17/18 SEM 1

CV2013 ENGINEERING GEOLOGY AND SOIL MECHANICS

1(a)(i) Granite and rhyolite are both felsic igneous rocks of which their dominant minerals are quartz and potassium feldspar. However, granite is a coarse-grained phaneritic rock while rhyolite is a fine-grained aphanitic rock. Granite is an intrusive rock and therefore underwent slow cooling whereas rhyolite is an extrusive rock which underwent rapid cooling.

1(a)(ii) A porphyritic texture indicates that coarse minerals were formed first, followed by relatively faster cooling to produce smaller crystals. The rock was formed at depth, and the movement of magma from one depth to another caused the different rates in cooling.

1(a)(iii) As the top layers of rock are removed through weathering, the granite batholith deep down is exposed. Weathering extends to the now-exposed granite batholith which breaks it down physically and chemically. Then, erosion carries away granite particles produced by weathering. Transportation via streams, glaciers and wind moves these particles towards the mountain chain. Deposition occurs when these granite particles settle out or dissolved minerals precipitate. As layers of sediments accumulate and compact previous layers, burial occurs. Finally, diagenesis lithifies the sediment to form sedimentary rocks on the mountain chain.

1(b)(i) Rock material is the intact rock between discontinuities. Rock mass is the total in-situ medium containing bedding planes, faults, joints, folds and other structural features.

1(b)(ii) Persistence of a discontinuity is the areal extent or size of a discontinuity within a plane. Aperture of a discontinuity is the perpendicular distance separating the adjacent rock walls of an open discontinuity in which the intervening space is filled with air or water.

1(b)(ii) RQD = $\frac{100\Sigma x_i}{L}$

0.74 = $\frac{100\Sigma x_i}{86}$

Σx_i = 63.6 m

1(c)(i) Mean normal spacing of Set A = 0.55sin53° = 0.439 m

Mean normal spacing of Set B = 0.58sin19° = 0.277 m

1(c)(ii) For a scanline of length L,

Number of intersections with Set A = $\frac{L}{0.55}$

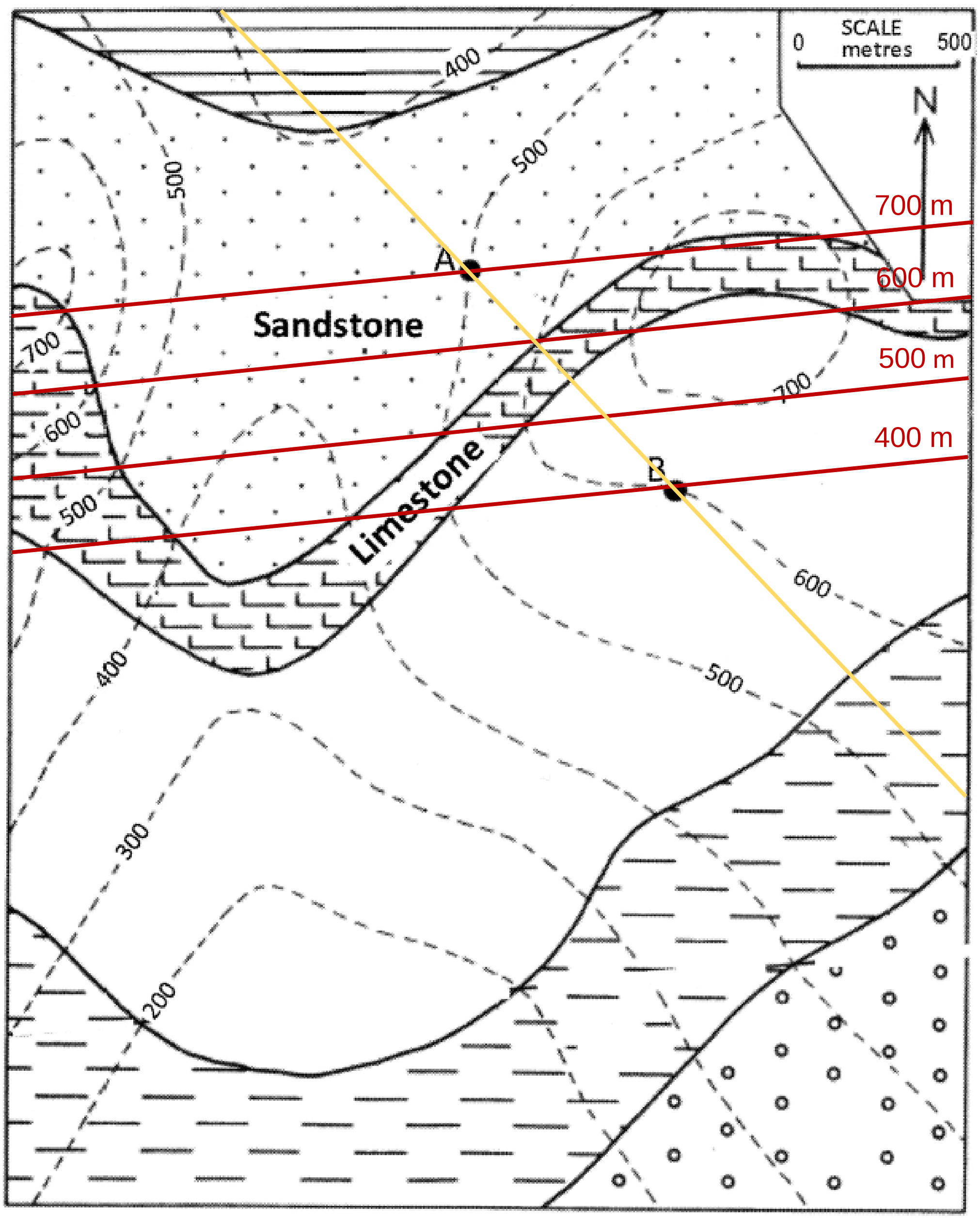
Number of intersections with Set B = $\frac{L}{0.85}$

Mean spacing of all discontinuities = $\frac{L}{\text{Expected total number of intersections}}$

$= \frac{L}{\frac{L}{0.55}+\frac{L}{0.85}}$

= 0.334 m

2(a)



2(b) 175/22

2(c) 265/22S or 85/22S

2(d)(i) Borehole B. At borehole A, the topographical contour = 500 m < structural contour = 700 m, which shows that the sandstone-limestone contact plane has already been eroded away. At borehole B, the topographical contour = 600 m > structural contour = 400 m, which shows that the contact plane is below ground surface.

2(d)(ii) Depth below ground surface = 600 – 400 = 200 m

2(e) True dip = 22°
β = angle between dip direction and direction AB = 39º
tan(apparent dip) = cosβ × tan(true dip) = cos39° × tan22º
Apparent dip = 17.4º

3(a)(i) $q = kiA$

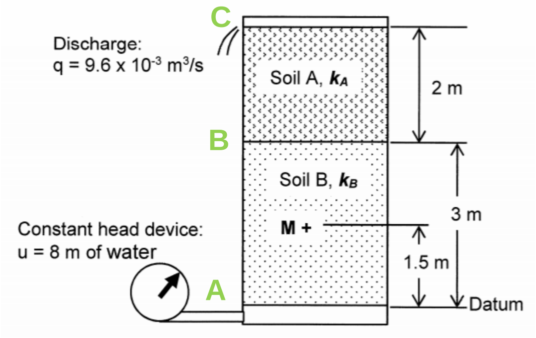
q = volume of water flowing per unit time

k = coefficient of permeability or hydraulic conductivity

i = hydraulic gradient

A = cross-sectional area of soil

3(a)(ii)



Point	z (m)	h_p (m)	h (m)
A	0	8	8
B	3		
C	5	0	5

$q_A = q_B$

$k_A i_A A = k_B i_B A$

$k_A i_A = 6k_A i_B$

$i_A = 6i_B$

$\frac{h_B - h_C}{2} = 6(\frac{h_A - h_B}{3})$

$\frac{h_B - 5}{2} = 6(\frac{8 - h_B}{3})$

$h_B - 5 = 32 - 4h_B$

$h_B = 7.4$ m

3(a)(iii) $i_A = \frac{7.4-5}{2} = 1.2$

$i_B = \frac{1}{6}(1.2) = 0.2$

3(a)(iv) $q = kiA$

$9.6 \times 10^{-3} = ki(1)$

$k = \frac{9.6 \times 10^{-3}}{i}$

$k_A = \frac{9.6 \times 10^{-3}}{1.2} = 0.008$ m/s, $k_B = \frac{9.6 \times 10^{-3}}{0.2} = 0.048$ m/s

3(a)(v) $i_B = \frac{h_A - h_M}{1.5}$

$0.2 = \frac{8 - h_M}{1.5}$

$h_M = 7.7$ m

$z_M = 1.5$ m

$h_{p,M} = 7.7 - 1.5 = 6.2$ m

$u_M = 6.2 \times 9.81 = 60.8$ kPa

3(b)(i) Note: there was a change in the question, $q = 9.5 \times 10^{-5}$ m/s (not cm/s)

$q = kh\frac{N_f}{N_d} = (9.5 \times 10^{-5})(6)\frac{3}{10} = 0.000171$ m/s = 14.8 m/day

3(b)(ii) Total head at P = 4.2 m

Elevation head at P = 1.5 – 10 = -8.5 m

Pressure head at P = 4.2 – (-8.5) = 12.7 m

Pore water pressure at P = 12.7 × 9.81 = 125 kPa

3(b)(iii) $h_Q = 0.6$
$z_Q = -1.5$
$h_{p,Q} = 0.6 - (-1.5) = 2.1$ m
$u = 2.1 \times 9.81 = 20.6$ kPa
$\sigma = 1.5 \times 18 = 27$ kPa
$\sigma' = 27 - 20.6 = 6.40$ kPa

4(a)(i) $\sigma = 18 \times 5 + 16 \times 2 = 122$ kPa
$u = 9.81 \times 7 = 68.67$ kPa
$\sigma' = 122 - 68.67 = 53.33$ kPa
$\mathrm{OCR} = \frac{\sigma_p'}{\sigma_0'} = \frac{\sigma_p'}{53.33} = 1.5 \Rightarrow \sigma_p' = 1.5 \times 53.33 = 80.0$ kPa

4(a)(ii) $\Delta\sigma = 17 \times 4 = 68$ kPa
$u = 68.67 + 68 = 136.67$ kPa
$\sigma' = 53.33$ kPa

4(a)(iii) $\sigma_2' = 53.33 + 68 = 121.33$ kPa
$s_c = \frac{H}{1+e_0}\left(C_r \log\frac{\sigma_p'}{\sigma_0'} + C_c \log\frac{\sigma_2'}{\sigma_p'}\right) = \frac{5}{1+1.8}\left(0.04 \log\frac{80.0}{53.33} + 0.4 \log\frac{121.33}{80.0}\right) = 0.1134$ m

4(a)(iv) For U = 90%, $T_v = 0.848$
$t = \frac{T_v d^2}{c_v} = \frac{0.848(\frac{4}{2})^2}{0.85} = 3.99$ years

4(b)(i) $u_e = 12.4 \times 9.81 - 68.67 = 52.97$ kPa
$U_z = 1 - \frac{u_e}{u_i} = 1 - \frac{52.97}{68} = 0.221 = 22.1\%$

4(b)(ii) $\frac{z}{d} = \frac{2}{2} = 1$
$T_v = 0.195$
$\frac{\pi}{4}U^2 = 0.195$
$U = 0.504 = 50.4\%$

Done by:
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