CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
3550 N. Central Ave, 2nd floor
Phoenix, AZ, 85012
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

ARIZONA GEOLOGICAL SOCIETY

FIELD TRIP GUIDE

to

RED MOUNTAIN

SANTA CRUZ COUNTY, ARIZONA

March 21, 1981

Prepared by

James J. Quinlan
Kerr-McGee Corporation

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ROAD LOG FOR
RED MOUNTAIN PORTION OF
ARIZONA GEOLOGIC SOCIETY FIELD TRIP TO
PATAGONIA-RED MOUNTAIN-HARDSHELL DEPOSITS
MARCH 21, 1981

START

Mile 0.0 (11.9)

Patagonia, Arizona Post Office at the junction of State Highway No. 82 and county road leading to the San Rafael Valley, Harshaw and Lochiel. Good view of Red Mountain on right.

Mile 1.6 (13.5)

The Patagonia fault is exposed in outcrop across wash. Fault zone consists of several strands, with consolidated Tertiary gravels on northwest and Meadow Valley Andesite (72.1 ± 3 m.y.) on southeast side of fault zone. Bold outcrops on southeast side of outcrop area are silicified breccias along fault strand in Meadow Valley andesite.

STOP 1

Mile 2.7 ([illegible])

Road cut exposures of Meadow Valley Andesite. These exposures are typical of many Meadow Valley exposures outside of main Red Mountain alteration zone. Would call attention to purple color and propylitic alteration. In core of Red Mountain alteration zone, andesite is typically altered to a black-colored, biotite-magnetite rich rock. Clay and limonite are common along many fractures in the exposures and quartz veinlets and manganese oxides may be seen along some of the fractures.

STOP 2

Mile 4.7 (16.6)

Locations of Stops 2 through 8 shown on Figure 2. Turn off from San Rafael Valley-Harshaw-Lochiel county road on to road leading to Red Mountain. Will transfer from bus to four-wheel drive vehicles at this point. Outcrops in wash ahead are generally propylitically altered Meadow Valley Andesite. Local bleach zones are mainly controlled by linear structures. Clay, gypsum and limonite are the most common minerals in these zones.

STOP 3

Mile 5.2

View point of southeast side of Red Mountain. Would call attention to route of road leading up mountain, talus covered slopes, land slide blocks and cliffs in upper layered Tuff unit. This upper layered altered Tuff unit is much more resistant to erosion than the underlying andesite and this accounts for the present topographic high at Red Mountain.

STOP 4

Mile 7.1

At outcrop in altered Tuff unit 5,000 feet east of alteration center at Red Mountain (See Figures 2 and 3). Rock is principally clay altered, also note alunite veinlets. Stop is at about outer limit of visible sericite in Red Mountain alteration zone.

STOP 5

Mile 7.5

At collar of Hole No. 158. Road cuts and outcrops of altered Tuff unit + 2,000 feet closer to Red Mountain alteration center than at Stop 4. Note increase in sericite and pyrite (2 to 2.5 weight %) content over that at Stop 4.

See Map Figures 2 and 3 and Cross Section Figures 4, 6, 10 and 11 illustrating geology, alteration and sulfide changes at and between Stops 5 and 6.

STOP 6

Mile 8.0

Crest of Red Mountain ridge and near collar of Hole No. 151. Road cuts and outcrops of the Tuff unit are inside the area of relative abundant sericite and iron oxides after pyrite. Adjacent drill hole data shows original pyrite content of up to 18 weight percent and an average content of from 10 to 12% (see Figure 6).

11.5

STOP 7

Mile 8.8
20.7

At collar of Hole No. 148. Road, drill pad cuts and outcrops are in altered Tuff unit, within zone of relatively abundant sericite and iron oxide. Note quartz and alunite veinlets in drill pad cut. Will discuss and point out feature of deposit from view point at this stop. Core specimens illustrating changes in alteration and mineralization with depth will be available at the lunch stop.

STOP 8

Mile 9.0
20.9

End of Red Mountain tour-view sight overlooking Hardshell or afternoon tour area.

GEOLOGY AND SILICATE-SULFIDE ALTERATION ZONING AT THE RED MOUNTAIN PORPHYRY COPPER DEPOSIT, SANTA CRUZ COUNTY, ARIZONA

James J. Quinlan

Abstract

This paper is the result of a study of the Red Mountain, Arizona porphyry copper deposit. The bulk of the copper recognized in the deposit lies about 5,000 feet below the summit of the mountain and 3,500 feet below a small, partly dissected, secondary enriched chalcocite blanket.

The copper deposit at Red Mountain occurs within an altered complex of volcanic and intrusive rocks of Cretaceous and early Tertiary age. Silicate alteration, sulfide distribution and assay data have been used to define the deposit and alteration system.

Alteration at Red Mountain is complex. A near classic porphyry-copper silicate-sulfide alteration pattern, including a partially defined copper shell is recognized at depth. This has been superimposed over an earlier potassic alteration assemblage which in turn is a part of a much larger zoned alteration system. Though modified by supergene agents, the early system accounts for much of the alteration recognized at the surface.

The Red Mountain deposit can be divided into three parts: (1) a near surface chalcocite blanket deposit, (2) a deep level bulk sulfide deposit and (3) a copper-molybdenum breccia pipe within the core area of the deep porphyry copper system.

The most obvious clue to the deep orebody at Red Mountain is the shallow chalcocite blanket. This apparently has formed from a low grade copper halo or plume which extends upward to the present surface or at least 5,000 feet above the deep orebody.

Introduction

The Red Mountain copper deposit is at the northern end of the Patagonia Mountains, 50 miles southeast of Tucson, Arizona (Fig. 1). The deposit was discovered and is controlled by the Kerr-McGee Corporation of Oklahoma City, Oklahoma.

The bulk of the copper recognized in the deposit lies about 5,000 feet below the summit of the mountain and 3,500 feet below a partly dissected enriched chalcocite blanket.

The geology of the Red Mountain deposit and surrounding area has been described by a number of authors. The most pertinent publications are: Schrader (1915), Drewes (1971 A & B and 1972 A & B), Simons (1971 and 1974), Corn (1975) and Bodnar and Beane (1980).

Geology

Geologic Setting

Red Mountain is underlain by an altered complex of volcanic and intrusive rocks of Cretaceous and early Tertiary age. Figures 2 and 3 are generalized maps illustrating surface geology and alteration features. Figures 4 and 6 are diagrammatic cross sections showing geologic and alteration features.

Three layered volcanic units are recognized at Red Mountain. The upper or Tuff unit, consists mainly of tuffs, flows and breccias of rhyolitic and dacitic composition. It crops out over much of the mountain and is up to 2,400 feet thick (Fig. 2 and 4). It is essentially the same as the "Volcanics of Red Mountain" described by Drewes (1971 A) and which he correlates with the Gringo Gulch volcanics of Paleocene (?) age.

Underlying the Tuff unit are approximately 3,000 feet of andesite and trachyandesite flows, breccias, sills and dikes locally referred to as the Andesite unit. Hornfels bands occur near the base of the unit. The Andesite unit crops out on the flanks of Red Mountain and is cut in drill holes (Fig. 2 and 4). It is a part of the upper Cretaceous Trachyandesite or Doreite (Ka) unit, mapped and described by Simons (1974). Simons reports a potassium argon date of 72.1$\pm$ three million years for a sample from the unit.

The lowest layered rock unit is the Felsite-Latite unit. It underlies the Andesite unit and includes interlayered andesites near the top. It consists mainly of volcanic conglomerates and breccias, silicified tuffs, flows(?), interlayered and cut by latite sills and dikes. The unit crops out in Alum Gulch on the south side of Red Mountain and is recognized in deep drill holes on the south and west flanks of the mountain (Fig. 2 and 4). It correlates with the upper Cretaceous Silicic Volcanics (Kv and Kla units) mapped by F. S. Simons (1974).

The layered rocks at Red Mountain are cut by several textural varieties of porphyritic rocks which range in composition from granodiorite to quartz monzonite. The porphyries are recognized as dikes and irregular bodies in outcrop and drill holes (Fig. 2 and 4).

The layered rocks generally strike north and dip 15° E. The dominant trend of local shears and fractures is N 20° E with steep dips toward the northwest and southeast. Less numerous are shears and fractures which strike N 70° E and dip steeply northwest or southeast. No large faults are recognized on the mountain but several occur on its flanks (Fig. 2).

Silicate Alteration

Silicate alteration at Red Mountain is easy to recognize but difficult to interpret. Near the center of the deposit, changes in the alteration assemblage with depth are most obvious (Fig. 6). Lateral zoning at depth, which is a critical guide to ore, is much more subtle and to date has been best quantified by thin section studies (Fig. 5).

The strong vertical alteration zoning recognized at Red Mountain is partly controlled by differences in rock types with depth. Near the center of the system, the Tuff unit is intensely altered to an assemblage of quartz-sericite-pyrite-kaolinite-alunite. The sericite content increases with depth while the content of kaolinite and alunite decreases. At the Tuff-Andesite contact, the assemblage abruptly changes to quartz-sericite-chlorite-pyrite with minor hematite and kaolinite. With the exception of outlying Hole 158, the pyrite content rapidly decreases in depth through the upper Andesite interval (Fig. 10). The alteration assemblage further changes with depth within the andesite through a biotite-magnetite-pyrite assemblage to a biotite-orthoclase-anhydrite-magnetite-chalcopyrite assemblage. Within the Felsite-Latite unit, the assemblage is orthoclase-quartz-anhydrite-chalcopyrite-biotite. The alteration within the porphyritic rocks is generally reflective of the adjacent intruded rock and depth. It is expressed by a quartz-sericite-pyrite-kaolinite assemblage at shallow depths and an orthoclase-anhydrite-biotite-chalcopyrite assemblage at greater depth.

Lateral changes in alteration are much more subtle. At the surface hypogene alteration is strongly masked by supergene effects but is discernible. Within the Tuff unit, the lateral zoning is expressed as a central core area of more abundant sericite, quartz veining and limonitic stain (Fig. 3). Outward from the core area, a more argillic zone is characterized by abundant clays and alunite with less sericite and silica. The transition from sericitic-argillic alteration within the Tuff unit to propylitic alteration in the surrounding andesite to the northeast, east, south and southwest appears to be partly due to change in rock type. The suggestion is that the alteration mushroomed or extended farther laterally from a mineralization center in the Tuff unit than in the underlying andesite. Within the andesite on the west and northwest flanks of the mountain an intense supergene argillic alteration is superimposed directly upon hypogene biotite-magnetite alteration. Within this area of relatively low original pyrite, chalk turquoise has formed as the more common supergene copper mineral within the argillized andesite.

At depth, the central core area is marked by an orthoclase-quartz-biotite-anhydrite alteration mineral assemblage. There is a general decrease in the amount of these minerals outward from the core area with increasing amounts of sericite and chlorite. This is illustrated on Figure 5 which was developed from a study of thin sections obtained from selected holes between elevations of 2,000 and 2,500 feet.

Farther out, as seen in Holes 157 and 161, a biotite-magnetite assemblage is recognized in the andesite. In Hole 157, this assemblage changes to biotite-orthoclase in the Felsite-Latite unit. Though the assemblage is potassic, the intensity of the potassic alteration appears much less than that recognized in the core area of the deposit. Locally, late quartz-pyrite veinlets enclosed in sericitic envelopes cut the previously described alteration features.

Figure 6 illustrates in cross section the writer's concept of the major silicate alteration features at Red Mountain. That is, a large early zoned alteration system which accounts for most of the alteration recognized at the surface. The primary porphyry copper deposit lies in the potassic zone of this large early system. The alteration associated with the primary deposit has been superimposed on the early alteration system and zoning is similar to that described by J. D. Lowell and J. M. Guilbert (1970) and A. W. Rose (1970). It is suspected that the two silicate alteration systems are closely related in origin and time with the porphyry copper phase representing a late event in the development of the complex Red Mountain hydrothermal system. The sulfide distribution data also clearly points to two distinct alteration phases as does the fluid inclusion data of Bodnar and Beane (1980).

Sulfide Distribution

The principal sulfide minerals at Red Mountain are pyrite and chalcopyrite. Secondary chalcocite is present, particularly in the blanket deposit. Small amounts of molybdenite are present and bornite, enargite, tennantite, galena and sphalerite have been identified locally.

The sulfide content of the rocks at Red Mountain has been estimated during core logging and in the deep holes has been determined on the basis of sulfur and sulfide sulfur assays.

For the purposes of the sulfide distribution studies, it has been assumed that pyrite and chalcopyrite are the only significant primary sulfide minerals in the Red Mountain system. The amounts of each below the zone of secondary enrichment are calculated from copper and sulfide sulfur data by assigning the amount of sulfide sulfur needed to convert the amount of copper present in an interval to chalcopyrite and assigning the remaining sulfide sulfur to pyrite. Sulfate data has been converted to anhydrite equivalent where anhydrite is recognized in the deep drill holes.

The sulfide data has been assembled and posted in several different manners on plans and cross sections, i.e., by rock type and at various elevation intervals. Most revealing is the bulk data when assembled and posted at elevation intervals of 500 feet or more. In general, plans and sections have been prepared showing pyrite, chalcopyrite, and total sulfide (combined pyrite and chalcopyrite) distribution and pyrite to chalcopyrite ratios. The pyrite and total sulfide maps and sections are so reflective of each other that maps and sections showing pyrite distribution have not been included with this report.

Plan illustrations accompanying the report show relative bulk chalcopyrite (Fig. 7) and total sulfide distribution (Fig. 8) and relative pyrite to chalcopyrite ratios (Fig. 9) between elevations of 500 and 1,500 feet. All three maps show the same basic pattern and closely match the silicate alteration pattern shown in Figure 5. Though drilling has yet to outline the entire system, available data indicates an elongate but nearly classic sulfide copper shell. Thus all three plans, and in particular the ratio map (Fig. 9), are useful in indicating where a drill hole lies within the system.

Cross sections prepared from the sulfide data, i.e., data assembled at 500-foot elevation intervals, not only confirm the picture developed in plan but add to it. Total sulfide and chalcopyrite data have been assembled on Section A-A' which passes through the core area of the lower sulfide system as well as outlying Holes 157 and 158 (Fig. 10 and 11). The section showing total sulfide distribution (Fig. 10) clearly demonstrates a two-part system. A large primary sulfide high, mostly pyrite, is recognized near the surface in the upper parts of the central drill area and in Hole 158. This pyrite is within and generally an integral part of the intense quartz-sericite alteration assemblage. The section also suggests that Hole 157 lies in the core area of the large primary sulfide system and would account for the potassic alteration recognized in the hole. It is also apparent that the strong iron oxides recognized on the upper western slope of Red Mountain (Fig. 3) are related to the upper sulfide system.

The copper system recognized at depth in the central drill area and shown on the sulfide distribution and ratio maps (Fig. 7-9) is also apparent in the cross sections showing the total sulfide and chalcopyrite distribution (Fig. 10 and 11). Although the amount of total sulfides in the lower system (Fig. 10) is less than that in the upper system, it is clear from Figure 11 that the copper is associated with the lower system. Further it is apparent in section that the lower sulfide system closely follows the central area silicate system and like the silicate system is superimposed on the earlier and larger system.

The Ore Deposit

For discussion purposes, the Red Mountain deposit is divided into three separate and distinct parts: (1) an upper level chalcocite blanket deposit, (2) a deep level bulk sulfide deposit and (3) a breccia pipe deposit within the core area of the deep porphyry copper system.

Chalcocite Blanket

Chalcocite is recognized along fractures and as coatings on pyrite grains from the surface to a depth of 2,500 feet or more. Much of the chalcocite appears to be concentrated in a flat blanket-like deposit near an elevation of 5,000 feet (Fig. 11). As currently defined, the blanket ranges in thickness from 15 to 150 feet. It appears to be in the process of being destroyed by weathering and erosion and the deeper scattered chalcocite showings which are usually controlled by fissures or shears probably represents recent copper migration.

The chalcocite blanket almost directly overlies the deep porphyry copper orebody (Fig. 3 and 11). The distribution of copper above the deep porphyry copper system as reflected by the relative copper or chalcopyrite values shown in Figure 11, suggests the blanket was formed by enrichment of a protore halo or plume extending at least to the present surface or 5,000 feet above the main ore system. Bodnar and Beane's (1980) description of the late stage of mineralization in a quartz-pyrite veinlet containing minor chalcopyrite and galena in a surface sample, RM 11, also is evidence that the ore stage primary mineralization extends far above the main deposit.

Deep Level Bulk Sulfide Deposit

The zone of deep level porphyry copper mineralization at Red Mountain is an integral part of the copper shell as recognized in the alteration and sulfide study. Holes 146, 165 and the deeper parts of Hole 144 describe the low-sulfide, low-copper core of the system. A low-sulfide, low-copper tail extends from the core and is recognized in seven holes, 133, 135, 154, 162, 147, 143 and 152. A breccia pipe is defined in Holes 148, 148B, 148C and 155 and lies within the elongated tail area.

Nine drill holes are immediately peripheral to the core area and the elongated tail and it is in the area of these nine holes that most of the deep level copper outside the breccia pipe occurs. Seven of the nine holes contain thick and/or higher grade ore intervals. Ore is recognized on both the west and east limbs of the copper shell (Fig. 4).

Much, if not most, of the deep level copper occurs as chalcopyrite along veinlets and fractures and only a small amount occurs as disseminated grains. From work to date, it is obvious that the area of the copper shell is not uniform in grade and everywhere of interest. Local controls and structure apparently played an important part in copper mineralization within the shell area. For example, chalcopyrite enrichment is noted along both sides of andesite-porphyry contacts in several holes.

148-155 Breccia Pipe

The 148-155 breccia pipe recognized at Red Mountain has many features common to mineralized breccia pipes at other porphyry copper deposits. It is perhaps the deepest copper-molybdenum breccia pipe presently known anywhere in the world. Not only is it of potential economic interest because of the higher grade ore associated with it, but it is also of considerable scientific interest because of its depth, position within the system, and the mineralization and alteration associated with it.

The Dyna-drill has been used to control the direction of drill holes for a better evaluation of the pipe. In all, four holes have intersected the pipe, Holes 148, 148B, 148C and 155 (Fig. 12).

The 148-155 breccia pipe, as envisioned from drill hole data, is shown in plan and diagrammatic section in Figure 12. Though in part diagrammatic, the plan and section represent a reasonable interpretation based on drill hole intercepts within the pipe and the confining restrictions of adjacent holes. In plan the intercepts in Holes 148 and 155 are about 800 feet apart and define the minimum dimension of the long axis of the pipe. The pipe has been assigned a long axis of 1,100 feet. The section better illustrates the information available. As shown, the top of the pipe is at an elevation of 1,750 feet or approximately 4,000 feet below the surface and ore has been exposed over a vertical range of 1,300 feet. Hole 148 bottoms in ore within the pipe near sea level elevation.

As mentioned before, the 148-155 pipe lies within the high-potassic, low-sulfide and low-copper tail extending southward from the core of the deep porphyry copper system (Fig. 9). The alteration within the pipe is separate and generally distinct from that of the surrounding rock. This is well exemplified in Holes 148B, 148C and 155. These holes enter the pipe near its top from an area of low-sulfide, low-copper and strong potassic alteration. At or within a few feet of the pipe contact, alteration abruptly changes to phyllic with abundant sericite and up to 30 percent by weight of pyrite. Strong phyllic alteration persists near the top of the pipe but gives way to potassic alteration with depth. Only in hole 155 is a significant amount of possible mineralization leakage recognized above the pipe. Though the pipe contact in this hole is sharp and distinct, bands of pipe-type mineralization are evident for 40 feet above the pipe. Shears with chlorite, sericite and quartz-sulfide veinlets similar to pipe mineralization are recognized up to 775 feet above the pipe.

Unlike many breccia pipes described in the literature, the mixing and movement of fragments great distances up or down the pipe has not been recognized in the 148-155 breccia pipe. Though fragments are broken and rotated, the composition of fragments, with but a few exceptions, appear to be similar to those in the immediate wall of the pipe. More detail is needed to substantiate this observation.

The ore breccia generally consists of angular fragments of felsite and andesite in a matrix of orthoclase, quartz, anhydrite, chalcopyrite and pyrite. Sericite is abundant near the top and also is recognized close to the sides of the pipe in deeper intercepts. Calcite, molybdenite and a dark gray sulfosalt, tenatively identified as tennantite, are accessory minerals. Breccia fragments are commonly an inch or less in diameter. The largest fragment recognized was 18 inches in diameter. Open vugs are common.

A definite enrichment of copper, molybdenum and silver is recognized at the pipe margin, particularly in the deeper intercepts. The enrichment is related to the concentration of chalcopyrite and molybdenite rich sulfide lenses at the margins. The grade of copper at the margins of the pipe is from 1.8 to 4.8 times that in the core area of the pipe. Molybdenum enrichment at the margins is ten times and that of silver from two to four times that of the pipe core.

The silicate alteration and sulfide distribution pattern recognized in the pipe, though different in scale, is much the same as that recognized in many large porphyry copper systems, that is, a core area of strong potassic alteration with lower sulfide content. This is followed upward and to a lesser extent outward towards the pipe margins by a phyllic zone with increased sulfides. The suggestion is that the pipe itself may represent a more intense but miniature zoned porphyry copper system superimposed over the main or bulk phase of porphyry copper alteration and mineralization.

Discussion

Most of the alteration recognized at the surface of Red Mountain results from the supergene modification of a large zoned hypogene alteration system formed prior to the emplacement of the deep porphyry copper deposit.

The deep level porphyry copper is related to a more intense, less extensive event in the evolution of the complex hydrothermal system. The superposition of the breccia pipe alteration and mineralization over the main phase porphyry copper alteration and mineralization indicates an even more confining, more intense alteration, mineralization pulse late in the evolution of the system.

Though the three hydrothermal events appear separate and distinct, all three are undoubtedly closely related in time and origin to each other and to the emplacement of porphyry intrusives at Red Mountain. The indicated sequence of formation appears to start with the development of the large, barren, zoned system, with succeeding but more restrictive and intense pulses of ore mineralization within the confines of the large barren system.

The zoned nature of alteration and mineralization within the breccia pipe indicates the pipe itself may represent a miniature zoned porphyry copper system. Whereas the pipe contains open vugs, most evidence indicates that it must have formed many thousands of feet below the surface.

The most obvious clue to the deep orebody at Red Mountain is the shallow chalcocite blanket. This appears to have formed from a low-grade copper halo or plume which extends upward to the present surface or at least 5,000 feet above the deep orebody. Undoubtedly, pyrite from the early alteration system played an important part in the generation of acid for leaching of the plume mineralization.

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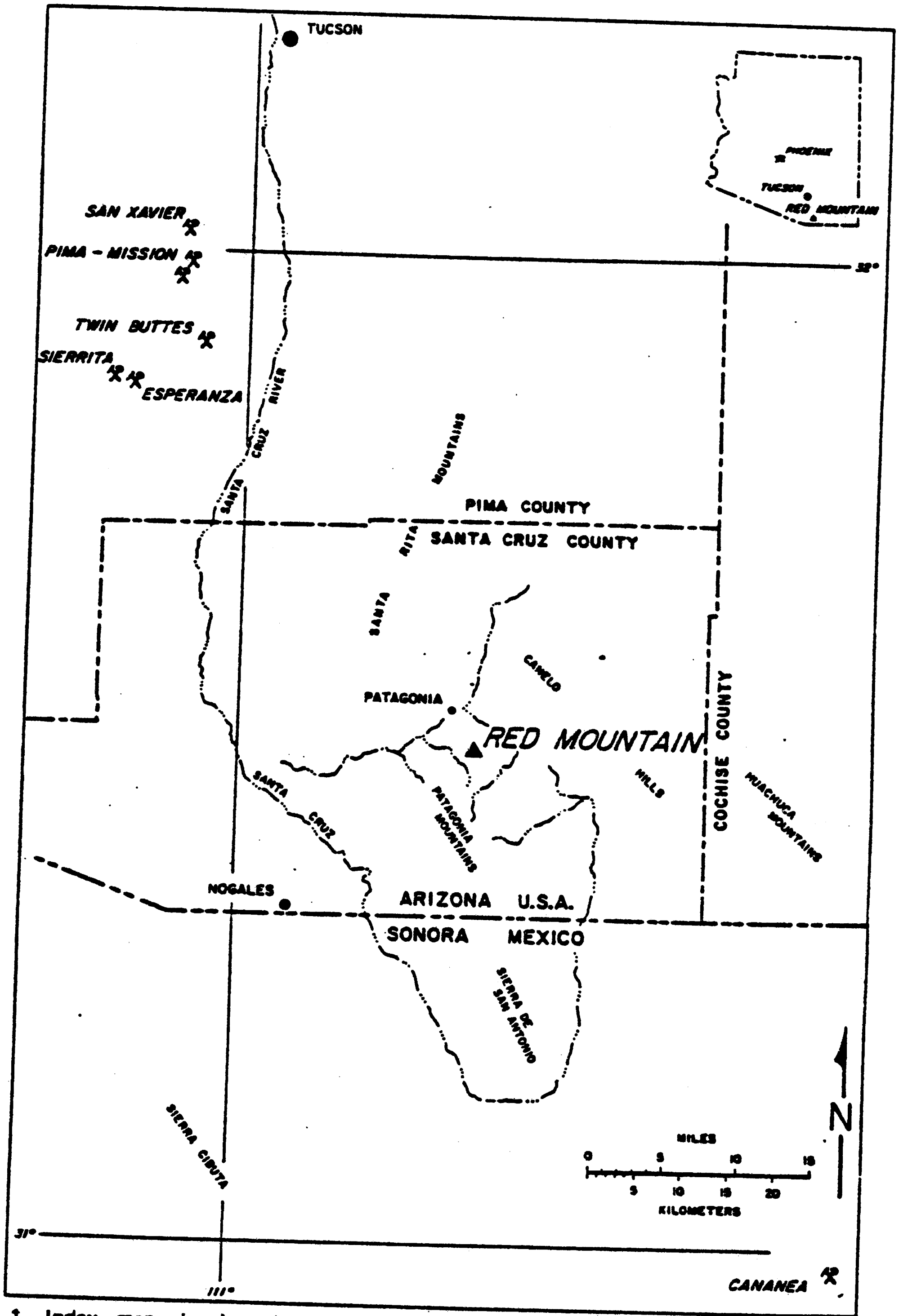

Fig. 1. Index map showing the location of the Red Mountain porphyry copper deposit. After R.M. Corn, Economic Geology, Vol. 70, No. 8, Dec. 75

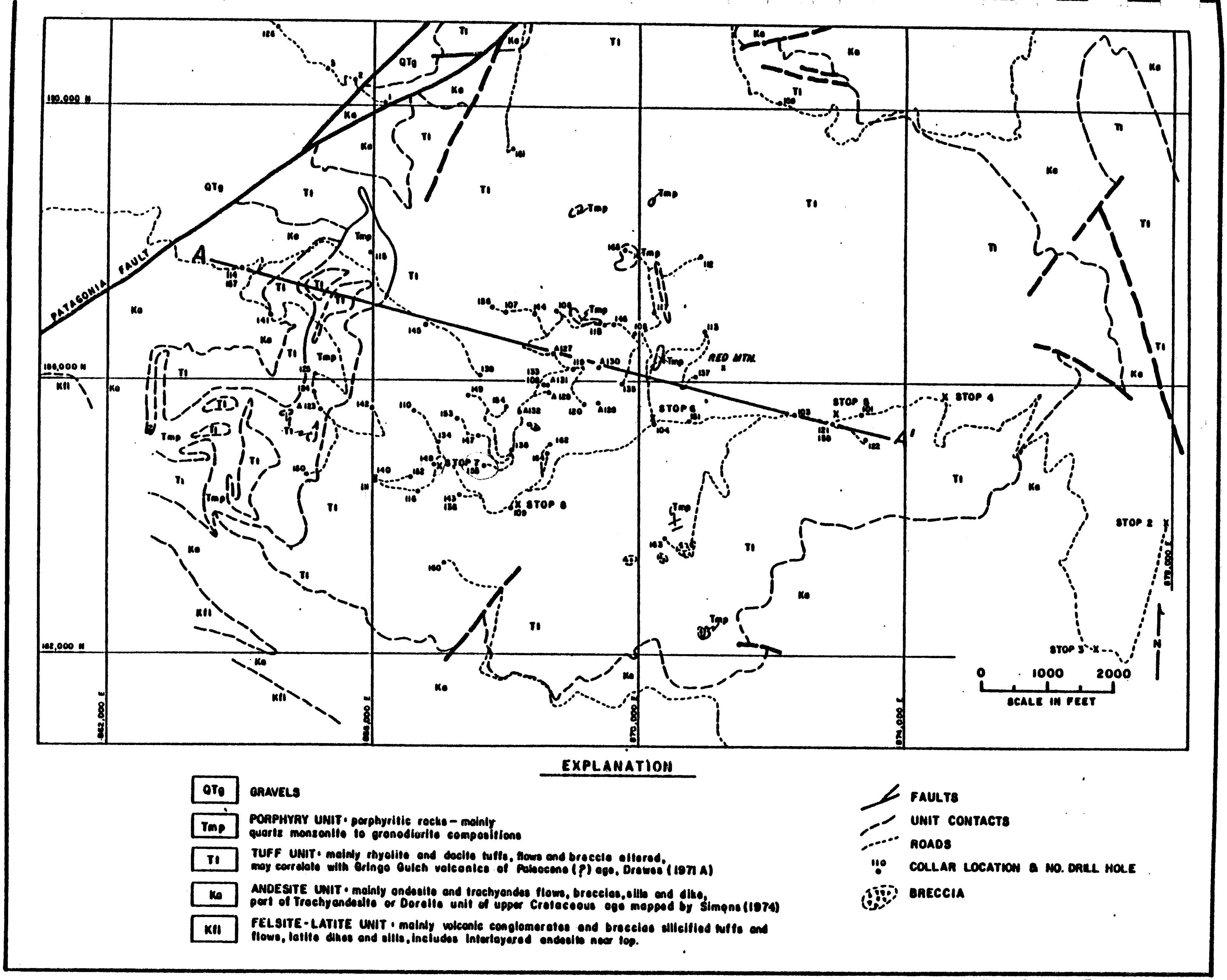

Fig. 2. Generalized surface geologic map of Red Mountain, Arizona. Modified after D.L.E. Huckins, 1975.

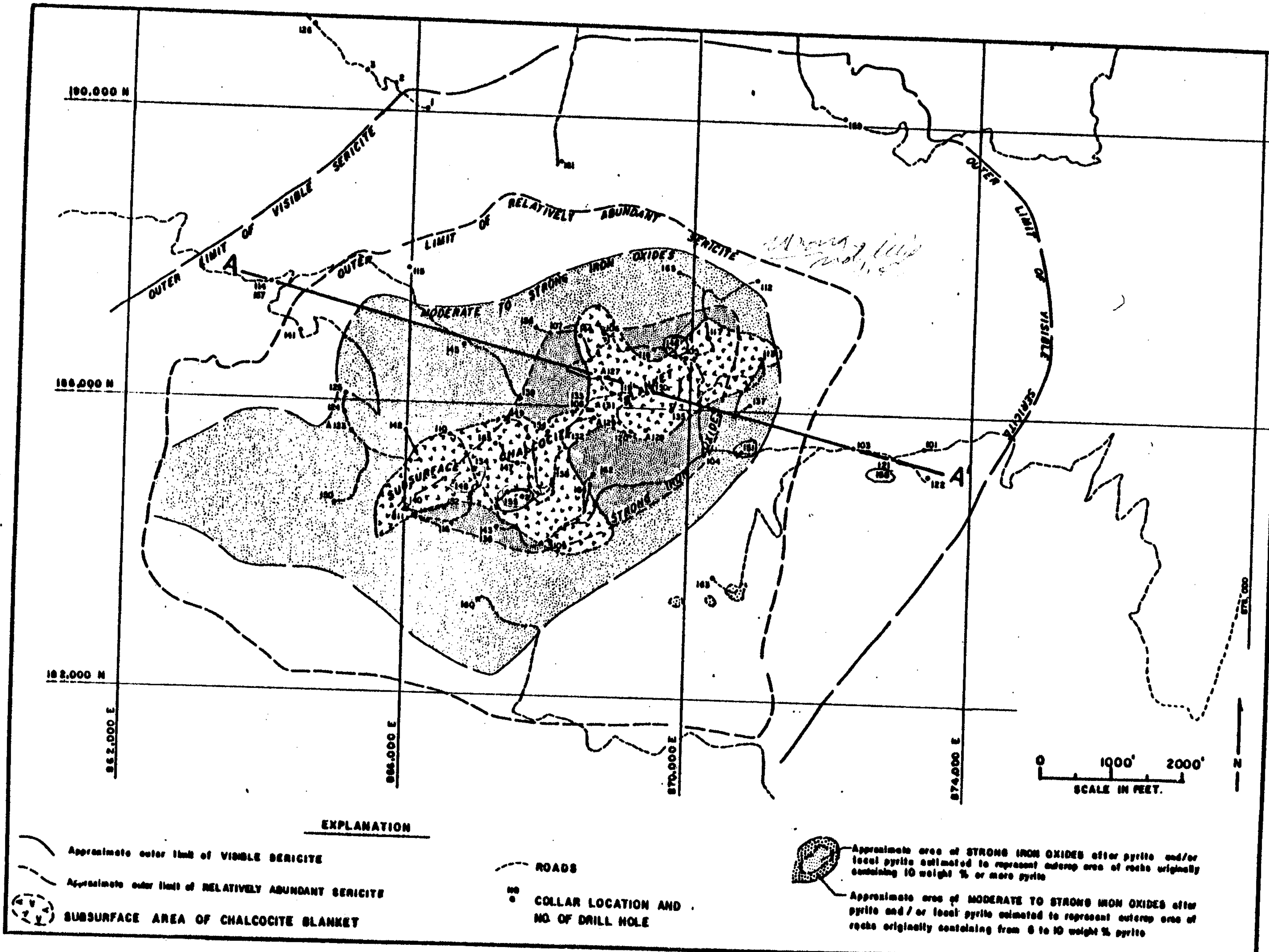

Fig. 3. Generalized surface alteration map of Red Mountain, Arizona. Modified after D.L.E. Huckins, 1975.

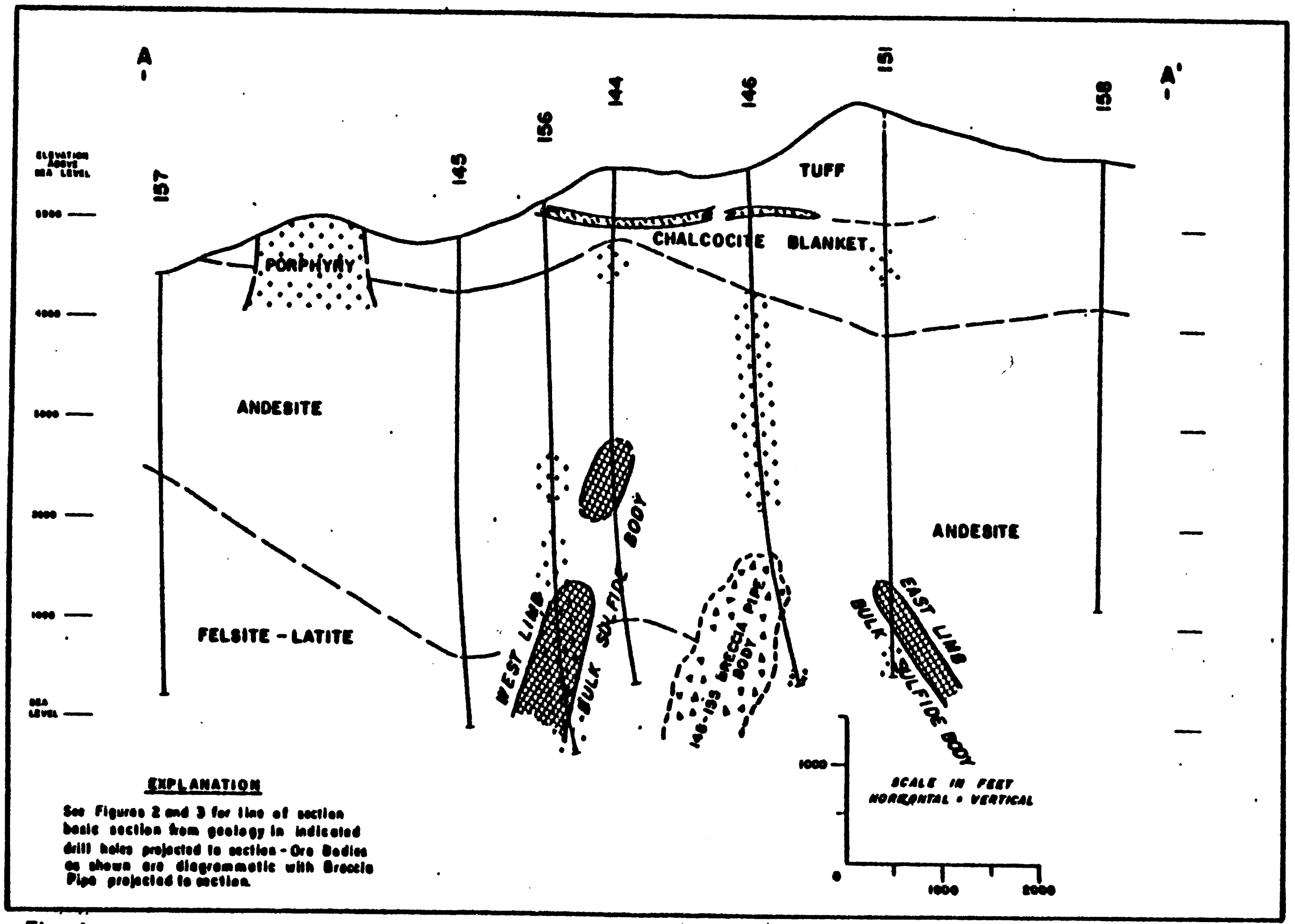

Fig. 4. cross-section A—A'. looking northeasterly, diagrammatically showing geology at Red Mountain, Arizona .

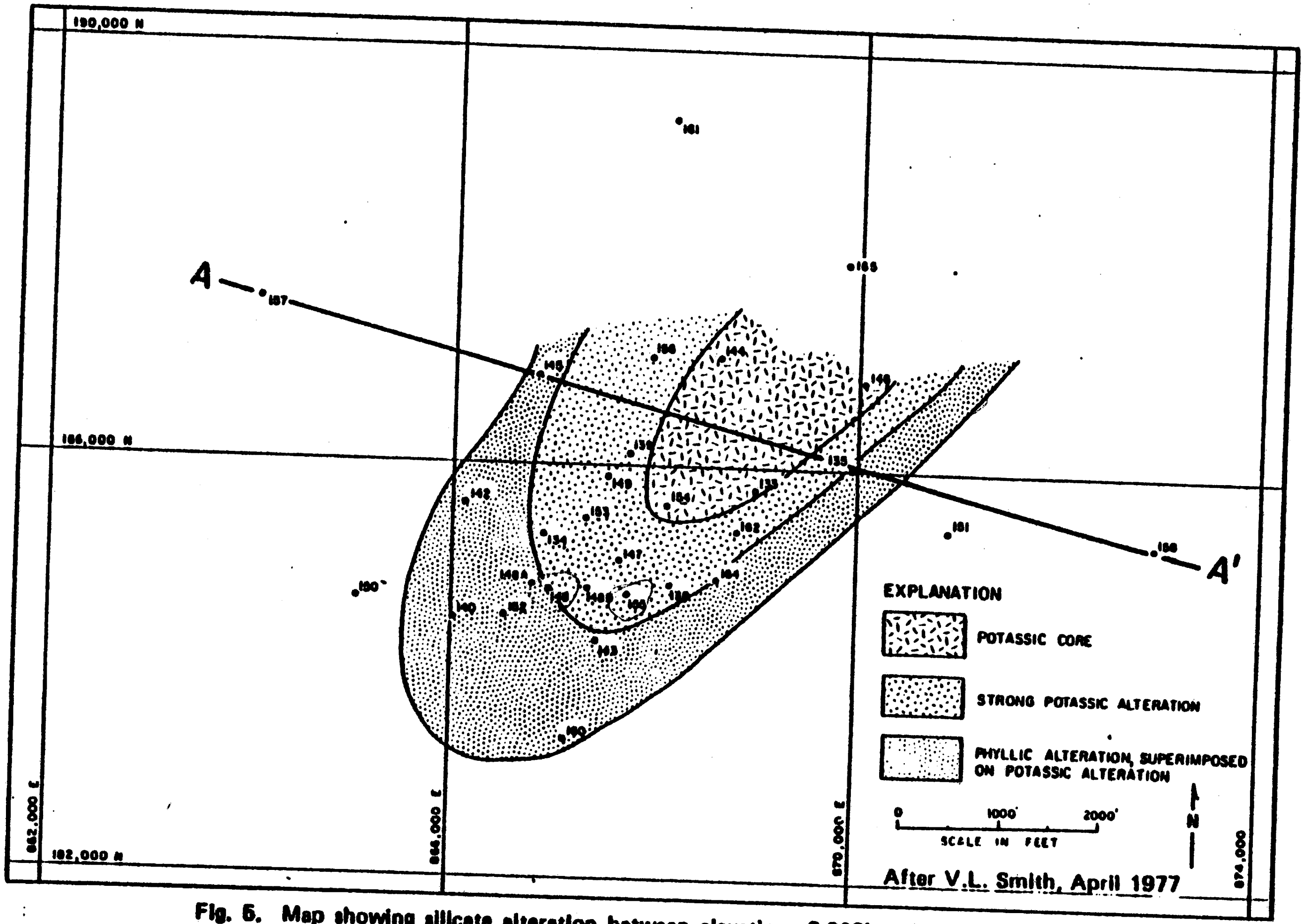

Fig. 5. Map showing silicate alteration between elevations 2,000' and 2,500' at Red Mountain, Arizona. Developed from petrographic study of thin sections from selected holes.

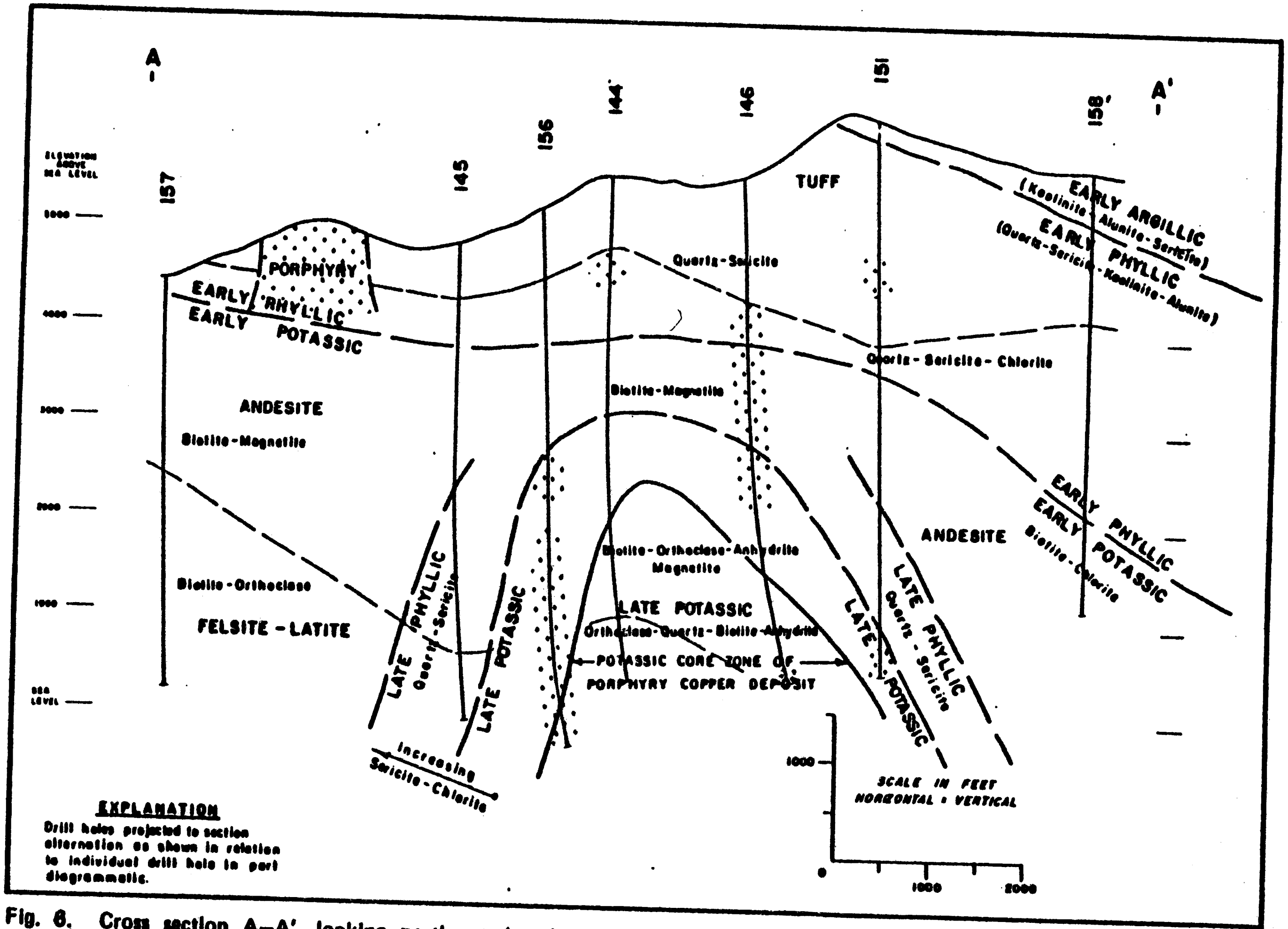

Fig. 6. Cross section A–A', looking northeasterly, diagrammatically showing silicate alteration at Red Mountain, Arizona.

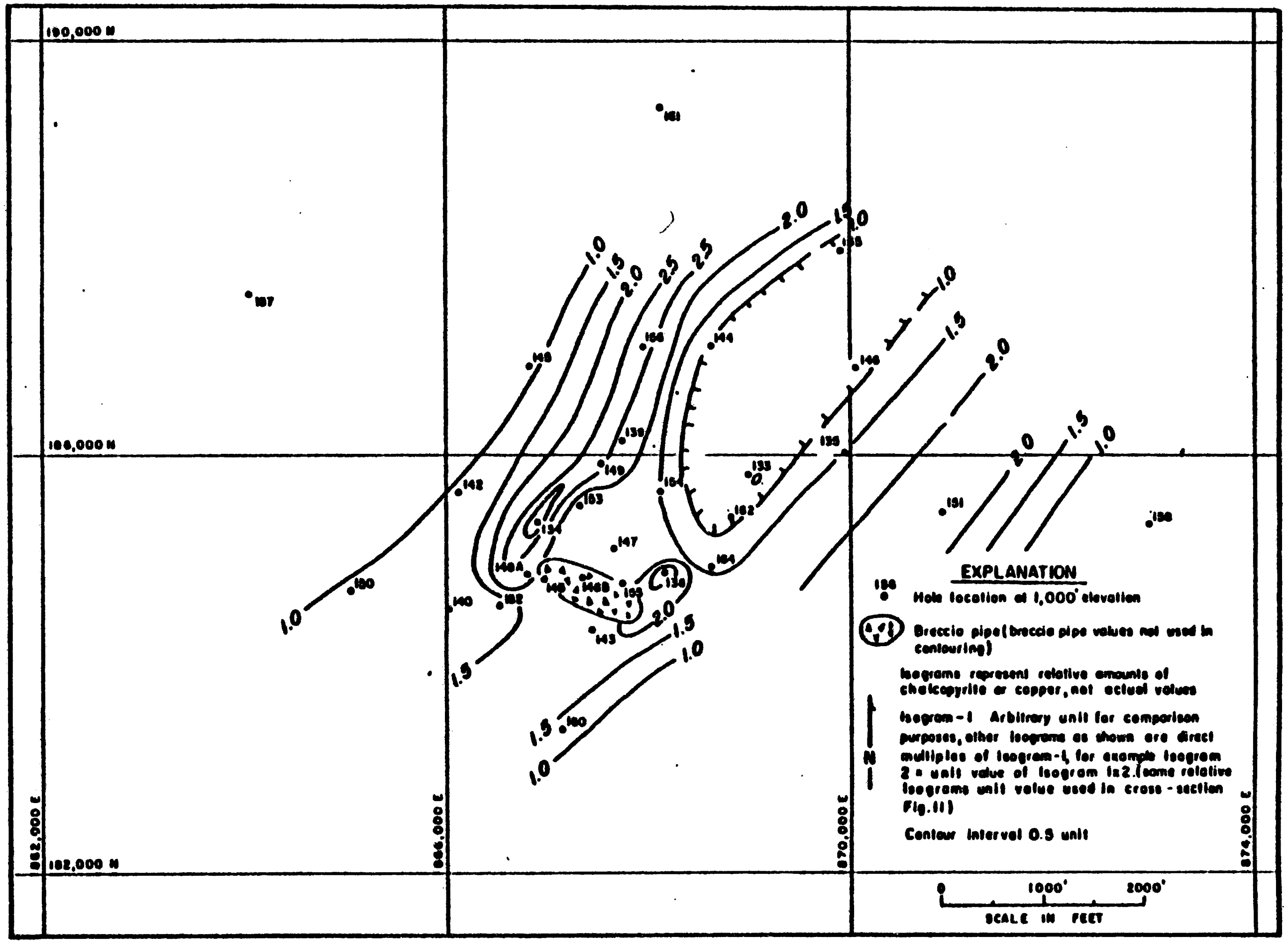

Fig. 7. Map showing relative chalcopyrite distribution between elevations 500' and 1,500' at Red Mountain, Arizona.

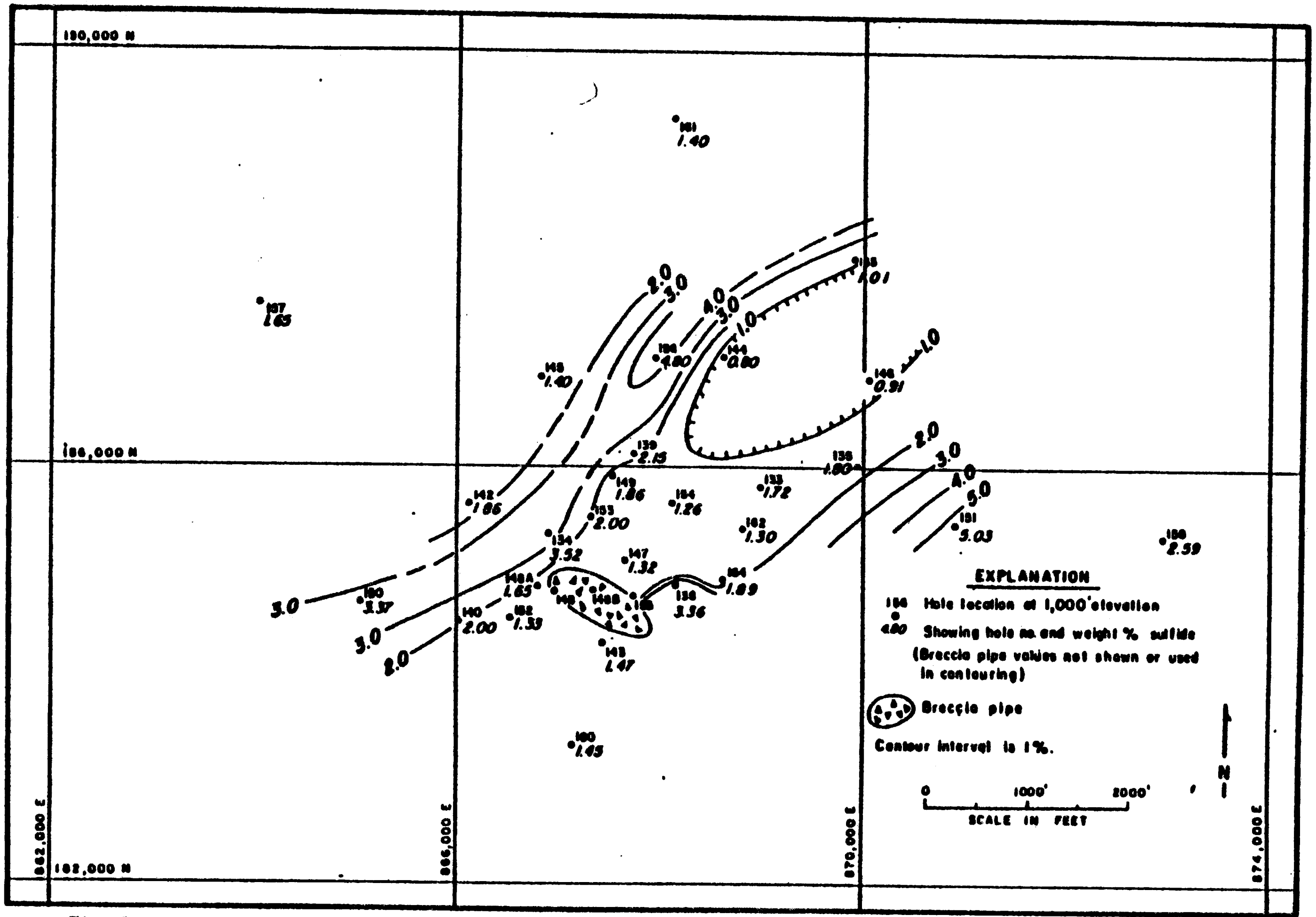

Fig. 8. Map showing total sulfide distribution between elevations 500' and 1,500' at Red Mountain, Arizona.

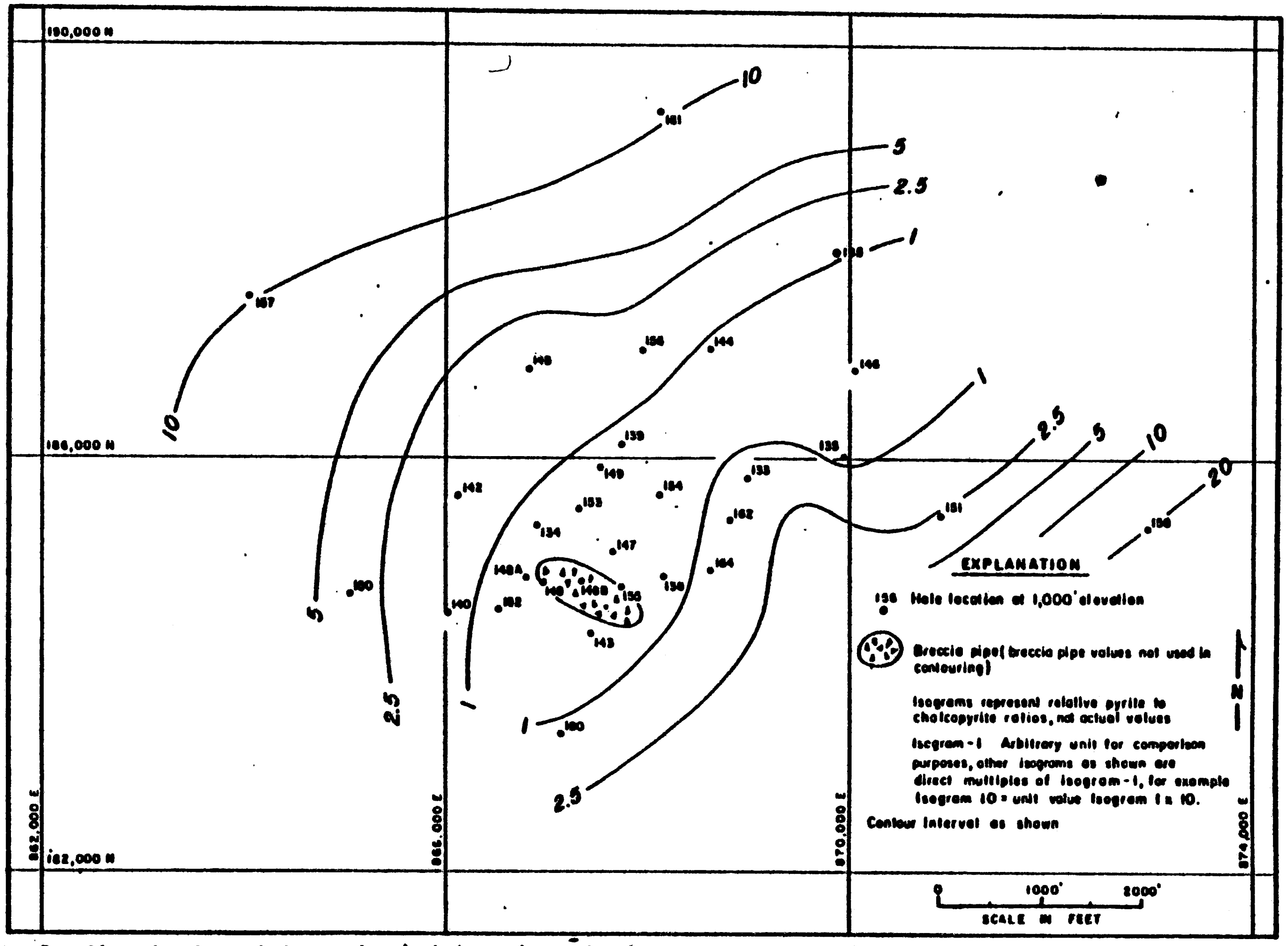

Fig. 9. Map showing relative pyrite / chalcopyrite ratios between elevations 500' and 1,500' at Red Mountain, Arizona.

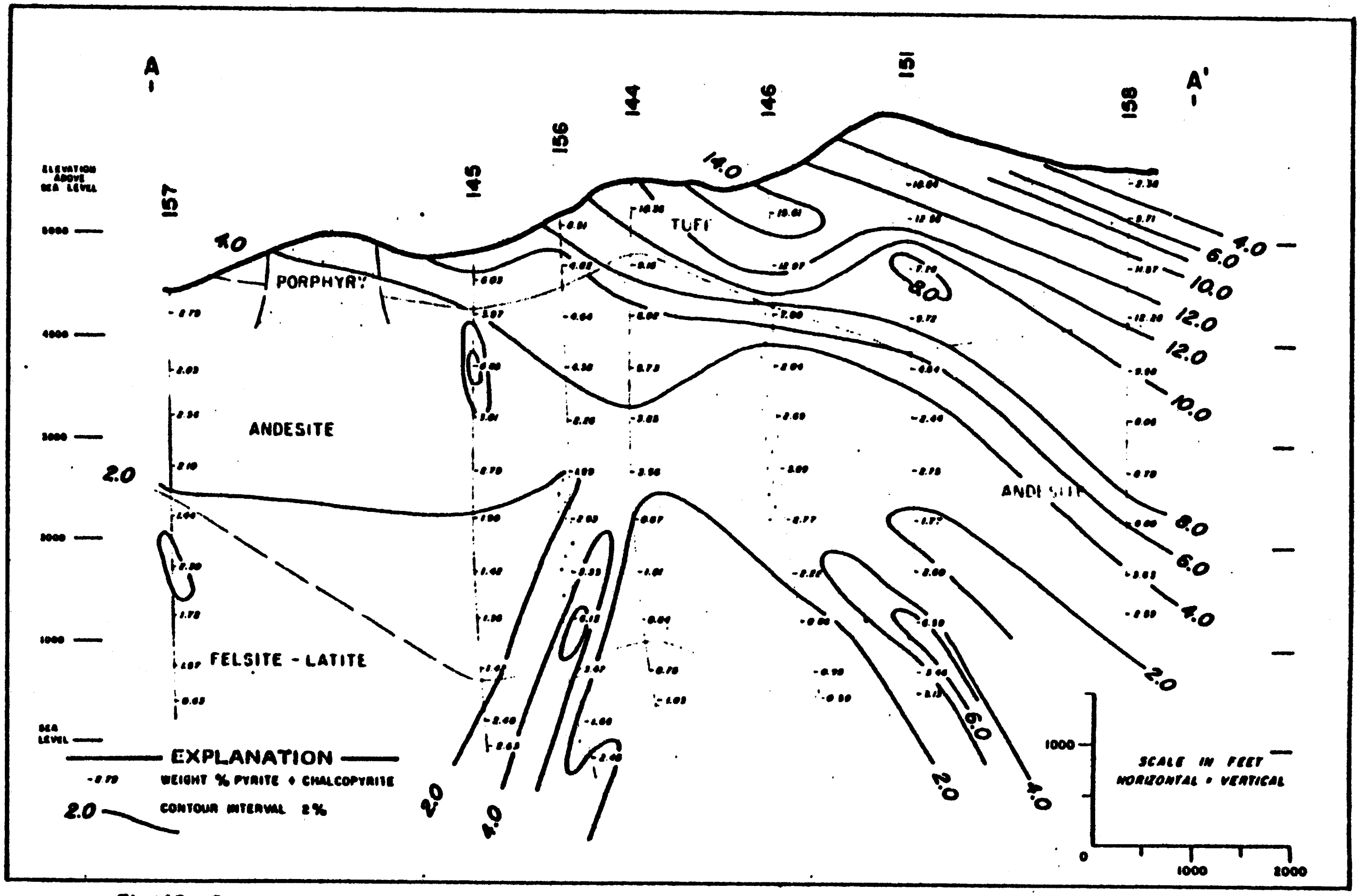

Fig. 10. Cross section A–A', looking northeasterly, showing total sulfide distribution at Red Mountain, Arizona.

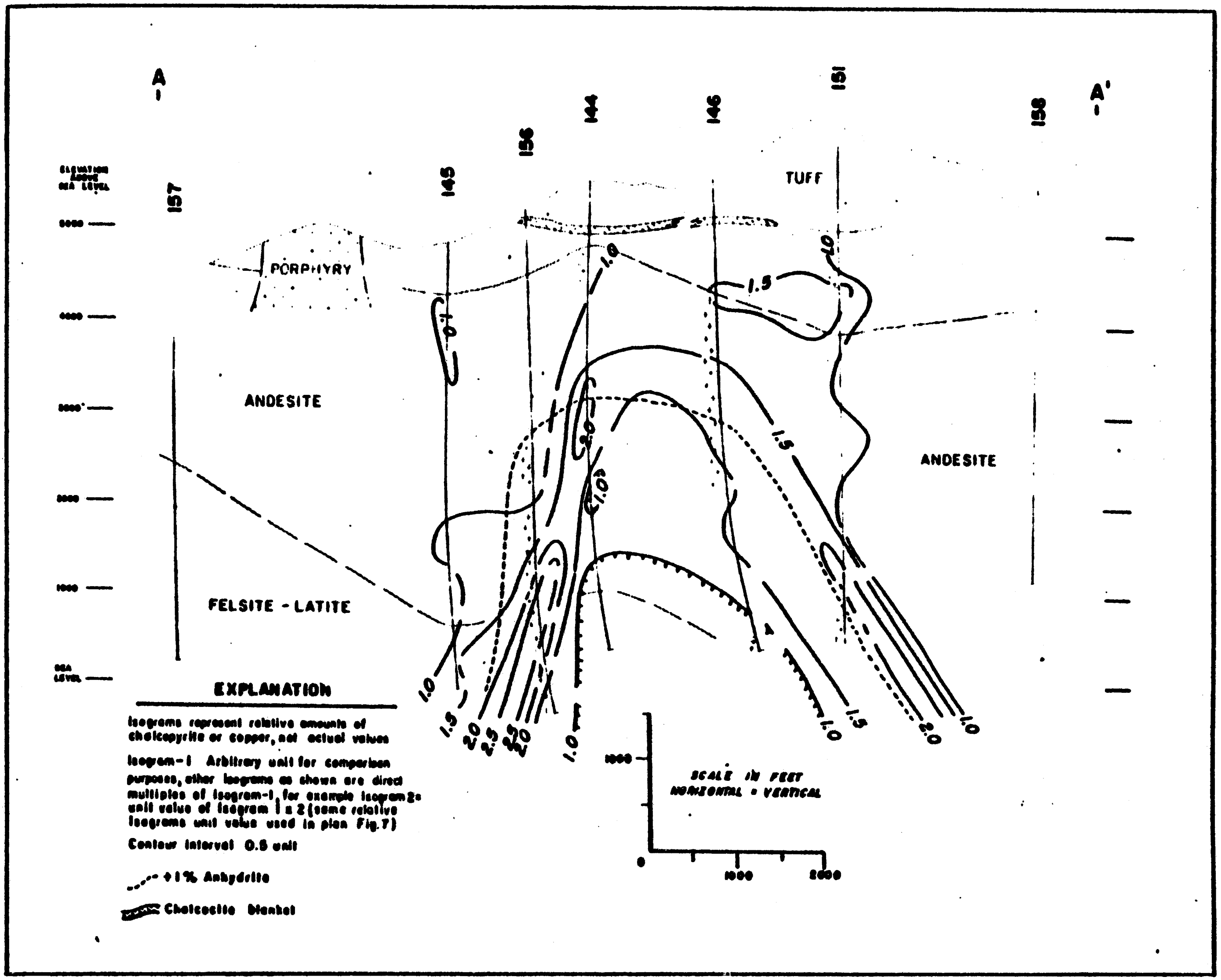

Fig. 11. Cross section A–A', looking northeasterly, showing relative chalcopyrite and anhydrite distribution at Red Mountain, Arizona.

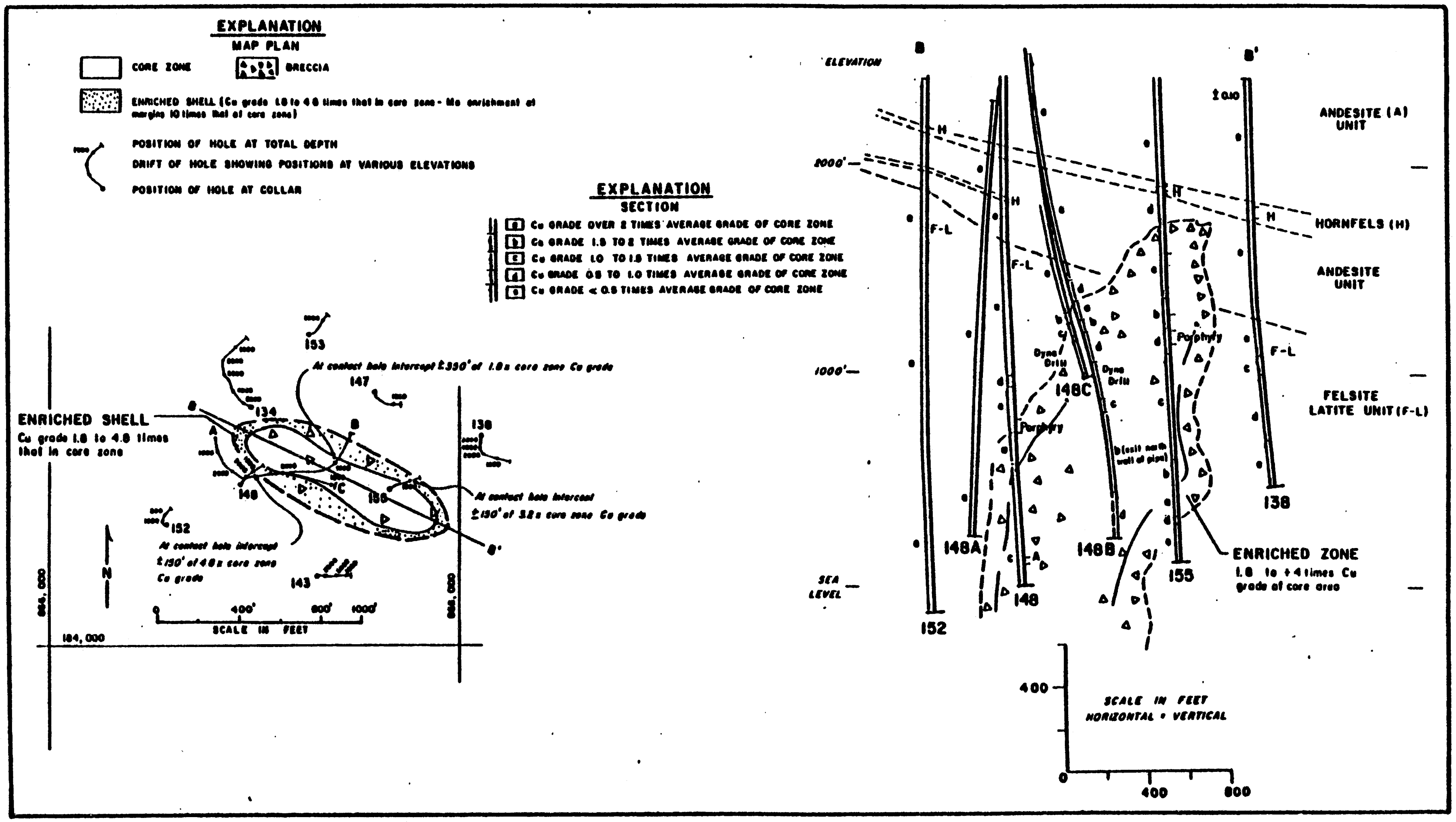

Fig. 12. Plan map and diagramatic cross section, looking northeasterly 148–155 breccia pipe at Red Mountain, Arizona.

L. CLARK ARNOLD
CONSULTING GEOLOGIST Ariz. Reg. #8883

August 3, 1989

Mr. J. David Lowell
Route 3 Box 197
Nogales, AZ 85621

Dear Dave,

I made a trip last week to the Cottonwood Canyon area east southeast of Florence Junction where John Kinnison's phantom water well is supposedly located. John had done a good bit of research on the location which I checked very carefully and I feel confident that the area investigated is correct.

I searched both north and south of Cottonwood Canyon and although I found a well developed mineral cluster which includes quite a number of mineralized pits, cuts, adits, etc., I saw only one "shaft" at the end of a road of about the right vintage. A bank composed of soil has collapsed, closing the shaft, but one timber still protrudes. The associated dump has been largely removed by erosion in a wash in which it was placed so estimation of the amount of material is impossible. No well casings were found but the area is sufficiently disturbed that they could have been concealed.

The shaft was sunk on a north-south shear zone in Pinal schist which is strongly iron stained, carrying green copper oxides and hematite after sulfides, probably at least in part chalcocite. The mineral cluster has a strong north-south or N20W trend. The shaft is located within 50 feet of the edge of alluvial cover but is actually in schist outcrop showing no recognizable pervasive alteration. I had hoped of course that it would prove to be in an area of extensive alluvial cover and as such constitute a scout drilling target.

In scouting the area I found a single air rotary drill hole probably drilled three to five years ago and probably to a depth of several hundred feet, according to my gravity-sonic depth measuring technique. Drill cuttings suggest that it bottomed in unmineralized schist. The hole location is shown on the sketch map.

Upon returning to Tucson, I checked our pediment gravity map which Bob and Gordon produced and found a small pediment area located in the area shown on my sketch. The drill hole nearly a mile from the edge of cover tends to confirm the gravity interpretation. I also checked my BLM microfiche and found that the area was staked in 1983 by Renaissance Resources. The claims lapsed in 1987 and part of the area was located by Julius Nelson and Don Fry who currently hold is under BLM Lead File #266547.

3131 North Country Club Rd. Suite 110 602/326-2700 Tucson, Arizona 85716