Progressively shorter magma storage and rapid remobilization prior to voluminous eruptions of Vesuvius

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Vesuvius is one of the most iconic active volcanoes on Earth. Historic and archaeological records document numerous hazardous eruptions. Today, more than one-million people live around Vesuvius and are threatened by future volcanic activity. Petrologic and geochemical studies of eruptive products provide important insights into the evolution of the magma reservoir prior to explosive eruptions but the timescales and physical conditions of magma storage remain poorly constrained. This is largely due to the absence of uranium-rich accessory minerals such as zircon and allanite that have been used at other active and dormant volcanoes to quantify the timescales of pre-eruption upper crustal magma storage employing U-series dating [1, 2]. Here we document the pre-eruption evolution of phonolitic magmas prior to major Plinian to sub-Plinian eruptions of Vesuvius (Pollena, Pompeii, Avellino and Mercato) employing a novel approach that combines detailed geochemical characterization and in-situ uranium-thorium disequilibrium dating of garnet phenocrysts [3]. Garnet U-Th dates provide evidence for progressively shorter pre-eruption storage times throughout the lifetime of the volcano. While Mercato garnets are compositonally homogeneous [4], individual crystals of the Avellino, Pompeii and Pollena eruptions are complexely zoned with respect to major and trace elements. These compositonal variations suggest that eruptions are preceded by successive recharge events rapidly rejuvenating crystal-rich magmas that were stored at near-solidus temperatures for several hundreds to thousands of years. Detection of a growing subvolcanic reservoir by geophysical techniques may therefore indicate the formation of an eruptible phonolitic magma body that could erupt within a few hundred years or less.

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