Pre-eruptive volatile contents of Vesuvius magmas: constraints on eruptive history and behavior. I - The medieval and modern interplinian activities

FEDERICA RAIA*¹, JAMES D. WEBSTER*², and BENEDETTO DE VIVO**

* Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY 10024-5192, USA
** Dipartimento di Geofisica e Vulcanologia, Via Mezzocannone 8, 1-80134 Napoli, Italy

Abstract: The eruptive history of Mt. Vesuvius is characterized by a large variation in eruptive styles during the last 2000 years. As part of an extensive investigation on the pre-eruptive magma geochemistry, we have analyzed, by EMPA and SIMS, silicate melt inclusions (MI), hosted in clinopyroxene phenocrysts, to gain insight into the eruptive processes and history of this significant magmatic system. The rock samples analyzed are lavas and scoriae erupted during two intervals of interplinian volcanic activity: 472 to 1139 A.D. and 1631 to 1944 A.D. The compositions of MI from samples of the modern and medieval periods are consistent with petrological and geochemical evidence of melt evolution via fractional crystallization. Although fractional crystallization played a decisive role in the evolution of medieval and modern magmas, other processes may also have been active. In MI from the medieval eruptive products, the fixed Cl contents, and relationships involving other elements soluble in aqueous volatile phases (e.g. H₂O, S, B, Be, Li) indicate crystallization of magmatic vapor-phase-saturated silicate melt(s). Conversely, MI from the modern eruptive activity are characterized by linear increases in the abundances of Cl, SO₂, and K₂O in fractions of residual melt. Furthermore, no evidence was found that volatile abundances were fixed or buffered by the presence of an aqueous vapor (or liquid), which is consistent with fractional crystallization of a magma under volatile-phase-absent conditions. The modern and medieval periods, separated by the violent 1631 eruption, exhibit dramatically different eruptive behavior. The medieval magmas erupted less often, but with comparatively greater violence, which may have been facilitated by the presence of a pre-eruptive volatile phase in magma. The modern magmas erupted more frequently and in a relatively passive manner, which is consistent with the absence of textural or geochemical evidence for fluid saturation before eruption.

Key-words: Mt. Vesuvius, interplinian activity, silicate melt inclusions, EMPA, SIMS.