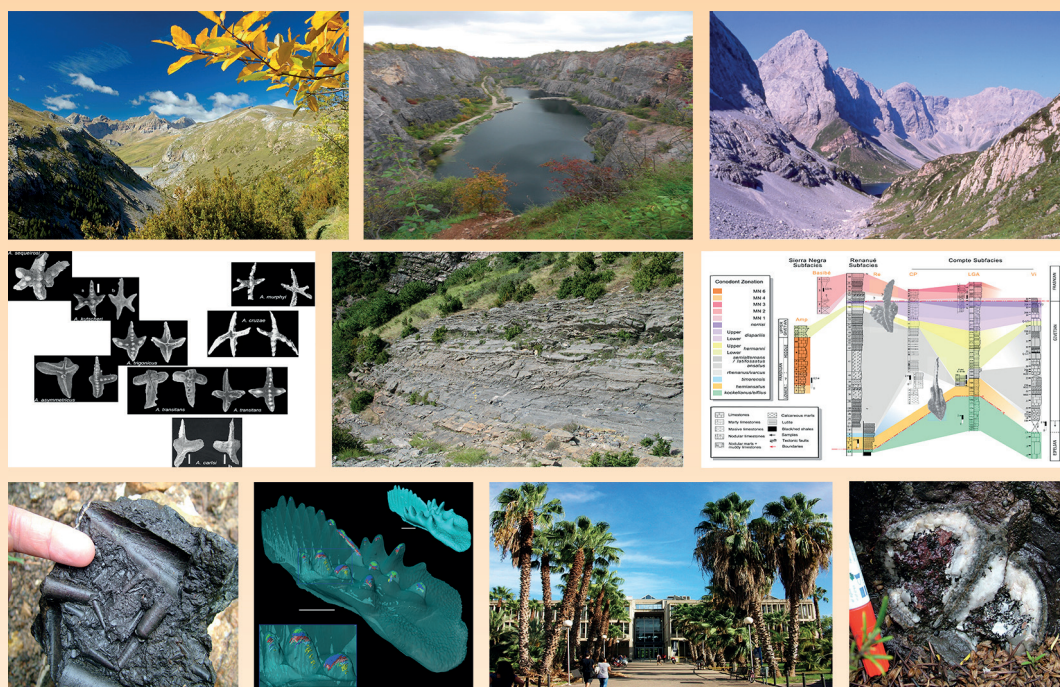


FOURTH INTERNATIONAL CONODONT SYMPOSIUM. ICOS IV "PROGRESS ON CONODONT INVESTIGATION"



Editores: Jau-Chyn Liao
José Ignacio Valenzuela-Ríos



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ICOS IV
“PROGRESS ON CONODONT INVESTIGATION”

JOINTLY WITH:

THE INTERNATIONAL SUBCOMMISSION ON DEVONIAN STRATIGRAPHY ***SDS***

THE INTERNATIONAL SUBCOMMISSION ON SILURIAN STRATIGRAPHY ***ISSS***

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Cover images (photos by members of the organizing committee of the 4th ICOS meeting)

Upper left: Palaeozoic outcrops of the Tena valley, Aragonian Pyrenees (Spain). Photo by Jau-Chyn Liao.

Upper centre: Lower Palaeozoic succession in the Barrandian area (Bohemian Massif, Czech Republic). Photo by Ladislav Slavík.

Upper right: Palaeozoic succession in the Volayer Area (Carnic Alps, Italy-Austria border). Photo by Carlo Corradini.

Middle left: Ancyrodelloides lineage proposal, lower to middle Lochkovian (Lower Devonian) in the Central Pyrenees (Spain). Photo by José I. Valenzuela-Ríos.

Middle centre: Pragian-Emsian succession in the Baliera section, Benasque area, Aragonian Pyrenees. Photo by José I. Valenzuela-Ríos.

Middle right: Regional correlation in the southern part of the Central Pyrenees for the Middle to Upper Devonian. Photo by Jau-Chyn Liao.

Lower left: Orthoceras limestones (Lower Devonian) from Gerri La Sal section, Noguera Pallaresa valley. Photo by Jau-Chyn Liao.

Lower centre one: Reconstruction in 3D of the Epigondolella quadrata (Upper Triassic) of the Pizzo Mondelo (Italy). Photo by Michele Mazza and Carlos Martínez-Pérez.

Lower centre second: Main library "Eduard Boscà" in the Campus of Burjasot, University_of_Valencia (Spain).

Lower right: Schiphocrinites from the Silurian/Devonian in Gerri La Sal section. Photo by Jau-Chyn Liao.

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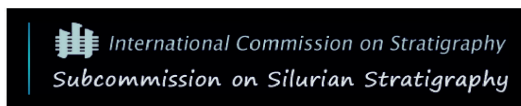
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MINERALOGICAL CHARACTERIZATION OF APATITE BIOMINERALS: PRELIMINARY RESULTS

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The term "bioapatite" has often been used improperly in the past and in different scientific fields to characterize apatite mediated by the intervention of organisms. Conodonts, for a long time considered enigmatic, represent an extinct group of jawless vertebrates that were the first among the group to experiment skeletal biomineralization with tooth-like elements in their feeding apparatus. Their use of apatite is shared with many other vertebrates that have applied calcium-phosphate biominerals to grow their skeletal structure and to shape their teeth. However, microbes are thought to play a role in apatite precipitation (e.g., Crosby and Bailey, 2012). Although development of mineralized parts seems controlled by specifically produced organic molecules that remain entrapped within the mineral units, the growth mechanisms and the diagenetic evolution of apatite fossils are still poorly understood.

Ferretti et al. (2016) recently described peculiar diagenetic apatite overgrowths on Late Ordovician (*A. ordovicicus* Zone) conodonts from Normandy. The conodont specimens exhibit a CAI of 4-5, indicating a heating up to 400°C. Diagenetic neo-crystals observed on the surface of conodont elements show distinctive large columnar, blocky or web-like microtextures. Apatite crystals were analyzed in terms of size, morphology, composition, geometry and spatial arrangement by integration of optical and scanning electron microscopy (SEM), environmental scanning electron microscopy coupled with chemical microanalyses (ESEM-EDX) and X-ray microdiffraction (μ XRD). X-ray diffraction technique had been used in the past to characterize lattice parameters in apatite crystals (e.g., Ellisson, 1944; Pietzner et al., 1968; Nemliher and Kallaste, 2012). Microdiffraction, applied to conodont structural characterization, proved to be a reliable tool in describing overgrowths that otherwise cannot be resolved by the use of microscopic methods alone. In fact μ XRD method allows for small volumes of material to be probed: X-rays are collimated to form a very small beam (up to 10 μ m in diameter) before irradiating a sample, giving the possibility to check for local "micro" environment such as defects or preferred orientations of the crystallites. Microdiffraction measurements were carried out on various points of the surface using a 50 μ m collimator and changing specimen orientation (fixed Omega revolution angle and varying Phi rotation angle). The integration of μ XRD with chemical analyses allowed Ferretti et al. (2016) to reveal that diagenetic apatite neo-crystals exhibit the same chemical composition as the original fossil structure, and that no significant difference in unit cell parameters appears to exist between

the newly formed apatite crystals and those of the smooth (with no crystal overgrowth) conodont surfaces. In other words, diagenesis has strictly replicated the unit cell signature of the older crystals. The application of this approach, coupled with RAMAN analysis, has been extended to encompass conodont elements of different age and having diverse CAI in order to better constrain variability of apatite cell parameters. These results have been compared with those derived from apatite documented in other fossil and living organisms.

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REFERENCES

- Crosby, C.H. and Bailey, J.V. 2012. The role of microbes in the formation of modern and ancient phosphatic mineral deposits. *Frontiers in Microbiology*, 3, 1-7.
- Ellisson, S.P. 1944. The composition of conodonts. *Journal of Paleontology*, 18, 133-140.
- Ferretti, A., Malferrari, D., Medici, L. and Savioli, M. 2016. Crystals on the rocks. Apatite overgrowth on conodont elements from the Late Ordovician of Normandy, France. In P. Gurdebeke, J., De Weirtdt, T.R.A. Vandenbroucke and B.D. Cramer (eds.), *IGCP 591: The Early to Middle Paleozoic Revolution*. Closing Meeting, Ghent University, Belgium, 6-9 July 2016, 103.
- Nemliher, J. and Kallaste, T. 2012. Conodont bioapatite resembles vertebrate enamel by XRD properties. *Estonian Journal of Earth Sciences*, 61(3), 191-192.
- Pietzner, H., Vahl, J., Werner, H. and Ziegler, W. 1968. Zur chemischen Zusammensetzung und Mikromorphologie der Conodonten. *Palaeontographica*, 128, 115-152.