SnT 2023
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
HOFBURG PALACE - Vienna and Online
19 TO 23 JUNE

Modeling Low Frequency Acoustical Propagation in a Shallow-Water Wedge

Piotr Borejko
TU Wien, Institute of Structural Engineering, Karlsplatz 13, 1040 Vienna, Austria

Lightning Talks
P1.3-267

Introduction: In shallow-water environments long-range propagation proceeds by repeated reflections from the surface and the bottom of the channel, as is the case for underwater sound of a wide spectral range, whose low frequencies may propagate over large distances (several tens of kilometers), without significant losses [1].

Objective: Explain low frequency long-range propagation from a source submerged in shallow water over a sloping elastic-type seabed, such as a marine sediment possessing enough rigidity (elasticity in shear) allowing hydroacoustic-to-seismic conversion at a water-sediment interface.

Geo-Acoustic Model: A 3-D benchmark model of the fluid wedge over an elastic bottom (Fig. 1).

Wave-Theory Approach: A method of generalized ray providing a complete signal recorded by a remote receiver, composed of contributions from all of the waveforms typical for the model [not only from the source signal and the regularly reflected waves but also from the critically refracted (lateral) waves and the Scholte interface waves], received in order of their arrivals at a large distance from the source [2].

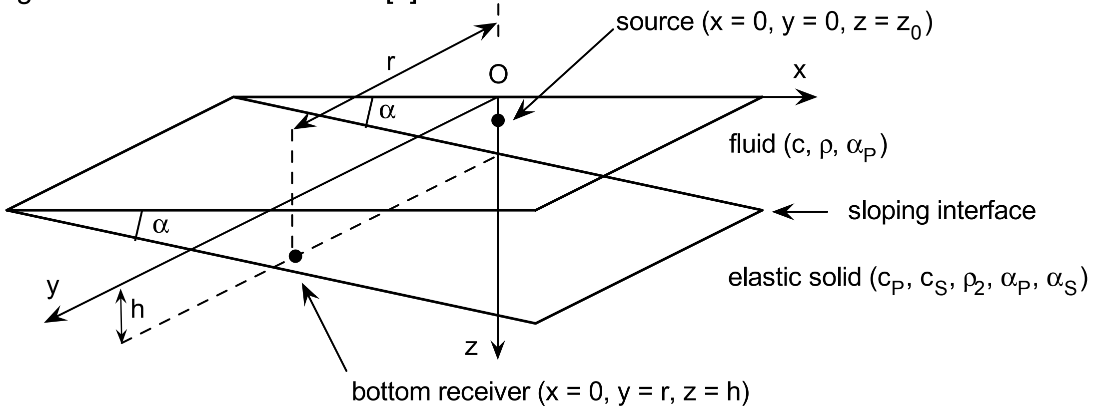

Fig. 1 Fluid wedge over an elastic bottom with a bottom receiver located cross-slope off the source; α = 3 deg, r = 40 km, h = 200 m, z_0 = 100 m; fluid (water): ρ = 1 g/cm^3, c = 1500 m/s, α_P = 0 dB/λ, i.e., negligible attenuation of the source signal and the regularly reflected waves; slow-speed elastic bottom (limestone): ρ_2 = 2.4 g/cm^3, c_P = 3000 m/s, α_P = 0.1 dB/λ, i.e., attenuation of the critically refracted wave $\alpha_{Refr} = \alpha_P$, c_S = 1460 m/s, $c_S < c_P$, α_S = 0.2 dB/λ, i.e., attentuation of the Scholte wave $\alpha_{Sch} = 1.1\alpha_S$.

Results:

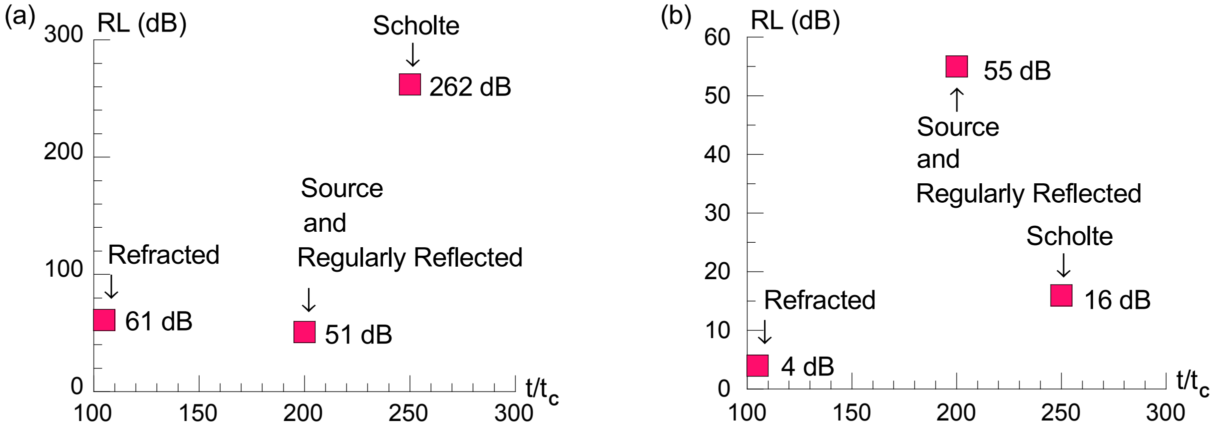

Fig. 2 Received levels (RLs) of the three (critically refracted, source signal and regularly reflected, and Scholte) waveforms, recorded in order of their arrivals at the receiver shown in Fig. 1; (a) due to a Gaussian-weighted source signal with a center frequency of c_f = 3 Hz, a bandwidth of w = 0.5 Hz, and a sound-pressure level of 171 dB re 1 μPa at 1 m; (b) due to a Gaussian-weighted source signal with a center frequency of c_f = 36 Hz, a bandwidth of w = 0.5 Hz, and a sound pressure level of 171 dB re 1 μPa at 1 m.

Conclusion: When a source emits signals of a low-frequency content, like of 3 Hz, the contribution from the Scholte waves becomes dominant at large distances. Hence, low frequency long-range propagation in a shallow-water wedge (coastal wedge) over an elastic seabed may indeed be governed by the Scholte waves.

References:

[1] Hovem J.M. and Korakas A., *Marine Technology Society Journal*, Vol. **48**, pp. 72-80, 2014.
[2] Borejko P., Chen C.F., and Pao Y.H., *J. Comput. Acoust.*, Vol. **9**, pp. 41-68, 2001.

In-Person Lightning Talk: Wintergarten, Tuesday, 20 June 2023, 09:00