Structure contours

A *structure contour* is an imaginary line connecting points of equal elevation (a contour) on a single surface, such as the top of a formation. Structure-contour maps are analogous to topographic maps: the former shows the surface of a geologic horizon, the latter shows the surface of the earth.

Structure-contour maps are most commonly constructed from drill-hole data. See Fig. 2.8, for example, which shows a faulted dome. Notice that unlike topographic contours, structure contours sometimes terminate abruptly. Gaps in the map indicate normal faults, and overlaps indicate reverse faults.

Structure contour maps are used extensively in petroleum exploration to identify structural traps and in hydrology to determine the subsurface configuration of aquifers. The objective here will be to introduce you to structure-contour maps so that you are generally familiar with them and can use them to determine outcrop patterns later in the chapter.

Figure 2.11 is a map showing the elevation (in feet) of the top of a formation in 26 drill holes. This area is in the northeastern corner of the Bree Creek Quadrangle, and the formation involved is the Bree Conglomerate. The geologic map of the Bree Creek Quadrangle may be found on six pages in the back of this book. As explained later in this chapter, you will combine these into one big map and use it often as you work through the following chapters.

There are various techniques for contouring numerical data such as the elevations in Fig. 2.11. In the case of geologic structure contours, there are usually not enough data to produce an unequivocal map, so experienced interpretation becomes extremely valuable.

Problem 2.2

Draw structure contours on Fig. 2.11. Use a 400-ft contour interval (including 0, 400, 800, 1200, etc.).

If you do not know how to begin, here are some suggestions. Find a point whose elevation is close to the elevation of a contour line, for example, the 779-ft point. You know that the 800-ft contour passes very close to this point, but where does it go? To the east and northeast are two points with elevations of 516 ft and 1013 ft. 800 lies between these two elevations, so the 800-ft contour must pass between these two points, closer to the 1013-ft point than to the 516-ft point. Once you have a few lines drawn, the rest will fall into place. Your structure contours should be smooth, subparallel lines. Use a pencil, because this is a trial-and-error operation.

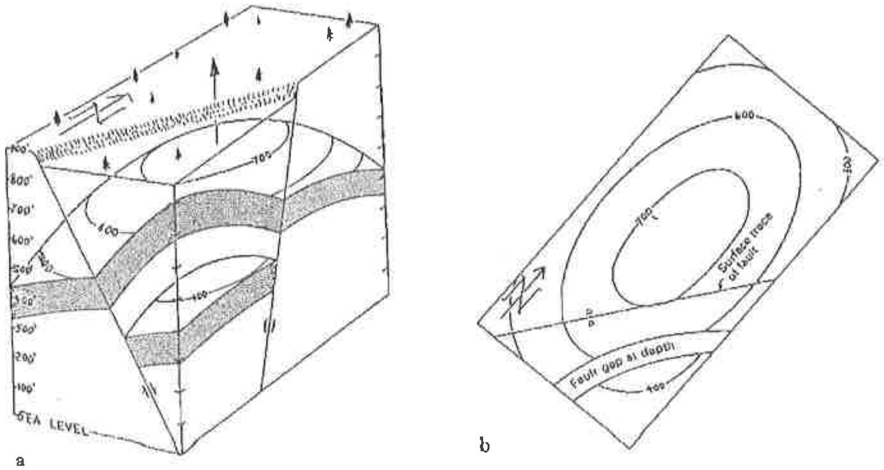


Fig. 2.8 Block diagram (a) and structure contour map (b) of a faulted dome.

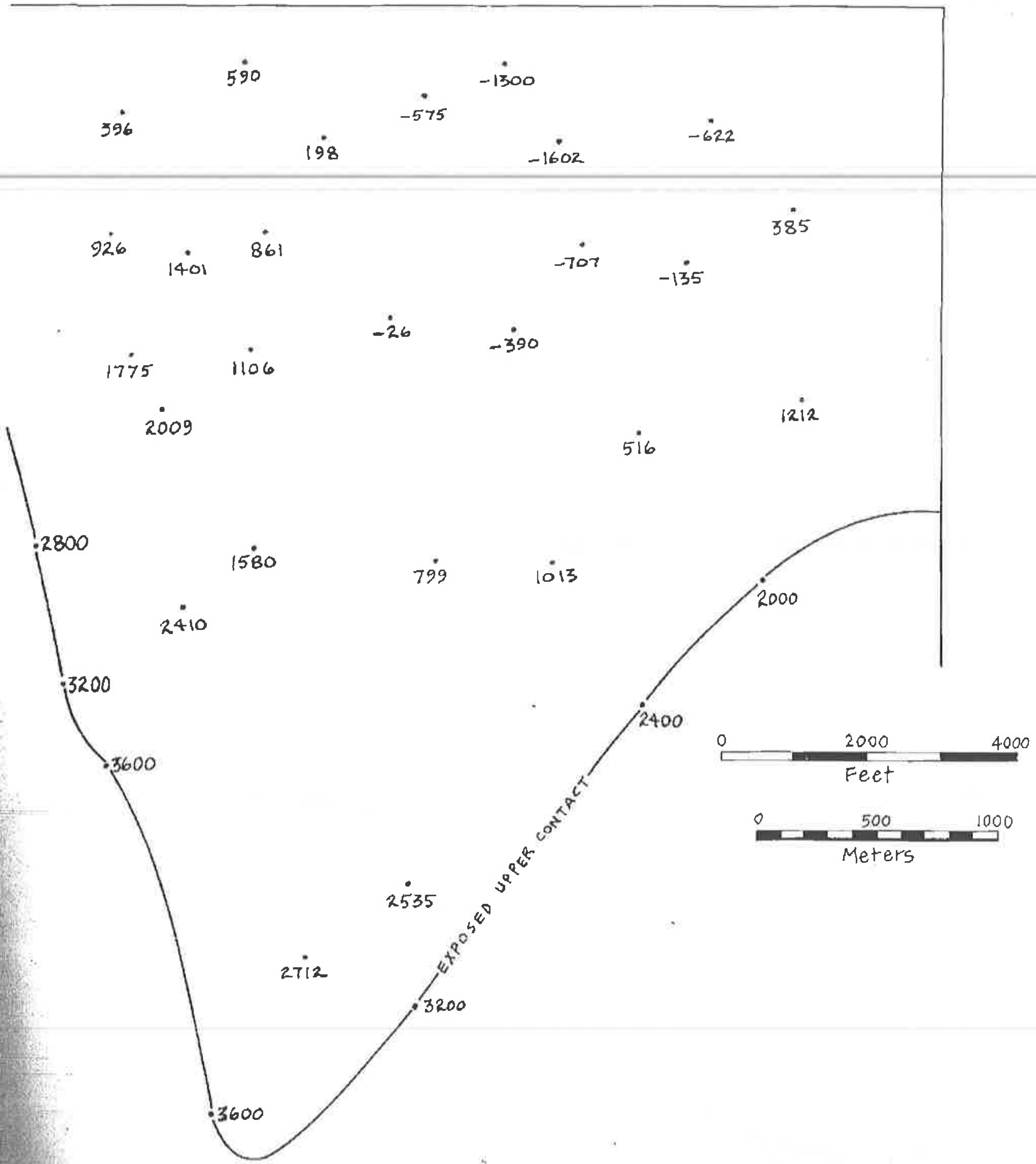
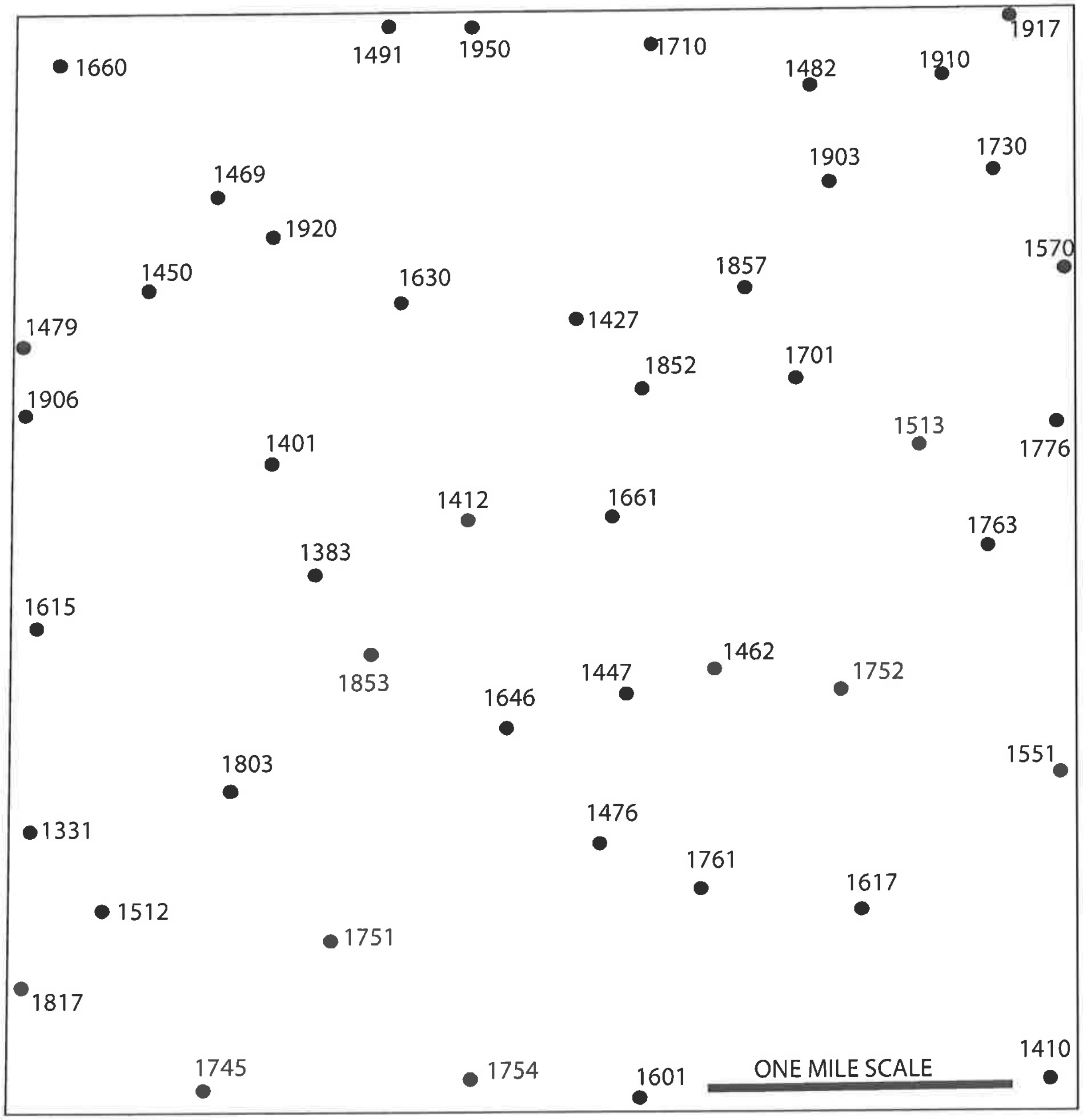


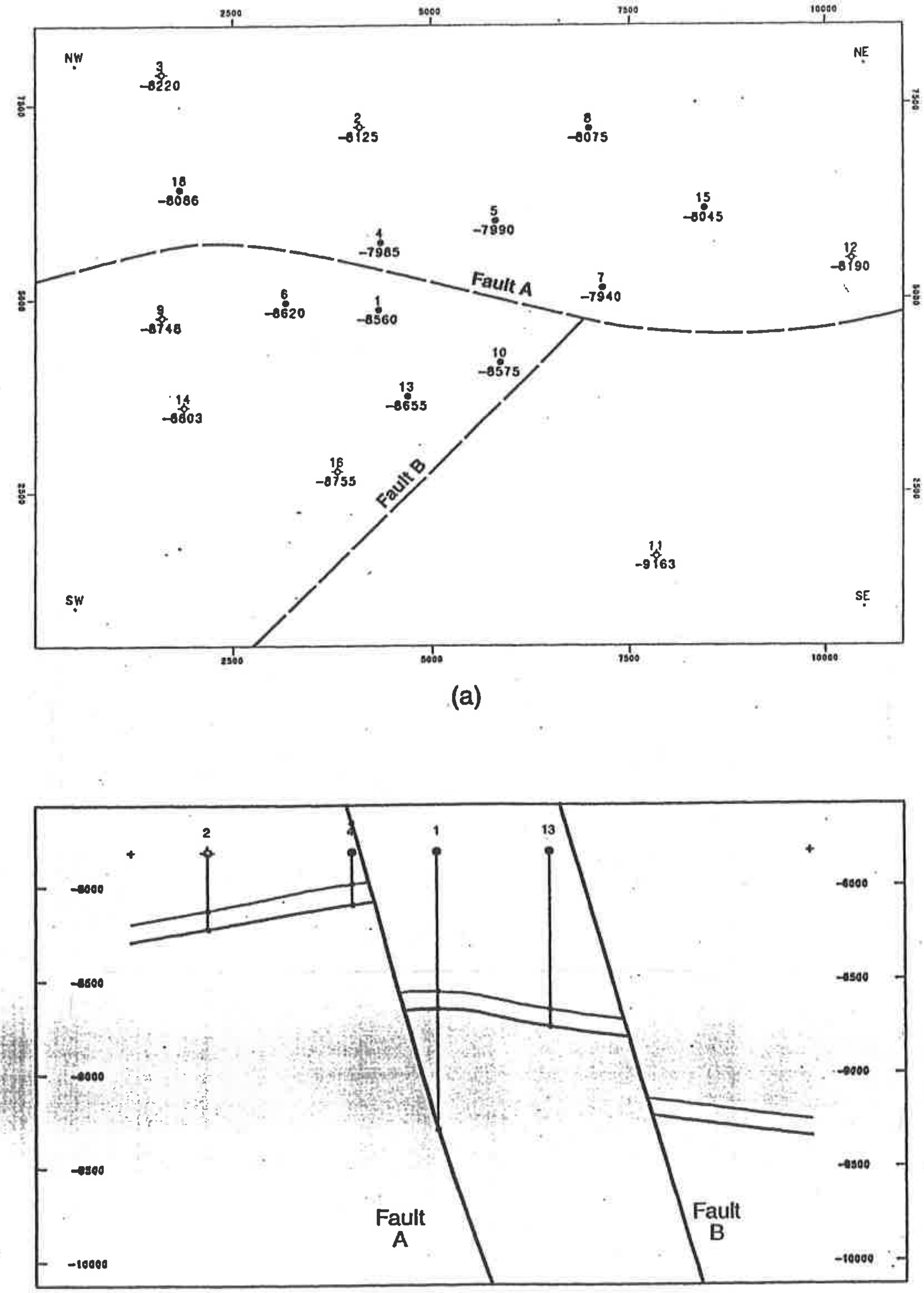
Fig. 2.11 Map to accompany Problem 2.2. Elevation of *upper surface* of Bree Conglomerate in 26 drill holes, northeastern Bree Creek Quadrangle.

MAP #2

Below is a map showing subsurface elevations on top of the Devonian Leduc Limestone, a formation in southern Alberta, which is prone to the development of pinnacle reefs. There are no faults in the map area.

Please spend about 30 minutes making a contour map on top Leduc, honoring all data points. Use a 100-foot contour interval. Note that subsurface elevations here are positive (i.e., above sea-level). The top of the map is north.





(a)

(b)

Figure 2-38 (a) Base map with Top-of-Unit elevations and approximate traces of Faults A and B. (b) North-south cross section before restoration of faults. (Published by permission of Subsurface Consultants & Associates, LLC.)

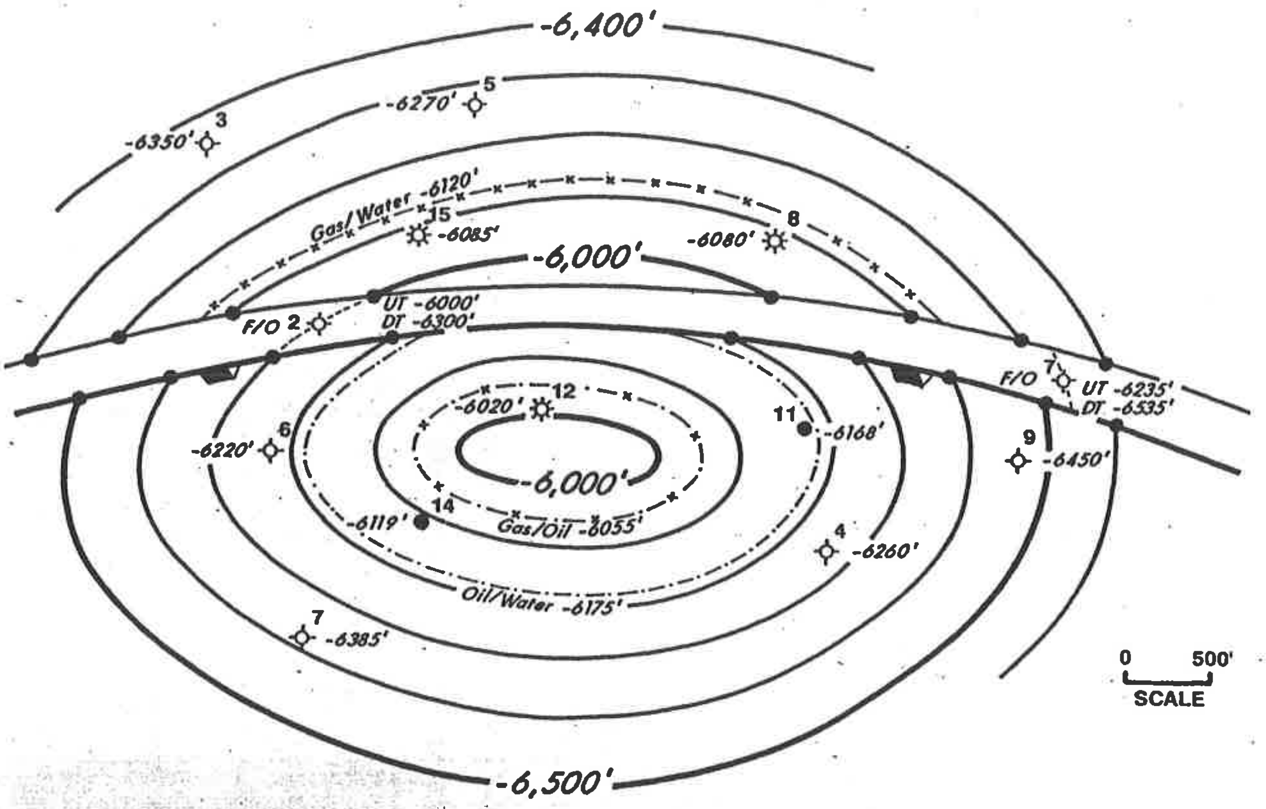


Figure 8-10 Integrated fault and structure map for the 6000-ft Horizon. The darkened circles delineate the intersection of each structure contour with the fault contour of the same elevation.

Techniques for Contouring Across Normal Faults

A **fault trace** is defined as a line that represents the intersection of a fault surface and a structural horizon; it is sometimes referred to as a fault cutoff. Two fault traces (lines) are normally required to delineate a fault on a structure map. One line represents the footwall cutoff, or upthrown trace, and the other line represents the hanging wall cutoff or downthrown trace of the fault. Two conventions have been designed to indicate the direction of fault dip: (1) some type of symbol, like a "tent," on the hanging wall cutoff (downthrown trace), and (2) the downthrown trace is heavier or thicker than the upthrown trace. The structure map in Fig. 8-11a shows a fault displacing a contoured surface, using the conventional symbols described.

The techniques presented in this section demonstrate the correct method for projecting established contours from one fault block across a fault into another fault block. Using the available data (Fig. 8-11a), contours are first established for the block with the best control, which in this case is the upthrown block with four wells. These contours are extended to the upthrown trace of Fault 1. To contour across the fault, project the contours from the upthrown block through the fault into the downthrown block. This is shown in Fig. 8-11a by a set of dashed contour lines continued across the fault gap indicating what the structural attitude of the horizon would be if the fault were not there. *In other words, where would the contours be drawn if the fault were not there?* Once the contours are projected through the fault gap to the downthrown fault trace, they are adjusted relative to the upthrown contour values by *using the amount of vertical separation,* which in this case is 400 ft. The downthrown block is then contoured. For example, the –8400-ft contour in the upthrown block, when projected into the downthrown block, becomes the –8800-ft contour.

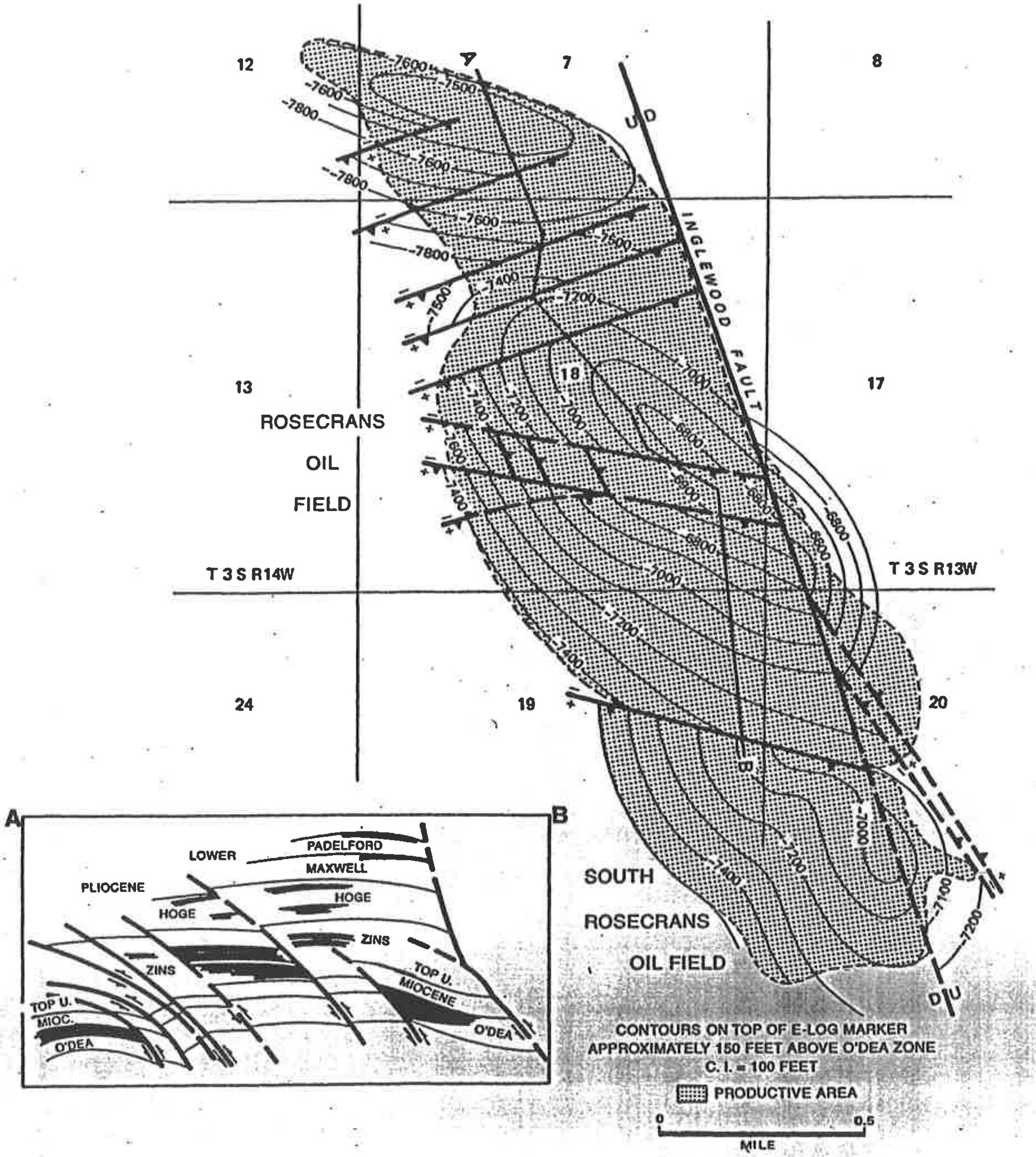


Figure 8-76 Rosecrans field structure (After California Div. Oil & Gas, 1961) shows a distinct pattern of reverse-faulted anticlinal folds oriented obliquely to the Inglewood Fault. (Modified from Harding 1973; AAPG©1973, reprinted by permission of the APPG whose permission is required for further use.)