

**Report from Anders McCarthy, PhD student at University of Lausanne
Core describer and igneous petrologist on IODP Drilling Vessel Joides Resolution**



Early-morning breakfast on Exp. 351, image courtesy of Alex Bandini. From left to right: Ivan Savov, Marco Maffione, Anders McCarthy, Sebastien Meffre.

Expedition 351: Where? When?.....

Expedition 351 took place in June-July 2014 in the Philippine sea, South-west of Japan... during typhoon season of course. Exp. 351 was part of a series of three IODP expeditions that targeted the intraoceanic Izu-Bonin-Mariana Arc (IBM) during the spring and summer 2014. The Exp. 351 drill site (Site U1438) is located on the Philippine Sea Plate in the Amami Sankaku Basin, a preserved section of oceanic crust surrounded by Mesozoic remnant arcs (Daito Ridge group) and the Amami plateau.

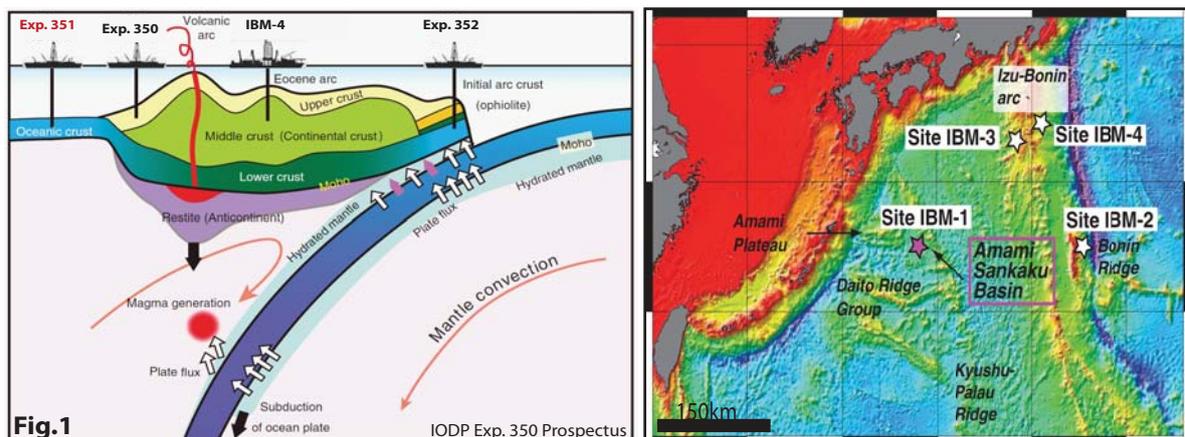


Figure 1: geological illustration and map of the drilling locations of the three expeditions (Exp. 350-351-352) that took place during spring and summer 2014. (images modified from IODP Exp. 350 and 351 prospectus)

...and Why?

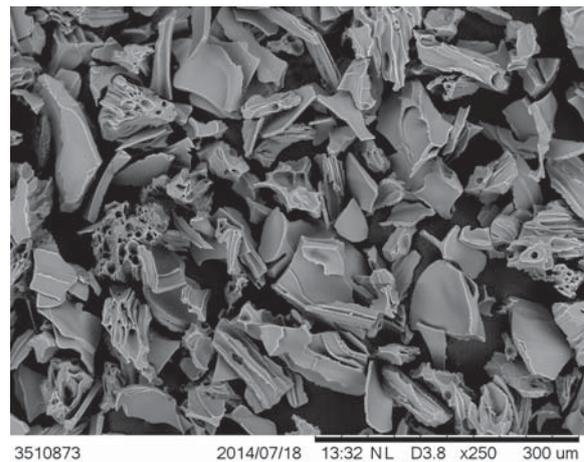
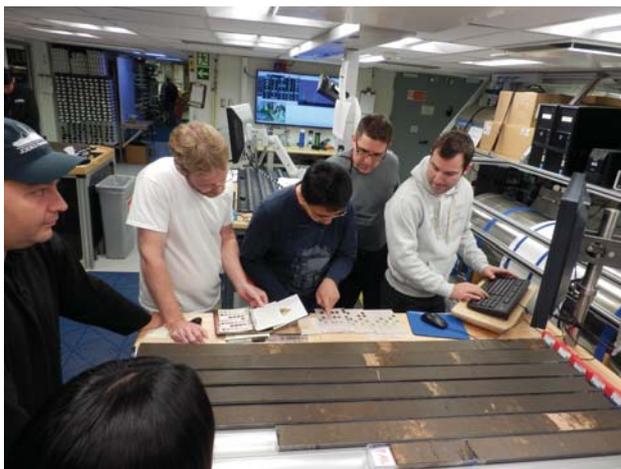
Subduction initiation and volcanic arc inception are fundamental processes which remain poorly constrained and which have been identified as Challenge 11 of the 2013-2023 International Ocean Discovery Program science plan. Specifically, the initiation of a subduction zone, the cycle of volatiles and the generation of continental crust remain poorly understood. These three expeditions (Exp. 350-351-352) all aimed to drill different locations of this intraoceanic IBM volcanic arc to help constrain how volcanic arcs spatially evolve through time. Expedition 351 specifically aimed at drilling a remnant part of the preexisting oceanic crust preserved to the west of the active IBM arc.

We left Yokohama in the early morning on the 4th of June aboard the JR (not knowing we were heading directly into heavy seas, high winds and strong currents) with the aim of drilling ~1.3 km of oceanic sediments and the underlying oceanic crust in order to resolve three main goals:

- a) The age and geochemistry of the crust and mantle prior to the beginning of the IBM subduction
- b) The sedimentary sequence directly overlying the oceanic crust to understand the process of subduction initiation. Specifically, do intraoceanic subductions initiate in a compressional or extensional regime, i.e. was the subduction initiation spontaneous or induced.
- c) Study the compositional evolution of the volcanic arc through the sampling of the volcanoclastic deposits originating from the Kyushu-Palau Ridge, the remnant part of the IBM arc which was active between 50-25 Ma.

Two months at sea

As an igneous petrologist and core describer, I was part of a team of diverse geologists who had to describe the drilled cores as they came up on deck. After having agreed on the nomenclature to be used, we set forth to describe core halves, section after section, core after core, of (mainly) sedimentary deposits by specifically describing the types of sedimentary structures found, the presence of fossils, of volcanic input (e.g. variably thick ash beds, presence of igneous minerals, volcanic glass) the alteration and color of the deposits (lots of greyish-greens and greenish-grays) and their mineralogy, with the help of smear slides, thin sections and... a brand new SEM (which produced amazing images of volcanic glass shards). We were greatly helped by paleontologists who determined the fossil species and age of these sediments and X-ray diffraction-team in helping us analyze specific samples to determine their mineralogy, especially in more altered samples.



Left: Core describers describing a new core (mud with light colored ash layers). From left to right: Ivan Savov (Sedimentologist, University of Leeds, UK), Andy Barth (Igneous Petrologist, Indiana University–Purdue University, USA), Fuqing Jiang (Sedimentologist, Institute of Oceanology, Chinese Academy of Sciences, China), Frank J. Tepley III (Igneous Petrologist, College of Earth, Ocean and Atmospheric Sciences, USA) and Philipp Brandl (Igneous Petrologist, ANU College of Physical and Mathematical Sciences, Australia) Picture courtesy of Anders McCarthy. Right: SEM image of volcanic glass shards and pumice.

In the Eye of the Raccoon dog

Every new core on deck is an event, with scientists constantly waiting for the next “batch” of sediments/rocks to be brought on board to see whether a new sedimentary unit or a new lithology has been drilled. Will we continue finding well preserved ash beds? Will we finally hit the igneous crust? Will we finally sample less altered siltstones? Will we find some radiolaria?

As we were slowly drilling through the sedimentary sequence, the excitement started to rise at the thought of (finally) reaching the igneous basement, when, slowly but surely, a small tropical depression started to form to the south of us. Unfortunately, our drill site was to be right in the

path of the then formed Super Typhoon Neoguri, or Raccoon dog (much less frightening in English). So, obviously, we removed the drill string and rapidly moved east to wait out the storm. Though, since expedition reports had to be written, figures made, core descriptions looked over and corrected, there wasn't much waiting involved. After moving back to the drill site a few days later we were able to drill further down and reach the main goal of our expedition: sampling the sedimentary sequence overlying the igneous basement and the igneous basement itself!

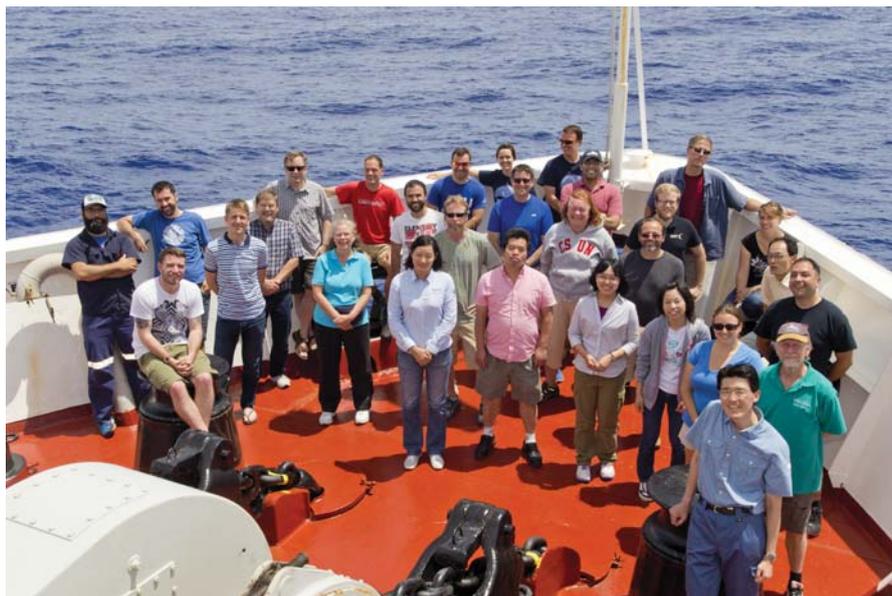
A "Tuff" life on board



But an IODP expedition is not summed up by “just” our core description work. It is also about meeting and interacting with so many people from such diverse backgrounds! We would now and then stop by the ice-cream machine (some more than others) during our daily “cookie break(s)“, enjoy a coffee (or two) together, have a nice meal in the sunshine during one of our Sunday BBQs, or breakfast on deck looking at the sunrise (though admittedly it wasn't always that sunny), or watch one of the many soccer games during the World Cup. The IODP staff made sure everything went smoothly, even organizing a sports competition between the day-shift and night-shift (ahh, the famous egg-race).

Paleomagnetist Marco Maffione (Institute of Earth Sciences, Utrecht University, The Netherlands) handedly leading his competitor during the egg-race, with paleontologist Alex Bandini (Paleontologist, University of Western Australia, Australia) cheering him on. (picture courtesy of our Co-chief Richard Arculus).

We managed to successfully sample the whole sequence of sedimentary rocks and igneous basement, fulfilling the three main goals Expedition 351 set out to achieve. This success, combined with the wonderful atmosphere between shipboard scientists, education- and IODP staff as well as the drill crew lead to the filming of the IODP Flash mob “Happy” song (*which can be viewed on Youtube*), a fitting ending to a wonderful 2 months at sea.



Expedition 351 science party, courtesy of imaging specialist Bill Crawford, IODP/TAMU.