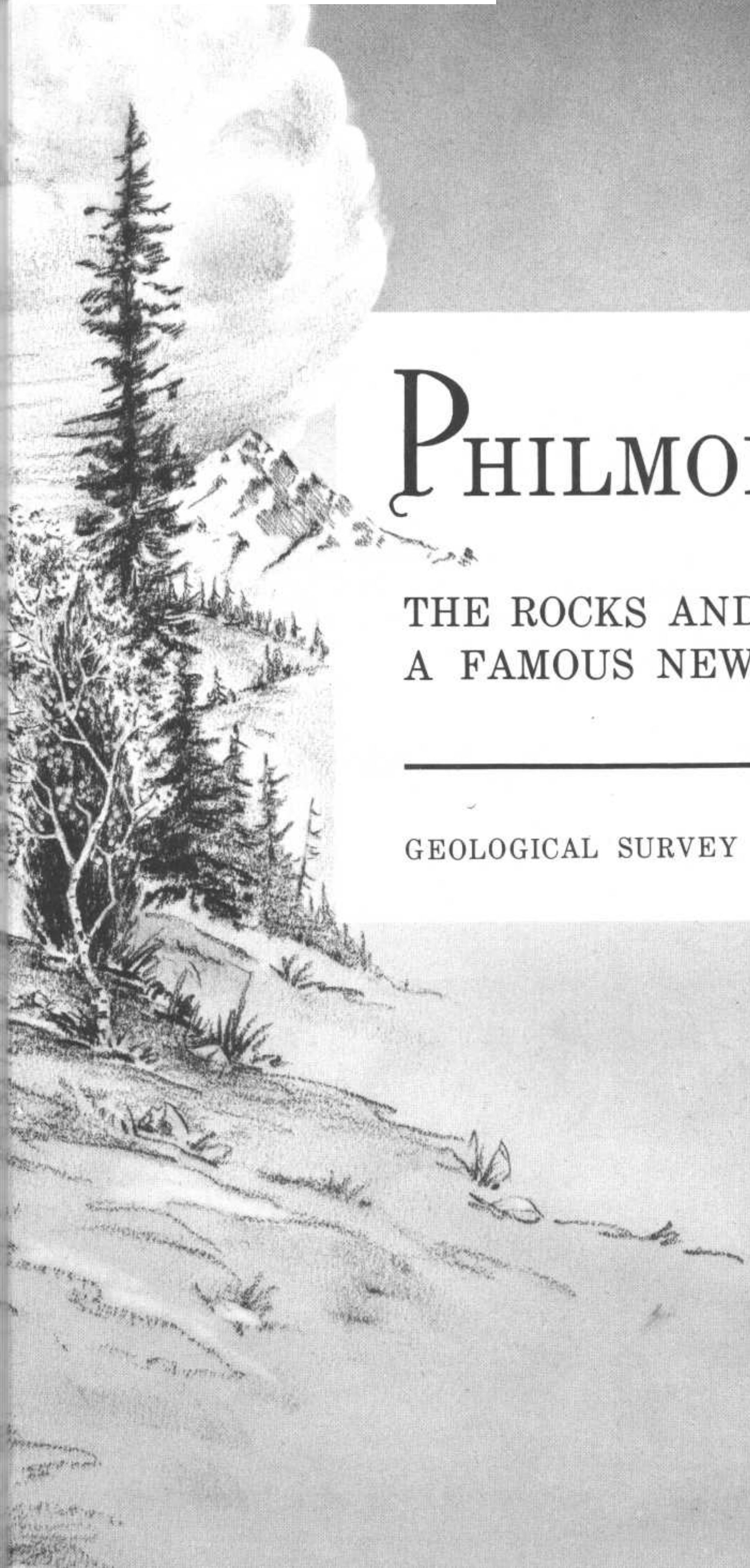

PHILMONT COUNTRY

THE ROCKS AND LANDSCAPE OF A FAMOUS NEW MEXICO RANCH

GEOLOGICAL SURVEY PROFESSIONAL PAPER 505

A CLOSER LOOK AT BEACH SANDSTONE. A, Piece of sandstone. B, Slice of sandstone, magnified 24 times; doubly polarized light. Because of double polarization, grains of the same mineral may be shaded in all tones of white to black. Most of the grains are of clear quartz; a few lined or striped ones are feldspar, biotite, or hornblende. Bright rims on some grains are clay and calcite. (Fig. 42)

Andesite

Some thin sheets of salt-and-pepper andesite and andesite porphyry (andesite that has many large crystals of feldspar) make striking ridges that can be traced for miles in the northwest corner of Philmont. Nearly all are vertical, like the lamprophyre of Horse Ridge, but a few are nearly flat, like the dacite porphyry of Wilson Mesa. Because all the andesite sheets in the benchlands are hard to reach or are in mining areas closed to visitors, no more will be said of them.

Coal

Shiny-black coal is a fairly common rock along the southern edge of the northern benchlands, from the north side of Cimarron Creek, below Ute Valley, to the north side of Ponil Creek, below Chase Canyon. Beds of coal as much as 4 feet thick are interlayered with shale and sandstone. The coal, however, rarely crops out, because it falls to pieces on exposure to air. A little coal was once mined here, and countless chips of disintegrated coal can be seen on waste-rock dumps at the openings of abandoned mines on the slopes of Slate Hill (see fig. 79) and on lower Ponil Creek (fig. 49). It is interesting to see the coal and other rock debris on the dumps, but it is unwise to enter the mines. They were dangerous when mining was still going on and are much more so now, after decades of neglect.

Coal, when magnified enough (fig. 50), is seen to be made mostly of altered and compressed plant fragments. Such material accumulates in swamps and becomes peat, an early stage product in the coal-forming process. There are many present-day peat bogs. Plants are made almost wholly of compounds of carbon, oxygen, and

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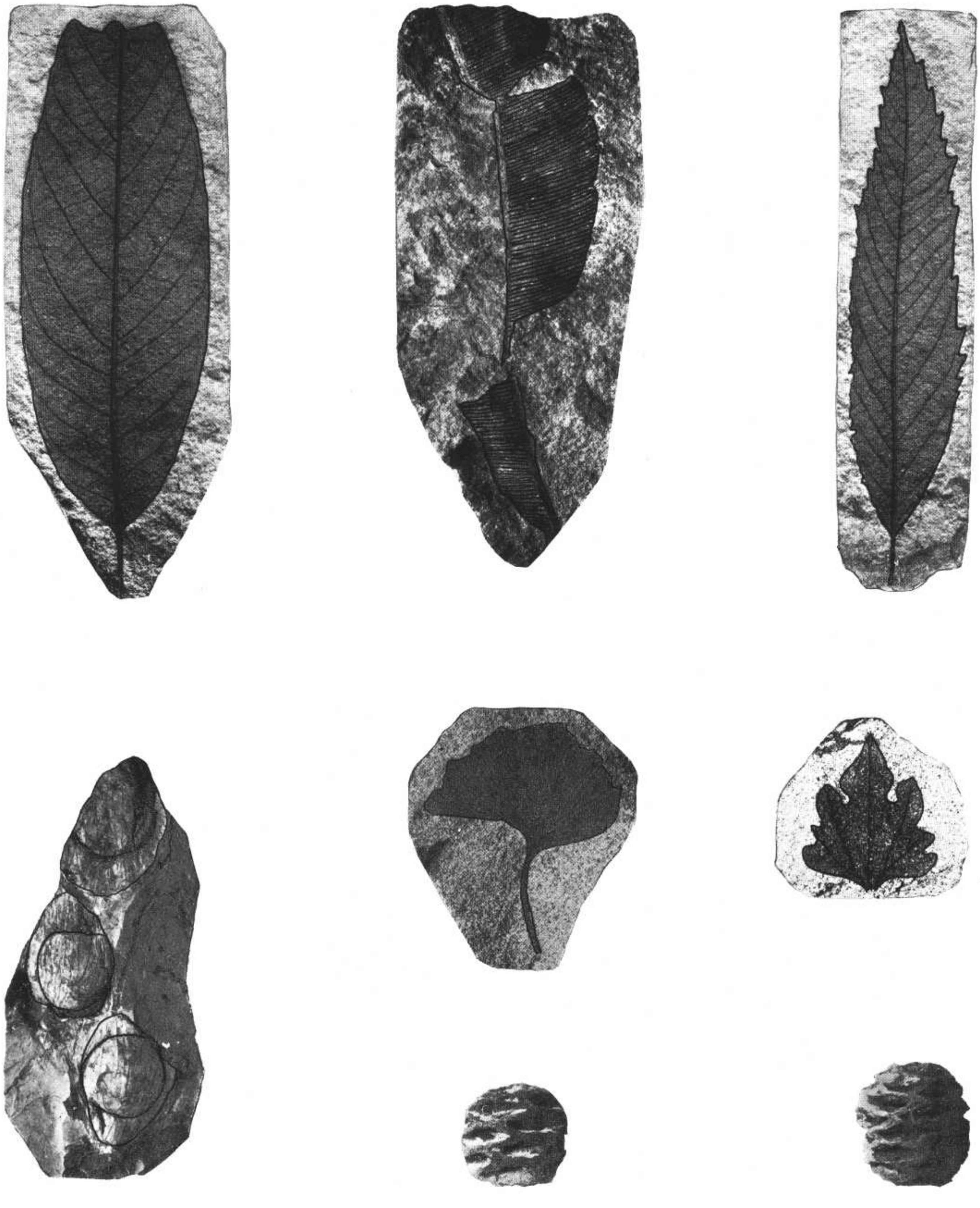
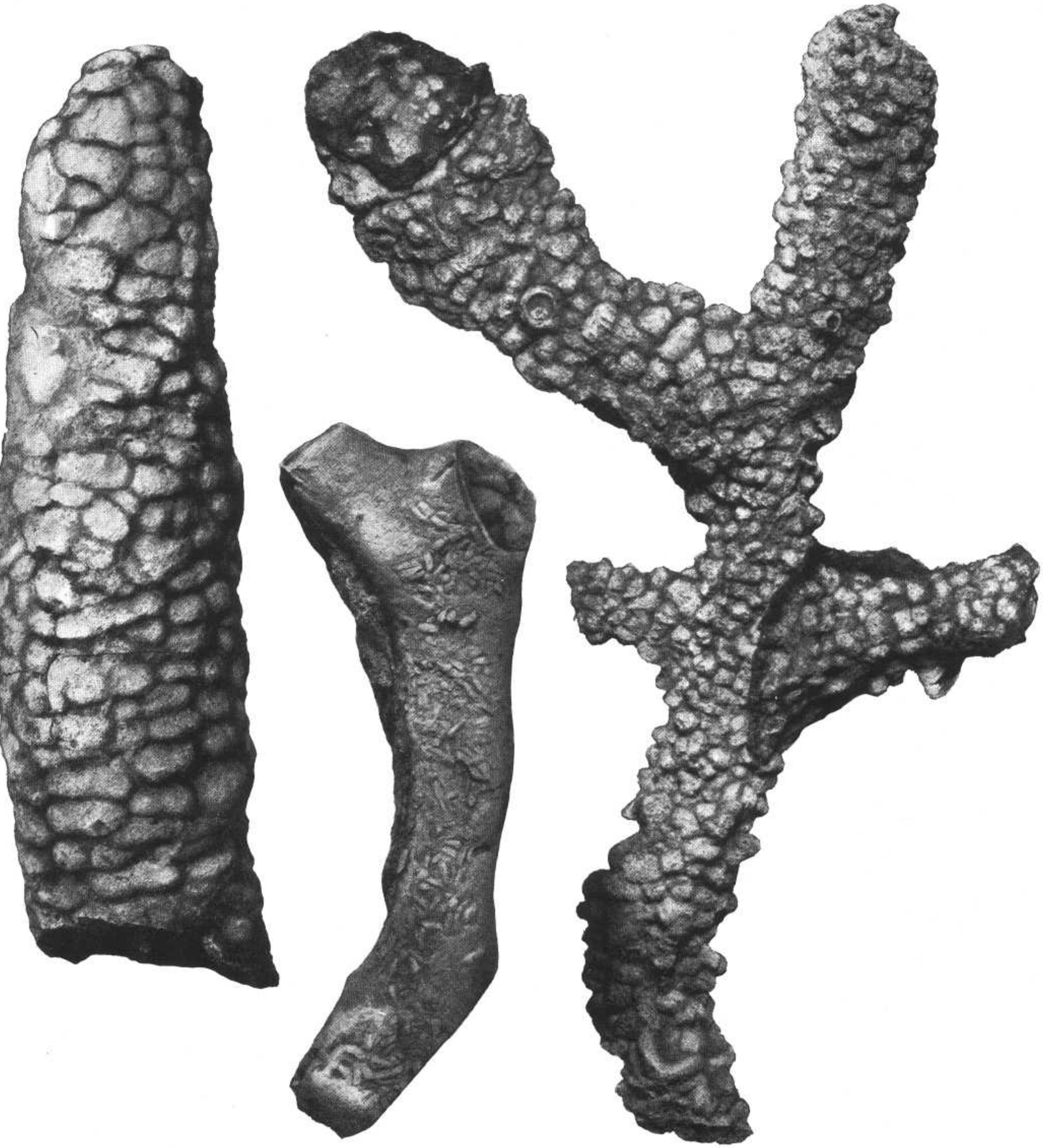
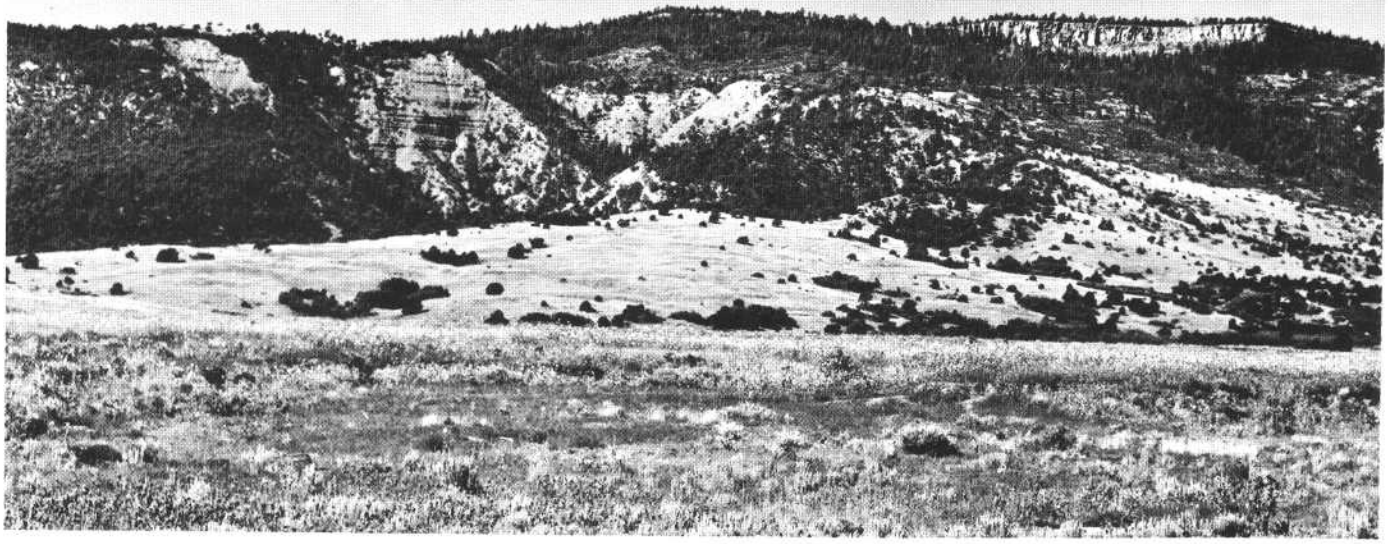


PLANT FOSSILS: leaves, cones, and nuts. (Fig. 43)

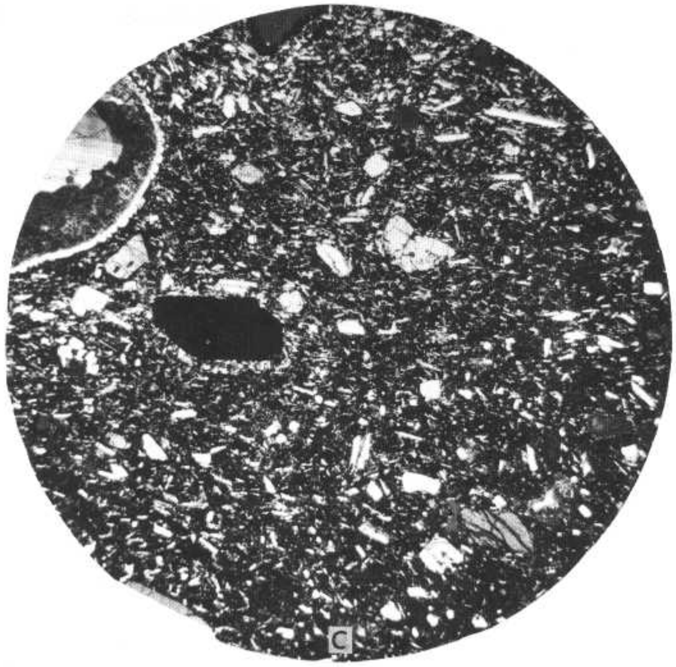


TUBES made by unknown plant or animal. (Fig. 44)

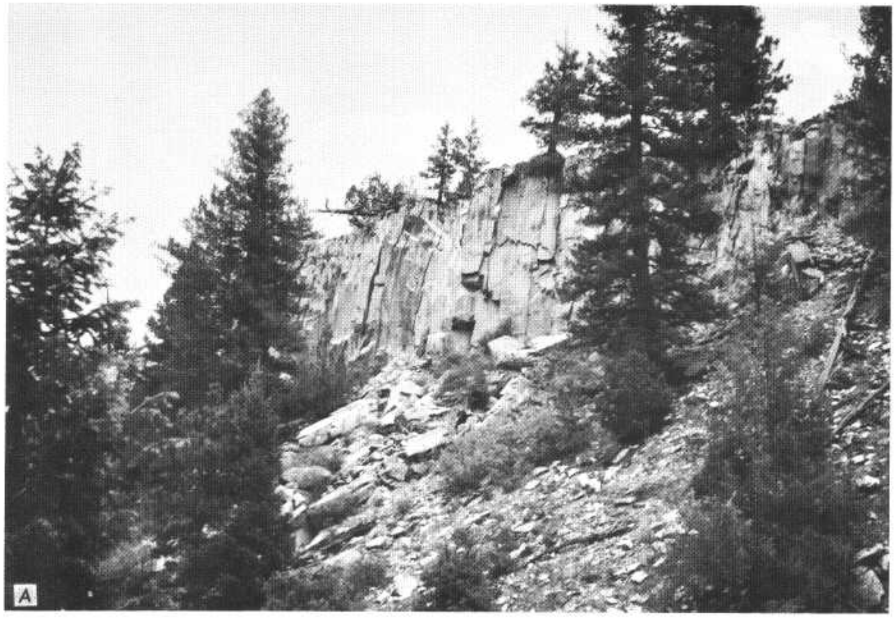


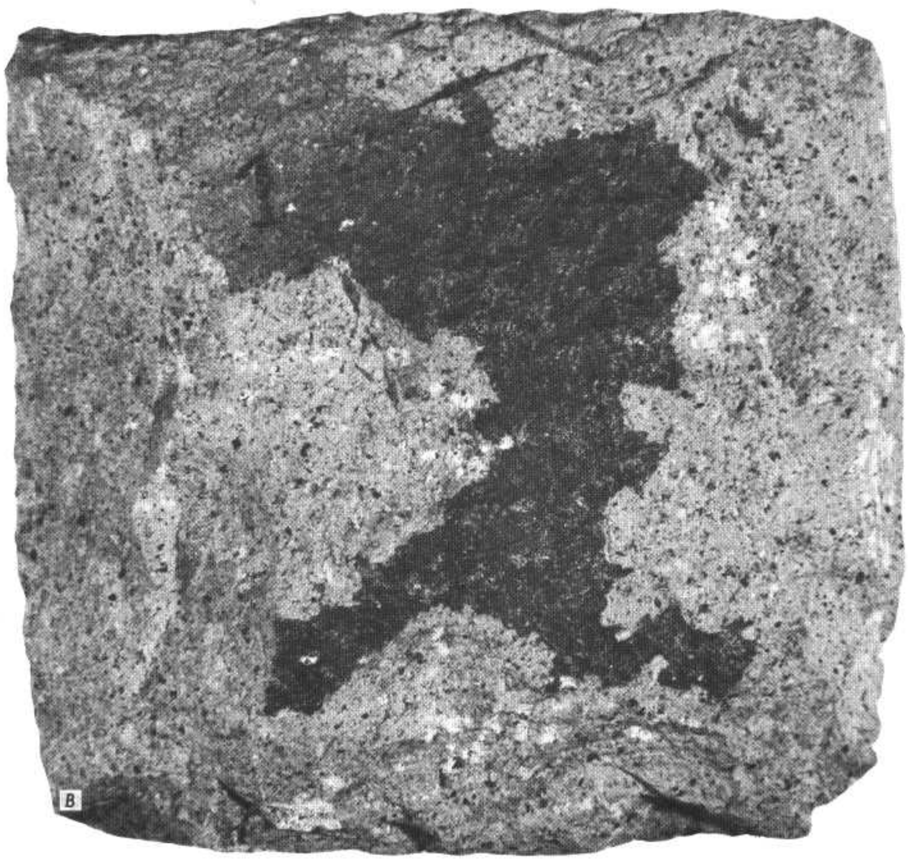
BLACK SHALE AND BASALT in the benchlands. East side of Urraca Mesa seen from State Highway 21. Layered rocks (left rear) are black shale (Pierre Shale). Except for the mesa cap, all the high ground in the view is underlain by shale, mostly covered by soil, trees, slopewash, and landslides. The mesa capping, of hard rock that has many vertical cracks (right rear), is basalt lava, poured out from a volcano that is now extinct. (Fig. 45)

BASALT RUBBLE on Urraca Mesa. (Fig. 46)



A CLOSER LOOK AT BASALT. A, Piece of dense basalt, natural size. B, Basalt that has many bubble holes, now filled by calcite and zeolite; half size. C, Slice of basalt, magnified 8 times. Large crystals of olivine with corroded edges (upper left) "floating" in a mixture of glass (dark gray) and tiny crystals of feldspar, pyroxene, and olivine. Large black area is a hole where a crystal was pulled out of the rock slice during grinding. Doubly polarized light. (Fig. 47)



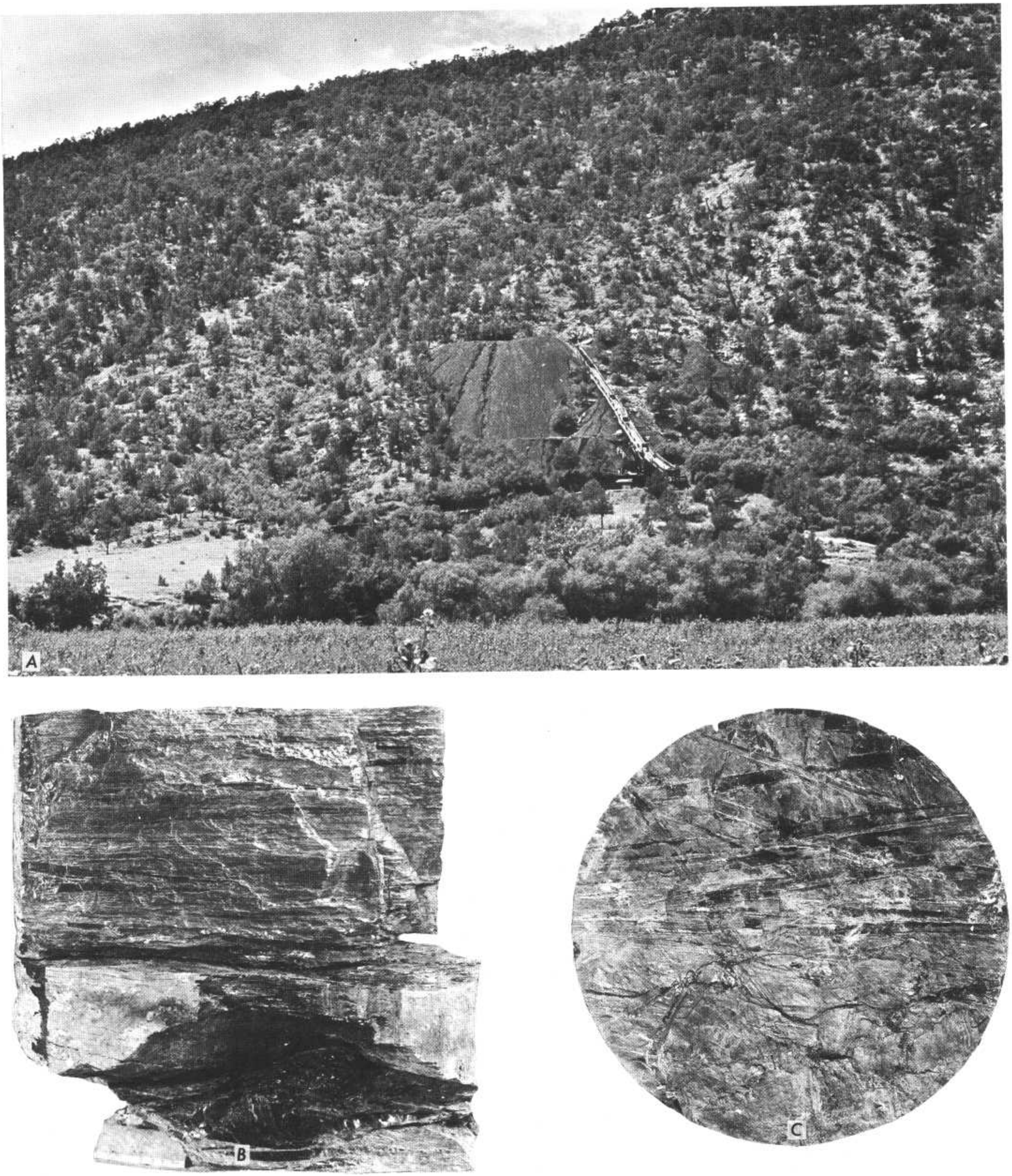


DACITE PORPHYRY. A, Outcrop of a sheet of light-colored dacite porphyry near Dan Beard Trail Camp. The cliff is the edge of the sheet. Beneath, covered by dacite porphyry rubble, is sandstone. B, Specimen. The dark stains are the result of weathering. (Fig. 48)

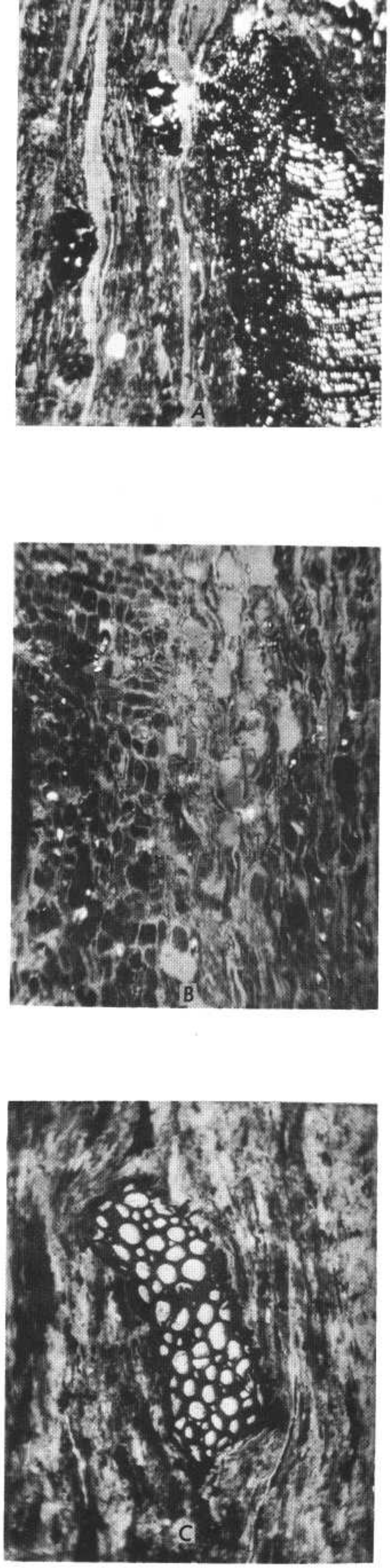
hydrogen. When the oxygen and hydrogen of decaying vegetation are driven off—mostly combined as water—by chemical reactions, heat, and pressure, the carbon remains as coal. The kind, or rank, of coal that results depends mainly on how completely the hydrogen and oxygen are driven off. The quality of the coal depends on how nearly the deposit was pure plant debris to begin with. The coal at Philmont, much like that shown in figure 49, began impure and still contains much moisture (this is why it falls apart so quickly); therefore, it is low in both quality and rank. It is higher rank than peat or brown coal and is classed as low-quality bituminous. Poor as it is, this coal would still be mined at least for local use if Philmont were not near the great Raton coalfield.

Rocks of the hummocky hillsides

The hummocky hillsides are mainly covered with soil, grass, and trees; rare indeed is a glimpse of the rocks beneath. Where visible, the rocks do not have the neat layering of the other sedimentary rocks we have seen but instead are a jumble of sharp-edged blocks of hard rocks, in assorted sizes and shapes, surrounded by fragments of black shale (fig. 51). Most of the blocks are a few inches to a few feet across, but a few are as big as a house. The blocks are not of the same kind of rock everywhere. In the large areas of hummocky landscape west and north of Cimarron town they are mainly yellow and gray sandstone. Those bordering Fowler, Ocaté, and Urraca Mesas are nearly all basalt. Along Ute Creek and near Cimarroncita Girls Camp, they are mainly dacite



COAL AT PHILMONT. A, Abandoned mine (in Vermejo Formation) on west side of Ponil Creek, below gaging station. B and C, Piece of fresh bituminous coal, like that at Philmont, from drill core collected 100 feet below earth's surface. A multitude of worn and decayed plant fragments, solidly packed together. Left view (B) is across the layering; right view (C) is of the top of a layer. Stalks and long narrow leaves are like those of modern cattail. Bottom third of left view is gray shale containing a lens of coal that was once a woody stem. Half natural size. (Fig. 49)



SLICES OF BITUMINOUS COAL magnified 100 times to show some different kinds of plant structures that become coal. (Fig. 50)

ROCK DEBRIS on a hummocky hillside near U.S. Highway 64. The largest blocks are 6 feet across. (Fig. 51)

SLOPE MANTLE, unusually thick, in the mountain country, on the trail near Beaubien Camp. It is only a few feet thick in most places. (Fig. 52) porphyry. In each area, the main hard rocks in the hills above are the same as those in the blocks on the hillside. Black shale underlies the hard rocks near all the hummocky areas.

Without much help from running water, the blocks have simply slid off the nearest hillside, mixing with the shale which acted as a lubricant as they slid. These rock jumbles, then, are landslides. They have not moved much lately, for the trees standing on them are not tilted or toppled and must have grown after sliding stopped.

Rocks of the rugged mountains

Bare rock outcrops are few in the mountain country, except at the mountain front and at the highest altitudes, above timberline. The solid rocks are mostly hidden by a mantle of sharp-edge rock fragments of varied size and shape that have broken off former outcrops and crept, slid, or been washed a little way downhill. These aprons of broken rock in turn are generally covered by soil and vegetation, but their edges can be seen here and there where they have been cut into by streams or by man (fig. 52).

The solid rocks at the jagged mountain front are mostly sheetlike bodies of the same kinds of sedimentary and igneous rocks that underlie the benchlands and plains. But instead of being flat or dipping gently, these sheets stand at high angles; and their upturned edges make ridges if the rock resists erosion, or valleys if it does not. Farther back in the mountain country, however, some bodies of igneous rocks are not sheetlike but are of irregular shape, and some are tremendously large.

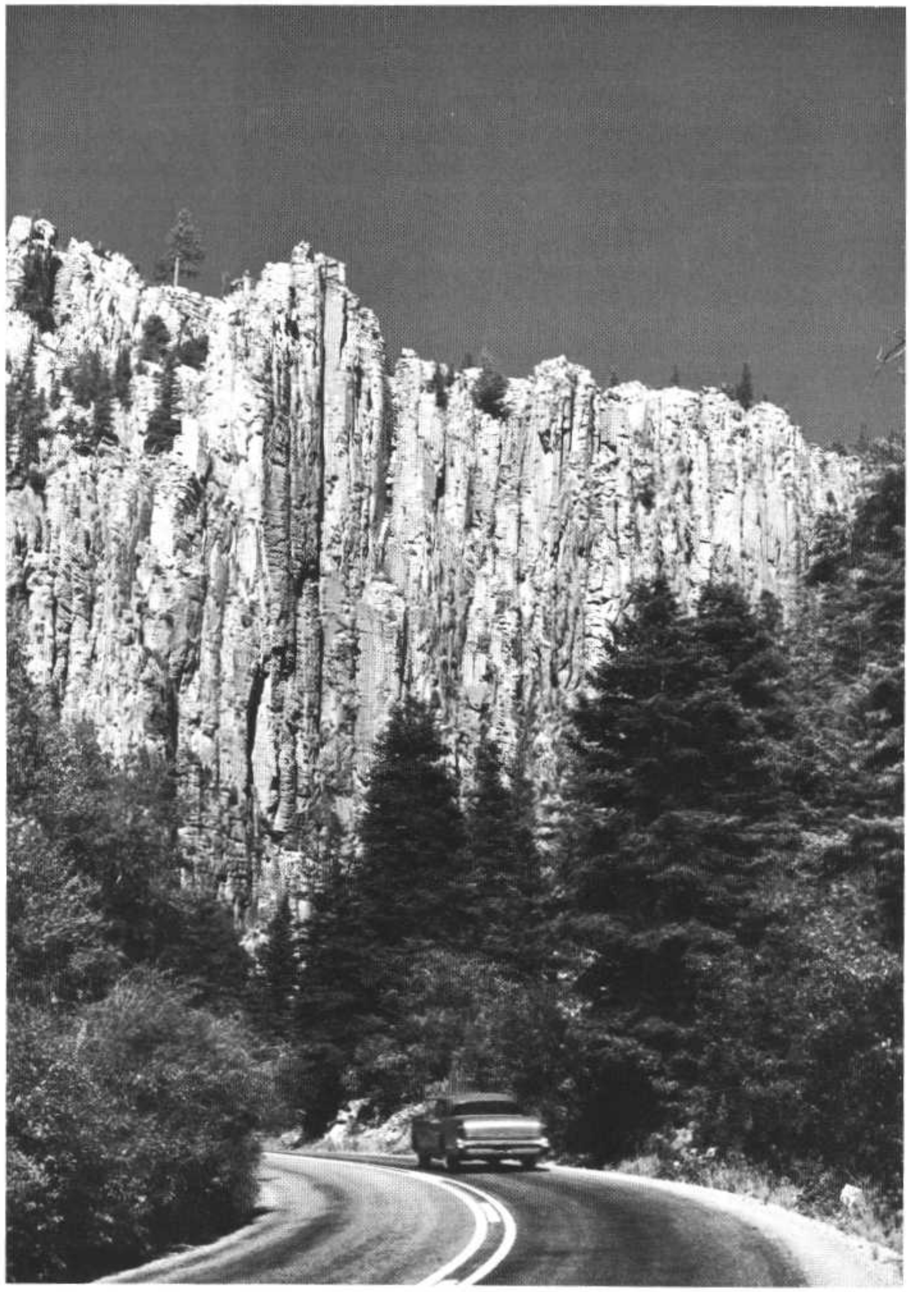
DACITE PORPHYRY—the great cliff maker. A, Lovers Leap, on South Fork Urraca Creek. B, Cathedral Rock, at Cimarroncito Reservoir on Cimarroncito Creek. (Fig. 53)

Spotted dacite porphyry

Dacite porphyry makes nearly all the great ridges and cliffs in the mountain country. The spectacular light-colored cliffs at the mountain front are carved in sheets of this rock: Lovers Leap, on South Fork Urraca Creek (fig. 53*A*); Cathedral Rock, on Cimarroncito Creek (fig. 53*B*); and the Palisades in Cimarron Canyon (fig. 54) are examples. Like the andesite and basalt, the dacite porphyry has innumerable cooling joints, so that it weathers into tall thin columns. The less resistant rocks above and below have been scooped out to make valleys. North of Cimarron Canyon, layers of other rocks thin and disappear, so that Touch-Me-Not Mountain (seen in figs. 75, 76) is mostly dacite porphyry.

The rock is crowded with four different kinds of large phenocrysts set in a fine-grained gray matrix (fig. 55). This rock looks different from the dacite porphyry of the benchlands (compare with fig. 48*B*) only because its phenocrysts are larger and a little more abundant. Most of the phenocrysts are stubby laths of cloudy white plagioclase feldspar. Many are of clear quartz, some having crystal faces but more being egg shaped. Less common are thin bundles of dark-brown biotite plates and rods of dark-green hornblende. Surrounding the phenocrysts are tiny interlocking crystals of orthoclase, plagioclase, quartz, and altered biotite.

This is another igneous rock that crystallized from a melt, or magma, in distinct stages. In the first stage it cooled slowly, so that more than half the melt solidified into large well-shaped crystals. Then cooling was speeded up, and the rest of the melt froze into minute crystals.

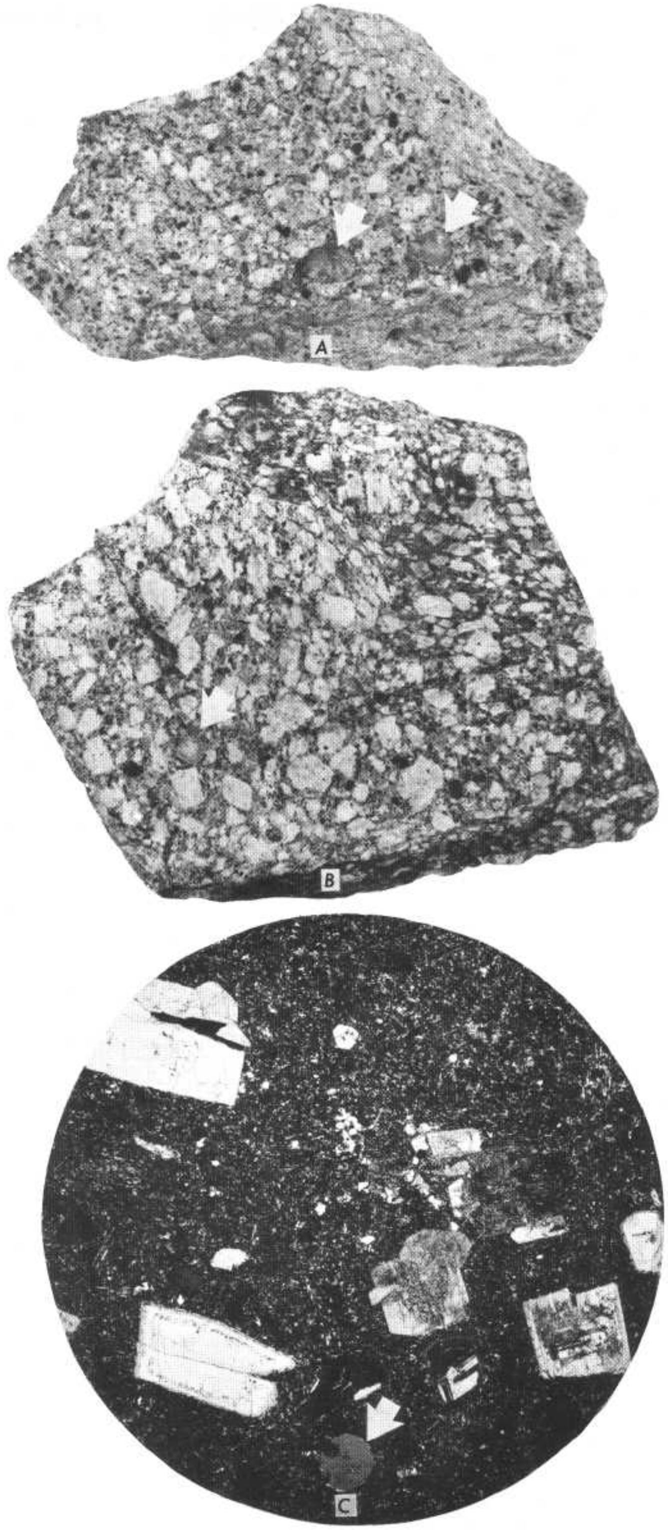


THE PALISADES in Cimarron Canyon. (Fig. 54)

Early in the second stage, the melt attacked and corroded the quartz phenocrysts, rounding them, but freezing prevented the process from going very far. A reasonable guess is that the first stage of slow crystallization was at great depth, perhaps 10 miles or more. The second stage probably followed oozing of the partly solid mush into the cover of colder sedimentary rocks.

Striped gneiss and schist

Gneiss and schist are almost as abundant at Philmont as dacite porphyry, for the heart of the mountains, from upper Cimarron Canyon southeastward to Trail Peak, is made mainly of these rocks. Yet little can be said about them, for, as the timber warns from afar, they are rarely exposed. Scattered small outcrops reveal that these rocks, where unweathered, are fine to coarse grained, hard, and banded or layered (figs. 56, 57). Some bands are several feet thick; others are visible only under a microscope. Hard as they are, these rocks split easily and cleanly parallel to the layering. They are mainly composed of familiar minerals: clear quartz, dull white or pink plagioclase, shiny black biotite, silvery white muscovite, dark-green hornblende, and lighter green chlorite. The grains have sharp crystal outlines and are closely packed. The banding is due to varied proportions of the light- and dark-colored minerals. The grains do not lie at random; their long dimension, if they have one, is parallel to the layering, which, in crystalline rocks like this, is called foliation or schistosity, to distinguish it from the bedding in fragmental rocks like sandstone and shale. It is this alinement, especially of the flaky micas, that makes the rock split easily.



DACITE PORPHYRY: A CLOSER LOOK at two common varieties. A, Porphyry with medium-size phenocrysts of cloudy feldspar, dark biotite and hornblende, and larger egg-shaped grains of glassy quartz (white arrows). B, Porphyry with large phenocrysts of feldspar and smaller ones of biotite, hornblende, and quartz (white arrow). Natural size. C, Slice of dacite porphyry, magnified 8 times. Doubly polarized light. (Fig. 55)