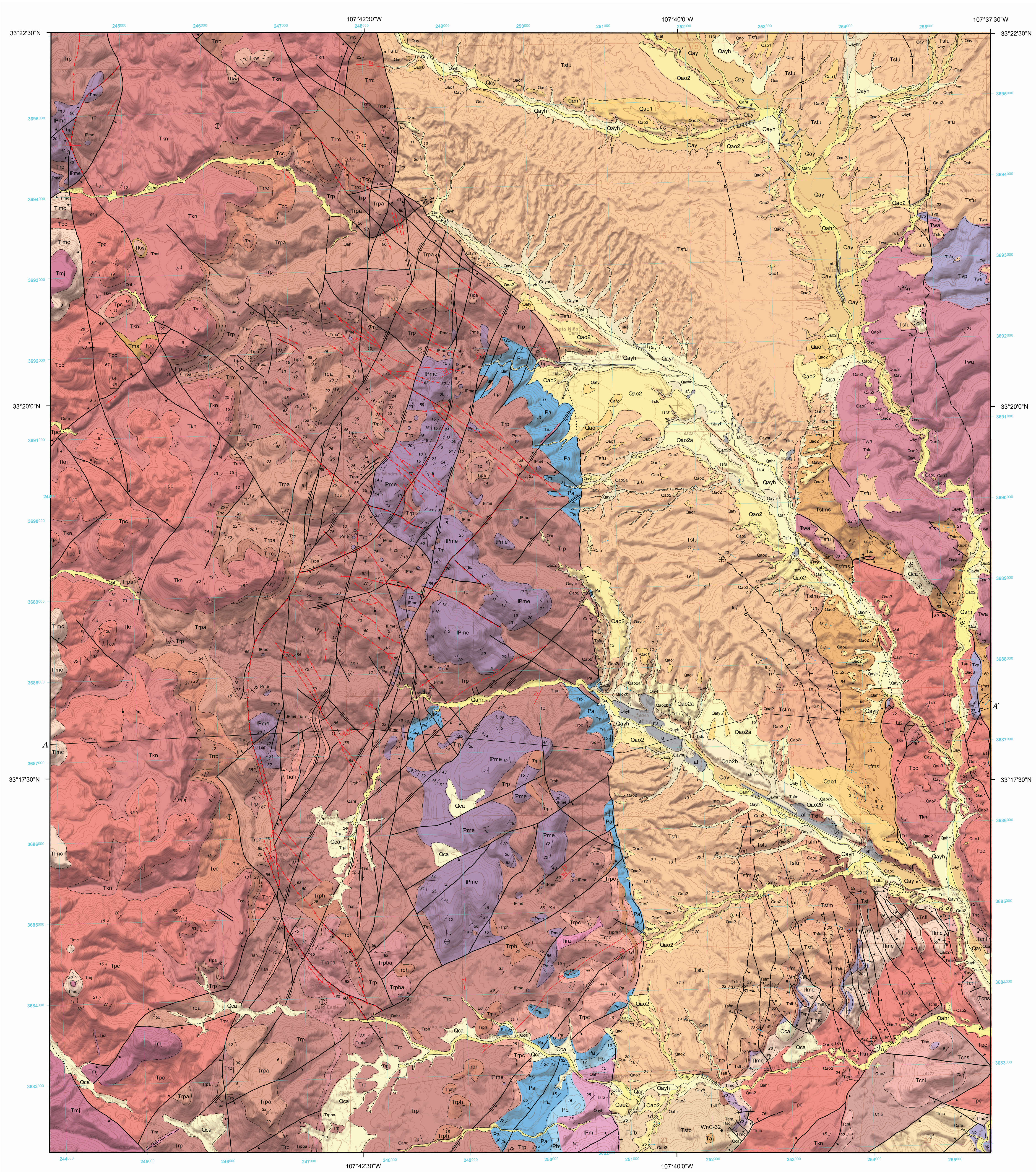
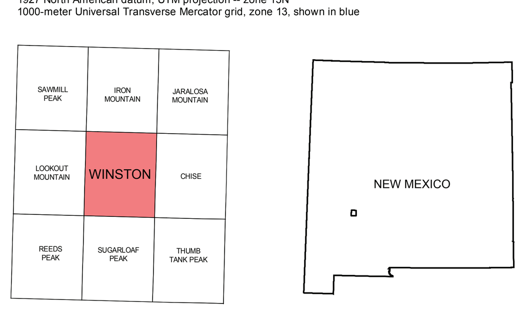
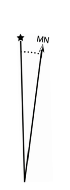


Base map from U.S. Geological Survey 1970, from photographs taken 1965, field checked in 1970, edited in 1993.
1927 North American datum, UTM projection -- zone 13N
1000-meter Universal Transverse Mercator grid, zone 13, shown in blue

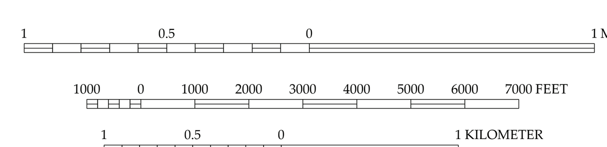


QUADRANGLE LOCATION



Magnetic Declination
July 2011
9º 25' East
At Map Center

1:24,000



CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

New Mexico Bureau of Geology and Mineral Resources
Open-File Geologic Map 230

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (L. Greer Price, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).

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This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

Geologic map of the Winston quadrangle, Sierra County, New Mexico.

by
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June 2012

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COMMENTS TO MAP USERS

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross-sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

Map Unit Descriptions

QUATERNARY

Artificial and Colluvial Units

af — **Artificial fill**—Compacted sand, silt, and gravel. Located along South Fork Creek, includes areas affected by the St. Cloud mining operation, including waste and ore piles, fill from reclamation efforts, and disturbed ground around the mines and processing plant. Mostly 0–2 m thick, up to 40 m thick around the mines.

Qca — **Colluvium and alluvium, undivided**—Gravel, sand, and silt burying geologic features in the interior of the Black Range. Includes gravity-, slopewash-, and minor channel-transported material. 0–2 m thick.

Alluvial units

Qar — **Recent alluvium (0–50 years BP)**—Gravel, sand, and silt associated with recent flows of active channels. Includes low terraces with treads up to 1 m above the channel floor. Poorly sorted silt to cobbles with local boulders, with no soil development and little vegetative cover. 0–1 m thick.

Qah — **Historic alluvium (50–500 years BP)**—Gravel, sand, and silt associated with historic river flows. Includes old channels blocked by artificial fill and thin deposits atop **Qay** deposits associated with very large flood events. 0–1 m thick.

Qafy — **Small alluvial fans**—Silty fine sand with rare pebbles associated with small alluvial fans locally burying older alluvial units. 0–1 m thick.

Qay — **Younger alluvium**—Gravels, sand, and silt with weakly-developed soils underlying terraces with treads 2–3 m above the local channel floors. Gravels occur as broad paleochannels, typically surrounded by silty sand that accumulated outside of channels. Poorly-to moderately-sorted, with subangular to rounded clasts, commonly bioturbated. Soil development includes several weak buried soils, distinguished by darkened A horizons, and carbonate horizons locally up to Stage II but generally Stage I in development. 0–3 m thick.

Qahr — **Historic and recent alluvium, undivided**—Units **Qah** and **Qar**, undivided. See individual unit descriptions.

Qayr — **Younger and recent alluvium, undivided**—Units **Qay** and **Qar**, undivided. See individual unit descriptions.

Qayh — **Younger and historic alluvium, undivided**—Units **Qay** and **Qah**, undivided. See individual unit descriptions.

Qayhr — **Younger through recent alluvium, undivided**—Units **Qay**, **Qah**, and **Qar**, undivided. See individual unit descriptions.

Qao3 — **Older alluvium, youngest subunit**–Gravels and pebbly sands underlying terraces with treads 5–10 m above local channels. Poorly-exposed, but surface sediments and rare exposure suggest gravels are mainly fine-to medium-pebbles, with rare coarse pebbles and cobbles, that are poorly-sorted and angular to rounded, with a matrix of silty-fine to medium sand. At least 1–6 m thick.

Qao2 — **Older alluvium, intermediate subunit**—Gravels and pebbly sands with well-developed soils underlying terraces with treads 15–20 m above local channels along Poverty, Cuchillo Negro, and Monument Creeks; increasing to 40 m upstream along Chloride and South Fork Creeks; and to 27 m upstream along Dry Creek. Gravels are poorly-to moderately-sorted subangular to rounded pebbles to cobbles, and sands are poorly-sorted silty-fine to medium grains. Generally finer grained along minor tributary streams, coarser along major creeks, with a particularly coarse cap present along Chloride and South Fork Creeks. Up to Stage III carbonate horizon development, with colors of 5YR 5/3 to 7/3 measured. 4–40 m thick along Chloride and South Fork Creeks, at least 2–15 m thick along other Creeks.

Qao2b — **Older alluvium, younger intermediate subunit**—Locally, a continuous scarp divides **Qao2** into upper (**Qao2a**) and lower (**Qao2b**) units, with local exposures suggesting there is a coarse-fill deposit associated with **Qao2b**. Exposure is poor, however, and the scarp may simply be an erosional feature. Unit only divided where scarp is present.

Qao2a — **Older alluvium, older intermediate subunit**—Locally a continuous scarp divides **Qao2** into upper (**Qao2a**) and lower (**Qao2b**) units. Exposure is poor, however, and the scarp may simply be an erosional feature. Unit only divided where scarp is present.

Qao1 — **Older alluvium, oldest subunit**—Gravels and pebbly sands underlying terraces with treads lying above that of **Qao2**. Poorly-exposed, but surface clasts and rare exposures indicate the deposit is similar to coarse-grained **Qao2** in composition. Widespread along South Fork Creek, where tread heights increase upstream from 35–60 m above the channel, and along Dry Creek, where heights are 22–28 m above the local channel, but otherwise rare. Up to 25 m thick.

Qao — **Older alluvium, undivided**—Older alluvium, undivided. Used where specific unit correlation is not clear. 0–3 m thick.

TERTIARY

Ta — **Pediment alluvium**—Poorly-sorted pebbles locally truncating coarser, tilted Santa Fe Group sediments on top of high mesas. Gravels occur at the same elevation as the basalt of Tabletop Mountain on the Chise quadrangle, and likely correlate to the same pediment surface as that underlying the basalt. This basalt has Ar/Ar ages of 4.68±0.10 and 4.91±0.03 Ma (McLemore et al., 2012). Up to 4 m thick.

Santa Fe Group

Tsf — **Santa Fe Group, undivided**—Conglomerates and sandstones filling the Winston graben, up to the maximum level of aggradation. Hence does not include inset alluvium. Typically divisible here into lower, middle, and upper units based on intercalated volcanics, an angular unconformity, and lithologic characteristics.

Tsfu — **Upper Santa Fe Group**—Brown to light-reddish-brown to pale, poorly-to moderately-cemented pebble conglomerates to sandstones. Overlies **Tsfm** and **Twa** with angular unconformity. Dominated by fine to medium pebbles with uncommon coarse pebbles and rare cobbles; conglomerate beds are noticeably less coarse than **Tsfm**. Clast suites and pebble imbrications indicate derivation from both the west and east. Poorly-sorted silty, fine to medium sand matrices with colors of 5YR 5/3 to 7/3 and 7.5YR 5/6 to 7/3 measured.

Tsfm — **Middle Santa Fe Group**—Very-pale-brown to light-pink pebble to cobble conglomerates and interbedded pebbly sandstones. Conglomerate beds typically consist of common coarse pebbles and cobbles, with lesser fine to medium pebbles and rare boulders up to 60 cm across. Clayey, silty, fine to medium sand matrices have colors of 10YR 7/1 to 8/3. Appears to have an interfingering contact with adjacent Tsfms; contact placed where ratio of sandstones and mudstones to conglomerates drops below 1:1.

Tsfms — **Middle Santa Fe Group, sandstone-dominated subunit**—Very pale-brown to light-pink silty sandstones, sandy siltstones, and mudstones with interbedded conglomerates. Sandstones and siltstones are poorly-sorted with silts to medium sand grains in varying proportions with very locally abundant fine to medium pebbles. Colors of 7.5 YR 8/2 to 9/3. Clay-rich mudstones with rare visible silt and sand grains are common to the southern end of this unit. Appears to have an interfingering contact with **Tsfm**; contact placed where the ratio of sandstones and mudstones to conglomerates rises above 1:1.

Tsfb — **Boulder-rich Santa Fe Group**—Poorly-sorted, relatively boulder-rich Santa Fe Group sediments. Consists of angular to rounded clasts from fine pebble up to 2 m across boulders, mainly of Moccasin John Rhyolite. Contacts with adjacent middle and upper Santa Fe Group are gradual, basal contact is conformable with lower Santa Fe Group.

Tsfl — **Lower Santa Fe Group**—Light-gray to pale-yellow tuffaceous pebble to cobble conglomerates, lithic-rich tuffs, and tuffaceous sandstones. Conglomerates dominate and consist of poorly-sorted pebbles and rare cobbles, with matrices of poorly-sorted clayey fine to coarse sand. Conglomerate beds are commonly channel-shaped and discontinuous, with common cross-bedding and normal grading. Tuffs are poorly-to non-welded, with 5–25% lithic fragments of aphyric rhyolite. One continuous tuff that is up to 8 m thick has been tentatively correlated to the 27.73±0.14 Ma South Canyon Tuff based on stratigraphic position and lithologic similarity to known South Canyon Tuff outcrops (Harrison, 1990, 1994).

Volcanics intercalated with the Santa Fe Group

Twa — **Andesite of the Winston graben**—Gray to dark-gray and dark-reddish-gray aphanitic to sparsely porphyritic andesitic flow dome complex and outflow lavas. Rare phenocrysts of mainly plagioclase, but also pyroxene, olivine, and biotite, up to 3 mm across. Typically discontinuous flows, with common autobrecciated tops and bottoms.

Mogollon Group

Tvp — **Vicks Peak Tuff**—Light-gray to light-brown, massive, moderately-to densely-welded, crystal-poor ash-flow tuff. Phenocrysts of sanidine (1–3%) and sparse quartz. Bears conspicuous large, elongate pumices, most of which bear a granular texture from vapor-phase mineralization and recrystallization. Correlation to the Vicks Peak Tuff is based on stratigraphic position, distinctive textures, and a single-crystal sanidine $^{40}Ar/^{39}Ar$ age of 28.78 ± 0.18 Ma, comparable to the average age of 28.93 ± 0.12 Ma published by McIntosh et al. (1991).

Ttlm — **Tuff of Lookout Mountain**—Light-gray, weathering brown, moderately-welded, moderately-crystal-rich, moderately-pumice-rich, lithic-poor ash-flow tuff. Contains 10–15% phenocrysts of dominantly sanidine, with rare biotite and sparse quartz. Also contains up to 10% medium gray elongate pumices. Correlation to tuff of Lookout Mountain based on a single-crystal sanidine $^{40}Ar/^{39}Ar$ age of 29.08 ± 0.02 Ma, comparable to the 29.06 ± 0.06 Ma average age published by McIntosh et al. (1991).

Ttsc — **Tuff of Stiver Canyon**—Poorly-to moderately-welded, moderately-crystal-rich, pumice-poor, lithic-poor, ash-flow tuff. Contains 10–20% sanidine, quartz, and minor biotite, with sanidine 2–3 times more abundant than quartz. Rare lithics are of flow-banded rhyolite and andesite. Up to 170 m thick.

Tlmc — **Tuff of Little Mineral Creek**—White to yellow poorly-welded, pumice-rich, very lithic-rich, crystal-poor ash-flow tuff. Lithic fragments of red and gray, angular, aphanitic, commonly flow-banded lavas consititute 10-50% of the tuff. 1–4% phenocrysts of quartz and sanidine, as well as trace biotite. Includes local, thin, fluvially reworked zones. Average single-crystal sanidine 40Ar/39Ar age of 29.39 ± 0.20 Ma (McIntosh et al., 1991).

Tmj — **Moccasin John Rhyolite**—Phenocryst-poor, strongly-flow-banded rhyolite flow domes and lava flows. Contains 1–3% quartz, sanidine, plagioclase and biotite. Commonly contains volcanic glass and spheulitic textures, as well as basal vitrophyres. Rare carapace breccias and interbedded perlitic tuffs and tuffaceous sediment. Thought to be genetically related to the tuff of Little Mineral Creek (Harrison, 1990).

Tsrr — **Unnamed sanidine-rich rhyolite**—Light-gray to pink crystal-rich rhyolitic volcanic rock. Occurs as two isolated, elongate outcrops toward the top of unit Tpc. Contains 20-40% phenocrysts of dominantly sanidine with minor biotite. Also contains sparse lithic fragments and a few elongate dark- gray bands that may be strongly flattened pumices.

Tpc — **Basaltic andesite of Poverty Creek**—Gray to dark-gray, aphanitic-to sparsely-porphyritic basaltic andesites. As much as 10% phenocrysts of plagioclase, pyroxene, and rare biotite, generally <1 mm across. Belongs to the widespread SCORBA suite of Cameron et al. (1989). Includes rare interbedded volcaniclastic rocks.

Datil Group

Tkw — **Tuff of Koko Well**—Two local ash-flow tuffs, locally welded together. Lower is moderately-to densely -welded and moderately-crystal-rich, with 6% sanidine, 2–3% plagioclase, 1% biotite, and trace honeblende and pyroxene. Upper is massive, poorly-welded, pumice-rich, and crystal-poor, with 5% sanidine, up to 1% plagioclase, and trace quartz and biotite. Upper tuff tentatively correlated to Rock House Canyon Tuff (Harrison, 1990; 34.87±0.24 Ma: McIntosh et al., 1991). Two tuffs together up to 75 m thick.

Tms — **Sandstone of Monument Park**—Local sandstone interval with minor purple siltstones and pebble to cobble conglomerates. Sandstones are well-sorted and consist of subrounded to rounded grains of quartz, sanidine, plagioclase, and minor biotite. Conglomerates dominated by clasts of Tkn with minor andesitic lavas.

Tcns — **Cuchillo Negro complex, tuff subunit**—Local ash-flow tuffs and intercalated sediments. Tuffs are dacitic, tan to white, generally lithic-rich, with phenocrysts of biotite (2–4%) and plagioclase (2–10%). Sediments vary from thin planar bedded sandstones to heterolithic, chaotic pebble to boulder conglomerates interpreted to be co-ignimbrite lag breccias (Harrison, 1990).

Tcnl — **Cuchillo Negro complex. lava subunit**—Local instrusive-extrusive andesitic and rhyolitic vent complex. Consists of a rhyolitic intrusive/extrusive member that is flow-banded with 5–10% plagioclase and sanidine phenocrysts, a basaltic andesite intrusive/extrusive member with 20–25% phenocrysts of plagioclase and pyroxene up to 5 mm across, and an amygdule-rich intrusive trachytic member than cuts the other two members. K-Ar age of 34.7±0.8 Ma (C.E. Chapin, pers. comm., cited in Harrison, 1990).

Tkn — **Kneeling Nun Tuff**—Light gray to gray to tan to pink, poorly to moderately welded, crystal-rich ash-flow tuff. 20–45% phenocrysts, of quartz, sanidine, plagioclase, and biotite. Normally zoned, with more abudant quartz and sanidine at the base, and more abundant biotite toward the top. Ar/Ar age of 35.34±0.10 Ma (McIntosh et al., 1991).

Trrc — **Tuff of Rocque Ramos Canyon**—Moderately-to poorly-welded, moderately-crystal-rich ash-flow tuff. 10–20% phenocrysts of subequal sanidine and plagioclase, and 1–2% biotite. Common small (1.5–2 cm across) devitrified pumice. Rare andesitic lithic fragments. Correlated to the Bell Top 4 tuff by Ar/Ar age and paleomagnetic data; Ar/Ar age of 35.41±0.08 Ma (McIntosh et al., 1991).

Tcc — **Cliff Canyon Sandstone**—Purplish to white, fine-grained and well-sorted arkosic to quartzose volcaniclastic sandstone. Grains are typically subrounded to rounded and of quartz, sanidine, plagioclase, and minor biotite. Includes purple to blue-gray siltstones, and a basal conglomerate. Poorly consolidated and exposed.

Trpa — **Upper Rubio Peak Formation, andesitic lavas**—Plagioclase ± hornblende ± pyroxene andesitic porphyry lavas. Multiple flows overlying the debris flows of the lower Rubio Peak Fm.

Trph — **Upper Rubio Peak Formation, hornblende phyric lavas**—Plagioclase + hornblende ± pyroxene andesitic porphyry lavas. Multiple flows overlying debris flows of the lower Rubio Peak Fm.

Trpba — **Upper Rubio Peak Formation, basaltic andesite lavas**—Dark, aphanitic, intermediate lavas. Multiple flows overlying the debris flows of the lower Rubio Peak Fm.

Trp — **Rubio Peak Formation, debris flow-dominated unit**—Volcaniclastic-dominated Rubio Peak Fm. Dominantly massive, heterolithic, matrix-supported debris flow deposits, with pebbles to boulders of aphanitic and porphyritic intermediate volcanic rocks. Interbeds with sandstones to the south. Surrounds landslide blocks of limestone (ℙme).

ℙme — **Exotic blocks of Madera limestone**—Exotic blocks of Pennsylvanian limestone surrounded by debris-flows of the lower Rubio Peak Fm.

Trpc — **Rubio Peak Formation, basal conglomerate**—Local very-poorly-sorted pebble to boulder conglomerate bearing significant nonvolcanic detritus. Clasts are of monzonite, red siltstone, andesitic lava, and limestone, in order of decreasing abundance. Fills paleovalleys carved into underlying non-volcanic strata. Includes minor sandstones.

Trpm — **Tuff of Miranda Homestead**—Strongly-altered, moderately-welded, lithic-rich, moderately crystal-rich ash-flow tuff. 10–15% phenocrysts of white to beige feldspars, quartz, and biotite. Maximum thickness of 20 m.

PALEOZOIC

Pre-volcanic units

Pa — **Abo Formation**—Reddish-brown siltstones, fine to coarse sandstones, and mudstones. Thin-to medium-bedded with abundant cross-stratification. Thickness up to 120 m.

Pb — **Bursum Formation**—Gray, fossiliferous limestone and calcareous shale, interbedded with gray, green, and red shale and siltstone. Up to 40 m thick.

ℙm — **Madera Limestone**—Light-to medium-gray fossiliferous limestone. Thin-to thick-bedded, commonly cherty and locally nodular. Includes rare interbedded shale and siltstone. Thickness up to 100 m.

Intrusive units

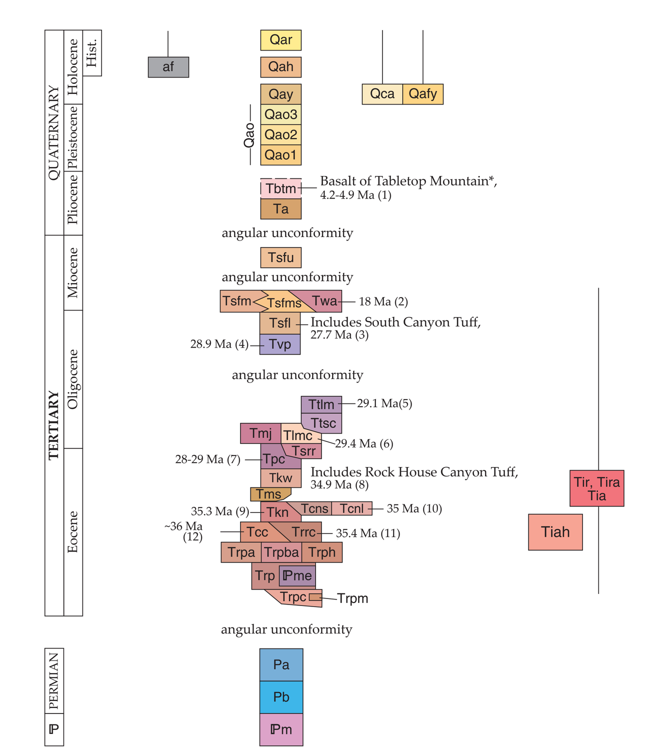
Tir — **Rhyolitic dikes**—Porphyritic dikes with phenocrysts of quartz, sanidine, and biotite.

Tira — **Aphanitic rhyolitic dikes**—Aphanitic, locally flow-foliated, rhyolitic dikes and intrusions.

Tia — **Andesitic dikes**—Dark and aphanitic and plagioclase±pyroxene porphyry dikes.

Tiah — **Hornblende porphyry dikes**—Porphyritic dikes with phenocrysts of plagioclase, horneblende, and locally pyroxene.

Correlation of Map Units



Numbers refer to entries in **Table 1** (see report).

* - Basalt of Tabletop Mountain is exposed on the neighboring Chise quadrangle, capping upper Santa Fe Group and pediment alluvium (Jahns et al., 2006).

Map Symbols

Contact—Well-located, approximately located, concealed. Queried where existence is uncertain. Contact attitudes shown with tick, giving dip value.

Fault—Well-located, approximately located, concealed. Queriedwhere existence uncertain. Bar on down-thrown side of normal faults, square on up-thrown side of reverse faults, shear arrows show relative movement of strike-slip faults. Fault plane measurements shown with ticks, giving dip value; trend of fault striae and mullions shown with arrow, giving plunging value.

Dikes—well located; silica-mineralized veins. Both often intrude minor faults, but only faults with map-scale offset are shown as black lines beneath the vein or dike line. Dike and vein attitudes shown with tick, giving dip value.

- Inclined bedding, showing dip value
- Horizontal bedding
- Inclined foliation, showing dip value
- Vertical foliation
- Minor fault attitude, showing dip value
- Minor dike attitude, showing dip value
- Vertical joints in outcrop
- Paleocurrent direction from pebble imbrications
- Paleocurrent direction from channel trend and imbrication direction
- WnC-32 Geochronology sample, showing sample name

FIGURE 1—Winston. The small town of Winston, the namesake of the quadrangle. Photo faces west-northwest. Tree-covered topography in background is the Black Range, underlain by Eocene to Oligocene volcanic rocks. Lighter colored, grass-covered hills directly behind the town are underlain by the upper Santa Fe Group, derived from the Black Range. Dark brownish gray areas in front of town are underlain by the andesite of the Winston graben.

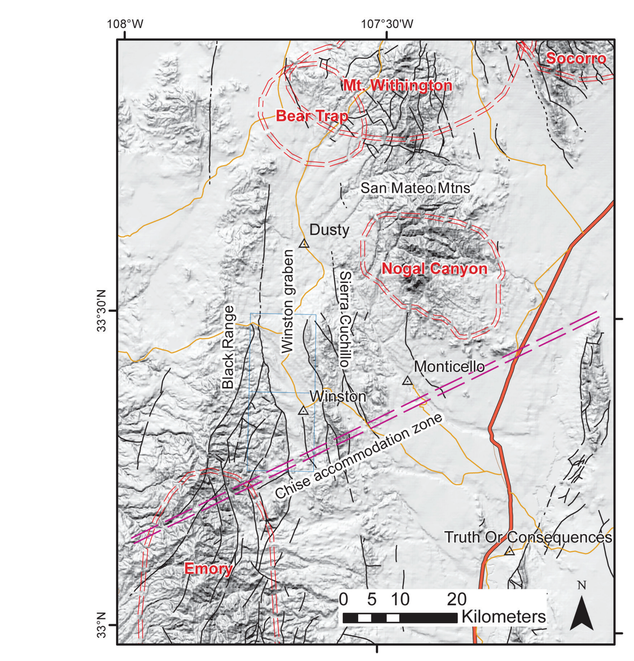


FIGURE 2—Generalized geology of the Winston graben area. Black lines are major faults, red double lines are outlines of calderas (or calderons), and purple double line is the Chise accommodation zone ("Chise lineament" in Harrison, 1990, 1994). Triangles locate area towns, orange lines are state roads, and the thick red line is Interstate 25. Blue rectangles locate the Iron Mountain (northern) and Winston (southern) quadrangles.

FIGURE 3—Old St. Cloud zeolite mine, looking north-northeast. Lower, dipping, white strata is the lower Santa Fe Group (**Tsfl**), massive white blocks are tuffaceous sandstones, gray layers are conglomerates. Overlying brown sediments are **Qao2** Pleistocene gravels.

FIGURE 4—Middle Santa Fe Group conglomerates (**Tsfm**). Note degree of cementation, abundance of coarse pebbles and cobbles, and moderate dip angle.