

Extraction of layer-specific seismic velocity in a porous medium through seismic interferometry applied to ultrasonic measurements of CO₂ sequestration

Draganov, Deyan; Ghose, Ranajit; Heller, Karel

Publication date

2016

Document Version

Accepted author manuscript

Citation (APA)

Draganov, D., Ghose, R., & Heller, K. (2016). *Extraction of layer-specific seismic velocity in a porous medium through seismic interferometry applied to ultrasonic measurements of CO₂ sequestration*. Abstract from 2nd international conference on ultrasonic-based applications, Caparica, Portugal.

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

Extraction of layer-specific seismic velocity in a porous medium through seismic interferometry applied to ultrasonic measurements of CO₂ sequestration

D. Draganov¹, R. Ghose¹, K. Heller¹

1. Department of Geoscience and Engineering, Delft University of Technology, The Netherlands

Abstract

Purpose: Time-lapse seismic monitoring constitutes the foundation for most monitoring programmes involving CO₂ storage. When using time-lapse seismics, two major sources of uncertainty in the estimation of changes in the reservoir properties, like saturation and pressure, are the non-repeatability of the source positions and the difficulty to separate the effect of the overburden from that of the changes taking place in a CO₂ reservoir. The goal of this research is to propose a new concept of using non-physical (ghost) reflection events retrieved by seismic interferometry and test this concept through ultrasonic laboratory experiments that mimic realistic CO₂ sequestration in a porous reservoir rock.

Experimental description: Results from two laboratory experiments will be presented. In both experiments, a two-layer sample consisting of a top layer of epoxy, representing the impervious cap rock, and a lower layer of Bentheimer sandstone (porosity ~ 22%, permeability 1.34 Darcy, density 2080 kg/m³), representing the reservoir rock, is used. In the first experiment, ultrasonic tests using piezoelectric transducers were performed under ambient (room) conditions of temperature and pressure, and water was displaced by ethanol. In the second experiment, elaborate ultrasonic experiments were carried out under controlled (elevated) pressure and temperature conditions mimicking a true CO₂ reservoir where supercritical CO₂ displaced brine. An array of seismic receiver was used to record the ultrasonic reflections from the top and the bottom of the porous layer.

Results and conclusions: Using non-physical (or ghost) reflections retrieved by seismic interferometry, we could successfully estimate the acoustic wave velocity in the porous reservoir and its temporal change associated with changes in pressure and fluid-content in the pores. The estimation of layer-specific wave-velocity, eliminating effectively the effect of the changes occurring in the overburden and that of source irreproducibility, has been possible for the first time. The advantage of using cross-coherence over cross-correlation in the application of seismic interferometry, in order to address velocity changes in a thin reservoir layer, has been established. It was possible to obtain reliable values of the rock-physical properties from the estimated layer-specific acoustic wave velocity obtained by the proposed approach.

Key Words: ultrasonics, interferometry, monitoring, CO₂, CCS, reflections, seismics

Acknowledgements: This research is sponsored by the Dutch national program CATO2. D.D. is additionally supported by the Division for Earth and Life Sciences (ALW) with financial aid from the Netherlands Organization for Scientific Research (NWO, VIDI grant 864.11.009).

Correspondence: Stevinweg 1, 2628 CN Delft, The Netherlands. Emails: d.draganov@tudelft.nl, r.ghose@tudelft.nl, h.k.j.heller@tudelft.nl