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Calcium isotopic biogeochemistry: Application to the dietary reconstruction of middle Paleolithic Neandertals

PIERRE-JEAN DODAT[1,2], CHRISTINE COUTURE-VESCHAMBRE[3], MAURICE HARDY[4], BRUNO MAUREILLE[3] AND VINCENT BALTER[1]

[1]ENS de Lyon, Univ Lyon 1, CNRS UMR 5276, LGL-TPE
[2]LGLTPE UMR5276, CNRS
[3]Univ. Bordeaux, CNRS, MC
[4]Univ. Nanterre, CNRS, MC

Presenting Author: pierre-jean.dodat@ens-lyon.fr

Since the first discoveries in paleoanthropology, the nature of the relationships between human evolution and dietary habits is a fundamental question. The development of accurate analysis of stable isotope ratios in geochemistry, particularly due to MC-ICP-MS, has now allowed the measurement of calcium (Ca) isotopes in fossil vertebrates in minute amount of bone or tooth material. The Ca isotopic composition ($\delta^{44/42}$Ca) of mammals is largely defined by the Ca dietary intake and represent an important source of information that has hitherto been unexploited. In natural conditions, the $\delta^{44/42}$Ca value of bone and teeth varies according to dietary intake with a constant isotopic offset of about -0.57 ‰ [1], resulting in a difference between prey and predator close to -0.30‰ [2]. The $\delta^{44/42}$Ca value of bone therefore has the potential to reconstruct the ecology of existing or extinct mammals.

Using a bone-muscle Ca isotopic offset determined on extant animals, we show that the $\delta^{44/42}$Ca value of predator cannot be accounted for by the consumption of meat only, as plants and meat have indistinguishable $\delta^{44/42}$Ca values. Mass balance calculations indicate that the low $\delta^{44/42}$Ca values of carnivore are explained by the accidental or intentional ingestion of bone during prey consumption.

Our study focused on the potential of Ca isotopes for dietary behavior reconstruction in paleo-anthropology. Here, we have studied the Ca isotopic variability in fossil bone samples from the upper part of the Middle Paleolithic (Regourdou, Marillac and La Grotte du Bison) covering about 50 Ky of Neandertal occupation in France. The results allow us to discuss the evolution of subsistence strategies of Neandertals until their extinction.

[1] Tacail, Le Houedec, Skulan (2020), *Chem. Geol. 537*, 119471.

[2] Martin, Tacail, Cerling, Balter (2018) *Earth Planet. Sci. Lett.* 503, 227-235