Geophysical Research Abstracts, Vol. 7, 04802, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04802

Re-evaluation of focal depths and source mechanisms of selected earthquakes in the Afar depression

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We present a stepwise inversion procedure, to assess the focal depth and model earthquake source complexity by studying eight moderate sized earthquakes of Mw>5 that occurred in the Afar depression and the surrounding region. The area under study is generally characterized by shallow earthquakes in the depth range of 10-35 km. Linear moment tensor inversion was performed to model direct P, S and a joint inversion of P and S waves of teleseismic data. Greens functions were computed for two simple source velocity structures, for a half space and a simple two layered earth model at the source. For each model, the first step was to fix the depth and to let all other parameters vary in the inversion. Waveform inversion is done for both a single and a double event source, and in each case a representative focal depth is found to correspond to the minimum misfit between the synthetic and observed seismograms. The measure of the misfit is the ratio of the weighted residual variance to the weighted data variance (R/D%) which is calculated in the inversion procedure for a step of 2.5 km in depth. This procedure is repeated for a given source time function (STF), with its elements being forced to remain positive. At each depth step, we examined the variations of the moment tensor elements and the estimated source duration with depth. Some elements of the moment tensor are found to be more sensitive to depth than others. More analysis was also done to determine parameters associated with source directivity (rupture

velocity, azimuth and plunge). We used fixed rupture velocity and performed the inversion by varying the azimuth with a span of 30^o until further minimum in the misfit is obtained. The effect of source velocity structure on the moment tensor elements is also investigated. Broadband stations with fairly reasonable azimuthal coverage around the events and in the distance range of 30- $90^o$are selected for our analysis. We used a graphical method of Riesdsel and Jordan (1989) to display the significance of the non-double couple components. These numerical experiments are believed to have resolved the focal depth and the source mechanisms of the examined events.