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An integrated petrophysical-geophysical approach for the characterization of a potential caprock-reservoir system for CO_2 storage.

Silvana Fais (1), Paola Ligas (1), Francesco Cuccuru (1), Giuseppe Casula (2), Maria Giovanna Bianchi (2), Enrico Maggio (3), Alberto Plaisant (3), and Alberto Pettinau (3)

(1) University of Cagliari, DICAAR, Department of Civil and Environmental Engineering and Architecture (DICAAR), Cagliari, Italy (sfais@unica.it), (2) Istituto Nazionale di Geofisica e Vulcanologia (INGV) – Sezione di Bologna (Italy), (3) Sotacarbo S.p.A. - Grande Miniera di Serbariu 09013 - Carbonia (CA), ITALY

The selection of a CO_2 geologic storage site requires the choice of a study site suitable for the characterization in order to create a robust experimental database especially regarding the spatial petrophysical heterogeneities and elasto-mechanical properties of the rocks that make up a potential caprock-reservoir system. In our study the petrophysical and elasto-mechanical characterization began in a previously well drilled area in the northern part of the Sulcis coal basin (Nuraxi Figus area - SW Sardinia - Italy) where crucial geologic data were recovered from high-quality samples from stratigraphic wells and from mining galleries. The basin represents one of the most important Italian carbon reserves characterized by a great mining potential. In the study area, the Middle Eocene - Lower Oligocene Cixerri Fm. made up of terrigeneous continental rocks and the Upper Thanetian - Lower Ypresian Miliolitico Carbonate Complex in the Sulcis coal basin have been identified respectively as potential caprock and reservoir for CO_2 storage. Petrophysical and geophysical investigations were carried out by a great number of laboratory tests on the core samples and in situ measurements on a mining gallery in order to characterize the potential caprock-reservoir system and to substantially reduce geologic uncertainty in the storage site characterization and in the geological and numerical modelling for the evaluation of CO_2 storage capacity. In order to better define the spatial distribution of the petrophysical heterogeneity, the seismic responses from the caprock-reservoir system formations were also analysed and correlated with the petrophysical and elasto-mechanical properties

In a second step of this work, we also analysed the tectonic stability of the study area by the integrated application of remote-sensing monitoring spatial geodetic techniques. In particular, the global positioning system (GPS) and interferometric synthetic aperture radar (inSAR) were considered useful tools to test the tectonic stability of the storage site. We computed the crustal strain rate of the Sulcis basin starting from the horizontal and vertical velocities detected by applying the two above remote sensing techniques. At the beginning we calculated the Eurasian intra-plate velocity and position time series of some good quality permanent GPS sites present in the study area. We then compared the computed GPS height variation of these sites with the line of sight (LOS) component of InSAR permanent scatters time series detected with the aid of the small baseline (SBAS) method and located closer to the GPS stations. The horizontal components show insignificant residual intra-plate velocities ranging between 0-1 mm/y, while the vertical velocities are comprised between 0 to 2 mm/y, testifying to the stability of the area. The same remote techniques mentioned above can be used during and after the injection of the CO_2 to monitor the storage site. This remote monitoring option can be effective, cheap and repeatable.

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