Oral | Symbol S (Solid Earth Sciences) | S-VC Volcanology

[S-VC54_1AM1]Volcanic and igneous activities, and these long-term forecasting

Convener:*Teruki Oikawa(Institute of Geology and Geoinformation, Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology), Daisuke MIURA(Geosphere Sciences, Civil Engineering Research Laboratory, Central Research Institute of Electric Power Industry), Takeshi Hasegawa(Department of Earth Sciences, College of Science, Ibaraki University), Nobuo Geshi(Geological Survey of Japan, The National Institute of Advanced Industrial Science and Technology), Yoshihiro Ishizuka(Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology), Chair:Maya Yasui(College of Humanities and Sciences, Nihon University), Mitsuhiro Yoshimoto(Faculty of Science, Hokkaido University)

Thu. May 1, 2014 9:00 AM - 10:45 AM 411 (4F)

This session focuses on generation and accumulation processes of magmas, magma-crust interaction and degassing, and modes of eruption, long-term forecast of eruption, dispersal and emplacement of the volcanic products. The discussion spans petrological, geochemical, geophysical, and geological processes related with volcanic activity and products in the past, the present and the future.

10:15 AM - 10:30 AM

[SVC54-P05_PG]Factors governing fragmentation of submarine lava - mechanism of hyaloclastite formation

3-min talk in an oral session

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Hyaloclastite is water-lain volcanic breccia embedded in a matrix of glassy clasts by fragmentation of brittle lava under thermal stress. Fluidal basalt lava tends to form coherent flows like pillow lava and sheet flows. In contrast, viscous lava such as andesite and dacite is more likely to form hyaloclastite. This preference of hyaloclastite on lava composition indicates that mechanical response of solidified lava under stress is strongly dependent on composition. Fracturing of lava occurs when the rate of stress accumulation exceeds the rate of stress relaxation and ultimately reaches the mechanical strength of the lava. The rate of stress relaxation decreases with the increase in lava viscosity. Therefore, hyaloclastite is more common in viscous silicic lava. However, the occurrences of pillow lava of dacite and rhyolite are known from the Ogasawara Islands, Unalaska Island, Oman Ophiolite, etc. Pillow lava is commonly associated with hyaloclastite of the same compositions. These examples demonstrate that factors other than lava composition determines fragmentation of lava. Then, the problem arises what are the governing factors that control the mechanical response of lava under stress. We will address these issues through comparative study on glass, quenched melt, of pillow lava and hyaloclastite of variable compositions spanning from basaltic andesite to rhyolite from the Eocene submarine volcanic strata in Chichijima, Ogasawara Islands.Samples of glass from these sites were analyzed by EPMA for major elements and by SIMS for water contents. Eruption temperatures were estimated by clinopyroxene-liquid geothermometer of Putirka (2008). Crystal number densities of groundmass plagioclase and clinopyroxene were determined on COMPO images and modal abundance of constituent minerals were determined on element distribution maps of EPMA. Bulk viscosity of lava was estimated by the methods of Giordano et al. (2008) and Pinkerton and Stevenson (1992). Dacite has phenocrysts of

clinopyroxene, orthopyroxene, plagioclase and magnetite. Groundmass consists of clinopyroxene and plagioclase microlites and magnetite set in glass. In dacite glass, there is little difference in melt composition, eruption temperature, crystal number density between pillow lava and hyaloclastite. However, lower water content in hyaloclastite glass than in pillow margin glass yields higher bulk viscosity. Andesite has phenocrysts of clinopyroxene, orthopyroxene, plagioclase and magnetite. Groundmass consists of clinopyroxene and plagioclase microlites and magnetite set in glass. Clinoenstatite xenocrysts enclosed by orthopyroxene rim are occasionally present. Hyaloclastite is higher in crystal number density and mode of groundmass plagioclase than associated pillow lava. Hyaloclastite glass is lower in Al_2O_3 than associated pillow glass, consistent with preferential crystallization of plagioclase. However, the cpx-saturated melt temperatures show little difference between pillow lava and hyaloclastite. Bulk viscosity estimated for the lava to become hyaloclastite is higher than the lava that formed pillows because of the larger crystal number density in hyaloclastite. The above observations on dacite glass clearly indicate that water played an essential role in formation of hyaloclastite. Degassing either within the conduit or during flowage through lava tubes raised the bulk viscosity of lava and stress relaxation time, resulted in fragmentation of lava to form hyaloclastite. Although water content was not determined for andesite glass, higher crystal number density and modal amount of plagioclase in hyaloclastite with the same temperature as the coexisting pillow lava can be explained by volatile loss which raised the liquidus of plagioclase and its preferential crystallization, resulted in higher bulk viscosity and fragmentation of lava.