

metamorphic rocks. Gravel is shingled and well-stratified any

interlayered with lenses of sand. Uppermost part of alluvium composed of 2-4 ft (0.6-1.2 m) of sandy silt of probable windblown origin. Soil formed in this sandy silt consists of a

and a spotty accumulation of calcium carbonate in the upper par of the parent material. Deposited on floor of older valley but

now perched above modern valley floors and floodplains. Locally

rraces above modern streams. Thickness of the alluvium on each

hree terrace levels are mapped, based on the elevation of

gray, yellowish-brown, brown, or light-brown, well-consolidated clayey, silty, very fine to medium sand deposited by the wind.

moderate-brown B horizon 24 in. (61 cm) thick and C_{ca} horizon 1

stratified gravel composed chiefly of flat basalt and sandstone pebbles, cobbles, and boulders that decrease in size downslope.

Locally the lowest part of the unit is a conglomerate cemented by calcium carbonate. The upper part of the alluvium is less gravelly and and includes eolian sandy silt. A well developed

il in this silt unit consists of a brown or dark-brown silt

ay B horizon with strong prismatic structure underlain by a

as a strong concentration of calcium carbonate that forms 1/4-

luvium locally forms three terraces near its source in the high

norizon developed in the upper part of the parent material that

esas; down valley these terraces merge into a single terrace.

The alluvium lies on the youngest of three pediments described by Pillmore and Scott (1976). The Barela Alluvium is equivalent to

176; Scott, 1984) and probably was deposited during interglacia

locum Alluvium of the Colorado Front Range (Pillmore and Scot

stratified, silty, sandy gravel. Most clasts are basalt and sandstone. Near the high mesas, unit includes many boulders larger than 4 ft (1.2 m) in diameter; some boulders that project

horizon 24 in. (61 cm) thick and a white K horizon 30 in. (75 cm

Beshoar Alluvium locally forms two terraces that are mapped separately. The Beshoar Alluvium is equivalent to the Verdos Alluvium of the Colorado Front Range (Pillmore and Scott, 1976;

Lower (younger) terrace; about 120 ft (33 m) above major streams Higher (older) terrace; about 140-165 ft (50 m) above major streams

bouldery gravel. Composed chiefly of basalt and minor sandstone but includes some Precambrian rocks. Many clasts are larger tha

norizons of a strongly developed soil were removed by erosion

therefore, small remnants of alluvium have only the calcium-

ft (0.3 m) in maximum dimension near their sources. The upper

carbonate-enriched K horizon preserved. In the SW1/4 sec. 15, T 22 N., R. 21 E., Mora County, in the Springer quadrangle (Scott,

(D.) simplicidens, a fossil horse of probable early Pleistocene Blancan age (T.M. Bown, written commun., 1982) was found. The alluvium is about 20 ft (6 m) thick. The San Miguel Alluvium is

quivalent to Rocky Flats Alluvium of the Colorado Front Range

deposited about 1.4 m.y. ago. Two levels of alluvium were observed west of Rayado about 12 mi (16 km) south of Cimarron in

Pillmore and Scott, 1976; Scott, 1984) and probably was

Lower (younger) level, about 200 ft (60 m) above modern streams Higher (older) level, about 280 ft (85 m) above modern streams

esicular, porphyritic olivine basalt. Composition varies and

also includes latiandesite and trachyandesite. Contains unfilled

Clayton Basalt (Quaternary and Tertiary) -- Medium-gray to black, har

the Springer quadrangle (Scott, 1986

86), a worn right mandible of Equus (Dolichohippus) sp., cf. E

cott, 1984) and probably was deposited during an interglacial

ime, starting about 600,000 yr ago and ending thousands of yea

above the gravel surface are polished by wind abrasion. Soil

eveloped in sandy silt at the top of the Beshoar Alluvium

thick. The alluvium is as much as 20 ft (6 m) thick. The

(0.63-cm) rinds on the bottoms of clasts. The Barela

me alluvium of each level is about 15-20 ft (4.5-6 m) this

time, about 120,000-130,000 yr ago
Lower (younger) terrace; 60-70 ft (18-24 m) above major streams

Higher (older) terrace; 95-130 ft (29-40 m) above major streams.

Beshoar Alluvium (lower middle Pleistocene)—Brownish-gray,

Middle terrace; 70-80 ft (21-24 m) above major streams

Middle terrace level; about 40 ft (12 m) above streams

in. (46 cm) thick. Thickness 5 ft (1.5 m) or more

Qba Barela Alluvium (lower middle Pleistocene)—Brownish-gray or brown

Higher (older) terrace level; about 60 ft (18 m) above streams Eolian sand and silt (Holocene and upper Pleistocene)—Yellowish-

level is as much as 30 ft (9 m)

moderately well-developed, dark-yellowish-brown, clayey B horizon

nese deposits are divisible into two parts: The upper part, only

a few feet thick, is gray, loosely consolidated, sandy, peoble alluvium that lacks a soil. It was deposited between about 1,500 yr ago and the beginning of the last arroyo cutting (about 1900

A.D.); the lower part, about 23 ft (7 m) thick, is more firmly consolidated and consists of 15 ft (4.5 m) of crudely stratifie

andy alluvium containing sparse pebbles, commonly underlain by 8

(2.4 m) of gravel composed chiefly of pebbles, cobbles, and

oulders of mostly sedimentary rocks, but some is finer grained

than gravel. A weakly developed soil is formed in the upper 30 in. (0.7 m) of the lower part of the alluvium. The soil has a

between 4,000 and 2,000 yr ago. Unit locally more than 40 ft (

compacted silt exposed on the floors of ephemeral lakes in wind

of poorly sorted, crudely to well-stratified, cross-stratified,

ullies draining mountainous areas. Generally deposited on

lopes steeper than those covered by sheetwash alluvium (Qsw)

aterial derived chiefly from sandstone and shale. Generally

olive-gray, or brownish-gray, pebbly, sandy, poorly sorted, gravelly alluvium deposited on gentle slopes; grades downward to

less gravelly alluvium of valley floor floodplains. Sheetwash alluvium is well stratified and has a 2-ft- (0.6-m-) thick soi

in the upper part. The younger part of this unit is equivalent in age to unit Qal. Thickness locally exceeds 20 ft $(6\ m)$

grayish-brown, fine- to coarse-grained, unconsolidated, gravel

o bouldery deposits on the steep slopes of high mesas. Differs

contains large blocks of the basalt, basanite, and phonolite tha cap the mesas. Thickness probably less than 10 ft (3 m)

uld occur where the toe of a slide is undercut or the head is

blocks of glassy hornblende rhyodacite on the steep southwestern flank of Laughlin Peak and deposits of blocks of the basalt that

consisting of angular fragments of hornblende rhyodacite in steep valleys near the top of Palo Blanco Mountain, in the southeastern

earthflow deposits consisting of large blocks in a fine-grained matrix. Surface of landslides is hummocky and littered with

Aurther sliding of landslide deposits and underlying bedre

blown depressions, mostly in the east-central part of the

quadrangle. Probably about 10 ft (3 m) thick

Fan alluvium (Holocene and upper Pleistocene)—Fan-like accumulations

gravelly alluvium below the Trinidad Sandstone at mouths of

Qsw Sheetwash alluvium (Holocene and upper Pleistocene) -- Yellowish-grav

Colluvium (Holocene and upper Pleistocene) -- Yellowish-gray to

Qls Landslide deposit (Holocene and upper Pleistocene) -- Large slump and

Qt Talus (Holocene and upper Pleistocene) -- Small deposits of angular

The names of the volcanic and subvolcanic rocks in this quadrangle are

Capulin Basalt (Holocene) -- Dark-gray to black, vesicular, porphyritic

andesibasalt to latibasalt but are mostly olivine basalt.

height from a few hundred feet to 1500 ft (450 m); they are

younger and the different flow sheets are mapped separately

composed of ash, scoria, bombs, and blocks in various states of

induration. Unit is equivalent to the Capulin Basalt of Collins (1949) and Stormer (1972a, b). Where the sequence of flows from

flows and, less commonly, dikes that range in composition from

Phenocrysts are olivine and augite. Groundmass is holocrystalline, finely crystalline, or aphanitic, and composed

of laths of plagicclase, clinopyroxene (mostly augite), clivine, magnetite, and accessory apatite. Texture is intergranular.

it forms volcanic cones and flows in young valleys. The flows,

here not mantled by ash, generally are only sparsely vegetated,

those used by Scott and others (in press) and Staatz (1985) to describe the igneous rocks of the Raton quadrangle. This classification system (fig. 1)

based on chemical composition, was devised by De la Roche and others (1980)

and is well suited to the igneous rock units of the Raton area.

Bartlett, Barela, and Horse mesas

Qrg Rock glacier (Holocene and upper Pleistocene) -- Rock streams

Classification of Volcanic and Subvolcanic Rocks

Coarse columnar joints in the B horizon are coated with calcium carbonate. The lower part of the alluvium probably was deposited

ark-yellowish-brown B horizon about 20 in. (50 cm) thick

Qla Lake sediment (Holocene and upper Pleistocene) -- Gray, clayey,

QUATERNARY

TERTIARY

> CRETACEOUS

JURASSIC

TRIASSIC

Pleistocene

1.8 m.y.

Pliocene

5.0 m.y.

Miocene

24 m.y.

Oligocene

Paleocene

66.2 m.y.

> Cretaceous

Upper Jurassic

*Upper Triassic

Tp Tps Tpg

-

Tv Tbt

Ttr

Jm Jmbe KJ1kr

in several pits were not identifiable. Unit is 60 ft (18 m) thick at best exposure in the NW1/4 sec. 10, T. 26 N., R. 25 E. measured K-Ar ages show only a range from 1.27 \pm 0.71 to 0.66 \pm Canyon, and the other intruded into the Pierre Shale about 7 11 km) northwest of Vermejo Park, yielded ages of 23.4±0.4 m.y QTbc Basalt cinder cone (Quaternary and Tertiary) -- Ash, cinders, bombs, Springer 30' X 60' quadrangle, south of the Raton quadrangle
Trm Red Mountain Rhyodacite (Miocene) -- Domes of gray to orange-pink or and 28.8±0.4 m.y., respectively (J.D. Obradovich, written commun., 1976). A fission-track age for a 3-ft- (1-m-) thick and lapilli of basaltic composition. Shapes of most cinder cones and superjacent craters of this age are somewhat modified pale-red, porphyritic rhyodacite. Varies from a red and gray, sill at the mouth of Potato Canyon is 26.0±4.1 m.y., which agrees luidal-banded rhyodacite that has as much as 85 percent glass with ages calculated for similar rocks in the area. T High-level gravel (Pliocene?) -- Largely composed of Precambrian nesostasis (at Laughlin Peak and Green Mountain) to a crysta fission-track age was determined on annealed zircon from a igneous and metamorphic rocks as large as 2 ft (0.6 m) in maximum rich porphyry having little more than 30 percent glassy or dimension, but locally contains boulders of basalt; consists mostly of boulders near Manco Burro Pass. Deposit lies both cryptocrystalline material. Phenocrysts are plagioclase (mostly andesine), oxyhornblende, oxybiotite, and opaque oxides. The commun., 1984). Fission-track ages from sandstones adjacent t other sills and dikes in the western part of the map, range from 53.5±4.2 m.y to 64.9±3.3 m.y. These ages are older than above and below early basalt flows of unit Toa in abandoned groundmass is similar in composition but also contains paleovalleys. Only small remnants of unit are preserved; few deposits beneath basalt flows are exposed and were not mapped opected; it is assumed that the annealing temperature of zircon microlites, cristobalite, and glass. The texture generally is pilotaxitic. Forms large symmetrical mountains and one prominent was not reached in the rocks sampled.

Ankaratrite (Miocene and Oligocene?)—Medium-dark-gray, dense like ridge. The dome at Laughlin Peak vented and produced Elevation of gravel above major streams ranges from about 330 abundant pumice and vitrophyre that are included with th hard. Texture is porphyritic or seriate. Phenocrysts include abundant olivine, nepheline, plagicclase, and clinopyroxene. arron, to about 1,000 ft (305 m) near Manco Burro Pass idespread lahar (T1) that extends northward from the peak. The Raton Basalt (Pliocene) -- Medium - to dark-gray or black, hard vitrophyre was used as a source of stone tools by local Indian tribes. K-Ar ages of several samples averaged about 7 m.y. proundmass contains interstitial nepheline and clinopyroxe vesicular, porphyritic olivine basalt in thick widespread flows. The texture is intergranular or trachytic. Basalt Scott and others, in press) up a prominent hill. Exposed only on Tres Hermanos Peak, about mi (6 km) north of south-central border of the quadrangle Lahar (Miocene) -- Pinkish-gray to medium-gray, unsorted, volcanic mudflow. Clasts include pumice as much as 6 ft (1.8 m) in some flows has silvery sheen on fresh surface. Olivine is the most abundant phenocryst and commonly is completely altered to Diatreme (Miocene and Oligocene) -- Three small diatremes, less than 100 ft (30 m) in diameter, were identified. One, in the Joyce faulted dome in the NW1/4NW1/4 sec. 25, T. 27 N., R. 25 E., diameter, banded hornblende rhyolite, quartz, plagiocla labradorite), augite, altered amphibole, and apatite. 7 hormblende, and biotite. Clasts are not in contact, be apparently floated in a "muddy" matrix of pumiceous fine sand aphanitic groundmass is trachytic; common minerals of the Colfax County is a lamprophyric diatreme having trachyandesite composition (M.H. Staatz, written commun., 1981). Contains many proundmass include olivine, plagioclase, opaque oxides, and clinopyroxene. The Raton Basalt caps the highest and longes and silt. Forms northward-sloping carapace on steep slopes of Laughlin Peak. The lahar probably is at least 25 ft (7.6 m) clasts of gneiss, pegmatite, and quartzite of probable
Precambrian age. The second forms a small conspicuous knob in
the SE1/4 sec. 28, T. 27 N., R. 23 E., just north of Piñon Road,
2.5 mi (4 km) east of Maxwell and contains an irregular plug of mesas in the area. Many sheets of lava are included in the uni Trachyandesite of Middle Pine Butte (Miocene?) -- Light-gray but the vents of individual sheets are generally no longer marks porphyritic, trachyandesite dome. Rock is subtrachytic and contains phenocrysts of plagioclase, oxyhornblende, apatite, an by cinder cones. Unit may be equivalent to the Raton Basalt of collins (1949) and Stormer (1972a, b) in part, for which Stormer peridotite with jumbled borders and many clasts of pegmatite ar determined a K-Ar age of 3.5 m.y. Also occurs as dense, fine opaque oxides. The groundmass contains subparallel plates of tic gneiss of probable Precambrian age. The third is a plagioclase (oligoclase?), clinopyroxene prisms, and opaque oxides in an alkali feldspar(?) mesostasis. Forms large rained dikes in northwest quadrant of map. K-Ar ages range from small kimberlite diatreme on a gently sloping hill at about 9,600 ft (2,926 m) about 1 mi (1.6 km) east of Interstate 25, just Basaltic cinder cone (Pliocene) -- Mainly basaltic ash containing prominent mountain that is the central peak of the Pine Butte north of State Highway 72. The diatreme intrudes Pierre Shale and contains large bedrock fragments from the Pierre and other Tsd Symmodiorite (Miocene) -- Mesocratic, fine- to medium-grained, phaneritic; composed chiefly of plagicclase, orthoclase, biotite, scoria, bombs, and lapilli. Cones are steep (30°), generally symmetrical, and have a crater at the top. Some appear to be edrock units, such as fossiliferous limestone from the Niobran yroxene, and amphibole; border zones locally contain olivine; Formation. Peridotite makes up a small part of the diatreme. Mafic feldspathoidal rocks-The mafic feldspathoidal rocks are chiefly alteration of orthoclase to analcite and stilbite is commo he peridotite contains dunite lapilli composed of olivine flows but also form cinder cones and plugs. They are Forms sill-like body intruded into Poison Canyon Formation in altered to serpentine and some phlogopite and probably chromit Long Canyon, near the New Mexico-Colorado Stateline in the and perovskite. Zircon from sandstone blocks in the diatreme northwest quadrant of the map. A K-Ar age of hornblende from the intrusive is 10.4±0.2 m.y. (J.D. Obradovich, written commun., ephritic. The rocks called nepheline basalt and hauvne basal gave an average fission-track age of about 28 m.y. in the by Stobbe (1949, p. 1060) are nephelinite and hauyne basanite, boratory of Charles W. Naeser (written commun respectively, in the rock classification of De la Roche and others (1980). The mafic feldspathoidal rocks crop out over age is roughly concordant with ages of the mafic and ultramafi This age is concordant with a fission-track age of 12.9± m.y. on sphene (Charles W. Naeser, written commun. mprophyric) dikes and sills in other parts of the region. Chico sill complex (Miocene and Oligocene) -- Complex of sills and other intrusive rocks in the southeastern part of the broad area from near Raton eastward to Capulin, just east of the Syenite and trachyte sills east of Cimarron (Miocene) -- Medium-gray map area. They apparently comprise both the oldest and some of the youngest flows on high mesas, such as Johnson Mesa, at aphanitic; weathers light olive gray. Texture is jack straw-like. Contains alkali feldspar, dark mica, needle-like crystal quadrangle. A detailed description of these igneous rocks is given in Scott and others (in press). Rocks of the complex elevations of from 1200 to 400 ft (360 to 120 m), respectively, above present drainage. Dale Mountain on Johnson Mesa (fig. 21 of amphibole, and apatite. Vugs contain carbonate minerals and quartz crystals. Forms sills interlayered in Pierre Shale east nclude phonolite, tephrite, syenite, and quartz monzonite of of Cimarron. Sills generally 1-6 ft (0.3-1.8 m) thick
Mafic and ultramafic rocks--Mafic dikes are common from Rator urkey Mountain, and trachyte and range in age from 20 to 37 m.y. Basanite (Pliocene and Miocene) -- Medium-light-gray to dark-gray, tz, 1985; Scott and others, in press) southward to beyond Eagle Tail Mesa, but less common in the area of the Chico sill complex. An extensive dike swarm just south of Eagle Tail Mesa and Tinaja Mountain, trending east by southeast, ard, aphanitic, slightly vesicular, feldspathoidal basalt Chico phonolite-Phonolite, medium-gray, porphyritic; has a Texture is porphyritic and the groundmass texture is intersertal, pilotaxitic, or hyalopilitic. Phenocrysts are olivine, sparse plagicclase (labradorite), feldspathoids (typically nepheline but rachytic to intergranular texture. Phenocrysts are eldspathoids (analcime and nepheline), alkali feldspar as much ontains more than 20 dikes per mi (12 per km), in a belt as much locally analcime), clinopyroxene, magnetite, and glass. Contains quartz xenocrysts. Groundmass composed of plagicclase laths, as 3 mi (4.8 km) wide. One of the thickest of these is the spectacular Eagle Rock dike, 30 ft (9 m) wide where it is cut by Groundmass contains feldspar and clinopyroxene (acmite). Makes bold outcrops along ridge crests and around the erstate 25 about 17 mi (27 km) south of Raton. This basaniti nopyroxene, opaque oxides, carbonate minerals, and glass(? crests of hills. Includes green and silver-gray varieties of Unit consists of extensive lava flows that form prominent cliff and ledges. Harald H. Mehnert (Scott and others, in press) like is composite and has several thin parallel members of varie honolite that were mapped separately in some areas. An ocellar exture. Category includes mafic dikes and sills, ankaratrite, analcime phonolite is locally exposed in the area from Hogeye Mesa northeast to secs. 13 and 24, T. 27 N., R. 26 E., (Stobb and diatremes (Scott and others, in press).

Mafic dikes and sills (including lamprophyric rocks) (Tertiary) etermined a K-Ar age of 8.2+0.3 m.y. for the oldest flow, but Basanite plug (Pliocene and Miocene) -- Medium-gray to dark-gray Dark-gray to medium-gray or rarely olive-black, dense, rocks Silver-gray variety-Medium-gray, dense, porphyritic, hard hard, aphanitic basanite. Texture is porphyritic to pilotaxitic. Usually coarser than in the lithologically equivalent flows. Phenocrysts include olivine, clinopyroxene vaving coarse to fine intersertal or intergranular textures phonolite that weathers yellowish gray to yellowish brown and shaly or platy. Texture generally trachytic but locally occurs as dikes, sills, and plugs. Generally contain euhedral mafic minerals, chiefly hornblende, biotite, and accessory subtrachytic or intersertal. Contains phenocrysts of curved phenocrysts of augite(?) and olivine. Calcic feldspar is sparse (augite), and plagicclase (labradorite). Unit occurs in the conduits of extinct volcanos that weather to small conical pearly, potassium feldspar crystals, nepheline, plagioclase or absent. Pyrite and brown iron oxide are present. Chemical compositions of samples from two large dikes show them to be itanite, apatite, leucite, and opaque oxides. Groundmass is asanite. Some dikes, including the basanite dikes, contain is the common feldspathoid; in other plugs, nepheline probably i phanitic and contains acmite, potassium feldspar, nepheline eldspathoids. Dikes metamorphose wall rocks to hornfels, which umphibole, opaque oxides, and sparse biotite. Forms sills interlayered with sedimentary rocks. Basanite cinder cone (Pliocene and Miocene) - Ash, scoria, bombs is more resistant to weathering and erosion than most of the dik cks; therefore, the dikes may weather to valleys between and lapilli. Most cones are steep-flanked and are in the Green variety-Medium- to dark-greenish-gray, dense, hard, northeastern part of the quadrangle, about 3 mi (4.8 km) north of Capulin Lake. Cones at Robinson Peak and Jose Butte were the resistant hornfels ridges. Many dikes cut the rocks of the Chico relatively little weathered phonolite. Texture is porphyritic to trachytic. Weathered surface is dark yellowish brown and has prominent white alkali feldspar crystals. Phenocrysts of alkali l complex. Hornblende from the Eagle Rock dike gave a K-Ar entral vents for many basanite flows. The cones are old and ge of is 24.16±1.01 m.y. (Harald H. Mehnert, written commun. most have been breached by erosion 2). A sill northeast of Eagle Tail Mountain intruded the feldspar, amphibole ghosts, nepheline, clinopyroxene, sodalite, sparse biotite, titanite, and muscovite. Groundmass aphanitic alcareous shale unit of Smoky Hill Shale Member of Niobrara Ogallala Formation (Miocene) -- Light-brown, poorly sorted, pumiceous gravel, sand, and silt. Gravel contains clasts as large as 3 ft ormation. A complex of sills intruded the Vermejo and Rator and composed of alkali feldspar, acmite, nepheline, analcime, and riebeckite. Occurs as sills and dikes that cap mesas and form Formations in Coal and Cottonwood Canyons in the west-central (1 m) in diameter, mostly of Precambrian quartzite, micaceous

light-gray inclusions of quartz and clinopyroxene and sparse plagioclase (andesine?) phenocrysts. Texture is porphyritic subtrachytic. Apparently injected into the phono-tephrite along oe Cabin Arroyo, about 12 mi (19 km) west of southeastern corner Phono-tephrite--Medium-dark-gray, fine- to medium-grained, crystalline; has abundant small needle-like hornblende crystals small platy crystals of biotite, and sparse plagicclase (andesine?) phenocrysts. It also contains many light-gray inclusions of quartz and clinopyroxene and sparse plagicals (andesine?) phenocrysts. Texture is subtrachytic. The groundmass consists of plagioclase, clinopyroxene, some brown oxyhornblende, and dark-brown biotite. Forms the gently slopin walls of a short segment of Joe Cabin Arroyo, along with later intruded tephrite. A K-Ar age determination on hornblende from nono-tephrite about 3 mi (4.8 km) southwest of Pine Buttes gave an age of 25.3±0.9 m.y. (Staatz, 1985) Vent rocks at Turkey Mountain—Quartz syenite and quartz monzonite. Quartz syenite is gray, nearly equigranular, and shows no flow structure; phenocrysts are oligoclase-andesine, quartz, clinopyroxene, opaque oxide, apatite, and titanite. Quartz syenite occurs at the prominent main summits of Turkey Mountain (SW1/4 sec. 11, T. 27 N., R. 25 E.). The quartz monzonite is light brownish gray to pinkish gray, and porphyritic; contains phenocrysts mostly of albite-oligoclas rimmed by alkali feldspar; forms knobby outcrops typical of on a subsummit about 1,200 ft (366 m) to the southwest. Vents on rkey Mountain contain a breccia composed of Graneros Shale ntruded by syenite and mineralized by epidote and hematite ission-track age of zircon from the quartz syenite is 29.0±1.6 Biotite trachyte southwest of Turkey Mountain--Light-olive-gray yellowish-gray, pink, or red, and dense. Some rocks are porphyritic, have intersertal texture, and contain phenocrysts o hormblende, clinopyroxene, biotite, opaque oxides, and sparse apatite. Others are nonporphyritic. Forms inconspicuous sills dikes, and plugs that weather to subdued ridges and hills. Sill crop out 14 mi (22 km) east of Maxwell, north of Chico Road, and west of Slagle Canyon. A medium-gray melasyenite dike (not mapped), in the SE1/4 sec. 4, T. 26 N., R. 27 E., south of Palo Blanco Mountain, is porphyritic, has a seriate texture, and contains phenocrysts of amphibole, clinopyroxene, labradorite interstitial alkali feldspar, analcime or sodalite(?), and an unknown zeolite mineral

Trachyte and trachyandesite southwest of Laughlin Peak—Medium—
gray, dense, hard, porphyritic. Phenocrysts are hormblende,
plagicclase, augite, magnetite, apatite, titanite, and pyrite.

Groundmass is aphanitic and contains phenocrysts of quartz. Vug contain well-formed crystals of smoky quartz and calcite. Bitumen, fills vugs and occurs as inclusions in quartz crystals. Unit occurs as sills intruded into Cretaceous sediments 2 mi (3 km) southwest of Laughlin Peak. Weathers to subdued ledges or gently sloping hillsides

Slagle Trachyte—Light-olive-gray, hard, porphyritic; contains
prominent phenocrysts of hornblende as much as 0.3 in. (8 mm) long and alkali feldspar phenocrysts. Rock weathers pale orange dark yellowish gray or brown; hornblende crystals alter to palebrown iron oxide. Flow structure is well displayed by hormblende crystals. Forms sills interlayered with sedimentary rocks throughout the Chico sill complex in the southeastern part of the quadrangle. Sill remnants commonly cap mesas. A K-Ar age determination on hormblende from a large sill southwest of aughlin Peak, yielded an age of 36.7±1.3 m.y. (Staatz, 1985, p E-12). Unit is soda trachyte of Stobbe (1949, p. 1072)

Poison Canyon Formation (Paleocene)—Sandstone with interbeds of sandy claystone. Sandstone is light gray to yellowish gray, weathers grayish orange, dusky yellow, and grayish yellow with tains of red, pink, and brown; arkosic; conglomeratic in upper part, containing pebbles of quartzite, chert, gneiss, feldspar and quartz; medium grained to granule sandstone in lower part numerous plant impressions in lower part; massive; forms prominent ledges; caps flat-topped ridges. Sandy claystone is medium gray to grayish yellow and weathers to grayish-orange or dark-yellowish-orange soil; micaceous; contains medium to coarse sand; forms slopes between and intertongues with sandstone Contact with underlying Raton Formation is generally indefinite and occurs within a transition zone (not mapped) a thick as 100 ft (30 m). This zone consists of very fine to medium-grained sandstone in discontinuous beds that intertong and interbed with poorly bedded, dusky, yellow-weathering micaceous, sandy claystone and mudstone and contains seams and tringers of arkosic granules. Transition zone also contains hin, discontinuous, carbonaceous seams and zones and numerous ant impressions. Where lithologies of the Poison Canyon and Raton Formations do not differ significantly, the contact is mapped above the highest coal or carbonaceous zone and beneath e lowest persistent bed of arkosic granule sandstone and is rojected across areas of indefinite lithologic change. In the f the upper coal beds of the Raton Formation in the Poison nyon Formation and placed the contact about 75-100 ft (23-30 m) ower than mapped in this area. In the western part of the Rat basin, rocks of the Raton Formation intertongue regionally with coarser grained rocks of Poison Canyon lithology. In the southwestern corner of the map area, Wanek (1963) mapped a tongue of the Poison Canyon Function f the Poison Canyon Formation that is here mapped as the upper aton Formation. As much as 500 ft (152 m) of rocks here ncluded in the upper part of the Raton Formation were mapped by Namek (1963) as Poison Canyon Formation in the vicinity of Turke Creek and Dean Canyon, northwest of Cimarron. Thickness of Poison Canyon Formation rocks preserved in the quadrangle slightly more than 500 ft (150 m Raton Formation (Paleocene and Upper Cretaceous) -- Consists of three zones: an upper coal zone, which contains most of the commercia coal deposits; a middle barren zone, mostly sandstone and little r no coal; and a lower coal zone, is characterized by mostly discontinuous coal beds, and in most areas, a conglomerate at the base. On this map, the upper coal zone and the barrer zone were mapped together as the upper part of the Raton formation; the lower coal zone is called the lower part of the Raton Formation. The Raton Formation consists of sandstone rbedded with siltstone, claystone, mudstone, carbonaceous shale, and coal; exposures are generally poor to fair and dividual beds are difficult to trace. Sandstone is very fine to medium grained; light gray to yellowish gray, weathers grayis yellow to grayish orange; locally calcareous and carbonaceous ntains numerous plant impressions; some crossbeds; generally forms ledges. Siltstone is light gray to medium gray; cross

Tephrite—Dark-gray, hard, aphanitic. Phenocrysts of clinopyroxene, hornblende, and plagicclase. The groundmass consists of plagicclase, clinopyroxene, some brown oxyhornblende,

enocrysts of quartz containing inward-growing acmite-augite

crystals having abundant small needle-like hornblende crystals and small platy crystals of biotite. Tephrite also contains many

ark biotite and interstitial alkali feldspar. Contains

laminated; contains streaks of carbonaceous shale, coaly material, and plant fossils. Claystone and mudstone are medium gray to brownish gray; silty and sandy; contain scattered plant impressions and carbonaceous plant fragments; lack bedding. Carbonaceous shale is mostly associated with coal or occurs as abundant plant fossils. Coal beds are single beds or composite zones of coal and partings of carbonaceous shale, claystone, and ony or impure coal. Lower part of formation is mostly mudstone iltstone, and fine- to medium-grained sandstone that, in most he area, coarsens downward to conglomeratic sandstone in lower 50 ft (15 m). Clasts in the conglomeratic sandstone consist of pebbles and cobbles of quartz, chert, quartzite, feldspar, smal fragments of siltstone, and some coal. Thickness 0-2200 ft (0-Upper part (Paleocene) -- Includes the upper coal zone and the barren zone of the Raton Formation. Major potentially economic coabeds (unmapped) that are as thick as 10-13 ft (3-4 m) in the and York Canyon beds. The barren zone, near Cimarron, conform approximately with a tongue of the Poison Canyon, as mapped by

Lower part (Upper Cretaceous) -- Includes lower coal zone of Rator formation and the conglomerate at the base. The Cretaceous-Tertiary (K-T) boundary, as defined by pollen, occurs beneath sandstones of the barren zone, at or near the top of the lower coal zone Pillmore and others, 1984 and Pillmore and Flores, 1987). Where preserved, the boundary commonly occurs in a sequence of coal and carbonaceous shale. It is characterized by a 0.5-1 in.- (1-2 cm-) thick kaolinitic claystone bed directly overlain by a thin laminated clay layer that contains high concentrations of iridium and shock-metamorphosed quartz grains both evidence of asteroid impact at the end of the Cretaceous Period about 66 m.y. ago (Obradovich and Sutter, 1984). The contact between the upper and lower parts of the Raton Formation was mapped along the eastern margin of the Raton coal field, from imarron to Raton, as a guide for future study of the K-T Lower part of the Raton Formation and the Vermejo Formation, undivided (Upper Cretaceous) -- Locally the Vermejo Formation and the lower part of the Raton Formation are combined into a single map unit for areas where the contact cannot be recognized. Northward from the vicinity of Koehler, in the west-central part of the map, the Vermejo Formation is either too thin to show at the map scale or it is missing beneath the conglomerate at th base of the Raton Formation. In the vicinity of Raton, in Dillo Canyon, and along the north wall of the canyon of the Canadian River, the basal conglomerate of the Raton Formation is not present and the Vermejo Formation is combined with the lower par of the Raton. Consequently, from Koehler northeastward through Raton to the Colorado Stateline, the lower part of the Raton Formation and the Vermejo Formation were mapped together Vermejo Formation (Upper Cretaceous)—Sandstone, siltstone, silty carbonaceous shale, and coal; generally poorly exposed on tre covered slopes beneath cliffs of the basal conglomerate of the Raton Formation; contains numerous thick coal beds and abundan plant fossils. Major coal beds (not shown on map) include the Raton coal bed (the most extensive coal bed in the quadrangle and he greatest economic resource) at or near the base of the ormation and the Vermejo coal bed near the top of the formation to medium grained, but contains some coarse grains, mostly of quartz but also chert and feldspar; light gray to light medium y, and weathers light gray to yellowish gray and dark yellowish brown; irregularly calcareous; locally carbonaceous massive to thin bedded and locally highly contorted; contains angular fragments of siltstone and mudstone; interbeds of siltstone, carbonaceous shale, and impure coal that are mostly Siltstone is medium to dark gray; bedding highly contorted; includes laminae and seams of carbonaceous material. Contains lenticular beds of silty, carbonaceous and fossiliferous shale that locally grade laterally into coal. Coal commonly appears dirty, granular, and nonbanded in outcrop. Formation commonly intruded by sills, especially in Cottonwood, Dillon, and Canadian River canyons. Intertongues with the Trinidad Sandstone along the southern margin of the Raton basin, from near Cimarron at the mouth of Ponil Canyon, eastward about 12 mi (19 km) t Dawson, at the mouth of the Vermejo River. Thickness 0-380 ft Trinidad Sandstone (Upper Cretaceous) -- Sandstone, very fine to fine dusky yellow with stains of grayish orange and brown; most partz but some chert and magnetite grains; calcareous; thick bedded and massive in the upper and middle parts, thin bedded in the lower part. Contains few thin seams of faintly crossbedded alcite and limonite concretions. Too few feet thin bedde locally stained medium gray to grayish brown; abundant Ophiomorpha. Forms prominent, persistent cliffs below the Vermejo Formation. Thickness 50-100 ft (15-30 m). The Trinidad

Sandstone near Cimarron consists of an upper and a lower unit separated by a thin carbonaceous shale and coal beds of a lower tongue of the Vermejo Formation. The tongue can be traced from near Dawson to the junction of Chase and Ponil Canyons, northorthwest of Cimarron (Wanek, 1963). The lower tongue of the are too thin to show at the scale of this map, but they are shown n the map by Wanek (1963). Pierre Shale (Upper Cretaceous) -- Shale, siltstone, and sandy shale; exposures fair to poor; susceptible to landsliding on steep slopes of high mesas. Formation is divided into four parts that were not mapped separately: 1) upper transition member; 2) bed equivalent to the cone-in-cone zone of Lavington (1933), the tepee zone of Gilbert (1897), and the rusty zone of Gilbert 397); 3) Sharon Springs Member; and 4) lower member Upper transition member--Upper part of member composed of yellowish-gray sandstone layers that contain <u>Ophiomorpha</u>. Less sandy in lower part and contains brownish-gray, dense, limestone concretions with marine molluscan fossils, probably in faunal one of <u>Baculites reesidei</u>. Fossil identifications by William A. Beds equivalent to the cone-in-cone zone of Lavington (1933), the tepee zone of Gilbert (1897), and the rusty zone of Gilbert (1897)—Medium-dark-gray, olive-gray, and brownish-gray siltstone, silty shale, and claystone that contain: abundant red weathering, sideritic ironstone concretions as large as 12 in concretions as much as 3 ft (0.9 m) in diameter; and olive-gray limestone concretions that weather yellowish gray. Some concretions are fossiliferous. This part of the Pierre contains sparse, thin, yellowish-orange bentonite (weathered volcanic as beds. Fossil range zones identified (in descending order) are Didymoceras chevennense, Exiteloceras jennevi, Didymoceras stevensoni, Baculites scotti, B. gregoryensis, and B. perplexus Sharon Springs Member--Medium-dark-gray, hard, fissile, silty sha and siltstone that weather medium gray; contains several oran pentonite beds, probably equivalent to Ardmore Bentonite Beds Lower member—Olive-gray and gray fissile shale and claystone; contains beds of slightly fossiliferous, orange-weathering, oblate, septarian, limestone concretions as much as 4 ft (1.2 in diameter and rusty, silty, platy, ironstone concretions. Part of section contains sandy shale. Contains the fossil range zone of <u>Scaphites hippocrepis</u> III and <u>Glyptoxoceras</u>. Because the upper orange chalk of the Niobrara is missing in the Raton basin, peds of the calcareous lower transition member of the Pierre

hale of Colorado (Scott, 1969, p. 65) are here assigned to the upper part of the Niobrara Formation. Therefore, the boundary is mapped between noncalcareous shale of the Pierre Shale and alcareous shale of the Niobrara Formation. Thickness of the Pierre Shale is 1780-1930 ft (518-580 m) Niobrara Formation (Upper Cretaceous) -- Details about the Niobrara following units: Smoky Hill Shale Member that includes the calcareous shale unit, sandy unit, lower shale unit, and shall thickness of the Niobrara Formation is about 693-885 ft (183-27) Smoky Hill Shale Member--Includes three map units; total thickness of the member possibly as much as 850 ft (260 m)
Calcareous shale unit—Yellowish-gray to gray, calcareous, blocky to fissile, silty, micaceous, slightly sandy shale. Contains gray concretionary, clayey, dense, hard, limestone beds 1-2 ft (0.3-0.6 m) thick that contain Foraminifera and well-preserved fossil mollusks, including <u>Inoceramus</u>, <u>Pseudoperna</u>, <u>Baculites</u>, Scaphites, and <u>Desmoscaphites</u>. Some <u>Inoceramus</u> are more than 22 in. (56 cm) in diameter. Shale contains crushed fossils alor bedding planes. Some limestone beds weather yellowish orange, halky or earthy; concretionary beds contain brown calcite and white barite. Limestone commonly is vertically jointed and splits poorly along plane of bedding. Upper part of unit : characterized by speckled calcareous shale. Speckles are occospheres and tiny calcareous plates (coccoliths) that ormerly covered marine flagellate organisms olithophoridae). The calcareous shale also contains rhabdolith plates; except for the cement, the shale is exclusively composed of randomly oriented nanoplankton skeleta . Faunal range zones of the upper unit include, in descending order, <u>Scaphites hippocrepis</u> II and I, <u>Scaphites leei</u> III, <u>Demoscaphites bassleri</u>, <u>Demoscaphites erdmanni</u>, <u>Clioscaphites choteauensis</u>, <u>Clioscaphites vermiformis</u>, and noceramus (Cladoceramus) undulatoplicatus. The upper unit is bout 265-295 ft (81-90 m) thick Sandy unit-Gray to yellowish-gray, fine-grained, platy, well-layered, calcareous sandstone, shaly sandstone, and sandy shale. Weathers yellowish brown to pale yellowish brown. Upper art contains several layers of gray limestone concretions, 4 About 50 ft (15 m) below the top is 15-20 ft (4.5-6 m) of black calcareous shale containing <u>Inoceramus</u> (<u>Cladoceramus</u>) undulatoplicatus. The lower and major part varies from platy shaly sandstone to sandy or silty shale having lenses and plate of fine-grained sandstone and calcarenite. Characterized by th

ammonite zone of <u>Protexanites shoshonensis</u>; the most common fossil is <u>Inoceramus (Magadiceramus) subquadratus</u>. Well-preserved trace fossils are abundant. Thickness is 410-440 ft

small ridges. Some sills and dikes contain sufficient acmite to

Lower shale unit and shale and limestone unit Lower shale unit-Black, platy to fissile, calcareous shale ower part, perhaps 25 ft (7.6 m) thick, contains repetitions of everal thin beds of black, platy limestone and black fissile . Contains sparse bentonite beds a few inches thick. Uni s characterized by <u>Inoceramus</u> (<u>Volviceramus</u>) <u>involutus</u>. Unit is Shale and limestone unit--Beds of gray, platy, thin to thick limestone and gray, calcareous, platy shale. The limestone weathers light gray and shaly. Characterized by <u>Inoceramus</u> (<u>Cremnoceramus</u>) <u>deformis</u>. Thickness is 35-40 ft (10-12 m)

Fort Hays Limestone Member—Gray, massive, dense, hard limestone

Beds are 3-26 in. (7.6-66 cm) thick and weather to light-gray chips and blocks. Contains faunal zones of Mytiloides fiegei and at base Prionocyclus quadratus. Member is 30-38 ft (9-11 m Carlile Shale (Upper Cretaceous) -- Formation is 166 ft (50 m) thick; includes four members that are not mapped separately

Upper member—Dark-gray, silty, calcareous shale containing several

orange bentonite layers 1-2.5 in. (2.5-6 cm) thick. Contains

Inoceramus cf. I. perplexus. Member is 14 ft (4 m) thick

Juana Lopez Member—Shale, dark-gray, sandy, mostly noncalcareous; ontains calcarenite lenses and thin layers of orange bentonite. Calcarenite contains abundant fossils, including <u>Lopha lugubris</u>,
<u>Inoceramus dimidius</u>, and <u>Prionocyclus macombi</u> (Hook and Cobban,
1980). Member is 33 ft (10 m) thick

Blue Hill Shale Member—Dark-gray, silty, noncalcareous shale. Characterized by abundant septarian limestone concretions, some as large as 6 ft (1.8 m) in diameter. Smaller, more poorly developed septarian concretions contain well-preserved fossils of Collignoniceras hyatti, Coilopoceras springeri, and other ammonites. The upper 18 ft (5.5 m) of the member is sandy and is equivalent to the Codell Sandstone Member of the Carlile Shale (Hook and Cobban, 1980, p. 43). The Blue Hill Shale Member is 95 ft (29 m) thick
Fairport Chalky Shale Member--Gray, chalky to very calcareous,

platy to fissile shale that weathers to grayish-orange flakes of shale or flocculent calcareous clay. Contains orange bentonite beds, and in the lower part, lenticular limestone beds that weather shaly. Characterized by <u>Collignoniceras woollgari</u> and <u>Mytiloides hercynicus</u>. Member is 24 ft (7 m) thick Greenhorn Limestone (Upper Cretaceous)—The Greenhorn Limestone, as mapped by Wood and others (1953), included only the Bridge Creek Limestone Member. In the southeastern part of the quadrangle, he Hartland Shale Member and the Lincoln Limestone Member, are also recognized as part of the Greenhorn Limestone. Formation is 130 ft (40 m) thick Bridge Creek Limestone Member-Gray, massive, hard, dense, Bridge Creek Limestone Member—Gray, massive, hard, dense, limestone beds, 1-14 in. (2.5-35 cm) thick, separated by gray or brownish-gray, silty, calcareous, platy shale. Limestone commonly weathers shaly and yellowish gray. Contains several white and orange bentonite layers 3.5-8.5 in. (9-21.5 cm) thick. Sparsely fossiliferous, but contains Mytiloides labiatus and Greenhormoceras birchbyi in the upper part and Sciponoceras gracile in the lower part. Thickness is about 22 ft (7 m) Hartland Shale Member—Dark-brownish-gray, fissile, calcareous shale and thin lenses and beds of platy calcarenite. Contains shale and thin lenses and beds of platy calcarenite. Contains crushed specimens of <u>Inoceramus ginterensis</u> and many species of ammonites. The Hartland Shale Member in the NE1/4NW1/4 sec. 2

T. 27 N., R. 25 E., Colfax County, is metamorphosed, apparently by a buried intrusive body to a garnet-bearing rock. Thickness is about 97 ft (30 m) Lincoln Limestone Member--Dark-yellowish-brown, hard, crystalline calcarenite and limestone and interbedded, dark-gray, calcareous shale and bentonite. Contains <u>Inoceramus prefragilis</u> and Calycoceras? canitaurinum. At base is limestone coquina composed of Ostrea beloiti. Thickness is 11 ft (3 m)

Graneros Shale (Upper Cretaceous)—Dark-gray, blocky, noncalcareous shale containing orange bentonite layers. A few feet above the base is the 1-ft- (0.3-m-) thick, dark-yellowish-brown, hard Matcher Limestone Member that contains <u>Calycoceras</u> (Conlinoceras) gilberti. Thickness ranges from 73 to 84 ft (22 Dakota Sandstone and Purgatoire Formation, undivided (Upper(?) and Lower Cretaceous)—The Dakota Sandstone is chiefly thick-bedded, cliff-forming, white to light-gray, fine—to medium-grained, cross-stratified, quartz sandstone. The Dakota includes some conglomerate beds that weather yellowish gray to yellowish brown or dark brown. It also contains lenticular shale layers 5-10 ft (1.5-3 m) thick. The formation ranges from 80 to 110 ft (24 to 33 m) in thickness. The Purgatoire Formation consists of a dark-gray, silty, probably marine shale unit in the upper 20-30 ft (6-

gray, silty, probably marine shale unit in the upper 20-30 ft (6-9 m) and light-gray to white, fine- to medium-grained, crossbedded, quartzose sandstone in the lower part. Well logs show that the shale is discontinuous. The shale and sandstone units apparently are correlative with the Glencairn Shale Member nd the Lytle Sandstone Member, both members of the Purgatoire Formation in southeastern Colorado. The Purgatoire Formation ranges from 55 to 90 ft (17 to 27 m) in thickness
Morrison Formation (Upper Jurassic)—Varicolored calcareous claystone and siltstone interbedded with greenish-gray, gray, and brown ine- to medium-grained sandstone. Most sandstone beds are 1-10 t (0.3-3 m) thick; however, a basal, crossbedded sandstone in the canyon of the Canadian River is about 60 ft (18 m) thick and has a basal granule to peoble conglomerate (J-5? unconformity of Pipiringos and O'Sullivan, 1978, p. A25). The conglomerate contains fragments of jasper and balls of clay. Thickness of the Morrison probably averages about 350 ft (107 m) and ranges from Morrison Formation (Upper Jurassic), and the Bell Ranch Formation ar seter Sandstone (Middle Jurassic), undivided—Thickness about 0 ft (137 m). On Temple Dome, near the southeastern corner of quadrangle, the Morrison, Bell Ranch, and Exeter are mapped ogether because steep slopes on the dome make it impossible to map the units separately at the scale of this map sell Ranch Formation--Even-bedded, reddish-brown sandstone and eddish-brown and green claystone. Where New Mexico Highway 12

crosses the Canadian River, 10 mi (16 km) west of Roy, New Mexico and 6 mi (9.6 km) south of the Raton 1⁰ X 2⁰ quadrangle, the Bell Ranch Formation is divisible into three units: an upper 10-ft-(3-m-) thick unit of reddish-brown and green claystone, siltstone, and sandstone; a middle unit, 20 ft (6 m) thick, of evenly stratified evenly stratified, brown, sandstone beds interlayered with iltstone beds; and a lower unit about 60 ft (18 m) thick of thin-bedded, reddish-brown siltstone and sandstone. In most of the map area, the thickness probably averages about 50 ft (15 m) but is nearly twice that thick south and west of the map area

Exeter Sandstone—White to grayish-orange, cross bedded, massive
sandstone composed of very fine to fine, subrounded to rounded, quartz grains. The larger grains are frosted (Wanek, 1962) ch suggests an eolian origin. Thickness ranges from 40 to 110 ft (12 to 33 m) and averages about 50 ft (15 m) Rocks from Dakota Sandstone through Dockum Formation, undivided—On east flank of Palo Blanco Mountain in the southeastern part of the quadrangle, these rocks are thinned by the rhyodacite intrusive and impossible to map separately at the map scale. Identities and thicknesses of units in thinned zone are uncertain Dockum Formation (Upper Triassic)—Only the upper part of the Dockum Formation is exposed in the quadrangle and only at Temple Dome in the southeastern part near the southern border. Exposed part is chiefly reddish-brown to light-brown sandstone and minor retails hiefly reddish-brown to light-brown sandstone and minor pebble

conglomerate, interbedded, reddish-brown, micaceous siltstone and grayish-brown to gray, limestone-pellet, conglomerate yers. Contains sideritic ironstone nodules mostly 1 in. (2.5 n) or larger in diameter. Contains thick-shelled pelecypods (called <u>Unio</u> sp. by Griggs, 1948, p. 19) larger than 1 in. (2.5 cm) in length on southwest side of Temple Dome, in southeastern part of map area. Exposed thickness only a few hundred feet EMPLACEMENT AND CLASSIFICATION OF IGNEOUS ROCKS

Basalt and basanite flows in the northern part of the quadrangle and a large sill complex in the southeastern part form most of the igneous rocks i the Raton quadrangle. The sill complex consists of many sills separated by thin or thick layers of Cretaceous sedimentary rocks. The sills arch the upper sedimentary rocks almost a thousand feet. Multi-layered mafic and ultramafic sills also intruded rocks of the Raton and Vermejo Formations west and southwest of Raton. Mafic dikes are abundant in the area northwest of the ill complex. Although most igneous rocks are volcanic or subvolcani plutonic intrusive rocks, such as holocrystalline syenite, nepheline syenite, and quartz monzonite are present at Turkey Mountain. Igneous rocks have metamorphosed contiguous sedimentary rocks to varying degrees. Small grossularite garnets formed by contact metamorphism in one bed of limestone. Mafic dikes commonly metamorphosed their wall rocks to hornfels that is more resistant to weathering than the intruding dike. The hornfels border zone locally is as thick as 50 ft (15 m). The names of the igneous rocks described in this report were determined from x-ray fluorescence chemical analyses, using the classification devised by De la Roche and others (1980; see also Staatz, 1986,1987; and Scott and others, in press). This classification was used for both plutonic and volcanic rocks. Sixty-three chemical analyses of igneous rocks from within this quadrangle were used to determine the rock names. Eighteen analyses were supplied by M.H. Staatz; a few others were from previously published reports. Within each map unit (for instance, basalt) there are significant variations in composition. Thus, one rock unit may overlap into the compositional boundaries of <u>another</u> rock unit. In the case of the Capulin Basalt, for instance, the overlapping rock types, andesibasalt and latibasalt, are included in the description to illustrate the total compositional variation. Some rock units, such as the mafic dikes, are so variable in composition that, although all are black, fine-grained, mafic, igneous rocks mey cannot be separated into specific rock types without the use of thin ections and chemical analyses. Some of the mafic dikes include basanite, trachybasalt, and ankaratrite; many of the dikes are lamprophyric, but the individual types of lamprophyric rock were not identified.

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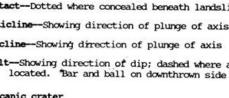
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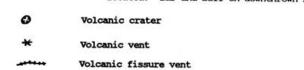
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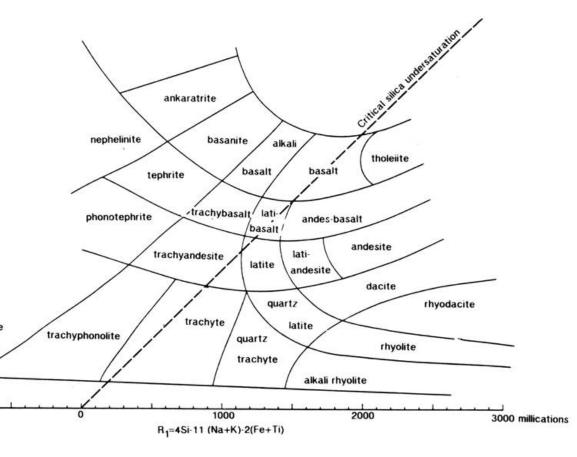
EXPLANATION

...... Contact--Dotted where concealed beneath landslide deposits Anticline-Showing direction of plunge of axis Syncline-Showing direction of plunge of axis Fault-Showing direction of dip; dashed where approximately

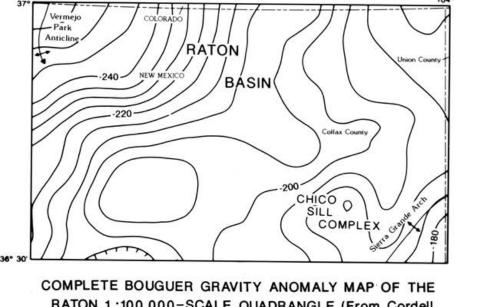




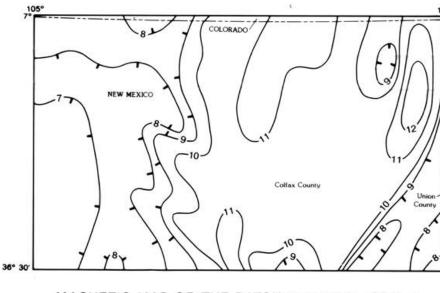
Paleovalley—Arrow indicates direction of flow



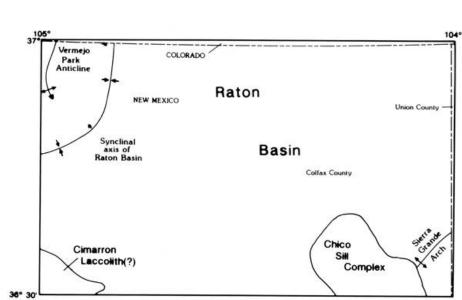
GRID FOR CLASSIFICATION OF IGNEOUS ROCKS (AFTER DE LA ROCHE AND OTHERS, 1980)



RATON 1:100,000-SCALE QUADRANGLE (From Cordell Keller, and Hildenbrand, 1982). Contour interval 5 milligals

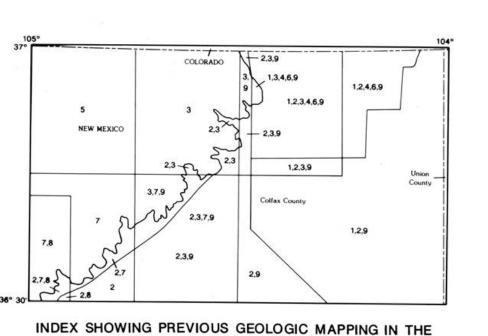


MAGNETIC MAP OF THE RATON 1:100,000-SCALE QUADRANGLE (From Zietz and Kirby, 1968) 100 gammas; datum arbitrary. Hachures show area of lower magnetic intensity. Main magnetic field of the Earth, supplied by the U.S. Coast and Geodetic Survey and based on Epoch 1955, has been removed from all aeromagnetic data (from



Zietz and Kirby, 1968)

SKETCH MAP SHOWING LOCATIONS OF MAJOR GEOLOGIC STRUCTURES IN THE RATON 1:100,000-SCALE QUADRANGLE



8. Wanek and others, 1964

9. Wood and others, 1953

RATON 1:100,000-SCALE QUADRANGLE Most of the area was remapped in 1980-1982. Numbers refer to authors of maps as follows: 1. Collins, 1949 6. Pillmore and Scott, 1976 2. Griggs, 1948 7. Wanek, 1963

3. Lee, 1922

4. Levings, 1951

5. Pillmore, 1969

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

llimanitic quartzite, and pegmatite from the Sangre de Cristo

Mountains, rhyolite from Ash Mountain, west of Vermejo Park;

part of the map, southwest of Raton. Sills are also present on Red River Peak, 2 mi (12 km) west of Clifton House, and the

ridges to the west, between Willow Canyon and Cottonwood Canyon