Sampling locations and ancillary data for bulk chemical and molecular characterization of organic carriers and their partition coefficients with radionuclide marine tracers.

Website: https://www.bco-dmo.org/dataset/764754
Data Type: experimental
Version: 1
Version Date: 2019-04-11

Project
» Biopolymers as carrier phases for selected natural radionuclides (of Th, Pa, Pb, Po, Be) in diatoms and coccolithophores (Biopolymers for radionuclides)

Contributors	Affiliation	Role
Santschi, Peter	Texas A&M, Galveston (TAMUG)	Principal Investigator
Quigg, Antonietta	Texas A&M, Galveston (TAMUG)	Co-Principal Investigator
Schwehr, Kathleen	Texas A&M, Galveston (TAMUG)	Co-Principal Investigator
Xu, Chen	Texas A&M, Galveston (TAMUG)	Co-Principal Investigator
Biddle, Mathew	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
To study the binding mechanisms of radionuclides to organic moieties in colloidal organic matter (COM),marine colloids (1 kDa–0.2 µm) were isolated by cross-flow ultrafiltration from seawater of the west Pacific Ocean and the northern Gulf of Mexico. For the same purpose, exopolymeric substances (EPS) produced by laboratory cultured diatoms were collected as well. In our study areas, colloidal organic carbon (COC) concentrations ranged from 6.5 to 202 µg-C/L in the Pacific Ocean, and were 808 µg-C/L in the Gulf of Mexico. The COM compositions (organic carbon, organic nitrogen, proteins, total hydrolysable amino acids, total polysaccharides, uronic acids, hydroxamate siderophores, hydroquinone) were quantified to examine the relationships between partition coefficients (Kc) of five different radionuclides, 234Th, 233Pa, 210Pb, 210Po and 7Be, and concentration ratios to COC of individual chelating biomolecules that could potentially act as a chelating moiety. The range of partition coefficients (Kc, reported as logKc) of radionuclides between water and the different colloidal materials was 5.12 to 5.85 for 234Th, 5.19 to 6.01 for 233Pa, 4.21 to 4.85 for 210Pb, 4.87 to 5.68 for 210Po, and 4.49 to 4.92 for 7Be, similar to values previously reported for lab and field determinations under different particle concentrations. While any relationship obtained between Kc and abundance of specific moieties could not be taken as proving the existence of colloidal organic binding ligands for the different radionuclides, it could suggest possible organic moieties involved in the scavenging of these natural radionuclides. Together with results from isoelectric focusing of radiolabeled COM, we conclude that binding to different biomolecules is nuclide-specific, with colloidal hydroxamate siderophoric moieties being important for the binding of Th and Pa radionuclides. Hydroquinones/ quinone (HQ/Q) facilitated redox and chelation reactions seem to be involved in the binding of Pa and Be. However, the actual mechanisms are not clear. Individual amino acids, proteins, total polysaccharides and uronic acids did not yield significant relationships with logKc values of the different radionuclides. Nonetheless, our results provide new insights into the relative importance of different potential ligand moieties in COM in the binding and possible scavenging of specific radionuclides in the ocean.

Table of Contents

Coverage

Spatial Extent: **N**:28.95 **E**:-94.94 **S**:21.75 **W**:-125

Dataset Description

Sampling locations and ancillary data.

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- converted latitude and longitude values from degrees minutes to decimal degrees

[table of contents | back to top]

Data Files

File
sample_information.csv (Comma Separated Values (.csv), 1.01 KB) MD5:66fcb5e5ce1206aeb8b8685decccd3af Primary data file for dataset ID 764754

[table of contents | back to top]

Related Publications

Chuang, C-Y., Santschi, P. H., Xu, C., Jiang, Y., Ho, Y., Quigg, A., Guo, L., Hatcher, P. G., Ayranov, M., & Schumann, D. (2015). Molecular level characterization of diatom-associated biopolymers that bind 234 Th, 233 Pa, 210 Pb, and 7 Be in seawater: A case study with Phaeodactylum tricornutum. In Journal of Geophysical Research: Biogeosciences (Vol. 120, Issue 9, pp. 1858–1869). American Geophysical Union (AGU). https://doi.org/10.1002/2015jg002970 https://doi.org/10.1002/2015JG002970
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Sample_ID	Sample_ID	unitless
Cruise	Cruise	unitless
Station	Station	unitless
Latitude	Latitude in decimal dregrees. North is positive	decimal degrees
Longitude	Longitude in decimal degrees. East is positive	decimal degrees
Water_depth	water depth	meters (m)
Sampling_depth	sample depth	meters (m)
Salinity	salinity	unitless
Temperature	temperature	degrees Celsius
descriptive_location	text description of location	unitless
notes	additional notes	unitless

[table of contents | back to top]

Project Information

Biopolymers as carrier phases for selected natural radionuclides (of Th, Pa, Pb, Po, Be) in diatoms and coccolithophores (Biopolymers for radionuclides)

NSF Award Abstract:

Particle-associated natural radioisotopes are transported to the ocean floor mostly via silica and carbonate ballasted particles, allowing their use as tracers for particle transport. Th(IV), Pa (IV,V), Po(IV), Pb(II) and Be(II) radionuclides are important proxies in oceanographic investigations, used for tracing particle and colloid cycling, estimating export fluxes of particulate organic carbon, tracing air-sea exchange, paleoproductivity, and/or ocean circulation in paleoceanographic studies. Even though tracer approaches are considered routine, there are cases where data interpretation or validity has become controversial, largely due to uncertainties about inorganic proxies and organic carrier molecules. Recent studies showed that cleaned diatom frustules and pure silica particles, sorb natural radionuclides to a much lower extent (by 1-2 orders of magnitude) than whole diatom cells (with or without shells). Phytoplankton that build siliceous or calcareous shells, such as the diatoms and coccolithophores, are assembled via bio-mineralization processes using biopolymers as nanoscale templates. These templates could serve as possible carriers for radionuclides and stable metals.

In this project, a research team at the Texas A & M University at Galveston hypothesize that radionuclide

sorption is controlled by selective biopolymers that are associated with biogenic opal (diatoms), $CaCO_3$ (coccolithophores) and the attached exopolymeric substances (EPS), rather than to pure mineral phase. To pursue this idea, the major objectives of their research will include separation, identification and molecular-level characterization of the individual biopolymers (e.g., polysaccharides, uronic acids, proteins, hydroquinones, hydroxamate siderophores, etc.) that are responsible for binding different radionuclides (Th, Pa, Pb, Po and Be) attached to cells or in the matrix of biogenic opal or $CaCO_3$ as well as attached EPS mixture, in laboratory grown diatom and coccolithophore cultures. Laboratory-scale radiolabeling experiments will be conducted, and different separation techniques and characterization techniques will be applied.

Intellectual Merit : It is expected that this study will help elucidate the molecular basis of the templated growth of diatoms and coccoliths, EPS and their role in scavenging natural radionuclides in the ocean, and help resolve debates on the oceanographic tracer applications of different natural radioisotopes (230,234Th, 231Pa, 210Po, 210Pb and 7,10Be). The proposed interdisciplinary research project will require instrumental approaches for molecular-level characterization of these radionuclides associated carrier molecules.

Broader Impacts: The results of this study will be relevant for understanding biologically mediated ocean scavenging of radionuclides by diatoms and coccoliths which is important for carbon cycling in the ocean, and will contribute to improved interpretation of data obtained by field studies especially through the GEOTRACES program. This new program will enhance training programs at TAMUG for postdocs, graduate and undergraduate students. Lastly, results will be integrated in college courses and out-reach activities at Texas A&M University, including NSF-REU, Sea Camp, Elder Hostel and exhibits at the local science fair and interaction with its after-school program engaging Grade 9-12 students from groups traditionally underrepresented.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1356453

[table of contents | back to top]