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ERA-MIN2

RESEARCH & INNOVATION PROGRAMME ON RAW MATERIALS
TO FOSTER CIRCULAR ECONOMY

ERA-MIN Joint Call 2019 (EU Horizon 2020 ERA-NET Co-fund Project ERA-MIN2, Grant agreement N° 730238)



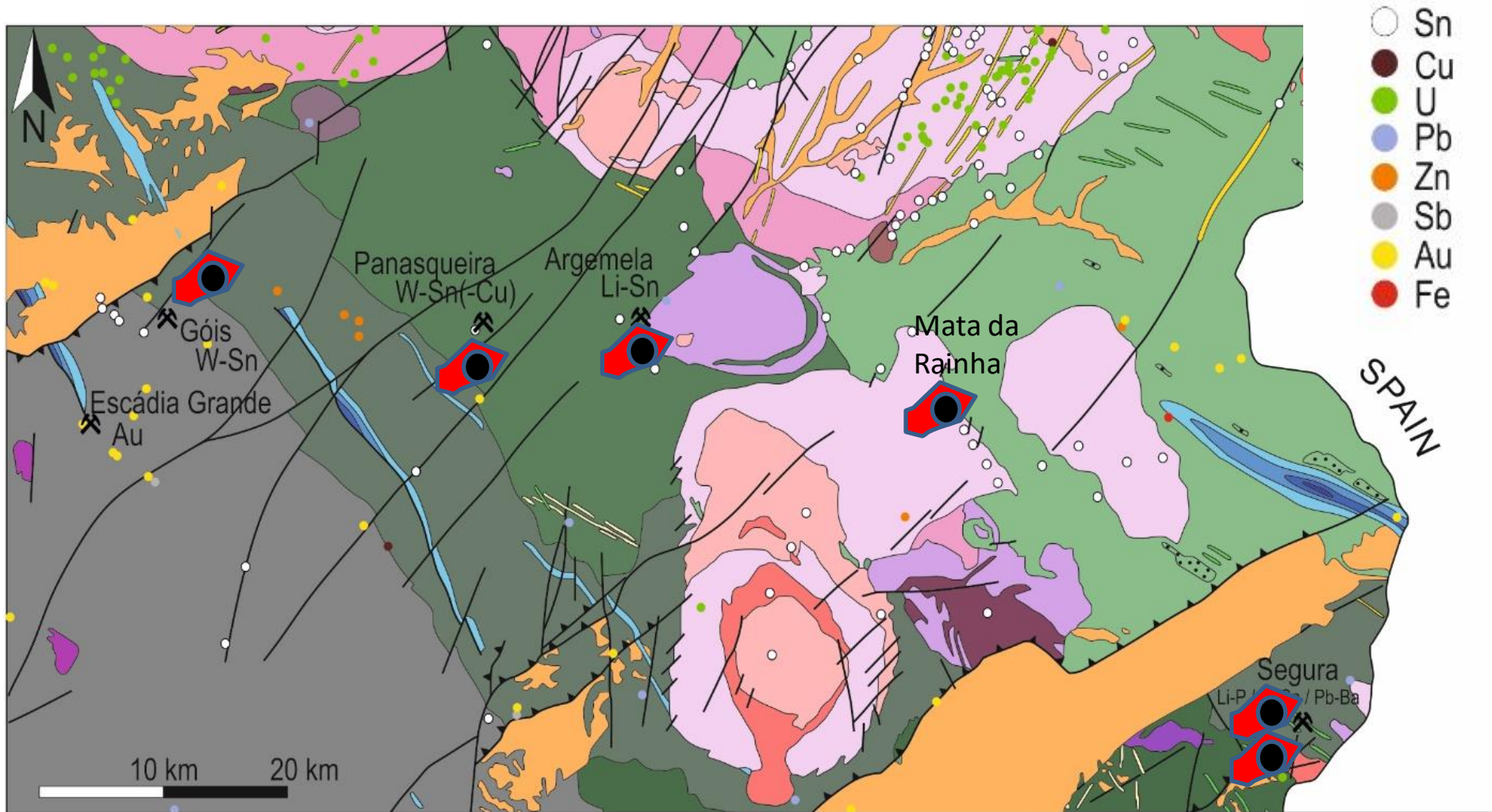
Fluid evolution and PTX-t path during the long-lived magmatic systems related to Sn-W mineralizations Panasqueira, Mata da Rainha and Segura

Michel Cathelineau, Marie-Christine Boiron,
Lahcen Khouya, Gnieman Yeo

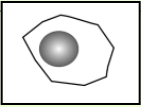
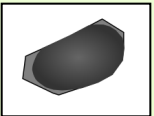

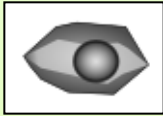
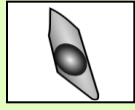
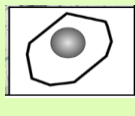

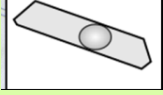
in coll.

Alina Yakovenko, Alexandra Guedes

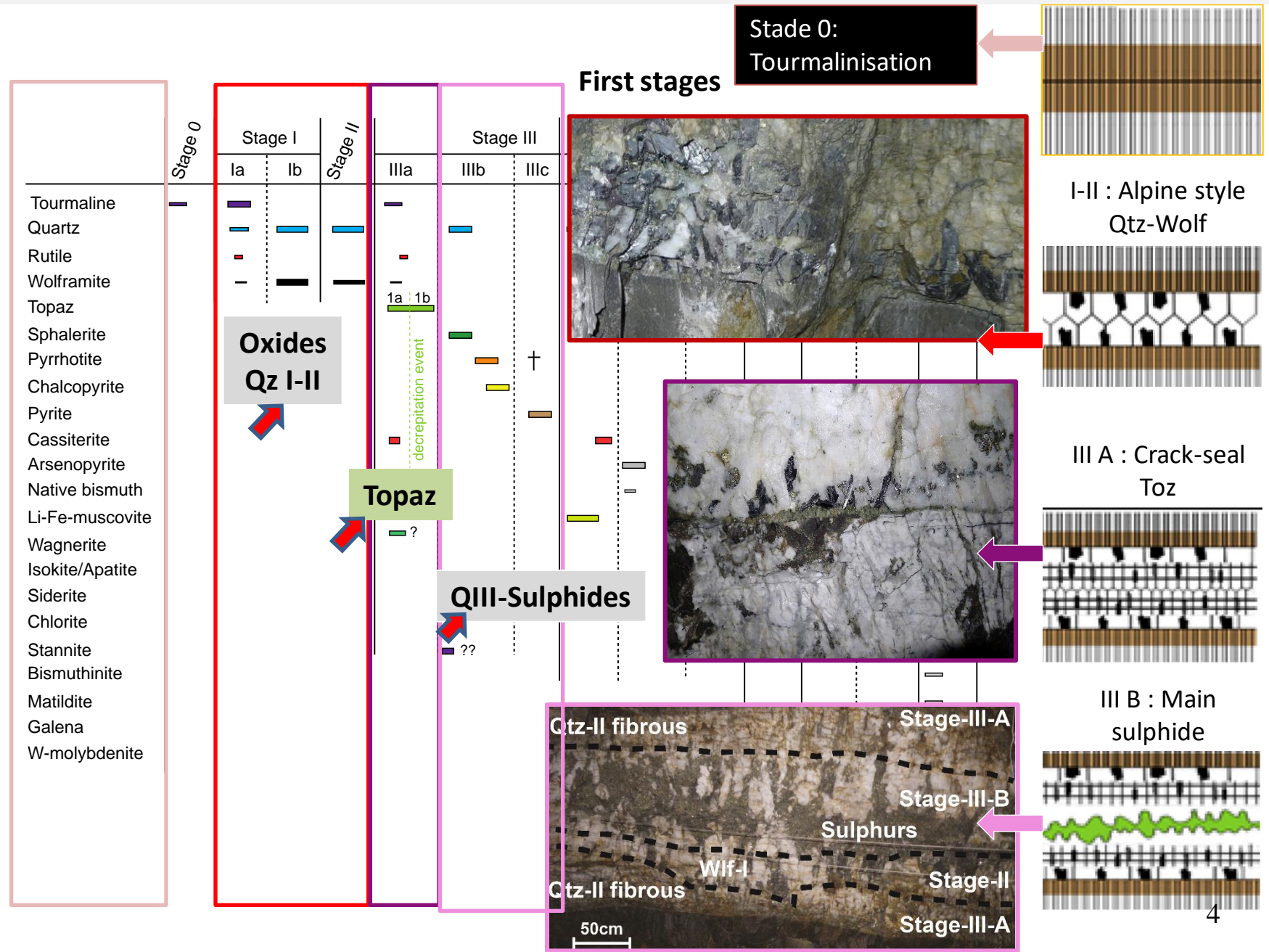
Fluid inclusion studies – A synthesis



PANASQUEIRA- Fluids as fluid inclusions

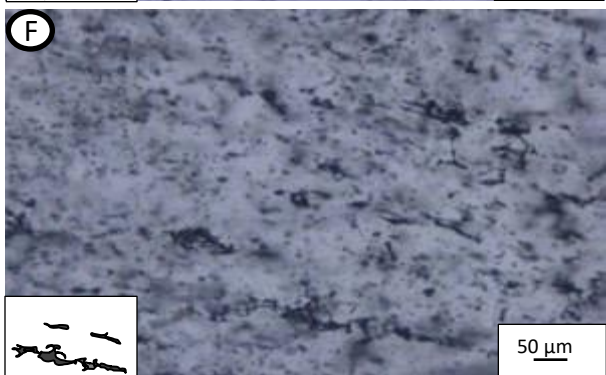
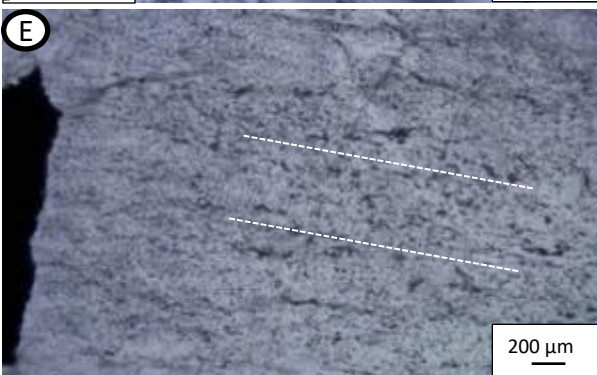
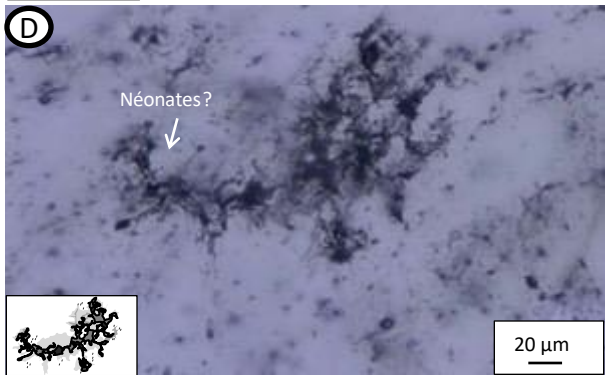
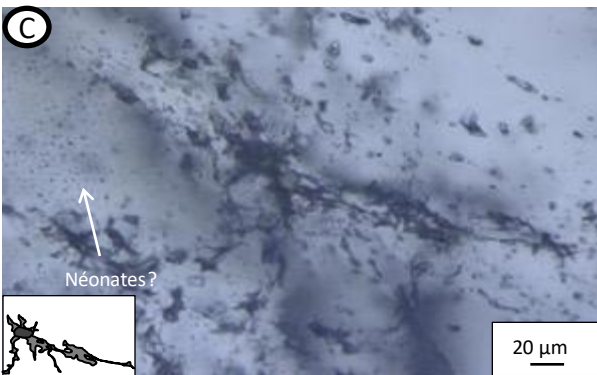
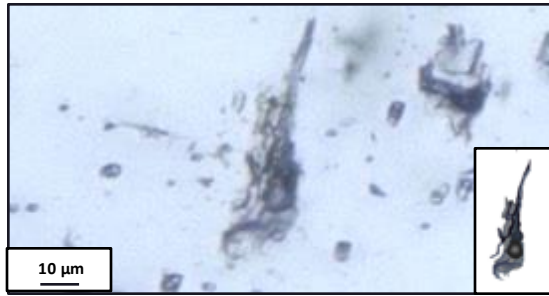
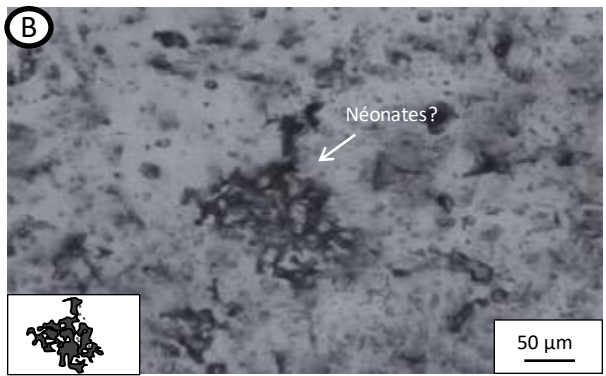
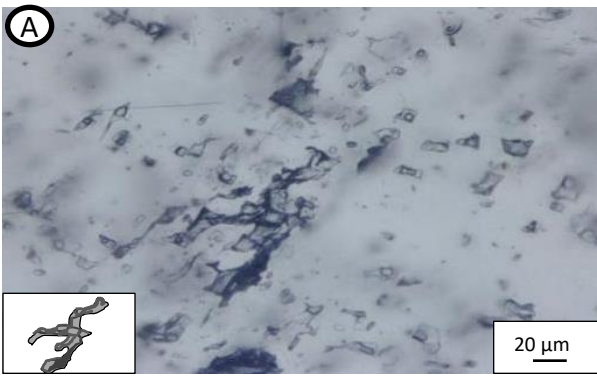
Typology	TH		Dominant species	Observations
Aqueous-carbonic				
Lc-w	(L-V) L		CO₂-(CH₄-N₂)-H₂O-NaCl	Liquids and vapors, high density volatile phase TmCO₂ and ThCO₂ visible up to 15 mole % CH₄.
Vc-w	(L-V) V			
Vc and Vc-n				
Lw-c	(L-V) L		H₂O-CO₂-(CH₄-N₂)- NaCl	ThCO₂ non observed Tm Clathrate. >> Low density volatile phase
Lw-c (n)	(L-V) L		H₂O-CO₂-N₂-(CH₄)- NaCl	
Lw-(c-m-n)	(L-V) L		H₂O-(CO₂-CH₄-N₂)- NaCl	
Lw-m	(L-V) L		H₂O-CH₄-(N₂-CO₂)- NaCl	
Aqueous				
Lw	(L-V) L		H₂O-NaCl	No clathrate

Panasqueira-(NewOres results-for memory)

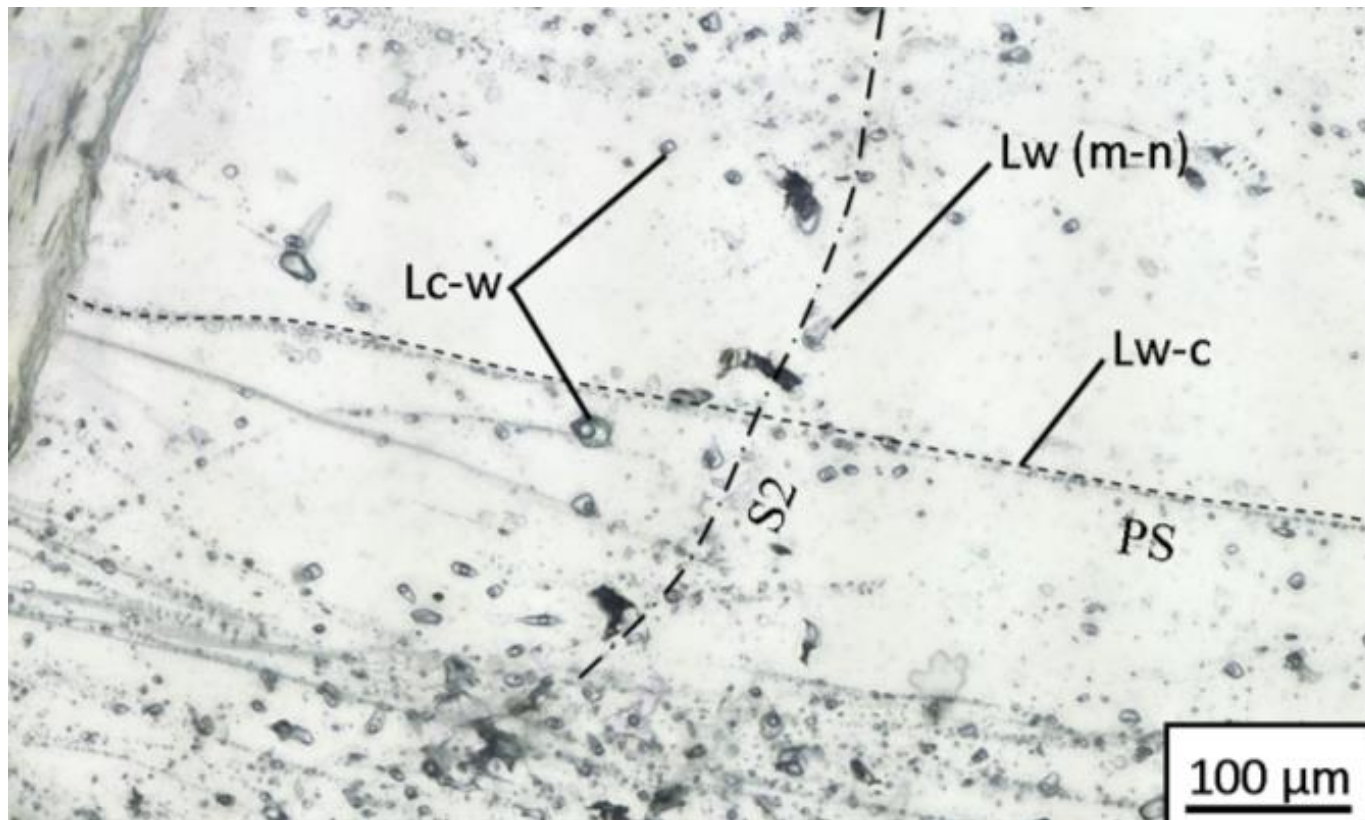


QI-QII (if non recrystallized) : deformed and decrepitated inclusions

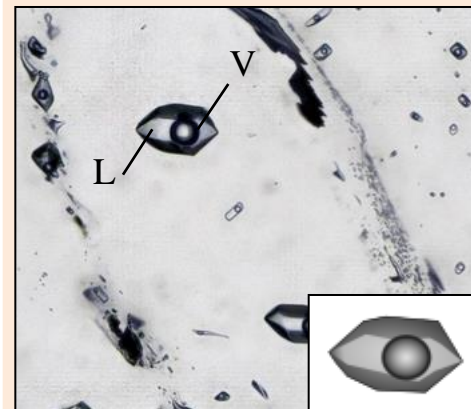
Stage I = QI - (II)



Stage III a TOPAZ



Lw-c

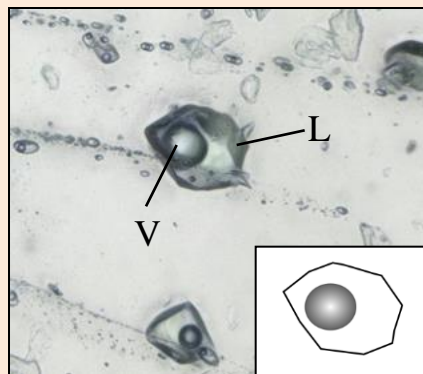


Primary
 TH (L): 245 / 255 °C
 TmCl: 5.5 / 8.4 °C
 Salinity: 6 – 7 wt% NaCl

Lc-w

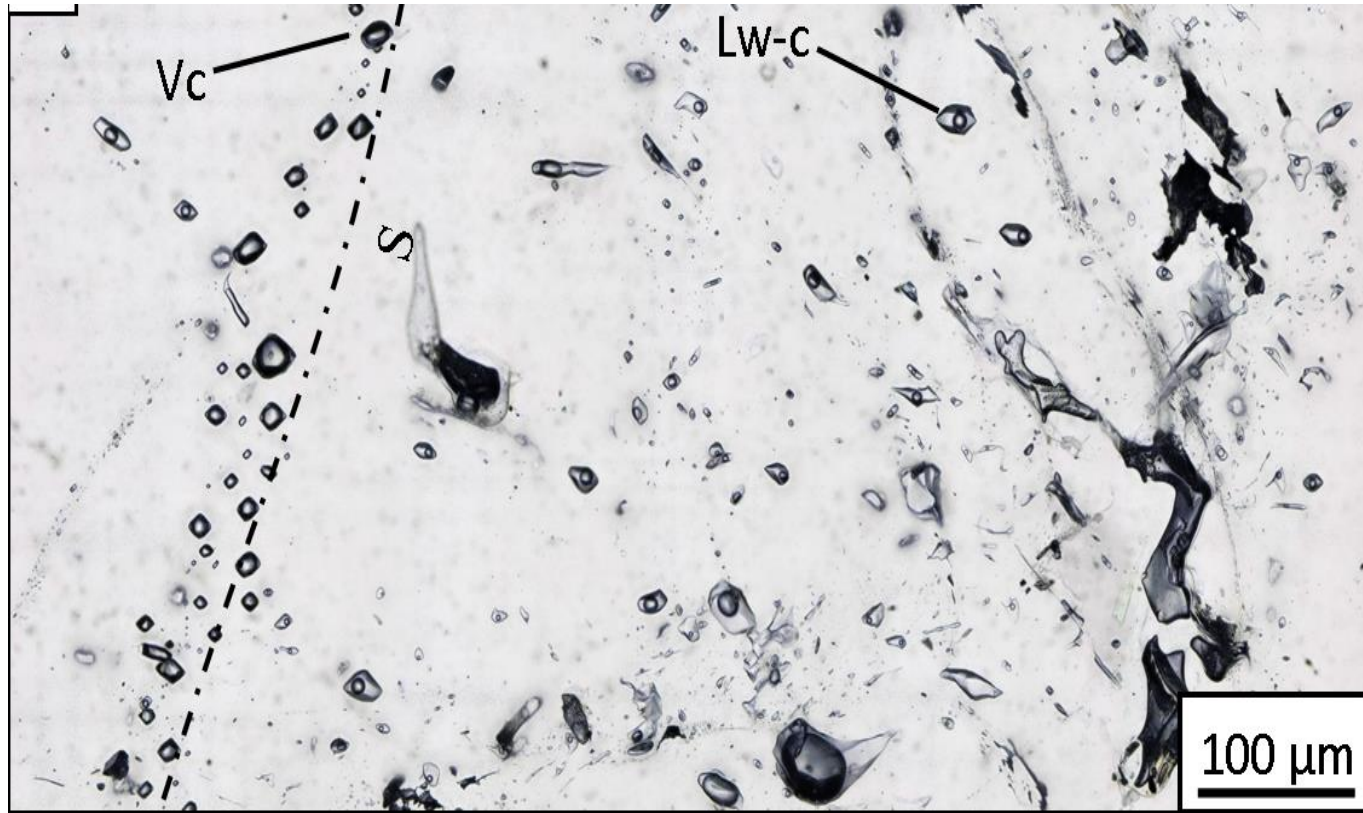
Primary FI
 TH (L): 245 / 256 °C
 Th_{CO₂} (V): 17.8 / 19.4 °C
 Salinity: 5 - 10 wt% NaCl

Volatile phase
 CO₂ : 86 – 90%
 CH₄ : 2 – 7%
 N₂ : 6 – 9%



volatile phase :
 CO₂ : 80– 90%
 CH₄ : 4 – 9%
 N₂ : 5 – 10%

Stage IIIa TOPAZ



Vc-w (but with dense volatile phase)

Secondary FI (S)

TH (V): 300 / 320 °C

Th_{CO₂} (L): 10.3 / 12.5 °C

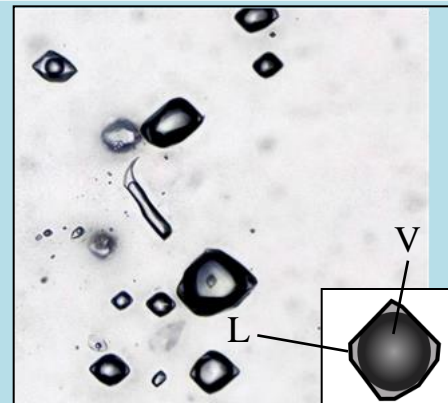
Salinité: 1 – 3 wt% NaCl

volatile phase :

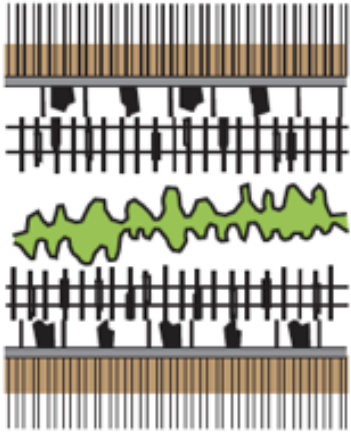
CO₂ : 83 – 88%

CH₄ : 3 – 4%

N₂ : 9 – 13%



Stage IV- quartz



Wolframite -stage IV

Reopening of the selvage
(muscovite –arsenopyrite)



Reopening of the selvage
(arsenopyrite)



Wolframite -stage IV

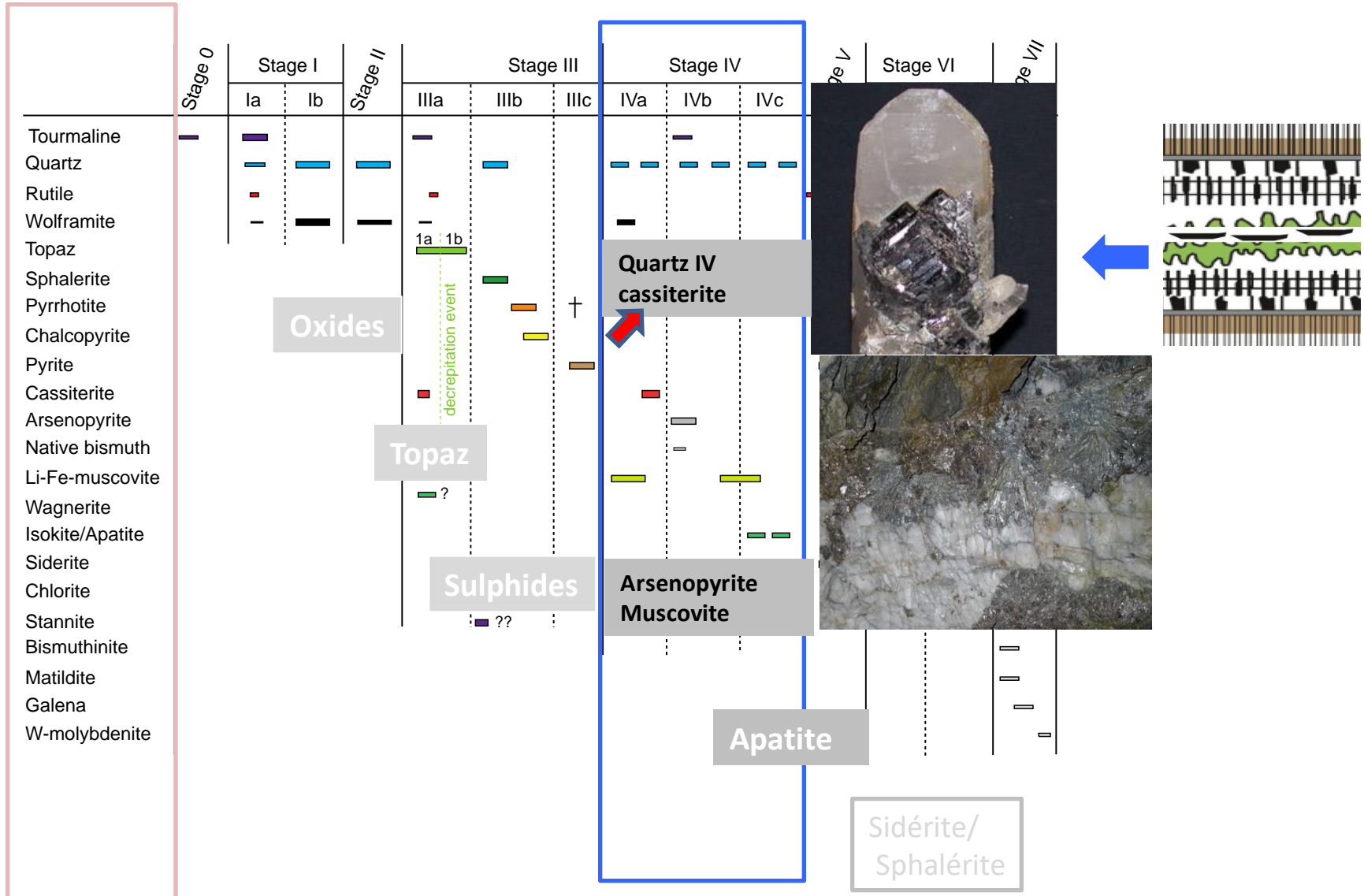


Reopening of the selvage (muscovite)

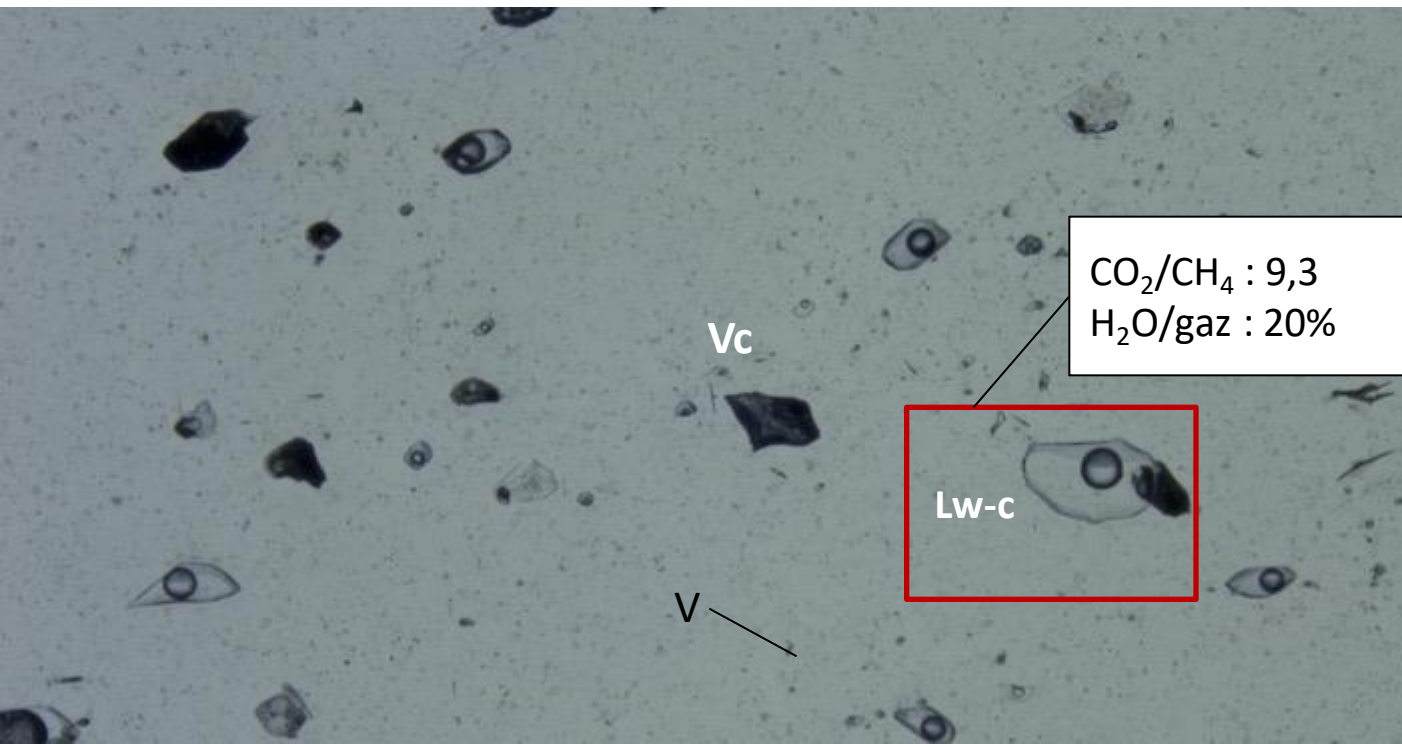


Geode quartz
+ muscovite/ apatite
+ cassiterite

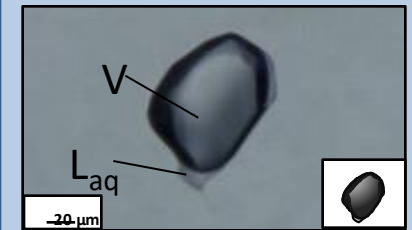
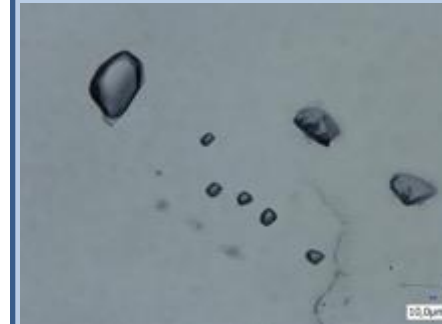
Stage IV- quartz



Quartz QIV



Vc-n as FIP



Vc-n

Th (V): 210-220°C

Tm ice: -5°C

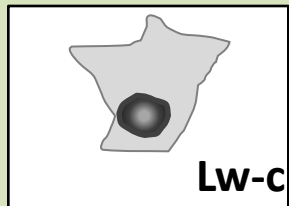
Density: 0,05 – 0,06 g/cc

Volatile phase:

CO₂ : 40-55 %

CH₄ : 11-21 %

N₂ : 30-43 %



LW-c



Vc



Lw-c

Th (L): 200-350°C

Tmlce: -13,4°C à - 4,6°C

Salinity: 3-10 wt% NaCl

Density: 0,6 g/cc

Volatile phase:

CO₂ : 70-99 %

CH₄ : 1-20 %

N₂ : 0-20 %

Vc

Density: 0,21 g/cc

Volatile phase:

CO₂ : 67-98 %

CH₄ : 2-14 %

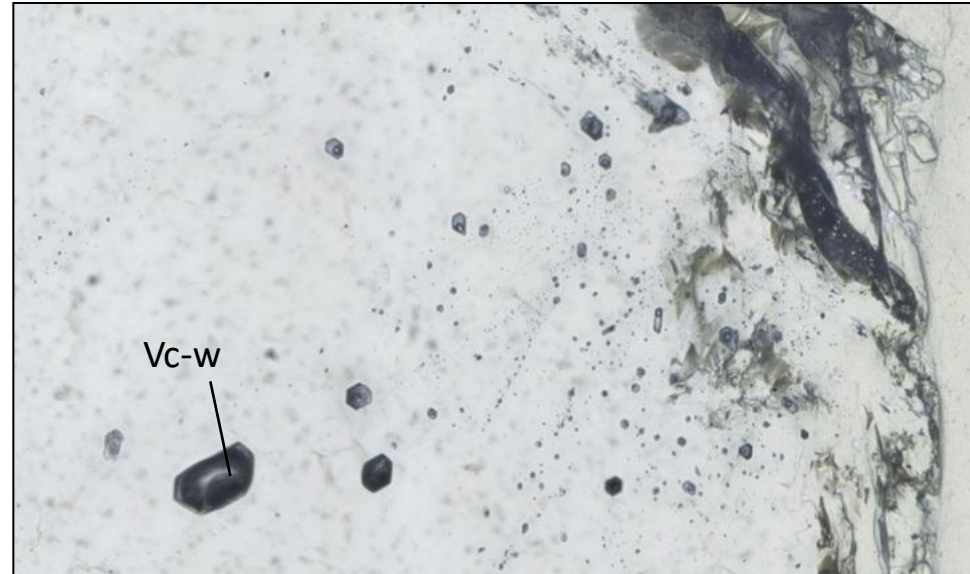
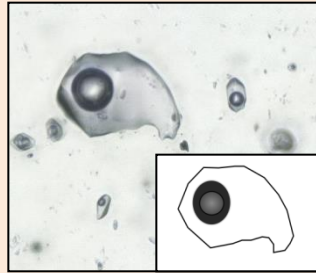
N₂ : 0-25 %

Quartz IV

Lc-w

Primary inclusions
TH (L): 259 / 297 °C
Th_{CO₂} (V): -10.6 / 9.8 °C
Salinité : 1 – 9 wt% NaCl

Volatile phase
CO₂ : 72 – 87%
CH₄ : 4 – 18%
N₂ : 8 – 19%

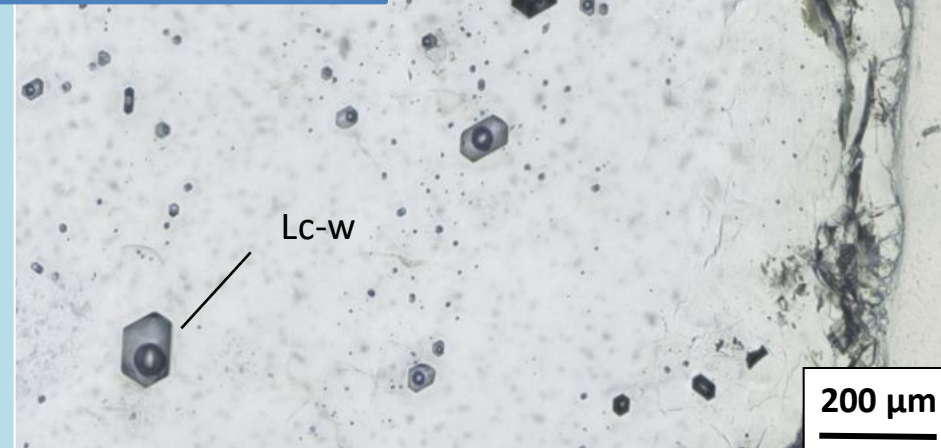
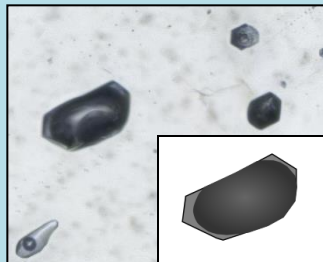


Vc-w

Heterogeneous trapping

Primary inclusions
TH (V): > 200 °C
Th_{CO₂} (V): 10.6 / 11.2 °C
Salinité : 4 – 5wt% NaCl

Volatile phase
CO₂ : 78%
CH₄ : 13%
N₂ : 8%



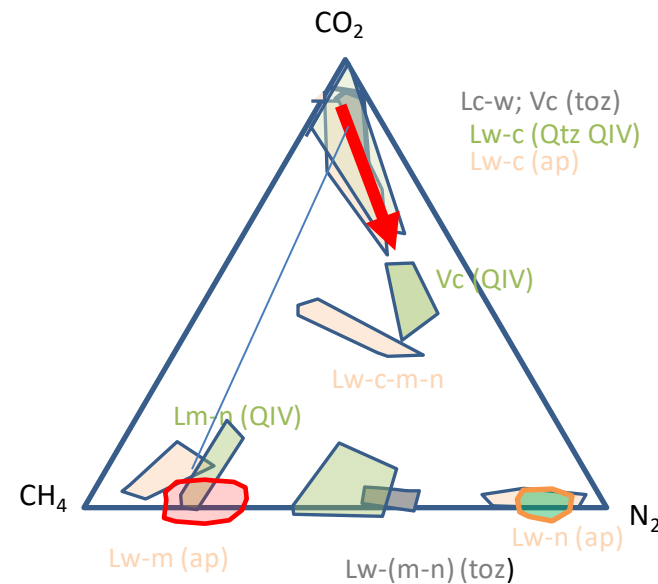
200 μm

Comparison of Panasqueira with new data

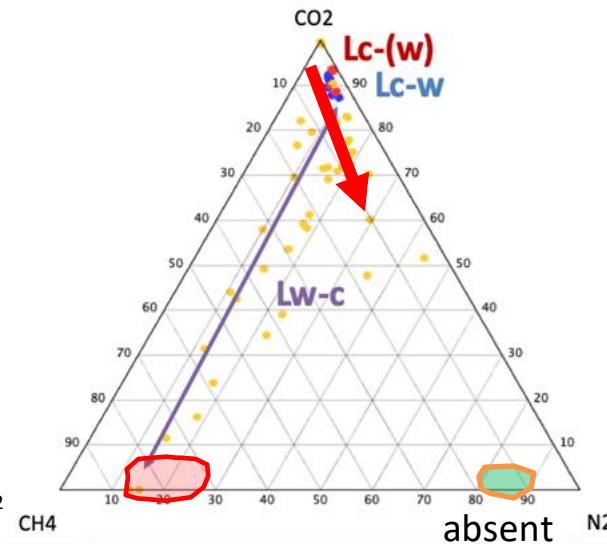
3 main fluid end-members

- A predominant $\text{H}_2\text{O}-\text{CO}_2-\text{CH}_4$ fluid : a fluid \pm equilibrated with graphite
- A volatile rich end-member (product of fluid unmixing ?) which can mix with water issued from unmixing with two sub-types
 - A methane rich
 - A nitrogen rich

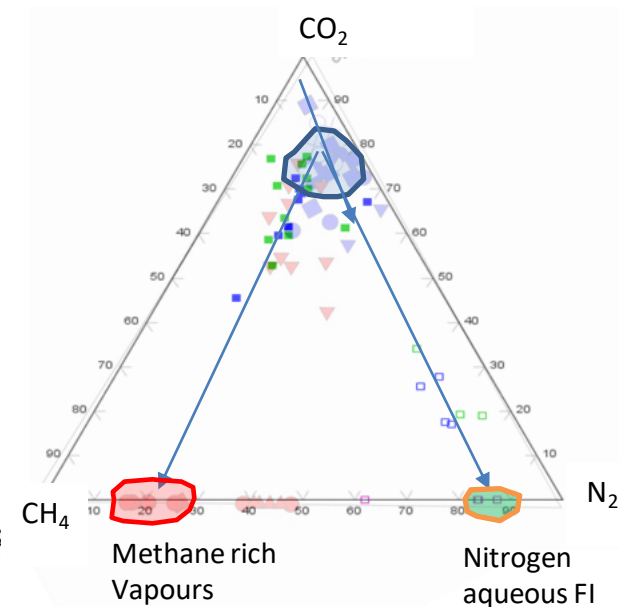
Panasqueira



Mata da Rainha

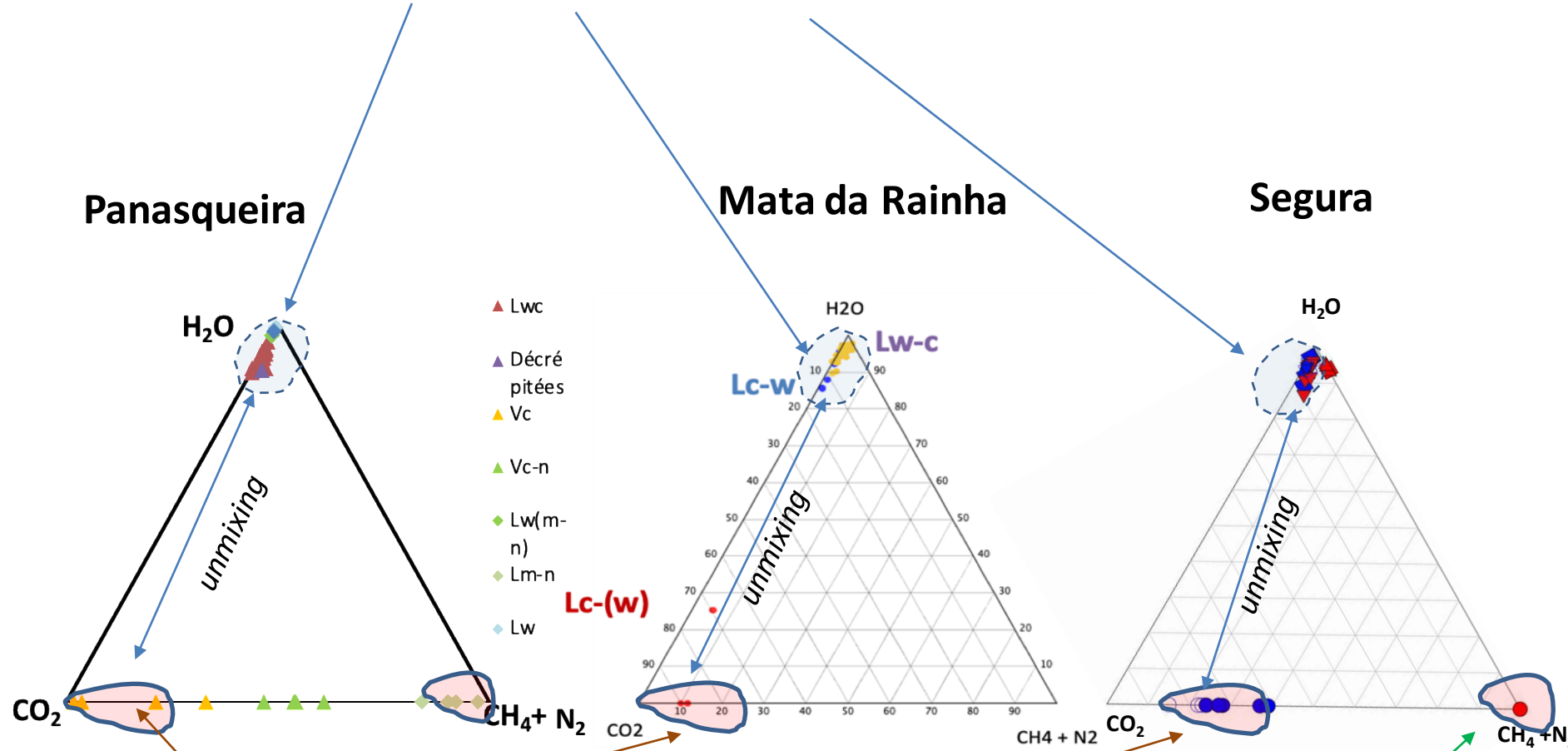


Segura



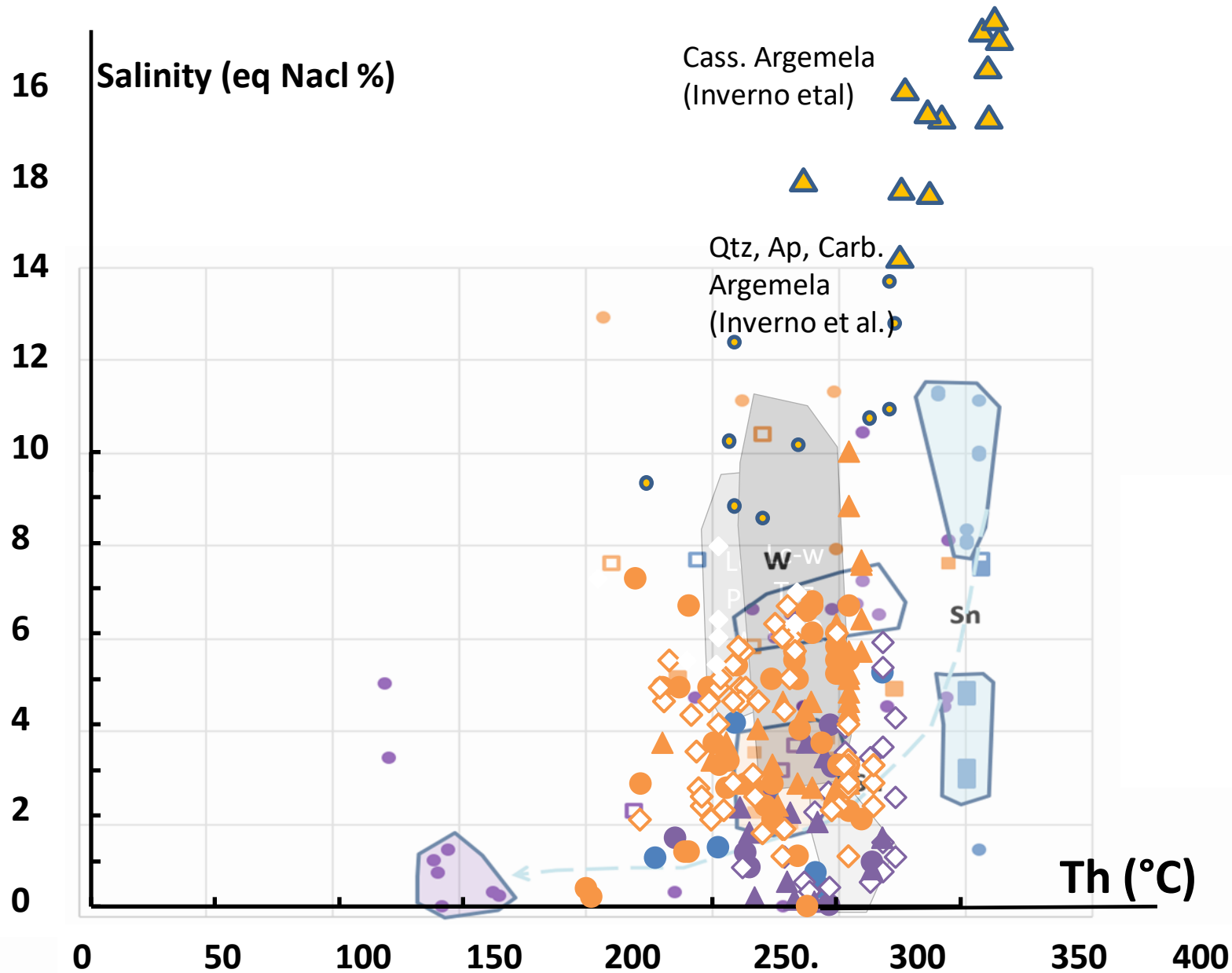
Comparison of Panasqueira with new data

1- Waters equilibrated with metamorphic units (graphite at more than 400°C)

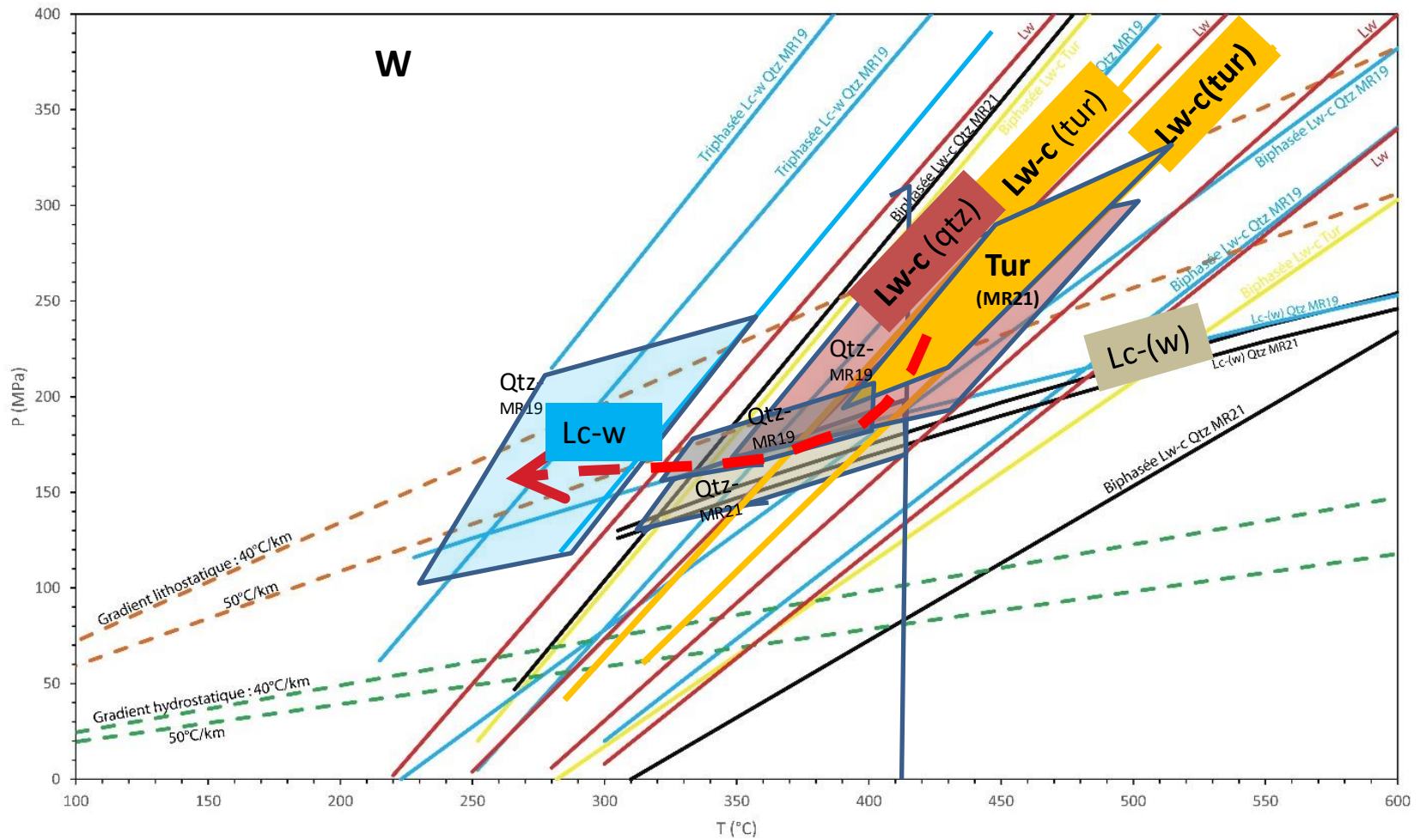


2- Products of unmixing when the decrease in pressure (and in T°C) is sufficient to reach the isopleths of the system (end of the orogeny, after uplift)

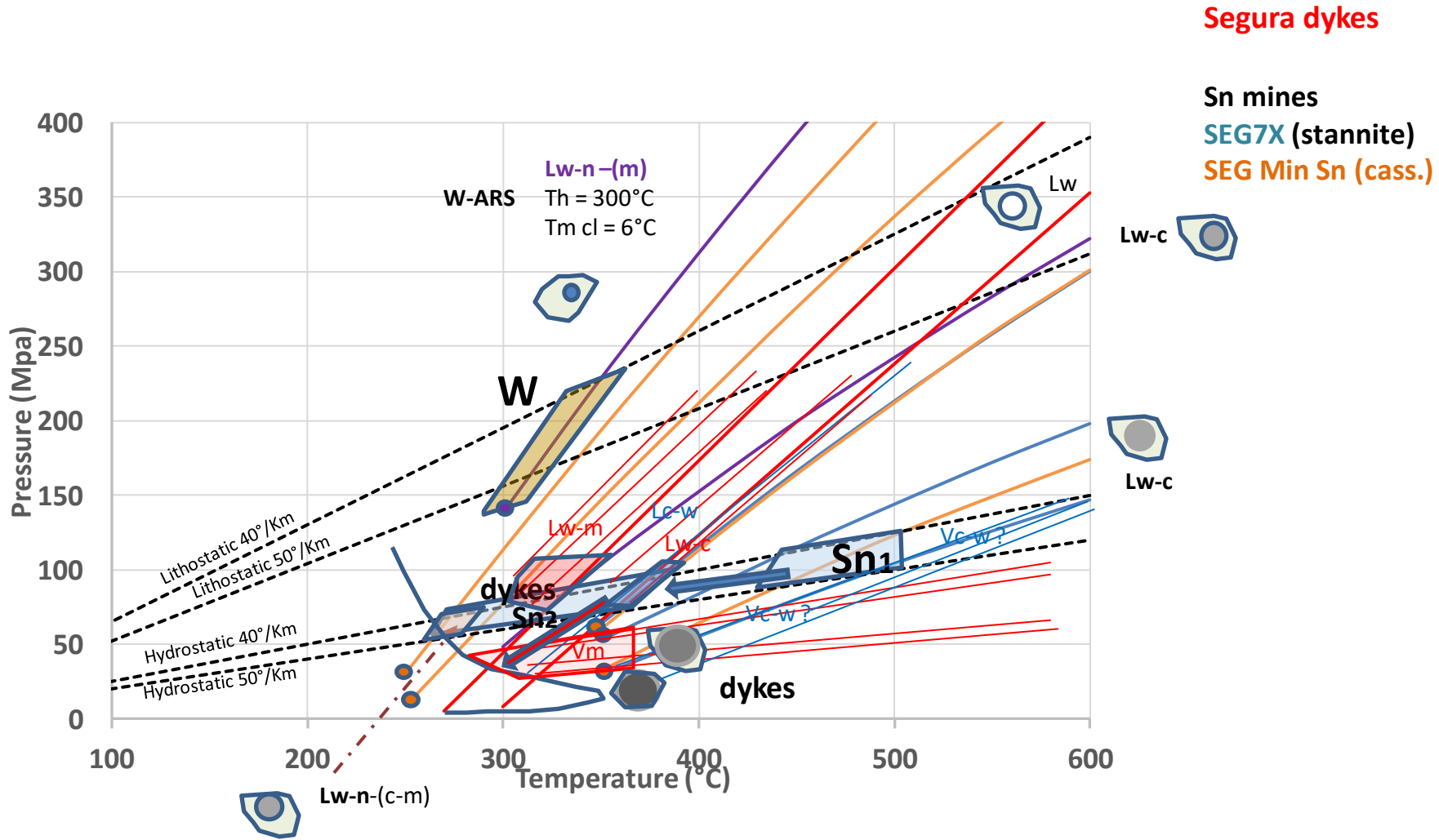
3- <400°C methane or nitrogen produced at the very end of the orogeny Low pressure (even < hydrostatic ?) or local reactions with intrusives

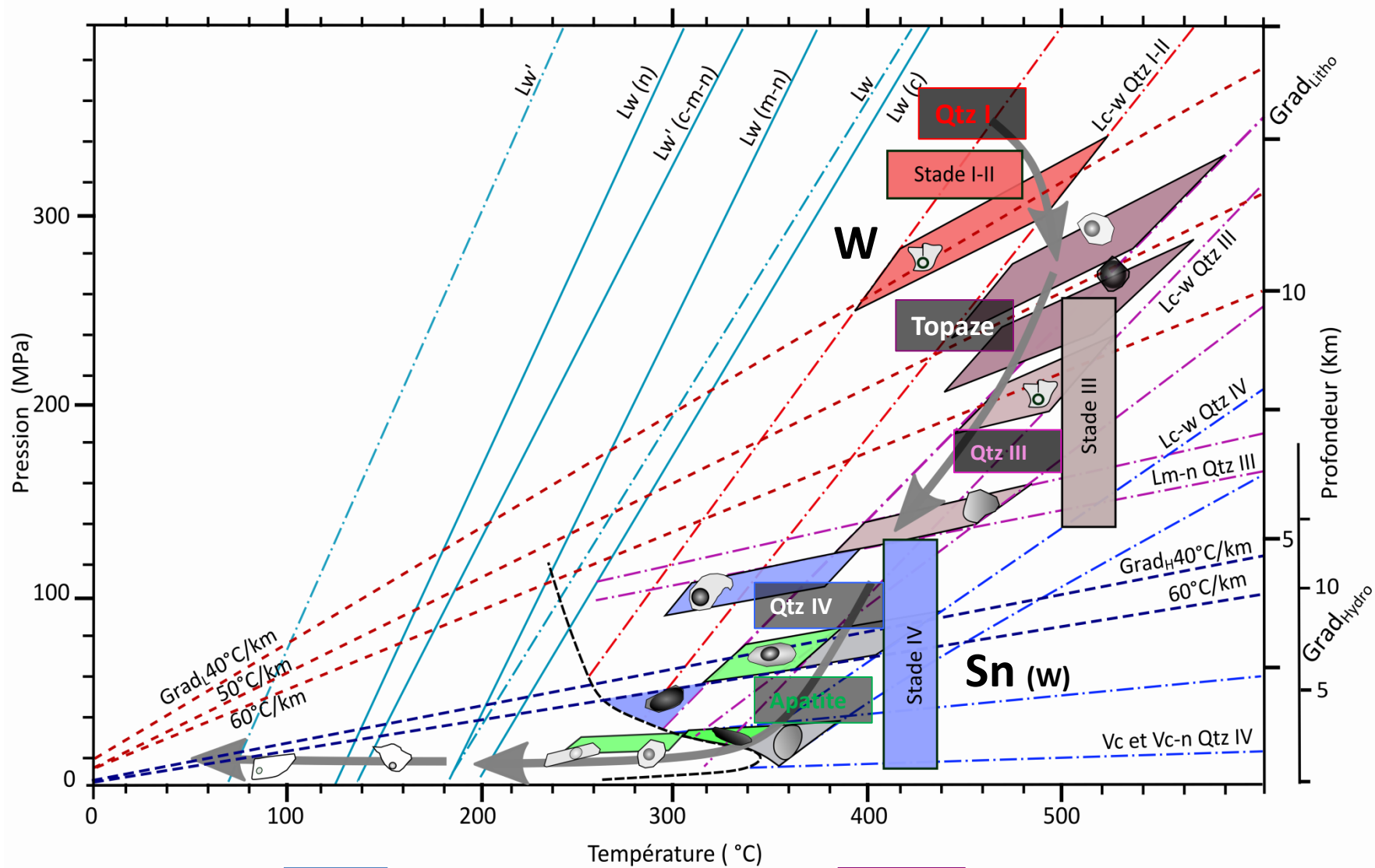


Mata da Rainha

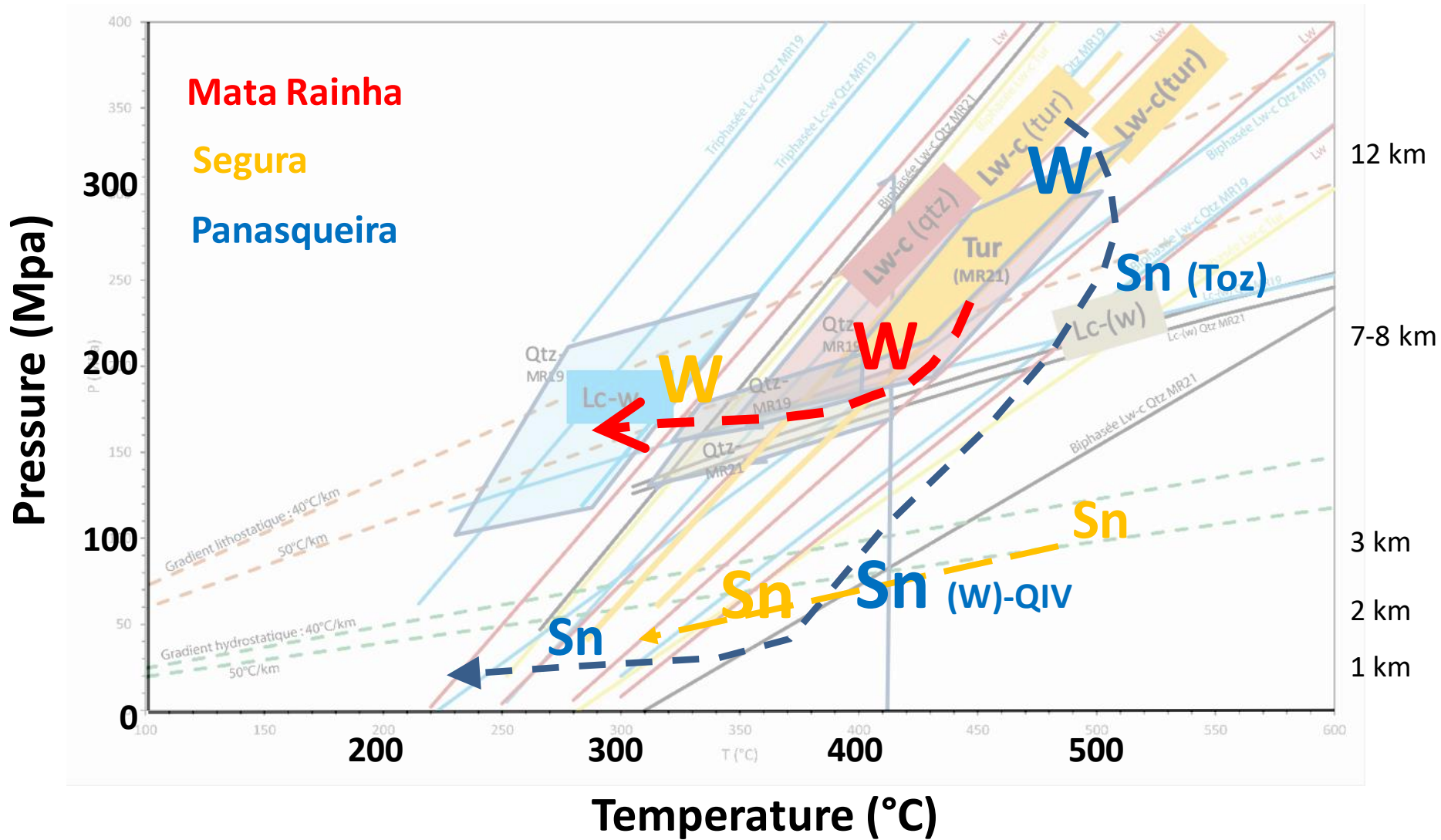


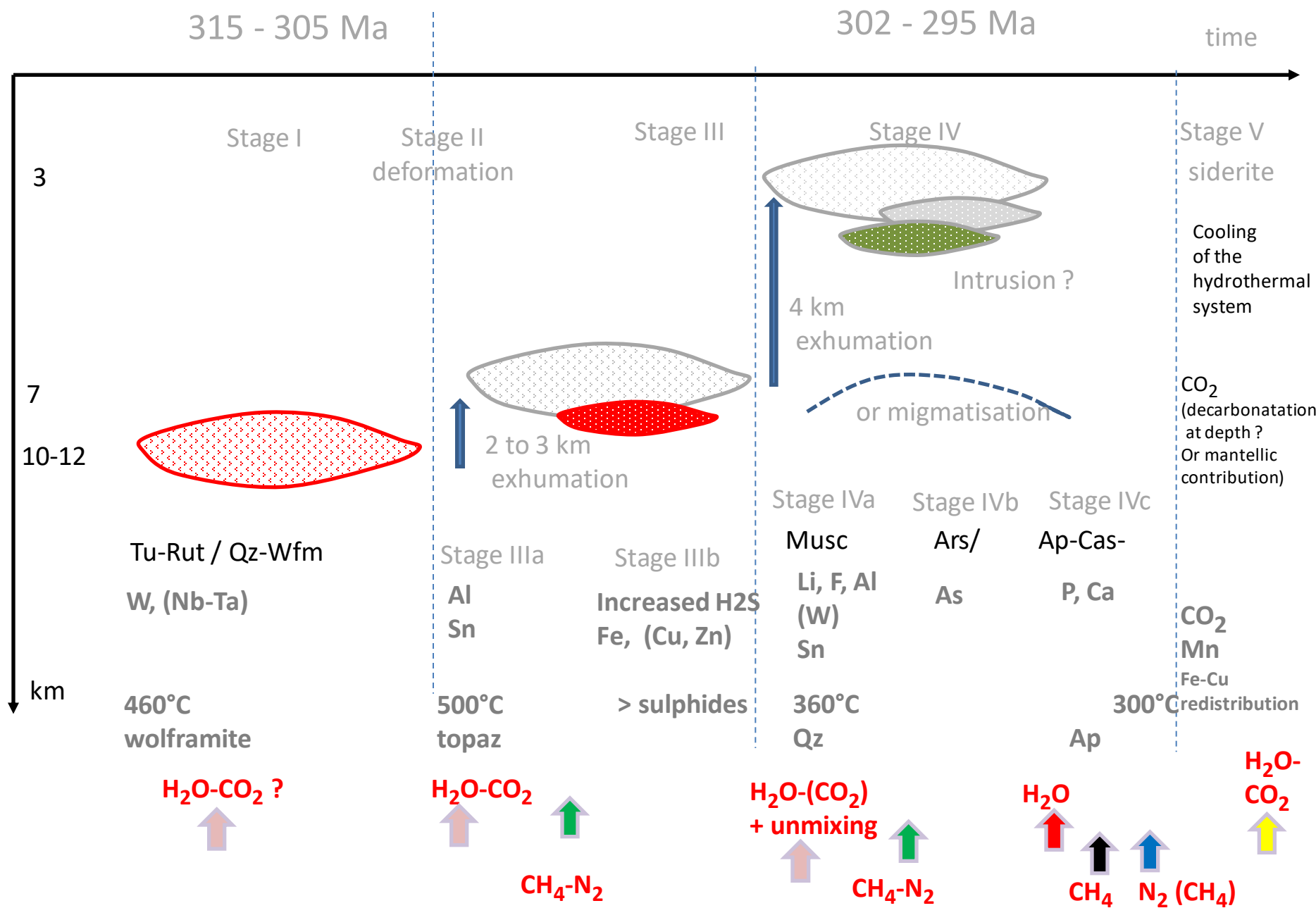
SEGURA area - all data





Dejean (2017)	Qtz I	Topaze
Rolland (2016)	Qtz III	Qtz IV
		Dour (2018)
		Qtz IV
		Apatite

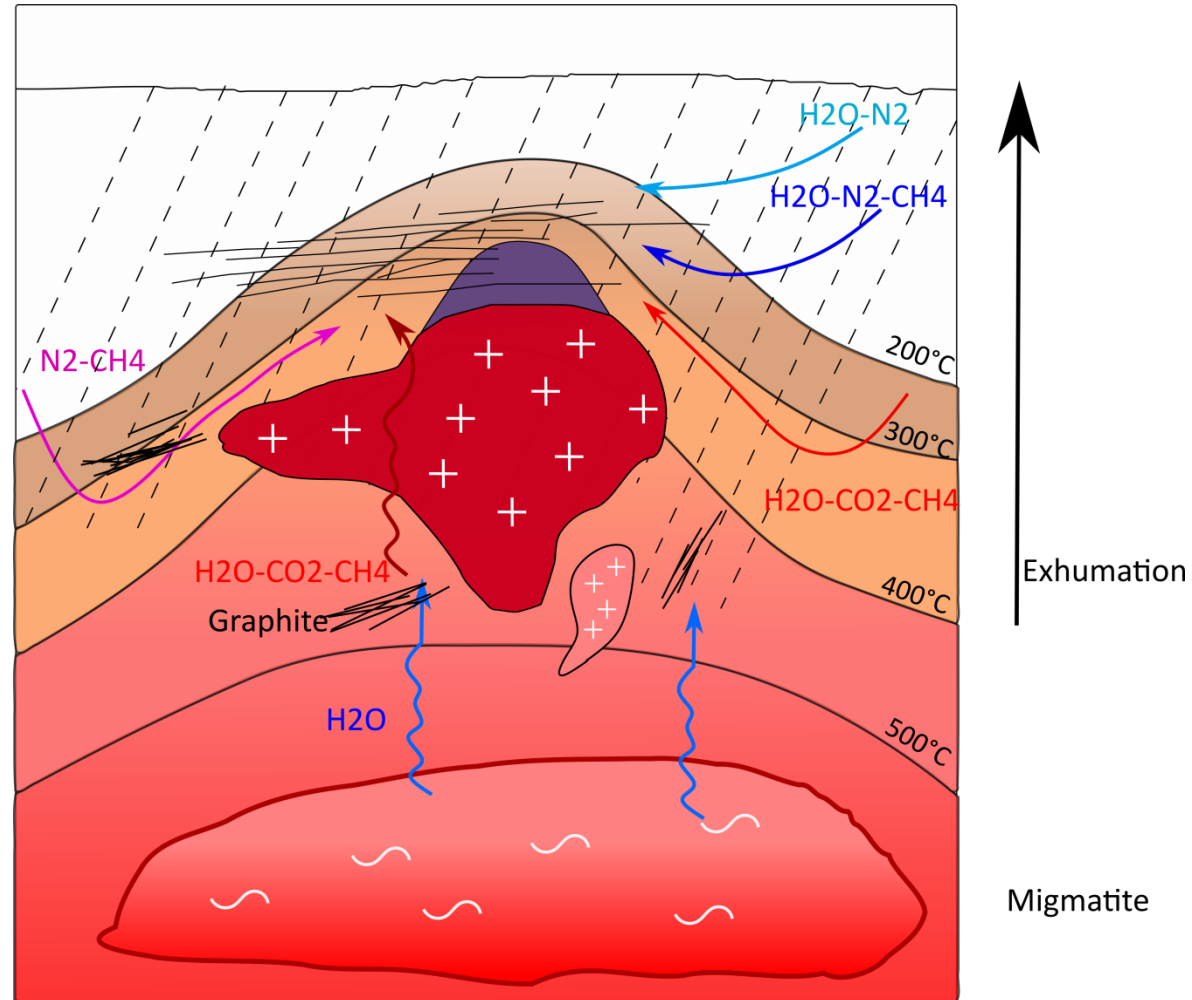




Long lived system : 15-20 Ma

Aqueous carbonic fluids
predominant
Fluids in equilibrium with
metamorphic host-rocks
but several end-members

Magmatic fluid inputs not
recorded by FI, only by
minerals (trace elements)



Superimposed (in time) fluid sources

