Rabal Caldera, Papua New Guinea, is an active volcanic complex whose recent activity, including an increasing uplift and intra-caldera ring-faults reactivation, culminated in 1994 with the last eruption of Tavuruvu and Vulcan volcanoes that led to the formation of Vulcan Island.

The current structure of Rabaul Caldera is the result of multiple caldera-forming events. The last one occurred 1.4 ka ago and resulted in an elliptical plan-view collapse structure of 8.6 x 7.2 km that nowadays hosts most of Blanche Bay. In its interior, the oval shape of the segment, registered between 1971 and 1994, revealed en echelon-dip-oriented active faults whose role during the last caldera-forming event 1.9 ka ago is not clear. For authors, it is the extension of a system of faults along which subsidence occurred at the time of the 1.4 ka caldera event (Marti and Martí, 2017). For others, it is a more recently formed or still-forming un-deformed structural boundary of a caldera block (Taylor, 1994).

Understanding the roles of the structures of active calderas is fundamental for the interpretation of deformation data and thus for the structural hazard assessment. In order to shed some light on the role of elliptical outward-dipping active faults, we here compare the collapse structures resulting from our analogue models to those of the 1.4 ka caldera event. The geometric information obtained from these analogue models is then applied to develop a 3D model of the area using the Finite Element Method (FEM) in order to assess the effects of the structural parameters on the surface deformation field. The 3D model includes different strikes and dip angles of the various collapse events as well as the topography and the different mechanical properties of the subsurface materials.

We focus our attention on the impact of the elliptical ring faults on the surface deformation. Among the many ring fault shapes identified from field-three main structures: (Figs. 1a):
- E0, relative to a collapse older than 7 ka ago
- E1, relative to the 1.4 ka ago collapse
- E2, relative to the outer-dipping seismicity. It has no topographic expression and it reaches about 3.9 km in depth (Fig. 2).

The seismic data were interpreted as two sectors of a ring fault (James and Stewart, 1997).

**MODELS & RESULTS**

Analogues models

**Experimental device**

The experimental device has been set up in a tank filled with dry quartz sand (high rigidity analog) with the magma chamber analog (silicone reservoir) buried at a certain depth. The experiment is divided in two parts: 1) in the first part, the rock analogue simulates the magma chamber and its surrounding; 2) in the second part, the rock analogue simulates the fault zone. The deformation recorded is different for different experiments with the same parameter set.

**Experimental results**

In cross section it is possible to distinguish the structural unit diameter (OL-D), the non-deformed area diameter (N-D) and the planar extension (P-D). The external areas of flexure and extension (EXT-W) are computed as the area of the rock where the surrounding silicone is placed in an elastic cylinder with P-D as diameter. The silicone is placed in a cylindrical area (N) and the tilted area (T).

**Finite Elements Model**

As input parameters of the 3D finite element model we have used: 1) topographical and structural maps, 2) processed 2D seismic data, 3) a digital elevation model, and 4) the information obtained from the analogue model.

The computational domain is a block (10 x 10 km) divided in three different layers: 1) the magma chamber (5 km); 2) the non-deformed area (5 km); 3) the tilted area (5 km).

**Application to Rabaul caldera**

The known structures (Figs 1a) and the DEM are used to define the geometrical laws (P-D and Q-D). The geometry of the caldera rim (Fig. 5) is compared with the result of the finite elements model. The calibration of the model is performed by comparing the structural and mechanical properties of the subsurface materials. We focus our attention on the impact of the elliptical ring faults on the surface deformation. Among the many ring fault shapes identified from field three main structures: (Figs. 1a):
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**PRELIMINARY CONCLUSIONS & ONGOING WORK**

1. Outward-dipping faults are inherited from the collapse of the last 1.4 ka caldera event.
2. Studying the characteristic relationships between the fundamental structures of the 1.4 ka collapse and finding the correspondence with the structures generated during analogues experiments, we can, for the first time, give insights of the depth (3-4.5 km) - of the magma chamber that could have caused the 1.4 ka event.
3. Analogue results and their comparison with real structures provide important geometric information that can be used to build the FEM.
4. We are currently running different SEM simulations to understand the role of the different defined structures on ground deformation processes occurring during caldera unrest.

**REFERENCES**


**MATERIALS & METHODS**

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