Volatile composition of the Aira pyroclastic eruptions, SW Japan

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Most volatile components are released to the atmosphere by explosive degassing from magma,and emission of volatiles during huge eruptions plays an important role in the global environment. For pre-historic eruptions, however, estimation of the composition and volume of volatiles released to the atmosphere is very difficult. Here we report volatile compositions in inclusions in phenocrysts and matrix glasses of pumices and widespread tephra from the 25 ka Aira pyroclastic eruption. This is one of a number of giant eruptions which occurred in Japan during the Pleistocene. The analyses were made using EPMA areal compositional mapping and quantitative analysis, C-H-N-S elemental analysis, and pyrolysis-gas chromatography mass spectrometry (py-GC-MS).

The results were:

(1) EPMA areal compositional mapping show the presence of inclusions containing C,Cl,S,N and B in phenocrysts (plagioclase, orthopyroxene, quartz) within pumices.

(2) Py-GC/MS analysis at 600degC detected aromatic compounds with O and N in phenocrysts from pumices from the Osumi pumice fall and Ito pyroclastic flow deposits. Combined with (1) we infer that the inclusions probably originated from volatile components derived from Shimanto Belt sedimentary rocks which surround the Aira magma chamber, by entrapment in phenocrysts and polymerization during magma cooling. Some volatiles may also have originated from Shimanto Belt basement.

(3) C-N-S analyses for bulk matrix glass and phenocrysts from pumices: (A) Osumi pumice fall: (a) phenocrysts: carbonate C: less than450ppm, non-carbonate C:250ppm, N :30ppm, (b) matrix glass: carbonate C :10 ppm, non-carbonate C :800ppm, N :15ppm. (B) Ito pyroclastic flow deposits:(a) phenocrysts: carbonate C :420ppm, non-carbonate C :190ppm, N :21ppm, (b) matrix glass: carbonate C :56ppm, non-carbonate C :330ppm, N :10ppm. C and N contents of phenocrysts and matrix glass from the Osumi pumice fall deposit decrease from the bottom to the upper part, over an interval of 250cm.

(4) Quantitative EPMA analyses of matrix glass of pumice and tephra, and glass inclusions in phenocrysts show S, F, and Cl contents are: (A) Osumi pumice fall deposit: (a) glass inclusions - S :less than1200ppm, F:6300ppm, Cl:3000ppm (b) matrix glass - S:400ppm, F:2600ppm, Cl :1900ppm; (B) Ito pyroclastic flow deposits: (a) glass inclusions - S:less than800ppm, F:8600ppm, Cl:1400ppm, (b) matrix glass S:380ppm, F:2300ppm, Cl:2200ppm, (C) Aira Tn (AT): S:60ppm, F:1200ppm, Cl:1200ppm.

The volatile compositions of glass inclusions in both the phenocrysts and matrix glasses are variable. This suggests that the time and pressure conditions under which the glasses were formed, trapped, or quenched were also variable. Mass balance calculations indicate minimum volatile release during the Aira pyroclastic eruptions was in the order of 10E8 -10E9 tonnes for S, and 10E8 -10E10 tonnes for F and Cl.