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Better understanding of Hawaiian volcanoes through double-difference tomography and mechanical modelling

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Double-difference location and tomography have been performed with similar earthquakes occurring in and around the Kilauea volcano, Hawaii. Double-difference locations evidenced not only a subhorizontal decollement plane below the southern flank of Kilauea, whose depth coincidates with the top of the oceanic crust, but also deeper, steeper, southward-dipping reverse faults. We first discussed the existence of these faults from a seismological point of view. Tomography showed that the rift zones and calderas were constituted from high-velocity cores (found as dense bodies by gravimetric surveys, and interpreted as of intrusive origin), surrounded by low-velocity covers (light bodies, interpreted as of effusive origin). Double-difference location in the tomographic model shows clearly that the reverse faulting is occurring at the southern limit of the high-velocity core in the southern flank of Kilauea. The depth of the reverse faults locates them in the oceanic crust. After carefully discussing that such reverse faulting is not an artefact due to the velocity model, we perform a 2D finite-element mechanical modelling of the volcano/oceanic crust interaction to check the existence of such reverse faults in the crust. We show that reverse faulting may be induced in the crust, due the load of the volcano, if there is a large enough rheological contrast between the elastic (high-velocity and dense) core and the elastic-plastic (low-velocity and light) cover. The use of realistic parameters shows that this faulting can cut entirely through the oceanic crust. The simple load of the volcano can therefore cause intense plastic deformation of the oceanic crust. This model also shows that the effusive cover between Mauna Loa and Kilauea volcanoes, and on the southern flank of Kilauea volcano is plasticized by the squeezing action of the dense and rigid cores of the volcanoes.