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Influence of near surface ground conditions on seismic monitoring setups

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A one-year active seismic monitoring experiment was carried out at the German Continental Deep Drilling Site (KTB) as a supplement to an injection experiment in the KTB pilot borehole between spring of 2004 and spring of 2005. The aim of the monitoring with a geophone array and a vibrator source was to detect changes of the seismic reflection amplitudes of the SE2 shear zone as a result of a systematic hydraulic pressure increase within that shear zone through water injection.

One of the basic results of the seismic data analysis is the following: The recorded seismic signals seem to depend more on the variations of the near surface ground conditions than on changes at the target zone at depth. The signal amplitude and the signature of the seismic traces vary not only in a small section of the traces but in a larger time window, depending on the date of the repeat measurements. One source for that variability could be the coda of surface waves that possibly masks the later target reflection onsets. Surface waves show strong variations. The surface waves of two different measurement cycles for example that were carried out during one day show phase shifts of 180 degrees or travel time delay, respectively as opposed to the direct waves. The reason for that could be the varying moisture content of the near surface during the day.

Passive seismic imaging or interferometric studies that rely on surface waves must take such changes into account.