Analogue modeling and tectono-stratigraphic evolution of the eastern Sicilian fold-and-thrust belt

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In Central Mediterranean, the Sicilian Fold and Thrust Belt (SFTB) and Calabrian Arc, as well as the whole Apennine-Maghrebian belt, result from the subduction and collision with drifted micro-continental terranes. These terranes detached from the European margin and migrated southeastward in response to Neogene slab roll-back and associated back-arc extension. From N to S, the SFTB is divided in 4 main tectono-stratigraphic domains: (1) the Calabro-Peloritani terrane, drifted from the European margin and detached from the Corso-Sarde block since the back-arc opening of the Tyrrhenian basin, (2) the Neotethyan pelagic cover, constituting the remnants of the Alpine Tethys oceanic accretionary wedge, (3) the folded and thrusted platform (Panormide) and basinal (Imerese-Sicanian) series of the down-going African margin, and (4) the undeformed african margin foreland (Hyblean).

The scarce good quality outcrops of key tectono-stratigraphic units and crustal scale seismic lines makes the structural architecture of the SFTB very controversial, as testified by the wide variety of tectonic interpretations (Bianchi et al., 1987; Roure et al., 1990; Bello et al., 2000; Catalano et al., 2013). Major outstanding issues particularly concern: (1) the occurrence of Alpine Tethys units far from the region where the remnants of the Tethyan accretionary wedge outcrop (Nebrodi range); in a forearc position above the Peloritani block north of the SFTB and in an active foreland context along the southern front of SFTB; (2) the diverging suggested tectonic styles, from stacked large-scale tectonic nappes to foreland imbricated thrust systems rooted into a main basal décollement; and (3), the deposition environment of substantial units such as the widespread Numidian Flyschs, from syntectonic foreland basin to wedge-top sedimentation.

We used 2D analogue models to investigate the mechanical processes involved in the formation of the SFTB starting from the Oligocene Tethys subduction to the Middle Miocene - Late Pliocene continental collision with the African paleo-margin. Based on a detailed tectono-stratigraphic synthesis, complemented by field observations, we reproduce the first-order mechanical stratigraphic of the sedimentary and basement units involved in the SFTB as well as the structural inheritance of the African margin. Our models also include: syntectonic erosion and sedimentation, syn-orogenic flexure and adjustable material output via a “subduction channel”.

The analog models succeed in reproducing the general structure of the SFTB and main
tectono-stratigraphic correlations. For instance, the Panormide platform is underthrust beneath the Alpine Tethys accretionary wedge, then stacked above the Imerese basinal units and belatedly exhumed in response to basement anticlinal stack. Our results also suggest that the Alpine Tethys units couldn’t overthrust the whole African foreland in the Middle Miocene, nor be back-thrusted over the forearc basin during the Burdigalian. We rather favor a gravity-induced sedimentation process inducing reworking of the tethysian sediments at specific building stages of the accretionary wedge. The structural architecture of the modeled orogenic wedge is also consistent with a SFTB growing by frontal accretion and basal underplating of mechanically resistant stratigraphic units rather than by large-scale nappe overthrusting.