ARAGONITE SEDIMENTATION IN A RESTRICTED MARINE ENVIRONMENT (MLJET LAKES, ADRIATIC SEA)

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ABSTRACT

Unusual sedimentation of aragonite mud in the Malo and Veliko jezero on Mljet island is discussed. Earlier investigations (1) already suggested that aragonite mud ("drewit") was being deposited in Malo Jezero. However, Seibold (2) denied the existence of aragonite. Here we present results that unequivocally confirm the existence of aragonite needles in suspended matter and in the Lake sediments. The origin of aragonite needles is discussed.

Key-words : lagoons, particulates, sediments, coastal waters

Introduction

Veliko and Malo Jezero (the Mljet Lakes) are located on the western part of Mljet Island (Adriatic Sea) (Fig. 1). Due to its scenic beauty, ecological peculiarities, and environmental values this western part of the island was proclaimed a National Park in 1960. Veliko and Malo Jezero (Large and Small Lake = Mljet Lakes) are semi-enclosed depressions connected with the open sea by a narrow, shallow channel. The "lakes" are typical karst depressions (a dolina and an uvala), which were formed under subaerial exposure and are now submerged due to Holocene sea-level rise (3). Being connected with the sea, they have saline water and therefore are not true lakes. Due to their depth (46 and 29 m respectively) they can hardly be termed lagoons because lagoons are often defined as shallow semi-enclosed water bodies (4), "having depths that seldom exceed a couple of meters" (5).

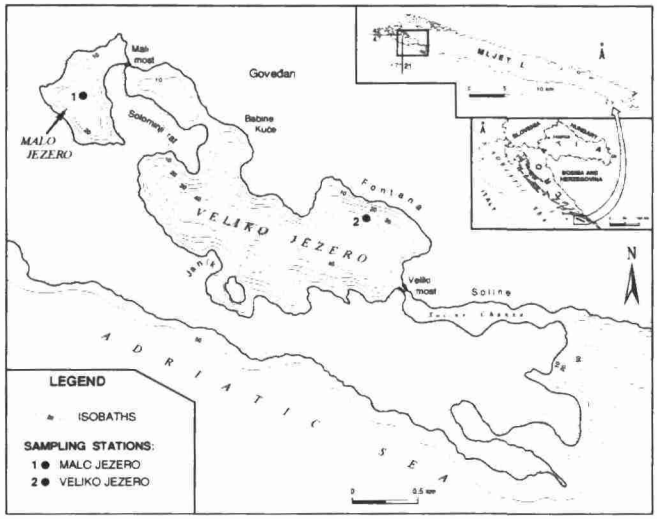

Figure 1. Map of the Mljet Island, Croatia, showing the study area and sampling stations

Water exchange with the open marine waters is only at the surface layer through very shallow and narrow straits. The water exchange is driven by tidal currents, but is insufficient for aeration of deeper water layers (6). This latter situation, coupled with a weak wind influence favours water stratification and give rise to temporary stagnant conditions with anoxia in deeper parts of the "lakes", especially in Malo Jezero (7). Hydrographic data indicate that the surface of the lakes may reach temperatures over 27°C and salinity over 38 ‰ during summer (7). Therefore the Mljet Lakes are restricted environments not only in spatial sense, but also in the sense of stress-producing environmental factors (8). Within the broader frame of investigation of sedimentation in the Mljet Lakes, the aim of this paper is to clarify the long lasting dilemma on aragonite sedimentation in "lakes".

Sampling and methods

Sediment cores up to 80 cm long were collected by scuba diving in Mljet Lakes (Fig. 1) in May 1995. On the same locations suspended matter samples were collected from the surface (0,5 m) by filtration of 2 litres of water through 0.45 μm Millipore filters. Sediment cores and suspended matter samples were frozen within 4 hours, and transported frozen to the laboratory. After freeze-drying in the laboratory, adequate subsamples were used for analysis.

Gross mineral composition was analysed by powder X-ray diffraction analysis (Philips, mod. PW 1050). Suspended matter and sediment-particle gross morphology was analysed on scanning electronic microscope (SEM) micrographs (Philips, SEM 515), whereas detailed investigation of crystal structure and morphology of particles was performed by using electronic microscope Philips EM 400T (operating at 100kV) in transmission imaging mode (magnification: 3.000 - 30.000 times), and in diffraction mode (with goniometer tilt: ± 60°). Selected-area diffraction patterns from individual grains were taken with the spot size 1 μm and the smallest diffraction aperture (30 μ), giving the size of the selected area (about 1 μ at the specimen plane). Carbonate content was determined volumetrically by measuring CO^2 evolved by dissolving a 0.5 g dry sample in 15 % HCl.

Results

Preliminary investigation of suspended matter and surface sediment samples from Malo Jezero by SEM and powder X-ray diffraction analysis revealed a high carbonate mineral content with prevalence of aragonite, and lower incidence of calcite, Mg-calcite (2 mol. % of $MgCO_3$) and dolomite (total carbonate content in surface sediment sample was 72 weight %) (9). SEM micrographs reveal the prevalence of needle-like particles in surface-sediment samples from Malo Jezero (Fig. 2). Combining these two results it can be assumed that these are aragonite needles. In order to clarify and support this assumption, additional transmission electron microscopy and diffraction analysis (TEM&ED) on selected samples were performed. The most dominant morphology was confirmed to be elongated particles with a needle-like shape and particle sizes ranging from 0.1 to 1 mm in thickness and 1 to 10 μm in length (Fig. 3). Crystalline features of these particles were confirmed by electronic diffraction.

Polycristalline ring pattern obtained from clusters (Fig 3. c) revealed the presence of abundant aragonite and some calcite. Spot patterns of properly oriented grains with needle-like morphology (as in fig. 3a) could be unambiguously indexed on the basis of aragonite orthorom-

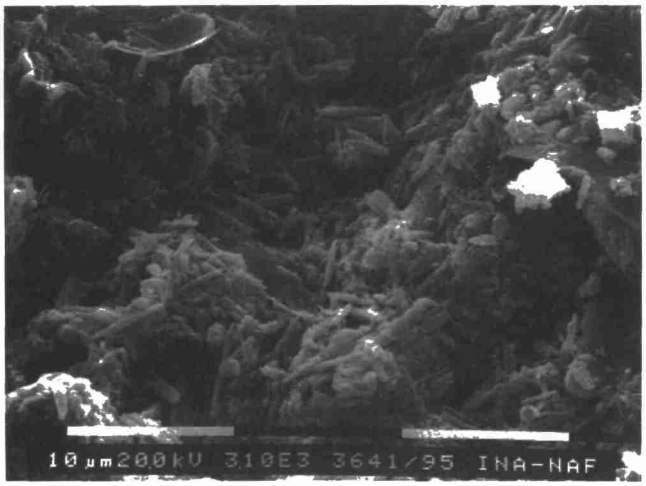

Figure 2. SEM micrograph of recent surface sediment from Malo Jezero showing prevalence of needle-like particles.