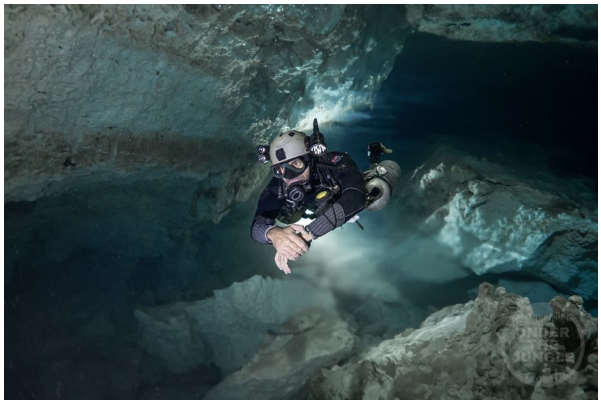
# Under the Jungle - Geo Karst challenge - Sunday Aug 2
# Yucatan sed-strat - and how do rocks control speleogenesis



Nat shares Adam Hanlon's question -- "Can we have a Science post about bedding planes and strata? Why one type of rock gets removed faster than another? Is it to do with flow and rock type or is one factor more important than another?"

A very powerful question - that can be cast as nature-versus-nurture. In geology, the rocks you have set the range of what is possible, but then it is water that may only realize great speleogeneis in some of the rock strata.

**If you have the right kind of rocks…. Then the halocline may be hyper effective at making cave…**

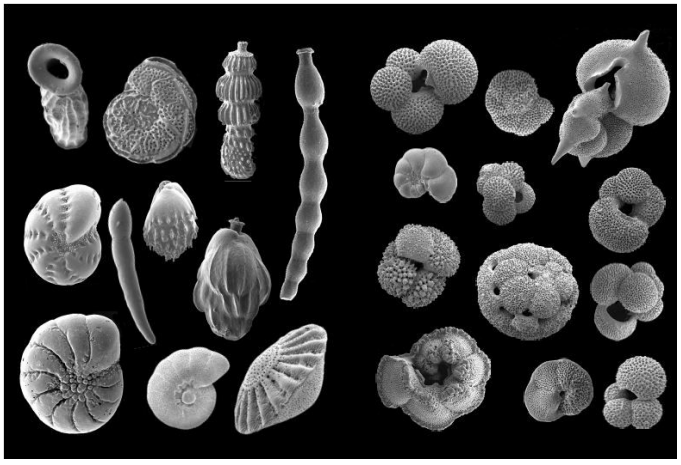
**I suggest that coastal/lagoon/clam-bivalve/reef rock - maybe particularly good at making caves.**

## What is the rock ?

The rock of the Yucatan is pretty much all carbonate limestone - and as the name implies it is mostly "lime" which is fine grained mud. The vast majority of limestone is marine in origin - so the sediment grains and pieces are all chemically and biologically grown in the ocean environment, and then sedimented down in ocean bottoms. We have higher sediment production in shallow marine since there are more nutrients and sunlight, but also more sediment laid down since the tiny pieces can reach the bottom.

In contrast to deep marine, where small carbonate sediments dissolves sometimes completely as they fall through km's of the ocean water column.

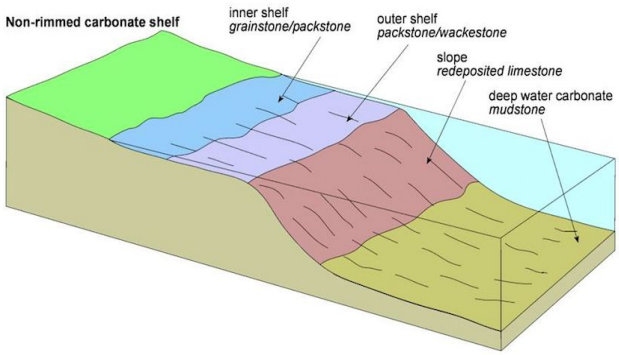
In the shallow marine and reefs - we have abundant forams and diatoms… pretty picture of these amazing calcifying tiny organisms to the right. These are the true heavy lifters of biological formation of carbonate. If you are onthe beach, you can see some of the larger ones with a good eye (or a hand lens).

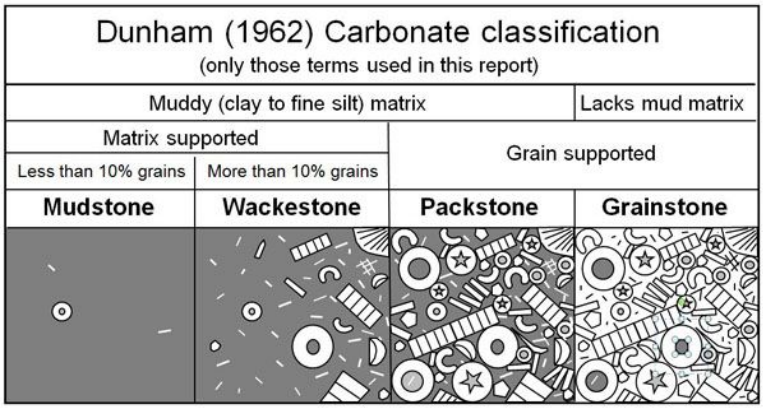


## How do we get layers?

If we start with a platform / coastal ramp, we also see different types of carbonate sediments being deposited on different sections. Some are nearly pure chemical lime mud without any discernible biological grains. Alot of that is in the deeper waters where the critters don't survive, but even the ones that do grow in the shallow water their tiny fragile shells don't survive the trip to the ocean bottom as they get dissolved passing through so much sea water (there is also a chemical gradient in the ocean that really dissolves them).

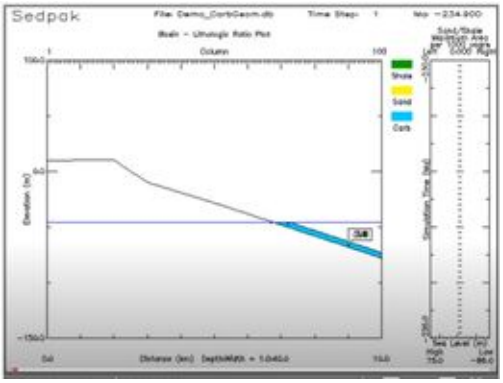
In the shallows, the majority of the sediment may be identifiable (under magnification) biological grains.

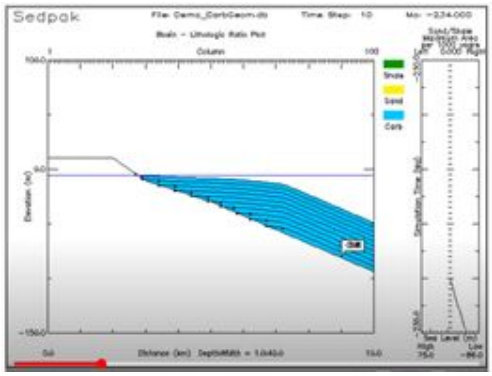


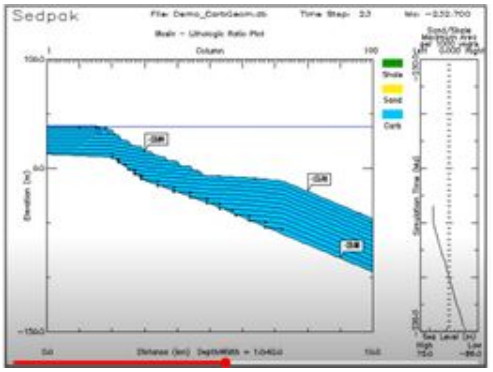




If we start with a ramp - layers of sediments are deposited in sequence and progressive inland as the shoreline moves inland with higher sea level.

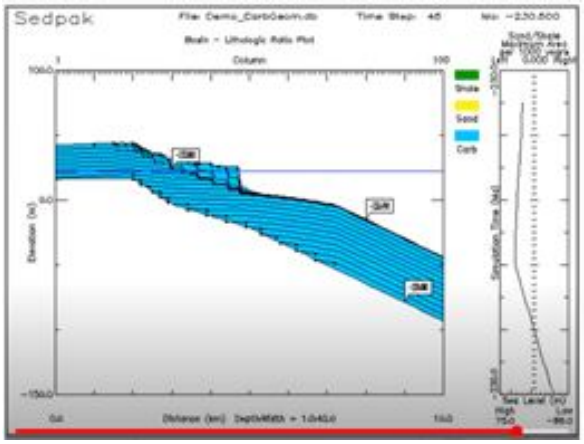
NOTICE THE RIGHT HAND LITTLE SQUIGGLE TRACE - that is showing sea level go up and down and you can see that also with the horizontal sea level line on the figures.



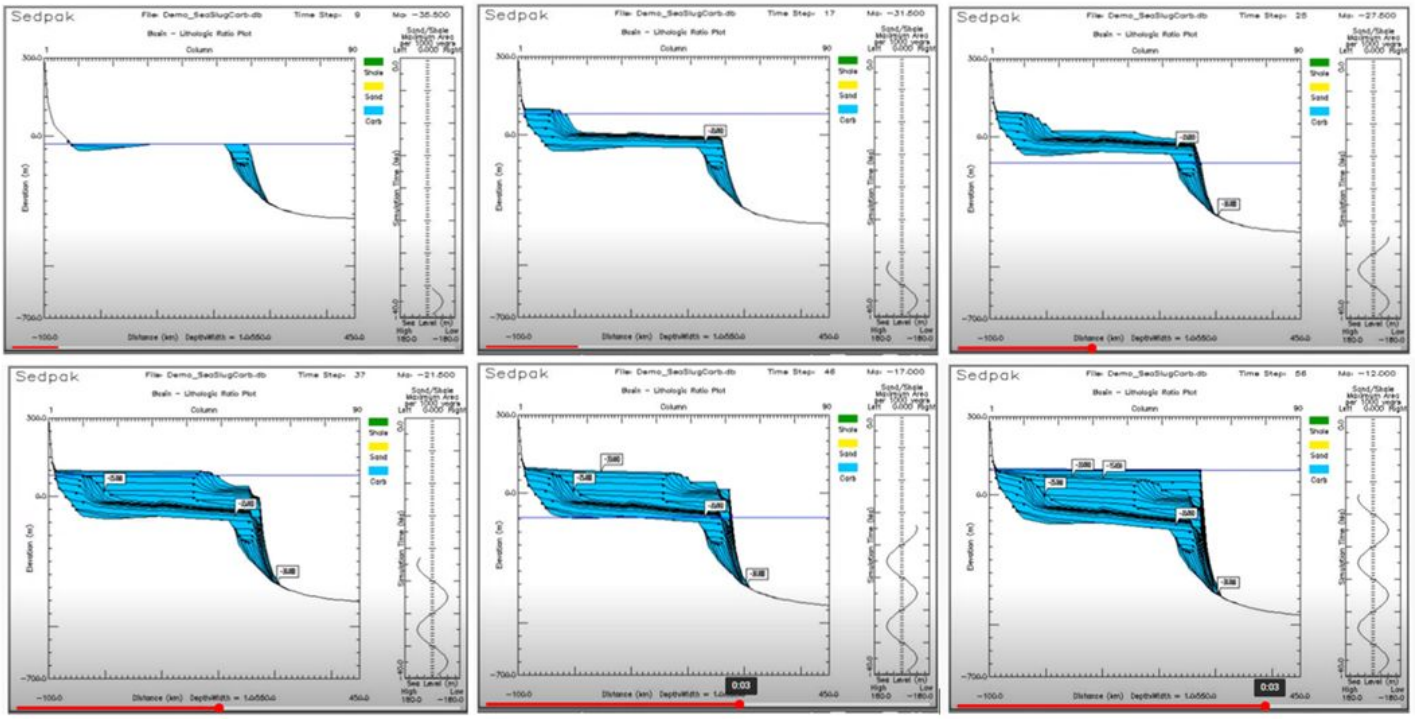




However - the once sea level drops.... Then the new new sediment gets deposited OUTWARDS - and on top of the old sediment



It can become super more complicated if we have more than a simple ramp to start, and if the sea level curve is also complicated.

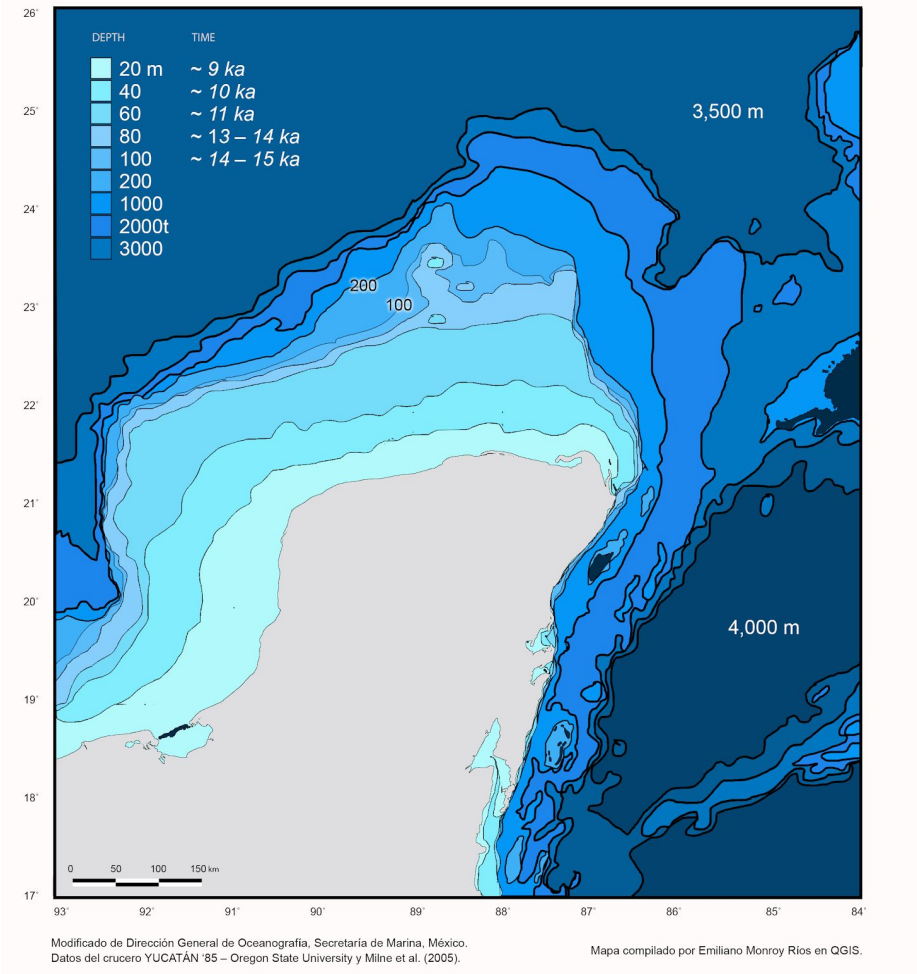
Furthermore, the sediments piling up get heavy - and they compact and compress the sediments underneath pushing them down and making them more dense. Overall - there is gross reduction in porosity with depth.




There is vast carbonate deposition happening today on the Yucatan, but it is mostly offshore on the north coast!!!!

That vast area of the shallow sub-marine carbonate platform is a massive **carbonate factory.**

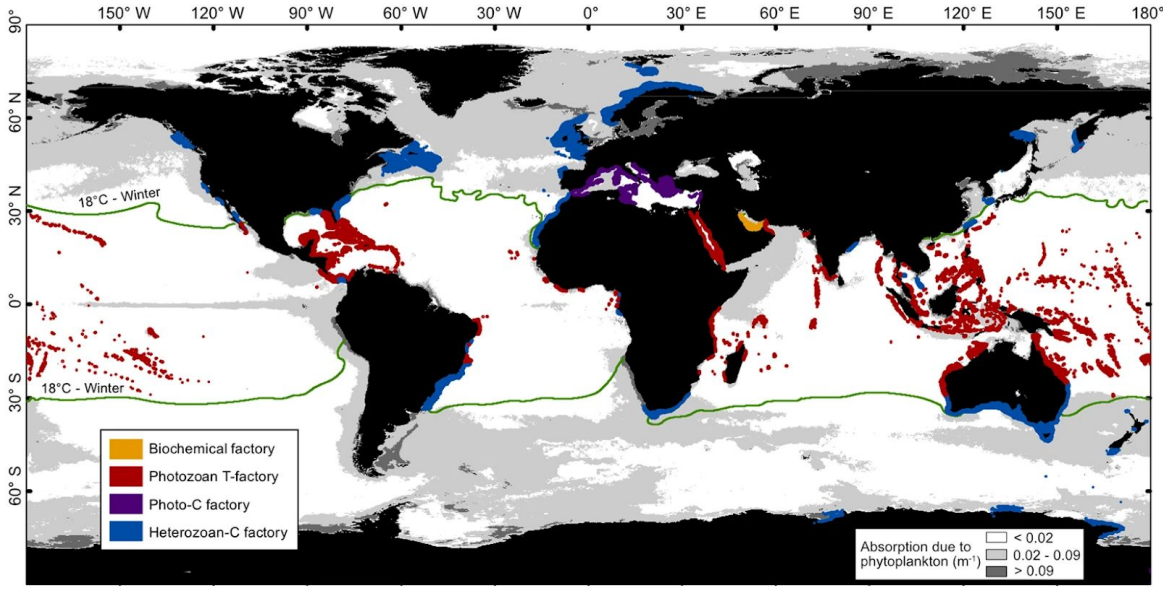
**Endless carbonate mud....**



## Wait - I thought the Yucatan Peninsula was an ancient coral reef?

Nope. The vast majority of the rock is stinking lime mud with pretty, but tiny innumerable micro-organisms. Take a boat 10 km north off the coast of Rio Logartos and dive in the water - that is the **Carbonate Factory**…. I suspect that Tamita will be disappointed…. Mud matters more than hard corals in global carbonate…. Also when we hear about carbonate production on reef complexes, that definition includes the reef foraminifera, invaluable calcifying algae, etc etc - and the hard corals are only one small part of the reef complex. I don't have a good number on what % of glocal carbonate are the massive hard corals, but it is a fraction.

[ see 2019 article - https://www.nature.com/articles/s41598-019-52821-2 - Global distribution of modern shallow-water marine carbonate factories ] Hard coral occurs in only tiny strips of these red carbonate factory regions

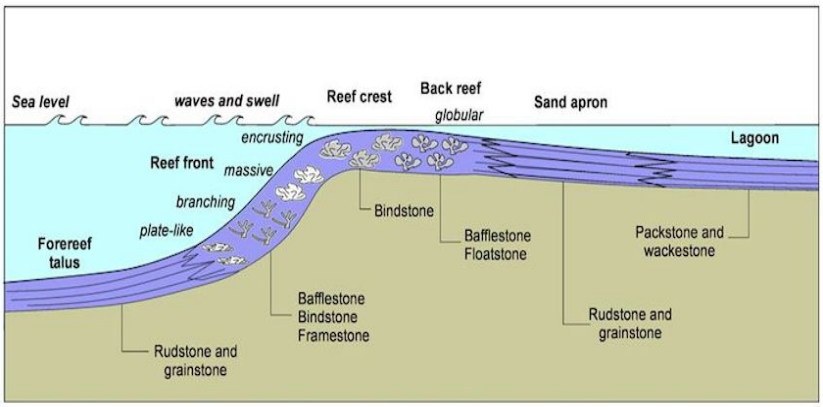



## How come I see so many corals then in the caves of the Riviera Maya then?

**First - it is because it is commonly there, and it is often visually stunning!!!**

Myself or Emiliano might notice a gorgeous massive bedded mudstone / grainstone/ whackestone - but really everyone else is noticing the corals / other fossils.

**Second - the caves in QR cross-cut many paloe reefs!**




The modern hard coral reef grows along the Caribbean coast, and that is where the geological reefs also grew. But overall - it is **an unbelievably thin strip compared to the whole carbonate factory** that is not covered in hard corals. You will also notice bivalves/clams and other notable creatures of the reef complex in the caves - but alot of them are from the lagoon "facies".

**Third - I think that Adam Hanlon nailed it with his question - which is that some rock strata are just really good at forming caves.** I think what we see in QR is that where halocline happens to have worked on lagoon / reef layers - BOOM we have good cave. When I get close to the rock in sites like the one in the picture below, I am seeing coarse sediments and often identifiable reef rubble pieces. Have you noticed the holes in Chicken Ha which looked like a chicken pecked at the rock - those are branching coral fragments. It often not massive coral heads, but it is still reef materials, and that is just more irregular within the strata, higher porosity, and overall much more permeable

There is also likely a chemical aspect as Tamita also asked about. The BIOLOGICAL CARBONATE STARTS AS ARAGONITE - AND ARAGONITE IS MORE SOLUBLE THAN CALCITE. Yes - in general - reef fossils (but also those foraminifera) do tend to erode out faster.


## General comment on Sedimentology and stratigraphy of the Yucatan Peninsula - and where are the caves!!!

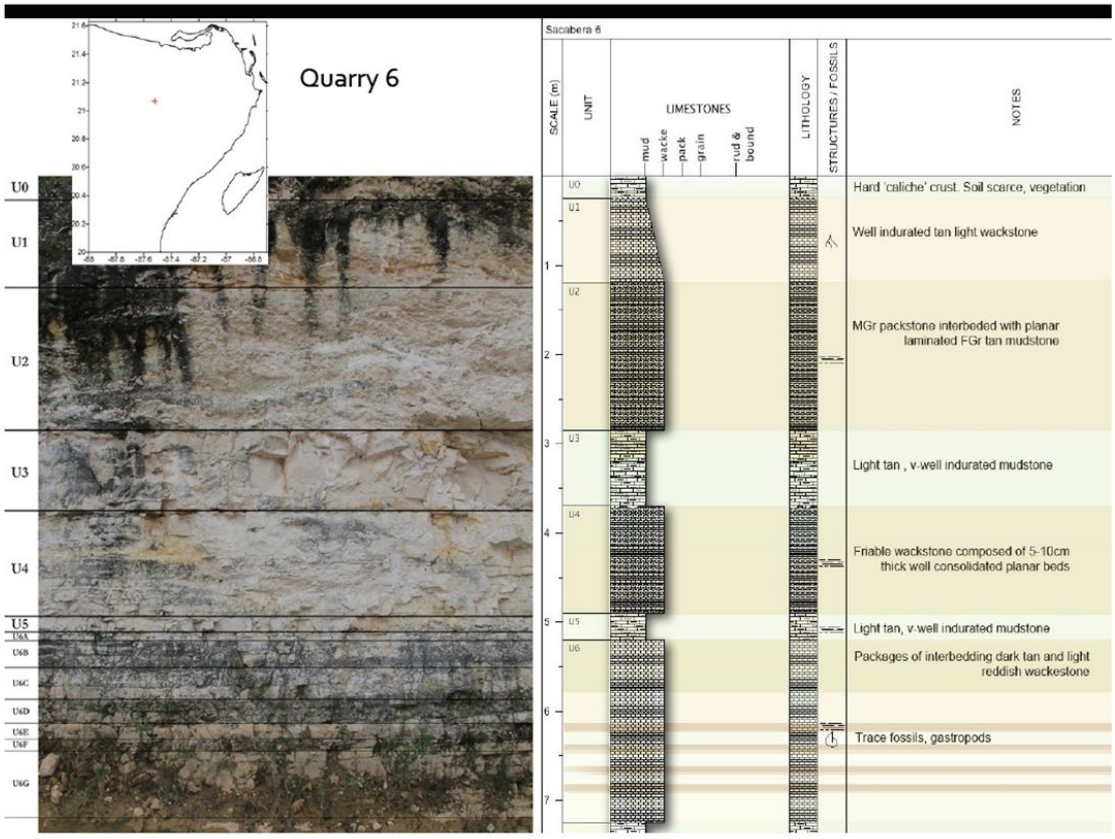
Emiliano Monroy Rios has been working intensively to figure out the sedimentology/ stratigraphy of the peninsula - and he is just barely scratching the surface. The idea was that with enough

sections above the water table in Quarries, and then below the water table in caves - it would be possible to start to see some patterns of what-was-where, and when-how deposition happened.

We do not yet have marker beds that could be used to trace individual strata on a regional basis - right now we don't have enough data to even correlate beds between quarries!!!! This is in part due to the shallow and coastal marine deposits being too patchy. It has proven much harder than we imagined even though the work is showing some super interesting chemical aspects too.

A question I have for you all - those who dive inland caves. We have yet to find massive coral layers (facies) in the inland sites/quarries..... Who has seen massive corals (or any identifiable coral) at 40+ km inland? It is even likely that it is not there - since the whole peninsula was completely under the ocean when those sediments were deposited at depths beyond what coral can grow in.

We have some clam/bivalve strata that say lagoon or shallow platform.... But not corals.




## So - if not much coral inland - does that mean there is no cave?

If it is correct that coastal/reef/lagoon layers just make caves more easily - and the reef runs along the Caribbean coast now - and did so in the past - is that a reason why there is so much more cave in QR???? And does that mean that there is NOT as much cave inland and on the west coast? [ hint - I would argue there must be as much cave inland and west... but there is no reason it has to be as pretty and big as in QR.... maybe a discussion for another Sunday.]

**Shout out - Applications of 3D photogrammetry to wall rock!!!!**

Last August, we had a great adventure with Nat and Adam applying 3D photogrammetry to the wall rock in The Pit to see if this was a good way to extend the geo mapping underwater…..

Check this out!

We may be heading to a new frontier in underwater cave geology….

**http://chei.ucsd.edu/potree/mexico_el_pit/pit.html**

Scroller for moving in and out.

Left Mouse button is tilt and swivel.

Right hand mouse button - slide current view up and down.

http://chei.ucsd.edu/potree/mexico_el_pit/pit.html