Abundant manganese microparticles in oxic pelagic clay of the South Pacific Gyre

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Manganese nodules ubiquitously occur in the abyssal plain, with varying concentrations of metals, including manganese, iron, nickel, cobalt, and copper. Typical manganese nodules observed in pelagic sediments are in centimeter to sub-millimeter size of spherical crusts and often concreted to the pavement over the seafloor. During the Integrated Ocean Drilling Program (IODP) Expedition 329 in 2010, we drilled the entire sedimentary sequence at 6 sites in the ultra-oligotrophic region of the South Pacific Gyre (SPG), where dissolved O_2 and aerobic microbial communities are present from the seafloor to the sediment-basement interface [1]. Massive manganese nodules often occur at the seafloor of these drilling sites, and the subseafloor sediments generally consist of zeolitic metalliferous clay. Using a newly developed sediment observation technique [2], we observed numerous micrometer-scale particles of (ferro-)manganese minerals in the oxic zeolitic clay from present-day to several tens of millions of years. Using a synchrotron-based X-ray microtomography and FIB-SEM-EDS, high-resolution three-dimensional micro-textures of manganese microparticles, as well as elemental compositions, were visualized, suggesting that those particles were deposited from the water column, and well preserved in the widespread area of deep-sea oxic sediments over geologic time.

[1] D'Hondt, S., Inagaki, F., Zarikian, C. A., Abrams, L. J., Dubois, N., Engelhardt, T., Evans, H., Ferdelman, T., Gribsholt, B., Harris, R. N., Hoppie, B. W., Hyun, J.-H., Kallmeyer, J., Kim. J., Lynch, J. E., McKinley, C. C., Mitsunobu, S., Morono, Y., Murray, R. W., Pockalny, R., Sauvage, J., Shimono, T., Shiraishi, F., Smith, D. C., Smith-Duque, C., Spivack, A. J., Steinsbu, B. O., Suzuki, Y., Szpak, M., Toffin, L., Uramoto, G., Yamaguchi, T. Y., Zhang, G., Zhang, X.-H., and Ziebis, W. Presence of oxygen and aerobic communities from seafloor to basement in deep-sea sediment. *Nature Geosciences,* 8(4), 299-304, 2015.

[2] Uramoto, G.-I., Morono, Y., Uematsu, K., and Inagaki, F. An improved sample preparation method for imaging microstructures of fine-grained marine sediment using microfocus X-ray computed tomography and scanning electron microscopy. *Limnology and Oceanography: Methods*, 12, 469-483, 2014.

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