

Various modes of oceanic subduction initiation in a modern Earth

Serge Lallemand ^{*1}, Diane Arcay ¹

¹ Géosciences Montpellier, CNRS, Université de Montpellier - France

To address the question of the triggers and mechanisms involved in the process of subduction zones formation, we have explored all available clues attesting for subduction initiation (SI) during the Cenozoic. We have initially targeted a total of 70 subduction candidates cumulating ~70,000 km of trench, two thirds being still active and a majority still immature. Our strategy consists in defining four stages reached for each subduction candidate starting from incipient-diffuse, incipient-localized, achieved to self-sustained subduction. We have paid special attention to prematurely extinct, i.e., aborted, subduction attempts in order to better understand the reasons for the stoppage of the subduction process, and thence to specify the conditions of success. Failure in subduction initiation results from a combination of hindering parameters (lithosphere cooling, frictional resistance, unfavorable age contrasts for intra-oceanic SI ...) and insufficient external forcings (too low convergence velocity ...). This comprehensive study enables us to observe that new subductions regularly initiate, at a mean rate of about once every Myr, and with a rate of success exceeding 70% to reach subduction maturity, usually within less than ~15 Myr, ~4 Myr for the shortest time lapse from the very early stage to the self-sustained stage. A majority formed at the transition between an ocean and a continent, a plateau or a volcanic arc, thereby demonstrating that large compositional, topographical differences and/or lithospheric weaknesses favor SI. Lithospheric forces are needed to guarantee the success of the process in the early (immature) stages, with the help of mantle forces in one third of the cases. Multiple triggers are common. The stress at SI is compressive in most cases if not all and oriented oblique to the nascent plate boundary in more than half of the cases. The becoming plate boundary generally reactivates a former lithospheric fault, most often with a change in its kinematics. Sometimes, the new lithospheric fault reactivates a former subduction fault. There is no rule regarding the age of the subducting plate which varies from 0 to 140 Ma in the studied examples. In the same vein, the subducting plate is not necessarily older than the overriding plate when oceanic. Both situations are equally observed.

Mots-Clés : subduction initiation, Cenozoic, lithospheric forcing, mantle forcing