EGU2020-137, updated on 11 Jun 2020
https://doi.org/10.5194/egusphere-egu2020-137
EGU General Assembly 2020

Syenite formation after TTG gneiss: evidence from the Madiapala massif (Limpopo complex, South Africa) and experiment

Natalia Seliutina[1,2], Oleg Safonov[1,2], and Dmitry Varlamov[2]
[1]Lomonosov Moscow State University, Geology, Moscow, Russian Federation (nata-me98@mail.ru)
[2]D.S. Korzhinskii Institute of Experimental Mineralogy RAS

The Madiapala syenite massif is situated within the host Alldays TTG gneisses in the western part of the Central Zone(CZ) of the Limpopo Complex (South Africa). The age of the massif 2010.3±4.5 Ma corresponds to the period of Paleoproterozoic tectono-thermal event(D3/M3) in the CZ, which was characterized by fluid activity along regional and local shear-zones.

The model for the syenite rocks formation within the TTG gneisses was suggested in [1] on the basis of experiments on the interaction of a biotite-amphibole tonalite gneiss with H_2O-CO_2-(K,Na)Cl fluids at 750 and 800°C and 5.5 kbar. These experiments demonstrated that the leading factor for formation of the syenite assemblages in a tonalite gneiss is an increase of potassium activity in a fluid. Thus, the Madiapala syenites could be a product of the syenitization of the TTG gneisses. ICP-MS and ICP-AES for the syenite rocks, syenitized gneisses and host TTG gneisses reveal two varieties of syenite rocks in the massif (syenites and syeno-diorites), confirm the crustal source of the syenites and their close genetic relationship with the Alldays tonalite gneisses. The REE pattern for the syenite rocks indicate active crystallization differentiation within the syenite massif.

The earliest assemblage of the syenite rocks is K-feldspar + clinopyroxene + titanite ± apatite. The latter assemblage is albite+amphibole. In order to estimate the conditions for formation of the earliest assemblage, we constructed the P-T pseudosections for syenite assemblage and isopleths of Na and #Mg in clinopyroxene coexisting with K-feldspar and titanite using the PERPLE_X software. It showed that the earliest assemblage was formed in the temperature range 800-850°C and pressures between 6 and 9 kbar. The $lg(a_{H2O}) - lg(a_{K2O})$ pseudosections for the Alldays gneiss composition showed that the formation of the syenite assemblage proceeds via the increase of the K_2O activity at constant P and T.

In order to reproduce the syenite mineral assemblage, experiments on the interaction of a biotite tonalite Alldays gneiss with a H_2O-CO_2-(K,Na)Cl fluid with variable salt concentrations were performed at 850°C and 6 kbar for 10 days using an internally heated gas pressure vessel. The starting materials were cylinder fragments of the Alldays gneiss and a mixture of oxalic acid with KCl and NaCl as a fluid.

Run products of experiments with KCl contain the assemblage of clinopyroxene + K-feldspar +

titanite formed by reactions of Ti-bearing biotite with quartz and plagioclase, initiated by the alkali-bearing aqueous-carbonic fluid. At the run temperature, the assemblage coexists with a syenitic melt enriched in F, Cl and H_2O, which was confirmed by Raman spectroscopy of studies of quenched glasses. Amphibole was formed only in the experiments with NaCl. Thus, the formation of amphiboles can be attributed to a later stage of the massif evolution, which was characterized by an increase in chemical potential of sodium. This result is consistent with the suggested model for the formation of the Madiapala syenite rocks.

This study is supported by RSCF project No18-17-00206

Literature

1. Safonov O. G., Aranovich L. Y. Alkali control of high-grade metamorphism and granitization//Geoscience Frontiers. 2014. Vol.5. pp.711-727.