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Magma chamber formation by magma intrusion into the Earth's crust

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The main mechanism of transport of magma in the Earth's crust is the formation of cracks, or dikes, through which the melt moves towards the surface under the action of buoyancy forces and tectonic stresses. Due to the structural features of the crust or external stress fields, dikes often do not reach the surface, but penetrate the localized region in which the rocks melt, leading to the formation of magmatic chambers, whose volume can exceed thousands of cubic kilometers. We present a model of the formation of a magma chamber during the intrusion of dikes at a given flow rate. The model is based on the solution of heat equation and considers the actual melting diagrams of magma and rocks. It Is shown that, in case of magmatic fluxes typical of island arc volcanoes, magma chambers are formed over hundreds of years from the beginning of magma intrusion. The influence of the magma flow rate, the size of the dikes and their orientation on the volume of the formed magma chamber and its shape was investigated. The size of the chamber significantly exceeds the area of dike intrusion due to the displacement of magma and rocks of the crust, their heating up and melting. To calculate displacement of rock and magma in a numerical simulation, a hybrid method based on PIC/FLIP interpolation is developed, making it possible to avoid unphysical mixing due to numerical dissipation, thus preserving the fine details of the formed magma chamber.

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