Conclusions

Substantial errors in conventional velocity analyses can result if the medium velocity varies laterally. In such areas, the measurement of velocity from hyperbolic moveout traveltimes must account for the fact that the raypaths of the recorded energy actually have sampled the medium below all midpoints within the cable-length. The method of doing this presented here is to approximate the slowness in the area of each midpoint as a second-order Taylor-series expansion. Truncating the Taylor-series at second order limits the resolution of the lateral derivative method to approximately two cable-lengths. The Taylor series approximation and a straight ray approximation limit the range of applicability of the LDM to velocity variations over a cable-length between approximately 2% to 30% and to reflector depths of less than about one cable-length. Although only a 1 to 2% velocity variation is enough to produce observable velocity errors, the LDM does not substantially change the velocity function unless the velocity fluctuations are greater than the error associated with picking the stacking velocities.

The overall effect of the lateral derivative method is to provide an intelligent low pass and inversion of the low wavenumber (> two cable-lengths) components of the conventional velocity estimates. Simply smoothing the velocity function also provides a low-pass filtering operation but there exists no objective way of determining the filter length.

The results from the synthetic models show that the three major assumptions used in the derivation of the lateral derivative method do not cause any substantial artifacts in the results, even when these assumptions are obviously not met. In particular, the results from Model 2 suggest that the lateral derivative method can dramatically improve velocity estimates below localized velocity inhomogeneities such as reef structures. A field data test shows that conventional velocity estimates, even in areas of moderate lateral velocity variation, can be substantially improved with the lateral derivative method.

From a theoretical standpoint, velocity estimates can be improved in regions with diffracting and dipping energy by first preprocessing the common-offset sections with a partial migration operator. The theory presented is valid for dips up to approximately 20 degrees.