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Melt inclusions suggest that small-scale heterogeneities in H_2O and degrees of melting exist in the sources of monogenetic volcanoes on the Izu Peninsula, Japan

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The Izu Peninsula, central Japan, is at the northern end of the Izu-Bonin-Mariana Arc system (IBM) where it abuts the Japan Arc. The Peninsula consists of a basement of Miocene submarine deposits upon which a number of polygenetic and monogenetic volcanic centres have erupted. Along the eastern coast of the Izu Peninsula over 70 monogenetic volcanoes, produced over the last 300 ka and covering 350 km^2, form the Higashi-Izu Monogenetic Volcano Group (HIMVG). The field also extends offshore into Sagami Bay where a further 50 monogenetic volcanoes form the Higashi-Izu Oki Submarine Volcano Group, and where the most recent eruption (in 1989) occurred. The monogenetic activity is associated with a change in the local stress field as the Izu block collided with Honshu. The HIMVG are mostly basaltic, but towards the centre there are a number of dacitic cones.

In order to better understand the sources of the HIMVG, and this area of the IBM, inclusions hosted in crystals from scoria produced by two basaltic monogenetic volcanoes have been analysed. The inclusions provide access to magmas prior to the widespread crustal assimilation, differentiation and degassing processes that have affected other rocks erupted in the IBM. The two monogenetic volcanoes, Takatsukayama and Sukumoyama, from which the inclusions were collected are 5 km apart and located in the north of the HIMVG. They erupted contemporaneously at the initiation of HIMVG volcanism. The major (measured by EPMA), trace (LA-ICP-MS) and volatile (FTIR spectroscopy) element compositions of the inclusions show bimodal distributions. Inclusions from both volcanoes can be divided into a high alumina (14.89 – 18.81 wt.% Al_2O_3) basalt type (HAB) and low alumina (11.02 – 13.73 wt.% Al_2O_3) basalt type (LAB), with some crystals containing both types of inclusion. LAB inclusions from Sukumoyama, with higher MgO contents (11.52 – 12.38 wt.%), can be related to their HAB counterparts (8.00 – 10.24 wt.%) through fractional crystallisation. However, the Takatsukayama LAB inclusions, with a similar range of MgO contents (6.62 – 10.25 wt.%) to their HAB counterparts (6.38 – 9.16 wt.%), cannot be related so easily. Furthermore, whereas LAB inclusions from Sukumoyama have similar incompatible major element (e.g., TiO_2 and K_2O) and trace element signatures to HAB inclusions from both volcanoes, the Takatsukayama LAB inclusions show significant enrichments in incompatible major elements and most trace elements. Melts with the geochemical characteristics of the Takatsukayama LAB inclusions have not been found elsewhere in the IBM to date. In terms of volatiles, LAB inclusions are generally characterised by lower H_2O contents. This could be a result of the LAB melts being entrapped at shallower levels in the crust, but this is difficult to reconcile with the occurrence of both types of inclusion in the same crystal. Alternatively, combining all the available geochemical data, the Sukumoyama HAB and LAB inclusions appear to be derived from lower degree melts and drier sources than the HAB inclusions from Takatsukayama. The LAB inclusions from Takatsukayama are also derived from dry sources, but even lower melt fractions, producing melts enriched in incompatible elements. To be incorporated in the same crystal these heterogeneities must occur on a very small scale. Finally, the lack of whole rock LAB compositions elsewhere in the IBM suggest that LAB sources are a minor component that usually become fully integrated within HAB melts.