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Driving mechanisms of correlated thallium isotopic compositions and oxygen penetration depth in modern marine sediments

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Sedimentary thallium isotopic compositions ($\varepsilon^{205}Tl$) are emerging as a robust tracer of ocean oxygenation through geologic history [1]. Seawater $\varepsilon^{205}Tl$ indirectly tracks the oceanic O_2 inventory through changes in the global magnitude of manganese oxide burial, as Tl is strongly adsorbed and isotopically fractionated on deep-sea Mn oxides ($\Delta_{seawater}$ of 16 ε-units). Seawater $\varepsilon^{205}Tl$ values are conventionally derived from anoxic depositional conditions, where Tl removal is thought to be quantitative. However, a recent study shows that $\varepsilon^{205}Tl$ seawater signatures may even be preserved in sediments that were deposited under moderately oxygenated water columns [2]. The local redox and depositional conditions permitting this isotopic preservation are not well understood.

Here we explore diagenesis and Tl dynamics in sediments from the Benguela upwelling system (SE Atlantic) and a Skagerrak shelf transect (eastern North Sea). We find a clear positive correlation between oxygen penetration depth/bottom water oxygen contents and authigenic ^{205}Tl enrichments. Initial sedimentary ^{205}Tl enrichments are observed under moderately oxygenated waters (100 μM O_2). These enrichments linearly extend up to a $\Delta_{seawater}$ of ~4 ε-units in Mn-rich Skagerrak shelf sediments with an oxygen penetration depth of 1.8 cm. We will discuss the potential mechanisms driving this correlation and address their importance in relation to the marine Tl mass balance, Holocene dissolved oxygen dynamics, and novel geologic archives for $\varepsilon^{205}Tl$ paleoredox reconstructions.

[1] Owens *et al.* (2017), *Geochimica et Cosmochimica Acta*. **213**, 291-307

[2] Wang *et al.* (2022), *Geochimica et Cosmochimica Acta*. **333**, 347-361