

# Geothermobarometry of the Evje-Iveland granitic pegmatite district, South-Norway

Rune B. Larsen<sup>a</sup>, Kristian drivenes<sup>b</sup>, Axel Müller<sup>c</sup> and Bjørn E. Sørensen<sup>a</sup>

<sup>a</sup>Department of Geoscience, Norwegian University of Science and Technology (NTNU), Trondheim, Norway, rune.larsen@ntnu.no; <sup>b</sup>Geological Survey of Norway, Trondheim, Norway; <sup>c</sup>Natural History Museum, University of Oslo, Oslo, Norway

The NYF-type REE pegmatites of the Evje-Iveland granitic pegmatite field are part of the Setesdalen pegmatite district in the Telemark lithotectonic domain and formed at Ma 900-930. Generally, it is assumed that they were emplaced at 4-5 kbar and 550-600 °C, i.e. at very high pressures compared to most other fertile pegmatite fields. In this study we aim at better constraining P and T based on a combination of fluid inclusion isochores and Ti in quartz geothermometry.

Primary fluid inclusions are common in both the Intermediate Zone (IZ) and the quartz dominated Core Zone (CZ) of the pegmatites. Here, we studied the CZ only, given that it is a well constrained part of the pegmatites enabling easy comparison of different pegmatite localities throughout the district. Thousands of FI data were obtained from 16 localities consistently showing H<sub>2</sub>O-CO<sub>2</sub>-NaCl fluids. Salinities varies from 6 to 14 wt% NaCl equivalents for most pegmatites and X<sub>CO<sub>2</sub></sub> of 0.03-0.09. Two localities demonstrated phase separation into CO<sub>2</sub>-rich and H<sub>2</sub>O rich fluids, respectively.

The newest revision ([Osborne et al., 2022](#)) of the TitaniQ geothermometer was used to calculate T's assuming a Ti activity  $a_{\text{TiO}_2}$  at 1 given the common observation of rutile in the pegmatites. Ti in quartz data are from Larsen et al., ([2004](#)). Fluid inclusion isochores were calculated with the computer packages developed by R. Bakker (<https://fluids.unileoben.ac.at/Home.html>).

Combining isochores and TitaniQ data yielded a cluster of 10 localities forming at 3.8-5.5 kb's essentially confirming earlier P estimates. T's were 400-520 °C i.e. lower than previous estimates. However, this is as expected given that the CZ quartz is expected to solidify later than the IZ and at lower T's. At the two localities showing phase separation of the fluids, we calculated P's at 2.8 and 4.1 kbar, respectively, with the latter overlapping with the TitaniQ/isochore P's.

We also observe a cluster of 3 localities forming at 1.1-1.5 kb, 415-450 °C demonstrating that some pegmatites are much more shallow. Perhaps they are belonging to a younger pegmatite forming event emplaced after a period of uplift of the Telemark domain. This is supported by significantly higher salinities of c. 23 wt% compared to most pegmatites emplaced at higher P's.