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Osmium Isotopes and Continental Weathering

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A reliable tracer of past continental weathering of silicates is needed in order to understand how the Earth's geochemical cycle, that of CO2 in particular, evolved. The marine Os isotopic record has attracted much attention because of its gross similarity to the oceanic Sr isotope record in its general increase during the past 40 Ma but also because of its departure from the latter starting about 17 Ma. The question remains as to what brings about these changes. Marine black shales have been proposed as a source of very radiogenic Os because of their large enrichments in Re (Colodner et al., 1993) and because they can even at trace amounts weather very fast due to oxidative processes (Edmond et al., 1996). If true, this then has the possibility of tracking exposure and weathering of organic carbon in the form of black shales in the past, e.g. uplift of the Himalayas or the Andes. On glacial-interglacial timescales, preferential weathering of Os-rich trace phases in glacial tills of the Precambrian shields is proposed as an important source of radiogenic Os to seawater (Peucker-Ehrenbrink and Blum, 1998). The most direct means of confirmation is to analyse the dissolved load input at present from the black shale and recently glaciated Precambrian shield terrains.

A survey of mouth samples from large rivers (n=18) identified the peri-Himalayan rivers (Ganges, Xijiang and Changjiang) and the Mackenzie as the most radiogenic (Levasseur et al., 1999), though the flux of radiogenic Os from these rivers are not enough to explain the recent increase in oceanic 187Os/188Os. Sharma et al. (1999) came to similar conclusions by analysing 4 Himalayan rivers.

Data on direct Os isotopic analyses on dissolved load is still meagre and does not have systematic coverage. We have analysed Os concentrations and isotopic ratios in the rivers of the Mackenzie basin and also those draining the western Rockies into the Pacific, including dissolved, suspended and bed materials. These samples were chosen because of relatively complete sample coverage and the availability of accompanying chemical data from an on-going program.

Dissolved Os concentrations (n~30) range over an order of magnitude from 21 to 255 fmol/kg, and 187Os/188Os range from 0.72 to 3.88. Mackenzie at the mouth is 131 fmol/kg and 1.87, and average riverine input is estimated at 42 fmol/kg (24 to 274) and 1.54 (0.64-2.94)(Levasseur et al., 1999). The data set can be broadly grouped into three. The tributaries draining the igneous and metamorphic rocks of the eastern Rockies (n=8) have radiogenic values (2.1 to 3.9) at high concentrations (55 to 255 fmol/kg). For comparison, published value for the Himalayas, thought to be responsible for the rise in at least the marine Sr isotope ratios, is 45fmol/kg and 2.65 in the headwater of Ganges and 171 fmol/kg and 1.07 at the mouth (Sharma et al., 1999). Rivers draining the volcanic formations of the western Rockies have relatively nonradiogenic values (<1) and medium concentrations (~50 fmol/kg). Sharma et al (1999) found Indus and Brahmaputra less radiogenic than the Ganges, presumably due to the erosion of ophiolitic assemblages exposed along the Indus-Tsangpo suture zone. Rivers draining the Canadian Shield (n=6) have radiogenic values (~3) at low concentrations (24 to 35 fmol/kg). They are more radiogenic than the Zaire draining the Congo shield (1.4) or the Tapajos draining the Amazon Shield (1.33) in the tropics (Levasseur, 1999). Other rivers draining marine Cretaceous (where black shales signature would be most pronounced) or bentonite-rich or hot-spring affected areas of the Rockies have ratios between 1 and 2, near the global average.

Based on available dissolved Os data from rivers, a clear continental source of radiogenic Os at high flux that could explain the rise in oceanic Os isotopic record, could not be found. Metamorphic and igneous terrain of eastern Andes is a candidate, but the exact lithology responsible for the radiogenic Os is not clear at this point.

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