Importance of rock physics for CO_2 geosequestration

Boris Gurevich[1,2,3], Stas Glubiokovskikh[1,2] and Roman Pevzner[1,2]
[1] *Curtin University*
[2] *CO2CRC*
[3] *CSIRO*
b.gurevich@curtin.edu.au
ORCID: orcid.org/0000-0002-2752-3528

Geophysics is an essential component of monitoring and verification for CO2 storage projects. In this context, rock physics relates geophysically measurable parameters (velocity, acoustic impedance etc) to rock and fluid properties, and is essential for forward modelling of the geophysical signature of injected CO2 and for quantitative interpretation of the geophysical observations.

CO2 is usually injected into the subsurface in supercritical form, and has density of a liquid but compressibility close to that of gas. The acoustic impedance of reservoir rocks partially saturated with CO2 is controlled by spatial distribution of CO2. When the distribution is spatially uniform, injection of a small amount of CO2 causes a sharp decrease of acoustic impedance, allowing detection of small CO2 saturation (on the order of 10%) by time-lapse reflection seismic method. However if saturation is heterogeneous, the seismic response is much less sensitive to small CO2 saturation. Poroelasticity theory predicts that at seismic frequencies the saturation can be considered uniform on the sub-meter scale, and this was the basis for predicting a significant reflection seismic response to a small (5,000 tonnes) injection of CO2 in the Otway experiment [1] – a prediction confirmed by field observations [2]. Modelling shows that CO2 injected into a depleted gas reservoir is unlikely to be detectable.

Quantitative interpretation of the geophysical response is challenging due to strong non-linearity of elastic properties as a function of saturation. However it is possible to map the CO2 plume body in 3D (parts of the reservoir with CO2 saturation above a certain threshold). Tests on Otway data show that seismic inversion coupled with statistical detection criteria gives a robust and contiguous plume image but leaves out parts thinner than 8m or with very low saturation [3]. Much smaller amounts (~15 tonnes) are detectable if CO2 is in gas form [4].

Acknowledgement
The Otway Project received funding through CO2CRC's industry members and research partners, the Australian Government under the CCS Flagships Program, the Victorian State Government and the Global CCS Institute. The authors wish to acknowledge financial assistance provided through ANLEC R&D supported by the Australian Coal Association Low Emissions Technology Limited and the Australian Government through the Clean Energy Initiative.

References
[1] Caspari, E., R. Pevzner, B. Gurevich, T. Dance, J. Ennis-King, Y. Cinar, M. Lebedev, 2015, Geophysics, 80, B95-B104, 10.1190/geo2014-0459.1
[2] R. Pevzner, M. Urosevic, D. Popik, V. Shulakova, K. Tertyshnikov, E. Caspari, J. Correa, T. Dance, A. Kepic, S. Glubokovskikh, S. Ziramov, B. Gurevich, R. Singh, M. Raab, M. Watson, T. Daley, M. Robertson, B. Freifeld, 2017, International Journal of Greenhouse Gas Control, 63, 150-157, 10.1016/j.ijggc.2017.05.008
[3] Glubokovskikh, S, R. Pevzner, J. Gunning, T. Dance, V. Shulakova, D. Popik, S. Popik, M. Bagheri, B. Gurevich, 2020, International Journal of Greenhouse Gas Control, 92, 102854.
[4] Tertyshnikov, K., R. Pevzner, 2019, B. Freifeld, L Ricard, and A. Avijegon, 2019, SEG Technical Program Expanded Abstracts, 4888-4892.