☒ **Talk** ☐ **Poster**

Novel imaging reveals nanoparticulate hydrothermal iron is available for export to iron-poor open ocean waters

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Iron (Fe) is a necessary but limiting nutrient for life on Earth. Supply by sediments and dust deposition are the main sources of iron to Earth's oceans, but recent work suggests hydrothermal vents could also be an important source of bio-essential iron to ocean basins. Dissolved iron concentrations in hydrothermal fluids are a million times those of surrounding ocean water. Most iron (>90%) precipitates close to vent sources, but recently, signatures of hydrothermally derived iron were revealed transported across deep ocean basins worldwide. Models show that this iron could support up to 30% of primary production in the Southern Ocean. It remains unclear how this iron persists in the water column rather than settling to sediments.

Critical processes constraining the export of iron from vent sources to open ocean waters occur within the first ~100 km of plume evolution. We compare hydrothermal plume particulate matter collected from the first 100 km of plumes in the low-sulfur, high-oxygen Rainbow vent system (Mid Atlantic Ridge) and high-sulfur, low-oxygen Endeavour vent field (Juan de Fuca Ridge, North Pacific) to determine effects of plume chemistry on particulate iron transport. We use a novel multimodal approach combining bulk to nano-scale synchrotron-based methods (bulk extended X-ray absorption fine structure spectroscopy, X-ray fluorescence spectromicroscopy, scanning transmission X-ray microscopy, and ptychography) and electron microscopy. Application of ptychography to environmental samples represents the cutting edge of geochemical imaging methods and reveals nano-scale heterogeneity that influences basin-scale iron transport and bioavailability.

We show that plume chemistry affects the mineral phase of iron, with reduced phases persisting longer in the high-sulfur, low-oxygen Endeavour plume. Nevertheless, the morphology of suspended particulate iron is similar in both environments. Nanoparticulate iron embedded within carbon matrices persists in each plume, drives export of iron from hydrothermal vents to open ocean waters, and is a signature of nutrient-rich hydrothermal activity globally.

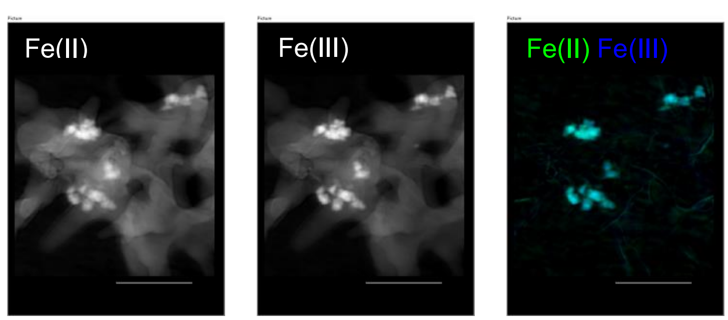

Figure 1. Ptychographic imaging of particles in water column 10s of km from a hydrothermal vent shows mixed valence iron nanoparticles embedded in a particulate matrix. Scale bars 700 µm.