Making Big GeoData Accessible for Education:
Strategies Used and Lessons Learned in Making a Surficial Sea Floor Sediment Map for Education in Google Earth

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1. **Start with data types and databases you are familiar with.**

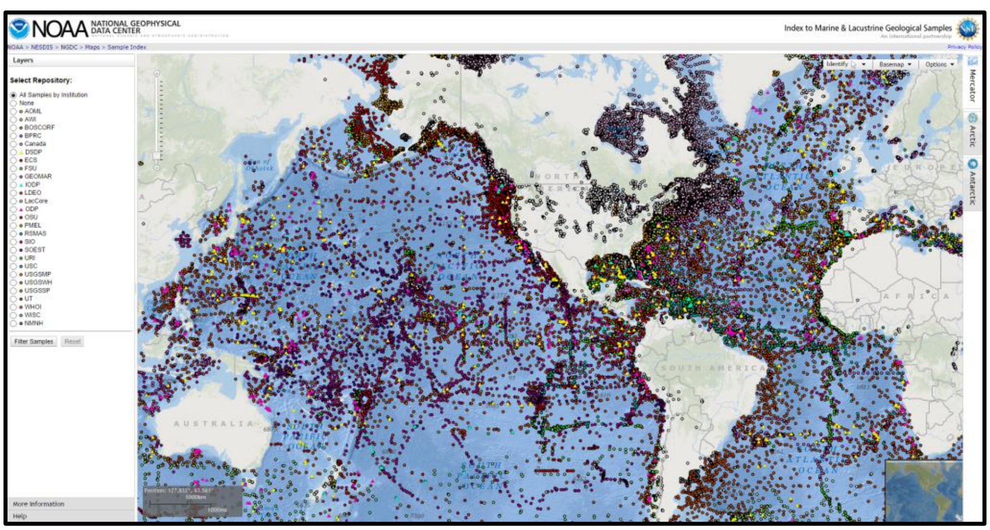
   Example: I was already familiar with the online data from DSDP, ODP, and IODP (http://www.iodp.org/) because of helping generate the data via (a) my own scientific research experience with these program and (b) the curriculum I have already developed (e.g., St. John et al., 2012, Reconstructing Earth's Climate History; http://serc.carleton.edu/NAGTWorkshops/intro/activities/29154.html) that accessed online data (e.g., core images, compositional data, online publications).

2. **Take advantage of what already exists – look for opportunities to make science accessible.**

   Example: IODP already developed a **borehole KML file** (http://www.iodp.org/borehole-map) for Google Earth showing the locations of all holes drilled during DSDP, ODP, and IODP, and which provided access to the online data and publications for these locations.

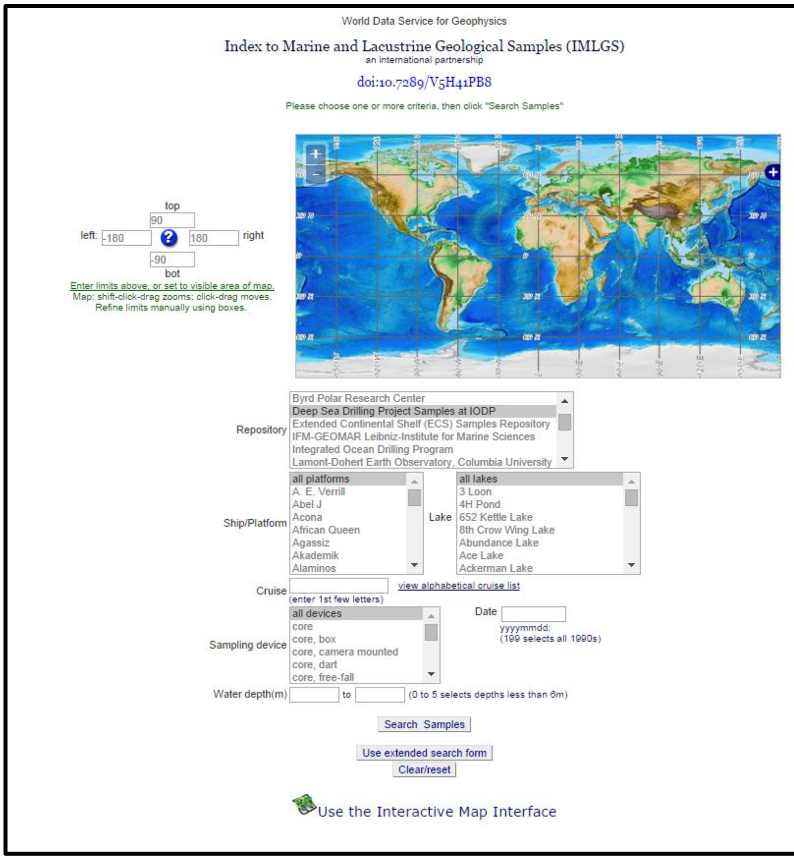
   > Challenge: The KML file however was underutilized by scientists (*why access the data via Google Earth if you already how to access it otherwise?)* and by educators (*scientific ocean drilling not as well known as NASA or NOAA)*).

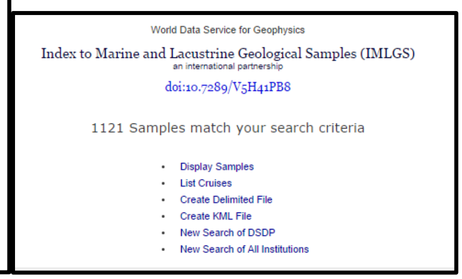
   Example: All of the IODP data is also included in a larger database, **NOAA's National Geophysical Data Center Index to Marine and Lacustrine Geologic Samples** (http://maps.ngdc.noaa.gov/viewers/sample_index/). The mission of the data center is to provide long-term scientific data stewardship for the Nation's geophysical data, ensuring quality, integrity, and accessibility. So it became **a one-stop-shop for accessing robust marine sediment data, connecting to original sources, and selecting all or portions of it to download as KML files.**



In the NGDC-IMLS database, one can search via an interactive map interface or by entering search parameters (http://www.ngdc.noaa.gov/geosamples/index.jsp). In either case, **obtaining the search**

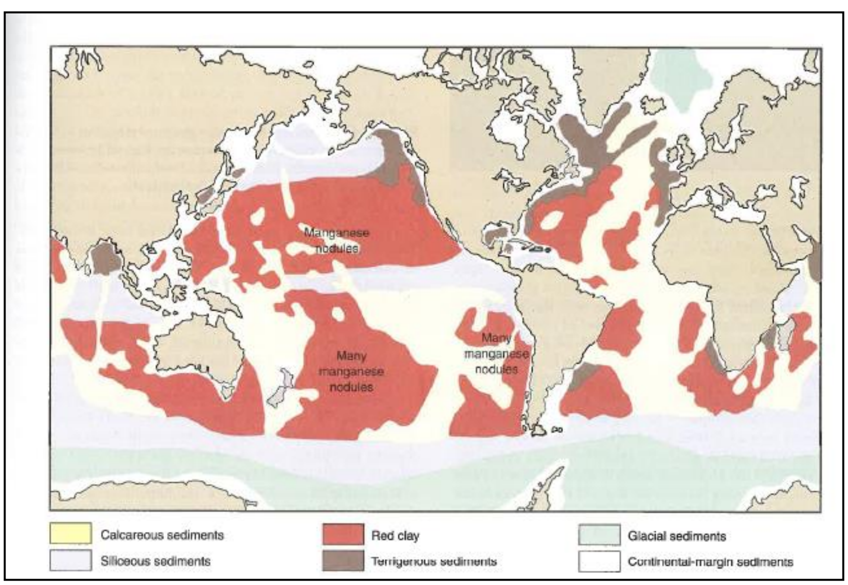
output as a KML file was essential for being able to transfer the data in the database to the Google Earth platform.





3. **Focus on a data type that would support widely-taught geologic content, AND has a reason to be views geo-spatially.**

<u>Example</u>: My goal is to construct a surficial sea floor sediment map in Google Earth. Marine sediment types and their distribution are essential topics in undergraduate oceanography and marine geology courses. The geographic distribution of marine sediments in the global ocean depends on factors such as water depth, distance from land, biological productivity, surface currents, climate, and ocean chemistry. Therefore it is also an interdisciplinary topic that can be used to show complex interactions in the Earth system.



Example Oceanography textbook figure showing the distribution of the main sediment types on the ocean floor. From Sverdrup and Armbrust, *Introduction to the World's Oceans* 9th ed, 2008 (based on Rothwell, 1989, and Davies and Gorsline, 1976).

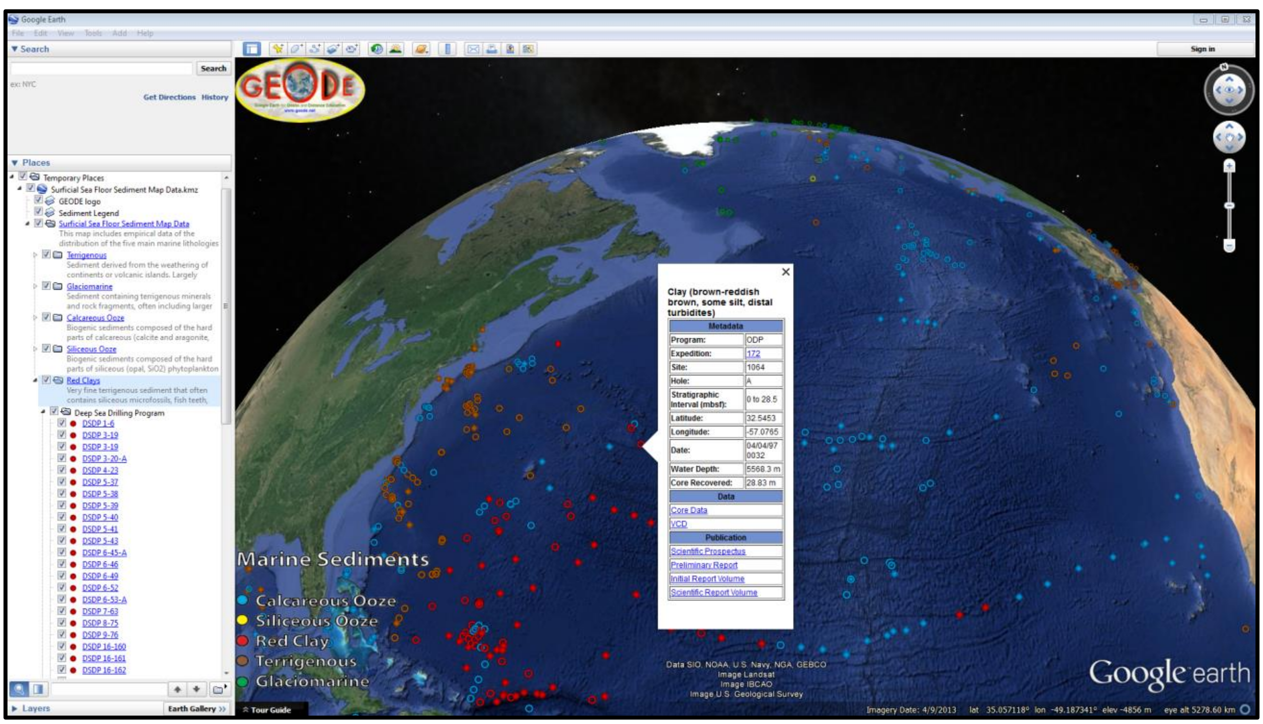
4. **Providing a Google Earth gateway to the data is NOT enough to make the big-data useful to educators. Develop Google Earth curriculum that accesses the data AND is designed to model scientific practices** (e.g., asking students to make observations about the data, develop hypothesis-generating questions, and synthesize what they see). Go beyond a virtual "show and tell" and move towards a "do-talk-do-talk-do" (inquiry-learning) approach.

   Example: See student exercise, **Exploring Marine Sediments Using Google Earth**. It contains three parts, each of which depends on data viewed in Google Earth. It starts by asking students to make initial observations on a small dataset, then moves to a larger dataset and asks for more complex observations and hypothesis generation, and finally advances to a follow-up unit where students are introduced to additional data to look for potential causal relationships:

   1. *A First Look at Marine Sediments*
   2. *Exploring the Distribution of the Primary Marine Sediment Types on the Sea Floor*
   3. *Refining Your Hypotheses on Biogenic Sediment Distribution*.

5. **Mining databases takes time, so decide on whether you first want to have high spatial resolution for a small geographic region or have low spatial resolution but global coverage**. Eventually you can expand your geographic coverage/increase your spatial resolution.

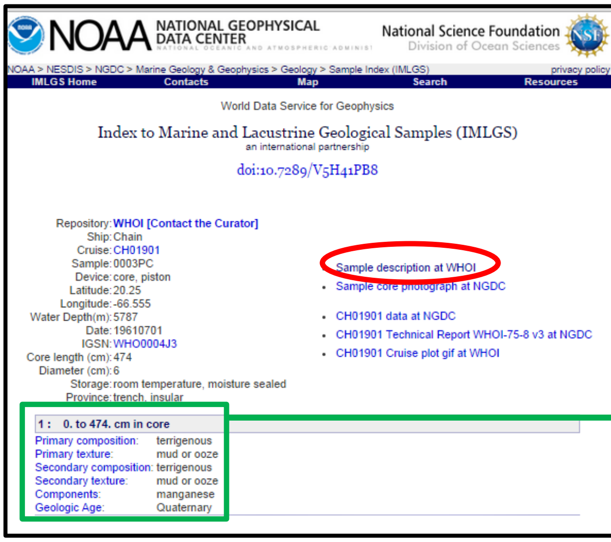
   Example: Because I already was comfortable with the DSDP-ODP-IODP data management system, I decided to start with these, the result being low spatial resolution, but global coverage. Then I focused on adding programs that I was less familiar with, (e.g., WHOI), and at first just regional coverage (e.g., North Atlantic Ocean). To date, this includes ~2000 placemarkers in Google Earth, each color coded based on their primary sediment type, and linked to the IMLGS database and to their original sources. There are >10,000 more sites to be added.

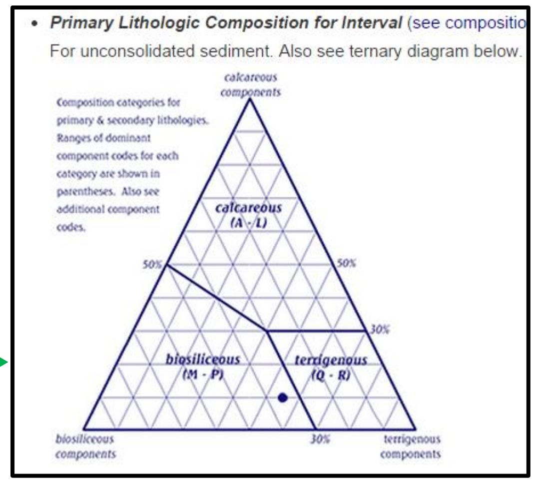


6. **Mining the database for what you really want requires decision-making. What a data search spits out isn't always useful – you may need to dig into the database and go to original sources to ensure you get what you want. By having links already embedded in the placemarker information, it makes it easier (but still time consuming) to get to that original data and make your decisions.**

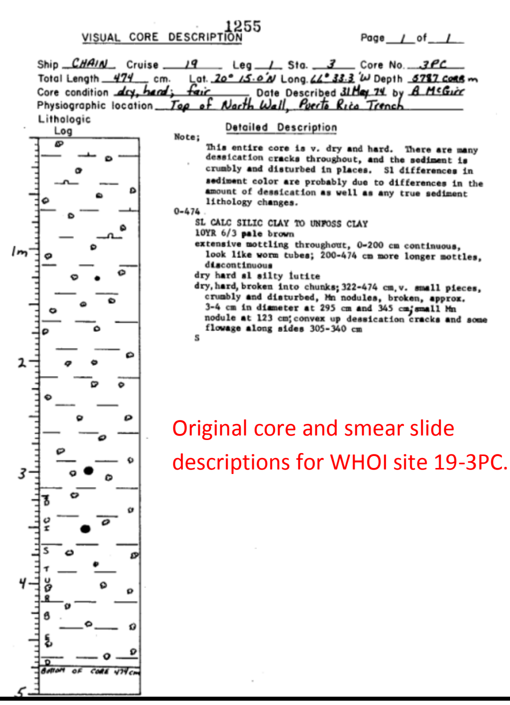
   Example: I wanted to show the distribution of the primary marine sediment types on the sea floor. Some of the WHOI gravity core sites that were included in the KMZ file had no data (other than coring location), so I did not include these in my Google Earth map.

   Example: Other WHOI sites had data on marine sediment types, but the IMLGS database used a slightly different naming protocol than I was using so even though a primary composition was easily accessible via link for the placemarker, I needed to dig-deeper and access the original sample description to give it a more meaningful name, consistent with the protocol I was using.





IMLGS sediment naming protocol
http://www.ngdc.noaa.gov/mgg/curator/curatorcoding.html#comp



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VISUAL CORE DESCRIPTION — Page 1 of 1

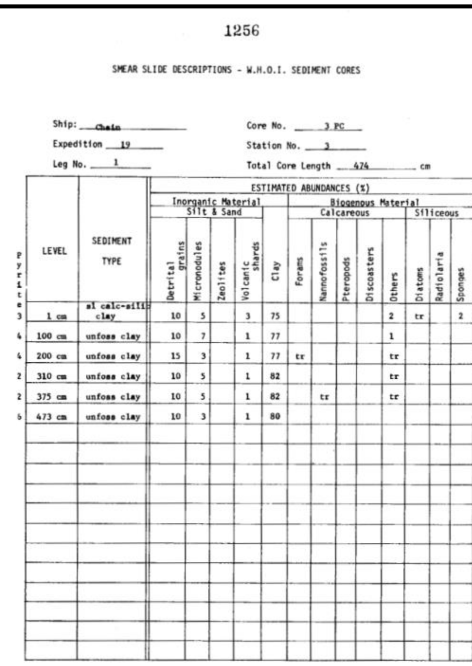
Ship CHAIN Cruise 19 Leg 1 Sta. 3 Core No. 3PC
Total Length 474 cm. Lat. 20° 15.0'N Long. 66° 33.3 'W Depth 5787 corr m
Core condition dry, hard; fair Date Described 31 May 74 by B McGirr
Physiographic location Top of North Wall, Puerto Rico Trench

Lithologic Log

Detailed Description

Note;
This entire core is v. dry and hard. There are many dessication cracks throughout, and the sediment is crumbly and disturbed in places. Sl differences in sediment color are probably due to differences in the amount of dessication as well as any true sediment lithology changes.

0-474
SL CALC SILIC CLAY TO UNFOSS CLAY
10YR 6/3 pale brown
extensive mottling throughout, 0-200 cm continuous, look like worm tubes; 200-474 cm more longer mottles, discontinuous
dry hard sl silty lutite
dry, hard, broken into chunks; 322-474 cm, v. small pieces, crumbly and disturbed, Mn nodules, broken, approx. 3-4 cm in diameter at 295 cm and 345 cm; small Mn nodule at 123 cm; convex up dessication cracks and some flowage along sides 305-340 cm
S



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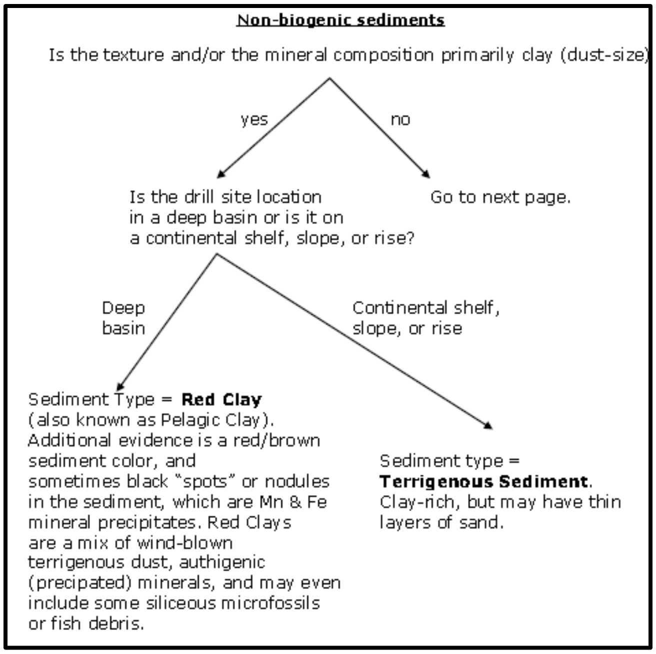
SMEAR SLIDE DESCRIPTIONS - W.H.O.I. SEDIMENT CORES

Ship: Chain — Core No. 3 PC
Expedition 19 — Station No. 3
Leg No. 1 — Total Core Length 474 cm

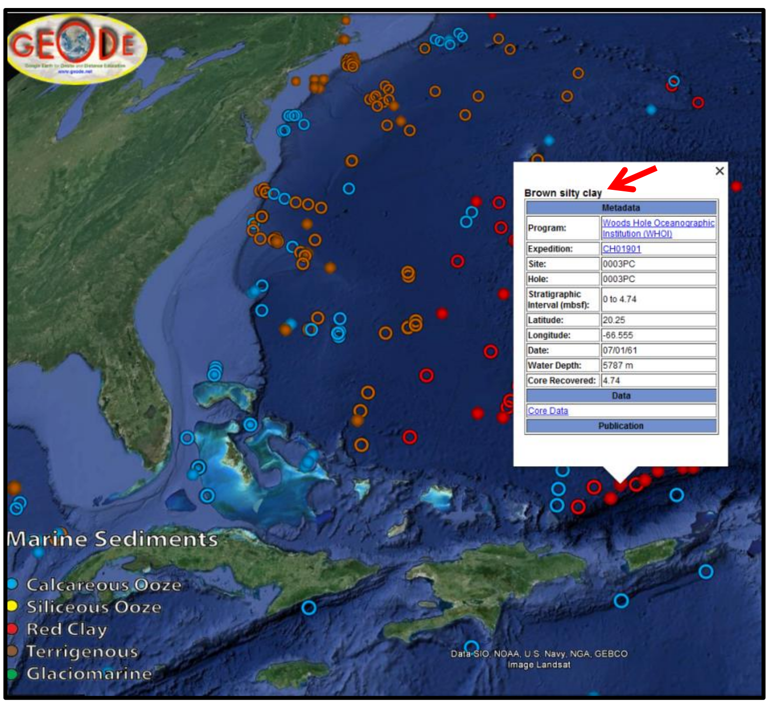
Pyrite	LEVEL	SEDIMENT TYPE	Inorganic Material: Silt & Sand: Detrital grains	Micronodules	Zeolites	Volcanic shards	Clay	Biogenous Material: Calcareous: Forams	Nannofossils	Pteropods	Discoasters	Others	Siliceous: Diatoms	Radiolaria	Sponges
3	1 cm	sl calc-silic clay	10	5		3	75					2	tr		2
4	100 cm	unfoss clay	10	7		1	77					1			
4	200 cm	unfoss clay	15	3		1	77	tr				tr			
2	310 cm	unfoss clay	10	5		1	82					tr			
2	375 cm	unfoss clay	10	5		1	82		tr			tr			
5	473 cm	unfoss clay	10	3		1	80								

(ESTIMATED ABUNDANCES (%))

Original core and smear slide descriptions for WHOI site 19-3PC.



Example of the naming protocol from St. John et al., (2012; see http://serc.carleton.edu/NAGTWorkshops/intro/activities/29154.html). The protocol is based on IODP-ODP-DSDP protocols and on categories of marine sediment in oceanography textbooks). Lithologies are determined using that protocol and the original core description and smear slide data.

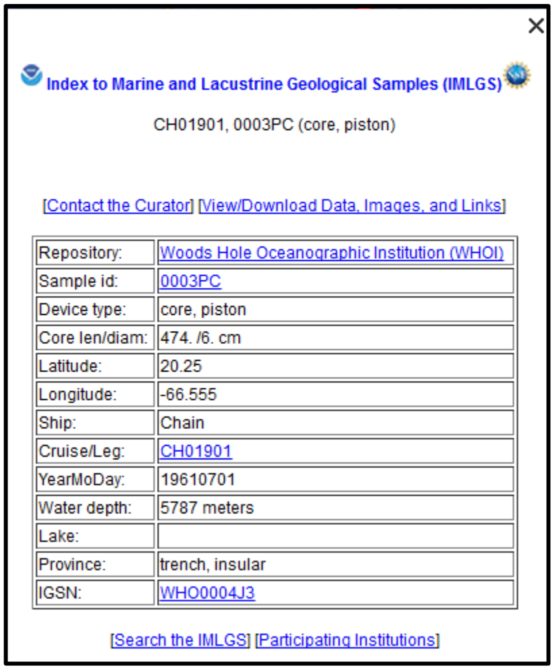


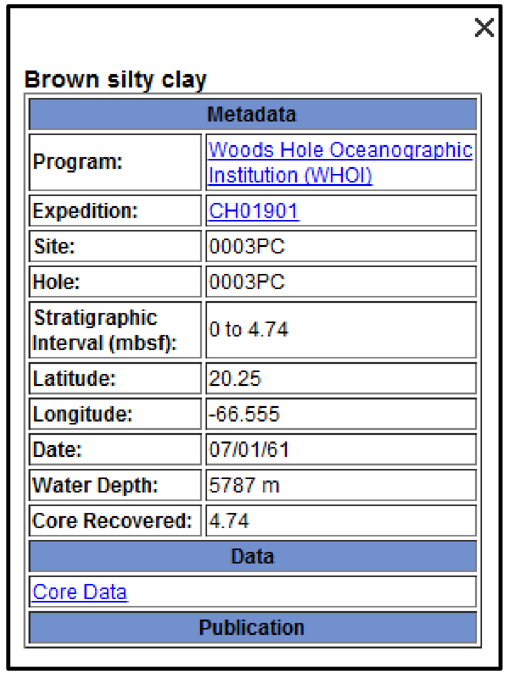
WHOI site 19-3PC **general lithology** (**Red Clay**) and **more descriptive lithology** (**brown silty clay**) using the protocol from St. John et al., (2012).

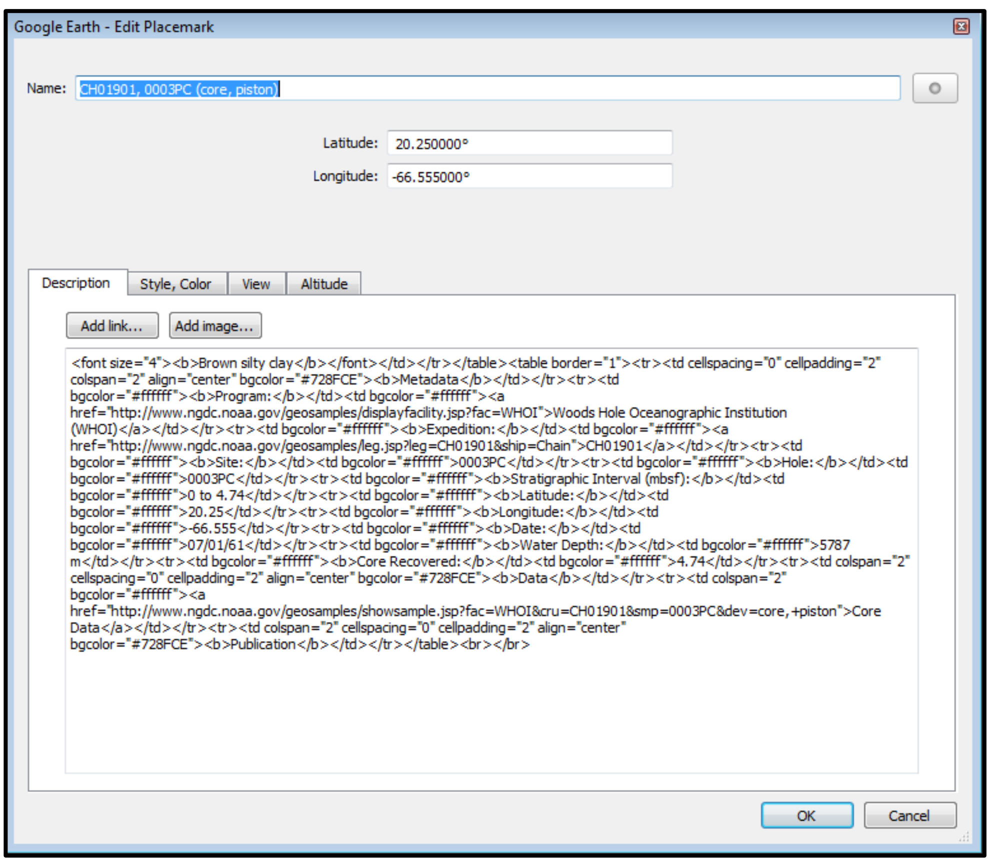
Example: While core length (or total core depth) was easily available for each placemarker, I was more interested in defining stratigraphic interval of the sediment type that is found on the seafloor at each location. In other words, how far down into the cored sedimentary sequence did that particular lithology extend? This was particularly important for the DSDP-ODP-IODP core locations as sometimes the total core length would be >100 m, but depending on sedimentation rates, this may represent a very long period of time, during which the controls on sedimentation at that location could have changed drastically (e.g., consider sedimentation in the North Atlantic during last ice age vs now). To obtain this data I needed to dig-deeper and access the original data and/or publications associated with the coring expeditions.

7. Learn a little about html code and know a programmer.

Example: As I integrated new data from programs other than IODP-ODP-DSDP, the format of the Google Earth placemarker information boxes were no longer consistent. To make the consistent, I needed to modify the placemarker properties, which are in html code. If they were easy changes (e.g., changing field name, changing the color and size of the placemarker), then I would make them myself, if they were harder (needing to change the table format on hundreds of placemarkers at one time), then I asked for help.







<u>Example</u>: I wanted students to be able to pull-up core from the seafloor so they could see what it looks like but also experience in a small way the coring process by controling an animation of the core coming out of the sea floor. Making this happen took programing, but now an online interface exists that does that work behind the scenes. See the document ***"How to Find, Edit, and Posiiton a Core Image to Pull-Up from the Sea Floor in Google Earth"*** for instructions.