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THE CAMERON CREEK LACCOLITH: A TRAP-DOOR INTRUSION NEAR SILVER CITY, NEW MEXICO

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INTRODUCTION

The Cameron Creek laccolith is a small intrusion in the Silver City region whose structural setting, good exposure, and accessibility make it an ideal student problem in mapping and structural interpretation.

The Silver City region contains a variety of intrusive igneous bodies—dikes, sills, laccoliths, and stocks—in a terrane characterized by a complex pattern of normal faults (Jones and others, 1961). Recent mapping in the Hurley West quadrangle has revealed an intriguing sequence of events in the intrusion of one of these igneous bodies, the Cameron Creek laccolith. The laccolith made room for itself by lifting its roof like a trap-door; the "trap-door" fault was later engulfed and obliterated by the magma as it broke across the fault and intruded a stratigraphically higher horizon on the south side. The present distribution of formations and the shape of the laccolith are shown on the accompanying geologic map and cross sections.

GEOLOGIC SETTING

The laccolith crops out in and near the valley of Cameron Creek along the northeast side of Lone Mountain. The area lies in the southwest limb of a broad northwest-trending syncline of Paleozoic and Mesozoic sedimentary formations; the laccolith is intruded mostly near the base of one of these formations, the Oswaldo Limestone of Pennsylvanian age. The stratigraphic section in the vicinity of the laccolith is summarized in the accompanying table.

FORM

The first geologists to study the Lone Mountain area in detail interpreted the Cameron Creek intrusion variously as a sill (Graton, 1910, p, 320)and a stock (Paige, 1916, structure sections)—the latter interpretation a quite understandable one in view of the scarcity of outcrops showing the contact surfaces of the body, and the short time that was available to Paige for mapping the entire 30-minute quadrangle. Recognition of the conformable nature of the intrusion is also recorded in the unpublished data of M. W. Cox of the U.S. Geological Survey, who made a reconnaissance of the Cameron Creek area in 1945. The laccolith dips rather gently to the northeast and is generally conformable with the enclosing sedimentary rocks.

The exposed portion of the laccolith is nearly a mile and a quarter long at the base, and a maximum of about 1,500 feet thick. The floor is essentially flat and strikes about N. 30° W.; where the actual surface of the floor is exposed, near the center of the south edge of sec. 22, it is approximately parallel to the dip of

TABLE 1

Paleozoic and Mesozoic sedimentary rocks in the vicinity of the Cameron Creek laccolith.

Age	Formation	Lithology	Approximate maximum exposed thickness (ft)
Late Cretaceous	Colorado Formation	Interbedded brown and gray sandstone, siltstone, shale, and mudstone	255
Late(?) Cretaceous	Beartooth Quartzite	Light gray fine-grained quartzite and beds or lenses or siliceous conglomerate	105
		Unconformity	
Early Permian	Abo(?) Formation	Light brown and green silty mudstone	?
Late Pennsylvanian	Syrena Formation	Fissile gray shale containing mudstone nodules	?
Late and Middle Pennsylvanian	Oswaldo Limestone	Thick-bedded gray lithographic limestone and thin shale partings; distinctive dark brownish-red shale and siltstone, 22 feet thick, at base	850
		Disconformity	
Early Mississippian	Lake Valley Limestone	Light gray massive to slabby limestone; crinoid fragments or chert lenses in many beds	580
Late Devonian	Percha Shale	Upper part: Light gray shale containing limestone nodules	410
		Lower part: Black fissile shale	

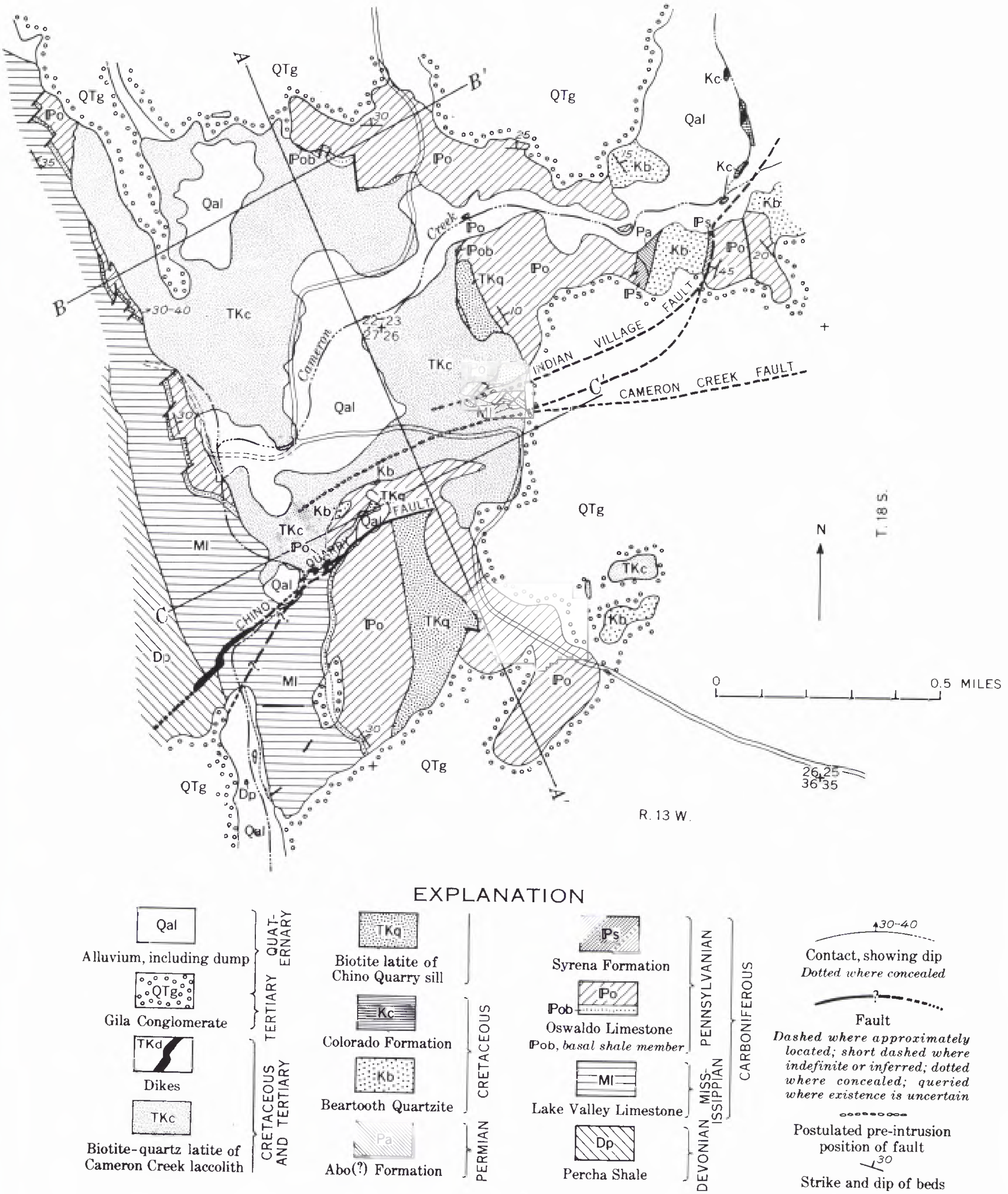

FIGURE 1

Geologic map of Cameron Creek laccolith area, Grant County, New Mexico.

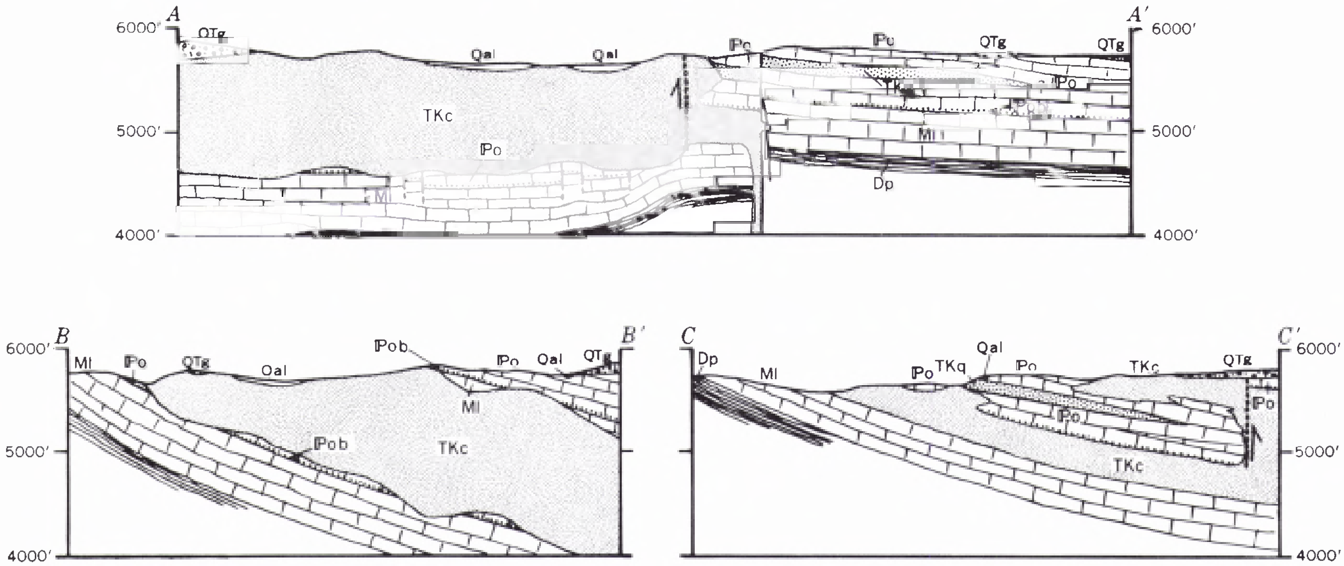

FIGURE 2

Cross sections through Cameron Creek laccolith.

bedding in the underlying limestone. The roof contact is arcuate in plan view, convex to the east, but in most places approximately parallel to the strike of bedding in the overlying rocks. To the north the roof appears to be converging on the floor, and probably the laccolith does not extend much beyond the center of sec. 22. On the south the lower part of the laccolith terminates abruptly against the Chino Quarry fault, and the upper part presumably extends beneath the Gila Conglomerate to the center of sec. 26, where identical rock is exposed.

Some geologists may take issue with our designation of this intrusion as a laccolith instead of merely an irregular sill. We feel that the readily visible conformability of the floor and arching of the roof clearly point to "laccolith" as the more nearly accurate term, despite the absence of exposures of the presumed pinch-out to the north and south.

The dike along the Chino Quarry fault southwest of the laccolith, in the Percha Shale and Lake Valley Limestone, is lithologically so similar to the laccolith that the two may well have solidified from the same magma. For this reason the dike is interpreted as a feeder of the laccolith, even though the two masses are not now visibly connected.

PETROGRAPHY

The rock of the laccolith, a biotite-quartz latite, is a homogeneous porphyry composed of 10-15 percent phenocrysts, mostly plagioclase but a little biotite and quartz, in a medium gray aphanitic matrix. The plagioclase phenocrysts are as much as 1 cm long and are milky white, being slightly but pervasively altered to sericite and carbonate. Quartz phenocrysts are uncommon and are generally large, measuring ½ to 1 cm; they are anhedral to subhedral, and unaltered. Biotite phenocrysts are small, less than 5 mm across and generally less than 2 mm thick, but readily visible in hand specimen; thin sections show them to be bleached, and in part altered to chlorite, carbonate, and magnetite. The matrix has an average grain size of .05-0.1 mm and consists of fresh quartz, plagioclase and probable potassic feldspar altered to montmorillonite and carbonate, minor biotite altered to chlorite, minor magnetite, and a trace of sphene. The argillic alteration is only slight in volume, but is manifested as dense tiny grains that permeate the matrix (as montmorillonite) and the phenocrysts (as sericite), so that the phenocrysts are almost indistinguishable in plane polarized light.

METAMORPHIC EFFECTS

The laccolith has had the following slight contact-metamorphic effects on the invaded rocks within a few feet of the contact:

1. Whitening and recrystallization of limestone ("marmorization").

2. Formation of contact-metamorphic minerals in limestone: *grossularite* is fairly common, as fine-grained pale green aggregates replacing limestone sporadically, and in places preferentially replacing fossil fragments; *prehnite* is rare, as fine-grained radiating

fibers, recognized only in thin section; and *wollastonite* is rare, as fine-grained prismatic aggregates, recognized only in thin section.

3. Local silicification, apparent partial or total replacement of limestone by fine-grained quartz.

4. "Baking" of siltstone of the basal shale member of the Oswaldo Limestone—in places the basal shale member is hardened and appears "baked" for a few feet from the laccolith, but thin sections show no evidence of metamorphism, either as recrystallization or as introduction of new minerals.

MECHANISM OF INTRUSION

The mechanism of the development of the laccolith and the structures around it might have been altogether undecipherable but for the presence of two key units. One of these is the basal shale member of the Oswaldo Limestone—a distinctive dark red shale and siltstone only about 22 feet thick in this area. Faulted segments of this unit occur both above (east of) and below (west of) the laccolith; indeed, the map pattern is so suggestive that it is tempting to "fit" the shale segments east of the laccolith into the gaps west of it, until one remembers that the uplift of the roof has been largely vertical rather than horizontal. Nevertheless, the shale unit serves to define clearly the nature of the displacement, and indicates that the laccolith was emplaced largely by forcible intrusion and not by stoping or assimilation. The other key unit is the Chino Quarry sill, a grayish-green biotite latite, whose several segments facilitate interpretation of faulting that preceded intrusion of the laccolith.

We conclude that the emplacement of the laccolith culminated a rather complicated series of structural events, which we interpret as follows (see accompanying figure):

1. Pre-Late Cretaceous tilting and normal faulting of the Oswaldo Limestone, with dominantly right-lateral apparent offset. Erosion to an irregular surface, followed by deposition of Beartooth Quartzite and Colorado Formation in Late Cretaceous time. ("A" in figure.)

2. Emplacement of Chino Quarry sill within the Oswaldo Limestone at different distances above the base because of the earlier faulting. Southernmost of earlier faults is locus of feeder channel. ("B" in figure.)

3. Renewed faulting, with left-handed separation. Principal movement is on Indian Village fault, which splits westward into two (or more) faults, southernmost of which is later to coincide with part of Cameron Creek fault. ("C" in figure.)

4. Intrusion of Cameron Creek laccolith along surface indicated by dotted line in "C". Room for laccolith is created by vertical uplift of roof rocks—1100 feet at its thickest point—along a new fault, the Cameron Creek fault (which represents the open side of the "trap-door"), so that entire block north of fault after erosion is apparently offset to east ("D" in figure). (Hinge of "trap-door" is represented by point where laccolith wedges out to north—now concealed under Gila Conglomerate). Rocks within Indian Village fault zone are severely faulted by drag along Cameron Creek fault. Some of the magma spread southward into a stratigraphically higher horizon (section C-C′). The extent and volume of this tongue of the intrusion, as well as the effect its emplacement had on the position of the Oswaldo-Beartooth contact is masked on the east by the Gila Conglomerate and removed on the west by erosion.

5. Erosion; deposition of Gila Conglomerate; and later erosion to present surface.

Evidence that the Chino Quarry fault preceded, and in part limited, emplacement of the Cameron Creek laccolith is found in the fault zone in the NE ¼SE¼ sec. 27, where the laccolith intrudes the rock of the fault zone (see sketch map)). The presence in the fault zone of dark green latite like that of the Chino Quarry sill suggests that the original fault acted as a feeder channel for the sill—as it did later for the Cameron Creek laccolith. According to this interpretation, renewed movement on the fault after emplacement of the Chino Quarry sill deformed the feeder dike and left the isolated remnants now exposed.

The postulated series of events is by no means the only possible interpretation of the field relations. One alternative interpretation would account for the two small outcrops of Beartooth Quartzite near the east edge of sec. 27 as a result of faulting, rather than deposition on an undulating erosion surface of Oswaldo Limestone. However, a fault of the required throw and trend would almost certainly have continued into the Lake Valley Limestone below, and no such fault occurs there. Other possible interpretations would differ from ours mainly in assuming that the Chino Quarry sill preceded faulting of the Oswaldo Limestone and was originally intruded at different horizons in the Oswaldo on opposite sides of joints—as is typical of diabase sills in the Arizona asbestos region. Each interpretation has its own difficulties. We prefer the one presented above because in spite of the assumed obliteration of the Cameron Creek fault, it appears to be the simplest explanation of all the observed facts.

GEOLOGIC AGE

The faults and intrusions postdate the Colorado Formation of early or middle Late Cretaceous age, and predate the Rubio Peak Formation of Miocene(?)

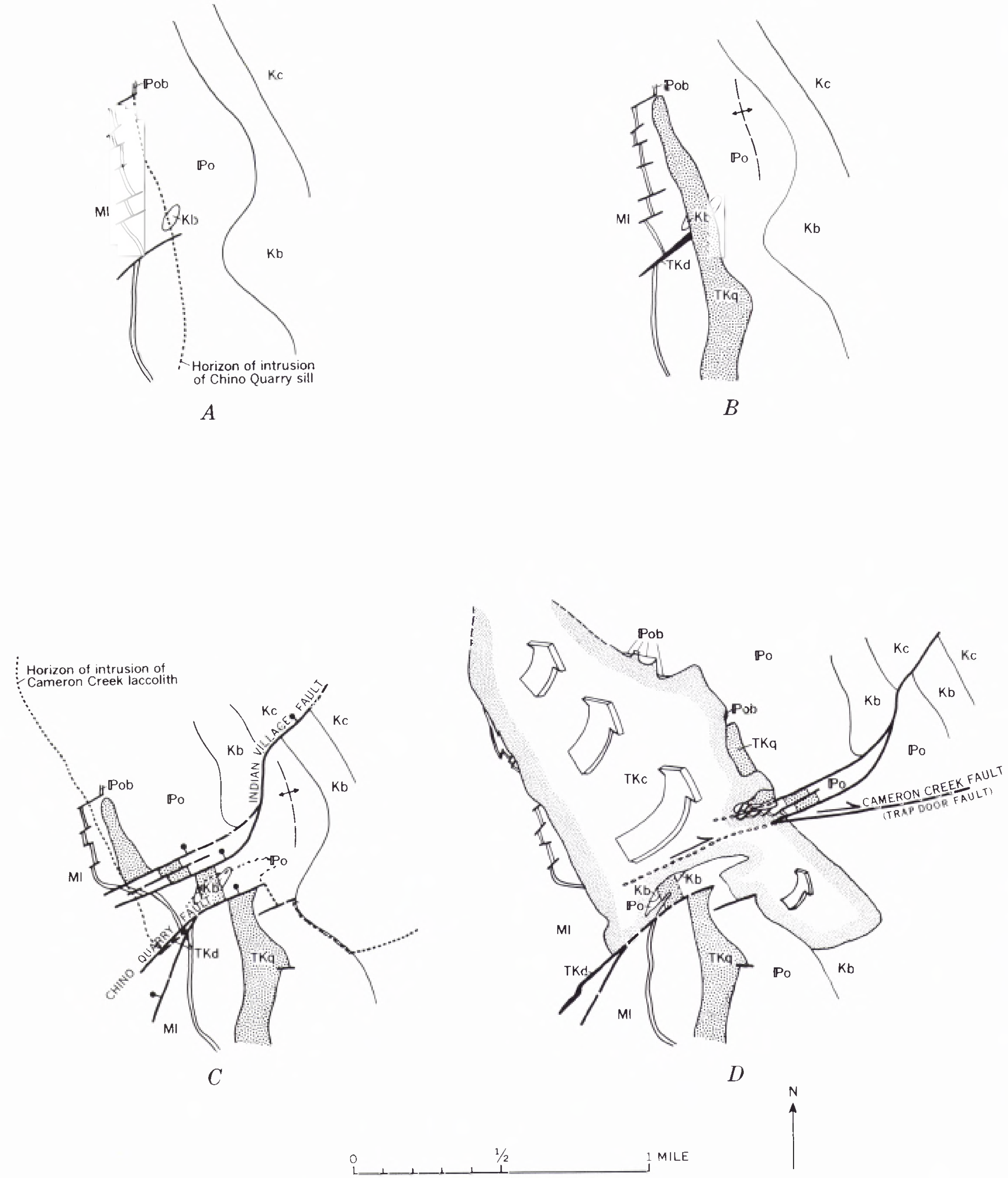

FIGURE 3

Inferred history of deformation in the vicinity of the Cameron Creek laccolith, shown as successive maps at level of present ground surface.

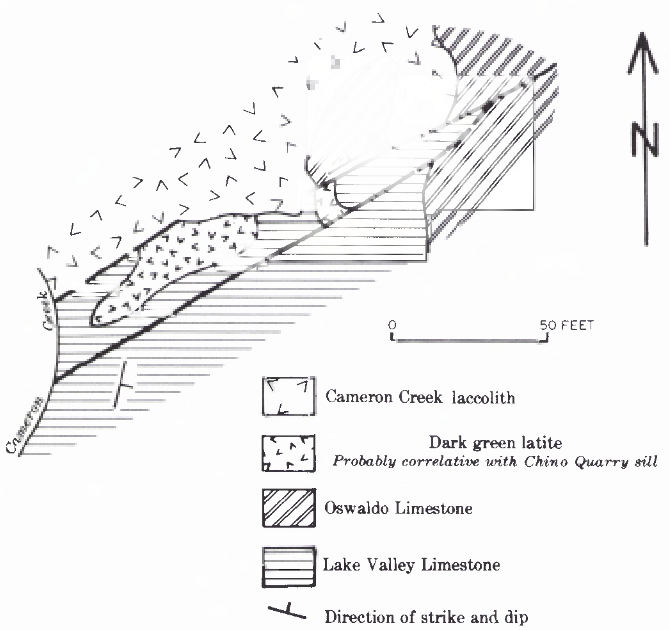

FIGURE 4

Sketch map of Chino Quarry fault zone in NE ¼ SE ¼ sec. 27, T. 18 S., R. 13 W.

age, exposed a short distance east of the map area. Within these limits they can be dated only with respect to each other and therefore cannot be correlated with any specific epoch of the Tertiary. They are, however, correlated with other concordant intrusions in this region that were emplaced early in the sequence of Late Cretaceous to Tertiary events (Jones and others, 1961).

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