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アクティブソースによる高周波地震波の伝搬の研究
Study of high-frequency seismic wave propagation by active-source experiments

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Seismic wavefields generated by resonant shaking experiments of the Millikan Library, on the campus of California Institute Technology (Pasadena, California, USA), were analyzed. Because the resonant shaking frequencies are 1.12 Hz (the east-west direction) and 1.64 Hz (the north-south direction), this active-source experiment can provide opportunities for studying high-frequency seismic wave propagation in Southern California.

Two such experiments for each frequency were analyzed; for the north-south shaking experiments, the harmonic signals were observed up to distance 323 km in one experiment and up to 396 km in another experiment. For the east-west shaking (1.12 Hz), the maximum distance was 200 km but most observations were confined to less than 100 km.

Spectral amplitudes showed a systematic decaying trend with distance in all cases. Numerical simulations indicated that the predominant signals were surface waves. Assuming that all signals were surface waves, we obtained estimates for the parameter QU for surface waves where Q is the attenuation parameter and U is the group velocity (in km/s). There was, however, a major break in the amplitude-distance trend at a distance about 50 km; for data with distance less than 50 km, QU = 95 $\pm$16 , where U is in km/s. For data beyond 50 km, we obatined QU= 1454 $\pm$ 226. This change in trend must be related to the regions sampled by waves, as the shorter-distance data were dominated by paths in the Los Angeles basins while the longer-distance data did not contain paths in the basin structures.

Through cross correlations between MIK (station in the Millikan library) and a station in the regional network, phase information was also analyzed. For many stations, phase was stable for frequencies between 1.637 and 1.638 Hz which meant that phase is locked between MIK and a station. While it was not possible to estimate phase velocity, because the number of cycles cannot be resolved for high-frequency waves, a stacking approach for multiple-window data allowed us to estimate frequency derivative of phase and group velocity for 25 paths. Group velocity between MIK and network stations are mostly less than 2 km/s. For stations with distance less than 50 km, most group velocity results were about 0.5 km/s or less. Combined with the estimate for QU from the amplitude-distance data, Q is estimated to be 190 for distances less than 50 km. This estimate, however, contains uncertainty up to a factor of two as variations in group velocity estimates differ from station to station.

キーワード: 地震波伝搬, 地殻構造, アクティブソース実験
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