Earth-Science Reviews 142 (2015) 60–78

Contents lists available at ScienceDirect

Earth-Science Reviews

journal homepage: www.elsevier.com/locate/earscirev

Onshore to offshore correlation of regional unconformities in the Plio-Pleistocene sedimentary successions of the Calabrian Arc (central Mediterranean)

Massimo Zecchin [a,*], Daniel Praeg [a], Silvia Ceramicola [a], Francesco Muto [b]

[a] OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), 34010 Sgonico, TS, Italy
[b] Dipartimento di Scienze della Terra, Università della Calabria, 87036 Arcavacata di Rende, CS, Italy

ARTICLE INFO

Article history:
Received 9 June 2014
Accepted 21 January 2015
Available online 29 January 2015

Keywords:
Unconformity
Pliocene
Pleistocene
Calabria
Tectonics
Forearc basin

ABSTRACT

Three regional unconformity surfaces typify the Plio-Pleistocene fill of the onshore to offshore basins of the Calabrian Arc, an arcuate terrane migrating to the SE above the NW subducting Ionian lithosphere, between the southern Apennines and Sicily. These unconformity surfaces formed in the mid-Pliocene (late Zanclean to early Piacenzian), the early Pleistocene (intra-Gelasian) and the mid-Pleistocene (late Calabrian). Their expression varies significantly across the area, so that from one to three unconformities may be recognized within any given basin. Several lines of evidence suggest that the spatially variable development of the unconformities across the Arc records interruptions of subsidence by phases of uplift and deformation, related to the extent and nature of successive tectonic events linked to episodic subduction zone retreat and slab fragmentation during the Plio-Pleistocene interval. In particular, the mid-Pliocene unconformity is associated with uplift and deformation on the Ionian flank of the Calabrian Arc that interrupted a phase of basin subsidence coeval with opening of the Vavilov back-arc basin, and may record either interference of the Arc with the Apulian microplate, or an episode of out-of-sequence tectonic thickening within` the advancing accretionary wedge. The two Pleistocene unconformities bracket a phase of basin collapse in northern Calabria that coincides with the ultra-fast opening of the Marsili backarc basin, and are associated with uplift and contractional–transpressional deformation that record interference of the subducting slab with adjacent microplates. The recognition of a synchronous development of unconformities in the Calabrian basins provides key references for further studies of the geodynamic evolution of the central Mediterranean.

Contents

* Corresponding author.
E-mail address: mzecchin@ogs.trieste.it (M. Zecchin).

http://dx.doi.org/10.1016/j.earscirev.2015.01.006
0012-8252/

1. Introduction

The study of the stratigraphic architecture of basin fills to understand their evolution and the parameters controlling sedimentation is crucial for precise reconstructions of accommodation development and consumption through time, as largely demonstrated by studies in a variety of tectonic contexts (e.g., Miall, 1997; Catuneanu et al., 2000; Hampson et al., 2001; Zecchin et al., 2004a; Jackson et al., 2005; Zecchin et al., 2012; Csato et al., 2013; Massari and Prosser, 2013; Zecchin et al., 2013a,b). A further step of this approach consists in studying the geodynamic evolution of the lithospheric blocks that host sedimentary basins, the fills of which typically record the signature of large-scale tectonic drivers (Cloetingh, 1988; Einsele, 2000; Leeder, 2011). Understanding the origin and timing of the unconformities found in basin fills is fundamental to achieve these objectives, as they document major breaks in sedimentation that may be linked to deformation phases associated with basin reorganizations, depocenter modifications and changes in sediment transport pathways (Catuneanu et al., 1998; Zecchin et al., 2012, 2013a,b). The superposition of eustatic changes of different ranks on base-level changes linked to tectonics can be discriminated through accurate sequence-stratigraphic analysis and a multidisciplinary approach (Miall, 1997; Catuneanu, 2006; Catuneanu and Zecchin, 2013; Zecchin and Catuneanu, 2013).

The present study is aimed at recognizing the relationships between the genesis of Plio-Pleistocene unconformities and major tectonic events within the Calabrian Arc, a composite terrane forming the inner part of an arcuate accretionary complex in the central Mediterranean that has undergone SE-ward migration since the late Serravallian in conjunction with NW-ward subduction of Ionian lithosphere and the opening of back-arc basins in the Tyrrhenian Sea (Malinverno and Ryan, 1986; Sartori, 1990, 2003) (Fig. 1). Episodic subduction zone retreat has taken place due to changes in the geometry of the downgoing slab, involving stepwise narrowing conditioned by interference with continental blocks of the adjacent southern Apennines, Apulia and Sicily (Faccenna et al., 2001, 2004; Chiarabba et al., 2008; Guillaume et al., 2010). This complex Neogene geodynamic evolution has had consequences for the structural and stratigraphic records of the Apennines that are difficult to unravel, as reflected in the range of reconstructions that have been proposed (e.g., Rehault et al., 1987; Patacca et al., 1990; Sartori, 1990; Knott and Turco, 1991; Van Dijk and Scheepers, 1995; Schettino and Turco, 2011).

In a previous study, Zecchin et al. (2012) reviewed the Plio-Pleistocene fill of the Crotone Basin, a partly uplifted forearc basin located on the Ionian margin of the Calabrian Arc (Fig. 2), and showed its stratigraphy to contain unconformities that interrupt phases of subsidence corresponding to the main phases of forward migration of the Calabrian accretionary system contemporaneous with extensional episodes in the Tyrrhenian backarc area. The present contribution provides a comparison of the character and timing of regional unconformities found in the Plio-Pleistocene infill of the main onshore and offshore sedimentary basins on both sides of the Calabrian Arc (Fig. 2), with the aim of recognizing a relationship between the genesis ofunconformities and large-scale tectonic events, and obtaining new insights into the geodynamic evolution of the central Mediterranean.

2. Methods

This work integrates several offshore datasets: 1) 2D multichannel seismic profiles and well logs available from VIDEPI (http://unmig.sviluppoeconomico.gov.it/videpi/); 2) a compilation of bathymetric datasets of variable resolution, including GEBCO (DTM cell size 1′), CIESM (Medimap Group, 2008; cell size 500 m) and swath bathymetric data acquired by OGS (5–50 m cell sizes) (Fig. 2). All spatial data were gathered in a digital GIS, while seismic raster data were converted to SEGY and interpreted on a digital platform. Unconformities of regional significance were identified on seismic reflection profiles and correlated to stratigraphic data available from wells, mainly distributed along the northern part of the Ionian coast (Fig. 2). The correlation between wells and seismic profiles was done by comparing stratigraphic logs with identified seismic facies and reflectors, and by using average time–depth relationships based on interval velocities from multichannel seismic profiles. In the absence of well data, unconformities were correlated to regional tectonic events on the basis of information available from a review of the literature regarding onshore and offshore basins. The basins considered in this study (Crotone, Crati plus Sibari, Catanzaro, East Serre, Siderno, Spartivento, Corigliano, Paola and S. Eufemia, Fig. 2) were selected on the basis of the availability of data documenting the presence and age of Plio-Pleistocene unconformities within their successions.

3. Geological setting

The Calabrian Arc forms the SE tip of the arcuate Apenninic–Maghrebide fold and thrust belt (Fig. 1), which has been generated through episodic Neogene roll-back of a NW-dipping subduction zone and produced the opening of backarc basins in the western Mediterranean (Malinverno and Ryan, 1986; Patacca et al., 1990; Sartori, 1990; Gueguen et al., 1998). Slab consumption and fragmentation during episodes of tearing has narrowed the subduction zone to a tongue of Ionian lithosphere confined between the Maltese and Apulian escarpments and descending into the mantle beneath the Aeolian volcanic arc (Faccenna et al., 2001, 2005; Guillaume et al., 2010) (Fig. 1). The overlying Calabrian accretionary complex is about 300 km wide, and extends nearly 300 km from its frontal thrust at water depths of 4000 m in the Ionian Sea to onshore elevations of up to 1000 m in Calabria (Fig. 1). The Calabrian 'Arc' (so-called due to its shape), also known as the Calabria–Peloritani Arc or Terrane, is a nappe stack of metamorphic and sedimentary units including Hercynian and pre-Hercynian continental basement and Jurassic to Early Cretaceous ophiolite-bearing sequences (Amodio Morelli et al., 1976; Bonardi et al., 2001; Butler et al., 2004; Iannace et al., 2007). During Oligocene to early Miocene times, these nappes were emplaced on the Mesozoic sedimentary and metasedimentary terranes of the Apennine chain along regional overthrusts (e.g., Haccard et al., 1972; Alvarez, 1976; Amodio Morelli et al., 1976; Tortorici, 1982; Van Dijk et al., 2000; Bonardi et al., 2001). This inner core of the Calabrian accretionary complex is onlapped on both its Tyrrhenian and Ionian sides by the Neogene sedimentary basins of interest to this study (Fig. 2).

The Neogene evolution of the Calabrian accretionary complex is the result of geodynamic processes in which subduction zone retreat has