# Ultra-shallow seismic reflection imaging using a towed Land Streamer tool

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Recent advances of measurement methods, survey instruments, and inversion techniques in exploration geophysics have successfully contributed to image internal structure of the earth up to several 100 km in depth. In contrast, exploration geophysics has tackled with imaging of the near-surface in urban areas at most several 10 m, mainly caused by significantly large inhomogeneity in the target zone along with the interference by large amplitude of artificial noises in urban areas. Thus the near-surface has been one of the frontier areas for the exploration geophysics.

Pavement may play an important role when applying seismic reflection surveying in urban areas because its homogeneous structure accommodates suitable condition for underground imaging. However, difficulty in planting spike geophones on the pavement had caused an obstacle to set a survey line along road. Land Streamer tool developed by the author enables us to conduct high-performance survey even at the paved areas.

The Land Streamer consists of a pair of woven belts, a seismic cable, and geophone units. The tool is featured as the non-stretch woven belts on which geophone units are mounted to form a multichannel geophone array similar to a marine streamer. The tool can be easily towed by hand, or by a vehicle. The geophone units are coupled to the paved surface with the metallic baseplate. Even this non-planted coupling through the baseplate, the tool can receive comparatively clean data on the pavement.

Figure compares common shot gathers for an S-wave source recorded at the same site under the same geometry (geophone spacing: 50cm; shot offset: 3.0m) but with different surface conditions (paved/unpaved) or different tools (Land Streamer/spike geophone). Distinct reflection events were evident in the shot gather recorded on the pavement using the Land Streamer (a), whereas their alignments were considerably disturbed in the record by spike geophone with clay pad on the pavement (b). In contrast, shot gathers recorded at unpaved roadside ground using spike geophones (d) or the Land Streamer (c) contained relatively strong surface waves whereas the reflection events were faint. These records demonstrate the pavement surface acts as a strong reduction filter against surface waves. In addition, it also acts as a statics filter which improves the alignment of reflection events as well as first breaks. As a result, when setting the line on pavement, we can effortlessly reduce the influence of surface waves and weathering layers in the seismic reflection data acquisition.

Until now the author manufactured a total of 5 types of Land Streamers, and utilized them to the production surveys at 24 sites including 41 lines since 1997. High-resolution seismic reflection survey using S-wave type Land Streamer successfully imaged layered structure within the alluvial deposits up to 60 m. Ultra-shallow seismic reflection using a short-spacing type Land Streamer was applied to river bank survey and reconstructed internal structure of the bank body in range from 2 m to 15 m. P-wave type Land Streamer tool provided detailed structure of shallow part up to 200 m.