A micro-X-ray spectroscopic investigation of CL colors in albite from the Georgeville granite, Nova Scotia

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Chemical zonation in optically continuous albite (~An_1) grains, in the 560 Ma A-type Georgeville granite, are readily revealed by cathodoluminescence (CL) as shown in single grains where red CL overprints earlier blue CL regions. The CL colors are indicative of the chemical state of the system during mineral formation or alteration. Microscale analyses, including X-ray Excited Optical Luminescence (XEOL), of the different CL regions in albite provides complementary information about the CL activators and the geochemical evolution of the granite.

Because of its sensitivity to luminescence activators, XEOL is a powerful tool for investigating the cause of CL activation in minerals. Our XEOL measurements show that different de-excitation processes occur in the red and blue CL regions. Using an x-ray excitation energy above the Fe K-edge, a 720 nm XEOL peak dominates red CL regions, and a 280 nm XEOL peak dominates blue CL regions. XEOL collected above the Fe L-edge also show that red CL regions are dominated by a 720 nm peak, while a weak 430 nm peak characterizes blue CL areas. Although red CL in feldspar is known to relate to the presence of Fe^{3+}, our XEOL results show that neither Fe L- nor K-edge excitation is responsible for the red CL. X-ray absorption (XAS) and fluorescence (XRF) measurements on the blue and red CL regions indicate that the oxidation state of Fe is unchanged between the areas, and that the red regions are relatively enriched in Fe and depleted in Ca compared to blue regions. In addition, Laser Ablation Inductively Coupled Plasma Mass Spectrometry analyses show that blue CL regions are characterized by higher concentrations of Ti, ΣREE's and Pb compared to red CL areas.

The texture and chemistry of the red and blue CL regions indicate pervasive modification of the albite chemistry by late, fluid-related processes.

The ^{81}Kr-Kr dating technique for meteorites

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The long standing question whether CAIs and/or chondrules are pre-exposed to galactic cosmic-rays relative to the rest of their host meteorites or not can only be answered using advanced dating techniques. We therefore checked the ^{81}Kr-Kr dating technique (e.g., [1,3]) for meteorites. This technique is reliable and independent of the size of the meteorite, the shielding depth of the sample, and its chemical composition. We performed a systematic comparison of ^{81}Kr-Kr and ^{36}Ar-^{36}Cl ages for ordinary chondrites with long exposure ages and high metamorphic grades (H5, L5, L6).

We separated and cleaned metal samples for all 13 selected chondrites and measured ^{10}Be, ^{26}Al, and ^{36}Cl by AMS and ^{3,4}He, ^{21,22}Ne, and ^{36,38}Ar by noble gas mass spectrometry. Based on the thus obtained data we determined reliable cosmic-ray exposure ages using the ^{36}Cl-^{36}Ar method. Bulk samples of the selected objects have already been analyzed for ^{3,4}He, ^{21,22}Ne, and ^{36,38}Ar. The data enabled us to experimentally check model calculations of cosmogenic nuclide production rates [2] as well as to study diffusion losses of ^{3}H and/or ^{3}He in metal and silicate phases. Additionally, we calculated cosmic-ray exposure ages for all 13 objects using either the correlations given by Nishiizumi *et al.* (1980) [4] and Eugster (1988) [5] or production rates based on state-of-the art modeling [2].

The study is currently be completed by the analysis of Kr and Xe isotopes, with a special emphasis on ^{81}Kr. In addition we currently perform first model calculations for cosmogenic production rates of Kr and Xe isotopes. This study will not only improve our understanding of the ^{81}Kr-Kr-dating technique for meteorites, it will also significanly increase our knowledge about cosmogenic heavy noble gases.

Additional exposure age studies of e.g. CAIs, chondrules, rims around chondrules, dark and light inclusions, using the improved ^{81}Kr-Kr system will follow.

[1] Eugster *et al*. (2006) *MESS II*, 829-851. [2] Leya & Masarik (2008) *MAPS* (accepted). [3] Wieler (2002) *RiMG* **47**, 125-170. [4] Eugster (1988) *GCA* **52**, 1649-1662. [5] Nishiizumi *et al*. (1980) *EPSL* **50**, 156-170.