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Understanding collapse calderas dynamics and ring fault formation

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Collapse calderas have been analyzed through field studies, analogue models and numerical simulations. Whereas caldera morphology and structure yield information on subsidence mechanisms and geometry of the associated magma chamber, studies of eruptive products address aspects of magma composition and eruption dynamics. During the last decades, great efforts have been made to classify or to explain the different types of collapse calderas depending on their morphology, composition, etc. Lately, a new genetic classification of calderas has been proposed based on the stress conditions that permit ring faults formation and the pressure evolution inside the magma chamber during the caldera-forming event. Two main end-members are distinguished: overpressure and underpressure calderas. In the case of overpressure calderas the magma chamber is overpressurized at the moment of the collapse, whereas in the case of underpressure ones, the magmatic system has experimented a decompression due to a previous eruptive episode. With overpressure calderas, stress field conditions leading to the formation of ring faults are achieved prior to initiation of the eruption, when an overpressurized sill-like magma chamber is loaded by magmatic regional doming or subjected to regional extension. By comparison, underpressure calderas result from ring fault subsidence after significant decompression of the magma chamber following a pre-caldera eruptive episode. The main point of this work is to understand if both caldera types behave similar from the mechanical point of view and if they can be modeled under the same assumptions concerning host rock rheology, rock failure criteria and mechanical properties of the surrounding media. Contrary to the overpressure ones, underpressure calderas are commonly associated to long-lived stratovolcanoes. In such cases, volcanic edifice growth, pre-existing fractures and host rock stratigraphy are of high relevance. Several authors have studied the influence of previous structures and mechanical heterogeneities on collapse caldera stress field conditions. The results are clear, prior structures or deformation processes, mechanical heterogeneities or mechanical properties contrast or weakness zones may alter the ability of the local stress-field to satisfy the critical conditions for ring-fault initiation, and hence caldera collapse. To understand the influence of these key parameters and how to model both caldera types is vital in understanding caldera collapse mechanism in general and forecasting future collapse events.