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Thermo-mechanical two-phase flow models of magma ascent in the continental crust with and without extension

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Melting within the lower continental crust with and without extension and subsequent ascent of silicic melts is modelled by a thermo-mechanical two-phase flow approach. The approach is based on the conservation equations of mass, momentum, and energy for melt and solid, respectively, and includes a simplified binary melting model, as well as compaction / decompaction of the solid matrix. The rheology is based on dislocation creep of quartzite or granite, and includes plasticity. 2D models are carried out for cases without and with differential melt-matrix flow. As control parameter the heat flow is varied between 75 and 90 mW m^{-2} at the base of a thickened continental crust. In the case of no differential flow (batch melting) the model predicts episodic melting, rise and freezing of partially molten magmatic bodies. The recurrence time inversely scales with the bottom heat flux. In the case of allowing for melt migration, no such episodicity is observed anymore. Melt accumulates within melt rich layers and bodies, which subsequently rise through the crust by a combination of diapirism and decompaction related sinking of solid material through the melt rich layer. Final emplacement depths are between 30 and 15 km, shapes of the resulting plutons are visualized by the evolved enrichment and depletion fields. They show a strong dependence on the applied bottom heat fluxes.