Cooling rates of lunar volcanic glass beads

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It is widely accepted that the Apollo 15 green and Apollo 17 orange glass beads are of volcanic origin. The diffusion profiles of volatiles in these glass beads are believed to be due to degassing during eruption (Saal et al., 2008). The degree of degassing depends on the initial temperature and cooling rate. Therefore, the estimations of volatiles in parental magmas of lunar pyroclastic deposits depend on melt cooling rates. Furthermore, lunar glass beads may have cooled in volcanic environments on the moon. Therefore, the cooling rates may be used to assess the atmospheric condition in an early moon, when volcanic activities were common.

The cooling rates of glasses can be inferred from direct heat capacity measurements on the glasses themselves (Wilding et al., 1995, 1996a,b). This method does not require knowledge of glass cooling environments and has been applied to calculate the cooling rates of natural silicate glasses formed in different terrestrial environments. We have carried out heat capacity measurements on hand-picked lunar glass beads using a Netzsch DSC 404C Pegasus differential scanning calorimeter at University of Munich. Our preliminary results suggest that the cooling rate of Apollo 17 orange glass beads may be ~12 K/min, based on the correlation between temperature of the heat capacity curve peak in the glass transition range and glass cooling rate. The results imply that the parental magmas of lunar pyroclastic deposits may have contained more water initially than the early estimations (Saal et al., 2008), which used higher cooling rates, 60-180 K/min in the modeling. Furthermore, lunar volcanic glass beads could have been cooled in a hot gaseous medium released from volcanic eruptions, not during free flight. Therefore, our results may shed light on atmospheric condition in an early moon.