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WP ISMAR-BOLOGNA, Responsible Dr. M.Ravaioli

REPORT ON THE MORPHOBATHYMETRIC, OCEANOGRAPHIC, GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS DURING CRUISE MNG02_09 (11-24 July 2009, R/V *MARIA GRAZIA*, MONTENEGRO.)

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ISMAR-CNR Interim Technical Cruise Report

Bologna, August 2009

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Report on the morphobathymetric, oceanographic, geological and geophysical investigations during cruise MNG02_09 (13-25 July 2009, R/v *MARIA GRAZIA*)
by G.Bortoluzzi, F.Del Bianco, F.D'Oriano, F.Giglio, C.Vada, F.Muccini, A.Bulatović, Z. Kljajić

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Abstract - We present the shipboard activities and results of Cruise MNG02_09 on R/V *Maria Grazia* (13-25 july 2009) on Southern Adriatic Sea. Morphobathymetric, geological and geophysical works were performed on the montenegrinian margins within the framework of international Projects ADRICOSM-STAR and MEDPOL. The cruise was scheduled to continue the systematic mapping of the montenegrinian shelf areas by Multibeam and CHIRP SBP, magnetometer and gravimeter, sample the seabottom by box-corer and gravity corer and acquire classic hydrological data on the water column. Most of the proposed work have been performed, and some results are presented hereinafter, alongwith tecnical details on procedures and instrumentation.

Sommario - Vengono presentate le attivita' ed i risultati preliminari della crociera MNG02_09 con R/V *Maria Grazia* (11-25 Luglio 2009). Sono stati raccolti dati morfobatimetrici, magnetometrici, gravimetrici e SBP sul margine montenegrino e nalla baia di Cattaro, all'interno dei progetti internazionali ADRICOSM-STAR e MEDPOL. Di seguito vengono mostrati alcuni dei risultati ottenuti, assieme alle metodologie e alle strumentazioni impiegate.

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ACRONYMS

ACRONYM	DESCRIPTION	URL-email
CNR	Consiglio Nazionale Delle Ricerche	www.cnr.it
ISMAR	Istituto di Scienze Marine	www.ismar.cnr.it
ISMAR-BO	Istituto di Scienze Marine, Bologna	www.bo.ismar.cnr.it
UNIBO	University, Bologna, Italy	www.unibo.it
INGV	Ist.Naz.Geofisica Vulc.	www.ingv.it
CMCC	Centro EuroMediterraneo Cambiamenti Climatici	www.cmcc.it
IBMK	Inst.Marine Biology, Kotor	
SOPROMAR	SOPROMAR, Fiumicino, Italy	www.sopromar.it
ADRICOSM	ADRIatic sea integrated COastal areaS	gnoo.bo.ingv.it/adricosm
ADRICOSM-STAR	ADRICOSM integrated river basin an coastal zone management system: Montenegro coastal area and Bojana river catchment	gnoo.bo.ingv.it/adricosm-star
MEDPOL	Program for the Assessment and Control of Pollution in the Mediterranean region	http://195.97.36.231/medpol
SIS	Sea Floor Inf. System	www.kongsberg.com
NEPTUNE	Multibeam Processing	www.km.kongsberg.com
SBE	Sea Bird Electronics	www.seabird.com
BENTHOS	Teledyne Benthos	www.benthos.com
SWAN-PRO	Communication Technology	www.comm-tec.com
GMT	Generic Mapping Tool	gmt.soest.hawaii.edu/gmt
MBES	Multibeam Echosounder System	
SBP	Sub Bottom Profiling	
SVP	Sound Velocity Profile	
CTD	Conductivity/Temperature/Depth	
ADW	Adriatic Deep Water	
LIW	Levantine Intermediate Water	
GPS-DGPS-RTK	Global Positioning System	samadhi.jpl.nasa.gov
DTM	Digital Terrain Model	en.wikipedia.org

Table 1: Acronyms of Organizations, Manufacturers and Products

ACKNOWLEDGMENTS

We thank the Master C.L.C. Giuseppe Gallo, first officer A.Patane' and crew members of R/V *Maria Grazia* for their efforts in assuring the success of the cruise. We thank Dr. Cosmo Carmisciano (INGV La Spezia) and ENI for the use of gravimeter. Work done in the framework of the Adricosm-Star Project.

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1 INTRODUCTION

Cruise MNG02_09 , coordinated by ISMAR-CNR of Bologna, has been dedicated to the ADRICOSM-STAR project (coordinating Institution CMCC, scientific Coordinator Prof. Nadia Pinardi) and to MEDPOL activities. ADRICOSM-STAR "... aims at the development and partial implementation of an integrated coastal area and river and urban waters management system that considers both observational and modelling components." The research area is the Montenegro and Albanian coastal and marginal zone, inclusive of Kotor Bay (Boka Kotorska). The project involves 19 public and private partners from Italy, Montenegro, Serbia and Albania and has a duration of 3 years starting from March 2007.

This is the fourth cruise in the area of Montenegro, following the cruise ADR08 R/V Dalla Porta July 2008, ADR02_08 R/V *Urania* of October 2008 [Bignami et al.(2008)] and MNG01_09 R/V *Urania* of April 2009 [Bortoluzzi et al.(2009)]. The cruise objectives were:

- To continue the systematic mapping of the study zone sea bottom and sub-bottom with Multibeam and CHIRP technology
- To start collecting magnetometric and gravimetric data
- To collect sediment samples in selected stations for sedimentological and chemical analysis
- To provide on-field training

Multibeam and CHIRP data will be used to assess the geological and surficial and subsurficial morphological setting, other than help to update bathymetric maps. Magnetometric and gravimetric data will be used for tectonics investigations and studies. Among the settings we may cite sediment transport pathways, such as accumulation and erosion areas, and risk and hazard studies. In addition, high resolution bathymetric data will be used to construct digital terrain models useful for regional modelling of wave and current dynamics. As a result of this investigation the owners of the data will also be able to produce environmental and geological maps at variuos scales. In particular, Kotor Bay data, along with pollution data from sediment samples, will be used to optimize the wastewater disposal effort in environmentally safe conditions.

This paper reports the shipboard activities during the cruise, including description of the ship, equipment and their usage, along with details of the general settings, performances and some scientific and technical results.

CHIRP SBP, magnetometric, gravimetric and Multibeam bathymetric data were acquired allover planned routes or during transits, from the southeastern to northern sectors of the shelf, and the seafloor was sampled by box-corer and gravity corer in predetermined stations in front of the Bojana River and S of Kotor. On some areas, the planning of routes were dictated by the aim of obtaining full coverage multibeam images. In addition to this, long, straight lines were run for obtaining acceptable gravimetric and magnetometric data.

Hydrological measurements were performed by CTD vertical profiles (pressure, temperature, conductivity). T, S, and Pressure data were used to provide to the MBES the necessary water column speed of sound profile (Chen and Millero). Data were extracted from the 0.25 m averaged profiles, and input on the MBES console. A procedure was set up in order to make easier the handling of the procedure, in particular for the extension of data to the depth of 12000m, as required by the SIS Kongsberg's software. The procedure is explained in Appendix 6.1.

1.1 Geological and Oceanographical Setting

Geological setting

The Montenegrinian and Northern Albanian margins and coastal areas are part of the seismically active W-verging Dinaride/Albanide fold-and-thrust belt along the eastern Adriatic basin boundary (see Fig.1), 2) [Argnani et.al.(1996)],[Argnani A. (2006,A)]. The margins have relict shelf edge, with sediment stored on the albanian coastline, and evidence of large-scale mass wasting [Argnani et al.(2006,B)], [Roure et al.(2004)]. The continental shelf is very narrow from N in

Croatia to C. Patamuni S of the Bay of Kotor, near Budva, where it develops offshore down to C.Rodonit.

The seismic activity is present in the study area as moderate to strong intensity events. In particular, it must be cited the M6.9 destructive event of 1979-04-15 and aftershock in the Bar region [Console and Favali(1981)], [Boore et al.(1981)], whose epicenter was located offshore 5-10 NM, at the most external thrust. The area south of the mouth of Bojana River to W and SW of Cape Rodonit is also seismically active, being interested by a WNE pure-compression thrust and by ENE trending strikeslip faults [Aliaj et al. (2004)], [Aliaj (2008)]. According to [Tiberti et al.(2008)] and therein cited authors, the events have large potential for generating tsunamis.

Because of karst environment in the Dinaric range, especially in N Montenegro, coastal aquifers may also develop at sea with submarine syphons, springs and resurgences, within a geological and hydrogeological setting strongly related to tectonics and to past and future climate and sea level fluctuations [**?**]

Oceanographical Setting

The dynamics of the Southern Adriatic is dominated by the presence of a quasi-permanent cyclonic gyre that in the winter season creates the conditions for the open-ocean convection and the production of dense and oxygenated waters. Studies show that two types of dense water formation processes occur during winter within the Adriatic Sea: the major portion of the Adriatic Deep Water (ADW) is formed through open ocean convection inside the Southern Adriatic Pit (SAP) within the cyclonic gyre, while the remaining dense water is formed on the continental shelf of the Northern and Middle Adriatic that moves southward and ultimately sinks to the bottom of the SAP ([Ovchinnikov et al. (1985)][Bignami et al. (1990)] [Malanotte-Rizzoli (1991)]). The eastern margin is characterized by the influence of the incoming water of Ionian origin which flow northward being restricted mainly to the continental slope. This area is interested by the Levantine Intermediate water (LIW) that occupies the layer between 150 and 600m.

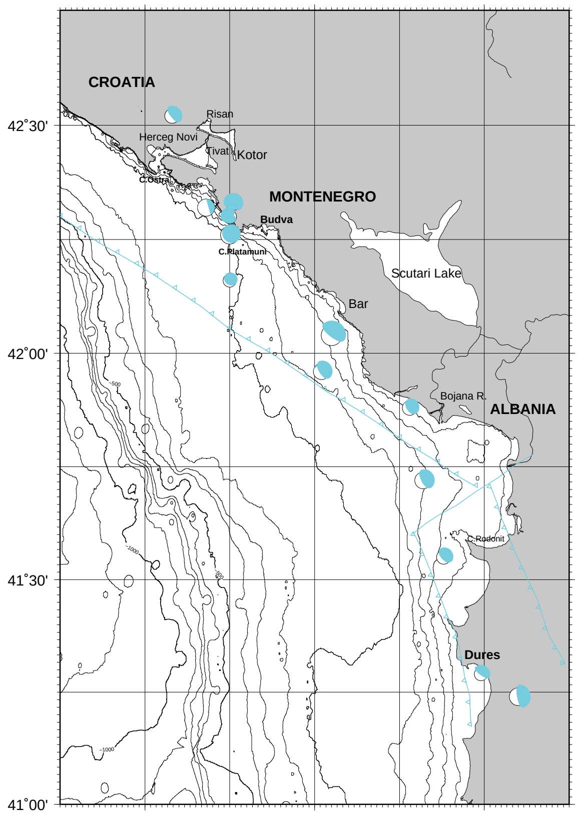

Figure 1: Geological setting of Montenegro-Albania. Structural lineaments, left and rigth fronts, strike-slip transform fault from [Aliaj et al. (2004)] and [Aliaj (2008)]. Centroid moment tensor solutions by [Pondrelli et al.(2006)]. Bathymetry by GEBCO.

Figure 2: Geological structures, Budva.

2 CRUISE SUMMARY

SHIP: R/V *Maria Grazia*
START: 2009-07-11 PORT: Messina
END: 2009-07-25 PORT: Monopoli
SEA/OCEAN: Southern Adriatic Sea, Mediterranean Sea
LIMITS: NORTH 42:40 SOUTH: 41:00 WEST: 18:00 EAST: 19:30
OBJECTIVE: MORPHOBATHYMETRIC AND GEOLOGICAL SURVEY
COORDINATING BODIES: ISMAR-CNR
CHIEF OF EXPEDITION: Mr. Giovanni Bortoluzzi
CONTACT: G.Bortoluzzi@ismar.cnr.it
DISCIPLINES: PHYSICAL AND BIO-GEOCHEMICAL OCEANOGRAPHY, SWATH BATHYMETRY, GEOPHYSICS
WORK DONE: , 1400 KM SBP, 900 KM magnetometric, 2000 KM gravimetric data, about 200 KM^2 Of SWATH MULTIBEAM, 36 CTD STATIONS, 25 BOX-CORERS (19x19x25 cm), 13 CORES (1 6.0m, 11 3.6m pipe).

LOCALIZATION:

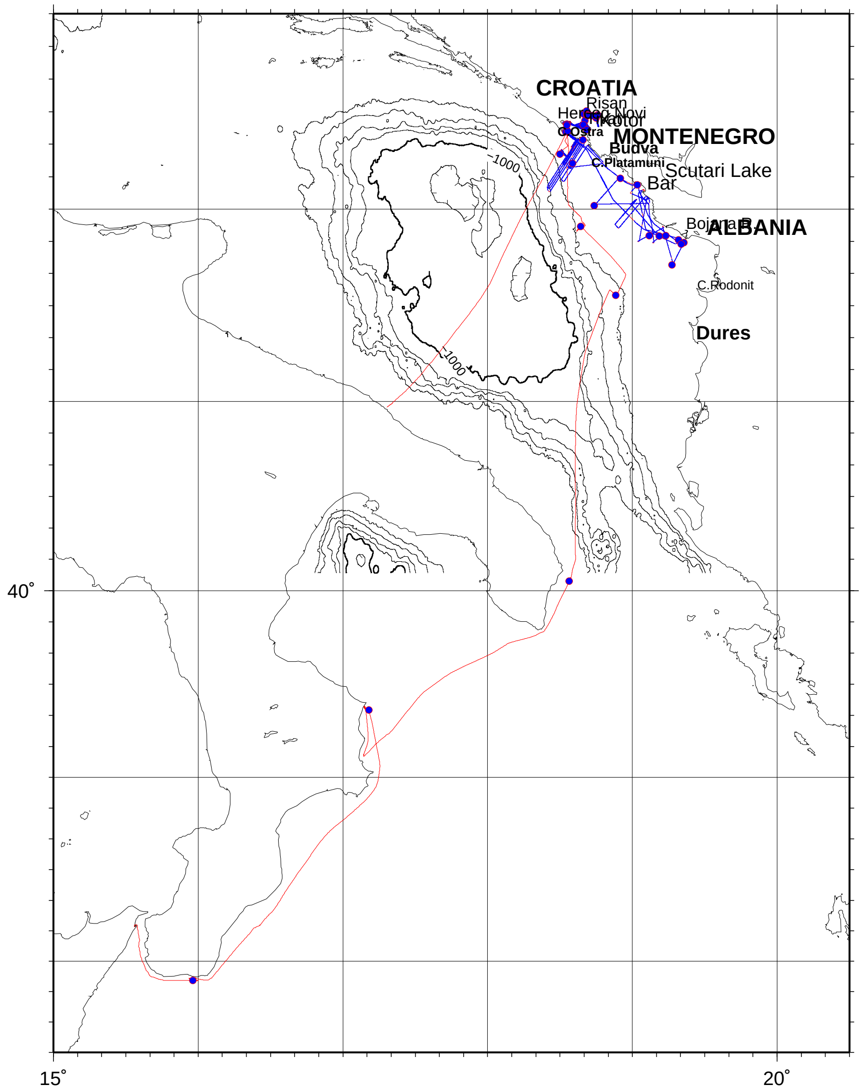

Figure 3: Whole ship track during Cruise MNG02_09 . Blue circles are CTD stations. Red squares are bottom Stations.

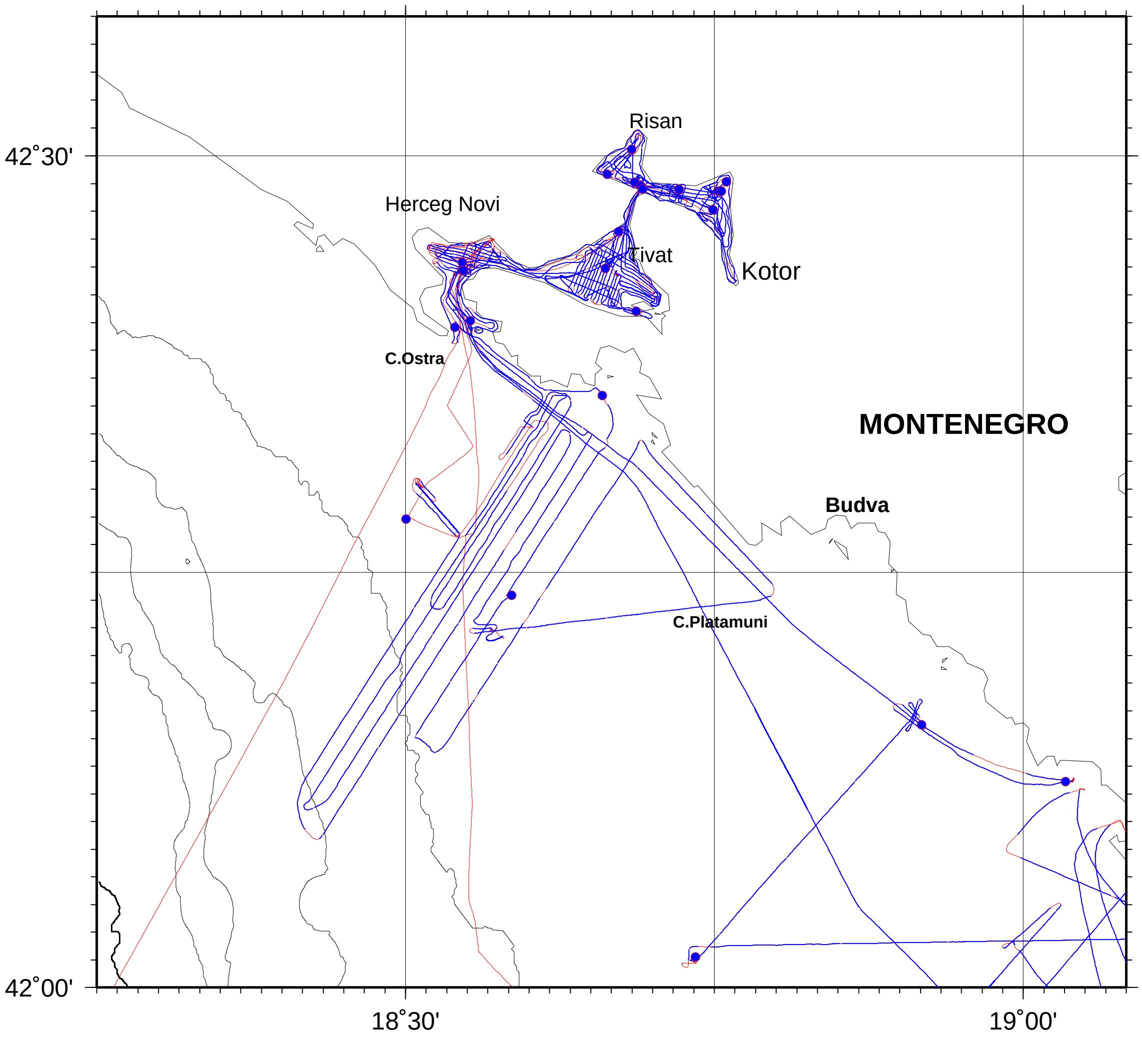

Figure 4: Whole ship track during Cruise MNG02_09 , Northern area. Blue circles are CTD stations. Red squares are bottom Stations.

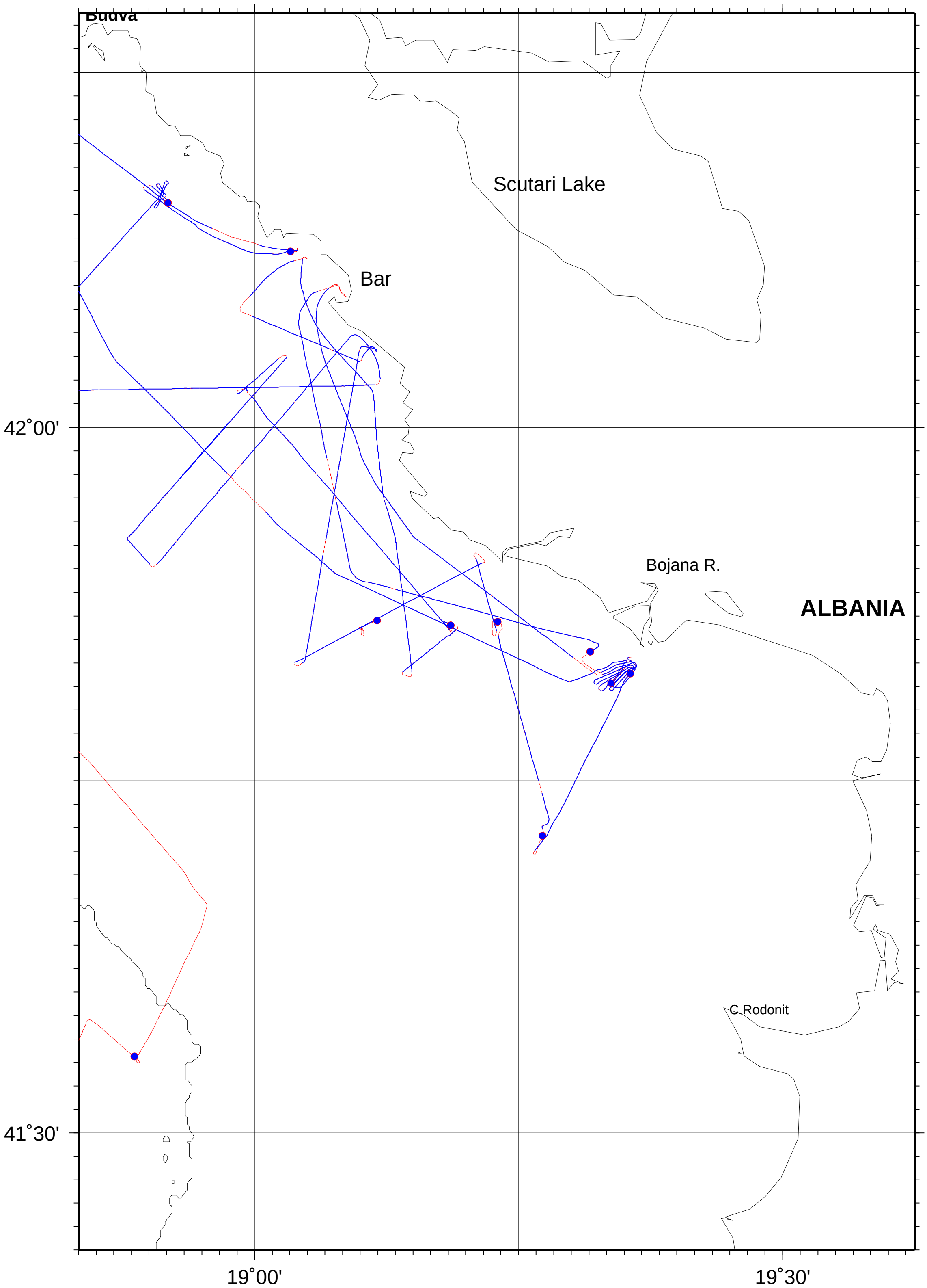

Figure 5: Whole ship track during Cruise MNG02_09 , southern area. Blue circles are CTD stations. Red squares are bottom Stations.

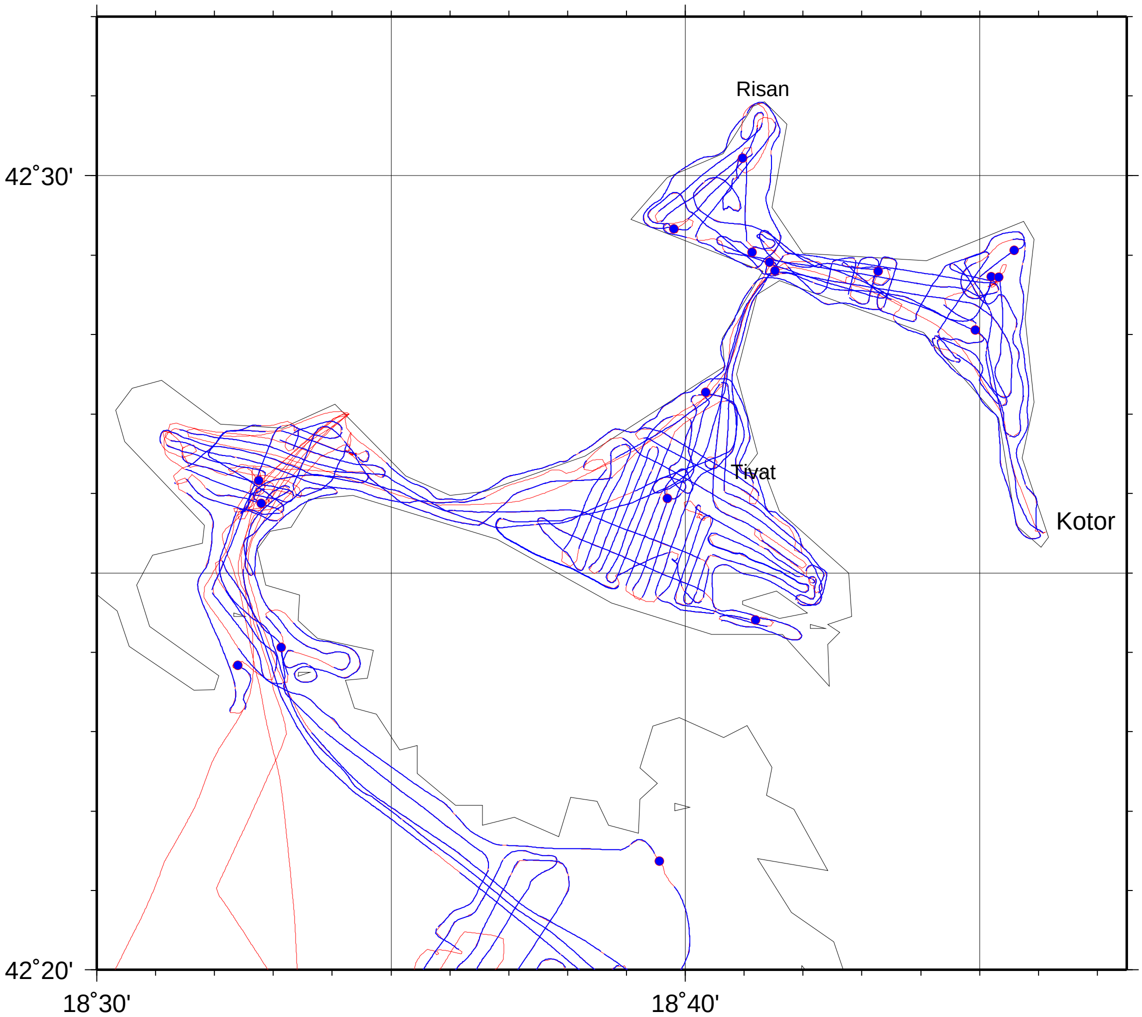

Figure 6: Whole ship track during Cruise MNG02_09 , southern area. Blue circles are CTD stations. Red squares are bottom Stations.

SCIENTIFIC AND TECHNICAL PARTIES

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Table 2: Scientific and technical parties

3 MATERIALS AND METHODS

The research cruise was carried out with the 42 m R/V *Maria Grazia* owned by GALLO PESCA of Salerno, operated by SO.PRO.MAR. and on lease to CNR. Ship is used for geological, geophysical and oceanographical work in the Mediterranean Sea.

Figure 7: R/V *Maria Grazia* port and starboard.

R/V *Maria Grazia* is equipped with DGPS positioning system (satellite link by FUGRO), single-beam and multibeam bathymetry and integrated geophysical and oceanographical data acquisition systems, including Kongsberg SEAPATH and Communication Technology NAVPRO Navigation Systems, ADCP, CHIRP SBP and other Sonar Equipment, other than water and sediment sampling. Additional equipment can be pole-mounted or towed, e.g. Side Scan Sonars.

3.1 NAVIGATION, SWATH BATHYMETRY, CHIRP SBP DATA ACQUISITION

The vessel was set-up for data acquisition and navigation with NAVPRO software, interfacing by a MOXA multiserial and Ethernet link several instruments, among them the DGPS by SEAPATH, the Kongsberg EA60 Scientific single-beam echosunder, and the Aanderaa 3660 meteorological station. The position and depth data were also distributed to the CTD data acquisition console (????). A Kongsberg processor running the SIS software, collected the multibeam data, including a SEAPATH MRU, compass, and DGPS. The MBES was the 300kHz, 508 beams 0.5°, 170°aperture EM3002D Dual Head (400 m range) model by Kongsberg. The sonar head is positioned on the ship's keel using a V-shaped steel frame. A Sound Velocity probe at the the Sonar Head is interfaced directly to the MBES processor, thus providing the necessary real-time data for the beam-forming. CTD casts were normally used for input of the sound velocity profile to the system.

POSITION	ACROSS	ALONG	HEIGHT
REFERENCE POINT	0.00	0.00	0.00
SEAPATH_GPS	-4.039	0.163	-18.211
MRU	-0.341	-1.342	-1.596
MBEAM_TX	0.0936	10.2964	5.0623
MBEAM_RX	-0.0031	11.0144	5.0600
SEALEVEL	0	0	-0.0875
MAGNETOMETER	2.0	-145.0	0.0
CHIRP	1.5	7.0	-2.00
STERN	4.0	-10.0	3.0
CORER	-8.0	8.0	0.0

Table 3: Instrumental Offsets of Kongsberg's SEAPATH and EM3002D R/V *Maria Grazia* . The DGPS antenna (primary positioning system) is located on point SEAPATH_GPS.

MULTIBEAM BATHYMETRY

The SIS (EM3002D) was able to build real-time DTM at the resolution of 2.5 m during the acquisition of the entire surveyed areas. The data from these production DTMs were exported and used for planning and update of the SIS projects. The raw data were instead saved in the Kongsberg's .all format, for postprocessing with packages like NEPTUNE or MB-SYSTEM or other. The processed data will therefore be used for an up-to-date regional and local bathymetric compilation.

CHIRP SBP

A Teledyne Benthos CHIRP-III SBP system (4 pole-mounted MASSA transducers) was used. The data were acquired by the SWANPRO software by Communication Technology. The NAVPRO system delivered the DGPS SEAPATH coordinates (geographical latitude and longitude), therefore actual positioning data have to be converted according to the offsets of Tab.3.

3.2 BOTTOM SAMPLING

Bottom samples were taken by a 19x19x25cm box-corer. Some samples were washed and sieved on board. On 13 stations a 1.2T, 3.6m pipe, gravity corer was used (1 used a 6.0m pipe). Table 4 shows the positioning data of the stations. The sediment recovered by the box-corer was subsampled using 1 or 2 10cm liners , that were sealed and stored at +20°C . Some levels were sampled on the exposed sediment column (surface, mid depth and bottom) and stored in sealed plastic bags. Photographs in Fig. 8 and following show some of the operations.

Table 4: Stations positions. Lat/lon data expressed as DDMM.xxxx (WGS84). B=Box-corer,C=gravity core. Recovery in m.

EAST NORTH UTM-34 LON LAT	STAT	DATE	DEP	WHERE	RECOV.
294936.80 4686178.09 1830.7344 4218.0514	GR01	2009-07-15	109	bioherms off Kotor	3-4 cm
294916.94 4686265.17 1830.7181 4218.0981	GR02	2009-07-15		Bioherms off Kotor, top	
294972.00 4686281.53 1830.7578 4218.1078	GR03	2009-07-15		Bioherms off Kotor, base	
294837.60 4686307.50 1830.6595 4218.1197	BC04	2009-07-15		Bioherms off Kotor	few cm

302334.52 4689986.46 1836.0364 4220.2222	CO05	2009-07-15		Bokakotorska bay, outside	132 cm + bottom
314923.72 4704129.72 1844.9254 4228.0445	BC06	2009-07-16		Kotor bay	full box
315863.97 4705978.37 1845.5755 4229.0561	BC07	2009-07-16		Kotor bay	full box
312188.69 4705683.06 1842.9003 4228.8437	BC08	2009-07-16		Kotor Bay, between karstic springs	full box
312710.42 4705589.01 1843.2827 4228.8005	GR09	2009-07-16	65	Kotor Bay, karstic Hole	
307511.40 4706461.35 1839.4730 4229.1950	GR10	2009-07-16	33.8	Risan bay, S, Hole	
309983.41 4709041.52 1841.2249 4230.6247	BC11	2009-07-16		Risan Bay, Sopot	2 cm
309091.13 4708149.66 1840.5916 4230.1300	BC12	2009-07-16	24	Risan Bay, Middle	30 cm
309752.16 4706118.28 1841.1144 4229.0430	BC13	2009-07-17	34	Risan bay , S, church Island	poll- out
307639.68 4700458.05 1839.6873 4225.9557	BC14	2009-07-17	39	Risan Bay, middle	18 cm
309817.82 4699240.42 1841.2990 4225.3305	BC15	2009-07-17	24	Tivat bay, S, air-port - new marina.	full box
310913.98 4698414.43 1842.1141 4224.9006	BC16	2009-07-17	16	Tivat Airport	full box
309568.14 4697546.23 1841.1507 4224.4121	BC17	2009-07-17	21	Tivat bay, S	full box
296149.52 4702256.19 1831.2752 4226.7504	BC18	2009-07-18	14	Herzeg-novi bay	17 cm
298279.96 4700976.00 1832.8551 4226.0927	BC19	2009-07-18	42	Herzeg-novi bay	19 cm
299074.45 4702311.57 1833.4061 4226.8261	BC20	2009-07-19	31	Herzeg-novi bay	14 cm
297837.43 4700458.85 1832.5435 4225.8066	BC21	2009-07-19	46	Herzeg-novi bay	full box
297801.36 4700412.11 1832.5182 4225.7808	CO22	2009-07-19	46	Herzeg-novi bay	320 cm
298119.72 4700924.69 1832.7394 4226.0625	CO23	2009-07-19		Herzeg-novi bay	273 cm
307718.57 4699008.04 1839.7739 4225.1740	CO24	2009-07-19	45	Tivat bay, S	400 cm
306402.52 4698652.47 1838.8221 4224.9624	BC25	2009-07-19	32	Tivat bay, S	21 cm
309472.23 4707842.88 1840.8758 4229.9700	CO26	2009-07-19	28	Risan Bay, S	177 cm
309138.93 4707128.18 1840.6469 4229.5792	CO27	2009-07-19	31	Risan Bay	195 cm
307505.09 4688878.42 1839.8213 4219.7017	BC28	2009-07-20	83	S Cape ...	14 cm
300653.80 4678777.56 1835.0449 4214.1449	BC29	2009-07-20	118	SW Budva	6/7 cm
294440.05 4669358.49 1830.7303 4208.9632	BC30	2009-07-20	197	Offshore Kotor, S	18 cm
299815.25 4676266.26 1834.4876 4212.7762	BC31	2009-07-20	163	Offshore Kotor, S	13 cm
328023.56 4669643.20 1855.0952 4209.6025	BC32	2009-07-21	72	SE Budva	14 cm
312157.28 4654043.11 1843.8807 4200.9603	BC33	2009-07-21	125	S Budva	16 cm
311529.79 4653821.80 1843.4306 4200.8318	CO34	2009-07-21	131	S Budva	273 cm
333786.01 4654733.97 1859.5322 4201.6253	CO35	2009-07-21	73	SE bar	218 cm
348937.83 4636103.65 1910.7949 4151.7458	CO36	2009-07-21	66	SW Ulcinji	262 cm
342417.35 4635777.61 1906.0888 4151.4934	CO37	2009-07-22	82	SW Ulcinji	275 cm
342395.63 4635709.40 1906.0742 4151.4563	BC38	2009-07-22	83	SW Ulcinji	24 cm
352799.75 4636206.27 1913.5839 4151.8449	BC39	2009-07-22	47	S Ulcinji	21 cm
352984.89 4636124.32 1913.7189 4151.8027	CO40	2009-07-22	47	S Ulcinji	200 cm
356093.77 4619780.11 1916.2031 4143.0083	CO41	2009-07-22	74	S Bojana	227 cm
356149.18 4618803.03 1916.2572 4142.4811	BC42	2009-07-22	74	S Bojana	23 cm
362581.55 4631693.47 1920.7154 4149.5127	BC43	2009-07-23	27	Bojana Mouth	17 cm
362636.00 4631716.67 1920.7544 4149.5258	CO44	2009-07-23	27	Bojana Mouth	153 cm
363182.48 4632321.13 1921.1407 4149.8580	BC45	2009-07-23		Bojana Mouth	13 cm
362854.16 4632044.76 1920.9074 4149.7053	BC46	2009-07-23	23	Bojana Mouth	18 cm
362332.25 4631474.46 1920.5384 4149.3918	BC47	2009-07-23	30	Bojana Mouth	22 cm
361955.78 4631082.44 1920.2720 4149.1761	BC48	2009-07-23	35	Bojana Mouth	21 cm

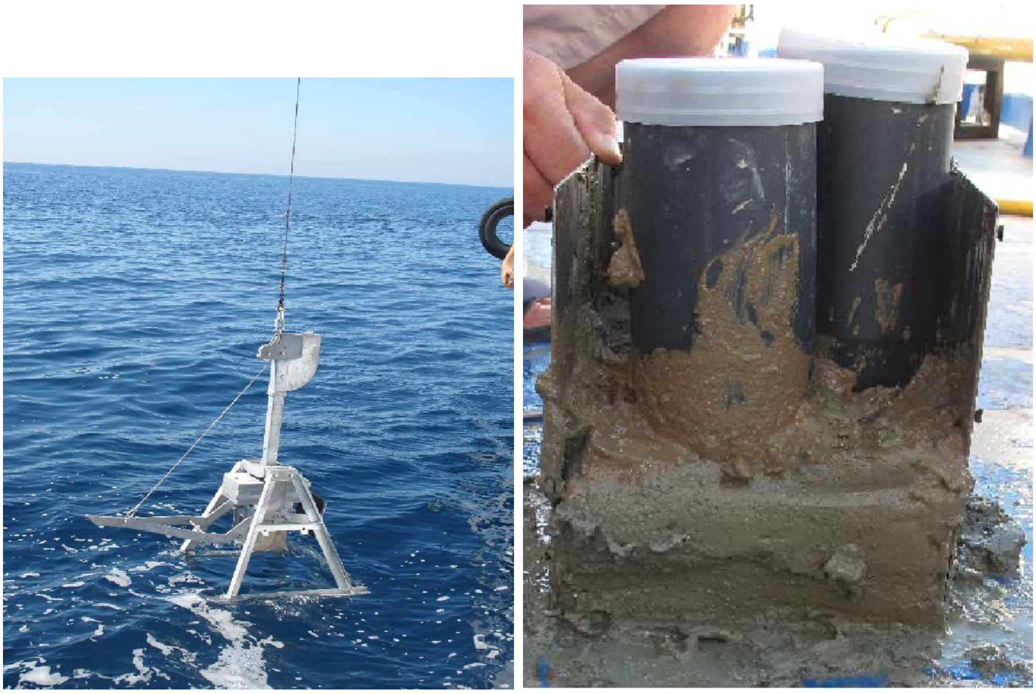

Figure 8: Box-corer and liner sampling..

Figure 9: Corer (3.6m pipe) and grab.

3.3 CTD CASTS

CTD sampling casts were taken on surveyed area. Conductivity and temperature data were collected by a Seabird SBE 11 PLUS using the SEASAVE software. The pressure data were measured by a ParoScientific Digiquartz. Data were acquired at 24Hz and the descent rate was aproximately 1 m/s, much less when close to bottom or on interesting interfaces. To facilitate the handling of the equipment during the coring operations, the Bottle Caroussel and some sensors were removed.

The conversion from pressure to depth on the SEA-SAVE software was done at latitude 40N. See Tables 5and Figs.4, 5 and 6 for the station locations.

The binary data were converted to the CNV and ASCIIOUT (for CTD) formats. The Sound Velocity data from the acquired profiles were made available for import into the SIS Software for multibeam data acquisition and corrections.

Lon	Lat	Date Time	Station
1557.760	3753.780	2009-07-12T11:17:50	001
1710.740	3921.820	2009-07-13T00:19:05	002
1833.830	4003.040	2009-07-13T15:35:10	003
1853.170	4133.260	2009-07-14T06:39:10	004
1838.642	4154.582	2009-07-14T10:14:39	005
1830.020	4216.930	2009-07-14T22:13:26	006
1833.135	4224.061	2009-07-15T16:18:18	007
1832.793	4225.876	2009-07-15T18:41:12	008
1841.521	4228.800	2009-07-15T20:10:45	009
1845.195	4228.729	2009-07-15T21:09:33	010
1844.923	4228.059	2009-07-16T09:57:40	011
1845.584	4229.062	2009-07-16T10:21:01	012
1843.275	4228.797	2009-07-16T13:00:42	013
1839.807	4229.330	2009-07-16T15:31:43	014
1840.969	4230.221	2009-07-16T17:41:52	015
1845.326	4228.720	2009-07-17T07:10:21	016
1841.132	4229.038	2009-07-17T09:00:59	017
1840.343	4227.273	2009-07-17T11:05:48	018
1839.693	4225.939	2009-07-17T11:58:03	019
1841.197	4224.406	2009-07-17T14:00:46	020
1832.749	4226.167	2009-07-18T19:06:28	022
1832.393	4223.838	2009-07-19T08:24:36	023
1841.434	4228.908	2009-07-19T17:46:11	024
1839.559	4221.369	2009-07-20T08:04:08	025
1835.139	4214.165	2009-07-20T10:06:31	026
1902.040	4207.440	2009-07-21T07:07:39	027
1855.070	4209.490	2009-07-21T08:21:03	028
1844.080	4201.100	2009-07-21T10:56:55	029
1911.140	4151.600	2009-07-21T20:23:47	030
1906.960	4151.810	2009-07-22T10:38:42	031
1913.810	4151.760	2009-07-22T13:39:05	032
1916.360	4142.660	2009-07-22T15:19:48	033
1921.340	4149.560	2009-07-22T16:46:57	034
1919.075	4150.483	2009-07-23T08:49:12	035
1920.267	4149.150	2009-07-23T11:21:38	036

Table 5: CTD Stations, MNG02_09 . Lat, Lon expressed as DDMM.xxx. Time is UTC.

Gravimetry and Magnetometry

A Lacoste&Romberg AIRSEA gravimeter was installed in the mess room, firmly secured to the wall (Fig.10). The positiong data were provided by ISMAR's EGNOSS DGPS Trimble DFM-32, trough the GGA,GLL,ZDA and RMC NMEA sentences. The system's console was positioned in the acquisition room by running RS-232 cables. A Marine Magnetics Sea Spy magnetometer was towed astern on the port side, at distance of 130m from stern (Fig.11. The data were collected with MM SEALINK and ISMAR's MAGREC.

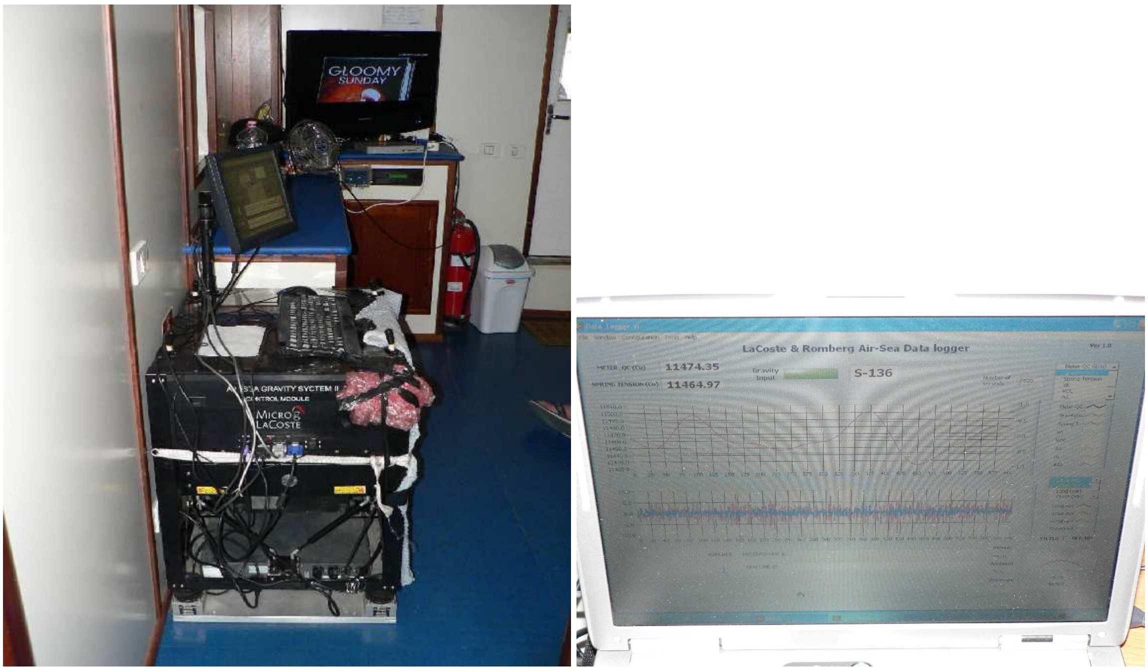

Figure 10: Gravimeter Lacoste and Romberg.

Figure 11: Marine Magnetics magnetometer deployment..

3.4 DATA PROCESSING

Multibeam and CHIRP data

The multibeam data were pre processed on board by the MB-System [Caress and Chayes (2009)] and GMT software and ISMAR's routines and scripts, using the SIS production DTMS or XYZ ASCII converted data. Further analysis will be performed by industrial packages, like Kongsberg's Neptune. DTM data will be produced, further analyzed and mapped by the GMT package [Wessel and Smith (1995)]. The CHIRP data will be processed by the ISMAR's SEISPHRO package [Gasperini and Stanghellini(2008)], to produce enhanced images of the subsurface seafloor, strata geometry, isopachs etc.

Sediment analysis

The sediments will be analyzed for:

- magnetic susceptibility, X-Ray
- physical properties (granulometry, density, mineralogy)
- chemical properties (N,C by CHN) and stable isotopes of C and N, heavy metals, short (^{210}Pb and ^{137}Cs, ^{7}Be) and medium ($^{1}4C$) life radionuclides to obtain the chronology of the sedimentary sequences.

3.5 MAPPING AND MISCELLANEOUS

The datum was set to WGS84 and the UTM (zone34) was chosen for navigation, 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)].

ISMAR's computing center employed several INTEL based PC running the GNU-Linux and Windows.

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

4 INITIAL RESULTS

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

4.1 SWATH BATHYMETRY

Several square KM of data were collected and will require several months of work for processing.

Tha bay of Kotor was almost fully mapped. The Verige Strait, connecting the Central Bay of Tivat to the Bay of Kotor, shows very steep flanks that continue into the embayment, being stopped by a steep, narrow ridge, parallel to the S coastline, which elevates above surface with the man-made Island of Gospa od Skrpjela We present (Fig.12) multibeam images of the strait from the two Urania cruises performed in October 2008, April 2009 and this one, aiming at the comparison between three different multibeam systems (Reson 8160, Kongsberg EM710 and Em3002D).

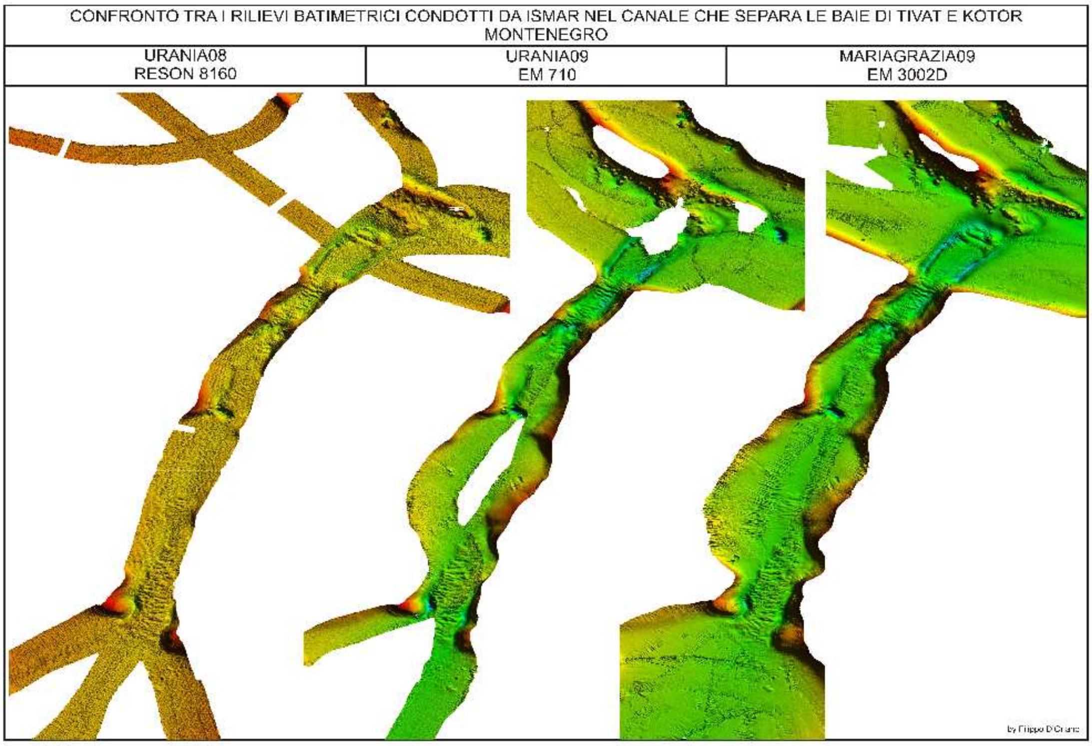

Figure 12: Comparison of three different Multibeam systems, Verige Strait. From Left to right: Reson 8169, R/V *Urania* , October 2008, Kongsberg EM710, R/V *Urania* , April 2009, Kongsberg EM3002D, this cruise.

4.2 CHIRP SBP PROFILING

Chirp data showed extremely interesting subbottom geometries, in all of the studied areas. Among many others, we present some of them, as examples of data quality and potential for further studies and interpretation (Fig.13 and 14).

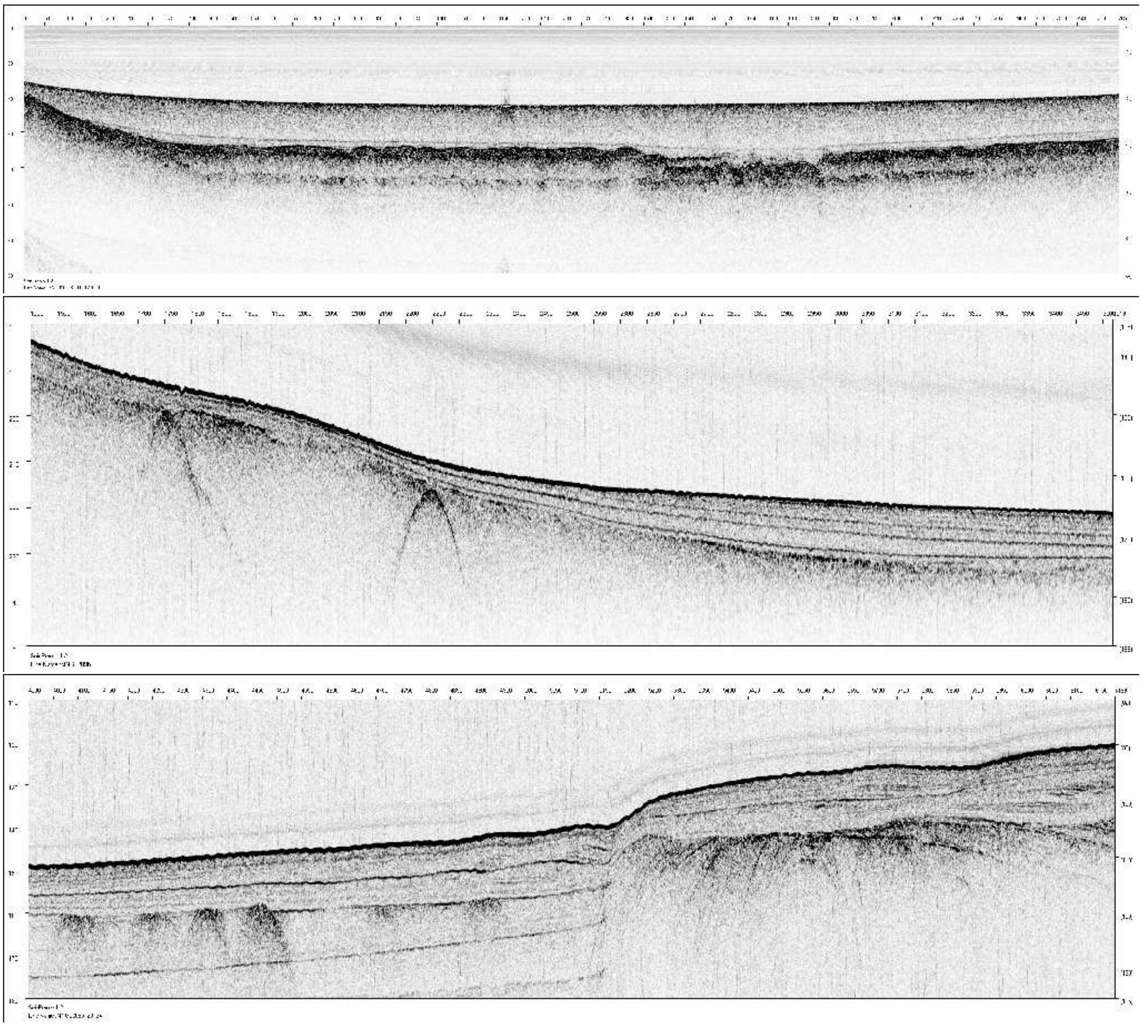

Figure 13: Examples of CHIRP Images.

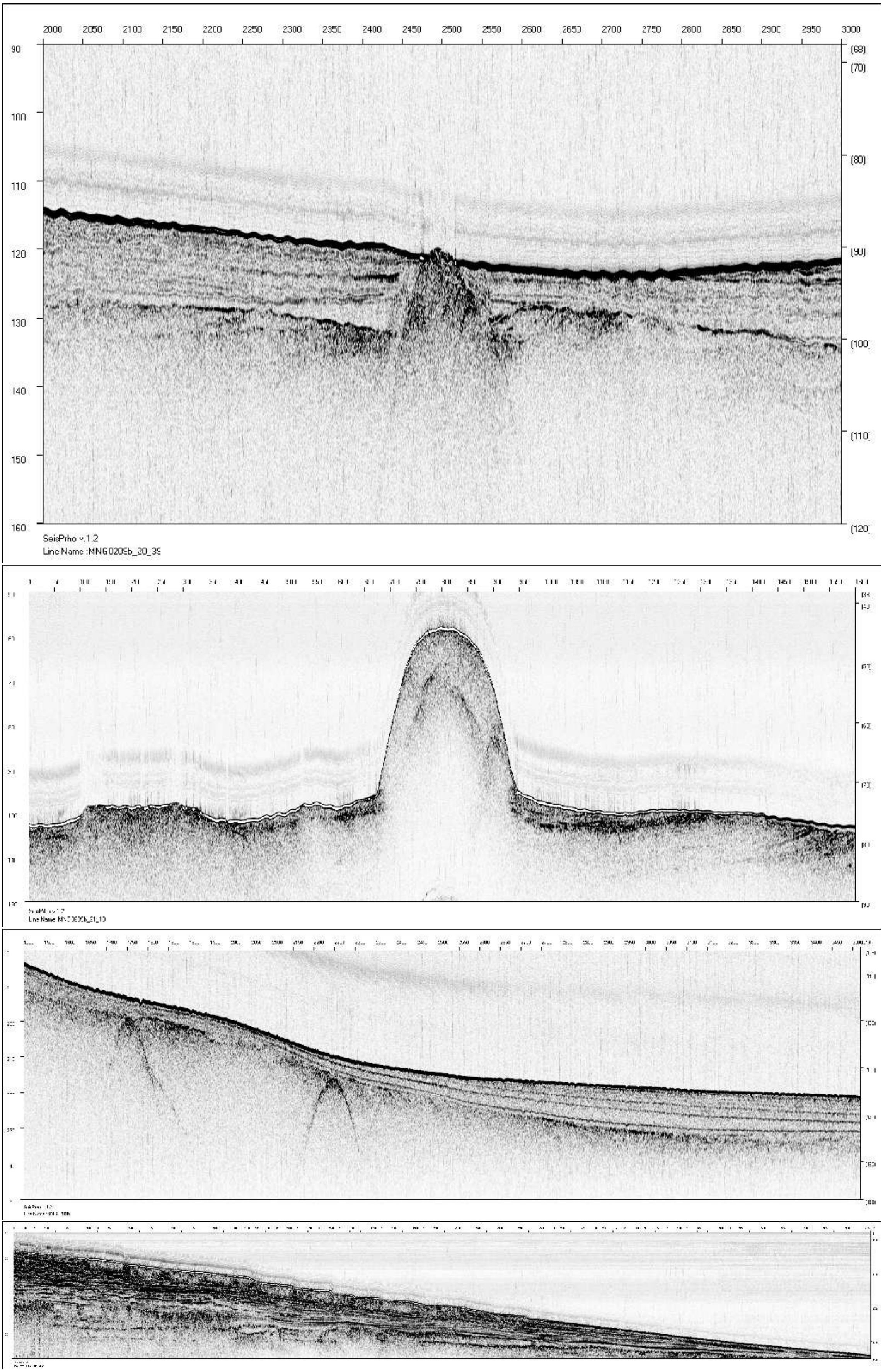

Figure 14: Examples of CHIRP Images.

4.3 MAGNETOMETRY

Magnetometric data showed just a general trend, with very little anomalies, except on very localized objects, probably shipwrecks (15), one of which is particularly impressive (see Fig.16).

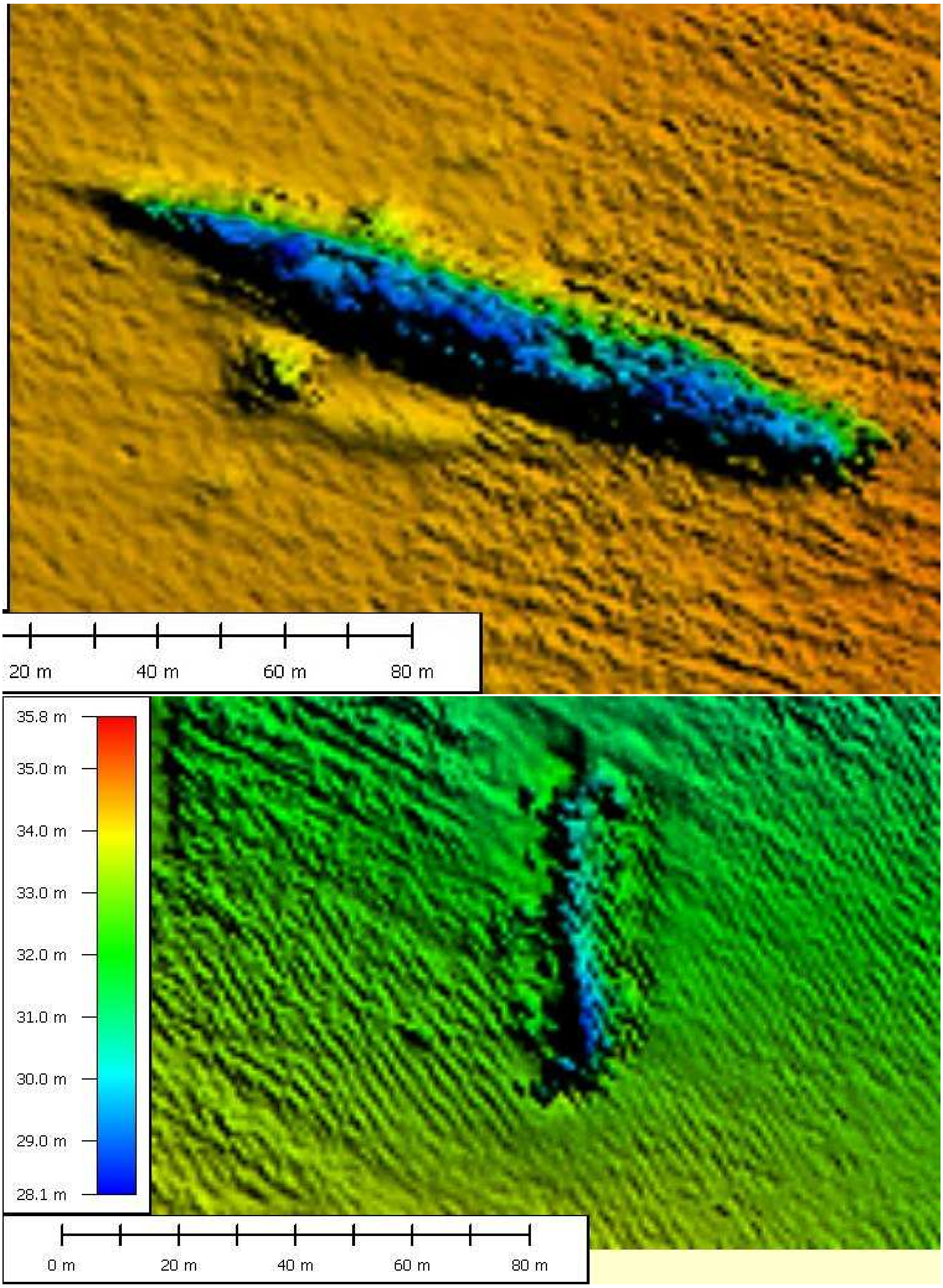

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Figure 15: Shipwrecks.

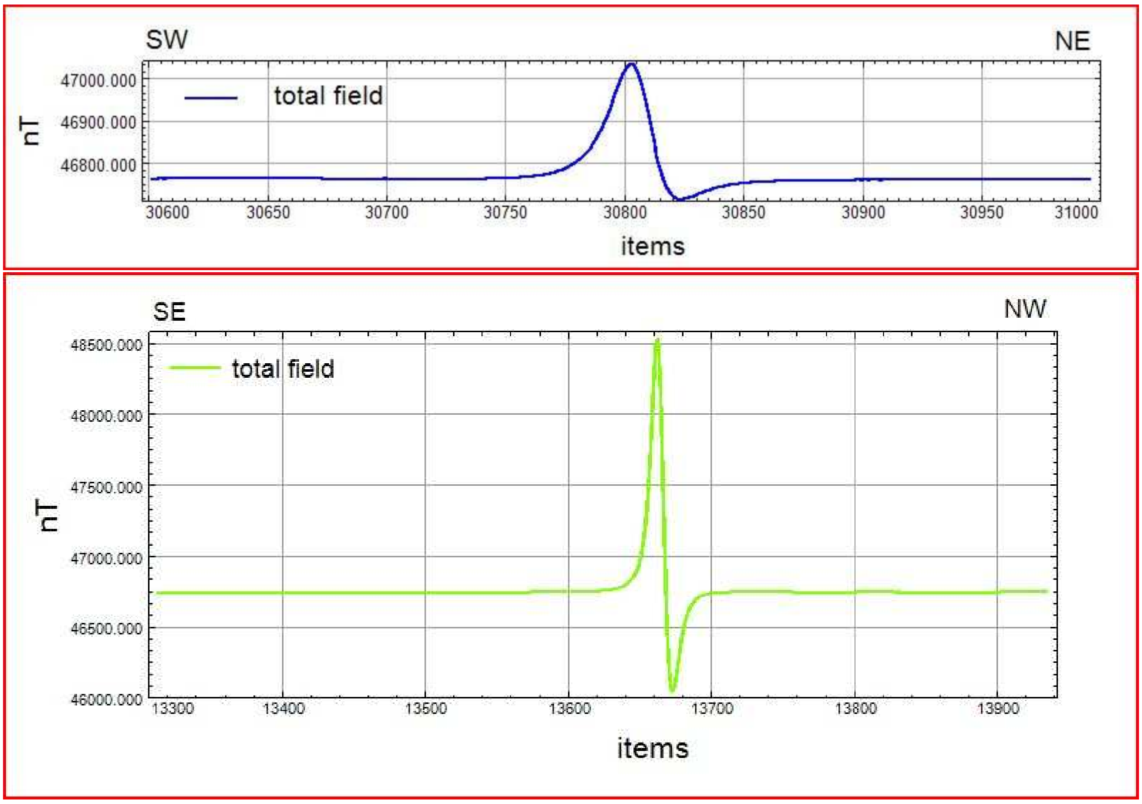

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Figure 16: Total Magnetic Field of objects lying on seabottom.

4.4 BOTTOM SAMPLING

Table 6 shows the description of bottom samples.

Table 6: Bottom samples description. G=grab, B=Box-corer,C=gravity core.

STATION	DATE	DESCRIPTION
GR01	2009-07-15	Bryozoa corals sponges
GR02	2009-07-15	Corals bryozoa bivalves , bio- clast and mud color: olive green
GR03	2009-07-15	Bioclast and fine mud color: olive green
BC04	2009-07-15	Sand/silty sand color: grey-green
CO05	2009-07-15	Tube 6 m (bent] penetration 2 m. Fine overconsolidated with shell fragment.
BC06	2009-07-16	Clay sediment, color olive green/Yellow. Subsampled with 2 sub-cores (1 for IS-MAR,1 for IBM)
BC07	2009-07-16	Clay sediment, color olive green/Yellow. Recovery still the top. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC08	2009-07-16	Ligtly anoxic, Hydrated top, decrease the water content still the bottom. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
GR09	2009-07-16	Coarse sandy/clay sediment. Bottom water with high salinity from CTD. Lives corals bivalves and severals organic fragments
GR10	2009-07-16	Acient bivalves, silty clay, color gray-green. Anthropic residues (plastic bottles - more than 10 years old, and cup)
BC11	2009-07-16	Very hydrated clay sediment with several subcentimetric clast. Sampled strongly reworked. No subsampling.

BC12	2009-07-16	Top first 2 cm very hydrated clay sediment, color olive green. 3 cm- to bottom, more compact, color olive/gray. Bioturbated, worm. Between 15- 20 cm probably torba (coal wood-marsh?). Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM) bottom, more compact color: olive gray. Bioturbated (worm)
BC13	2009-07-17	Silty clay color olive-green/gray, no variation are present under the top level (water sediment interface). Some oxidated levels around 15 cm. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC14	2009-07-17	Anchor trace that possibly allow to a physical reworking of the sediment. First 2 cm are very Hydrtated color: green/brown. More consolidated on the bottom part color: gray, probably light oxidated. Several centimetric clast. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC15	2009-07-17	Top level: sandy silt, color: gray/ gray-green, lightly oxidated. The bottom sediment seems to be finer probably increase the clay component color: gray green. Shell fragments on the bottom . Bioturbated, Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC16	2009-07-17	Silty sediment. Color olive gray oxidated in the first 10 - 15 cm. Bioturbated-polichete tubes. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC17	2009-07-17	Silty sediment. Olive green Rare millimetric stones. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC18	2009-07-18	Silty clay, color: light gray, first 5 cm high water content. 6 cm to bottom silty clay more consolidate, dark gray. Several shell are present in all the sediment. Bioturbated. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM)
BC19	2009-07-18	Silty clay brown green, first 2 cm high water content. On the bottom, last 2 cm, the sediment in more gray in color and overconsolidated, coarse sediment with gravel levels (more than 2 mm in size). The medium part is light gray with millimetric clast and shell fragment .
BC20	2009-07-19	Sandy silt, colour: green-gray, very uniform along almost all the sediment column, low water content. On the top are present some centimetric clast and well preserved shell.
BC21	2009-07-19	Sandy silt, green-gray, very uniform along almost all the sediment column, the sediment is compacted and with low water content. Bioturbated, some biogenic fragment.
CO22	2009-07-19	Penetration of the corer: ca . 450 cm, sandy sediment on the bottom. Top of first section: overconsolidated silty caly. Top of second section: silty clay with low water content and normal consolidated. Top of third section: silty caly.
CO23	2009-07-19	Penetration of the corer: ca . 500 cm. Bottom silty clay/clay. Top of first section: silty sand. Top of second section: silty clay with high water content.
CO24	2009-07-19	Penetration of the corer: ca . 400 cm. Probably loss of the top (Pull out). Bottom silty sand. Top of first section: silty clay. Top of second section: silty clay . Top of third section: silty clay
BC25	2009-07-19	Very uniform sediment sequence, silty clay with a coarse sendy level 13 and 16 cm with biogenic (shell and bryozoa) fragment.
CO26	2009-07-19	Penetration of the corer: ca. 200 cm. Bottom biogenic sand. Top composed by fine sediment, probably silty-caly
CO27	2009-07-19	Bottom silty sand clay with several biogenic fragment. Top of first section: silty clay. Top of second section: silty clay.
BC28	2009-07-20	Sandy sediment, bioturbated. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM) and top in a plastic bag.
BC29	2009-07-20	Sandy sediment, with shell fragment. Subsampled: first 3 cm and total sequence in plastic bags.
BC30	2009-07-20	Sandy clay, bioturbated, first 3 cm with high water content and Yellow green in colour, 4-18 cm green/gray. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM) and top in a plastic bag.
BC31	2009-07-20	Sandy sediment with biogenic fragment. Subsampled: top (0-3 cm), upper part (0-7 cm), bottom part (8-13 cm).

BC32	2009-07-21	Top (2 cm) Sandy sediment, colour: green/brown, 3cm to bottom more compact and coarse, gray/green color
BC33	2009-07-21	Silty-sand with black layer, color yellow/brown; on bottom sandy-silt color gray/-green
CO34	2009-07-21	Bottom first section, sandy silt with low water content, color: gray; of first same; top second section sandy silt gray normal consolidated ; top 3 clayey-silt
CO35	2009-07-21	Coarse sand on core catcher; bottom first section silty sand low water content, color: gray; top first section clayey silt color gray/green; top second section clayey silt more hydrated, less plastic that top 1, more greenish.
CO36	2009-07-21	Silty clay with low water content, color green-gray on core catcher (core catcher subsample with short liner); bottom first section Silty clay with low water content, color green-gray; top second section clayey silt/silty clay.
CO37	2009-07-22	Bottom first section, Slty clay,color: gray;top ofthe first same; top second section silty clay more Hydrated color, green gray.
BC38	2009-07-22	Sediment water interface not well preserved. clay Silty clay, color yellow brown olive gray, Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM) and top in a plastic bag.
BC39	2009-07-22	From top to 3 cm depth silty clay with high water content, color yellow brown. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM). Top, levels 0-10 cm fine cllay, 11-21 smell probaby anoxic condition on the bottom Silty caly.
CO40	2009-07-22	Bottom first section Silt, with low water content, Top of the first section silty clay color grey, top second section clayey color olive gray.
CO41	2009-07-22	Bottom first section sandy silt, color grey, Top of the first section sandy silt color grey, top second section sandy silt, more Hydrated.
BC42	2009-07-22	Top: silty clay high Water content, color Yello/Green; bottom: part silty clay color grey /green, with lower water content. Subsampled with 2 sub-cores (1 for ISMAR,1 for IBM). Top, levels 0-10 cm higher water content, 11-23 cm low erwater content, color dark grey.
BC43	2009-07-23	Fine clay sediment on the top (ca. 3 cm), high water content. All the sediment column is strongly bioturbated. Many well preserved shell. Color: olive gray. 0-10 cm clay/ silty clay, color: olive gray, 10-17 cm silty clay, color: dark gray. Susbsampled both levels in plastic box. No subcores.
CO44	2009-07-23	Bottom first section silty clay, color dark grey, low water content. Top of the first section silty clay color grey-green, lower water content.
BC45	2009-07-23	Oxidated top layer 1 cm with high water content, yellow green. 2cm to bottom very compact sediment with lower water content Color gray/dark gray. All the sequence has been subsampled in a plastic box.
BC46	2009-07-23	Oxidated top layer 3 cm with high water content. Color yellow olive green. 0-8 cm fine clay sediment, with high water content. Many well preserved shell. 8-18 cm silty clay, color: gray/green. All the sequence is strongly bioturbated. Both the levels has been subsampled in plastic box. 1 short core has been done.
BC47	2009-07-23	Oxidated top layer 4 cm with high water content. Color brown olive green. 0-12 cm fine clay sediment, with high water content. Many well preserved shell. 12-22 cm silty clay, color: gray/green. All the sequence is strongly bioturbated. Both the levels has been subsampled in plastic box. 1 short core has been done.
BC48	2009-07-23	Oxidated top layer 5 cm with high water content. Color brown-green. 0-5 cm fine clay sediment, with high water content. Many well preserved shell. 5-14 cm clay color: dark green. 14-21 cm silty clay color gray. All the sequence is strongly bioturbated. All the 3 levels has been subsampled in plastic box.

4.5 CTD

Figure 17 shows the CTD data of all the samples collected.

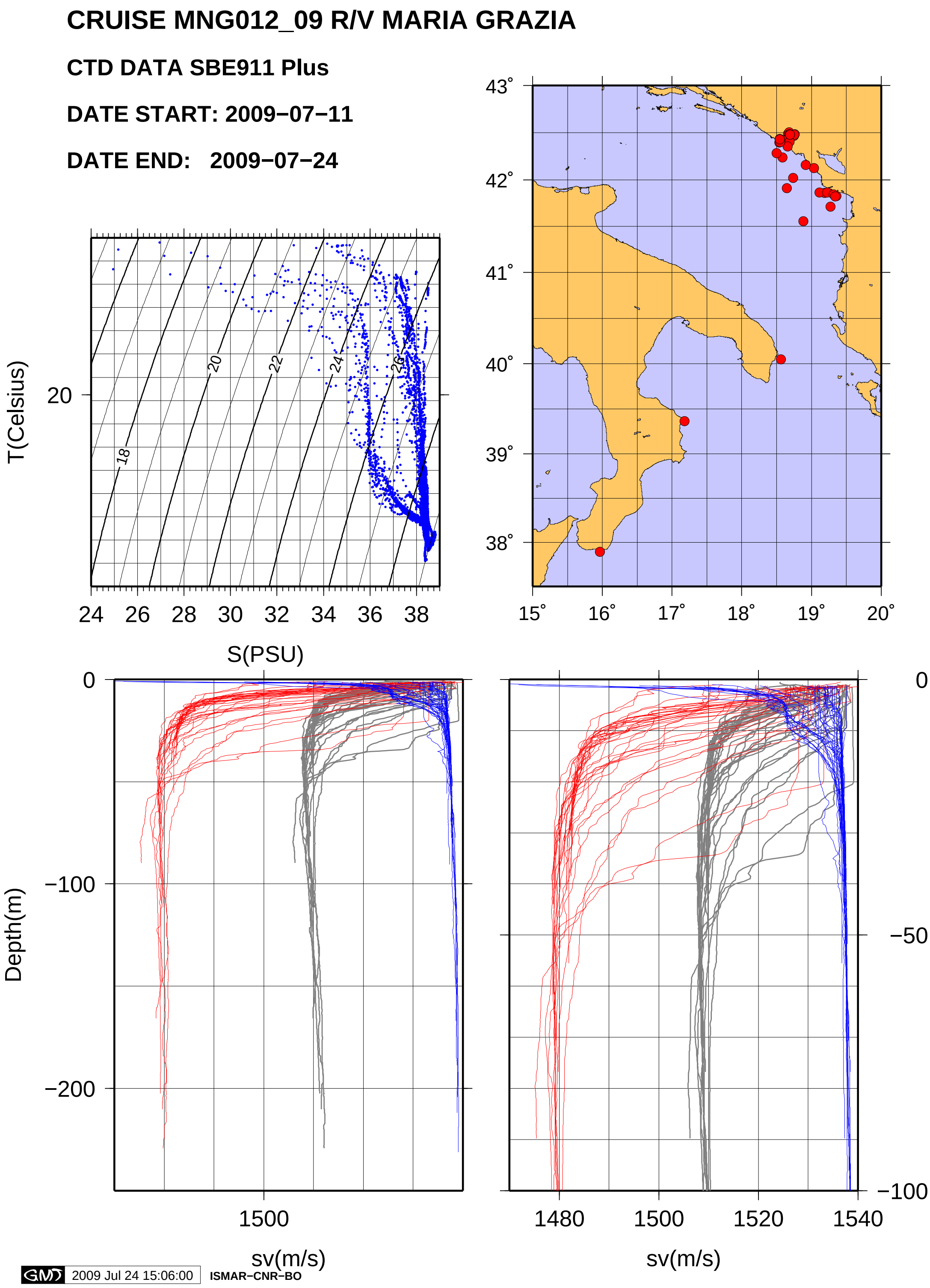

Figure 17: Cruise MNG02_09 . CTD data.

5 CONCLUSIONS

During the 7 days of cruise MNG0209, including transits and port calls, we obtained:

- aproximately 200KM^2 of swath bathymetry, 1400KM of high resolution SBP profiles, aproximately 900KM of magnetic lines, plus 2000 KM og gravimetric data.
- sampling of the sea bottom on 45 stations
- measurements of the water column proprties on 35 CTD stations.

Several morphological features were revealed by the swath bathymetry and Chirp SBP mapping, providing good chances to further explore, finalize and better detail a very interesting marine area.

Analysis of the data collected during the expedition is under process, and will continue during the forthcoming several months.

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

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6 APPENDIX

6.1 DIARY OF OPERATIONS

- 2009-07-10 Departure from Bologna
- 2009-07-11 Arrival in Messina, mobilization
- 2009-07-12 Departure from Messina 07:30. Transit to calabrian coast for multibeam calibration. Final multibeam calibration Ciro' Marina.
- 2009-07-13 Disembark Konsberg technitian Crotone, depart for Montenegro. In the afternoon test of multibeam (CTD04) and magnetometer on a wreck SE Otranto, 90 m depth. In the evening sailing to Montenegro, 20 NM S of territorial waters.
- 2009-07-14 06:45 CTD05, first line multibeam. Test magnetometer. 11:00 problems Multibeam, sailing to Zelenika. Practice, embark Dr. Bulatovic, sail for work outside Kotor Bay
- 2009-07-15 Box-corer bioherms off Kotor Bay,
- 2009-07-16 Work in Kotor Bay
- 2009-07-17 Work in Risan and Tivat Bay
- 2009-07-18 08:00 docked in Zelenika, disembark Dr. D'Oriano, finish work in Kotor Bay,
- 2009-07-19 Work in Herzeg-Novj and Risan Bay (BC,Coring)
- 2009-07-20 Sampling offshore Kotor, Budva, 18:00 Docked in Zelenika, disembark Dr. Bulatovic, embark Dr. Kljajic.
- 2009-07-21 Work in Bar Region, sampling. Anchor NW breakwater Bar
- 2009-07-22 Work in Bojana region, sampling. Docked Bar 20:00.
- 2009-07-23 Bojana River Mouth, Box-cores, Core, transit to Zelenika. Docked 18:15, disembark Dr. Kljaijc, leave for Italy 20:00
- 2009-07-24 Docked in Monopoli 08:00, de-mob 18:00.

6.2 CTD TO SIS ASVP PROCEDURE

The Kongsberg's SIS package handles the Sound Velocity profiles by its own GUI, requiring manual or external file input in the Kongsberg's ASVP ASCII format. After proper editing, the profile is thinned, the Absortion coefficient are calculated and data stored for future usage within the package. The edit phase requires that the profile is continued down to the full ocean depth of 12000m, even if water depth or used MBES was much less of that, e.g. the EM3000, 400m range , or the EM710, 3000m range systems or when operating on the continental shelf or rise. The operation was found to be somewhat error-prone, mostly when dealing with defaults that may merge data from other areas of world ocean.

The idea of producing a (semi)automated procedure for the generation of a SV profile continued down to 12000m, hence directly usable for thinning and Absorption coefficient calculations was carried on by the availability of Oceanographical statistical data in the Ocean, namely the Levitus Database ([Levitus (1982)]), and by programs that have interfaced them and made available the data, namely the `mblevitus~`in the Open Source MBSystem package for Multibeam processing ([Caress and Chayes (2009)] and [Schmidt et al.(2004)]). `mblevitus~`is able to create a water velocity profile which is representative of the mean annual water column for a specified 1 by 1 °region. Therefore, we firstly developped a routine to create data for a wide ocean region in a format to be used independently by other programs, without the need of having the MBSystem package installed. We have chosen to use widely used and available programming languages, like the BASH shell and Perl ([Bash (2009)],[Perl (2009)]), available in the Unix, Mac-OSX, and Windows (Cygwin or native) O.S. Environments.

The Bash routine `CREATE_LEVITUS_PROFILE~`(6.1) creates a directory where Ascii files are produced for a certain Ocean Region. Then, the Bash routine `FROM_CNV_TO_ASVP~`(6.2) produces the conversion of SBE's CNV file to ASVP, by calling the Perl `cnv2asvp.pl~`routine (6.3). The routine have code translated from `fortran~`to `Perl~`from the UNESCO/IOC adopted Oceanographical formulae in the Woods Hole Oceanographic Institution's Package (for converting depth values to dbar and calculate Sound Velocity from salinity, temperature and pressure). The routine can be changed to fit with other CTD systems, producing different formats, as long as they are able to provide depth and Sound velocity data. The ASVP profiles can be used for input to the SIS Acquisition system or for further processing by other packages like Kongsberg's Neptune.

6.1 CREATE_LEVITUS_PROFILES

```
#!/bin/bash
#
# CREATE_LEVITUS_PROFILE

MBLEVITUS=mblevitus
if [ "`mblevitus | grep -i 'command not found'`" == "" ] ; then
        echo
        echo " mblevitus program not found. Please make it available"
        echo " by PATH variable setting or direct path!".
        echo
        exit
fi

# Region

LONMIN=-20
LONMAX=43
LATMIN=28
LATMAX=48

for i in `seq $LONMIN $LONMAX` ; do
  for j in `seq $LATMIN $LATMAX` ; do
        VNAME=SVFILES/SV_${i}_${j}
        $MBLEVITUS -O$VNAME -R${i}/${j} 2>&1 > a
#       if [ `grep "No output file created" $VNAME` != "" ] ; then
#               echo "$j $j $VNAME"
#       fi
  done
done
```

6.2 FROM_CNV_TO_ASVP

```
#!/bin/bash

# DA_CNV_TO_ASVP
# It converts SBE CNV ASCII FILES (0.25,0.5,1,... m binned)
# to Kongsberg's ASVP format (suitable for import in SIS or
# Neptune packages.

# USAGE: FROM_CNV_TO_ASVP file.cnv [LAT LON]
# Lat and lon must be given in the compact format DDMM.xx in case
# the SBE software was not interfaced to the NMEA position
# (parsing Latitude and Longitude strings with "=" token).
#
# CNV data in ../CNV/$CRUISE/ and ASVP data in ../ASVP/$CRUISE/
# directories

CRUISE=MNG02_09


LAT=$2 LON=$3
if [ "$1" == "" ] ; then
        echo "Usage: $0 file.cnv [ LAT_DDMM.x LON_DDMM.x ] ..."
        exit
```

```
fi

if [ -e "$1" ] ; then
        FILE_ASVP=`basename $1 | sed s/\.cnv// | sed s/\.CNV//`
        ./cnv2asvp.pl $1 -lat $2 -lon $3 > ${FILE_ASVP}.asvp
        echo
        echo "Da $1   ---->   ${FILE_ASVP}.asvp .... per SIS"
        echo
        cp ${FILE_ASVP}.asvp ../ASVP/$CRUISE/${FILE_ASVP}.asvp
else
        echo
        echo "File $1 not available !! "
        echo
fi
```

6.3 cnv2asvp.pl

```
#!/usr/bin/perl
###
### cnv2asvp.pl

### Function to convert CNV FILES TO SIS ASVP
### It also inserts points up to 12000m
###

sub dmhd60 { local ($alfa)=@_;
         local ($segno)=$alfa<0?(-1):1;
         local ($temp)=$segno<0?$alfa*(-1):$alfa;
         local ($xd)=int($temp/100); $yd=$temp-($xd*100);
        return $segno*($xd+$yd/60);
}
##
## Routines from the UNESCO Oceanographical Package, translated from
## WHOI's fortran to perl ...

sub m2dbar { my ($M0,$LAT)=@_;
        local ($X,$GR,$P);
        $X=sin($LAT/57.29578);
        $X=$X*$X;
        $P=$M0/10;
        $GR = 9.780318*(1.0+(5.2788E-3+2.36E-5*$X)*$X)+1.092E-5*$P;
        return ($M0)*10/$GR;
}

sub svel { my($S,$T,$P0)=@_;
        local ($SR,$D,$P,$B,$B0,$B1,$A,$A0,$A1,$A2,$A3,
               $C,$C0,$C1,$C2,$C3);
# ******************************
# SOUND SPEED SEAWATER CHEN & MILLERO 1977,JASA,62,1129-1135
# UNITS:
#       PRESSURE        P0      DECIBARS
#       TEMPERATURE     T       DEG CELSIUS (IPTS-68)
#       SALINITY        S       PSU (IPSS-78)
#       SOUND SPEED     SVEL    METERS/SECOND
# CHECKVALUE: 1731.995 M/S FOR P0=10000 DECIBARS,T=40 DEG C,S=40 PSU
#
```

```
#    SCALE PRESSURE TO BARS
        $P=$P0/10.0;
        $SR = sqrt($S);
# S**2 TERM
        $D = 1.727E-3 - 7.9836E-6*$P;
# S**3/2 TERM
        $B1 = 7.3637E-5 +1.7945E-7*$T;
        $B0 = -1.922E-2 -4.42E-5*$T;
        $B = $B0 + $B1*$P;
# S**1 TERM
        $A3 = (-3.389E-13*$T+6.649E-12)*$T+1.100E-10;
        $A2 = ((7.988E-12*$T-1.6002E-10)*$T+9.1041E-9)*$T-3.9064E-7;
        $A1 = (((-2.0122E-10*$T+1.0507E-8)*$T-6.4885E-8)*$T-1.2580E-5)*$T
             +9.4742E-5;
        $A0 = (((-3.21E-8*$T+2.006E-6)*$T+7.164E-5)*$T-1.262E-2)*$T
             +1.389;
        $A = (($A3*$P+$A2)*$P+$A1)*$P+$A0;
# S**0 TERM
        $C3 = (-2.3643E-12*$T+3.8504E-10)*$T-9.7729E-9;
        $C2 = (((1.0405E-12*$T-2.5335E-10)*$T+2.5974E-8)*$T-1.7107E-6)*$T
             +3.1260E-5;
        $C1 = (((-6.1185E-10*$T+1.3621E-7)*$T-8.1788E-6)*$T+6.8982E-4)*$T
             +0.153563;
        $C0 = ((((3.1464E-9*$T-1.47800E-6)*$T+3.3420E-4)*$T-5.80852E-2)*$T
             +5.03711)*$T+1402.388;
        $C = (($C3*$P+$C2)*$P+$C1)*$P+$C0;
        $SVEL = $C + ($A+$B*$SR+$D*$S)*$S;
        return $SVEL;
}

##########################  MAIN PROGRAM

use Getopt::Long;
@optl = ("lon:s","lat:s");
GetOptions @optl;

while (<>) {
           s/\r\n/\n/g; chop;
          if (/FileName/) {
            ($a,$b) = split (/\=/);
            @F=split(/\\/,$b);
            $STA = $F[$#F];
            $STA =~ s/\.dat//i;
          }
          if (/System UpLoad Time/) {
            ($a,$b) = split (/\=/);
            ($a,$m,$d,$y,$t) = split (/\s+/,$b);
            $M=4;
            $DATE=sprintf "%00004d-%002d-%002dT%s", $y,$M,$d,$t;
          }
           if (/Latitude/i)  { ($a,$lat) = split (/\=/); $lat =~ s/\s+|N//g; }
           if (/Longitude/i) { ($a,$lon) = split (/\=/); $lon =~ s/\s+|E//g; }
           if (/UTC/i) { ($a,$utc) = split (/\=/); }
           if (/Station/i) { ($a,$sta) = split (/\:/); }
          last if /\*END\*/;
}
```

```
if (not $lon or not $lat) {
        $lat = $opt_lat; $lon = $opt_lon;
        if not ($lon or $lat) {
          print "Lon Lat Missing !!! Must exit ...\n\n";
          print "usage $0 -lat ddmm.xx -lon ddmm.xx\n\n";
          exit;
        }
}
#$lat=4058;$lon=1718;
$LAT = dmhd60($lat); $LON = dmhd60($lon);
$ILAT= int $LAT+0.5; $ILON=int $LON+0.5;

$fn = "SV_${ILON}_${ILAT}";
$svfile = undef; $i=0;
if ( -e "SVFILES/$fn" ) {
        open SVFILE, "<SVFILES/$fn" or die "Cannot open $fn ...";
        $svfile = "ok";
        while ($_=<SVFILE>) {
                next if $.<=17;
                ($d,$sv) = split;
                $LEVITUS[$i]="$d $sv";
                $i++;
        }
        close SVFILE;
}

$np=0;
while (<>) {
        s/\r\n/\n/g;
        ($depth[$np],$sv[$np]) = split;
        $np++;
}
$np-=1;
$tc = $np + ($svfile ? 56 : 4);
$LT1000 = "y" if $tc > 1000; # or die "Cannot use more than 1000 points!!";

$lat_lon = sprintf "%.6f %.6f", dmhd60($lat), dmhd60($lon);
print "( SoundVelocity 1.00 $STA 20090101000000 $lat_lon 100000 ";
print "20090101000000 20111231235959 SBE-CNV P $tc )\r\n";

for ($i=0;$i<$np;$i++) {
        $mod = $i<=500 ? 1 : 5;
#       next if $depth[$i]=~/\.250/;next if $depth[$i]=~/\.750/;
        print "$depth[$i] $sv[$i]\r\n" if $i%$mod==0;
}

## Profile adjustment at 12000 depth...
## these data can be changed to fit particular regions
# (water temperature, salinities)

$SAL = 38.5     ## Mediterranean ...

if ($depth[$i]<400) {
  print "500.000  1516.00\r\n";
  print "1000.000  1524.00\r\n";
```

```
}
if($depth[$i]<1000) {
  print "1500.000 ",  sprintf "%.2f", svel($SAL,13.5,m2dbar (1500,dmhd60($lat)));
  print "\r\n";
 }
if ($depth[$i]>1000 and $depth[$i]<1500){
  print "1500.000 ",  sprintf "%.2f", svel($SAL,13.5,m2dbar (1500,dmhd60($lat)));
  print "\r\n";
}

print "3000.000 ",  sprintf "%.2f", svel($SAL,12.5,m2dbar (3000,dmhd60($lat)));
print "\r\n";
print "6000.000 ",  sprintf "%.2f", svel($SAL,11.0,m2dbar (6000,dmhd60($lat)));
print "\r\n";
print "12000.000 ", sprintf "%.2f", svel($SAL,9.0,m2dbar(12000,dmhd60($lat)));
print "\r\n";

exit;
```