

Werner Schreyer and the MASH-system: Results from investigations on natural rocks and experiments

HANS-PETER SCHERTL¹, THOMAS FOCKENBERG¹ AND MICHAEL BURCHARD²

¹Ruhr-Universität Bochum, Institut für Geologie, Mineralogie und Geophysik, D-44780 Bochum; Germany.

(hans-peter.schertl@rub.de; thomas.fockenberg@rub.de)

²Universität Heidelberg, Mineralogisches Institut, Im Neuenheimer Feld 236, 69120 Heidelberg, Germany; (burchard@min.uni-heidelberg.de)

Nearly iron-free metamorphic rocks of sedimentary and metasomatic origin are found in several parts of the world (e.g. Sar-e-Sang/Afghanistan, Dora-Maira-Massif/Western Alps, Eastern Alps/Austria). All these rocks have experienced metamorphic conditions at moderate temperatures and relatively high to ultrahigh pressures. Chemically, these rocks can be well described with the MgO-Al₂O₃-SiO₂-H₂O (MASH) experimental model system, and thus provide an excellent independent check on it. In so-called leucophyllites from the Eastern Alps the assemblage chlorite + quartz is found which is stable to only 600°C (Chopin and Schreyer, 1983). Towards higher pressures these phases react to the "whiteschist" assemblage talc + kyanite (Sar-e-Sang) with a large P-T field ranging from 5 to 40 kbar (Schreyer, 1988). At temperatures of 750 - 800°C this is replaced by the ultra-high-pressure assemblage pyrope + coesite (Schreyer and Yoder, 1964) found in the Dora-Maira Massif (Chopin, 1984; Schertl *et al.*, 1991). Particularly here, several in part new high-pressure phases near Mg-end-member compositions were found such as pyrope, Mg-staurolite, Mg-chloritoid, ellenbergerite, and Mg-dumortierite.

At all times, Werner Schreyer recognized the significance and interaction of nature and experiment. From experimental studies in the MASH-system he and his working group mapped out petrogenetic grids which allow HP-metamorphic sequences in natural rocks to be seen in a geodynamic context, while at the same time these natural occurrences also served as a template for delineating stability/compatibility fields of the observed nearly iron-free phases and assemblages in the laboratory (e.g. Fockenberg, 1995).

References

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What governs the transition from miaskitic to agpaitic assemblages in peralkaline rocks?

JULIAN SCHILLING, MICHAEL A.W. MARKS AND GREGOR MARKL

University of Tuebingen, Wilhelmstr. 56, 72074 Tuebingen, (julian.schilling@student.uni-tuebingen.de)

Peralkaline igneous rocks (molar (Na+K)/Al>1) are characterized by exceptionally high contents of generally incompatible elements like Na, Li, Be, Rb, REE and HFSE (Ti, Zr, Hf, Nb, Ta). However, based on their mineral assemblages, they can be subdivided into two groups: In the case of peralkaline miaskitic rocks, HFSE are incorporated in minerals like zircon, titanite and ilmenite, whereas in agpaitic varieties, these elements occur in complex Na-(Zr,Ti)-silicates such as eudialyte, rinkite and lāvenite (Sørensen, 1997). Commonly, peralkaline igneous complexes worldwide show either a miaskitic or an agpaitic character, or at least distinct melt batches within the same complex tend to develop to either miaskitic or agpaitic assemblages. Still, it is not clear, which processes cause either miaskitic or agpaitic assemblages to crystallize.

In the special case of the Eocene Tamazeght complex (Moroccan High Atlas mountains), a continuous transition from miaskitic nepheline syenites to agpaitic ones, including late-stage agpaitic pegmatites and veins, is observed. The earlier miaskitic rocks are characterized by nepheline, K-feldspar, aegirine-rich clinopyroxene, sodalite, titanite and rarely developed zircon. In contrast, the agpaitic varieties bear eudialyte instead of titanite and zircon, without showing any replacement textures between these minerals. However, the major mineral assemblages in the agpaites show no obvious difference compared to their miaskitic counterparts.

In this study, we compare electron microprobe data for nepheline, sodalite and clinopyroxene as well as mineral stable isotope data (O, H) of both miaskitic and agpaitic samples. Additionally, eudialyte from agpaitic samples was analyzed by electron microprobe. Preliminary fluid inclusion investigations indicate two types of inclusions in both nepheline and eudialyte, including a methane- and hydrogen-bearing population, which is known to be typical of peralkaline rocks (Potter & Konnerup-Madsen, 2003).

Based on this, we will try to shed light on the relevant changes of parameters being responsible for the transition from miaskites to agpaites.

References

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