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Structure contours, vertical cross-sections, three-point problems and applications

The goals of this exercise are to: 1) review learned knowledge of specific structures; 2) identify and interpret structural geometries based on the topographic expression of geologic units and associated structural measurements through the construction of map outcrop patterns and cross-sections; and 3) conceptualize and characterize three-dimensional geometric surfaces in the subsurface using well data and three-point analytical techniques.

Part I: Structure contours and vertical cross-sections: part 1 is modified from a structural geology class exercise originally presented by Arthur W. Snoke at the University of Wyoming

The attached geologic map covers an area in which the following formations are exposed:
(1) A series of massive marine sandstones (stippled) lying unconformably upon older rocks (see b and c below).
(2) Three uniformly oriented sedimentary formations A (oldest), B, and C (youngest) cut by a thick dike (patterned with dashes) of mafic igneous rock.
(3) Unconformably below formation A is an older series of sedimentary rocks striking due North and dipping uniformly 27º W containing a thick limestone member. The upper and lower surfaces of this limestone member outcrop at the two circled points.

Complete the following problems (Show all of your work on additional sheets to supplement the results you present on the map. Remember: Neatness is critical!):
(1) Prepare a structure contour map of the surface between formations A and B.
(2) Determine the strike and dip of the unconformity below the massive sandstone.
(3) Determine the thickness of the dike.
(4) Determine the stratigraphic thickness of formations A and B.
(5) Construct the outcrop of the limestone member to the northeast of the lower unconformity. This outcrop must be completed on both sides of the dike.
(6) A vertical hole is to be drilled from point P on the surface to intersect the upper surface of the limestone. At what depth below the ground surface will the upper limestone surface be reached?
(7) Draw an accurate vertical cross section along line X-X' showing topography and all formation contacts with correct apparent dips.

Part II: Application of three-point problems:
An oil company has been doing exploratory drilling in the Gulf of Mexico and has found particularly oil-rich sandstone that they would like to drill a fourth well into to begin production. They have already drilled three wells at points A, B and C. The elevations of the well collars and depths to the oil-rich sandstone are as follows:

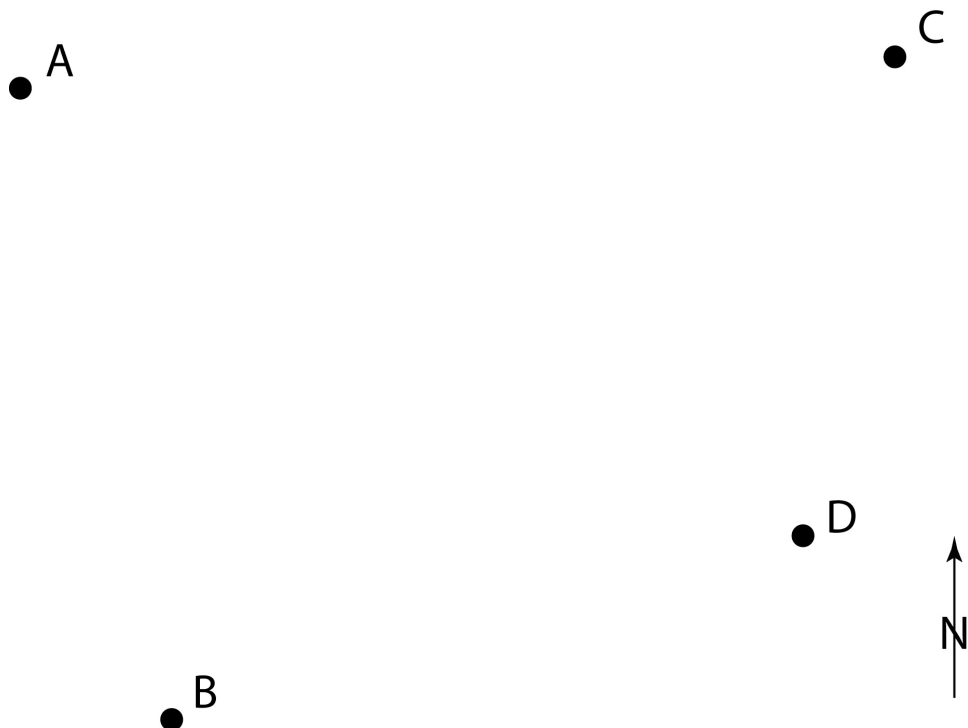| Well #	Collar elev. below sea level	Depth to bed from collar	Depth below sea level of bed
A	-1300 m	920 m	
B	-3752 m	1017 m	
C	-826 m	321 m	
D	-1920 m		

Complete the following problems (Show all of your work on maps and additional sheets):
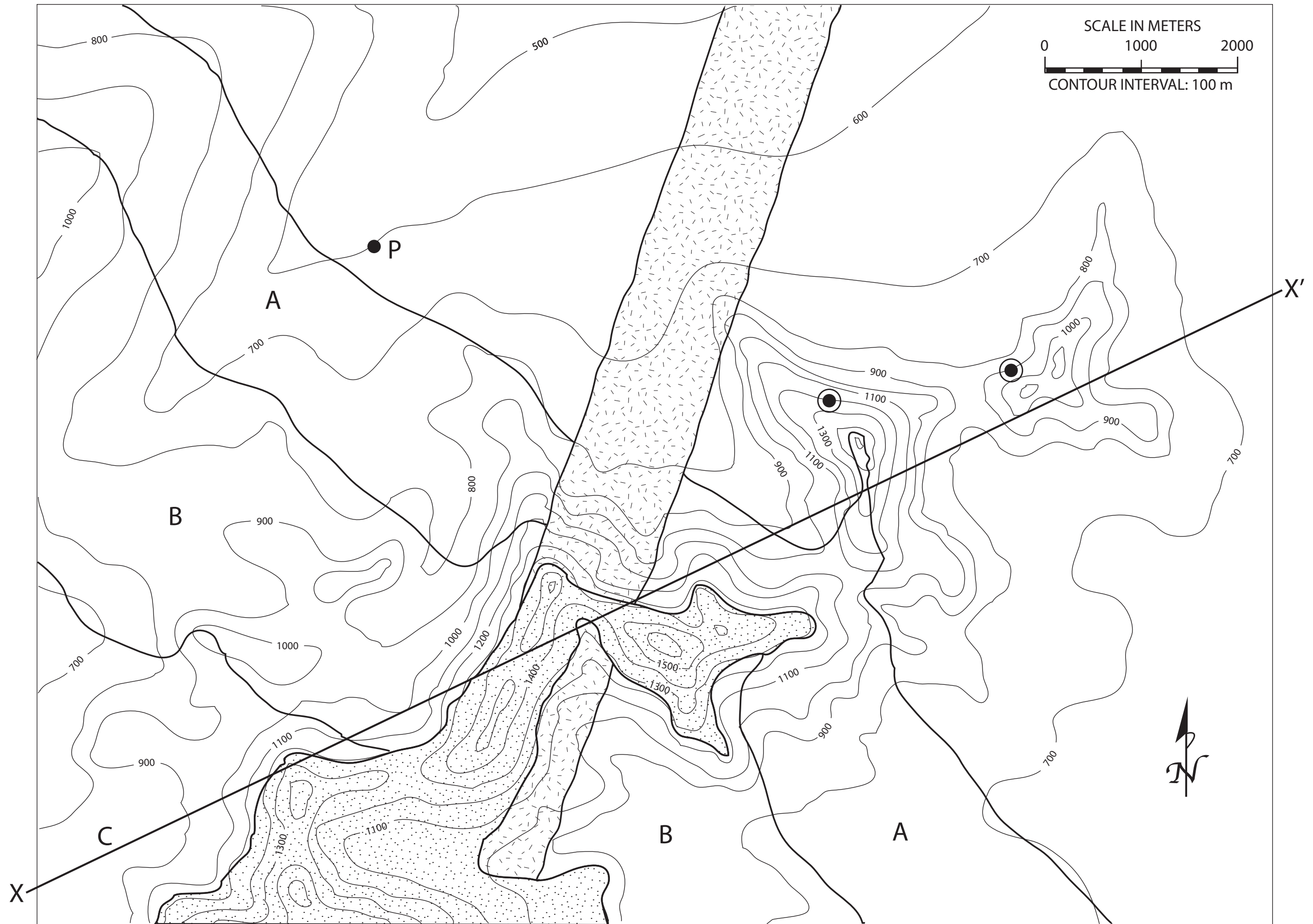(1) What is the strike and dip of the oil-rich sandstone bed?
(2) How deep will Well D have to go in order to intersect the sandstone layer?
(3) What would the apparent dip of the sandstone layer be along a seismic line that was run between drill rigs A and D?
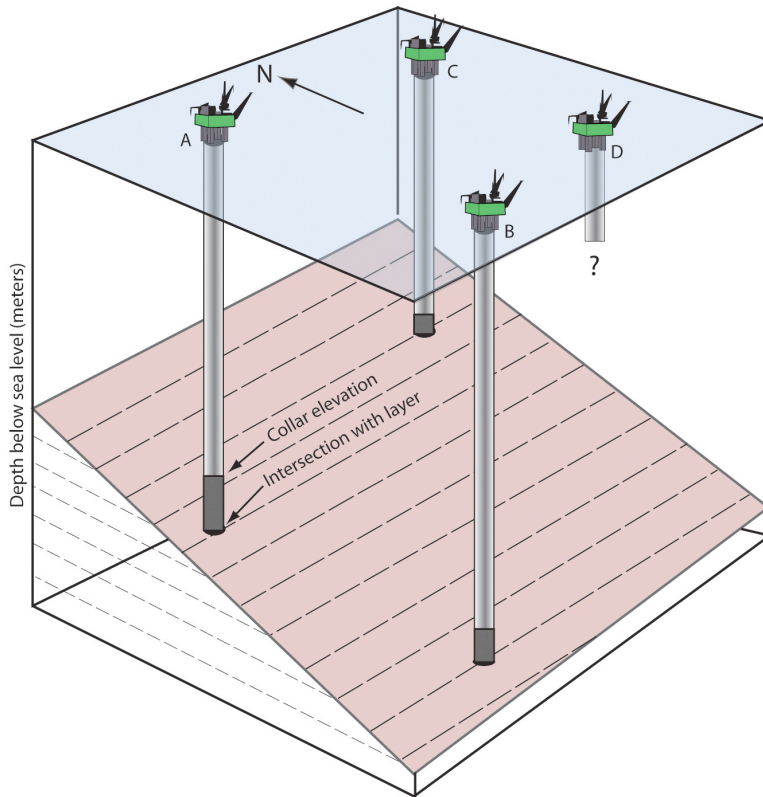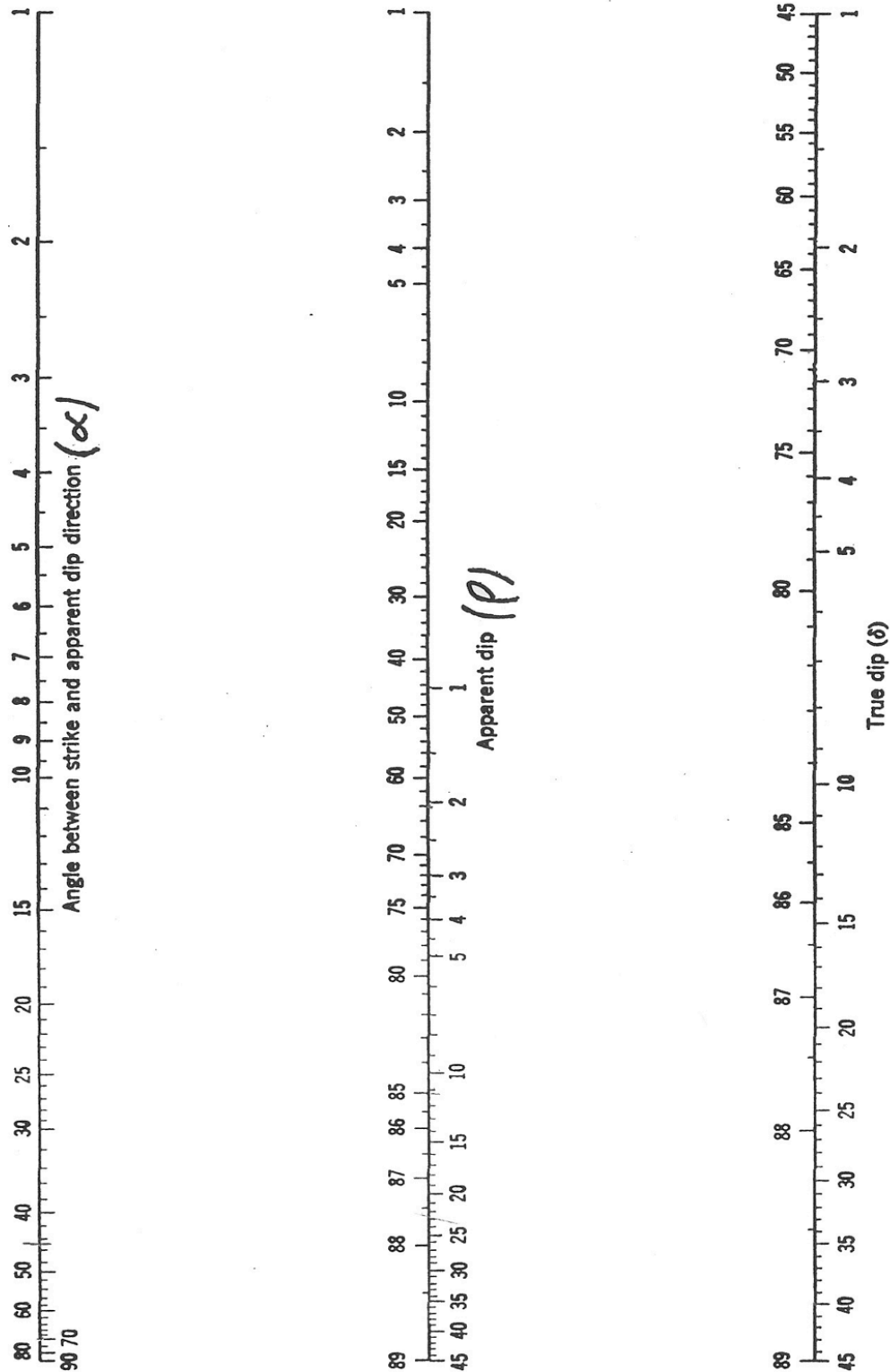

This 3D view is provided to help you visualize the problem. The map below shows the locations of the various drill rigs as if you were looking down on the ocean surface (map view).

Map of drill rig and core locations. In your calculations, use a scale of 1" = 2000 meters. Show all your work on this map and on attached calculations.

SCALE IN METERS

0 1000 2000

CONTOUR INTERVAL: 100 m

X

X'

P

A

B

C

B

A

N

Angle between strike and apparent dip direction (α)

Apparent dip (ρ)

True dip (δ)

Alignment diagram (nomogram) for determining apparent dip (From Nevin, 1949, Principles of Structural Geology). Using a straight edge join the points representing the angle between the strike and apparent dip direction on the first row and the true dip on the third row. The apparent dip is read off the middle row.