The metamorphic evolution on Utö

Joakim Mansfeld and Alasdair Skelton

Department of Geological Sciences, Stockholm University, Stockholm, Sweden, joakim.mansfeld@geo.su.se; alasdair.skelton@geo.su.se

The bedrock of Utö in the outer part of the southern part of Stockholm archipelago comprises a well-preserved sequence of older Svecofennian supracrustal rocks metamorphosed and deformed during the Svecokarelian orogeny. Recent studies by our group have resulted in a more detailed knowledge of the formation and evolution of the bedrock, especially regarding the metamorphic conditions.

We divide the stratigraphy of Utö, from southeast to northwest, in a lower, middle and upper formation, where the boundary between the two first coincides with the lower boundary of the "leptites and hälleflintas" in the stratigraphy of Gavelin et al. (1976).

The lower formation begins with turbidites that suggest an upwards shallowing of the depositional environment. The turbidites are followed by a several hundred meter thick sequence of ignimbrites and layered tuffs, which at the top are gradually replaced by sandy and silty sediments deposited at shallow depths, or even in deltas or tidal flats. Metamorphism here is characterized by two generations of andalusite, one early together with cordierite, and one later with andalusite and garnet. Peak metamorphism was at rather high temperatures (540–580°C) but low pressures (≈3 MPa).

The middle formation is less exposed, and details of the stratigraphy are only seen along the northernmost tip of Utö. The unit is dominated by carbonates, both dolomitic and calcitic, intercalated with iron rich fine-grained sediments, maybe of volcanic origin. Individual beds range in thickness from decimeter-sized to some meters. A few less than meter-sized units of layered tuffs are also present. Furthermore, the old iron mine of Utö probably lies high up in the stratigraphy of the middle formation. So far, we have not been able to characterize peak metamorphism here, but retrograde metamorphism as seen as replacement of calcic pyroxene by calcic amphibole, and formation of a later generation of muscovite in skarns is evident. Metamorphic temperatures based on Ca/Mg equilibrium in calcite yield temperatures of 230–440°C, which probably reflects the fluid induced retrograde metamorphism.

The upper formation is separated from the middle by the Utö Shear Zone and is found on Stora Persholmen, Ängsholmen and Näsudden further to the southwest. The supracrustal units probably represent turbidites with a high amount of feldspar (10–40%). Units of possible volcanic origin are rare and differ from the rest of Utö in being more mafic in composition. The rocks of the Upper formation are more deformed and of higher metamorphic grade than the rest of Utö. Sillimanite is seen to replace andalusite and temperature estimates yield temperatures of 650–680°C. A later retrograde event is recognized as chlorite replacing biotite along discrete shear zones, probably as part of the Utö Shear Zone. Chlorite bearing units record metamorphic temperatures at 520–540°C

Our studies together with earlier petrographic works suggest three different metamorphic events on main Utö, one early high T–low P forming cordierite and andalusite. This was followed by a later event producing garnet and a second generation of andalusite at peak metamorphic conditions of 540–580°C. The third event is a fluid induced low temperature retrogression at c. 350°C. This is in contrast to the upper formation that records a different metamorphic history. Only one prograde event, at high temperature producing sillimanite, followed by a retrograde event, but still at elevated temperatures have been recognised. This suggest that the upper formation originally was formed far away from the rest of Utö's bedrock and emplaced in its current position after peak metamorphism but before intrusions of the pegmatites.

References

Gavelin, S, Lundström, I. & Norrström, S., 1976: Svecofennian stratigraphy on Utö, Stockholm archipelago. Correlations with Finland and Sweden. *Sveriges geologiska undersökning C719*, 44 p.