Osmium isotope evidence for a large impact event in the Late Triassic

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Seawater $^{187}Os/^{188}Os$ ratios reflect contributions to the global ocean from riverine ($^{187}Os/^{188}Os \approx 1.4$), and hydrothermal and extraterrestrial inputs ($^{187}Os/^{188}Os \approx 0.12$ - 0.13). Given the distinctive $^{187}Os/^{188}Os$ ratios of these inputs and the relatively short residence time of Os in the ocean, seawater $^{187}Os/^{188}Os$ ratios are highly sensitive to change in these fluxes. Thus, Os isotope has been used to demonstrate the 65 Ma impact event at Chixhulub in Mexico [1, 2], based on an abrupt decline in seawater $^{187}Os/^{188}Os$ ratios during the Cretaceous/Paleogene (K-Pg) boundary.

We report the marine $^{187}Os/^{188}Os$ ratios of the middle Norian bedded chert and claystone succession in Japan to provide new evidence of an extraterrestrial input. These bedded cherts are considered to be deep-sea sediments that accumulated in a pelagic, open ocean setting within the Upper Triassic paleo-Pacific Ocean (Panthalassa).

The initial $^{187}Os/^{188}Os$ ratios exhibit an abrupt and marked negative excursion from 0.477 to unradiogenic values of 0.127 in a claystone layer. The Os concentration of this claystone layer is ca. 3 ppb which is three orders of magtinude higer than those of chert layers. Moreover, a plenty amounts of spherule and Ni-rich spinel granules and extraodrinary PGE-enrichment was reported from the claystone [3]. The amplitude of this negative Os isotope excursion is comparable to those of the late Eocene (0.5 to 0.28) [4] and the K-Pg boundary (0.4 to 0.157) [1]. These geochemical lines of evidence strongly suggest that a large, kilometer-sized impactor is requisite to explain high Os concentration and unradiogenic $^{187}Os/^{188}Os$ ratios of the Upper Triassic claystone layer.

[1] Ravizza & Peucker-Ehrenbrink (2003) *Science* **302**, 1392-1395. [2] Luck & Turekian (1983) *Science* **222**, 613-615. [3] Onoue *et al.* (2012) *Proc. Natl. Acad. Sci. USA* **109**, 19134-19139. [4] Paquay *et al.* (2008) *Science* **320**, 214-218.

Let's use metastable geomaterials in environmental protection: An intelligent geotechnology learnt from natural processes

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In order to ensure sustainable development, engineering technologies used in environmental protection (e.g. purification, remediation) must utilize safe, cost-effective and environmentally efficient materials. As such, the use of ubiquitous geomaterials, rather than synthetic materials, is envisioned. The use of geomaterials for environmental applications, referred to as "geotechnology", is based on principles learnt from natural processes. Therefore, naturally occurring physical, chemical and biological processes can serve as useful analogs in designing cost-effective and intelligent geotechnologies to address environmental problems.

Geomaterials such as clays, carbonates and iron minerals, which are generally stable under Earth surface conditions, have been used widely for environmental applications. This is due to their cost-effectiveness and stability over a range of conditions. However, metastable materials widely observed in nature have been found to be more environmentally efficient due to their higher reactive surface areas and reactivity to hazardous contaminants compared to more stable materials. For example, iron oxides such as hematite, goethite, ferrihydrite and schwertmannite are seen as important naturally occurring sorbents of arsenate and phosphate. However, poorly crystalline and metastable ferrihydrite and schwertmannite exhibit higher capacities for arsenate and phosphate adsorption compared to crystalline goethite and hematite. Similarly, metastable aragonite and monohydrocalcite show better anion adsorption capabilities compared to calcite. Recently, it has been found that the stability of these materials can be modified by the adsorption of certain ions. Therefore, the long-term stability and efficient performance of metastable materials can be controlled in order to maximize their effectiveness. In this presentation, intelligent geotechnologies learnt from natural processes using metastable geomaterials will be introduced, with natural iron oxides and calcium carbonates as examples.

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