Preliminary investigation on PT path of garnet-bearing mafic rocks in the Neoproterozoic Ougda magmatic complex, Tuareg Shield, Algeria

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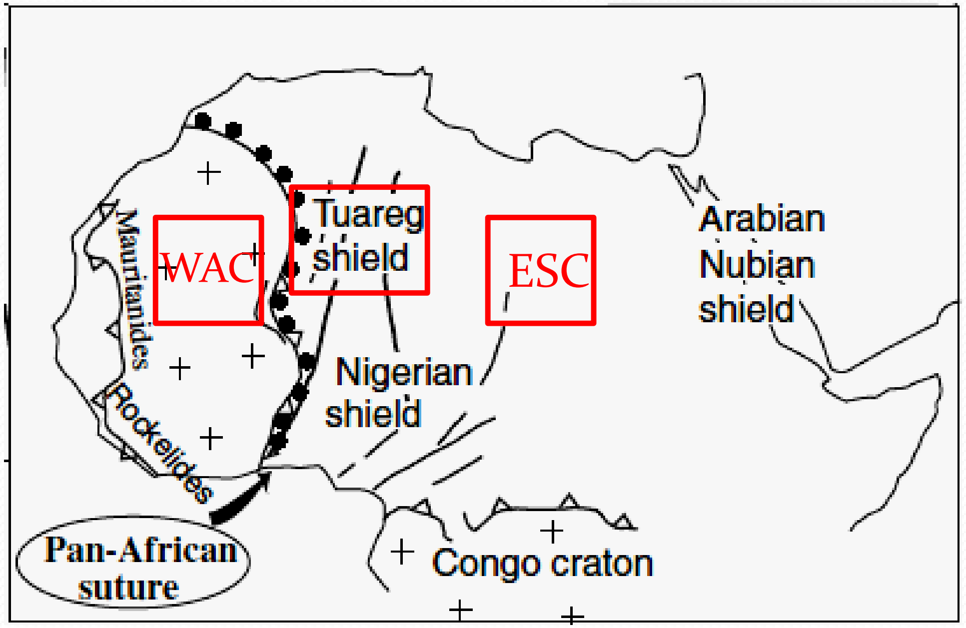
By

Chaouki Djallel Eddine BENDIMERAD

جامعة هواري بومدين للعلوم والتكنولوجيا

U S T H B

- The Touareg shield (Hoggar) is located in south Algeria and north Mali.
- At Est, Est African Cratons (EAC), and at west, West African Craton (WAC).
- 23 terranes in Hoggar [*Black et al 1994*].
- Three domains separated by two north-south strike-slip shear zones (4°50 and 8°30).
- The mafic-ultramafic Ougda complex is located between Tassendjanet terrane, at east, and Ahnet, at west,



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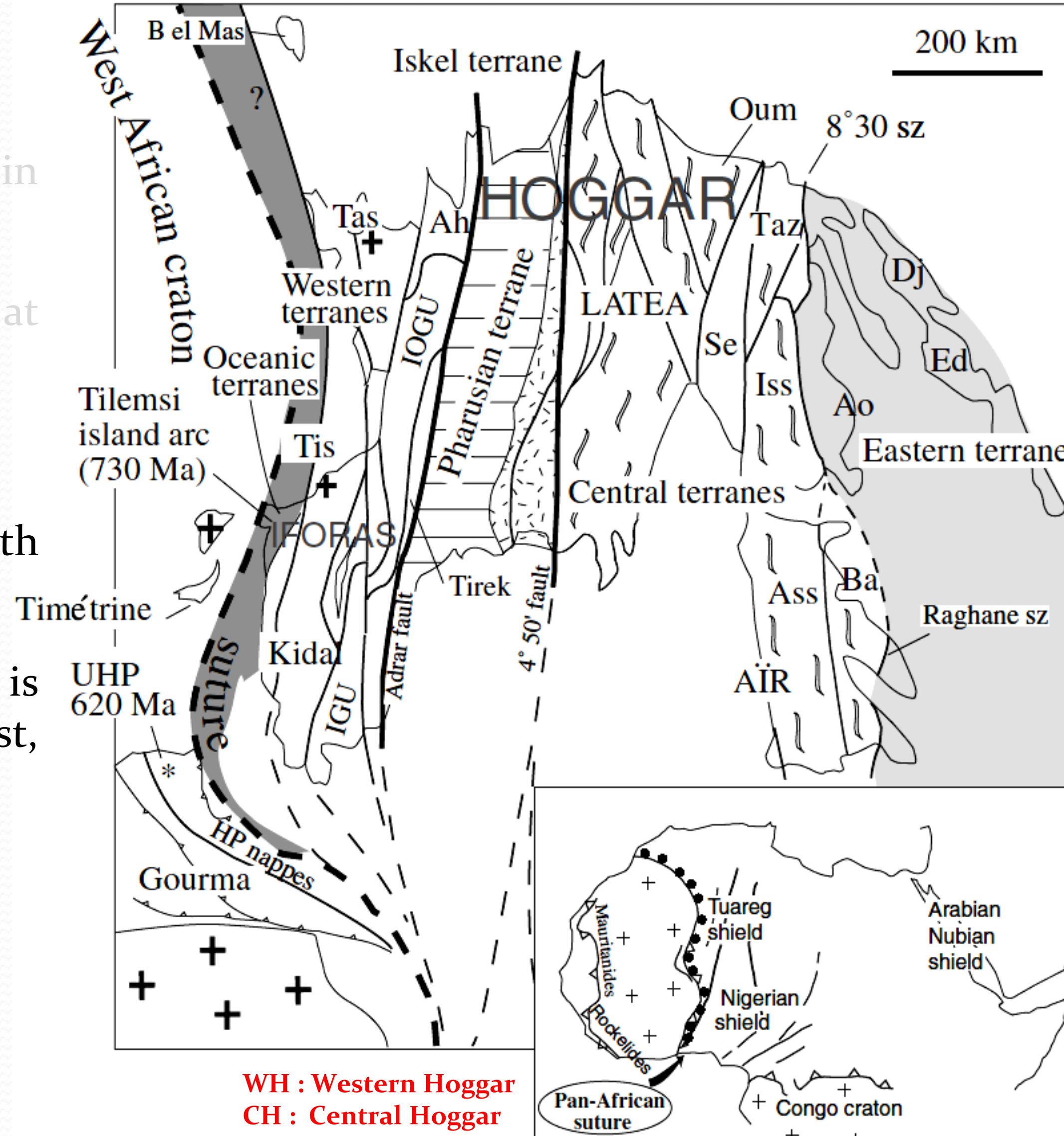

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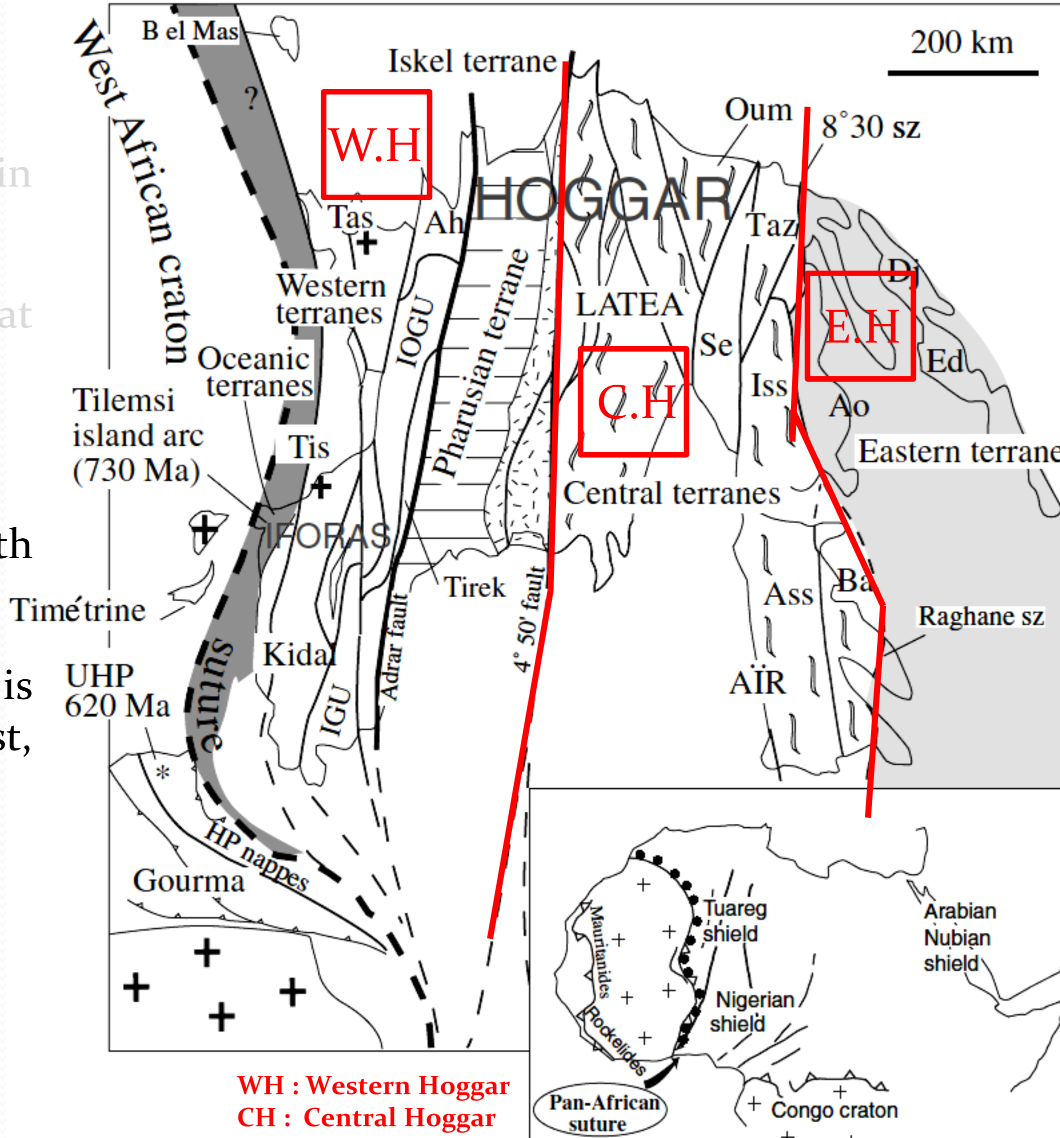

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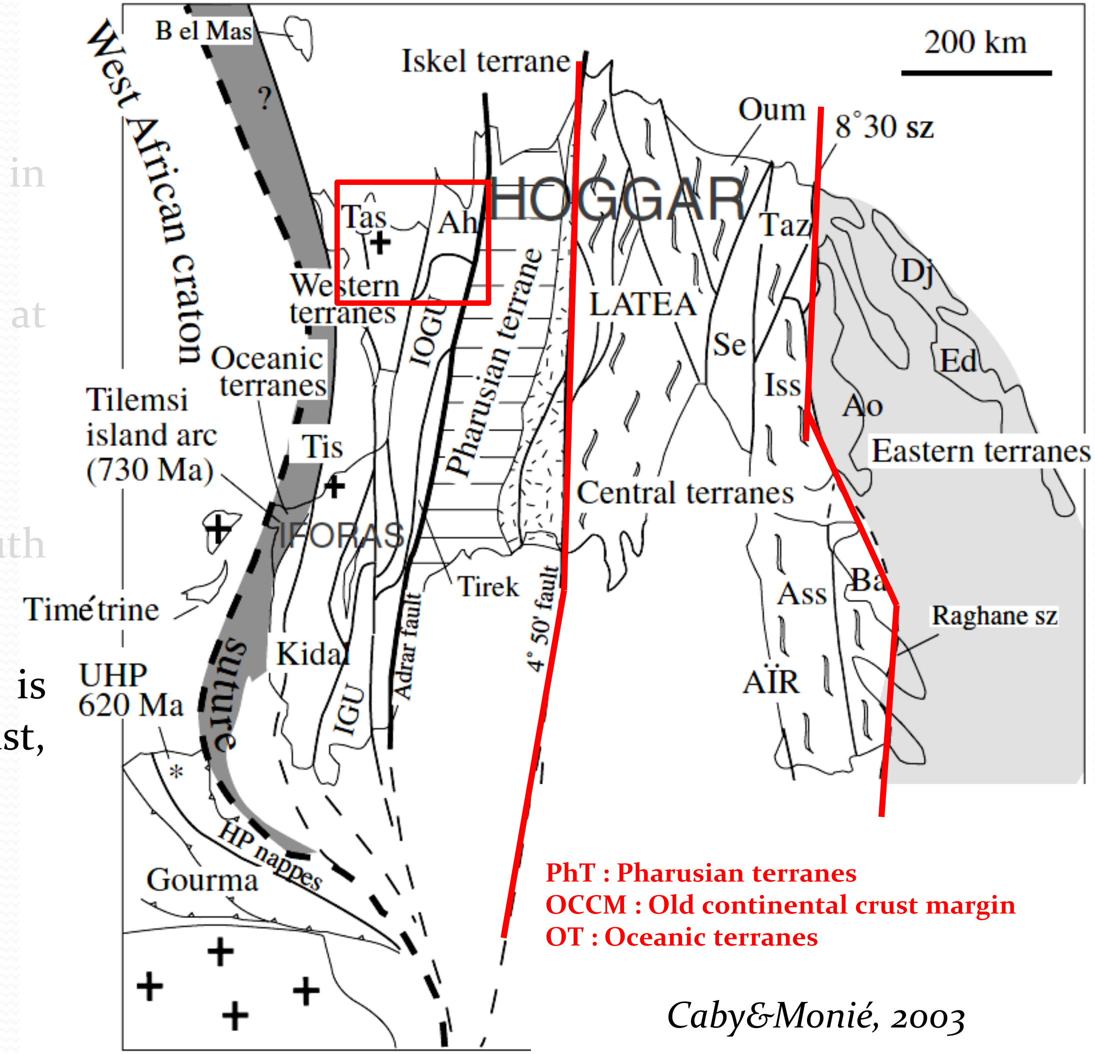

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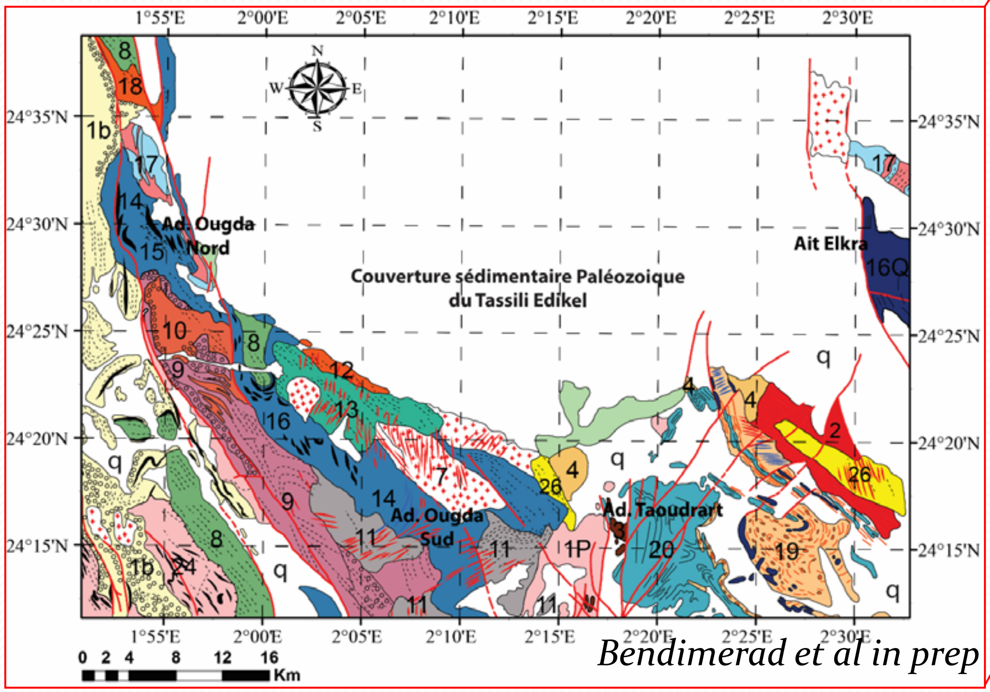
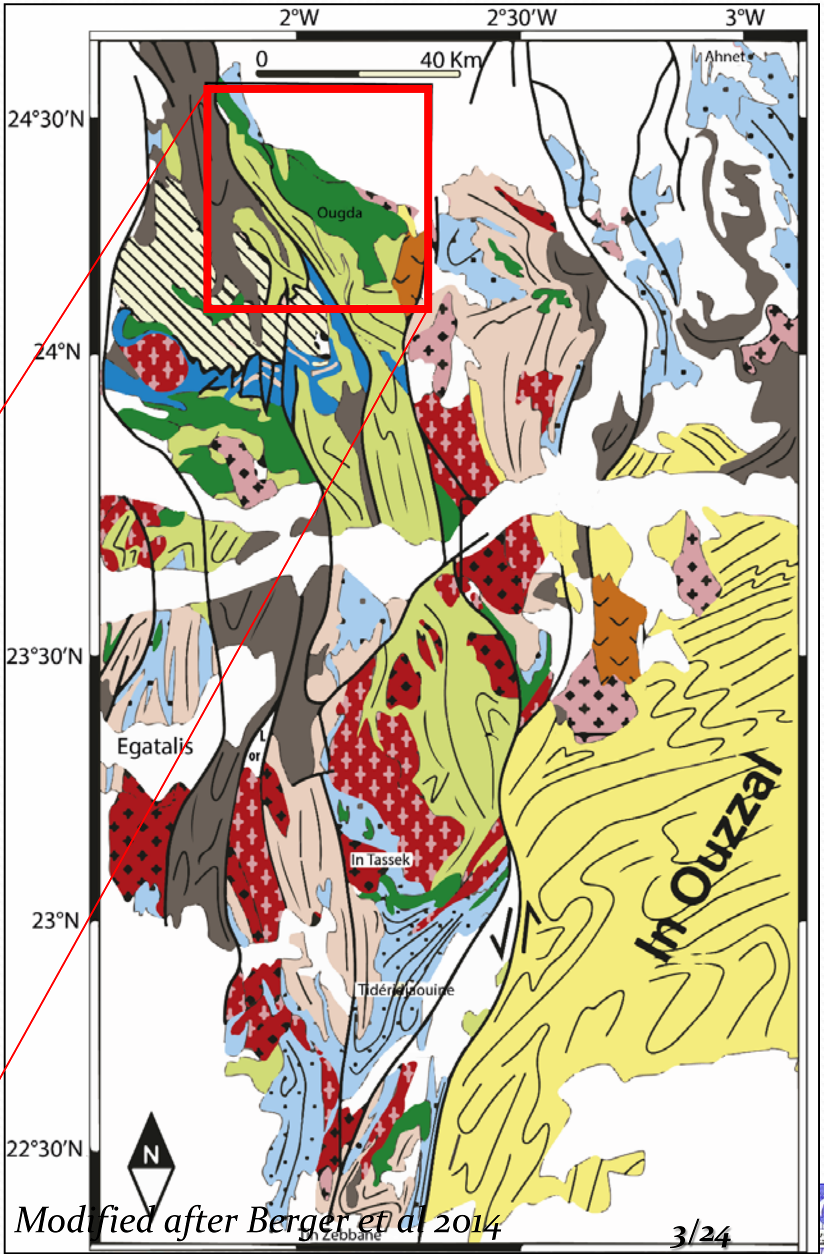


Bendimerad et al in prep



Modified after Berger et al 2014

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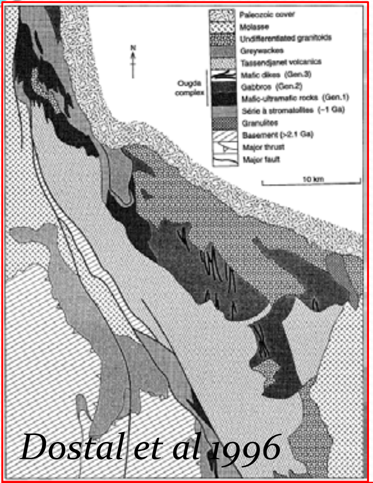
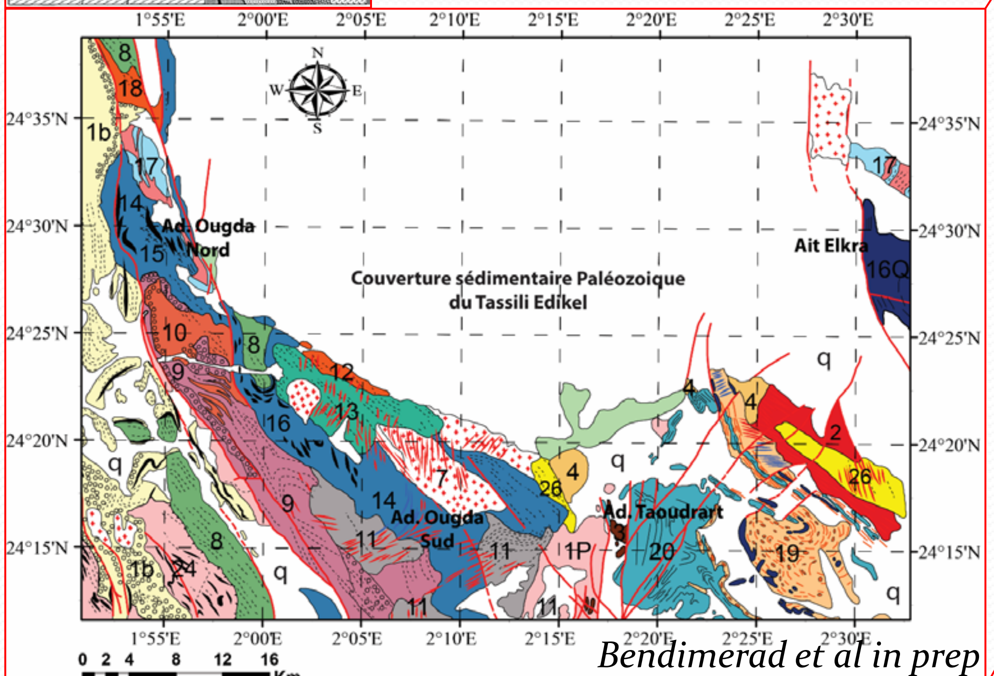


Dostal et al 1996



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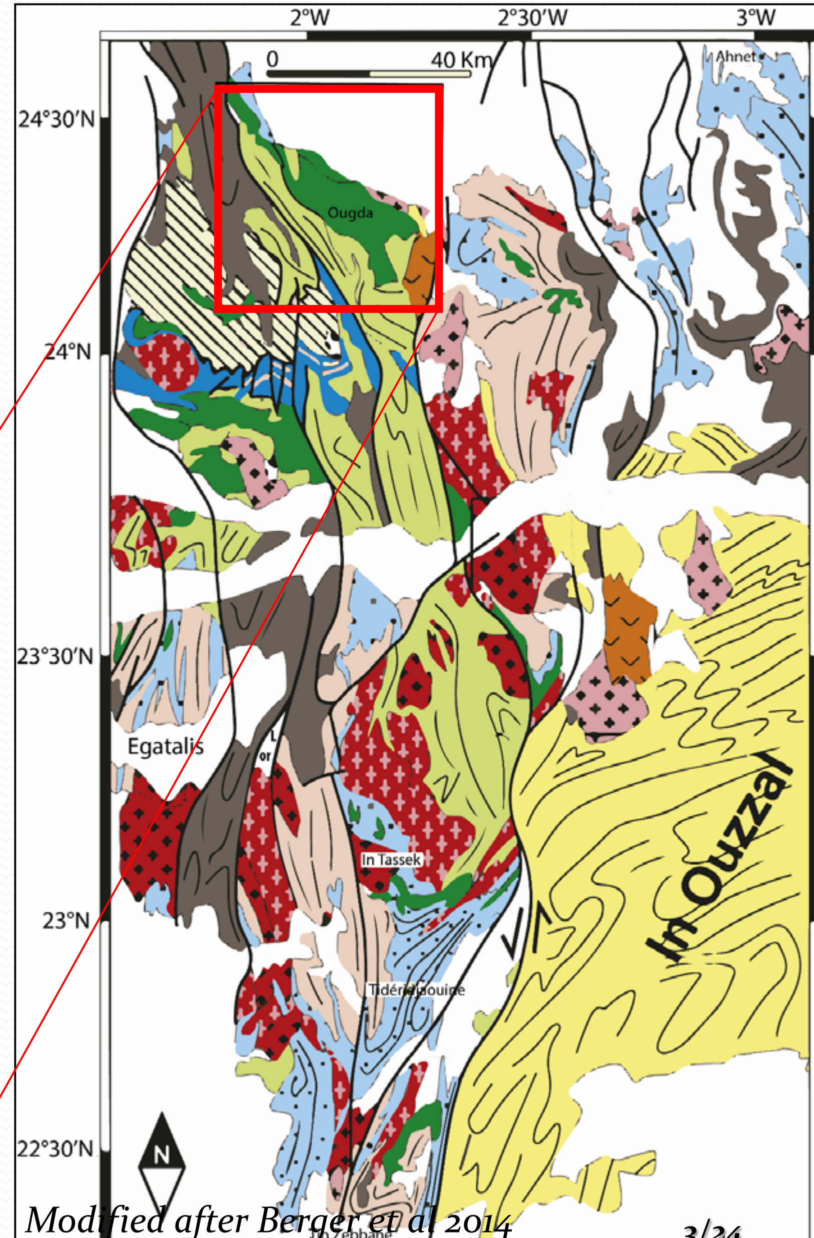

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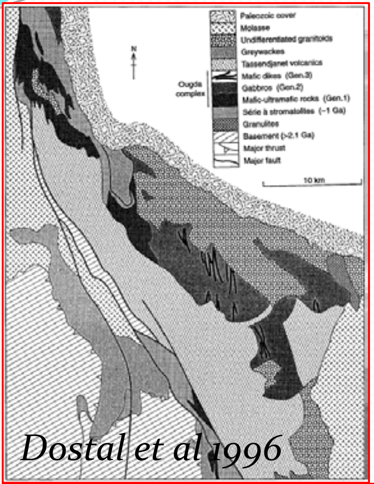

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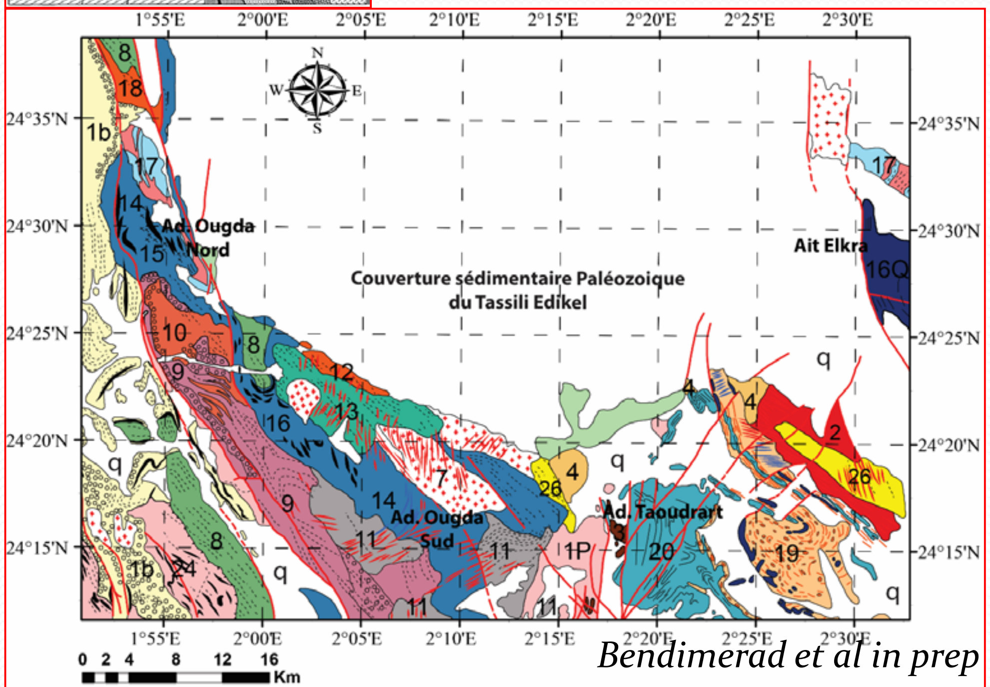
• Three generations of mafic and ultramafic rocks at Ougda (Dostal et al 1996)

1 – The first generation located in north, includes ultramafic rocks cut by dikes of cumulate garnet-bearing mafic rocks and quartz diorite sheets.

2 - The second and third generation located in the south, includes undeformed cumulate and non-cumulate gabbros and intermediate to mafic dikes.



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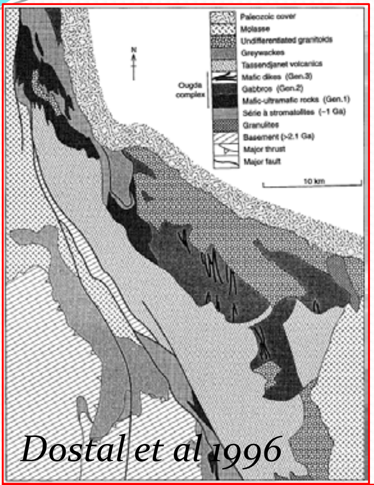

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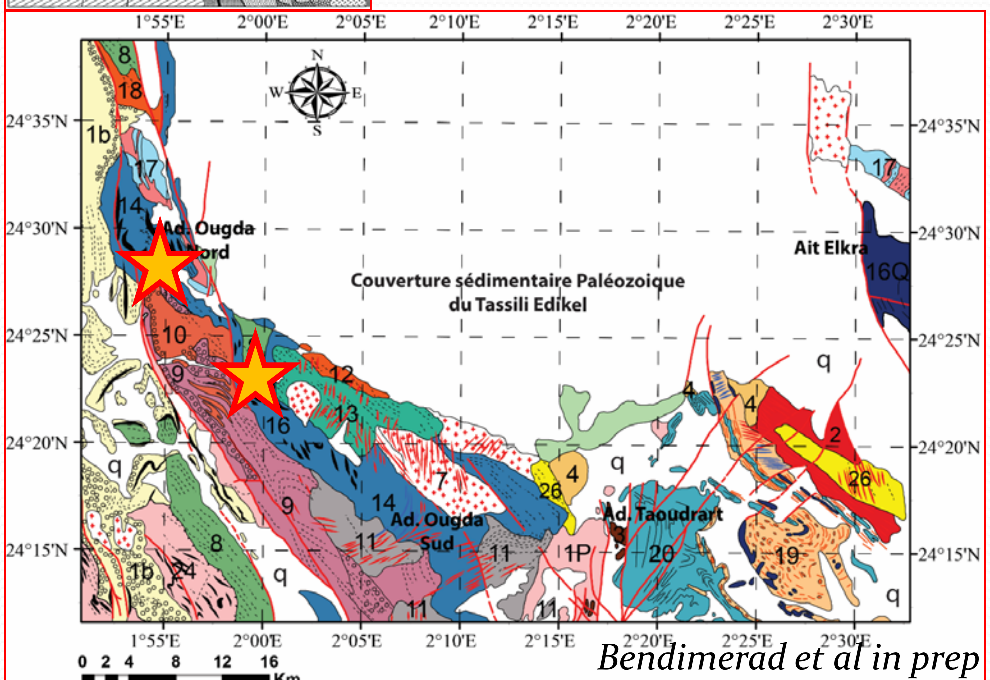

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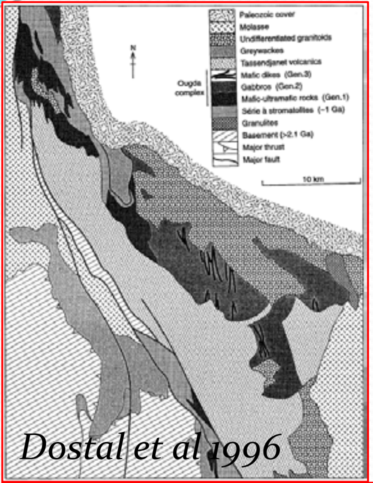

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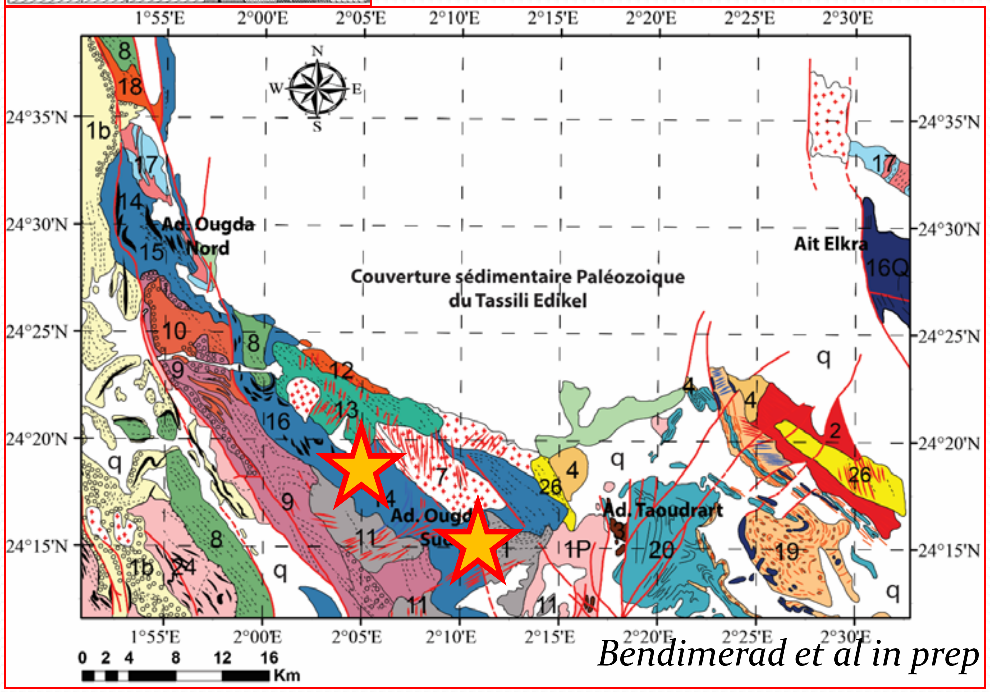

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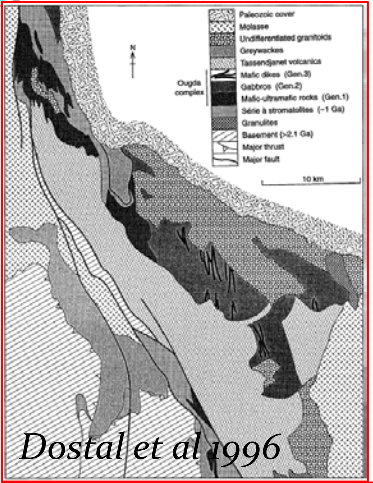

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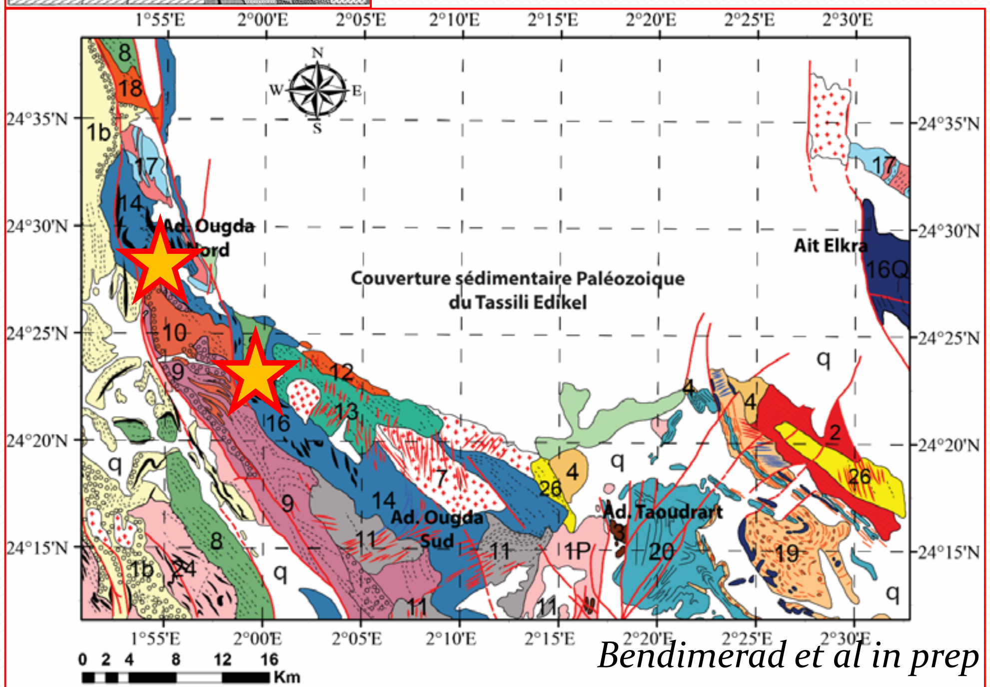
- The Ougda complex intrude the stromatolithes series of Tassendjanet terrane at west.

• Garnet-bearing rocks at Ougda complex are the only lithology that is affected by high-grade metamorphism, granulitization, between Tassendjanet and Ahnet terranes, Western Hoggar.



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• Garnet-bearing rocks show highly variable modal composition, even within a single dike or stock (centimeter scale), and ranges from metagabbros, anorthosites to amphibolites.

• Constraining the evolution of pressure-temperature conditions (P-T path) is crucial to understand of the evolution of the oceanic crust in this area from its early stages, during the Panafrican orogeny (Dostal et al., 1996).

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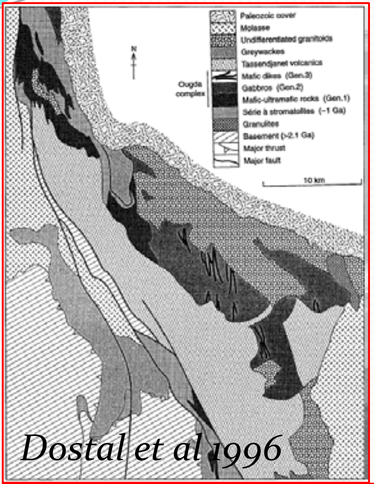

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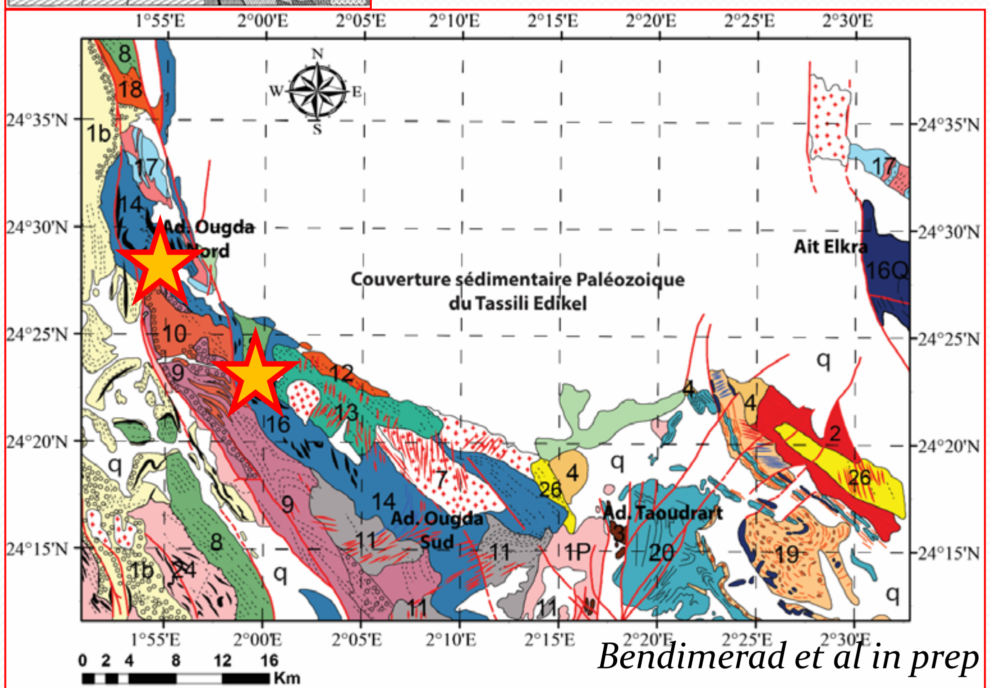

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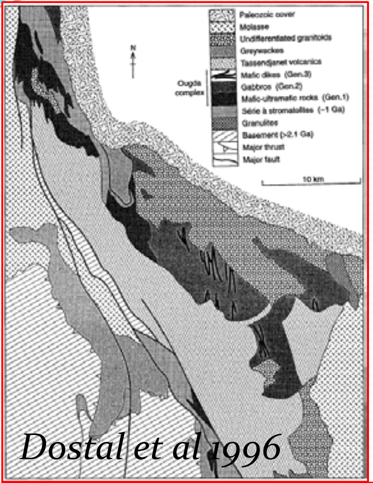

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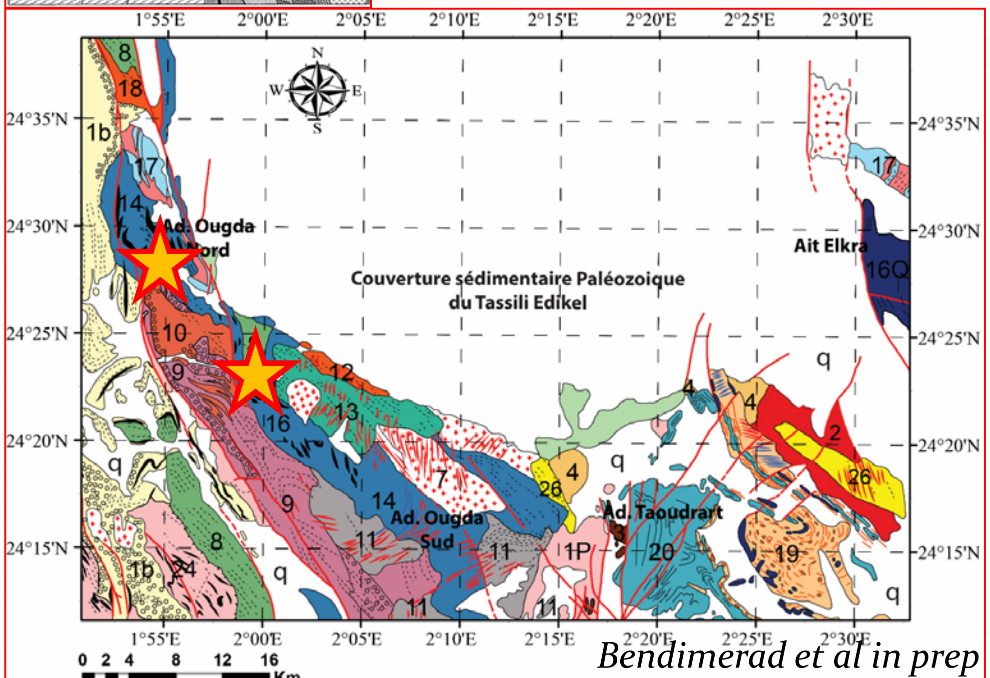

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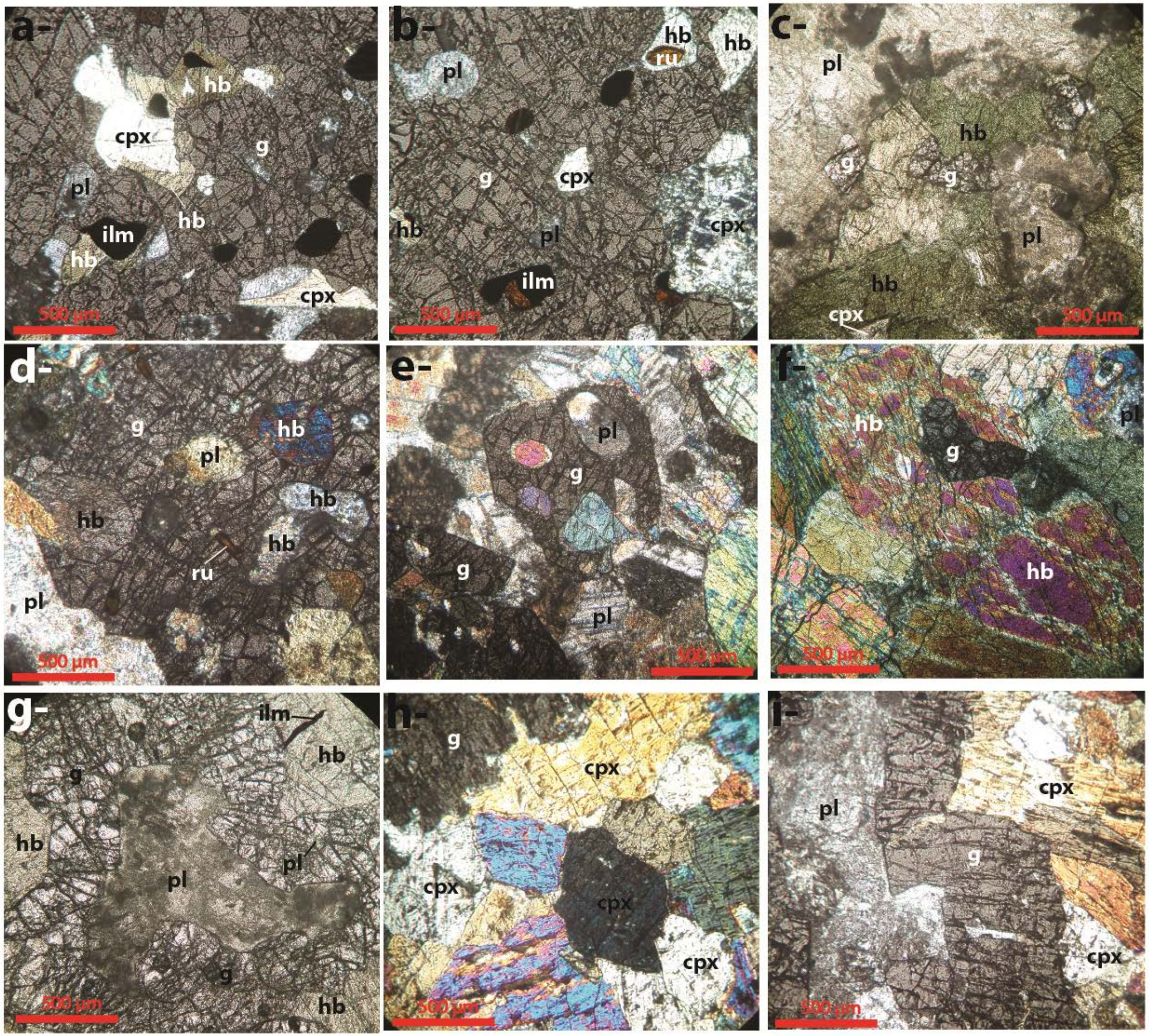
- Constraining the evolution of pressure-temperature conditions (P-T path) is crucial to understand of the evolution of the oceanic crust in this area from its early stages, during the Panafrican orogeny (Dostal et al., 1996).

- All samples share similar mineralogical assemblages with garnet, plagioclase, amphibole, clinopyroxene, ilmenite and rutile.

- They are affected by high temperature metamorphism, granulites facies.

- The variability of modal composition ranges between metagabbro, anorthosites and amphibolites.



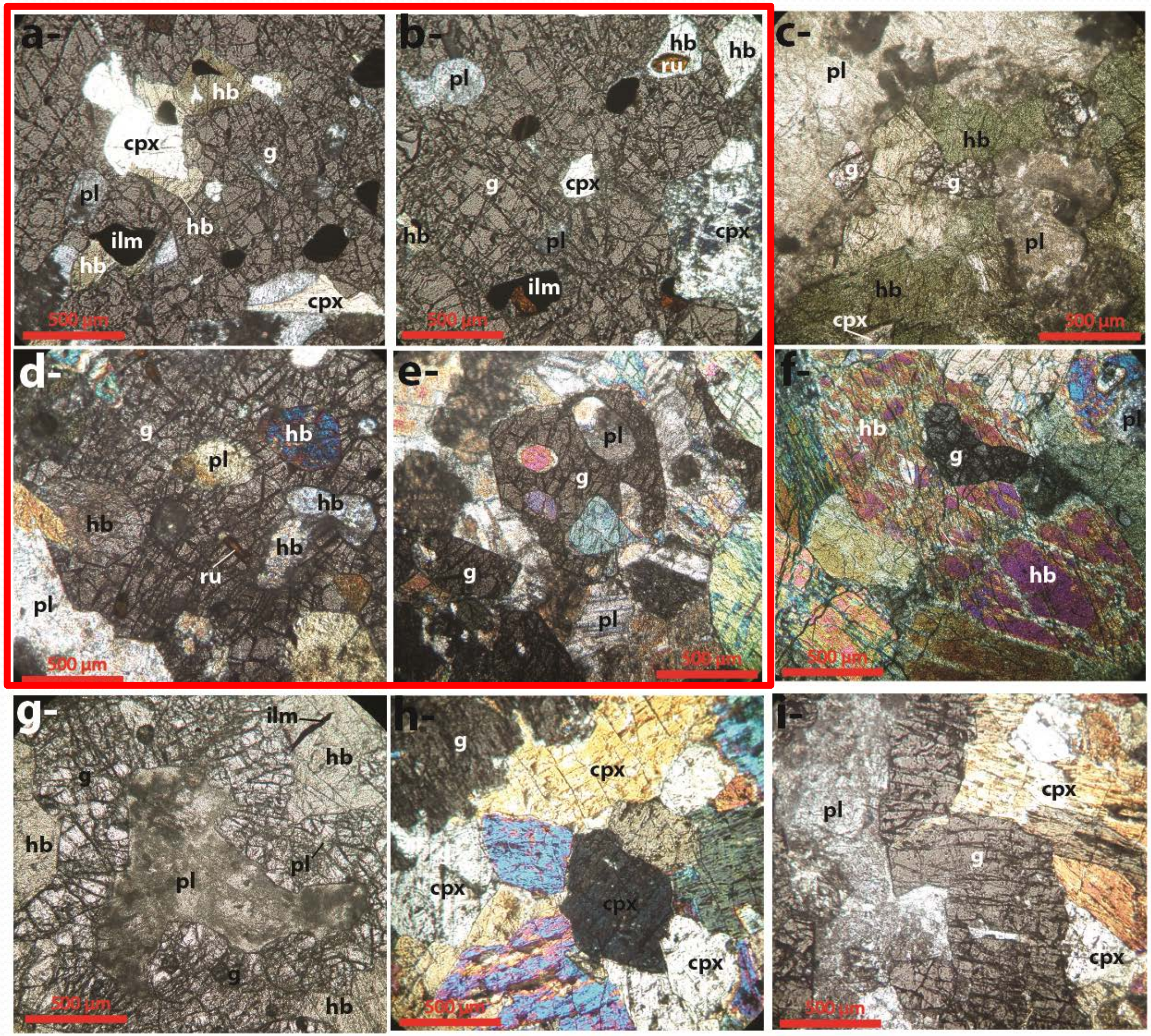
- All samples share similar mineralogical assemblages with garnet, plagioclase, amphibole, clinopyroxene, ilmenite and rutile.

- Garnet is the dominate phase and show different textural types :

Pokioblastic garnet with inclusions of amphibole, clinopyroxene, plagioclase, ilmenite and rutile.

In large garnet, **ilmenite** is observed in **garnet core** and **rutile** appears with ilmenite in **garnet rims**.

Clinopyroxene in garnet is a primary phase, it is surrounded by amphibole.



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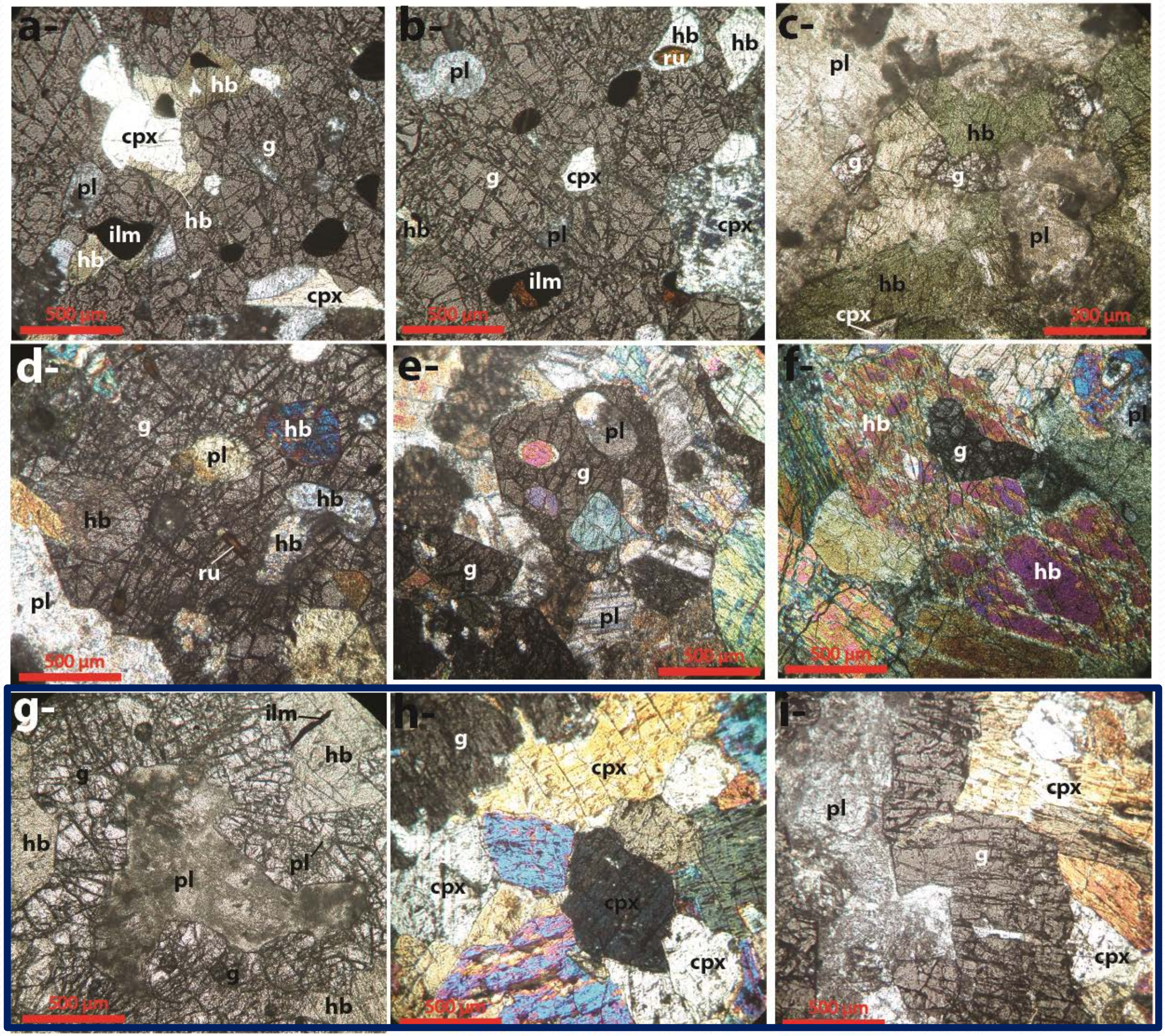
- Garnet is the dominate phase and show different textural types :

Garnet corona surround amphibole, clinopyroxene and plagioclase.

clinopyroxene and plagioclase are not in contact with each other.



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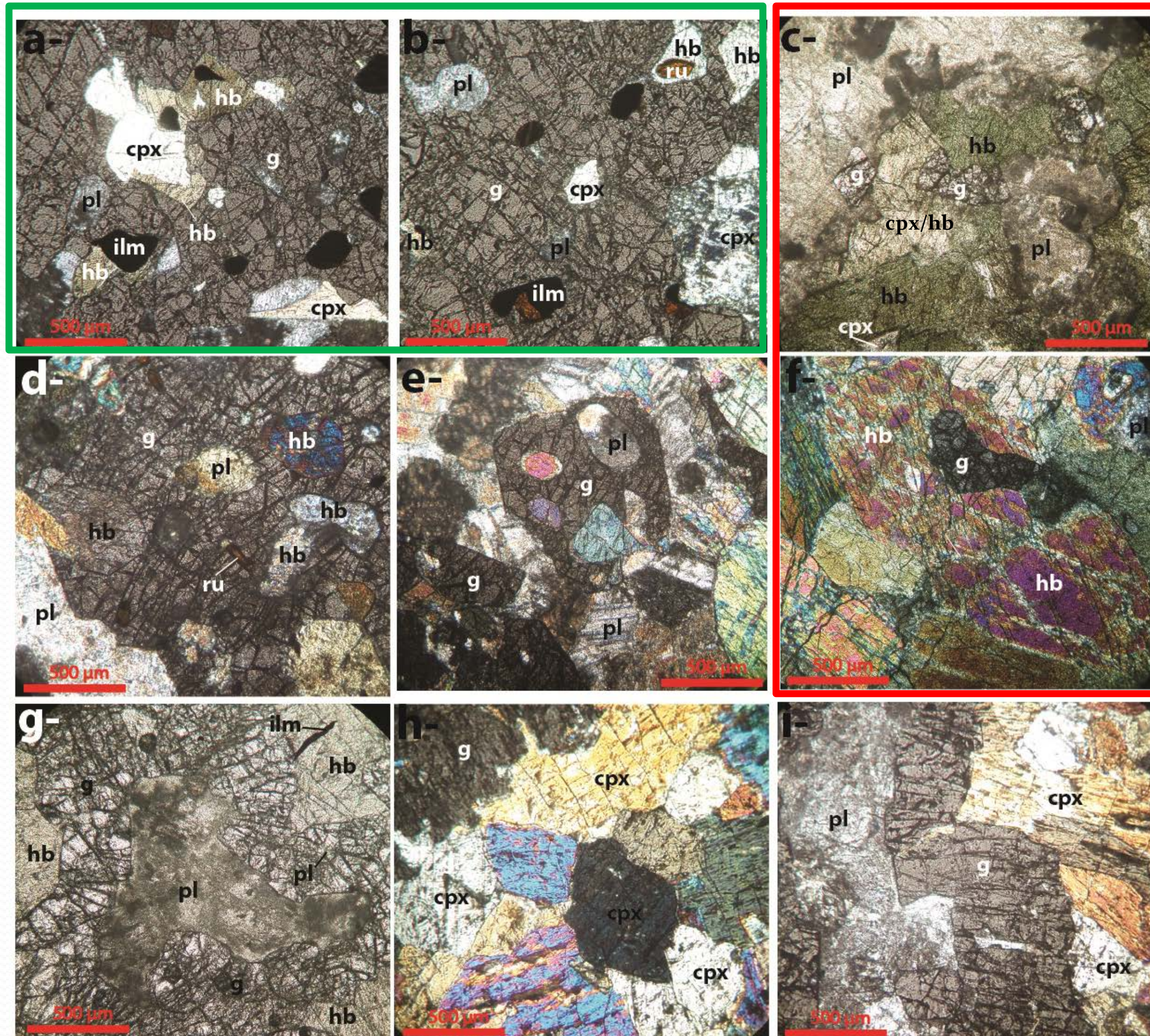

Amphibole appears as product of clinopyroxene transformation through hydration.

Amphibole is also product of reaction between primary clinopyroxene and garnet.

Amphibole shows inclusions of rutile and ilmenite.

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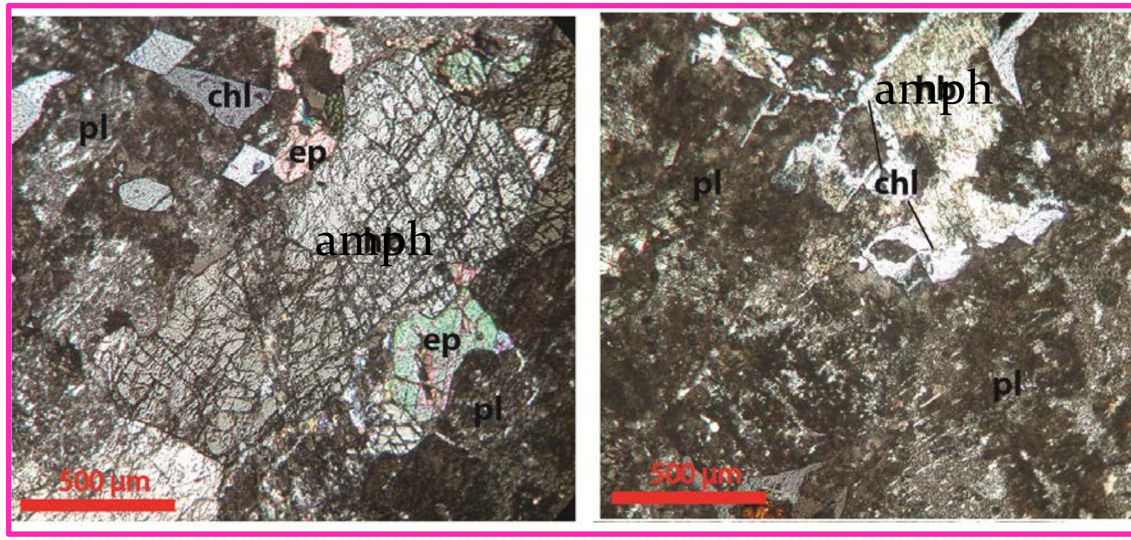

Hydration in low grade, **greenschist facies**, is recorded in garnet- and clinopyroxene-free microdomains with hydrous phases; **amphibole (tremolite?), chlorite and epidote**.

Plagioclase and sphene are also observed outer part of garnet with epidote and amphibole.

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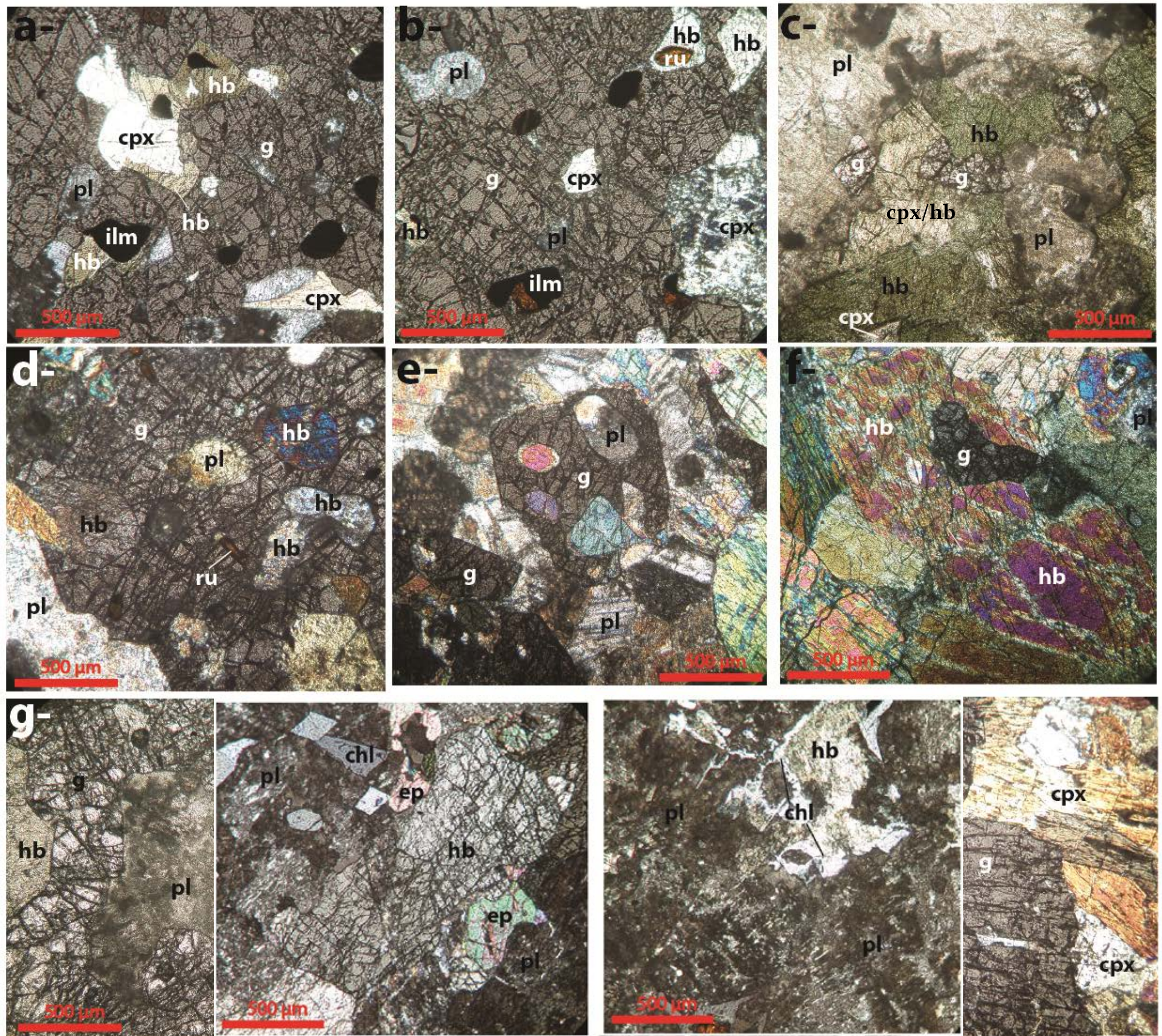

Mineral assemblages :

(M1) : g + cpx + pl + amph ± ilm

(M2) : g + cpx + pl + amph ± ru ± ilm

(M3) : amph + pl + g ± cpx ± ru ± ilm

(M4) : amph + pl + ep + chl ± sph

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Modeling phase relationship

All calculations were performed in NCKFMASHTO compositional system, THERMOCALC 3.45 (ds62, Holland and Powell, 2011)

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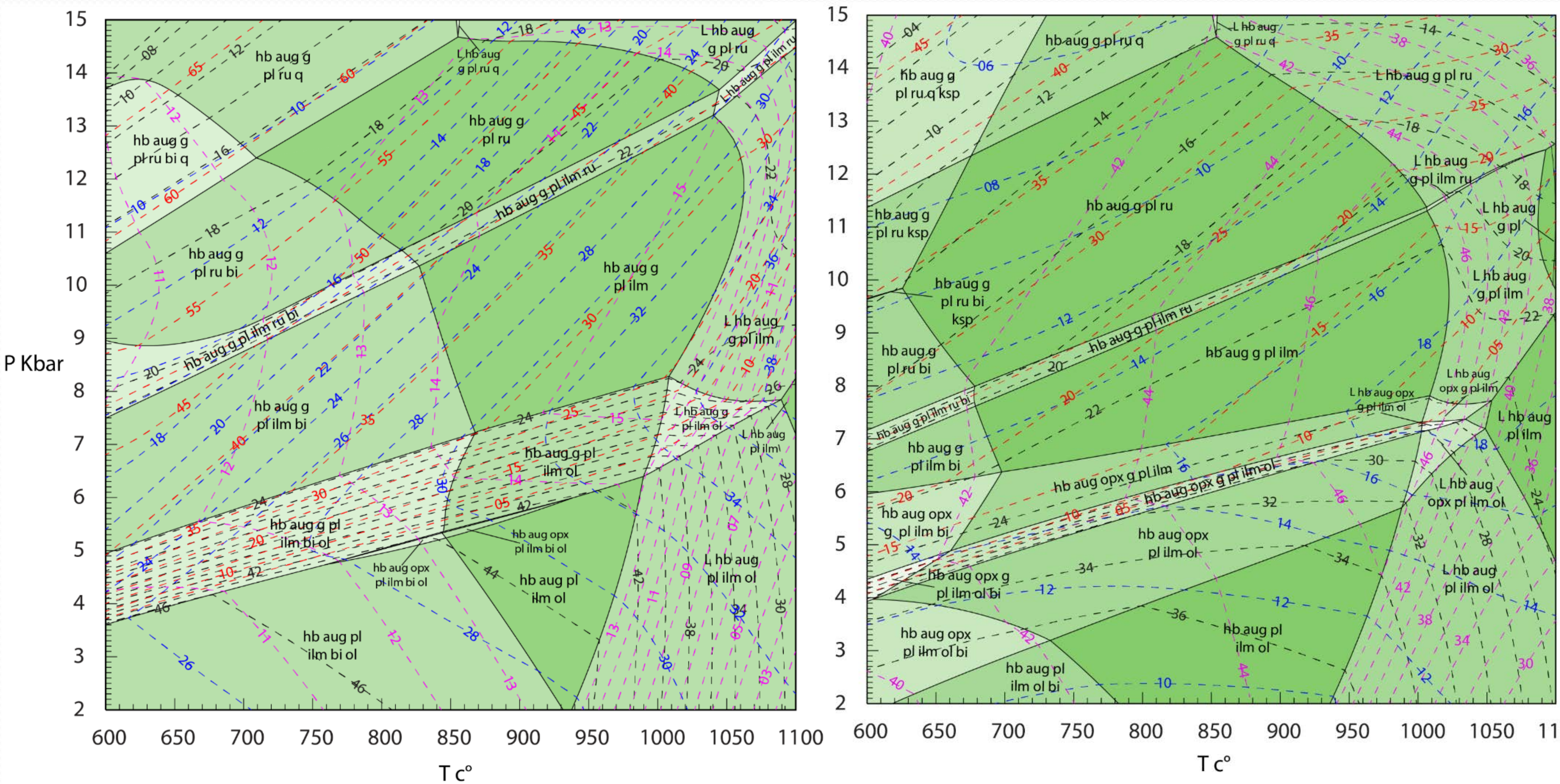

PT pseudosections for two garnet-bearing rocks; metagabbro (left) and amphibolite (right)

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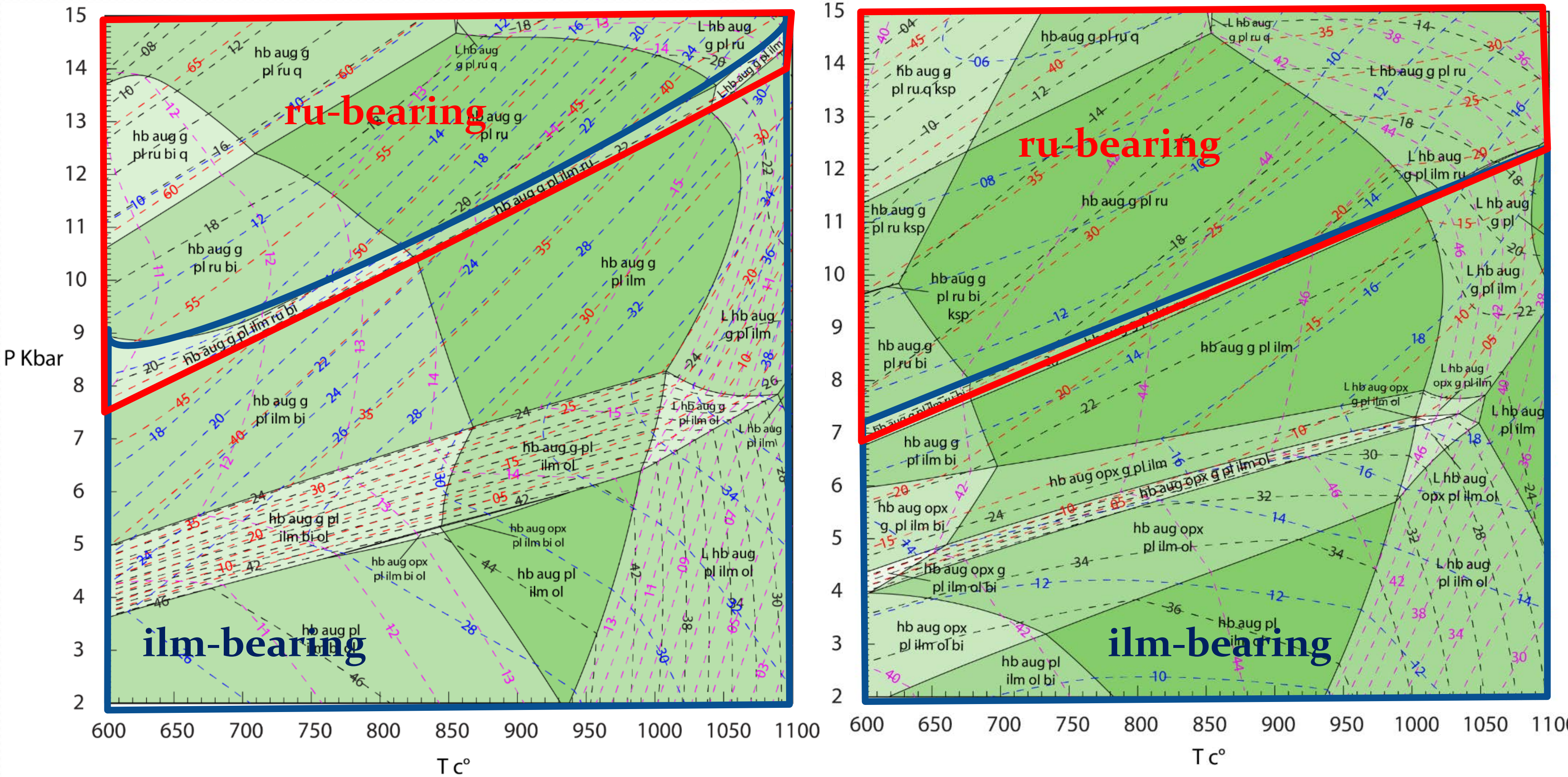

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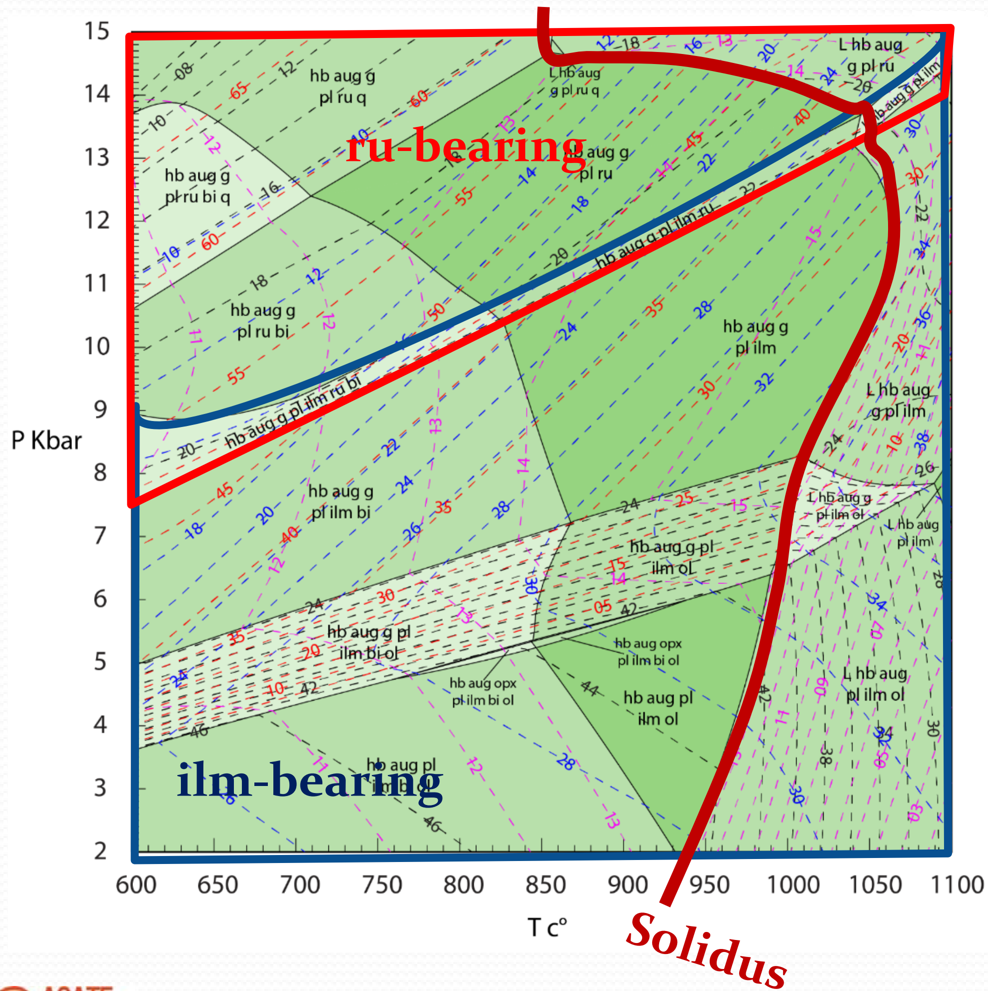

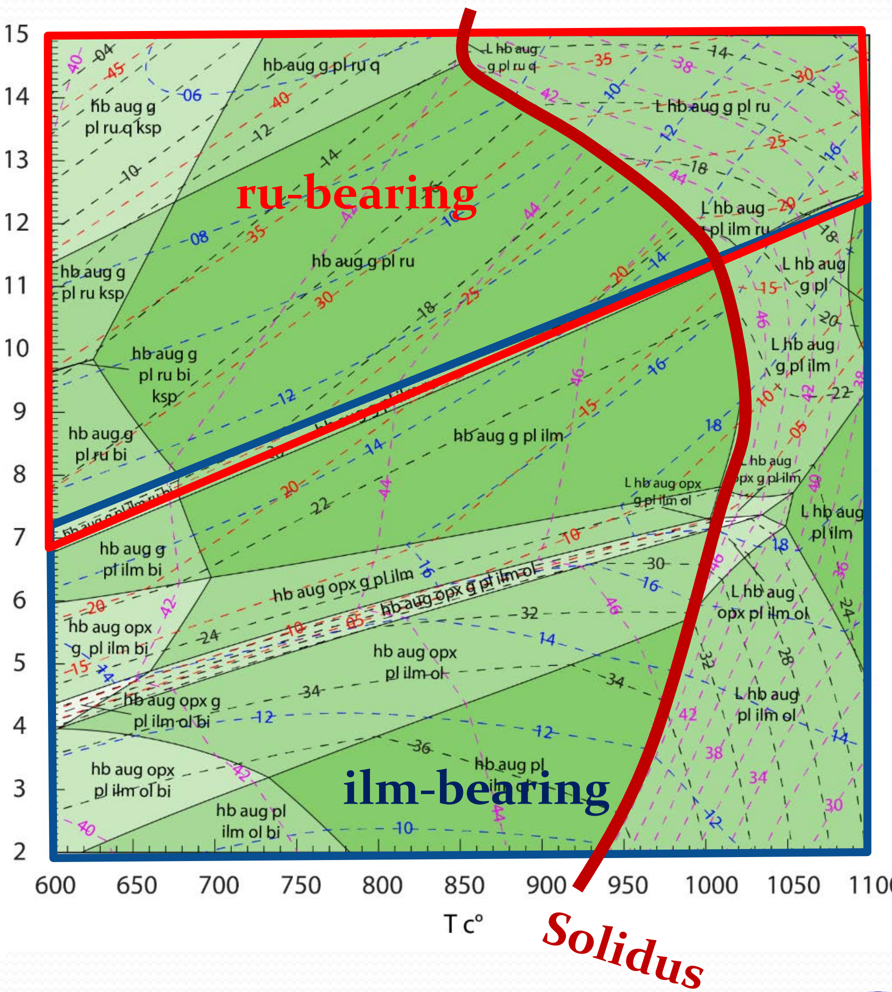

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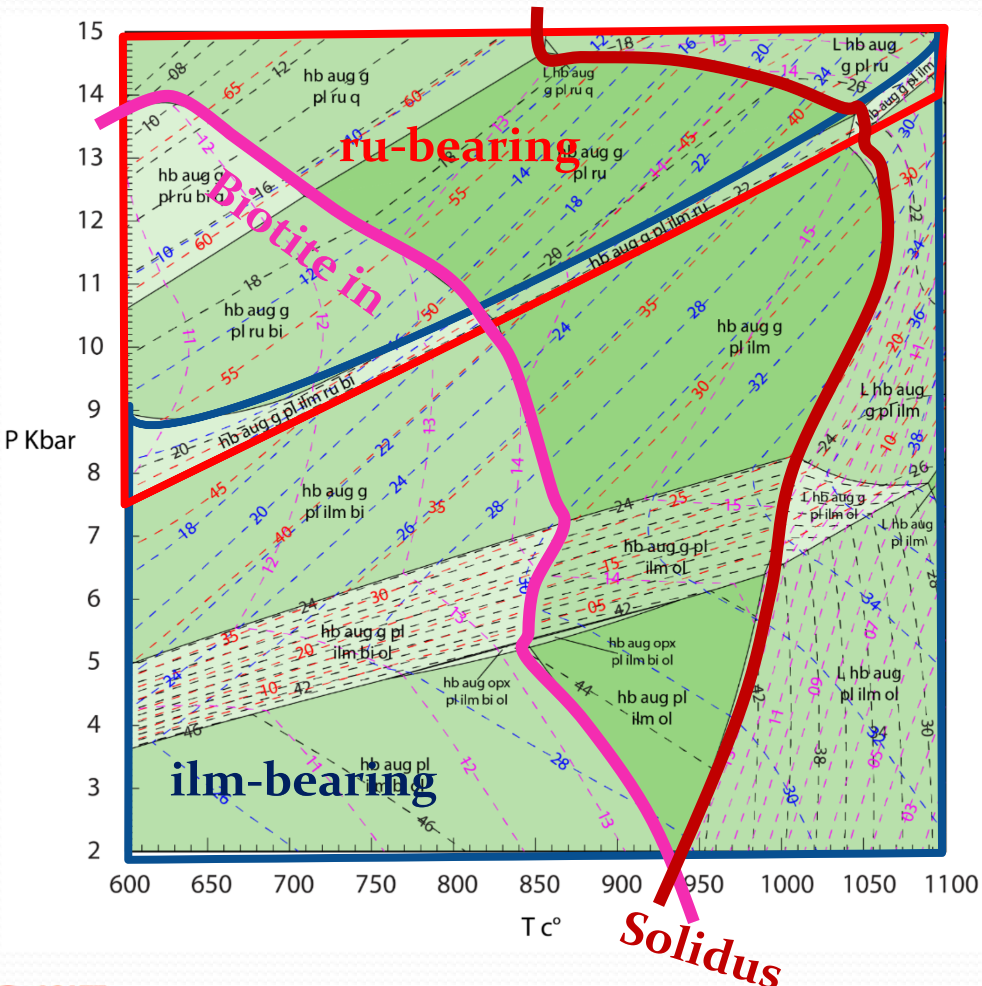

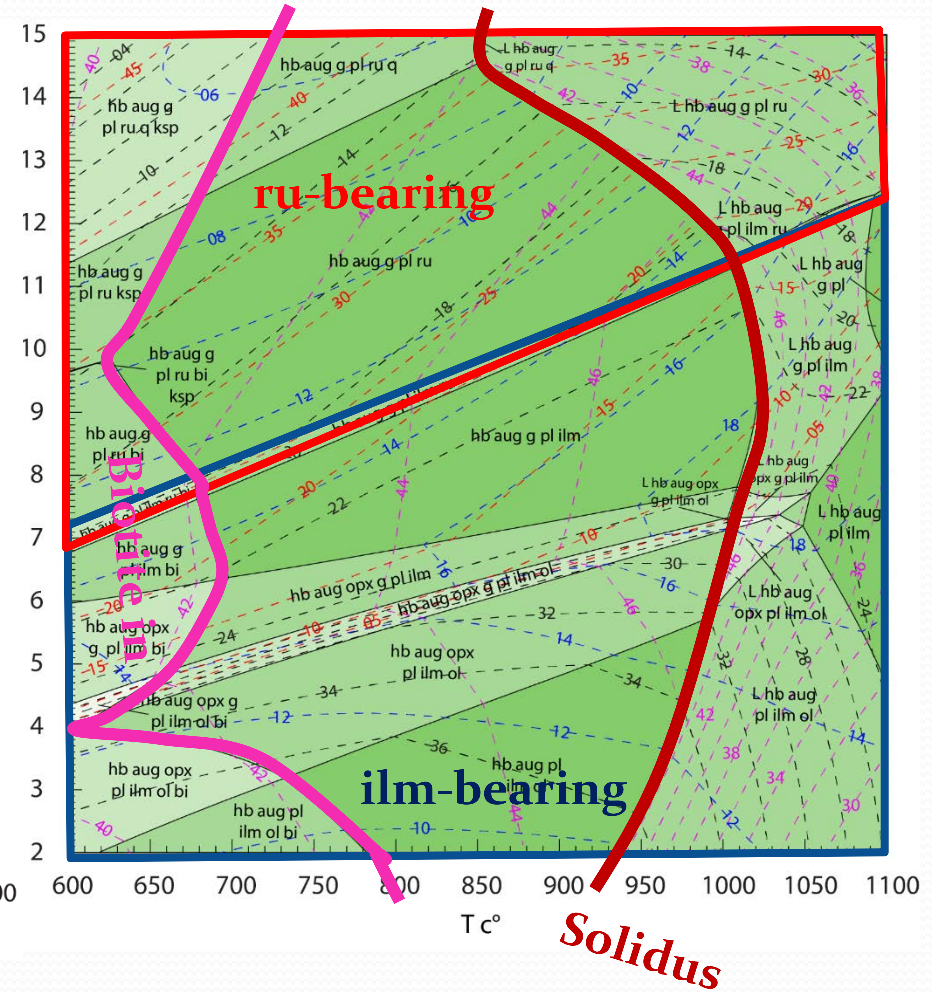

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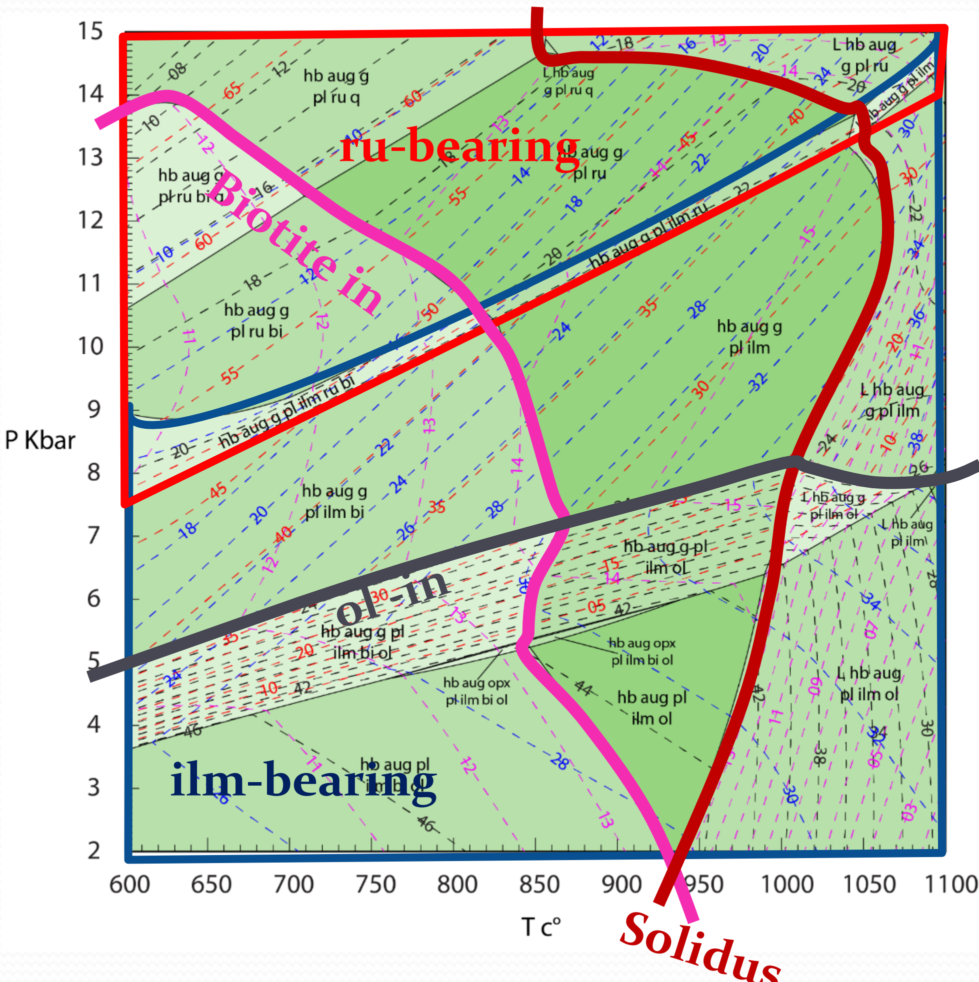

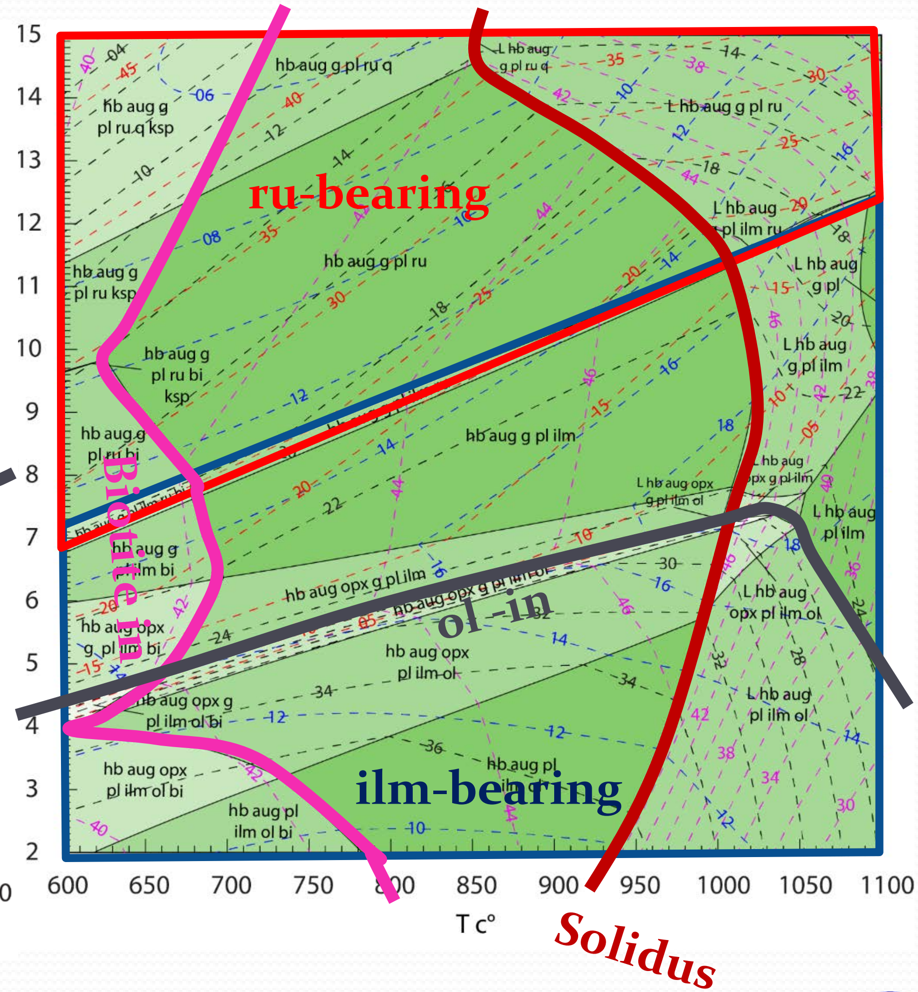

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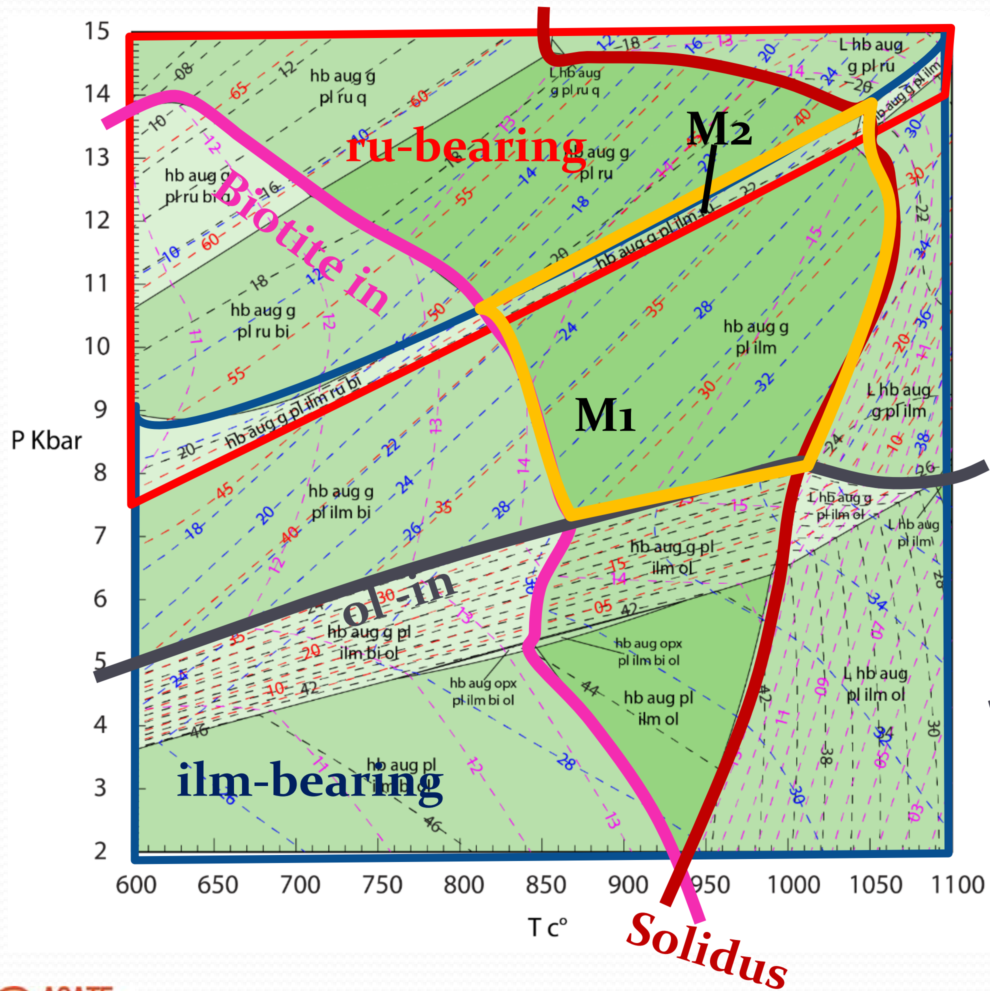

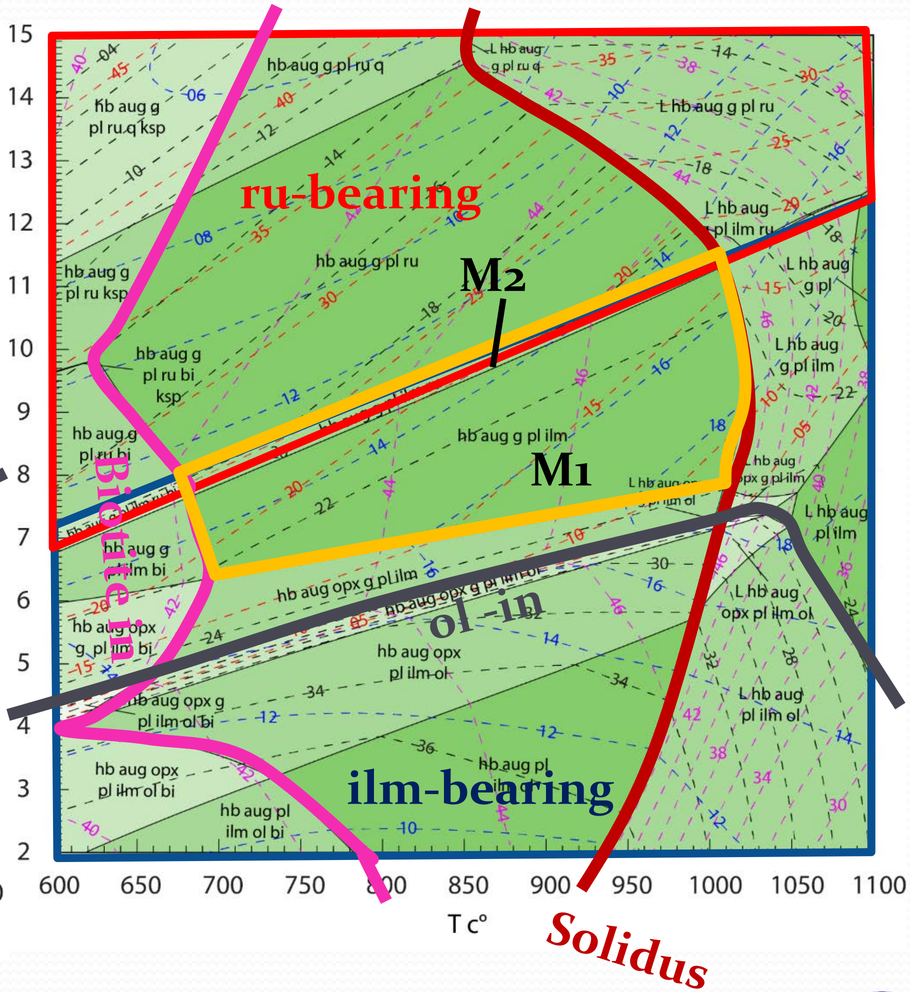

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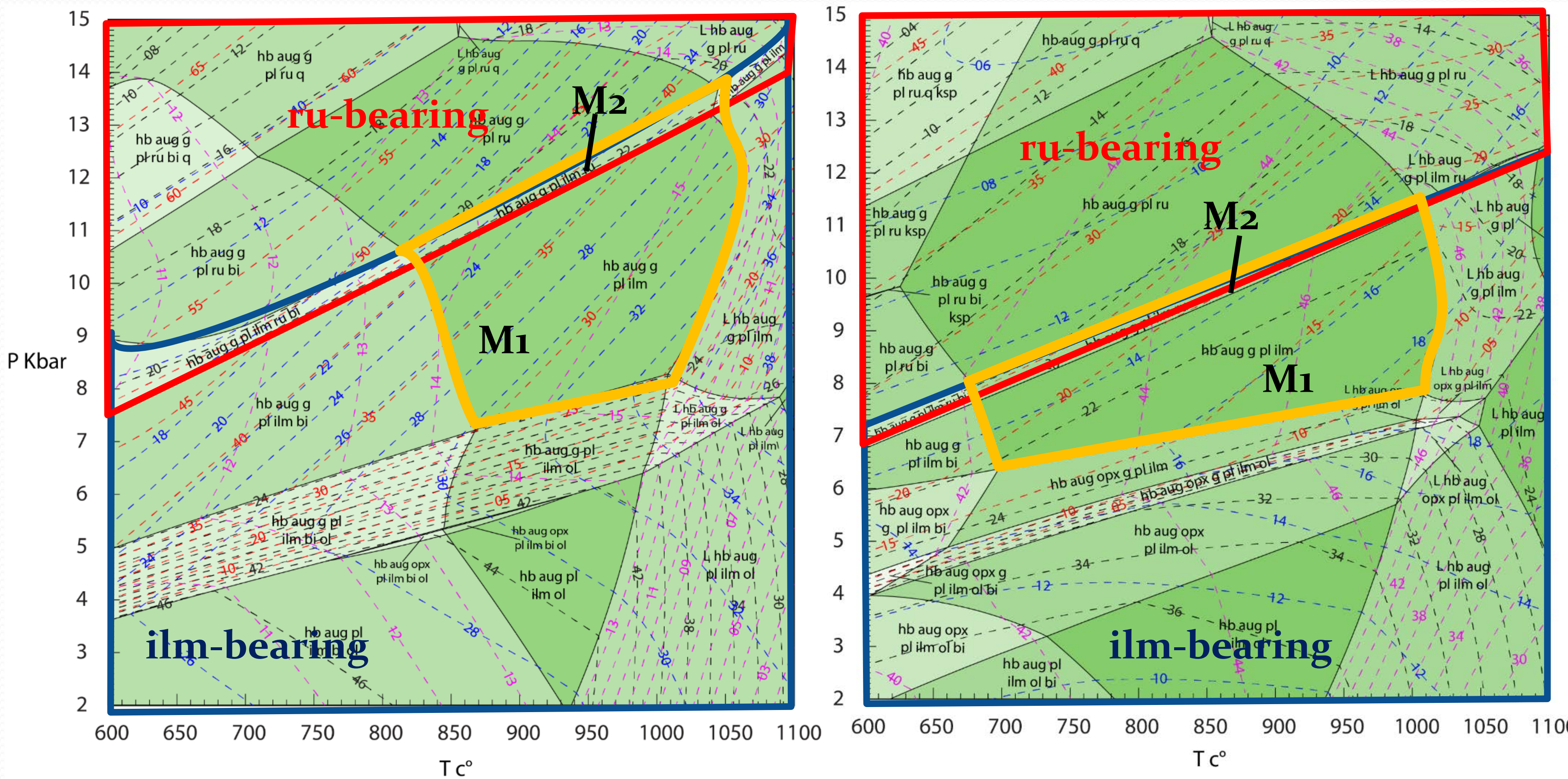

Modal calculations (isopleths) with textural relationships are more consistent with a solid-state reaction where clinopyroxene and plagioclase are consumed to produce garnet.

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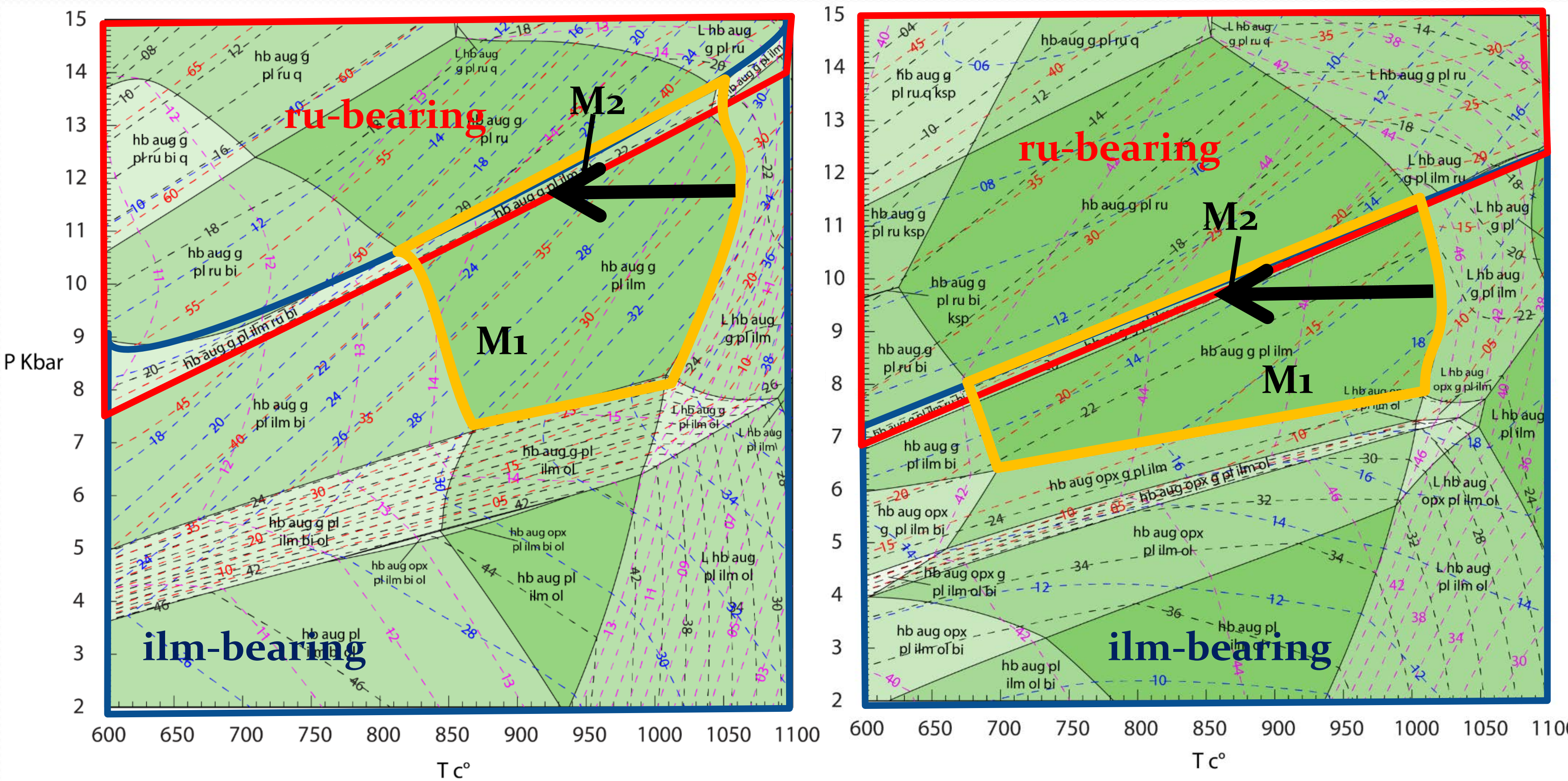

The first stage of PT path (Prograde path) is either related isobaric cooling at high pressure or pressure increase with cooling stage, linked to garnet growth.

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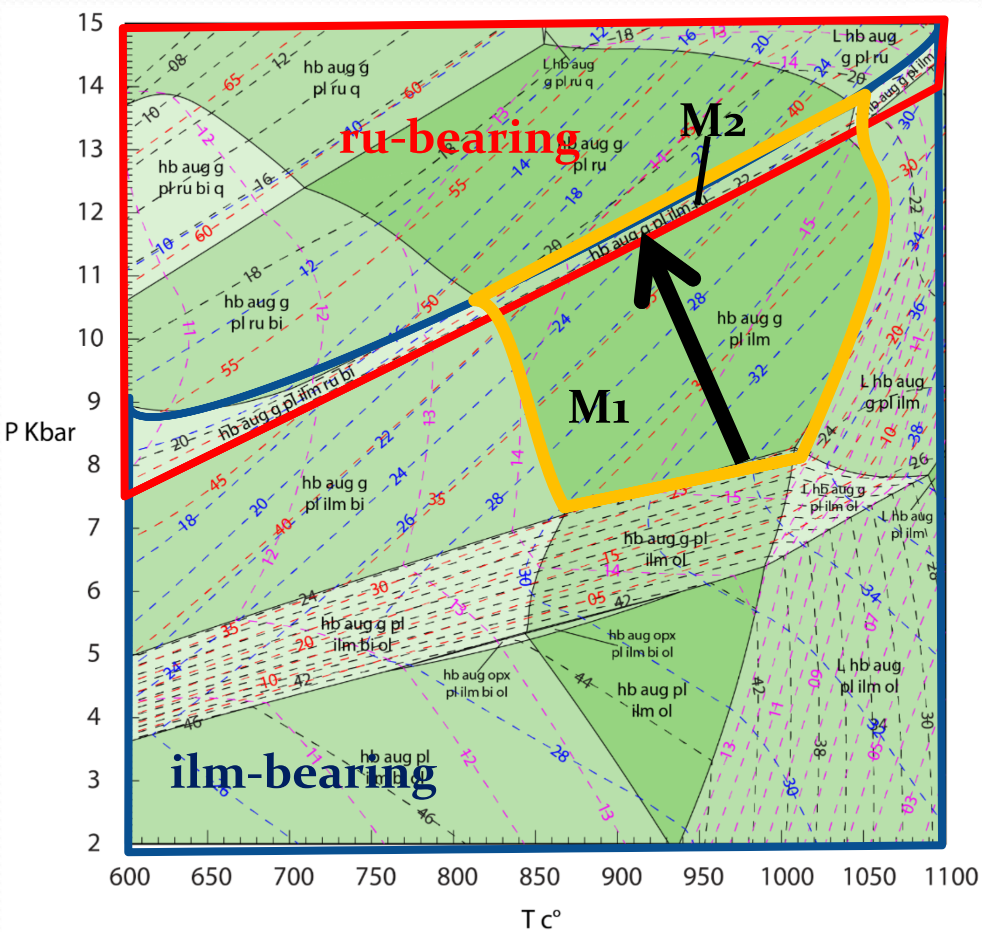

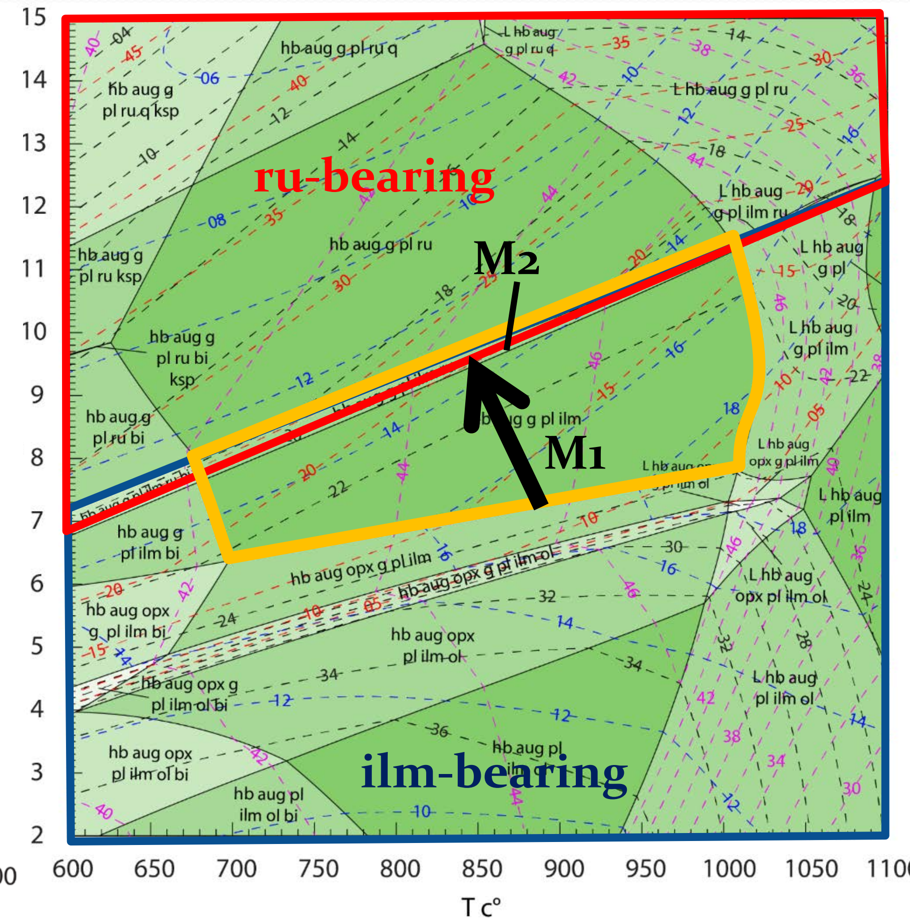

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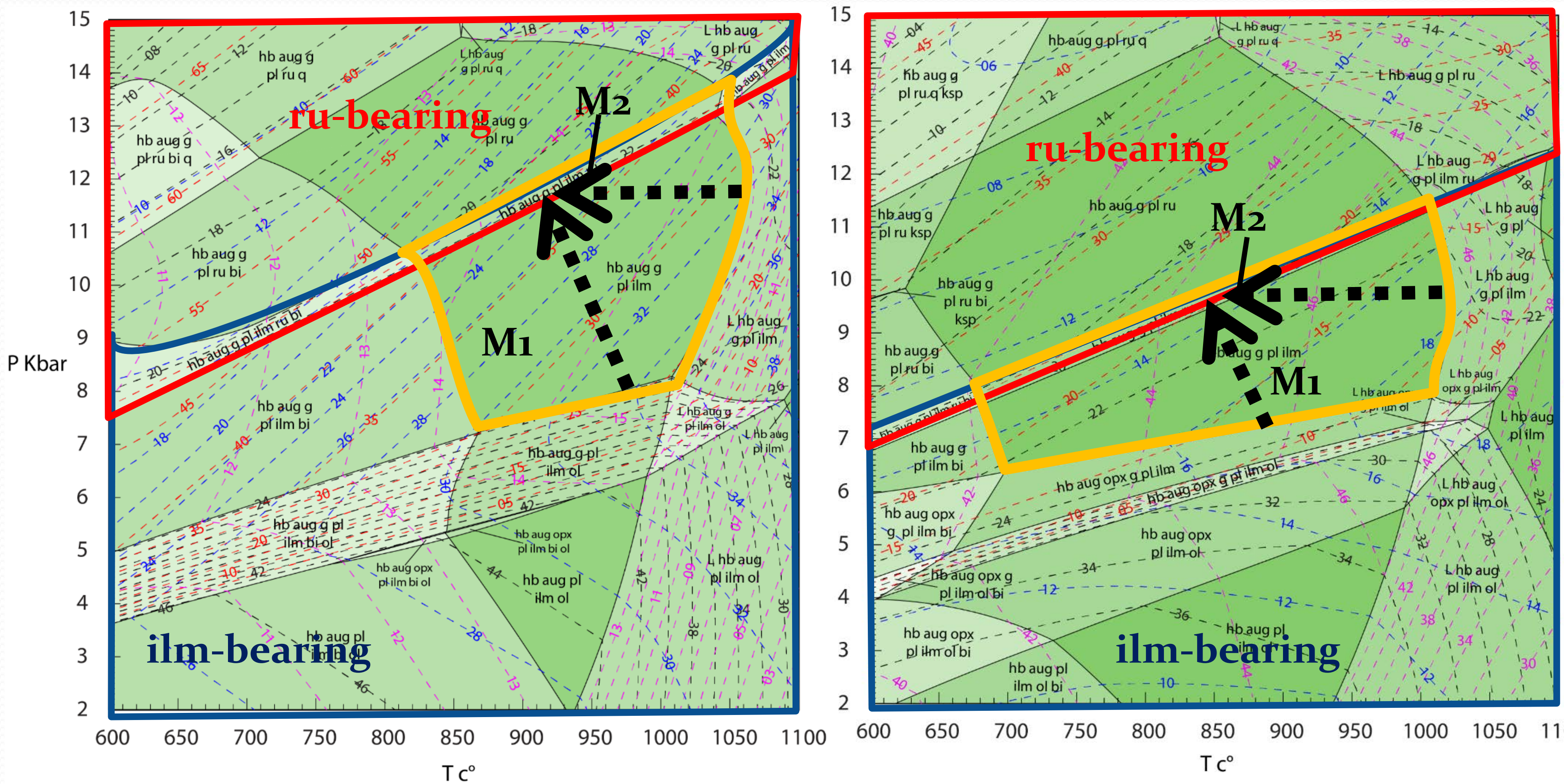

The first stage of PT path (Prograde path) could be constrained through Thermobarometry with mineral chemistry on garnet inclusions

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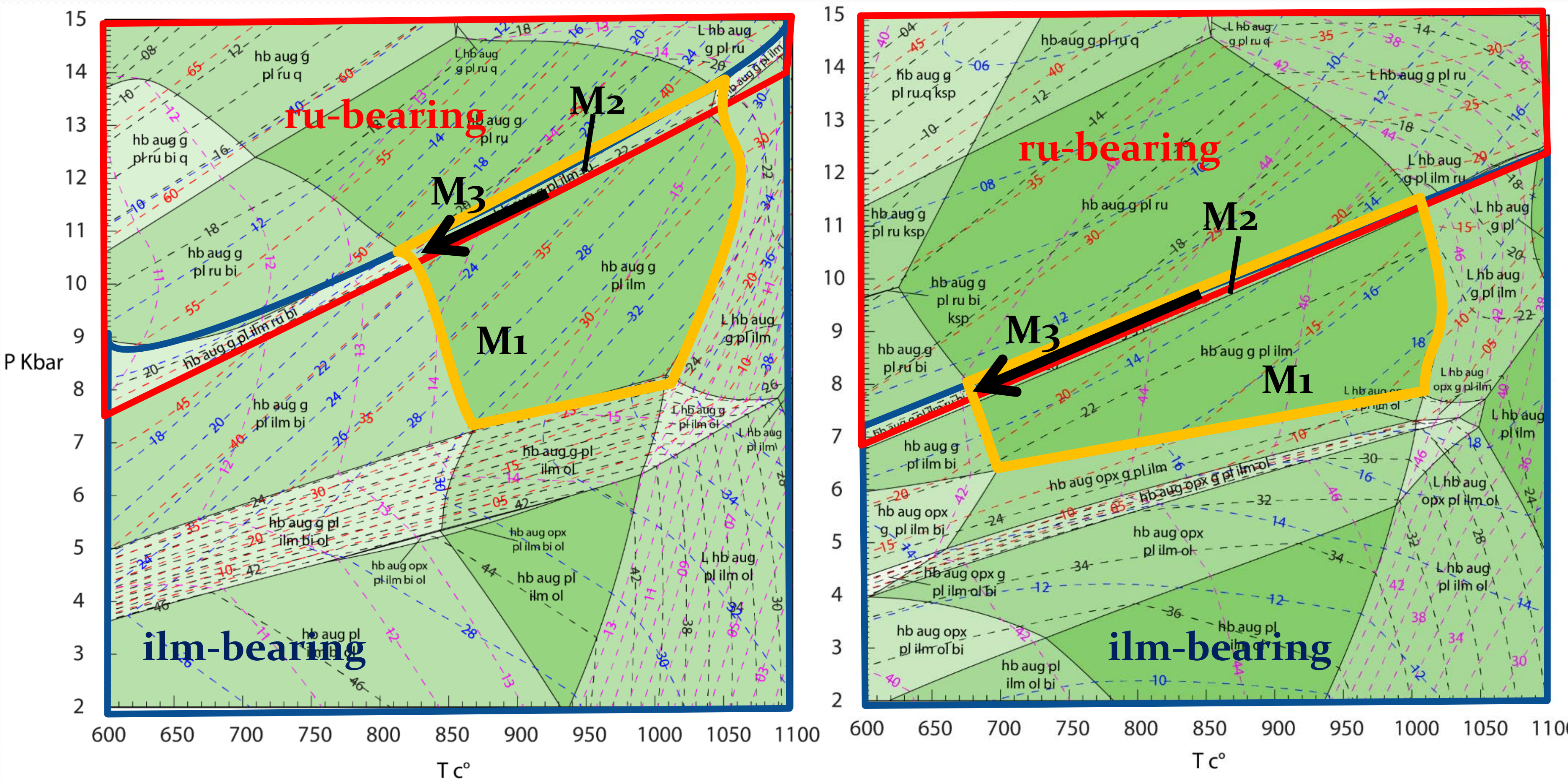

M3 is linked to amphibole production either as the product of clinopyroxene transformation or reaction between primary clinopyroxene and garnet. Amphibole shows inclusions of rutile/ilmenite.

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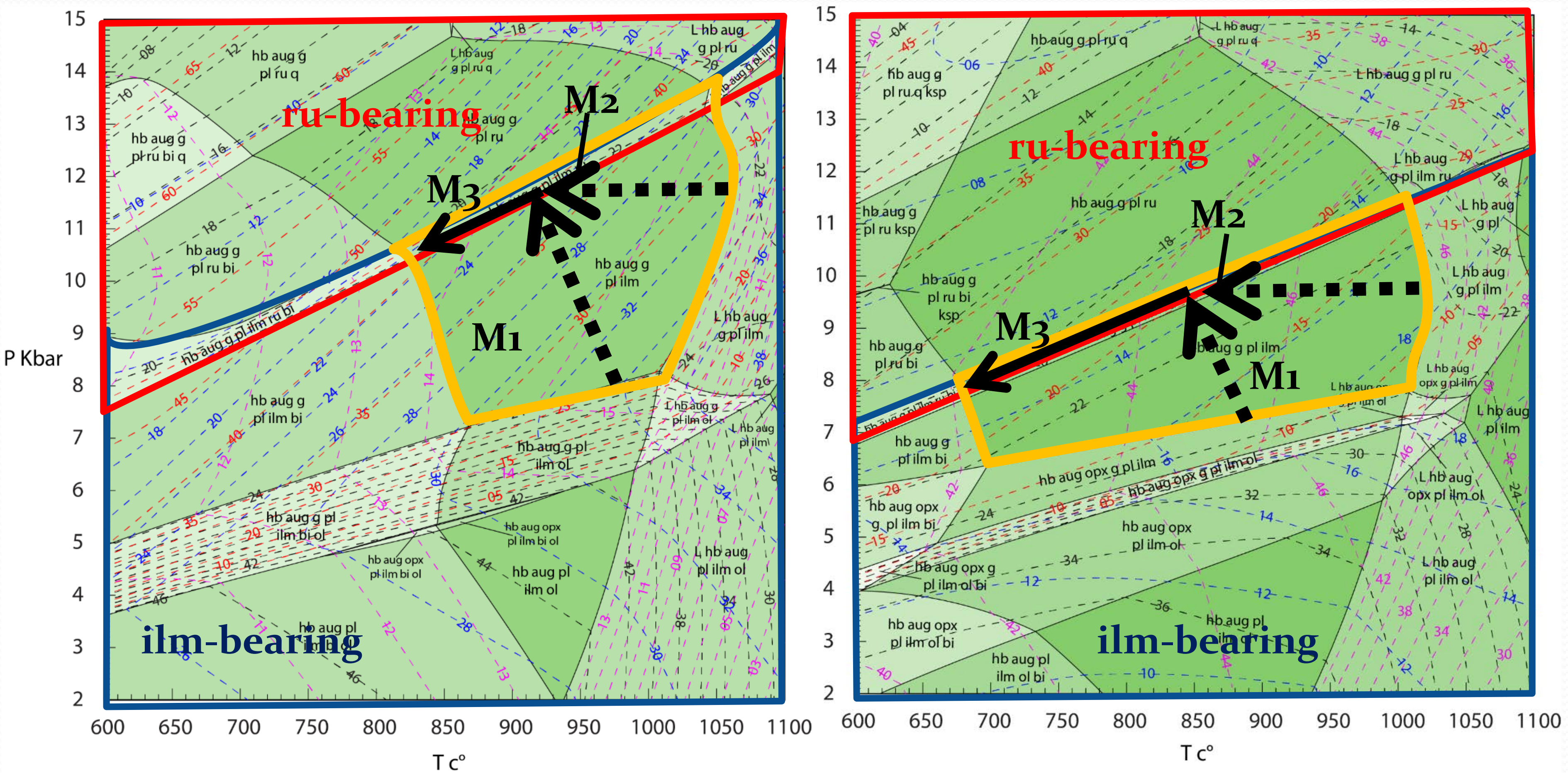

P-T conditions of M1, M2 and M3, 7-14 Kbar and 700-1000 °C, are limited by the appearance of biotite at low temperature, solidus at high temperature and olivine at low pressure

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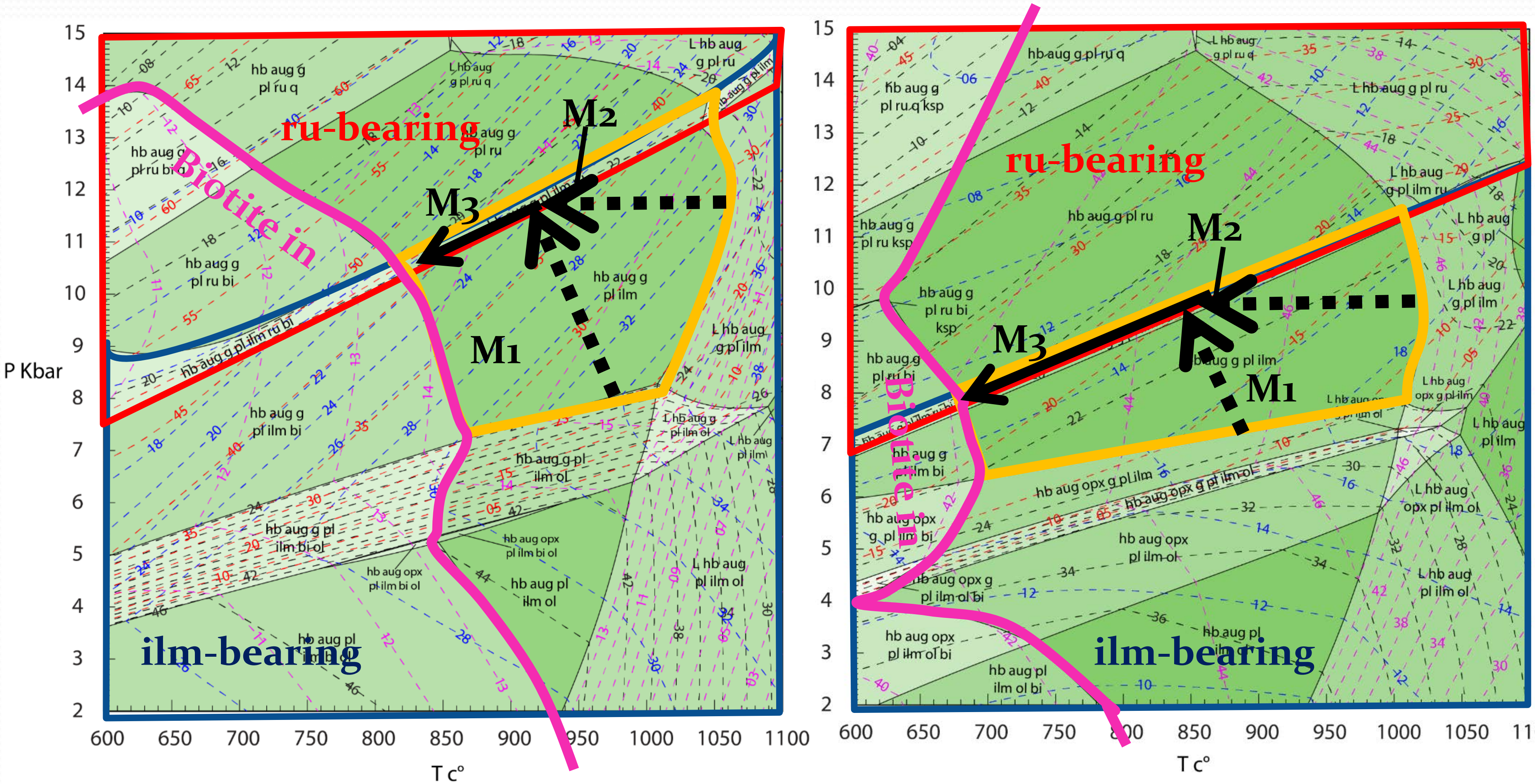

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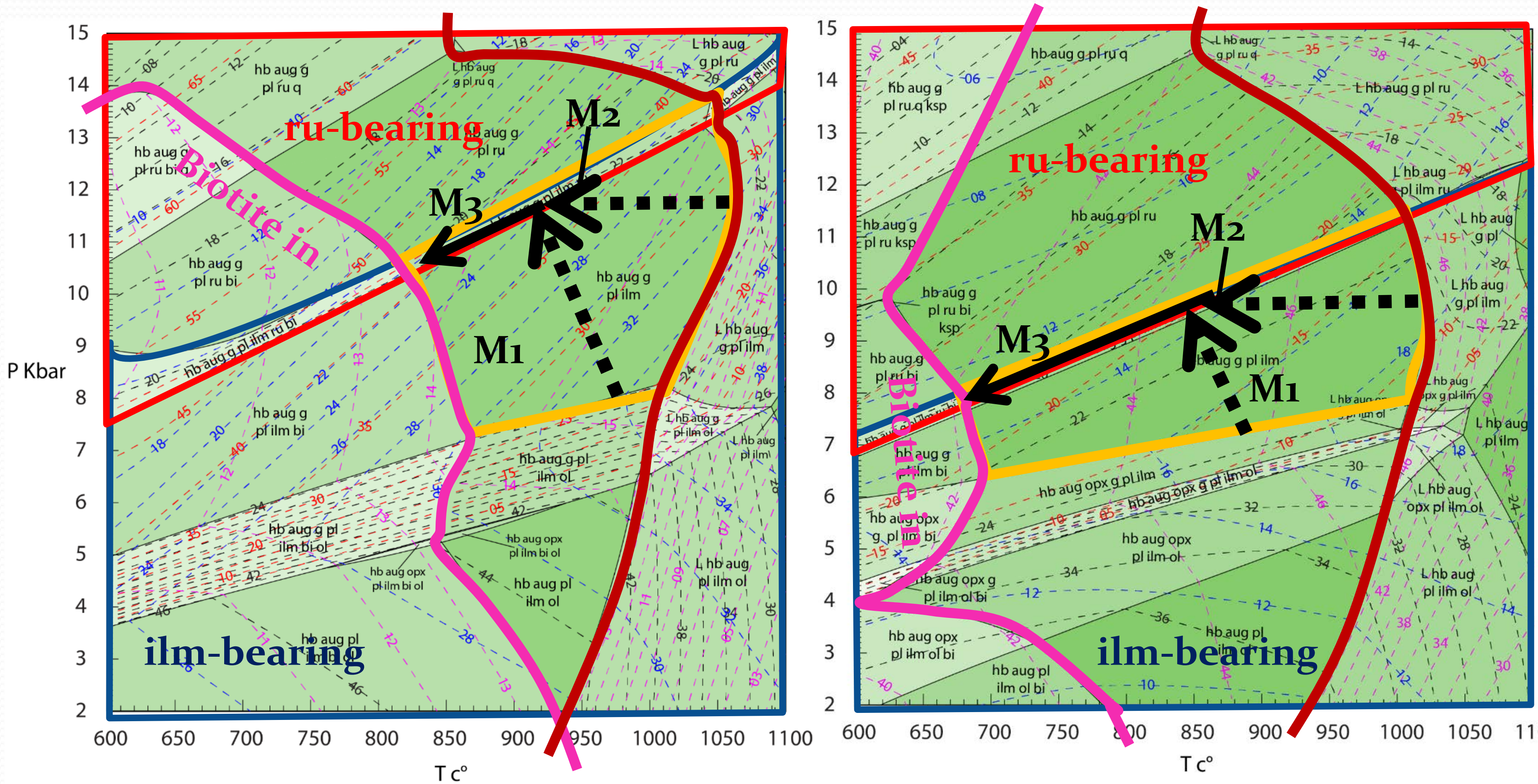

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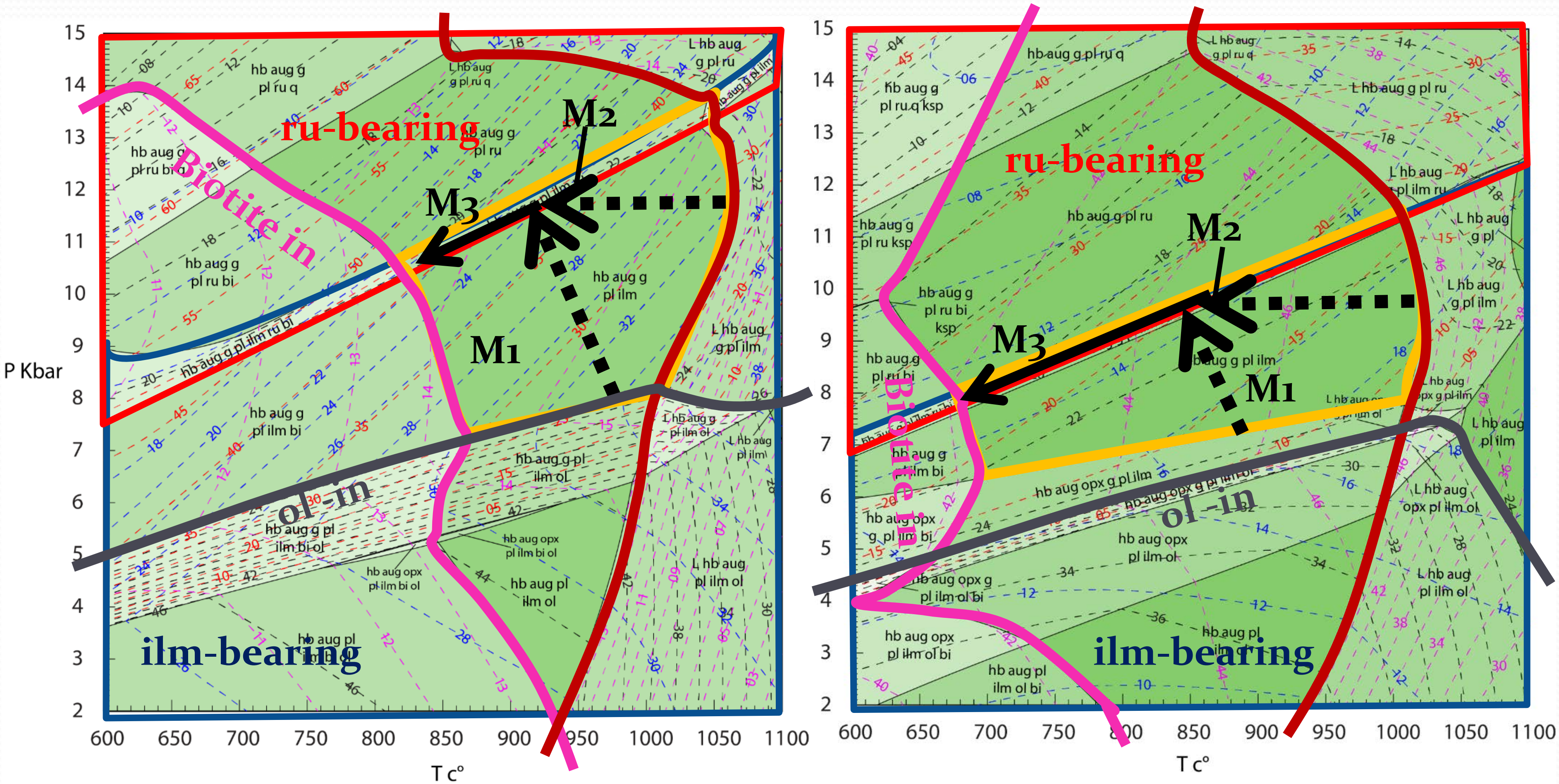
AGATE PROJECT

Modeling phase relationship

All calculations were performed in NCKFMASHTO compositional system, THERMOCALC 3.45 (ds62)



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Modeling phase relationship

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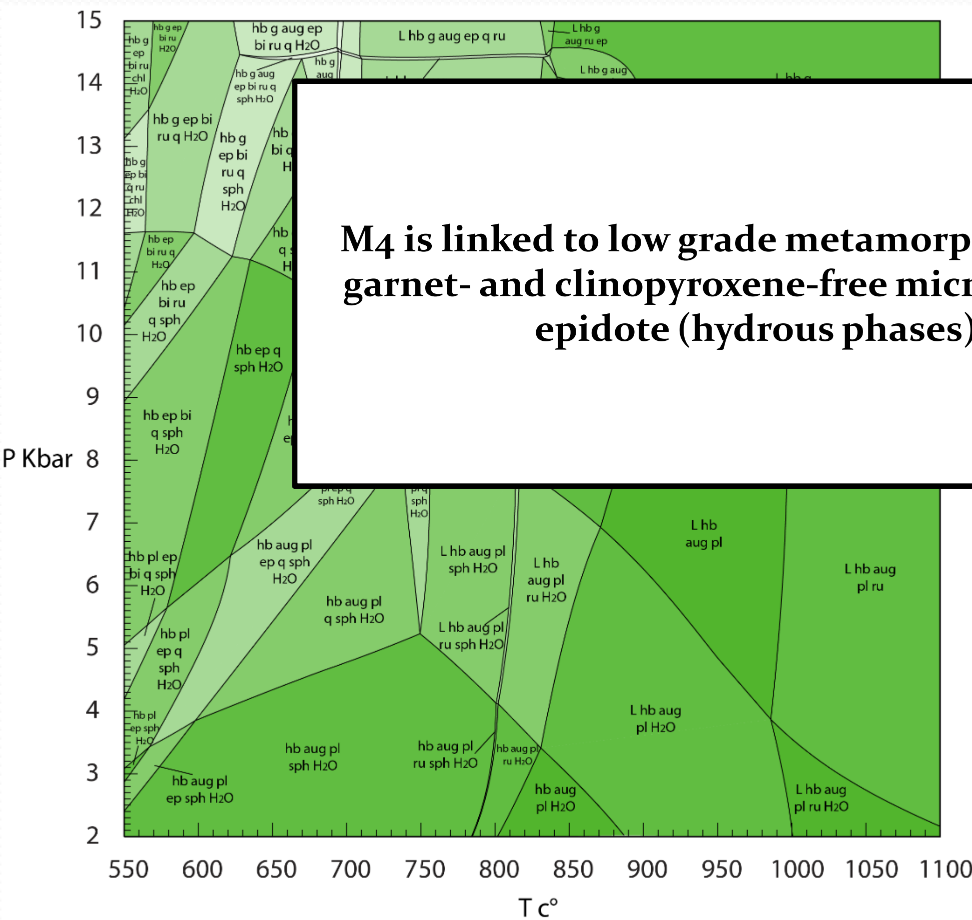

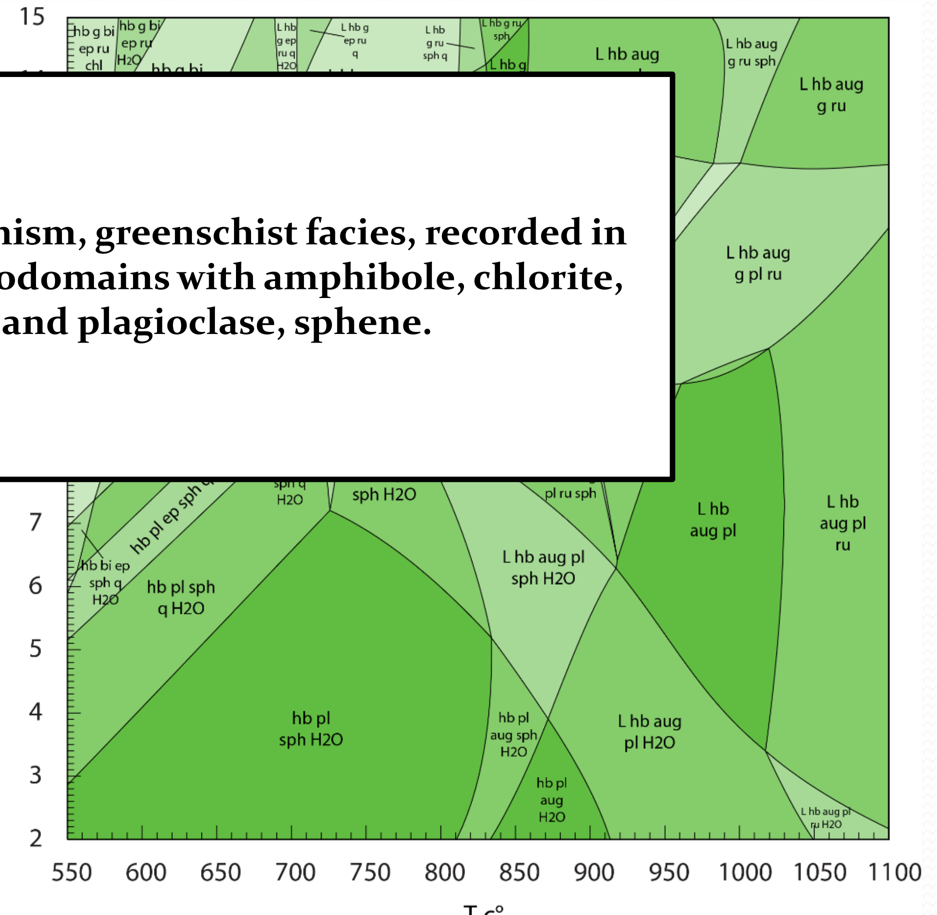

M4 is linked to low grade metamorphism, greenschist facies, recorded in garnet- and clinopyroxene-free microdomains with amphibole, chlorite, epidote (hydrous phases) and plagioclase, sphene.

PT pseudosections for two garnet-bearing rocks; metagabbro (left) and amphibolite (right)

Modeling phase relationship

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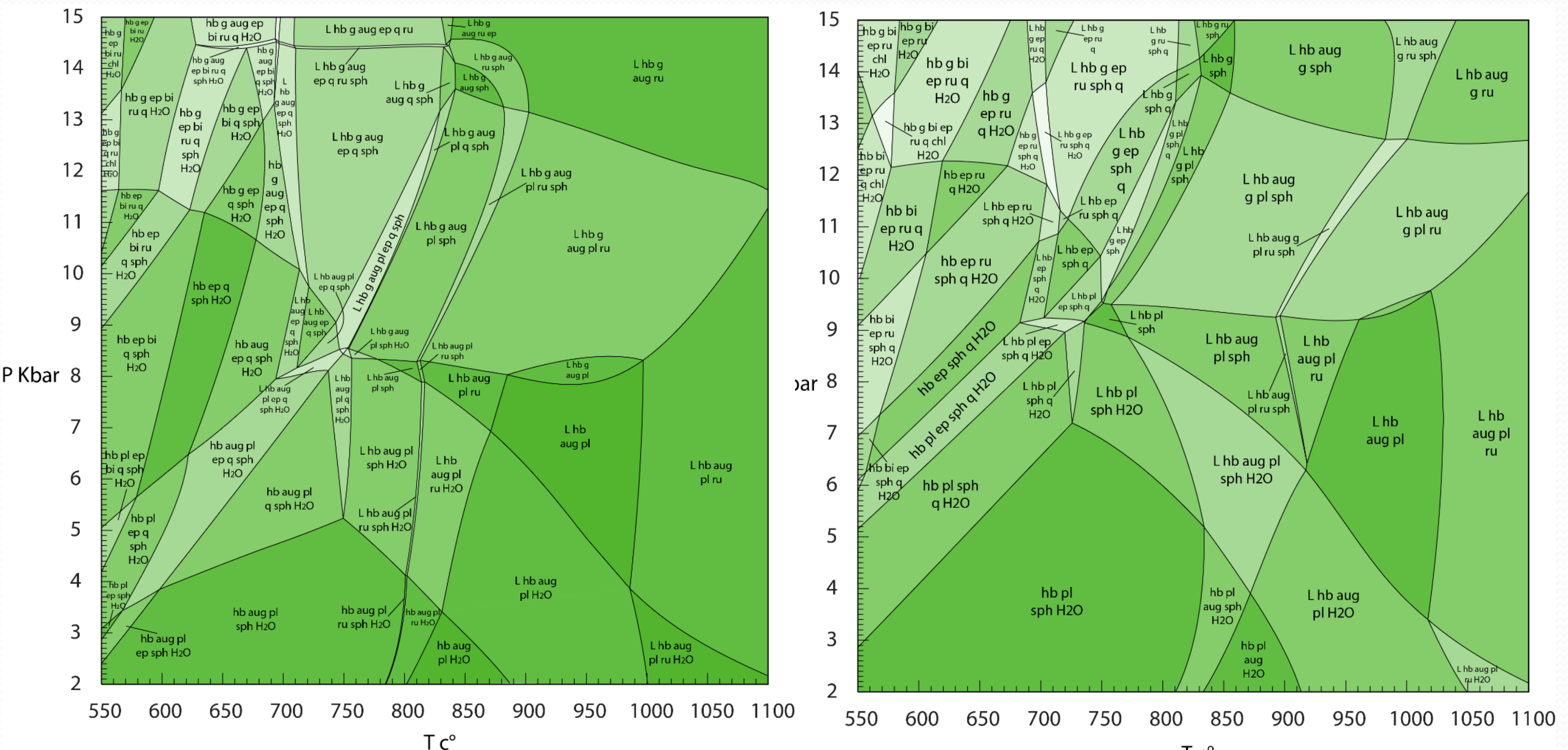

PT pseudosections for two garnet-bearing rocks; metagabbro (left) and amphibolite (right)

AGATE PROJECT

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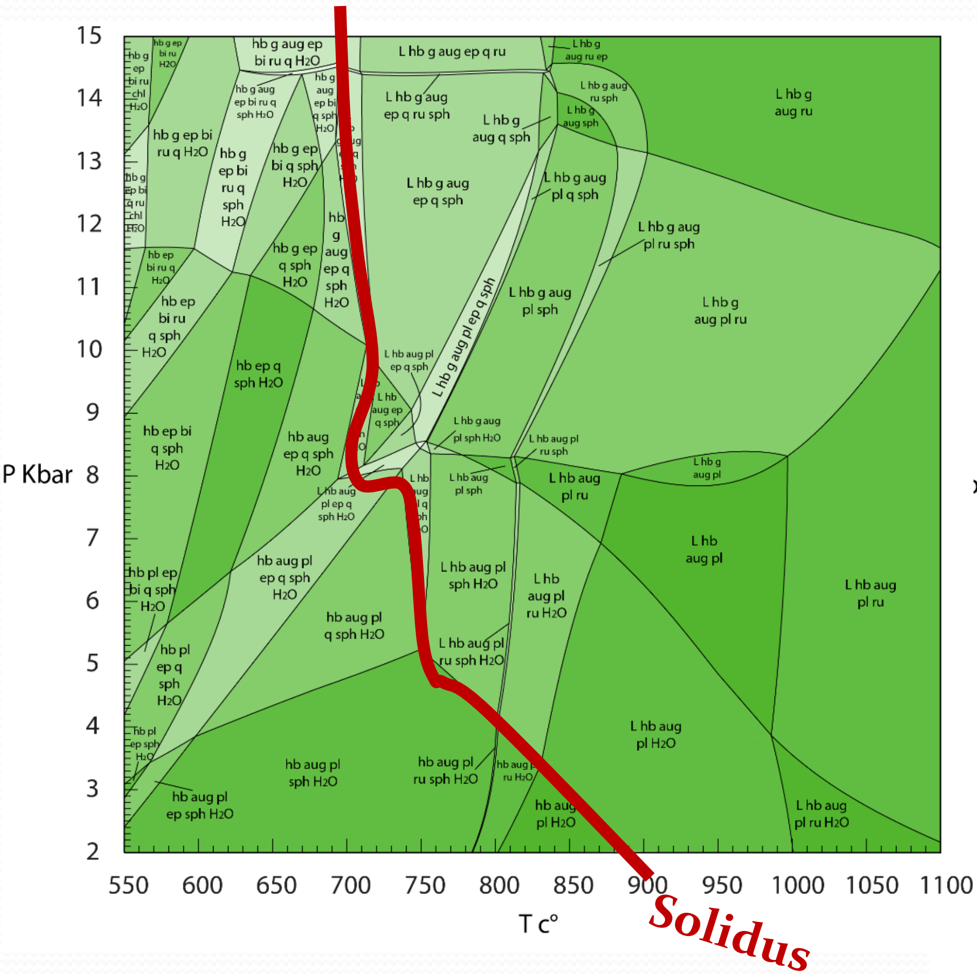

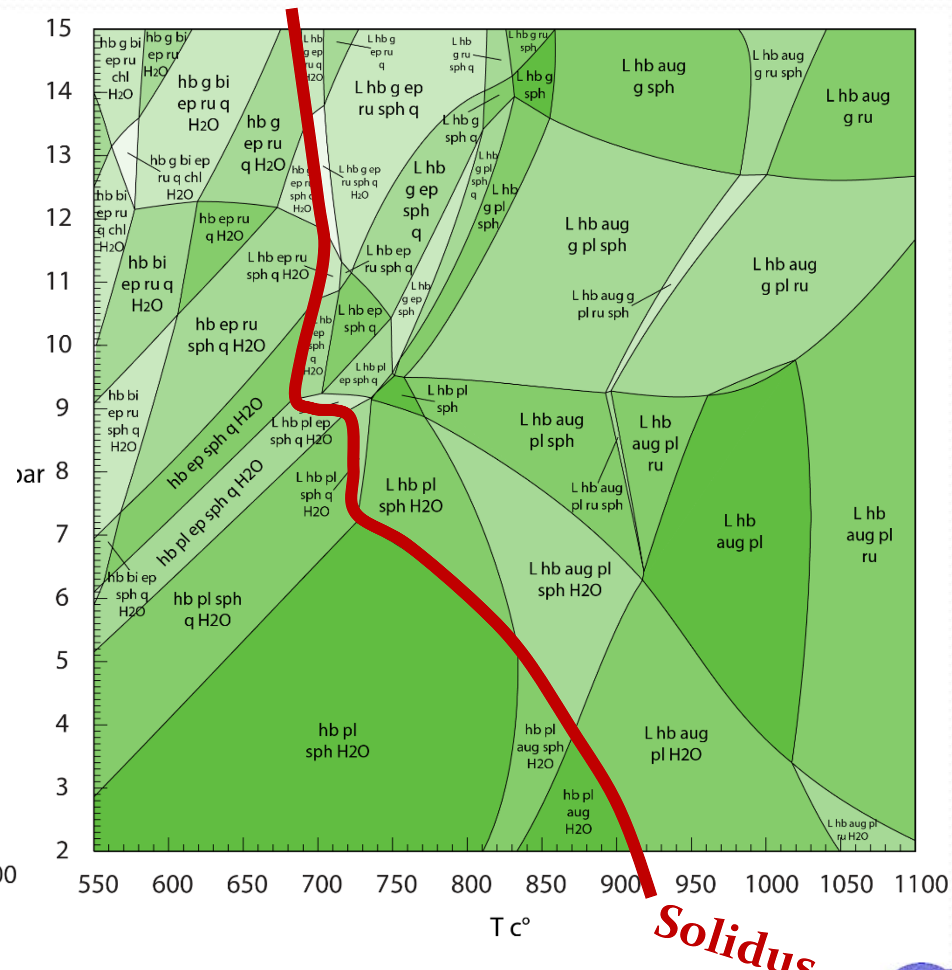

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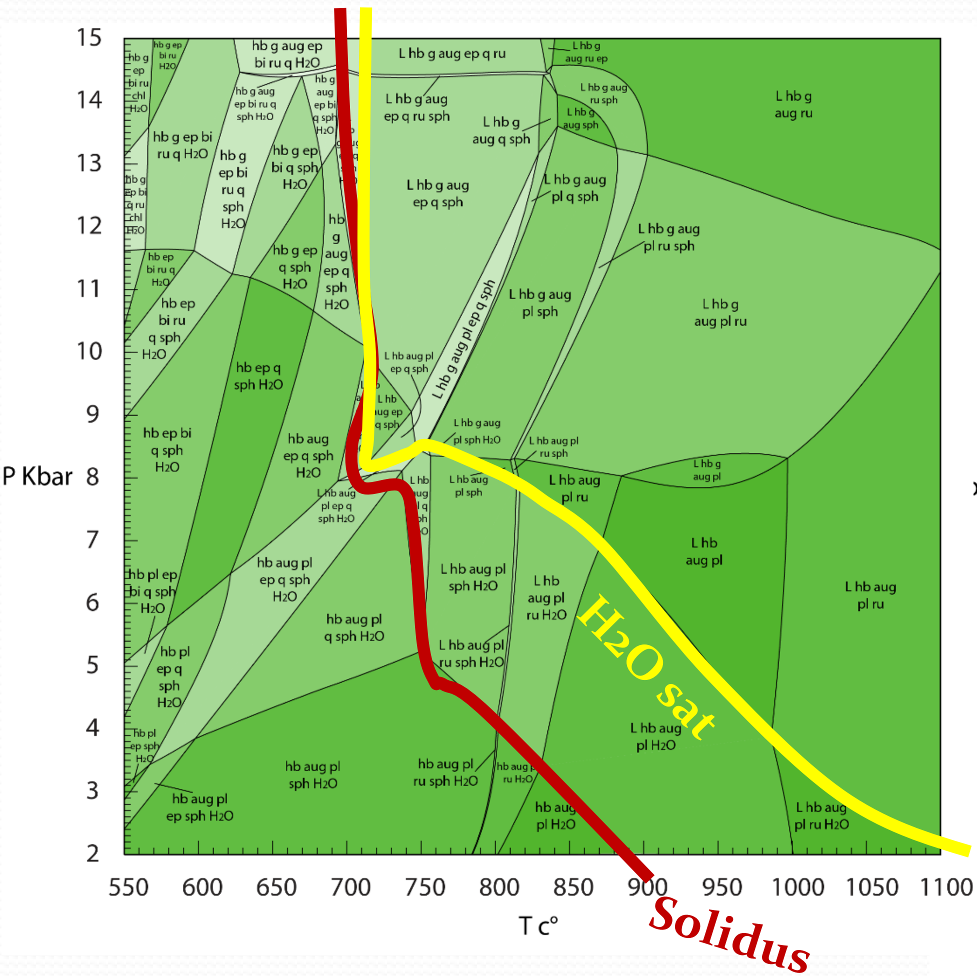

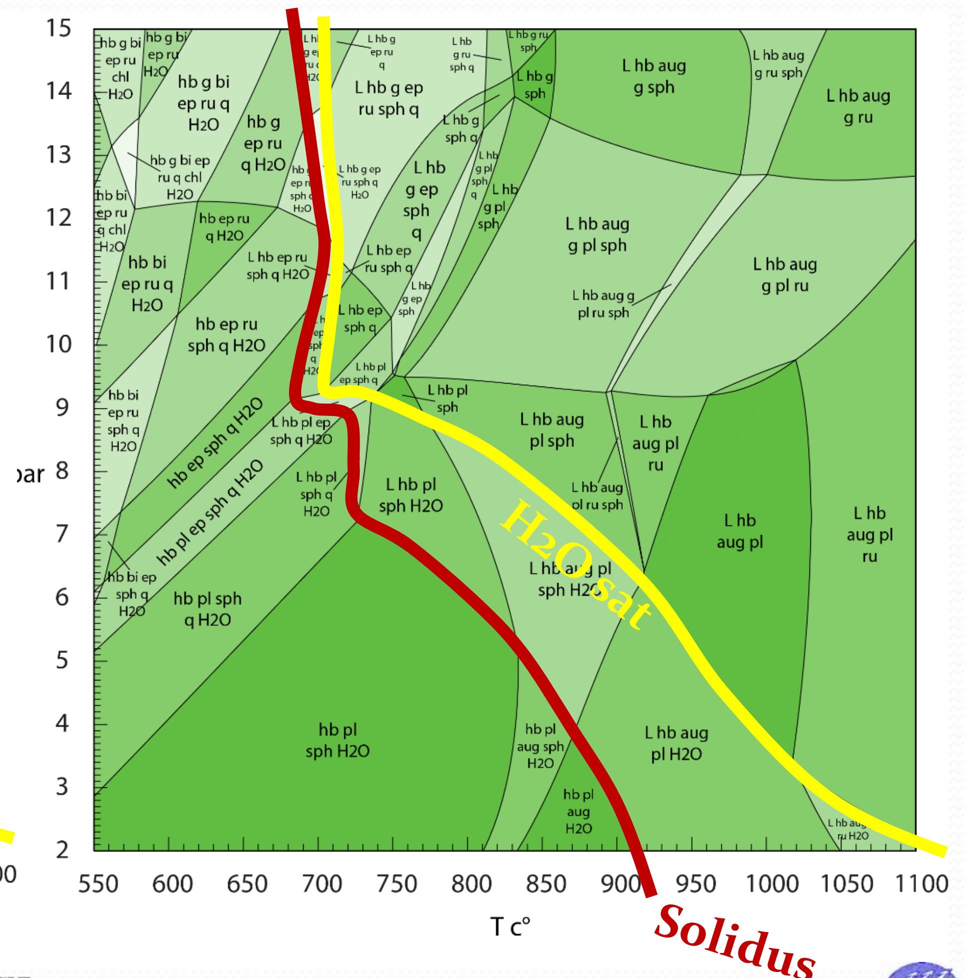

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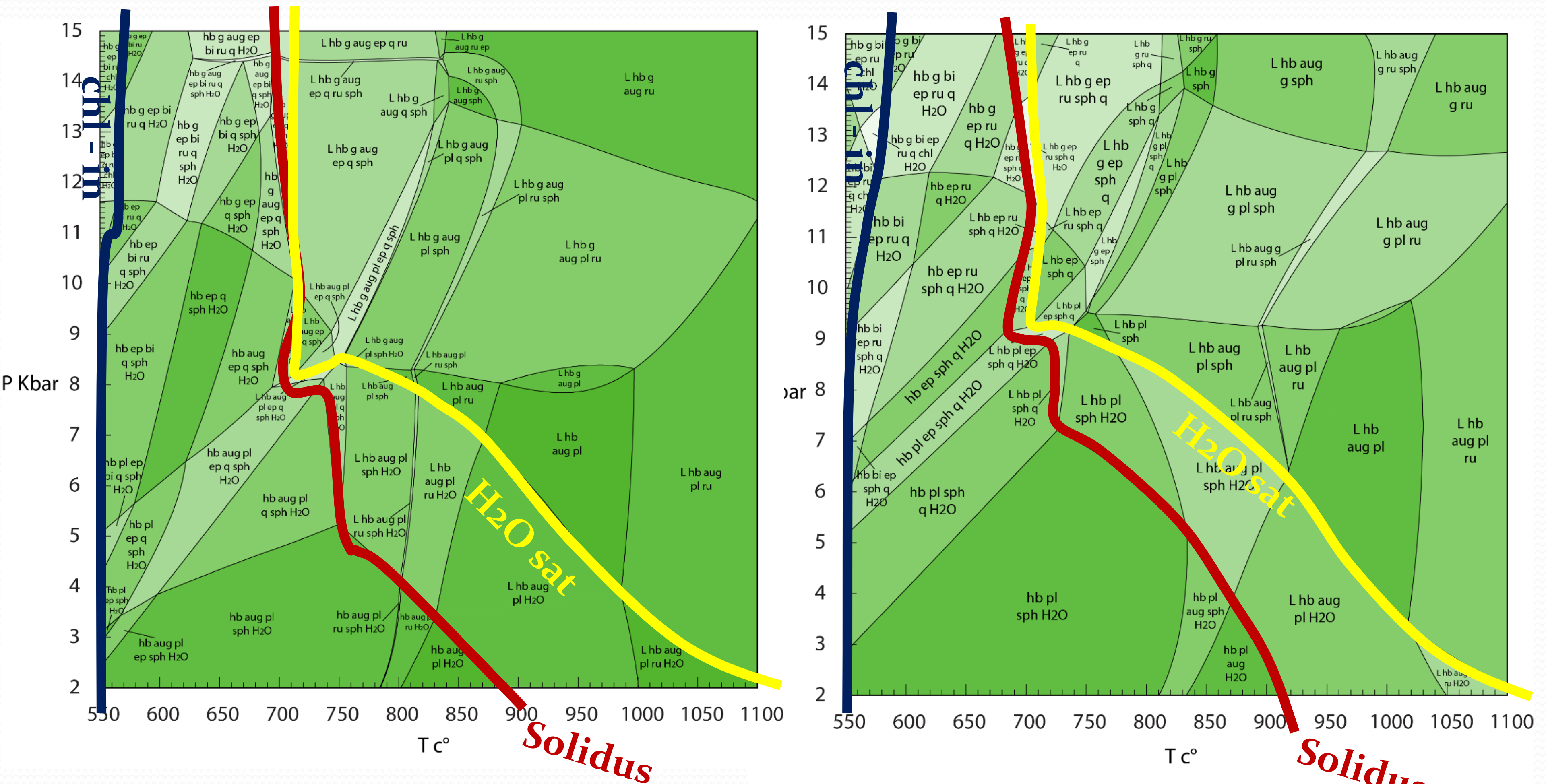

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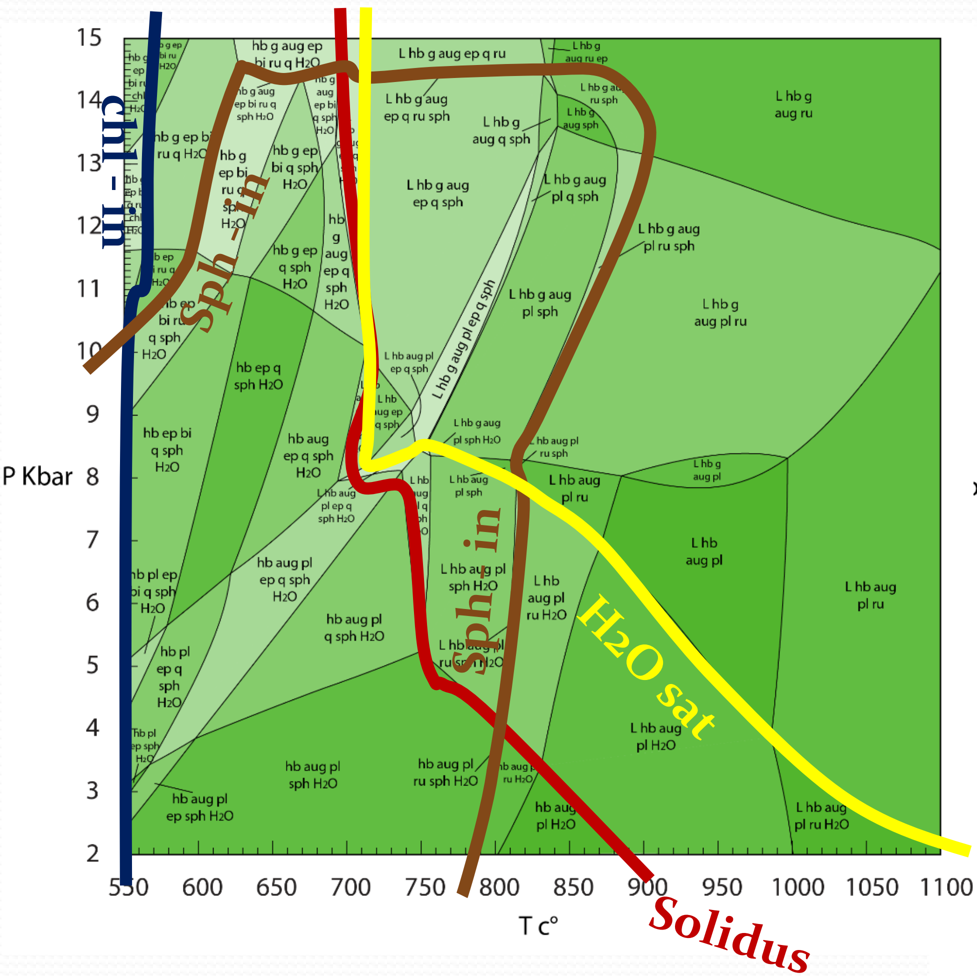

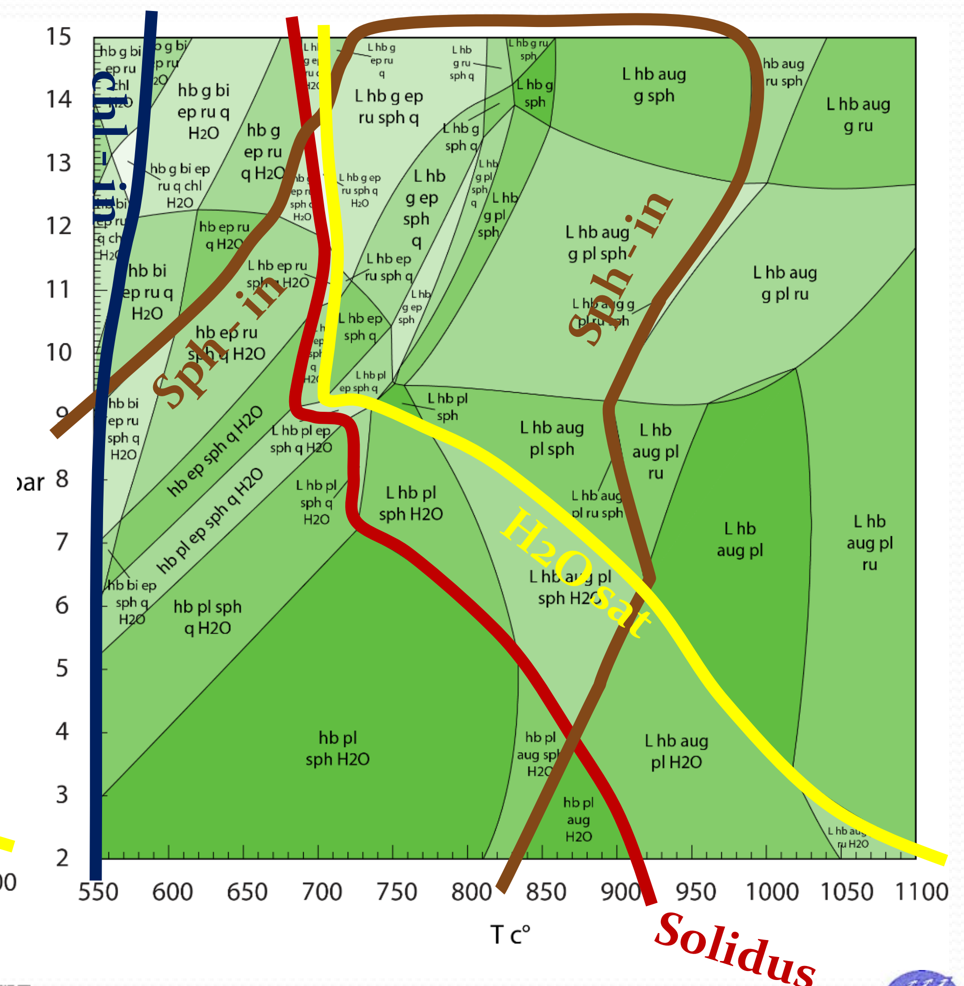

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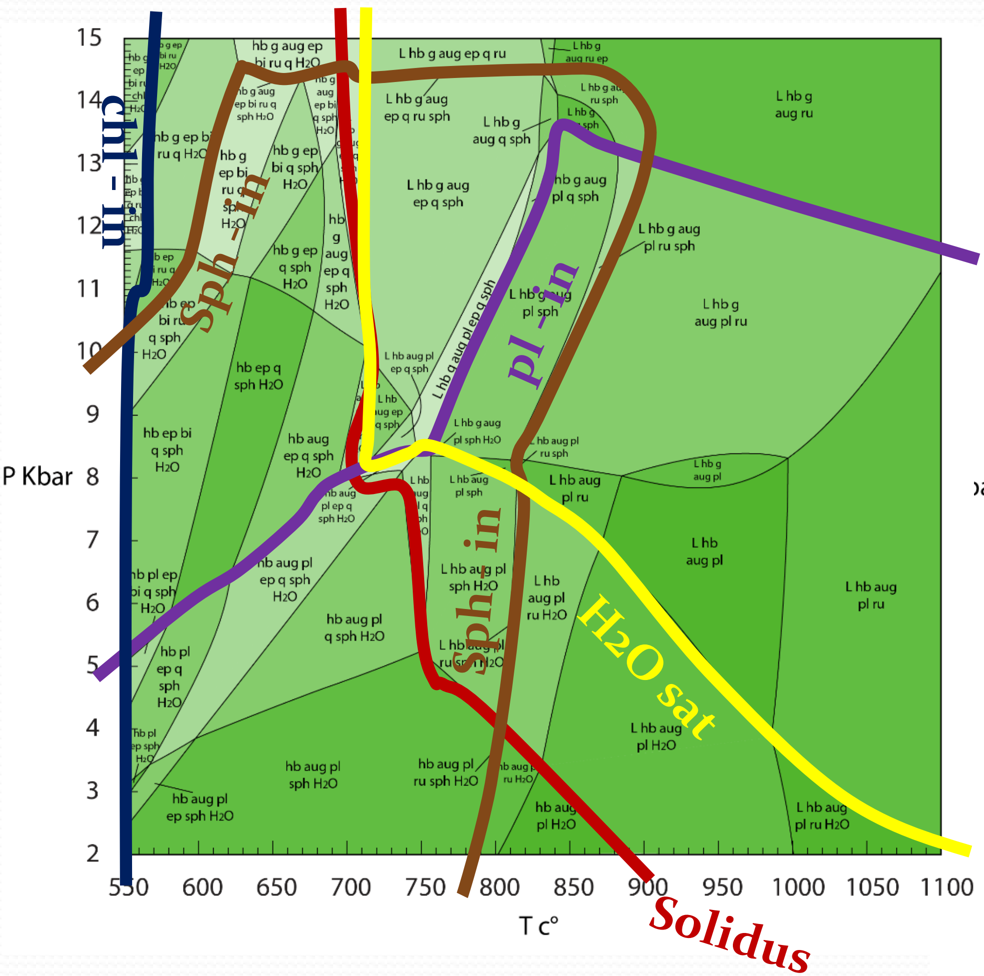

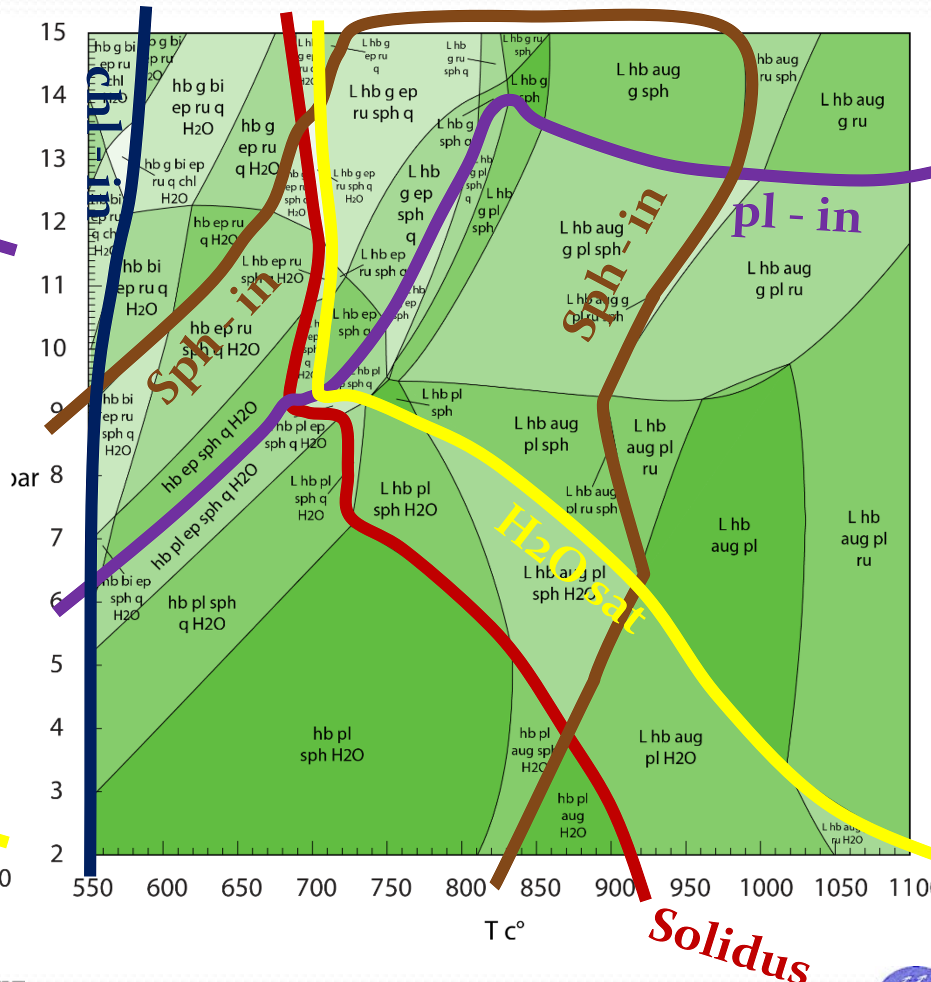

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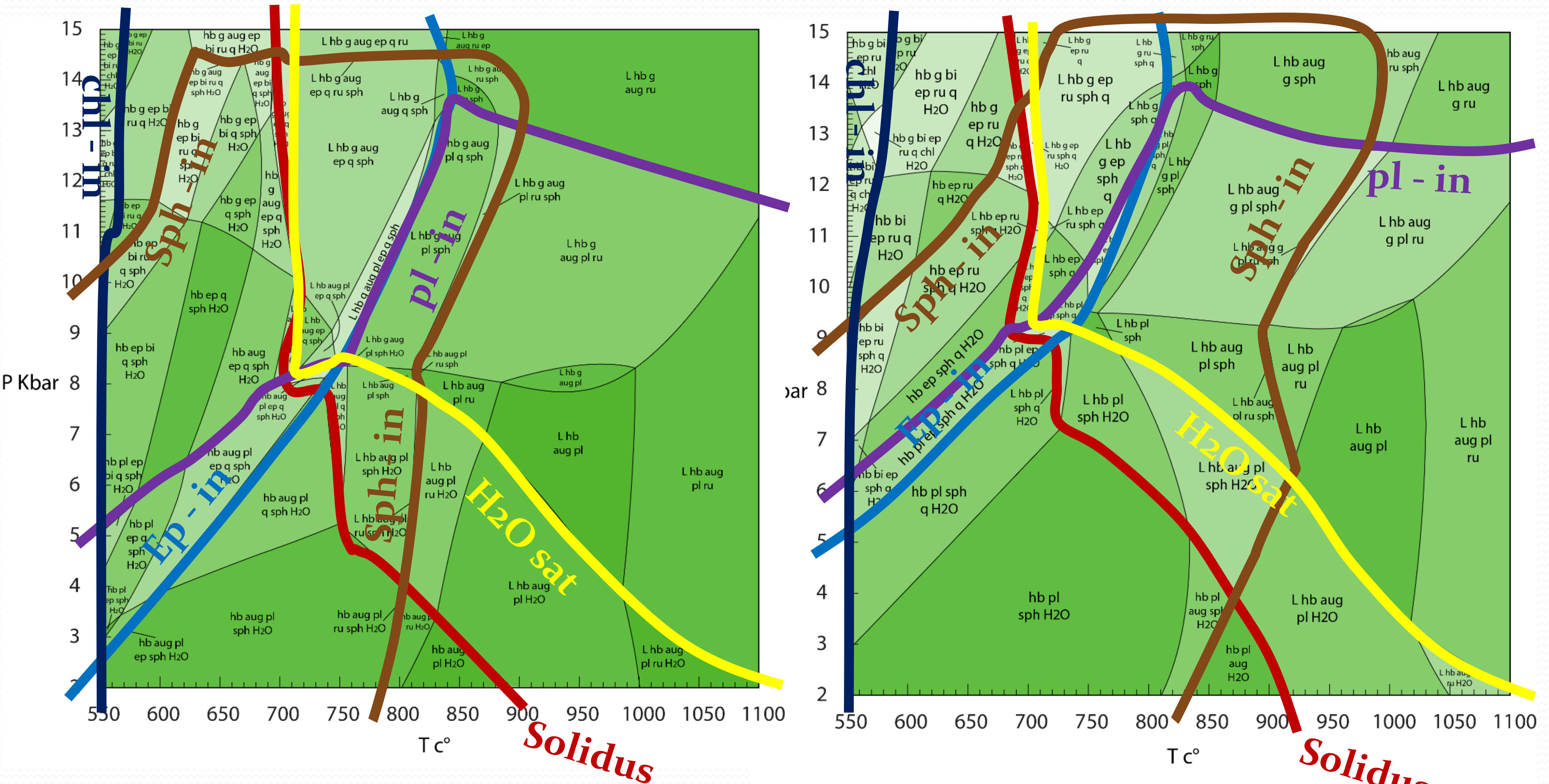

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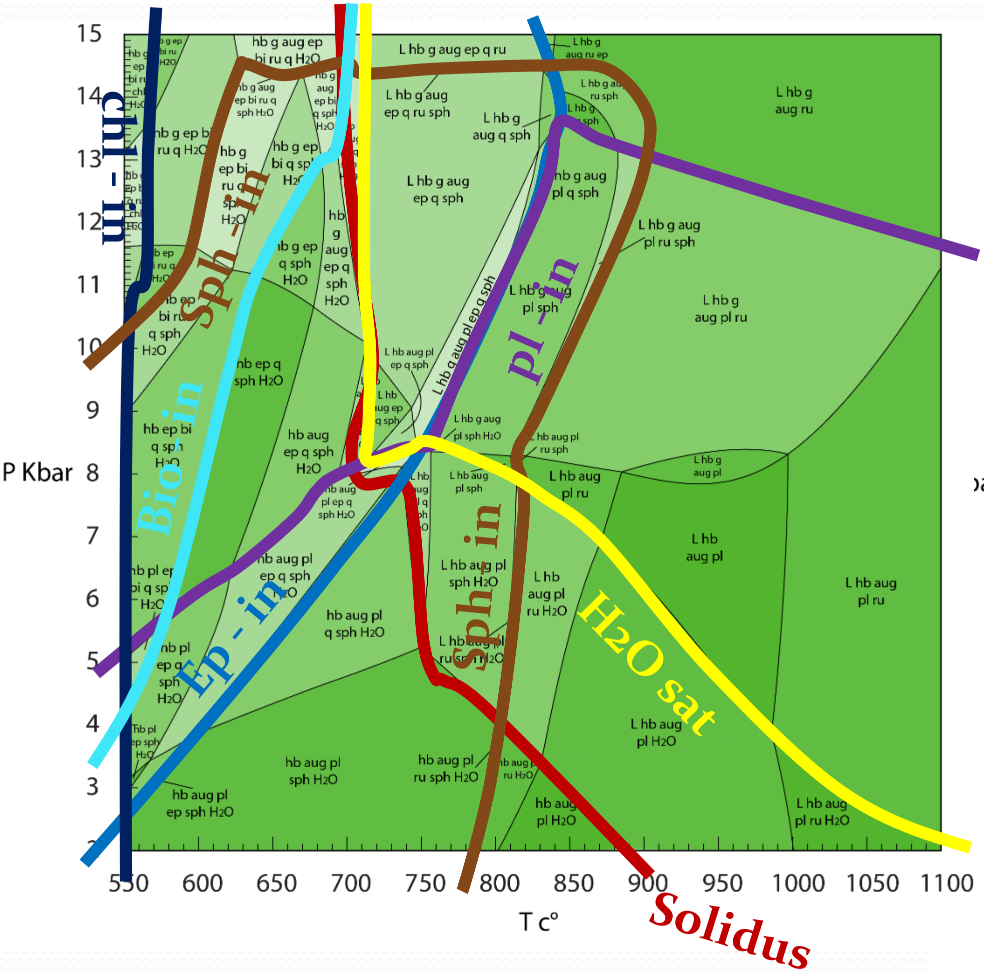

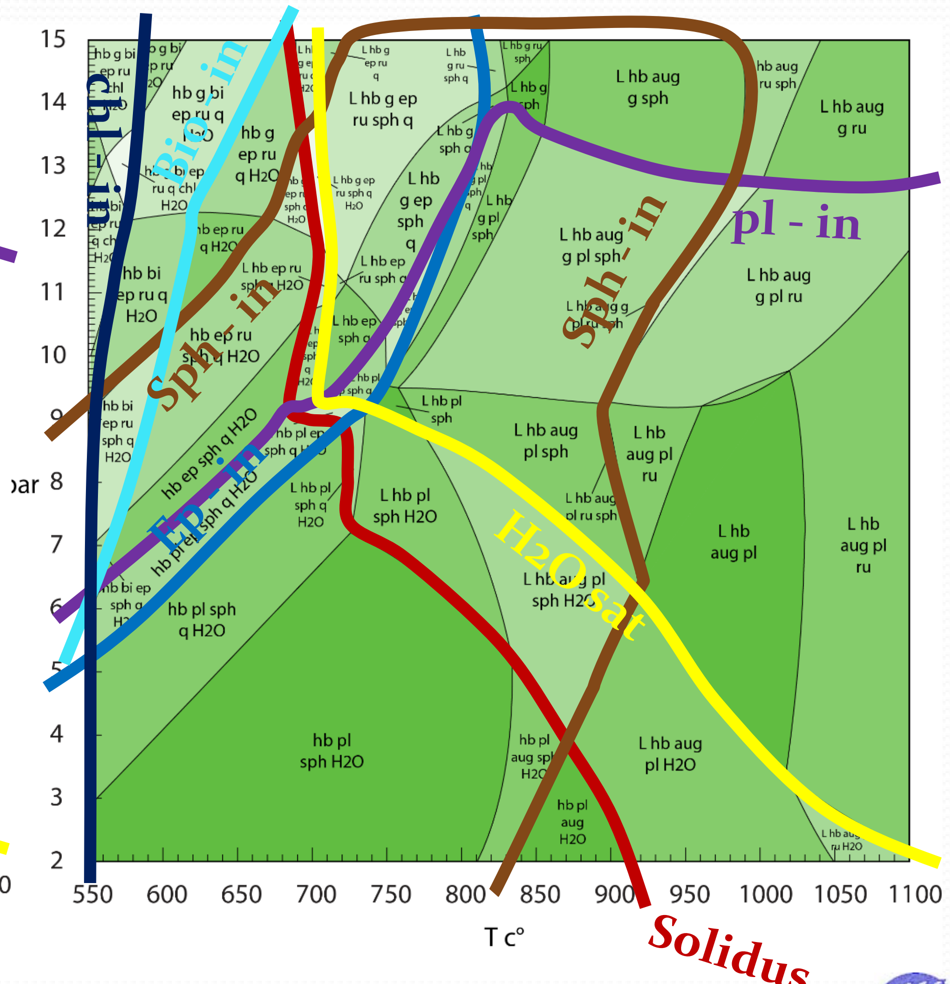

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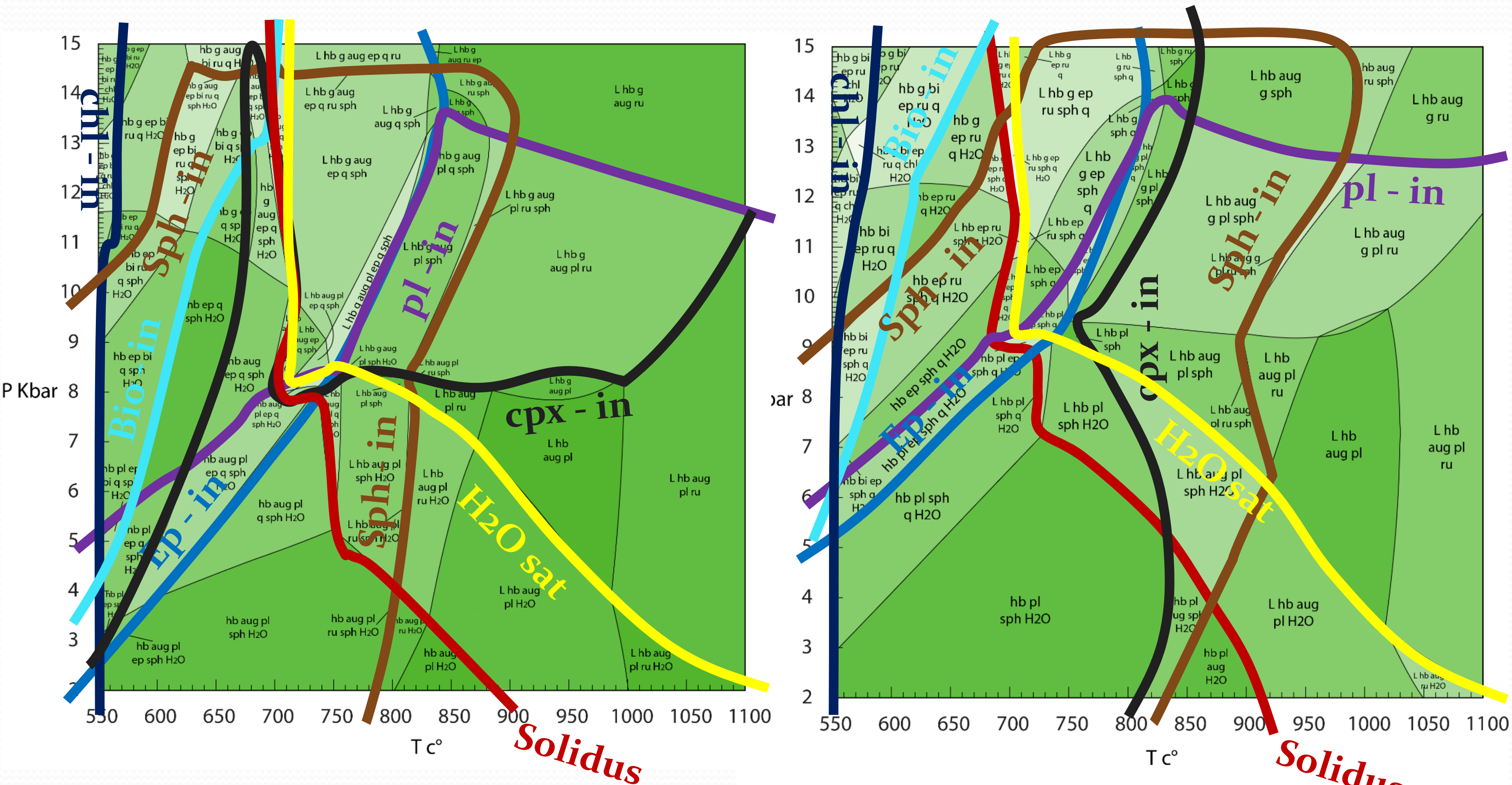

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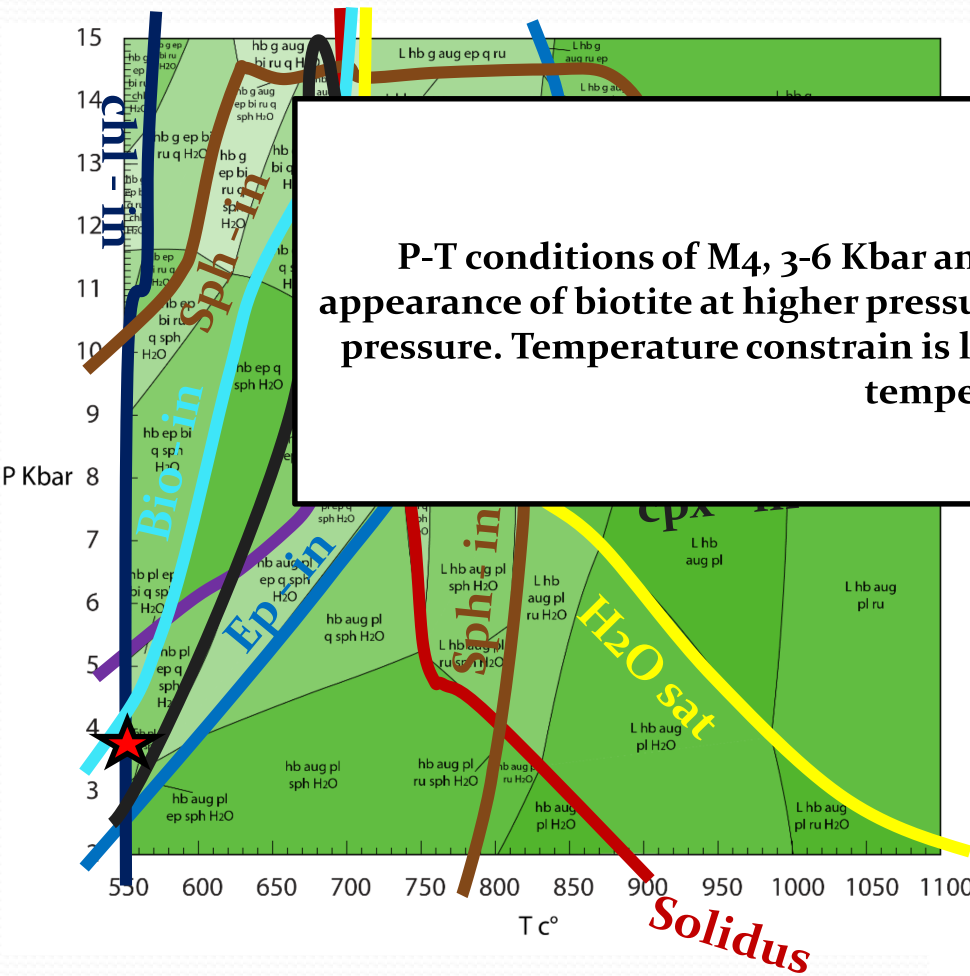
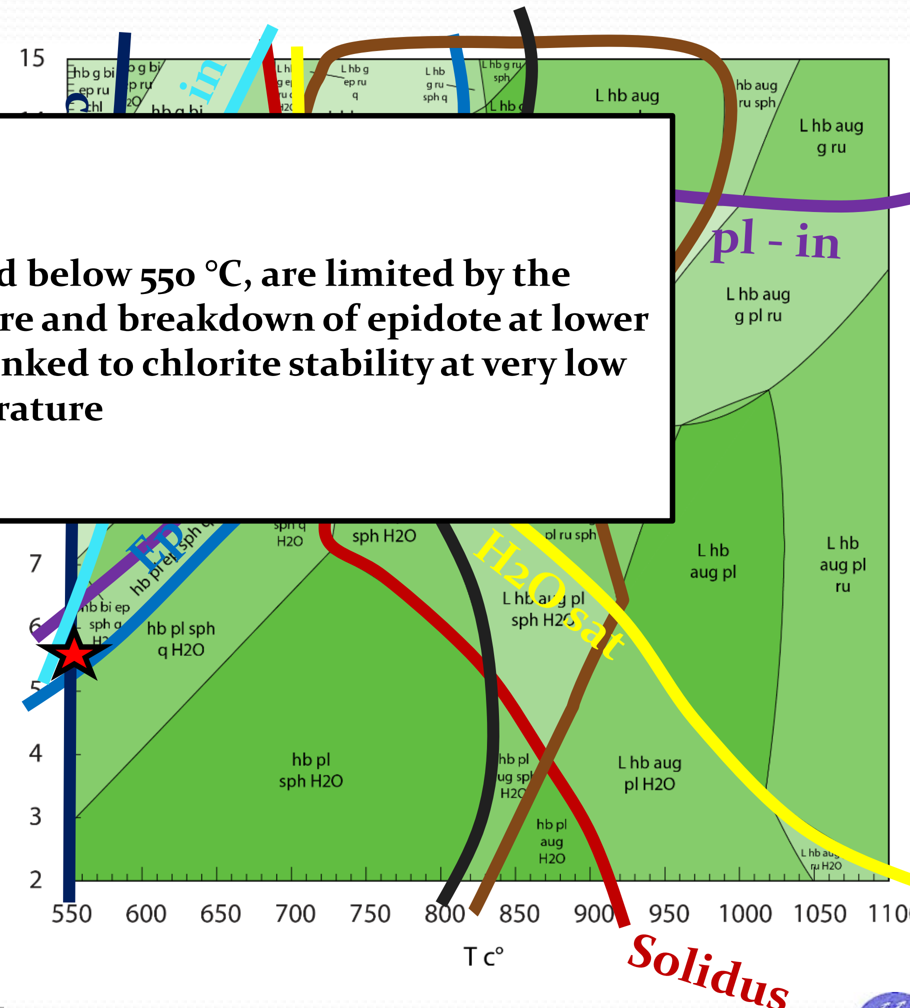
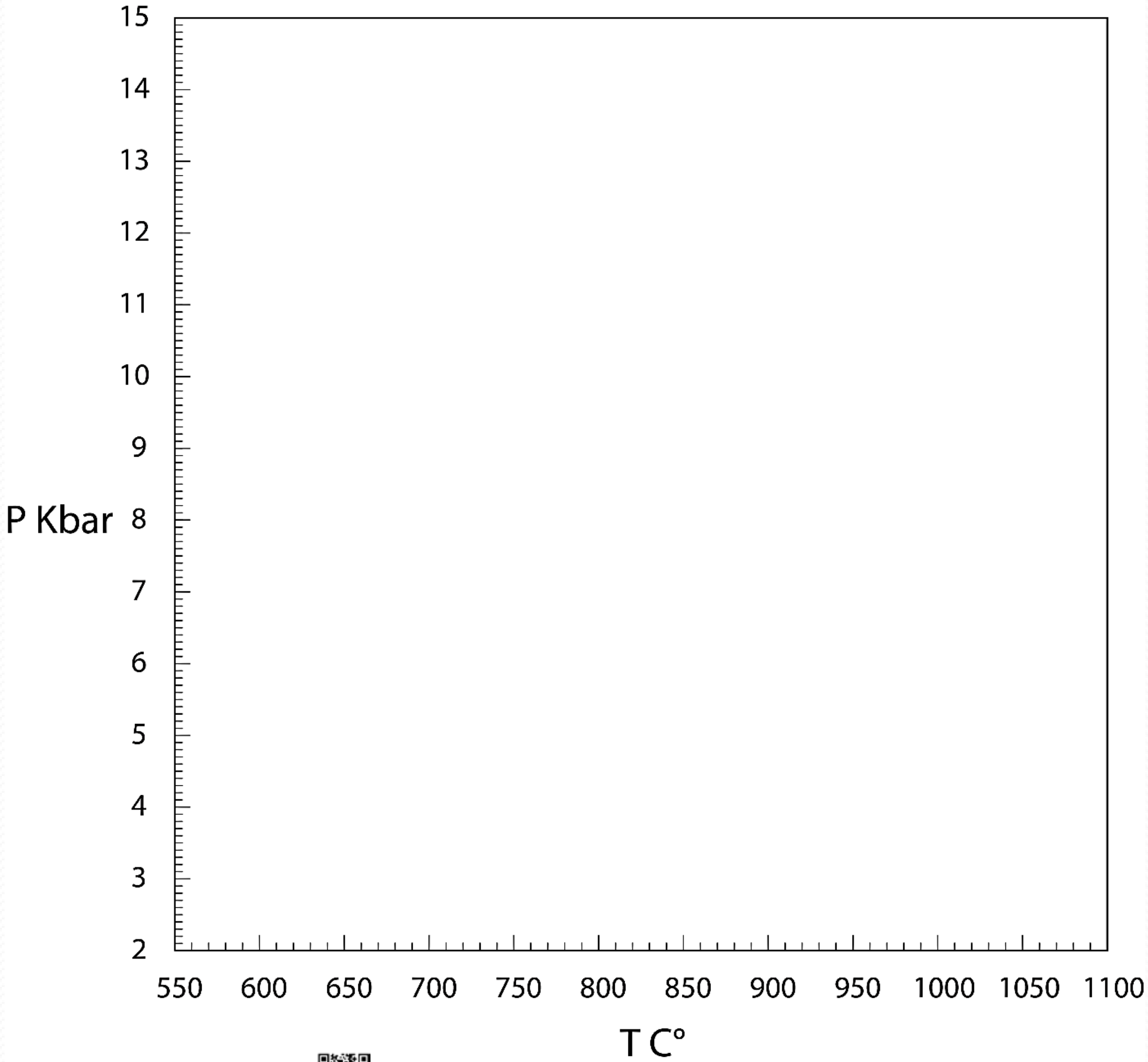




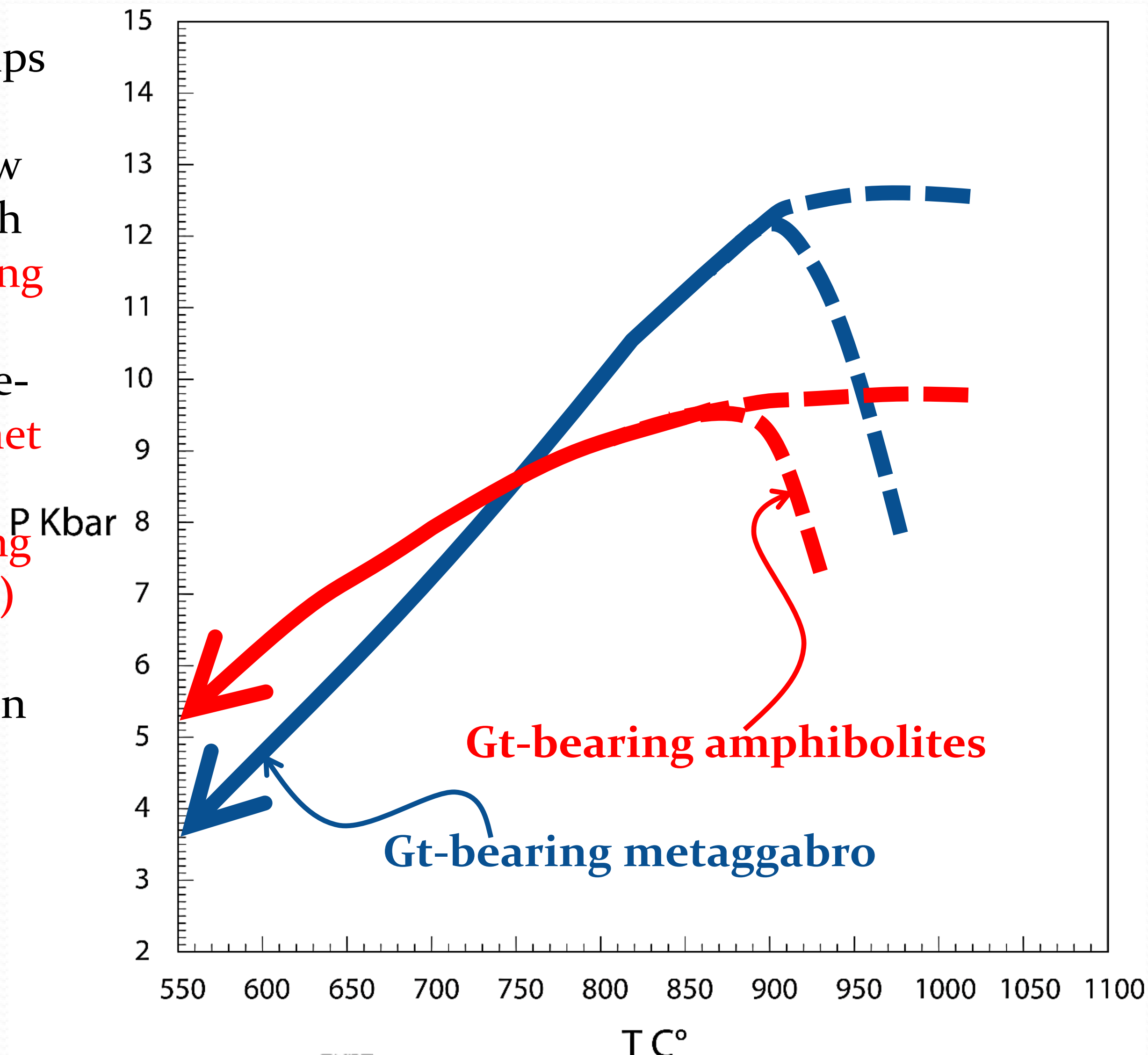
P-T conditions of M4, 3-6 Kbar and below 550 °C, are limited by the appearance of biotite at higher pressure and breakdown of epidote at lower pressure. Temperature constrain is linked to chlorite stability at very low temperature

PT path of Garnet-bearing rocks of Ougda



PT path of Garnet-bearing rocks of Ougda

Modeling phase relationships (PT pseudosections) and textural relationships show anticlockwise PT path with granulitisation stage showing peak of metamorphism recorded by rutile-ilmenite-bearing assemblage in garnet (M2). Followed by a decompression with cooling in amphibolite facies (M3) with production of amphibole and ended up in geenschist facies (M4).



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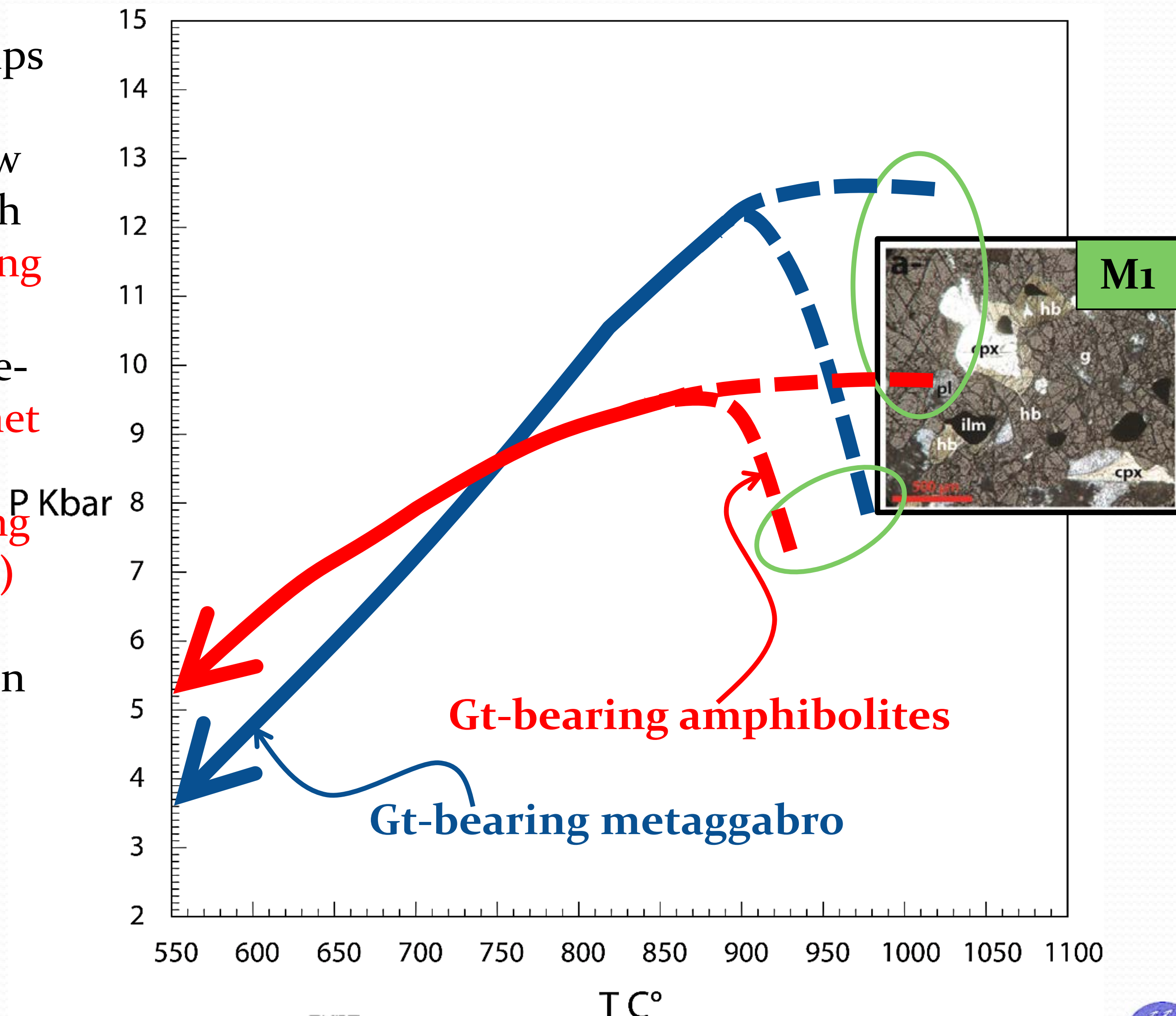

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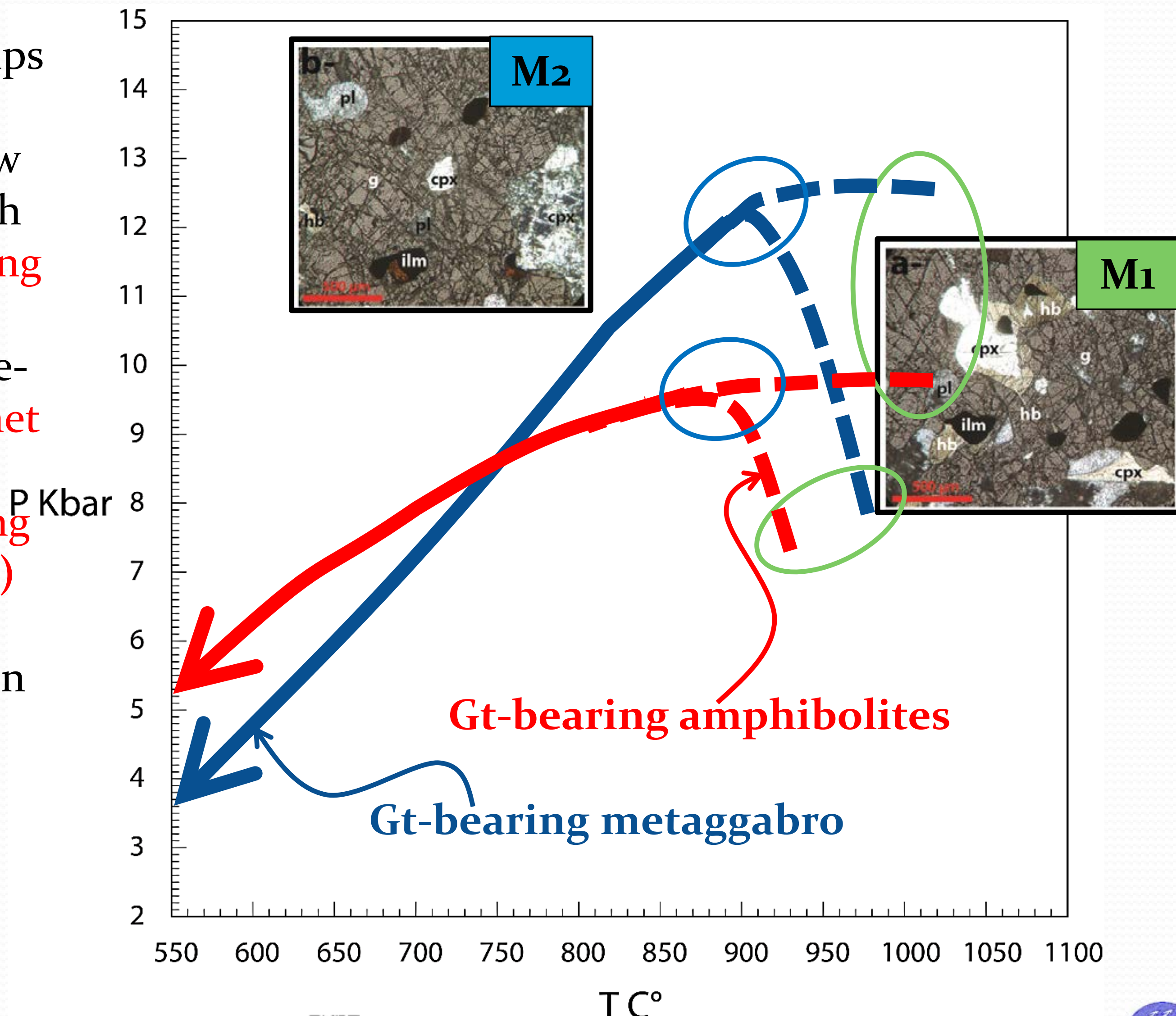

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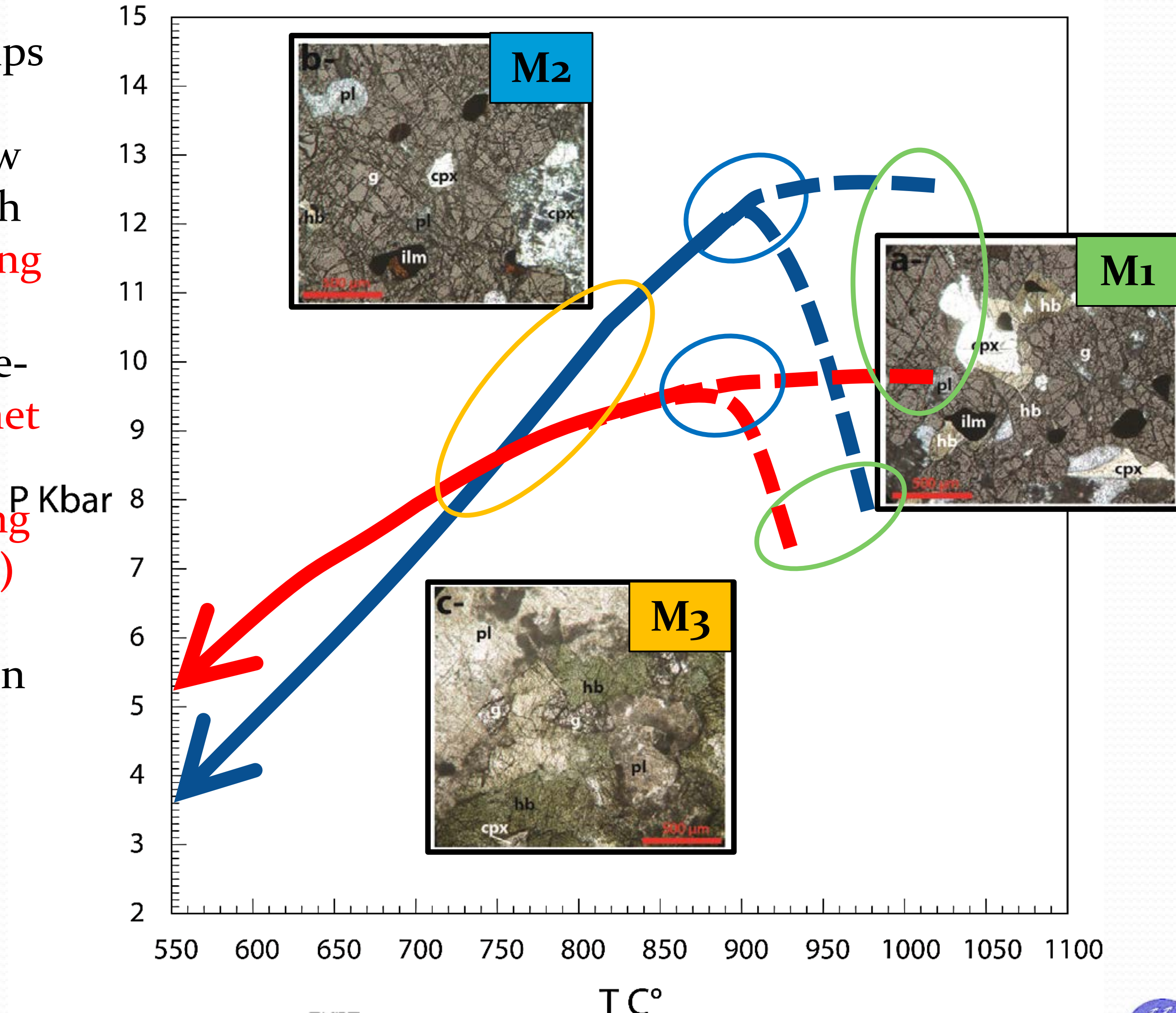

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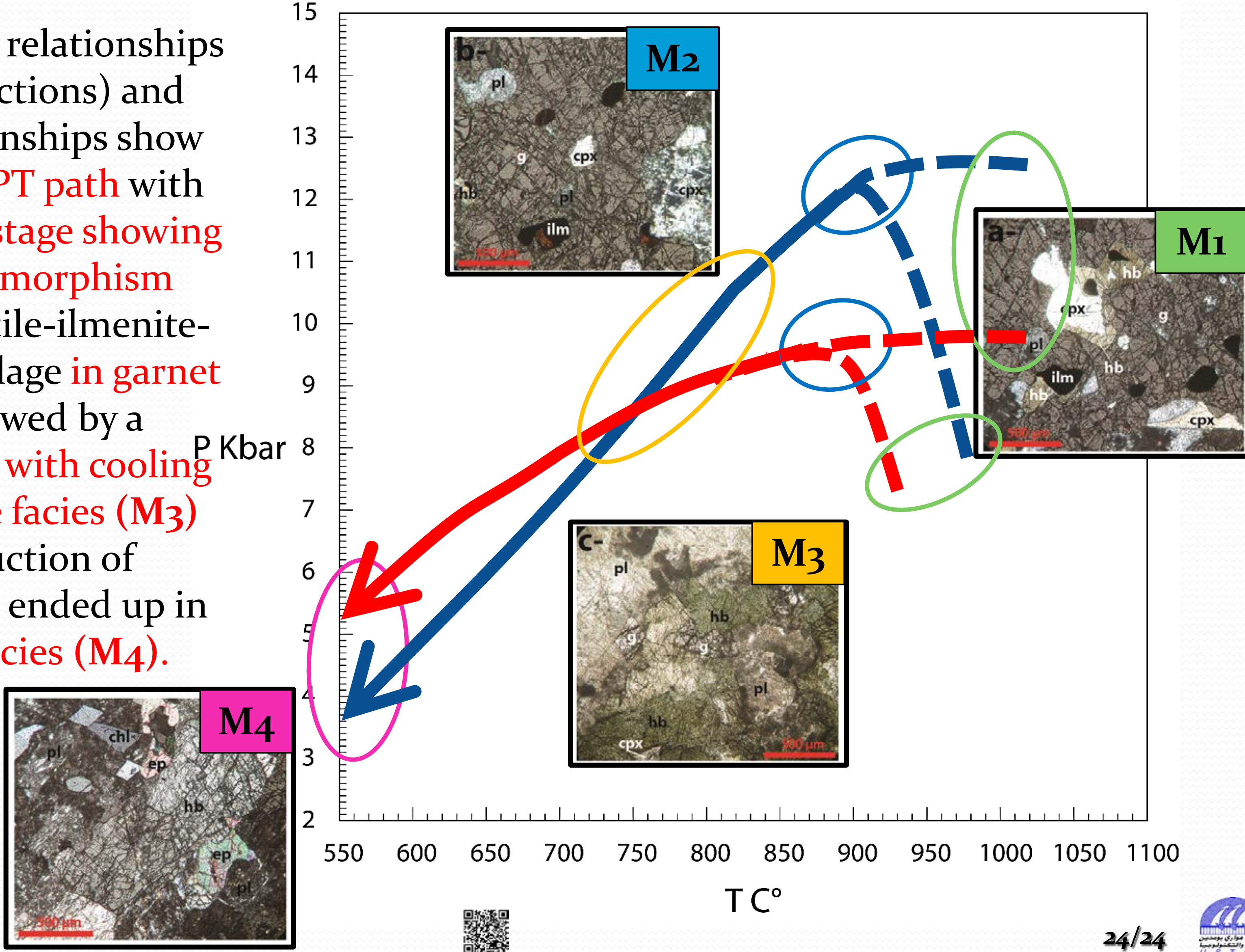

Thank you

Acknowledgements

A special thank to the Australian group Agate Project for their support in providing funds for bulk rock analyses