Chromium in garnet as tracer of the metamorphic evolution of pyroxenite from the Pohorje Mountains, Slovenian Eastern Alps

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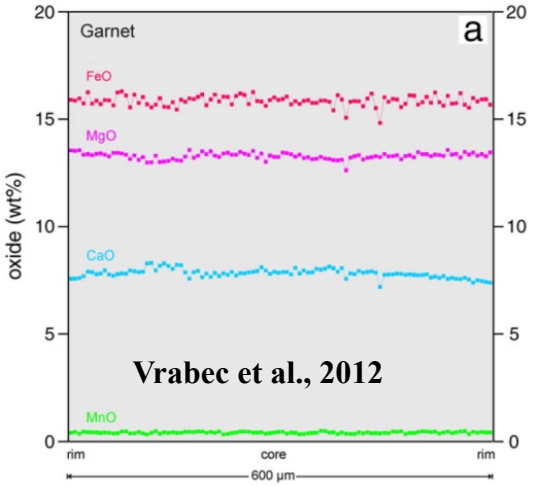
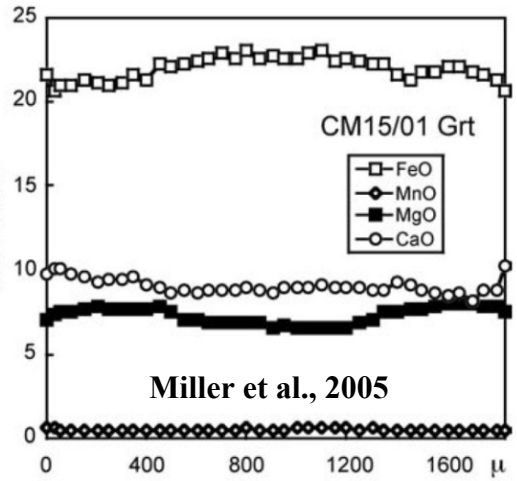
1. Motivations

- **Motivations to study Cr in garnet in order to decipher the P-T path of clinopyroxenite (gabbroic cumulate) in the Pohorje Mts.**

(1) Reported weak garnet zonation (Ca, Mn, Fe^{2+}, Mg) in metabasic rocks in Pohorje





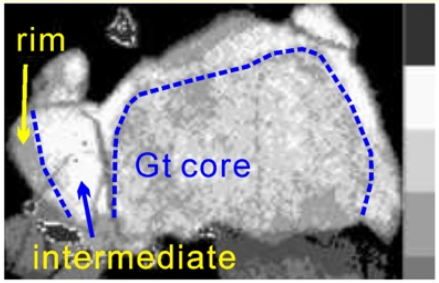
(2) Reported Cr-rich gabbroic cumulates in Pohorje

Hauzenberger et al. (2016). Genesis of chromium-rich kyanite in eclogite-facies **Cr-spinel-bearing gabbroic cumulates, Pohorje Massif,** Eastern Alps. Am. Mineralogist 101, 448-460.

- **Chromium** in garnet may belong to the group of **slowly diffusing** cations.

(e.g., **Cr zonation in garnet in peridotite, Erzgebirge, peak T at ca. 1000 °C)**

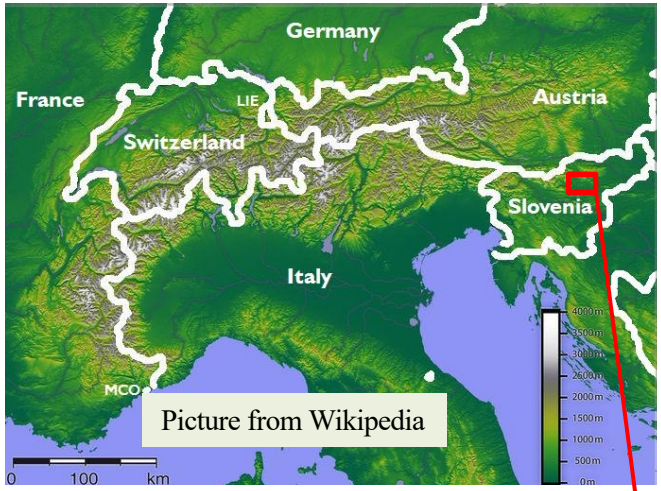
Cr zonation in Gt (peridotite), Erzgebirge

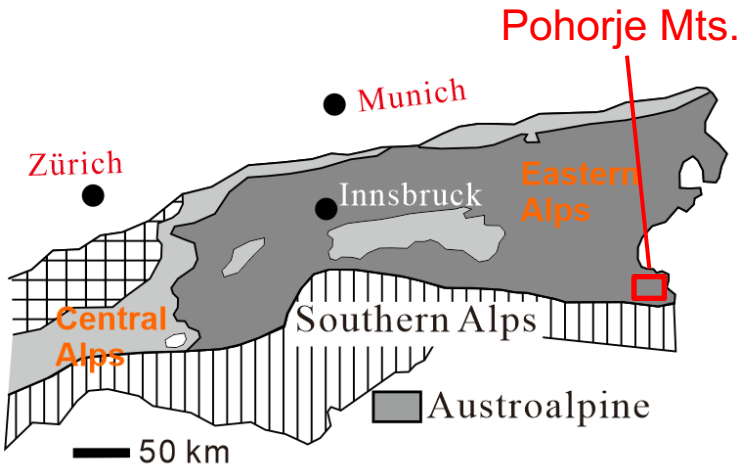


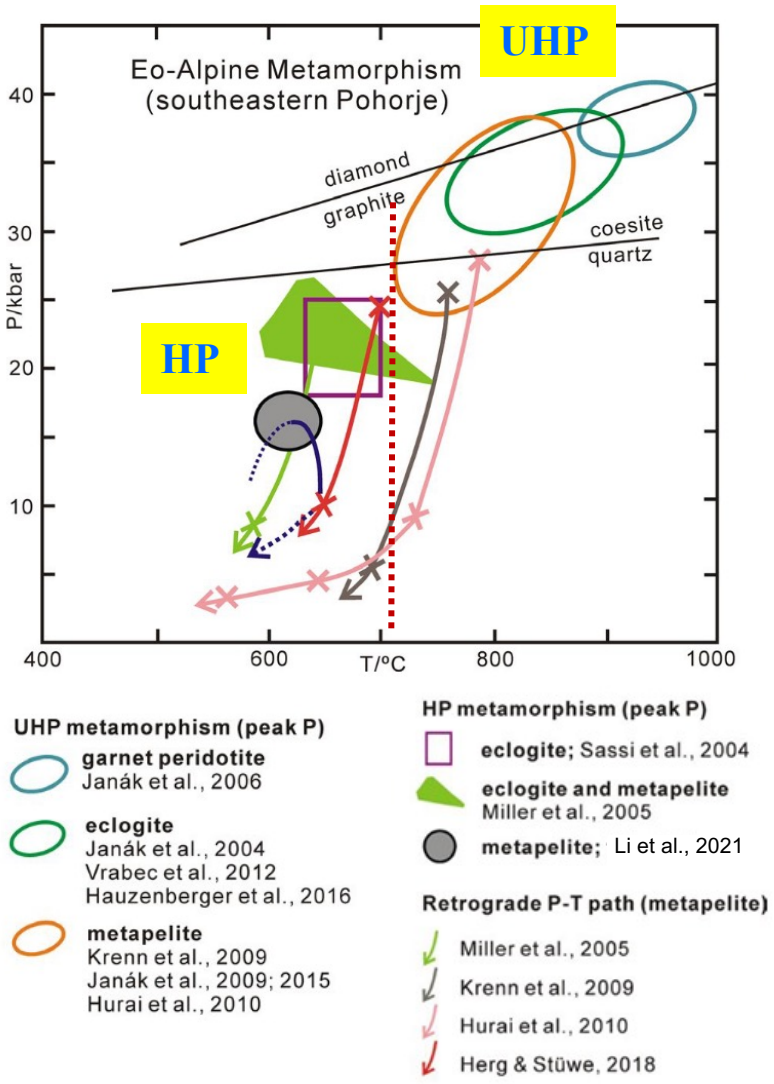
Massonne & O'Brien, 2003

1. Motivations

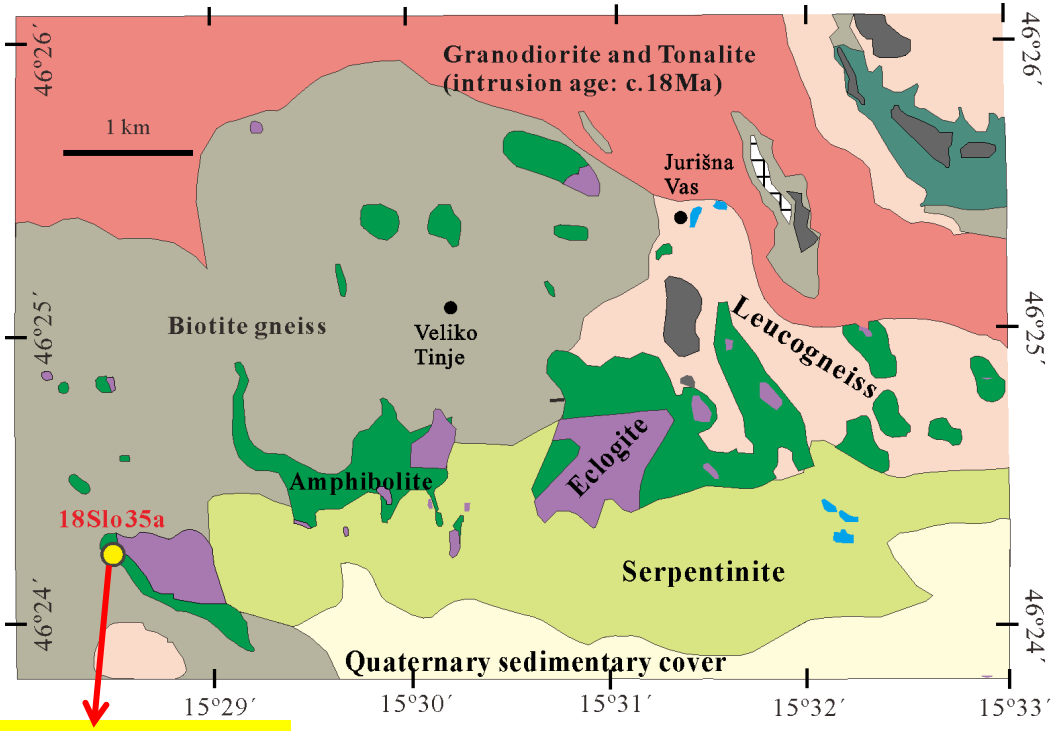
- **(3) The only reported UHP area in the Eastern Alps is in the Pohorje Mts., but there is a debate on the true occurrence of UHP metamorphism.**







2. Geological setting

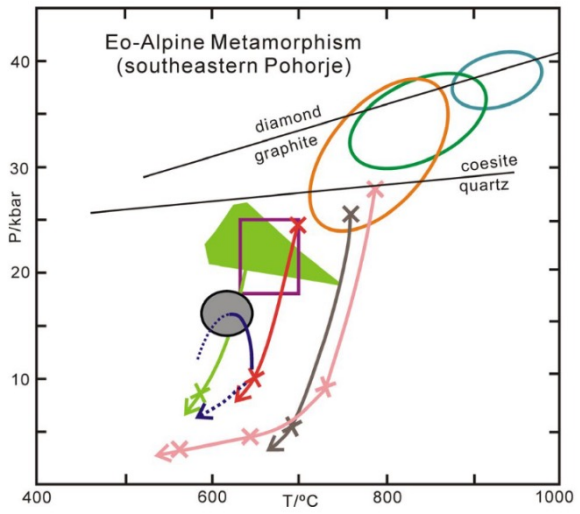


Sample location

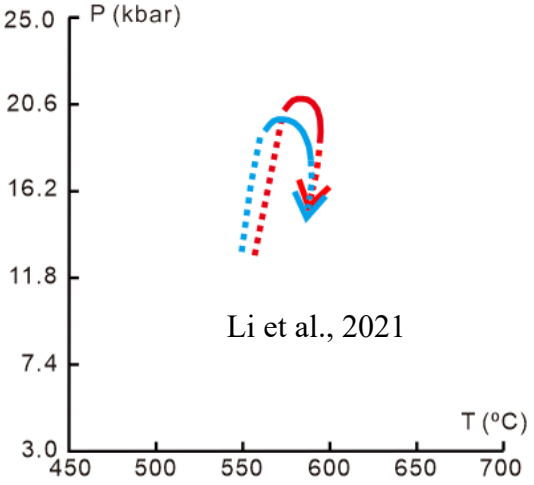
Geological map modified after Kirst et al., 2021

	Age	Method	lithology	reference
Eo-Alpine HP/UHP event	106-84 Ma	U–Pb Zircon	eclogite metapelite	Janák et al., 2009 Miller et al., 2005
		Sm–Nd Gt	eclogite	Miller et al., 2005
		Lu–Hf Gt	eclogite	Thöni et al., 2008
		U-Th-Pb Mnz	metapelite	Krenn et al., 2009
		U-Th-Pb Mnz	metapelite	Li et al., 2021
Eocene HP event	ca. 48 Ma	U-Th-Pb Mnz	metapelite	Li et al., 2021

reported Eo-Alpine P-T paths



recently reported Eocene P-T path

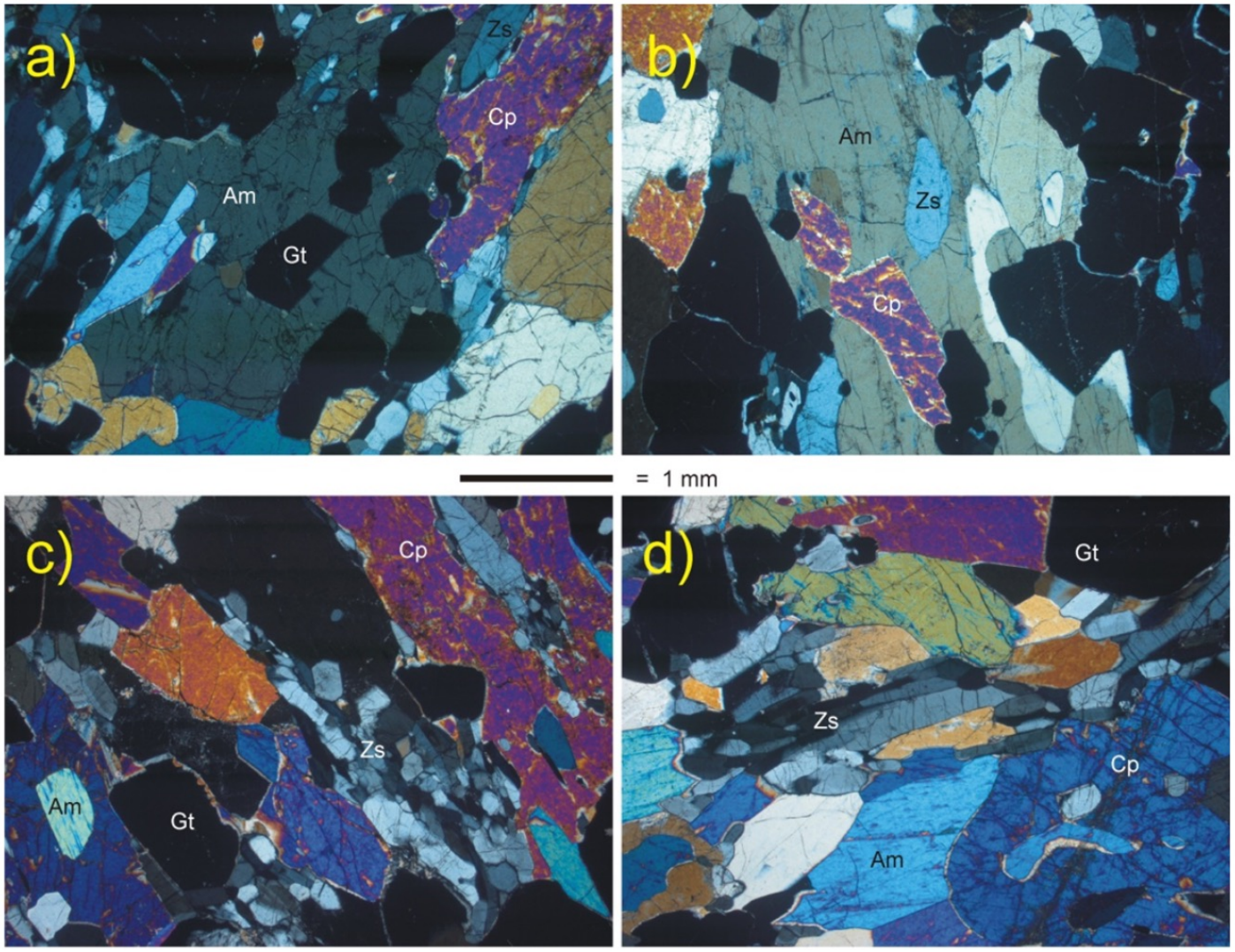


3. Petrography and mineral chemistry (sample 18Slo35a)

Major (in matrix):
Cp (33-35 vol.%, **high Cr**)
Gt (32-34 vol.%)
Am (17-19 vol.% **high Cr**)
Zs (13-15 vol.%, **high Cr**)

Am = amphibole
Cp = clinopyroxene
Gt = garnet
Zs = (clino)zoisite

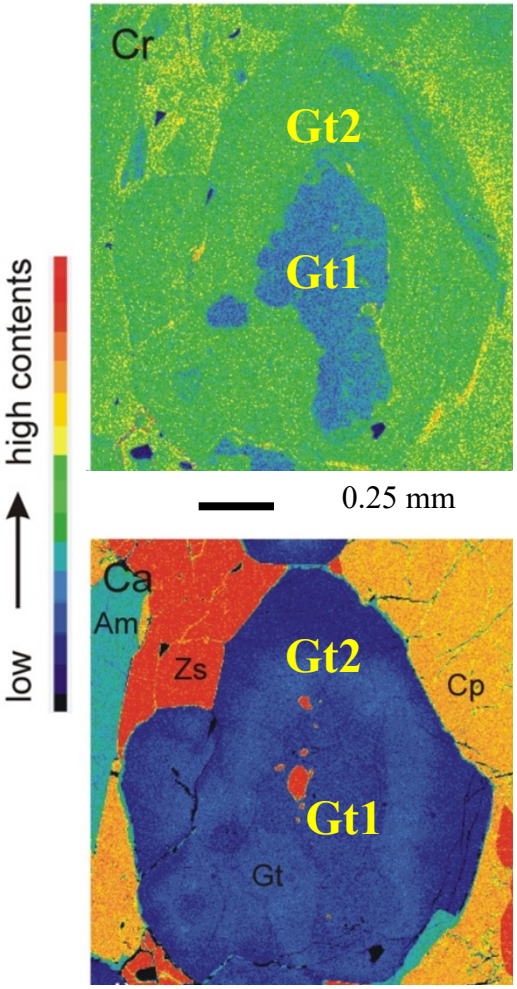
Ky = kyanite
St = staurolite
Rt = rutile
Pl = plagioclase

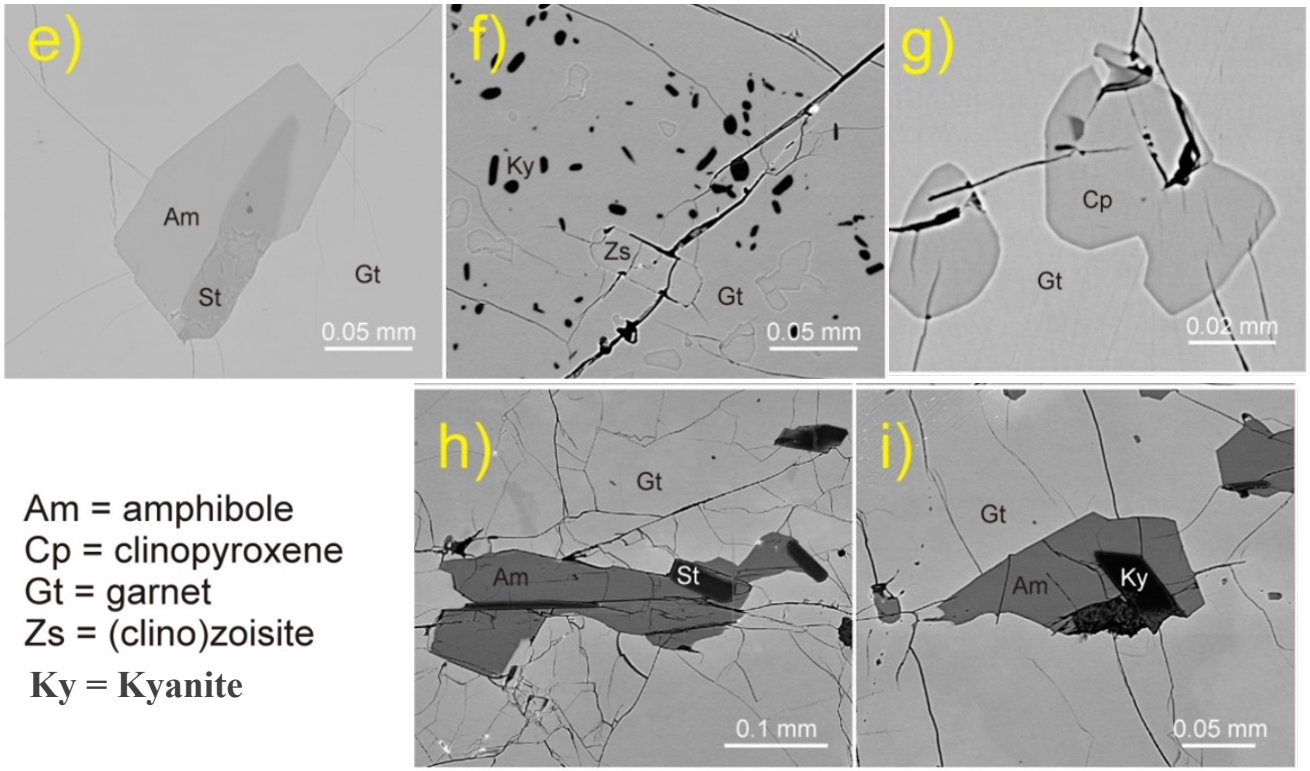


Accessories: Ky (only in Gt), St (only in Gt), Rt, Pl (secondary in matrix), Sulfides (in matrix)

3. Petrography and mineral chemistry

Gt zonation





Am = amphibole
Cp = clinopyroxene
Gt = garnet
Zs = (clino)zoisite
Ky = Kyanite

low Cr----Inclusions in Gt1(core): Am, St, Ky, Zs (e, f, h, i)
high Cr----Inclusion in Gt2 (mantle): Cp (g)

Summary:

- **Two generations of mineral assemblage**

Stage I (low Cr): Gt1, Am, St, Ky, Zs
Stage II (high Cr): Gt2, Cp
Assumption: Cr-rich spinel ➡ high Cr minerals

4. Pseudosection modelling

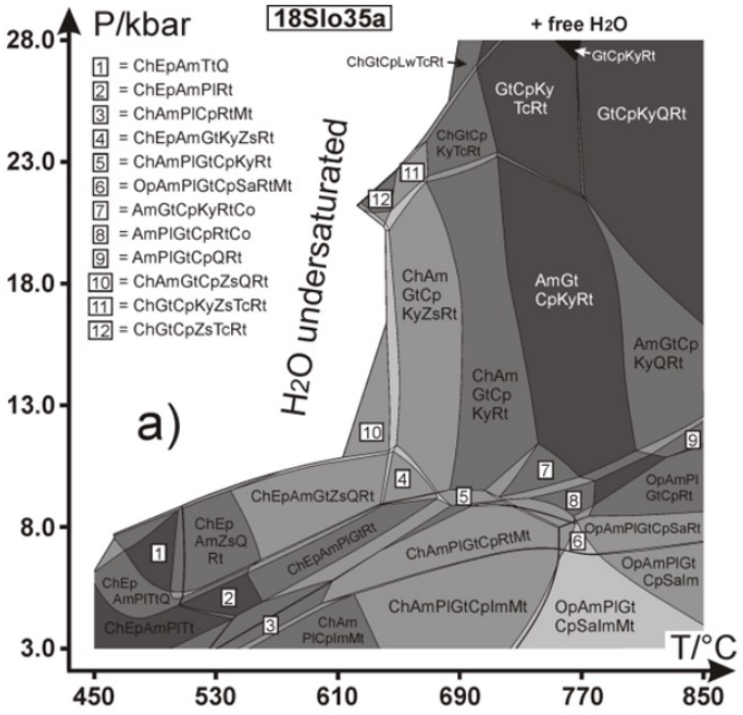
PERPLE_X

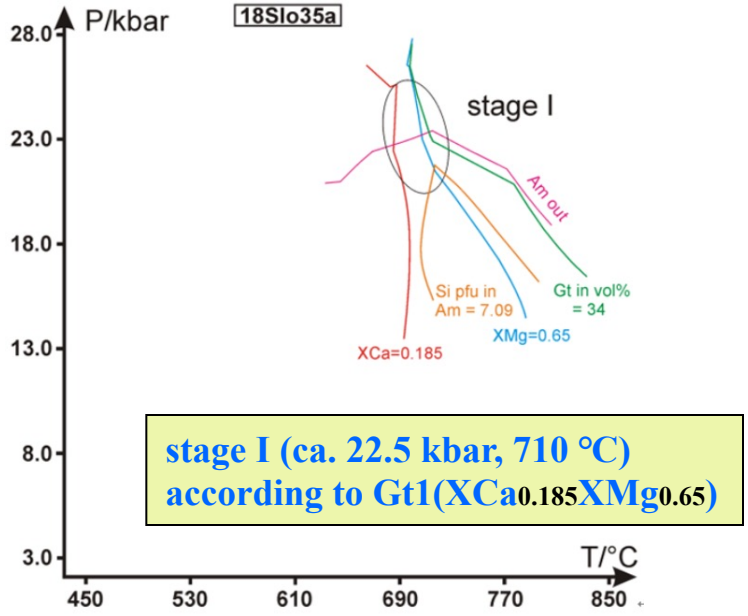
- **Thermodynamic data set:** Holland & Powell (1998, updated 2002)
- **Solution models:** GlTrTsPg, Carp, Chl(HP), Ctd(HP), Ep(HP), IlGkPy, Mica(M), Omph(HP), Opx(HP), feldspar, St(HP)

Pure phases: magnetite, Zs, Rt,Tt, Al-silicates, Lw, Tc

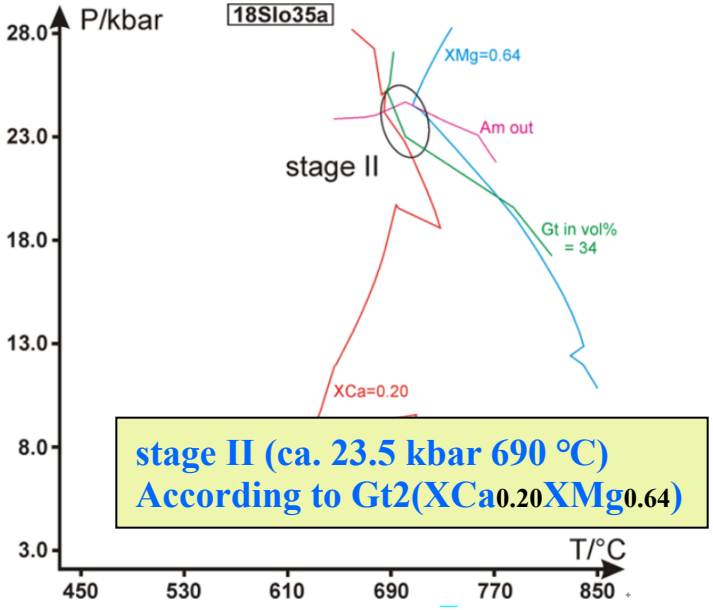
- **The used bulk-rock composition(wt%)**

SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	H_2O	O_2	SUM
45.4	0.1	16.6	4.4	0.09	15	14	0.94	4	0.1	100



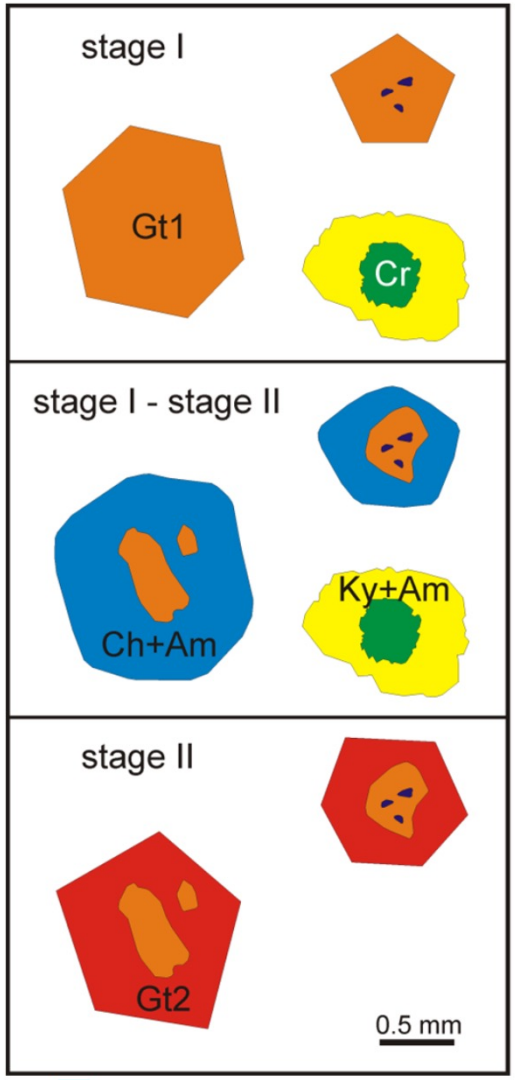


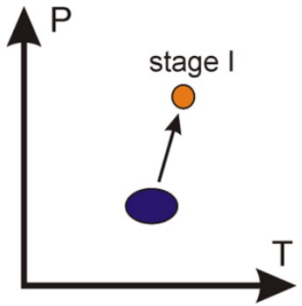
stage I (ca. 22.5 kbar, 710 °C) according to Gt1($XCa_{0.185}XMg_{0.65}$)

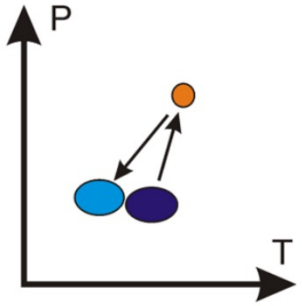


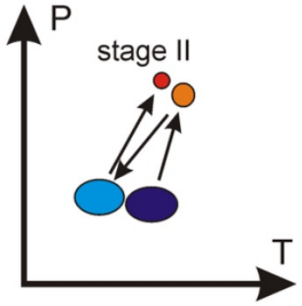
stage II (ca. 23.5 kbar 690 °C) According to Gt2($XCa_{0.20}XMg_{0.64}$)

5. P-T evolution









stageI (1st HP event)
(ca. 22.5 kbar, 710 ℃)
✓assumed euhedral Cr-poor Gt1
✓Cr-rich spinel relics

Decrasing P and T
✓ Irregular Cr-poor Gt1 relics
✓ Cr-rich spinel relics

stageII (2nd HP event)
(ca. 23.5 kbar, 690 ℃)
✓The breakdown of Cr-rich spinel relics
✓The formation of Cr-rich Gt2

Summary:
The obtained two HP events support the previous reported two HP events

6. Conclusions

Metamorphism in the Eastern Alps:
The obtained **two HP events** in Gt pyroxenite **support** the finding by Li et al. (2021) that two HP events (**Eo-Alpine + Palaeogene)** also occurred in the southeasternmost part of the Eastern Alps.

Benefit of chromium in garnet from metabasite:
The distribution of Cr in garnet and associated minerals (Cr-rich/poor minerals) can help to better understand the metamorphic evolution.

Thank you for your attention!