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Summary of geologic formations of the Klondyke quadrangle, Arizona—Continued

Age		Formation: Galiuro Mountains	Formation: Aravaipa Valley	Formation: Santa Teresa and Turnbull Mountains	Thickness (feet)	Lithology and Location
Age relationship and relative stratigraphic position of some units unknown	Tertiary	Not recognized	Not exposed	Goodwin Canyon Quartz Monzonite		Light-colored equigranular to porphyritic quartz monzonite and granite, subordinate diorite. Head of Goodwin Canyon. Age relative to that of Santa Teresa Granite unknown.
		Not recognized	Not exposed	Santa Teresa Granite		Pale-red medium-grained equigranular perthite leucogranite. Santa Teresa Mountains.
	Tertiary or Late(?) Cretaceous	Copper Creek Granodiorite	Not exposed	Not recognized		Grayish medium-grained porphyritic granodiorite of Copper Creek basin. Contains numerous breccia pipes. Age relative to that of Santa Teresa Granite or Goodwin Canyon Quartz Monzonite unknown; all may be of nearly the same age.
		—Intrusive contact—				
		Not recognized	Horse Mountain Volcanics	Horse Mountain Volcanics	3,000+	Silicic lava, tuff, welded tuff, obsidian, and vitrophyre; subordinate andesite and dacite. Lenticular conglomerate at base, locally fossiliferous. Numerous necks and vent breccias. Southwest flank of Santa Teresa and Turnbull Mountains.
				—Angular unconformity—		
		Not recognized	Not exposed	Williamson Canyon Volcanics	2,500+	Nondescript massive pyroclastics, porphyritic lavas, and flow breccia, probably mostly andesitic or dacitic. Local basal conglomerate. Head of Williamson Canyon and along Old Deer Creek.
				—Disconformity—		
	Cenozoic and Mesozoic	Not recognized	Not exposed	Buford Canyon Formation: Volcanic member	1,500+	Dark fine-grained altered flows and flow breccia of andesite or basalt; minor silicic pyroclastic rocks.
		Not recognized	Not exposed	Buford Canyon Formation: Conglomerate member	700+	Moderately indurated conglomerate with interlayered andesite or basalt flows and silicic pyroclastics. Buford Canyon and Klondyke Wash. Age relative to that of Horse Mountain or Williamson Canyon Volcanics unknown.
				—Unconformity—		
		Glory Hole Volcanics	Not exposed	Not recognized	1,500+	Heterogeneous, probably mostly andesite or dacite pyroclastics, subordinate flows, and flow breccias. Numerous breccia pipes. Copper Creek region. Age known only to be post-Mississippian, pre-Miocene(?).
		—Unconformity?—				
Late Cretaceous		Pinkard(?) Formation	Not exposed	Pinkard Formation	900–1,000?	Gray to olive graywacke, feldspathic sandstone, siltstone, and shale, minor quartzite and conglomerate. Sparingly fossiliferous. Iron Cap mine and along Old Deer Creek.
		—Unconformity—		—Angular unconformity—		
Carboniferous	Pennsylvanian	Not exposed	Not exposed	Horquilla Limestone	350–400	Gray to light-gray thin-bedded fine-grained fossiliferous limestone, subordinate coarse-grained and thick-bedded limestone. Aravaipa and Landsman Camp areas.
				—Disconformity—		
	Mississippian	Escabrosa Limestone	Not exposed	Escabrosa Limestone	300–400	Light- to medium-gray thick- to thin-bedded medium- to fine-grained limestone; some crinoidal, oolitic, or cherty limestone. Locally cliff forming. Aravaipa and Landsman Camp areas, Table Mountain mine, Copper Creek basin.
		—Disconformity—		—Disconformity—		
Devonian		Martin Formation	Not exposed	Martin Formation	0–150	Variegated marl, limestone, dolomite, shale, and sandstone. Aravaipa and Landsman Camp area, Copper Creek basin.
		—Disconformity?—		—Disconformity—		
Cambrian		Bolsa(?) Quartzite	Not exposed	Bolsa Quartzite	300–400	Light-colored massive cliff-forming orthoquartzite and grit; basal conglomerate, purplish shaly partings. Aravaipa and Landsman Camp areas, Quartz Hill, Copper Creek region?.
				—Unconformity—		
Precambrian		Not exposed	Not exposed	Diabase		Dikes, sheets, and irregular bodies intruding Pinal Schist and Laurel Canyon Granodiorite.
		Not recognized	Not exposed	Laurel Canyon Granodiorite		Coarse-grained porphyritic granodiorite, commonly containing prominent phenocrysts of pink perthite. Local red granophyre and siliceous granite facies. Laurel and Tule Canyons region.
				—Intrusive contact—		
		Pinal(?) Schist	Not exposed	Pinal Schist	?	Schistose graywacke, quartz-muscovite-chlorite schist, quartzite, metavolcanics, and hornfels. Santa Teresa and Turnbull Mountains; Galiuro Mountains?.

USGS Prof. Paper 461
Frank S. Simons (1964).

is exposed along the canyon bottom downstream from Stowe Gulch.

The geologic formations mapped in the three broad areas of the quadrangle—Galiuro Mountains, Aravaipa Valley, and Santa Teresa-Turnbull Mountains—are summarized in the following table.

Summary of geologic formations of the Klondyke quadrangle, Arizona

Age		Formation				Thickness (feet)	Lithology and Location
		Galiuro Mountains		Aravaipa Valley	Santa Teresa and Turnbull Mountains		
Quaternary	Recent	Younger alluvium		Younger alluvium	Younger alluvium	80?	Unconsolidated flood-plain deposits along Aravaipa Creek, and alluvium along its tributaries and Copper Creek.
Quaternary	Recent or Pleistocene	Not exposed		Lake beds and terrace deposits	Not exposed	100?	Unconsolidated gravel capping terraces 50-200 ft above Aravaipa Valley; weakly consolidated brown sandy to silty lake deposits. In Aravaipa Valley and tributaries.
				—Unconformity—			
Quaternary	Pleistocene or Pliocene	Not recognized		Older alluvium	Older alluvium	700+	Partly consolidated essentially flat-lying alluvium along southwest flank of Santa Teresa and Turnbull Mountains and northeast flank of Galiuro Mountains.
				—Unconformity—			
Tertiary	Late or middle	Hell Hole Conglomerate		Hell Hole Conglomerate	Not recognized	2,000+	Well-indurated buff conglomerate, locally strongly deformed, along northeast flank of Galiuro Mountains. Composed mainly of volcanic debris; includes few beds of tuff and ash.
		—Unconformity—					
Tertiary	Middle Miocene?	Galiuro Volcanics	Upper tuff unit			200-300	Coarse-grained light-colored rhyolitic tuff, mostly near Aravaipa Canyon.
			—Local unconformity—				
			Upper andesite unit			100-500	Dark fine-grained olivine andesite or basaltic andesite lava and agglomerate, north of Aravaipa Canyon.
			—Local unconformity—				
			Quartz latite unit of Hawk Canyon			0-200	Reddish coarse-grained porphyritic quartz latite in upper Hawk Canyon.
			Rhyolite-obsidian unit			0-700	Obsidian, obsidian agglomerate, vitrophyre, and minor tuff and breccia in lower part; light-colored fine-grained rhyolite in upper part. North of Aravaipa Canyon.
			Tuff unit of Hawk Canyon			0-100	Light-colored massive silicic vitric-crystal tuff in upper Hawk Canyon.
			Intermediate andesite unit	Not exposed	Not recognized	150-450	Mostly coarse-grained porphyritic olivine andesite or basaltic andesite, minor fine-grained to porphyritic andesite. Along and south of Aravaipa Canyon.
			White tuff unit			0-100	Massive coarse-grained vitric-lithic silicic tuff, locally welded at top. South of Aravaipa Canyon.
			Upper welded tuff unit			75-200+	Pinkish cliff-forming massive vitric or vitric-crystal rhyolite welded tuff. Includes porphyritic rhyolite lava of Black Butte. Lower walls of Aravaipa Canyon, and extensive stripped surfaces along Parsons and Virgus Canyons.
			—Local disconformity?—				
			Lower tuff unit			0-550	Heterogeneous assemblage of light-colored silicic tuff and welded tuff, hornblende andesite, and a thin flow of olivine basalt. South of Aravaipa Canyon.
			Biotite dacite unit			0-400	Reddish porphyritic dacite, andesite, and latite flows, locally cliff forming. Upper Parsons and Oak Grove Canyons.
			—Disconformity—				
			Lower welded tuff unit			250-350	Brownish vitric-crystal biotite latite welded tuff. Upper Virgus, Parsons, and Oak Grove Canyons.
			—Local unconformity?—				
			Lower andesite unit			1,300+	Red to gray fine-grained andesite and olivine andesite flows, flow breccia, and agglomerate; latite lava and tuff; minor coarse-grained porphyritic olivine andesite, tuff and conglomerate. Includes several pyroclastic cones and breccia pipes. Summit of Galiuro Mountains.
			Unconformity				

Elliot Gillerman (1958): N. Mex. Bur. of Mines Bull. 57.

TABLE 1. ROCKS OF THE CENTRAL PELONCILLO MOUNTAINS

Intrusive rocks	Age	Rock unit	Lithology	Thickness (feet)
			Sedimentary and extrusive rocks (layered rocks)	
	Quaternary	Animas Valley basalt	Dark-gray to black fine-grained vesicular olivine basalt	0-60
	Quaternary	Alluvial and lacustrine deposits	Includes older alluvial deposits of poorly sorted coarse gravel upon which a hilly topography is developed; lake beds of interbedded fine sand and clay estimated to be 10-20 feet thick; and younger alluvial deposits of unsorted and unconsolidated sand and gravel on the lower slopes of the mountains and in parts of Animas and San Simon Valleys	
Rhyolite dikes	Tertiary	Weatherby Canyon ignimbrite	Rhyolite and some trachyte ignimbrite and thin interbeds of nonwelded tuff. Most of the ignimbrite is a light-gray to red, hard, compact, aphanitic-porphyritic rhyolite, with phenocrysts of quartz, sanidine, and orthoclase in a devitrified matrix of shards and glass shreds. Numerous elongated lenticular cavities impart a eutaxitic structure to the ignimbrite. Microscopic examination shows that the finer particles are also alined parallel to the bedding. The ignimbrite is confined to the area south of Cowboy Pass	3,000+
Quartz latite dikes and plug	Tertiary	Vanar Hills volcanic rocks	Flows, vitric tuffs, crystal tuffs, and pitchstone; pinkish-gray latitic rocks, with phenocrysts of feldspar and biotite in a hypocrystalline groundmass. Similar to the intrusive latite porphyry	
Latite porphyry sills and dikes	Tertiary	Steins Mountain quartz latite porphyry	Columnar jointed flows and devitrified tuffs which form the upper part of Steins Mountain and adjacent hills. The rock is pinkish-gray porphyritic-aphanitic, with quartz and feldspar phenocrysts and numerous lithic and vitric fragments, many of which are flattened and elongated, imparting a eutaxitic structure to the rock	
Rhyolite, latite, and monzonite porphyry dikes, sills, and plugs	Tertiary	Basalt	Dark-gray to black, fine-grained, holocrystalline, nonporphyritic; consisting wholly of andesine and magnetite. Occurs north of Steins	
	Tertiary	Quarry Peak rhyolite complex Gil Mt. type?	Flows, breccias, and tuffs of rhyolite composition. In general the rock is light gray to white, with a few small inconspicuous quartz or feldspar megacrystals. Many of the breccias and tuffs are well bedded. Occurs north of the Southern Pacific Railroad and forms prominent Quarry Peak	1,000±
Quartz monzonite porphyry dikes and sills	?	Andesite S-Bell type	Dark-gray, red, and grayish-purple flows and breccias, most of which are fine grained, with small phenocrysts of epidotized feldspar and pyroxene. Epidote is very abundant in the rock. Some dacite and basalt are included in the sequence	5,000+
	?	Bobcat Hill conglomerate Clayton type	Interbedded impure volcanic arkose sandstone and conglomerate. The conglomerate is characterized by the presence of fragments of limestone and volcanic rocks. A 1-foot bed of limestone, which in places consists entirely of algal remains, occurs near the base of the formation in the eastern part of the outcrop area	720-1,140
	?	Quartz latite ?	A holocrystalline equigranular fine-grained to aphanitic gray to brown rock, with small phenocrysts of quartz, feldspar, and biotite, and lithic fragments. Flow structures are present in the upper part	
Cienega Peak granite	Cretaceous	Johnny Bull sandstone	Interbedded light-colored fine-grained well-sorted well-cemented orthoquartzite, dark grayish-brown fine-grained well-cemented subgraywacke, and brown shale	1,047+
	Cretaceous	Still Ridge formation Paulsen type	Silty and sandy limestone, sandstone, calcareous sandstone, and limestone pebble conglomerate. The limestone pebble conglomerate, which is prominent in the sequence, consists of black limestone pebbles which weather light gray, in a dark-gray to black limestone matrix which weathers brown. Interbedded volcanic rocks	575-650
	Cretaceous	Carbonate Hill limestone	Medium-gray thin-bedded sandy calcarenite with prominent beds, 8-10 feet thick, consisting almost wholly of pelecypod shells. Pelecypods, gastropods, and ammonites are common	200+
	Cretaceous	McGhee Peak formation	Alternating beds of conglomerate, shale, sandstone, and limestone. The conglomerate contains limestone fragments but no volcanic rock fragments	470-600
	Permian	Chiricahua limestone	Thick-bedded light-gray medium-grained limestone containing abundant irregularly shaped grayish-pink nodules of chert. Very fossiliferous	800+
	Permian	Scherrer formation	Thick-bedded well-cemented dusky-red siltstone	0-50(?)
	Permian	Colina limestone	Mostly dark-gray to black very fine-grained limestone with calcite segregations which are probably recrystallized fossils. No chert. Large gastropods and scaphopods are characteristic. A few siltstone beds	500+
	Permian	Earp formation	The lower part consists of alternating beds of limestone, siltstone, and sandstone, with some shale. The upper part is dominantly limestone, with some beds of dolomite near the top. Fusulinids are abundant	831+
	Permian / Pennsylvanian	Horquilla limestone	Thin- and thick-bedded dark- and light-gray limestone with abundant fusulinids, except in the lowermost part. Pinkish-gray and black chert are common.	1,350-1,500
	Mississippian	Paradise formation	Alternating beds of black, gray, and brown limestone, oolitic limestone and calcarenite, calcareous sandstone, and conglomerate. Fossils are abundant	217
	Mississippian	Escabrosa limestone	Lower member mostly thin-bedded to medium-bedded light-gray limestone, with some thin shale interbeds and some beds of dark-gray limestone, about 100 feet thick. Middle member consists of dark-gray to black	

TABLE 1. GENERALIZED CENOZOIC STRATIGRAPHIC SECTION

AGE		FORMATION	LITHOLOGY	THICKNESS* (in feet)	
Quaternary		Alluvium	Bolson deposits, stream gravels, etc.	0-200 +	
		Terrace gravels	Stream gravels on raised terraces	0-125	
		Unconformity			
Tertiary	Upper Volcanic Series	Santa Fe formation	Consolidated fanglomerates and minor andesites	0-500 +	
		Unconformity, major faulting			
		Swartz rhyolite	Intrusive banded rhyolite, with associated flows, breccias, and tuffs	0-75	24.4±0.8 p. 65 (Damon AEC, 1967.)
		Disconformity			
		Bear Springs basalt	Flows, breccias, and agglomerates	0-650 +	
		Disconformity			
		Razorback rhyolite member†	Flows, tuffs, and breccias	300-800	
		Razorback andesite member†			
		Major disconformity			
	Lower Volcanic Series	Caballo Blanco rhyolite†	Pumiceous porphyritic ignimbrite	0-300	29.8 ±0.8 p. 65 (Damon AEC, 1967).
		Rustler Canyon basalt†	Flows and breccias (local)	0-50	
		Box Canyon rhyolite	Massive porphyritic ignimbrite	0-75	
		Mimbres Peak formation	Banded pinkish rhyolite flows and intrusive bodies, red tuff, bedded pumiceous tuff, pitchstone, perlite, and perlite breccia	0-2,500 +	
		Disconformity			
		Kneeling Nun rhyolite	Rhyolitic ignimbrite	0-500	33.4 p. 68 (Damon AEC, 1967).
		Sugarlump rhyolite and latite	Tuffs, sandy tuffs, tuffaceous sandstones, ignimbrites, conglomerates, etc.	50-1,300	
		Unconformity, faulting			
		Rubio Peak andesite and latite	Andesite and latite flows, tuffs, agglomerates, breccias, conglomerates, red sandy shale at base	600-5,000 ?	
		Disconformity			
(Early Tertiary?)‡		Macho andesites	Present in Lake Valley quadrangle; probably absent in Dwyer quadrangle		Schiebell [illegible]
		Unconformity, Laramide faulting			

* Thicknesses given for composite extrusive-intrusive formations refer to extrusive members only.

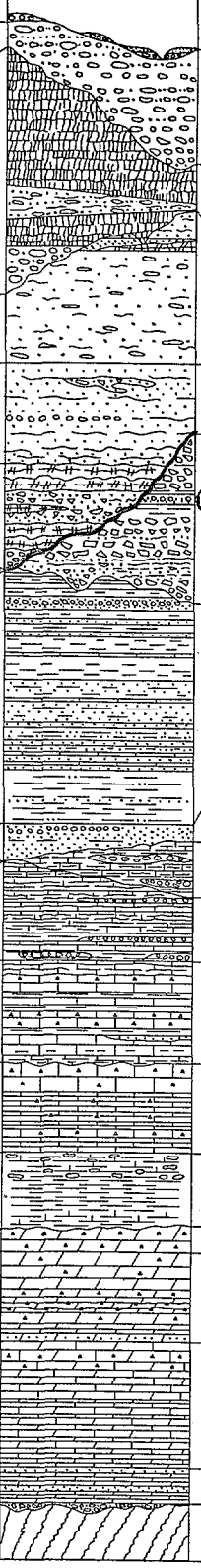
† Interbedded with Piloncillo sediments (sandstone, fanglomerate, and conglomerate; 0-400 ft).

‡ Tertiary(?) volcanic rocks of unknown stratigraphic position: White Eagle rhyolite, Pollack rhyolite, Faywood rhyolite.

N. Mex. Bur. Mines Bull. 38.
Wolfgang E. Elston (1957).

By William R. Jones, Robert M. Hernon, and Samuel L. Moore.

USGS. Prof. Paper 555. 144 pages. 1967



SYSTEM OR SERIES	FORMATION	APPROXIMATE RANGE IN THICKNESS (FEET)	LITHOLOGY
Recent and Pleistocene	Younger alluvium Older alluvium		Unconsolidated alluvium and colluvium in valley floors, flat uplands, and on slopes. Includes sand, silt, and gravel.
Pliocene and Miocene(?)	Gravel deposits in Mimbres River system	0-800	Somewhat consolidated poorly sorted bolson deposits ranging from silt to boulder deposits. Similar and in part equivalent to Gila Conglomerate and Santa Fe Formation.
Miocene(?)	Basaltic andesite flows and underlying gravel and boulder deposits	0-850	Dark-gray finely crystalline porphyritic flows; weather reddish brown; contain phenocrysts of pyroxene, magnetite, and olivine in matrix of labradorite.
	Pitchstone, sandstone, and indurated rhyolite tuff underlain by Kneeling Nun Tuff	0-600	Crystal fragments of quartz, sanidine, biotite, and oligoclase, and rock fragments imbedded in compacted glass shards, in part devitrified and in part replaced by chalcedony. Black pitchstone contains rock fragments and is locally vesicular.
	Sugarlump Tuff	0-600	Pumiceous tuff, gravel, and sandstone locally replaced by clinoptilolite. Generally well stratified.
			Andesite breccia.(See below.)
	Rubio Peak Formation	0-600	Conglomerate containing intercalated indurated tuffs and rhyodacite and andesite flows. (Rubio Peak Formation)
Lower Tertiary and Upper Cretaceous(?)	Andesite breccia Silver Bell equiv.	0-500	Andesite breccia and fine-grained crystal tuff, volcanic sandstone, and some nonvolcanic sandstone and mudstone.
Upper Cretaceous	Colorado Formation	0-1000	Upper 800 feet consists of tan, greenish-brown, and white sandstone interbedded with dark-green, brown, and black shale. Lower 225 feet is black limy shale except for 20 feet of quartzite about 80 feet above base. Thin beds of fossiliferous impure limestone conspicuous in lower part above the lower beds of black shale.
Upper(?) Cretaceous	Beartooth Quartzite	66-142	Fine-grained quartzite containing thin black-shale partings locally. Conglomerate beds near top.
Lower Permian	Abo Formation	0-265	Red shale, mudstone, and limy mudstone containing lenses of algal conglomerate locally.
Upper Pennsylvanian	Syrena Formation	170-390	Impure limestone and limestone interbedded with irregular lenses of red calcareous shale and with shale beds particularly in lower 140 feet.
Upper and Middle Pennsylvanian	Oswaldo Formation	330-420	Blue-gray limestone, fairly pure except in upper part, interbedded with thin shale beds; gray to red siliceous shale or grit about 20 feet thick occurs at base; known locally as "Parting shale."
Lower Mississippian	Lake Valley Limestone	300-400	Limestone, pure crinoidal and massive in upper part, argillaceous and thin bedded in central part. Much nodular chert throughout.
Upper Devonian	Percha Shale	230-315	Upper member, or Box Member, is gray calcareous shale containing abundant limestone nodules; lower member, or Ready Pay Member, is black fissile shale, calcareous at base.
Silurian	Fusselman Dolomite	100-300	Gray cherty finely crystalline vuggy massive dolomite.
Upper and Middle Ordovician	Montoya Dolomite	300-350	Light-gray to gray very finely crystalline massive dolomite containing interbedded dolomite and dark chert in central part and concentrations of opalescent quartz sandstone at base.
Lower Ordovician	El Paso Limestone	500-519	Thin- to thick-bedded light-gray limestone and dolomite. Chert nodules in upper part; abundant fucoidal markings in lower part.
Upper Cambrian	Bliss Formation	140-188	Predominantly dark-brown massive quartzite, locally hematitic and glauconitic. Grayish-brown shaly dolomite and basal coarse conglomerate locally.
Precambrian			Granite, granite gneiss, and greenstone.

FIGURE 2.—Columnar section of layered rocks Santa Rita quadrangle, Grant County, N. Mex.

of a bay in the Late Cretaceous sea which expanded from the Rocky Mountain trough westward and southwestward as far as the northeast margin of the Sonoran geosyncline.

UPPER MESOZOIC(?) AND CENOZOIC ROCKS

Because of the absence of fossils and the lack of crosscutting relations, a definite separation of Upper Cretaceous rocks from lower Tertiary rocks is not possible in the Santa Rita quadrangle. Similarly, upper Tertiary rocks cannot be separated from lower Quaternary deposits. Table 1 shows the chronological sequence in which the principal rock types were deposited or intruded. The Lower Cretaceous rocks—the Bisbee Group and the Hidalgo Volcanics, which are present elsewhere in southwest New Mexico—do not occur in the Silver City–Santa Rita region and are described only in table 1.

The lower Tertiary quartz monzonite or granodiorite discordant plutons, which were emplaced after the sills, are not in contact with the Laramide volcanic rocks in the Santa Rita quadrangle, and their age with respect to those volcanic rocks cannot be established conclusively. At Pinos Altos, 6 miles west, a stock that is chemically and mineralogically similar to the plutons intrudes the Laramide volcanic rocks; this fact, together with the nature and degree of alteration within the volcanic rocks, suggests that the Laramide volcanic rocks are older than the stocks in the Santa Rita area.

Sills of syenodiorite porphyry and dikes of diorite are the oldest known igneous rocks in the Santa Rita quadrangle. They are present only in the northwest quarter of the quadrangle. Their early age is proved by the fact that parts of them were exposed by erosion before deposition of the andesite breccia, probably in Late Cretaceous time. Only one syenodiorite porphyry sill is certainly older than the Laramide volcanic epoch; the relative age of the other sills with respect to the volcanic epoch is less certain.

TABLE 1.—*Rocks of late Mesozoic and Cenozoic age in the Santa Rita quadrangle and southwestern New Mexico, and related episodes of mineralization*

Epoch	Sedimentary	Extrusive	Intrusive	Related mineralization
Recent	Younger alluvium, talus, and landslide debris. Older alluvium and colluvium.	Basalt flows and sheets of "malpais." (Not in Santa Rita quadrangle)		Placer gold deposits. Manganese oxide deposits. Supergene enrichment of old deposits.
—— Unconformity ——	Development of pediments			
Pliocene and Miocene(?)	Semiconsolidated gravels in the Mimbres River valley; basin-fill material similar to Gila or Santa Fe Formations.	Vesicular olivine basalt flows and silicic tuffs. (Not in Santa Rita quadrangle)	Few basalt plugs and dikes. (Not in Santa Rita area)	None.
—— Unconformity ——				
Miocene(?)	Gravel and sandstone deposits interbedded in volcanic sequence.	Predominantly basaltic andesite flows.	Few basaltic andesite plugs and dikes.	None.
		Rhyolite to quartz latite vitric-crystal tuffs and flows. (For example, Kneeling Nun Rhyolite Tuff and Sugarlump Tuff)	Few dikes and plugs of felsite, aplite, granite, and rhyolite porphyry.	Small deposits of tin, tungsten, lead, zinc, fluorite, silver, gold, copper, and beryllium, spatially and probably genetically related to granite and rhyolites. None in Santa Rita quadrangle, however.
		Rhyodacite and andesite flows, agglomerate, tuff, breccia, and conglomerate of the Rubio Peak Formation.		None.
—— Unconformity ——				
Miocene(?) to Late Cretaceous(?)	Conglomerate and sandstone filling Hanover Hole. Hole formed near close of intrusive series.		Plugs, stocks, and dike swarms of predominantly intermediate composition, granodiorite to quartz monzonite. Some quartz diorite sills may be earliest intrusives of this episode.	Major deposits of copper, zinc, lead, silver, iron, gold, and molybdenum. Porphyry copper deposits enriched before Miocene(?) volcanism.
	Shale and sandstone, similar to parts of Colorado Formation, interbedded in volcanic rocks.	Andesite-latite breccia, conglomerates, and flows; generally ubiquitously propylitized and compacted; deposited on deeply dissected surface.	Orthoclase gabbro and other mafic plugs and great swarms of mafic dikes.	No metalization genetically related to sills, laccoliths, or mafic plugs and dikes.
—— Unconformity ——				
Late Cretaceous(?)			Syenodiorite and some quartz diorite sills and few dikes; intrude Colorado and older formations in Santa Rita area.	
Late(?) Cretaceous and Late Cretaceous	Beartooth Quartzite and Colorado Formation.			
Early Cretaceous	Bisbee Group: limestone, shale, and sandstone in southwest corner of New Mexico only. Sarten Sandstone north of Deming, N. Mex.	Hidalgo Volcanics (Lasky, 1947): basalt, andesite flows, and pyroclastic material. Southwest corner New Mexico.		

Silver Bell Formation equiv.

similar to most of the hypabyssal rocks of Late Cretaceous and early Tertiary age. However, the intrusive suite does not include a rock type as mafic as the Miocene(?) basaltic andesite (Bear Springs Basalt of Elston, 1957), the youngest igneous rock in the quadrangle. This fact is also obvious in figure 13, a normative mineral plot of several intrusive and extrusive rocks.

RUBIO PEAK FORMATION

The Rubio Peak Formation crops out in the southeast and southwest corners of the Santa Rita quadrangle. Beyond the quadrangle to the southeast it underlies a broad belt extending through the northwestern and central parts of the Dwyer quadrangle. In this belt it is reported to be as much as 3,200 feet thick, and possibly 5,000 feet thick (Elston, 1957). The Rubio Peak Formation probably extends westward beneath the younger volcanic rocks of the Cobre Mountains and the Hurley East quadrangle, because it is present in the valley of Whitewater Creek and in Bayard Canyon. The formation was believed by Elston (1957, p. 19) to fill a structural basin that reaches its maximum depth in the northwestern part of the Dwyer quadrangle. Farther west, north, and northwest, beyond the margin of the basin, the upper beds of the formation were deposited on a surface that had strong relief, and some of the topographic highs of that time were not covered. Such a high evidently existed over much of the south-central part of the Santa Rita quadrangle, for the formation is not present there.

The unevenness of the surface beneath the Rubio Peak Formation accounts for the variability in the thickness of the formation. The maximum thickness in the Santa Rita quadrangle is about 870 feet. Two series of flows aggregate about 600 feet.

Westward from the Mimbres fault, the Rubio Peak Formation lies on successively younger rocks—the Fusselman Dolomite of Silurian age to the quartz diorite sills of Late Cretaceous(?) age (Kuellmer, 1956). This truncation of older beds suggests that the southwest homoclinal dip of the older rocks west of the Mimbres fault developed prior to deposition of the Rubio Peak Formation in Miocene(?) time. The Rubio Peak Formation seems to be overlain conformably by Sugarlump Tuff throughout the Santa Rita quadrangle, but Elston (1957, p. 23–24) stated that in the Dwyer quadrangle the contact is unconformable in some places and conformable in others. He also stated, and showed on his map (pl. 1), that the two formations interfinger in the area of Mimbres. The white tuffs and tuffaceous gravels lying between the two groups of flows in the southeast corner of the Santa Rita quadrangle might be considered as an interfingering of Sugarlump Tuff on lithologic grounds alone, but the authors saw no reason at the time of mapping to consider it as such. The upper contact of the Rubio Peak Formation is arbitrarily placed at the top of the highest rhyodacite flow or at the top of the highest dark-colored poorly sorted conglomerate such as is exposed in Bayard Canyon and in the Bayard area.

Neither Elston (1957) nor Jicha (1954) described typical stratigraphic sections of the Rubio Peak Formation, because many of the flows are of such limited extent that no one section could be considered typical. In the Santa Rita quadrangle the basal part of the section consists of poorly sorted coarse gravels derived from sedimentary and igneous rocks of the adjacent area. In Bayard Canyon and for a mile or two farther west, the pebbles and boulders in the gravel are largely fragments of andesite breccia, mafic porphyry dikes and plugs, and a hornblende quartz diorite sill that crop out to the north and northwest. Fragments of magnetite, tactite, skarn, and metal sulfides were looked for but not found. If drainage were dominantly toward the southeast, the eroded parts of the ore bodies of the Central district might be concentrated in the gravels of the basal part of the Rubio Peak Formation beneath Rustler Canyon. Immediately west of the Mimbres fault, the base of the Rubio Peak Formation is characterized by a red sandy shale (Elston, 1957, p. 19). Neither the base nor the gravel beds are well exposed farther west. The following section is characteristic of the formation in the southeast corner of the Santa Rita quadrangle.

Rubio Peak Formation

[Near section *I–I'*, pl. 2]

	Thickness (feet)
Sugarlump Tuff.	
Rubio Peak Formation:	
Porphyritic rhyodacite flows: two massive dark-gray slightly vesicular flows separated by oxidized very vesicular material marking the top of the lower flow and by detrital rock. The flows contain phenocrysts of glassy feldspar, dark pyroxene, and red-brown iddingsite pseudomorphs of olivine phenocrysts	200–400
White lithic and pumiceous tuff grading to tuffaceous gravel, and interfingering thin flows of andesite. Lithic fragments are mainly andesite and older lithic tuff. Mineral framgents are biotite, chalcedony, sanidine, and frosted subrounded quartz grains	100–200
Porphyritic flows similar to upper flows	100–200
Semiconsolidated gravel derived from sedimentary and intrusive formations in the area immediately to the north	0–70
Angular unconformity.	
Cretaceous sedimentary and intrusive rocks.	

by the Rittman method on the universal stage. Average compositions are given. Norms have been calculated by the CIPW system (Washington, 1917) as modified by Barth (1931).

TABLE 3. GENERALIZED TERTIARY SECTION, LAKE VALLEY QUADRANGLE, NEW MEXICO

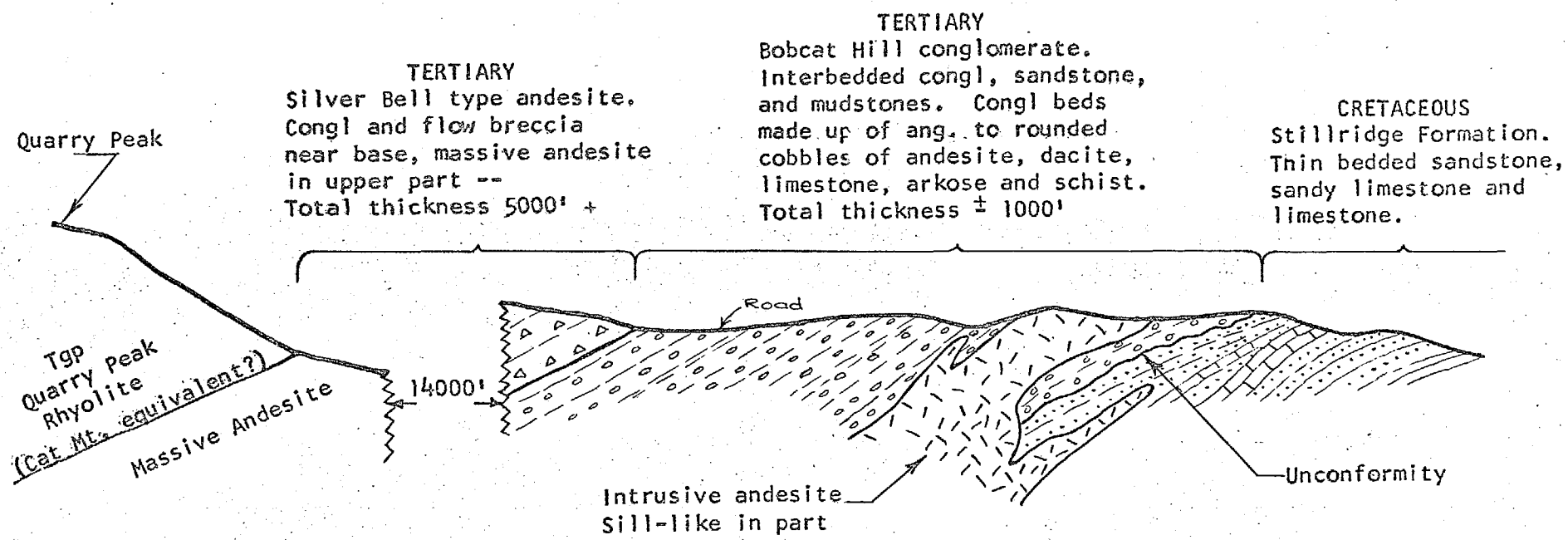
Age	Formation	Lithology	Thickness in feet
Pliocene-Pleistocene (?)	Santa Fe (?) formation	Consolidated sands and gravels, fanglomerate, water-laid fragmental volcanic material	0-1500
	Unconformity; major faulting		
Late Tertiary	Bear Springs basalt	Flows of purple, porphyritic, iddingsite-bearing rock, at times scoriaceous	150 ±
	Unconformity		
	Razorback formation	Fine-grained pyroxene andesites and possibly some rhyolite flows, with minor interbedded sandstone layers	250-500
	Disconformity		
	Pollack quartz latite	Pinkish-brown quartz latite flow with large phenocrysts of feldspar and fewer of quartz	300 ±
	Disconformity		
	Mimbres Peak formation	Banded pink-gray rhyolite flows and intrusive rhyolites, spherulitic and stony rhyolites, perlite, and associated red intrusive rhyolites. Possibly also pumiceous tuffs with rhyolite fragments	200 ±
	Disconformity		
	Kneeling Nun rhyolite	Pale lavender-gray and dark-brown welded tuffs with prominent quartz phenocrysts, columnar jointing	10-200
	Disconformity		
	Sugarlump tuffs	Pink and white explosion tuffs of quartz latitic composition	1000 ±
	Unconformity; faulting (?)		
	Rubio Peak formation	Varied porphyritic flows and breccias of intermediate composition, ranging from sodic to calcic (amphibole latites and pyroxene andesites)	2500 ±
	Unconformity		
Early (?) Tertiary	Macho pyroxene andesites	Purple porphyritic pyroxene andesite flows, breccia, and varicolored tuffs, with interbedded sandstones	1000 ±
	Major unconformity; late Cretaceous and early Tertiary orogeny		

Silver Bell Fm equiv.

Macho Pyroxene Andesites

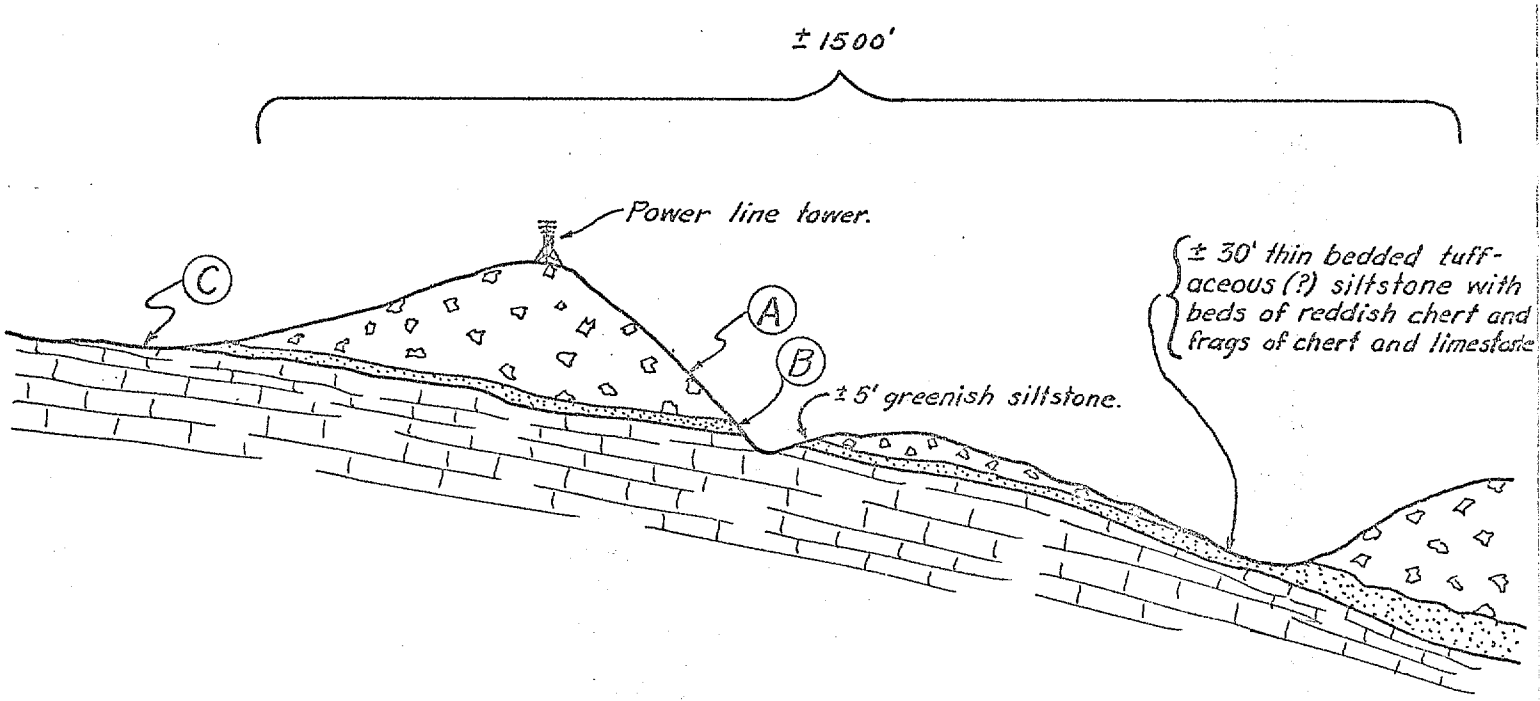
The Macho pyroxene andesites and andesite tuffs are named from the Macho mining district at W½ sec. 20, T. 19 S., R. 7 W., where they form a fairly thick series of flows, flow breccias, and tuffs. The tuffs are

New Mexico Bur of Mines Bulletin 37.
Henry L. Jicha, Jr. (1954).



SKETCH SECTION
NEAR STEINS, N. M.
Looking Easterly

Approx. Scale 1" = 1000'
February, 1960 JHC



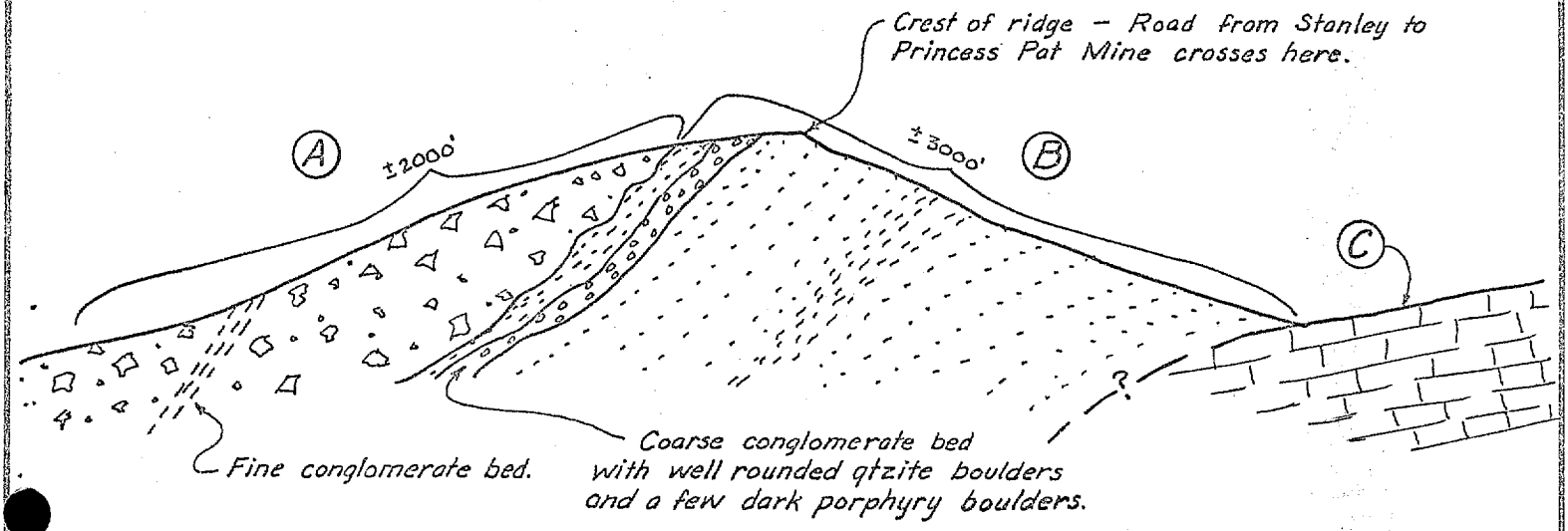
(A) - Silver Bell-type andesite porphyry conglomerate, angular to sub-rounded, dark gray to purplish porphyry boulders (ranging mainly from 1" to 6" in diam.) in muddy (tuffaceous ?) matrix. Locally conformable with underlying Paleozoic.

(B) - Greenish sandy, silty (tuffaceous ?) bed varying from 3' to 30 feet in thickness. Contains some red chert beds, also fragments of red chert and limestone from underlying Paleozoics.

(C) - Medium thick bedded, cherty limestone. Tornado (Ross).

SKETCH SECTION
(Looking Northerly)

Along Power Line Access Road about 1½ miles up O'Carroll Canyon from highway to Xmas Mine.
Gila County, Arizona



(A) - Andesite porphyry conglomerate (Silver Bell type) composed mainly of angular to subrounded boulders of andesite porphyry in sandy mud matrix. Massive, with only very rare evidence of bedding. Has generally dark gray to purplish color tones. Contact with underlying Cretaceous beds appears conformable.

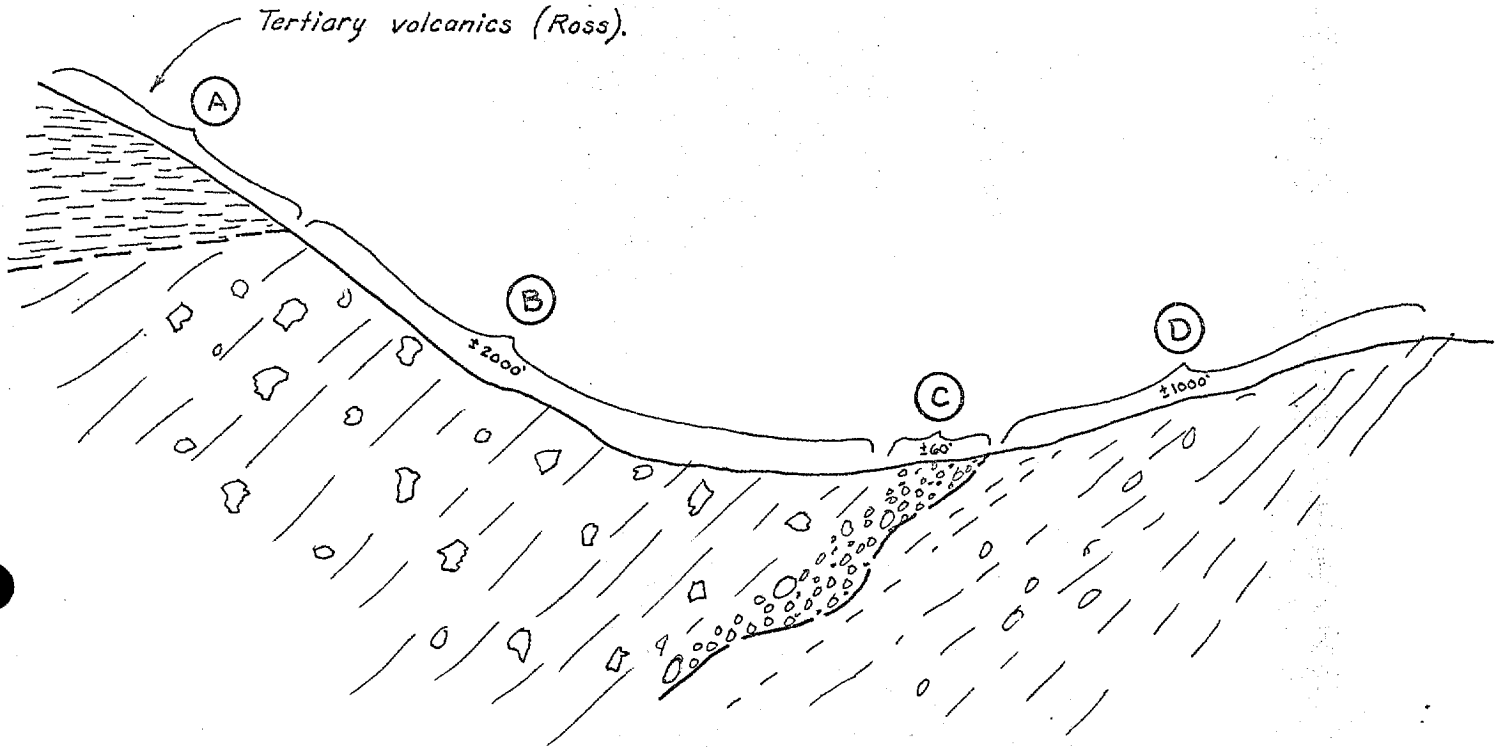
(B) - Upper Cretaceous (Ross). Thin bedded. Composed of pinkish, slightly arkosic sandstones or quartzites interbedded with pale greenish siltstones. Occasional dark carbonaceous bed. Contact with underlying Paleozoics appears conformable.

(C) - Tornado (Ross) Paleozoic limestone. Medium thick bedded, cherty.

Note: Porphyry dikes and sills occur, but are not shown on section.

SKETCH SECTION
(Looking Northwesterly)

APPROXIMATELY 2 Mi. S.E. OF STANLEY. GRAHAM CO, ARIZONA



(A) Volcanic cap. (Not observed in place — boulders eroded from cap appear similar to Brown's Cat Mt. rhyolite.)

(B) Silver Bell Formation (early Tertiary ?) — Mainly coarse conglomerate of angular to sub-rounded andesite porphyry boulders in muddy matrix. (Some boulders up to 15' in diam.) Occasional thin, sandy, pebbly horizons.

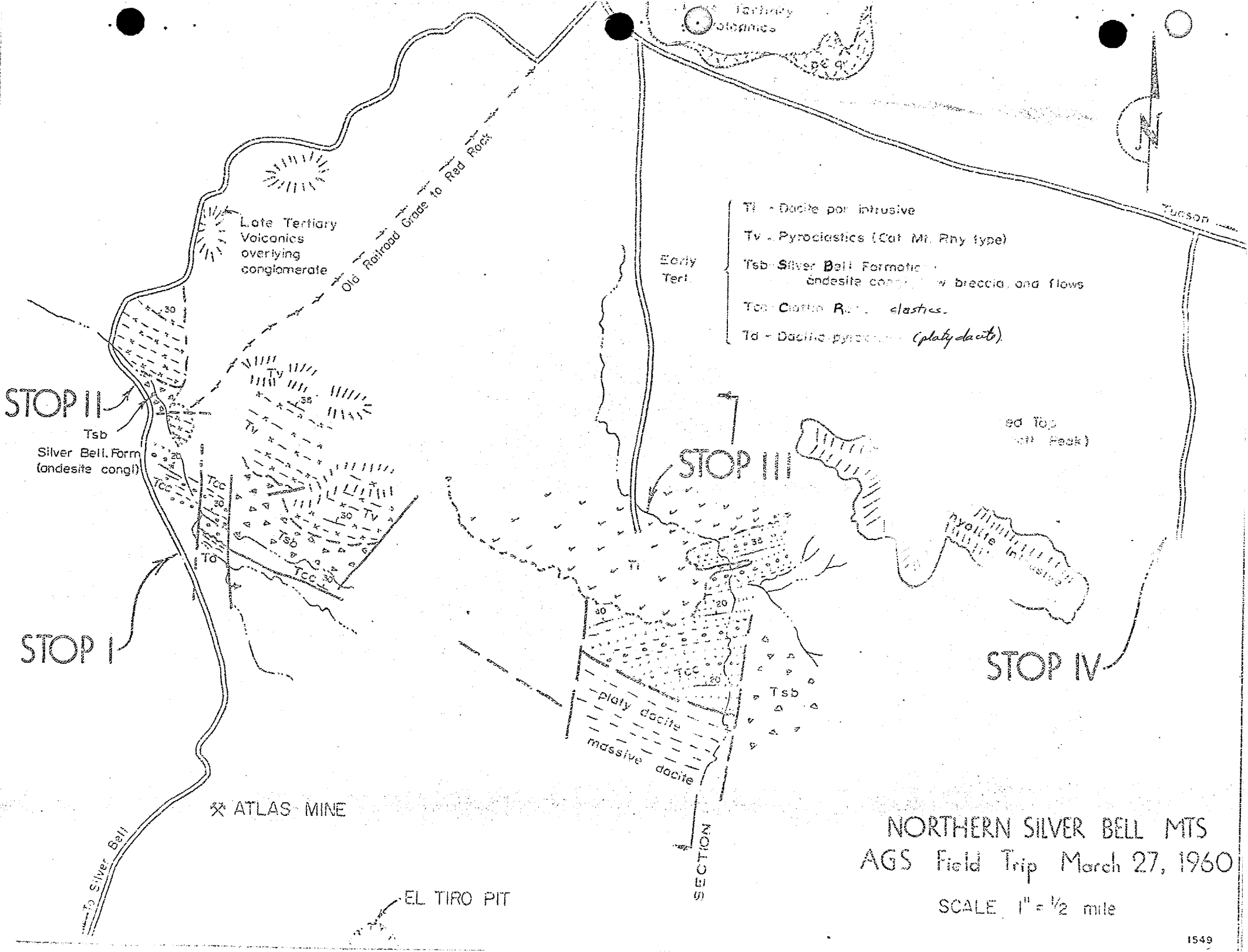
(C) Conglomerate at base of Silver Bell Formation. Composed mainly of well-rounded cobbles of quartzite; some rounded boulders of andesite porph.

(D) Cretaceous. Mainly thin-bedded, medium-grained, pale gray-greenish silty sandstones — some quartzite conglomerate.

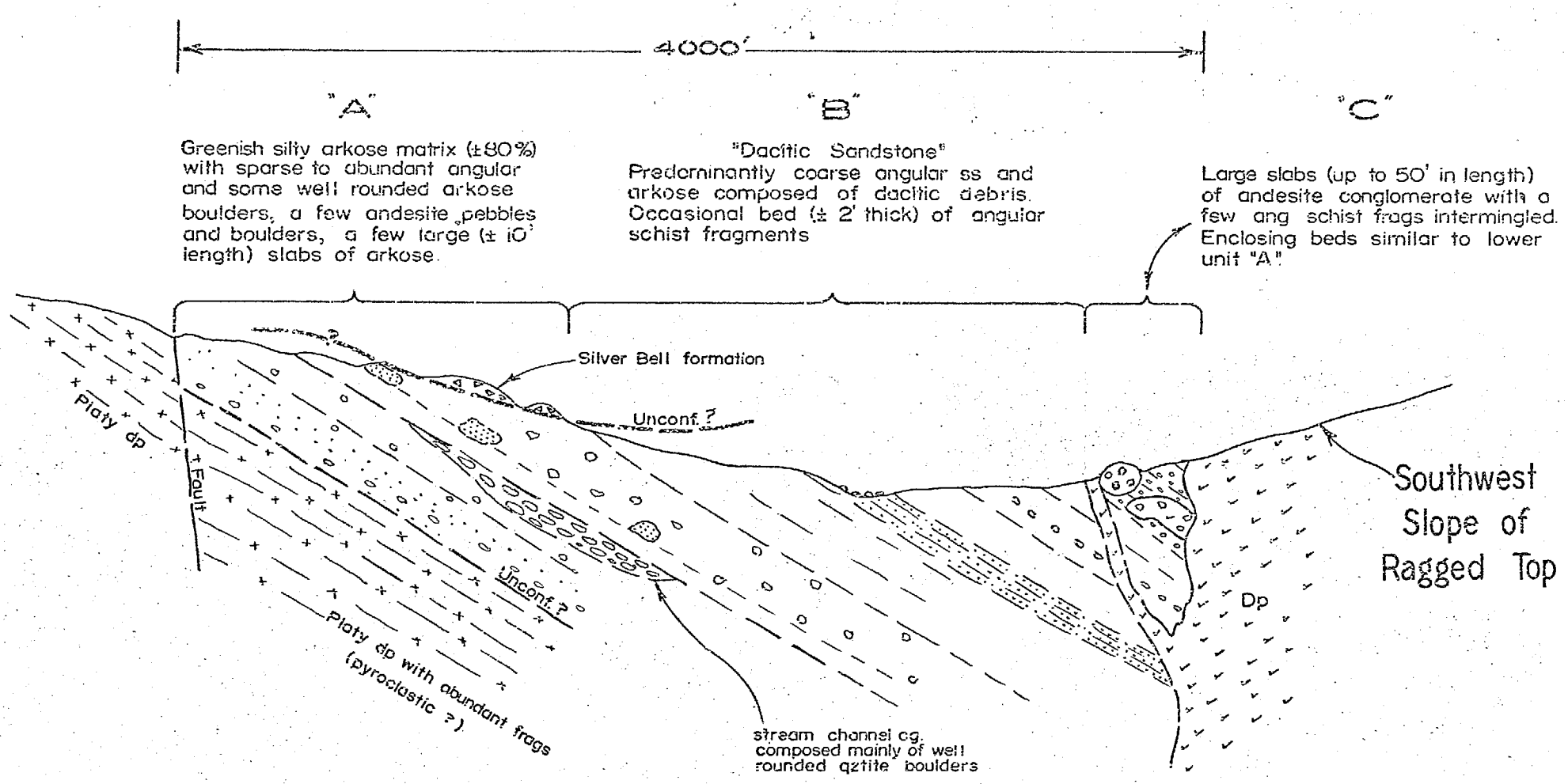
Location:

± One mile west of Copper Reef Mine.

SKETCH SECTIONS
(Looking Northwesterly)
HAWK CANYON, STANLEY DISTRICT.
Graham County, Arizona
by K.R. & J.H.C. - Feb. 13, 1958



Tertiary Volcanics
Tucson
Late Tertiary Volcanics overlying conglomerate
Old Railroad Grade to Red Rock
Early Tert.
Tl - Dacite por intrusive
Tv - Pyroclastics (Cat Mt. Rhy type)
Tsb - Silver Bell Formation andesite congl. w breccia, and flows
Tcc - Clatter R... clastics.
Td - Dacitic pyroclastics (platy dacite).
STOP II
Tsb
Silver Bell. Form (andesite congl)
STOP I
STOP III
STOP IV
Tv
Tcc
Tsb
Td
Tl
platy dacite
massive dacite
ATLAS MINE
To Silver Bell
EL TIRO PIT
SECTION
NORTHERN SILVER BELL MTS
AGS Field Trip March 27, 1960
SCALE 1" = 1/2 mile
1549



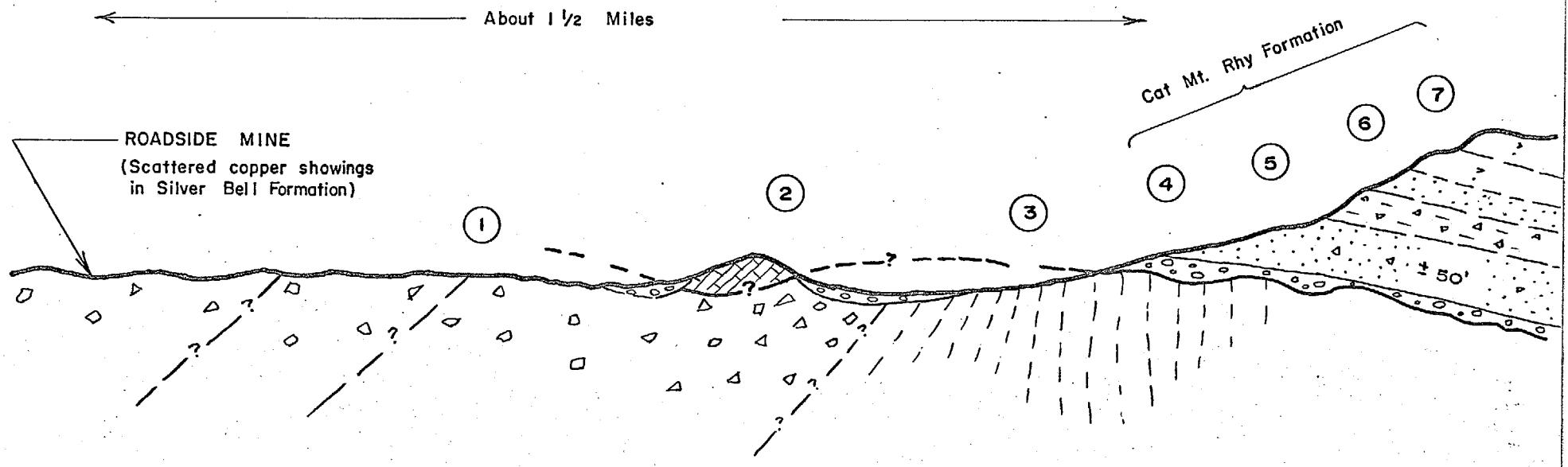
Sketch Section
Thru Claflin Ranch Formation
Looking Westerly

In North Silver Bell Mts., SW of Ragged Top

J.H.C. Sept. '59

1548

Roadside Mine
Pima County



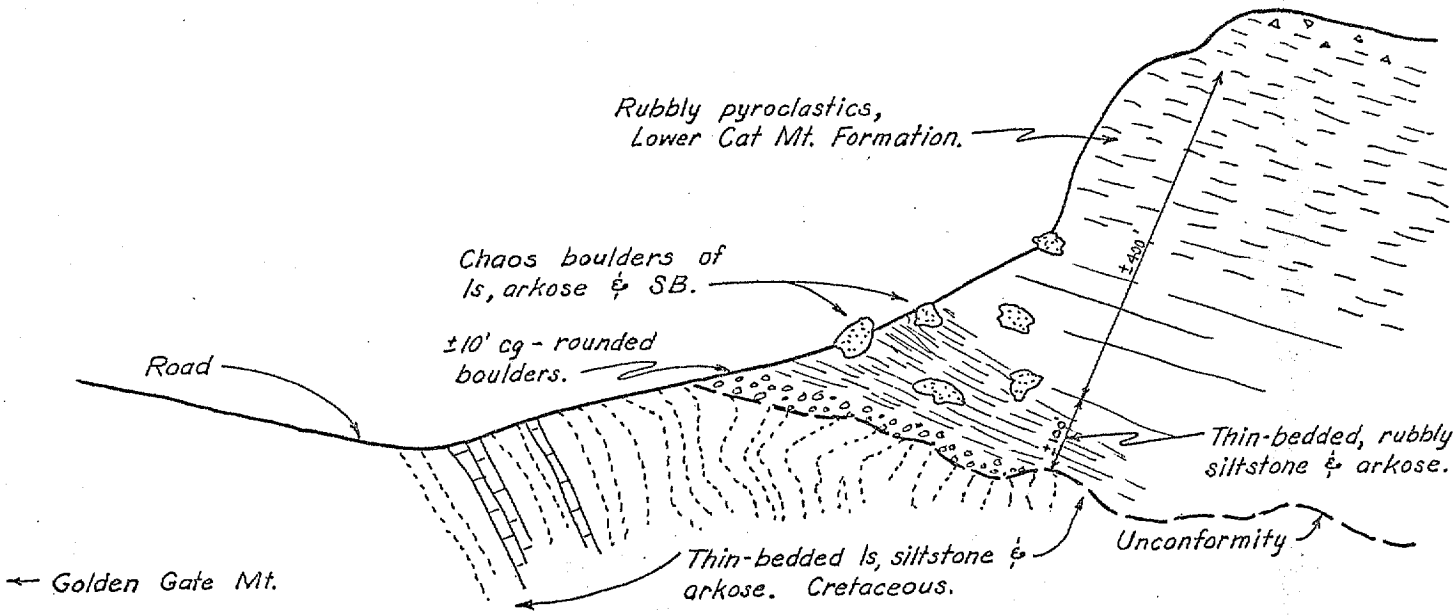
"Tkac" (1) "Andesite Congl." (Silver Bell Formation) - Andesite flows, breccias and conglomerates - no bedding observed.
(2) Limestone (Chaos block?) - gray, thin to thick bedded ls (Rain Valley?) - ± 50' thick. May be within Silver Bell formation, rather than overlying it, as indicated above.
(3) Clastics and pyroclastics(?) - thin to thick bedded (may correlate with beds which underlie Silver Bell formation in north Silver Bell Mts.)
(4) Fine angular conglomerate (3' to 6' thick) in sharp angular discordance with underlying rocks.
"Tgl" (5) Pyroclastics - light gray to purplish - small angular fragments - basal member of Cat Mt. Fm.
(6) Typical Cat Mt. Rhy. Dark, dense, flinty with thin tabular inclusions - ignimbrite?
(7) Pyroclastic - similar to basal member.

Note: Roadside Mine located about 35 miles west of Tucson, just north of Ajo Highway.
See Geologic Plan by Fair and Kurtz, 1959 AGS Guidebook.

Sketch Map
Looking Northeasterly

NOT TO SCALE

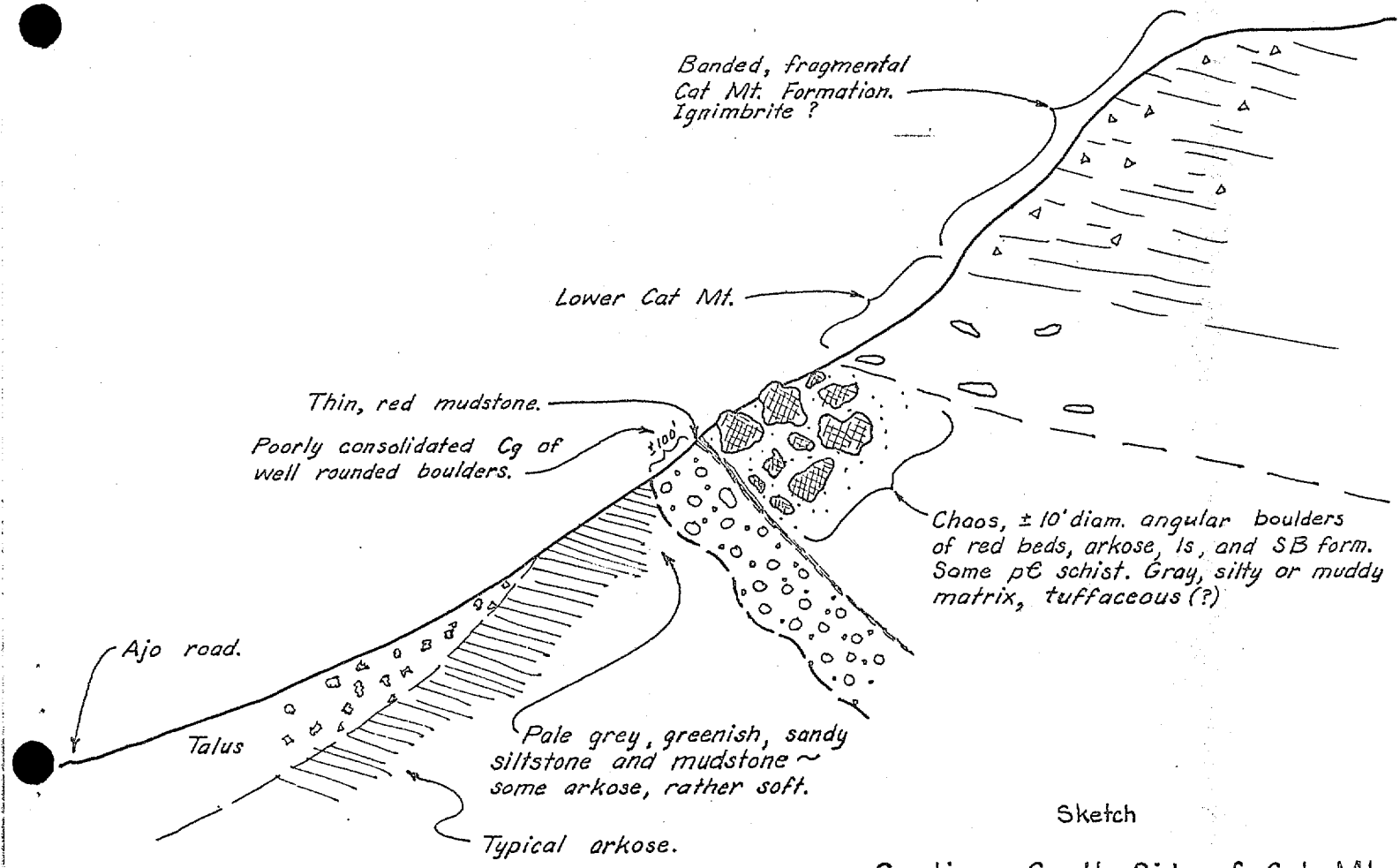
J.H.C. ay, 1959



Sketch

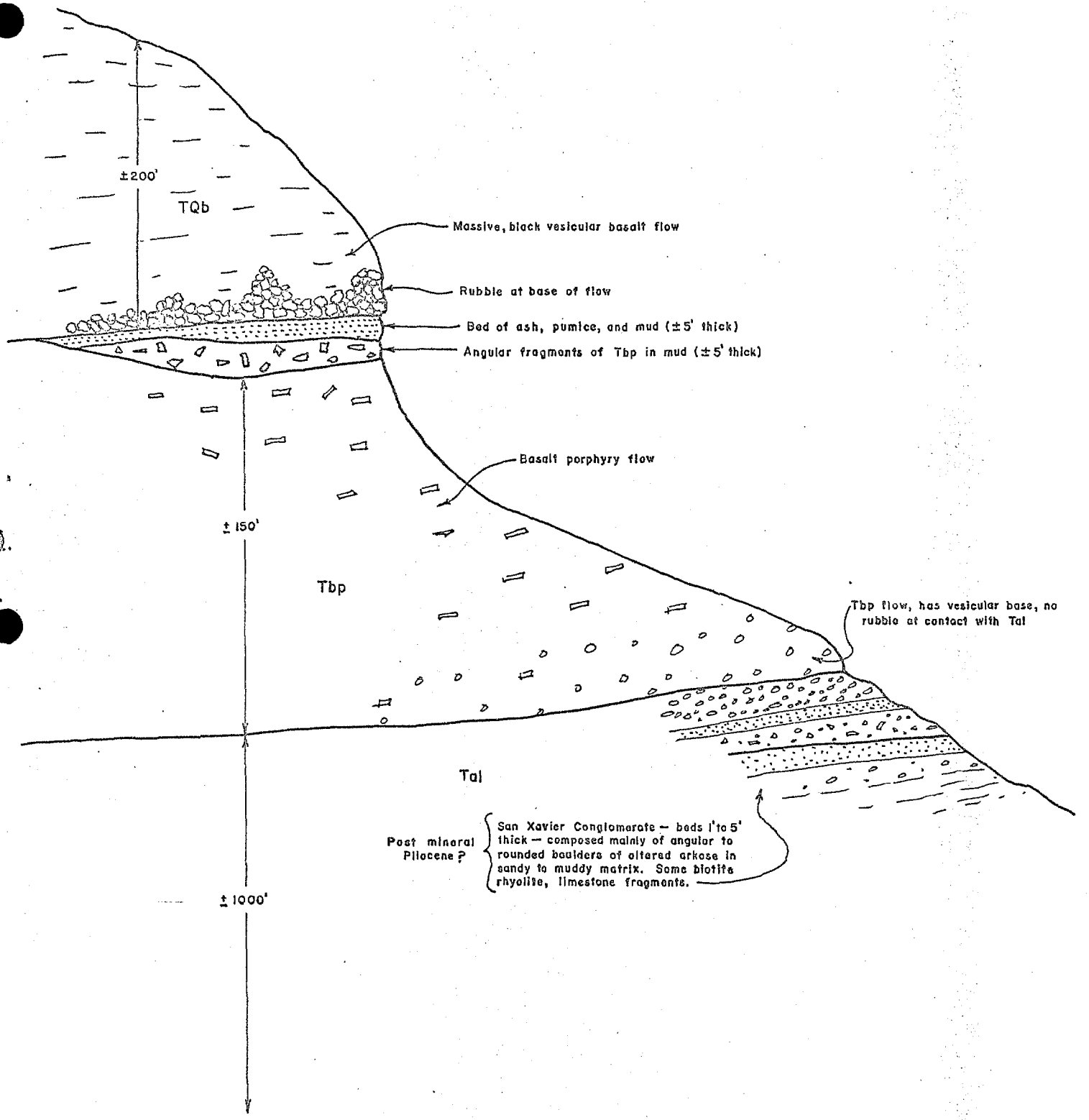
Section: ½ mi. S. of Gates Pass.
(Looking Northerly)
by J.H.C. 1957

1530



Sketch

Section: South Side of Cat Mt.
(Looking Westerly)
by J.H.C. 1957

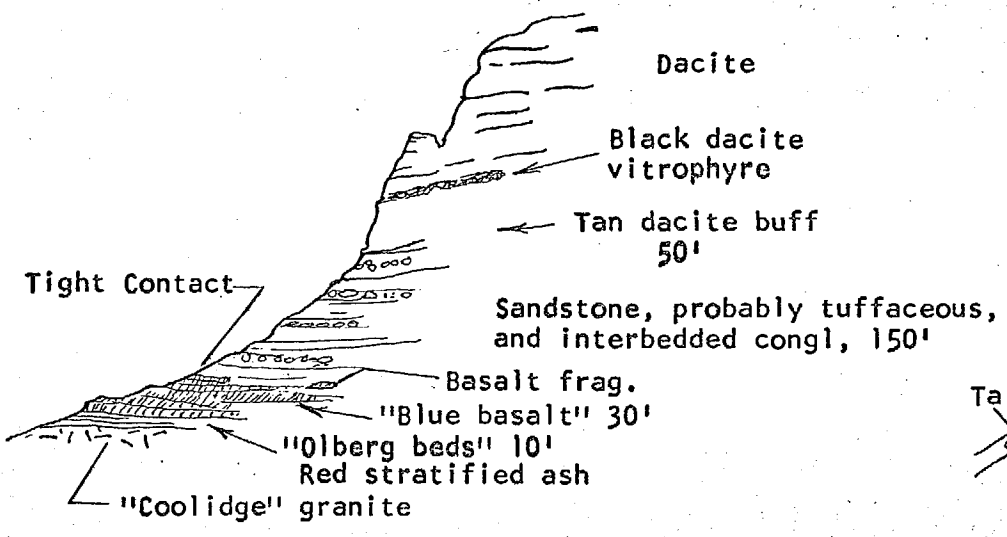


SKETCH SECTION

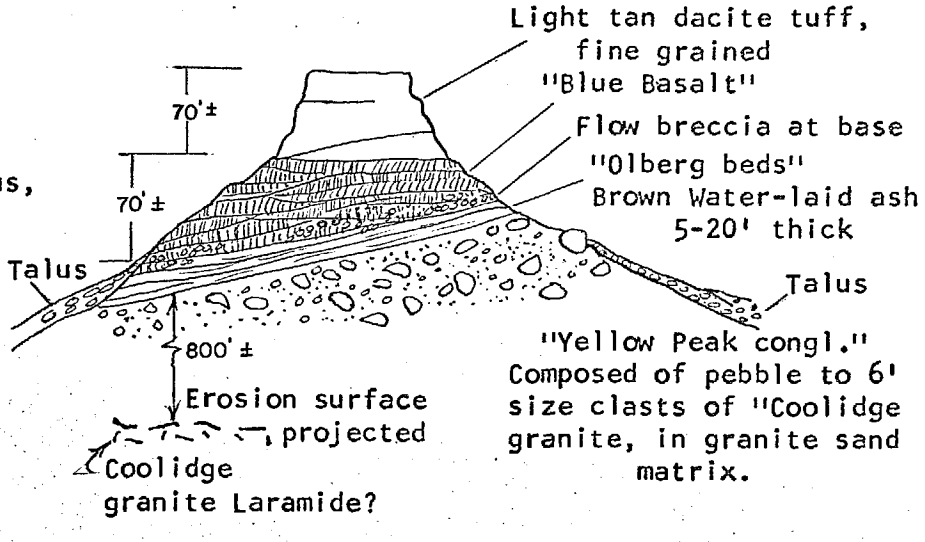
ON NORTH SLOPE OF BLACK MT.

±1500' North of triangulation station — looking Westerly

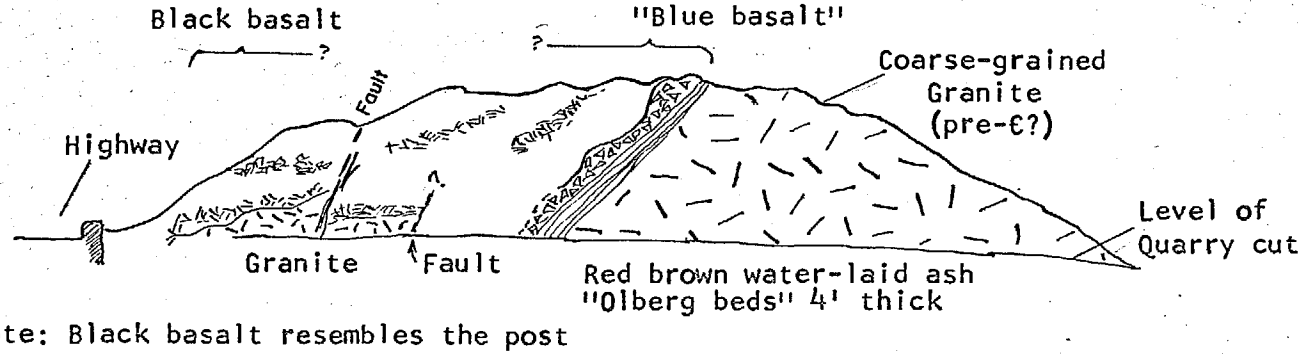
by J.H.C. Feb. 26, 1958



THROUGH PART OF LUMPY BUTTE
1 MILE WEST OF ROCK PEAK
Looking North



THROUGH TOP OF YELLOW PEAK
SAN TAN MOUNTAINS
Looking North



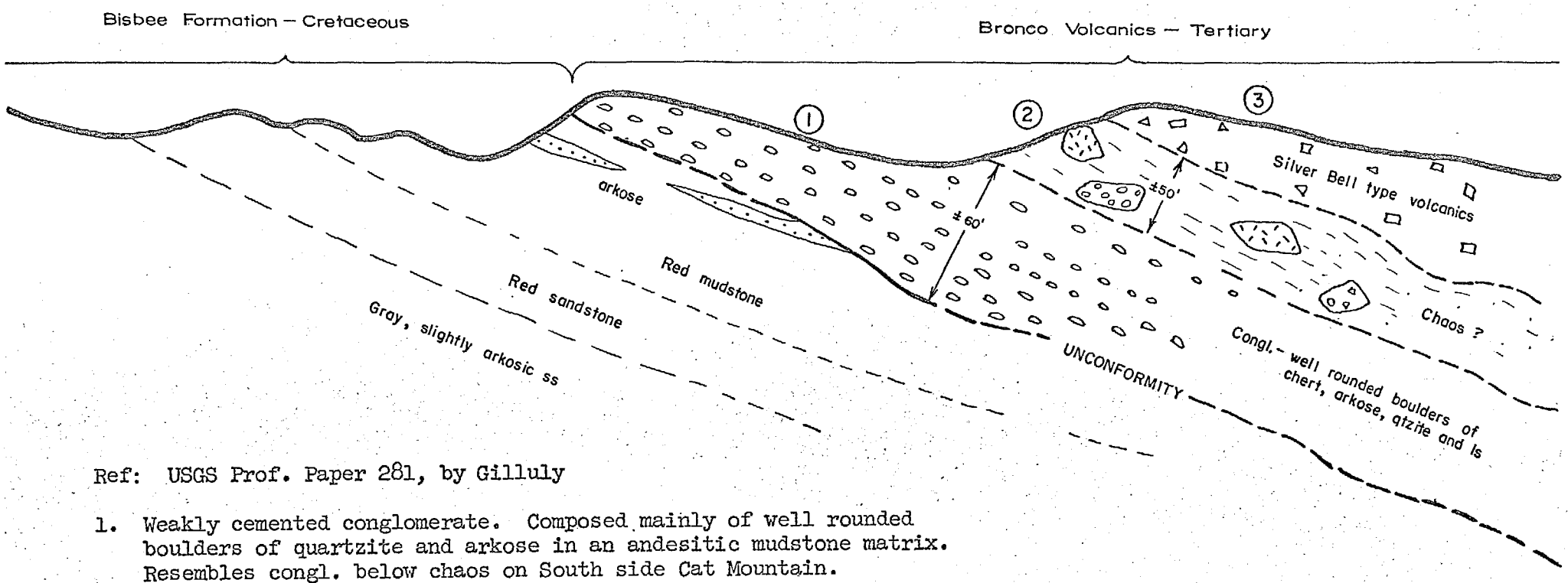
Note: Black basalt resembles the post dacite "Walker Butte" basalt. This outcrop may consist of Walker basalt overlying the "Blue Basalt". The contact is not apparent, however.

THROUGH OLBERG HILL, THE SMALL HILL AT OLBERG STATION,
SAN TAN MOUNTAINS
Looking North

DIAGRAMMATIC CROSS SECTIONS
SAN TAN MOUNTAINS
Showing Some Stratigraphic Relationships of Tertiary Volcanics and Sediments

A. G. Blucher Reconnaissance
J. E. Kinnison February, 1960

1571



Ref: USGS Prof. Paper 281, by Gilluly

1. Weakly cemented conglomerate. Composed mainly of well rounded boulders of quartzite and arkose in an andesitic mudstone matrix. Resembles congl. below chaos on South side Cat Mountain.

2. Chaos? Angular blocks up to 8' dia. of andesite por congl. (Silver Bell type), massive andesite por., and limestone congl. in a matrix of pale greenish sandy mudstone. Matrix appears to have been derived largely from erosion of andesitic rocks.

3. Dark grey to pale maroon volcanics. Described by Gilluly as being composed of andesitic mud flows and flow breccias.

Sketch Section Looking Southwesterly

Location: 7 miles S 60° W from Tombstone
or 2 miles due east of Bronco Hill

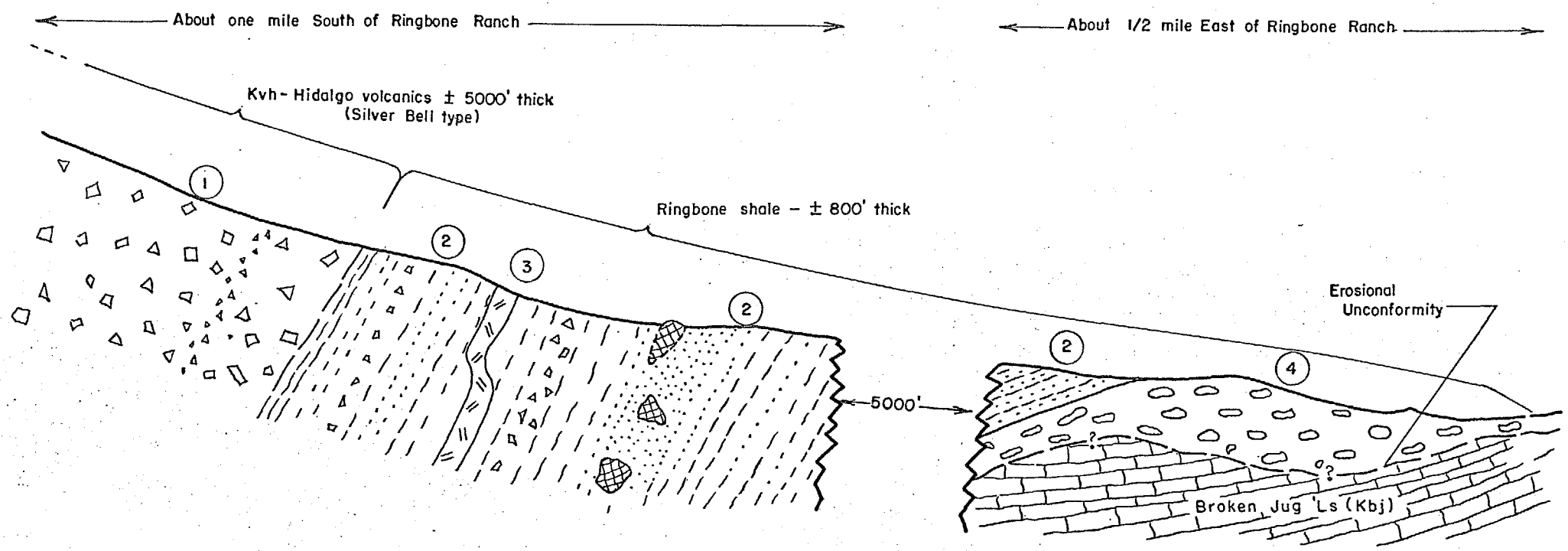
1531

No Scale

J.H.C.

May, 1959

1539

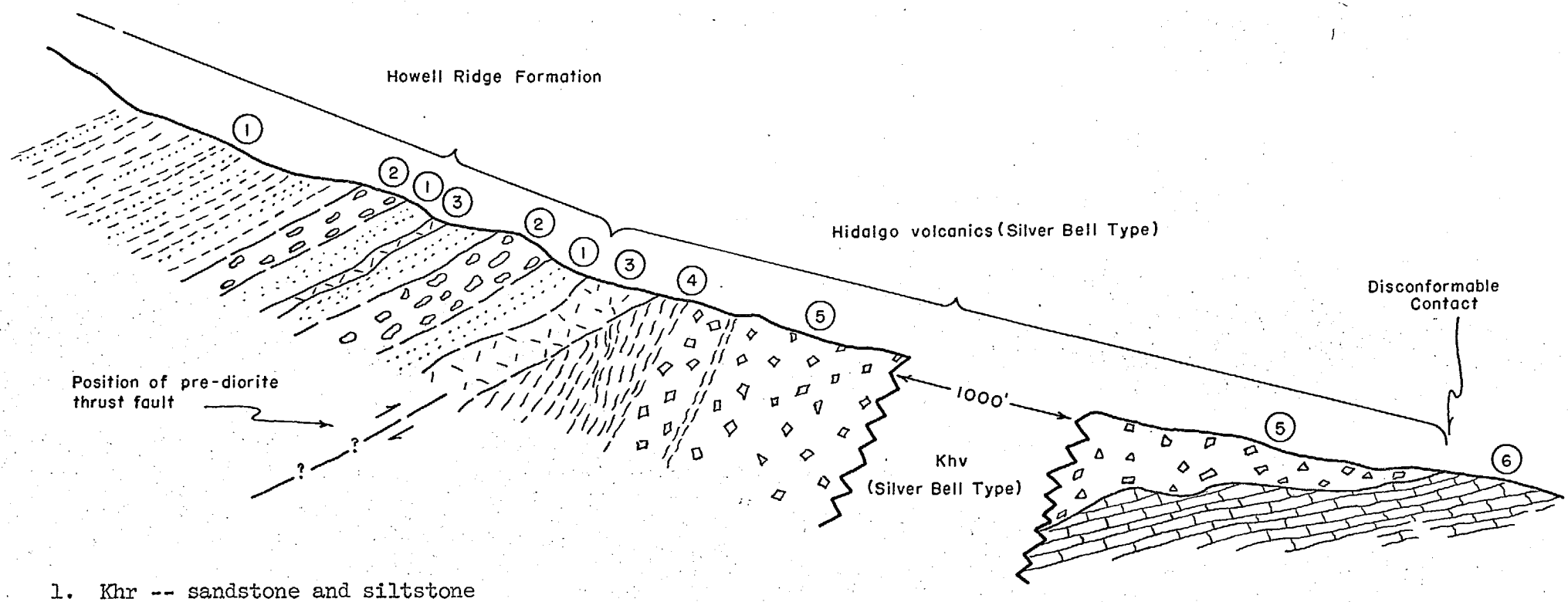


1. Andesite flow breccias, mudflows etc., with thin interbeds of fine, angular conglomerate. Dark gray to dull maroon. Lithologically similar to Silver Bell formation.
2. Thin bedded, greenish-gray, fine angular conglomerate and siltstone with interbeds of andesitic conglomerate and few, thin limey beds. Similar to congl. of Hidalgo volcanics, also some large boulders of andesitic conglomerate. This formation (Lasky's Ringbone shale) may correlate with "Claflin Ranch formation" -- Early Tertiary(?) -- clastics which underlie the Silver Bell formation in the north Silver Bell mountains.
3. Basalt porphyry sill. Lasky (USGS pp. 208) considered this to be a volcanic flow.
4. Limestone conglomerate -- basal unit of Ringbone shale formation.

Sketch Section
Looking Northwesterly

LITTLE HATCHET MTS, NEW MEXICO
Scale 1" = 100'

J. H. C. 6-12-59



1. Khr -- sandstone and siltstone
2. Khr -- coarse limestone conglomerate
3. Tkd -- diorite sill
4. Khs(?) Hidalgo sediments -- thinbedded greenish silt and fine congl - apparently derived from andesitic rocks
5. Khv -- Hidalgo volcanics -- Andesite flow breccias, mudflows and conglomerates (Silver Bell type)
6. Kbj -- Broken Jug limestone -- Lower Cretaceous

Note: According to Lasky (USGS pp. 208), Howell's Ridge formation is in sedimentary contact with underlying Hidalgo volcanics. As may be noted, a diorite intrusive separates the two formations. Thus a pre-diorite fault may be responsible for the apparent overlying relationship of the Howell's Ridge formation.

Sketch Section

LITTLE HATCHET MTS, NEW MEXICO

Looking Northwesterly along NE side of Howell Ridge, near center Section 12, T 28 S., R. 16W.

Scale 1" = 20'

J.H.C. 6-11-59