

**Supplementary Table S1. Elemental quotas and oceanic concentrations**

Element	Phytoplankton quota <sup>a</sup> (mol:mol C)	Observed maximum phytoplankton quota <sup>b</sup> (mol:mol C)	Observed minimum phytoplankton quota <sup>b</sup> (mol:mol C)	Mean ocean concentration <sup>c</sup> ( $\mu\text{mol kg}^{-1}$ )	Residence time <sup>c</sup> (years)	Estimated % in preformed pool
C	1	1	1	2247	130000	
H	2.12					
N	0.129	0.169	$5 \times 10^{-2}$	30	3300	52
O	0.339					
P	$8.07 \times 10^{-3}$	$2.58 \times 10^{-2}$	$1.29 \times 10^{-3}$	2.0	53000	55
S	$1.05 \times 10^{-2}$			28010	8700000	>99.99
K	$1.37 \times 10^{-2}$			10205	12000000	>99.98
Mg	$4.52 \times 10^{-3}$			52664	13000000	>99.99
Ca	$4.03 \times 10^{-3}$			10279	1000000	>99.99
Sr	$4.03 \times 10^{-5}$			89.0	5100000	>99.99
Fe	$6.05 \times 10^{-5}$	$2.58 \times 10^{-4}$	$2.13 \times 10^{-6}$	$5.37 \times 10^{-4}$	350	<0*
Mn	$2.26 \times 10^{-5}$	$3 \times 10^{-5}$	$9 \times 10^{-7}$	$3.64 \times 10^{-4}$	60	<0*
Ni	$8.06 \times 10^{-6}$	$3.05 \times 10^{-5}$	$1.86 \times 10^{-7}$	$8.17 \times 10^{-3}$	6000	99
Zn	$6.45 \times 10^{-6}$	$1.1 \times 10^{-4}$	$1.74 \times 10^{-7}$	$5.35 \times 10^{-3}$	51000	87
Cu	$3.06 \times 10^{-6}$	$1.04 \times 10^{-4}$	$2.18 \times 10^{-7}$	$2.36 \times 10^{-3}$	5000	86
Cd	$1.69 \times 10^{-6}$	$3.35 \times 10^{-4}$	$1.6 \times 10^{-9}$	$6.23 \times 10^{-4}$	50000	70
Co	$1.53 \times 10^{-6}$	$2.56 \times 10^{-5}$	$4.7 \times 10^{-10}$	$2.04 \times 10^{-5}$	340	<0*
Mo	$2.42 \times 10^{-7}$			0.104	800000	>99.97
Si	0.129	1.01	0.08	99.7	20000	

Notes:

**a)** Phytoplankton quotas representative of means across a range of taxa<sup>41,117,118</sup>. The observed composition will depend on the characteristics of the culture media, particularly for trace metals. Further nutrient elements include: Li, B, F, Na, Cl, V, Cr, Se and I.

**b)** Maximum and minimum observed elemental quotas across different growth conditions and taxa, the latter representing a more restricted set than (a). Maximum and minimum values will typically correspond to nutrient replete or limited cultures respectively and ranges could potentially be extended through observations of other taxa and growth conditions. References are: N ref 28, P refs 25,136, Fe refs 137,138, Mn ref 139, Ni ref 140, Zn refs 141,142, Cu ref 143, Cd refs 141,142, Co ref 144, Si refs 145,146 (diatoms only).

**c)** Mean ocean concentrations and residence times<sup>119,147-149</sup>. Global surveys of trace elements (e.g. GEOTRACES<sup>150</sup>) should considerably improve these estimates.

**d)** Values for preformed P were calculated from the difference between the mean concentration and the oceanic mean Apparent Oxygen Utilisation scaled by a Redfield ratio for remineralisation<sup>80</sup>. For the other elements, the remineralised pool is calculated by scaling the value for remineralised P to quotas (a) for the organic material in comparison to mean oceanic concentrations. For N and P a consistent alternative calculation can be performed by assuming the deep ocean is composed of an approximate 50:50 mix of NADW and AABW<sup>78</sup>, then comparing end-member preformed N and P concentrations calculated for these water masses with the mean deep ocean concentration. \*calculated values for scavenged elements are negative as the pool size which would result from remineralisation of organic matter would be greater than the total ocean inventory.

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