Deformation and fluid-infiltration influence in the evolution of the Krossøy dyke-swarm in the northern part of the Bergen Arcs, Norway

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Krossøy in the context of the Bergen Arcs

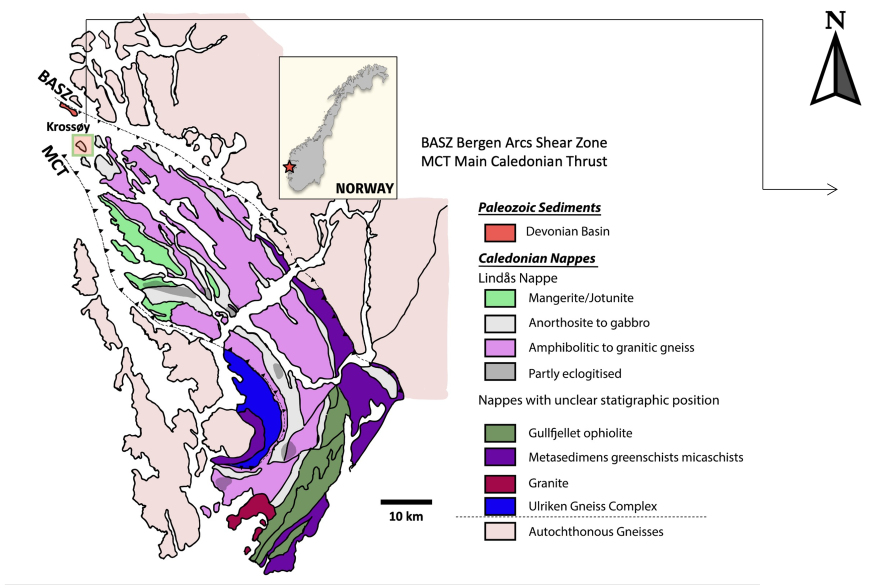
Krossøy is located in the northern part of the Lindås Nappe. Two major events affected the metamorphic history of the Lindås Nappe:

- **930 Ma – Granulite facies metamorphism** [1]
- **440-420 Ma – Caledonian Orogeny** [1,2] that exposed the anorthosites from the 930 Ma granulitic basement and overprinted many of these rocks.

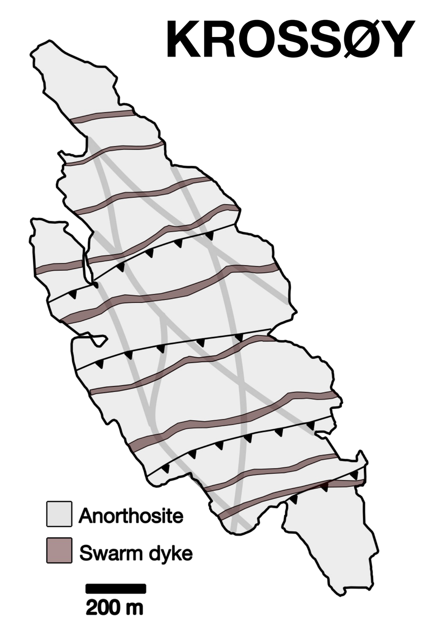
The overprint resulted in both amphibolites and eclogites and have been observed in shear zones within the rocks of the well-studied island of Holsnøy.

No eclogites have been found so far in Krossøy. Here the anorthosites are intruded by a series of subparallel mafic granulitic dykes forming the Krossøy dyke-swarm, that has never been previously described elsewhere in the Bergen Arcs. The style of deformation in the granulites and the textural evolution in the amphibolite facies overprint are markedly different from the rocks on Holsnøy.

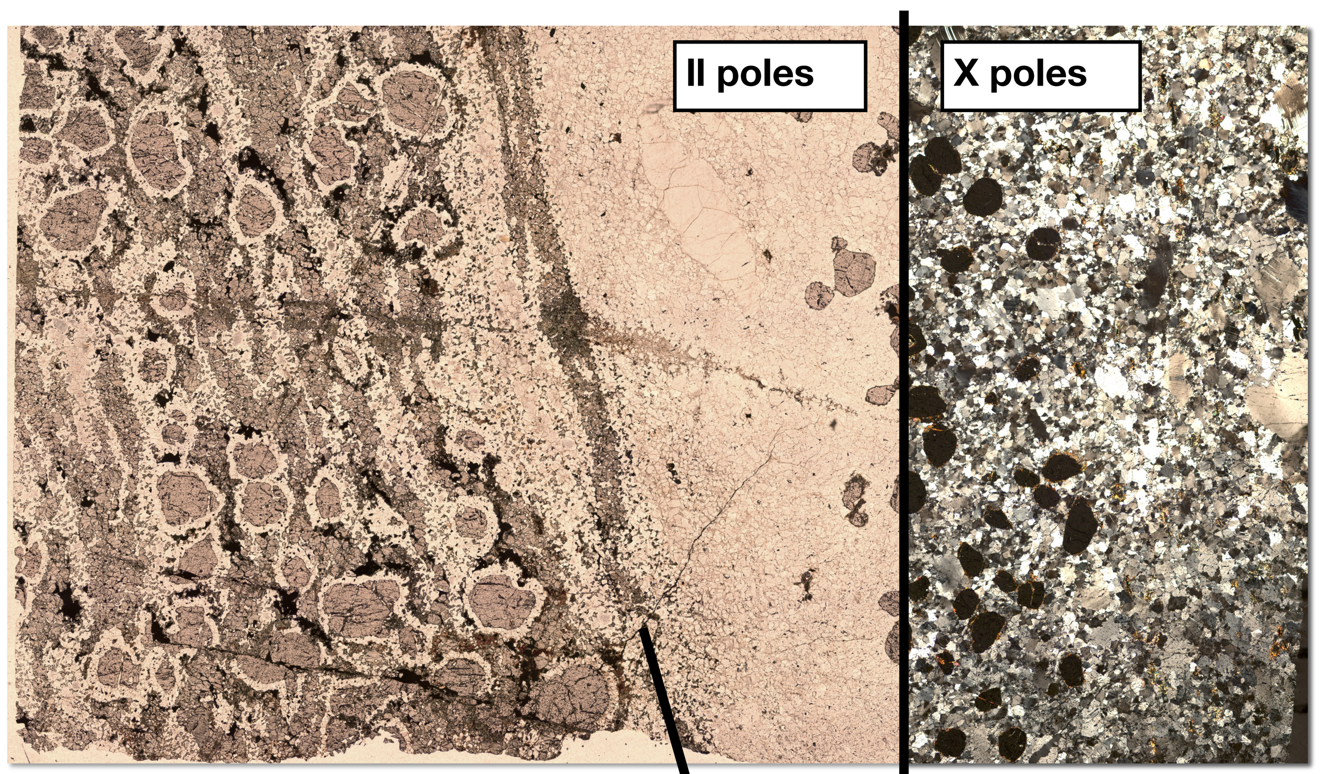
The NW-SE shear zone, in conjunction with the W-E oriented fault systems traversing the island facilitated the fluid infiltration.



The Bergen Arcs after [3]



Granulitic mineralogy

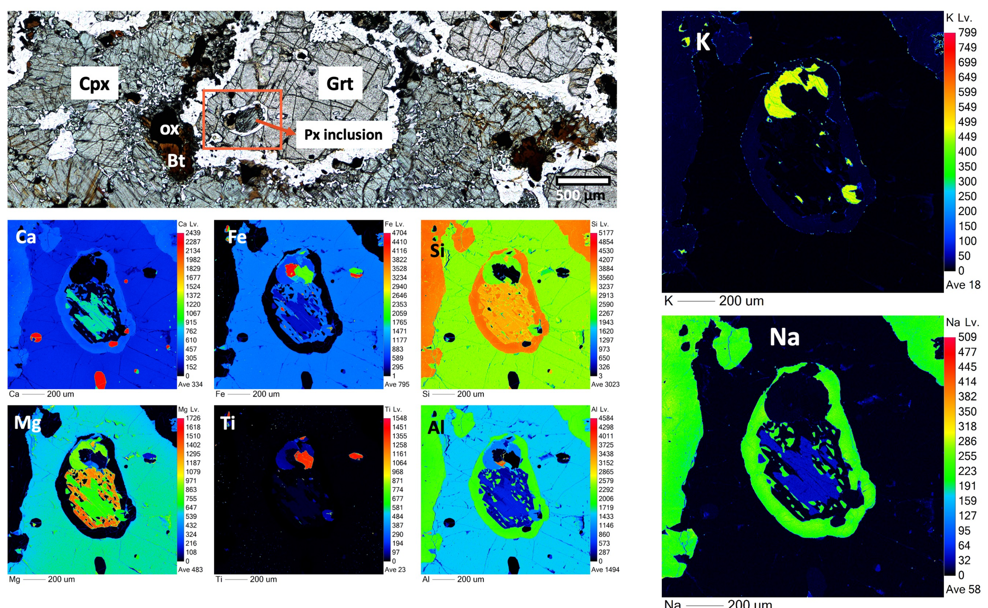


DYKE
Garnet
Clinopyroxene
Plagioclase
Fe-Ti oxides
Biotite
K-fsp
Orthopyroxene
Spinel

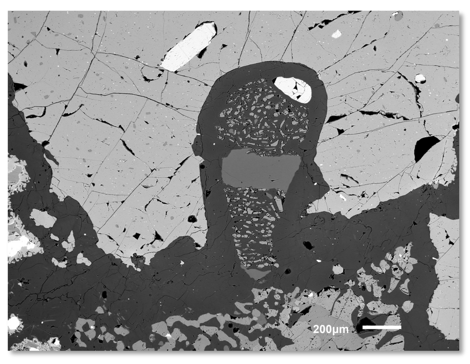
ANORTHOSITE
Plagioclase
Garnet
Pyroxene
Spinel
Biotite
K-fsp
Fe-Ti oxides

Breakdown products

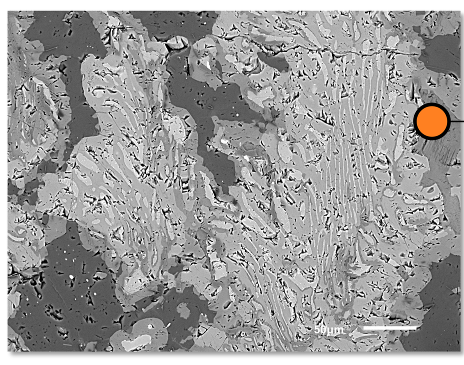
Dykes are characterized by the presence of plagioclase coronas around garnets in a clinopyroxene matrix. These coronas often present a symplectite of radially grown plagioclase around the garnet with Fe-oxides, cpx or opx, and K-fsp. Anorthositic garnets may breakdown into a symplectite of orthopyroxene and spinel.



Microprobe element maps of a pyroxene inclusion in a garnet.



Opx + K-Fsp + Plg symplectite after Cpx inclusion in garnet



Spl + Opx symplectite after garnet

Temperature estimations for symplectitic breakdown are around 515°C (Caledonian) [4].

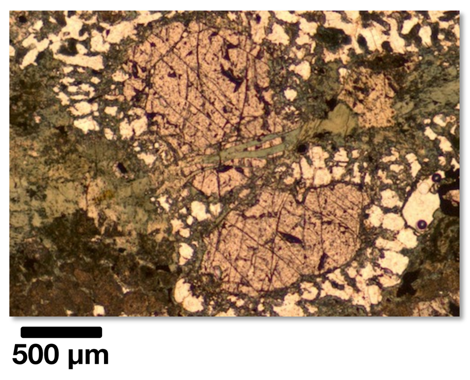
Hydration stage

After fluid infiltration, the breakdown products of the granulitic paragenesis from the dykes are either:

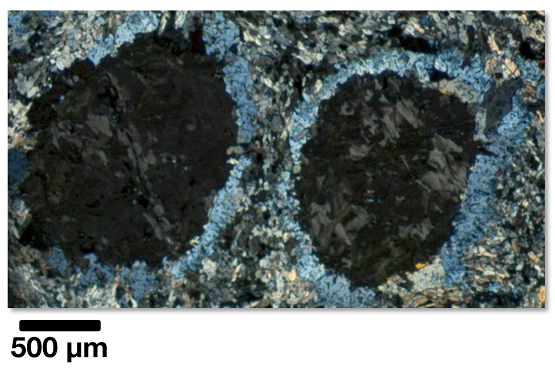
(1) Replaced by different types of amphiboles and epidote intergrowths. Sometimes the garnets are preserved.

(2) Replaced by chlorite (garnets) and epidote (plagioclase).

The second type of replacement has been observed in areas with strong deformation.

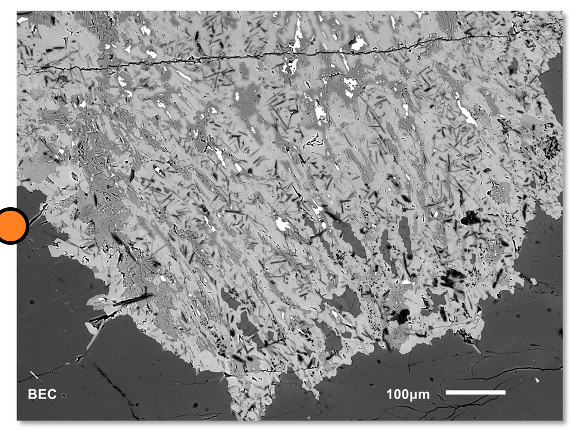


Amphiboles replacing garnet and symplectite



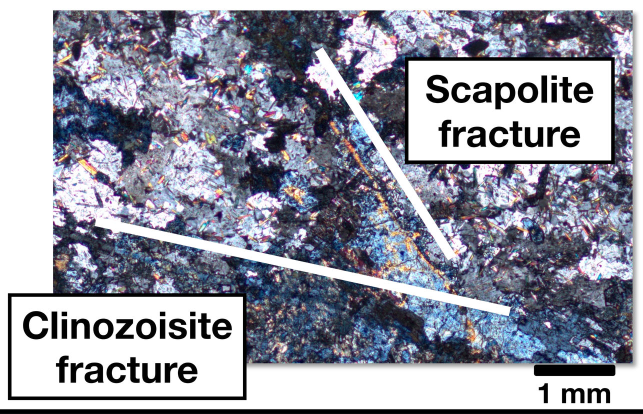
Chlorite replacing garnets and epidote replacing plg coronas

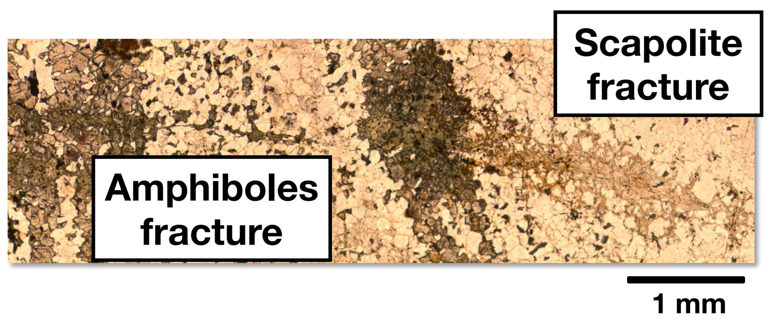
In the anorthosite:



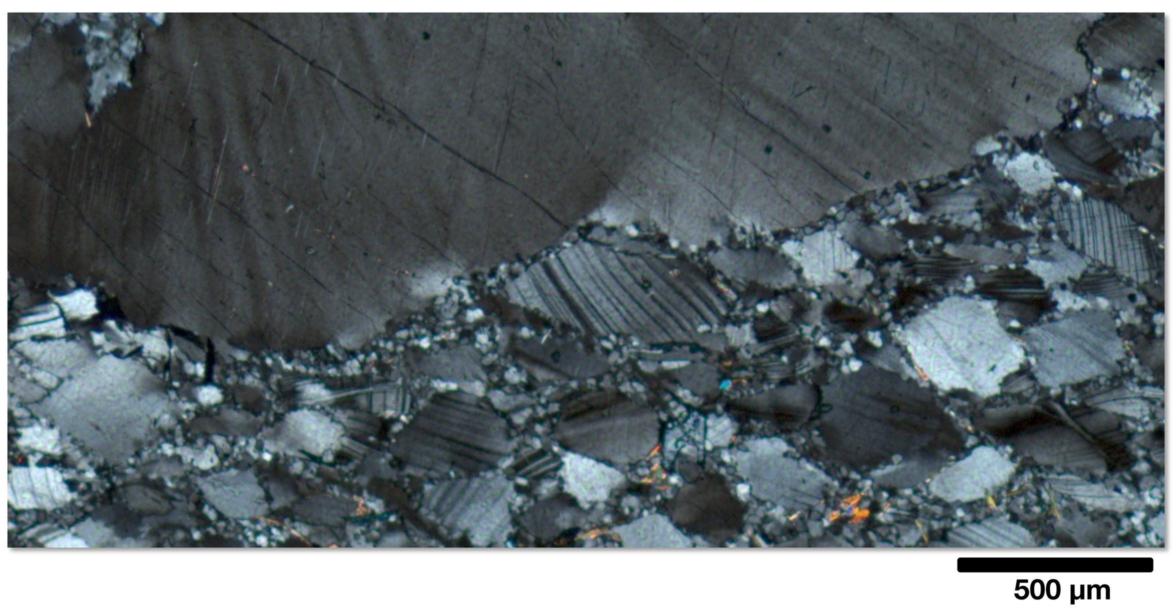
Hydrated symplectitic aggregate: Sapphirine replaces the spinel and different amphiboles replace the opx. Biotite, kyanite, epidote, oxides, quartz and sulphides are also present

Compositional variations along fractures



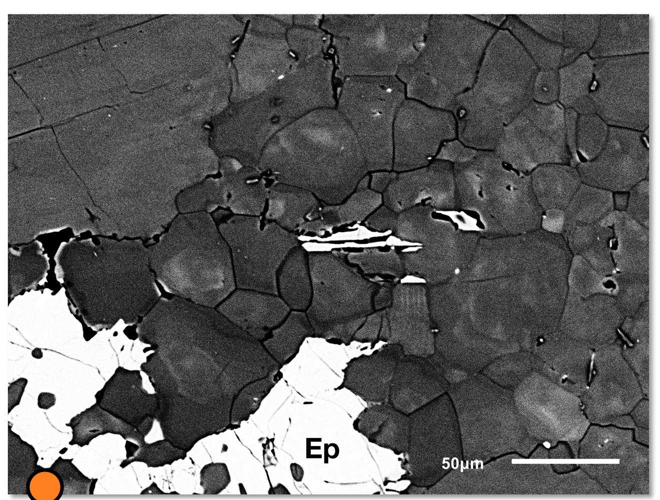


Tri-modal grain size distribution in the anorthosite

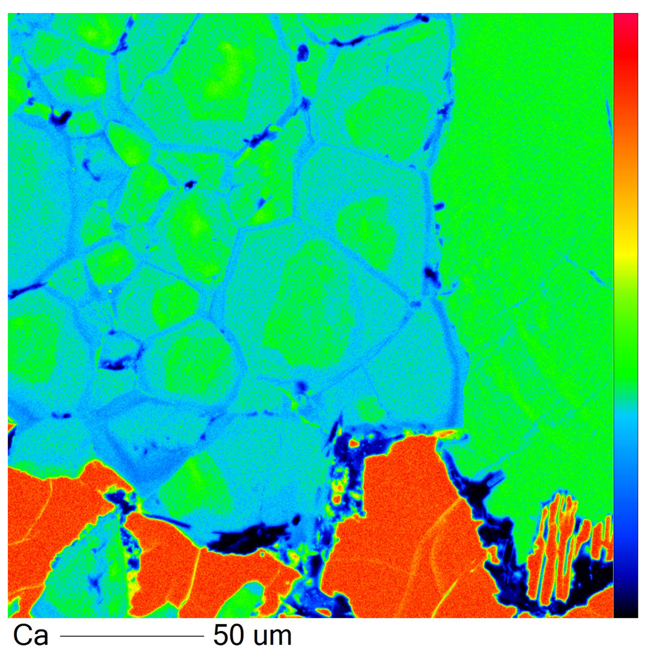


- Large plagioclase grains (1 to 5 mm) with deformed grain boundaries
- Medium plagioclase grains (100 – 200 µm), brittle deformation?
- **Small plagioclase grains** (5 – 10 µm) along the grain boundaries of larger feldspar grains and healed fractures

Feldspars deformation



Smaller plagioclase grains, with Na-rich rims and Ca-rich cores, being replaced by clinozoisite



Microprobe Ca map on small plagioclase grains

Next steps

- EBSD on grains along fractures to investigate the effects of grain orientation in replacement products
- Compositional analysis on feldspars to determine possible fluid influence in recystallization
- Mass/Volume balance studies
- Phase equilibrium modelling

Once we have determined which areas in Krossøy represent the local higher stress conditions and fluid influence, we will try to connect the presented features with different local conditions.

Deformed dyke Krossøy

References

[1] Bingen B et al. (2001) GSA Bull 5
[2] Glodny J et al. (2008) Contrib to Mineral Petrol 156: 27-48
[3] Helliksen and Ragnhildstveit (1997) Geologisk kart over Norge, berggrunnskart Bergen M 1.250000. ngu.no
[4] Roffeis C et al. (2012) Contrib to Mineral Petrol 164: 81-99

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