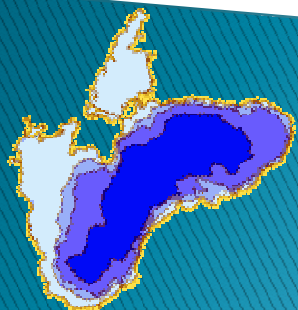
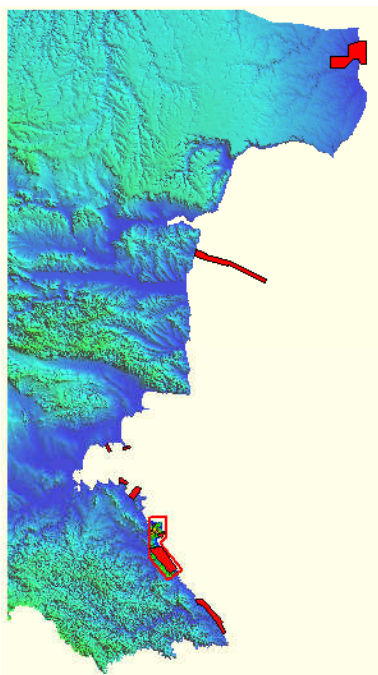
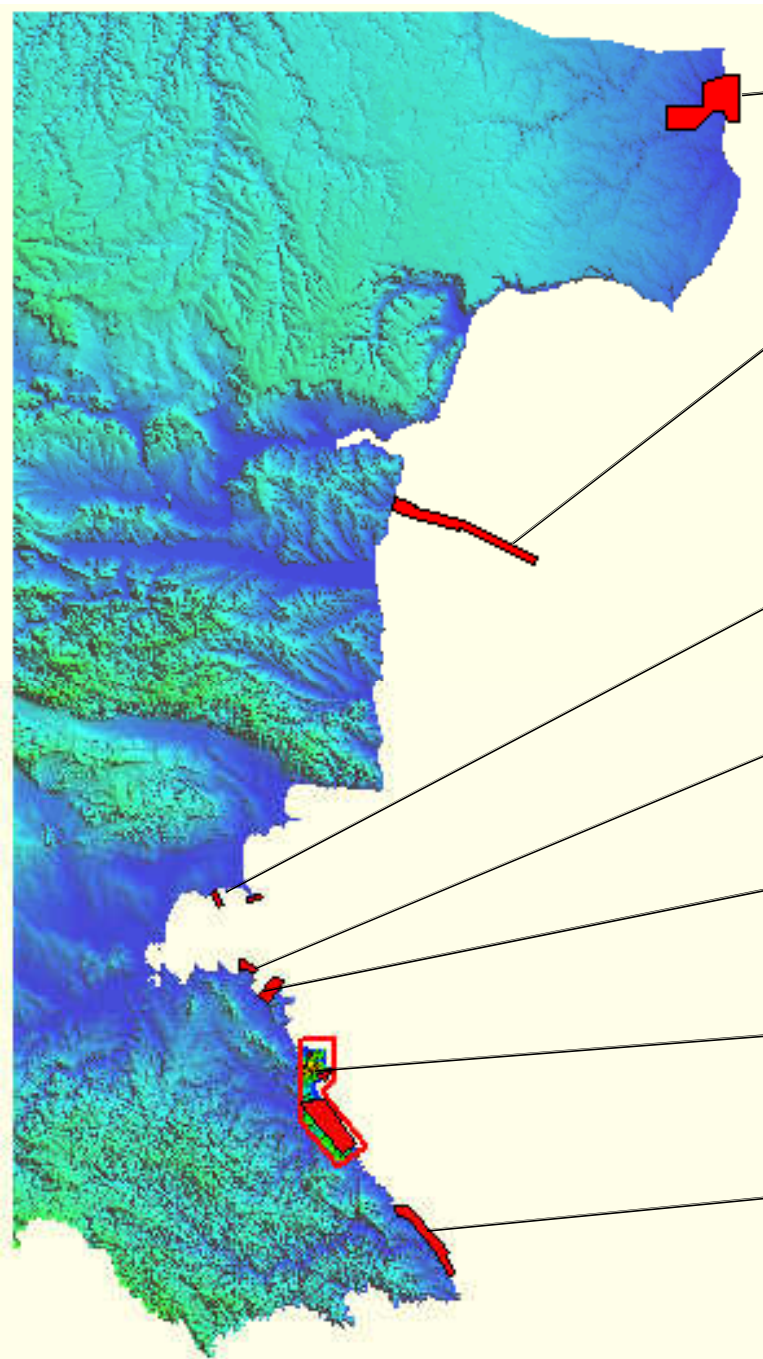


UNDERWATER ARCHAEOLOGICAL SURVEYS

Application of geophysical prospecting methods
for the purposes of underwater archaeological
research in the Black Sea



***CENTRE FOR UNDERWATER
ARCHAEOLOGY, K.Velkovsky, L.
Trendafilova***



Durankulak Like and shallow sea
Bathymetry.

South Stream
Bathymetry Multi-beam, Magnetic/Gradient,
Side Scan, Sub-Bottom and Electrical survey.

Pomorie 2 areas.
Bathymetry Multi-beam, Side Scan, Sub-
Bottom and Electrical survey.

Chernomoretz
Bathymetry Multi-beam, Side Scan, Sub-
Bottom and Electrical survey.

Sozopol
Bathymetry Multi-beam, Side Scan, Sub-
Bottom and Electrical survey.

Ropotamo-Primorsko-Kiten-Oazis
Bathymetrical, LiDAR, side scan and sub-
bottom.

Ahtopol – Silistar
Bathymetrical, side scan.

***CENTRE FOR UNDERWATER ARCHAEOLOGY,
K.Velkovsky, L. Trendafilova***

RESEARCH METHODOLOGY

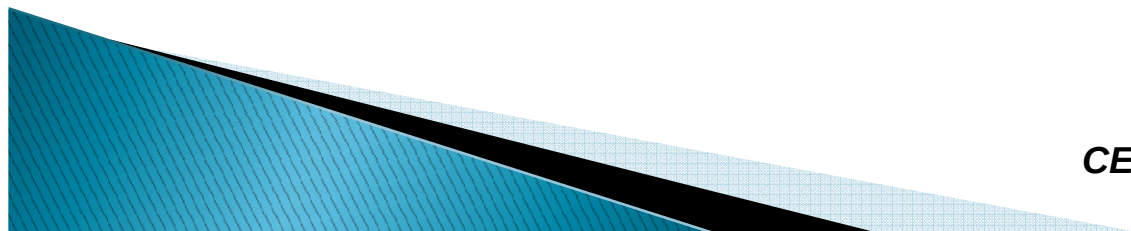
The systematic remote-sensing investigation conducted by CUA on several sites was designed to provide accurate location and reliable identification of potentially significant targets, as well as assessment, and documentation of submerged cultural resources in the study areas.

Considering the limitations of each single geophysical prospecting method, a set of magnetic, acoustic and electric remote-sensing equipment was employed for the purposes of the survey.

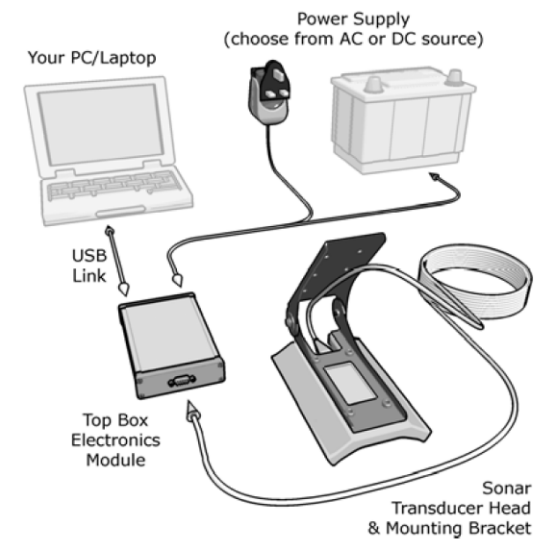
EQUIPMENT USED:

1. **Side scan sonar** as an imaging system for acquisition of data about the character of the sea bottom and for locating sites/objects of potential cultural value;
2. **Single-beam echo sounder** – as a back-up control system for depth measurement, as well as for data acquisition in areas, where other methods cannot be applied;
3. **Multi-Beam echo sounder** – for the development of Digital Terrain Models;
4. **Sub-bottom profiler** – for obtaining vertical sections of sediment layers;
5. **Four DGPS systems** – for heading and positioning;

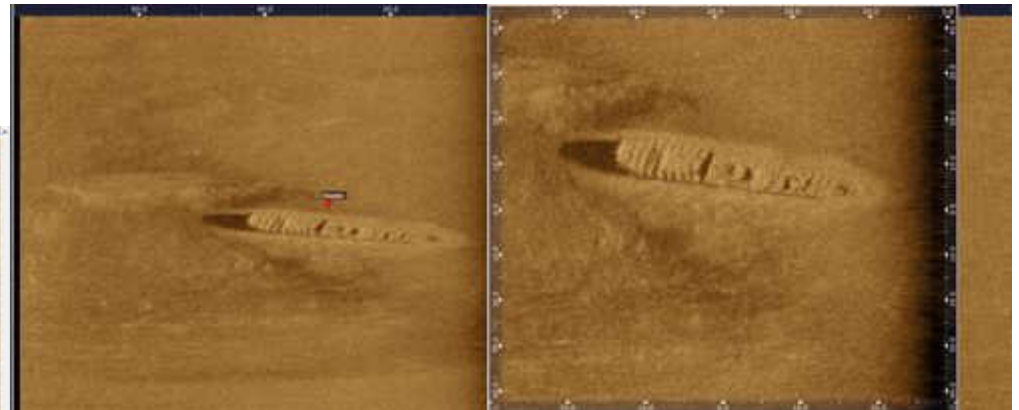
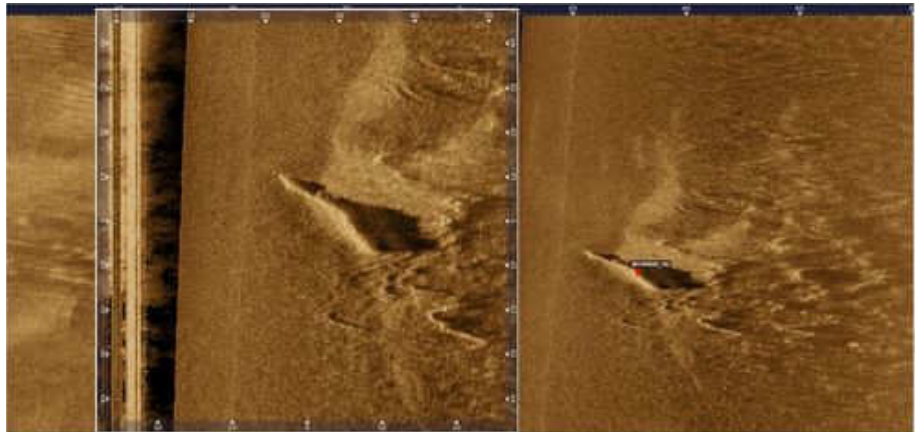
6. **Marine acquisition 10 channels resistivity-meter** of a “dipole-dipole array” type; with a tow cable with 5 m electrode spacing, and a symmetrical Schlumberger scheme with maximal electrode spacing of 100 m for land measurements;
7. **Magnetometer/gradiometer** for conducting of magnetic and magnetic gradient survey for locating magnetic anomalies caused by metal objects of different size;
8. **Supporting computer systems with the relevant software** for data acquisition and post-processing.
9. **Metal detector** with different coils;
10. **Video and camera equipment** (tow & drop camera, ROV, still camera);
11. **Diving equipment** – surface supply and scuba.



Side scan sonar as an imaging system for acquisition of data about the character of the sea bottom and for locating sites/objects of potential cultural value

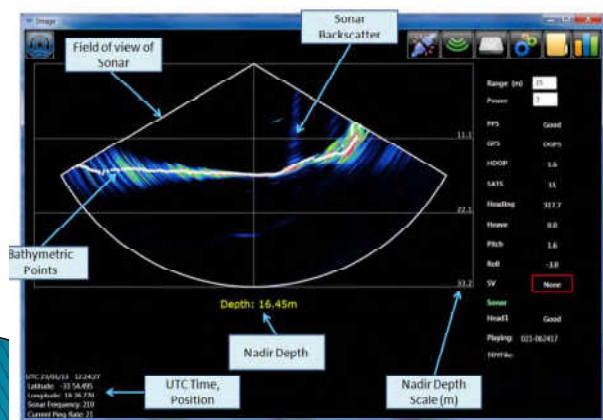
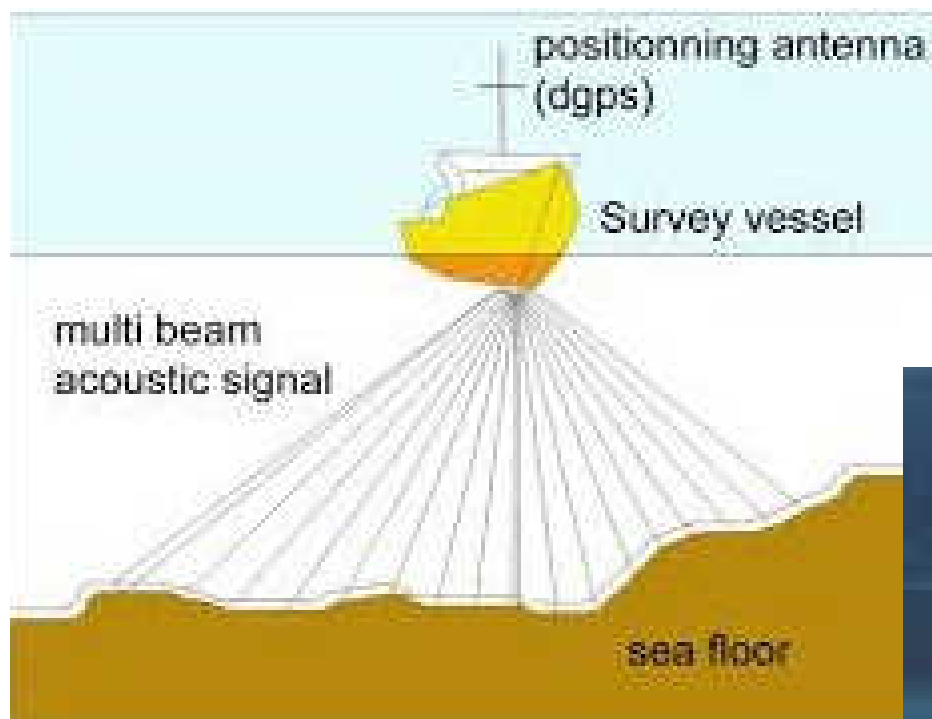


**SIDE SCAN SONAR, STARFISH 450H,
TRITECH CO. UK**



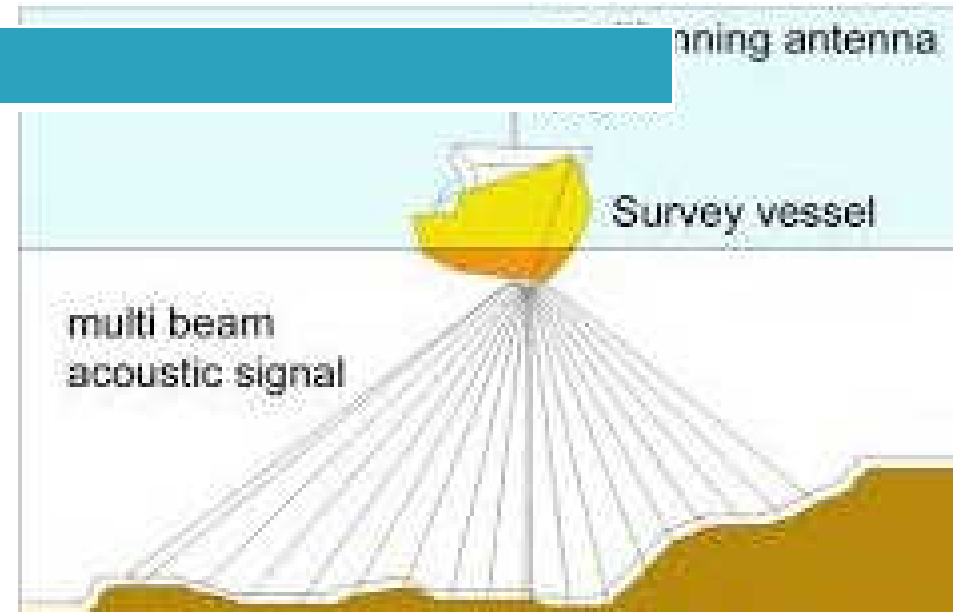
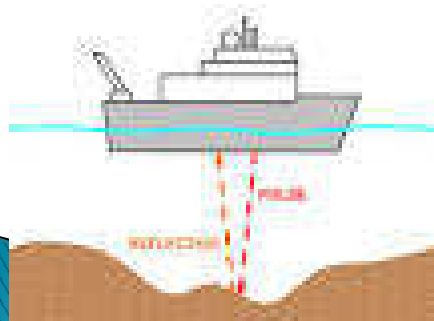
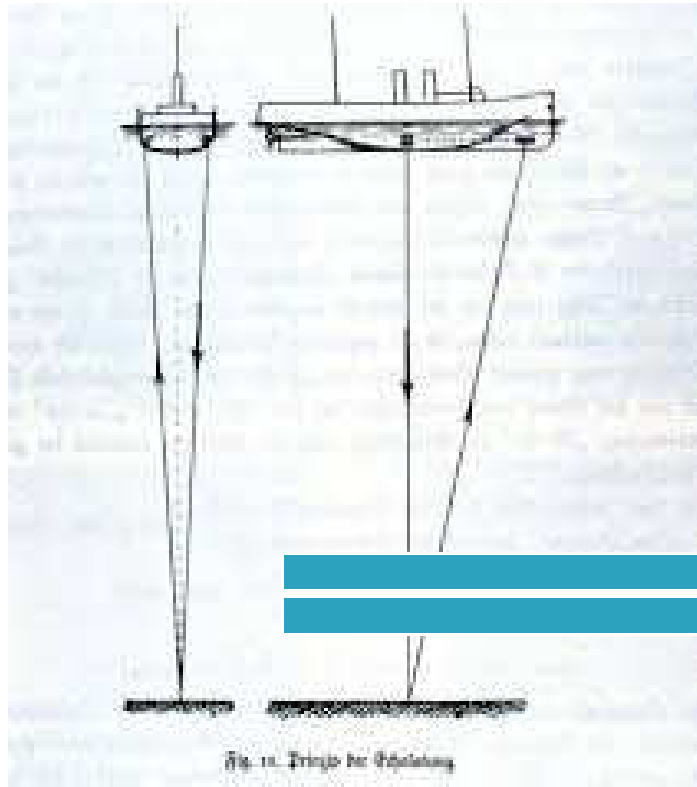
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Multi-beam echo sounder – for the development of Bathymetric Charts and Digital Terrain Models;



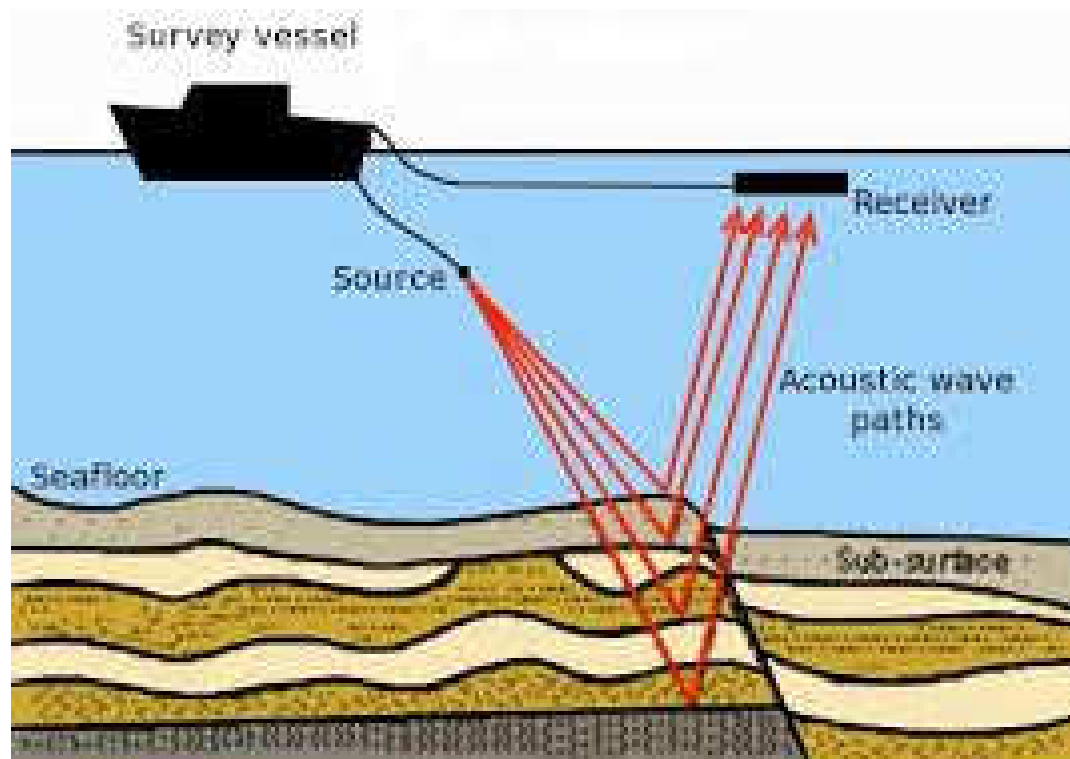
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Single-beam echo sounder – as a back-up control system for depth measurement, as well as for data acquisition in areas, where other methods cannot be applied

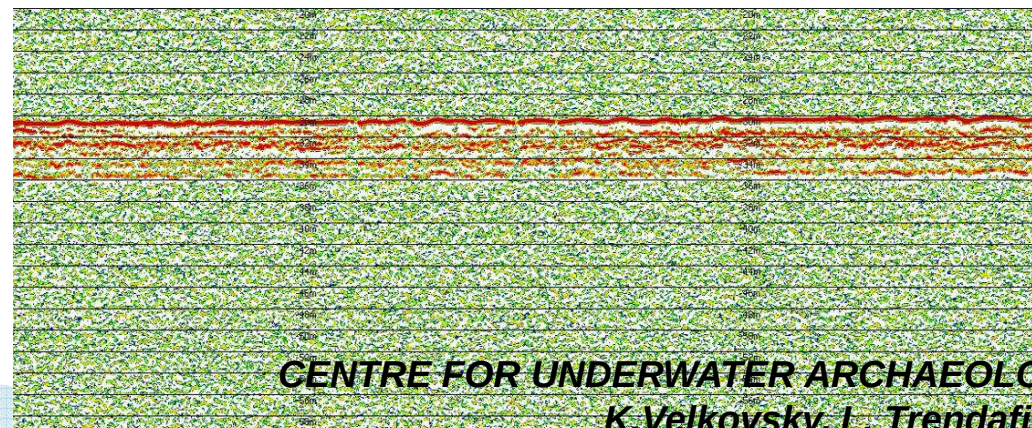
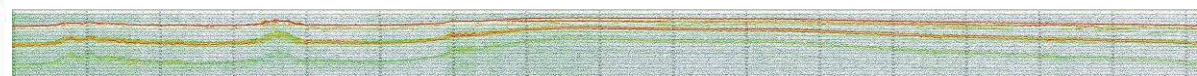
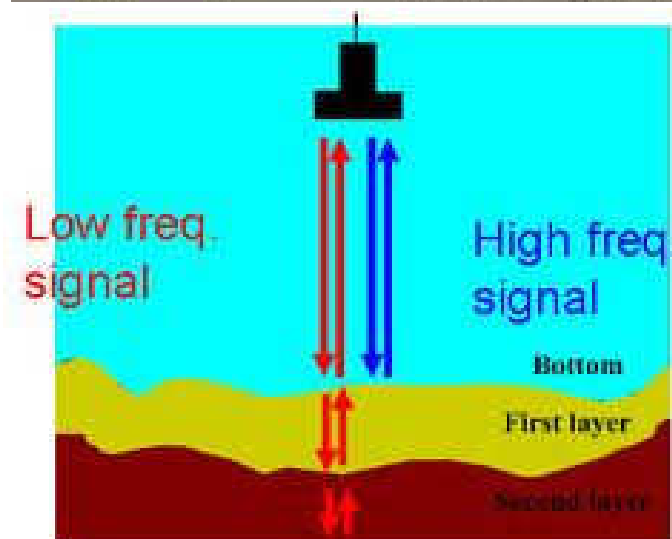


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Sub-Bottom Profiler – for receiving a vertical section of the sea bottom.



**SUB BOTTOM
PROFILER SES-
2000, INNOMAR
TECHNOLOGIE
GMBH**

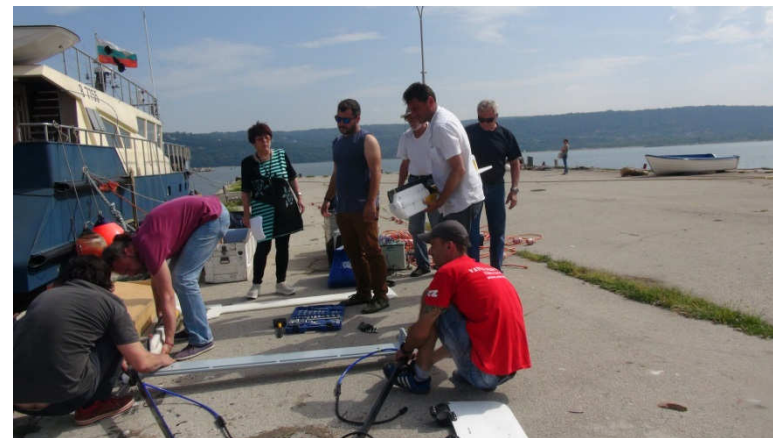
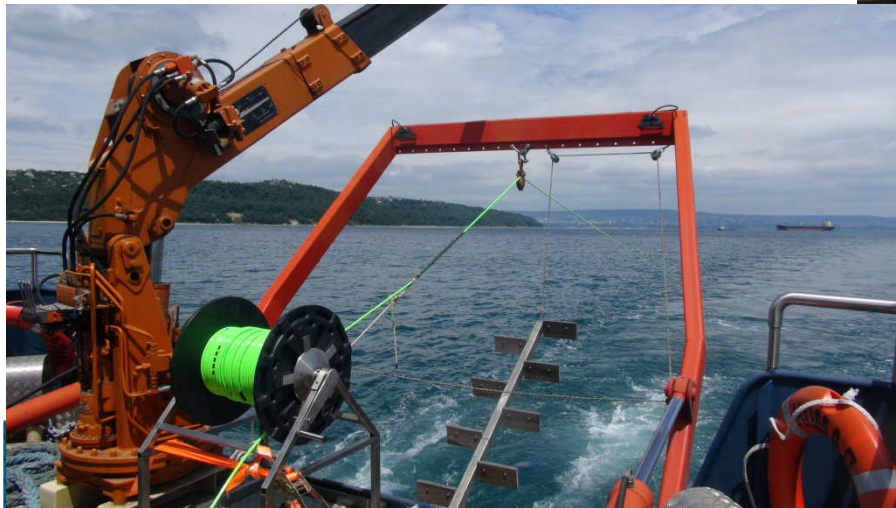


**CENTRE FOR UNDERWATER ARCHAEOLOGY,
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Magnetometer/gradiometer for conducting of magnetic and magnetic gradient survey for locating magnetic anomalies caused by metal objects of different size

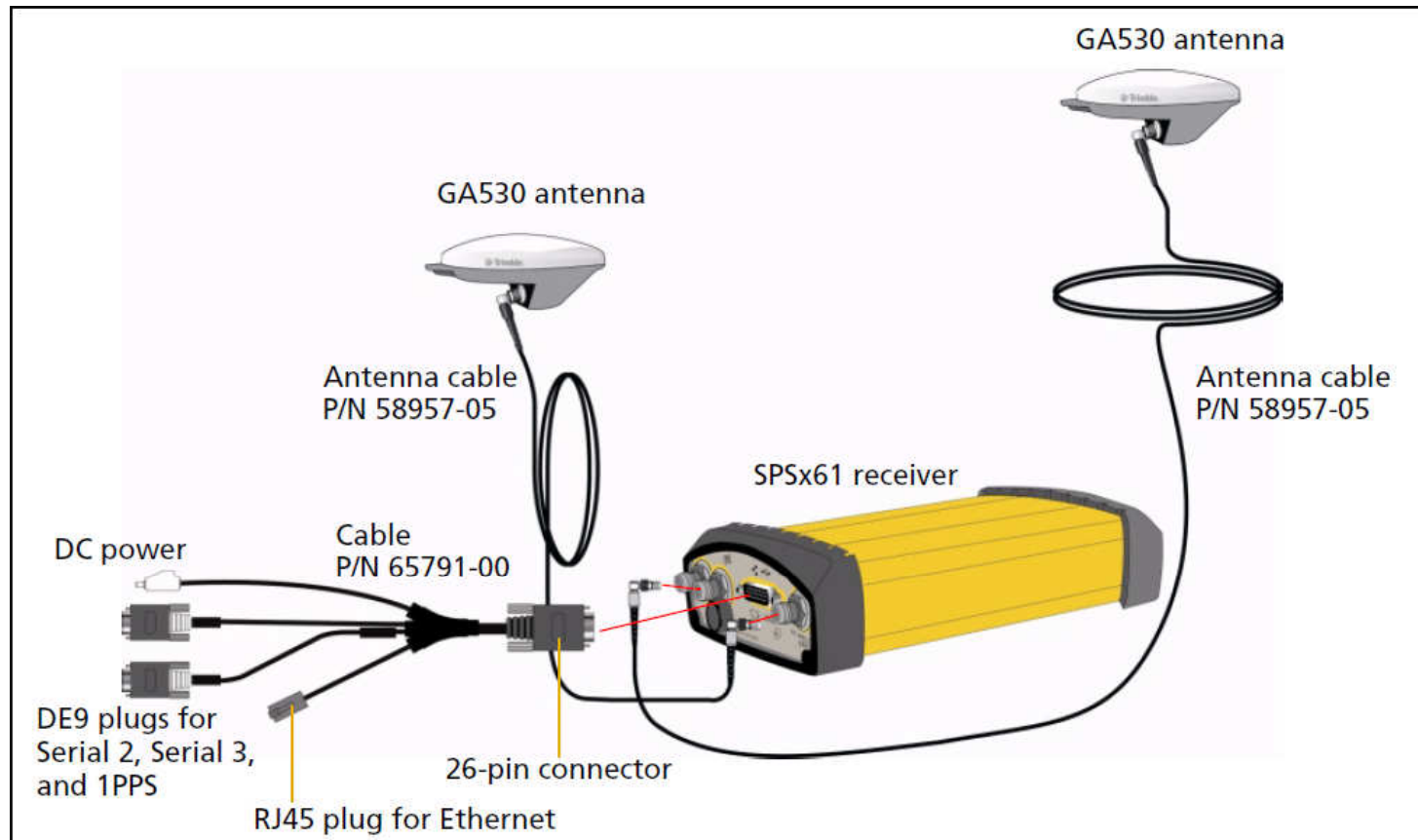


G-882TVG CESIUM MAGNETOMETER & TRANSVERSE GRADIOMETER



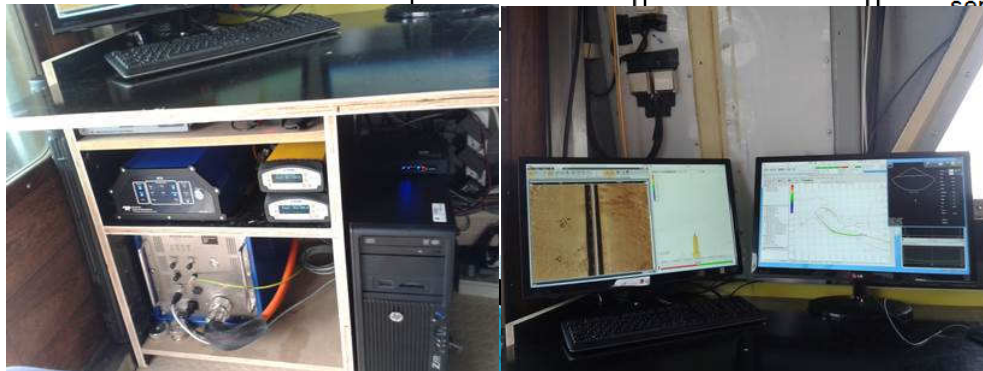
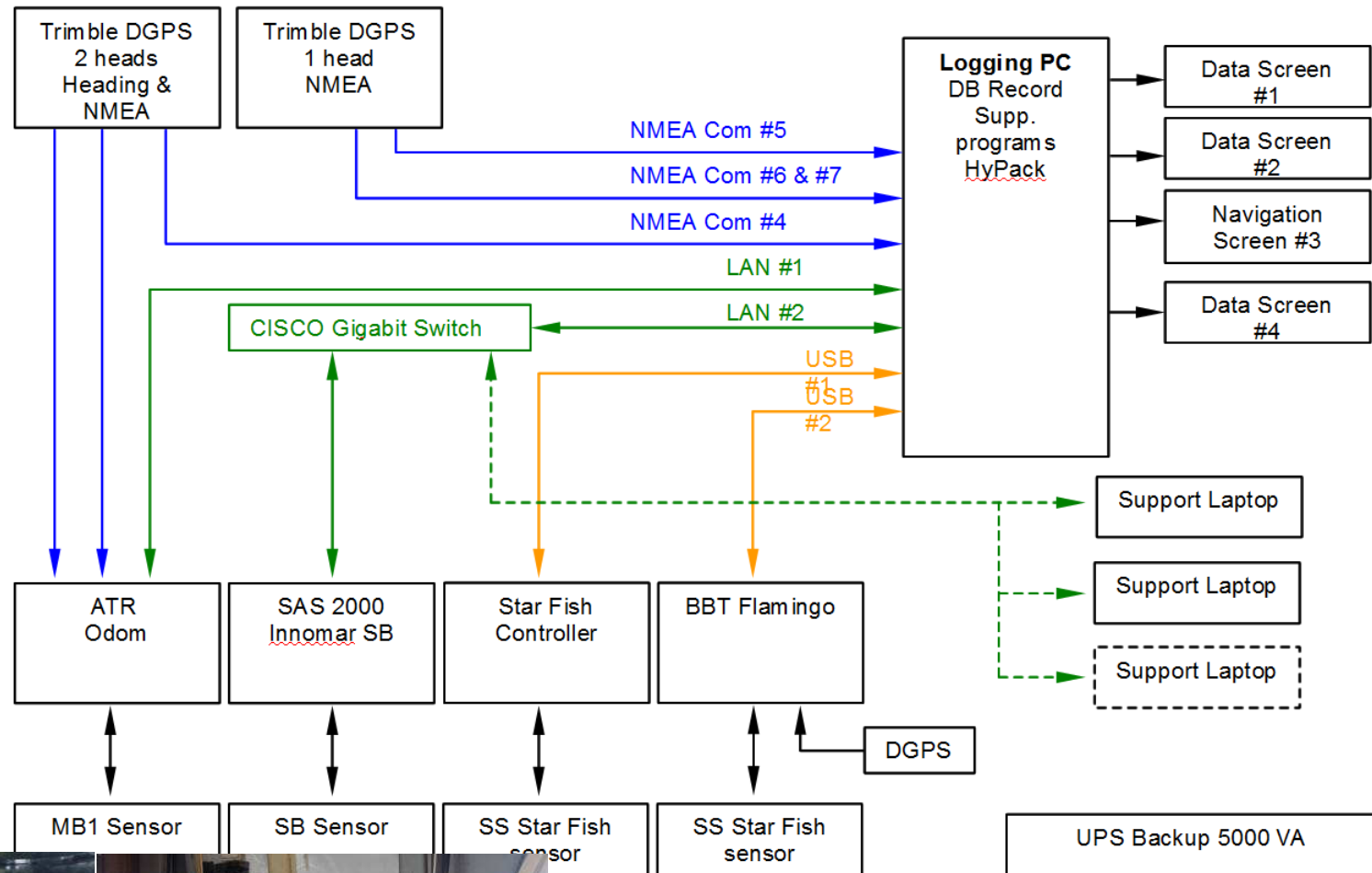
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Up to four DGPS systems – for heading and positioning



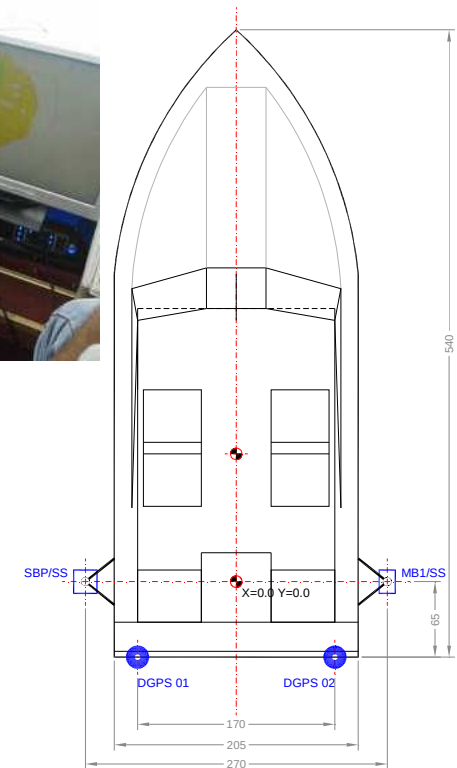
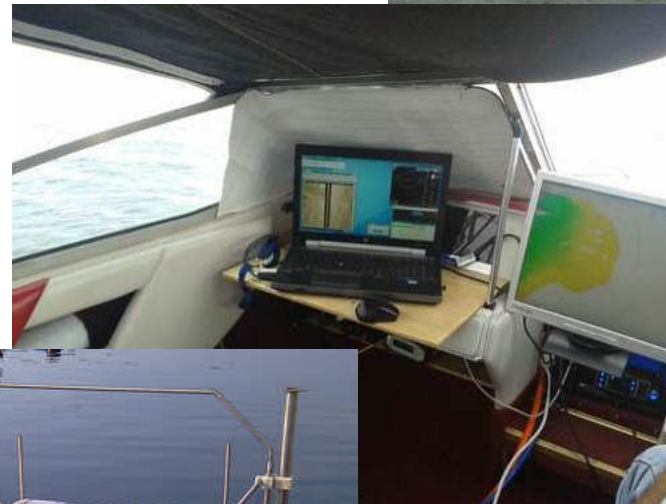
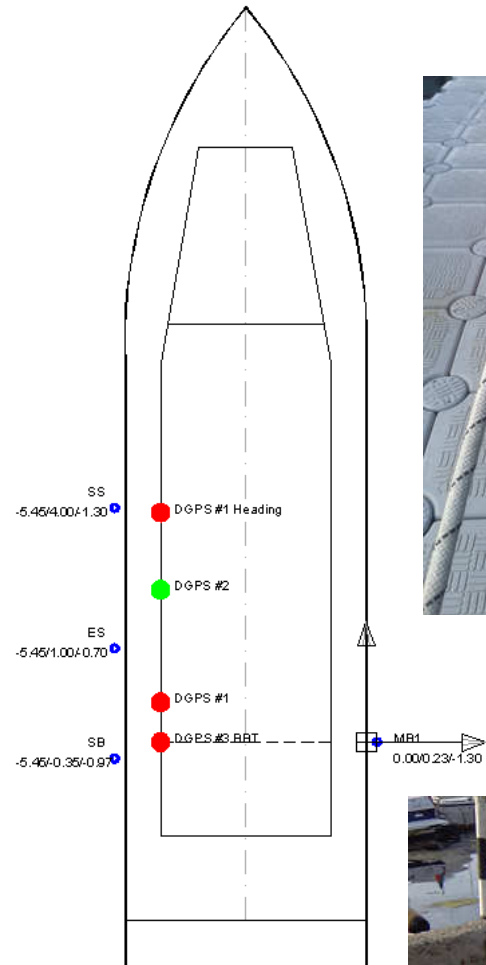
8. Supporting computer systems with the relevant software for data acquisition and post-processing

Principal block scheme of the device connections

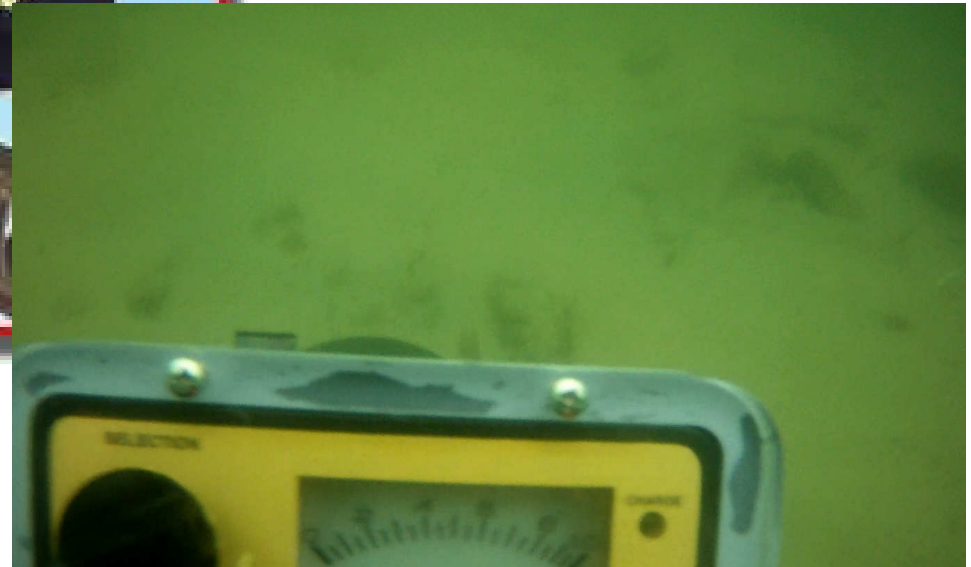


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SENSOR INSTALLATION



Pulse 8X



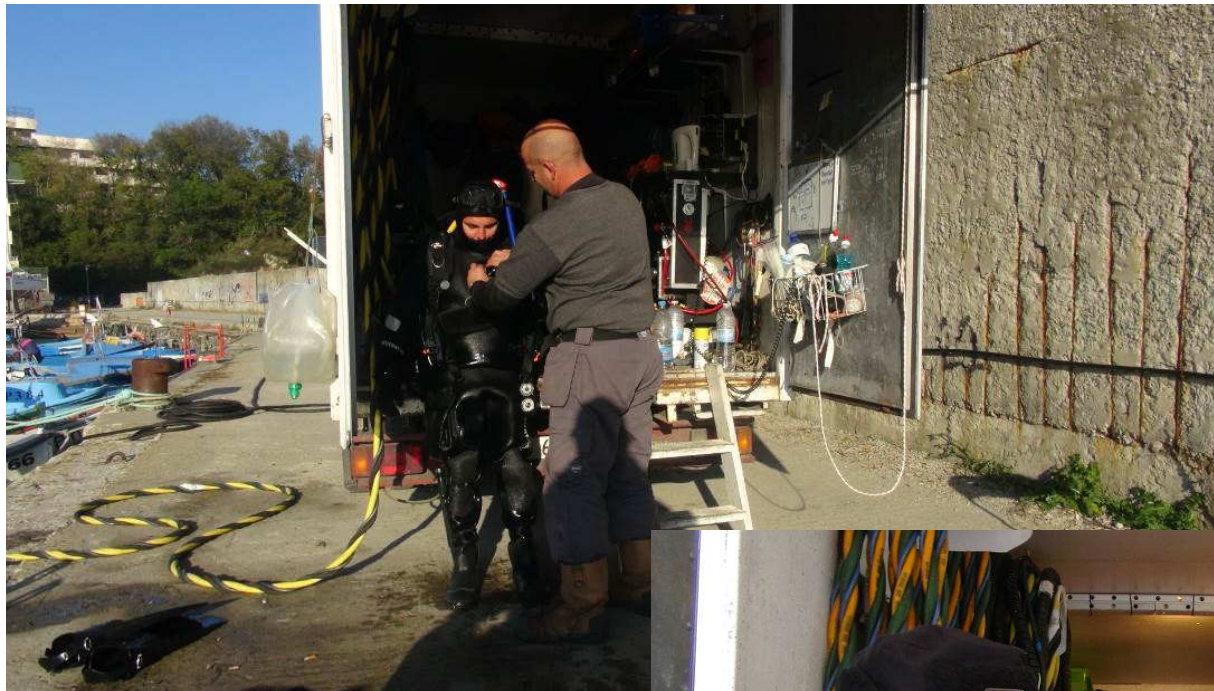
Video and camera equipment (tow & drop camera, ROV, still camera)

TOV-1 Camera



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11. Diving equipment – surface supply and scuba



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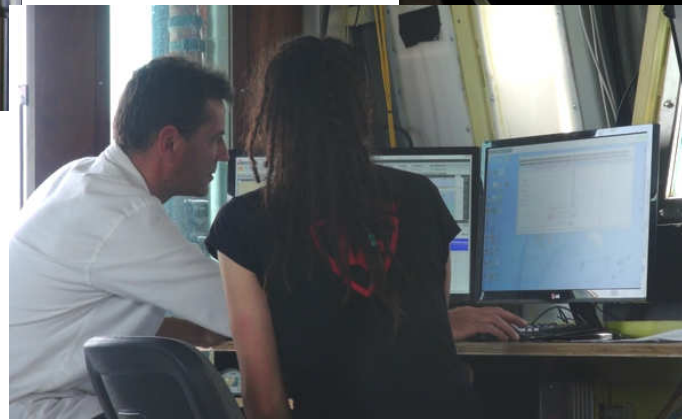
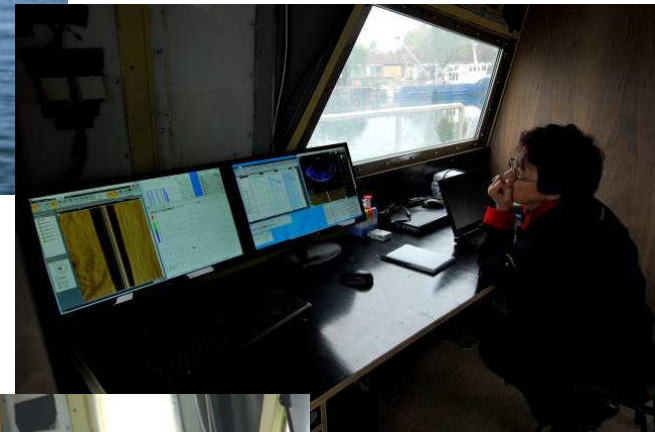


Diving equipment – surface supply and scuba



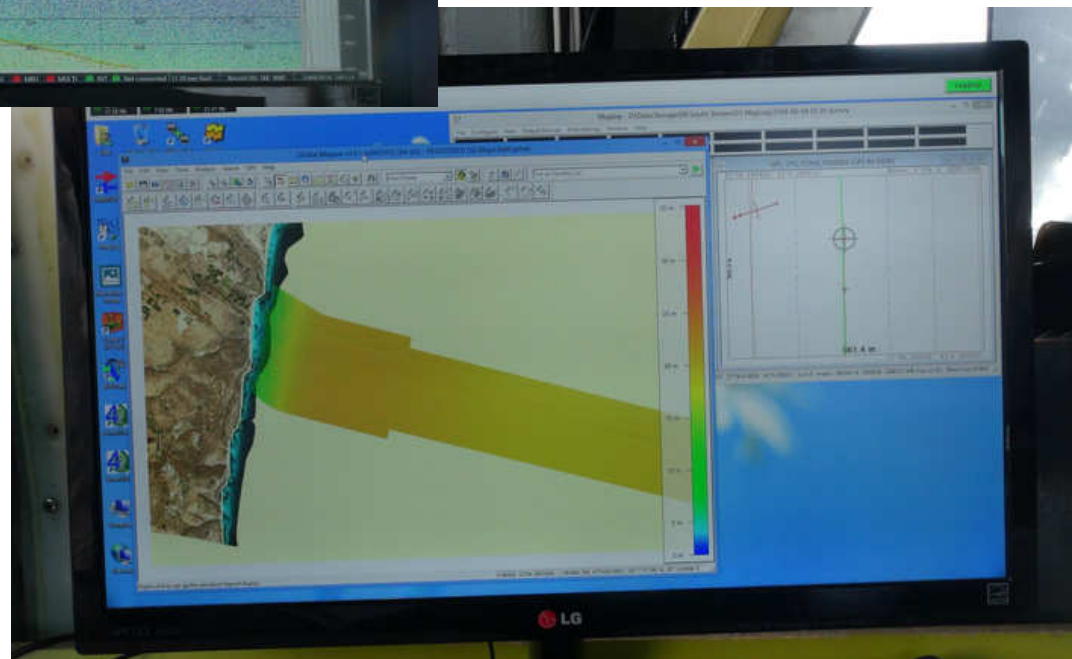
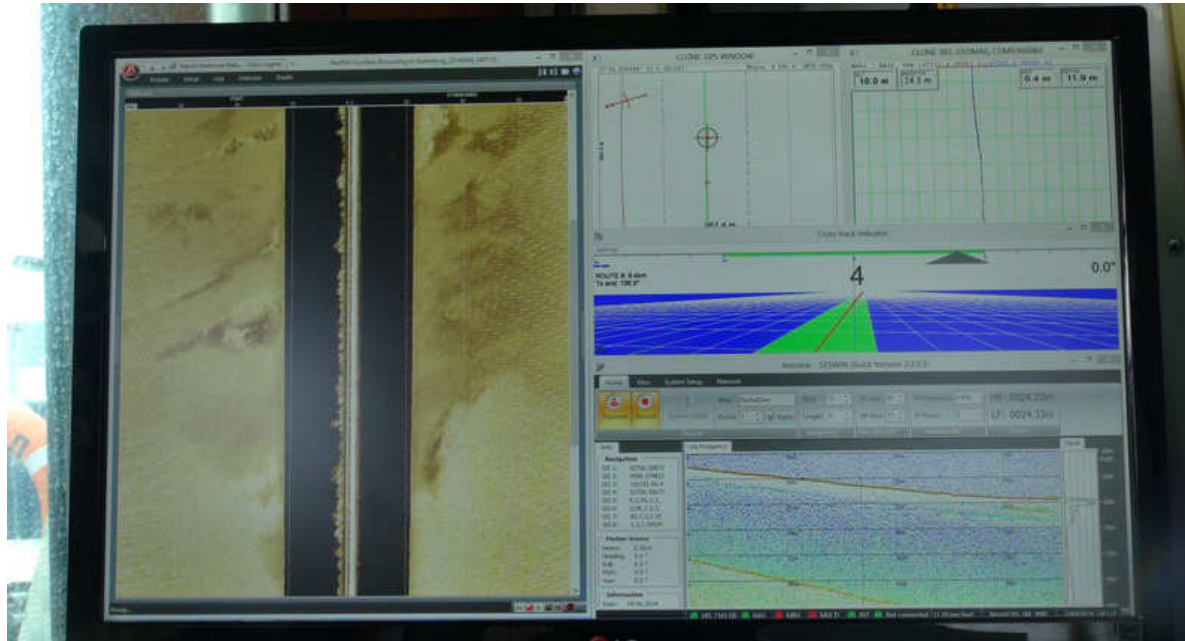
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MOMENTS IN ACTION



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EQUIPMENT IN ACTION



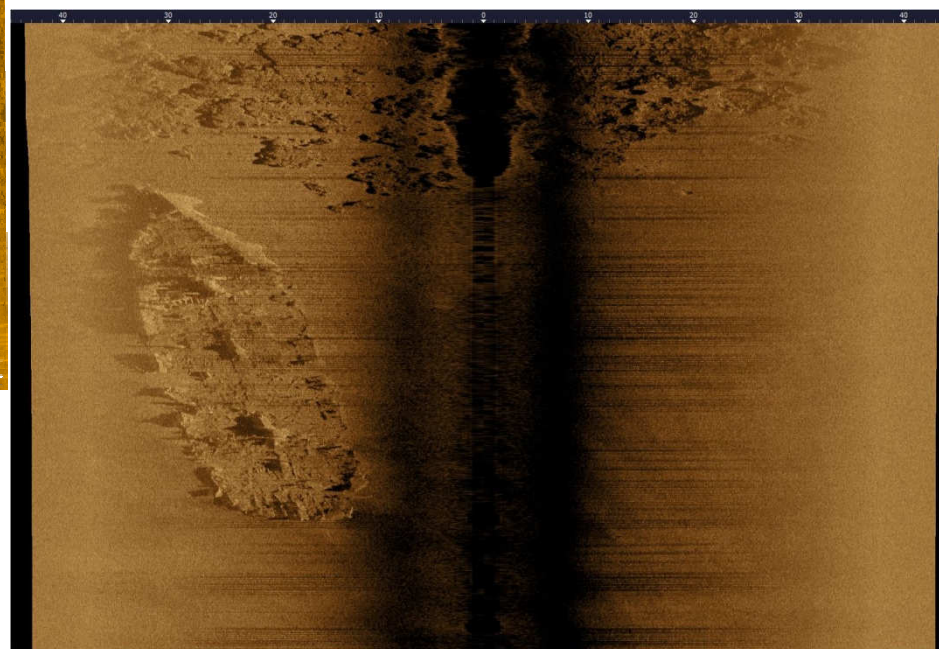
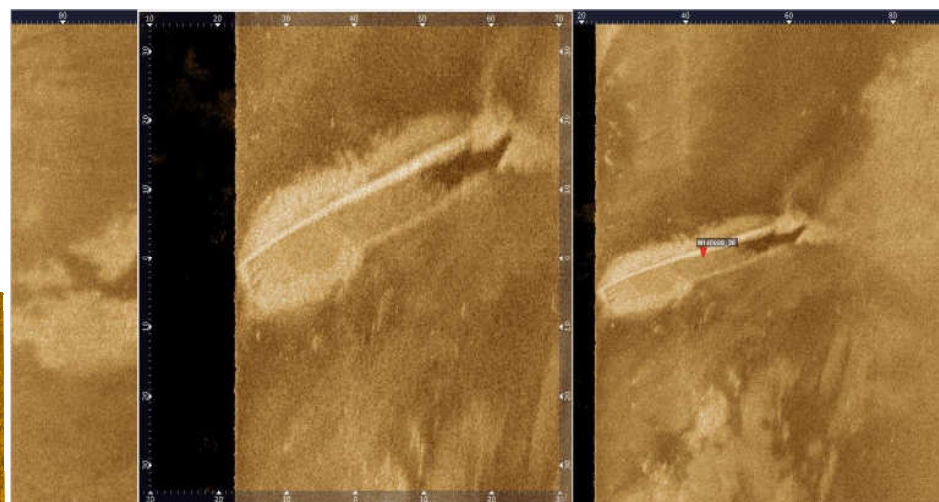
**CENTRE FOR UNDERWATER ARCHAEOLOGY,
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OTHER MOMENTS



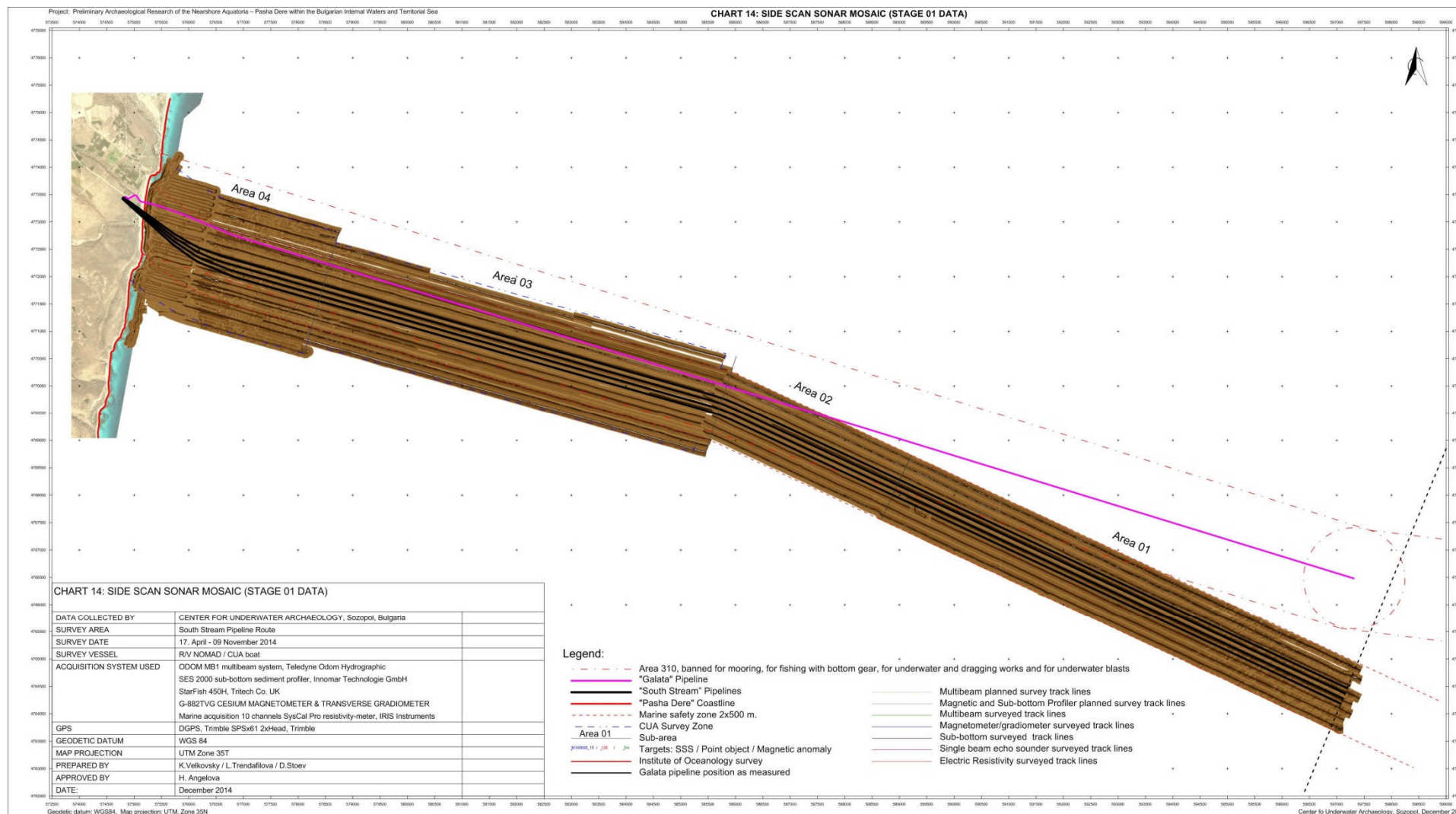
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SIDE SCAN SONAR SURVEY



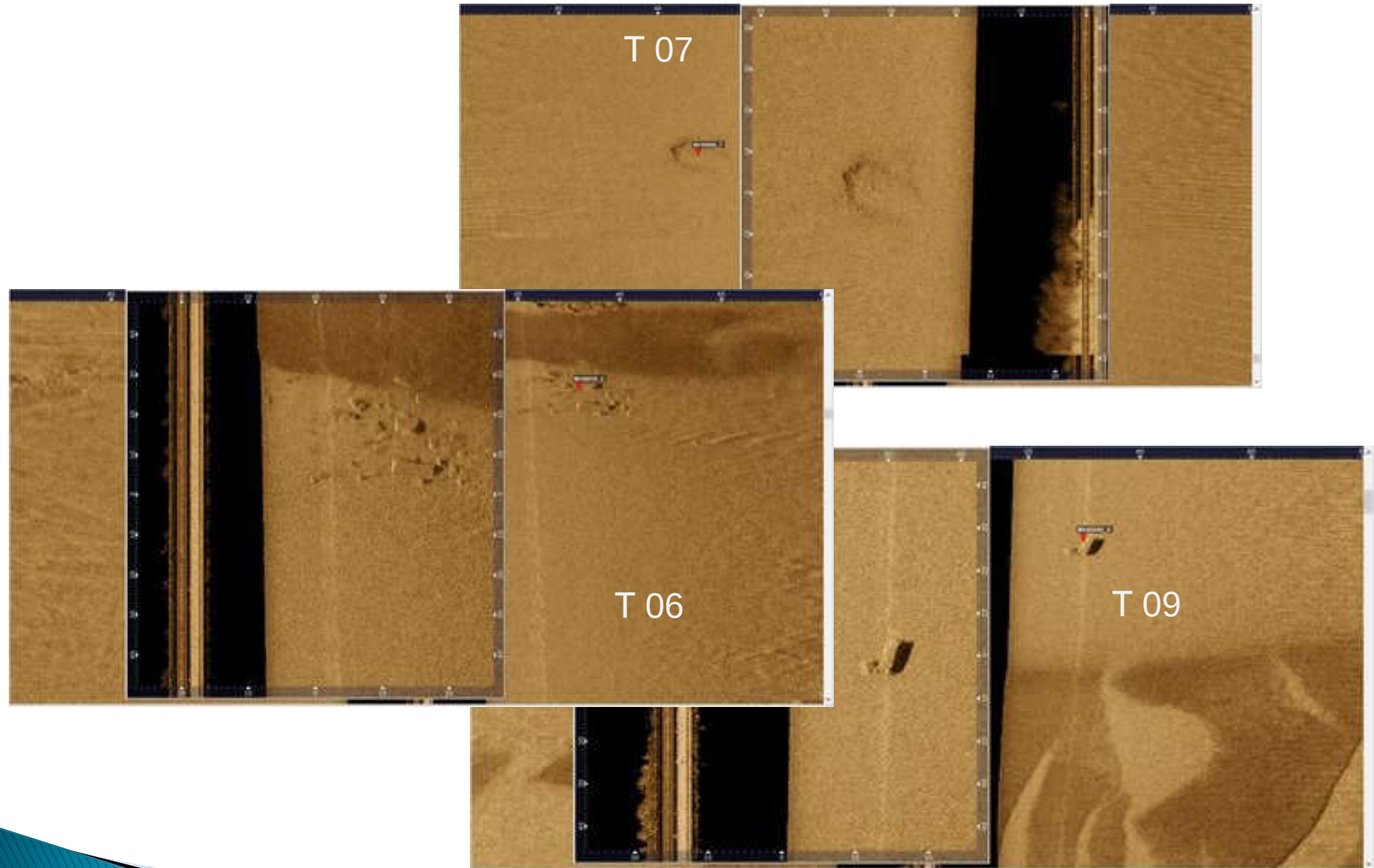
***CENTRE FOR UNDERWATER ARCHAEOLOGY,
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SIDE SCAN SONAR SURVEY



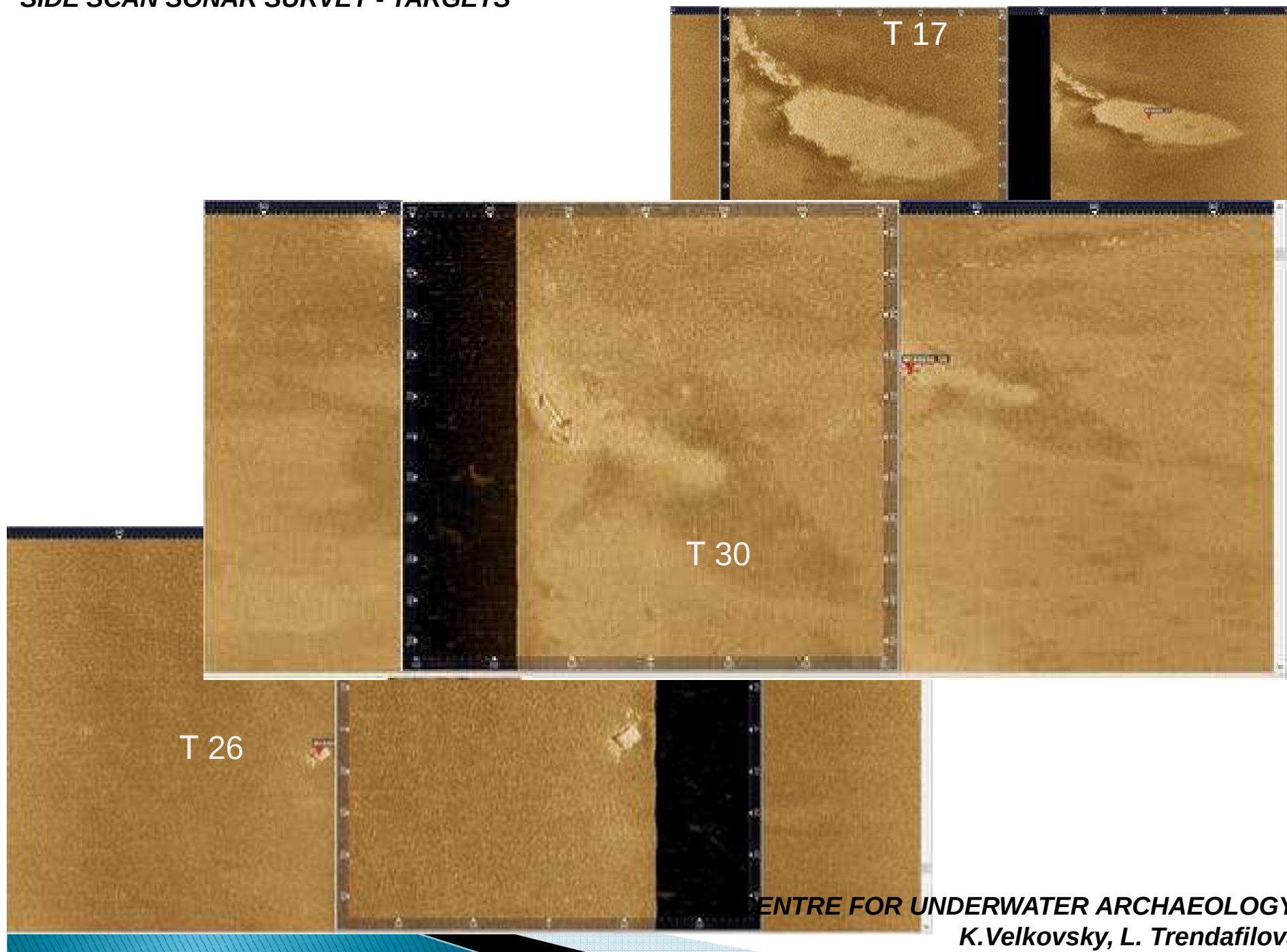
**CENTRE FOR UNDERWATER ARCHAEOLOGY,
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SIDE SCAN SONAR SURVEY - TARGETS



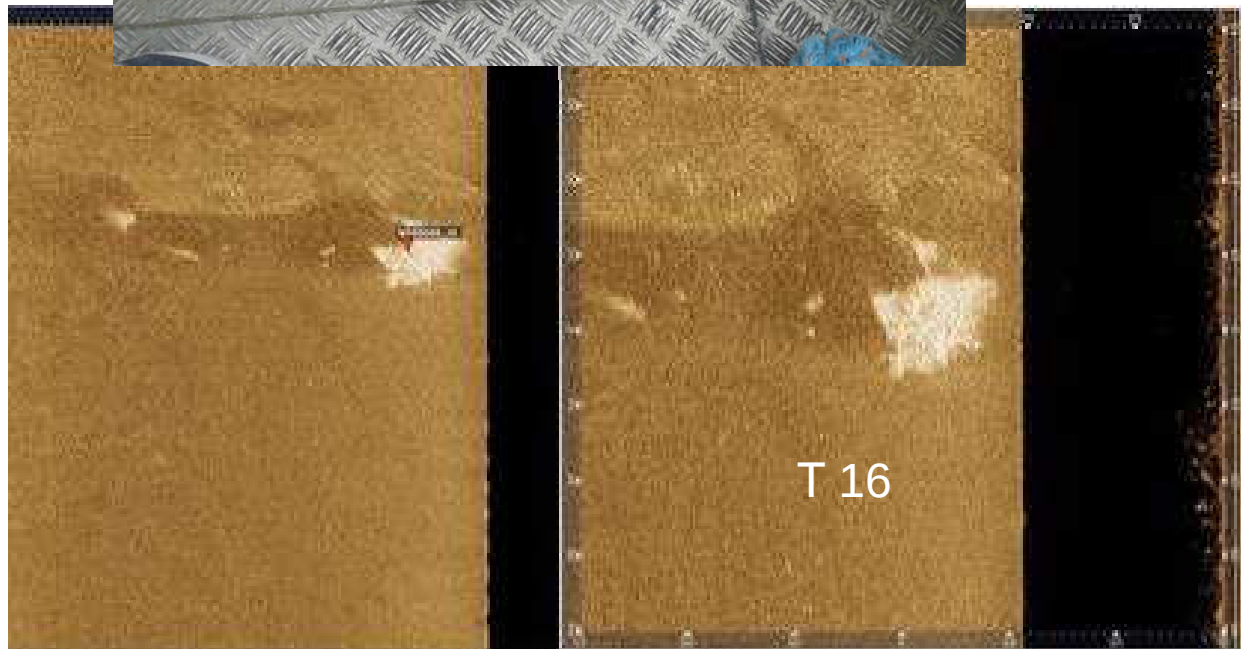
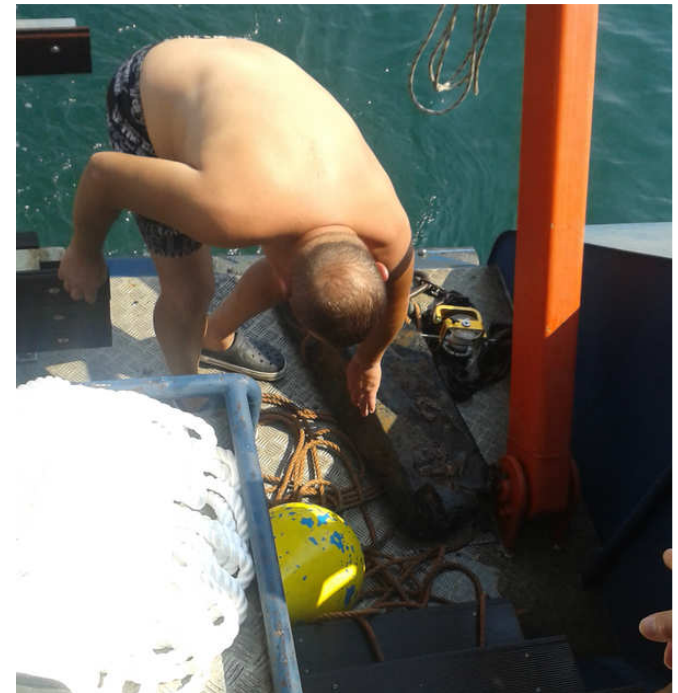
***CENTRE FOR UNDERWATER ARCHAEOLOGY,
K.Velkovsky, L. Trendafilova***

SIDE SCAN SONAR SURVEY - TARGETS



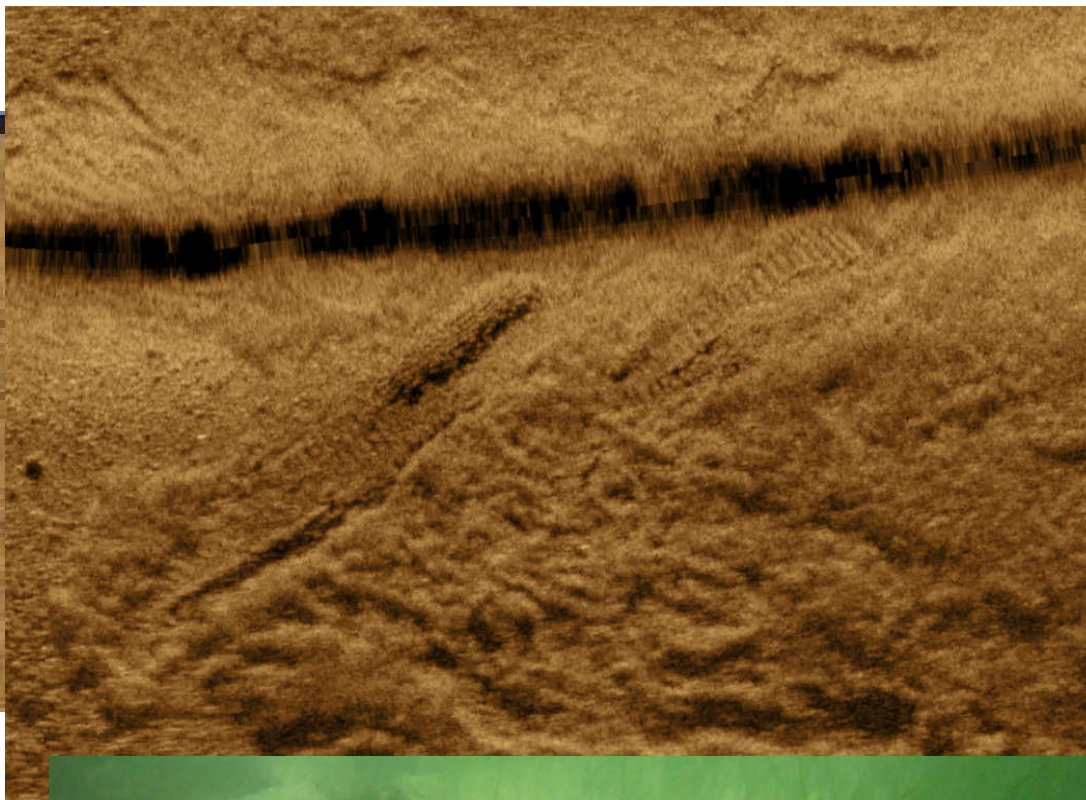
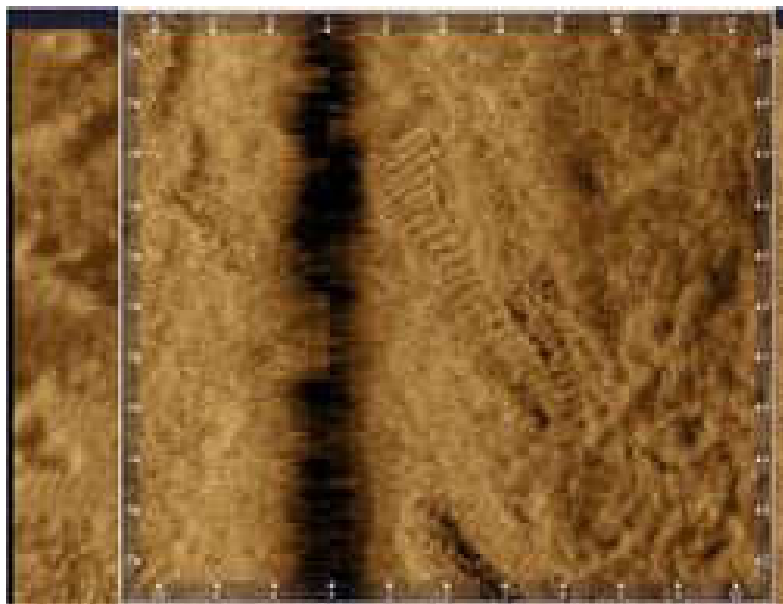
***CENTRE FOR UNDERWATER ARCHAEOLOGY,
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SIDE SCAN SONAR SURVEY - TARGETS



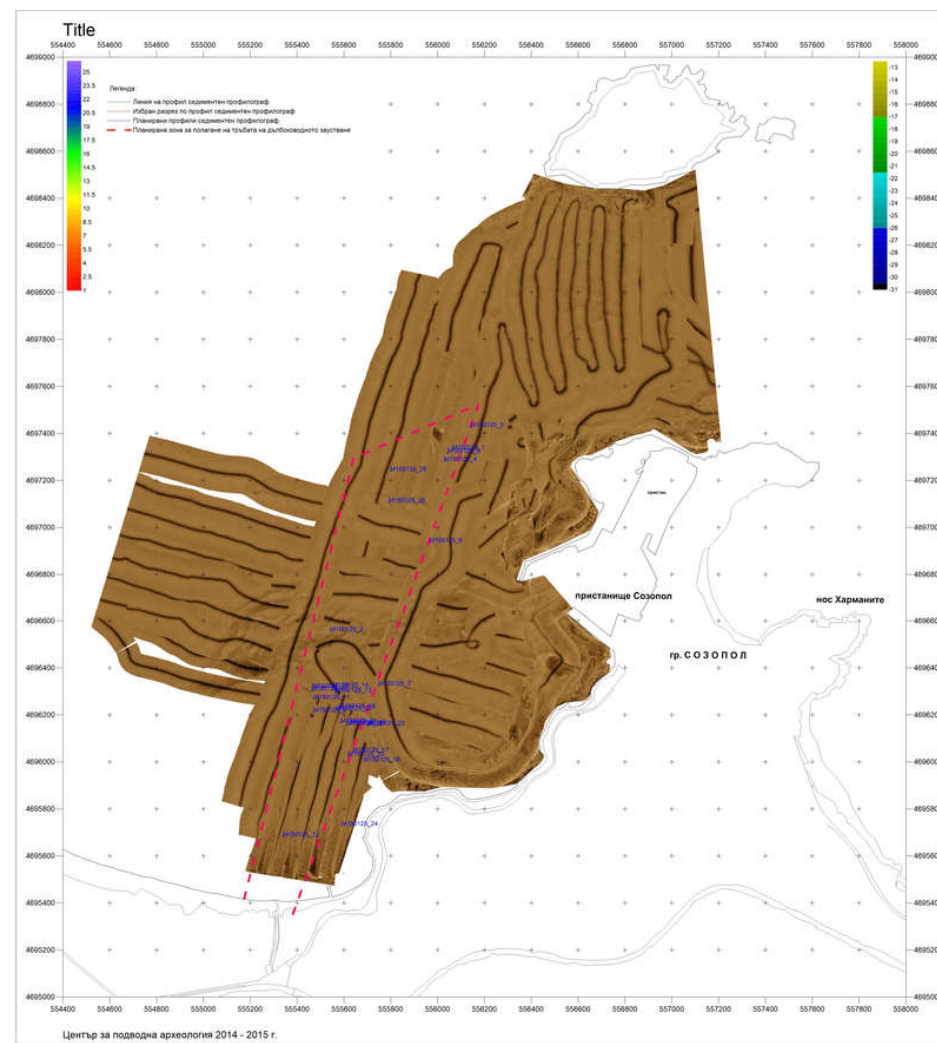
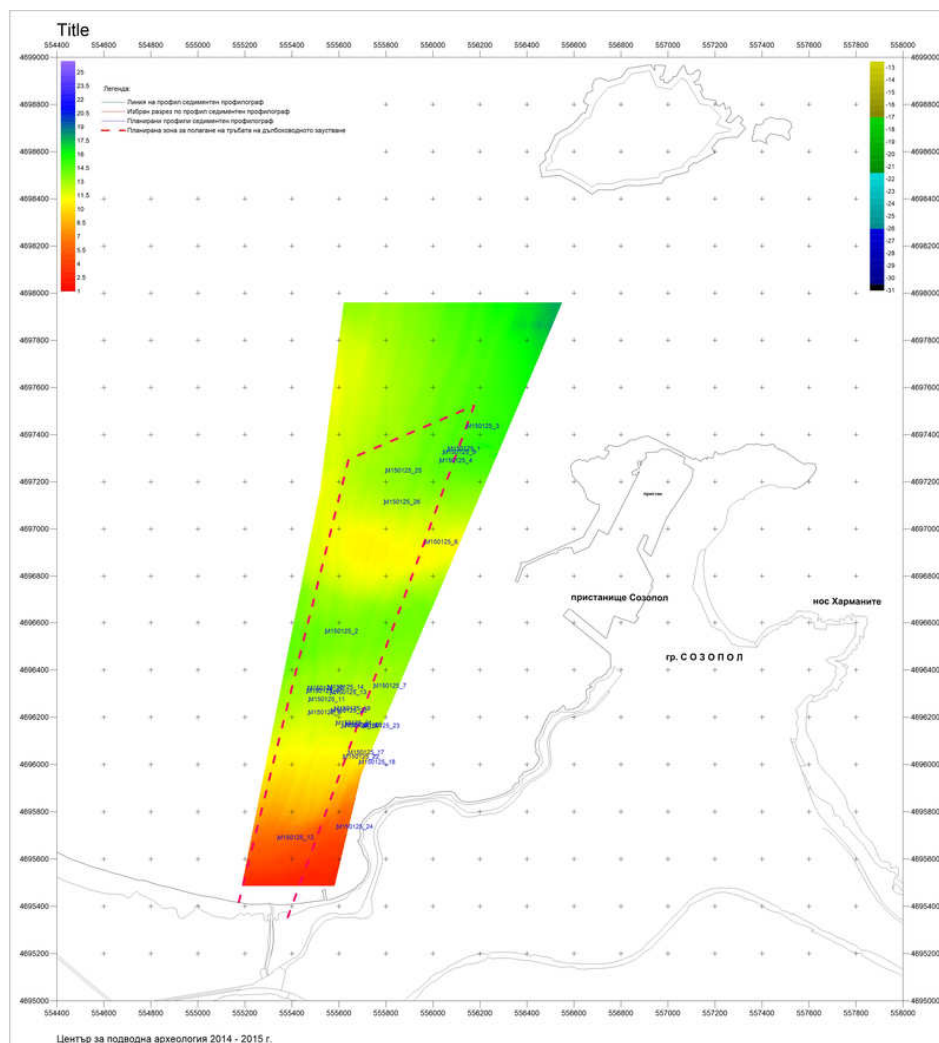
***CENTRE FOR UNDERWATER ARCHAEOLOGY,
K.Velkovsky, L. Trendafilova***

SIDE SCAN SONAR SURVEY - TARGETS



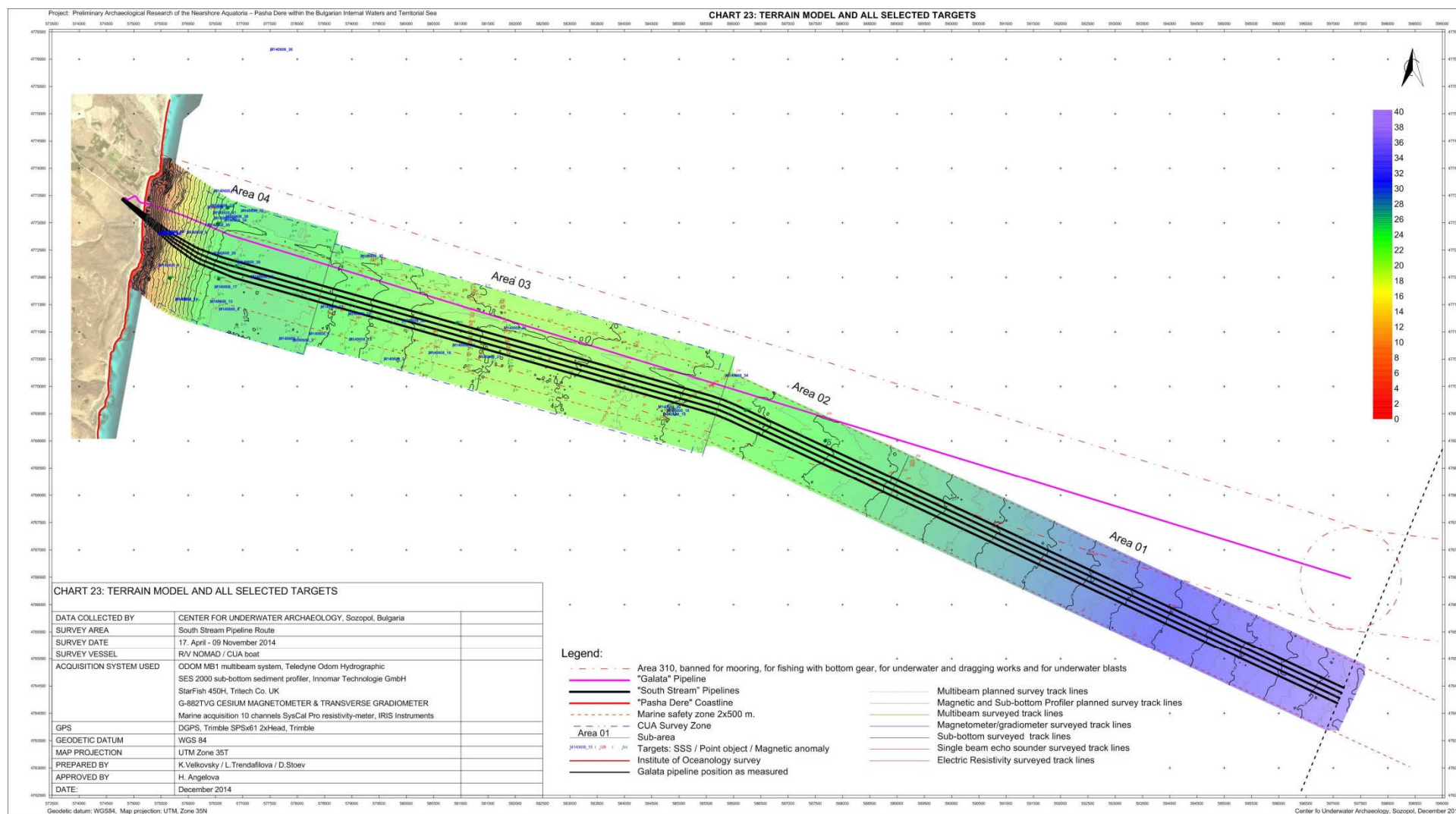
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SIDE SCAN & MULTIBEAM SURVEY



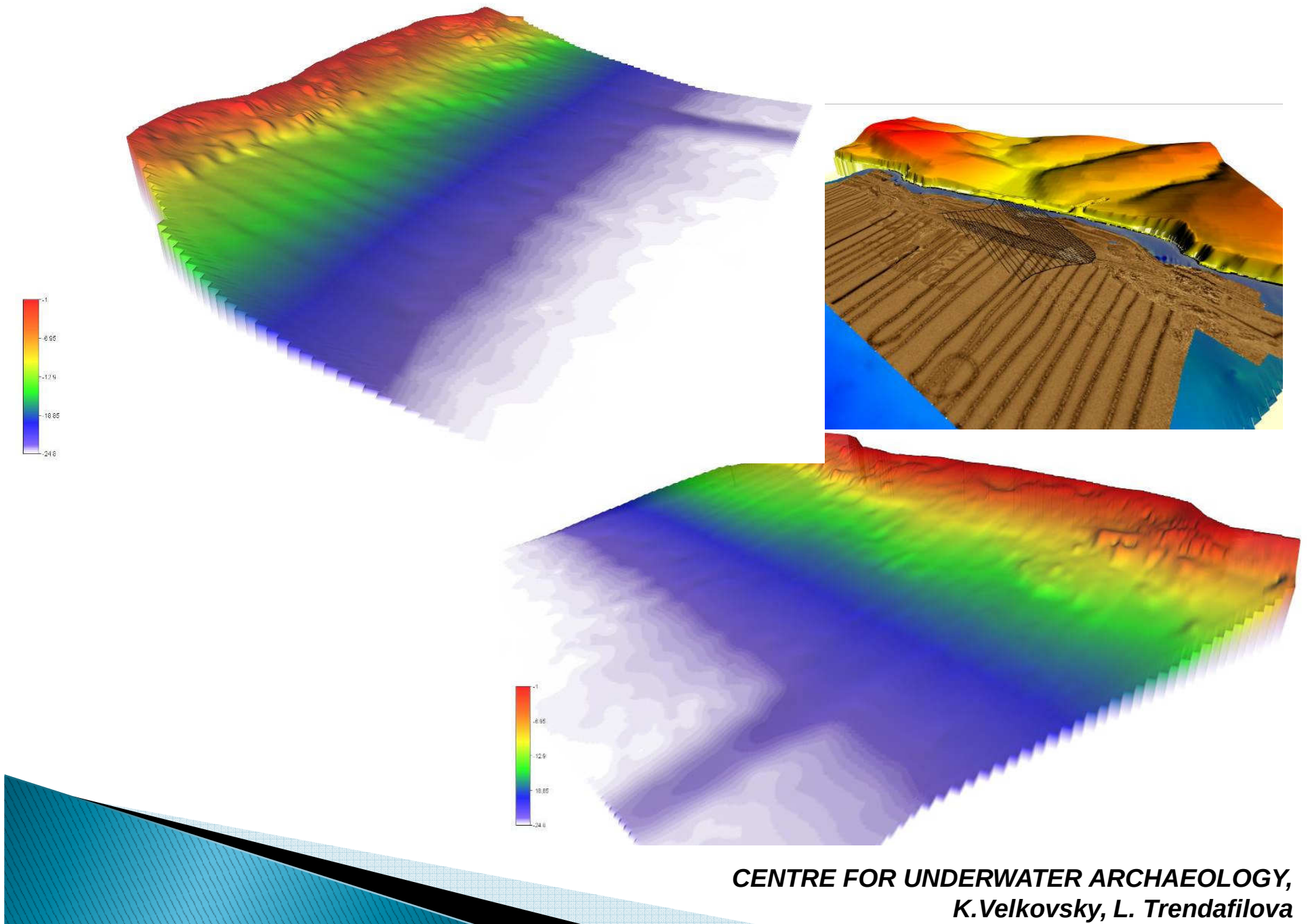
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MULTIBEAM SURVEY – Pasha Dere@Varna



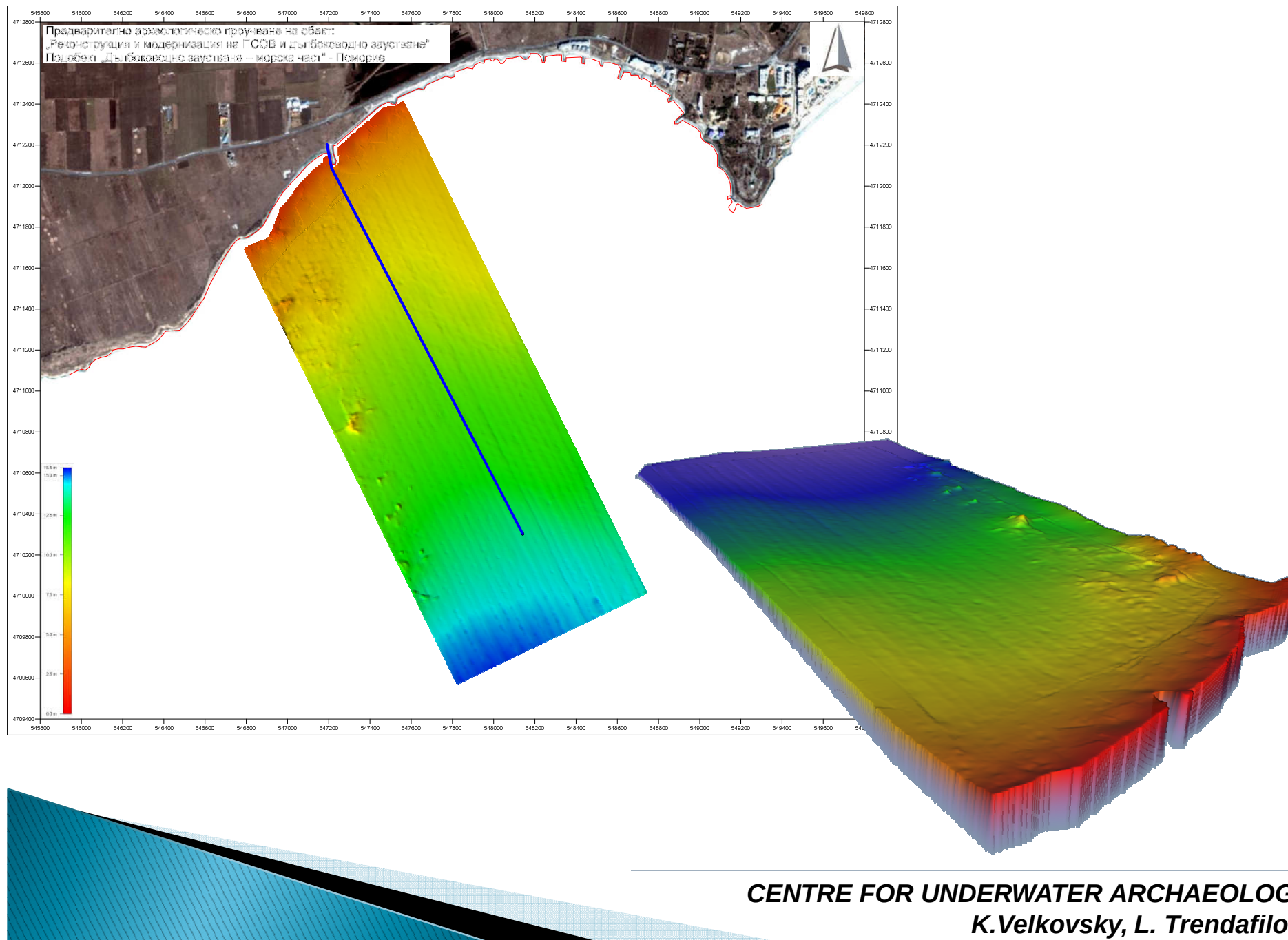
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MULTIBEAM SURVEY – Pasha Dere@Varna / 3D Digital Terrain Model

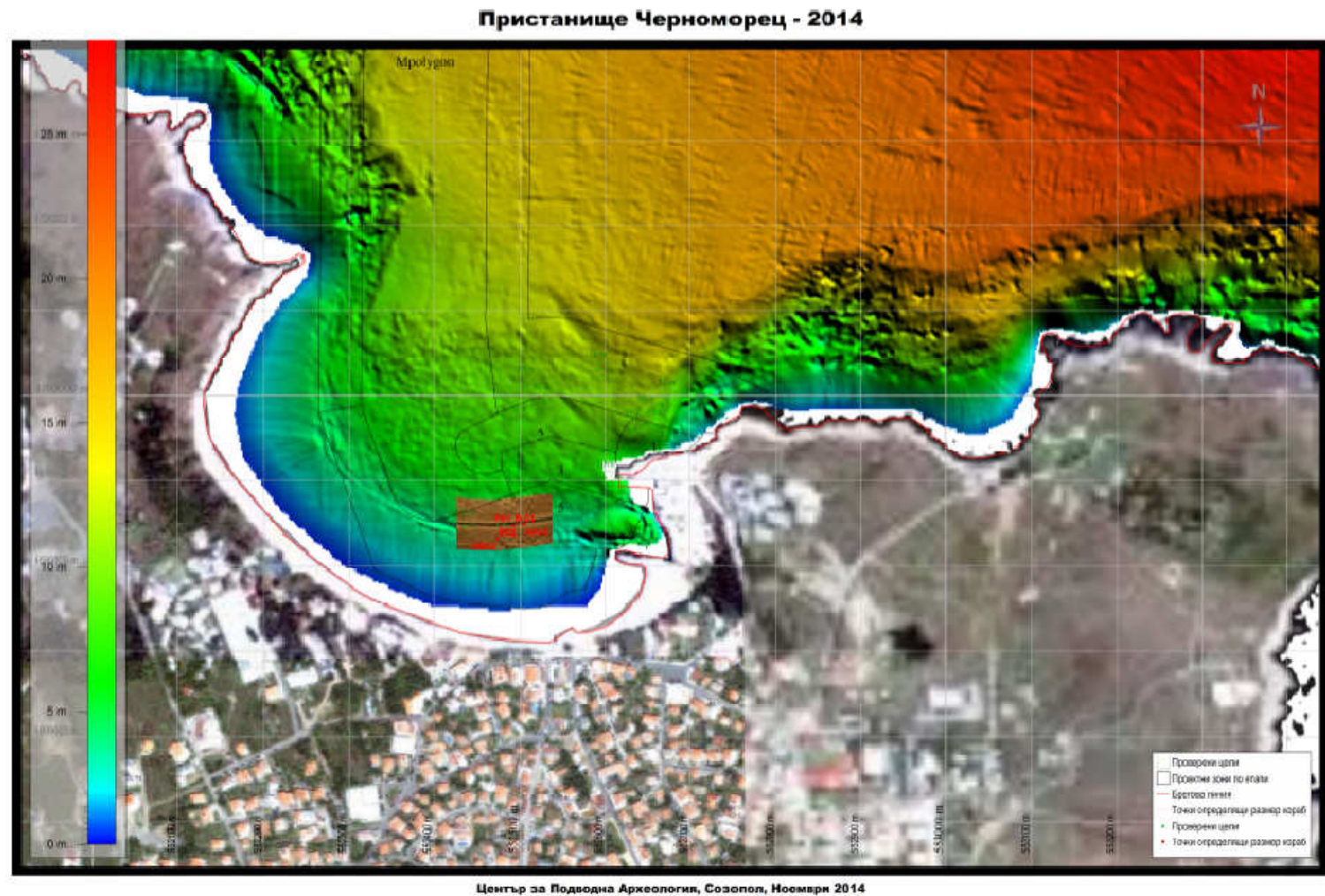


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MULTIBEAM SURVEY – Pomorie #01

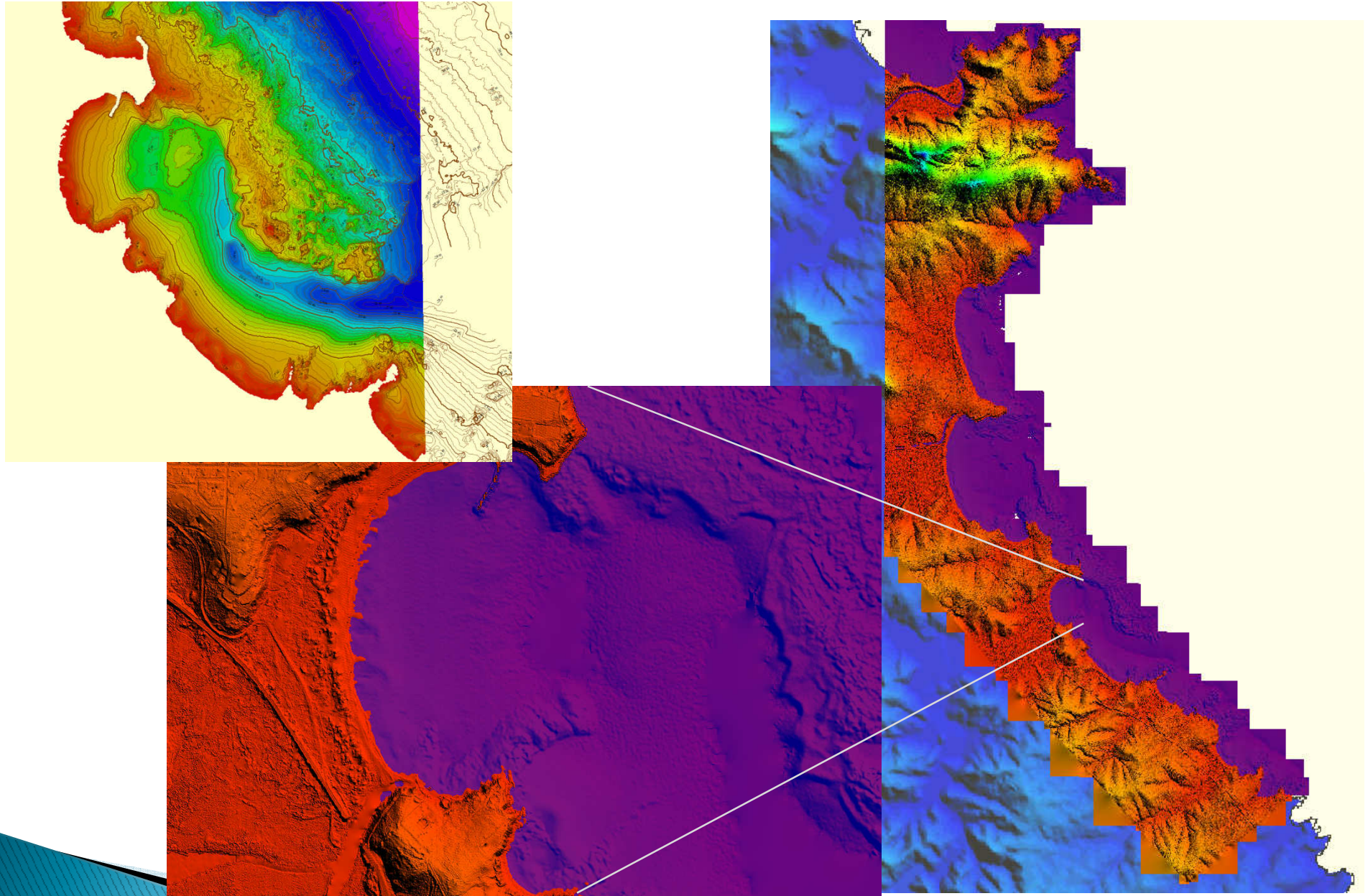


MULTIBEAM SURVEY – Chernomorets



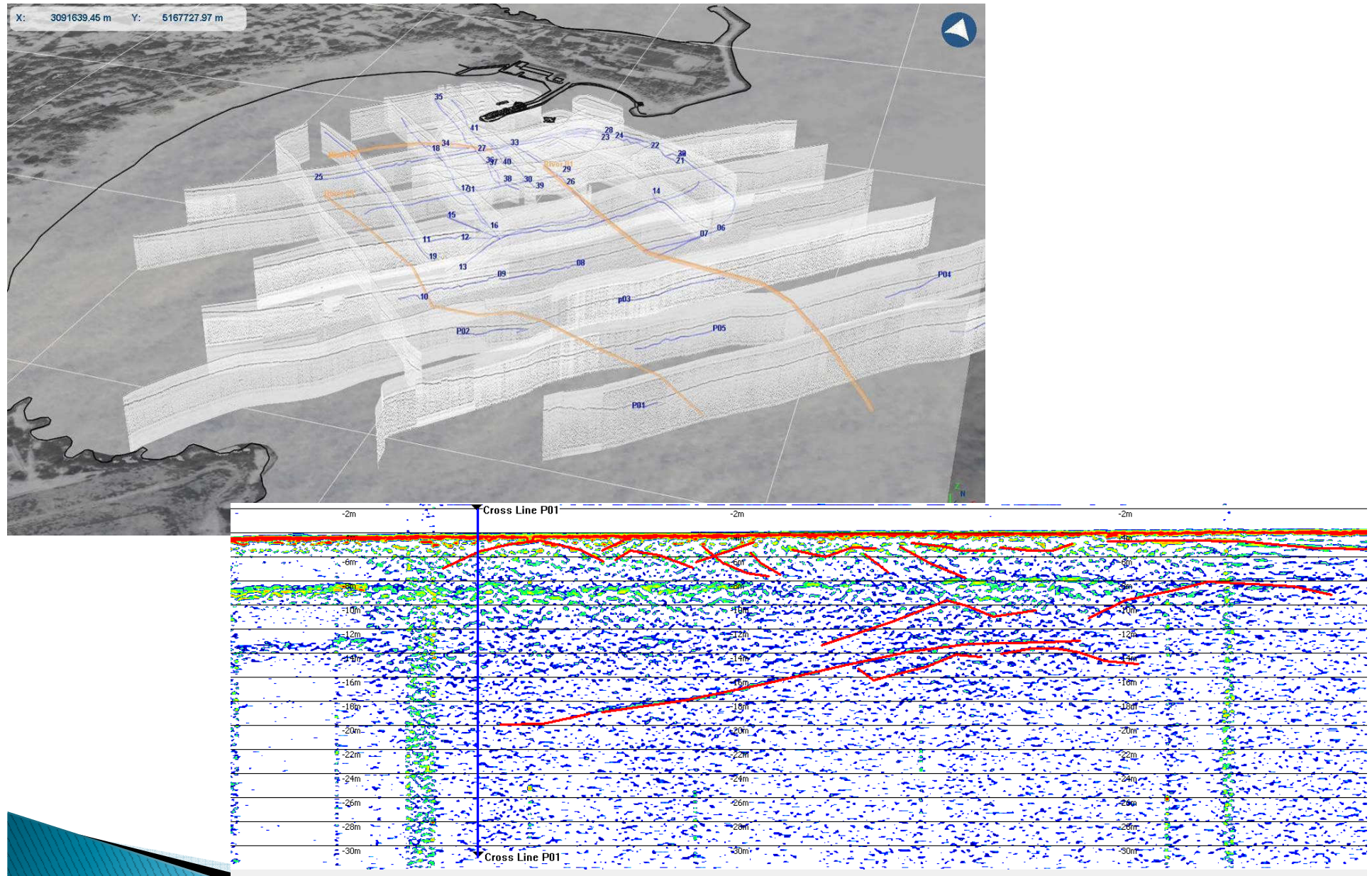
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K.Velkovsky, L. Trendafilova

MULTIBEAM & LiDAR SURVEY – Kiten



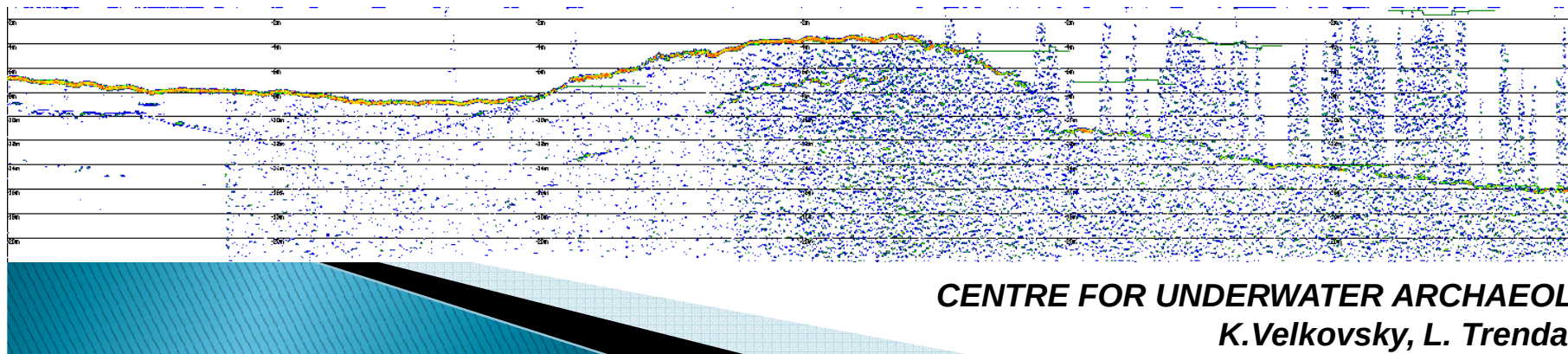
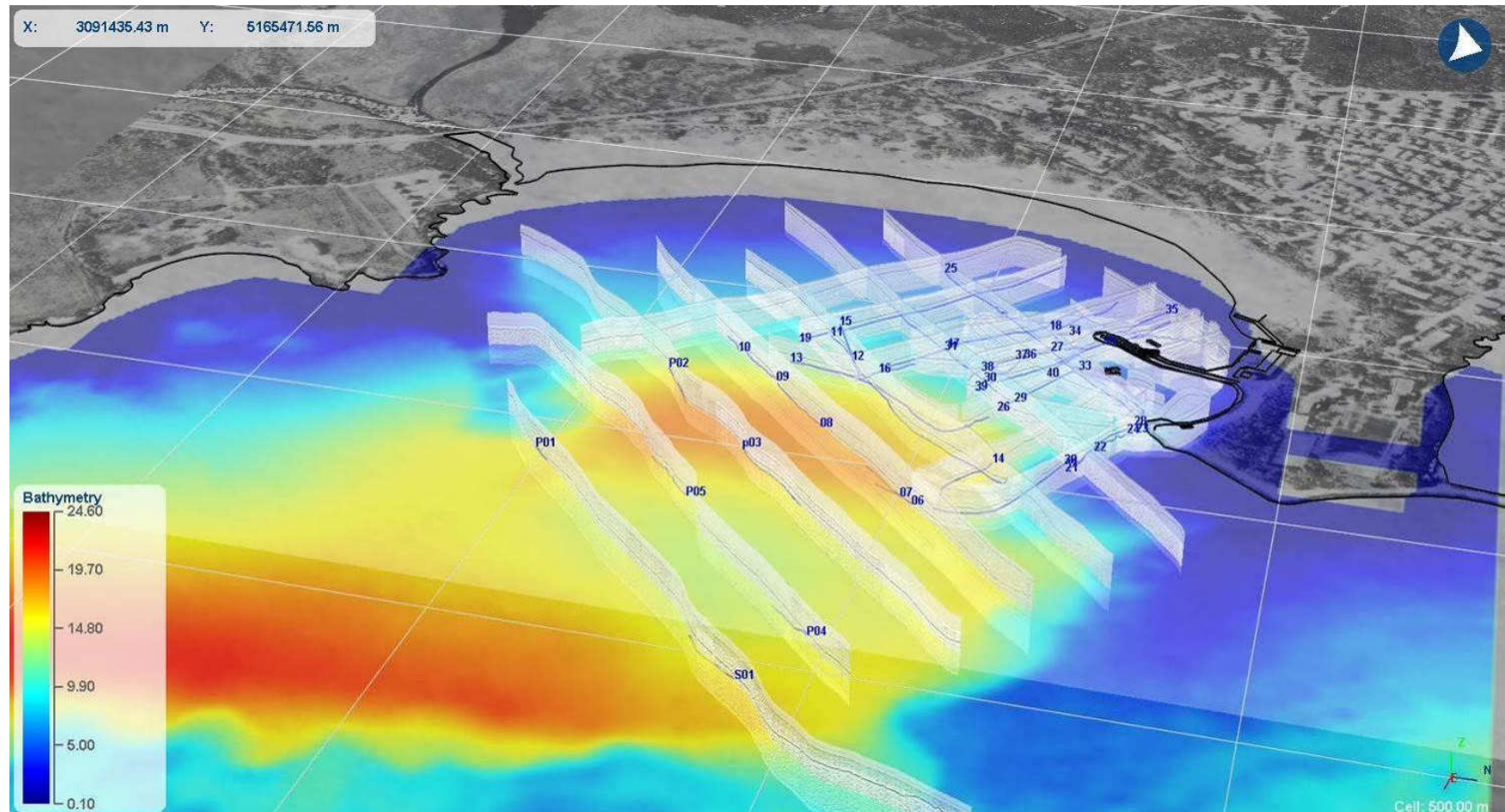
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SUB-BOTTOM SURVEY – Kiten



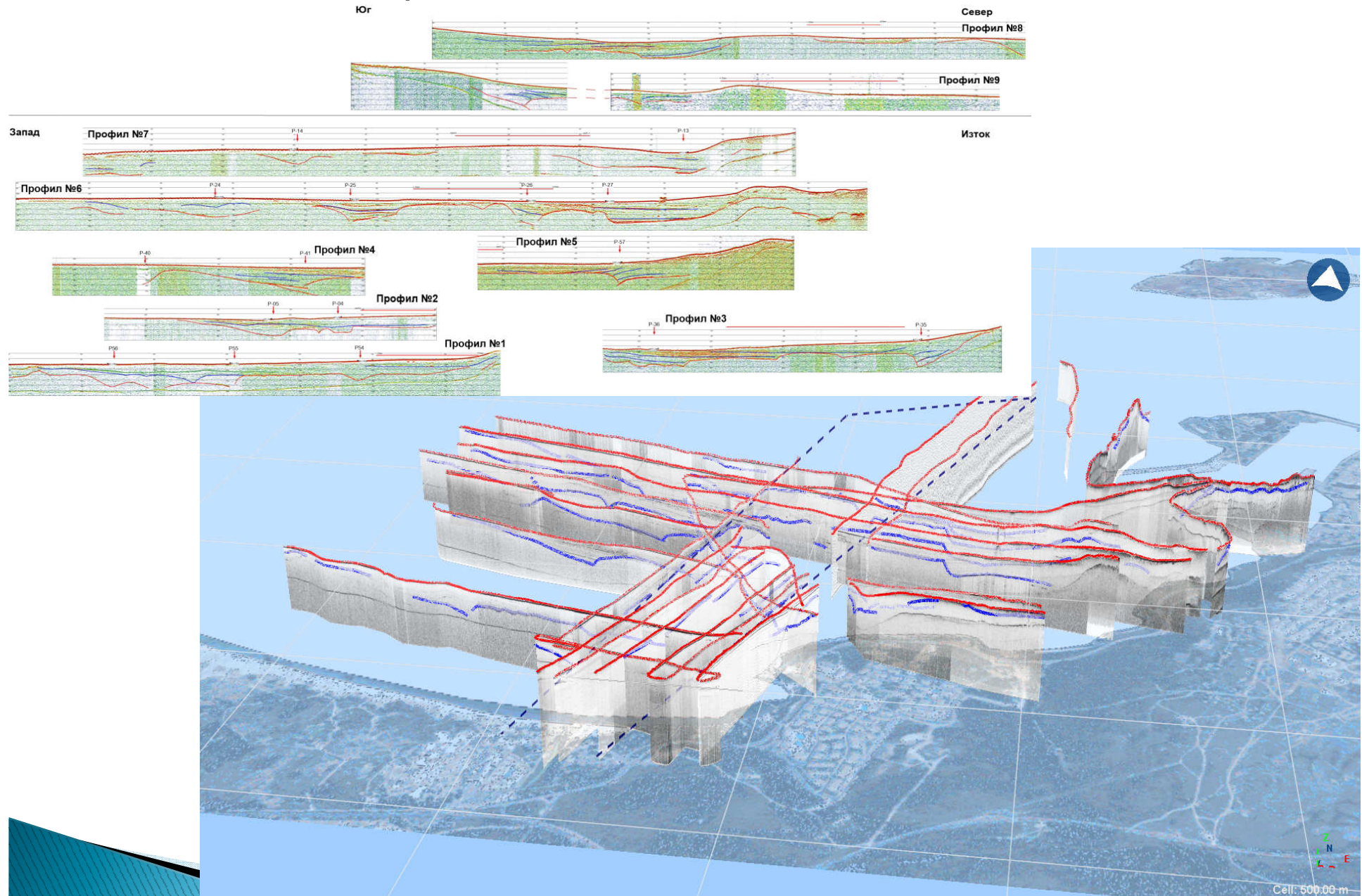
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SUB-BOTTOM SURVEY – Kiten



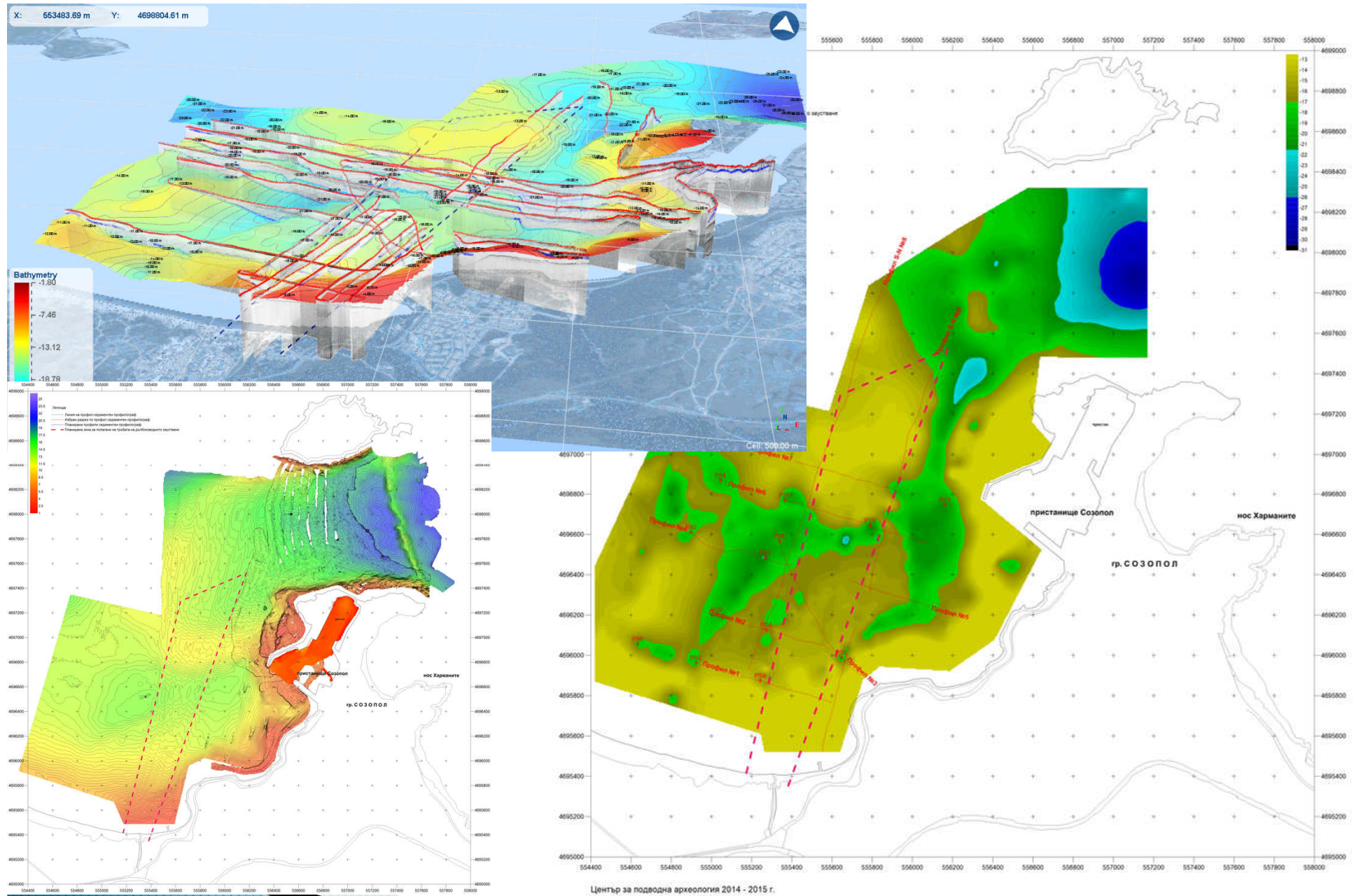
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SUB-BOTTOM SURVEY – Sozopol



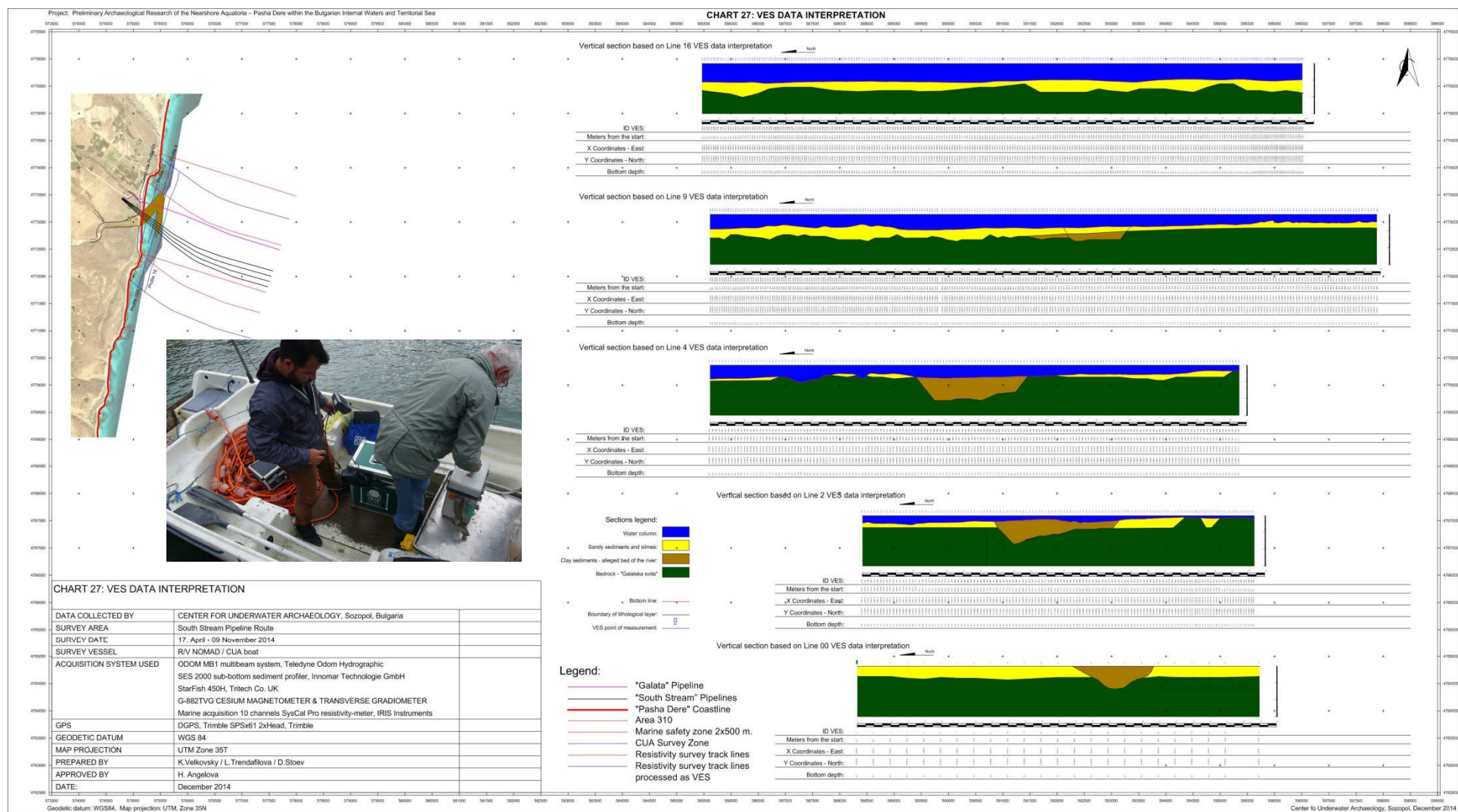
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SUB-BOTTOM SURVEY – Sozopol / reconstruction of the palaeo-terrain by sub-bottom data



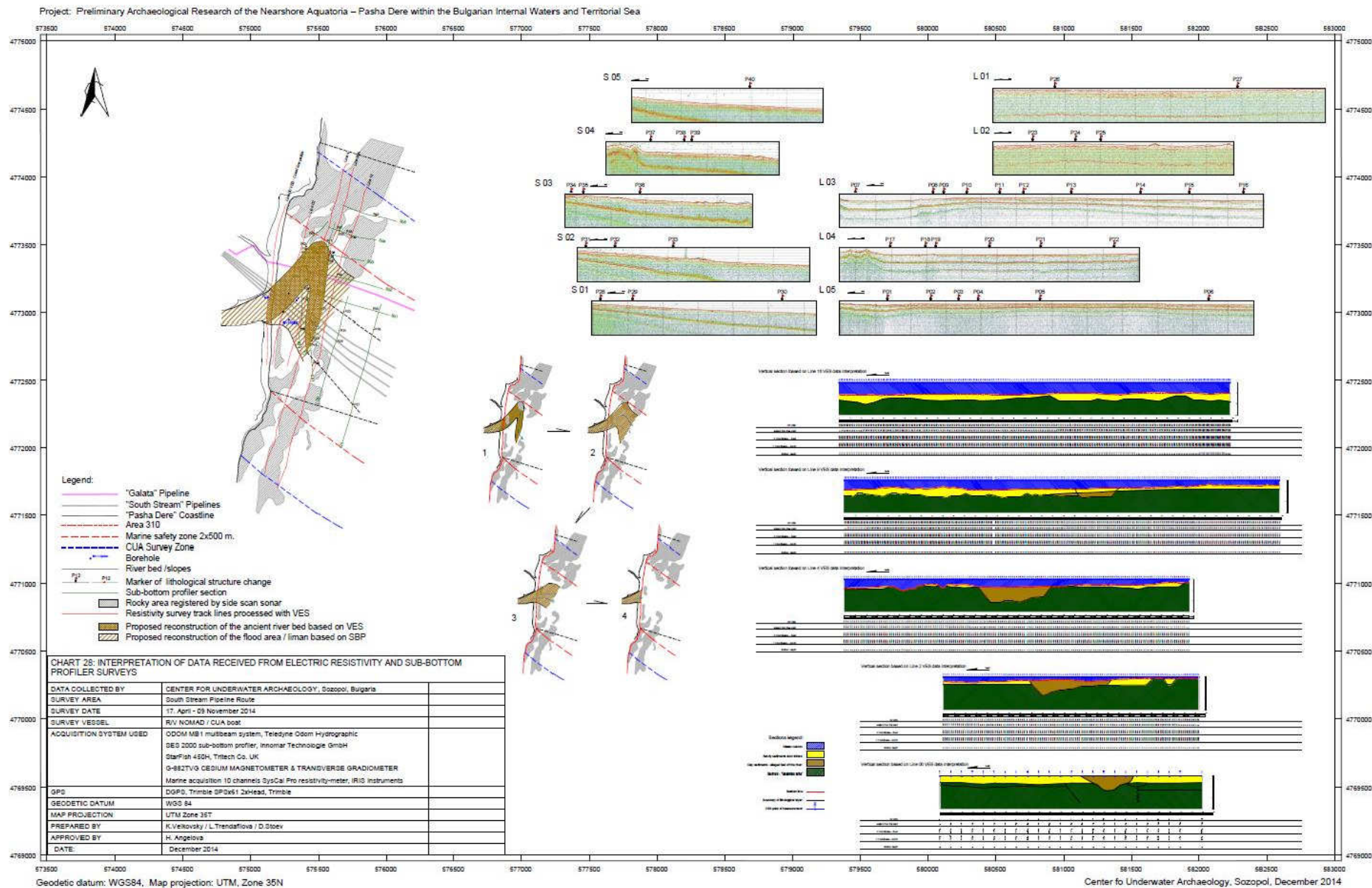
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Electro-resistivity Survey – Pasha Dere @ Varna



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K.Velkovsky, L. Trendafilova**

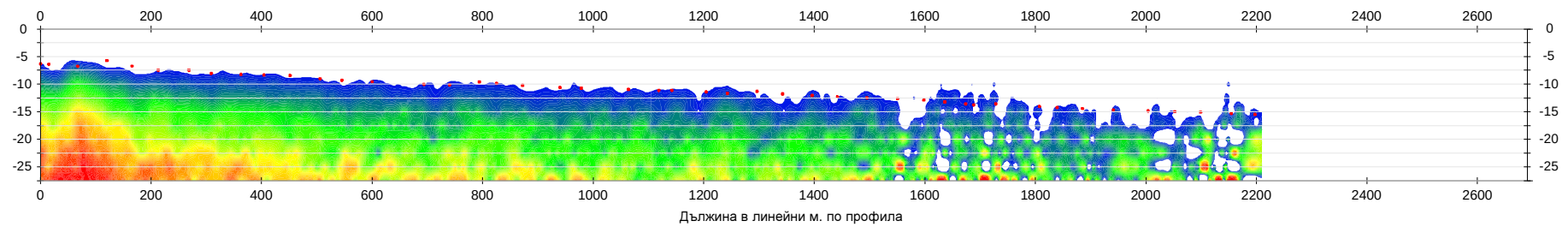
Complex interpretation Electrical&Sub-Bottom data – Pasha Dere @ Varna



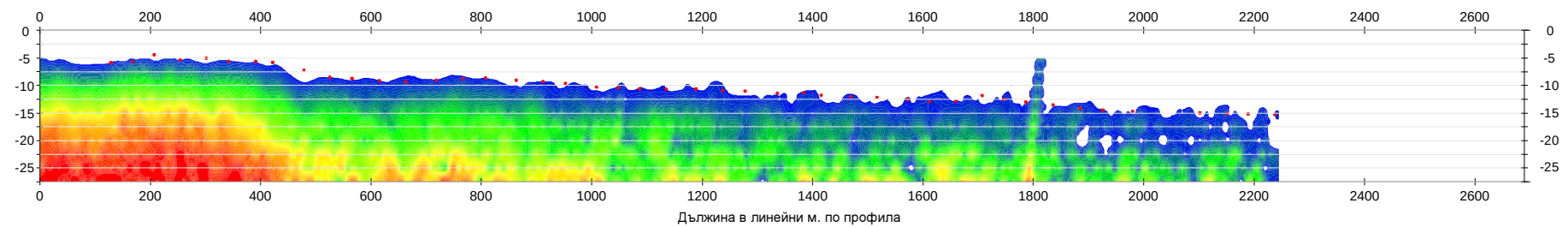
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Electro-resistivity Survey – Pomorie #01

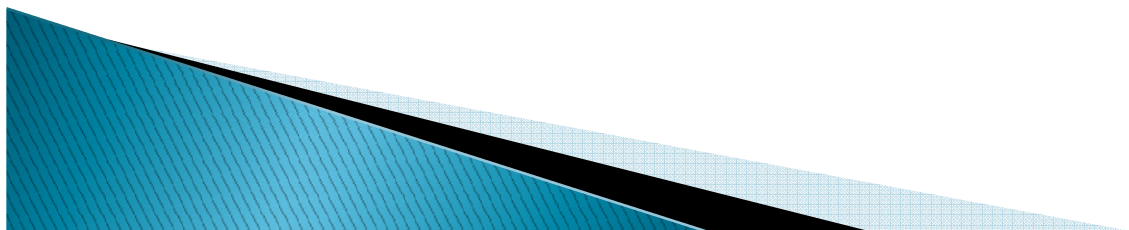
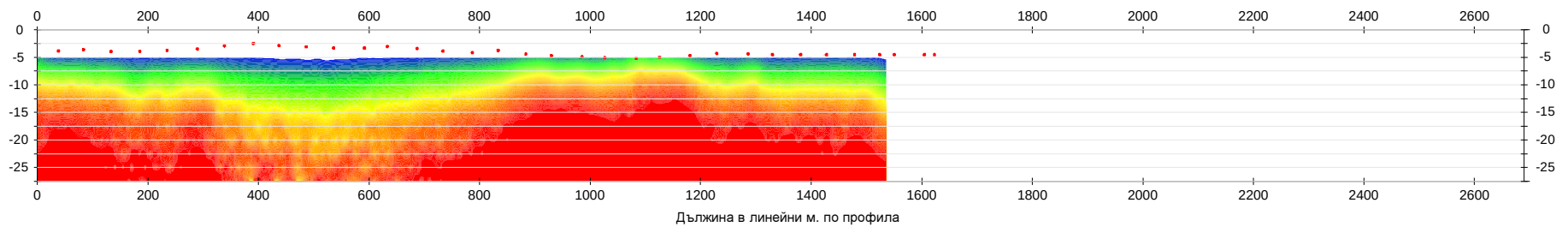
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Line 15

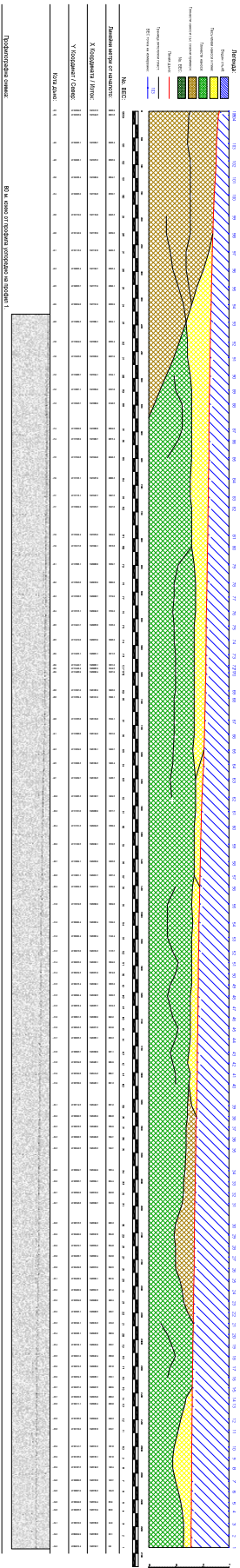


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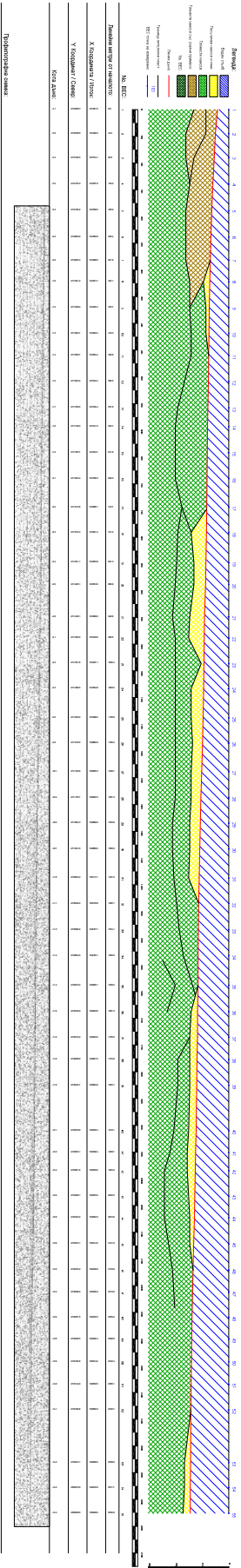


Electro-resistivity Survey – Pomorie #01

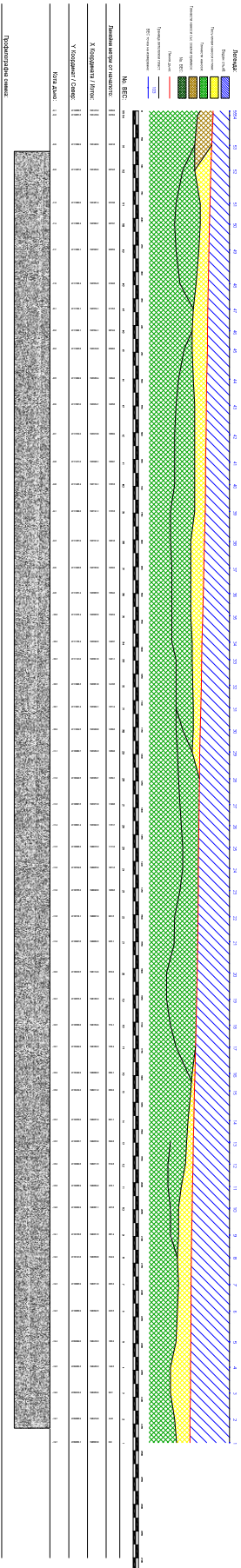
Вертикален разрез на интерпретирани данни от гео-електрическо профилиране по Профил 1.



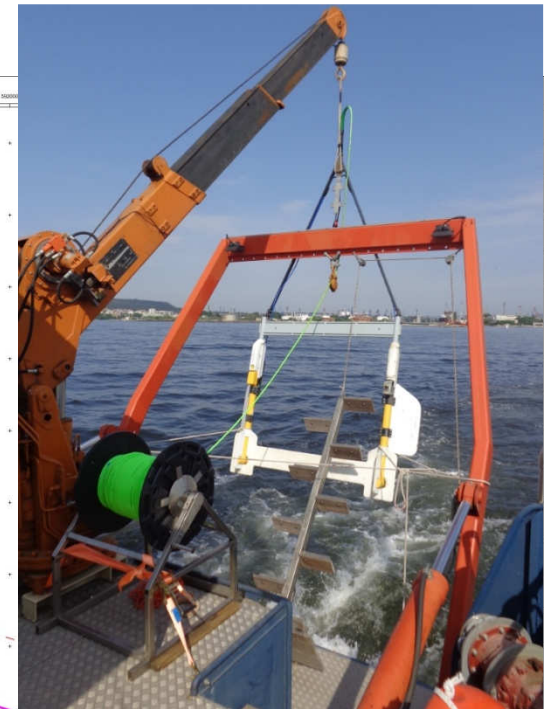
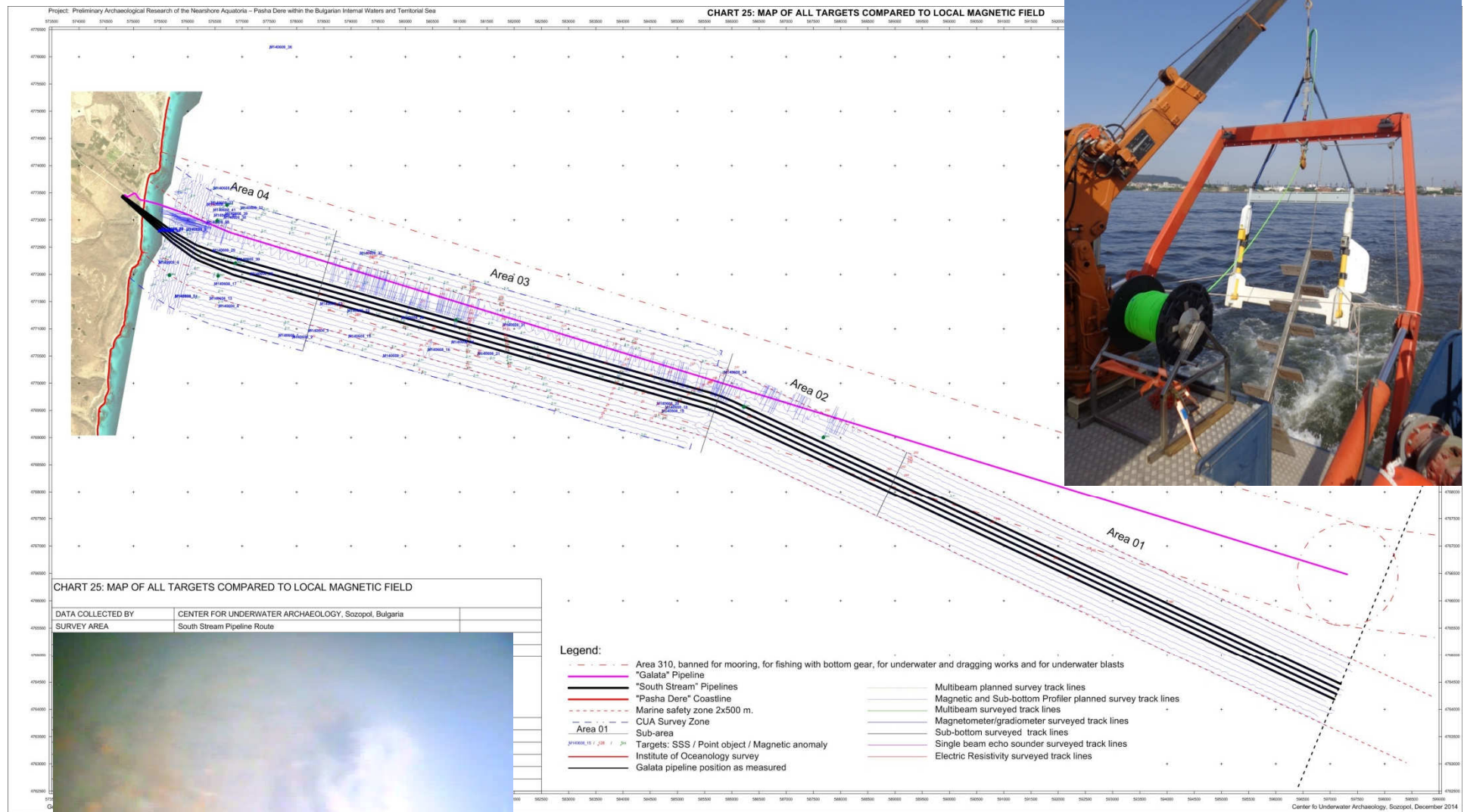
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Вертикален разрез на интерпретирани данни от гео-електрическо профилиране по Профил 5.

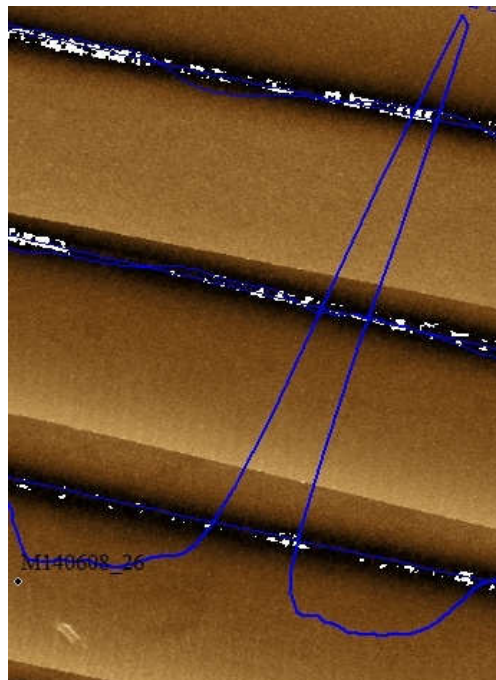
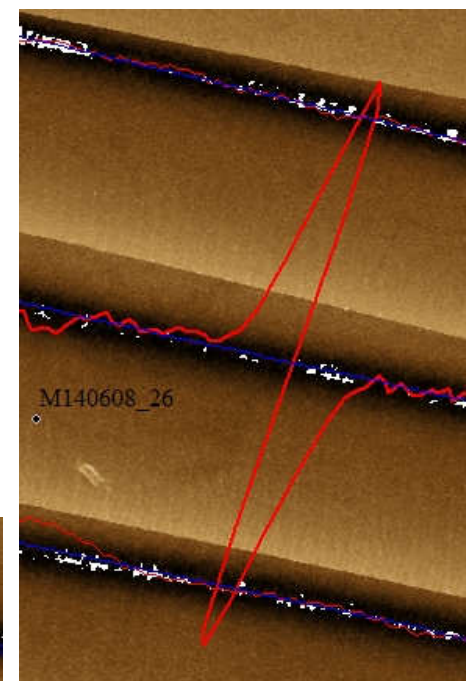
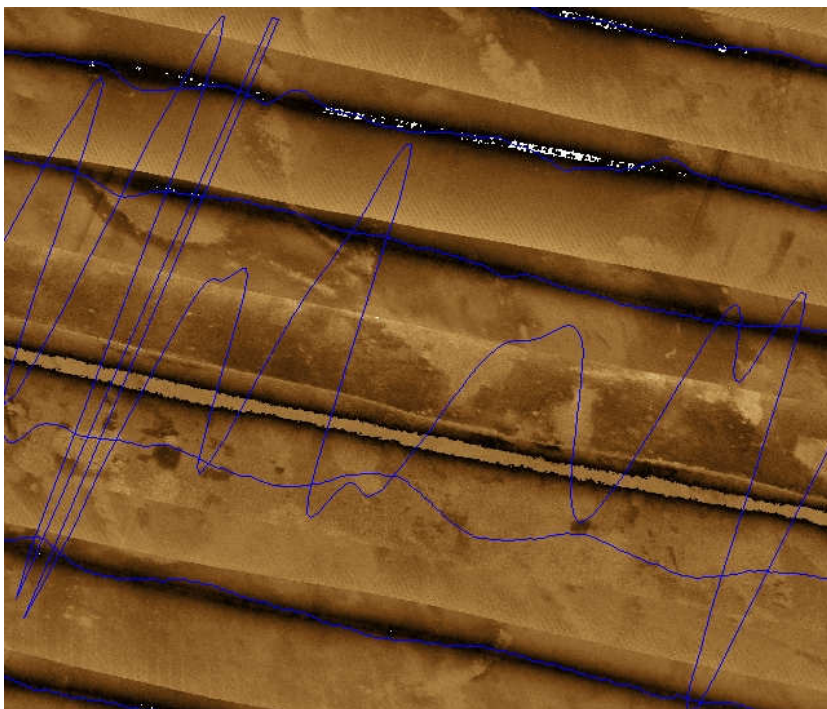


Magnetic & Magnetic Gradient Survey – Pasha Dere @ Varna



**CENTRE FOR UNDERWATER ARCHAEOLOGY,
K.Velkovsky, L. Trendafilova**

Magnetic & Magnetic Gradient Survey – Pasha Dere @ Varna



***CENTRE FOR UNDERWATER ARCHAEOLOGY,
K.Velkovsky, L. Trendafilova***



THANK YOU !

**CENTRE FOR UNDERWATER ARCHAEOLOGY,
K.Velkovsky, L. Trendafilova**

**Facebook / Centre for Underwater Archaeology
<http://museum.cua-sozopol.com/>**

www.kvelkovsky.eu