Paper Number: 1630

# Metamorphic control on REE redistribution in alkaline complexes – the Norra Kärr example

Atanasova P.[1], Marks M.A.W. [2], Krause J.[1], Gutzmer J.[1,3], Markl G.[2]

[1] Helmholtz-Zentrum Dresden - Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Halsbruecker Str. 34, 09599 Freiberg, Saxony, Germany, p.atanasova@hzdr.de
[2] Universität Tübingen, Fachbereich Geowissenschaften, Wilhelmstraße 56, 72074 Tübingen, Germany
[3] TU Bergakademie Freiberg, Department of Mineralogy, Brennhausgasse 14, 09596 Freiberg, Germany

---

During the last decade the economic interest on rare earth elements (REE) rapidly increased due to their broad application in high-tech products. Beside carbonatites and lateritic deposits, alkaline and peralkaline rocks comprise one of the most promising sources for future REE supply, in particular heavy REE (HREE). As a reaction to increased global demand, a large amount of relatively unknown and/or difficult to access occurrences have been intensely explored and large geological data sets have been generated providing detailed insight into hidden/unknown geologic formations.

The Norra Kärr alkaline complex in Southern Sweden is a very good example of this development. It represents one of the largest resources of REE in Europe. The Norra Kärr rocks are characterized by a very high ratio of (Na+K)/Al ≥ 1.2 and a complex and highly unusual mineralogy, including rock-forming catapleiite, eudialyte group minerals (EGM) as well as minor rinkite and britholite group minerals. EGM incorporate significant concentrations of more than 30 different elements, including the group of 14 naturally occurring lanthanides, Y and Zr. Catapleiite hosts large amounts of Zr, but is essentially REE-free. The Norra Kärr body intruded at around 1.49 ± 0.01 Ga [2]. In contrast to other well-studied examples of so-called agpaitic rocks, such as the Ilímaussaq complex (Greenland) or the Lovozero Complex (Kola peninsula/Russia), it has been deformed during the Sveconorvegian/Grenvillian orogeny and is preserved within a westward-dipping synform. This specific feature has now been used to amplify the restricted knowledge on the behavior of agpaitic rocks during metamorphism. Earlier work on deformed agpaitic rocks in Canada and Malawi (e.g. [1] & [3]) mainly used compositional changes of clinopyroxene (CPX) to trace magmatic and metamorphic processes in agpaitic rocks. Our study investigates additionally textural and compositional features of the main ore-forming minerals (EGM) to provide direct insight into ore formation and subsequent REE (re-)distribution due to metamorphism.

Magmatic and metamorphic processes in the Norra Kärr complex are distinguished based on rock textures and textural and compositional changes of CPX and EGM. CPX is invariably sodic, but is characterized by early magmatic Zr-rich cores, overgrown by presumably late magmatic Zr-poor aegirine. Both are anhedrally overgrown by Al-rich aegirine (jadeite) of metamorphic origin. EGM show complex distribution patterns of major and minor elements suggesting multiphase influence of fractional crystallization, recrystallization, fluid-induced re-mobilization and late-stage alteration. Oscillatory and sector zoned as well as porous areas of EGM are enriched in Zr, but depleted in Si, Ca, REE, Y, and Cl and are interpreted to be of magmatic origin. In contrast, presumably metamorphosed areas are characterized by either Ce-rich flamy textures or Y-rich, but Ce-depleted poikilitic textures, cracks, veins and/or vugs, and rim areas of single crystals. Furthermore, we observe a general increase of REE, Y, Nb and/or Mn content with increasing degree of deformation.

*References:*

[1] Curtis LW and Currie KL (1981) Bulletin / Geological Survey of Canada 294
[2] Sjöqvist ASL et. al (submitted)
[3] Woolley A et. al (1996) Canadian Mineralogist 34: 423-434