STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

CHIRICAHUA WILDERNESS AREA, ARIZONA

GEOLOGICAL SURVEY BULLETIN 1385-A

Mineral Resources of the Chiricahua Wilderness Area, Cochise County, Arizona

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With a section on AEROMAGNETIC INTERPRETATION
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An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

Under the Wilderness Act (Public Law 88–577, Sept. 3, 1964) certain areas within the National forests previously classified as "wilderness," "wild," or "canoe" were incorporated into the National Wilderness Preservation System as wilderness areas. The act provides that the Geological Survey and the Bureau of Mines survey these wilderness areas to determine the mineral values, if any, that may be present. The act also directs that results of such surveys are to be made available to the public and submitted to the President and Congress. This bulletin reports the results of a mineral survey of the Chiricahua Wilderness, Arizona.

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MINERAL RESOURCES OF THE CHIRICAHUA WILDERNESS AREA, COCHISE COUNTY, ARIZONA

By Harald Drewes, U.S. Geological Survey, and
Frank E. Williams, U.S. Bureau of Mines

SUMMARY

The Chiricahua Wilderness encompasses about 28 square miles of the rugged central part of the Chiricahua Mountains near the southeast corner of Arizona. The Chiricahua Mountains are a fault block typical of many of the ranges in southeastern Arizona. The rocks in the wilderness are mainly weakly deformed mid-Tertiary volcanic and intrusive rocks — chiefly rhyolite and monzonite — that lie on shale and sandstone of Cretaceous age. Paleozoic formations, such as the Permian Concha Limestone exposed 2 miles northeast of the wilderness, presumably are present locally at a depth of several thousand feet beneath the wilderness. The Cretaceous and older rocks of the area are considerably folded and faulted, but the mid-Tertiary volcanic rocks are nearly flat and have been deformed only by a few high-angle faults.

Southeastern Arizona and southwestern New Mexico is a region of high mineral production. Evidence indicates, however, that the wilderness itself has very low mineral potential, inasmuch as the volcanic rocks covering most of the wilderness are younger than the major mineralization of the region, which is Late Cretaceous or early Tertiary. Furthermore, the mineralization in the Cretaceous and older rocks exposed within a few miles of the wilderness is mostly weak and at only one place, 6 miles to the north, is of modest size. Thus, although the occurrence of similar deposits beneath the thick cover of volcanic rocks is conceivable, finding such deposits would be difficult, and recovering the metals in them would not be economically attractive.

The wilderness is virtually devoid of mining activity. Traces of mineralization were found mainly in the east-northeast and southwest corners of the area. A few mining claims have been located at these places, but there is virtually no evidence of mineral-exploration activity. The older rocks of the wilderness and some of the mid-Tertiary rocks contain widely scattered quartz veinlets which have traces of silver and other metals. In the east-northeast and the southwest corners of the area, some of the rocks are argillized and discolored reddish brown by iron oxide. Some of these rocks contain small amounts of silver, molybdenum, mercury, and gold, but the small amounts of copper, lead, and zinc the rocks probably contained before they were altered have mostly been removed.

INTRODUCTION

PRESENT INVESTIGATION

The U.S. Geological Survey and the U.S. Bureau of Mines conducted a reconnaissance study of the mineral resources of the Chiricahua Wilderness in 1970. The study consisted of geologic mapping, geochemical exploration, geophysical studies, and deciphering the history of claim staking and mining activities, all of which are used herein as a basis for evaluating the geologic and economic mineral potential of the area. Accordingly, U.S. Bureau of Land Management records in Phoenix, Ariz., and U.S. Forest Service records in Albuquerque, N. Mex., were examined to ascertain the locations of patented mining claims near the wilderness. Cochise County records (Bisbee, Ariz.) were examined to find unpatented claims located within and (or) adjacent to the wilderness. Mineral-production data for nearby mines were obtained from the files of the U.S. Bureau of Mines, and reports of the Director of the Mint, dating back to the 1880's, were also reviewed. The nearest large prospect is more than 3 miles north of the wilderness.

GEOGRAPHY

The Chiricahua Wilderness, an area of about 28 square miles, is in the highest and remotest part of the Chiricahua Mountains, in extreme southeastern Arizona (fig. 1). The area is about midway between Douglas and Willcox, Ariz., and Lordsburg, N. Mex. It lies about 10 miles southeast of the Chiricahua National Monument, 6 miles southwest of the village of Portal, Ariz., and is entirely within the Coronado National Forest.

The wilderness is centered around Chiricahua Peak, which reaches an elevation of almost 9,800 feet. North of this peak the wilderness lies athwart the main crest of the range, which consists mostly of gently rolling uplands that separate the deeply incised flanks of the range. South of Chiricahua Peak the area extends across a series of ridges somewhat lower than the crest to the north and across deep southward-draining canyons. Along the borders of the wilderness, the valley floors are at an elevation of about 6,800 feet; the local relief is thus 3,000 feet. Although cliffs are conspicuous along both flanks of the mountains, particularly at the elevations of the wilderness boundary, the terrain in most of the area comprises steep slopes and sharp ridges between narrow canyons.

As a result of high relief and considerable elevation, the Chiricahua Mountains receive precipitation, mainly as summer thunderstorms and winter snows, usually more than 20 inches a year. Consequently, the area is forested, and the high valleys are densely

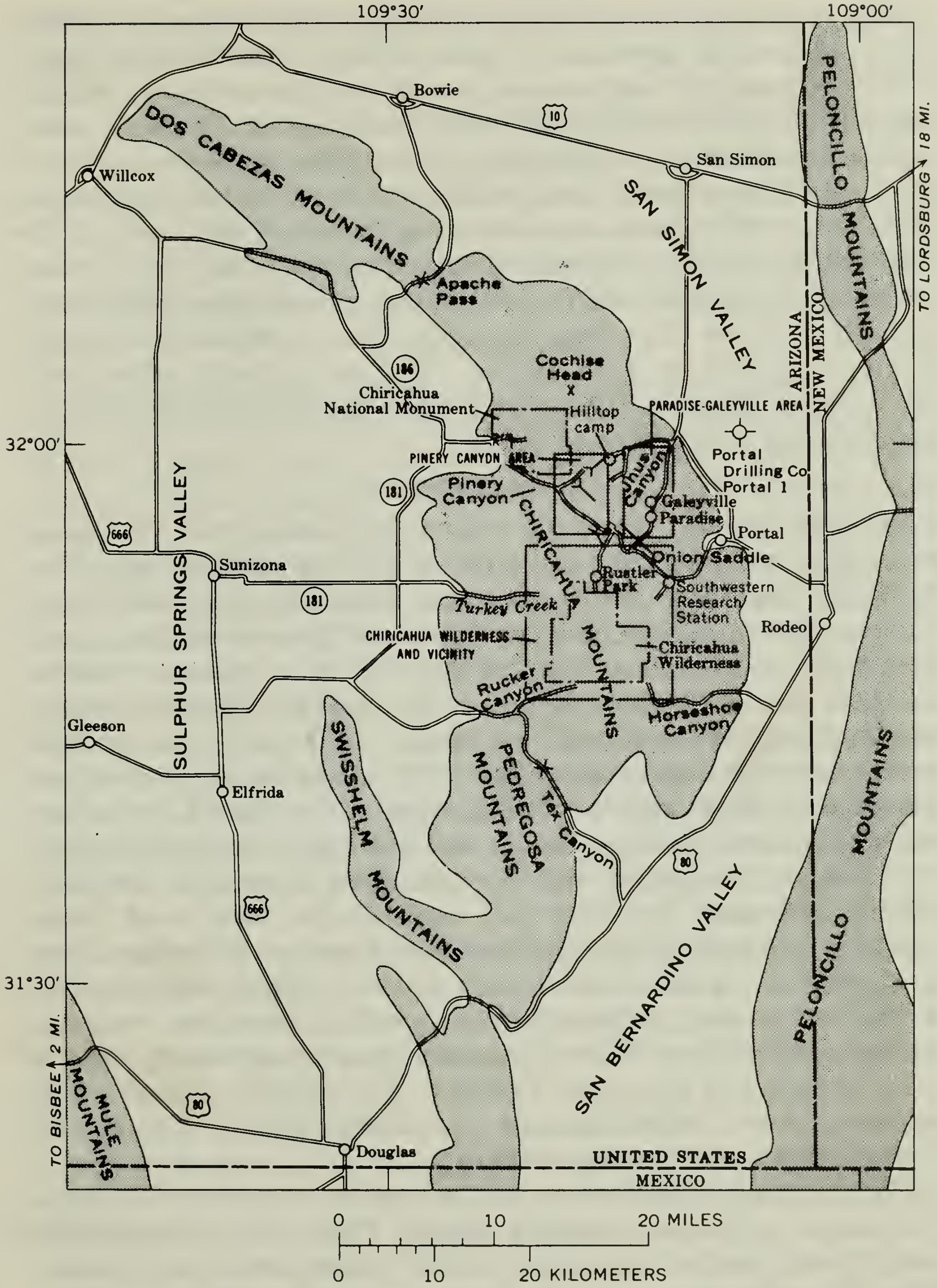


FIGURE 1. — Index map showing location of the Chiricahua Wilderness, southeastern Arizona, and areas of the three geologic maps shown on plate 1.

timbered. Pine, juniper, and oak are the dominant trees at lower elevations; spruce, fir, and some extensive stands of aspen are dominant at higher elevations. The fairly abundant precipitation results in a fairly abundant supply of surface water; nevertheless, many streams are ephemeral.

Despite the remoteness of the wilderness, the country surrounding it is accessible by means of several U.S. Forest Service roads. A well-maintained road crosses the mountains at Onion Saddle, between Portal and the Chiricahua National Monument, skirts the north edge of the wilderness, and provides access to a recreation and summer-home area at Rustler Park. Other maintained roads extend to recreation areas along Turkey Creek west of the area and to Rucker Canyon southwest of the area, and a more primitive road extends up Horseshoe Canyon southeast of the area. Many trails cross the wilderness from these roadheads, making it readily accessible on foot. Indeed, the trail network, along with a U.S. Forest Service cabin within the area, proved to be a major logistic asset to the present study.

GEOLOGIC SETTING

Through geologic time, the area encompassing the Chiricahua Mountains was, successively, part of (1) an obscure early Precambrian terrane of sedimentary and volcanic rocks, which were metamorphosed and intruded by granitoid plutons ranging in age from 1,450 to 1,700 m.y. (million years) ; (2) a Paleozoic shallow sea near the southwest margin of the North American craton, where abundant carbonate sediments and some noncarbonate clastic sediments were deposited; (3) a region of intermittent Mesozoic faulting, uplift, erosion, magmatic intrusion, volcanism, much continental sedimentation, and some marine sedimentation, all of which culminated with the Laramide orogeny of Late Cretaceous and early Tertiary age; and (4) the Basin and Range province, typified by mid-Tertiary and younger volcanism, block faulting of the present mountains, and continental sedimentation in the intervening valleys. The mineralization of the region is mainly associated with the Laramide orogeny, although some of it is Jurassic and some mid-Tertiary. The geologic history of the region is more fully discussed by Gilluly (1956), Cooper and Silver (1964), and Drewes (1971).

The Chiricahua Mountains are geologically typical of many of the ranges of the surrounding region. They are a block-faulted range, tilted gently westward, that is underlain by an extensive cover of mid-Tertiary rhyolitic volcanic rocks and by some Mesozoic rocks. Beneath the volcanic cover the Mesozoic rocks are probably fairly extensive and may contain structurally controlled masses of Paleozoic and Precambrian rocks. Precambrian schist and granitoid rock underlie the entire area at greater depth. During the Laramide orogeny, the Cretaceous and older rocks were intruded by plutons, folded, and thrust faulted. The older rocks and their complex structure are described by Epis (1956), Sabins

(1957), Cooper (1959), and other workers cited later in this report. Mid-Tertiary volcanic rocks cover many of the older rocks, and a few plutons intrude them. Pliocene and Pleistocene volcanic and sedimentary deposits fill San Bernardino Valley southeast of the mountains, and sedimentary and possibly volcanic deposits fill San Simon Valley to the northeast and Sulphur Springs Valley to the west. These deposits conceal most or all of the range-front faults. The younger rocks are described in greater detail by Enlows (1955) and Marjaniemi (1968, 1969), and by other workers cited in this report.

HISTORY OF MINING

The earliest known mining in the Chiricahua Mountains was in the first part of 1881, when Jack Dunn began work on the Hidden Treasure claim, later to become part of the present Hilltop mine, which is 6 miles from the wilderness. Hand-sorted high-grade ore was packed by mules to shipping points at Willcox, Ariz., or Lordsburg, N. Mex. (Brittain, 1954). A lead-silver furnace was constructed near the mine in 1884, the ores from several prospects were smelted, and "the base bullion was hauled by wagon 86 miles to the nearest railroad station, then freighted to San Francisco" (Badger, 1911). Early production came from lead oxides near the surface. Badger further said that "as depth was attained the lead began to disappear, and copper ore was found in its stead, and as the copper could not be handled at a profit, the mines were generally abandoned, except for a few prospectors." Not until 1902 did extensive prospecting and development take place. More than $600,000 was expended in mine development of two properties, but apparently no ore was shipped. On a third property, according to Badger, a large body of copper ore was developed. Copper, lead, and silver were produced for several years, but shipments were small, and profits were not great.

The California (Chiricahua) mining district covers almost all of the Chiricahua Mountains, extending from Apache Pass on the north to Tex Canyon on the south. Although 4,100 unpatented claims are on file in the Cochise County records for this district, none of them falls within the boundaries of the Chiricahua Wilderness, and only 12 claims are within 2 miles of it. These 12 claims are so vaguely described in the courthouse records that they cannot be plotted accurately on a map. Recorded production for the entire district spans 53 years, from 1902 to 1954. Known production during this time amounted to 28,700 tons of ore and concentrates, which had an estimated value of $1,072,000 and which yielded about 290 ounces of gold, 117,000 ounces of silver, 4,035 tons of lead, 582 tons of zinc, and 176 tons of copper.

The mine nearest the wilderness is the El Tigre mine, more than 3 miles north of the area. A reported 12 tons of ore was shipped from the mine in 1945.

The most productive mine near the wilderness is the Hilltop; 68 percent of the total production from the California mining district came from this mine. The mine property consists of 84 unpatented claims and contains more than 5 miles of workings. Although production continued intermittently during the years in which prices for lead, silver, and copper were high, most of the production was limited to only 5 years, in 1924–26 and 1952–53.

ACKNOWLEDGMENTS

The efficient completion of this study was facilitated by the friendly cooperation of Richard Albert and Peter Rouden of the U.S. Forest Service and by the field assistance of Matthew Paidakovich and H. C. Meeves. We are also grateful for the generosity of Mr. and Mrs. Vincent Roth of the Southwestern Research Station, Ariz., a field station of the American Museum of Natural History, N.Y.

STRATIGRAPHY

The rocks of the Chiricahua Wilderness and adjacent areas (pl. 2) comprise some Permian, Cretaceous, and Cretaceous or Tertiary rocks, abundant mid-Tertiary volcanic rocks, and some Holocene alluvium. Other rocks that will be mentioned, but not described in detail, because they lie more than 5 miles from the wilderness, are older Paleozoic sedimentary formations and the quartz monzonite of Jhus Canyon (fig. 1; pl. 1).

In the Paleozoic sequence, which may lie beneath part of the wilderness, are rocks ranging in age from the Cambrian Bolsa Quartzite to the Permian Concha Limestone, tabulated on the following page.

A quartz monzonite pluton in Jhus Canyon a few miles northeast of the wilderness (pl. 1) cuts rocks ranging in age from Precambrian to Cretaceous. A potassium-argon age of 30.9 ± 1.0 m.y. was obtained by R. F. Marvin, H. H. Mehnert, and Violet Merritt (written commun., 1969) from the biotite in the quartz monzonite. This age is virtually the same as that of the oldest of the mid-Tertiary volcanic rocks of the Chiricahua National Monument (Enlows, 1955) and is only slightly older than that of the mid-Tertiary volcanic rocks in the wilderness.

PERMIAN ROCKS

The Concha Limestone crops out in two small anticlines(?) near Cave Creek, 2 miles northeast of the wilderness (pl. 1). The limestone there is largely silicified and weathers to brownish-gray

Age	Formation	Thickness (ft)	Description
Early Permian	Concha Limestone	To 650	Cherty limestone.
	Scherrer Formation	120–300	Quartzite and limestone.
	Colina Limestone	500±	Dark-gray limestone.
Early Permian and Late Pennsylvanian	Earp Formation	1,500±	Limestone and red and green shale.
Late and Middle Pennsylvanian	Horquilla Limestone	2,000±	Thin- to thick-bedded light-gray limestone.
Late Mississippian	Paradise Formation	150–275	Limestone and shale.
Late and Early Mississippian	Escabrosa Limestone	730±	Massive crinoidal limestone.
Late Devonian	Portal Formation of Sabins (1957)	200–342	Limestone and shale.
Early Ordovician	El Paso Formation	700±	Limestone, dolomite, and siltstone.
Late and Middle Cambrian	Abrigo Formation	700±	Shale and limestone.
Middle Cambrian	Bolsa Quartzite	60±	Coarse-grained quartzite.

massive to bouldery knobs and ledges. Indeed, the rock of the eastern anticlines one-fourth mile southwest of the Southwestern Research Station is only identifiable — through its relict chert nodules — as an altered carbonate rock of the Paleozoic sequence. Much of the rock in the larger western anticline is similarly altered, but some of the rock toward its east and west ends is moderately coarsely crystalline to bioclastic, medium-dark-gray limestone containing dark-gray chert nodules. Some of the limestone also contains gastropods, corals, and productoid brachiopods, such as those characteristic of the Concha Limestone.

The rock of the western outcrop area, 1 mile west of the Research Station, is cavernous. Solution of the caves and smaller voids is believed to have preceded the silicification because the walls of the openings are commonly encrusted with drusy quartz that probably formed contemporaneously with silicification and because silicified rock is not readily dissolved to form caves. The silicification is probably of either Laramide age, a time when many of the rocks in nearby districts were altered, or mid-Tertiary age, a time when siliceous fluids that accompanied the widespread volcanism were possibly available. If either the mid-Tertiary or the older age assignment of the silicification is accepted, then the age of the cave solution must be old, for there are few known erosion cycles that could have caused an ancient groundwater table to be near the level of the caves. It is doubtful that the erosion cycle which predates the mid-Tertiary volcanics had proceeded deeply enough to have properly influenced the local ground-water level. Possibly, then, the caves were formed as early as the pre-Cretaceous erosion cycle.

The contact between the Concha Limestone and the overlying Bisbee Formation of Cretaceous age is either sheared or concealed. The shearing may be related to minor slippage between lithologies of contrasting competence during the folding, or it could indicate the presence of bedding-plane thrust faulting. The fact that the folds within the Bisbee above the sheared contact are tighter than the folds in the Concha beneath it also suggests disharmonic deformation compatible with a faulted contact. Thus, the structure and distribution of the Concha Limestone and other Paleozoic rocks are uncertain in the subsurface of the wilderness.

CRETACEOUS ROCKS

Rocks of Cretaceous and early Tertiary age crop out in less than 1 square mile of the northeastern part of the wilderness but are more extensive in the adjacent areas to the northeast and southwest (pl. 1). These rocks are the youngest exposed basement rocks beneath the extensive cover of mid-Tertiary volcanic rocks. In these areas the basement rocks include the Bisbee Formation; to the northeast they also include dacitic rocks overlying the Bisbee.

BISBEE FORMATION

The Bisbee Formation of the central Chiricahua Mountains is estimated to be at least 2,500 feet thick, and it may be considerably thicker. The formation is mostly a medium- to dark-gray siltstone and shale that includes many beds of intercalated light-brownish-gray sandstone and some beds of limestone and conglomerate. Locally, the formation also includes volcanic rocks. Most of the dominant siltstones and shales are poorly exposed because they weather rapidly and slump readily on steep slopes.

The beds of sandstone are typically a few feet to a few tens of feet thick. Most of the sandstone is in beds a few inches to a few feet thick, and the grains are well size sorted. Crossbedding, graded bedding, and scour marks in some beds provide the most reliable evidence that the beds are probably nowhere overturned in the area of plate 1. The sandstone beds seem to be fairly arkosic, and some of them are calcareous.

The limestone beds are thickest and most abundant near the middle of the formation, such as in the area between elevations of 6,400 and 6,800 feet on the spur northwest of Herb Martyr Forest Camp. However, this zone is discontinuous, as are the individual limestone beds, so that south of this spur the presence of limestone beds is more commonly marked by colluvial blocks of limestone than by outcrops. Some calcareous beds contain fossil shell fragments, most of which are probably derived from thick-shelled oysterlike pelecypods and *Orbitolina*-like Foraminifera. Fine-grained limestone is most common, but laminated limestone, which is present locally, is most characteristic of this formation.

Conglomerate beds are few and thin, and in many places conglomerate grades upward into sandstone. The clasts are subrounded pebbles of sandstone, quartzite, and, less commonly, chert, and some of the lower beds contain limestone clasts derived from Paleozoic rocks. A basal conglomerate is not everywhere present above the local outcrops of Concha Limestone, although such a thick basal conglomerate, composed of cobbles and pebbles, does occur a few miles northeast of the wilderness. Its absence locally could as well be due to an initial lenticularity as to faulting.

Andesitic volcanic rocks in the Bisbee Formation, as mapped in this study, are particularly abundant along the road between the Southwestern Research Station and Onion Saddle (fig. 1), where they seem to be most widespread in the upper part of the formation. Indeed, it is possible that this upper part is actually a post-Bisbee formation, such as the Upper Cretaceous clastic rocks described by Epis (1956). Elsewhere, however, volcanic-rich beds are known to be intercalated with laminated limestone beds and, thus, seem to be unequivocally part of the Bisbee.

The volcanic components of the Bisbee Formation are mostly tuffaceous, but they include some lava flows and possible intrusive rocks. Some tuffaceous rocks are light colored and contain fragments of volcanic rocks that have tiny phenocrysts of feldspar, suggesting that the rocks are rhyolite or latite. Other volcanic rocks, such as those along the road about 1 mile east of Onion Saddle are medium gray and contain altered mafic minerals, suggesting that the rocks are andesitic. Structurally, some of the andesitic rocks resemble flows or sills, whereas others form dikes or irregular crosscutting bodies. Vesicular and amygdular sheets suggest that they are lava flows or shallow sills, all indicative of volcanism penecontemporaneous with the deposition of the Bisbee Formation.

In thin section, one specimen of a dark-gray intrusive rock is seen to be an olivine(?) andesite, which consists of andesine laths and intergranular clinopyroxene and subordinate amounts of olivine(?), amphibole(?), magnetite, and apatite.

CRETACEOUS OR TERTIARY ROCKS

DACITIC ROCKS

Dacitic rocks form discontinuous outcrop belts along the east and west sides of the large outcrop area of Bisbee Formation that is northeast of the wilderness. The rocks in these belts consist of about 100–500 feet of dacitic lava, volcanic breccia, and volcanic sandstone and conglomerate that lie unconformably upon the Bisbee Formation.

The western outcrop belt extends northward from the edge of the wilderness, where the rocks are mainly propylitized, and probably also albitized, breccia. Farther north the unit is represented by volcanic conglomerate and some sandstone. The conglomerate is exposed in a roadcut between Rustler Park and Onion Saddle, where it dips 35° westward. Such volcanic conglomerate also occurs above the El Tigre mine along Pinery Canyon (pl. 1), and a similar one appears near the Silver Prince mine. Some of the clasts in the conglomerate along Pinery Canyon are made up of sandstone that is probably derived from the underlying Bisbee Formation.

The eastern outcrop belt of dacitic rocks consists of lavas, some of which contain hornblende phenocrysts. Although these rocks are as poorly exposed as the other dacitic rocks of this unit, they appear to be less intensely altered than those in the western outcrop belt. This alteration difference need only reflect a more massive internal structure of the less altered rocks, but further study might reveal that the dacitic lavas are younger than the dacitic fragmental rocks.

In part, the dacitic rocks may be correlated with the Nipper Formation of Sabins (1957), which is widespread northeast of the Hilltop mining camp. Sabins assigned this formation a Cretaceous or Tertiary age, which is compatible with the field relations observed in this study. If the Nipper Formation is correlative with the lower part of the Salero Formation (Drewes, 1971), which it resembles, it is Late Cretaceous. The somewhat less altered dacitic lava may be Tertiary and is perhaps more closely related in age to the rhyolitic volcanic pile that overlies it than to the Nipper Formation, but provisionally it, too, is mapped with the dacitic rocks of Cretaceous or Tertiary age.

MID-TERTIARY ROCKS

Volcanic and subordinate amounts of intrusive rocks of rhyolitic to latitic composition underlie most of the Chiricahua Wilderness. The volcanic rocks consist mainly of lava flows and welded tuff, but they also include some tuff and tuff breccia. The intrusive rocks are mostly monzonite and latite in a rock complex that also includes some extrusive bodies. In order of decreasing age, the mid-Tertiary rocks comprise (1) the lower rhyolite volcanic rocks, (2) the Rhyolite Canyon Formation, (3) the monzonite and latite complex, (4) the upper rhyolite volcanic rocks, and (5) the rhyolite and andesite dikes.

LOWER RHYOLITE

The lower rhyolite volcanic rocks in the eastern part of the wilderness lie on the Bisbee Formation and on dacitic rocks and are overlain by the Rhyolite Canyon Formation. The lower volcanic rocks extend northeastward toward Portal, where they form a thick sequence of tuffs, welded tuffs, and flows; they are mostly rhyolite but include some rocks that are probably dacite. Along Cave Creek and its South Fork, the rhyolite forms massive reddish-gray to yellowish-brown cliffs and some lighter colored intervening benches.

Within the wilderness much of the formation is a very light gray to pale-yellowish-brown faintly bedded or layered moderately friable tuff and tuff breccia. These rocks crop out in small scattered areas, chiefly low on the canyon walls of South Fork but over the entire canyon wall west of the knob that has an elevation of 7,890 feet. These rocks are pervasively altered to argillic minerals and sparse iron oxides. Locally, the tuff contains beds of tuffaceous sandstone.

Reddish-brown cliff-forming flow breccia and flow-laminated rhyolite overlie the tuffs along South Fork Cave Creek. Although this rock is believed to be mainly deposited upon the tuffs, some of it may be intrusive into the tuffs. Critical contacts are covered, but steep to vertical flow laminae suggest vertical movement and, hence, intrusive bodies.

The cliff-forming rocks are strongly argillized and impregnated with iron oxides, perhaps chiefly hematite, causing the rock to be a conspicuous red. This alteration is believed to be a deuteric feature related to the volcanism, rather than to later hydrothermal activity.

In thin section the flow-laminated rhyolite is seen to contain 20-percent phenocrysts, mostly less than 5 mm long, scattered in a groundmass of devitrified glass. The glass contains abundant granular microlites or granular cryptocrystalline material. The phenocrysts consist mostly of quartz and sanidine; trace amounts of magnetite and zircon occur in all rocks, and traces of apatite, sphene, and biotite also occur in some of them.

The lower volcanic rocks may be correlative with part of the Cave Creek Formation of Enlows (1955), as adapted from an unpublished thesis by Raydon (1952); however, such a specific correlation is avoided in this report because neither formation is mapped in sufficient extent or detail for correlation, and because the rocks between these areas differ from those within the areas. For example, in the basin north of Horseshoe Pass, the lower volcanic rocks contain some thin rhyolite flows, tuffs, and welded tuffs, as well as a trachyandesite flow. This trachyandesite is ophitic and contains, in percent, calcic andesine, 75; pyroxene, 10; amphibole, 7; magnetite, 4; biotite, 3; and apatite, quartz, and potassium feldspar(?), each less than 1.

A sample of the youngest member of the Cave Creek Formation is dated as 25.7±0.8 m.y. old (Marjaniemi, 1969, p. 40) by means of the potassium-argon method on sanidine. This date suggests that most of the formation is probably of late Oligocene age; also, some of it may be early Miocene. The age of the mapped unit is considered to be Oligocene and Miocene(?).

RHYOLITE CANYON FORMATION

The Rhyolite Canyon Formation is an extensive thick composite sheet of rhyolite welded tuff that conformably overlies the lower volcanic rocks. The formation continues northward and is widespread in the Chiricahua National Monument, where it was studied in detail and named by Enlows (1955).

The welded tuff of this formation is distinguished from the other mid-Tertiary welded tuffs by its greater extent and thickness, its slightly greater abundance and size of phenocrysts, and the more common occurrence of a small amount of biotite.

The formation underlies steep slopes in the western and southeastern parts of the wilderness. Being lenticular, the formation commonly ranges in thickness from 350 to 1,500 feet, but on the west flank of Chiricahua Peak it is probably more than 2,000 feet thick, and on the east flank of the peak it is absent. At Turtle Mountain, in the southwestern part of the wilderness, the formation may also be 2,000 feet thick. Rhyolite (or latite?) welded tuff between Sentinel Peak and Horseshoe Canyon in the southeast corner of the area is provisionally correlated with the Rhyolite Canyon Formation; it thins northwestward from about 2,000 feet to less than 400 feet.

In much of the wilderness the Rhyolite Canyon Formation is a single cooling unit, but on Raspberry Peak, Chiricahua Peak, and east of Sentinel Peak, the formation contains two cooling units separated by a tuff or a vitrophyre. In these places the upper cooling unit is thinner than the lower one. The slight variations in the kinds of phenocrysts seen from place to place and the slight variations in bulk chemistry between the main body of welded tuff and the welded tuff west of Horseshoe Canyon are also indications that the formation is a composite welded tuff sheet, such as was described by Enlows (1955).

The Rhyolite Canyon typically forms light-gray to brownish-gray bold outcrops, cliffs, or steep slopes above extensive deposits of blocky talus. It has widely spaced polygonal joints and a subtle but widespread flow foliation and sheeting.

Chemical and spectrographic analyses of two specimens of welded tuff assigned to the Rhyolite Canyon Formation are listed in table 1. Specimen 1, representing the lower cooling unit, was collected along the trail one-third mile northwest of Flys Peak, and specimen 2, representing the upper cooling unit, was obtained

TABLE 1. — *Chemical and semiquantitative spectrographic analyses of rocks from the Chiricahua Wilderness*

[Chemical analyses were by the rapid-rock method, supplemented by the atomic-absorption method. Analysts: Gillison Chloe, P. L. D. Elmore, John Glenn, John Kelsey, and Hiram Smith. <, less than. Spectrographic analyst: J. L. Harris. N, looked for but not detected. Other elements looked for but not detected: As, Au, B, Bi, Cd, Eu, Pd, Pt, Pr, Re, Sb, Sm, Sn, Ta, Te, Th, Tl, U, W, and Zn. Ag detected in all samples but below the limit of determination (0.5 ppm)]

Specimen No.	1	2	3	4	5
Field No.	70D55	70D192	70D13	70D119	70D27
Rock unit	Rhyolite Canyon Formation	Rhyolite Canyon (?) Formation	Latite and monzonite complex		Upper volcanic rocks
Rock type	Rhyolite and latite(?), welded tuff		Latite, extrusive	Monzonite, intrusive	Rhyolite, flow
Chemical analyses, in percent					
SiO_2	74.1	65.9	62.3	62.2	74.8
Al_2O_3	12.7	16.5	15.4	15.5	13.2
Fe_2O_3	2.1	2.5	4.7	2.4	1.1
FeO	.08	.32	1.0	3.1	.40
MgO	.19	.41	1.9	1.9	.16
CaO	.26	.90	3.0	3.4	.33
Na_2O	4.4	4.0	3.9	4.1	3.5
K_2O	5.2	6.5	4.4	4.5	5.4
H_2O+	.38	1.5	.50	.74	.43
H_2O-	.09	.43	1.3	.46	.07
TiO_2	.25	.78	1.1	1.1	.20
P_2O_5	.04	.20	.40	.39	.03
MnO	.05	.04	.06	.07	.03
CO_2	<.05	<.05	<.05	<.05	<.05
Spectrographic analyses, in parts per million					
Ba	100	3,000	1,000	1,000	100
Be	3	1	1.5	1	5
Ce	700	700	500	500	500
Co	N	N	10	10	N
Cr	200	30	20	20	5
Cu	2	2	7	10	1
Ga	15	15	15	15	15
La	200	150	150	150	150
Li	N	N	N	N	700
Mo	3	10	10	5	15
Nb	30	20	10	20	50
Nd	200	N	200	N	N
Ni	100	7	10	10	N
Pb	15	15	10	15	30
Sc	7	10	15	15	7
Sr	15	300	500	700	30
V	15	30	70	70	15
Y	100	100	70	70	30
Yb	10	10	7	7	3
Zr	700	700	300	700	300

along the trail 1 mile northeast of Sentinel Peak. The chemical differences between these specimens corroborates the inference of the presence of several cooling units made from other observations. Specimen 1 resembles Nockolds' (1954, p. 1012) alkali rhyolite. Specimen 2 seems most like a silica-poor alkali-rhyolite, having affinities to latite.

The Rhyolite Canyon Formation is of early Miocene age. Sanidine concentrates from several members of the formation have been radiometrically dated as 24.2 to 25.0 m.y. old (Fernandez and Enlows, 1966; Marjaniemi, 1969). Marjaniemi (1969, table 17) reviewed some other less reliable ages that had previously been obtained from the formation.

MONZONITE AND LATITE

One or several intrusive and extrusive bodies of coarsely porphyritic monzonite and latite, referred to here as "monzonite-latite," underlie about 5 square miles of the wilderness. That part of the formation which is clearly intrusive cuts rocks as young as the Rhyolite Canyon Formation. The extrusive part is conformably (?) overlain by the upper volcanic rocks, and its base—where it is exposed immediately northeast of the wilderness — conformably overlies tuffaceous sandstone of the lower volcanic rocks.

The monzonite-latite typically is a massive brownish-gray to medium-gray rock that is faintly sheeted and is conspicuously steeply jointed. It forms prominent cliffs, such as those near Winn Falls and those above the forks of Ward Canyon; elsewhere, it weathers to steep slopes with scattered outcrops or smaller cliffs. The rock that may lie farthest from the borders of the body, as near the junction of Saulsbury Canyon and Turkey Creek and over much of the basin of Turkey Creek west of the wilderness, is a nearly fresh coarse-grained dark-gray monzonite. Within the wilderness most of the rock is porphyritic latite. Near some of the upper and lower contacts of the body, the porosity of the rock increases, the groundmass grain size decreases, and the color is a darker brown and, locally, even reddish brown. Near the upper contact of the body east of Flys Peak, the rock is a highly contorted flow-banded red-oxidized crusty latite that resembles the top of a lava flow or extrusive dome. These characteristics are absent from the rock of the upper contact west of Chiricahua Peak. West of Flys Peak, furthermore, a several-hundred-foot-thick zone of rock adjoining the monzonite-latite is subtly recrystallized, suggesting that it has been contact metamorphosed.

Quartz veinlets too small to be mapped but of special interest in this study are scattered in some of the west- to northwest-trending steeply inclined fractures of the latite body near Winn Falls and northwest of the lower part of Bear Canyon. Most of these veinlets are less than 2 inches thick, but a few of those along Bear Canyon are as much as 2 feet thick. In hand specimen, only quartz and a little iron oxide are recognized, but analyses of some vein rocks, to be discussed in the section "Geochemical Survey," show that they also contain trace amounts of some metals.

The monzonite-latite commonly consists of about 20 percent phenocrysts in a groundmass having an ophitic or hyalopilitic to intergranular texture. Phenocrysts are commonly as much as 6 mm long but are even longer in some rocks. They are not as conspicuous in the coarser grained monzonite as they are in the latite. Quartz and feldspar are in the cavities and vugs of the porous rock at the top of the extrusive body at Winn Falls. Argillic and iron oxide alteration are ubiquitous in the latite but are virtually absent in the monzonite.

A typical specimen of monzonite from a roadcut midway between Turkey Creek and Morse Canyon Campground (pl. 1) contains the following minerals in the mode:

Mineral	*Percent*
Quartz	9.9
Plagioclase	38.6
Orthoclase	35.1
Hornblende	9.9
Clinopyroxene	1.9
Biotite	1.2
Magnetite	2.7
Apatite	.7
Total	100.0

The plagioclase in this specimen is probably labradorite, although in some others it is andesine. Additional estimated modes, not reported here, suggest that the monzonite and latite are fairly uniform. A few specimens of latite contain a trace of zircon.

The monzonite is similar to the latite in chemical as well as mineral composition, as can be seen by comparing the chemical and spectrographic analyses of specimens 3 and 4 (table 1). These specimens have a general similarity to Nockolds' (1954, p. 1016, 1017) average monzonite or latite, although his averages indicate less SiO_2 and more CaO. Specimens 3 and 4 have a similarity to Nockolds' trachytes.

The age of the monzonite-latite is probably early Miocene, as shown by the radiometric dating of the next older Rhyolite Canyon Formation and of a dike cutting the monzonite. Potassium-argon ages on the Rhyolite Canyon Formation range from 24.2 to 25 m.y. old, and the age of the dike, to be described in the section "Rhyolite and Andesite Dikes," is 24.8 m.y. old. The potassium-argon ages of these rocks are identical within analytical error, so the monzonite-latite must also be about 24.5 m.y. old.

The origin and structure of the monzonite-latite body or bodies remain problematical, and the solution of this problem is of major geologic interest in connection with a caldera structure proposed by Marjaniemi (1968, 1969) and briefly described in the present report in the section entitled "Structure." The location of the upper contacts of the several outcrop areas at a common elevation and the subhorizontal attitude of these contacts suggest that these outcrops may be parts of one body, as shown in the structure sections of plate 1, despite the evidence that the complex was intrusive in the west and extrusive in the east. The available field evidence indicates that the body may be the uppermost part of a plug, sill, or laccolith, which locally breached the surface to form an extrusive dome on the flank of a volcanic pile. Further structural considerations are discussed in connection with the geophysical data described in the section by Eaton.

UPPER RHYOLITE

The upper rhyolite comprises a sequence of lava flows and some tuff, tuff breccia, and tuffaceous sandstone at least 1,200 feet thick. This sequence underlies much of the southern half of the wilderness and extends along the crest of the mountains in the northern half. The formation overlies the crusty monzonite-latite, which resembles the top of a lava flow or extrusive dome, and the Rhyolite Canyon Formation. Apparently, the basal contact of the upper rhyolite is a disconformity on a surface of moderate relief. The rocks of the upper rhyolite are light colored, commonly shades of gray. Their phenocrysts are small and are sparse to virtually absent. The upper rhyolite unit differs from the lower rhyolite mainly in that it contains more lava flows, the flows do not as commonly form cliffs, and the flows are light gray rather than reddish brown or yellowish brown.

Lava flows make up about 90 percent of the formation within the wilderness. Probably several flows exist, as indicated by scattered occurrences of discontinuous vitrophyre zones in the lava sequence, by internal variations in texture, and by variations in kinds and abundance of phenocrysts. For example, a thin platy, strongly laminated flow forms a widespread lower unit and a thick platy to massive flow forms an upper unit on the ridge between Sentinel Spring and Sentinel Peak. Intercalated tuffaceous rocks occur within the lava sequence north of Cima Park, on Monte Vista Peak, on the south flank of Sentinel Peak, and in the saddle between Price and Rucker Canyons. One small outcrop at the big bend of Rucker Canyon, just south of the wilderness, may be a welded tuff; it is mapped as part of the upper volcanic rocks, although it may prove to be correlative with the Rhyolite Canyon Formation. The sparse vitrophyric rocks in the sequence are dark gray to yellowish gray, and many of them contain bands of abundant reddish-brown spherulites.

The laminated lava has a flow-layered cryptocrystalline texture, and the massive flow is hypidiormorphic granular, with crystals mostly 0.1–0.2 mm long. Phenocrysts generally make up 3 percent of the laminated flows and their vitrophyres but less than 1 percent of the massive flow. Only two specimens have as much as 10 percent of phenocrysts; one is from the welded tuff at the bend in Rucker Canyon, and the other is from a large block (?) of vitrophyre near the trail junction at Anita Park, which also contains an anomalous mineral assemblage.

Phenocrysts consist mainly of either or both sanidine and quartz, and of trace amounts of magnetite, olive-brown hornblende, and biotite or oxybiotite. A few specimens also have trace amounts of zircon and apatite. The vitrophyre at Anita Park contains phenocrysts of calcic andesine or sodic labradorite (7 percent), pyroxene (3 percent), and magnetite (1 percent).

Specimen 5 of table 1 is representative of the massive flow of the upper volcanic rocks; it was collected along the trail about midway between Sentinel Spring and Lone Juniper Spring (pl. 1), a mapped but nonexistent spring. Its chemical composition is that of a typical alkali rhyolite. Spectrographic analyses of its trace elements show it to have significant amounts of molybdenum (15 ppm) and lithium (700 ppm), although the rock seems to be unaltered or unmineralized.

The upper volcanic rocks of the wilderness are the youngest extrusive rocks of the mid-Tertiary sequence. Because of their petrologic similarity to the underlying rocks they are presumably only slightly younger and are assigned a Miocene age.

RHYOLITE AND ANDESITE DIKES

Several rhyolite dikes and two andesite dikes intrude rocks as young as the upper volcanic rocks, and probably a few other unobserved dikes are scattered throughout the wilderness. A rhyolite dike as much as 500 feet thick was intruded along the fault contact between the Bisbee Formation and the Rhyolite Canyon Formation in the southwest corner of the wilderness. Narrow dikes, typically 5–40 feet wide, are mostly short, but one of them in the eastern part of the area is more than 1 mile long. The narrow dikes are not associated with faults.

Both andesite dikes are short and only a few feet wide; in hand specimen they are seen to contain abundant mafic crystals, which give the rock a dark-gray appearance.

In thin section the rhyolite dikes are seen to be porphyritic flow-laminated cryptocrystalline to fine-grained rocks. Phenocrysts make up 10–20 percent of the rock and are rarely more than 8 mm long. Quartz and sanidine are the most abundant of the phenocrysts and probably are also abundant in the groundmass. Some dikes also contain small quantities of biotite, plagioclase, or amphibole phenocrysts and trace amounts of magnetite and zircon and, less commonly, apatite and sphene.

The east end of the thick dike contains many small (½–1 in.) inclusions of wallrocks. The inclusions of sandstone and siltstone were derived from the Bisbee Formation south of the dike, and the inclusions of trachyte and rhyolite welded tuff were derived from the mid-Tertiary volcanics to the north.

The dikes are assigned a Miocene age, inasmuch as they are petrographically similar to the volcanics of late Oligocene and Miocene(?) ages which they intrude. A similar rhyolite dike, 5 miles west of the wilderness and 1 mile north of Turkey Creek, was dated as 24.8 m.y. old by Marjaniemi (1969, p. 110, 153), who used the potassium-argon method on sanidine.

QUATERNARY GRAVEL

Gravel composed of cobbles and boulders and containing lentils of coarse sand occurs along all the larger valleys. Most of the mapped deposits are remnants of one or several stream terraces, which have been incised to various depths from valley to valley. The terraces in the mountains (pl. 1) are probably correlative with similar but more extensive features along the major drainages in the adjacent piedmont areas. Because similar terrace deposits in many of the intermontane valleys of southeastern Arizona are of Quaternary age, the gravel deposits in the Chiricahua Wilderness are also assigned to this age.

STRUCTURE

The rocks of the Chiricahua Mountains were strongly faulted and folded during the Laramide orogeny (Late Cretaceous to early Tertiary), and they were also deformed before and after the Laramide. The rocks exposed in the Chiricahua Wilderness, being mainly of mid-Tertiary age, were deformed only in mid-Tertiary or younger time, but the rocks underlying the mid-Tertiary volcanic cover were probably deformed like the old rocks of the Chiricahua Mountains.

Pre-Laramide deformation in the Chiricahua Mountains occurred during the Precambrian Era and at several times during the Paleozoic and Mesozoic Eras (Sabins, 1957). An ancient orogeny deformed the oldest rocks of the mountains — the Pinal Schist — and granitoid rocks intruded the schist. Uplift of the entire area occurred from time to time during the Paleozoic, and more local uplifts also occurred during the Mesozoic. No specific structural features attributable to these events have been identified during the studies of the areas adjacent to the wilderness.

Laramide structural features in the Chiricahua Mountains consist of thrust faults and normal faults and some folds, which, typically, are distributed in northwest-trending belts separated by belts of less deformed rocks. Because the available outcrops of older rocks are mainly northeast and southwest of the wilderness, projections of specific structural features cannot be made beneath the volcanic pile in the wilderness. The older rocks present within the northeast and southwest corners of the wilderness and extending into the adjacent areas are relatively undeformed. The Bisbee Formation and Concha Limestone near the Southwestern Research Station, for instance, are warped into anticlines, and the contact between them is sheared, but the anticlines are local features, and the significance of the shearing is unknown, owing to the limited extent of the contact. The older rocks 6–10 miles northeast and southwest of the wilderness, on the other hand, are strongly deformed. Near Galeyville (fig. 1), the older rocks dip steeply northeastward and are cut by bedding-plane thrust faults and normal faults largely or wholly of Laramide age. More detailed study of this belt of deformed rocks may provide evidence of strike-slip movement along it. Southwest of Tex Canyon (fig. 1) similarly deformed rocks were described by Epis (1956). However, discussion of the kind of Laramide structure and the intensity of Laramide deformation to be expected beneath the volcanic pile in the wilderness is too speculative to be included in the present report.

Post-Laramide structures in the Chiricahua Mountains are largely normal faults and features related to volcanism. Some predate the mid-Tertiary volcanic events, many are probably related to these events, and some are distinctly younger than this volcanism. The large normal fault along the flank of the mountains 5 miles east of the wilderness is clearly a postvolcanic fault. In the wilderness the volcanic rocks are virtually unfolded, and they are broken only by a few normal faults. In the absence of post-Laramide rocks other than the mid-Tertiary volcanics and small bodies of Quaternary alluvium, faults of post-Laramide and prevolcanic age are not recognized; likewise, in the absence of upper Tertiary rocks, no distinction is made between structural features associated with the volcanism and substantially postvolcanic features. The following discussion, then, will present the kinds of folds, faults, and intrusive features of mid-Tertiary or younger age.

One or two broad open folds warp the flow foliation in the Rhyolite Canyon Formation northwest of Flys Peak. The axes of these folds are not shown on plate 1, because their position and extent are inadequately known. These features have been taken into account in the estimate of the thickness of the formation, and they account for the more modest thickness reported herein, as compared with that mentioned by Marjaniemi (1969).

A few normal faults cut the rocks of both the southwest corner and the eastern part of the wilderness and adjacent areas. The Bisbee Formation just outside the southwest corner of the area is part of an uplifted block, or horst, which was shown by Epis (1956) and Cooper (1959) to extend southward to the Tex Canyon area (fig. 1). The fault along the east side of the horst extends north-northwestward beyond the outcrop of the Bisbee Formation and through the southwest corner of the wilderness, where it forms two strands that extend at least into the Turkey Creek drainage. Judged by the offset of the Rhyolite Canyon Formation across the fault, the east side of the eastern strand has been dropped relative to the west side about 500 feet, and the western strand has a similar direction of displacement on the order of several thousand feet. The relatively large displacement on the western strand suggests that the strand may extend northward, perhaps along Pole Bridge Canyon and along unnamed alined small valleys tributary to Turkey Creek and Rock Canyon, 1–2 miles west of the wilderness.

The Bisbee Formation and volcanic rocks of the eastern part of the wilderness are cut by a few east- to northeast-trending normal faults. These faults are poorly exposed, and their extent is largely inferred from the alinement of apparent offsets of units or from the abrupt terminations of units. Relative displacements across the faults are random, the southeast blocks being as commonly raised as dropped. Amounts of offset on these faults probably ranges from less than 100 feet to several thousand feet.

Small volcanic necks or pipes may intrude the tuffs and flows in the several places in which steep flow foliation and altered rocks are fairly extensive, but intrusive contacts are concealed if they exist. One such problematical area occurs in the southeastward-dipping unit of rhyolite flow and breccia capping the ridge east of knob 7,890. The significance of the steep foliation northeast of knob 7,890, the abrupt ending of the cliffy rock west of this knob, and the nearly pervasive iron oxide alteration or discoloration are unknown, but all these features may be related to a local obscure vent. Another such problematical area of steep foliation occurs in the upper volcanic rocks at the narrows of Rucker Canyon, near the south border of the wilderness. Although the rocks of the massive cliffs of this area are not strongly altered, much of the tuffaceous rock southeast of the cliff is argillized, to suggest that, together, the two types of rock may represent the solfataric area of a vent.

A large subcircular area of volcanic collapse, or caldera structure, has been proposed by Marjaniemi (1969) to underlie the west-central part of the Chiricahua Mountains. As proposed, the southeast quarter of the caldera is approximately coextensive with the Chiricahua Wilderness, excepting only the southeasternmost corner of the area. Marjaniemi believed that the caldera collapse occurred during Rhyolite Canyon Formation time and further suggested that the monzonite-latite bodies, in the more restricted distribution in which he recognized them, are a central resurgent dome and peripherally located ring dikes. The subcircular fault zone that formed during caldera collapse was reported by him in only a few places, such as east of Winn Falls; much of the fault zone has been obliterated by the ring dikes or has become covered by younger volcanic rocks.

Whereas the caldera hypothesis is of general volcano-genetic interest, the location of the peripheral fault zone and the position of the base of the mid-Tertiary volcanics are of more particular interest to an evaluation of the potential mineral resources of the wilderness. The geologic reconnaissance reported herein did not supply strong evidence either to substantiate or to refute the caldera hypothesis; apparently, such evidence will require a more thorough investigation. However, the following observations are offered:

1. The Winn fault of Marjaniemi (1969, pl. 1), the largest remnant of his proposed peripheral fault zone, has no basis for support, because the contact between the Bisbee Formation on the east and the volcanics on the west is covered, and the distribution of the available outcrops suggests that the contact dips somewhat irregularly but mostly gently westward, as an unconformity would.
2. Foliation in the monzonite-latite bodies shows no signs of vertical structure. However, geophysical evidence supports the contention that concealed feeder pipes may be distributed in an arc subparallel to the proposed peripheral fault zone, but the proposed resurgent dome, by geophysical evidence, seems to be unrooted, as discussed in the following section.

3. At least some of the monzonite-latite lies upon a nearly flat floor.
4. At the edge of the proposed caldera in the Rucker Canyon–Baker Canyon area, the "moat rhyolite" of Marjaniemi contains a facies change between lava flows of the moat to the northwest and tuffaceous rocks to the southeast just outside the moat. This relation seems incompatible with a breached zone of a caldera depression, into which the lava should be expected to have flowed.

AEROMAGNETIC INTERPRETATION

By Gordon P. Eaton

In the fall of 1970 the U.S. Geological Survey flew an aeromagnetic survey of a 365-square-mile area in the Chiricahua Mountains, approximately centered on the Chiricahua Wilderness. The survey was flown at a constant barometric elevation of 10,000 feet and at a flightline spacing of 1 mile. Aeromagnetic data for the central 90 square miles of the area flown are shown on plate 1 on the geologic map. Nine anomalies, judged to be of possible geologic significance, occur within this central area, and five of these lie wholly within the wilderness. These five were studied in detail. In addition, the magnetic susceptibilities of seven samples — two each from the three principal rock units which underlie most of the wilderness and one from a dike rock — were measured in the laboratory and are tabulated as follows:

[No measurements of remanent magnetization were made]

Sample	Lithology	Map unit (pl. 1)	Magnetic susceptibility $\times 10^4$ (emu/cc)[1]
71D97	Porphyritic andesite	Tia	18.1
70D42	Laminated rhyolite	Tu	3.2
70D66a	Massive rhyolite	Tu	1.1
70D13	Latite	Tml	7.5
70D119	Monzonite	Tml	18.7
70D28	Welded rhyolite tuff	Tr.	1.9
70D55	do	Tr.	Not detectable.

[1]Electromagnetic units per cubic centimeter.

The most prominent magnetic feature is a belt of highs (from north to south, magnetic peaks 628, 677, 702, 643, and the anomaly southwest of Turtle Mountain), that crosses the wilderness in an arc from its north-central part to a point just north of the southwest corner. This belt of anomalies is just inside of, and is concentric with, the approximate eastern and southern topographic walls of Marjaniemi's (1969) Turkey Creek caldera. Magnetic data for adjacent areas, not included on plate 1, show a similar relationship to the rest of the margin of the proposed caldera. Although the magnetic map could thus be regarded as a geophysical expression of the caldera, the origin of at least some of the anomalies in the belt under discussion appears to be, in part, topographic. Magnetic peaks 628, 677, and 702 are centered along the backbone of the Chiricahua Mountains, where the crest is at elevations in excess of 8,700 feet. Depth estimates based on the method of Vacquier, Steenland, Henderson, and Zietz (1951) place the anomaly sources approximately at the surface, except for magnetic peak 702, for which the source is several hundreds of feet below the surface. Although magnetic peak 643 and the anomaly southwest of Turtle Mountain occur over lower areas, depth estimates place their sources at the surface, too. Thus, all these anomalies are related to exposed rocks or to those at shallow depth, and where the surface is at relatively high elevations, there are corresponding magnetic highs. In effect, the topographic eminences carved from these rocks are acting as magnetic bodies.

An inverse relationship to topography is displayed by the magnetic low with a minimum value of 351 gammas north of Sentinel Peak. It is coaxial with the crest of a spur ridge that reaches an elevation of more than 8,900 feet, and the anomaly source is estimated to be at the surface. The lithologic unit underlying this spur — the upper rhyolite — evidently is reversely magnetized in this area. However, inasmuch as magnetic high 538, nearby, also occurs over this unit and likewise appears to have its source at the surface, some of local members within the unit may have contrasting magnetic polarities.

Areal correlation of magnetic anomalies with lithology indicates that several of the magnetic highs are associated with the monzonite-latites. As might be expected, the preceding table reveals that the monzonite-latite has the highest magnetic susceptibility of the three major rock units studied. Magnetic peaks 628 and 648 occur over outcrops of this unit, and peak 643 occurs where the monzonite-latite is in the shallow subsurface. Peak 702, although centered over the Rhyolite Canyon Formation, has its source 500–900 feet below the surface and may also arise from the monzonite-latite unit. The contact relations south and southwest of Snowshed Peak indicate that the upper surface of the monzonite body is rising toward the axis of anomaly 702 and achieves a maximum elevation of 9,200 feet. Note, however, that the highest exposure of monzonite-latite in Rucker Canyon, immediately to the west, is at only 8,000 feet. The source of magnetic peak 677 may also be the monzonite-latite, for although it is centered over the upper rhyolite volcanic rocks and has a source estimated to be at the surface, a wide latitude of uncertainty exists in the source-depth estimates for tilted rock masses with tabular configurations, particularly in areas of highly irregular topography.

The fact that some of the anomalies (peaks 648, 643, and 538) observed on plate 1 are not related to topography and the fact that the configuration of many of the highs is indicative of steep-sided bodies suggest that perhaps most of the magnetic highs arise from parts of the monzonite body with considerable vertical extent, namely its feeder conduits. Thus, the relationship of magnetic and topographic highs, mentioned above, may, in effect, be an indirect one. That is, the crest of the range may occur along the structurally highest part of the monzonite-latite body, which, in turn, is located directly above a zone of feeders.

Comparison of the magnetic map with the geochemical maps (figs. 2–9) indicates little or no correlation between geochemical and geophysical anomalies. Parts of the zones of copper and lead enrichment cross magnetic peak 702 on Raspberry Ridge, but the trends of both these zones are to the northwest, whereas the magnetic anomaly trends slightly north of east and extends beyond the enriched zones on both sides. It is concluded on the basis of these observations that none of the magnetic anomalies are indicative of rocks with promising economic mineral potential.

GEOCHEMICAL SURVEY

SAMPLING TECHNIQUES

A reconnaissance geochemical survey of the Chiricahua Wilderness showed the kind and distribution of elements that may have economic potential. About 250 samples were analyzed for about 30 elements. Most elements were determined by semiquantitative spectrographic methods, but gold, mercury, silver, arsenic, and antimony were analyzed by both spectrographic and either instrumental or colorimetric methods. A suite of 135 samples was taken of alluvium in and near the wilderness (pl. 1), and a suite of 42 was taken of alluvium farther away, as control samples (pl. 1). The rest of the samples were taken from rocks that appeared to be altered or mineralized. In addition, 12 samples were taken for gold-silver assay, which resulted in the detection of only traces of gold and silver.

Alluvial samples were collected according to consistent sampling procedure except for those few that consist of chips of iron oxide stained detritus, which are described separately. Each sample of alluvium consisted of about a cupful of silt or fine sand taken in several scoops either across the width of a larger drainage or along a 100- to 300-foot segment of a smaller drainage. Each scoop was taken from the youngest alluvium along dry canyon bottoms or from sand bars built alongside streams, from which the uppermost half inch of material was brushed aside to minimize possible eolian contamination. Lentils of exceptionally strongly concentrated black sand, rich in iron minerals and possibly also in other heavy minerals, were avoided. Wherever possible, lentils of organic detritus were also avoided, but in many of the higher basins, some contamination from forest duff could not be avoided; indeed, a few samples were made up largely of such material. The effect of this organic contamination in this environment is not known, but most probably metals would be concentrated by complexing as organic compounds. Preparatory to analysis the samples were sieved, and the minus-80-mesh fractions were mixed and split.

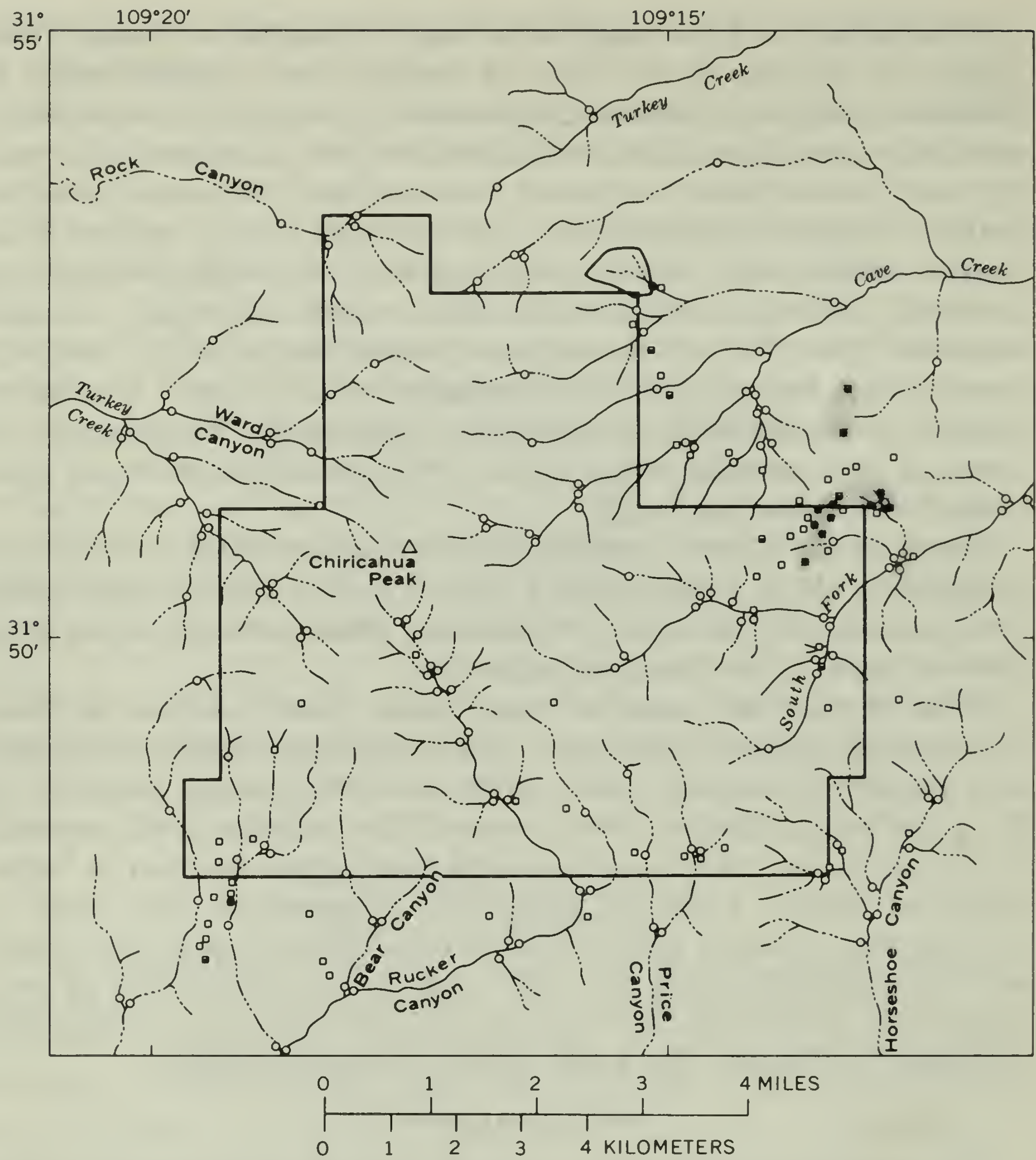
Some of the control samples collected a few miles north of the wilderness along North Fork Pinery Canyon (pl. 1) were taken from silty lentils in terrace deposits to check contamination from mine dumps in the youngest alluvium.

Most of the rock samples were taken from outcrops or from very locally derived colluvium. The few samples taken of cobbles and pebbles of altered rock, from near the sample sites of the finer grained alluvium, were treated like regular rock samples. Each sample typically consisted of 5 to 10 chips selected to represent the various kinds of potentially mineralized rock, such as red- or black-stained rock, silicified or argillized rock, and gossan or vein material found near the sample site. The chips of each sample were divided, and one set of half-chips was composited, crushed, and sieved, the same as the alluvium samples.

ANALYTICAL RESULTS

The analytical results are shown in table 2, and the distribution of the anomalous values of selected metals are shown in figures 2–9. These figures also show the sample localities and the boundaries of small drainage basins, which under ideal circumstances, have contributed to the alluvium sampled at sites at the lower ends of the basins. For cartographic simplicity, the source areas of detritus sampled along the lower reaches of long canyons are shown to extend only to the border of the drainage-basin segment lying upstream, although the actual source areas are the entire basin.

Gold is present in only one sample of alluvium, and it is in very small amounts (0.02–0.1 ppm) in only a few rock samples, mainly in and beyond the northeastern and southern parts of the wilderness (fig. 2). Most of these samples with measurable gold are from quartz veinlets that also contain measurable silver.



EXPLANATION

0-0.02 0.02-0.1 0.1-0.3
Gold content of samples of rock, in parts per million

0-0.02 0.02-0.1
Gold content of samples of alluvium, in parts per million

Drainage area underlain by rocks that may contain weakly anomalous concentration of gold

Area of slight enrichment of gold

FIGURE 2. — Distribution of gold in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are listed in table 2.

Mercury in alluvium samples has a background value that probably is slightly less than 0.2 ppm, and the mercury content in rock samples is probably considerably less than 0.2 ppm. Mercury seems to be concentrated in alluvium. Alluvium containing anomalous amounts of mercury is almost randomly scattered, with a weak concentration of mercury (0.4–0.6 ppm) occurring in alluvium samples from the higher basins and particularly around Chiricahua Peak (fig. 3). Inasmuch as these samples contained the greatest admixture of organic material, the mercury may have become concentrated in the sample areas by complexing with the organic material.

Silver appears in measurable quantities only in a few alluvium samples from northeast of the wilderness and in some rock samples, mainly those of quartz veinlets also from northeast of the wilderness (fig. 4). Silver values range from 0.5 to 70 ppm in the northeastern part of the wilderness, and a few samples from the southern part contain 0.5–24 ppm silver. The samples of the northeastern area that contain slightly anomalous amounts of silver are from a northwest-trending belt that overlaps with the zone of weak enrichment of gold (fig. 2).

Beryllium in alluvium has a background value of about 2 ppm, and in erratically scattered localities it reaches slightly anomalous concentrations of 5–10 ppm (fig. 5). Whereas relatively unaltered rocks contain 1–5 ppm beryllium (table 1), most of the altered ones contain less than 2 ppm, suggesting that alteration leached the beryllium. The slight increase in beryllium in alluvium over that in rocks may also be the result of the retention of beryllium as organic complexes in alluvium that contains some forest duff. The beryllium content of the volcanic rocks suggests that the area may well be part of the Arizona–New Mexico beryllium belt, as proposed by Shawe (1967).

By spectrographic analysis copper content of alluvium has a background value of about 20 to 30 ppm, and no values are greater than 30 ppm except the value for sample 124. Some of the colorimetric analyses, however, show slightly higher values of copper, mostly in two loosely knit northwest-trending zones between Horseshoe Canyon and Ward Canyon (fig. 6). The copper content of altered rocks along the south edge and in the northeast and southwest corners of the wilderness seems to be abnormally low, suggesting that the alteration in these areas has removed copper.

Lead has a background value of about 30 ppm in alluvium and generally less than 20 ppm in fresh and altered rocks. Lead concentration in alluvium is about twice the background concentration in two broad northwest-trending zones (fig. 7) similar to those of copper (fig. 6). Only a few rock samples show a similarly

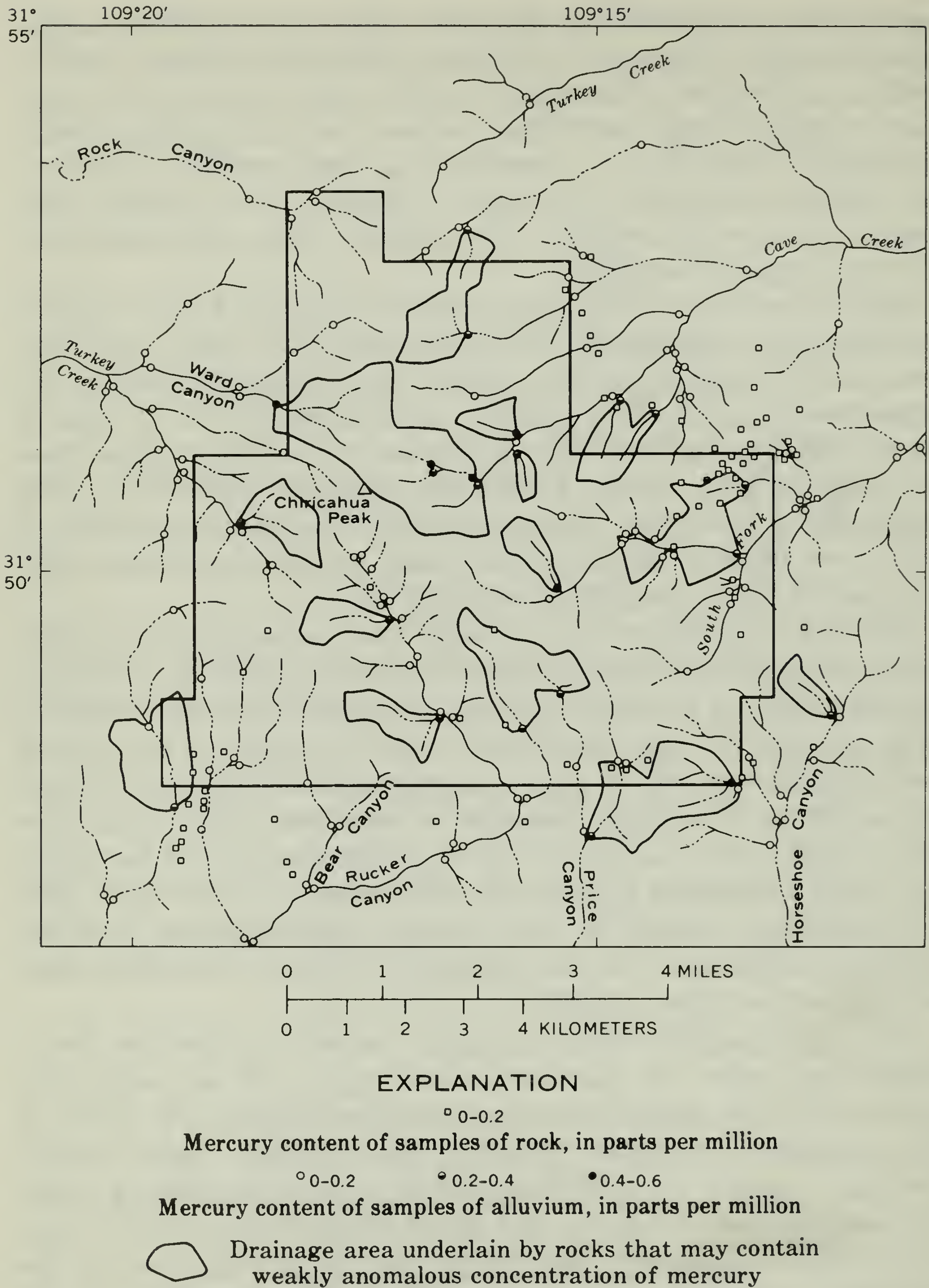
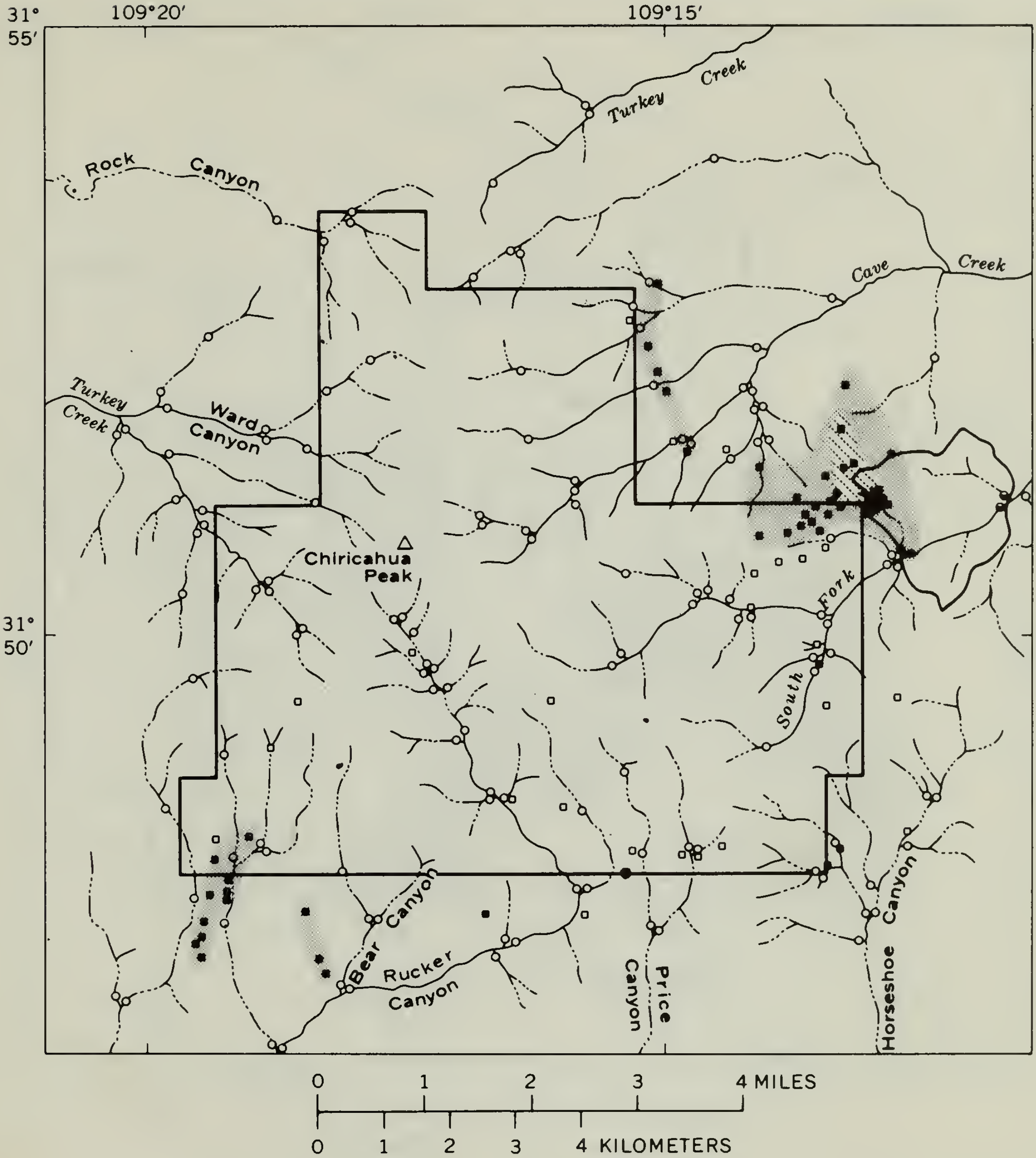


FIGURE 3.—Distribution of mercury in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are listed in table 2.



EXPLANATION

0–0.5 0.5–5 5–70
Silver content of samples of rock, in parts per million

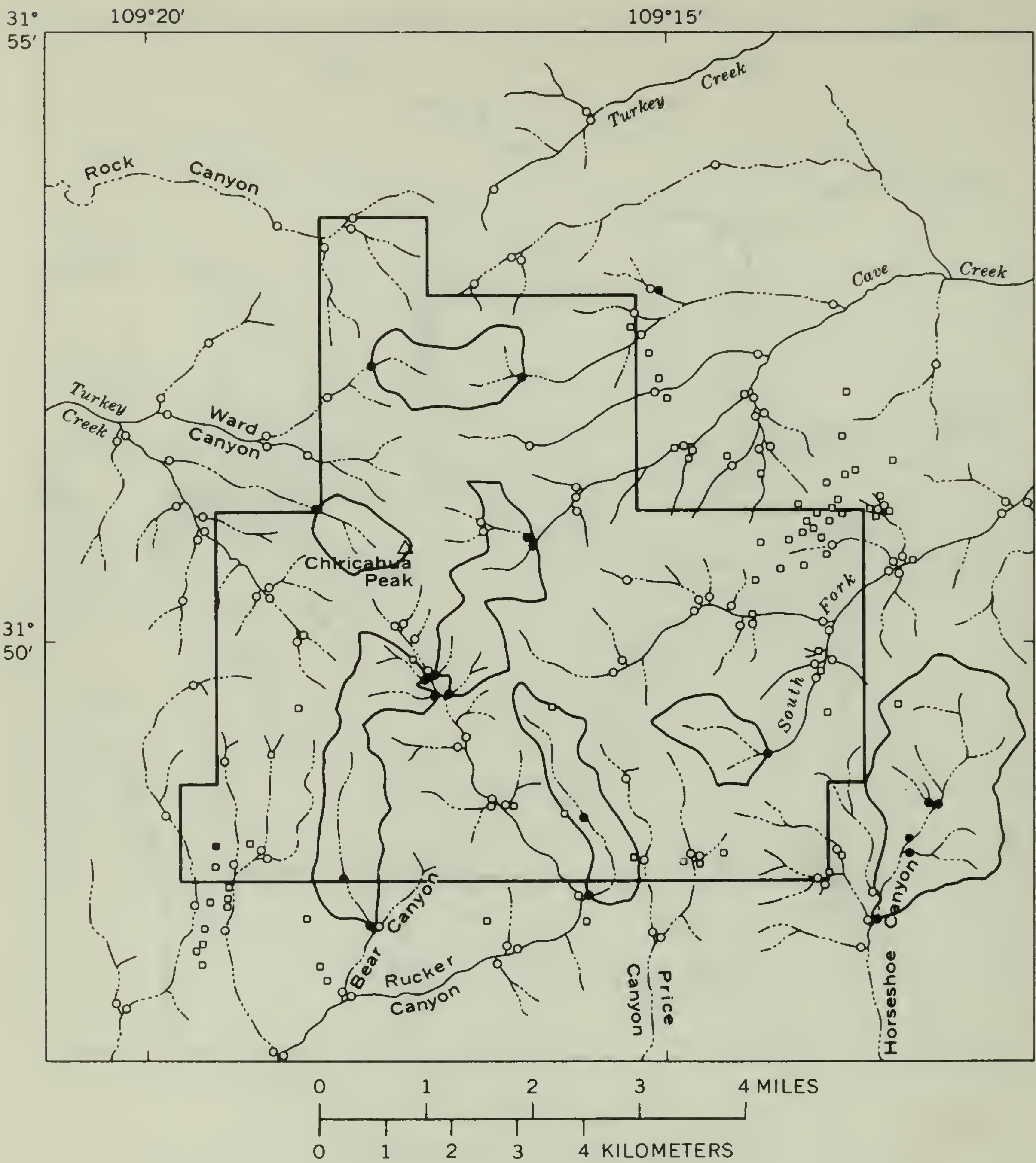
0–0.5 0.5–5
Silver content of samples of alluvium, in parts per million

Drainage area underlain by rocks that may contain weakly anomalous concentration of silver

Area of slight enrichment of silver

Area of moderate enrichment of silver

FIGURE 4. — Distribution of silver in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are listed in table 2.



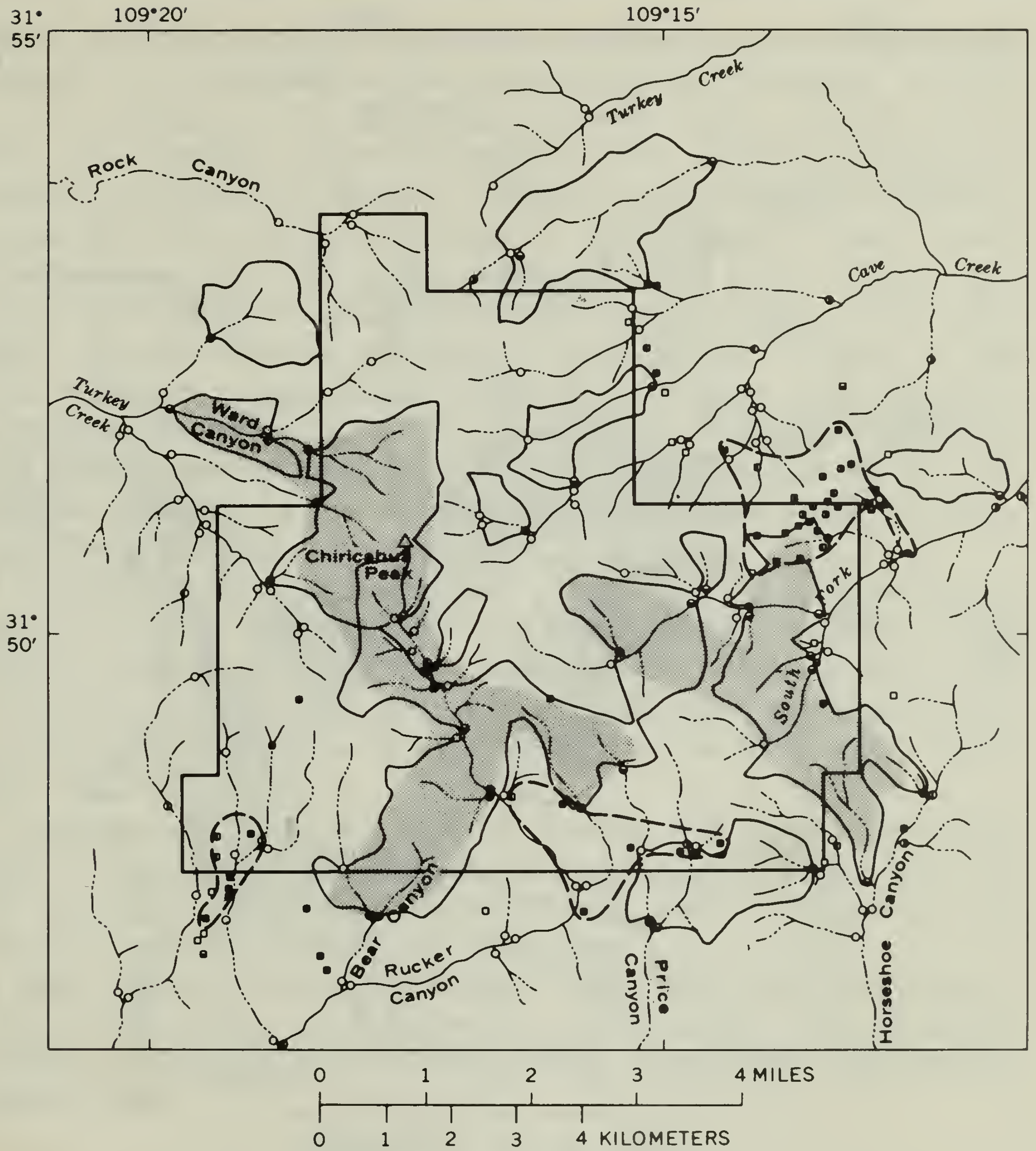
EXPLANATION

▫ 0–5 ▪ 5–10
Beryllium content of samples of rock, in parts per million

○ 0–5 ● 5–10
Beryllium content of samples of alluvium, in parts per million

Drainage area underlain by rocks that may contain weakly anomalous concentration of beryllium

FIGURE 5.—Distribution of beryllium in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are listed in table 2.



EXPLANATION

0–15 15–35 35–50 50–80

Copper content of samples of rock, in parts per million

0–15 15–35 35–50 50–80

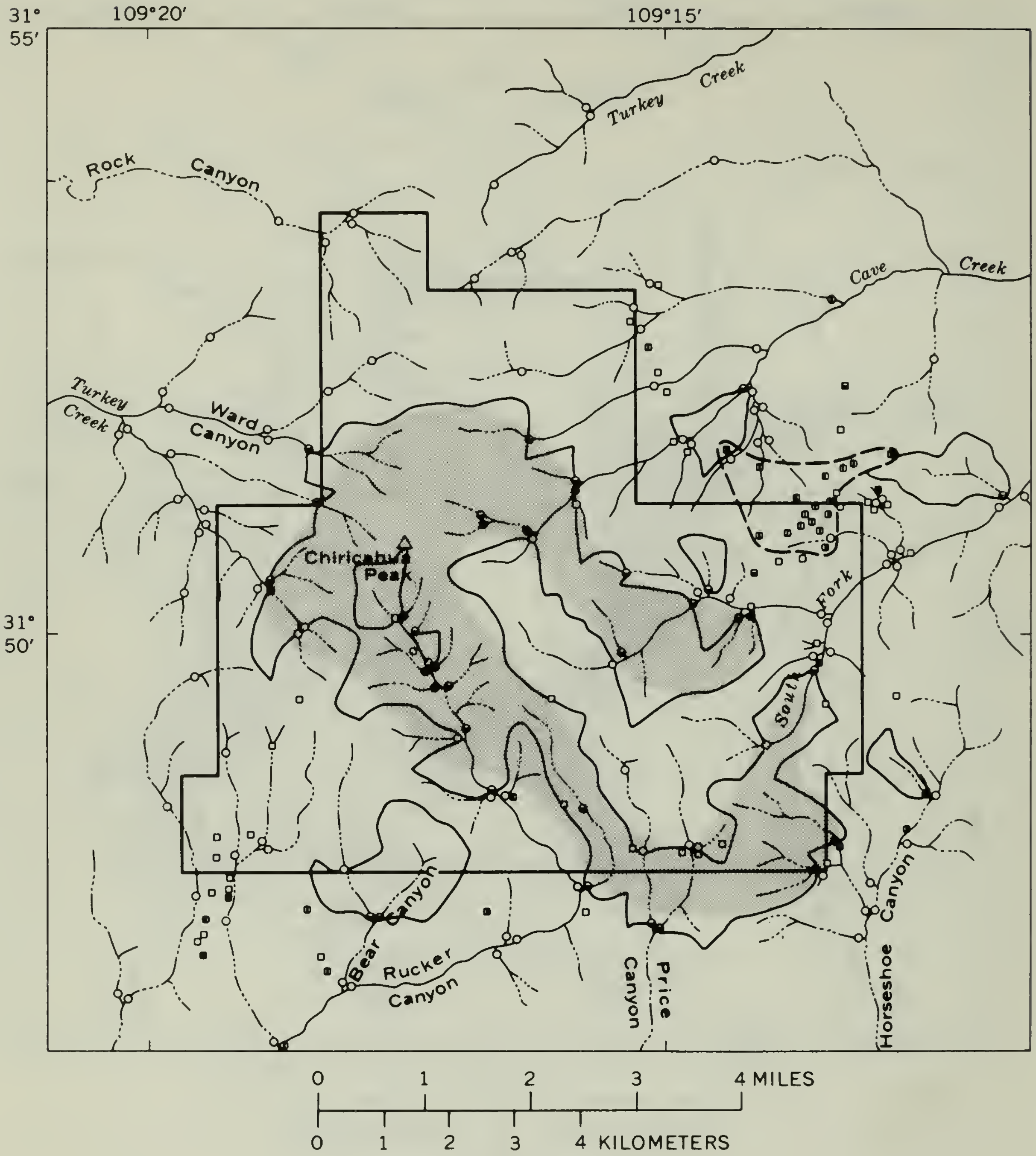
Copper content of samples of alluvium, in parts per million

Drainage area underlain by rocks that may contain weakly anomalous concentration of copper

Area of slight enrichment of copper

Area of below average concentration of copper

FIGURE 6.—Distribution of copper in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are listed in table 2.



EXPLANATION

0–15 15–50 50–80 80–120
Lead content of samples of rock, in parts per million

0–15 15–50 50–80 80–120
Lead content of samples of alluvium, in parts per million

Drainage area underlain by rocks that may contain weakly anomalous concentration of lead

Area of slight enrichment of lead

Area of below average concentration of lead

FIGURE 7.—Distribution of lead in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are listed in table 2.

slight increase in lead, and many samples in the northeastern part of the wilderness contain abnormally low amounts of lead.

Zinc content in alluvium has a broader range (10–160 ppm) than other metals, reflecting perhaps the greater geochemical mobility of zinc or its stronger affinity for complexing as organic compounds. The background value of zinc is about 60 ppm. Areas of anomalous zinc are widely scattered, with only a slight tendency for them to be clustered between Turkey Creek, on the west flank of the mountains, and Cave Creek (fig. 8). In most of the rock samples, zinc content is less than 50 ppm, and the only samples with greater than 50 ppm zinc are those in which gold and silver were detected, from the northeastern part of the wilderness. However, some samples from this area contain abnormally small amounts of zinc.

In only one sample of alluvium (71D59) is the molydenum as much as 5 ppm. In rocks it is 7–70 ppm, with the greater values mainly from the northeastern part of the wilderness. Like gold and silver, molybdenum concentrations are also associated with the quartz veinlets near Bear Canyon, just south of the wilderness (fig. 9).

Tungsten occurs as scheelite in sheared and altered limestone beds in the Paradise-Hilltop mine area (pl. 1). These beds do not occur in the Chiricahua Wilderness, and no tungsten was detected in samples from the wilderness.

Many highly altered or shattered zones, particularly in monzonite-latite complex, were tested for radioactivity with a Geiger counter. None of these zones showed more than background radioactivity.

ECONOMIC APPRAISAL

The results of this investigation of the Chiricahua Wilderness indicate that the area is largely barren of mineralization. The presence of veins, ore minerals, and geochemical anomalies are far fewer and weaker in the wilderness than they are in nearby mining camps, which themselves have been only small producers, marginal prospects, or money losers. Therefore, it is highly unlikely that the Chiricahua Wilderness contains deposits of minerals of current economic interest. Favorable host rocks for mineral deposits may be present locally beneath many hundreds of feet to several thousand feet of unmineralized volcanic and sedimentary rocks. But, even if the favorable hosts are present, the chance of finding ore bodies in them is remote by present techniques, and if any are found, mining these ore bodies would probably be uneconomical.

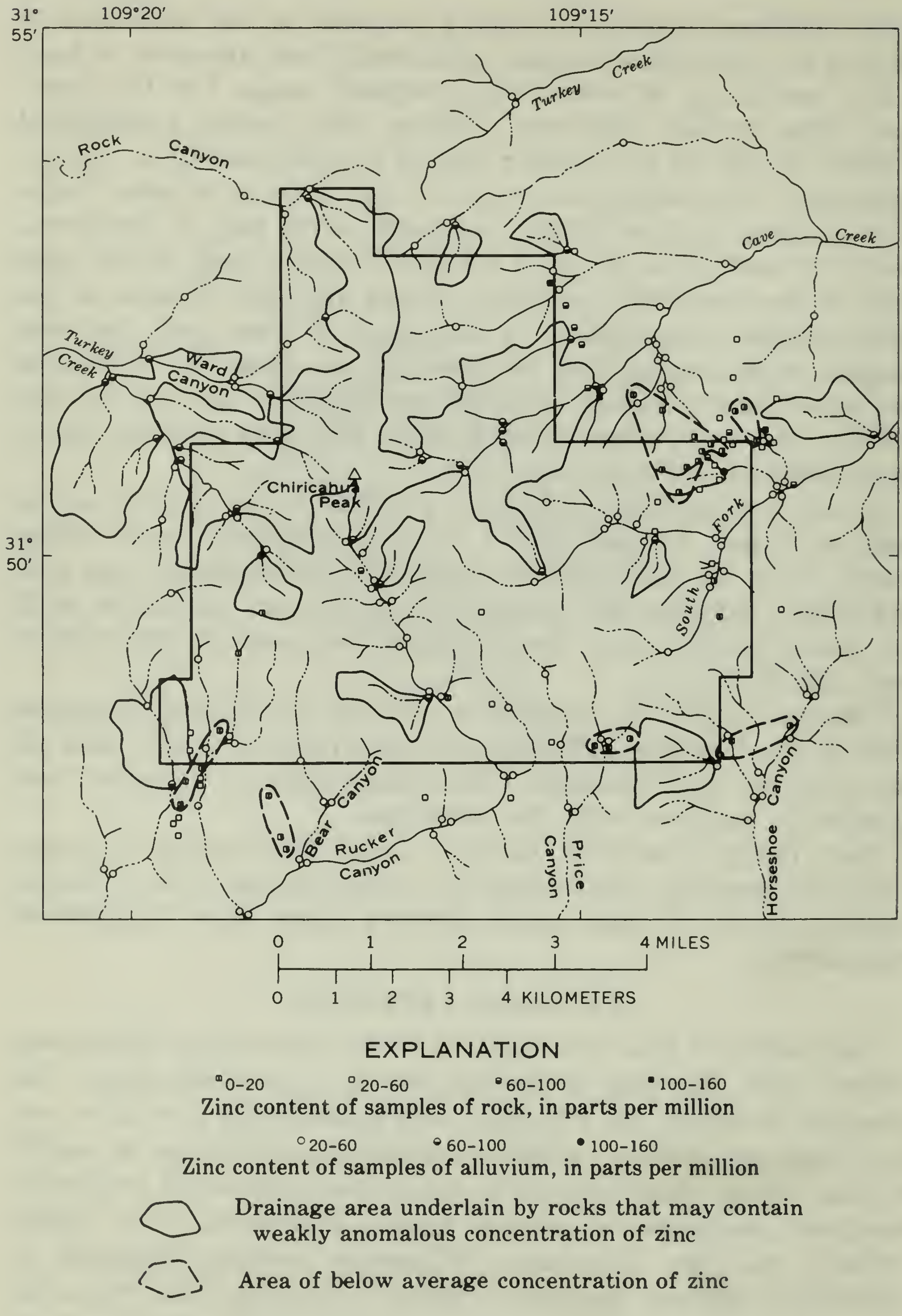
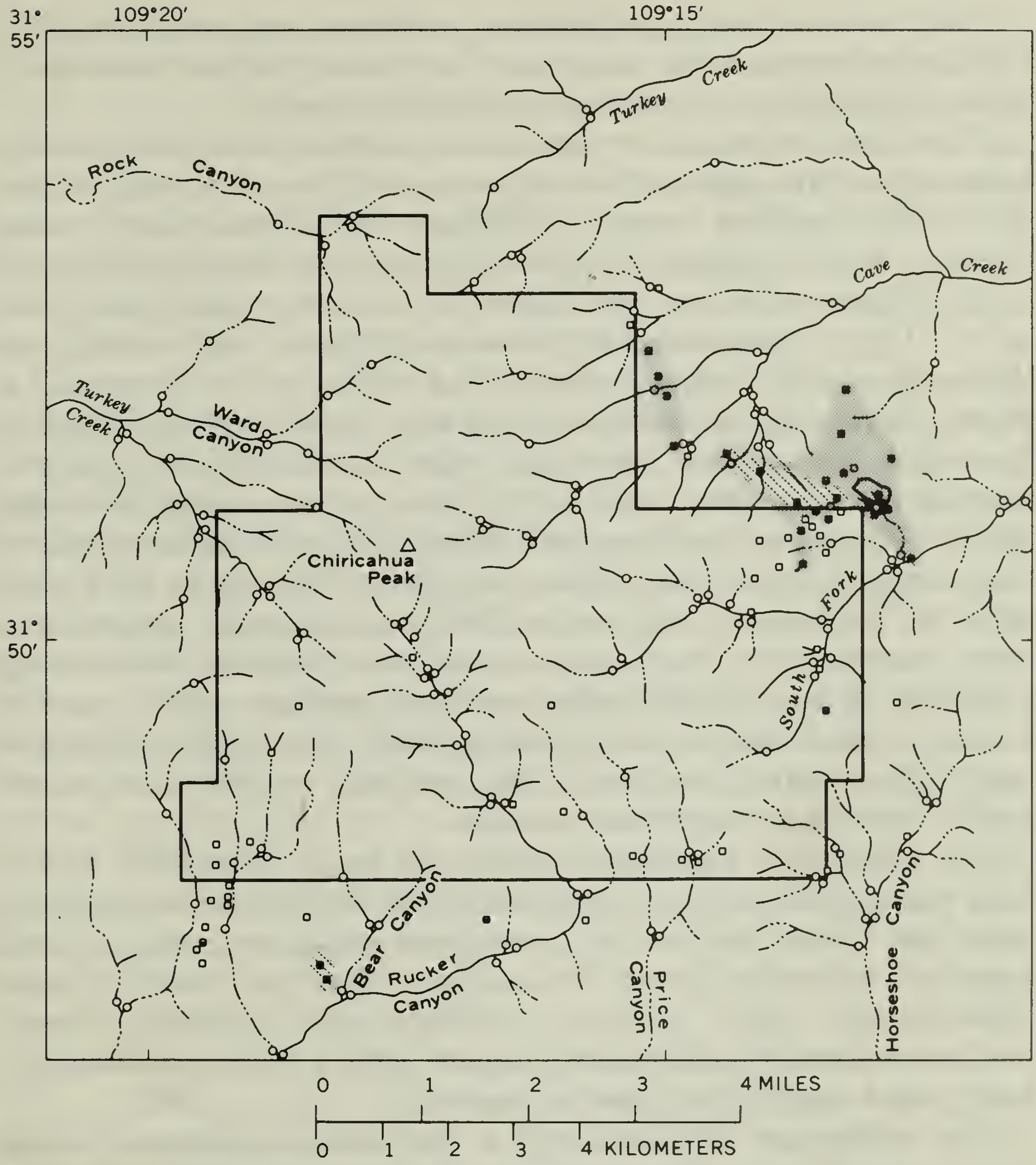


FIGURE 8.—Distribution of zinc in the Chiricahua Wilderness. Sample numbers are shown on plate 1, and analytical values are shown in table 2.



EXPLANATION

0–5 5–20 20–70
Molybdenum content of samples of rock, in parts per million

0–5 5–20
Molybdenum content of samples of alluvium, in parts per million

Drainage area underlain by rocks that may contain weakly anomalous concentration of molybdenum

Area of slight enrichment of molybdenum

Area of moderate enrichment of molybdenum

FIGURE 9.—Distribution of molybdenum in the Chiricahua Wilderness. Sample bers are shown on plate 1, and analytical values are shown in table 2.

Field observations, geochemical analyses, and geophysical investigation support the judgment that the wilderness contains no mineral deposits in a near-surface environment.

Field observations show that at the surface the wilderness contains almost no rocks of the types most likely to be mineralized. In nearby mining camps, Paleozoic limestones and, rarely, strongly metamorphosed Cretaceous rocks are the most favorable hosts. These rocks are most likely to be mineralized near Laramide (Upper Cretaceous to Paleocene) stocks and, rarely, near Jurassic or mid-Tertiary stocks. The wilderness is underlain almost entirely by mid-Tertiary volcanic rocks that are intruded by only a few shallow intrusives, also of mid-Tertiary age. Furthermore, the quartz veins in the area are too small, too widely scattered, and too weakly mineralized to be of economic interest. The slightly larger veins observed during this study all lie outside the wilderness and are of little consequence, inasmuch as they contain only small amounts of ore minerals. Nonmetallic products of commercial value, such as pumice, perlite, and intensely altered volcanic ash, have not been seen in the wilderness, and if they were to be found, they probably would not be of economic interest in so remote an area.

The wilderness similarly contains no major structural feature that would seem to be a potential host or conduit for mineralizing solutions. Faults are few and are simple structures without broad zones of brecciated rock. The caldera that has been proposed (Marjaniemi, 1969), although of conceivable economic interest, needs considerable additional support before it can be used as a basis for a search for mineral deposits.

The wilderness contains only a few weak geochemical anomalies; most of the area contains no signs of abnormal concentration of metals. The strongest geochemical anomaly lies mainly northeast of the wilderness. Selected mineralized rocks from this belt contain concentrations of as much as 70 ppm silver, 0.04 ppm gold, 70 ppm molybdenum, and 140 ppm zinc. This zone and other still more weakly mineralized zones of copper and lead trend northwest without apparent relation to the distribution of rocks or to structural features at the surface. However, the northwest trend does parallel the regional structural grain in older rocks, suggesting that the rocks or structural features beneath the cover of mid-Tertiary volcanic rocks may have had an influence on the very weak mineralization of the volcanics themselves. Indeed, the rocks beneath the volcanic cover may be more strongly mineralized than the covering rocks.

An evaluation of the economic potential of the rocks beneath the mid-Tertiary volcanics, while necessarily speculative, can be made by considering the geology of the older, more mineralized rocks nearby and by estimating the thickness of the volcanic cover. The rocks north of the wilderness are older and more mineralized, and a brief description of the mineral deposits and resulting geochemical anomalies at El Tigre and Hilltop mines and in the Paradise-Galeyville area will show what kind of deposits could underlie the volcanic cover within the wilderness and what kind of geochemical anomalies might be associated with them.

El Tigre mine (pl. 1) is a prospect on a vein in the upper part of the Bisbee Formation and in the volcanic conglomerate of the overlying dacitic rocks. These rocks are overlain by the monzonite-latite and are intruded by small rhyolite dikes and irregular bodies of andesite or diorite. The exposed part of the vein is 3–15 feet wide, and it strikes northwestward and dips about vertically. Although quartz is the dominant mineral in the vein, the vein also contains some calcite, traces of iron and manganese oxides and of cerussite(?), and cavities from what may have been barite and sphalerite. The gold content of the vein was not checked directly, but possibly gold does occur, judged on the basis of the sporadic occurrence of gold in similar veinlets northeast of the wilderness area and from Waldemar Lindgren's report (written commun., 1897) of sparse and extremely light and flaky gold in panned concentrates from an unlocated site in the upper part of Pinery Canyon. A reported 12 tons of ore was shipped from the El Tigre mine in 1945.

The Hilltop mine (pl. 1) is described by the Arizona Bureau of Mines (1969, p. 189) as a "lead-silver, lead-copper-silver, and lead-zinc replacement deposit." Ore occurs as "irregular masses associated with monzonitic to dioritic dikes that are intrusive into Paleozoic limestone. Locally pipes or chimneys of massive sulfides, 1 to 6 feet in diameter, follow fractures into limestone wall rock for distances of 50 feet from the dikes." Best estimates from conflicting sources suggest that during the years 1911–18, 1924–27, and 1938–54 about 5,000–10,000 short tons of ore was shipped from the Hilltop mine.

The geochemical anomalies in the alluvium along both forks of Pinery Canyon are shown by the analyses in table 2 and by sample-distribution maps for lead (fig. 10) and zinc (fig. 11). The abundance of silver, lead, and zinc in the alluvium near El Tigre mine is scarcely greater than that downstream from the minor anomalies near the northeast corner of the wilderness. However, the concentration of these metals, and especially of lead, is greater in the youngest alluvium and in the adjacent terrace deposits

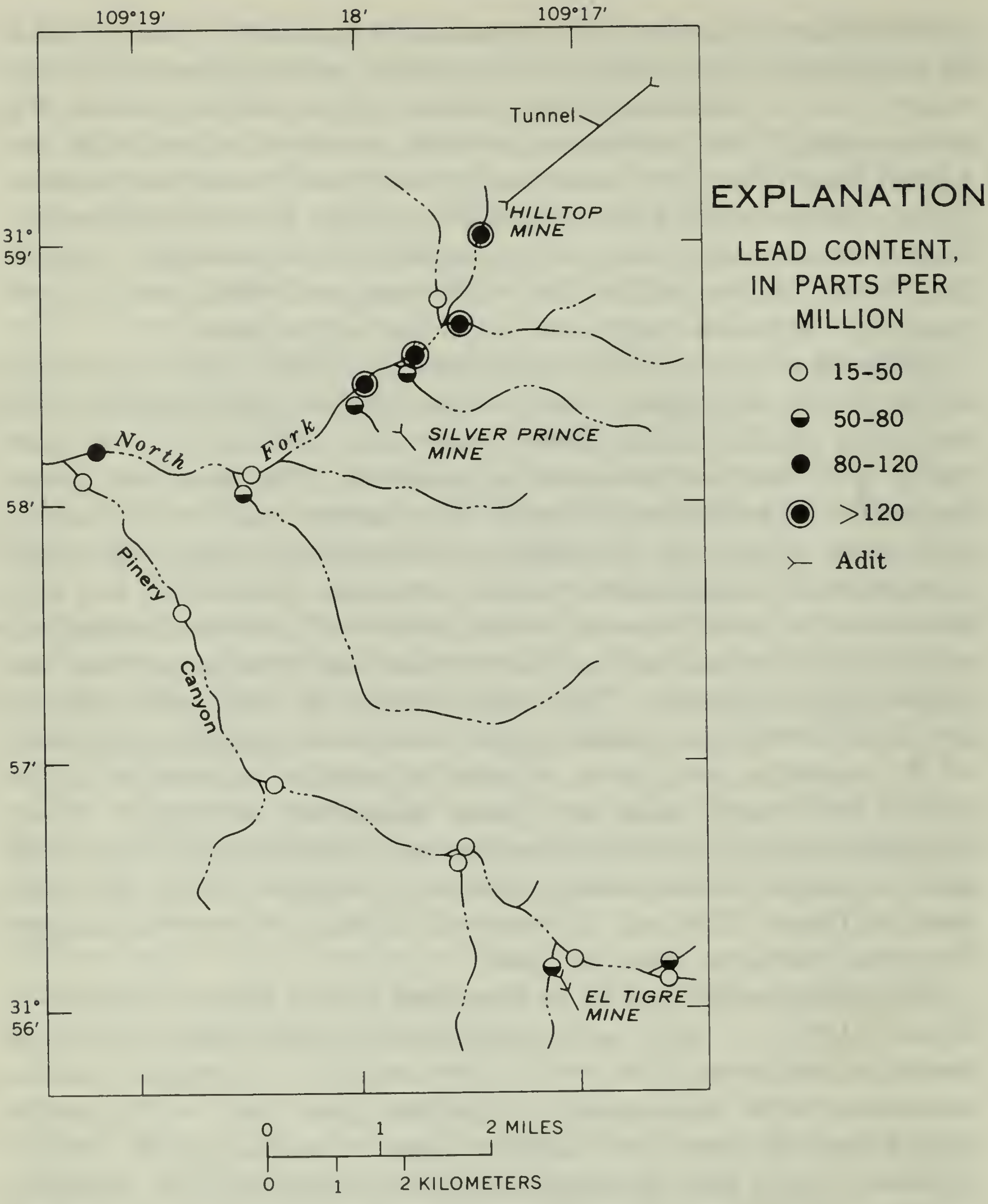


FIGURE 10.—Distribution of lead in the Pinery Canyon area, Chiricahua Mountains, Ariz. Sample numbers are shown on plate 1, and analytical values are listed in table 2. Lead content shown along the North Fork is for samples of terrace deposits. Nearby youngest alluvium generally contains more lead.

below the Hilltop mine than it is anywhere in the wilderness. Silver, gold, and mercury are also anomalous in alluvium near the mine.

The mineralization in the Paradise-Galeyville area occurs as small replacement deposits of lead, zinc, silver, and minor tungsten (Dale and others, 1958) in metamorphosed Paleozoic lime-

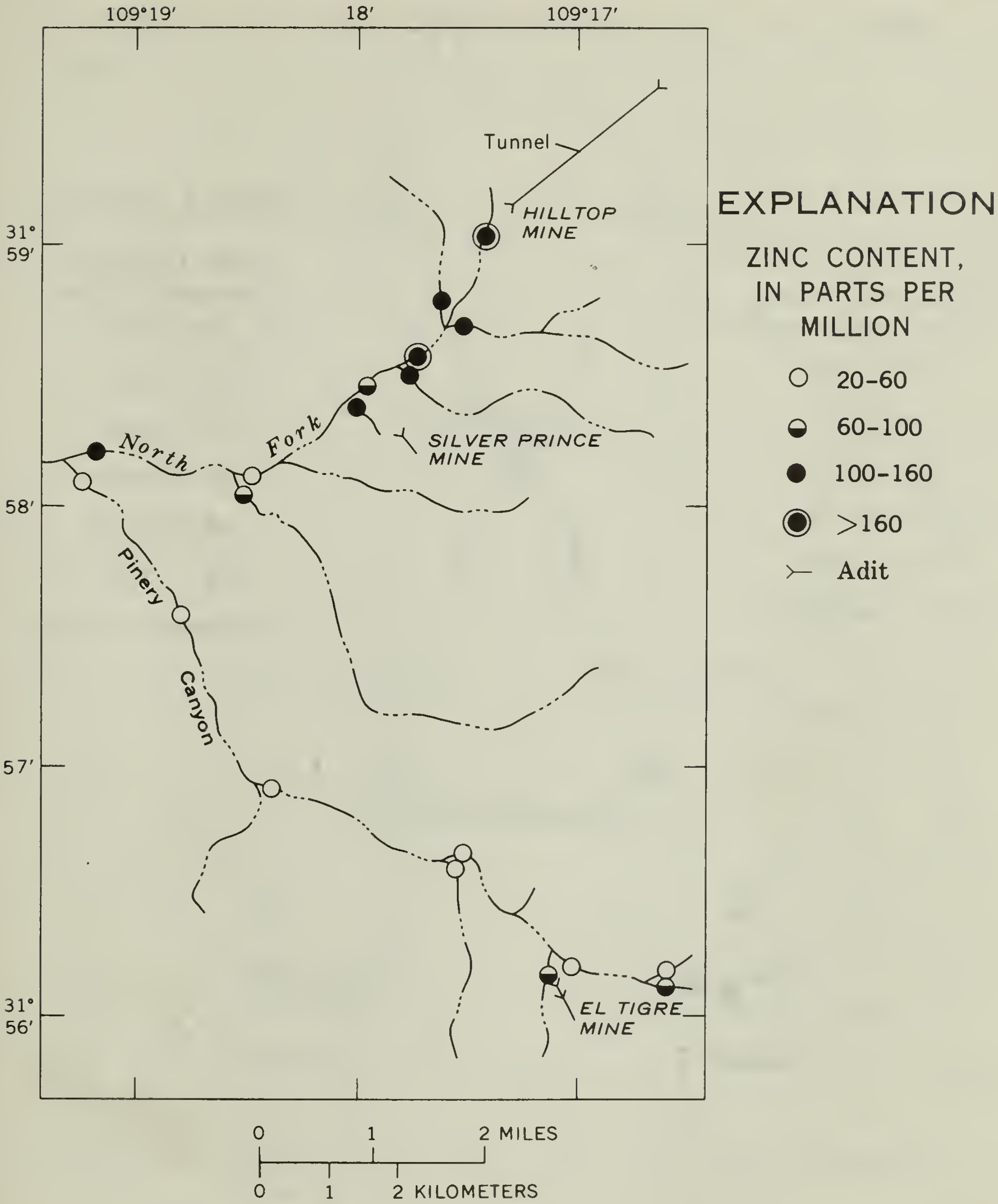


FIGURE 11. — Distribution of zinc in the Pinery Canyon area, Chiricahua Mountains, Ariz. Sample numbers are shown on plate 1, and analytical values are listed in table 2. Zinc content shown along the North Fork is for samples of terrace deposits. Nearby youngest alluvium generally contains more zinc.

stone (pl. 1). The limestone is intruded by aplitic dikes, which probably are related to the stock at Jhus Canyon, of mid-Tertiary age, and by darker colored dikes. Very probably, the exploration and development costs were not recovered by the value of the metals produced in the district. The geochemical values in alluvium, especially of lead (fig. 12), zinc (fig. 13), silver, and mer-

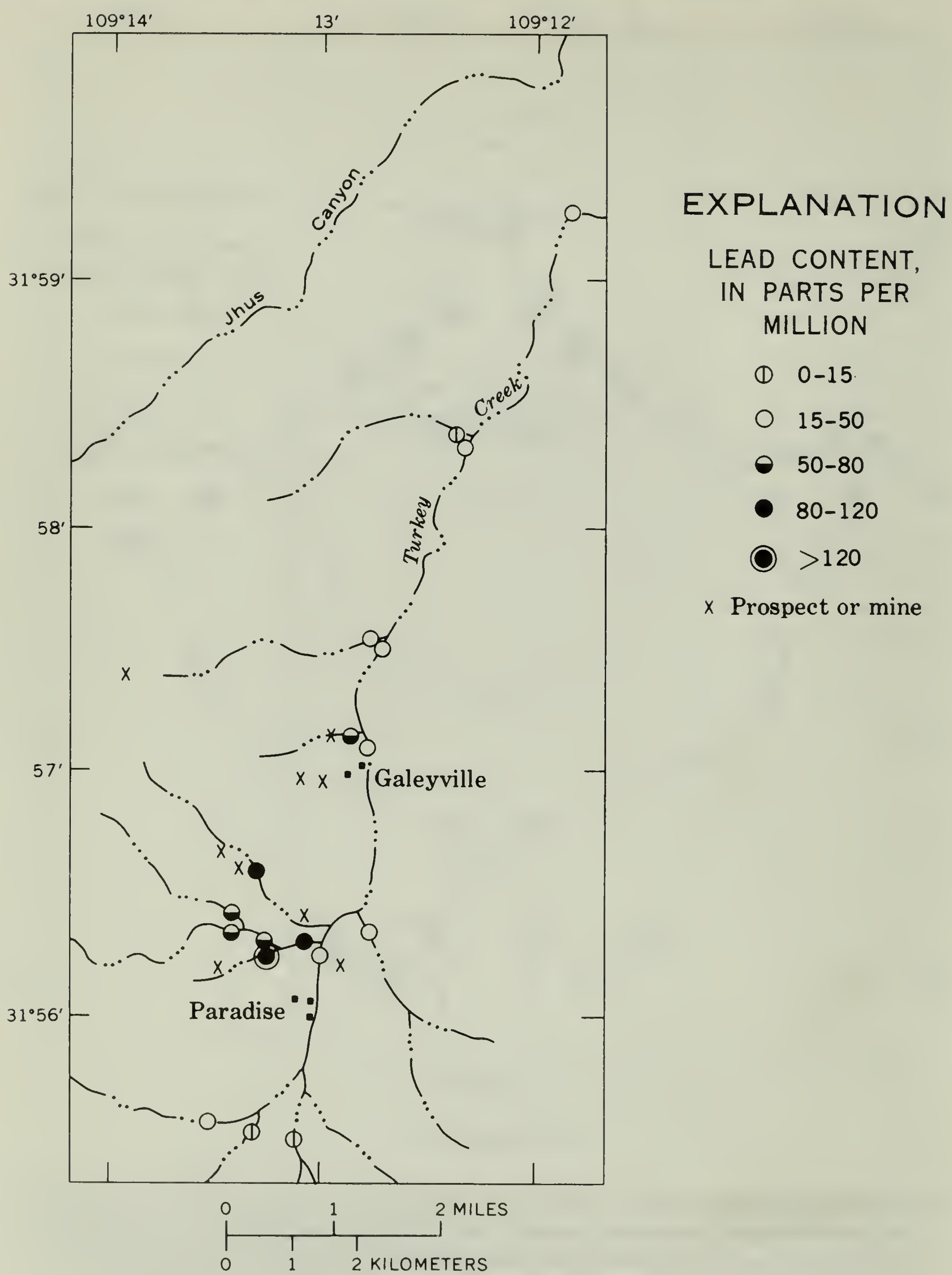


FIGURE 12. — Distribution of lead in the Paradise-Galeyville area, Chiricahua Mountains, Ariz. Sample numbers are shown on plate 1, and analytical values are listed in table 2.

cury, are somewhat larger than those found in the Chiricahua Wilderness. Because the dumps in this district are so small, they probably had only a minor influence on the values of metals in the alluvium downstream.

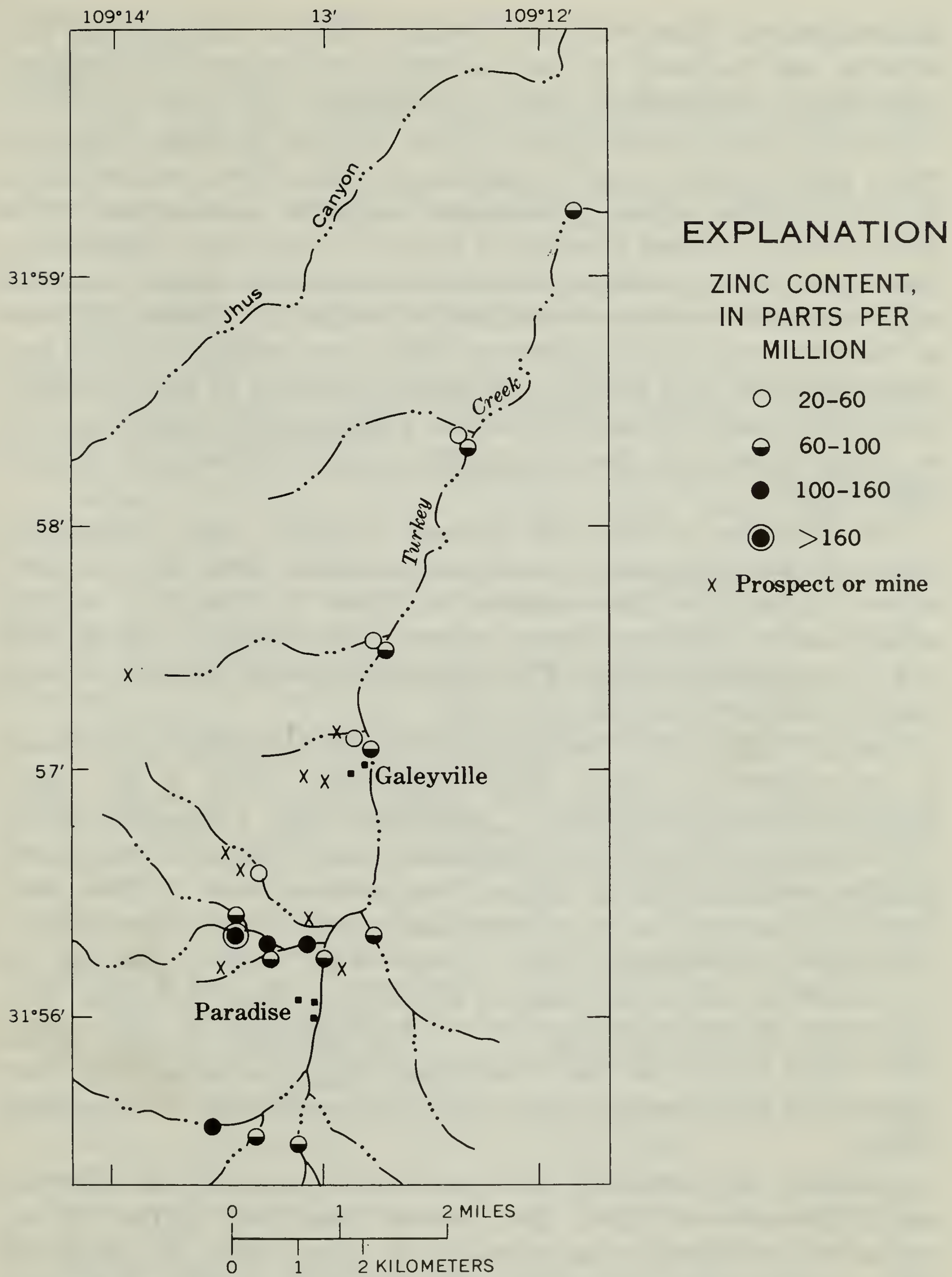


FIGURE 13. — Distribution of zinc in the Paradise-Galeyville area, Chiricahua Mountains, Ariz. Sample numbers are shown on plate 1, and analytical values are listed in table 2.

In the absence of direct information about the buried basement rocks of the wilderness and their mineralization, it is necessary to postulate that these rocks and their mineralization are generally similar to correlative rocks of nearby areas and to their mineralization. Thus, the mid-Tertiary volcanic rocks of the wilderness are believed to be underlain by northwest-trending, sporadically mineralized belts of Paleozoic rock and by barren Cretaceous rock. Small quartz veins in some of these basement rocks might contain small amounts of gold, silver, molybdenum, and some other metals. Replacement deposits in basement rocks might contain modest amounts of lead, zinc, and silver. The northwest trend of the weak geochemical anomalies of copper and lead might reflect a northwest-trending, sporadically mineralized zone in Paleozoic rock in the basement. This is exceedingly tenuous evidence, however, and finding the precise locations of such mineralized rocks would, at best, be difficult. The economic success of such an undertaking may depend largely on the thickness of the volcanic cover.

The thickness of the mid-Tertiary volcanic rocks underlying much of the wilderness is scarcely less than 1,000 feet, as projected in the structure sections on plate 1. Should a caldera underlie much of this volcanic terrane, the collapse of the caldera and the subsequent filling of the depression would suggest an even greater thickness of volcanic rocks.

Coal, oil, and other leasable minerals are not likely to be found in the wilderness. Pierce, Keith, and Wilt (1970, p. 38) mentioned that coaly material is associated with Cretaceous shale (presumably of the Bisbee Formation) near Cochise Head, about 5 miles north of Hilltop Camp. They quoted Blake (1898), who described the rock as a "glassy black graphitic anthracite over twelve feet in thickness," but "it cannot be claimed that any of this material has much value as a fuel. It is hard to ignite. The percentage of ash is large * * *." Furthermore, no such rocks were found in or near the wilderness. Thus, the probability that commercial coal-bearing rocks exist in the wilderness is extremely remote.

Likewise, the possibility that petroleum occurs in the Chiricahua Wilderness is slight. The nearest deep hole drilled in exploration, the Portal 1, is in sec. 9, T. 16 S., R. 31 E., about 12 miles northeast of the wilderness. The hole, drilled to a total depth of 5,353 feet in 1953, bottomed in Tertiary volcanics (Pierce and others, 1970, p. 193).

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TABLE 2. — *Geochemical analyses of alluvium, altered rocks, and veinlets*

[For sample locality, see plate 1. Instrumental and colorimetric analyses were made by: J. G. Frisken, R. L. Miller, J. D. Hoffman, J. H. Reynolds, J. R. Hassemer, R. W. Leinz, R. M. O'Leary, D. G. Murrey, L. A. Vinnola, and A. L. Meier. Semiquantitative spectrographic analyses were made by: K. J. Curry, C. L. Forn, D. F. Siems, R. T. Hopkins, Jr., G. W. Day, and R. N. Babcock. Letter symbols: L, detected but below limit of determination; N, not detected; G, greater than; H, interference; ...., not looked for. Number below ele-

	Instrumental and colormetric analyses (ppm)								Semiquantitative spectrographic analyses (ppm)				
Sample	Au (.02)	Hg (.005)	Cu (5)	Pb (10)	Zn (5)	Ag (.2)	As (10)	Sb (.5)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)
					Alluvium, Chiricahua Wilderness								
1	N	0.09	20	20	H	---	N	2	N	30	300	L	5
2	(N)	.11	20	30	50	---	N	2	N	20	300	2	7
3	N	.20	20	30	55	---	N	2	N	15	700	1.5	7
5	(N)	.16	25	45	70	---	N	2	N	L	500	2	5
8	(N)	.15	40	40	60	---	N	2	N	10	700	1.5	10
12	N	.15	15	40	45	---	N	2	N	L	300	2	5
14	N	.50	50	50	85	---	N	2	N	15	300	1.5	L
15	N	.16	30	45	65	---	N	2	N	10	500	3	5
16	N	.30	30	40	95	---	N	3	N	10	700	1.5	7
17	N	.26	20	45	50	---	N	2	N	10	300	7	L
18	(N)	.70	60	90	70	---	N	2	N	10	150	7	N
19	N	.30	20	50	80	---	N	2	N	15	300	3	N
20	N	.40	25	50	55	---	N	2	N	15	300	3	5
22	N	.07	20	35	45	---	N	2	N	20	500	2	7
24	N	.40	50	60	70	---	N	1	N	10	300	2	7
25	(N)	.16	20	35	40	---	N	2	N	10	300	3	10
30	N	.09	25	35	40	---	N	1	N	10	150	2	L
31	N	.13	40	65	60	---	N	2	N	15	200	2	L
32	N	.05	20	35	35	---	N	2	N	15	200	3	N
34	N	.15	5	20	20	---	N	1	N	15	150	3	N
35	N	.14	50	75	65	---	N	2	N	10	150	7	L
36	N	.09	45	45	50	---	N	2	N	15	150	5	L
37	(N)	.20	35	50	45	---	N	2	N	15	150	5	L
38	N	.18	25	40	40	---	N	2	N	15	300	5	L
39	N	.10	35	45	45	---	N	1	N	15	300	3	L
40	N	.08	25	30	30	---	N	1	L	10	200	3	N
46	N	.09	20	30	100	---	N	2	N	15	300	3	L
47	(N)	.09	20	25	50	---	N	2	N	15	200	3	L
48	N	.07	20	30	40	---	N	2	N	10	150	3	L
51	N	.10	15	20	55	---	N	2	N	10	500	2	7
52	N	.60	50	70	80	---	N	1	N	15	150	3	L
52a	N	.18	50	50	85	---	N	2	N	15	150	5	N
54	N	.20	15	45	45	---	N	2	N	15	150	5	L
61	N	.14	20	30	30	---	N	2	N	15	150	5	L
62	N	.08	35	55	50	---	N	2	L	15	150	5	N
63	N	.13	35	35	40	---	N	2	N	10	300	3	10
64	N	.05	10	20	30	---	N	1	L	10	150	3	L
65	(N)	.05	15	20	30	---	N	2	N	10	150	2	N
67	N	.20	35	40	70	---	N	1	L	15	300	3	5
68	(N)	.14	50	45	55	---	N	2	N	15	300	3	5
69	(N)	.05	15	30	25	---	N	1	N	10	150	3	L
73	N	.20	35	55	45	---	N	2	N	15	150	5	N
76	N	.12	30	40	55	---	N	2	N	15	150	5	5
77	N	.08	10	45	40	---	N	2	N	15	150	3	5
79	N	.16	60	60	55	---	N	2	L	15	150	3	L
80	N	.24	40	50	50	---	N	2	N	15	150	3	N
81	N	.05	15	25	20	---	N	1	N	10	100	3	N
83	N	.07	20	30	25	---	N	1	N	15	150	2	L
87	N	.20	35	35	45	---	N	1	N	15	150	3	N
88	N	.09	20	35	35	---	N	1	N	10	150	3	5
89	N	.18	20	40	30	---	N	1	N	10	100	3	L
91	N	.13	15	20	30	---	N	1	N	15	150	3	N
92	N	.11	25	30	35	---	N	1	N	15	150	3	N
95	N	.11	20	40	25	---	N	1	N	10	100	3	N
99	N	.20	25	35	60	---	N	1	N	15	200	3	5

from the Chiricahua Wilderness and nearby areas, Cochise County, Arizona

ment symbol is usual lower limit of determination. The lower limit of determination of some gold analyses, shown by (N), ranges from 0.04 to 0.10. Elements looked for spectrographically but not found and their lower limits of determination: As(200), Bi(10), Cd(20), Sb(100), Sn(10), and W(50). Hg determinations on most samples of alluvium are too high as a result of interference caused by organic matter]

Semiquantitative spectrographic analyses--Continued

Sample	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)
							(ppm)							
					Alluvium, Chiricahua Wilderness--Continued									
1	50	30	L	N	10	7	15	10	N	300	70	20	N	150
2	20	30	50	L	15	7	50	7	N	100	70	30	N	300
3	20	30	70	L	10	10	30	7	N	100	70	30	N	300
5	15	30	50	L	10	7	30	7	N	100	50	50	N	300
8	30	30	70	L	10	15	30	7	N	100	150	30	N	300
12	20	30	70	L	15	7	50	10	N	L	70	70	N	500
14	20	30	30	N	10	5	30	7	N	100	30	30	N	150
15	20	30	70	L	15	7	50	5	N	100	50	70	N	500
16	30	30	30	L	10	7	20	7	N	L	50	20	N	300
17	15	15	150	L	30	7	30	7	N	L	15	100	N	300
18	15	30	150	N	15	L	30	7	N	100	15	70	N	500
19	15	15	70	L	20	5	30	5	N	100	15	70	N	300
20	20	30	100	L	20	7	30	7	N	L	30	70	N	300
22	30	30	70	L	30	10	50	10	N	150	50	50	N	300
24	20	30	70	L	20	7	30	7	N	100	50	70	N	300
25	30	30	150	L	20	15	30	15	N	100	100	150	N	300
30	15	30	70	L	30	7	30	7	N	L	15	50	N	300
31	20	30	100	L	20	7	70	7	N	100	15	50	N	300
32	15	20	100	L	20	7	50	7	N	100	15	70	N	300
34	10	15	70	N	30	L	30	5	N	L	15	50	N	300
35	10	30	100	N	30	L	70	7	N	100	15	70	N	200
36	15	30	150	L	30	7	50	7	N	100	15	70	N	300
37	15	30	150	L	30	7	30	7	N	100	20	70	N	700
38	15	30	150	L	30	7	50	7	L	100	20	70	N	150
39	10	30	70	L	20	7	50	7	L	100	20	70	N	300
40	10	20	100	N	20	7	30	5	L	L	15	100	N	200
46	10	15	70	L	20	7	30	7	N	100	30	70	L	300
47	10	20	150	L	30	7	30	5	L	L	20	70	N	300
48	15	30	100	L	30	5	50	5	L	100	15	50	N	700
51	20	30	70	L	20	10	30	7	N	100	70	70	N	300
52	10	30	70	L	20	5	50	5	N	L	30	70	N	500
52a	10	30	70	N	15	L	30	L	N	100	15	70	N	300
54	10	10	150	N	15	7	30	5	N	L	20	100	N	150
61	10	15	50	L	30	7	30	L	L	100	15	70	N	150
62	15	30	30	N	30	7	70	L	N	100	15	50	L	200
63	30	30	150	L	30	15	50	15	L	100	70	G200	N	300
64	10	30	50	L	30	5	30	L	N	L	15	50	N	500
65	10	20	70	L	30	5	30	5	L	L	50	50	N	300
67	15	30	150	L	30	7	30	7	N	100	50	G200	N	300
68	10	30	100	L	30	7	50	7	N	100	50	70	N	300
69	10	20	70	L	30	7	30	5	L	L	20	70	N	200
73	10	30	200	L	30	5	70	5	L	100	15	200	N	200
76	15	30	100	L	30	7	50	7	L	100	30	100	N	300
77	15	15	100	L	30	7	30	7	N	100	50	70	N	300
79	20	30	100	L	20	7	50	5	L	100	30	70	N	150
80	15	30	70	L	20	5	30	L	L	100	15	50	N	200
81	10	10	70	L	20	5	30	L	L	100	10	30	N	150
83	10	10	50	L	30	5	30	L	L	L	15	70	N	200
87	15	20	100	L	20	7	30	5	L	100	15	70	N	300
88	15	20	100	L	30	7	30	5	L	100	30	70	N	300
89	10	10	70	L	20	5	30	5	L	L	L	50	N	150
91	10	15	50	N	30	5	30	L	L	L	L	50	N	300
92	15	15	70	L	30	5	30	5	10	L	10	70	N	200
95	10	30	50	L	30	L	30	L	N	L	L	50	N	200
99	10	20	70	L	20	7	30	5	N	100	20	50	N	500

TABLE 2. — *Geochemical analyses of alluvium, altered rocks, and veinlets from*

Sample	Instrumental and colormetric analyses (ppm)								Semiquantitative spectrographic analyses (ppm)				
	Au (.02)	Hg (.005)	Cu (5)	Pb (10)	Zn (5)	Ag (.2)	As (10)	Sb (.5)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)
						Alluvium, Ciricahua Wilderness--Continued							
106	N	0.08	25	25	35	---	N	1	N	L	150	2	L
107	N	.07	20	30	30	---	N	1	N	10	150	3	L
108	N	.07	20	30	35	---	N	1	N	10	150	1.5	5
109	N	.06	20	25	40	---	N	.5	N	10	150	3	L
110	N	.06	10	20	35	---	N	.5	N	10	150	2	5
113	N	.09	20	30	40	---	N	.5	N	15	150	3	L
115	N	.11	25	40	40	---	N	.5	N	20	150	3	7
116	N	.13	30	40	60	---	N	1	N	15	200	3	7
117	N	.09	25	40	80	---	N	.5	N	15	150	3	10
118	N	.09	15	20	60	---	L	.5	N	10	300	1.5	10
120	N	.07	20	25	45	---	N	.5	N	15	300	1.5	5
121	(N)	.04	20	30	65	---	N	1	N	10	300	1.5	15
122	N	.05	20	30	60	---	N	.5	N	10	300	1.5	15
123	N	.05	20	25	50	---	N	L	N	L	300	1.5	15
124	N	.05	35	30	50	---	L	1	N	L	700	1.5	7
125	N	.09	25	25	50	---	N	.5	N	L	700	1.5	5
127	N	.08	30	45	60	---	N	.5	N	10	500	2	5
128	N	.07	15	25	55	---	N	.5	N	10	500	1.5	5
129	N	.09	20	20	45	---	N	1	N	L	700	1.5	7
130	(N)	.11	25	35	60	---	N	1	N	10	200	7	L
131	N	.07	20	30	50	---	L	.5	N	L	500	2	5
132	N	.50	60	55	90	---	N	1	N	20	150	3	N
133	N	.09	10	20	45	---	N	1	N	10	500	2	7
134	N	.05	10	15	40	---	N	1	N	L	700	1.5	7
135	N	.08	45	25	65	---	N	1	N	10	500	1.5	7
138	(N)	.28	40	35	70	---	N	1	N	10	300	3	L
139	N	.11	15	30	45	---	N	1	L	15	300	3	7
140	N	.14	20	40	50	---	N	1	N	10	300	3	L
141	N	.10	15	25	45	---	N	1	N	15	500	1.5	7
149	(N)	.22	30	30	40	---	N	1	N	30	300	1.5	5
150	N	.04	20	25	H5	---	N	.5	N	50	200	1	5
151	(N)	.05	15	25	H25	---	N	.5	N	30	150	1	5
152	N	.04	15	20	H5	---	N	.5	L	30	150	1	L
153	.02	.05	20	20	H20	---	N	.5	N	30	150	1	L
164	.02	.20	70	80	160	---	10	1	L	15	300	2	7
170	N	.04	30	30	45	---	N	1	.5	30	300	1.5	5
171	N	.06	30	40	45	---	L	1	L	15	300	1.5	L
172	N	.09	25	35	40	---	L	1	L	10	700	1.5	7
173	(N)	.18	30	35	50	---	N	.5	N	10	500	1.5	L
174	(N)	.30	35	40	50	---	L	1	L	15	300	2	N
175	(N)	.15	45	80	80	---	L	1	L	10	300	3	N
177	(N)	.07	30	45	40	---	L	1	L	10	300	2	5
178	N	.05	20	30	H30	---	N	1	N	15	500	1	5
179	(N)	.14	45	50	H40	---	N	1	N	15	300	1.5	L
180	N	.11	30	35	40	---	N	2	N	10	700	1.5	5
181	N	.18	45	55	50	---	L	2	N	10	300	3	L
182	N	.11	20	30	40	---	L	1	N	L	700	2	7
183	N	.18	40	50	95	---	10	2	.5	30	300	3	7
184	N	.14	15	25	45	---	N	2	N	10	300	2	7
185	N	.18	30	40	50	---	20	2	N	10	700	1.5	5
187	N	.11	45	40	50	---	N	2	N	10	700	1.5	10
188	N	.07	35	30	45	---	N	1	N	10	700	2	5
191	N	.14	25	40	20	---	N	1	N	L	300	5	L
198	N	.17	35	40	35	---	N	1	N	10	700	3	L
199	N	.45	80	80	110	---	10	2	N	15	300	2	N
200	(N)	.11	30	35	35	---	N	1	N	10	300	3	5
203	N	.13	20	20	30	---	N	.5	L	10	500	2	L
205	N	.08	15	25	20	---	N	.5	N	15	300	7	N
206	N	.24	50	55	45	---	N	1	N	10	300	7	5
208	N	.07	10	20	10	---	N	.5	N	15	70	7	N

the Chiricahua Wilderness and nearby areas, Cochise County, Arizona—Cont.

Semiquantitative spectrographic analyses--Continued

Sample	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)
	(ppm)													
					Alluvium, Chiricahua Wilderness--Continued									
106	10	15	50	L	20	7	30	5	L	100	20	50	N	200
107	15	10	70	L	20	5	30	L	L	L	L	50	N	200
108	15	15	70	L	30	7	30	7	L	L	70	70	N	500
109	10	30	50	L	30	7	30	5	L	L	30	50	N	300
110	15	10	70	L	20	7	30	5	N	100	30	70	N	300
113	10	30	70	L	30	5	30	L	L	100	10	30	N	300
115	15	30	70	L	30	7	30	5	N	100	15	50	N	150
116	20	30	100	L	30	10	30	10	N	150	100	70	N	300
117	20	30	70	L	30	7	30	10	N	150	100	70	N	500
118	15	10	70	L	20	15	15	15	N	150	100	50	N	300
120	15	20	70	L	30	7	30	7	N	100	30	30	N	300
121	20	30	70	L	30	10	20	10	N	100	150	30	N	500
122	20	30	50	L	30	15	30	15	N	150	200	30	N	500
123	20	30	70	L	30	10	20	15	N	150	150	30	N	500
124	20	50	50	L	15	7	30	10	N	150	100	30	N	300
125	15	30	30	L	10	7	20	10	N	150	70	30	N	300
127	70	30	70	L	15	7	30	7	N	150	30	50	N	300
128	20	30	50	L	15	7	30	7	N	150	50	30	N	700
129	20	30	30	L	15	7	20	7	N	100	70	30	N	300
130	15	30	150	L	30	7	30	7	L	100	30	100	N	700
131	10	30	50	L	15	7	15	7	N	100	50	30	N	300
132	10	30	70	N	15	L	30	5	N	100	30	30	N	200
133	10	15	50	L	15	7	30	7	N	150	50	30	N	500
134	10	30	50	L	30	5	20	10	N	150	100	30	N	700
135	15	30	70	L	20	10	30	10	L	150	100	30	N	300
138	15	15	50	N	15	7	15	5	N	100	50	50	N	200
139	15	30	70	L	20	15	30	10	N	150	70	70	N	300
140	15	20	70	N	20	5	30	7	N	150	50	70	N	500
141	20	15	50	L	20	7	15	10	N	150	50	50	N	300
149	20	30	50	L	15	7	30	10	N	150	70	30	N	300
150	30	15	20	N	10	7	15	10	N	150	70	30	N	300
151	30	30	L	N	10	7	15	10	N	100	50	30	N	300
152	20	15	20	N	L	7	15	7	N	150	50	20	N	150
153	30	15	20	L	L	7	15	10	N	150	70	30	N	300
164	10	30	50	L	10	5	30	5	N	100	30	30	N	300
170	15	30	20	L	10	7	20	10	N	100	50	30	N	150
171	15	30	30	L	10	5	20	7	N	150	50	20	N	300
172	20	30	70	L	10	10	30	7	N	150	50	50	N	300
173	20	15	50	N	10	7	20	5	N	150	30	50	N	200
174	15	30	70	L	10	7	30	5	N	100	30	50	N	300
175	10	20	70	L	10	5	30	5	N	100	20	70	N	300
177	15	20	70	L	15	7	50	5	N	100	30	70	N	200
178	70	20	L	N	L	7	15	5	N	150	30	15	N	200
179	15	30	20	L	L	7	20	5	N	150	30	15	N	200
180	15	30	70	L	10	7	30	7	N	150	50	30	N	300
181	20	30	70	L	15	7	30	5	N	L	30	70	N	200
182	20	20	70	L	15	10	20	5	N	100	30	50	N	300
183	30	30	50	L	10	7	30	7	N	L	30	50	N	200
184	15	15	70	L	20	7	20	5	N	100	30	70	N	300
185	15	30	30	L	10	7	30	5	N	L	30	50	N	300
187	20	30	50	L	10	15	30	7	N	150	50	50	N	500
188	15	30	30	L	15	7	50	L	N	L	30	30	N	300
191	15	30	150	N	20	5	30	L	N	L	15	G200	N	300
198	10	30	70	L	15	5	30	5	N	100	30	50	N	700
199	10	30	30	L	15	5	50	5	N	100	20	30	N	200
200	15	30	50	L	20	5	30	5	L	100	20	50	N	300
203	10	15	50	L	20	7	50	5	L	100	20	30	N	300
205	10	10	70	L	30	5	30	5	L	100	15	100	N	300
206	15	30	50	L	15	7	50	5	N	L	30	70	N	700
208	10	7	70	L	30	7	30	L	L	L	L	100	N	150

TABLE 2. — *Geochemical analyses of alluvium, altered rocks, and veinlets from*

Sample	Instrumental and colormetric analyses (ppm)								Semiquantitative spectrographic analyses (ppm)				
	Au (.02)	Hg (.005)	Cu (5)	Pb (10)	Zn (5)	Ag (.2)	As (10)	Sb (.5)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)
					Alluvium, Ciricahua Wilderness--Continued								
210	N	0.09	25	40	30	---	N	1	N	10	300	3	L
211	N	.11	25	40	20	---	N	1	N	10	300	7	N
212	N	.11	30	40	40	---	L	1	N	10	300	3	N
213	N	.16	15	30	40	---	N	1	N	L	500	1.5	7
215	N	.13	25	30	55	---	N	1	N	L	700	1.5	7
216	.06	.11	35	30	60	---	L	1	N	L	700	1.5	10
218	N	.04	45	30	50	---	N	1	N	10	300	1	30
219	N	.05	10	20	40	---	N	1	N	L	700	1.5	7
220	N	.13	15	20	40	---	N	.5	N	10	700	1.5	10
71056	L	.04	10	20	50	---	N	1	.5	L	500	1.5	5
71D57	L	.02	15	25	50	---	N	1	L	20	200	1.5	7
71D59	L	.02	25	30	55	---	20	2	.5	L	300	1	7
71066	L	.04	15	20	50	---	N	1	N	20	200	1.5	L
71067	L	.04	15	20	40	---	N	1	N	10	200	1.5	5
71W72	L	L	15	15	45	---	N	1	N	L	500	1.5	7
71096	L	.05	10	20	40	---	N	1	N	L	150	2	L
71W98	L	.02	20	25	45	---	L	1	N	10	200	1.5	L
71W99	L	.02	20	25	70	---	N	.5	N	10	200	2	L
71D103	L	.04	20	25	40	---	N	1	N	L	150	2	L
71D104	L	.04	5	15	30	---	N	1	N	L	200	2	L
					Alluvium, control areas								
222	0.10	0.10	40	70	90	---	10	2	3	10	500	1.5	20
223	N	.09	30	20	50	---	L	1	N	10	700	1	30
224	N	.09	30	25	45	---	N	1	N	10	500	1	20
225	N	.04	40	30	55	---	N	1	N	10	500	1.5	50
226	N	.05	30	30	50	---	N	1	N	10	500	1.5	20
227	N	.05	25	25	45	---	N	1	N	10	300	1.5	15
228	N	.02	25	160	H140	---	N	1	N	30	200	1.5	15
229	N	.02	15	70	60	---	L	1	L	20	300	2	15
230	N	.02	15	55	110	---	L	1	N	50	300	1.5	10
231	N	.02	15	190	H170	---	N	.5	L	30	150	1.5	L
232	N	.05	20	140	H90	---	N	1	N	30	300	1.5	5
233	N	.09	60	9,000	1,400	---	10	2	5	50	200	1.5	5
234	N	.07	65	950	H170	---	N	2	.7	50	200	1.5	5
235	N	.04	45	65	85	---	N	2	L	15	300	L	20
236	N	.05	25	140	120	---	N	1	N	10	300	1.5	10
237	N	.05	15	40	50	---	N	1	N	15	200	1.5	10
239	N	.03	30	110	110	---	N	1	N	10	300	1.5	15
71018	L	.04	30	25	110	---	L	1	N	L	200	L	20
71D20	L	.01	30	10	60	---	N	1	N	L	500	L	20
71D21	L	.02	30	10	60	---	N	1	N	L	300	L	20
71022	L	.02	30	15	75	---	N	1	N	10	300	L	20
71023	L	.02	25	90	110	---	N	1	N	L	300	L	7
71024	L	.01	20	110	35	---	N	1	.7	L	200	L	5
71D25	L	.02	30	3,500	90	---	N	1	.5	10	200	L	10
71W26	L	.02	20	60	110	---	N	1	N	10	300	L	7
71D27	L	.02	20	60	60	---	L	1	N	10	200	L	5
71D28	L	.3	35	70	170	---	L	2	N	L	150	L	30
71D29	L	L	35	20	80	---	N	1	N	L	300	L	30
71W30	L	.04	30	30	70	---	N	1	N	L	300	L	20
71D31	L	.04	25	75	45	---	N	2	N	L	100	N	5
71032	L	.03	35	30	80	---	N	1	N	L	200	L	10
71W33	L	.02	30	20	25	---	N	1	N	L	300	1	5
71W34	L	.02	30	30	70	---	N	.5	N	L	500	L	10
71W35	L	L	10	10	20	---	N	1	N	L	500	L	N
71W36	L	.02	25	25	65	---	N	1	N	L	500	L	7

the Chiricahua Wilderness and nearby areas, Cochise County, Arizona—Cont.

Semiquantitative spectrographic analyses--Continued

Sample	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)
	(ppm)													
Alluvium, Chiricahua Wilderness--Continued														
210	10	30	50	L	30	5	50	5	L	100	20	50	N	300
211	15	30	70	L	30	5	30	L	N	100	20	70	N	200
212	10	30	30	N	20	5	30	5	N	100	15	30	L	150
213	30	30	70	L	15	15	20	15	N	100	70	70	N	200
215	20	30	70	L	15	10	30	10	N	150	70	30	N	200
216	20	30	50	L	15	15	30	10	N	150	100	30	N	300
218	200	30	30	L	15	100	15	20	N	200	200	30	N	300
219	20	30	50	L	30	10	20	10	N	150	100	30	N	700
220	20	30	50	L	20	15	30	10	N	150	100	30	N	300
71056	N	15	20	L	15	L	20	7	N	100	30	20	N	150
71057	30	10	20	N	10	10	15	15	N	100	50	20	N	100
71059	10	15	20	5	N	7	20	10	N	100	50	15	N	150
71066	20	10	L	N	N	10	15	7	N	L	30	15	N	100
71067	L	10	20	N	N	7	15	7	N	L	30	15	N	100
71W72	10	15	50	N	15	10	15	10	N	150	70	30	N	200
71096	N	10	50	N	15	L	20	5	L	L	20	30	N	150
71W98	N	15	20	N	10	L	15	5	N	L	20	20	N	200
71W99	10	15	20	N	10	5	15	5	N	L	30	20	N	150
710103	N	10	30	N	10	L	15	L	N	N	20	30	N	70
710104	N	10	50	L	15	5	15	7	L	L	30	30	N	150
Alluvium, control areas--Continued														
222	50	30	30	L	20	30	70	10	N	150	100	30	N	200
223	150	30	30	L	15	70	15	20	N	300	150	30	N	200
224	150	30	20	L	20	70	15	15	N	300	150	20	N	300
225	200	30	30	L	20	150	15	20	N	200	150	30	N	200
226	100	30	20	L	20	70	15	15	N	200	100	30	N	200
227	70	30	20	N	20	50	15	10	N	150	70	30	N	200
228	50	30	20	L	15	15	70	7	N	300	70	15	L	200
229	30	20	20	L	20	15	30	7	N	150	50	30	N	200
230	70	20	30	L	15	30	30	10	N	200	70	30	L	300
231	30	20	L	L	15	10	100	5	N	200	30	30	300	300
232	50	30	20	L	15	15	70	7	N	200	70	20	N	200
233	70	70	20	70	10	15	10,000	7	N	200	70	20	3,000	200
234	70	50	30	L	10	15	700	7	N	200	70	20	200	300
235	100	50	20	L	15	70	30	15	N	200	150	30	N	200
236	10	15	30	L	10	15	70	7	N	200	50	20	L	150
237	20	20	20	L	15	15	15	7	N	150	70	20	N	300
239	50	30	20	L	10	50	50	10	N	300	70	20	L	200
71018	100	15	20	N	N	70	20	15	N	300	100	15	N	70
71D20	100	15	20	N	N	70	10	15	N	200	70	15	N	70
71D21	100	15	20	N	N	70	10	15	L	300	70	15	N	50
71022	150	15	20	N	N	70	20	15	N	300	100	20	N	50
71D23	50	15	20	N	N	15	50	15	N	700	70	15	N	70
71024	30	7	20	N	N	10	300	5	N	200	20	10	N	50
71D25	50	20	20	L	N	20	2,000	7	N	500	50	15	N	70
71W26	50	10	20	N	N	20	30	10	N	700	50	15	N	30
71D27	30	10	20	N	N	7	30	5	N	200	20	10	N	30
71D28	70	20	20	N	N	50	50	15	N	700	70	15	200	100
71029	100	20	20	N	N	70	10	15	N	500	70	15	N	50
71W30	70	15	20	N	N	50	10	15	N	500	70	20	N	70
71031	30	10	L	N	N	15	30	5	N	200	20	15	N	50
71032	70	10	20	N	N	30	10	10	N	200	30	15	N	70
71W33	10	15	30	N	20	L	10	10	10	100	50	70	N	100
71W34	70	15	20	N	N	50	15	10	N	200	50	20	N	70
71W35	N	L	30	N	10	N	10	10	L	100	20	30	N	150
71W36	50	10	20	N	10	20	15	10	L	300	70	20	N	100

TABLE 2. — *Geochemical analyses of alluvium, altered rocks, and veinlets from*

Sample	Instrumental and colormetric analyses (ppm)								Semiquantitative spectrographic analyses (ppm)				
	Au (.02)	Hg (.005)	Cu (5)	Pb (10)	Zn (5)	Ag (.2)	As (10)	Sb (.5)	Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)
Alluvium, control areas--Continued													
71W37	L	0.02	10	240	150	---	N	1	N	10	150	L	L
71W38	L	.02	15	45	100	---	N	1	N	10	200	2	5
71039	L	.07	15	70	120	---	N	1	N	15	200	1	5
71040	.08	.02	25	380	320	---	N	.5	N	10	150	1	N
71041	L	.01	20	30	55	---	N	1	N	L	200	2	7
71D42	L	.05	65	75	130	---	N	1	N	L	200	L	15
71043	L	.03	30	15	75	---	N	1	N	10	300	L	7
Altered rocks and veinlets, Chiricahua Wilderness													
4	N	0.04	10	15	60	0.2	80	2	0.7	L	700	1.5	5
6	N	.04	10	15	50	L	10	4	N	L	700	1.5	5
7	.04	.05	10	20	80	15	120	6	7	L	300	2	5
10	N	.06	15	25	50	1.6	140	.5	1	L	500	1.5	5
11	.02	.05	5	10	50	.6	20	L	.5	L	300	1.5	10
26	N	.06	L	10	40	L	N	1	N	L	70	3	N
33	N	.04	L	20	50	.2	N	2	N	L	70	3	N
44	N	.05	L	10	10	L	N	2	N	L	70	3	N
57	N	.03	5	10	15	4.5	120	10	7	10	300	2	5
58	N	.04	5	20	20	24	20	10	15	10	300	3	N
60	N	.02	L	10	10	.6	N	4	N	L	500	1.5	N
66	N	.05	10	10	40	L	140	3	.5	10	500	1.5	7
70	N	.02	5	10	20	L	120	1	N	L	300	10	5
71	N	.06	L	20	25	L	N	2	N	10	70	3	N
74	N	.05	L	35	30	L	N	2	N	10	70	3	N
75	N	.02	L	15	30	.2	N	1	N	L	70	1.5	N
82	N	.02	L	20	20	L	10	.5	N	L	70	2	N
84	N	.02	L	20	15	L	N	.5	N	10	70	3	N
85	N	.02	L	10	20	L	N	.5	N	10	70	3	N
90	N	.04	L	10	10	L	40	3	.5	10	70	2	N
94	N	.02	L	15	20	L	L	L	N	10	70	3	N
96	N	.04	L	25	25	L	10	4	L	L	100	7	N
97	N	.07	L	20	25	L	30	5	.5	L	150	3	N
98	N	.04	5	20	20	L	40	2	.5	L	300	L	5
100	N	.05	L	10	10	L	40	2	.5	L	70	1.5	N
101	N	.02	5	15	10	.4	80	2	1	L	500	1.5	N
103	N	.03	5	20	25	L	150	3	1	L	300	L	5
104	.1	.05	L	15	35	L	20	2	.5	L	300	1	5
148	N	.02	L	15	15	L	80	8	N	10	300	1.5	N
154	N	.03	L	10	20	.2	60	3	.7	L	70	L	N
155	N	.03	L	15	15	L	10	3	1.5	L	200	1	N
156	.04	.10	L	10	50	L	20	3	1	L	700	1.5	5
157	.02	.04	L	10	10	L	160	1	.7	10	70	1	N
158	N	.06	L	50	25	L	L	1	N	10	70	3	N
160	N	.07	L	30	20	L	L	.5	N	10	70	1.5	N
161	.02	.08	L	20	25	L	40	4	N	L	1,000	L	N
162	N	.03	L	15	30	L	10	1	N	L	200	1	N
165	N	.01	L	20	35	.4	20	2	.7	L	300	1	N
166	.02	.02	5	10	30	4	20	2	3	L	150	1	N
167	.04	.04	10	30	90	13	L	5	10	L	300	1	N
168	N	.03	15	10	15	9	10	1	2	50	70	1	N
169	N	.02	10	20	50	2	120	1	.7	L	500	1.5	5
176	N	.02	5	20	30	L	20	.5	N	L	300	L	N
186	N	.03	L	10	10	L	10	1	N	L	70	1	N
189	.02	.02	35	10	5	L	20	L	.5	L	70	L	N
194	N	.02	5	25	20	L	L	.5	N	L	500	L	N
195	N	.03	20	15	40	L	L	.5	N	L	50	2	N
201	N	.02	L	20	10	L	20	1	.5	L	70	1	N
204	N	.02	L	30	10	L	30	1	.7	L	150	1	N
207	N	.04	L	15	20	L	L	L	N	10	70	5	N

the Chiricahua Wilderness and nearby areas, Cochise County, Arizona—Cont.

Semiquantitative spectrographic analyses--Continued

Sample	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)
	(ppm)													
	Alluvium, control areas--Continued													
71W37	20	5	L	N	N	10	500	5	N	200	30	10	N	50
71W38	N	5	20	N	15	5	20	5	L	100	20	15	N	100
71D39	20	10	20	N	10	15	20	5	N	150	30	10	N	100
71D40	10	5	20	N	N	5	200	L	N	150	20	10	L	70
71D41	30	10	20	N	15	15	15	7	N	150	30	15	N	100
71D42	100	20	L	N	N	50	30	10	N	150	50	10	N	50
71D43	70	15	L	N	N	20	10	10	N	150	30	10	N	70
	Altered rocks and veinlets, Chiricahua Wilderness--Continued													
4	10	20	70	L	20	7	20	10	N	100	70	30	N	300
6	L	20	50	7	20	7	20	7	N	100	50	30	N	300
7	L	20	20	5	10	7	20	7	N	100	50	20	N	200
10	10	10	30	30	10	7	20	10	N	100	50	30	N	300
11	L	10	20	7	10	7	10	7	N	100	30	15	N	200
26	L	7	20	N	30	5	30	5	N	N	10	30	N	150
33	L	20	20	N	30	5	30	5	15	N	10	30	N	150
44	L	7	30	N	30	5	30	5	10	100	10	30	N	150
57	L	5	20	50	N	5	N	5	N	100	30	10	N	150
58	L	5	N	30	N	5	N	L	N	N	20	10	N	20
60	L	10	20	N	10	5	N	5	N	100	30	15	N	150
66	10	20	30	5	15	7	10	7	N	100	50	30	N	300
70	L	5	20	N	10	7	N	7	N	100	30	15	N	200
71	L	7	30	N	30	5	30	5	N	N	10	30	N	200
74	L	5	20	N	30	L	30	5	10	N	10	30	N	200
75	L	7	20	N	30	L	30	L	N	N	10	30	N	150
82	L	5	30	N	30	L	30	L	10	N	10	30	N	200
84	L	10	30	N	30	L	30	L	10	N	10	30	N	200
85	L	10	20	N	30	L	30	L	10	N	10	30	N	200
90	L	15	20	N	30	L	30	L	N	N	10	30	N	150
94	10	7	20	N	30	L	20	L	10	100	10	30	N	150
96	L	15	20	N	30	L	30	L	10	N	10	30	N	150
97	L	10	30	N	20	5	30	L	15	100	10	30	N	150
98	L	30	30	N	20	7	20	7	N	100	50	30	N	300
100	L	7	70	N	20	L	10	5	N	100	10	30	N	200
101	10	5	70	N	15	7	20	10	N	100	70	30	N	300
103	15	5	70	N	10	7	L	10	N	100	70	30	N	300
104	L	10	50	N	30	5	10	7	N	100	30	30	N	300
148	L	5	50	30	15	5	15	7	N	N	70	30	N	200
154	L	5	N	30	N	5	N	5	N	N	50	10	N	100
155	L	5	N	N	N	5	N	5	N	100	20	10	N	100
156	L	7	20	N	10	L	10	5	N	100	30	20	N	500
157	L	5	N	L	N	5	N	5	N	200	70	10	N	100
158	L	7	20	N	20	L	50	5	N	N	10	30	N	150
160	L	5	20	N	20	L	20	5	10	N	10	20	N	150
161	L	5	70	7	10	L	30	7	N	150	30	30	N	500
162	L	5	20	N	10	L	10	L	N	N	10	20	N	150
165	L	5	20	L	20	L	20	L	N	N	15	30	N	200
166	L	15	N	L	N	5	N	L	N	N	30	10	N	100
167	L	7	N	30	N	7	10	L	N	N	30	10	N	150
168	L	10	N	N	N	5	N	L	N	N	20	N	N	30
169	L	5	20	50	N	5	10	7	N	100	70	20	N	150
176	L	7	N	N	N	L	10	L	N	100	20	10	N	150
186	L	5	L	N	20	L	10	L	N	N	10	30	N	150
189	15	10	L	N	20	L	L	L	N	N	10	30	N	150
194	L	5	20	7	10	L	20	L	N	100	20	15	N	150
195	L	30	20	N	20	L	30	L	10	N	10	20	N	150
201	L	5	20	N	20	L	30	L	N	N	10	30	N	150
204	L	7	20	N	10	5	50	L	N	N	10	30	N	150
207	L	7	50	N	30	5	10	L	N	N	10	50	N	150

TABLE 2.—*Geochemical analyses of alluvium, altered rocks, and veinlets from*

Sample	Instrumental and colormetric analyses (ppm) Au (.02)	Hg (.005)	Cu (5)	Pb (10)	Zn (5)	Ag (.2)	As (10)	Sb (.5)	Semiquantitative spectrographic analyses (ppm) Ag (.5)	B (10)	Ba (20)	Be (1)	Co (5)
				Altered rocks and veinlets, Chiricahua Wilderness--Continued									
214	N	0.05	10	30	140	L	10	L	N	10	300	1.5	5
217	N	.04	15	25	40	.4	10	1	.5	10	200	5	5
71D44	.06	.02	35	50	95	---	100	1	2	N	1,500	L	5
71D45	.3	.04	5	45	30	---	40	1	70	N	500	L	N
71D46	L	L	15	15	20	---	80	1	20	N	150	1	L
71D47	L	.02	5	15	30	---	N	1	.5	N	150	L	7
71D48	.4	L	5	10	10	---	L	2	3	N	200	L	L
71D49	L	.02	L	5	10	---	L	1	1	N	70	1	N
71D50	L	.20	5	10	20	---	N	2	3	N	70	1	L
71D51	L	.02	5	10	10	---	10	2	3	N	100	1	N
71W52	.08	L	5	5	20	---	20	2	5	N	1,500	L	N
71D53	.04	.02	L	10	25	---	10	2	1	N	1,500	L	N
71D54	L	.02	L	10	10	---	20	4	2	N	200	1	L
71D58	L	.01	45	45	40	---	10	2	15	N	200	1.5	L
71D60	.04	.02	15	20	40	---	20	1	3	N	200	1.5	L
71D61	.04	.02	10	20	15	---	N	2	7	N	1,000	1	L
71D62	.04	.05	70	120	75	---	20	2	30	N	700	1.5	L
71D63	L	.03	25	15	25	---	10	1	1.5	L	2,000	1.5	L
71D100	L	.02	30	55	30	---	400	2	.7	L	150	1.5	L
71D101	L	.02	25	25	25	---	N	2	1.5	N	100	1	N
71D102	.06	.01	40	90	40	---	N	1	15	N	30	1	N

the Chiricahua Wilderness and nearby areas, Cochise County, Arizona—Cont.

Semiquantitative spectrographic analyses--Continued

Sample	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)	Pb (10)	Sc (5)	Sn (10)	Sr (100)	V (10)	Y (10)	Zn (200)	Zr (10)
	(ppm)													
Altered rocks and veinlets, Chiricahua Wilderness--Continued														
214	L	30	20	N	10	7	20	5	N	100	30	30	L	200
217	L	5	20	N	10	5	L	10	N	N	30	15	N	150
71D44	20	30	20	5	N	10	30	7	N	150	20	15	N	70
71D45	20	10	20	7	N	L	15	5	N	L	20	10	N	150
71D46	20	15	L	5	N	5	L	L	N	N	10	L	N	50
71D47	30	7	L	5	N	10	L	5	N	N	20	10	N	150
71D48	L	10	N	7	N	5	L	L	N	L	10	10	N	150
71D49	10	10	L	L	N	5	L	L	N	L	10	L	N	70
71D50	L	10	N	L	N	5	10	N	N	L	10	10	N	20
71D51	L	5	N	7	N	5	L	L	N	N	15	L	N	70
71W52	L	7	30	5	L	L	10	7	N	150	20	30	N	300
71W53	L	7	30	L	L	N	15	5	N	100	10	20	N	200
71W54	10	5	L	30	N	5	L	L	N	N	15	10	N	150
71D58	L	15	L	20	L	L	30	L	N	L	10	10	N	30
71D60	L	7	N	7	L	L	10	L	N	100	15	10	N	70
71D61	30	10	20	5	L	5	10	10	N	100	150	15	N	150
71D62	15	50	20	15	L	L	70	5	N	L	15	30	N	70
71D63	20	15	20	7	N	7	L	7	N	150	20	20	N	70
71D100	10	30	N	5	N	5	20	5	N	N	15	10	N	100
71D101	L	15	20	N	N	L	10	L	N	N	30	10	N	70
71D102	L	15	L	N	N	L	15	N	N	N	L	L	N	10

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