

Hydrogen sulfide as a trace metal ligand in the surface Pacific Ocean

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Dissolved hydrogen sulfide in the surface ocean can exist in a number of chemical species: as the dissolved gas, uncomplexed ions (“free sulfide”), metal-sulfide complexes (free+metal complexes = total dissolved sulfide, TDS). In the oxic water column, hydrogen sulfide is largely produced via assimilatory sulfate reduction by phytoplankton during photosynthesis and by the hydrolysis of the dissolved gas carbonyl sulfide (OCS). As a strong inorganic ligand for many trace metals, the existence of H₂S species in the oxic water column has implications for metal cycling.

In order to evaluate the role of this inorganic ligand in metal cycling and its production mechanisms, we measured TDS, free sulfide, and OCS during the 2018 US GEOTRACES GP15 Pacific Meridional Transect from 56°N to 20°S. Dissolved samples were collected using a trace metal-clean sampling fish towed at ca. 3 m depth between vertical profile stations. Clean water was delivered to the main ship’s laboratory using a Teflon bellows pump and 3/8” Teflon tubing, with water passing through 0.2 μm poly sulfone filter cartridge before being hermetically collected in a modified 2L cubitainer that allowed filling and discharge without exposure to the atmosphere. TDS and OCS were determined by acidification, gas stripping, cryogenic trapping, and determination by gas chromatography with flame photometric detection (0.2 pmol S/L detection limit). Free sulfide was determined via a head space method coupled with accurate measurements of pH, salinity, and temperature.

Along the 8450 km transect at 33 surface stations, TDS ranged from 10 to 200 pmol S/L, with an average of 158±28 pmol S/L at the northernmost coastal stations and 31±14 pmol S/L in the oligotrophic, open ocean stations. With the exception of two coastal stations, free sulfide was undetectable, meaning that virtually all of the TDS was complexed with trace metals. Although trace metal concentrations are not yet available for the GP15 transect, results in the literature and existing metal-sulfide stability constants that are equivalent to, or larger than, organic ligands suggest that picomolar concentrations of zinc, cadmium, and nickel in surface waters could be complexed by these equivalent hydrogen sulfide concentrations. These implications and likely production mechanisms for H₂S will be discussed.