Towards retrieval of reflections using ambient-noise recorded during drilling operations: iron ore formation imaging in Pilbara, Western Australia

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In June 2017, a dense ~1000 single-component receiver station array (PilbArray) was deployed by BHP Minerals Australia, in Pilbara region of Western Australia and recorded a complete drilling survey consisting of 19 explorations wells. Aim of this experiment was to establish a cost-effective methodology for imaging numerous shallow iron formations in the Pilbara region using passive seismic. This reach dataset is supplemented with field notes documenting the type of recorded activity (e.g. drilling), allowing us to correlate ambient noise (AN) patterns with the quality of the retrieved virtual shot gathers (VSGs) and final images.

In this study we investigate the influence of the specific segments of the recorded wavefield for imaging our target. For each entry in the field notes, we analyze 15-minute long AN segments using PSD and a set of metrics in the cross-correlated domain, providing frequency-amplitude description and the QC of retrieved VSGs. Illumination diagnosis of VSGs obtained using different parts of the data reveals that using AN segments induced by various operations allows to retrieve stationary sources for multiple locations inside the array. Thanks to that we can produce reliable VSG for every receiver position. To prove this, we visually inspected VSG calculated for every 15-minute long segment of data. Next, for each receiver position, we select one specific period providing VSGs with proper illumination characteristic and visible reflection content. As a result, we obtained VSGs showing reflectivity comparable with active-source data. Consequently, we link best VSGs with the specific operations and show the spatial and temporal distribution of drilling-associated activities acting as stationary sources. Finally, we show the performance of PilbArray passive imaging using selected receiver lines.

Our study suggests that using AN data acquired during various field operations, e.g. transportation of equipment, tracks movement, maintenance, or pre-drilling tests allows to populate stationary regions otherwise uncovered by using only hammering actions. Moreover, we indicate that acquisition time can be reduced to shorter time, by focusing on repeatable sequences of specific operations. The automatic curvelet/illumination-diagnosis based approach developed as part of this study can be used for selection of passive data segments assuring reflection content.