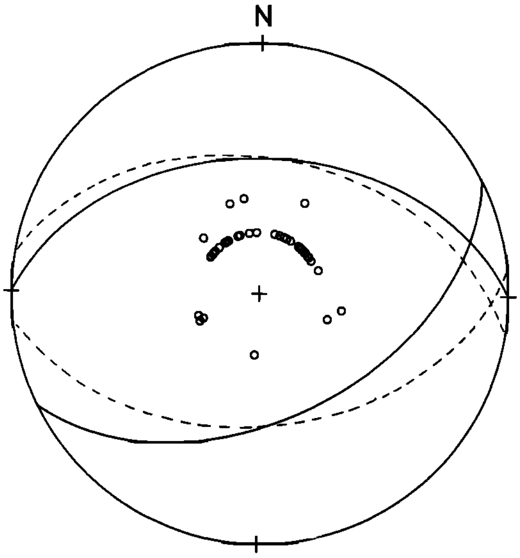

Fig. 2. Lower hemisphere equal-area projection of *Given and Kanamori*'s [1980] mechanism (ϕ=270°, δ=45°, λ=−70°; solid line) and *Spence*'s [1986] *P* wave first-motion mechanism (ϕ=279°, δ=45°, λ=−80°; dashed line). Also shown are the first motions, all dilatations, of the phases used in this study.

violates some of the *P* wave first motions. In any case, most of the phases for which we could recover waveforms leave the focal sphere near the lobe of the *P* radiation pattern, rendering them fairly insensitive to the choice of the focal mechanism.

Depth Determination

Another fundamental parameter that must be specified to construct the Green's function is the depth of the earthquake. As noted earlier, the depth of the Sumba event is problematical and must be treated as a variable. The source process of this event is long enough to obscure depth phases in the observed body waves, as indicated in the representative *P* waveform in Figure 3. However, the main impulsive arrival is preceded by a precursory stage of low energy release beginning about 15 s earlier. (The onset of this precursory radiation actually corresponds to the ISC epicenter and origin time.) Owing to its small size and clear separation from the main pulse, the depth phase *pP* can be identified in some of the seismograms (Figure 4, top). The *P–pP* delay time is generally about 6–7 s, corresponding to a depth of about 29 km (Figure 4, bottom) using the upper mantle model PA2 of *Lerner-Lam and Jordan* [1987]. Thus the Sumba earthquake appears to have nucleated with weak radiation near the downdip edge of the subsequent aftershock zone.

In order to determine the location of the onset of the main pulse relative to the hypocenter we measured the differential time between the first arrival and the main pulse on 39 seismograms, including many used in the subsequent deconvolutions. We then applied a master event relocation procedure to the differential times, assuming a half-space velocity of 7.6 km/s. This procedure indicated that the main pulse initiated 2±4 km to the south, 30±3 km to the west, and 28±22 km above the focus of the precursor. The relative origin time is 12±3 s. The relative depth obviously trades off severely with the relative origin time, so the exact depth of nucleation of the main pulse is still uncertain. Nevertheless, it appears that the main pulse did not initiate below 30 km depth.

The waveform complexity of the principal radiation for the Sumba earthquake makes any forward modeling approach impractical for determining the rupture extent, as there are inherent tradeoffs between source function and depth. *Christensen and Ruff* [1985] have examined these tradeoffs by deconvolving finite source synthetic seismograms using Green's functions for point sources at several different depths. They found that deconvolutions performed using source depths below the true rupture extent produce source time functions with a characteristic "ringing." To illustrate this behavior, deconvolutions of a synthetic seismogram computed for a point source 15 km deep are shown in Figure 5. Note that the use of an overestimated depth (40 km) in the deconvolutions produces an excellent fit to the seismogram, but at the expense of an oscillatory source function. Underestimating the depth causes only a moderate broadening of the source function [*Christensen and Ruff*, 1985].

In order to determine the best depth for the purposes of deconvolution, we deconvolved the undiffracted phases, starting at the onset of the main pulse, using Green's functions computed for finite sources extending from 1 km depth to depths of 20, 30, 40, 50, 60, and 70 km (Figure 6), assuming a water depth of 4 km. The most reasonable depth extent to adopt is that which minimizes spurious oscillations (i.e., fulfills a parsimony criterion for the moment rate functions) and produces the most consistent source functions for stations with similar azimuths. This depth experiment should provide some resolution on the depth extent of the 1977 Sumba earthquake, at least in so far as the higher-frequency radiation is concerned.

For all of the seismograms, the shallower depths produce the most stable source functions with the smallest number of oscillations. For instance, the moment rate functions for the greater depth extents at DAG have late oscillations nearly as high as the

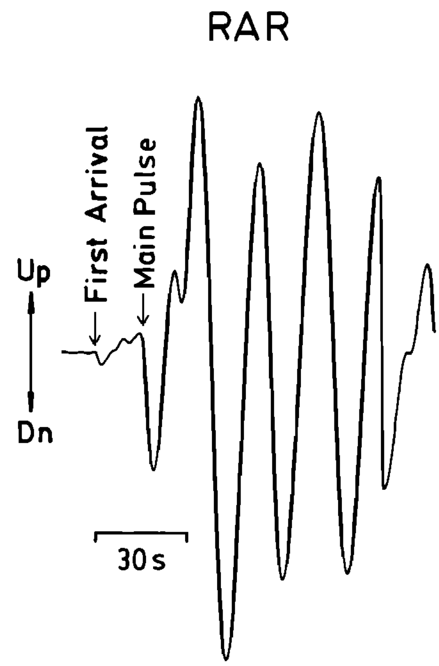

Fig. 3. *P* wave from the vertical component of WWSSN station RAR (Δ=79°, azimuth=110°). The main pulse of the 1977 Sumba earthquake is preceded by a low level of precursory radiation beginning about 15 s earlier, corresponding to the actual origin as reported by ISC.