GEOPHYSICS MID TERM EXAM 2008

SOLUTION

(1a) $g_{sun} = \frac{GM_S}{R_{ES}^2} = \frac{6.67\times10^{-11}\times2\times10^{30}}{(1.5\times10^{11})^2} = 592$ mgals

(1b) $g_{moon} = \frac{GM_M}{R_{EM}^S} = \frac{6.67\times10^{-11}\times7.36\times10^{20}}{(3.84\times10^{8})^2} = 3.33$ mgals

(1c) Spatial gradient of $\underline{g}$ causes tides

$g_{sun} > g_{moon}$ but gradient due to moon is greatest;

(1d) ① ⇒ observations of historical eclipses; they would not have been observed if LOD was constant;

② ⇒ tidal rhythmites show more days per year in geological past (also per month)

③ ⇒ coral growth rings, similar arguments to ②

2(a) $g_{anom} = -205$ mgals

$C_{FA} = 0.3086\times560 = 172.8$ mgals

$\Delta g_{FA} = -32.2$ mgals

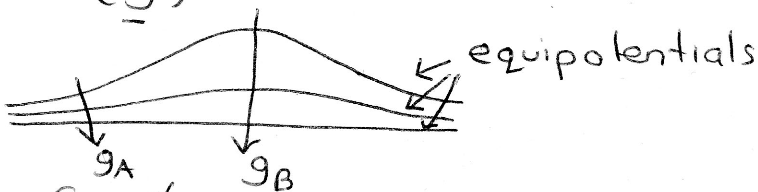
$C_B = -2\pi G\times2670\times560 = -62.7$ mgals

$\Delta g_B = -94.9$ mgals

2(b) ⇒ sea surface deflected by mass excess; elevation can be measured from a satellite by radar

⇒ monitor precise orbit of a satellite; either by tracking from surface of Earth OR measuring distance between two satellites (e.g. GRACE mission)

2(c) Sea surface is surface of constant gravitational potential NOT constant gravitational acc'n ($\underline{g}$)



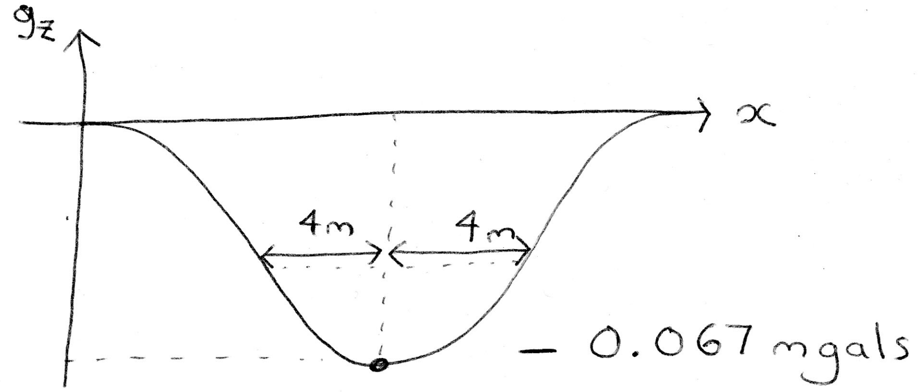
$g \propto$ gradient of ϕ

$g_A > g_B$

3(a) $$g_z = \frac{2\pi G a^2 z \Delta\rho}{(x^2+z^2)}$$ (formula sheet)

peak value when $x = 0$ ⇒ $g_z^{max} = -0.067$ mgals

3(b)



⇒ anomaly negative

⇒ $x_{1/2}$ = 4 m = depth of cylinder

⇒ approx. shape

3(c) If change elevation by 1 m

⇒ change $\underline{g}$ by 0.3086 mgals

change elevation by 0.1 m ⇒ change $\underline{g}$ by

~~0.308~~ 0.03 mgals

⇒ max anomaly of tunnel is - 0.067 mgals, which is is greater than change from 0.1 m elevation change;

so tunnel <u>will be detected</u>;

(4a)

P-wave reflected $\theta = \sin^{-1}(0.127 \times 6.8) = 60°$

S-wave reflected $\theta = \sin^{-1}(0.127 \times 3.9) = 29.8°$

S-wave transmitted $\theta = \sin^{-1}(0.127 \times 4.5) = 35°$

P-wave transmitted $\theta = \sin^{-1}(0.127 \times 8.1) =$ (?)

may get head wave with $\theta = 90°$
although amplitude could be small;

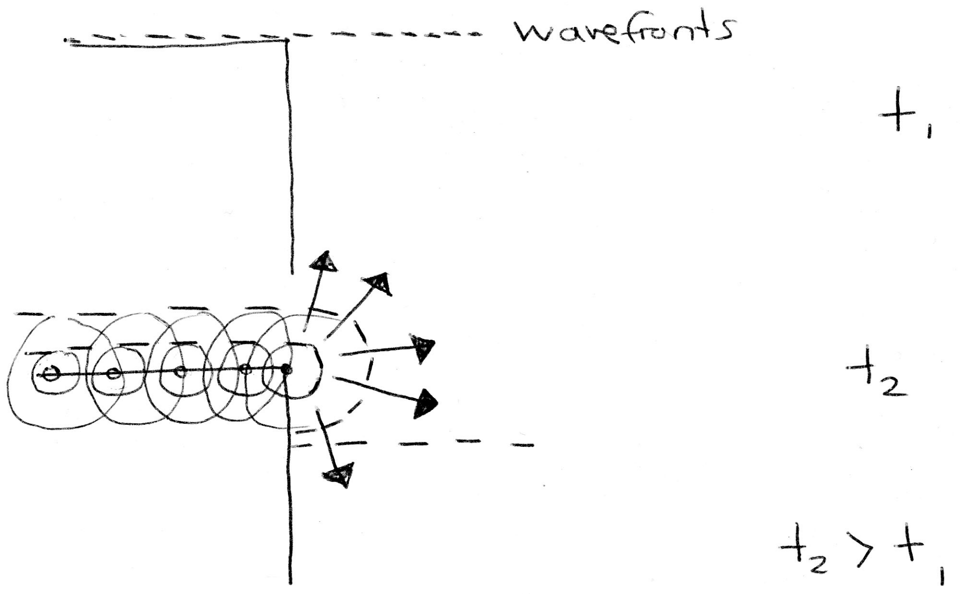
(4b)

HUYGHENS PRINCIPLE

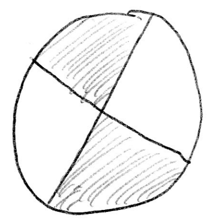
⇒ points on wave front generate 2° wavelets that spread out;

⇒ position of wavefront at a later time is the envelope that can be drawn around secondary wavelets

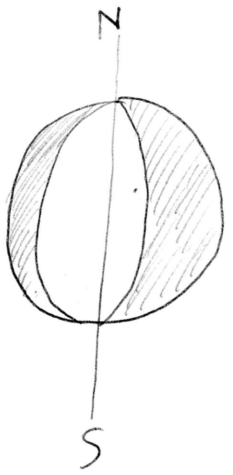
⇒ corner scatters energy in all directions;



(5a)



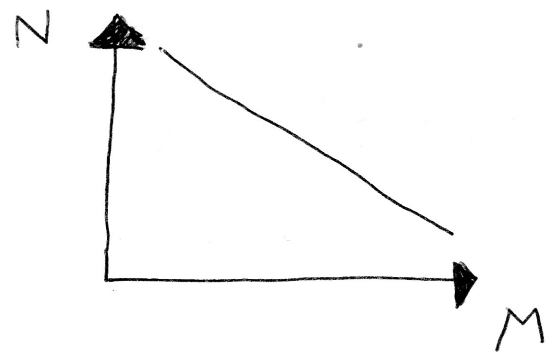
⇒ pattern of quadrants;
⇒ strike of fault



⇒ white in middle (normal fault)
⇒ asymmetric (dip <u>not</u> 45°)
⇒ axis N-S

(5b) <u>GUTENBERG-RICHTER LAW</u>

more small earthquakes than large in a given area



$$\log N = a - bM$$

a, b are constants