The Phanerozoic minimum in seawater $^{87}Sr/^{86}Sr$: Middle Permian mid-Panthalassan seamount record

TOMOMI KANI[1*], CHIHIRO HISANABE[1], AND YUKIO ISOZAKI[2]

[1]Kumamoto University, Kumamoto, Japan
kani@sci.kumamoto-u.ac.jp (* presenting author)
[2]The Univerisity of Tokyo, Meguro, Japan
isozaki@ea.c.u-tokyo.ac.jp

We report a detail secular change of the Late Guadalupian (Permian) seawater $^{87}Sr/^{86}Sr$ ratio with the unique "Permian minimum" interval detected in mid-Panthalassa (superocean) paleo-atoll carbonates. The analyzed two sections at Akasaka and Kamura (Japan) occur as exotic blocks within the Jurassic accretionary complex. The two sections are separated from each other for 500 km at present, thus were likely derived from different paleo-seamounts formed in mid-Panthalassa. The detected intervals of the minimum and the following increase in $^{87}Sr/^{86}Sr$ are common between the two sections. The new data of the lowest ratio (0.706808) in the Capitanian *Yabeina* (fusuline) Zone at Akasaka give the minimum $^{87}Sr/^{86}Sr$ ratio not only of the Paleozoic but also of the entire Phanerozoic. The extremely low values lower than 0.70690 were detected from 18 samples in the *Yabeina* Zone and the barren interval. In particular, the extremely low values continued up to the topmost barren interval immediately below the Guadalupian-Lopingian (G-L) boundary.

The newly detected Sr record likely represents the general trend of the Guadalupian seawater in mid-Panthalassa. The rapid increase during the Late Permian-Early Triassic interval suggests that a large amount of radiogenic terrigenous clastics have been shed into Panthalassa through rift-related new drainage systems in Pangea [1]. The initial breakup of Pangea may have started around the G-L boundary, clearly before the final opening of the Atlantic in the Jurassic [2].

[1] Kani *et al.* (2008) *J. Asian Earth Sci.* **32**, 22-33.
[2] Isozaki (2009) *J. Asian Earth Sci.* **36**, 459-480.

Effect of fluid flow rate on Fe^{3+}/Fe^{2+} ratios of Paleoproterozoic paleosols and its implication for atmospheric oxygen levels

YOSHIKI KANZAKI* AND TAKASHI MURAKAMI

Department of Earth and Planetary Science, the University of Tokyo, Tokyo 113-0033, Japan
(*Correspondence: kanzaki@eps.s.u-tokyo.ac.jp)

The Great Oxidation Event (2.5 – 2.0 Ga) is one of the most important events in the Earth's history because of its coevolution with organisms and redox surface-environments. Compiled geological records constrain the timing of the oxygen rise and the threshold levels of oxygen concentration, but few investigations have not shown quantitative estimation of oxygen variation as a function of age during the Paleoproterozoic. As demonstrated by Murakami et al. (2011) [1], paleosols allow us to challange such estimation. The recorded behavior of Fe(II) and Fe(III) in paleosols can lead us to understand redox conditions of the Earth's surface at the time of ancient weathering. To properly interpret the behavior of Fe, one must consider: (1) dissolution from primary minerals, (2) oxidation of Fe(II) into Fe(III) (which immediately precipitates as (oxyhydr)oxides), and (3) transport of dissolved Fe(II) outside the weathering profile by fluid (groundwater). The weathering model that considers these factors can calculate Fe(III)/Fe(II) ratios for a given oxygen level, and therefore, predict inversely the P_{O_2} levels from the recorded Fe(III)/Fe(II) ratios in paleosols [2].

The sensitivity analysis of the weathering model revealed that the relationships between Fe(III)/Fe(II) ratios and oxygen levels vary with fluid flow rate. This causes large uncertainty in the predicted levels of P_{O_2}. To properly predict the P_{O_2} levels, the fluid flow rates must be constrained.

The estimation of fluid flow rates for five Paleoproterozoic paleosols has been made based on Si behavior during weathering; loss of Si in each paleosol (mol km^{-2}) against Si in corresponding parent rock was used for the estimation. Using the calculated amounts of Si loss from the paleosols and assuming 50 kyr – 5 myr of weathering duration, the relationships between silica flux (mol km^{-2} yr^{-1}) and runoff (cm yr^{-1}) for basalt and granite [3] gave estimated values of fluid flow rate ranging from 8×10^{-3} to 46 m yr^{-1}. These estimates match well with those calculated based on the mass balance principal of Si between water and rock assuming steady state concentrations of dissolved silica as 10^{-4} – 10^{-3} mol L^{-1}, average porosity of a whole weathering profile as 0.2 and weathering duration as 50 kyr – 5 myr.

The weathering model adopting an average value of the estimated fluid flow rates, that is ~ 0.1 m yr^{-1}, have calculated P_{O_2} levels from the Fe(III)/Fe(II) ratios of the five Paleoproterozoic paleosols. Although there remains an uncertainty about the fluid flow rate, the most likely results suggest a gradual rise of atmospheric oxygen, from $< \sim 10^{-6}$ to $> \sim 10^{-3}$ atm between 2.5 and 2.0 Ga.

[1] Murakami et al. (2011) *Geochim. Cosmochim. Acta* **75**, 3982-4004. [2] Murakami and Yokota (2008) *Geochim. Cosmochim. Acta* **72**, Suppl. 1, A665. [3] Bluth and Kump (1994) *Geochim. Cosmochim. Acta* **58**, 2341-2359.