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Application of geoelectrical monitoring techniques at a natural CO_2 release site to identify degassing areas and related transport processes

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The complexibility of fluid transport and dissolution processes of CO_2 in the subsurface represents challenges in evaluating monitoring methods for leakage detection at Carbon Capture and Storage (CCS) sites. Within the framework of the R&D project "MONACO" (MONACO=Monitoring approach for geological CO_2 storage sites using a hierarchical observation concept), surface-based CO_2 soil gas concentration measurements in combination with geophysical methods, such as DC geoelectrics, electromagnetic (EMI) and self-potential (SP) measurements, were applied for the mapping and monitoring of CO_2 spread in the subsurface and atmosphere within an hierarchical monitoring concept. The applied geophysical methods are used to characterize geological settings and provide insights into the structural features of the covering sediments. Especially, the repeated determination of spatial resistivity distribution in subsurface using Electrical Resistivity Tomography (ERT) is considered to be useful when investigating disturbances caused by variations in lithological parameters and fluid content. In addition, the presence of flow and concentration gradients, CO_2 dissolution effects in groundwater and fluid transport (CO_2 and H_2O) factors influence the measured self-potentials (SP). The investigations were carried out at a natural degassing site, which provides excellent opportunities for evaluating and validating methods used for the detection and monitoring of CO_2 migration in the shallow subsurface and leakage into the atmosphere. Since 2009 we have been undertaken geoelectrical monitoring at this test site to gain information about the influence of changing soil properties and meteorological conditions on the diffused degassing process. These measurements indicate that the correlation between environmental, geophysical and soil gas parameters needs to be considered when attempting to give an interpretation about potential migration paths and CO_2 leakages.