Abstracts of Session 3 of the 1st International Biopetrological Congress (Shijiazhuang, China, Sept. 22-25, 2023): Advances in study of travertines and modern microbial rocks

--Edited by Qun-Wei Dai

Publisher: IBA

Journal: Biopetrology, 3(3): 1-6.

Prepublished date: Sept. 21, 2023

Revised: Oct. 10, 2023

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Calcite mineral generation in travertine/tufa of Huanglong and Jiuzhaigou, China

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Abstract.

Since the size of calcite in travertine/tufa reflects the rate of sedimentation, it is the result of physical, chemical, and biological synergy during sedimentation. Therefore, the mineralogical generation can help us understand the physical, chemical, and biological processes in its formation, the study of different calcite mineral formations can reconstruct the paleoenvironment and paleoclimate of its sediments. In this study, calcite rocks mainly from sedimentary rocks were systematically sampled after comprehensive field geological surveys, and calcite in cold-water travertine/tufa in Huanglong and Jiuzhaigou was mineralogical by polarized light microscopy, XRD, and SEM to determine their intergenerational relationship, which can be divided into three generations of mineral generations according to the sedimentary environment and evolutionary time series, namely calcite in Mesozoic carbonate rocks, calcite in late Cenozoic travertine and calcite re-precipitated after travertine leaching. It reveals two different sedimentary environment systems respectively. They are the generations of the marine carbonate rock diagenesis system, and the descendant generation is the continental freshwater karst sedimentary system. Unlike conventional weathering, which converts terrestrial carbonate rocks to the ocean phase, this is done in the opposite direction. The study of different calcite mineral generations can reconstruct the paleo-environment and paleo-climate of its sedimentation.

In the study of sedimentary environmental conditions, calcite in layered travertine and calcite in porous travertine were mainly selected for mineral characterization, and their sedimentary environment and paleoclimate were discussed and reconstructed according to climatic conditions. Furthermore, in the calcium cycle, calcite mineral generation exposes a step in recycling marine matter to the land, and it also allows the land to proliferate, which mainly manifestes in the addition of plant debris, algae, and microbial residues, so that the topography has been accumulating.

Key words: Cold-water travertine, Mineral generation, Paleo-environment, Huanglong.

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A Brief Introduction to the Sparkling Lake Restoration Project in Jiuzhaigou, China

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Abstract

Jiuzhaigou in Sichuan Province was inscribed on the World Heritage List in 1992 for its superlative natural phenomena or exceptional natural aesthetic value. Tufa landscapes are one of the keys for Jiuzhaigou's natural aesthetic value. On 8th August 2017, a Ms 7.0 earthquake caused serious damage to Sparkling Lake. Especially, the dam of Sparkling Lake burst, and the lake dried up. Supported by the United Nations Educational, Scientific and Cultural Organization's World Heritage Center (UNESCO WHC) and the International Union for Conservation of Nature (IUCN), Jiuzhaigou Administration Bureau organized the ecological restoration of Sparkling Lake to protect Jiuzhaigou's outstanding universal value (OUV) and biodiversity, and to satisfy the public will. The earthquake and ecological restoration may affect the aesthetic value of tufa landscape, tufa deposition, water chemistry, and hydrology, so we carried out relevant field observations. Environmental monitoring data is divided into four time periods: before the earthquake (before August 2017), after the earthquake but before the restoration (from September 2017 to September 2019), during the restoration (from October 2019 to June 2020), and after restoration (from July 2020 to August 2021). The monitoring results suggest that the earthquake seriously damaged the aesthetic value of Sparkling Lake, but the ecological restoration project have significantly restored the aesthetic value. After the restoration was completed, the hydrology of the Sparkling Lake was restored, and the hydrochemistry indicated that the surface water was favorable for the deposition of new tufa and the conservation of existing tufa. However, the intensified soil erosion in the catchment after the earthquake led to the increase of DOC and NO3－ concentration, the decrease of alkalinity and HCO3－ concentration, and the increase of soil content in the water body and tufa. The aforementioned changes in water chemistry and tufa increase the challenges for tufa landscape conservation in Jiuzhaigou. In the future, it is necessary: (1) to continuously observe the stability of the tufa dam repaired in Sparkling Lake and (2) to further evaluate the long-term effects of soil erosion and its control measures on Jiuzhaigou surface water chemistry and tufa deposition.

Key words: World Natural Heritage Site; Ecological Restoration; Surface Water Chemistry; Tufa; Soil Erosion

Unraveling the role of algae in the process of travertine deposition based on microscale observations: A case study of Huanglong, Sichuan, China

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Abstract

In terrestrial and open-water settings, travertine deposits are often formed through the interplay of physiochemical (abiotic) and biotic processes responsible for carbonate precipitation. Algae are widespread in travertine-depositing environments, and the growth of them has an important influence on the process of travertine deposition and its macro- and micro-morphology. In this study, we conducted a systematic investigation into the hydrochemical compositions of water that is actively depositing travertine, the composition of living algae community, and the micro-structure and fabrics of neo-precipitated travertine from typical travertine-depositing sites in the Huanglong Ravine, Sichuan, China. Our objective was to examine the role played by algae during the process of travertine deposition. A large number of prokaryotic and eukaryotic algae, such as cyanobacteria, green algae, and diatoms, were found growing in the water environment of Huanglong Ravine. Their metabolic processes (both photosynthesis and respiration) could lead to changes in the chemical compositions of water where travertine forms, but this is only observable in pools with stagnant water. Mostly, algae form microbial mats or biofilms that are several hundred microns to 1-2 mm in thickness and serve as an important place for carbonate precipitation (i.e. active depositional zone). Within such a zone, the algae and secreted extracellular polymer substances (EPS) are likely to provide many favorable nucleation sites and growth templates for carbonate crystals, thereby greatly promoting travertine precipitation. Meanwhile, the EPS could control or affect the morphology of calcite crystals and travertine fabrics. Better understanding and more quantification events of the role algae playing in travertine deposition require further studies at a microscale so as to gain more insights into the mechanism of travertine deposition, lay the foundations for accurate interpretation of fabrics and geochemical proxies of ancient travertine deposits, and shed more light on the evolution and conservation of travertine landscape.

Key words: cyanobacteria, diatoms, extracellular polymer substances, neo-precipitated travertine, biotic processes