

Uptake and partitioning of metals by microphytobenthic diatoms: metadata for the ARCoES project

Keywords: Diatoms, *Cylindrotheca closterium*, intertidal sediment, cadmium, Microphytobenthos, mesocosm, metals, NDVI, temperature, disturbance, Ribble Estuary, ARCoES

Data were collected as part of the EPSRC funded ARCoES project (research grant EPSRC EP/I035390/1) at University of Stirling as part of research to determine the uptake and mobilisation of metals associated with estuarine intertidal sediment by microphytobenthic diatoms. Data are associated with a PhD thesis which can be downloaded from the Stirling Online Research Repository (STORRE), <http://dspace.stir.ac.uk/>.

The research was carried out as three studies at a range of scales and levels of realism, from a laboratory experiment in a controlled environment facility, through a study using an intertidal mesocosm, to the field.

Controlled environment facility

A laboratory study was carried out in the first quarter of 2015 using a single diatom species *Cylindrotheca closterium* ((Ehrenberg) Lewin & Reimann (1964)) purchased from CCAP (Culture Collection of Algae and Protozoa) and cadmium (Cd) spiked sediment (collected from Loch Fleet, Scotland, 57°56'N, 4°2'W) and growth media (f2+Si) was repeated three times for replication purposes in the CEF at University of Stirling. The experiment was run for 96 hours (following U.S. Environmental Protection Agency guidelines for toxicity tests) illuminated on a 12/12-hour light/dark cycle at an irradiance of 60 $\mu\text{mol photons m}^{-2}\text{s}^{-1}$ at 15°C. Samples were taken at three, 24 and 96 hours.

It was found that uptake of Cd varied with sediment properties revealing the importance of sediment particle size and organic matter content on metal bioavailability to diatoms. Additionally the presence of diatoms altered the partitioning of Cd between the sediment, overlying water and pore water.

These data can be downloaded from Stirling online repository for research data (DataSTORRE) <http://hdl.handle.net/11667/110>. There are six .csv files, three files containing data and three accompanying files containing information to explain the data categories. The files are as follows;

- LabExperimentCdData.csv
Cadmium concentration (mg kg^{-1}) data, analysed by XSERIES 2 ICP-MS (Thermo Scientific, Germany) for sediment, overlying water, pore water and diatom compartments of each experimental unit and supporting information
- MetadataForLabExperimentCdData.csv
- LabExperimentLOIData.csv
Percentage organic matter in sediment measured using the loss on ignition (LOI) method
- MetadataForLabExperimentLOIData.csv
- LabExperimentPSData.csv
Sediment particle size data measured using a Coulter LS 230 laser granulometer and classified according to the Udden-Wentworth scale
- MetadataForLabExperimentPSData.csv

Intertidal mesocosm

To examine the uptake of metals under varying conditions of temperature and disturbance from historically contaminated sediment (collected at Lytham St. Anne's, 53°43'58"N, 2°57'37"W) to a natural microphytobenthic community a study was conducted using an intertidal mesocosm. The study ran for a total of 231 days (from 16th September 2015 to 3rd May 2016) under three water temperatures (ambient, plus 1.5°C and plus 4.0°C) with sampling of algae and water at 10 intervals. Biomass on the sediment surface was monitored using Normalised Difference Vegetation Index (NDVI) as a proxy.

Diatoms were found to have a higher uptake of the metals analysed (except tin) than other types of algae (filamentous and sheet macroalgae), confirming their importance as a study organism with respect to metal uptake and potential mobilisation through the food chain. Sediment disturbance was shown to increase metal uptake from the sediment to algae, which is of concern due to predicted increases in storminess, as a consequence of climate change, which is likely to increase sediment disturbance and therefore future metal uptake to algae. There were indications of an antagonistic effect of temperature on sediment disturbance. Whilst disturbance increased uptake of metals to algae, increasing temperatures reduced this for some metals.

These data can be downloaded from DataSTORRE <http://hdl.handle.net/11667/112>. There are eight .csv files, four files containing data and four accompanying files containing information to explain the data categories. The files are as follows;

- MesocosmAll.csv
Concentration (mg kg⁻¹) data of 14 metals (Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Ag, Cd, Sn and Pb), analysed by XSERIES 2 ICP-MS (Thermo Scientific, Germany) for sediment, overlying water and diatom compartments of each experimental unit. Air, mud and water temperature data, normalised difference vegetation index (NDVI) values, sediment water and organic matter content and supporting information.
- MetadataForMesocosmAll.csv
- MesocosmHourlyTemperature.csv
Hourly data for air, mud and water temperatures in the polytunnel and individual mesocosm tanks
- MetadataForMesocosmHourlyTemperature.csv
- MesoParticleSize.csv
Sediment particle size data measured using a Coulter LS 230 laser granulometer and classified according to the Udden-Wentworth scale
- MetadataForMesoParticleSize.csv
- NDVI.csv
NDVI values derived from reflectance measurements of the sediment surface and supporting information. Reflectance measurements were made using the ASD FieldSpec® UV/NIR throughout the course of the experiment, initially daily then switching to weekly as the growth rate slowed.
- MetadataForNDVI.csv

Field study

Field study carried out on two dates 25th September 2014 and 23rd April 2015 on the mudflats at Lytham St. Anne's, UK (53°43'58"N, 2°57'37"W). Sampling was carried out from 10 points on a 100 m grid. Diatoms were sampled using a variation of the lens tissue method and sediment was sampled using short cores and surface scrapes.

Concentrations of some metals in diatoms were related to the position on the mudflat, whilst others were related to sampling date indicating that there may be seasonal controls, such as diatom biomass on metal uptake from the sediment.

These data can be downloaded from DataSTORRE <http://hdl.handle.net/11667/111>. There are nine .csv files, five files containing data and four accompanying files containing information to explain the data categories. The files are as follows;

- LythamSiteCoords.csv
Co-ordinates of sample locations used on both sampling dates
- FieldMetals.csv
Concentration (mg kg⁻¹) data of 14 metals (Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Ag, Cd, Sn and Pb), analysed by XSERIES 2 ICP-MS (Thermo Scientific, Germany) for sediment, overlying water, pore water and diatom compartments at each sampling location and supporting information.
- MetadataForFieldMetals.csv
- FieldLOI.csv
Percentage organic matter in sediment (at three depths at each site) measured using the loss on ignition (LOI) method and supporting information.
- MetadataForFieldLOI.csv
- FieldParticleSize.csv
Sediment particle size data measured using a Coulter LS 230 laser granulometer and classified according to the Udden-Wentworth scale
- MetadataForFieldParticleSize.csv
- CollectionMassField.csv
Mass of diatoms (mg) collected from sediment samples in the field and laboratory on both sampling dates
- MetadataForCollectionMassField.csv

All data are associated with a PhD Thesis which contains further detailed information on sample collection and analysis;

Becker, A.E. (2017) Uptake and mobilisation of metals associated with estuarine intertidal sediment by microphytobenthic diatoms, PhD Thesis, University of Stirling, UK, pp. 293
<http://hdl.handle.net/1893/25388>

These data are owned by the department of Biological and Environmental Sciences, Faculty of Natural Sciences, University of Stirling.