THE MECHANICS AND PHYSICS OF CHEMICALLY ACTIVE FAULTS

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Episodic Tremor and Slip (ETS) events display a rich behaviour of slow and accelerated slip with simple oscillatory to complicated chaotic time series. It commonly believed that the fast events that appear as non-volcanic tremors are signatures of deep fluid injection. The fluid source is suggested to be related to the breakdown of hydrous phyllosilicates, mainly the serpentinite group minerals such as antigorite or lizardite that are widespread in the top of the slab in subduction environments. Similar ETS sequences are recorded in different lithologies in exhumed crustal carbonate-rich thrusts. Here, the fluid source is suggested to be the more vigorous carbonate decomposition reaction. If indeed both events can be understood and modelled by the same generic fluid release reaction $AB_{(solid)} \rightleftharpoons A_{(solid)} + B_{(fluid)}$ the ETS sequences in subduction zones reveal a geophysical tractable temporal evolution with no access to the fault zone while conversely the exposed carbonate thrust offer direct access to the spatial manifestations without access to the temporal evolution. This work reviews recent advances in modelling ETS events considering the multiphysics instabilities triggered by the fluid release reaction and develops a thermal-hydraulic-mechanical-chemical oscillator THMC (spring) model for such mineral reactions (like dehydration and decomposition) in Megathrusts [1,2]. We describe advanced computational methods for THMC instabilities and discuss spectral and finite element solutions. We apply the presented numerical methods to field examples of this important mechanism and reproduce both the temporal signature of the Cascadia and Hikurangi trench (Fig. 1) with a serpentinite oscillator [3], as well as match the spatial manifestation of a canonical carbonate-driven crustal thrust, the Glarus thrust in the Swiss Alps [4].

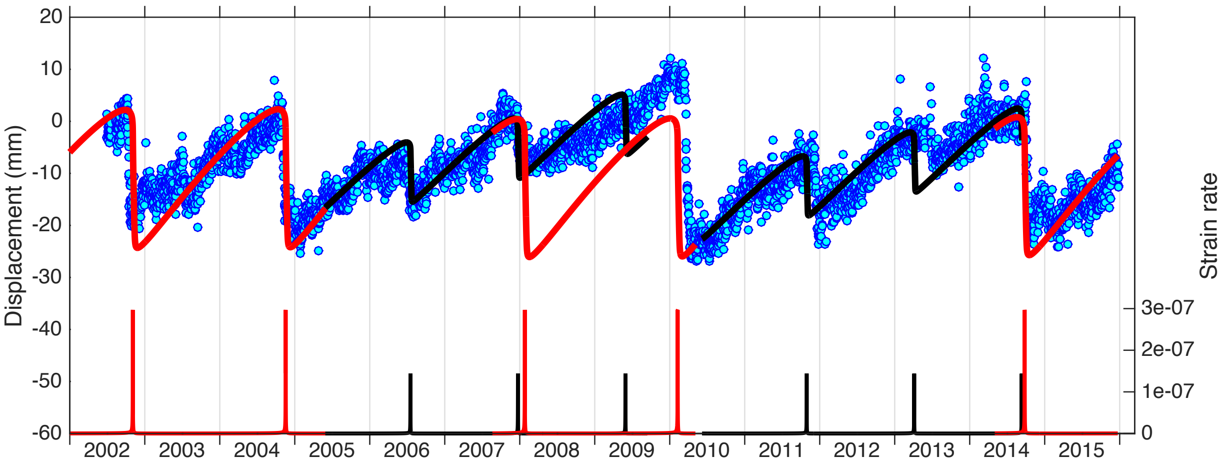

Figure 1. Irregular ETS sequence of Gisborne, New Zealand, station GISB (NASA, 2013). The GPS data (blue dots) represent raw displacement data with its linear trend removed. The signal is non-periodic and the suggested fit consists of 2 modes. The first mode (red line) has higher displacement and strain rates (shown at the bottom) per event and a period of 2 years, and the second one (black line) has a period of about 14 months. Figure last updated on the 31st of December 2015.

References

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