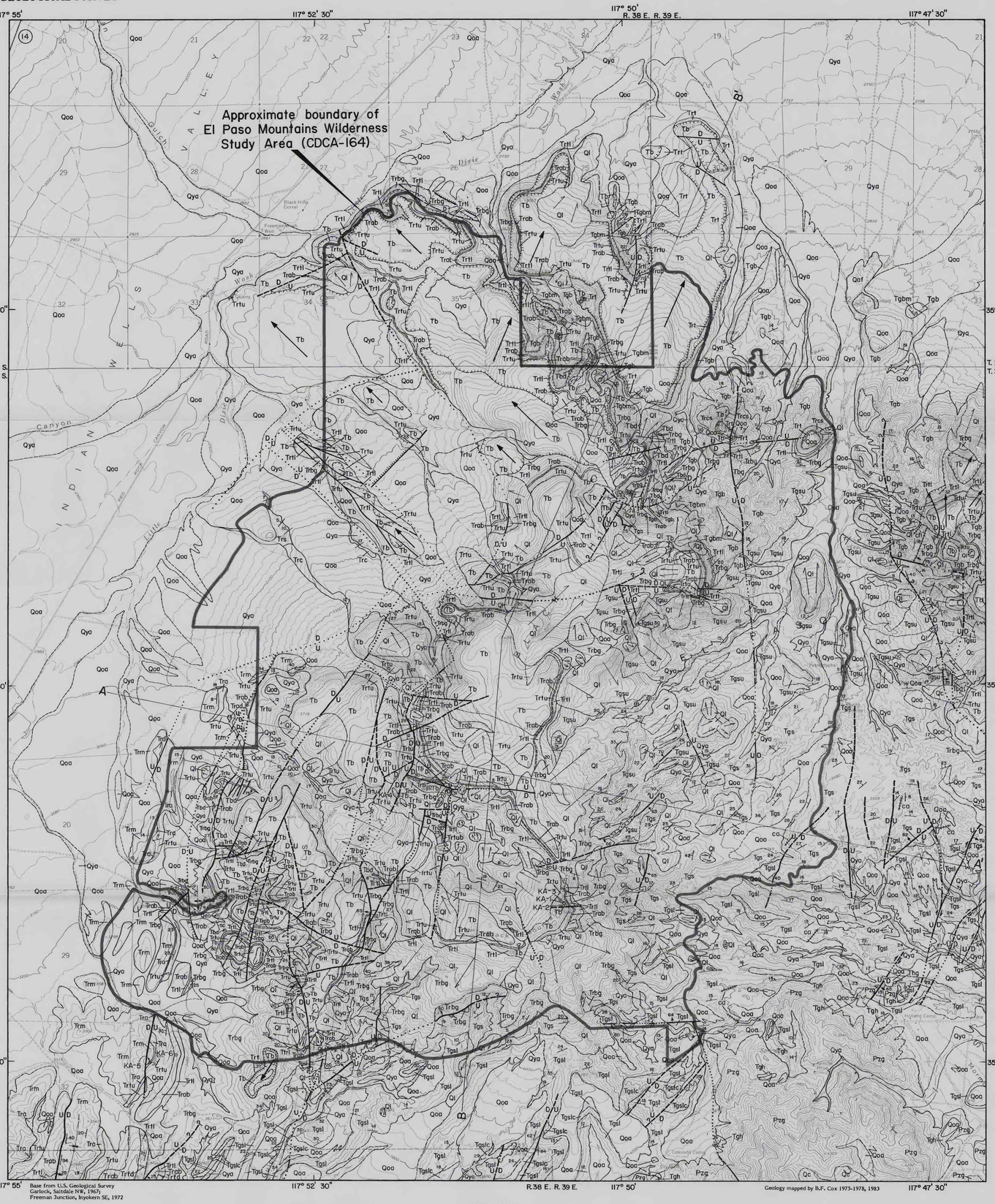
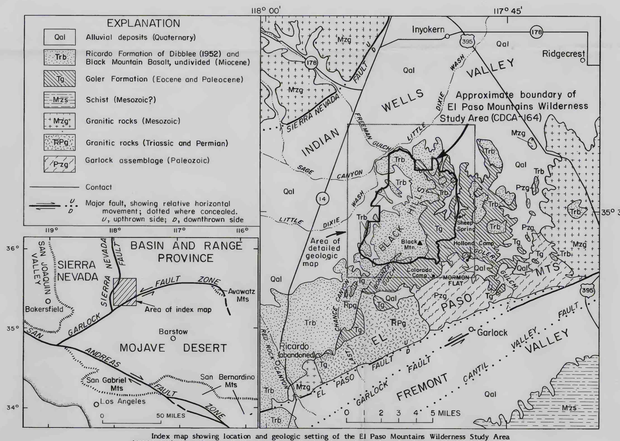
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1827





Index map showing location and geologic setting of the El Paso Mountains Wilderness Study Area (CDCA-164), Kern County, California. Generalized geology adapted from Jennings and others (1962), Cox (1982a, pl. 1), and this report. Inset map shows location of the index map area with respect to regional physiographic provinces and major fault zones.

GEOLOGIC MAP OF THE EL PASO MOUNTAINS WILDERNESS STUDY AREA, KERN COUNTY, CALIFORNIA

By

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1986

Explanatory pamphlet accompanies map

Interior—Geological Survey, Reston, Va.—1986

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225

CORRELATION OF MAP UNITS

DESCRIPTION OF MAP UNITS[1]

Qaf ARTIFICIAL FILL (HOLOCENE)— Piles of sand and gravel beside quarry in sec. 32, T. 27 S., R. 39 E.

Qya YOUNGER ALLUVIUM (HOLOCENE)—Unconsolidated light-gray sand and gravel; forms unweathered and undissected to slightly dissected deposits occupying modern washes, low stream terraces, alluvial fans, and landslide depressions. Texture varies from pebbly sand to boulder gravel

Qc COLLUVIUM (HOLOCENE)—Unconsolidated rubbly talus and slope-wash deposits on steep slopes. Deposits typically contain abundant blocks of the Black Mountain Basalt

Ql LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)—Detached blocks of strata and rubble produced by slumping on steep slopes. Most deposits consist of debris from the Black Mountain Basalt and underlying tuffaceous units (Trtu and Trtl) of the Ricardo Formation of Dibblee (1952). Large tilted masses of relatively unbroken strata are common in the headward regions of landslide blocks, whereas the distal regions consist of more thoroughly broken, chaotic mixtures of rubble. Large landslide masses on the flanks of Black Mountain consist of multiple slump units that are progressively older in a downhill direction. Landslide deposits highest on the slopes have youthful features, including undrained depressions and uneroded scarps in their head regions; these deposits are as young as late Holocene. Landslide deposits lower on the slopes are more eroded, forming isolated erosional remnants perched on hill tops, and are locally overlain by the older alluvium unit (Qoa); these deposits are Pleistocene and early Holocene in age. The unit excludes large slide blocks of intact strata as well as extensive sheets of unidentifiable debris; such large landslide blocks and sheets are delineated separately on the map with bold single arrows and a hachured-line symbol (see discussion in explanatory pamphlet)

Qoa OLDER ALLUVIUM (HOLOCENE AND PLEISTOCENE)—Unconsolidated to slightly consolidated alluvium ranging from pebbly sand to boulder gravel; moderately to strongly dissected. Color ranges from light yellowish gray to moderate orangish brown. A weathered zone of yellowish-orange or orangish-brown moderately indurated sand and gravel is present near the top of many deposits. Calcareous soil horizons are present in some of the deposits. Unit forms piedmont alluvial plain northwest of Little Dixie Wash, as well as numerous eroded remnants of small alluvial fans, pediment veneers, and stream-terrace deposits that radiate outward from Black Mountain. The extensive deposits northwest of Little Dixie Wash consist of relatively homogeneous sand and pebble gravel derived from granitic and basinal rocks of the Sierra Nevada. The eroded remnants southeast of Little Dixie Wash consist of texturally and compositionally heterogeneous pebbly sand to boulder gravel derived from nearby outcrops of the Goler Formation, the Ricardo Formation of Dibblee (1952), and the Black Mountain Basalt. The erosional remnants comprise a nested series of terrace-forming deposits, each typically no more than 30 ft thick, perched as much as 350 ft above the floors of modern canyons

RICARDO FORMATION OF DIBBLEE (1952) (MIOCENE)—Nonmarine sedimentary and volcanic rocks. Divided into

Trcs Conglomerate and sandstone—Pale-yellowish-gray pebbly sandstone and pebble-cobble conglomerate; weakly to moderately indurated. Correlation with type section of the Ricardo Formation as mapped by Dibblee (1952) is uncertain; probably equivalent to uppermost part of his member 7, which is best exposed southwest of the map area near Red Rock Canyon. Exposed thickness at northwest edge of Black Hills is approximately 150 ft, but top is concealed by alluvium. Lower third of exposure consists of homogeneous, well-sorted, very-fine-grained micaceous arkosic sand; upper two-thirds consist of poorly sorted, fine- to coarse-grained, volcaniclastic sandstone that contains abundant pumice fragments and subangular to subrounded pebbles of porphyritic andesite and rhyolite. The volcaniclastic sandstone forms thick, internally massive beds that commonly appear bioturbated; some beds contain abundant calcium carbonate that resembles caliche

Trs Sandstone—Pale-yellowish-gray to grayish-orange sandstone; weakly to moderately indurated. Correlation with type section of the Ricardo Formation as mapped by Dibblee (1952) is uncertain; probably equivalent to uppermost part of his member 7, which is best exposed southwest of the map area near Red Rock Canyon. Exposed thickness is approximately 300 ft, but base is concealed by alluvium, and unit probably is separated from the cherty mudstone unit (Trm) by a buried fault. Conglomerate contains subrounded to rounded pebbles and small cobbles of pink, lavender, and light-gray andesite and rhyolite. Interlayered lithic-arkose sandstone contains similar andesitic and rhyolitic detritus, and locally contains abundant vitric ash

Trm Cherty mudstone—Pale-yellowish-gray to pale-greenish-gray lacustrine deposits, including mudstone, ostracodal marlstone or argillaceous limestone, fine-grained tuffaceous sandstone, and altered fine-grained tuff; moderately to well indurated. Equivalent to northeast part of member 7 of the Ricardo Formation as mapped by Dibblee (1952). Exposed thickness near southwest corner of the map area is at least 450 ft; however, top of unit is concealed by alluvium, and total exposed thickness is unknown due to faulting. Abundant secondary silica occurs as disseminated cement and as large irregular masses of white, gray, and brown chert. Silicified roots or stems are also common. Conglomerate and pebbly sandstone that are present locally near the base of the unit contain angular clasts of greenish-gray andesite eroded from the disconformably underlying andesite flows unit (Tra). Imbrication of these clasts indicates that the conglomerate was deposited by northward-flowing streams

Tra Andesite flows—Dark-gray to dark-greenish-gray aphanitic-porphyritic andesite. Equivalent to andesite flow B in member 2 of the Ricardo Formation as mapped by Dibblee (1952). Lenticular deposits and erosional remnants of the andesite crop out discontinuously near the southwest corner of the study area. Within the area of the map, the unit is no more than 40 ft thick and many outcrops apparently consist of a single flow; southwest of the map area, in Last Chance Canyon, the unit locally is as much as 150 ft thick and comprises several flows. The andesite contains phenocrysts of plagioclase and sparse altered grains of ferromagnesian minerals in an aphanitic pilotaxitic groundmass of plagioclase microlites and abundant interstitial opaque minerals. A conspicuous platy fracture is developed parallel to the pilotaxitic fabric. Two potassium-argon ages and two major-element analyses were obtained for the unit (tables 1 and 2 in explanatory pamphlet). The radiometric ages consist of a whole-rock age of 17.2±0.8 m.y. (sample EP103A), and a mineral age of 14.0±0.4 m.y. on plagioclase (sample GA88); the latter of these two ages probably is unreliable. Both radiometric-age samples were collected about midway between the base and top of the unit; the plagioclase separate is from the thickest deposit of andesite flows, located outside the area of the map about 2 mi south of the southwest corner of the map area

Trad Andesite dike—Dark-green-gray aphanitic-porphyritic andesite forming a single small body, 300 ft long and elliptical in map view, that intrudes the upper tuff unit (Trtu) approximately 3 mi northwest of the east summit of Black Mountain. The andesite dike is very similar in mineralogy and texture to the andesite flows unit (Tra) and probably fills a conduit that fed the andesite flows unit

Trtu Upper tuff—Lapilli-ash tuff, interlayered with lesser amounts of ash tuff and tuffaceous sandstone; moderately indurated. Equivalent to the upper tuff-breccia unit in member 2 of the Ricardo Formation as mapped by Dibblee (1952). Unit thickens southwestward from 50 to 75 ft near Black Mountain and northeast end of the Black Hills, to as much as 300 to 400 ft near the southwest end of the Black Hills. Principal lithology is homogeneous pale-gray to pale-grayish-orange lithic-vitric lapilli-ash tuff that forms structureless cliff-forming beds ranging from 10 to 100 ft thick. These beds were deposited as unwelded ash flows. Most lapilli in the tuff measure 2 in. or less in diameter and are composed of silicic pumice, perlite, and a diverse assemblage of andesitic to rhyolitic volcanic rocks. A major-element analysis of pumice lapilli (table 2 in explanatory pamphlet) indicates a rhyolitic composition. The lapilli are surrounded by an ash matrix consisting of glass shards, small pumice fragments, and sparse crystals of plagioclase, quartz, and ferromagnesian minerals. The lapilli-ash tuff is locally interstratified with brownish-gray, poorly sorted, tuffaceous pebbly sandstone that forms structureless beds 10 to 30 ft thick. These thick beds of pebbly sandstone, displayed most prominently 2 to 3 mi west-northwest of the east summit of Black Mountain, probably are volcanogenic debris-flow deposits. White ash tuff and interstratified olive-gray to brownish-gray tuffaceous sandstone each comprise beds 4 in. to 6 ft thick that are abundant locally, especially near the base of the unit. Northwest of Black Mountain, unit contains a local basalt flow that is mapped separately:

Trtub Basalt flow—Dark-gray olivine basalt. Forms a single highly vesicular autobrecciated flow, approximately 15 ft thick, located near the middle of the upper tuff unit about 1 mi northwest of the east summit of Black Mountain. The basalt contains abundant phenocrysts of plagioclase and olivine, sparse small phenocrysts of hypersthene and pigeonite, and sparse glomeroporphyritic clusters of hypersthene that are bordered by pigeonite and olivine. In thin section, most phenocrysts of plagioclase and pyroxene are strongly corroded. Fine-grained pilotaxitic groundmass consists of plagioclase, olivine, and magnetite or ilmenite. A major-element analysis was obtained for the basalt (table 2 in explanatory pamphlet)

Trab Andesite breccia—Flow breccia and sedimentary breccia containing clasts of porphyritic andesite and dacite; moderately to well indurated. Equivalent to andesite flow A in member 2 of the Ricardo Formation as mapped by Dibblee (1952). At the southwest corner of the map area, the unit is approximately 200 ft thick and consists predominantly of unstratified flow breccia. Farther northeast, on Black Mountain and throughout the Black Hills, the unit typically is only 10 to 40 ft thick and is locally absent. In this northeastern region, the unit consists largely of unstratified cobble and boulder sedimentary breccia of probable debris-flow origin; lenses of flow breccia are present locally. Deposits of light-gray to dark-gray andesitic sandstone commonly underlie the deposits of sedimentary breccia and locally form the entire thickness of the unit. Most of the clasts in the flow breccia and sedimentary breccia are composed of moderate- to dark-brownish-gray andesite and dacite that weather light to dark reddish brown. Abundant phenocrysts of plagioclase and sparse altered phenocrysts of hypersthene, augite, and olivine are enclosed by an aphanitic pilotaxitic groundmass of plagioclase microlites and interstitial cryptocrystalline material that probably includes devitrified glass. The andesite flow breccia has yielded a potassium-argon whole-rock age of 18.1±1.2 m.y. (table 1, sample EP208A). Two major-element analyses were obtained for flow-breccia clasts (table 2 in explanatory pamphlet).

Trtl Lower tuff—Lapilli-ash tuff, ash tuff, and tuffaceous sandstone; moderately indurated. Equivalent to lower tuff-breccia unit and underlying tuff-and-ash unit in member 2 of the Ricardo Formation as mapped by Dibblee (1952). The unit generally thickens eastward; locally it appears to be missing along the west edge of the Black Hills northwest of Black Mountain; it is approximately 100 ft thick near the southwest and northwest margins of the Black Hills, 150 ft thick at Black Mountain, and at least 200 ft thick on buttes along the east boundary of the map area. The lower one-third to one-half of the unit contains several beds of white ash tuff and lapilli-ash tuff that are interlayered with beds of pale-gray to moderate-grayish-brown tuffaceous sandstone. The tuff beds are 2 to 30 ft thick and are composed of vitric ash and sparse to abundant pumice lapilli; grains of quartz and feldspar that apparently represent accidental ejecta of granitic origin are disseminated sparsely through some of the beds. Some beds are structureless and apparently consist of air-fall tuff; others are laminated and clearly have been reworked by streams. The interlayered beds of tuffaceous sandstone include laminated stream deposits as well as structureless beds that may be volcanogenic mud-flow deposits. The upper one-half to two-thirds of the unit consists of a cliff-forming bed of orange-pink lapilli-ash tuff that ranges from less than 40 ft to more than 100 ft thick. This tuff bed consists of several structureless layers, each containing lapilli and small blocks of pumice, perlite, and distinctive grayish-red laminated felsite ranging up to 4 in. (locally up to 10 in.) in diameter. A major-element analysis of pumice lapilli collected near the base of the bed (table 2 in explanatory pamphlet) indicates a dacitic composition. The clasts of pumice, perlite, and felsite are disseminated through a vitric-ash matrix composed of glass shards, small pumice fragments, and sparse crystals of feldspar and quartz. Near the northeast end of the Black Hills, the lowest part of the tuff bed is white to pale gray and contains abundant fragments of nonvolcanic rocks, including monzogranite, granodiorite, and quartz diorite, that measure as much as 4 in. across. In both texture and structure, the thick bed of pink tuff closely resembles principal lithology of the upper tuff unit (Trtu) and, like the latter, consists of unwelded ash flows

Trfd Felsic dike—Light-gray pumiceous rhyolite or dacite forming a vertical tabular dike approximately 10 ft wide with glassy chilled margins. Intrudes the lower tuff unit (Trtl) near southwest corner of the map area. Consists of two dike segments, offset by east-dipping low-angle fault, located approximately 0.15 mi and 0.3 mi southeast of SE corner sec. 32, T. 28 S., R. 38 E.

Trt Tuffaceous rocks, undivided—Consists of the lower tuff unit (Trtl), upper tuff unit (Trtu), and minor amounts of the andesite breccia unit (Trab) occurring with landslide sheets at the northeast edge of the Black Hills. Units are strongly brecciated and mechanically thinned but generally preserve original stratigraphic order

Trbg Conglomerate unit of Bonanza Gulch—Pale-gray and pale-grayish-brown granitic conglomerate and arkosic sandstone; weakly to moderately indurated and generally nonresistant. Equivalent to member 1 of the Ricardo Formation as mapped by Dibblee (1952). Maximum thickness of 600 to 800 ft is exposed on northeast and southwest flanks of Black Mountain. From there, the unit thins toward both the southwest and northeast; it is approximately 250 ft thick near the southwest corner of the map area, and crops out discontinuously in deposits 10 to 100 ft thick in the northeastern Black Hills. The unit fines upward. The lowermost 200 to 300 ft contain abundant lenses of coarse-grained cobble conglomerate that grade laterally and vertically into pebbly sandstone. The coarsest deposits, typically located within 30 ft of the base of the unit, contain abundant granitic boulders as much as 3 ft in diameter. The uppermost 300 to 600 ft of the unit consist of interlayered pebbly granule conglomerate and pebbly arkosic sandstone, with only sparse lenses of cobble conglomerate. The relatively fine-grained sandy deposits tend to be resistant and crop out as low ledges; horizontal lamination and trough cross-bedding are common in these deposits. Throughout the unit, clasts are predominantly angular to subrounded and consist mostly of plutonic rocks including granite, granodiorite, quartz diorite, and tonalite. Clasts of metavolcanic rocks, quartzite, chert, and siliceous argillite are present in lesser amounts. Subrounded to well-rounded cobbles and small boulders of metavolcanic rocks, quartzite, and silicic plutonic rocks that are locally abundant near the base of the unit probably were in large part recycled from underlying conglomeratic deposits of the Goler Formation. Prominent clast imbrication and channeling indicate that the unit was deposited by northwest-flowing streams. Unstratified to crudely bedded conglomerate in the uppermost 20 to 60 ft of the unit on the northeast face of Black Mountain may include debris-flow deposits. A zone of clay-rich sandstone and conglomerate that ranges from several feet to several tens of feet thick is commonly present at the top of the unit. The clay may have been produced by weathering of the conglomerate; alternatively it may have been translocated from overlying deposits of ash tuff

Tb BLACK MOUNTAIN BASALT (MIOCENE)—Flows of dark-gray olivine-augite basalt. Forms cliffs at and northwest of Black Mountain, where the basalt is relatively unfractured; forms rubbly slopes in most other areas owing to intense fracturing by faulting and landsliding. The unit thins westward to an abrupt termination near the southwest margin of the Black Hills. This termination is preserved only at one small outcrop, 2.7 mi northwest of the east summit of Black Mountain, where the basalt pinches out westward beneath the cherty mudstone unit (Trm) of the Ricardo Formation of Dibblee (1952). Everywhere else, superjacent strata have been eroded away so the original thickness of the basalt is unknown. The present thickness is approximately 200 ft on the northeast face of Black Mountain, where as many as 15 superimposed flows are well exposed. A greater unit thickness, possibly exceeding 300 ft, occurs 2.2 mi north-northwest of the east summit of Black Mountain. The basalt contains sparse phenocrysts of plagioclase and olivine in a holocrystalline fine-grained intergranular to subophitic groundmass of plagioclase, augite, olivine, and ilmenite or magnetite. Olivine commonly is partly or completely altered to iddingsite. There are no conspicuous reaction relations between olivine and pyroxene. Abundant ellipsoidal vesicles contain fillings of chalcedony, calcite, and zeolite minerals. Diktytaxitic texture is rarely present. Four potassium-argon whole-rock ages (table 1 in explanatory pamphlet) range from 17.9±1.6 m.y. (sample EP302A) near the base of the unit to 15.1±0.3 m.y. (sample G49C) near the top. Five major-element analyses were obtained for the basalt (table 2 in explanatory pamphlet)

Tbd BASALT DIKES (MIOCENE)—Dark-gray to dark-greenish-gray olivine-augite basalt; commonly weathering reddish brown. Unit forms several dikes, the largest approximately 300 ft wide and 3000 ft long, that are prominently exposed near the southwest and northeast ends of the Black Hills. The dikes intrude strata up to and including the upper tuff unit (Trtu) of the Ricardo Formation of Dibblee (1952). Similar dikes are present southwest of the map area (Dibblee, 1952; Cox, 1982a, pl. 1). The basalt dikes characteristically trend approximately east-west, but a large dike in the northeastern Black Hills trends north-south. The basalt contains sparse phenocrysts of plagioclase and olivine in a holocrystalline fine-grained optitic to subophitic groundmass of plagioclase augite, olivine, and ilmenite or magnetite. Olivine commonly is partly or completely altered to iddingsite. The basalt is locally vesicular and contains amygdules of chalcedony, calcite, and zeolite minerals. A large dike located about 1.3 mi southwest of the study area yielded a potassium-argon whole-rock age of 17.3±0.5 m.y. (table 1 in explanatory pamphlet, sample EP111A). A major-element analysis was also obtained for this dike (table 2 in explanatory pamphlet). The dikes apparently were feeders for the Black Mountain Basalt, which is very similar in texture, mineralogy, chemistry, and age

GOLER FORMATION (EOCENE AND PALEOCENE)—Sedimentary rocks, mostly nonmarine. Divided into

Tgb Conglomerate unit of Black Hills (Eocene and Paleocene?)—Pale-gray to pale-yellowish-brown cobble conglomerate and subordinate mudstone and pebbly sandstone. Moderately indurated, generally nonresistant; forms low rounded hills at northeast end of the Black Hills. Equivalent to part of member 2 of the Goler Formation as defined by Dibblee (1952), but located north of the area of his map (1952, pl. 1). Top is not exposed and total thickness of the unit is consequently unknown. Exposed thickness is at least 800 ft near the northeast end of the Black Hills. The unit fines upward and westward. The lower half consists mostly of cobble conglomerate with sparse beds of pebbly sandstone; boulders ca. much as 2 ft in diameter are common near the east margin of the map area, whereas the largest clasts in the westernmost outcrops do not exceed 1 ft in diameter. In the upper half of the unit, cobble conglomerate is interlayered with abundant beds of sandstone and contains a thick bed of marine mudstone (subunit Tgbm). Throughout the unit, the cobble conglomerate consists of structureless to crudely horizontally stratified layers 1 to 15 ft thick. Subrounded to rounded clasts of silicic metavolcanic rocks are most abundant (50 to 70 percent), followed by subrounded to well-rounded clasts of laminated and cross-laminated quartzite (20 to 40 percent) and granitoid rocks (5 to 15 percent). Prominent clast imbrication indicates that the conglomerate was deposited by west-northwest-flowing streams. Subordinate sandstone consists of medium- to coarse-grained, moderately to well-sorted, pebbly lithic arkose that forms beds 1 to 10 ft thick. The sandstone is grayish white, pale grayish yellow, pale yellowish brown, or moderate yellowish orange, and generally is uncemented. Tabular zones and large (1 to 6 ft diameter) ellipsoidal concretions of dark-grayish-brown calcite-cemented sandstone are present locally, particularly near the tops of sandstone beds. The sandstone is mostly horizontally laminated but locally contains trough and tabular cross-bedding. It is composed of subangular to angular grains of quartz, silicic metavolcanic rocks, potassium feldspar, plagioclase, and fine-grained quartzite. Thick deposits of marine mudstone in the conglomerate unit of Black Hills are mapped separately:

Tgbm Mudstone (Eocene)—Pale-yellowish-gray argillaceous siltstone containing abundant thin (2 to 10 in.) tabular interbeds of pale-grayish-yellow very-fine-grained to medium-grained feldspathic sandstone; soft, nonresistant, weathers to low relief. Interbedded with cobble conglomerate near base and top. Deposits as much as 60 to 80 ft thick are exposed in five separate areas near the north end of the Black Hills. These separate outcrops probably represent a single layer that is repeated by folding and faulting. The siltstone typically is slightly calcareous, and contains sparse thin (4 to 20 in.) layers of grayish-white-weathering indurated calcareous siltstone. The siltstone typically is laminated; burrowing locally is abundant especially in sandstone interbeds. Fine-grained carbonaceous detritus is locally abundant in layers of sandstone and coarse-grained siltstone. Marine dinoflagellate fossils have been identified in samples of carbonaceous siltstone from a mine dump in the center of NE 1/4 SW 1/4 sec. 36, T. 27 S., R. 38 E. (Cox and Edwards, 1984). The adjacent mine shaft, now completely filled by alluvium, is shown on the map. A lucinid pelecypod (identified by E.J. Moore, written commun., 1984) was collected from an indurated layer of calcareous siltstone 950 ft S.40° E. from the mine shaft. Benthic and planktic foraminifers have been identified in samples from the mine dump and from the southernmost outcrop of the mudstone subunit about 5750 ft S. 10° E. of the SW corner of sec. 31, T. 27 S., R. 39 E.; the benthic and planktic assemblages both indicate an early Eocene age (K.A. McDougall, written commun., 1985; G. Keller, oral commun., 1983)

Tgsu Upper sandstone and siltstone (Eocene? and Paleocene)—Pale sandstone and variegated siltstone with minor amounts of pebble and cobble conglomerate; moderately indurated. Equivalent to part of member 2 of the Goler Formation as mapped by Dibblee (1952). Forms colorful badlands 1 to 2 mi northeast of Black Mountain, where the unit is approximately 2500 ft thick. The sandstone and siltstone are rhythmically interlayered in approximately equal amounts. The sandstone typically is grayish white to pale yellowish brown, horizontally laminated, and locally contains trough and tabular cross-bedding. It typically consists of medium-grained, moderately to well-sorted lithic arkose which is grossly similar in composition to sandstone in the overlying conglomerate unit of Black Hills. The sandstone comprises sedimentation units 1 to 6 ft thick that commonly are stacked to form composite beds as much as 23 ft thick. Fossil branches and logs, replaced by calcite and goethite, are common in the thickest composite sandstone beds. Subrounded to well-rounded pebbles and small cobbles of metavolcanic rocks, granitoid rocks, and quartzite are distributed sparsely through the sandstone beds and form sparse lenticular beds of conglomerate 1 to 25 ft thick. Siltstone is variably olive, grayish green, yellowish brown, or reddish brown, and forms layers as much as 30 ft thick. Dark-gray carbonaceous siltstone is present locally, typically interlayered with fine-grained sandstone. Vertebrate fossils of middle Paleocene age have been reported in situ near the base of the unit (McKenna, 1960, locs. V-3292, site 1; V-5502 = V-3292, site 3; and V-3870 and from Quaternary alluvium that apparently was derived from the middle part of the unit (West, 1970)

Tgs Conglomerate and sandstone unit of Sheep Spring (Paleocene)—Pale-gray to pale-yellowish-brown cobble conglomerate and pebbly sandstone, with minor olive siltstone and gray limestone. Moderately indurated, showing variable resistance to erosion. Equivalent to part of member 2 of the Goler Formation as mapped by Dibblee (1952). Approximately 2150 ft thick where best exposed northwest of Mormon Flat. The unit fines westward near the east margin of the map area, thick intervals of cobble conglomerate are interlayered with lesser amounts of pebbly sandstone; approximately 2.5 mi northeast of Black Mountain, the intervals of cobble conglomerate grade westward into pebbly sandstone and minor siltstone; south of Black Mountain, the unit consists of interlayered pebbly sandstone and abundant siltstone. Conglomeratic parts of the unit resemble the conglomerate unit of Black Hills but contain relatively few quartzite clasts (0 to 5 percent) and greater amounts of metavolcanic clasts (80 to 90 percent) and granitoid clasts (10 to 20 percent). One-half mile northeast of Black Mountain the unit contains impressive cliff-forming composite sandstone layers ranging up to 75 ft thick, in which planar cross-bedding is locally very abundant. Cross-bedding and clast imbrication indicate that the sandstone and conglomerate were deposited by streams flowing west or west-northwest. Siltstone is generally similar to that found in the overlying upper sandstone and siltstone unit (Tgsu) but is almost exclusively olive or greenish gray. Moderate-gray micritic argillaceous limestone forms a local lens approximately 5 to 10 ft thick intercalated within a siltstone-rich interval south of Black Mountain. Paleocene vertebrate fossils have been reported from the lower half of the unit north of Mormon Flat (McKenna, 1960, loc. V-3871)

Tgsl Lower sandstone and siltstone (Paleocene)—Pale sandstone, variegated siltstone and silty sandstone, and minor pebble and cobble conglomerate; moderately indurated. Equivalent to part of member 2 of the Goler Formation as mapped by Dibblee (1952). Forms colorful badlands south and east of Black Mountain. Thickness varies markedly owing to deposition across an irregular bedrock surface; from approximately 1,425 ft near Mormon Flat, thickness decreases to 1000 ft where unit crosses large bedrock ridge west of Mormon Flat, and increases gradually southwestward to approximately 3,700 ft near Bonanza Gulch. Unit consists of thick (5 to 20 ft) resistant beds of grayish-white to pale-yellowish-brown arkosic sandstone, rhythmically interlayered with thicker (5 to 50 ft) recessive intervals of variegated siltstone and poorly sorted silty sandstone. The resistant sandstone beds locally contain tabular zones and large (1 to 6 ft diameter) ellipsoidal concretions of dark-grayish-brown calcite-cemented sandstone. Most beds are structureless or horizontally laminated, but trough cross-bedding is present locally. The sandstone typically is moderately sorted, subangular to angular, medium to very coarse grained, and commonly grades into granule conglomerate. Lenses of pebble conglomerate are common near the base of thick sandstone beds; most of the pebbles are subrounded clasts of granitoid rocks, but subangular pebbles of quartzite, quartzite, and chert are locally abundant in the lower half of the unit. Intraformational siltstone clasts and water-deposited fossil logs are also common in the conglomerate lenses. Sedimentary structures indicate that the sandstone and associated pebble conglomerate were deposited by southward-flowing streams. The interlayered intervals of nonresistant strata consist of siltstone interbedded with poorly sorted micaceous silty sandstone. Reddish-brown siltstone and silty sandstone are particularly abundant, whereas grayish-brown and greenish-gray siltstone and grayish-white silty sandstone are present in lesser amounts. Dark-gray carbonaceous siltstone and lignite are present locally, and are associated with sparse thin (4 to 15 in.) stratiform lenses of colloform goethite and goethite-impregnated sandstone near Colorado Camp. A layer of cobble conglomerate in the lower part of the unit is mapped separately:

Tgslc Cobble conglomerate—Pale-grayish-brown cobble conglomerate and minor pale-yellowish-brown pebbly sandstone; moderately indurated. Forms low ridges that project above less resistant strata of the lower sandstone and siltstone unit near south margin of the map area. The layer on the map is approximately 100 ft thick where best exposed north of Colorado Camp. Two similar conglomerate layers are present lower in the same unit south of the map area (Cox, 1982a, pl. 1); all three layers pinch out eastward before reaching the bedrock ridge east of Colorado Camp. The cobble conglomerate subunit contains subrounded to rounded pebbles and cobbles of metavolcanic rocks, granitoid rocks, and quartzite, in a sparse to abundant sandy matrix. Lenses of pebbly lithic-arkose sandstone are locally abundant. Clast imbrication indicates that the subunit was deposited by west-northwest-flowing streams. The subunit closely resembles typical conglomeratic deposits of the conglomerate and sandstone unit of Sheep Spring (Tgs) in all details of texture, sedimentary structure, clast composition, and paleocurrent trend

Tgh Sedimentary breccia unit of Holland Camp (Paleocene)—Dark-reddish-brown pebble-cobble breccia and pebbly mudstone; moderately to well indurated, forming craggy outcrops. Equivalent to part of member 1 of the Goler Formation as mapped by Dibblee (1952). Forms several isolated upward-fining deposits as much as 900 ft thick that are nestled in depressions on the bedrock surface between Colorado Camp and Mormon Flat. Unit consists of thick (1 to 10 ft) structureless beds of poorly sorted breccia and pebbly mudstone containing angular to subangular clasts of chert, argillite, and quartzite that are similar to lithologies in the underlying Garlock assemblage. An abundant matrix of clay, silt, or sand is typically present. Most of the unit was probably deposited by debris flows and muddy streams. Some of the deposits, particularly those 1.2 mi northeast of Colorado Camp, contain very little matrix and may represent talus deposits

Pz g GARLOCK ASSEMBLAGE (PALEOZOIC)—Eugeoclinal metasedimentary and metavolcanic rocks consisting predominantly of chert, argillite, siltstone, and quartzite. Subordinate lithologies include feldspathic sandstone, quartz- and chert-pebble conglomerate, limestone and marble, metabasalt, meta-andesite, and metatuff. Age ranges from Ordovician to Permian. The rocks have been folded isoclinally and metamorphosed to the greenschist facies

75 90 CONTACT—Dashed where approximately located. Arrow indicates dip cross bar indicates vertical contact

60 U D FAULT—Dashed where approximately located; dotted where concealed; queried where doubtful. Single arrow indicates dip. Paired arrows indicate sense of lateral-slip on oblique-slip faults. U, upthrown side; D, downthrown side

FAULT SCARF—Hachures indicate direction that scarp faces

75 VEIN—Mineral that fills vein or impregnates walls of fracture is indicated by letter symbol ca, calcite; ch, chalcedony and opal. Arrow indicates dip

ANTICLINE—Showing direction of plunge. Dashed where approximately located

SYNCLINE—Dashed where approximately located

STRIKE AND DIP OF BEDS

25 Inclined

84 Overturned

Horizontal

⊙ KA-3 RADIOMETRIC-AGE SAMPLE LOCALITY—Numbers refer to text and table 1 of accompanying explanatory pamphlet.

LANDSLIDE DEPOSIT—Tilted blocks of strata and broken rubble produced by slumping. Many of the landslide masses consist of multiple slump units. Arrows indicate inferred direction of movement.

Tb Trl LANDSLIDE SHEET OR BLOCK—Includes large sheets of monolithologic rubble as well as large stratigraphically coherent blocks that contain two or more rock units. Constituent rock units are labelled within blocks. Hachured line indicates outcropping major surface of dislocation within or at base of slide mass. Arrow indicates inferred direction of movement.

[1] See accompanying pamphlet for references cited.