Polishing Experiments of Rock Thin Sections for EBSD Analysis -Verification of the effect of Colloidal Silica and Plasma Etching-

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[Introduction]
SEM (Scanning Electron Microscopy)-EBSD (Backscattered Electron Diffraction) analysis is one of the main methods used to obtain crystallographic information of rock forming minerals. In particular, the crystallographic fabric of olivine, a major constituent mineral of the upper mantle, is important information for understanding convection patterns and deformation environments in the interior of the Earth and has been actively studied using SEM-EBSD analysis. The analysis surface of rocks is usually damaged by polishing during the preparation of thin sections. In the case of EBSD analysis, the information is obtained from the topmost surface of several tens of nm, therefore it is important to remove the damaged layer. In a previous study, colloidal silica treatment conditions for quartz and calcite for SEM-EBSD analysis have been verified (Kanai et al., 2015), but the pretreatment procedure for olivine has not been verified yet.
In this study, the optimal pretreatment conditions for crystal orientation analysis of peridotite were verified by combining (1) colloidal silica solution vibratory polishing, which is used as a common pretreatment method for SEM-EBSD analysis, and (2) plasma etching, which is usually used in the engineering field but rarely used in the earth science field.
[Sample and Methods]
We used Horomann peridotite collected in the Hidaka Belt, Hokkaido, as an analytical sample. Rock thin sections were prepared in planes parallel to lineation and foliation (XY plane) and polished with 1 μm diamond for 30 minutes. Then, vibratory polishing using colloidal silica solution and finishing treatment using a plasma etching system were performed. The treatment conditions of colloidal silica were verified for 0, 1, 3, 6, 9, and 12 hours. The plasma etching process was verified for 0, 10, 20, 30, 40, 60, and 90 seconds at 6 Pa/8-10 mA. To evaluate the surface condition of the samples under each processing condition, we used Band Contrast (BC) for the contrast of EBSD patterns, Mean Angular Deviation (MAD) for the accuracy of indexing, Hit Rate for the success rate of indexing, and *J*-index for the concentration of crystal orientation. Higher BC, Hit Rate, and *J*-index are better, and MAD should be less than 1. EBSD mapping of the entire thin section was also performed to verify the influence of the crystal orientation of olivine.
[Results]
At 0, 1, and 3 hours of colloidal silica, the mean value of BC and hit rate increased with longer treatment time and stabilized at a constant value at more than 6 hours. The *J*-index values showed a tendency to increase with longer colloidal silica treatment times. In the case of 3 hours of colloidal silica treatment and plasma etching for more than 40 seconds, the quality of indexing became equivalent to the result as 6 hours of colloidal silica treatment.
Comparing the plunge angle of each crystal axis of olivine with respect to the analysis plane and the indexing parameters, it was observed that the larger the plunge angle of *b*-axis and the smaller the plunge angle of *c*-axis, the larger the values of BC and *J*-index, and the higher the indexed Hit Rate.
[Discussion and Conclusions]
From the above results, the optimum pretreatment condition for olivine is colloidal silica for more than 6 hours.
By applying the pretreatment conditions proposed in this study, it will be possible to obtain olivine crystal

orientations with equivalent data quality in SEM-EBSD analysis, which is expected to facilitate the understanding of the inner Earth environment from the viewpoint of structural petrology.

[References]

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