

STRUCTURE

Lower Precambrian schist exposed in the western part of the quadrangle is overlain by a sequence of chiefly sedimentary upper Precambrian and Paleozoic rocks that dip east. Diabase intrudes the Precambrian rocks and dioritic plutonic and hypabyssal rocks intrude the entire sequence. Conglomerate and lava and ash flows of Cenozoic age blanket the older rocks in the eastern part of the quadrangle.

ORE DEPOSITS

The most productive ore deposits of the quadrangle are those of the Magma mine. In its 90-year history it has yielded more than 13 million tons of ore, which has provided nearly 1.5 billion pounds of copper and smaller amounts of gold, silver, zinc, and lead. The Magma quartz-sulfide vein has provided most of the ore, but in recent years replacement deposits in limestone have been the principal source of ore.

Chief ore minerals are chalcophyllite, bornite, enargite, tennantite, chalcocite, digenite, and sphalerite. Principal gangue minerals are pyrite and quartz, and less common are carbonate minerals and hematite. The Magma mine is discussed in greater detail by Short and others (1943) and Hammer and Peterson (1968).

The Silver King mine produced silver for about 15 years prior to 1890, but subsequent efforts to re-establish the mine have not been successful. The ore body was a stockwork of intersecting veins within a plug of diorite porphyry that intrudes a quartz diorite stock. Although the mine was worked for silver, the ore consisted chiefly of zinc, lead, and copper sulfides. The mine history, production, geology, and literature are summarized by Short and others (1943), p. 139-154.

Several other formerly productive mines in the quadrangle are described by Short and others (1943). Included are the Lake Superior and Arizona (p. 135-139), Belmont (p. 154-158), Grand Pacific (p. 158), and Queen Creek (p. 158-159). The entire area has been extensively prospected, and the chief targets have been the mineralized east-striking faults and the beds near the base of the Martin Limestone.

Manganese oxides fill fractures, chiefly in the Escabrosa Limestone. Several of these deposits have been mined, particularly in Queen Creek Canyon just east of Superior.

Perlite has been mined from several pits in rhyolitic rocks in the southwestern part of the quadrangle, though the major perlite production of the Superior area has been beyond the western quadrangle boundary. Asbestos deposits in the Mesal Limestone in the southern part of the quadrangle have sporadically supported small operations.

ACKNOWLEDGMENTS

This work has greatly benefited from the experience and guidance of N. P. Peterson, and his contributions are gratefully acknowledged. Stratigraphic studies by Krueger (1961) and Shride (1967) in nearby areas have provided evidence enabling the Troy and Bola Quartzites of this quadrangle to be separately identified and mapped. The management and staff of the Magma Copper Company have provided cordial cooperation and important information throughout the course of the project. Particular thanks are extended to members of the geological and engineering staff, who at the time of the fieldwork included R. Van Vorst, chief engineer, R. N. Webster, chief geologist, and J. D. Sell, D. F. Hammer, and Locke Yot, geologists.

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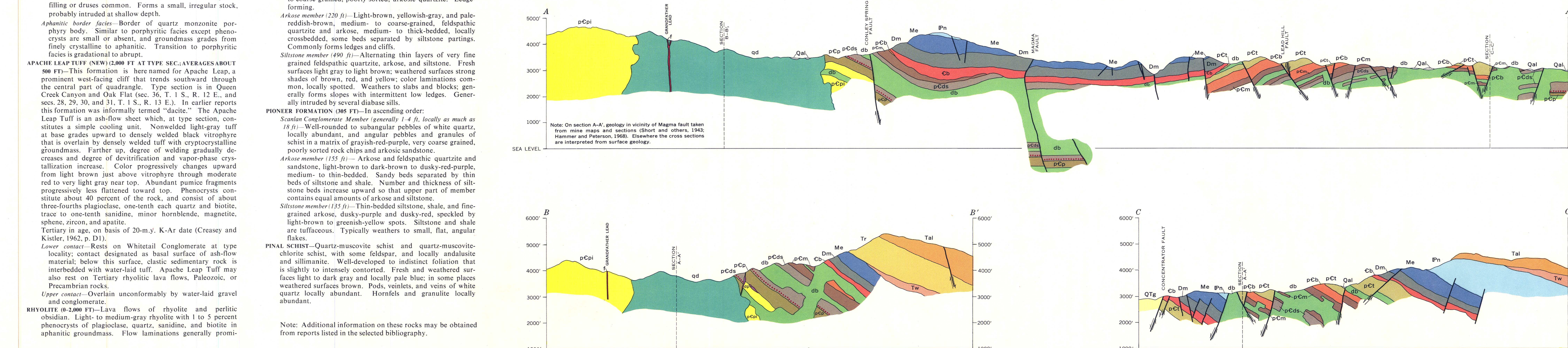
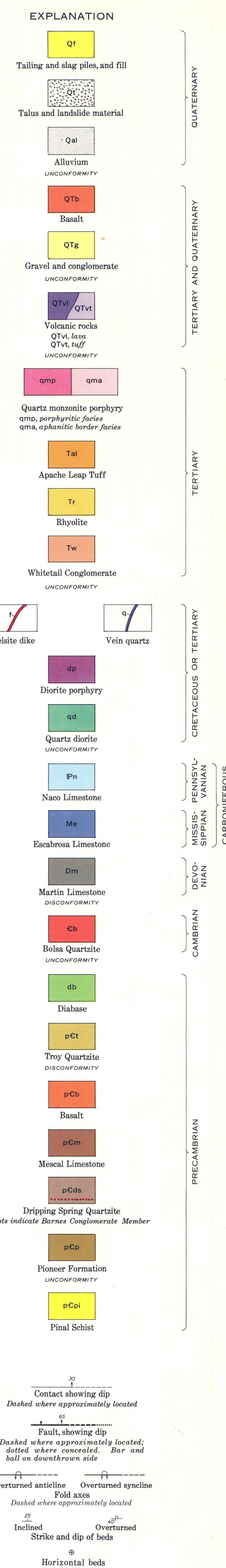
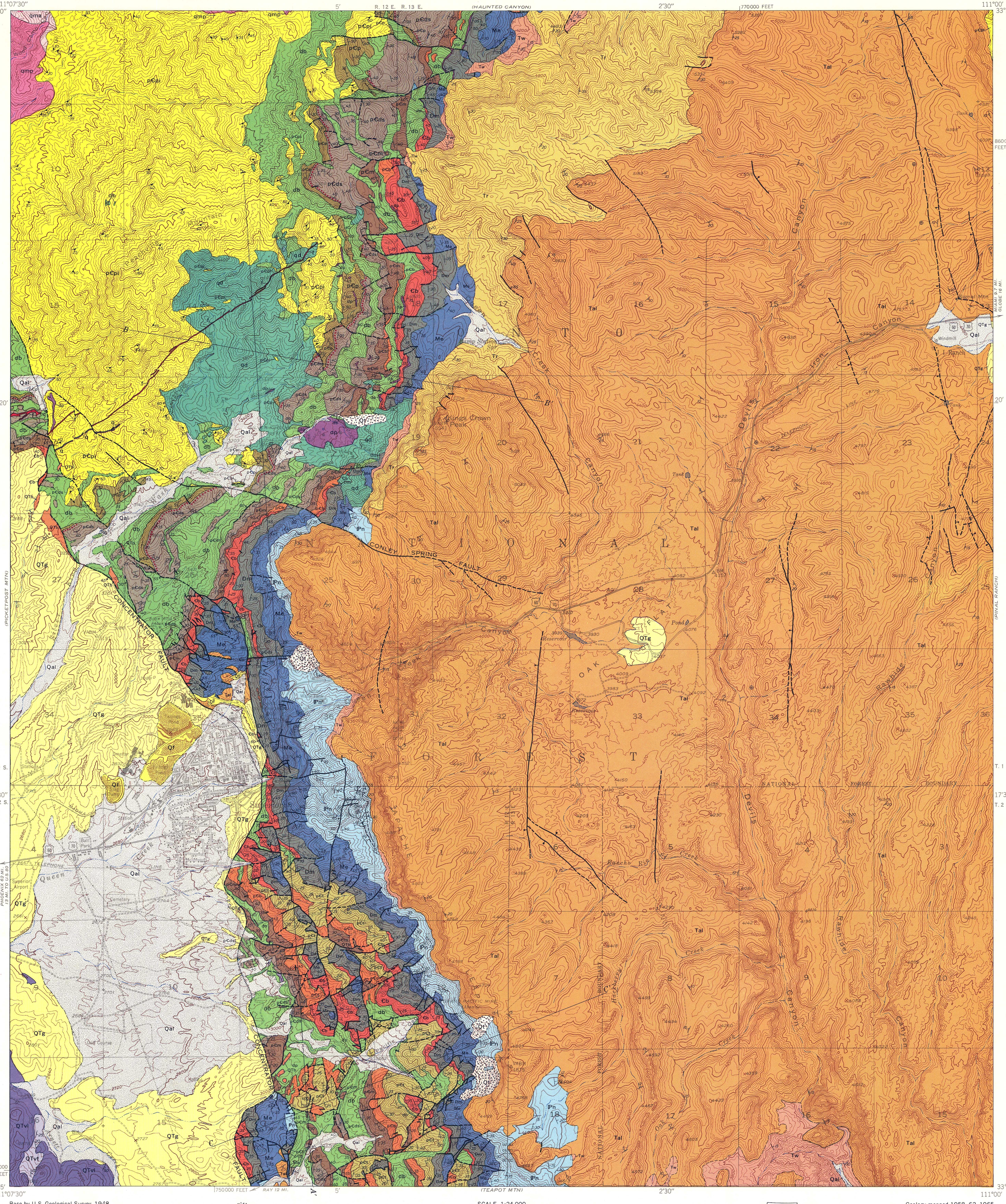
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DESCRIPTIONS OF MAP UNITS

TALUS AND LANDSLIDE-Accumulations of loose, angular blocks from nearby outcrops. Common throughout range but shown only where especially prominent.
ALLUVIUM-Sand and gravel deposits in partly enclosed basins or along streambeds. Generally unconsolidated.
BASALT-Gray aphanitic basalt. Groundmass chiefly plagioclase and pyroxene; may contain small olivine phenocrysts, some of which are altered to iddingsite. Locally vesicular. Occurs as small, irregular, intrusive bodies, commonly along faults.
GRAVEL AND CONGLOMERATE-Stream deposits derived from older rocks. Contains pebbles, cobbles, and boulders, which range from angular to subrounded. Matrix is coarse, poorly sorted arkosic sandstone that varies from well-consolidated to poorly consolidated. Crude to well-defined bedding.
VOLCANIC ROCKS (0-200 FT)
Lava-Flows of tholeiitic with aphanitic texture and glassy to pumiceous outer envelopes; rock contains sparse phenocrysts of quartz, feldspar, and biotite. Aphanitic rhyolite in gray and varies from massive to strongly flow laminated laminations vary from planar to contorted. Spheroidal structures locally abundant along contacts between aphanitic and glass phases. Glass phase, generally light gray, is locally perlite of commercial quality.
Tuff-Light-yellow, white, and light-brown air-fall and water-laid tuff. Crudely bedded to well-bedded, with beds ranging from about 1 to 4 feet in thickness. Generally poorly sorted, composed of coarse and medium grains of quartz and feldspar, pumice and rhyolite chips, vesiculates, and volcanic dust. Some beds separated by partings of ash.
QUARTZ MONZONITE PORPHYRY
Porphyritic facies-Phenocrysts of quartz, K-feldspar, and plagioclase, 1-3 mm in diameter, make up 10-15 percent of the rock. Finely crystalline groundmass is composed of quartz, feldspar, and mafic minerals. Cavities with quartz filling or druses common. Forms a small, irregular stock, probably intruded at shallow depth.
Aphanitic facies-Border of quartz monzonite porphyry body. Similar to porphyritic facies except phenocrysts are small or absent, and groundmass grades from finely crystalline to aphanitic. Transition to porphyritic facies is gradational to abrupt.
APACHE LEAP TUFF (NEW) (2000 FT AT TYPE SECTION; AVERAGES ABOUT 500 FT)-This formation is here named for Apache Leap, a prominent west-facing cliff that trends southward through the central part of quadrangle. Type section is in Queen Creek Canyon and Oak Flat sec. 36, T. 1 S., R. 12 E., and sec. 28, 29, 30, and 31, T. 1 S., R. 13 E. In earlier reports this formation was informally termed "dacite." The Apache Leap Tuff is an ash-flow sheet which, at type section, constitutes a simple cooling unit. Nonwelded light-gray tuff at base grades upward to densely welded black vitrophyre that is overlain by densely welded tuff with cryptocrystalline groundmass. Further up, degree of welding gradually decreases and degree of devitrification and vapor-phase crystallization increases. Color progressively changes upward from light brown just above vitrophyre through moderate red to very light gray near top. Abundant pumice fragments progressively less flattened toward top. Phenocrysts consist about 40 percent of the rock, and consist of about three-fourths plagioclase, one-tenth each quartz and biotite, trace to one-tenth sanidine, minor hornblende, magnetite, sphene, zircon, and apatite.
Tertiary in age, on basis of 20-m.y. K-Ar date (Creasey and Kistler, 1962, p. D1).
Lower contact-Rests on Whietail Conglomerate at type locality; consists, designated as basal surface of ash-flow material below this surface, elastic sedimentary rock is interbedded with water-laid tuff. Apache Leap Tuff may also rest on Tertiary rhyolite lava flows, Paleozoic, or Precambrian rocks.
Upper contact-Overlain unconformably by water-laid gravel and conglomerate.
RHYOLITE (0-2000 FT)-Lava flows of rhyolite and perlite obsidian. Light- to medium-gray rhyolite with 1 to 5 percent phenocrysts of plagioclase, quartz, sanidine, and biotite in aphanitic groundmass. Flow laminations generally prominent, locally contorted; laminations locally absent resulting in massive structure. Tops and bottoms of flows generally composed of black to brown obsidian with well-developed perlitic cracks. Obsidian slightly to completely devitrified and grades to grayish-yellow felsite. Unit includes local deposits of tuff and tuff breccia, and flows of andesite and trachyte.

WHIETAIL CONGLOMERATE OUTCROPS (0-30 FT, SUBSURFACE, 0-200 FT)-Stream deposits derived from all older rocks. Fragments are angular to subrounded, pebble to boulder size, and coarsest near base. Fragment composition generally is like nearby bedrock. Matrix typically coarse-grained, poorly sorted, arkosic to lithic sandstone, but matrix of some beds is fine grained. Moderately to well-sorted. Bedding planes generally poorly defined, locally absent, become distinct upward. Upper part locally interstratified with water-laid tuff.
Age is here changed from Tertiary(?) (Ransome, 1903, p. 47; Peterson, N. P., 1962, p. 36) to Tertiary on basis of 20-m.y. K-Ar date for overlying Apache Leap Tuff (Creasey and Kistler, 1962, p. D1), and on basis of alternating sedimentary and tuffaceous beds in upper part of Whietail. The tuff in the Whietail is from pyroclastic eruptions that immediately preceded the ash-flow eruptions of the Apache Leap Tuff.
FELSITE DIKE-Known locally as "Grandfather lead." Light-gray aphanitic rock largely altered to clay, mica, and calcite. Relict phenocrysts of plagioclase discernible. Forms prominent outcrops.
VEIN QUARTZ-White "ball" quartz forming prominent outcrops. No metallic minerals detected.
DIOIRITE PORPHYRY-Silts, dikes, and small irregular hypabyssal bodies of light- to medium-gray porphyritic altered rock. Phenocrysts that constitute 20-60 percent of rock consist chiefly of euhedral and subhedral plagioclase, 1-10 mm in diameter, and euhedral hornblende prisms 1/2-15 mm long. Groundmass aphanitic to very fine grained, chiefly plagioclase, K-feldspar, hornblende, biotite, locally pyroxene; quartz generally absent but locally abundant. Partly to completely altered to sericite, clay, calcite, and chlorite. Contains disseminated pyrite near Silver King mine.
QUARTZ DIORITE-Small stock intruding Precambrian and Paleozoic rocks. Medium- to fine-grained, generally hypidomorphic granular, locally grades to panidiomorphic granular. Consists mostly of euhedral to subhedral plagioclase and variable amounts of euhedral hornblende, pyroxene, and biotite; interstitial quartz ranges from trace to 15 percent.
There are two major but intergradational rock types: one is medium grained and contains 10-20 percent mafic minerals and 10-15 percent quartz; the other is fine grained and contains 20-40 percent mafic minerals and trace to 10 percent quartz. Common in both types are irregular masses of coarse-grained rock containing euhedral hornblende as much as 4 cm long or euhedral pyroxene as much as 2 cm wide. Plagioclase shows slight to moderate alteration to sericite and clay, and mafic minerals are altered to uranite, epidote, biotite, and chlorite.
NAO LIMESTONE (0-100 FT)-Medium- to thin-bedded, light-gray, white, pale-blue, and pink limestone that locally contains irregular light-brown chert nodules and layers. Bedding planes distinct and most are flat, though some are wavy. Fossils that are common and locally abundant include fusulinids, brachiopods, corals, bryozoa. Base of formation generally marked by 15-foot bed of very dark red to dusky-purple fissile shale; similar shale is sporadically interbedded with limestone higher in section. Thin discontinuous beds of chert conglomerate crop out locally below the shale and mark the base.
Variability of thickness due to post-Nao erosion that occurred before deposition of overlying Tertiary rocks.
ESCABROSA LIMESTONE (0-50 FT)-Thin- to thick-bedded, very light gray to dark-gray limestone. Lower beds are dark gray, thick to medium bedded, and overlain by very light gray thick-bedded limestone that forms one or more prominent cliffs. Upper part is light- to medium-gray, medium- to thin-bedded limestone that contains abundant chert and interbedded shale partings. Moderately fossiliferous; crinoid stems, brachiopods, and corals most abundant forms.
MARTIN LIMESTONE (0-40 FT)-In ascending order: 15-20 feet of grayish-yellow limestone abundant frosted quartz grains and dusky-red spheroidal spots. 10-30 feet of medium-bedded dark-gray crystalline limestone that is the host rock for replacement ore bodies in Magma mine and is locally mineralized elsewhere. 150-200 feet of dark- to light-gray to grayish-yellow, thin-bedded, unfossiliferous dolomite with dense texture; one or more thin beds of medium-grained quartzite or sandstone may be interbedded. 160-200 feet of alternating thin to medium beds of limestone, dolomite, and a little sandstone and gray to grayish-yellow to grayish-red shale; some of the limestone is crowded with brachiopods and crinoid stems. 10-30 feet of gray to grayish-yellow, highly fissile, calcareous shale.
BOLA QUARTZITE (0-40 FT)
Lower part-Heterogeneous class lithologies with abrupt changes both laterally and vertically. Includes poorly sorted pebble conglomerate, arkosic sandstone, gray-wackes, and wavy bedded mudstone; most rocks deeply iron stained and are dark shades of grayish to reddish brown. This material is largely derived from nearby older rocks and fills irregularities on a eroded surface of moderate relief.
Upper part-Medium- to fine-grained quartzite, feldspathic quartzite that locally may grade to sandstone, and some beds of grit. White to light gray where fresh, grayish yellow to light brown where weathered; red to brown colorations are common and locally prominent. Bedding distinct, medium to thick, generally even, locally undulating; crossbedding common. Locally forms cliffs.
Changes in thickness chiefly due to pre-Paleozoic relief.
DIABASE-Sills and dikes. Chiefly subhedral and euhedral plagioclase and pyroxene, with lesser amounts of amphibole, biotite, and opaque oxides; minerals commonly moderately altered. Freshly broken surfaces dark gray to greenish black; weathered surfaces dark shades of brown, green, and gray. Texture ophitic and subophitic; generally medium grained, locally coarse grained, aphanitic to finely crystalline. Intrudes Troy Quartzite and other formations, and is depositionally overlain by Bola Quartzite.
TROY QUARTZITE (700 FT)
Lower member (155 ft)-Alternating beds of conglomerate, poorly sorted coarse-grained feldspathic quartzite and arkose, and siltstone; conglomerate beds most abundant near base; beds are lenticular and have highly variable thickness. Crossbedding and local Liesegang banding are common. In upper part, a medium-grained feldspathic sandstone bed as much as 50 feet thick shows well-developed convolute laminations.
Upper member (545 ft)-Chiefly fine-grained, locally medium- to coarse-grained quartzite and arkosic quartzite. Weathers to resistant, blocky ledges. Bedding medium, generally even but locally wavy. White to light gray where fresh, light gray to light brownish gray where weathered. Chiefly rounded to subrounded, well-sorted grains; beds locally contain scattered quartz granules and small pebbles, which in some places extend surface just below parting plane. Many beds contain clots of powdery hematite interstitial to grains, giving rock a spotted appearance.
BASALT (MAXIMUM 20 FT)-Dark-gray to dark-brown aphanitic rock composed of microcrystic plagioclase tablets partly altered to clay and calcite, and pyroxene and olivine largely altered to opaque oxides, serpentine, calcite, iddingsite, and other minerals. Locally vesicular and amygdaloidal. Some layers are volcanic breccia consisting of angular basalt blocks in a matrix of basaltic lava.
MESAL LIMESTONE (0-50 FT)-Medium-gray to light-brown to white dolomite and limestone; generally thin-bedded with undulating to even bedding planes. Texture generally aphanitic or fine grained, locally medium or coarse grained, crystalline. Black to light-brown variegated chert abundant in some beds as uneven layers alternating with carbonate or as irregular nodules. Near base is layer of poorly exposed breccia of angular chert dolomite fragments in a matrix of silty, local calcareous, dolomite. Near top an algal member contains abundant wavy concentric structures characteristic of stromatolites. Locally near intrusive bodies of diabase in southern part of quadrangle, seams of chrysolite asbestos occur parallel to bedding.
DRIPPING SPRING QUARTZITE (700 FT)-In ascending order:
Bornes Conglomerate Member (generally 1-4 ft, locally as much as 18 ft)-Well-rounded to subangular pebbles of white quartz, locally abundant, and angular pebbles and granules of schist in a matrix of grayish-red-purple, very coarse grained, poorly sorted rock chips and arkosic sandstone.
Arkose member (220 ft)-Light-brown, yellowish-gray, and pale-red-brown, medium- to coarse-grained, feldspathic quartzite and arkose, medium- to thick-bedded, locally crossbedded, some beds separated by siltstone partings. Commonly forms ledges and cliffs.
Siltstone member (490 ft)-Alternating thin layers of very fine grained feldspathic quartzite, arkose, and siltstone. Fresh surfaces light gray to light brown; weathered surfaces strong shades of brown, red, and yellow; color laminations common, locally spotted. Weathers to slabs and blocks; generally forms slopes with intermittent low ledges. Generally intruded by several diabase sills.
PIONEER FORMATION (0-85 FT)-In ascending order:
Sandstone Conglomerate Member (generally 1-4 ft, locally as much as 18 ft)-Well-rounded to subangular pebbles of white quartz, locally abundant, and angular pebbles and granules of schist in a matrix of grayish-red-purple, very coarse grained, poorly sorted rock chips and arkosic sandstone.
Arkose member (155 ft)-Arkose and feldspathic quartzite and sandstone, light-brown to dark-brown to dusky-red-purple, medium- to thin-bedded. Sandy beds separated by thin beds of siltstone and shale. Number and thickness of siltstone beds increase upward so that upper part of member contains equal amounts of arkose and siltstone.
Siltstone member (155 ft)-Thin-bedded siltstone, shale, and fine-grained arkose, dark-purple and dusky-red, speckled by light-brown to greenish-yellow spots. Siltstone and shale are tuffaceous. Typically weathers to small, flat, angular flakes.

Note: Additional information on these rocks may be obtained from reports listed in the selected bibliography.



GEOLOGIC MAP OF THE SUPERIOR QUADRANGLE, PINAL COUNTY, ARIZONA

By Donald W. Peterson

Arizona (Superior quad.) Geol. 1:24,000. 1969. cop. 2.