H. Gjoystdal, J. E. Reinhardsen and B. Ursin. *Traveltime and wavefront curvature calculations in three-dimensional inhomogeneous layered media with curved interfaces*

The seismic rays and wavefront curvatures are determined by solving a system of nonlinear ordinary differential equations. For media with constant velocity and for media with constant velocity gradient, simplified solutions exist. In a general inhomogeneous medium these equations must be solved by numerical approximations. The integration of the ray-tracing and wavefront curvature equations is then performed by a modified divided difference form of the Adams PECE (Predict–Evaluate–Correct–Evaluate) formulas and local extrapolation. The interfaces between the layers are represented by bicubic splines. The changes in ray direction and wavefront curvature at the interfaces are computed using standard formulas. For three-dimensional media, two quadratic traveltime approximations have been proposed. Both are based on a Taylor series expansion with reference to a ray from a reference source point to a reference receiver point. The first approximation corresponds to expanding the square root of the result. The second approximation corresponds to expanding the traveltime in a Taylor series. The two traveltime approximations may be expressed in source–receiver coordinates or in midpoint-half-offset coordinates. Simplified expressions are obtained when the reference source and receiver coincide, giving zero-offset approximations, for which the reference ray is a normal-incidence ray. A new method is proposed for computing the second derivatives of the normal-incidence traveltime with respect to the source–receiver midpoint coordinates. By considering a beam of normal-incidence rays it is shown that the second-derivative matrix may be found by computing the wavefront curvature along a reference normal-incidence ray starting at the reflection point with the wavefront curvature equal to the curvature of the reflecting interface. From this second-derivative matrix the normal moveout velocity can be computed for any seismic line through the reference source–receiver midpoint. It is also shown how a reverse wavefront curvature calculation may be used, in a time-to-depth migration scheme, to compute the curvature of the reflecting interface from the estimated second derivatives of the normal-incidence traveltime. Numerical results for different three-dimensional models indicate that the first traveltime approximation, based on an expansion of the square of the traveltime, is the most accurate for shallow reflectors and for simple models. For deeper reflectors the two approximations give comparable results, and for models with complicated velocity variations the second approximation may be slightly better than the first one, depending on the particular model chosen. A simplified traveltime approximation may be used in a three-dimensional seismic velocity analysis. Instead of estimating the stacking velocity one must estimate three elements in a 2×2 symmetric matrix. The accuracy and range of validity of the simplified traveltime approximation are investigated for different three-dimensional models.

M. Tygel and P. Hubral. *Transient representation of the Somerfeld–Weyl integral with application to the point source response from a planar acoustic interface*

Point source responses from a planar acoustic and/or elastic layer boundary (as well as from a stack of planar parallel layers) are generally obtained by using as a starting point the Somerfeld–Weyl integral, which can be viewed as decomposing a time-harmonic spherical source into time-harmonic homogeneous and inhomogeneous plane waves. This paper gives a powerful extension of this integral by providing a direct decomposition of an arbitrary transient spherical source into homogeneous and inhomogeneous transient plane waves. To demonstrate with an example the usefulness of this new point source integral representation, a transient solution is formulated for the reflected/transmitted response from a planar acoustic reflector. The result is obtained in the form of a relatively simple integral and essentially corresponds to the solution obtained by Bortfeld (1962). It, however, is arrived at in a physically more transparent way by strictly superimposing the reflected/transmitted transient waves leaving the interface in response to the incident transient homogeneous and inhomogeneous plane waves coming from the centre of the point source.

C. Z. Tarlowski, A. P. Raiche and M. Nabighian. *The use of summary representation for electromagnetic modeling*

The method of summary representation developed by G. N. Polozhii is a quasi-analytical method for solving self-adjoint, finite-difference boundary value problems expressed on regular meshes. In principle, the method should allow considerable savings in computing time as well as improved accuracy when compared to commonly used finite-difference schemes. We have used summary representation as the basis for a new hybrid scheme to solve the two-dimensional Helmholtz equation for electromagnetic modeling. The theory behind this hybrid scheme is presented. Preliminary results for the two-dimensional problem show that substantial computing time and storage savings can be made.

P. E. Wannamaker, G. W. Hohmann and S. H. Ward. *Magnetotelluric responses of three-dimensional bodies in layered earths*

The electromagnetic fields scattered by a three-dimensional (3-D) inhomogeneity in the earth are affected strongly by boundary charges. Boundary charges cause normalized electric field magnitudes, and thus tensor magnetotelluric (MT) apparent resistivities, to remain anomalous as frequency approaches zero. However, these *E*-field distortions below certain frequencies are essentially in-phase with the incident electric field. Moreover, normalized secondary magnetic field amplitudes over a body ultimately decline in proportion to the plane-wave impedance of the layered host. It follows that tipper element magnitudes and all MT function phases become minimally affected at low frequencies by an inhomogeneity. Resistivity structure in nature is a collection of inhomogeneities of various scales, and the small structures in this collection can have MT responses as strong locally as those of the large structures. Hence, any telluric distortion in overlying small-scale extraneous structure can be superimposed to arbitrarily low frequencies upon the apparent resistivities of buried targets. On the other hand, the MT responses of small and large bodies have frequency dependencies that are separated approximately as the square of the geometric scale factor distinguishing the different bodies.