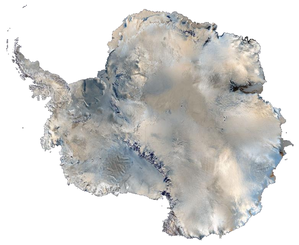

Smear slide analysis to assess variability of ^{210}Pb dates in sediment cores from offshore Thwaites Glacier, Antarctica

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Introduction and Background

What is Thwaites Glacier?

- Thwaites Glacier is part of the West Antarctic Ice Sheet (WAIS), with Thwaites being the widest glacier on Earth at around 80km.
- Thwaites is an area of interest for researchers with one reason being its interaction with a water feature known as the Circumpolar Deepwater Current (CDW) which is a mass of warmer water that melts the ice from underneath. (Fig. 1)

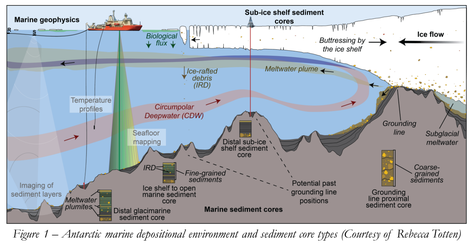
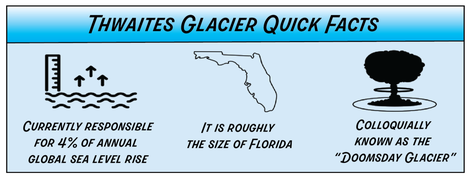


Figure 1 – Antarctic marine depositional environment and sediment core types (Courtesy of Rebecca Totten)

Why research Thwaites?

- There is rapid negative change at Thwaites Glacier driven by the CDW and other environmental factors.
- Determining when the ice sheet lost contact with the sea floor can aid in the creation of predictive models for the future behavior of WAIS and Thwaites.
- Lost ice mass is contributing to global sea-level rise, so the goal is to find out how much and in how long.



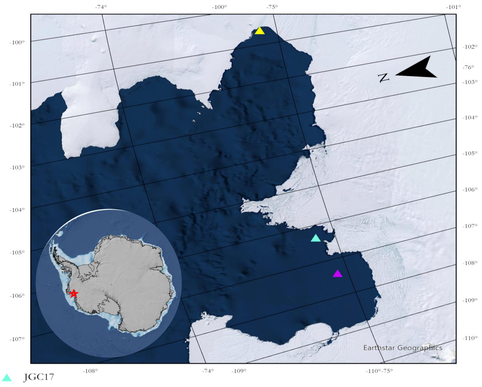


Figure 2 – Map of Thwaites Glacier with relevant core sites labeled and superimposed Thwaites Glacier location above (WGS1984, South Pole Projection)

Why these cores?

- The primary cores, KC08 and JGC17, were chosen due to their proximal position to thwaites in the Amundsen Sea.
- KC08 is from a deep trough – which means… (Fig. 1, 2)
- JGC17 was collected from a seafloor high where researchers believe that Thwaites' grounding line used to contact the sea floor. (Fig. 1, 2)
- MC24 is proximal to Pine Island Glacier? – where looking for tephra (volcanic fragments) in the smear slides will be useful for looking at trace element geochemistry (from mineral phenocrysts) that could potentially be matched to a source near by.
- KC08 and JGC17 both have incomplete 210Pb dating profiles. (Fig. 4)

Methods

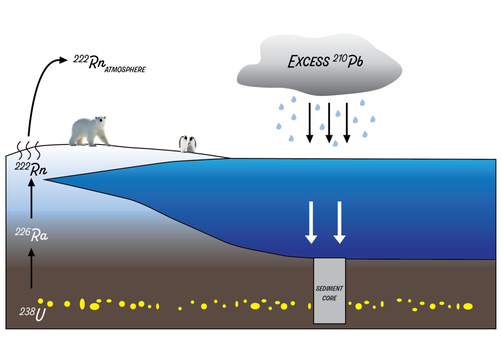


Figure 3 – Shorthand decay to 210Pb in glaciomarine environments.

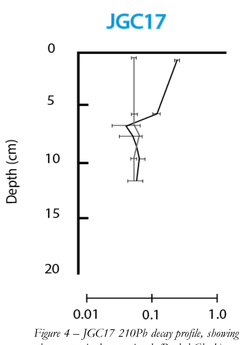


Figure 4 – JGC17 210Pb decay profile, showing abrupt stop in data retrieved. (Rachel Clark)

What is ^{210}Pb dating?

- ^{210}Pb dating is a method that is used to determine sediment accumulation rates in bodies of water like lakes and oceans.
- Typically, the accumulation rate can go back around 100 years and we can extrapolate age data from this, although this data can come back incomplete (Fig. 4).
- ^{210}Pb is an element that is part of the ^{238}U radioactive decay series (Fig. 3).
- All gamma ray spectroscopy analysis is performed in house at the University of Houston.

Smear Slides

- Preparation of the smear slides is crucial – the sediment needs to be laid thin enough so identifications of individual minerals can be made.
- Using a 300-point count method, a scheme to systematically identify minerals was devised (Fig. 6)
- Relying on typical petrographic knowledge can be deceiving as these grains can be larger than 30µm and reflect light differently – so, looking at relief and cleavage is more helpful in some cases, especially with differentiating quartz from lithic fragments. (Fig. 5)
- Looking at the samples through cross polarized light it's easier to see volcanic fragments that appear "black" against the background – whereas when looking at them in plane light the relief may be slightly difficult to distinguish due to the grain sizes.

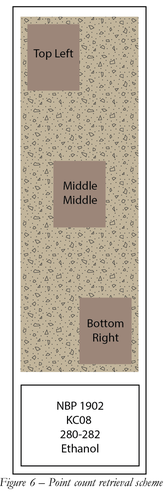


Figure 6 – Point count retrieval scheme

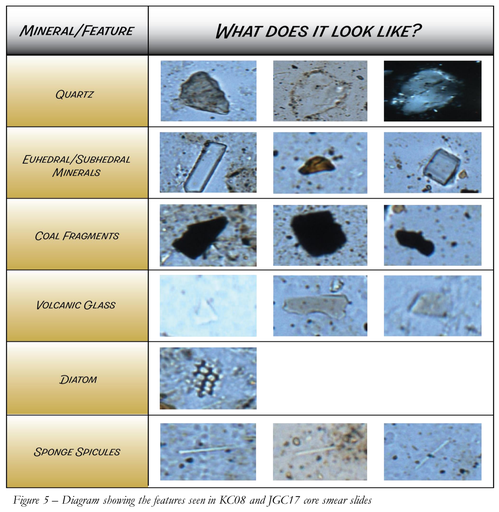


Figure 5 – Diagram showing the features seen in KC08 and JGC17 core smear slides

Results

Results at a Glance…

- Looking at the slides and completing 300-count analyses on them, the overall results point towards typical marine environments relative to the area – with a few exciting features in the mix.
- Overall, both cores observed (JGC17 and KC08, partially) are primarily quartz with variable amounts of lithics and volcanic fragments.
- Neither core was rich in biogenic components, which was surprising – this could be due to error in sample preparation with JGC17 as they were rehydrated and had a fair amount of water on top of the sediment. However, when biogenic components were seen, they were either spicules or dissolved diatoms.
- The high quartz content is not surprising due to its relative robust nature compared to the fragility of other minerals, such as clays like mica's.

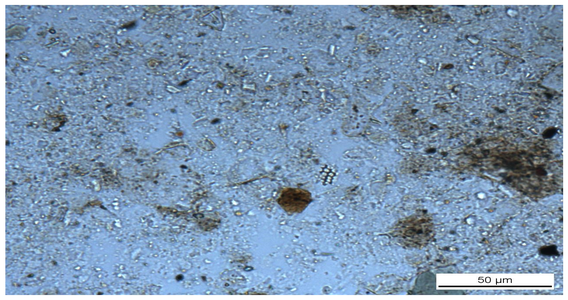


Figure 7 – Smear slide from NBP1902-JGC17 with dissolved diatom, spicules, quartz, and other mineral/lithic fragments

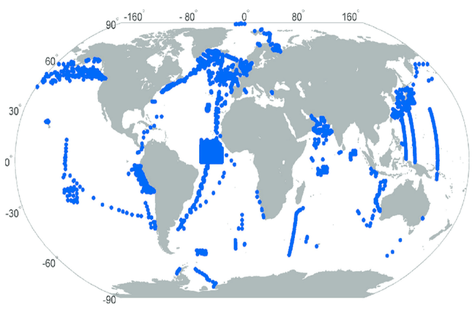


Figure 9 – Distribution of coccolithophores on Earth (Charalampopoulou et al.)

JGC17

- JGC17 had a consistent abundance of quartz down core at around 75%, but at 74-76 cmbsf the abundance was observed to be ~90%. If we can extrapolate why there was a drastic change in the composition, maybe we can determine the environment needed to facilitate this change. (Fig. 8)
- Looking to the CT scan for the core, the 74-76 cmbsf section is particularly gravelly with higher pebble counts. (Fig. xx)
- Dissolved diatom also found in 94-96 cmbsf – diatoms can be radiocarbon dated (Fig. 7)

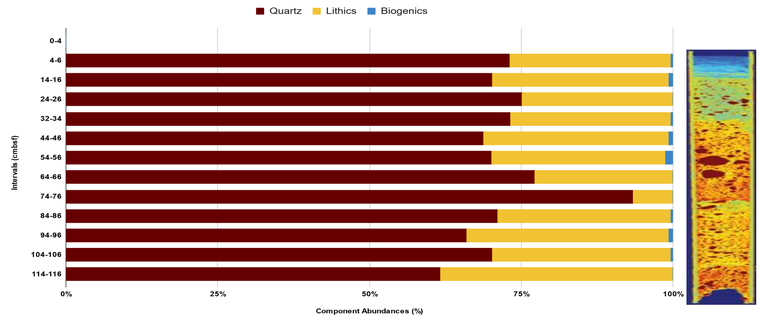


Figure 8 – Chart showing abundances in each core interval alongside CT scan (Rachel Clark) exhibiting the gravel-rich properties of the core.

Coccolithophores found in KC08?

- In the KC08 core, from 280-282 cmbsf, we noticed a feature where there are too many to be a metamorphic mineral, such as staurolite, the other possibility is biogenic coccoliths? (Fig. 10)
- Typically, these calcareous plated marine creatures are found in tropical to sub-tropical environments… though they have been discovered around the Antarctic Peninsula and throughout Drake Passage. (Fig. 9)
- Coccolithophores can be used to date the core by using ^{14}C – but confirmation that these features are indeed biogenic coccoliths is needed.

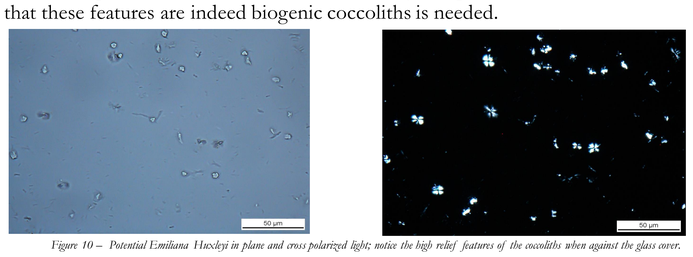


Figure 10 – Potential Emiliana Huxleyi in plane and cross polarized light; notice the high relief features of the coccoliths when against the glass cover.

Conclusions

- Instead of looking to the standard dating method using ^{210}Pb, we can use the presence of biogenic components to date the cores.
- What we understand about the Antarctic and variability in ice mass loss is continually changing.
- Sudden increases in quartz and lithics down core could be substantial data as it relates to a change in the glaciomarine environment.

Future Work

Volcanics

The next step in this research is to complete smear slide analysis for core MC24 to look for tephra from hyaloclastite material that's unique to subglacial volcanic activity and allows for rigorous dating capabilities.

Acknowledgements

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