SEP Synopsis and Prognosis

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The original success of wave-equation migration established both the Stanford Exploration Project and the belief of its staff and sponsors that wave-equation data processing would be useful in extracting more geological information from reflection seismograms. The principal commercial success has been simply the migration of CDP stacked data. Progress in algorithms (and in computers) has brought us to the point where migration before stack is becoming economically feasible, often useful, but by no means the industry standard in 1977. Indeed, there is no general agreement on how to do it. Much work has also been done on the use of the wave equation to suppress deep-water multiple reflections and to estimate rapid lateral variations in velocity. Although a commercially viable process has not yet been demonstrated, considerable progress has been made. Let us review.

In the case of primary reflections in a constant-velocity material, simple geometrical considerations show how to migrate a *constant offset section*. Each seismogram is simply stacked into the depth section along the ellipsoid which has one focus at the shot point and the other focus at the geophone point. Something similar can be done with the wave equation (SEP-4). But we have not been able to find any systematic procedure for a constant offset section when the velocity is laterally variable, or when we are trying to predict diffracting multiple reflections (SEP-7, p. 42). Then it seems that CDP stacks and constant offset sections must be abandoned, and we must turn our attention either to unstacked data, to plane-wave stacked data (introduced in SEP-5), or to more general wave stacks (SEP-8, p. 1). Such data are wave fields of real physical experiments, and hence they can be handled with the wave equation in a systematic fashion (i.e., errors are comprehensible and reduceable by means of obvious, but more exhaustive, analysis).

The advantage of the plane wave stack is the great reduction of data volume at an early stage of processing. The disadvantage may be that some irrecoverable destructive interference can take place at that time. The choice is not purely economic. The slanted plane wave stack provides both a higher signal-to-noise ratio during processing and a convenient display for geophysical or geological analysis. Presently, we find it appropriate to proceed on our multiple reflections project with slanted plane wave stacks and to proceed on our lateral velocity estimation project with unstacked data. One conclusion of our multiple reflection work is the realization of the importance of shot waveform estimation.

We do not yet have a clear concept of how to create a satisfactory method for "deep statics" or "dynamics" although the beginnings are in SEP-8 and SEP-9 and current work by Walt Lynn is very relevant.

Over the longer term, I believe that, besides improved analysis techniques, 3-D data recording will lead to much sharper earth images. This should lead to more oil, and ultimately to more 3-D data. The greatest promise would seem to be at sea where drilling costs are high and seismic costs are low. The principal problem at the moment seems to be the inability of ships simultaneously to two several parallel streamer cables. Thus, many traverses are required. The result is that the data are very expensive and even then they are likely to be aliased in the direction perpendicular to the streamer.

Another potentially important direction in prospecting research is shear waves. As with 3-D recording the best data are privately held, so that we at the Stanford Exploration Project will not be heavily committed to such research. We continue, however, to be alert to the possibility of exploitation of wave equation data processing concepts in these areas.