CRUISE SUMMARY REPORT

CRUISE Name: BONIFACIO2011 **No:**
enter the unique number, name or acronym assigned to the cruise (or cruise leg, if appropriate).

CRUISE PERIOD start: 09/11/2011 to end : 23/11/2011
PORT OF DEPARTURE (enter name and country) **MESSINA (ITALY)**
PORT OF RETURN (enter name and country) **MESSINA (ITALY)**

SHIP Name: R/V URANIA **Call Sign:**
Type of ship: RESEARCH VESSEL
enter the full name and international radio call sign of the ship from which the data were collected, and indicate the type of ship, for example, research ship; ship of opportunity, naval survey vessel; etc.

RESPONSIBLE LABORATORY
enter name and address of the laboratory responsible for coordinating the scientific planning of the cruise

Name: IAMC CNR, U.O.S. ORISTANO
Address: LOC. SA MARDINI snc, TORREGRANDE (OR)
Country: ITALY

Name: IAMC CNR, U.O.S. MESSINA
Address: Spianata S. Raineri 86, 98122 Messina
Country: ITALY

CHIEF SCIENTIST(S) Name: MR MIRENO BORGHINI (ISMAR CNR U.O.S. LA SPEZIA)
DR ALBERTO RIBOTTI (IAMC CNR U.O.S. ORISTANO)
DRSSA GINA LA SPADA (IAMC CNR U.O.S. MESSINA)
enter name and laboratory of the person(s) in charge of the scientific work (chief of mission) during the cruise.

OTHER PARTICIPATING LABORATORIES
enter name and address of the participating laboratories, apart the responsible

Name: ISMAR CNR, U.O.S. LA SPEZIA
Address: Forte Santa Teresa, 19036 Pozzuolo di Lerici (SP)
Country: ITALY

Name: Utrecht University, department of Biogeochemistry, faculty of Geosciences
Address: Budapest laan 4, 3584 CD Utrecht
Country: THE NETHERLANDS

Name: Dip.Te.Ris., Genova University
Address: Via Balbi 5, 16126 Genova
Country: ITALY

OBJECTIVES AND BRIEF NARRATIVE OF CRUISE:

enter sufficient information about the purpose and nature of the cruise so as to provide the context in which the report data were collected.

Objectives

The cruise has been planned to reach the following objectives:

1. Water masses characteristics and biological structures

Several measurements along key sections localised inside and on the board of the central Mediterranean basin in order to define the main paths of the circulation and the physical-chemical-biological properties (temperature, salinity, dissolved oxygen, nutrients, chlorophyll, phytoplankton, primary production, etc) of the water upper, intermediate and deep central (Sicily Strait) and western (Tyrrhenian sea, Sardinia Channel, Algero-Provencal basin) Mediterranean water masses. Check of the diffusion of the new deep waters found during several cruises from 2005 to November 2011 in the Sardinia Channel area.

2. Validation of numerical models

Measurements will be used to validate four numerical circulation models implemented at IAMC-CNR in Oristano (SCRM32, WMRM). The two models at IAMC-CNR in Oristano are operational as they give daily forecasts for the following 5 days of the main oceanographic parameters (temperature, salinity, water and surface heat fluxes, currents, waves).

3. Exploration of microbial diversity in specific sites

Water analyses will be used to establish site-specific collections of highly specialized microbial strains and mixed microbial cultures, novel or improved enzymes, biosurfactants and other microbial products that can be exploited in general as well as in site-tailored intensified bioremediation approaches. The aim is to explore the microbial diversity associated to different polluted environments in the Mediterranean Sea searching new microbial resources to be applied for the bioremediation of matrices polluted with three types of pollutants, petroleum hydrocarbons, chlorinated compounds and heavy metals.

4. Methodological developments

- measurements of velocity profiles by Lowered ADCP and Shipboard ADCP;
- water sampling at different levels to explore microbial diversity;
- final coverage of the north-western Sardinian shelf through sparker acquisition.

Brief narrative

The cruise has been strongly influenced by bad weather conditions that has divided the cruise time in two periods with the following re-planning of the activities on-board. In the first period the stations in the Sardinia Channel have been realised to check the status of diffusion of the new deep water, the maintenance of the mooring in the Corsica Channel and other activities box corers on Marsili and Vector sites (southern Tyrrhenian Sea). In the second period, after the passage of the low pressure over the western Mediterranean, the MU* stations in the Algero-Provencal basin and the geophysical activities with the sparker on the north-western Sardinian shelf have been realised. Unfortunately neither the activities in the Bonifacio Strait nor the whole main transect between Balears and Sardinia have been realised. Station MU07 has been moved due to the missing of the permits from Tunisia.

PROJECT (IF APPLICABLE) if the cruise is designated as part of a larger scale cooperative project (or expedition), then enter the name of the project, and of organisation responsible for co-ordinating the project.

The cruise has been organised in the framework of the following projects:

- MyOcean, (EU IP);
- SOS-Bonifacio (Italian Ministry for Environment);
- MaGIC - Marine geohazard along the Italian coast (Dipartimento della Protezione Civile Nazionale);
- ULIXES - Unravelling and expLoiting MedIterranean Sea microbial diversity and ecology for XEnobiotics' and pollutantS' clean up (EU FP7).

PRINCIPAL INVESTIGATORS Enter the name and address of the Principal Investigators responsible for the data collected on the cruise and who may be contacted for further information about the data. (The letter assigned below against each Principal Investigator is used on pages 2 and 3, under the column heading 'PI', to identify the data sets for which he/she is responsible)

PI	name	Body	address	country	e-mail
A	MIRENO BORGHINI	ISMAR CNR	LA SPEZIA	ITALY	mireno.borghini@sp.ismar.cnr.it
B	ALBERTO RIBOTTI	IAMC CNR	ORISTANO	ITALY	alberto.ribotti@cnr.it
C	GINA LA SPADA	IAMC CNR	MESSINA	ITALY	gina.laspada@iamc.cnr.it

MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS

This section should be used for reporting moorings, bottom mounted gear and drifting systems (both surface and deep) deployed and/or recovered during the cruise. Separate entries should be made for each location (only deployment positions need be given for drifting systems). This section may also be used to report data collected at fixed locations which are returned to routinely in order to construct 'long time series'.

LEGENDA: R (recovery) D (deployment)

PI	Date, time	Latitude	Longitude	TYPE	DESCRIPTION
	18/11/2011, 14:00	40° – 37' - N	007°– 50' – E	G75	Acquisition of 150 Nm of high resolution single channel seismic data by using, as energy source, the Multitips Sparker device at 1 kJ. The seismic profiles were acquired between the outer shelf margin and the upper slope of the western Sardinia margin.
	20/11/2011 07:30	39° - 48' N	008°- 13' - E	G75	End of Seismic data acquisition

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

Except for the data already described on page 2 under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the cruise, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls).
Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) BT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc.
Each data set entry should start on a new line – it's description may extend over several lines if necessary.
NO, UNITS : for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

Table CTD casts list

Sampling type and institute: N = Nutrients; C = Box Corer/Benna; O = dissolved oxygen; S = salinity; E = marine microbic ecology; B = biomolecural analisys

Start CTD cast Date & Time (UTC)	Station	Lat [° 'N]	Long [° 'E]	Bottom [m]	Activity type
10/11/2011, 06:39	Tede1	38 29.9725	013 06.0170	2090	S, O
10/11/2011, 22:52	Canyon	38 38.3493	010 23.3062	2418	S, O
11/11/2011, 07:04	MU07b	37 50.2013	009 48.8252	1172	S, O, C, E, N, B
11/11/2011, 12:07	Acq05	38 22.7844	009 31.2553	2034	S, O
11/11/2011, 14:01	Acq04	38 21.8577	009 26.4338	2013	S, N
11/11/2011, 16:14	Acq08	38 24.725	009 35.5236	2054	S, N
12/11/2011, 06:48	51	39 46.4150	011 53.2510	3497	S, N
12/11/2011, 16:15	Vector	39 31.9908	013 22.2635	3445	S, O, N, B
12/11/2011, 19:46	Vector_pump	39 32.0619	013 22.2800	3447/3000	E
13/11/2011, 04:40	Vector_pump_50	39 32.0337	013 22.2889	3447/50	B
13/11/2011, 05:48	Vector_B	39 32.0462	013 22.2732	3447/300	S, O, N, C
13/11/2011, 14:50	Marsili	39 17.0352	014 26.7282	500	S, O, N
13/11/2011, 16:13	Marsili_bocca	39 17.2263	014 24.0020	625	
15/11/2011; 07:05	MU02	41 22.9923	006 27.8593	2688	S, O, C, E, N, B
15/11/2011; 14:04	MU02_Pump	41 22.9485	006 27.8520	2709/2222	C, E, B
15/11/2011; 23:12	MU02_Pump2	41 22.9963	006 27.8321	2710/2222	E
16/11/2011; 07:20	MU02_Pump-50	41 22.9370	006 27.799	2688/50	E
16/11/2011; 13:43	MU03	40 33.346	006 36.001	2829	S, O, N, B
16/11/2011; 23:21	S6	39 48.1505	005 24.3789	2823	S, O, N, B
17/11/2011; 03:27	S8/MU04	39 48.2007	005 48.8613	2842	S, O, N, B, C
17/11/2011; 10:44	S12	39 48.1829	006 36.592	2853	N
17/11/2011; 16:20	S16	39 48.172	007 23.7603	2766	S, O, C, B, N
17/11/2011; 21:45	S18	39 48.1655	007 49.0152	1642	O, N

On-board operations

CTD casts

At all the 24 hydrological stations (with two repetitions) pressure (P), salinity (S), potential temperature (θ) and dissolved oxygen concentration (DO) were measured with a CTD-rosette system consisting of a CTD SBE 911 plus, and a General Oceanics rosette with 24 12-l Niskin Bottles. Temperature measurements were performed with a SBE-3/F thermometer, with a resolution of 10-3 °C, and conductivity measurements were performed with a SBE-4 sensor, with a resolution of 3 x 10-4 S/m. In addition, dissolved oxygen was measured with a SBE-13 sensor (resolution 4.3 μM), and data were checked against Winkler titration. The vertical profiles of all parameters were obtained by sampling the signals at 24 Hz, with the CTD/rosette going down at a speed of 1 m/s. The data were processed on board, and the coarse errors were corrected.
CTD data have been acquired also by two IDRONAUT probes put on the rosette whose data, starting from station MU07, have been compared with those from SBE.

Laboratory: ISMAR CNR, IAMC CNR

Nutrients

Seawater samples for nutrient measurements were collected at different depths, when the system CTD /rosette was going up, according to the vertical profiles of salinity, potential temperature and dissolved oxygen, recorded in real time. Samples of 100 ml of seawater were collected at different depths and immediately filtered through a polycarbonate filter (0.47 μm Ø and pore size 0.4 μm) under slight vacuum. The filtered samples were transferred in 20 ml polyethylene vials and frozen at -20°C. The analysis of inorganic nutrients will be performed in the laboratory on land by the AutoAnalyser AAIII Bran+Luebbe (Grasshoff,1999).

- Not filtered 60 ml bottles and immediately frozen at -20°C

Laboratory: IAMC CNR, ISMAR CNR

Acquisition of seismic data

About 200 nM of high resolution single channel seismic data have been acquired by using, as energy source, the Multitips Sparker device at 1 kJ. The seismic profiles were acquired between the outer shelf margin and the upper slope of the western Sardinia margin in order evaluate the geological structures related to specific seabed morphologies revealed by multibeam data. Those features include giant pockmarks, buried canyon head and outcropping volcanic bodies. Seismic data integrated previous geophysical, sedimentological and stratigraphic data in the framework of the research programs of IAMC on the western and northern Sardinian margin.

Laboratory: IAMC CNR

Isolation and caracterization of HCB (Hydrocarbonoclastic bacteria).

Hydrocarbonoclastic bacteria (HCB) uses hydrocarbons as carbon sorce, they are ubiquitarian in marine water and becam dominants within 10-15 days, in oil contaminated areas.

Their effectiveness in degradation is strongly influenced by the concentration of nutrients.
The study of this natural process, said bioremediation, has as its aim the use of these bacteria as natural baghouse, thus avoiding the negative effects of chemicals.
During the cruise superficial, deep waters and sediments were sampled to perform the following analysis: Policiclic Aromatic Hidrocarbons (PHA) analisys; nutrient concentration; isolation of HCB communities; microbic caracterization; richness DAPI counts.

Laboratory: IAMC CNR

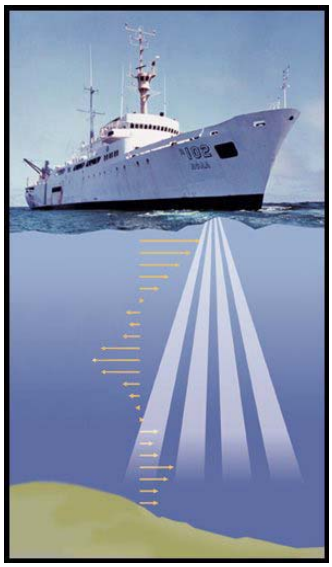
LADCP

Two Lowered Acustic Doppler Current Profilers (LADCP) were used to measure velocity profiles. We used two RDI Workhorse 300 kHz ADCP. For data post-processing we used the LDEO LADCP (versione 8.1) software.

Laboratory: ISMAR CNR

Vessel-mounted ADCPs

The hydrographic data set has been integrated with direct current measurements. During the whole campaign two VM-ADCPs (RDI Ocean Surveyor, 75 kHz, and RDI Workhorse, 300 kHz) which operated during the whole campaign, along the whole ship track. The depth range of the two current profilers is about 700 m (OS75) and 150 m (WH300). Data acquisition is carried out using the RDI VMDAS software vers. 1.44. The ADCP data will be submitted to a post-processing with the CODAS3 Software System, which allows to extract data, assign coordinates, edit and correct velocity data. Data will be corrected for errors in the value of sound velocity in water, and misalignment of the instrument with respect to the axis of the ship.



Laboratory: ISMAR CNR

Characterisation of the deep-sea microbial comunity and investigation of their carbon sources

Thaumarchaeota belong to the Archaea, which form one of the three Domains of life, next to the Eukarya and the Bacteria. They are an ubiquitous component of marine plankton, being among the most widely distributed and most abundant groups of microorganisms on the planet; Taumarchaeota even exeed Bacteria in abundance below 1000 m waterdepth. Nevertheless, our understanding on their physiology and their biogeochemical function remains mostly speculative because only very few of these organisms could be cultivated.

The aim of this project is 1) to characterise the microbial community in the deep-sea using lipid biomarkers for bacteria, archaea and eukaryotes, 2) to investigate the carbon sources for these organisms using compound specific ^{13}C and ^{14}C analyses and 3) to elucidate the flow of carbon in deep-sea microbial communities using ^{13}C labeling studies.

Laboratory: ***Utrecht University***

Discrepancy analisys

Several studies have shown that Crenarchaeota play a key role in nitrogen (N) and carbon (C) clycling.

The purpose of our sampling is to investigate the temporal variation of known crenarchaeal target genes related to autotrophy (acetyl-CoA carboxylase-***accA***; 4-hydro- xybutyryl-CoA dehydratase -***4-hbd***) and ammonia oxidation (ammonia monooxygenase -***amoA***).

In order to reach our goal, deep and minimum oxigen zone (MOZ) waters has been sampled, dark incubated and filtered at temporal interval of T_0, 24h, 72h and 7gg. The filters has been incubated in RNA later (24h 4°C) and then frozen to -20°C.

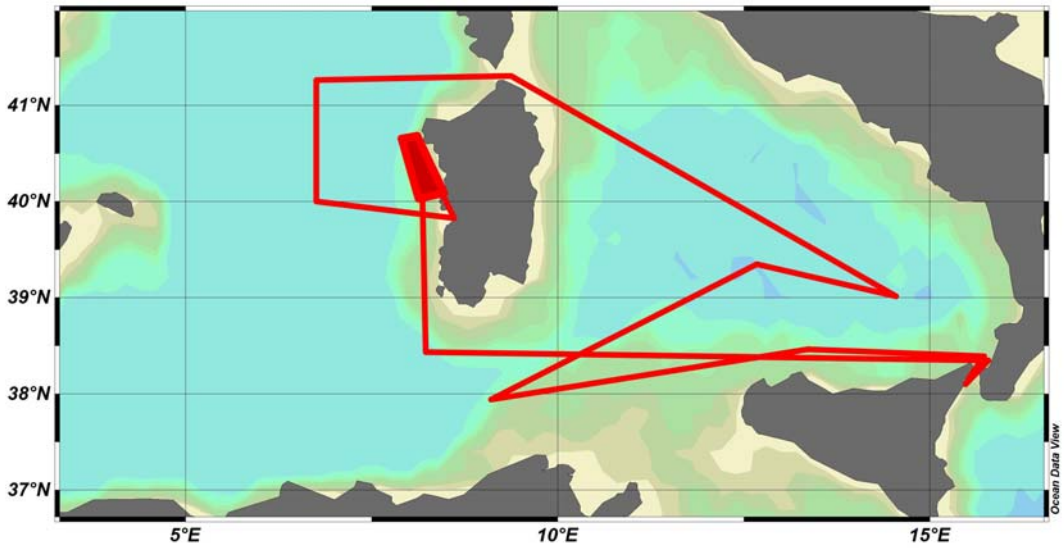
Biomolecular analisys will be performed in IAMC laboratories.

Laboratory: IAMC CNR

TRACK CHART

You are strongly encouraged to submit, with the completed report, an annotated chart illustrating the route followed and the points where measurements were taken.

The geographical limits of the study area are 38.00°N - 42.00°N of latitude and 6°E – 16°E of longitude. Due to bad sea conditions, the expected sampling plan has been partially reorganised (see pictures). Sparker activities has been realised in the north-western part of Sardinia (red area on the pitcure).



GENERAL OCEAN AREA(S) :

Enter the names of the oceans and/or seas in which data were collected during the cruise - please use commonly recognised names(see, for example, international Hydrography Bureau Special Publication No. 23, iLimits of Oceans and Seas').

TYRRHENIAN SEA
SARDINIA CHANNEL
ALGERO-PROVENCAL BASIN
SARDINIAN SEA

SPECIFIC AREAS

if the cruise activities were concentrated in a specific area(s) of an ocean or sea, then enter a description of the area(s). Such description may include references to local geographic areas, to sea floor features, or to geographic coordinates.

Please insert here the number of each square in which data were collected from the below given chart 143, 179

The Mediterranean sea is a semi-enclosed sea at medium latitudes. Some fundamental processes for the general circulation of the oceans (ex. deep water formation) happen or are given by such sea. The salty waters in the Atlantic, exiting from the Mediterranean, cn influence the water formation processes, the variability and also the equilibrium state of the global thermohaline circulation, a mechanism by which large amounts of heat are exchanged inside and through the basins. The global thermohaline circulation has a fundamental role in contributing in the stabilization of the climatic system. The Mediterranean circulation, in the western basin, is forced by the wind stress, by the general floating forces generated by the heat and fresh water fluxes at

the air-sea interface. The geography of the western Mediterranean is really complex with a really complex deep morphology and a distribution of its coasts, a variety of islands, straits, channels and openings. The exchanges through the different basins depend on the morphology of these straits, channels and openings. Due to a complex topography and geometry and of the high external forcing variability, the response time of the water masses and the spatial and temporal variability scales of the currents are really short than the oceanic ones. The recirculation time of the particles, inside the deep water formations areas, is around a hundreds years at Mediterranean scale, a really short climatic scale if compared with the Atlantic temporal scales of millenniums. The general view that grows up is that of a Mediterranean climatic system always interacting with the atmosphere that stores the information of the changes at the air-sea interface and modifies currents at the abyssal depths. This allows the Mediterranean, and then its western basin, to "react" really quickly to the changes of atmospheric forcing and then to be a "sensor" of the Earth climate. The study of the functioning of marine ecosystems and their response to external forcing is then controversial because really complex. The hydrological characteristics of the different water masses behave differently following depth and geographic position with different modifications in act. In the 30's two different behaviours have been observed, a constant increase in temperature and salinity in the deep and intermediate levels of the western Mediterranean and a more complicated variability of the eastern basin, followed by the climatological transient. What is sure it is then the observation of a phenomenon in the yearly '90s that, due to its dimension and speed, is one of those events characterised by a strong discontinuity: the so called climatological transient. This transient shows as the collapse of a system apparently stable can happen suddenly. In a few years the vertical structure of the basin has been completely modified. The possible reasons of the climatological phenomenon in the eastern basin have been widely described in the specialised literature (Malanotte-Rizzoli et al., 1999; Demirov and Pinardi 2002, Rupolo et al, 2003). This anomaly begun to propagate in the western basin (Schroeder et al., 2006; Schroeder et al., 2007, Schroeder et al., 2008). Actually it is difficult to forecast the effects of such an anomaly in the western Mediterranean even if the long times of run of the intermediate waters in the western basin probably will contribute to absorb it decreasing its effects. Vice versa the occurrence of such a phenomenon has underlined once more as the balances of a complex system can be strongly modified also by small variabilities of one of its components.

The temporal analysis of the analysed data does not permits to understand if these oscillations are characteristics of a natural state of the basin or, viceversa, if they represent an anomalous situation.

The cruise is part of a strategy for the periodic monitoring of this new hydrodynamic regime in order to evaluate the hydrodynamic and biogeochemical characteristic trends of the waters along the column and their interannual variabilities. For this reason the cruises have been repeated every year. Furthermore the biogeochemical anomalies N/P and the difference between the variables north and south of the basin, with two different hydrodynamic regimes, have been analysed.

Then in the area two sub-regional hydrodynamic numerical models are operative giving a 5-days forecast of the sea state of the central and western Mediterranean updated daily. These cruises are also organised in order to calibrate and validate the circulation models at sub-basin and coastal scales. Comparative studies with in-situ data, from satellite and models outputs will be used to evaluate the interannual variability of the dynamics at basin scale. Furthermore they will be used

to study the mechanisms regulating and modulating the Chlorophyll distribution in mesoscale processes.
This cruise is strictly linked with the previous ones Medgoos1-13 (2000-2006), MedOc05, 06 (2005-2006), MedBio (2006), MedCO07 (2007), SESAME-IT4 and MedCO08 (2008), Tyrrhmounts and Sicily09 (2009), Venus1 and Bonifacio 2010-SIC (2010) where zonal trends of the hydrodynamic and biogeochemical characteristics of the water masses in the western basin.
Furthermore the cruise has been associated to another from IAMC CNR in Messina to optimize the activities in the same marine area. Its aim is to unravel, categorize, catalogue, exploit and manage the microbial diversity available in the Mediterranean Sea for addressing bioremediation of polluted marine sites. The intent is sto provide the proof of concept that it is possible to establish site-specific collections of highly specialized microbial strains and mixed microbial cultures, novel or improved enzymes, biosurfactants and other microbial products that can be exploited in general as well as in site-tailored intensified bioremediation approaches. The associated ULIXES project will explore the microbial diversity associated to different polluted environments in the Mediterranean Sea searching new microbial resources to be applied for the bioremediation of matrices polluted with three types of pollutants, petroleum hydrocarbons, chlorinated compounds and heavy metals.

Main hydrodynamic characteristics in the study areas

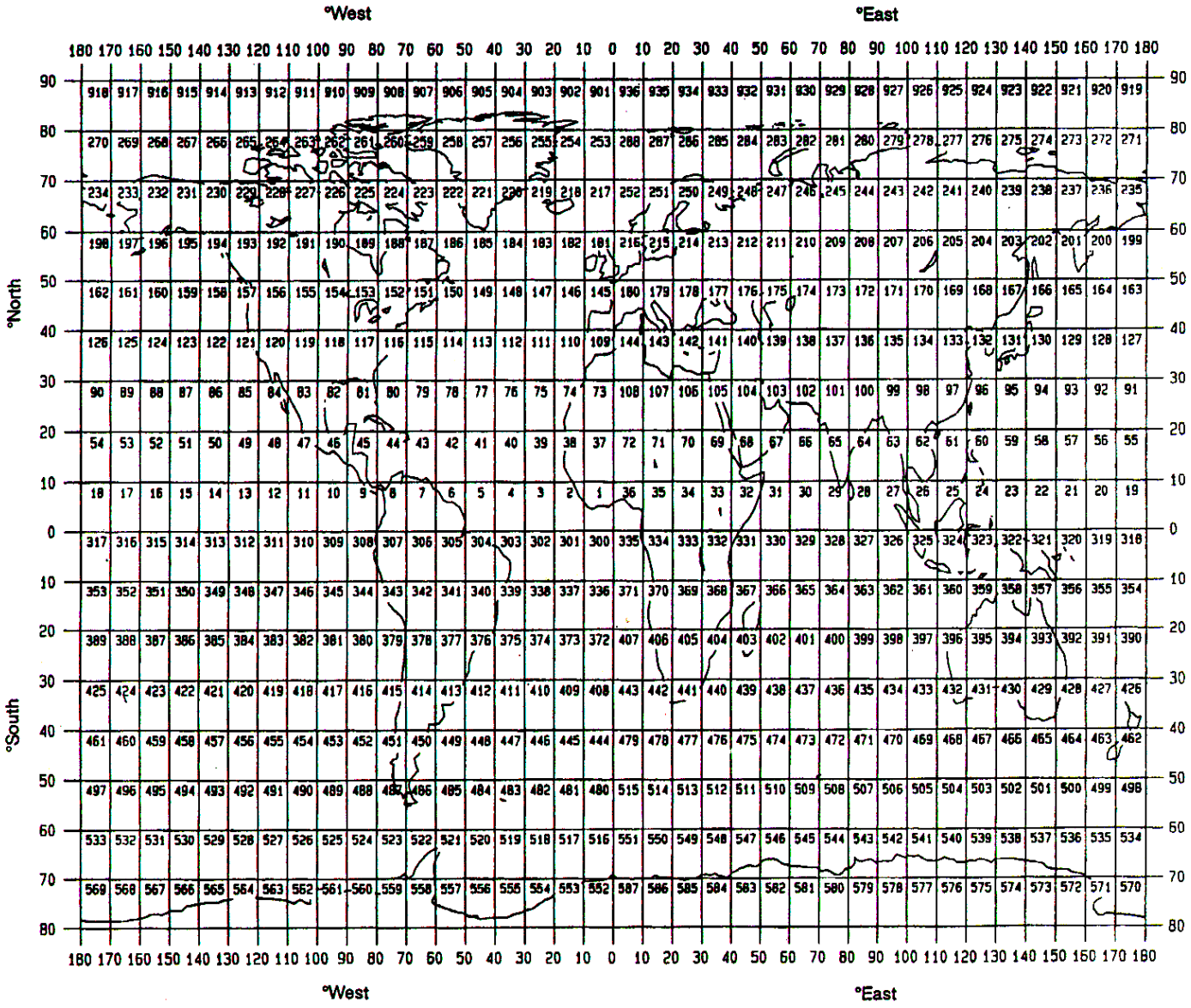
The **central Mediterranean** (Sardinia channel) is characterised by a really complicated bottom topography directly influencing on the water exchanges between the two Mediterranean basins (eastern and western). In the Sardinia Channel the threshold depth is about 1900 m. This allows the exchange of deep waters in the western Mediterranean.
The **Tyrrhenian sea** is linked both with the western Mediterranean as the eastern and is an intermediate basin whose southern part is linked to the central Mediterranean through a shallow channel permitting the passage of the LIW and of the tEMDW that, sinking at the entrance of the Tyrrhenian sea, origins the TDW that will move over the WMDW. The Opening Sicily-Sardinia is mainly formed by two channels with a wide intermediate plain. The deepest, in its central part, directly links the Tyrrhenian sea to the Sardinia Channel and to the rest of the western Mediterranean. All the water masses composing the water column from the surface to the bottom pass through it.
The **Algerian-Provencal area** represents a crucial region to understand the exchanges between different Mediterranean sub-basins (Ribotti et al., 2004; Santinelli et al, 2006; Puillat et al., 2006; Schroder et al., 2006), the Eastern and the Western. The region is interested by two different hydrodynamic regimes mainly driven by the wind at north (Gulf of Lions and Liguro-Provencal area) and from the mesoscale structures, mainly anticyclonic eddies for the instability of the Algerian Current, at south (Algerian area) playing a key role in the detachment of the LIW (Ribotti et al., 2004). Particularly the **Algerian area,** along the Algerian coast, is characterised by an abyssal plain 2500-2900 m deep and crossed by the AW (*Atlantic Water*) coming from the Gibraltar strait that mixes with the Mediterranean water originating the MAW (*Modified Atlantic Water*). Such a flux moves eastward (*Algerian Current)* along the north African coast with a meandering path due to the coastal morphology and whose closed meanders originate cyclonic and anticyclonic eddies (the latter named AEs – *Algerian Eddies*) with dimensions from 50 to 200

km in diameter and a “life” from a few days to some month. These eddies move eastward to the Sardinia Channel but, due to very shallow bathymetries, the deep eddies (until 1000 m) remain in the western basin circulating anticlockwise in the central-southern part of the Algerian-Provencal basin, while a large part of Atlantic water masses cross the Sicily Strait to the eastern basin.

Resuming, the study area is a very complex system with an almost sub-tropical climate. Furthermore in the central Mediterranean area is present the widest community of marine mammals and fishes of the whole Mediterranean basin.

Other interesting aspects regard the hydrological properties (temperature and salinity) of the deep and intermediate layers, that show a positive trend for some decades. The reasons of this trend are still unknown.

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED



PARAMETER CODES

METEOROLOGY

M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

PHYSICAL OCEANOGRAPHY

H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

CHEMICAL OCEANOGRAPHY

H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

MARINE CONTAMINANTS/POLLUTION

P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

MARINE BIOLOGY/FISHERIES

B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

MARINE GEOLOGY/GEOPHYSICS

G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements