Age and geochemistry of black shales from Baltica margins: role of tectonics in marine productivity and water column anoxia

VINEET GOSWAMI[1*], JUDITH HANNAH[1,2], HOLLY STEIN[1,2], PER AHLBERG[3], FRANS LUNDBERG[3], JÖRG MALETZ[4]

[1] AIRIE Program, Colorado State University, Fort Collins, CO 80523-1482, USA [vineet.goswami@colostate.edu]
[2] Geosciences, University of Oslo, 0317 Oslo, Norway
[3] Department of Geology, Lund University, Sweden
[4] Institut für Geologische Wissenschaften, Freie Universität Berlin, Germany

The Re-Os geochronometer efficiently constrains the depositional age of black shale, providing key time pins in Earth's geologic history. Further, chemical and isotopic archives in the same shales serve as proxies for paleoenvironmental conditions at the time of deposition. Here we present Re-Os ages for the organic-rich Tøyen (Early-Middle Ordovician) and Alum (late Cambrian) shales from Sweden, deposited at the margin of Baltica. A Model 1 isochron for the Tøyen shale yields an age of 469.8 ± 1.4 Ma (2σ; MSWD = 1.5; n = 10) for the Floian-Dapingian stage boundary with an initial $^{187}Os/^{188}Os$ (Os_i) of 0.801 ± 0.002. A Model 1 isochron for the Alum shale (middle Stage 10, 120 cm below the Cambrian-Ordovician boundary) yields an age of 488.4 ± 5.1 Ma (2σ; MSWD = 1.5; n = 25), with an Os_i for the latest Cambrian of 0.82 ± 0.04. These Re-Os ages provide the first absolute time lines for two significant boundaries in the Early Paleozoic. Limited data suggest that the Os_i declines significantly from the late Cambrian to the early Silurian, consistent with reduced chemical weathering and seawater temperatures during the Ordovician [1].

Redox Sensitive Elements (RSEs) are enriched in the Tøyen and Alum shales relative to world average shale. RSEs correlate well with TOC, affirming their sequestration from the water column along with organic matter. Relevant proxies clearly indicate accumulation under anoxic conditions. The available geochemical data for black shales from the margins of Baltica suggest that these organic-rich sediments were deposited in a highly productive and anoxic temperate ocean. In contrast, margin sediments near Avalonia and Gondwana were deposited in colder and less reducing waters at higher latitudes [2]. These results highlight the significance of paleogeography in regulating marine productivity, water column anoxia and ocean circulation.

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[1] Trotter et. al., (2008) Science **321**, 550-554, [2] Cocks and Torsvik (2002) J. Geol. Soc., **159**, 631-644