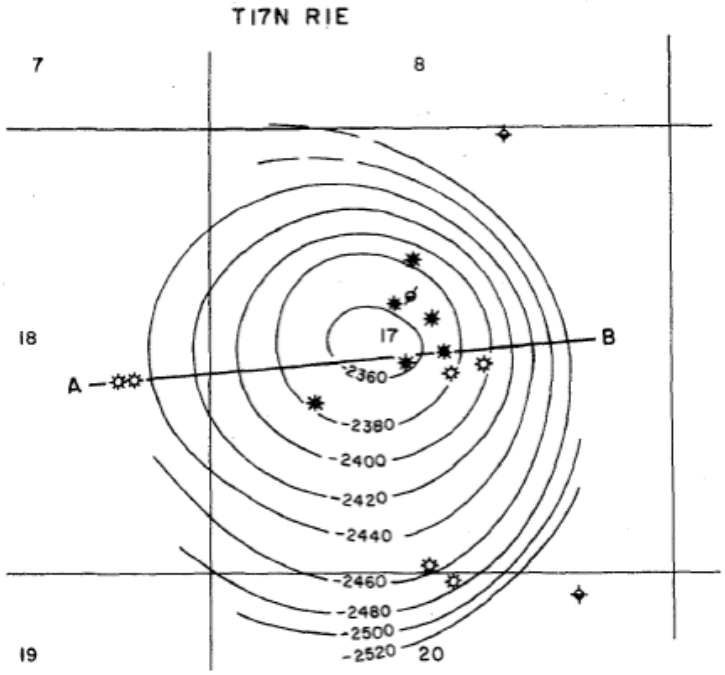
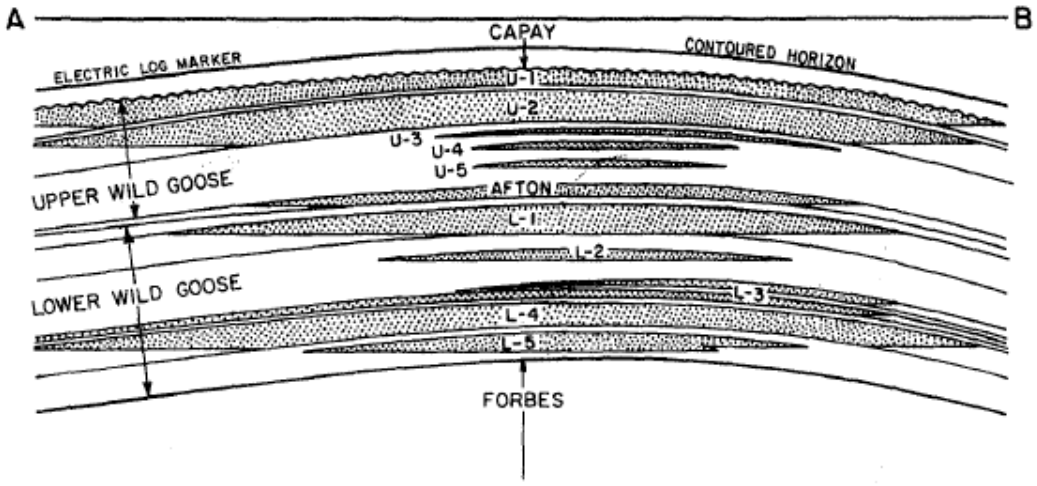
Appendix 1.A. California gas storage and geologic trap type

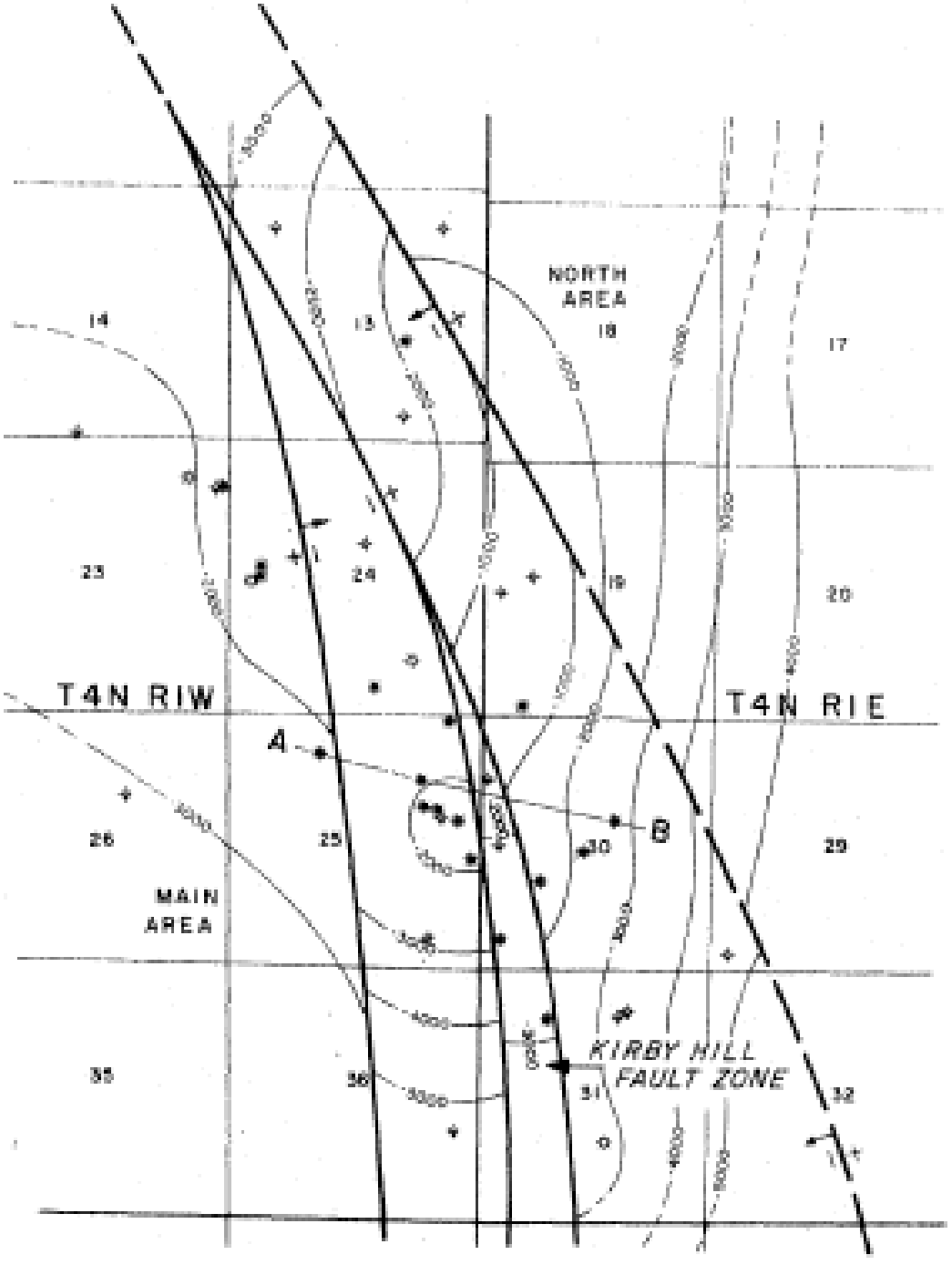
As mentioned in Section 1.1.5 and listed in Table 1.1.3, gas is stored underground in three different types of geologic traps in California. Figure 1A-1 provides an example of each type.



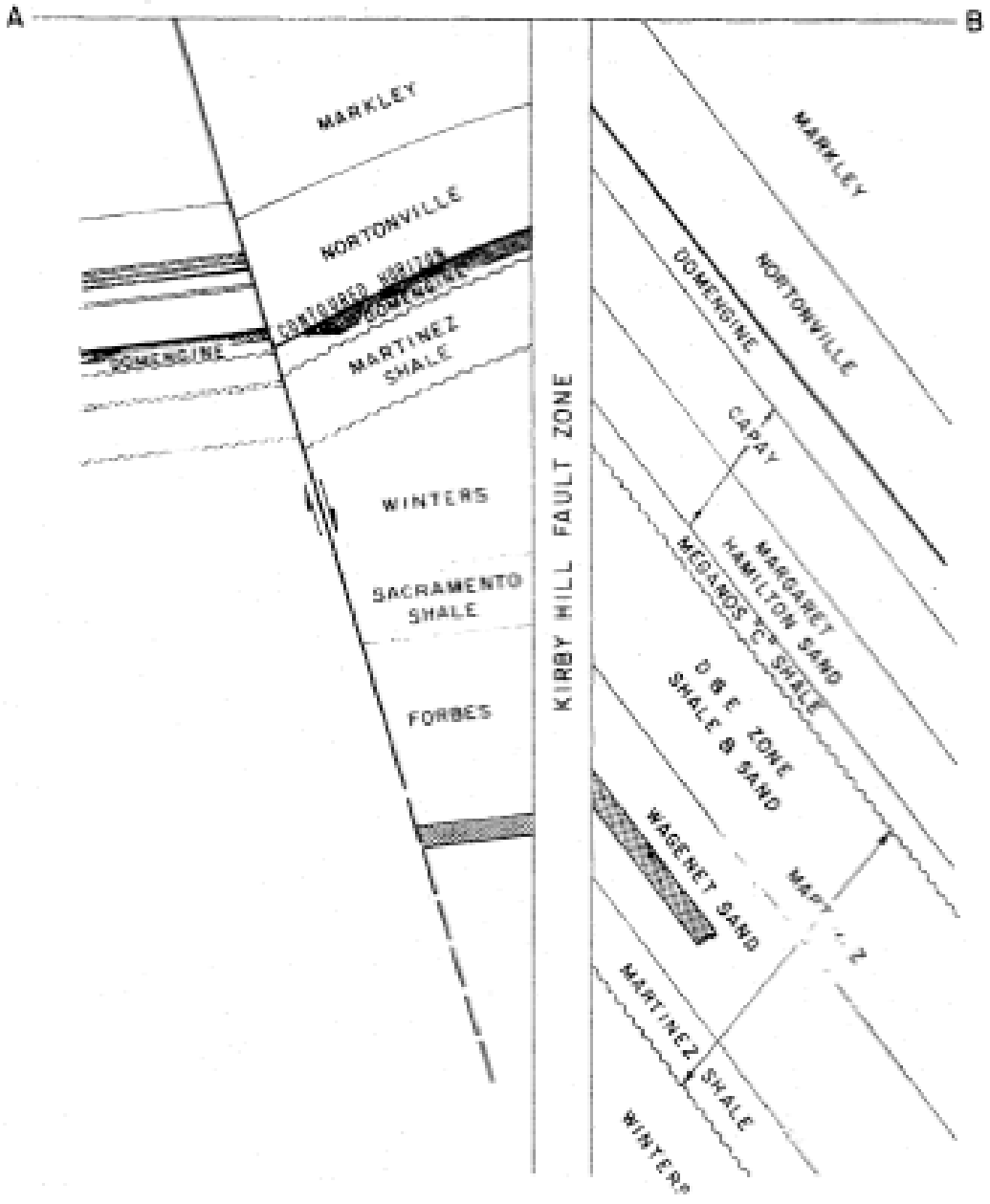
(a)



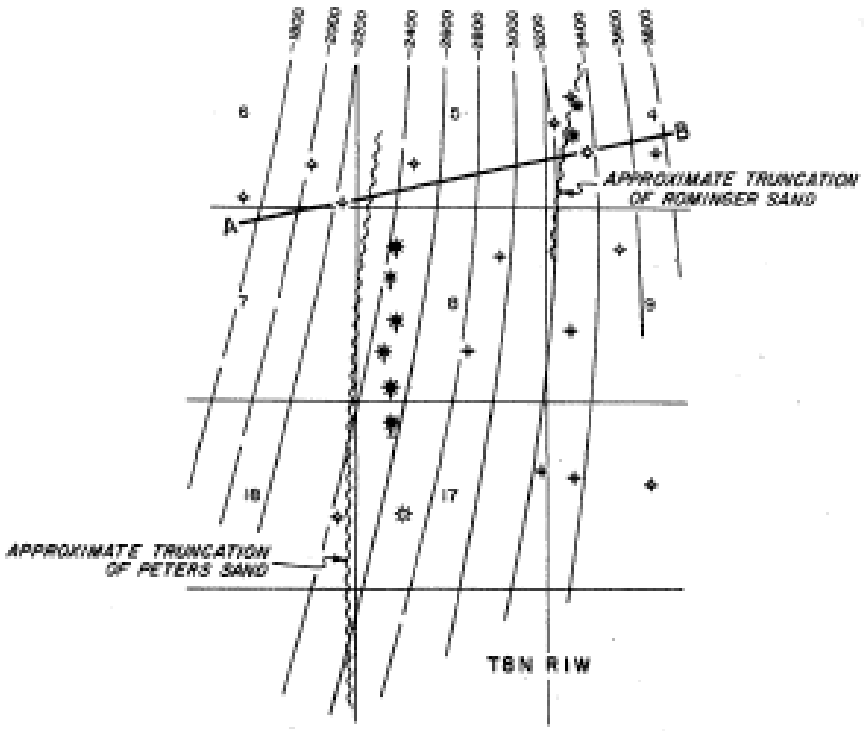
(b)


NORTH
AREA
MAIN
AREA
T4N R1W
T4N R1E
KIRBY HILL
FAULT ZONE
A
B
14
13
18
17
23
24
19
20
26
25
30
29
35
36
31
32
CONTOURS ON TOP OF DOMENGINE

(c)

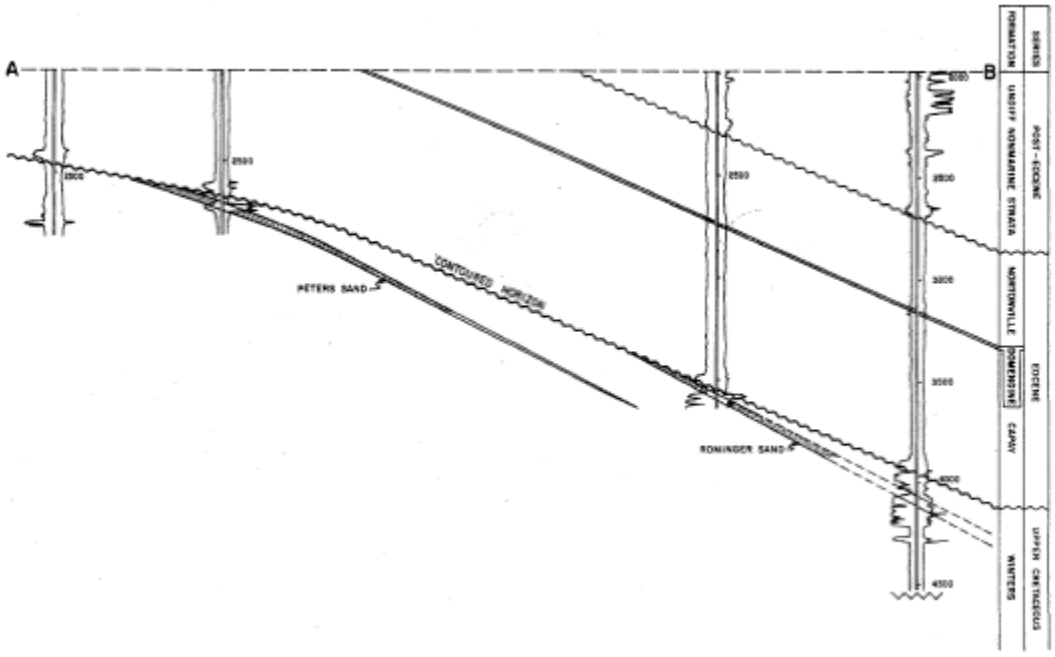

A
B
MARKLEY
NORTONVILLE
DOMENGINE
MARTINEZ SHALE
WINTERS
SACRAMENTO SHALE
FORBES
KIRBY HILL FAULT ZONE
MARKLEY
NORTONVILLE
DOMENGINE
CAPAY
MARGARET HAMILTON SAND
MEGAROS "C" SHALE
D & E ZONE SHALE & SAND
WAGENET SAND
MARTINEZ SHALE
WINTERS

(d)



CONTOURS ON TOP OF WINTERS

(e)



(f)

Figure 1.A-1. Macroscopic trap types: (a) structure contour of and (b) cross section through the Wild Goose Gas field's structural trap, (c) structure contour of and (d) cross section through the Kirby Hill Gas field's fault trap, (e) structure contour of and (f) cross section through the Pleasant Creek Gas field stratigraphic trap. Structure contour maps are akin to topographic maps. Instead of ground surface contours however, they show contours of a contact between geologic materials in the subsurface, such as between the top of a sandstone reservoir and the overlying caprock. Dots and circles on the maps represent well locations. Lettered lines on the maps are the location and orientation of the cross section subsequent to each map. Unlettered lines on the maps indicate section boundaries with each section number indicated within. Remaining lines are generally geologic features, consisting of faults in (c) and geologic unit edges in (e).

Structural traps are created by folding of the reservoir and caprock into an inverted bowl of some shape. Gas and oil are buoyant relative to the water that otherwise occupies the pore space in the rocks, and consequently rises into the structure, from whence all or some of it is unable to escape through the caprock. Various processes can fold the reservoir and caprock, such as lateral shortening due to tectonic compression (convergence between tectonic plates) and differential consolidation of sediments as they are buried by additional deposition.

Fault traps are created by tilting of a reservoir and caprock, and faulting through the reservoir and caprock that creates a seal. Faulting can create this seal through a few mechanisms. It can cause caprock to be juxtaposed against reservoir rock. It can smear caprock across reservoir rock. It breaks reservoir rock constituents into finer particles with smaller pores between them.

Stratigraphic traps consist of the reservoir rock transitioning to a caprock along its length. This can occur during initial deposition, such as sand deposited against a sloping surface of bedrock with low permeability. Lateral stratigraphic transition can also occur due to erosion of a portion of the reservoir rock subsequent to deposition followed by deposition of a caprock.

More than one of these macroscopic trap types can occur in a single reservoir/pool, as indicated on Table 1.1-3. For instance, a structural trap can be offset and sealed by a fault, trapping gas and oil on only one side of the fault for a variety of reasons. The fault zone might have sufficiently large pores on one side to allow gas or oil to escape. Or gas and oil might have migrated into the structure from only one direction.