Propagation of Sound from an Explosive Source Placed in a Shallow-Water Wedge or Deep Water near the Ocean Bottom

Piotr Borejko
Technische Universität Wien, Institute of Structural Engineering, Karlsplatz 13-E212-03, 1040 Vienna, Austria

Objective: The predictions made in my E-poster about propagation situations referred to in the title are based on a theoretical analysis of the propagation of impulsive signals from an explosive point source placed in two benchmark models: the wedge of fluid (Fig. 1) and the half-space of fluid (Fig. 2), each of which is over an elastic solid bottom.

Wave-Theory Analysis: Using a semi-analytical method of generalized ray, the received wave motion in each model has been evaluated exactly in the form of a complete time-series of the acoustic pressure, exhibiting three distinct phases: the phase of the critically refracted (lateral) waves, the phase of the source signal and the regularly reflected waves, and the phase of the Scholte waves.

Conclusion: When frequency-dependent attenuation in the solid bottom is accounted for, only low frequencies of the source spectrum may be transmitted over great distances with little attenuation. Notably, at these frequencies, the Scholte-wave phase becomes dominant at remote receivers placed in each model. And it might then dominate the propagation in the SOFAR channel, upon entering it from the coastal wedge or deep water.

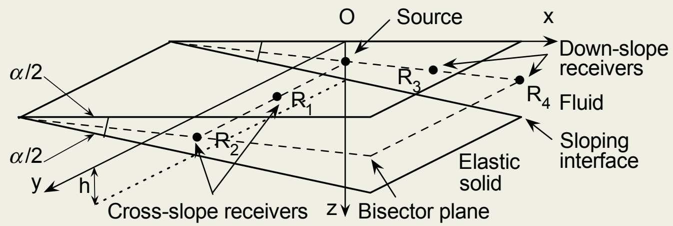

FIG. 1. Cartoon (not to scale) of a three-dimensional (3-D) benchmark model of the fluid wedge of apex angle $\alpha = 3$ deg over an elastic solid (sandstone) bottom, used to explain cross- and down-slope long-range acoustical propagation of explosive sound in the coastal wedge. A point source is placed below the origin O of a Cartesian coordinate system (x, y, z) at the bisector plane of the wedge, where the depth of the fluid is h = 200 m. Four receivers R_1, R_2, R_3, R_4 are also placed at the bisector plane of the wedge; R_1 and R_2 cross-slope off the source at ranges of $r_1 = 20$ km and $r_2 = 40$ km; R_3 and R_4 down-slope off the source at ranges of $r_3 = 20$ km and $r_4 = 40$ km. The geoacoustic properties of the fluid (water) are: $\rho = 1$ g/cm^3; $c = 1500$ m/s; $\alpha_P = 0$ dB/λ. Those of the elastic solid (sandstone) are: $\rho_2 = 2.2$ g/cm^3; $c_P = 2670$ m/s; $\alpha_P = 0.1$ dB/λ; $\alpha_{Refr} = \alpha_P$ dB/λ; $c_S = 1090$ m/s, $c_S < c$; $\alpha_S = 0.2$ dB/λ; $\alpha_{Sch} = 1.1\alpha_S$ dB/λ.

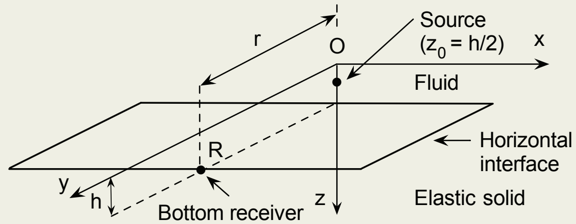

FIG. 2. Cartoon (not to scale) of a three-dimensional (3-D) benchmark model of the fluid half-space over a semi-infinite elastic solid (sandstone) bottom, used to explain long-range acoustical propagation of explosive sound along a flat bottom of the deep ocean. The origin O of a Cartesian coordinate system (x, y, z) is placed above a horizontal fluid-solid interface at a height of h = 200 m, and a point source is placed at a height of h/2 = 100 m, thus the depth of the source (relative to the origin O) is then $z_0 = 100$ m. A bottom receiver R is placed in the source medium (fluid) at the interface at a range of r = 40 km. The geoacoustic properties of the fluid (water) are: $\rho = 1$ g/cm^3; $c = 1500$ m/s; $\alpha_P = 0$ dB/λ. Those of the elastic solid (sandstone) are: $\rho_2 = 2.2$ g/cm^3; $c_P = 2670$ m/s; $\alpha_P = 0.1$ dB/λ; $\alpha_{Refr} = \alpha_P$ dB/λ; $c_S = 1090$ m/s, $c_S < c$; $\alpha_S = 0.2$ dB/λ; $\alpha_{Sch} = 1.1\alpha_S$ dB/λ.