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Effects of structural parameters on earthquake ground motion characteristics in sedimentary basins

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Sedimentary basins and valleys generate strong effects on earthquake ground motion (EGM). These effects are rarely accounted for even in site-specific studies due to the cost of the required geophysical surveys to constrain the site model, lack of data for empirical prediction, and poor knowledge of the key controlling parameters.

We investigated effects of a variety of structural parameters on 10 EGM characteristics in sedimentary basins and valleys. We used a set of representative models defined by a major Research & Development project SIGMA (SeIsmic Ground Motion Assessment), jointly organized by energy giants EDF, AREVA, CEA and ENEL – Mygdonian basin, deep Alpine Grenoble valley, and 4 other typical valleys in France – two small, one mid-sized and one relatively large.

The valleys differ considerably in size, geometry of sediment-bedrock interface, velocity structure and attenuation. The variety of structural parameters is considerably extended by model modifications which include
a) variations in interface geometry, velocity and velocity distribution in sediments, velocity in bedrock, attenuation in sediments,
b) small-scale random heterogeneities in P-wave velocity, S-wave velocity and density described by three different autocorrelation functions and three different values of standard deviation,
c) presence of a porous water-saturated sediment layer described by a depth of a water table, porosity and permeability.

We calculated amplification factors, and 2D/1D and 3D/2D aggravation factors for 10 EGM characteristics, using a set of recorded accelerograms to account for input motion variability.

We used robust statistical analysis as well as specific targeted analysis of the calculated EGM characteristics for thousands of receivers. We identified a few key structural parameters and quantified their impact on amplification and geometrical aggravation factors for a few key characteristics.