The Salton Sea and its impact on Air Quality in the Coachella Valley

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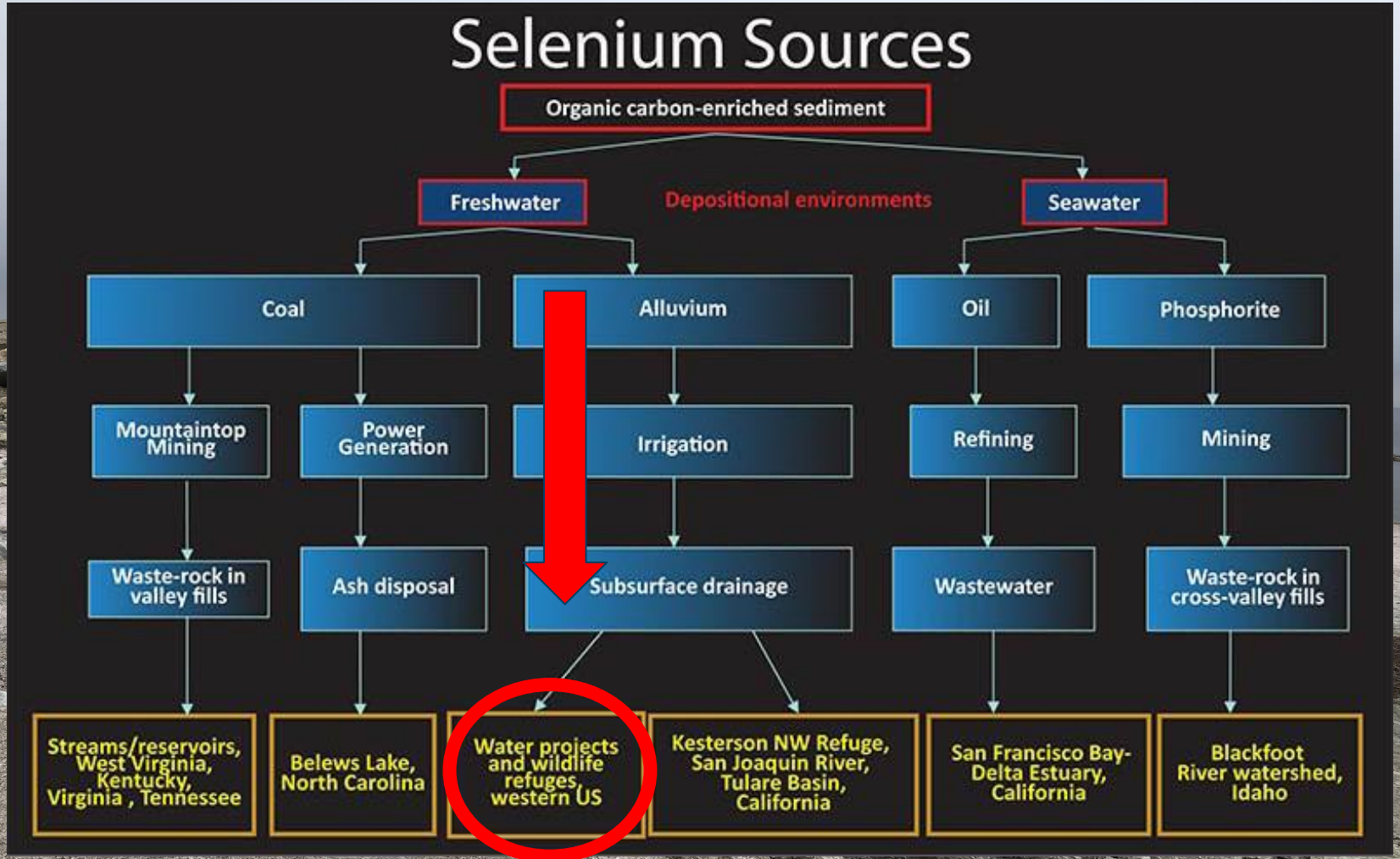
A Three Week Study

- Four group members :
  - A Mathematician, an Engineer, a Chemist, and a Computer Scientist
- 2002 Quantification Settlement Agreement
  - Ending 2017
  - Contributing to the Salton Sea's receding shoreline
- A focus on Methodology:
  - We know selenium is present in the Salton Sea, but can we detect it in the air?


Selenium Sources
Organic carbon-enriched sediment
Freshwater
Depositional environments
Seawater
Coal
Alluvium
Oil
Phosphorite
Mountaintop Mining
Power Generation
Irrigation
Refining
Mining
Waste-rock in valley fills
Ash disposal
Subsurface drainage
Wastewater
Waste-rock in cross-valley fills
Streams/reservoirs, West Virginia, Kentucky, Virginia , Tennessee
Belews Lake, North Carolina
Water projects and wildlife refuges, western US
Kesterson NW Refuge, San Joaquin River, Tulare Basin, California
San Francisco Bay-Delta Estuary, California
Blackfoot River watershed, Idaho

Observed Negative Effects of Selenium

Teratogenesis in Birds and Fish

- Selenium accumulation in tissues of birds and fish through consumption of invertebrates.
- Feasibility of eggs decreases in areas of markedly high Selenium exposure[1]
    - Food chain organisms: 30-270 µg/g
    - Aquatic birds: 3 µg/g (eggs) to 10 µg/g (liver).
    - Fish affected: 4 µg/g - 10 µg/g.

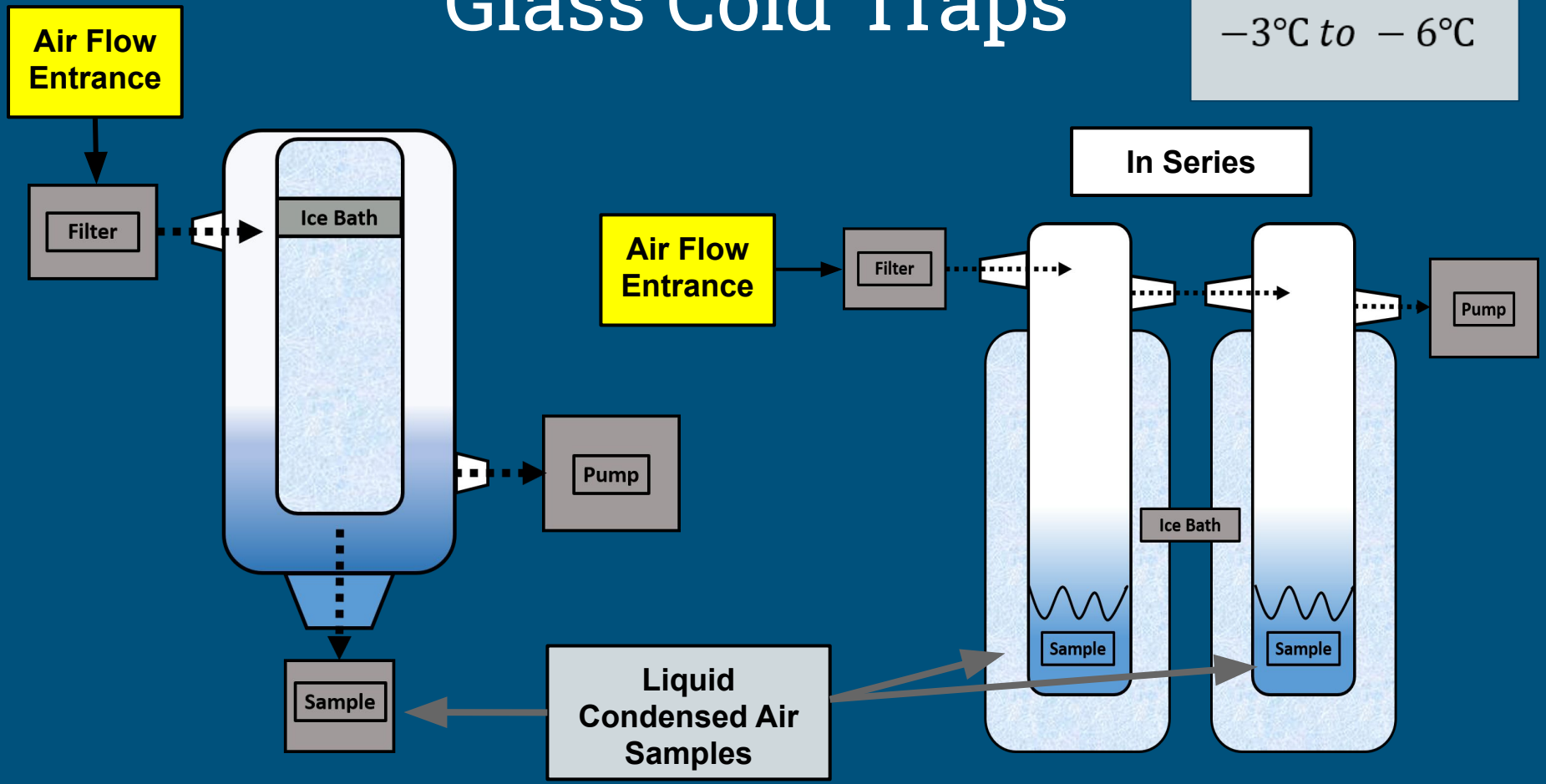
Effects of Selenium Toxicity in Humans

- Brittle nails with white spots, loss of feeling in limbs, thin hair or hair loss.
- No human population has been reported with selenium toxicity in the United States.
- In humans, no quantitative data exists on rate of absorption of Se from the lungs or skin.

Cold Traps with Cassette Filter

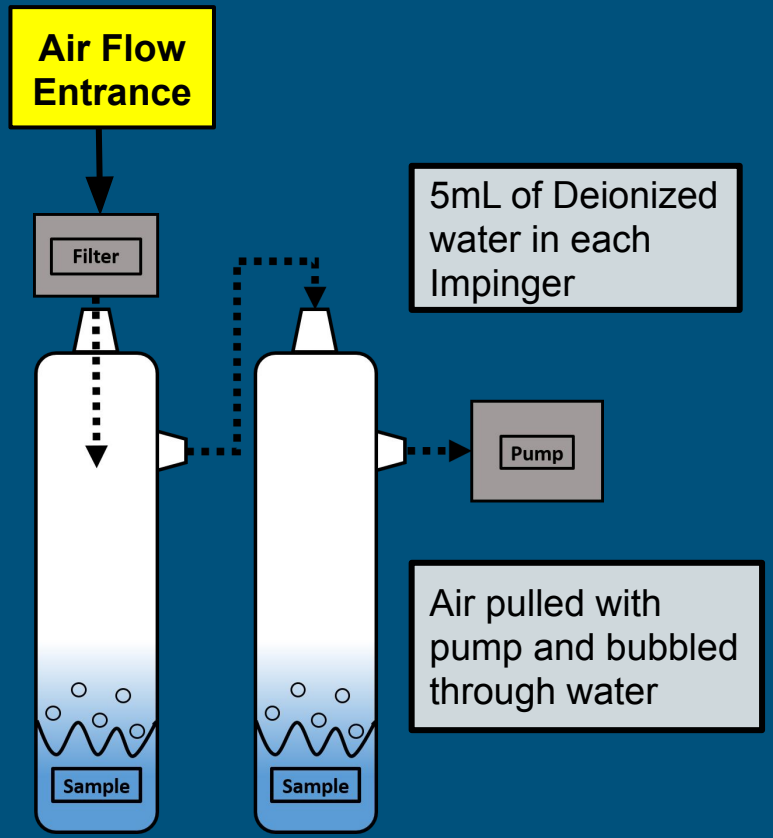
Glass Cold Traps

Ice Bath:
$-3°C$ *to* $-6°C$



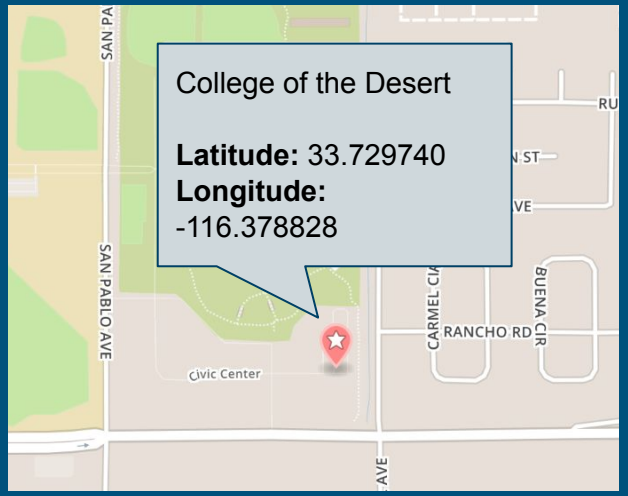
Impinger with Cassette Filter

Impingers and Measurements



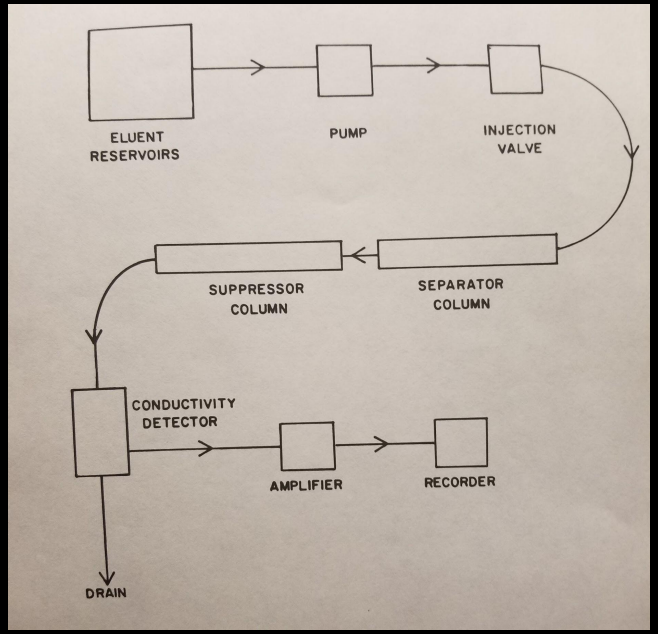
5mL of Deionized water in each Impinger

Air pulled with pump and bubbled through water



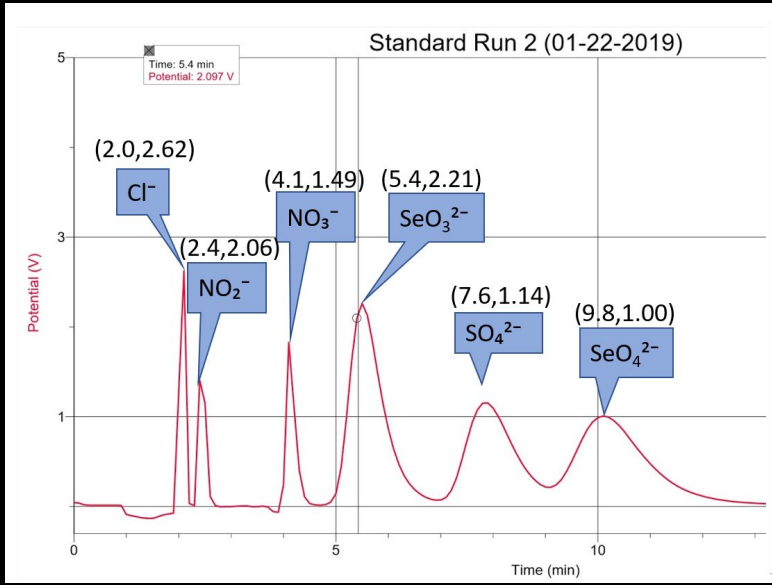
Eastside of the Salton Sea

Ion Chromatography

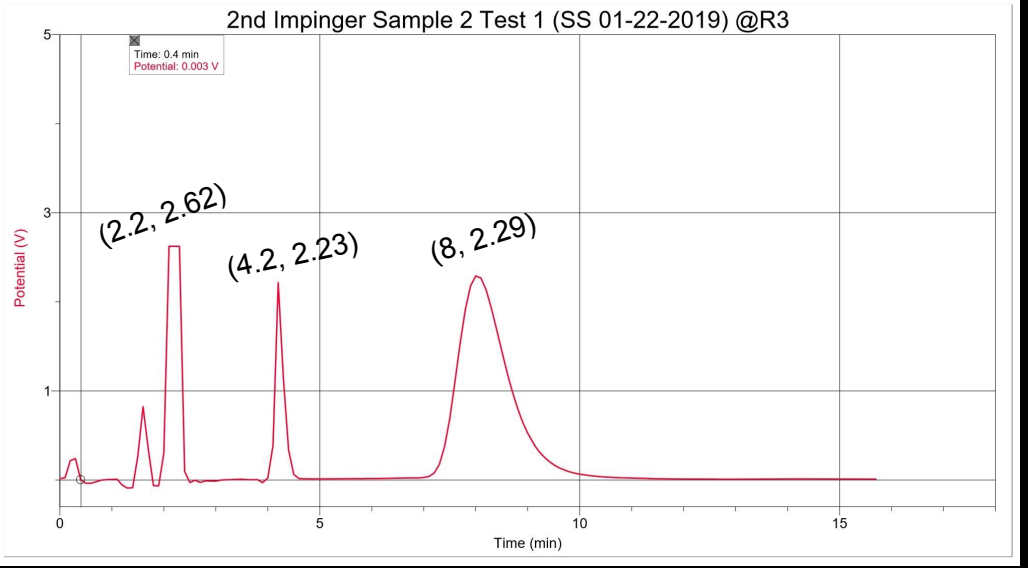


Ion Chromatograph: Standards Volt vs Time

Standard



Sample



Calculations and Results

1. **Assumption**: Soluble gases should collect similar to water vapor

$$1\ mL\ H_20 = 1g\ H_20$$

2. **Concentration collected:**

$$2.2\ PPM = \frac{2.2\ \mu g\ SO_4^{2-}}{1mL H_20}$$

3. For every 1 m³ of air we can potentially collect a net amount of 5.131g of water

$$1m^3 Air = 5.131g\ H_20$$

4. **Goal**: To have 1g of water to use as a conversion of collected air.

Air Collected

$$1g\ H_20 = \frac{1}{5.131} m^3 \text{Air} \approx 0.194 m^3 Air$$

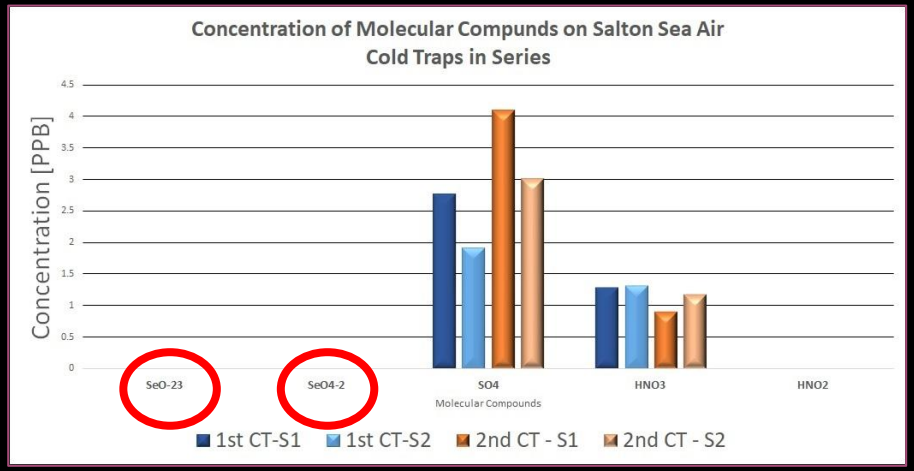
5. Convert to Liters of air

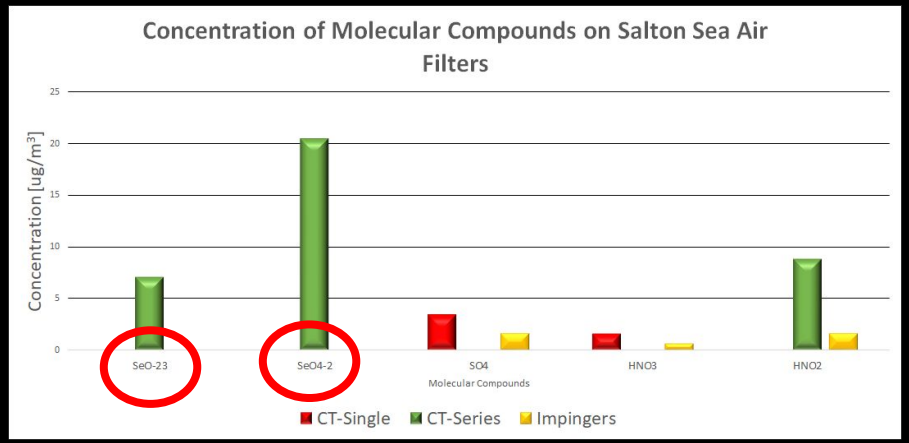
$$1g\ H_20 = 1\text{ml}\ H_20 = 0.194 m^3 Air = 194 L\ Air$$

$$\frac{2.2\ \mu g\ SO_4^{2-}}{194\ L\ Air} * \left(\frac{23.67 L\ Air}{1\ mole\ Air}\right) * \left(\frac{10^{-6} g}{1\ \mu g}\right) * \left(\frac{1\ mole\ SO_4^{2-}}{96 g\ SO_4^{2-}}\right) * \left(\frac{1 mole\ H_2SO_4}{1 mole\ SO_4^{2-}}\right) = \frac{2.8\ nmole\ H_2SO_4}{1\ mole\ Air} = 2.8\ ppb$$

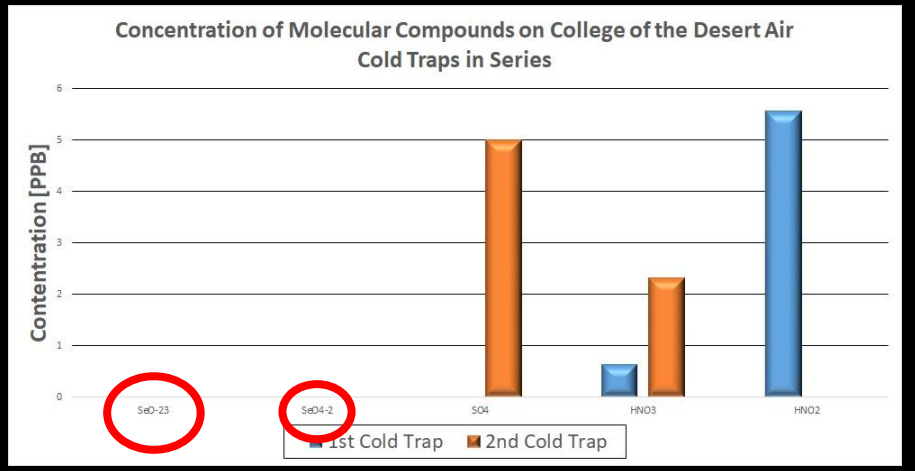
Results

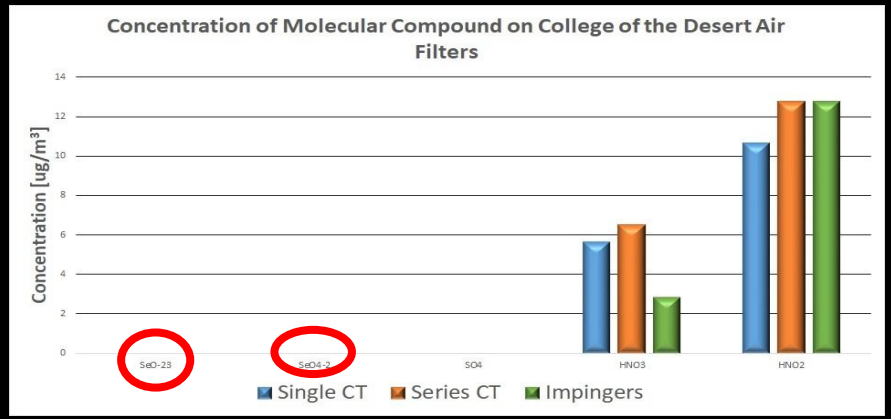
Salton Sea





College of the Desert





Moving Forward

Potential research expansion for future internships:

- Taking air samples during dry, hot, windy weather to compare vs damp, cold weather.

- Determine lifetime (half-life) of hydrogen selenide in the air.
  - Does it degrade, to what form, and under what conditions?
- Collaboration with Engineering to determine if removal and refinement of selenium for use in electronics could be financially feasible as a path to remediation

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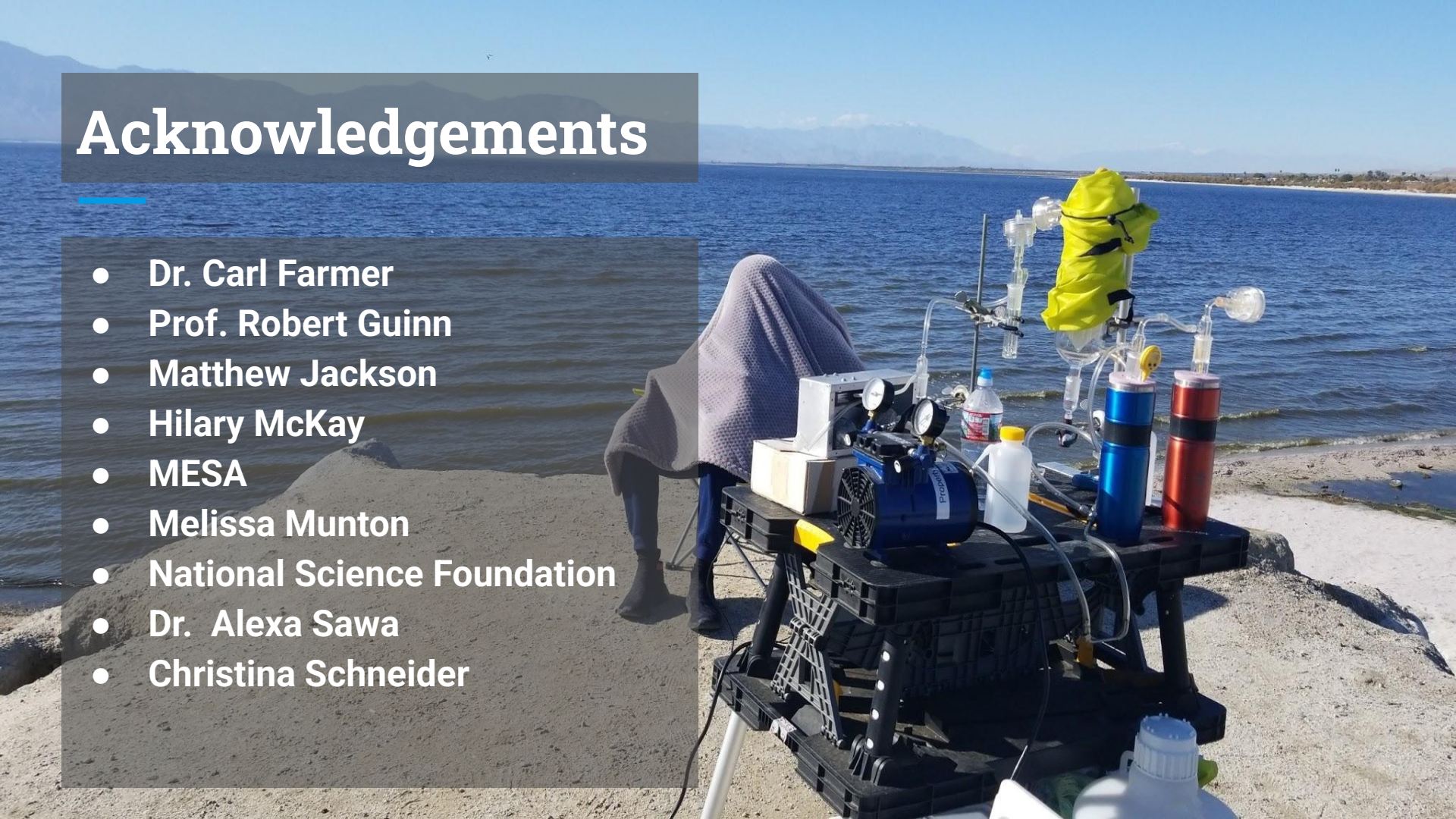

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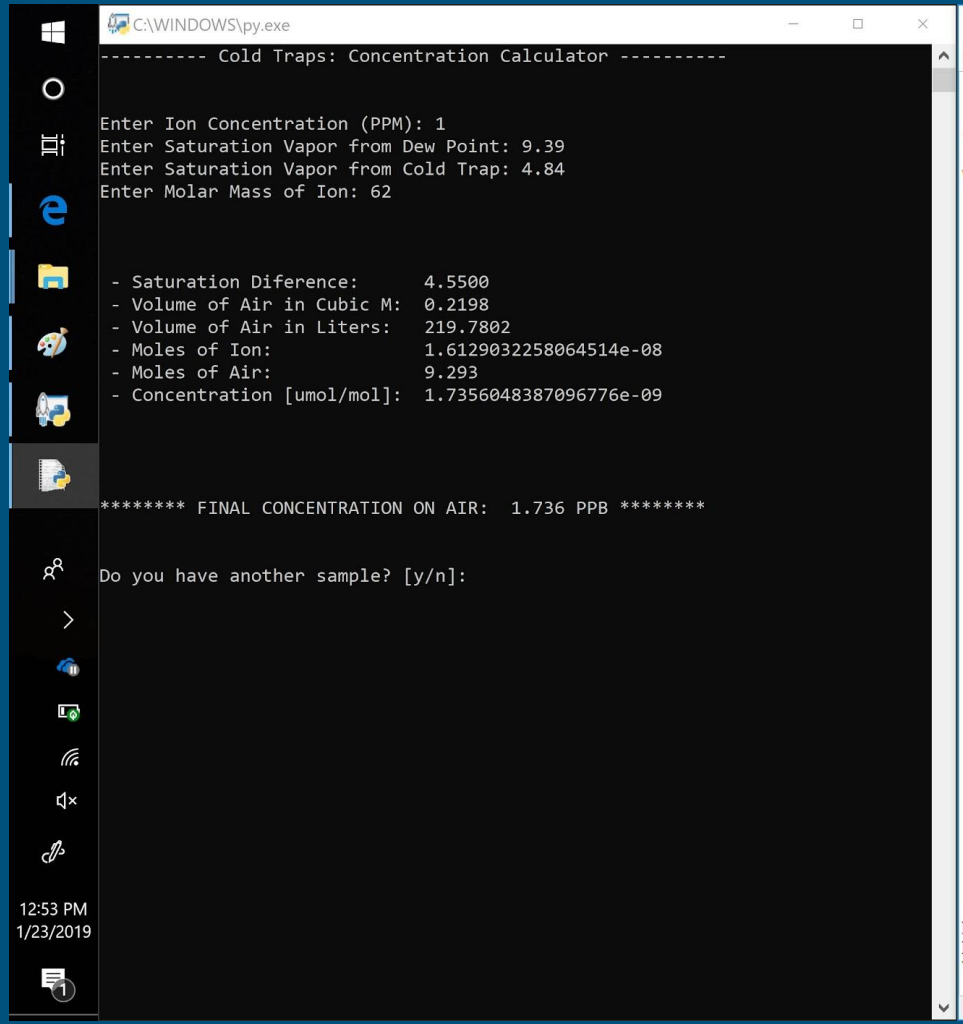
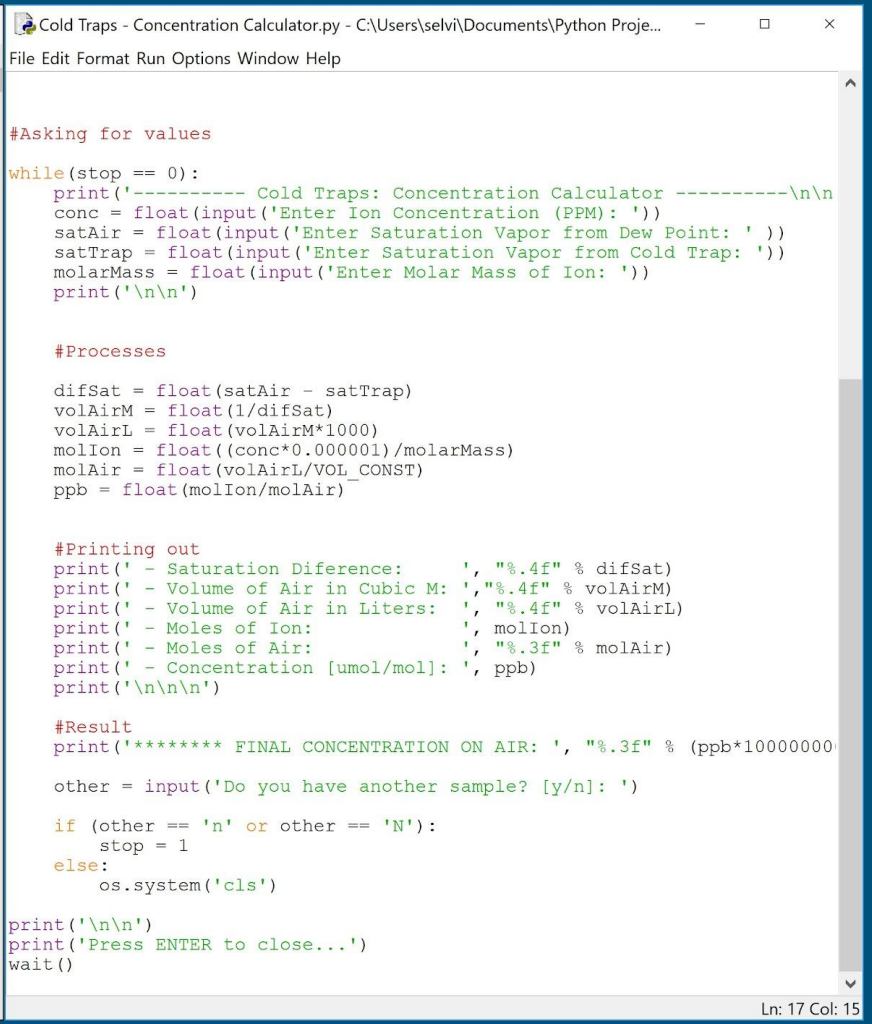
The Salton Sea's Receding Shoreline

- Inflow:
  - Agricultural runoff
  - Municipal Effluent
- No outlets
- 2002 QSA: "Quantification Settlement Agreement":
  - 15 year act Ended 2017
  - Less water for agricultural runoff
  - Solidifying final allocations
- Predictions:
  - Receding shoreline
  - Exposure and Concentration of lake bed chemicals


C:\WINDOWS\py.exe
---------- Cold Traps: Concentration Calculator ----------
Enter Ion Concentration (PPM): 1
Enter Saturation Vapor from Dew Point: 9.39
Enter Saturation Vapor from Cold Trap: 4.84
Enter Molar Mass of Ion: 62
- Saturation Diference: 4.5500
- Volume of Air in Cubic M: 0.2198
- Volume of Air in Liters: 219.7802
- Moles of Ion: 1.6129032258064514e-08
- Moles of Air: 9.293
- Concentration [umol/mol]: 1.7356048387096776e-09
******** FINAL CONCENTRATION ON AIR: 1.736 PPB ********
Do you have another sample? [y/n]:
12:53 PM
1/23/2019


Cold Traps - Concentration Calculator.py - C:\Users\selvi\Documents\Python Proje...
File Edit Format Run Options Window Help
#Asking for values
while(stop == 0):
print('---------- Cold Traps: Concentration Calculator ----------\n\n
conc = float(input('Enter Ion Concentration (PPM): '))
satAir = float(input('Enter Saturation Vapor from Dew Point: '))
satTrap = float(input('Enter Saturation Vapor from Cold Trap: '))
molarMass = float(input('Enter Molar Mass of Ion: '))
print('\n\n')
#Processes
difSat = float(satAir - satTrap)
volAirM = float(1/difSat)
volAirL = float(volAirM*1000)
molIon = float((conc*0.000001)/molarMass)
molAir = float(volAirL/VOL_CONST)
ppb = float(molIon/molAir)
#Printing out
print(' - Saturation Diference: ', "%.4f" % difSat)
print(' - Volume of Air in Cubic M: ',"%.4f" % volAirM)
print(' - Volume of Air in Liters: ', "%.4f" % volAirL)
print(' - Moles of Ion: ', molIon)
print(' - Moles of Air: ', "%.3f" % molAir)
print(' - Concentration [umol/mol]: ', ppb)
print('\n\n\n')
#Result
print('******** FINAL CONCENTRATION ON AIR: ', "%.3f" % (ppb*10000000
other = input('Do you have another sample? [y/n]: ')
if (other == 'n' or other == 'N'):
stop = 1
else:
os.system('cls')
print('\n\n')
print('Press ENTER to close...')
wait()
Ln: 17 Col: 15

Selenium

Selenium is a metalloid element, meaning it has properties of both metals and nonmetals...

- Comes in three allotropes: red powdery form, black vitreous (glassy), & silvery metal
- **Photovoltaic:** converts light to electricity
- **Photoconductive:** resistance ↓ with ↑ illumination
- Used in photocopiers, solar cells
- Used to provide red color in glass
- Can convert AC electricity to DC electricity

Biological Uses:

- Human bodies contain about 14 mg, with each cell containing more than 1 million Se atoms (trace mineral).[2]
- Used in some amino acids and enzymes.
- Used in dandruff shampoos
- Low Se levels may increase cancer risk, heart problems and thyroid hormone issues.[3]
- Excess selenium ingestion is suspected to be carcinogenic and teratogenic.[3]

[Se] Data from Salton Sea Samples vs Control (PD)

Factors Affecting Results

Possible reasons:

- Rainfall during project period may depress amount of dust that would be present during a drier period, resulting in a false negative.
- Rainfall may have temporarily increased lake surface, covering otherwise exposed sediment possibly contributing to airborne Se.
- Instrument or operator error.
- Higher density of water from concentrated salt and other matter may prevent Se from entering gas phase, similar to undersea brine lakes that contain dissolved hydrogen sulfide gas.