# Near-isothermal exhumation of lower crust in the Caledonian Orogen: Metamorphic path of kyanite eclogite from the Danmarkshavn area, North-East Greenland Caledonides

Wentao Cao[1], Jane Gilotti[2], Hans-Joachim Massonne[3,4]

[1]State University of New York at Fredonia, Fredonia, NY, USA; [2]University of Iowa, Iowa City, IA, USA

[3]Universität Stuttgart, Stuttgart, Germany; [4]China University of Geosciences, Wuhan, China

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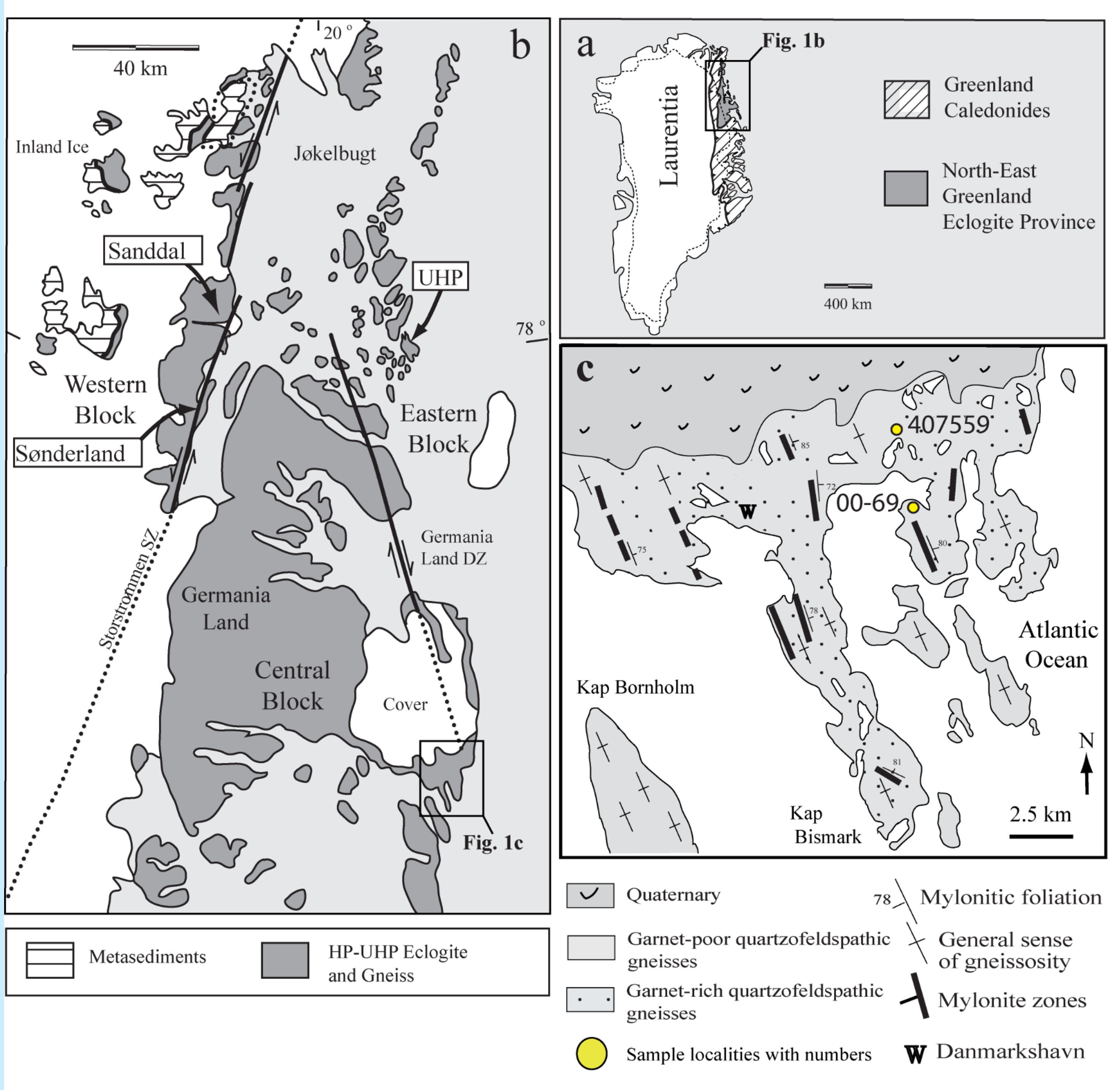
# North-East Greenland Eclogite Province




Modified after Sartini-Rideout et al. (2006)



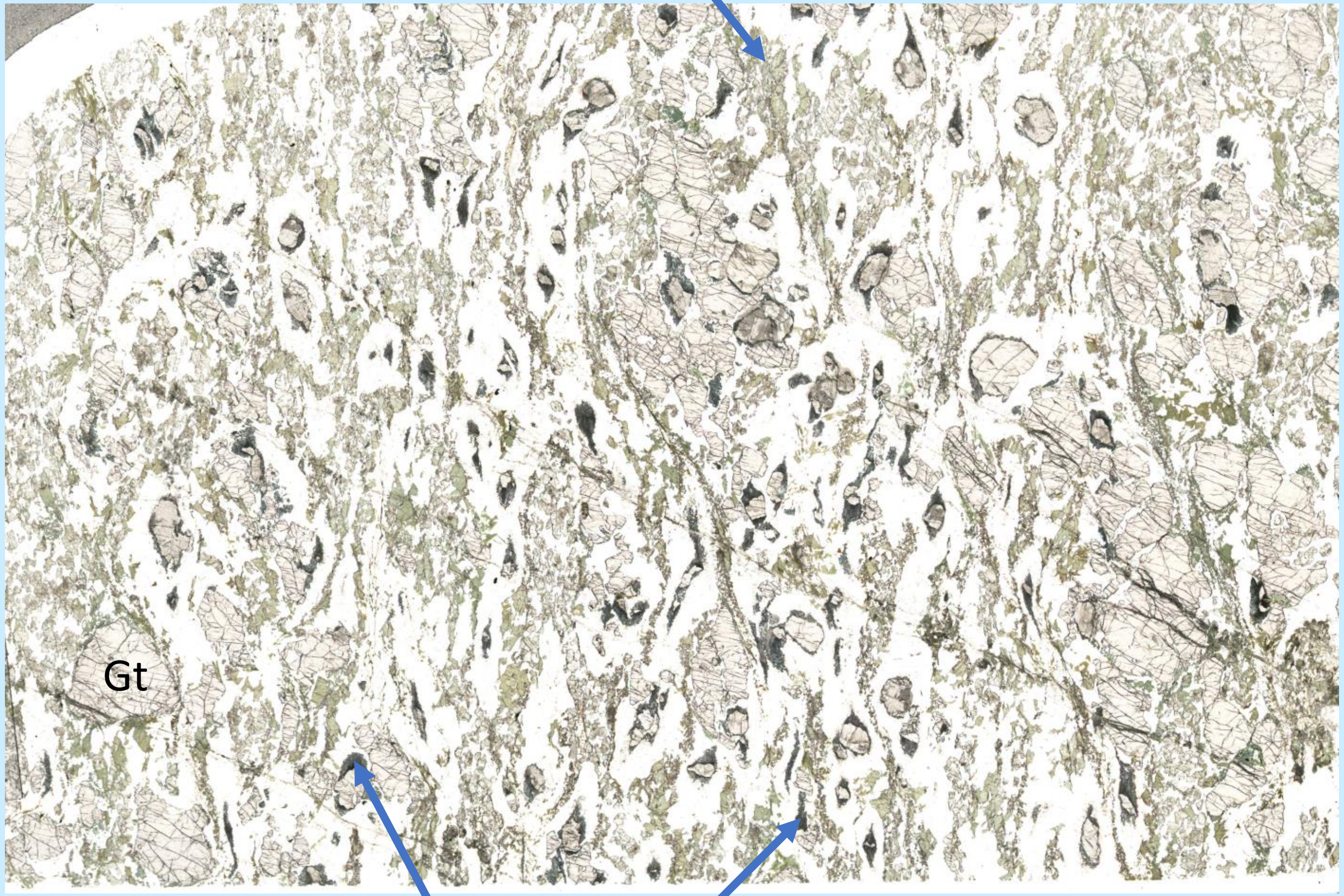
The North-East Greenland Eclogite Province

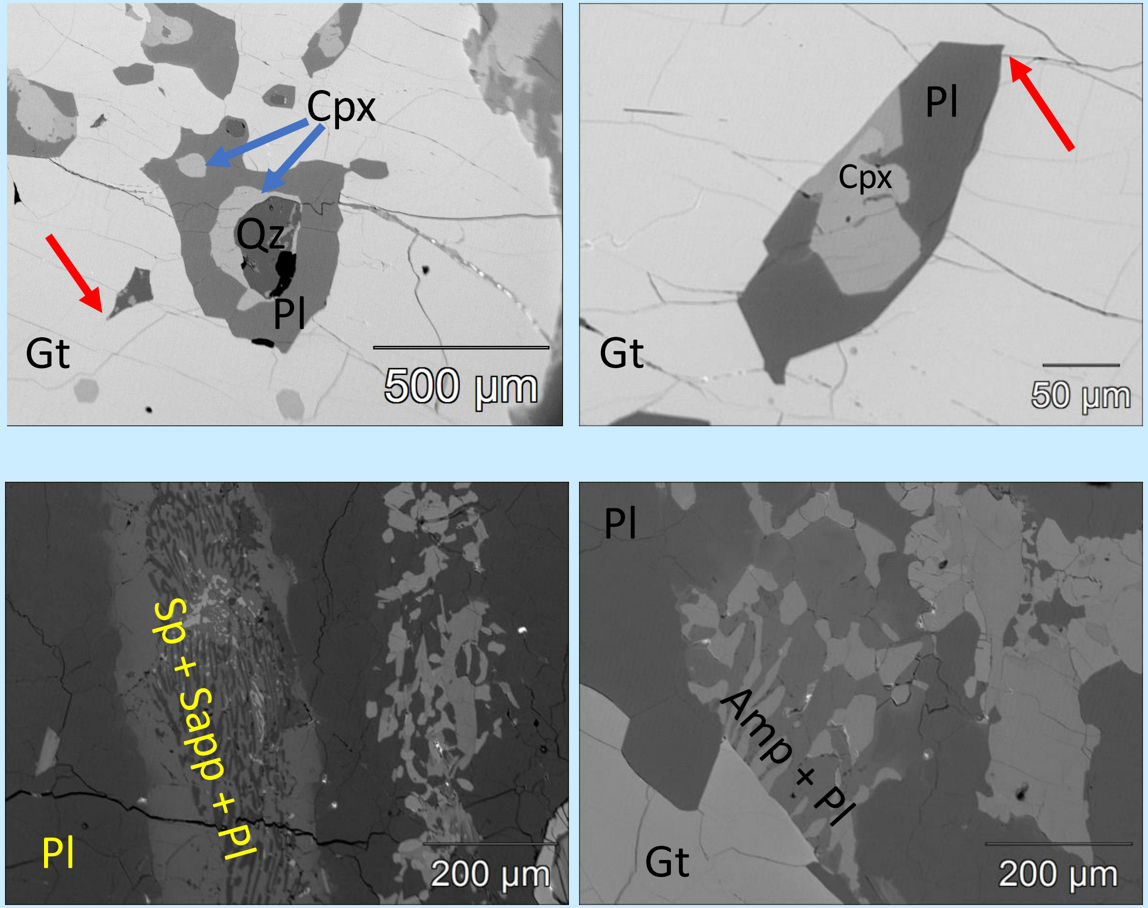
- Upper plate during the Caledonian Orogeny
- HP metamorphism and UHP metamorphism
- Separated into eastern, central and western block by Storstrommen Shear Zone & Germania Land Deformation Zone.

**The problem**: What are the metamorphic conditions in the southeastern part of the Central Block?

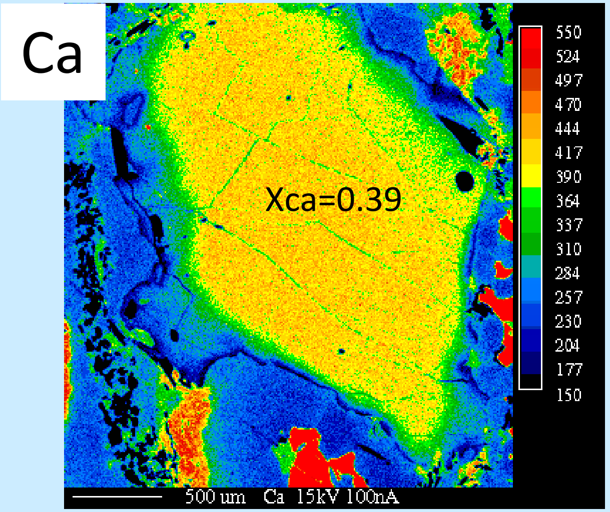
Two samples studied: 407559 & 00-69
~3 km apart along strike.

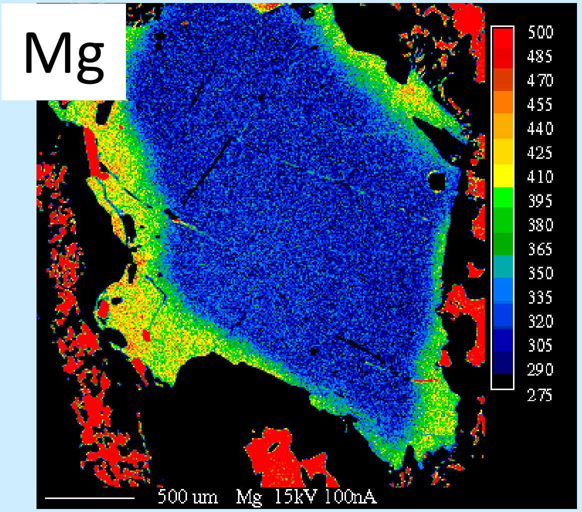
# 407559 partially melted retrogressed kyanite eclogite



# 407559 Partially melted retrogressed kyanite eclogite



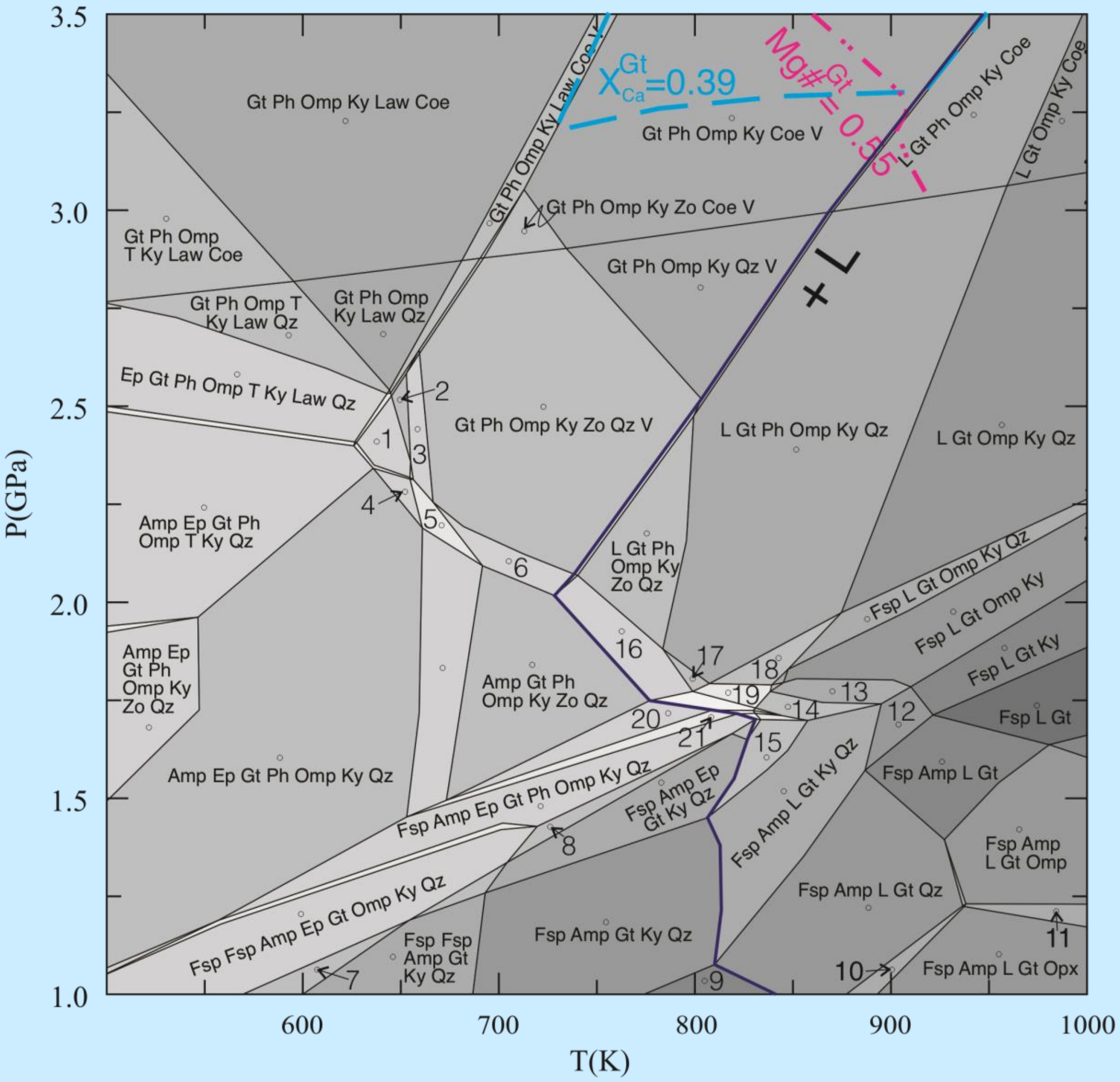




## Model parameters

- **Perple_X 6.9.0 (Connolly, 2009) with Holland & Powell (2011) thermodynamic dataset (ver. 6.2).**
- **Solution models: garnet (Gt), white mica (Ph), biotite (Bi), orthopyroxene (Opx; White et al., 2014), feldspar (Fsp; Fuhrman & Lindsley, 1988), omphacite (Omp), amphibole (Amp), tonalitic-trondhjemitic melt (L; Green et al., 2016), olivine (Ol; Holland & Powell, 1998), spinel (Sp; White et al., 2002), sapphirine (Sapp; Kelsey et al., 2004), talc (T), epidote (Ep; Holland and Powell, 2011) with pure phases lawsonite (Law), zoisite (Zo), kyanite (Ky), coesite (Coe) and quartz (Qz).**
- **Bulk composition (wt%), XRF-derived bulk with Ca adjusted**

**$Na_2O$ 3.181; CaO 9.892; $K_2O$ 0.572; FeO 4.933; MgO 6.353; $Al_2O_3$ 23.935; $SiO_2$ 50.229; $O_2$ 0.175; $H_2O$ 0.730.**

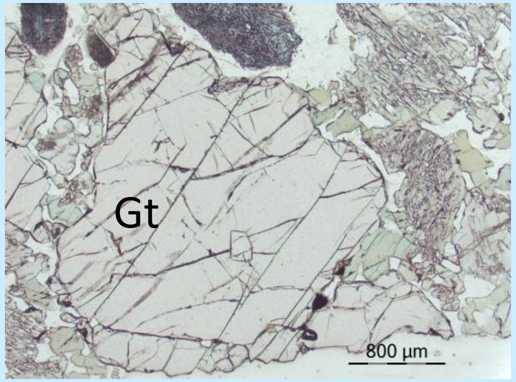


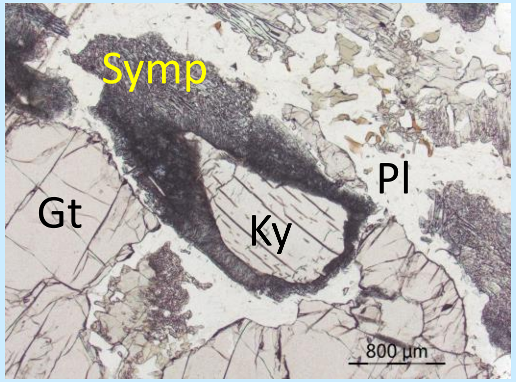


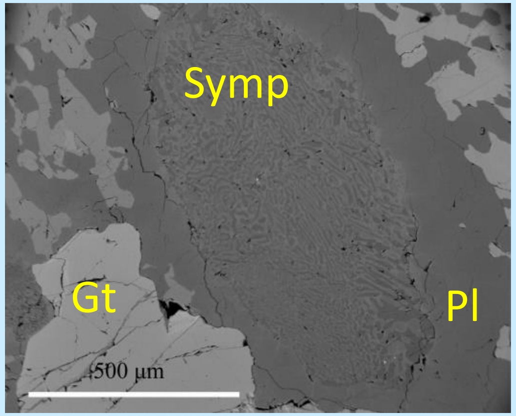

1 Ep Gt Ph Omp T Ky Qz V
2 Ep Gt Ph Omp Ky Qz V
3 Ep Gt Ph Omp Ky Zo Qz V
4 Amp Ep Gt Ph Omp Ky Qz V
5 Amp Ep Gt Ph Omp Ky Zo Qz V
6 Amp Gt Ph Omp Ky Zo Qz V
7 Fsp Fsp Amp Gt Omp Ky Qz
8 Fsp Amp Ep Gt Omp Ky Qz
9 Fsp Amp Gt Qz
10 Fsp Amp L Gt Opx Qz
11 Fsp Amp L Gt Opx Omp
12 Fsp Amp L Gt Ky
13 Fsp Amp L Gt Omp Ky
14 Fsp Amp L Gt Omp Ky Qz
15 Fsp Amp L Ep Gt Ky Qz
16 Amp L Gt Ph Omp Ky Zo Qz
17 Amp L Gt Ph Omp Ky Qz
18 Fsp L Gt Ph Omp Ky Qz
19 Fsp Amp L Gt Ph Omp Ky Qz
20 Fsp Amp Gt Ph Omp Ky Zo Qz
21 Fsp Amp Ep Gt Ph Omp Ky Zo Qz

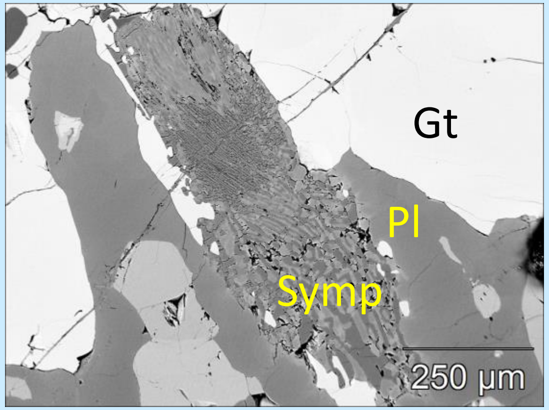
# 00-69 retrogressed kyanite eclogite


Symplectite after Ky

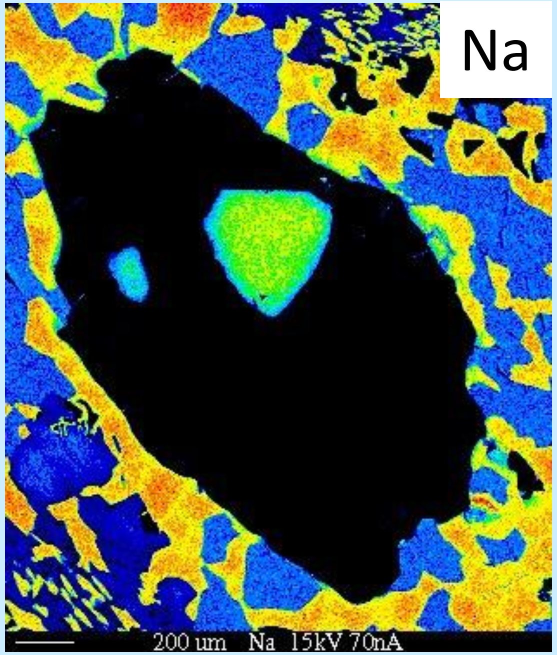


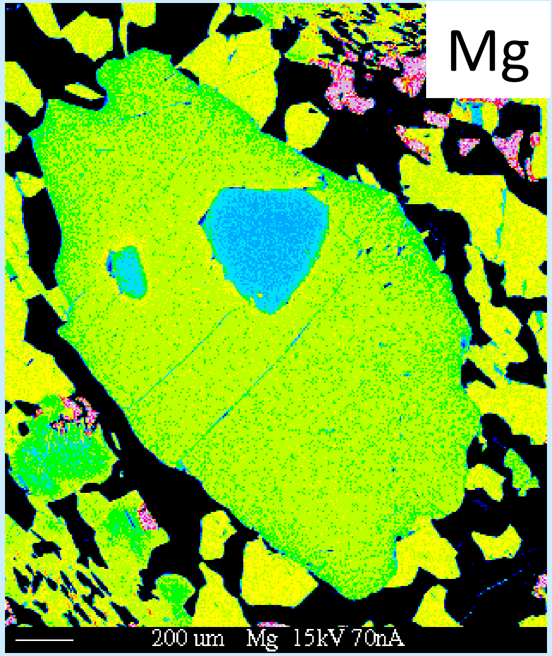



# 00-69 retrogressed kyanite eclogite



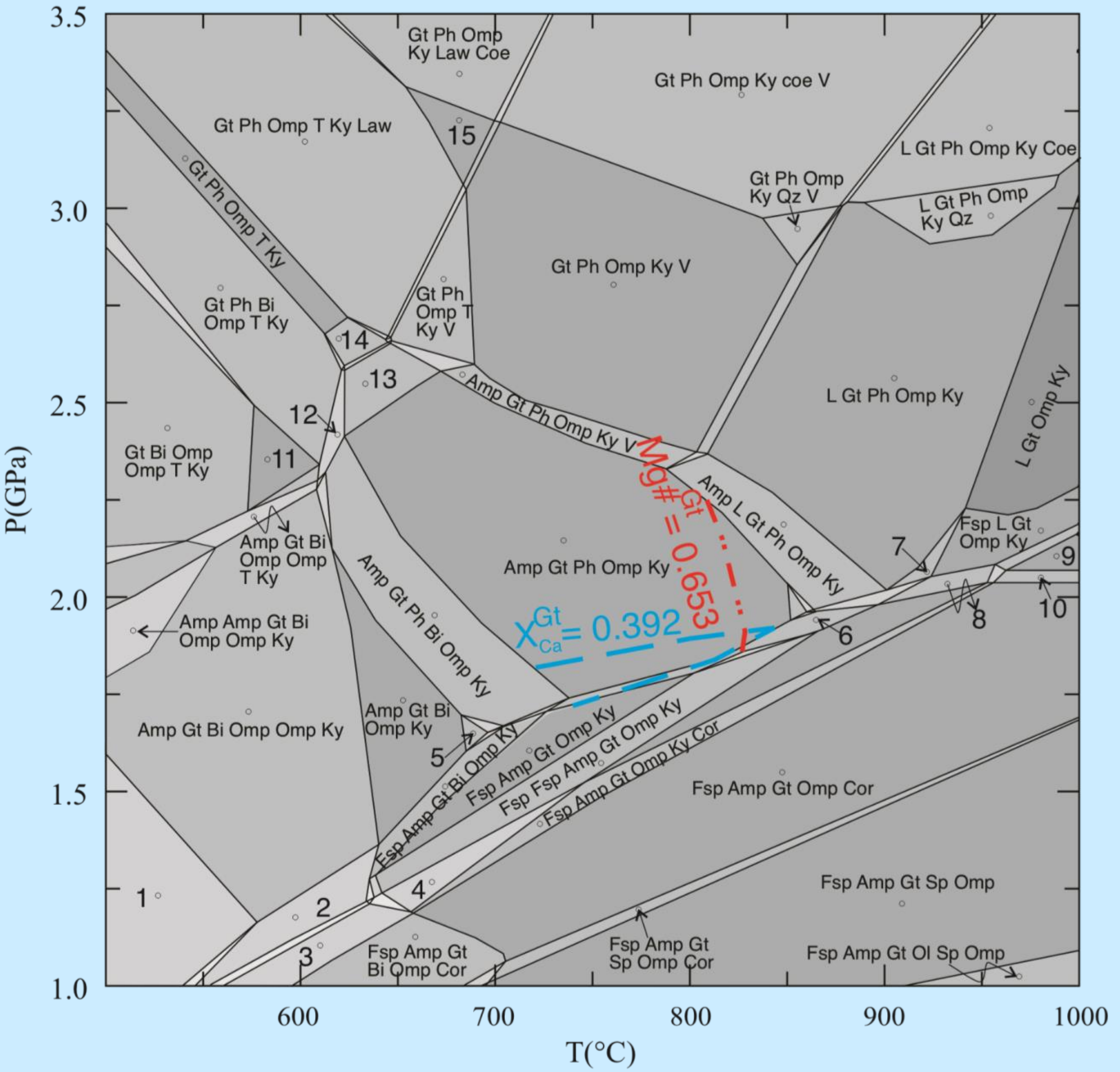




## Model parameters

- **Software, thermodynamic dataset and solution models: Same as 407559.**
- **Bulk composition (wt%), XRF-determined bulk composition with adjusted CaO assuming pure apatite.**

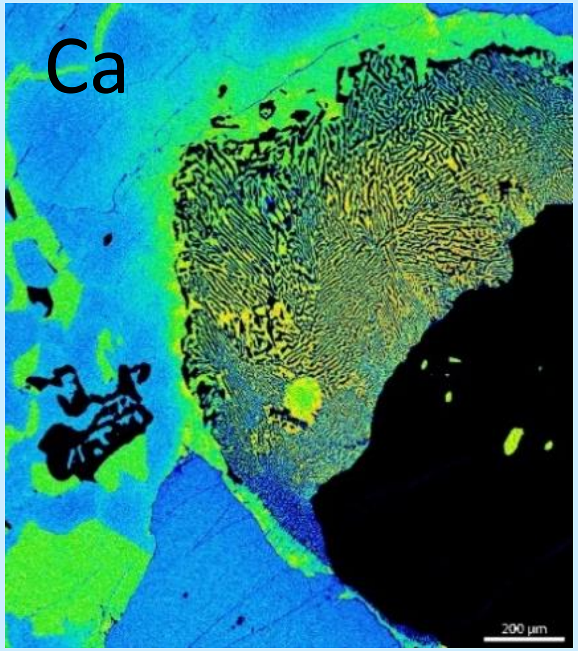
**$Na_2O$ 2.872; CaO 11.103; $K_2O$ 0.119; FeO 5.619; MgO 7.427; $Al_2O_3$ 20.274; $SiO_2$ 51.865; $H_2O$ 0.300.**

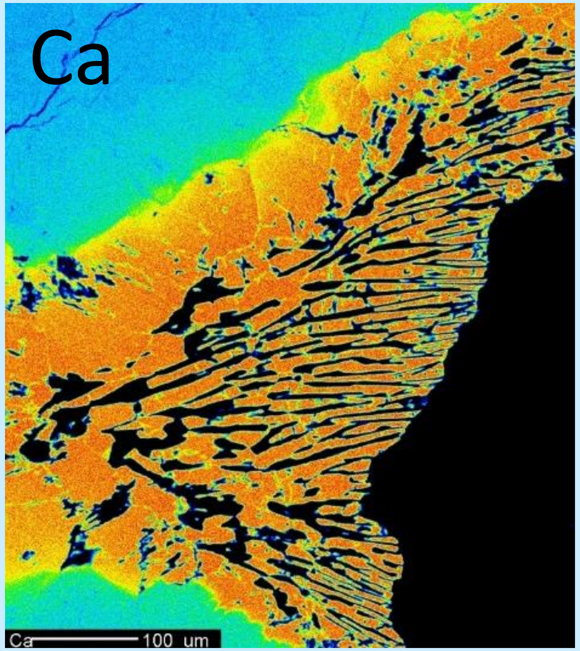


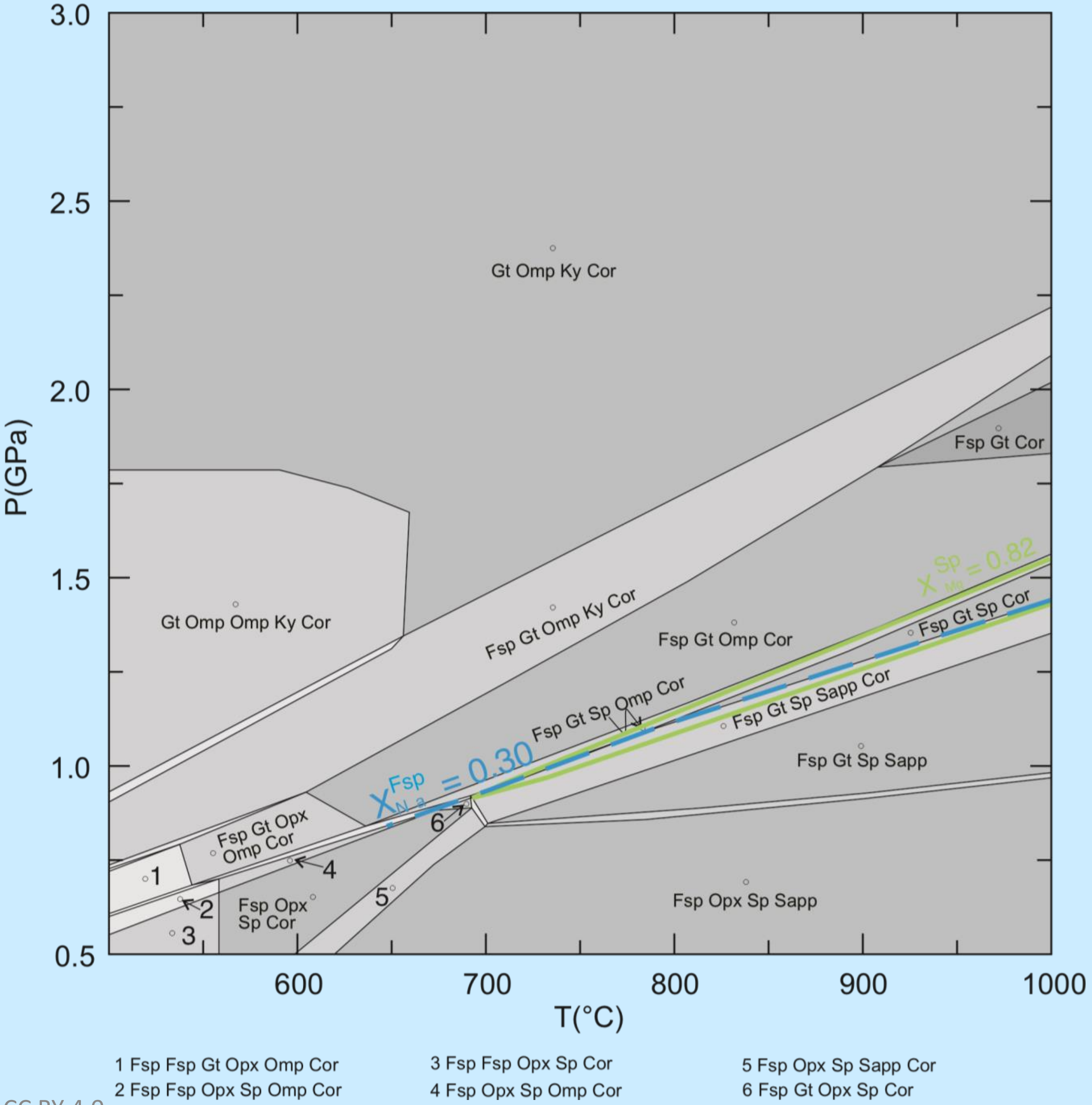



1 Amp Gt Opx Bi Omp Omp Ky
2 Fsp Amp Gt Bi Omp Omp Ky
3 Fsp Amp Gt Bi Omp Ky Cor
4 Fsp Fsp Amp Gt Omp Ky Cor
5 Amp Gt Bi Omp Ky Qz
6 Fsp Amp Gt Ph Omp Ky
7 Fsp L Gt Ph Omp Ky
8 Fsp Amp L Gt Omp Ky
9 Fsp L Gt Omp Cor
10 Fsp Amp L Gt Omp Cor
11 Gt Bi Omp T Ky
12 Amp Gt Ph Bi Omp T Ky
13 Amp Gt Ph Omp T Ky
14 Chl Gt Ph Omp T Ky
15 Gt Ph Omp Ky Law

# 00-69 retrogressed kyanite eclogite




## Model parameters

- **Software, thermodynamic dataset and solution models: Same as 407559.**
- **Bulk composition (wt%), averaged results using electron microprobe with a 20-μm beam size**

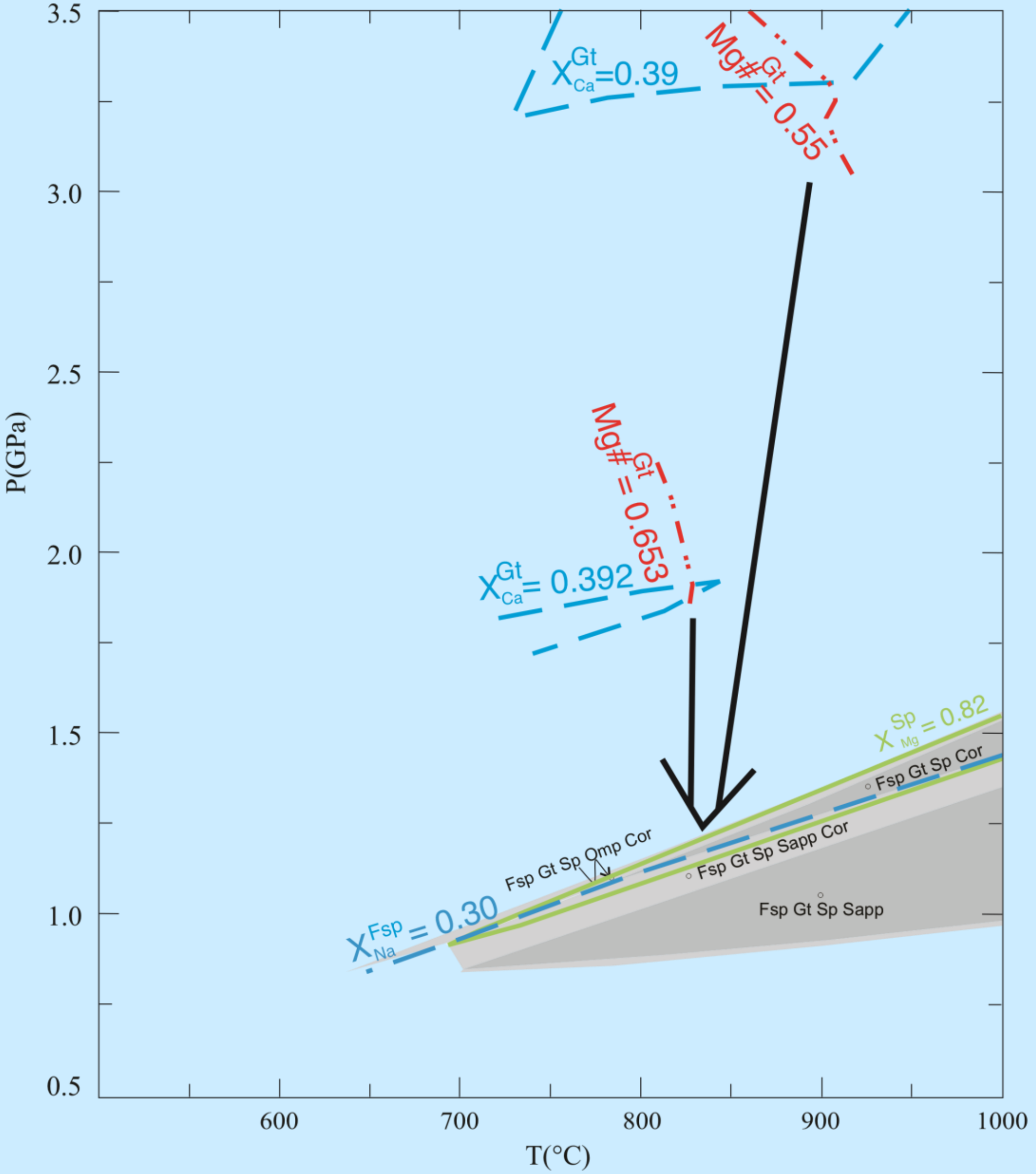
**$Na_2O$ 2.188; CaO 10.575; FeO 1.982;**
**MgO 5.576; $Al_2O_3$ 41.187; $SiO_2$ 38.466;**

# Implications

- **The Danmarkshavn region in the North-East Greenland Eclogite exposes both UHP and HP eclogites.**

- **The large pressure differences within small horizontal distance, which could be due to 1) differential exhumation of eclogites, 2) diffusional modification of garnet composition, and 3) small increase of pressure due to melting.**

- **The region was exhumed near-isothermally from UHP and HP conditions to shallower crust, potentially through vertical extrusion mechanism.**



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Thank you for your interest in our work!  If you have any question or comments, feel free to reach me (Wentao Cao) at cao@fredonia.edu. Thanks!