Generation of voluminous felsic magma in 7.3ka Kikai-Akahoya eruption

*Kimihiro Nishimura[1], Yoshiyuki Tatsumi[2], Keiko Suzuki-Kamata[2], Jun-Ichi Kimura[3], Qing Chang[3], Koji Kiyosugi[4], Reina NAKAOKA[2], Kazuki Hayashi[1]

1. Graduate School of Science, Kobe University, 2. Kobe Ocean-Bottom Exploration Center, Kobe University, 3. JAMSTEC, 4. Organization of Advanced Science and Technology, Kobe University

Kikai caldera is located to the south of the Kyushu Island, SW Japan. Two islands, Take-shima and Satsuma Iwo-jima, are the subaerial parts on the northern rim of this caldera. Kikai-Akahoya eruption occurred at 7.3 ka is the latest caldera-forming eruption (>500km^3 of magma) in the Japanese Archipelago. Kikai-Akahoya eruption was commenced by plinian pumice-fall (Fk-fl), intraplinian flows, followed by climactic Takeshima-Koya pyroclastic flow (Tk-pf and Ky-pf) and co-ignimbrite ash. The Pre-caldera stage activity includes formation of mafic small stratovolcanoes and felsic lava flows. At the Caldera-forming stage, at least there voluminous pyroclastic flows: Koabi, Nagase and Takeshima-Koya pyroclastic flows at 140, 95 and 7.3 ka, respectively, were outflowed. At the Post-caldera stage, a giant rhyolite lava dome (~32km^3) were created with the central caldera, in addition to mafic magma and felsic magma eruptions at Inamura-dake and Iwo-dake, respectively. In order to understand the generation mechanism of voluminous felsic magma through this caldera cycle, major and trace elements and Sr isotopic compositions of plagioclases in ejecta of all stages were examined.
The juvenile materials of Tk-pf are composed of white pumice, scoria and banded pumice while Ky-pf doesn’t contain scoria and banded pumice. Fk-fl is composed of white pumice. The rim of plagioclases in white pumices are mainly composed of An_{52-61} and $^{87}Sr/^{86}Sr$=0.7047-49, whereas Sr and LREE content in the rim of Fk-fl plagioclases is higher than Tk-pf and Ky-pf. The core of plagioclases in white pumice are classified into three types: ①core with similar compositions to rim, ②higher An core (>An_{65}) in Fk-fl and Tk-pf and ③lower An core (<50) with high $^{87}Sr/^{86}Sr$ in Ky-pf. Plagioclases in scoriae show An_{59-82} in core and An_{67-83} in rim and lower $^{87}Sr/^{86}Sr$ (= 0.7044-48) than white pumices. The melt equilibrated with the rim of plagioclases in white pumices concentrates Sr=200-300ppm based on plagioclase-melt equilibria. The $^{87}Sr/^{86}Sr$ in plagioclases of scoriae increases with decreasing Sr content in the melt. Plagioclase compositions of felsic ejecta in both Pre- and Post-caldera stage are similar to those of white pumice at 7.3ka although the $^{87}Sr/^{86}Sr$ in Iwo-dake slightly higher than Pre-caldera stage. Plagioclase compositions of mafic ejecta in both Pre- and Post-caldera stages show $^{87}Sr/^{86}Sr$ higher than scoriae at 7.3ka. Plagioclase compositions of Koabi pyroclastic flow deposit are similar to those of white pumice at 7.3ka while Nagase pyroclastic flow have lower An (<50) than them and homogeneous $^{87}Sr/^{86}Sr$ (=~0.70475).
The compositions of rim in plagioclases in white pumice at 7.3ka suggest melt compositions of a large magma chamber immediately before Kikai-Akahoya eruption (L_1 melt). The rims of Fk-fl plagioclases with higher Sr and LREE content than others at 7.3ka suggest their partitioning coefficients between plagioclase and melt changed higher along with decreasing both An and pressure or increasing H_2O in melt. H_2O increased in the upper part but melt compositions, especially Sr content and $^{87}Sr/^{86}Sr$ were homogeneous in the magma chamber immediately before the eruption. The difference of $^{87}Sr/^{86}Sr$ in high An plagioclases between white pumices and scoriae suggest that they were crystallized from different melts. Scoriae may have tapped a magma experienced by mixing of a mantle-derived basaltic magma with lower $^{87}Sr/^{86}Sr$ and L_1 melt. On the other hand, $^{87}Sr/^{86}Sr$ of mafic magmas erupted at Pre- and Post-caldera stages are higher than scoriae, suggesting the contribution of crustal components to those magmas. Homogeneous felsic melt compositions from the Pre-caldera stage through Kikai-Akahoya eruption suggest felsic magmas were formed by partial melting of lower crust and rose and accumulated

in the upper crust to form a large magma reservoir with crystal mush. Voluminous felsic magma generation in Kikai-Akahoya eruption can be explained by rejuvenation of crystal mush when mafic magma penetrated into crystal mush. The slightly higher $^{87}Sr/^{86}Sr$ in the Post-caldera stage than Pre-caldera stage suggests creation of a new magma system after Kikai-Akahoya caldera-forming eruption.

Keywords: Kikai caldera, caldera-forming eruption, felsic magma

