EXPERIMENTS IN EXPLOSIVE VOLCANISM; Alene M. Jones, John R. Holloway, and Ronald Greeley, Department of Geology, Arizona State University, Tempe, AZ, 85287.

Glass beads in lunar soils indicate at least some minor amounts of explosive activity on the Moon (1). The morphology of martian deposits indicate periods of phreatomagmatic volcanic activity (2). We have begun experiments to investigate the nature of particles produced in explosive volcanic eruptions on the Moon and Mars.

Experimental design limitations dictated working at temperatures of less than 850° C at pressures up to 30 bars. This required a composition analogous to natural basalt-andesite which would melt at low temperatures yet have viscosities similar to basalts and andesites. The phase diagram for the Na_2O-SiO_2 system is shown in figure 1 (3,4,5). The lowest eutectic for the system occurs at 25% Na_2O. At this composition the compound melts between 780° and 800° C. The viscosity of the melt at 850° C is about 10^4 to 10^5 poise (6). At a temperature of 1200° C basalt has a viscosity of between 10^2 and 10^4 poise (7).

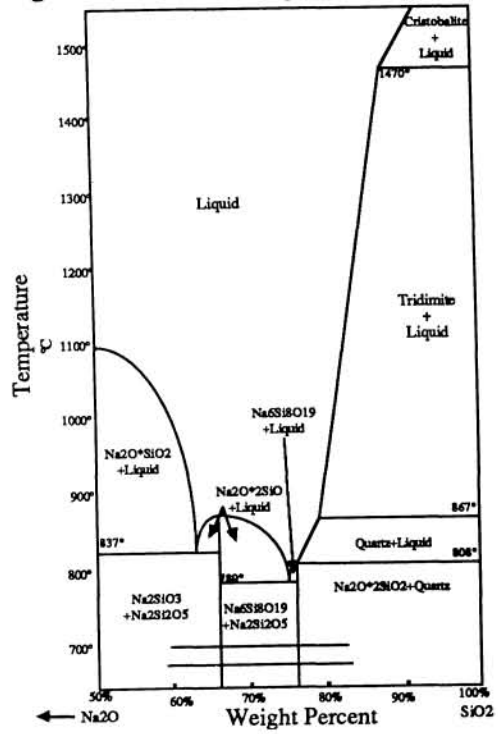

Figure 1: Phase diagram for the Na_2O-SiO_2 system. The lowest eutectic is at about 790° C with a composition of 75% SiO_2 and 25% Na_2O. After Kracek (1930,1939) and Williamson and Glasser (1965).

The experimental system consists of a vessel that is a stainless steel pipe which can be sealed on both ends. The lower end is sealed with a lid that connects to a pressure generating and monitoring system. An internal thermocouple also enters through this port. The upper end is sealed with a removeable lid that is held in place by a lever arm which is released by a solenoid. Figure 2a shows a schematic representation of the lid and solenoid system while figure 2b shows a steam run with the lid in the process of opening. Both upper and lower lids are sealed with O-rings.

A) B)

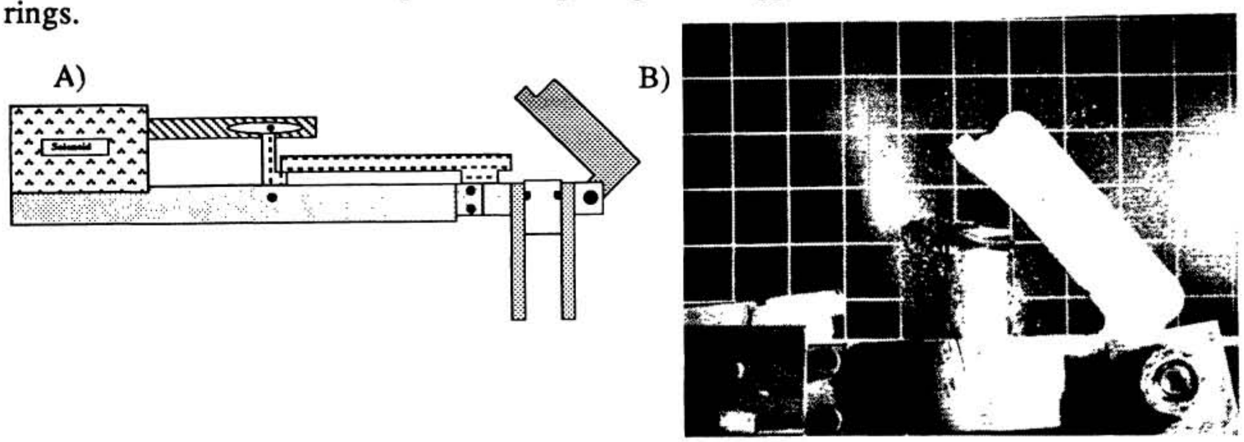

Figure 2: Lid system. A) Schematic diagram of lid, lever arm, and solenoid. B) Opening of lid during steam run.

EXPERIMENTS IN EXPLOSIVE VOLCANISM: Jones, A. M. et al.

Initial tests of the apparatus were conducted using steam eruptions. These took place in two phases, low pressure and moderate pressure. The low pressure steam eruptions used small volumes of water placed in the reaction vessel in a crucible. These low pressure eruptions reached a pressure of about 10 bars. In the moderate pressure eruptions the vessel is attached to a water pump that can attain higher pressures. For the moderate pressure runs we used an internal pressure of 25 bars. Figure 3 shows the eruption cloud of a moderate pressure steam eruption.

Figure 3: Steam eruption at an internal pressure of about 25 bars.

After the steam runs we began melting and erupting a sodium silicate composition. Photographic records are made of each run using both high resolution film and a polaroid view camera with a flash used to freeze movement at about one ten-thousandth of a second. The silicate runs thus far have produced minor amounts of pyroclastic particles and pumice puffballs that remain attached to the crucible. The particles can be seen in photographs swirling around in the eruption cloud (Figure 4). To date no particles have been collected. The pumice puffballs typically have fibrous surfaces. The internal structure of the pumice is composed of numerous interconnecting vesicles of various sizes (Figure 5).

References: (1) Heiken and McKay, (1978) PLSC 9, (2) Greeley and Spudis (1981) Rev Geophys Space Phys 19, (3) Kracek (1930) J. Phys. Chem. 34, (4) Kracek (1939) J. Am. Chem. Soc. 61, (5) Williamson and Glasser (1965) Science 20, (6) Lillie (1939) J. Am. Ceram. Soc. 60, (7) Murase and McBirney, (1973) GSA Bull. 84.

Figure 4: Eruption of sodium silicate. Note swirling of particles on the right side.

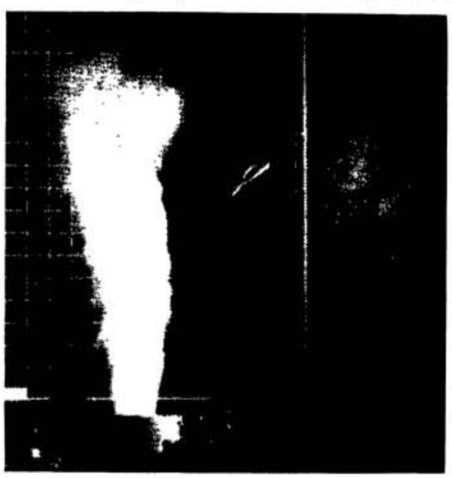

Figure 5: Pumice puffball with fibrous surface and interior of interconnecting vesicles of various sizes.