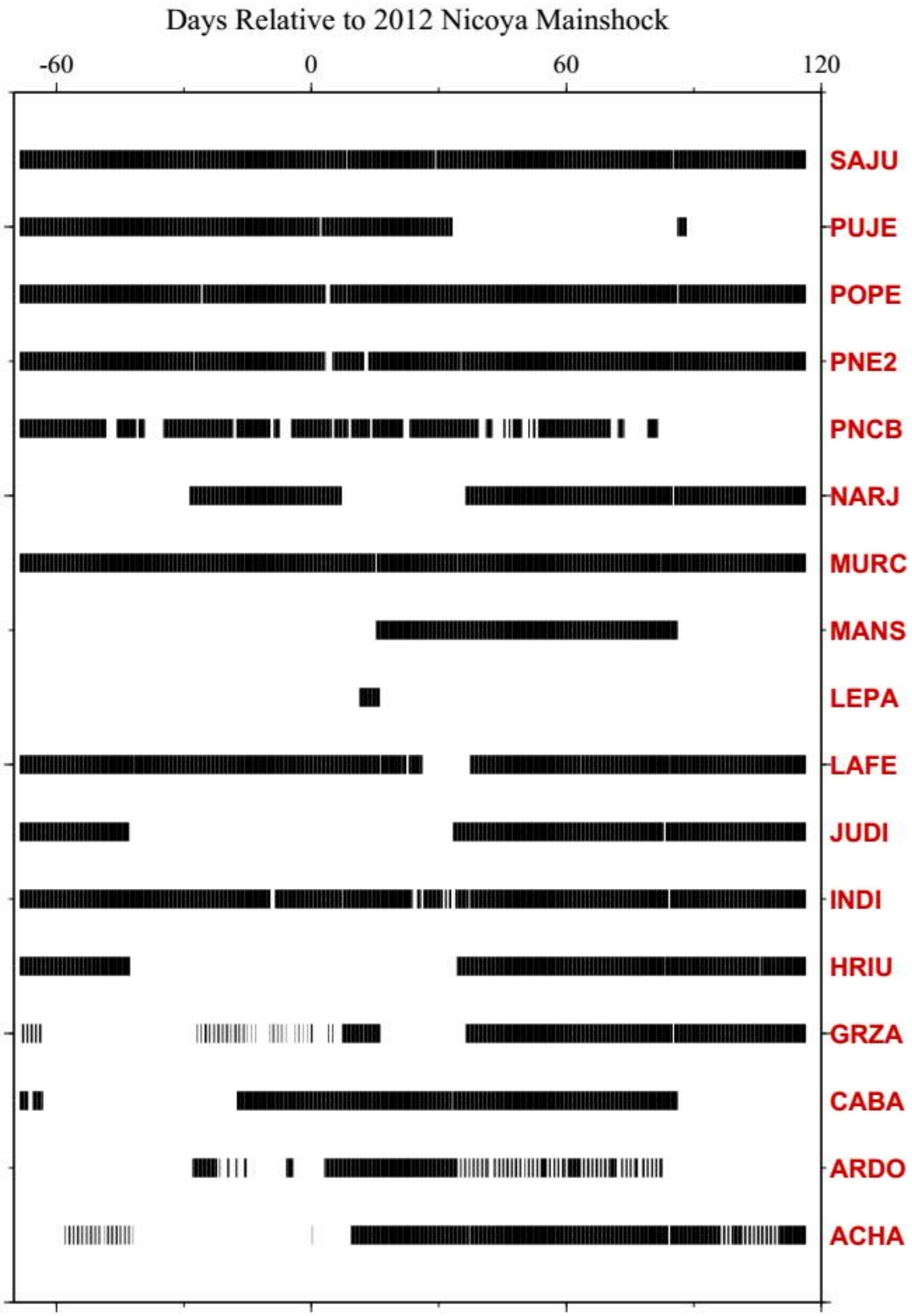

Figure S1. Temporal availability for different stations around the 2012 Nicoya mainshock. Station names are marked to the right.

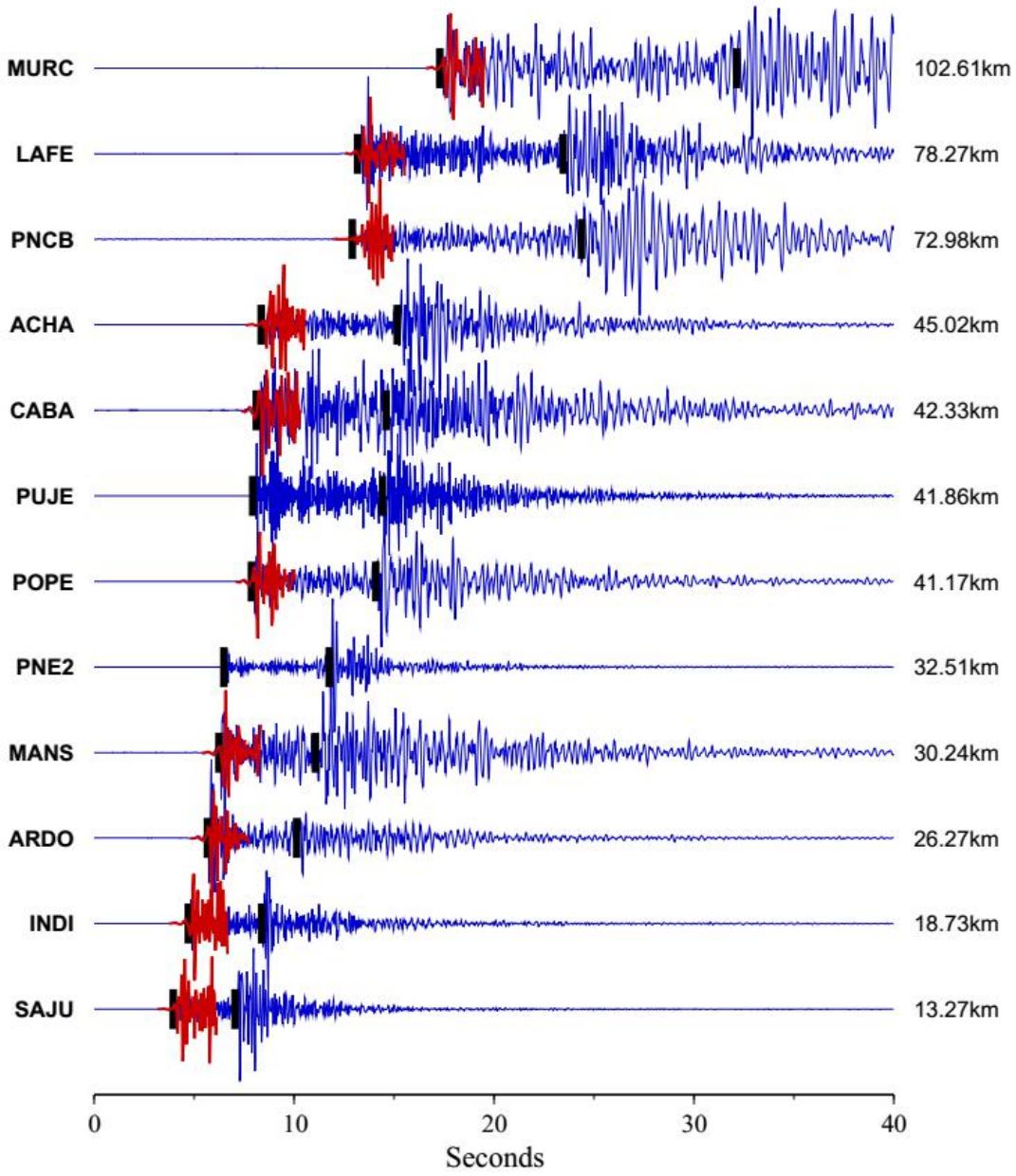

Figure S2. An example showing the updated phase library. Original phases are marked with red waveforms, while the dark bars indicate the resulting available phases. Station name and epicentral distances are marked to the left and right sides, respectively.

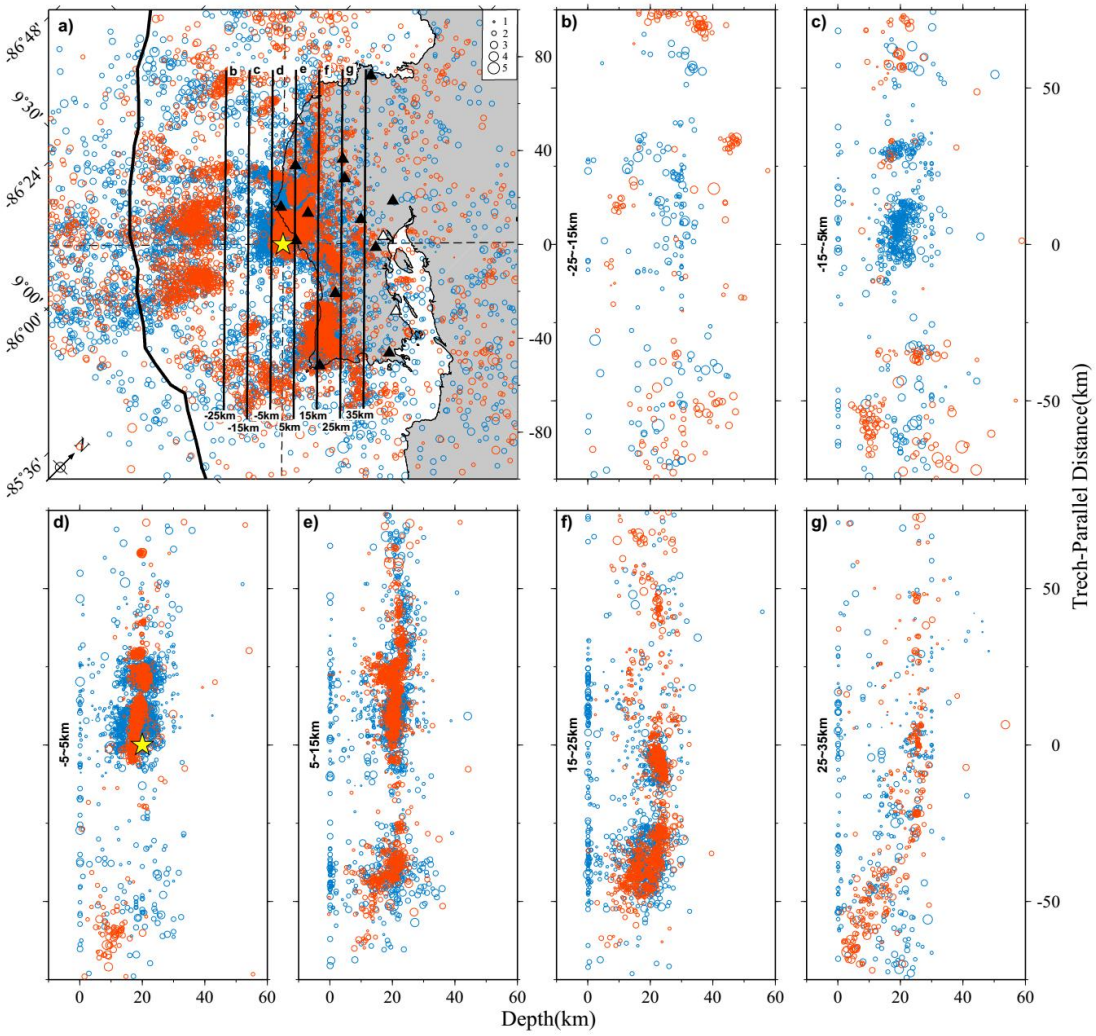

Figure S3. Seismicity depth distribution along the trench parallel direction. a) All events are projected along N45E and use the mainshock epicenter (longitude: -85.5271, latitude: 9.8193, depth: 20 km; yellow star) as the projection center. Seismic activities before (blue circles) and after (red circle) relocations are plotted. The trench-normal distances relative to the mainshock epicenter and bin ids are labeled to the bottom and top, respectively. b-g) the depth profile within each bin.

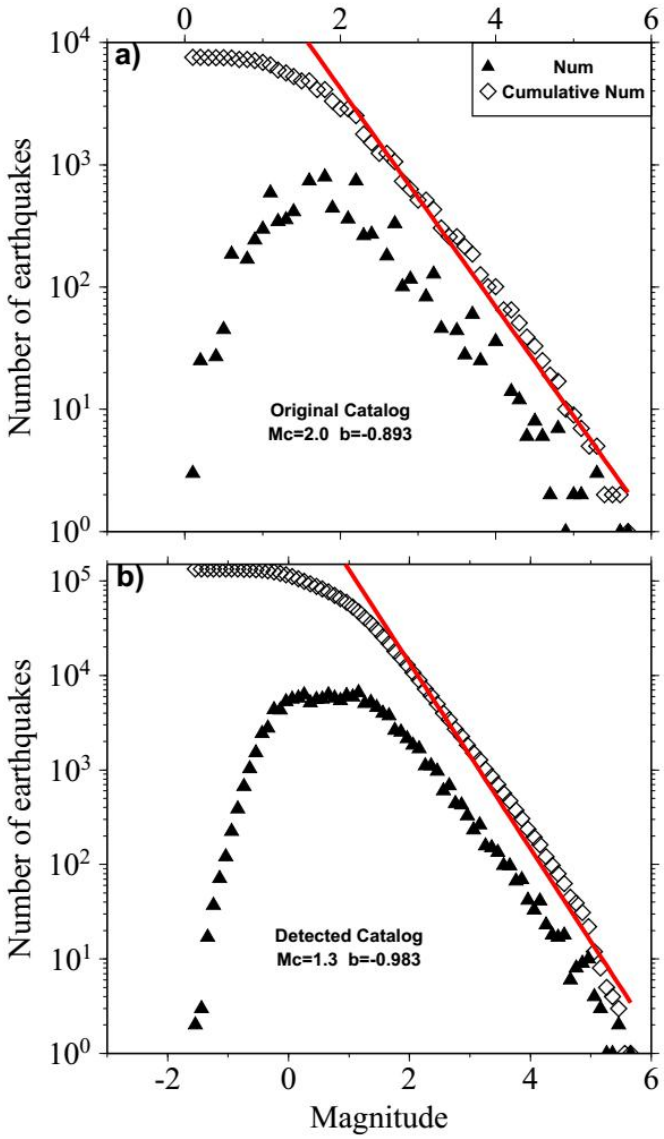

Figure S4. Gutenberg-Richter (G-R) law. Diamonds show the cumulative number of earthquakes, while black triangles are number of events for different magnitude bins. a) Original catalog, b) Detected catalog. Red bold curves are maximum-likelihood G-R fitting. The *Mc* and b value are labeled in each panel.