4.6 Biogenic Silica (BSi) — Megan French

Objective

The primary objective of the analysis undertaken in this work was to obtain concentration profiles for Biogenic Silica (i.e. SiO_2, opal) through the upper water column (to 500 m).

The relevance of determining Biogenic Silica (BSi) profiles is that it provides insight into the occurrence of silicon dependant marine organisms such as diatoms, silicoflagellates, and radiolarians. In the interests of this study BSi concentration data potentially offers key information since it provides a means of distinguishing between different phytoplankton assemblages. Almost all the BSi produced in the oceans is precipitated by planktonic organisms in the surface layers and the global production of BSi is dominated by diatoms (Nelson et al., 1995). The existence of diatom communities is controlled by the availability and distribution of silicic acid ($Si(OH)_4$) (Yool and Tyrrell, 2003), which is up taken by diatoms and subsequently used to construct their cell walls (i.e. BSi). $Si(OH)_4$ is not passed up the food chain to any degree, and its regeneration is not by organic degradation but by dissolution of opaline SiO_2 (Broecker and Peng, 1982, in Dugdale et al., 1995).

Method

BSi concentration profiles were determined for stainless steel CTD sampling stations over Legs 1 and 2 of the cruise (refer to Tables 4.5 and 4.6). 500 ml samples of seawater were taken from each Niskin bottle for depths 5 - 500 m. Water samples were then filtered through 0.4 m GF/F polycarbonate filters, with additional size fractionated filtrations (20 m and 2 m) made at 2 selected depths for each station. Filters were placed into 20 ml plastic vials and frozen whilst awaiting analysis.

In order to determine the concentration of BSi accumulated on each sample filter, it was first necessary to dry filters (in uncapped vials) for a 12 h period at 60°C. Once dried, 4 ml 0.2 mol L^{-1} sodium hydroxide was added to each filter/vial. It was necessary to ensure that filters were fully submerged before vial caps were replaced and samples heated for 2 h at 90°C in order to digest the BSi. Samples were subsequently allowed to cool before being neutralised with 10 ml 0.1 mol L^{-1} hydrochloric acid. Blank samples were prepared accordingly. Each sample was vigorously shaken and approximately 5 ml was transferred to a plastic analysis cup which was immediately placed in the auto analyser (Skalar San-plus Segmented Flow Analyser) in order to determine the silicate concentration (from calibration samples prepared and analysed prior to each set of station samples).

Full details of the technique, chemistry and equipment specifics involved in the determination of silicate are outlined in Skalar Seawater Analysis Handbook (1994). Briefly, the technique is based on the ammonium molybdate method, whereby dissolved silicate reacts with ammonium molybdate under acidic conditions to form silicomolybdic acid of which there are α and β isomers. Reagent ratios and pH are optimised to favour the formation of β isomers, which is then reduced by ascorbic acid. Absorbance is measured at 810 nm.

Table 4.5 Station numbers sampled for BSi from D285 with respective maximum [BSi] and corresponding depth

Station	JDay	Latitude	Longitude	$[BSi]_{max}$	$[BSi]_{max}$ Dep
		S	E	uM L^{-1}	m
489	314	42 00.35	48 00.68	0.90	10
490	316	43 52.68	50 14.77	3.25	80
493	317	44 30.00	51 15.20	3.83	5
494	318	46 03.23	51 47.17	4.25	150
498	323	46 03.15	51 47.41	2.63	20
504	325	47 45.96	52 52.90	1.86	100
506	325	48 11.50	52 24.30	2.08	40
507	326	49 00.26	51 29.42	1.67	40
513	328	48 35.96	51 57.09	1.28	10
518	330	46 04.09	51 46.64	3.65	80
520	331	45 23.96	52 14.94	5.88	20
525	332	45 29.75	48 59.76	3.26	80
527	333	45 29.96	48 20.00	4.90	60
528	334	45 29.48	47 38.48	1.95	5
532	335	44 54.96	49 54.24	1.42	40
538	337	44 51.39	49 39.13	3.97	100
544	339	43 06.58	47 11.11	1.36	60

Summary of provisional findings

Depth profiles of [BSi] were obtained for each of the stations listed in Tables 4.5 and 4.6. Details of the maximum [BSi] and corresponding depth are also provided in these tables for each station. Overall the data obtained appears to be of good quality, with profiles demonstrating general decreasing trends of BSi with depth. Figures 4.5 and 4.6 present a compilation of station profiles for D285 and D286 respectively. The most pronounced profiles, with highest surface (upper 100 m) occurring at stations 494, 520 and 527 during D285 and stations 573 (M3), 596, 606 and 614 during D286. The data also indicates that during D285 a higher fraction of surface BSi was being exported to a greater depth (i.e. up to ~200 m) in comparison to that on D286 (Figures 4.5 and 4.6).

Table 4.6 Station numbers sampled for BSi from D286 with respective maximum [BSi] and corresponding depth

Station	JDay	Latitude	Longitude	$[BSi]_{max}$	$[BSi]_{max}$ Depth
		S	E	uM L^{-1}	m
553 M9	354	43 00.00	47 00.00	1.36	200
556	354	43 29.90	47 39.90	0.72	200
557	355	43 59.95	49 00.00	0.51	150
562	355	44 31.67	49 57.60	3.20	20
565	356	45 08.30	51 11.73	2.31	5
573	357	46 04.60	51 46.40	4.28	10
582 M5	363	46 00.00	56 09.00	0.66	150
584	364	45 59.57	55 00.41	0.75	20
585	365	46 00.00	54 00.00	1.18	80
586	365	45 59.91	53 15.61	2.24	100
587	365	45 59.93	52 31.58	1.90	100
589 M3	366	46 03.86	51 46.86	1.38	80
596	003	49 00.00	51 32.00	4.22	80
606	007	47 48.13	52 51.04	5.04	80
614	009	46 09.27	51 51.25	4.64	20
620	010	46 01.93	51 32.17	3.44	20
623	011	45 59.47	51 40.60	1.89	20
628	012	46 02.45	51 57.62	3.92	10

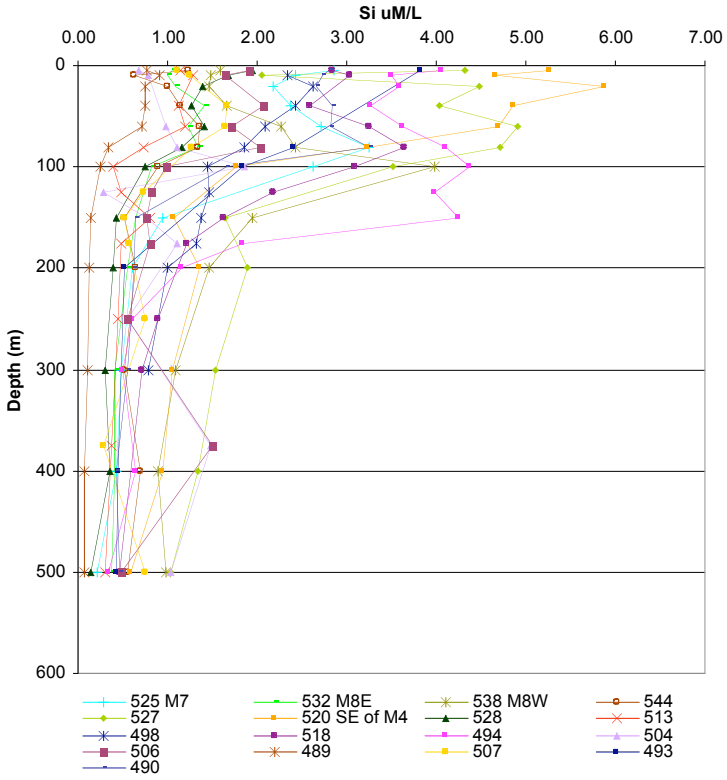

Fig. 4.5 Biogenic Silica profile for stations during leg 1

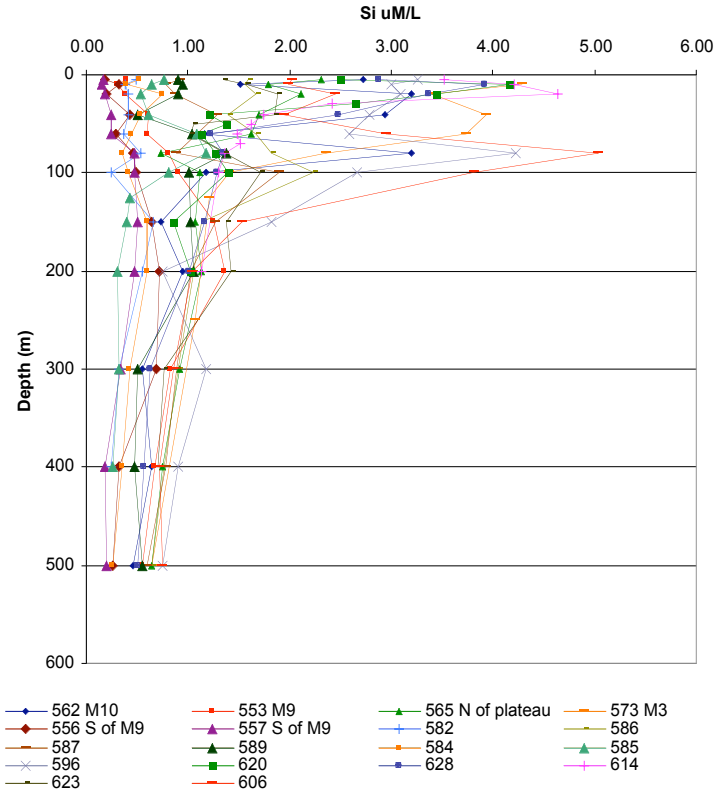

Fig. 4.6 Biogenic Silica profile for stations during leg 2

Table 4.5 highlights data showing that the highest and lowest BSi_{max} concentrations found during D285 were 5.88 µM L^{-1} (station 520 at a depth of 20 m) and 0.9 µM L^{-1} (station 489 at a depth of 10 m) respectively. During D286 (Table 4.6), the highest and lowest BSi_{max} concentrations were 5.04 µM L^{-1} (station 606 at a depth of 80 m) and 0.51 µM L^{-1} (station 557 at a depth of 150 m) respectively. During D285, 64.7 % of the BSi_{max} concentrations occurred at depths ≤ 60 m, whereas this decreased to 44.5 % during D286. Interestingly, 63.6 % of the maximums occurring at ≤ 60 m were <2.3 _M L^{-1} during D285 whereas during D286, 75 % of the maximums occurring at ≤ 60 m were >2.3 µM L^{-1}. This information is illustrated graphically in Figs 4.7 and 4.8.

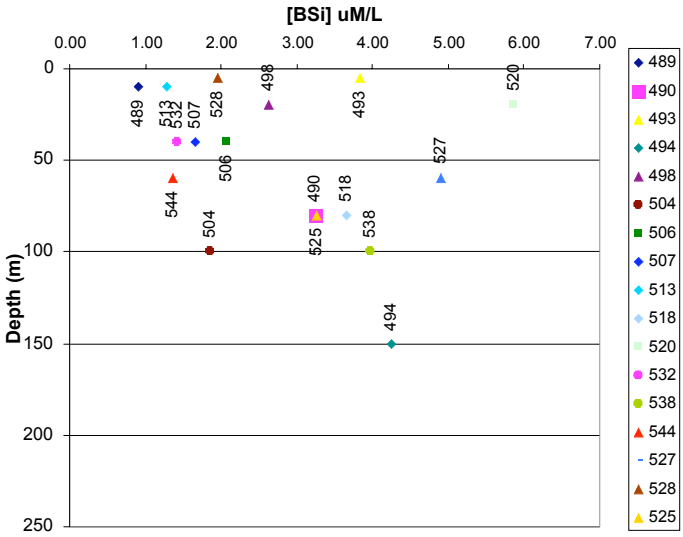

Fig. 4.7 Maximum Biogenic Silica values for each Station on D285

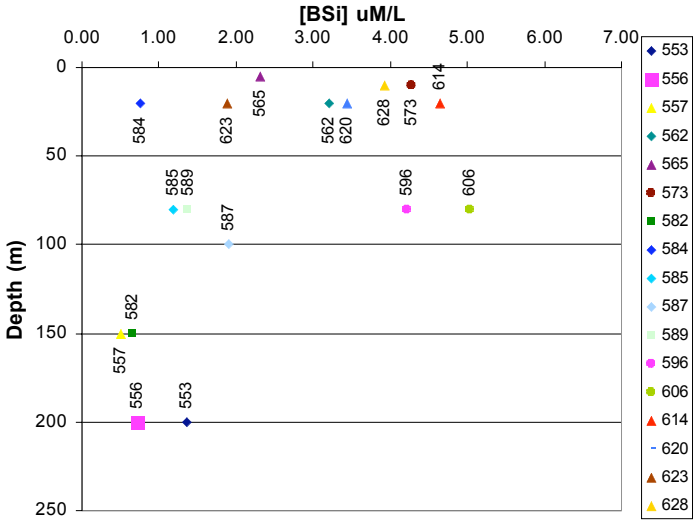

Fig. 4.8 Maximum Biogenic Silica values for each Station on D286