X-RAY MICROTOMOGRAPHY APPLICATION TO A PREDICTIVE EVALUATION OF CORALLINE ALGAE STRUCTURE

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INTRODUCTION

The red calcareous algae (Corallinales) play a major role in submarine ecosystems. These algae are widely distributed from the warm regions to the cold ones, and from the present to the Terziary fossils thalli [1]. Thus these plants are extremely useful as paleomarkers in stratigraphic research. Concerning their presence in the world, the Corallinales have to be considered a very important tool for structural and functional investigations for environmental evolution. The goal of this study is to set up a non-invasive method to analyze samples when they seemingly lack features to enable a correct identification as well as a reliable ecological interpretation.

MATERIAL AND METHODS

The samples have been collected in the Gulf of Trieste; air dried and transferred to Elettra, where two facilities for X-ray microtomography (μ-CT) are available: the SYRMEP beamline and the TOMOLAB, a new μ-CT laboratory based on a microfocus source [2]. μ-CT is one of the most advanced techniques in the field of non-destructive evaluation tests [3]. The SYRMEP beamline, delivering monochromatic synchrotron radiation in the energy

Figure 1. Virtual slice of a rhodolith sample (see photo insert) obtained from the TOMOLAB μ-CT.

Figure 2. SEM image corresponding to a 100μm x 80μm area close to the fourth gallery in the region of interest.

Figure 1

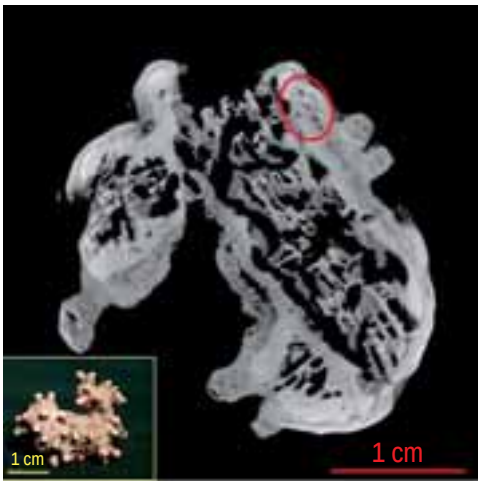
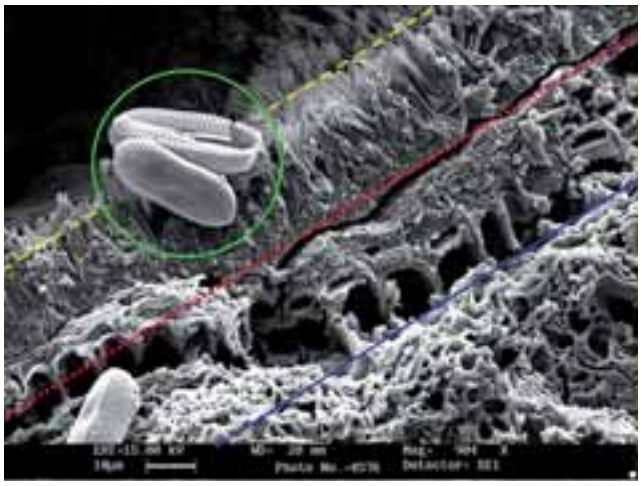


Figure 2



range 8-35 keV, is suited to study calcareous algae with a maximum thickness of about 1.5 cm. The TOMOLAB source operates in a complementary range (40-130 kVp) and, due to its larger field of view, it can examine the whole sample, with a dimension up to 3-4 cm, in a single CT scan. Our approach was, first to investigate the samples at TOMOLAB and then to examine a subset of thinner samples containing some relevant features, at the beamline. The 3D volume rendering obtained by both methods was used as a predictive method to find the best orientation of a micro biopsy for the subsequent structural analysis by SEM at CSPA.

RESULTS

Thanks to the µ-CT studies, for the first time the hidden presence of reproductive characters (e.g. conceptacles) immersed in the thalli has been revealed using a non invasive /destructive method. Figure 1 shows a virtual slice of a rhodolith sample obtained from a TOMOLAB µ-CT (80 kV, I=200 µA, filter =1mm Al, magn.= 1.7, focal spot size = 12µm): in the system complexity, one can recognize the structure of the interacting organisms, living together in this small community (micro-biocenosis) mainly built by the coralline algae and the anthozoans. On this basis a very interesting site was highlighted for a deeper analysis using SEM. The attention has been focused on four holes localized at the upper part of the sample, next to the surface (in Figure 1 the region of interest indicates the target for our further investigation), galleries probably produced by a serpulid. In Figure 2 the SEM image corresponding to a 100µm x 80µm area close to the fourth gallery is shown. The layered distribution of diatoms (green circle), serpulids (yellow dashed line), coralline algae (red dotted line), cyanobacteria (blue solid line) are clearly visible on the border of this gallery. Figure 3 shows a slice of the same sample obtained by a µ-CT performed at SYRMEP in the phase contrast mode (E=26 keV, sample-detector distance = 30cm) on a limited portion of sample. Thanks to the phase contrast effects, the beam monochromaticity and the lower X-ray energy, the visibility of the inner structures is further enhanced. In this image it is possible to identify a succession of bands

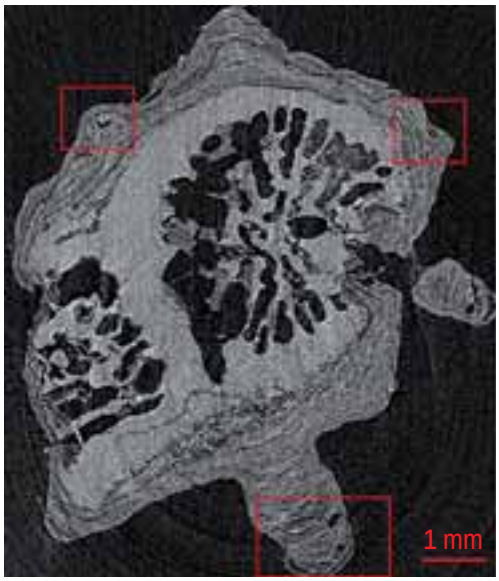


Figure 3. A virtual slice obtained from the SYRMEP beamline µ-CT scan.

produced during the progressive calcification of the cell walls. The early identification of the reproductive organs immersed in the thallus, identified by the red boxes in the image, allowed a prompt and correct determination of the life cycle of our specimen.

CONCLUSIONS

The high quality of µ-CT images, in terms of anatomical resolution, has led to the success of this exploratory phase [4]. This application reveals an unexplored research field characterised especially by the integrity of the samples.

References

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