Calculation of hypocentral loci for locating earthquakes in transversely isotropic media

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Earthquakes can be located visually and robustly using their hypocentral loci. However, it is difficult to find the analytical expressions of hypocentral loci in models with seismic anisotropy. A method is presented for calculating hypocentral loci of seismic events in transversely isotropic media, which exist widely in the Earth's interior.

The method for calculating hypocentral loci consists of two steps. The first step is selection of reference points of the hypocentral locus. As for each model node in the field of residuals between observed and calculated arrival time differences or arrival times, it is combined with its adjacent nodes differing from it in residual polarity (positive, zero, or negative) into node pairs. Among these node pairs, the one with maximum absolute gradient is referred to as a normal node pair and its node with smaller absolute residual is selected as a focal locus reference point (FLRP), which is based on the facts that (1) the hypocentral locus lies between such adjacent nodes that they have different residual polarity; (2) the absolute gradient of residual is maximum along perpendiculars to the hypocentral locus; (3) in a normal direction, the closer to the hypocentral locus, the smaller the absolute residual. The other step is calculation of ray paths representing the focal locus. In low absolute residual connected regions of which each completely contains only one of the segments constituting a hypocentral locus, the ray paths from the separate regional minimum points to their respective FLRPs within the same connected regions are calculated to represent the hypocentral locus.

Numerical examples show that the presented method is adapted to transversely isotropic media with tilted symmetry axis, and has no restrictions in the stability and the number of hypocentral locus segments. The calculated hypocentral loci are fine and complete enough for accurate earthquake location.