# Ocean oxygenation across global climate perturbations recorded by thallium isotopes

SUNE G. NIELSEN[1], CHADLIN OSTRANDER[1,2], JEREMY D. OWENS[1,3]

[1]NIRVANA laboratories, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, snielsen@whoi.edu
[2]Arizona State University, cmostran@asu.edu
[3]Florida State University, jdowens@fsu.edu

The thallium (Tl) isotope composition of seawater is homogenous with a residence time of ~20ka. The modern mass balance of Tl isotopes in seawater dictates that the two main outputs: (1) adsorption onto manganese (Mn) oxides and (2) low temperature oceanic crust alteration exerts the primary control of the marine Tl isotope budget. Because changes in the intensity of oceanic crust alteration are likely driven by slowly evolving ocean crust production rates, it can be assumed that for million-year or shorter climatic events the Tl isotope composition of seawater is almost exclusively driven by changes in global Mn oxide precipitation rates. In turn, Mn oxides may only precipitate from seawater when free oxygen exists at the sediment-water interface. Therefore, the Tl isotope composition of seawater may become a robust indicator of the global extent of ocean anoxia and deoxygenation for short-term climatic perturbations.

An overview of the modern Tl isotope cycle will be presented together with an introduction to the different sedimentary archives that can be used to reconstruct the Tl isotope composition of seawater. Examples from the early Cenozoic and ocean anoxic event 2 (OAE2) highlight the utility of Tl isotopes to track Mn oxide precipitation in the past.

Data from the early Cenozoic imply long-term gradual changes in Mn oxide precipitation rates that appear largely decoupled from major climatic indices such as temperature or atmospheric $CO_2$ concentration. It is, therefore, difficult to ascertain the mechanism responsible for driving the changes in Mn oxide precipitation in the early Cenozoic.

Recently obtained data from OAE2, on the other hand, show that Tl isotopes in seawater changed rapidly towards more positive values ~30-50ka before the carbon isotope anomaly that defines the OAE. The Tl isotope shift is consistent with a rapid decrease in Mn oxide precipitation just prior to the onset of OAE-2. The Tl isotope data, therefore, indicate that the ocean gradually transitioned from primarily oxic to oxygen depleted ~30-50ka before globally significant increased carbon burial commenced as recorded by carbon isotopes.