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EVIDENCE FOR NON-UNIFORM UPLIFT RATES IN SOUTHERN ITALY (CALABRIA AND EASTERN SICILY) ON GLACIAL-CYCLE TIMESCALES

keywords: uplift ratea, neotectonic, sea level rise, Southern Italy

1. INTRODUCTION

In the Mediterranean tectonically active coastlines occur in many locations, including Crete (Pirazzoli et al. 1994), southwest coast of Greece (Dia et al. 1997, Kershaw, Guo 2002) and southern Italy (Miyauchi et al. 1994). Other coastal areas such as south eastern Spain (Zazo et al. 1999), Sardinia (Antonioli et al. 1999) and southern Latium (Hearty, Dai Pra 1986) appear to be stable on the glacial timescales. Many studies of sea level change, with accurate positional measurements and precise datings have been published for Italy in the past decade. The use of markers whose formation positions are closely linked to mean sea level allows precise estimates to be made of local sea-level change.

If the data are from tectonically active zones, then these observations must be corrected for tectonic vertical movements. Examples include the records from

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Huon Peninsula, Barbados or Tahiti. Often the corrections are based on a long term rates estimated from Quaternary data and in the best cases the last interglacial (125 ka BP) shoreline is used as reference level. Uncertainties in these tectonic corrections may in some instances exceed the accuracy of the age-height measurements of the more recent shorelines.

2. DATA

We have obtained new Holocenic uplift rates for eastern Sicily and southern Calabria (Fig 1) using Holocene observational data published for Sicily (Milazzo: Gringeri et al. 2004; Taormina and St. Alessio Cape: Stewart et al. 1997; Antonioli et al. 2003) and Calabria (Scilla: Antonioli et al. 2004; Ioppolo: unpublished data; Capo Rizzuto: Pirazzoli et al. 1997) together with new models for the eustatic and glacio-hydro-isostatic contributions to Holocene sea level change where the latter have been calibrated against data from 30 sites in Italy (Lambeck et al. 2004) (Tab 1).

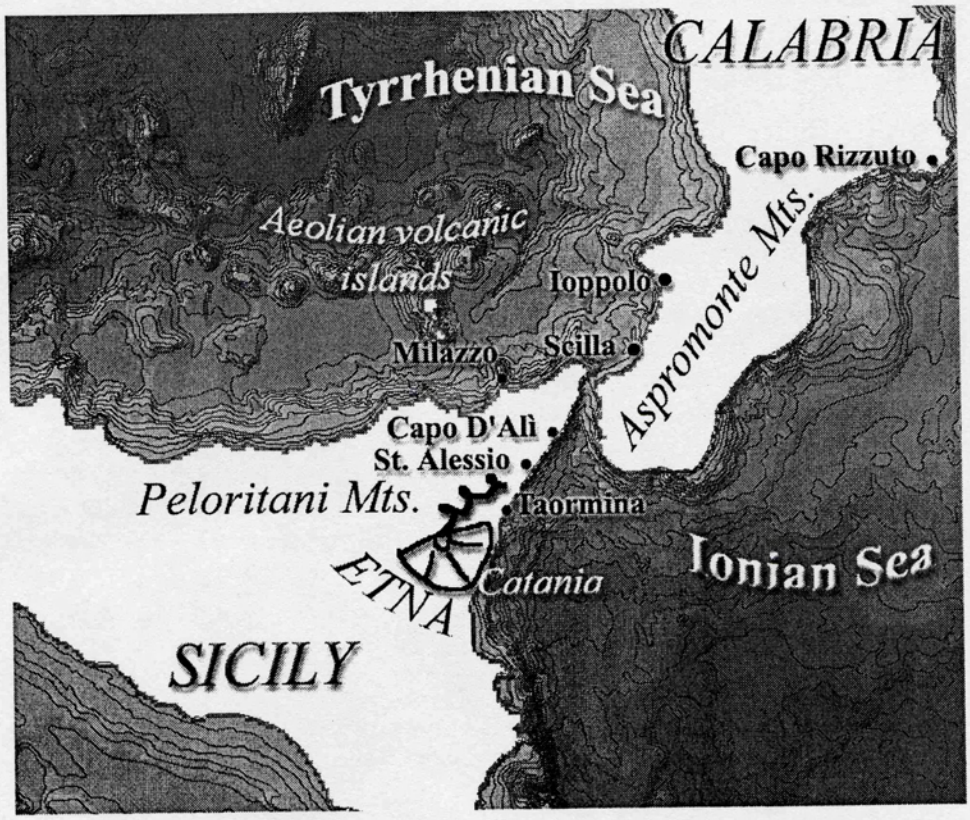

Fig. 1: Sites of Sicily and Calabria

1 Location	2 Coordinates	3 Lab N°	4 Species	5 Observed Elevation (m)	6 Seafloor depth (m b.s.l.)	7 Conventional ^{14}C age	8 Calibrated ^{14}C age	9 Sea level correction (m)	10 Corrected elevation range (m)	11 Uplift rate mm/yr	12 Average mm/yr	References
Sicily - Milazzo	15.252 - 38.237	UTC 11356	*Patella*	2	-1	5665±36	**5999±80**	8.1	10.1-11.1	1.6-1.8	1.7	1
Sicily - St.Alessio	15.346 - 37.915	β-81856	*Lithophaga*	4.9	-2	4880±60	**5067±180**	6.4	11.3-13.3	2.2-2.6	2.4	2
Sicily - St.Alessio		β-81857	*Lithophaga*	4.5	-2	4780±70	**4944±210**	6.3	10.8-12.8	2.2-2.6	2.4	2
Sicily - Taormina	15.294 - 37.850	UCL-362	*Cladocora*	3.4	-3.8	4295±120	**4399± 320**	5.1	8.5 - 12.3	1.9 - 2.8	2.3	2
Sicily - Taormina		β-81859	*Lithophaga*	2.0	-2	3470±210	**3331±210**	3.3	5.3 - 7.3	1.6 - 2.2	1.8	2
Sicily - Taormina		β-81859	*Lithophaga*	1.5	-2	5570±150	**5963±390**	8.2	9.6 - 11.6	1.6-1.9	1.7	2
Sicily - Taormina		GX28038	*Lithophaga*	2.1	-1	3160±50	**2936±150**	2.6	4.7 - 5.6	1.6 - 1.9	1.8	3
Sicily - Taormina		GX28039	*Bolma rug.*	1.5	-1	2500±50	**2168±180**	1.7	3.2 - 4.2	1.4 - 1.9	1.7	3
Sicily - Taormina		GX28040	*Dendropoma P.*	2.8	0	2570±80	**2229±150**	1.7	4.5	2	2	3
Sicily - Taormina		R-3540	*Dendropoma P.*	1.9	0	2203±62	**1791±160**	1.3	3.2	1.8	1.8	4
Calabria - Scilla	15.703 - 38.253	GX28045	*Spondylus*	2.1	-2.2	2930±60	**2668±164**	2.7	4.8 - 7.0	1.8-2.6	2.2	4
Calabria - Scilla		GX28332	*Spondylus*	2.5	-2.2	3450±40	**3318±103**	3	5.5-7.7	1.7-2.3	2.0	4
Calabria - Scilla		GX28331	*Hexaplex*	2.5	-2.2	3930±40	**3901±125**	4.2	6.7-8.9	1.7-2.3	2.2	4
Calabria - Scilla		R- 2625	*Spondylus*	1.2	-2.0	2683±40	**2370±105**	1.8	3.0-5.0	1.3-2.1	1.7	4
Calabria - Ioppolo	15.886 - 38.579	GX 28045	*Dendropoma*	2	-	5120±50	**5358±100**	6.8	8.8	1.6	1.6	this paper
Calabria - Ioppolo		GX28332	*Columbella*	2.2	-	5380±40	**5667±80**	7.3	9.5	1.6	1.6	this paper
Calabria - C. Rizzuto	17.095 - 38.893	GX 28045	Algal rim	0.6	-	-	**2990±50**	2.9	3.5	1.2	1.2	5

TABLE 1: Location, fossils species, observed elevation of fossils, sea floor depth, ^{14}C and ^{14}C Cal age of fossils, sea level correction, corrected elevation range, uplift rates. The GX sample are all AMS ^{14}C, age determinations were provided by Geochron Laboratories, USA. R - conventional ^{14}C, age determinations were provided by Physics Department of La sapienza Roma University. A reservoir age of 400 years was added taking into consideration the paper by Siani et al. (2000) that reported values for southern Italy. Observed elevation (5) is relative to present sea level. Seafloor depth (6) is based on the present day morphology assuming that coastal erosion at the bottom played at the same rate of tectonic uplift. Relative sea level change (i.e. sea level correction, 9) is referred to the age of the living shells and includes eustatic and isostasy components (Lambeck et al. 2004). The range of the corrected elevation (effective tectonic uplift, 10) depends on the sea level change and on the maximum depth of the sea floor. Sketches of seafloor features were made together with seafloor profiles, with the aim of providing an outline of the depth and morphology of the seafloor, because the uplifted marine fossils that we have discovered are circalittoral: the maximum depth of the sea bottom immediately below the marine fossils allows us to assume that such fossils, when alive, had a maximum depth limit. References caption: 1 Gringeri et al. this volume. 2 Stewart et al. 1997; 3 Antonioli et al. 2003; 4 Antonioli et al. this volume; 5 Pirazzoli et al. 1997.

For both regions of eastern Sicily and southern Calabria the Holocene uplift rates are greater than the long term average rates based on the position of the last (MIS 5.5) and earlier interglacial shorelines (Bordoni, Valensise 1998). All surveyed sites have also been studied underwater. Each data point was compared with the predicted sea level curve, calculated at the coordinates of the sampled sites. Age and elevation data of uplifted Late Holocene (6-2 ka cal BP) shorelines in Southern Calabria and northeastern Sicily are plotted in Fig. 2, together with the theoretical curve of sea-level rise predicted by the refined glacio-hydro-isostatic model for the sites of Scilla (Calabria) and St. Alessio (Sicily). All the observed Holocene shorelines are displaced upward, and the amount of vertical displacement is given by the distance between the data points and the predicted sea-level curve .

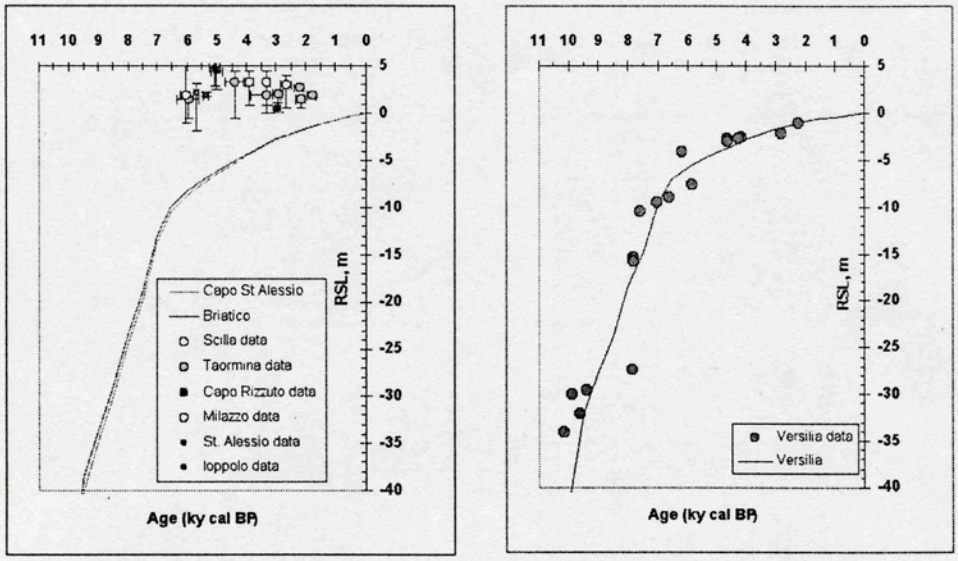

Fig 2: a) Observed (with error bars) and predicted sea level curves for the tectonically active site of southern Italy. The latter are from Lambeck et al. (2004); b) Observed (circles) and predicted sea level curve for the tectonically stable site of Versilia plain, central Italy, from Lambeck et al. (2004).

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Abstract

A combination of published and new radiometric dates on uplifted fossils beach from the Eastern Sicily and Calabria are analysed in relation to eustatic sea-level curves, and glacio-hydro-isostatic modelling. New data from Ioppolo (southern Calabria) and Milazzo (northeast Sicily) play a critical part in this analysis. The results show that uplift rates of the Late Holocene have an acceleration when compared with the longer-term uplift rates calculated from the MIS 5.5 highstand. The uplift rates are highest at St. Alessio close to Taormina in east Sicily (2.4 mm/y) and Scilla in southwestern Calabria (2.0 mm/y), areas that are near each other across the Messina Straits. Uplift rates decrease towards the south and north of S. Alessio and are lower in the coast north of Scilla.

Riassunto

Nel Mediterraneo vi sono numerose aree costiere che presentano tettonica attiva, per esempio Creta (Pirazzoli et al. 1994), il litorale sud-ovest della Grecia (Dia et al. 1997, Kershaw, Guo 2002), in Italia i litorali della Calabria meridionale (Miyauchi et al. 1994). Altre zone costiere quali la Spagna sud-occidentale (Zazo et al. 1999), la Sardegna (Antonioli et al. 1999) e il Lazio meridionale (Hearty, Dai Pra 1986) mostrano di essere stabili nel corso dell'ultimo ciclo glaciale. Molti studi sul cambiamento del livello del mare, con precise datazioni e misure, sono stati pubblicati per l'Italia negli ultimi dieci anni. L'uso di indicatori sempre più strettamente correlati con il livello del mare ha permesso che tali valutazioni acquistassero precisione e minimi errori. Quando i dati di *marker* marini provengono da zone tettonicamente attive, queste osservazioni devono essere corrette per i movimenti verticali tettonici. Molti esempi vengono dai classici siti di Huon Penisula, Barbados o Tahiti. Le correzioni sono basate spesso sui tassi di lunga durata valutati dai dati quaternari o, nei casi migliori dall'ultimo periodo interglaciale (125 ka). Le incertezze raggiunte in queste correzioni tettoniche possono in alcuni casi eccedere l'esattezza delle misure di età ed altezza delle *shorelines* più recenti.

In questa ricerca sono stati calcolati i tassi di sollevamento Olocenici usando i dati pubblicati per la Sicilia Orientale (Taormina e Capo S. Alessio: Stewart et al. 1997, Antonioli et al. 2003; Milazzo: Gringeri et al. 2004) e per la Calabria (Scilla: Antonioli et al. 2004; Ioppolo: dati inediti; Capo Rizzuto: Pirazzoli et al. 1997) e considerando le curve di risalita del livello del mare, calcolate sulla base del modello di Lambeck nei siti descritti. Lambeck et al. (2004) hanno paragonato in 30 siti italiani costieri i dati osservati con quelli predetti, trovando una ottima corrispondenza e validando in questo modo il modello geofisico.

Per entrambe le regioni della Sicilia orientale e della Calabria meridionale i tassi olocenici di sollevamento se paragonati a quelli dell'ultimo interglaciale (MIS 5.5, Bordoni, Valensise 1998) risultano sempre più alti.