GREGORIO Salvatore[2], IOVINE Giulio[3], LUPIANO Valeria[1], RONGO Rocco[1], SPATARO William[2]
1 - Department of Earth Sciences and High Performance Computing Center, University of Calabria, Arcavacata di Rende - 87036, CS, Italy
2 - Department of Mathematics and High Performance Computing Center, University of Calabria, Arcavacata di Rende - 87036, CS, Italy
3 - CNR-IRPI - Sezione di Cosenza, via Cavour, 6 - 87030 Rende, CS, Italy
Presenter e-mail: rongo@unical.it

Key terms: Modeling; Simulations; Lava flows; Hazard; Cellular Automata

Cellular Automata (CA) are a powerful tool for modelling natural phenomena and were one of the first parallel computing abstract models. In many cases CA may represent an alternative to differential equations in modelling physics. The research group Empedocles of the University of Calabria, Italy, developed the CA model SCIARA for simulating Etnean lava flows with interesting results, both in simulation and in hazard areas determination; the model can be further developed, validated and applied to more complex situations of risk. The evolution of simulated cases permits an assessment of the area, which might be invaded by the flow. The model has recently been successfully applied to numerous real cases of lava flows occurred at Mt. Etna (Sicily). Simulations satisfactorily predicted the limits of the real lava flows, permitting the application for predictive purposes during the eruptive crises of 2001 and 2002. The same methodology has been applied with success for the simulation of debris/mud flows, as those occurred in the Sarno area (Campania, Italy).
The objective of this work is the realization of lava hazard maps, by the use of the SCIARA model, showing the susceptibility to lava invasion in the NE Etnean area near Linguaglossa (Catania). Maps were obtained by means of a statistical approach, simulating hundreds of lava flows, characterized by different eruptive histories (i.e. effusion rate, duration) and rheological parameters, each originated from plausible emission points.
Source areas for lava flows were individuated starting form historical, prehistoric and geological records, and by the identification of the areas characterized by highest probabilities of opening of eruptive vents. Accordingly, the main volcanological characteristics were set through selection of eruption typology (summit, flank) and location; the most representative physical parameters to be used for simulation were derived from the above mentioned records. Once that source areas and volcanological parameters were defined, a large number of simulations of lava flows were carried out, in order to realize maps depicting the relative frequency of lava affecting the considered areas. Eventually, a weight value (depending on the probability of occurrence of the simulated event) was assigned to each simulation, based on location and altitude of the source, event duration, lava volume and event history. The relative weights of the areas involved in the simulations were summed by overlapping, thus obtaining a lava invasion hazard map at a resolution of about 65 square meters (i.e. the area of the cell).
First results are encouraging, permitting the application of the methodology to other sectors of Mt. Etna, as well as to other threatened areas worldwide which are characterized by similar types of lava flows. Eventually, the use of parallel computers can permit to speed up execution times to simulate an exhaustive number of events for a more detailed hazard map definition.

SESSIONE 8

T19 - I processi di biomineralizzazione nei sistemi sedimentari/Metodologie integrate in biostratigrafia - Biomineralization processes in sedimentary systems/Integrated methodology in biostratigraphy
Mercoledì 21 Settembre 2005 - ore: 11:15
Aula: 8

Convener e Chairperson: Di Stefano Agata, Iaccarino Silvia, Russo Franco

8-1 Orale Stolarski, Jaroslaw

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NANOCOSM OF THE BIOGENIC AND ABIOGENIC CALCIUM CARBONATE CRYSTALLITES

STOLARSKI Jaroslaw[1], MAZUR Maciej[2]
1 - Instytut Paleobiologii PAN, Twarda 51/55, PL-00-818 Warszawa, Poland
2 - Wydzial Chemii, Uniwersytet Warszawski, ul. Pasteura 1, PL-02-093 Warszawa, Poland
Presenter e-mail: stolacy@twarda.pan.pl

Key terms: Nanostructure; aragonite; calcite; biominerals; AFM

Atomic Force Microscopy (AFM) research on recent calcareous biominerals published so far, revealed that these seemingly monocrystalline fibers are actually composed of densely packed granules, tens of nanometers in diameter, embedded in a thin layer of organic material. From the biological perspective, it is tempting to relate formation of these nanograins to physiological/biochemical processes of the boundary-organized biomineralization that operates at the sub-cellular scale. On the other hand, the extent of purely chemophysical factors that may control the formation of skeletal nanocomponents has not yet been sufficiently assessed pending experimental work. Another poorly explored aspect of nano-scale properties of biominerals is their diagenetic degradation, especially in the time-frame of millions of years.
In research reported here we assessed diagenetic effect on nanostructure of fossil calcium carbonate biominerals (mostly aragonitic skeletons of scleractinian corals) that from the traditional microstructural and mineralogical view points were classified as "excellently preserved". In the experimental setting, we also studied the influence of organic components on the formation of nanograins in abiotically, in vitro precipitated calcium carbonate (aragonite) crystals. All polished skeletal samples were, prior to examination with AFM DI Nanoscope IIIa (Veeco), submitted to the buffered ammonium persulfate oxidizing solution, that selectively etches the organic components.
Skeletal fibers (composed of aragonite mineral phase) of various extant scleractinians (zooxanthellate Favia, Goniastrea, non-zooxanthellate Stephanocyathus) entirely consist of grains ca. 30-60 nm in diameter clearly separated from each other by spaces of a few nanometers. A similar pattern of nanograin arrangement was observed in calcite basal skeleton of extant calcareous sponges (Petrobiona) and stylasterid aragonite coralla (Adelopora). Aragonite fibers of the Neogene (Tethocyathus, Paracyathus) and Cretaceous (Rennensismilia, Trochocyathus) corals were nanogranular, though boundaries between individual grains were occasionally not well resolved. A nanogranular pattern was hardly recognizable in aragonite and microstructurally fibrous skeleton of the Triassic corals (Pachysolenia). Aragonite fibers produced synthetically in sterile environment and with addition of organic components (aminoacids and polypeptides) did not exhibit nanogranular pattern. On the other hand, distinct nanogranulae were recognized in some "crystals" of sparry calcite regarded as abiotically precipitated.
Our findings support the idea that nanogranular organization of calcium carbonate fibers is per se not evidence of their biogenic vs. abiogenic origin nor their aragonitic vs. calcitic composition but seems to be a general feature of $CaCO_3$ formed in aqueous solution in the presence of molecules controlling nanograin formation. Consistent orientation of crystalographic axes of polycrystalline fibers suggest that nanograins are monocrystalline and crystallographically ordered. Distinctly granular vs. packed pattern of nano-organization of $CaCO_3$ fibers seems to correspond, respectively, to "normal" vs. diagenetically depleted amount of organic matter bounded within mineral phase. This is consistent with qualitative and quantitative analyses of organic matter content in extant and fossil skeletons. A practical application of this research is envisaged to find a link between nanoscale organization and physicochemical properties of the biominerals.

8-2 Orale Gautret, Pascale

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BIOCHEMICAL CONTROL OF CALCIUM CARBONATE PRECIPITATION IN MODERN LAGOONAL MICROBIALITES, TIKEHAU ATOLL, FRENCH POLYNESIA

GAUTRET Pascale[1], CAMOIN Glbert[2], GOLUBIC Stjepko[3]
1 - Institut des Sciences de la Terre d'Orléans (ISTO), UMR 6113 du CNRS, Université d'Orléans, Bâtiment Géosciences, F-45067 Orléans Cedex 2, France
2 - CEREGE, UMR 6635 du CNRS, Europole Méditerranéen de l'Arbois, B.P. 80, F-13545 Aix-en-Provence Cedex 4, France
3 - Biological Science Center, Boston University, 5 Cummington Street, Boston, Massachusets 02215, USA
Presenter e-mail: gautret@cnrs-orleans.fr

Key terms: microbialites; calcification; cyanobacteria; organic matrices; amino acids

Hemispheroidal domes (microbialites) produced by natural populations of filamentous cyanobacteria belonging to four distinct Phormidium species, and one probable new species of Schizothrix were collected alive from 0-25 m depth habitates in the lagoon of Tikehau atoll (Tuamotu, French Polynesia). This study aims to establish the biochemical control on in-situ carbonate precipitation processes ("organomineralization" processes) occuring merely in the alveolate network of non-coalescent microfibrils that characterizes the degraded parts of the microbialite domes. The comparison between amino acid and monosaccharide composition of purified cyanobacterially produced organic matter and that of intramineral (soluble and insoluble) organic matrices associated with carbonate precipitates emphasizes the importance of dicarboxylic (aspartic and glutamic) acids, released by the decay of cyanobacterial sheaths, in $CaCO_3$ formation and demonstrates that the in situ precipitation of ultra-fine micrites is a highly selective process regarding the available external organic matter. This diagenetic process is thought to result from incipient hydrolysis of cyanobacterial S-layer proteins attached to extracellular polysaccharide fibrils composing the sheath.
Taxonomic affinity of cyanobacterial populations responsible for microbialite construction is one of the major factors allowing biochemical discrimination of in-situ precipitated carbonates, indicating that specific mucilages or their degradational products are guiding forces for the calcification processes. Another possible source for the formation of carbonate-associated organic matrices is derived from metabolites (e.g. mucus) released in water by lagoonal dwelling benthic organisms.

8-3 Orale Stefani, Marco

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THE CHANGING ROLE OF BIOMINERALIZATION IN THE TRIASSIC BUILDUP GROWTH OF THE DOLOMITES

MASTANDREA Adelaide[1], RUSSO Franco[1], STEFANI Marco[2]
1 - Università della Calabria, Rende
2 - Università di Ferrara
Presenter e-mail: stm@unife.it

Key terms: Biomineralization; Stratigraphy; Sedimentology; Paleontology; Triassic

Since the XIX Century, the Dolomites have been a classical study area for the role played by organisms in the growth of carbonate platforms. The Middle and Upper Triassic platforms of the region often show an abundance of carbonate bioclasts, witnessing the great lithogenetic role played by the biocontrolled calcareous precipitation of skeletons, both by in situ biocontructors or by loose organisms. The study carbonate producing biota experienced large evolutionary modification, leading from the lack of bioconstructors following the Permian-Triassic mass extinction, to the Carnian appearance of well diversified, coral-sponges dominated reefal associations. Bioinduced precipitation also largely influenced the buildup growth, sometimes reaching dominance over the entire depositional process. The occurrence of bioinduced carbonate production is suggested by the evidence of micro-dispersed organic matter, together with geochemical and sedimentological data. The role of the organic matter in the syndepositional cementation and automicrite precipitation is only now starting to be understood, also because of its low concentration, unstable chemical nature and difficult analytical detectability. The relative importance of biocontrolled and bioinduced precipitation largely changed through the Triassic. Phases dominated by loose, mud-rich carbonate sediments alternated with pervasive marine cementation episodes of syndepositionally lithified limestones. Regional factors also played a major role. Episodes of accelerated

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Indirizzo della redazione: Prof. Grazia Martelli, Dipartimento di Georisorse e Territorio, Via Cotonificio, 114, 33100 Udine. e-mail: epitome@geoitalia.org