Imaging a Hydrocarbon Field in SE Albania Using Seismic Interferometry and Passive Seismic Tomography

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Abstract

In the last decade Passive Seismic Tomography (PST) methodologies have started to be applied in hydrocarbon exploration with an increasing resolution and providing solutions where conventional seismic were either unsuccessful (seismic penetration problems) or un-economical (difficult topography, large areas of exploration, field conditions. Recently, in the field of ultrasonic, it has been shown both theoretically and experimentally that a random wave field has correlations, which on average, take the form of the Green's function of the medium. This idea has now found rapid applications in seismology and in particular the retrieval of surface waves from the cross-correlations of ambient seismic noise between pairs of seismic stations. This new type of data has rapidly been used for tomographic mapping at regional scales. According to our knowledge no one has applied ANT in a local scale over a known hydrocarbon field.

The purpose of the present investigation is to evaluate the potential of ANT to be applied in local mapping of structures of hydrocarbon interest. To achieve this, we selected a region with known hydrocarbon oil and gas producing fields in SE Albania for which we have high resolution PST data and we can use it as a blind test for the ANT methodology.

Microearthquake and ambient noise data were recorded for a period of 12 months on 50 3C seismometers spaced at 5Km and at a sampling frequency of 100Hz. The instruments have a flat transfer function for velocity in the 1-80 Hz frequency range. 1860 events were selected for the tomographic inversion.

For ANT, data corresponding to 1 day are cross correlated for each station pair and stacked over 12 months. We then estimated the group velocity dispersion curves for each stacked trace and we performed a tomographic inversion of the arrival time measurements deduced from the group velocities at each period.

Both PST and ANT methods gave comparable results with PST giving a higher resolution. On the other hand ANT showed good resolution at the shallow layers showing the potential of this method in case that micro-seismicity is deep resulting in low ray coverage of the shallow space. Thus, in addition to the fact that ANT can be applied in areas with no background seismicity it can also act as complementary to PST methodology and even facilitate the construction of the necessary model for the PST inversion first 1D velocity model.

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