Carbon dioxide sequestration by using acid mine lakes and industrial by-products: Applicability of a niche solution.

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The aim of the study is to reduce the emission of carbon dioxide into the atmosphere on the one hand, and improving the water quality in areas seriously affected by lignite mining on the other hand by means of carbon dioxide (CO_2) which ist precipitated in sustainable form as calcite ($CaCO_3$).

The BMBF-funded project CDEAL (Carbon dioxide elimination by using acid mine lakes and calcium oxide suspensions) is designed to to show that by-products (fly ash, sludge from treatment plants) as well as carbon dioxide can be used to improve the water quality of open pit lakes. The investigation area is situated in the Lusatian Area. Lake Burghammer is an ideal investigation case as it received fly ashes from the power plant "Schwarze Pumpe" from 1973 to 1997. Approximately a total of 26 mill. m³ of suspended fly ash were deposited in Lake Burghammer.

First, geochemical and mineralogical investigations of the settled ash body have been conducted followed by different laboratory experiments. Theoretical conclusions (modelling with phreeqC) and experimental results show that settled fly ashes can be used to trap carbon dioxide in form of carbonates (e.g. calcite and siderite). Simultaneously, an improvement of the water quality, particularly with regard to alkalinity, occurs. In all experiments conducted it was possible to raise the acidic buffer capacity in the lake water. The use of the by-product CO_2 during the treatment of acid mine lakes in former mining districts, in regard to both CO_2 sequestration and water treatment, is matter of particular interest. CO_2 sequestration occurs in 2 steps: by storage in the water phase and by storage in solid phase; the former is only temporary whereas the latter is permanent.

In the context of a field experiment different injection techniqes (pure gas or gas-water mixture) were applied and evaluated in particular with respect to the distribution of gas or gas-water-mixture in the sediment and its impact on the adjacent water quality. For this purpose both sediment cores were taken and gas lances installed to a sediment depth of 12 m by means of a heavy hydraulic hammer mounted on a floating platform. A tank with liquid CO_2 placed close to the shore of the lake was used for carbon dioxide supply. CO_2 was transported as gas by means of a swimming pressure hose (8 bar) to the platform and from there injected into the ash body. CO_2 was applied with a pressure of 2.2 bar and 1.4 m³/h. The duration of the pilot experiment comprises 3 months. Different monitoring devices have been installed: the CO_2 partial pressure of water, pH-value and electrical conductivity are monitored online. Water samples are taken in certain time intervals with an automatic sampling device.

Mineralogical and geochemical investigations conducted in the end of the pilot experiment will show how the adjacent ash body is affected by carbon dioxide injection. The comparison of TIC-contents before and after injection, as well as mineralogical investigation (SEM, Cathodoluminescence) will show whether carbonation occurred.

Using gaseous CO_2 in combination with industrial by-products can be accounted as a sustainable method for CO_2 sequestration and for treatment of AMD. Nevertheless this method presents only a niche solution due to the dependence on alkaline materials, e.g. fly ash.