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Application News

No. P106

Electron Probe Microanalyzer

Trace Element Mapping of Plagioclase

Introduction

The minerals contained in rocks record physical and chemical information from the time when the rocks were formed. Shimadzu EPMA is useful for investigating the precise chemical composition and 2-dimensional distribution of the elements in these rock-forming minerals. Here, element mapping of plagioclase in lava from Mt. Unzen volcano in Japan was carried out using a Shimadzu EPMA™ electron probe microanalyzer (EPMA-8050G, hereinafter, EPMA). As a result, it was possible to discover the microstructure in the rim part of the plagioclase.

The thin-slice specimens used here were provided by Mr. Hideto Yoshida (Technical Director, Technical Division, School of Science) Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo.

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Element Mapping of Plagioclase

Plagioclase, the principal component mineral of volcanic rock, is a solid solution consisting of anorthite ($CaAl_2Si_2O_8$) and albite ($NaAlSi_3O_8$). In the cooling process of high-temperature magma, first, crystals with a large anorthite component form, and then, as cooling proceeds, the composition changes to one with a large albite component. Areas where the chemical composition changes discontinuously appear as stripes. This is referred to as "zonal texture."

Fig. 1 shows the result of a wide-area EPMA mapping analysis of the principal elements of plagioclase, O, Na, Al, Si, and Ca, and the trace elements Mg, K, and Fe. Concentric zoning can be seen, and as a general tendency, the core area has a large anorthite content, while the rim area has an albite-rich composition. However, the outermost rim has an anorthite-rich composition, which is termed "reverse zoning," and a reaction rim can be observed (Fig. 2). These facts suggest that the temperature, pressure, and abundance of H_2O changed during the crystal cooling process, and interaction with other magma also occurred.

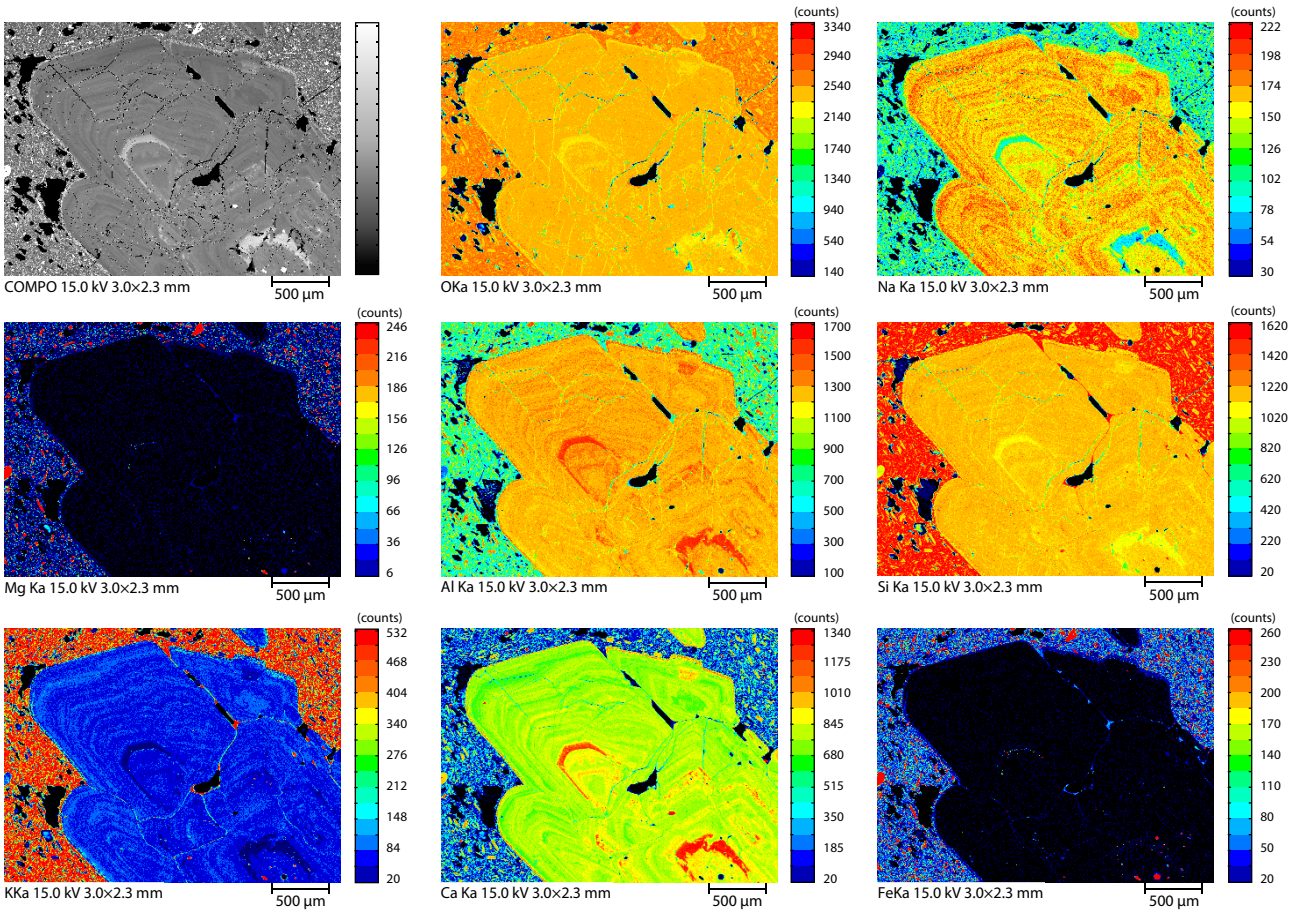

Fig. 1 Wide-Area Element Mapping of Plagioclase

Mapping of Rim Area of Plagioclase

In the rim area of phenocrysts in rocks, various phenomena occur as a result of contact with other magma following once cooling. To elucidate those changes, the rim area of the plagioclase was mapped under higher magnification. As a result, it was found that counts of Na decreases in the rim area, while counts of Al, Ca, and trace elements Mg, K, and Fe increase (Fig. 2).

Further enlargement of the rim area revealed that the contents of the principal elements of plagioclase, namely, Na, Al, and Ca are small in parts where the K content is large, and in contrast, particles of Mg and Fe had collected in those parts (Fig. 3).

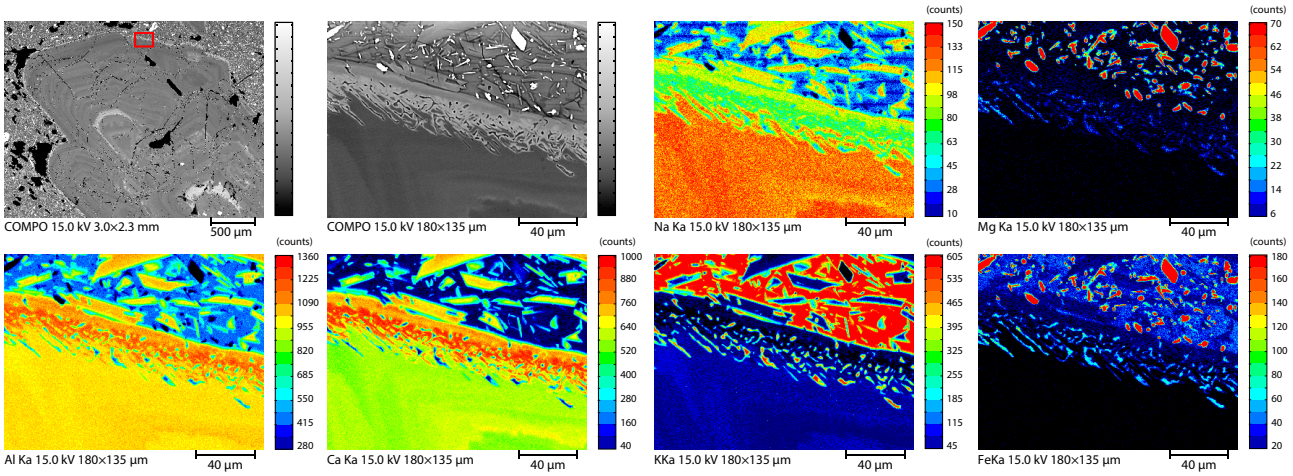

Fig. 2 Element Mapping of Rim Area of Plagioclase

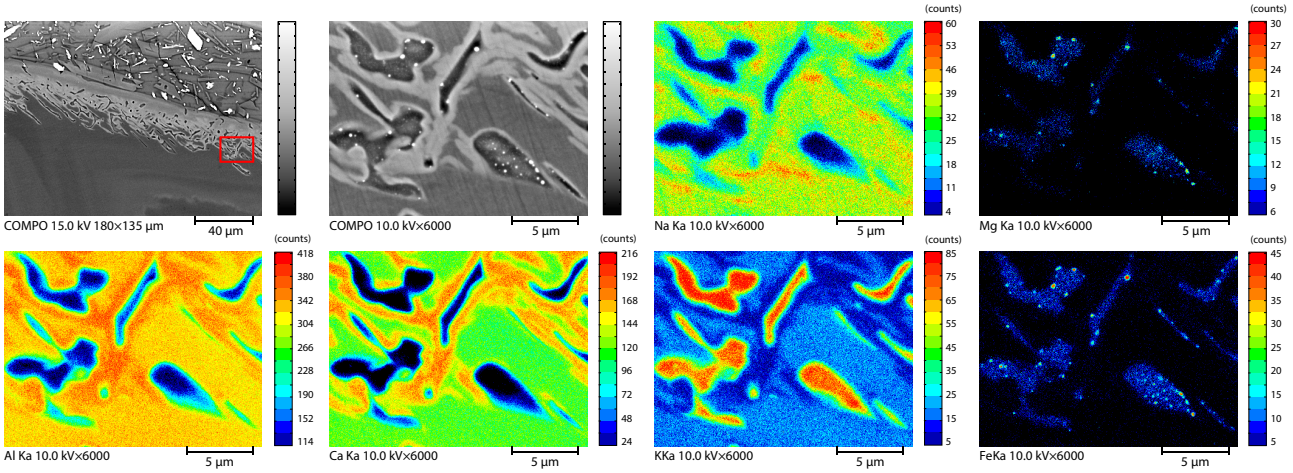

Fig. 3 Element Mapping of Rim Area of Plagioclase (Enlarged Views)

Trace Element Mapping of Rim Area of Plagioclase

High magnification mapping revealed that Mg- and Fe-containing inclusions that concentrated in parts of the rim with high K contents existed at a number of scattered points as microscopic particles with a maximum size of several 100 nm and a minimum size of several 10 nm or less (Fig. 4).

As this experiment shows, it was possible to obtain valuable information for understanding the history of interaction between phenocrysts and magma by high resolution mapping with the Shimadzu EPMA.

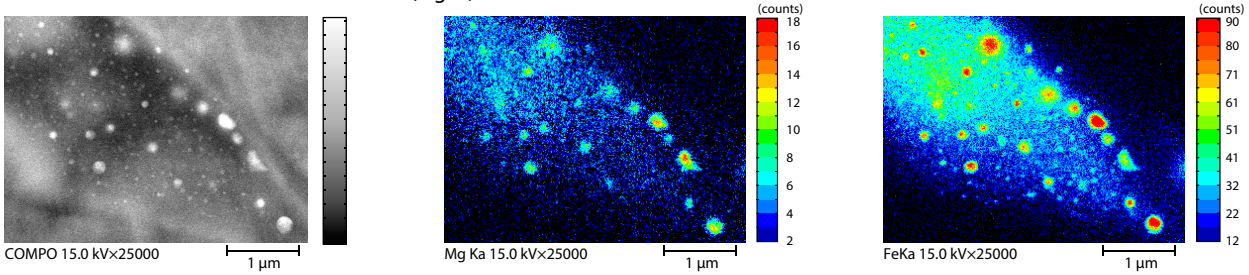

Fig. 4 Mapping of Inclusions Consisting of Mg and Fe

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