Paleogeographic reconstruction of the submerged prehistoric landscapes of the Farasan continental shelf, Saudi Arabia, South Red Sea: preliminary results

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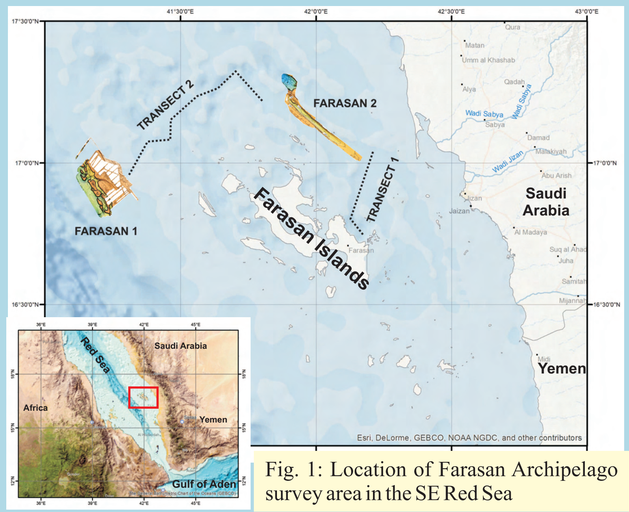

Fig. 1: Location of Farasan Archipelago survey area in the SE Red Sea

Background and Aims:

A joint archaeological and geoscientific exploration of the continental shelf of Farasan Islands, Saudi Arabia, South Red Sea **(Fig. 1)**, has been conducted in May–June 2013 aboard HCMR's Research Vessel AEGAEO with the aim of exploring systematically the submerged landscapes and targeting features of significance in relation to their archaeological potential. This project has been developed as an international and interdisciplinary collaboration arising directly out of the SPLASHCOS COST Action (www.splashcos.org) and within the ERC-funded project DISPERSE. The region is regarded as one of the primary pathways of dispersal for early human populations expanding out of Africa during the Pleistocene.

The main objectives of the project are (1) to reconstruct the broad outlines of the now-submerged landscape and identify specific locations that might have preserved archaeological evidence of past human settlement when sea level was lower than present, down to approximately the -120m bathymetric contour – the approximate position of sea level at its maximum regression 20,000 years ago and (2) to identify more localised features that might have been focal points for repeated human activity and the deposition and accumulation of archaeological materials such as stone tools and shell mounds, e.g. rockshelters, caves, undercut shorelines, flat areas close to stream channels and water sources, and elevated plateaus with good views over the surrounding terrain.

Fig. 2: The DISPERSE-Farasan cruise was conducted aboard HCMR's research vessel AEGAEO.

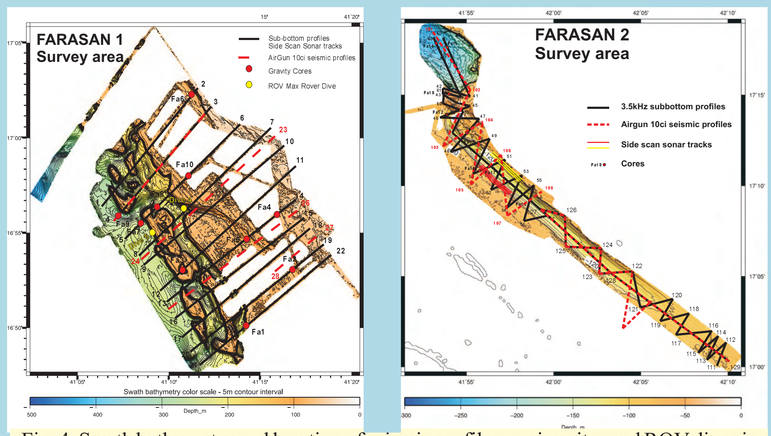

Fig. 4: Swath bathymetry and location of seismic profiles, coring sites and ROV dives in area 1(left) at the outer Farasan shelf and area 2 in the inner Farasan shelf.

Methods:

The marine survey conducted in the Farasan area aboard R/V AEGAEO **(Fig. 2)** comprised a wide variety of geological-geophysical techniques **(Fig. 3)**: (1) Multi-beam bathymetry by using two hull-mounted systems (20kHz and 180 kHz), (2) High-resolution sub-bottom profiling with a 3.5 kHz pinger, (3) Deep-towed, 110/410 kHz, digital side scan sonar imaging, (4) Deep penetrating seismic profiles were recorded with a 10 cubic inches airgun, (5) Gravity coring, 3–5m long, (6) Box coring, 40 x 40 x 60 cm, to take undisturbed seafloor samples, (7) A CTD device was used to obtain vertical profiles of the physical parameters of the seawater column and (8) A remotely operated vehicle (ROV) was used for seafloor visual inspection at sites identified from the bathymetric, acoustic and profiling data.

Two areas (FARASAN 1 and FARASAN 2) and two seismic transects (TRANSECT 1 and TRANSECT 2) were systematically surveyed **(Fig. 1 & 4)**. About 500 sq. km have been mapped with the multi-beam systems, 170 nautical miles of airgun seismic profiles, 250 nautical miles of 3.5kHz sub-bottom profiles and 140 nautical miles (260 km) of side-scan sonar lines have been acquired. 18 gravity cores and 2 box cores have been recovered and 5 dives of the Max RoverROV have been accomplished.

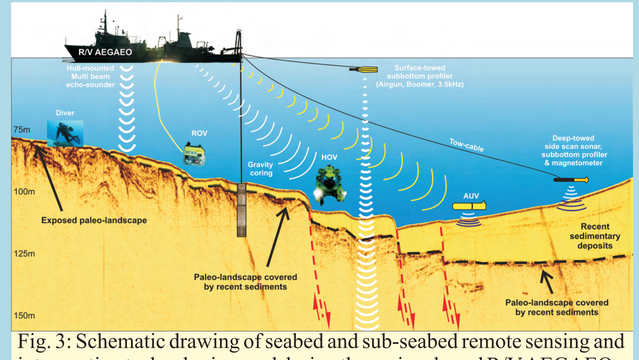

Fig. 3: Schematic drawing of seabed and sub-seabed remote sensing and intervention technologies used during the cruise aboard R/V AEGAEO.

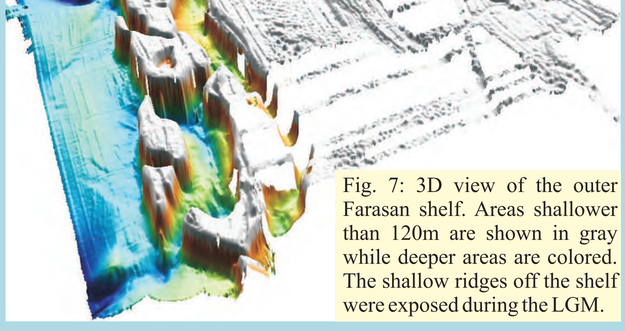

Fig. 5: Subbottom profile showing two prominent, seawards indlined terraces at 70–80m and 38–40m depth on the shelf. Shallow mounds on the shelf are coral reefs.

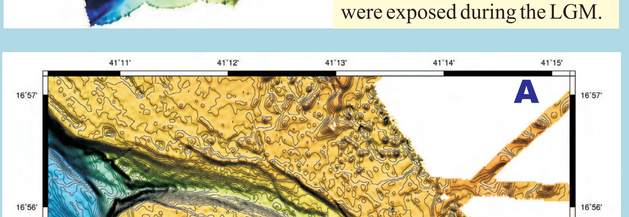

Fig. 6: Air Gun 10ci seismic profile across the edge of the outer shelf, Area 1. Note the prominent, 70-80m deep terrace on the shelf, which is displaced by NW-SE trending faults and the shallow ridges.

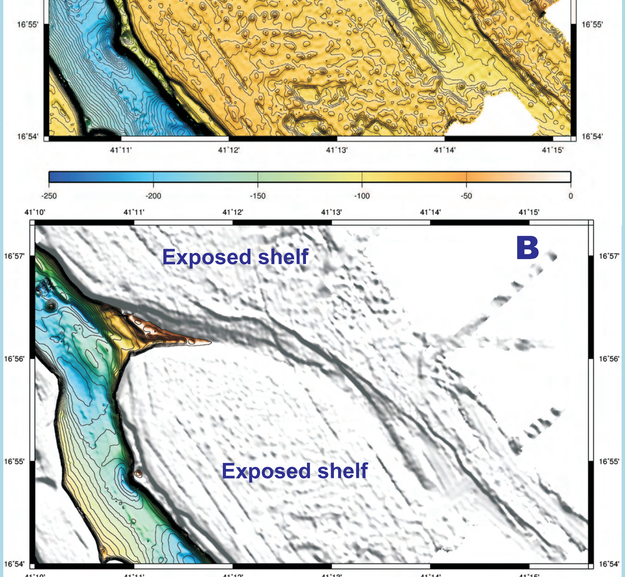

Fig. 7: 3D view of the outer Farasan shelf. Areas shallower than 120m are shown in gray while deeper areas are colored. The shallow ridges off the shelf were exposed during the LGM.

Fig. 8: A) High-resolution shaded bathymetry of the central part of area 1. B) the same area with exposed part (<120m depth) not colored.

Results:

Area 1, Outer Farasan Shelf

Preliminary interpretation of the acquired geophysical data in Area 1 indicate two prominent terraces at about 70–80m **(Fig. 5)** and 38–40m depth on the shelf and one more, locally preserved terrace at 120m depth on the slope. The outer edge of the continental shelf is controlled by normal faults trending NW-SE, parallel to the rifting axis of the Red Sea **(Fig. 6)**. Elongate ridges, running parallel to and off the shelf edge, are characterized by steep faulted slopes and flat, 80-90m shallow tops **(Fig. 7 & 8)**. They may were exposed above sea-level during Pleistocene low sea-level periods, forming thus a series of flat islands, the "prehistoric Farasan Archipelago", separated from the paleo-coastline by deep troughs. Holocene sediment deposition on the shelf is very limited. Sedimentological description of cores indicates lacustrine-type sedimentation below the Holocene marine drape in the isolated depressions on the 80m deep terrace.

Area 2, Inner Farasan Shelf

Area 2 comprises a 120m deep, elongate basin **(Fig. 4 right)** bounded by NW-SE trending normal faults **(Fig. 9)** and incised on the 70-75m shallow, prominent terrace of the inner shelf. One more morphological terrace has been mapped along the flanks of the basin at about 112m depth. Gravity coring in the basin penetrated the presumably Holocene, marine drape and recovered gypsum fragments from its substrate at about 2-2.5m below the seafloor. A narrow gorge on the seafloor, at the north-western tip of the valley-like basin **(Fig. 10)**, connects it with a >200m deep, circular depression which hosts a >250m thick sedimentary sequence **(Fig. 11)**. Preliminary laboratory analyses on sediment cores from the deep depression reveals lacustrine-type sedimentation below the 1-2m thick marine silt deposits **(Fig. 12)**. This observation indicates that the numerous deep and shallow depressions which have formed due to evaporite solution on the shelf and occur along NW-SE trending faults may were lakes during Pleistocene low sea-level stands **(Fig. 13)**. This type of landscape might have served both as attractor of human settlement and as location for the preservation of archaeological evidence.

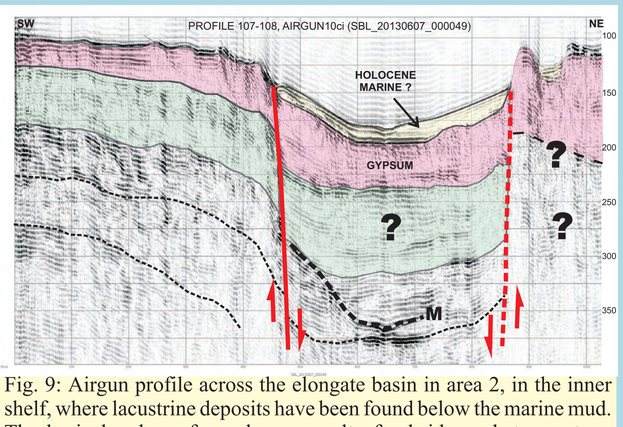

Fig. 9: Airgun profile across the elongate basin in area 2, in the inner shelf, where lacustrine deposits have been found below the marine mud. The basin has been formed as a result of subsidence between two, opposite, NW-SE trending faults

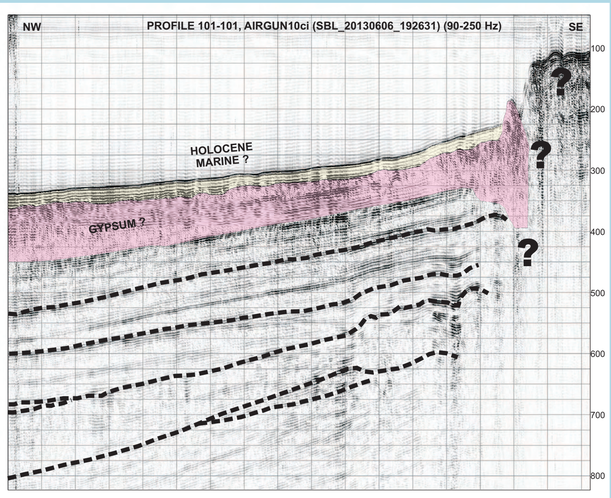

Fig. 11: Airgun profile across the deep depression in the northern part of area 2 in the inner shelf, which hosts a >250m thick sedimentary sequence , where lacustrine deposits have been found below the marine mud.

Conclusions:

This is one of the first attempts anywhere in the world to apply a suite of underwater techniques to the purposeful and systematic exploration of a submerged land surface across the whole depth range of the continental shelf exposed at maximum lowering of sea level. Our strategy of investigation, and the techniques we have used to implement it, have proved a successful starting point, and have clarified ways in which improvements in approach and the deployment of additional technologies can be applied in future work. It is clear that a landscape with interpretable features of geological structure, geomorphology, topography, and potential for human settlement lies now submerged on the extensive shelf region surrounding the Farasan Islands, and that this forms a promising basis for future investigations.

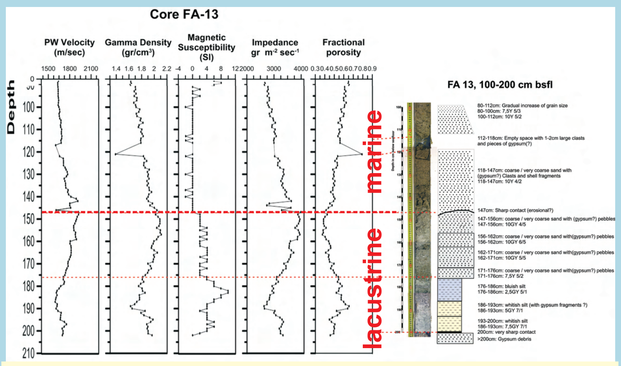

Fig. 12: Sedimentological description and down-core multi-logger measurements of sediments' physical properties. The abrupt change in sediment color and properties at 147cm below seafloor marks the transition between the lacustrine and marine sedimentation.

Acknowledgements

We thank the Saudi Commission for Tourism and Antiquities (SCTA) for permission to undertake fieldwork, and the President, HRH Prince Sultan bin Salman bin AbdulAziz al Saud, the Vice-President, Professor Ali Al-Ghassan, and the Director General, Jamal al Omar, for their continued support of our research. We also thank HRH Crown Prince Salman bin Abul Aziz Al Saud and the Department of General Survey of the Ministry of Defense for permission to undertake the cruise of R/V AEGAEO. We also thank Lt Fahad Al Shwish for his support and valuable assistance, and Captain Theodoros Kanakaris and the crew of R/V AEGAEO for their untiring efforts during the offshore survey work. The research is funded by the European Research Council through Advanced Grant 269586 DISPERSE under the 'Ideas' Specific Programme of the Seventh Framework Programme.

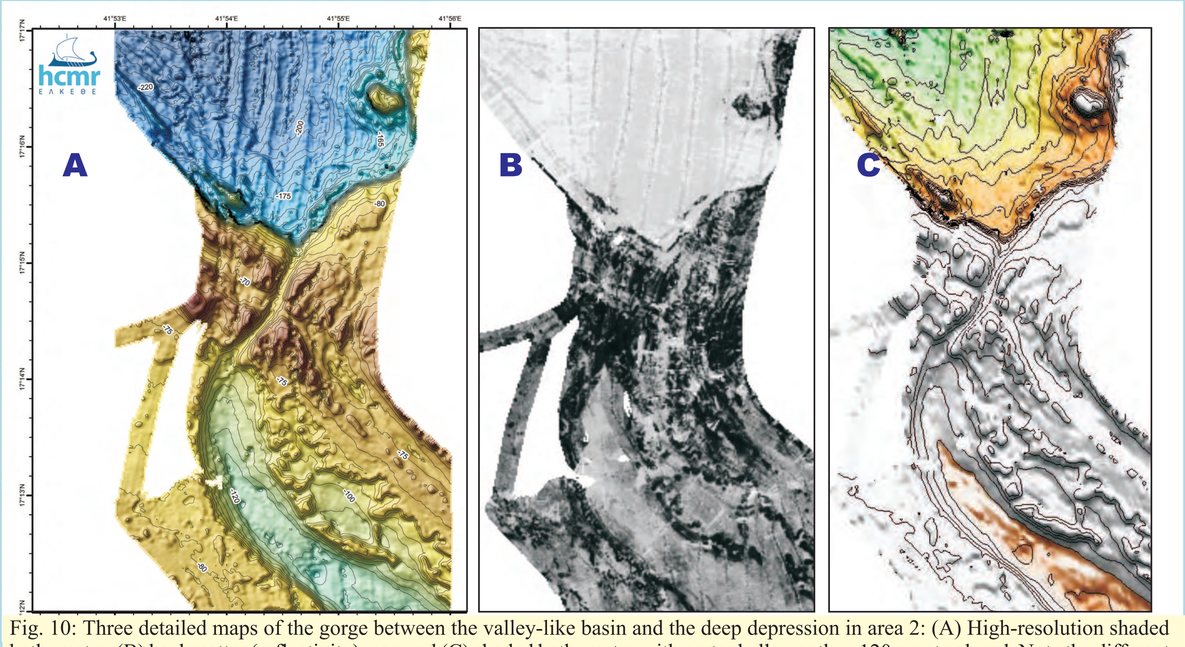

Fig. 10: Three detailed maps of the gorge between the valley-like basin and the deep depression in area 2: (A) High-resolution shaded bathymetry, (B) backscatter (reflectivity) map and (C) shaded bathymetry with parts shallower than 120m not colored. Note the different reflectivity patterns (B) which coincide with the submarine topography and indicate the differences in deposition character. The gorge was exposed above the sea-level during the Last Glacial Maximum while the two depressions at both ends were filled with water (C).This morphological configurationd may have served to the prehistoric humans as a suitable site for hunting.

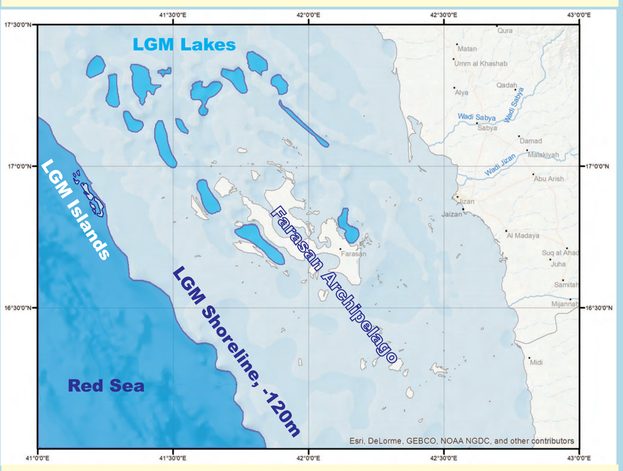

Fig. 13: GEBCO bathymetry of Farasan area with the assumed Last Glacial Maximum shoreline at -120m. Note the emerged islands at short distance off the paleoshoreline and the lakes on the inner part of the shelf.