Project Update: Assessment of Deep Brine Layer Extent and Geochemistry Prior to and After Opening of a New Causeway Bridge, Great Salt Lake, Utah

Discussion Topics

- Deep Brine Layer project objectives and approach
- Highlights of USGS Deep Brine Layer project data collected thus far
- Nutrient data

John Solder (USGS) working on the LakeESP
Deep Brine Layer Project

Objectives

- Monitor development of the DBL after the bridge is opened.
- Characterize vertical development of the DBL in the water column.
- Determine the timing of and evolution of sulfate reduction and mercury methylation in the deep brine layer.

From left to right: Carla Valdez (U of U), Shu Yang (U of U), and Christine Rumsey (USGS)
Monitoring Locations

- 23 Profile Sites
- 6 ~ Monthly profile Sites
- 4 Thermistor Buoys
Approach

- Complete field water quality profiles with Troll 9500
- Log water temperature via thermistor buoys equipped with HOBO Pro V2 temperature loggers
- Analyze water samples from shallow and deep locations in water column (University of Utah)
Deep Brine Layer Characteristics

- DBL source = inflow/seepage from GSL North Arm
- DBL has higher salinity (~16.5 to 22.9%) relative to upper brine layer (~12.6 to 14.7%)
- DBL has relatively high specific conductance, low pH, low dissolved oxygen (anoxic), and low ORP (strongly negative)
- DBL approximately 1-1.5 m thick

K. Beisner and others, 2009
- DBL can have large spatial extent
- DBL is associated with elevated methyl mercury
Based on specific conductance, pH (not shown), and temperature (not shown), the south arm of GSL (Carrington and Gilbert Bays) was well mixed (no DBL) prior to opening of new breach.
Pre-Breach Opening Dissolved Oxygen

- Deep water in Carrington Bay was anoxic during pre-breach opening monitoring.

***D.O. values uncorrected for salinity***
Specific Conductance Color Maps

CB-2

- New breach opened
- Appearance of north arm water

3510


Water Quality Profiles: Pre and Post Breach Opening

Dissolved Oxygen Color Maps

**CB-2**

**3510**

- **CB-2:** no profiles Sep. and Oct. 2016, and May 2017
- **3510:** no profiles in Sep. and Dec. 2016, and Jan. 2017

***D.O. values uncorrected for salinity***
Water Quality Profiles: Pre and Post Breach Opening

**pH Color Maps**

**CB-2**

- No profiles Sep. and Oct. 2016, and May 2017

**3510**

Thermistor Buoy Data

GSL GB-3 temperatures 2017

- Water temperature (°C)
- Wind speed at GSL 3510 (m/s)

- 0.5 m above bottom
- 0.8 m above bottom
- 1.1 m above bottom
- 1.4 m above bottom
- 1.7 m above bottom
- 4.6 m above bottom

*Lines indicate where wind ~ 13 m/s*
Nutrient speciation and the DBL

Site Locations

GSL 3510 - deep
Data from 2005-07-26 to 2018-02-07 (n=91)

GSL 3510 - shallow
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Nutrient speciation and the DBL

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GSL 3510 - shallow
Data from 2005-07-26 to 2018-02-07 (n=91)
The deep brine layer (DBL) dissipated after closure of the old causeway culverts, and redeveloped after opening of a new causeway breach in December 2016.

Anoxic conditions were relatively persistent in Carrington Bay and occurred at site 3510, even in the absence of the DBL.

The DBL began to develop in Carrington Bay in June 2017 and near the Center of Gilbert Bay in September 2017.

Nutrient concentrations in deep water are greater when the DBL is present.
Nutrient speciation and the DBL

GSL 2565 - deep
- Data from 2005-07-25 to 2018-02-07 (n=80)
- Box plots showing N concentration (mg/L as N) for DBL and no DBL conditions.

GSL 2565 - shallow
- Data from 2005-07-25 to 2018-02-07 (n=80)
- Box plots showing N concentration (mg/L as N) for DBL and no DBL conditions.
Nutrient Speciation and
the DBL

GSL 2565 - deep
data from 2005-07-25 to 2018-02-07 (n=80)

GSL 2565 - shallow
data from 2005-07-25 to 2018-02-07 (n=80)
Profiles Along North to South Transect

*pH Color Maps*

November 2016

May 2018

Distance from Causeway (Kilometers)

Depth (meters)

pH

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<td>7.600</td>
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</tr>
</tbody>
</table>
GSL ammonia at 2565 and 3510

Ammonia, filtered (mg/L) vs Date

Most recent data from 02-07-2016
Thermal stratification

Well mixed, isothermal

Thermistor Buoy Data

GB-2

GB-3

GB-14

Site Location

Water temperature (°C)

0.5 m above bottom
0.8 m above bottom
1.1 m above bottom
1.4 m above bottom
1.7 m above bottom
4.6 m above bottom

Aug-16 Oct-16 Dec-16 Feb-17 Apr-17 Jun-17 Aug-17 Oct-17 Dec-17
Nutrient speciation and the DBL

Site Locations

GSL 2267 - deep
data from 2005-07-25 to 2018-02-07 (n=38)

GSL 2267 - shallow
data from 2005-07-25 to 2018-02-07 (n=38)
Specific Conductance Color Maps

Profiles Along North to South Transect

November 2016

May 2018
Dissolved Oxygen Color Maps

Profiles Along North to South Transect

***D.O. values uncorrected for salinity***

Profiles:
- CB-2/5 km
- Split Mid/7 km
- N1018/12 km
- GB-3/20 km
- GB-14/46 km

Data:
- November 2016
- December 2017
- May 2018

D.O. values range from 0.2000 to 17.10.

***D.O. value***
Nutrient speciation and the DBL

GSL 2267 - deep

GSL 2267 - shallow

Site Locations