



# **Marine Aggregates: Prospecting and Exploitation Methods, Environmental Impact and Usage possibilities in Greek waters - Scope and preliminary results of MARE (THALES project)**

**M. Stamatakis, S. Poulos, A. Tsoutsia, N. Papavlassopoulou, A. Karditsa and M. Anastasatou**

*National & Kapodistrian University of Athens, Faculty of Geology & Geoenvironment, Panepistimioupoli, Zografou GR-15784, Athens, Greece. e-mail for correspondence: poulos@geol.uoa.gr*

**A. Velegrakis, T. Hasiotis,**

*Department of Marine Sciences, School of Environment, University of the Aegean, University Hill, Mytilene 81100, Greece*

**V. Kapsimalis and G. Roussakis**

*Hellenic Centre of Marine Research, Athens, Institute of Oceanography, PO BOX 712, Anavyssos, Greece*



European Union  
European Social Fund



MINISTRY OF EDUCATION & RELIGIOUS AFFAIRS, CULTURE & SPORTS  
MANAGING AUTHORITY

Co-financed by Greece and the European Union



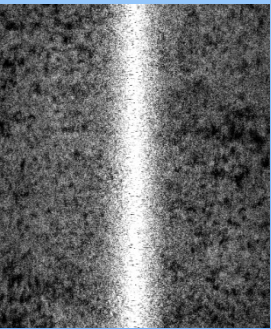
EUROPEAN SOCIAL FUND

# SCOPE

***The present contribution aims*** to present the outlines and some preliminary results of the research project that is currently materialized within the THALES Program (phase II) of the Ministry of Education, Lifelong Learning and Religious Affairs.

***The PURPOSE of the project*** is to investigate the Greek continental shelf, including the Cyclades Plateau, for the:

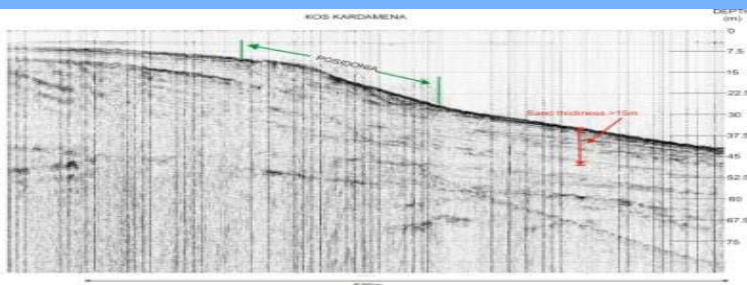
**identification    prospecting**



**dredging**



**usage of MA deposits**



# BACKGROUND

---

**MARINE AGGREGATES** are sands and gravels dredged from the seabed and are used in concrete and mortar manufacture, asphalt and coated products, block making, drainage and fill materials, leisure and sport facilities and beach replenishment (BMAPA, 2004).

**The *exploitation* of the Marine Aggregates involves:**

- 1.the discovery of the deposit (often linked to older works, scientific or not, e.g. mapping);**
- 2.the study of deposit's characteristics (prospecting) by acoustic devices (multi beam, side-scan sonar, seismic and ground-truthing, corer, grab, video); and**
- 3.the environmental impact of its extraction that deals with the selection of dredging equipment, trying to minimize the environmental**

# National marine aggregate extraction for the period 1989-2005 (in million m³).

[Data from ICES Reports, Meakins *et al.* (1999) and Belgian Fund for Sand Extraction - The UK data have been estimated on the basis of a volume/weight coefficient 1/1.66 (ICES, 2005, 2006) - The first value for Germany and Denmark refers to the total production volume, whereas the values in parentheses refer to production volumes from the North Sea]

Year	Extraction volumes in million m³							
	Germany	Polland	UK	France	Netherlands	Spain	Dennmark	Belgium
1989	1.97 (1.97)	0.96	16.27	nd	8.43		7.68	0.96
1990	2.27 (2.27)	1.35	15.24	nd	13.36	0.08	5.74	0.95
1991	2.02 (2.02)	0.99	12.23	2.00	12.77	0.66	6.40	1.75
1992	2.49 (2.08)	1.58	12.41	1.90	14.80	1.32	4.38	1.22
1993	3.26 (2.21)	1.35	10.78	1.90	13.02	2.19	4.32	1.45
1994	10.12 (8.81)	0.74	13.13	2.50	13.55	2.75	5.17	1.60
1995	2.91 (1.54)	0.81	15.72	2.50	16.83	0.42	5.31	1.66
1996	4.26 (1.38)	0.85	13.61	2.30	23.15	1.48	6.32	1.44
1997	2.22 (0.00)	0.96	15.00	2.60	22.75	1.67	6.40	3.86
1998	0.70 (0.70)	0.69	13.80	2.60	22.51	1.41	6.66	1.40
1999	0.71 (0.71)	0.74	12.60	2.60	22.40	0.49	12.04	1.69
2000	2.97 (1.67)	0.82	13.89	2.60	25.42	0.41	7.12	1.90
2001	nd	nd	13.71	2.43	36.45	0.30	7.86	1.92
2002	nd	0.53	13.22	2.43	33.84	0.08	5.57 (3.50)	1.62
2003	1.14 (0.70)	nd	13.39	nd	23.97	1.19	8.13 (6.18)	1.65
2004	nd	0.85	12.98	0.34	23.59	0.79	6.46 (4.18)	1.50
2005	14.00 (13.61)	nd	12.78	nd	28.76	0.05	11.05 (9.28)	1.36
<b>Average</b>	<b>3.64 (2.00)</b>	<b>0.94</b>	<b>13.57</b>	<b>2.21</b>	<b>20.92</b>	<b>0.96</b>	<b>6.86</b>	<b>1.64</b>

## Summary of national aggregate extraction activities in 2002.

(Report of the Working Group on the Effects of Extraction of Marine Sediments  
on the Marine Ecosystem Ostend, Belgium 1–5 April 2003)

[illegible]

# Different usages of marine aggregates (volumes (upper) and corresponding percentages (lower) of the overall production).

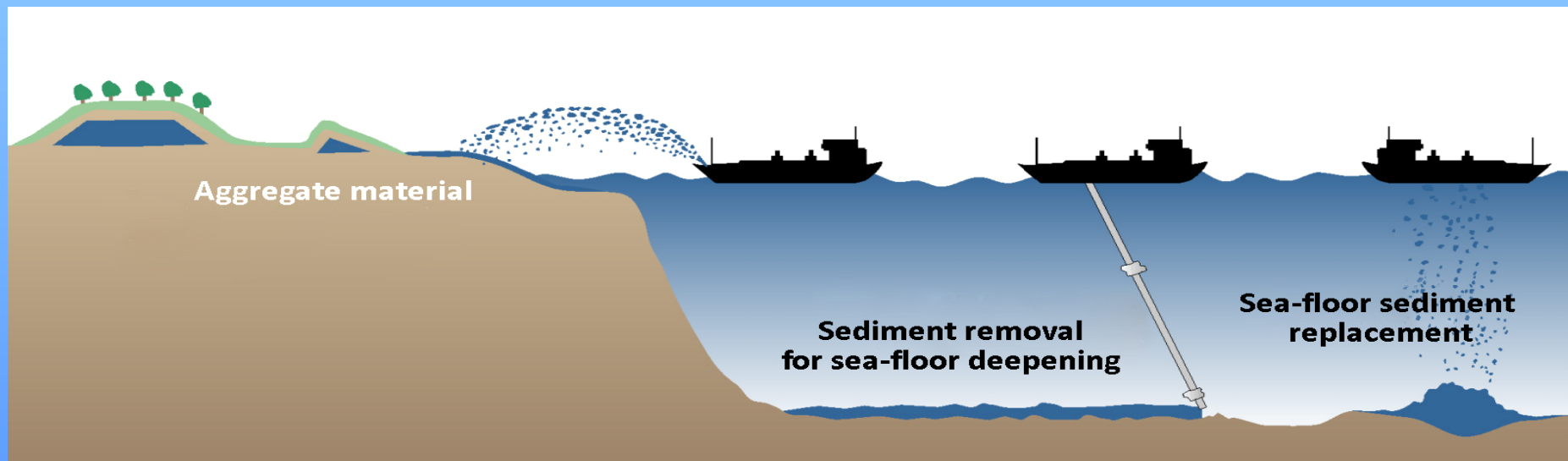
Country	MA extracted (million m <sup>3</sup> )	Construction industry (m <sup>3</sup> )	Beach replenishment (m <sup>3</sup> )	Exports (m <sup>3</sup> )
Belgium	1.63	1,532,103	100,843	0
Denmark	7,005,500	4,194,500	2,715,000	96,000
France	2,767,333	2,767,333	0	0
Germany	7,572,548		Nd	0
Netherlands	29,065,733	14,307,252	12,601,318	2,157,164
Poland	636,667	18,533	506,800	111,333
Spain	482,827	0	482,827	0
UK	13,130,176	8,724,194	624,182	3,781,801
Country		Construction Industry (%)	Beach replenishment (%)	Exports (%)
Belgium	1,632,945	93.8	6.2	0
Denmark	7,005,500	59.9	38.8	1.4
France	2,767,333	nd		0
Germany	7,572,548	nd		0
Netherlands	29,065,733	49.2	43.4	7.4
Poland	636,667	2.9	79.6	17.5
Spain	482,827	0.0	100	0
UK	13,130,176	66.6	4.8	28.8

Data from ICES, 2003; 2004; 2005; 2006. Note: data for Spain is taken from ICES 2006.

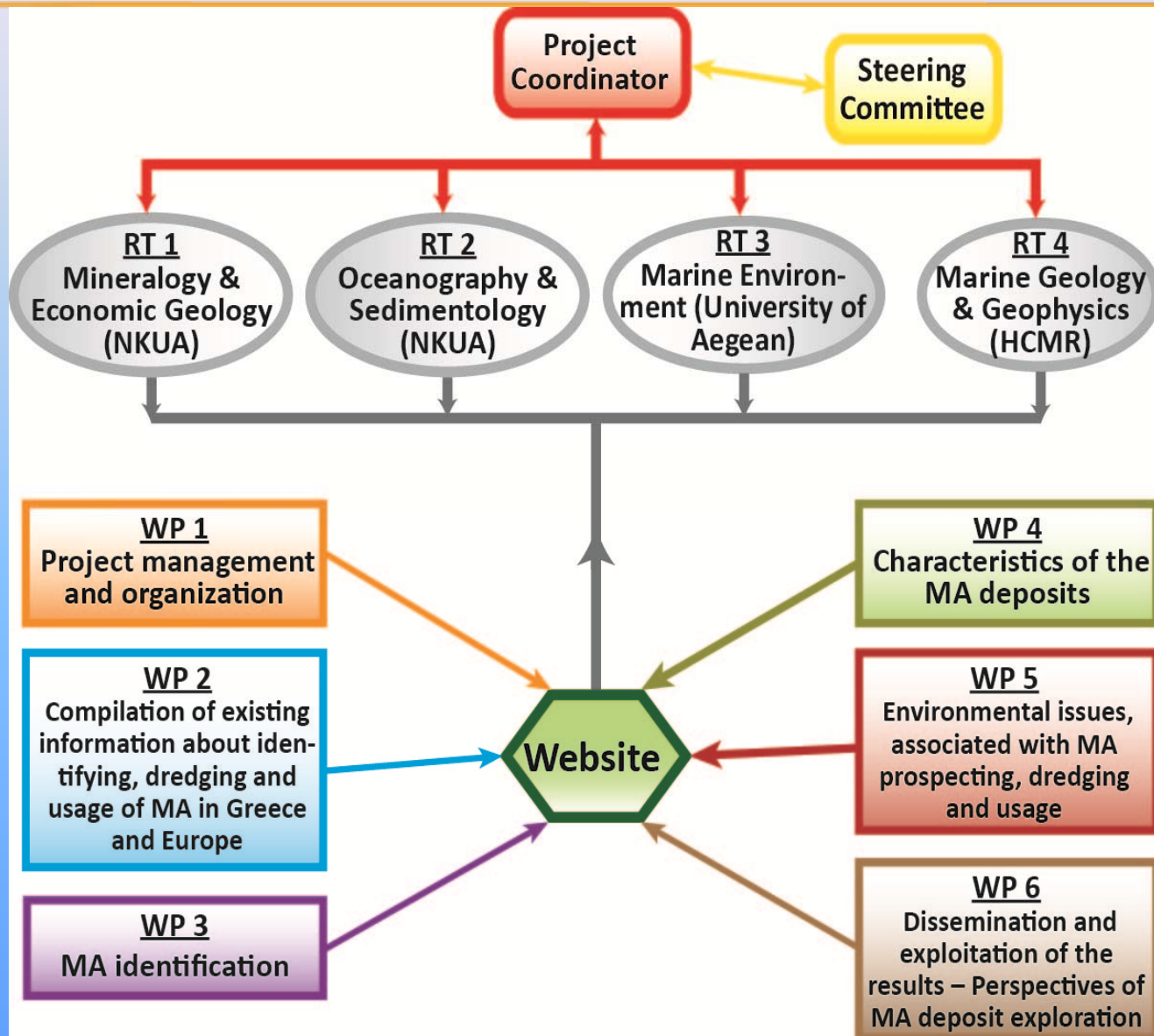


# OBJECTIVES of MARE Project

- *compilation* and *integration* of the available information concerning prospecting, dredging, and usage of MAs in Greece and Europe
- MA prospecting *techniques* and *methods* (transfer of knowledge);
- *sedimentological* characteristics of the MAs occurring in Greek waters;
- an assessment of the *environmental issues* related to MA prospecting and dredging in Greece;
- the *exploitation* of the project's results (e.g., industrial use); and
- the *training of young researchers* in related innovative research aspects



# PROJECT'S STRUCTURE





## PROJECT'S STRUCTURE

WORK PACKAGE		Scientific Responsible
WP-1	Project management and organization (months: 1-42)	M. Stamatakis, Professor
WP-2	Compilation of existing information regarding prospecting, dredging and usage of MA in Greece and in Europe (months: 1-36)	S. Poulos, Associate Professor
WP-3	MA deposits identification (months: 7-36)	V. Kapsimalis, Researcher B'
WP-4	Sedimentological characteristics of the MA deposits (months: 10-36)	S. Poulos, Associate Professor
WP-5	Environmental issues associated with MA prospecting, dredging and usage (months: 13-42)	A. Velegrakis, Professor
WP-6	Dissemination and exploitation of the results (months: 7-42)	M. Stamatakis, Professor

## PROJECT'S STRUCTURE

TASKS	
WP-1	Task1.1. Organization of actions – Financial management (months: 1-42)
	Task 1.2. Training issues (months 7-42)
	Task 1.3. Project's internal evaluation (month: 12, 24, 36 and 42)
WP-2	Task 2.1. Compilation of all the existing information for the presence of MA deposits in Greek coastal waters (months: 1-9)
	Task 2.2. European experience in MA prospecting, dredging and usage (months: 1-12)
	Task 2.3. Potential industrial use of MA (months: 7-24)
	Task 2.4. Assessment of the volume required for beach nourishment in Greece (months 7-30)
	Task 2.5. Data base development for the storage and utilisation of all the information gathered (months: 4-12 and 31-36)

## PROJECT'S STRUCTURE

### TASKS

WP-3

- Task 3.1. Selection of submarine areas with potential MA deposits (months: 7-12)**
- Task 3.2. Geo-physical data acquisition and analysis (months: 10-32)**
- Task 3.3. Stratigraphical - morphological characteristics of the sea bed, hosting the identified MA deposits (months: 19-32)**
- Task 3.4. A quantitative assessment of the identified MA deposits (months: 25-36)**

WP-4

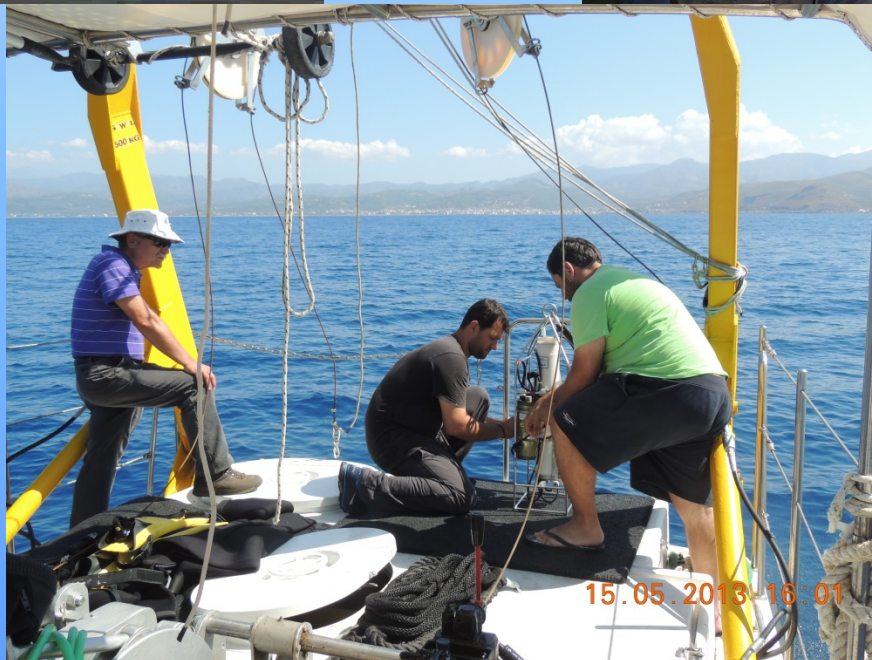
- Task 4.1. Seabed sediment sampling related to the MA identified deposits (months: 10-30)**
- Task 4.2. Granulometric analysis of MA deposits (months: 13-36)**
- Task 4.3. Mineralogy of MA deposits (months:13-36)**
- Task 4.4. Geochemistry of MA deposits (months: 13-36)**

TASKS	
WP-5	Task 5.1. Environmental legislation (Greek and European), for MA prospecting extraction (months: 13-30)
	Task 5.2. Benthos investigation in the potential locations of MA extraction (months 13-36)
	Task 5.3. Environmental impact assessment (months: 25-42)
	Task 5.4. Decision making tool for the most suitable method of extraction (months: 31-42)
	Task 5.5. Development of a “Protocol for MA Extraction” (months: 31-42)
WP-6	Task 6.1. Potential possibilities for the use of the identified MA deposits (months: 31-42)
	Task 6.2. Investigation for new industrial applications of MA (months: 31-42)
	Task 6.3. Dissemination of project's results (months: 31-42)
	Task 6.4. Project's website (months: 7-42)

# FIELDWORK: WORK ONBOARD



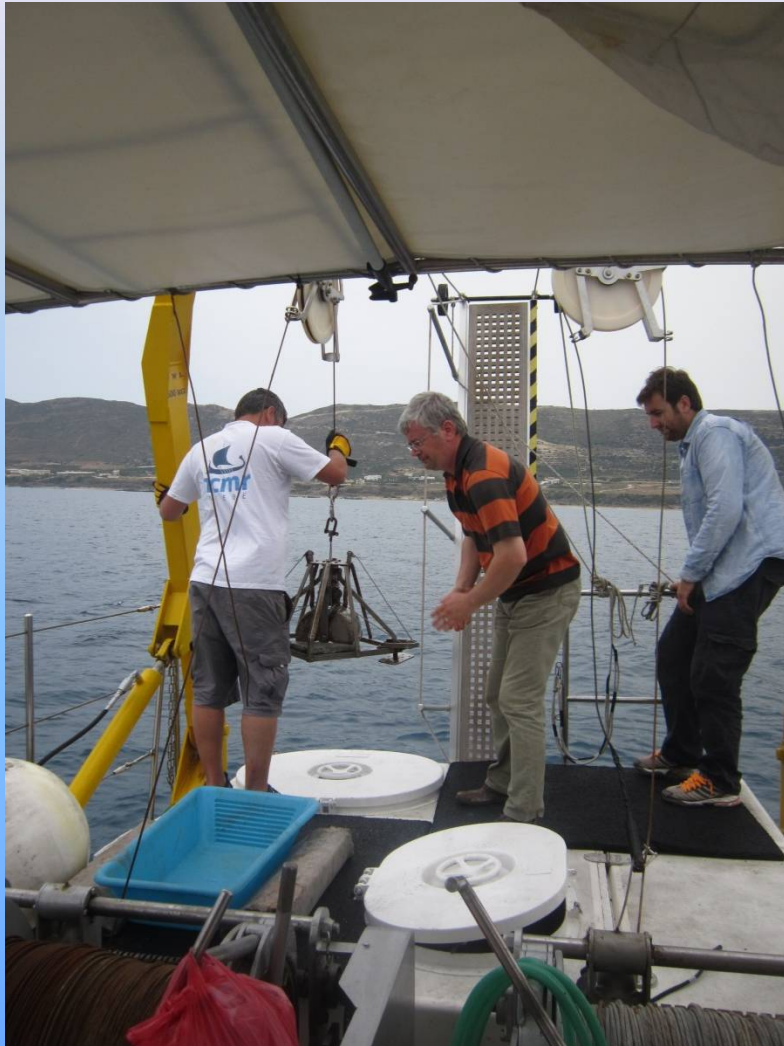
**R/V ALKYON**



- positioning (dGPS)
- multibeam
- chirp

**CTD,**  
sound velocity





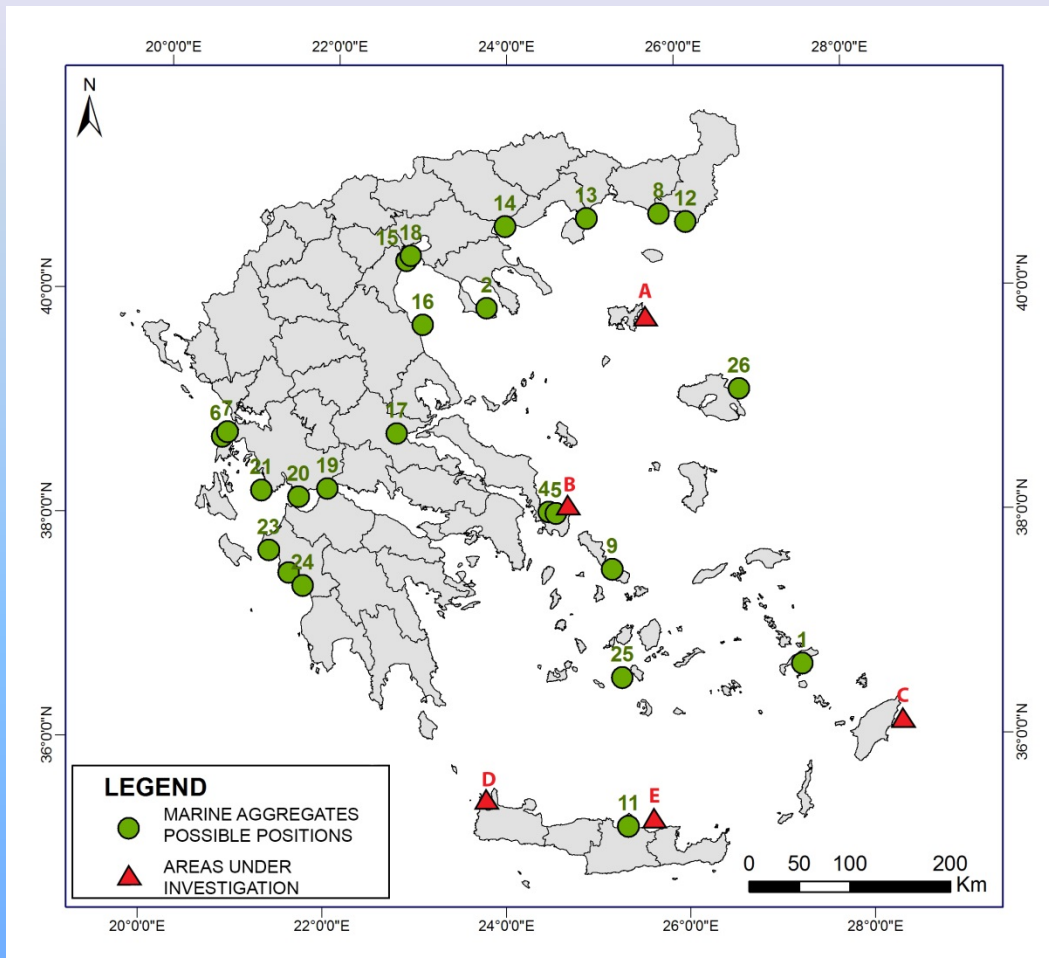
**Grab (sediment sampler)**



**Coarse grained sediment**



# PRELIMINARY RESULTS



**Potential locations of MA deposits, on the basis of:**

**(i) the geological environment of the inner continental shelf (including the Cyclades Plateau),**

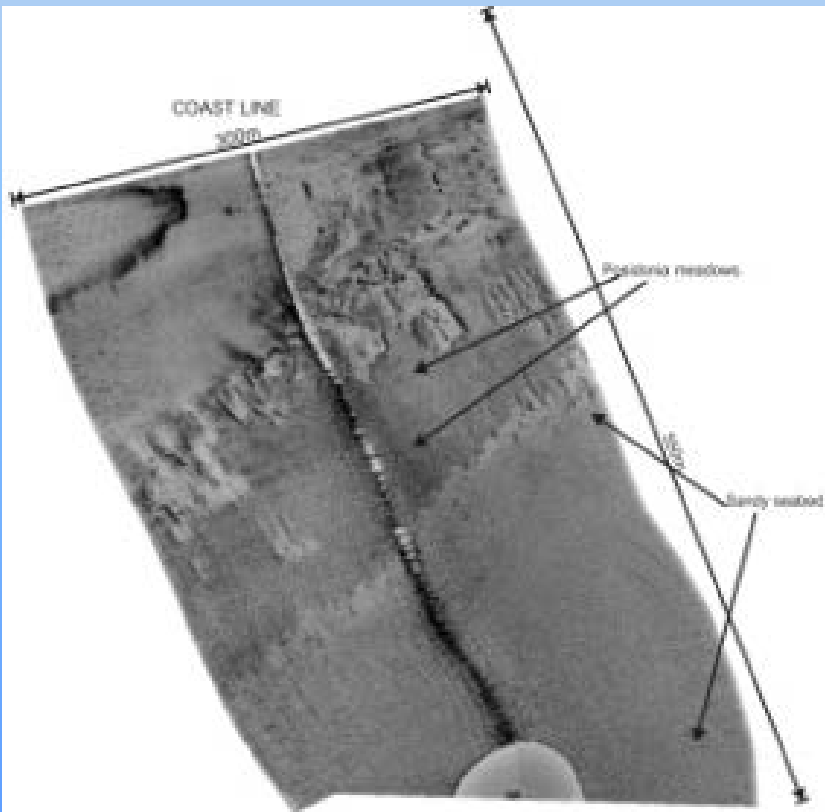
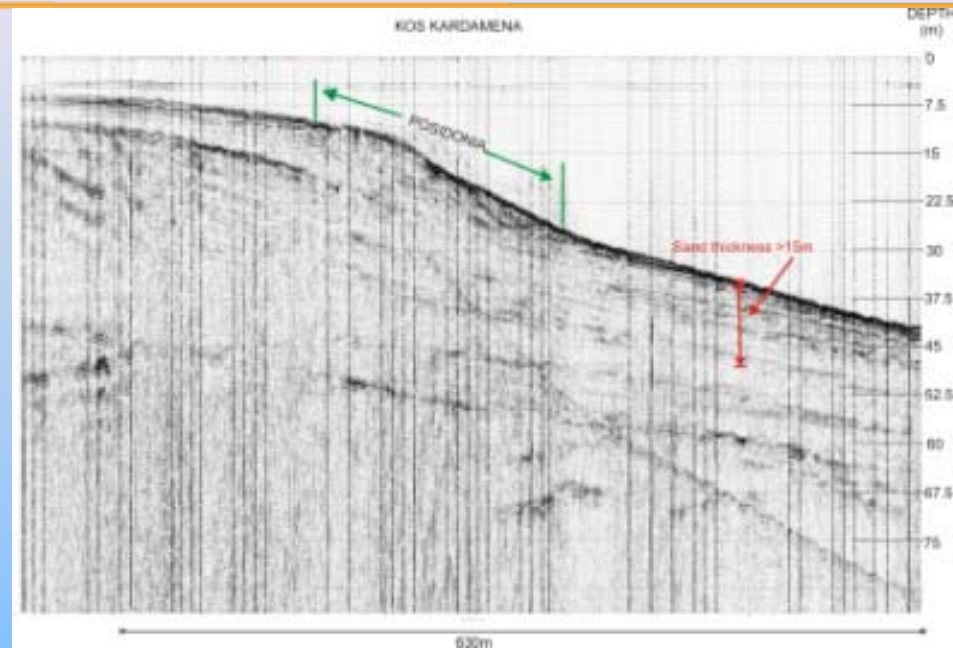
**(i) coastal lithology and geomorphology**

**(ii) the locations of active river mouths**

Marine aggregates positions in Greek Marine Areas: 1: Kos Isl. - Kardamena, 2: Chalkidiki- Pefko-chori, 3: Naxos Isl. Kleido, 4: Evoia-Akteo, 5: Evoia- Ag.Dimitrios, 6: Lefkada Isl.- Ag. Nikitas, 7: Lefkada Is-land- Ag. Ioannis, 8: Aleksandroupoli - Mesimvria, 9: Ti-nos Isl.- Rohari, 10: Tinos Isl.- Ag. Sostis, 11: Iraklio Gournes, 12: Evros Delta, 13: Nestos Delta, 14: Strimo-nas Delta, 15: Aliakmonas Delta, 16: Pinios (Th) Delta, 17: Sperchios Deta, 18: Aksios Delta, 19: Mor-nos Delta, 20: Evinos Delta, 21: Acheloos Delta, 22: Alfios Delta, 23: Pinios (Pel) Delta, 24: Kiparissiakos Gulf, 25: Sikinos Island-Dialiskari, 26: Mitilini Isl., A: Limnos Island, B: S.Evoia, C: Rhodes Island, D: Chania – W.Crete and E: Iraklio- Crete.

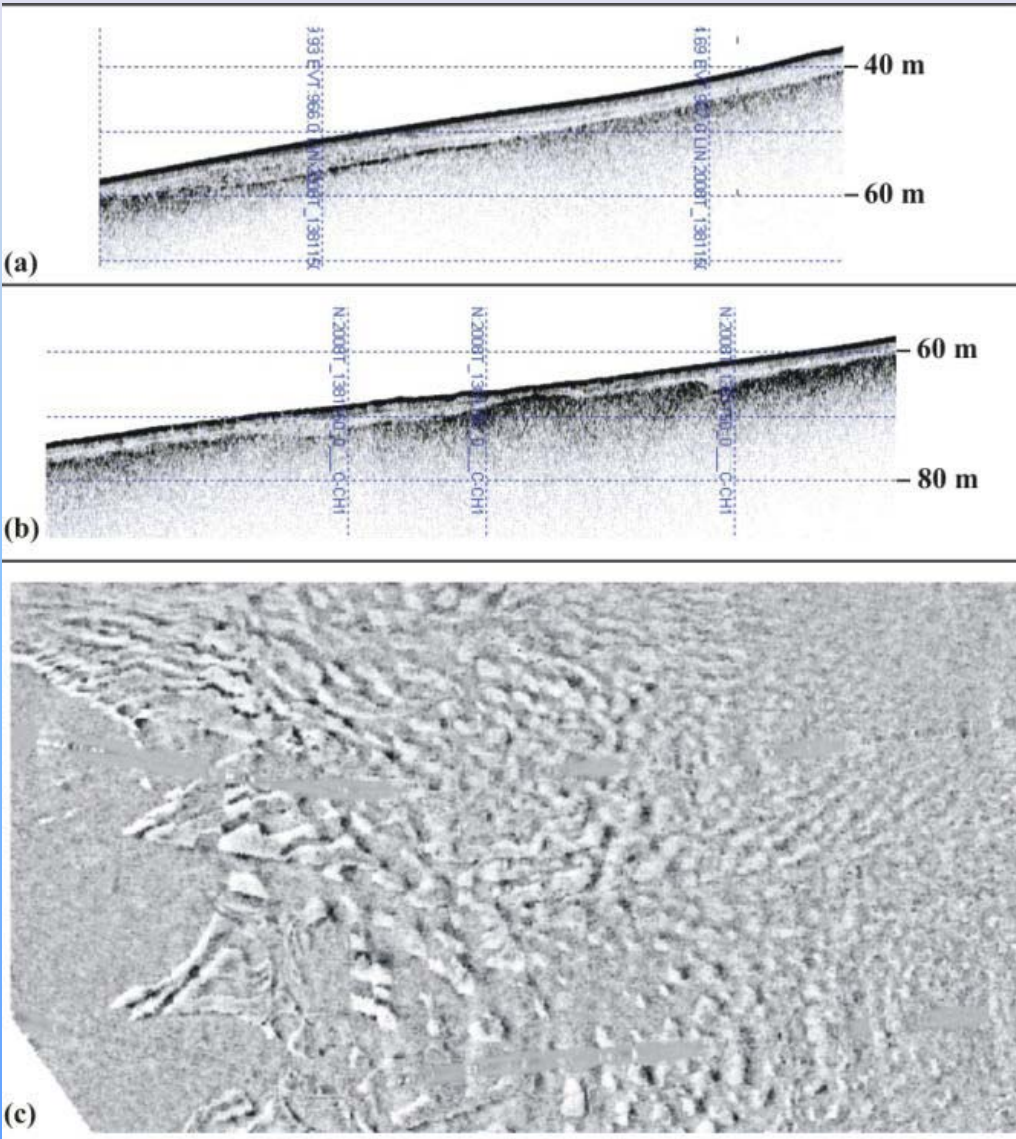
## Side scan sonar image and sub-bottom profiles from Cyclades plateau

The sub-bottom (*boomer type*) profile shows a thick layer of sandy material to be present in water depths >25-30 m; such deposits are regarded suitable for exploitation if there are not other environmental constraints



The *side scan* image reveals the boundary between a sandy bed and *Posidonia* meadows that are environmental sensitive and they are regarded as protected species.

## *Side scan sonar images and sub-bottom profiles from the Greek shelf*



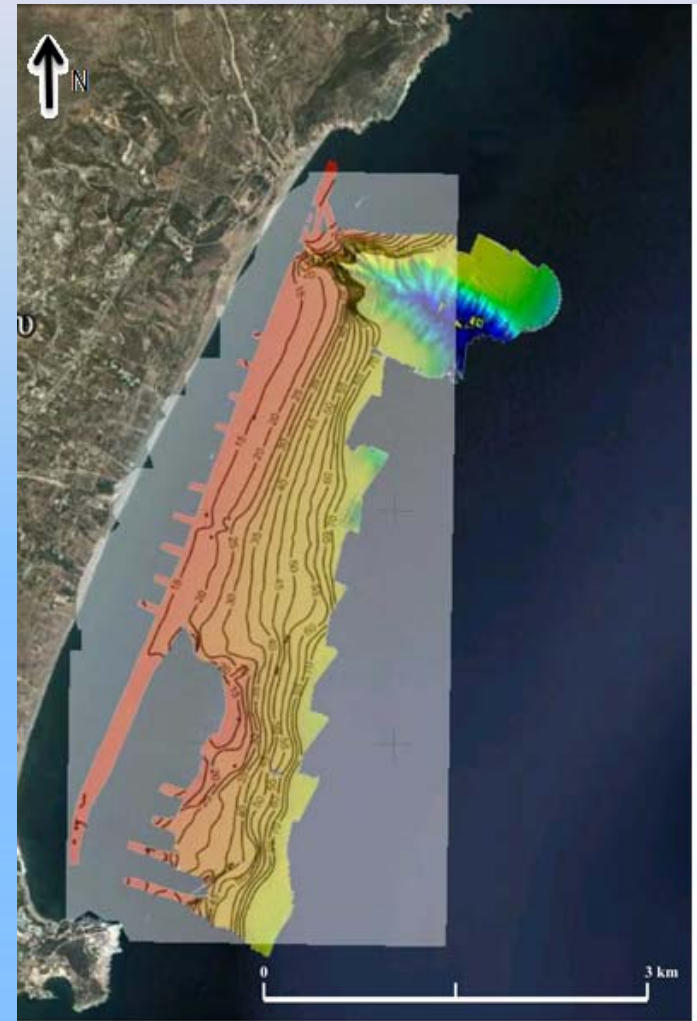
The subbottom profiles suggest the presence of a surficial sandy layer (2-5m in thickness) over the acoustic basement

The *side scan sonar image* reveals seabed micro-relief that is probably related to near bed current activity,.

# Bathymetry – seabed relief of the Afantou coast (Rodos Isl.)



*Positions of seismic profiles and of seabed sediments' from Afantou Bay*



*The Bathymetry os Afantou Bay, after multibeam data prossecing*



# CONCLUDING REMARKS

---

- ✓ *The Greek coastal zone to water depths <50 m seems to be promising with respect to the presence of MA deposits*
- ✓ *There is an increasing demand for MA is associated with beach replenishment (tourist industry), while the construction industry has started to be interested as well*
- ✓ *In recent years limited extraction of sand deposits have been reported, with the appropriate licenses had been given by Prefectures and/or municipalities*
- ✓ *There is not an official procedure to get a license both for identification and extraction of MA deposits, including environmental assessment protocols*
- ✓ *The Greek marine geologists, although have not been involved in such studies have the capacity to carry out such investigations*

---

Thank you  
for your attention



# REFERENCES

**Alexandrakis, G., A. Karditsa, S. Poulos, G. Ghionis and N.A. Kampanis (2009).**

Vulnerability assessment for the erosion of the coastal zone to a potential sea level rise: the case of the Aegean Hellenic Coast, in Environmental Systems, [Ed. Achim Sydow], in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK.

**Anonymous (2003).** A Development Plan for Marine Aggregate Extraction in England: A Scoping Study. Prosford Haskoning Ltd, David Tyldesley Associates and CEFAS & HR Wallingford Ltd, 2003. Report to the Office of the Deputy Prime Minister.

**BMAPA (British Marine Aggregate Producers Association) (2004).** The Crown Estate. The area involved; 6th Annual Report, London.

**BMAPA (British Marine Aggregate Producers Association) (2011).** The Crown Estate. Marine Aggregate terminology, 93pp, London.

**BRE (2008).** Digest BRE Digest 507. Marine aggregates in concrete. Supersedes Digest 473

**EUROSION (2004).** Living with coastal erosion in Europe: Sediment and Space for Sustainability. PART II – Maps and statistics “Directorate General Environment, European Commission.

## REFERENCES

**ICES (2005).** Report of the Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT), 5–8 April, San Sebastian, Spain. ICES CM 2005/E:06. 104 pp.

---

**ICES (2006).** Report of the Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT). 4-7 April 2006, Cork, Ireland, 91pp.

**Lykousis, V., M.B. Collins and G. Ferentinos, (1981).** Modern sedimentation in the NW Aegean Sea. *Marine Geology*, 43, 111-130.

**Lindsay, M. (2009).** Marine Sand and Gravel Ex-traction- Impacts and Mitigation, Eco-friendly Dredg-ing in the Modern Word, 13-14 October, St Peters-burg, Russian Federation.

**Perrisoratis, C., S.A. Moorby, C. Papavasiliou, D.S. Cronan, I. Angelopoulos, F. Sakellariadou and D. Mi-tropoulos (1987).** The geology and geochemistry of the surficial sediments off Thraki, Northern Greece. *Marine Geology* 74: pp. 209-224.

**Tillin, H.M., A.J. Houghton, J.E. Saunders, R. Drabble and S.C. Hull (2011).** Marine Aggregate Levy Sustainability Fund (MALSF) Science Monograph Series: No. 1.

**Velegrakis, A., A. Ballay, S. Poulos, R. Radzevicius, V. Bellec and F. Manso (2010).** European marine aggre-gates resources: Origins, usage, prospecting and dredging techniques. *Journal of Coastal Research*, 51, pp. 1-14.

**Working Group** on the Effects of Extraction of Marine Sediments on the Marine Ecosystem, Ostend, Belgium, 1–5 April 2003