Expedition Log for IODP Expedition 347
Baltic Sea Paleoenvironment
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A trip around the drill floor

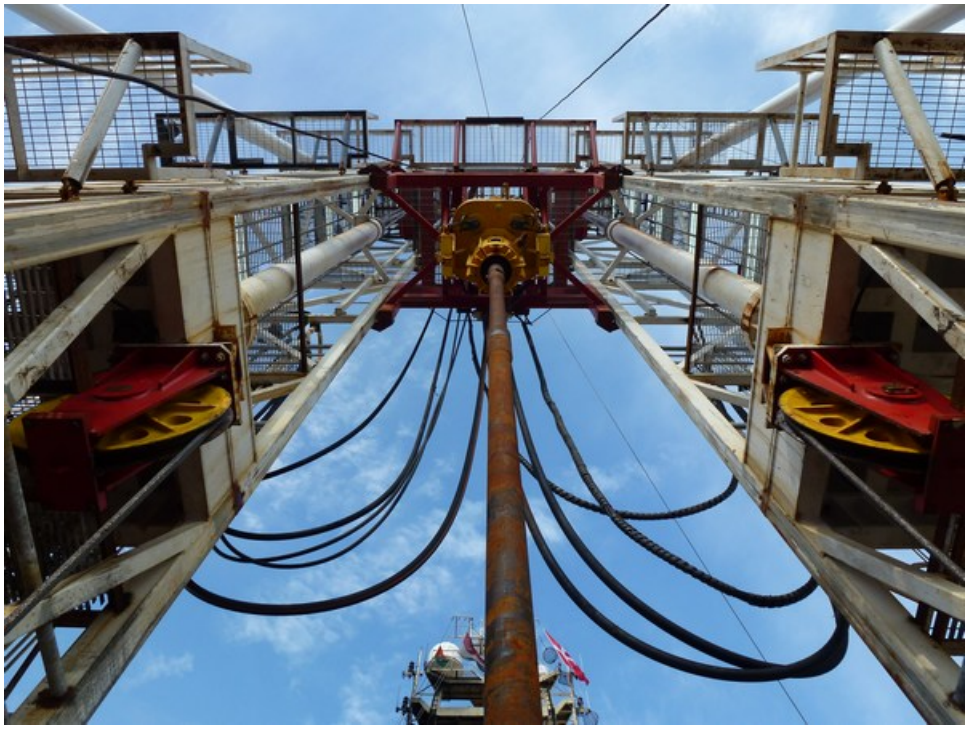
Carol Cotterill

At the stern of the main deck of the Greatship Manisha you enter the weird world of the turquoise "Science Garden". This is where the scientists work in the various containerised labs, analysing many aspects of the sediments and pore water – you will hear more about this over the next few weeks as we encourage them to write about their roles onboard. But always in the background is the constant hum and rattle of the drilling operations…..so how does the core start its journey? Hopefully the following description can act as a virtual tour of the drill floor!

David McInroy©ECORD/IODP: Greatship Manisha, showing the drilling derrick and legs

Carol Cotterill©ECORD/IODP: The Science Garden

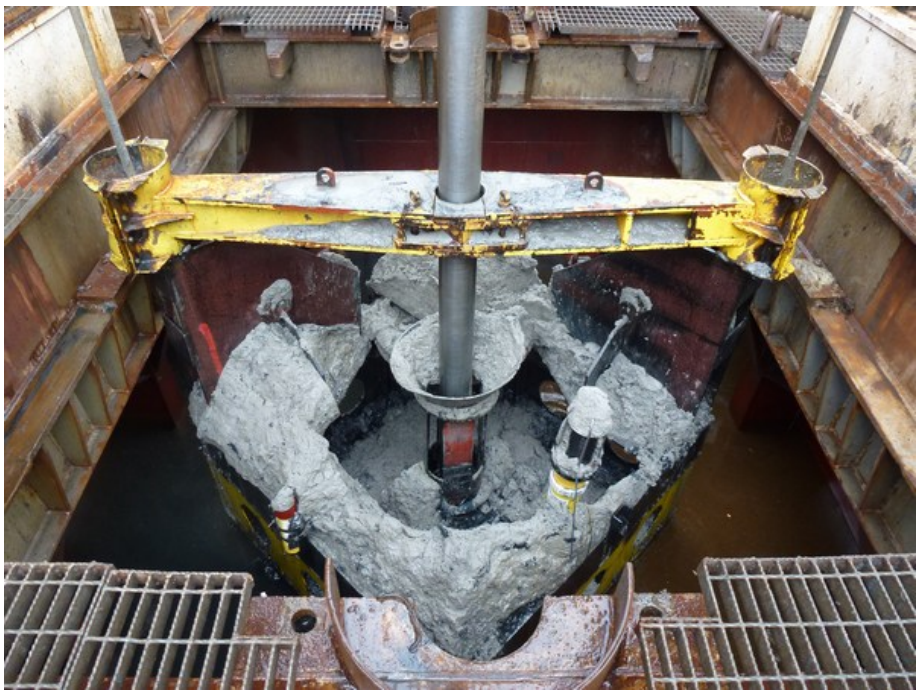
The coring rig is the Geoquip GMTR 120 heave compensated system. The Top drive has a 120 tonne capacity, 0-200 rpm with 23,000ft/lbs of torque and through bore of 4 inches for deployment of in-hole tools (for those technically minded who might be reading this!). This rig has a combined bore hole and water depth capacity of 2,000 metres when using a standard geotechnical drill string of 7" x 4 drill collars and 5.5 inch API (American Petroleum Industry) drill pipe. The Top Drive rotates the drill string, and handles the pipes, mechanically picking up and screwing new pipes onto the string already in the hole. On top of the top drive is the mud valve – it is through this that the various tools get lowered down into the pipe, opening to accept the tools and closing when mud is being pumped down. This is accessed by a roughneck (a member of the drilling crew who is not a driller) located on the rooster box (platform that sits on top of the drill string). The coring rig, top drive and rooster box are surrounded and supported by the load bearing drilling derrick that is anchored to the main vessel structure by four large legs.



Carol Cotterill©ECORD/IODP: Looking up the drill string to the yellow top drive

To help guide the drill string into the hole we use a seabed template, which gets lowered down through the moonpool and onto the seabed at each hole we drill. Attached to this is a guide that keeps the wires, on which the template is hoisted up and down, at the correct distance apart. The template has a transponder beacon attached which provides a back-up location to the ships dynamic positioning system should we lose DGPS signal from satellites. The mass of the template is 12 tonnes – this mass is controlled by a series of hydraulic compensators, which can adjust how much weight

gets transferred to the seabed. The template also has a set of clamps that can hold the drill string providing additional reaction weight for piston coring and a means of drill string active compensation – another means to prevent “swabbing” (causing a reduction in bottom hole pressures as the drill pipe rides up and down the hole), which can cause hole collapse.



Carol Cotterill©ECORD/IODP: Seabed template and guide hanging in the moonpool

Carol Cotterill©ECORD/IODP: Marianne and Liam inside the template fixing the transponder beacon

So what happens if the boat is going up and down with waves or tides – how do we maintain our position down the hole without swabbing the hole? This is achieved through a complex hydraulic Heave Compensation system, which gives us a 4m stroke equating to a heave of 2m in each direction. We can therefore work with swells of up to 2m in height without any effect on our drilling capability. The vessel and drilling derrick effectively ride up and down around the drill string, which is held in one place through a series of compensators. From the deck this looks as if it is the drill string and rooster box moving – but appearances can be deceptive as it is actually us on the boat moving.

Mary Mowat©ECORD/IODP: Rooster box working in the dawn light

A number of different barrels and bits are being used in the expedition due to the range of lithologies encountered – from very soft Gyttja Holocene muds, slightly harder glacial clays to units with lots of boulders and very dense glacial tills that are more similar to concrete than the mud we find in our back gardens!

The basic principle is that we have a drill string with drill collars at the bottom which provide weight and stability to the string. At the bottom of this is a BHA (Bottom Hole Assembly) which has an outer bit attached to it. Through the centre of the drill string we pass an inner barrel that can be used to either drill ahead without collecting core, or with an inner liner and variety of barrels to collect the cores.

Carol Cotterill©ECORD/IODP: Drill string and slip bowl and stack of API pipes waiting to be run.

- 6 cone roller outer bit – can be used with an insert bit to advance through tough formations, or with any of the inner barrel coring bits to collect core.
- PCD (PolyCrystalline Diamond) outer bit – as above.
- Geoset outer bit – as above.
- Piston Corer – this fires the core tube into the sediment ahead of the bit. It is pressurised using drilling fluid, firing when the pressure breaks two pins.
- Extended corer – this rotates with the drill string, but a few centimetres ahead of the main drill bit. This prevents us washing away the sediment we are trying to core.
- Non-rotating core barrel – outer rotates with the drill string whilst the liner and a steel inner maintain position relative to the core. This is used when we are in a hard formation.
- Push sampler – a small section of sample tube is pushed ahead of the bit to assess material when core runs are not successful. Seeing these small samples can inform the drillers on what best approach to continue using.
- Hammer corer – when push sampler gets nothing we hit the sediment with a 100kg hammer blow to a sample tube several times (in sheer frustration)!
- Insert bit – small non coring bit to advance through difficult formations without coring (PCD or tri-cone 3 roller bit).

Different drill bits. Image taken from the Scientific Prospectus.

Carol Cotterill©ECORD/IODP: Outer bit and tri-cone insert bit

Inside the drill string is the inner core barrel, containing an inner plastic liner to collect the core, and fitted with a shoe to aid penetration of the barrel. It can also contain a basket catcher, flapper catcher or dog tooth catcher, which are fitted internally and are used to prevent sediments slipping out of the barrel as it is being raised.

Carol Cotterill©ECORD/IODP:

Various drill bits on drill floor

Dave Smith©ECORD/IODP:

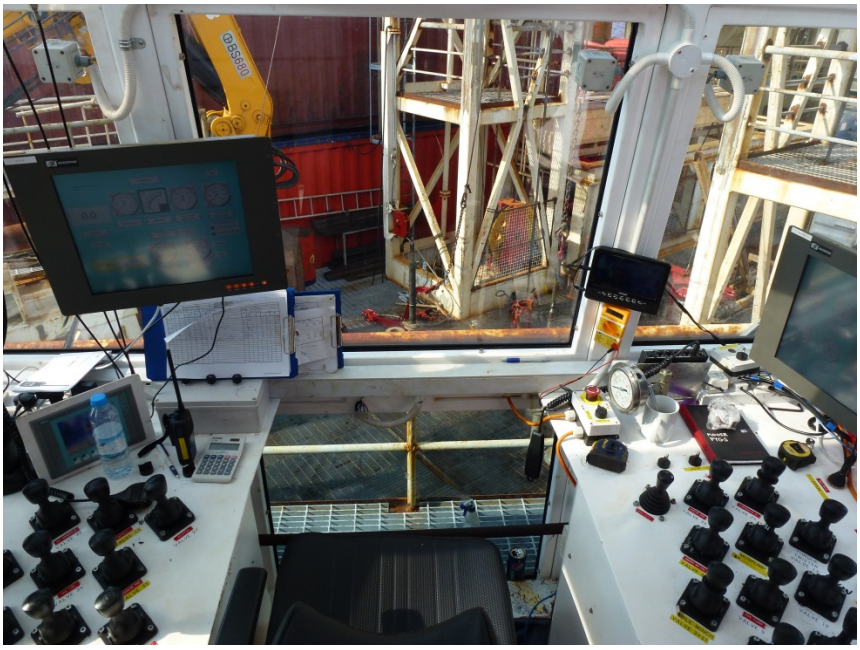
6 cone roller bit and insert bit

We use a combination of drilling fluids to help the coring, depending on the different lithologies and drilling strategy. Our preferred option is to use seawater. However on occasion when we need to stabilise the hole and flush drill cuttings away from the drill bit more effectively we can move to either Guar Gum or GS550. Guar Gum is derived from a ground bean, and is a common constituent in ice cream, chewing gum, toothpaste and shampoo! It is a natural organic and biodegradable substance. However, as a source of food, it can also feed the microbial communities that we are hoping to capture. Therefore, on microbiology holes we will be switching to GS550, when seawater is no longer suitable, which is a synthetic polymer, non-organic and non-hydrocarbon. In order to track any potential contamination by drilling fluid on the microbiology holes, we are using a Perfluorocarbon Tracer (PFT). This is an inert chemical tracer that is microscopic in size. It is injected into the drilling fluid at a known volume and rate. The samples taken from these cores can be tested back in the laboratories for traces of the PFT, and so will help the microbiologists assess any impact on their sample communities from the ingress of drilling fluid.

Carol Cotterill©ECORD/IODP: PFT tracer injection pumps and mud hoses

Other factors to be considered when assessing which drilling fluid to use include changes in hole pressure, often associated with high-pressure artesian water zones or changes in lithology. On this expedition we also have the capability to mix a “kill“ mud which is a very dense mud useful for damping down high pressure, using a combination of salt and guar gum.

The Dog House is the hub of the drilling operation and is described (by the drillers) as the “Palatial accommodation on the drill floor”. It is often where the best biscuit stock is to be found – normally due to Moose – our midnight to midday driller. Entry is by invitation only but bribery by biscuits or Roses chocolates is welcomed and encouraged! The driller on shift sits up here, overlooking the drill floor so that he can see all operations easily. He controls the rate of drilling, mud pressure, torque on the drill string, pushdown and pullback weight on the drill string…..along with numerous other controls that I have yet to figure out myself!



Carol Cotterill©ECORD/IODP: View from the Dog house onto the drill floor

Dave Smith©ECORD/IODP: Sophie, one the EPM's onboard, at the controls in the Dog House

One of the most time consuming jobs when drilling and coring is when the drillers have to trip or round trip the drill pipe. When drilling down, pipe is added or "run". If there is a problem at depth, or a bit needs replacing, the pipe has to be "tripped" and brought back up to the drill floor. A round trip involves bringing it up and then sending it back down again. The deeper the hole gets the longer it takes to trip pipe or retrieve the core barrel after drilling or piston coring a 3.3 m run. As an example, to trip 200 m of pipe from shallow depths can take ~90 minutes if all goes to plan!

Once a core run is completed (one pipe at 3.3 m), an overshot is sent down the barrel. This latches onto the top of the core barrel enabling the barrel to be winched out of the hole, bringing the core back with it, encased in a clear plastic rigid inner liner which sits inside the core barrel during the coring process.

Carol Cotterill©ECORD/IODP: Breaking the pipe to add another run and tripping out a core barrel

Once on deck the liner containing the core is removed from inside the core barrel, and gets taken straight to a bench for the core curators to work on it. They cut the core into 1.5 m sections, capping each end – the top of each section with a blue cap and the bottom with a white cap. The core then begins its journey from the drill floor into the Science Garden and through the containers.....

Carol Cotterill©ECORD/IODP: The core gets curated on the drill floor