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Geophones on a board

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ABSTRACT

We examined the feasibility of using seismic reflections to image the upper 10 m of the earth's surface quickly and effectively by rigidly attaching geophones to a wooden board at 5-cm intervals. The shallow seismic reflection information obtained was equivalent to control-test data gathered using classic, single-geophone plants with identical 5-cm intervals. Tests were conducted using both a .22-caliber rifle source and a 30.06-rifle source. In both cases, the results were unexpected: in response to our use of small, high-resolution seismic sources at offsets of a few meters, we found little intergeophone interference that could be attributed to the presence of the board. Furthermore, we noted very little difference in a 60-ms intra-alluvial reflection obtained using standard geophone plants versus that obtained using board-mounted geophones. For both sources, amplitude spectra were nearly identical for data gathered with and without the board. With the 30.06 source, filtering at high-frequency passbands revealed a wave mode of unknown origin that appears to be related to the presence of the board; however, this mode did not interfere with the usefulness of the shallow-reflection data. The results of these experiments suggest that deploying large numbers of closely spaced geophones simultaneously—perhaps even automatically—is possible. Should this method of planting geophones prove practical after further testing, the cost-effectiveness of very shallow seismic reflection imaging may be enhanced. The technique also may be useful at greater reflector depths in situations employing bunched geophones. However, this approach may not be applicable in all circumstances because larger energy sources may induce interference between the geophones and produce undesirable modes of motion within the medium holding the geophones.

INTRODUCTION

Seismic reflection methods can be useful when analyzing very-near-surface geology at depths of less than 15 m (Pakiser and Warrick, 1956; Birkelo et al., 1987; Miller et al., 1989). However, the expense of shallow subsurface seismic imaging may be prohibitive when shotpoint and geophone intervals of only a few centimeters are required to maintain the coherency and distinctness of recorded shallow reflections (Baker et al., 1999).

Hence, in an effort to develop a fast and cost-effective method of deploying large numbers of closely spaced geophones for use in seismic reflection imaging, we conducted experiments in which 12 geophones were attached firmly to a wooden board at 5-cm intervals, as discussed in the field-experiments section [see Figure 1(a)]. The presence of the board did not cause the geophones to interfere with each other extensively or distort useful seismic signals substantially. As a result, we were able to obtain shallow seismic reflections that were comparable to control-test data gathered using conventional, single geophones planted at identical 5-cm intervals.

Recent experiments using a land streamer (van der Veen and Green, 1998) were motivated also by a desire to decrease the cost of shallow reflection surveys. A similar land streamer equipped with gimbal-mounted geophones has been in use in the southwestern United States for several years by C. B. Reynolds Associates. The land-streamer approach, however, fails to develop strong geophone coupling to the ground, which is essential for recording high frequencies.

To some degree, the relative amplitude of a reflection from any depth is a function of geophone coupling to the ground, which in turn determines how well geophones are able to measure actual ground motion (Krohn, 1984). In most circumstances, the best coupling is obtained when geophones are mounted on long spikes and planted firmly in the earth (see, e.g., Hoover and O'Brien, 1980; Krohn, 1984).

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