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Analog Experiment for Rootless Cone Eruption

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Abstract

Rootless cone is one of peculiar types of pyroclastic cones, which is formed by magma-water interaction when hot lavas flow into water-logged regions. Though the occurrence on the Earth is quite limited large numbers of small cones on Mars are suspected to be rootless cones. Identification of rootless cone is crucially important in the characterization of terrane origin.To explore the formation mechanism we conducted a series of analog experiment.

1. Introduction

In planetary geology identification of rootless cone is quite crucial in the characterization of terrane origin. A lava plain composed of low viscosity lava flow is usually lack of noticeable landmarks and difficult to discriminate from other similar flows such as mud flow. Once lava plain, igneous origin is identified important implications are obtained such as the internal thermal state and activity. In this point rootless cone is a unique geomorphological signature for hot lava flow. On the martian surface there exist a plenty of rootless cones([1],[2]). They are far more abundant than the terrestrial ones. The reason is not clear. At the same time the formation of rootless cone (hereafter rootless eruption) is not fully understood. Comparing to other types of magma-water interaction such as phreatic/phreatomagmatic eruptions rootless cone eruption seems rather steady. This can be inferred from morphological comparison of the cones([3]). Phreatic/phreatomagmatic eruptions are usually violently explosive and transient while rootless cone eruption continues for a certain time steadily to form a regular cone. To understand the difference as well as the martian peculiarity we conducted analog experiments to simulate magma-water interaction by using hot syrup.

2. Experiments

The basic experimental framework to simulate the rootless eruption utilizes the reaction of thermal decomposition of sodium bicarbonate solution by touching high temperature material, which induces vesiculation of CO2 gas. The experimental procedure is as follows; we put a mixture of sodium bicarbonate powder and sugar syrup in a container at room temperature. The mass fraction of the sodium bicarbonate is changed 0 to 100 % . The viscosity of the mixture layer depends on the mass fraction. Heated condensed sugar syrup($T \sim 130^\circ$) is poured at the top of the mixture layer. When the heated sugar syrup gradually sinks as Rayleigh-Taylor Instability the mixture layer is gradually heated and decomposes to emit CO2 gas, which forms vesiculated structure until the temperature cools down to solidified. We measured the mass loss associated with the thermal decomposition.

3. Results

3.1. Vesiculation

Figure 1 shows variations of mass for various initial mass fractions of sodium bicarbonate. Mass decreased with time but the magnitude of mass loss shows a peculiar variation. At the mixture of 15g sodium bicarbonate-35g sugar syrup the mass loss is maximum. Figure 2 shows the amount of mass loss at 500sec. as a function of mass of sodium bicarbonate. Figure 3 displays images of vesiculated samples.The left image is for the sample of 35g sodium bicarbonate-15g sugar syrup.The right image is for the sample of 15g -35g, which corresponds to the maximum mass loss. Severe vesiculation can be seen.

3.2. Rheology

Figure 4 shows viscosity of the mixture as a function of mass of sodium bicarbonate. The viscosity values were measured at room temperature by a cone-plate type rheometer. As the amount of sodium bicarbonate

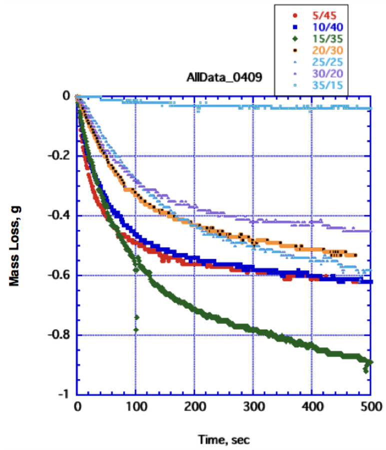

Figure 1: Variation of Mass with time.

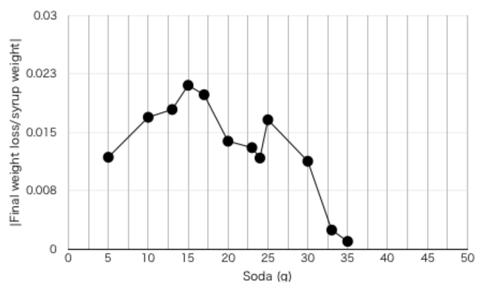

Figure 2: Amount of Mass Loss.

increases the viscosity increases and above 35 g the mixture behaves as a solid.

4. Importance of rheology

Combining the results of mass loss and rheology control of the rheology in vesiculation is remarkable. The large amount of mass loss at relatively low concentration of sodium bicarbonate(source material) shows low viscosity of the mixture can enhance the thermal decomposition. In low viscosity medium high temperature syrup can sink deeply within a limited time to cool having short scale heterogeneities at the interface. This can cause efficient mixing and heat transfer to the medium, which promotes the reaction of thermal decomposition. In rootless eruptions a similar control should be important;the rheological properties of water-logged region which is covered by hot lava flows

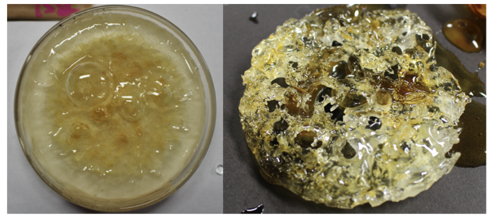

Figure 3: Photos of vesiculated sample.Left 35g sodium bicarbonate,Right 15g sodium bicarbonate

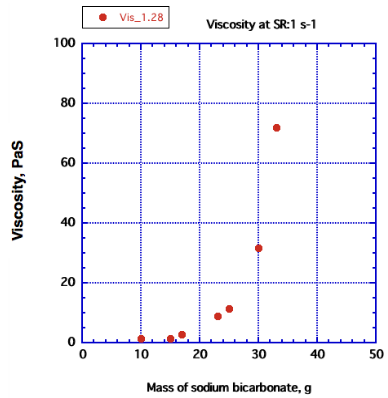

Figure 4: Viscosity

determines efficiency of mixing/contact area([1], [4]). The abundant occurrence of rootless cone on the martian surface may indicate unique properties of subsurface material rather than the terrestrial environments.

References

[1] Fagents, S. and Thodarson,: Rootless volcanic cones in Iceland and on Mars. In Geology of Mars,Cambridge Univ.Press p151-1777, 2007.

[2] Fagents,S.,Lanagan,P. and Greeley,R.: Rootless cones on Mars, Geol.Soc.London,SP202,295-317,2002.

[3] Noguchi,R.,Hoskuldsson,A. and Kurita,K.: Detailed topographical, distributional and material analyses of rootless cones in Myvatn,Iceland, J.Volcan.Geotherm.Res.,318 89-102,2016.

[4] Wohletz,K.,Zimanowski,B., and Buttner R.: Magma-water interactions, In Modeling Volcanic Processes, Cambridge Uni.Press, 230-257,2013.