A novel GNSS-based crustal velocity field for western Sicily

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Western Sicily (WS) is part of the Sicilian Fold and Thrust Belt, a sector of the SE-verging orogenic belt in the central Mediterranean. This part of the complex Apennine-Maghrebian chain has been described as a thick embricate wedge of Mesozoic carbonate (platform and deep-water) and siliciclastic rocks formed during the Neogene-Quaternary. According to deep seismic explorations in the area, the tectonic belt is composed of tectonically overlapping imbricate thrust-stack systems separated by regional basal detachments (Catalano et al., 2013 and references therein).
Active tectonic deformation is well documented in the northern offshore of Sicily, where geodetic, geological, and earthquake focal mechanisms highlight a near continuous E-W-oriented belt characterized by a significant crustal shortening (Billi et al., 2023 and reference therein). Conversely, the few available geodetic data suggest that WS is characterized by a contractional pattern occurring at rates lower than 1-2 mm/yr (Palano et al., 2012). Moreover, WS has been historically hit by significant earthquakes (M≥5) as the two occurred close at Selinunte (between the fourth and third centuries B.C., and between the sixth and thirteenth century A.D., respectively) (Guidoboni et al., 2002), Sciacca (1578) with estimated magnitude of 5 (Scarfi et al., 2024), as well as the one (M ~ 6) occurred in 1968 in the Belice region (Barreca et al., 2014) (Fig. 1a).
Despite this last event is considered as the most destructive earthquake hitting WS, the available seismic and geological data do not allow the identification of a specific seismogenic structure. The scientific debate about the possible source, its geometry, and its movement is still ongoing. The focal mechanisms do not provide unambiguous solutions, showing results that range from pure strike-slip to pure reverse faulting.
Given these still-present uncertainties, we established a new geodetic network of 24 episodic benchmarks crossing the main tectonic system of the Belice region. In addition, we collected all available episodic and continuous GNSS observations to provide a dense velocity field in a wide area encompassing the study region. Such a large dataset includes data acquired by continuous (RING, ASI, NETGEO, and ITALPOS) and episodic (IGM95, PTGA, and TYRGEONET) GNSS networks (Fig. 1b). RING (https://webring.gm.ingv.it) and ASI (http://geodaf.mt.asi.it) networks have been established for geodynamic and monitoring purposes, while NETGEO https://shop.netgeo.it) and ITALPOS (https://hxgnsmartnet.com) have been developed for general navigation and cadastral purposes. The IGM95 network was established and surveyed by the Italian Istituto Geografico Militare during the time span 1992-1996 to provide a set of 3D coordinates based on the GPS reference system for cartographic and civil applications. The TYRGEONET (Achilli et al., 1993) and PTGA (Ferranti et al., 2008) networks have been developed to study crustal deformation of central mediterranean and southern Italy, respectively. We re-surveyed most of these episodic sites in order to i) extend over the time their time series and ii) provide a fine refinement of site velocity estimation. All raw observations have been processed by using the GAMIT/GLOBK software and adopting the approach

described in Billi et al. (2023). The achieved crustal velocity field have been framed into the ongoing geodynamic of the study area.

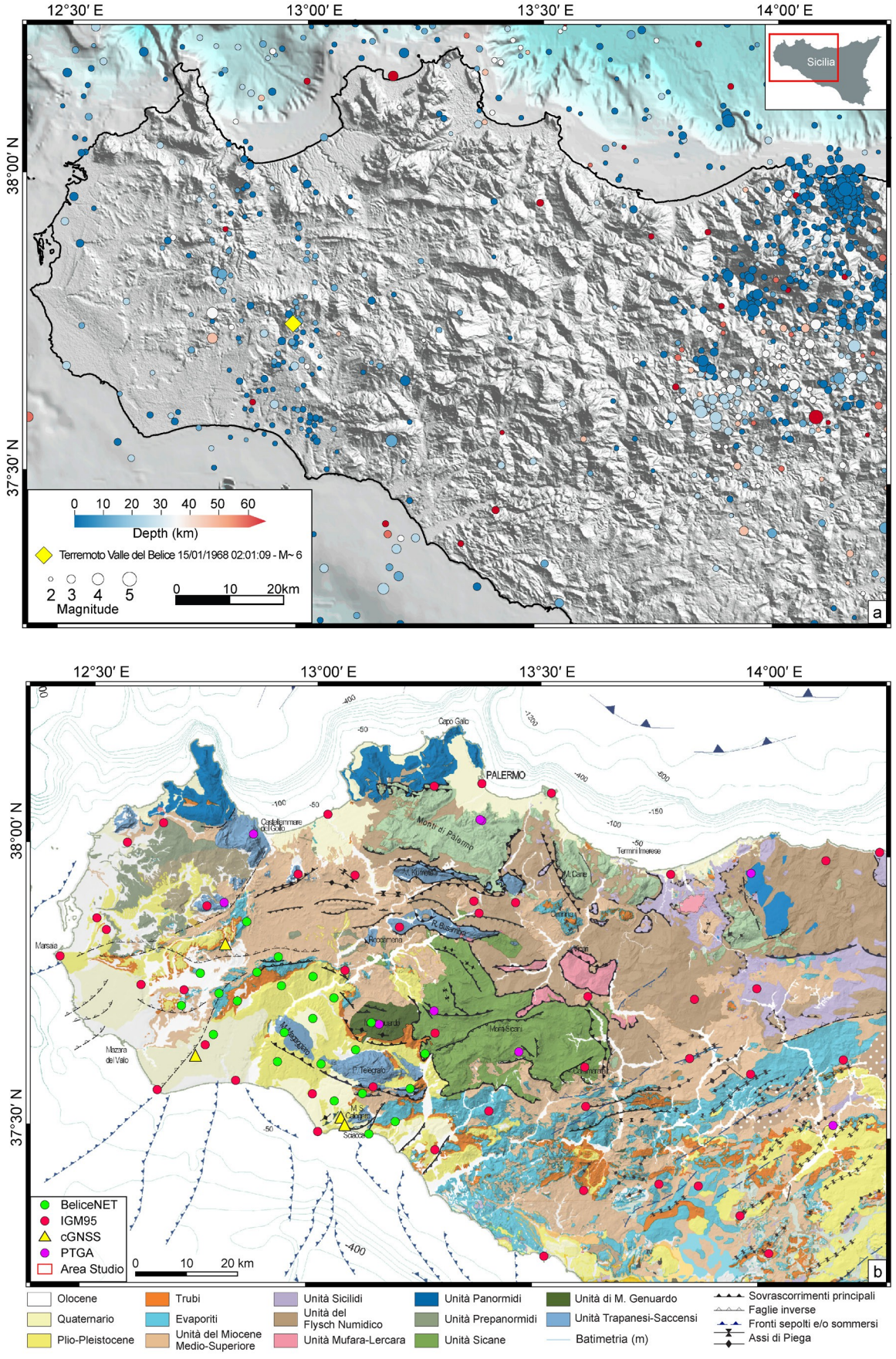

Fig. 1 - Figure shows the study area of the present work (Western Sicily). (a) Earthquake locations from 1981 to 2018 (CLASS Catalogue) and from 2019 to the present (ISIDE Catalogue). (b) Regional geological map showing the locations of geodetic networks with episodic measurements (BeliceNET, IGM95, PTGA, and TYRGEONET), indicated by colored points, and continuous GNSS (cGNSS) stations (RING, ASI, NETGEO, and ITALPOS), shown as yellow triangles.

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