Analogue caldera collapse models characterized with radiography and computerized X-ray micro-tomography

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Analogue models are widely used to investigate volcano-tectonic processes, their structural geometries, kinematics and dynamics. Past models explored caldera collapse structures mainly via 2D model cross–sections. For interpreting field and monitoring data, however, it is essential to understand the kinematics and geometry of caldera collapse structures in 3D. We applied high resolution radiography and computerized X–ray micro–tomography (μCT) to image the deformation during analogue fluid withdrawal in small-scale caldera collapse models. High resolution interval radiograph sequences provide an unprecedented ′2.5D′ documentation of the surface and internal model geometries, as well as of the kinematics of a collapsing column into an emptying fluid body. Subsidence was controlled by ring faults and associated with dilatation of the analogue granular material within the collapsing column. The subsidence rate within the collapse column showed three main phases: 1) Upward migration of a high velocity zone associated with ring fault propagation, 2) Rapid subsidence with the highest subsidence rates within the uppermost subsiding volume, 3) Relatively slower subsidence rates over the whole column but with intermittent accelerations of discrete sections of the column. By using radiograph sequences, it is possible to obtain a continuous observation of fault propagation, down sag mechanisms and the subsequent development of collapse structures in a non-destructive manner. μCT scans of the post collapse model enable a full 3D reconstruction of the model and its internal structure. The models highlight the possibilities and limitations of μCT scanning to qualitatively image and quantitatively analyse deformation of analogue volcano–tectonic experiments. Despite some practical model limitations, the radiograph and μCT method is hence a step towards a quantitative documentation of analogue models that would render experimental data more immediately comparable to recent monitoring data. The models also carry the potential for a better understanding of the kinematics of caldera collapse amongst a variety of volcano–tectonic processes.

