Geophysical Research Abstracts
Vol. 12, EGU2010-7741-1, 2010
EGU General Assembly 2010

Spreading pulses of the Tyrrhenian Sea during narrowing of the Calabrian slab

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The opening of the Tyrrhenian Sea has been punctuated by short-lived episodes of oceanic accretion on separate small backarc basins during early Pliocene (Vavilov basin) and early Pleistocene (Marsili basin). These spreading pulses have been related to the rollback of the Ionian slab. They occurred following the reduction of the subduction zone width by the horizontal propagation of slab detachments, forming the narrow Calabrian arc. Nevertheless, the mechanisms leading to the episodic and transient behavior of the backarc region are hitherto unclear.

To investigate the long term and transient effects of the reduction of slab width on the subduction kinematics, we perform dynamically self-consistent laboratory models consisting in a two-layer linearly viscous system simulating the roll-back of a fixed subducting plate (simulated using silicone putty) into the upper mantle (simulated using glucose syrup). We first show, with a set of experiments in which slab width is kept constant throughout experiment, that a six times increase in slab width (from 300 to 1800 km) produces a reduction of trench velocity of about 30%. We also observe that the abrupt reduction of the subducting plate width (from 1800 to 600 km) during experiment results in a pulse of acceleration of the trench retreat velocity of about 50%, as the balance between driving and resisting forces acting on the slab is temporarily modified. The Tyrrhenian acceleration phase can be reproduced if the slab is two to three orders of magnitude stronger than the uppermost part of the mantle, giving a range of mantle viscosity between 10^{19}-10^{20} Pa s. Those values are low but reasonable as they may represent the shallow (first 100-200 km) and hot asthenosphere wedge expected in backarc regions.

We propose that the fast and short pulses of spreading of the Tyrrhenian Sea resulted from the abrupt fragmentation of the subducting lithosphere, forming large windows. This model can be exported to other settings where the formation of slab tear and windows correlates with fast backarc spreading episodes.