

Ultraclean sampling of trace elements and isotopes in the ocean by the TiTAN sampler

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A new international study of the biogeochemical cycles of trace elements and isotopes in the Arctic and Southern Oceans (GEOTRACES) during the International Polar Year urged the development of an improved sampling system for trace metals and isotopes. A novel rectangular frame was designed and constructed of titanium, holding two rows of 12 Go Flo samplers, as well as various CTD sensors. Testing and daily use of this TiTAN system during cruises by RV Pelagia and RV Polarstern showed that the system is ideal for ultraclean water sampling. TiTAN enables the collection of vertical sections of trace elements and isotopes at the same efficiency and resolution as hitherto only feasible for 'traditional' variables like nutrients.

In the recent past, the ultraclean sampling of ocean waters for trace elements and isotopes was a very time-consuming process. The sampling was done by using Go Flo bottles mounted on a Kevlar wire. Only 10 bottles maximally could be used per cast irrespective of depth and thus the sample capacity was limited in view of the desired resolution over the total water column. Moreover, all the bottles were mounted manually on and off the cable and carried over the deck to a clean room container for the processing. All in all, it was a time consuming and back-breaking exercise.



Traditional way of sampling trace metals.

In order to increase the number of sampling bottles, a pilot experiment was executed: a CTD rosette sampler frame was modified in such a way that Go Flo bottles could be used. The frame itself was epoxy-coated. Also, a new winch with Kevlar wire was used. This new experimental setup was successfully tested onboard RV Pelagia during the third IRONAGES cruise in October 2002, when deposition events of iron-dust from the Sahara were quantified in the waters west of the Canary Islands. The big advantage over the traditional way of sampling was the higher resolution, i.e. more depths in the water column could be sampled. However, the Go Flo bottles still had to be transferred manually to the laboratory.

A further step involved the design and construction of a novel rectangular titanium frame with 2 rows of 12 Go Flo samplers. A new pneumatic system was developed at NIOZ and used for closing the Go Flo's. Upon recovery the frame is placed inside an ultraclean laboratory container (Fig. 1) where water can be drawn via filtration units into storage flasks. The whole procedure is very time-efficient with a shipboard turnover time of 3 hours. We are now able to collect vertical sections of trace elements and isotopes at the same efficiency and resolution as hitherto only feasible for 'traditional' variables like nutrients.

The system functioned excellently and yielded large numbers of samples during a cruise by RV Pelagia in the Canary Basin in November 2005. Dissolved iron was measured by Flow Injection



The new TiTAN system.

Chemiluminescence. The concentrations of dissolved iron as obtained with the new all titanium frame were very similar to the results from the water samples collected by the traditional Kevlar wire cast. An example is given for the station at 17.5°N, 30°W (Fig. 2 left panel). Very low dissolved Fe values of ~0.4 nM (1-4 km depth) were found, similar to the values observed earlier in the Canary Basin by the prototype (epoxy-coated) CTD frame during the 2002 pilot study. For comparison, the results of the JGOFS NABE cruise program 1988/89 by the well-known Fe-studygroup led by John Martin (Moss Landing Marine Laboratories, USA) were plotted as well (Fig. 2). Although their station was at 47°N, 20°W, so north of our study area, the profiles showed great

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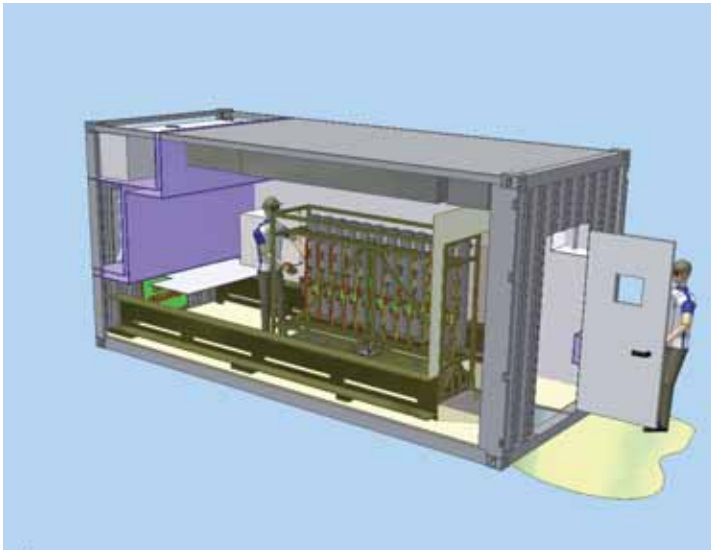


Fig. 1. Design drawing of the new frame and container.

similarity for the 1-4 km depth zone. The comparisons warrant the suitability of the new frame for trace metal sampling. Nitrate concentrations were used to check for leakages of the new closing system of the sampling bottles. Again, the new titanium frame with Go-Flo bottles proved identical to the traditional sampling systems (Fig. 2 right panel). It can be concluded that the new all titanium frame (TiTan) in combination with the clean container enables an efficient trace metal sampling of 24 depths in one cast (including CTD profile), saving expensive ship time. During the GEOTRACES cruise onboard RV Polarstern in 2007 along a section near the North Pole, the new NIOZ Titan sampler was the main gear as it was used for the collection of water samples for all participants.

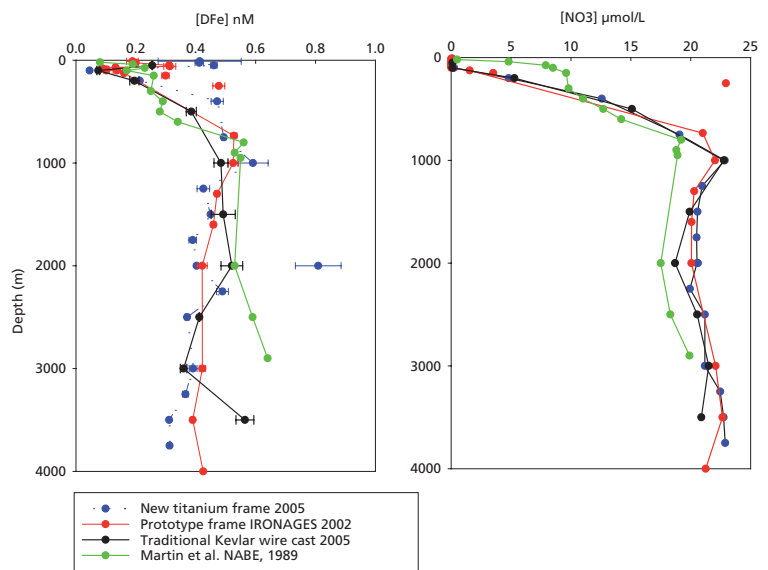


Fig. 2. Vertical profiles of dissolved iron (DFe) and nitrate (NO₃) by casts of the new all titanium frame and a traditional cast, both during the test cruise of November 2005, and compared to results by the prototype epoxy-coated CTD frame during the pilot study 2002 and data by the NABE program by Martin et al. (1993; DSR II 40: 115-134)