

A Spectroscopic Method for Identifying Biotic Carbonates in Terrestrial Rocks and Application to Mars

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Searching for traces of extinct and/or extant life on Mars is one of the major objectives for remote-sensing and in-situ exploration of the planet. In previous laboratory works [1], [2], [3], we have investigated the infrared spectral modifications induced by thermal processing on different carbonate samples, in form of fresh shells and fossils of different ages, whose biotic origin is easily recognisable (see Table 1). The goal was to discriminate them from their abiotic counterparts.

Sample Name	Geologic period/epoch
<i>Tellina exigua</i>	Max 1 years old
<i>Cardites antiquata</i>	Max 10 years old
<i>Pecten sp.</i>	Middle Pleistoc. 0.8-0.1 Ma
<i>Ostrea sp.</i>	Lower Pleistoc. 1.8-0.8 Ma
<i>Arctica islandica</i>	Lower Pleistoc. 1.8-0.8 Ma
<i>Myriapora truncata</i>	Lower Pleistoc. 1.8-0.8 Ma
<i>Clypeaster</i>	Miocene 20-18 Ma
<i>Haliotis lamellosa</i>	Oligocene 34-23 Ma
<i>Xenophora</i>	Pleistocene 1.8-0.1 Ma
<i>Natica</i>	Pleistocene 1.8-0.1 Ma
<i>Anomia</i>	Oligocene 34-23 Ma
<i>Trochidae sp.1</i>	Oligocene 34-23 Ma
<i>Trochidae sp.2</i>	Oligocene 34-23 Ma
<i>Potamitidae sp.</i>	Oligocene 34-23 Ma
<i>Ampullinopsis cr. 1</i>	Oligocene 34-23 Ma
<i>Ampullinopsis cr. 2</i>	Oligocene 34-23 Ma
<i>Ampullinopsis cr. 3</i>	Oligocene 34-23 Ma
<i>Cerithium</i>	Oligocene 34-23 Ma
<i>Rudista</i>	Cretaceous 145-65 Ma
<i>Ortoceras</i>	Devonian 416-359 Ma
Fossil stromatolites	Meso-proter. 1.6-1.0 Ga

Table 1

Analyzed carbonate samples (CaCO_3 , aragonite and calcite) in form of fresh shells and fossils of different ages.

In general, it is difficult to identify biotic signatures, especially when the organisms inducing the carbonate precipitation have low fossilization potential (i.e. microbes, bacteria, archaea). Ac-

tually a broad variety of microorganisms are implicated in the carbonatogenesis, and their direct characterization is very difficult to be evaluated by traditional methods, both in ancient sedimentary systems and even in recent environments.



Figure 1. Study section (panel A) and general view of the Rossano Basin (panel B) showing the position where six samples have been collected. The black box in B indicates the location shown in A.

In the present work we apply our analysis to problematic carbonate samples - collected from the Calcare di Base (CB) formation, which crops out in the Rossano Basin (Northern Calabria, Italy) and formed in the Late Miocene - in which there are no clear evidences of controlled or induced biomineralization (see Fig. 1). This analysis indicates a very likely biotic origin of the aragonite samples under study, in perfect agreement with the conclusion previously reported by Guido et al. [4], who followed a completely different approach based on a complex set of sedimentary, petrographic, geochemical and biochemical analyses. We show that our method is actually reliable for discriminating between biotic and abiotic carbonates [5], and therefore it is a powerful tool

for the search of life on Mars in the next generation of space missions to the planet. We are now applying our analysis to different kinds of microbialites (stromatolites, thrombolites and leiolites) in order to test our method with simpler form of calcitic formations more likely to be found on Mars.

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