Size-fractionated particulate trace element concentrations determined by ICP-MS from the 2021 North Atlantic EXPORTS cruise (RRS Discovery cruise DY131)

Website: https://www.bco-dmo.org/dataset/946504
Data Type: Cruise Results
Version: 1
Version Date: 2024-12-23

Project
» Collaborative Research: Estimation of particle aggregation and disaggregation rates from the inversion of chemical tracer data (Particle aggregation)

Program
» EXport Processes in the Ocean from Remote Sensing (EXPORTS)

Contributors	Affiliation	Role
Lam, Phoebe J.	University of California-Santa Cruz (UCSC)	Principal Investigator
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Abstract
Total minor and trace element concentrations were determined by ICP-MS on profiles of size-fractionated (0.8-51um, >51um) particles collected by battery-operated in-situ filtration during the 2021 North Atlantic EXPORTS cruise (RRS Discovery cruise DY131).

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Coverage

Location: North Atlantic, ~170km east of Porcupine Abyssal Plain, ~49°N, 15°W
Spatial Extent: **N**:49.0766895 **E**:-14.7392035 **S**:48.7892275 **W**:-15.1089135
Temporal Extent: 2021-05-06 - 2021-05-27

Methods & Sampling

1. Sampling

Size-fractionated (0.8-51um; >51um) particles were collected using dual-flow McLane Research in-situ pumps (WTS-LV) and 142mm “mini-MULVFS” filter holders (Bishop et al., 2012; Lam et al., 2018; Lam et al., 2015; Xiang and Lam, 2020) deployed on regular hydrowire on the RRS Discovery. One filter holder/flowpath was

loaded with a 51 um Sefar polyester prefilter and followed by paired 0.8 um Pall Supor800 polyethersulfone filters (“Supor-side”). A 150 um Sefar polyester mesh was placed underneath all 51 um prefilters to facilitate filter handling but not analyzed. All filters and filter holders were acid leached before use based on the recommended methods in the GEOTRACES sample and sample-handling protocols (Cutter et al., 2010). Samples were processed in a laminar flow hood at sea. After collection, each 51 um/150 um prefilter pair and 0.8 um Supor pair was transferred to an acid-leached 150mm PET petri dish, bagged in ziploc bags, and frozen at -20°C at sea and shipped back to UCSC frozen.

In the lab, a 1/8 slice of the frozen 51 um prefilter was rinsed with filtered TM-clean surface North Atlantic seawater by vacuum filtration onto a 25mm 0.8 um Supor filter in a laminar flow hood. The 25mm Supor filters were dried until ready for analysis. Half of the frozen paired 142mm Supor filters were dried in a laminar flow hood until ready for analysis.

While every effort was made to handle samples in a trace-metal clean manner after recovery, regular metal hydrowire was used in the sampling, so data for contamination-prone elements should be viewed with caution.

2. Analytical Procedures

The digestion method of particulate minor and trace elements is based on a refluxing method (Planquette and Sherrell, 2012) with light modifications as described in (Xiang and Lam, 2020). In brief, the Supor filter was adhered to the wall by surface tension in a 15 mL flat-bottom screw-cap Savillex vial to avoid immersion. After 4-h refluxing at 110 ˚C with an ultrapure (ARISTAR® or Optima grade) 50% HNO3/10% HF (v/v) mixture, digestion acids were transferred into secondary vials and heated to near dryness. The residue was heated in 50% HNO3/15% HF (v/v) to dryness at 110 ˚C. The final residue was re-dissolved with 2 ml 5% HNO3 spiked with 1 ppb In. Two certified reference materials (BCR-414 and PACS-2) were digested routinely alongside the samples to assure the quality of each digestion. Sample solutions were analyzed using an Element XR high-resolution ICP-MS (Thermo Scientific) at the UCSC Plasma Analytical Facility. Elemental concentrations were standardized using multi-element, external standard curves prepared from NIST atomic absorption-standards in 5% HNO3. Instrument drift and matrix effects were corrected using the internal 1ppb In standard and monitored using a mixed element run standard. Concentrations were determined using external standard curves of mixed trace elements standards.

Data Processing Description

Blank subtraction:

The median of db filters was used in blank subtraction to account for adsorption of TMs from seawater and sample handling.

Errors:

The reported errors are determined as the standard deviation of the dipped blank filters for each element, divided by the equivalent volume filtered in that sample.

Quality Flags:

The detection limit was defined as three times the standard deviation of the dipped blank filters. Values below the detection limit were flagged as QF=6 in the GTSPP convention (also adopted by SeaDataNet and recommended by the GEOTRACES programme).

All data have been assigned quality flags using the GTSPP convention and interpretation:

1=good—passed lab QC and oceanographically consistent

2=possibly good—oceanographically consistent, but have minor sampling/instrumental issues

3=possibly bad—not oceanographically consistent, or have major sampling/instrumental issues

4=bad—failed lab QC (including all failed pumps when only small or no volume was pumped through the filter), or known issue with samples.

6=below detection limit

9=data missing (including all “nd”). For a measured parameter, this QF applies to lost or missing samples that were not measured.

Note about missing data identifiers:
In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

BCO-DMO Curation Notes

* Data table within file "EXPORTS2021_merge_SPT_LPT_BCODMO.csv" was imported into the BCO-DMO data system for this dataset. Values "NaN" imported as missing data values.
** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]
* example: "1SD_Ce_SPT_CONC_PUMP_pM" changed to "Ce_SPT_CONC_PUMP_pM_1SD"

* Datetime converted to Datetime with timezone (ISO 8601 format, UTC as "Z").

* trace concentration decimals were rounded to 5 decimal places (as discussed with data submitter).

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Data Files

File	
946504_v1_exports2021-sizefrac-trace-elements.csv	(Comma Separated Values (.csv), 43.68 KB) MD5:106c629ad55477997345c9d3ea59e167
Primary data file for dataset ID 946504, version 1	

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Supplemental Files

File	
Isotopes, detection limits, and ICP-MS resolution filename: EXPORTS2021_supp_isotope_medconc_detlim.csv	(Comma Separated Values (.csv), 1.73 KB) MD5:1b3a3719d23ba3230f478273ce6fbd73
Supplementary table giving isotope and resolution (low resolution, LR, or medium resolution, MR) used for measurement on Element XR ICP-MS, as well as the median concentration and median detection limit, in pM, for each element in each size fraction (SPT and LPT). Parameter information (Column names, definitions, and units): "Element", Symbol for element (e.g. "Sr"), unitless "isotope", Isotope and resolution (e.g. "Sr86LR"), unitless "SPTmedconc_pM", median concentration in pM for size fraction SPT (1-51um), picomolar (pM) "SPTmedDL_pM", median detection limit in pM for size fraction SPT (1-51um)., picomolar (pM) "LPTmedconc_pM", median concentration in pM for size fraction LPT (>51um) , picomolar (pM) "LPTmedDL_pM", median detection limit in pM for size fraction LPT (>51um), picomolar (pM)	

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Related Publications

Lam, P. J., & Morris, P. J. (2013). In situ marine sample collection system and methods (U.S. Patent Application No. 20130298702). Washington, DC: U.S. Patent and Trademark Office. https://patents.google.com/patent/US20130298702
Methods

McLane Labs. (2023). WTS-LV (Large Volume Pump). McLane Labs. https://mclanelabs.com/wts-lv-large-volume-pump/
Methods

Planquette, H., & Sherrell, R. M. (2012). Sampling for particulate trace element determination using water sampling bottles: methodology and comparison to in situ pumps. Limnology and Oceanography: Methods, 10(5), 367–388. doi:10.4319/lom.2012.10.367
Methods

Roca-Martí, M., Benitez-Nelson, C. R., Umhau, B. P., Wyatt, A. M., Clevenger, S. J., Pike, S., Horner, T. J., Estapa, M. L., Resplandy, L., & Buesseler, K. O. (2021). Concentrations, ratios, and sinking fluxes of major bioelements at Ocean Station Papa. Elementa: Science of the Anthropocene, 9(1). https://doi.org/10.1525/elementa.2020.00166
Methods

Xiang, Y., & Lam, P. J. (2020). Size-Fractionated Compositions of Marine Suspended Particles in the Western Arctic Ocean: Lateral and Vertical Sources. Journal of Geophysical Research: Oceans, 125(8). doi:10.1029/2020jc016144
Methods

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Parameters

Parameter	Description	Units
StationID	Station identification	unitless
PumpCast	Pump cast number (sequential)	unitless
Epoch	Epoch number. The cruise was divided into 3 sampling epochs	unitless
LatdegN	latitude in degrees N	decimal degrees
LondegE	longitude in degrees E	decimal degrees
pumpmid_datetime	Datetime with timezone (time midway through pumping time), in ISO 8601 format	unitless
depthm	Depth of sampling	meters (m)
Pump	pump number	unitless
volumeSuporL	volume filtered through flow path	liters (L)
SPTsampleID	sample ID of the Supor small size fraction filter	unitless

Sr_SPT_CONC_PUMP_pM	Small (1-51um) particulate total strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Y_SPT_CONC_PUMP_pM	Small (1-51um) particulate total yttrium (Y) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mo_SPT_CONC_PUMP_pM	Small (1-51um) particulate total molybdenum (Mo) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ag_SPT_CONC_PUMP_pM	Small (1-51um) particulate total Silver (Ag) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cd_SPT_CONC_PUMP_pM	Small (1-51um) particulate total cadmium (Cd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ba_SPT_CONC_PUMP_pM	Small (1-51um) particulate total Strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
La_SPT_CONC_PUMP_pM	Small (1-51um) particulate total lanthanum (La) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ce_SPT_CONC_PUMP_pM	Small (1-51um) particulate total cerium (Ce) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Nd_SPT_CONC_PUMP_pM	Small (1-51um) particulate total neodymium (Nd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Pb_SPT_CONC_PUMP_pM	Small (1-51um) particulate total lead (Pb) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

Th_SPT_CONC_PUMP_pM	Small (1-51um) particulate total thorium (Th) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Al_SPT_CONC_PUMP_pM	Small (1-51um) particulate total aluminum (Al) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
P_SPT_CONC_PUMP_pM	Small (1-51um) particulate total phosphorus (P) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Sc_SPT_CONC_PUMP_pM	Small (1-51um) particulate total scandium (Sc) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ti_SPT_CONC_PUMP_pM	Small (1-51um) particulate total titanium (Ti) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
V_SPT_CONC_PUMP_pM	Small (1-51um) particulate total vanadium (V) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mn_SPT_CONC_PUMP_pM	Small (1-51um) particulate total manganese (Mn) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Fe_SPT_CONC_PUMP_pM	Small (1-51um) particulate total iron (Fe) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Co_SPT_CONC_PUMP_pM	Small (1-51um) particulate total cobalt (Co) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ni_SPT_CONC_PUMP_pM	Small (1-51um) particulate total nickel (Ni) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

Cu_SPT_CONC_PUMP_pM	Small (1-51um) particulate total copper (Cu) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Sr_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Y_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total yttrium (Y) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mo_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total molybdenum (Mo) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ag_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total Silver (Ag) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cd_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total cadmium (Cd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ba_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total Strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
La_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total lanthanum (La) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ce_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total cerium (Ce) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Nd_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total neodymium (Nd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

Pb_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total lead (Pb) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Th_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total thorium (Th) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Al_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total aluminum (Al) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
P_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total phosphorus (P) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Sc_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total scandium (Sc) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ti_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total titanium (Ti) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
V_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total vanadium (V) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mn_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total manganese (Mn) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Fe_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total iron (Fe) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Co_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total cobalt (Co) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

Ni_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total nickel (Ni) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cu_SPT_CONC_PUMP_pM_1SD	Error (1 SD) for small (1-51um) particulate total copper (Cu) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Flag_Sr_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Y_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total yttrium (Y) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Mo_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total molybdenum (Mo) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ag_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total Silver (Ag) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Cd_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total cadmium (Cd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ba_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total Strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_La_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total lanthanum (La) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ce_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total cerium (Ce) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless

Flag_Nd_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total neodymium (Nd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Pb_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total lead (Pb) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Th_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total thorium (Th) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Al_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total aluminum (Al) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_P_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total phosphorus (P) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Sc_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total scandium (Sc) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ti_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total titanium (Ti) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_V_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total vanadium (V) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Mn_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total manganese (Mn) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Fe_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total iron (Fe) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless

Flag_Co_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total cobalt (Co) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ni_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total nickel (Ni) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Cu_SPT_CONC_PUMP_pM	Quality Flag (GTSPP) for small (1-51um) particulate total copper (Cu) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
LPTsampleID	sample ID of the Supor flow path large size fraction filter	unitless
Sr_LPT_CONC_PUMP_pM	Large (>51um) particulate total strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Y_LPT_CONC_PUMP_pM	Large (>51um) particulate total yttrium (Y) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mo_LPT_CONC_PUMP_pM	Large (>51um) particulate total molybdenum (Mo) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ag_LPT_CONC_PUMP_pM	Large (>51um) particulate total Silver (Ag) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cd_LPT_CONC_PUMP_pM	Large (>51um) particulate total cadmium (Cd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ba_LPT_CONC_PUMP_pM	Large (>51um) particulate total Strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

La_LPT_CONC_PUMP_pM	Large (>51um) particulate total lanthanum (La) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ce_LPT_CONC_PUMP_pM	Large (>51um) particulate total cerium (Ce) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Nd_LPT_CONC_PUMP_pM	Large (>51um) particulate total neodymium (Nd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Pb_LPT_CONC_PUMP_pM	Large (>51um) particulate total lead (Pb) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Th_LPT_CONC_PUMP_pM	Large (>51um) particulate total thorium (Th) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Al_LPT_CONC_PUMP_pM	Large (>51um) particulate total aluminum (Al) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
P_LPT_CONC_PUMP_pM	Large (>51um) particulate total phosphorus (P) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Sc_LPT_CONC_PUMP_pM	Large (>51um) particulate total scandium (Sc) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ti_LPT_CONC_PUMP_pM	Large (>51um) particulate total titanium (Ti) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
V_LPT_CONC_PUMP_pM	Large (>51um) particulate total vanadium (V) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

Mn_LPT_CONC_PUMP_pM	Large (>51um) particulate total manganese (Mn) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Fe_LPT_CONC_PUMP_pM	Large (>51um) particulate total iron (Fe) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Co_LPT_CONC_PUMP_pM	Large (>51um) particulate total cobalt (Co) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ni_LPT_CONC_PUMP_pM	Large (>51um) particulate total nickel (Ni) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cu_LPT_CONC_PUMP_pM	Large (>51um) particulate total copper (Cu) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Sr_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Y_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total yttrium (Y) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mo_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total molybdenum (Mo) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ag_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total Silver (Ag) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cd_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total cadmium (Cd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

Ba_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total Strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
La_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total lanthanum (La) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ce_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total cerium (Ce) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Nd_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total neodymium (Nd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Pb_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total lead (Pb) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Th_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total thorium (Th) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Al_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total aluminum (Al) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
P_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total phosphorus (P) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Sc_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total scandium (Sc) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ti_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total titanium (Ti) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)

V_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total vanadium (V) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Mn_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total manganese (Mn) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Fe_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total iron (Fe) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Co_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total cobalt (Co) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Ni_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total nickel (Ni) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Cu_LPT_CONC_PUMP_pM_1SD	Error (1 SD) for Large (>51um) particulate total copper (Cu) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	picomolar (pM)
Flag_Sr_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Y_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total yttrium (Y) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Mo_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total molybdenum (Mo) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ag_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total Silver (Ag) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless

Flag_Cd_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total cadmium (Cd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ba_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total Strontium (Sr) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_La_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total lanthanum (La) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ce_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total cerium (Ce) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Nd_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total neodymium (Nd) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Pb_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total lead (Pb) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Th_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total thorium (Th) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Al_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total aluminum (Al) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_P_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total phosphorus (P) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Sc_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total scandium (Sc) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless

Flag_Ti_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total titanium (Ti) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_V_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total vanadium (V) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Mn_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total manganese (Mn) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Fe_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total iron (Fe) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Co_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total cobalt (Co) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Ni_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total nickel (Ni) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless
Flag_Cu_LPT_CONC_PUMP_pM	Quality Flag (GTSPP) for Large (>51um) particulate total copper (Cu) concentration. See supplemental table 'EXPORTS2021_supp_isotope_medconc_detlim.csv' for more information.	unitless

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Instruments

Dataset-specific Instrument Name	dual-flow McLane Research in-situ pumps (WTS-LV)
Generic Instrument Name	McLane Large Volume Pumping System WTS-LV
Dataset-specific Description	Sampling equipment: dual-flow McLane Research in-situ pumps (WTS-LV). More details can be found in the patent description (https://patents.google.com/patent/US20130298702) and official website of the manufacturer (https://mclanelabs.com/wts-lv-large-volume-pump/).
Generic Instrument Description	The WTS-LV is a Water Transfer System (WTS) Large Volume (LV) pumping instrument designed and manufactured by McLane Research Labs (Falmouth, MA, USA). It is a large-volume, single-event sampler that collects suspended and dissolved particulate samples in situ. Ambient water is drawn through a modular filter holder onto a 142-millimeter (mm) membrane without passing through the pump. The standard two-tier filter holder provides prefiltering and size fractioning. Collection targets include chlorophyll maximum, particulate trace metals, and phytoplankton. It features different flow rates and filter porosity to support a range of specimen collection. Sampling can be programmed to start at a scheduled time or begin with a countdown delay. It also features a dynamic pump speed algorithm that adjusts flow to protect the sample as material accumulates on the filter. Several pump options range from 0.5 to 30 liters per minute, with a max volume of 2,500 to 36,000 liters depending on the pump and battery pack used. The standard model is depth rated to 5,500 meters, with a deeper 7,000-meter option available. The operating temperature is -4 to 35 degrees Celsius. The WTS-LV is available in four different configurations: Standard, Upright, Bore Hole, and Dual Filter Sampler. The high-capacity upright WTS-LV model provides three times the battery life of the standard model. The Bore-Hole WTS-LV is designed to fit through a narrow opening such as a 30-centimeter borehole. The dual filter WTS-LV features two vertical intake 142 mm filter holders to allow simultaneous filtering using two different porosities.

Dataset-specific Instrument Name	Element XR high-resolution ICP-MS (Thermo Scientific)
Generic Instrument Name	Thermo Scientific ELEMENT XR high resolution inductively coupled plasma mass spectrometer
Generic Instrument Description	A high-resolution (HR) inductively coupled plasma (ICP) mass spectrometer (MS) composed of a dual mode secondary electron multiplier (SEM) and a Faraday detector. The ELEMENT XR instrument has a dynamic range of 5 x 10^7 to 1 x 10^12 counts per second (cps), and allows simultaneous measurement of elements at concentrations over 1000 ug/g.

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Deployments

DY131

Website	https://www.bco-dmo.org/deployment/893299
Platform	RRS Discovery
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/dy131.pdf
Start Date	2021-05-01
End Date	2021-06-01
Description	See additional information at: https://www.bodc.ac.uk/resources/inventories/cruise_inventory/report/17779/ https://seabass.gsfc.nasa.gov/cruise/EXPORTSNA

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Project Information

Collaborative Research: Estimation of particle aggregation and disaggregation rates from the inversion of chemical tracer data (Particle aggregation)

Coverage: Ocean Station Papa, North Atlantic, North Pacific

NSF Award Abstract:
The biological carbon pump in the ocean is an important process by which atmospheric carbon dioxide (CO2) is effectively transported from the surface ocean to the deep ocean, and thereby removing CO2 from the atmosphere. This transport occurs in a multi-step process. First, phytoplankton carry out photosynthesis in the surface, sunlit waters of the ocean, taking up atmospheric CO2 and fixing it into particulate organic carbon. A portion of the organic carbon contained in the phytoplankton is packaged into larger clusters (aggregates) that can sink to the deep ocean. The deeper these aggregates sink, the longer the carbon contained in them is removed from the atmosphere. The depth to which aggregates sink varies greatly over time and space and are difficult to predict. In general, larger aggregates sink more quickly, and thus more deeply, than smaller particles. Processes that promote aggregation to larger particles should enhance the biological pump, and processes that promote disaggregation (breakdown of particle clusters) and regeneration (decomposition) of the organic carbon should decrease the strength and efficiency of the biological pump. Particle aggregation and disaggregation rates are thus crucial to understanding the variability of the biological pump, but are very difficult to measure directly. This project will use chemical tracers and a modeling approach to quantify the rates of these important processes. The investigators will apply the approach to a variety of oceanic environments and provide the first large-scale effort to quantify these rates in the upper 500 meters of the ocean. As part of this project, they will interface with the CalTeach program, which is a University of California Science and Math Initiative to place university science, math, and engineering majors in K-12 classrooms. Many of these CalTeach interns go on to become K-12 science teachers in California. Two undergraduate students enrolled in the CalTeach program at the University of California, Santa Cruz (UCSC) will participate as laboratory assistants and develop a hands-on teaching module on the carbon cycle and biological pump for K-12 classrooms.

Scientists from the University of California at Santa Cruz and Woods Hole Oceanographic Institution propose to estimate the rates of particle aggregation and disaggregation in the mesopelagic zone through the inversion of observations of three chemical tracers, namely thorium (Th)-234, lithogenic particles, and particulate organic carbon (POC) distributed between small, suspended particles and large, sinking particles. The isotopes of Th have long been used to estimate rates of particle dynamics processes because of their known source function and particle-reactive behavior. Previous work has shown that lithogenic particles act as an inert, passive tracer of particle dynamics. The investigators will couple thorium and lithogenic particle measurements to measurements of POC to estimate particle aggregation and disaggregation rates from a wide range of oceanographic environments. Estimates of particle cycling rates deduced from the inversion of chemical tracer data provide a crucial quantitative constraint to which rates derived from other approaches can be compared. The main objective of this work is to estimate depth- varying (dis-) aggregation rates at each station of the EXPORTS and GEOTRACES cruises that are most consistent with the tracer data. This work will also produce depth-varying estimates of POC remineralization rates and particle sinking rates.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Program Information

EXport Processes in the Ocean from Remote Sensing (EXPORTS)

Website: http://oceanexports.org/

EXport Processes in the Ocean from Remote Sensing (EXPORTS) is a large-scale NASA-led field campaign that will provide critical information for quantifying the export and fate of upper ocean net primary production (NPP) using satellite observations and state of the art ocean technologies.

Ocean ecosystems play a critical role in the Earth's carbon cycle and the quantification of their impacts for both present conditions and for predictions into the future remains one of the greatest challenges in oceanography. The goal of the EXport Processes in the Ocean from Remote Sensing (EXPORTS) Science Plan is to develop a predictive understanding of the export and fate of global ocean net primary production (NPP) and its implications for present and future climates. The achievement of this goal requires a quantification of the mechanisms that control the export of carbon from the euphotic zone as well as its fate in the underlying "twilight zone" where some fraction of exported carbon will be sequestered in the ocean's interior on time scales of months to millennia. In particular, EXPORTS will advance satellite diagnostic and numerical prognostic models by comparing relationships among the ecological, biogeochemical and physical oceanographic processes that control carbon cycling across a range of ecosystem and carbon cycling states. EXPORTS will achieve this through a combination of ship and robotic field sampling, satellite remote sensing and numerical modeling. Through a coordinated, process-oriented approach, EXPORTS will foster new insights on ocean carbon cycling that maximizes its societal relevance through the achievement of U.S. and International research agency goals and will be a key step towards our understanding of the Earth as an integrated system.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829614

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