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1. Aims and cruise objectives

The Farasan Islands cruise of the research vessel R/V AEGAEO (HCMR) is the first stage in a sub-project of DISPERSE (Work Package 3), concerned with offshore and underwater investigation of the submerged landscapes in the southern Red Sea. The Farasan Islands cruise is a joint mission with the Hellenic Centre for Marine Research (HCMR), Greece. The cruise took place between 29th May and 13th June, with a research team of 22 personnel from the HCMR, the University of York, King Saud University, King Abdul Aziz University and the Saudi Geological Survey, 20 of whom took part in the on-board activities (Appendix 1; Figure 1). This is a Cruise Report on the survey works accomplished and the achievements during the 2-week marine survey. The cruise took place between 29th May and 13th June.

DISPERSE – Dynamic Landscapes, Coastal Environments and Human Dispersals – is a 5-year (2011–2016) Advanced Grant (Agreement No. 269586), funded by the European Research Council under the ‘Ideas’ specific programme of the EU Seventh Framework Programme, with Prof. Geoff Bailey (University of York) as Principal Investigator, Prof. Geoffrey King (Institut de Physique du Globe de Paris) as co-Investigator, a small team of postgraduate and postdoctoral researchers funded by the project, and a wider team of participating international specialists, including Saudis, in archaeology, geochronology, geology, geophysics, tectonic geomorphology and palaeoclimatology. The project is concerned with a wide range of research including fieldwork in East Africa, Saudi Arabia and the Eastern Mediterranean. The Saudi Arabian work is a joint Saudi-UK project co-directed
by Prof. Geoff Bailey (University of York), and Prof. Abdullah Alsharekh (King Saud University), in partnership with the Saudi Commission for Tourism and Antiquities.

The general aims were as follows:

- Undertake a preliminary underwater survey of selected areas of the offshore continental shelf in the Farasan-Gizan region
- 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.

These aims were realised through the following specific objectives and activities:

- Reconstruct specific features of the submerged landscape as it would have existed when sea levels were lower than the present, focusing on geological structure, geomorphology and topographic features such as hill and valley systems, drainage basins palaeoshorelines, stream channels, lake basins, spring lines, sediment-filled valleys, cliff lines, caves, and rockshelters, of potential significance for understanding the prehistoric landscape and its potential for human occupation
- 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 plateaux with good views over the surrounding terrain
- Select particular localities that might be rewarding for more detailed examination by diver investigation at a later phase of the DISPERSE project.
- Take measurements, sediment cores, and dating samples to provide data on the palaeoenvironment and new benchmarks for reconstructing a more detailed sea-level curve.

2. **Target areas and locations**

For the Farasan survey, we have selected general target areas so as to sample a number of different types of geological and environmental features on the seabed. Areas of particular interest are the shorelines that would have been formed at different sea-level stands during the glacial cycle, major valley systems and drainage channels, areas of topographic complexity that might have trapped sediment and water and provided ecological diversity and tactical advantage for prehistoric hunters and gatherers, and deep solution hollows resulting from the solution of salt deposits (evaporites), which would have formed potential traps for sediment and freshwater when exposed on the pre-inundation land surface. In the light of survey in these areas, we aim to identify more localised features for more detailed inspection.

Initial strategy included the target areas shown as black boxes on the hydrographic chart of Figure 2. This map was submitted along with the application form for a permit from the Hydrographic Service of the Saudi Ministry of Defense.
Figure 2: Preliminary target areas (Blocks 1 to 6) within the bigger box A-B-C-D included in the application form for a permit from the Hydrographic Service of the Saudi Ministry of Defense. Chart annotated by D. Sakellariou.

With such a large potential area to cover, the DISPERSE team has studied the existing bathymetry available from satellite and chart data in York and Paris, particularly SRTM30PLUS data and standard navigational charts, to produce preliminary maps of the shelf area, and to define more specific target areas within the general area covered by our permit from the Ministry of Defense. These target areas have been defined in the light of what would be feasible within the constraints of our available time and resources (Figure 3). We have also used our knowledge of archaeological site locations on the mainland and on the Farasan Islands discovered in our previous fieldwork campaigns, on the assumption that these should provide a good analogy in the search for archaeological material on the submerged landscape.

**Target Area 1**: Outer edge of shelf, expected to have relatively limited cover of later marine sediments over the original terrestrial land surface. Possibility of identifying the shoreline formed at the Last Glacial Maximum (at c. –120 m and 20,000 BP), of finding spring lines – often located at the foot of low cliffs and fault scarps – and of finding sediment-filled basins that show the transition from marine to terrestrial sediments in the early stages of sea-level rise.

**Target Area 2**: An area with a major valley system and complex topography that appears to drain into a deep solution hollow. This could have been a freshwater trap at lowered sea level, and may contain a sediment sequence showing the transition from marine to terrestrial/lacustrine conditions with changing sea levels.

**Target Area 3**: An area of complex topography close to the present-day Farasan Islands with a deep solution hollow.
**Target Area 4:** Similar to Target Area 4.

**Target Area 5:** An area showing the confluence of different drainage systems draining water and sediment from the Gizan mainland, and also an area of interest in defining the history of land connections between the mainland the Farasan Islands.

**Target Area 6:** An area of complex topography and deep solution hollows between the outer shelf and the Farasan Islands, with palaeoshorelines potentially protected from exposure to the open sea. This is also an area that was examined by deep-diving in 2006.

Within these general target areas, our objective is to obtain an overview of topography and geomorphology and to identify and examine local features, as described above.

**Figure 3:** General overview of shelf bathymetry in the Farasan region, showing Target Areas for more detailed survey. Note the large number of very deep basins on the shelf area, presumably representing solution of evaporites. When sea level was low, these would have represented deep and steep-sided basins in the terrestrial landscape, with the potential to accumulate freshwater and bottom sediments with a palaeoenvironmental record of terrestrial or lacustrine conditions. When sea level rose, the sea would have entered these basins, leading to the accumulation of marine sediments stratified above earlier material, providing the possibility of dated sea-level index points for sea-level rise. Base map prepared by Maud Devès, IPGP.
3. Methodology and survey techniques

In the search for prehistoric archaeological sites on land, we know that three factors need to be taken into account: (1) the distribution of areas within a broader region that are especially attractive to the concentration of human population because of their general ecological and physiographic characteristics; (2) specific locations that are likely to act as a focus for repeated human activity and the deposition of artefacts and food remains such as shells because of highly localised features such as shelter, water supplies, raw materials for making stone artefacts, and concentrations or localised patches of food resources; (3) locations where archaeological material has been well preserved but is also sufficiently visible to be identified.

Similar principles apply to the search for underwater sites. The main differences are that it is much more difficult and costly to traverse and inspect at close quarters large areas of the seabed compared to survey on land, and that archaeological material is likely to be more vulnerable to destruction or dispersal during the course of inundation by surf action and vigorous marine currents in shallow water, or to burial by a thick overburden of marine sediments after inundation.

Nevertheless, we know from the successful survival and discovery of many hundreds of underwater prehistoric archaeological sites in other parts of the world that underwater material can survive inundation during sea level rise, either because its location is protected from the full force of wave action during inundation by local topographic conditions, because of partial burial in sediments that accumulate during the course of sea-level rise, or because of shallow gradients that moderate the destructive effects of wave action (Masters and Flemming, 1983; Flemming, 1998; Bailey and Flemming, 2008; Evans et al. in prep; Flemming et al., in prep; Fischer et al., in prep).

Of course, factors of differential preservation and visibility apply almost as much, if not equally so, to site survey on dry land, requiring the development of predictive models and careful sampling strategies. Under water, these requirements apply with even more force. As on land, so in underwater survey it is essential – alongside the application of judgemental searches and opportunistic hunches – to develop a systematic methodology of exploration, which can be applied in a staged manner from the general examination of regional characteristics to the localized search for individual sites, and a systematic record of the results, including a photographic record, details of survey methods, transects, locations and time spent in exploration, and curation of a digital archive, so that the survey results can be evaluated independently by others, and serve as a foundation for future work (see Devès et al., in press).

The marine survey conducted in the Farasan area aboard R/V AEGAEAO comprised a wide variety of geological-geophysical techniques (Figure 4):

1. Swath bathymetry (multi-beam) mapping was performed by using two hull-mounted multi-beam systems (20kHz and 180 kHz) operating simultaneously.
2. High-resolution sub-bottom profiles were acquired with a 3.5 kHz pinger to obtain precise images of the structure and stratigraphy at shallow depths (<20m) below the seafloor.
3. Mapping of the acoustic character of the seafloor was implemented by using a deep-towed, 110/410 kHz, digital side scan sonar. Acoustic images (sonographs) of the seafloor helped to better understand the various structures exposed on or developed on the seafloor.
4. Deep penetrating seismic profiles were recorded with a 10 cubic inches airgun. Penetration of the profiles reached locally >500–800m below the seafloor and provided insight into the geological and tectonic structure of the surveyed area.

5. Gravity cores, 3–5m long, were used for coring and sampling the subseafloor sedimentary layers.

6. A box core, 40 x 40 x 60 cm, was used to take undisturbed samples of the topmost seafloor sediments.

7. A CTD device was used to obtain vertical profiles of the physical parameters of the seawater column (sound velocity, temperature, salinity, density, conductivity). The sound velocity profile was entered into the swath bathymetry software to calculate precisely the water depth.

8. A remotely operated vehicle (ROV) was used for underwater missions at sites identified from the bathymetric, acoustic and profiling data, aimed at inspecting visually seafloor structures of palaeo-morphological or archaeological interest.

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Figure 4: Schematic presentation of the marine geological-geophysical techniques applied during the Farasan research cruise aboard R/V AEGAEO.

Our survey strategy during the Farasan cruise followed the methodology below:

Within each target area the general approach adopted was to conduct swath bathymetry at 9 knots cruising speed in contiguous and slightly overlapping transects, in order to produce a continuous digital elevation model (DEM) for all or selected parts of the target area. This gave an immediate overview of the general topography of the seafloor (Figure 5).

Transect lines were then identified for the deployment of the sub-bottom profiler, to obtain high-resolution profiles of the stratigraphy and the sedimentological and geological structure of the shallow substrate of the seafloor and to locate sediment-filled depressions suitable for coring (Figure 6).

The side-scan sonar was deployed simultaneously with the sub-bottom profiler to provide more detailed 3-D information on topographic features and the acoustic character and nature of the seafloor in a narrow corridor either side of the transect line (Figure 6).
Air-gun seismic survey was also conducted, in order to provide deeper penetrating seismic profiles of the geological structure, showing features such as faulting and layering that can help to identify the nature of the bedrock and structural and geomorphological alterations caused by tectonic activity or other processes (Figure 4).

Shorter transects were run over areas of particular interest in order to narrow down the search for local features of particular potential significance, where ROV inspection could provide additional information including collection of seabed samples.

Sub-bottom profiling, side scan sonar prospecting and airgun seismic profiling were performed at 4 knots cruising speed.

The scheduling of work and the choice of areas for running continuous transects was also determined by the need to choose areas for night-time work that avoided hazards best dealt with during daylight hours, such as variable and shallow bathymetry, and local fishermen and their nets. Coring was also best done early in the morning or late in the evening when temperatures were cooler.

Coring sites were identified on the high resolution sub-bottom profiles. The selection of precisely located coring sites served the need for understanding the nature of the seafloor sediments and aimed at reaching the oldest possible layers below the recent Holocene marine drape (Figure 3).

4. Research equipment
4.1 Research Vessel “AEGAEO”

The cruise was conducted aboard the HCMR owned research vessel “AEGAEO” (Chalkis 19 Ship Registry). R/V AEGAEO was built in 1985 at the Chalkis shipyard and started her scientific operations in the Eastern Mediterranean. In 1987 the scientific expeditions extended to the western Mediterranean Sea. It was refitted in 1997 and comprises a completely modernized floating laboratory, equipped with state of the art technology, able to support HCMR’s multidisciplinary research projects and operations. R/V AEGAEO is the
mother ship for the submersible THETIS and the ROVs (Remotely Operated Vehicles) Max Rover and Super Achilles (Figures 7 and 8).

R/V AEGAEO is a dedicated research vessel equipped for underwater research in all aspects of marine science including oceanography, marine biology, geology and underwater archaeology. The ship is 62m long and 173 tonnes weight, with a crew of 21, on-board scientific laboratories, and accommodation for up to 21 scientific personnel. It is equipped for this cruise with remote sensing and coring equipment including hull-mounted multi-beam (for swath bathymetry), a tow-fish with side-scan sonar, a sub-bottom profiler, an air gun for deep-penetrating seismics, a gravity corer for sediment sampling, the Max Rover ROV equipped with lights and cameras, and GPS recording equipment. Normal cruising speed is 9 nautical miles per hour (9 knots) when conducting swath bathymetry, and 4 nautical miles per hour (4 knots) when conducting higher resolution measurements using side-scan sonar and sub-bottom profiling. Underwater measurements are continuously recorded, and converted into digital maps and images that are displayed on computer monitors in real time. The ship is organised to operate continuously 24 hours per day, with shift working by the crew and by the scientific team, to ensure continuous measurement and monitoring of equipment, and maximum coverage, with stoppages only to deploy and retrieve underwater equipment and to undertake sediment coring.

### Detailed Specifications

<table>
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<tr>
<th>Name</th>
<th>AEGAEO</th>
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<tbody>
<tr>
<td>Built</td>
<td>1985</td>
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<tr>
<td>Classification Society</td>
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<tr>
<td>Consumption</td>
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Cruise speed: 12 knots
Autonomy: 20 days
Main Engines: 2 x 950 BHP MAN B&W 20/27 VO
Bow Thrusters: Schottel ski-87 unit, 2 knots/hr
Propellers: 2 x twin V.P.P.
Generators: 2 x MAN 331 Kw/370 KVA (296 Kw) 450 BHP
Emergency generator: 1 x MAN DO2006ME 46 Kw / 62.5 BHP / 45 KVA - 36 Kw

Navigation Equipment
Autopilot: 1 A/P NECO 728, D-GPS TRIMPLE, GPS NORTH STAR 941X, gyrocompass SPERRY, 1 magnetic compass SH-165-A, 1 Furuno 96 mil. and 1 RACAL DECCA 96 mil. radar, electronic chart system TELECHART 2026, echo sounders OCEAN DATA BATHY 1000 & FURUNO FE824ET, log Doppler SIMRAD NL, INMARSAT-C, NAVTEX NMR 108.

4.2 Swath Bathymetry – Multi-Beam
Multi-beam or swath bathymetry sonars transmit a broad acoustic pulse from specially designed transducers across the full swath across the track. The swath width is determined by the depth of the seafloor being surveyed. The ping is emitted in a fan shape outward from the transmitter. If the speed of sound in the water column is known, the depth and position of the return signal can be determined from the receive angle and the two-way travel time. In order to determine the transmit and receive angle of each beam, a multi-beam echosounder requires accurate measurement of the motion of the sonar (heave, pitch, roll, yaw, heading).

The sound frequencies used in multi-beam usually range from 12 to 500 kHz. A higher frequency device provides better resolution and accuracy than a lower frequency one for a certain water depth. Multi-beam sonars can provide highly accurate charts of the bottom bathymetry. The accuracy will depend not only on the frequency but also on the precision of the position of the transducer and the precision of the sound speed. In general the latest multi-beam sonars have a horizontal resolution in the decimeter range, in some cases even up to the centimeter-range in shallow water depths.

R/V AEGAEAO is equipped with two, hull-mounted, multi beam systems: 1) SeaBeam 2120, 20kHz and 2) Seabeam 1180, 180kHz. Both systems have been used for the acquisition of swath bathymetry data during the Farasan cruise.

SeaBeam 2120 is a multi-beam system for complete swath bathymetry survey in deep and shallow water depths. It is based on a cross-fan beam-forming technique employing Mills Cross-type T-shaped arrays (transmitter and receiver arrays) and electronically steering sound beams in a fan-shaped plane. The transmitter array (Figure 9) is mounted along the vessel’s hull, and transmits echo signals (pings) in the form of downward fanning beams (swath). The receiver array (hydrophones, Figure 10) is mounted perpendicular to the transmitter array projectors, and therefore receives multiple reflections representing seafloor pixels which are aligned parallel to the ship-track (along track) and narrow ones perpendicular to it (across-track). Thus, each received beam comprises only echo signals lying within that area where transmit and receive beams intersect (Figure 11). Taking all receive beams together, a complete cross-section of the bottom, perpendicular to the direction of the vessel travel (across-track), is measured on each ping cycle. Ping cycles, bottom depth and other information related to the returned signals are displayed on an operator control station (OCS), whilst real-time viewing of the sea floor characteristics is accomplished.
The array elements have short pigtail cables with wet mateable connectors, which interface through the hull to the dry side. System electronics are contained within a single cabinet (Figure 12).

Figure 9: The transmitter (projector) of the SeaBeam 2120 multi-beam system.

Figure 10: Hydrophone of the SeaBeam 2120 multi-beam system.

Figure 11: Cross-fan beam-forming technique.

Figure 12: SeaBeam 2120 system electronics cabinet.

The SeaBeam 2120 system is supported by the L3 ELAC NAUTIK, located at Kiel, Germany, and its technical characteristics are referred to below:

- Operating frequency of 20 kHz.
- Optimum performance within 100-5500 m.
- 149 beams (maximum), beam width 2 degrees or less. The transmitter array comprises fourteen transmitters and the receiver array eight 8-element hydrophones.
- Maximum swath width of 148 degrees. The swath coverage may range from ~750 to ~6500 m (depending on the water depth).
- Measured depth error lies within 0.5% of the actual water depth.
- Horizontal position error lies within ±5 m depending on the accuracy of the GPS.
- Optimum vessel speed during acquisition is 4 to 6 knots.
- The system fulfils the standards for hydrographic surveys of the International Hydrographic Organization (IHO).
The 180 kHz **SeaBeam1180 multi-beam system** (L3 ELAC Nautic) has been designed for operation at water depths down to 500 m and transmits 126 beams arrayed over a maximum arc of 153°. The acoustic signal is transmitted and, subsequently, received by two transducers, hull mounted and fixed symmetrically at 52° from the vertical axis perpendicular to the ship’s length. The spacing between soundings (beam footprint) is a function of received beam width, water depth and beam incidence angle, resulting in beam dimensions of 1.2° x 1.2°. The swath coverage may range from ~600 to ~1000 m, depending on the water depth (Figure 13). A TSS/DMS (Teledyne) motion sensor is used to compensate for the vessel’s motion (i.e., roll, pitch and heave) during transmit and receive cycles with an accuracy of ~0.05° for the roll and pitch and ~5 cm for the heave. Finally, the measured depth error lies within 0.5% of the actual water depth.

**Figure 13:** Drawing of the relationship between water depth and swath width for the SeaBeam 1180 multi beam system.

Acquisition of swath bathymetry data requires accurate sound-velocity profiles of the water-column. For that, a CTD system (Sea Bird E-9 with dissolved oxygen probe and Sea-Tech transmission-meter) (Figure 14) has been used during the cruise and multiple sound-velocity profiles have been measured at different stations and on different time-points.

4.3 High-Resolution Sub-bottom Profiler

The conventional echosounders (also called ‘pingers’) are single frequency sub-bottom profilers. They employ a signal with a narrow bandwidth (= a narrow ’peak’) normally within the range 3–10 kHz (Figure 15).

Vertical resolution achieved by high-resolution sub-bottom profilers ranges typically between 20 to 50 cm, while the maximum penetration rarely exceeds 30 to 50 m in soft, fine-grained sediments and is significantly lower in coarse-grained sediments. The fact that the transducer is also used as a receiver allows for a higher precision in the horizontal positioning of features observed than if the reflected signal was picked up by a separate hydrophone array located some distance away from the source.

**Figure 14:** Sea Bird E-9 CTD system used during the Farasan cruise for measuring the sound-velocity profile of the water-column.
High-resolution sub-bottom profiles have been obtained during the Farasan cruise utilizing a 3.5kHz sub-bottom profiler of GEOACoustics LTD (U.K.) with a 4 transducer towing vehicle (fish) (Figures 16 and 17). The expected maximum sub bottom penetration is about 15–20m in a muddy bottom with a vertical resolution of 0.2–0.8m.

Figure 15: Diagram of the amplitude versus frequency of the signal emitted by the 3kHz pingers during sub-bottom profiling.

Figure 16: Deployment of the 3.5kHz sub-bottom profiler tow fish over the left side of R/V AEGAEo during the Farasan cruise.

Figure 17: Receiver and transmitter (GeoAcoustics Ltd. GB) devices used as deck units for controlling the 3.5kHz acoustic signal.

Figure 18: Side scan sonar tow-fish and tow-cable winch on the working deck of R/V AEGAEo during the Farasan cruise.

4.4 Side-Scan Sonar

Side-scan sonars emit conical or fan-shaped pulses across a wide angle perpendicular to the path of their towed sensors ('towfish'). The received signals create a detailed image of the reflectivity of the sea floor ("sonograph") and its anomalies within the swath (coverage width) of the beam. The reflectivity of the seafloor depends on its roughness and the nature of the topmost material: coarse-grain sediments display higher reflectivity than fine-grain deposits, rocky outcrops reflect higher than sediments, etc.

Side-scan sonars are very useful for mapping archaeological features that are visible on or above the bottom (wrecks, exposed pole and rock structures, etc.) They are unable to penetrate the sediments and can therefore only provide information about the exposed
surface of the sea floor. Normally frequencies between 100 and 1000 kHz are used. Higher frequencies yield better across-track resolution (perpendicular to the direction of movement) but involve a narrower swath. Depending on the frequency of the emitting signal, a resolution of up to a few centimetres can be achieved. Along-track resolution (parallel to the direction of movement) depends on the cruising speed and the triggering rate of the emitted signal. Slow cruising speed and high triggering rates enable higher resolution along track.

Side-scan sonar survey of the seafloor in the Farasan area has been conducted using a 110–410 kHz digital side-scan sonar (Geoacoustics Ltd, U.K.) with towing coaxial cable of 2,000m (Figure 18). The dual frequency operation provides high-resolution imaging (when scanning in 410 kHz). The side-scan sonar system consists of the tow fish, the electro-hydraulic winch with the tow-cable, and the deck unit, which hosts the data acquisition and image processing unit. Side-scan sonar data were digitally acquired by using the SonarWiz Map software of Chesapeake Technology Inc. (Canada). Real time and post-acquisition raw-data mosaics were produced and used during the cruise to better understand the nature of the seafloor and locate sites for visual inspection with the remotely operated vehicle (Figure 19).

Figure 19: Acquisition of side-scan sonar data using the SonarWiz Map software.

4.5 Seismic Profiling
Seismic profiling during the Farasan cruise was conducted with the use of an Air Gun (Bolt, USA) seismic profiling system (Figure 20). An air chamber of 10 in³ volume and air pressure of 2000 psi was used. A Sauer Compressor Type WP4351 (J.P. SAUER & SOHN, DE) was used for the supply of compressed air to the airgun chamber.

This configuration produces a sound signal with a frequency between 40–250 Hz and provides penetration of up to 1 second two-way travel-time (>750m) in sedimentary deposits.
The reflected signal was received by a SIG (FR), Model 16.48.65 streamer, of 65m active length, and 48 hydrophones (1m spacing). The SBLogger seismic acquisition software (Triton Imaging, USA) was used for the acquisition of the seismic data and the SBInterpreter software was used for post-processing the seismic profiles (Figure 21).

Figure 20: Deployment of Air Gun tow fish from the stern of R/V AEGAEO

Figure 21: Real-time seismic acquisition using the SBLogger seismic acquisition software (Triton Imaging, USA) during the Farasan Cruise.

4.6 Gravity / Box Coring
Gravity coring was carried out with a BENTHOS-type gravity corer with core barrels 3 to 5m long (Figure 22). Box coring was carried out with a box corer with a 40x40x60cm box (Figure 23).

4.7 Remotely Operated Vehicle (ROV) Max Rover
The remotely operated vehicle (ROV) Max Rover was used during the cruise for the visual identification of selected side-scan targets. Max Rover was purchased in 1999 and upgraded in 2011. It is rated for 2000m depth, and is a working class ROV (Figures 24 and 25).

Detailed Specifications
**Constructor:** Deep Sea Systems International Inc. (USA)
Type: Max Rover Mark II
Maximum depth: 2000 m
Weight: 850 kg  Length: 2.2 m.  Width: 0.90 m  Height: 2.2 m
Payload: 50 kg
Flotation: syntactic foam floatation
Power: ROV 14kW, 220V
Hydraulic winch: 380 V, 25 hp, slip ring assembly, dimensions 2 X 2 X 2 m., 4.5 tonnes.
Tow cable: fibre optics cable 2200 m.
Motos: 6 electrical motors X 2.0 hp, internal, brushless, DC
Speed: 1.0 knot (horizontal), 1.5 knots (vertical)
Lifting capacity: 160 kg.
Autopiloting: direction, depth, height above seafloor
Positioning: Trackpoint II USBL,- LinkQuest-Tracklink 10.000m Positioning system & georeferencing through Hypack Max software
Sonars: Tritech Dual Frequency Scanning Sonar (675/1200 kHz) & Tritech Side-Scan Sonar (910 kHz)
Cameras: 3 Color CCD video cameras (wide angle, pan & tilt, macro-zoom pan & tilt), 2 full HD video cameras, digital Still Camera (3.2 Mpixel, 1Gb) with 4 πράσινα lasers.
Scaling: two red Laser beams 10 cm apart.
Lights: 4 X 100 W HID lights και 4 X 150 W Quartz lights
Arms: two electro-hydraulic arms Hydrolek of 5 degrees of freedom
Mother ship: R/V AEGAEKO

Figure 22: Gravity corer deployed through the A-frame at the stern of R/V AEGAEKO in the Farasan area.

Figure 23: Box corer deployed through the A-frame at the stern of R/V AEGAEKO in the Farasan area.
5. **Cruise achievements**

R/V Aegaeo sailed from Jeddah early in the morning of Thursday, May 30th and arrived in the Farasan area in the morning of Friday, June 1st. Research work lasted till the evening of Monday, June 10th. During the 12 days of survey, two main areas (FARASAN 1 and FARASAN 2) were systematically surveyed with all the techniques described above (Figure 26).
In addition, two seismic transects (TRANSECT 1 and TRANSECT 2) were conducted with the use of Airgun and multi-beam. In total, about 450–500 square kilometers of the seafloor have been mapped with the multi-beam systems. A total length of 170 nautical miles (315 km) of airgun seismic profiles has been acquired in areas FARASAN 1 and FARASAN 2 and along TRANSECT1 and TRANSECT 2. A total length of 250 nautical miles (460 km) of 3.5kHz sub-bottom profiles has been acquired in areas FARASAN 1 and FARASAN 2, and a total length of 140 nautical miles (260 km) of side-scan sonar tracks at 200m and 100m swath in both areas. We have also recovered 18 gravity cores and 2 box cores from areas FARASAN 1 and FARASAN 2. Finally, 5 dives of the remotely operated vehicle Max Rover took place with a total duration of 10 hours and 25 minutes.

Preliminary results of the cruise are presented in brief here. Final conclusions and results are expected in the next months, after thorough processing of the acoustic and geophysical data obtained and interpretation of the acoustic and seismic profiles as well as after the completion of laboratory analyses and dating of the sediment cores.

5.1 Survey area FARASAN 1
FARASAN 1 survey area is located on the outer edge of the continental shelf, northwest of the Farasan Islands (Figure 27). The objectives of the survey included the following:

1. Understanding the role of tectonics in the shaping of the general geological structure of the outer continental shelf and therefore in the development of the submerged prehistoric landscape.
2. Mapping submerged terraces as indicators of paleo-sealevels during previous periods in the Pleistocene
3. Mapping recent sedimentary deposits covering the submerged landscape
4. Investigating the seafloor to locate landscape features suitable for prehistoric habitation
5. Sampling of sedimentary deposits for paleo-oceanographic analyses.
6. Visual inspection of the seafloor for paleo-sealevel indicators and possible traces of prehistoric human and animal presence.

Characteristic examples of high-resolution sub-bottom profiles and airgun seismic profiles are shown in Figures 28 and 29 respectively. Ten cores have been recovered from the
FARASAN 1 area. Figure 30 shows a typical side-scan sonar image of coral reefs developed on the 80m terrace, and Figure 31 a detail of the deep shelf photographed by the ROV.

Figure 28: 3.5kHz sub-bottom profile in survey area FARASAN 1 with locations of coring sites. Note that coring sites have been defined on the sub-bottom profiles and served the need to core and sample the recent, Holocene marine sedimentary drape and reach its pre-Holocene substrate below.

Figure 29: Air Gun 10ci seismic profile in survey area FARASAN 1. Note prominent, SW-facing normal faults and antithetic NE-facing normal faults, compatible with the rifting process of the Red Sea.

Figure 30: Real-time side-scan sonar image showing coral reef formations on the 80m deep platform.

Figure 31: Video snapshot taken during the 5th dive of ROV Max Rover at 200m depth on the outer SW-facing slope of the continental shelf.
Preliminary interpretation of the collected data shows the presence of two prominent terraces at about 75–80m and 38–40m depth and one more terrace at 120m depth observed locally along the outer slope.

Preliminary results allow us to suggest that during lower sea-level periods several lakes existed on the 80m platform of the outer continental shelf. We suspect that some of the recovered cores have penetrated the Holocene marine drape and reached the lacustrine sediments deposited in these lakes. Laboratory analyses on these cores will be performed after the cruise.

5.2 Survey area FARASAN 2
FARASAN 2 survey area is located in the inner part of the continental shelf, north of the Farasan Islands (Figure 32). The continental shelf is characterized by shallow platforms at 70–75m depth and numerous deep sinkholes, presumably formed by the dissolution of evaporite deposits.

The FARASAN 2 area includes one deep sinkhole (>200m depth) and one NW–SE trending, elongate, 120m-deep basin.

The objectives of the survey in this area included the following:

1. To investigate if the deep sinkhole and the elongate basin were transformed into isolated lakes during low sea-level periods
2. To understand the role of tectonics in the creation of the sinkholes and basins on the shallow platform and map possible faults.
3. To map submerged terraces as indicators of paleo-sea levels during Pleistocene low sea-level periods
4. To map recent sedimentary deposits covering the submerged landscapes
5. To investigate the seafloor and locate landscape features suitable for prehistoric habitation
6. To sample sedimentary deposits for paleo-oceanographic analyses.
7. To inspect visually the seafloor for paleo-sea level indicators and possible traces of prehistoric human and animal presence.

Figure 32: Swath bathymetry map of the FARASAN 2 survey area, showing the tracks of sub-bottom profiles, side-scan sonar survey, airgun profiles and location of coring sites and ROV dives.
An overview map of the FARASAN 2 survey area is presented in Figure 32. Figure 33 shows the backscatter obtained from the multi-beam system for the northern half of the FARASAN 2 area.

Figure 33: Backscatter image of the northern part of the FARASAN 2 survey area. The low reflectivity area (very light gray) to the north marks the soft sediments deposited in the deep sinkhole. Medium reflectivity (medium gray) areas indicate sedimentary deposits in the elongate basin and smaller scattered areas. High reflectivity (dark gray) derives from the shallow platform. Black spots indicate coral reef formations.

Characteristic examples of high-resolution sub-bottom profiles and airgun seismic profiles are shown in Figures 34 and 35 respectively. Eight cores have been recovered from the FARASAN 1 area.

Figure 34: 3.5kHz sub-bottom profile in survey area FARASAN 2 with location of coring site. Note that coring sites have been defined on the sub-bottom profiles and served the need to core and sample the recent, Holocene marine sedimentary drape and reach its pre-Holocene substrate below. Core FA13 shown here reached the substrate and recovered pieces of gypsum.

Preliminary interpretation of the collected data shows the presence of one prominent terrace at about 70–75m depth on top of which coral reefs have been developed, forming circular, up to 10–15m high mounds. One more terrace has been mapped along the flanks of the
elongate basin at about 112m depth. Figure 36 shows the side scan sonar mosaic obtained from this terrace and Figure 37 the use of the ROV to collect a sample of coral from the seabed.

Figure 35: Air Gun 10ci seismic profile (top) and preliminary interpretation of the geological structure (bottom) in survey area FARASAN 2.

Preliminary results allow us to suggest that during lower sea-level periods several lakes existed on the 80m platform of the outer continental shelf. Gravity coring in the 120m deep elongate basin penetrated the Holocene marine drape and reached its substrate. Short cores indicate that gypsum deposits form the floor of the depressions. Laboratory analyses on these cores will be performed after the cruise.
6. Conclusion

No firm conclusions about the interpretation of the observations made during the cruise should be drawn at this time. The acoustic data needs much processing work before it can be used to produce final maps, and the sediments from the cores need to be extracted, described, examined, and subjected to a variety of palaeoenvironmental and geochronological analyses in the laboratory. The major stages of this work will take place in the laboratories of the HCMR in Athens in the coming months, with sediment samples made available to the Saudi Geological Survey, and to other members of the DISPERSE team in the UK and Australia. The acoustic data will be made freely available to the Department of Hydrography. No archaeological material has yet been recovered and it is unlikely (though not impossible) that artefacts will be found in the sediment cores. Nevertheless, preliminary indications suggest that the cruise has been successful in meeting its principal objectives. 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.

7. Acknowledgements
This research is funded through a five-year research grant (2011–2016) to G. N. Bailey and G.C.P. King from the European Research Council (ERC) as Advanced Grant 269586 ‘DISPERSE: Dynamic Landscapes, Coastal Environments and Human Dispersals’ under the ‘Ideas-specific’ Programme of the 7th Framework Programme (FP7). We thank the Hydrographic Department of the Saudi Ministry of Defense, and HRH Crown Prince Salman bin Abul Aziz Al Saud, Minister of Defense, for granting permission to undertake the cruise. We also thank HRH Prince Sultan bin Salman bin Abdul Aziz al Saud, President of the Saudi Commission for Tourism and Antiquities (SCTA), Dr Ali Al Ghabban, Vice-President, and Jamal S. Omar, Director General, for their continued support of our work. We thank Professor Costas Synolakis, President of HCMR, Dr. Vassilis Lykousis, Director of the Institute of Oceanography, HCMR, and Dr. Vangelis Papanathanassiou, HCMR, for supporting the expedition. We also thank the personnel of SETE, in particular Captain Costas Papaliolios, for their untiring efforts in ensuring the successful implementation of the cruise, and Professor AbdulAziz Suwailem of KAUST for his valuable cooperation. We are grateful to Lt Fahad Al Shwish, Observer from the Hydrographic Department of the Saudi Ministry of Defense, for his support and his valuable assistance in overcoming unexpected logistical difficulties during the cruise. Last but not least, we thank Captain Theodoros Kanakaris and the crew of R/V Aegaeo for their untiring efforts to ensure the smooth running of the scientific operation and for supporting the research team throughout the survey work conducted during the cruise.

8. References

* * * * *
# Appendix 1. Research Team

## Hellenic Centre for Marine Research, GR

<table>
<thead>
<tr>
<th>Name</th>
<th>Surname</th>
<th>Role / Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dimitris</td>
<td>Sakellariou</td>
<td>Chief Scientist, Dr, Research Director, Structural/Marine Geology, Geophysics</td>
</tr>
<tr>
<td>2. Grigoris</td>
<td>Rousakis</td>
<td>Dr, Researcher, Sedimentology, Marine geology, Geophysics</td>
</tr>
<tr>
<td>3. Spyros</td>
<td>Stavrakakis</td>
<td>Dr, Researcher, Sedimentology, Marine geology</td>
</tr>
<tr>
<td>4. Panos</td>
<td>Georgiou</td>
<td>Marine Geologist, Geophysics</td>
</tr>
<tr>
<td>5. Ioannis</td>
<td>Pampilis</td>
<td>Engineer, seismics, coring</td>
</tr>
<tr>
<td>6. Prokopis</td>
<td>Mantopoulos</td>
<td>Engineer, seismics, coring</td>
</tr>
<tr>
<td>7. Panagiotis</td>
<td>Renieres</td>
<td>Engineer, seismics, coring</td>
</tr>
<tr>
<td>8. Ioannis</td>
<td>Panagiotopoulos</td>
<td>Research Assistant, Marine geology, multi-beam engineer</td>
</tr>
<tr>
<td>9. Ioannis</td>
<td>Morfis</td>
<td>Research Assistant, Engineer, multi-beam engineer</td>
</tr>
<tr>
<td>10. Stefanos</td>
<td>Kalogirou</td>
<td>Dr, Research Assistant, Marine biology, Multi-beam engineer</td>
</tr>
<tr>
<td>11. Leonidas</td>
<td>Manousakis</td>
<td>ROV Engineer</td>
</tr>
<tr>
<td>12. Manolis</td>
<td>Kallergis</td>
<td>ROV Engineer</td>
</tr>
<tr>
<td>13. Vasilis</td>
<td>Stasinos</td>
<td>ROV Engineer, diver</td>
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</tbody>
</table>

## University of York, UK

<table>
<thead>
<tr>
<th>Name</th>
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</tr>
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<tbody>
<tr>
<td>14. Geoffrey</td>
<td>Bailey</td>
<td>Project Coordinator, Professor, Prehistoric Archaeology</td>
</tr>
<tr>
<td>15. Garry</td>
<td>Momber</td>
<td>Maritime and Underwater Archaeology, Coastal and Underwater Landscape</td>
</tr>
<tr>
<td>16. Matthew</td>
<td>Meredith-Williams</td>
<td>Dr, Prehistoric Archaeology, Geoarchaeology</td>
</tr>
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</table>

## King Saud University, Riyadh, KSA

<table>
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<tr>
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<tbody>
<tr>
<td>17. Abdullah</td>
<td>Alsharekh</td>
<td>Dr, Prehistoric Archaeology</td>
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## King Abdulaziz University, Jeddah, KSA

<table>
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<tr>
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<tr>
<td>18. Rashad</td>
<td>Bantan</td>
<td>Dr, Marine Geology</td>
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## Saudi Geological Survey, KSA

<table>
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<tr>
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<tr>
<td>19. Salem</td>
<td>Al Nomani</td>
<td>Sedimentology</td>
</tr>
<tr>
<td>20. Najeeb</td>
<td>Rasul</td>
<td>Dr, Marine Geology, Sedimentology</td>
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## Department of General Survey, Ministry of Defense, KSA

<table>
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<tr>
<th>Name</th>
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<tr>
<td>21. Lt. Fahad</td>
<td>Al Shwish</td>
<td>Observer</td>
</tr>
<tr>
<td>22. Ahmad</td>
<td>Al Harbi</td>
<td>Observer's Assistant</td>
</tr>
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## Appendix 2. List of Gravity Cores

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<tr>
<th>Date</th>
<th>Time</th>
<th>Core Number</th>
<th>Latitude (Y)</th>
<th>Longitude (X)</th>
<th>Depth (m)</th>
<th>Length (m)</th>
<th>Note</th>
</tr>
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<tbody>
<tr>
<td>3-Jun-2013</td>
<td>0630</td>
<td>FA-3</td>
<td>16° 53.058</td>
<td>41° 10.752</td>
<td>121</td>
<td>1.46</td>
<td>SPLIT</td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>0730</td>
<td>FA-3</td>
<td>16° 53.060</td>
<td>41° 10.733</td>
<td>121</td>
<td>2.88</td>
<td>samples obtained from the catcher seem lighter in colour, probably brackish??!!</td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>0815</td>
<td>FA-1</td>
<td>16° 49.904</td>
<td>41° 13.918</td>
<td>217</td>
<td>3.82</td>
<td>20 cm from Top of sample in nose of Gravity Core collected</td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>0900</td>
<td>FA-2</td>
<td>16° 53.276</td>
<td>41° 16.943</td>
<td>87</td>
<td>3.10</td>
<td></td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>1000</td>
<td>FA-4</td>
<td>16° 56.128</td>
<td>41° 16.943</td>
<td>65</td>
<td>2.04</td>
<td></td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>1025</td>
<td>FA-5</td>
<td>16° 54.647</td>
<td>41° 14.237</td>
<td>92</td>
<td>3.71</td>
<td>White sediment bottom probably biogenic, lake??!!</td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>1900</td>
<td>FA-10</td>
<td>16° 58.917</td>
<td>41° 12.083</td>
<td>76</td>
<td>3.82</td>
<td>Broken shells at bottom. Upper sediment lost in Barrel.</td>
</tr>
<tr>
<td>3-Jun-2013</td>
<td>2000</td>
<td>FA-10B</td>
<td>16° 58.873</td>
<td>41° 12.047</td>
<td>76</td>
<td>1.85</td>
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<tr>
<td>4-Jun-2013</td>
<td>0700</td>
<td>FA-7</td>
<td>16° 55.548</td>
<td>41° 08.478</td>
<td>259</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td>4-Jun-2013</td>
<td>0730</td>
<td>FA-8</td>
<td>16° 56.261</td>
<td>41° 09.235</td>
<td>187</td>
<td>4.53</td>
<td>20 cm Top Disturbed.</td>
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<tr>
<td>4-Jun-2013</td>
<td>0800</td>
<td>FA-9</td>
<td>16° 56.014</td>
<td>41° 07.253</td>
<td>300</td>
<td>2.53</td>
<td></td>
</tr>
<tr>
<td>4-Jun-2013</td>
<td>0900</td>
<td>FA-6</td>
<td>17° 02.357</td>
<td>41° 11.227</td>
<td>83</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0615</td>
<td>FA-14</td>
<td>17° 18.281</td>
<td>41° 53.043</td>
<td>245</td>
<td>3.05</td>
<td></td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0700</td>
<td>FA-11</td>
<td>17° 17.215</td>
<td>41° 53.968</td>
<td>210</td>
<td>2.80</td>
<td></td>
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<tr>
<td>6-Jun-2013</td>
<td>0730</td>
<td>FA-12A</td>
<td>17° 13.719</td>
<td>41° 54.070</td>
<td>105</td>
<td>1.24</td>
<td>Olive Top (Sandy) Light gray bottom with shells</td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0750</td>
<td>FA-12B</td>
<td>17° 13.737</td>
<td>41° 54.069</td>
<td>105</td>
<td>1.32</td>
<td></td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0815</td>
<td>FA-13</td>
<td>17° 12.838</td>
<td>41° 55.131</td>
<td>102</td>
<td>2.09</td>
<td>Olive Top. Light gray bottom with gypsum</td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0840</td>
<td>FA-16</td>
<td>17° 10.756</td>
<td>41° 55.622</td>
<td>80</td>
<td>1.42</td>
<td>Shell fragments at the bottom Biogenic formation</td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0900</td>
<td>FA-17</td>
<td>17° 11.077</td>
<td>41° 56.421</td>
<td>129</td>
<td>2.72</td>
<td></td>
</tr>
<tr>
<td>6-Jun-2013</td>
<td>0945</td>
<td>FA-15</td>
<td>17° 09.174</td>
<td>41° 58.681</td>
<td>130</td>
<td>2.24</td>
<td>Gray bottom with fragments of crystallized gypsum</td>
</tr>
</tbody>
</table>
Appendix 3. Daily Cruise Report

WENDESDAY, 29th MAY 2013

<table>
<thead>
<tr>
<th>Local Time</th>
<th>Position</th>
<th>Activities</th>
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<tbody>
<tr>
<td>12:00 - 22:00</td>
<td>Jeddah Port</td>
<td>Embarkation of Research Team on R/V AEGAEO</td>
</tr>
<tr>
<td>23:00</td>
<td>Jeddah Port</td>
<td>Stand by for Departure</td>
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THURSDAY, 30th MAY 2013

<table>
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<th>Position</th>
<th>Activities</th>
</tr>
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<tbody>
<tr>
<td>02:05</td>
<td>Jeddah Port</td>
<td>Departure, heading to Farasan Islands area</td>
</tr>
<tr>
<td></td>
<td>At Sea</td>
<td>Heading to Farasan Islands area</td>
</tr>
</tbody>
</table>

FRIDAY, 31st MAY 2013

<table>
<thead>
<tr>
<th>Time</th>
<th>Position</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00</td>
<td>WNW of Farasan Islands</td>
<td>Arrival on site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CTD station CTD 1:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lat: 16° 53', Long: 41° 05', Depth: 1015m</td>
</tr>
<tr>
<td>09:30</td>
<td>Area FARASAN 1</td>
<td>Start Swath bathymetry (multi-beam) survey of area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FARASAN 1, west of the entrance of the Northern</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approach to Jizan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ELAG 2120, 20kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ELAG 1180, 180 kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vessel speed: 9 knots</td>
</tr>
</tbody>
</table>

SATURDAY, 1st JUNE 2013

<table>
<thead>
<tr>
<th>Time</th>
<th>Position</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30</td>
<td>Area FARASAN 1</td>
<td>Stop multi-beam survey</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preparations for sub-bottom profiling and side scan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sonar survey</td>
</tr>
<tr>
<td>11:00</td>
<td>Area FARASAN 1</td>
<td>Deployment of sub-bottom profiler and side-scan sonar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Continue surveying area FARASAN 1 with multi beam,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sub-bottom profiler (SBP) and side-scan sonar (SSS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>synchronously at 4 knots vessel speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SBP: 500 milliseconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSS: 200m per channel, 110/410 kHz</td>
</tr>
</tbody>
</table>

SUNDAY, 2nd JUNE 2013

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<th>Activities</th>
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<tr>
<td>14:00</td>
<td>Area FARASAN 1</td>
<td>Stop multi-beam, sub-bottom profiler and side-scan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sonar survey</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preparations for Air Gun seismic survey</td>
</tr>
<tr>
<td>20:30</td>
<td>Area FARASAN 1</td>
<td>Continue multi-beam survey</td>
</tr>
</tbody>
</table>
MONDAY, 3rd JUNE 2013

06:00  Area FARASAN 1  Stop multi-beam survey
       Preparations for gravity coring

06:30  Start gravity coring:
       Lat: 16°53,058  Core FA 3a (pre-split core to be sent to Saudi
       Long: 41°10,752  Geological Survey)
       Depth: 121m - Length: 164cm
       Lat: 16°53,060  Core FA 3b
       Long: 41°10,733  Depth: 122m - Length: 300cm

08:15  Lat: 16°49,904  Core FA 1
       Long: 41°13,918  Depth: 217m - Length: 382cm

09:00  Lat: 16°53,276  Core FA 2
       Long: 41°16,943  Depth: 87m - Length: 310cm

10:00  Lat: 16°56,128  Core FA 4
       Long: 41°16,943  Depth: 217m - Length: 382cm

10:25  Lat: 16°54,647  Core FA 5
       Long: 41°14,237  Depth: 92m - Length: 371cm

11:00  Area FARASAN 1  Continue multi-beam survey

18:30  Stop multi-beam survey

19:00  Lat: 16°58,917  Core FA 10a
       Long: 41°12,083  Depth: 76m - Length: 380cm + about 30cm left inside
       the core barrel
       Lat: 16°58,873  Core FA 10b
       Long: 41°12,047  Depth: 73m - Length: 185cm

20:30  Stop coring. Preparations for Airgun seismic survey

20:45  Airgun seismic survey in area FARASAN 1
       10 cubic inches, trigger 2 seconds, vessel speed 4 knots

TUESDAY, 4th JUNE 2013

05:30  Area FARASAN 1  Stop Airgun seismic survey
       Seismic lines recorded: 4-3, 23-24, 25-26, 27-28
       Preparations for Gravity Coring

06:30  Start gravity coring:
       Lat: 16°55,548  Core FA 7
       Long: 41°08,478  Depth: 259m - Length: 420cm

07:30  Lat: 16°56,261  Core FA 8
       Long: 41°09,235  Depth: 187m - Length: 453cm
08:00  Lat: 16°56,014  Core FA 9  Depth: 302m - Length: 253cm  
       Long: 41°07,253
09:00  Lat: 17°02,357  Core FA 6  Depth: 83m - Length: 300cm  
       Long: 41°11,227
09:30  FARASAN 1 area  End gravity coring in FARASAN 1 area  
       Start multi-beam survey in shallow area
14:00  TRANSIT from  End of beam survey in the entrance of the North  
       FARASAN 1 to  Approach Channel to Jizan.  
       FARASAN 2  Start transit through the Channel to the survey area  
                 FARASAN 2
17:30  FARASAN 2 area  Multi-beam survey in FARASAN 2 area at 9 knots

WEDNESDAY, 5th JUNE 2013

18:30  Area FARASAN 2  End of multi-beam survey  
       Start of sub-bottom profiling and multi-beam at 4 knots

THURSDAY, 6th JUNE 2013

05:00  Area FARASAN 2  End of sub-bottom profiling  
       Preparations for gravity coring.
06:15  Lat: 17°18,281  Core FA 14  Depth: 245m - Length: 305cm  
       Long: 41°53,034
06:45  Lat: 17°17,215  Core FA 11  Depth: 106m - Length: 280cm  
       Long: 41°53,968
07:30  Lat: 17°13,719  Core FA 12a  Depth: 106m - Length: 124cm  
       Long: 41°54,070
       Lat: 17°13,737  Core FA 12b  Depth: 106m - Length: 132cm  
       Long: 41°54,069
08:15  Lat: 17°12,838  Core FA 13  Depth: 102m - Length: 209cm  
       Long: 41°55,131
08:40  Lat: 17°10,756  Core FA 16  Depth: 80m - Length: 142cm  
       Long: 41°55,622
09:00  Lat: 17°11,077  Core FA 17  Depth: 128m - Length: 271cm  
       Long: 41°56,421
09:45  Lat: 17°09,174  Core FA 16  Depth: 130m - Length: 224cm  
       Long: 41°58,681
10:15  Scientific meeting of the research team
13:00  FARASAN 2  Start side-scan sonar - sub-bottom profiling along the  
       flanks of the elongate basin
19:00  End of side-scan sonar - sub-bottom profiling
Preparations for coring

19:45  
Lat: 17°14, 764  
Core FA 18a  
Long: 41°54,177  
Depth: 70m - Length: little sediment

Lat: 17°14, 757  
Core FA 18b  
Long: 41°54,167  
Depth: 70m - Length: about 30 cm of disturbed fine, silty sand

Lat: 17°14, 769  
Core FA 18  
Long: 41°54,162  
Depth: 70m - Length: 164cm

20:45  
Lat: 17°14,767  
Box Core FA 18  
Long: 41°54,171  
Depth: 70m - Length: no sample

Lat: 17°14,767  
Box Core FA 18 (2nd try)  
Long: 41°54,166  
Depth: 70m - Length: 30cm  
One plastic tube to SGS  
One plastic to HCMR

22:00  
FARASAN 2  
Start Airgun seismic survey

FRIDAY, 7nd JUNE 2013

03:30  
Area FARASAN 2  
End of Airgun survey  
Start of multi-beam mapping in the southeast part of FARASAN 2 area.

18:00  
End of multi-beam mapping

19:00  
Start sub-bottom profiling and multi-beam in the southeast part of FARASAN 2 area.

SATURDAY, 8th JUNE 2013

05:00  
Area FARASAN 2  
End of sub-bottom profiling and multi-beam  
Heading to Jizan port

09:00  
Jizan  
Birthed in Jizan port to embark Prof. Abdullah Alsharekh and ROV engineer Leonidas Manousakis

17:30  
Sailing from Jizan port to FARASAN 2 area

20:00  
Start airgun survey in the southeast part of FARASAN 2 area.

SUNDAY, 9th JUNE 2013

05:00  
Area FARASAN 2  
End of airgun seismic profiling  
Preparations for ROV dive.

06:45  
FARASAN 2  
1st ROV dive  
Lat: 17°10,397  
North flank of elongate basin, 112m terrace  
Long: 41°58,002  
Rock sample F1

09:45  
End of dive, ROV on deck

10:25  
Lat: 17°09,585  
2nd ROV dive
Long: 41°57,645  South flank of elongate basin, 112m terrace.

Very poor visibility

11:05  End of dive, ROV on deck
Heading to Farasan port

14:00  Off Farasan port  Disembarkation of Prof. Abdullah Alsharekh on a Coast Guard boat

14:30  Airgun survey along Transect 1.

19:00  End of Airgun Transect 1
Start of multi-beam survey

21:30  Lat: 17°10,280  3rd ROV dive
Long: 41°56,641  South flank of elongate basin, 112m terrace.

23:30  End of dive, ROV on deck

MONDAY, 10th JUNE 2013

00:30  Transit from FARASAN 2 to FARASAN 1  Start of airgun seismic profiling along Transect 2

10:30  End of airgun survey

11:30  FARASAN 1  4th ROV dive,
Lat: 16°56,444  FARASAN 1, 120m terrace
Long: 41°11,831  Rock sample F2

14:50  End of dive, ROV on deck

15:50  Lat: 16°55,197  5th ROV dive,
Long: 41°08,997  FARASAN 1, possible wavecut notches on the outer slop, 120m

17:30  End of dive, ROV on deck
Start multi-beam survey.

19:00  End of multi-beam survey
End of survey works
Heading to Jeddah port.
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<tr>
<th>Photo</th>
<th>Name</th>
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<tbody>
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