Introduction to special section: Ambient noise

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Many efforts of geophysical processing have traditionally been devoted to the separation, attenuation, and elimination of noise from seismic acquisition data. However, one geophysicist's noise is another geophysicist's signal. Aki (1957) formulated the spatial autocorrelation method, which became a widely used tool in site investigations for determining surface-wave phase velocities from microtremors. Later, Claerbout (1968) proposed to correlate passive seismic recordings to simulate seismic reflection data.

Since the early 2000s, noise crosscorrelations have revolutionized the way global seismologists probe the earth's interior. Crosscorrelations of seismic noise yield body and surface-wave traveltimes that are routinely used to image the earth's crust and upper mantle. With recent developments in noise imaging, the ambient seismic field has shown potential for reservoir monitoring and near-surface applications at a regional scale.

In this section we provide a comprehensive overview of the state of the art in applications of ambient seismic-noise imaging and inversion. The first paper abandons the paradigm of crosscorrelating passive records. Two papers exploit the energy of local earthquakes or tremors. Two more papers focus specifically on extracting body wave energy from the ambient seismic noise. The final two papers discuss the interpretation of velocity changes observed in ambient noise correlations.

Pascal and Yuan formulate a novel acquisition and processing technique to derive surface-wave dispersion curves from seismic ambient noise. The authors show that the use of spatial gradients of the wavefield provides new opportunities for high-resolution near-surface characterization with minimal field effort.

Nishitsuji et al. propose a method — local-earthquake P-wave coda seismic interferometry — for crustal-scale reflection imaging. Their method can aid in better understanding and enhancing geothermal systems without the cost of traditional seismic acquisition.

Civilini et al. present a pilot study of the refraction microtremor method at the Ngatamariki geothermal field (central North Island, New Zealand), where refraction and reflection studies are hindered by energy scattering and attenuation. The authors determine shear velocities for the upper 200 m and constrain a previously inferred fault, suggesting that the method can provide important constraints on near-surface geology in noisy geothermal settings.

Pascal and Halliday propose an iterative gapped spiking deconvolution technique (in place of the conventional correlation technique) for zero-offset imaging using the upcoming body-wave arrivals extracted from ambient-noise land seismic data.

Nishitsuji et al. propose a method — global-phase seismic interferometry — for high-resolution reflection imaging of seismic and aseismic parts of slabs, the mantle, and the Moho. Their method uses earthquakes at teleseismic distances to retrieve reflection responses from colocated virtual sources and receivers.

Voisin et al. focus on an environmental application of seismology to monitor a large landslide using ambient seismic noise crosscorrelations; over time, these reveal variations in the level of the water table that agree with modeled predictions from the Biot-Gassmann theory. The technique offers great potential to monitor fluid substitutions in a medium and to infer its poroelastic parameters.

Olivier and Brenguier discuss one of the first applications of noise-based seismic velocity monitoring in a mining context and attempt to separate mining-induced stress changes from variations caused by other environmental factors. Their results have implications for the mitigation of seismic hazards associated with stress perturbations induced by mining activities.

References

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Published online 27 July 2016. This paper appears in *Interpretation*, Vol. 4, No. 3 (August 2016); p. SJi.
http://dx.doi.org/10.1190/INT-2016-0627-SPSEINTRO.1.