Halogen behaviour in sodalite and eudialyte of the Ilímaussaq Intrusion, South Greenland

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Peralkaline nepheline syenites of the Ilímaussaq intrusion (South Greenland) contain variable amounts of Cl-rich eudialyte (0.5 to 1.5 wt.% Cl) and sodalite (6 to 7 wt.% Cl). The intrusion consists, simplified, of three major rock units: Roof cumulates (naujaites) are rich in sodalite, a low-density mineral that floated to the top of the magma chamber, whereas floor cumulates (kakortokites) are rich in eudialyte, a high-density mineral that sank to the floor. More evolved rocks (lujavrites) are fine-grained and form a sill complex, which intrudes the roof cumulates. In this intrusion, sodalite could only be analyzed in naujatites, eudialyte in all rock units. In most magmatic systems, Cl^- tends to concentrate in the fluid phase. Under extremely reduced conditions (DeltaFMQ<-3) such as Ilímaussaq, however, Cl^- prefers to stay in the magma, as magmatic fluids are CH_4- instead of H_2O-rich. Sodalite and eudialyte are the only minerals containing significant amounts of Cl and are, therefore, the most appropriate minerals to study the behaviour of Cl^- and related ions in peralkaline intrusions.

Cl^- in sodalite is rather constant at 6.5 to 7.5 wt.%. In eudialytes, it decreases from 1.5 to 1.1 wt.% in the naujaites, is low (on average 0.7 wt.%) in the lujavrites and is relatively constant at 1.3 wt.% in the kakortokites.

In both minerals, Cl^- can be replaced by anions such as bromide (Br^-) or fluoride (F^-). Br^- fits generally well into the Cl^- site, but its abundance is much lower than Cl^-. In sodalite, the Br/Cl ratio decreases from 0.002 in the upper to 0.0007 in the lower naujaites. In eudialyte, the Br/Cl ratio is mostly 2 to 4 times lower than in sodalite. In the naujaites, the Br/Cl trends of eudialyte and sodalite seem comparable. In lujavrites and kakortokites, the Br/Cl ratio is variable, but has mostly lower values down to 0.0001.

The F^- ion is much smaller than Cl^- and does not always fit well on the Cl^- site. As a result, F^- prefers to form minerals of its own (e. g. fluorite, villiaumite). It is, however, present in small quantities in sodalite and eudialyte. In sodalite, the F/Cl ratio is about 0.01, with an increasing trend from the top to the base of the naujatie section. In eudialyte, it is on average 0.1. In the naujaites, the F/Cl ratio trend folows that of sodalite. In the lujavrites a relatively steep increase from top to base is observed and F/Cl ratios can be above 1. In the kakortokites, the ratio is relatively constant at 0.15.