Cathodoluminescence of high-pressure feldspar minerals

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Cathodoluminescence (CL) of high-pressure silica minerals have been investigated, although high-pressure feldspar minerals such as $KAlSi_3O_8$-hollandite has not been studied from the perspective of CL spectroscopy. In this study, high-pressure feldspar minerals have been characterized by CL spectral analysis to clarify their emission mechanisms.

$KAlSi_3O_8$-hollandite ($Or_{97}Ab_3$) synthesized from adularia at a static condition of ~15 GPa and ~1200°C for 1 hour and experimentally shock-induced sanidine ($Or_{87}Ab_{13}$) from Eifel, Germany at pressure of 10 to 40 GPa by a propellant gun were selected for CL measurements. A scanning electron microscopy-cathodoluminescence (SEM-CL) was used to obtain CL spectra of these minerals.

CL spectrum of $KAlSi_3O_8$-hollandite consists of emission bands at 330 and 380 nm in UV-blue region. Similar UV-blue emission bands were detected in experimentally shocked sanidine above 20 GPa (diaplectic glass), but not observed in the samples below 20 GPa (diaplectic feldspar), where these emission intensities increase with increasing shock pressure. Diaplectic glasses in shergottites also exhibit UV-blue emissions at 330 and 380 nm. $KAlSi_3O_8$-hollandite has higher intensities of the UV-blue emissions than shocked samples at 40 GPa as well as diaplectic glasses in shergottite which might be responsible for completely octahedral coordination of Si (Al) in $KAlSi_3O_8$-hollandite and partially one in diaplectic glass. The UV emissions at 330 and 380 nm might be assigned to defect centers in Al and Si octahedral coordination produced by static and shock metamorphism. Furthermore, CL spectrum of $KAlSi_3O_8$-hollandite shows emissions at 550, 580, 660, 710 and 730 nm, which were undetectable in experimentally shocked sanidine above 20 GPa and diaplectic glasses in shergottite. These emission bands are characteristics of CL signals derived from $KAlSi_3O_8$-hollandite. Therefore, the CL signals can be used to identify high-pressure feldspar minerals and to observe its distribution in meteorite with high spatial resolution (~1 μm).

Long-term production rates of cosmogenic nuclides: Millions of years of rock exposure in Antarctica and the Atacama Desert

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Introduction

Production rates (PR) for terrestrial cosmogenic nuclides are typically estimated by measurements of independently dated samples, by exposure of artificial targets for a known duration or by coupling cross-sections with model-generated particle fluxes. The determination of PRs for extraterrestrial samples, on the other hand, utlizes samples that have achieved secular equilibrium during long exposure in a low erosion environment. Here we adopt this approach to derive terrestrial cosmogenic ^{10}Be and ^{26}Al production rates.

Results and Discussion

Sets of paired ^{10}Be-^{26}Al results were selected from our published and unpublished data (28 Antarctica, 45 Atacama Desert). All samples contain more than $4x10^6$ atoms ^{10}Be/g quartz, sea level at high latitude. The ^{10}Be concentrations were plotted against corresponding $^{26}Al/^{10}Be$ values, and a range of possible 'saturated' ^{10}Be production rates.

A ^{10}Be production rate (P_{10}) of 5.1-5.3 atom/yr g-quartz is the best fit to the measurements. This P_{10} is much higher than the recently proposed P_{10} of ~4.5. Known geologic processes cannot reconcile these two production rates. In fact, the P_{10} based on Atacama and Antarctic samples is a minimum production rate since: (1) samples must have experienced some erosion and even 5 cm/Myr erosion yields a 16 % P_{10} increase; (2) any soil, ash or snow cover would artificially depress our PR estimate; (3) saturation may not have been achieved, since for many samples ^{26}Al-^{21}Ne exposure ages do not show more than 8 Myr exposure age (98 % saturation for ^{10}Be); (4) uplift of the Transantarctic Mountains and Atacama Desert moves the samples into higher PR. The high P_{10} indicates that the long-term cosmic ray flux is higher than that of the last few tens of thousands of years, probably due to a higher GCR flux and lower geomagnetic field in the past.