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Toxic anthropogenic pollutants reach the deepest ocean on Earth

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Supplementary Information

The Supplementary Information includes:

- Sampling locations
- Methods
- Tables S-1 to S-8
- Figures S-1 and S-2
- Supplementary Information References

Sampling locations

Table S-1 Sampling details of Mariana Trench sediments.

Sample Name	Location	Water Depth (m)	Core Length (cm)	Coring method	ΣPCBs (pg/g)
C1-I-M-S015B02	10°59.38'N; 141°57.87'E	6980	50	**Box** 	3373
C1-I-M-S078B10	11°13.706'N; 141°41.376'E	8638	50	**Box** 	2157
TS03-S106GT02 (S) TS03-S106GT02 (D)	11°13.5384'N; 142°00.4764'E	9373	216	**Gravity** 	931 4195
TS03-S090LANDER11	11°19.4914'N; 142°11.4527'E	10908	25	**Lander system** 	1462

Note: * TS03-S106GT02 (S) and TS03-S106GT02 (D) denotes the top 2 cm (S) and the bottom 2 cm (D) of the same core.

Methods

Extraction and clean-up

Sediments for analysis were scooped up carefully from the 0-2 cm surface of the cores, avoiding any contamination that may result from contact with the walls. Samples were wrapped in pre-burned Al-foil and transferred to 4 °C, without any exposure to plastics. Sediment samples were homogenised and freeze-dried. The extraction/clean-up procedure for the sediment samples has been described previously (Gong *et al*., 2007). A 10 g sediment subsample was spiked with 2,4,5,6-tetrachloro-m-xylene (TCmX) and decachlorobiphenyl (PCB209), as surrogate standards, and Soxhlet extracted with dichloromethane (DCM) for 24 hours. Anhydrous Na_2SO_4 and activated copper were added for dehydration and desulphurisation, respectively. The extracts were concentrated and solvent-exchanged to hexane by rotary evaporator. The hexane solution was purified by an alumina/silica (1:2, v/v) gel column. The column was eluted with 30 mL of DCM/hexane (2:3, v/v). The final solvent was concentrated to 0.2 mL under a gentle nitrogen stream, and spiked with penta-chloronitrobenzene (PCNB) (purchased from o2si Smart Solutions, SC, United States) as an internal standard for instrument analysis.

Instrumental analysis

Analysis of the PCBs was conducted using an Agilent 7890A gas chromatograph with a 63Ni electron capture detector (GC-μECD) at China University of Geosciences, Wuhan, having a DB-5 capillary column (30.0 m×320 μm×0.25 μm film thickness). Nitrogen was used as carrier gas at 2.5 mL/min under constant-flow mode. Injector and detector temperatures were maintained at 290 °C

and 300 °C, respectively. 2.0 μL of each sample was injected into the GC-μECD for analysis. The oven program was as follows: start at 100 °C (with an equilibration time of 1 min), then to 200 °C at a rate of 4 °C/min, then to 230 °C at 2 °C/min, and finally to 280 °C at 8 °C/min, held at 280 °C for 15 min. Individual PCBs were identified by comparison of their retention times and quantified using internal standard.

For PBDEs, Agilent 6980/5973 Gas Chromatograph-Mass Spectrometer (GC-MS) was used at Jiaxing Tongji Environmental Research Institute, Zhejiang, China. Analytes were separated using DB-5 (0.25 mm i.d. × 15 m; 0.15 um film thickness). The GC conditions were as follows: 1 uL splitless injection at 280 ˚C, He as carrier gas at constant flow rate of 1.0 mL/min, with an oven temperature program of 110 ˚C (1 min hold), 10 ˚C/min to 290 ˚C (20 min hold). Single ion monitoring (m/z of 79 and 81) was used as the scanning mode, with a negative ionisation potential (NCI) detector.

Quality control

Analytical procedures for PCBs were monitored using strict quality control measures, as follows: TCmX and PCB209 were spiked as surrogate standards to judge procedural performance. The surrogate recoveries for TCmX and PCB 209 were 80 % and 114 % respectively. The target compounds were identified by the comparison of their retention times, and quantified by a six-point internal standard calibration curve obtained from the PCB standard reagents with concentration of 200, 150, 100, 50, 20 and 10 μg/L. A procedural blank sample was run to check for interferences and cross contamination. No significant peaks overlapping the PCB standards appeared in the chromatograms of the procedural blanks. No target PCBs were detected in the solvent blank. The results from blank samples were used to establish the limit of detection (LOD). The LOD of each analyte was calculated as the average plus three standard deviations of its blank levels. The limit of detection (LOD) of PCBs ranged from 0.0001-0.0399 ng/g. Actual values of the PCB congeners were calculated by subtracting the respective LOD from the obtained values.

Supplementary Tables

Table S-2 Concentrations of PCBs (pg/g d.w.) in Mariana Trench sediments across all depths.

PCBs	C1-I-M-S015B02	C1-I-M-S078B10	TS03-S106GT02 (S)	TS03-S106GT02 (D)	TS03-S090LANDER11	∑iPCB
CB-8	290	272	63.4	1520	320	2470
CB-29	0	0	19.9	0	39.9	59.8
CB-28	9.00	21.2	6.10	93.8	20.9	151
CB-52	0	1040	155	480	358	2030
CB-49	0.90	5.50	12.2	34.4	470	100
CB-44	3.60	104	4.30	4.70	37.0	154
CB-37	380	268	99.7	583	125	1460
CB-74	20.0	45.8	20.4	54.5	32.2	172.9
CB-70	5	103	15.0	46.9	23.8	194
CB-66+CB-95	150	67.3	2.60	19.9	40.8	281
CB-60	2180	14.1	373	707	28.3	3300
CB-101	0	52.9	7.60	29.6	74.2	164
CB-99	7.00	36.2	8.10	37.3	28.5	117
CB-87+CB-81	4.00	36.2	1.50	13.4	20.2	75.3
CB-110+CB-77	33.0	0	1.20	6.70	7.70	48.6
CB-82+CB-151	0	13.5	5.00	3.80	9.50	31.8
CB-82+CB-152	28.0	0	2.60	11.8	10.5	52.9
CB-118	13.0	0	0.800	5.70	13.0	32.5
CB-114	42.0	14.2	0.600	1.90	16.7	75.4

CB-146	13.0	0	1.80	14.3	0	29.1
CB-153	2.00	0	1.40	13.4	24.1	40.9
CB-105	2.00	0	1.10	79.5	17.0	99.6
CB-179	2.00	0	1.80	15.4	14.3	33.5
CB-138	103	18.1	41.0	49.4	28.1	240
CB-158	2.00	7.70	2.00	35.2	6.7	53.6
CB-126	20.2	19.3	1.40	145	17.5	203
CB-166	13.0	12.4	2.70	27.7	7.10	62.9
CB-187	2.00	0	5.00	4.30	7.10	18.4
CB-183	2.00	0	5.00	3.90	9.00	19.9
CB-128	4.00	0	1.20	7.70	7.00	19.9
CB-177	7.00	0	12.3	35.3	5.70	60.3
CB-156	0	0	0	0	0	0
CB-180	2.00	0	11.5	19.3	8.00	40.8
CB-169	30.0	8.70	17.1	13.5	21.4	90.7
CB-170	2.00	0	3.60	12.2	9.90	27.7
CB-189	2.00	0	21.3	60.7	13.6	97.6
ΣPCBs	3373	2157	931	4195	1462	12118

Table S-3 Concentrations of PBDEs (pg/g d.w.) in Mariana Trench sediments across all depths.

PBDEs	C1-I-M-S012B02	C1-I-M-S078B10	TS03-S106GT02 (S)	TS03-S106GT02 (D)	TS03-S090LANDER11
BDE-28			1.80		
BDE-49			7.50	32.7	7.70
BDE-47			7.50	63.3	12.6
BDE-66			9.80	47.3	
BDE-100			37.9	19.8	
BDE-99			11.4	40.0	
BDE-153			26.6	166	24.1
BDE-196	84.8		77.0		
BDE-208	36.9		65.0		280
BDE-207	118				266
∑PBDEs	240		245	369	591
∑$_8$PBDEs	0	0	85.2	289	36.7

Note: PBDEs highlighted in grey indicate the most commonly occurring eight congeners in the environment. While five (BDE-28, 47, 99, 100, and 153) were detected, BDE-54, 183, 209 were not detected. ∑$_8$PBDEs indicates the summation of the PCBs highlighted in blue.

Table S-4 ICES Convention inventory of 7 PCBs.

PCBs (pg/g)	C1-I-M-S015B02	C1-I-M-S078B10	TS03-S106GT02 (S)	TS03-S106GT02 (D)	TS03-S090LANDER11
PCB028	9.0000	21.2000	6.1000	93.8000	20.9000
PCB052	0.00	1036.9000	154.7000	479.8000	358.2000
PCB101	0.000	52.9000	7.6000	29.6000	74.2000
PCB118	13.000	0.00	0.8000	5.7000	13.0000
PCB138	103.000	18.1000	41.0000	49.4000	28.1000
PCB153	2.000	0.00	1.4000	13.4000	24.1000
PCB180	2.000	0.00	11.5000	19.3000	8.0000
Σ_7PCBs	129.0000	1129.1000	223.1000	691.0000	526.5000
Mean Σ_7PCBs	18.4286	161.3000	31.8714	98.7143	75.2143

Table S-5 TEF values of dl-like PCBs.

PCBs (pg/g)	TEF
PCB110+PCB077	0.0001
PCB087+PCB081	0.0003
PCB126	0.1
PCB169	0.03
PCB105	0.00003
PCB114	0.00003
PCB118	0.00003
PCB123	0.00003
PCB156	0.00003
PCB157	0.00003
PCB166	0.00003
PCB189	0.00003

Table S-6 Toxic Equivalence (TEQ) of Mariana Trench sediment samples.

Samples	TEQ (∑PCBi*TEF)
C1-I-M-S015B02	2.92666
C1-I-M-S078B10	2.202598
TS03-S106GT02 (S)	0.654365
TS03-S106GT02 (D)	14.874955
TS03-S090LANDER11	2.400852

Table S-7 Comparison of PCB concentrations of Mariana sediments with other marine sediments.

Location	Mean ΣPCBs (pg/g d.w.)	Ocean Depth (m)	Number of congeners	References
Bering Sea	71	<500	46	Hong *et al*., 2012
Gulf of Alaska	2,000	249	36	Iwata *et al*., 1994
Gulf of Lion, Mediterranean	900	1,000		Burns and Villeneuve, 1987
Southern Cretan Margin	270	2,560	33	Mandalakis *et al*., 2014
Adriatic Sea	5,200	40-60	28	Combi *et al*., 2016
Bering Strait	214	<500	46	Ma *et al*., 2015
Chukchi Sea	185	<500	46	Ma *et al*., 2015
Iceland Station, Arctic Ocean	99	<500	46	Ma *et al*., 2015
Mariana Trench	3373	6,980	36	This study
Mariana Trench	2157	8638	36	This study
Mariana Trench	931	9373 (S)	36	This study
Mariana Trench	4,195	9373 (D)	36	This study
Mariana Trench	1,462	10,908	36	This study

Table S-8 Relative percentage concentration of clays (illite, nontronite, clinochlore, and gismondine) and other minerals detected from three Mariana Trench sediment samples, by XRD analysis.

Samples	Quartz	Albite	Illite	Nontronite	Clinochlore	Gismondine	Halite
TS03-S090LANDER11	7.0 %	17.3 %	5.4 %	32.4 %	13.3 %	17.9 %	6.8 %
TS03-S106GT02 (S)	4.9 %	14.9 %	6.3 %	41.5 %	17.5 %	14.9 %	
TS03-S106GT02 (D)	6.3 %	37.3 %	11.6 %	23.3 %	16.9 %		4.7 %

Supplementary Figures

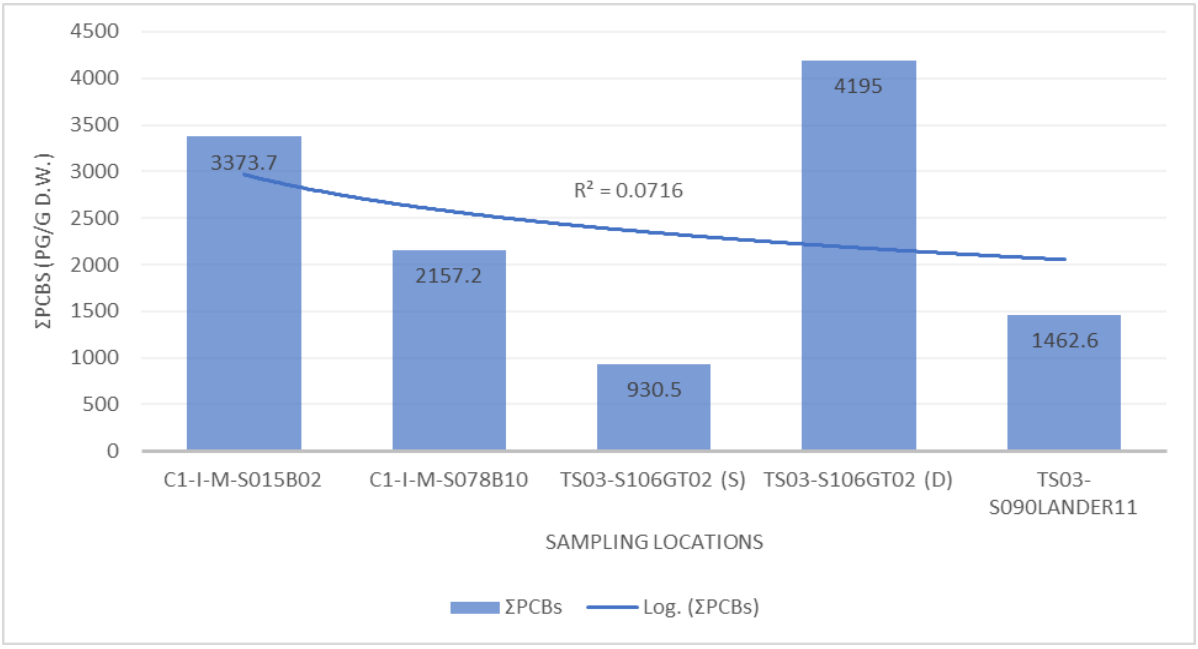

Figure S-1 ΣPCBs along with logarithmic trendline for the five sediment samples across different water depths in Mariana Trench.

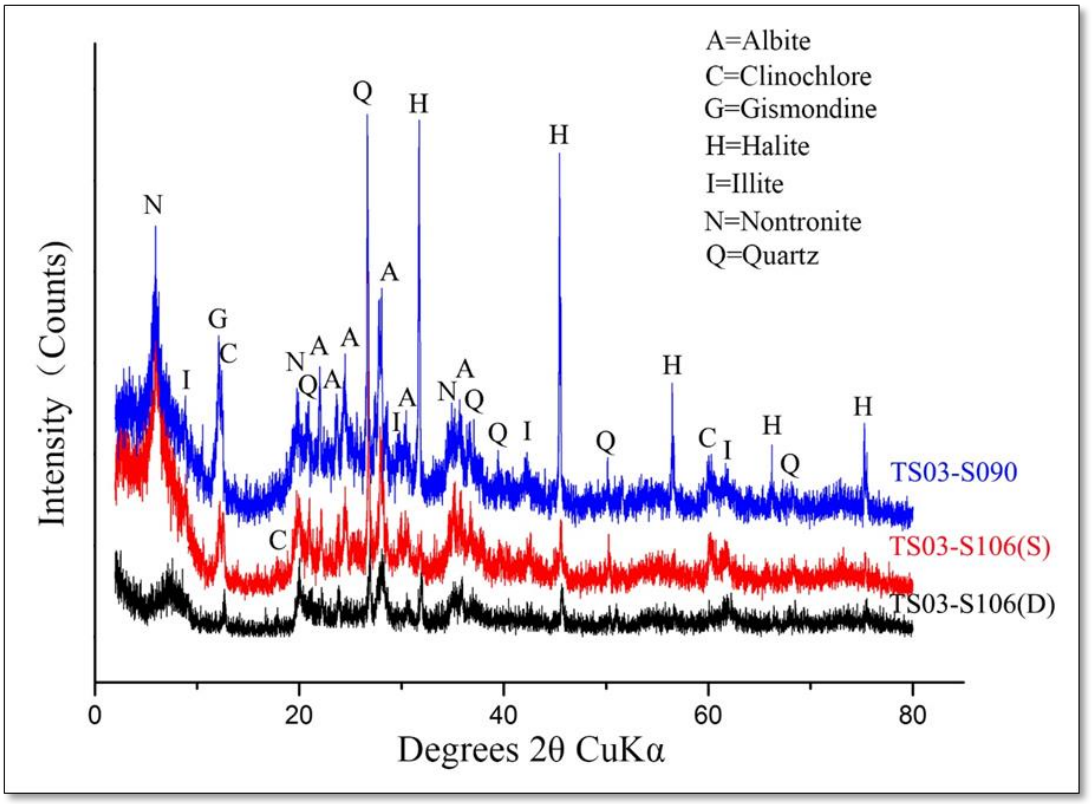

Figure S-2 XRD analysis of Mariana Trench sediments samples TS03-S090, TS03-S106(S), and TS03-S106(D). Clinochlore, nontronite, illite, and gismondine are clay minerals, while albite, and quartz represent non-clay minerals. Halite originates from sea-water, and is not a component from the Trench sediments.

Supplementary Information References

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