Rend. Online Soc. Geol. It., Vol. 21 (2012), pp. 198-200.

Stepwise behavior of the Eastern Sicily thrust belt: propagation vs thickening by means of thermal and thermochronological constraints

L. DI PAOLO (*), S. CORRADO (*), V. OLIVETTI (*), L. ALDEGA (**), M.L. BALESTRIERI (***) & R. MANISCALCO (****)

Key words: *wedge dynamics, Eastern Sicily thrust belt, thermal and thermochronological constraints*

INTRODUZIONE

The Sicilian wedge, in Eastern Sicily, is part of the collisional system grown in response to Eurasia-Africa convergence.

Previous studies on the Sicilian chain are based on structural and stratigraphic analysis of seismic sections and syn-orogenic deposits (ROURE *et alii*, 1990; ADAM AND REUTHER, 1995; BUTLER AND LICKORISH, 1997; LICKORISH *et alii*, 1999; BELLO *et alii*, 2000; NIGRO AND RENDA, 2000) whereas recent works have unraveled complex burial and exhumation history (THOMSON, 1994; ALDEGA *et alii*, 2007; 2011; CORRADO *et alii*, 2009; OLIVETTI *et alii*, 2010; DI PAOLO *et alii*, 2012).

In this work, published thermal and thermochronological data have been integrated to propose a stepwise evolution of the Sicilian wedge through time.

GEOLOGICAL SETTING

The Eastern Sicily thrust belt is formed by thrust sheets of Mesozoic to Paleogene basin- platform-derived tectono-stratigraphic units overlying the Hyblean foreland. This consists of a thick carbonate platform sequence with interleaved marls and mafic volcanic levels (BIANCHI *et alii*, 1987). The thrust belt is organized into two main structural zones: the Internal Zone to the north and the External Zone to the south.

The Internal Zone consists of south-verging thin crystalline nappes of the Peloritani Mts. (GIUNTA AND NIGRO, 1999; OLIVETTI *et alii*, 2010).

The External Zone is made up of three main tectono-stratigraphic units. The structurally highest units, widely exposed in the Nebrodi Mountains, are represented by the remnants of the Neotethyan accretionary wedge (CORRADO *et alii*, 2009), made up of a portion of the Sicilide Accretionary Complex (OGNIBEN, 1960) consisting of an upper Cretaceous to lower Miocene pelagic succession and by the Oligocene-Langhian foredeep deposits of the Numidian Flysch (CARBONE *et alii*, 1990; CATALANO *et alii*, 1996). Tectonically beneath these units, the more external Imerese-Sicano Unit forms an imbricate thrust system with a regional backthrust cropping out in the centre of Sicily (MANISCALCO *et alii*, 2010), and to the south a series of thrusts with top-to-the-South sense of transport. The succession is made up of mainly pelagic basin Mesozoic carbonates with radiolarian cherts, overlain by Paleogene marly limestones and younger clastic deposits (BIANCHI *et alii*, 1987).

METHODS

Analytical inorganic and organic thermal indicators concern:

- Organic matter optical analysis. Random reflectance (VRo%) was measured under oil immersion, with a Zeiss Axioplan microscope, in reflected monochromatic non-polarised light.

- Fourier Transform Infrared Spectroscopy on organic matter. FTIR experiments were carried out at the Indiana Geological Survey using a Nicolet 6700 spectrometer equipped with a DTGS detector. Ground kerogen was mixed with potassium bromide in the proportion of 1 mg/ 100 mg and was analyzed as KBr pellets. Two hundred scans per sample were

(*) Dipartimento di Scienze Geologiche, Università degli Studi "Roma Tre", 00146 Roma. Email: ldipaolo@uniroma3.it

(**) Dipartimento di Scienze della Terra, Sapienza Università di Roma, 00185 Roma.

(***) Consiglio Nazionale delle Ricerche, Istituto di Geoscienze e Georisorse, 50121 Firenze.

(****)Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, 95129 Catania.

Lavoro eseguito nell'ambito del progetto di dottorato "Burial and Exhumation History of the Apenninic-Maghrebian fold-and-thrust belt in Eastern Sicily by means of integrated studies of thermal and thermochronological constrains" con il contributo finanziario dell'Università degli Studi "Roma Tre" (Fondi ex 60% Corrado e Scuola Dottorale in Geologia dell'Ambiente e delle Risorse).

recorded in absorption mode from 500 to 4000 cm−1 with a 4 cm−1 resolution.

- XRD analysis of clay minerals. Qualitative identification and quantification of I-S in the <2 μm grain-size fraction was performed with a Scintag X1 XRD system (CuKα radiation). Oriented air-dried and ethylene-glycol solvated samples were scanned from 1 to 48 °2q and 1 to 30 °2θ with a step size of 0.05 °2q and a count time of 4 s per step at 40 kV and 45 mA, respectively.

- Apatite fission tracks analysis. Apatite fission track ages were calculated using the external-detector and the zeta-calibration methods. The samples were irradiated with thermal neutrons in the Lazy Susan facility of the Triga Mark II reactor of the University of Pavia (Italy).

- (U-Th)/He analysis. Inclusion-free apatite for (U-Th)/He analysis were hand-picked under a high- magnification binocular microscope with cross-polarized light. Helium was extracted by heating the Pt-tubes at 600–700°C for 1–2 min using a laser diode. ^{4}He concentrations were measured by comparison to a calibrated standard ^{4}He using a Hiden HAL3F quadrupole mass spectrometer equipped with an electron multiplier.

THERMAL AND THERMOCHRONOLOGICAL CONSTRAINTS FOR TECTONIC MODEL

Thermal and thermochronogical constraints indicate that the structural and stratigraphic Units constituting the Eastern Sicily fold-and-thrust belt are divisible in two levels of thermal maturity: a less evolved level that records limited sedimentary burial and minor heating and a more evolved level tectonically buried and then exhumed. The lower level of thermal maturity is characterized by (1) R0 mixed layer illite smectite with an illite content <60%, (2) vitrinite reflectance <0.5%, (3) vitrinite reflectance values derived from FTIR analysis <0.5% and (4) no resetting of apatite fission tracks. The higher level of thermal maturity is characterized by (1) R1 and R3 mixed layer illite-smectite with an illite content in the range of 60-85%, (2) vitrinite reflectance values between 0.61 and 0.96% and (3) AFT ages ranging between 35 and 6 Ma either totally or partially annealed.

Thermal and structural history of the "colder" Units is linked to phases of propagation of deformation forward in piggy back style through low angle thrusts, whereas the "hotter" Units are linked to tectonic thickening phases of the orogenic wedge in which the deformation concentrates in narrow belts through the formation of duplexes (e.g.., antiformal stacks) and up-thrusts. The two different tectonic styles are localized in different sectors of the FTB, alternate through time and are related to the maintenance of the critical taper linked with eustatic/climatic variations.

ACKNOWLEDGEMENTS

Thanks are due to R. Somma for her help in the field during sampling, to M. Mastalerz and A. Schimmelmann for their support in the kerogen extraction and FTIR lab facilities.

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