Blended shot migration with an inverse source

B. Arntsen, NTNU

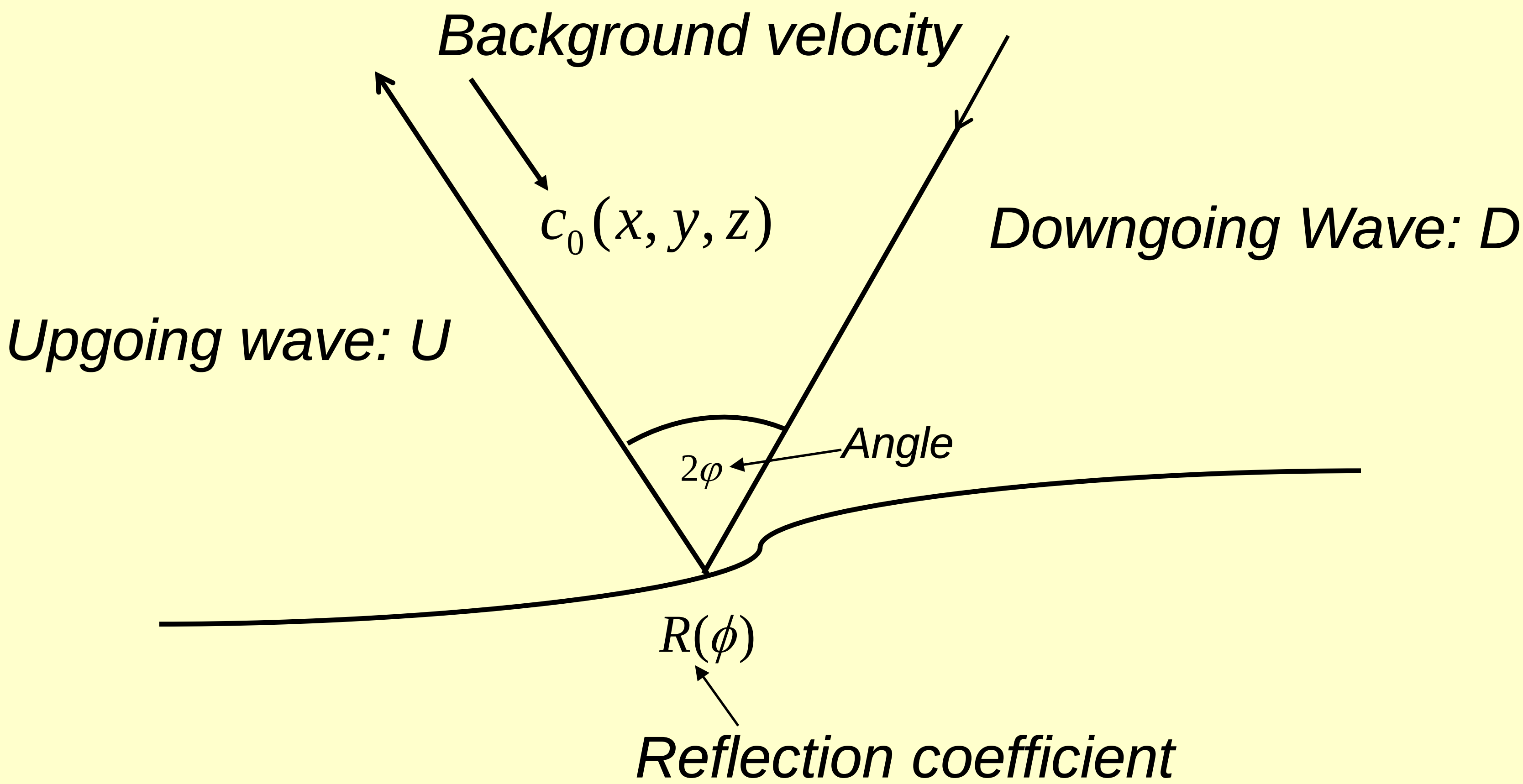
ROSE meeting

MAY 3, Trondheim

OVERVIEW

- Introduction
- True-amplitude shot-profile migration (Arntsen and Amundsen, 2010, Arntsen et al. 2010)
- Migration with blended shots
- Conclusions

INTRODUCTION



BLENDED SHOTS

Shot 1

+

Shot 2

=

Blended (simultaneous) shots (1+2)

- Shot processing time recuced by 50% for two blended shots
- Shot procesing time reduced by factor of N for N blended shots

(Beasley et al. 1998, Sava 2007, Verschuur and Berkhout, 2011)

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IMAGING CONDITION

Reflection matrix

Horisontal Wavenumber

Frequency

$$U(k_r, z, \omega) = \int dk_s R(k_r, k_s, z, \omega) D(k_s, z, \omega)$$

Depth

$$R(k_r, k_s, z, \omega) = \sum_{shots} U(k_r, z, \omega) D'^*(k_s, z, \omega)$$

Source signature

$$D'^*(k_s, z, \omega) = \int dk'_s \underbrace{\exp[ik_z(k_s, k'_s)z)]}_{\text{Extrapolator}} \underbrace{\left(\frac{S(\omega)}{2ik_z(k_s')}\right)^{-1}}_{\text{Inverse source}}$$

Vertical wavenumber

IMAGING CONDITION

$$R(x_m, h, z, \omega) = \sum_{shots} U(x_m + h, z, \omega) \quad \underbrace{D'^{*}(x_m - h, z, \omega)}_{\text{Modified downgoing wavefield}}$$

Midpoint   Offset

$$R(x_m, p_h, z) = \int \mathrm{d}\omega \int dh \, \exp(i\omega p_h h) \, R(x_m, h, z, \omega)$$

(De Bruin, 1990)

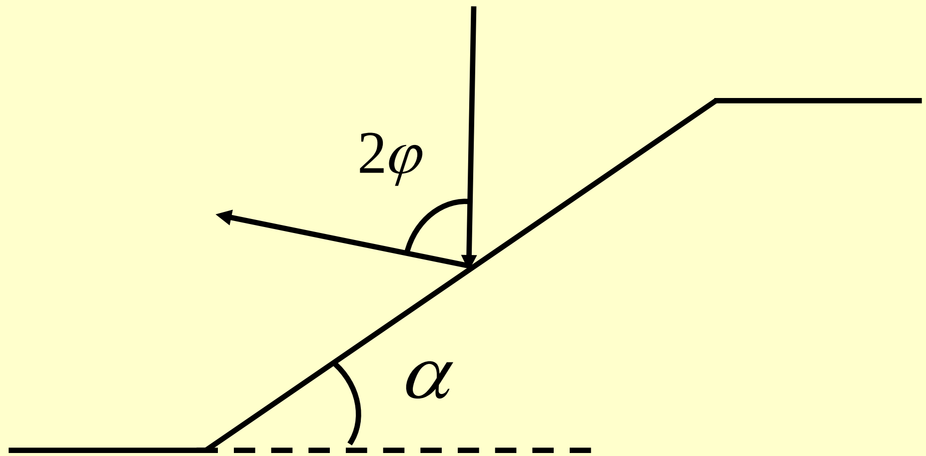
Offset slowness

Dip angle

$$R(x_m, \phi, \alpha) = R[x_m, p_h(\phi, \alpha)]$$

Opening angle

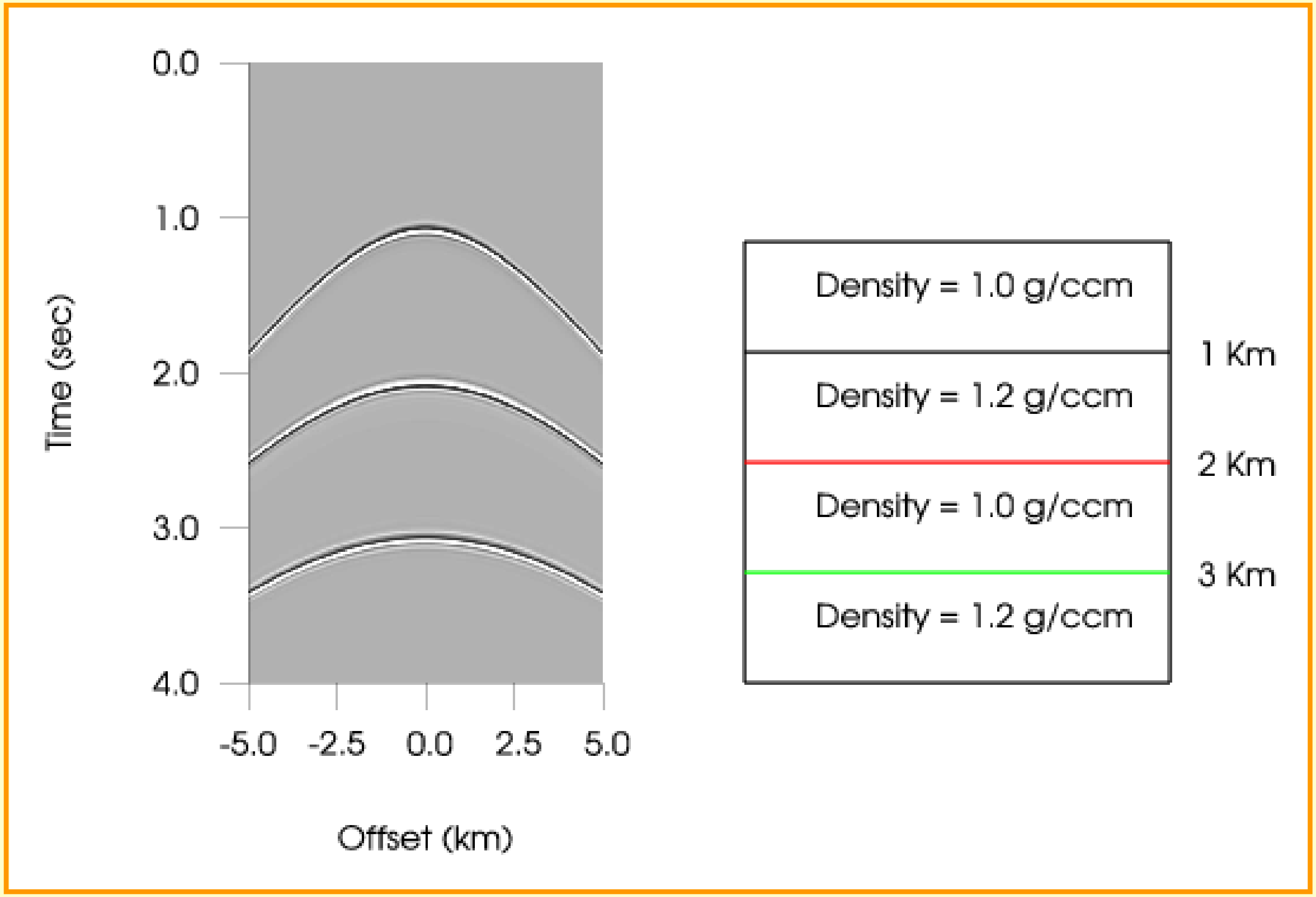
DIP CORRECTION



$$r_A(\phi) \propto R(\phi,\alpha)\left[\frac{\cos(\phi+\alpha)}{\cos(\phi-\alpha)+\cos(\phi+\alpha)}\right]$$

Plane layer Reflection coefficient

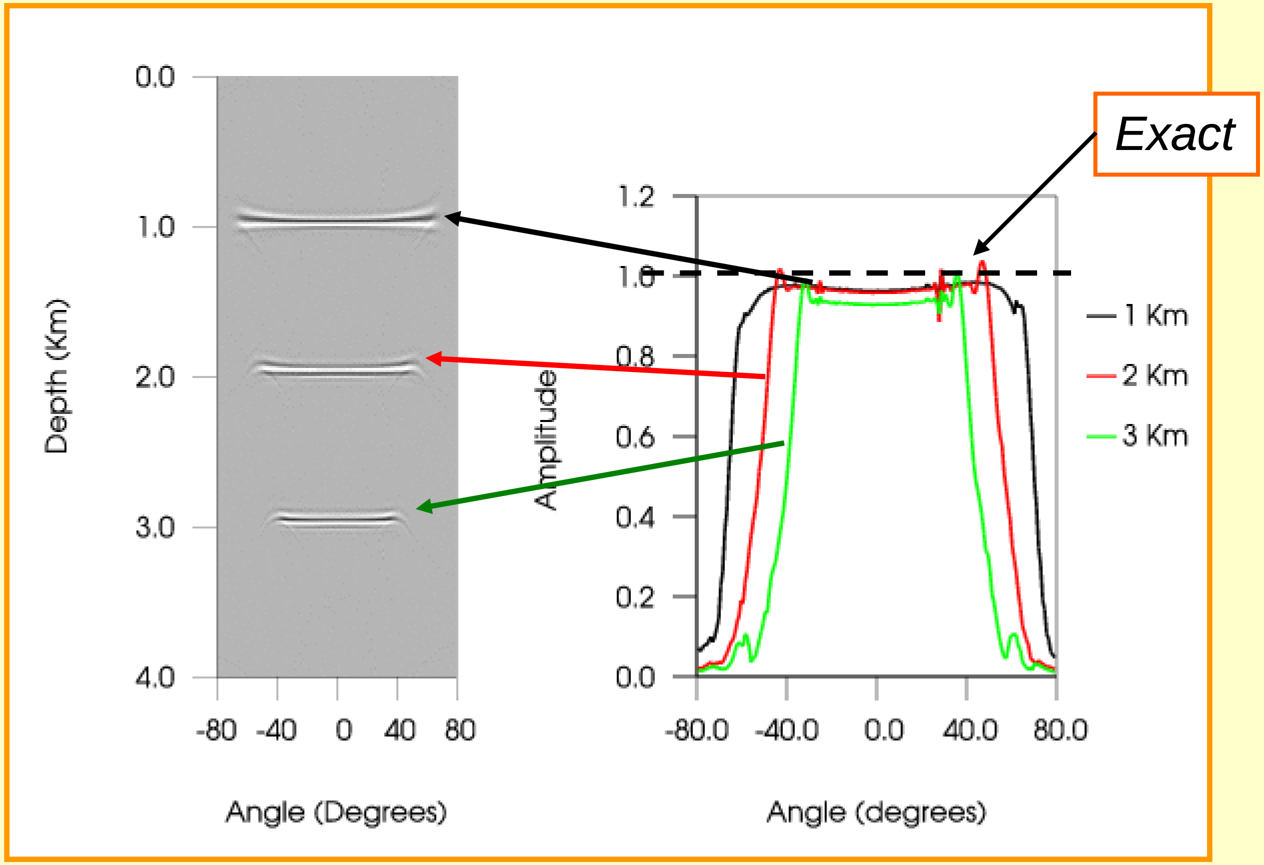
DENSITY CONTRAST



Density contrast only = angle independent reflection coefficients

DENSITY CONTRAST

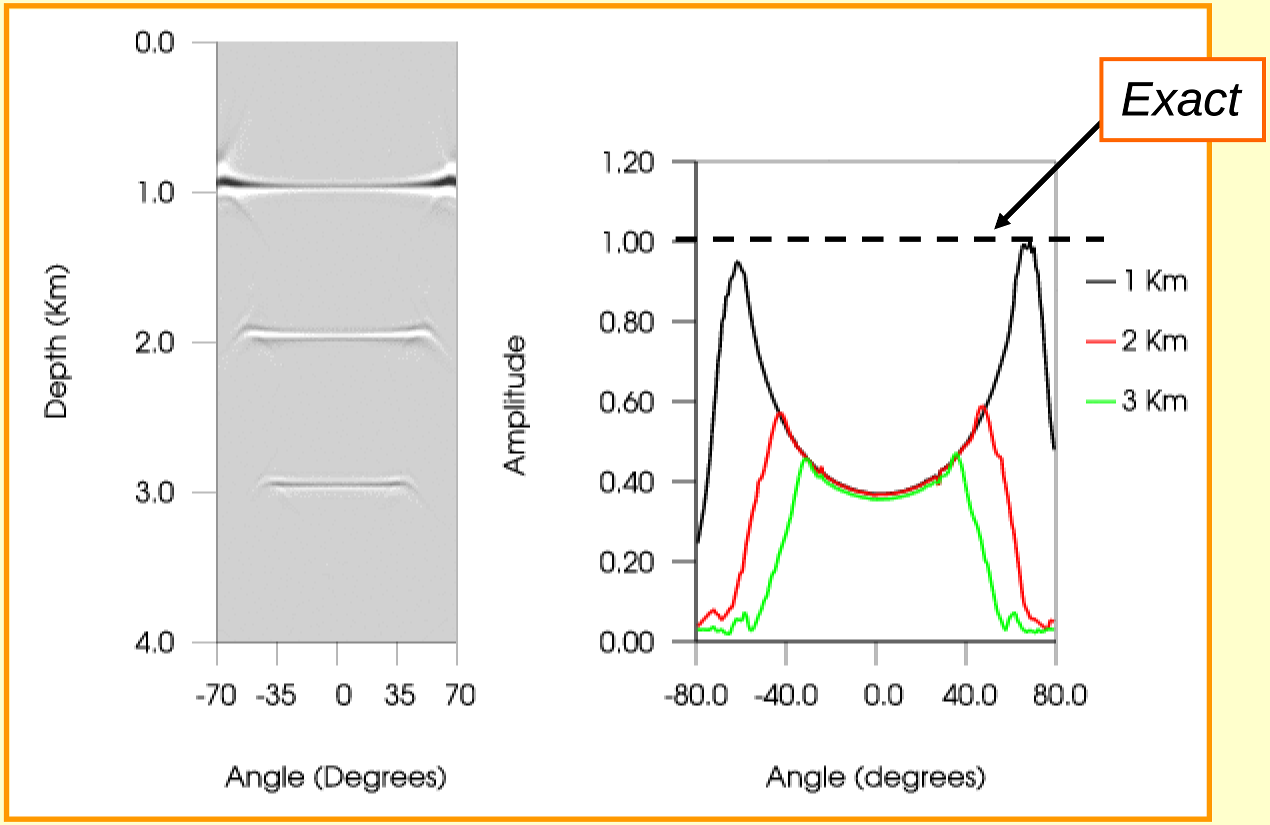
New imaging condition **Amplitude picks**



Density contrast only = angle independent reflection coefficients

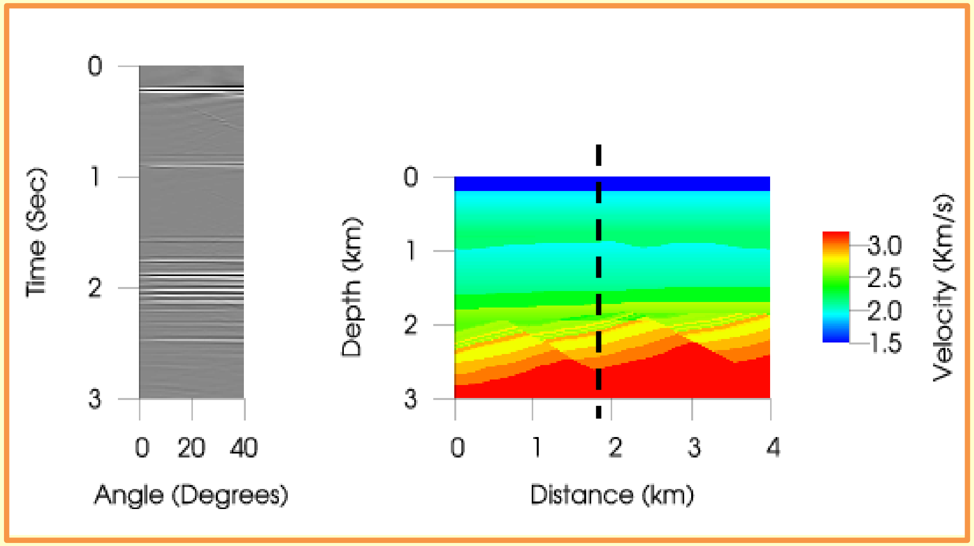
CONVENTIONAL IMAGING

Conventional cross-correlation **Amplitude picks**

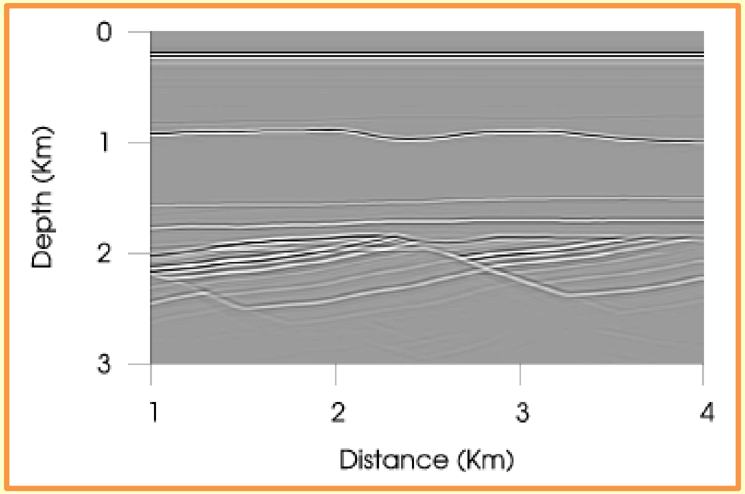


Density contrast only = angle independent reflection coefficients

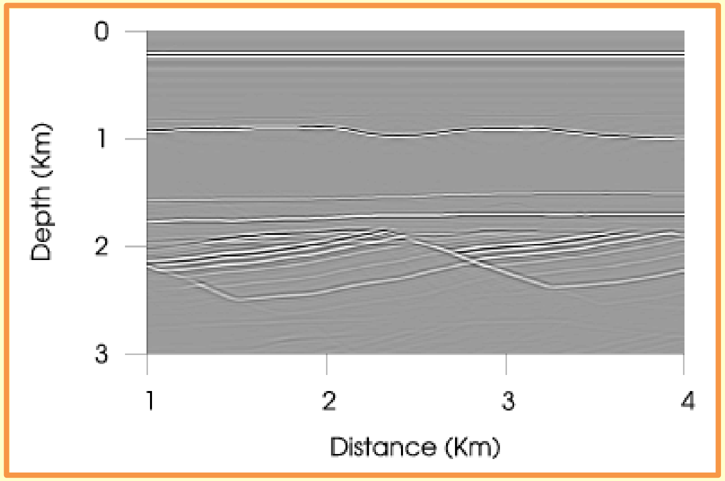
GULLFAKS MODEL



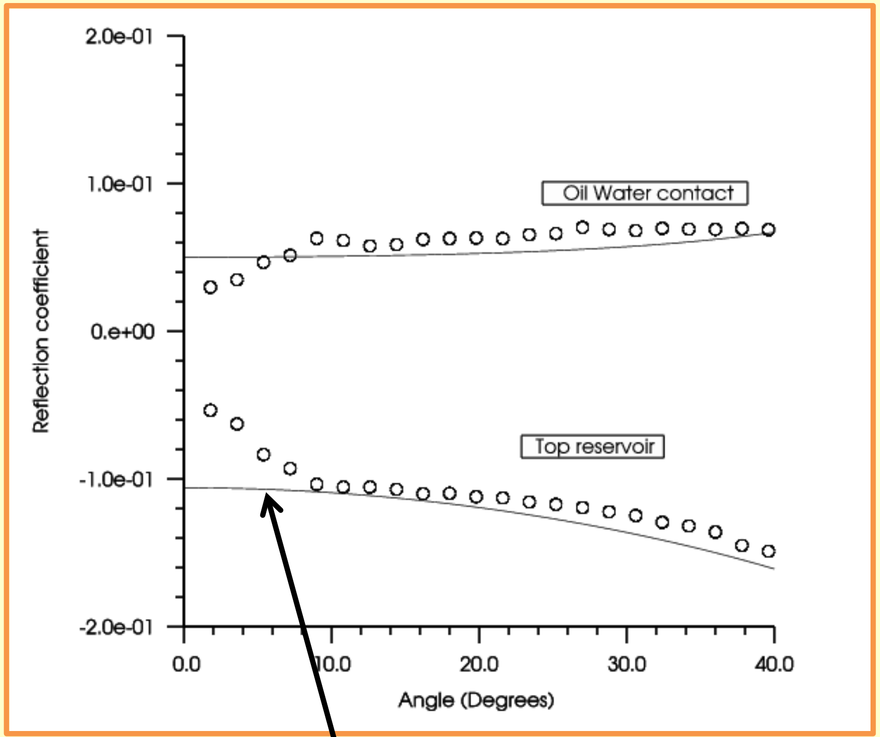
25-40 degrees

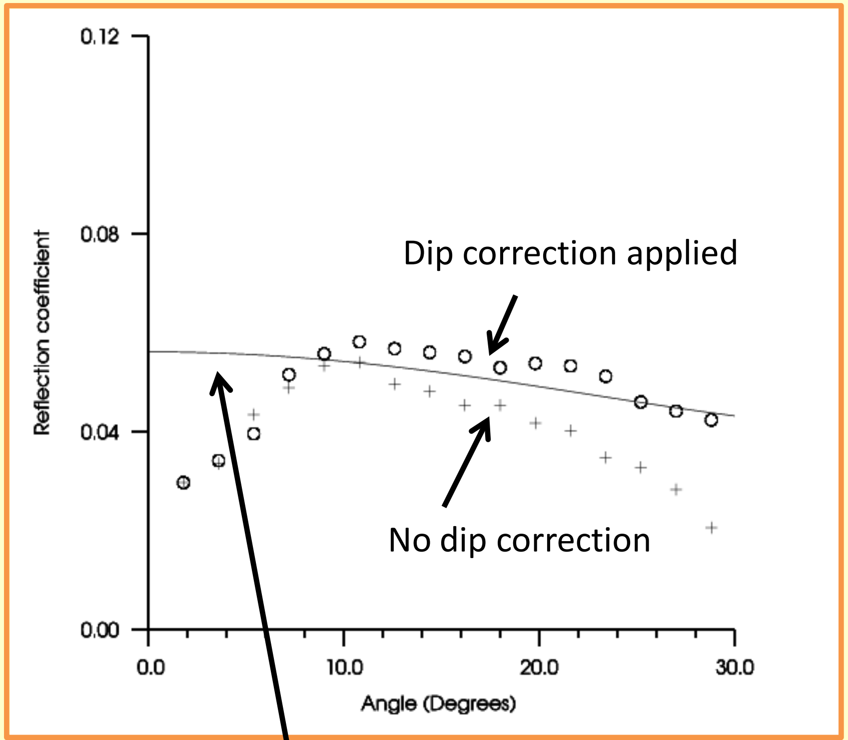


8-15 degrees



GULLFAKS AVA





True RC

True RC

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+

+ .....

=

- Shot processing time recuced by 50% for two blended shots
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IMAGING CONDITION BLENDED SHOTS

$$R(x_m, h, z, \omega) = \sum_{shots} U_{Blended}(x_m + h, z, \omega)\, D^{'*}(x_m - h, z, \omega)$$

Shot spacing

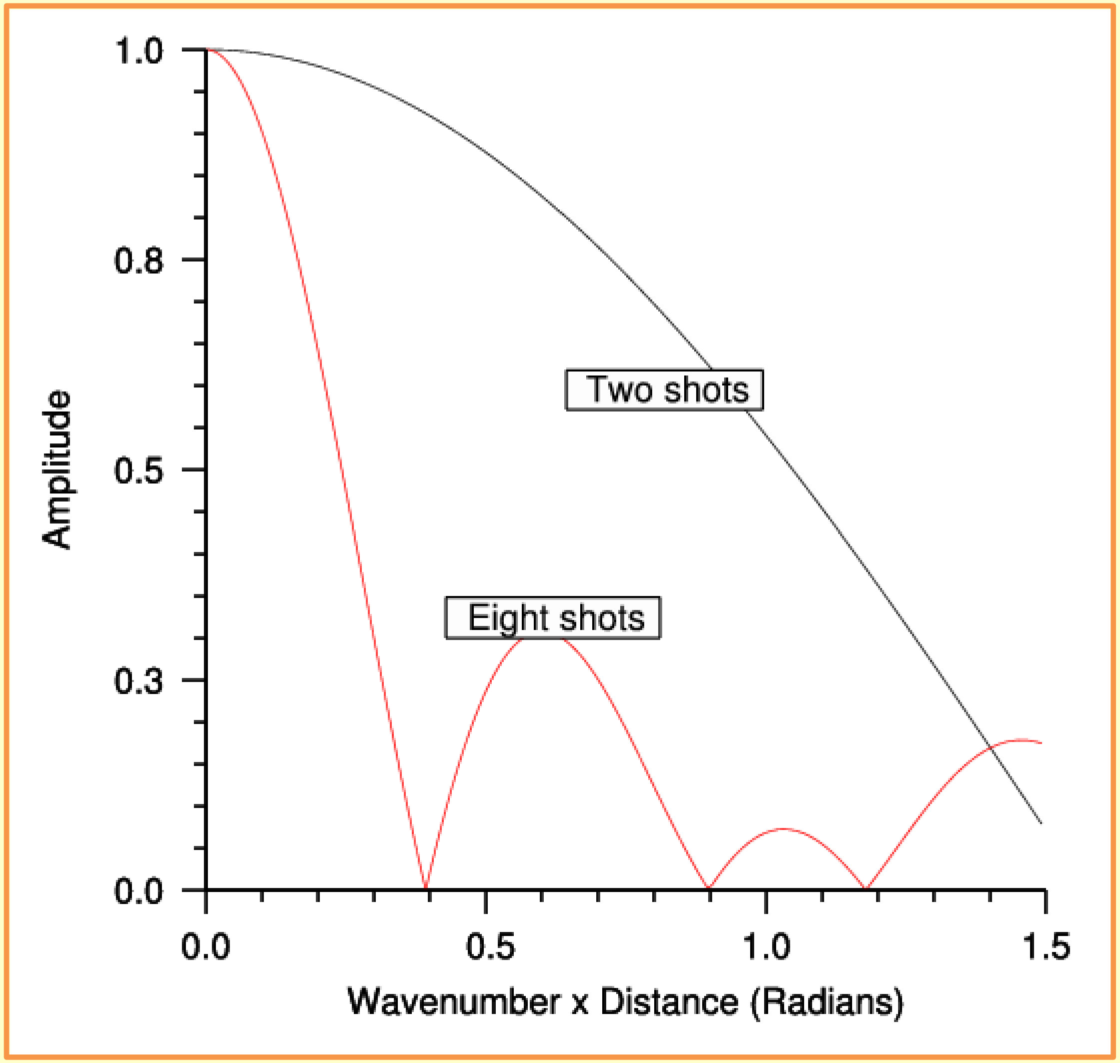
$$D^{'*}(k_s, z = 0, \omega) = \left(\frac{S(\omega)}{2ik_z(k_s)} \right)^{-1} \underbrace{C[k_s \Delta x (N-1)/2]^{-1}}_{Cross-talk-correction}$$

No of shots

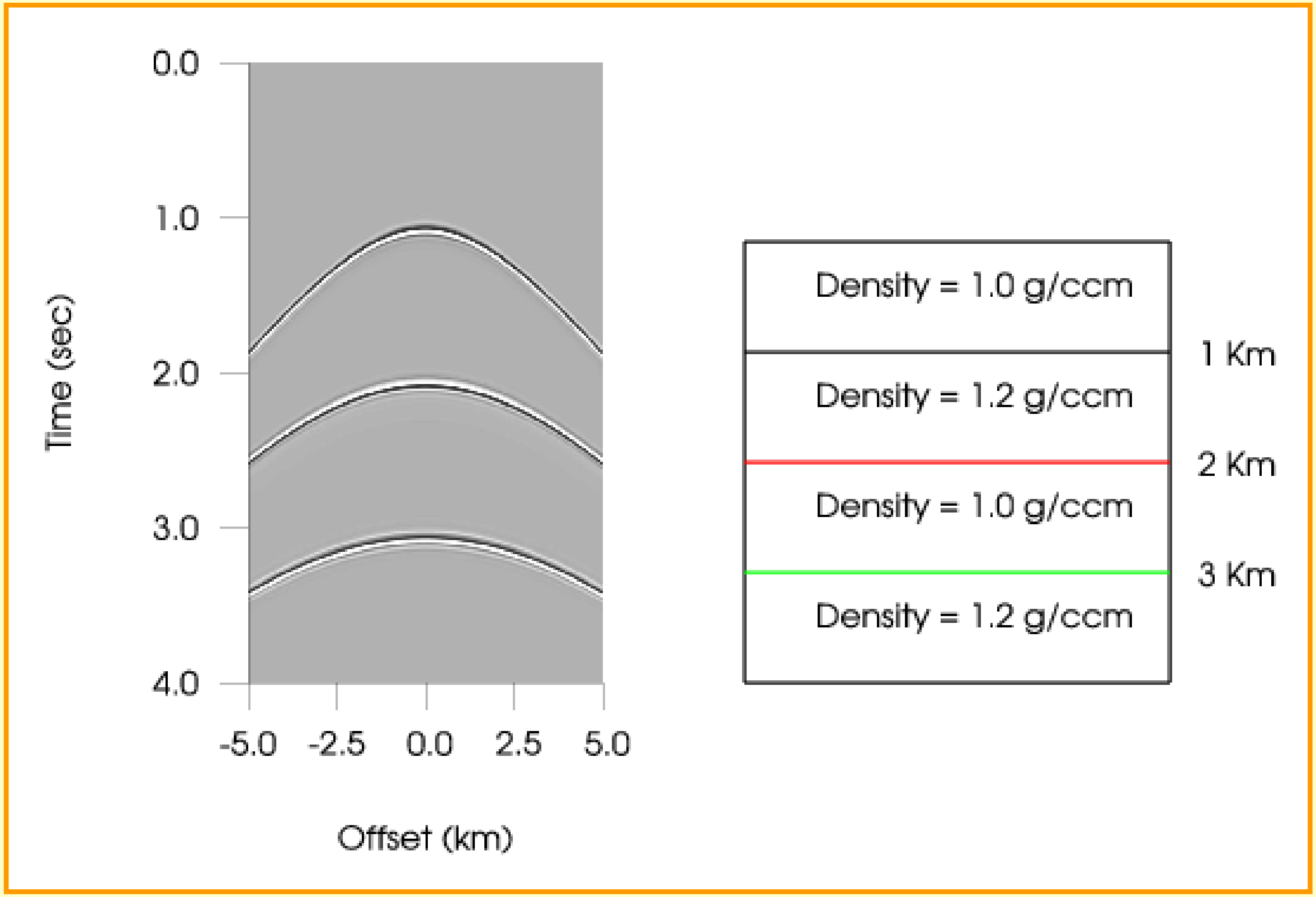
$$R(x_m, p_h, z) = \int \mathrm{d}\omega \int dh \exp(i\omega p_h h)\, R(x_m, h, z, \omega)$$

$$R(x_m, \phi, \alpha) = R[x_m, p_h(\phi, \alpha)]$$

CROSS-TALK SPECTRUM

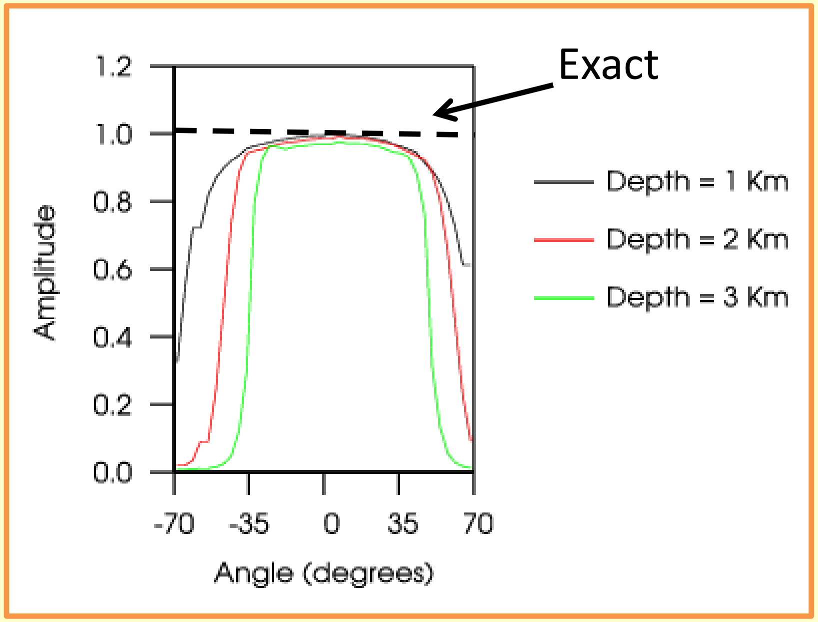


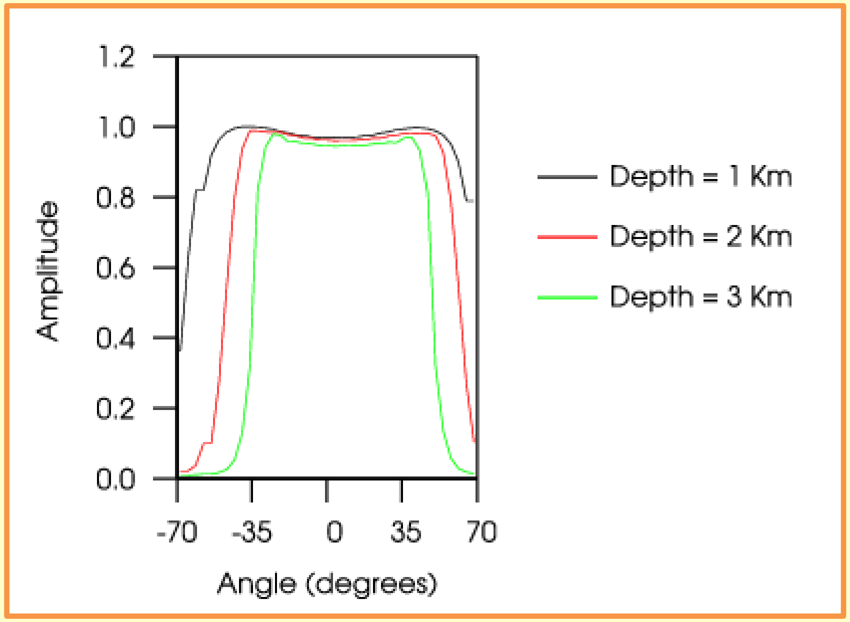
DENSITY CONTRAST



Density contrast only = angle independent reflection coefficients

AVA 2 BLENDED SHOTS

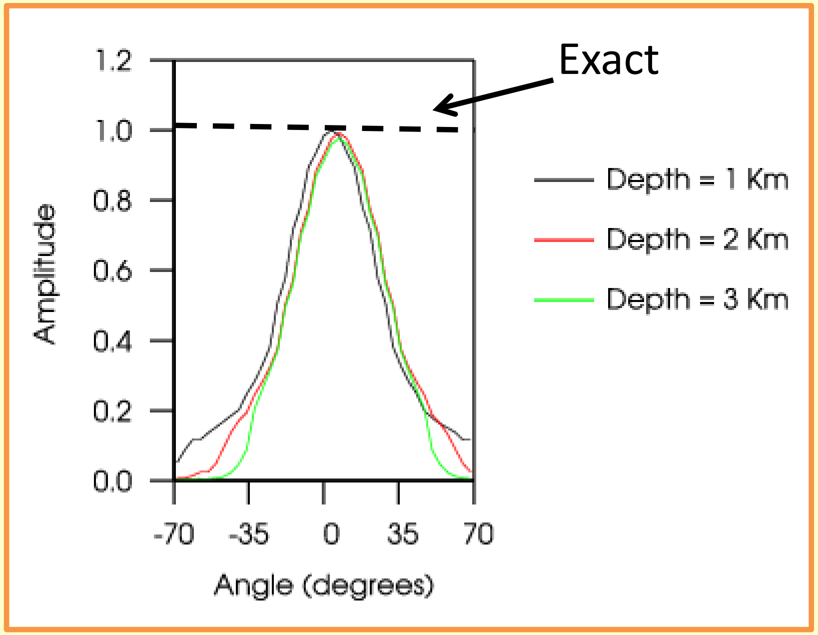


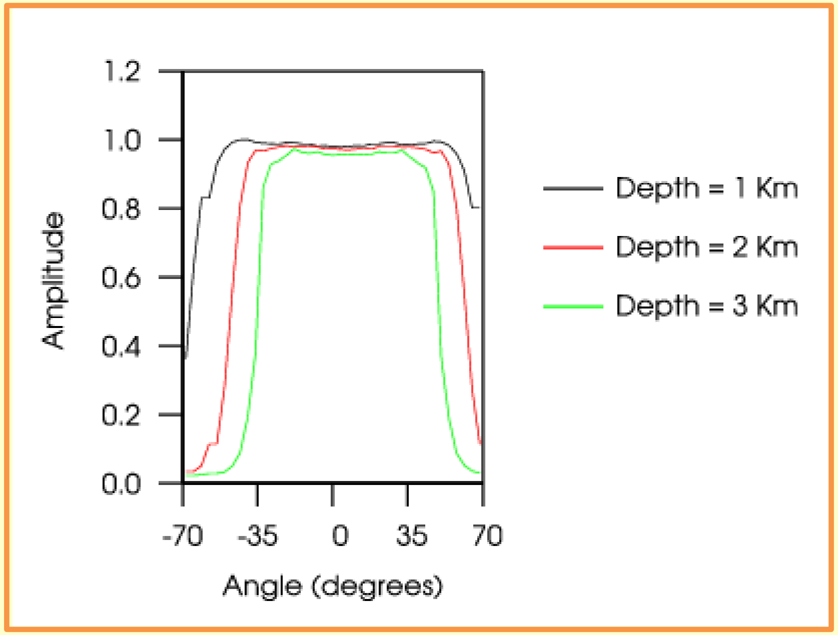


2 BLENDED SHOTS
NO CROSS-TALK CORRECTION
COMPUTATIONAL SPEED-UP FACTOR: 2

2 BLENDED SHOTS
CROSS-TALK CORRECTION
COMPUTATIONAL SPEED-UP FACTOR: 2

AVA 8 BLENDED SHOTS

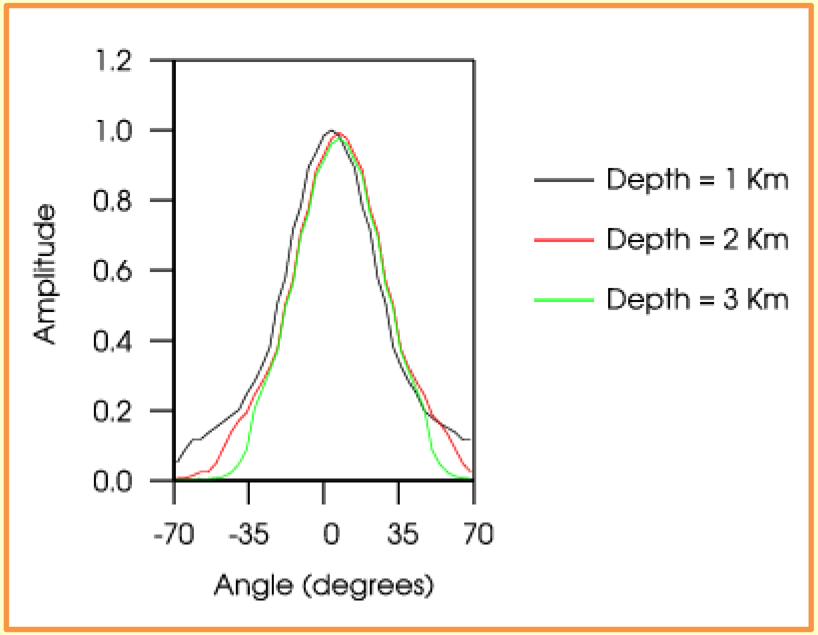


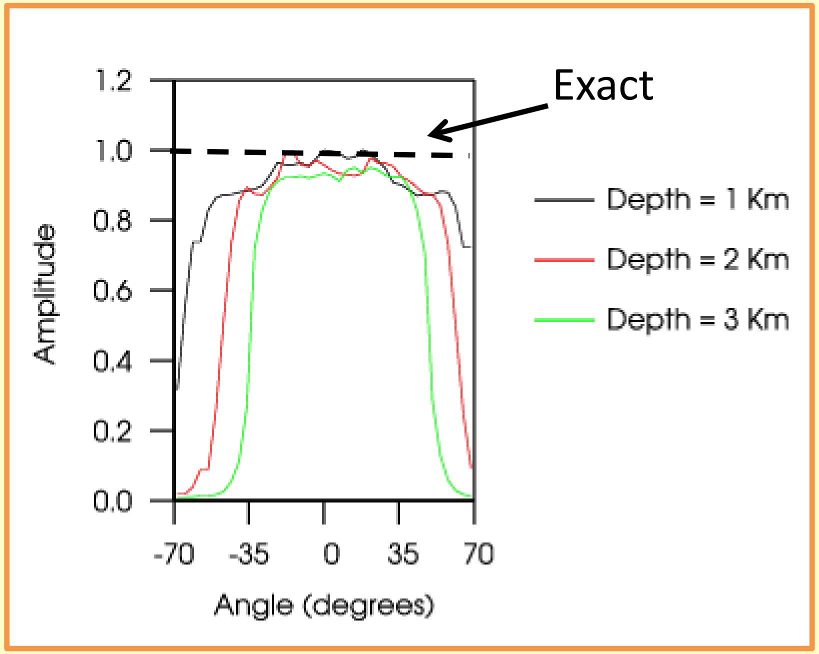


8 BLENDED SHOTS
NO CROSS-TALK CORRECTION
COMPUTATIONAL SPEED-UP FACTOR: 8

8 BLENDED SHOTS
CROSS-TALK CORRECTION
COMPUTATIONAL SPEED-UP FACTOR: 8

AVA 8 BLENDED SHOTS WITH 20 % NOISE



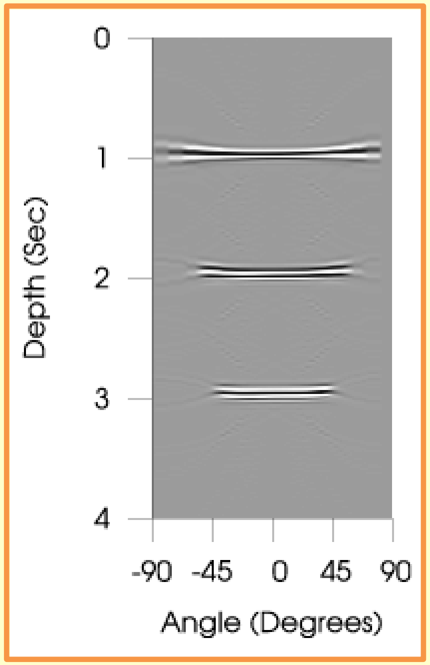


8 BLENDED SHOTS
NO CROSS-TALK CORRECTION
COMPUTATIONAL SPEED-UP FACTOR: 8

8 BLENDED SHOTS WITH 20% NOISE
CROSS-TALK CORRECTION
COMPUTATIONAL SPEED-UP FACTOR: 8

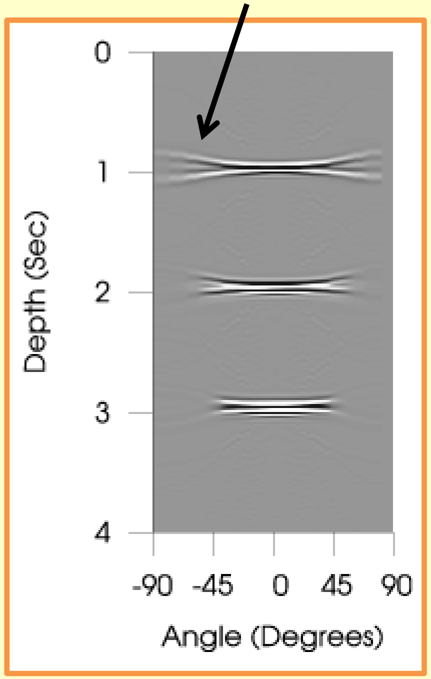
AVA GATHERS (201 shots)

No blending



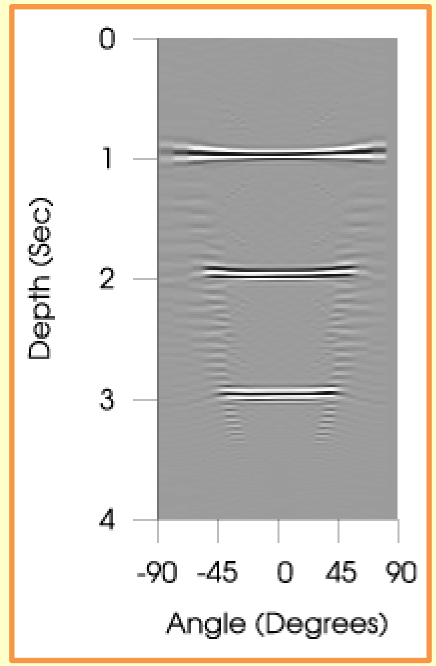
8 blended shots

Cross-talk



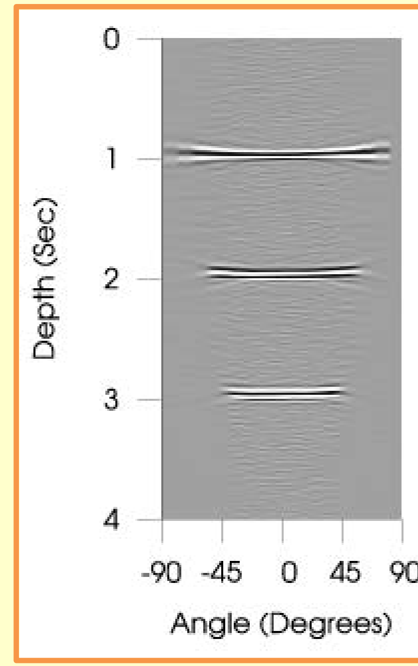
No cross-talk correction

8 blended shots



With cross-talk correction

8 blended shots +20% noise



With cross-talk correction

CONCLUSION

- Use of the inverse source idea is a simple way to correct for cross-talk effects in blended shot-profile migration
- Substantial reduction (2-8 times) in compute time for true-amplitude shot migration possible in exchange for tolerable quality reduction of AVA gathers.

ACKNOWLEDGEMENTS

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