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Geometrical Focusing as a Mechanism for Significant Amplification of Ground Motion in Sedimentary Basins

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In this study we investigate the parameters which lead, by mechanism of geometrical focusing, to exceptionally high ground shaking during strong earthquakes. We have previously shown that the deeper structure of sedimentary basins can produce a range of intra-basin effects, i.e. edge-effect above faults and other steep structures, diversion of seismic energy by convex diapirs or magmatic intrusions and convergence of seismic waves above "bowl-shaped" sub-basins (Shani-Kadmiel et al., 2012). We find by means of analytical solution the point at which seismic energy converges and employ a 2-D finite difference numerical solution for a more detailed analysis in the time and frequency domains.

Our results indicate that effective geometrical focusing occurs for a very specific set of interface eccentricities and velocity ratios, converging seismic energy at ± 0.5 km from the surface. In cases where the span of the convergence zone is sufficiently small and close to the surface, this mechanism leads to significant amplification of PGV at the center of the basin by up to a factor of 3.5. The spectral amplification ratio of ground motions as a result of effective geometrical focusing is frequency dependent such that amplification is proportional to frequency up to the corner frequency of the source. Effectively focusing basins with low velocity ratio equate the travel-time of body- and surface-waves causing them to converge at the center of the basin. Overlapping resonant frequencies of these phases cause a ground motion pulse with exceptionally large amplitude.