**Abstract**

The April to May 2010 eruption of Eyjafjallajökull (Iceland) volcano was characterized by a large compositional variability of erupted products. To contribute to the understanding of the plumbing system dynamics of this volcano, we present new EMPA and LA-ICP-MS data on groundmass glasses of ash particles and minerals erupted between April 15 and 22. The occurrence of disequilibrium textures in minerals, such as resorption and inverse zoning, indicate that open system processes were involved in determining the observed compositional variability. The variation of major and trace element data of glasses corroborates this hypothesis indicating that mixing between magma batches with different compositions interacted throughout the whole duration of the eruption. In particular, the arrival of new basaltic magma into the plumbing system of the volcano destabilized and remobilized magma batches of trachyandesite and rhyolite compositions that, according to geophysical data, might have intruded as sills over the past 20 years beneath the Eyjafjallajökull edifice. Two mixing processes are envisaged to explain the time variation of the compositions recorded by the erupted tephra. The first occurred between basaltic and trachyandesitic end-members. The second occurred between trachyandesite and rhyolites. Least-squares modeling of major elements supports this hypothesis. Furthermore, investigation of compositional histograms of trace elements allows us to estimate the initial proportions of melts that interacted to generate the compositional variability triggered by mixing of trachyandesites and rhyolites.

**Keywords:** Eyjafjallajökull, volcanic ash, magma mixing, plumbing system dynamics.

**Introduction**

On March 20, 2010, a mainly effusive fissure eruption at the flank of Eyjafjallajökull (EFJ) volcano began, changing to an explosive phase from the summit on April 14, lasting until the end of May (Sigmundsson et al. 2010). During this time frame, a large amount of ash was injected into the atmosphere and transported toward Europe and the North Atlantic area. This caused a disruption of the European air traffic, forcing millions of passengers to stay grounded, and producing a huge economic loss of several hundred million U.S. dollars per day, as industrial production had to stop in the affected parts of Europe (Miller 2011; O'Regan 2011; Gudmundsson et al. 2012).

Several works suggest that the eruption was initiated by arrival of new basaltic magma into the shallow plumbing system of the volcano initiating mingling and mixing by transporting mass, heat, and volatiles (e.g., Sigmundsson et al. 2010; Sigmarsson et al. 2011, 2015; Borissova et al. 2012; Viccaro et al. 2016). Initially, a Fe-Ti-basalt erupted effusively. The successive explosive activity mainly emitted trachyandesite tephra, intermingled with more evolved basalts and trachyandesite to trachydacite compositions. Borissova et al. (2012) pointed out that those more evolved basalts occurring together with the trachyandesite tephra were produced by mixing of the Fe-Ti-basalt with a trachydacite magma. Trachyandesite melts were considered by Borissova et al. (2012) as the product of further mixing between the more evolved basalt and trachydacites. Support to this hypothesis was provided by the occurrence of olivine, clinopyroxene, and plagioclase phenocrysts displaying bimodal compositions (Sigmarsson et al. 2011; Borissova et al. 2012; Keiding and Sigmarsson 2012). However, Sigmarsson et al. (2011) indicated that trachyandesites possibly represented the hybrid composition resulting from mixing between an older silicic component and Fe-Ti-basalts. Despite the variation of end-members envisaged by the different authors, it is noteworthy that both studies focus the origin of trachydacite melts in the reheating and remobilization of a rhyolitic magma body that possibly remained in the plumbing system of the volcano since AD 1821–23 eruption. However, although magma mixing is undoubtedly involved in generating the large compositional variability shown by EFJ 2010 eruptive products, some issues related to the precise identification of potential end-members that took part to the magma mixing processes still remains unclear.