Metal-Aid project

In Europe, large efforts have been made to minimise the release of harmful substances into the environment and to reduce the environmental impact generated by the industrial production. However, this is not enough! The pollution of soil and groundwater is an issue which never ceases to be very serious and relevant.

According to a statistic provided by the European Soil Data Centre of the European Commission in 2011-2012, in Europe there are more than two million of potentially contaminated sites. So far, only a tiny percentage of these have been remediated. The conventional remediation methods (i.e. excavating soil, pumping contaminated groundwater and treating) used to clean-up polluted sites are often disruptive and partially successful. Innovative and new strategies are therefore strongly required.

In 2016, Arcadis joined together with other four consulting firms, six universities and a government agency, the Metal-Aid project: "*Metal oxide aided subsurface remediation: from invention to injection*" (for more information about the project, please follow this link http://nanogeoscience.dk/metalaid/). This project is a Marie Sklødowska Curie Innovative Training Network, which is funded by the European Horizon 2020 research and innovative programme. Metal-Aid is aimed at the development of an innovative approach and new reactants for the decontamination of sites polluted by heavy metals and chlorinated solvents. The project addresses the training of 14 young researchers (each one is based at one of the involved hosts), who will be working with the support of several experts in natural materials, contaminant reactivity and environment policy.

At Arcadis in Karlsruhe, we host the doctoral student Flavia Digiacomo. She studied Geosciences in Italy and started working on the project in October 2016. Flavia said she was delighted to be joining this project. "I have always been keen in environmental issues and fascinated by the increasingly widespread technologies aimed to solve them. I am very pleased to have had this chance, this is for me my first big opportunity to contribute to the environmental cause," she commented.

Each one of the 14 young researchers works in a specific field in order to identify and design the most promising novel reactants that will be tested in the pilot site in Skowlunde Byvej (Denmark). The studied reactants are: layered double hydroxides (LDHs) and green rusts (GRs). They are naturally occurring minerals, which, thanks to their mineral structure, are able to adsorb or reduce contaminants such as chromate, nitrate and chlorinated compounds.

Flavia focuses on the study of the reactivity and the transport behaviour of the GR particles as they are injected into the soil. To aim her tasks, she performs her laboratory experiments at KIT (Karlsruhe Institute of Technology) and runs the experiments under anoxic conditions (GR minerals are very sensitive to oxygen) by using a glovebox. A glovebox is an isolated enclosure that is designed to maintain an inert atmosphere. Using this apparatus, Flavia can manipulate the chemicals and the reactants in Oxygen-free conditions (fig.1).

Our doctoral student took the first months in designing and optimising the column reactors and the experimental set-up which she uses for her reactivity experiments (fig.2). Her focus lies on the study of the GR sulphate (green rust mineral which contains sulphate anions) and its potential application for the remediation of hexavalent chromium (Cr(VI)) from aqueous solutions. It is known that this reactant is effective in the reduction of Cr(VI), but nothing is known about how this process proceeds within porous matrices such as soils and sediments. Studying the interactions between GR and Cr(VI) within a porous matrix as well as assessing their fate, is critical to apply such a technique in the field. The obtained results showed that the inlet Cr(VI) concentration affects the capacity of the green rust particles in the reduction process of chromium.

In the last weeks, Flavia started performing transport experiments to answer questions such as: are these particles injectable into porous substrates? How does the flow rate affect particles distribution? Will the particles be attached to the grains or will they be rinsed after water perfusion? To do that, she is investigating what happens during the injection of the particles into the sand. That is possible thanks to the non-destructive magnetic resonance imaging (MRI) technique. MRI is well-known and frequently used technique in medicine, but only recently it has shown its “geological” potential to characterize porous media and to elucidate transport mechanisms of very small particles.

Next summer, Flavia will be visiting the laboratories of the University of Copenhagen, where she will have the opportunity to work side by side with some other young researchers of the project. There, they will share their knowledge and expertise to help each other and to achieve the Metal-Aid´s objectives.

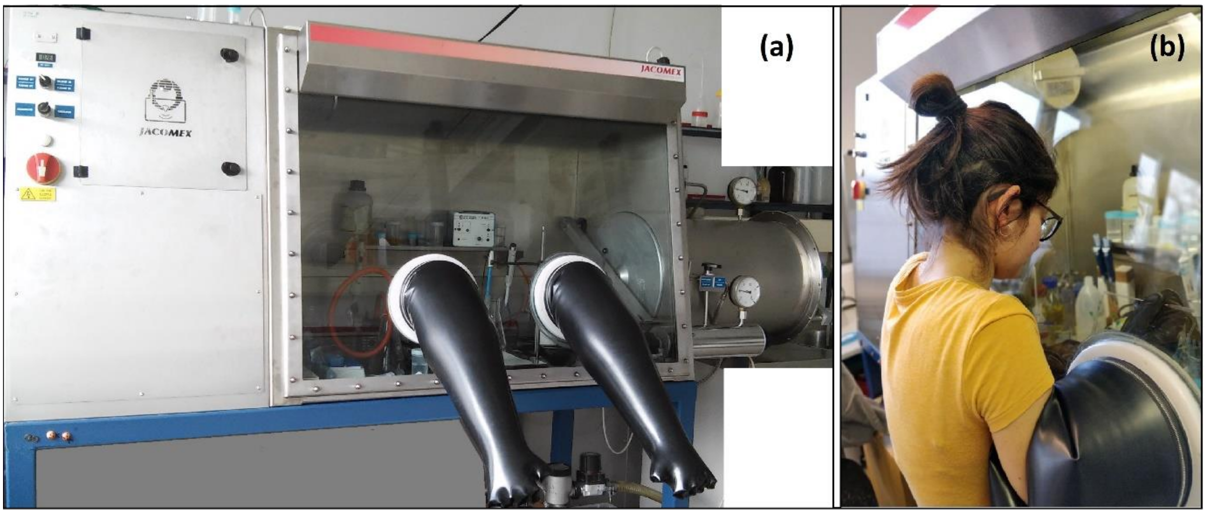

Fig.1 (a) The glovebox for the experiments in Oxygen-free atmosphere, (b) Flavia during one of her experiments under anoxic conditions.

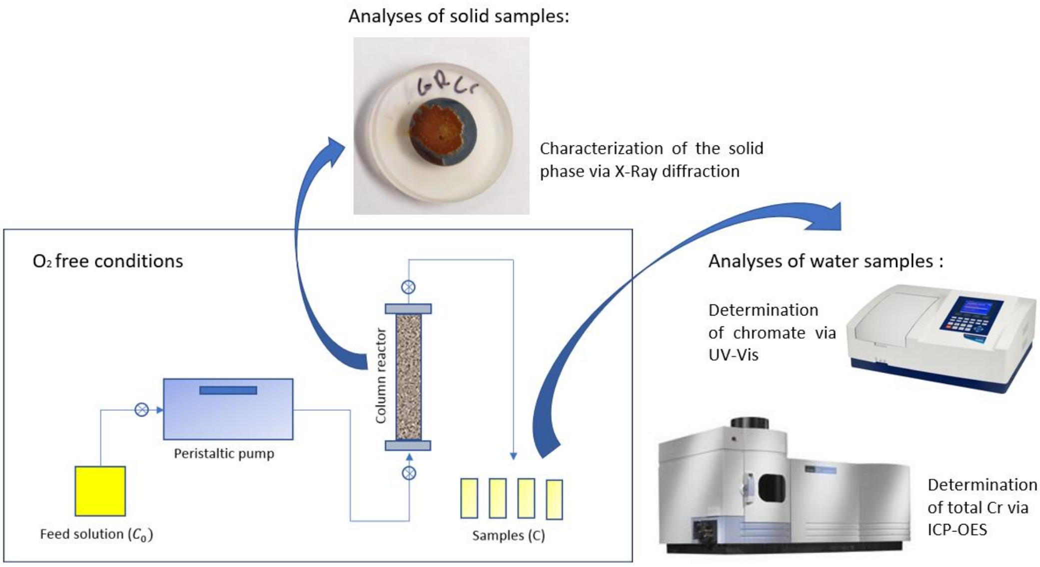

Fig.2 Schematic working set-up used for the reactivity experiments (free oxygen conditions): the collected water samples were analysed spectrophotometrically (determination of the Cr(VI) content) and via ICP-OES

(determination of the total Cr concentration); after the injection of chromium(VI) solution, the filling material of the column (sand mixed with sulphate green rust) was treated, filtered and analysed via XRD.

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