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INSTITUTE OF MARINE SCIENCES
MARINE GEOLOGY SECTION (BOLOGNA)

JOINT RESEARCH PROJECT "MARMARA"

ACTIVE FAULTS AND HISTORICAL EARTHQUAKES
IN THE MARMARA REGION, TURKEY

GEOPHYSICAL AND GEOLOGICAL STUDIES IN THE SEA OF MARMARA AND GULF OF SAROS

REPORT ON THE MORPHOBATHYMETRIC, GEOPHYSICAL, CORING AND OCEANOGRAPHICAL INVESTIGATIONS DURING CRUISE MARM05 ABOARD R/V URANIA

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Report on the morphobathymetric, geophysical, oceanographic, coring and dredging investigations during cruise MARM05 aboard R/V Urania.

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Includes bibliographical reference and index.
1. tectonics 2. stratigraphy 3. paleoseismology 4. oceanography

Abstract - A summary of methodologies, technical details and ship-board results of the MARM05 swath bathymetry, geological and oceanographical survey in the Sea of Marmara and Saros Gulf with R/V Urania is presented.

Sommario - Vengono presentati le metodologie e l'insieme dei risultati ottenuti durante la campagna MARM05 di rilievi batimetrici e geologici nel Mar di Marmara e nel Golfo di Saros. E' stata utilizzata la nave da ricerca R/V Urania del CNR,

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ACRONYMS

ACRONYM	DESCRIPTION	URL-email
CNR	Consiglio Nazionale Delle Ricerche	www.cnr.it
ISMAR	Istituto di Scienze Marine	www.bo.ismar.cnr.it
DISGAM	Dip. Sc. Geologiche. Amb. Marine, Univ. Trieste	www.univ.trieste.it/ dipsgaem/
ITU	İstanbul Technical University	www.itu.edu.tr
EMCOL	Eastern Mediterranean Center for Oceanography and Limnology	www.mines.itu.edu.tr/emcol/
IBB	İstanbul Buyuksehir Belediyesi	www.ibb.gov.tr
MTA	Maden Tetkik ve Arama Genel Mudurlugu	www.mta.gov.tr
SHODB	Seyir, Hidrografi ve Osinografi Dairesi Baskanligi	www.shodb.gov.tr
LDEO	Lamont-Doherty Earth Observatory	www.ldeo.columbia.edu
SEG	Soc. of Exploration Geophysicists	www.seg.org
XTF	Extended Triton Format	www.tritonelics.com
UNESCO	United Nations Scient. and cultural org.	www.unesco.org
IOC	Intergov. Oceanogr. Comm. of UNESCO	ioc.unesco.org
IHO	Int. Hydrographic Organization	www.iho.org
GPS-DGPS-RTK	Global Positioning System	samadhi.jpl.nasa.gov
DTM	Digital Terrain Model	en.wikipedia.org
GEBCO	General Bathym.Chart Oceans	www.ngdc.noaa.gov/mgg/gebco
SRTM	Shuttle Radar Topogr.Mission	www2.jpl.nasa.gov/srtm/
MBES	MULTIBEAM ECHOSOUNDER SYSTEM	
SBP	Sub Bottom Profiling	
MCS	Multichannel Seismic	
PSU	Practical Salinity Scale	ioc.unesco.org
TS	Temperature-Salinity Diagram	
XBT	Expendable BathyTermograph	www.sippican.com
UTM	Universal Transverse Mercator	
UTC	Universal Time Coordinated	
WGS84	World Geodetic System 1984	
NMEA	National Marine Electronics Association	www.nmea.org
DHCP	Dynamic Host Configuration Protocol	en.wikipedia.org
NAT	Network Address Translation	en.wikipedia.org/wiki/NAT
SO.PRO.MAR.	Societa' Promozione lavori Marittimi	Fiumicino (Italy)
SBE	Sea Bird Electronics	www.seabird.com/
RESON	Reson	www.reson.it
COMM-TECH	Communication Technology	www.comm-tec.com
NEPTUNE	Simrad MBES Software	www.kongsberg-simrad.com
CARAIBES	Traiment Cartographique Batimetrie	www.ifremer.fr/dnis_esi
MB-SYSTEM	MB-SYSTEM	www.ldgo.columbia.edu/MB-System
GMT	Generic Mapping Tool	gmt.soest.hawaii.edu/gmt
GNU,GPL	GNU is not Unix,General Pub. License	www.gnu.org

Table 1: Acronyms of Organizations, Manufacturers and Products

HOW TO READ THIS REPORT

Section 1 gives the introductory and background information, including some technological and scientific issues of the organization and execution of tasks, whereas section 2 summarizes the cruise operations. Section 3 provides the technical aspects that were involved in the data acquisition and processing. Sections 4 and 5 discuss the initial results, the on-going data processing and usage, and give concluding remarks. Some data processing procedures that were used in the production of this report along with additional technical details and data are presented in the Appendix.

ACKNOWLEDGMENTS

Many people contributed to the success of the research cruise (MARM05 *R/V Urania*). We are particularly indebted to the officers and crew members of *R/V Urania* for their professionalism and efforts in assuring the success of the cruise. The project was co-funded by Italian CNR and Ministry of University and Research (MIUR). We thank Dr. A.Polonia for revisions and criticisms.

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1 INTRODUCTION

The Sea of Marmara lies between the Aegean Sea and the Black Sea (Fig.1 and 3) and it connects to these basins trough the Dardanelles and Bosforus Straits. It forms an active system of strike-slip basins developed along the submerged portion of the NAF system. The NAF extends east-west for over 1600 km across Turkey representing a major continental transform plate boundary between Anatolia and Eurasia (Fig.2). Earthquake epicenters and focal mechanism solutions in western Anatolia show a clustering on or near the major faults. A sequence of eight M7+ earthquakes has ruptured this boundary progressively from east to west during the last century. The most recent and westernmost events in this sequence, the M7.4 Kocaeli and M7.1 Düzce mainshocks in 1999 [Celebi et al.(2005), USGS(2000), Reilinger et al.(2000)], located in the eastern Marmara Sea region, were particularly destructive. Together they ruptured about 160 km of this fault system including its submarine portion in the Gulf of İzmit. Except for the 1912 M7.3 earthquake in the west of the Sea of Marmara and the Ganos region however, relatively little strain is thought to have been released by earthquakes along 150km long part of the transform fault in the Marmara Sea and since the mid 1700's. This portion of the transform is, therefore, identified as a seismic gap where accumulated elastic strain is about as much as it was released by slip in the 1999 earthquake sequence.

After the 1999 earthquakes the international community is collecting geological and geophysical data to study the fault distribution, dynamics and kinematics in the Sea of Marmara, focusing in particular on the seismic risk assessment in the region close to İstanbul[Le Pichon et al.(2001), Imren et al.(2001), Armijo et al(2002), Le Pichon et al.(2003), Flerit et al.(2003), Kurt et al.(2000), Polonia et al.(2002), Polonia et al.(2004)].

There are two reasons for the strong interest in this region. First, this area is high seismic risk, including the city of İstanbulwith its 15 million inhabitants. Second, there is no consensus on the geometry of the faults strands underwater, the likely mechanism of strain partitioning along the main fault strand, and on the components of shortening and extension within the dominantly transcurrent regime [Okay et al.(2000), Le Pichon etc al.(1999), Parke et al.(1999), Aksu et al.(2000), Armijo et al(2002), Armijo et al.(2005)]. These uncertainties prevent a reliable evaluation of hazards in this region.

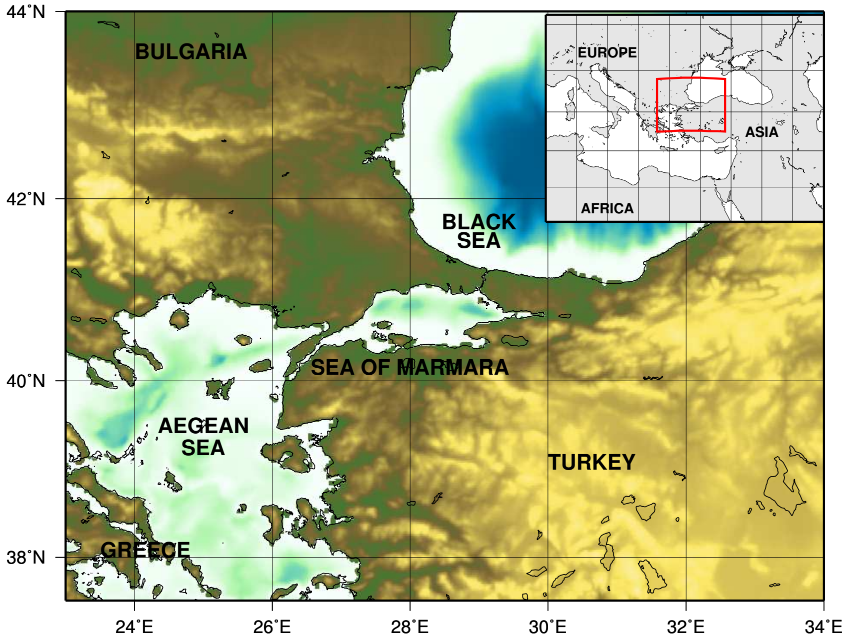

Figure 1: Geographical setting of the study area. Topographic and bathymetric data by Sandwell and Smith [Sandwell and Smith(2001)].

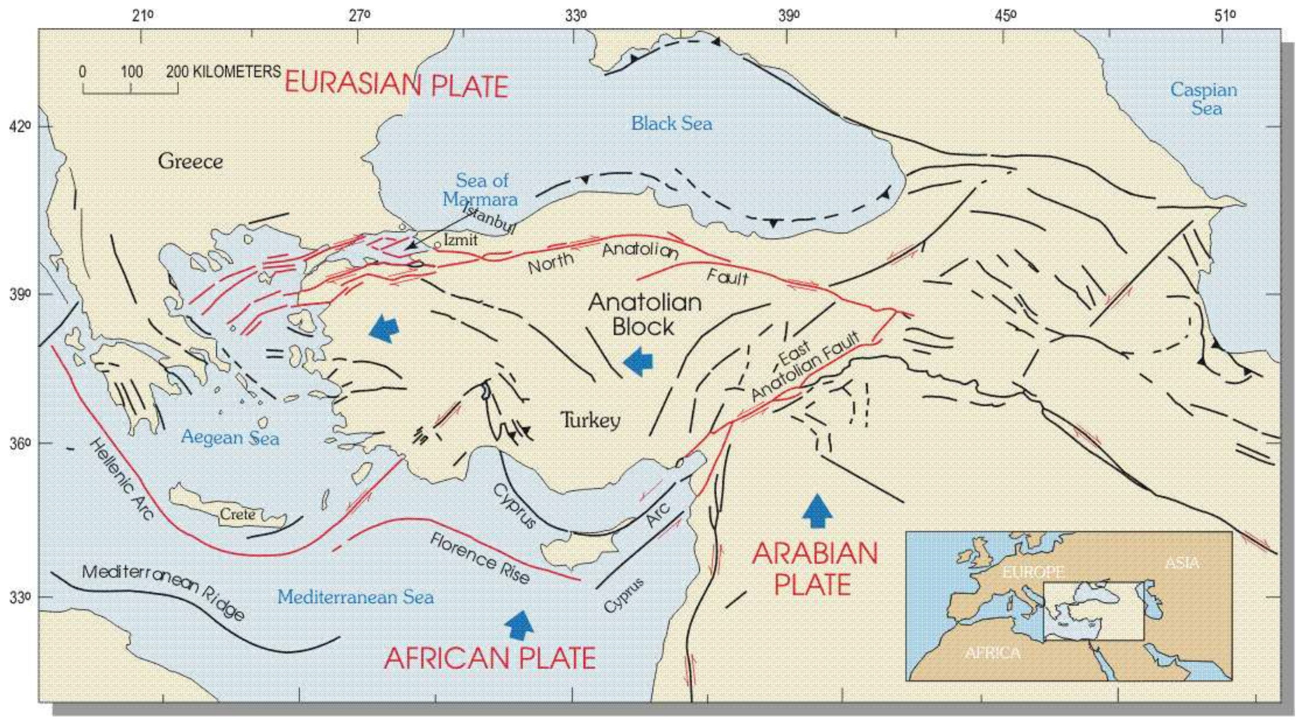

Figure 2: Image from [USGS(2000)]. Modified by [Barka (1992), Rockwell et al.(2001)].

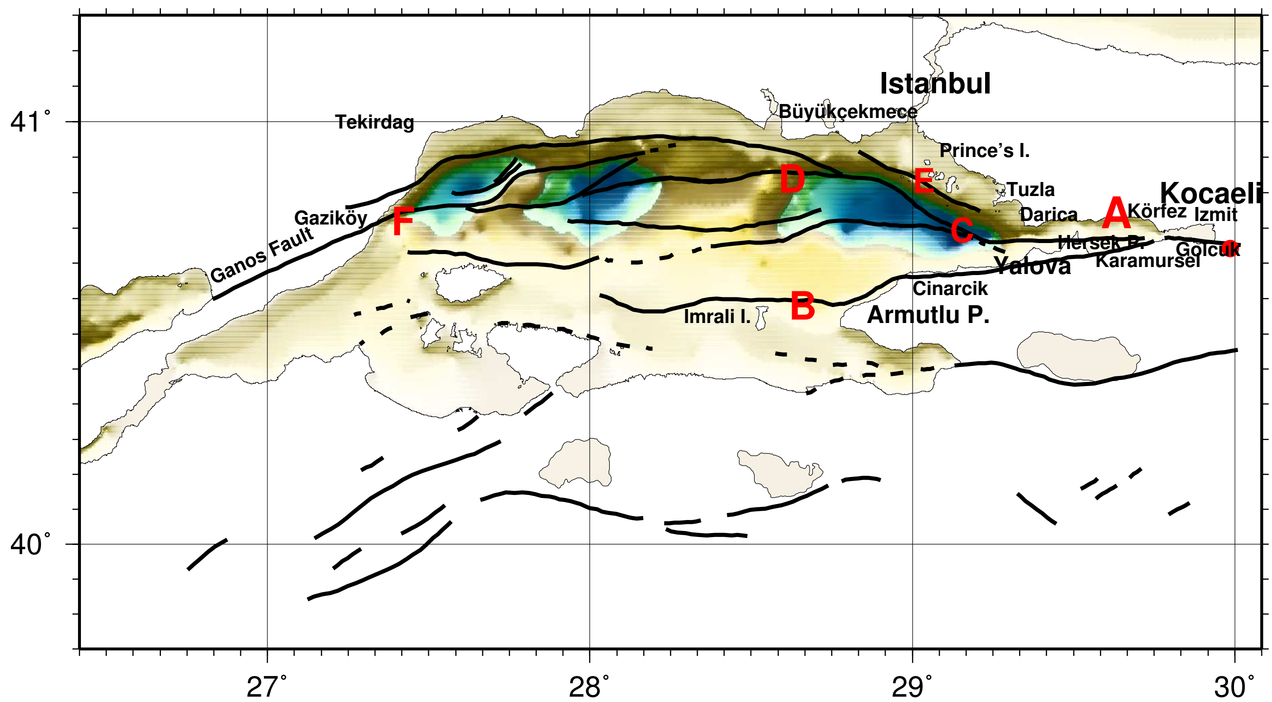

Figure 3: Geographical and structural setting of the study area, showing the active faults.

Two geological/geophysical expeditions were carried out in the Sea of Marmara by ISMAR-CNR , in the frame of an international collaboration between the Istanbul Technical University (ITU), TÜBİTAK and L-DEO (Columbia University).

The first cruise [Bortoluzzi et al.(2001,a)] (MARM2000) with R/V Odin Finder started in late October 2000 and produced detailed multibeam, chirp and SSS profiles and some cores in the areas of İzmit and on the shelf SW of İstanbul. The second cruise [Bortoluzzi et al.(2001,b)] (MARM2001) took place in spring 2001 with R/V CNR Urania. High and very high resolution geophysical data were acquired during this expedition (Multibeam morphobathymetry, side-scan sonar, chirp sonar, MCS, magnetometry), together with 166 m of gravity and piston cores. The main aim was to identify the seismogenic strands of the NAF and to define their kinematics in the studied area. The principal results of these two cruises were published in [Polonia et al.(2002), Polonia et al.(2004), Cagatay et al.(2003), Seeber et al.(2004), Cormier et al.(2005,in press)].

Since then, an additional project collaboration was signed between Turkish ITU-EMCOL and Italian ISMAR-CNR. University of Trieste (DISGAM) and University La Sapienza from the Italian side, and MTA, IBB and SHOD from the Turkish side were also partners of the project.

The ISMAR-CNR presented a proposal for R/V Urania ship time.

The main objectives may be listed as folllows:

- identify the main faults carrying the current plate motion through Marmara
- dating of their most recent ruptures at a similar scale as typical paleoseismic studies on land;
- measuring fault offsets using morphological and sedimentary features;
- determining the average slip-rate over long periods (e.g. 10-25 ka) on the faults using C dating of sub-bottom reflectors and displaced features along the faults.

Starting from the work already done, we planned to acquire a new set of geophysical data and to map at various vertical scales (from a few cm to a few m of resolution and from few tens of m to 1 to 2 km of penetration) the active strands of the NAF in two key areas at the eastern and western ends of the Marmara basin. The work planned is mainly located in shallow water to understand the transition from the subaerial to the submerged portion of the NAF system close to the epicenter of 1999(Izmit) and 1912 (Ganos) eartquakes. To further investigate the geology of the Marmara region we focused on other areas, such as (a) the Saros Gulf, as the continuation of the northern strand of NAF in the Aegean Sea and (b) the Gemlik Gulf, interested by the Central strand of NAF. Other work was also planned in order to find active faults in the Northern shelf of the Sea of Marmara, from Gaziköy to Siliviri and Büyükçekmece, but principally on the shelf around the Prince Islands, from the Marmara junction of the Bosphorus in the west to the Tuzla Gulf in the east.

A ship period of 26 days, including 5 days of transit was assigned to the project by CNR and scheduled for late summer 2005. This paper reports the shipboard activities during the cruise MARM05 with R/V Urania of CNR.

We focused on multibeam swath bathymetry, CHIRP-SBP, MCS, coring, core-logging and description, to study five areas of the continental shelf and slope in the Sea of Marmara and of the Northern Aeagean Sea(Fig. 3):

The cruise started in Rhodes 2005-09-08 and ended in Bari 2005-10-05. Weather conditions were generally good to very good, except for one day in the Aegean Sea during the transit to Italy.

Hereafter, a description of the ship, equipment and their usage is given, along with details of the general settings, performances and some scientific and technical results.

GEOLOGICAL SETTING

The North Anatolian Fault (NAF) is a major dextral transform fault controlling the westward motion of the Anatolian Plate [Armijo et al.(1999)]. It extends for more than 1.600 km from the Karliova triple junction in the east, to the northern Aegean Sea in the west [Sengor (1979), Barka (1992), Cagatay et al.(1998), Hubert-Ferrari et al.(2002), Sengor et al.(2004)]. It is a widely held notion that the NAF originated in the Miocene following the development of the Bitlis suture along the Arabia-Eurasia collision zone (e.g. [Sengor et al.(1985)]) and reached the Marmara-Aegean region during the Pliocene (5 Ma; [Armijo et al.(1999)] or 3.4 Ma; [Yaltirak et al.(2000)]).

East of the Marmara Sea the NAF is constituted by a single strand characterized by a narrow deformation zone [Hubert-Ferrari et al.(2002)]. In the Sea of Marmara region the right lateral NAF splays into two major fault branches about 100 km apart. According to geological and geodetic data [Armijo et al.(1999), McClusky et al.(2000)] most of the lateral motion is transferred obliquely from the southern to the northern branch, across the Marmara basin [Armijo et al(2002)].

Different structural models have been put forward for the NAF in the Marmara Sea region and the tectonic regime is described as :

1 resulting from the interaction of Anatolia strike slip with Aegean extension [Wong et al.(1995), Parke et al.(1999)]

2 a single through-going master strike slip fault [Le Pichon et al.(2001), Le Pichon et al.(2003), Aksu et al.(2000), Imren et al.(2001), Gokasan et al.(2001), Kuscu et al.(2002), Alpar and Yaltirak (2002), Demirbag et al.(2003)]

3 a pull apart system produced by fault segmentation, oversteps and slip partitioning [Armijo et al.(1999), Armijo et al(2002), Barka and Kadisky-Cade (1988), Barka (1992), Stein et al.(1997), Okay et al.(2000), Parke et al.(2002), Flerit et al.(2003), Polonia et al.(2004)]

Geodetic measurements [McClusky et al.(2000)] suggest a 24 mm/yr right lateral motion between Anatolia and Eurasia in this region, with more than 80 % of the total motion, i.e., > than 20 mm/y, along the northern branch [Armijo et al(2002), Meade et al.(2002)]. GPS geodetic measurements cover a period of ten years, a short interval of time compared to recurrence period of major earthquakes in the region [Ambraseys and Finkel (1991)]. Recently, [Povost et.(2003)] through a 3-D mechanical modeling of the GPS velocity field, provided an estimate of the NAF slip rate in the Marmara Sea in the order of 17.5 mm/yr, which is a value significantly smaller than the 24 mm/yr rate of [McClusky et al.(2000)].

Long term slip rate estimates from geological reconstructions [Armijo et al.(1999), Shindler (1997)] are systematically smaller than 24 mm/yr being in the range of 14-20 mm/yr during the last 3-4 Ma. The slip rate over a very large time scale (5 Ma) has been reconstructed through the analysis of displaced geological features in the Ganos region [Armijo et al.(1999)]. This estimate implies a total dextral slip of about 85 km in the past 5 Ma. However, the use of the particular displaced geological features has been questioned by [Okay et al.(2004)].

Estimates of the slip rate along the NAF over geological time scales and distribution of motion along the various strands of the NAF can help reach a realistic assessment of seismic hazards for this densely populated area of Turkey. During MARM2000 and MARM2001 cruises we obtained high-resolution acoustic images of the NAF in the floor of the eastern Marmara Sea (Gulf of İzmit), and measured fault-related offsets of ^{14}C dated subseafloor channels and paleo-shorelines [Polonia et al.(2002)]. The resulting average slip rate on the fault is $\tilde{1}0$ mm/yr for the last 10 kyr (see Fig.4 and [Polonia et al.(2004)]). This is less than half the total Anatolia-Eurasia relative motion, estimated from satellite geodetic measurements.

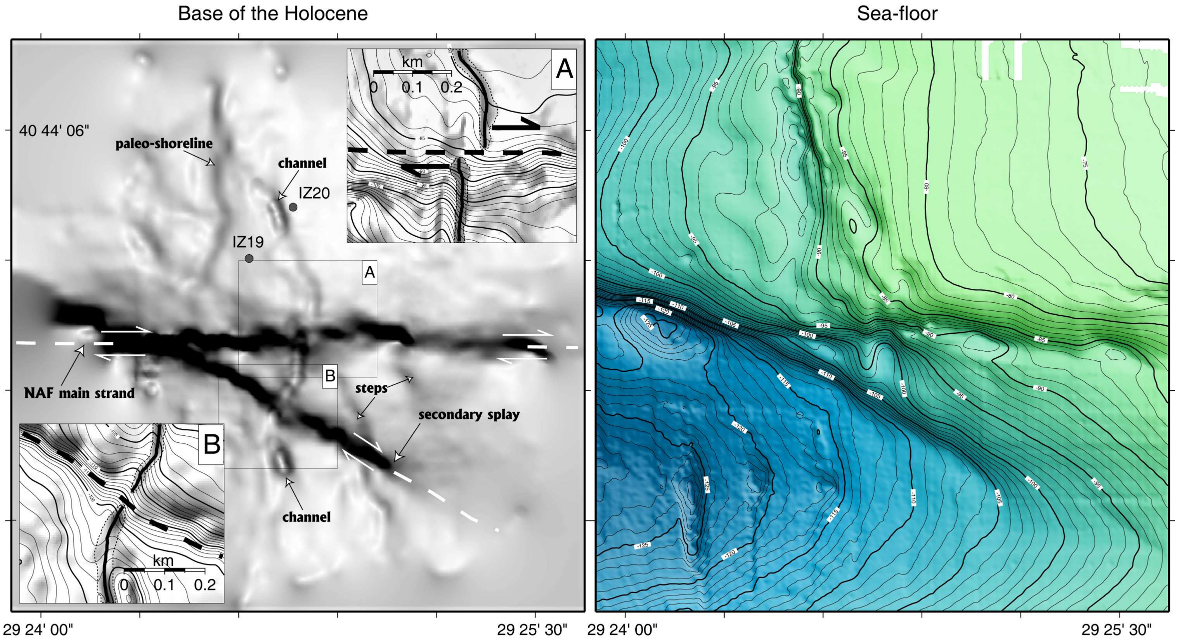

Figure 4: CHIRP SBP data analysis (MARM2001): fault-related offsets of ^{14}C dated subseafloor channels and paleo-shoreline [Polonia et al.(2002), Polonia et al.(2004), Cagatay et al.(2000), Cagatay et al.(2003)]

The lack of understanding of the structural configuration and deformation rates of the NAF in the Marmara Sea has important effects on seismic hazard estimates for this densely populated region. Key areas for determing whether or not the NAF is segmented and at which scale such segmentation occurs are the Bay of İzmit in the east and the Ganos Basin and Saros Gulf, in the west, as well as the surrounding regions on land. These two areas characterize the transition from an almost purely transcurrent regime to transtensional tectonics.

The Urania 2005 cruise has been planned in order to acquire new geological-geophysical data in these key areas. The new dataset will be integrated with preexisting data gathered by us and by other researchers, thus connecting detailed neotectonic, paleoseismological, and seismological information on Quaternary events with low-temperature thermochronology and seismic structural-stratigraphic interpretations on a longer time range, to ultimately elucidate the style of the transition between the strike-slip- dominated and the extensional regimes and to constrain the development of the NAF system.

Morphobathymetric and seismic surveys made by French oceanographic vessels [Le Pichon et al.(2005), ?, Armijo et al.(2005)] imaged in detail the surficial and deep structure of the sedimentary basins located in the deepest portions of the Marmara Sea. Despite these surveys, there are still unresolved disputes concerning the geological evolution of the deep basins. During cruises MARM2000 and MARM2001 the seismogenic branches of the NAF in shallow waters were identified and their kinematics was quantified. This project aims at integrating data at various spatial and temporal scales. The study of the geometry and evolution of transform faults requires the correlation of surficial and deep structures and the reconstruction of the temporal evolution of the deformation across the entire section of the fault system. High-resolution analysis of seismic images is necessary in order to reconstruct the deformational regime on the fault plane (purely transcurrent, transtensional, or transpressional) as determined by fault geometry and the stress field. This is the only approach to reconstruct the degree of deformation, the strain rates and their variations through time, the strain transfer on adjacent fault planes, and the formation of the various fault systems, thus identifying the segments most at risk.

The Marmara region is characterized by intense crustal fragmentation, with discrete blocks, tectonic rotations, and complex transtensional and transpressional movements. Integrated geophysical studies at various scales of resolution are not presently available. In order to characterize the complexity of the Marmara region we will compare geological/geophysical data at various scales and correlate the structures on land and at sea. For this reason, we propose to integrate the available marine seismic profiles with high-resolution (from a few decimeters to a few meters) geophysical investigations both on land and at sea. These geophysical data have the potential to resolve the geometry of single fault branches of the NAF system and will be integrated by geological data on-shore (field mapping, structural analysis of brittle deformation, low-temperature thermochronology) and off-shore (deep coring down to 20 m, well-logs data).

PLANNING AND STRATEGY

Ship time of the R/V Urania was provided by CNR upon request of ISMAR. The application for clearances to perform the geophysical survey in the Marmara Sea and Gulf of Saros and the plan of the cruise were submitted to the Turkish embassy in Rome early 2005 as well as to the Italian Embassy in Ankara, upon confirmation of Cruise scheduling for September 2005. Turkish authorization was released to the R/V Urania through the Italian Embassy in Ankara on early august-2005.

The survey was planned to carry out the following tasks

- MBES with a high resolution multibeam, capable of investigating the sea bottom down to depths between 10 and 2500 m, alongwith SV measurements either by CTD probe or XBTs,
- CHIRP SBP ultra high resolution profiling
- Multichannel reflection seismic profiling
- sediment sampling (by gravity corers and grabs)

The areas to investigate were :

1. the Gulf of Saros
2. the Gulf of Izmit
3. the Gulf of Gemlik

In addition to these main targets, we also planned to investigate the continental shelf from Gaziköy to Büyükçekmece, and SE of İstanbul (Prince Islands to Tuzla Gulf), to map possible active faults. During transit to the Dardanelles Strait the submarine canyon north of İmrali Island was also investigated.

Furthermore, a malacological study was planned in order to obtain a better knowledge of the Sea of Marmara sediments, in particular in the İzmit Gulf, with the target of identifying associations related to the deformation patterns caused by the NAF.

The accurate bathymetric DTMs, DGPS positioning and ship's capabilities to keep position on station were used also to recover cores strategically positioned along the CHIRP-SBP profiles that crossed the faults. Some cores were also taken for stratigraphic control. A particular focus was put on areas 1,2 and 3, which lie directly on the Northern and Central strands of the NAF.

2 CRUISE SUMMARY

SHIP: *R/V Urania*
START: 2005-09-08 PORT: Rhodes
END: 2005-10-05 PORT: Bari
SEA/OCEAN: Sea of Marmara, Mediterranean Sea
LIMITS: NORTH 40:00.0 SOUTH: 41:15.0 WEST: 25:30.0 EAST: 30:00
OBJECTIVE: Active Faults and historical earthquakes in the Marmara Sea
COORDINATING BODIES: ISMAR-Bologna BOLOGNA (ITALY)
CHIEF OF EXPEDITION: Luca Gasperini (ISMAR-CNR)
CONTACT: Luca.Gasperini@ismar.cnr.it
DISCIPLINES: SWATH BATHYMETRY, SBP, MCS, SEABED SAMPLING
WORK DONE: 1300 KM^2 SURVEY + 200 KM^2 TRANSIT MULTIBEAM,
4900 KM SBP, 274 KM MCS
7 GRABS, 23 GRAVITY CORES (1 EMPTY), 5 SW CORES
25 CTD CASTS, 18 XBT

LOCALIZATION:

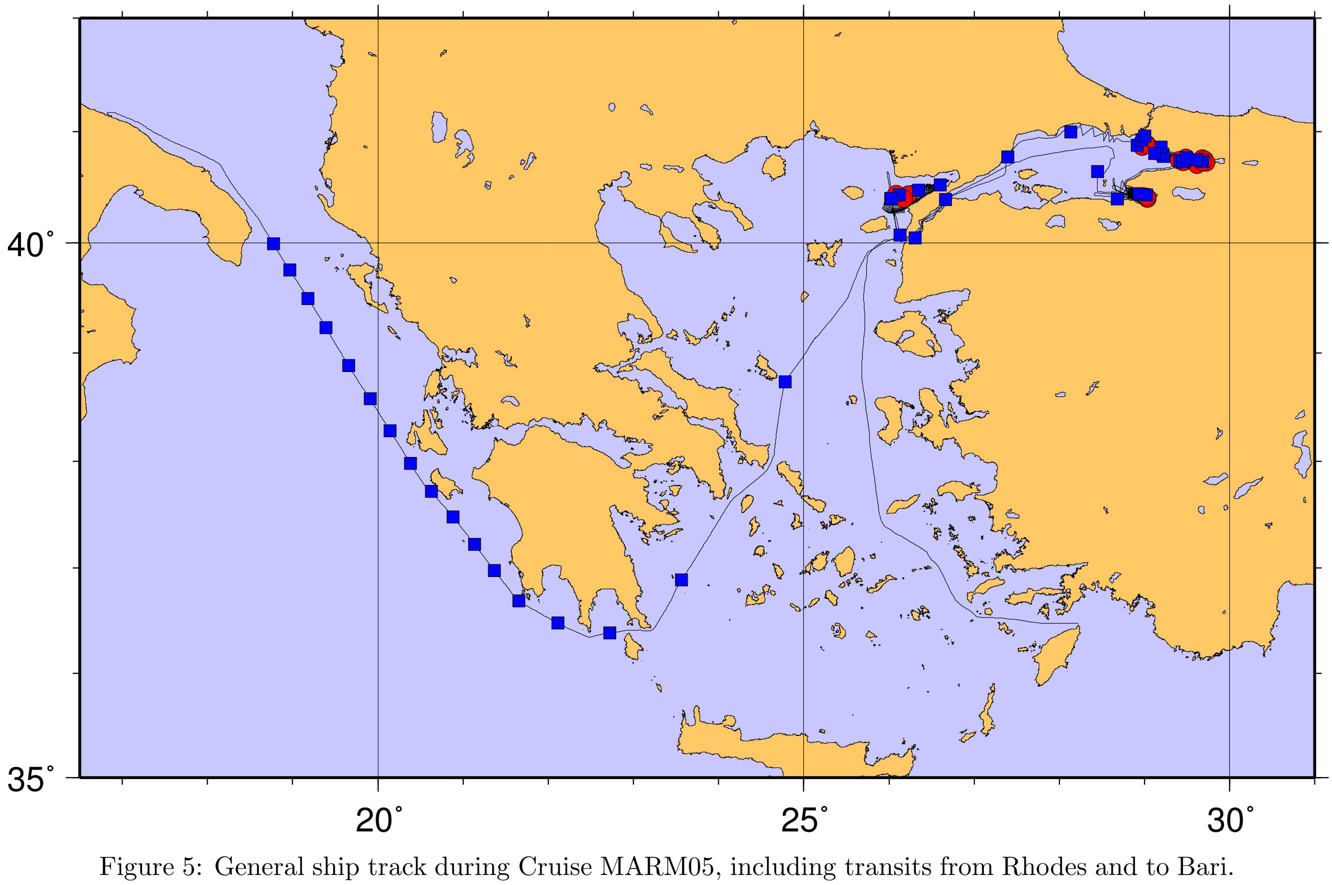

Figure 5: General ship track during Cruise MARM05, including transits from Rhodes and to Bari. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

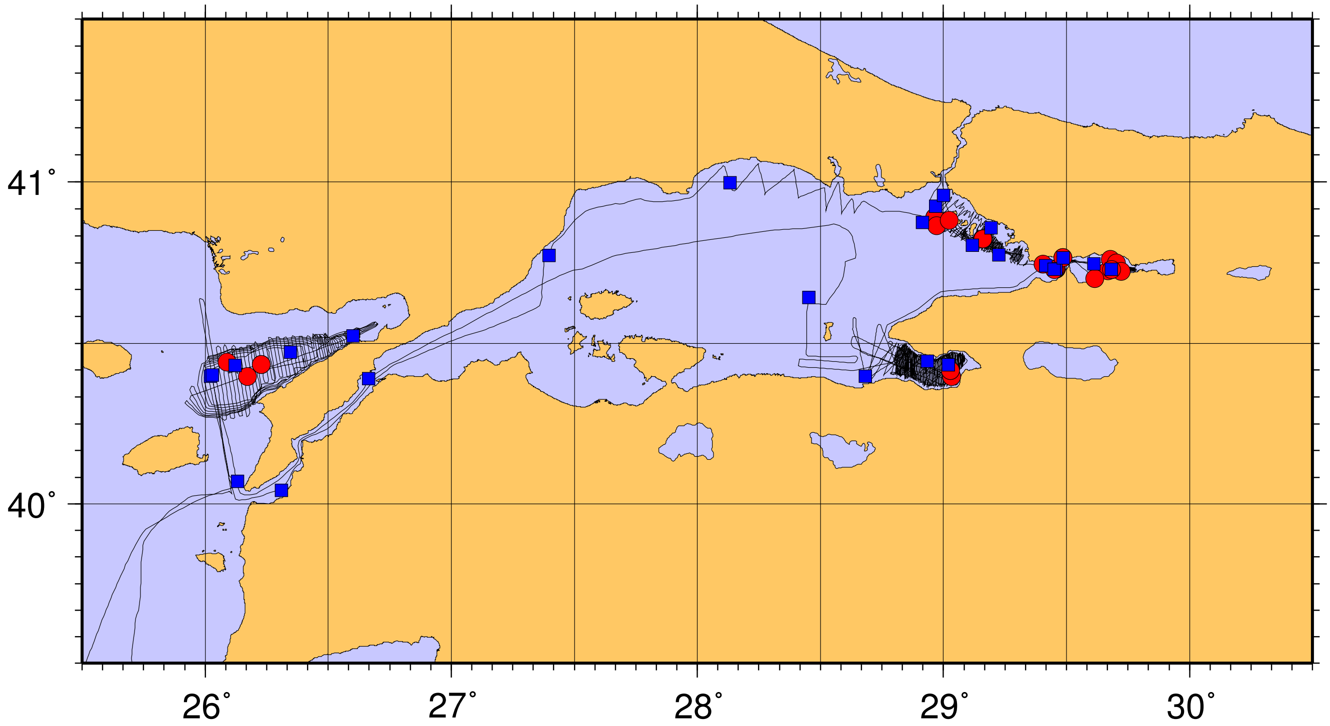

Figure 6: Ship track during Cruise MARM05 in the Marmara Sea and Gulf of Saros. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

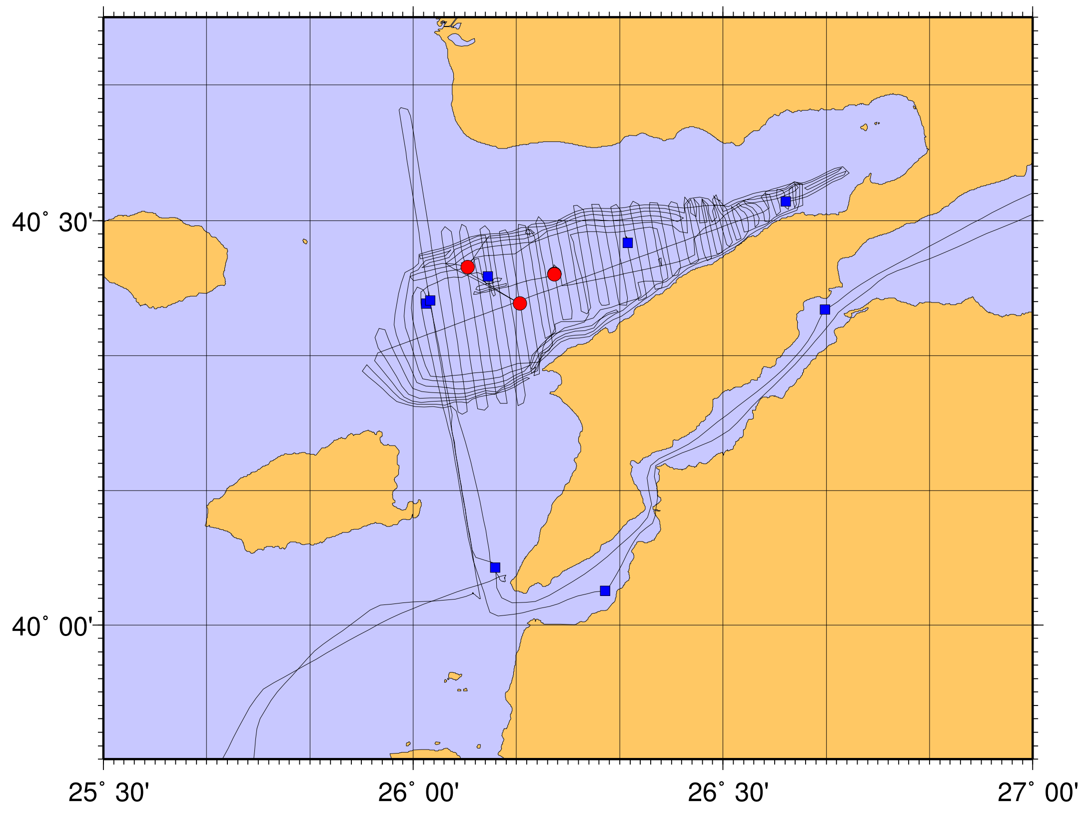

Figure 7: Ship track during Cruise MARM05 in the Gulf of Saros. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

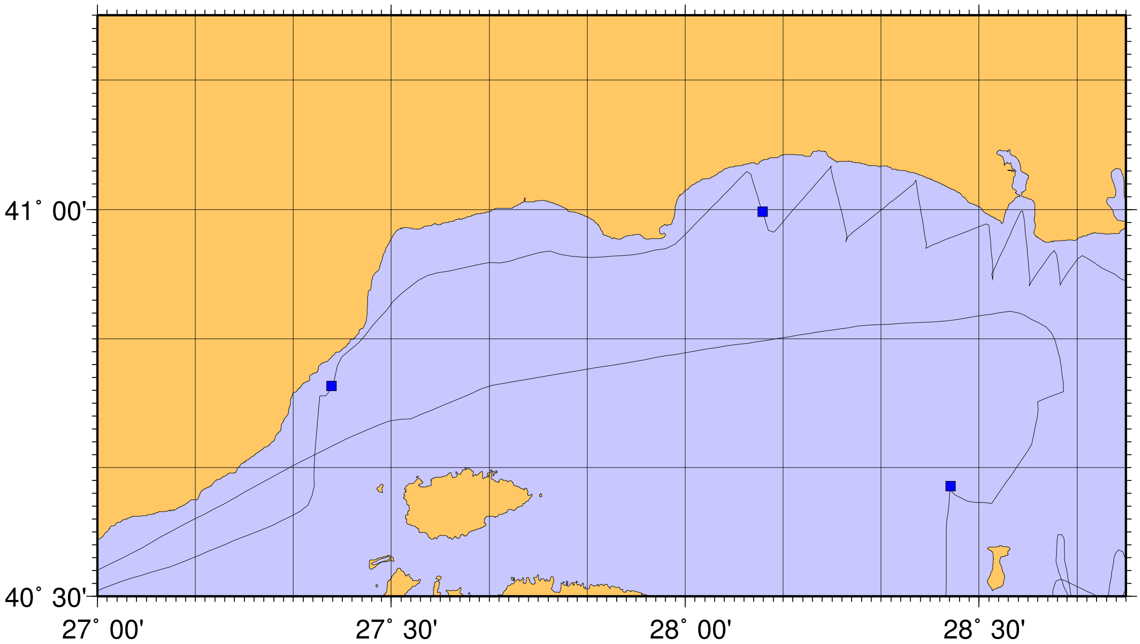

Figure 8: Ship track during Cruise MARM05 in western and central Marmara Sea. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

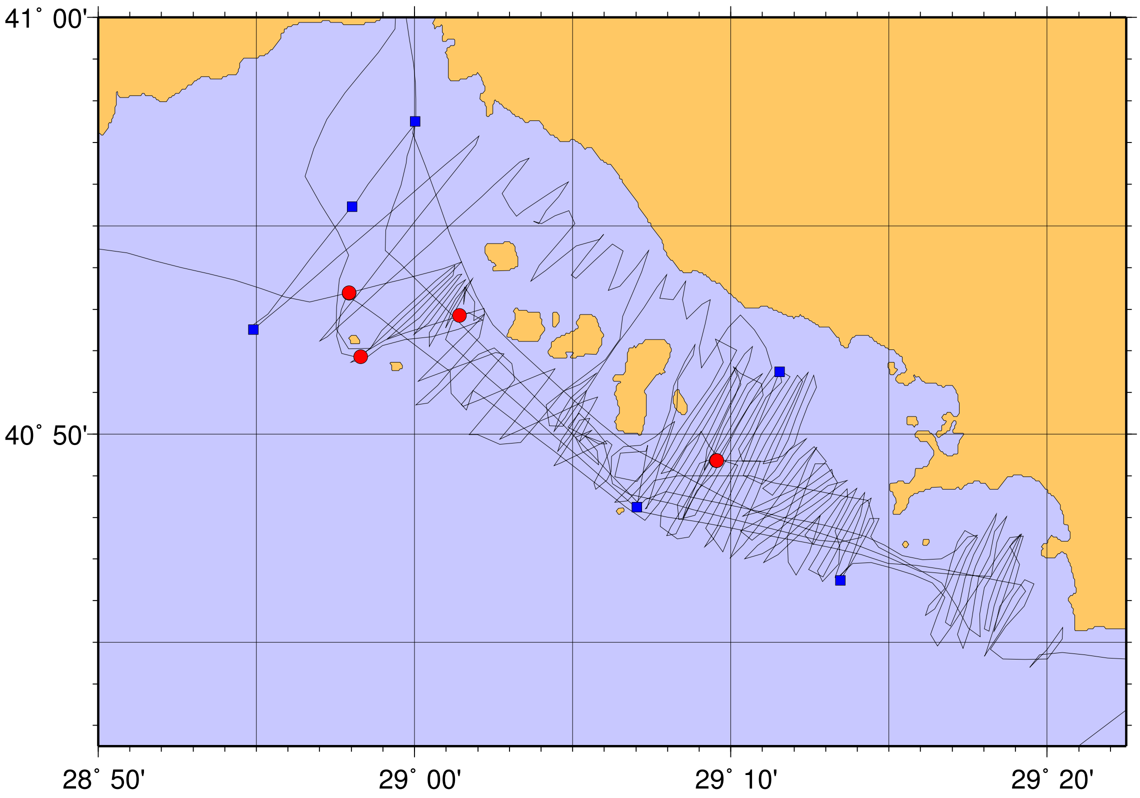

Figure 9: Ship track during Cruise MARM05 in the Princes Islands region. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

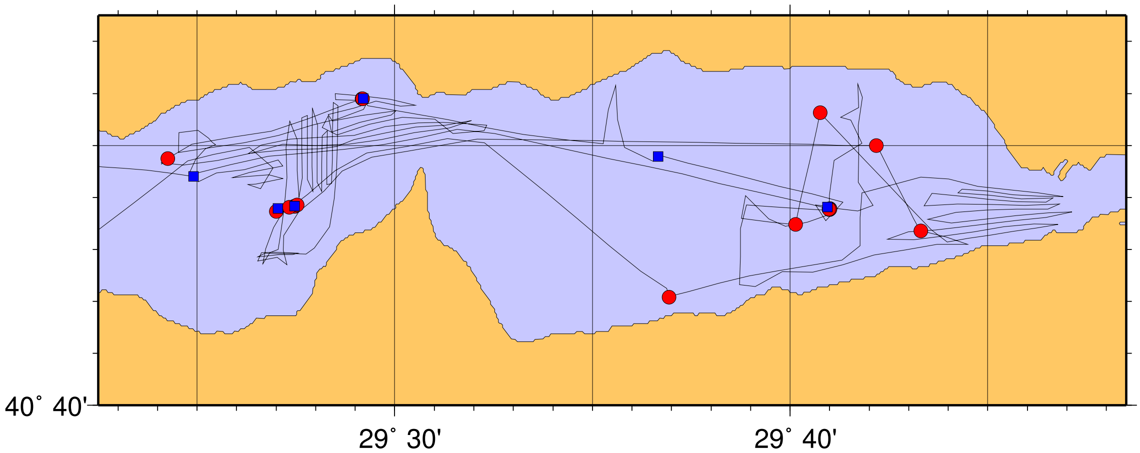

Figure 10: Ship track during Cruise MARM05 in the İzmit gulf. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

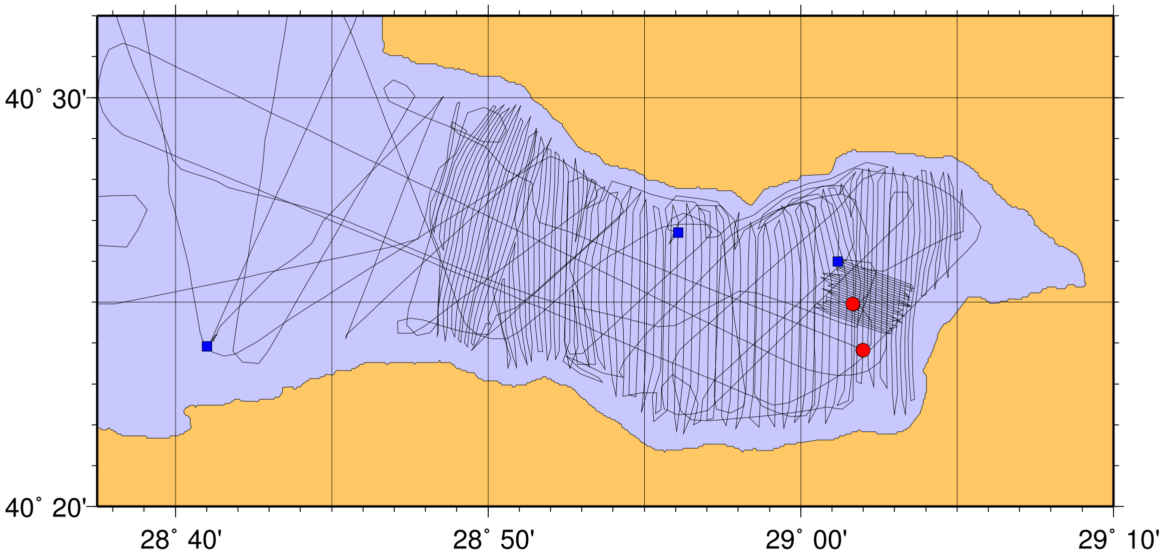

Figure 11: Ship track during Cruise MARM05 in the Gulf of Gemlik. The red circles are sediment samples (cores,grabs), the blue squares are CTD casts and XBT launches.

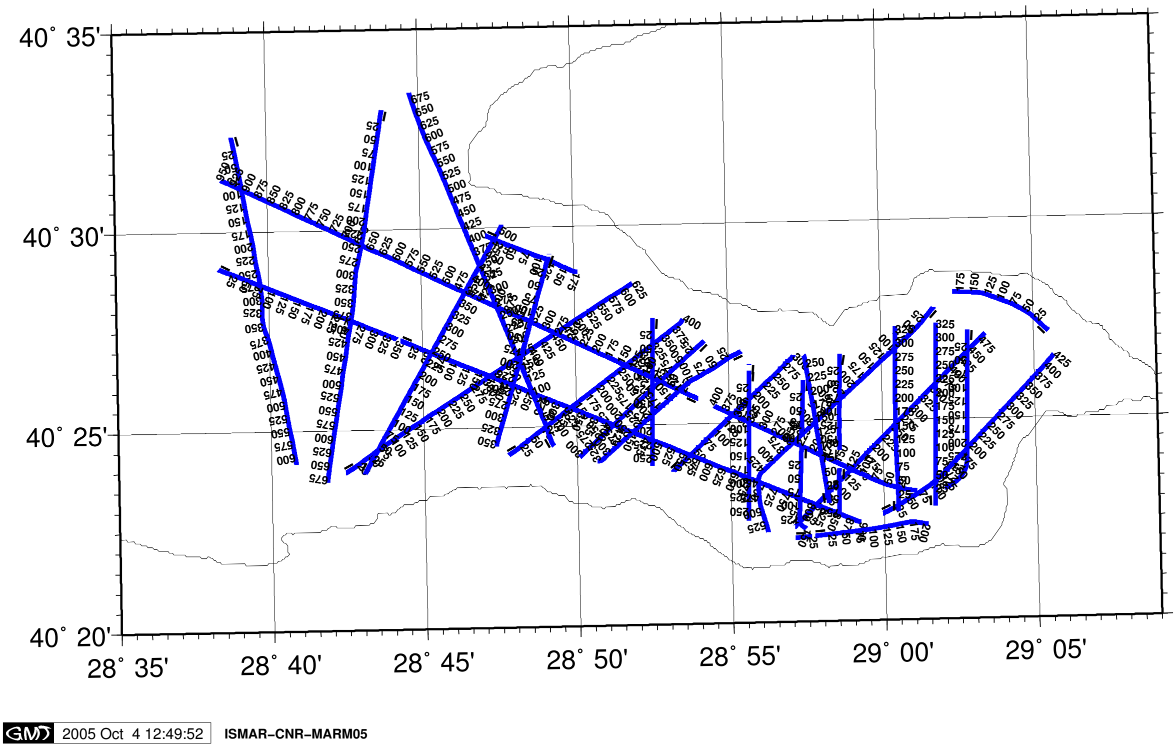

Figure 12: MCS Ship track in the Gemlik Gulf during Cruise MARM05.

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Table 2: Scientific and technical parties

SUMMARY OF OPERATIONS

The Italian staff boarded the *R/V Urania*in Rhodes, the afternoon 2005-09-08. Morning 2005-09-09 ship sailed N to Çannakale, where the Turkish staff joined the expedition late morning 2005-09-10. The operations on the Saros Gulf area started immediately after the departure from the Dardanelles, aiming to obtain a first bathymetric image and chirp SBP data on the Aegean strand of the NAF. Three corings by SW104 and some CTD casts were performed also. 2005-09-13 late afternoon ship moved to cross the Dardanelles and entered the Sea of Marmara morning of 2005-09-14, going to Gaziköyand performing chirp and multibeam investigations on the shelf to Siliviri and Büyükçekmece. The night of 2005-09-14 Urania sailed to the Princes Islands and Tuzla area, where continuous chirp SBP, multibeam and coring operations were performed up to late afternoon of 2005-09-17, when ship docked in Istanbul at the Cruise Ship Terminal at the Galata Bridge. On 2005-09-18 a press conference took place on board. After receiving fuel and provisions late afternoon we crossed the Bosphorus to SE to continue the Chirp and multibeam operations in the Tuzla area. On 2005-09-19 ship reached the Karamursel basin in the Izmit gulf, where it operated (multibeam, chirp and coring) up to the evening of 2005-09-20 when it moved SW bordering the Armutlu Peninsula toward the Gulf of Gemlik. Early afternoon of 2005-09-27 the operation in Gemlik ended after successful multibeam and chirp mapping, coring and MCS profiling, and ship directed W to the delta of the Kokasu R. and N to the İmrali Canyon and then W to the Dardanelles, that were crossed morning of 2005-09-28. Ship moved then to the Saros Gulf, to complete mapping and coring of the NAF. 2005-10-01, early in the morning ship anchored outside of the Dardanelles to disembark the Turkish team and get the clearance for leaving Turkey. Upon receipt of this latter, late morning ship sailed full steam SW to Greece and NW to Bari, where it docked 2005-10-04 late afternoon. Demobilitazion took place 2005-10-05 late morning. See in chapter 2 additional information on the cruise.

Figure 13: *R/V Urania*.

3 MATERIALS AND METHODS

The research cruise was carried out with the 61 meter *R/V Urania* (Fig.13), owned and operated by SO.PRO.MAR. and on long-term lease to CNR.

The boat is normally used for geological, geophysical and oceanographical work in the Mediterranean Sea and adjoining waters, including but not limited to, the Atlantic Ocean, the Red Sea, and the Black Sea.

*R/V Urania*is equipped with DGPS positioning system (satellite link by FUGRO), single-beam and multibeam bathymetry and integrated geophysical and oceanographical data acquisition systems, including ADCP, CHIRP SBP and other Sonar Equipment, other than water and sediment sampling. Additional equipment can be accommodated on the keel or towed.

3.1 NAVIGATION AND DATA ACQUISITION

The vessel was set-up for multibeam data acquisition and navigation with RESON PDS-2000 and COMM-TECH NAVPRO softwares. Two workstations were used forthe acquisition of

- (PDS-2000) multibeam data, interfacing by a multiserial and Ethernet link a RESON 8160 P1 processor, an TSS MAHRS MRU and FOG compass, DGPS receiver, by a MOXA Multi/serial I/O, TC/P and UDP network sockets;
- (NAVPRO) Microtecnica gyrocompass, Atlas Krupp's DESO echosounders, coring cable tension and the DGPS receiver, by a Digiboard Multi/serial I/O card.

The latter workstation also collected the navigational data every 5 minutes.

The MBES was the 50kHz, 126 0.5°, 150°aperture RESON 8160 (5000 m range). The sonar head is positioned on the ship's keel using a V-shaped steel frame. A sound velocity probe at the Sonar Head is interfaced directly to the MBES processor, thus providing the necessary real-time data for the beam-forming.

The datum WGS84 and the UTM, zone 35, were chosen for navigation and display purposes. Timing was set to UTC for data acquisition. The PDS-2000 production DTM was set to grid sizes ranging from 1 to 15-20m. The SBP-CHIRP workstation received positions trough an NMEA sentence by the DGPS receiver. The positions were therefore recorded on the XTF trace headers as lat/long of the DGPS antenna.

The instrumental offsets (PDS-2000) are presented in Fig. 14 and in Tab. 3

POSITION	ACROSS	ALONG	HEIGHT
REFERENCE	0.00	0.00	0.00
DGPS	1.64	14.30	14.18
MBEAM	0.00	14.36	-4.96
MAHRS	0.00	0.0	-3.40
CHIRP	-1.0	11.80	-4.00
CORER	6.5	-6.70	0.0
STERN	0.00	-30.60	0.00
STERN-LEFT	-4.00	-30.60	0.0
STERN-RIGHT	4.00	-30.60	0.0
GI-GUN ARRAY	4.0	-48.0	0.0
FIRST ACTIVE 48CH	0.0	-168.0	0.0

Table 3: Instrumental Offsets on Ship Urania (PDS2000). The GPS antenna (primary positioning system) is located on point DGPS.

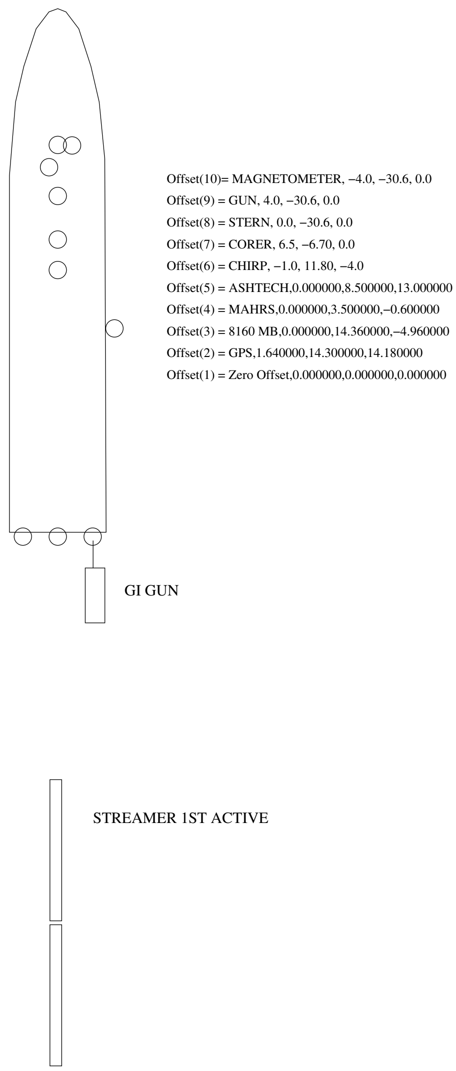

Figure 14: Cruise MARM05. Instrumental Offsets (PDS-2000) on *R/V Urania*

3.2 CTD AND SOUND VELOCITY DATA

CTD casts were taken throughout the surveyed areas, for sound velocity analysis.

The SV profiles were calculated from the data obtained by an SBE Mod.911Plus CTD probe, and were used for real-time MBES acquisition and post-processing. On the way to Italy, several XBT launches data were collected by a Sippican Mod. MK21 profiler.

The position of the CTD and XBT stations are reported in Table 4 and can be viewed in Fig.25 and in Fig.5, respectively.

STA	TYPE	DATE	TIME	LON	LAT
01	CTD	2005-09-10	13:07:07	29:27.47141	40:43.83070
02	CTD	2005-09-10	19:02:05	26:01.22762	40:23.86153
03	CTD	2005-09-12	06:59:54	26:20.79389	40:28.35575
04	CTD	2005-09-13	13:31:43	26:07.24548	40:25.85777
05	CTD	2005-09-13	18:18:54	26:18.58657	40:02.54983
06	CTD	2005-09-14	02:33:53	27:23.89720	40:46.34770
07	CTD	2005-09-14	08:03:10	28:07.90357	40:59.85091
08	CTD	2005-09-15	14:49:27	28:54.90	40:52.51
09	CTD	2005-09-15	16:04:28	28:58.03172	40:55.45593
10	CTD	2005-09-15	16:51:11	29:00.02000	40:57.50000
11	CTD	2005-09-15	20:20:07	29:13.45880	40:46.48178
12	CTD	2005-09-16	01:43:50	29:11.54539	40:51.49434
13	CTD	2005-09-17	09:04:01	29:07.02812	40:48.24146
14	CTD	2005-09-19	05:33:49	29:24.90426	40:44.40033
15	CTD	2005-09-19	09:12:32	29:40.94215	40:43.81161
16	CTD	2005-09-20	00:28:51	29:27.04539	40:43.78506
17	CTD	2005-09-20	12:12:14	29:36.66362	40:44.79052
18	CTD	2005-09-20	13:17:27	29:29.20431	40:45.90209
19	CTD	2005-09-21	03:31:26	28:41.01684	40:23.92210
20	CTD	2005-09-21	19:39:37	28:56.07572	40:26.69476
21	CTD	2005-09-25	03:35:00	29:01.18918	40:25.99417
22	CTD	2005-09-27	18:18:02	28:27.11113	40:38.57202
23	CTD	2005-09-28	06:38:19	26:39.88435	40:23.40980
24	CTD	2005-09-28	10:10:55	26:07.91391	40:04.25028
25	CTD	2005-09-28	13:16:00	26:01.66260	40:24.09326
26	CTD	2005-09-30	16:39:33	26:36.06081	40:31.41078
A1	XBT	2005-10-01	23:01:43	24:46.716	38:44.136
A2	XBT	2005-10-02	12:42:32	23:33.970	36:53.154
A3	XBT	2005-10-02	18:20:45	22:43.258	36:23.149
J1	XBT	2005-10-02	21:29:06	22:06.637	36:28.731
J2	XBT	2005-10-03	00:08:22	21:39.104	36:41.339
J3	XBT	2005-10-03	02:24:36	21:22.239	36:58.522
J4	XBT	2005-10-03	04:17:05	21:08.028	37:13.310
J5	XBT	2005-10-03	06:09:15	20:53.055	37:28.807
J6	XBT	2005-10-03	07:56:00	20:37.666	37:43.085
J7	XBT	2005-10-03	09:50:35	20:22.780	37:58.849
J8	XBT	2005-10-03	11:53:02	20:08.685	38:16.817
J9	XBT	2005-10-03	13:54:03	19:54.407	38:34.714
J10	XBT	2005-10-03	15:56:26	19:39.340	38:53.093
J11	XBT	2005-10-03	18:12:34	19:23.382	39:13.865
J12	XBT	2005-10-03	19:59:53	19:10.796	39:29.795
J13	XBT	2005-10-03	21:45:25	18:57.859	39:45.184
J14	XBT	2005-10-03	23:22:02	18:46.284	39:59.636

Table 4: Cruise MARM05: location of the CTD casts and XBT launches.

3.3 CHIRP SBP

SBP data was acquired by the 16 transducers, hull mounted BENTHOS (DATASONICS) Mod.CAP-6600 CHIRP-II profiler, with operating frequencies ranging between 2 and 7 kHz. The pulse length was mantained at 20 ms while the trigger rates varied from 0.25 to 1 and 2 seconds according to water depth. Digital data acquired by the Communication Technology SWANPRO software were recorded in the XTF format on local disks and transferred on the network upon request. Backups were loaded on DAT tapes and DVD. The navigation data was made available to the system as lat/long by NMEA sentences of the DGPS receiver at a rate of aproximately 1 Hz. The XTF data were then converted to SEG-Y by the Triton-Elics's Xtf2Seg software. This latter data were then input to the ISMAR's SEISPRO software [Gasperini and Stanghellini(2005)] for data processing and display. Since the SEG-Y converted positions were found to be truncated, the accurate position data were recovered from the XTF headers by routines developed at ISMAR, and re-input to SEISPRO. The operation was also useful to check data integrity, other than for producing the navigation map and database.

3.4 SEABED SAMPLING AND CORE LOGGING

The sea bottom samples were collected with 2.3 Ton gravity corer (Fig.15), the ISMAR's Mod.SW-104 water/sediment corer [Magagnoli A. and Mengoli M. (1995)] (Fig.16) and a 60L Van-Veen grab (Fig.17).

The sample locations are shown in Figg.7,9, 10 and 11 and are reported on Tab.5

Some of the cores were opened and described. All the cores were analyzed for magnetic suceptibility (2cm) using the ISMAR's automatic logger SAAS-01 by a Bartington loop sensor [Masini L. (2001)].

The volume magnetic susceptibility χ measures the capability of the material to become magnetized and to produce a noise in the inducing magnetic field, and can be used for stratigraphic correlations between cores and in the frequency analyses of temporal series to detect sedimentary cycles. Knowing χ (adimensional) and density, is it possible to determine the mass susceptibility. Minerals could be

- diamagnetic ($\chi << 0$),
- paramagnetic ($\chi >> 0$) e.g. iron and nickel,
- ironmagnetic ($\chi >>>> 0$) e.g. (a) iron oxides, like magnetite, hematite, ilmenite, maglemite, (b) iron hydroxides like limonite and goethite, and (c) sulfurs, such as pyrite.

The obtained χ data were corrected for the loop sensor diameter (10 cm or 12,5 cm) and the sediment thickness, cleaned, filtered and plotted against core depth.

The grabs and two core-catcher were washed, sieved and described.

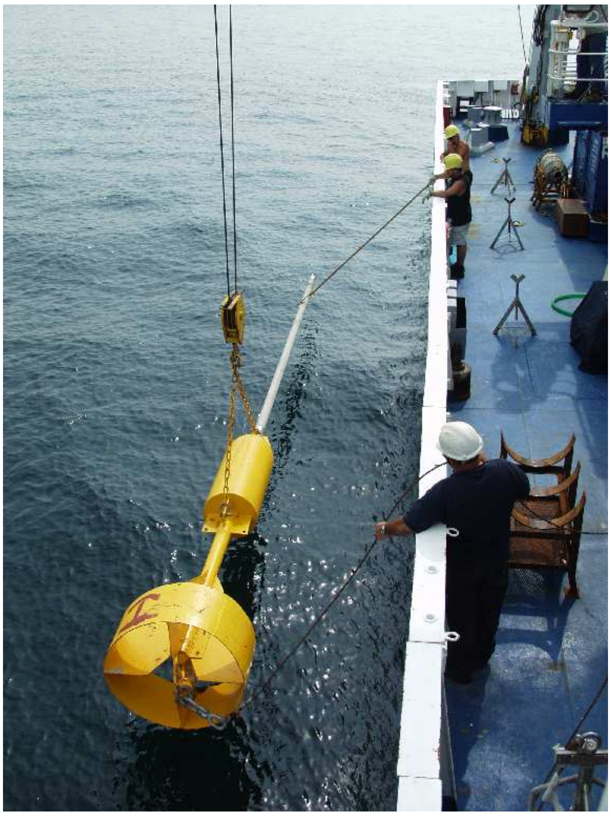

Figure 15: 2.3 T gravity corer.

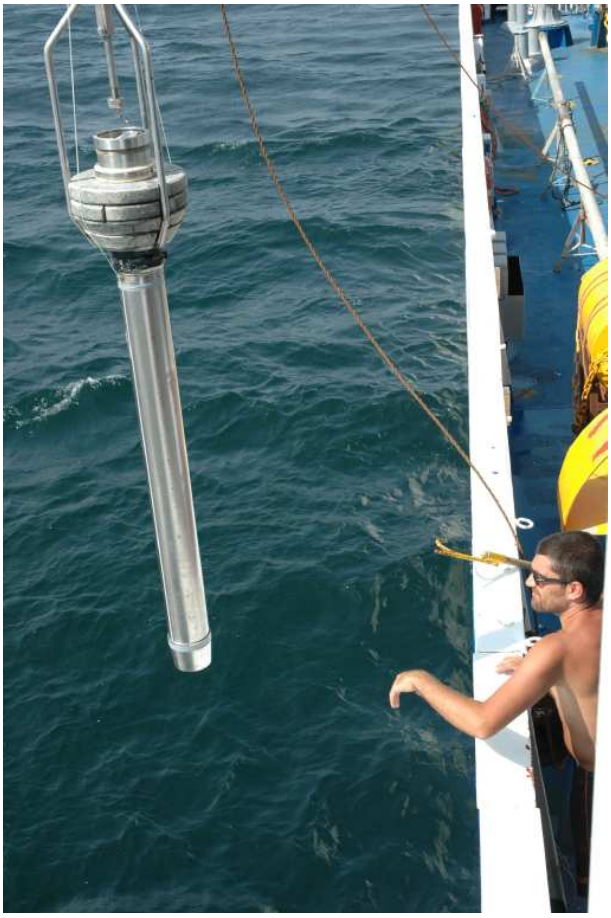

Figure 16: SW-104 water/sediment corer.

Figure 17: Sediments recovered with the 60L. grab.

STATION	TYPE	DATE	TIME	LON	LAT
SA-101	SW104	2005-09-13	05:46:55	26:13.68152	40:26.04119
SA-102	COR2	2005-09-13	06:56:52	26:13.69103	40:26.04936
SA-103	SW104	2005-09-13	08:17:33	26:13.67555	40:26.03650
PI-104	COR2	2005-09-16	06:21:49	29:09.54222	40:49.36678
PI-105	COR2	2005-09-16	07:04:32	29:09.54888	40:49.37142
PI-106	COR2	2005-09-16	08:02:38	29:09.55057	40:49.37111
PI-107	COR2	2005-09-16	11:29:59	28:57.92607	40:53.38996
PI-108	COR2	2005-09-16	12:13:49	28:57.93107	40:53.39460
PI-109	COR2	2005-09-16	13:07:02	28:58.29240	40:51.85500
PI-110	COR2	2005-09-16	14:15:47	29:01.42309	40:52.84784
IZ-111	SW104	2005-09-19	08:05:12	29:40.99199	40:43.77069
IZ-112	SW104	2005-09-19	08:48:28	29:41.01076	40:43.78409
IZ-113	SW104	2005-09-19	10:39:12	29:40.99589	40:43.77682
IZ-114	COR2	2005-09-19	11:41:50	29:41.00798	40:43.77287
IZ-115	COR2	2005-09-19	13:17:13	29:40.13402	40:43.47816
IZ-116	COR2	2005-09-19	14:09:59	29:40.76140	40:45.63010
01	GRA	2005-09-19	20:25:46	29:36.93581	40:42.08339
02	GRA	2005-09-19	21:46:00	29:27.47141	40:43.83069
03	GRA	2005-09-19	22:03:32	29:27.46081	40:43.83149
04	GRA	2005-09-19	22:35:25	29:27.46081	40:43.83149
05	GRA	2005-09-19	22:54:16	29:27.53270	40:43.85649
06	GRA	2005-09-19	23:26:32	29:27.33632	40:43.80858
07	GRA	2005-09-20	00:15:22	29:27.00764	40:43.73295
IZ-117	COR2	2005-09-20	07:41:06	29:42.18165	40:44.99639
IZ-118	COR2	2005-09-20	08:42:56	29:43.30675	40:43.36072
IZ-119	COR2	2005-09-20	10:53:08	29:40.98832	40:43.77744
IZ-120	COR2	2005-09-20	13:32:38	29:29.17731	40:45.90078
IZ-121	COR2	2005-09-20	14:10:05	29:29.18850	40:45.89901
IZ-122	COR2	2005-09-20	15:07:26	29:24.25779	40:44.75079
GE-123	COR2	2005-09-24	06:15:21	29:01.98169	40:23.82868
GE-124	COR2	2005-09-24	06:59:14	29:01.99450	40:23.82587
GE-125	COR2	2005-09-24	07:52:23	29:01.67126	40:24.94506
GE-126	COR2	2005-09-24	08:33:37	29:01.65890	40:24.95295
SA-127	COR2	2005-09-29	05:49:16	26:10.34994	40:23.85527
SA-128	COR2	2005-09-29	10:49:58	26:05.28425	40:26.56273

Table 5: Cruise MARM05: location of the sediment samples.

3.5 MULTICHANNEL REFLECTION SEISMIC

We employed high resolution Multichannel Seismic using a GI-GUN (in the 105+105 c.i. Harmonic configuration) pneumatic source by SODERA/SSI, powered by a 2500 L/Min electrically driven air compressor by BAUER. The seismic data were collected by a MOD.29500 TELEDYNE 48 channel streamer and digitized and recorded on DAT tapes by a GEOMETRICS's STRATAVISOR seismograph in the SEG-D 8105/Revision D format. The group interval was of 12.5m for a total active length of 600m. The 140m tow leader and two 50 m stretch sections made up the streamer to a total length of 840m. The seismic sources were fired by ISMAR's gun-control equipment [Masini and Ligi (1995)]. Shot distances at the speed of 4.2-4.7 Kn was set by the NAVPRO software every 25m, thus achieving a coverage of 600%. The depth of the source was at 3m, whilst the streamer was kept between 8m and 12m depth.

3.6 MISCELLANEOUS

The datum was set to WGS84 and the UTM, zone 35 was chosen for navigation and display, and data acquisition. The time zone was set to the UTC for the instrumental data acquisition. The positioning maps and bathymetric images were produced with GMT [Wessel and Smith (1995)]. The multibeam data were pre processed on board by the GMT software and ISMAR's routines and scripts, using the PDS-2000 production DTMS, after conversion to the ASCII format.

Bathymetric data were complemented by the GEBCO data. On-land SRTM topography data was used for mapping, structural analysis, after conversion to NETCDF GMT grid files.

The computing center employed three INTEL based PC running the SUSE GNU-Linux and the Microsoft Windows 2000 O.S., and one SUN workstations running Solaris 8, in addition to portable computer for data acquisition and personal processing. The Linux machines were used as data repositories using the SAMBA software, providing alse network services like WWW server, to share ongoing information and results, and DHCP and NAT.

Photographs and video were taken by digital cameras and video-camera.

4 INITIAL RESULTS

Initial results are presented, in order to address the importance of the preliminary findings and processing sequence of the data acquired.

4.1 BATHYMETRY

The grid of the multibeam lines acquired during the 22 days of operation in the study area are presented in Figures 7,9, 10 and 11.

A surface of approximately 1300 km^2 was covered in the surveyed areas during the cruise. Mapping on board was performed by using the PDS-2000 production DTM, converted to ASCII, filtered by ISMAR's routine `filter_bat`, gridded by the `nearneighbor` GMT routine. The latter grids were used for navigation and structural analysis.

Figures 18 and 19 show examples of the acquired bathymetric data.

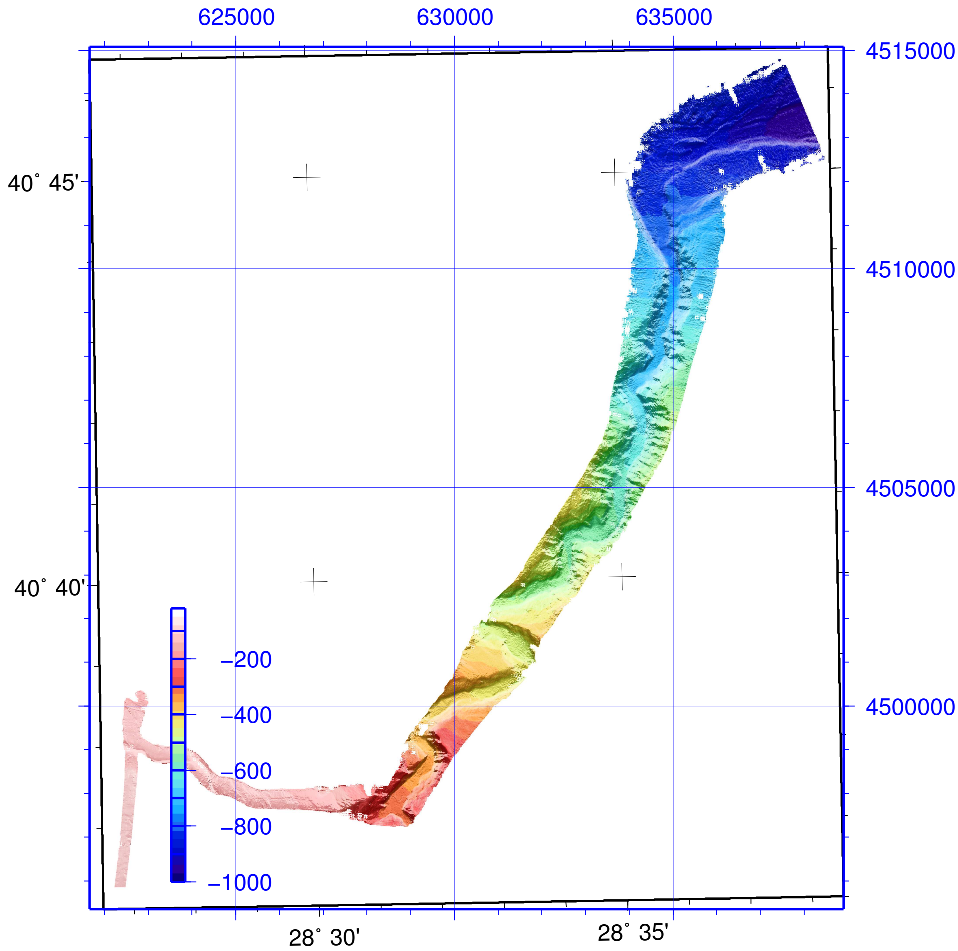

Figure 18: One multibeam swath over the Canyon N of the Imrali I.. Projection UTM-35.

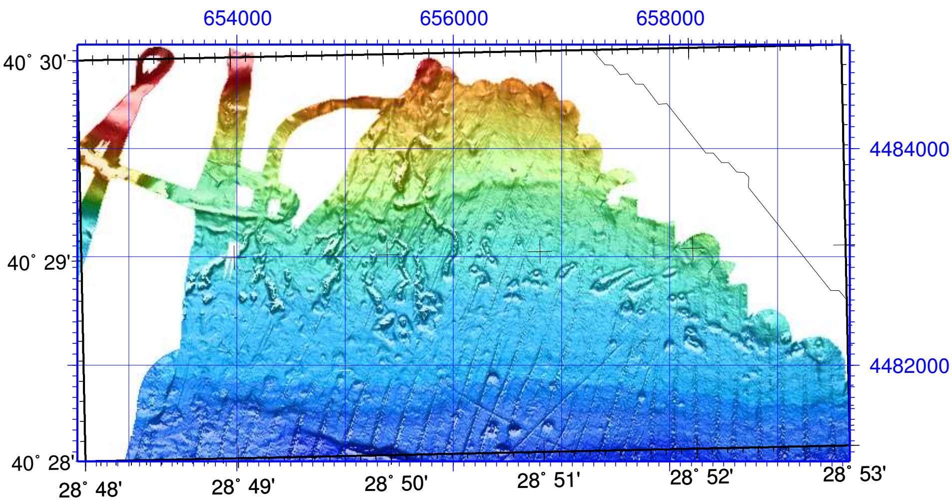

Figure 19: A field of dunes in Gemlik. Projection UTM-35.

4.2 SEABED SAMPLING

A total of 27 cores were recovered during the cruise. Some of them were opened and described (Fig.20) and described onboard. One of the SW-104 cores were split every 2cm and sampled. The grabs (Fig.21) were washed and described for shell and coral samples. Table 6 gives sampling information.

Tables 7 and 8 describe the sediment samples collected with the grab SW of the Hersek Delta and 2 core catches in Gemlik. Figure 22 presents the volume magnetic susceptibility data for the analyzed cores.

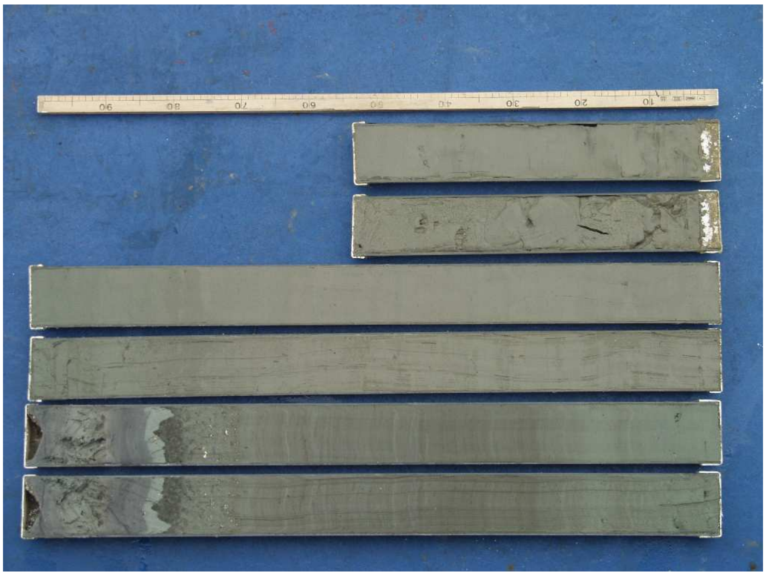

Figure 20: Example of a gravity core opened on board.

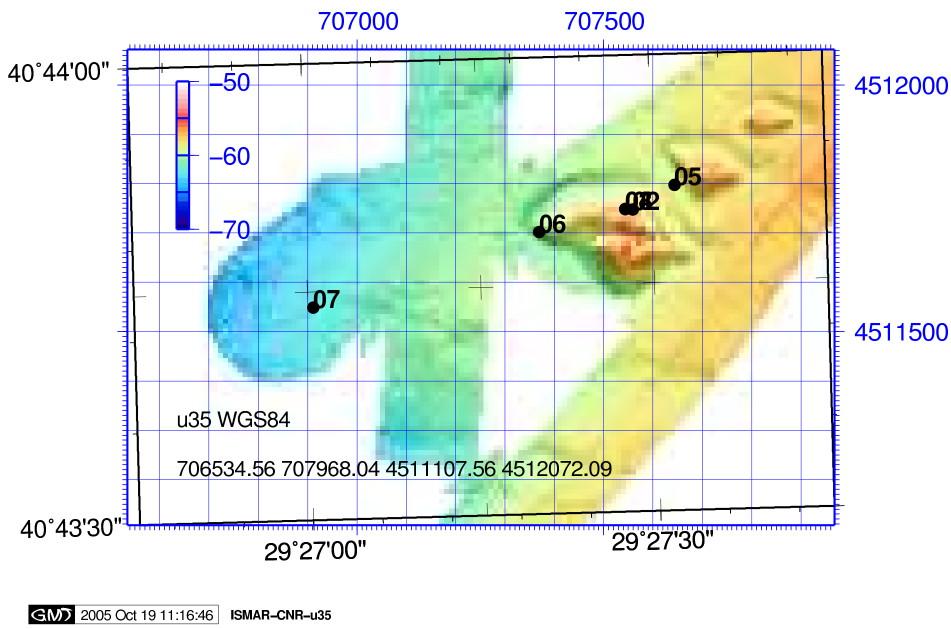

Figure 21: Gulf of Izmit. Grab location on "mounds".

CORE	TYPE	MOUNT	PENETRATION	REC.	SPEED	NOTES
SA-101	SW104	1x130	105	99	0.8	Extruded
SA-102	COR2	2x600	570	198	1.2	Opened/splitted to ITU-ISMAR
SA-103	SW104	1x130	105	99	0.8	To ITU
PI-104	COR2	1x400	370	210	0.8	To ITU
PI-105	COR2	1x400	360	236	0.6	To ISMAR
PI-106	COR2	1x600	400	225	1.0	To ISMAR
PI-107	COR2	1x600	475	374	1.0	To ITU
PI-108	COR2	1x600	462	372	1.1	To ISMAR
PI-109	COR2	1x600	600	355	1.15	Opened/splitted To ITU-ISMAR
PI-110	COR2	1x600	450	313	1.1	Opened/splitted To ITU-ISMAR
IZ-111	SW104	1x130	135	135	0.5	To ISMAR
IZ-112	SW104	1x130	133	132	0.4	Extruded
IZ-113	SW104	1x130	133	133	0.4	To ITU
IZ-114	COR2	2x600	1060	272	0.7	To ISMAR
IZ-115	COR2	1x600	600	229	0.33	To ITU
IZ-116	COR2	1x600	430	249	0.52	To ITU
IZ-117	COR2	1x600	700	250	0.80	Opened/splitted ToITU-ISMAR
IZ-118	COR2	1x600	550	207	0.34	To ISMAR
IZ-119	COR2	1x600	600	267	0.28	O pened/splitted ITU-ISMAR
IZ-120	COR2	1x600	250	152	1.25	To ISMAR
IZ-121	COR2	1x600	280	170	1.20	To ITU
IZ-122	COR2	1x600	200		1.0	Empty(gravel in catcher)bent at 0.5m
						saved sample outside pipe
GE-123	COR2	1x600	355	231	0.38	To ISMAR
GE-124	COR2	1x600	360	208	0.55	To ITU
GE-125	COR2	1x600	440	233	0.41	To ITU
GE-126	COR2	1x600	435	266	0.36	To ISMAR, P1 5cm polyst. at BOT
SA-127	COR2	1x600	660	363	0.30	To ISMAR
SA-128	COR2	2x600	1089	340	1.06	To ISMAR
						P1 2.5cm polystyrol at BOT (washed)

Table 6: Cruise MARM05: sampling notes for coring operations.

GRAB	DESCRIPTION	PALEONTOLOGY
01	Depth: 56.4 m., 65l of mud; the upper part (about 10 cm) is very organic mud (N2), plastic with some clasts and bio-clasts; lower part is less plastic mud (5GY 4/1) with molluscs (Turritella communis), woods, seeds and industrial scoria. A minicore was taken.	-bottom- *Cuspidaria rostrata, C.cuspidata, C.abbreviata, T.communis, N.cochlear, Miniacina mineata, serpulids, Nucula gr.hanley (N.sulcata-N.hanley), Timoclea ovata, Corbula gibba, Thyasira flexuosa, Scapharca demiri, Myrtea spinifera, Dentalium sp., Epitonium commune, Xilophaga dorsalis, Cardiomya costellata, Mangelia sp., Capulus ungaricus, Abra longicallus, Acteon tornatilis, Aequipecten spp., Kelliella abyssicola, Alvania spp., Cylichna crossei, Roxania(?) sp.* -top- *very similar assemblages less abundant species and specimens.*
02	Depth: 56.4 m. grab full, the upper 2 cm. are soapy brownish mud; the lower part is bioclastic mud with shell layers of N.cochlear and Chama gryphoides. Shell layers are 3-4 cm. thick, there are interbedded by 5-10 cm of mud. The colour is omogeneous in thickness (5Y 5/2). A minicore was taken.	*N.cochlear, C.gryphoides, Cuspidaria rostrata, C.cuspidata, C.abbreviata, Delectopecten vitreus, Saccella commutata, A.longicallus, Mathilda cochlaeformis, M.spinifera, Arca noae, Hiatella artica, Pododesmus sp., C.gibba, Pitar rudis, X.dorsalis, Plagiocardium papillosum, Dentalium spp., T.communis, Heliacus architae, Chlamys sp., Emarginula adriatica, A.tornatilis, C.crossei, Mangelia sp.*
03	Depth: 56.5 m; grab is full (similar grab 02) surface is very rich in organic matter, (5GY-5/2) very plastic with layer N.cochlear, living ophiura	*N.sulcata, T.comunis, T.flexuosa, A.longicallus, M.spinifera, C.gibba, Pododesmus sp., S.commutata, C.crossei, H artica, H. architae, M.mineata, Calliotropis ottoi, M.cochleaformis, Mathilda retusa, E adriatica, Cariophyllia sp., A.noae, C ungaricus, D. vitreus, Mangelia sp., X.dorsalis, P.papillosum, P.rudis, Venus sp., Dentalium spp., K.abissicula, Alvania spp., S.demiri*
04	Depth: 56.1 m; same of GRAB03; grab is full (similar grab 02) surface is very rich in organic matter, (5GY-5/2) very plastic with layer N.cochlear, living ophiura, crabs, octocorals	*Cariophylla sp., M.mineata, T.communis, A.longicallus, T.flexuosa, C.gryphoides, N.cochlear, C.gibba, Pododesmus sp., S.commutata, E.adriatica, Dentalium spp., M.cochlaeformis, C.crossei, C.ottoi, M.spinifera, H.architae, N.sulcata, C.cuspidata, C.rostrata, C.costellata, A.tornatilis*
05	Depth: 53.9 m; about 60l of mud, upper 10 cm. (10Y 4/2) are incoherent with a lot of bioturbation pocket; the lower part is plastic mud with molluscs like N.cochlear and polychaetes (5GY 5/2). A minicore was taken.	*Dentalium spp., C.gibba, C.gryphoides, Pododesmus sp., Rissoa sp., A.longicallus, T.flexuosa, S.demiri, M.spinifera, Nassarius sp., N.sulcata, T.communis, T.ovata, P.papillosum, S.commutata, A.noae, Cariophyllia sp., H.architae, Calliostoma sp., C.ungaricus, A.tornatilis, Chlamys sp., Aequipecten sp., M.miniata, C.rostrata, C.costellata, C.cuspidata, H.artica, C.crossei, Calyptrea chinensis*
06	Depth: 60.2 m; grab is full, plastic mud (5G 4/1) reddish on surface (about 1 cm. on surface), with bioturbation pocket with molluscs and living shrimp	*Mysella bidentata, T.flexuosa, C.gibba, M.spinifera, C.ungaricus, S.commutata, H.architae, T.communis, N.sulcata, T.ovata, P.rudis, S.demiri, C.rostrata, C.costellata, C.cuspidata, C.chinensis, A.noae, Pteria hirundo, H.artica, Cariophyllia sp., Nassarius spp., Dentalium spp., Epitonium spp., Mangelia spp.*
07	Depth: 62.4 m; about 60l of mud (5GY 5/2), the upper part is md with bioclasts, lower part is plastic mud	*Alvania sp., T.flexuosa, P.papillosum, Chlamys sp., A.longicallus, R.labiosa, M.spinifera, P.hirundo, N.sulcata, S.commutata, C.gibba, S.demiri, T.communis, C.crossei, Nassaris spp., Epitonium sp., H.architae, C.abbreviata, C.costellata, C.cuspidata*

Table 7: Cruise MARM05: grab description.

CORE	DESCRIPTION	PALEONTOLOGY
GE-124	core catcher, external tube; Sandy mud and fine sand, greysh, with marine and lagoonal malacofauna, partly reworked	*Turricaspia(?) sp., Didacna(?) sp., Monodacna(?) sp., Dreissena rostriformis, P.rudis, N.hanley, C.gibba, T.communis*
GE-126	core catcher; Fine sand and sandy mud, reddish, probably lacustrine facies or lagoonal, with caspian and mediterranean malacofauna, both rewoked.	*Theodoxius sp., Turricaspia(?) sp., Monodacna(?) sp., Didacna(?) sp., Hydrobia sp., D.rostriformis*

Table 8: Cruise MARM05: core catcher description.

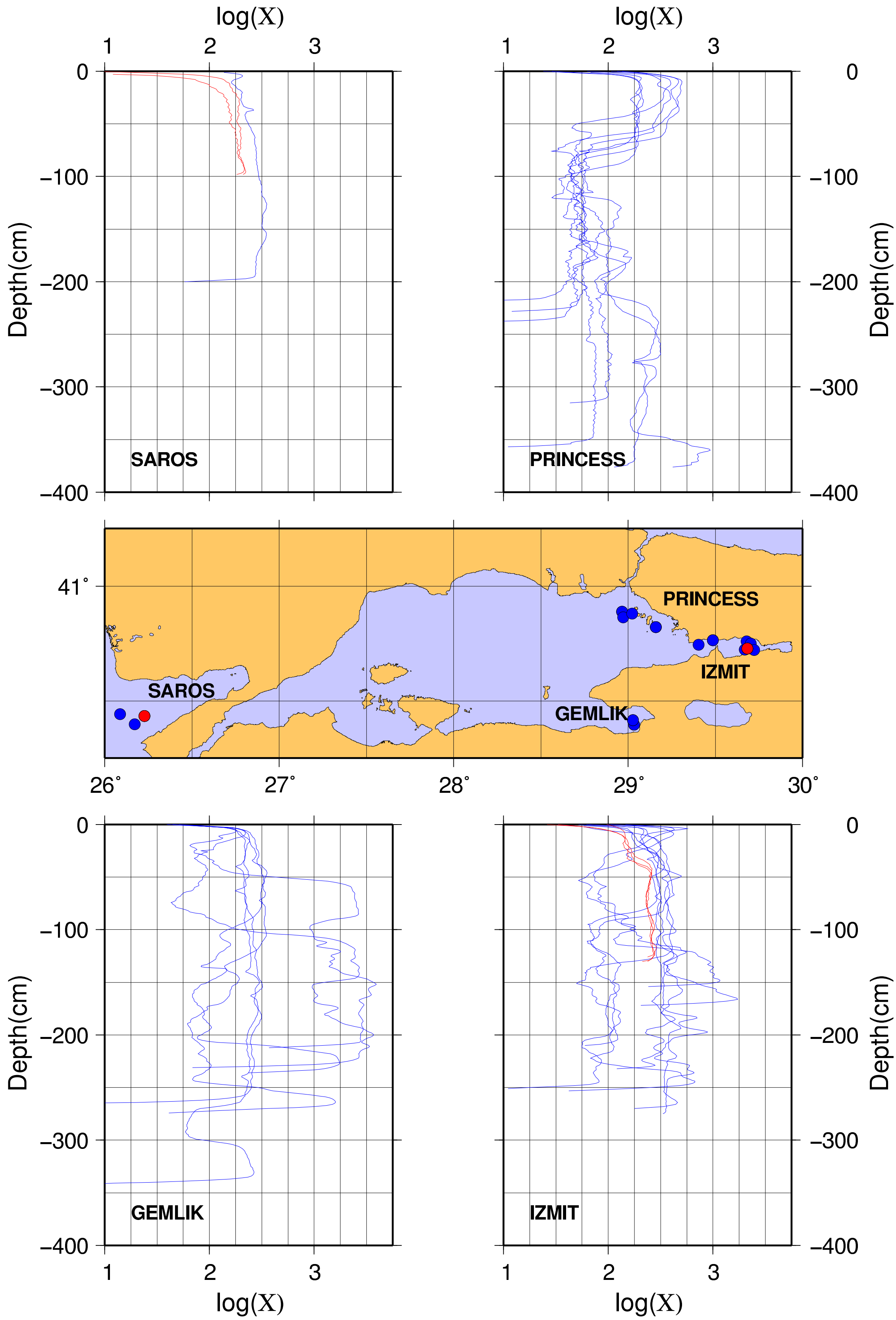

Figure 22: Magnetic susceptibility data of the cores. The red lines are the SW-104 corer data. Log10 of susceptibility data were taken for ease of confrontability for the different sampling areas.

4.3 CHIRP SBP

A quick processing with SEISPRO was made on board for navigation and geological target selection, other that structural and stratigraphical analysys. Example of the recorded and processed data are shown in Fig.23 and 24.

The data qiality ranged from good to very good, with penetration down to 40m. Two ultra-high resolution closely-spaced grid of profiles were performed in Gemlik and Saros Gulfs, to obtain information on NAF offsets and slip rates.

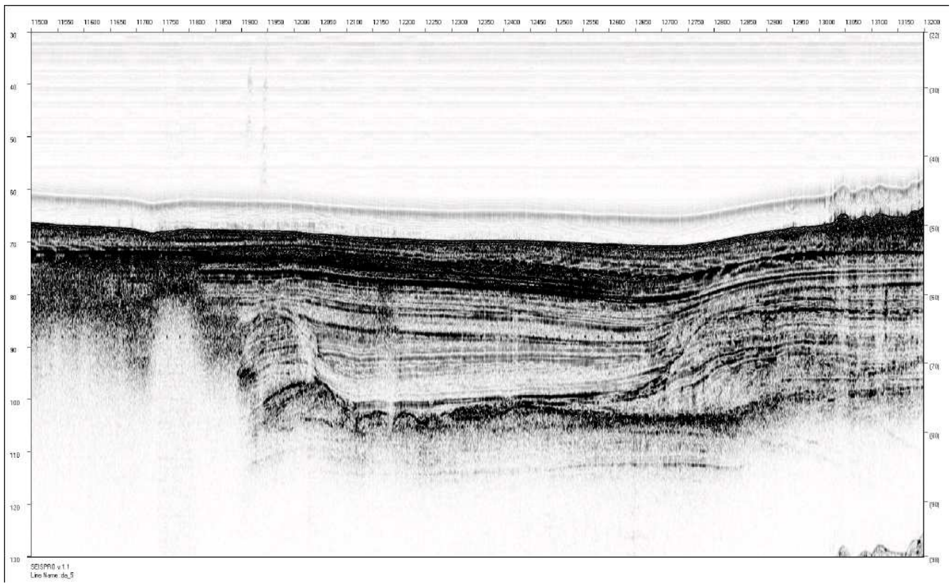

Figure 23: Example of SEISPRO SEG-Y SBP processed data.

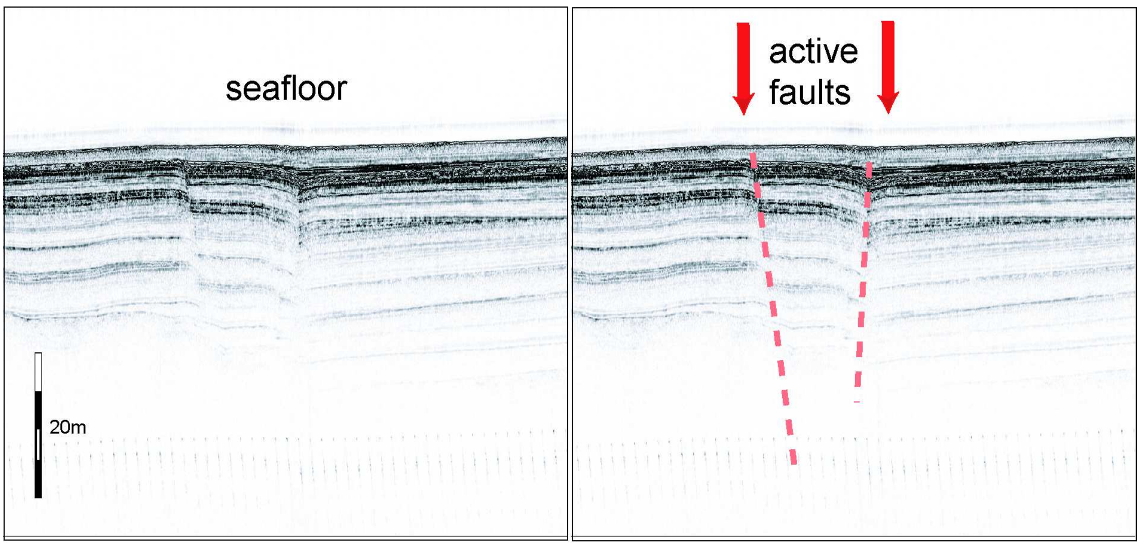

Figure 24: Example of SEISPRO SEG-Y SBP reprocessed data.

4.4 MULTICHANNEL REFLECTION SEISMIC

274 km of Multichannel lines were shot in the Gulf of Gemlik (Fig.12). All the lines underwent a preliminary QC processing on board, to obtain the neartrace and shot-gathers. One line was

stacked.

4.5 CTD AND SOUND VELOCITY DATA

Figure 25 shows the SV profiles, the TS diagram and location of the CTD casts, in Marmara and the Aegean Sea.

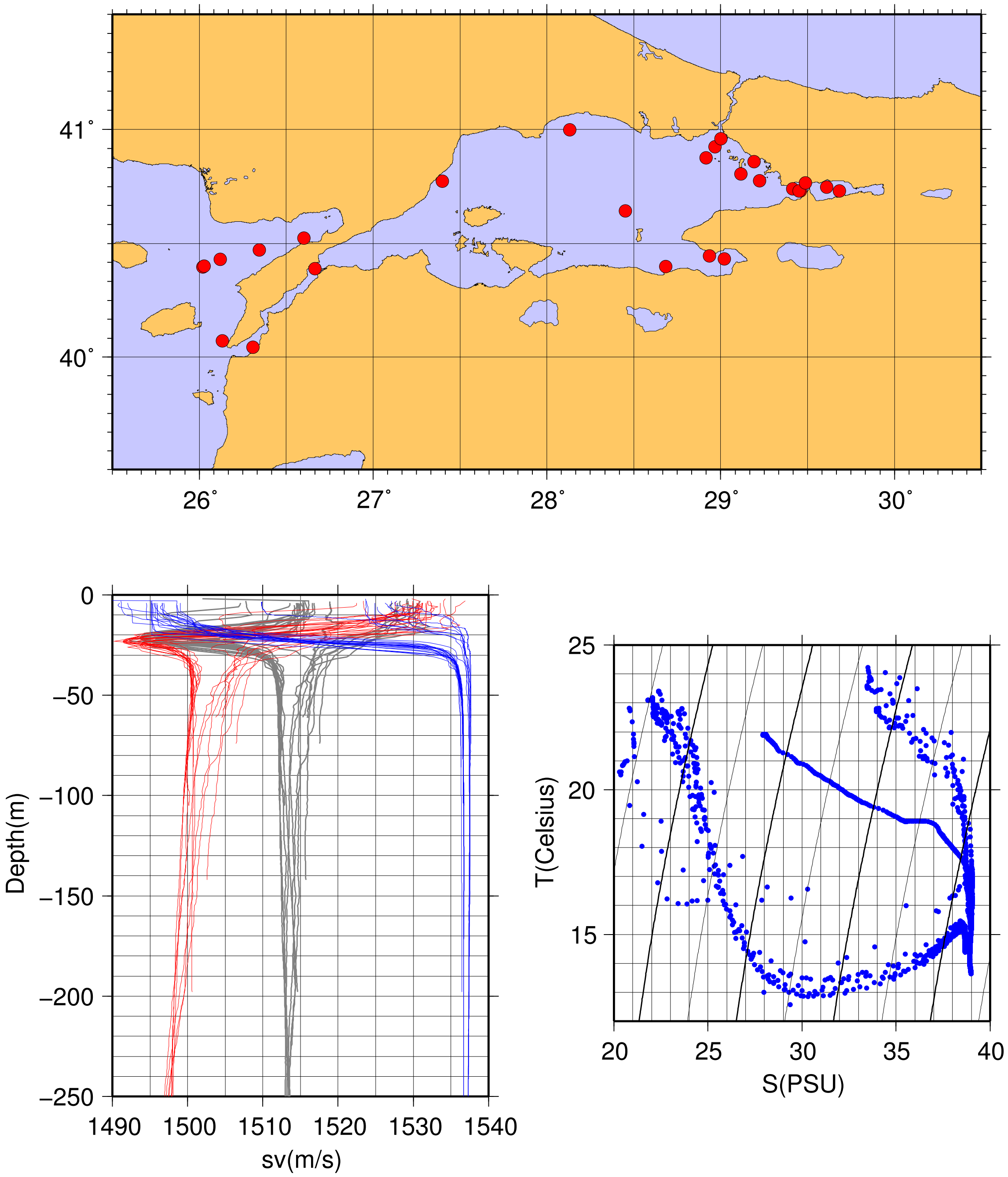

Figure 25: Cruise MARM05 CTD casts. Lower left: Sound Velocity(gray), T(red,12.5-25), S(blue, 20-40PSU). Lower right: TS diagram.

5 CONCLUSIONS

Analysis of the data collected during the MARM05 expedition is under process, and will continue during the forthcoming several months. However, because of the potential impact of our findings in term of earthquake risk assessment, and requests from IBB and other Turkish institutions, a preliminary data analysis was carried out on board of Urania during the cruise, for two areas: (a) the northern Marmara shelf in the Princes Island area, and (b) the Gulf of Gemlik, in the southern shelf.

During a 22 days (of total 27 including transits) cruise in the Marmara and NE Aegean Sea we obtained:

- high resolution bathymetric images and DTMs of the investigated areas (aproximately 1300 km^2).
- a detailed grid of high resolution CHIRP-SBP (ping rate 0.25,1,2s) profiles to examine fault traces and sedimentary processes (4900 km)
- high resolution MCS lines (274 km)
- bottom samples (28 cores, 7 grabs)
- water column CTD profiling

Multibeam swath bathymetry and chirp-sonar subbottom profiles have been processed and preliminarly interpreted to address the following tasks:

- identification of morphotectonic features related to the NAF;
- identify active faults;
- define a seismostratigraphic framework;
- look for ”piercing points” for slip-rate estimates along the main fault strand.

Preliminary morpho-structural maps compiled on the basis of these data show the presence of several active faults, outcropping at the seafloor (Fig.24). Strike-slip and dip-slip extensional segments oriented E-W and NW-SE, respectively, were observed.

Although a further processing and interpretation of the data is required to define strain pattern and deformation rates, we could observe that:

- the seafloor of the Princes Island shelf and of the Gulf of Gemlik is affected by diffuse faulting and fracturing, mainly due to transtensional deformation patterns possibly related to a left-stepping offset along the NAF;
- most of the faults observed appear to be active, as they displace the uppermost sedimentary sequence and, from place to place, the seafloor;
- some sedimentary features formed during the Last Glacial Maximum observed in the area appear also displaced along major fault strands; this occurrence will be analyzed for long-term strain rate estimates.

The data is under detailed processing and analysis, and we expect to have new insights into the geology of the investigated areas.

No problems were encountered regarding neither the people nor environment during the cruise.

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