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Spontaneity is unlikely in modern subduction initiation processes

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The concept of spontaneous subduction has been taken forward in the late seventies when S. Uyeda and H. Kanamori compared two end-member subduction zones (SZ): Mariana versus Chile. On one side, the old Pacific slab was supposed to "sink" vertically under its excess mass. On the other side, the young Nazca slab was "forced" to subduct beneath the Andes. A few years later, following DSDP Leg 60, magmatic rocks called boninites (similar to those outcropping in Bonin Islands), were collected in the forearc of the Mariana subduction zone. The magmatic sequence sampled there was dated around 50 Ma, i.e. the oldest lavas ever sampled in the arc. These rocks also combined the geochemical characteristics of arc lavas and MORB. Petrologists quickly realized that their forearc position, their geochemistry as well as geodynamic considerations argued for an asthenospheric invasion of the "neo-forearc" during subduction initiation (SI), supporting the concept of spontaneous gravitational collapse of an old lithosphere fringing a young one along a transform fault (TF). This concept and process has been further tested using numerical models and recently rejuvenated at the light of the new discoveries from IODP Expeditions 351 & 352.
After reviewing and analyzing the geodynamic conditions of about thirty SZ initiated on Earth during Cenozoic time, we propose an updated classification based on various geodynamic settings such as SZ jump/flip, SI at TF, SI by SZ lateral propagation . . . . We also examine the mechanics prevailing during SI in the light of physical models combined with field and marine observations. Lastly, we conclude that all subductions, which started during the Cenozoic, were triggered by external forces, i.e. originating out of the SI site. About half of them initiated along TF, fracture zone or strike-slip fault and most the others resulted from a flip (or jump) of subduction. The age of the newly subducting plate range between 0 and 130 Ma but mostly less than 30 Ma and indifferently younger or older than the newly overriding one. Spreading centers are common in the vicinity of incipient subduction zones in either of the two plates. At the end, there is neither field or model evidence to reasonably support the concept of spontaneous subduction in a cold Earth.