Fundamental study to monitor sweep front location using seismic AVO in Foam-assisted EOR practice

*Rei Tamura[1], Hitoshi Mikada[1], Junichi Takekawa[1]

1. Kyoto University

Recently, foam-assisted EOR has attracted attention as a method to reduce the risk of viscous fingering or gravity tonguing of injected fluids in the practice of EOR. Foam is gas bubbles to control the mobility of fluids in porous media and helps improving the sweep efficiency for the production of hydrocarbon resources. Since it is surely important to see how the front of injected moves towards the production wells in the foam-assisted EOR, the monitoring could be a key technology in the practice. Therefore, it is worthwhile revisiting exploration methods for detecting the location and spatial distribution of the foam front in the situation that the form-assisted EOR put into practice in some oil fields. Although an approach of trial and error is dominant in the application of the form-assisted EOR, the introduction of monitoring methods would surely improve the efficiency of EOR.

In typical foam-assisted EOR field, pore space in reservoir rock is filled by three types of fluids, i.e. the original formation fluids, injected foam, and the injected flooding fluids. The difference of pore fluids could generate high impedance contrasts in the reservoir. Since the behavior of seismic waves is affected by the type of pore fluids, seismic exploration methods have the potential for the estimation of fluid distribution in the subsurface. To prove the effectiveness of monitoring using seismic methods, it is necessary to understand what kind of seismic response could be obtained in seismic monitoring.

In the present study, we hypothesized that the amplitude of reflected seismic waves includes information about pore fluid. To validate our hypothesis, we conduct numerical experiments using the finite-difference method. Numerical model includes fluid filled reservoir with different type of fluid, i.e. oil, water, foam and CO_2 in CO_2 injection model, and oil, water and foam in water injection model. We calculate AVO intercept and AVO gradient for each CMP gather created by synthetic data set, and see the features of spatial distribution of them. This numerical experiment indicated that simple AVO analysis would be of help in monitoring foam-assisted EOR and that seismic methods would be effective for monitoring it.

Keywords: AVO, AVO intercept, AVO gradient, foam-assisted EOR

