Appendix C

Geophone transfer functions

This appendix describes how to remove the predicted frequency-dependent sensitivity from the LoFS geophones. Geophone transfer functions are the relationship between the input (particle velocity) and output (electrical potential) of the seismic sensors. These sensors are usually formed by a mass suspended by a spring in a reference frame (Keller, 2014). As a wave passes by, the reference frame is displaced but the proof mass stays in place. The mass, a suspended magnet, is enclosed by a coil. The relative motion between the coil and the magnet induces a current in the coil that flows through a resistor. The potential is measured across the resistor. The transfer function, $T(\omega)$, is straightforwardly that of a damped, forced simple harmonic motion system (Lowrie, 2007; Hons and Stewart, 2006):

$$T(\omega) = \frac{\omega^2}{-\omega^2 + 2i\lambda\omega_0\omega + \omega_0^2}, \tag{C.1}$$

where natural angular-frequency, ω_0, and the damping ratio, λ, are properties of the suspension spring and electrical circuit. The transfer function is scaled by an overall sensitivity factor, G, with units $\propto Vm^{-}1\ s$. A high-cut filter eliminates aliasing during digitization.

Valhall has a GeoRes SubSea Sensor Array Cable installed with OMNI-X-LT Geophones (Geospace Technologies, 2014b). These exhibit a natural frequency of

$f_0 = 15$ Hz, a sensitivity of $G = 0.220$ mV cm^{-1} s and a circuit-damping ratio of $\lambda = 68$ % (Geospace Technologies, 2014a). Figure C.1 contains the amplitude and phase of the geophone transfer function.

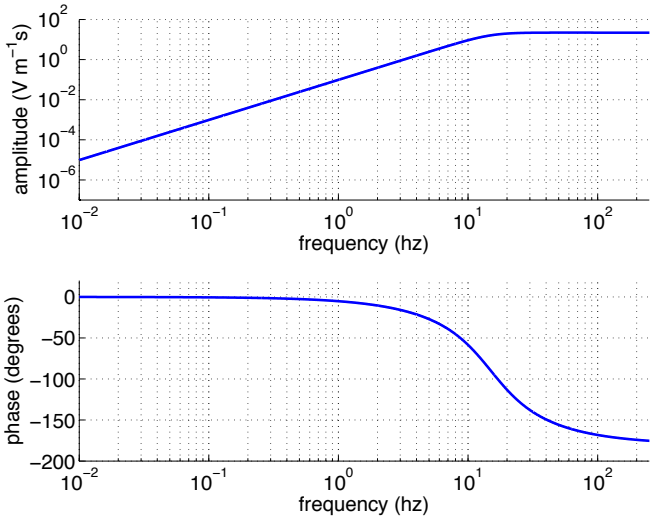

Figure C.1: Amplitude and phase of geophone transfer functions. The amplitude has a 12 db per octave analogue low cut down from the resonance frequency (15 Hz). The phase rotates 180 degrees over several octaves on either side of the resonant frequency. [**ER**] stresponse

The microseism frequency regime ($0.1 - 2.0$ Hz) falls on the lower end of the natural frequency regime. At these frequencies, the geophones exhibit almost no phase shift but also a low sensitivity. The phase of the transfer function is of no concern as long as only crosscorrelations between geophones are studied and as long as it is equal for all channels. When crosscorrelating two geophones the phase of the transfer function is annihilated. When crosscorrelating a geophone recording with a hydrophone recording, the phases of both the geophone and hydrophone transfer functions are subtracted but the remainder would still need to be corrected.

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