Use of ATV Traffic as a Passive Seismic Source – Implications for Surface Wave Inversion

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ABSTRACT

A five-minute interval of passive seismic data was analyzed to determine the presence of surface waves. This dataset was obtained incidentally when an all-terrain vehicle (ATV) traversed an active 2D seismic line employing continuous recording (autonomous nodes). The resulting passive seismic records yielded coherent surface wave information. Utilizing a standard MASW processing workflow, integration of the passive dataset notably improved the low-frequency spectrum and significantly increased the investigation depth in the shear wave velocity model compared to results derived solely from active source data.

INTRODUCTION

During acquisition of a one-mile 2D active seismic line, two Kawasaki Mule ATVs (1700 lbs.) were deployed to ferry crew and equipment along the line, and many traverses were made during the 2-day acquisition period. As continuous recording (autonomous nodes) was employed, this traffic and other human activity was captured as passive seismic data. Upon inspection of the continuous record, it appeared the ATV signal contained appreciable amounts of surface wave information (Figure 1a). We analyzed the robustness of this signal using a standard MASW (Multi-channel Analysis of Surface Wave) work process, including the generation of dispersion images, and we compared them to those generated from active seismic sources.

METHODS

At each receiver position along the line, we windowed the continuous records found to contain the ATV traffic signal by selecting 1.6 S of data for 200 receivers. We time-shifted the data such that the apex of the coda at the central receiver was at 0 time, resulting in a "virtual" shot (Figure 1b). A comparison to an active source seismic record (Figure 1c) suggests surface waves are robustly represented on the passive record. A 12-gauge impulsive source deployed at a depth of 1 meter was used as the source for the active data acquisition

We employed a phase shift method to generate the dispersion images for active and passive sources for the entire line (520 shot & receiver positions, each deployed at a 3-meter intervals). An average (sum) of the dispersion images for each analysis point for the entire line is shown for the passive (Figure 1d) and active (Figure 1e) datasets.

RESULTS

The passive data generated dispersion images that closely resemble those from the active data for the frequencies in common (6-20 Hz), demonstrating that this ATV traffic produces robust surface wave information. In addition, the passive data contributed information in the 3–6 Hz frequency range, where the active data provided little/no usable information.

CONCLUSIONS

All-terrain vehicle (ATV) traffic produces substantial usable surface wave energy in this area. Notably, the passive data contributed invaluable information within the lower frequency range, allowing the depth of investigation for shear wave velocity models derived from the MASW work process to expand from approximately 11 meters, with active data, to nearly 35 meters using passive data.

The concept of using anthropogenic data to supplement active data for surface wave information is not new. In this case, however, the location of the passive source

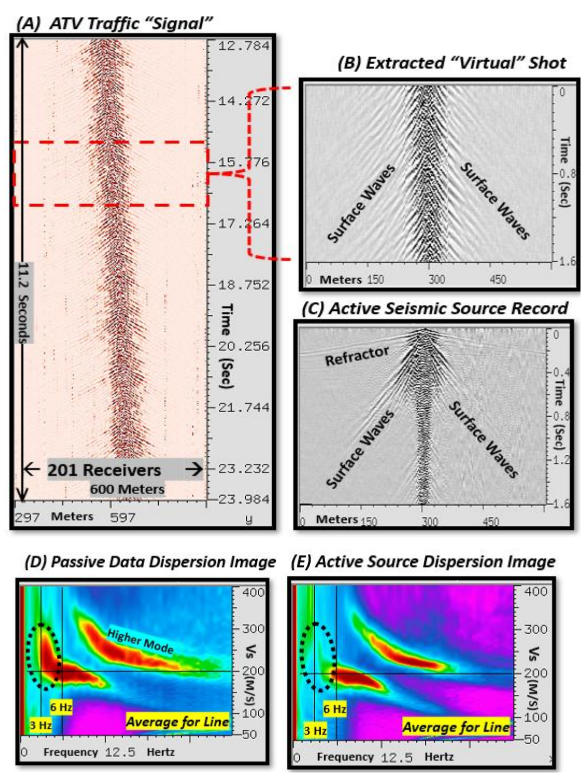

Figure 1. (a) continuous seismic record. (b) time & spatially windowed passive time series used for MASW analysis. (c) active source seismic record. (d) dispersion image of passive record. (e) dispersion image of active source seismic record

is known to be directly along the line of receivers, allowing for traditional MASW work processes to be employed. This type of passive data (ATV traffic along the receiver line) can be acquired at little/no additional cost and, in some cases, could replace entirely the use of active seismic sources.