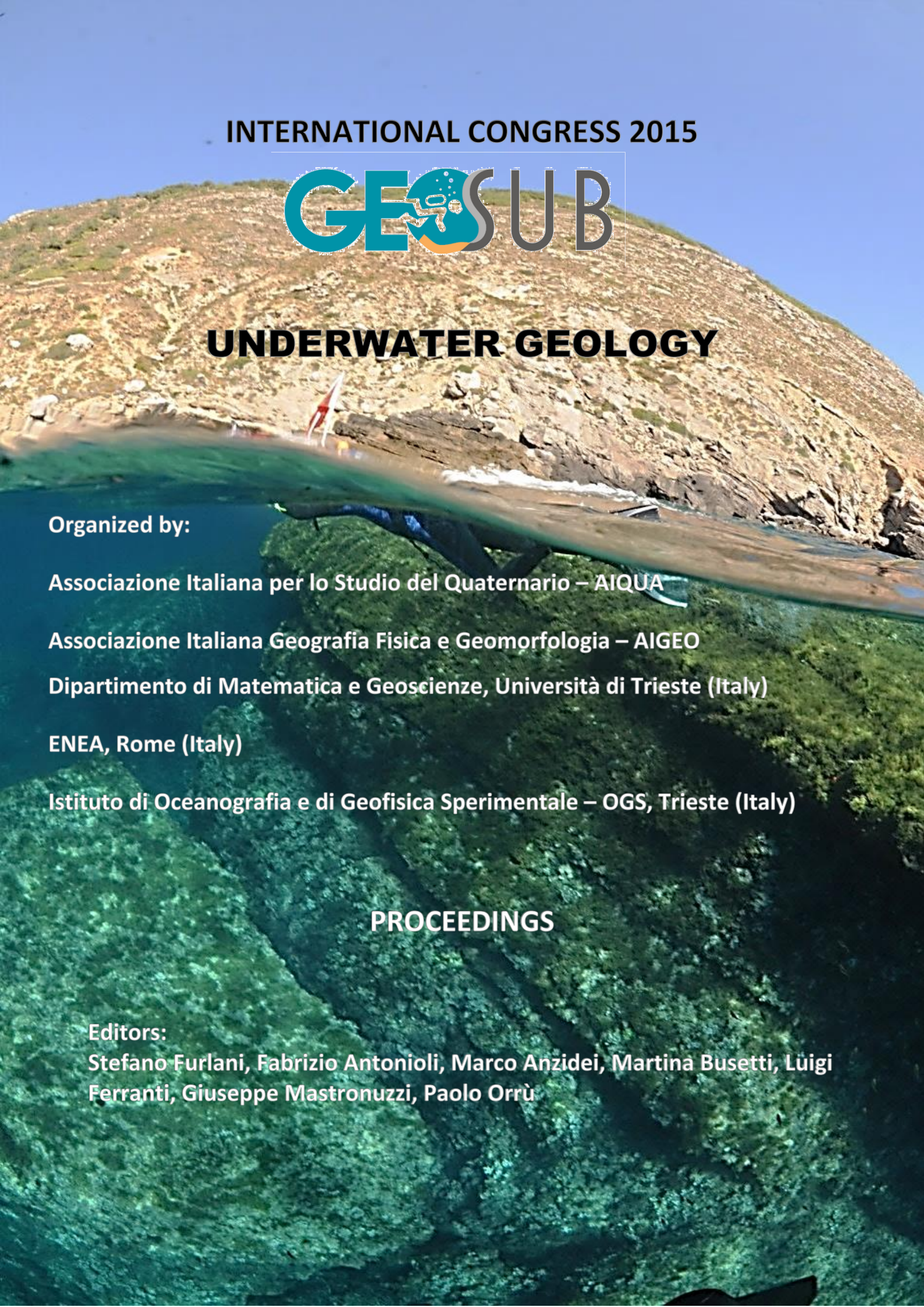
INTERNATIONAL CONGRESS 2015

GEOSUB

UNDERWATER GEOLOGY



Organized by:

Associazione Italiana per lo Studio del Quaternario – AIQUA

Associazione Italiana Geografia Fisica e Geomorfologia – AIGEO

Dipartimento di Matematica e Geoscienze, Università di Trieste (Italy)

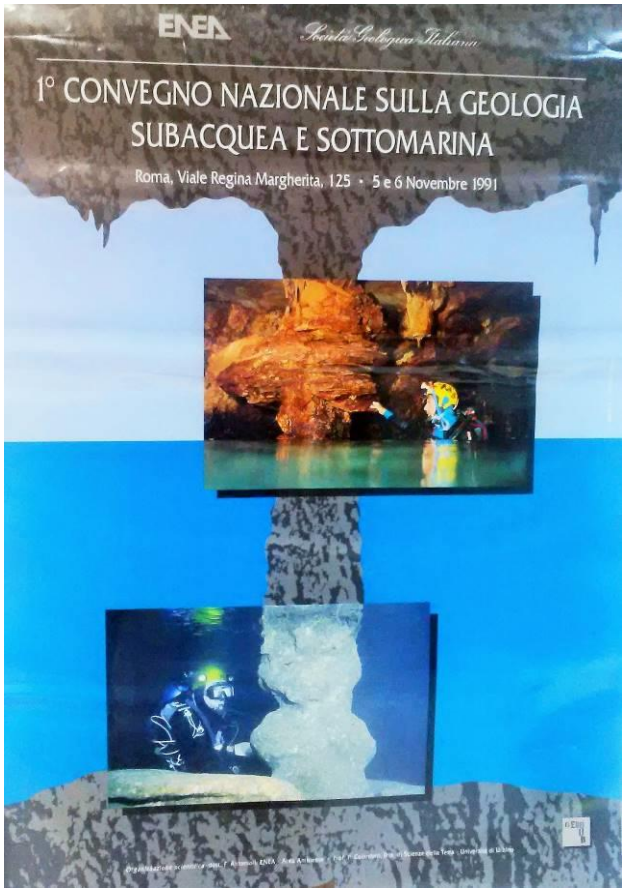
ENEA, Rome (Italy)

Istituto di Oceanografia e di Geofisica Sperimentale – OGS, Trieste (Italy)

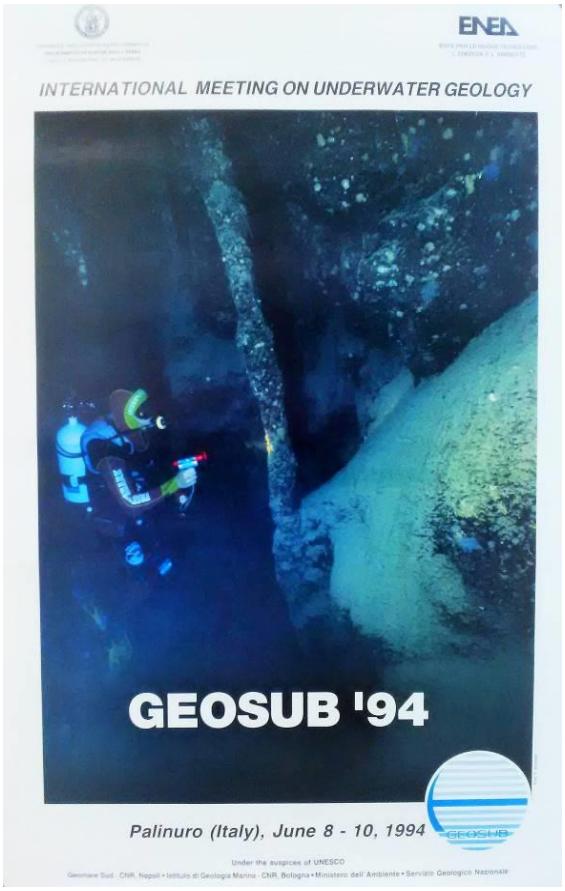
PROCEEDINGS

Editors:
Stefano Furlani, Fabrizio Antonioli, Marco Anzidei, Martina Busetti, Luigi Ferranti, Giuseppe Mastronuzzi, Paolo Orrù

GEOSUB 1991



GEOSUB 1994



"GEOSUB – Underwater geology": experiences in underwater environments

"GEOSUB - Underwater geology" is the third meeting about the most recent challenges in submarine and submerged geology. The meeting aims at bringing together all the experts involved in the underwater researches and explorations.

Cover photo: Fabrizio Antonioli

ORGANIZING COMMITEE

Fabrizio Antonioli (ENEA-SSTP MET CLIM, Roma, Italy), Marco Anzidei (INGV, Italy), Martina Busetti (INOGS, Italy), Luigi Ferranti (University of Napoli, Italy), Stefano Furlani (University of Trieste, Italy), Giuseppe Mastronuzzi (University of Bari, Italy), Paolo Orrù (University of Cagliari, Italy)

SCIENTIFIC COMMITTEE

Fabrizio Antonioli (ENEA-SSTP MET CLIM, Roma, Italy), Rita Auriemma (University of Salento, Italy), Marco Anzidei (INGV, Italy), Jonathan Benjamin (Flinders University, Australia), Martina Busetti (OGS, Italy), Stefano Covelli (University of Trieste, Italy), Franco Cucchi (University of Trieste, Italy), Jadran Faganeli (Marine Biology Station Piran, Slovenia), Luigi Ferranti (University of Napoli, Italy), Alessandro Fontana (University of Padova, Italy), Giorgio Fontolan (University of Trieste, Italy), Stefano Furlani (University of Trieste, Italy), Ritienne Gauci (University of Malta), Mladen Juračić (University of Zagreb), Paolo Montagna (CNR-ISMAR, Bologna, Italy), Giuseppe Mastronuzzi (University of Bari, Italy), Paolo Orrù (University of Cagliari, Italy), Alessio Rovere (MARUM, Potsdam, Germany), Giovanni Scicchitano (University of Messina – Geologis srl Academic Spin-off University of Messina), Giovanni Zanchetta (University of Pisa, Italy)

PROGRAM

13th OCTOBER 2015 – First day

8.30-9.00. Registration

9.00-9.15. Opening of the Conference

9.15-09.45. The history of GeoSUB (Antonioli F., Ferranti L.).

Projection of the movie Palinuro 1994

09.45-10.00. In memory of Paolo Colantoni (M. Taviani)

10.00-10.15. Presentation of GeoSUB 2015

10:15-10:45 - Coffee break

SESSIONS

IMPORTANT: **ORAL PRESENTATIONS: ALLOTTED TIME IS 15 MINUTES (12+3)**. When time expires, presentations will be closed.

10.45-12.00 - Paleogeographical reconstructions and coastal monitoring using remote survey solutions (AUV/UAV).

Convener: G. Scicchitano (University of Messina – Geologis srl Academic Spin-off University of Messina), E. Casella (Leibniz Center for Tropical Marine Ecology, Bremen, Germany - SEAMap srl, Environmental Consulting, MAGRI)

Anzidei M., Bosman A., Carluccio R., Casalbore D., Chiappini M., D'Ajello Caracciolo F., Esposito A., Fabris M., Nicolosi I., Pietrantonio G., Sepe V., Vecchio A.: ULTRA HIGH RESOLUTION DEM FROM THE INTEGRATION OF AERIAL AND MULTIBEAM SURVEYS: THE CASE OF LIPARI AND THE MULTITEMPORAL MAPS OF SEA LEVEL FLOODING FOR 2100

Feo R., Barbera G., Giuliano S., Pampalone V., Savarino S., Liuzzo M., De Marchis M., Freni G.: A COMBINED REMOTE SENSING APPROACH IN COASTAL ZONE: LASER SCANNER SURVEY AND AUV ECOMAPPER MONITORING IN ACI CASTELLO (CATANIA, SICILY)

Allotta B., Bartolini F., Costanzi R., Gelli J., Monni N., Natalini M., Pugi L., Ridolfi A., Rindi A.: AUTONOMOUS UNDERWATER VEHICLES: SOME TUSCAN EXPERIENCES

Allotta B., Bartolini F., Brandani L., Casagli N., Conti R., Costanzi R., Gelli J., Monni N., Mugnai F., Natalini M., Pugi L., Ridolfi A.: NEMO AND FEELHIPPO: LOW-COST UNMANNED UNDERWATER VEHICLES

D'Argenio A., Tulone M., Chemello R.: THE USE OF SMALL RPAS FOR THE HIGH RESOLUTION MAPPING OF THE MEDITERRANEAN INTERTIDAL VERMETID REEFS

12:00-13:30 – Lunch (Free)

13.30-15.45 - Underwater habitat mapping.

Convener: C.N. Bianchi (University of Genoa, IT), P.E. Orrú (University of Cagliari), A. Rovere (MARUM, University of Bremen & ZMT, Leibniz Center for Tropical Marine Ecology, Bremen) & LDEO, Columbia University, NY, M.Taviani (CNR-ISMAR, Bologna).

Foveau A., Dauvin J.-C., Lozach S., Baffreau A., Poizot E., Trentesaux A.: UNDERWATER IMAGERY AS A COMPLEMENTARY TOOL IN BENTHIC HABITATS DESCRIPTION

Misson G., Vacchi M., Montefalcone M., Bianchi C.N., Ferrari M.: *POSIDONIA OCEANICA* AND REFERENCE CONDITIONS: APPLICATION OF AN INNOVATIVE MODELING APPROACH

Micu D., Taviani M.: THE SHALLOW-WATER BIO-CONCRETIONNED HABITAT OFF PLAKATA CAPE, BULGARIA (BLACK SEA)

Tosi L., Donnici S., Bergamasco A., Da Lio C., Franchi F., Mazzoli C., Montagna P., **Taviani M.**: NEW INSIGHT IN UNDERSTANDING THE FORMATION OF NORTH ADRIATIC BIOGENIC HARD BOTTOMS (TEGNÙE)

De Sabata E., Vaccher V., Guallart J., Antonioli F., Anzidei M., Bellotto M., Dal Bo E., Furlani S., Montagna P., Orru' P., Navone A., Taviani M., Trainito E., Vacchi M.: BEDROCK TYPE AND OCCURRENCE OF PATELLA FERRUGINEA: THREE CASE STUDIES IN NORTH SARDINIA

Grande V., Angeletti L., Campiani E., Conese I., Foglini F., Leidi E., Mercorella A., Taviani M.: "HABITAT MAPPING" GEODATABASE, AN INTEGRATED INTERDISCIPLINARY AND MULTI-SCALE APPROACH FOR DATA MANAGEMENT

Orrù P., Cau A., Deiana G., Lo Presti V., Paliaga E.M., Todde S.: GEOHAB MAPPING ON SOUTH WESTERN SARDINIA CONTINENTAL SHELF (S. PIETRO ISLAND)

Angeletti L., Berov, D., Foglini, F., Grande, V., Taviani, M.: SCUBA TO ROV VISUAL GROUNDTRUTHING AND HABITAT MAPPING: MEDITERRANEAN AND BLACK SEAS EXAMPLES

15:30-16:00 - Coffee break

16.00-18.30 - Relative sea-level changes in the coastal and underwater area based on geomorphological, sedimentological and biological markers.

Convener: F. Antonioli (ENEA-SSTP MET CLIM), L. Ferranti (University of Napoli), P. Montagna (CNR-ISMAR)

Antonioli F., Furlani S.: THE USE OF SPELEOTHEMS AS SEA-LEVEL MARKERS

Ronchi L., Fontana A., Correggiari A.M., Remia A., Moscon G.: VERY-HIGH RESOLUTION SEISMO-ACOUSTIC AND MORPHOLOGIC INVESTIGATIONS OF A HOLOCENE TRANSGRESSIVE SYSTEM IN THE OFFSHORE OF COMACCHIO (NW ADRIATIC SHELF)

Scicchitano G., Antonioli F., Spampinato C.R., Monaco C., Lo Presti V.: SWIM-SURVEY OF THE ROCKY COASTS OF TINDARY PROMONTORY (SICILIY)

Ferranti L., Antonioli F., Carotenuto F., Fulgione D., Trapanese M., Raia P.: WHEN THE LIZARD BECAME BLUE? A PREDICTION OF SEA-LEVEL CHANGE ON SEA FLOODED ISLANDS BASED ON INTEGRATED DNA SEQUENCE AND MORPHOBATHYMETRIC DATA

Putignano M.L., Schiattarella M.: LATE PLEISTOCENE MORPHOTECTONIC EVOLUTION OF THE RIVIERA DI ULISSE BETWEEN MONTE DI SCAURI AND GAETA, CENTRAL ITALY

Antonioli F., Lo Presti V., Mannino M.A., Palombo M.R., Orrù P.: THE COLONIZATION OF SARDINIA BY ANATOMICALLY MODERN HUMANS

Foresta Martin F., Furlani S., Antonioli F., Cavallaro D., Chirco P., Caldareri F., Morticelli M.G., Monaco C.: SWIM-SURVEY OF THE ROCKY COASTS OF USTICA ISLAND (SICILIY)

Brunovic D., Miko S., Ilijanić N., Hasan O., Bakrač K., Hajek Tadesse V.: EARLY HOLOCENE MARINE DROWNING OF THE „KARST LAKE" PIROVAC BAY (COAST OF DALMATIA, CROATIA)

Faivre S., Bakran-Petricioli T., Barešić J., Horvatinčić N.: TWO MILLENNIA RELATIVE SEA-LEVEL CHANGE AND CLIMATE CHANGE IN THE NORTHERN ADRIATIC BASED ON ALGAL RIMS

Busetti M., Melis R., Antonioli F., Auriemma R., Biolchi S., Covelli S., Cucchi F., Dal Cin M., Furlani S., Trobec A., Vrabec M., Zampa L.: LATE QUATERNARY EVOLUTION OF THE EASTERN SECTOR OF THE GULF OF TRIESTE (NE ADRIATIC SEA)

Miko S., Ilijanić N., Hasan O., Papatheodorou G., Razum I., Bakrač K., Hajek Tadesse V., Christodoulou D., Brunović D., Iatrou M.: LOST LAKE LANDSCAPES OF THE EASTERN ADRIATIC SHELF (LOLADRIA)

14th OCTOBER 2015 – Second day

08.45-10.00 - Submarine and coastal morphodynamics: new legends and thematic mapping.

Convener: G. Mastronuzzi (University of Bari), S. Furlani (University of Trieste), P. Orrù (University of Cagliari), G. Fontolan (University of Trieste), R. Gauci (University of Malta)

Roner M., D'Alpaos A., Ghinassi M., Bellucci L., Brivio L., Fedi M.E., Vigliotti L.: ANALYSIS OF THE MORPHODYNAMIC EVOLUTION OF A SALT-MARSH SYSTEM IN THE LAST 1000 YEARS: INSIGHTS FROM THE SOUTHERN VENICE LAGOON

Devoto S., Foglini F., Prampolini M., Soldati M.: SUBMERGED LANDSLIDES ALONG THE NW COAST OF MALTA AND THE RELATIONSHIP WITH TERRESTRIAL LANDFORMS

Brandolini P., Baldassarre M.A., Bellotti P., Bini M., Bontempi S., Chelli A., Davoli L., Donadio C., Ferrari M., **Mastronuzzi G.**, Marsico A., Mucerino L., Nesci O., Pennetta M., Piacentini D., Raffi R., Sansò P., Tarragoni C., Valente A.: THE GEOMORPHOLOGICAL MAP OF THE ITALIAN COASTS: FROM A DESCRIPTIVE TO A MORPHODYNAMIC APPROACH

Mahmoud H., Regnauld H.: PAST AND PRESENT EVOLUTION OF THE COAST LINE ALONG THE CHANNEL IN THE REGION OF SAINT MALO: A MAN-MADE NATURAL COAST.

Furlani S.: SWIM SURVEYING AND ROCKY COASTS: THE GEOSWIM PROJECT FOR ROCKY COAST MAPPING

10.00-12.45 - Challenges in diving and cave diving: exploration and research.

Convener: L. Casati (Speleosub), A. Fabbricatore (CAI, Commissione Grotte E. Boegan"), S. Furlani (University of Trieste)

Casati L.: SPELEODIVING IN THE MEDITERRANEAN AREA (**Invited**)

Luchesi P., **Zini L.**: TIMAVO SYSTEM EXPLORATION

10.45-11:15 - Coffee break

Cavallaro D., Coltelli M., Chiocci F.L.: UNDERWATER GEOLOGICAL SURVEY IN THE SURROUNDINGS OF THE CICLOPI ISLANDS, ACITREZZA, CATANIA (ITALY)

Mo G., Provenzani C., Marassich A., Romano E.: CHARACTERIZATION OF MEDITERRANEAN MONK SEAL (MONACHUS MONACHUS) BONES IN BEL TORRENTE CAVE (SARDINIA, ITALY)

Bergamin L., Romano E., Celia Magno M., Berto D., Provenzani C., Marassich A.: THE ENVIRONMENTAL CHARACTERIZATION IN BUE MARINO CAVE (SARDINIA, ITALY) USING BENTHIC FORAMINIFERA

Romano E., Bergamin L., Pierfranceschi G., Berto D., Provenzani C., Marassich A.: THE ENVIRONMENTAL CHARACTERIZATION IN BEL TORRENTE CAVE (SARDINIA, ITALY) USING BENTHIC FORAMINIFERA

Petricioli D., Radolović M,. Bakran-Petricioli T.: IMPORTANCE OF IN SITU OBSERVATION IN UNDERSTANDING THE ECOLOGY OF MARINE CAVES (EASTERN ADRIATIC COAST)

Torlo E.: EXPLORATION AND ROUGH SURVEY OF THE CRITICAL ISSUES OF THE SUBMERGED PART OF THE DAM IN FRONT OF THE OLD PORT IN TRIESTE

12:45-14.00 – Lunch (Free)

14.00-15.15 - Maritime archaeology and sea level changes.

Convener: R. Auriemma (University of Salento), M. Anzidei (INGV)

Anzidei M., Antonioli F., Auriemma R., Benini A., Kolaiti E., Mourtzas N.: THE ARCHAEOLOGICAL EVIDENCE OF SEA LEVEL CHANGE IN THE MEDITERRANEAN: GUIDELINES AND SOME CASE STUDIES

Torab M., El Bardan E., Farghaly E., Moustafa S., Alaam E.: SUBMERGED ARCHAEOLOGICAL AND GEOMORPHOLOGICAL EVIDENCE OF THE HOLOCENE SEA LEVEL CHANGE IN RAS EL HEKMA COASTLINE, NW COAST OF EGYPT

Anzidei M., Bosman A., Casalbore D., Tusa S., La Rocca R.: EVIDENCE OF CONTINUOUS LAND SUBSIDENCE AT LIPARI ISLAND (AEOLIAN ISLANDS) FROM THE SUBMERGED ROMAN AGE PIER AT MARINA LUNGA

Lodolo E., Ben-Avraham Z.: A SUBMERGED MESOLITHIC SETTLEMENT DISCOVERED IN THE SICILIAN CHANNEL

Mastronuzzi G., Alfonso C., Antonioli F., Anzidei M., Auriemma R., Scarano R., Calcagnile L., Quarta G.: NEW ARCHAEOLOGICAL EVIDENCES OF RELATIVE SEA LEVEL CHANGES ALONG THE COASTLINES OF APULIA (SOUTHERN ITALY)

15:15-15:45. Coffee break

15.45-17.15 - Ancient and modern tidal channels: morphology and evolution.

Convener: Federica Rizzetto (Istituto di Scienze Marine, CNR)

Ceregato A., Rizzetto F., **Parente L.**: EVOLUTION OF TIDAL CHANNEL MORPHOLOGY OVER THE PAST CENTURIES: EVIDENCES FROM THE HISTORICAL MAPS OF THE "COMITATO TALASSOGRAFICO ITALIANO" AND THE "ISTITUTO DI STUDI ADRIATICI OF VENICE"

Madricardo F., Campiani E., Donnici S., Grande V., Fogarin S., Foglini F., Leidi E., Kruss A., Maselli V., Montereale Gavazzi G., Pellegrini C., Rizzetto F., Sarretta A., Sigovini M.: STUDY OF TIDAL CHANNEL AND PALAOCHANNEL MORPHOLOGY WITH UNDERWATER ACOUSTICS AND GROUND TRUTH SAMPLES

Finotello A., D'Alpaos A., Ghinassi M., Lanzoni S., Marani M., Howes N., Rinaldo A.: MIGRATION RATES OF TIDAL MEANDERS IN THE VENICE LAGOON.

Ghinassi M., D'Alpaos A., Brivio L., Finotello A., Roner M., Carniello L. Gasparotto A., Howes N.: STRATAL ARCHITECTURE AND FLOW DISTRIBUTION IN A TRANSLATING TIDAL POINT BAR, NORTHERN VENICE LAGOON (ITALY)

Brivio L., Ghinassi M., D'Alpaos A., Finotello A., Roner M., Fontana A., Howes N.: SEDIMENTARY FEATURES OF AN EXPANSIONAL TIDAL POINTBAR IN THE NORTHERN VENICE LAGOON (ITALY)

Moscon G., Correggiari A., Stefani C., Remia A., Fontana A.: MULTI-DISCIPLINARY APPROACH TO CHARACTERIZE ONE TRANSGRESSIVE DEPOSIT IN THE NORTHERN ADRIATIC SEA

17:15-17:45. Poster session

POSTERS

Berden Zrimec M., Poklar M., Moškon S.: UNDERWATER HABITAT MAPPING USING REMOTE SENSING TECHNIQUES

Busetti A., Furlani S., Antonioli F., Lo Presti V., Biolchi S., Zavagno E., Torricella F., Venturini E., Donati S.: GEOSWIM3.0 AT EGADI ISLANDS (SICILY, ITALY): RESULTS FROM 70 KM OF SWIM SURVEYING

Cirilli S., Gordini E., Petronio L., Fernetti M., Piscanc J., Cotterle D., Baradello L., Torlo E.: HIGH RESOLUTION INTEGRATED SURVEYS FOR THE STUDYING OF SEDIMETARY STRUCTURES IN MARINE ENVIRONMENTS: "IL DOSSO DI S. CROCE"

Dal Bo E., Furlani S., Antonioli F., Antonioli M., Anzidei M., Bellotto M., Vaccher V., Canziani F., Gauci R., Schembri J.: THE USE OF ROUGH BATHYMETRIC PROFILES FOR THE

GEOMORPHOLOGICAL CLASSIFICATION OF SUBMERGED ROCKY COASTS: THREE CASE STUDIES (NORTHERN SARDINIA, NE MALTA, EASTERN ISTRIAN COAST)

Dalal N., Torab M.: UNDE WATER GEOMORPHOLOGICAL MAP OF MEGA BOULDERS ON ALAM EL RUM, NW COAST OF EGYPT.

Donadio C., Pennetta M., Stanislao C.: GEOARCHEOLOGICAL AND GEOMORPHOLOGICAL EVIDENCES OF RECENT GROUND VERTICAL MOVEMENTS ALONG THE COAST OF CAMPANIA, SOUTHERN ITALY

Nour N., Torab M.: SUBMERGED COASTAL KARST LANDFORMS IN RAS EL-HEKMA, NW COAST OF EGYPT

Primoz V.: AN ANCIENT ROMAN ROAD OR JUST ANOTHER FLYSCH OUTCROP?

Rende F., Bacci T., Gennaro P., Penna M., Trabucco B., Cicero A.: OVERVIEW OF THE OPTICAL 3D MODELING APPLICATIONS FOR RECOSTRUCTION SHALLOW WATER HABITAT

Rende F., Dattola L., Corigliano C., Oranges T., Cozza R., Bitonti B., De Rosa R.: OPTICAL 3D MODELING APPLICATIONS FOR RECOSTRUCTION SHALLOW WATER HABITAT

Rizzetto F., Campiani E., Grande V., Kruss A., Leidi E., Madricardo F., Maselli V., Pellegrini C., Sarretta A.: GEOMORPHOLOGICAL INVESTIGATIONS ON PRESENT TIDAL CHANNELS: CASE STUDIES FROM THE NORTHERN VENICE LAGOON (ITALY)

Saleem A.: A RAISED MARINE SURFACE CORRELATED TO MARINE ISOTOPE STAGE (MIS7) IN THE NW MEDITERANEAN COAST OF EGYPT

Torab M., Moustafa S.: GEOMORPHOLOGY AND GEOARCHAEOLOGY OF HERMAEA ANCIENT HARBOUR, NW COAST OF EGYPT

Travan G., Morelli D., Furlani S., Passaro S., Ferranti L., Pepe F.: MORPHOBATHYMETRIC ARRANGEMENT AND RECENT TECTONIC OF THE GULF OF PATTI FROM NEW OCEANOGRAPHIC SURVEYS

Trobec A., Vrabec M., Busetti M., Zgur F., Baradello L., Babich A., Cova A., Gordini E., Romeo R., Tomini I.: THICKNESS OF MARINE HOLOCENE SEDIMENT IN THE GULF OF TRIESTE

Zampa L., Busetti M., Furlani S., Baradello L., Romeo R.: EVIDENCE OF NEO-TECTONIC TILTING IN THE GULF OF TRIESTE

Zecchin M., Ceramicola S., Lodolo E., Casalbore D., Chiocci F.L.: EVIDENCE OF RAPID SEA-LEVEL CHANGES ON THE CENTRAL MEDITERRANEAN SHELVES AFTER THE LAST GLACIAL MAXIMUM

ABSTRACTS OF ORAL AND POSTER PRESENTATIONS

(alphabetical order)

AUTONOMOUS UNDERWATER VEHICLES: SOME TUSCAN EXPERIENCES

Allotta B.[1,2], Bartolini F.[1], Costanzi R.[1], Gelli J.[1], Monni N.[1], Natalini M.[1], Pugi L.[1,2], Ridolfi A.[1], Rindi A.[1,2]

[1] *MDM Lab, Dept. of Industrial Engineering, University of Florence, Italy*
[2] *MDM Team SRL, Spinoff University of Florence, Italy*

This paper describes some experiences gained by the MDM Lab of the Dept. of Industrial Engineering of the University of Florence (UNIFI) in the framework of recent research projects. Some Autonomous Underwater Vehicles (AUV) and their operation in various Mediterranean and Baltic scenarios will be described.

AUVs are increasingly used for data collecting (e.g. optical images, sonograms, measurements about water properties and quality, etc.) in "rich" fields, such as defense, security, and Oil&Gas. Nowadays AUVs can be used in "poor" fields such as biology, geology, archaeology, as well as monitoring of fresh-water and marine infrastructures. The integration with sensors, such as CTD probes or magnetometers, makes the AUVs suitable for application in environmental monitoring or sea lines and cable ducts identification / inspection. In the coming future AUVs may be used in the monitoring of alpine lakes, whose characteristics are quickly modifying due to rapid climate changes. An integrated system based on the cooperation among AUVs, aimed at collecting and georeferencing bottom (and water column) sensory data, is an effective tool for many of the tasks described above.

The THESAURUS project http://thesaurus.isti.cnr.it/ was funded by Tuscany Region in the framework of the program PAR FAS, Action Line 1.1.a.3, devoted to "Sciences and Technologies for the Safeguard and the Promotion of Cultural Assets." THESAURUS stands for "TecnicHe per l'Esplorazione Sottomarina Archeologica mediante l'Utilizzo di Robot aUtonomi in Sciami." In the framework of the project, a novel class of AUVs named "Typhoon" has been designed and a dyad of Typhoon vehicles with rated depth 300m is operative since 2013. The main requirements for the Typhoon-class AUVs were: Moderate cost, Multi-role (different payloads), 8h autonomy, High manoeuvrability (hovering capabilities), Acoustic Communication Capabilities for Cooperative Underwater Exploration. A number of different mission has been performed with the Typhoon class AUVs, either in single vehicle fashion or in dyad configuration. Results from mission performed in Italy, Israel, and Croatia will be presented. 2D video and sonar mosaics as well as 3D reconstructions will be shown.

The FP7 project ARROWS http://www.arrowsproject.eu/ coordinated by the University of Florence proposes to adapt and develop low cost AUV technologies to significantly reduce the cost of archaeological operations. A modular hovering vehicle named MARTA (MArine Robotic Tool for Archaeology) with rated depth of 120m has been developed by the University of Florence in the framework of ARROWS and is now in operation. Results from a campaign to be performed in the Baltics in July 2015 will be presented.

NEMO AND FEELHIPPO: LOW-COST UNMANNED UNDERWATER VEHICLES

Allotta B.[1], Bartolini F.[1], Brandani L.[1], Casagli N.[2], Conti R.[1], Costanzi R.[1], Gelli J.[1], Monni N.[1], Mugnai F.[2], Natalini M.[1], Pugi L.[12], Ridolfi A.[1]

[1] *MDM Lab, Dept. of Industrial Engineering, University of Florence, Italy*
[2] *Dept. of Earth Science, University of Florence, Italy*

This paper describes some experiences gained by the University of Florence (UNIFI) on the development of two low-cost Unmanned Underwater Vehicles (UUV). The first one, named NEMO, is a Remotely Operated Vehicle (ROV) specifically designed for the exploration of the Costa Concordia wreck, Isola del Giglio, Italy. The second one, named FeelHippo, is an Autonomous Underwater Vehicle (AUV) purposely developed to participate to the 2013 edition of the SAUC-e student competition organized every year by at the NATO-STO Centre for Maritime Research and Experimentation (CMRE), La Spezia, Italy. SAUC-e 2013 has been a good test field for the preliminary testing of the AUV capabilities and FeelHippo ranked third in the competition.

On request of the Italian "Dipartimento della Protezione Civile (DPC) della Presidenza del Consiglio dei Ministri", the Department of Earth Science of the University of Florence, Center of Jurisdiction of the Protezione Civile itself, has coordinated the activities of monitoring and control of the ship stability. Such activities have been carried out in the framework of the coordination among the technical structure of the Protezione Civile and the operating forces (Vigili del Fuoco, Capitaneria di Porto, Marina Militare). In an emergency phase associated with a shipwreck, the underwater inspection, search and raising activities are strictly limited by the safety conditions of the operators. The ship deformations, the activities linked to the raising of the ship itself, make the safety conditions of the scuba-divers really critical. The employment of a versatile and handy underwater robot is consequently fundamental to reduce the exposure to risk for the underwater operators. Nemo ROV was born in this context. The specific goal of Nemo, was to have a detailed vision of the areas which are hardly accessible by divers. Particularly, the submarine, remotely piloted, had to operate as a robotized camera. Besides, the ROV had to be cheap and simple enough to pilot in order to allow a non-specialist to employ it easily. For this reason an on board control system based on IMU, compass, and pressure sensor so that the pilot had only to specify rotational speed, forward speed, heading, and depth. Auto depth, auto heading, and auto speed are implemented on board. Later on some patents on the use of NEMO for mapping submerged slopes and close-to-vertical surfaces and for collecting water samples have been produced.

Based on the experience made with NEMO ROV, a new low-cost vehicle, this time an AUV, has been developed by the University of Florence in order to participate to the student competition SAUC-e 2013. FeelHippo is a low-cost AUV (its cost is around 13000 Euro, less than a small commercial ROV). It is able to perform monitoring and patrolling tasks and may result useful in various scientific applications. The vehicle can be used either as an ROV or as an AUV, depending on the task at hand. It has several navigation sensors allowing to perform quite accurate dead reckoning, an acoustic modem for underwater comms as well as sonar and video payload to acquire data from the field.

SCUBA TO ROV VISUAL GROUNDTRUTHING AND HABITAT MAPPING: MEDITERRANEAN AND BLACK SEAS EXAMPLES

Angeletti L.[1], Berov D.[2], Foglini F.[1], Grande V.[1], Taviani M.[1]

[1] *ISMAR-CNR, Bologna, Italy*
[2] *IBER-BAS, Bulgaria*

The new EU CoCoNET classification scheme described by Grande et al. (*this volume*) identifies three main levels for multiscale habitat mapping that organized in a hierarchical structure: 1) Geomorphological Level; 2) Substrate Level; 3) Biological Level. The applicability of this scheme was tested for coastal and deep sea situations in the two CoCoNET Pilot Project areas, i.e. the Black Sea and southern Adriatic Sea, respectively.

Visual groundtruthing of a coastal sector of the Bulgarian Black Sea was performed by SCUBA diving, providing a detailed coverage of the area through several photographic transects. This survey resulted in a complete microscale habitat mapping of the area, identifying six different habitats, variously dominated by macroalgae (e.g., *Phyllopora*, *Cystoseira*), seagrasses (e.g., *Zoostera*) or aggregations of macroalgae and invertebrates (e.g., *Cystoseira* and *Mytilus*).

We did apply this GIS-based method to meso- and microscale habitat mapping of the deep (> 200 m) western and eastern slopes of the southern Adriatic margin (Central Mediterranean Sea). The 'visual' groundtruthing was performed here by means of the Remote Operating Vehicle (ROV) which can provide direct information deep water mega- and macrobenthic communities. Five different benthic habitats along the western (Italian margin) and eastern slopes (Montenegrin, Albanian and Greek margins) have been recognized and mapped, which are dominated by large cnidarians (e.g., *Madrepora*, *Desmophyllum*, *Leiopathes* and *Callogorgia*), and sponges.

These examples demonstrate that this approach is functional at describing in a consistent way Mediterranean and Black Sea marine benthic habitats, at different scale and bathymetries. It is somewhat independent from the sampling methods, and also represents an efficient method for monitoring the coastal and basinal environments.

References

GRANDE V., ANGELETTI L., CAMPIANI E., CONESE I., FOGLINI F., LEIDI E., MERCORELLA A., TAVIANI M., 2015. "Habitat Mapping" Geodatabase, an integrated interdisciplinary and multi-scale approach for data management. International Conference 2015 GEOSUB, Underwater Geology, Trieste, 13-16 October 2015.

THE COLONIZATION OF SARDINIA BY ANATOMICALLY MODERN HUMANS

Antonioli F.[1], Lo Presti V.[2], Mannino M.A.[3], Palombo M.R.[2], Orru P.[4]

[1] *ENEA, SSPT MET CLIM, Italy*
[2] *La Sapienza University, Rome, Italy*
[3] *Max Plank institute, Lipsia, Germany*
[4] *University of Cagliari, Italy*

The time and mode of human dispersal onto Mediterranean islands is a hotly debated question. A multidisciplinary approach combining palaeogeographical reconstructions with biological and archeological evidence is of crucial importance to acquire information on island colonization by Homo sapiens during the Late Pleistocene.

The hypothesis of a Mid-Pleistocene dispersal on Sardinia by hominins is questionable. H. sapiens remains have been found in early Holocene deposits at Corbeddu cave and S Omu e S Orku respectively 8.7 and 8.5 ka BP, while further evidence is required to support the hypothesis of a presence during the LGM.

A study of a human tooth from Dragonara cave (Porto Conte gul), and a reappraisal of the geological-environmental context of this site provide fresh data for debate, confirming the presence of H. sapiens on the island when the minimum distance between Corsica and the mainland coasts of Italy was about 15 km. The palaeogeographic reconstruction allows us to evaluate the navigation exploits of Sardinian settlers, when hunter-gatherers were colonizing Sicily on foot (Antonioli et al., 2014). Using new radiocarbon analysis on human and mammals tooth, Patella food remain and archaeological site of Grotta Verde, we provide a paleogeografic reconstruction of the Porto Conte Capo Caccia area during last 21 ka cal BP, focusing on Neolithic time slice.

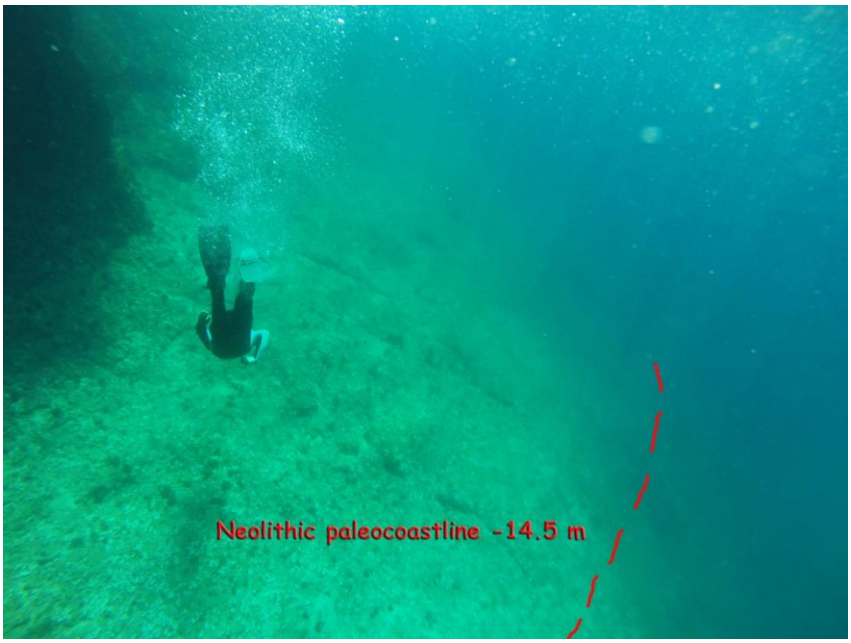


Fig. 1: Paolo Orru' diving above the Neolithic coast, Portoconte (Sardinia)

References

F. ANTONIOLI, V. PRESTI, M. MORTICELLI, L. BONFIGLIO, M. MANNINO, ET AL. (2014). Timing of the emergence of the Europe–Sicily bridge (40–17 cal ka BP) and its implications for the spread of modern humans (2014) Geological Society, London, Special Publications 411, SP411. 1.

SWIM-SURVEY OF THE ROCKY COASTS OF TINDARY PROMONTORY (SICILIY)

Antonioli F.[1], Scicchitano G.[2,3], Spampinato C. R.[4], Monaco C.[5], Lo Presti V.[6]

[1] *ENEA, SSPT MET CLIM Roma, Italy*
[2] *Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Messina, Italy*
[3] *Geologis, SpinOff del Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Messina, Italy*
[4] *INGV, Sezione di Catania, Italy*
[5] *Dipartimento di Scienze Biologiche, Geologiche ed Ambientali, Università di Catania, Italy*
[6] *Dipartimento di Scienze della Terra, "Sapienza" Universita', Roma, Italy*

The Geoswim project (www.facebook.com/geoswim) aims at surveying the Mediterranean rocky coasts (Furlani et al., 2014), it started in 2012 and now other group of research adopted the same method in several part of Mediterranean. In September 2015 we surveyed a short but interesting coastal site: the Tindari promontory located along the Tyrrhenian coast of Sicily, its impervious and steep shorelines do not permit a direct access to the area, that results to be accessible only from the sea. The promontory face at the sea with vertical escarpment up to 80-100m in height, it composed of metamorphic crystalline rocks, middle to high methamorphic grade, sometimes, when felsic Ca-silicatit marbles outcrop, the morphology results interested by the presence of different notches, emerged and submerged, and several biogenic encrustation such as litophaga and bryozoa.

Vertical tectonic uplift rates have been estimated for the (Ferranti et al 2010, Scicchitano et al., 2011) MIS 5.5 in less than 1mm\yr and they result higher during the Holocene for which a rate of 1,6 mm/yr has been calculated for the site of Brolo (Sulli et al., 2012) located close to the Tindari promontory. Although data suggest an important tectonic uplift during the Holocene for the area of Tindari, no evidences have been found at now confirming this uplifting.

The survey was carried out during one day of skin diving using instruments such as two underwater cameras to observe the tidal zone, a DGPS to georeference morphologies and deposits, an invar rods to measure the geometry of the surveyed area. Many geomorphological data have been collected: position and height of notches, geometry of the main morphologies of the notches, position and height of deposit and bio encrustation levels.

We observed and surveyed a semi continuous present day roof notch, that results more evident and preserved in the coastal sector where the carbonatic component of metamorphic crystalline rocks is higher, an uplifted marine notch at an altitude between 7 and 5.8 m and a submerged erosional notch more evident in sheltered area was studied. The marine notch higher respect the present sea level, although it have always the same geometry, show an important difference in altitude in only 500 metres of coast. We sampled and gave a radiocarbon age ot a fossil Lithophaga shell. We will describe the uplifted and the submerged notches trying to determinate their origin and development and to estimate rate of vertical movement for the Holocene on the basis of the analyses of their position and age.

Fig. 1. Submerged marine notch at Tindari promontory

References

BONFIGLIO L., MANGANO G., PINI P., (2010). The contribution of Mammal-bearing deposits to timing late Pleistocene Tectonics of Cape Tindari (NE Sicily). Rivista Italiana di Paleontologia e Stratigrafia, 116, 103-118.

FERRANTI L., ANTONIOLI F., ANZIDEI M., MONACO C., STOCCHI P., (2010). The timescale and spatial extent of vertical tectonic motions in Italy: insights from relative sea-level changes studies. Journal of the Virtual Explorer, Electronic Edition, ISSN 1441-8142, 36, paper 30.

SCICCHITANO G., LO PRESTI V., SPAMPINATO C., ANTONIOLI F., FERRANTI L., GASPARO M., MONACO C., AURIEMMA R., (2011). Millstones as indicators of relative sea level changes in northern Sicily and southern Calabria coastlines Quat. Int. 232, 1-2, 92-104 doi:10.1016/j.quaint.2010.08.019

SCICCHITANO G., SPAMPINATO C., FERRANTI L., ANTONIOLI F., MONACO C., LUBRITTO L., (2011). Uplifted Holocene shorelines at Capo Milazzo (NE Sicily, Italy): evidence of co-seismic and steady state deformation, Quat. Int. 232, 1-2, 201-213 doi:10.1016/j.quaint.2010.06.028

SULLI A., LO PRESTI V., MORTICELLI M.G., ANTONIOLI F., (2012). Vertical movements in NE Sicily and its offshore. Outcome of tectonic uplift during the last 125 kyr. Quat. Int. 10.1016/j.quaint.2012.01.021.

THE USE OF SPELEOTHEMS AS SEA-LEVEL MARKERS: NEW DATA FROM FAVIGNANA

Antonioli F.[1], Furlani S.[2]

[1] *ENEA SSPT-MET-CLIM, Rome, Italy*
[2]*University of Trieste, Italy*

The potential of using speleothems to reconstruct former sea levels was first recognized in the early 1970s. The numerous studies of submerged speleothems up to 84 m deep from Holocene age up to MIS 37 in Pleistocene allowed a significant advance in unravelling the timing and duration of glacial and interglacial relative sea-level changes. Speleothems keep track of past sea-level fluctuations because their sequential steady growth occurring in subaerial conditions is interrupted during inundations. Therefore, series of marine transgressions may show up as hiatuses within a speleothem section. Dating the cessation and re-initiation of speleothem growth, and thereby delimiting the hiatuses, can be achieved by sampling the carbonate bellow and above the growth hiatus.

Speleothem overgrowths have also been used for sea-level studies. Radiocarbon dating of Litophaga that colonised the speleothem surface when the cave was flooded provided an age constraint of the sea-level rise to the radiocarbon sampling level. Uranium-thorium dating of calcite overgrowths forming within the tidal range in cave pools in coastal areas on the other hand provide sea level timing, fluctuation, and elevation during sea-level stands.

The case studies of the main sites (Bahamas, Argentarola (Italy), Mallorca (Spain), Krk (Croatia) have been described by Van Hengstum et al. (2015). However, promising preliminary results have been recently obtained from on-going studies of phreatic overgrowths on Minami Daito island (Japan) and in Favignana (Italy).

Fig. 1. Speleothems in a coastal cave

References

PETER J. VAN HENGSTUM, DAVID A. RICHARDS, BOGDAN P. ONAC, JEFFREY A. DORALEV (2015). Coastal caves and sinkholes, Handbook of sea level, Handbook of Sea Level Research Ian Shennan Antony Long, Benjamin Horton Eds. 268 – 280.

MIKLAVIČ B., URATA K., YOKOYAMA Y., KANO A., KAN H., (2015): Phreatic overgrowths on speleothems on Minami-Daito Island in Northern Philippine Sea as a Holocene sea level indicator. Poster presented at: XIX INQUA Congress, Quaternary perspectives on climate change, natural hazards and civilization; 26 July – 2 August 2015, Nagoya, Japan.

ULTRA HIGH RESOLUTION DEM FROM THE INTEGRATION OF AERIAL AND MULTIBEAM SURVEYS: THE CASE OF LIPARI AND THE MULTITEMPORAL MAPS OF SEA LEVEL FLOODING FOR 2100

Anzidei M.[1], Bosman A.[2], Carluccio R.[1], Casalbore D.[2], Chiappini M.[1], D'Ajello Caracciolo F.[1], Esposito A.[1], Fabris M.[3], Nicolosi I.[1], Pietrantonio G.[1], Sepe V.[1], Vecchio A.[1]

[1]*Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy*
[2] *Istituto di Geologia Ambientale e Geoingegneria, Consiglio Nazionale delle Ricerche, Rome, Italy*
[3]*Università di Padova, Italy*

The villages of Marina Lunga and Marina Corta, which are the main harbors of the island of Lipari (Aeolian islands, Italy), developed along the shoreline during the past centuries as most of the villages of the Mediterranean. These areas are undergoing to land subsidence, beach retreat, heavy flooding caused by large flow of debris from inland and severe storms.

In this framework, very high resolution Digital Elevation Models (DEM) represent a main tool for hazards analysis and landscape changes of coastal areas. During the past years, DEMs of terrestrial areas have been traditionally generated by aerial photogrammetric surveys from aircrafts, providing accurate results, by at high costs. The recent developments of ultra-light Unmanned Aerial Vehicles (UAV) open new opportunities on the acquisition of fast high resolution topographic data from low altitude flights at low costs. Therefore acquisition and mapping activities are becoming more cost effective compared to traditional aerial vehicles from airborne surveys. In addition, the merging with high resolution multibeam bathymetry data in very shallow water, can provide excellent integrated DEM of coastal zones.

On these bases, the first ultra-high resolution DEM for the island of Lipari at Marina Lunga and Marina Corta harbors was recently realized, by combining rapid UAV surveys along with multibeam bathymetric data. Taking into account the current isostatic rates, the expected climate change from IPCC reports and rates of land subsidence estimated from historical and instrumental data, we provided the first relative sea level rise projections and multitemporal maps of flooding scenarios for the coast of Lipari for the year 2100.

EVIDENCE OF CONTINUOUS LAND SUBSIDENCE AT LIPARI ISLAND (AEOLIAN ISLANDS) FROM THE SUBMERGED ROMAN AGE PIER AT MARINA LUNGA

Anzidei M.[1], Bosman A.[2], Casalbore D.[2], Tusa S.[3], La Rocca R.[3]

[1] *Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy*
[2] *Istituto di Geologia Ambientale e Geoingegneria, Consiglio Nazionale delle Ricerche, Rome, Italy*
[3] *Soprintendenza del Mare della Sicilia, Palermo, Italy*

We show and discuss data on the relative sea level change estimated from a submerged pier of Roman age dated back at 2100±100 years BP, located along the coast of Marina Lunga, at Lipari island (Aeolian islands, Italy). This pier, of about 140x60 m of size, was accidentally discovered in 2008 during preliminary excavations for the construction of a new pier. Its top surface is presently located at -9.1±0.05 m, while the foundations at the outer end of the pier are at -11.6±0.05 m, above a shoreline placed at -13.0±0.05 m. We studied this site through direct archaeological investigations and ultra-high resolution multibeam bathymetry.

We explain the current position of this pier by the cumulative effect of the relative sea level changes caused by the regional glacio-hydro-isostatic signal, active since the end of the last glacial maximum, and the local volcano-tectonic land subsidence. From our investigations, a relative sea level change at 12.3±0.7 m with a subsidence rate at 5.79±0.01 mm/yr-1 and an average value of volcano-tectonic contribution at 5.17±0.01m/yr-1 for the last 2100±100 years BP, is estimated from the comparison against the latest predicted sea level model for the Southern Tyrrhenian Sea. These rates of relative sea level change, led to the disuse of the harbor after around the fourth century AD, in agreement with archaeological interpretations. Our results are in agreement with recent instrumental data and provide new insights on the recent coastal evolution of this active volcanic island.

THE ARCHAEOLOGICAL EVIDENCE OF SEA LEVEL CHANGE IN THE MEDITERRANEAN: GUIDELINES AND SOME CASE STUDIES

Anzidei M.[1], Antonioli F.[2], Auriemma R.[3], Benini A.[4], Kolaiti E.[5], Mourtzas N.[5]

[1] *Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy*
[2] *ENEA - UTMEA, S. Maria di Galeria, Rome, Italy*
[3] *Dipartimento di Beni Culturali, Università del Salento, Lecce*
[4] *Dipartimento di Archeologia e Storia delle Arti, Università della Calabria, Italy*
[5] *Gaiaergon, Athens, Greece*

The maritime archaeological indicators play a crucial role for the reconstruction of past relative sea levels in the Mediterranean basin, filling the gap between geology and modern instrumental data. During the last decades several studies have presented different estimates of the relative sea level change in same locations using these indicators. Discrepancies can be mainly addressed to: i) preserved sea level markers within these structures, ii) archaeological interpretations, iii) methods of investigations and analysis, iv) geophysical models.

Therefore, it is crucial to define rigorous guidelines to use the archaeological indicators for relative sea level studies. In particular, the functional elevation which is defined from the elevation of specific architectural parts with respect to the local mean sea level at the time of its construction at that location. It provides the reference plane for determining the amount of relative sea-level change from the type of structure, its use and the local tide amplitudes. Results arising from the archeological indicators show the effects of the geodynamic processes and landscape evolution in consequence of active tectonics, volcanism, glacio-hydro-isostatic and eustatic factors that have affected the Mediterranean basin during the last ~ 2.5 ka BP.

Here we show and discuss some recent results for the Mediterranean and new relative sea level change estimates for and the Tyrrhenian coast of Italy from a robust set of Roman age fish tanks.

UNDERWATER HABITAT MAPPING USING REMOTE SENSING TECHNIQUES

Berden Zrimec B.[1], Poklar M.[1], Moškon, S.[1]

[1] *Harpha Sea, d.o.o. Koper*

Marine environment is facing declining ecosystem health and productivity. The ocean plays a central role in supporting all life on Earth as well as provides a wide range of services and resources that directly support human health, societies and economies (Global Ocean Commission, 2014). According to European Commission the marine based economy is held back by a lack of information about the sea, the seabed and the life it supports. Increased knowledge of our seas will indeed promote growth, but only if based on the understanding of ecosystem dynamics and processes.

In the case of seabed, the knowledge about habitats as well as seabed integrity is crucial to support biodiversity, functioning of the ecosystem and its sustainability. By a frequent monitoring of the environmental status, whish enables prompt and relevant information, we can address the lack of knowledge and subsequently achieve a good environmental status. After realizing the environmental and economical importance of the seabed habitats (especially seagrass meadows and coral reefs), monitoring and classification have become widespread in many countries. Nevertheless, the knowledge remains deficient. One of the reasons is expensive, time-consuming and logistically complicated methodology.

Remote sensing enables frequent monitoring of large areas, providing detailed information on the seabed habitats. Geo-referenced data can be easily utilized for providing an easily accessible and interoperable maps of seabed habitats, and represent a good basis for a more detailed inspection directly on the field (ground truthing).

Recently, the advancement in technology enabled significant progress in the mapping of land using optical methods as well as automatic classification. In the water environment, optical methods are challenging due to the limitations in light penetration, especially in the turbid waters. On the other hand, acoustic techniques using single-beam acoustic ground discrimination systems, sidescan sonar systems, and recently also multi-beam echo sounders, represent excellent tools for studying large areas of the sea-bottom.

We developed an automatic methodology for the seabed mapping of large areas. The data from multibeam sonar were treated by the specially developed automatic processing of the acoustic data, to generate seabed types maps in the period of few hours. Multibeam sonar enables measurements of up to 10 square kilometers of seabed a day, with resolution of less than 20 centimeters.

Our method enables continuous coverage (no need for interpolation), speed and applicability to a large scale mapping. In the case of seagrass meadows, indicators of distribution like presence/absence, area distribution and distribution limits can be easily monitored. These indicators can be affected by eutrophication, changes in coastal infrastructure, dredging, anchoring, traffic, etc.

Geo-referenced data from remote sensing can be easily utilized for providing an easily accessible and interoperable maps of seabed habitats, and represent a good basis for a more detailed inspection directly on the field. The method is currently being upgraded with video imaging and 3D maps.

THE ENVIRONMENTAL CHARACTERIZATION IN BUE MARINO CAVE (SARDINIA, ITALY) USING BENTHIC FORAMINIFERA

Bergamin L.[1], Romano E.[1], Celia Magno M.[1], Berto D.[1], Provenzani C.[2], Marassich A.[2]

[1]ISPRA, Institute for Environmental Protection and Research. Via V. Brancati 48, 00144 Rome (Italy)
[2]GUE, Global Underwater Explorers, Highsprings, Florida, USA

Benthic foraminifera are a group of marine protozoans very abundant in sediments, which quickly respond to environmental changes due to their short life-cycle. Most species have a hard shell, which may be agglutinated (built with sediment collected on site), calcareous perforate (hyaline) or calcareous imperforate (porcelaneous) and that may be preserved in the sedimentary record. Because they are present also in brackish environments they are supposed to be an ideal tool to identify distinct environments in underwater caves, where the contribution of marine and continental waters determines a seasonal change of environmental parameters. The use of foraminifera as environmental indicators in underwater caves of Mediterranean Sea is a new challenge that has to be tested by the present research, because the presence of foraminifera was never recorded before.

The Bue Marino Cave is located 4 km south of the Cala Gonone village, East Sardinia (Italy). It is a very complex cave, organized in three main branches and has several entrances, with a network of minor intersecting branches in the outer part. This area was sampled with a total of 15 sampling stations, placed from the entrance to the inner zone, at 30 m distance, after the re-survey of guideline in order to have a georeferred position of each station in the cave, starting from GPS position of the open water primary station. Sediment was sampled and analyzed for benthic foraminifera (living and dead), grain size, Total Organic Carbon (TOC), Total Nitrogen (TN), $\delta^{13}C_{org}$, $\delta^{15}C_{org}$, C:N, with the aim to identify distinct cave environments characterized by different terrestrial and marine contributions by means of abiotic and biotic parameters.

As a preliminary result, an environmental characterization was based on the total (living + dead) foraminiferal assemblages and their composition and structure were considered for environmental reconstruction of the cave. The Q-mode cluster analysis was applied as a tool to recognize groups of samples characterized by homogeneous assemblages. These clusters correspond to distinct ecological zones inside the cave: entrance zone, outer cave zone, and the intermediate cave zone. The entrance zone is limited to the first 30 m of the cave and is characterized by the typical marine assemblage with the prevalence of hyaline taxa, particularly the symbiont-bearing *Peneroplis pertusus*, associated to *Elphidium crispum*, and higher abundance of porcelaneous taxa, with respect to the other zones. The outer cave zone is distributed between 60 and 300 m from the entrance and is characterized by the highest foraminiferal abundance, with the prevalence of hyaline taxa such as the epifaunal *Gavelinopsis praegeri* and the infaunal *Bolivina variabilis*. However, also agglutinated taxa like as *Cribrostomoides jefferysi* may be rather abundant. The intermediate cave zone ranges from 330 to 450 m from the entrance. It shows the lowest foraminiferal abundance with the prevalence of agglutinated taxa such as *Reophax nana*, *Eggerella advena* and *Lepidodeuterammina ochracea*. The epifaunal *Rosalina bradyi* characterizes the whole cave environment, being ubiquitous both in the outer and intermediate zone. The increasing environmental stress from marine to cave environment is not recorded by species diversity, while it is highlighted by lower foraminiferal abundance in the intermediate cave zone. Entrance and outer zone reflect stronger marine influence being dominated by marine coastal hyaline taxa, while the passage from a hyaline-dominated to an agglutinant-dominated assemblage marks the transition from the outer to the intermediate cave zone to indicate a possible $CaCO_3$ under-saturation.

THE GEOMORPHOLOGICAL MAP OF THE ITALIAN COASTS: FROM A DESCRIPTIVE TO A MORPHODYNAMIC APPROACH

Brandolini P.[1], Baldassarre M.A.[2], Bellotti P.[2], Bini M.[3], Bontempi S.[2], Chelli A.[4], Davoli L.[2], Donadio C.[5], Ferrari M.[1], Mastronuzzi G.[6], Marsico A.[6], Mucerino L.[1], Nesci O.[7], Pennetta M.[5], Piacentini D.[7], Raffi R.[2], Sansò P.[8], Tarragoni C.[2], Valente A.[9]

[1] *Università degli Studi di Genova, Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Italy*
[2] *Università degli Studi di Roma Sapienza, Dipartimento di Scienze della Terra, Italy*
[3] *Università degli Studi di Pisa, Dipartimento di Scienze della Terra, Italy*
[4] *Università degli Studi di Parma, Dipartimento di Fisica e Scienze della Terra"M. Melloni", Italy*
[5] *Università degli Studi Napoli Federico II, Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Italy*
[6] *Università degli Studi di Bari, Dipartimento di Scienze della Terra e Geoambientali, Italy*
[7] *Università degli Studi di Urbino, Dipartimento di Scienze della Terra, della Vita e dell'Ambiente, Italy*
[8] *Università degli Studi del Salento, Lecce, Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Italy*
[9] *Università degli Studi del Sannio, Benevento, Dipartimento di Scienze e Tecnologie, Italy*

This work has been carried out in the framework of the Working Group (WG) "Coastal Morphodynamics" of the Italian Association of Physical Geography and Geomorphology (AIGeo), in the wider context of AIGEO cooperation with the Institute for the Protection and Environmental Research (ISPRA) for the updating of the legend for the "Geomorphological Map of Italy".

The WG dealt with the coastal part of the legend and the attention has been focused on marine, lagoon, lacustrine and eolian landforms, processes and deposits. The legend has been particularly addressed to coastal zoning of geomorphological hazard and risk situations to support land planning and management.

With this task, the proposed legend aims to represent at different scale not only the coastal landscape highlighting the origin of every landform but also its dynamics and trend. The legend has been drown to provide information about the morphological characteristics at small and great detail. The relict morphological features and the active ones are reported together with the quantitative parameters useful in the description of the present morphodynamic and wave climate conditions.

On the basis of the activities and experiences carried out by the "Coastal Morphodynamics" AIGeo WG, during the last year some examples of coastal geomorphological mapping at different scale (1:5.000 and 1:25.000) are performed. They have been addressed particularly to the problems both of littoral plain and rocky coast dynamics and to the interactions with anthropic interventions.

SEDIMENTARY FEATURES OF AN EXPANSIONAL TIDAL POINTBAR IN THE NORTHERN VENICE LAGOON (ITALY)

Brivio L.[1], Ghinassi M.[1], D'Alpaos A.[1], Finotello A.[1], Roner M.[1], Fontana, A.[1], Howes, N.[2]

[1] *Dept. of Geosciences, University of Padova, Via Gradenigo 6, 35131 Padova, Italy*
[2] *Shell Technology Center Houston, 3333 Highway 6 South, Houston, TX 77082-3101, US*

Tidal settings are dissected by networks of branching and meandering channels, which actively control the hydrodynamic circulation and morphodynamic evolution of these areas. Despite their key role, the description of the morphodynamic evolution of tidal meanders is still poorly investigated. Moreover, their internal architecture is relatively unexplored and is usually investigated on the basis of facies models developed in analogy with their fluvial counterparts.

The present study aims at improving current understanding of these issues by investigating the internal architecture of an abandoned intertidal meander loop, located in the NE sector of the Venice Lagoon (Italy), and by defining high-resolution facies models of related point bar deposits. The abandoned meandering channel is 6 m wide, the loop axis is oriented NW-SE, and the radius of curvature is approximately 24 m. The analysis of historical photos reveals that the channel was active until the latest 40's of 20th century.

Using a hand auger core sampler, which minimizes sediment compaction,150 cores were collected over an area of about 450 m^2. Cores are 3.5 cm in diameter, and coring depth spans from 1 to 3 m. Core logging was carried out following the basic principles of facies analysis, and allowed us to distinguish five types of deposits, namely: sub-tidal platform, salt-marsh, channel lag, point bar, and channel fill. Sub-tidal platform deposits are made up of grey-bluish mud with shell-rich sandy layers. Salt-marsh deposits are characterized by brown mud, with a variable amount of fine to very fine sand, which commonly occurs in millimetric laminae. Bioturbation, roots and wood fragments are common. Channel lag deposits consist of massive grey-bluish medium sand, with mud clasts, wood fragments and shells, overlying an erosional surface cut onto the sub-tidal platform deposits and covered by point bar deposits. The latter show a clear fining upward trend, defined by

grey-bluish fine sand sediments grading into sandy mud. These deposits are commonly bioturbated, although traces of the primary lamination are locally preserved. Channel fill deposits consist of massive, dark grey-bluish, organic-rich mud. Rare shells in life position occur.

An high-resolution 3D architectural model was developed from logs correlation, and four key surfaces were defined: sub-tidal platform/salt-marsh boundary, point bar base, point bar top and channel base. From the 3D model we observed that during meander bend expansion, thalweg migration followed a horizontal trajectory, generating a flat surface floored by channel lag deposits, while the trajectory defined by lateral migration of the inner channel bank shows a clear rising trajectory, pointing to a progressive increase in channel depth. Such a process reflects meander bend migration under strong aggradation of surrounding overbanks, and appears to be a distinctive feature of tidal channels in salt-marsh settings.

EARLY HOLOCENE MARINE DROWNING OF THE „KARST LAKE" PIROVAC BAY (COAST OF DALMATIA, CROATIA)

Brunović D.[1], Miko S.[1], Ilijanić N.[1], Hasan O.[1], Bakrač K.[1], Hajek Tadesse V.[1]

[1] *Croatian Geological Survey, Sachova 2, 10000 Zagreb, Croatia*

Eastern Adriatic shelf along Croatian coast is dominated by karst relief that is submerged and covered with thick succession of sediments. Pirovac Bay is a great example of such type of environment. It is a relatively large submerged shallow karst doline located in the central part of the eastern Adriatic shelf. High-resolution seismic study coupled with multyproxy (geochemical, grain-size, mineralogical and paleontological) sediment core analysis was carried out in order to reconstruct paleoenvironmental evolution of the area in relation to climate variability and the sea-level fluctuations during the Late Glacial and Holocene.

Karst bedrock of Pirovac Bay is covered with up to 12 m of sediments in the deepest part of the bay and six distinct seismic units were identified. Four of them can be confidently correlated with analysed sediment cores. Unit 3 in the geophysical profiles represents the remnants of the loess-like sediments that appear in the outcrops on the surrounding islands, mostly in the south-western part of the area. This unit is well preserved in the deepest part of the bay and in the Murter Channel. The deposition of sediments from seismic Unit 4 commenced with the formation of the floodplain/alluvial fan in the bay. Furthermore, results also indicate that Pirovac Bay was a lacustrine environment (Unit 5). Seismic reflections show laminated lacustrine deposits with total thickness of ~3,5 m in the deepest part of the bay. The topmost unit (Unit 6) contains ~3 m thick sequence of marine sediments that have almost uniform thickness at the water depth from 20-25 m. In the shallower, NW and SE part of the bay thickness of this sequence is 1 m or less.

The seismic units correlate with the existing 7.2 m long sediment core extracted from the central part of the bay (25 mbsl) and 1.3 m long core extracted from the NW part of the bay (6 mbsl). The bottom of the 12 m long sedimentary package remains to be retrieved. Multiproxy analysis of the longer core, which spans to the last ~14.000 years, confirmed that the lake sediments preceded marine deposits. Typical lake ostracod assemblage was found at 5 mbsf, which corresponds to 11.000 cal years BP, followed by mixed fauna-brackish to freshwater with typical marine fauna at 2.5 mbsf which is dated to 7.500 cal years BP. „Karst lake" Pirovac Bay existed from 12.000 cal years

BP until 8.000 cal years BP when the karst relief was inundated by marine waters. Inundation by the sea was restricted until that time by a sill that is located in the northern part of the bay. Further sea-level rise allowed marine waters to reach the elevation of the sill. This caused marine flooding of lacustrine environment and development of fully marine conditions. Marine sediments accumulated in the bay from 8.000 cal years BP to the Present. The share of Sr and Sr/Ca also indicates that transgression of the sea started 8.000 years ago. Additionally, grain size distribution shows that marine sediments are coarser than lake sediments. Mineralogical composition reflects catchment karst area. Following mineral phases are present: calcite, quartz, dolomite, small amount of Mg-calcite and aragonite. Domination of endogenic calcite is typical for lake sediments and deep lake water environment. Clay mineral composition of the sediments from 7.2 to 5 mbsf has signature of loess sediments that appear on the islands that surround the bay.

Sedimentary succession in Pirovac Bay was highly influenced by climatic conditions and sea-level rise that enabled development of different depositional environments during the Late Glacial and Holocene. It is possible to track the evolution of the bay, from alluvial, lacustrine, brackish to fully marine environment. Pirovac Bay is significant in terms of its position as well. It is situated close to the Lake Vrana (Dalmatia), separated only by the karstified limestone ridge (800 to 2500 km wide) through which the connection between the two systems exists, so as through the artificial channel Prosika, excavated in the 18th century in the southeastern part. The evolution of the Pirovac Bay had strong influence on the formation of the Lake Vrana, and the two lakes coexisted for about 1000 years in the Early Holocene, before the drowning of the „karst lake" Pirovac Bay due to the sea-level rise.

We thank Innomar Technologie GmbH for granting the equipment (SES-2000 subbottom profiler system) and techical support for the seismic survey.

GEOSWIM 3.0 AT EGADI ISLANDS (SICILY, ITALY): RESULTS FROM 70 KM OF SWIM SURVEYING

Busetti A.[1], Furlani S.[1], Antonioli F.[2], Lo Presti V.[3,2], Biolchi S.[1], Zavagno E.[1], Torricella F.[1], Venturini E.[1], Donati S.[4]

[1] *University of Trieste, Department of Mathematics and Geosciences, Trieste, Italy*
[2] *ENEA UTMEA, Rome, Italy*
[3] *CNR, Rome, Italy*
[4] *Area Marina Protetta Isole Egadi, Sicily, Italy*

The Geoswim project (www.facebook.com/geoswim) aims at surveying the Mediterranean rocky coasts (Furlani et al., 2014). In September 2014 we surveyed the coasts of Egadi Islands (Marettimo, Favignana and Levanzo), which are dominated by limestone or dolomitic rocky coasts, mainly plunging cliffs, low-lying surfaces or vertical slopes. The geoswim3.0 project, in particular, aimed at surveying the present-day and MIS5e tidal notches along the coasts of the Egadi Islands, at surveying the occurrence and extent of vermetids and *Lithophyllum lichenoides*, etc trottoirs, the location and geomorphological features of the sea caves and submarine freshwater springs.

The survey was carried out through a more than 70 km snorkel-surveying. The route was covered by swimming in 7 days. A small raft (Ciclope I) with surveying instruments was pushed

during the survey. The instruments allowed to collect geomorphological and hydrogeological data, such as two underwater cameras placed in a plexiglass hemisphere for observing the tidal zone, a CTD diver to collect temperature and electrical conductivity, a GPS, an invar rods, an ultrasonic depth meter, etc.

The present-day notch occurs along most of the coasts of the islands, but it is well carved mainly along limestone coasts. At Marettimo, along the dolomitic shoreline, it is lacking or slightly carved. Vermetid trottoirs are well developed at Favignana, in the northern and southern sector of Levanzo and in the northern part of Marettimo, while Lithophyllum trottoirs occur along most of the Marettimo coast, along the western and eastern part of Levanzo and they occur only along the western sector of Favignana. A well-carved MIS5e notch was surveyed along short tracts at Marettimo, as previously reported by Antonioli et al. (2002).

Sea caves were roughly surveyed along all the studied coast. In particular, we mapped 39 semi-submerged caves. Some caves are significant as refuge for the monk seal.
Hydrological data show that freshwater springs are located mainly in correspondence of sea caves, in particular along the Levanzo coast.

Data collected confirm the effectiveness of the snorkel surveying on long sectors of rocky coasts in geomorphological studies and coastal hydrogeological studies.

References

ANTONIOLI F., CREMONA G., IMMORDINO F., PUGLISI C., ROMAGNOLI C., SILENZI S., VALPREDA E., VERRUBBI V. (2002). New data on the Holocenic sea-level rise in NW Sicily (Central Mediterranean Sea). Global Planetary Change 34, 121-140.

FURLANI S., NINFO A., ZAVAGNO E., PAGANINI P., ZINI L., BIOLCHI S., ANTONIOLI F., COREN F., CUCCHI F. (2014). Submerged notches in Istria and the Gulf of Trieste: results from the Geoswim Project. Quaternary International 332, 37-47.

LATE QUATERNARY EVOLUTION OF THE EASTERN SECTOR OF THE GULF OF TRIESTE (NE ADRIATIC SEA) FROM GEOLOGICAL, SEDIMENTOLOGICAL AND UNDERWATER SURVEYS

Busetti M.[1], Melis R.[2], Antonioli F.[3], Auriemma R.[4], Biolchi S.[2], Covelli S.[2], Cucchi F.[2], Dal Cin M., Furlani S.[2], Trobec A.[4], Vrabec M.[4], Zampa L.[1, 2]

[1]OGS, Trieste, Italy
[2]University of Trieste, Italy
[3]ENEA, Roma, Italy
[3]Università del Salento, Lecce, Italy
[4]University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia

The Gulf of Trieste (GOT) is an epicontinental semi-enclosed shallow marine basin in the NE Adriatic Sea, about 20 m deep. Marine sedimentation is strongly affected by local inputs of freshwaters. In

particular, the main fresh-water inflow is the river Isonzo and the Timavo in the north and some minor rivers in the southeastern sector. The eastern side of the GOT is bordered by rocky coasts and it is dominated by Cenozoic limestone plunging cliffs and Eocene cliffs and shore platforms.

The neotectonic behaviour of the Gulf was firstly highglighted during the '80 by many authors. Recently, field surveys on geomorphlogical and archaeological remains stimulated new researches along the whole coastline. In particular, Antonioli et al. (2007) and Furlani et al. (2011) established the Late Holocene tectonic rates using submerged notches and archaeological remains, Melis et al. (2012) using sedimentological and archaeological markers, while Braitenberg et al (2005), using short-term data, such as tide gauges and the Grotta Gigante pendulum, suggested that the SE-NW tilting is still active. Busetti et al. (2010) and Carulli (2011) also highlighted the neotectonic activity of some faults in the Gulf.

New geophysical data collected in the southernmost sector of the Gulf allowed to integrate but also to highlight some local discrepancies in previous models. We aim at presenting a review of published and new data on the Late Quaternary evolution of the GOT on the base of geological, geomorphological, sedimentological and archaeological markers.

References

ANTONIOLI F., ANZIDEI M., LAMBECK K., AURIEMMA R., GADDI D., FURLANI S., ORRÙ P., SOLINAS E., GASPARI A., KARINJA S., KOVACICV., SURACE L. (2007): Sea level change during Holocene from Sardinia and northeastern Adriatic (Central Mediterranean Sea) from archaeological and geomorphological data, Quaternary Science Reviews, 26, 2463-2486.

BRAITENBERG C., NAGY I., ROMEO G., TACCETTI Q. (2005): The very broad-band data acquisition of the long-base tiltmeters of Grotta Gigante (Trieste, Italy). Journal of Geodynamics, 41, 164-174.

BUSETTI M., VOLPI V., NICOLICH R., BARISON E., ROMEO R., BARADELLO L., BRANCATELLI G., GIUSTINIANI M., MARCHI M., ZANOLLA C., WARDELL N., NIETO D., RAMELLA R. (2010): Dinaric tectonic features in the Gulf of Trieste (Northern Adriatic). Boll. Geof. Teor. Appl., 51, 117-128.

CARULLI G.B. (2011): Structural model of the Trieste Gulf: A proposal. Journal of Geodynamics, 51, 156-165.

FURLANI S., BIOLCHI S., CUCCHI F., ANTONIOLI F., BUSETTI M., MELIS R. (2011): Tectonic effects on Late-Holocene sea level changes in the Gulf of Trieste (NE Adriatic Sea, Italy), Quaternary International, 232, pp. 144-157.

MELIS R., FURLANI S., ANTONIOLI F., BIOLCHI S., DEGRASSI V., MEZGEC K. (2012): Sea level and paleoenvironment during roman times inferred from coastal archaeological sites in Trieste (northern Italy), Alpine and Mediterranean Quaternary, 25(1), 41-55.

UNDERWATER GEOLOGICAL SURVEY IN THE SURROUNDINGS OF THE CICLOPI ISLANDS, ACITREZZA, CATANIA (ITALY)

Cavallaro D.[1,2], Coltelli M.[2], Chiocci F.L.[3]

[1] *Dipartimento di Scienze Biologiche, Geologiche ed Ambientali, University of Catania (Italy)*
[2] *Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Catania (Italy)*
[3] *Dipartimento di Scienze della Terra, Università of Roma "La Sapienza" (Italy)*

The coastal area between Acicastello and Acitrezza (north of Catania, Sicily) is considered the "cradle" of Mont Etna, since it exhibits the products (basalts with tholeiitic and transitional affinity) related to the earliest (about 500 ka old) volcanic activity (Branca et al., 2008). They consist of sub-volcanic bodies erupted by fissure vents into the marly-clay sediments of the seafloor and lava flows emplaced in shallow water environment (Corsaro and Cristofolini, 2000). Presently some of these volcanics form the Ciclopi Islands, made up by Lachea Island and a group of sea stacks locally named "Faraglioni", very famous not only because they represent the mythological place of Homer's Odyssey, but also for a fascinating seabottom, which safeguard is entrusted to the Protected Marine Area "Isole Ciclopi".

In the last years several scuba diving were performed around the Ciclopi Islands on the first 40 m wd to directly observe the shallow geologic features outcropping in the area and to collect volcanic samples and sediments. Moreover, in 2005 a shallow water bathymetric survey was carried out along all the Etnean coast by using a small boat equipped with a 455 kHz multibeam sonar and the collected data allowed to obtain a very high resolution (1 m grid) DEM (Digital Elevation Model) of the seafloor (Chiocci et al., 2011). The bathymetric data together with the information deriving from scuba diving were used to correlate the submarine geological features with those outcropping along the coast.

The underwater survey carried out offshore Acitrezza allows to delineate precisely the boundaries of the intrusive volcanic body that formed both "Lachea Island" and "Faraglione della Madonnina" (the two biggest of the Cyclops Islands); it represents an elliptical-shaped laccolite with a 500 m long NNE-SSW major axis. This body is clearly offset by several NW-SE trending fault forming elongated emerging rocks and narrow inlets. Between these two islands, in a water depth ranging from 3 to 20 m, several huge columnar joints, showing polygonal cross sections with diameters up to 2.5 m, were observed. They are much bigger than those outcropping both in the submerged and subaerial portions of the area. This evidence allows to place there the centre of the laccolith since the cooling of the intrusive body was longer than in the external portions; in fact longer is time of cooling of an intrusive volcanic body larger are the cross sections of the columnar joints formed as consequence of the body's contraction. North of Lachea Island a group of morphological highs (locally named "Panettoni"), rising up to 8 m from the seafloor and showing a sub-cylindrical shape and a basal diameter of 25-30 m, were identified; they are interpreted, in agreement with Corsaro and Cristofolini (1997), as apophysis of the same laccolith forming the two biggest islands.

In the shallow offshore between Acitrezza and Acicastello a set of NE-SW to NW-SE steep scarps up to few meters high were mapped. They represent the splays of a flower-type fault system which master fault, developed for more than 1 km in a E-W direction, clearly offsets with a dextral transcurrent component, the Saurari shoal (Chiocci et al., 2011); this last is interpreted as another intrusive body, located at water deep of 60-100 m, belonging to the same volcanic activity.

The framework presented is preliminary, further geophysical investigations are needed in order to prove and detail the interpretations.

References

CHIOCCI F.L., COLTELLI M., BOSMAN A., CAVALLARO D., (2011). Continental margin large-scale instability controlling the flank sliding of Etna volcano. EPSL, 305, 57–64,

CORSARO R. A., CRISTOFOLINI R., (1997). Geology, geochemistry and mineral chemistry of tholeiitic to transitional Etnean magmas. Acta Vulcanologica, 9, 55-66.

CORSARO R. A., CRISTOFOLINI R., (2000). Subaqueous volcanism in the Etnean area: evidence for hydromagmatic activity and regional uplift inferred from the Castle Rock of Acicastello. J. Volcanol. Geotherm. Res., 95, 209–225.

BRANCA S., COLTELLI M., DE BENI E., WIJBRANS J., (2008). Geological evolution of Mount Etna volcano (Italy) from earliest products until the first central volcanism (between 500 and 100 ka ago) inferred from geochronological and stratigraphic data. Int. J. Earth Sci., Geol. Rundsch. 97, 135–152.

EVOLUTION OF TIDAL CHANNEL MORPHOLOGY OVER THE PAST CENTURIES: EVIDENCES FROM THE HISTORICAL MAPS OF THE "COMITATO TALASSOGRAFICO ITALIANO" AND THE "ISTITUTO DI STUDI ADRIATICI" OF VENICE

Ceregato A.[1], Rizzetto F.[1], Parente L.[1]

[1] *Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Venezia (Italy)*

The present work is aimed at identifying the geomorphological modifications of the Venice lagoon tidal channels, occurred since the 18th century, through the analysis of a number of historical maps rediscovered in the old library of the Institute of Marine Sciences in Venice during the reorganization and cataloging of the documents here preserved. The majority of them belong to the collection of the former "Comitato Talassografico Italiano" and the "Istituto di Studi Adriatici" of Venice (Ceregato et al. 2014, Balletti et al. 2015). In particular, the maps of the Venetian littorals have been examined in the frame of the RITMARE Project to better define the historical evolution of the coast, as they provide an almost continuous record of information covering the last three centuries. With reference to the Venice Lagoon, these documents have been also used to identify the morphological changes of the tidal channel network from 1763 (using the map realized by Angelo Emo) to the present and to deepen the knowledge of the evolution of tidal flats in relation to natural and anthropogenic processes, a topic that was previously discussed by Rizzetto and Tosi (2011, 2012) with respect to a briefer time span.

The available maps, which have been georeferenced, analyzed and compared using a Geographic Information System software, have provided significant geomorphological details useful for investigations on the planimetric features (e.g. length, width, sinuosity) and planform changes of the channels (including migration and lengthening), on the formation of new ones and on the disappearance of minor ramifications.

As the present work is still in progress, only the first results are exposed. They are referred to the northern lagoon, a sector that, in the past decades, did not experienced the general erosional

trend occurred in other parts of the basin. The morphological evolution of the tidal network will be interpreted in the light of sea-level variations, climatic changes, sediment availability, coast hydrodynamics and anthropogenic interventions.

References

BALLETTI C., CEREGATO A., GOTTARDI C., RIZZI F., VIANELLO A. (2015). 3D digitization and web publishing of an ISMAR Cartographic Heritage: historical maps of Venice Lagoon. 10th Conference Digital Approaches to Cartographic Heritage, Corfu, 27-29 May 2015.

CEREGATO A., VIANELLO A., BALLETTI C., CAMPIANI E., GOTTARDI C., MENEGON S., RIZZI F., TRINCARDI F. (2014). Le mappe e i portolani dell'Istituto di Studi Adriatici: valorizzazione di un patrimonio storico per la ricerca e la divulgazione. Atti della 18ª Conferenza Nazionale ASITA, Firenze, 14-16 ottobre 2014, 331-337, ISBN 978-88-903132-9-5.

RIZZETTO F., TOSI L. (2011). Aptitude of modern salt marshes to counteract relative sea-level rise, Venice Lagoon (Italy). Geology, Vol. 39, 8, 755-758, doi: 10.1130/G31736.1.

RIZZETTO F., TOSI L. (2012). Rapid response of tidal channel networks to sea-level variations (Venice Lagoon, Italy). Global and Planetary Change, 92-93, 191-197, doi: 10.1016/j.gloplacha.2012.05.022.

DIGITIZING THE CORAL REEF: BIODIVERSITY SURVEYS USING UNDERWATER HYPERSPECTRAL IMAGING

Chennu A.[1]

[1] *Max Planck Institute for Marine Microbiology, Bremen (Germany)*

Coral reefs are complex and diverse ecosystems that occur throughout the shallow tropical waters, and support a wide range of ecosystem and human functions. However, they are not stable and are quite sensitive to disturbances from a variety of factors such as cyclones, fish recruitment, pollution, ocean acidification and climate change. Long-term quantitative studies on coral reefs are necessary to differentiate the human impact on reefs from natural variability. Coral reefs are characterized by a high degree of biodiversity and spatial complexity, and capturing the spatial structure of the biodiversity is an important requirement for meaningful analysis of their ecological status.

We describe a new method to survey and map the biodiversity of coral reef benthos using a novel diver-operable hyperspectral imager called hyperdiver. The technique combines the information derived from high-resolution spectra and imagery to feed a machine learning analysis which can be used to create classified reef maps down to the genera level. Hyperdiver surveys were conducted in a pacific coral reef, covering several kilometers with a 1-2 cm spatial resolution which could be converted into biodiversity maps. Overall the technique promises to deliver rapid and repeatable assessment of the biodiversity and spatial structure of coral reef benthos.

UAV SURVEY SOLUTIONS TO MONITOR COASTAL BOULDER FIELDS IN MADDALENA PENINSULA (SOUTH-EASTERN SICILY)

Crupi A.[1,2], Lanza S.[1,2], Mastronuzzi G.[3], Piscitelli A.[3], Spampinato C.R.[4], Tarascio S.[2], Scicchitano G.[1,2]

[1] *Department of Physics and Earth Science, University of Messina*
[2] *Geologis s.r.l, Academic Spin Off Department of Physics and Earth Science, University of Messina*
[3] *Dipartimento di Scienze della Terra e Geoambientali, Università di Bari*
[4] *Istituo Nazionale di Geofisica e Vulcanologia, sez. Catania*

Extreme waves impact wreaks havoc on the coastal areas and, with the increasing growth and development of coastal regions, greater loss of life and property damage will occur an even large scale. In order to guarantee the coexistence between this dangerous phenomena and human activities, it is essential to develop models, that provide forecasting, planning and warning, and to test survey solutions able to supply the most accurated data to improve the models.

Extreme waves flooding, usually, occurs in low-lying region and implies erosion, transport and mixtures of debris/sediment deposit inland. Recent studies highlight as tsunami and extreme waves are able to detach megaclasts weighting up to hundreds tons from intertidal/adlittoral zone and to transport them onshore at different distances and altitudes above sea level.

Eastern Sicily is one of the most seismically active areas of the central Mediterranean, it is marked by a high level of crustal seismicity producing earthquakes with intensities of up to XI-XII MCS and M ~7, such as the 1169, 1693 and 1908 events (Postpischl, 1985; Boschi et alii, 1995). Cause of in eastern Sicily the normal faults are mostly located offshore, several of these earthquake have generated tsunamis struck the coast in historical times (AD 365, 1169, 1329, 1693, 1818, 1908, 1990; Soloviev *et alii*, 2000; Tinti *et alii*, 2004).

The effects of the 1169, 1693 and 1908 tsunamis are still recognizable in the Siracusa coastal area where boulders up to 182 ton in weight, encrusted by dated marine organisms, were removed and transported inland at a distance of up to 70 m (Scicchitano *et alii*, 2007).

The major boulder accumulation has been found along the north-eastern coast of the Maddalena peninsula, south of the Siracusa natural harbour. The peninsula is a calcareous semi-horst gently tilted to the ENE, formed by Miocene sediments that along the coast are unconformably covered by Pleistocene calcarenites. Most boulders are up to 40 t in weight and are scattered at a distance of up to 70 m from the coast on a large terrace located 5 m above sea level, gently sloping towards the sea. The blocks are mostly arranged in isolated elements and have also been found on a flat anthropogenic platform at 1–2 m a.s.l. inside an ancient Greek quarry located along the coast.

Monitoring performed since 2009 along the coastal sector of Maddalena peninsula with Terrestrial Laser Scanner and DGPS survey techniques, highlighted that storm generated waves are able to detach and move boulders as well as tsunami, in particular have been documented several displacements of boulders some of which up to 40 ton in weight.

Since the beginning of 2015 we implemented the monitoring of boulder field in Maddalena peninsula adopting UAV aero photogrammetry solutions. The high resolution and precision of Digital Ortophoto and DTM reconstructed, defined displacements and changing in volume of boulders with higher accuracy respect LS and DGPS survey techniques. Displacements have been related to storms occurred in south eastern Sicily during the winter season.

UNDER WATER GEOMORPHOLOGICAL MAP OF MEGA BOULDERS ON ALAM EL RUM, NW COAST OF EGYPT

Dalal N.[1], Torab M.[2]

[1] *Ph.D. student, Geography Department, Menoufia University, Egypt soso_soso1734@yahoo.com*
[2] *Prof. of Geomorphology, Geography Department, Damanhour University, Egypt.*

Earthquakes, tsunamis and storms waves cause various natural hazards and disasters during historic and recent times, which affected both directly and indirectly on the coasts.

Tsunami waves and storms cause the displacement of huge boulders from sea bottom and sub-marine terraces (platforms) to the beach due to its major power and ability of carving and graving it is also capable of pulling other boulders from the land and re-deposits it on the beach or coastline, specially the Mediterranean coast of Egypt has recorded a number of seismic or tsunami events during recent times (tsunamis of 23 AD, 365 AD, 746 AD, 881 AD, 1202 AD, 1303 AD, 1870 AD and 1908 AD attested at Alexandria city.

The study area located on Alam El-Rum headland, between 27°20`9.738``, 27°13`48.02``E and 31°22`13.03``,31°22`24.62``N , stretching length of 13km. It lies on the NW coast of Egypt, east of Marsa Matruh city for not more than 15km, and west of Alexandria city of about 280 km, on the Mediterranean coast of Egypt, in an area exposed to N and NW wave regime.

An accumulation of submerged boulder fields was discovered along submerged platforms of Alam El Rum rocky beaches, it deposited in this area on the beaches and submerged platforms as a result of the mega storms or tsunami waves on the coast. This paper aims to define origin, sources and geomorphic distribution of accumulated submerged blocks on marine platforms by high-energy waves of recent storms and paleo tsunami waves, mapping underwater geomorphological map for submerged boulder fields as well as reconstruction historical events of mega waves affected on the study area, especially the accumulated blocks on the submerged platforms.

This work depends upon the following methods and techniques; intensive underwater geomorphic mapping, measurement and surveying of submerged boulder`s accumulated by tsunami and storm waves, satellite images interpretation, statistical analysis of detailed field current weather records, morphometric analysis in addition to GIS mapping, and C14 dating.

THE USE OF ROUGH BATHYMETRIC PROFILES FOR THE GEOMORPHOLOGICAL CLASSIFICATION OF SUBMERGED ROCKY COASTS: THREE CASE STUDIES (NORTHERN SARDINIA, NE MALTA, EASTERN ISTRIAN COAST)

Dal Bo E.[1], Furlani S.[1], Antonioli F.[2], Antonioli M., Anzidei M.[3], Bellotto M.[1], Vaccher V.[1], Canziani F.[4], Biolchi S.[1], Gauci R.[5], Schembri J.[5]

[1] *University of Trieste, Department of Mathematics and Geosciences, Trieste, Italy*
[2] *ENEA UTMEA, Rome, Italy*
[3] *Istituto Nazionale di Geofisica e Vulcanologia, Roma*

[4] *University of Bologna, Bologna, Italy*
[5] *University of Malta, Malta*

Bathymetric data is usually collected using ultrasonic echo sounders like multibeams or side scan sonars. However, these methods are very useful to describe the sea bottom, but they do not allow the exploration of the coast. Similarly, there are specific terrestrial remote detection methods, such as LidAR, which cannot penetrate under water, except in specific cases. It appears that there is a lack of information in the sea-land transition zone due to the inability to associate data obtained by these two methods.

Most of the studies about rocky coasts are usually carried out using punctual surveys, while only some restricted sectors were studied using methods of continuous surveying, such as the Geoswim project (Furlani et al., 2014). Anyway, in the previous editions of the project, data were collected mainly following the coastal length. In Geoswim2015 we integrated longitudinal data with perpendicular rough morphobathymetric profiles, averagely 30/40 m long, which were verified using free immersions up to -18m.

We discuss the results obtained from 95 profiles in Sardinia (55 profiles at Capo Caccia, 32 in Tavolara Island, 8 in Molara Island and Scoglio del Fico), 42 profiles along the NE coast of Malta and 14 along the SE Istrian coasts. Moreover, we analyse the advantages and disadvantages of this method of acquisition.

The use of rough morphobathymetric profiles allow to retrieve significant semi-quantitative information about the sea-land transition zone.

References

FURLANI S., NINFO A., ZAVAGNO E., PAGANINI P., ZINI L., BIOLCHI S., ANTONIOLI F., COREN F., CUCCHI F. (2014b). Submerged notches in Istria and the Gulf of Trieste: results from the Geoswim Project. Quaternary International, 332, 37-47.

THE USE OF SMALL RPAS FOR THE HIGH RESOLUTION MAPPING OF THE MEDITERRANEAN INTERTIDAL VERMETID REEFS

D'Argenio A.[1], Tulone M.[1], Chemello R.[2]

[1] *Panoptes srl, via Giovanni di Giovanni 14, 90139 Palermo (Italy)*
[2] *Department of Earth and Marine Sciences, University of Palermo, via Archirafi 28, 90123 Palermo (Italy)*

RPAS (Remotely Piloted Aircraft Systems) are the major novelty of the last decades in aerial surveys. These systems (and in particular the smallest ones, with MTOW < 25 kg) can be easily used in a wide range of technical and scientific applications, producing very high resolution spatial data in short time and at affordable costs. Due to their easiness, cheapness and reliability, small RPAS are now widespread and their diffusion is increasing. Their introduction in everyday life is producing effects comparable with other technological revolutions (positioning systems, internet, mobile communication), with particular emphasis on the availability of updated data on the territory and the environment.

In Mediterranean sea, the intertidal biogenic reefs built by the vermetid Mollusc *Dendropoma petraeum* and the coralline red Alga *Neogoniolithon brassica-florida* have a clear

ecological role, protecting the coasts from erosion, regulating sediment transport and accumulation, serving as carbon sinks and providing habitat for a variety of fish and invertebrates of commercial, recreational or conservation interest. Despite their role as provider of ecosystem services, vermetid reefs are not explicitly taken into account in marine mapping activities due to their intertidal position, small width and irregular coastal distribution.

The RPAS used during the survey was a Skyrobotic SF6, an Italian hexarotor equipped with a SONY DSC-QX100 20 Mpx camera. The survey has been finalized to the photogrammetry of the intertidal vermetid reefs of the Favignana Island (Trapani) and Capo Gallo (Palermo). Two areas of about 70 m of width and 850 m of length have been selected for each location. In order to have the best meteorological conditions and the maximum reef exposure, weather forecasts and tides trends have been carefully analyzed during the operation planning. For each survey have been designed 2 planned flight with a wide overlap, each of one formed by 4 parallel photogrammetric strips. Relative flight altitude was 40 m. Single image overlap was 70%, sidelap 60 %. Flight speed was 2 m/s. Triads of ground control points (side: 20 cm) have been distributed and measured over the two areas. The target resolution value, established during the survey design phases, is 0,95 cm/px. This value allow to recognize objects greater than 2-3 cm per side. Image processing techniques (using Photoscan, an image bundle software) have been applied to realize very high resolution orthophotos, DSM (Digital Surface Models) and 3D textured models of the reefs. The orthophotos have been joined to create mosaics of the each area.

The result are two georeferenced mosaics, each of about 800 m of length and 60 m of width. The orthophotos and the mosaics have been imported in a GIS application (Quantum GIS) and compared with the geodata already available (Capo Gallo: Flight ATA 2012-2013, 15 cm/px; Favignana: Flight ATA 2007-2008, 25 cm/px) in order to verify positioning accuracy, deformation and resolution improvement. Lower resolution mosaics (5 cm/px, 10 cm/px) have been also created for those tasks which do not require 1 cm/px data resolution (e.g. reef boundaries mapping). For selected region of the two areas have been also realized 3D metric models of the reefs. Models can be inspected using mesh and DSM software viewers, but can also distributed as 3D PDF.

BEDROCK TYPE AND OCCURRENCE OF *PATELLA FERRUGINEA*: THREE CASE STUDIES IN NORTH SARDINIA

De Sabata E.[1], Vaccher V.[2], Guallart J.[3], Antonioli F.[4], Anzidei M.[5], Bellotto M.[2], Dal Bo E.[2], Furlani S.[2], Montagna P.[6], Orrù P.[7], Navone A.[8], Taviani M.[6], Trainito E., Vacchi M.[9]

[1]*Medshark, Italy*
[2]*University of Trieste, Italy*
[3]*Departamento de Biodiversidad y Biología Evolutiva, Museo Nacional Ciencias Naturales (CSIC), Madrid, Spain*
[4]*ENEA, Rome, Italy*
[5]*INGV, Rome, Italy*
[6]*CNR, Bologna, Italy*
[7]*University of Cagliari, Italy*
[8]*AMP Tavolara, Italy*
[9]*CNRS, Aix-En-Provence, France*

The large limpet (*Patella ferruginea* Gmelin 1791) is among the most threatened macro-invertebrates in the Mediterranean Sea. A sharp decline during the 20th century has been driven by human overcollection as food or bait, but also from anthropic impact such as coastal infrastructures. Reaching over 10 cm of length, it lives on exposed mid-littoral rocky coasts. It is endemic in the western Mediterranean, although it appears at present almost completely eradicated from the mainland. It survives mostly as scattered populations in Corsica, Sardinia and other smaller islands, with consistent populations still known at places of the North African coast.

Little is known about a preference of this large limpet for specific bedrock lithologies, what has been demonstrated for other marine species. During a geomorphological survey of Mediterranean rocky shores (GeoSwim2015 Project), we examined three separate locations in Sardinia (Italy), in order to explore a possible lithological control on the settlement of *P. ferruginea*.

A dedicated snorkelling observer assessed the presence, density and morphometrics of limpets over a total of 10 km in Tavolara Marine Protected Area, La Maddalena National Park and Capo Caccia MPA, respectively in North-East, North and North-West Sardinia. Limpets were measured, photographed and georeferenced. The nature of the bedrock was recorded during the survey and later further assessed with geological maps.

Overall, about 200 live *P. ferruginea* were identified in the surveyed sites sitting on carbonate and granitic rocks. A comprehensive review of bibliographic data, combined with our own results, seem to suggest that the species does not show an exclusive preference for a specific lithology. We hypothesize that other factors, such as wave exposure, slope, roughness, biofilm composition and site accessibility to people, could play a more important role in the distribution and abundance of this large limpet, rather than type of rocky substrate.

SUBMERGED LANDSLIDES ALONG THE NW COAST OF MALTA AND THEIR RELATIONSHIP WITH TERRESTRIAL LANDFORMS

Devoto S.[1], Foglini F.[2], Prampolini M.[3], Soldati M.[3]

[1]*Department of Mathematics and Geosciences, University of Trieste, Italy*
[2]*National Research Council, Research Institute for Marine Sciences (CNR-ISMAR), Bologna, Italy*
[3]*Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, Italy*

The NW coast of the Island of Malta (central Mediterranean Sea) is characterised by a horst-and-graben structure constituted by the superimposition of a fractured coralline limestone plateau above clayey terrains. This geological setting has favoured the development of different types of landslides affecting the limestone plateaus including large block slides reaching the sea (Devoto et al., 2012, 2013, 2015; Mantovani et al., 2013; Piacentini et al., 2015).

In 2012, multibeam and LiDAR surveys were performed offshore the north-western coast of Malta and the seafloor bathymetry was acquired from the coastline to 154 m of depth. This investigation revealed the occurrence of large block accumulations offshore the headlands. Slope-failure deposits were interpreted as their submerged prolongation, constituting a unique landslide

accumulation (Foglini et al., 2015). They extend from the coast reaching a depth of about 50 m and stretching out for a maximum distance of 700 m from the shoreline.

The most probable hypothesis is that they developed during a lowstand, such as during the Last Glacial Maximum (LGM), when the sea level was about 130 m lower (Furlani et al., 2013) than at present and the seafloor now covered by the block accumulations was emerged. If they occurred during or in proximity of the LGM, they would have developed in a sub-aerial environment, far from the sea. Thus, the triggering factors would not have been the marine action or the sea level fluctuations, but the geological settings and a climate wetter than the present one would have influenced the landsliding. The predisposing factors are the tectonics and the superimposition of geological formations with opposite geotechnical properties: they both caused the fracturing of the limestone cap. Then, during the LGM, the higher amount of precipitations would have increased the rainwater infiltration within the clay: this must have been an important factor contributing to the acceleration of the movement. The post-glacial sea level rise must have sealed, without reshaping the landforms, that are extremely well preserved, till the present configuration.

Ongoing analyses are aiming at dating these landslides ant this would clarify the palaeo-enviromental conditions in which they occurred.

Further investigations will concern the influence of future climate changes, in terms of precipitations, extreme events and sea level rise, on landslide kinematics.

References

DEVOTO S., BIOLCHI S., BRUSCHI V., FURLANI S., MANTOVANI M., PIACENTINI D., PASUTO A., SOLDATI M. (2012). Geomorphological map of the NW coast of the Island of Malta (Mediterranean Sea). Journal of Maps, 8, 33-40.

DEVOTO S., BIOLCHI S., BRUSCHI V.M., GONZALEZ DIEZ M., MANTOVANI M., PASUTO A., PIACENTINI D., SCHEMBRI J.A., SOLDATI M. (2013). Landslides along the north-west coast of the Island of Malta. In: Margottini C., Canuti P., Sassa K. (eds.), Landslide Science and Practice, Volume 1: Landslide Inventory and Susceptibility and Hazard Zoning, Heidelberg Springer, ISBN: 978-3-642-31324-0, 57-64.

DEVOTO S., MANTOVANI M., PASUTO A., PIACENTINI D., SOLDATI M. (2015). Long-term monitoring to support landslide inventory maps: the case of the north-western coast of the Island of Malta. In: Lollino G. et al. (eds.), Engineering Geology for Society and Territory – Volume 2, Springer International Publishing Switzerland, 1307-1310.

FOGLINI F., PRAMPOLINI M., MICALLEF A., ANGELETTI L., VANDELLI V., DEIDUN A., SOLDATI M., TAVIANI M. (2015). Late Quaternary coastal landscape morphology and evolution of the Maltese Islands (Mediterranean Sea) reconstructed from high resolution seafloor data. In: Harff J., Bailey G., Lüth F. (eds), Geology and Archaeology: Submerged landscapes of the continental shelf. Geological Society, London, Special Publications, 411, http://doi.org/10.1144/SP411.12.

FURLANI S., ANTONIOLI F., BIOLCHI S., GAMBIN T., GAUCI R., LO PRESTI V., ANZIDEI M., DEVOTO S., PALOMBO M., SULLI A. (2013). Holocene sea level change in Malta. Quaternary International, 288, 146-157.

MANTOVANI M., DEVOTO S., FORTE E., MOCNIK A., PASUTO A., PIACENTINI D., SOLDATI M. (2013). A multidisciplinary approach for rock spreading and block sliding investigation in the north-western coast of Malta. Landslides, 10, 611-622.

PIACENTINI D., DEVOTO S., MANTOVANI D., PASUTO A., PRAMPOLINI M., SOLDATI M. (2015). Landslide susceptibility modeling assisted by Persistent Scatterers Interferometry (PSI): an example from the northwestern coast of Malta. Natural Hazards, 78, 681-697.

GEOARCHEOLOGICAL AND GEOMORPHOLOGICAL EVIDENCES OF RECENT GROUND VERTICAL MOVEMENTS ALONG THE COAST OF CAMPANIA, SOUTHERN ITALY

Donadio C.[1], Pennetta M.[1], Stanislao C.[1]

[1]*Department of Earth Sciences, Environment and Resources, University of Naples Federico II, Napoli, Italy*

Geoarchaeological and geomorphic surveys in progress along the submerged coastland of Campania are contributing to evaluate type, entity and rate of ground vertical movements responsible of archaeological heritage submersion, as well as of littoral erosion. Discrimination of vertical motions linked to bradyseismic, tectonic, volcano-tectonic and subsidence phenomena, sometimes mutually interacting each other, plays a key role to understanding coastal morphoevolutionary dynamics since the last 3000 years. The ancient sea levels registered along the regional waterscapes show geomorphologic elements related to their settlement phases during the Holocene. Palaeo shorelines are often located at different depths, so they supply information about sea-level changes due to tectonic-eustatism and volcano-tectonic interactions. The study of archaeological structures, currently at depth not compatible with the sea level of their age, allows to deduce both palaeo-sea level traces and ground vertical deformations in the analyzed case studies. In particular, different sectors of the Gulf of Naples were surveyed, among which (1) the Vesuvius coast (Portici-Castellammare di Stabia), (2) the Neapolitan-Phlegrean Fields area (Castel dell'Ovo-Posillipo and Baia-Cape Miseno), (3) the Phlegrean Islands (Procida, Vivara and Ischia), (4) the Gulf of Gaeta (Torregaveta and Sinuessa), and finally (5) the Island of Capri. Preliminary results highlight differential vertical movements mainly linked to (1) volcano-tectonic, (2, 3) bradyseismic, (4) complex vertical motions (bradyseism, subsidence, tectonics and volcano-tectonics interplay), and (5) coseismic or landsliding displacement. The highest values registered (i.e., -4.3 m along the Vesuvius coast, -4.5/-12 m along the Neapolitan-Phlegrean Fields coast, -3.5/-7 m at Torregaveta-Sinuessa, -9/-4.5 m in the islands of Vivara and Ischia, respectively), and recently -4.2 m in the Island of Capri, vary in the different morphostructural sectors of the gulfs of Naples and Gaeta, resulting higher than 2 mm/y which represents the average subsidence rate during the last 125 kyr. Among the case studies, the underwater survey of Sinuessa was particularly interesting: actually, it was possible to reconstruct the coastline morphoevolution phases through the identification of submerged geoarchaeological markers as a millstone carved into the Campanian Ignimbrite, 24 Roman pilae and the ruin of a stone-paved road. The highest value of ground vertical downlift (-7 m) likely indicates recent tectonic activity. In the carbonate Island of Capri, the Roman ruins of a Tiberius' villa maritima lies down to -4.20 m depth. Even considering the sea level during Roman age (-1 m lower than the present-day), the downlift is incongruent with the general island uplift of ~1.5 m due to tectonics, marked along the cliffs by the current elevation of the palaeo-sea notch modeled

at 5.5 m ~125 kyr BP (MIS 5.5 high stand, Tyrrhenian).Therefore, a rapid displacement due to coseismic or landslide phenomena during post-Roman age occurred. In addition to the study of geoarchaeological elements, like fish farms or planking levels, also mineral-petrographic and minerogenetic analysis of Roman age mortar (opus cementicium) are significant. Actually, through these data it can be hypothesized both the provenience of material and the environment where artifacts were emplaced. An example is the differentiation between lime mortar and seawater concretes: the first is a mix of lime and aggregates that could be used only on the mainland, while the second one consists of lime, aggregates and pozzolanic material which manages to be efficient even if submerged.

TWO MILLENNIA RELATIVE SEA-LEVEL CHANGE AND CLIMATE CHANGE IN THE NORTHERN ADRIATIC BASED ON ALGAL RIMS

Faivre S.[1], Bakran-Petricioli T.[2], Barešić J.[3], Horvatinčić N.[3]

[1] University of Zagreb, Faculty of Science, Department of Geography, Marulićev trg 19/II, 10 000 Zagreb, Croatia
[2] University of Zagreb, Faculty of Science, Department of Biology, Rooseveltov trg 6, 10 000 Zagreb, Croatia
[3] Ruđer Bošković Institute, Radiocarbon Laboratory, Bijenička 54, 10 000 Zagreb, Croatia

The bimillennium sea-level curves along the Eastern Adriatic coast are based on a number of markers. Those are primarily archaeological coastal remains as well as geomorphological and sedimentological markers. The studies of sea-level variations are today pluridisciplinarily approached so different markers are used and, if possible, combined. However, most of the methods used till now do not provide enough precision. As the studying period is short the error bars are still too large. In order to provide more precision and better accuracy of sea-level curves the latest research along the eastern Adriatic has been centred on algal rims as sea-level markers.

Fossil bio-constructions formed by alga *Lithophyllum byssoides* (Lamarck) Foslie have proven to be precise sea-level indicators (±10 cm) in microtidal environments. Under favourable conditions *L. byssoides* build up reef like bioconstructions just above the biological mean sea-level which can be ^{14}C dated.

Algal rims from different locations in the Northern Adriatic have been analysed. The obtained ^{14}C ages of 31 algal carbonate samples have been further corrected for the marine radiocarbon reservoir effect and then related to phases of relative sea-level changes and climate changes during the last two millennia.

The coralline algae growth and cell calcification depend on temperature and light variability so they could also register environmental signals. The $\delta^{18}O$ values of algae from temperate environments could be used as a paleotemperature proxy, because they deposit carbonate in isotopic equilibrium with ambient seawater. Consequently, a strong temperature dependence of algal $\delta^{18}O$ ratios in comparison with sea surface and air temperatures was demonstrated.

Our results reveal the close relationship between biological, geomorphological and archaeological sea-level markers and environmental conditions on the studied area in the past and the clear need of such multidisciplinary approach in the study of the relative sea level changes.

A COMBINED REMOTE SENSING APPROACH IN COASTAL ZONE: LASER SCANNER SURVEY AND AUV ECOMAPPER MONITORING IN ACI CASTELLO (CATANIA, SICILY)

Feo R.[1], Barbera G.[1], Giuliano S.[1], Pampalone V.[1], Savarino S.[1], Liuzzo M.[1], De Marchis M.[1], Freni G.[1]

[1] *Faculty of Engineering and Architecture - Università di Enna "Kore", Enna, Italy*

In the last decades the growing awareness to protect the cultural heritage and historical patrimony from the natural risk drives the European Community, Nations and local bureaus to encourage the scientific world to assess geological hazards and manage natural events. Technological innovation, together with the remote sensing development, can provide useful tools for design and planning mitigation actions in an economically sustainable risk assessment scenario. This study aims to evaluate the marine erosion along the Aci Castello cliff (Catania, Italy), which is a part of the "Riviera dei Ciclopi", a marine protected area in Ionian Sea. In Aci Castello town, over the sea cliff is located an important medieval castle, home of a civic museum and historical point of interest. The headland where the castle is situated, called "Castel Rock", is a near-vertical 15 meters stack surrounded by a wave-cut platform, which separates it from the sea by 40 meters. The cliff and the sea floor are characterized by outcroppings of Pleistocene successions of tholeiites pillow lavas interbedded with hyaloclastite breccia beds, that represent volcanic activity happened between 600.000 and 500.000 years ago in deep water environment (Tanner et al., 1999). Among 2014 and 2015, the cliff and the castle of Aci Castello have been mapped with a terrestrial 3D laser scanner and a mobile mapping technology affixed on a boat to create a high precision three-dimensional model (Liuzzo et al., 2015). To complete and integrate the surface morphological data, bathymetry and morphology of Aci Castello seafloor has been acquired during summer 2015, using an Automatic Underwater Vehicle (AUV) EcoMapper made by YSI obtained by a Imagenex Yellow Fin side scan sonar, with a hardware setup of 16 beams and a frequency range between 330 and 800 kHz. Data were gained for operational depth of 1m from sea surface and an average distance of 100 m from the shore. Sampled data were collected and filtered from erroneous measures and corrected in function of navigation velocity. Moreover the drone has an YSI 6600 V2 bulkhead built in for collection of water chemical-physical quality parameters and it includes 2.4 GHz radio link to download missions and upload collected data, side-scan sonar imaging, GPS to track the programmed path, doppler velocity log (DVL) and compass to follow the submarine route.

This integrated remote sensing approach represent the new frontier to assess natural hazard in a security way reducing times and cost. The above-mentioned factors make remote survey an alluring solution for corporations, company and public authorities.

References

TANNER H.T. AND CALVARI, (1999) Facies analysis and depositional mechanisms of hydroclastite breccias, Acicastello, eastern Sicily. Sedimentary Geology, 129. 127-141.

LIUZZO M., GIULIANO S., SAVARINO S. (2015). Survey on the landscape and morphological singularities of the Cliff of Aci Castello. In "Heritage and Technology. Mind Knowledge Experience" Proceedings of the XIII International Forum "Le Vie dei Mercanti". Napoli: La Scuola di Pitagora, 2015, 623-631

WHEN THE LIZARD BECAME BLUE? A PREDICTION OF SEA-LEVEL CHANGE ON SEA FLOODED ISLANDS BASED ON INTEGRATED DNA SEQUENCE AND MORPHOBATHYMETRIC DATA

Ferranti L.[1], Antonioli F.[2], Carotenuto F.[1], Fulgione D.[1], Trapanese M.[1], Raia P.[1]

[3] University of Naples, Italy
[2] ENEA, SSPT MET CLIM Roma, Italy

We started an integrated study on past-sea level change using both biological and geological analysis. This approach was tested on the "Faraglioni", two small islets off Capri island (Gulf of Naples, Italy), and on two additional sites in Southern Italy (Licosa and Vetara islets), where the blue lizard *Podarcis siculus* is nested. The lizard has changed color from green to blue once the islets became isolated from the mainland following the Holocene sea level rise. We chose these sites not only for the presence of the blue lizard but also for the lack of vertical tectonic movements as testified by the eustatic position of the last interglacial notch.

We surveyed the sea-bottom between Capri and the Faraglioni, which turned to be mainly Mesozoic "hard" carbonate bedrock with minimal sediment cover, lying at about -20 meters depth. On these basis and using an updated Lambeck prediction for the sea-level change at this site we estimated the timing of isolation of the Faraglioni.

The biological approach relied on the molecular clock method analysis of the blue lizard. The divergence data between pairs of species and clades was once best approximate by using fossil calibration techniques and occurrence of inferred common ancestor into the fossil record. While fossil information still remains prominent into the discipline of dating phylogenetic tree nodes, a recent genetic techniques is now gaining ground in the field. Such a method relies on the accumulation of genetic distance in selected mtDNA strands as to infer the age of the most recent common ancestor between a pair. This so-called molecular clock method was somewhat criticized on the ground of its strong assumptions and all too possible exceptions. Anyhow, we used the method on the blue lizard of the three studied sites. We present here the comparison between the mtDNA estimate of the divergence date in the blue lizard and the estimate of Faraglioni first isolation based on the relative sea-level change analysis.

Fig. 1: A lizard

MIGRATION RATES OF TIDAL MEANDERS IN THE VENICE LAGOON

Finotello A.[1], D'Alpaos A.[1], Ghinassi M.[1], Lanzoni S.[2], Marani M.[2,3], Howes N.[4], Rinaldo A.[2,5]

[1] Department of Geosciences, University of Padova, Padova, Italy
[2] Department ICEA, University of Padova, Padova, Italy,
[3] Nicholas School of the Environment and Earth Sciences, Duke University, Durham, NC, USA,
[4] Shell Technology Center Houston, Houston, TX, US,
[5] Laboratory of Ecohydrology, ECHO/IEE/ENAC, Ecole Polytechnique Fèdèrale de Lausanne, Lausanne, Switzerland.

Meandering channels are ubiquitous features of tidal landscapes. However, despite the fundamental role they play on the eco-morphodynamic evolution of these landscapes, tidal meanders have received less attention in comparison with their fluvial counterparts. Improving current understanding of tidal meander migration, a largely-examined topic in fluvial landscapes, is a key step to highlight analogies and differences between tidal and fluvial cases. The migration of about 400 meander bends, belonging to 40 salt-marsh channels in the Northern Venice Lagoon (Italy), from 1968 to nowadays, has been investigated by means of both a classical method in fluvial frameworks and new procedure. Similarities with fluvial meanders occur, although important difference also emerge. Meanders cutting through the San Felice marsh follow the relationship between cartesian length and channel width, typical of meanders developed within different settings. However, meander migration rates proved to be smaller than those characterizing fluvial meanders. Indeed, the analysis of meander migration suggests a mean migration rate of about 0.10 m/year, consistent with the few data available in the literature. As for the fluvial case, the maximum-potential migration rate (i.e. the envelope curve of the relationship between migration rate and bend radius, both divided by channel width) reaches a maximum for radius-over-width ratio included between 2 and 3, regardless of the considered method. Nevertheless, the new-proposed method allows us to provide a more objective and continuous characterization. By using this new procedure, the channel curvature has finally been Fourier-analyzed, confirming the importance of even harmonics along the curvature spectrum. A correlation between migration rates and dominant harmonics seems to drive the evolution of tidal meanders and might represent a key-feature to distinguish them from their fluvial counterparts.

SWIM-SURVEY OF THE ROCKY COASTS OF USTICA ISLAND (SICILIY)

Foresta Martin F.[1], Furlani S.[2], Antonioli F.[3], Cavallaro D.[4], Chirco P.[5], Caldareri F.[5], Morticelli M.G.[5]

[1]Laboratorio Museo di Scienze della Terra Isola di Ustica, Rocca della Falconiera, 90010 Ustica PA (Italy)

[2]*Dip. di Matematica e Geoscienze, University of Trieste, via Weiss 2, 34127 Trieste (Italy)*
[3]*ENEA SSPT-MET-CLIM*
[4]*Dip. di Scienze Biologiche, Geologiche ed Ambientali, University of Catania, Corso Italia 55, 95129 Catania (Italy)*
[5]*Dip. di Scienze del Mare, Palermo*

The Geoswim project (www.facebook.com/geoswim) aims at surveying the Mediterranean rocky coasts (Furlani et al., 2014). In June 2015 we surveyed the coasts of the island of Ustica (some 53 km offshore northwestern Sicily), which consists entirely of volcanic rocks. The Geoswim2015 project, in particular, focused on surveying for first time the geomorphotypes and coastal features along basalt rocks together with sea level markers. Moreoverer the occurrence and extent of vermetids and *Lithophyllum lichenoides* or Corallinae alghae trottoirs, remeasurements of the geomorphological features of the sea caves studied by many Authors (e.g. Colantoni et al., 1990; Alessio et al 1997, Mannino and Ailara, 2014) and the location of submarine freshwater springs, were achieved.

The survey was carried out during two days of snorkel investigation, along the whole perimeter of the island, about 17 km long. A small raft (Ciclope II) with surveying instruments was pushed during the survey. The instruments used during the survey, such as two underwater cameras placed in a plexiglass hemisphere for observing the tidal zone, a CTD diver to collect temperature and electrical conductivity, a GPS, an invar rods, an ultrasonic depth meter, etc., allowed to collect many geomorphological and hydrogeological data.

The survey highlighted that basalts are generally very few weathered by marine processes, but locally some small inclusions of basalts can be corroded to form a slightly carved tidal. In the northern side of the island we found out a tidal notch with a well-developed vermetid trottoir on basalts.

We will discuss the recent vertical movements on the basis of the altitude of the Last Interglacial terrace (Foresta Martin 2000, Buccheri et al 2014), the lithophaga holes found up to an altitude of 4.5 meters, the radiocarbon dating carried out on submerged stalactites (Grotta Azzurra) and ctamalids sampled up to 1.4 m in the cave of...(Maurizio...)

Hydrological data show that very small freshwater outflows are located in correspondence of sea caves or small fractures and are mainly the result of water dripping.
Data collected confirm the effectiveness of the snorkel surveying also on volcanic coasts, both for geomorphological and sea level change studies.

References

BUCCHERI G., D'ARPA C., FORESTA MARTIN F. (2014). A geosite to be saved: the thyrrenian fossil deposit on the Island of Ustica. Il Naturalista Siciliano, XXXVIII, 2, pp. 179-191.

COLANTONI P., GAMBA R., ALVISI M. (1990). Il complesso sotterraneo Grotta Azzurra-Grotta S. Francesco e la grotta Rosata nell'Isola di Ustica. Accademia di Scienze e Tecniche Subacquee, quaderno n. 2.

ALESSIO M., ALLEGRI L., ANTONIOLI F., BELLUOMINI G., IMPROTA S., MANFRA L., PREITE M. (1997). La curva di risalita del Mare Tirreno negli ultimi 43 ka ricavata da datazioni su speleotemi sommersi e dati archeologici. Memorie Descrittive del Servizio Geologico Nazionale, Congresso GEOSUB 94, 52, 261-276.

FORESTA MARTIN F., (2000). I terrazzi marini dell'isola di Ustica. Lettera del Centro Studi e Documentazione Isola di Ustica, II, 6, pp. 26-28.

FURLANI S., NINFO A., ZAVAGNO E., PAGANINI P., ZINI L., BIOLCHI S., ANTONIOLI F., COREN F., CUCCHI F., (2014b). Submerged notches in Istria and the Gulf of Trieste: results from the Geoswim Project. Quaternary International, 332, 37-47.

MANNINO G., AILARA V., (2014). Le grotte di Ustica. Centro Studi e Documentazione Isola di Ustica, pp. 143.

UNDERWATER IMAGERY AS A COMPLEMENTARY TOOL IN BENTHIC HABITATS DESCRIPTION

Foveau A.[1*], Dauvin J.C.[1], Lozach S.[2], Baffreau A.[1], Poizot E.[3], Trentesaux A.[4]

[1] CNRS, UMR 6143 M2C, Laboratoire Morphodynamique Continentale et Côtière, 24 Rue des Tilleuls, 14000 Caen, France
2 Centre for Environment, Fisheries & Aquaculture Science (Cefas), Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, NR33 OHT, UK
[3] Conservatoire National des Arts et Métiers, Laboratoire Universitaire des Sciences Appliquées de Cherbourg LUSAC, CNAM/Intechmer, 50100, Cherbourg, France
[4] Université Lille 1 & CNRS, laboratoire Géosystèmes UMR 3298, 59655 Villeneuve d'Ascq cedex, France

The use of optical methods to document the marine environment helps us to detect the organization and the structure of an environment which we cannot see or manipulate directly because of environmental requirements (depth, temperature, currents, etc.). The optical imagery, when realized in good conditions, supplies data in the contents rich in information which can be used in several purposes. In some cases, it constitutes the solution of sampling which represents the best compromise in terms of cover, ease to spread the equipment and quality of the information which we can extract from it. The optical imagery also offers the undeniable advantage to constitute which can be broadcast and appreciated estimated by a large public.

The main objective of the oceanographic surveys VIDEOCHARM on 2010 and 2011 was to better characterize the habitats of the central zone of English Channel, by realising a series of rectangular boxes combining side scan sonar profiles, Hamon grab samplings and the ROV video shots from the meridian of Greenwich up to the western entrance of the English Channel. All the boxes are situated south of the line of separation of both countries, in French waters area. The obtained quantitative observations will bring new information on benthic habitats: on one hand on the submarine landscapes and the sedimentary profiles and on the other hand on the biological communities (sessile and vagile epifauna, scattered megafauna). This sampling helps to increase quantitative data available in this central region of the English Channel and to complete benthic data of the eastern part of the Channel.

STRATAL ARCHITECTURE AN FLOW DISTRIBUTION IN A TRANSLATING TIDAL POINT BAR, NORTHERN VENICE LAGOON (ITALY)

Ghinassi M.[1], D'Alpaos A.[1], Brivio L.[1], Finotello A.[1], Roner M.[1], Carniello L.[2], A. Gasparotto [2], Howes N.[3]

[1] Department of Geosciences, University of Padova, Padova, Italy.
[2] Department ICEA, University of Padova, Padova, Italy.
[3] Shell Technology Center Houston, Houston, TX, US.

A number of studies demonstrates that fluvial meander bends evolve following two basic mechanisms: expansion and translation. Expansion leads to the increase in point-bar radius and to the shift of the bend apex transversely to the valley axis. Translation keeps the point-bar radius as constant and leads to downstream migration of the bend apex. These two mechanisms generate different stratal architectures of related point bars deposits. Although tidal meanders are ubiquitous features of the tidal landscape, our knowledge about their planform evolution is still poorl and facies models for tidal point bars were formulated assuming a similarity between them and their fluvial counterparts. The present study contributes at understanding tidal meander bends in saltmarsh settings, through a sedimentological study of an active bend located in the NE sector of the Venice Lagoon (Italy). The study channel, which is about 15-18 m wide and 2-3 m deep, forms a bend with a radius of curvature of about 17 m. ADCP measurements in the bend apex zone show a maximum speed of about 0.25 m/s and highlight that the zone of maximum velocity is located along the inner and outer bank during the flood and ebb stages respectively. The analyses of historical photos show that during the past 70 years the bar shifted seaward about 10 m without changing significantly its planform geometry. A total number of 85 cores were collected on the study bar. Cores were collected using a hand auger core sampler, 3.5 cm in diameter, whereas coring depth spans from 2 to 3 m. Sedimentological analyses show that the study bar covers a 5-10 cm thick, shell-rich layer consisting of mud-free medium sand, which accumulated as a bypass lag in the deepest part of the channel. Overlying bar deposits increase in thickness from 1.3 to 2 m moving from the landward to the seaward side of the bend. Bar deposits show an overall fining-upward trend from medium sand to silt and are characterized by a constant dipping of beds, which are inclined 10-15° seaward. The landward side of the bar appears to be mainly sandy, whereas its seaward side is characterized by the occurrence of 3-5 cm thick muddy layers. Bar sand is commonly massive because of the intense bioturbation, although locally plane-parallel stratifications can be observed. Shells and shell fragments are common in the lower part of the bar. Bar sand is covered by muddy deposits, which are 0.7 m thick in the seaward side of the bar and thin seaward to pinch out on the downstream side. These mud consist of organic-rich, tidal flat mud grading upward into saltmarsh, oxidized mud. Sedimentary cores from the outer bank, show that the channel cut through 1.7 m thick saltmarsh to tidal flat mud overlaying 0.3 m muddy sand tidal flat deposits. The results stemming out from the present study show that point bar translation occurs also in tidal meander bends. Translation of the study meander causes erosion along the landward side of the bar an deposition along its seaward side. As for fluvial bars, the occurrence of cohesive, non-erodible deposits along the outer bank seems to be a key forcing for promoting bar translation. Differently from fluvial setting, however, bar translation occurs here under aggradational conditions, as attested by the seaward thickening of point bar deposits.

"HABITAT MAPPING" GEODATABASE, AN INTEGRATED INTERDISCIPLINARY AND MULTI-SCALE APPROACH FOR DATA MANAGEMENT

Grande V.[1], Angeletti L.[1], Campiani E.[1], Conese I.[1], Foglini F.[1], Leidi E.[1], Mercorella A.[1], Taviani M.[1]

[1]*CNR-ISMAR Via Gobetti 101 40129 Bologna, Italy*

Historically, a number of different key concepts and methods dealing with marine habitat classifications and mapping have been developed to date. The EU CoCoNET project provides a new attempt in establishing an integrated approach on the definition of habitats. This scheme combines multi-scale geological and biological data, in fact it consists of three levels (Geomorphological level, Substrate level and Biological level) which in turn are divided into several hierarchical sublevels. This system allows to identify, describe and map in a consistent way habitat distribution from shallow coastal to deep sea (*Foglini et al, 2014*).

Starting from this idea, we have designed and developed a ESRI File Relational Geodatabase (GDB) dedicated to habitat mapping, focusing particularly on storage and management of groundtruthing data and products. In the GDB, the contents are organized in three major groups as follows: the SamplingFeatures dataset stores the elements related to the sampling, the ROVs dataset groups all the information about the ROV surveys and, the maps are located in the HabitatMaps dataset. According to the CoCoNET classification scheme, we have the Geomorphological layer, the Substrate Layer and the Biological layer, and from the sum of these levels we obtain the Habitat layer. The hierarchical structure allows building maps with several possibilities of combination between all the levels, so we can produce multi-scale outputs and legends.

An innovative approach is adopted for processing ROV dives. The video tracks are analyzed with the Adelie software and are represented with: (i) the ROV navigation, (ii) the habitat description (also this Habitat layer is organized according to the CoCoNET classification levels), (iii) the heading of the ROV cameras, (iv) the georeferenced position of the images along the path and (v) the biological samples. While the images are stored in the GDB, the videos are linked through a hyperlink and can be visualized on the ROV navigation lines with the Adelie software.

An organized system, such as the "Habitat Mapping" GDB, is crucial for a correct data management, since it allows to store, visualize, query and elaborate data to produce customized maps in an easy and efficient way. Moreover the use of the CoCoNET classification scheme gives to the system a multidisciplinary and multi-scale trait, essential while dealing with habitat mapping.

References

Foglini F., Angeletti A., Campiani E., Canese S., Fraschetti S., Grande V., Leidi E., Marchese F., Mercorella A., Prampolini M., Savini A., Taviani M., Tessarolo C., (2014). Habitat mapping for establishing Coast to Coast Network of marine protected areas in the framework of COCONET Project: from coastal area to deep sea in the South Adriatic (Italy). Conference proceedings of GeoHab-2014 (Marine Geological and Biological Habitat Mapping) 4-8 May Lorne, Australia.

A SUBMERGED MESOLITHIC SETTLEMENT DISCOVERED IN THE SICILIAN CHANNEL

Lodolo E.[1], Ben-Avraham Z.[2]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), Trieste, Italy (elodolo@ogs.trieste.it)
[2] Department of Earth Sciences, Tel Aviv University (Israel) and Charney School of Marine Sciences, University of Haifa (Israel)

The NW sector of the Sicilian Channel, known as Adventure Plateau, is studded by isolated shoals mostly composed by Late Miocene carbonate rocks and by some volcanic edifices. These shoals, until at least the Early Holocene, formed an archipelago of several islands separated by stretches of extremely shallow sea. One of these submerged relieves - the Pantelleria Vecchia Bank - located 60 km south of Sicily, has been extensively surveyed by geophysical and geological methods. It is composed by two main shoals, connected seaward by a rectilinear relief which encloses an embayment. Here we present morphological evidence, underwater observations, and results of petrographic analysis of a man-made, 12 m long pillar of square section, resting on the sea-floor of the embayment at a water depth of 40 m. It is broken into two parts, and has two regular holes: one at its end which passes through from part to part, the other in one of its sides. The pillar is composed by calcirudites of Late Pleistocene age, as determined from radiocarbon measurements conducted on several shell fragments extracted from the rock samples. The same age and composition characterize the metre-size blocks forming the rectilinear relief. The rest of the rocks composing the shoals are mostly Tortonian limestones-sandstones, as revealed by their fossil content. The presence of this pillar suggests a permanent human occupation within the bay. It probably had the function of an ancient lighthouse for spotting the settlement from the sea. The gradual increase in sea level after the Last Glacial Maximum has profoundly changed the landscape and the fate of the settlement. Extrapolating ages from the local sea level curve, we infer that seawater inundated the inner lands at 9240 ±180 yr B.P. presumably forcing inhabitants to migrate. This discovery provides evidence for one of the most ancient human settlements in the Mediterranean region, and demonstrates both their considerable technological capacity and their navigational skills.

TIMAVO SYSTEM EXPLORATION

Luchesi P.[1], Zini L.[2]

[1] Società Adriatica di Speleologia, Trieste, Italia
[2] Dipartimento di Matematica e Geoscienze, Università di Trieste, Italia

The Classical Karst is a limestone plateau of about 750 km^2, extending from SE of the Isonzo River to Postojna town crossing the Slovene-Italian border. This plateau consists mainly of deeply

karstified limestones where rainfall and surface waters are immediately swallowed by a network of caves and fractures through the epikarst and vadose zones. The aquifer itself is characterized by horizontal or sub-horizontal conduits that quickly convey the waters to the springs area.The Timavo outlet represent one of the springs with one of the highest-discharge in the Mediterranean area (average discharge of 35 m^3/s, maximum of 175 m^3/s).

In this framework fits the Timavo System Exploration speleodiving program. Born from a simple idea of the Società Adriatica di Speleologia, it reached its third year of activity involving one of the top international diving teams: the french of FFESMM of Marseille that came back after 20 years.

In these last three years, the French-Italian collaboration widened involving slovenian and other italian speleological groups, the researchers of the Mathematics and Geosciences Department of the Trieste University and the local municipalities.

The surveys were realized in two different well known caves as Pozzo dei Colombi at San Giovanni di Duino (227VG) near Timavo Springs and Trebiciano Abyss (17VG) at Trebiciano. At approximately 30 km one from each other, the two caves are important window on the Timavo aquifer system. They are completely different from the phisical and logistical point of view requiring different speleodiving approaches. The Pozzo dei Colombi cave is a 60 m vertical shaft partially filled by water where the water table is at 2 m a.s.l. A lift was installed, for equipment transport , and used a floating raft where the speleosub prepared all the material before the immersion.

Trebiciano Abyss is instead a deeper cave with several shafts that at approximately 300m in depth from the entrance reaches the big Lindner chamber where Timavo waters are flowing. The water table in low flow conditions is here detectable at about 12 m a.s.l.

The first two expeditions were not fully successfully due to the adverse hydrogeological conditions in the Pozzo dei Colombi (high turbidity and flow velocity). This summer (2015) the conditions were better and the speleodivers had the chance to restart the exploration at the Pozzo dei Colombi where the speleodivers found the way to the wide flooded conduit exploring 240m toward north reaching a depth of 72 m below sea level.

At Trebiciano Abyss, thanks to the help of the different speleological groups who helped in the material transferring and the installation of a phone line, the research operations has been well covered over the three years giving good results. The logistical organizations permit the start of the operation with two teams at the same time in both caves.

In the Trebiciano Abyss the explorations are difficult not for the encountered increasing depths, but mainly for the turbidity (visibility of 50cm) and the low flow water that do not allow to clearly understand which is the right direction to follow. The speleodivers, anyway went pass through the siphone, exploring it for 250m of a conduit network finding in the end a new chamber with the free surface water, named "La sala dell'amicizia" (The friendship chamber). The discovered new path was later routed for future explorations.

The international cooperation among Italians, French and Slovene has been the key for the success of the Timavo System Exploration Project. The reached results upgreaded the knowledges on the Classical Karst aquifer and on the developement of the Timavo underground network.

STUDY OF TIDAL CHANNEL AND PALAOCHANNEL MORPHOLOGY WITH UNDERWATER ACOUSTICS AND GROUND TRUTH SAMPLES

Madricardo F.[1], Campiani E.[2], Donnici S.[1], Grande V.[2], Fogarin S.[1], Foglini F.[2], Leidi E.[2], Kruss A.[1], Maselli V.[2], Montereale Gavazzi G.[1], Pellegrini C.[2], Rizzetto F.[1], Sarretta A.[2], Sigovini M.[1]

[1]*Istituto di Scienze Marine, ISMAR-CNR, Arsenale - Tesa 104, Castello 2737/F, 30122 Venezia (Italy).*
[2]*Istituto di Scienze Marine, ISMAR-CNR,* Via Gobetti *101, 40129* Bologna*, Italy.*

Tidal channels are crucial for the tidal environment hydrodynamics and sediment and biota exchange with the open sea. Despite their importance, there is still a gap in knowledge about their migration and sedimentation rates and their intrinsic morphological properties. This is because, up to recent times, the physical characteristics of tidal environments (extremely shallow waters, turbidity, relatively strong currents, etc.) had prevented a systematic investigation of tidal channels and palaeochannels. In order to fill this gap, in the last ten years, ISMAR-CNR has carried out extensive acoustic remote sensing and ground truth surveys in the Lagoon of Venice.

To explore the properties of tidal palaeochannels, we crossed high resolution sub-bottom acoustic data with cores, radiocarbon dating and historical maps. The sub-bottom surveys conducted between 2003 and 2009 allowed the reconstruction of an intricate network of palaeochannels. This network was drastically simplified in the last century mainly by radical anthropogenic morphological changes of the lagoon.

Furthermore, in order to study the internal architecture of tidal channels, in 2013, we collected very high resolution multibeam (by mean of a Kongsberg EM2040DC system) and ground truth data (grab samples, seafloor photographs and videos). These datasets shed light on an almost unexplored environment, allowing the mapping of tidal channel seafloor morphological features and benthic habitats with unprecedented detail.

These case-studies document the importance of high resolution acoustic remote sensing and ground truthing for the study of tidal channels and, more generally, for the monitoring and management of extremely shallow tidal environments.

NEW ARCHAEOLOGICAL EVIDENCES OF RELATIVE SEA LEVEL CHANGES ALONG THE COASTLINES OF APULIA (SOUTHERN ITALY).

Mastronuzzi G.[1], Alfonso C.[4], Antonioli F.[2], Anzidei M.[3], Auriemma R.[4], Scarano R.[4], Calcagnile L.[5], Quarta G.[5]

[1] *Dipartimento di Scienze della Terra e Geoambientali, Università degli Studi "Aldo Moro", Bari*
[2] *ENEA UTMEA, Roma*
[3] *Istituto Nazionale di Geofisica e Vulcanologia, Roma*
[4] *Dipartimento di Beni Culturali, Università del Salento, Lecce*
[5] *CEDAD, Centro di Diagnostica e Datazioni, Università del Salento*

The coastal landscape of Southern Apulia from Monopoli to Taranto is characterised by gently sloping rocky coasts marked by deep rias and bays alternate with low cliffs. In these sheltered areas, due to the presence of wetlands rich in fresh water springs, the human settlements have been about continuous in time since the Bronze age with a sea level lower than present.

The presence in the Bronze age of small villages, landing places, and in the more recent - during the Iron age and the Roman Empire - of structured cities with important harbours are testified by the extensive outcropping of archaeological sites both submerged or emerged along the coastline. Generally they are exposed to waves washing along the gently sloping rocky coasts or buried by Holocene aeolian or colluvial sediments or by soil.

The position of quarries, hut bases, tombs, sewer channels, cisterns, piers, fish tanks and shipwrecks of Bronze, classical and Middle age have been surveyed through topographic measurements to evaluate their precise elevations respect present mean sea level and corrected for the tidal range. The study of the archaeological sites of Torre San Vito (Ba), Egnatia (Br), Torre Santa Sabina (Br), Torre Guaceto (Br), San Cataldo (Le), Porto Cesareo (Le), Torre Ovo (Ta) and Torre Saturo (Ta) allowed us to obtain a new dataset useful to compare our observed data with the predicted relative sea level curve for the last 5ka for this region.

References

ALFONSO C., AURIEMMA R., SCARANO T., MASTRONUZZI G., CALCAGNILE L., QUARTA G., DI BARTOLO M. (2012). The ancient coastal landscape of the Marine Protected Area of Porto Cesareo (Lecce-ITALY): recent researches. International Journal of the Society for Underwater Technologies, 30, 4, 207-215.

ANTONIOLI F., FERRANTI L., FONTANA A., AMOROSI A., BONDESAN A., BRAITENBERG C., DUTTON A., FONTOLAN G., FURLANI S., LAMBECK K., MASTRONUZZI G., MONACO C., SPADA G., STOCCHI P. (2009). Holocene relative sea-level changes and tectonic movements along the Italian coastline. Quaternary International, 206, 102-133.

AURIEMMA R., MASTRONUZZI G., SANSO' P. (2004). Relative sea-level changes during the Holocene along the Coast of Southern Apulia (Italia). Géomorphologie, 1, 19-34.

SCARANO T., AURIEMMA R., MASTRONUZZI G., SANSÒ P. (2008). L'archeologia del paesaggio costiero e la ricostruzione delle trasformazioni ambientali: gli insediamenti di Torre Santa Sabina e Torre Guaceto (Carovigno, Br). Secondo Simposio Internazionale "Il Monitoraggio Costiero Mediterraneo: Problematiche e Tecniche di Misura", Napoli, 1-6 giugno 2008, CNR-IBIMET, Firenze, 391-402.

THE SHALLOW-WATER BIO-CONCRETIONNED HABITAT OFF PLAKATA CAPE, BULGARIA (BLACK SEA)

Micu D.[1], Taviani M.[2]

[1] *National Institute for Marine Research and Development Grigore Antipa, Constanta, Romania*
[2] *Institute of Marine Research (ISMAR)-CNR, Bologna, Italy*

The scientific attention paid to the check of marine habitats in the Mediterranean and Black Sea regions is gaining increasing impetus through international programmes, with major discoveries mainly related to the comparably poorly surveyed deep sea environments. Yet, relevant habitats

can still be recognized at shallow depth, such as the case of the biogenic 'reef' located ca. 200 m offshore the rocky coast of Bulgaria at Plakata Cape in the Black Sea. Here, the submerged rocky bedrock and boulders serve as substrate to a conspicuous calcified benthic life which turned into bio-concretions distributed between 7-23 m, with maximum growth observed at 11-13 m. The biogenic constructions are irregularly shaped, somewhat porous, crumbly, and appear mainly engineered by serpulid clusters and oysters (*O.edulis*), binding trapped sediment in the frame. The bio-concretions appear as dm- to plurimetric thick often vuggy aggregates, attached to the smooth crystalline substrate at their initial stages, at places evolving in thicker formations, including aggradational overhangs which can mask completely the non-organogenic bedrock. Oysters were known to be still alive until the late'80s, when they eventually overcome an almost complete mortality. This habitat is included in the Natura 2000 protocol and was first identified and described by Micu et al. (2007), and Todorova et al. (2009). In some respect the Plakata reef resembles biogenic rocky constructions punctuating the shallow shelf of the northern Adriatic Sea (Donnici et al., 2015). We have revisited the Plakata reef by SCUBA diving in summer 2015, under the umbrella of the EU Coconet project, in order to gain further bio-sedimentologic and ecologic information, and verify its current status. Although we confirm the absence of living oysters, at present the 'reef' is a remarkable biodiversity hotspot, being fertile site to the settlement of numberless *Mytilus edulis* and *Mytilaster lineatus*, hunting ground for the large non-native *Rapana venosa* gastropod, barnacles, sponges, and decapods. Algae include *Ulva* at shallower depth, *Cystoseira*, mainly growing on the rocky bedrock as deep as 13 m, and a few other species (Todorova et al., 2009). The reefs offer habitat to various demersal fishes (mainly scorpenids, gobids, and blennids), whilst schools of other fishes, including *Chromis*, occur in the water column above the reefs. The corridors among individual substrate outcrops and reefs are draped by very coarse sand and shelly hash, prevalently made by *Mytilus* remains, that offer substrate to *Gibbula rarilineata* and juveniles of the non-native arcid bivalve *Anadara kagoshimensis*. The carbonate frame of the reef is infested by the endobiont bivalve *Petricola lithophaga* that thus strongly contribute in weakening the structure. The size of the reef suggests that its growth required a still un-quantified by substantial amount of time, possibly centuries if not millennia and our on-going research will hopefully clarify this point. Clearly, the Plakata reef are in need of due consideration for their protection and management, also in consideration of their little areal extent and proximity to a highly impacted coastline. As such, a proposition to give it the status of a Site of Community Interest, and potentially of a Marine Protected Area for the Black Sea is highly recommendable.

References

DONNICI S., TOSI L., BERGAMASCO A., DA LIO C., FRANCHI F., MAZZOLI C., MONTAGNA P., TAVIANI M. (2015). Stratigraphy, fluids and ecology: The genesis of bio-concretionned rocky outcrops (tegnue) of the northern Adriatic shelf. 31st IAS Meeting of Sedimentology, Krakow.

MICU D., TODOROVA V., WOLFF W. (2007). Newly discovered oyster reefs of the Black Sea: in time for restoration? 10th International Conference on Shellfish Restoration (ICSR) 12-16 November 2007, Vlissingen, The Netherlands.

TODOROVA V., MICU D., KLISUROV L. (2009). Unique Oyster reefs discovered in the Bulgarian Black Sea. Comptes Rendus de l'Academie Bulgare des Sciences 62, 871-874.

LOST LAKE LANDSCAPES OF THE EASTERN ADRIATIC SHELF (LoLADRIA)

Miko S.[1], Ilijanić N.[1], Hasan O.[1], Papatheodorou G.[2], Razum I.[2],. Bakrač K.[1], Hajek Tadesse V.[1], Christodoulou D.[2], Brunović D.[1], Iatrou M.[2]

[1] *Croatian Geological Survey, Sachova 2, 10000 Zagreb, Croatia*
[2] *Laboratory of Marine Geology & Physical Oceanography ,Department of Geology, University of Patras, 26504 Rio, Patras, Greece*
[3] *Croatian Natural History Museum, Demetrova 1, 10000 Zagreb, Croatia*

The LoLADRIA project represents a multidisciplinary effort to recover, for the first time, long paleoenvironmental and paleoclimate records from existing coastal karst lakes and submerged karstic lakes of the eastern Adriatic shelf in Croatia. At glacial low sea levels large areas of the continental shelf were exposed, making them available to early humans. The project will attempt to reconstruct the specific karst lake landscapes and their surroundings in view of environmental and climate change and human migration from the Last Glacial Maximum (LGM) through the Holocene. Lakes and submerged karst depressions (lagoons) along the coastal region of Croatia are repositories of sediments which accumulated at various rates continuously during late Pleistocene and the Holocene, offering a rich and detailed archive of an environmental history. While terrestrial sequences in the Croatian coastal karst regions are often incomplete due to erosion, lake and marine sediments offer complete and well-dated archives spanning throughout most of the Holocene. The LoLADRIA project is using cores (5-10 m long) collected from 17 sites (5 lacustrine and 12 marine) along eastern Adriatic coast. These sediments allowed multyproxy reconstructions of the Holocene millennial- and centennial-scale environmental changes. A landscape reconstruction based on high resolution geophysical methods allowed insight to the preserved changes in marine sediments and submerged lake landscapes in Lošinjski kanal, Novigradsko more, Karinsko more and Pirovački zaljev. The thickness of marine sediments reaches 5m and the underlying paleo-lake sediment sequences vary from up to 2 m in Karinsko more to more 10 m in Lošinjski kanal. Details of environmental change are extracted for the by integrating mineralogy, lithostratigraphy, biostratigraphy (pollen, foraminifers, ostracodes), tephrostraigraphy and chemical stratigraphy with a well defined 14C AMS radiocarbon chronologies. The study sites and the chronological spanning of the Holocene sediment sequences, gathered during the past five years, are presented to stress major environmental changes recorded during the Holocene. Intensive terrigenous fluxes are recorded in some cores by mineralogy, grain size distribution and major and minor element geochemistry, as well as pollen assemblages up to the period of ca. 7000 cal BP, indicating links with the Mediterranean sapropel (S1) sediment layers formation. The late Holocene from ca. 4500 cal BP onwards is characterized by changes in sediment composition which seem to be in agreement with the beginning of the Neoglacial in the Central Mediterranean observed in lake and marine cores from Italy. Erosion triggered by deforestation during the past millennia is documented in cores from the Zrmanja River catchment by major and minor element geochemistry. The dating of sediments from lakes and marine lagoons so far reviled the existence of tephra ranging from Neapolitan Yellow Tuff(NYT) to Agnano Monte Spino (AMS) and Avellino tephra.

POSIDONIA OCEANICA AND REFERENCE CONDITIONS: APPLICATION OF AN INNOVATIVE MODELING APPROACH

Misson G.[1], Vacchi M.[2], Montefalcone M.[1], Bianchi C.N.[1], Ferrari M.[1]

[1] *DiSTAV, Department of Earth, Environmental and Life Sciences, University of Genoa*
[2] *CEREGE CNRS-IRD UMR 34, Aix-Marseille Université, Aix en Provence*

The European Directive 2008/60/EC known as the Marine Strategy Framework Directive (MSFD) requires Member States to determine the conservation conditions of marine environments by considering structure, functions and processes that govern the ecosystem. The purpose of the Directive is to attain or maintain a good environmental condition of the marine environment by 2020. Assessing the reference conditions of ecosystems, i.e. the baseline, is crucial to define their reference status in order to distinguish the impact of natural processes as opposed to anthropogenic factors.

With this aim, we developed a model able to predict the reference conditions of Posidonia oceanica meadows, the most important coastal ecosystem of Mediterranean Sea. The model was developed at regional scale (Liguria Region) and tested at Mediterranean scale. This model, comparing the position of the meadow upper limit with the beach morphodynamics (i.e. the distinctive type of beach produced by topography and wave climate), defines a portion of seabed where the upper limit of the meadows of P. oceanica is expected to be located in the natural conditions (i.e. without anthropogenic influence), thus determining the reference conditions. This approach has been applied to 7 western Mediterranean coastal areas with different coastal morphologies and hydrodynamic characteristics: Murcia and Valencia (western Balearic Sea), Cavalaire-sul-Mer (Gulf of Lion), Alassio (northern Ligurian Sea), Saleccia (southern Ligurian Sea), Marina di Pescia Romana (Tyrrhenian Sea), Acharavi (Ionian Sea).

The results showed good applicability of the predictive model at the Mediterranean spatial scale, but its applicability is restricted to the meadows set on sandy or matte substrate.

In conclusion, we validated the predictive model at the Mediterranean scale. Its application allowed determining the reference conditions (i.e. those governed only by hydrodynamics, in absence of significant anthropogenic impact) requested by the European Directive (MSFD) and thereby to quantify the regression of meadows of P. oceanica caused by human activities.

CHARACTERIZATION OF MEDITERRANEAN MONK SEAL (*MONACHUS MONACHUS*) BONES IN BEL TORRENTE CAVE (SARDINIA, ITALY)

Mo G.[1], Provenzani C.[2], Marassich A.[2], Romano E.[1,2]

[1]*ISPRA, Institute for Environmental Protection and Research. Via V. Brancati 48, 00144 Rome (Italy)*
[2]*GUE, Global Underwater Explorers, Highsprings, Florida, USA*
corresponding author: e-mail: giulia.mo@isprambiente.it

Bel Torrente is a marine cave located in the north-eastern coast of Sardinia (Italy), discovered and explored by Jochen Hasenmayer in the 1970s, while the first 500 m were surveyed in the 1990s. It is characterized by a 5-20 m wide tunnel with an average height of 5 m and a depth of 12 m.

During the 20th century, the caves in this area of Sardinia were used as haul-out and reproductive sites by the Mediterranean monk seal (Monachus monachus), a species classified as critically endangered by the IUCN (International Union for Conservation of Nature) Red List of Threatened Species (http://www.iucnredlist.org). Mediterranean monk seals live mostly at sea but they use caves with internal emerged platforms or sandy beaches, that are well protected by wave action and by human intrusion, as haul out areas where they can rest, birth and lactate their pups. The species was declared extinct in Italy in the early 80s, but monk seal sightings have continued to occur along Italian coasts until the present. As of 1998 the Italian Protection and Research Institute (ISPRA) has been collecting and validating monk seal sightings reported by third party observers and has also been monitoring monk seal cave use in the Egadi islands (northwestern Sicily) through the use of phototraps.

Evidence of monk seal cave use in the Mediterranean has been documented since classical antiquity, however there is little information on the species' use of this habitat in earlier periods. A recent and extraordinary finding of monk seal bones was reported in 2004 by Sgualdini *et al.* in the Bel Torrente cave (Spiaggia del Bue and Ramo del Bue). The ages of these bones were estimated at 5,000-6,500 B.P. by de Waele *et al.* (2009).

The present work aims to document the bone remains present in the Bel Torrente cave with respect to the extension of the cave. The cave was surveyed, mapped and documented by means of photomosaic and detailed pictures of all bone remains, with particular emphasis on the lateral/ventral views of the skulls and lateral view of the jaws. The photomosaic was carried out to visually census the location of all the bone fragments, which were each identified by numbered markers. This allowed to subsequently analyse each remain according to major bone typology (i.e. skull, spinal, limb etc.). This implied that the cave was object of a more specific survey in order to georeference the bones in each cave section.

UNDERWATER GEOLOGY CLASSIFICATION METHODS OF MULTIBEAM DATA FOR BENTHIC HABITAT MAPPING

Montereale-Gavazzi G.[1], Madricardo F.[1], Sigovini M.[1], Kruss A.[1], Janowski L.[2], Foglini F.[3]

[1] *Institute of Marine Science - National Research Council ISMAR-CNR, Castello 1364/a, 30122 Venice, Italy*
[2] *Institute of Oceanography, University of Gdansk, al. Marszalka Pilsudskiego 46, 81-378 Gdynia, Poland*
[3] *Institute of Marine Science - National Research Council ISMAR-CNR, Via Gobetti 101, 40129 Bologna, Italy*

Within the context of Ocean Zoning (OZ), Marine Spatial Planning (MSP) and Ecosystem Based Management (EBM) require sustainable and intelligent tools and applications for the adequate management of marine resources. The cartographic and thematic representation of benthic habitats has become a fundamental prerequisite to fulfil national and international legal

requirements, providing the necessary information to inform policy-making. The application of conventional surveying instruments in shallow coastal seas and lagoons has been largely limited by water turbidity and the application of hydro acoustic tools by depth. Nonetheless, we show that Multibeam echosounder (swath acoustics) coupled with ground truth sampling, can yield high-quality and high-resolution data in such a context, thereby justifying their application in the realm of mapping and monitoring of yet scarcely understood and acknowledged submerged environments.

Our research focused on the application of a multibeam Kongsberg EM2040-DC within a natural tidal channel (Scanello - UTM 33N, 45.4898, 12.4386) of the Venice Lagoon ranging -0.5 cm to -12 m in depth. Starting from bathymetric and backscatter data, we identified a set of acoustic signatures and related them to ground truth samples, starting the caractherisation of benthic habitats in this context. Overall, five habitat (*sensu lato*) classes were identified, including noteworthy biogenic habitats of which Submerged Aquatic Vegetation (SAV) and newly acknowledged subtidal sponge field.

Nonetheless, different methods of segmenting and classifying acoustic data exist and have their advantages and disadvantages depend on the context. A fundamental step in making the most of such data is investigating different methods and understand their relative merits. We propose a comparison of segmentation methodologies (both object and pixel oriented) which may be useful in a range of contexts (beyond lagoon environments) and discuss their pros and cons. Additionally, we show how complex morphometric feature-extraction tasks can be readily automated using algorithms of spatial analysis.

MULTI-DISCIPLINARY APPROACH TO CHARACTERIZE TRANSGRESSIVE DEPOSITS IN THE NORTHERN ADRIATIC SEA

Moscon G.[1], Correggiari A.[2], Stefani C.[1], Remia A.[2], Fontana A.[1]

[1] *Dipartimento di Geoscienze, Università degli Studi di Padova, Via Gradenigo 6, 35131 Padova, Italy*
[2] *ISMAR (CNR), Via Gobetti 101, 40129 Bologna, Italy*

The Adriatic Sea is an epicontinental semi-enclosed basin characterized by a low axial gradient shelf in the northern and central part and by a steeper gradient in the southern sector. During the Last Glacial Maximum (LGM, 30,000-19,000 ^{14}C a BP) the sea-level was about 120-130 m lower than today and the northern continental shelf was completely in subaerial conditions. The drainage network of this alluvial plain likely comprised a main trunk river, with Alpine and Apenninic tributaries. During the late-glacial to early-Holocene transgression, a glacio-eustatic, non-steady sea-level rise of approximately 120 meters caused substantial basin widening coupled by changes in energy regimes across the basin. The low gradient of the northern Adriatic shelf together with the approximately 10-15 mm/a sea-level rise favoured the deposition and in-place drowning of different generations of transgressive barrier-lagoon system sedimentary bodies. Nowadays from Trieste to Ravenna, these transgressive deposits are located between -10 and -35 m w.d, in restricted areas showing a dominant longshore trend similar to the modern high-stand deposits. These transgressive deposits rest on an erosive surface of regional extent (transgressive surface, TS) that truncates older low-stand deposits (LST), and are below the maximum flooding surface (MFS).

They generally are formed by a basal portion of silty-clayey layers interbedded with peat layers and a top portion of fine-sorted sand.

The characterization of these transgressive deposits is based on a large dataset of CHIRP-sonar profiles, bathymetric and isopach maps of the Late Pleistocene -Holocene deposit on the Adriatic shelf, where integrated stratigraphic studies from sediment cores allow a very high chronological resolution.Moreover compositional analysis of sand samples were necessary in order to highlight their provenance. The detailed study of these transgressive deposits allows the paleo-geographic reconstruction during the last transgressive cycle, and could give solid framework of the past relative position of the sea-level, using proxy indicators belonging brackish lagoon facies.

Two transgressive deposits, located northern of the Po delta, offshore Chioggia at 30 m w.d, are shown as example. These deposits rest on the same ancient erosive surface dated 24000 cal. yr BP. They are two builds-up oriented EW and divided by a gentle trough (RV_C the northern one and RV_H the southern one). The RV_C deposit is formed by sandy-silty bodies alternated to peat layers, while the RV_H deposit is characterized by a thick sand portion upper to 4 m which fills a depression. The quantitative compositional sand analysis of both RV_C and RV_H sand portions highlights a quartzolithic signature comparable to the Po river composition. The characterization of these two deposits give information about different environment of sedimentation during the last relative sea-level rise. The RV_C highlights different aggradation steps marked by peat layers, while RV_H highlights the infilling of a morphological depressions representative of previous topography. Moreover the petrographic analysis suggests a northward shifting of the paleo-Po river system during the sedimentation of RV_C and RV_H deposits.

SUBMERGED COASTAL KARST LANDFORMS IN RAS EL-HEKMA, NW COAST OF EGYPT

Nour N.[1], Torab M.[2]

[1] *PH.D student, Damietta University, Egypt, e-mail: nourhannour3@yahoo.com*
[2] *Prof. of Geomorphology, Damanhour University, Egypt, e-mail: magdytorab@hotmail.com*

Ras El-Hekma area is located in the NW coast of Egypt, west of Alexandria city about 220 km and east of Marsa Matruh city about 60 km. It coordinates is 31˚ 05´11.24˝ to 31˚ 15´ 30.04˝ N, and 27˚ 38´ 13.96˝ to 28˚ 00´ 34.13˝ E. It has equilateral triangle shape, and the stretches generally were NE/SW direction, which the length of eastern side of the coastline about 16 km, it consists of several wave cut platforms and bays, while the western coastline length about 18 km, and consists of cliffs only the maximum of elevation is 40 m, and altitude was 110 km in the south and begin to decline gradually up to the shoreline.

This paper observes on study submerged karst landforms, which formed when the sea level was lower during the last Late Pleistocene-Holocene. The evidence of continued karstification can be exposed to processes mechanical erosion and bio-erosion today. Coastal carbonate areas are characterized by unique karst features related to the marine environment.

The aims of this paper to study origin and geomorphic distribution of some submerged landforms such as solutions sinkholes, collapse sinkholes, solution pans and micro-features "karren" effects by the Holocene sea level change. Various submerged karst forms by the rising of the sea level, and some related processes in the submarine environment. This study depends upon

extensive field surveying in some selected submerged coastal karst profiles and measurements of submerged features in addition to GPS and GIS.

GEOHAB MAPPING ON SOUTH WESTERN SARDINIA CONTINENTAL SHELF (S. PIETRO ISLAND)

Orrù P.E.[1], Cau A.[2], Deiana G.[1], Lo Presti V.[3], Paliaga E.M.[1], Todde S.[1]

[1] *Dipartimento Scienze Chimiche e Geologiche – Cagliari University*
[2] *Dipartimento di Scienze della vita e dell'ambiente – Cagliari University*
[3] *La Sapienza University, Rome, Italy*

Study area is located on south-western Sardinian continental shelf, several miles off San Pietro island. The structural setting of this continental margin is the result of the superimposition of two successive deformational regimes during the Oligocene - Miocene age, contemporary to the Sardinia – Corsica microplate rotation. The proximal continental shelf was detected within the CARG Project by side-scan sonar survey calibrated and detailed by diving geological survey, in joint was measured in detail the litho-structural characters of volcanic outcrops, together with the mapping of the biological communities of hard substrates: tidal algae bioconstructions, photophilic algae Biocenosis. , *Posidonia oceanica* on "*mattes*" and rocky bottom. We have distinguished the main sedimentary facies and the biocenosis the coastal detritic bottom with particular reference to *Maerl* facies (*Lithothamnion corallioides* and *Phymatholithon calcareum*).

The distal platform was detected with multi beam ultrasouder and high resolution seismic (Chirp and Sparker 0.1-1 kHz) during the project "MaGIC" (Marine Geohazard along Italian Coasts) (2009 and 2010 cruises, R/V Universitatis). The continental shelf is characterized by an irregular morphology with large outcrops of the Oligo-Miocene volcanic-sedimentary succession. The proximal area is characterized by large mesas, cuestas and other typically volcanic morphotypes such as calderas, necks and mega-dykes. The distal area is filled at the basis by the Miocene sedimentary series and by the prograding Plio Pleistocene succession (Lecca, 2000). 10 miles off Cape Sandalo an paleocliff alignment shows numerous gravitative morphologies, the lithological character of these cliffs assumes long evolution times and a polycyclic processing, however, the erosive and gravitative morphologies now observables, are mainly due to the last stage of low standing sea level (MIS 2 - LGM) at the - 120/-130 m depth; at the same depth a paleo-lagoon has been sampled sandy muds, containing a thanatocoenosis with mesolittoral/lagoonar mollusks (*Mytilus galloprovincialis* 15360±280 BP cal.; *Acmaea virginea* 19,100±270 BP cal).

A geomorphological analysis of all these elements on a huge amount of data, performed in GIS environment, provided a guideline to plan the further ROV survey, as data obtained through Multibeam echosounder were used to create different maps: 3D georeferenced shaded relief maps of investigated sites; slope of the substrata; aspect maps of sea bottom related DTM and backscatter mosaic data (Wilson et al., 2007). Geological hypothesis calibration and biological data were collected by researchers during a Remotely Operated Vehicle survey (ROV "Pollux") carried out onboard the R/V Astrea during Autumn 2011 & 2013. In particular on rocky bottoms of the distal continental shelf have been mapped Coralligenous plateforms (*Mesophyllum lichenoides; Lithophyllum frondosum; Laminaria ochroleuca)* and Semi-dark caves facies with *Corallium rubrum,*

while in the deeper area (-200, -250 m) the Biocenosis of shelf-edge rock facies with *Leiopathes glaberrima* and the Biocenosis of bathyal compact *Isidella elongata.*

References

Cau A., Follesa M.C., Cannas R., Sacco F., Orrù P.E., Deiana G., Todde S., Paliaga E., (2013). Preliminary data on habitat characterization relevance for red coral conservation and management. Italian Journal of Geosciences 134:60–68.

LECCA L., (2000). La piattaforma continentale miocenico-quaternaria del margine occidentale sardo: blocco diagramma sezionato. Rend. Sem. Fac. Sc. Università di Cagliari, Fascicolo 1, 70.

ORRÙ P.E., DEIANA G., TAVIANI M., TODDE S., (2012). Palaeoenvironmental reconstruction of the Last Glacial Maximum coastline on the San Pietro continental shelf (Sardinia SW). Rendiconti Online Società Geologica Italiana. Volume 21, Issue PART 2, 2012, Pages 1182-1184.

WILSON M.F.J., O'CONNELL B., BROWN C., GUINAN J.C., GREHAN A.J., (2007). Multiscale Terrain Analysis of Multibeam Bathymetry Data for Habitat Mapping on the Continental Slope. Marine Geodesy 30, 3-35.

IMPORTANCE OF *IN SITU* OBSERVATION IN UNDERSTANDING THE ECOLOGY OF MARINE CAVES (EASTERN ADRIATIC COAST)

Petricioli D.[1], Radolović M.[2], Bakran-Petricioli T.[2]

[1] *D.I.I.V. Ltd., for marine, freshwater and subterranean ecology, Obala Petra Lorinija bb, 23281 Sali, Croatia, diiv@zg.t-com.hr*
[2] *University of Zagreb, Faculty of Science, Department of Biology, Rooseveltov trg 6, 10000 Zagreb, Croatia*

Speleo diving is a very demanding and complicated activity, and only very skilled, prepared and well equipped divers can perform tasks needed in biological and ecological exploration of marine caves. Numerous marine caves and pits along the eastern coast of the Adriatic Sea provide an opportunity to dive with SCUBA in some caves which are a bit simpler e.g. those usually directly approachable by boat (without the need to transport heavy equipment), shallower (usually less than the depths which demand TRIMIX dives), warmer (seawater temperatures almost always higher than 12°C) and with simpler morphology. However, even experienced scientist divers have a limited amount of time to perform all the necessary observation/measuring/sampling in those caves/pits. We think that a broad ecological knowledge is needed to assess what to explore *in situ* (where, when and what to measure and sample), in order to obtain quality data needed to understand processes that shape living communities inside the caves.

In our contribution we present four case studies in which 25 years of our diving experience from various caves and pits along the karstic eastern coast of the Adriatic Sea coupled with our biological and ecological expertise, helped us to 1) observe peculiarities inside the caves (that could easily be overlooked without that experience/expertise), and to 2) decide and determine the course of exploration. In that way we explained: the unusual impact of mixed corrosion and hydrodynamics of water masses on biota along the "Y" Cave at Dugi otok Island; the finding of the deep sea carnivorous sponge *Asbestopluma hypogea* at only 24 m depth on the rim of the underwater pit at Veli Garmenjak Island; the particular distribution of a fouling community (predominantly mussels) within a chimney type vrulja "Zečica" at the foot of the mountain Velebit, and the uncommon

hypoxic/anoxic environment and its impact on biota inside the cold water marine pit near Island Šolta.

LATE PLEISTOCENE MORPHOTECTONIC EVOLUTION OF THE RIVIERA DI ULISSE BETWEEN MONTE DI SCAURI AND GAETA, CENTRAL ITALY

Putignano M.L.[1], Schiattarella M.[2]

[1] *Istituto di Geologia Ambientale e Geoingegneria, CNR, Rome, Italy*
[2] *Dipartimento di Scienze, University of Basilicata, Potenza, Italy*

The *Riviera di Ulisse* is part of one of the most representative coastal segment of the Italian peninsula in which many markers of Late Quaternary sea-level changes are well-known and largely exposed. It is an about 70 km-long coastal belt facing to the south and including, from east to west-north-west, the Monte di Scauri promontory, the Gaeta Bay with the Formia-Vindicio plain crossed by several streams, the Monte Orlando promontory, the beach system of Ariana, Arenauta, and S. Agostino shores, separated by minor headlands (Torre Viola, Torre Scissura, San Vito, and Torre Capovento), the beaches and the associated spur of Sperlonga, the Fondi plain, the Terracina coastal belt, and the Circeo promontory. New data came from the portion comprised between Gianola to the east and Vindicio to the west.

The whole south-facing arched coastal plain is relatively narrow being immediately bordered at its back by an impressive mountain ridge (Aurunci Mts.) made of Mesozoic carbonate rocks. The coastal belt ranges from the sea level to about 30 m a.s.l. and is geologically constituted of several Quaternary (pre-Holocene) units, partly cropping out in the inner portion of the study area, and by a Holocene sequence known only by well logs.

The field survey carried out in an area close to the Vindicio beach, between Formia and Gaeta towns, has revealed that carbonate clastic deposits – laying on upper Pliocene marine clay and never reported before in this sector of the *Riviera di Ulisse*, have been uplifted up to ~17 m a.s.l.; such a deposit may be attributed to the Late Pleistocene, so testifying a recent and intense tectonic activity. Further, this formation is very similar to a marine carbonate-bioclastic deposit (the so-called "panchina carbonatica" *Auctt*.), often morphologically hung along the coasts of southern Italy. Not far from the study area, fossil notches, beach deposits, lithodome holes, and other geomorphological markers attributed to a roughly coeval chronological interval are well-exposed along the rocky cliffs between Gaeta and the Circeo promontory at an elevation ranging from 5 to 10 m a.s.l. (Ozer et al., 1987; Antonioli, 1991; De Pippo et al., 2007).

New data from the subaqueous survey have to be correlated with those markers to obtain a clear pattern of the late Pleistocene tectonic behaviour of the entire coastal belt here examined.

References

ANTONIOLI F., (1991). Geomorfologia subacquea e costiera del litorale compreso tra Punta Stendardo e Torre S. Agostino (Gaeta). Il Quaternario 4 (2), 257-274.

DE PIPPO T., DONADIO C., MIELE P., VALENTE A., (2007). Morphological evidence for Late Quaternary tectonic activity along the coast of Gaeta (central Italy). Geogr. Fis. Dinam. Quat. 30, 43-53.

OZER A., DEMOULIN A., DAI PRA G., (1987). Les indices morphologiques témoins de la stabilité tectonique de la bordure littorale du Lazio méridional (Italie). Zeit. für Geomorph. N. F., suppl., Bd. 63, 103-117.

OVERVIEW OF THE OPTICAL 3D MODELING APPLICATIONS FOR RECOSTRUCTION SHALLOW WATER HABITAT.

Rende S.F.[1], Bacci T. [1], Gennaro P. [1], Penna M. [1], Trabucco B. [1], Cicero A. [1]

[1]ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale, Department of Biocenotic Monitoring and Environmental Quality Assessment, Roma

The 3D modeling techniques has the purpose to capture the geometry of a real object by the use of special procedures and instruments. Nowadays, this techniques are applied to many sectors, ranging from the industrial, medical, virtual and finally also to the cultural heritage conservation and environmental monitoring. Currently, there are active and passive methods to acquire the shape of an object. In the active methods light is projected in a structured way (light pattern, laser, infrared, etc.) and, by measuring the distortion determines the shape of the object. In passive methods however, are not used auxiliary light sources but natural light reflected by the object. In the latter case optical devices are used, such as cameras and high-resolution cameras. In the context of marine sciences and observation of marine biodiversity the use of optical instruments or vehicles capable of capturing video and photos has had wide application. Today are available hardware and software tools increasingly powerful and sophisticated, with relatively low costs. This work shows the applications of the "Structure from Motion" (SfM) methodology, with which it is possible to obtain the 3D structure of a scene through a simple camera with incognito motion, in the mapping of marine habitats in shallow water, especially on *Posidonia oceanica* meadows, on hard substrates, on intertidal macroalgal assemblages and on the mapping of individuals of *Pinna nobilis*.

MULTISCALE MAPPING TO ASSESS THE EFFECTS OF COASTAL EROSION ON THE *POSIDONIA OCEANICA* MEADOWS IN ALIMINI (APULIA REGION/ADRIATIC SEA)

Rende S.F.[1], Dattola L.[2], Corigliano C.[3], Oranges T.[2], Cozza R.[3], Bitonti B.[3], De Rosa R.[3]

[1]ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale, Roma
[2]ARPACAL - Agenzia Regionale per la Protezione dell'Ambiente della Calabria - Centro di Geologia e Amianto
[3]DIBEST - Dipartimento di Biologia, Ecologia e Scienze della Terra (Università della Calabria)

Mediterranean Seagrasses are represented by five species, whose most representative are *Posidonia oceanica* (L.) Delile and *Cymodocea nodosa* (Ucria) Ascherson. Meadows of these two species have been also considered as priority habitat according Annex I of the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (EEC, 1992). But the importance of these seagrassess is also due to the considerable biomass – especially *P. oceanica* meadows – that represents an obstacle that hinders and effectively dampens hydrodynamics (waves and currents) of the sea bottom (hydrodynamic forces are reduced from 10% to 75% under the leaves following Gacia *et al*., 1999). Very severe storms can be the cause of a very important natural issue: the massive sediment progradation of allochthonous and autochthonous sediments tends to bury the leafs of *P. oceanica*, determining its death.

Project SIGIEC "Integrated Management System for Coastal Erosion" has applied an experimental technique of multiscale mapping to assess the effects (mesoscale and macroscale level) of coastal erosion over the *P. oceanica* meadows and in this paper we'll present the preliminary results. The study has been conducted in Alimini, Southern Adriatic Sea (Apulia), in April 2015.

The mesoscale level has been analysed with 8 transects (4 perpendicular and 4 parallel to the coastline). A towing vehicle equipped with (HD) high-definition vertical cameras. Images were processed by Structure From Motion (SfM) algorithms that allowed us to generate 3D models for identifying and classifying physiographic and structural features of the meadow. Processing and image analysis has been performed trough **unsupervised** classification algorithms.

The macroscale level has been analysed by processing a WorldView-2 multispectral satellite 8-band scene, with 1.8 meters resolution (dated April 2012). The relevant spectral signatures have been identified for the different physiographic - structural features in the Alimini meadow. Processing and image analysis has been performed trough **supervised** classification algorithms.

Cartographic data acquired at different scales were then integrated in order to assess the effects of coastal erosion over the *P. oceanica* meadows.

EEC. 1992. Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities. Law 206 of 22 July 1992.

Gacia E, Granata T., Duarte C. 1999. An approach to measurement of particle flux and sediment retention within seagrass (Posidonia oceanica) meadows. Aquatic Botany 65: 255–268.

This study has been conducted in the SIGIEC Project "Sistema di Gestione Integrata per l'Erosione Costiera", financed in the Italian Programme **PON01 02651/F6** - Programma Operativo Nazionale Ricerca e Competitività 2007-2013, financed by the Italian Ministry for Education, University and research with the ESFR co-financement (Objective **Convergence)** including regions Calabria and Apulia. http://www.sigiec.sister.it

GEOMORPHOLOGICAL INVESTIGATIONS ON PRESENT TIDAL CHANNELS: CASE STUDIES FROM THE NORTHERN VENICE LAGOON (ITALY)

Rizzetto F.[1], Campiani E.[2], Grande V.[2], Kruss A.[1], Leidi E.[2], Madricardo F.[1], Maselli V.[2], Pellegrini C. [2], Sarretta A.[2]

[1] *Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Arsenale - Tesa 104, Castello 2737/F, 30122 Venezia, Italy*
[2] *Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Via Gobetti 101, 40129 Bologna, Italy*

Tidal channels play an essential role in the morphodynamic evolution of coastal wetlands and in the development of their ecosystems, as they allow the distribution of water, sediments, nutrients, and pollutants. They are characterized by different size, shape, length, width and sinuosity and form complex dense branching networks. They develop in response to tidal energy and tidal prism, which have a significant impact on their morphology (Pethick, 1992). However, channel geometry influences sediment transport and local hydrodynamic processes.

In the last years, the evolution and the morphological characteristics of the Venice lagoon tidal channels have been analyzed in detail using different approaches. In particular, Rizzetto and Tosi (2011; 2012) identified, measured and compared their planimetric features (i.e. width, length, sinuosity) through the interpretation of high resolution aerial photographs taken since 1938, which were georeferenced using a Geographic Information System (GIS) software and edited to create maps representative of the channel planform changes occurred over time. At present, the study is mainly focused on the identification and classification of the related channel bedforms. The investigations are carried out within the frame of the RITMARE Project through the analysis of ultra-high-resolution bathymetric data, acquired using a multibeam echosounder and stored, processed and interpreted in a GIS platform. Different kinds of depositional and erosional features have been recognized and described (e.g. bars, 2-D and 3-D ripples and dunes, scours, tool marks, obstacle marks, dredging marks, cut banks, slump blocks) and morphometric measurements have been performed. Moreover, details on the origin of the morphological structures (i.e. natural or anthropogenic) have been added. The results obtained from the morpho-bathymetric investigations are useful for other multidisciplinary studies, e.g. hydrodynamic modelling, habitat mapping, calculation of sediment budgets, geoarchaeological investigations, and allow to better understand the response of the tidal network to processes and factors responsible for the lagoon development.

References

PETHICK J.S., (1992). Saltmarsh Geomorphology. In: Allen J.R.L., Pye K. (eds.), Saltmarshes:

Morphodynamics, Conservation and Engineering Significance. Cambridge Univ. Press, Cambridge, U.K., 41-62.

RIZZETTO F., TOSI L., (2011). Aptitude of modern salt marshes to counteract relative sea-level rise, Venice Lagoon (Italy). Geology, Vol. 39, 8, 755-758, doi: 10.1130/G31736.1.

RIZZETTO F., TOSI L., (2012). Rapid response of tidal channel networks to sea-level variations (Venice Lagoon, Italy). Global and Planetary Change, 92-93, 191-197, doi: 10.1016/j.gloplacha.2012.05.022.

THE ENVIRONMENTAL CHARACTERIZATION IN BEL TORRENTE CAVE (SARDINIA, ITALY) USING BENTHIC FORAMINIFERA

Romano E.[1], Bergamin L.[1], Pierfranceschi G.[1], Berto D.[1], Provenzani C.[2], Marassich A.[2]

[1]*ISPRA, Institute for Environmental Protection and Research. Via V. Brancati 48, 00144 Rome (Italy)*
[2]*GUE, Global Underwater Explorers, Highsprings, Florida, USA*

Benthic foraminifera are a group of marine protozoans very abundant in sediments, which rapidly respond to environmental changes due to their short life-cycle of some weeks/months. Most species have a hard shell, which may be agglutinated (built with sediment collected on site), calcareous perforate (hyaline) or calcareous imperforate (porcelaneous) and that may be preserved in the sedimentary record. For these features they have been increasingly used in the last decades for environmental assessment and monitoring to detect both natural and anthropogenically-induced environmental changes. Because they are present also in brackish environments they are supposed to be an ideal tool to distinguish different habitats in underwater caves, where the contribution of marine and continental waters determines a seasonal change of environmental parameters. The use of benthic foraminifera as environmental indicators in Mediterranean marine caves is a new challenge that was tested in the present research.

Bel Torrente is a marine cave is located in the north-eastern coast of Sardinia (Italy), discovered and explored by Jochen Hasenmayer in the 1970s, while the first 500 m were surveyed in the 1990s. It is characterized by a 5-20 m wide tunnel with an average height of 5 m and a depth of 12 m. A total of 15 sampling stations were placed from the entrance to the inner zone, at 30 m distance after the re-survey of guideline in order to have a georeferred position of each station in the cave, starting from GPS position of the open water primary station. Sediment was sampled and analyzed for benthic foraminifera (living and dead), grain size, Total Organic Carbon (TOC), Total Nitrogen (TN), $\delta^{13}C_{org}$, $\delta^{15}C_{org}$, C:N, with the aim to identify distinct environments characterized by different terrestrial and marine contributions by means of abiotic and biotic parameters.

As a preliminary result, an environmental characterization was based on the total (living + dead) foraminiferal assemblage. The quantitative study of benthic foraminifera allowed to recognize 4 well-distinct ecological zones regarded as different environments: cave entrance, outer, intermediate and inner cave zone. The cave entrance is characterized by the highest species diversity, the prevalence of hyaline taxa, particularly the symbiont-bearing *Peneroplis pertusus*. In the outer cave (60-90 m from the entrance) diversity is similar to that of cave entrance as well as the proportion among hyaline, porcelaneous and agglutinated taxa. However, the dominant species is the epifaunal *Gavelinopsis praegeri* associated to infaunal *Bolivina* spp. The intermediate cave (120-240 m from the entrance) is characterized by decreased species diversity and agglutinant *taxa* such as *Eggerella advena* and *Reophax nana* are prevalent. Finally, the inner cave (from 270 m onwards) is nearly of totally barren of foraminifera. The transition from marine to inner cave environment is marked by a clear decreasing pattern of species diversity due to the increasing environmental stress, represented by the variation of chemical-physical parameters with respect to the normal marine conditions. Particularly, the decrease of seawater temperature probably makes seawater under-saturated with respect to $CaCO_3$ and this favors the presence of agglutinated *taxa* with respect to the calcareous ones. Entrance and outer zone reflect stronger marine influence being dominated by marine coastal hyaline taxa, while the passage from a hyaline-dominated to an agglutinant-dominated assemblage marks the transition from the outer to the intermediate cave ecological zone. The barren samples of the inner cave zone indicate mean prohibitive environmental conditions for foraminifera, probably due to the prevailing influence of continental waters.

VERY-HIGH RESOLUTION SEISMO-ACOUSTIC AND MORPHOLOGIC INVESTIGATIONS OF A HOLOCENE TRANSGRESSIVE SYSTEM IN THE OFFSHORE OF COMACCHIO (NW ADRIATIC SHELF)

Ronchi L.[1], Fontana A.[1], Correggiari A.M.[2], Remia A.[2], Moscon G.[1]

[1] *Università di Padova – Dipartimento di Geoscienze*
[2] *Istituto Scienze Marine CNR-ISMAR Bologna*

The Adriatic Sea has been characterized by a progressive sea-level increase since the end of the Last Glacial Maximum, inducing a northward shifting of the coastal environments and the submersion of the late-Pleistocene alluvial plain. The recent geological surveys of the Italian side of the Adriatic seafloor (CARG Project, Geological map of the Italian sea at the scale 1:250,000 of the Italian Seas) collected a huge amount of geophysical and stratigraphical data that allowed to reconstruct the regional framework of the late-Quaternary evolution, but detailed and specific investigations on selected key areas are still largely lacking.

In this work several seismo-acoustic profiles are analysed, along with other geophysical data from an area of 45 km^2 (6x7.5 km) in the Northern Adriatic Sea; the data were collected during the oceanographic cruise ASCI14, carried out by CNR-ISMAR Bologna onboard of the Research Vessel "Urania" in collaboration with Department of Geosciences of Padova University. Through the analysis of these profiles three detailed 3D paleo-surfaces were reconstructed, representing different moments during the sea-level rise. The combination of data inferred by paleo-morphologies and sedimentary structures allows to hypothesize the evolution of the study area approximately during the last 11,000 years. In particular for the period between 10,500-9000 years cal BP, when the coastline temporary paused in this area, before the sea transgressed over it. The depositional record is about 6-m thick and consists of different stacked environments. These gradually shift from an alluvial plain, characterized by meandering-pensile rivers, to a lagoon-brackish swamp, which was then drowned, partly eroded and after covered by prodelta-offshore deposits. The investigated zone is characterized by the presence of a deep erosive scour, which has been interpreted as a tidal inlet on stratigraphic and geomorphological basis. This information has interesting implications on the interpretation of the numerous similar erosive features of the northern Adriatic basin. Moreover, the studied tidal inlet is related to lagoon/brackish deposits and this system represents a wide and robust indication of the past sea-level position.

ANALYSIS OF THE MORPHODYNAMIC EVOLUTION OF A SALT-MARSH SYSTEM IN THE LAST 1000 YEARS: INSIGHTS FROM THE SOUTHERN VENICE LAGOON.

Roner M.[1], D'Alpaos A.[1], Ghinassi M.[1], Bellucci L.[2], Brivio L.[1], Fedi M.E.[3], Vigliotti L.[2]

[1] *Dept. of Geosciences, University of Padova, Via Gradenigo 6, 35131 Padova, Italy*
[2] *ISMAR-CNR, Via Gobetti 101, 40129 Bologna, Italy*
[3] *INFN Section of Florence, Via Rossi 1, 50019 Sesto Fiorentino, Italy*

The Venice lagoon represents an outstanding example of man-landscape co-existence. Among the typical lagoonal features, salt marshes are governed by the interaction between physical and biological processes. Because of their unique position in the tidal frame, salt marshes represent a crucially important ecosystem providing valuable services to the environment. In the Venice lagoon salt marshes are currently exposed to possibly irreversible transformations due to the effects of climate changes and human interferences, as in other cases worldwide. The increasing rate of relative sea level rise and the decreasing sediment supply associated with reclamation of lagoonal areas are the dominant factors controlling salt-marsh drowning.

Analysing signatures of landscape changes in the stratigraphic record is crucial to refine our knowledge of tidal landform dynamics and it is a first step to develop predictive morphodynamic models. The southern Venice lagoon is suited to analyze the response of tidal morphologies to changes in environmental forcing. The upper part of the Holocene succession is suggested to be the result of a human-induced transgression, where salt marshes started to intensively contract since the 16th century. The Brenta River, re-directed twice into the lagoon during the 16th and the 19th century, used to play quite a relevant role in terms of freshwater and sediment supply input in southern Venice.

To analyze the response of the environment to these changes, we collected 25 cores (1.0 to 1.5 m deep) along a NE-SW linear transect about 5 km long cutting through salt-marsh, tidal-flat and subtidal-platform deposits. By high-resolution sedimentological analyses we defined the spatial arrangement of the different deposits along the transect, whose cores were dated through ^{14}C, ^{210}Pb and ^{137}Cs geochronological analyses. Magnetic susceptibility, the evaluation of the organic/inorganic sediment content along the cores and the geochronological data were used to determine the accretion rates of this study area during the last 1000 years.

Our results suggest that salt-marsh sedimentation occurred above fresh-water peat since the 14th century. Salt-marsh aggradation, stemming out from both mud settling and organic accumulation, is characterized by different rates of accretion through time and occurred in parallel with the decrease in salt-marsh extent and tidal-flat expansion. In tidal-flat areas, the basal peat is overlaid by shell-rich sandy deposits which were originated as a selection pavement due to wave-winnowing erosion triggered by salt-marsh drowning. The organic mud accumulation took place above the shell-rich lag as a consequence of the progressive water deepening.

A RAISED MARINE SURFACE CORRELATED TO MARINE ISOTOPE STAGE (MIS7) IN THE NW MEDITERANEAN COAST OF EGYPT

Saleem A.[1]

[1] *Ain Shams University, Faculty of Arts, Department of Geography, Cairo, Egypt*

The North West Mediterranean coast of Egypt stretches 500 km from Alexandria to Libyan borders. This coastal plain is built up on Miocene carbonate rocks which are covered by Quaternary deposits. Its topography is controlled by alternation of synclinal basins and monclinal headland.

A raised marine surface is positioned on the two flanks of Ras EL-Siraa (i.e. headland). It lies at + 20 meters above current MSL. On the west site of Ras EL-Siraa, this marine surface extends approximately two kilometers and it is at distance of 200 meters from active shoreline.

Paleo sea level indicators on Ras EL-Siraa are:

- Consolidated old beachrock extending horizontally. It bears *Glycymeris* marine fossils. Microscopic examination testifies that beachrock is composed of bioclast-rich grain stone deposited in shallow marine environment.
- Discoidal marine cobbles standing above a beach rock unit.

Applying ESR dating on *Glycymeris* yielded 201.0 ± 16.4 ka that corresponds to Marine Isotope Stage (MIS7). Based on dating submerged speleothems, Argentrola cave, South Italy (Bard et al. 2002; Dutton et al. 2009) a tectonic uplift rate of 0.18 mm/a is estimated.

GEOMORPHOLOGY AND GEOARCHAEOLOGY OF HERMAEA ANCIENT HARBOUR, NW COAST OF EGYPT

Torab M.[1], Moustafa S.[2]

[1] *Prof. of Geomorphology, Damanhour University, Egypt. President of The Egyptian Society of Environmental Change*
[2] *Master degree student, Dameitta University, Egypt*

Some historical writers (Fourtau, 1914 & Ball, 1942) show that Hermaea harbour was situated in Ras El Hekma area on the Mediterranean sea, this area seems as triangle headland extending into the Mediterranean sea for about 15 km, it lies west of Alexandria City for about 220 km, and some 70 km east Marsa Matruh city.

Hermaea harbour was located on the NE side of the triangle, a short distance from the headland, it was constructed inside a bay and protected from the northern waves by a tombolo, and bordered to the west by some coastal dunes accumulated upon calcareous ridges, in addition to a coastal sabkha and wadi mouths.

At the moment some archaeological evidence were discovered by the authors under sea water, it can be considered as a part of Hermaea ancient harbour, all found indicators lies under recent sea level for about 3-4 m as a result of sea level change and monoclonal subsidence.

This study aims to define geomorphological characteristics and geoarchaeological evidence of the Hermaea ancient harbor, and to study effect of Holocene sea level change on the study area, by depending upon detailed geoarchaelogical and geomorphological surveying and mapping, coring of sediment samples, interpretation of multi-dates RS images, as well as GIS techniques.

References:

BALL J., (1942). Egypt in the Classical Geographers, Survey of Egypt, Ministry of Finance, Cairo.

FOURTAU R., (1914). La côte de la Marmarique d'après les anciens géographes grecs, Bulletin de **Z**

SUBMERGED GEOMOPHOLOGICAL AND GEOARCHAEOLOGICAL INDICATORS OF THE HOLOCENE SEA LEVEL CHANGES ON RAS EL HEKMA AREA, NW COAST OF EGYPT

Torab M.[1], El Bardan E.[2], Farghaly E.[3], Moustafa S.[4], Alaam E.[5]

[1] *Prof. of Geomorphology, Geography Department, Damanhur University (magdytorab@hotmail.com)*
[2] *Ph.D. student, Geography Department, Damietta University*
[3] *Master degree student, Geography Department, Faculty of Girls, Ain Shams University*
[4] *Master degree student, Geography Department, Damietta University*
[5] *Undergraduate student, Geography Department, Damanhur University*

Ras El Hekma area is a part of NW coast of Egypt, it lies on the Mediterranean sea west of Alexandria City for about 220 km, it seems as triangle headland extending into the Mediterranean sea for about 15 km, and is occupied by sedimentary rocks belonging to the Tertiary and Quaternary Eras, the western coastline consists of Pleistocene oolitic limestone ridges with separated steep scarps, while the eastern coastline consists of sandy beaches, coastal spits, coastal bars, tombolos and bays.

The present work is mainly devoted to define submerged geomorphological and geoarchaeological indicators of The Holocene sea level change on the study area, especially underwater geomorphic features such as: marine notches, sea caves, arches, submerged benches, submerged fluvial channels in addition to geoarchaeological evidence related to the relative sea level variations such as: submerged ruins of Greek and Roman harbors which have been discovered near the coastline such as Leuke Akte, Hermaea, Phoinikous and Zygris. The evaluation of both the height and functional depth to the mean sea level depends on the typology of the archaeological evidence. The study based on detailed under sea water geomorphological and geoarchaelogical surveying, sampling, dating and mapping as well as satellite image interpretation and GIS techniques.

NEW INSIGHT IN UNDERSTANDING THE FORMATION OF NORTH ADRIATIC BIOGENIC HARD BOTTOMS (TEGNÙE)

Tosi L.[1], Donnici S.[1], Bergamasco A.[1], Da Lio C.[1], Franchi F.[2,3], Mazzoli C.[4], Montagna P.[2], Taviani M.[2]

[1]*Institute of Marine Sciences – National Research Council, Venice, Italy*
[2]*Institute of Marine Sciences – National Research Council, Bologna, Italy*
[3]*Department of Earth and Environmental Sciences, Botswana International University of Science and Technology, Palapye, Botswana*
[4]*Dept. of Geosciences, University of Padova, Padova, Italy*

The North Adriatic biogenic concretionned outcrops known as *tegnùe* have defied for long a full understanding of their genetic processes (Casellato and Stefanon, 2008). Some evidence has

been recently reported supporting the involvement of hydrocarbon-enriched fluids in driving the precipitation of authigenic carbonate cement to bind sediment (Casellato and Stefanon, 2008; Gordini et al., 2012). Then, following the formation of a rocky substrate, a subtype of pre-coralligenous habitat may develop.

In the last two years, a marine geological and oceanographic survey of a *tegnùe* field offshore Chioggia (Venice), which also included considerable SCUBA diving effort, has been carried out under the umbrella of a project funded in 2013 by the municipality of Chioggia. We have concentrated our attention on a few rocky outcrops up to 2-3 m high, at the site known as *Boa Chioggia* (Chioggia buoy). There, we have recovered a metric-sized lensoid limestone at 23 m water depth, which proved to be our 'Rosetta Stone' in deciphering the various formative stages of this specific *tegnùa*. In practice, a shelly sand deposit from the last postglacial condensed section (7.3 and 9.2 kyrs BP cal) has turned into a fossiliferous calcarenite, prime nucleus for the settlement of the present pre-coralligenous, habitat to a variety of animal and redalgal life (Donnici et al., 2015).

As proved by the radiocarbon chronology, the process therefore happened under marine conditions after this sector of the continental shelf has been flooded following the sea-level rise. Cathodoluminesce, SEM-EDS, and geochemical mapping of samples document a single generation of calcium carbonate cement (scalenohedral calcite), interpreted as reflecting a marine-phreatic genetic ambient, governed by the interaction between marine and less saline (freshwater?) waters.

References

CASELLATO S., STEFANON A., (2008). Coralligenous habitat in the northern Adriatic Sea: an overview. Marine Ecology, 29, 321–341.

DONNICI S., TOSI L., BERGAMASCO A., DA LIO C., FRANCHI F., MAZZOLI C., MONTAGNA P., TAVIANI M., (2015). Stratigraphy, fluids and ecology: the genesis of bio-concretionned rocky outcrops (Tegnùe) of the northern Adriatic shelf. 31st IAS Meeting of Sedimentology, Krakow, Abstracts.

GORDINI E., FALACE A., KALEB S. DONDA F., MAROCCO R., TUNIS G., (2012). Methane- related carbonate cementation of marine sediments and related macroalgal coralligenous assemblages in the Northern Adriatic Sea. In: Harris PT, Baker EK (Eds), Seafloor Geomorphology as Benthic Habitats, Elsevier, 183-198.

MORPHOBATHYMETRIC ARRANGEMENT AND RECENT TECTONIC OF THE GULF OF PATTI FROM NEW OCEANOGRAPHIC SURVEYS

Travan G.[1], Morelli D. [1], Furlani S.[1], Passaro S.[2], Ferranti L.[3], Pepe F.[4]

[1]*University of Trieste, Italy*
[2]*Istituto per l'ambiente marino costiero, Napoli, Italy*
[3]*University of Naples, Italy*
[4]*University of Palermo, Italy*

The Gulf of Patti, located in the southern Tyrrhenian Sea in proximity to the north-eastern Sicily margin, has been object of many studies because of the likely prosecution at sea of the Tindari-Letojanni Fault System that affects this area. The activity of this fault system seems to be connected with the coastal uplift of Capo Milazzo and the deformation of a broad sector of the continental slope.

The survey Milazzo_2013, carried out on board R/V Urania, has allowed to obtain high resolution bathymetric data and seismic profiles of the work area, considerably increasing the quality of the available information.

With the new ecometric and seismic data it has been possible to better define the morphobathymetric aspect, the structural arrangement and the recent tectonic in the study area.

We focalised the attention on a more detailed definition of the erosive and gravitative processes active on the slopes (canyon heads) and on the other processes capable of conditioning the slopes stability, but above all on the identification of evidences of potentially seismogenic fault activity.

The mapping of the main morphological elements (erosive channels and morphological highs) has confirmed the NNW-SSE preferential development trend, probably due to the effects of the active tectonic.

Moreover, the interpretation of the seismic profiles has allowed to define more clearly the step-over zone in which the Patti Ridge would be located.

THICKNESS OF MARINE HOLOCENE SEDIMENT IN THE GULF OF TRIESTE

Trobec A.[1], Vrabec M.[1], Busetti M.[2], Zgur F.[2], Baradello L.[2], Babich A.[2,3], Cova A.[2], Gordini E.[2], Romeo R.[2], Tomini I.[2]

[1] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Privoz 11, 1000 Ljubljana, Slovenia
[2] OGS – Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Borgo Grotta Gigante 42/c, 34010 Sgonico, Trieste, Italy
[3] Dipartimento di Matematica e Geoscienze, Università di Trieste, Via Weiss 2, 34127 Trieste

The youngest sediment succession in the Gulf of Trieste is represented by Holocene marine sediments deposited on top of Plio-Pleistocene deposits predating the last sea transgression. Numerous geophysical surveys and well data from the gulf and its surroundings provided us with sufficient coverage and quantity of data to define the thickness of the Holocene succession.

Multibeam and singlebeam sonar data acquired during several geophysical surveys since 2000 were used to determine the depth of the seafloor. In addition, ultra high resolution seismic profiles (boomer, chirp sonar and sub-bottom parametric sonar) acquired since 2000 were used for the determination of the depth of the seafloor and the base of the Holocene. Due to lack of geophysical data in the Gulf of Panzano (northern Gulf of Trieste) depth values for the seafloor from a former OGS digital relief model of the Gulf of Trieste were used. Published data from several onshore and offshore wells in Slovenia and in the Gulf of Trieste were also used to calibrate and discern the depth of the base of the Holocene succession. The seismic data were interpreted using the IHS Kingdom Suite® software while the time to depth conversion and the gridding of the data was done with the Petrosys Mapping software.

The resulting map exhibits the thickness of the Holocene marine sediment in the Gulf of Trieste. Holocene sediment generally exceed 10 meters of thickness in the close proximity of the coastline where progradational sequences occur and in the internal parts of the smaller bays from where they quickly thin seawards. A peculiar feature is the difference in thickness between the

western and eastern part of the gulf. Thin drapes of Holocene sediment are deposited in the western part that exceed 2 meters of thickness only on the Trezza Grande bank, in the coastline progradational sequence and where they overlay the former paleo-channels of the river Isonzo. The eastern part of the Gulf of Trieste generally exhibits thicker Holocene sediments than the western part of the gulf. The northern part of the gulf is characterised by thick prograding Holocene successions of the river Isonzo derived sediments while in the southern section the Holocene sediments are approximately 4 meters thick up to five kilometres from the shoreline. The Holocene sequence is eroded in the seafloor depression near Cape Madona. Southwest of Cape Madona thicker Holocene sediments overlay the dune shapes expressed in the seafloor morphology.

We attribute the difference in the thickness of the Holocene sediment in the Gulf of Trieste to a complex entanglement of sedimentological, erosional and tectonic processes mostly controlled by current action, sediment supply, subsidence and available accommodation space.

AN ANCIENT ROMAN ROAD OR JUST ANOTHER FLYSCH OUTCROP?

Vodnik P.[1], Kelemen M., Kadivec K., Jereb M., Klančič K., Štamcar M., Prašnikar K.

[1]*Bleiweisova 6, 4000 Kranj, Slovenia*

A local tourist glass-bottom-ship excursion organizer in Piran has been advertising remains of an ancient Roman road as part of their trip. The road, now between 2-3 meters underwater, was supposedly connecting via Flavia to Piran through Fiesa, tracing the seashore. Due to its location we decided to investigate whether it really is a road or merely a flysch layer.

We correlated the "road's" orientation to that of the cliff's strata, investigated the structure of the "road" visually and compared it to similar structures of proven natural origin.

The results proved the tourist agency wrong - the "road" is a geomorphological phenomenon, that occurs after exhumation of flysch and its topmost layers tend to break in equal square-ish blocks. Historical data further proves that via Flavia crossed further inland and a branch towards Piran would not pass over a beach under the cliffs.

EVIDENCE OF NEO-TECTONIC TILTING IN THE GULF OF TRIESTE

Zampa L.S.[1], Busetti M.[2], Furlani S.[1], Baradello L.[2], Romeo R.[2]

[1]*Dipartimento di Matematica e Geoscienze - Università di Trieste*
[2]*Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) - Trieste*

Recent studies about late Holocene tectonic movements in the Gulf of Trieste, evidenced the occurrence of a tilting still active, responsible for the lowering the northern sector of the gulf (Braitenberg et al., 2005, Furlani et al., 2011).

The aim of this work is the characterization of Late Pleistocene subsidence and tectonic movements in the Gulf of Trieste, in particular along the south-eastern coast, near the city of Trieste.

For this purpose, single-channel high-resolution seismic boomers profiles, acquired in the area by the OGS from 2003 to 2013 (Baradello et al., 2013, Romeo 2009), have been analyzed.

In the profiles a system of late Pleistocene-Holocene marine terraces and prograding wedges has been recognized in the Flysch formation, buried by marine and continental sediments, at depth from 25 to 90 meters below sea level. The formation of these terraces has been referred to sea level highstands, which caused cliffs recession and the consequent formation of shore platforms, as a result of differential erosion of costal rocks developed in the intertidal marine zone (Furlani et al., 2009).

The acoustic facies analysis allowed to identify an alternation of marine and fluvial-continental units, and to hypothesize the age of terraces. In particular the terrace B, found at a depth between -36 m and -38 m, present with continuity in almost all seismic profiles, has been referred to the Tyrrhenian highstand (125 ky B.P), which would imply an average subsidence of about -0.36 mm/year. This value is a little bit lower, but however within the error, compared with -0.46 ± 0.2 mm/year of subsidence recorded in the south of Friuli Plain, where the Tyrrhenian was identified in two wells at a depth of about -54 m (Fontolan and Antonioli, personal communication).

Besides, a more complex process has been evidenced by a local tilting, identified in the southward deepening of about 1-2 m of the terrace B. This structure is located at a depth of about -36 m near Miramare (northern part of the study area) and it goes lowering southward, where in Punta Sottile it is located at a depth of about -38 m.

The results of this study show that the south-eastern coast of the Gulf of Trieste is subjected to complex tectonic movements on a local scale that modulate those observed on a regional scale.

References

BARADELLO L., BUSETTI M., NIETO Y.D.G., ROMEO R., VISNOVICH G., (2013). Survey VHR Sismico Boomer del Sito di Interesse Nazionale (SIN) di Trieste, Relazione OGS 2013/14, 29 pp., 33 all.

BRAINTEBERG C., NAGY I., ROMEO G., TACCETTI Q., (2005). The very broad-band data acquisition of the long-base tiltmeters of Grotta Gigante (Trieste, Italy). Journal of Geodynamics 41, 164-174.

FURLANI S., BIOLCHI S., CUCCHI F., BENSI S., BURELLI G., (2009). Surveying of a submerged flysch outcrop at Sistiana-Duino (Gulf of Trieste, Italy). Atti e Memorie della Comm. Grotte "E. Boegan" 42, 85-94.

FURLANI S., BIOLCHI S., CUCCHI F., ANTONIOLI F., BUSETTI M., MELIS R., (2011). Tectonic effects on Late-Holocene sea level changes in the Gulf of Trieste (NE Adriatic Sea, Italy). Quaternary International, 232/1-2, 144-157, doi:10.1016/j.quaint.2010.06.012.

ROMEO R., (2009). Studio geofisico integrato ad alta risoluzione dei depositi marini e della struttura del substrato della Riviera di Miramare (Golfo di Trieste). Tesi di dottorato, Università di Trieste.

EVIDENCE OF RAPID SEA-LEVEL CHANGES ON THE CENTRAL MEDITERRANEAN SHELVES AFTER THE LAST GLACIAL MAXIMUM

Zecchin M.[1], Ceramicola S.[1], Lodolo E.[1], Casalbore D.[2], Chiocci F.L.[3]

[1] *OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), Sgonico, TS, Italy*
[2] *Istituto di Geologia Ambientale e Geoingegneria, Consiglio Nazionale delle Ricerche, Area della Ricerca di Roma 1, Roma, Italy*
[3] *Università degli Studi di Roma La Sapienza, Dipartimento Scienze della Terra, Roma, Italy*

Submerged palaeo-shorelines on the central Mediterranean shelves, identified from CHIRP sub-bottom and high-resolution seismic profiles and bathymetric data, mark distinct water depths at which sea level stationed between -100 m and -70 m, and between -65 m and -40 m, in most places irrespective of the different tectonic context, even in presence of significant vertical rates. These morphological features are thought to have been drowned during melt-water pulses 1A and 1B, which occurred between 15 and 10 ka. The evidence presented here confirms drowned shorelines documented elsewhere at similar water depths and shows that melt-water pulses have punctuated the post-glacial relative sea-level rise with rates up to 60 mm/yr for a few centuries. The identification of morphological features related to melt-water pulses in the central Mediterranean Sea has important implications to improve our knowledge on episodes of rapid glacio-eustatic sea-level rise. This issue is critical to be able to forecast future sea-level rises in thefor a period of time during the relative sea-level rise that followed the Last Glacial Maximum (LGM). The shorelines are commonly represented by palaeo-coastal cliffs and barrier-beaches that lie today at water depths

LIST OF PARTICIPANTS

Name	Surname	Affiliation	e-mail
Benedetto	Allotta	University of Florence, Italy	benedetto.allotta@unifi.it
Lorenzo	Angeletti	ISMAR-CNR, Venezia, Italy	lorenzo.angeletti@bo.ismar.cnr.it
Fabrizio	Antonioli	ENEA, Rome, Italy	fabrizio.antonioli@enea.it
Marco	Anzidei	INGV, Rome, Italy	marco.anzidei@ingv.it
Rita	Auriemma	Villa Manin di Passariano, Italy	rita.auriemma@ipac.regione.fvg.it
Giuseppe	Barbera	University of Enna "Kore", Italy	giubarbera84@gmail.com
Marianna	Bellotto	University of Trieste, Italy	mariannabell8@yahoo.it
Maja	Berden Zrimec	Harpha Sea, d.o.o., Koper, Slovenia	majabz@icloud.com
Lara	Brivio	University of Padua, Italy	lara.brivio@studenti.unipd.it
Dea	Brunovic	Geological Survey, Croatia	dbrunovic@hgi-cgs.hr
Martina	Busetti	OGS, Trieste, Italy	mbusetti@ogs.trieste.it
Alice	Busetti	University of Trieste, Italy	alicealic@hotmail.it
Oliviero	Candoni	OGS, Trieste, Italy	oliviero.candoni@gmail.com
Luigi	Casati	Speleodiver, freelance, Italy	casgi@tin.it
Danilo	Cavallaro	University of Catania, Italy	danilocav@tiscali.it
Massimo	Celio	ARPA FVG, Italy	
Tina	Centrih	Institute for Natural Conservation, Piran, Slovenia	tina.centrih@zrsvn.si
Alessandro	Ceregato	CNR, Venezia, Italy	alessandro.ceregato@ve.ismar.cnr.it
Federico	Cervi	Univesity of Bologna, Italy	federico.cervi2@unibo.it
Antonio	Codarin	ARPA FVG, Italy	
Mauro	Coltelli	INGV Catania, Italy	mauro.coltelli@ingv.it
Elisa	Dal Bo	University of Trieste, Italy	elisadb93@libero.it
Nora	Dalal	Damanhour University, Egypt	soso_soso1734@yahoo.com
Eleonara	De Sabata	Medsharks, Rome, Italy	info@medsharks.org
Stefano	Devoto	University of Trieste, Italy	sdevoto@units.it
Sandra	Donnici	CNR, Venezia, Italy	sandra.donnici@ismar.cnr.it
Alessio	Fabbricatore	CAI SGI, Trieste, Italy	alexstor@libero.it
Sanja	Faivre	University of Zagreb, Croatia	sfaivre@geog.pmf.hr
Roberto	Feo	University of Enna "Kore", Italy	rofeo@yahoo.it
Luigi	Ferranti	University of Naples, Italy	luigi.ferranti@unina.it
Alvise	Finotello	University of Padua, Italy	alvise.finotello@studenti.unipd.it
Alessandro	Fontana	University of Padua, Italy	alessandro.fontana@unipd.it
Franco	Foresta Martin	LMST, Ustica, Italy	sidereus@rocketmail.com
Aurelie	Foveau	CNRS, France	aurelie.foveau@unicaen.fr
Stefano	Furlani	University of Trieste, Italy	sfurlani@units.it
Andrea	Geniram	University of Trieste, Italy	a.geniram@gmail.com
Massimiliano	Ghinassi	University of Padua, Italy	massimiliano.ghinassi@unipd.it

Valentina	Grande	ISMAR-CNR, Venezia, Italy	valentina.grande@bo.ismar.cnr.it
Ozren	Hasan	Croatian Geological Survey, Croatia	ohasan@hgi-cgs.hr
Marko	Jereb	University of Ljubljana, Slovenia	
Galena	Jordanova	University of Ljubljana, Slovenia	
Katarina	Kadivec	University of Ljubljana, Slovenia	
Matej	Kelemen	University of Ljubljana, Slovenia	
Klemen	Klančič	University of Ljubljana, Slovenia	
Eleni	Kolaiti	Gaiaergon, Athens, Greece	kolaitieleni@gmail.com
Emanuela Claudia	La Marca	University of Palermo, Italy	emanuelaclaudia.lamarca@unipa.it
Emanuele	Lodolo	OGS, Trieste, Italy	elodolo@ogs.trieste.it
Pietro	Luchesi	SAS, Trieste, Italy	piero_luchesi@yahoo.it
Fantina	Madricardo	ISMAR-CNR, Venezia, Italy	fantina.madricardo@ve.ismar.cnr.it
Haya	Mahmoud	University of Rennes 2, France	hayamahmoud@gmail.com
Giuseppe	Mastronuzzi	University of Bari, Italy	gimastronuzzi@libero.it
Slobodan	Miko	Geological Survey, Croatia	slobodan.miko@hgi-cgs.hr
Gloria	Misson	University of Genoa, Italy	gloria.misson.23@gmail.com
Giulia	Mo	ISPRA, Roma, Italy	giulia.mo@isprambiente.it
Paolo	Montagna	CNR, Bologna, Italy	paolo.montagna@bo.ismar.cnr.it
Giorgia	Moscon	University of Padua, Italy	giorgia.moscon@studenti.unipd.it
Nikos	Mourtzas	Gaiaergon, Athens, Greece	nikosmourtzas@gmail.com
Maria Elena	Musco	University of Trieste, Italy	meri.musco@gmail.com
Nourhan	Nour	Damanhour University, Egypt	nourhannour3@yahoo.com
Elisabetta	Olivo	OGS, Trieste, Italy	
Gabriele	Oppo	Freelance geologist, Italy	gabrieleoppo.geo@libero.it
Luigi	Parente	ISMAR-CNR, Venezia, Italy	luigi.parente@ve.ismar.cnr.it
Klavdija	Prašnikar	University of Ljubljana, Slovenia	
Maria Luisa	Putignano	IGAG-CNR, Rome, Italy	m.putignano@alice.it
Fadl	Raad	University of Trieste, Italy	fadel-raad@hotmail.com
Herve	Regnaud	University of Rennes 2, France	herve.regnauld@uhb.fr
Federica	Rizzetto	ISMAR-CNR, Venezia, Italy	federica.rizzetto@ve.ismar.cnr.it
Elena	Romano	ISPRA, Roma, Italy	elena.romano@isprambiente.it
Livio	Ronchi	University of Padua, Italy	livio.ronchi@gmail.com
Marcella	Roner	University of Padua, Italy	marcella.roner@studenti.unipd.it
Amr	Saleem	Ain Shams University, Cairo, Egypt	amr_saleem@art.asu.edu.eg
Luigi	Sante Zampa	University of Trieste, Italy	zampa_luigi@virgilio.it
Martin	Štamcar	University of Ljubljana, Slovenia	
Corrado	Stanislao	University of Naples, Italy	corradostanislao@gmail.com
Marco	Taviani	CNR, Bologna, Italy	marco.taviani@bo.ismar.cnr.it,
Magdy	Torab	Damanhour University, Egypt	magdytorab@hotmail.com
Fiorenza	Torricella	University of Trieste, Italy	fioreangel@hotmail.it
Gaia	Travan	University of Trieste, Italy	gaiatravan@gmail.com
Ana	Trobec	University of Ljubljana, Slovenia	ana.trobec3@gmail.com
Valeria	Vaccher	University of Trieste, Italy	valeria.vaccher@gmail.com
Elisa	Venturini	University of Trieste, Italy	elisa.vnt@gmail.com

Primož	Vodnik	University of Ljubljana, Slovenia	pvodnik@tano.si
Enrico	Zavagno	University of Trieste, Italy	ezavagno@units.it
Massimo	Zecchin	OGS, Trieste, Italy	mzecchin@ogs.trieste.it
Luca	Zini	University of Trieste, Italy	zini@units.it
Sara	Živkovič	University of Ljubljana, Slovenia	

INDEX OF AUTHORS