Migration of chalcophile metals through the lower oceanic crust: Insights from IODP Hole U1473A

Popular science summary

Precious metals such as copper, gold or silver will always be in the spotlight of industry and individual consumers. These metals belong to the group of chalcophile elements, which are chemically affined to sulfur. The on-shore sulfide deposits are intensively exploited and the metal reserves plummet quickly. That's why marine sulfide deposits draw more and more attention. The oceans cover most of the Earth, and the developing technology enables machines to work deep on the ocean floor under high water pressure. There are now several private companies aiming at the underwater resource exploitation, and major countries compete to buy exploration licenses in various parts of all the three oceans.

To minimize economic and ecological costs of future exploitation, we need to understand processes behind the formation of marine deposits. Scientists observed a spatial relationship of marine sulfide deposits to the lower crust and upper mantle's exposures on the ocean floor. Nearly 200 of such exposures have been discovered to date. Due to the high costs of oceanic expeditions, few lower crust's exposures could have been thoroughly investigated. Careful investigation of these sites is however important. Although the sulfide deposits occur on the ocean floor, metals migrate to the surface from deeper portions of the lithosphere. Deep ocean drilling is thus the best way to understand these processes.

Only three deep boreholes have been drilled into the lower crust so far: the first between 1989 and 1997, the second in 2004/2005, and the third in 2015/2016. I took part in the third drilling realized during *International Ocean Discovery Program Expedition 360*. The borehole is located at the Atlantis Bank on the Indian Ocean 1000 km south from Mauritius. Atlantis Bank was probably an island in Miocene and now is 700 m below sea level. A total of 30 scientist took part in the expedition representing 13 countries (USA, Japan, China, Germany, France, Italy, Great Britain, Netherlands, Poland, India, South Korea, Brazil, Australia). Within two months, we managed to drill 800 m through the lower crust. I collected 100 rock samples to investigate the migration of chalcophile metals and sulfur.

In this project, I will use a combination of traditional techniques, such as optical microscopy, with the most modern and sophisticated techniques such as femtosecond laser ablation – inductively coupled plasma mass spectrometry (fs LA-ICPMS). Thanks to fs LA-ICPMS we can determine the isotopic composition of important metals such as copper or iron, and measure the concentrations of even very rare metals such as gold or tellurium. The laser beam enables determination of chemical or isotopic composition of a given mineral in a field of only five micrometers in diameter. The fruition of this project will help us to better understand the processes forming sulfide deposits on the ocean floor.