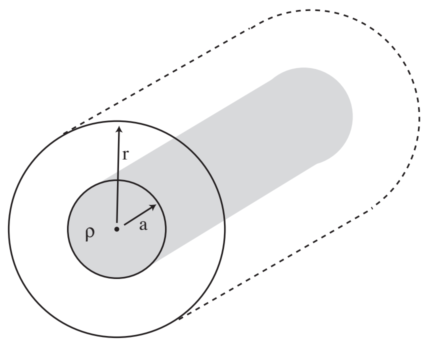
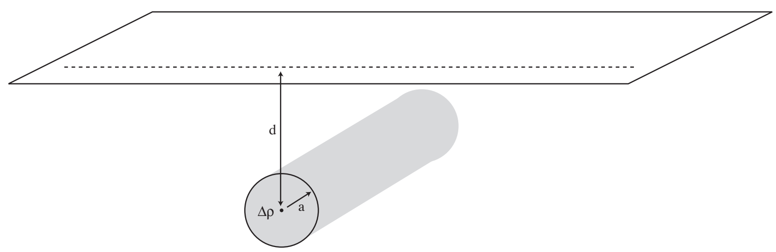
SIO 182 Assignment 3. Given 28th January, due 4th February

1) a) Use Gauss' Law and symmetry arguments to find an expression for the gravitational attraction at distance r outside an infinitely long cylinder of radius a (less than r) and density ρ (i.e. the cylinder is sitting in free space). (Both the Gauss surface and the mass are infinite, so you need to work out how to scale things so that isn't a problem.)

b) Use the result for the cylinder to derive an expression for the vertical component of gravity across the earth's surface due to an infinite, horizontal, perpendicular cylinder of excess density $\Delta\rho$ and radius a buried at a depth (to the center) d.





c) Compute and plot the profile of the vertical component of gravity across a horizontal cylinder with a density of 3 g/cm^3 (3000 kg/m^3) in surrounding rock of density 2 g/cm^3 (2000 kg/m^3), a diameter of 50 m, buried at a depth of 50 m to its center. Compare this result to your 50 m and 100 m sphere results from the first assignment (re-calculate these if you got them wrong!), by plotting profiles normalized to the peak value (i.e. divide the results by the maximum so that all curves go from zero to one). Comment on your result.

2) Estimate the excess mass of the Elura ore body using the plan on page 2 of the gravity anomaly (the units on the map are GU, or 10^{-6} ms^{-2}).

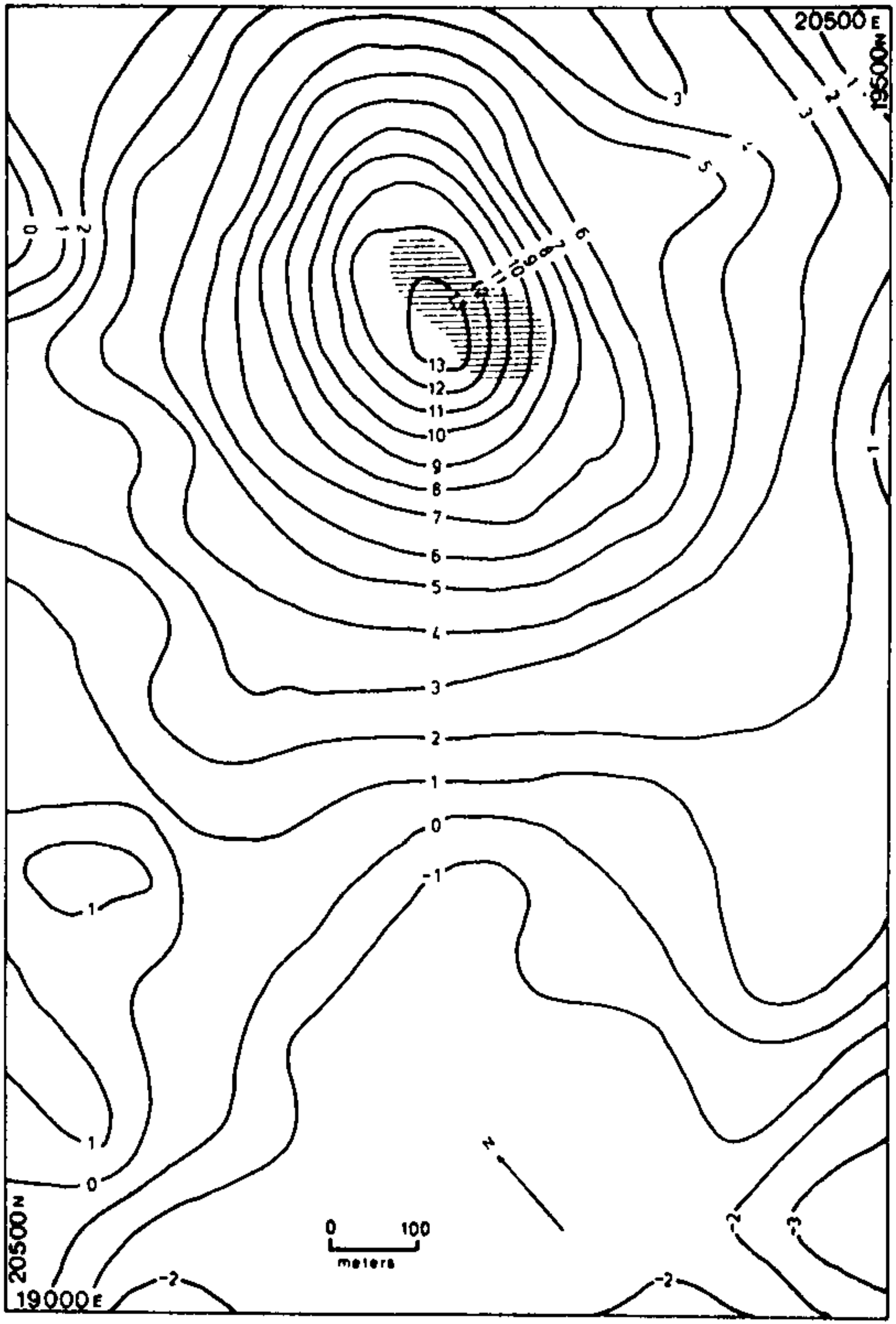
3) The Elura host rock density is 2600 kg/m^3, and the ore body average density is 4200 kg/m^3. What is the actual mass of the ore body? The average grade of the ore body is 8.3% zinc and 5.6% copper (by weight). Zinc is currently valued at about \$3.20 per kilogram and copper \$6.80 per kilo. What is the current market value of the reserves?

4) Estimate the maximum possible depth to the top of the Elura ore body using the half-width rule for a point mass in the notes.

5) The Elura body is roughly a vertical cylinder. The vertical field due to a narrow cylinder extending from z to infinite depth is approximately

$$g_z(x) = \frac{G\pi R^2 \Delta\rho}{(z^2 + x^2)^{1/2}}$$

where $\Delta\rho$ is the density contrast of the cylinder, R is the radius of the cylinder, z is the depth to the upper surface of the structure and x is the horizontal distance for the observation point to the axis of the body. Derive a half-width rule for this cylinder. Compute a new depth estimate for the Elura body based on this geometry. Comment on any difference with the result from (5).



20500 E
19500 N
20500 N
19000 E
0
100
meters
N