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Salted matters: modifying gelatine rheology for subduction thrust fault seismicity models

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Most of the world's greatest earthquakes (Mw > 8.5, usually known as mega-earthquakes) occur at shallow depths along the subduction thrust fault (STF), i.e. the frictional interface between the subducting and overriding plates. The contribution of each subduction zone to the globally released seismic moment is not homogeneous, as well as the maximum Mw recorded in the instrumental and historical catalogues. To contribute to the unravelling of the seismic cycle along the STF, we used analogue models.
Viscoelastic laboratory experiments realised with type A gelatine 2.5 wt% at 10 °C (Corbi et al., 2013) successfully simulate the seismic cycle along the STF, providing dynamic similarities with earthquakes in nature. However, analogue earthquakes are still not perfectly comparable to the natural prototype. In this work, we try to improve STF seismicity models by modifying the rheological behaviour of gelatine with the addition of NaCl.
After testing salted gelatine rheology as a function of increasing concentration of NaCl, we selected 20 wt% NaCl gelatine, as this NaCl concentration provides a quasi-viscoelastic lithospheric analogue. Subduction interplate seismicity models were performed using both pure and salted gelatine to highlight the strengths and advantages this new material can provide for simulating the seismic cycle along the STF.
We analysed analogue earthquakes Mw, recurrence time and rupture duration, which at first-order characterise the seismogenic behaviour of the STF. Results show that the experimental source parameters cover a wider range of values than obtained with pure gelatine, which is more compatible to the high variability globally observed. In particular, salted gelatine allows to simulate also smaller seismic events, giving the opportunity to apply the G-R law to the experimental seismicity of STF. Recurrence time and rupture duration are also characterised by an increased range of values when salted gelatine is used as analogue material, suggesting the contribution of the lithospheric rheology in controlling mega-earthquakes frequency occurrence and highlighting the possibility to model with laboratory experiments also slow earthquakes, whose understanding is still at an early stage. These new outcomes open new perspectives on the use of this modified material to investigate experimentally the seismic behaviour of the STF.