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# Microbial and inorganic control on the composition of clay from volcanic glass alteration experiments

**Javier Cuadros,[1,*] Beytullah Afsin,[1,†] Premroy Jadubansa,[2] Mahmoud Ardakani,[3] Carmen Ascaso,[4] and Jacek Wierzchos[4]**

[1]Department of Mineralogy, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.
[2]Department of Zoology, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.
[3]Department of Materials, Faculty of Engineering, Imperial College London, London SW7 2AZ, U.K.
[4]Department of Environmental Biology, National Museum of Natural Sciences, CSIC, Serrano 115, 28006 Madrid, Spain

## Abstract

Biological activity plays a substantial role in the geochemistry of the Earth's surface. Particularly interesting are effects on clay formation because clays are abundant and have high surface-to-volume ratio, resulting in clays making up a large fraction of the overall mineral-fluid interface and having an effective control of mineral reactions. Thus, biological control on clay composition would affect element budget globally and the mineralogy of subsequent diagenetic processes. Biological acceleration of clay production would result in enhanced clay control of mineral reactions and faster organic C sequestration, by adsorption on clay minerals, with implications for the C and related cycles. We investigated the combined effect of microbial activity and water chemistry on the composition of neoformed clay by reacting volcanic glass with natural waters covering a large composition range (fresh water from a lake and a spring, seawater, and hypersaline water). The microbes (bacteria, fungi, and algae) were totally or partially identified using molecular and microscopy techniques. The solid alteration products were analyzed using cryo-SEM to investigate the mineral-microbe interface and TEM-AEM to study the composition of the neoformed clay. The solution chemistry was also investigated. We found that clay composition was controlled mainly by glass chemistry, rather than biological activity, through a mechanism of in situ transformation. The resulting clay was Al-rich (dioctahedral composition). In one case (inorganic experiment, freshwater lake), the specific inorganic conditions of pH and Mg and Si concentration promoted formation of Mg-rich (trioctahedral clay). Microbes, however, did influence clay composition by confining glass grains in biofilms where water chemistry is significantly different from the bulk solution. Alteration in such conditions generated significant amounts of trioctahedral, Mg-rich clay in the hypersaline water experiment, whereas it favored production of dioctahedral, Al-rich clay in the freshwater lake experiment. It is thus demonstrated that biofilms can exert an effective control on clay mineralogy.

**Keywords:** Cryo-SEM, glass alteration, mechanism of clay formation, microbial control on clay generation, TEM-AEM