

ULTRASTRUCTURE, COMPOSITION, AND $^{87}\text{Sr}/^{86}\text{Sr}$ DATING OF SHARK TEETH FROM EARLY MIOCENE SEDIMENTS OF SOUTHWESTERN PERU

Giulia BOSIO^{1*}, Giovanni BIANUCCI², Alberto COLLARETA², Walter LANDINI²
& Claudio DI CELMA³

¹ Dipartimento di Scienze dell'Ambiente e della Terra, Università degli Studi di Milano-Bicocca, Milano, Italy.

² Dipartimento di Scienze della Terra, Università di Pisa, Pisa, Italy.

³ Scuola di Scienze e Tecnologie, Università di Camerino, Camerino, Italy.

* Presenting author; e-mail: giulia.bosio@unimib.it

As other marine minerals, phosphates - and in particular bioapatite - incorporate Sr from seawater during formation (Staudigel et al., 1985). Due to long-term variations in the relative abundance of Sr isotopes in the global ocean, $^{87}\text{Sr}/^{86}\text{Sr}$ values can be measured in minerals and compared to calibration curves for obtaining age estimates via Strontium Isotope Stratigraphy (SIS) (McArthur et al., 2020). Although hydroxyapatite is susceptible to alteration and Sr concentration in fish teeth can change during burial and diagenesis (Martin & Scher, 2004), fossil shark teeth have been successfully used for Sr-dating, especially when enameloid is analyzed (Schmitz et al., 1997; Harrell et al., 2016). In order to test the feasibility of this method in the fish tooth-rich marine sediments of the East Pisco Basin (Peru), and aiming to date some poorly-constrained strata of this region, we analyzed the ultrastructure and composition of fossil shark teeth from the Chilcatay Formation. This Miocene formation consists of massive sandstones and basement boulders overlain by bioclastic sandstones and diatomaceous and tuffaceous siltstones (Di Celma et al., 2019). It is characterized by an abundant marine vertebrate assemblage, among which elasmobranchs are present (Landini et al., 2019). Teeth of *Isurus* sp., *Cosmopolitodus hastalis*, *Isurus oxyrinchus*, *Megalolamna paradoxodon* and *Physogaleus contortus* were collected from Chilcatay beds at the localities of Zamaca, Media Luna and near Cerro Colorado. Teeth were investigated through an optical microscopy and SEM. After taphonomic observations, 11 teeth underwent ICP-OES and $^{87}\text{Sr}/^{86}\text{Sr}$ analyses. Shark teeth show a compact and non-porous outer enameloid layer that is distinctly separated from the more porous and heterogeneous inner core of dentine. Ultrastructure analysis shows that the enameloid is formed by highly-ordered bundles of fluoroapatite crystallites, which are often well-preserved, whereas the dentine displays a bone-like structure showing tubuli and crystalline artefacts from diagenesis (Lübke et al., 2015). SEM-EDS mapping shows differences in distribution of Ca, P, F, and S in the enameloid and dentine, and the shiny layer is compositionally recognizable (Enax et al., 2014). ICP-OES data show Sr contents that are comparable to those of recent lamniform teeth. $^{87}\text{Sr}/^{86}\text{Sr}$ results compared to the LOESS 6 calibrated on GTS2020 (McArthur et al., 2020) give ages between 19 and 18 Ma for the Chilcatay strata at the Ica Valley localities, in agreement with radioisotopic and biostratigraphic ages (Bosio et al., 2020). At Media Luna, a locality 25 km to the west of the Rio Ica, the Chilcatay strata have here been dated for the first time, resulting in a slightly older age ranging between 22 and 20 Ma. Not least, these results strengthen the notion that the Sr-ratio of shark teeth can be successfully used for obtaining reliable age estimates through SIS.

References

- Bosio G., Malinverno E., Villa I.M., Di Celma C., Gariboldi K., Gioncada A., Barberini V., Urbina M. & Bianucci G. (2020). Tephrochronology and chronostratigraphy of the Miocene Chilcatay and Pisco formations (East Pisco basin, Peru). *Newsletters on Stratigraphy*, 53 (2): 213-247.
- Di Celma C., Pierantoni P.P., Malinverno E., Collareta A., Lambert O., Landini W., Bosio G., Gariboldi K., Gioncada A., de Muizon C., Molli G., Marx F.G., Varas-Malca R.M., Urbina M. & Bianucci G. (2019). Allostratigraphy and paleontology of the lower Miocene Chilcatay Formation in the Zamaca area, East Pisco basin, southern Peru. *Journal of Maps*, 15 (2): 393-405.
- Enax J., Janus A.M., Raabe D., Epple M. & Fabritius H.O. (2014). Ultrastructural organization and micromechanical properties of shark tooth enameloid. *Acta biomaterialia*, 10 (9): 3959-3968.