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How hydrothermal systems act in the deformation of basaltic shield volcanoes: insights from numerical modelling.

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Two main types of hydrothermal systems (HS) develop in shield volcanoes and strato-volcanoes. Superficial and local HSs are directly linked to magma and fluid ascent through the surface. These systems are located below or in the vicinity of the active craters and their presence is generally attested by fumaroles. The second HS type develops at depth and is associated with magmatic intrusions (i.e. magma chambers, dykes and sills). The global shape of such structures presents a rift zone along-strike elongation and depends on the volcano internal geometry. Geophysical data suggest that the superficial can be relatively thick (∼1000 m) while deep HS can correspond to widespread thin levels (∼200 m thick).

We propose to study with a numerical approach the role of the second HS type in the low-rate deformation of basaltic shield volcanoes. We used the finite element ANSYS® engineering software to build and solve our models. Different parameters were tested such as the HS size, temperature and number. In total, 10 different models are compared to quantify the influence of the temperature and the initial geometry of the HS in the deformation path of the volcano.

These results allow us to explain the development of sub-circular bulges in the Piton de la Fournaise volcano (La Réunion island) and the Karthala volcano (Grandes Comores) as resulting from low-rate deformation above hydrothermal systems.