B033 SHOT CONTINUATION OPERATOR

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The operator

Several authors (e.g. Deregowski and Rocca, 1981) have examined the operator called offset continuation or DMO that allows the mapping of common offset to zero offset sections; thus cheap post-stack imaging easily converts reflections to depth.

We introduce the Shot Continuation Operator (SCO) that allows, for a given velocity model, the extrapolation of a common shot gather (CSG) from a neighbouring one. SCO is a time and space varying operator, i.e. the impulsive response to an isolated event depends on both the receiver location and the event's time. To obtain the SCO impulse response we have considered the CSG with the shot at $s=s_i$. In a uniform medium, the locus of the reflectors corresponding to an impulse at the receiver location $r=r_j$ at time T_{ij} is the well known ellipse with foci in (s_i,r_j). The traveltimes impulse response of SCO can be estimated using geometrical optics and illuminating the elliptic reflector from the new shot position.

Fig.1 shows the impulse response for two shot displacements. Amplitudes have been determined by geometrical spreading. The shot continued seismogram and the data in the displaced location share the same subsurface image but have slightly different angular spectra; therefore the SCO should also operate as a dip filter of CSGs.

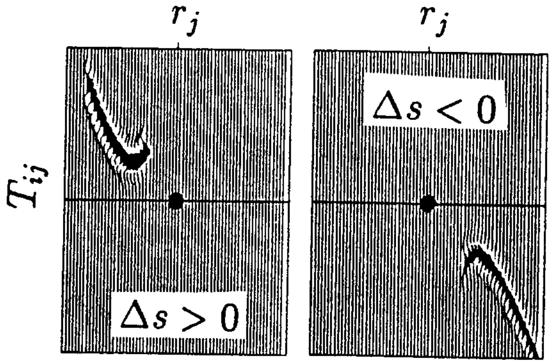

Fig.1 *SCO impulse responses for two opposite shot displacement* Δs.

Applications

Continuation on data space, data interpolation and velocity analysis of CSGs are some of the most interesting applications. Let us consider velocity analysis using SCO. After the continuation of the contiguous CSGs toward the same shot location, the data are sorted to obtain common receiver gathers (CRG). An analysis of these gathers allows the determination of whether or not the velocity used for shot continuation was correct. If a correct velocity was used the reflections from all the sources will be aligned independently of the structure, if not they will be misaligned (shot dependent) and a residual curvature will be observed. The curvature contains information that helps to correct our velocity model. The criterion to check for this alignment is the visual inspection or the coherency measurement. However not all CRG's will give reliable velocity information. Those shots and receivers near the end of the illuminated area will not be aligned even when the correct velocity is used, mainly due to the edge effects . This approach differs from velocity analysis using pre-stack depth migration (Al-Yahya, 1987; Versteeg et al. 1991) because: *i)* SCO allows the computation of velocity residuals using shorter operators than depth focusing; *ii)* SCO performs the analysis in time domain instead of the depth domain.

Examples

The response due to a reflection on a point scatterer located at receiver location $r=r_j$ and depth z is the hyperbola with the apex at r_j and time delay that depends on the shot location. Fig.2 shows the traveltime hyperbolas (a) correspondent to three point scatterers with the same receiver location but at different depths in a uniform medium. The envelope of the convolution of the hyperbolas (a) with the SCO impulse response with the correct velocity gives the shot continued responses (solid line) corresponding to the new shot position. The comparison of the continued responses with the responses obtained by illuminating the point scatterers from the new shot position (b) explains the dip filtering behaviour of the SCO that is more tangible when shallower depths are considered, i.e. the envelope of the impulsive responses is dip limited when compared with (b). SCO has been applied to flat reflector CSGs. Fig.3 shows the CRGs (zero offset CRGs at the continued shot location) that correspond to the application of the SCO with three velocities to ten CSGs. CRG alignment means correct velocity while the misalignment is proportional to the square of the slowness error. Since depth migration of CSGs with wrong velocity gives curved reflector (Maeland 1991), the symmetry of CRGs is guaranteed only for zero offset. The correct velocity could be estimated by flattening the CRGs, either looking at (Constant Velocity ,Shot Continuation Analysis) or measuring the residual curvature at each CRG, and updating the velocity model. The former approach is time consuming since it requires several shot continuations, the latter allows the establishment of a simple time to depth conversion of the residual velocity model. For lateral velocity variation, a tomographic correction to the model is advisable and this is the subject of the running research.

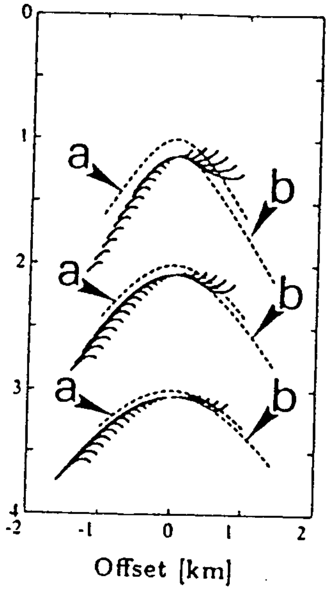

Fig.2 *Shot continuation of reflections from 3 point scatterers.*

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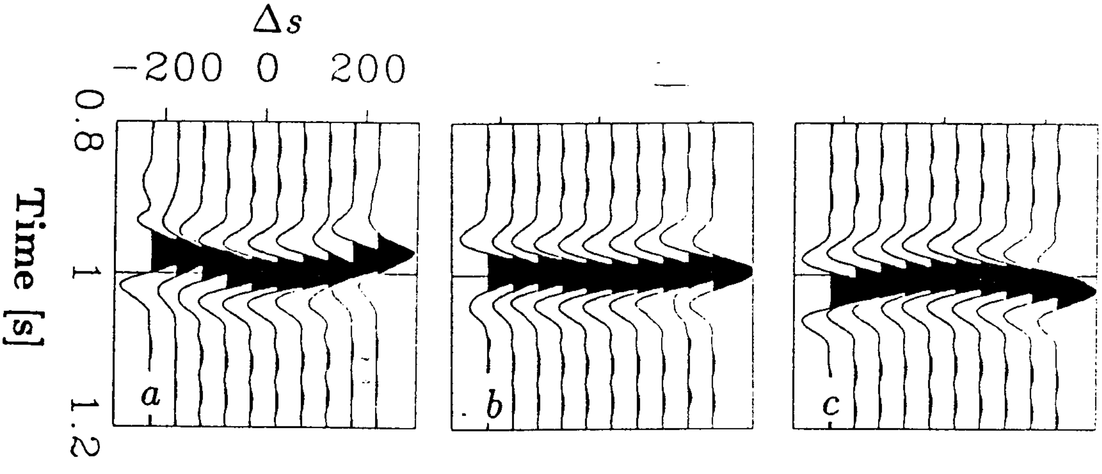

Fig.3 *Application of SCO for velocity analysis. The continued CSGs are sorted as to obtain a CRG; if the continuation velocity is correct, the reflections are aligned independently from the initial shot position (b). The same residual curvature results in the CRG using the same absolute value of the square slowness error. Continuation velocity too low (a), continuation velocity too high (c).*