Sulfide differentiation and enrichment in metals at the lower oceanic crust and crust-mantle transition zone: ICDP OmanDP holes

Abstract for the general public

Precious metals such as gold, silver, or copper will always be in the spotlight of industry and individual consumers. These metals belong to the group of chalcophile elements chemically affined to sulfur. The on-shore sulfide reserves are intensively exploited and plummet quickly. That's why marine sulfide deposits draw more and more attention. Developing technology gradually enables machines to work under high water pressure on the ocean floor. There are now several private companies aiming at the underwater resource exploitation. Major countries compete to buy exploration licenses in various parts of all the three oceans. Up to 2017 only India, China, South Korea, France, Russia, and Germany were able to search for sulfides in the oceans. In 2018, International Seabed Authority granted the seventh license to Poland. First Polish scientific expedition to search for sulfides are planned in early 2020s. Understanding metal migration through the oceanic lithosphere can therefore open up a broader scientific perspective during the first stages of this exploration.

To minimize economic and ecological costs of future exploitation, we need to understand processes behind the formation of marine deposits. Although the sulfide deposits occur on the ocean floor, metals migrate to the surface from deeper portions of the lithosphere. Sulfide deposits seem to be especially large where linked to a lower crustal or upper mantle source. Deep ocean drilling would could elucidate the link between ocean floor deposits and their major source in the deep lithosphere. However, due to the high costs of oceanic expeditions, drilling to a depth of typical lower oceanic crust (<2 km) and mantle (<7 km) is yet impossible. Alternatively, these can be accessed on land via so called ophiolites. Ophiolite are remnants of the ancient oceanic lithosphere tectonically emplaced onto continental margins. In the northern part of the world's largest ophiolites in Oman, crust-mantle transition zone is often rich in igneous sulfides. In 2016-2018, the Semail ophiolite in Oman was drilled in the frame of International Continental Scientific Drilling Program (ICDP) Oman Drilling Project (OmanDP). The project has received multimillion funding from across the globe including the Unites States' National Aeronautics and Space Administration (NASA), the U.S. National Science Foundation (NSF), the Japan Society for the Promotion of Science (JSPS), and the European Research Council (ERC). Over two drilling seasons, the comprehensive drilling program has sampled the Semail Ophiolite sequence from the upper mantle to the lowest upper crust with a total cumulative drilled length of >5 km.

In Poland, we will focus on metal migration between the mantle and ocean floor and its role on the subsequent ore-forming processes by investigating a set of representative 120 samples from four ~400-m-long holes drilled through the lower oceanic crust and crust-mantle transition zone. We will combine traditional (optical microscopy) and the most modern techniques, such as Sensitive High Resolution Ion MicroProbe (SHRIMP) and femtosecond laser ablation – inductively coupled plasma mass spectrometry (fs LA-ICPMS). Fs-LA-ICPMS can determine the isotopic composition of important metals such as copper, nickel or iron, and measure the concentrations of even very rare metals such as gold or tellurium with a resolution down to five microns. The fruition of this project will allow us to identify key magmatic processes causing rock enrichment in sulfides, and determine their role in shaping the global distribution of seafloor massive sulfides (SMSs). This is particularly important in the context of the planned Polish research expeditions to search for SMSs along the northern Mid-Atlantic Ridge (26-33°N).