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The effect of fluids on thermal and mechanical processes in the plate interface zone

A. Kellner (1), N. Kukowski (1), S. Medvedev (2), F. Schilling (1) and TIPTEQ Research Group

(1) GFZ Potsdam, Telegrafenberg, 14473 Potsdam, Germany, (2) PGP, University of Oslo, 0316 Oslo, Norway, (akellner@gfz-potsdam.de / phone: +49 331 288 1305)

The seismogenic coupling zone is one of the most interesting characteristics of a subduction zone. Here, mega-thrust earthquakes are suggested to initiate, but the triggering mechanism and processes that shape them are only vaguely understood. In spite of the fact that fluids may significantly alter the thermal structure of a subduction zone, the rheological behaviour and the position of the seismogenic coupling zone, their specific impact on the position of the seismogenic coupling zone and the processes taking place in and around it, still is only very poorly understood. The numerical experiments are applied to the South Chilean subduction zone, for which ample geophysical and geological data are available in the framework of the TIPTEQ project. The main target of the presented study is to understand the role of fluids on the thermal and mechanical structure of a subduction zone. The complex interrelation between fluids and deformation processes, such as the cycle of frictional sliding of the two plates, is elucidated.

Thermal and mechanical numerical experiments are used to figure out the important role of fluids in a subduction zone environment. The thermally controlled updip and downdip limit of the seismogenic coupling zone is investigated applying thermal numerical models. Fluid and heat sources/sinks are studied to understand their effect on the width and depth of the seismogenic coupling zone. The mechanical numerical models aim to investigate the strength of coupling between the plates. The frictional structure at the plate interface plays a key role for the determination of the downdip limit of the seismogenic zone and the deformational pattern of the overriding plate. By means of the variation of physical parameters we study the effect on the width and depth of the seismogenic coupling zone, as well as the style of deformation evolving in the upper plate. The results of the thermal experiments show, that only heat sources can explain a reasonable depth extent of the seismogenic coupling zone. The mechanical experiments show, that a sharp transition in the strength of coupling is necessary to achieve strain partitioning in the upper plate as observed in nature.