Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC11-P01 会場:コンベンションホール 時間:5 月 24 日 18:15-19:30

イエローストーン、ローンスター間欠泉において観測された噴火規模の二極化
Bimodal Distribution of Geyser Preplay Eruptions: Lone Star Geyser, Yellowstone National Park, USA

並木 敦子 [1*] ; Hurwitz Shaul[2] ; Murphy Fred[2] ; Manga Michael[3]
NAMIKI, Atsuko[1*] ; HURWITZ, Shaul[2] ; MURPHY, Fred[2] ; MANGA, Michael[3]

[1] 広島大学・総科, [2] 米国地質調査所, [3] カリフォルニア大学バークレー校
[1]Hiroshima University, [2]USGS, [3]UC Berkeley

Geyser eruption intervals are determined by rates of water and heat discharge into shallow subsurface reservoirs and the conduit. In some geysers, small amounts of water discharge prior to a main eruption ('Preplay') can affect eruption intervals. Water discharge during preplay reduces the hydrostatic pressure, which in turn, induces boiling of water that is at, or near the critical temperature. Ascending steam slugs from depth can also lead to shorter eruption intervals (Namiki et al., 2014). In April 2014, we carried a five day experiment at Lone Star Geyser, Yellowstone National Park. Eruptions and their preplays were recorded with an infrared sensor that measured temperature variations immediately above the geyser cone (3.4~m high), temperature loggers that measured water temperature at the base of the cone and in the outflow channels, water discharge, and visual observations. At Lone Star Geyser, during the preplay phase of the eruption, mainly liquid water is erupted, whereas the main phase of the eruption begins with the liquid-water dominated eruption and turns into the steam discharge. The temperature rise in an outflow channel indicates the occurrence of preplays and initiation of the main eruption. The acquired data suggests that the preplay patterns of Lone Star Geyser are vigorous and complex, consistent with previous observations (Karlstrom et al., 2013). Our new observations reveal two typical styles: 1) vigorous preplays with few events (<5) and long intervals (>20~minutes), and 2) less vigorous preplays that include several events (>5) with short intervals (few minutes), and continue approximately for one hour. Probability distributions of preplay durations show two peaks indicating the bimodal activity. The bimodality of Lone Star preplays may be a result of subtle change of temperature distribution in a convecting reservoir which has been observed in laboratory experiments (Toramaru and Maeda, 2013).

キーワード: geyser, preplay, bimodal
Keywords: geyser, preplay, bimodal

SVC11-P02 会場:コンベンションホール 時間:5 月 24 日 18:15-19:30

マグマだまりの底面および壁に付着した気泡が地震波により離脱する条件を調べるアナログ実験
The analogue experiment to investigate the condition of bubble detachment from magma chamber wall by seismic wave

吉野 信央 [1*] ; 寅丸 敦史 [2] ; 荒木 愛美 [1]
YOSHINO, Shio[1*] ; TORAMARU, Atsushi[2] ; ARAKI, Manami[1]

[1] 九州大学大学院理学府地球惑星科学専攻, [2] 九州大学大学院理学研究院地球惑星科学部門
[1]Department of Earth and Planetary Sciences, Graduate School of Sciences, 33 Kyushu University, [2]Department of Earth and Planetary Sciences, Faculty of Sciences, 33 Kyushu University

Volatile components, such as SO_2, CO_2 and H_2O, are saturated in magmas. These components are nucleated as bubbles when magmas are further oversaturated. Seismic waves will reduce the nucleation barrier to facilitate the heterogeneous bubble nucleation under a low supersaturation. Bubbles which heterogeneously nucleate on the wall or bottom of magma chamber get buoyancy then detach the wall or bottom and ascent with keeping internal pressure. According to the principle of advective-overpressure, the magma chamber is overpressurized. This overpressure may trigger eruptions and other geophysical phenomena such as low frequency earthquakes at geothermal fields. Thus the detachment condition of bubbles from wall or bottom surfaces is a key factor to control the onset of seismic triggering. In order to evaluate the effect of seismic wave and surface tension on the detachment condition, we conduct the analogue experiment.

Using a carbonated water as magma and experimental vessel as magma chamber, we design the experimental setup to find out that what kind of waves cause the bubble departure. We oscillate the experimental vessel containing a supersaturated carbonated water at various frequency and amplitude. In addition, we conduct the experiment to evaluate the effect of the bubble shape on the detachment condition because buoyancy to drive the detachment is controlled by bubble shape, such as contact angle and bubble radius. The contact angle is decided by surface tension which varies with ethanol concentration in carbonated water. Further, we investigate the effect of oscillation on the bubble morphology such as bubble radius or contact angle.

From a series of experiments, we obtained following results. 1) If the amplitude is small, the bigger CO_2 bubbles are detached and when the frequency is higher, the amplitude is small at the moment of detaching of bubble. 2) The increase in the ethanol concentration decreases the contact angle and detachment bubble radius. 3) When the experimental vessel is oscillated at the same frequency and amplitude, the increase in the ethanol concentration decreases the detachment bubble radius but contact angle is various and has no systematic features.

We consider that the reason why the contact angle has no systematic features is that during vertical oscillation, the contact angle has different value because the contact angle becomes small, when the experimental vessel goes down, whereas when the experimental vessel goes up, the contact angle becomes large.

Integrating experimental results, we summarize the detachment condition as follow: The thresholds of oscillation amplitude and bubble radius at the detachment condition decrease as the frequency of oscillation increases and as the contact angle decreases. In natural systems, it has been reported that the contact angle is small approximately 20 degrees for silicate minerals such as quartz or feldspar in magmas rather than oxide minerals (larger than 90 degrees) such as magnetite. So we can speculate that the seismic triggering for overpressure may occur in the ordinary magma chamber with silicate minerals-rich walls. Furthermore, the addition of other volatile components reduces the surface tension, leading to less threshold of oscillation amplitude and bubble radius.

SVC11-P03 会場:コンベンションホール 時間:5 月 24 日 18:15-19:30

Significance of vapor bubbles to the volatile budget of melt inclusions from West Zealandia seamount, Mariana arc

Significance of vapor bubbles to the volatile budget of melt inclusions from West Zealandia seamount, Mariana arc

NICHOLS, Alexander[1*] ; TAMURA, Yoshihiko[1] ; STERN, Robert[2]
NICHOLS, Alexander[1*] ; TAMURA, Yoshihiko[1] ; STERN, Robert[2]

[1]JAMSTEC, Yokosuka, Japan, [2]Department of Geosciences, University of Texas at Dallas, USA
[1]JAMSTEC, Yokosuka, Japan, [2]Department of Geosciences, University of Texas at Dallas, USA

Vapor bubbles are common in glassy silicate melt inclusions. They can develop during post-entrapment cooling and crystallization because the melt phase contracts more than the host crystal and crystallizing minerals resulting in the formation of a void within the melt. If the melt contains volatiles, such as H_2O or CO_2, that become less soluble with decreasing pressure, the decrease in pressure associated with melt contraction causes some of the volatiles to exsolve into the void (bubble) (1, 2). A significant proportion of the volatiles originally dissolved in the melt at the time of entrapment can reside in the bubble once the inclusion and its host have been erupted and quenched. If the volatiles in melt inclusion-hosted vapor bubbles are not considered, this could result in a significant underestimation of the original volatile budget of the trapped melt. Volatiles in the vapor bubble can be analyzed directly by Raman spectroscopy and then added to the volatiles still dissolved in the melt to reconstruct the volatile content of the melt at the time of entrapment (e.g., 1, 3). Alternatively, prior to analysis of the quenched, glassy melt inclusion, the inclusion can be heated until the bubble dissolves and the melt inclusion rehomogenized (e.g., 3). However, for an inclusion that has already been analyzed, if a vapor bubble was present, sample preparation is likely to have opened the bubble resulting in its volatiles being lost. In this case, calculations based on the volume of the inclusion, the volume of the vapor bubble and the ideal gas law can indirectly estimate the contribution from the vapor bubble to the overall volatile budget of the melt inclusion (e.g., 4).

The melt phase of olivine-hosted glassy basaltic melt inclusions from West Zealandia seamount (16^o 53' N) in the southern Mariana arc have already been analyzed for H_2O and CO_2 (by FTIR spectroscopy), major elements, S and Cl (by EPMA), and trace elements (by LA-ICP-MS). Dissolved volatiles range from 1.9-4.5 wt % H_2O, below detection (20 ppm)-856 ppm CO_2, 952-2260 ppm S and 454-2590 ppm Cl. Vapor bubbles were present in most of the inclusions, but as the inclusions were prepared for micro-analysis, the bubbles have been opened and the vapor phase lost. As a result, after correction for post-entrapment crystallization and Fe-loss, the measured volatile concentrations underestimate the original volatile content of the melt, and indirect calculations of the amount of volatiles that these bubbles could contribute to the overall volatile budget of each inclusion need to be performed. Firstly, we estimate the volatiles that were in the bubble based on the volume of the bubble after quenching, using photomicrographs of the inclusions collected during their preparation for analysis. However, because the bubble may grow during the final quench from eruption temperature to the glass transition temperature on a timescale too fast to allow significant diffusion of volatiles from the melt to the vapor phase, this may result in an overestimation of the volatiles residing in the bubble. Thus, secondly we estimate the volatiles that were in the bubble based on the volume as a function of the difference between the trapping and pre-eruption temperatures calculated using the olivine liquidus temperature of the measured melt inclusion composition and the extent of Fe-loss that has occurred in the melt inclusions during cooling between trapping and eruption. We will evaluate the effects that volatiles in the vapor phase estimated in these two ways have on the total volatile budget of each inclusion. In turn, we will examine how this affects inclusion trapping pressures inferred from the volatiles in the melt inclusions, and the significance this has for interpreting the magma plumbing system and crustal structure beneath West Zealandia.

1 Moore et al., In Press, Am Min.
2 Wallace et al., In Press, Am Min.
3 Hartley et al., 2014, EPSL, 393, 120.
4 Shaw et al, 2008, EPSL, 275, 138.

キーワード: arc volcanoes, melt inclusions, volatiles, vapor bubbles
Keywords: arc volcanoes, melt inclusions, volatiles, vapor bubbles