Energies associated with large caldera-forming eruptions

Supervisor: Agust Gudmundsson

Many large explosive eruptions and, in particular, the formation of a collapse caldera are normally associated with a shallow crustal magma chamber. A necessary condition for such a caldera to form is that high local shear stresses concentrate above the magma chamber in a zone within which the ring fault (caldera fault) subsequently develops. The rocks that constitute most volcanic edifices are heterogeneous and anisotropic and include numerous layers with different mechanical properties. For the ring fault to form or reactivate, the appropriate shear-stress conditions in the potential ring-fault zone must be reached in all the rock layers and units between the shallow magma chamber and the surface. Because of the different mechanical properties of these layers and units, these conditions can, in principle, be reached only occasionally, as is confirmed by the general rarity of caldera collapses in active volcanic edifices. Here I present numerical models explaining why the conditions of ring-fault formation are so rarely satisfied, particularly in edifices such as stratovolcanoes, which are commonly composed of layers with widely different mechanical properties.

Once the conditions for caldera formation are satisfied in the potential ring-fault zone, energy is needed (a) to propagate the ring fault through all the layers and to the surface, and (b) to drive the vertical displacement (the subsidence) along the ring fault. There are many potential energy sources in volcanic edifices, but the principal one for fracture formation in general, and ring-fault development in particular, is the potential energy. The potential energy is composed of two parts: (i) the strain energy related to magma-chamber inflation and deflation, and (ii) the work done by the forces moving the boundary of the edifice and, in this case, the piston-like segment during the caldera collapse (subsidence).

Normally, during an eruption, it is only the strain energy stored in the volcano during magma-chamber inflation that is available to generate the feeder-dike fracture. For a collapse caldera to form, large potential energy must be available, simply because the ring fault normally has a large surface are so that large surface energy must be overcome to produce the fault.

The principal aims of this PhD project are to assess and explore:

(a) Which part of the potential energy needed for the ring fault is derived from the inflation of the associated magma chamber and, commonly, doming of a part of the volcanic field or zone within which the caldera-hosting volcanic edifice is located.

(b) The part of the potential energy that comes from the work done by the forces moving the boundary of the caldera/edifice itself.

(c) The strain energy released during the slips on the ring fault during the subsidence of the caldera along the developing ring fault.

(d) The contribution of the gas exsolution and expansion in the chamber during the caldera slip in maintaining the overpressure necessary to drive out much of, or all, the magma in the chamber.

Two alternative scenarios will be studied: inward-dipping ring faults and outward-dipping ring faults and the energies released and their contribution to squeezing out the magma during a typical caldera collapse and associated large eruptions are explored. The project includes compiling data from the caldera database and making analytical and numerical models of the processes and energies associated with large caldera-forming eruptions.

How to Apply:

Please use the **online application system (http://www.rhul.ac.uk/studyhere/postgraduate/applying/home.aspx) to** submit an application for this project. Applications will require 2 letters of reference, plus a cover letter and CV- applicants are also requested to email a copy of their CV directly to the lead supervisor of this project (**a.gudmundsson@es.rhul.ac.uk**). **Please ensure you complete your application by mid-December. Suitable candidates will be invited for interviews, which will take place in February/March, and offers are made by the end of March.**

For any queries please contact the Postgraduate Programmes Co-ordinator (email: pgadmin@es.rhul.ac.uk or tel: 01784-443581) and further information can also be found on the Department's Website (http://www.rhul.ac.uk/earthsciences/home.aspx).