Kinematic Modeling and Complete Moment Tensor Analysis of the Anomalous, Vertical CLVD, BÃ¡rÃ°arbunga, Iceland, Event

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Using the complete moment tensor time domain inversion method, we investigated the September 29, 1996 volcanic event of Mw=5.6 originated beneath the BÃ¡rÃ°arbunga caldera in Iceland. The corresponding moment tensor is characterized by a significant non-double-couple component (NDC) previously reported in the Harvard centroid moment tensor catalog (CMT) and confirmed by analysis of long-period and intermediate surface wave data. The deviatoric inversion performed by using Iceland Hotspot Project IRIS-PASSCAL stations, yields a NDC solution with a 67% vertically oriented compensated linear vector dipole (CLVD) component, while the full moment tensor solution shows a similar, 66% CLVD component, 32% of double-couple component (DC) and a small volumetric contraction (ISO) of 2%. Statistical tests confirm that CLVD is a stable component of the moment tensor, while ISO is statistically insignificant. Using an elastic finite difference code, with a large number of equidistantly distributed point sources we simulated various rupture scenarios on the walls of a conical surface of the BÃ¡rÃ°arbunga caldera in order to compare them with the observations. Suites of seismograms for each independent run were produced at locations corresponding to HOTSPOT stations. We then inverted these synthetic data to investigate what portion of the original source information can be recovered by the moment tensor inversion. We were able to identify physical characteristics of a rupture scenario that produces synthetics which resemble the observed data to a quite high level of detail. For example, we obtained the best results for the ruptures extending along one-half perimeter of the caldera, while one-quarter or full-length perimeter ruptures were unlikely scenarios. We found that the rupture velocity, which took place at BÃ¡rÃ°arbunga could have been a super-shear one, and we hypothesize that it could have been triggered by a compressional wave field that spread throughout the volume of the caldera.