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SAFe: Sampling and Analysis of Iron in the ocean

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It is generally acknowledged that Fe is a limiting nutrient in significant regions of the ocean. Yet there is still very little data defining the oceanic distribution of iron, and it is sometimes difficult to know whether existing data is afflicted by errors in sampling or analysis. In order to prepare the way for a global survey of Fe in the ocean, the SAFe project was initiated to intercompare different sampling and analysis methods, with the intent to understand why different techniques produce different Fe estimates, and to develop standardized protocols for Fe analysis that can be employed in future Fe sampling expeditions. The SAFe cruise was undertaken on the R/V Melville between Hawaii and San Diego Oct. 15 – Nov. 8, 2004 with a scientific crew of 30 scientists of 11 nationalities from 17 research groups. Water was collected from the surface along the track and at 7 stations including a coastal site, but most of the effort was devoted to a station at 30˚N 140˚W which had low levels of iron ($\sim$0.1 nM) in near-surface waters but high levels of iron in intermediate waters ($\sim$0.8 nM). A prime objective was to obtain uncontaminated homogenized large-volume (500 liter) samples of these surface and intermediate waters, and to split these into 500 half-liter acidified samples that could be distributed to laboratories that measure oceanic Fe. Shipboard Fe analyses indicated that SAFe was successful in this objective. A second objective was to sample these waters using different sampling techniques: underway pumps, conventional (Go-Flo) and unconventional sampling devices mounted on Kevlar, hydrowire, and rosettes operated by different laboratories. These samples were then analyzed by 10-15 shipboard analytical methods (with shore laboratory analyses in progress). SAFe found that the agreement between most sampling methods was moderately good, but with some significant differences. The various shipboard analyses were compared re-

peatedly on the ship, and this work led to several conclusions: (a) the pH and duration of sample acidification significantly affected the shipboard analyses, (b) methods that required a pre-treatment (to ensure a specific oxidation state) must be carefully controlled for optimum reaction conditions and duration, and (c) some methods that were supposed to be Fe2+ specific appear to have significant positive and negative interferences. When these findings were taken into account, the low-level surface waters resulted in consistent results within ∼0.05 nM (with uncertainties in the blank appearing to account for most of the differences), and the high-level analyses appear consistent to within ∼0.1 nM. These results show much better agreement than previous intercalibration efforts and suggest that it will be possible to go forth with a global-scale Fe measurement program.