ELASTIC GAUSSIAN BEAMS TRUE-AMPLITUDE IMAGING: MULTI-COMPONENT SURFACE DATA FROM VOLUMETRIC SOURCES

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We present an approach of true amplitude seismic imaging by means of weighted summation of multi-shot multi-offset data. We consider 2D half-plane filled by a heterogeneous elastic medium with Lamé parameters decomposed into the sum of smooth (macrovelocity) model supposed to be known and its unknown rapid perturbations. This decomposition introduces representation of the full wave field as superposition of the incident (downward) and reflected/scattered/diffracted (upward) wave fields. We assume that magnitude of perturbations permits to use linearized (Born) approximation for representation of upward wave field. The goal is to recover rapid perturbations, or some of their combinations by resolution of the linear integral equation of the first kind if macrovelocity model is a priori known.

Algorithm is based on the version of stacking integral that involves not Green's function, but a couple of P-Gaussian beams (Cerveny, Popov, Psencik, 1982) shot from the current point of the target area towards surface acquisition system. Thus, in order to compute PP image at some current point of the target area, we shot from this point P-Gaussian beam towards the receivers positions with some specific dip and opening angles and compute distribution of stresses induced by this P-Gaussian beam at the receiver positions. The scalar Gaussian beam is shot as well from the same point towards the source positions and its vertical derivative is computed at the sources line.

Next, the input multi-shot/multi-offset data are multiplied turn by these two functions and the product is integrated with respect to receiver and source positions. Double application of Green theorem to this integral simplifies the result and reveals its connection with rapid perturbation of the reference medium. We show that this leads to pseudo-differential operator, the principal term of the asymptotic expansion of which is the orthogonal projection on a set in phase space. This set is exactly the same as that introduced in Protasov and Tcheverda (2005) for scalar wave equation. This projector now acts onto function which depends on Lamé parameters λ, μ and density ρ and opening angle as well (in particular for incidence angle equal to zero this function is nothing else but P-impedance). The latter dependence gives the possibility to perform AVO-like analysis and to recover elastic parameters below interface.

The evident advantages of the proposed approach are the following:

1 As Gaussian beams are globally regular there is no necessity to claim the regularity of the rays;
2 Shooting from the bottom helps to avoid the problems due to multiarrivals;
3 There is no need for preliminary separation of the data to P-and S-waves.

Numerical experiments we are going to present are done with 2D North Sea synthetic model. Presented numerical results clearly confirm effectiveness of the suggested method and demonstrate that it is really true-amplitude imaging.

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