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Monitoring seismic velocity variations at a experimental CO2 geological storage site in Hontomín (northern Spain)

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The Spanish “Ciudad de la Energía” (CIUDEN) Foundation is developing a carbon dioxide (CO2) geological storage program in saline aquifers in Spain. One of the main objectives of the program, which is now at its pre-operational stage, is to set up a pilot plant to develop technology and test methodologies on CO2 storage operation. The selected experimental and demonstration site for the plant is Hontomín (northern Spain), where numerous geophysical monitoring techniques are currently being tested for the purpose of characterizing the reservoir, which is at depths of about 1550 meters. Passive seismic monitoring is one of the complementary techniques that are being considered for microseismicity location and to image changes in the medium within the storage complex that could be related to the presence or migration of CO2. For this purpose, a seismic network consisting of 20 Sara SS45 (4.5 Hz natural frequency) and 10 Lennartz LE-3D (20 s natural period) seismometers together with Sara SL-06 digitizers has been installed in the study zone. The sensors are placed at about 2-m in depth. The network is centered at the planned injection well and the minimum interstation distances range from 1 to 2 km, thus covering a whole area of about 9 x 8 km. Data are acquired at a sample rate of 200 Hz and they are continuously recorded on-site. In this work we present first results of Hontomín reservoir characterization in terms of ambient seismic noise after a three-month interval operation of the seismic network. The method used here is Passive Image Interferometry (PII), which allows monitoring temporal relative changes of mean shear wave velocity using correlations of ambient seismic noise. The autocorrelation at a single station and the cross-correlation at two stations using noise data in the frequency band 4.5-10 Hz give the Green’s function (GF). Then, relative velocity changes are measured by means of an inversion scheme based on stretching and compressing the GFs and comparing them to a reference trace, which is the mean of all the GFs for the whole 3-month time interval. Although the results are only preliminary, they serve to show the importance of characterizing the site before the gas injection activities start, because through the continuous monitoring, very small seismic velocity perturbations at the reservoir may be later detected and ascribed to the CO2 injected plume. In this sense, this project constitutes a good opportunity to validate, under favorable conditions, the application of the PII technique to monitor CO2 storage in deep saline formations