The control of water on the crystallization of magmas at Mt. Etna volcano (Sicily, Italy)

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Mt. Etna volcano (Sicily, Italy) is the largest volcano in Europe and one of the most active volcanoes on Earth. The plumbing system is governed by frequent inputs from mantle depths of volatile-rich magmas that mix with degassed melts residing at shallow crustal levels. The most intriguing feature of this process is that, in the last decades, both primitive and more differentiated magmas were systematically buffered to the composition of trachybasalt due to the continuous supply of deep-seated magmas. In order to better constrain the evolutionary behaviour of magmas at depth, we have performed crystallization experiments at $P = 800$ MPa, $T = 1200\text{-}1020$ °C, $H_2O = 2\text{-}10$ wt.%, and QFM buffer using as starting compositions two trachybasalts from 1991-1993 and 2011-2013 eruptions. Results indicate that both clinopyroxene and titanomagnetite crystallize at near-liquidus conditions followed by the formation of plagioclase and the late appearance of olivine. For $H_2O < 4$ wt.%, the original trachybasaltic liquid evolves towards basaltic trachyandesitic, phonotephritic and tephriphonolitic compositions. Conversely, for $H_2O > 4$ wt.% the trachybasaltic melt produces basaltic trachyandesitic and trachyandesitic liquids. Considering the T-P arrays estimated for the crystallization of clinopyroxene phenocrysts from 2011-2012 lava fountains, these magmas formed at 800 MPa in equilibrium with at least 5-6 wt.% H_2O. The comparison of our experimental data with those reported in literature indicates that at intermediate pressures (250-400 MPa) the minimum amount of H_2O dissolved in magmas decreases to 2.5-4 wt.%. Whereas, at shallow crustal levels (27-80 MPa), the crystallization occurs under water-saturation conditions, corresponding to 1.5-3 wt.% H_2O.