

## Sr isotopes at the Onset of the Ice Ages

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The stable  $^{88}\text{Sr}/^{86}\text{Sr}$  isotope ratio in marine fossils is a new tool for constraining the marine Sr budget throughout the geologic history that complements the commonly used secular variations in the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios. A long-standing problem is the imbalance of the Sr budget in seawater considering the weathering flux [1,2]. Here, we report for the first time on  $^{88}\text{Sr}/^{86}\text{Sr}$  coupled with  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope ratio in molluscs, brachiopods and foraminifera's skeleton that were collected in the Pliocene to Mid Pleistocene section of the Stirone River, northern Apennines, Italy. The fractionation factor  $\Delta^{88/86}\text{Sr}_{\text{fossil-seawater}}$  was determined by measuring modern organism and their habitat seawater. These fractionation factors were used to calculate  $\delta^{88/86}\text{Sr}$  of seawater during the time interval of  $\sim 5$ -1 Ma, the onset of ice ages in the northern hemisphere. While the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios follow the marine temporal increase during this interval, the  $\delta^{88/86}\text{Sr}$  ratio remained constant. We used the  $^{88}\text{Sr}/^{86}\text{Sr} - ^{87}\text{Sr}/^{86}\text{Sr}$  in the late Miocene-mid Pleistocene seawater to estimate the Sr fluxed to the Mediterranean Sea and found that an additional flux -possibly from brackish nearshore aquifers- contributed Sr.

[1] Vance D., Teagle D. A. H. and Foster G. L. (2009) Variable quaternary chemical weathering fluxes and imbalances in marine geochemical budgets. *Nature* 458, 493–496.

[2] Krabbenhöft, A., A. Eisenhauer, F. Böhm, H. Vollstaedt, J. Fietzke, V. Liebetrau, N. Augustin, et al. (2010) Constraining the Marine Strontium Budget with Natural Strontium Isotope Fractionations ( $^{87}\text{Sr}/^{86}\text{Sr}$ ,  $\delta^{88/86}\text{Sr}$ ) of Carbonates, Hydrothermal Solutions and River Waters. *Geochimica et Cosmochimica Acta* 74 (14): 4097–4109.