CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
1520 West Adams St.
Phoenix, AZ 85007
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

03/20/87

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES FILE DATA

PRIMARY NAME: TIRE

ALTERNATE NAMES: TIKY

YAVAPAI COUNTY MILS NUMBER: 1369

LOCATION: TOWNSHIP 15 N RANGE 4 W SECTION 6 QUARTER S2
LATITUDE: N 34DEG 45MIN SEC LONGITUDE: W 112DEG 37MIN SEC
TOPO MAP NAME: MOUNT JOSH - 7.5 MIN

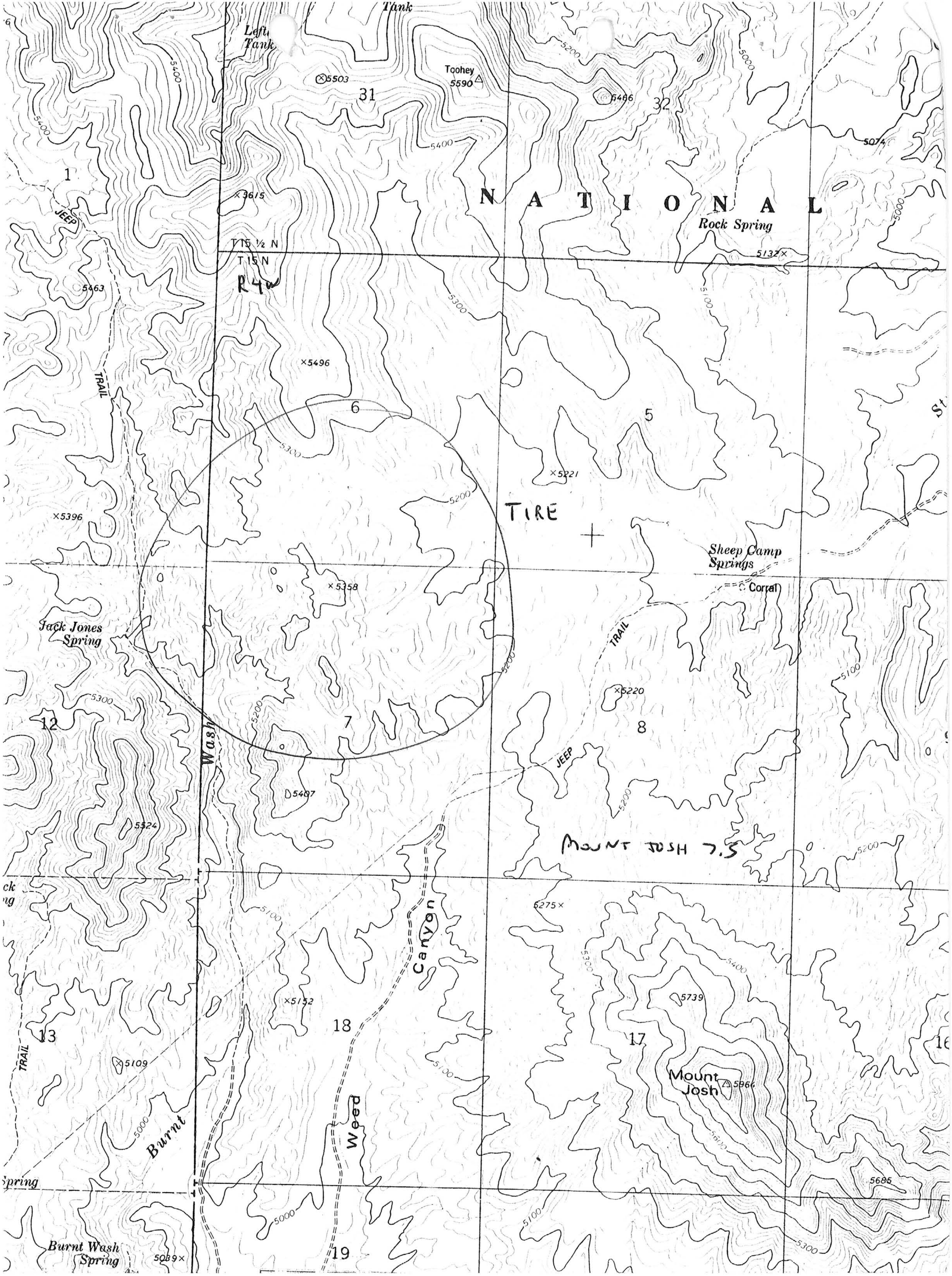
CURRENT STATUS: EXP PROSPECT

COMMODITY:

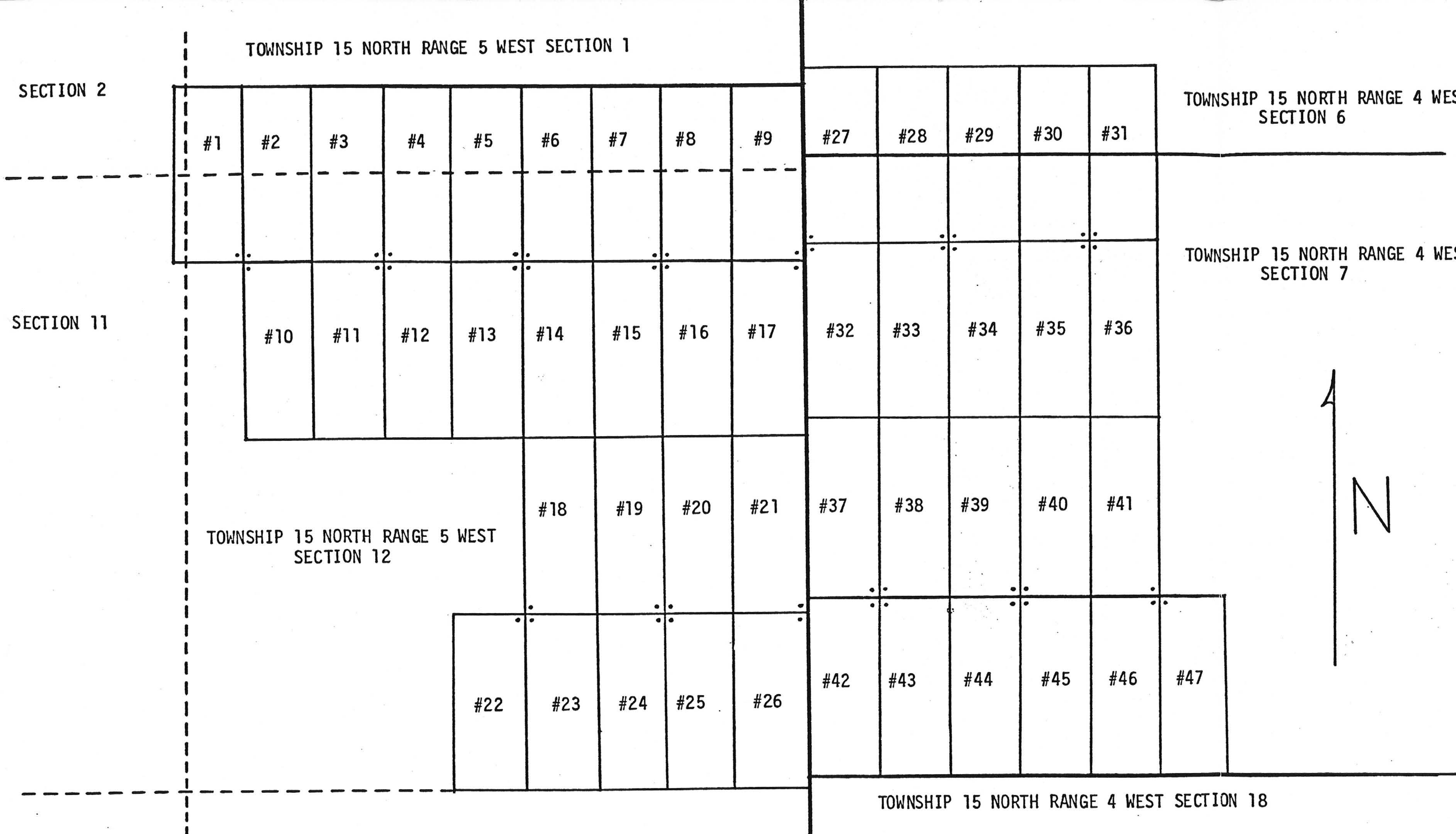
KYANITE	KYANITE
TITANIUM	ILMENITE
RARE EARTH	YITRIUM

BIBLIOGRAPHY:

ADMMR TIRE FILE
CLAIMS ALSO EXTEND INTO SEC 7, N2
MINERAL MUSEUM SPECIMEN MM-L542-3

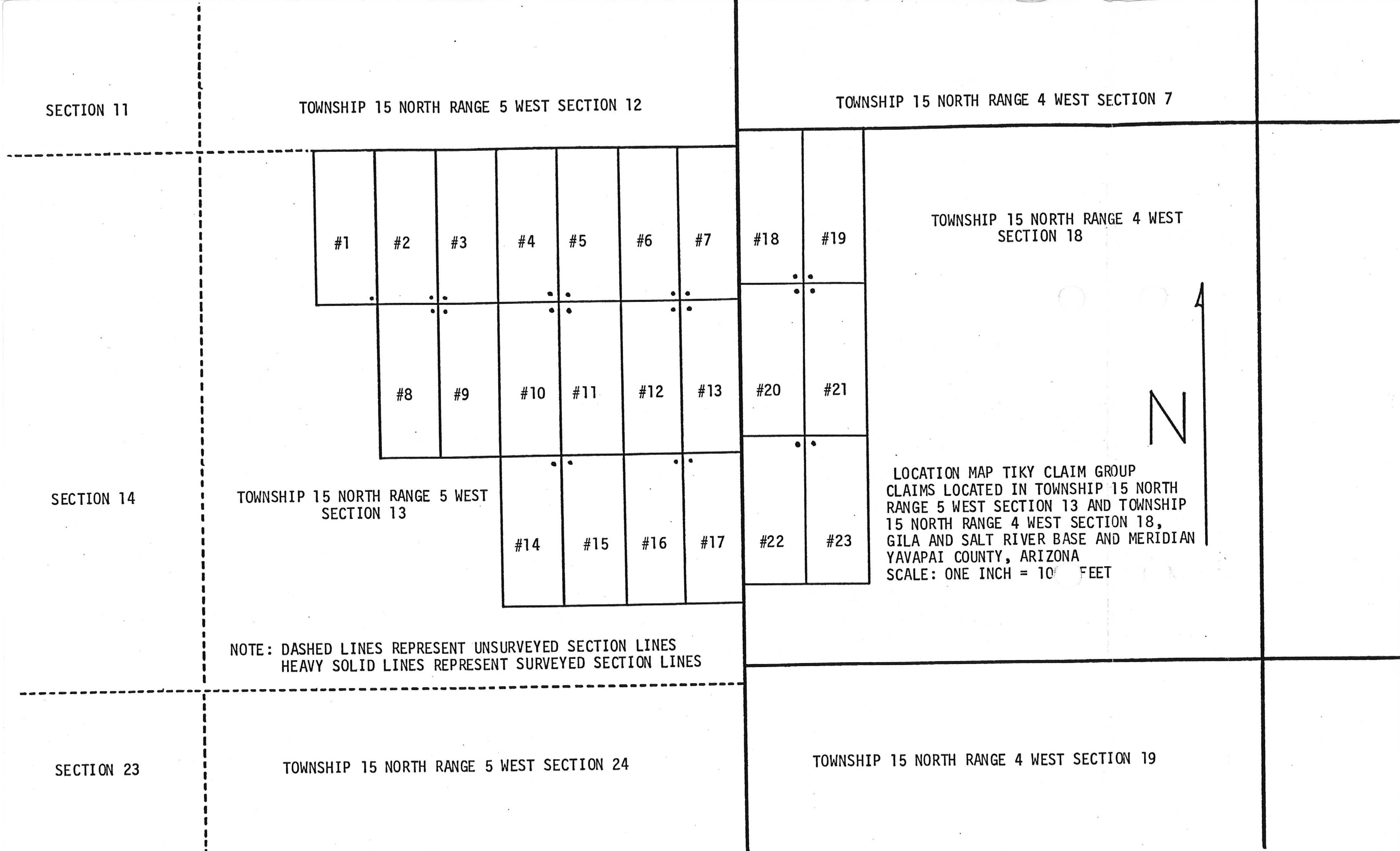


Tank
Left Tank
5503
31
Toohey
5590
5466
32
5074
5400
1
JEEP
3615
N A T I O N A L
Rock Spring
5132
T15 ½ N
T15N
R4W
5463
5300
5496
TRAIL
6
5
5221
5200
TIRE
5396
Sheep Camp Springs
Corral
5358
Jack Jones Spring
TRAIL
5220
5300
12
7
8
Wash
JEEP
5407
5324
5200
MOUNT JOSH 7.5
5275
5100
Canyon
5300
5400
5739
5152
13
18
17
16
TRAIL
5109
Mount Josh
5966
Weed
5000
Burnt
Spring
5685
5000
5100
Burnt Wash Spring
5039
19
5300



LOCATION MAP***TIRE CLAIM GROUP***TOWNSHIP 15 NORTH RANGE 5 WEST SECTIONS 1,2,11,and 12***TOWNSHIP 15 NORTH RANGE 4 WEST SECTIONS 6 and 7.*** YAVAPAI COUNTY, ARIZONA*SCALE: ONE INCH = 1000 FEET

NOTE: DASHED LINES REPRESENT UNSURVEYED SECTION LINES
HEAVY SOLID LINES REPRESENT SURVEYED SECTION LINES


SECTION 11
TOWNSHIP 15 NORTH RANGE 5 WEST SECTION 12
TOWNSHIP 15 NORTH RANGE 4 WEST SECTION 7
#1
#2
#3
#4
#5
#6
#7
#18
#19
TOWNSHIP 15 NORTH RANGE 4 WEST SECTION 18
#8
#9
#10
#11
#12
#13
#20
#21
N
LOCATION MAP TIKY CLAIM GROUP
CLAIMS LOCATED IN TOWNSHIP 15 NORTH RANGE 5 WEST SECTION 13 AND TOWNSHIP 15 NORTH RANGE 4 WEST SECTION 18, GILA AND SALT RIVER BASE AND MERIDIAN
YAVAPAI COUNTY, ARIZONA
SCALE: ONE INCH = 10 FEET
SECTION 14
TOWNSHIP 15 NORTH RANGE 5 WEST SECTION 13
#14
#15
#16
#17
#22
#23
NOTE: DASHED LINES REPRESENT UNSURVEYED SECTION LINES
HEAVY SOLID LINES REPRESENT SURVEYED SECTION LINES
SECTION 23
TOWNSHIP 15 NORTH RANGE 5 WEST SECTION 24
TOWNSHIP 15 NORTH RANGE 4 WEST SECTION 19

United States Department of Agriculture | Forest Service | Bradshaw Ranger District | 2230 East Highway 69 Prescott, AZ 86301

Tire (file) YAVAPAI Co.

Reply To: 2810

Date: June 1, 1993

Dear Concerned Citizen:

The Bradshaw Ranger District has received (3) Plans of Operation for the following projects:

(1) The proposed STOCKS Project is located at the Climax Mine, which is 4 miles east of Wilhoit. The legal description for the proposal is Section 1, Township 12 North, Range 3 West.

The first stage of the proposal calls for the sampling of a 50,000 ton ore dump located adjacent to the mine. Sampling will be done off-site and the disturbed area will be reclaimed before beginning the next stage.

Stage 2 calls for opening and expanding the existing Climax Mine portal. Approximately 3,000 tons of waste will be removed to make the portal safe and to develop underground loading stations. The proponent hopes to remove another 50,000 tons of material from underground workings. The material will be stockpiled near the portal entrance and then removed from the site. Access in to the project is via existing roadways, although some maintenance will be necessary to insure safety. As part of the approval for this project, the proponent will be required to post a reclamation bond sufficient for rehabilitation of all disturbed areas.

(2) The proposed YAHN Project is adjacent to the Hassayampa River, 2 miles southwest of Groom Creek. The legal description for the proposal is Sections 26 & 35, Township 12 1/2 North, Range 2 West.

The proposal calls for excavating and processing materials dug from 3 trenches approximately 300 feet long, 50 feet wide and 10 feet deep. The material will be run through a grizzly, vibrating shaker screen, washed and sluiced and fed back into the trenches. Only one trench at a time will be open and reclamation will be on-going. The initial water source will be the Hassayampa River, however, water will be stored and utilized from 15,000 gallon holding pond, that is currently in place. A 5,000 gallon settling pond will be constructed to catch and filter wash water before it is allowed to return to the river. There will be no blockage or diversion of the river. The settling pond and excavations will be a sufficient distance from the river to avoid disturbance and pollution. Access in to the project will be via existing roadways. As a part of the approval of this project, the proponent will be required to post a reclamation bond sufficient for rehabilitation of all disturbed areas.

See next page

(3) The proposed POLEY Project is about seven miles north/northwest of Skull Valley and two miles southeast of Rancho Moano. The legal description for the proposed operation is Sections 12 & 13, T15N, R5W and Section 7, T15N, R4W.

The proposal calls for the excavation of ten 15' by 15' by 3' sample trenches and the construction of approximately one quarter mile of access road. Equipment to be used in the proposed operation includes a backhoe and 4WD pickup trucks. The proposed operation is in chaparral vegetation; total disturbance for the proposal is estimated at approximately one quarter acre. As a part of the approval of this project, the proponent will be required to post a reclamation bond sufficient for rehabilitation of all disturbed areas.

Initial concerns identified with these projects include the need to minimize soil erosion and impact on wildlife, and the preservation of timber and other vegetation, and cultural resources. Biological Evaluations including evaluation of the effect on spotted owl habitat and cultural inventories will be completed prior to approval of the proposals, and all other issues and concerns will be mitigated through the Appended Conditions to each Operating Plan approval.

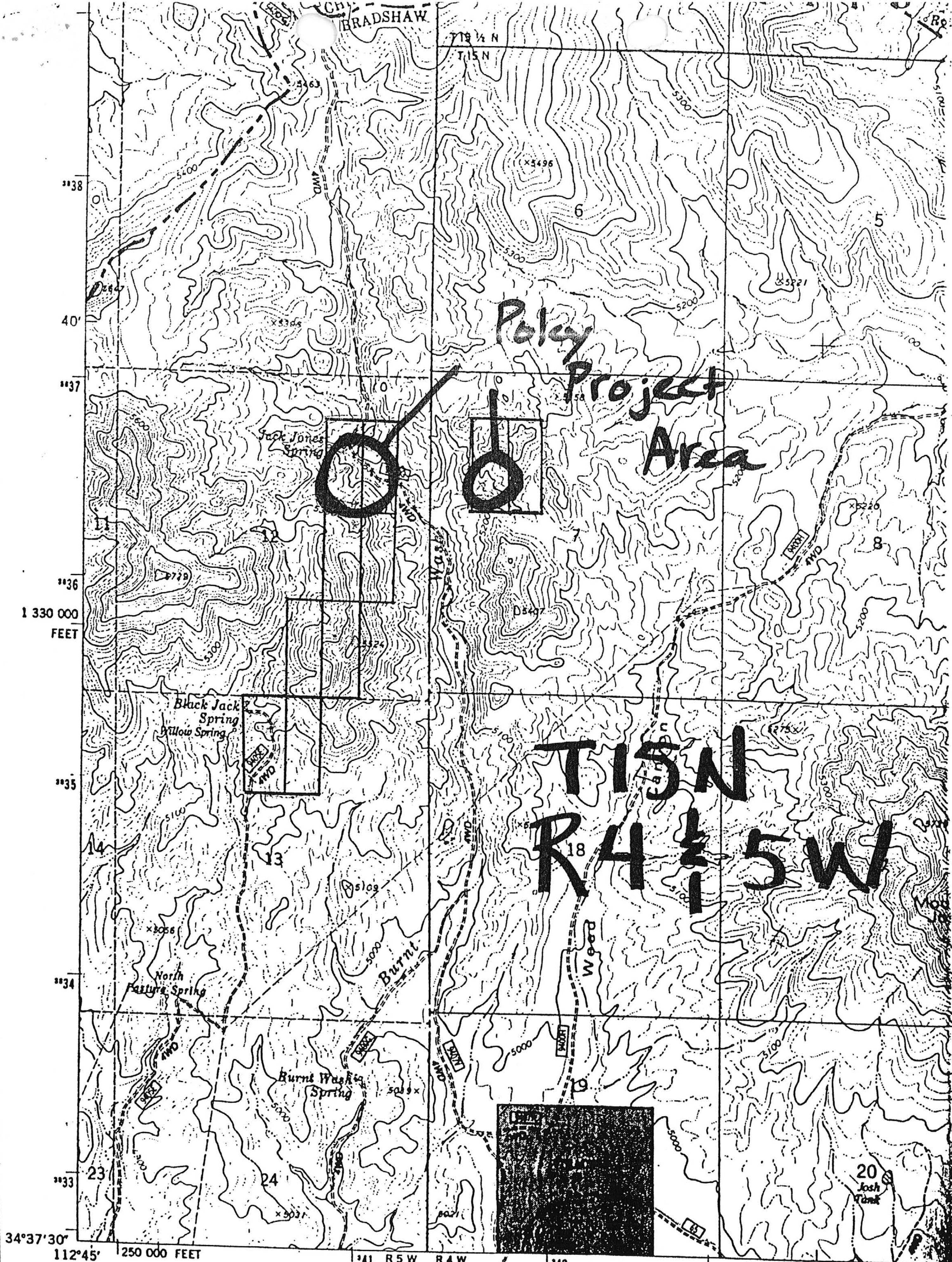
If you have any additional concerns or comments for Projects 1 or 2 direct them to Doug Franch. Concerns or comments for Project 3 should be directed to Beverly Morgan and all comments and concerns must be received by June 14, 1993. Copies of these proposals are available at the Bradshaw Ranger Station, 445-7253.

Sincerely,

John W. Holt

JOHN W. HOLT
District Ranger

Enclosures



Base map prepared by the U.S. Geological Survey

VIS9.13

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

FIELD VISIT

1. **Information from:** Bob Poley, dba Sweetwater Minerals

2. **Address:** 2020 Rockford Dr., Prescott, Az 86201

3. **Phone:** ~~(602)~~ 928 445-0356

4. **Mine or property name:** TIRE Group TIKY Group
5. **ADMMR Mine file:** TIRE Group

6. **County:** Yavapai

7. **MILS number:** 1369

8. **Operational Status:** Active Prospect, Process Development, Market Study

9. **Summary of information received, comments, etc.:**

I spent a day in the field reviewing the geology of the Lode and Placer TIRE Group. The claimant has been conducting geologic mapping both regional and detailed, making radiometric surveys, collecting and selling mineral and lapidary speciments, collecting 100's of stream sediment samples to define the ultimate claim area. More recent work is directed towards determining mineralogy and rare earth content in greater detail. He is also developing a recovery process for the placer material to produce 3 basic products - 1. Kyanite, 2. Monazite and Xenotime, and 3. Magnetite/Ilmenite. Mr. Poley is interested in any development or lease agreements. Attachments detailing the property's geology, mineralogy, rare earth content, and mining claims are courtesy of Mr. Poley. Especially intriguing are the Lu, Eu, and Y contents compared to the Mountain Pass deposit in California.

Date: 4-11-90 NJN Nyal J. Niemuth

TIRE YAVAPAI COUNTY

NJN WR 4/19/85: Bob Poley visited with samples from an ilmenite and Kyanite prospect in Yavapai County. He donated two specimens to the Museum - MM-L542 and L543. The specimens were a kyanite crystal cluster and ilmenite crystals in quartz. Mr. Poley plans to investigate company interest of the kyanite and ilmenite as they occur in a wide schistose zone (up to 160 yd) with dikes. If interest warrents, he will acquire mineral rights and divulge the prospects locality.

NJN WR 6/14/85: Robert Poley (c) reported that concentrates from his ilmenite prospect run up to 3% yttrium and minor amounts of some of the other rare earths.

NJN WR 1/9/87: Bob Poley (c) visited and reported that he continues to prepare ilmenite and kyanite concentrates from his Tire (new file) property in Yavapai County.

PROPERTY SUBMITTAL

Robert Poley Jr.
2020 Rockford Dr.
Prescott, Ariz. 86301
(602) 445-0356

July 20, 1989

Dear Sirs:

Enclosed is a breif summary and prelimenary report of an unusual mineral deposit located in Northcentral Arizona 20 miles west of Prescott, Arizona. I would like to lease or sell the claim groups which show to be very promising upon prelimenary evaluation.

Subsequent examination of the region and interpretation of geochemical analysis results has resulted in a more defined interpretation of the mineralizing system present on the claim groups. The system appears to be a tin greisen system with associated tungsten and molybdenum mineralization. The kyanite-rare earth-yttrium-tin-titanium-magnetite-zirconium disseminated zone could be related to late stage fluids derived from the above mentioned system by pervasively mineralizing a large block of schist which was spatially or chemically receptive to the mineralizing fluids.

Please return the prelimenary report if you have no interest in the property. Copies of all Location Notices and Assessment Affadavits can be reviewed in Prescott, Arizona.
Please contact me if I might be able to provide any additional information or to schedule a field tour. Additional information is being collected and will be forwarded when complete.

Sincerely,

Robert Poley Jr.

Robert Poley Jr.

Preliminary Geologic Investigation of the Tire-Tiky Lode Claim Groups Yavapai County, Arizona

by Robert Poley Jr.

Minerals Consultant

Introduction

The Tire-Tiky Lode claim group lies within Central Yavapai County between the Santa Maria Mountains and the Bradshaw Mountains. The area is within the Mountain Region, which lies between the Colorado Plateau to the northeast and the Desert Section of the Basin and Range Province to the southwest.

The oldest rocks within the region consist of the Yavapai Series which are 1.82-1.775 b.y. old and consist of some 40,000 feet of mafic to felsic submarine volcanics and clastic sediments. This greenstone belt has been folded, metamorphosed and intruded by granites 1.76-1.63 b.y.B.P. There is no record of sedimentary deposition or igneous activity in this area until the Laramide orogeny at which time small granodiorite plutons were intruded regionally into the Precambrian schist and granite. During the Late Tertiary (20-9 m.y.B.P.) basalt flows were erupted, and to the south Basin and Range faulting became important. During the last 9 m.y. volcanism and tectonism subsided and the dominant geologic processess have been erosion and deposition of alluvium.

The Tire-Tiky claim group lies within Central Yavapai County approximately 20 miles west of Prescott, Arizona. Widespread disseminated Kyanite-Ilmenite-Monazite-Xenotime-Magnetite mineralization occurs in appreciable enough amounts to warrant further exploration of the claim group to assure that an ore deposit exists. Examination of the property has been conducted by Robert Poley Jr., Minerals Consultant.

The economic minerals present on the Tire-Tiky claim group are ilmenite and other titanium minerals (leucoxene and rutile). Kyanite and sillimanite are Al_2O_3 compounds which are used in the manufacture of ceramics and refractories. Mines in Georgia and Virginia must ship across the country to users in southern California and the Western United States.

Monazite and xenotime minerals are present over extensive areas of the claim group. These minerals contain large amounts of rare earth elements and yttrium which are being used in a number of new and expanding technological fields including the super conductors and high strenght magnets. Rare earths are currently used in petroleum catalysts, metallurgical uses, ceramics and glass, phosphors, electronics, magnets, lighting and research.

Several rare earth elements found on the property have very high unit value. The primary processors for rare earths and scandium are located in Phoenix, Arizona, about 100 miles south of the claim group.

Purpose and Methodology

The primary objective of exploration and evaluation of the mineral deposits on the Tire-Tiky claim groups is to delinate the extent of mineralization, determine all the minerals and metals associated with the mineralization, and to determine the economic potential of the minerals of the deposit on a preliminary basis.

The goal is to obtain the necessary data for estimating the grade, tonnage, and market potential for all prospective mineral commodities of the Tire-Tiky claim groups. Future evaluation of the property should be geared toward gathering useful data for completing the principal objective. The report outlines recommendations for subsequent steps in the evaluation of the property and its commodities.

The purpose of the present study is to assess the potential for an economic mineral deposit within the Tire-Tiky claim groups. This assessment has been carried out by reconnaissance, prelimenary geologic mapping and sampling of the region, through literature study of the geology, structure, and economic geology of the area. A literature study of the geology of titanium, kyanite, monazite, xenotime, and rare earths was conducted. Consideration of the regional paleogeographic, plate tectonic and metallogenic setting of the region within the southern Cordillera.

The compilation of pertinent geologic data and commodity information was undertaken to aid in further investigation and development of the mineralized zones on the Tire-Tiky claim groups.

Location and Accessibility

The Tire-Tiky claim groups are situated in northcentral Arizona in the central part of Yavapai County, 20 miles west of Prescott, Arizona (Fig. 1). The property can be reached by driving 16 miles westerly from Prescott on Iron springs Road, 3.7 miles northerly on USFS Road #102 (Tonto Road) and 3.0 miles northwesterly on USFS Road #65 (Tank Creek Mesa) to the property. The area is approximately 10 miles north-northwest of Skull Valley, Arizona, a small ranching community and rail station on the Santa Fe Railroad (See Appendix A for detailed road log to property).

The area occupies the southwest portion of the Mount Josh Quadrangle (1979), the northwest portion of the Skull Valley Quadrangle (1979), the northeast portion of the Martin Mountain Quadrangle (1986), and the southeast portion of the Smith Mesa Quadrangle (1986) which are all 7.5 minute topographic maps printed by the U.S. Geological Survey.

An operating rail line owned by the Santa Fe Railroad is located 5 miles to the east of the property. A suitable location for a spur and stockpile exists about 6 miles southeast of the property with good roads and access. High voltage lines which carry electricity to the Bagdad open pit copper mine pass within 1 mile of the southern boundary of the claim groups.

Numerous springs dot the area (Fig. 1) and ranches in the region grow alfalfa and winter wheat as well as maintain permanent pastures.

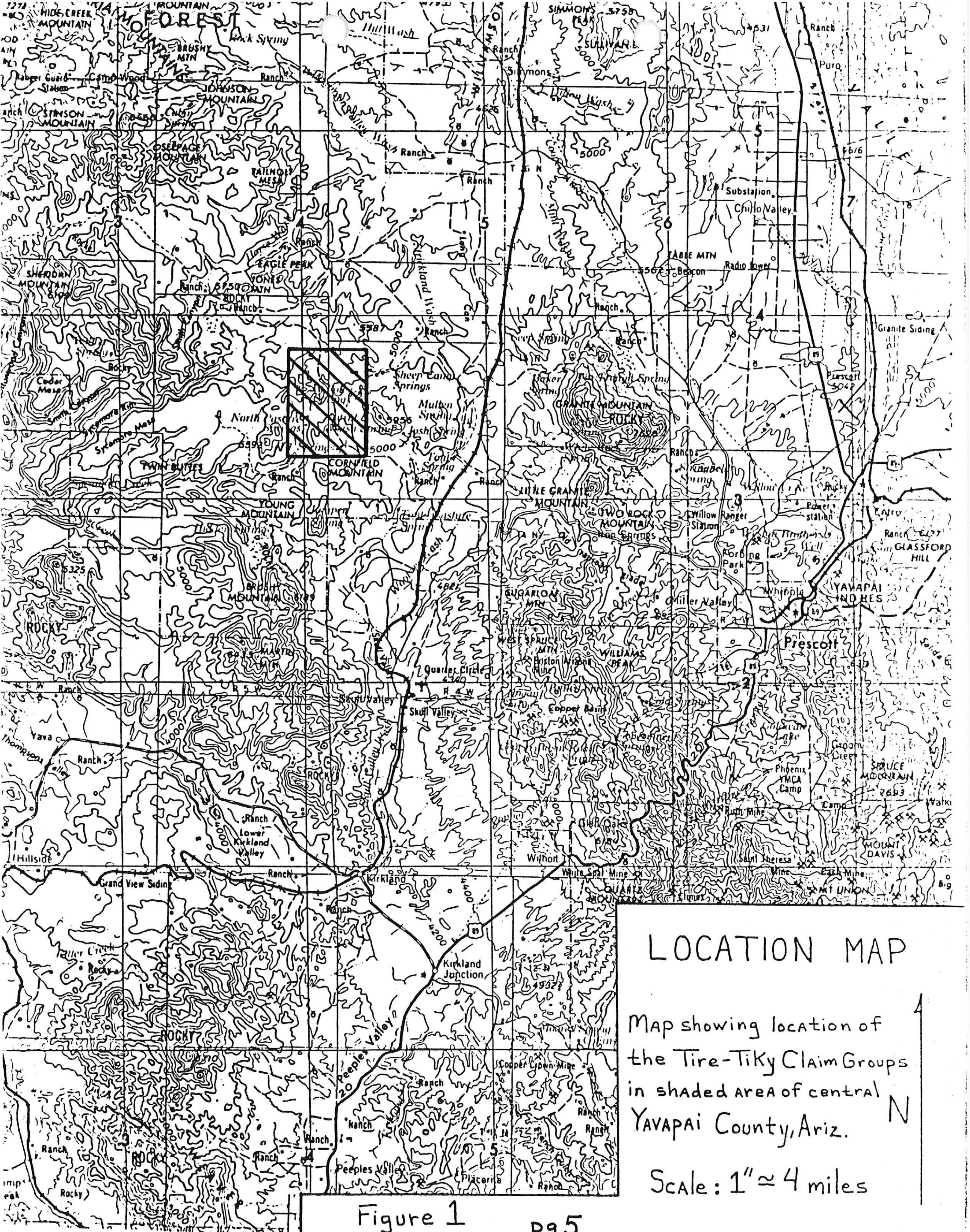

LOCATION MAP
Map showing location of the Tire-Tiky Claim Groups in shaded area of central Yavapai County, Ariz.
N
Scale: 1" ≃ 4 miles
Sheep Camp Springs
CORNFIELD MOUNTAIN
North Pasture
Kirkland Wash
GRANITE MOUNTAIN
LITTLE GRANITE MOUNTAIN
TWO ROCK MOUNTAIN
YOUNG MOUNTAIN
TWIN BUTTES
Skull Valley
Quarter Circle
Kirkland
Kirkland Junction
Peeples Valley
Lower Kirkland Valley
Grand View Siding
Prescott
Whipple
Miller Valley
GLASSFORD HILL
YAVAPAI IND RES
Willow Ranger Station
Chino Valley
Substation
TABLE MTN
SPRUCE MOUNTAIN
MOUNT DAVIS
Copper Basin
Hillside
Yava
Placerita
Wilhoit

Figure 1

Physical Features and Climate

The area that encompasses the Tire-Tiky claim group lies within Central Yavapai County approximately 20 miles west of Prescott, Arizona. The area lies within the Mountain Region, which lies between the Colorado Plateau to the north and the Desert Section of the Basin and Range Province to the south.

The Tire-Tiky claims are located in a region of moderate relief. The highest part of the property has a altitude of 5,400 feet, and the lowest outcrops are at an altitude of about 4,900 feet. Water for operations may be obtained from several springs on the claim groups. Additional water may be obtained from springs and groundwater just south and north of the properties.

The climate of the region is moderate year-round. Access is restricted only by infrequent winter storms. Access to different areas on the property is accomplished by several established dirt roads, generally accessable by 4 WD year-round. The region lies within the transition zone of Arizona, a region typified by diverse vegetation and terraine. Vegetation in the area consists of chapparel, juniper, manzanita, catclaw minosa, pinyon, prickly pear and emory oak.

The U.S. Forest Service conducted controled burns of thick chapparel-manzanita brush on and around the claim group during the summer of 1987.

Road Log to Tire-Tiky Claim Group

Starting from the five point intersection (intersection of Iron Springs Road and Willow Creek Road) in Prescott, Arizona. Proceed out Iron Springs Road 12.6 miles. Turn right on Tonto Road, a well maintained all weather dirt road (maintained by the county) U.S. Forest Service Road #102 .

Proceed 3.2 miles on Tonto Road to the intersection of Tonto Road and U.S.F.S. Road #65. Turn left on U.S.F.S. Road #65 (same as Z3 Ranch Road). Proceed 3.5 miles to Tank Creek Mesa Road/Sycamore Mesa Road intersection, turn right toward (north) on Road #65 and proceed 1.7 miles to the intersection of U.S.F.S. Road #65 and Private Road. Turn left. Road still #65. Proceed 0.7 miles to well traveled dirt road on right hand side of road. Turn right on dirt road. Proceed 0.6 miles to windmill and tank. Turn left after stock tank on left, but before windmill and steel tank. Continue along the most traveled dirt road to a group of several large juniper trees and old campfire pits on the left. Turn on the faint road on the left and travel approximately 100 yards to where the road dead ends at a large juniper tree along Burnt Wash sandwash. Park here.

History of Mining Activity

No records of mineralization or mining claim location have been located to date. The region lies in an area of minimal past geologic investigation, no recorded mining claim location, and no mineral production. The area is not in any known mining district. No other claims to date have been located and recorded in the area that the Tire-Tiky Lode Claims are located in.

Several small pits have been found on the property and in the surrounding area. They are located on small generally east-west trending narrow discontinuous quartz veins which display copper oxide and copper sulfide mineralizaiton. Chalcopyrite, pyrite, limonite, hematite, malachite and azurite are the primary and secondary mineralization. Glass ware and old metal around several of the diggings suggest the excavations occured during the Depression (early 1930's).

Previous Work

The mining districts of Yavapai County have had a moderate amount of published literature but generally those regions outside areas of prior economic interest are poorly lacking in study. Reports on the Bagdad porphyry copper deposit are numerous, Anderson, D.A., Scholz, E.A., and Strobell, J.D. Jr., 1955 and others. See References. The Bruce and Dick lead-zinc-copper massive sulfide system just southwest of Bagdad has been studied by Anderson, C.A. 1950 and Baker, A. and Clayton 1968. Bagdad is located 25 miles west of the claim groups. The U.S. Geological Survey reported on the geology and economic mineral deposits of the Prescott and Paulden Quadrangles, Kreiger (1965). The area encompassing the Tire-Tiky claim groups was regionally mapped on a scale of 1:62,500 by the U.S. Geological Survey while studying the settings of regional massive sulfide deposits, Kreiger, M.H. 1967.

Numerous small to medium greisen type tungsten deposites occur around Bagdad and to the north east of Bagdad. Black Pearl and Tungstonia are the most notable, Dale, V.B., 1961. A northeast trending tungsten anomaly appears to exist. The Coppers Basin porphyry copper deposit occurs 15 miles to the southeast of the claim groups. Gambell, N.A., 1973; Johnston, W.P., 1955; Johnston, W.P., and Lowell, J.D., 1961.

The area around Copper-Basin contains numerous gold-silver vein type deposits, placer gold deposits and lead-zinc veins.

Known Rare-Earth occurences crop out about 50 miles northwest of the claim group in the Aquarius Mountains near Wickiup, Arizona in pegmatite zones (Heinrich, W.E. 1960). The rare earth minerals chevkinite, smarskite, allanite, gadolinite, fergusonite, yttrotantalite, monazite and xenotime occur in the pegmatite zones.

Property and Ownership

The property consists of about 1480 acres of land with original mineral rights held by the United States Government. The property lies in the Prescott National Forest under the jurisdiction of the USFS Prescott Regional Office, Bradshaw Mountain Ranger District.

The Tire-Tiky claims lie in sections 6, 7, and 18 of Township 15 North, Range 4 West, and sections 1, 11, 12, 13 and 14 of Township 15 North, Range 5 West, Gila and Salt River Base and Meridian, Yavapai County, Arizona. The owner of the deposit is Robert Poley Jr., 2020 Rockford Drive, Prescott, Arizona, 86301.

The Tire Lode Claim Group consists of 47 lode claims located in April of 1986. Assessment work completed on the Tire claims for the 1987 assessment year consisted of excavation and removal of ore from numerous sites throughout the contigous claim group for testing and analysis. Work and improvements also consisted of road maintainance and improvement, construction of roads and access-ways to excavation sites. The layout of a rectangular grid was undertaken in order to simplify and increase accuracy of geological and geophysical surveys planned for 1988.

An Assessment Affadavit was filed for work completed on the Tire Lode Claims during the 1987 Assessment year in Yavapai County Courthouse and with the Bureau of land Management. The Tiky claim group consists of 27 lode claims located in

December 1986. The Tiky claims are contigous with the southern boundary of the Tire group and extend to the south.

Claim name, number, book and page in the Yavapai County Recorders Office and Bureau of Land Management AMC numbers are as follows:

EXHIBIT A

The following unpatented mining claims which are located in sections: 1, 2, 11 and 12 Township 15 North, Range 5 West, and sections 6 and 7 Township 15 North, Range 4 West, Gila and Salt River Base and Meridian, in an unnamed Mining District, Yavapai County, State of Arizona; all which are recorded in the Office of the County Recorder of said county, the book and pages along with the BLM serial numbers are as follows:

Claim Name	Yavapai County Recorders Office Book	Page	BLM Serial Number AMC Number
TIRE #1	1833	81	258166
TIRE #2	1833	82	258167
TIRE #3	1833	83	258168
TIRE #4	1833	84	258169
TIRE #5	1833	85	258170
TIRE #6	1833	86	258171
TIRE #7	1833	87	258172
TIRE #8	1833	88	258173
TIRE #9	1833	89	258174
TIRE #10	1833	90	258175
TIRE #11	1833	91	258176
TIRE #12	1833	92	258177
TIRE #13	1833	93	258178
TIRE #14	1833	94	258179
TIRE #15	1833	95	258180
TIRE #16	1833	96	258181
TIRE #17	1833	97	258182
TIRE #18	1833	98	258183
TIRE #19	1833	99	258184
TIRE #20	1833	100	258185
TIRE #21	1833	101	258186
TIRE #22	1833	102	258187
TIRE #23	1833	103	258188
TIRE #24	1833	104	258189

EXHIBIT A

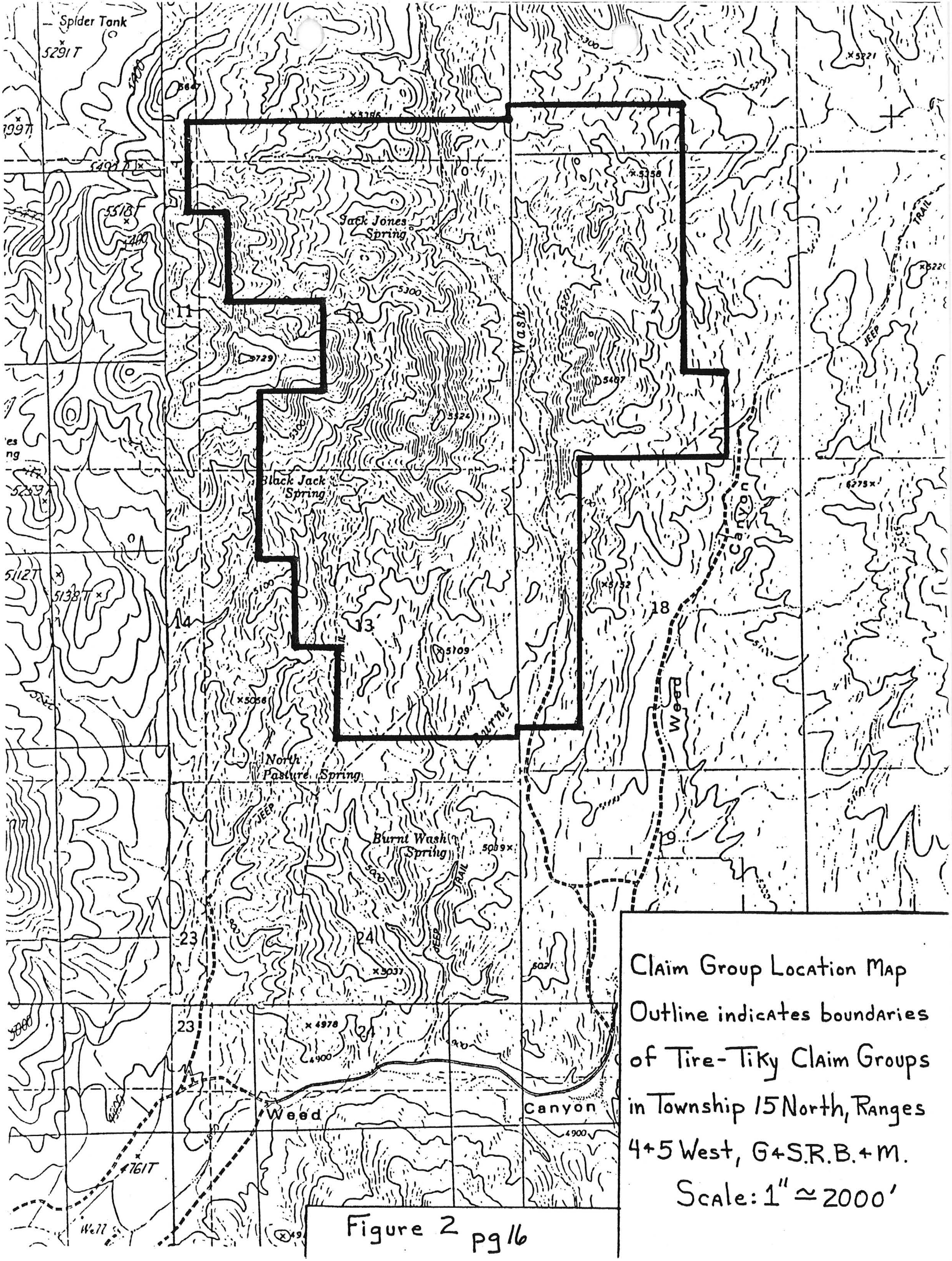
continued from previous page

Claim Name	Yavapai County Recorders Office Book	Page	BLM Serial Number AMC Number
TIRE #25	1833	105	258190
TIRE #26	1833	106	258191
TIRE #27	1833	107	258192
TIRE #28	1833	108	258193
TIRE #29	1833	109	258194
TIRE #30	1833	110	258195
TIRE #31	1833	111	258196
TIRE #32	1833	112	258197
TIRE #33	1833	113	258198
TIRE #34	1833	114	258199
TIRE #35	1833	115	258200
TIRE #36	1833	116	258201
TIRE #37	1833	117	258202
TIRE #38	1833	118	258203
TIRE #39	1833	119	258204
TIRE #40	1833	120	258205
TIRE #41	1833	121	258206
TIRE #42	1833	122	258207
TIRE #43	1833	123	258208
TIRE #44	1833	124	258209
TIRE #45	1833	125	258210
TIRE #46	1833	126	258211
TIRE #47	1833	127	258212

EXHIBIT A

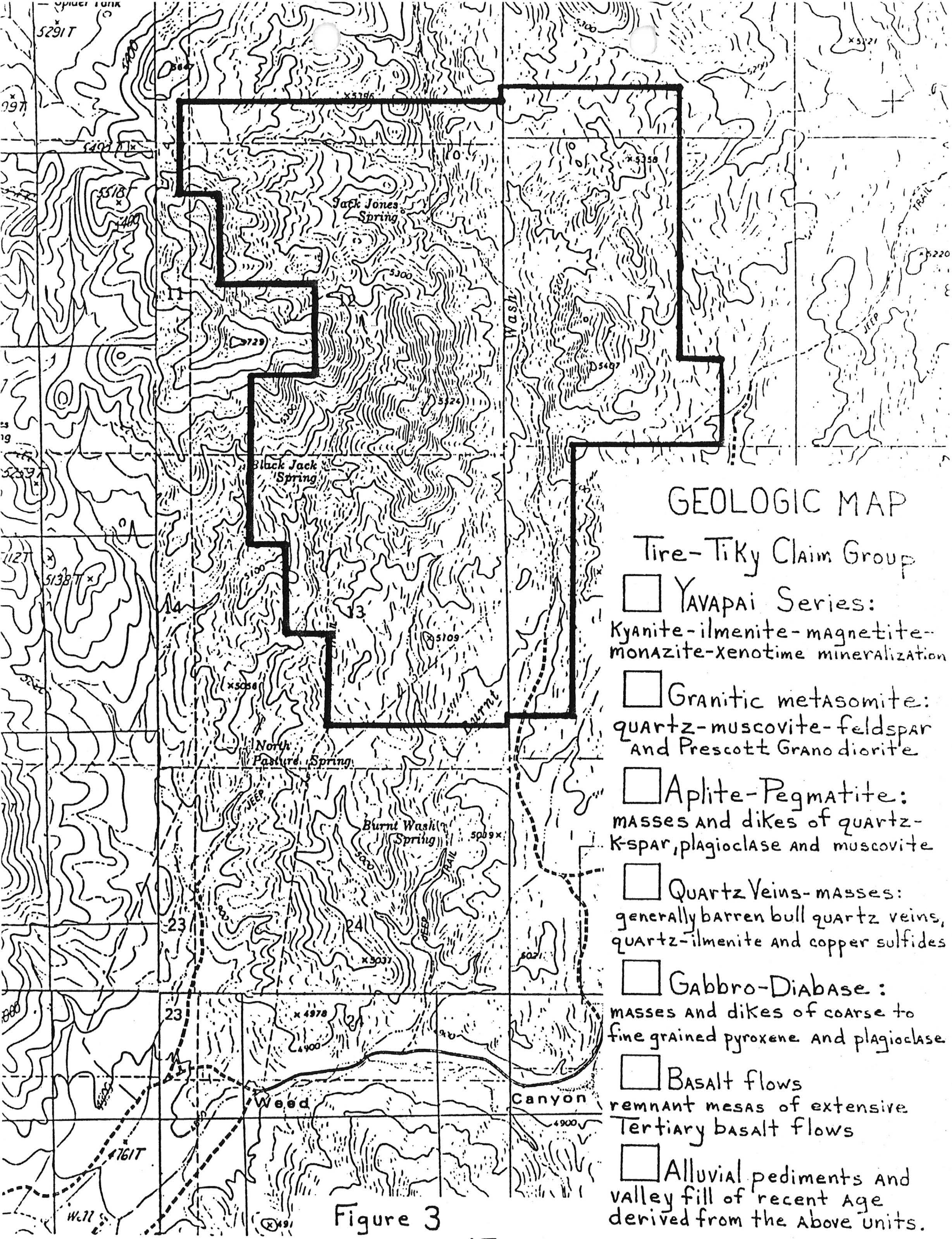
The following unpatented mining claims which are located in section 13 Township 15 North Range 5 West, and section 18 Township 15 North Range 4 West, Gila and Salt River Base and Meridian, in an unnamed Mining District, Yavapai County, State of Arizona; all which are recorded in the Office of the County Recorder of said county, the book and pages along with the BLM serial numbers are as follows:

Claim Name	Yavapai County Recorders Office Book	Page	BLM Serial Number AMC Number
TIKY #1	1906	976	265400
TIKY #2	1906	977	265401
TIKY #3	1906	978	265402
TIKY #4	1906	979	265403
TIKY #5	1906	980	265404
TIKY #6	1906	981	265405
TIKY #7	1906	982	265406
TIKY #8	1906	983	265407
TIKY #9	1906	984	265408
TIKY #10	1906	985	265409
TIKY #11	1906	986	265410
TIKY #12	1906	987	265411
TIKY #13	1906	988	265412
TIKY #14	1906	989	265413
TIKY #15	1906	990	265414
TIKY #16	1906	991	265415
TIKY #17	1906	992	265416
TIKY #18	1906	993	265417
TIKY #19	1906	994	265418
TIKY #20	1906	995	265419
TIKY #21	1906	996	265420
TIKY #22	1906	997	265421
TIKY #23	1906	998	265422



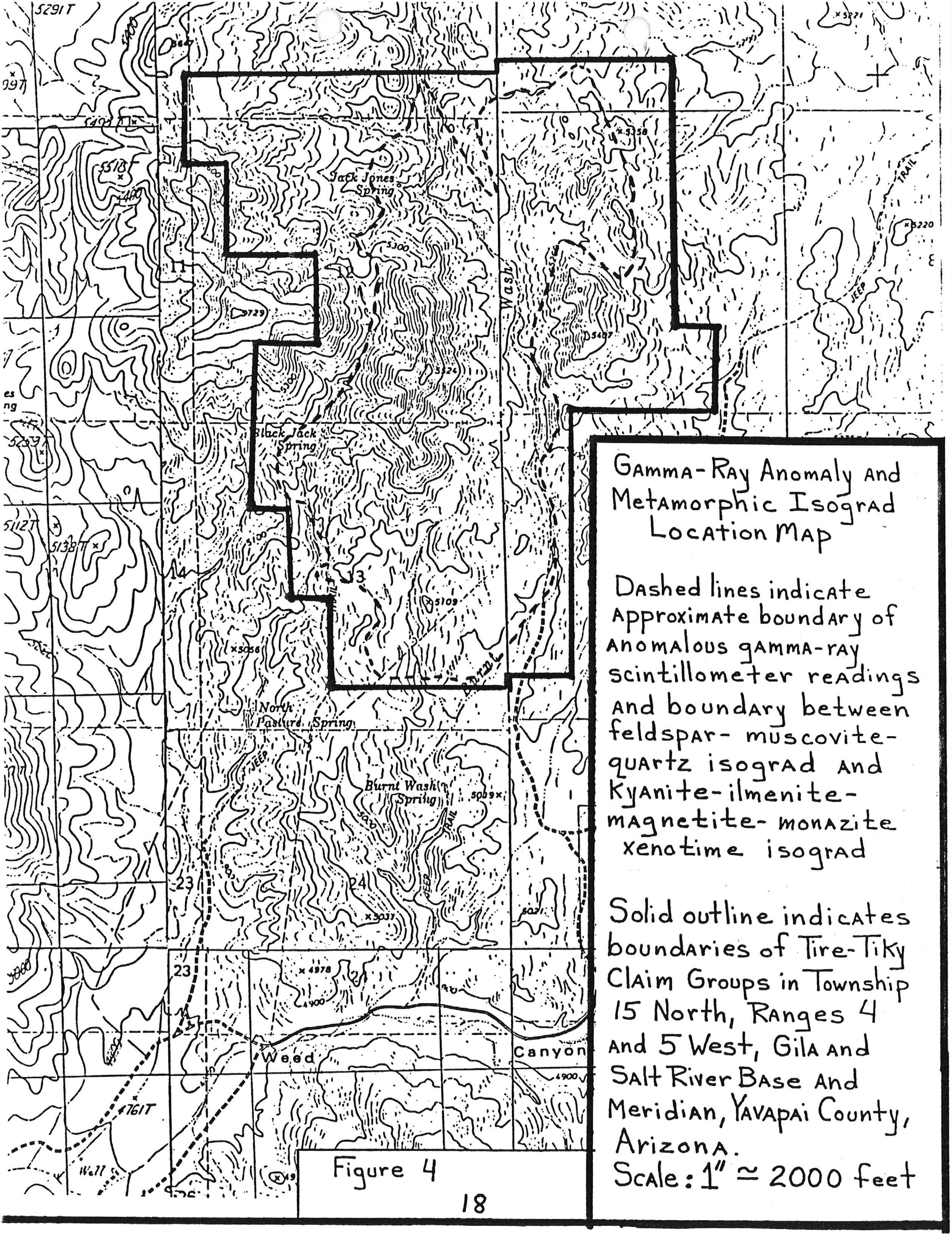
Claim Group Location Map
Outline indicates boundaries
of Tire-Tiky Claim Groups
in Township 15 North, Ranges
4+5 West, G+S.R.B.+M.
Scale: 1" ≃ 2000'

Figure 2 pg 16



GEOLOGIC MAP
Tire-TiKy Claim Group
Yavapai Series:
Kyanite-ilmenite-magnetite-monazite-xenotime mineralization
Granitic metasomite:
quartz-muscovite-feldspar and Prescott Granodiorite
Aplite-Pegmatite:
masses and dikes of quartz-K-spar, plagioclase and muscovite
Quartz Veins-masses:
generally barren bull quartz veins, quartz-ilmenite and copper sulfides
Gabbro-Diabase:
masses and dikes of coarse to fine grained pyroxene and plagioclase
Basalt flows
remnant mesas of extensive Tertiary basalt flows
Alluvial pediments and valley fill of recent age derived from the above units.
Jack Jones Spring
Black Jack Spring
North Pasture Spring
Burnt Wash Spring
Burnt
Wash
Weed
Canyon
JEEP
TRAIL
5291T
5518T
5138T
5729
5109
5056
5037
4978
5300
5100
4900
11
12
13
14
23
24
7

Figure 3



Gamma-Ray Anomaly and Metamorphic Isograd Location Map

Dashed lines indicate approximate boundary of anomalous gamma-ray scintillometer readings and boundary between feldspar-muscovite-quartz isograd and kyanite-ilmenite-magnetite-monazite xenotime isograd

Solid outline indicates boundaries of Tire-Tiky Claim Groups in Township 15 North, Ranges 4 and 5 West, Gila and Salt River Base and Meridian, Yavapai County, Arizona.

Scale: 1" ≃ 2000 feet

Figure 4

REGIONAL GEOLOGY

The Mountain Region of central Arizona is an area where the geology is transitional between the Colorado Plateau to the northeast and the Desert section of the Basin and Range Province to the southwest. In the Colorado Plateau area, little deformation has occurred since the Precambrian, and Paleozoic and Mesozoic sedimentary rocks are typically little deformed. To the southwest, the area has been affected by a mid-Mesozoic orogeny and magmatic arc; Laramide orogeny magmatic arc and metallogenic event; a mid-Tertiary orogeny, magmatic arc, metamorphic core complex emplacement and a metallogenic event; and a Basin and Range disturbance accompanied by basaltic and locally bimodal volcanism (Reynolds, 1980). The structure in this central part of Arizona is in general extremely complex.

The lithology and stratigraphy, structural geology and tectonics, and geologic history of the region are described in this section in order to facilitate the assessment of mineral potential within the region and specifically within the Tire-Tiky Lode Claim groups.

Rock Units

In the region rock units present include metamorphic and igneous Precambrian rocks, Paleozoic sedimentary rocks, Cretaceous intermediate and felsic intrusives, and Late-Tertiary tuffaceous and basaltic volcanics.

Older Precambrian Rocks

Older Precambrian rocks in Arizona crop out extensively along the northwest-trending Mountain Region which encompasses the area of study. They have been divided into three distinct northeast-trending belts. (Titley, 1982), which according to Anderson (1976) accreted onto the North American craton from the southeast. The northwestern of these belts consists of gneisses which are in part metavolcanic, were deposited about 1.8 b.y.B.P. (Anderson and Silver, 1976). According to Anderson and Silver (1976) and Title (1982) this is a greenstone belt which is some 40,000 feet thick deposited in a slowly sinking geosynclinal trough. The southeastern belt consists of the Pinal Schist which was deposited 1.7-1.6 b.y.B.P. (Silver, 1978) and consists of quartz, muscovite schist, arkose, and quartzite (Titley, 1982). These Older Precambrian rocks were metamorphosed and intruded by granites during the Arizonan Revolution 1.76-1.63 b.y.B.P. (Damon, 1981), and were intruded by anoregenic granites 1.5-1.4 b.y.B.P. (Silver et al., 1977).

The Tire-Tiky Lode claims lie entirely within the central belt of the Yavapai Series which have been extensively intruded by Precambrian granodiorite, granite, gabbras and diabase. Volcanic rocks of the Yavapai Series are subaqueous rocks generally considered to be of oceanic or continental-margin calc-alkaline arc affinity. These volcanic rocks and associated penecontemporaneous batholiths are broadly similar to those of late Phanerozoic circum-Pacific magmatic arcs. The geology of the

Yavapai Series in central Arizona has recently been summarized by Donnelly and Hahn (1981). Within the region they provide stratigraphic information southeast of the area (the Cleator Belt); (the Black Canyon Belt); and (the New River District). Stratigraphic information to the west, in the Bagdad area is also summarized by Donnelly and Hahn (1981). The character of the Yavapai Series in the Tire-Tiky region is very unique and poorly understood. It is considered exotic.

Within the Yavapai Series in general, volcanism tends to follow cycles from mafic to intermediate to felsic followed by deposition of sediments. The exhalites typically occur on top of, or on the flanks of a rhyolitic volcanic center or in the immediately overlying sediments (Anderson and Nash, 1972; Anderson and Guilbert, 1979; and Hahn, 1981). The metavolcanic rocks have undergone two periods of folding and are generally in the greenschist facies. They have been altered to chlorite-rich rock near massive sulfide deposits (Anderson and Nash, 1972), and contact with Tertiary dikes.

Precambrian granites are widespread throughout the region and they intrude the Yavapai Series. They range in composition from quartz monzonite to granodiorite, and in the Cleator, Jerome, and Bagdad areas were intruded 1.77 by.B.P. (Donnelly and Hahn, 1981). Elsewhere in central Arizona batholiths were emplaced 1.77-1.72; 1.70-1.65 and 1.5-1.4 b.y.B.P. (Silver et al., 1977; Donnelly and Hahn, 1981). The Prescott Granodiorite is the host in the region surrounding the Tire-Tiky claim group. The latest Precambrian granitic intrusions

(1.5-1.4 b.y.B.P.) are anorogenic calc-alkaline to alkaline rapakivi granodiorite to granite plutons that extend anorogenic along a northeasterly - striking zone from southeastern California to Labrador (Silver et al., 1977).

Younger Precambrian

Younger Precambrian sediments including the Pioneer Formation, Dripping Springs Quartzite and the Mescal Limestone (Apache Group) crop out to the southeast (Wilson, 1962) but do not crop out in the area nor to the south, north or west of the region. Apparently this region was an upland at this time and no sedimentation took place. Intruded into the Apache Group sediments are diabase sills which, according to Damon (1968) and Silver et al. (1977) were intruded 1.2 to 1.1 b.y. B.P. In the Tire-Tiky region diorite porphyries, diorites, and gabbros intrude Precambrian Yavapai Series and Precambrian granitic rocks and could be correlative of the diabase which intrudes the Apache Group.

Paleozoic

Paleozoic sedimentary rocks in Arizona range in age from Cambrian to Permian and consist mainly of quartzite, dolomite and limestone. They consist of Tapeats Sandstone, Bright Angel Shale, Martin Formation, Redwall Limestone, Supai Formation, Coconino Sandstone and Kaibab Limestone or their stratigraphic equivalents (Wilson, 1962). The sediments were laid down in a shelf environment, to the east of the Cordillerean geosyncline from which they are separated by the Wasatch line (Burchfiel, 1979). No Paleozoic sediments currently crop out within the region but approximately 15 miles to the north extensive outcrop exists of Tapeats Sandstone, Bright Angel Shale, Martin Limestone, Redwall Limestone and Supai Formation. Paleozoic sediments were probably deposited in the area covered by the Tire-Tiky Claim group in very thin near short deposits which have been subsequently eroded.

Laramide Orogenid Period

The Laramide was a period of volcanism intrusion and intense tectonic activity in southern Arizona. It is of particular importance because a large number of porphyry copper deposits were formed at this time, especially in southeastern Arizona (see, for instance, Damon and Manger, 1966; Shafiqullah e. al., 1980; Titley, 1981; Heidrich and Titley, 1982). The magmatic and tectonic activity took place during the southeastward sweep of the magmatic arc, possibly as a result of the decrease in the dip of the Benioff zone at this time (Conely and Reynolds, 197; Clark et al., 1982).

The local region lies within a northwest-striking Laramide arc, known Laramide intrusions occur within the region at the Copper Basin porphyry copper deposit to the southeast and at the Bagdad porphyry copper deposit to the west. Scant copper sulfides are associated with small intrusives locally; a few local east-west quartz copper sulfide outcrops.

Mid-Tertiary Rocks

Mid-Tertiary rocks are here defined to include all sedimentary and igneous rocks deposited after the Laramide orogeny and the post-Laramide period of peneplanation, and before Basin and Range-type faulting became dominant. These pre-Basin and Range rocks have been divided into three units by Eberly and Stanley (1978) and Scarborough and Wilt (1979).

The lwest unit consists of indurated brown arkosic fluvial sandstone, fanglomerates of gneissic and granitic provenance up to 300 feet thick, and minor lacustrian sediments with some algal limestone. Andesitic to rhyolitic volcanics increase in abundance toward the upper part of this unit.

The middle unit is characterized by voluminous intermediate to felsic volcanism that is associated with the mid-Tertiary orogeny. The volcanics consist of flows, ash flow tuffs, tuff breccias and ash of latitic, quartz latitic, rhyolitic and trachytic composition, and flows and flow breccias of basaltic, balaltic andesite and andesitic composition (Reynolds, 1980). Small intrusions of the above compositions are also present. The volcanic rocks are interbedded with red sand and gravel fluvial deposits, massive fanglomerates and lacustrine deposits with local organic-rick facies, algal limestones and water-laid tuffs.

The upper unit consists of grayish brown poorly consolidated sandstones, fanglomerates, mudstone and water-laid tuffs. The rocks contain abundant volcanic debris. They are overlain and intercalated with basaltic volcanics.

The mid-Tertiary rocks rest undonformably on Precambrian, Paleozoic, Mesozoic and Laramide rocks. They were deposited in northwest-striking basins which were tilted northeastward and southwestward. (Scarborough and Wilt, 1979).

Tertiary units crop out in south, north, west and northwestern part of the area. They have been examined in the southern part of the region by Scarborough and Wilt (1979) at Lake Pleasant, New River Mesa and New River. Here they consist of calcareous mudstones, limestone and dolomites, red lithic tuffs, rhyolitic air-fall deposits, agglomerates, ash-flow tuffs, andesite flows and breccias. They have been dated at 26.5-21.3 m.y.B.P. They rest unconformably on Precambrian and are overlain unconformably by a basalt dominated sequence.

The units south of the local area but north of Lake Pleasant are also part of the mid-Tertiary sequence. Scarborough and Wilt (1979) indicate that it is alkali-calcic in nature and was deposited 30-13 m.y.B.P. It consists of andesitic flows and tuffs (Wilson et al., 1969) but also contains dacite rhyolite and felsic tuffs (U.S.G.S., 1981). The mid-Tertiary rocks in the area are thus dominated by extensive basalt flows, fanglomerates, and water-laid tuffs and can probably be correlated with the upper unit of Eberly and Stanley (1978).

Late Tertiary

Late Tertiary deposits are found in most of the tectonic basins formed during the Basin and Range disturbance. The deposits consist of poorly consolidated, tan-colored fanglomerate sandstone and siltstone of fluvial and lacustrine origin and lesser basaltic volcanics. (Scarborough and Wilt, 1979; Reynolds, 1980). The Late Tertiary deposits rest unconformably on mid-Tertiary rocks and were deposited after the transition from the mid-Tertiary orogeny to the Basin and Range disturbance. According to Shafiquallah et al. (1981) this transition took place sometime between 19-12 m.y. B.P., depending on the location within central Arizona.

Latest Tertiary and Quatrnary

During the late 9 m.y. vocanic activity and tectonism have slowed down (Shafiqullah et al., 1981) and during the last 4 m.y. the dominant geological procession in the Mountain-Province have been erosion of mountain ranges, formation of extensive pediments, deposition of fanglomerates and deposition of alluvium along the major creeks and drainages.

Regional Structural Geology

The area northwest of the Bradshaw Mountains lies within the North American craton, east of the Wasatch line and close to the boundary between the Colorado Plateau and the Basin and Range Province. It has been affected by tectonism during the Proterozoic, Laramide and mid-Tertiary orogenies, and most recently by the Basin and Range disturbances.

During the Arizona Revolution 1.76 to 1.65 b.y.B.P. according to Damon (1968), the Precambrian rocks were foled about EME striking axes and underwent N-S to NNW faulting (Davis, 1981). The Colorado Lineament, a major strike-slip fault, was initiated about this time according to Warner (1978).

No pronounced tectonic or igneous activity took place during the Paleozoic. During the Mesozoic southwestern Arizona was strongly affected by a mid-Mesozoic magmatic arc and a later period of metamorphism and folding, but the effects of these apparently did not reach central Yavapai County.

The Larmide was a period of intense tectonism and localized magmatic activity which was associated with the southeastward migration of the magmatic arc (Coney and Reynold, 1977; Lowell, 1974). Probably related to ENE plate motion and compression are basement-colored uplifts and thrust faults which strike NNW to NW (Nielsen, 1979; Davis, 1981); WNW left lateral strike slip faulting of the Texas zone of Schmitt (1966); and the ENE-striking tensional features (Rehrig and Heidrick, 1976). Laramide plutons associated with porphyry copper mineralization have a pronouned NNW to NW trend and a secondary ENE trend (heidrick and Titley, 1982). The former is parallel to the Larmide magmatic arc and the trend of the basement-colored uplifts and the latter is parallel to Precambrian fold axes and Laramide tensional features. The most pronounced Laramide tectonism and magmatic activity lies to the south of the region but a NW and an ENE trend of mineralized Laramide plutons intersects to the southeast of the area (copper Basin).

The mid-Tertiary orogeny lasted approximately from 34 to 14 m.y.B.P. (Shafiqullah et al., 1980) and involved eruption of large volumes of volcanics, emplacement of metamorphic core complexes and listric normal faulting. The geologic events accompanied the westward migration of the magmatic arc, possibly as a result of the steepening of the Benioff zone at this time (Coney and Reynolds, 1977). In southern and southwestern Arizona enormous volumes of egnimbrites were erupted. South of the area andesites and associated more felsic rocks were erupted at this time.

Between 19 and 17 m.y.B.P. a transition occurred between the mid-Tertiary orogeny and Basin and Range fulting. In the local area transition appears to have been between about 21 and 16 m.y.B.P. The Basin and Range faults strike NW to N-S and are high angle faults. The present day ranges and basins result from this tectonic episode. South of the region structural depressions filled with Late Tertiary sediments formed at this time, as was the Phoenix Basin. The Basin and Range tectonic episode was terminated about 4 m.y.B.P. (Shafiqullah et al., 1980).

Geologic History

The geologic history of central Arizona is long and complex and only a brief synopsis is presented here. Excellent summaries of the main geological events that affected the southern part of North American Cordillera are given by Burchfiel (1979) and Dickinson (1981). The geologic history can be summarized as follows:

1. Volcanic and clastic rocks of the Yavapai Series were accreted onto the North American continent from the southeast 1.8-1.7 b.y.B.P. (Anderson, 1976; Anderson and Silver, 1978: Titley, 1982). The rocks were folded and about northeasterly axes, metamorphosed to the greenschist facies and intruded by granitic batholiths during the Arizona Revolution about 1.7-1.6 b.y.B.P. (Damon, 1968).

2. Sometime after this the area was uplifted and eroded. To the east the land was submerged beneath epicontinental seas and shallow marine clastic sediments and carbonstes of the Late Proterozoic Apache Group were deposited. These were intruded by diabase sills 1.1 to 1.2 b.y.B.P. The local region remained above sea level at this time. Mafic intrusions in the Tire-Tiky area may be related to the diabase sills.

3. During the Paleozoic a clastic and carbonate shelf sequence was deposited over much of Ariozna. The Bradshaw Mountains remained an upland (Mazatzal Land) during much of this time, and no Paleozoic sediments were deposited there (Wilson, 1962); however 15 miles north of the Tire-Tiky claim group extensive outcrop of Paleozoic rocks occur and the Colorado Plateau Region begins. Most likely a thin veneer of Paleozoic rocks (Supai) were deposited over the local area and subsequently eroded.

4. During the Mesozoic, continental red beds were deposited to the north (Dickinson, 1981), and in southwestern Arizona a magmatic arc developed and was followed by a period of folding and metamorphism (Reynolds, 1981). The area covered by the Bradshaw Mountains remained upland (Mogollon Highlands) (Dickinson, 1981) and apparently was not affected by the above events.

5. The Laramide was a period of intense tectonic activity in central Arizona. It was characterized by tectonixm resulting from compression in the northeast-southwest direction (Davis, 1981) and intrution of epizonal granitc

plutons along NW and ENE trends (Heidrick and Titley, 1982). Two of these trends, which are related to popphyry copper mineralization, intersect to the southeast (Copper Basin), and to the west (Bagdad).

6. The mid-Tertiary orogeny lasted from about 35-14 m.y.B.P. in southern Ariozna. During this time a great thickness of fluvial and lacustrine sediments and felsic to intermediate volcanics were deposited in northwest-striking basins, metamorphic core complexes were emplaced, and the area was effected by listric normal faulting (Eberly and Stanley, 1978; Scarborough and Wilt, 1979; Shafiquallah et al., 1980; Davis, 1981). Mid-Tertiary intermediate to felsic volcanics are present in the southern part of the region, but the effects of metamorphic core emplacement and listric normal faulting are not evident.

7. Between 19 and 17 m.y.B.P. the mid-Tertiary orogeny subsided and a transition into Basin and Range steep normal faulting took place (Shafiqullah et al., 1980). Within the local region this transition probably took place between 20 and 16 m.y.B.P. The Basin and Range faulting was accompanied by think accumulation of fluvial and lacustrine sediments in the basins and eruption of basaltic valcanics. In the Tire-Tiky area and surrounding region basalts, fanglomerates and interlayered tuffaceous sediments were deposited at this time.

8. During the last 9 m.y. volcanism and tectonism have subsided (Shafiqullah et al., 1980) and the dominant geological processes have been erosion and deposition of alluvium.

Local Rock Units

Yavapai Series

The oldest of the major units to crop out on the Tire-Tiky Lode claim group; the Yavapai schist, comprises thinly foliated kyanite-ilmenite schist, kyanite-quartz-mica-ilmenite schist and gneiss, feldspathic biotite monazite gneiss, quartz-feldspar-mica schist and gneiss, epidosite, impure quartzite?, and a variety of migmatitic rocks. Most of these are rocks of middle metamorphic rank, as evidenced by the presence of kyanite, sillimanite, biotite and monazite. In general they are reddish brown to very dark greenish gray and form darker more eroded surfaces that contrast with the lighter colored more resistant granitic rocks, aplite and pegmatite dikes.

The Yavapai schist was first described from the Bradshaw Mountains to the southeast. Its general characteristics have been summarized by Darton and some of its occurences to the north and northeast described by Lindgren, Wilson, Anderson and others. They have shown that these rocks are divisible into stratigraphic and lithologic units that can be traced for considerable distances. The Yavapai Series represents a volcano-sedimentary sequence comprising a differentiated mafic to felsic volcanic pile (Donnely and Hahn, 1982) and records three stages of development: an opening phase of basaltic and andesitic volcanism with attendant volcanogenic sedimentation, and intermediate stage of rhyolitic volcanism and hypabyssal intrusions, and a closing sequence of tuffaceous and clastic sedimentation.

The Yavapai Series in the Northern Bradshaw Mountains generally consists of submarine volcanics and volcano clastic rocks and penecontemporaneous batholiths most likely of oceanic or continental-margin arc derivation.

The local character, composition and stratigraphy of the Yavapai Series is the least studied and probably the poorest understood. Its character does not fit into the known stratigraphy and is considered exotic. However the final stage of tuffaceous and clastic sedimentation appears to be the most likely portion of the sequence represented.

The geology in the area around the claim group generally consists of voluminous batholithic rocks of probably Precambrian age. Compositionally the rocks range from granodiorite to quartz monzonite with several distinctly different porphyritic and equigranular intrusive phases. Swarms of aplite and pegmatite dikes which crop out over the surrounding area are probably genetically associated with the previously mentioned rocks. Generally equigranular and unfoliated the batholithic rocks weather into spherodial boulders with a light tan color. Portions of the intrusions near contacts with a light tan color. Portions of the intrusions near contacts with the schists assume gneissic structural lineations. Scattered outcrops of migmatite and gneiss crop out through out the area. Composition varies widely and small scale folding within some migmatites is impressive.

Strata of Yavapai Series are cross cut and absorbed by the batholiths and intrusions. The Yavapai Series sometimes occurs as scattered zones of fairly uniform character and trend, which cover hundreds of acres, to metasomites which resemble granitic schist and gneiss due to strong metasomatism.

Within the batholithic rock scattered lenses and pods (Xenoliths) of strongly metamorphosed and metasomatized Yavapai Series range in size from several inches to hundreds of feet. Generally of amphibolite grade, xenoliths range in composition from felsic to mafic.

To the southeast possibly three episodes of deformation occurred in metavolcanic and metasedimentary rocks of the Bradshaw Mountains during the Precambrian. A foliated greenschist facies resulted. The granodiorite-quartz monzonite units apparently intruded preexisting foliated and metamorphosed rocks of the Yavapai Series. This caused local folding and faulting of the metamorphosed rocks, but did not disturb the trend of foliation in many areas. The strong foliation possibly imposed the exisitng subparallel structure on the intruding quartz monzonite-granodiorite.

The intruding quartz monzonite possibly displaced, absorbed, and melted much of the Yavapai series regionally. The remaining slivers and wedges of Yavapai series were trapped as zenoliths in the host. Generally the mafic zenoliths display chloritic alteration and the felsic zenoliths are generally altered to sericite.

Regional metamorphism is not related to the emplacement of the Cornfield Mountain intrusive. Some local retrograde metamorphism or hydrothermal alteration is associated with the intrusive; implying that the scattered zenoliths of Yavapai Series of amphibole metamorphic grade possibly had wider extent.

Greenschists - Phyllites - Amphibolites

Greenschists are fairly abundant in the area surrounding the claim group. They are sometimes more resistant to weathering than the granitic or pegmatitic rocks they are encased in. They form darker streaks and patches on the hill and ridges. The thickness of individual units ranges from less than one foot to 100 feet or more generally occuring as very large xenaliths many strike to the north and impart foliation on the surrounding granitic host.

There is great variation in the texture and composition visible in hand sample. Foliation ranges from poor to well developed and locally crenulated textures have been observed. Schist compostion vaires dramatically and phyllite to amphibolite composition occurs locally.

Fresh samples of green schist vary from dark green to dark gray, weathered sample vary from light tan to dark brown. Only a few minerals are recognizable in hand samples because of the small grain size. Locally blastophenocrysts of plagioclase and vugs filled with epidote are recognizable in the poorly foliated greenschists.

The major minerals are chlorite, plagioclase, epidote, muscovite, quartz, biotite, actinolite, and opaques.

The subparallel orientation of the chlorite flakes define the foliation in the greenschists, muscovite flakes define the foliation in the phyllites.

An amphibole, probably actinolite occurs in some xenoliths as weakly foliated blades and needles. When amphibole is predominate with plagioclase amphibolite facies is suggested. Higher concentrations of biotite occur in chlorite rich areas. Biotite is common as randomly oriented flakes but sometimes defines foliation.

Prescott Granodiorite

Distritution

The Prescott Granodiorite, named for extensive exposures in the western part of the city of Prescott, forms isolated masses in the region to the west and northwest of the city of Prescott, Arizona, (Kreiger, M.H. 1965). The granodiorite complex surrounds the Tire-Tiky area regionally.

General Character

The various masses of Prescott Granodiorite have been correlated on the basis of similarity in hand samples, mineral composition, and gross morphology. The Prescott mass is the least altered and deformed and is described in detail; masses in the claim group region are similar-just coarser grained.

Weathering of the Prescott mass characteristically results in large erosional mounds of relatively fresh rock surrounded by sand flats formed by accumulation of angular fragments, some of crystal-grain size. Disintigration along joints results in piles of rounded boulders, some balanced, whose form depends largely on the spacing and attitude of joints.

The Prescott mass is a fine- to medium-grained massive slightly altered rock, having a poikilitic, hypidiomorphic-granular texture. Fresh granodiorite is medium gray, light gray, or greenish gray. Slightly darker or lighter shades are principally a function of grain size, but lighter shades in places are due to less abundant biotite or to the opaque character of the more altered plagioclase. The weathered surface is grayish orange; some is reddish brown owing to baking by basalt or is light brown owing to weathering of introduced pyrite.

The granodiorite contains plagioclase, quartz, potassium feldspar, biotite, epidote, and accessory minerals. Most plagioclase is translucent to greasy; some is glassy, and some is chalky or greenish. Individual grains are hard to distinquish in hand specimen. The plagioclase forms zoned subhedral laths and anhedral grains. Some plagioclase encloses other mineral grains; the margins of some are intergrown with quartz and microcline.

Quartz occurs as glassy colorless to light-gray slightly strained anhedral grains.

Most of the potassium feldspar is microcline, but some occurs as orthoclase and as perthitic or microperthitic intergrowths. Microcline forms clear, colorless square to rectangular, poikilitic crystals having irregular margins. The crystals average about a quarter of an inch long; some are as much as 1½ inches across. The poikilitic microline is scattered sparsely to abundantly through out the rock and encloses the other minerals. Commonly, the inclusions are distrituted rather evenly through the microcline; some are so abundant that the enclosing microcline is easily overlooked. Locally the inclusions are concentrated around the margins of the microcline.

Biotite forms greenish-black flakes, books, and granular aggregates. Some biotite is replaced by magnetite (or ilmenite), epidote, or chlorite.

Epidote is widely distributed, from minor quantities to amounts nearly as abundant as biotite. Some grains are cubedral, but epidote is probably metamorphic; it also occurs in veinlets.

Accessory minerals are sphene, magnetite, ilmenite(?), apatite, and zircon. Leucoxene has formed from sphene and from ilmenite or titaniferous magnetite.

Although most of the Prescott mass is uniform, some of it is spotted, layered or altered. Contamination from mafic rocks produced sparse to abundant rounded, irregular, or angular spots. Most of the spots are about a quarter of an inch in diameter. They are composed of green biotite and minor amounts of epidote, sphene, magnetite, apatite, and leucoxene.

Parallel dikes of aplite and pegmatite produced layered rocks in a few places. The layers strike north-northeast and dip about vertically. Individual layers average 1-3 feet wide, but range from 1 inch to more than 10 feet. Some can be traced along the strike for several hundred feet. Some layers consists of compound dikes, the centers being aplitic and the margins pegmatitic, or vice versa; others are made up of irregular aplitic and pegmatitic zones. The layers are cut by younger pegmatite and aplite dikes.

Most of the Prescott mass has been altered by mild regional metamorphism. Most intense alteration is probably the result of hydrothermal solutions associated with quartz, quartz-tourmaline, and tourmaline veins. It formed a mafic-poor aplitic-looking rock containing dark specks composed of granular mixtures of magnetite, specular hematite, and leucoxene that are pseudomorphic after magnetite, pyrite, or original mafic minerals.

Except for small parts of the Lynx Creek and Mineral Point masses, the other masses do not resemble the Prescott mass. Thet are more deformed and altered, lack poikilitic microcline, and are generally coarsere grained. The northern part of the Salida Gulch mass is intensely foliated quartz-feldspar-biotite schist and augen gneiss. Masses in the Tire-Tiky region are generally coarser grained but similar. Grain size in undeformed parts of these masses ranges from 1 to 5 mm, but the size of some of the feldspar augen suggests an original coarse-grained or porphyritic rock containing feldspar crystals more than 8 mm long. The calcic cores of plagioclase are highly saussuritized.

Potassium feldspar forms fine intergrowths or granular mixtures with quartz and albite.

Relations to Other Rocks

The conclusion that the rocks mapped as the Prescott Granodiorite are part of the same intrusion is based primarily on similarities in handsample, gross morphology, and mineralogical composition, but this correlation is open to question. Refinements in age determinations may prove or disprove this conclusion.

Monazite and xenotime minerals are abundant over extensive areas of the claim groups. These minerals contain large amounts of rare-earth elements and yttrium which are being used in a number of new and expanding technological fields including the super conductors and high strength magnets. Rare earths are currently used in petroleum catalysts, metallurgical uses, ceramics and glass, phosphors, electronics, magnets, lighting and research. Several rare earth elements found on the property have very high unit value. The primary processors for rare earths and scandium are located in Phoenix, Arizona, about 100 miles south of the claim group.

The mineralized zones on the Tire-Tiky Lode claims occur in strongly altered and metamorphosed Yavapai Series rocks of exotic character. The strike length of the mineralized zones and associated structures extend for almost 10,000 feet with widths of up to 4000 feet locally. The disseminated nature, extensive strike length and widths, favorable assay results, and number of strongly mineralized zones suggests an economic deposit might be developed from a number of zones on the claim group containing rare earths and several economic minerals. Anomalous scandium values occur in the magnetic fraction of the heavy mineral concentrate and appear to have probable ecomonic potential. The Tire-Tiky Lode Claims are located on north-south trending schist zones with minor gneiss and occasional migmatites; the zones generally form low rolling brushy hills. They consist of strongly metamorphosed Precambrian sediments and possibly volcanics.

The schists are cut by aplite and pegmatite dikes which are generally unmineralized except along contacts with the schist where some concentration occurs. The geology in the area around the claim group generally consists of voluminous batholithic rocks of probable Precambrian age. Compositionally the rocks range from granodiorite to quartz monzonite with several distinctly different porphyritic and equigranular phases. Swarms of aplite and pegmatite dikes which crop out over the surrounding area are probably genetically related to the previously mentioned rocks.

Mineralization is not confined to fault zones or to highly faulted areas. It appears spatially unrelated to dikes of any composition. Probably the rare earth concentrations formed early either before or during metamorphism. The schist appears to be a metasedimentary rock deposited in a near shore shallow water environment, possibly interbedded with water-laid metarhyolites.

Xenotime, monazite, zircon, magnetite, ilmenite, and rutile could have been detrital grains in the original sediment, perhaps concentrated locally along bedding planes. These planes would represent zones of relative weakness in which growth and/or migration of the rare earth minerals, silica, and alkali ions (K^+ and Na^+) could have taken place during metamorphism. The Al-rich silicates kyanite, sillmanite, talc, and pyrophyllite suggest a metamorphic environment that was low in alkalis, because otherwise the alkalis would have reacted with these minerals to produce micas and feldspars. The leaching processes involved have been characterized as an exchange of protons (H^+) for alkali ions (K^+ and Na^+)

Field relations prove that most of the masses of Prescott Granodiorite intrude the Yavapai Series, or contain xenoliths of the Yavapai Series, but because of intense deformation and mechanical mixing, relations are obscure in some places. Most of the masses are cut by dikes of aplite and pegmatite and veins of quartz, quartz-tourmaline, and tourmaline that are probably related.

The granodiorite bodies in some parts of the region parallel the regional foliation within the zone. The bodies were intruded prior to final deformation within the zone or, more probably, were dragged into it. Postintrusive deformation produced augen gneiss and mylonite in the granodiorite and obscured the original relations of granodiorite to other intrusives and the Yavapai Series. The contacts are gradational, and the granodiorite may nowhere be in contact with rooks that it originally intruded.

Aplites - Pegmatites

Zones of coarse to fine grained pegmatite and aplite cut the granitic rocks as well as the schist and gneiss. Pegmatites are simple and generally not well zoned. It appears that tectonic activity during the emplacement of the pegmatites caused shearing and intermixing of some partially zoned pegmatites. Common pegmitite minerals are quartz, k-spar, plaginclase, muscovite, tourmaline and ilmenite.

Numerous subparallel branching aplite-pegmatite dikes were observed to have slight different mineralogical compositions as they swarm to the northeast from almost two miles. The dikes are intersected and faulted by mostly barren quartz veins and by several copper mineralized veins striking east and northeast and numerous minor barren quartz veins and veinlets. The dikes are generally fairly narrow, 10-15 feet wide, but they can swell to over 100 feet wide.

The aplite-pegmatites in the field area occur in the form of dikes, sills, pods, and large masses. Most of the pegmatite bodies are highly irregular, while aplites are usually narrow and very long. Some of the Pegmatites and most of the aplites are continuous for distances of hundreds of feet or more. Many of the aplites, especially those in the central portion of the claim groups are subparallel to each other, becomming more dendritic to the north.

Despite the irregularity of pegmatities and aplites, most of them show broad consistencies of orientation and in general, they trend to the north. Aplites on the southern half of the map area are usually parallel and they generally trend northeast.

The aplite-pegmatite dikes, sills, and masses intrude the granitic rocks, schist, gneisses, and migmatites.

Masses and dikes of pegmatite are abundant in both the granitic rocks and the older metamorphic rocks.

The concentration of aplite and pegmatite bodies is very high in the area north of Cornfield Mountain. Further north of Cornfield Mountain the bodies are more aplitic, trending northeast and sub-parallel to foliaiton of the schist.

In general, the sizes of the aplites and pegmatites are different depending on the type of country rock. Those that lie in granite and other relatively massive rocks are ordinarily small and thin. Those in the foliated rocks like schist, in contrast, commonly are much larger.

Much of the country rock adjacent to masses of pegmatite and aplite seems to have been little deformed or altered. They have remained uniform in texture and mineralogy as traced up to the contacts. Schistose types of country rocks, in contrast, show a widespread growth of large ilmenite, magnetite, and kyanite segregations. Tourmalinization of schists is another type of alteration seen in the country rocks to the southeast.

Aplites usually are fine-grained, and white, with a sugary texture. They appear as a swarm of sills and dikes sugparallel to each other. Aplites consist of quartz, microcline, plagioclase, and muscovite.

The pegmatites consist of quartz, microcline, and plagioclase. Microcline is perthitic. In places microcline is in graphic intergrowth with quartz. Greenish white muscovite is a common accessory mineral. Those pegmatites in the schist are very rich in muscovite, and muscovite in some instances grew perpendicular to the margin of the pegmatite. Black tourmaline is also a common accessory mineral. Locally prisms of tourmalines are a few inches long. In places the tourmaline crystals grew perpendicular to the margin of the pegmatite. Garnet is found rarely in pegmatites as small reddish-brown crystals. Greenish-blue beryl crystals are also found in one of the permatites to the southwest of the claim group.

Pegmatities are the portion of a melt from a large grantitic intrusion that were not used in the initial formation of the bulk of the granite. They intruded the parent rock along zones of weakness during the last stages of igneous activity.

Quartz Veins

Several generations of quartz veins are recognizable in the Tire-Tiky area. The earliest quartz veins appear to be associated with the pegmatites and contain muscovite orthoclase, plagioclase and tourmaline. Many of the earliest veins are fractured and deformed.

Quartz veins and lenses are rather common and quite variable in appearance and compositon. A few have been prospected for gold, silver, tungsten, copper and lead in several parts of the region. Also present are somewhat thicker more irregular masses of pegmatitic quartz, most of which contain a little perthite and some of the accessory minerals that are typical of the less quartz rich pegmatites of the district.

Occasional large barren bull quartz veins can be traced for up to a mile. To the north and northwest large quartz veins tens of feet wide trend to the northeast.

The copper sulfide mineralized veins are fairly rare and discontinuous. Generally they are uniform in character, with the vein being strongly silicified and having moderately defined hanging and foot walls. Quartz is the dominant and almost only gangue mineral. Sometimes the veins occur as lenses or pods in sheared zones in the main structures, or as parallel systems in the brecciated host. Brecciated weakly mineralized and moderately silicified wallrock commonly occurs adjacent to the veins.

Vein width ranges from 1 inch or less to 2 feet but averages slightly less than 6 inches. Where the strike changes or the dip flattens, their thicknesses appear to be above average. Generally the old workings in the area occur on swells in the vein in oxidized ore. The vein filling is chiefly milky-white quartz which is stained on weathered surfaces and in fractures by limonite. Locally it contains vugs lined with quartz crystals. The earlier deposited quartz is coarse quartz and the latter fine grained and mineralized. Sulfide minerals are rare on exposed outcrops.

Most oxidized surface material has strong limonite and hematite stain. Limonite and hematite occur as coatings and fracture filling but more importantly as well developed boxwork or gossan after oxidized sulfides.

Adjacent to the quartz veins, limonite has stained the quartz monzonite and pegmatitic zones orangish and rusty brown. Most alteration of the granitic host is of the contact type rather than pervasive.

Gabbro

Gabbro and related rocks are widely distributed throughout the local area in small isolated outcrops. Many lenticular to dike-like masses, many too small to show on the geologic map intrude all other map units including late stage quartz vein. Generally fresh in appearance, the gabbro and dacite appear unaffected by alteration and metamorphism.

The gabbro is a variable generally dark colored granular rock. Where fresh, much of it is dark bluish green, but the color ranges from nearly black to light grey, greenish grey and greyish green. Much altered gabbro is green tinted. Weathered outcrops are various shades of brown.

Grain size ranges from coarse to fine. Most of the gabbro is medium grained, the crystals ranging from 2 to 5 mm. Crystals in coarse grained rocks are 5-10 mm long; some euhedral pyrozene crystals are an inch across.

Original minerals in the gabbro were plagioclase and monoclinic pyroxene (augite); accessory magnetite, ilmenite, apatite, and zircon; and possibly some pyrite. Metamorphism has saussuritized the plagioclase, replaced pyrone by amphibole and serpentinized the olivine.

Locally, more or less feathery masses of suspected tremolite, anthophyllite and zoesite have partially replaced plagioclase and pyroxene.

Gabbroic rock appear to be the youngest intrusive rock in the local area. They have been observed cutting late stage barren quartz veins, aplite and pegmatite dikes as well as the schistose and granitic rocks.

Diabase is a gabbro-like rock with a larger percentage of plagioclase feldspar than gabbro. The diabase is less common than gabbro, not as dark a color, and generally finer grained. Accessory minerals, distribution, mode of emplacement, and other characteristics suggest that it is genetically related to the gabbro.

Talc and serpentine occur as smears, fracture fillings and plates in granitic and schistose rocks of the region. These minerals might have been derived from the alteration of rocks with peridotite composition.

Tertiary Basalt

Remanants of Tertiary basalt flows occur just to the north of the claim groups. Large extensive flows of the same character cover hundreds of square miles to the south and west of the area obscuring the Precambrian rocks.

The basalt is typical of plateau basalts. Most of it is medium dark to dark gray; some is lighter or darker gray. The weathered surface is dark gray or brownish black to very light grey.

Most of the flows have massive interiors and blocky, brecciated tops and bottoms that may be vesicular to scoriaceous or agglomeratic. Thicker, more massive flows generally form steep-walled cliffs along canyons. A few inches of basaltic tuff underlie many flows.

The basalt spread out as sheets, 10-20 feet but locally 50 feet or more thick. Most flows are nearly horizontal and maintain a fairly uniform thickness for considerable distances.

Structural Geology

The general structure of the Tire-Tiky claim group is characterized as nearly vertically dipping lithologic units trending approximately due north. In detail the structure is moderately complex. Numerous aplite and pegmatite dikes generally follow and sometimes cross-cut the north-south foliation trend of the schistose and gneissic units. Faults, small scale folding, and lateral compositional variations in the rock units complicate separating structural, stratigraphic, and metamorphic boundaries. Crenulated textures in gneiss and schist units are wide spread.

Structure in Central Arizona

Outcrops of Precambrian rocks are seen in most parts of central Arizona. The oldest Precambrian rocks are high grade metamorphic rocks (1.7 b.y. B.P., Anderson and Silver, 1976). These rocks are generally interlayered with or intruded by variably foliated granitic to dioritic sills, dikes, and lenses. Foliation in metamorphic and interlayered rocks is mostly steeply dipping and strikes north to northeast, or less commonly to the northwest.

In many places, the metamorphic rocks are intruded by Precambrian granodioritic to granitic plutons (Reynolds, 1980). Silver (1969) recognized three major generations of intrusives of batholithic size in Arizona: 1720 to 1760 m.y.; 1650 to 1700 m.y.; and 1430 m.y. ago. The two oldest generations represent syntectonic and post-tectonic intrusion into the eugeosynclinal pile while the youngest plutonic bodies do not demonstrate any time relationship to regional geosynclines or major deformation peiods.

Structure in the Tire-Tiky Region

Only a small part of the Yavapai Series, which is a volcano-sedimentary sequence, has been mapped in the field area. As already mentioned, this sequence represents a differentiated mafic to felsic volcanic pile (Donnely and Hahn, 1982) and records three stages of development: an opening phase of basaltic and andesitic volcanism with attendant volcanogenic sedimentation, an intermediate stage of rhyolitic volcanism and hypabyssal intrusions, and a closing sequence of tuffaceous and clastic sedimentation. This sequence became subject to Mazatzal orogeny (Wilson, 1939) and was invaded by intrusions during and after the disturbance.

Pegmatitic and aplite dikes intruding the area are usually sill-like and they follow the same trend as the foliation of the schist. Remnants of the schists on the top of the intrusions in and around the claim group are crenulated.

What is clear is that the field area was subject to a major structural disturbance (Mazatzal Revolution). Evidence of dynamic metamorphism is seen on the schist and gneiss.

The small size of the study area also restricts discussion of regional structure. The most obvious structural aspects of the study area are discussed below.

Planar Features

The determination of bedding is critical in determining the structural history of an area. Most of the units present in the area lack any internal bedding features, which fact made necessary the use of lithologic contacts.

Foliation is defined by the preferred orientation of micas and kyanite. The foliation is assumed paralled to bedding except in the hinges of isoclinal folds. In hinges of the later, open folds, the foliation is deformed with the bedding.

Lineations

Lineations present are of tectonic origin rather than as primary depositional features. These include elliptical quartz and ilmenite blastophenocrysts, elliptical kyanite and sericite segregations, crenulations, and schlieren.

Folds

Large scale folds have not been observed in the study area and, if they exist, may only be found by very careful mapping. Mapping of a much larger area than was examined in this study may help locate folds.

A few folds are visible on the scale of a single outcrop. Some isoclinal fold were observed in kyanite-ilmenite schist which was fairly massive.

Numerous migmatites displayed very complex fold patterns on an outcrop scale.

Faults

High angle faulting is moderately common in the region. The displacements are difficult to determine and no attempt has been made to do so. Most faults in the area are poorly exposed. Evidence used for recognition of faults includes offset lithology, shear zones, gabbro dikes between dissimilar lithology, drainage pattern, location of springs, mineralized and brecciated quartz vein with east-west trends. Abrupt changes in foliation also suggest faulting.

No attempt has been made to determine the age or ages of these faults since economic mineralization appears not to have been negatively affected. Presumably the faults are of Precambrian, Laramide, and most obviously Tertiary Age.

Faults occur in the major drainages of the area. They are generally near vertical and strike to the north-north-east. Minor faults which trend east-west and nearly vertical are mineralized by copper sulfide bearing quartz veins. Gabbro and dacite dikes tend to be emplaced along north-south faults.

Gneissosity

The presence of the gneissosity in the plutonic rocks (except those which are post-orogenic) is also an indication of the dynamic metamorphism in the area. Anderson (1954) concludes that the dynamic metamorphism is related to shearing stress and that the foliation planes are essentially the surface of slip. With the same reasoning, he believes that the foliation in tuffaceous beds and mica schist of the Yavapai Series in the Bagdad, Arizona area can be explained on the basis of the hypothesis that the bedding planes offered the least resistance to the shearing stress and thus became the surface of slip.

Local Geochronology

The Yavapai Series was deposited in a slowly sinking geosynclinal trough. Locally water-laid tuffs, rhyolites, and shallow water clastic sediments of possible continental origin may represent fluvial or strandline deposits. Regionally the Yavapai Series is characteristic of a greenstone belt: 1.82 - 1.775 b.y. B.P.; comprised of inafic to felsic submarine volcanics and clastic sediments.

The Yavapai Series was folded, metamorphosed and intruded by "granites" 1.76 - 1.63 b.y. B.P. The probable development of economic mineral assemblages by oxidation, alteration, alkali metasomatism and concentration occured. Locally different phases of the Prescott Granodionite were emplaced. Several different textural and compositional granitic phases occur locally. Migmatites and gneisses developed, followed by emplacement of pegmatites, aplites, and several generations of late stage quartz veins. Quartz veins range in compostion from pegmatitic, graphic ilmenite, quartz-tourmaline and barren bull quartz. The Cornfield Mountain Intrusion was possibly emplaced during Precambrian or Laramide. Age dating would confirm. Gabbro and dacite plugs and dikes were probably emplaced during late Precambrian. Gabbro dikes cut the late stage quartz veins and earlier faults.

The Cornfield Mountain intrusion is possibly of Laramide age and may be genetically related to the sparse copper-molybdenum-tungsten mineralization. The greisen environment to the south is probably of Precambrian or Laramide Age.

Pyrite-sericite-quartz mineralization, quartz-tourmaline veins (east-west trend), wolframite-quartz-pyrite veins (east-west trend) occur. A mega cryst K-spar-biotite-copper intrusive resembling eip-seynite similar to Gold Basin Mohave Co. Ariz. occurs to the south.

Copper-Molybdenum-Tungsten Sulfide Quartz Veins with east-west trends were emplaced across the region. Barren bull quartz veins were emplaced across the region as the final event associated with the base metal mineralization.

Extensive Tertiary basalt flows, fanglomerates and tuffaceous are deposited in the area. Basin and Range faulting regionally and locally. Erosion of Tertiary and Precambrian rocks. Alluvial pediments along washes accumulate in recent times.

Description of Mineralization

The mineralized zones on the Tire-Tiky Lode claims occur in strongly altered and metamorphased Yavapai Series rocks of exotic character. The strike length of the mineralized zones and associated structures extend for almost 10,000 feet with widths of up to 4,000 feet locally. The disseminated nature, extensive strike length, and width, favorable assay results and number of mineralized zones suggests an economic deposite might be developed from a number of zones on the claim group containing rare-earths and several economic industrial minerals.

Mineralization is not confined to fault zones or to highly faulted areas. It appears spatially unrelated to dikes of any composition. Probably the rare earth mineral concentrations formed early, either before or during metamorphism. The schist appears to be a metasedimentary rock deposited in a near shore, shallow water environment possibly interbedded with water-laid meta rhyolites. Xenotime, monazite, zircon, magnetite, ilmenite and rutile could have been detrital grains in the original sediment, perhaps concentrated locally along bedding planes. These planes would represent zones of relative weakness in which growth and/or migration of the rare-earth minerals could readily have taken place during metamorphism.

The Tire-Tiky lode claims are located on north-south trending schist zones with minor gneiss and occasional migmatites. Extensive zones contain mineralization of probable economic potential. The zones generally form low rolling brushy hills. They consist of steeply dipping, strongly metamorphased Precambrian sediments and possibly volcanics. The schists are cut by numerous aplite and pegmatite dikes which are generally unmineralized except along contacts with the schist. The mineralization is disseminated throughout the schist over a large area. Mineralization generally consists of a kyanite-monazite-ilmenite-magnetite schist. Porphyroblasts of quartz and Ilmenite are surrounded by a groundmass of kyanite which is well foliated and fairly pure. Kyanite-ilmenite-quartz schist grades into feldspar-quartz-muscovite schist laterally along the boundries of the claim groups. The feldspar-quartz-muscovite schist is void of potential economic mineralization.

The rare earth minerals xenotime and monazite are most concentrated in biotite rich zones in schist, gneiss and migmatites. They also are disseminated through the kyanite-ilmenite-magnetite schist.

In reviewing the literature on rare-earth deposits similarities in mineral assemblages, grade of metamorphism, and suspected protoliths wree noted in the Central City District of Colorado (Young, E.J. and P.K. Sims, 1961) and in the Southern Music Valley Areas of Riverside County, California (Evans, J.R., 1964) with the characteristics observed on the Tire-Tiky Claim Groups.

The Geologic Occurrence of Monazite

Monazite is generally distributed throughout the world as a minor accessory mineral in intermediate and high ranking metamorphic rocks derived from argillaceous sediments. The mineral is most common in argillaceous schists, gneisses, and migmatites of the upper subfacies of the amphibolite facies and of the granulite facies. Monazite occurs in magmatic rocks ranging in composition from diorite to muscovite granite, and in associated pegmatite, greisen, and vein quartz. Of this group it is most commonly observed in biotite quartz monzonite, two mica granite, muscovite granite, and cassiterite-bearing granite. Monazite enrichment in some plutonic terrane is concentrated by metamorphic differentation.

Monazite eroded from crystalline rocks is transported by streams and accumulates in sedimentary rocks. Locally the processes of erosion and transportation may be varied and complex, and detrital monazite may have gone through several cycles before arriving at its present site.

Monazite is concentrated at the site of weathering in streams, and on beaches, but the richest and largest concentrations are the beach deposits.

Monazite has a restricted occurrence in crystalline and sedimentary rocks. In crystalline rocks its presence can be related to conditions of temperature and pressure during metamorphic or magmatic crystallization. In metamorphic rocks the temperature and pressure conditions are shown by the grade of regional metamorphism. In magmatic rocks they are indicated by the composition of the rock and the degree of alteration of the wallrocks. In sedimentary rocks the occurrence of monazite is controlled by mechanical processes.

Monazite in metamorphic rocks participates in a metamorphic cycle whose chief feature is the loss of detrital monazite and the formation of authigenic metamorphic monazite. Detrital monazite is unstable in early stages of regional metamorphism. It breaks down and shares its components with other minerals. As the grade of regional metamorphism increases, an environment is reached in which monazite becomes stable. Metamorphic monazite begins to form at a few centers of crystallization: these centers multiply with increasing grade of metamorphism until the rock finally contains far more metamorphic monazite than it originally had detrital monazite. The main sources for the metamorphic monazite are thorium, rare earths, and phosphorus held by other detrital components of the original sediment, chiefly hydolyzates, clays, mica, and apatite.

Many features of monazite in paraschists and paragneisses show that it is of metamorphic origin. Chief among them are direct relation between grade of metamorphism and amount of monazite in the rock; inverse relation between amount of monazite in metamorphic rock and grain size of original sediment; lack of similarity between the range in grain size of particles of monazite in paraschists and paragneisses and the probable size range in the original sedimentary rock; correlation between physical properties of monazite and metamorphic grade of host rock; inclusions in monazite identical with metamorphic minerals in the host rock; intergrowths between monazite and metamorphic minerals in the host rock: a reverse relation between monazite, allanite, and other thorium-bearing minerals in metamorphic rocks; and a direct relation between the amount of thorium in monazite and the grade of regional metamorphism. The last feature is particularly convincing: the average amount of thorium oxide in monazite from rocks of the greenschist facies is 0.4 percent: from rocks of the albite-epidote-amphibolite facies, 3 percent; from rocks of the amphibolite facies, 4.9 percent; and from rocks of the granulite facies, 8.9 percent.

A striking relation exists in metamorphic rocks - that is, as monazite becomes more abundant, allanite and (or) sphene become less abundant. At low metamorphic facies, allanite and sphene are common and monazite is sparse. As metamorphic facies increases to the staurolite-kyanite subfacies, the quantity of the three minerals increases. Above that subfacies, allanite and sphene decline in abundance and monazite increases. Monazite is common, but allanite and sphene are uncommon in the sillimanite-almandine subfacies. In the granulite facies, monazite is rarely accompanied by allanite or sphene: however, it may be associated with thorite and thorianite. The literature contains much evidence that allanite and sphene proxy for monazite as a host mineral for thorium at low grades of regional metamorphise, and it gives some evidence that thorite and expecially thorianite, proxy for monazite in rocks of highest facies. This relation between monazite and the minerals mentioned seems to be an expression of a sequential partition of thorium among mineral species in metamorphic rocks, beginning with thorium in chlorite, biotite, apatite, garnet, and allanite in the low grades, changing to allanite, sphene, and monazite in the middle grades, and to monazite, thorite, and thorianite at the highest grade. If, as sometimes supposed, the monazite consists of relict detrital grains, the arrangement here described is inexplicable.

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