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Geodetic and geological perspectives on lateral interactions between magmatic systems

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Geological observations, particularly those from tephrastratigraphy, show that volcanic eruptions are often coupled and/or fed by multiple magma reservoirs. This requires lateral interactions between magmatic systems - attributed to stress changes or hydraulic connections - and has broad implications for magma budgets, frequency-magnitude relationships and cascading hazards. We compile geodetic observations of unrest and small eruptions, and historical and geological evidence from larger eruptions to demonstrate that simple scaling relations can be used to explain the length-scales over which responses occur. A case in point is the volcanoes of the Kenyan rift, where inter-bedded tephra demonstrate synchronous eruptions have occurred in the past. Deformation associated with unrest at the same volcanoes illustrates interactions among multiple active sources at depths of 2-5 km beneath individual edifices, but volcanic centres >25 km apart behave independently. Simple scaling laws suggest that stress changes may couple large eruptions over distances of 20-40 km, but are insufficient to explain the response during small eruptions or unrest, where we suggest that the interaction distance is controlled by either the extent of a shallow crystal mush or a common deep source. Large dyke intrusions or subduction earthquakes are required to explain simultaneous unrest and eruptions over distances of 50-100 km.