Example Problems

1. Covered in class today, 22.11
   Only minimal identification given

Figure

1. Correction for geometric spreading

2. (a) → (b) muting of 1st arrivals
   (b) → (c) correction for geometric spreading

3. Correction for statics

4 Deconvolution

5. Migration

6. Low-cut (or high-pass) filter

7. VSP upgoing events ~~shifted~~ time-shifted to 2-way traveltime.

8. Velocity (or wavenumber) filtering of low-velocity (~~low~~ high-wavenumber) events.

9. Low-pass filtering or separation of regional from observed data

10. Same as 9 (or upward continuation).

11. Deconvolution

12. Statics correction

2. (a)

$$DR = 20 \log_{10} (A_{max} / A_{min})$$

$A_{min} = 1$

A 24-bit word can represent values from 2^0 to $2^{24}-1$ or from 1 to 16777215

So $DR = 20 \log_{10} (16777215) = 144$ dB

(b) We want DR = 100 dB, how many bits?

$$100 \text{ dB} = 20 \log_{10} (A_{max}) \quad [A_{min} = 1]$$

$$5 = \log_{10} (A_{max})$$

$$A_{max} = 10^5 = 100\,000$$

16 bits would represent up to $2^{16}-1 = 65535$ — not enough

17 bits would represent up to $2^{17}-1 = 131071$

So we'd need at least 17 bits

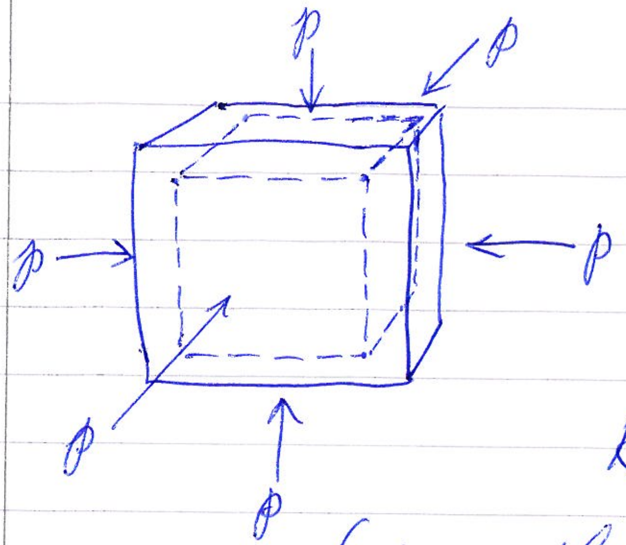
3. (a) K is incompressibility or bulk modulus

Defined by: $K = \dfrac{\text{volumetric stress}}{\text{volumetric strain}} = \dfrac{-p}{\left(\frac{\Delta V}{V}\right)}$

where p = hydrostatic pressure

and $\dfrac{\Delta V}{V}$ = relative change of volume.

(diagram on next page)

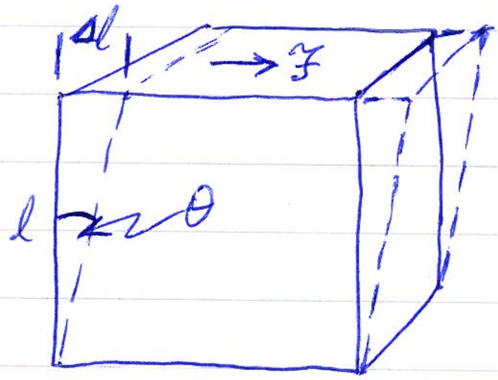


Note: positive p produces negative $\frac{\Delta V}{V}$ (volumetric strain)
Thus the minus sign in

$$K = -\frac{p}{(\Delta V/V)} \quad (\text{so } K > 0)$$

(p is the same in all directions.)

(b)



Shear stress = $\frac{\text{force } F \text{ on top}}{\text{area of top}}$

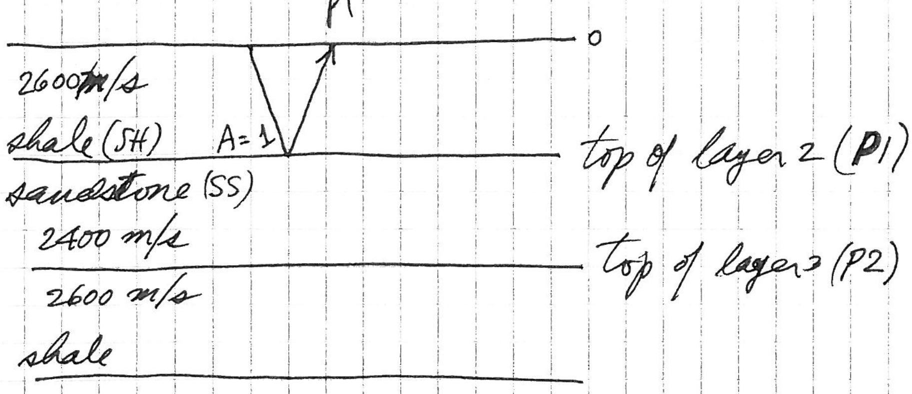
$= F/A$

Shear strain $= \frac{\Delta l}{l} = \tan\theta \simeq \theta$
(θ small)

Shear modulus or rigidity $\equiv \mu$

$$\mu = \frac{\text{shear stress}}{\text{shear strain}} = \frac{F/A}{\theta}$$

4.



(a) Assume $\rho_{SS} = \rho_{SH} = \rho$

For P1: $R_1 = \dfrac{\rho_2 V_2 - \rho_1 V_1}{\rho_2 V_2 + \rho_1 V_1} = \dfrac{\rho (V_2 - V_1)}{\rho (V_2 + V_1)}$

$$R_1 = \frac{24 - 26}{24 + 26} = -\frac{2}{50} = -0.04$$

(b) For P2

$$R_2 = \frac{26 - 24}{26 + 24} = \frac{2}{50} = 0.04$$

[Or since $V_1 = V_3$ (& $\rho_1 = \rho_3$) we could see at once that R_2 should be equal to $-R_1$ (like reflection at top of layer 2 from below).]

(c) $A'(P1) = 1 \times |R_1| = \underline{0.04}$ (A' = A without geom. spr.)

(d) Arriving at surface receiver, the wave has travelled 2 times as far as at the bottom of layer 1.

$$A(P1) = \frac{A'(P1)}{2} = \underline{0.02}$$

(e) $A'(P2) = 1 \times (1 - R_1) \times R_2 \times (1 + R_1) = 0.04 (1 - 0.0016)$

$A'(P2) = \underline{0.039936}$ ($\approx A'(P1)$) [or 0.0399 or 0.040]

(f) Arriving at the receiver, the wave has travelled 4 times as far as at the bottom of layer 1.

4f. cont.

$$\text{So } A(P2) = \frac{A'(P2)}{4} = \underline{0.009984} \quad [\text{or } 0.0100]$$

(g.)

$$V_{rms,2} = \left[\frac{\sum_{i=1}^{2} V_i^2 t_i}{\sum_{i=1}^{2} t_i}\right]^{1/2} = \left[\frac{V_1^2\left(\frac{60}{V_1}\right) + V_2^2\left(\frac{60}{V_2}\right)}{\frac{60}{V_1} + \frac{60}{V_2}}\right]^{1/2}$$

$$V_{rms,2} = \left[\frac{60\,(2600+2400)}{\frac{60(2400+2600)}{2400\times 2600}}\right]^{1/2} = \left[2400\times 2600\right]^{1/2}$$

$$= \underline{\underline{2498 \text{ m/s}}}$$

5. $\rho = 0.310\alpha^{0.25}$

(*) This was incorrectly said to apply for α in m/s and ρ in kg/m^3. It should have said ρ in Mg/m^3. —OR—

Or it should have said $\rho = 310\alpha^{0.25}$ for ρ in kg/m^3 and α in m/s.

I'll use $\rho = 310\alpha^{0.25}$

For $V_1 = 2600$ m/s, $\rho_1 = 2214$ kg/m^3 (2213.630)

For $V_2 = 2400$ m/s, $\rho_2 = 2170$ " (2169.774)

At Top of layer 2 (for P1):

$$R_1 = \frac{2170\times 24 - 2214\times 26}{2170\times 24 + 2214\times 26} = -0.049985$$

$$R \simeq -\underline{0.050}$$

For P2, $R_2 = -R_1 = \underline{0.050}$ (0.049985)

6. (a)

$$t_0(P2) = \frac{2\times60}{2600} + \frac{2\times60}{2400} = 0.09615\ s$$

or <u>96 ms</u>

For $t(x)$, $x=120$ m
See last page, after #8.
* * *

(b) $$t_0(M1) = \frac{4\times60}{2600} = 0.0923\ s$$

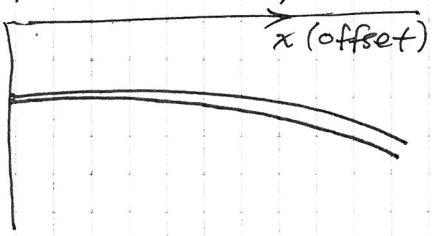
$= \underline{92\ ms}$

(c) M1 and P2 arrive at very nearly the same time, M1 ~~less~~ than 4 ms earlier

Because $V_{rms,2} = 2498$ m/s and $V_1 = 2600$ m/s

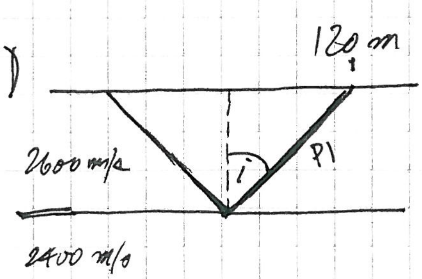
they will have similar moveouts BUT, in this case, P2 will dip downward slightly more steeply than M1, since $V_{rms,2} < V_1$.

They'll look like



But they are so close together that they'll interfere to considerable offset

(d)



At $x = 120$ m we have $i = \tan^{-1}\left(\frac{60}{60}\right) = 45°$

$\sin i = 0.7071$ $\left(\frac{\sqrt{2}}{2}\right)$

$$V_a = \frac{2600}{0.7071} = 3677\ m/s\ \text{for P1}$$

(e)

For M1, $\tan i = \frac{30}{60} = 0.5 = \text{atan}\ 26.6°$

$\underline{V_a} = 2600/\sin(26.565) = \frac{2600}{0.44721}$

$= \underline{5814\ m/s\ \text{for M1}}$

6 (f.)

$f = 45\,Hz$ for P1

$V = \lambda f$ ~~so~~ $\lambda = V/f = \frac{2600}{45}$

$\lambda = 57.8\,m$

$k = \frac{1}{\lambda} = 0.01731\,m^{-1}$

(g) $\lambda_a = \frac{\lambda}{\sin i} = \frac{2\lambda}{\sqrt{2}} = \sqrt{2}\,\lambda = 81.7\,m$

and $k_a = \frac{1}{\lambda_a} = 0.01224\,m^{-1}$

7. (Covered in class today – 22.11)

(a) (i) to provide basement depth ~~maps~~

(ii) to help distinguish among possibilities when seismic is ambiguous
e.g. is it a salt body, a reef, basement uplift? (Another possibility is an igneous intrusion where the salt body is pictured.)

(b) Salt remnant can have overlying drape caused by collapse on sides by salt dissolution. And can have velocity pull-up below.

A reef can have drape above by differential compaction and could have velocity pull-up below – or real structure

Basement faulting could cause similar displacement in pre-existing overlying beds.

8. Also covered in class 22.11
Only minimal identification here.

(a) CMP (common midpoint) gather

(b) Static correction

(c) P-wave and S-wave particle motion (polarization)

(d) Fan shooting (refraction) for salt detection and location

(e) Nettleton's method for estimating density in the shallow subsurface

(f) Fresnel zone

(g) pulse broadening by attenuation

(h) geomagnetic field vectors

(i) centrifugal effect of rotation

(j) 3D seismic

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6 (a) $t(x)$ for $x = 120$ m

P2: $t^2 = t_0^2 + \frac{x^2}{V^2}$ where $V \approx V_{rms,2}$

or $t^2(120\,m) = (0.09615)^2 + \left(\frac{120}{2498}\right)^2 = 0.0115525133$

or $t(120\,m) = 0.107486 = 107.49$ ms
[or 107.5 ms or 107 ms]

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6 (b) $t(x = 120\,m)$ for M1:

$t^2 = (0.0923)^2 + \left(\frac{120}{2600}\right)^2 \Rightarrow t(120\,m) = 103.2$ ms
[or 103 ms]