mélange on top. Westward directed ophiolite obduction and thrusting in Jurassic time largely occur in the Dinaridic-Albanide realm, but the exact age of the emplacement is still a matter of discussion: Middle to early Late Jurassic or latest Jurassic to earliest Cretaceous. Our new data confirm (a) an allochthonous derivation of the ophiolitic mélange and the overlying ophiolite nappes (obduction), (b) the Middle to early Late Jurassic formation of the radiolaritic-ophiolitic mélange in the Dinaridic Ophiolite Belt and (c) their westward transport in Jurassic time. A younger, second westward thrusting phase, is documented by underlying radiolarite sequences with intercalated shallow-water debris of Kimmeridgian to Tithonian age. These occurrences are tectonic windows below the overthrusted ophiolitic and carbonate mélanges. This clearly shows a polyphase thrusting of the ophiolithic mélange in westward direction.

An autochthonous origin of a Triassic Ocean between the Outer Dinarides and the Drina-Ivanjica Unit as northward continuation of Pelagonia/Korabi units, as proposed by another group of authors, can be excluded. This would exist in the lagoonal area of the Triassic carbonate platforms in the Dinarides, separating for example in Late Triassic time the restricted lagoon (Hauptdolomit) from the open lagoon (Dachstein Limestone).

Genetic significance of the Cretaceous black and red shales from the Eastern Carpathians (Romania)

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In the outer nappe systems of the Eastern Carpathians, namely the Moldavids, marine Upper Cretaceous red sediments overlay the Lower Cretaceous organic-rich black shales. The oldest parts of the black shale units are composed of Upper Valanginian-Upper Barremian hemipelagic and pelagic muddy siliciclastic rocks and carbonate muds, commonly intercalated with fine-grained turbidites. These features indicate an abyssal plain setting. During the sedimentation of the middle part of the black shale units, in the Late Barremian-Early Albian interval, the depth of the basin increased. This assumption is based on the occurrence of mainly hemipelagic sediments, with a few thin turbiditic intercalations.

The youngest part (Albian *pro parte*) of the black shale units is characterized by a turbiditic sedimentation, with mainly sandy sequences of middle and lower deep-water fans. A continuous decreasing of the basin depth is to be assumed. The presence of the authigenic glauconite in the Albian sandstones suggests a palaeoenvironmental change, linked to the occurrence of oxygenated turbidity current circulation.

A significant shift in the sedimentation regime of the Eastern Carpathian Moldavids took place in the Late Albian, when Cretaceous Oceanic Red Beds (CORB) occurred. This type of sedimentation lasted up to the Coniacian. The lower part of the CORBs, composed of radiolarites intercalated with variegated shales, pyroclastic tuffs and thin sandstones, is interpreted as a hemipelagic and pelagic sedimentation in an abyssal plain environment, where rarely turbidites occurred. Upwards, there are mainly burrowed variegated red and green shales. The youngest parts of CORBs are characterized by increased thickness and frequency of the turbidites. While the main part of the CORB is carbonate-free or has very low carbonate content, the upper part of these strata becomes rich in marls and mudstones, indicating a decreasing of the basin depth.

The accumulation of the black shales in the Eastern Carpathians during the Late Valanginian-Late Albian interval is linked to the existence of a small, silled basin of the Moldavian Trough, in which restricted circulation led to the density stratification of the water column, resulting in the deposition of anoxic Lower Cretaceous sediments (i.e., the black shales). Because of the tectonic deformation that took place during the Late Albian time, the restricted circulation changed to an open circulation regime in the Moldavian Trough. Hence, the anoxic regime was progressively replaced by an oxic one, across the Albian-Cenomanian boundary interval. The beginning and the end of the CORBs in the Moldavid units depend thus on various palaeogeographic and palaeoenvironmental settings, and it was controlled by the regional tectonic activity.

An Evaluation of High Resolution Mapping Techniques for Documenting Submerged Archaeological Sites

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The capabilities of robotic vehicles to locate and map submerged cultural sites has drastically improved in recent years. Benefiting from advances in high frequency sonar systems, high dynamic range cameras and the accompanying data processing techniques, the archaeological community now has access to data products approaching centimeter level accuracy over scales of 100's to 1000's of square meters. There are, however, many open issues stemming from the inherent capabilities of acoustic and optical mapping that need to be explored to bridge the gap between what the scientific and archaeological communities expect for quantifying and documenting these often complex sites.

The resolution of the data products is typically spatially varying and affected by sampling density, perspective limitations, surface and sediment characteristics and water clarity. As a result it is often difficult to capture all of the potential errors and distortions in the data products in a clear and repeatable manner.

This paper will present results from several years of field surveys in the Aegean and Blacks seas working at sites in water depths between 50 and 600 meters. Many of these sites were recently located using side scan sonar searching techniques and then subsequently mapped using the Hercules ROV system. The sensor suite for high resolution mapping has included both 675 kHz and 2250 kHz multibeam sonars, a 675 kHz pencil beam scanning sonar, 12bit stereo paired digital still cameras and a 532 nm structured light laser sheet. The accompanying navigation data have been collected during structured surveys with a Doppler velocity log (DVL), fiber optic gyroscope attitude sensor and a quartz crystal depth sensor. These data can be used to create site photomosaics, bathymetry maps and hybrid optical and acoustic texture mapped representations, each of which can be effective as components in a overall site characterization and documentation process.

Using navigation refinement techniques derived from the Simultaneous Localization and Mapping (SLAM) concept common in the robotics community we have been able to create gridded bathymetry maps to half-centimeter spacing with high frequency multibeam sensors and structured light imaging techniques. This level of detail can now enable the accurate measurement of handle sized features on amphorae and detect subtle variations in the sediments around a wreck. Hybridizing this with stereo vision has also provided insight into the shape and textural characteristics of objects as well as the fundamental characteristics of the visual and acoustic sensing modalities. Our challenge moving forward is connecting and enhancing these capabilities in line with the expectations of the archaeological community, while respecting that the primary funding, expertise, and applications for the technology will continue to be in the more established oceanographic sciences. This begins with an assessment of the effectiveness of different technologies for various archaeological objectives, which we define according to the rubrics of identification, characterization, mitigation, investigation, and excavation. Each approach places progressively more demanding requirements on the technology and laborintensive processing to translate the oceanographic data into comprehensible archaeological results. In order for site recording to be worthwhile, therefore, the capabilities and limitations of the technology must be factored into the research design and the archaeological objectives of the expedition. A survey that sets out with the goal