The hot springs associated with volcanic activity (e.g. Yellowstone, USA) are characterised with high acidity (pH 0-4) and moderately high temperatures (40-56°C). These extreme environments are rich in sulphur compounds and high concentrations of heavy metals, e.g., cadmium, nickel, mercury, iron and arsenic. Amazingly, life thrives in these hostile environments due to the presence of red microalgae of the *Cyanidiales* order. These photosynthetic organisms have attracted attention of many scientists thanks to their remarkable metabolic pathways and robust enzymes of unparalleled activities. For many years *Cyanidiales* have been the subject of research and development activities in the Solar Fuels Lab at CeNT UW, whereby the red algal highly robust and active solar-converting nanomachines (photosystems) provided an excellent biological material for construction of solar-to-fuel devices. As *Cyanidiales* thrive in the presence of heavy metals at concentrations that normally inhibit all forms of life, it is an attractive biotechnological concept to use these extremophiles for bioremediation of heavy metal polluted environments. Surprisingly, despite a plethora of evidence pointing towards tolerance of *Cyanidiales* to elevated levels of heavy metals, little is known about the precise molecular mechanisms underlying the heavy metal defense strategies at the cellular level or the effects of heavy metals on the structure and function of the photosynthetic apparatus that drives metabolic energy production in these fascinating ‘living fossils’.

To this end, we have embarked on an ambitious and highly interdisciplinary research programme that aims at unravelling the molecular components and metabolic pathways underlying heavy metal tolerance in extremophilic red microalgae associated with volcanic activity. We will apply a plethora of biophysical, biochemical, and ecotoxicological approaches to dissect the molecular mechanisms of heavy metal tolerance in two model species of *Cyanidiales*, *C. merolae* and *G. sulphuraria*, which in the near future is anticipated to allow to use these extremophilic microalgae for bioremediation of anthropogenically polluted environments.