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Frank E. Kottlowski and G. D. Robinson, 1990, pp. 237-239

*in:*

*Tectonic Development of the Southern Sangre de Cristo Mountains, New Mexico*, Bauer, P. W.; Lucas, S. G.; Mawer, C. K.; McIntosh, W. C.; [eds.], New Mexico Geological Society 41st Annual Fall Field Conference Guidebook, 450 p.

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# PHILMONT, MORE THAN FIFTY YEARS OF GEOLOGIC ENCHANTMENT

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**Abstract**—The Philmont Scout Ranch is a superb outdoor laboratory where more than half a million Scouts have become acquainted with geology. Exposed rocks range from Precambrian units through Cenozoic intrusive and basalt flows. Geologic structure is relatively simple except for some overturned folds and thrust faults. Many geologic features such as landslides, laccoliths and volcanic craters help interest the Scouts in geologic processes.

## INTRODUCTION

The geologic setting for the Philmont Scout Ranch is aptly labeled as the place where the Rockies rise from the Plains. The landscape is dominated by the Cimarron Range to the west with its foothills extending to the western edge of the High Plains to the east. The ranch headquarters, along Cimarroncito Creek where the stream leaves the mountains, is at 6600 ft. Westward the Cimarron Range of the Sangre de Cristo Mountains rises to Baldy Mountain (12,041 ft), Touch Me Not Mountain (12,045 ft), Clear Creek Mountain (11,711 ft) and Comanche Peak (11,326 ft). This is indeed high country. Philmont's 137,493 acres of mountains, mesas and plains provide the Scouts with a "University of the Outdoors," a striking example of north-central New Mexico's geology, flora and fauna.

The Ranch began as a generous gift from Waite Phillips, an Oklahoma oilman who, in 1938, donated the first segment, 35,857 acres of his cattle and sheep ranch in the northern Ponil Creek area. In 1941, he added 91,538 acres, the central and southern part of Philmont, and in 1963, Norton Clapp donated 10,098 acres, the northwestern area which includes Baldy Mountain.

Since its beginning, more than 550,000 Scouts have participated in the summer backpacking or horseback cavalcade programs. In recent years these have drawn about 20,000 Scouts and their leaders a year to hike the mountains and hone their scouting skills. The ten-day expeditions into the back country have shown the Scouts and their leaders the superb geologic features. The intimate experience on the rocks by the Scouts has given a large group a basic understanding and appreciation of geology. It is noteworthy that a number of practicing professional geologists had their first taste of earth science at Philmont.

## LANDSCAPES

The ranch headquarters are on a plain at the inner, western edge of the Las Vegas Plateau. The mesa lands on the northwest skyline are part of the Park Plateau, its southern tip at Deer Lake Mesa which borders the southern side of Cimarron Creek Canyon. The nearby flat-top benches to the west are part of the gravel-clad Las Vegas Plateau. It sweeps eastward in broad, low, treeless steps and continues eastward to the Canadian River about 20 mi to the east. To the southwest is the basalt-capped surface of Urraca Mesa and farther to the south the northern edge of Ocate Mesa. Major canyons cutting the Cimarron Mountains to the west are Rayado Creek south of Urraca Mesa, Cimarroncito Creek extending west from the headquarters and Cimarron Creek Canyon to the northwest extending westward from Cimarron and cutting across the northern part of the Cimarron Range. On the south slope of Baldy Peak to the northwest, Ute Creek Canyon flows southeastward to join Cimarron Creek. Prominent just to the west of the headquarters is the light-colored Tooth of Time Ridge which extends eastward from the main mountain front.

The Philmont landscape exhibits seven main types. These are: (1) the steplike gravel-capped plains which flank the main streams in narrow belts, but spread out to cover the southeastern area; (2) high, steep-sided, flat-topped, hardrock benchlands that make almost the whole northern half, the southern edges and a few scattered surfaces between such as Deer Lake Mesa, Antelope Mesa, Urraca Mesa, Fowler Mesa, and Crater and Rayado Peaks; (3) rough, hummocky hillsides along much of the mountain front and around the benchlands south of Cimarron Creek and in Ute Creek Valley; (4) rugged mountain country, without flatlands in the western part; (5) high, swampy meadows in the southwest corner and along Bonito and Agua Fria Creeks; (6) a network of streams that flow away from the crest of the Cimarron Range and join Cimarron Creek, which cuts across the range; and (7) scattered natural lakes, most of which are on the high meadowlands.

The broad lowland plains are almost entirely underlain by soft shales of the Graneros, Carlile, Niobrara and Pierre rock units. The high benchlands are carved on hard rocks that are essentially flat lying. The benches to the north are cut on the sandstones and conglomerates of the Trinidad, Raton and Poison Canyon Formations and in one area on a thick sill of dacite porphyry whereas the benchlands to the south are cut on sheets of basalt.

Along narrow ridges that reach out into the plains and benchlands, such as Tooth of Time Ridge, are dikes of dacite porphyry, andesite or lamprophyre. Below steep hill fronts are hummocky hillsides formed of landslides on exposures of soft shales, particularly the Pierre Shale. The mountain front is carved on upturned edges of relatively hard and soft, bent and broken rocks with the ledges made mainly of dacite porphyry and of hard sandstones of the Sangre de Cristo, Dockum, Entrada and Dakota sandstones, whereas the valleys are in soft shales. As you would expect, the streams flow away from the mountain core which has the appearance of being uplifted in a high arch. The swampy, high meadows and natural lakes are nearly all on essentially horizontal lava flows.

The northern and southern benchlands, although somewhat similar in appearance, are cut on different rocks. The level benches north of Cimarron Creek are capped by hard sandstones or conglomerates with the intervening softer rocks eroded away, with the valleys and valley walls being steplike; wide and nearly flat where they are in shale, and steep where cut through the sandstones. As these rock units are of alternating sandstones and shales, erosion has developed descending steps in some localities of benches with each successively higher bench cut in a higher, resistant sandstone.

Some of the benchlands, however, are formed by sheets of basaltic lava that cap the tops of areas such as Fowler Mesa and Urraca Mesa. On their rough, irregular and pitted surfaces with many depressions are marshy meadows and lakes.

The lowland plains are carved in giant steps like the benchlands that flank them. These are former stream terraces cut by the tributary and master streams of the area when those ancient waters flowed at higher elevations.

The area of hummocky hillsides are of fossil landslides formed on exposures of thick shale on steep slopes. Not much landsliding is occurring today in the Philmont region. This is an indication that these fossil landslides formed thousands of years ago when the climate was much wetter.

## STRATIGRAPHY

The oldest Paleozoic rocks in the Philmont area are the Sangre de Cristo Formation of Pennsylvanian and Permian age. These are ledges of dark-red or reddish-brown, coarse-grained sandstone and conglomerate; the sandstones contain large to small angular grains of quartz, feldspar, hornblende and biotite cemented by red, iron-stained clay and silica. The conglomerates are cemented by the same type of sand as in the sandstones and include poorly rounded pebbles and cobbles of gneiss, schist and pink granodiorite. A few lenses of red shale, containing fossil seed ferns, and gray limestone are interbedded with the coarser red beds. As far as is known, the uppermost beds of the Sangre de Cristo Formation in the Philmont area are of early Permian age; the formation ranges from a knife-edge to about 5000 ft in thickness.

The Sangre de Cristo Formation overlies the Precambrian rocks on an irregular surface and, along with the red color from the iron oxides, suggests that the Precambrian rocks were eroded and deeply weathered before and during deposition of the red-bed stream deposits.

The next youngest rock unit is the Triassic Dockum Group which overlies the Sangre de Cristo Formation sandstones and conglomerates on an undulating erosional surface. The upper Dockum beds, the Chinle Formation, about 300 to 400 ft thick, are of red shale and fine-grained sandstone with interbedded lenses of brown, tan and green shale. The lower part of the sequence, about 100 ft thick, the Santa Rosa Sandstone, is predominantly of red sandstone with thin lenses of conglomerate near the base. These are stream channel and flood-plain deposits.

Interbedded with the red shales and sandstones are lenses of dark-gray conglomerate which is made up mainly of pebble-size pieces of limestone. Most of the pebbles are biscuit shape and some are rounded, although some have angular edges. Very likely these limestone conglomerates were formed in or near shallow lakes on a broad flood plain and are thus fresh-water limestones as contrasted with the limestones higher in the geologic section which were deposited in marine waters.

The overlying Jurassic Entrada Sandstone is 30 to 60 ft thick and is made up almost entirely of quartz. The grains have a frosted look, are rounded, relatively uniform in size, and in most outcrops tightly cemented. This light-gray crossbedded sandstone, which forms low ledges and cliffs, appears to be fossil sand dunes as suggested by the rounding of the grains and the type of crossbedding of the individual units.

The Entrada Sandstone is one of the better water-bearing sandstones in the underground of the region and supplies water from wells drilled in Urraca Creek valley upstream from the headquarters.

The upper unit of the Jurassic-age rocks is the Morrison Formation which is about 400 ft thick, and is composed of relatively nonresistant red, gray, green and brown shale and sandstone. As it occurs mostly in the mountainous portions of the Philmont area, most of its outcrops are covered by vegetation or rock rubble. These are stream deposits with some flood-plain sediments and thin beds of fresh-water-lake limestone. A rather distinctive basal unit contains veinlets of red jasper which often occurs as scattered eroded fragments on the upper erosional slopes of the Entrada Sandstone.

The overlying Cretaceous-age rocks underlie many of the lower slopes of the eastern part of the Philmont Scout Ranch area and are extensive along the Las Vegas Plateau to the east and south.

The basal formation of the Cretaceous sequence is the Dakota Sandstone which is 100 to 200 ft thick in the region and is composed of three units. The lower sandstone, yellowish gray to light gray, is made up almost entirely of quartz with grains relatively uniform in size and tightly cemented. Small-scale crossbedding and chert-pebble conglomerates occur in the lower part of the unit indicating deposition by streams in braided and highly meandering channel patterns. The middle part of the Dakota consists of black carbonaceous shale with lenses of silty, fine-grained sandstone. Both the sandstone and shale contain dark disseminated carbonaceous material and abundant wood fragments partly replaced by iron oxides or coalified. The upper beds are light-gray to yellowish-orange sandstones forming ledges and cliffs with small-scale crossbedding, vertical fossil burrows and carbonized wood fragments. These sands were deposits along ancient beaches with variation from nearshore sandstone bars to seaward edges of lagoons.

Above the Dakota Sandstone is about 800 ft of black marine shale containing a few beds in lenses of dark-colored limestone and a few thin layers of orange shale composed of altered volcanic ash. These units are called the Graneros Shale, about 300 ft thick, the middle Greenhorn Limestone, 20 to 40 ft thick, and then the upper Carlile Shale which is almost 500 ft thick. Because the predominant rocks of this unit are soft shales, they are poorly exposed and are often covered by landslide material.

Above the Carlile Shale is the Fort Hays Limestone, about 40 to 60 ft thick, made up of gray marine limestone with thin layers of black shale; often the beds weather to tan or white. The limestone is in beds about a foot or two thick, is very fine-grained, is composed mainly of tiny calcite crystals with clay, mica, quartz and organic debris. The shale interbeds are highly fossiliferous containing oysters, clams, snails and ammonites.

The overlying Pierre Shale and upper limy shaly parts of the Niobrara Formation is 2000 to 3000 ft thick and is the bedrock around the Philmont Scout Ranch Headquarters and is the main rock unit eastward as far as Springer. Again, being a soft shale unit, it is covered in most areas but it appears in innumerable stream- and roadcuts such as along NM-21 from Cimarron to south of the ranch headquarters and along US-64 from Cimarron to the edge of the bench on the southwest side of Cimarron Creek.

Standing out from the black, finely layered shales of the Pierre are a few scattered beds of orange shale, in most areas only a few inches thick. When these orange shales are wet, they swell up because part of their clay is the swelling clay called bentonite. These bentonite beds are the remains of volcanic ash that was blown into the sea from eruption of distant volcanoes and mixed with the other clastic fragments that settled to the bottom of the sea.

Above the Pierre Shale is the Trinidad Sandstone. This light-gray beach sandstone, which forms cliffs along the valley of Cimarron Creek, particularly west of Cimarron, and along the lower part of Ponil Creek, is about 100 ft in thickness but in places, as just northeast of Ute Creek Ranch, has been entirely eroded away in early Tertiary time. Many of the sandstone cliffs are broken into the huge blocks by widely spaced joints. The light-gray sandstone is made up mostly of coarse grains with a small amount of feldspar, biotite and hornblende. The rock contains a few plant fossils and also the odd knobby tubular masses called *Ophiomorpha* (formerly *Halymenites*) which are similar to burrows made by modern crustaceans. The sandstone is a marine beach sand that was washed and rewashed many times to produce the even grain size and slight rounding of the coarse grains.

During the immediate succeeding interval of Cretaceous time, the main marine sea moved off to the east so that the rock unit overlying the Trinidad Sandstone, called the Vermejo Formation, consists of yellow and gray beach sandstone, alternating with coastal-swamp shale and coal. It is about 170 ft thick, where not removed by erosion. Beds of coal as much as 4 ft thick are interlayered with shale and sandstone, although the coal rarely is exposed because it breaks up upon exposure to air. Thicker and higher-grade coal occurs farther to the northwest near Raton and thus the coals in the Philmont area have been mined only for relatively small local use.

In the eastern part of the area, the Trinidad Sandstone and the Vermejo Formation are almost 300 ft in combined thickness, but toward the northwest, as shown by the rock exposures along Cimarron Creek, they are thinned by erosion so that the Vermejo is entirely removed a short distance north of Cimarroncito and within a mile to the northwest, the Trinidad Sandstone has been completely removed by erosion during early Tertiary time. The rock units overlying this erosional surface are the Raton Formation and the Poison Canyon Formation.

In the eastern part of the area north of Cimarron, the Raton Formation overlies the Vermejo Formation and is composed of fine-grained yellow to gray sandstone deposited by streams with dark-colored shale and coal deposited in flood-plain ponds and swamps. The unit is as much as 1300 ft thick and thins by intertonguing westward with the Poison Canyon Formation which also, in the area northeast of Cimarron, overlies most of the Raton Formation.

The Poison Canyon Formation, which thickens westward, is as much as 1500 ft thick in the area and is composed of coarse-grained yellow sandstone and conglomerate, washed eastward from relatively nearby mountains that occurred to the west and were being eroded.

The rocks of the Poison Canyon Formation are generally coarser-grained than those of the Raton Formation, although there is a yellow and gray stream-deposit conglomerate normally at the base of the Raton Formation. Sandstones are made up mostly of poorly rounded grains of glassy quartz and cloudy feldspar, but also have angular fragments of biotite, hornblende and dark shale. For the most part, sand grains are loosely held together by clay and calcite cement. Fossil sun cracks occur on the upper surface of some of the sandstone beds and many of the sandstones are marked by irregular and variable crossbedding.

The yellow-gray conglomerates are made up of pebbles and larger chunks of older rocks cemented together by sandstones; the older rocks that supplied the conglomerate pebbles and fragments crop out in the core of the Cimarron Range to the southwest and in the Sangre de Cristo Mountains still farther to the west; thus, these are ancient cemented stream gravels derived from hills and mountains of early Tertiary age that lay to the west.

Obviously, geologic conditions changed drastically from the marine and coastal swamp environments of deposition of the Trinidad Sandstone and Vermejo Formation to the streams and swamps in which the Raton Formation and the coarser-grained Poison Canyon Formation were deposited.

Igneous rocks make up prominent and significant parts of the Philmont landscape. Dacite porphyry makes up huge masses and is of two types. The dacite porphyry in the northwestern part of the area is somewhat finer grained and has less prominent phenocrysts. This fine-grained dacite porphyry caps Wilson Mesa on South Ponil Creek and makes ledges near the rims of the benches that border Middle Ponil Creek and its tributaries above Ponil Base Camp. Most of these rock outcrops are part of a single nearly flat layer of dacite porphyry that is about 100 ft thick but at least five miles long and lying parallel to the bedding of the overlying and underlying sandstones and conglomerates.

To the south, the dacite porphyry makes up nearly all of the great ridges and cliffs in the mountain country and contains many phenocrysts, thus is labeled a "spotted" dacite porphyry. The spectacular light-colored cliffs at the mountain front are carved in sheets of this rock such as at Lovers Leap on the South Fork of Urraca Creek, Cathedral Rock on Cimarroncito Creek and the well-known Palisades in Cimarron Canyon. This cliff-forming rock has numerous cooling joints so that it tends to weather into tall, thin columns.

Diorite masses occur scattered throughout the Precambrian gneisses and schists but also intrude the Paleozoic and Mesozoic sedimentary rocks. The largest and best exposures are on Cimarron Creek just upstream from the Palisades. The light-colored dacite porphyry of the Palisades can be called a "salt-and-pepper" rock, because most of the phenocrysts are light colored, whereas the dark diorite is "pepper-and-salt" color.

Dikes and sills occur in parts of the Philmont area. Many of the sills are in the softer shales; some appear to have wedged their way in by spreading the shale apart while others have entirely displaced the shale units.

Other masses of igneous rocks are much more irregularly shaped and form mushroom-like bodies, called laccoliths, such as the Tooth of Time Ridge. Other irregular masses are stocks and are of larger size intruding all of the previously formed rock units. Most of the dacite porphyry masses are sills, dikes and laccoliths.

In the northwest corner of the area, there are dikes and sills of brown andesite; one of these sills crops out on the east side of NM-21 at the top of a little hill 0.8 mi north of the ranch headquarters. Here the andesite forms a layer intruding the Pierre Shale and has baked and dried the shale along the contact. In the lowlands around the Philmont Scout Ranch Headquarters, a relatively rare rock, lamprophyre, forms dikes cutting the Cretaceous sedimentary rocks.

This is a coarse-grained greenish- to brownish-black rock that looks like it is made up entirely of closely packed flakes of glittering brown biotite mica. Under the microscope, however, the rock is composed of less than half biotite, partly in large crystals and partly in small crystals, and the rest of the matrix is mostly of small crystals of green pyroxene, intergrown with the biotite and a small amount of magnetite and calcite.

In the southern part of the Philmont Scout area are the mesas capped by dark basalt. The basalt, from a distance, appears to be broken up into vertical pencil-like columns, caused by the vertical joints, and thus much of the basalt on the edges of the mesas breaks down into rubble scattered down the slope below the basalt flows.

Most of the basalt at Philmont came from volcanoes to the south, but the basalt on Fowler Mesa and Urraca Mesa probably came from a vent at the mountain front, near Crater Peak.

The dacite porphyry, diorite, brown andesite and lamprophyre all intrude the sedimentary rock sequence so that they are younger than the early Tertiary Poison Canyon Formation. Armstrong (1969) suggested an isotopic age of 26 Ma for the dacite porphyry. The basalt flows have been recently dated by J. M. O'Neill and H. H. Mehnert, based in part on dating radioactive materials and in part on correlation of erosional and depositional surfaces. The basalt on Urraca Mesa is about 4.3 Ma with the basalt on Fowler Mesa being about 4.7 Ma. Most of the basalts on the north end of the Ocate Plateau appeared to be of the same age, but the high basalt on La Grulla Ridge to the southwest has been suggested to be about 8 Ma.

The bedrock of the Philmont area in many places is covered along the stream valleys and along the terraces that border the stream valleys by sand and gravel. These are the deposits of the present streams or of streams flowing in the same general pattern in the relatively recent past.

## GEOLOGIC STRUCTURE

Structures in the Precambrian rocks are complex. The Philmont area extending to the west consists of three separate Precambrian terranes separated by shear zones (Grambling and Dallmeyer, this guidebook). In gross aspect, the Cimarron Range is a huge, anticlinal arch. In the ranch area, on the east side of the mountain front, there are a number of gentle anticlines and synclines that are essentially wrinkles on the main structural feature. In some places the wrinkles are tightly folded and rocks are overturned. Several major faults cut transversely through the range in a northwest-southeast trend and outline essentially the higher portions of the range within the ranch. One of these faults, the Fowler Pass fault, trends southeastward to the east side of the range, to west of the ranch headquarters, and then turns abruptly south and extends southward beneath Ocate Mesa. Northward of the sharp bend in the Fowler Pass fault, the Sawmill Canyon fault extends in a northwest direction along the front of the higher part of the range to form the northeast side of the Baldy Mountain block. Both of these faults are reverse faults. One theory (Robinson et al., 1964) is that the Fowler Pass and Sawmill Canyon reverse faults dip steeply where they cut across the mountain front, but to the west and southwest flatten to become thrust faults which may have horizontal displacement of many miles.

## CONCLUSION

Philmont is a marvelous exhibit of geology, geologic rock units, active and ancient geologic processes and the foundation for the scenic beauty of the region. Much of this has been described in detail by Robinson et al. (1964). It would be difficult to find a better area to illustrate the many facets of geology to the Scouts.

## ACKNOWLEDGMENTS

Other than the first three paragraphs, this article is excerpted from Robinson et al. (1964), which was written to help the Scouts understand and enjoy rocks and landscapes of Philmont Scout Ranch.

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Willis T. Lee (1864–1926), schooled at Johns Hopkins University, early geologist-researcher in the Raton Mesa region, shown here in a self-portrait in Cimarron Canyon just prior to 1917. He became sidetracked in his coal studies of the Raton basin due to a keen interest in the K/T boundary, which he felt was represented by the unconformity at the contact between Trinidad and Raton Formations. Lee and Knowlton (1917) published "Geology and Paleontology of the Raton Mesa and Other Regions in Colorado and New Mexico" as U.S. Geological Survey Professional Paper 101. The following year Lee authored a paper on Early Mesozoic physiography of the southern Rocky Mountains. He had previously worked in the coal fields of Grand Mesa and West Elk Mountains, Colorado and summarized those investigations into U.S. Geological Survey Bulletin 510 (1912). Photo by W. T. Lee, courtesy of U.S. Geological Survey.