Geophysical Research Abstracts
Vol. 13, EGU2011-4940, 2011
EGU General Assembly 2011

2D magnetotelluric characterization of Hontomín (Spain) CO2 pilot plant

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Electrical and electromagnetic geophysical methods are sensitive to the electrical conductivity of pore fluid. The presence of CO2 inside the pore replaces a fraction of saline fluid within the storage aquifer, reducing the effective volume available for ionic transport. As a consequence, the bulk electrical resistivity of the rock increases significantly. Thus, the magnetotelluric method is a suitable geophysical technique not only to characterize the seal and reservoir units, but also for monitoring the CO2 plume evolution.

The area of study is a dome-like structure situated in the Basque-Cantabrian Basin, about 30 km north to the town of Burgos (Spain). The main reservoir is a Natural Saline Aquifer with a thickness of more than 100 m and constituted by fractured and dolomitic limestones at 1300 m depth. The seals rocks belong to the overlying series of the Lias and Dogger, of which the main seal rocks are the marls and black shales.

Magnetotelluric studies are providing a baseline model for estimating the CO2 plume distribution afterwards the injection (to be done at the end of 2011), making it possible to image the migration of the electrically resistive plume in the subsurface, using not only MT but also control source electromagnetic methods.

Here, we present the result of first stage of characterization. In total, 22 broadband MT (BBMT) soundings were acquired along a north-south profile crossing the main faults and folds of the structure in the period range of 15 Hz to 4096 Hz. The stations were deployed at roughly 200 m intervals, recording data during 24 to 48 hours. Data acquisition was carried out the last fortnight of May 2010. The instrumentation consisted of Metronix ADU06, Metronix ADU07 and Phoenix V8. A remote reference station was placed around 20 km away from the middle of the profile.

Different robust processing codes using remote reference methods have been tested and used at all stations of the profile to derive optimal MT responses. MT data at each site have been decomposed using the STRIKE code of McNeice and Jones (2001), which is based on the method of Groom and Bailey (1989), in order to model the best geoelectrical strike direction. The results confirm that all MT responses along the profile are consistent with a 2-D assumption and therefore, suitable for 2-D modelling.

The 2-D electrical resistivity model of the subsurface has been computed by 2-D simultaneous smooth inversion of all the MT responses along the profile. The inversion method used is that of Rodi and Mackie (2001). Hontomín 2D MT resistivity model obtained in the period range 0.001 to 10 s shows a clear correlation between the model and the resistivity data provided by exploration well Hontomín-2 situated close to the center of the profile. The seal rocks are associated to a resistive body while the reservoir is associated to the conductive body situated underneath. Several scenarios of CO2 plume evolution are examined trough synthetic modelling.