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Detection of hydrocarbon reservoirs in applying time reverse modeling for microtremors

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Localization of seismic events is very important in seismology and exploration. The localization helps to detect active seismic zones and to assess the geometry of the subsurface geology. Current procedures imply that the seismic event is visible and reliably definable on seismograms from several stations of a seismic network. Weak events are either badly identified or generally overlooked. Time reverse modeling is a method to also localize such weak events. The seismograms measured at the stations are reversed in time and are afterwards used as boundary values for the reverse modeling. It has been shown that the reverse modeling is able to track down events for an S/N-ratio lower than one. Time reverse modeling is a promising approach for the localization of so-called “hydrocarbon microtremors”. Several field surveys have shown that hydrocarbon reservoirs are very likely to act as a source of low frequency (i.e. 1.5Hz – 4.5Hz) seismic waves and these signals are sometimes termed “hydrocarbon microtremors“. A direct and quick detection of hydrocarbon reservoirs is of central interest for the development of new oil or gas fields. We apply an explicit finite difference method based on a velocity-stress formulation for numerical time reverse modeling. We perform numerical feasibility studies and show that, if there is a steady source of low-frequency seismic waves within a reservoir, we can reveal the location of the reservoir in applying time reverse modeling. Time signals of only a few sensors (as usually available for field campaigns) are enough to detect the reservoir in a geological complex environment. A further development of this application will be to visualize more than one reservoir in the subsurface, for example stacked reservoirs.