



Anthropogenic ^{236}U in Danish Seawater: Global Fallout versus Reprocessing Discharge

Qiao, Jixin; Steier, Peter ; Nielsen, Sven Poul; Hou, Xiaolin; Roos, Per; Golser, Robin

Published in:
Environmental Science and Technology

Link to article, DOI:
[10.1021/acs.est.7b00504](https://doi.org/10.1021/acs.est.7b00504)

Publication date:
2017

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):
Qiao, J., Steier, P., Nielsen, S. P., Hou, X., Roos, P., & Golser, R. (2017). Anthropogenic ^{236}U in Danish Seawater: Global Fallout versus Reprocessing Discharge. *Environmental Science and Technology*, 51(12), 6867-6876. <https://doi.org/10.1021/acs.est.7b00504>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

1 **SUPPORTING INFORMATION**

2 **Anthropogenic ^{236}U in Danish Seawater: Global Fallout vs. Reprocessing**
3 **Discharge**

4 *Jixin Qiao,^{*,a} Peter Steier^b, Sven Nielsen,^a Xiaolin Hou,^a Per Roos,^a Robin Golser^b*

5 ^a Center for Nuclear Technologies, Technical University of Denmark, DTU Risø Campus, DK-4000 Roskilde,
6 Denmark

7 ^b VERA Laboratory, Faculty of Physics – Isotope Research, University of Vienna, Währinger Straße 17, A-1090
8 Vienna, Austria

9

10

11

12 This Supporting Information in total of 4 pages contains one table and two figures.

13

14

Table S-1. Overall results of ^{236}U and $^{236}\text{U}/^{238}\text{U}$ for Danish seawater in 2013 and 2014

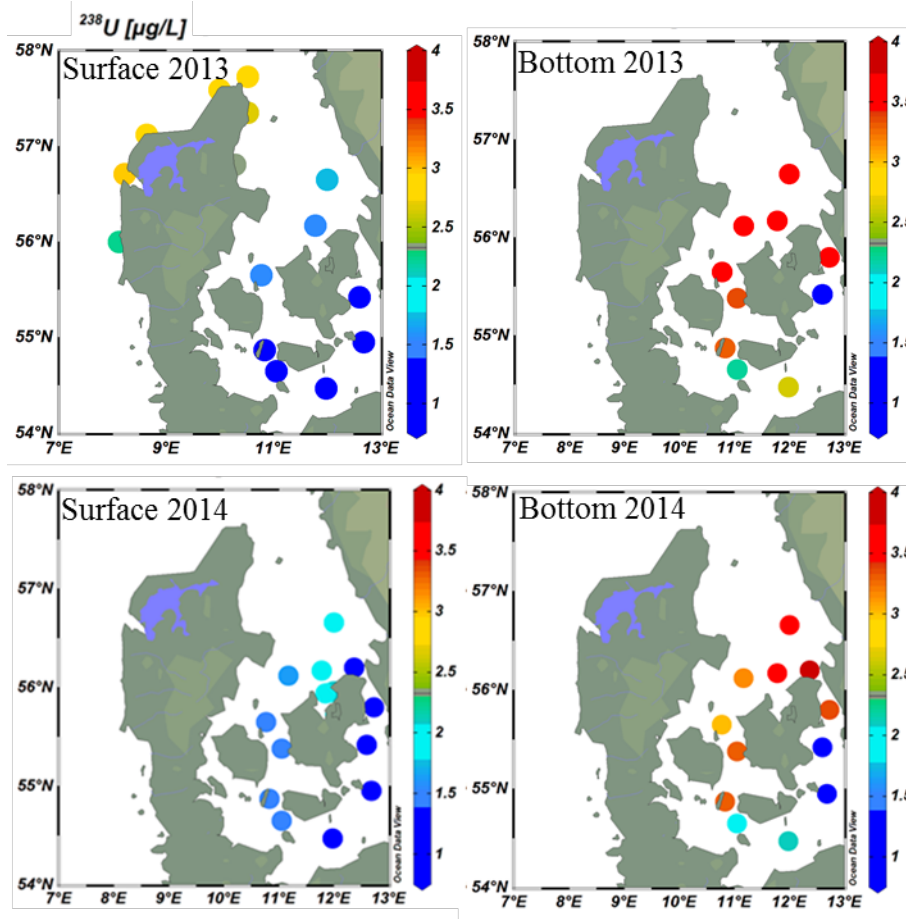
Station No.	Region	Location	N, °	E, °	Depth, m	Salinity, ‰		^{238}U , $\mu\text{g/L}^*$		^{236}U , atom/L $\times 10^7$		$^{236}\text{U}/^{238}\text{U}$ atomic ratio $\times 10^9$		^{137}Cs , Bq/m ³	
						2014	2013	2014	2013	2014	2013	2014	2013	2014	2013
1	Zealand surface	Kullen	56.20	12.37	2	12.79	-	1.33	-	4.52 ± 0.77	-	13.46 ± 2.30	-	24.10 ± 2.46	-
2		Hesselø	56.17	11.78	2	15.92	16.10	1.89	1.56	7.63 ± 0.91	5.30 ± 0.49	15.91 ± 1.90	13.43 ± 1.23	20.54 ± 2.23	21.61 ± 0.61
3		Kattegat, SW	56.12	11.17	2	15.80	-	1.63	-	4.00 ± 0.54	-	9.68 ± 1.32	-	23.10 ± 2.37	-
4		Asnæs Rev	55.65	10.77	2	14.61	14.95	1.53	1.56	7.63 ± 0.69	-	19.70 ± 1.78	-	23.60 ± 2.46	22.79 ± 0.91
5		Halskov Rev	55.38	11.05	2	13.09	-	1.43	-	5.52 ± 0.56	-	15.27 ± 1.56	-	22.74 ± 2.31	-
6	Langeland Bælt	Femern Bælt	54.87	10.83	2	13.55	11.18	1.48	1.24	4.45 ± 0.43	6.12 ± 0.58	11.88 ± 1.14	19.49 ± 1.84	22.50 ± 2.29	24.57 ± 0.69
7		Gedser Odde	54.47	11.98	2	9.03	7.78	1.02	0.86	8.16 ± 0.74	6.81 ± 0.77	31.61 ± 2.87	31.28 ± 3.53	29.70 ± 0.29	30.67 ± 0.37
8		Møn	54.95	12.68	2	8.61	7.61	0.94	0.75	5.73 ± 0.59	4.66 ± 0.47	23.98 ± 2.47	24.55 ± 2.48	30.55 ± 3.21	27.59 ± 0.50
9		Sundet, S	55.42	12.60	2	8.31	7.69	0.92	0.79	5.42 ± 0.70	5.34 ± 0.50	23.30 ± 3.02	26.73 ± 2.48	28.60 ± 2.89	29.00 ± 0.73
10		Sundet, N	55.80	12.73	2	9.69	-	1.02	-	3.56 ± 0.35	-	13.78 ± 1.37	-	25.66 ± 2.59	-
11		Kattegat-413	56.66	12.00	2	16.63	16.81	1.84	1.74	4.34 ± 0.70	5.37 ± 0.49	9.34 ± 1.50	12.18 ± 1.11	19.11 ± 1.98	19.39 ± 0.35
Average ± sd										5.69 ± 1.61	5.64 ± 0.70	17.24 ± 6.59	20.87 ± 7.01	24.22 ± 3.37	25.27 ± 4.03
1	Zealand bottom	Kullen	56.20	12.37	23	33.34	-	3.94	-	8.04 ± 0.73	-	8.07 ± 0.73	-	3.73 ± 0.50	-
2		Hesselø	56.17	11.78	24	33.98	34.72	3.62	3.45	6.50 ± 0.63	-	7.10 ± 0.69	-	3.47 ± 0.45	2.58 ± 0.34
3		Kattegat, SW	56.12	11.17	32	30.03	33.66	3.16	3.55	6.27 ± 0.57	-	7.83 ± 0.71	-	6.73 ± 0.86	4.17 ± 0.33
4		Asnæs Rev	55.65	10.77	33	28.27	33.26	3.01	3.47	7.96 ± 0.72	7.16 ± 0.67	10.45 ± 0.94	8.16 ± 0.76	8.58 ± 0.97	5.23 ± 0.48
5		Halskov Rev	55.38	11.05	26	30.09	-	3.32	3.36	4.50 ± 0.62	5.50 ± 0.58	5.37 ± 0.74	6.47 ± 0.68	7.61 ± 0.86	5.33 ± 0.63
6	Langeland Bælt	Femern Bælt	54.87	10.83	48	28.14	31.18	3.31	3.28	7.90 ± 1.09	5.83 ± 0.53	9.44 ± 1.31	7.03 ± 0.64	8.29 ± 0.98	6.07 ± 0.34
7		Gedser Odde	54.47	11.98	19	17.43	32.03	1.86	2.21	6.63 ± 0.62	6.30 ± 0.57	14.08 ± 1.31	11.27 ± 1.03	18.61 ± 1.99	17.98 ± 0.63
8		Møn	54.95	12.68	22	9.84	-	0.99	-	5.00 ± 0.58	7.01 ± 0.70	9.44 ± 1.09	10.57 ± 1.05	18.58 ± 2.06	15.61 ± 0.73
9		Sundet, S	55.42	12.60	16	8.70	8.00	0.97	0.86	4.75 ± 0.60	-	18.88 ± 2.39	-	28.26 ± 3.02	-
10		Sundet, N	55.80	12.73	18	8.70	8.00	0.97	0.86	4.64 ± 0.45	5.42 ± 0.51	18.90 ± 1.82	24.88 ± 2.34	26.59 ± 2.70	26.17 ± 0.63
11		Kattegat-413	56.66	12.00	22	31.56	34.24	3.37	3.6	7.74 ± 0.77	6.53 ± 0.67	8.57 ± 0.85	7.37 ± 0.75	4.08 ± 0.55	2.59 ± 0.24
Average ± sd										6.41 ± 1.38	6.11 ± 0.75	10.53 ± 4.43	10.18 ± 6.25	11.63 ± 8.98	9. ± 0.70
13	Jutland surface	Øster Hurup	56.81	10.28	2	25.95	-	-	2.33	-	3.22 ± 0.29	-	5.47 ± 0.50	-	-
14		Sæby	57.35	10.52	2	28.42	-	-	2.65	-	6.10 ± 0.56	-	9.10 ± 0.83	-	-
15		Højen Skagen	57.73	10.52	2	29.70	-	-	2.8	-	4.91 ± 0.47	-	6.92 ± 0.66	-	-
16		Hirtshals	57.59	9.99	2	30.48	-	-	2.85	-	4.20 ± 0.33	-	5.83 ± 0.53	-	-
17		Hanstholm	57.12	8.63	2	32.12	-	-	2.92	-	6.90 ± 0.64	-	9.34 ± 0.86	-	-
18		Thyborøn	56.71	8.22	2	32.50	-	-	2.96	-	12.16 ± 1.16	-	16.23 ± 1.55	-	-
19		Hvide Sande	56.00	8.12	2	32.03	-	-	2.25	-	8.70 ± 0.84	-	15.27 ± 1.47	-	-
20	Roskilde fjord surface	Frederiksværk Syd	55.96	12.02	2	-	-	2.08	-	6.63 ± 0.61	-	12.57 ± 1.17	-	-	-
21		Frederiksværk Nord	55.96	11.99	2	19.73	-	2.03	-	6.09 ± 0.58	-	11.84 ± 1.12	-	-	-
22		Langelse Hage	55.95	11.93	2	22.04	-	2.00	-	7.51 ± 0.80	-	14.83 ± 1.59	-	-	-
23		Lynæs vest	55.94	11.85	2	-	-	2.21	-	7.48 ± 0.68	-	13.37 ± 1.22	-	-	-
24		Lynæs øst	55.94	11.85	2	-	-	1.92	-	5.49 ± 0.71	-	11.32 ± 1.46	-	-	-
25		Gundeleve Hage	55.70	12.02	2	15.69	-	1.85	-	4.76 ± 0.58	-	10.15 ± 1.25	-	-	-
26		Ægholm Falk nord	55.72	12.02	2	-	-	1.85	-	4.43 ± 0.46	-	9.45 ± 0.99	-	-	-
27		Eskilsø vest	55.74	12.07	2	-	-	1.92	-	5.49 ± 0.71	-	11.32 ± 1.46	-	-	-
28		Risør DR3 Udløb	55.70	12.09	2	-	-	1.85	-	6.23 ± 0.59	-	13.28 ± 1.25	-	-	-

15

*Uncertainties for all the values in these two columns are less than 10%.

16

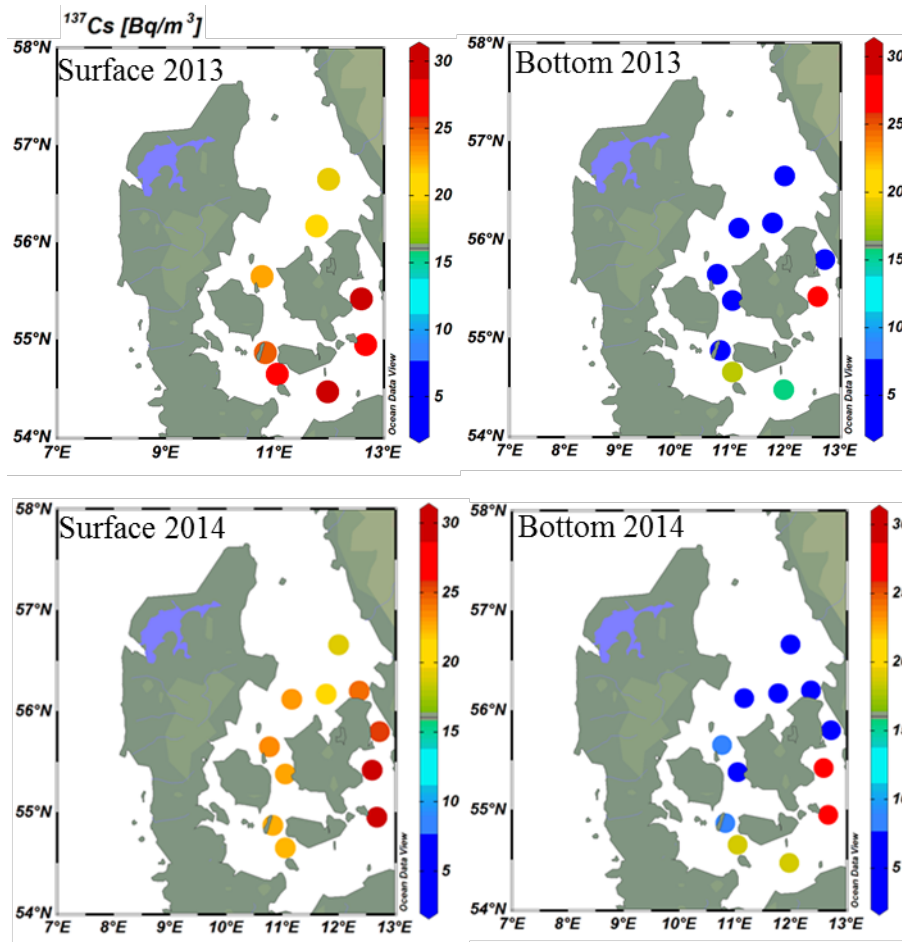
17 **Figure S-1.** Distribution of ^{238}U concentration in seawater along the Danish coasts in 2013 and 2014



18

19

20 **Figure S-2.** Distribution of ^{137}Cs concentration in seawater along the Danish coasts in 2013 and 2014



21

22