CV2013 Engineering Geology & Soil Mechanics 18/19 S1

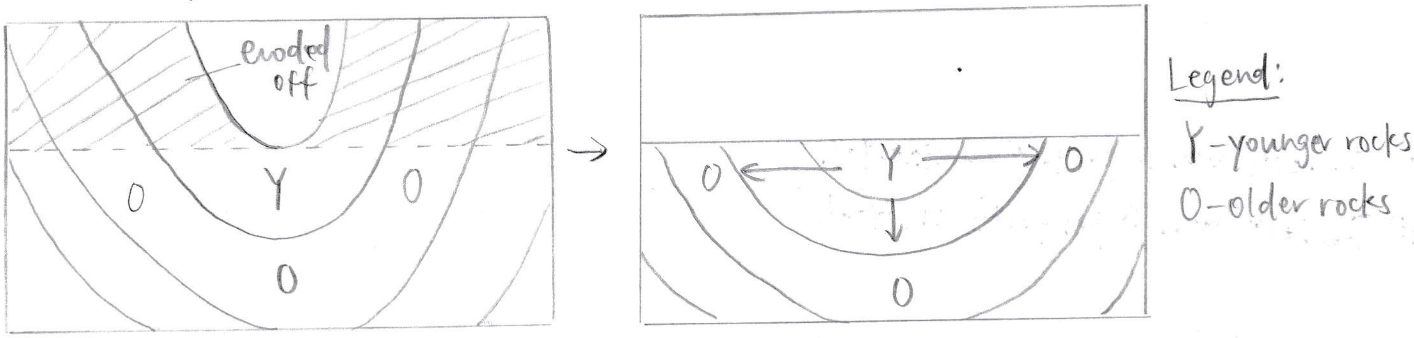
1(a) Trace elements found in the same common mineral can give the mineral different colours where small amounts of impurities produce the intense colours.

Three physical properties that can be used are hardness, cleavage and the fracture tendencies.

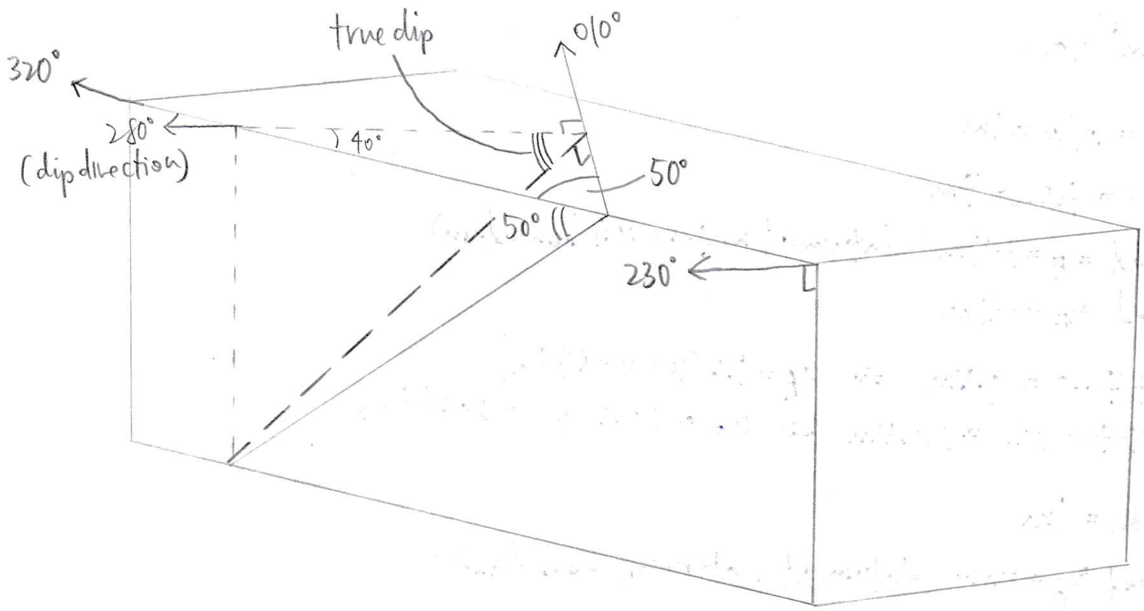
1(b) The principle of superposition states that each layer of an undeformed sedimentary sequence is younger than the one beneath it and older than the one above it, allowing strata to be vertically ordered in time from the lowest and oldest to the uppermost and youngest.

The cross-cutting relationships show that when a fault or intrusion cuts through another rock, the fault or intrusion is younger than the rocks cut through.

1(c) It can be inferred that a basin used to exist there before it was eroded off to give the flat plain.



1(d)



$\tan(\text{apparent dip}) = \cos\beta \times \tan(\text{true dip})$

$\tan 50^\circ = \cos 40^\circ \times \tan(\text{true dip})$

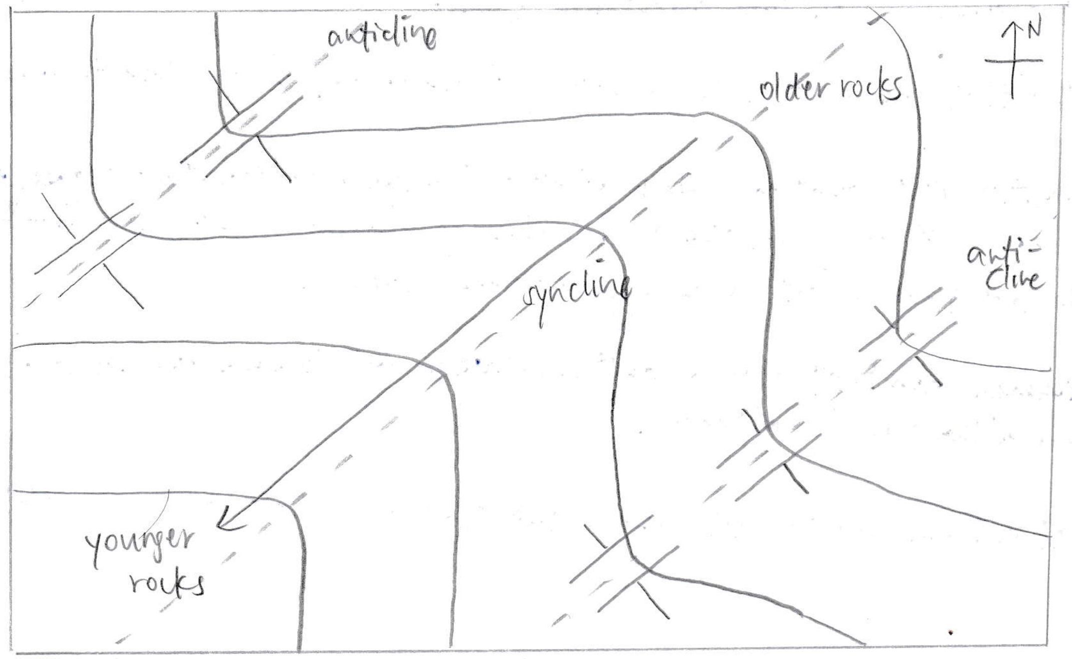
$\text{true dip} = \tan^{-1}\left(\frac{\tan 50^\circ}{\cos 40^\circ}\right)$

$= 57^\circ$

Orientation = 280/57.

2(a) Refer to last page / Appendix.

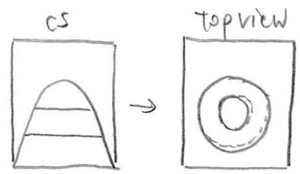
2(b)



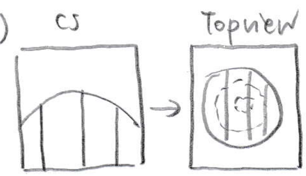
2(c)(i) The rock layer is perfectly horizontal.

(c)(ii) The rock layer is perfectly vertical.

(c)(i)



(c)(ii)



3(a)(i) $q = kh_L\left(\frac{N_f}{N_d}\right)$

$= 5\times10^{-6}\times(12.5-2.5)\left(\frac{3}{10}\right)$

$= 1.5\times10^{-5}\ m^3/s/m$

3(a)(ii) $\Delta h = h_L/N_d = 10/10 = 1m$

Total head loss $= 7\Delta h = 7m$

Elevation head $z_A = 0m$ (datum at water-soil boundary)

Elevation head $z_E = -11m$

$h_{pA} = 2.5+7-0 = 9.5m \Rightarrow u_A = 9.5(10) = 95kPa$

$h_{pE} = 2.5+7-(-11) = 20.5m \Rightarrow u_E = 20.5(10) = 205kPa$

3(a)(iii) Total head loss = 1m

Elevation head $z_B = -8m$ (datum at water-soil boundary)

$h_{pB} = 2.5+1-(-8) = 11.5m \Rightarrow u_B = 11.5(10) = 115kPa$

$\sigma_B = 8(20) + 2.5(10) = 185kPa$

$\sigma_B' = \sigma_B - u_B = 185 - 115 = 70kPa$

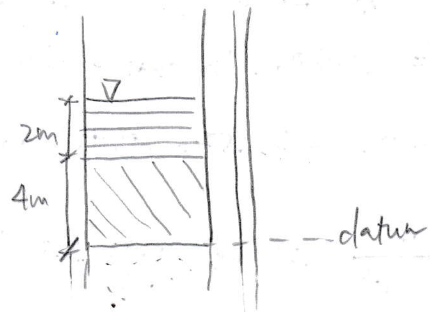
3(a)(iv) CB located 2.5m below the datum.

Total head loss $= 0.5\Delta h = 0.5m$

$$v = ki = kh_L/L = \frac{5\times10^{-6}\times0.5}{2.5} = 1\times10^{-6}\,m/s$$

3(b)(i) An artesian condition is one where groundwater experiences a positive pressure due to the confining pressures of the impermeable soil above it. It arises due to the impermeability of the soil above the confined aquifer.

3(b)(ii) Taking the 'coarse sand-silt boundary as the datum



At bottom of piezometer,

$$h_T = 3+4+4+5+5+3-3 = 21m$$

At water surface in well

$$h_T = h_p + z = 0+6 = 6m$$

Total head loss through silt & clayey silt in well $= 21-6 = 15m = h_{L,silt} + h_{L,clayey silt}$ —(1)

* No head loss in coarse sand since it is effectively fully permeable.

By continuity equation, $q_{silt} = q_{clayey silt}$

$$2k\frac{h_{L,silt}}{L_{silt}}A = k\frac{h_{L,clayey silt}}{L_{clayey silt}}A$$

$$h_{L,silt} = h_{L,clayey silt} \quad (2)$$

Substitute (2) into (1), $2h_{L,clayey silt} = 15m$

$$h_{L,clayey silt} = 7.5m = h_{L,silt}$$

$$q = k\frac{h_L}{L}A = 5\times10^{-5}\left(\frac{7.5}{2}\right)\left(\frac{\pi\times2^2}{4}\right) = 0.000589\,0m^3/s = 50.9\,m^3/day$$

4(a)(i) For 90% average degree of consolidation, $T_v = -0.933\log(1-0.9) - 0.085 = 0.848$

$$c_v = \frac{T_v d^2}{t} = \frac{0.848(0.02)^2}{85} = 3.99\times10^{-6}\,m^2/s$$

4(a)(ii) At middle of clay, $z/d = 0.5$

From graph using $T_v = 0.848$ and $z/d = 0.5$, $U_z = 0.89$

$$u_e = 100(1-0.89) = 11kPa$$

$$u = 11 + 0.01\times9.81 = 11.1kPa \text{ (3sf)}$$

4(b)(i) Let middle of clay be point A.

$\sigma_{A0} = 2 \times 16.5 + 3 \times 9.81 = 62.43 kPa$

$u_{A0} = (2+3) \times 9.81 = 49.05 kPa$ //

$\sigma'_{A0} = 62.43 - 49.05 = 13.38 kPa$ //

4(b)(ii) $\Delta\sigma_z = 16 \times 3 + 18 \times 3 - 9.81 \times 3 = 72.57 kPa$

$u_{A1} = u_{A0} + \Delta\sigma_z = 49.05 + 72.57 = 121.62 kPa$ //

$\sigma'_{A1} = 13.38 kPa$ // (no change since all $\Delta\sigma_z$ captured by PWP)

4(b)(iii) $\sigma'_{Af} = 13.38 + 72.57 = 85.95 kPa$ //

4(b)(iv) $S_c = \frac{8}{1+1.5}(0.5)(\log(85.95/13.38)) = 1.29m$ //

4(b)(v) $h_p = 2+3+3 = 8m \Rightarrow u = 8(9.81) = 78.48 kPa$

$u_e = 78.48 - 49.05 = 29.43 kPa$

$U_z = 1 - \frac{29.43}{72.57} = 0.594$

From graph using $U_z = 0.594$ and $z/d = 1$, $T_v = 0.47$

$t = \frac{T_v d^2}{c_v} = \frac{0.47(2)^2}{1.25} = 1.50 years$ //

4(b)(vi) $\gamma_{sat} = \frac{(G_s + \frac{wG_s}{S_r})\gamma_w}{1 + \frac{wG_s}{S_r}}$

$16.5 = \frac{(2.63 + \frac{w \times 2.63}{1})(9.81)}{1 + \frac{w \times 2.63}{1}}$

$16.5 + 43.395w = 25.8003 + 25.8003w$

$17.5947w = 9.3003$

$w = 0.529 = 52.9\%$ //

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[signature]

Appendix II to CV2013

Matriculation Number: ______________________

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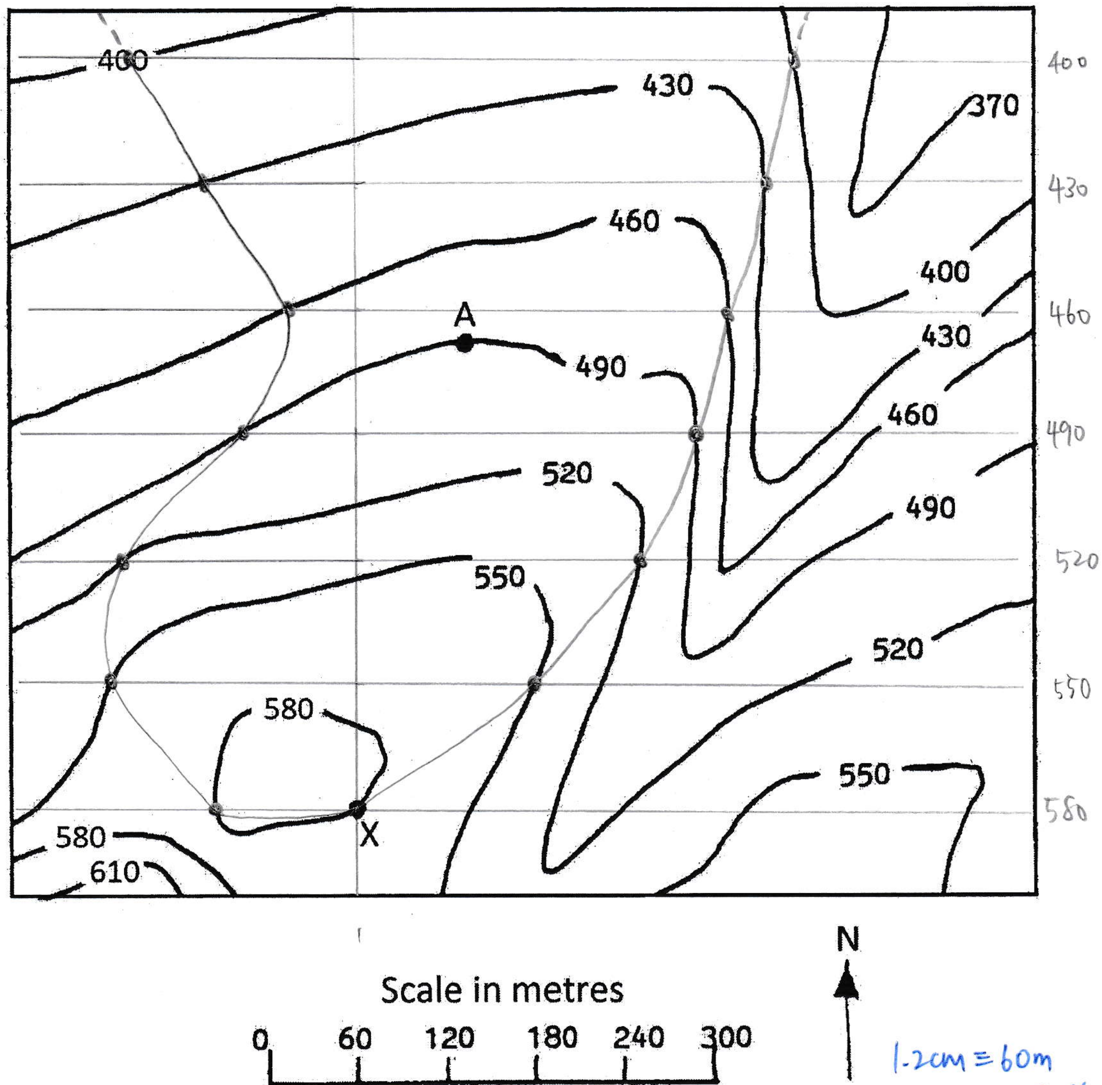
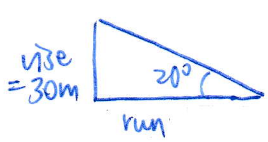
2(a)(i) & (ii) :



1.2cm ≡ 60m

$82.4m \approx \frac{82.4}{60} \times 1.2 = 1.65cm$

Figure Q2



$Rise = \frac{30}{\tan 20°} = 82.4m$

2(a)(ii) Topographic elevation = 490m

Structural feature elevation = $\frac{0.45}{1.65} \times 30 + 460 = 468m$

Depth to encounter = 490 − 468 = 22m