AN UPDATED SILICA BUDGET FOR THE EASTERN MEDITERRANEAN

Michael Krom [1]*, Kent Fanning [2] and Nurit Kress [3]
[1] Charney School of Marine Haifa University - M.D.Krom@leeds.ac.uk
[2] College of Marine Science, University of South Florida
[3] Israel Oceanographic & Limnological Research, National Institute of Oceanography

Abstract
An updated silica budget for the Eastern Mediterranean Sea (EMS) including both silicate and particulate biogenic silica (BSi) showed a net outflow of 27 x 10^9 molesSi/yr. This deficit suggests that the terms in the budget are still as not well defined. The major term in the budget is the exchange at the Straits of Sicily with 137 x 10^9 molesSi/yr flowing into the EMS and 258 x 10^9 molesSi/yr flowing out. Other important terms are the riverine input (34 x 10^9 molesSi/yr) and diagenetic supply of silicate from underlying sediment (54 x 10^9 molesSi/yr). Dust is a minor input (5 x 10^9 molesSi/yr). New focused measurements needed to close the budget should include improved riverine flux, better measurements of diagenetic weathering of clays in the water column and sediment, sediment burial flux and coastal recycling processes.

Keywords: Nutrients, South-Eastern Mediterranean

Nutrient budgets have been used extensively to understand biogeochemical cycling processes in the Eastern Mediterranean[1-2].The most recent silica budget for the EMS [3] found that the net flux of silica out of the basin was far higher (157-250 x 10^9 molesSi/yr) than the best estimates available for the inputs from rivers and other sources. Here we present an improved updated budget that takes into account fluxes of biogenic silica (BSi) which is likely to dissolve in the highly unsaturated waters of the EMS. The silicate flux through the Straits of Sicily was calculated using water flow rates determined in 1997 [4] . Measured silicate from the MTPII-MATER database was used. Crombet et al., [5] found 0.25 µmoles/l of BSi concentration in the upper (inflowing) water column with no BSi in the outflowing water in July 2009 when primary productivity was at a minimum. Here we assumed that dissolved silicate measured in November surface waters (mean value = 3 µmoles/l) was representative of the winter bloom conditions (6 months) and will be taken up as BSi and that total average BSi concentration of 1 µmoles/l during summer stratified conditions The calculated flux of silicate from diagenetic processes in the sediment was 54 x 10^9 MolesSi/yr [6]. We assume that this silicate is all formed from in-situ clay diagenesis since there is no evidence of dissolution of BSi derived silica in the uppermost layers[7]. The estimated average riverine flux between 1963 and 1998 was 23 x 10^9 molesSi/yr [8] but they underestimate the global flux of silica to the ocean because it does not include BSi [9]. We therefore used the global average of 50% for BSi to modify our riverine flux. Finally we determined the atmospheric flux as 5.2 x 10^9 molesSi/yr.

Tab 1 : of calculated fluxes of silicate and BSi into and out of the EMS

Input to the Eastern Mediterranean	**Flux (10^9 Mol/yr)**	**Comment**
Straits of Sicily – dissolved silicate	121	<100m in summer & <200m in winter [4]
Straits of Sicily – BSi	16	See text above for BSi concentrations converted to flux using Astraldi et al., [4] water flow rates.
Riverine input – dissolved silicate	23	Ludwig et al., [8]
Riverine input – BSi	11.5	Assumed value from Conley [9]
Sediment pore water flux	54	Jones [6] assumed to be all fluxing Si is diagenetic based on [7]
Atmospheric input – BSi	5.2	Krom unpublished data
Total input	**203.7**	
Output from the eastern Mediterranean		
Straits of Sicily – dissolved silicate	258	>100m in summer & >200m in winter.[4]
Sediment burial flux	0	Assumes all BSi dissolves
Net export flux	**-27.3**	

With the inclusion of BSi in this budget and maximising all possible external inflow terms, the net deficit of silica, 27.3 x 10^9 MolesSi/yr is much reduced compared to previous estimates of 157-250 MolesSi/yr. We conclude that dissolution of external biogenic silica and diagenetic clay weathering is an important source of silicate to the basin. Another potentially important process not included in this budget is silica cycling processes in coastal areas. To further improve the budget it is necessary to better quantify the annual BSi in the surface inflowing waters at the Straits of Sicily and contribution from rivers and from the sediments both offshore and in coastal regions. References:

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