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Edifice collapse as a window into the evolution of magmatic systems (Arne Richter Award for Outstanding Young Scientists Lecture)

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Large-scale collapses of volcanic edifices are a ubiquitous process, with the largest such events mobilising tens of cubic kilometres of volcanic rock. A host of questions relating to these events remain poorly understood, including controls on the magnitude, frequency and timing of collapses, the progression of collapse, and the transport and mobility of resultant debris avalanches. There is a wide range of evidence that collapses commonly mark transitions between major phases of activity at a volcanic system. This suggests that large collapses are either triggered by some change in the system, or that the collapse induces a step change in subsequent development of the magma storage and plumbing system.

Here, I first review ideas around the evolution of volcanic systems from the perspective of edifice growth, and examine a range of evidence that points to collapse-induced changes in the volcano-magmatic system. This is manifested in a range of chemical and petrological indicators, suggestive of changes to storage regimes and subsequent rates, styles and compositions of eruptive activity. By making assessments from case studies at Montserrat and in Chile, I investigate how edifice collapse may impact on underlying stored bodies of magma. These studies combine geophysical and geochemical analyses of collapse deposits and their bounding volcanic stratigraphy, with computational models of the impact of changing surface loads on stored magma. These results can be used to better understand how surface processes can mark major departures in the behaviour of a volcanic system, and to constrain the crustal storage system and transport processes of magma implied by the observed changes in volcanic activity.