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A numerical modelling toolbox for identifying the expression of dome-forming volcanism on exoplanets

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The presence of volcanism is often anecdotally used to define a "living planet". Since dome-building volcanism on Earth occurs primarily at plate boundaries, the identification of such domes could inform on exoplanetary development. Lava domes form when extruded magma is too viscous to flow from a vent, and their morphology on Earth varies from flat, pancake lobes to steep, blocky domes. Identification of lava domes on other terrestrial planets in our Solar System indicates that they likely also exist on rocky exoplanets. Here we show, using particle-based modelling, that the diversity of lava dome morphology in our Solar System is dwarfed by the diversity expected for exoplanets. Specifically, the height-to-diameter ratio of a dome decreases as a function of increasing gravity (i.e., planetary mass and radius). For example, lava domes on high-gravity super-Earths will be extremely wide and flat and a volcanic origin may not be immediately apparent. Creating a toolbox to help identify exoplanetary volcanism will allow us to make initial estimations as to the development and habitability of these alien worlds as images become available.