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Plate kinematics, slab shape and back-arc stress: a comparison between laboratory models and current subduction zones

A. Heuret (1), F. Funiciello (2), C. Faccenna (2), S. Lallemand (1)

(1)*G*eosciences Montpellier, UMR 5243 CNRS-UM2, Universite Montpellier 2, CC. 60, place *E*. Bataillon, 34095 Montpellier cedex 5, France, (2)*D*ip. Scienze Geologiche, Universita degli Studi Roma TRE, Largo *S*. Leonardo Murialdo 1, 00146Roma, Italy, (heuret@dstu.univ-montp2.fr / Fax: +33 467143642 / phone: +33 467143301)

A combination of statistical studies on present-day subduction zones and three-dimensional (3D) laboratory models is performed with the aim to clarify the way that plate kinematics control the geometry of the slab and the overriding plate deformation in subduction zones. In 3D laboratory models, the analogue of a two layer linearly viscous lithosphere-upper mantle system is achieved by means of silicon putty glucose syrup tank experiment. The subducting and overriding plate velocities are systematically changed by exploring the variability field of natural plate kinematics. Both statistical and modelling approaches recognize the importance of overriding plate motion on subduction process behavior: (1) trenches migrate at a rate close to the overriding plate motion, but always move slower than the overriding plates. The mechanism at work is a direct consequence of "slab anchoring" opposed by both lithosphere and mantle viscous resistance and is responsible for overriding plate deformation and slab geometry variability. (2) An overriding plate shortens when the overriding plate moves toward the trench and conditions that are favourable for overriding plate extension are created when the overriding plate moves away from the trench. (3) Shallow and steep dips are found if the overriding plate moves toward and away from the trench, respectively.