Oceanic distribution, properties, and temporal variability of iron colloids

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10-90% of the iron that passes through an 0.2 μm filter ("dissolved", dFe) will not pass through an 0.02 μm or 10,000 kilodalton ultrafilters (hence "colloidal", cFe, as contrasted to the "soluble", sFe, ultrafiltrate and the >0.2 μm "particulate", pFe). We have measured colloidal iron and some of its properties and variability in the North Atlantic and at the Hawaii HOT timeseries station. Under areas of high dust flux, the standing stock of dFe in the mixed layer is predominantly cFe. This is not true in areas where upwelling is the dominant source of Fe. Near the chlorophyll maximum, cFe is very low or absent, and the residual remaining dFe is sFe. In the mid-lattitude North Atlantic below the ChlMax, remineralized Fe occurs in roughly constant proportions of 1 cFe: 1 sFe. Despite the predominance of cFe, two-hour duration electrochemical titrations indicate that colloidal material has a low complexing capacity for Fe and that most of the organic Fe complexing agents are in the soluble fraction. Either colloidal Fe complexing agents are only slowly reactive, or the Fe exists in another form, such as inorganic iron hydroxide precipitates.

At the Hawaii HOT timeseries station from 1999-2014, our discontinuous measurements show that "total dissolvable iron" (weak acid soluble pFe + cFe + sFe) varies more than an order of magnitude, from 0.1-2.0 nM. Yet during the summer of 2013, an intensive C-MORE daily sampling of Fe showed nearly the same degree of variability. Over the longer term, the strong seasonal variability of Asian dust must play a role, but in the summer of 2013 there was no Asian dust and the short episode of high Fe was created by a passing eddy with coincident high diatom abundance. The peak of the ~4 day event occurred first for the reactive pFe (rising from 0.8 to 1.8 nM), a day later in the cFe (rising from 0.2 to 0.8 nM), and then another day later in the sFe (rising from 0.1 to 0.3 nM). For most of the rest of the summer, reactive pFe varied from 0.2 to 1.2 nM, while dFe was relatively constant at 0.4 nM and sFe held constant between 0.05 and 0.10 nM.

These data demonstrate that colloidal iron is a significant reservoir of iron in the oceans, but that there are many aspects of colloidal iron generation and removal that remain to be determined.