

**PENINSULA GEOLOGICAL SOCIETY + STANFORD GES-052Q
Field Trip, Sierra Nevada, Owens Valley, and Central White-Inyo
Range, Eastern California, June 1-3, 2002**

**Leaders W. G. Ernst and Mike Diggles
(Owens Valley geology jobbed from Steve Lipshie)**



Saturday (DAY ONE)

(0.0 mi) On Saturday, June 1, 8:30 am leave Geocorner and drive north on Junipero Sera, left at Alpine to I-280, northbound, to U. S. 92 (**12.8 mi**), then east over the San Mateo Bridge to I-880 northbound (**30.5 mi**) to I-238 eastbound (**34.4 mi**). WHEW!

I-238 turns into I-580 (**37.2 mi**), so continue east on I-580 past Livermore and over Altamont Pass and a wind turbine farm to I-205 eastbound (**66.0 mi**), continuing to join with CA-120 (**81.1 mi**), a short stretch on I-5 (but stay on CA-120) to U. S. 99 northbound (**87.2 mi**), then quickly off at CA-108/CA-120 eastbound at Manteca (**88.8 mi**). From here we continue eastward through Oakdale (a good place to buy Chevron gas at **108.4 mi**). Stay on CA-108 for Sonora Pass! Don't turn right for Yosemite Park!

At Knights Ferry we are well into the Mehrten Formation, an andesitic mudflow breccia (lahar) of Oligocene age. Its source was an andesitic volcanic arc deposited on the intensely eroded and peneplained Late Mesozoic Sierran calcalkaline volcanic-plutonic arc. Lots of breccia blocks of the lava were concentrated by erosion, and are sitting around on the surface, but fresh road cuts show only small-sized fragments; the maximum size of these breccia pieces increases as we head eastward toward the presumed source. During Miocene time, streams cut down through the Mehrten, and a dark lava—the Table Mountain Latite—flowed down from the crest (?) of the Sierra and just filled the stream valley. Subsequent differential erosion allowed the resistant Table Mountain Latite to stand out as a serpentinous ridge, characterized by good but not great columnar jointing. We now see it as an erosional remnant capping the Mehrten and older Sierran bedrock (Western Foothills Belt Jurassic Mariposa + Upper Paleozoic Calaveras metasedimentary and meta-igneous rocks and the Jura-Cretaceous granitoid plutons of the Sierran volcanic-batholithic arc.

Regional geologic relations are presented in Fig. 1. We pass through Jamestown (Mariposa complex, with tombstone-like slates sticking up out of the pastures, and farther east, pale green metabasalt, i. e., greenstone at **122.5 mi**) and at Sonora (**132.6 mi**) we are well into the upper Paleozoic Calaveras complex and the much later Standard pluton—part of the Sierran batholith. We drive on and on to Donnell Lake (a reservoir on the North Fork of the Stanislaus River) for a picnic lunch and rest stop at **184.9 mi**. YIPEE!

Refreshed, we continue eastward on CA-108 past more columnar jointed basalt on the right (at a walk-in campground), and the spectacular Cathedral Peak porphyritic granodiorite on the way to Sonora Pass (**204.5 mi**), then down the eastern faulted escarpment past the U. S. M. C Mountain Warfare training Center, to U. S. 395 (**219.0 mi**). Turn right, southbound for (continued after Figure 1, next page)



Fig. 1

Bridgeport (**235.3 mi**), Conway Summit (**248.5 mi**, where a glacial moraine containing weathered granitic cobbles is well exposed at a terrific scenic turnout at **249.4 mi**), Mono Lake (look for tufa towers along the southern shoreline), and on its south side,

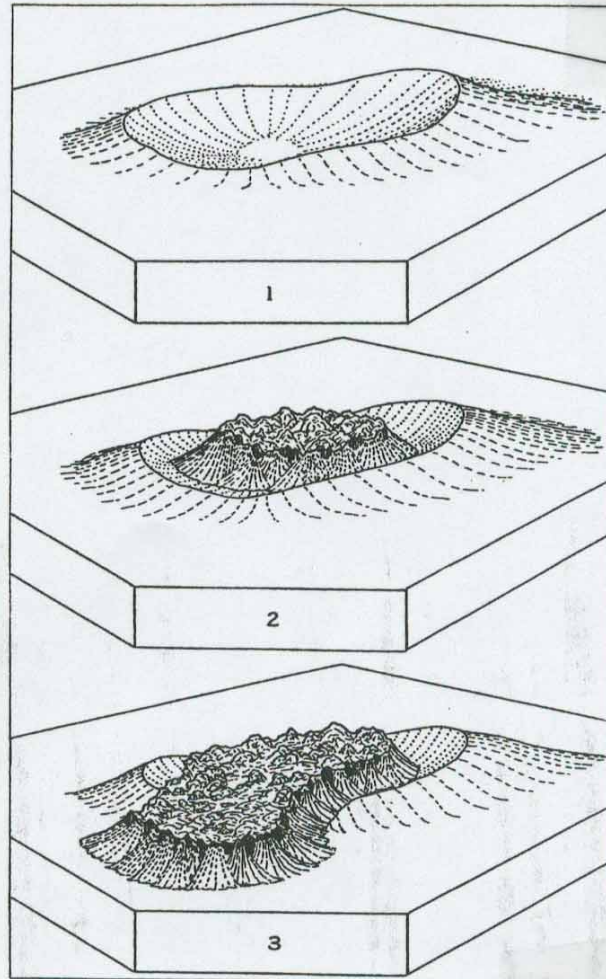
CA-120. Turn east for Benton Hot Springs on CA-120 (**265.6 mi**). The flats are called Pumice Valley. The Mono Craters to the south are rhyolite domes (see Fig. 2)

The arcuate form of the convex-eastward Mono Craters chain suggests that the chain lies along the ring-fracture zone of an incipient caldera that may still be underlain by a magma chamber (Bailey, 1982, p. 20). If so, the Mono Craters rhyolite could be analogous to the Glass Mountain rhyolite as a precursor to caldera formation. However, geophysical evidence (seismic and magnetotelluric) indicates the absence of a significant magma

Figure 2 Sequence of eruptive events in the development of a rhyolitic volcano. Eruptive forms may evolve through three stages during the growth of the volcano:

- (1) explosive eruptions form a shallow crater rimmed by a tephra ring;
- (2) a rhyolite dome is emplaced within the crater and may fill the crater and engulf the tephra ring;
- (3) if extrusion of magma continues, the dome may form a coulee that spills over the tephra ring as a thick, stubby lava flow.

(From Putnam, 1938; © American Geographical Society)



chamber at shallow depth (*i.e.*, depths less than 6 miles or 10 km) beneath the Mono Craters area. Thus, the geologic setting of the Mono Craters differs from that of the Long Valley caldera, where a residual magma chamber apparently still exists at a depth of about 4 miles (6 to 7 km) (Hill and others, 1984, p. 8). So the folks in Lee Vining and June Lake can sleep a little more soundly at night, for the time being.

Turn left (**268.6 mi.**), *i. e.*, north onto Panum Road, a gravel road to Panum Crater. Another unpaved road on the south side of CA-120 goes along the west side of the Mono Craters. Go straight ahead on the main road to the end (**269.5 mi**). Park and walk up the trail to the right (east) onto the tephra ring and cross the crater moat to the rhyolite plug (Panum Dome). Collection here is strictly VERBOTEN! An aerial view of the occurrence is shown in Fig. 3.



Figure 3. Aerial view looking southwestward across Panum Crater and its central dome of rhyolite. To the left (southeast) of Panum Crater is an older rhyolite dome, which used to be quarried for pumice. A “block avalanche” or block-and-ash flow deposit (Wood, 1977b, p. 94; Sieh and Bursik, 1986, p. 12,549) is to the right (northwest) of Panum. Highway 120 is in the upper lefthand corner of the photo.

Turn around, leave the parking area, return to CA-120, and turn right (west). Drive back to the intersection with U. S. 395 (**277.3 mi**). Turn south on U. S. 395, passing through menacing Long Valley caldera (Mammoth Airport and Crowley Lake), down Sherwin Grade to Bishop. Drive east and south through town and junction with U. S. 6 (**339.0 mi**), staying on U. S. 395 to Line Street (339.5 mi), turning eastward (left), continue 4.3 mi on Line Street to WMRS/Owens Valley Lab on the right. This is our happy home for tonight and tomorrow night.

SUNDAY (DAY TWO)

(0.0 mi) Exit WMRS/Owens Valley Lab, heading west on Line Street. At U. S. 395 in Bishop, turn north, staying on U. S. 395 as it turns west at the north end of town (don't follow U. S. 6), then off at Mill Creek Road (**13.1 mi**); park on right and examine the Bishop Tuff here.

Turn around and head west, then north toward Sherwin Grade on U. S. 395. (As we start up the grade in 0.1 mi. we'll turn right.) The regional geology and a cross-section of Long Valley are shown as Figs. 4 and 5.

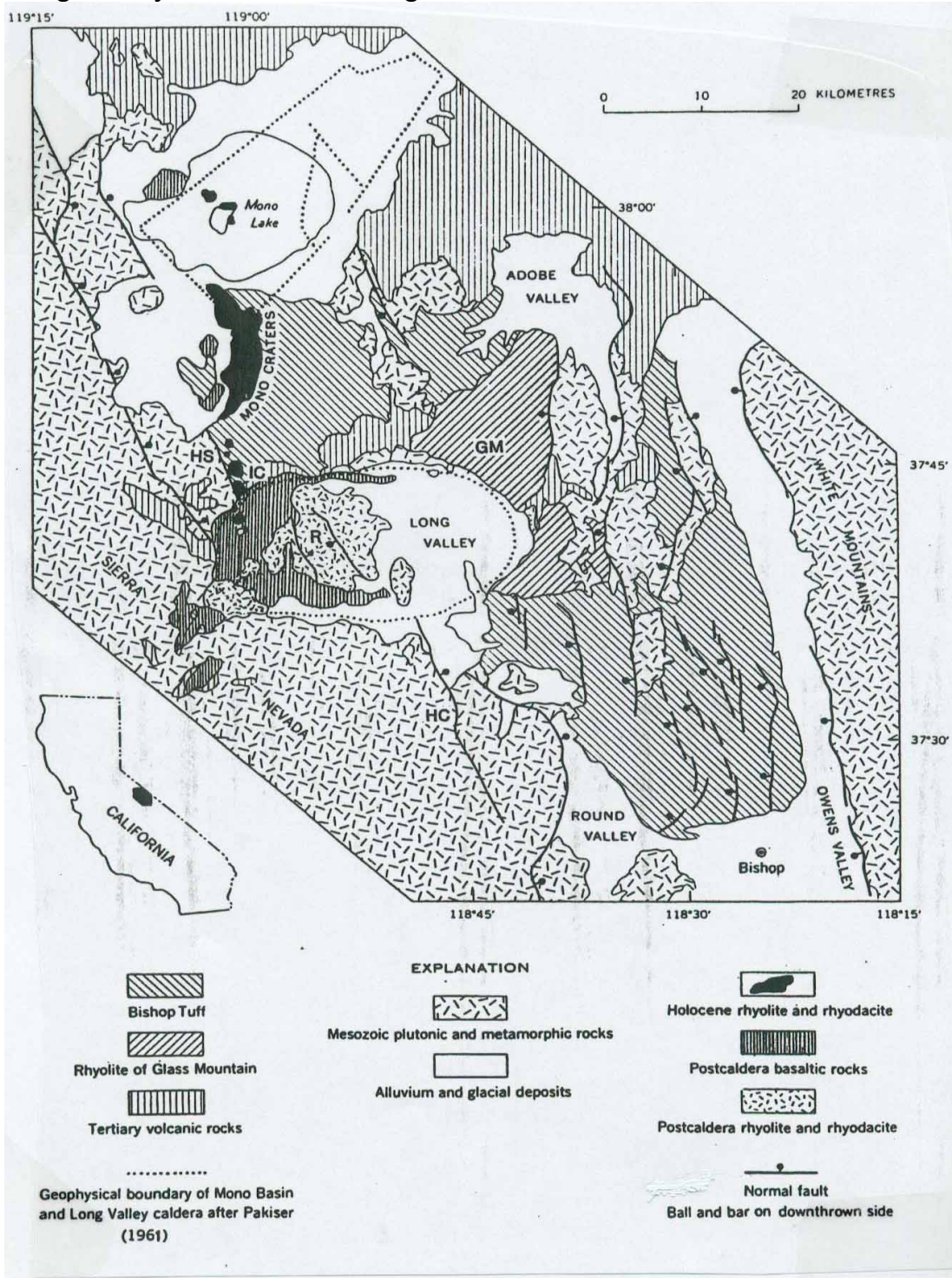


Fig. 4

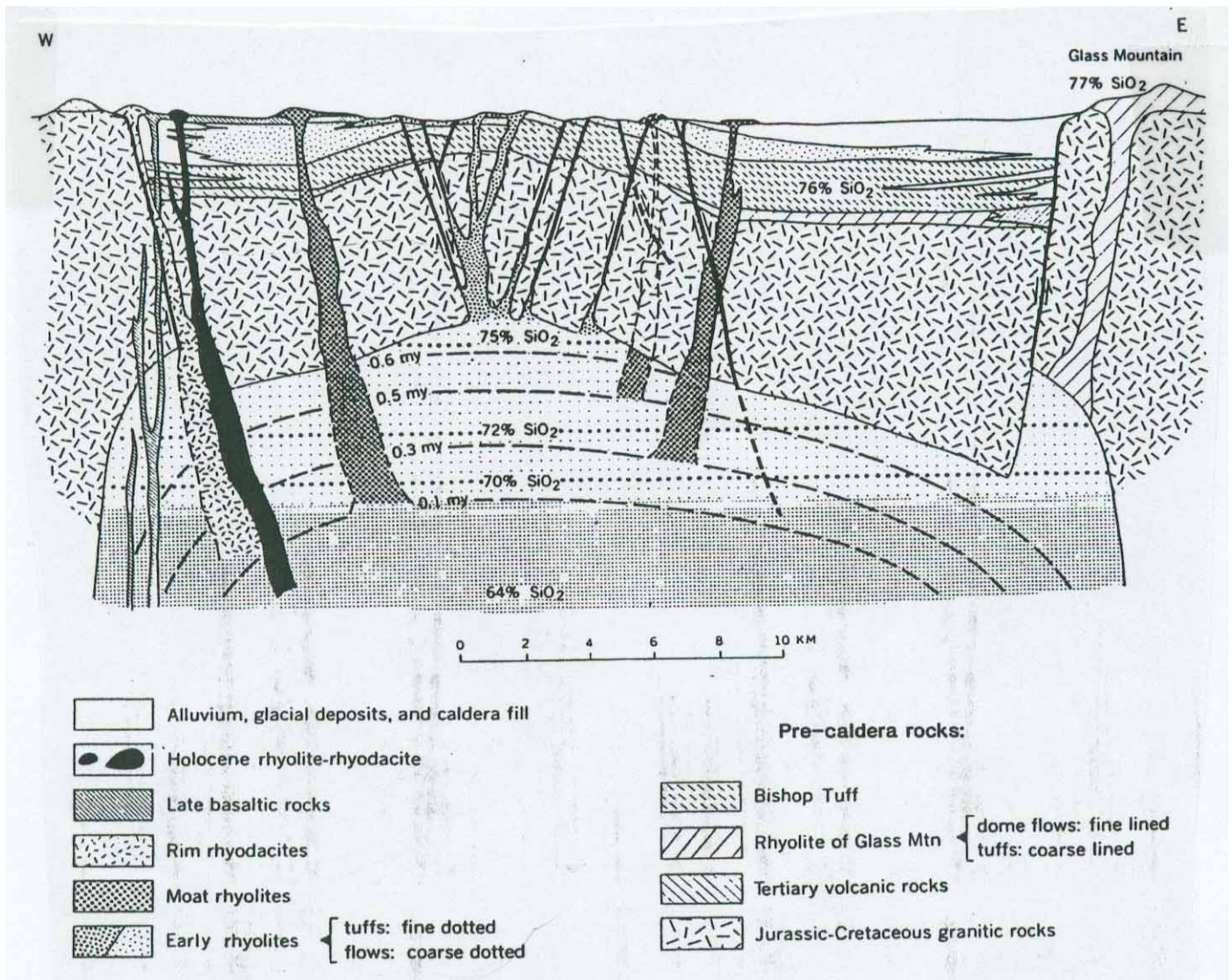


Fig. 5

Just as you begin the long ascent up Sherwin grade (the highway climbs 2500 ft in 10 miles!), park on the right shoulder of U. S. 395 along a roadcut in the Bishop Tuff. The tuff covers 580-sq mi between Bishop and Mono Lake, with the Volcanic Tableland shown in Fig. 6 constituting the largest part of the outcrop. It is a rhyolitic ignimbrite (gas-lubricated glowing avalanche) that consists of an upper sillar (induration of ash due to recrystallization rather than through welding of glassy shards) that grades downward to true welded tuff, thence to basal air-fall ash. The rhyolite is made up mostly of quartz and sanidine, ± minor plagioclase, biotite, augite, and hypersthene. The matrix is devitrified glass containing microcrystalline sanidine, cristobalite and/or tridymite.

The tuff is 400-500 ft thick but locally increases to 800 ft thick. Eruption took place in hours to days, at 0.76Ma. The total volume (some deposited as far away as Kansas and Nebraska—most exciting thing that ever happened there) was on the order of 600 cubic km.



Fig. 6

Turn right (**24.8 mi**) at Gorge Road, which goes to the City of Los Angeles Department of Water and Power (LADWP) powerhouses in Owens River Gorge.

Turn left (**25.4 mi**) at T-intersection. The road is paved and more-or-less maintained by LADWP. The big pipeline that parallels the road is a penstock (water conduit) that carries Owens River water from LADWP Tunnel No. 3 to Powerhouse No. 3. Note the small fumarolic mounds that dot the surface of the Volcanic Tableland. These represent groundwater converted to steam and expelled through the blanket of the hot ash; the condensing steam deposited dissolved silica etc. around the orifices. Mono County Line.

Keep on the main road past another LADWP surge tank on the right (**31.5 mi**). Road crosses small gulch in Bishop Tuff.

Paved road forks (**31.9 mi**). Take right fork that descends into the gorge and ends at LADWP Powerhouse No. 1. Park along the side of the road at locked gate (**32.5 mi**) but outside of it. Now walk down the road to view the Owens River Gorge. It is 450 ft deep here and is cut entirely in Bishop Tuff, providing a minimum estimate of its thickness here. Around the gate, we have a typical sillar. The lower portion of the unit is more highly welded and irregularly fractured, but the upper portion displays remarkable rosette-like columnar jointing (Fig. 7). Columnar jointing is a contractional response to a tabular body cooling across a planar surface, but this is PERPLEXING, to say the least.

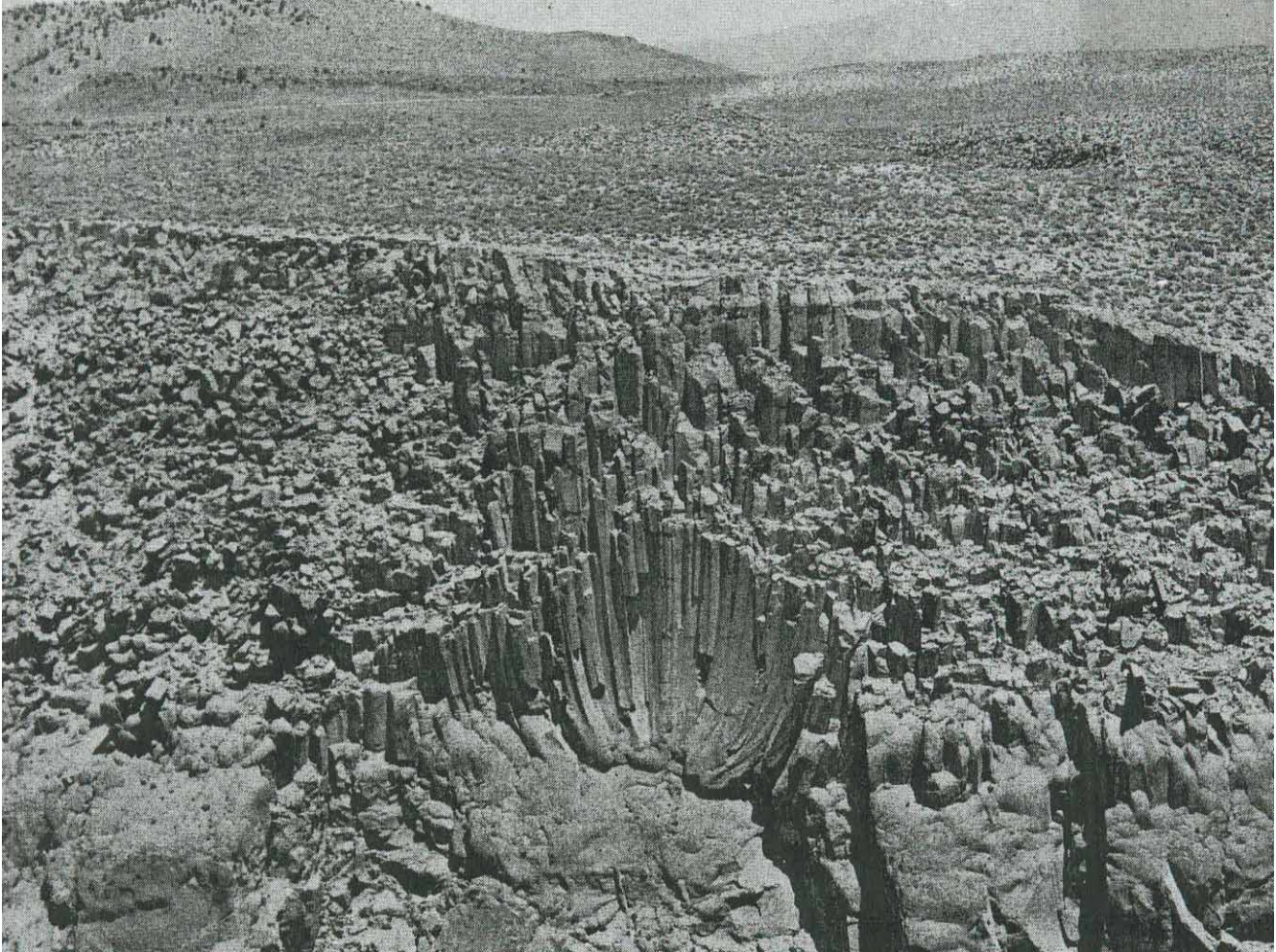


Fig. 7

Now we turn around and try to get out of here. We want to go mostly north and west (making a few left turns), generally northwest, in order to eventually come out at Sherwin Summit (**38.1 mi**). Here is the famous Pumice Cut, where the Bishop Tuff overlies Sherwin Till. Because the tuff is 760 ka, the glacial till must be older. It is deeply weathered so is probably about 0.8 Ma, fairly early in the Pleistocene.

Now we turn around and head south. Depending on the time, we may drive down Lower Rock Creek Road and eat our lunch there. But if it's late, we'll probably boogie on south on U. S. 395 through Bishop to the northern suburbs of Big Pine, noshing along the way. Here (**xx mi**) we turn east on CA-168 (Westgard Pass Road) to the junction with the Death Valley Road (**xx mi**). If there is snow at high elevations in the southern White Mountains, we will turn right for Waucobi Embayment. After passing a small

undated complex granitoid, we stop at the uppermost Proterozoic Wyman Argillite on the right (thinly laminated, locally calcareous). Farther on we examine the uppermost Proterozoic/Lower Cambrian Reed Dolomite + Hines Tongue Member exposed at Devil's Gate (**yy mi**); virtually the whole section exposed here is the Hines Tongue, much contorted and rumped). But here's a good place to introduce you to the basal part of the platform strata we'll see today or later in the season:

Brief Description of Superjacent Units and Alluvial Deposits

Wyman Argillite. The uppermost Proterozoic Wyman Formation consists mainly of dark-brown, calcareous and siliceous argillite interlayered with thin, discontinuous layers of thin-bedded, blue-gray metalimestone and rare calcareous metagraywacke sandstone. Nelson (1962) estimated a minimum thickness for the Wyman of 2,750 m, but its base is not exposed in the White-Inyo Range. The argillite fractures into platy slabs, and is locally phyllitic. Primary laminations, crossbedding, ripple marks, and mudcracks occur sporadically. An indistinct, low-angle angular unconformity or disconformity separates the Wyman Argillite from the overlying Reed Dolomite. A few interstratified metalimestone lenses in the Wyman Formation have been partly dolomitized, and these rock types are nearly indistinguishable from the main Reed lithology (Zenger, 1976).

Reed Dolomite. The uppermost Proterozoic-Lower Cambrian Reed Dolomite comprises approximately 650 m of massive, white to buff-colored, fine-to coarse-grained recrystallized dolomite (Nelson, 1962; Mount and Signor, 1991). Bedding is indistinct, even where oolitic horizons or algal mats are present. The rock weathers to form stark white, angular to spheroidal, erosion-resistant outcrops riven by joint sets of diverse attitudes. Small, diffuse patches, stringers, and pods of calcsilicates (monomineralic tremolite, wollastonite, or grossular) are present irregularly. In the SE White and northern Inyo Mountains, the base of the upper third of the Reed Dolomite contains a calcareous orthoquartzite, the Hines Tongue Member. Employing remote sensing multispectral data, Ernst and Paylor (1996) identified six regionally extensive, stratigraphically distinct subunits of the Reed Dolomite.

Deep Spring Formation. The Lower Cambrian Deep Spring Formation consists of about 400-570 m of metamorphosed interbedded limestone, dolomite, ferruginous quartzite, sandstone, siltstone, and shaley units that contain scattered worm tracks. Nelson (1966a, b; see also Loomis and Hall, 1991) divided the formation into three members. The lower member, ~100 m thick, comprises a sequence from bottom to top of finely laminated, recrystallized calcareous marl, gray dolomite, blue limestone, and buff-colored, coarse-grained metadolomite + dark metashale. The middle member is approximately 230 m thick. Its lower portion consists chiefly of fine-grained, white and orange, crossbedded orthoquartzite; this unit increases to a local thickness of 80 m in the northern Blanco Mountain quadrangle (Ernst and Hall, 1987). The quartzite is overlain by dark-brown, fine- to very fine-grained quartzitic metasandstone, dark gray metasiltstone, and well-bedded, blue-gray metalimestone, in turn overlain by a buff-colored metadolomitic siliciclastic unit. The upper member, ~75 m thick, is dark-brown to black, fine-grained quartzite at the base, capped by a massive but discontinuous gray, fine-grained, stromatolitic metadolomite.

Campito Formation. Finer grained, metashaley beds of the Lower Cambrian Campito Formation are characterized by abundant trace fossils; in contrast, metasandy layers are well laminated and most are not bioturbated. The formation consists of two intergradational members (Nelson, 1962), both of which contain albitic detritus. (1) The Andrews Mountain Member consists of about 850 m of dark-brown to greenish-black, fine-grained, massive to blocky quartzite. It forms imposing cliffs, mantled by abundant coarse, blocky talus. Magnetite-ilmenite averages around five volume percent of the rock. Laminations, crossbedding, and worm tracks are common; slump structures are locally abundant. (2) The overlying Montenegro Member is ~300 m thick. It consists of argillaceous, gray-green, thinly bedded metasiltstone, phyllite, and very fine-grained, laminated quartzite, with a few rare metalimestone lenses near its top. The Montenegro Member weathers to more subdued prominences and slopes; it provides lesser amounts of green, slabby to platy talus, compared to the craggy Andrews Mountain Member. Layer silicates are abundant, imparting a phyllitic or semischistose aspect to this unit; trace fossils are typical. To the north, near the southern margin of the Barcroft pluton, the lithologic contrast between the Andrew Mountain and Montenegro members becomes indistinct due to contact metamorphism (Krauskopf, 1971; Ernst, 1996). Thus in this area, the contact between these members shown on Plate 1 is somewhat problematical, and is locally indicated by question marks.

Poleta Formation and overlying Cambrian units. The Poleta Formation consists of feebly recrystallized to hornfelsed, rhythmically interbedded buff and blue recrystallized limestone, interstratified with green or olive-drab, fissile metashale and fine-grained quartzite beds. Archaeocyathans are present in some calcareous strata.

The overlying Harkless Formation (not shown on Plate 1) is chiefly green and gray, slaty metasilstone, argillite, and fine-grained quartzite. Overlying conformable Cambrian units consist chiefly of feebly recrystallized carbonate beds, interlayered fine metasilstones, and quartzites (Nelson, 1966 a, b). Metaquartzite inclusions in the Barcroft granodioritic pluton are intensely baked; although probably of different formational parentages, all are arbitrarily assigned to the Poleta Formation.

White Mountain Peak volcanic + volcanoclastic rocks, and coeval hypabyssal dikes/plugs. A mid-Mesozoic pile of intercalated metavolcanic, metavolcanoclastic, and consanguineous hypabyssal plugs crops out directly northwest of the Barcroft pluton (Crowder and Sheridan, 1972; Hanson, 1986; Hanson et al., 1987; Dunne et al., 1998). The exposed superjacent section is approximately 3 km thick. Flows constituting this eruptive center range from mafic andesite to rhyodacite, but compositionally intermediate rocks are scarce; the sequence also includes ash-flow tuff, tuff breccia, and irregularly shaped stocks. Pervasively recrystallized volcanic breccia, tuff, and associated fluvial or deltaic sandstone, siltstone, and conglomerate are stratigraphically interlayered with the extrusive igneous rocks. Rare metalimestone layers are present but are confined to the volcanogenic section north of White Mountain Peak, and an inclusion within the NE part of the Barcroft granodioritic pluton. The bimodal mafic and felsic flows are intensely albitized; near the western margin of the pluton, the volcanogenic metasedimentary units are strongly sheared. The section was intruded by the Middle Jurassic Barcroft pluton (Krauskopf, 1971). Although locally metasomatized as well as recrystallized, trace element data presented by Sorensen et al. (1998) indicate that the volcanic protoliths were shoshonitic. Based on geologic field relations and U/Pb dating chiefly obtained in the Inyo and more southerly ranges, Dunne et al. (1998) postulated that the main stage of eruption and deposition occurred at around 170+ Ma, with a less voluminous event at 148 Ma or older.

Two xenoliths of volcanogenic metasedimentary strata crop out within the NE portion of the Barcroft pluton, and several metavolcanic inclusions are scattered widely within the western part of the igneous body, demonstrating that at least some of the White Mountain Peak metavolcanic suite is older than the Barcroft pluton. Zircons separated from an ash-flow tuff interlayered with the White Mountain Peak metasedimentary rocks yielded a concordant U/Pb crystallization age of about 154 Ma, and an analyzed hypabyssal porphyritic stock exposed at the summit of White Mountain Peak gave an even younger, but highly discordant age of 137 Ma (Hanson et al., 1987). The times of formation of the metavolcanic and volcanogenic metasedimentary rocks thus appear to have overlapped the emplacement and solidification interval of the Barcroft pluton. However, geologic relationships presented in Plate 1 suggest that the Barcroft granodiorite pluton is intrusive into the southern margin of the volcanic pile. If our map is correct, the radiometric data reported by Hanson et al. (1987) either represent metamorphic cooling ages for the pre-Barcroft White Mountain Peak rocks, or the age-dated metavolcanogenic samples lie in a superjacent belt north of the Millner Creek fault and are younger than the Barcroft pluton.

Cenozoic volcanic rocks and alluvial/glacial deposits. Pliocene olivine basalt crops out east and SE of the mapped area. Layers of air-fall Bishop Tuff of middle Pleistocene age lie within Chalfant Valley and are draped on some of the westernmost, low-elevation exposures of the Barcroft granodioritic pluton (Plate 1). Glacial lake beds, morainal gravels and outwash, and landslide deposits present along the crest and adjacent, east-facing slopes of the central White Mountains are combined as a single map unit that also includes older alluvial deposits along the White Mountain fault system bounding the plutonic body on the west. Younger alluvial deposits are present in Chalfant Valley.

Brief Description of Intrusive Igneous Units

Middle and Late Mesozoic plutons. Numerous granitoids, ranging in bulk composition from gabbro/diorite to granite *sensu stricto* have invaded the country rocks in the central and southern White Mountains and northern Inyo Mountains. Episodic intrusions over a time span of approximately 100 m. yr. (80-180 Ma) supplied the heat necessary to cause the metamorphic recrystallization of the wall rocks (Barton and Hanson, 1989; Ernst, 1996). Based on prior geochronologic work (Crowder et al., 1973; Gillespie, 1979; Stern et al., 1981) as well as newly acquired $^{40}\text{Ar}/^{39}\text{Ar}$ data, McKee and Conrad (1996) provided ages of emplacement of the granitoid bodies mapped in this report, as follows: Beer Creek pluton, ~175 Ma (its northern extension is the closely similar Cottonwood Quartz Monzonite); Barcroft pluton, 163 ± 2 Ma; Pellisier Flat pluton, ~90 Ma; and McAfee Creek Granite, 83.6 ± 0.4 Ma (however, Hanson et al., 1987 reported a concordant U/Pb age of 100 Ma for the McAfee Creek body). The Middle Jurassic igneous bodies tend to exhibit disturbed radiometric systematics due to subsequent reheating, whereas the Late Cretaceous granitic plutons yield relatively unambiguous age spectra. Locally as well as regionally, Jurassic igneous bodies such as the Barcroft granodioritic pluton and the Cottonwood Quartz Monzonite (or granite, as reported by Bateman, 1992) are calcalkaline, whereas in general, the Cretaceous McAfee Creek Granite and unnamed Cretaceous (?) plutons near Mount Barcroft represent more

granitic compositions (Emerson, 1966; Krauskopf, 1968; Crowder et al., 1973; Sylvester et al., 1978; Stern et al., 1981; Bilodeau and Nelson, 1993; Ernst et al., 1993). New bulk-rock XRF data support this conclusion (Ernst, in review).

Tertiary diabase dikes. Fine-grained dikes of basaltic composition transect both superjacent and plutonic rock suites, and are distributed widely but sparsely throughout the mapped area. Few dikes exceed 1m in thickness, and all display sharp contacts with their wall rocks. Several have been pervasively but feebly altered, and may represent metadioritic/metadiabasic injections prior to the emplacement of the McAfee Creek Granite. Most, however, are unmetamorphosed. Correlation of these mafic dikes with basalt flows of Pliocene age (Dalrymple, 1963; Robinson et al., 1968), present as two small outcrops along the NE extremity of the mapped area and directly southeast of the region shown in Plate 1, is not justified. The basalt flows contain about 12 ± 5 modal percent olivine (Ernst and Hall, 1987), whereas the diabase dikes are sparsely quartz-bearing. The relatively fresh Tertiary diabase dikes have been examined petrographically, but otherwise have not been investigated in the present work.

Turn around, returning to CA-168 (**zz mi**), turn right (east) for Westgard Pass. How far we'll go will depend on the time and the amount of snow at high elevations. Drive through the Lower Cambrian Montenegro Phyllite (**aa mi**), then Andrews Mountain Quartzite (**bb mi**) members of the Campito Formation, then the buff-blue-buff limestones of the Poleta Formation (**cc mi**). Turn left (north) on White Mountain Peak Road (**dd mi**). Drive to Sierra Overlook (**ee mi**) for a breath-taking view of the Owens Valley and Sierran fault escarpment (also a rest stop). Now we'd better go back to Line Street (WMRS/Owens Valley Lab). Dinner is at 6:00 pm!

MONDAY (DAY THREE)

(0.0 mi) Exit WMRS/Owens Valley Lab, heading west on Line Street. At U. S. 395 in Bishop, turn north, staying on U. S. 395 as it turns west at the north end of town (don't follow U. S. 6), and stopping at the Chevron Station (**7.0 mi**) for gas. Then continue on west and north on U. S. 395 to just south of Lee Vining, where we turn left on CA-120 (**68.0 mi**) and drive up Lee Vining Canyon to Tioga Pass. On the way, we are in mixed metamorphic rocks (both metasedimentary strata and metavolcanic layers), and then near the Yosemite N. P. Check Station, the Saddlebag Lake roof pendant. Continue through Tuolumne Meadows and glaciated exfoliation surfaces to the west end of Tenaya Lake for picnic lunch and comfort stop, then west to Olmsted Point for a fantastic view of exfoliation domes.

Or, if Tioga Pass is snowed in (probably), continue on north through Bridgeport to Sonora Pass and thence home, jiggity jig.....What?

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## **MINERALS, MINES, AND ROCK HOUNDS - Some stories by Mike Diggles and Steve Schmauch**

The earliest known mining activity around 1861 was in the southern end of the White Mountains. The most important mines included the Sacramento, Twenty Grand, Southern Belle, and Poleta mines which produced ore containing gold, silver, copper, and lead. Ores from these mines were first processed at the Ida mill in Owensville, near the present town of Laws, California. The earliest discovery in the northern end of the White Mountains was in 1870 at the Indian Queen-Poorman mine. By 1888 it had a four-stamp mill; operations were continuous until around 1917, then intermittent until 1983. Other silver, lead, and zinc-rich areas were found in this area and south to Montgomery Canyon. Whiting (1888) reported that mines in Montgomery Canyon had produced \$60,000 worth of metals, but by 1890, most of the rich, easily accessible silver ores had been removed. In the Birch Creek area, the Wynne and Ward mine produced 164 tons of mostly lead and copper with minor silver and gold. Three principal mining districts within the Black Canyon area are the Bishop, Black Canyon, and Poleta districts. Since 1879, about 740 mining claims have been located in the Black Canyon area. The first reported mining activity was in the 1860's, when the Little Gem (also called Georgia and X-Ray) mine was worked (Knopf, 1918).

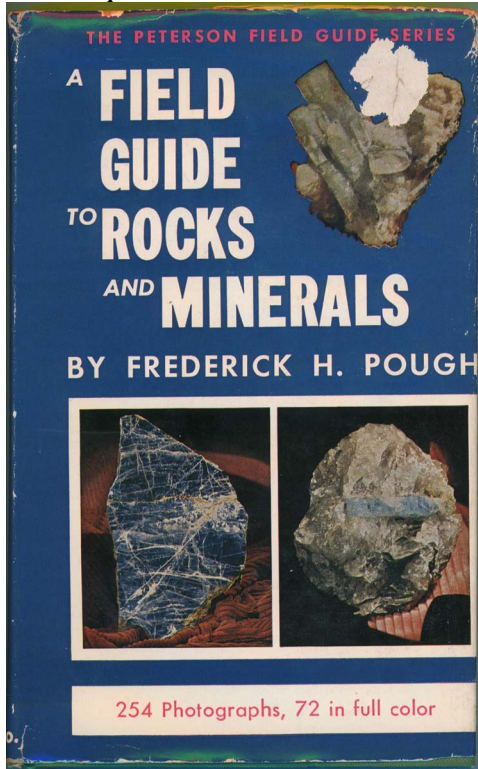
During the 1950's, scheelite-bearing rock (tungsten ore) was discovered at the R and R mine in the Black Canyon area. The property is currently known as the Mirage-Mariposa mine. The Birch Creek pluton, along its contact zone with the calcareous in intruded, formed calc-silicate minerals (skarn deposits) such as garnet, epidote, and scheelite. With the Pine Creek mine right across the valley (and it is presently idle; China has more), the little skarns at Birch Creek are best suited for hunting minerals at night with a blacklight. Interest in the nonmetallic deposits located on the west range front between Sacramento and Silver Canyons, began around 1920. A deposit of andalusite in Jeffrey Mine Canyon was mined from 1921 to 1945. This area also has rutile and assorted unusual minerals that make it a recreational destination for serious rock hounds. Deposits of sericite flank the andalusite deposits and have been mined since the mid-1940's. Barite was mined in the Gunter Canyon area from the late 1920's to the late 1950's. Some barite came from the Hobo property, but most of it came from the Gunter Canyon Barite mine. Production from several pumice deposits from the mid-1920's to 1983 has supplied local markets with this material.

At a geographers' meeting in Reno in January, 2001, there were a couple of scruffy geologists (are there any other kind?) whispering in the back of the room. Fred Pough, and Michael Diggles, were having a great time being mentor and mentee, in that order. Fred wrote the popular *Peterson's Field Guide to Rocks and Minerals* in 1953. His fifth edition came out in 1998, over 45 years later. This book is organized by mineral classifications and still written for the layperson. A mineral-testing section (flame tests, bead tests and such) is also included. Most guides to minerals have dropped that information much to Fred's dismay. He seemed quite proud that his book still has it included (perhaps much to the publisher's dismay).

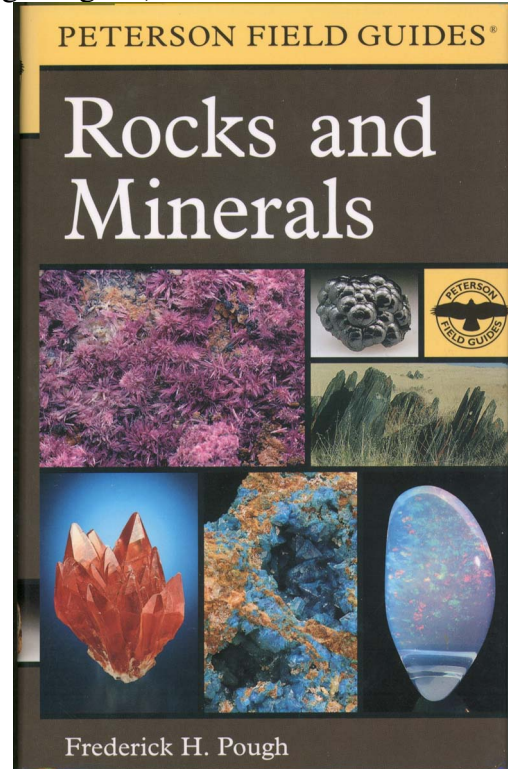
Fred has been a mineralogist for one or another of the museums that dabble in such baubles for many decades. One of the gigs he told Michael about was when C.D. Woodhouse talked him into working at the museum in Santa Barbara. Woodhouse, it turns out, married into the Champion Spark Plug family and became the foreman of the Champion Mine owned by Champion Sillimanite, Inc., from which the insulator material, andalusite, was produced. "Why does a sillimanite company produce andalusite?" you might ask. Sillimanite and andalusite are part of a trio of aluminum silicates that form at different pressures and temperatures, kyanite being the third member. The mine is up Jeffrey Mine Canyon in the White Mountains in eastern California (Diggles, and others, 1983, USGS MF-1361-D). The ore in the White Mountains was mined, hand-sorted, hauled out on mules, and shipped to the company in Michigan. The advent of Pyrex made the operation obsolete (Schmauch and others, 1983, USBM MLA 94-83). Rutile, titanium oxide, is also present in that canyon so grab a copy of Fred's

book, put your jeep in 4WD, and head up the canyon for an enjoyable weekend of mineral hunting. Among Woodhouse's claims to fame, besides hornswagging Fred Pough into coming to Santa Barbara, is the discovery of Woodhouseite, a calcium aluminum phosphate sulfate hydroxide (Lemmon, 1937, American Mineralogist, v. 22, p. 939-948).

"Why is the Champion Mine in Jeffery Mine Canyon?" you might ask. The deposit was discovered by Dr. J.A. Jeffery, President of the Champion Porcelain Company (Kerr, 1932, Economic Geology, v. 27, p. 614-643). Fred didn't know if Woodhouse's bride was a Jeffery but I suspect that perhaps she was; who else but somebody used to scruffy geologists would fall for a scruffy geologist? (That's a trick question; another answer is "another scruffy geologist")



1<sup>st</sup> edition (1954)



5<sup>th</sup> edition (1996)



Fred (second from right) at The Explorers Club in New York in 1946. This is GES-052Q's new look