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Reply to comment on the article "Propagation of a lithospheric tear fault (STEP) through the western boundary of the Calabrian accretionary wedge offshore eastern Sicily (Southern Italy)" by Gallais et al., 2013 Tectonophysics

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ABSTRACT

In his Comment, A. Argnani argues that our interpretation of the STEP fault (named STEP-1 fault, in the Comment) is poorly constrained by the seismic data used in Gallais et al. (2013), and he particularly disagrees with our identification north of the Alfeo Seamount. A. Argnani is convinced that the tear fault is expressed by a belt of surface deformation, close to the Malta Escarpment. However, none of the seismic images published by A. Argnani show a crustal scale structure that could be associated with the presence at depth of a lithospheric tear. In that paper we documented the presence of a sub-vertical crustal scale fault, located 50 km east of the Malta Escarpment, with a northward increasing vertical offset (Gallais et al., 2013). The track of this fault towards the north could be extended following the position of the fault "F6", mapped 20 km east of the Malta Escarpment by Nicolich et al. (2000). In fact these authors reported an offset of the crust associated with activity of the fault "F6", suggesting that the lithospheric tear at depth at the edge of the Ionian slab is distinct from the Malta Escarpment.

1. South of Alfeo Seamount: the southern tip of the STEP fault

A. Argnani pointed out that the grid of profiles used in our study is not enough dense to constrain the position of the STEP fault at the western edge of the Ionian slab. As we clearly stated in our paper, our study dealt primarily with the southern termination of the STEP fault, south of the Alfeo Seamount, based on newly processed seismic profiles (see position of the data used in Fig. 2, Gallais et al., 2013). Accordingly, our study allowed a quantification of the vertical displacement associated with the presence of a very steeply E-dipping fault, observed on two newly depth reprocessed Archimede lines (see Figs. 4 and 5, Gallais et al., 2013) and on other available seismic lines in the literature (ION-1 and CROP-M3) (Cernobori et al., 1996; Hirn et al., 1997; Polonia et al., 2011). The Archimede seismic profiles image a nearly vertical fault that cuts completely through the Calabrian accretionary wedge. Activity of this fault leads to a strong vertical offset of the entire sedimentary pile and of the crustal basement and the emplacement of a Pleistocene syntectonic basin (Hirn et al., 1997; Nicolich et al., 2000). The vertical offset decreases towards the south and the fault is no longer visible on the southernmost Archimede 02 line (Gallais et al., 2013).

A. Argani remarks that "the surface expression of a STEP is commonly ambiguous and poorly documented". However, in our main study area (south of Alfeo Seamount) there is a striking vertical displacement, which we were able to quantify using pre-stack depth migrated seismic profiles and which increases from 275 m (on Archimede line 16) to 645 m (on Archimede line 17). This amount of vertical throw on the fault is defined on the basis of a clear offset in the base of the Messinian and corresponds to an asymmetric syntectonic basin with a thickness of ~645 m. We attribute this vertical down to the East movement, to the presence at depth of a lithospheric tear (STEP) that propagates towards the south. We are also able to map the southern termination of this tear, since a vertical displacement is no longer imaged south of the latitude N36.4°.

2. The Alfeo Seamount and the northern end of the STEP fault

We described and emphasized that the proposed prolongation towards the north is based on other geophysical data (Fig. 1, in the reply). The prolongation to the north of the steeply E-dipping fault is based on correlation with previous seismic interpretations (Argnani and Bonazzi, 2005; Hirn et al., 1997; Nicolich et al., 2000). As already

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proposed in Gallais et al. (2013), two candidates could be retained from the literature for the prolongation of the fault:

- The fault “F6” that is located 20 km east of the Malta Escarpment, mapped by Nicolich et al. (2000),
- A set of faults that delineates a “belt of surface deformation, close the Malta Escarpment”, mapped by Argnani and Bonazzi (2005).

Undeniably, A. Argnani used a denser grid of MESC profiles to map the structures close to the Alfeo Seamount and towards the north (Fig. 1, in the comment). However, none of the faults mapped using these data have a crustal scale expression that indicates the presence of a tear at depth. Regarding the set of faults mapped by Nicolich et al. (2000), A. Argnani argued that the main fault identified by Nicolich and co-authors is the fault named “F4”. But these authors clearly recognized the fault “F6” as the best expressed feature on the ETNASEIS dataset (Hirn et al., 1997; Nicolich et al., 2000): “Moreover, this region is the site of a major intracrustal perturbation, fault F6, with a very clear large throw in the Mesozoic/Paleogene sediments and lower crust” (in Nicolich et al., 2000). Based on the MESC profiles shown in the Argnani papers (see position Fig. 1) (Argnani, 2009; Argnani and Bonazzi, 2005; Argnani et al., 2012), these authors cannot rule out the existence of a major fault “F6”. Indeed, in Fig. 2, the marked structure “F6?” appears to correspond exactly to the fault “F6” of Nicolich et al. (2000). The fault “F6” is our preferred interpretation for the prolongation towards the north of our quasi vertical fault. Hirn et al. (1997) and Nicolich et al. (2000) reported offset of the crustal basement associated to the fault “F6”.

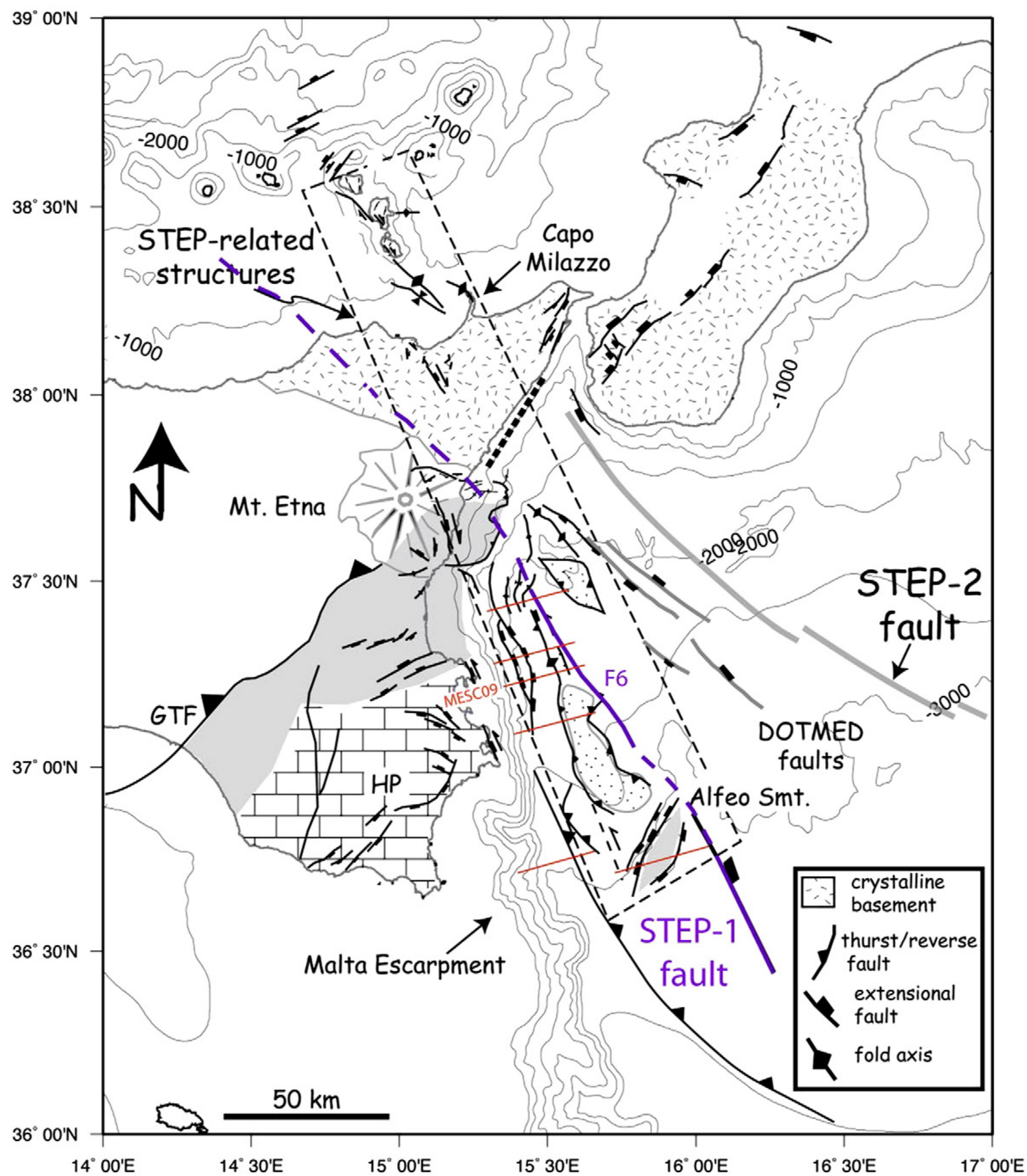

Fig. 1. Structural map of Argnani and Bonazzi (2005) with the position of our interpreted STEP-1 fault and its prolongation in the fault “F6” of Nicolich et al. (2000). We also add the position of the MESC profiles available in the literature (profile MESC 09 is shown in Fig. 2 (Argnani and Bonazzi, 2005; Argnani, 2009) and MESC 08 (Argnani et al., 2012)).