IODP Expedition 366: Mariana Convergent Margin and South Chamorro Seamount

9th December 2016 to 7th February 2017

Philip Eickenbusch (Department of Environmental Systems Science, ETH Zurich)

Expedition background

In the Mariana subduction system, the Pacific Plate subducts the Mariana Plate, which leads to the formation of the Mariana trench. During subduction, the Pacific Plate is altered under different temperatures and pressures, which increase with distance from the trench axis, and therefore subduction depth, of the subducting Pacific Plate (Figure 1). These alterations lead to dehydration of rocks. The released water rises up through conduits into the Mariana Plate where serpentinization of the Mariana Plate mantle rocks in the Décollement zone occurs. This leads to an expansion and density decrease of the Mariana Plate mantle rocks which get carried towards the seafloor where mud volcanos are formed. These mud volcanos each have a distinct fluid chemistry depending on the formation conditions and geochemical processes during rise of fluids. Carbon compounds like methane and formate form abiotically and provide a possible source of organic carbon and energy to microbes potentially present in these serpentinized muds.

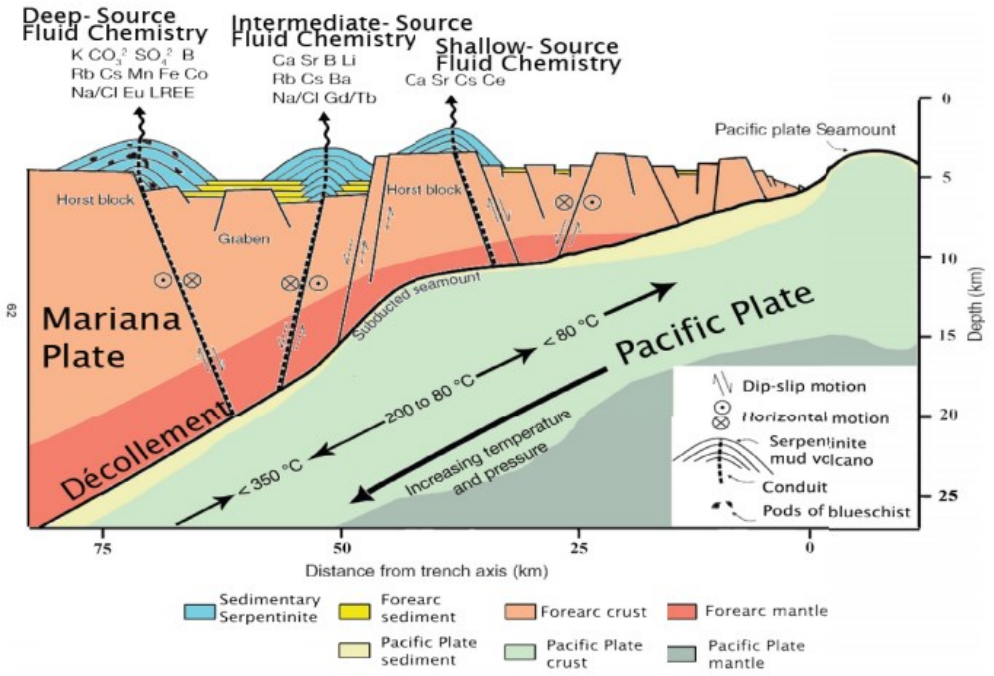

Figure 1: Schematic cross section of serpentinite mud volcano formation in the Mariana forearc. Extensive faulting resulting from regional tectonics creates conduits, particularly where faults intersect, and permits slab-derived fluids and serpentinized fault gouge of forearc mantle to rise, eventually reaching the seafloor. Fluid chemistry varies with the depth to the décollement. (Fryer, Wheat, & Williams, 2016, modified from Hulme et al., 2010).

We sampled flank and summit sites of three of these mud volcanos as windows to the otherwise inaccessible Décollement zone. Goals were to: *a)* examine processes of mass transport and geochemical cycling within the forearc of a non-accretionary convergent margin;

b) ascertain the special variability of slab related fluids within the forearc; *c)* study the metamorphic and tectonic history of the system; *d)* investigate the physical properties of the subduction zone in relation to dehydration reactions and seismicity; *e)* document the microbial activity associated with subduction zone material; and *f)* explore linkages between subduction related processes and historical context in the Mariana Convergent Margin.

Expedition summary

During two month at sea on the famous JOIDES Resolution, we recovered unique samples of high pH blue muds (figure 2 left). As part of the microbiology team, I was one of the first people to get my hands on the cores to quickly process and store samples for later analyses. Each core was somewhat different in lithology, color, or amount of clasts. During the expedition, I was in charge of contamination control using a chemical inert tracer which is mixed into the drill fluid. All cores were checked for recovery of this tracer. Recovery means drill fluid contamination what would make samples not usable for microbiological analyses.

Figure 2: Examples of successful (left) and unsuccessful (right) coring operations. The mud volcanoes showed to be a difficult matrix to core. The mix of soft but sticky mud and hard clasts and bigger rocks made progress difficult.

I retrieved personal samples for molecular analyses, short-chain organic acid analyses, dissolved organic carbon analyses and incubations back in the Environmental Microbiology laboratories at ETH Zurich. Apart from science, we had multiple highlights on the ship: Sighting of (presumably) minke whales hunting close to the ship, Christmas on the ocean with performances of Jingle Bells in various languages, Scottish Burns night with haggis and bagpipe music and two New Year's celebrations (Western and Chinese) in the middle of the Pacific Ocean.

Conclusion

I am tremendously happy that I got the chance to sail on the JOIDES Resolution. The two month at sea in company of various experts in fields like Geology or Geochemistry was an incredible experience teaching me a lot. Additionally it gave me the chance to retrieve unique samples of incredible scientific value. Obviously all that is only possible by all the extraordinary effort everyone involved puts into an expedition. This starts with shore-based pre-expedition organization, continues with the excellent people on board providing scientists with food, drilling expertise, technical support, and guidance in ship-life.

I would like to thank everyone involved in one or the other way for making this expedition a success. I would also like to thank IODP, ECORD and SwissDrilling for giving me the opportunity to sail and grow scientifically and personally.

Figure 3: IODP Expedition 366 Science Party captured wearing rose tinted unicorn glasses. Everyone needs a pair at one point or the other during an expedition..

References

Fryer, P., Wheat, C. G., & Williams, T. (2016). Expedition 366 Scientific Prospectus: Mariana Serpentine Mud Volcanism [Press release]