of garnet peridotite garnet pyroxenite(mantle rocks)
3. How they get together?
4. Pressure-temperature evolution of eclogite

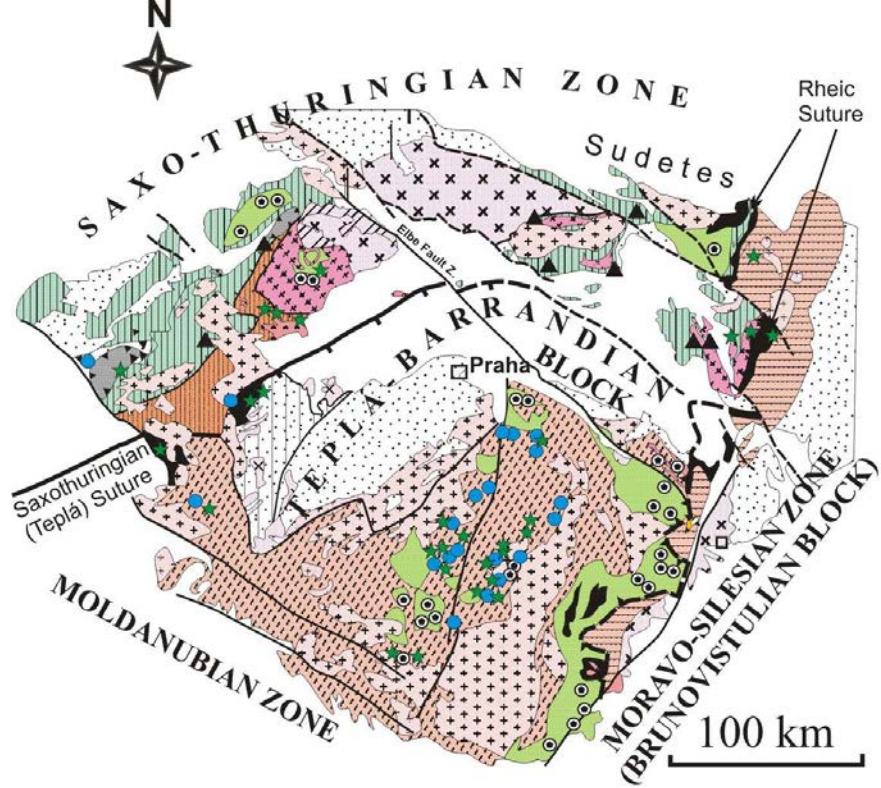




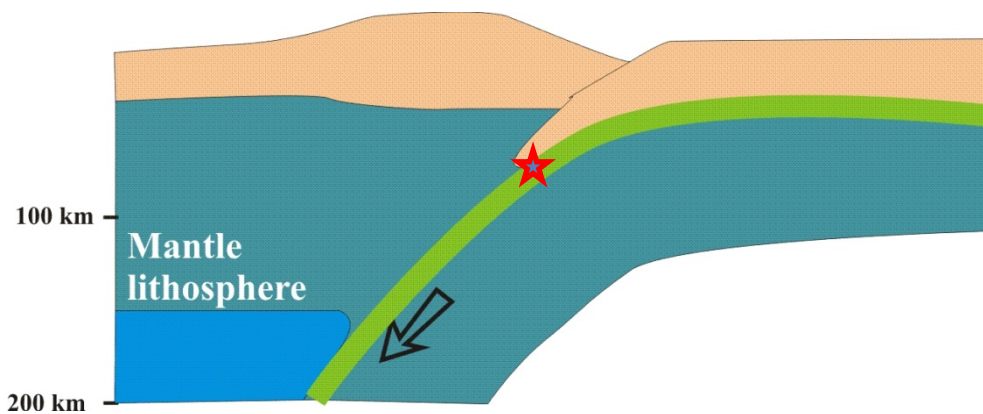
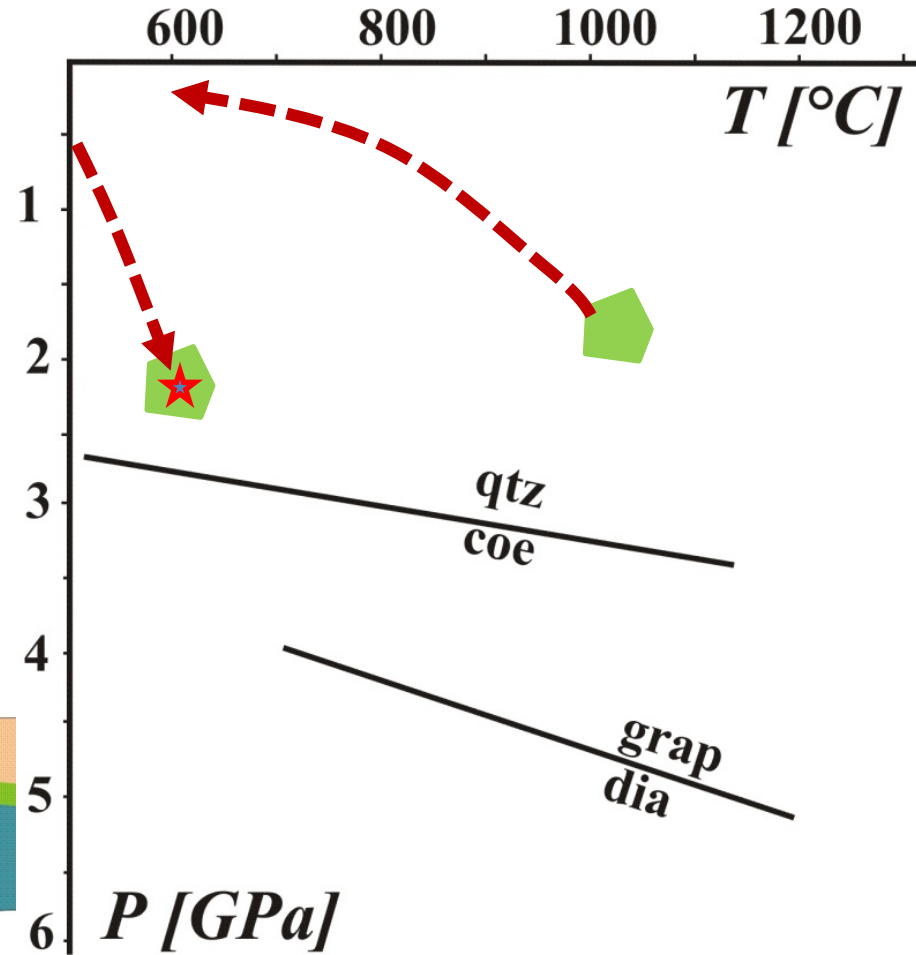
Crustal felsic rocks first passed LT-HP metamorphism

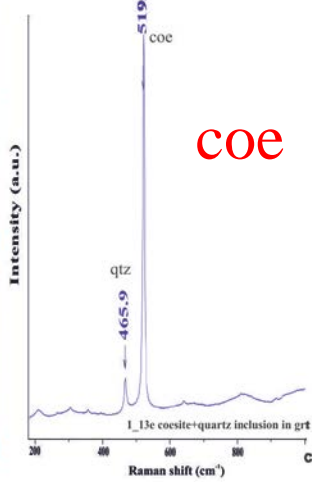
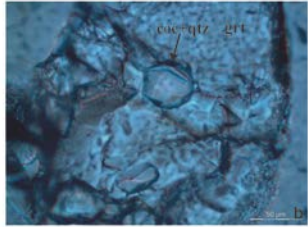
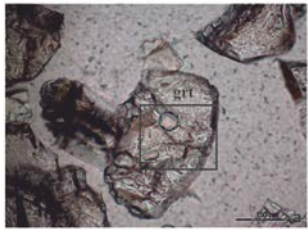


Faryad et al., (2010), Lithos

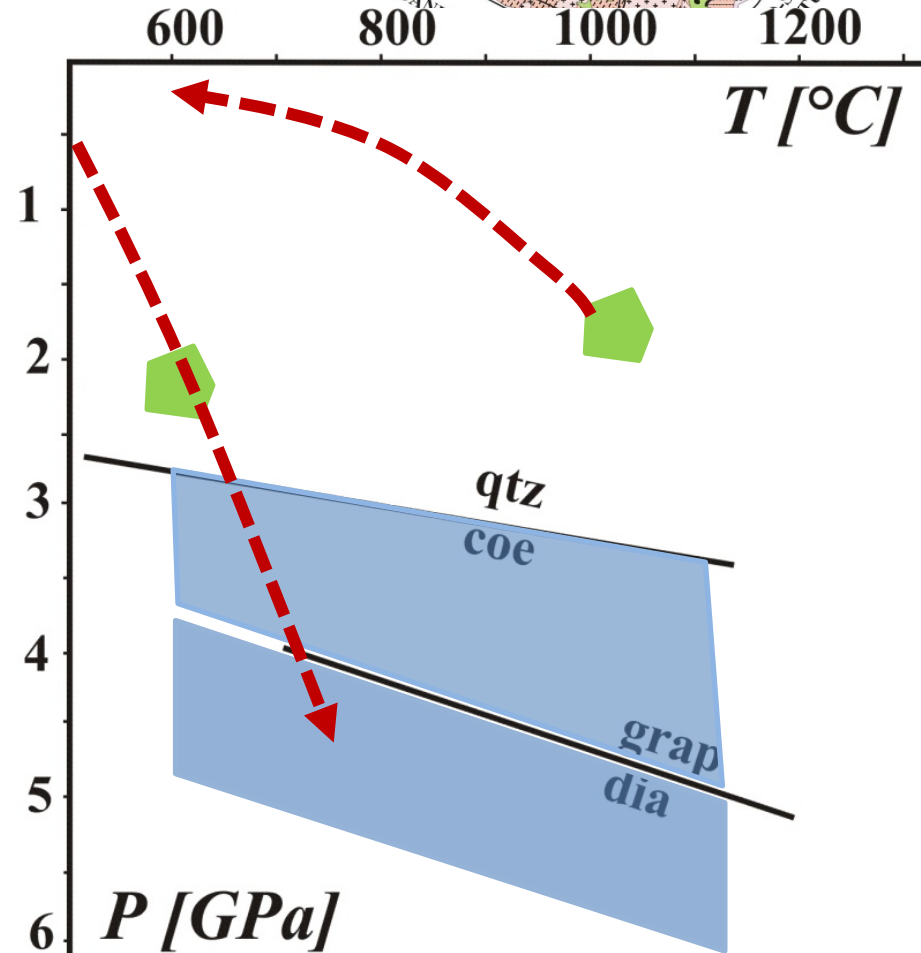
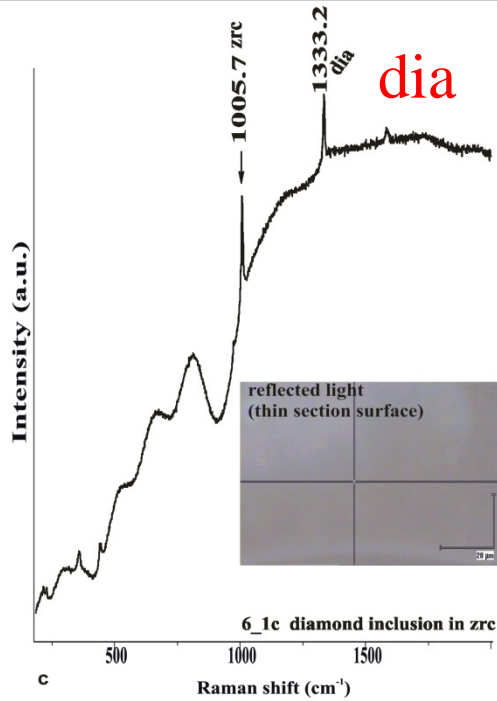
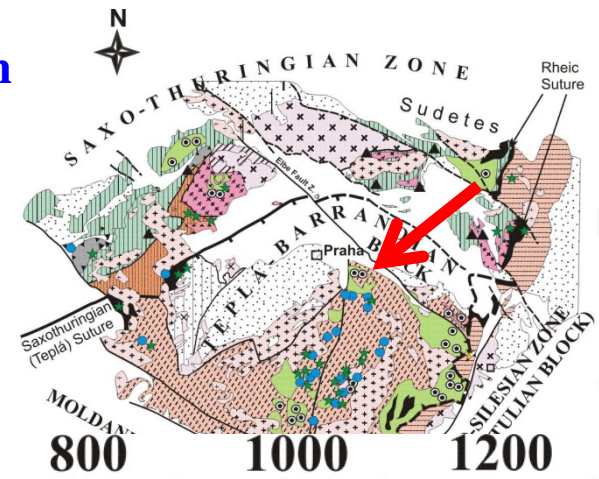


Crustal felsic rocks first passed LT-HP metamorphism





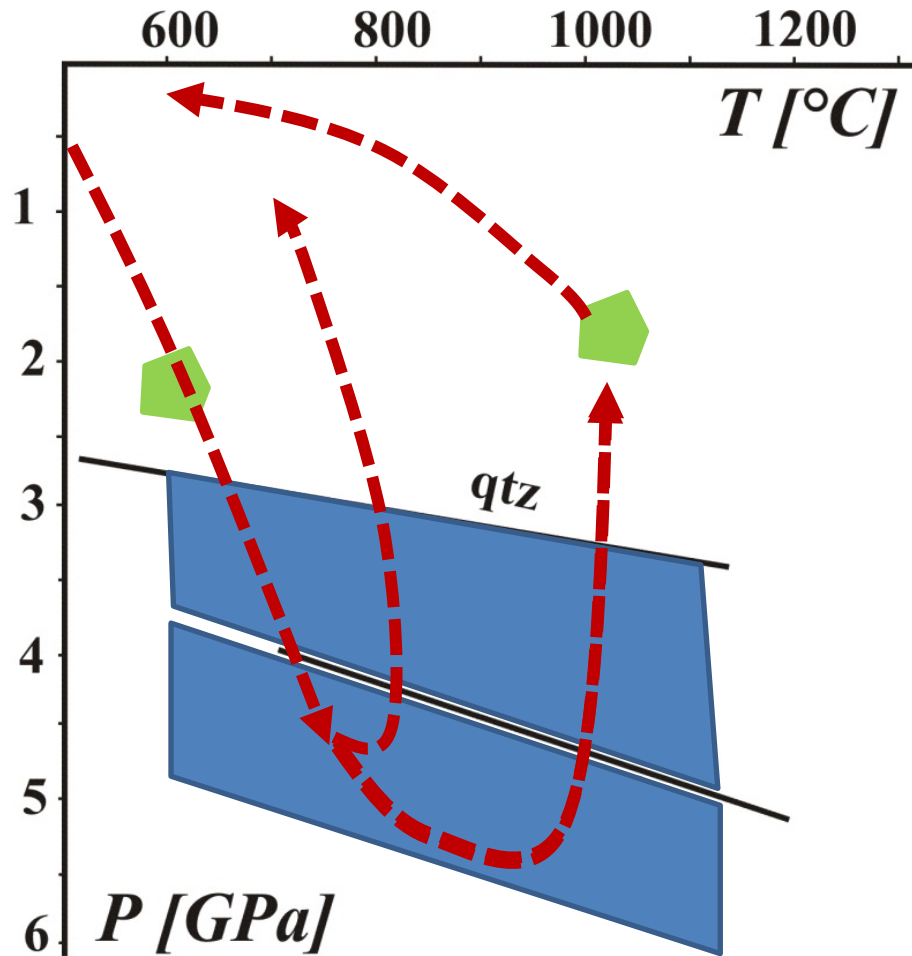
After LT-HP metamorphism
the felsic rocks reached
diamond stability field



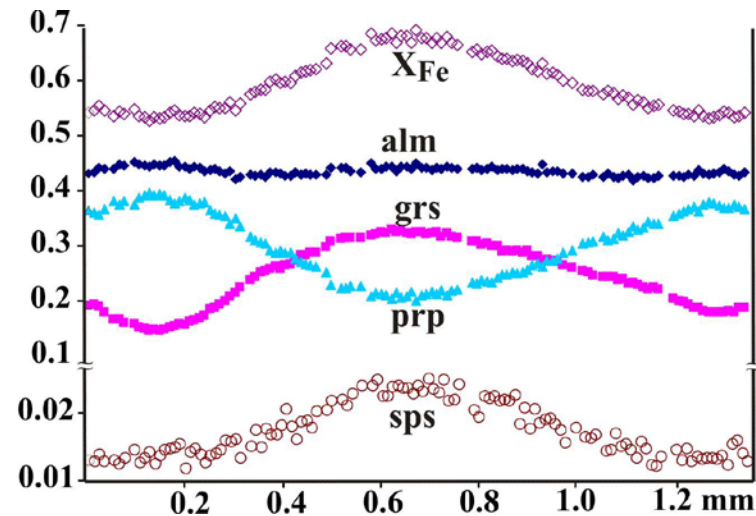
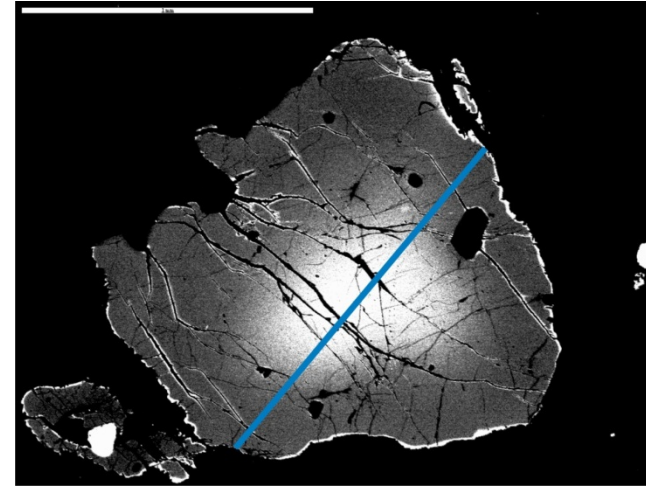
How the UHP rocks were exhumed to crustal positions?

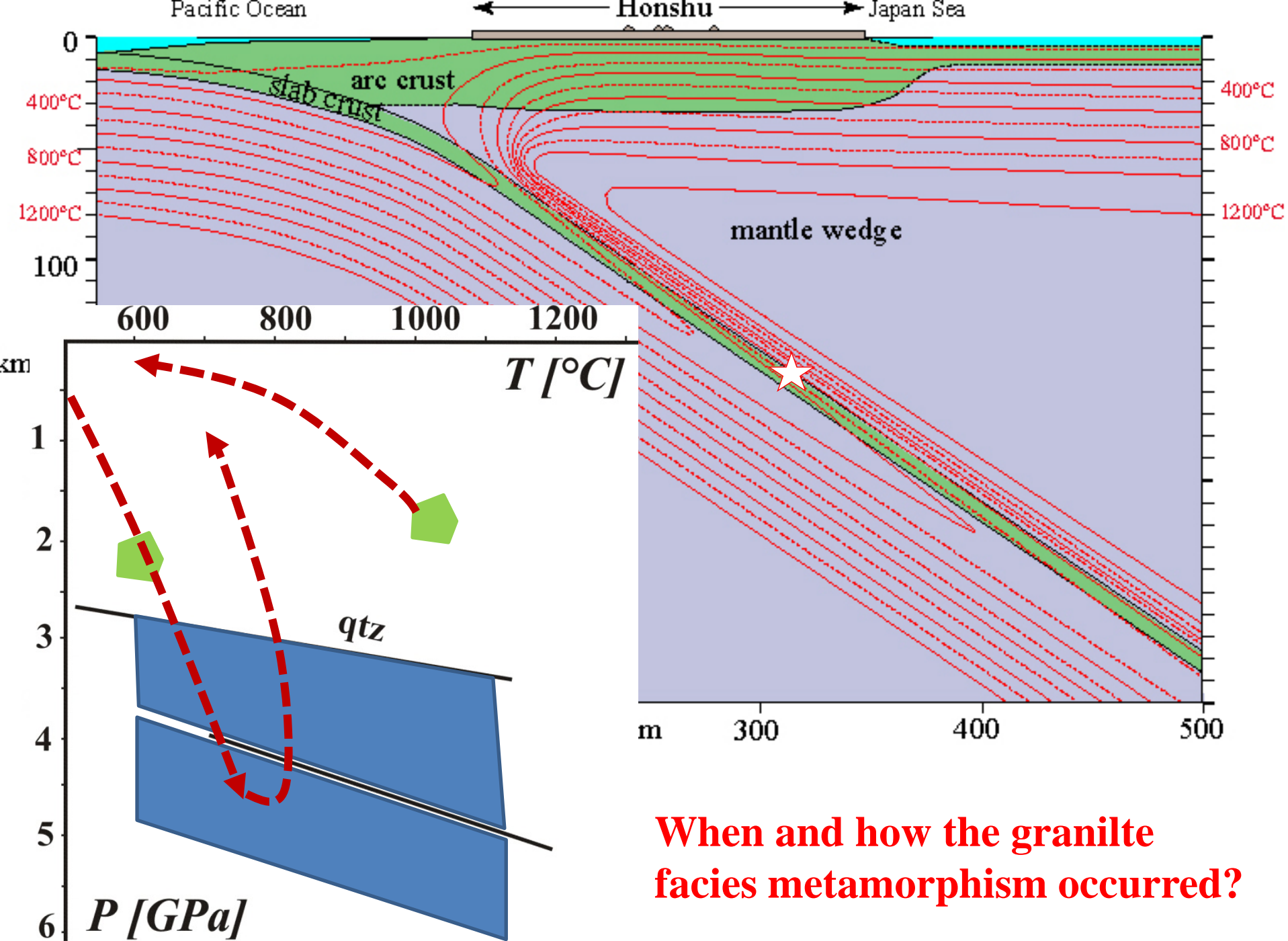
Isothermal decompression?

This would homogenise the garnet zoning

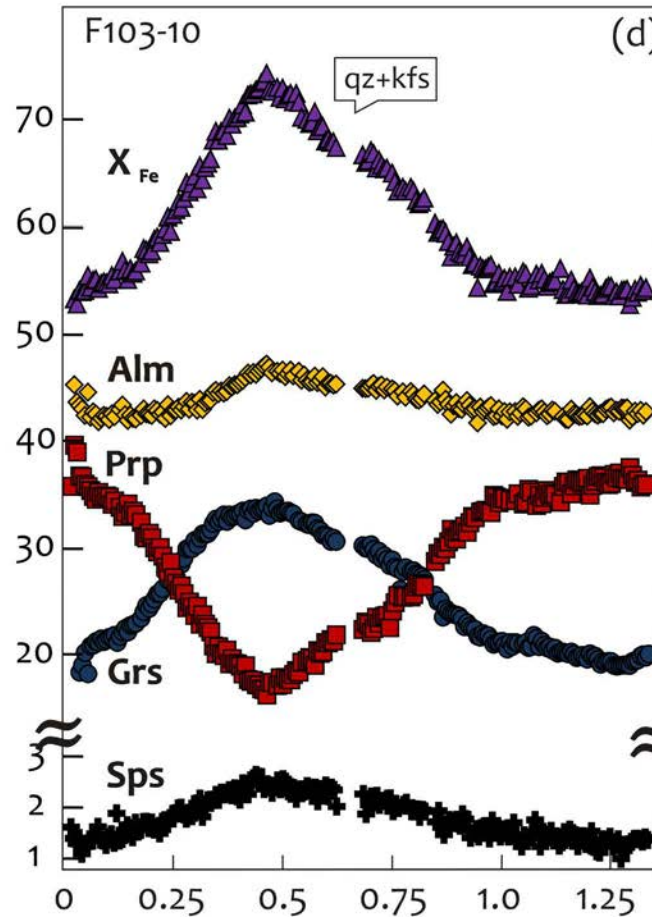
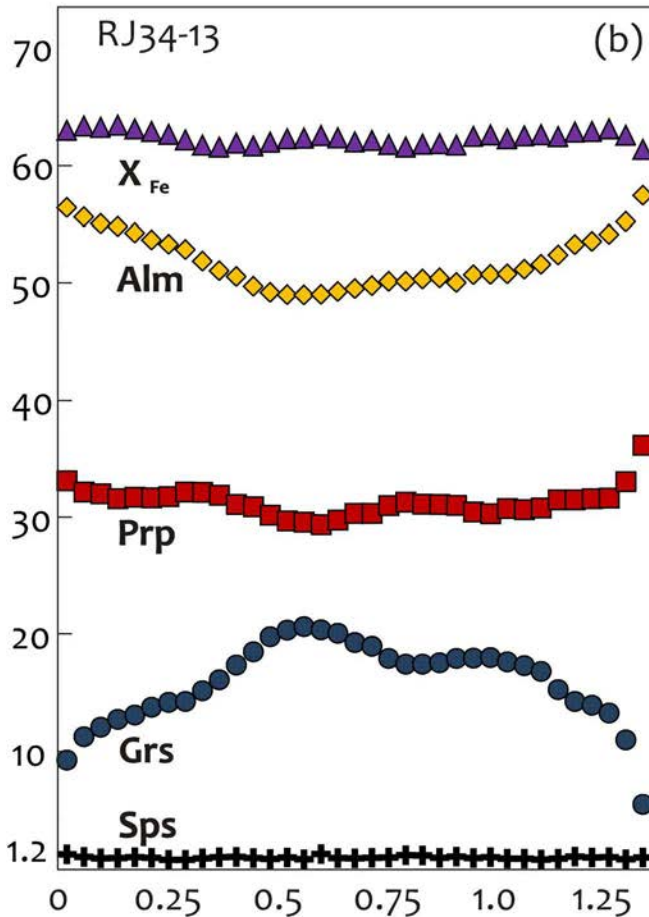
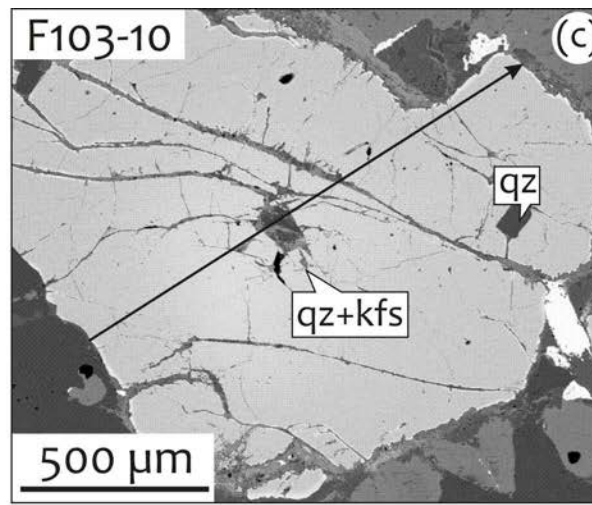
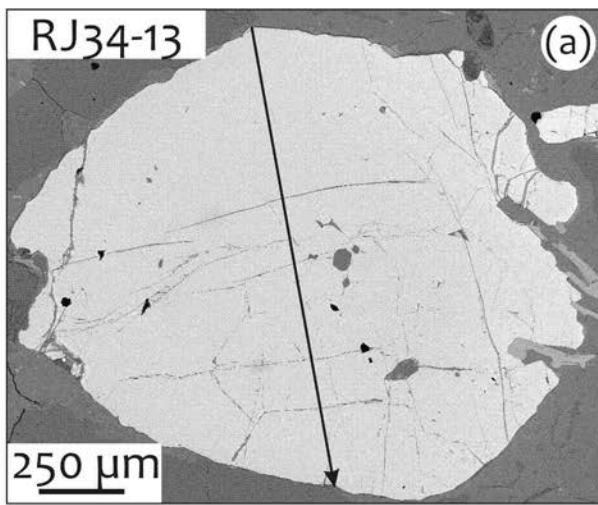


Prograde zoning garnet in felsic granulite

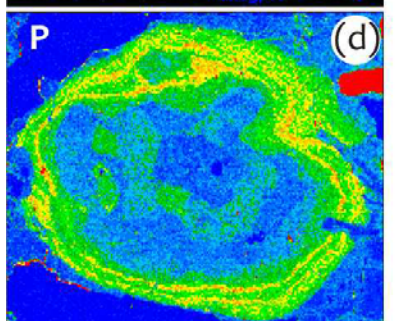
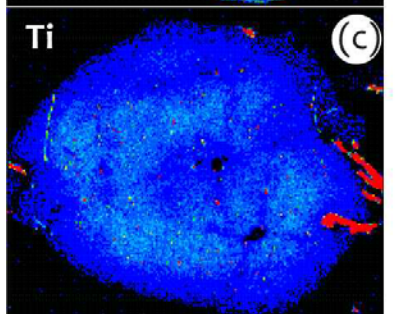
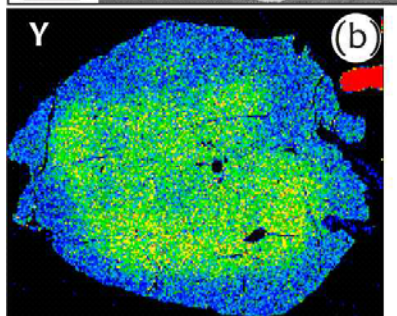
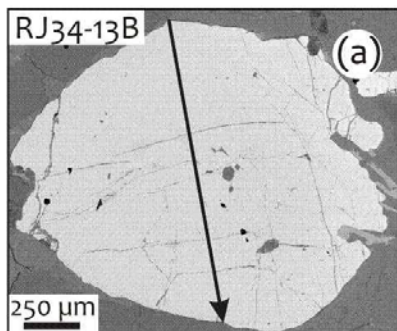




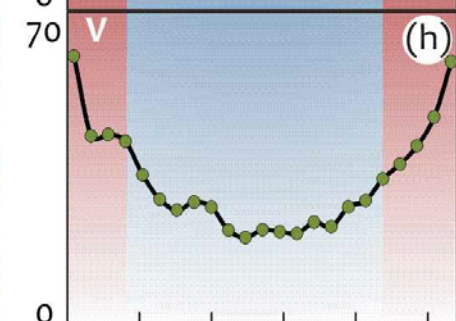
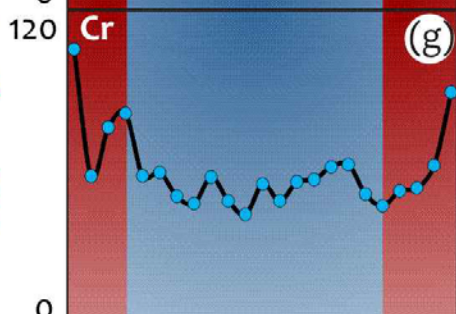
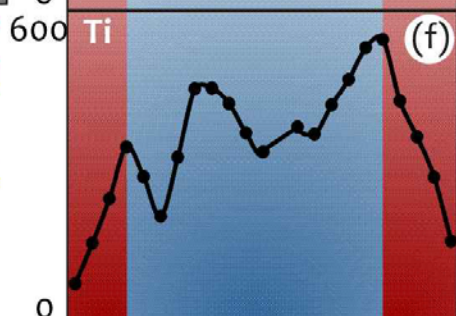
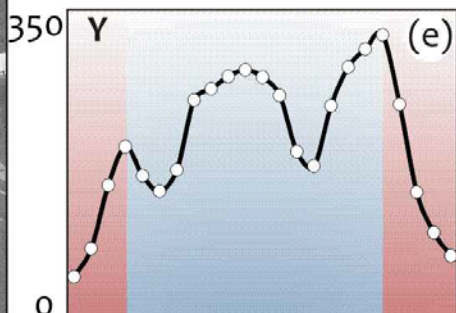
Prograde zoning garnet in felsic granulite



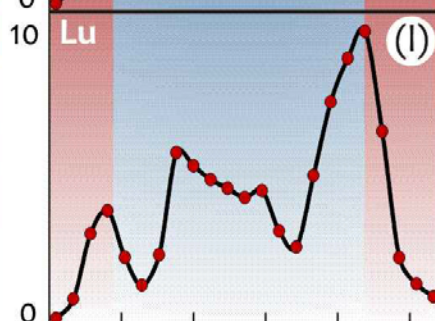
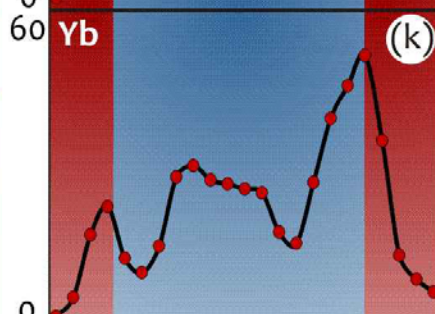
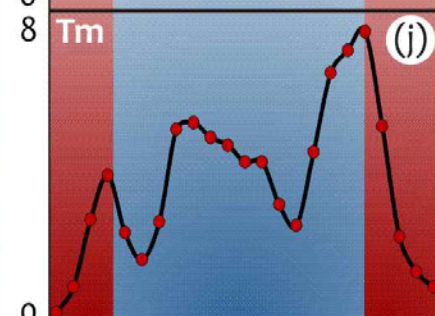
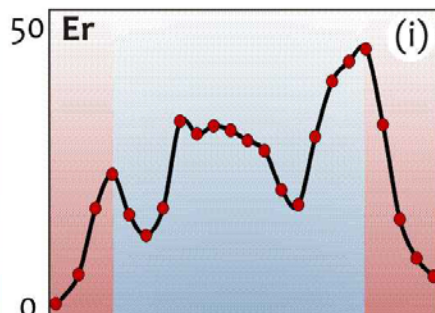
Jedlicka et al, JP
(in review)



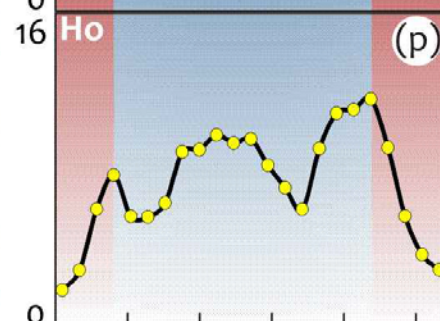
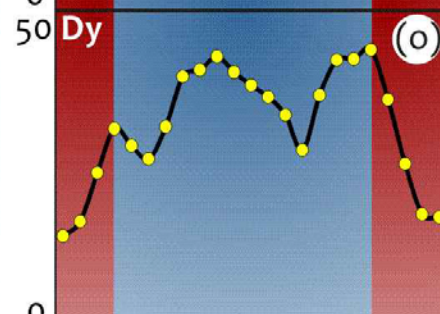
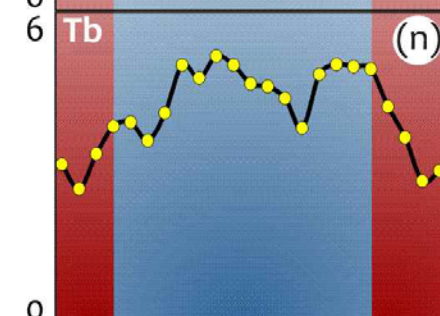
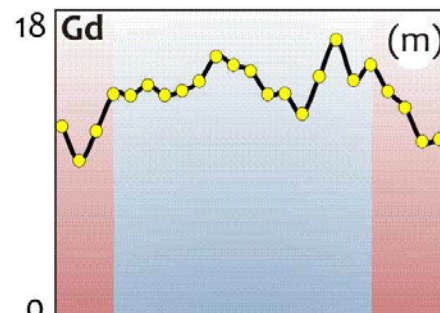
Trace elements



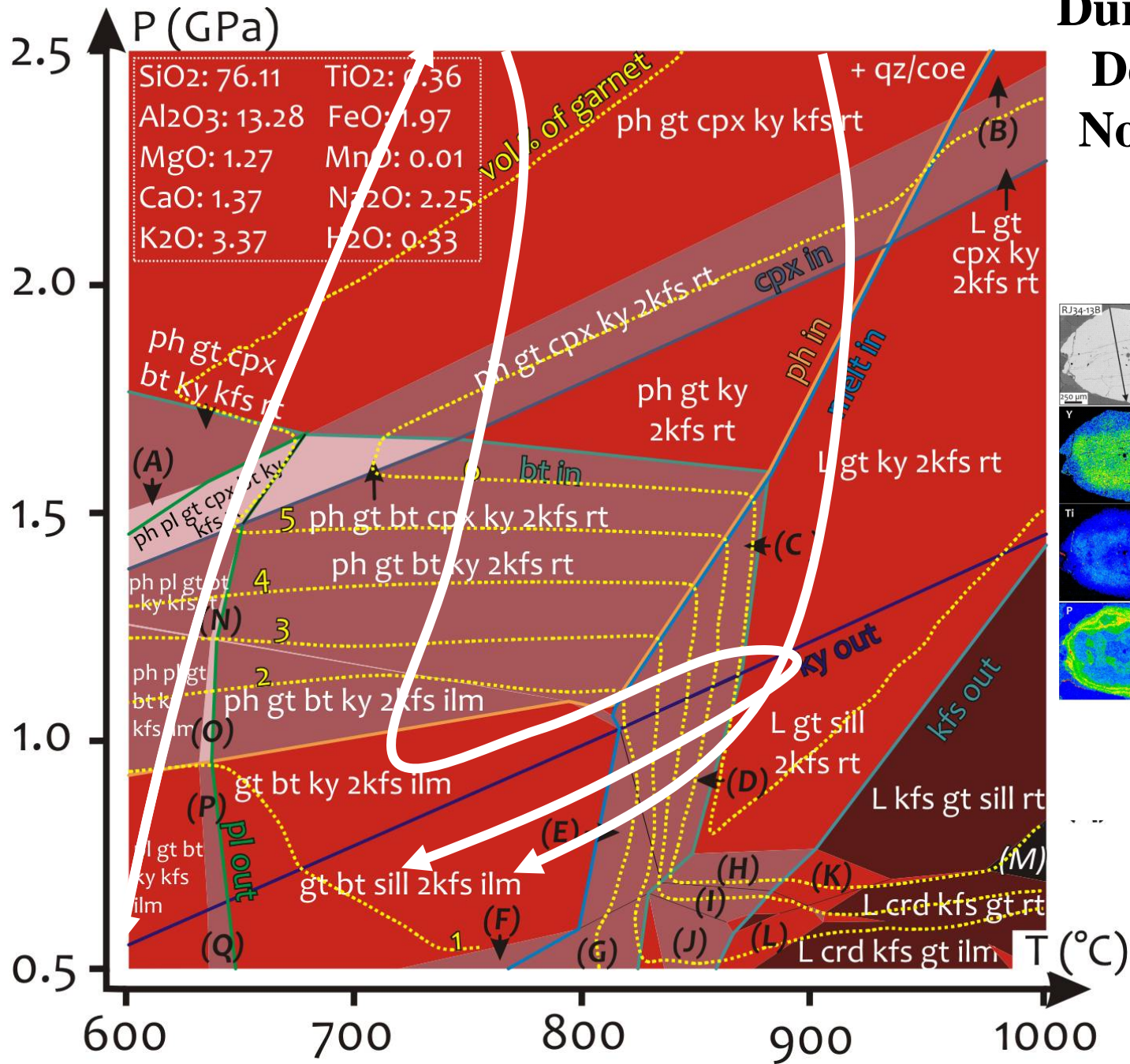
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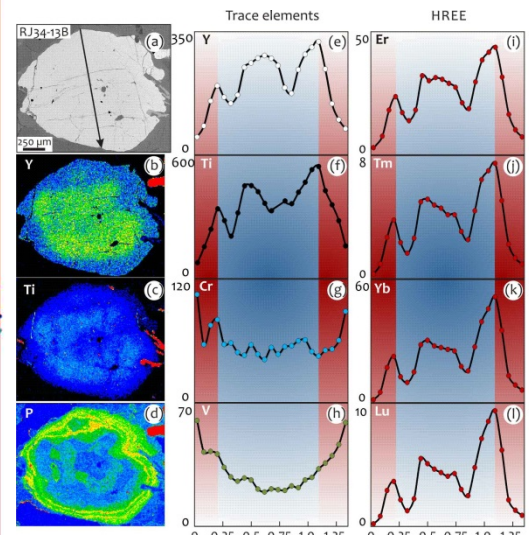
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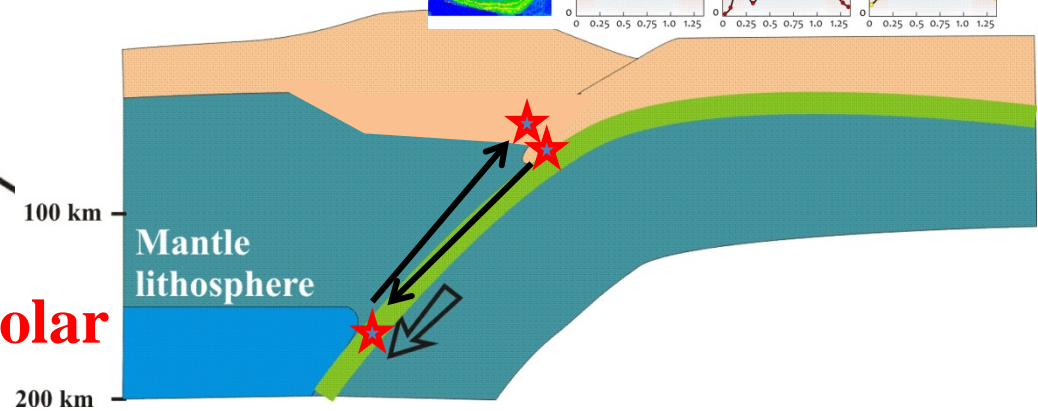
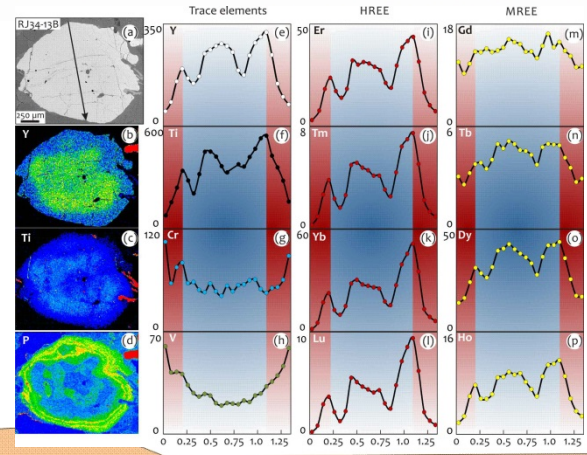
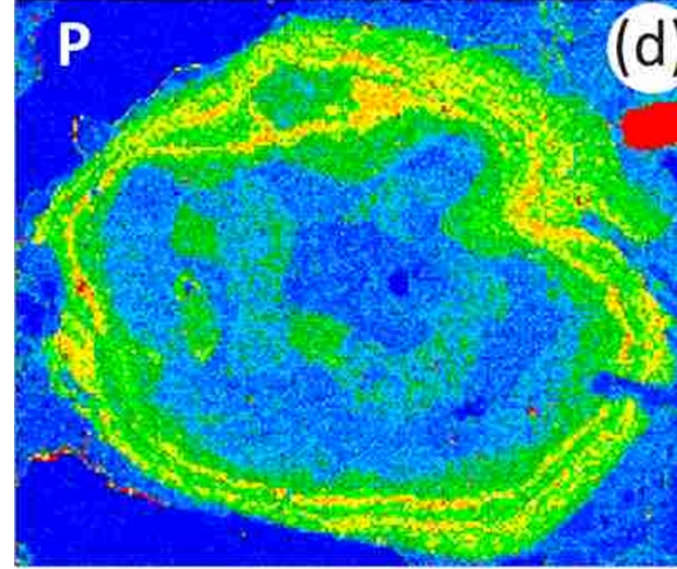
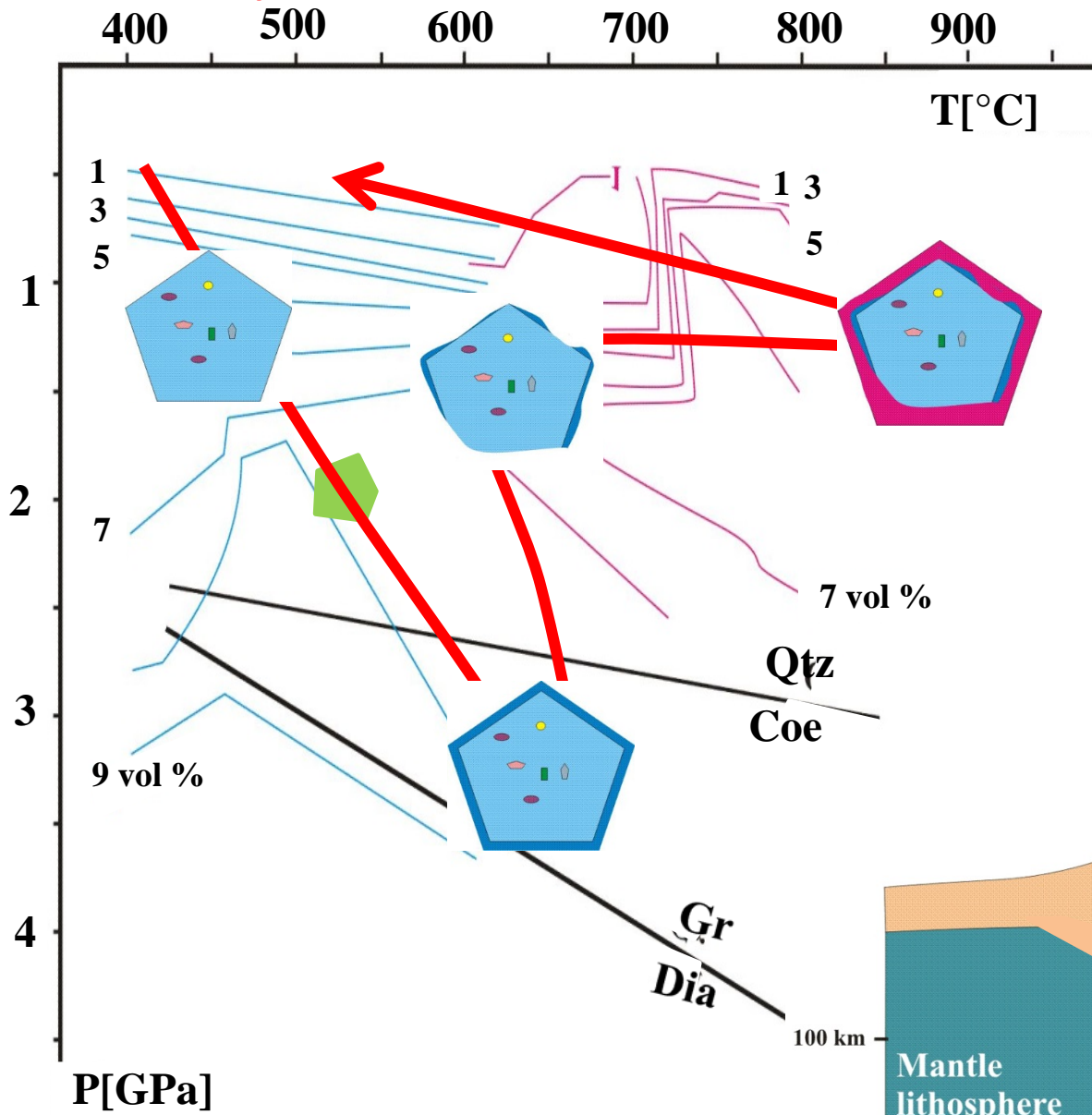
Isopleths of garnet volume contents



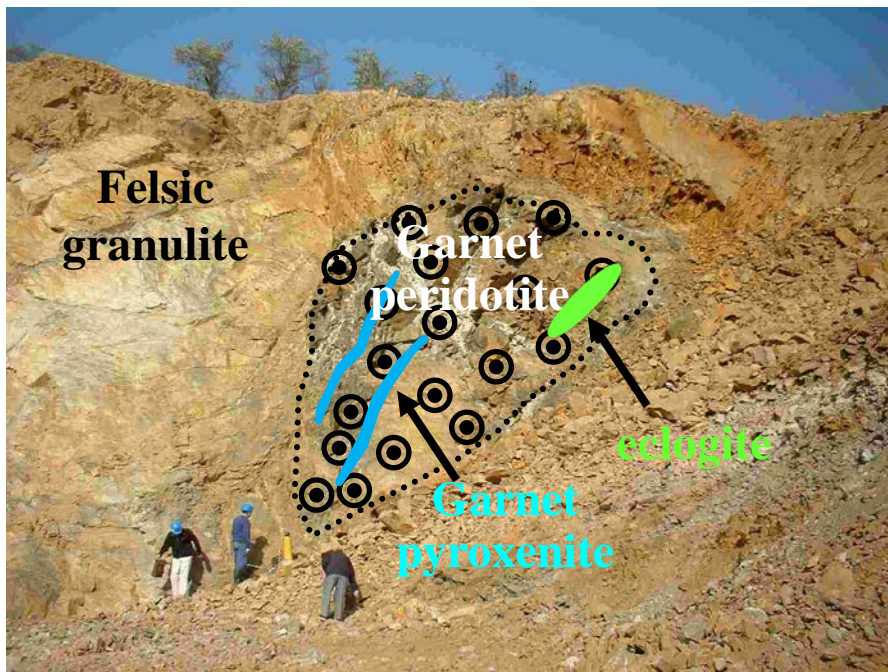
**During isothermal
Decompression
No garnet forms**



Summary I

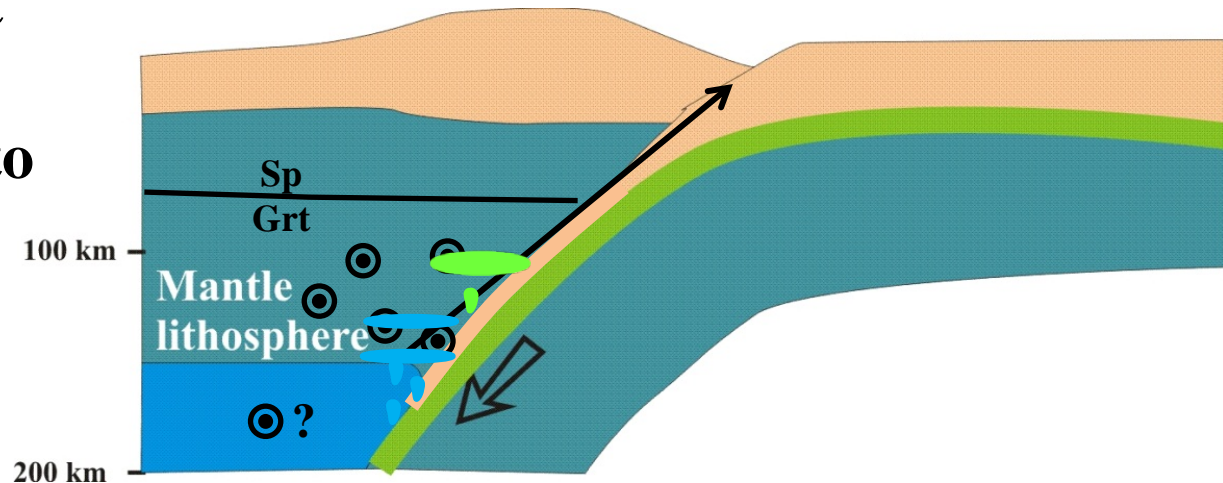


Inclusions, composition and molar amount of garnet : PT paths

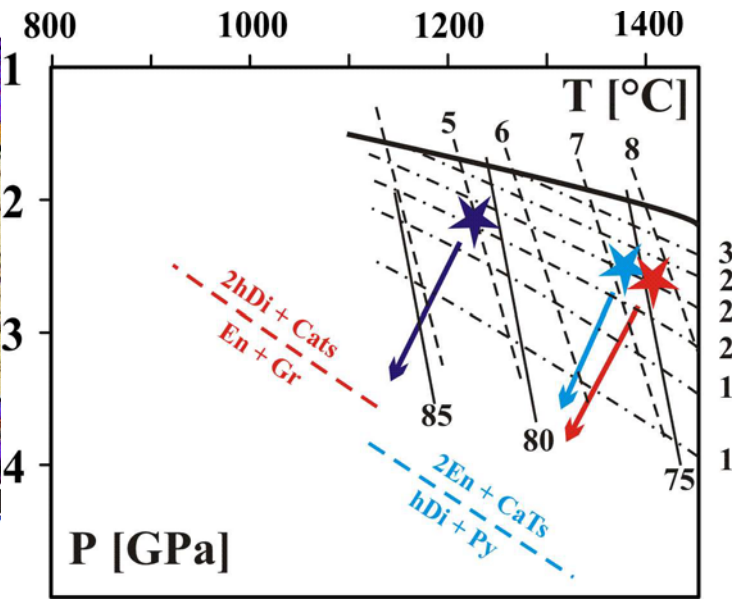
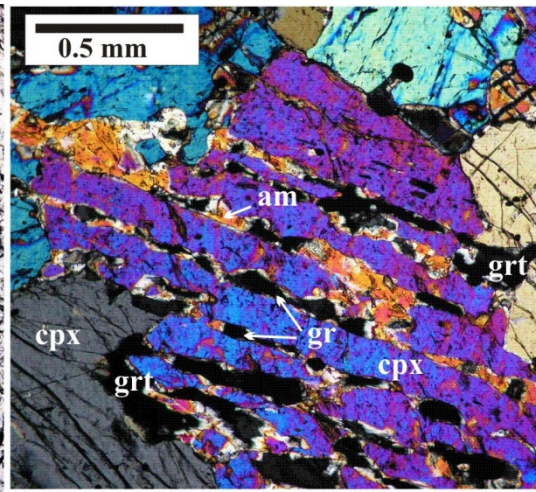
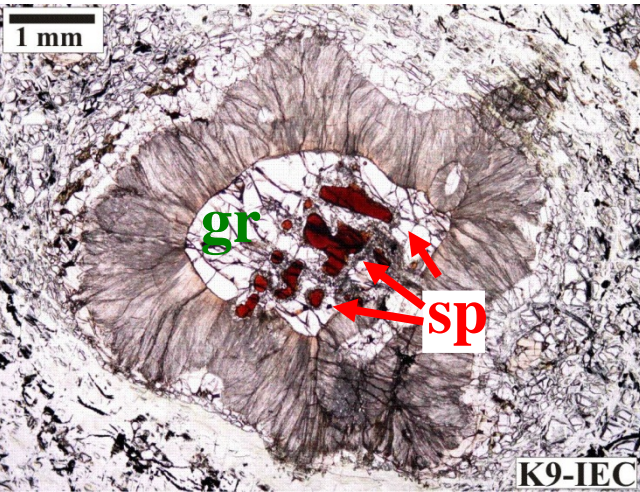


What is the origin of garnet peridotite, garnet pyroxenite and associated eclogite and how they were emplaced within crustal rocks?

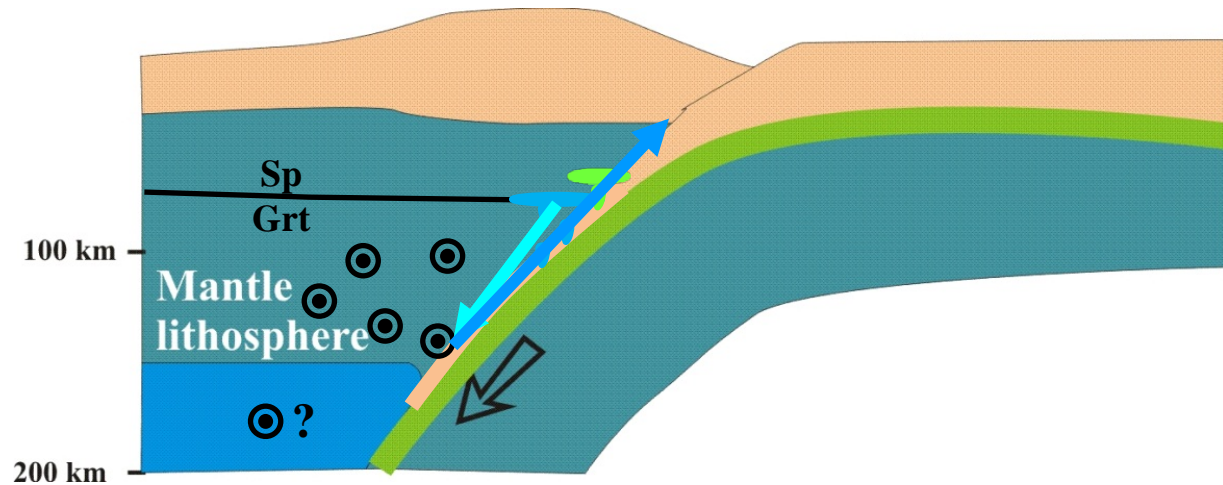
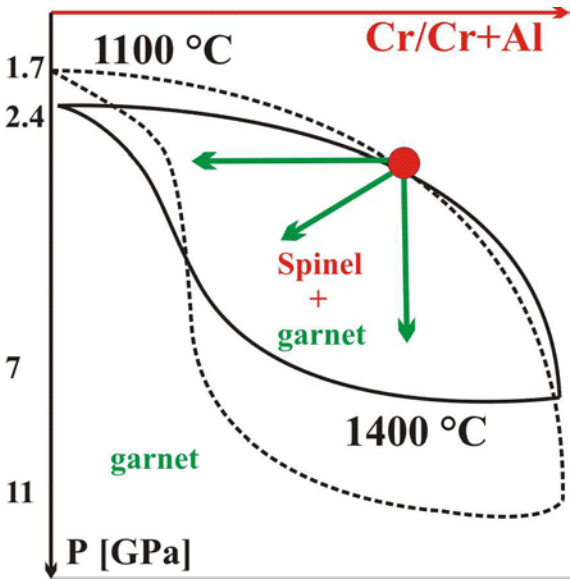
Based on geochemistry garnet pyroxenite and eclogite formed by melt infiltration from subduction material into overlying lithospheric mantle
 (Medaris et al., 2006)



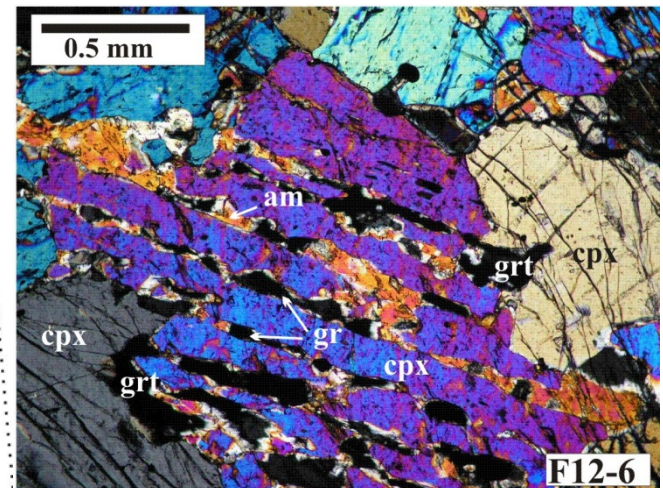
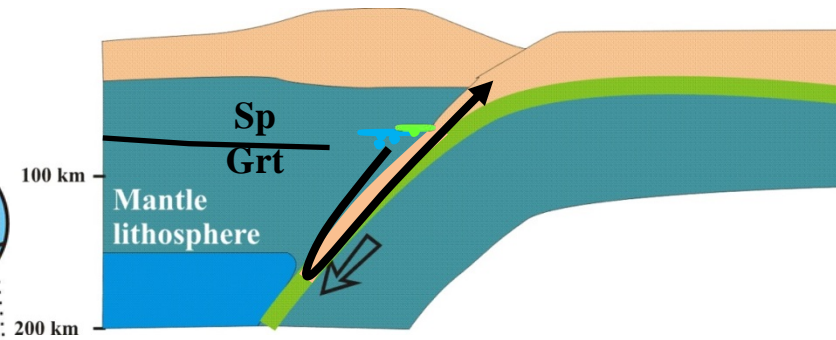
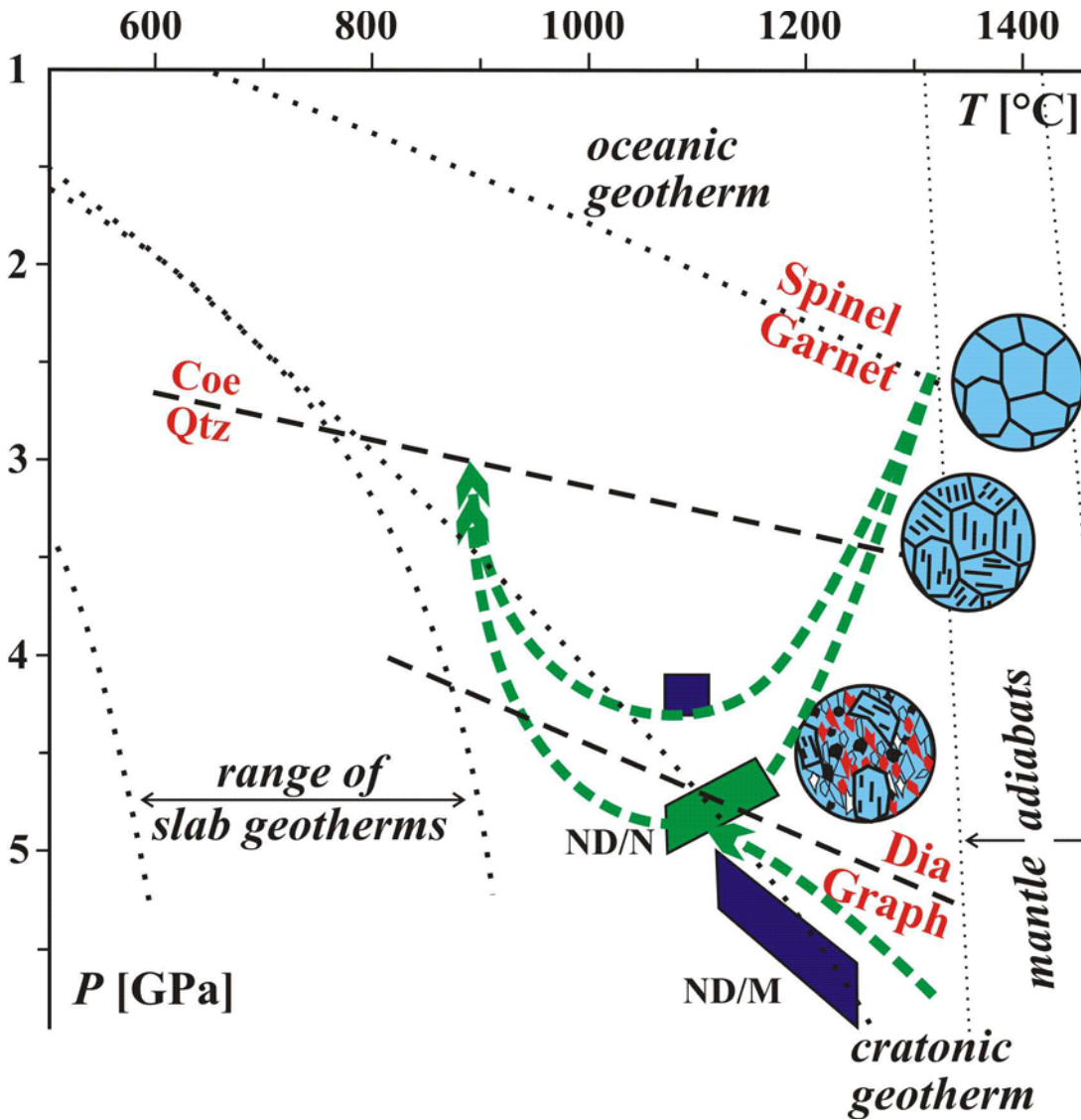
exsolution lamellae in Px



recrystallization of igneous
Cpx and Opx into
fine-grained matrix
(cpx + grt + opx + amph)
(Faryad et al., 2009)

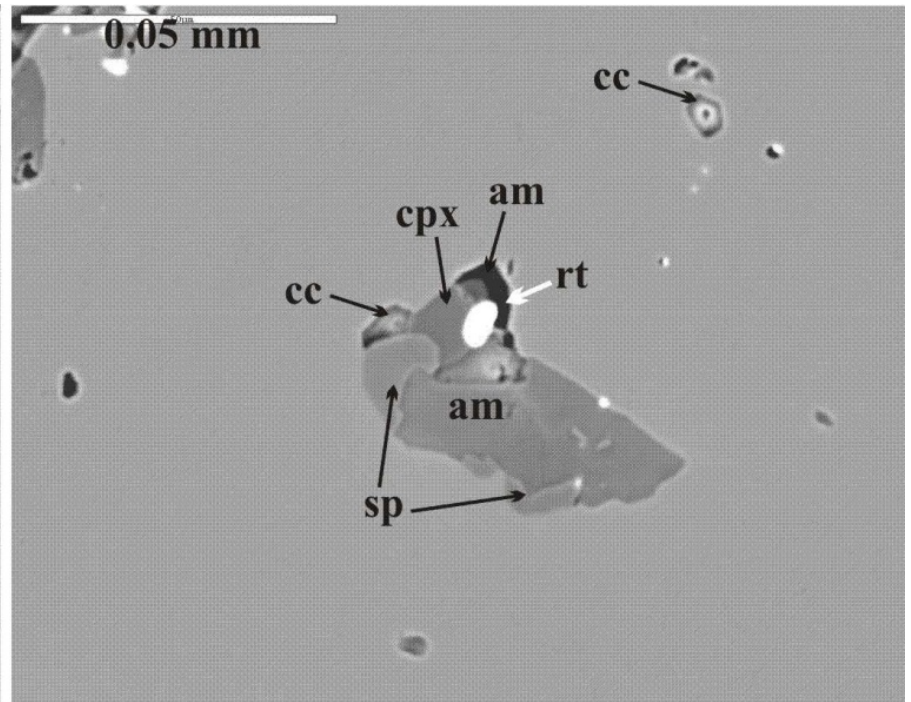
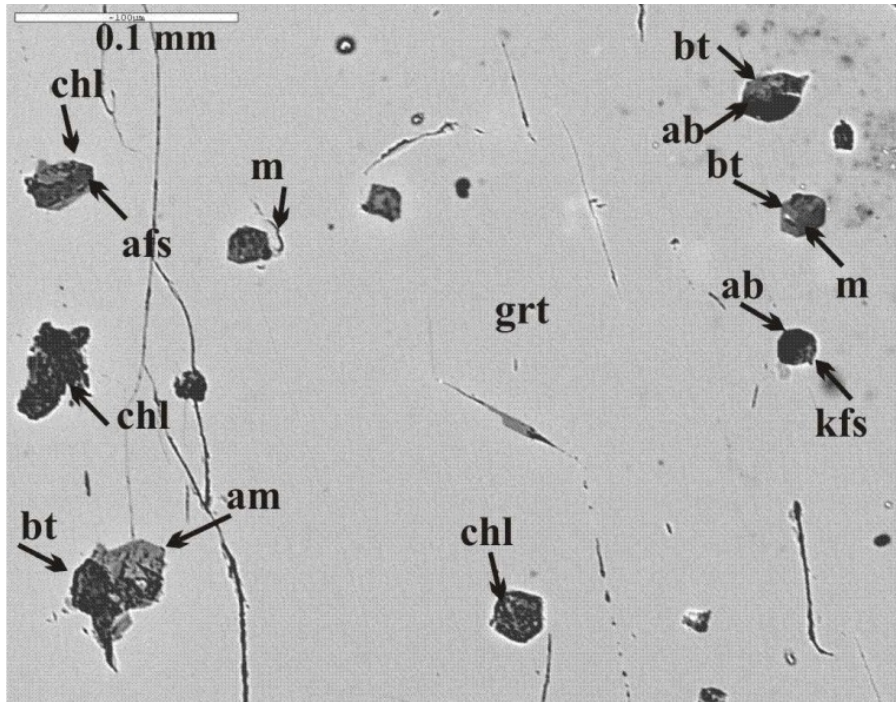


PT histories of peridotites with layers of pyroxenites

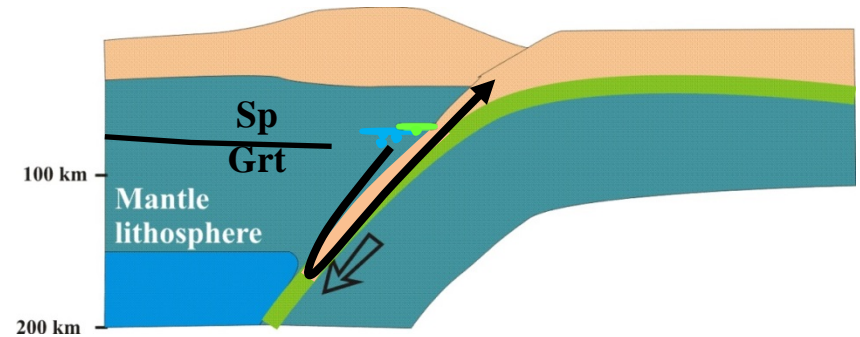


Peridotites and pyroxenites were formed in a shallow, high-temperature mantle and then buried to deeper mantle position (Fayad et al., 2009)

Garnet clinopyroxenite



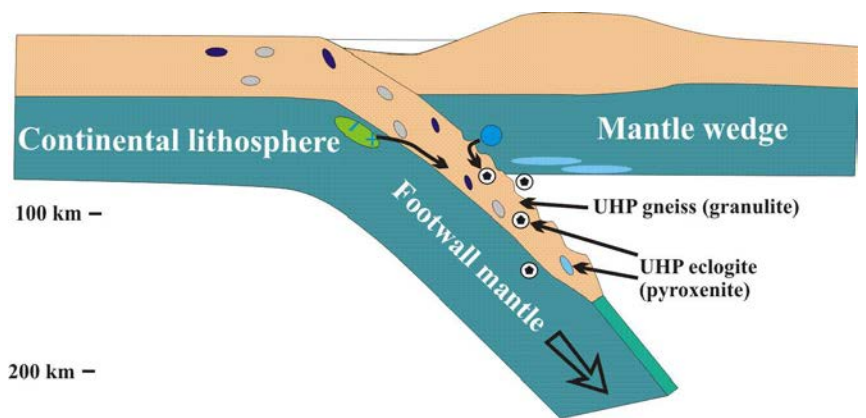
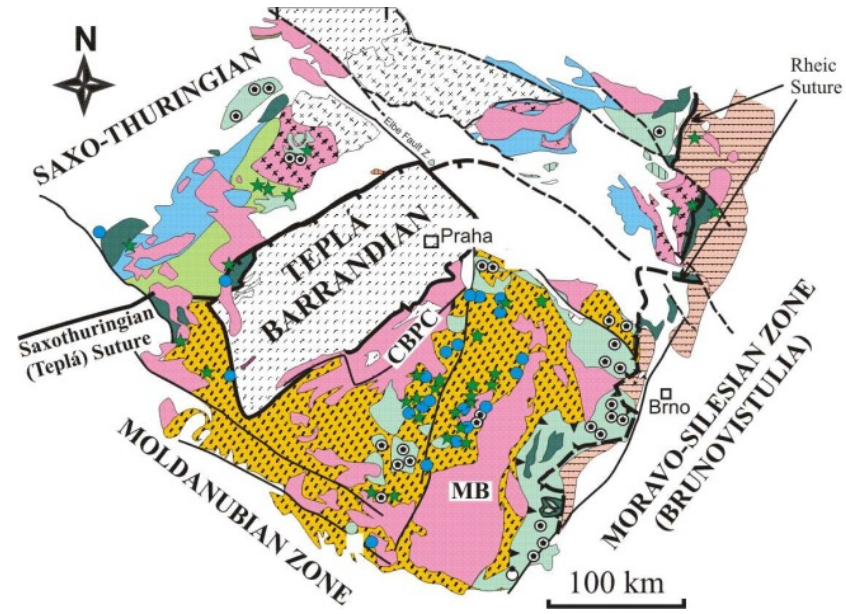
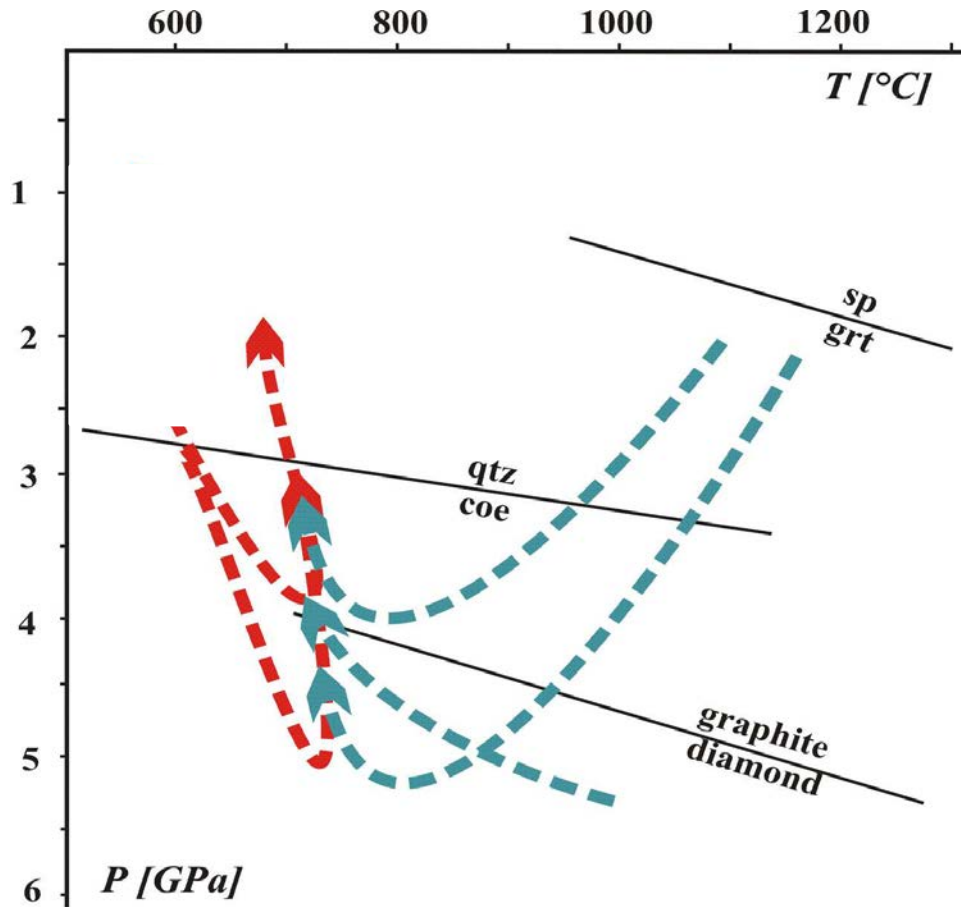
dolomite
K-feldspar
amphibole
paragonite
calcite
albite
F-apatite
chlorite
biotite



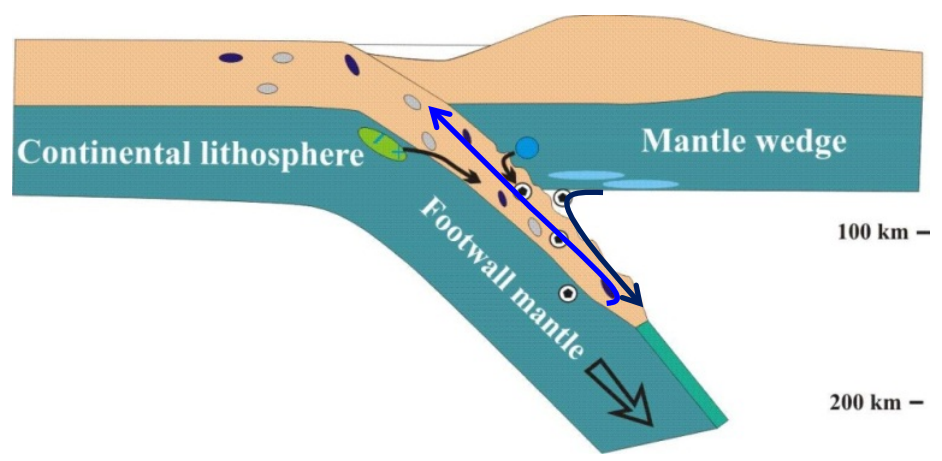
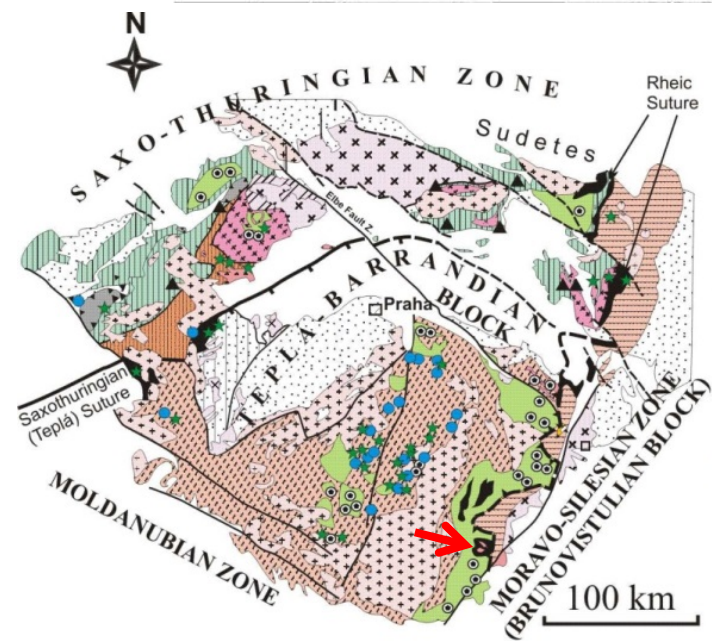
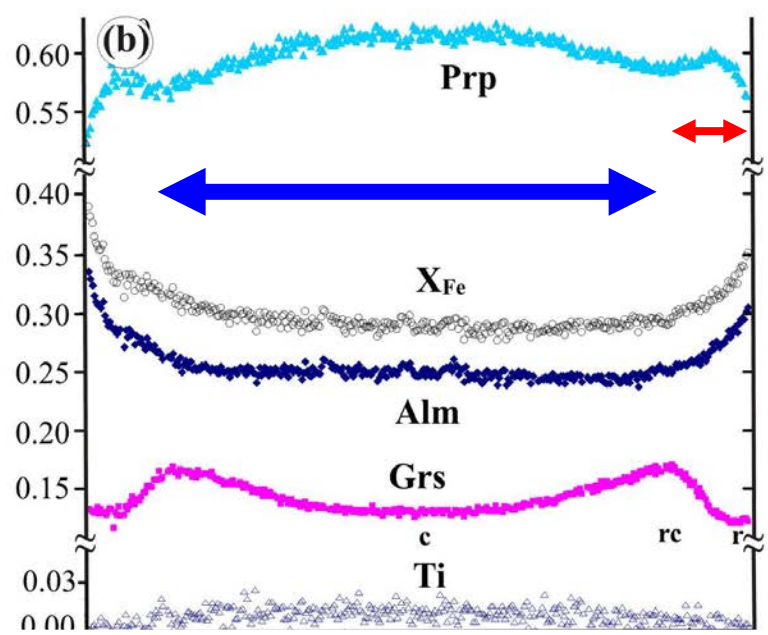
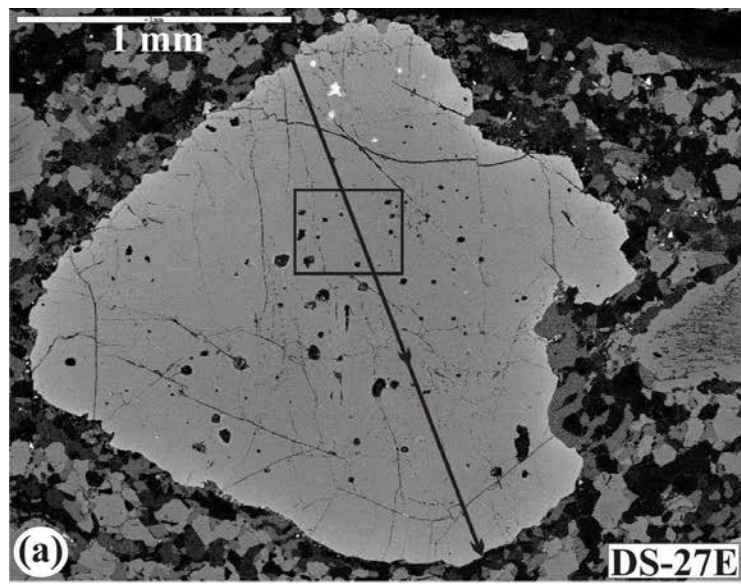
Garnet crystallization in the presence of fluids and lithophile elements is supported by solid phase inclusions (Faryad et al., 2013, Gondwana Res.)

III: Crustal and mantle HP-UHPM rocks

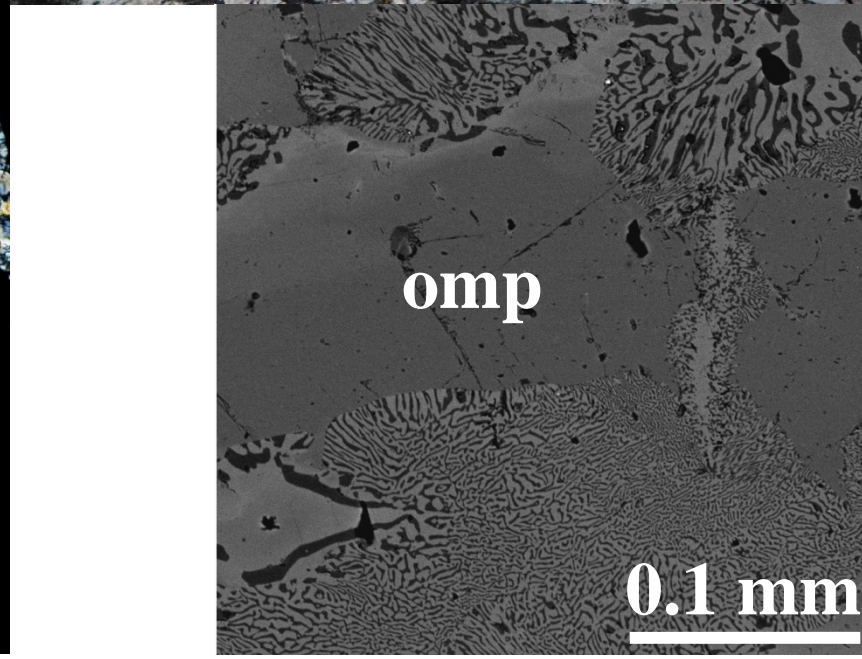
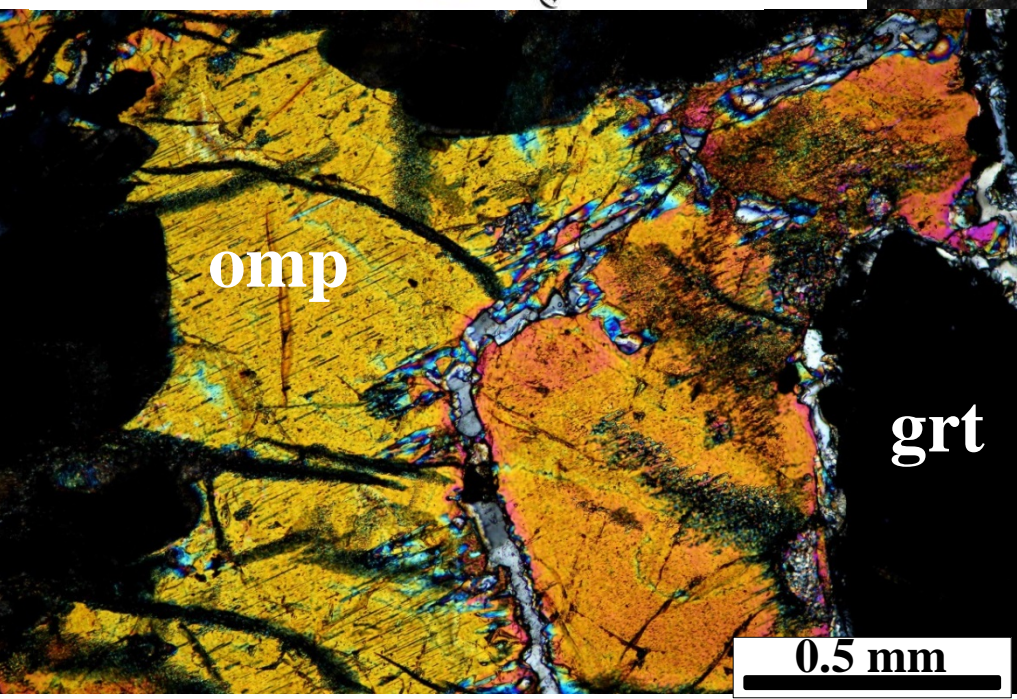
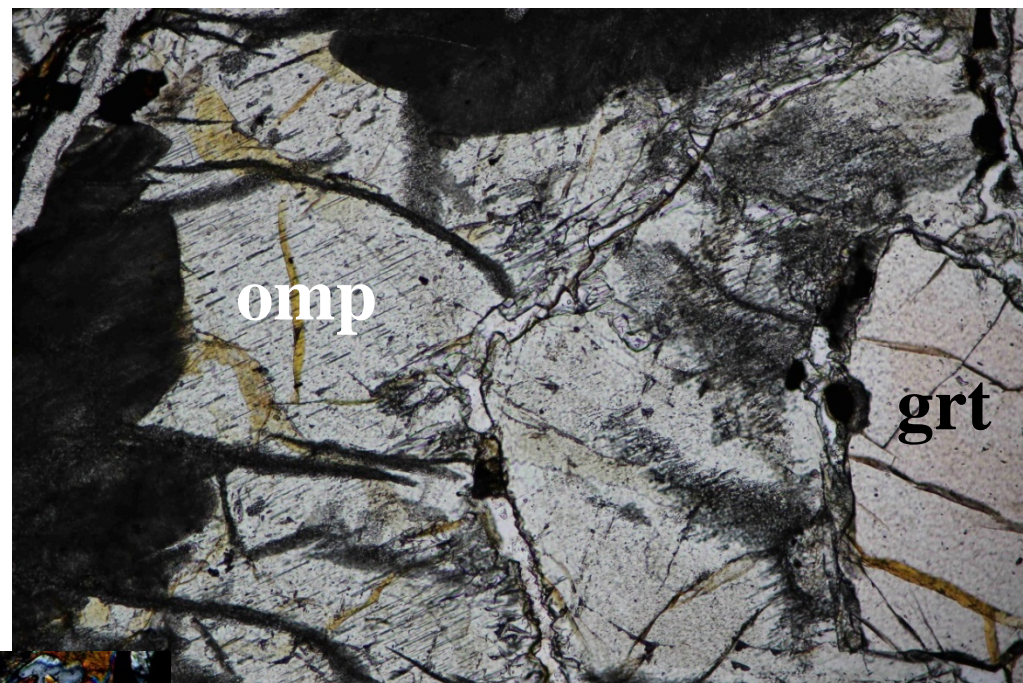
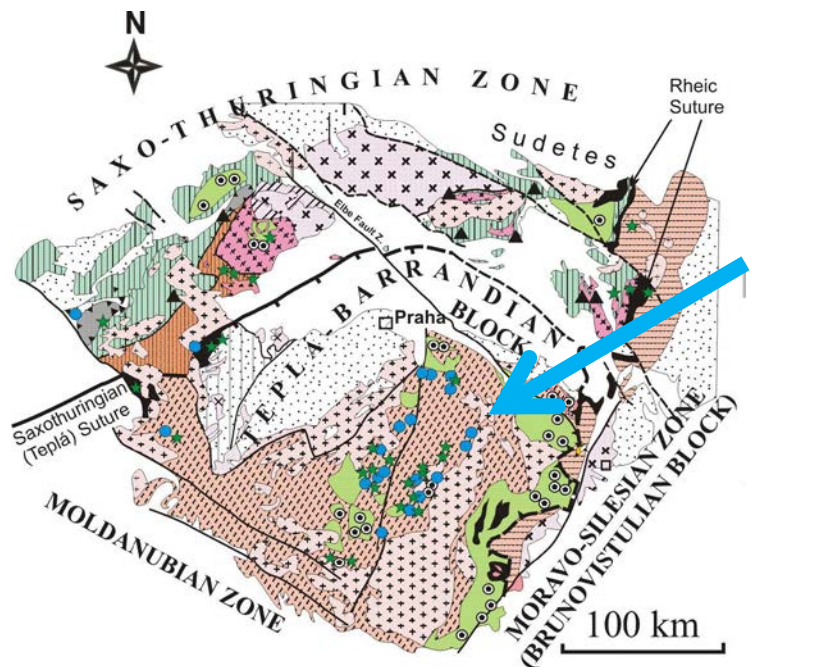
Is there any evidence of granulite facies overprint in mantle rocks?



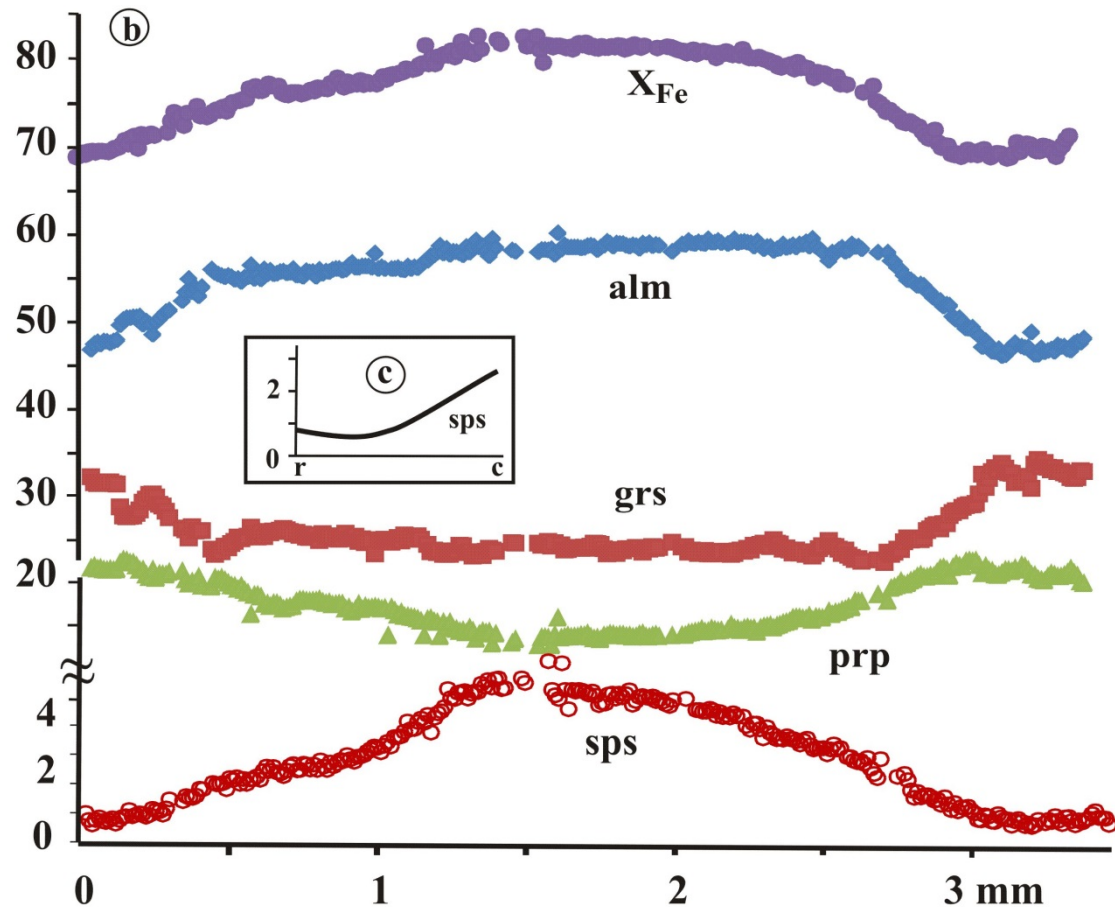
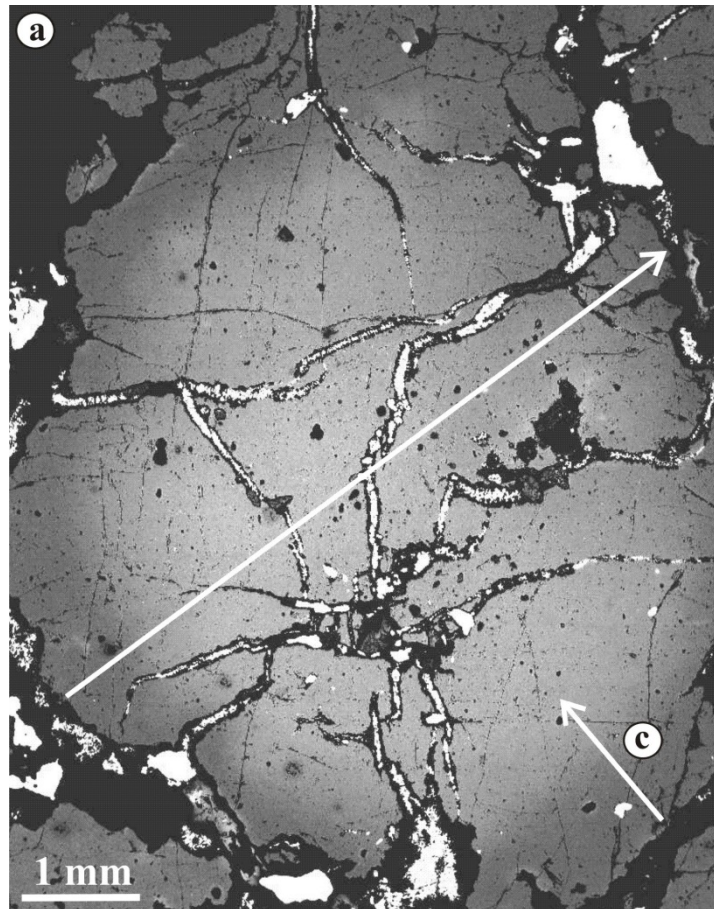
3.2. garnet in pyroxenite indicates heating after exhumation



Eclogite in the amphibolite facies units

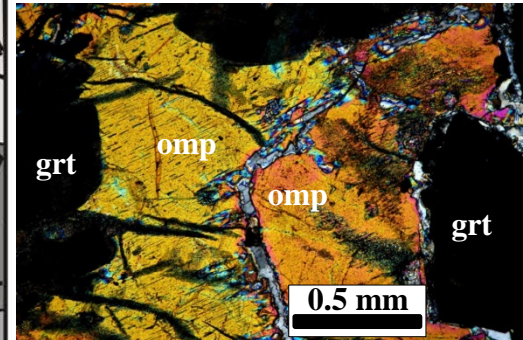
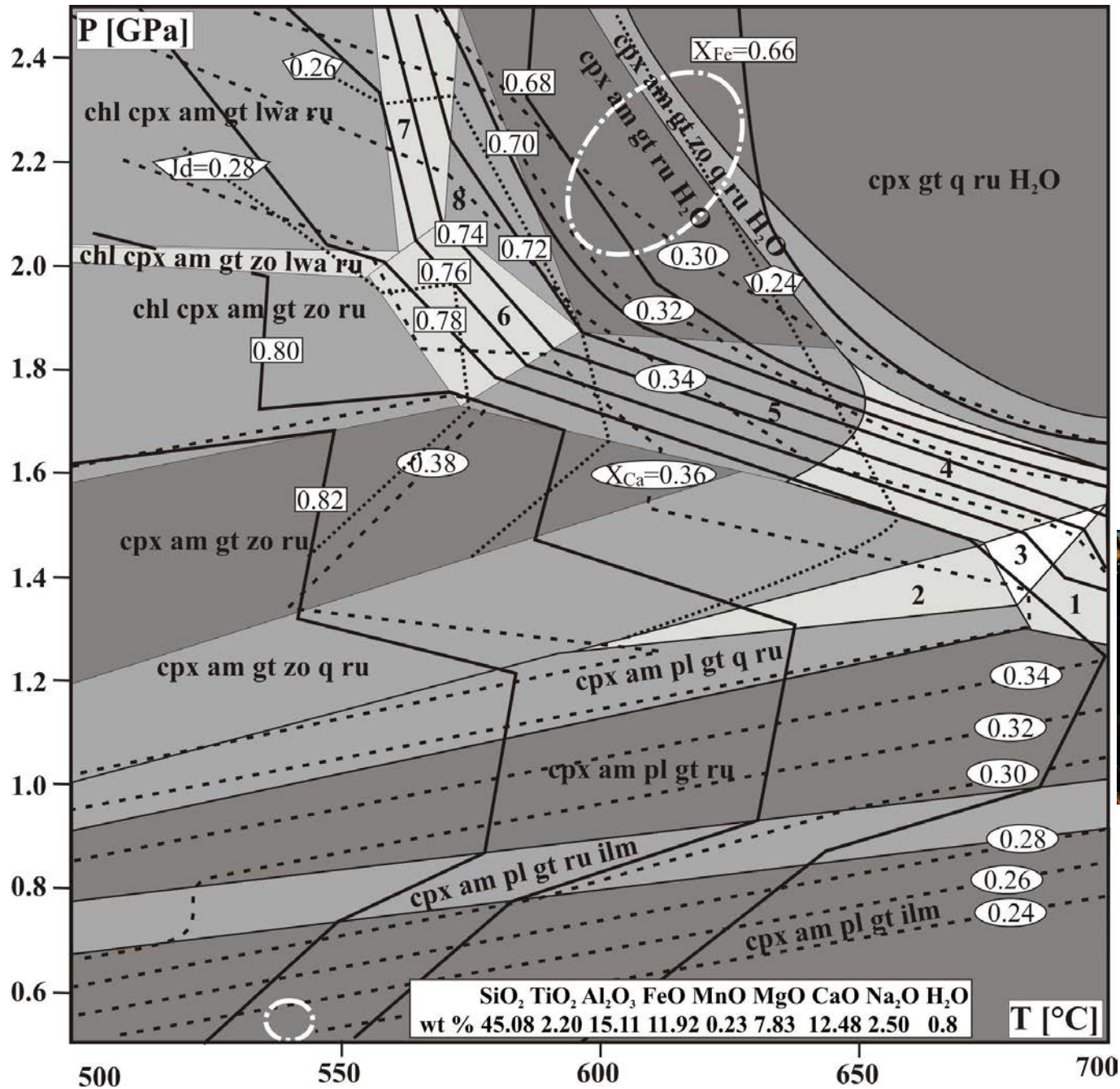


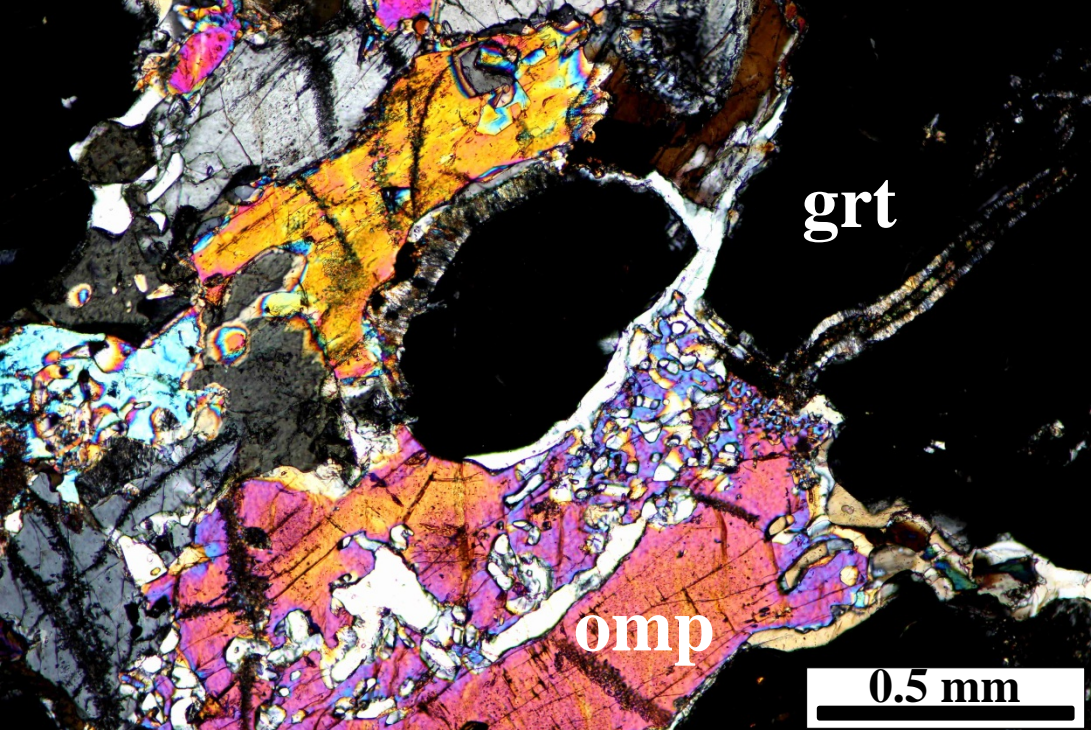
Preservation of prograde zoning garnet



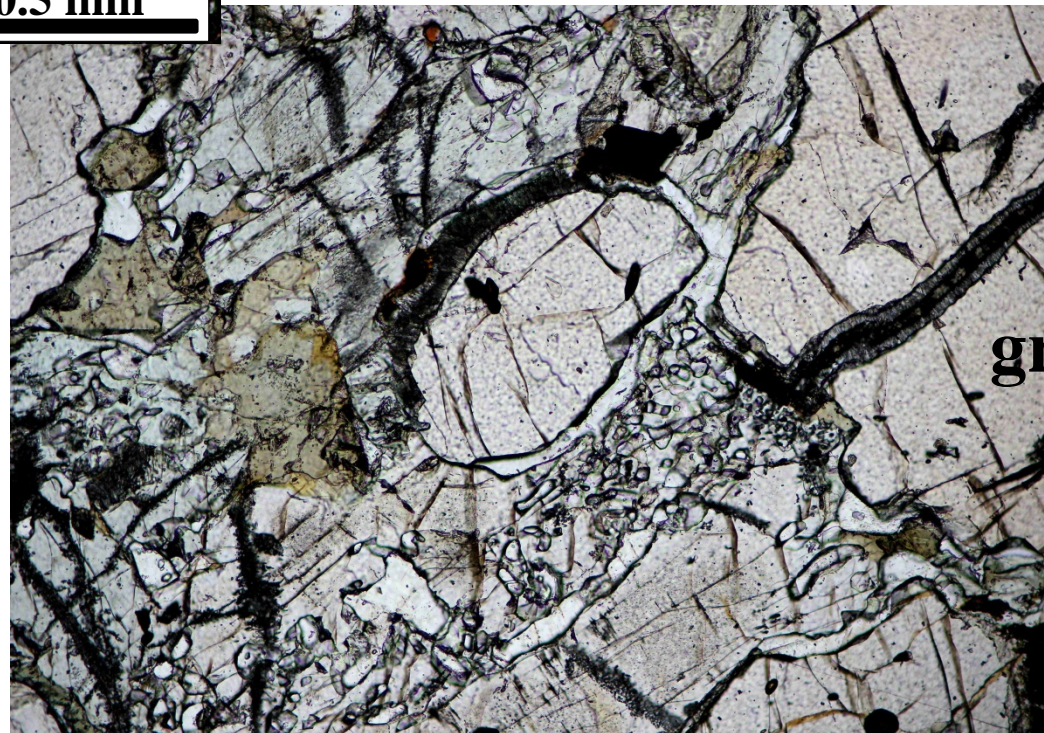
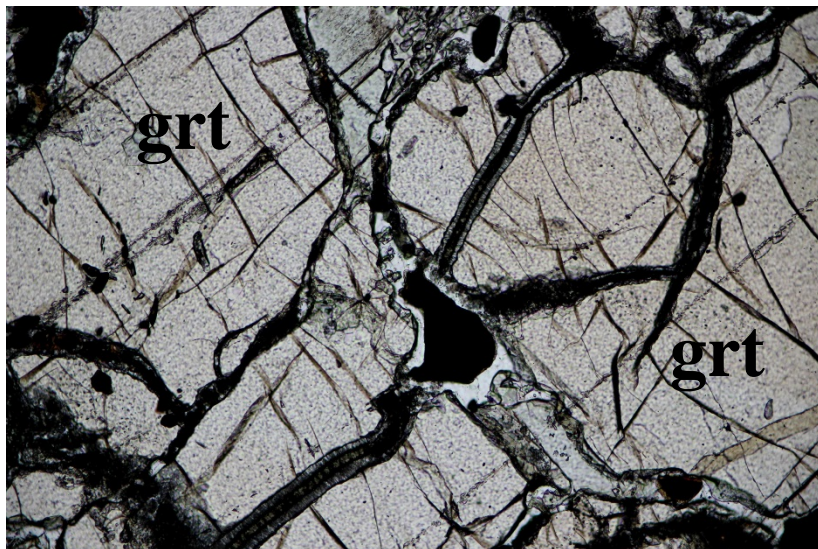
Note -back diffusion of Mn at rim (profile c) and -fractures in garnet

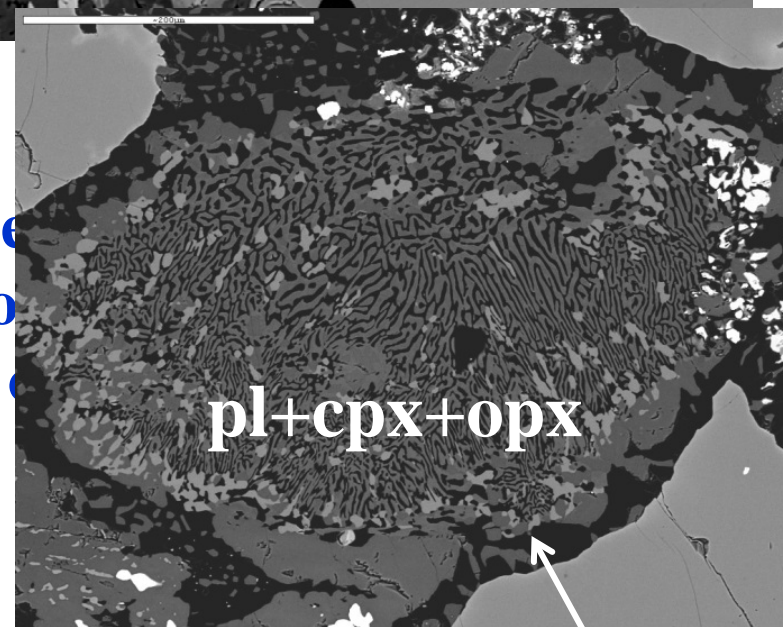
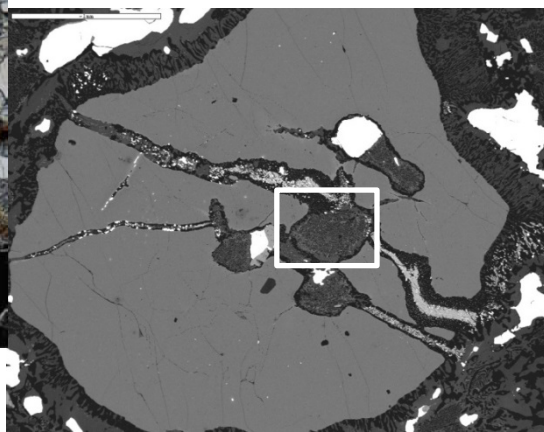
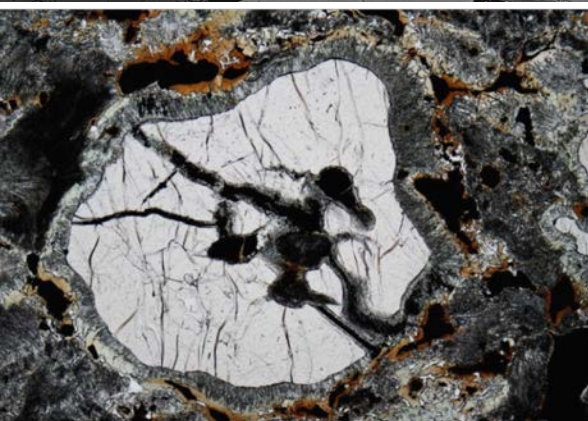
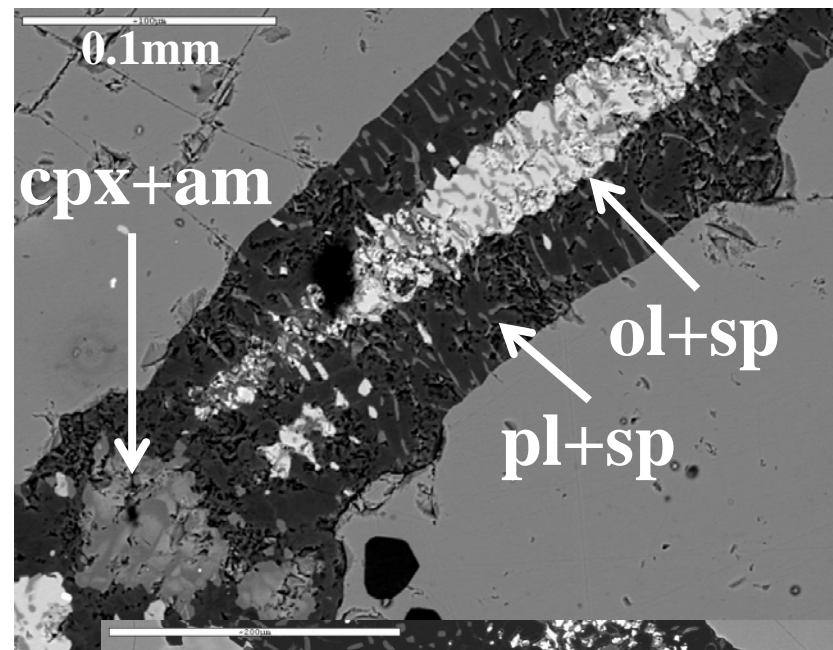
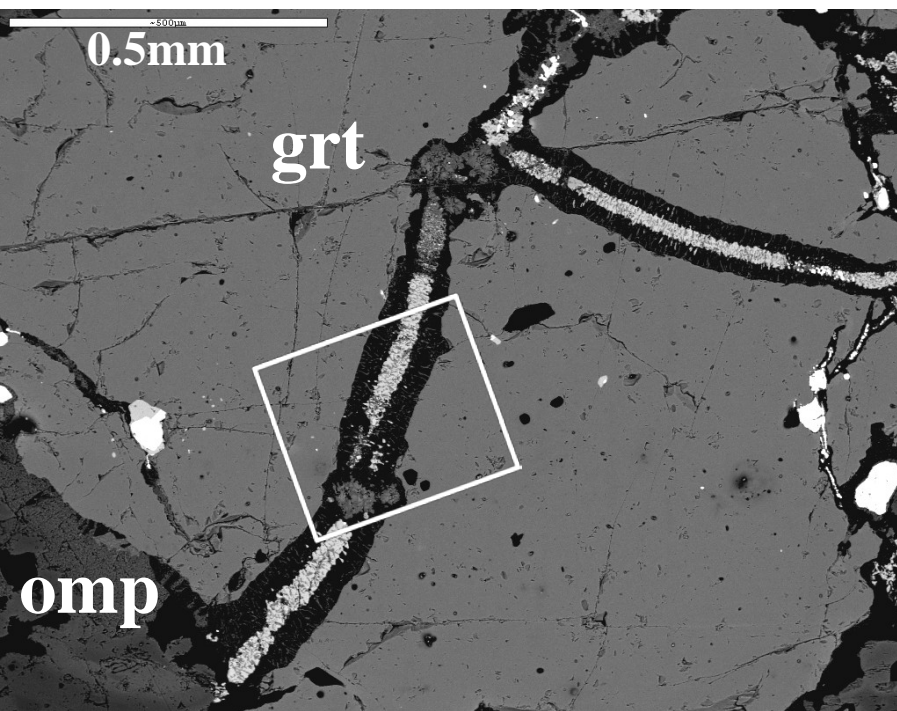
Eclogite facies metamorphism



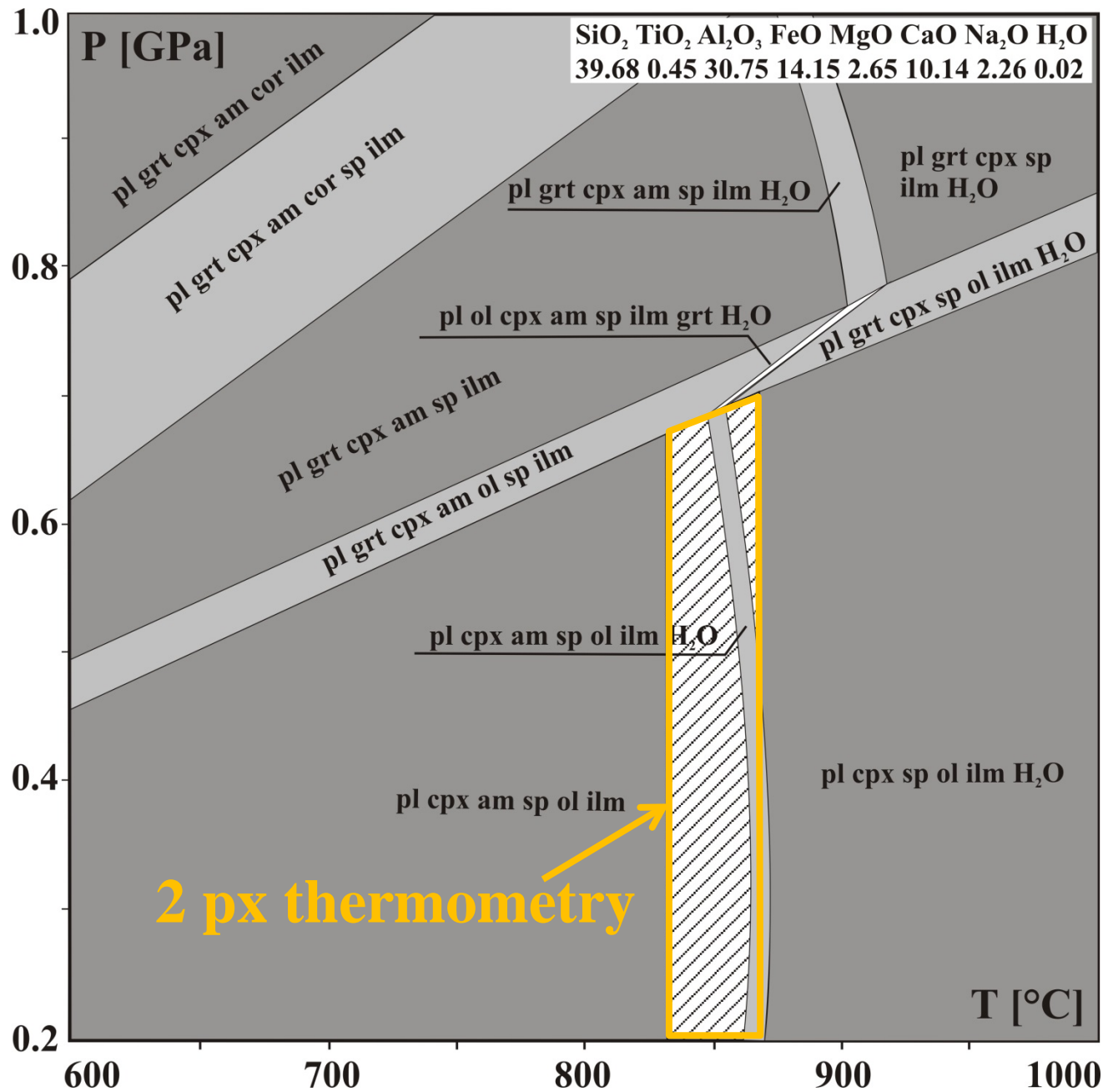


Fractures with fillings showing symmetric zoning (black axial and light marginal parts)

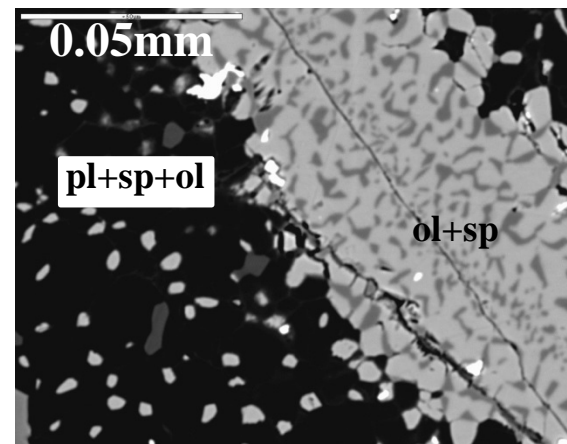




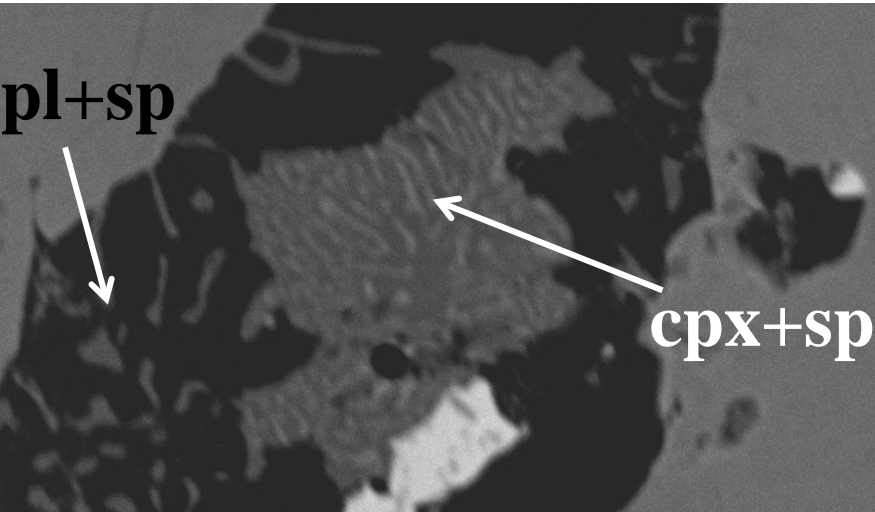
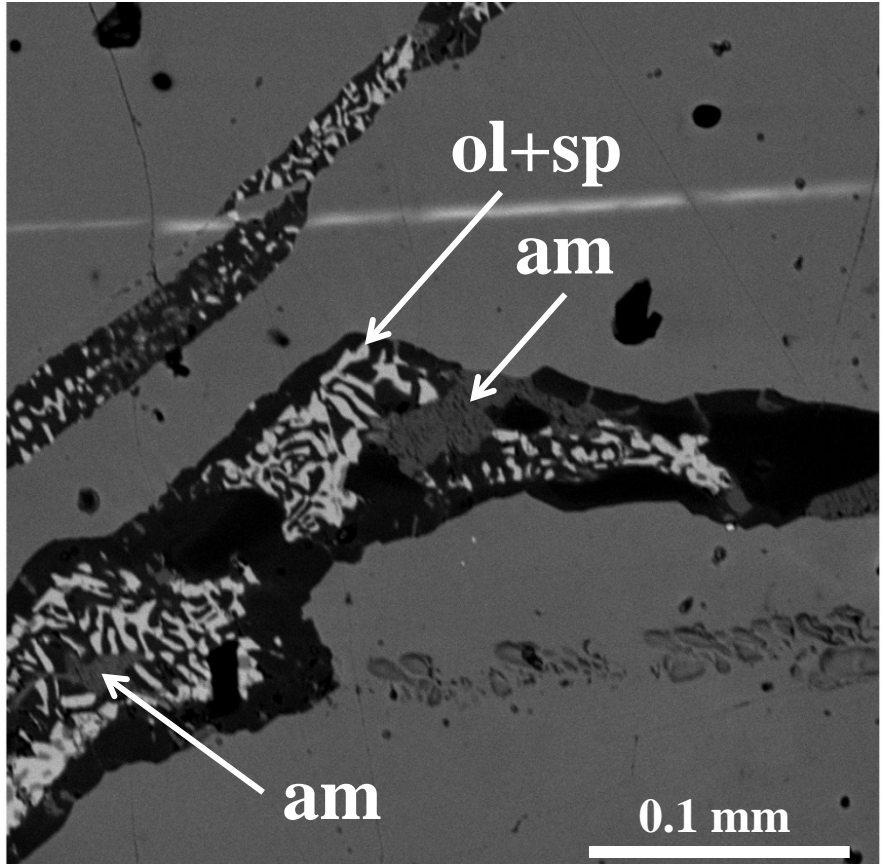
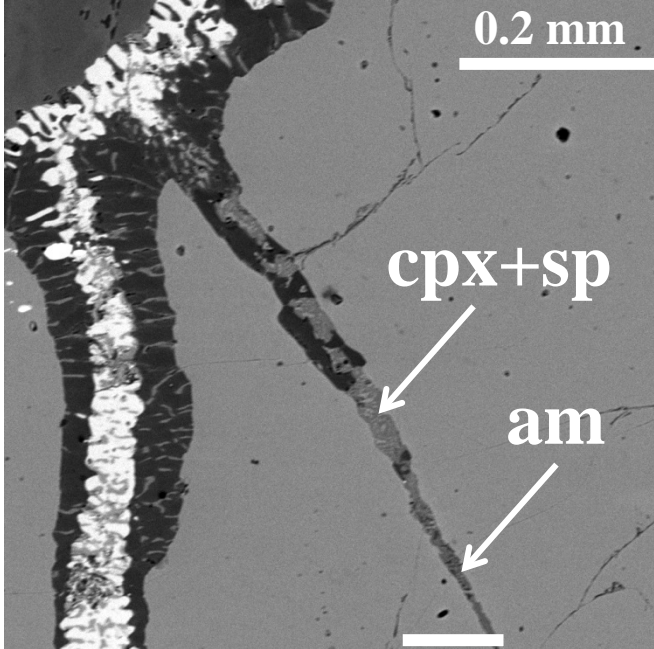
Strong retrograde eclogite with relatively high Mg content contains omphacite in the symplectite after omphacite



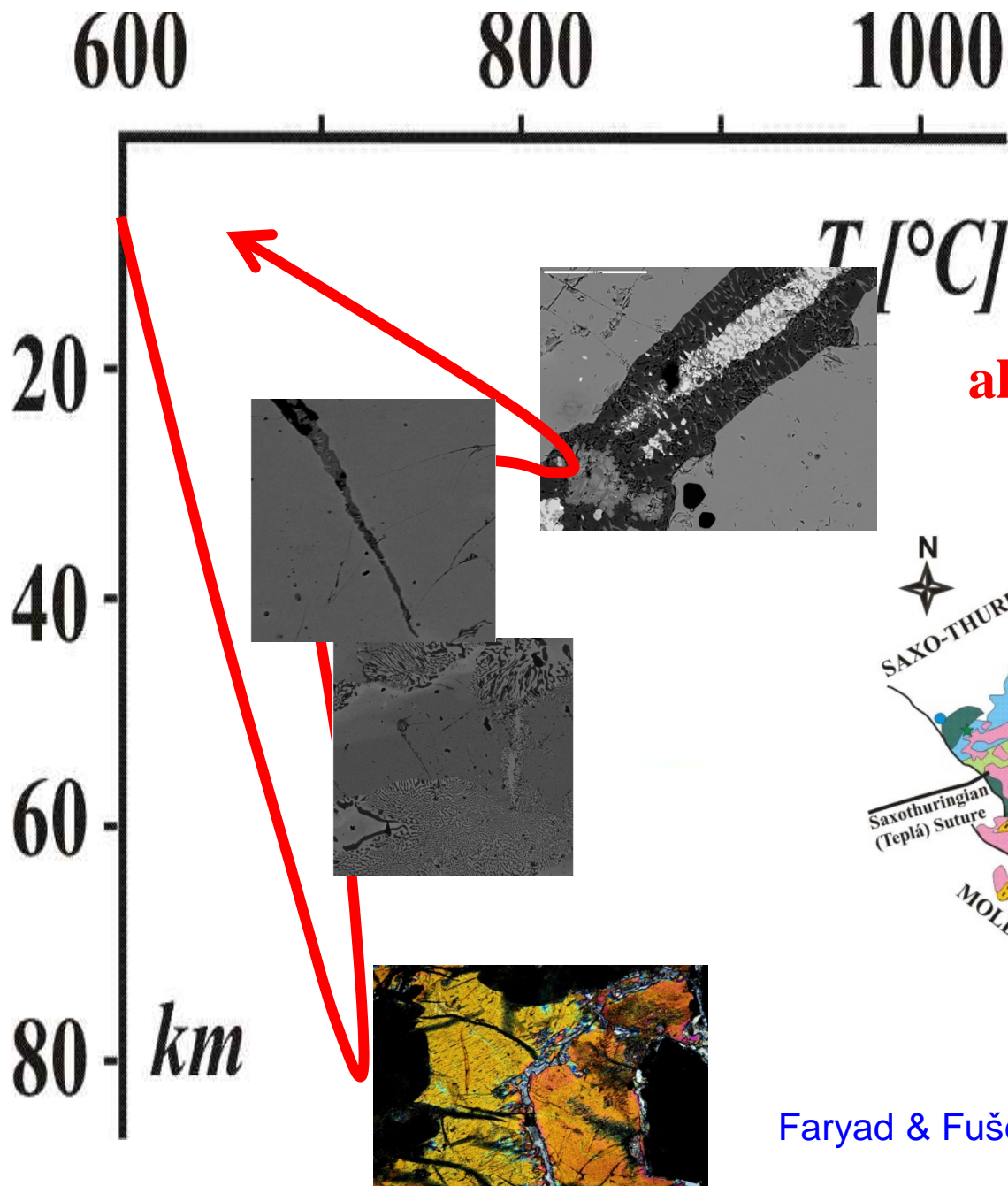
Granulite facies overprint



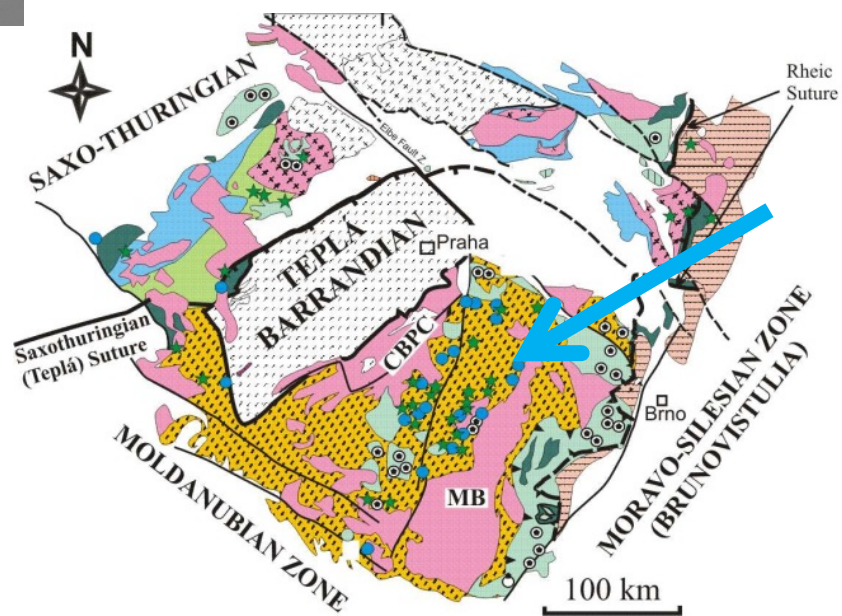
Amphibole is overgrown by symplectite of ol + sp or by cpx + sp



	EBC	am	EBC-am
SiO ₂	39.68	37.07	2.615
Al ₂ O ₃	30.75	18.17	12.585
TiO ₂	0.25	0.31	-0.06
FeO	14.14	17.42	0.175
MnO	0.41	0.15	-3.275
MgO	2.65	9.03	-6.38
CaO	10.14	13.22	-3.075
Na ₂ O	2.26	1.82	0.445

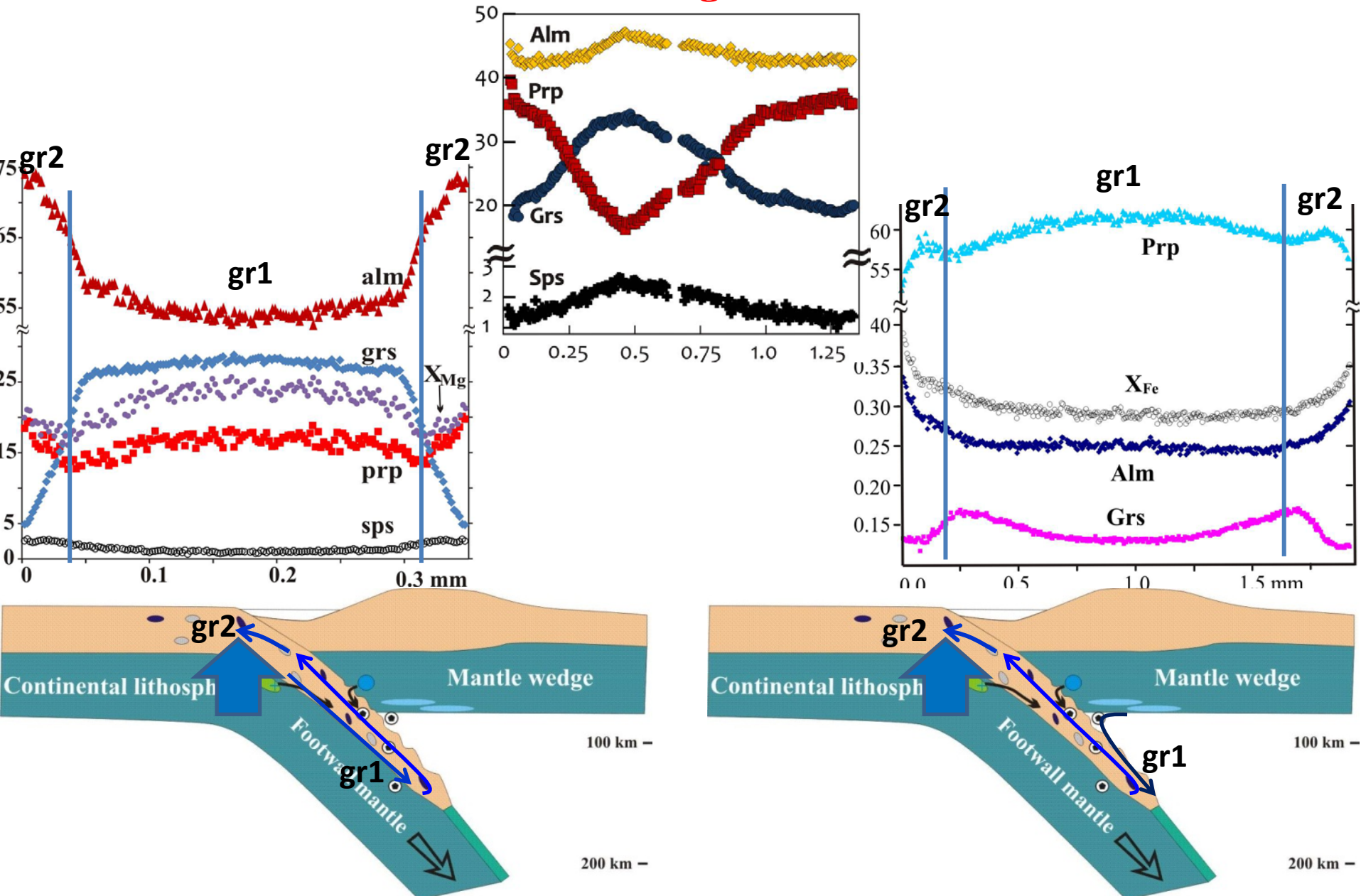


Eclogite from the amphibolite facies units also passed granulite facies overprint

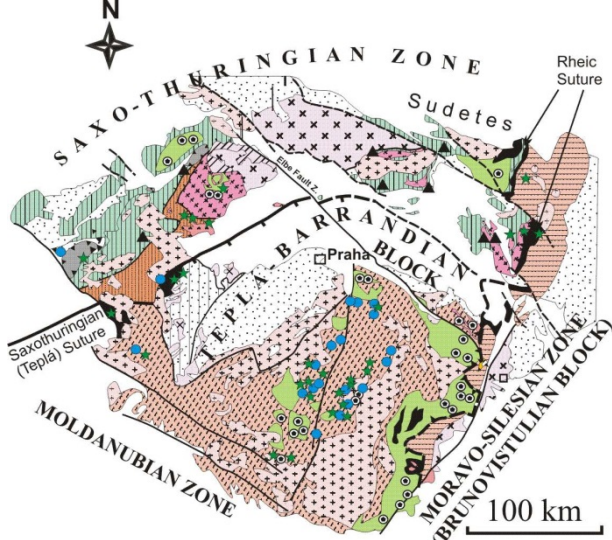


Faryad & Fušera (in review), JMG

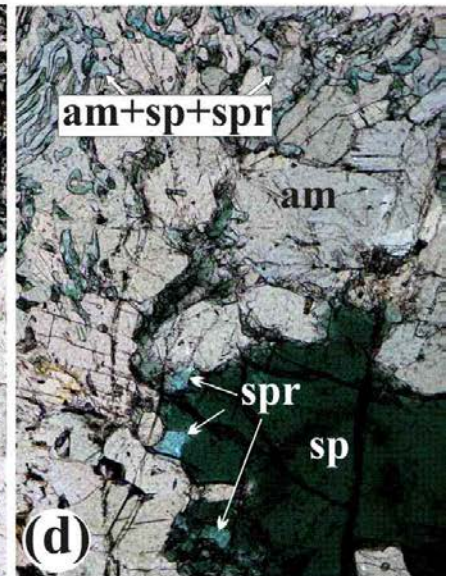
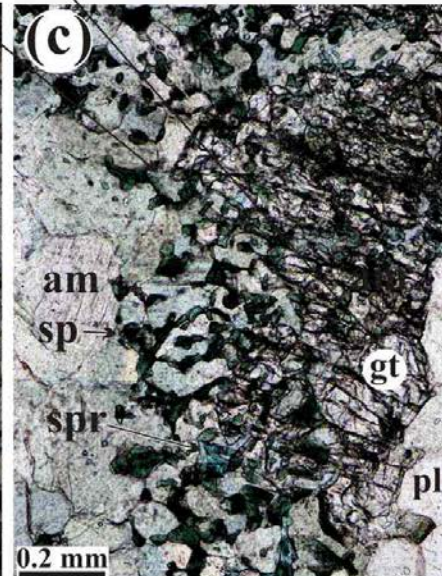
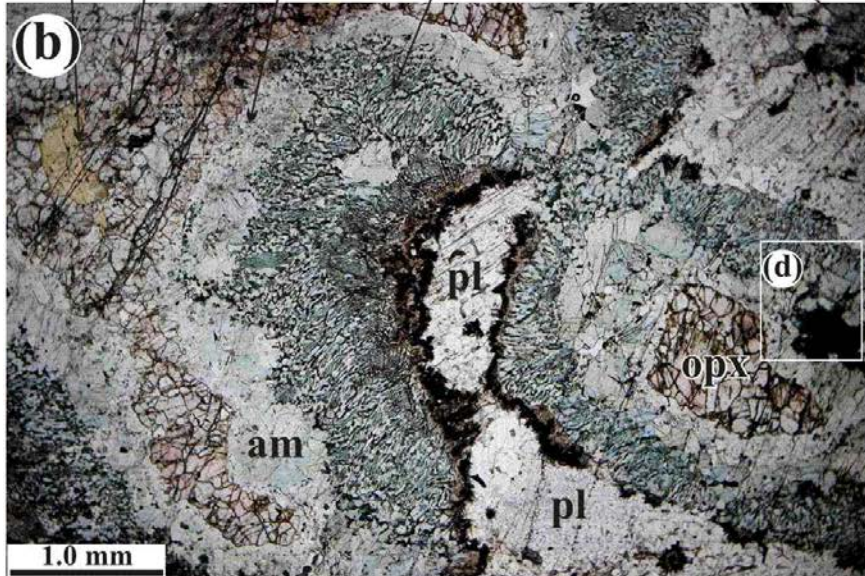
Two metamorphic processes of UHP and granulite facies are visible in felsic rocks and their mantle fragments in the Moldanubian Zone



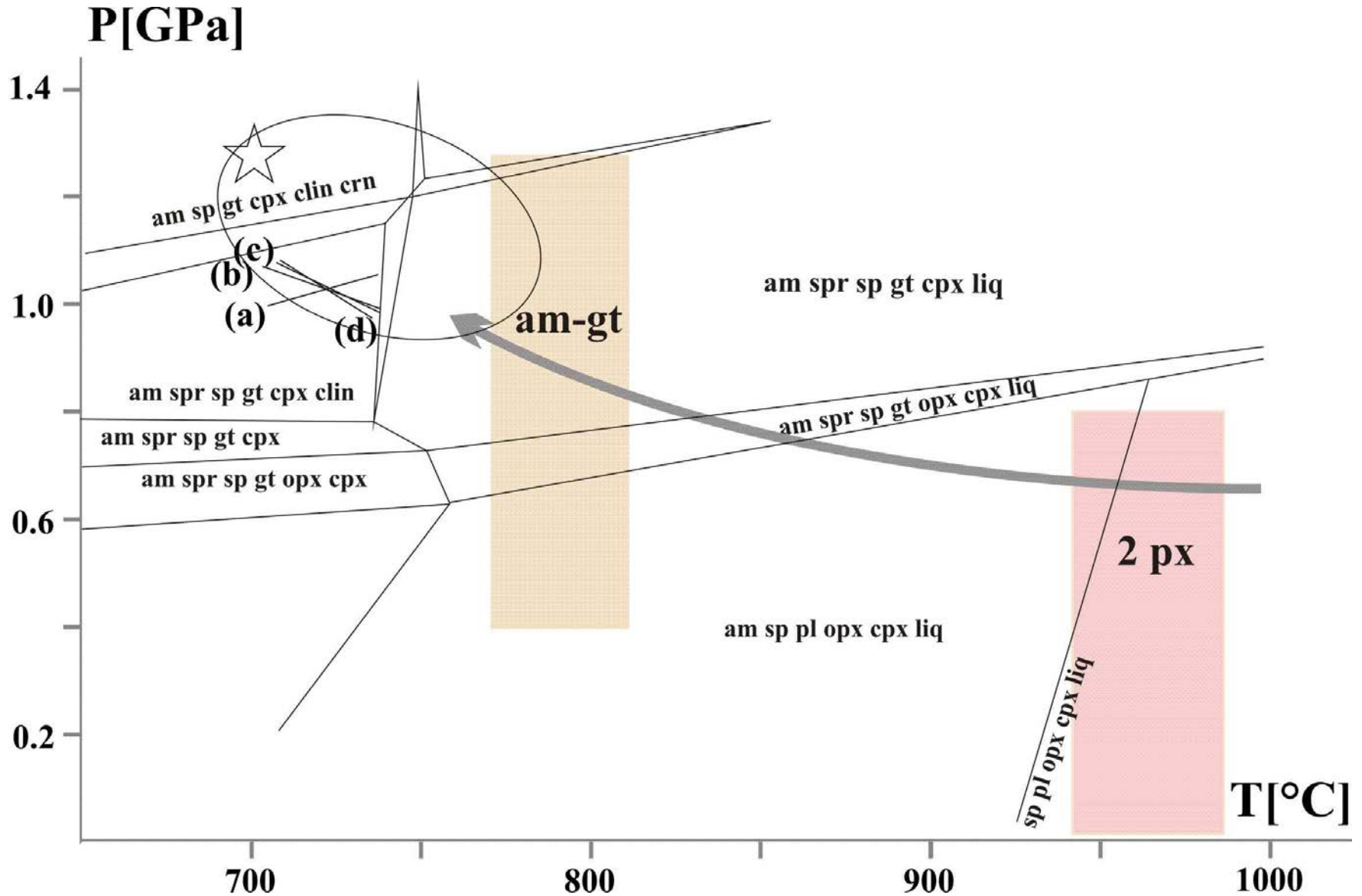
Source of granulite facies heating?

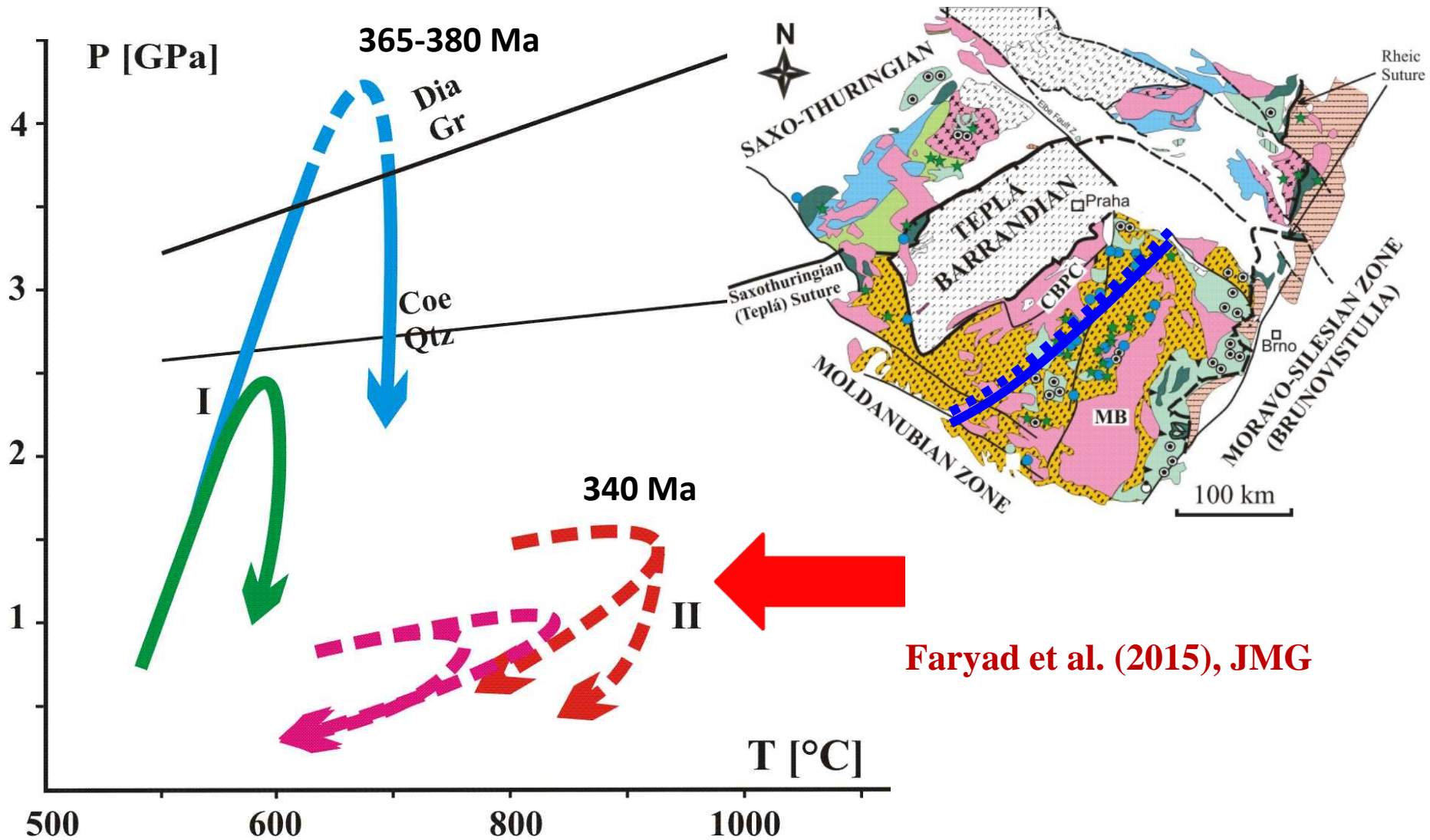


ol(?) : **opx** ↔ **am** ↔ **am+sp+spr** **gt+sp** : **pl**

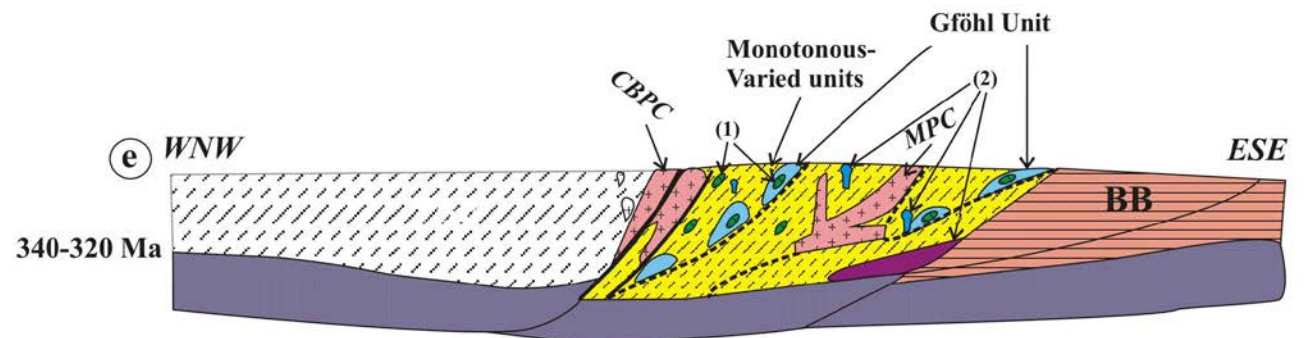
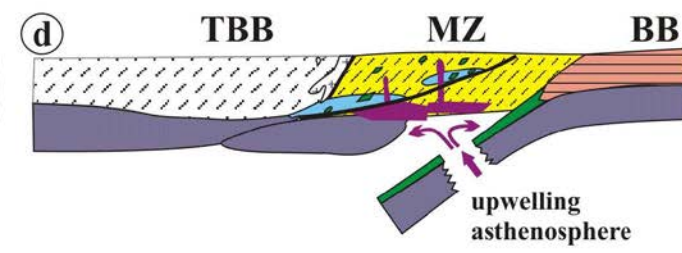
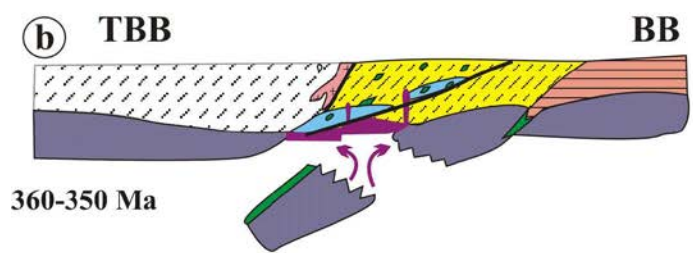
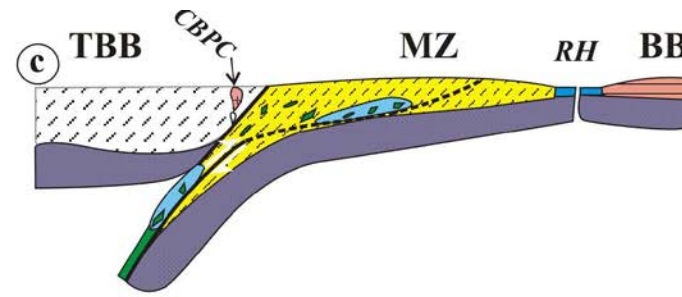
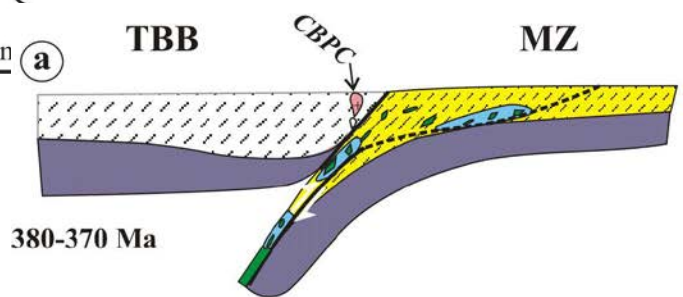
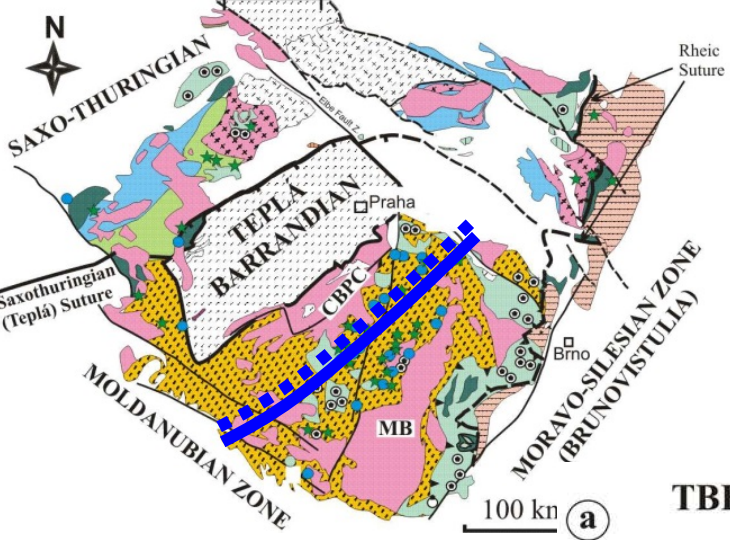


Source of granulite facies heating could be ultramafic magma

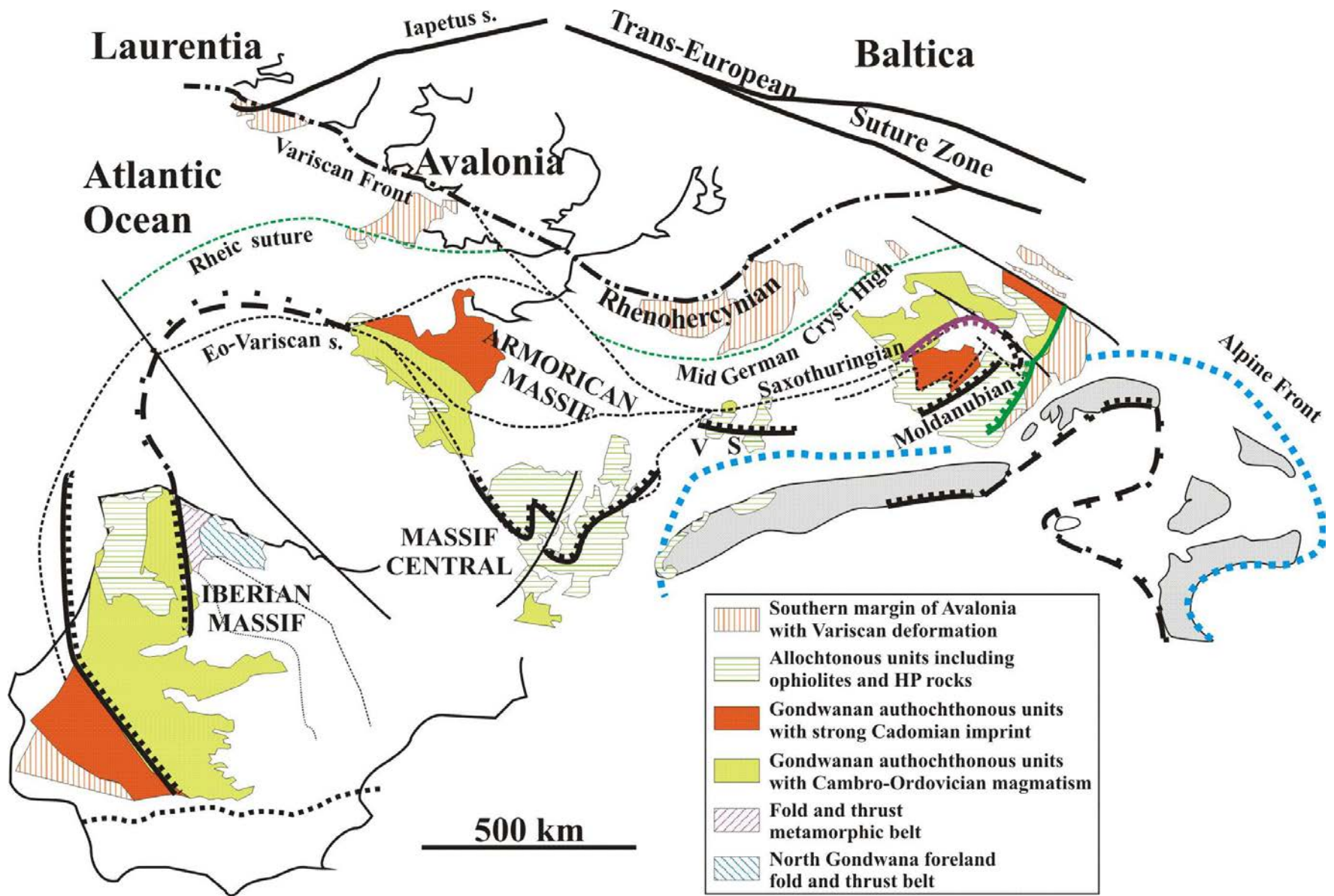




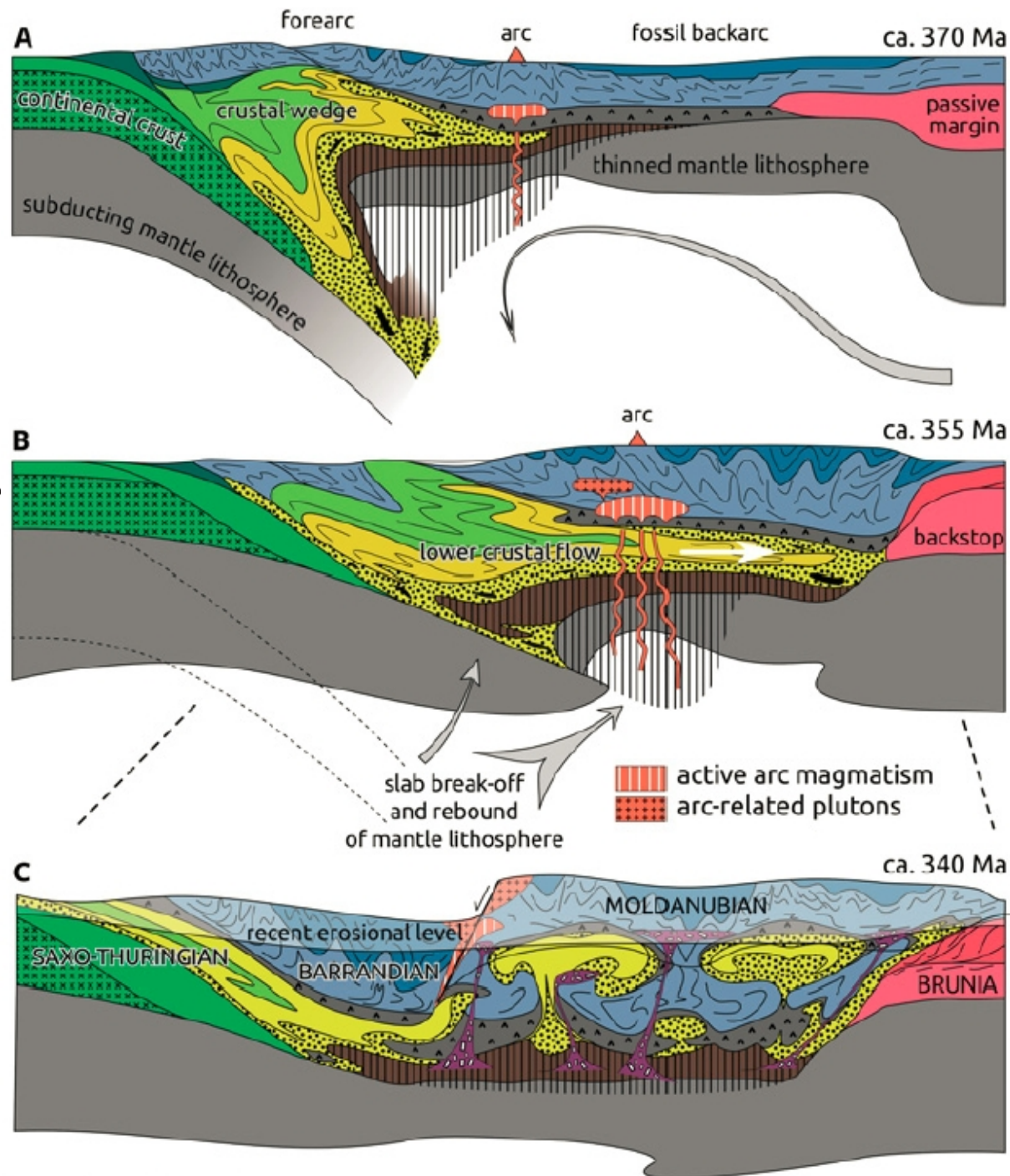
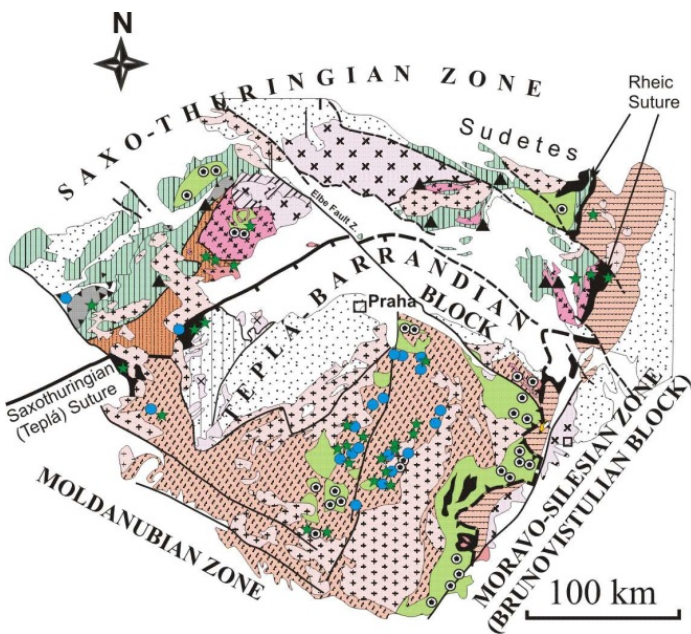
PT evolution of HP-UHPM rocks from the amphibolite and granulite facies units suggest their formation by a single subduction zone



Faryad et al. (2015), JMG



Suture zones along the allochthonous units of European Variscan Belt (Matte, 1986; Franke, 2000)

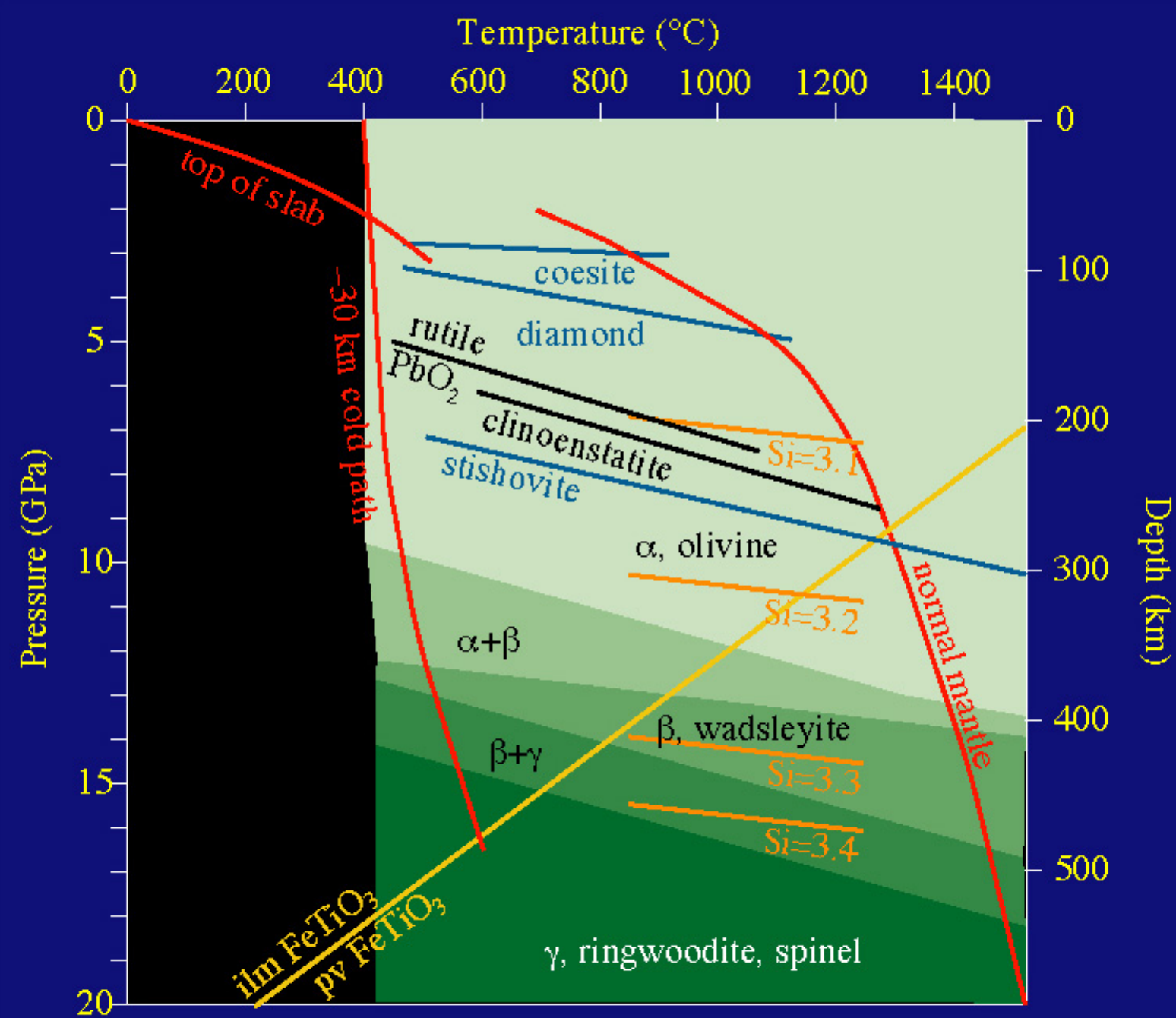


Schulmann et al. (, 2009, 2014)



Majorite
 $\text{Mg}_4\text{Si}_4\text{O}_{12}$

- Si_{3.1}
- Si_{3.2}
- Si_{3.3}
- Si_{3.4}



Garnet-granát $X_3Y_2Z_3O_{12}$

$Fe_3Al_2Si_3O_{12}$ Almandine

$Mg_3Al_2Si_3O_{12}$ Pyrope

$Ca_3Al_2Si_3O_{12}$ Grossular

$Mn_3Al_2Si_3O_{12}$ Spessartine



$(MgFeCaMn)_3Al_2Si_3O_{12}$

Majorite $Mg_4Si_4O_{12}$

$Si_{3.1}$

$Si_{3.2}$

$Si_{3.3}$

$Si_{3.4}$

