

Supplement of Biogeosciences, 13, 751–760, 2016
<http://www.biogeosciences.net/13/751/2016/>
doi:10.5194/bg-13-751-2016-supplement
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Biogeosciences  Open Access

Supplement of

Mussel shells of *Mytilus edulis* as bioarchives of the distribution of rare earth elements and yttrium in seawater and the potential impact of pH and temperature on their partitioning behavior

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Table 1. REY concentrations (ppb) in the *Mytilus edulis* shells from the ODAS site.

Element	ODAS I	ODAS II	ODAS III	ODAS IV	ODAS V	ODAS VI	ODAS VII	ODAS VIII
La	15.00	12.70	12.00	8.04	11.50	8.47	11.10	11.50
Ce	12.50	10.50	11.40	7.58	11.70	8.87	12.10	11.50
Pr	2.50	2.00	2.10	1.26	1.86	1.34	1.86	1.78
Nd	10.70	8.40	8.90	5.37	7.38	5.73	7.84	7.47
Pm								
Sm	2.50	2.00	2.20	1.23	1.62	1.24	1.75	1.58
Eu	0.70	0.50	0.50	0.338	0.45	0.34	0.46	0.42
Gd	3.80	3.10	3.40	2.06	2.40	2.1	2.77	2.48
Tb	0.50	0.40	0.40	0.245	0.29	0.24	0.31	0.26
Dy	2.40	2.00	2.20	1.2	1.35	1.22	1.58	1.40
Y	20.00	17.00	18.00	14.2	12.00	12.6	14.00	12.20
Ho	0.40	0.40	0.40	0.241	0.28	0.23	0.31	0.26
Er	1.00	0.90	1.00	0.527	0.65	0.52	0.66	0.52
Tm								
Yb	0.50	0.50	0.60		0.32	0.24	0.31	0.00
Lu	0.10	0.10	0.10	0.0464	0.05	0.03	0.05	0.05

Table 2. Mean REY concentrations (ppb) for the 4 replicate pools of *Mytilus edulis* used for analytical assessment during method development and international reference standard JLs-1 obtained in this study compared to the published values of Dulski (2001).

Element	Pool 1	Pool 2	Pool 3	Pool 4	JLs-1 (This study)	JLs-1 (Dulski 2001)
La	15.49	30.12	21.83	10.78	97.08	107.00
Ce	10.94	10.15	11.44	10.75	174.72	187.00
Pr	1.96	1.82	1.98	1.89	22.03	23.60
Nd	7.53	6.90	7.51	7.63	83.74	90.20
Sm	1.60	1.44	1.67	1.65	18.51	18.50
Eu	0.41	0.37	0.41	0.42	4.54	4.60
Gd	2.23	2.04	2.20	2.22	22.01	21.40
Tb	0.27	0.26	0.27	0.27	3.11	3.10
Dy	1.40	1.29	1.43	1.50	19.99	20.00
Y	11.67	11.52	13.63	15.72	199.17	216.00
Ho	0.26	0.24	0.26	0.27	4.28	4.50
Er	0.67	0.60	0.64	0.68	13.22	13.60
Tm						
Yb	0.41	0.37	0.42	0.42	11.74	12.60
Lu	0.05	0.05	0.06	0.06	1.75	2.00

Table 3. Modelled percentages of free REY³⁺ species in the North Sea seawater at 5°C Temperature for pH 8.2 and 7.6.

Element	pH 8.2	pH 7.6
La	8	23
Ce	6	20
Pr	5	17
Nd	4	14
Sm	2	10
Eu	2	9
Gd	2	8
Tb	1	7
Dy	1	6
Ho	1	5
Er	1	4
Tm		
Yb	1	4
Lu	1	3
Y	1	5

Table 4. REY concentrations (ppb) in shells from the 3 locations, *ODAS*, *Jade Bay* and *Roter Sand* and in North Sea seawater (ppb)

Element	<i>ODAS</i> (Mean)	<i>Jade Bay</i>	<i>Roter Sand</i>	North Sea seawater
La	12.75	8.91	13.38	2.89×10^{-3}
Ce	13.05	6.75	11.98	4.90×10^{-3}
Pr	1.91	1.48	2.02	1.05×10^{-3}
Nd	7.96	6.14	8.73	4.60×10^{-3}
Sm	1.82	1.46	2.02	1.23×10^{-3}
Eu	0.49	0.40	0.54	3.71×10^{-4}
Gd	2.83	2.32	3.12	2.47×10^{-3}
Tb	0.34	0.28	0.36	3.38×10^{-4}
Dy	1.72	1.37	1.80	2.40×10^{-3}
Y	15.50	14.22	15.61	2.60×10^{-2}
Ho	0.34	0.27	0.34	6.10×10^{-4}
Er	0.76	0.66	0.72	1.97×10^{-3}
Tm				
Yb	0.45	0.33	0.33	1.96×10^{-3}
Lu	0.07	0.04	0.04	3.50×10^{-4}

Table 5. Apparent Bulk and Modelled Partition Coefficients between shells and seawater

Element	Apparent Bulk ($_{app}D_{Tot.REY}$)	Modelled ($_{mod}D_{FreeREY}^{3+}$)
La	4.14	101.25
Ce	2.31	74.72
Pr	1.86	80.09
Nd	1.79	99.56
Sm	1.56	143.14
Eu	1.36	159.29
Gd	1.20	181.59
Tb	1.03	203.87
Dy	0.76	178.90
Y	0.61	176.95
Ho	0.57	166.14
Er	0.41	151.11
Tm	-	-
Yb	0.22	117.51
Lu	0.17	140.97