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GEOLOGY AND MINERALIZATION OF THE SIERRA BLANCA PEAKS, HUDSPETH COUNTY, TEXAS

W. N. McANULTY
Consulting Geologist
220 Stratus Rd.
El Paso, Texas 79912

INTRODUCTION

The Sierra Blanca Peaks near Sierra Blanca, Hudspeth County, Texas consist of five topographically prominent, uncovered rhyolite laccoliths clustered within an area of about 13 km^2 (fig. 1). The area lies between the northern Quitman Mountains and Devils Ridge on the south and the southern escarpment of the Diablo Plateau on the north. Sierra Blanca Peak, the largest and highest of the peaks, has an elevation of 2102 m above sea level and stands about 600 m above the surrounding flats. Listed in order of decreasing size, the other peaks are Little Blanca Mountain, Round Top, Triple Hill and Little Round Top.

The Sierra Blanca laccoliths were emplaced in sedimentary strata of Cretaceous age, probably during late Oligocene or early Miocene time. Erosion subsequently removed arched sedimentary beds and exposed the intrusive rhyolite bodies which presently form the upper part of the peaks. The floor of each laccolith is exposed in arroyos high on the steep slopes. The geology of the Sierra Blanca peaks area was studied by Albritton and Smith (1965).

Considerable geologic study, prospecting, geochemical sampling and exploration of the Sierra Blanca laccoliths has been done under the writer's direction since 1968, after he discovered widespread fluoritization on all of the peaks except Triple Hill. No commercial ore deposits have been found to date, but the widespread fluoritization associated with anomalous amounts of beryllium, uranium and tin probably will attract additional exploration in the future.

GEOLOGY

Stratigraphy

Sedimentary rocks exposed in an around the Sierra Blanca peaks are Cretaceous marine deposits of upper Comanchean and lower Gulfian Series. They consist of transgressive clastics and neritic carbonates deposited on the southern margin of the Diablo Platform along the northern edge of the Chihuahua Trough. The Cretaceous section is not well exposed in the immediate vicinity of the peaks, as most of the surface rocks consist of colluvium and alluvium shed from the high-standing rhyolite-capped peaks.

A brief summary of the Cretaceous stratigraphy, youngest to oldest, follows.

Gulf Series

Eagle Ford Group

Chispa Summit Formation. Thickness—1000 m; flaggy limestone, grading upward into thicker bedded, mottled greenish-brown limestone; contains intervals up to 10 m thick of fissile brown shale and sandstone. Overlying the shale section is 2 m of gray, nodular, bioclastic limestone, which in turn is overlain by greenish-brown, well-indurated quartz sandstone. The formation is abundantly fossiliferous.

Comanche Series

Washita Group

Buda Limestone. Thickness—50 m; massive-bedded, micritic limestone, with thin shale partings. Nodular limestone makes up lower 8 m. Weathers bluish-gray. Fossil oysters moderately abundant in nodular unit.

Del Rio Formation. Thickness—110 m; dominantly olive brown to black fissile shale, with interbeds of micritic limestone 2 to 10 cm thick. A massive-bedded limestone unit, 10 m thick, overlying 6 m of cleanly washed quartz sandstone is present near the top of the formation. Contains abundant *Haplostiche texana.* The formation rests disconformably on the Espy Limestone.

Espy Limestone. Thickness—200 m; gray, nodular limestone with interbedded marl and shale, units up to 3 m thick; thick shale unit (30± m) middle part of the formation; limestone and marl units are very fossiliferous, particularly oysters, but also other pelecypods, echinoids and gastropods. The Espy Limestone conformably overlies the Benevides Formation.

Fredericksburg Group

Benevides Formation. Thickness—60 m; dominantly light cream to olive-tan fissile shale, with interbeds of cleanly washed quartz sandstone up to 15 cm thick; scattered, discontinuous lenses of nodular limestone up to 25 cm thick; limestone and sandstone interbeds decrease in upper part of the formation. Megafossils are very abundant in lower 15 to 25 m of the formation, especially *Exogyra,* other pelecypods and echinoids. The Benevides Formation includes strata mapped as Kiamichi Formation by Albritton and Smith (1965) and overlying shale strata previously considered to be in the Washita Group. The Benevides Formation rests conformably on the Finlay Limestone.

Finlay Limestone. Thickness—40 m; basal marl grades upward into massive, coarsely crystalline bioclastic limestone, with scattered sandstone lenses up to 6 m thick. Shells and shell fragments make up 25 to 50 percent of the limestone. The Finlay Limestone conformably overlies the Cox Sandstone.

Cox Sandstone. Thickness—60 m; a heterogeneous clastic unit consisting dominantly of orthoquartzite, with interbeds of shale and siltstone. The sandstone is composed of subrounded to subangular, fine- to medium-grained quartz sand in a quartz matrix. Weathered surfaces are greenish-brown. The shale is laminated and fissile; weathers reddish-brown. The formation is gradational through upper 3 m into sandy limestone of the basal, overlying Finlay Limestone.

Intrusive Igneous Rocks

Diorite (field term). Dioritic plugs, dikes and sills cutting Cretaceous strata are exposed at many places on the flanks of the Sierra Blanca peaks. Large masses of these rocks are prominently

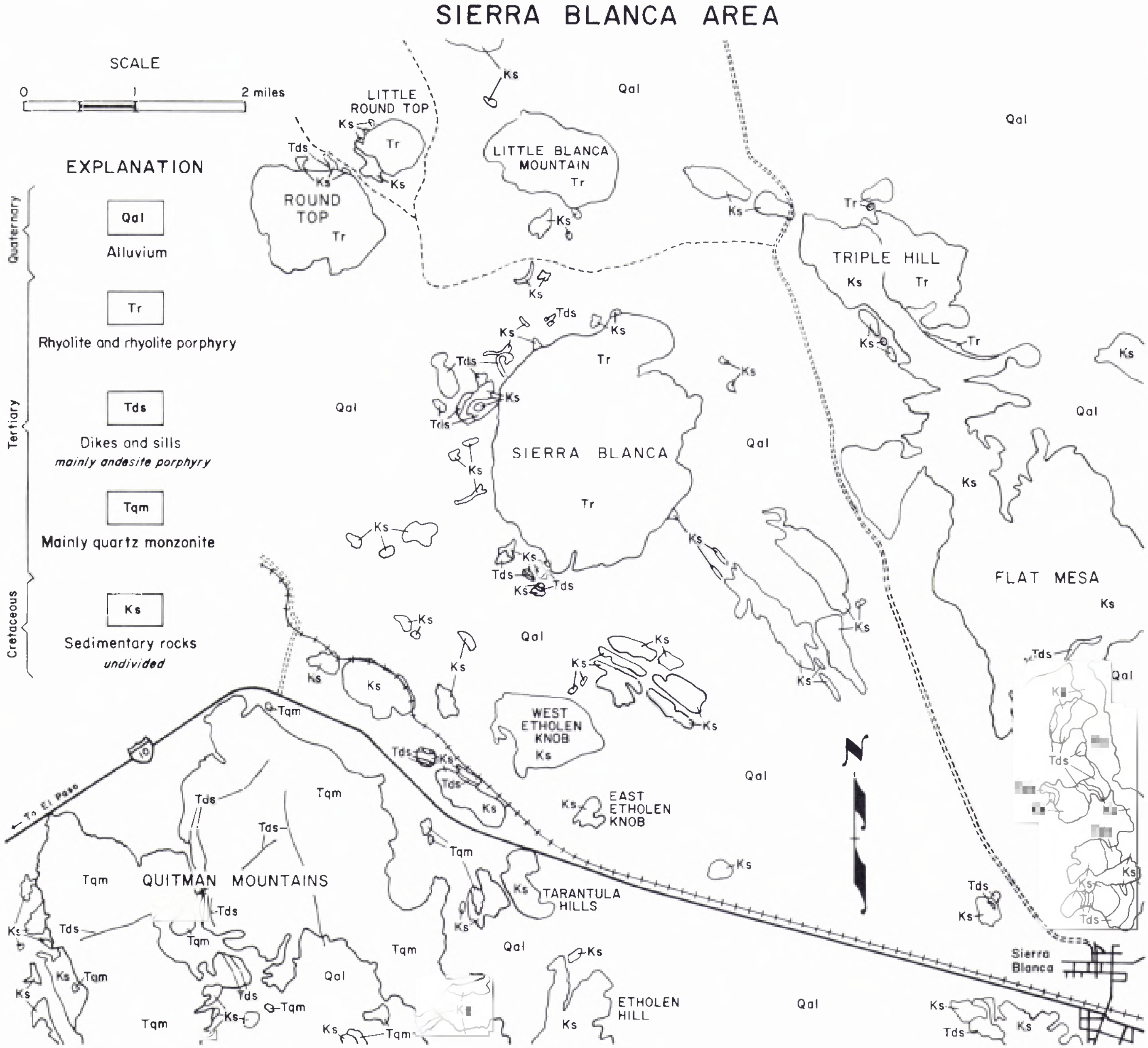


Figure 1. Index map of the Sierra Blanca Peaks area.

exposed on the west flank of Sierra Blanca Peak. Sill-like bodies 0.5 to 5 m thick are common throughout the area, generally intruding shale units. Sills were exposed in several bulldozer trenches cut along the bases of the rhyolite laccoliths. At many places the rhyolite laccoliths intruded the Cretaceous strata along pre-existing diorite intrusions. The diorite is partially replaced and veined with fluorite at many places where it is in contact with overlying rhyolite.

Similar dioritic intrusions, widespread in Cretaceous strata in West Texas and northern Mexico, probably were emplaced during Laramide time.

Rhyolite. Intrusive rhyolite caps all of the Sierra Blanca peaks. The base or floor of each of the rhyolite bodies which presently form the peaks is exposed in deeper arroyos high on the slopes, and drilling through the rhyolite on Little Blanca Mountain, Round Top and Little Round Top, revealed that the floors extend inward for at least 100 m (fig. 2). However, no discordant feeders were found. Where exposed at the lateral margins, on the slopes of the peaks, the laccolith floors appear to be generally concordant with the underlying strata, but drilling revealed that the floors are undulating and in contact with different Cretaceous formations at different places.

Several small erosional remnants of rhyolite sills cap low hills in the low areas between Round Top, Little Round Top and Little Blanca Mountain, and the southern escarpment boundary of the Diablo Plateau.

All the laccolithic intrusions are composed of rhyolite or porphyritic rhyolite. Most of the Sierra Blanca Peak and Round Top bodies are porphyritic, with quartz and K-feldspar phenocrysts (0.4 mm-1 mm) set in an aphanitic groundmass; a few small biotite phenocrysts may also be present. The Little Blanca Mountain and Little Round Top laccoliths are generally non-porphyritic.

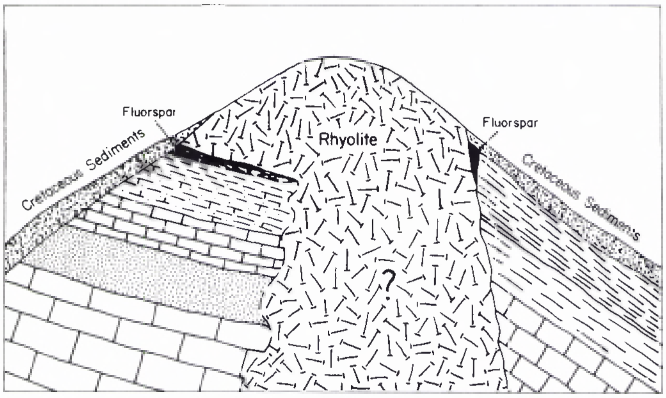


Figure 2. Diagrammatic cross-section of Round Top laccolith.

The basal 15 m of the laccoliths are strongly autobrecciated, and localized areas of crackle, rotated and fracture breccias are exposed at different places in the rhyolite bodies. Irregular-shaped pods and tabular masses of autobrecciated rhyolite are fairly common on Little Round Top and Little Blanca Mountain. A large brecciated zone crops out on the south and west flanks of the Sierra Blanca Peak laccolith. The breccias do not appear to be restricted to any particular position in the intrusions. Conspicuous lineations across the south flank of Round Top appear to be the result of abrupt changes in the dip of flow banding and subparallel fracturing.

The rhyolite bodies in the Sierra Blanca Peaks probably intruded autochthonous Cretaceous strata in late Oligocene or early Miocene time.

Structural Geology

The Sierra Blanca laccoliths are clustered in a structurally complex zone located on the northern margin of the Chihuahua Tectonic Belt, at the southern boundary of the Diablo Platform, astride the projection of the Texas Lineament, and near the northern edge of the Quitman Mountains caldera. Magmatic resurgence associated with the Quitman Mountain cauldron may have been the source of magma which produced the Siera Blanca laccoliths.

Definitive Laramide deformation in the immediate vicinity of the peaks consists only of gentle folding or warping. Cretaceous strata south of Sierra Blanca Peak, in low hills between the Southern Pacific Railroad and Interstate 10, dip 5 to 10 degrees to the northeast. No persistent faults of northwest trend (Laramide grain) were recognized in the scattered outcrops. The trace of the nearest thrust fault of the Chihuahua (Laramide) thrust belt is in the Etholin Hills, 3 km south of Sierra Blanca Peak. However, the whole area probably was overridden by thrust faults of Laramide age.

The laccolithic bodies are not symmetrical, mushroom-shaped masses with flat, concordant floors. Except for Triple Hill, all are floored above the Cox Sandstone. Steeply dipping strata on the flanks of the peaks indicate that some Washita and younger formations were domed or partially domed over the laccoliths. At places on the slopes the Cretaceous beds dip into the peaks at angles ranging from 5 to 30 degrees, whereas elsewhere on opposite sides the same units dip steeply away from the peaks, suggesting trapdoor doming. The symmetrical morphology of the present peaks is misleading as to the actual symmetry of the laccolithic bodies. Drilling on Round Top and Little Round Top failed to find feeders beneath the highest and thickest parts of those laccoliths.

Slump and landslide faults are the dominant structures on the slopes of the peaks. Large and small landslide blocks are present on the northwest and southwest flanks of Sierra Blanca Peak, on the north and northeast flanks of Little Blanca Mountain, on the east, north, and west flanks of Little Round Top, and on the north and southeast flanks of Round Top. Repetition of beds, steep and divergent bedding attitudes, hummocky topography, local thrust faults and overturned folds characterize the slide blocks. The landsliding occurred along shale units; slumping on Little Blanca Mountain and Little Round Top is in the Benevides Formation, and on Round Top it is in the upper Benevides and Del Rio Formations. Rocks overlying the shales along which movement took place were also affected, including the thin marginal portions of the rhyolite laccoliths. The uphill limit of the landslide faulting was where the laccoliths were thick enough to resist gravity faulting.

MINERALIZATION

Fluorite. Fluorite occurrences are numerous and widespread in all of the Sierra Blanca peaks, except Triple Hill. Deposits ranging from a few centimeters to several meters in thickness are present along or near the contact between the laccolithic bodies and the underlying Cretaceous sediments almost everywhere the contact is exposed. Several drill holes on Round Top and Little Blanca Mountain, which were collared in the rhyolite up to 60 m inward from the slope edge of the rhyolite, penetrated several meters of fluorite mineralization just below the base of the rhyolite. Bulldozer trenches cut along the floor at the outer margins of the laccoliths exposed 0.5 to 5 m of fluorspar. Unfortunately, at most places where the contact is exposed and where trenches and drill holes were located, Cretaceous rocks in contact with the rhyolite consist of shale, marl or marly limestone which are not favorable for replacement. The fact that the shales and marls are strongly fluoritized indicates that hydrothermal fluids associated with emplacement of the laccoliths were very rich in fluorine. Sills and dikes of dioritic rocks cut by the rhyolite of the laccoliths are also strongly fluoritized near contacts.

Most of the fluorite occurs as fine-grained, compact, siliceous replacement of shales or as fracture fillings and coatings. Much of it exhibits a cherty appearance and can easily be mistaken for gray chert. In addition to partial replacement of shales, impure limestones and diorite intrusions near the rhyolitic laccolith contacts, veinlets of fluorite occur in the diorite and the rhyolite away from contacts, particularly in autobrecciated zones. The CaF_2 content ranges from traces to 85 percent. Silica is the principal impurity. Anomalous amounts of beryllium and uranium are present in the fluoritized zones, and in the rhyolite. Gearksutite, ralstonite and thomsenolite, rare fluorine-bearing minerals associated with cryolite at several localities in the world, have been recognized in rhyolite breccias in the Sierra Blanca peaks. All rhyolite samples taken from the laccoliths were anomalously high in fluorine; samples from drill holes contained from 0.66 to 2.4 percent CaF_2, and averaged more than 1 percent CaF_2.

Beryllium. Geochemical sampling revealed that beryllium is widespread and abundant in the Sierra Blanca peaks. The sampling indicates that the beryllium content is greatest in the contact zones at the base of the rhyolite laccoliths, but, as the sampling was designed to emphasize the fluorite zone, the apparent association with fluorite may reflect some sample bias. Samples from the fluoritized contact zone contained 190 ppm to 12,000 ppm Be, and averaged 3219 ppm (equivalent to 0.89 percent BeO). The Be content of samples from rhyolite breccias ranged from 14 ppm to 4100 ppm, and averaged 402 ppm (equivalent to 0.11 percent BeO). Samples of unmineralized and unbrecciated rhyolite drill core contained 10 ppm to 200 ppm Be. The average Be content for all continental rhyolites and granites is approximately 5 ppm. Bertrandite ($H_2Be_4Si_2O_9$) has been identified, but a comprehensive mineralogical study remains to be done.

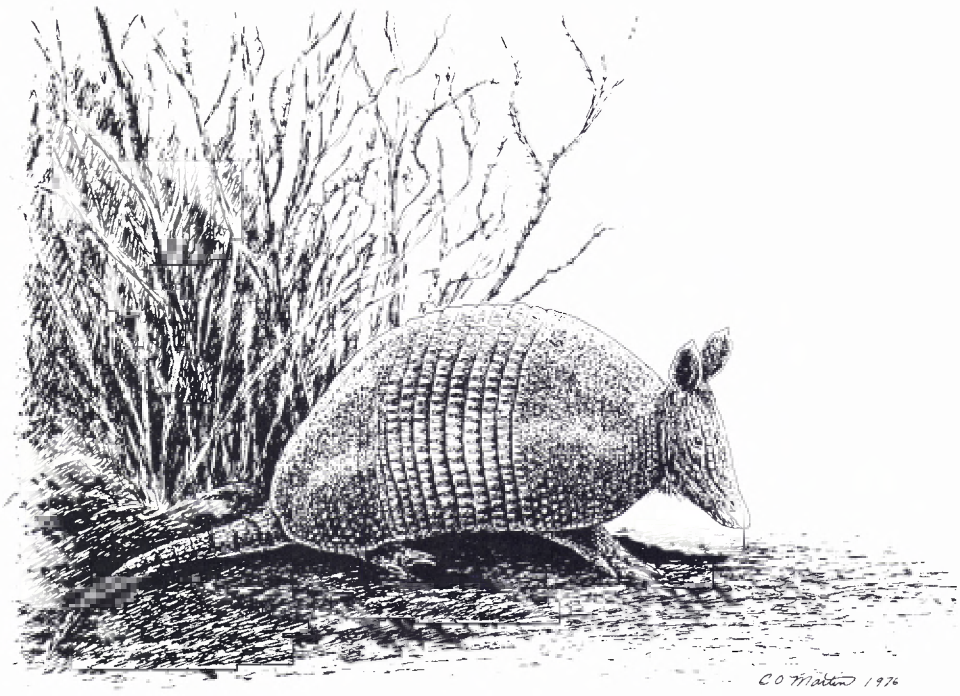
Uranium. Rhyolites and fluoritized zones in the Sierra Blanca peaks area have radiation counts of 4 to 5 times that of the surrounding sedimentary country rock, and the anomalous uranium content has been confirmed by chemical analyses. Samples from fluoritized zones at the rhyolite-sedimentary rock contacts contained 3 ppm to 485 ppm, and averaged 93 ppm U_3O_8. Core samples of unmineralized rhyolite contained 16 ppm to 25 ppm U_3O_8. The average uranium content for all rhyolites or granites is 4 ppm.

Tin. The tin content of 22 samples of Sierra Blanca rhyolites, surface and drill core samples, ranged from 70 to 1000 ppm, and averaged 216 ppm.

Other elements. The zinc content of 22 samples ranged from 85 ppm to 1000 ppm, and averaged 249 ppm. No anomalous amounts of Cu, Pb, Mo or W were found in the samples analyzed.

REFERENCE

Albritton, C. C., Jr., and Smith, J. F., Jr., 1965, Geology of the Sierra Blanca Area, Hudspeth County, Texas: U.S. Geological Survey Professional Paper 479, 70 p.



Nine-banded armadillo, *Dasypus novemcinctus*.