|  |  |  |
| --- | --- | --- |
| **Test Name** | **Tested Parameter** | **Description** |
| **Winkler 1e19** | **Winkler BC, viscosity: 1e19** | **The numerical simulation is similar to the reference scenario. The winkler internal boundary condition modulate the velocity of the mantle plume and thus the amount of new melt generated over time** |
| **Winkler 1e20** | **Winkler BC, viscosity: 1e20** | **Intermediate viscosity within the internal boundary condition produce a weaker plume flux and thus less melting. This, inhibits all the processes in the reference state** |
| **Winkler 1e21** | **Winkler BC, viscosity: 1e21** | **The plume it is extremely weak w.r.t. the reference scenarios, and the amount of melt is negligible. To account high viscosity it is necessary to account for an extra pressure source to introduce the integrated buoyancy force generated by the plume** |
| **R\_2000\_4000** | **X axis -2000 – 4000 km** | **There are no significant difference w.r.t the reference scenarios.** |
| **R\_4000\_2000** | **X axis -4000 – 2000 km** | **The age of the plate becomes old enough to prevent the generation of melt and sub-lithospheric mantle circulation, confirming the importance of the age of the plate at the top of the plume** |
| **R\_4000\_4000** | **X axis -4000 – 4000 km** | **The age of the plate is too old to allow production of new melt. Small gravitational instabilities are generated in the right most area of the model** |
| **R\_permeable** | **Lateral Internal permeable**  **BC** |  |
| **Refer\_Win\_3D** | **3D numerical simulation with Winkler 1e20** | **The 3D numerical experiments nicely reproduce most of the main feature, the amount of eruption are significant low, as a consequence of the weak plume that is generated in 3D, and further work is required.** |

**Table S7.**