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Geological features of Subduction Transfer Edge Propagator (STEP) faults, examples from the Betics and Rif

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Most of the geological features of the Betics and Rif have resulted from slab tearing, edge delamination and punctual slab breakoff events between offset STEP faults. New P-reciever function data of the deep structure under the Betics and Rif have helped to map the deep boundaries of slab tearing and rupture in the area. Linking surface geological features with the deep structure shows that STEP faulting under the Betics occurred along ENE-WSW segments offset towards the south, probably do to the westward narrowing of the Tethys slab. The surface expression of STEP faulting at the Betics consists of ENE-WSW dextral strike-slip fault segments like the Crevillente, Alpujarras or Torcal faults that are interrupted by basins and elongated extensional domes were exhumed HP middle crust occurs. Exhumation of deep crust erases the effects of strike-slip faulting in the overlying brittle crust. Slab tearing affected the eastern Betics during the Tortonian to Messinian, producing the Fortuna and Lorca basins, and later propagated westward generating the end-Messinian to Pleistocene Guadix-Baza basins and the Granada Pliocene-Pleistocene depocentre. At present slab tearing is occurring beneath the Málaga depression, where the Torcal dextral strike-slip fault ends in a region of active distributed shortening and where intermediate depth seismicity occurs. STEP fault migration has occurred at average rates between 2 and 4 cm/yr since the late Miocene, producing a wave of alternating uplift-subsidence pulses. These initiate with uplift related to slab flexure, subsidence related to slab-pull, followed by uplift after rupture and ending with thermal subsidence. This “yo-yo” type tectonic evolution leads to the generation of endorheic basins that later evolve to exhorheic when they are uplifted and captured above the region where asthenospheric upwelling occurs.