Pre-stack partial migration with post stack full migration programs

Shuki Ronen

Abstract

A time domain derivation of the exact DMO phase is given, based on the impulse responses of the migration and the pre-stack partial migration (DMO) operators.

A quick and dirty derivation of the exact DMO

The response of the migration operator is the semi-circle,

$$\left(\frac{2z}{vt}\right)^2 + \left(\frac{2x}{vt}\right)^2 = 1 \tag{1}$$

The response of the DMO, (Deregowski and Rocca, 1981) is the ellipse,

$$\frac{\tau^2}{t_0^2} + \frac{\chi^2}{h^2} = 1 \tag{2}$$

What we need, if we want to use a migration program to do DMO, is to substitute

$$x = \frac{vt_0}{2h}\chi \quad ; \quad z = \frac{v\tau}{2} \tag{3}$$

In the frequency domain the transform is

$$k_x = \frac{2h}{vt_0}k_\chi \quad ; \quad k_z = \frac{2k_\tau}{v} \tag{4}$$

The dispersion relation of the migration,

$$k_x^2 + k_z^2 = \frac{4\omega^2}{v^2} \tag{5}$$

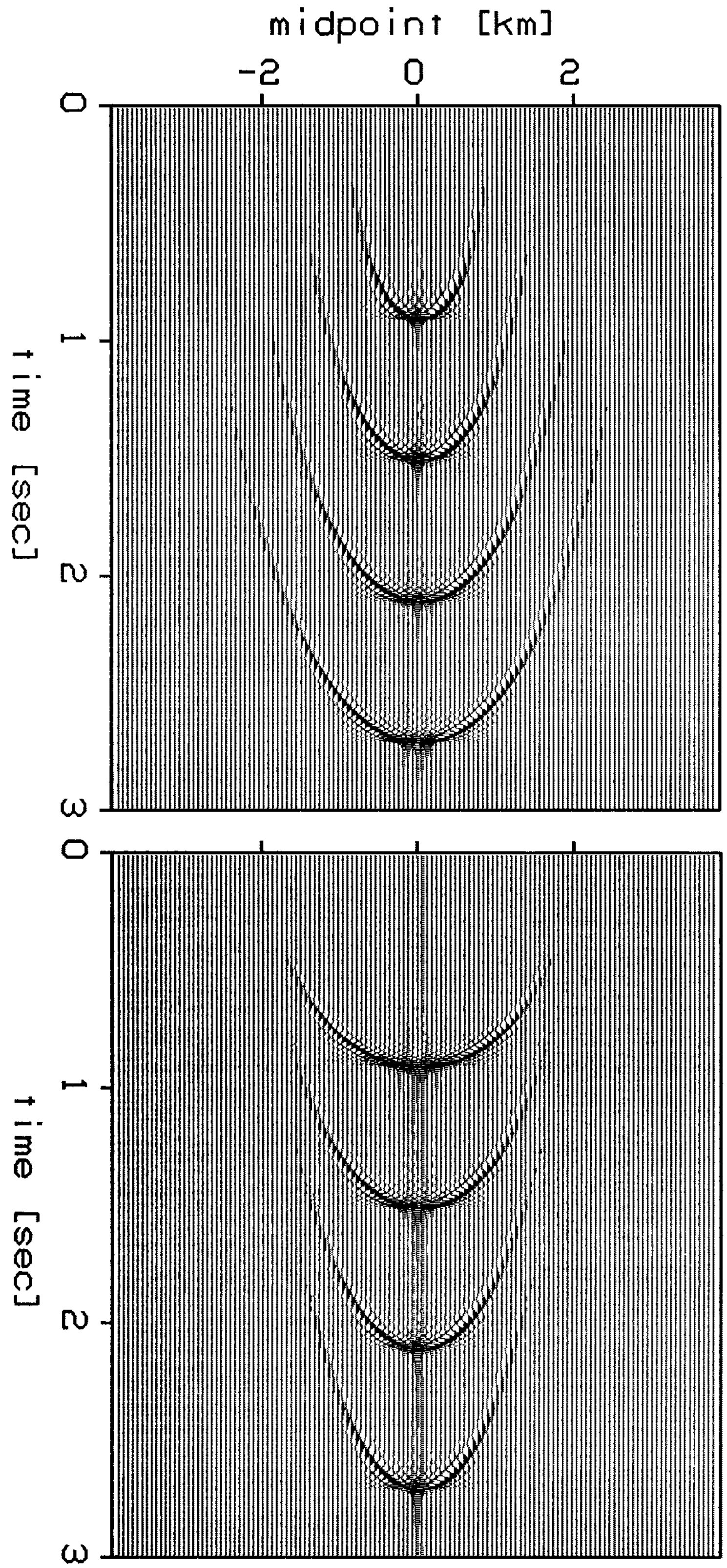

FIG. 1. Above: Migration. Below: DMO. The response of the second spike from the bottom, where $v/2=h/t$, is the same in both, except amplitude.

Transforms to the time dependent, velocity independent, dispersion relation:

$$\frac{h^2}{t_0^2} k_X^2 + k_\tau^2 = \omega^2 \tag{6}$$

which is migration with $v/2 = h/t$ as pointed by Dave Hale (Hale, 1983).

A straight forward approach is to decompose every common offset section to time slices and migrate each with $v/2 = h/t$. If the cost of the migration is linear with time and midpoint, then the whole pre-stack partial migration will be linear with midpoint and offset and square with time. Each of the migrations applied to each time slice, should be easier than post stack migration, since what we need is just the bottom of the ellipse (2), so we don't have to worry about steep dips. Also the velocity is constant, h/t, so we can use Fourier migration methods and the fact that the data comes from one time slice can be utilized in Stolt migration interpolation (Ronen, 1982).

The offset-time dependency is not general but on the ratio h/t. This is why Rick Ottolini prefers to do the DMO in angle-midpoint, $(h/t, x)$ coordinates; instead of doing the partial migration to every offset and to every time he has to do it only to every angle.

Conclusions

Any migration program can do DMO. The cost is high since the DMO is applied to every constant offset section, and since the coordinates transform is time dependent, it is equivalent to applying the migration to every time level separately. Alternatively, time dependency can be saved by transforming to angle-midpoint.

REFERENCES

Deregowski, S. M. and Rocca, F., 1981, Geometrical optics and wave theory of constant offset sections in layered media. Geophysical Prospecting v. 29, p. 374-406.

Hale, D., 1983, Dip move out by Fourier transform. Ph.D. thesis, Stanford, 1983.

Ottolini, R., 1982, Angle midpoint migration. Ph.D. thesis, Stanford, 1982.

Ronen, S., 1982, Interpolation artifacts is Stolt migration, SEP-30.