National Research Council

Core description collected during Oceanographic Survey NextData2013 (12 – 19 September 2013)

Project NEXTDATA WP–1.5
Paleoclimatic Data from Marine Sediments *(CNR-DTA, URT EvK2-CNR, INGV)*

Strait of Sicily - Gulf of Taranto

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Introduction: Objectives and short description of NextData Project (WP1.5)

The retrieval of series of proxy data on the past climate will serve to acquire a deeper understanding of the climate system and a more accurate prediction of its future development, as a priority task for the scientific community. In particular, the analysis of past climatic data is an essential tool to study the dynamics of the Earth's climatic system under conditions different from the current ones, and irreplaceable to test the validity of medium- and long-term forecasting models. The determination of the influence of anthropogenic impacts on the planet’s environment is supported by a clear understanding of the natural ways in which the earth's climate responds to the complex set of external forcing. Therefore, in last decades, many national and international research groups have focused their attention on the study of the climate evolution in late-Quaternary sediments from the Mediterranean area. By virtue of its close relationship with continental masses subject to several climatic processes, the Mediterranean basin allows the scientists to record the climatic evolution both globally and in the Northern Hemisphere. Finally, it is worth noting that shallow sea (continental shelf) areas are natural repositories for the monitoring of short-term climatic changes and of anthropogenic impacts on the marine system. To make available information on climate history and environment yielded by marine sediments, this WP will be devoted to analyse and, where possible, to collect marine sediments cores, especially the ones drilled in shallow sea environments, and to focus on climate dynamics in the Mediterranean over past centuries. During its course, the project will analyse marine sediment cores from the continental shelf environments and from different sectors of the Mediterranean basin. Previous studies have indicated the cited locations as key sites for the identification of major short-term climate fluctuations, due to global and local forces active during the Quaternary and particularly in the past thousand years. In fact, the possibility of enriching the databases referring to this time interval (to date, still limited to the Mediterranean basin) will provide new working hypotheses for the implementation of numerical models which attempt to simulate how the Mediterranean basin, in particular the marine-coastal sector, has reacted to past climate dynamics (Medieval Warm Period / Little Ice Age transition, Little Ice Age, the Industrial Age, and Modern Warming). The cores obtained will be the focus of multidisciplinary studies involving national and international research groups.

1 - Structural and Stratigraphic Framework of the investigated area

According to Maldonado and Stanley (1976) the Strait of Sicily platform occupies a geologically strategic position between the deep, fault bounded basins of the Balearic, Tyrrhenian, and Ionian seas and the emerged North African and southern European regions bounding it. Most workers envision this shallow area as a prolongation of the Tunisian-Southern Sicilian land mass and as a link between the North African Atlas chain and the Sicilian-Italian Apennine chain. The different tectonic provinces of the Strait region have been defined and mapped by Burollet (1967) and Zarudzki (1972). Seismic reflection exploration has provided both deep penetration (Flexotir records of Finetti and Morelli, 1972a, b) and shallower subbottom coverage (Woods Hole Oceanographic Institution sparker and air gun profiles, Zarudzki, 1972). Flexotir records show that this zone, separating the distinct eastern and western Mediterranean geodynamic sections, consists of thick continental crust comprising a generally thin Pliocene Quaternary unconsolidated section above a thick sequence of Triassic to Miocene rock units (Finetti and Morelli, 1972a). The reduced thickness of unconsolidated Pliocene and Quaternary sediments (except in some depressions such as the Malta Graben where these exceed 1 second, penetration two-way travel time) can be contrasted with the thick sections in the Balearic Basin west of the Strait. The underlying Upper Miocene units, correlated with limestone and dolomite sequences in cores and land sections, thicken toward Tunisia (Burollet, 1967). There is ample evidence of geologically recent (post-Miocene) structural displacement, and the different morphological-tectonic sectors of the Strait can be related to major fault patterns. Magnetic and gravity studies reveal that the main structural trends are oriented west northwest - east southeast, i.e., parallel to the major orientation of the Sicily Channel (Allan and Morelli, 1971; Colantoni and Zarudzki, 1973; and others). A northeast-southwest trend predominates at the westernmost sector of the Strait (Auzende, 1971; Auzende et al., 1974). The largely vertical structural displacement gives rise to a complex configuration of horsts (shallow tabular-shaped banks) and grabens (narrow, deep linear basins). Seismic profiles clearly display the vertical and subvertical offset of reflectors. The intensity of structural offset and seismicity (shallow earthquake epicenters), and the concentration of volcanoes (most are submarine cones) increase in the northern sector of the Strait. The islands of Linosa and Pantelleria reflect the importance of Pliocene and Quaternary eruptions in this part of the Mediterranean. Pantelleria rises from the 1300 m deep Pantelleria Basin. The position of other volcanic deposits, including some which accumulated in historic time, are reported by Zarudzki (1972) and Finetti and Morelli

(1972a); these are concentrated mostly in the northern sector of the Strait. The presence of dike swarms or narrow lava streams are also suggested on the basis of magnetic anomalies and appear aligned parallel to the principal tectonic provinces. Some Mesozoic and early Tertiary intrusions also have been penetrated by petroleum exploratory wells. In terms of regional Mediterranean-Alpine tectonics, the thick crustal sections of the platform are considered part of the African Plate, which underthrusts the Euro-Asiatic plate in the Ustica-Lipari region of Sicily (Caputo et al., 1970). Finetti and Morelli (1972b) also emphasize the role of compression but prefer to relate plate motion to subduction of the African Plate below what they define as the Mediterranean Plate. Like most geophysicists, these latter authors tend to agree that much of the Mediterranean, in particular the deep basins bounding the Strait, has undergone considerable subsidence since the end of the Miocene. Benson (1972) has proposed that the Strait platform was deeper during the Pliocene than at present. The development of vertical faults with offsets to 1000 m in the upper crust is believed to reflect isostatic adjustment following the main Alpine orogeny. Additional structural offset may also be due to alternating phases of compression and distension. Zarudzki (1972) relates the gentle folding of the more than 300 m of section in the northwest end of the Pantelleria Trough, as observed in continuous seismic profiles, to the above mentioned recent, postorogenic tectonic activity. The fault development, volcanism, and seismicity of this region are not unlike those postulated in some subduction models. An interpretative diagram showing the origin of this modern rift-tension relief in the Strait and associated volcanism in relation to subduction is presented by Akal (1972). These Quaternary neotectonic factors will be emphasized in the context of sedimentary processes and sedimentation rates in the Strait region.

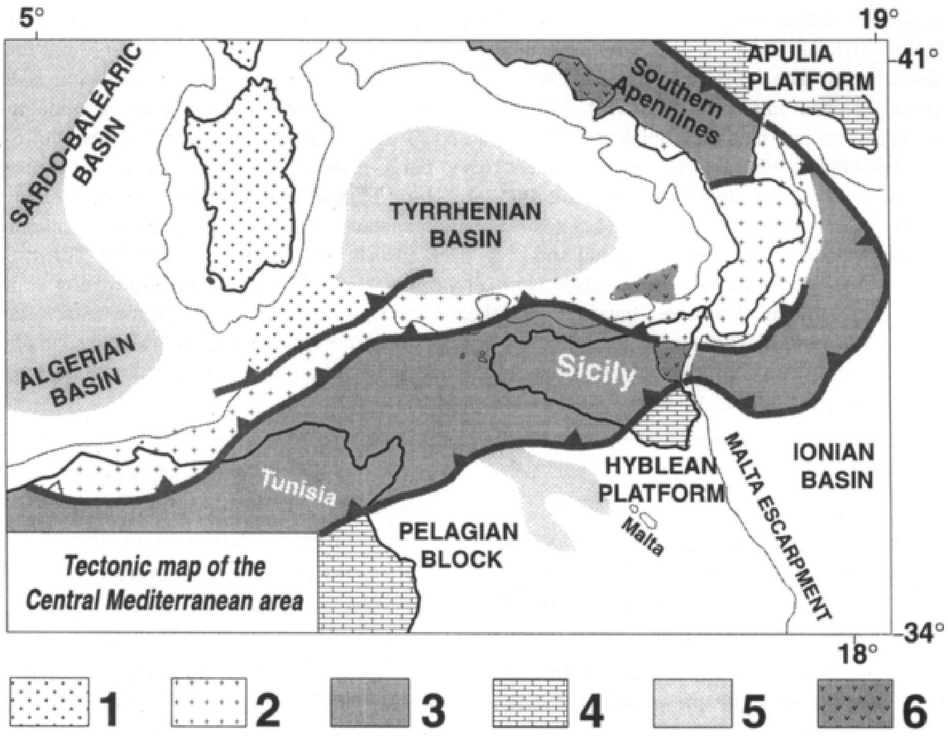

Fig. 1. Tectonic scheme of the central Mediterranean area showing: *1* = Corsica–Sardinia; *2* = Calabrian Arc, Kabylians and "Internal" Flysch sequence ophiolites; *3* = Maghrebian–Sicilian–Southern Apennine nappes and deformed foreland; *4* = foreland and mildly folded foreland (Tunisia, Hyblean plateau, Apulia); *5* = areas with superimposed extension; *6* = Plio-Quaternary volcanoes.

Fig. 1: Tectonic scheme of the central Mediterranean area. (Modified from Catalano et al., 1996)

2 - The Malta Plateau

During late Tertiary time, the northern edge of the African foreland (the continental Pelagian Block) collided with the southern edge of the European plate (the Kabies-Calabrian Crystalline Units), resulting in the partial subduction of the African foreland beneath the European plate (Dewey et al. 1989). This collision also resulted in the southward directed thrusting of the Maghrebian Arc across central Sicily when the Calabrian units slid past and overrode the Pelagian Block from late Oligocene time onwards. Further to the east, the Ionian Abyssal Plain, which is mainly composed of oceanic crust (Geiss, 1987), readily subducts beneath the overriding Calabrian units. The oceanic crust of the Ionian Plate is separated from the continental crust of the Hyblean-Malta Plateau by the Malta escarpment, a down to the east fault with 2000-3000 mt of throw (Fig. 2). The throw along the escarpment is greatest in the north where the Ionian Plate bends and plunges beneath the Calabrian Arc. (Grasso, 1993). In contrast, the Hyblean-Malta Plateau, which is composed of "buoyant" continental crust, cannot be subducted as easily. The crust of the plateau is thicker than the crust of the surrounding areas (Ben-Avraham and Grasso, 1990), causing it to behave more rigidly and resist post Miocene deformation. The Bouguer gravity map (AGIP, 1978, 1982) also shows a positive anomaly over the plateau, where it is structurally elevated relative to its surroundings. The net effect of this "buoyant" block, which is caught in the middle of the collision front between the Pelagian Block and the Calabrian Arc, is that the block acts as a mini indentor around which other blocks must move, thereby creating a wide variety of fault fabrics and structural styles across the Sicily-Malta Platform. The studied area of Malta continental shelf is located in the shallow water region between Sicily and Malta (Figs. 2-3). This area is characterized by the following bathymetric features: (a) a near constant depth of about 140 m in the central portion, (b) a contour of ~ 200 m which plunges steeply into the Ionian basin in the eastern portion, and (c) a more gentle deepening in the western part, with a slope break at about 160 m (Max et al., 1993). The Malta Plateau consists of thick, mainly Mesozoic–Cenozoic, carbonate sequences, with interleaved volcanic successions whose ages range from the Late Triassic to the Quaternary (Barberi et al., 1974 and Patacca et al., 1979).

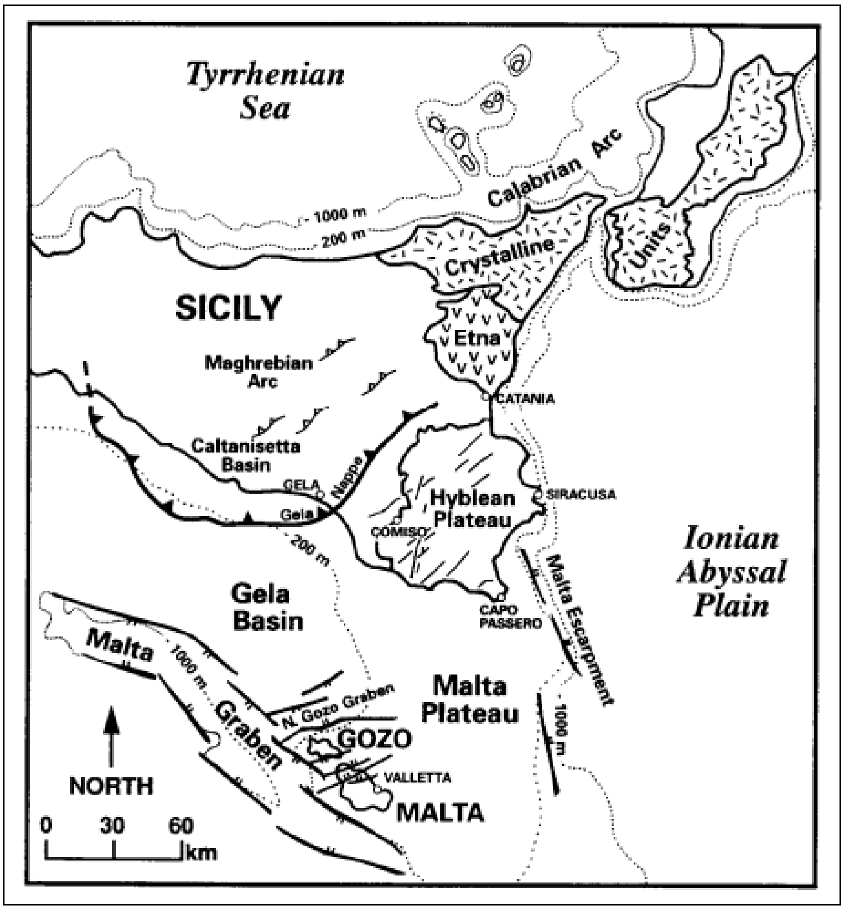

Fig. 2: Tectonic scheme of the studied area.

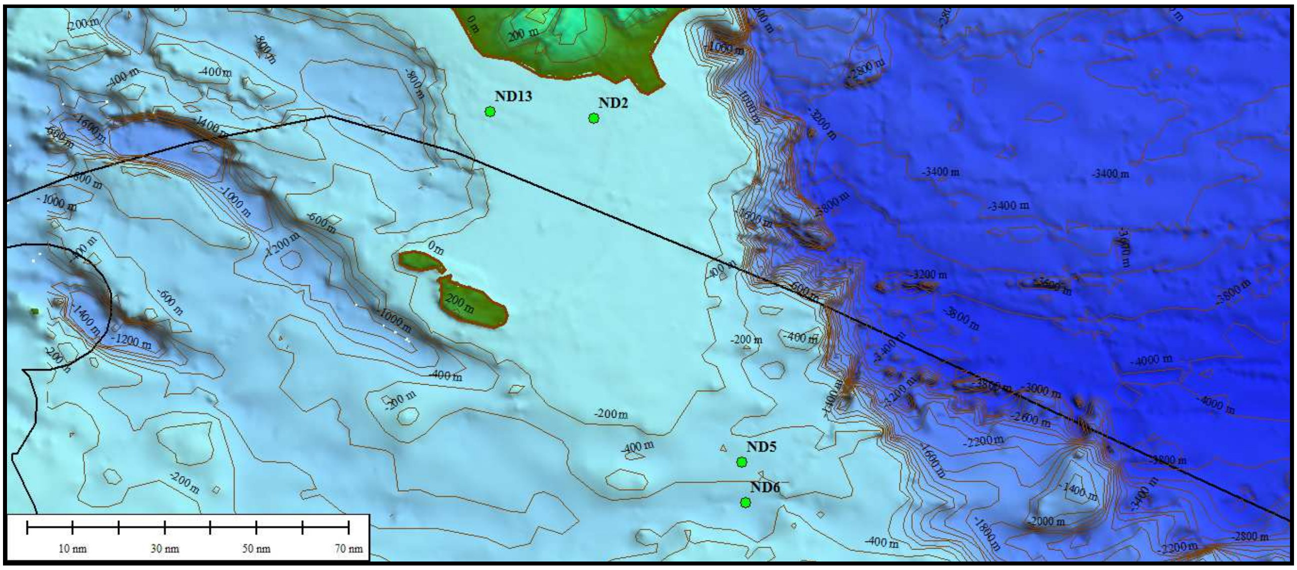

Fig. 3: Bathymetric map of the Malta Plateau and sampling sites.

2.1 - Core ND2:

Core ND2 was located about 10 nm from the Sicilian coast (Lat. 36° 33' 51'' N – Long. 14° 52' 59'' E) at -89 mt in the Sicily continental shelf (Fig. 3). The Chirp line shows a ~35 mt thick of well stratified silty sediments, intercalated by a clear stratification, probably accentuated by more sandy compound (Fig. 4). Below these intervals the seismic signal rapidly decays, showing a slight disturbance in the stratification pattern.

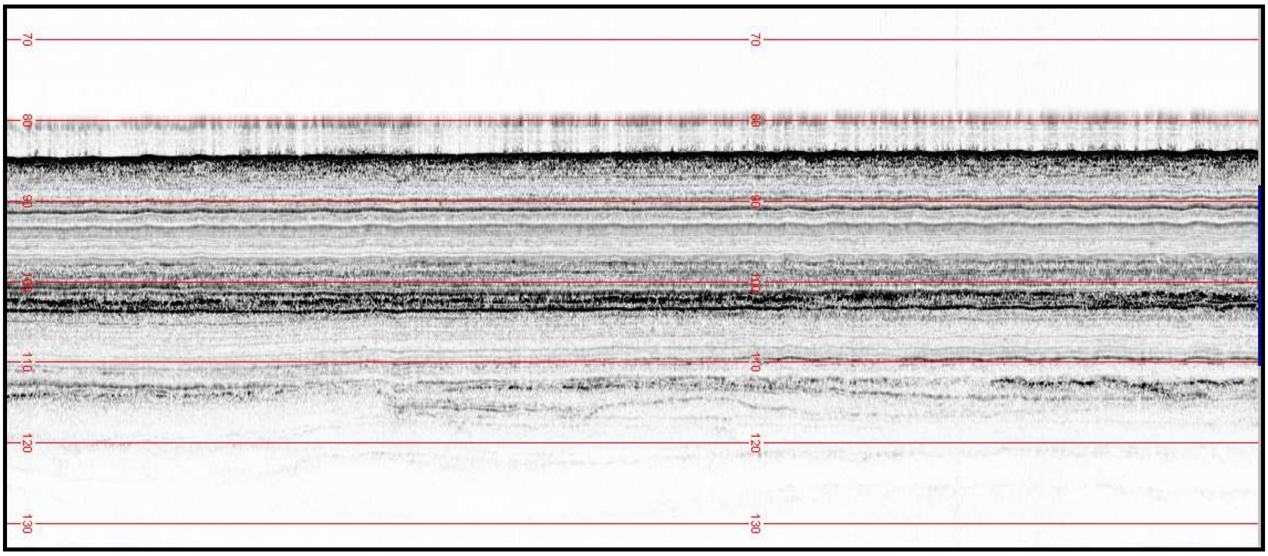

Fig. 4: Chirp line of Site ND2.

The gravity corer collected 455 cm of homogeneous "clayey muds" with shattered bivalve fragments and lithoclasts (Figs. 6-7). The core was cut and splitted in 5 sections (section A= bottom – section E=top) and sampled every centimetre. The magnetic susceptibility profile (Fig. 5), collected along the gravity core, shows 2 spikes at 2 and 3.9 mt respectively. These spikes probably can be correlated to 2 distinct volcanic events, not recognized in the preliminary sedimentological analyses, or at reworking events of "ferromagnetic" minerals. Further tephro-stratigraphic analyses will be able to establish the origin of these events.

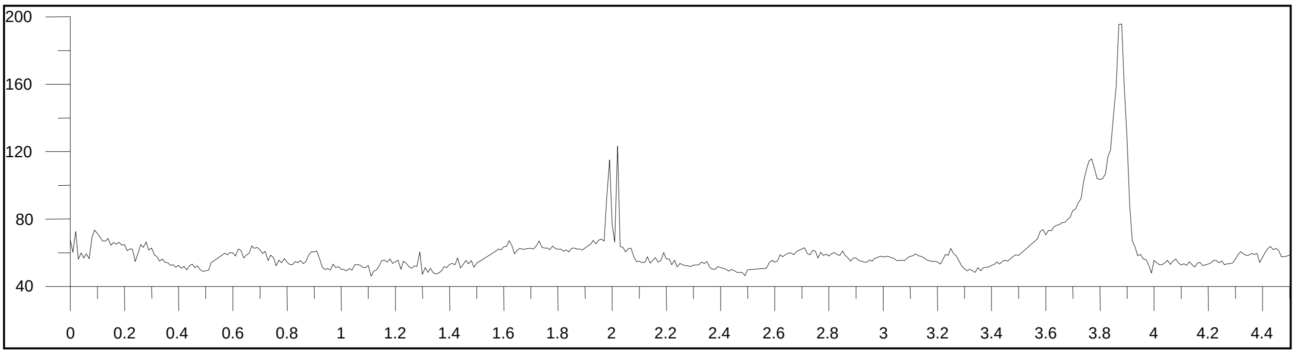

Fig. 5: Magnetic susceptibility profile of ND2 gravity core.

The SW104 corer collected 132 cm of homogeneous clayey muds (Fig. 8), confirming the lithology recovered by gravity corer. The water-sediment interface was collected too.

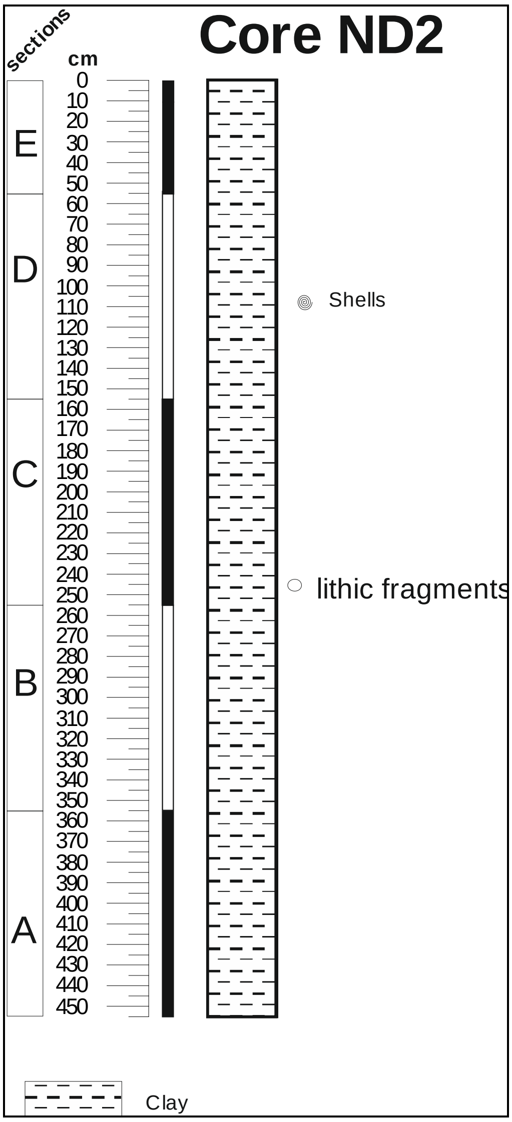

Fig. 6: Site ND2 chart.

Fig. 7: Site ND2 gravity core photo.

Fig. 8: Site ND2, SW104 core photo.

2.2 - Core ND13:

Core ND13 was located at about 12 nm from the Sicilian coast (Lat. 36° 35' 24'' N – Long. 14° 30' 29'' E), at -165 mt in the Sicily continental shelf (Fig. 3). The Chirp line shows a ~35 mt thick of well stratified silty muds, intercalated by a clear stratification probably accentuated by more sandy compounds (Fig. 9). At 20 mt below sea floor, the seismic signal abruptly decays up to 30 mt, showing the same stratification pattern of the upper layer. Finally a deep reflecting sloping surface closes the Chirp line .

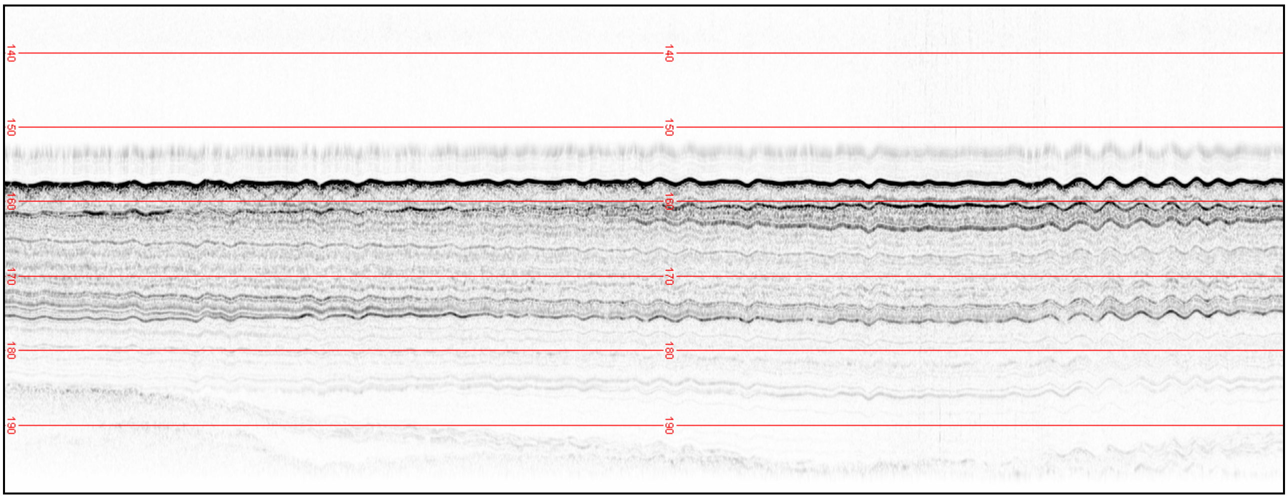

Fig. 9: Chirp line of Site ND13.

The gravity corer collected 390 cm of homogeneous clay with abundant bivalve gasteropods and coral fragments. The core was cut and splitted in 4 sections (section A= bottom – section D=top) (Figs. 11-12). The magnetic susceptibility profile, collected along the gravity core, does not show particularly variations along the whole core (Fig. 10). Additional tephro-stratigraphic analyses may be able to establish if crypto volcanic events were recorded. The SW104 corer collected 79 cm of homogeneous clayey sediments, confirming the lithology recovered by the gravity corer (Fig. 13). The water-sediment interface was collected too.

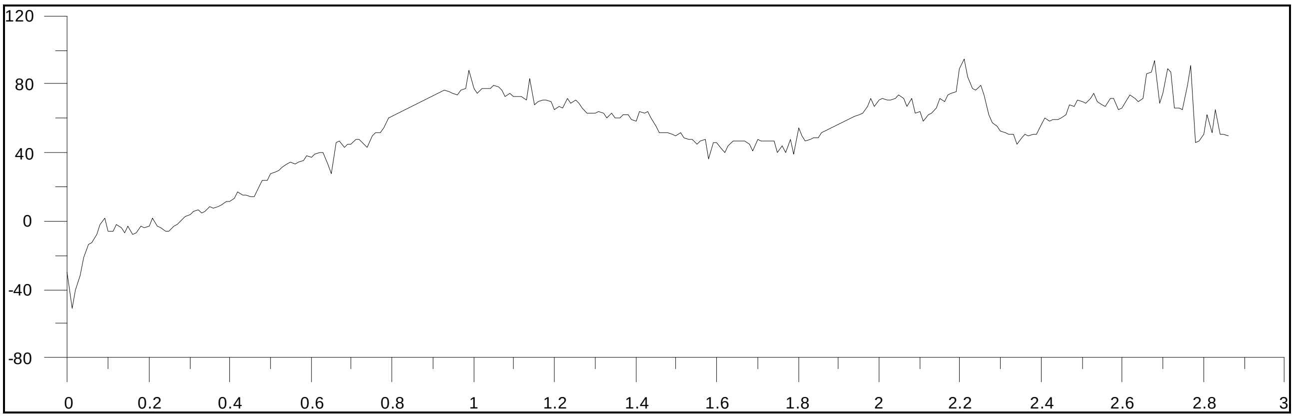

Fig. 10: Magnetic susceptibility profile of ND13 gravity core.

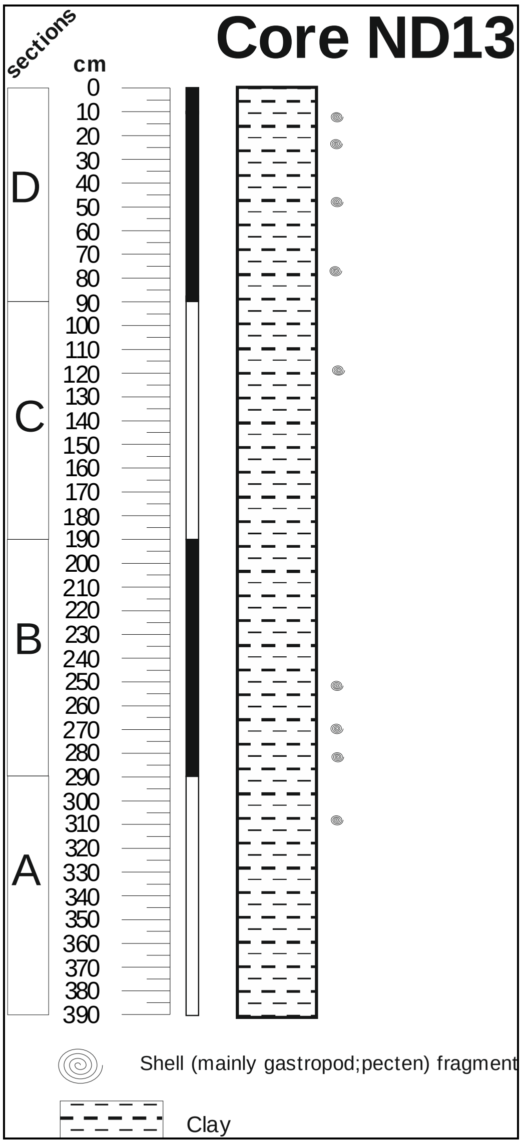

Fig. 11: Site ND13 chart.

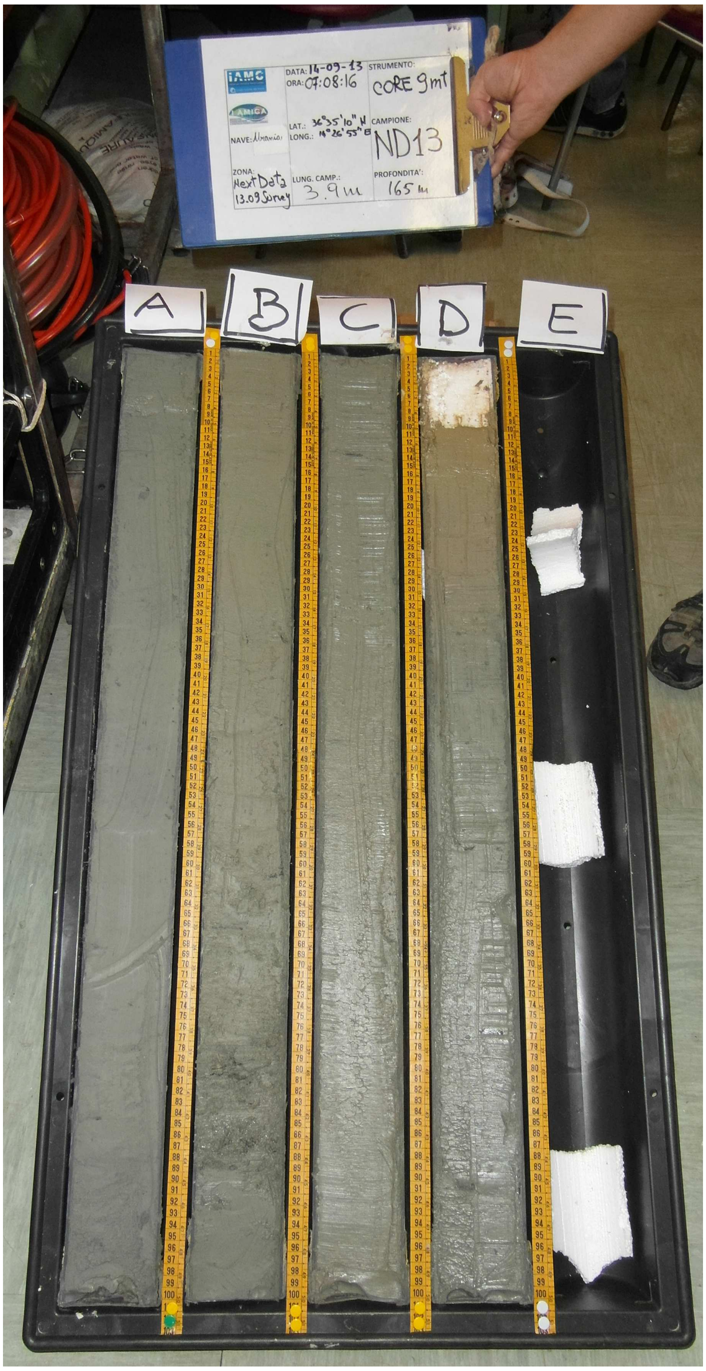

Fig. 12: Site ND13 gravity core photo.

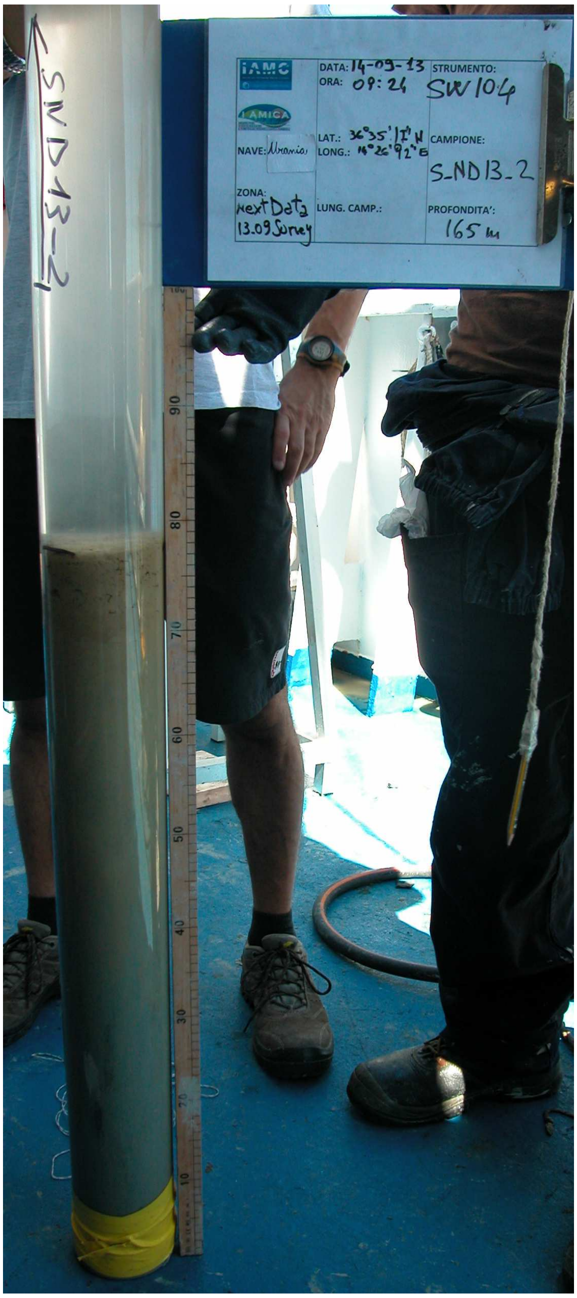

Fig. 13: Site ND13, SW104 core photo.

2.3 - Core ND5:

Core ND5 was located about at 52 nm from the Malta coast (Lat. 35° 19' 23" N – Long. 15° 25' 3" E), at -335 mt in the Malta Channel (Fig. 3). The Chirp line shows a ~25 mt thick of homogeneous silty - sandy sediments, intercalated by a stratification probably accentuated by more sandy compounds (Fig. 14). At 6 mt below the sea floor the seismic signal abruptly decays up to 25 mt, showing an enigmatic stratification pattern. Finally below 25 mt the Chirp signal completely decays.

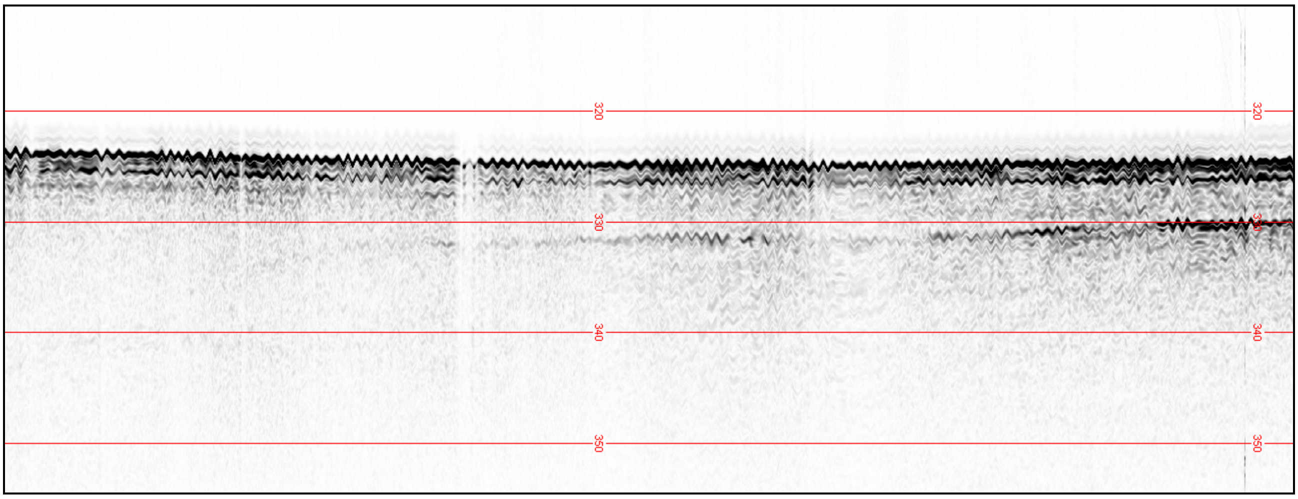

Fig. 14: Chirp line of Site ND5.

The gravity corer collected 319 cm of sediment, characterized by alternate clayey and silty intervals (Figs. 16-17). In particular, the sandy-silty interval is characterized by abundant coral fragments. The core was cut and splitted in 4 sections (section A= bottom – section D=top). The magnetic susceptibility profile, collected along the gravity core, does not show particularly variations along the whole core except a peak at 0.4-0.5 cm from the top core (Fig. 15). Further, tephro-stratigraphic analyses may be able to establish if these spikes can be imputated to a volcanic event or to reworked ferromagnetic minerals.

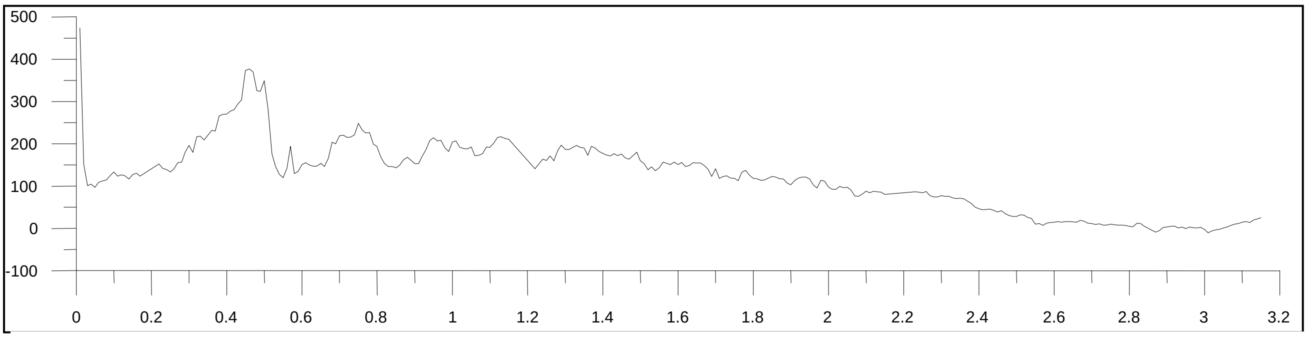

Fig. 15: Magnetic susceptibility profile of ND5 gravity core.

The SW104 corer collected 24 cm of clayey and silty deposits, according to the lithology recovered by the gravity corer (Fig. 18). The water-sediment interface was collected too.

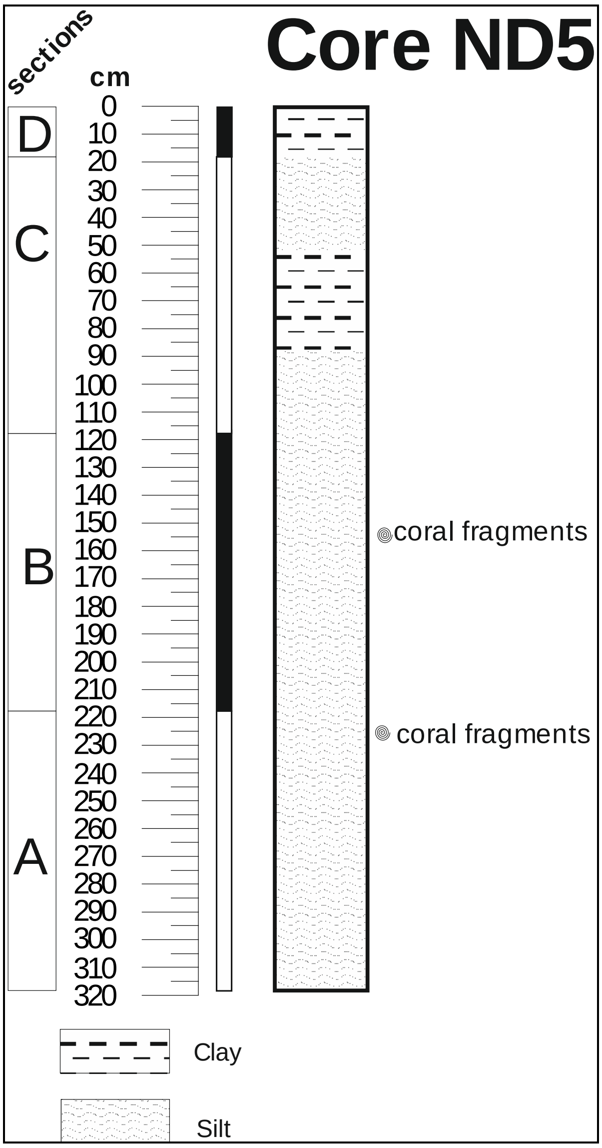

Fig. 16: Site ND5 chart.

Fig. 17: Site ND5 gravity core photo.

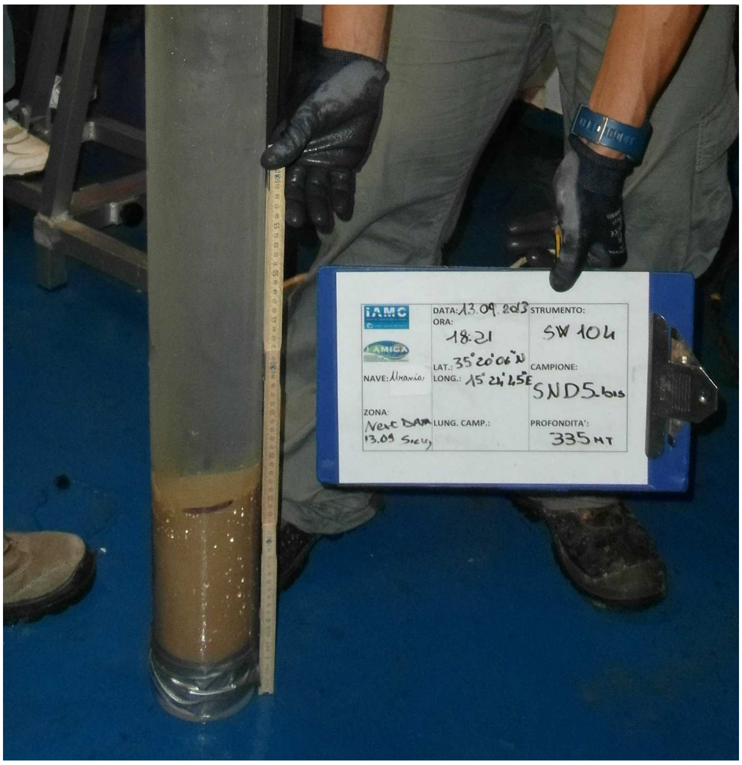

Fig. 18: Site ND5, SW104 core photo.

2.4 - Core ND6:

Core ND6 was located at about 58 nm from the Malta coast and at 90 nm from Sicily coast (Lat. 35° 10' 32" N – Long. 15° 25' 56" E), at -534 mt in the Medina Channel (Fig. 3). The Chirp line shows a ~30 mt thick of well stratified silty sediments, intercalated by a clear stratification accentuated by the same sandy layer (Fig. 19). From the sea floor to 30 mt, the seismic signal gradually decays without a visible discordant structure.

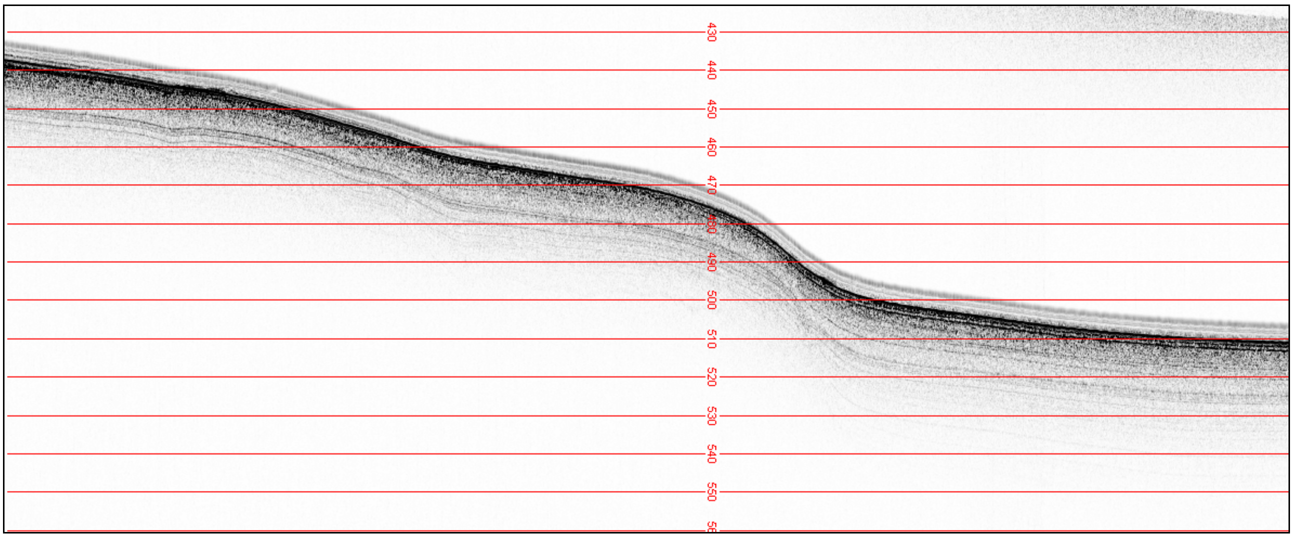

Fig. 19: Chirp line of Site ND6.

The gravity corer collected 447 cm of sediment with an alternation of clayey and silty levels (Figs. 21-22). At 162 cm from the top a “sapropel” layer occurs. A preliminary analysis of calcareous nannofossil revealed an assemblage dominated by Small *Gephyrocapsa.* According to Cramp & O’Sullivan (1999) this sapropel could be probably correlated to the S5 sapropel (125 ka). Further analyses could clarify the number and the age of the sapropel. Along ND6 abundant gasteropod fragments occurred. The core was cut and splitted in 5 sections (section A= bottom – section E=top) and sampled every centimetre. The magnetic susceptibility profile, collected along the gravity core, shows many positive variations along the whole core (Fig. 20). Further tephro-stratigraphic analyses may be able to establish if these spikes can be imputated to volcanic events.

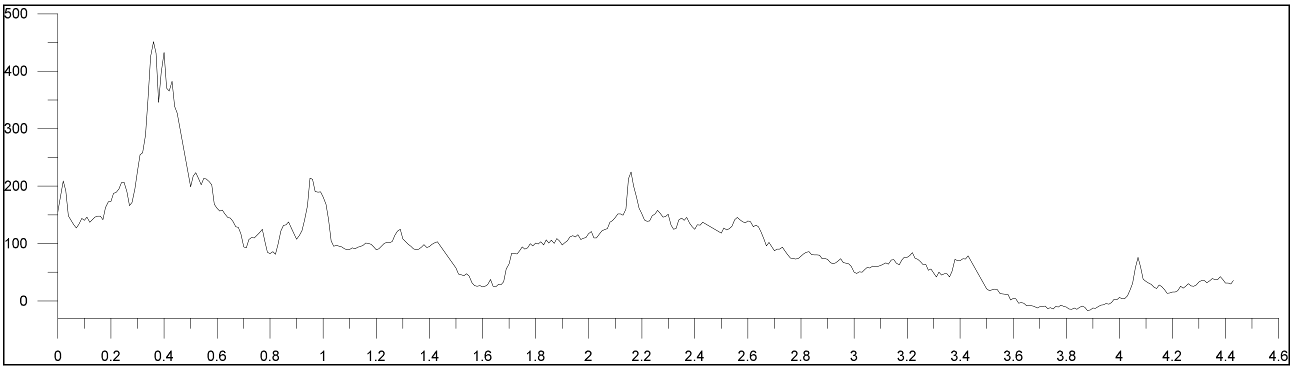

Fig. 20: Magnetic susceptibility profile of ND6 gravity core.

The SW104 corer collected 33 cm of homogeneous sandy-silt sediments, according to the lithology recovered by the gravity corer (Fig. 23). The water-sediment interface was collected too.

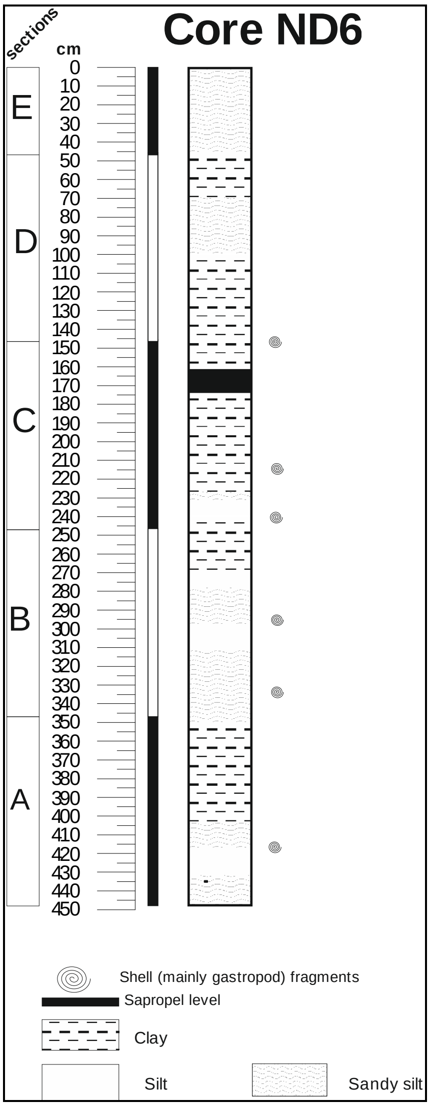

Fig. 21: Site ND6 chart.

Fig. 22: Site ND6 gravity core photo.

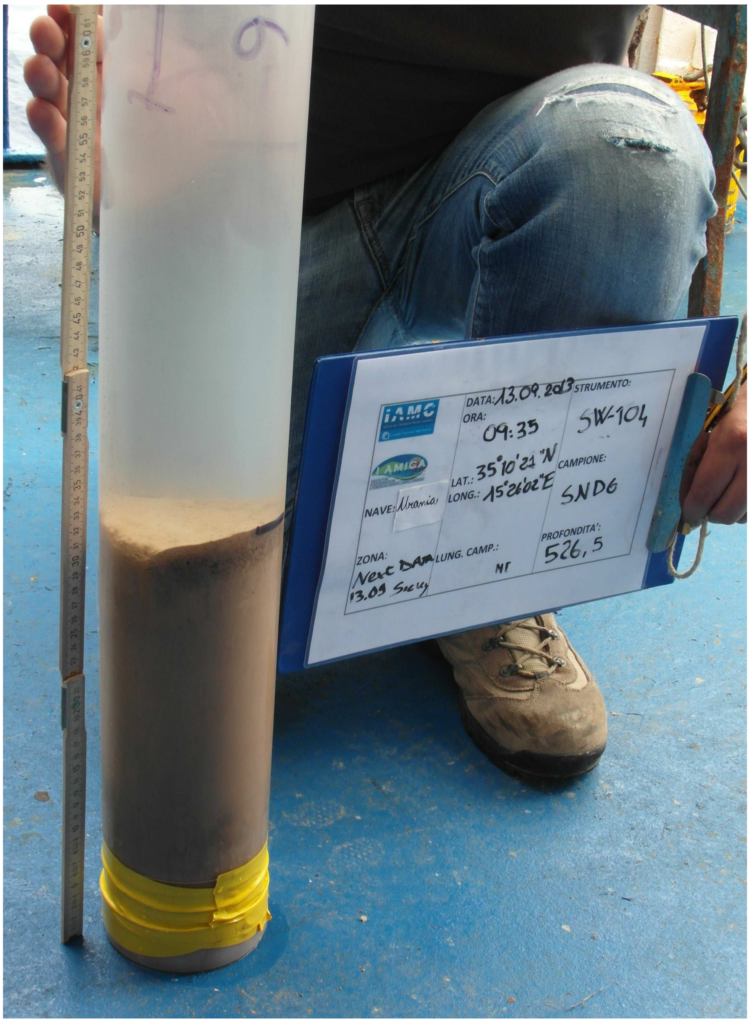

Fig. 23: Site ND6, SW104 core photo.

3 - The Strait of Sicily (replica of ODP Leg 160 Site 963)

The Strait of Sicily is located in an area affected by the convergence of Africa and Eurasia. Offshore southern Sicily lies on continental crust of the North African plate near the leading edge of the overriding crustal plate. In this area a promontory of Gondwana, represented by the Hyblean Platform, is in the process of irregular collision, giving rise to a complex tectonic scenario involving mainly northeast-oriented thrust faults in the overriding plate and mainly transtensional lineaments in the foreland (e.g., Malta, Linosa, and Pantelleria grabens). Much information is available for the area surrounding Site 963 (ODP Leg160) (e.g., Catalano et al., 1993a, 1993b; Di Stefano et al., 1993), notably concerning the Gela Nappe to the northeast and southeast and Adventure Bank to the northwest (Fig. 24). An interpretation of combined multichannel seismic data and well data suggests that major thrusting on the Gela Nappe last took place about 1.4 my. ago, followed by infill of the Gela Basin (Catalano et al., 1993a; Di Stefano et al., 1993). There is also evidence of large-scale submarine sliding on the inner shelf area, probably related to deformation of the Gela Nappe (Argnani, 1989; Trincardi and Argnani, 1990). The foreland was drilled in the Onda well, to the northwest of Site 963 (Fig. 24). This comprises a 500 m succession of Pleistocene sediments (dated only from 115 m above the base), underlain by a stratigraphic gap extending to within the upper Pliocene, then 155 m of uppermost lower Pliocene and upper Pliocene sediments (Di Stefano et al., 1993). On multichannel seismic Line C529, the uppermost, horizontal reflectors are underlain by prominent, gently northward-dipping reflectors that may correspond to a paleontologically determined erosional hiatus (i.e., upper Pliocene-lower Pleistocene). The underlying, gently northward-dipping reflectors may thus correspond to a cored, mainly upper Pliocene interval (Di Stefano et al., 1993). These reflectors truncate underlying folded reflectors, possibly marking a second hiatus that was recognized near the top of the lower Pliocene interval. On the foreland, a prominent acoustic surface above a tilted and deformed unit dated at 1.4 Ma can be traced beneath the leading edge of the Gela Nappe (Catalano et al., 1993a). This surface also shows some evidence of deformation. Overlying reflectors, of inferred early mid-Pleistocene age, can be traced into the Gela Basin, implying that major motion of the Gela Nappe did not take place until after the early Pleistocene. However, northward tilting has clearly taken place in inferred mid-Pleistocene time, giving rise to a sedimentary hiatus. The probable cause of this tilting is flexural loading, possibly related to thickening of the thrust wedge of the Gela Nappe in the hinterland.

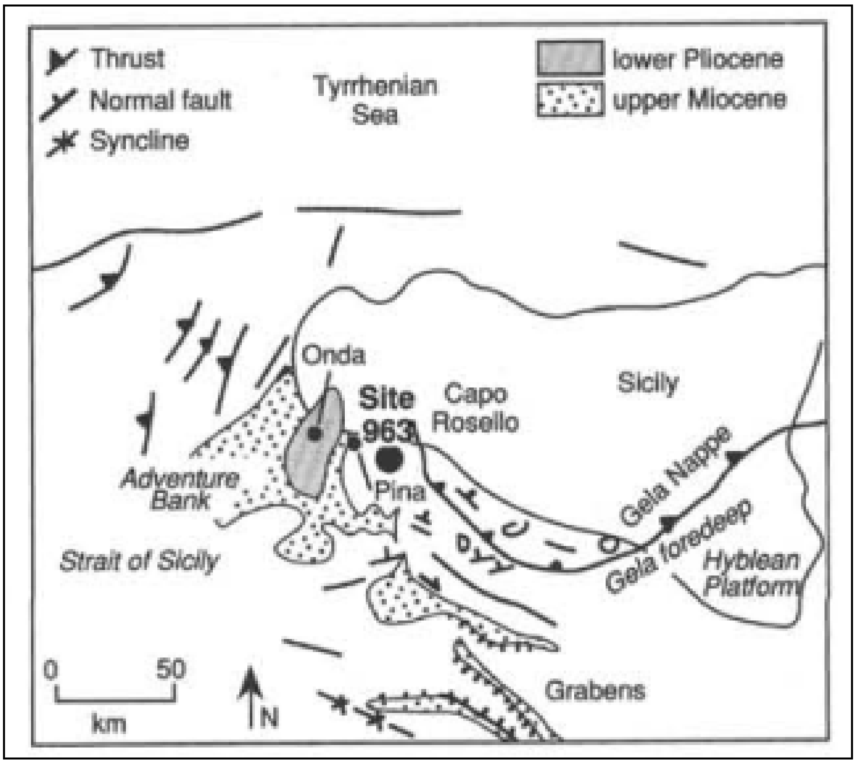

Fig. 24: Tectonic scheme of the studied area. (Modified from Emeis et al., 1996)

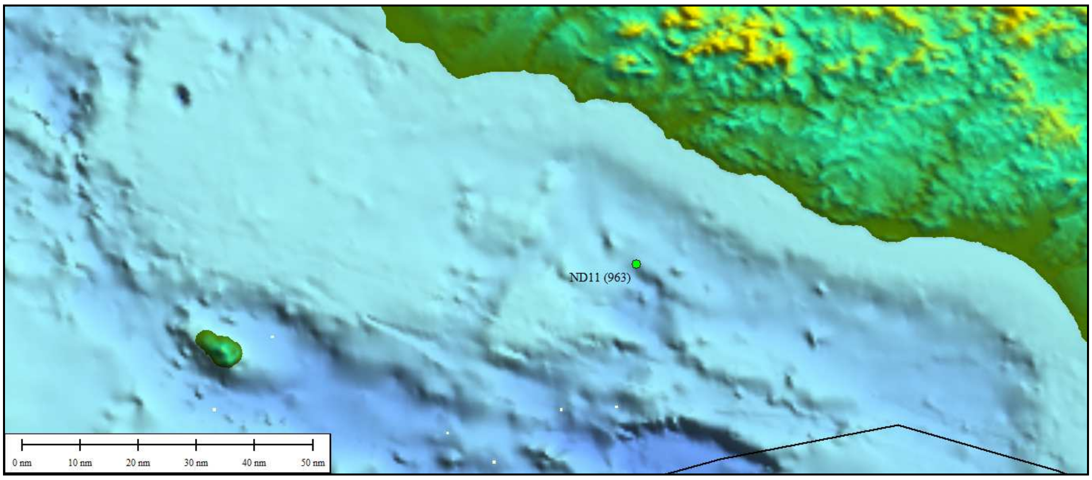

Fig. 25: Bathymetric map of the Strait of Sicily and sampling site.

3.1 - Core ND11:

Core ND11 was located at about 22 nm from the Sicily coast (Lat. 37° 01' 56'' N – Long. 13° 10' 53'' E), at -475 mt in the North-West of Gela Basin (Fig. 25). The Chirp line shows a ~80 mt thick of well stratified silty sediments, intercalated by a clear dark reflector probably accentuated by the same sandy layer (Fig. 26). From the sea floor to 50 mt the seismic signal is constant, afterwards it gradually decays without a visible discordant structure.

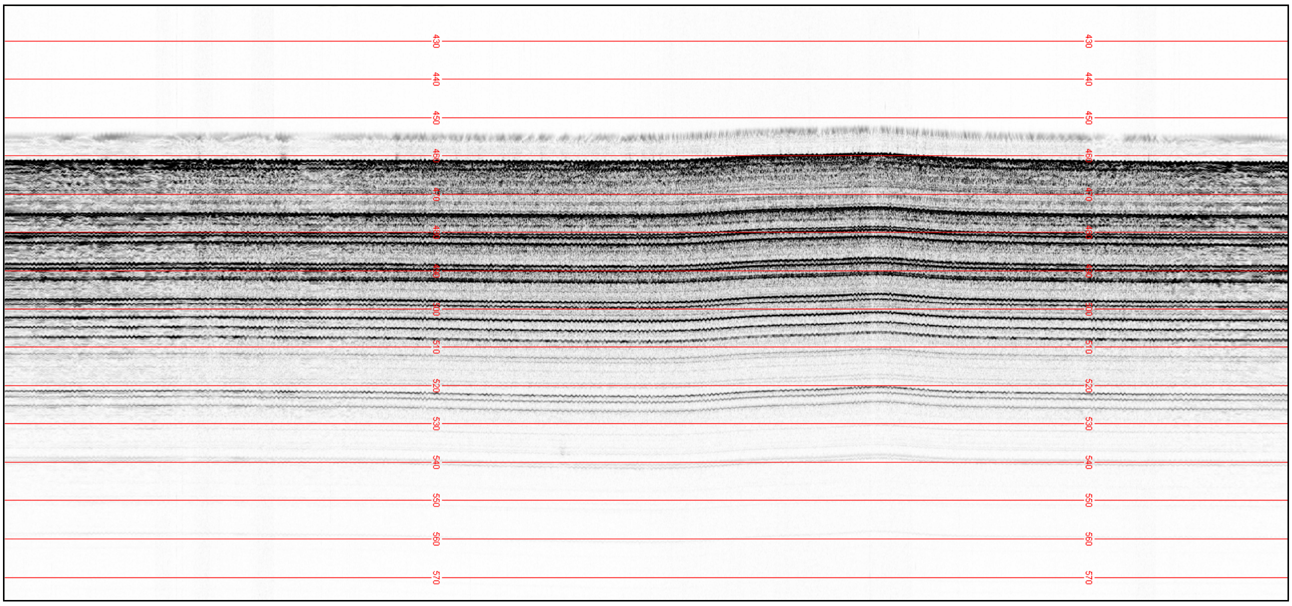

Fig. 26: Chirp line of Site ND11.

The gravity corer collected 487 cm of homogeneous clayey deposits. The core was cut and splitted in 5 sections (section A=bottom – section E=top) (Figs. 28-29). The magnetic susceptibility profile, collected along the gravity core, does not show a clear pattern along sediments (Fig. 27). Further tephro-stratigraphic analyses may be able to establish if crypto volcanic events were recorded. The SW104 corer collected 134 cm of homogeneous clay sediments, confirming the lithology recovered by the gravity corer (Fig. 30). The water-sediment interface was collected too.

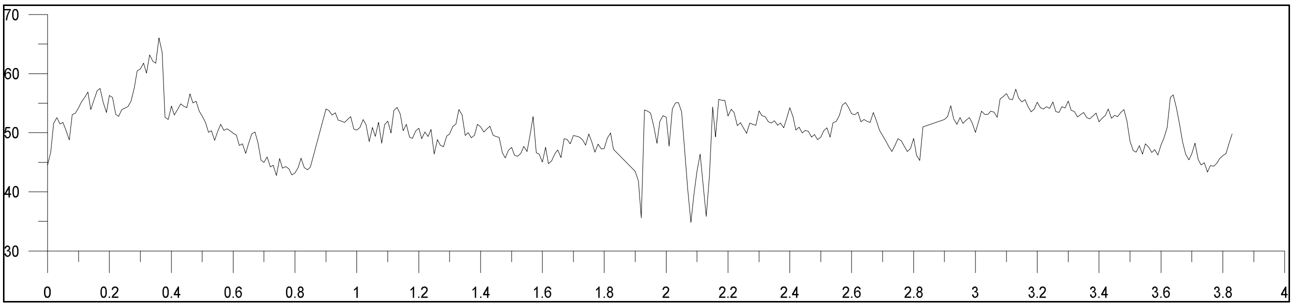

Fig. 27: Magnetic susceptibility profile of ND11 gravity core.

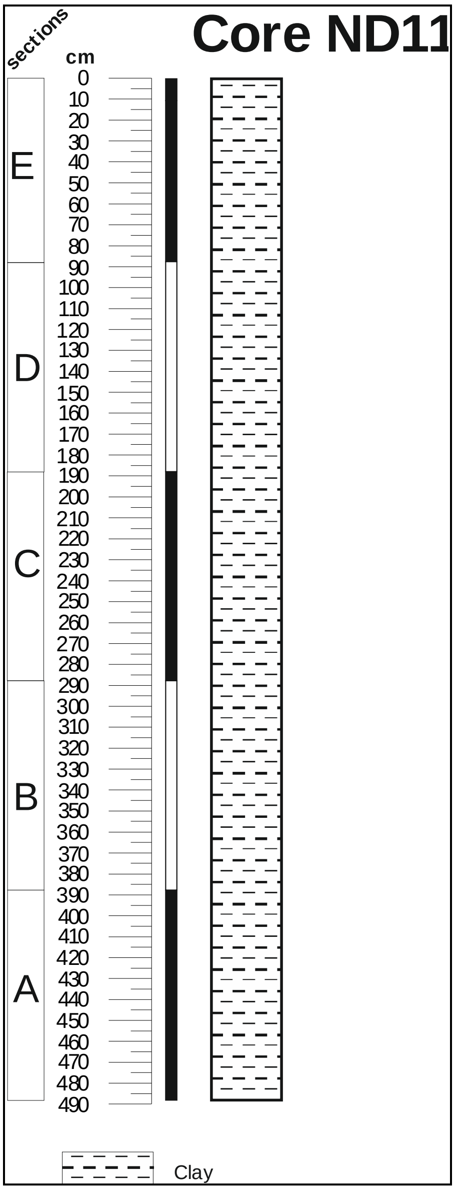

Fig. 28: Site ND11 chart.

Fig. 29: Site ND11 gravity core photo.

Fig. 30: Site ND11, SW104 core photo.

4 - Calabrian Arc and Gulf of Taranto

The geophysical characteristics of Southern Italy have been summarized by Panza (1979) and Cassinis et al. (1979). The heat flow and gravity data support a crustal thickening (and the presence of material less dense than normal) beneath the southern Apennines and eastern Calabria. The data shows a typical continental crust below Apulia and its western margin. Refraction data across Calabria, the Gulf of Taranto and Apulia (Morelli et al., 1975) indicate a comparable model interpreted in terms of continent - continent contact. The whole area, except Apulia, is characterized by intense seismic activity (Caputo et al., 1972; Brogan et al., 1975). Fault plane solutions imply regional uplift of the eastern region accompanied by strike-slip mechanisms (Riuscetti and Shick, 1975;Brogan et al., 1975). The distribution of intermediate and deep-focus earthquakes is scattered, which may indicate a detached lithospheric slab dipping almost vertically beneath the Tyrrhenian Sea (Caputo et al., 1972). This possibility, however, cannot be easily framed in a simple subduction model (Riuscetti and Shick, 1975; Panza, 1979) and finally agree relatively well with a complex continental collision history between Apulia and Europe (Dewey et al., 1973; Biju-Duval et al., 1976). Onshore, the Gulf of Taranto is bordered by three geological provinces. To the northeast is the stable Apulian Platform. The northwest margin of the Gulf crosses the Bradanic Trough which contains thick Neogene and Quaternary sediments. Highly tectonized rocks of the Apennines and Calabrian arc crop out to the southwest.

- The Apulian Platform is a continental foreland (with a typical continental crust; Mongelli and Ricchetti, 1970) made up of thick Jurassic to Cretaceous limestones; Pliocene deposits, where they exist, lie discomformably over these rocks. The whole platform is cut by normal faults following a general NW-SE trend. The faults continue below the Bradanic Trough where Mesozoic strata are deeply buried (Ricchetti, 1980; Ricchetti and Mongelli, 1980).

- The Bradanic Trough. Extending from the Molise region to the Gulf of Taranto, the NW-SE trending Bradanic depression contains thick upper Miocene and Pliocene deposits. Drilling (Crescenti, 1975) indicates the presence of imbricated allochtonous sediment related to the Apenninic front (Ogniben, 1968). At depth, Mesozoic limestone cut by normal faults occur indicating the continuation of the faulted Apulian Platform beneath the recent sedimentary fill (Ricchetti, 1980).

- The Apenninic and Calabrian zones . These zones are characterized by the presence of large, allochtonous bodies cut by Neogene grabens. Numerous authors (Ogniben, 1968;

Selli, 1975) recognize several complex nappes in the southern Apennines. They were emplaced during Mesozoic and Cenozoic times and overthrust each other towards the east. Thrusting is thought to have occurred in different phases (Maestrichtian, Paleocene, Middle Eocene and, locally, Oligocene). In Calabria, three nappes are distinguished (Ogniben, 1968; Bousquet, 1972; Dubois, 1976 ; Amodio-Morelli et al., 1976). They were also emplaced during the Alpine orogeny between Middle Cretaceous and Middle Eocene time. After Oligocene time, another phase of thrusting affected both the southern Apennines and the Calabrian chains. Progressive eastward overthrusting started during the Miocene; involving scaly clay (argille scagliose) it affected the Bradanic area (and the Calabrian margin) during the Pliocene (Ogniben, 1968; Bousquet, 1972; Dubois, 1976; Amodio-Morelli et al., 1976; Ortolani, 1978). At the same time (Mio-Pliocene, locally starting in the Oligocene Epoch) the whole area (southern Apennines, Calabria) was cut by a series of large-scale distensive fractures striking in two main directions, N30°W and N45°E; these fault zones (with possible strike- slip components) separate stable areas. Each area may have reacted independently to general tectonic stresses and was tilted to the east-southeast (Dubois, 1976; Amodio-Morelli et al., 1976). Tilting, also observed in the south-eastern Apennines (Vezzani, 1967), is thought to have originated gravity sliding and the emplacement of the new gravity nappes (Bousquet, 1972).

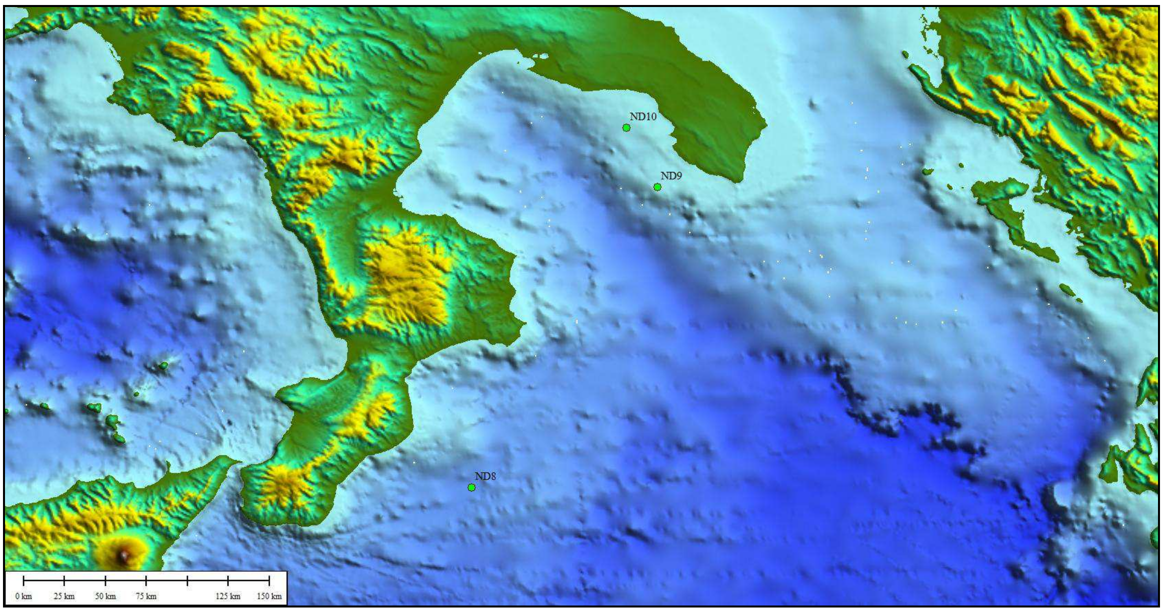

Fig. 31: Bathymetric map of the Calabrian Arc and Gulf of Taranto and sampling sites.

4.1 - Core ND8

Core ND8 was located at about 22 nm from the Calabrian coast (Lat. 38° 07' 45'' N – Long. 16° 53' 49'' E), at -1812 mt in the South-West of Taranto Gulf (Fig. 31). The Chirp line shows a ~40 mt thick of well stratified silty sediments, intercalated by a clear dark reflector probably accentuated by the sandy layers. The same vertical fault occurs. From the sea floor to 30 mt the seismic signal is constant, afterwards it rapidly decays with a visible discordant structure.

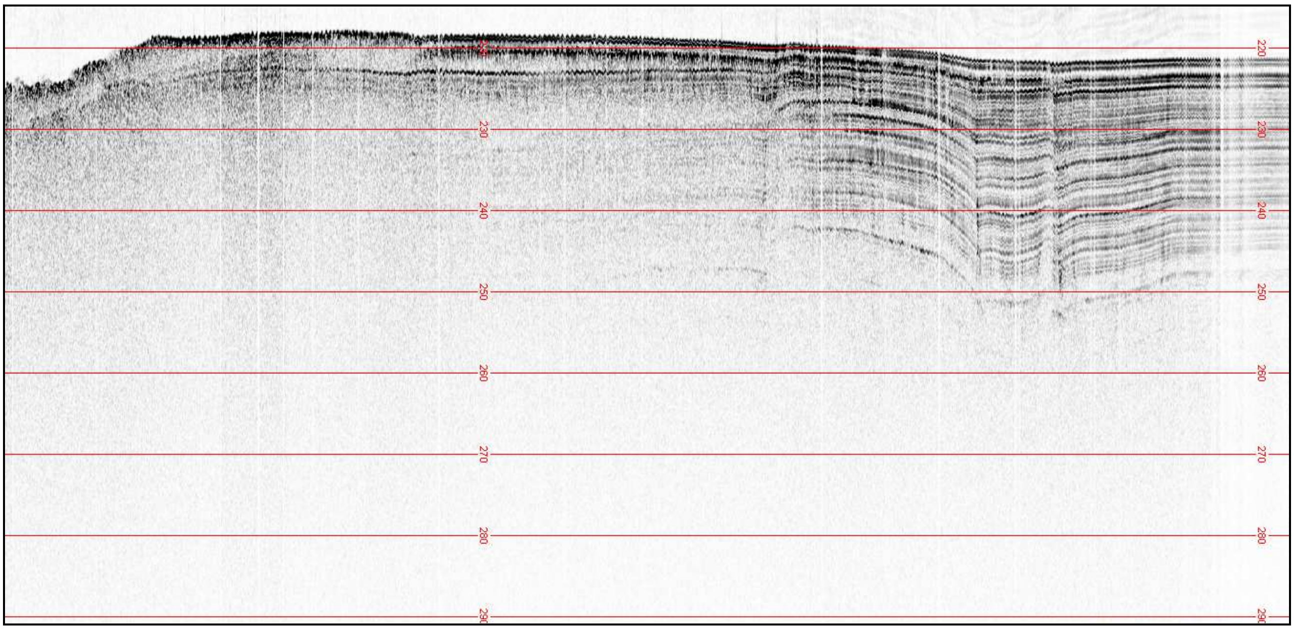

Fig. 32: Chirp line of Site ND8.

The gravity corer collected 493 cm of sediments with an alternation of light grey and dark grey clay and sandy-silt intervals, with some erosional surfaces. At 110 cm a "sapropel" like layer could be supposed, at 413 cm 2 pteropods layers occur. By comparing the stratification of the site ND8 with 964 and 967 ODP sites (collected in Ionian abyssal plain and south of Cyprus respectively) it is necessary to highlight an unbelievable similarity, not only in the alternation of the layers but also in the erosional surfaces and in the pteropods levels. The core was cut and splitted in 5 sections (section A= bottom – section E=top).

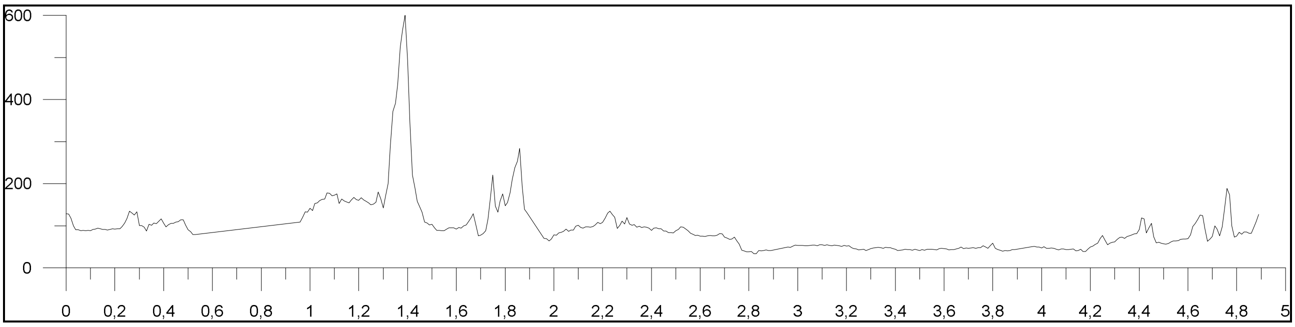

Fig. 33: Magnetic susceptibility profile of ND8 gravity core.

The magnetic susceptibility profile, collected along the gravity core, show clear variations along sediments. In particularly at 1.4 mt and at 1.9 mt 2 evident spikes occur. Additional tephro-stratigraphic analyses may be able to establish if crypto volcanic events were recorded too.

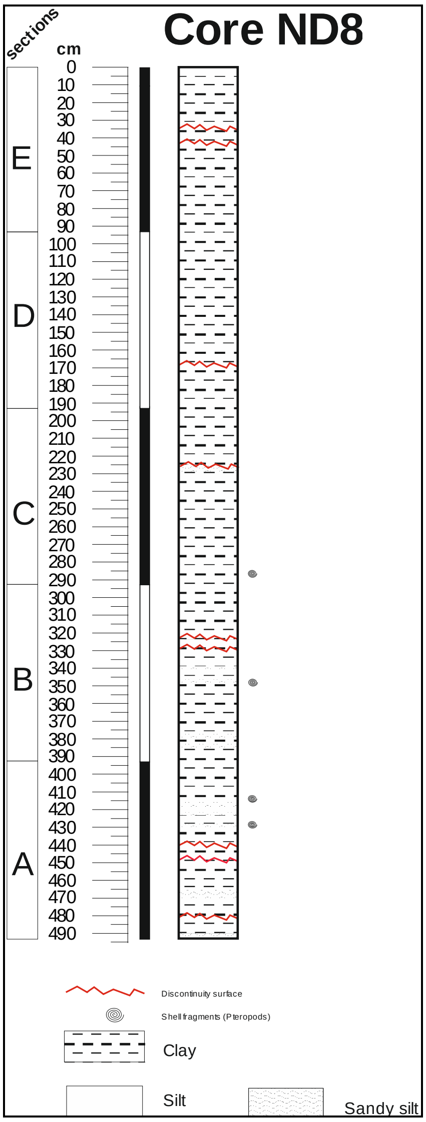

Fig. 34: Site ND8 chart.

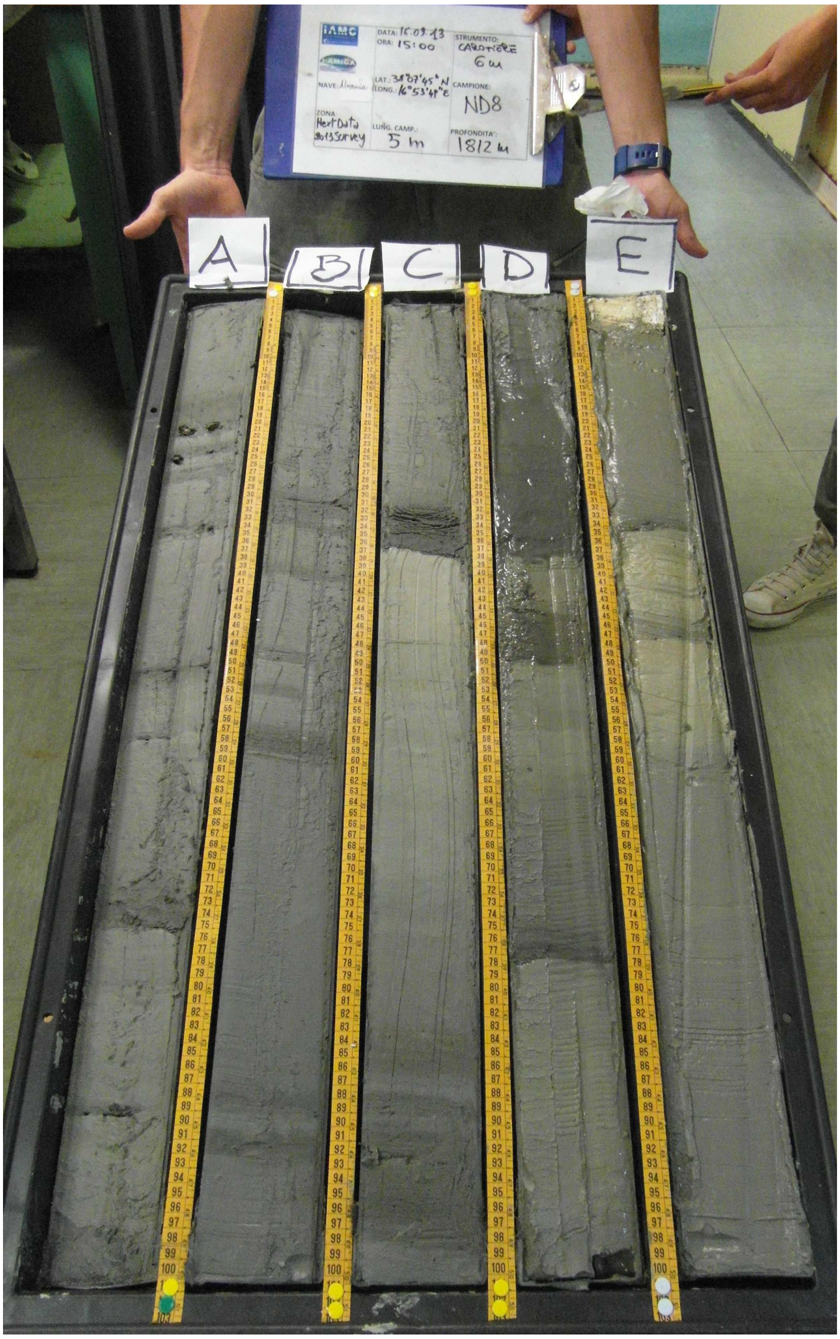

Fig. 35: Site ND8 gravity core photo.

4.2 - Core ND9

Core ND9 was located at about 11 nm from the Puglia coast (Lat. 39° 49' 24'' N – Long. 17° 52' 47'' E), at -176 mt in the North-Est branch of Taranto Gulf. The Chirp line shows a ~50 mt thick of well stratified silty sediments, intercalated by a clear dark reflector probably accentuated by the sandy layers. From the sea floor to 30 mt the seismic signal is constant, afterwards it rapidly decays without a visible structure.

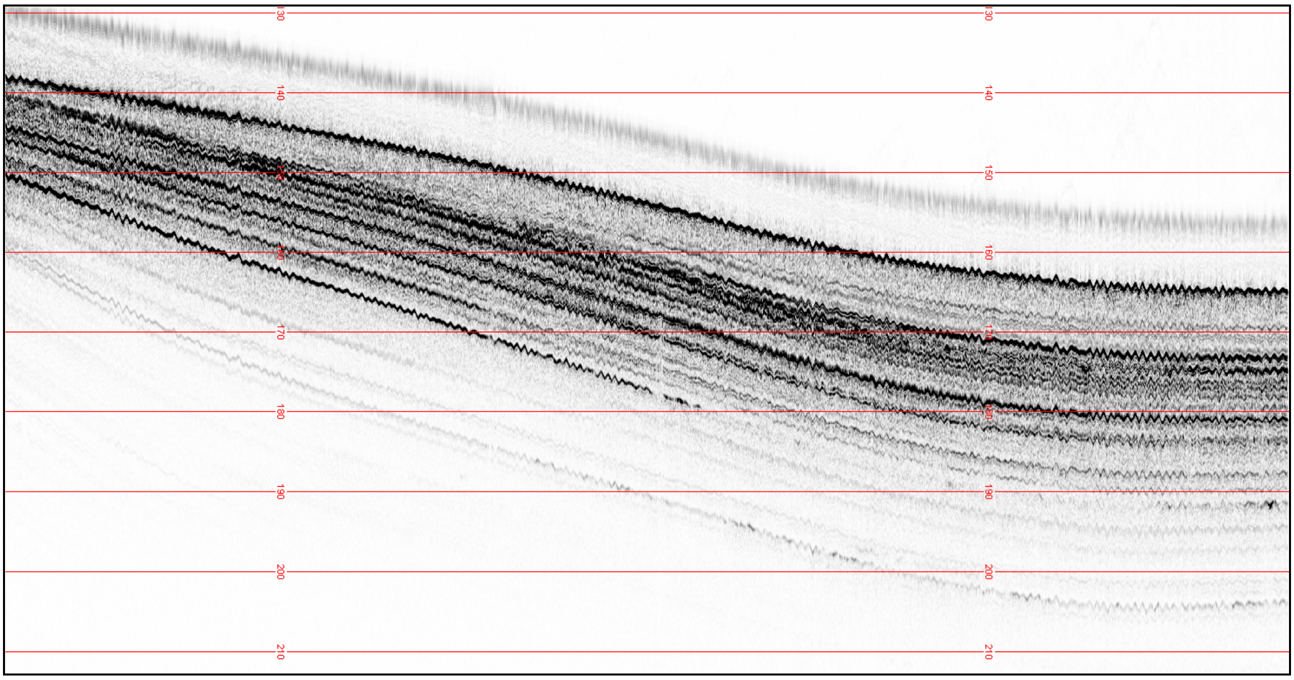

Fig. 36: Chirp line of Site ND9.

The gravity corer collected 460 cm of homogeneous clay sediments. The core was cut and splitted in 5 sections (section A= bottom – section E=top) and sampled every centimetre.

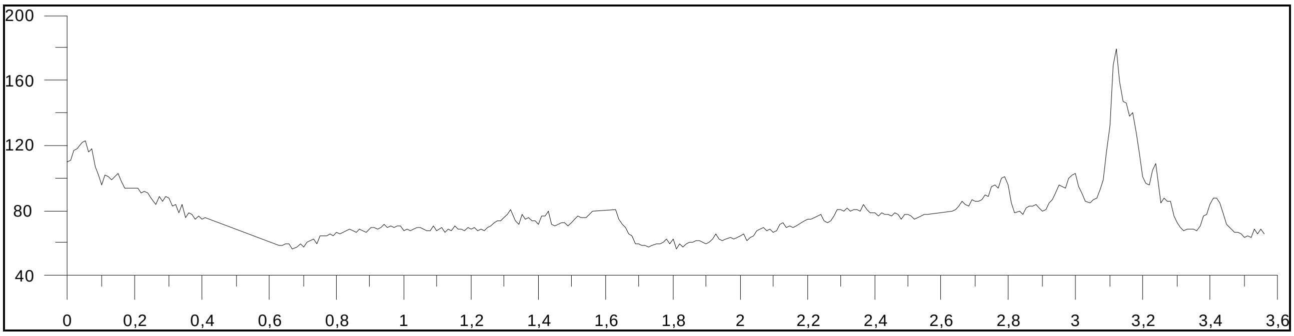

Fig. 37: Magnetic susceptibility profile of ND9 gravity core.

The magnetic susceptibility profile, collected along the gravity core, shows a clear variation along sediments. In particularly at 3.2 mt an evident spike occurs. Further tephro-stratigraphic analyses may be able to establish if crypto volcanic events were recorded too. The SW104 corer collected 134 cm of homogeneous clay-sediments, confirming the lithology recorded by the gravity corer. The water-sediment interface was collected too.

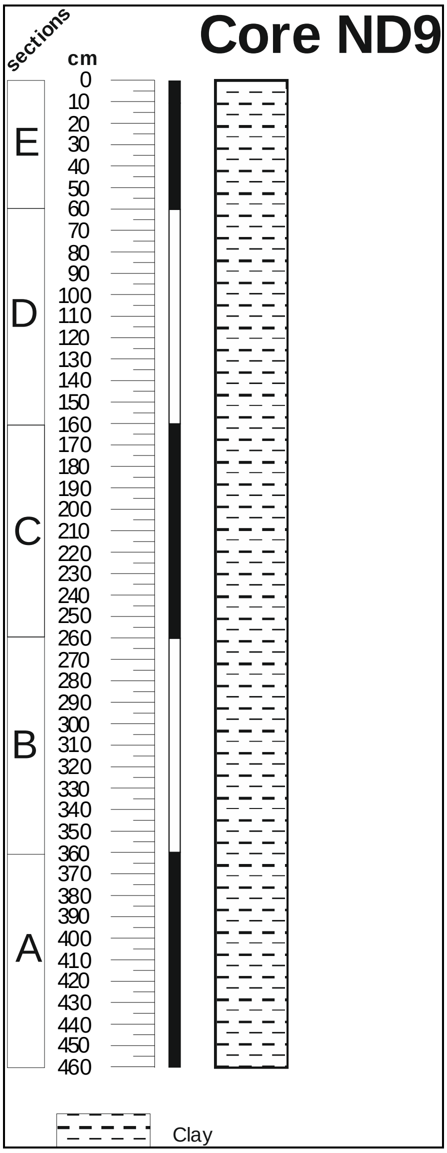

Fig. 38: Site ND9 chart.

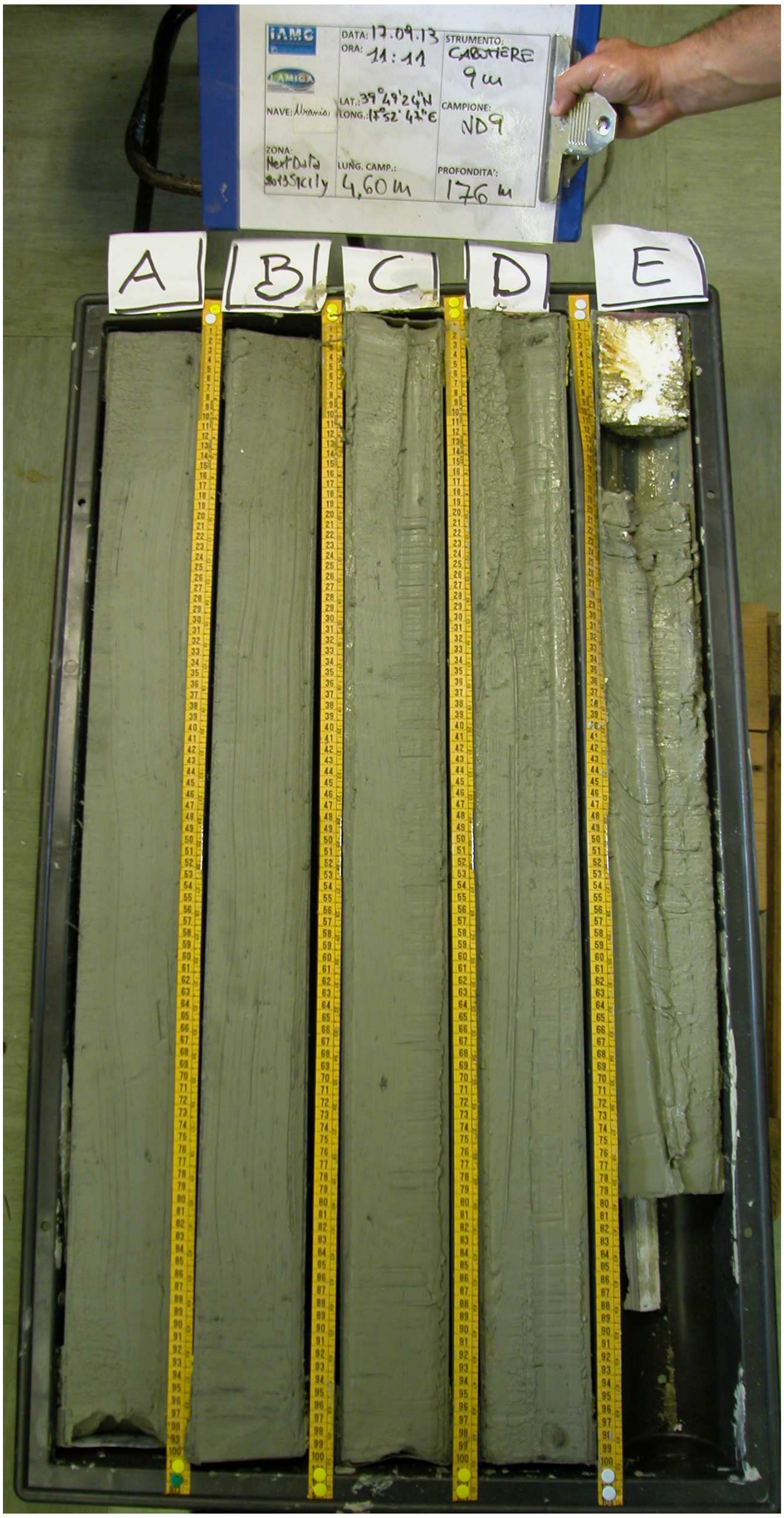

Fig. 39: Site ND9 gravity core photo.

Fig. 40: Site ND9, SW104 core photo.

4.3 - Core ND10

Core ND10 was located at about 10 nm from the Puglia coast (Lat. 40° 05' 49'' N – Long. 17° 44' 50'' E), at -174 mt in the North-Est branch of Taranto Gulf. The Chirp line shows a ~50 mt thick of well stratified silty sediments, intercalated by a clear dark reflector, probably accentuated by sandy layers. From the sea floor to 20 mt, the seismic signal is constant, afterwards it decays without a visible tectonic structure.

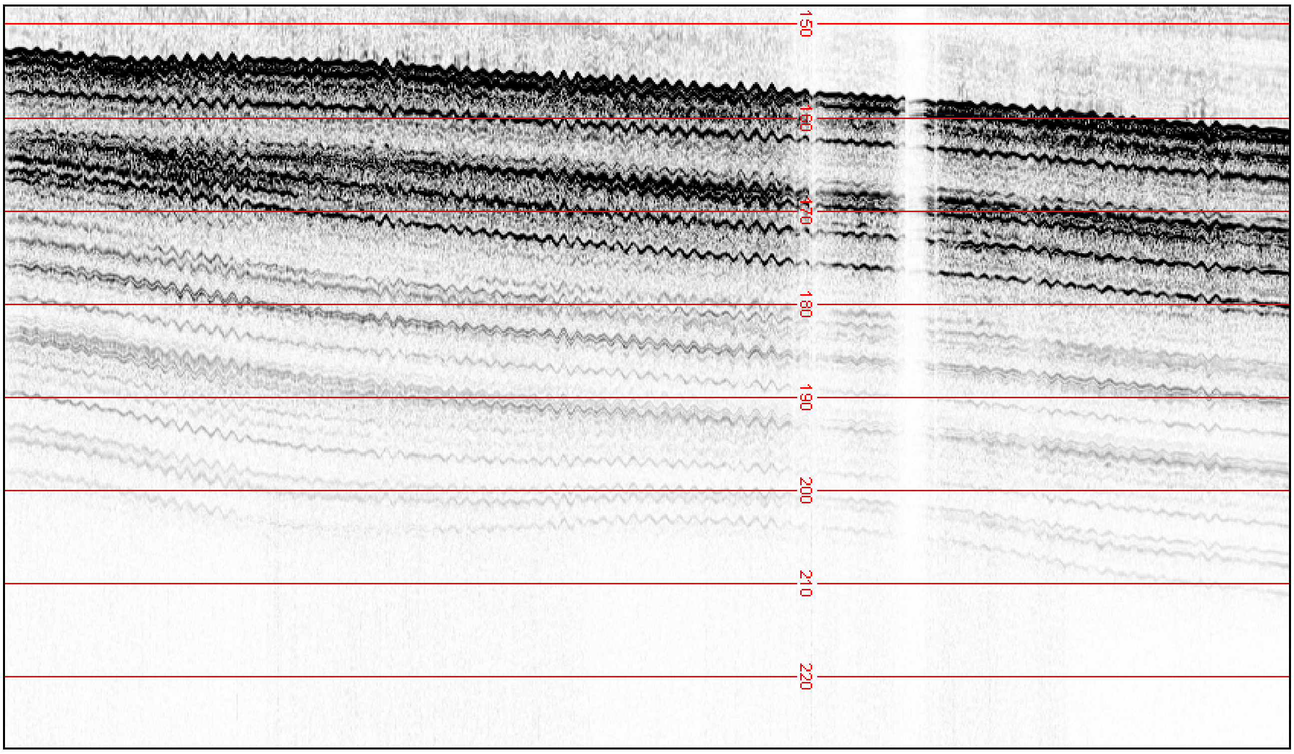

Fig. 41: Chirp line of Site ND10.

The gravity corer collected 314 cm of homogeneous clay sediments with abundant bivalve gasteropods and coral fragments, at 165cm a "tephra" layer occur. The core was cut and splitted in 4 sections (section A=bottom – section D=top) and sampled every centimetre.

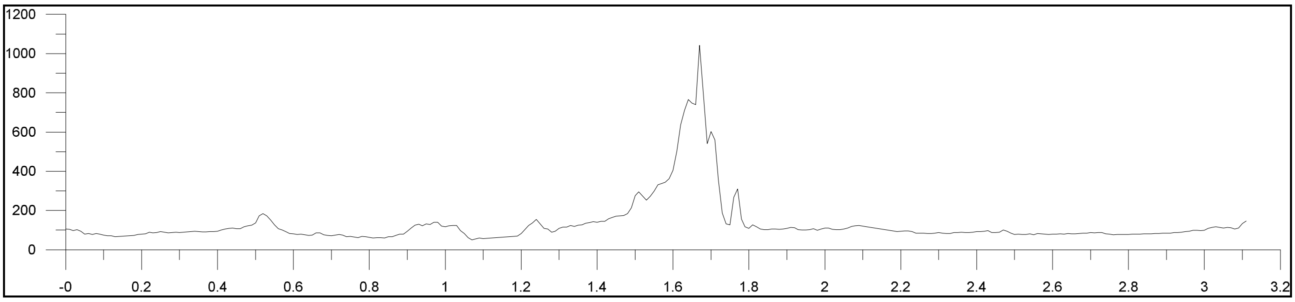

Fig. 42: Magnetic susceptibility profile of ND10 gravity core.

The magnetic susceptibility profile, collected along the gravity core, show a clear variation along sediments. In particularly at 1.6-1.7 mt an evident spike occurs, in perfect agreement with the lithological signal. Additional tephro-stratigraphic analyses may be able to establish if crypto volcanic events were recorded too. The SW104 corer collected 55 cm of homogeneous clay sediments, sampled every centimetre, confirming the lithology recorded by the gravity corer. The water-sediment interface was collected too.

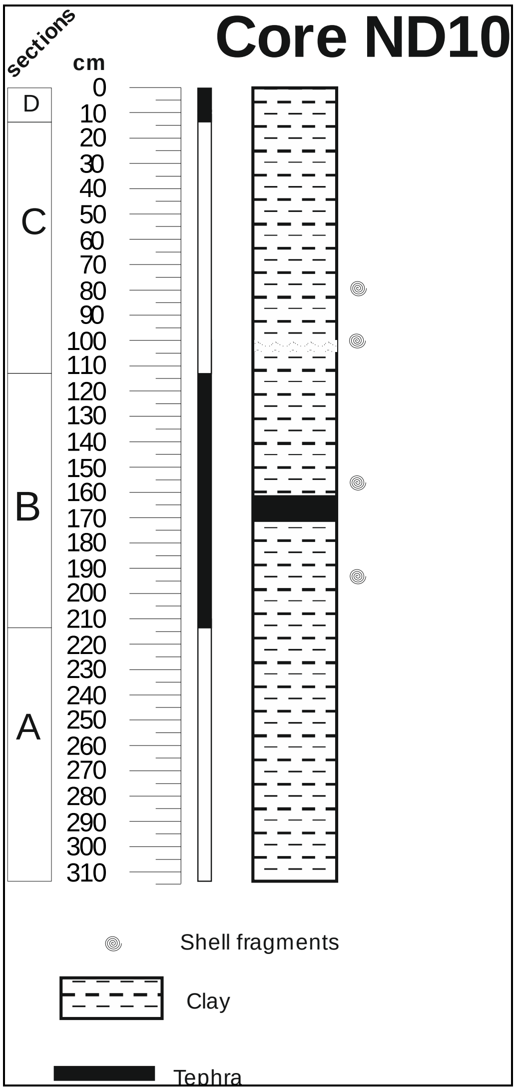

Fig. 43: Site ND10 chart.

Fig. 44: Site ND10 gravity core photo.

Fig. 45: Site ND10, SW104 core photo.

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Bibliographic index

- AGIP, 1978. Carta gravimetrica della Sicilia, anomalie di Bouguer, map scale 1:500.000. Ser. Geol. d'It. 99.
- AGIP, 1982. Carta magnetica d'Italia, anomalie del campo magnetico residuo, Foglio O, map scale 1:500.000.
- Akal, T., 1972. The General Geophysics and Geology of the Strait of Sicily. In: Allan, T.D., Akal, T., and Molcard, R., (Eds), Oceanography of the Strait of Sicily (Conference Proceedings No. 7). La Spezia, Italy: SACLANT ASW Research Centre. 177-192.
- Allan, T.D., Morelli, C., 1971. A Geophysical Study of the Mediterranean Sea. Bollettino di Geofisica Teorica ed Applicata. 13 (50), 99-134.
- Amodio-Morelli L ., Bonardi G., Colonna V., Dietrich D., Giunta G., Ippolito F., Liguori V., Lorenzoni S., Paglionico A., Perrone V., Piccarreta G., Russo M., Scandone P., Zanettin-Lorenzoni E. & Zuppetta A. 1976. L'Arco Calabro-peloritano nell'orogene appenninico-maghrebide. Mem. Soc. Geol. It., 17, 1-60.
- Argnani, A., 1989. The Gela Nappe: evidence of accretionary melange in the Maghrebian foredeep of Sicily. Mem. Soc. Geol. Ital. 38, 419-428.
- Auzende, J.M., 1971. La marge continentale Tunisienne: Resultats d'une etude par sismique reflexion; sa place dans le cadre tectonique de la Mediterranee occidentale. Marine Geophysical Researches. 1, 162-177.
- Auzende, J.M., Olivet, J.L., Bonnin, J., 1974. Le detroit Sardano-Tunisien et la zone de fracture Nord-Tunisienne. Tectonophysics., 21, 357-374.
- Barberi, F., Civetta, L., Gasparini, P., Innocenti, F., Scandone, R., Villari, L., 1974. Evolution of a section of the Africa–Europe plate boundary; paleomagnetic and volcanological evidence from Sicily. Earth Planetary Science Letters. 22 (2), 123–132.
- Ben-Avraham, Z., Grasso, M., 1990. Collisional zone segmentation in Sicily and surrounding areas in the Central Mediterranean. Annales Tectonicae, spec. issue. 4(2), 131-139.
- Benson, R.H., 1972. Ostracodes as Indicators of Threshold Depth in the Mediterranean During the Pliocene. In: Stanley, D.J., (Eds) The Mediterranean Sea: A Natural Sedimentation Laboratory. Stroudsburg: Dowden, Hutchinson & Ross, Inc. 63-73.

- Biju-Duval, B., Dercourt, J., Le Pichon, X., 1976. La Genèse de la Méditerranée. La Recherche, 71 (7), 811–822
- Bousquet, J.C., 1972. La Tectonique de l'Apennin Calabro Lucanien dans son Cadre Geologique et Geophysique. These Sciences, Université de Montpellier, 172 pp.
- Brogan, G.E., Cluff, L.S. and Taylor, C.L., 1975. Seismicity and uplift of southern Italy. Tectonophysics. 29, 323--330.
- Burollet, P.F., 1967. General Geology of Tunisia. In: Guidebook to the Geology and History of Tunisia. Petroleum Exploration Society of Libia. 51-58.
- Caputo, M., Panza, G.F., Postpischl, D., 1970. Deep Structure of the Mediterranean Basin. XXIIe Congres-Assemblee Pleniere, Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee. Rome.
- Caputo, M., Panza, G.F. and Postpischl, D., 1972. New evidences about the deep structure of the Lipari Arc. Tectonophysics. 15. 219--231.
- Cassinis R., Franciosi R., Scarascia S., 1979. The structure of the earth's crust in Italy. A preliminary typology based on seismic data. Boll. Geof. Teor. Appi. 21, 105-126.
- Catalano, R., Di Stefano, P., Nigro, F., and Vitale, F.P., 1993a. Sicily mainland and its offshore: a structural comparison. In: Max, M.D., and Colantoni, P. (Eds.), Geological Development of the Sicilian-Tunisian Platform. UNESCO Rep. Mar. Sci., 58, 19-24.
- Catalano, R., Infuso, S., and Sulli, A., 1993b. The Pelagian Foreland and its northward foredeep: Plio-Pleistocene structural evolution. In: Max, M.D., and Colantoni, P. (Eds.), Geological Development of the Sicilian-Tunisian Platform. UNESCO Rep. Mar. Sci., 58, 37-42.
- Colantoni, P., Zarudzki, E.F.M., 1973. Some Principal Sea Floor Features in the Strait of Sicily. Bulletin of the Geological Society of Greece. 10 (I), 204-205.
- Crescenti, V., 1975. Sul substrato pre-Pliocenico dell'avanfossa Appenninica della Marche allo Ionio. Boll. Soc. Geol. Ital., 94: 583--634.
- Dewey J.F., Pitman W.C., Ryan W.B.F. & Bonnin J. (1973) - Plate tectonics and the evolution of the alpine system. Geol. Soc. Am. Bull., 84: 3137-3180.
- Dewey, J.F., Helman, M.L., Turco, E., Hutton, D.H.W., Knott, S.D., 1989 Kinematics of the western Mediterranean, In: Coward MP,Dietrich D, Park RG (Eds) Alpine tectonics. Geol Soc London Spec. Publ. 45, 265-283.
- Di Stefano, E., Infuso, S., and, Scarantino, S., 1993. Plio-Pleistocene sequence stratigraphy of western offshore Sicily from well logs and seismic sections in a high-resolution calcareous plankton biostratigraphic framework. In: Max, M.D., and Colantoni, P. (Eds.), Geological Development of the Sicilian-Tunisian Platform- UNESCO Rep. Mar. Sci., 58, 37-42.
- Dubois, R., 1976. La suture calabro-apenninique Crétacée-Eocéne et l'ouverture tyrrhé-nienne néogéne. Etude pétrographique et structurale de la Calabre Centrale. Thése, Université de Paris, 567 pp.

- Finetti, I., Morelli, C., 1972a. Regional Reflection Seismic Exploration of the Strait of Sicily. In: Allan, T.D., Akal, T., and Molcard, R., (Eds.), Oceanography of the Strait of Sicily (Conference Proceedings No. 7). La Spezia, Italy: SACLANT ASW Research Centre. 208-216
- Finetti, I., Morelli, C., 1972b. Wide Scale Digital Seismic Exploration of the Mediterranean Sea. Bolletino di Geofisica Teorica ed Applicata. 14(56), 291-342.
- Geiss, E., 1987. A new compilation of crustal thickness data for the Mediterranean area. Ann. Geophys. 5B, 623-630.
- Grasso, M., 1993. Pleistocene structures at the Ionian side of the Hyblean Plateau (SE Sicily): implications for the tectonic evolution of the Malta Escarpment. In: Max, M.D., and Colantoni, P., (Eds), Geological Development of the Sicilian-Tunisian Plarform. Proceedings of International Scientific Meeting held at the University of Urbino, Italy, 4-6 November 1992. UNESCO Reports in Marine Science. 58, 49-54.
- Maldonado, A., Stanley, D.J., 1976. Late Quaternary Sedimentation and Stratigraphy in the Strait of Sicily. Smithsonian Contributions to the Earth Sciences. 16 (3).
- Max, M.D., Kristensen, A., Michelozzi, E., 1993. Small scale Plio-Quaternary sequence stratigraphy and shallow geology of the west-central Malta Plateau. In: Max, M.D., Colantoni, P. (Eds.), UNESCO Techical Reports in Marine Science. 58, 117–122.
- Mongelli, F. and Ricchetti, G., 1970. The earth crust and heat flow in the fossa Bradanica (southern Italy). Tectonophysics, 10: 103--125.
- Morelli, C., Giese, P., Cassinis, R., Colombi, B., Guerra, I., Luongo, G., Scarascia, S., Schütte, G., 1975. Crustal structure of southern Italy. A seismic refraction profile between Puglia-Calabria-Sicily. Boll. Geof. Teor. Appi., 17, 183-210.
- Ogniben, L., 1968. Schema introduttivo alla geologia del confine Calabro--Lucano. Mem. Soc. Geol. Ital., 8: 453--763.
- Ortolani, F., 1978. Alcune considerazioni sulle fasi tettoniche Mioceniche e Plioceniche dell'Appennino meridionale. Boll. Soc. Geol. Ital., 97: 609---616.
- Panza, G.F., 1979. The crust and upper mantle in southern Italy from geophysical data. Riv. Ital. Geo. Sci. Offic. 5, 17--22.
- Patacca, E., Scandone, P., Giunta, G., Liguori, V.,1979. Mesozoic paleotectonic evolution of the Ragusa zone (Southeastern Sicily). Geologia Romana. 18, 331–369.
- Ricchetti, G., 1980. Contributo alla conoscenza strutturale della fossa Bradanica e delle Murge. Boll. Soc. Geol. Ital., 99: 421--430.
- Ricchetti, G. and Mongelli, F., 1980. Flessione e campo gravimetrico della micropiastra apula. Boil. Soc. Geol. Ital., 99: 431--436.
- Riuscetti, M., Schick, R., 1975. Earthquakes and Tectonics in Southern Italy. Boll. Geofys. Teor. Appl. 27, 59--77.
- Selli, R., 1975. Laboratorio di Geologia Marina: Attività svolta nel 1974. Gn. Geol. Serv. 2, 1-19.

- Trincardi, F., Argnani, A., 1990. Gela submarine slide: a major basin wide event in the Plio-Quaternary foredeep of Sicily. Geo-Mar. Lett.. 10, 13-21.
- Vezzani, L., 1967. I depositi Plio Pleistocenici del litorale ionico della Lucania. Atti. Accad. Gioenia Sci. Nat. Catania, 18: 159--180.
- Zarudzki, E.F.K., 1972. The Strait of Sicily - A Geophysical Study. Revue de Geographie Physique et de Geologie Dynamique. 14 (1), 11-28.