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IGNEOUS CHARNOKITES AND RELATED ROCKS
FROM THE BILWINOWO BOREHOLE (NE POLAND)
- A COMPONENT OF AMCG SUITE - A GEOCHEMICAL APPROACH

Abstract: The sequence of rocks ranging from mafic to felsic with prevailing hypersthene has been evidenced at the Bilwinowo drill core on the SE edge of the Suwałki anorthosite massif within the Mazury Complex in NE Poland. Orthopyroxenes from studied rocks display variable, sometimes very high, Al contents what is an evidence of crystallisation at high pressures. Gabbronorites and charnockite 1386 m show similar geochemical pattern according to primitive mantle normalisation (except for P and HREE) while the rest of studied rocks (mangerites and anorthosites) show a slightly different pattern.

Keywords: charnockites, anorthosites, AMCG, high-Al orthopyroxene, Mesoproterozoic, NE Poland

INTRODUCTION

The Mesoproterozoic magmatism with anorthosites and porphyric granitoids, considered as anorogenic and/or postcollisional (Skridlaite et al. 2003) have been recognised in the Mazury Complex, an E-W trending plutonic belt in N Poland. Several intrusions mostly of granitic to monzonitic composition and three anorthosite massifs: Suwałki, Sejny and Kętrzyn have been described in this area (Lorenc, Wiszniewska 1999, Bagiński et al 2000, 2001, Skridlaite et al. 2003). These rocks according to their geochemical affinities are defined as an AMCG suite (anorthosite-mangerite-charnockite-granite). The U-Pb zircons ages indicate that igneous activity in Mazury Complex lasted from 1548 ± 7 Ma to 1513 ± 7 Ma (Dörr et al. 2001). The rocks drilled at Bilwinowo, although rich in hypersthene, have not been yet described as mangerites, quartz mangerites or charnockites (unpublished drilling documents) as the usual granitoid nomenclature has been in use instead.

The drill cores from Bilwinowo contain more than 1200 meters of magmatic rocks and are one of the best examples of the AMCG suite. This is the only appearance of so distinct and vast array of charnockite rock (hypersthene granitoids) types mutually and gradually intermingling with the decidedly mafic rock types, such as gabbronorites.

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MINERAL CHEMISTRY

Composition of plagioclases in gabbronorites (sample Bilwinowo 1949 m) change from rim to core from andesine/labradorite (An 46-58) to bytownite (An 84-86) while the andesine composition predominates in charnockites. They are accompanied by K-feldspars with Or 79-92 composition characterized by variable percentage of barium, in both charnockite (sample-Bilwinowo 1386 m) and mangerite (sample-Bilwinowo 1493 m) ranging from 0.36 to 1.75 wt % of BaO. In charnockites (samples Bilwinowo 1386 m and 1681 m) hypersthene with the composition of Wo: 0.5-1.3; En: 53-55; Fs: 44-46 is the main mafic mineral. In mangerite (sample-Bilwinowo 1493 m) ferrohypersthene with the composition of Wo: 0.1-0.2; En: 48-50; Fs: 49-41 appears, whereas in gabbronorite rich in magnesium hypersthene with the composition of Wo: 1; En: 59-60; Fs: 39-40, has been identified. At the Bilwinowo drill core, an occurrence of high alumina orthopyroxenes, albeit not in the form of megacrysts, has been detected in several samples (at the depths of 1493 m, 1305 m and 1250 m). The size of hypersthene grains does not exceed 2 mm. They are characterized by their intense pink-bronze pleochroism and contain from 5.9 to 6.4 wt % of Al₂O₃ (mangerite – Bilwinowo 1483 m). The highest Al₂O₃ contents in hypersthene reaches 7 wt %. Biotite, minor apatite, magnetite, ilmenite, zircon and monazite are typical for these rocks (in a different volume). Quartz is the most abundant in charnockites (> 20% of volume), and minor in Q mangerites. Clinopyroxenes appear sporadically in gabronorites together with hypersthene.

WHOLE-ROCK CHEMISTRY

The mafic rocks with hypersthene, ranging from gabbronorite, to leucogabbronorite associated with typical hypersthene-bearing granitoids have also been included in this study. This makes that analyzed samples from the Bilwinowo drill core span a wide range of SiO₂ from 44 to 77 wt% and display various total Fe calculated as Fe₂O₃ (3.9-18.3 wt %), TiO₂ (0.73-3.54 wt%) and K₂O (4.88-0.64 wt%) contents. The lowest silica contents display gabbronorites/leucogabbronorites (samples: Bilwinowo 1949 m, 1955.8 m and 1332.3 m). They build fairly linear trends, alike the Mazury Complex granitoid suite (Bagiński et al. 2001), which defines of decreasing total Fe₂O₃, TiO₂, MgO, CaO with increasing SiO₂ but both K₂O and Na₂O show considerable scatter. In the A/NK versus A/CNK diagram the charnockitic rocks show chemistry from marginally metaluminous to marginally peraluminous, but not reach the peralkaline field. The mafic rocks (gabbronoritic and anorthositic) are clearly metaluminous. They contain also lower concentrations of the large ion lithophile (LILE) elements than hypersthene-bearing granitoids (Fig. 1). One can observe consistently the enrichment in high-field-strength elements (HFSE) in the analyzed gabbronorites in the extent of Nb to Lu. It is visible not only when compared to anorthosite but also to mangerite. Interestingly, the shapes and the levels of the diagrams concerning the gabbronorites and charnockites are identical across the whole range of HFSE. Quartz mangerites abundant in the Bilwinowo drill core show the shapes

and the levels of the incompatible element diagrams normalized to PM in the LILE range, similar to charnockites and only in the range of HFSE it becomes similar to mangerites.

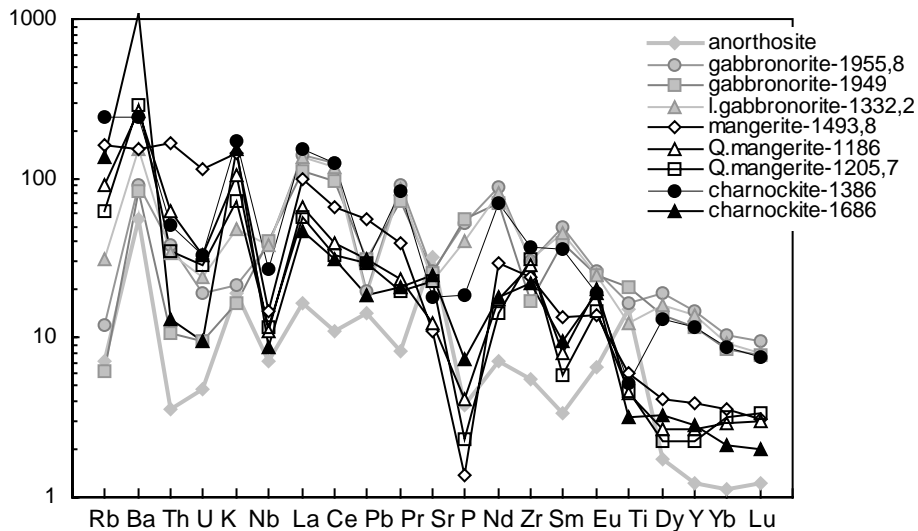


Fig.1 Primitive-mantle normalized multi-element patterns for mafic and felsic rocks from the Bilwinowo drill core. Normalisation after Sun & McDonough (1989).

The gabbronorites and charnockite 1386m show the highest enrichment along the whole range of elements comparing to chondrite. They have a degree of fractionation La/Yb_N between 12 to 13.4 as well as the negative europium anomaly expressed by the ca. 0.65-0.66 Eu/Eu^* ratio. The Q mangerites are characterized by a lower enrichment, and $La/Yb_N = 16-20$. They display, above all, the strong positive europium anomaly with Eu/Eu^* ratio between 3.27-3.29.

CONCLUSIONS

In the Bilwinowo borehole on the SE edge of the Suwałki anorthosite massif a sequence from mafic to felsic (charnockitic) rocks rich in hypersthene appears. The studied rocks do not have the geochemical features of the typical charnockitic C-type magmas (Kilpatrick et al. 1992). In respect of their spatiality, timeliness and cogenality, they are related to the anorthosite massif and AMCG formation. Just as in anorthosites, the presence of variable alumina contents in orthopyroxenes in mangerites (from 4 to 7% of Al_2O_3) indicates a polybaric crystallization of these rocks. In spite of the deficiency of phosphorus and the negative P anomaly, especially visible in mangerites from the Bilwinowo drill core, the multi-element diagrams normalized to PM point out to their certain respective similarities to two-pyroxene mangerites and amphibole charnockites from AMCG Rogaland –the Bjerkreim-Sokndal intrusion (Duchesne, Wilmart 1997). It is also necessary to

point out that low phosphorus contents differs described rocks from the most of granitic rocks of Mazury Complex where orthopyroxene is not present.

Recent petrologic data (Longhi et al. 1999) have shown that parent magmas pooling in deep-seated magma chamber can be the result of melting of gabbro-norite in dry conditions (jotunitic magma). And maintaining this last special condition could lead to so spectacular appearance of the charnockitic rocks at the Bilwinowo drill core.

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