



Fe behavior in iron-bearing phonolitic and pantelleritic melts and its significance for magma dynamics in the volcanic conduits

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The style of volcanic eruptions is determined entirely by dynamics of magma ascent in conduits. Physical properties of a silicate melt, particularly viscosity, are responsible for fragmentation processes, bubble growth and their ascent, which are in their turn related to explosivity of eruptions. Therefore, comprehension of the macroscopic properties of silicate melts is required for adequate conduit modelling.

Considering eruptions of Mt. Vesuvius, Italy, we observe that eruption style varies from strombolian to plinean and sub-plinean which is related to the changes of melts viscosity in conduits. At Vesuvius the composition of volcanic deposits (III phase) is mainly phonolitic with 5 – 8 wt. % FeO. Fe changes the valence and coordination depending on oxidation state. The changing of iron coordination causes increasing or decreasing viscosity because of the presence of higher or lower amounts of Fe species coordinated with stronger covalence bonds.

Mössbauer spectra of iron-bearing natural pantelleritic and phonolitic glasses were studied to get data on speciation and coordination state of iron. Mössbauer spectroscopy measures hyperfine interactions (isomer shift (IS)) and quadrupole splitting (QS)) at Fe atoms embedded in glass structure, which provide the amount of ferric and ferrous iron and their coordination state depending on Redox conditions. Based on these data, we have considered redox-viscosity relationships and also iron coordination effects on viscosity of both mentioned natural melt compositions.

For glasses, due to short range order, the Mössbauer spectra were fitted using mathematical procedures based on functional analysis (extended Voight lineshape included in "Recoil" and "Mosslab" software). Mössbauer spectra are deconvoluted in two sites: ferrous iron (IS=0,79-1,00 mm/s; QS= 1,78-2,25 mm/s) and ferric iron (IS=0,26-0,50 mm/s; QS= 0,75-0,95 mm/s). For both sites we observe that IS and QS gradually decrease towards more oxidized conditions. From functional analysis of Mössbauer spectra this increasing is due to transformation of iron coordination: Fe²⁺ [5]-Fe²⁺ [4] and Fe³⁺ [5]-Fe³⁺ [4], depending on Redox conditions.

XANES data helps us to prove coordination transformation of Fe clearly. This methods (Giuli et al., 2011) reveal that Fe³⁺ is always in tetrahedral coordination and Fe²⁺ is in the form of both [4] and [5] species. The presence of minor [5] or even [6] cannot be excluded.

Combining Mössbauer and XANES methods, we can suggest that more reduced samples include more high coordinated Fe species. Under oxidized conditions Fe³⁺ tends to be [4] - coordinated completely and amount of Fe²⁺ [5] decreases.

Viscosity for phonolitic and pantelleritic melts increases as well with more oxidized conditions, suggesting more polymerized structure. Under reduced conditions, low viscosity means that some higher coordinated Fe²⁺ and Fe³⁺ sites occur in structure and function as a depolymerizing factor.

Therefore, in the presence of iron-bearing peralkaline melts, the prediction of an eruptive style requires knowledge of the dependence of viscosity on thermodynamic parameters as well as dependence on RedOx conditions, which are responsible for ferric and ferrous iron structural transformations.