SEM-EDS Automated Particles Analysis—“INCA Mineral”—
Mineral Compositions of Koujaku Granite and Hakkoda Pyroclastic Flow Deposition

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Automated particle analysis is one of well matured methods of multiparticle analysis. In recent years, the automated particle analysis combined with a scanning electron microscope (SEM) with energy dispersive X-ray spectroscopy (EDS), which is called SEM-EDS automated particle analysis, has rapidly been advancing with the development of silicon drift detector (SDD) for EDS.

In this presentation, analysis of the mineral compositions of two rocks—the Koujaku granite and the Hakkoda second-stage pyroclastic flow deposition (Ht2)—was carried out with “INCA Mineral” (OXFORD INSTRUMENTS), a software based on the SEM-EDS automated particle analysis. The samples for this analysis were prepared as follows: two rocks were crushed separately, their broken pieces larger than 100 µm in diameter were sifted out, and the smaller pieces embedded in resin were polished. Figs. 1a and 2a show backscattered electron (BSE) composition images of the Koujaku granite and the Ht2, respectively. The number of tiny particles a few micrometers was larger in Fig. 2a than in Fig. 1a.

In the BSE composition image, brightness of particles mainly depends on their elemental composition: the particles with the composition with a larger average atomic number give a brighter contrast and the particles with similar composition exhibit almost the same brightness. Based on this observation, the particles in the BSE image can be classified into groups with similar compositions. Analytical points on the particles for EDS are automatically decided depending on the particle shape characterized by a specific brightness level. At each point, the X-ray spectrum is acquired and used for quantitative analysis. The results of the quantitative analysis of all the analytical points are stored and used to identify each particle as a previously known type of minerals reported in the literatures. More than 2,000 particles of the Koujaku granite and more than 8,000 particles of the Ht2 were analyzed as described previously. At least, six types of constituent minerals were identified in the Koujaku granite: they were shown in Fig. 1b together with their concentration. Quartz was a dominant constituent with 68%. K-feldspar and alkali feldspar were contained in higher concentration than plagioclase. In addition to these six types, iron-titanium oxide, zircon and rare earth elements were also observed in a small amount. The present composition was characteristic of the ordinary granite [1]. Sawada et al. [2] analyzed the same Koujaku granite with X-ray fluorescence analysis and inferred from the observed average concentrations of potassium and calcium that the mineral concentration of K-feldspar was larger than that of plagioclase. The present particle analysis: 12 % K-feldspar concentrated with 5 % plagioclase, produced the similar result. In the Ht2, quartz, plagioclase, zeolite and alkali feldspar were main constituent minerals as shown in Fig. 2b. Iron-titanium oxide, pyroxene, apatite and pyrite were also observed in a small amount. In this case, plagioclase was contained in higher concentration than alkali feldspar. This feature suggested that the Ht2 is rhyolite similar to dacite, as previously reported by Kudo et al [3].

Figs. 3a and 3b association graphs show the correlation of quartz with other minerals in the
Koujaku granite and the Ht2, respectively. The size range of particles containing quartz in the Koujaku granite was between 1 and 140 µm, whereas that in the Ht2 was 1 and 45 µm; the particles containing quartz in the Koujaku granite was substantially larger than those in the Ht2. The percentage of association types of quartz containing particles was difference in the same size range: in the Koujaku granite, more than 90 % of quartz containing particles with the size about 30 µm in diameter was “solo—did not associated with other mineral particle—”, whereas in the Ht2, about 60 % was “solo” in the same size range. This was due to the difference in the formation process of two rocks.

The SEM-EDS automated particle analysis “INCA Mineral” has great potential in mining industry and provides a new insight into studies of source and volcanic history by combining with other studies, for example Electron Spin Resonance and Thermoluminescence signals of quartz [4].

References:

**Figure 1, 2** Backscattered electron composition images and classification results by quantitative analysis

**Figure 3** Association graphs of quartz