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Ejected nodules from the 79 A.D. and 472 A.D. Plinian eruptions, Mt. Vesuvius: a fluid inclusion and petrographic study.

*Belkin, H.E., **De Vivo, B., ***Di Girolamo, P., ****Lima, A., and *Roedder, E.
*959 National Center, U.S. Geological Survey, Reston, VA 22092 (USA)
**Centro di Studio per la Geocronologia e la Geochimica delle Formazioni Recenti, c/o Istituto di Geochimica, Città Universitaria, 00100, Roma (Italia) ***Istituto di Mineralogia dell'Università di Napoli (Italia), ****Dipartimento di Scienze della Terra - Largo S. Marcellino 10, 80138 Napoli (Italia).

The Mt. Somma-Vesuvius volcano has erupted silica-undersaturated, potassium-rich lava and tephra during at least seven Plinian and numerous smaller-scale, mainly effusive episodes. Ejected nodules, usually related to explosive activity, have been subdivided into four varieties: cumulate, "skarn" (magmatic hybrid?), hornfels, and hypabyssal equivalents of lavas. Thirty cumulate, skarn and hypabyssal nodules were collected from the pyroclastic airfall and surge deposits of the 79 A.D. "Pompeii" and 472 A.D. "Pollena" Plinian eruptions. We have made systematic microthermometric studies of the fluid inclusions and petrographic and chemical (microprobe) studies of their host phases.

Cumulate nodules are composed mainly of subhedral to euhedral, usually zoned, clinopyroxenes ("FeO" ≅ 2 to 5 wt.%, Al_2O_3 ≅ 1 to 7 wt.%), with subordinate biotite, Mg-rich olivine, apatite, and interstitial glass. Skarn nodules are composed mainly of interlocking unzoned fassaitic clinopyroxene ("FeO" ≅ 2 to 9 wt.%, Al_2O_3 ≅ 6 to 9 wt.%), phlogopite, and low Cr and Ni hercynitic spinel but lack interstitial glass. Vugs are common in these nodules. Hypabyssal nodules contain zoned clinopyroxene ("FeO" ≅ 4 to 9 wt.%, Al_2O_3 ≅ 2 to 8 wt.%), biotite, apatite, olivine, hornblende, plagioclase, leucite, and interstitial glass. Mineral reaction phenomena were not observed in any nodule. Three types of primary fluid inclusions, formed by trapping of various ratios of silicate melt plus an immiscible CO_2 or CO_2+H_2O phase, are present: (1) silicate melt, now glass, in part crystallized to various daughter minerals plus a shrinkage bubble, (2) (CO_2 + H_2O) inclusions, now consisting of CO_2 L+V + H_2O L (± glass), and (3) CO_2 L+V (± glass). Silicate-melt inclusions are present in all mineral phases in all three nodule types studied. (CO_2 + H_2O) inclusions are found in the clinopyroxene (zoned and unzoned), micas (now empty from decrepitation), and hercynitic spinel of the cumulate and skarn nodules. CO_2 inclusions are much less common and occur only in the clinopyroxene of cumulate nodules. Secondary silicate melt and (CO_2 + H_2O) inclusions are common in certain cumulate and skarn nodules.

The homogenization temperatures of the two-phase CO_2 and the H_2O + CO_2 (CO_2 = 60 to 80 mole %) inclusions were determined with a CHAIXMECA stage and used to derive the trapping density. The melting point of CO_2(s) and CO_2 clathrate was also determined. Homogenization temperatures of silicate-melt inclusions determined by using a LEITZ 1350 stage average ~1200°C for the cumulate and hypabyssal nodules and ~1000°C for the skarn nodules. Differences in their quenching behavior suggest that melts of different compositions have been trapped. (CO_2 + H_2O) and CO_2 densities, plus calculated P-V-T data on CO_2 and (CO_2 + H_2O) at 1200° and 1000°C, provide estimates, with certain limitations, of the pressures during inclusion trapping. These estimates range from ~1.0 to ~2.5 kb in both the cumulate and skarn nodules, corresponding to ~4 to ~10 km trapping depth, assuming a density of 2.7 g/cm^3 for the magma column.

Nodules from non-Plinian eruptions, in contrast to the studied nodules from the 79 A.D. Pompeii and 472 A.D. Pollena Plinian eruptions, have very rare (CO_2 + H_2O) fluid inclusions, although their temperatures and pressures of formation are similar. This observation suggests that the magmas that produce Plinian eruptions have a different and perhaps higher initial volatile content than those supplying non-Plinian eruptions.