The Application of Seismic Array Techniques to Image UXO-Contaminated Littoral Environments

Roland Gritto [1] (rgritto@lbl.gov)
Valeri Korneev [1] (vakorneev@lbl.gov)
Kurt Nihei [1] (ktnihei@lbl.gov)
Lane Johnson [1] (lrjohnson@lbl.gov)

[1]Earth Sciences Division, Lawrence Berkeley National Laboratory, One Cyclotron Road, MS 90-1116, Berkeley, CA 94720, United States

We investigate the application of seismic array techniques to increase the energy radiation and resolution of seismic waves in littoral areas to improve the success rate of detecting UXO in contaminated underwater sites. The investigation is carried out based on numerical modeling, including 2-D finite difference modeling and 3-D analytical solutions of the problem. In addition to various UXO orientations, we also modeled the presence of clutter in the subsurface. An array of 31 source and receiver elements was located floating in the water as well as sited on the seafloor, which allowed the comparison between single source-receiver combinations and beam-forming techniques. The numerical forward modeling involved noise-free and noisy data as well as interferences by free surface reflections (off the water-air interface), which produced the strongest phases on the seismograms. The inversion of the scattered seismic energy was performed using a 2-D eikonal solver (curved rays), which stacked and located the recorded amplitudes in space to determine the location of the UXO. The inversion also included the determination of the best fitting velocity model for the bay mud. The results of the 2-D modeling indicated that a single, horizontally oriented, UXO could be well detected as a function of depth and horizontal location. In the case of the source-receiver array being placed on the seafloor, the edges of the UXO were resolved indicating its horizontal extent, while the top of the UXO was correctly located. The cases of a second, vertically oriented, UXO and clutter located 0.1 m next to the first UXO, produced similar results. In each case the two objects produced slight interference in the backscattered seismic signal, yet the resolution of the seismic wave was still good enough to resolve the two objects from each other. The introduction of a rippled water-seafloor interface during the forward modeling didn't change the results for the case of a floating source-receiver array even though a flat bottom was assumed in the inversion approach, which showed the robustness of the inversion approach.