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About ilvaite-epidote-skarns in the persodic Ilímaussaq intrusion, S-Greenland

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The Ilímaussaq intrusion is one of the major intrusive complexes in the rift-related Gardar igneous province, S-Greenland. The 1.16 Ga old complex records an extreme fractionation trend from silica saturated augite syenite (alkali feldspar, hedenbergite, magnetite, olivine, biotite) towards different varieties of silica undersaturated agpaitic nepheline syenites (sodalite, alkali feldspar, nepheline, aegirine, arfvedsonite and eudialyte in different proportions). This fractionation results in an enrichment in incompatible elements yielding lots of peculiar minerals [1,2]. A large number of late- magmatic veins are found in all Ilímaussaq rock types, mostly containing sodium-rich minerals like aegirine, albite, sodalite and analcime. Formation temperatures between 300 and 400˚C were inferred from phase equilibria and fluid inclusion data of these veins [3-5].

Skarn-like rocks occur in two different regions of the intrusion, although no carbonate-bearing rocks at all are known from the intrusion or its host rocks. The 'skarn' assemblage consists of ilvaite + epidote + F-bearing hydroandradite + albite + microcline + amphibole (arfvedsonite, hastingsite) + zircon $\pm$ aegirine $\pm$ allanite $\pm$ hematite $\pm$ titanite $\pm$ fluorite. Because of the lack of near-by carbonate rocks the formation of these 'skarns' was studied in greater detail.

In the simplified system Ca-Fe-Si-O-H activity-corrected phase relationships were calculated between andradite, hedenbergite, hematite, Fe-actinolite, quartz and water using the Unitherm software of [6] and were later combined with Al to integrate epidote- and grossular-stability. The formation temperature is in agreement with field observations which indicate that the ilvaite mineralization is related to hydrothermal veins for which temperatures of 250 to 400˚C have been inferred. The oxygen fugacity is above the hematite-magnetite-buffer reaction, which is in agreement with the evolution trend of Ilímaussaq melts investigated by [7].

The XRF-whole-rock trace element patterns of the ‘skarns’ are similar to the patterns of some of the Ilímaussaq rocks analysed by [1]. This supports the assumption of an autometasomatic origin of the ‘skarns’. However, the ‘skarns’ are significantly enriched in CaO, which may reach up to 6.6 wt.%, indicating the addition of calcium. In principle, there are the two possible sources, an internal and an external.

Internal calcium-sources such as decomposition of primary clinopyroxene and ternary feldspar (in the augite syenite) or eudialyte (in the naujaite) and redistribution of the components may explain parts of the calcium-rich mineralogy formed during the metasomatic process. The decomposition of eudialyte could not only be a Ca-source but also be the source for the large numbers of small, euhedral, secondary zircon crystals in the ‘skarns’ and the REEs found in allanite.

Release of calcium:

feldspar: $$\underset{(Ca-feldspar)}{3\ CaAl_2Si_2O_8} + 6\ Na^+ + 12\ SiO_2 = \underset{(albite)}{6\ NaAlSi_3O_8} + \mathbf{3\ Ca^{2+}}$$

clinopyroxene: $$\underset{(hedenbergite)}{2\ CaFeSi_2O_6} + 2\ Na^+ + 2\ H^+ + 0.5\ O_2 = \underset{(aegirine)}{2\ NaFeSi_2O_6} + \mathbf{2\ Ca^{2+}} + H_2O$$

Reprecipitation:

ilvaite: $$\mathbf{Ca^{2+}} + \underset{(arfvedsonite)}{Na_3Fe_4^{2+}Fe^{3+}Si_8O_{22}(OH)_2} + 0.5\ O_2 + H^+ = \underset{(ilvaite)}{CaFe^{3+}Fe_2^{2+}O(Si_2O_7)(OH)} + Fe_2O_3 + 6\ SiO_2 + 3\ Na^+ + H_2O$$

epidote: $$\mathbf{4\ Ca^{2+}} + \underset{(albite)}{4\ NaAlSi_3O_8} + 2\ Fe_3O_4 + 8\ OH^- + 0.5\ O_2 + 2\ SiO_2 = \underset{(epidote)}{2\ Ca_2Fe^{3+}Al_2(Si_2O_7)(SiO_4)O(OH)} + \underset{(aegirine)}{4\ NaFeSi_2O_6} + 3\ H_2O$$

$$\Sigma Ca^{2+} = 0$$

Hence, although the late-stage fluid was enriched in sodium [8], the alteration of the primary minerals by this fluid could result in an ilvaite-, epidote-, and hydroandradite-bearing rock by redistribution of the calcium.

An external source for calcium could be sought in the basaltic host rock which itself contains sporadically secondary epidote.

Stable isotope analyses ($\partial^{18}O$ and ∂D) of the ‘skarns’, which are in progress, should provide a deeper insight into the processes involved in the formation of the calcium-rich minerals, elucidate the provenance of the calcium and prove or disprove processes like fluid influx of meteoric waters. This could support or overrule the theory of a closed system evolution.

References

[1] Bailey, J.C.; Gwozdz, R.; Rose-Hansen, J. & Sørensen, H. (2001): Geochemical overwiew ot the Ilímaussaq alkaline complex, South Greenland. In: Sørensen, H. (ed): The Ilímaussaq alkaline complex. South Greenland: status of mineralogical research with new results. *Geol. Greenland Survey Bull.*, **190**, 35-53.

[2] Petersen, O.V. (2001): List of all minerals identified in the Ilímaussq alkaline complex, South Greenland. In: Sørensen, H. (ed): The Ilímaussaq alkaline complex. South Greenland: status of mineralogical research with new results. *Geol. Greenland Survey Bull*, **190**, 25-33.

[3] Sobolev, V.S.; Bazarova, T.Y.; Shugurova, N.A.; Bazarov, L.S. Dolgov, Y.A. & Sørensen, H. (1970): A preliminary examination of fluid inclusions in nepheline, sørensenite, tugtupiote and chkalovite from the Ilímaussaq alkaline intrusion, South Greenland. *Geol. Greenland Survey Bull*, **81**, 1-21.

[4] Konnerup-Madsen, J. & Rose-Hansen, J. (1982): Volatiles associated with alkaline igneous rift activity; fluid inclusions in the Ilímaussaq intrusion and the Gardar granitic complex (South Greenland). *Chem. Geol.*, **37**, 79-93.

[5] Markl, G. (2001): A new type of silicate liquid immiscibility macroscopically visible in Proterozoic peralkaline rocks from Ilímaussaq, South Greenland. *Contr. Min. Petrol.*, **141**, 458-472.

[6] Shvarov, Y. V. & Bastrakov, E. N., (1999): HCh: a software package for geochemical equilibrium modelling. *User's Guide: Australian Geological Survey Organisation*, Record 1999/25, 61 p.

[7] Markl, G.; Marks, M.; Schwinn, G. & Sommer, H. (2001): Phase Equilibrium Constraints on Intensive Crystallization Parameters of the Ilímaussaq Complex, South Greenland. *J. Petro.*, **42** (12), 2231-2258.

[8] Markl, G.; Baumgartner, L. (2002): pH changes in peralkaline late-magmatic fluids. Contr. Min. Petrol.,***144****, 331-346.*