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Education matters

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The present is the key to the past

It was the father of geology James Hutton who coined this phrase in the 18th century, while working to replace the catastrophism dogma of the day with an understanding of geological processes. This month Heather Tompkins brings us an overview of a spectacular 'key', the *Joides Resolution* deep ocean drilling vessel.

Heather's article crossed my desk at the time I was working as a session convener for the European Geophysical Union conference (scheduled for Vienna, April 2018) where we plan to run a session devoted to cycles of climate change of the Holocene. Ocean deep drilling is one of the essential sources of data for such studies, whereby sediments with a high rate of deposition in ocean trenches are sampled and studied for age and proxy sea-surface temperature data using a range of isotopic and organic molecular structure criteria. Such data is then used to build a time series of temperature change over tens or hundreds of thousands of years. The results have potential importance beyond mere geological history, for an understanding of past climate cycles feeds into our current understanding of climate change and the relative contributions of natural and anthropogenic CO2 forcing factors. Such relationships and their causative factors will keep today's students busy at their desks, and at the benches of vessels such as *Joides Resolution*, for decades to come.

An inspiring hour on *Joides Resolution*

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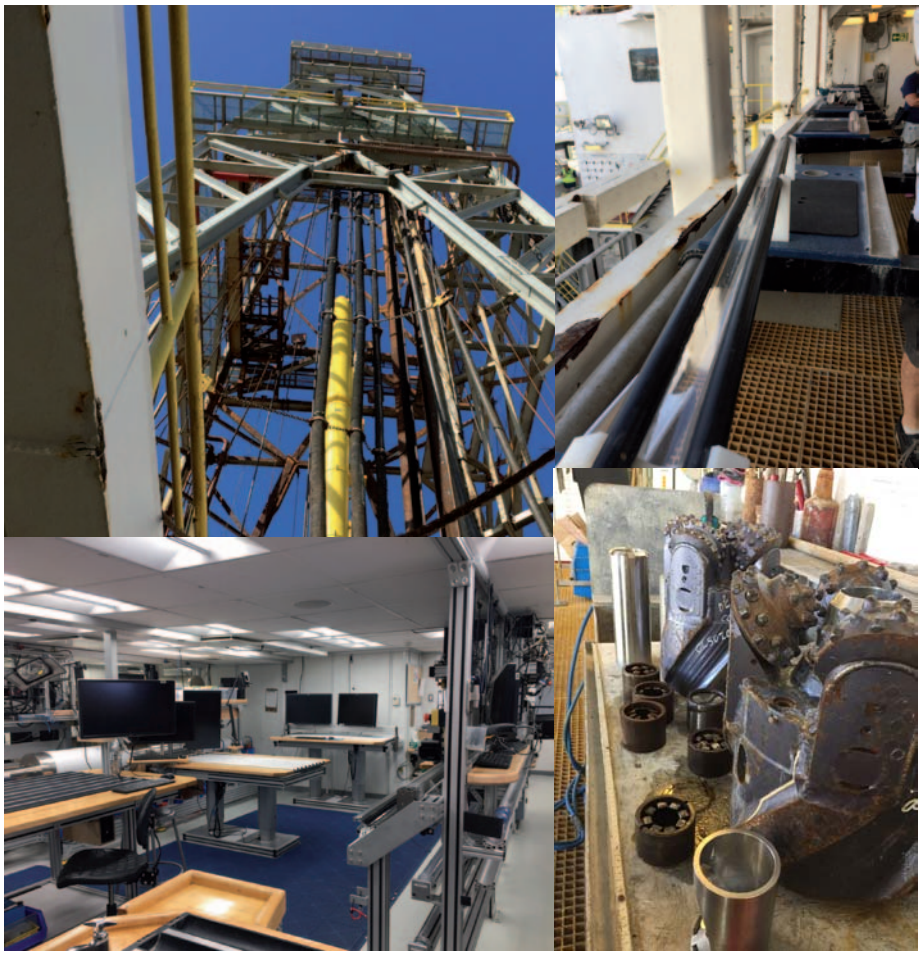
Joides Resolution came alongside Fremantle dockyard on Monday 27 November to resupply and participate in tours with local school children and members of the public. I was lucky enough to attend an hour-long tour on Monday afternoon.

Joides Resolution undergoes research as part of the Integrated Ocean Discovery Program (IODP), which is funded primarily by the United States, Japan, and a consortium of European countries. The vessel began working for the Ocean Drilling Program in 1985 and underwent various refits from 2006 and 2008. The ship is 143 m long and equipped to drill 4 km deep wells in water depths of up to 4 km.

Expedition 369 saw *Joides Resolution* complete studies of the Cretaceous climate and tectonics along the southern margin of Australia in the Bight and Mentelle Basins. The aim of the expedition was to improve the understanding of the Cretaceous hothouse, ocean anoxic events, paleoceanography, and the depositional history of the southern margin during the breakup of Gondwana. A total of 130 crew and scientists were on-board for the Australian expedition with Chief Scientists from Durham University, the Smithsonian Institute, and Texas A&M University.

During the tour we were taken through various workspaces on-board *Joides Resolution* and had the opportunity to speak with scientists from previous expeditions. The tour began near the base of the derrick on the catwalk, where core is carried in 10 m lengths from the drill string to core tables. We observed the various core bits, piston corers, and core catchers used during drilling and selected based on the properties of the substrate. The core is cut down to 1 m sections and stacked on racks inside the vessel to acclimatize before testing in the various lab spaces on-board. The first analysis completed on the core is semi-automated petrophysics including bulk density, magnetic susceptibility, p wave velocity, and natural gamma radiation. From here the core is split in half, one half for sampling and analysis and the other half is archived in one of three core repositories around the world. The core is logged using traditional core description methods by a team of sedimentologists and geologists. Subsequent on-board tests may include porosity, thermal conductivity, P wave velocity, density, scanning photography, colour spectra, magnetic susceptibility, paleomagnetism, and smear slides can be generated for microscope analysis. A world class, refurbished palaeontology lab is used to prepare samples for microscope and scanning electronic microscope (SEM) analysis including the classification of any forams, diatoms, dinoflagellates, or other microfossils within the core. A small section of each 10 m core length is also sent straight to the geochemistry lab to identify the presence of any hydrocarbon indicators. The lab is equipped with –80°C freezers to preserve samples and can complete additional tests such as interstitial pore fluid analysis,

Joides Resolution during expedition 369 in the Southern Ocean, captured from an altitude equal to that of the top of the derrick (63.4 m). Credit: Gabriel Tagliaro and IODP.



Top left: View of derrick from catwalk. Top right: Core tables on catwalk. Bottom left: Core logging and sampling laboratory. Bottom right: Drill and core bits.

gas chromatography, total carbon content, organic and inorganic chemistry analysis, thermal tests to determine porosity and permeability, and microbiology analysis.

The tour ended with a visit to the bridge and a quick discussion on the dynamic positioning capabilities of the vessel. Overall, the tour was very informative and a great opportunity to view a working research vessel. I'm confident that everyone ended the tour with a better appreciation for the information scientists can extract from beneath the ocean floor and how this can help unravel past climates and tectonic history. Walking away from the wharf, I couldn't help but feel an eagerness to submit an application to sail on a future expedition.

For further information check out http://joidesresolution.org/.