Marcel Regelous, Erlangen
Karsten M. Haase, Erlangen

Investigating the relationship between flood basalt volcanism, climate change and mass extinction using novel proxies for volcanism in marine sediments (MagmaTrace)

Four of the largest mass extinctions of the Phanerozoic (end Guadalupian, Permian-Triassic, end Triassic, and end Cretaceous) as well as several second-order extinction episodes, occurred simultaneously with continental flood basalt events. It is widely accepted that massive volcanism causes environmental change, often including rapid and significant global warming and marine anoxia, which may trigger mass extinctions. However, the exact nature of the climate altering gases (CO_2, SO_2, CH_4, halogens), as well as their source (degassing of magma, metamorphosed crustal sediments, recycled crustal material in the mantle) remain unclear. These questions could be addressed by determining the relative duration and timing of flood basalt volcanism and environmental and biological change. However, these processes act over timescales of <106 years, and possibly 104-105 years (comparable to current rates of anthropogenic greenhouse gas release), and thus outside the temporal resolution of radiometric dating techniques. We will develop new trace element proxies for volcanism in sediments, allowing us to determine the relative timing of volcanism, climate warming and extinction from analysis of sedimentary sections. Volatile trace elements present at high concentrations in volcanic gases, as determined by direct measurements of volcanic gas and volcanic sublimates at active volcanoes, include Hg, Tl, In, Pb, Bi, Cd, Te, Se, Sn, Cs, Sb and As. During volcanism, these elements are released into the atmosphere and later incorporated into sediments. Their relative concentration in sediments then represents a proxy for the intensity of volcanic activity. To date, only Hg has been explored as a proxy for volcanism, but concentrations of Hg are also affected by the organic content of sediments, and other elements have not been studied in detail before. We will measure volatile volcanogenic trace elements in sediments spanning the Changhsingian-Induan (Permo-Triassic) and Pliensbachian-Toarcian boundaries, in order to link the paleoclimate and fossil records in those sediments with the timing of Siberian and Karoo flood basalt magmatism, potentially at a resolution of better than 10,000 years. These results will reveal the timescales over which flood basalt volcanism affects climate and life, and the origin and nature of gases responsible for environmental change.