Elimination of seismic multiples by anisotropic, prestack depth migration and filtering

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Outline

- Introduction.
- Theory.
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- Acknowledgements.
Introduction

• Assume that $\psi_P(x, t)$ and $\psi_M(x, t)$ are a superposition of Huygens point scatterers.

• Given $\nu_{H_2O}$, focus WB multiples with ZOM, erase, un-focus.

• Derive group and phase velocity for ZOM.
Theory

• Seafloor model: a continuum of diffractors.

• Source $\psi_S \downarrow$ a diffractor.

• Primary $\psi_P \uparrow \Rightarrow \downarrow z=0$.

• Reflection $\psi_R \downarrow$ from $z = 0$.

• Multiple $\psi_M \downarrow \Rightarrow \uparrow z=0$. 
a) Source raypath to a diffractor.

b) Scattering to the surface by the diffractor.

c) Surface reflection.

d) Multiple scattering.
• For a diffractor at $z_0$ and a mirror diffractor at $z = 2z_0$, traveltimes for $\psi_P$ and $\psi_M$ are

$$\Delta t_0 (x, v_0) = \frac{z_0}{v_0} \sqrt{1 + \left( \frac{x}{z_0} \right)^2},$$

and

$$\Delta t_z (x, v_0) = \Delta t_0 (x) + \frac{z - z_0}{v_0}.$$
• Write $\psi_M$ traveltime as

$$
\Delta t_z (x, v_z) = \frac{z}{v_z} \sqrt{1 + \left(\frac{x}{z}\right)^2},
$$

where $v_z$ is associated with mirror depth $z$.

• Set $\Delta t_z (x, v_z) = \Delta t_z (x, v_0)$ and solve for $v_z$:

$$
v_z (x, z, z_0) = z v_0 \frac{\sqrt{1 + \left(\frac{x}{z}\right)^2}}{z - z_0 + z_0 \sqrt{1 + \left(\frac{x}{z_0}\right)^2}},
$$
or in terms of group angle $\tan \phi = x/z$:

$$v_z (\phi, z, z_0) = \frac{z v_0}{\cos \phi \left[ z - z_0 + z_0 \sqrt{1 + \left( \frac{z}{z_0} \tan \phi \right)^2} \right]}$$
Stolt migration

• Stolt migrate with $q(z_0, v_0, p)$.

• Assume that $\frac{d}{dx} z_0$ is small and modulate $v_0$ until $\psi_M$ focus satisfactorily.

• Erase multiples.

• Inverse Stolt.
Constant offset: 9112.5 ft
Conclusions

• Focusing velocity for WB multiples is anisotropic.

• Numerical group $\rightarrow$ phase velocity developed for use with reversible Stolt migration.

• Focus multiples, erase, unfocus.
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