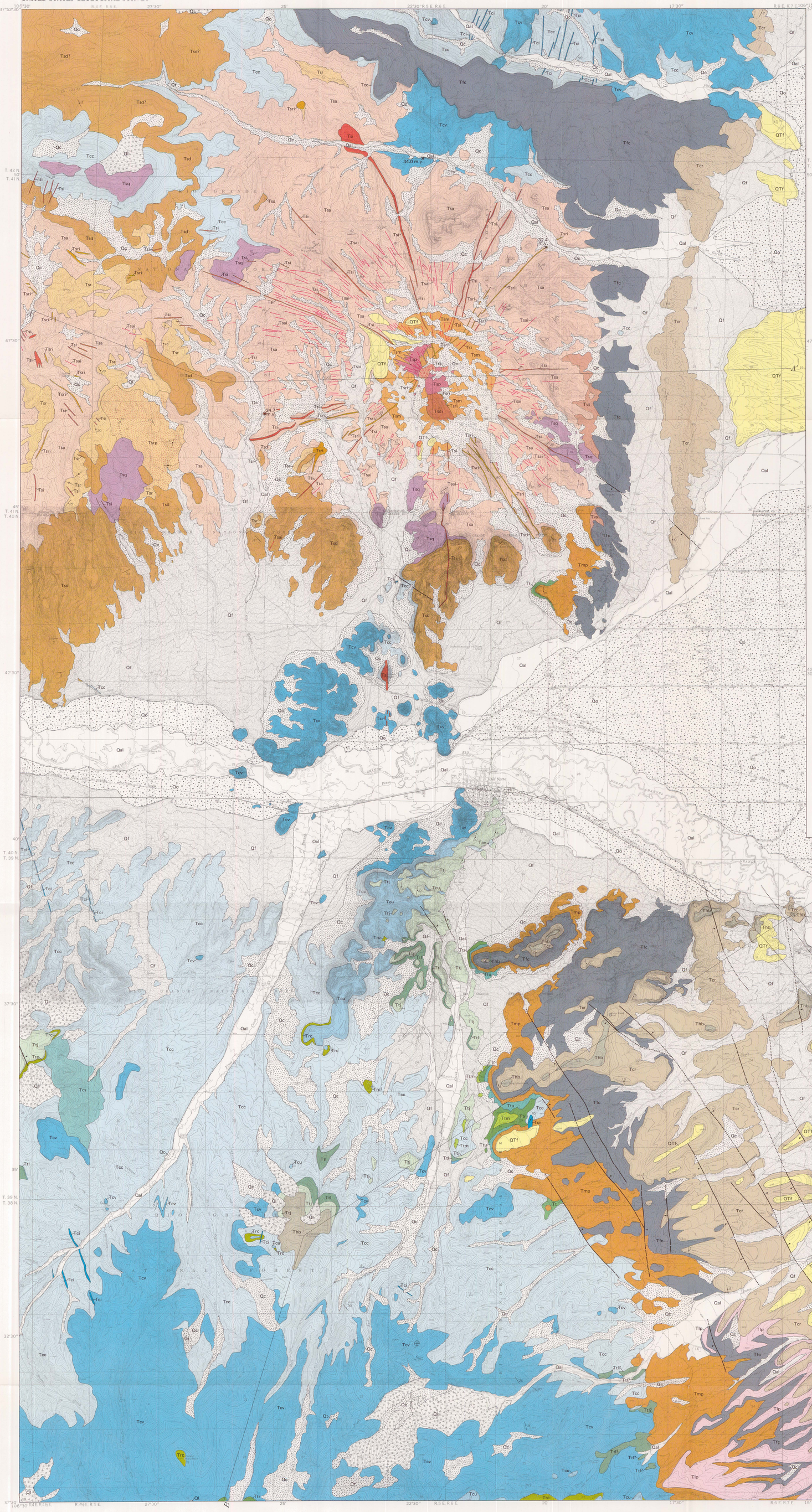
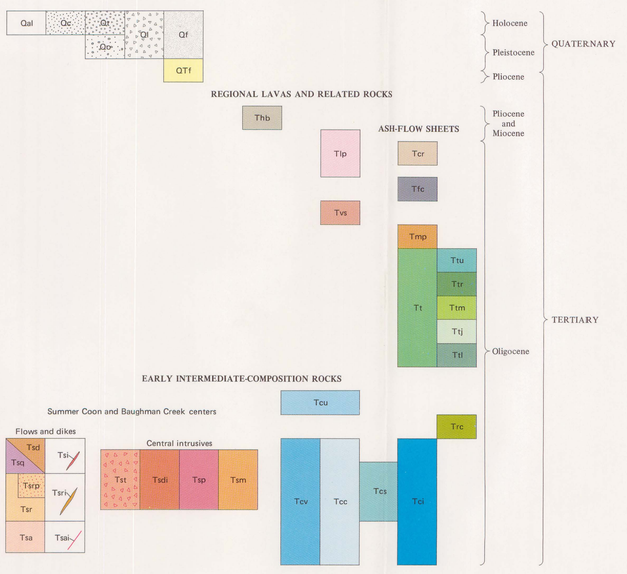
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-952



CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

K–Ar ages are from Lipman, Steven and Mehnert (1970)

SURFICIAL DEPOSITS

Qal Alluvium (Holocene) – Silt, sand, gravel, and peaty material in valley bottoms. Locally includes minor alluvial-fan and colluvial deposits at margins of valleys

Qc Colluvium (Holocene) – Poorly sorted material on slopes, ranging from silt to boulders. Locally includes small alluvial-fan, talus, landslide, and glacial moraine deposits

Qt Talus deposits (Holocene) – Angular rock fragments as much as 1 m in diameter, forming talus cones, talus aprons, and scree slopes. Locally well sorted. Grades into colluvium (Qc) with increase in sand and silt content

Ql Landslide deposits (Holocene and Pleistocene) – Poorly sorted rock debris derived from bedrock and glacial deposits; includes block-slide, slump, and earthflow deposits

Qo Glacial outwash (Pleistocene) – Fairly well sorted to well-sorted stratified terrace and fan deposits consisting of sand, gravel, and rounded boulders. Mostly of Pinedale age

Qf Alluvial-fan deposits (Holocene and Pleistocene) – Generally poorly sorted material, ranging from silt to boulders, which grades into colluvium (Qc) in upper parts of drainages. Only large low-angle fans are shown; most small steep fan deposits are mapped with colluvium. Fan deposits largely predate Pinedale outwash and are mostly derived from unglaciated drainages, but probably locally include some pre-Pinedale outwash

QTf Older fan deposits (Pleistocene and Pliocene) – Dissected alluvial-fan deposits of uncertain age along west margin of the San Luis Valley. Locally overlie youngest basalt flows of the Hinsdale Formation (Thb). Some older fan deposits that concordantly overlie Carpenter Ridge Tuff (Tcr) may be equivalent to youngest parts of the Los Pinos Formation (Tlp)

REGIONAL LAVAS AND RELATED ROCKS

Thb Hinsdale Formation (Pliocene and Miocene) – Fine-grained lava flows of silicic alkali-olivine basalt and basaltic andesite. Small sparse olivine phenocrysts, partly altered to iddingsite, are typical. Erosional remnants cap scattered mesas. Thickness 0–50 m

Tlp Los Pinos Formation (Pliocene to Oligocene) – Bedded conglomerate, sandstone, and mudflow breccia containing rhyodacite and quartz latite clasts derived from stratovolcanoes on the flanks of the Platoro caldera to the southwest. Thickness 0–40 m

Tvs Volcanic sandstone and conglomerate (Oligocene) – Local debris eroded from higher parts of the Summer Coon volcanic center. Thickness 0–25 m

ASH-FLOW SHEETS

Tcr Carpenter Ridge Tuff (Oligocene) – Nonwelded light-gray to densely welded red-brown rhyolitic ash-flow sheet containing 2–3 percent phenocrysts (mainly plagioclase, sanidine, biotite). Basal black vitrophyre and central lithophysal zone are conspicuous. Remanent magnetic polarity: reverse. Erupted about 27.5 m.y. (million years) ago from the Bachelor caldera (see index map). Thickness 0–75 m

Tfc Fish Canyon Tuff (Oligocene) – Nonwelded light-gray to moderately welded tan quartz latitic ash-flow sheet containing 35–50 percent phenocrysts (mainly plagioclase, sanidine, biotite, hornblende). Presence of sparse resorbed quartz, accessory sphene and hornblende, and absence of augite are distinctive characteristics. K–Ar age 27.8 m.y. Remanent magnetic polarity: normal. Erupted from the La Garita caldera (see index map.) Thickness 0–100 m

Tmp Masonic Park Tuff (Oligocene) – Nonwelded gray to partly welded yellow-brown quartz latitic ash-flow sheet containing 40–50 percent phenocrysts (mainly plagioclase, biotite, augite). Andesitic lithic fragments a few centimetres across are typically conspicuous. Erupted from Mount Hope caldera (see index map). K–Ar age 28.2 m.y. Remanent magnetic polarity: reverse. Thickness 0–50 m

Tt Treasure Mountain Tuff (Oligocene) – Pyroclastic sequence, erupted from Platoro-Summitville caldera complex, that, within map area, includes two widespread quartz latitic ash-flow sheets interlayered with more local quartz latitic to low-silica rhyolitic ash-flow and ash-fall deposits. Characteristic phenocrysts throughout are plagioclase, biotite, and augite; quartz is absent and sanidine is sparse. Shown as undivided (Tt) locally, where subunits are difficult to distinguish because of thinning, wedge outs, and decreased welding. Age of all units between 29–30 m.y. as bracketed by K–Ar dates of underlying and overlying rocks

Ttu Upper tuff – Local nonwelded to moderately welded gray-brown quartz latitic ash-flow sheet containing 10–15 percent phenocrysts. Thickness 0–25 m

Ttr Ra Jadero Member – Mostly densely welded red-brown quartz latitic ash-flow sheet enveloped by upper and lower black vitrophyric zones containing large red-brown devitrified pumice lenses. Contains about 20 percent large blocky phenocrysts and abundant small angular dark-colored volcanic rock fragments. Remanent magnetic polarity: reverse. Probably erupted from the Summitville caldera. Thickness 0–25 m

Ttm Middle tuff – Heterogeneous assemblage of ash-fall and local ash-flow tuffs, mostly relatively phenocryst poor (5–10 percent). Ash-flow tuffs typically nonwelded to partly welded and locally include thin black vitrophyric zones. Thickness 0–20 m

Ttj La Jara Canyon Member – Nonwelded gray to densely welded red-brown quartz latitic ash-flow sheet containing 20–40 percent phenocrysts and sparse red-brown andesitic fragments a few centimetres in diameter. Typically contains conspicuous black vitrophyric zone near base. K–Ar age 29.8 m.y. Remanent magnetic polarity: reverse. Erupted from the Platoro caldera. Thickness 0–100 m

Ttl Lower tuff – Local nonwelded to densely welded ash-flow sheets and interlayered ash-fall tuff, mostly relatively phenocryst poor (5–10 percent). In southern part of map area, quarried lower tuff consists of phenocryst-poor partly welded pink-brown tuff overlain by densely welded phenocryst-rich dark brown tuff. The phenocryst-rich tuff, although similar to the Ra Jadero Member, is tentatively correlated with a pre-La Jara Canyon unit exposed in Rock Creek Park, 1 km south of the map area. Thickness 0–25 m

Trc Tuff of Rock Creek (Oligocene) – Red-brown partly to densely welded ash-flow sheet containing black scoria lenses and abundant small volcanic rock fragments. Contains sparse phenocrysts of plagioclase and augite; lacks biotite. Erupted from the Platoro caldera area. Thickness 0–50 m

EARLY INTERMEDIATE-COMPOSITION ROCKS

Conejos Formation (Oligocene)

Tcu Upper lava unit – Sparsely porphyritic dark andesite to rhyodacite flows and breccias that overlie the tuff of Rock Creek (Trc). Thickness 0–150 m

Tcv Vent facies – Mostly lava flows and flow breccias of aphanitic to porphyritic andesite, rhyodacite, and quartz latite. Phenocrysts of plagioclase, typically accompanied by augite or hornblende, are common; biotite is sparsely present in the more silicic flows. Includes rocks from at least three volcanic centers: an eroded stratovolcano near the northeast rim of the Platoro caldera at the south edge of the map, one near Del Norte, and another centered north of the map area. A flow from the northern center has yielded K–Ar ages on biotite and hornblende averaging 34.0 m.y. Similar rocks of the Summer Coon and Baughman Creek centers were studied in more detail and are subdivided below. Maximum thickness more than 700 m

Tcc Volcaniclastic facies – Mostly reworked material derived from vent facies (Tcv). Consists of bedded conglomerate, sandstone, and mudflow breccia containing clasts of dark andesite and rhyodacite; accumulated as clastic aprons on flanks of and between penecontemporaneous stratovolcanoes. Thickness 0 to more than 500 m

Tcs Rhyolite of Schrader Creek – Local light-brown to gray lava dome containing small phenocrysts of plagioclase and biotite. Light gray to yellow zeolitized glassy margin exposed along Schrader Creek on northeast side of body. Maximum thickness more than 300 m

Tci Intrusive rocks – Scattered dikes and small plugs of porphyro-aphanitic intermediate compositional types. Probably mostly contemporaneous with the early intermediate-composition rocks of the Conejos Formation, but may include some younger intrusives

ROCKS OF SUMMER COON AND BAUGHMAN CREEK CENTERS (OLIGOCENE):

Produced by two volcanoes, which apparently were active concurrently. The rocks are similar in age and composition to the vent facies of the Conejos Formation (Tcv), but these two centers have been studied in more detail than other parts of the early intermediate-composition sequence (Lipman, 1968; Mertzman, 1971), and accordingly, more map units are shown

Flows and dikes

Tsd Rhyodacite – Brown to gray lava flows and breccias largely of rhyodacitic composition (60–65 percent SiO_2), but locally including rocks of slightly more mafic or silicic composition. Phenocryst contents are variable but typically 10–30 percent; plagioclase and augite are ubiquitous, hornblende is common, and biotite is sparse or absent. These are the youngest eruptive rocks of the Summer Coon volcano and are widely exposed low on its flanks. The queried rhyodacite in the northwest corner of the map may not be related to the Baughman Creek volcano and might better be mapped as Conejos vent-facies (Tcv) if a contact could be located. Thickness 0–300 m

Tsq Quartz latite – Light-brown to gray lava flows and breccias largely of quartz latitic compositon (65–70 percent SiO_2). Phenocrysts are typically 20–40 percent; plagioclase, biotite, augite, and in places hornblende. The quartz latite occurs mainly below the rhyodacite on the south sides of the two volcanoes, but to the north in the Blue Mountain area it overlies the rhyodacite. Thickness 0–200 m

Tsrp Porphyritic rhyolite – Single thick light-gray lava flow the capping northernmost peak of Twin Mountains on the southeast flank of of the Baughman Creek volcano. Well developed flow layering. Contains about 70–71 percent SiO_2 and 5–10 percent phenocrysts, mainly plagioclase and biotite. Thickness 0–150 m

Tsr Rhyolite – Finely flow-laminated phenocryst-poor rhyolite that forms local lava flows on both volcanoes. SiO_2 is 70–73 percent; phenocrysts of mostly plagioclase and biotite are only 1–2 percent. Mapped rhyolite along the west margin of the map probably includes some shallow vent intrusives; mapped rhyolite in Little La Garita Creek is bedded silicic tuff of unknown genetic associations. Age relation between rhyolite and quartz latite (Tsq) uncertain for Summer Coon volcano. Thickness 0–150 m

Tsa Andesite – Massive crudely bedded breccias and local lava flows of alkali olivine andesite that form the main cone of the Summer Coon volcano and probably also Baughman Creek volcano. Contains about 30 percent small phenocrysts of plagioclase, clinopyroxene, and olivine. Lava flows occur sparsely low on exposed parts of the cones, but on the high central parts of the cones bedded moderately sorted breccias, interpreted as explosion breccias, are the dominant type of andesite. Thin lenses of dense andesite, interlayered and intergrading with the breccias, are interpreted as agglutinated explosion breccia; they were formerly considered to represent remnants of flows that mostly moved farther down the flanks of the cone (Lipman, 1968, p. 217). On the southeast slope of Twin Mountains, the contact between the andesite and rhyodacite (Tsd) is approximately located. Maximum thickness greater than 1000 m

Tsi Intermediate-composition dikes – Equivalent in age and composition to the rhyodacite (Tsd) and quartz latite (Tsq). Most are extensive thick dikes, as much as 50 m wide, that stand as ribs because of greater resistance to erosion than country rocks. Phenocrysts of mainly plagioclase, clino- and orthopyroxenes, and sparse biotite and hornblende are 10–35 percent. K–Ar age of one rhyodacite dike of the Summer Coon center is 34.7 m.y.

Tsri Rhyolite dikes – Mostly phenocrysts-poor silicic dikes, equivalent in age and composition to the rhyolite (Tsr), but the dike cluster trending southeast from the Summer Coon center contains about 20 percent phenocrysts and more nearly resembles the porphyritic rhyolite flow (Tsrp) of the Baughman Creek volcano. These are also long thick dikes that form conspicuous ribs. K–Ar age of a Summer Coon dike is 32.4 m.y.

Tsai Andesite dikes – Numerous small inconspicuous dikes equivalent in age and composition to the andesite (Tsa)

Central intrusives

Tsm Fine-grained mafic rocks – Poorly exposed texturally heterogeneous rocks, ranging from andesite to fine-grained diorite that form the outer ring of the central intrusive complex. In part may consist of lava flows in eroded remnants of a summit caldera

Tsdi Diorite – Stock of dense gray medium-grained to porphyritic diorite. Possibly a more coarsely crystalline equivalent of the fine-grained mafic rocks (Tsm). Consists mainly of plagioclase and clinopyroxene, partly altered to actinolite, with finer grained interstitial biotite, orthoclase, and quartz

Tsp Quartz monzonite porphyry – Light-gray to buff porphyry containing about 25 percent small phenocrysts, mainly plagioclase, with sparse biotite and opaque minerals. The porphyry is everywhere altered to some degree, but it appears petrographically and chemically similar to the southeast-trending rhyolite dikes (Tsri), suggesting a possible genetic relation

Tst Tuff breccia – Highly altered light-tan to light-yellow tuff breccia that intrudes the quartz monzonite porphyry and appears to be the youngest part of the central intrusive complex. Phenocrysts, if originally present, are no longer identifiable, but the light color and pyroclastic texture suggest a rhyolitic composition. The tuff breccia may be genetically related to the northeast-trending phenocryst-poor rhyolite dikes (Tsri), with which it is alined. This interpretation, if valid, would indicate that the other central intrusives all predate the middle-stage rhyolite flow (Tsr) of the shield sequence

CONTACT – Dashed where approximately located

FAULT – Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

STRIKE AND DIP OF BEDS

Inclined

Horizontal

STRIKE AND DIP OF COMPACTION FOLIATION

Inclined

Vertical

Horizontal

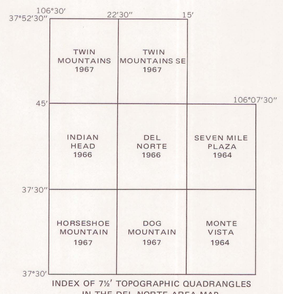
×34.7m.y. SAMPLE LOCALITY OF RADIOMETRICALLY DATED ROCK – Showing age in million years (m.y.)

REFERENCES

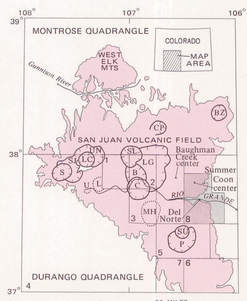
Lipman, P. W., 1968, Geology of the Summer Coon volcanic center, eastern San Juan Mountains, Colorado, *in* Epis, R. C., Editor, Cenozoic volcanism in the southern Rocky Mountains: Colo. School Mines Quart., v. 63, p. 211–236.

Lipman, P. W., Steven, T. A., and Mehnert, H. H., 1970, Volcanic history of the San Juan Mountains, Colorado, as indicated by potassium-argon dating: Geol. Soc. America Bull., v. 81, no. 8, p. 2329–2352.

Mertzman, S. A., Jr., 1971, The Summer Coon volcano, eastern San Juan Mountains, Colorado: N. Mex. Geol. Soc. Guidebook 22d Field Conf., p. 265–273.



INDEX OF 7½′ TOPOGRAPHIC QUADRANGLES IN THE DEL NORTE AREA MAP



MAP OF THE SAN JUAN VOLCANIC FIELD SHOWING CALDERAS AND RELATION OF THE DEL NORTE AREA (STIPPLED) TO ADJACENT U.S. GEOLOGICAL SURVEY GEOLOGIC MAPS

EXPLANATION

Known or readily inferred caldera

Buried caldera

B, Bachelor
BZ, Bonanza
C, Creede
CP, Cochetopa Park
L, Lost Lake
LC, Lake City
LG, La Garita
MH, Mount Hope
P, Platoro
S, Silverton
SJ, San Juan
SL, San Luis
SU, Summitville
U, Ute Creek
UN, Uncompahgre

Adjacent U.S. Geological Survey geologic maps

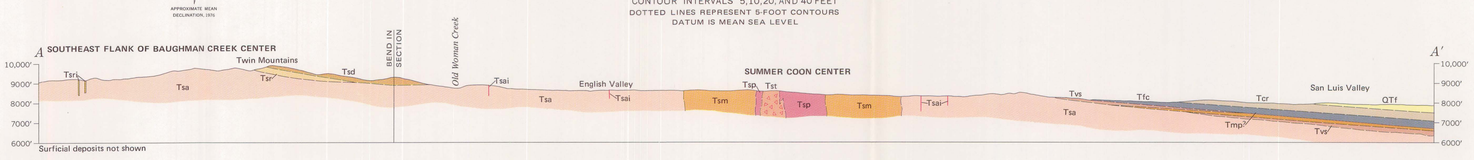
1. Bristol Head quadrangle (GQ-631)
2. Creede quadrangle (GQ-1053)
3. Spar City quadrangle (GQ-1052)
4. Durango quadrangle (I-764)
5. Platoro caldera area (I-828)
6. Lower Conejos River area (I-901)
7. Chama Peak quadrangle (MF-568)
8. Del Norte area (this map)

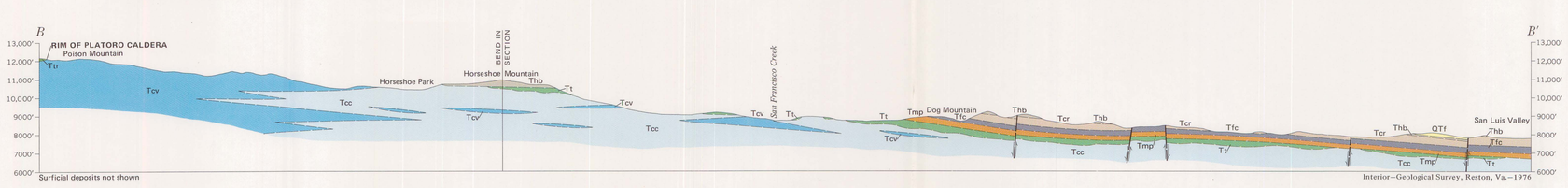
Base from U.S. Geological Survey

Geology mapped in 1965–67

SCALE 1:48 000

CONTOUR INTERVALS 5,10,20, AND 40 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL





Interior—Geological Survey, Reston, Va.—1976

GEOLOGIC MAP OF THE DEL NORTE AREA, EASTERN SAN JUAN MOUNTAINS, COLORADO

By

Peter W. Lipman

1976

For sale by U. S. Geological Survey
Denver, Colo. 80225 and Reston, Va. 22092, price $1.00