The influence of temperature on carbon chemistry of organomineral complexes

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Soil organic matter can interact with soil mineral surfaces to form stable organomineral complexes. These organomineral complexes effectively protect carbon compounds against microbial decomposition and play a large role in regulating global carbon cycling rates. Because the interactions between the organic matter and mineral surfaces are chemical reactions, there is reason to believe that they are regulated by temperature, but this remains unknown. As part of an ongoing study, we are investigating the impact of temperature on the rates of formation of organomineral complexes and the chemical properties of the carbon within those complexes. We are employing scanning transmission X-ray microscopy (STXM) and carbon near edge X-ray absorption fine structure (CNEXAFS) to map the spatial distribution of carbon forms in organomineral complexes at different temperatures. We are also using CNEXAFS with a spot size of 1000µm x 100µm to gather comprehensive chemical data on the effect of temperature on organic matter fractionation. We will present data from ongoing experiments utilizing two types of samples: synthesized iron oxide-organic matter complexes and soils gathered from field climate manipulation experiments. The climate manipulation experiments are part of the Old-field Community Climate and Atmospheric Manipulation Experiment carried out in Oak Ridge, Tennessee from 2003 to 2005. We fractionated the climate manipulation soils by density prior to measurement. The laboratory experiments provide the benefit of control over the materials used, while the climate manipulation soils are more representative of the effects of temperature that we would see in the field. Thus far, results suggest that temperature can impact organic matter fractionation at mineral surfaces. Of particular interest, we see an influence of temperature on the absorption peak at 290.2 eV, which under our experimental conditions may be caused by Fe-O-C bonds rather than carbonates. We also present methodological considerations for CNEXAFS measurements, as well as plans for future experiments.

Multiple glass transitions in natural volcanics: a demonstration of shallow magma mixing during Strombolian eruptions at Yasur Volcano, Vanuatu

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Introduction

Strombolian activity is often regarded as a product of the rapid ascent of gas slugs entraining a deep magma [1], which mingle with a batch of shallow magma upon eruption [2]. The presence of a range in crystallinities as well as bimodal bubble-size distributions, in the eruptive products, generally support this view. The regular intervals of strombolian activity suggest a continuum in an open system [3], where the surface activity is inferred to reflect the ascent of magma batches at various rates, driven by the relative buoyancy of bubbles with contrasting sizes [4,5]. Mt. Yasur volcano (Vanuatu) has been increasingly recognized for its high-frequency Strombolian eruptions, where three active vents display eruptions of different intensities at contrasting intervals of minutes to tens of minutes. Here, we constrain this range of behaviour using information locked in at the glass transition.

Result and conclusion

A rheological investigation of the eruptive products indicates that basaltic-andesitic eruptive products containing an apparently homogeneous glass phase exhibit evidence of a distinct range of glass transition temperatures with multiple peaks occurring in individual samples. Such anomalous behavior, is proposed to result from the mingling of magmas with contrasting oxidation state. We resolved this hypothesis through complementary calorimetric analyses on remelted rocks prepared under different oxigen fugacities, which attest of the range in glass transitions with oxidation states as well as reveal the instability of such basaltic-andesitic melts in the reduced state. The anomalous nature of the measured glass transition behavior of eruptive products leads us to the inference that mingling is located in the shallow parts of the eruptive conduits, in parts due to rejuvenation of material slumped from the crater walls into an open conduit system. The dynamics of this process may reflect the periodicity of the eruptions themselves.

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