Available online at www.sciencedirect.com
ScienceDirect
Journal of Applied Geophysics 63 (2007) 68–79
JOURNAL OF APPLIED GEOPHYSICS
www.elsevier.com/locate/jappgeo

Shallow velocity–depth model using first arrival traveltime inversion at the CO_2SINK site, Ketzin, Germany

Sawasdee Yordkayhun [a,*], Christopher Juhlin [a], Ruediger Giese [b], Calin Cosma [c]

[a] *Department of Earth Sciences, Uppsala University, Villavägen 16, SE-75236 Uppsala, Sweden*
[b] *GeoForschungsZentrum, Section 5.1, Potsdam, Germany*
[c] *Vibrometric Oy, Vantaa, Finland*

Received 15 February 2007; accepted 24 May 2007

Abstract

The CO_2SINK project, a carbon dioxide storage and monitoring project, has been in operation in the Ketzin area, Germany since 2004. Goals are to investigate the techniques and understand the processes related to geological storage of CO_2 in a saline aquifer. A key element of the project is comprehensive monitoring and the development of verification methods to track the long term spread of the injected CO_2. Time lapse seismic surveys in 3D and 2D are important monitoring components for tracking the movement of CO_2. Prior to the 3D baseline seismic survey in 2005, a pilot seismic survey was performed in 2004 in order to provide input parameters for the 3D survey and information on target depth. This pilot study, consisting of two perpendicular 2.4 km long profiles confirmed the geological structure based on 1960s vintage seismic data. However, the image is rather poor in the uppermost parts of the seismic sections. In order to obtain additional structural information and to improve the velocity function estimates, first arrival traveltimes were used to image the near-surface structure and to provide an improved velocity function for interpretation of reflection data. We used a generalized linear inversion (GLI) method, based on iterative least-squares inversion, to reconstruct the velocity–depth model. A simple and smooth starting velocity model was derived from traveltime plots and the stacked reflection seismic sections. Reliability of the resulting velocity models were estimated from analysis of the traveltime residuals (RMS error) and qualitative analysis of ray coverage. There appears to be a good correlation of layer boundaries in our model and higher amplitude reflections observed on the stacked sections. Comparison of the seismic depth sections computed using stacking velocities with the GLI inverted velocity shows that the depth sections obtained from the latter agrees better with the velocity models. The combination of borehole data and the depth converted stacked sections provides key constraints for interpretation of the velocity models. The estimated investigation depth of the seismic profiles is on the order of 400 m with rays penetrating the surface cover and sedimentary sequences. These sedimentary rocks are characterized by a gradual increase in the velocity field with depth without strong contrasts and insignificant lateral velocity variations.

Keywords: Traveltime inversion; Generalized linear inversion; Velocity–depth model; CO_2SINK project

1. Introduction

Carbon dioxide (CO_2) sequestration is an option and opportunity for reducing CO_2 emissions into the atmosphere by capturing CO_2 and injecting it into

* Corresponding author. Tel.: +46 18 471 7161; fax: +46 18 501110.
E-mail address: sawasdee.yordkayun@geo.uu.se (S. Yordkayhun)

0926-9851/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.jappgeo.2007.05.001