Assignment of blue luminescent emission in alkali feldspar

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Cathodoluminescence (CL) of alkali feldspar has been used as an important tool to characterize its texture for clarification of hydrothermal metasomatism and fluid-interacted alteration. CL intensity and peak position depend mainly on the variety of luminescence center and activator concentration, which are closely related to process of crystallization and subsequent metamorphism or alteration. Only a few detailed assignments of their blue CL, however, have been made for natural samples, where there are two possible emission centers of Ti^{4+} impurity and Al-O^--Al defect. CL of alkali feldspar has been studied to assign emission centers for blue CL emission by spectral analysis.

Alkali feldspar in a quartz syenite from the Patagonian Andes, Chile was used for CL measurements. It shows a variety of blue CL and red CL among its microtextures such as clear feldspar formed by magmatic process and patch microperthite (PMP) by subsequent hydrothermal metasomatic reaction. A scanning electron microscopy-cathodoluminescence (SEM-CL) was conducted to obtain CL spectra at 15 kV with an incident beam current of 2.0 nA.

CL spectra of CF (TiO_2: 0.005 wt.%) and Ab-rich PMP (TiO_2: 0.017 wt.%) show a blue narrow spectral peak at around 400 nm and broad one at around 420 nm, respectively. Both peaks can be fitted by two Gaussian curves in the energy unit. This fitting results in the deconvolution of CL spectral peak with two Gaussian curves centered at 3.04 eV and 2.90 eV. An integral intensity of the peak at 3.04 eV positively correlates to the content of Ti impurity among these samples. It suggests that the peak at 3.04 eV can be assigned to Ti^{4+} impurity center. CF has five to ten times higher intensity of the peak at 2.90 eV than the microtexture formed by a hydrothermal metasomatic reaction. The intensity negatively correlates to an intensity of red emission related to Fe^{3+} impurity center, which closely relates to Al-O^--Al defect center suggested by ESR study. It implies that CL emission peaked at 2.90 eV is responsible for Al-O^--Al defect center.

A quantitative estimation of Ti^{4+} impurity and Al-O^--Al defect using CL gives an important information on crystallization process and hydrothemal metasomatism reaction.

Laboratory experiments on the weathering of iron meteorites and carbonaceous chondrites by iron-oxidising bacteria

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Elucidating the effects of microorganisms on meteoritic material is necessary to determine whether terrestrial biological weathering could be confounded with purely abiotic chemical weathering, particularly that which has occurred prior to meteoritic fall either in space or other planetary bodies. A particularly important case is meteoritic material from Mars for which, in addition to chemical weathering, there is controversy about Martian biological involvement in weathering which will be investigated in samples returned from Mars.

Batch culture experiments were performed to investigate the weathering of meteoritic material by iron-oxidising bacteria. The aerobic, acidophilic iron oxidiser (*Acidithiobacillus ferrooxidans*) was capable of oxidising iron from both carbonaceous chondrites (Murchison and Cold Bokkveld) and iron meteorites (York and Casas Grandes). Preliminary iron isotope results clearly show contrasted iron pathways during oxidation with and without bacteria suggesting that a biological role in meteorite weathering could be distinguished isotopically.

Weathering experiments using enrichment cultures of facultative iron-oxidising anaerobes obtained from freshwater sediments in town ditches of Bremen, German were conducted. Anaerobic iron-oxidisers growing under pH-neutral conditions oxidised iron from iron meteorites. These results show that rapid biologically-mediated alteration of extraterrestrial materials can occur in both aerobic and anaerobic environments and they suggest the possibility of an iron cycle within meteoritic materials.

These results also demonstrate that iron can act as a source of energy for microorganisms from both iron and carbonaceous chondrites in aerobic and anaerobic conditions with implications for life on the early Earth and elsewhere.