XLIX. Geopolitics of Energy in the Kastellorizo-Cyprus Middle East Complex, Based on Existing Geophysical and Geological Indications of Hydrocarbon Deposits

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Abstract: The geophysical and geological indications (pockmarks, gas chimneys, salt domes, etc.) that have been traced on the seabed using multi–beam echo–sounders and side–scan sonars, as well as the corresponding seismic surveys in the region South, South–west and South–east of Cyprus, as well as the corresponding international interest of investors, especially in the marine region of the Levantine Basin, lead to the conclusion that, from a geopolitical perspective, Greece must be urged to accelerate the consolidation of its sovereign rights and understand anew and in practical terms, that "Cyprus is not far away, not at all actually". With respect to Kastellorizo and the submarine area of its EEZ, it is noted that de-tailed geophysical, bathymetric and sediment surveys have confirmed the fact that the region of the submarine Anaximander mountains presents active mud volcanoes, linked to the presence of gas hydrates. Samples of gas hydrates were collected using indicative samplings in mud volcanoes thoroughly mapped in sub–seabed layers of no more 1.5 m deep. Their form is "ice crystal". New mud volcanoes were also discovered ("Athens" and "Thessaloniki"). Gas hydrates were found in samplings conducted on–board the M/V "Thessaloniki". Based on preliminary assessments, the total capacity of the mud volcanoes of the Anaximander mountains complex is estimated between 2.56 6.40 c. km.[1]

1. See also: Lykousis, V., Alexandri, S., Woodside, J., Nomikou, P., Perissoratis, C.,

I. Indications of fluid seeps in deep water environments

Indications of fluid hydrocarbon seabed seeps detected in offshore areas have increased considerably since the 1970s[2] with the development of acoustic imagery/sub bottom profile (survey) systems and geomorphological imagery technologies. These phenomena, usually referred to as "cold vents" and "cold mud volcanism", have been observed in various regions of different physiographies, varying from accretionary wedges in active limits (margins), to salt bearing passive margin segments, shelves, and deep–sea fans. Submarine mud domes and cold seeps were observed for the first time, at the convergence boundaries of the lithospheric plates[3] or for example at the Mediterranean Ridge accretionary wedge.[4] The modes of cold seep emissions are substantially

Sakellariou, D., de Lange, G., Dahlmann, A., Casas, D., Rousakis, G., Ballas, D., Ioakim, C., «New evidence of extensive active mud volcanism in the Anaximander Mountains (Eastern Mediterranean): the "Athina" mud volcano», *Environmental Geology* 46 (2004), 1030-1037.

2. Hovland, M., & Judd, A.G, *Seabed pockmarks and seepages: Impact on geology, biology and the marine environment*, Graham and Trotman, London 1988. See also: Milkov, A. V., «Worldwide distribution of submarine mud volcanoes and associated gas hydrates», *Marine Geology* 167:1-2 (6/2000), 2942; Kopf, A., «Significance of mud volcanism», *Reviews of Geophysics* 40:2 (2002), 152.
3. Deville, E., Battani, A., Griboulard, R., Guerlais, S., Lallemant, S., Mascle, A., Muller, C., Prinzhofer, A., «Processes of mud volcanism in the Barbados Trinidad compressional system (SE Caribbean): New structural and geochemical data», *EGS Geophysical Research Abstracts*, Nice 2003, 14-128. Also in: (i) Griboulard, R., Bobier, C., Faugeres, J.C., Huyghe, P., Gonthier, E., Odonne, F., Welsh, R., «Recent tectonic activity in the South Barbados prism: Deeptowed sidescan sonar imagery», *Tectono-physics* 284:1/2 (1998), 79-99; (ii) Griboulard, R., Bobier, C., Faugeres, J. C., Vernette, G., «Clay diapiric structures within the strikeslip margin of the Southern leg of the Barbados prism», *Tectonophysics* 192:3/4 (1988), 383-387.
4. Cita, M.B., Camerlenghi, A., Erba, E., McCoy, F.W., Castadrori, D., Cazzani, A., Guasti, G., Gambastiani, M., Lucchi, R., Nolli, V., Pezzi, G., Redaelli, M., Rizzi, E., Torricelli, S., Violanti, D., «Discovery of mud diapirism in the Mediterranean Ridge, a preliminary report», *Bollettino della Società Geologica Italiana* 108 (1989), 537-543. Also in: (i) Cita, M.B., Ryan, W.B F., Paggi, L., «Prometheus mud breccia: An example of shale diapirism in the Western Mediterranean Ridge», *Annales Géologiques des Pays Helléniques* 30 (1981), 543-569; (ii) Limonov, A.F., Woodside, J.M., Ivanov, M.K., «Mud volcanism in the Mediter-

differentiated, whether they begin in the seabed and are diffused into the marine environment, or they are gathered through seeps and vents, and they may be altered considerably with time. Until recently, in regions with compressive settings, the thrust planes were considered to be fundamental factors of seep immigration into the seabed.[5] The case of Eastern Makran (Pakistan) is reported as an example in the literature: there, according to recent data, most mud domes are located above transcurrent faults that are also the result of the fast growth of accretionary wedges.[6] The passive continental margins are also identified as regions that possibly present important fluid seeps. Mud volcanoes and the seeps linked to them have been observed in regions with important sedimentation (e.g. Mississippi, the Delta of Niger and Nile),[7] where fluid seeps and gas emissions on the seabed are most probably due to tectonic factors. Special structures, such as deep channels, most probably release large quantities of fluid quite early, as far as the historical development of their burial is concerned.[8] All these regions present a

ranean and Black Seas and shallow structures of the Eratosthenes Seamount: Initial results of the geological and geophysical investigations during the Third UNESCOESF 'Training through Research' Cruise of RV Gelendezhik (June-July 1993)», *UNESCO Reports in Marine Science* 1994, 64.

5. Camerlenghi, A., Cita, M.B., Della Vedova, B., Fusi, N., Mirabile, N., Pellis, G., «Geophysical evidence of mud diapirism on the Mediterranean Ridge accretionary complex», *Marine Geophysical Researches* 17 (1995), 115-141.
6. Rabaute, A., Chamot-Rooke, N., DOTMED Team, «Tectonics and mud volcanism at the western Mediterranean Ridge backstop contact», *EGS Geophysical Research Abstracts* (2003), 1020-1027. See also: (i) Guerlais, S.H., Ellouz, N., Deville, E., Lallemant, S., Coletta, B., Muller, C., «Shale diapirism and mud volcanism processes in trans-form fault systems associated with accretionary prisms: Examples from east Makran (Pakistan) and south-east Caribbean», *in Subsurface Sediment Mobilisation Conference*, Gent 2001, 51.
7. Hovland, M., Gallagher, J.W., Clennell, M.B., Lekvam, K., «Gas hydrate and free volumes in marine sediments: Example from Niger delta front», *Marine and Petroleum Geology* 14:3 (1997), 245-255. See also: (i) Milkov, A.V., «Worldwide distribution of submarine mud volcanoes and associated gas hydrates», *Marine Geology* 167:1-2 (6/2000), 29-42; (ii) Milkov, A. V., Sassen, R., «Thickness of the gas hydrate stability zone, Gulf of Mexico continental slope», *Marine and Petroleum Geology* 17 (2000), 981-991.
8. Gay, A., *Les marqueurs géologiques de la migration et de l'expulsion des fluides sédimentaires sur le plancher des marges passives matures. Exemples dans le bassin du Congo*, Thèse de doctorat, Université des Sciences et Technologies de

high fluid production of biogenic or thermogenic origin (or even both simultaneously).

I.a The geophysical indications of seeps in the Eastern Mediterranean

The indications originate mainly from data gathered using multibeam echo-sounders, which produce high resolution mapping of the seabed morphology, and by means of seismic surveys conducted in the Eastern Mediterranean region during the recent years.

Modern technology has significantly supported the effort to locate hydrocarbon seeps, as it is based mainly on the alteration of physical attributes of sediment structures on the seabed surface, and on the alteration of its local morphology, creating, for example, mud domes and volcanoes or in lieu of the previously mentioned elevations abrupt depressions (e.g. caldera formations). All these formations are henceforth easily recognisable on the seabed, because of the high definition attributes of sounder impressions, as well as of the recordings of back scattering signals from sidescan sonars.[9]

The presence of hydrocarbons also leaves a characteristic "signature" in the acoustic imagery recordings of the back scattering signal from seismic soundings.[10] A general characteristic is that any emis-

Lille, Lille 1, 2002.

9. Behrens, E.W., «Geology of a continental slope oil seep, northern Gulf of Mexico», AAPG Bulletin 72 (1988), 105-114; and: (i) Bryant, W.R., Bryant, J.R., Feeley, M.H., & Simmons, G.R., «Physiographic and bathymetric characteristics of the continental slope, Northwest Gulf of Mexico», *GeoMarine Letters* 10 (1990), 182-199; (ii) Neurauter, T.W., Roberts, H.H., «Three generations of mud volcanoes on the Louisiana continental slope», *GeoMarine Letters* 14 (1994), 120-125.
10. Sager, W.W., MacDonald, I.R., Rousheng, H., «Geophysical signatures of mud mounds at hydrocarbon seeps on the Louisiana continental slope, northern Gulf of Mexico», *Marine Geology* 198 (2003), 97-132. Also in: (i) Anderson, A.L., & Bryant, W. R., «Gassy sediment occurrence and properties: Northern Gulf of Mexico», *GeoMarine Letters* 10 (1990), 209-220; (ii) Blondel, P., Murton, B. J., *Handbook of seafloor sonar imagery*, Wiley, New York 1997, 314; (iii) Bryant, W.R., Bryant, J.R., Feeley, M.H., Simmons, G.R., «Physiographic and bathymetric characteristics of the continental slope, northwest Gulf of Mexico», *GeoMa-*

sion of fluid seep, and the authigenic carbonate crust linked to cold seeps, generally scatters the acoustic energy in a circular or elliptic manner.[11] Using core analyses, it recently became evident that the strengthening returns from the seabed are also owed to seep matter (oil and natural gas) located on surface or subsurface sediments, increasing the acoustic reflection of the seabed and of the surface sedimentary cover. On the contrary, regions with low back scattering signal strength, indicate non–degraded regions with semi–pelagic sediment. In certain regions, the low back scattering signal is linked to brine pools on the seabed.[12] Many authors link high reflectivity patterns with mud volcano activity, e.g. in the case of the Mediterranean Ridge.[13] On seismic reflections, standard hydrocarbon seeps are characterised by loss of the seismic signal due to the high gas concentration in the sediments. In the Nile Deep–Sea Fan (NDSF), acoustic transparent sections reported in literature as gas chimneys, are relatively frequent.[14]

rine Letters 10 (1990), 182-199.

11. Sager, W.W., Lee, C.S., MacDonald, I. ., Schroeder, W.W., «High frequency near-bottom acoustic reflection signatures of hydrocarbon seeps on the northern Gulf of Mexico continental slope», *GeoMarine Letters* 18 (1999), 267-276.
12. Huguen, C., *Déformation récente a actuelle et argilocinèse associée au sein de la Ride Méditerranéenne (Méditerranée orientale)*, Thèse de doctorat en Géologie Marine. Université P. et M. Curie (Paris 6) 2001. Also: Woodside, J.M., Volgin, A.V., «Brine pools associated with Mediterranean Ridge mud diapirs: An interpretation of echofree patches in deep tow sidescan sonar data», *Marine Geology* 132 (1996), 55-61.
13. Sager, W.W., Lee, C.S., MacDonald, I. ., Schroeder, W.W., «High frequency nearbottom acoustic reflection signatures of hydrocarbon seeps on the northern Gulf of Mexico continental slope», *GeoMarine Letters* 18 (1999), 267-276. Also: Woodside, J.M., Volgin, A.V., «Brine pools associated with Mediterranean Ridge mud diapirs: An interpretation of echofree patches in deep tow sidescan sonar data», *Marine Geology* 132 (1996), 55-61.
14. Barsoum, K., Della Martera, M., & Menardi Noguera, A., «Gas chimneys in the Nile delta slope and gas fields occurrence», *in EAGE Conference on Geology and Petroleum Geology*, St Julians, Malta 2000. Also in: Mascle, J., Loncke, L., Sardou, O., Boucher, P., Felt, V., Prismed II and Fanil scientific parties, «Evidences of fluid escape structures and mud volcanoes on the Nile DeepSea Fan», *AAPG Meeting* 2002, A56.

I.b Reports on fluid seeps in the Eastern Mediterranean

In the region of Eastern Mediterranean, there is an abundance of mud volcanoes and hydrocarbon seeps, particularly in the area of the Mediterranean Ridge (MR) (see Figure 1). These are considered to be directly linked to active compressional and transcurrent, tectonic lineaments.[15]

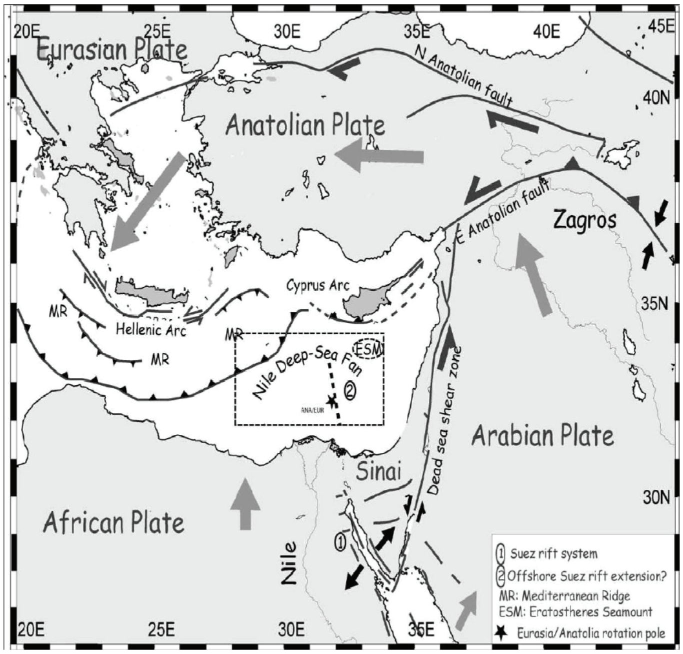

Fig. 1: Geodynamic description of the Eastern Mediterranean Basin.
Mediterranean Ridge (MR)
(Source: L. Loncke et al. 2004. *Marine and Petroleum Geology*. 21, 669-689)

15. Camerlenghi, A., Cita, M.B., Della Vedova, B., Fusi, N., Mirabile, N., Pellis, G., «Geophysical evidence of mud diapirism on the Mediterranean Ridge accretionary complex», *Marine Geophysical Researches* 17 (1995), 115-141. Also in: Huguen, C., *Déformation récente a actuelle et argilocinèse associée au sein de la Ride Méditerranéenne (Méditerranée orientale)*, Thèse de doctorat en Géologie Marine. Université P. et M. Curie (Paris 6) 2001. Also: Woodside, J.M., Volgin, A.V., «Brine pools associated with Mediterranean Ridge mud diapirs: An interpretation of echofree patches in deep tow sidescan sonar data», *Marine Geology* 132 (1996), 55-61.

Geophysical and geological surveys carried out in 1998 and in 2000 on the Nile boundary have identified and characterised more than 150 mud cones, and an abundance of large and small spot craters (pockmarks and mounds), in the Nile Deep Sea Fan system or NDSF. During approximately the same time period, there were also reports on the discovery of several active gas chimneys along the higher seawall of the NDSF, while in 2001 indications of cold hydrocarbon seeps appeared, which are linked to minor (with a diameter <10 m) mud mounds and authigenic carbonate crusts16 (see: Fig. 2).

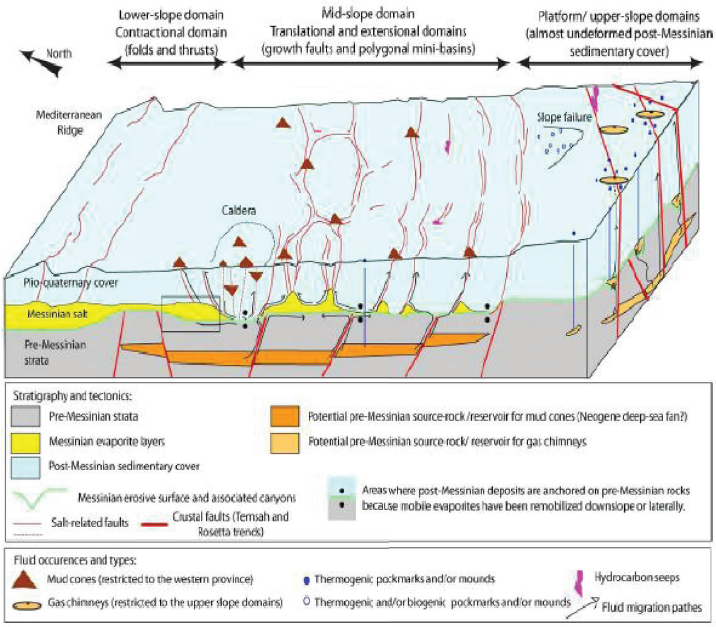

Fig. 2: Schematic interpretation of hydrocarbon seeps in the Eastern Mediterranean basin
(Source: L. Loncke et al. 2004. Marine and Petroleum Geology 21, 669–689)

16. Coleman, D.F., Ballard, R.D., «A highly concentrated region of cold hydrocarbon seeps in the south–eastern Mediterranean Sea», *GeoMarine Letters* 21 (2001), 162-167.

Finally, the existence of pockmarks is demonstrated probably associated to faults in the mountain of Eratosthenes, a large disrupted plateau like relief that connects the NDSF system in the North–east17 (see Figs. 3 and 4).

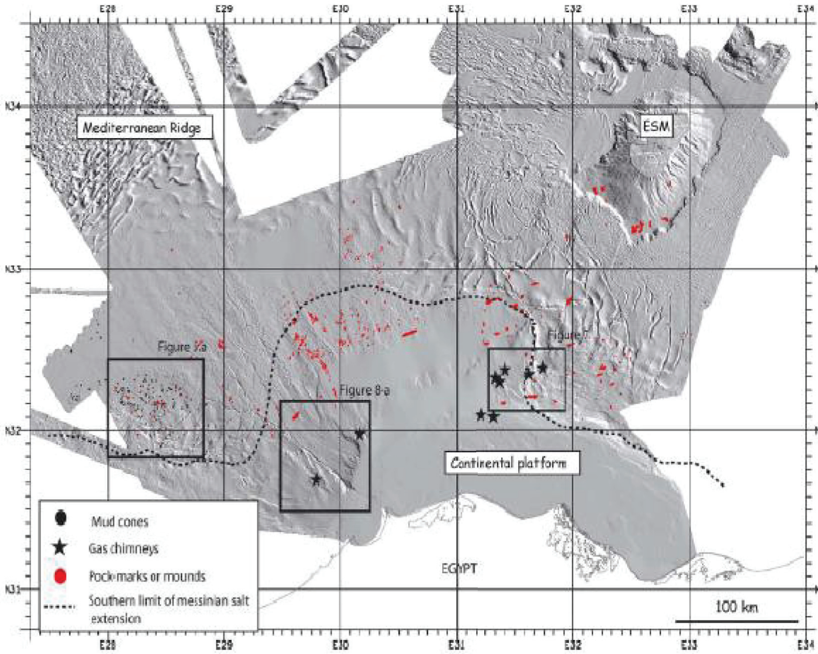

Fig. 4: Geomorphological indications of hydrocarbon seeps on the seabed surface in the Eastern Mediterranean region (Legend: ESM: Eratosthenes Mountain. Mud Cones, Gas Chimneys, Pockmarks, Mounds) (Source: L. Loncke et al. 2004. Marine and Petroleum Geology 21, 669-689)

17. Dimitrov, L. I., Woodside, J., «Deep–sea pockmark environments in the Eastern Mediterranean», *Marine Geology* 195:1-4 (3/2003), 263-276.

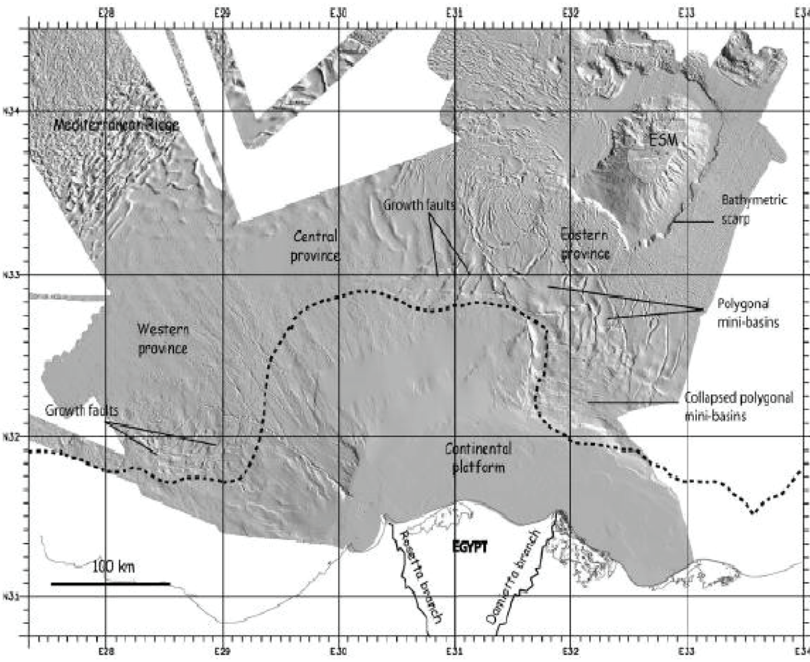

Fig. 3: Multi–beam backscattering image of the Eastern Mediterranean basin. The interrupted line represents is the extension of the southern limit of the Messinian Salinity Crisis
(Source: L. Loncke et al. 2004. Marine and Petroleum Geology 21, 669-689)

I.c The offshore area between Cyprus and Egypt with respect to hydrocarbon potential

All the geophysical indications on the existence of hydrocarbons in the broader region of the Eastern Mediterranean, and more specifically in the offshore area between Cyprus and Egypt, were known by 2004.[18] The Eastern Mediterranean region and particularly the area between Cyprus and Egypt, has been systematically explored during the last 10 years by petroleum companies. It is currently considered to be an oil

18. Loncke, L., Mascle, J., Fanil Scientific Parties, «Mud volcanoes, gas chimneys, pockmarks and mounds in the Nile deepsea fan (Eastern Mediterranean): geophysical evidences», *Marine and Petroleum Geology* 21 (2004), 669-689.

and natural gas producing site. By 2000, natural gas (mainly) and oil reserves corresponding to 3.8 billion barrels had been discovered.[19] The main source is located either in the Upper Cretaceous (black shales), in gas–rich sediments of the Miocene, or even in Pleistocene sapropyl, with exceptionally high TOC (Total Organic Carbon) values. It seems that reservoirs are mainly located in land deposits of the Miocene and in channel clusters of the Pleistocene.[20] On the seabed surface, incidents of high quality hydrocarbon seeps have been discovered, mainly above large fracture zones in the Eastern section of the NDSF. The presence of hydrocarbon seeps is most probably linked to recent sapropyl degradation.[21]

II. Petroleum and natural gas reserves in the Eastern Mediterranean

The land and offshore area of the Eastern Mediterranean Basin (see Figure 4) has proved to be quite promising for hydrocarbon production. As reported in numerous publications, until December 2006, the oil reserves were 15 bbl. and natural gas reserves were100 tcf (trillion cubic feet). The tectonic development of the basin[22] has been interpreted according to the following stages (Fig. 5):

19. Abdel Aal, A., El Barkooky, A., Gerrits, M., Meyer, H., Schwander, M., Zaki, H.A., «Tectonic evolution of the Eastern Mediterranean basin and its significance for hydrocarbon prospectivity in the ultra–deep water of the Nile delta», *The Leading Edge* 2000, 1086–1102. Also in: Abdel Aal, A., El Barkooky, A., Gerrits, M., Meyer, H., Schwander, M., Zaki, H.A., «Tectonic evolution of the Eastern Mediterranean basin and its significance for hydrocarbon prospectivity in the ultradeepwater of the Nile delta», *GeoArabia* 6:3 (2001), 363-384. Also: Samuel, A., Kneller, B., Raslan, S., Sharp, A., Parsons, C., «Prolific deepmarine slope channels of the Nile delta, Egypt», *AAPG Bulletin* 87 (2003), 541-560.
20. Samuel, A., Kneller, B., Raslan, S., Sharp, A., Parsons, C., «Prolific deepmarine slope channels of the Nile delta, Egypt», *AAPG Bulletin* 87 (2003), 541-560.
21. Coleman, D.F., Ballard, R.D., «A highly concentrated region of cold hydrocarbon seeps in the south–eastern Mediterranean Sea», *GeoMarine Letters* 21 (2001), 162-167.
22. Peck, J., «Giant oil prospects lie in distal portion of offshore East Mediterranean basin», *Oil & Gas Journal* (October 2008).

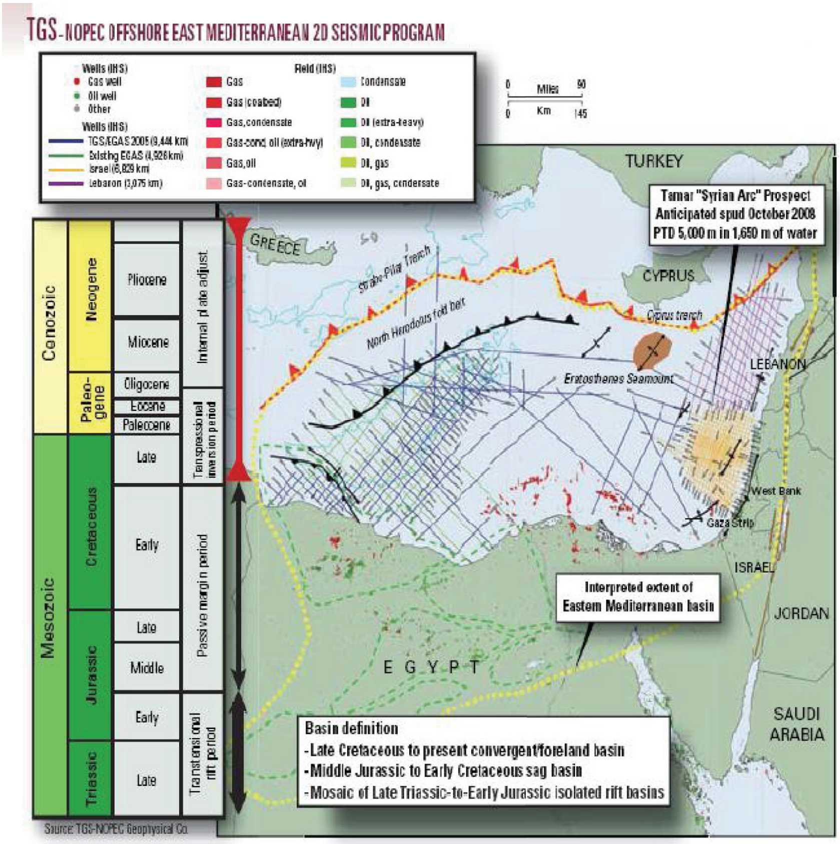

Fig. 5: Offshore Two–dimensional Seismic Measurement Program of the SE Mediterranean (Source: TGSNOPEC Geophysical Co)

- A period of compression–generated tectonic pit formation (Late Triassic to Early Jurassic).
- Middle Jurassic to Early Cretaceous sag period.
- A period of alpic reversal (Late Cretaceous to Early Paleocene period).
- An internal plate settlement period (Late Paleocene to Miocene) which is characterised by:
- The Suez Golf Tectonic pit (Oligo Miocene).
- The Red Sea Tectonic pit.
- The Salinity Crisis (Messinian).

• Flood Period (Pliocene).

The hydrocarbon reserves are distributed in three broader and proven oil systems (Systems A, B and C)23 (see Fig. 6). The basin's special characteristics are the following:

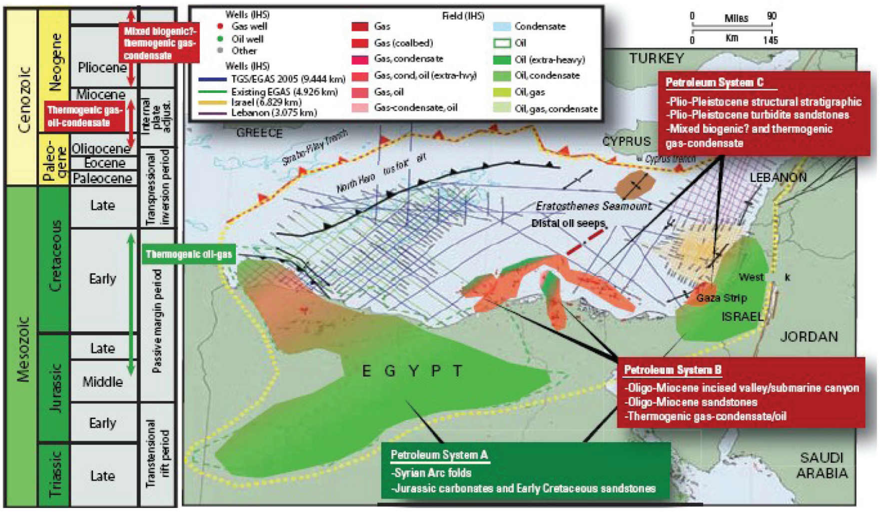

Fig. 6: Petroleum Systems of the S/E Mediterranean: A, B and C
(Source: TGSNOPEC Geophysical Co)

The offshore section of system C, parts of which are located in front of the Nile and Gaza, are mainly characterised by natural gas reserves. All Pleo–Pleistocene natural gas reserves are close to almost vertical palaeofractures extending throughout the length of the layer column. According to company reports, oil seeps from the seabed are linked to the previously mentioned palaeo–fractures that begin from the Mesozoic section until the corresponding Cenozoic (including the Messinian salinity and the overlaying Pleo–Pleistocene section) (cf. Fig. 6).

In spite of the abundance of EMB[24] reserves, based on the collected literature, the degree to which the deep section of the basin has been researched is unknown. Between 2001 and 2005, TGSNOPEC Geophysical

23. Peck, J., «Giant oil prospects lie in distal portion of offshore East Mediterranean basin», *Oil & Gas Journal* (October 2008).
24. EMB: International terminology referring to the Eastern Mediterranean Basin.

Co. acquired the data concerning the two–dimensional 19.256 km long seismic recordings off the coasts of Lebanon, Israel and Egypt (see Fig. 6).

The company has also reprocessed the seismic recording data for a length of 4.526 km, the rights of which are held by the EGAS and refer to the offshore region north of Egypt (see Fig. 6).

It should be stressed that, for reasons of seismic data reliability, this data was linked to data acquired by means of offshore drillings (up to the Mesozoic period). All the drillings are relatively close to the coastlines of Egypt and Israel.

III. Mud Volcanoes and gas hydrates in the region south of Kastellorizo

As reported in a very detailed publication by Lykousis et al, 2009 regarding the region of the Anaximander Mountains, detailed geophysical, bathymetric and sediment surveys have confirmed the fact that the region of the submarine Anaximander mountains presents active mud volcanoes that are linked to the presence of gas hydrates. Samples of gas hydrates were collected by means of indicative samplings in mud volcanoes thoroughly mapped in subsea bed layers that do not exceed 1.5 m. Their form is "ice–crystal". New mud volcanoes were also discovered ("Athens" and "Thessaloniki"). Gas hydrates were found in samplings conducted in the "Thessaloniki" M.V. According to preliminary assessments, the total mud volcanoes capacity of the Anaximander Mountains complex ranges between 2.56 and 6.40 c. km.[25]

General description

Mud volcanoes are a sovereign geological mechanism for the escape of hydro-carbon gases in deeply buried sediments. They are mainly lo-

25. Cf. also: Lykousis, V., Alexandri, S., Woodside, J., Nomikou, P., Perissoratis, C., Sakellariou, D., de Lange, G., Dahlmann, A., Casas, D., Rousakis, G., Ballas, D., Ioakim, C., «New evidence of extensive active mud volcanism in the Anaximander Mountains (Eastern Mediterranean): the "Athina" mud volcano», *Environmental Geology* 46 (2004), 1030-1037.

cated in subduction and orogenic areas, where tectonic compressional tendencies prevail.[26] Mud volcanoes are linked to the presence of solid gas hydrates which constitute a possible source of an exploitable natural resource, but also an environmental pollutant.[27] The presence of mud volcanoes in the Eastern Mediterranean is widespread in several points of the Mediterranean Ridge (see Fig. 7).

Their creation is owed to mud seeps hyper–pressurized by overlaying methane gas layers, which "spring up" via distorted sediments and reach the seabed surface, forming the characteristic form of a "dome". The first mud volcanoes in the Eastern Mediterranean were recorded in the 1970s.[28] Their connection with the presence of gas hydrates has boosted efforts to research and register them. The Anaximander mountain cluster is located in the region south of Kastellorizo (Fig. 8), with a characteristic geomorphology featuring mud volcanoes and associated gas hydrates.

The mapping of the region was carried out within the framework of EU–funded research programmes, on the initiative of the Institute of Geology and Mineral Exploration (Perissoratis et al., 2003),[29] and the

26. Milkov, A. V., «Worldwide distribution of submarine mud volcanoes and associated gas hydrates», *Marine Geology* 167:1-2 (6/2000), 2942. See also: Kopf, A., «Significance of mud volcanism», *Reviews of Geophysics* 40:2 (2002),1005; and: Mascle, J., Huguen, C., Benhelil, J., ChamotRooke, N., Chaumillon, E., Foucher, J.P., Griboulard, R., Kopf, A., Lamarche, G., Volkonskaia, A., Woodside, J., Zitter, T., «Images may show start of European–African plate collision», *EOS, Transactions American Geophysical Union* 80 (1999), 37.
27. Woodside, J.M., Ivanov, M.K., Limonov, A.F., «Neotectonics and fluid flow through the seafloor sediments in the Eastern Mediterranean and Black Seas: Part I: Eastern Mediterranean Sea», *IOC Technical Series* 48 (1997), 11-28. Also cf.: Woodside, J.M., Ivanov, M.K., Limonov, A.F., «Shipboard Scientists of the Anaxiprobe Expeditions. Shallow gas and gas hydrates in the Anaximander Mountains region Eastern Mediterranean Sea», in: Henriet, J.P., Mienert, J. (eds.), *Gas Hydrates: Relevance to World Margin Stability and Climate Change*, Geological Society of London, Special Publication 137, London 1998, 177-193.
28. Cita, M.B., Ryan, W.B F., Paggi, L., «Prometheus mud breccia: An example of shale diapirism in the Western Mediterranean Ridge», *Annales Géologiques des Pays Helléniques* 30 (1981), 543-569.
29. Perissoratis, C., Amann, H., Meyn, V., De Lange, G., Kalogerakis, N., Lykousis, V., Wooside, J., Ercilla, G., «Exploring the extreme environment of the gas hydrates and the associated biosphere in the Eastern Mediterranean: the ANAXIMANDER Project», *Conference Abstracts OMARC Conference*, Paris, September 15–17, 2003.

Anaximander program (EVK320010001233000). Below is the description of the results from the oceanographic voyages carried out within the framework of the previously mentioned programme, during the years 2003 and 2004. A detailed bathymetric surveying of the seabed was conducted and seismic profiles were taken.

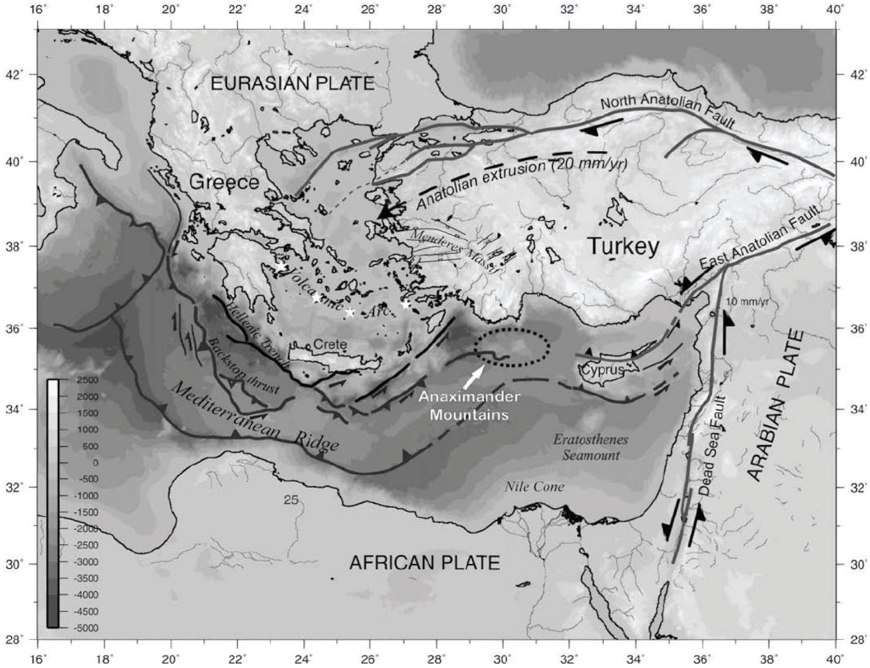

Fig. 7: General geo–tectonic and bathymetric map of the Eastern Mediterranean. The region of the Anaximander Mountains is marked with a dotted line (Source: Modified by MEDINAUT/MED-INETH Shipboard Scientific Parties, 2000; Ten Veen et al., 2004, in: Lykousis et al. 2009)

Geomorphology and description of the area

The research carried out in 2003 produced the precise morphology of the seabed and the possibility to determine the distribution of soft sediments and rocky elations from the acoustic tone's differentiations, resulting from analyzing intensity of the back scattering signal. The bathymetric map of the region was drawn on a 100 meter distance grid, while in the regions of interest the map was drawn on a more detailed grid (distances of 20 and 50 metres Fig. 8). The submarine mountain of Anaximenes presents a ridge–like structure with a SW-NE direction and is approximately 1300 metres long, with steep slopes. In contrast, the mountain of Anaxagoras, located east of Anaximenes, has an al-most square structure (approximately 30 km wide by 55 km long) and a relatively irregular topographic relief. Anaxagoras presents three distinguishable geomorphological units on its northern, southern and south–eastern sections. The large northern structure has an arc shaped form, with a slight upward gradient, up to a depth of less than 1000 m, and with a characteristic plateau in smaller depths. The Kula mud volcano presents a downward sediment movement, via the erosive channels which terminate towards the north–west into a deep level sinking. The southern structure is an oblong ridge with a SW-NE direction, bibliographically referred to as "Faulted Ridge".[30]

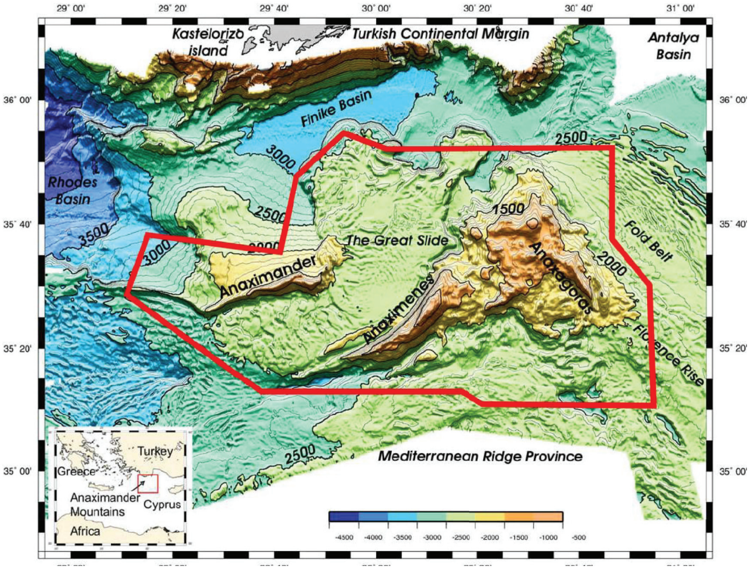

Fig. 8: The region of Anaximander Mountains, SSE of Kastellorizo
(Source : Woolside et al. 1997 [1998], in et al. 2009)

30. Zitter, T.A.C., Huguen, C., ten Veen, J., Woodside, J.M., «Tectonic control on mud volcanoes and fluid seeps in the Anaximander Mountains, eastern Mediterranean Sea», in: Dilek, Y., Pavlides, S. (eds.), *Postcollisional Tectonics and Magmatism in the Mediterranean Region and Asia*, Geological Society of America Special Paper Vol. 409 (2006), 615-631 <doi:10.1130/2006.2409(28)>.

North of Anaxagoras and northeast of Anaximenes, a linear sinusoidal subduction is formed (Fig. 8), starting at the Anaximenes front, with a breadth of 300 m and heading north–east, with a 10 km span that wears off between the deep basins of Antaleia and Finike. A system of deep canyons, most probably created by avalanches, originates in the northwest section of Anaxagoras and develops towards the channel's eastern side, along 30 km. The closing end of the Mediterranean Ridge is apparent in the same region, in a slightly rippled area that is clearly dissociated from the complex by a deep canal south of Anaximenes, at a depth of approximately 2800 m.

Description of mud volcanoes[31]

1. Amsterdam

It features a flat projection of 6 km^2 at the south slope of Anaximenes, at a depth of 2025 m (Fig. 8). The detailed bathymetric relief brought up two con-centric craters, linked to the characteristic slope and the 400 m deep sub–sea canyon, at the southern part exceeding the depth of 2250 m. In the crater area, 27 mud samplings were taken by means of coring. No presence of pelagic sediments was noted, which is indicative of the active state of the mud volcano. The sampling dataset shows also that gas hydrates are located in the centre and the southern slope of the Amsterdam SM (Figs. 9, 10). Gas hydrates were located at a depth of 0.31.5 m under the seabed surface. Particularly in the case of this specific mud volcano, it must be reported that the seismic profiles revealed a layer, located 40 m under the seabed surface, directly related to highest limit of gas hydrates. The lowest limit of the stability zone of gas hydrates is most likely located at approximately 200 m.[32] Based on

31. Paragraph 3 describes the physiography of the region and the findings, in order to serve the geopolitical view of the authors for the political conclusion that follows. A thorough and more detailed description for the region can be found in Lykousis et al. 2009.
32. Woodside, J.M., Modin, D.I., Ivanov, M.K., «An enigmatic strong reflector on sub–bottom profile records from the Black Sea the top of swallow gas hydrate deposits», *GeoMarine Letters* 23: 3/4 (2003), 269-277.

the topographic relief and sampling, the territorial expansion of the gas hydrates is estimated at 2628 km^2.

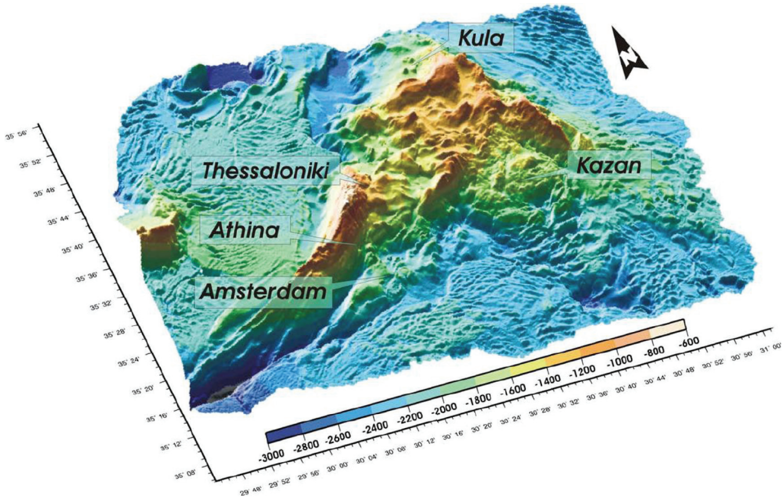

Fig. 9: Mud volcanoes mapped at the Anaximander mountain
(Source: Lykousis et al. 2009)

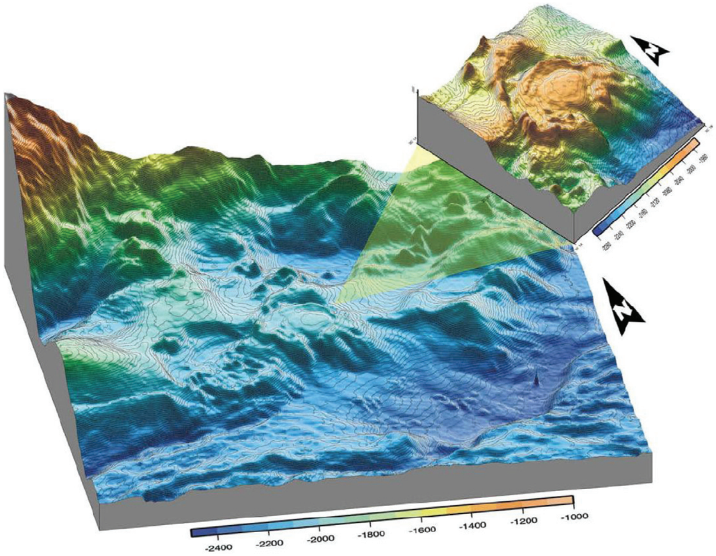

Fig. 10: Generic and more detailed 3D bathymetry map, Amsterdam mud volcano. The map clearly illustrates the avalanching process of mud seeps directed from NNW to SSE
(Source: Lykousis et al. 2009)

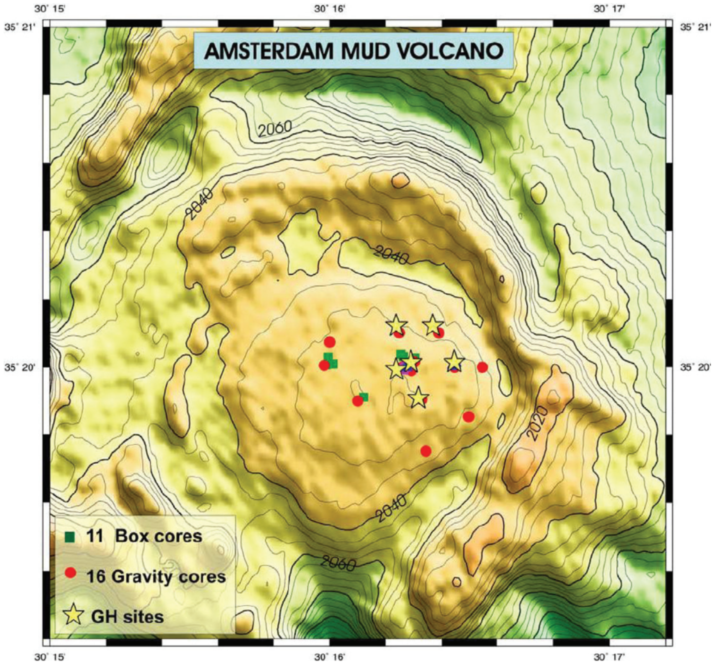

Fig. 11: Micro-topographic depiction with shading of the Amsterdam mud volcano. Sampling locations and points of discovered gas hydrates are identified (5 cm isobaths)

Fig. 12: Gas hydrates (8, 5 and 4 cm) (centre) from the Amsterdam mud volcano. Consecutive measurements after retrieving the core receivers produced min. temperatures of 34oC (Source: Lykousis et al. 2009)

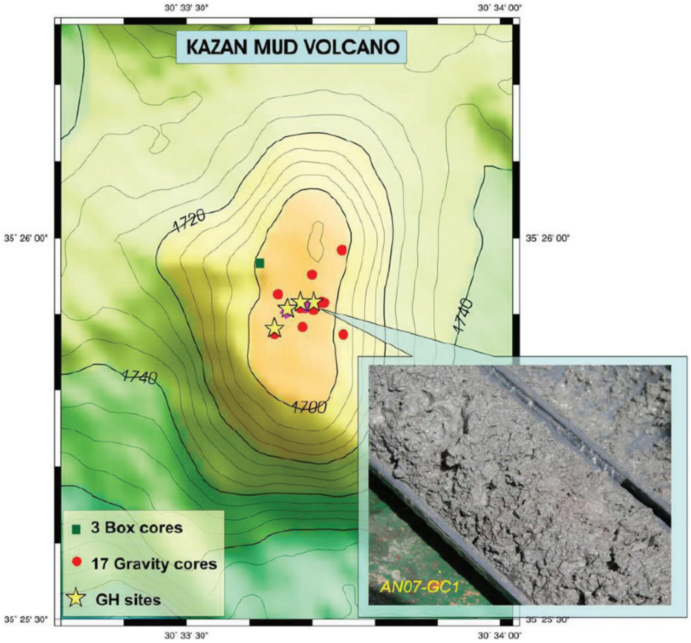

Fig. 13: Local 3D bathymetric map of Kazan mud volcano
(Source: Lykousis et al. 2009)

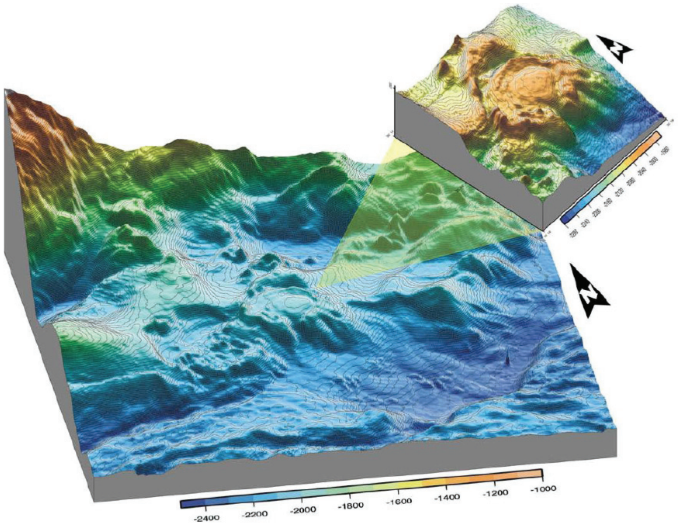

Fig. 14: Micro-topographic depiction with shaded Amsterdam mud volcano.
Sampling locations and points of discovered gas hydrates are identified
(5 cm isobaths)

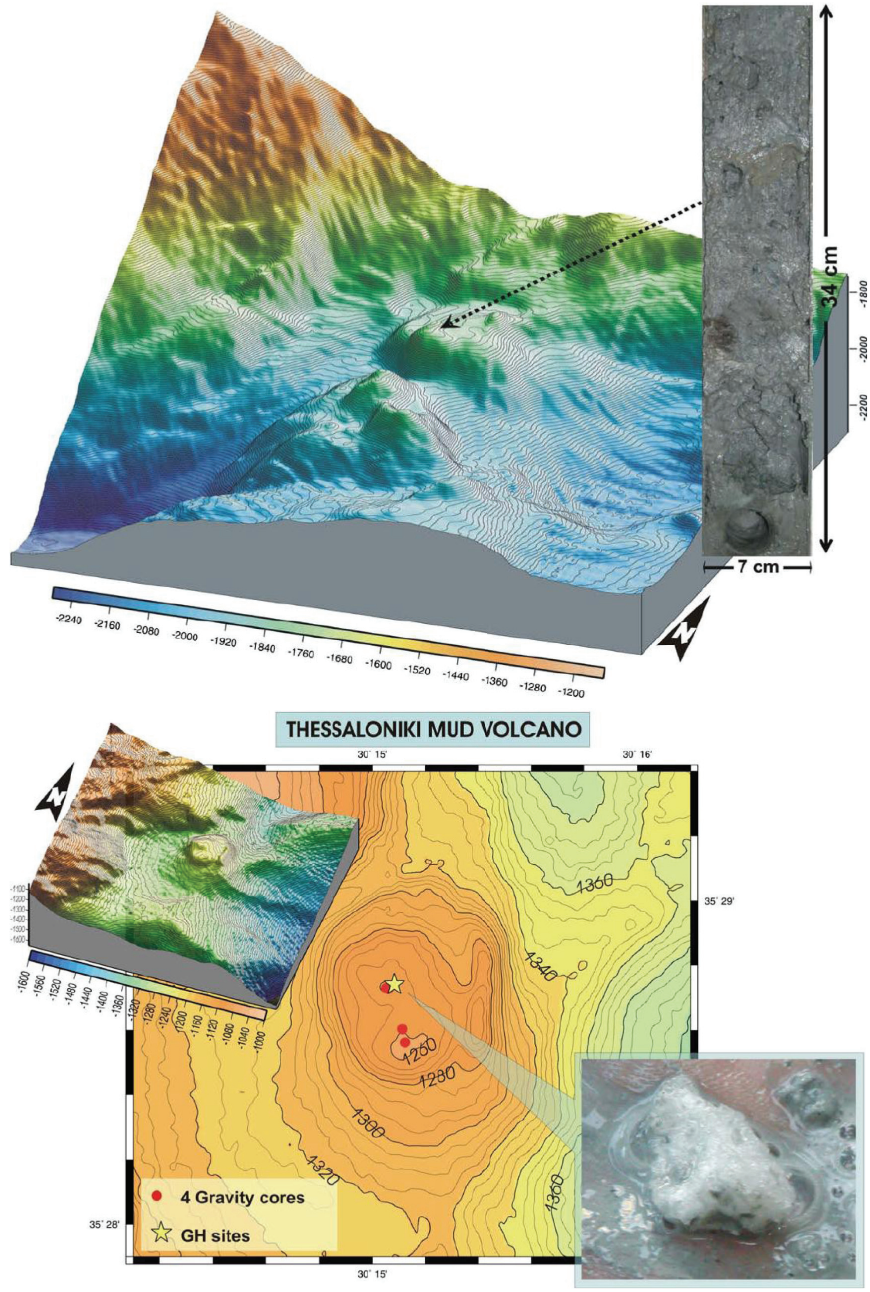

Fig. 15: Local 3D bathymetric map of Athina (left) and Thessaloniki (right) mud volcano (Source: Lykousis et al. 2009)

IV. History of actions and statements by interested state actors

A history of actions and statements between Turkey and Cyprus, according to A. Skordas,[33] is presented below as it took place following the delimitation of the EEZ of Cyprus and the subsequent concession of exploitation rights, coupled with some additional comments by the authors.

1. On February 17, 2003, Cyprus and Egypt signed the Agreement on the Delimitation of the Exclusive Economic Zone (EEZ). According to Article 1, paragraph 1, "the delimitation of the EEZ between the two Parties is effected by the median line of which every point is equidistant from the nearest point on the baseline of the two Parties."

2. A similar Agreement was signed on January 17, 2007 between Cyprus and Lebanon. In 2004, Cyprus enacted legislation for the proclamation of the EEZ extending not beyond 200 miles from the baselines from which the breadth of the territorial sea is measured, and contiguous zone, the outer limit of which should not extend beyond the 24 nautical miles from the same baselines.

3. On February 15th 2007, Cyprus opened a bidding process to license offshore gas and oil exploration. In January 2009, a US-Israeli company announced an 88 bcm natural gas find off the coast of Haifa, according to a Reuters[34] news article. This company holds exploration rights for an adjacent block belonging to Cyprus' Economic Exploitation Zone. Adjacency (distance between 2 countries is merely 250 km)[35] and geological indications suggest that there may be a link between these neighboring areas with respect to hydrocarbon deposits in this region. All said exploration fields are situated in the South, South-east and South-west of the Island, excluding thus any issue of EEZ settlement with Turkey, as shown in Figure 16. Despite this fact, Turkey has sharply pro-tested the move by Cyprus with Greece and the United States [...].

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33. Dr. Achilles Skordas, «Oil Exploitation in the Eastern Mediterranean: Cyprus, Turkey and International Law», Woodrow Wilson International Centre for Scholars 2007, http://www.wilsoncenter.org/index.cfm?fuseaction=events.event_summary&event_id=225758.
34. Michele Kambas, «Israeli Gas Find Raises Hopes in Cyprus», (Reuters) AFX News Limited, Thursday Jan. 22 2009.
35. It seems quite reasonable to use an already existing settlement of EEZ between Israel and Republic of Cyprus.

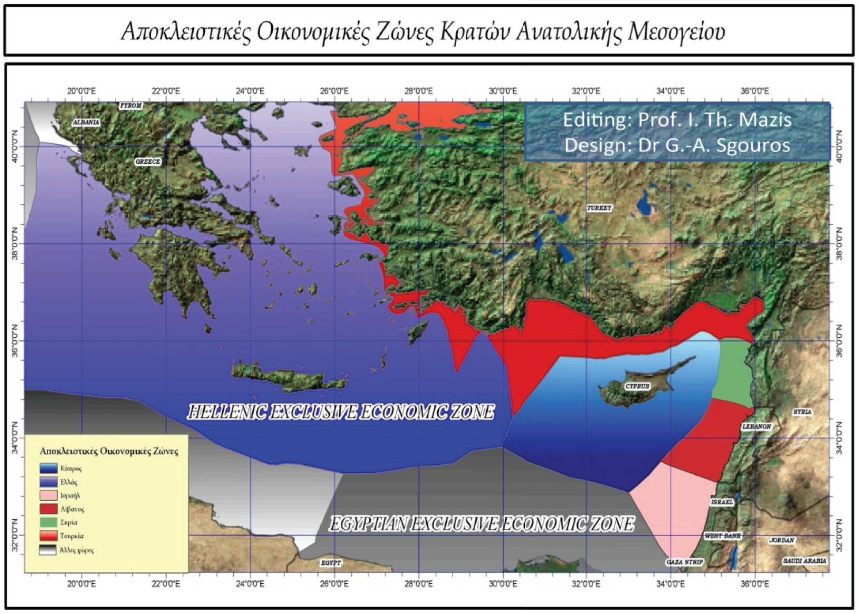

Fig. 16: Exclusive Economic Zones of Eastern Mediterranean countries (Based on the Flanders Marine Institute, Belgium Database and the Erosion GIS Database, Directorate General Environment European Commission)

4. In its statement of January 30, 2007, Turkey argued as follows:[36] "*... the TRNC (Turkish Republic of Northern Cyprus) also has rights and authority over the maritime areas around the Island of Cyprus. Moreover, Greek Cypriots do not represent the Island as a whole. Consequently, neither the legislation adopted nor the bilateral agreements concluded by the Greek Cypriot Authorities have any effect. In addition, it must also be kept in mind that Turkey has legitimate and legal rights and interests in the Eastern Mediterranean. Parts of the maritime areas that are subject of bilateral agreements intended to be concluded by the Greek Cypriot Authorities also concern Turkey's stated rights and interests. Turkey is determined to protect its rights and interests in*

36. Dr. Achilles Skordas, «Oil Exploitation in the Eastern Mediterranean: Cyprus, Turkey and International Law», Woodrow Wilson International Centre for Scholars 2007, http://www.wilsoncenter.org/index.cfm?fuseaction=events.event_summary&event_id=225758.

the Eastern Mediterranean and will not allow any attempt to undermine them. In this con-text, we would like to remind those countries and companies that might consider conducting research for oil and gas exploration, based on in-valid licenses Greek Cypriot Authorities may contemplate to issue for maritime areas around the Island of Cyprus, to take into account the sensitivity of the situation as well as the will of the Turkish Cypriots, the other constituent people of the Island".

5. In a further statement of February 15, 2007, Turkey refined its position: "*Accordingly, we expect the Greek Cypriot Authorities to end their calls for international tender which are not based on common understanding among the Eastern Mediterranean states, and thereby creating faits accomplis, violating the joint rights of the two peoples on the Island on is-sues like oil and natural gas exploration*".

It is obvious, A. Skordas continues, [that] the legal arguments of Turkey are not convincing, and there does not seem to be any real legal dispute between Turkey and Cyprus with respect to the latter's EEZ delimitation agreements, apart from potentially overlapping claims on some maritime areas between Turkey and Cyprus. Instead, Turkey attempts to exercise pressure on foreign companies and neighboring states to indirectly undermine the effective exploration and exploitation of the resources of the EEZ.

6. Through identical letters addressed to the United Nations (UN) Secretary General and to the President of the Security Council dated January 31, 2007 (A/61/726S/2007/52/2 February 2007), Cyprus responded by invoking its sovereign rights: "*Turkey has no right whatsoever to challenge the delimitation of the EEZ or the continental shelf between the Re-public of Cyprus and its neighboring States, in accordance with relevant provisions of international law and in areas that are neither opposite nor adjacent to Turkish coasts [...]. The Government of Cyprus has no doubts about the sovereignty of the Republic of Cyprus over the maritime areas surrounding the island and the natural resources therein and rejects any claim by the Government of the Republic of Turkey to the contrary.*"

The United States took a cautious approach, and avoided taking sides. On February 5, 2007, the spokesman of the State Department gave the following answer: "*US policy has not changed. Any dispute* *here is between the Republic of Cyprus [...] and Turkey. The United States is not a party to these agreements. The State Department has no recommendations as to whether American companies should participate in the bidding process. The controversy, however, points to the need for all parties to focus on restarting the UN's good offices mission to forge a comprehensive Cyprus settlement that reunifies the island into a bizonal, bicommunal federation. The next step should be to implement the agreement brokered by the Under-Secretary General Gambari on July 8, 2006. A final settlement will enable all Cypriots to benefit from the island's resources*".

Delimitation of EZZs[37]

Stability and viability of the EEZ delimitation agreements lies on the existing agreements between Cyprus, Egypt and Lebanon. There is no doubt that the two agreements have been concluded under international law; they become binding upon the parties by the completion of the ratification process. [...] None of them infringes upon Turkey's sovereign rights, according to the presented technical analysis. An important issue that may amend existing agreements is the future way to solve the Cyprus issue.[38]

37. Dr. Achilles Skordas, «Oil Exploitation in the Eastern Mediterranean: Cyprus, Turkey and International Law», Woodrow Wilson International Centre for Scholars 2007, http://www.wilsoncenter.org/index.cfm?fuseaction=events.event_summary&event_id=225758.
38. To facilitate the reader, Article 83 on the continental shelf is cited: "1.1. The delimitation of the continental shelf between States with opposite or adjacent coasts shall be effected by agreement on the basis of international law, as referred to in Article 38 of the Statute of the International Court of Justice, in order to achieve an equitable solution. 2. If no agreement can be reached within a reasonable period of time, the States concerned shall resort to the procedures provided for in Part XV. 3. Pending agreement as provided for in paragraph 1, the States concerned, in a spirit of understanding and cooperation, shall make every effort to enter into provisional arrangements of a practical nature and, during this transitional period, not to jeopardize or hamper the reaching of the final agreement. Such arrangements shall be without prejudice to the final delimitation. 4. Where there is an agreement in force between the States concerned, questions relating to

If a future state of affairs in Cyprus takes shape in any form of state succession, it might be asked, whether the successor entity could claim a fundamental revision of the treaties. [...] *The delimitation agreements concluded by Cyprus followed the median line, which corresponds to the principle of equidistance, as recognized by the law of the sea.*[39] This is an additional reason that practically precludes any future controversies on the agreed line".

Therefore, any further delay of Greece in delimiting its EEZ with Cyprus is deemed by Turkey as an indication of laxity on the part of Greece, the government of which has already "tacitly" agreed on some sort of new state formation that will not be covered by a Greece–Cyprus delimitation based on current data.

The Cyprus–Egypt agreement provides for review of the existing lies in two cases:[40] a) if more accurate data are available, thus giving the le-gal right to any part to ask for re–determination of the median line and b) the geographical coordinates [...] could be reviewed / extended as necessary in light of future delimitation of EEZ with other concerned neighboring states [...]".

This means that should existing lines infringe upon the continental shelf of third countries, the counterparts are obliged to proceed with relevant amendments.

It should also be added that, currently, there are natural gas deposits in the Levantine sea basin and particularly in Israel's EEZ, which the US–Israeli company Noble Energy has been contracted to drill. These are the following: (i) Tamar: 90 km off Haifa and at a depth of approximately 1680 m. Estimated re-serves: 142 bcm; (ii) Dalit: 13 km east of the Tamar deposit. Estimated reserves: 14 bcm; (iii) Leviathan.

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the delimitation of the continental shelf shall be determined in accordance with the provisions of that agreement". Article 74 is identical, differentiated however by the substitution of the term "Continental shelf" with the term "EEZ". When States are adjacent or facing each other, with a distance of less than 400 nautical miles, there is an overlap of sea limits. A useful reference covering major part of delimitation agreements until 1992 can be found in: International Maritime Boundaries by Charney and Alexander (1993), in two volumes, updated in 1996, and expanded with a third volume (1998).

39. Our emphasis.

40. http://goo.gl/sTe7Mc, http://goo.gl/3zPdta.

Moreover, it should be mentioned that hydrocarbon indications, such as pockmarks, gas chimneys etc., highlight the importance of the Levantine basin region with respect to other deposits as well.

It is therefore obvious that Israel's oil interests are being covered by the EEZ delimitation between Israel and Cyprus as implemented already by the government of the late Tassos Papadopoulos. The alignment of Israeli and Cypriot interests in the field of sub–sea hydrocarbons may act as a solid foundation for additional points of concurrence of political and economic interests, and partnerships on security. This is made even clearer in the light of two facts:

(i) the significant deterioration of the Turkish–Israeli relationships; and

(ii) the close ties developing between Turkey and Syria–Lebanon, via the occupied Cyprus territories, which act as transfer belts for projecting Turkey's neo–Ottoman power on Arabic–Muslim actors that are hostile to Israel and are located in the inflammable Levantine basin region. The latter becomes increasingly apparent by the coastal connection already established between occupied Cyprus areas and Tripoli of Lebanon, calling at Lattakia of Syria, inaugurated on August 25, 2009.[41]

In any case, the overall state of affairs provides the necessary and sufficient condition that may drive Greece into delimiting its own EEZ with Cyprus, thus ensuring to the west the existing favorable and legally binding balance in the Levantine Basin. That would be an act of utter diligence and optimum timing.

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41. "On Thursdays, a passenger carrier will bring 200 people with their vehicles from Tripoli, Lebanon, calling at Lattakia, Syria, to the port of [occupied] Famagusta. The return trip will be conducted on Mondays with a duration of 6 hours [see «Ankara implements connection agreements with Lebanon, Syria, Iran and Pakistan», *Amyntiki Epitheorisi* (Defence Review) 81 (9/2009), 10-11.

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