Full waveform inversion of seismic DAS-VSP data from Kijiyama geothermal field

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To develop the geothermal field, it is an essential step to characterize geothermal reservoirs that consist of faults and fractures. VSP survey can be executed for high spatial resolution images of seismic reflection and dipping faults in the vicinity of the well. However, this application for the geothermal field has been restricted because the measurement are exceed temperature tolerance of geophones and equipment. Nowadays, the development of Distributed Acoustic Sensing (DAS) makes the operation under high temperature environment possible so DAS-VSP survey can be performed the characterization and imaging for subsurface especially in geothermal field (Fujisawa et al., 2019). Moreover, in the progress of data processing technique, waveform analysis provides the quantitative and high resolution images of reservoir so Full Waveform Inversion (FWI) has been widely used in the petroleum industry. Therefore, FWI approach is also effective tools to reconstruct the high resolution quantitative image of characteristic parameters and reliable subsurface imaging even in the geothermal field.
Here, we investigate the applicability of FWI to the geothermal DAS-VSP dataset acquired in Kijiyama field in 2018 (Fujisawa et al., 2019). We conduct the 3D acoustic FWI to dataset that contained two crooked lines in the survey area. Because DAS receivers have the different directivity pattern from geophones, we introduce the normalized misfit function (Groos, 2013) to mitigate the different transverse sensibility for DAS. Compared with the initial model derived from TTT(Travel time tomography) result, FWI updates the velocity model more detailed and provide the reasonable P wave velocity contrast for the geological boundary between Sanzugawa Formation and Minasegawa Formation. We also apply pre-stack depth migration to the VSP and SSP data using velocity obtained from both TTT and FWI. PSDM section obtained from FWI velocity model acquire higher resolution images and both VSP section and SSP section become more consistent than the PSDM results obtained from TTT velocity model. Our results confirm the advantages of FWI for DAS-VSP data to acquire the high resolution and more reliable images in the vicinity of the well.

Keywords: 3D acoustic FWI, DAS, PSDM

