Racing to the surface – the dynamics of the feeder system to a cinder cone

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The West Eifel Volcanic Field in western Germany comprises more than 250 individual volcanic edifices spread over an area of ~ 500 km^2. The first eruptions occurred around 940 ka BP and the last recorded eruption was ~ 11 ka BP. Seismic data indicate that a thermal plume contains 1–2% melt in the asthenosphere below the field. This indicates that the field is still potentially active. As several large towns are located in the region and the Eifel is on the flight path for many major airports, any assessment of volcanic hazard must be based on the dynamics of magma emplacement. The Rockeskyllerkopf volcanic complex (RVC) first erupted ca 474 ka BP with the final eruption more than 100,000 years later at ca 360 ka BP. For each volcanic event the first stage was phreatomagmatic but as groundwater was reduced eruptions became increasingly strombolian. The deposits of the first event commonly contain mantle and high pressure cumulate xenoliths that were entrained in the rising magma over a range of depths of 3–45 km. Numerous studies have shown that olivine in mantle xenoliths is generally not in equilibrium with the magma that brought them to surface. This disequilibrium is reflected in the development of Fe-Mg diffusion profiles in the olivine. We know the rate of Fe-Mg diffusion and we can estimate temperature, so we can use such profiles to determine how long the xenoliths were in transit. We have analysed olivine in 10 peridotite and 5 high pressure cumulate xenoliths. The peridotite has the deepest source (~45 km) and our models show that the xenoliths took less than 5 days to reach surface. Olivine from fragmented xenoliths included in high pressure cumulates records a much longer contact time – from a week to nearly one year. These results indicate that magma was present below the RVC for up to as much as one year prior to the first eruption. The short transit times for the mantle xenoliths indicate that new batches of magma cross the lithosphere quickly at a minimum speed of 400 m/hr. If magma input is accompanied by significant seismic activity we can expect precursor events for approximately one year before an eruption. However, the rapid rise of the magma that is erupted indicates that there will be very little warning of the actual eruption itself.

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