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Large-scale obsidian emplacement at Obsidian Cliff, Yellowstone (USA)

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During its eruptive history, the large volcanic system at Yellowstone has experienced large outpouring of silicic material, both explosively and effusively. The trigger mechanism for explosive activity in Yellowstone are enigmatic, as the magmas are considered to be relatively too hot (850 - 1100°C to be explosive (Branney et al., 2008). The key to this enigma may reside in the concentration of volatiles present in the magmas. Here, we provide a study of magmatic volatiles present in a rhyolitic obsidian lava flow named Obsidian Cliff. Outcrop exposure at Obsidian Cliff (Yellowstone) exposes the interior of a thick rhyolitic lava flow erupted about 180,000 years ago. The rhyolitic lava flow has a thickness of 60m and extends for 6km down Obsidian Creek. The quenching of this obsidian trapped parts of the volatiles species present in the magma, thus providing the opportunity to study their rheological effects on eruption dynamics at Yellowstone. In detail, we investigate the volatile content, cooling rate and glass transition temperature of 15 samples across a 10m vertical section of the lava flow.

Bulk rock analysis using X-ray fluorescence technique, as well as glass analysis with an electron microprobe, show obsidian cliff to be a slight calc-alkaline rhyolite with 78% SiO2. In these analyses, only minor chemical variations were observed along the outcrop. Differential Scanning Calorimetric (DSC) analysis and the GRD model (2008) showed a glass transition (Tg) ranging between 730°C and 760°C (at a heating rate of 20K/min). The DSC data does not show systematic variations in Tg along the stratigraphy, but rather a 35°C range in Tg. The non-systematic variation in Tg of a glass with homogenous composition of major elements may be explained by the different volatiles in the melt phase. Directly Coupled Evolved Gas Analyzing System (DEGAS) data reveal that the obsidian contains H2O, OH, CO2, HF, F, SO2 and Cl. Detailed analysis are currently underway in order to distinguish the volatile content along the length of the cliff and shed light on the emplacement of this large obsidian lava flow.