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Geochemical heterogeneities and dynamics of magmas inside the plumbing system of a persistently active volcano: evidences from Stromboli

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Shallow processes such as degassing, crystallization and magma drain-back commonly operate in the upper parts of the plumbing systems of open-conduit basaltic volcanoes, often hindering the identification of potentially important geochemical changes in the volcano systems. Stromboli, known for its long-lived persistent activity over the last 18 centuries, is a suitable subject of study for addressing this issue, since basaltic magmas presently erupting at in this volcano record both deep and shallow processes. We report petrological and geochemical data on magmas erupted by Stromboli since the beginning of the persistent activity, in order to find a correlation between magma composition and the dynamics of magma in the plumbing system. Geochemical data on deep-derived magmas erupted as pumice during paroxysmal eruptions allowed us to identify two distinct parental melts (1944- and 2003-Type). These magmas, in which geochemical differences are linked to source processes rather than crystal fractionation, have alternately fed the deep reservoir in the last two millennia several times. The chemical heterogeneities recorded in lava flows and the products of Strombolian activity testify to the extent of homogenization after magma recharges at shallow depths. Persistent heterogeneities in the shallow plumbing system have important implications for magma residence times calculated on the basis of time-series analysis. These models are based on the assumptions that the reservoir is well stirred and chemically homogeneous and that the time for the re-homogenization after recharge (or mixing) is shorter than the residence time. We argue that these models do not apply to present-day activity at Stromboli and may not apply to other open-conduit, persistently degassing basaltic volcanoes. Thus compositional variations within the shallow magma bodies provide only a biased signal of ongoing changes within the plumbing system. We conclude that source changes responsible for significant modifications in eruptive style and/or volcano structure can only be identified by interpreting the geochemistry of pumice since they represent pristine magmas transferred directly from deep portions of the plumbing system.