ENHANCED EVENT LOCATIONS USING Lg-ARRIVALS

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Background

Lg-waves are with few exception the most prominent seismogram arrivals at local and regional distance ranges. The notation Lg refers to to shear (Love) waves travelling in the crustal wavewaveguide by means of multiple reflections at and beyond critical angles. Characteristic Lg-features are prominence in the 1 to 3 Hz band, group velocity typical 3.5+/- 0.2 km/sec and strong amplitudes on all 3 seismometer components. Peculiarities are inability to cross oceanic crust and occasionally wiped by prominent continental tectonic features like the grabens in the North Sea basin. Anyway, in a monitoring context Lg-amplitudes are just for mapping crustal Qs-distribution. A superior theoretical approach to Lg-propagations in the Earth is 2D finite difference solutions of the wave equation. Despite the prominence of Lg-waves and hence its importance for monitoring weak seismic events, only the Lg-amplitudes are used in practice. The problem dealt with here is reliable pickings of Lg-travel times and their usage in event location.

Measuring Lg-arrival times

Since Lg first arrivals are in the Sn-coda and besides being weak so it is hopeless to pick with confidence. Instead, we aim at its large maximum amplitudes which are easy to identify and pick accurately. Our strategy was bandpass prefiltering (1 to 3 Hz) and then Hilbert or STA transform of the original waveforms into envelopes and finally pick automatically the envelope peak (preference for 2 sec STA-window). This implies that Lg-arrivals can be extracted directly from the station detection logs. Our novel concept for extracting Lg-arrival times have been tested on real recordings from one of the Kaliningrad earthquakes of 21 Sep. 2004, network and time picks in Fig. 1 and 2. We have analyzed several other events in North and Central Europe with similar consistent results in picking Lg-arrivals. Interesting in this regard is that Lg-group velocities vary somewhat; between 3.4 to 3.5 km/sec for northwest propagation paths that is shield and platform provinces while to the significant younger regions to the south and southeast group velocities are between 3.15 to 3.30 km/sec. Really not surprising as crustal P- and S-velocities also reflect the tectonics of their propagation paths.

Lg-Arrival Times The Origin Time Problem

The advantage of using Lg-observations is their relative short wavelengths of only 3.5 km at 1 Hz. The drawback is that the origin time for such readings are hardly equal to that of the P- and S-body waves. Reason is that Lg-pickings are not at the first onset and besides focal depth are not likely to affect Lg-arrival times much. The problem is theoretically difficult so we are experimenting with 2D Finite Difference synthetics for various source types and focal depths (5 to 25 km). Such computations require exceptional computer resources and we use the CRAY machine at BCCS/UNIFOB/UoBergen. Preliminary results, as expected, have shown that Lg-arrivals are not sensitive to focal depth variations. In an event location context we have two options for solving this origin time (OT) problem:
• to treat Lg-arrivals independently of P- and S-observations and/or
• introduce a 5th source parameter that is a correction to the ordinary P-wave OT-parameter. We are working on this problem in close cooperation with dr. Vlad. Pinsky.

Concluding Remarks

Lg-waves are a prominent part of seismic records at local and regional distance ranges. Corresponding travel time observations extracted from Lg-envelopes would provide a potent mean for improving epicenter locations of weak, local events due to the short wavelength of Lg-waves. The challenge is Just Do It.

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