

**Data to Discovery Program**  
Jet Propulsion Laboratory,  
California Institute of Technology  
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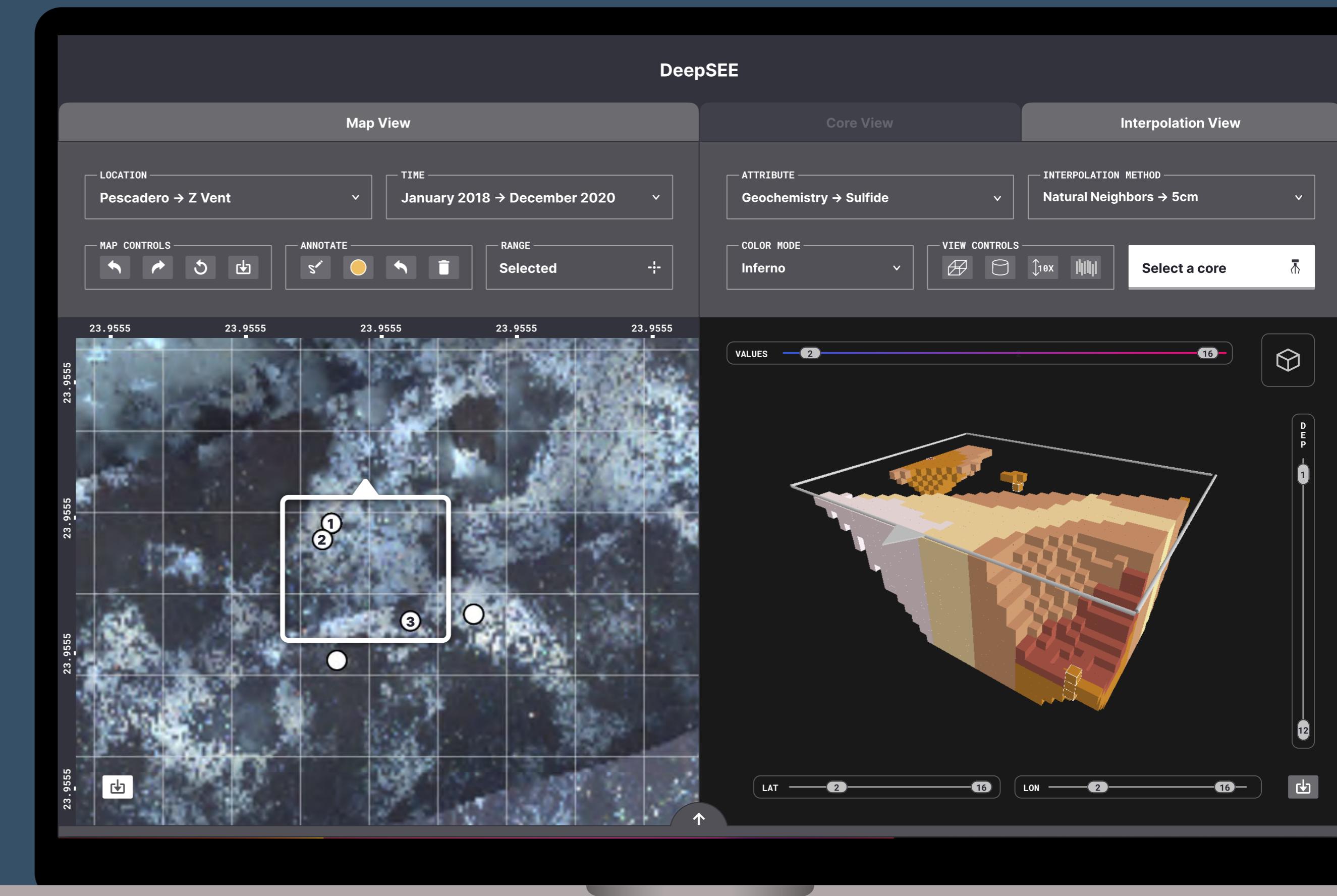
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# DeepSee

# DeepSee

Interpolating sparse data to guide  
deep sea core sample site selection



A dark, grainy underwater photograph showing several large, irregularly shaped, light-colored mounds or seeps rising from the ocean floor. The surrounding water is a deep blue-green, and small dark particles are visible, likely methane bubbles.

**Scientists at Caltech's Orphan Lab are actively studying microbial communities that live around methane seeps at the bottom of the ocean.**

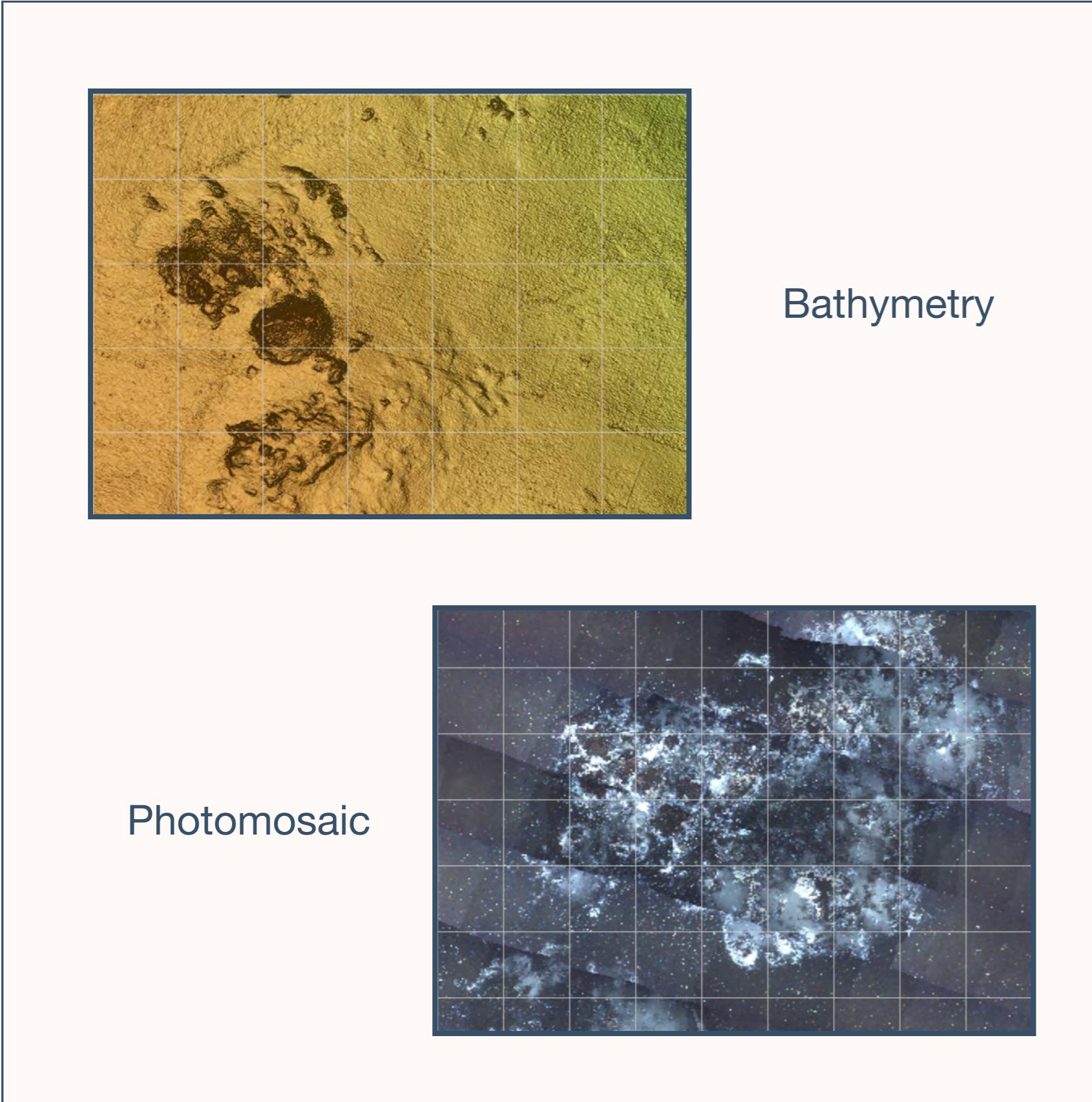
These microbes consume huge amounts of methane, preventing it from reaching the atmosphere and contributing to climate change.

To study these microbes, scientists survey the ocean floor and draw core samples using underwater robots.

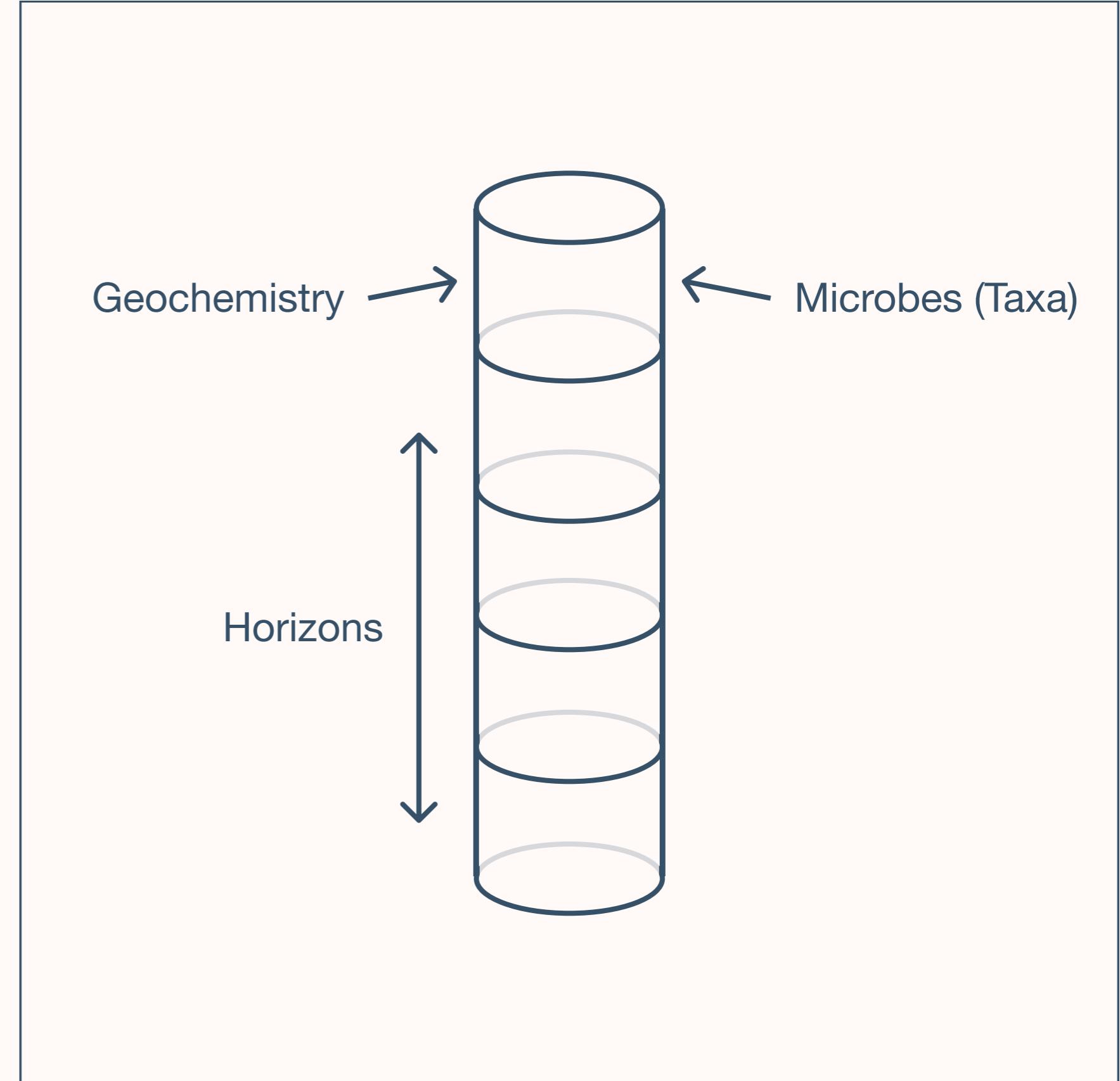
This process is expensive and time consuming, and so only a very limited number of samples can be taken.



## Pre-Dive Mapping Data



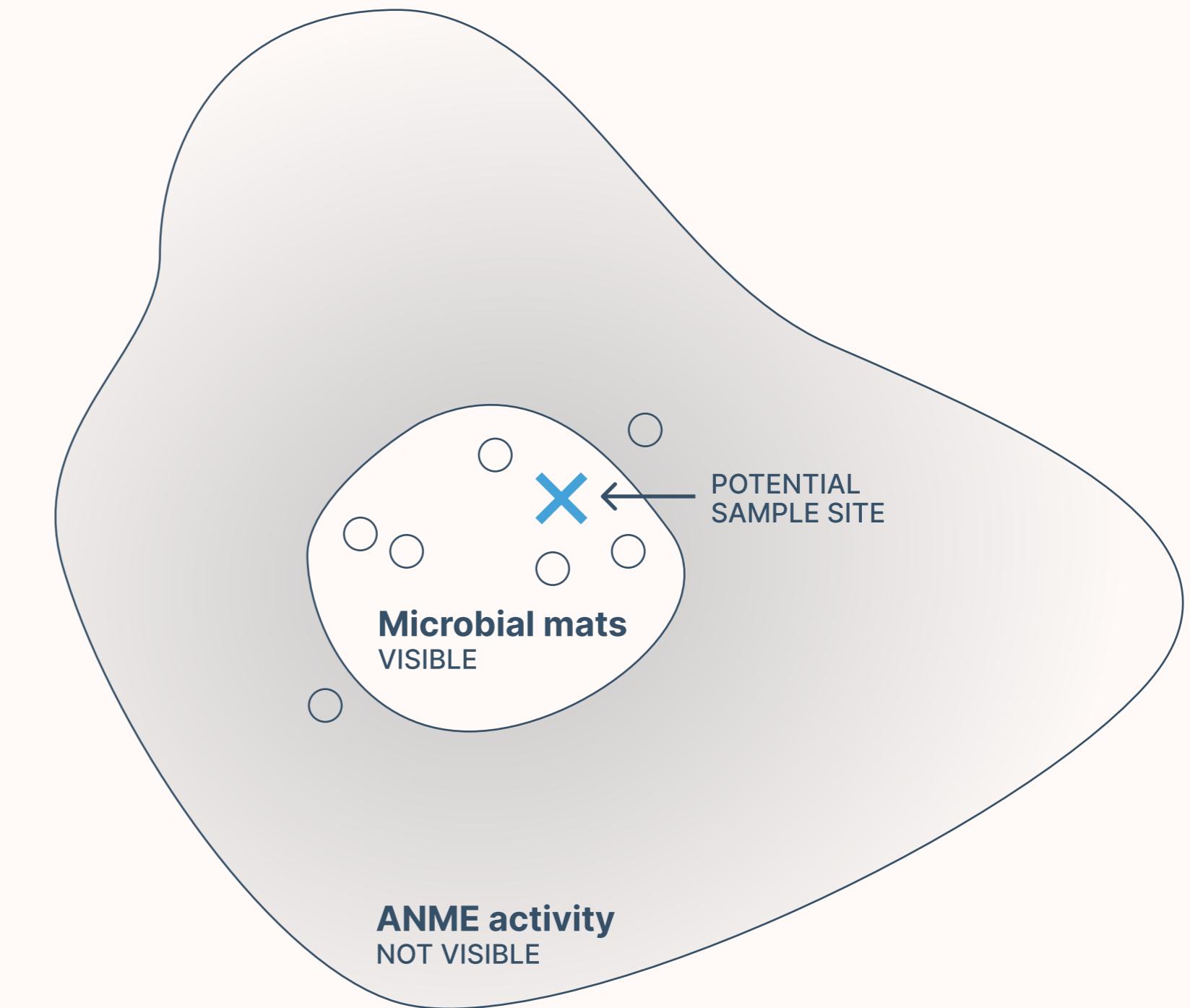
## Core Sample Data



## The Context

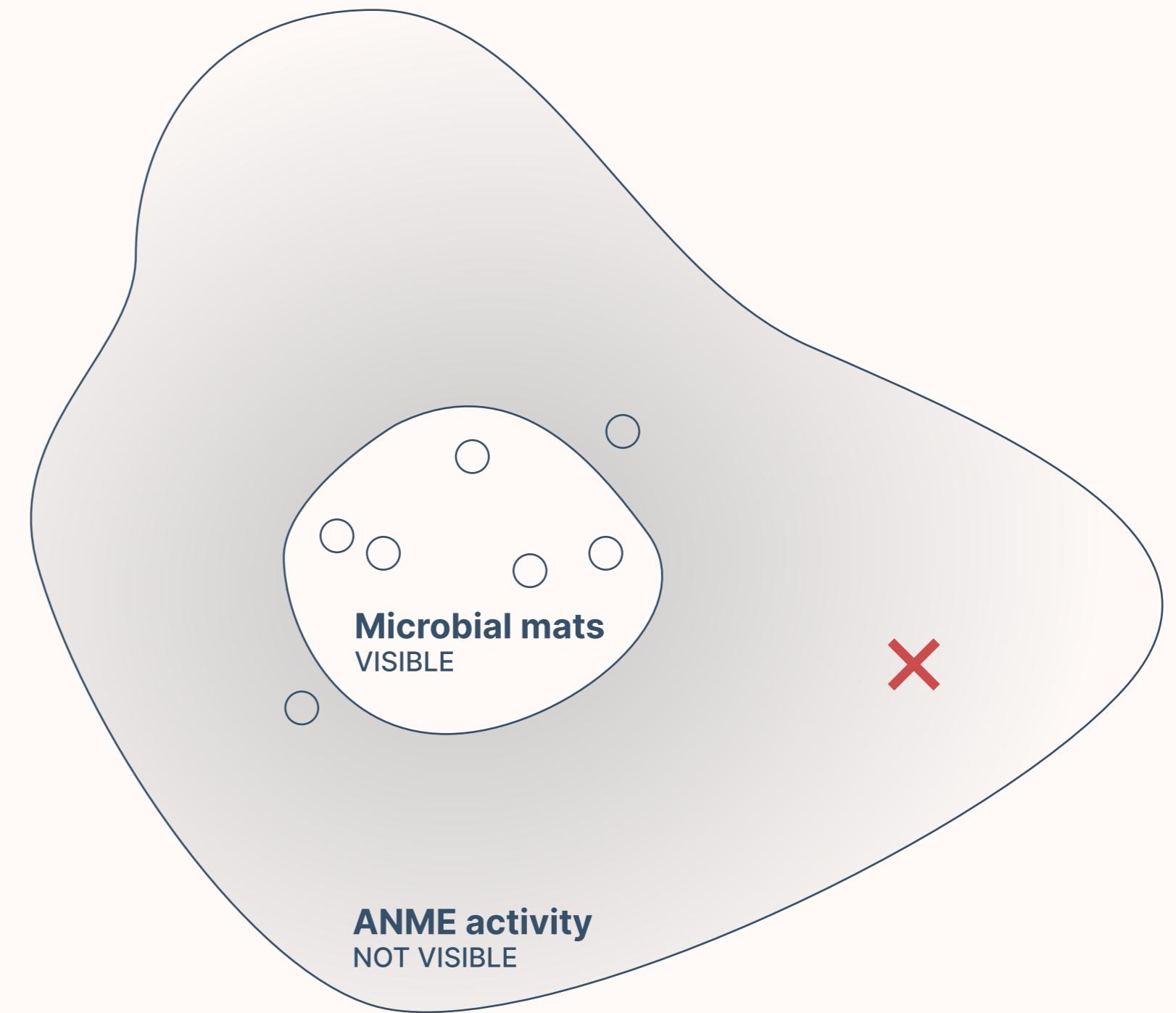
The cost associated with taking samples creates strong incentives to pick “obvious spots” where there is visible surface expression of microbial communities.

Samples that are taken outside surface expression are less likely to have scientific value.



## The Challenge

However, this approach limits scientists' ability to understand the true bounds of where these important microbes live and how this changes over time.



## Our Task

**Help scientists make more informed sample site selections in non-obvious locations to illuminate the “edges” of microbial activity around methane seeps.**

## Our Process

**Contextual  
Inquiry**

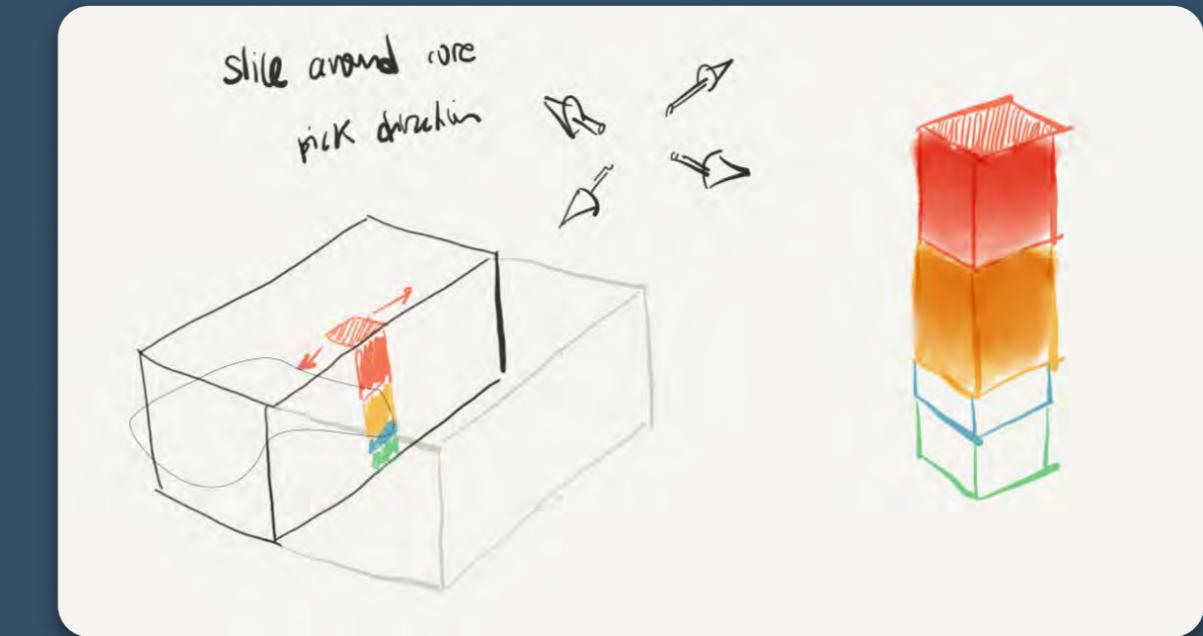
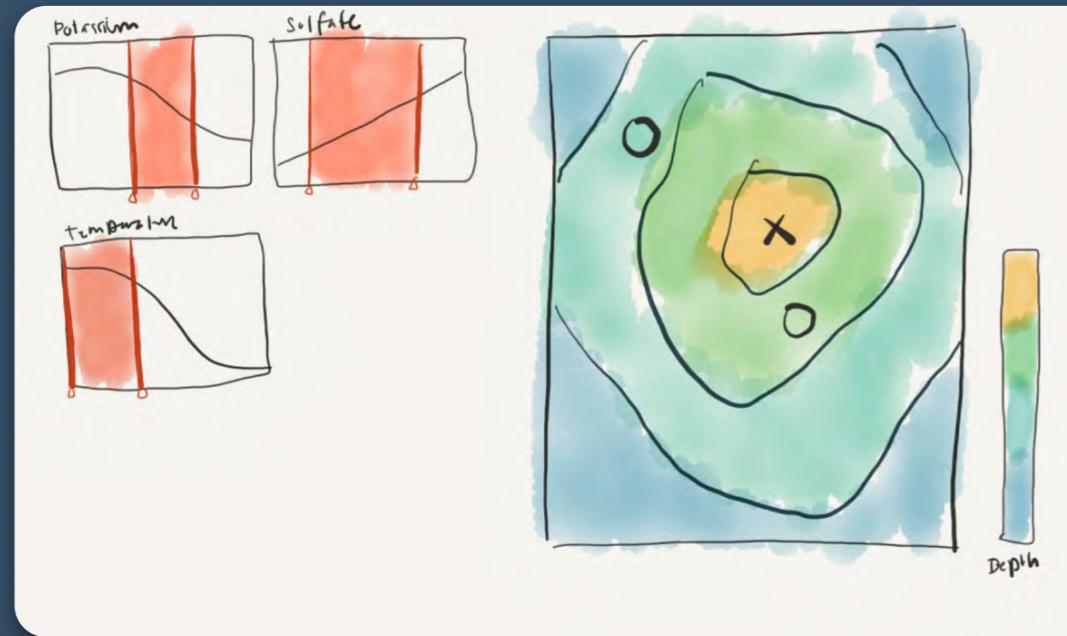
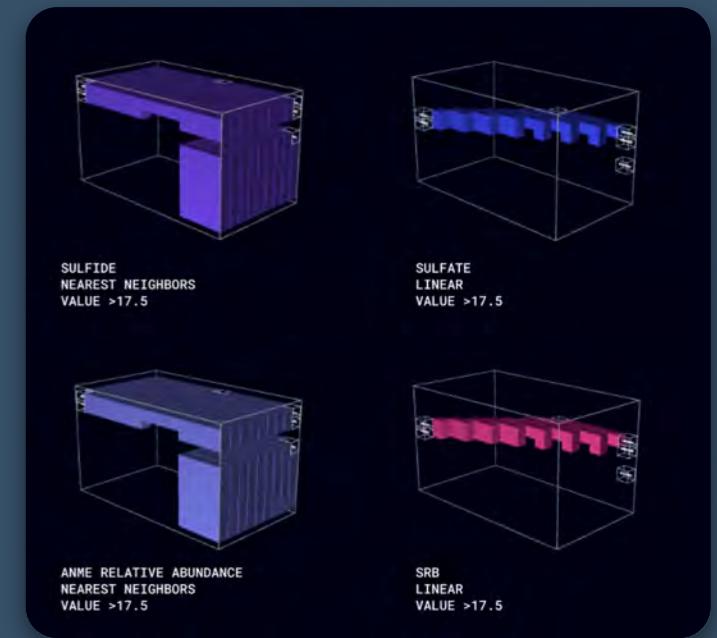
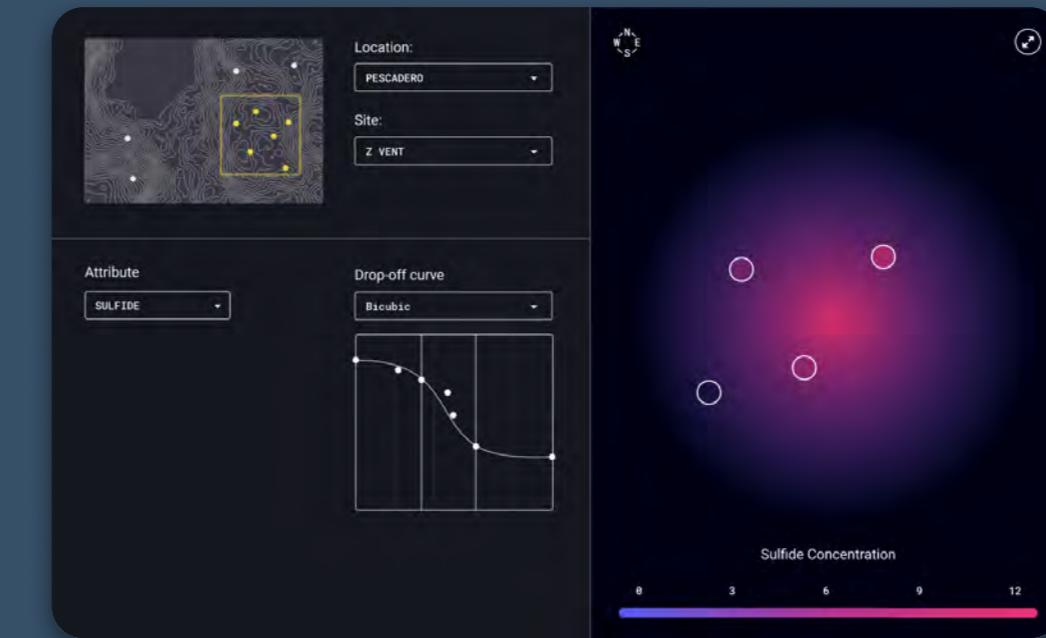
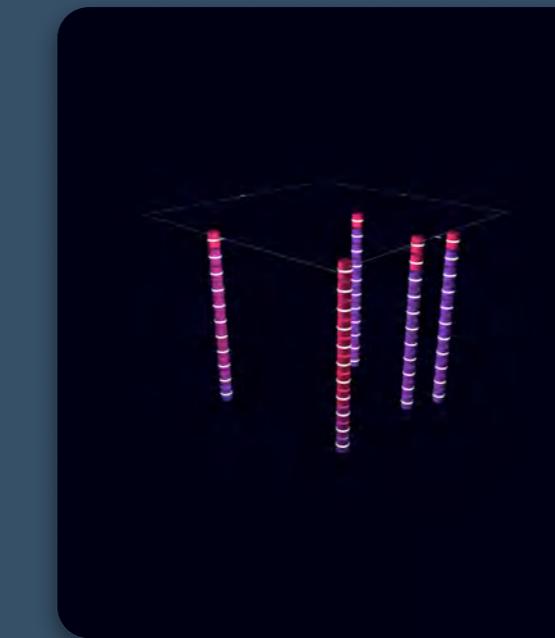
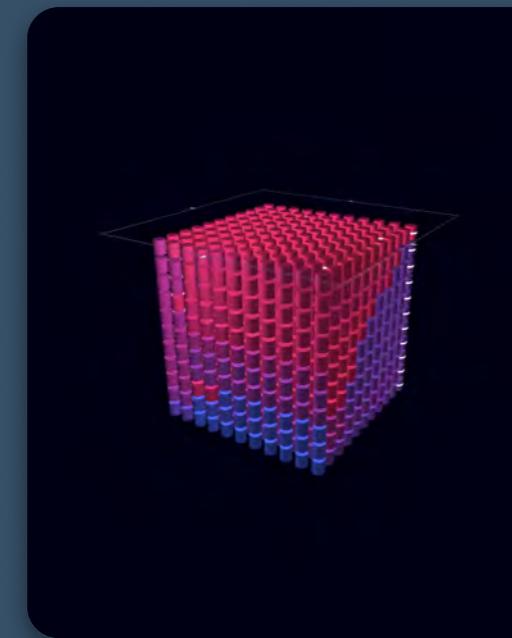
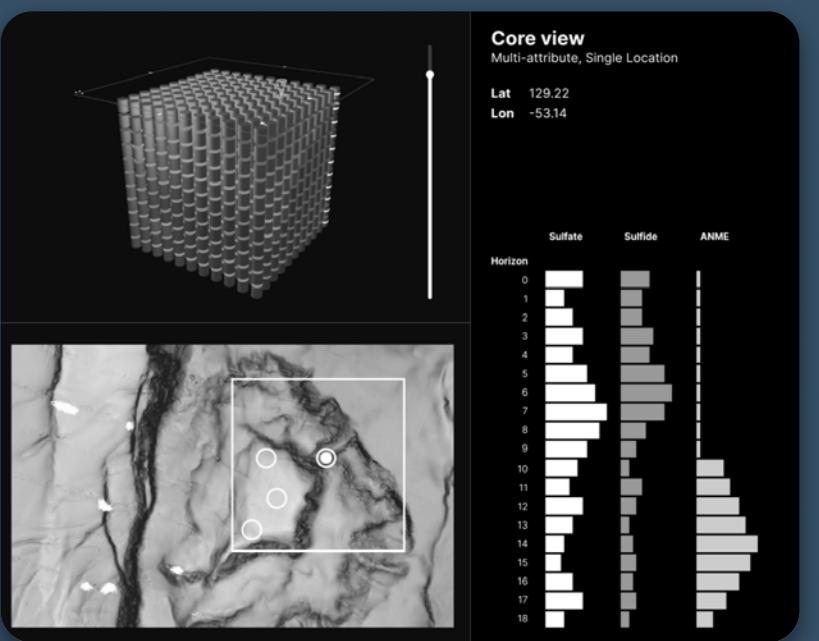
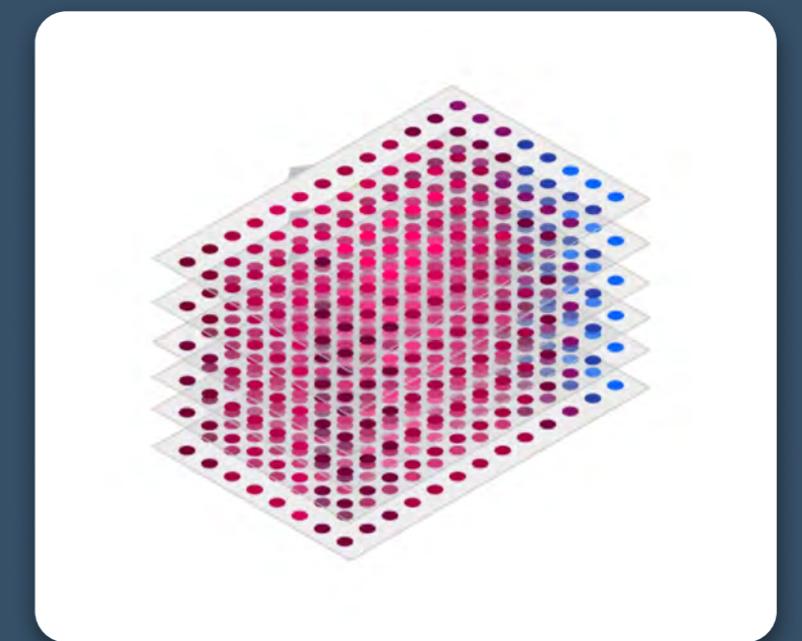
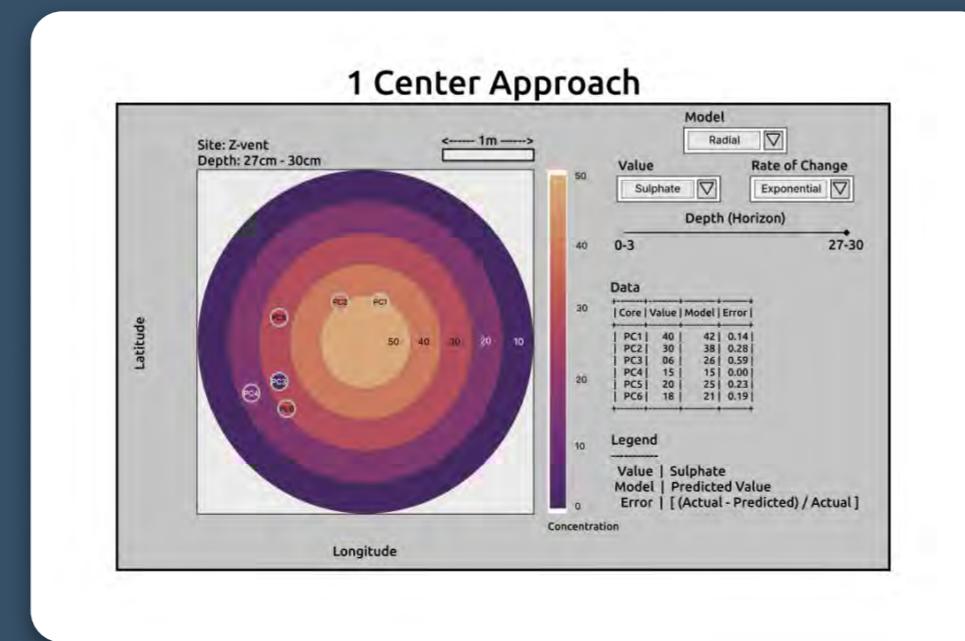
**Design & Data  
Exploration**

**Today's  
Prototype!**



**User Testing  
& Refinement**

# Alternative Explorations



## Our Solution

**DeepSee** provides a platform to generate and visually explore 3D interpolations between sparse core data to guide future sample site selection.

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DeepSee provides a platform to generate and visually explore 3D interpolations between sparse core data to guide future sample site selection.

*Interpolating between known samples to fill in gaps in data and identify previously invisible hotspots of activity.*

## Our Solution

DeepSee provides a platform to generate and **visually explore** 3D interpolations between sparse core data to guide future sample site selection.

*Allow scientists to visually explore interpolated data in 3 dimensions, building spacial intuition about distributions.*

## Our Solution

DeepSee provides a platform to generate and visually explore 3D interpolations between sparse core data to guide future sample site selection.

*Provide all the necessary contextual information to inform site selection, including bathymetry and photomosaic maps.*

## Use Cases

1

### Pre-cruise planning

Identify promising sample sites in advance of an upcoming research cruise

2

### On-site refinement

Interpolate on the fly with data collected before a dive occurs (i.e. temperature)

# Demo

1

## Backend server

*Python*

A Python Flask web app is running in the background, receiving the CSV data from the frontend and creating datasets of XYZ data to be plotted by Three.js in the frontend.

2

## Frontend interface

*Vue.js  
+ Vuetify  
+ Electron*

Vue.js serves static assets (PNG, CSV, JSON) and provides UI interactions styled with the Vuetify Material Design Framework, all wrapped into a standalone Electron desktop app.

3

## Visualization

*D3.js  
+ Three.js*

D3.js plots previously sampled cores on top of PNG images scaled by latitude and longitude. Three.js creates a traditional 3D render scene with lighting effects to show the distribution of interpolated values.

## Avenues for Future Work

- 1 **Integration with existing ecosystem of tools**  
Allow users to seamlessly analyze known cores in addition to interpolations.
- 2 **Robust comparisons and annotations**  
Allow users to save maps, interpolations, annotations, and entire files in addition to cores.
- 3 **Improved interpolation methods**  
Provide new ways to generate data, ranging from machine learning to nutrient flux modeling.
- 4 **Inform autonomous space sampling missions**  
Leveraging the information humans use in selecting sample sites to help train autonomous sampling systems on other planets.

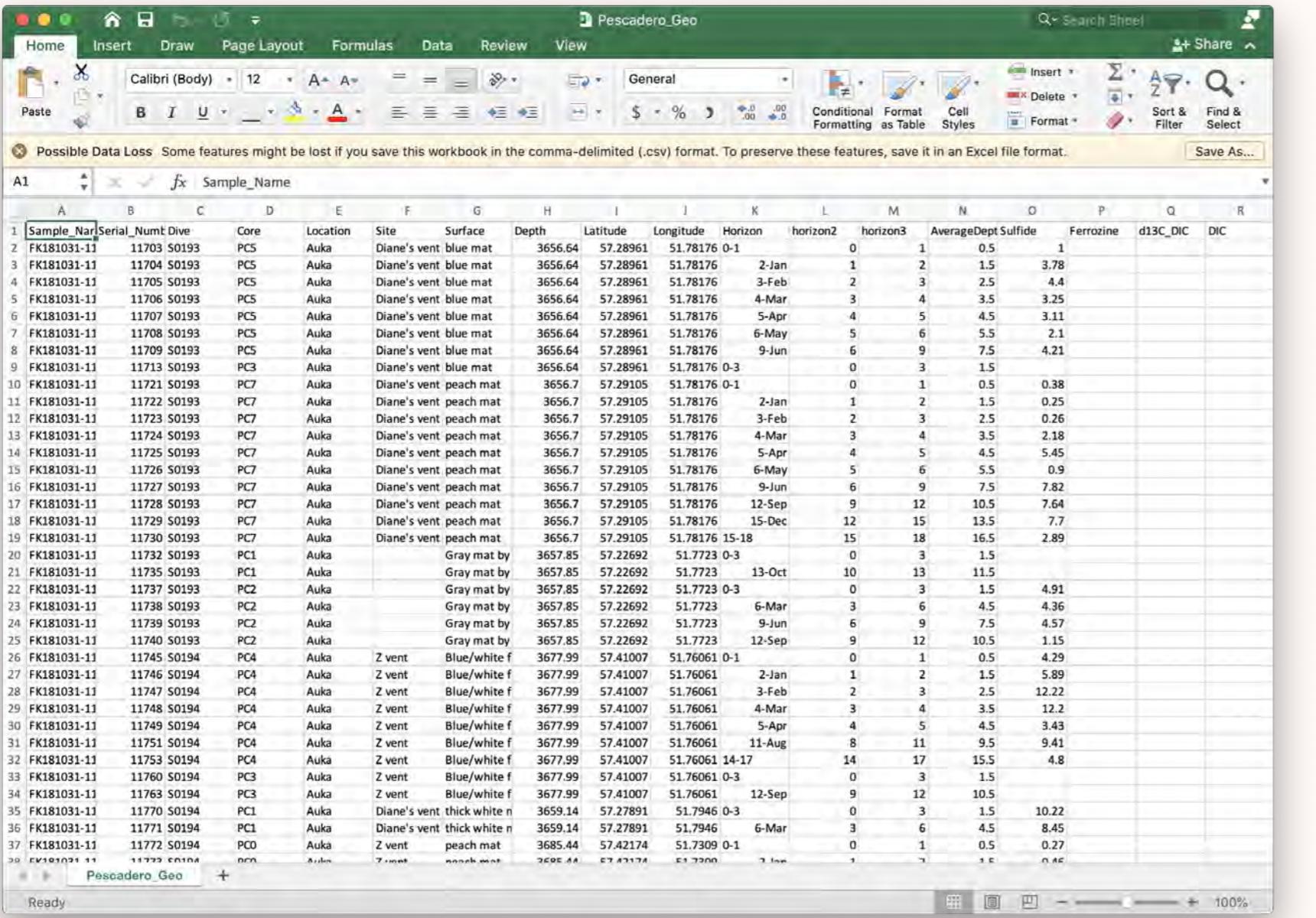
Next Steps



Test DeepSee on an  
upcoming research cruise!

# Summary of Contributions

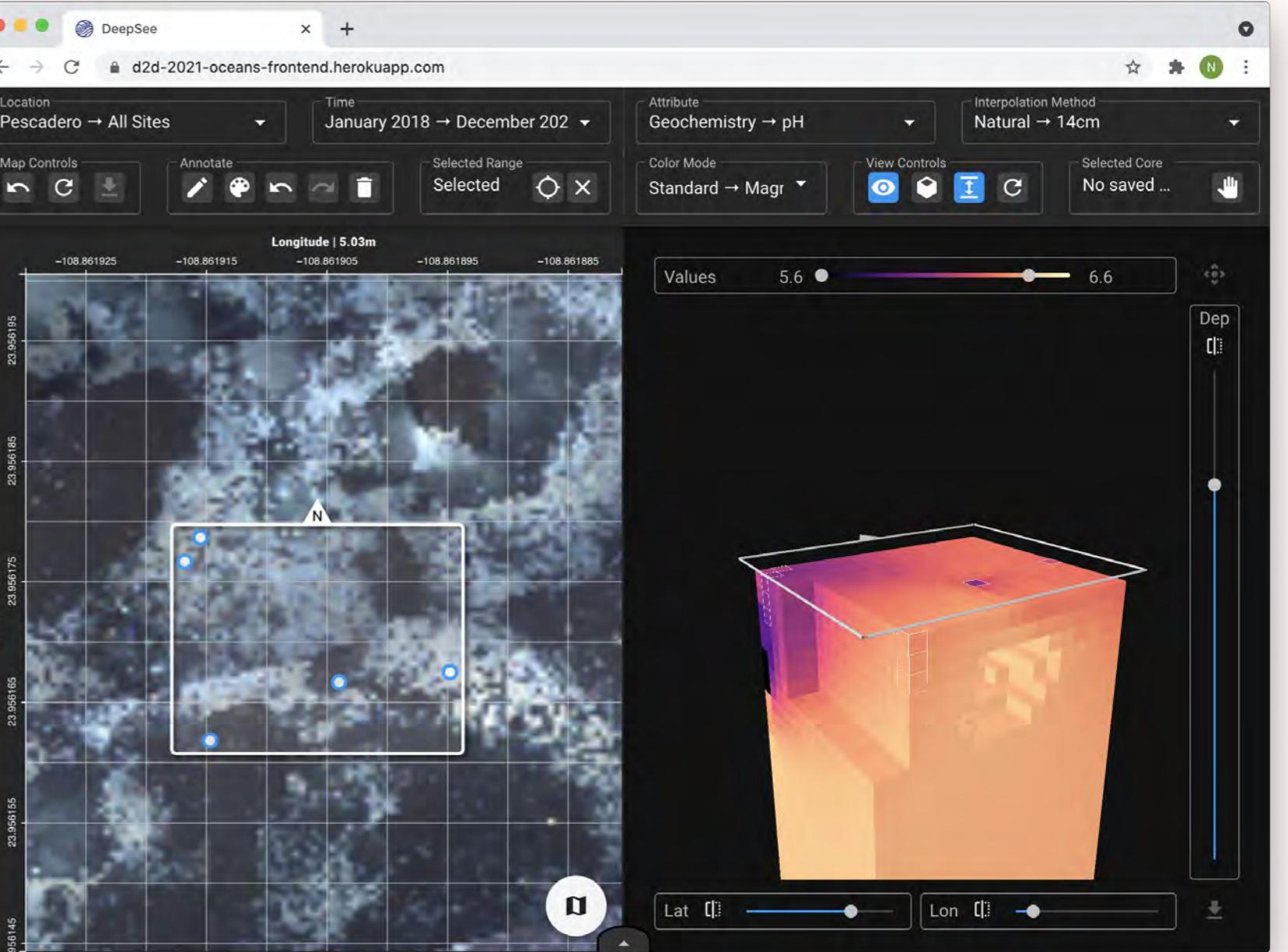
Before



A screenshot of a Microsoft Excel spreadsheet titled "Pescadero\_Geo". The spreadsheet contains a large dataset of geological samples. The columns include Sample\_Nr, Serial\_Num, Dive, Core, Location, Site, Surface, Depth, Latitude, Longitude, Horizon, horizon2, horizon3, AverageDeptSulfide, Ferrozine, d13C\_DIC, and DIC. The data spans from row 1 to approximately row 40, with many rows containing specific details like "Diane's vent blue mat" or "Z vent Blue/white f". The Excel interface shows various toolbars and a ribbon at the top.

Sample_Nr	Serial_Num	Dive	Core	Location	Site	Surface	Depth	Latitude	Longitude	Horizon	horizon2	horizon3	AverageDeptSulfide	Ferrozine	d13C_DIC	DIC
FK181031-11	11703	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	0-1	0	1	0.5	1	3.78	
FK181031-11	11704	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	2-Jan	1	2	1.5	3.78		
FK181031-11	11705	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	3-Feb	2	3	2.5	4.4		
FK181031-11	11706	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	4-Mar	3	4	3.5	3.25		
FK181031-11	11707	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	5-Apr	4	5	4.5	3.11		
FK181031-11	11708	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	6-May	5	6	5.5	2.1		
FK181031-11	11709	S0193	PCS	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	9-Jun	6	9	7.5	4.21		
FK181031-11	11713	S0193	PC3	Auka	Diane's vent	blue mat	3656.64	57.28961	51.78176	0-3	0	3	1.5			
FK181031-11	11721	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	0-1	0	1	0.5	0.38		
FK181031-11	11722	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	2-Jan	1	2	1.5	0.25		
FK181031-11	11723	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	3-Feb	2	3	2.5	0.26		
FK181031-11	11724	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	4-Mar	3	4	3.5	2.18		
FK181031-11	11725	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	5-Apr	4	5	4.5	5.45		
FK181031-11	11726	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	6-May	5	6	5.5	0.9		
FK181031-11	11727	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	9-Jun	6	9	7.5	7.82		
FK181031-11	11728	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	12-Sep	9	12	10.5	7.64		
FK181031-11	11729	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	15-Dec	12	15	13.5	7.7		
FK181031-11	11730	S0193	PC7	Auka	Diane's vent	peach mat	3656.7	57.29105	51.78176	15-18	15	18	16.5	2.89		
FK181031-11	11732	S0193	PC1	Auka	Gray mat	by	3657.85	57.22692	51.7723	0-3	0	3	1.5			
FK181031-11	11735	S0193	PC1	Auka	Gray mat	by	3657.85	57.22692	51.7723	13-Oct	10	13	11.5			
FK181031-11	11737	S0193	PC2	Auka	Gray mat	by	3657.85	57.22692	51.7723	0-3	0	3	1.5	4.91		
FK181031-11	11738	S0193	PC2	Auka	Gray mat	by	3657.85	57.22692	51.7723	6-Mar	3	6	4.5	4.36		
FK181031-11	11739	S0193	PC2	Auka	Gray mat	by	3657.85	57.22692	51.7723	9-Jun	6	9	7.5	4.57		
FK181031-11	11740	S0193	PC2	Auka	Gray mat	by	3657.85	57.22692	51.7723	12-Sep	9	12	10.5	1.15		
FK181031-11	11745	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	0-1	0	1	0.5	4.29		
FK181031-11	11746	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	2-Jan	1	2	1.5	5.89		
FK181031-11	11747	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	3-Feb	2	3	2.5	12.2		
FK181031-11	11748	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	4-Mar	3	4	3.5	12.2		
FK181031-11	11749	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	5-Apr	4	5	4.5	3.43		
FK181031-11	11751	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	11-Aug	8	11	9.5	9.41		
FK181031-11	11753	S0194	PC4	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	14-17	14	17	15.5	4.8		
FK181031-11	11760	S0194	PC3	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	0-3	0	3	1.5			
FK181031-11	11763	S0194	PC3	Auka	Z vent	Blue/white f	3677.99	57.41007	51.76061	12-Sep	9	12	10.5			
FK181031-11	11770	S0194	PC1	Auka	Diane's vent	thick white n	3659.14	57.27891	51.7946	0-3	0	3	1.5	10.22		
FK181031-11	11771	S0194	PC1	Auka	Diane's vent	thick white n	3659.14	57.27891	51.7946	6-Mar	3	6	4.5	8.45		
FK181031-11	11772	S0194	PC0	Auka	Z vent	peach mat	3685.44	57.42174	51.7309	0-1	0	1	0.5	0.27		
FK181031-11	11772	S0194	PC0	Auka	Z vent	peach mat	3685.44	57.42174	51.7309	0-1	1	3	1.5	0.46		

After



## Acknowledgments

Thank you to **Haley, John, Victoria**, and the entire **Orphan Lab** team for their time and effort in collaborating on this project with us!

Thank you to our mentors **Hillary, Santiago, Maggie**, and **Scott** for their guidance and support throughout!

Thank you!

Questions?

# Data to Discovery



Caltech





# **Jet Propulsion Laboratory**

## California Institute of Technology

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