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Reflection Response of the Parnaíba Basin (NE Brazil) from Seismic Ambient Noise Autocorrelation Functions

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Reflected-wave interferometry relies on the recording of transient seismic signals from random wavefields located beneath recording stations. Under vertical incidence, the recordings contain the full transmission response, which includes the direct wave as well as multiple reverberations from seismic discontinuities located between the wavefields and the receiver. It has been shown that, under those assumptions, the reflection response of the medium can be recovered from the autocorrelation function (ACF) of the transmission response at a given receiver, as if the wavefields had originated themselves at the free surface. This passive approach to seismic reflection profiling has the obvious advantage of being low-cost and non-invasive when compared to its active-source counterpart, and it has been successfully utilized in other sedimentary basins worldwide. In this paper we evaluate the ability of the autocorrelation of ambient seismic noise recorded in the Parnaíba basin – a large Paleozoic basin in NE Brazil - to recover the reflection response of the basin. The dataset was acquired by the Universidade Federal do Rio Grande do Norte during 2015 and 2016 under the Parnaíba Basin Analysis Project (PBAP), a multi-disciplinary and multi-institutional effort funded by BP Energy do Brasil aimed at improving our current understanding of the architecture of this cratonic basin. The dataset consists of about 1 year of continuous ground motion data from 10 short-period, 3-component stations located in the central portion of the basin. The stations were co-located with an existing (active-source) seismic reflection profile that was shot in 2012, making a linear array of about 100 km in aperture and about 10 km inter-station spacing. To develop the autocorrelation at a given station we considered the vertical component of ground motion only, which should result in the P-wave response. The vertical recordings were first split into 10 min-long windows, demeaned, de-trended, re-sampled, and band-pass filtered between 8 and 16 Hz before autocorrelation, and then stacked with phase-weighting to enhance coherency of the retrieved signal. The ACFs show coherent signal is recovered at lag times between 0.5 and 2 s, which we interpret as P- and S-wave energy reflected on top of an intra-sedimentary discontinuity. Our results are consistent, to first-order, with a previously developed active-source reflection response of the basin.