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

NEVADA RANCH SERVICE

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Salesman

P.O. Box 1328 • 990 Fifth Street
Elko, Nevada 89801
(702) 738-7169

Nevada Incorporated and Licensed Real Estate Brokerage

Prescott Az Prop.
from Tom Simms

Hugo A local prospector
brought this in. Any interest?

John Hogg

I do hereby certify that the within instrument was filed and recorded at the request of Elliot D. Z... in Book 1507 Official Records Page 245 - 249 ... Records of Yavapai County, Arizona. WITNESS my hand and official seal the day and year first above written.

PATSY C. JENNEY, County Recorder

By [signature], Deputy

REQUESTED BY AND WHEN RECORDED RETURN TO:

... Inc.
... Esq.
... Park East, Suite 1260
Los Angeles, CA 90067

3-

QUITCLAIM DEED

THIS QUITCLAIM DEED, made and entered into as of the 1st day of June, 1982, by and between DELBERT C. LAYTON, also known as D. C. LAYTON, and PRISCILLA A. LAYTON, his wife, of the County of Elko, State of Nevada, First Parties, and BAR ... LIVESTOCK, INC., a Nevada corporation, Second Party,

W I T N E S S E T H:

That the said First Parties, for and in consideration of the sum of TEN DOLLARS ($10.00), lawful money of the United States of America, to them in hand paid by the said Second Party, and other good and valuable consideration, receipt whereof is hereby acknowledged, do by these presents remise, release and forever quitclaim unto the said Second Party, and to its successors and assigns, an undivided one-half interest in and to the following described unpatented Lode Mining Claims located in the Kirkland and Weaver Mining Districts situate in the County of Yavapai, State of Arizona, and State Lease, more particularly described as follows, to-wit:

(See Exhibit A attached hereto and made a part hereof for a description of the mining claims).

TOGETHER WITH all improvements situate thereon.

TOGETHER WITH the tenements, hereditaments and appurtenances thereunto belonging or in anywise appertaining, and the reversion and reversions, remainder and remainders, rents, issues and profits thereof.

TO HAVE AND TO HOLD the said premises, together with the appurtenances, unto the said Second Party, and to its successors and assigns forever.

IN WITNESS WHEREOF, the said First Parties have hereunto set their hands as of the day and year first hereinabove written.

[signature]

DELBERT C. LAYTON, also known as ... PRISCILLA A. LAYTON

STATE OF NEVADA,)
) SS.
COUNTY OF ELKO.)

On June 1, 1982, personally appeared before me, a Notary Public, DELBERT C. LAYTON, also known as D. C. LAYTON, and PRISCILLA A. LAYTON, his wife, who acknowledged that they executed the above instrument.

NOTARY PUBLIC

STEWART B. WILSON
of Nevada

Mailing address for Grantee:

BAR BM LIVESTOCK, INC.
c/o Elliot D. Burick, Esq.
One Century Plaza, Suite 1260
2029 Century Park East
Los Angeles, CA 90067

1469 246

[illegible] DISTRICT	NAME OF CLAIM	BLM SERIAL NO.	NOTICE OF LOCATION BOOK OF OFFICIAL RECORDS	PAGE NO.
WEAVER	KACHINA DOLL #1	AMC NO. Not Required	937	590
[illegible]	VICTORIA #1 Amended Location Notice	AMC78215	97[illegible] 128[illegible]	
[illegible]	VICTORIA #2	AMC98902	1287	785
WEAVER	VICTORIA #3	AMC98903	1287	787
WEAVER	VICTORIA #4	AMC98904	1287	789
WEAVER	THUNDER[illegible] Amended Location Notice	AMC78227	923 941	945 750
WEAVER	SKY HIGH #1 Amended Location Notice	AMC 70222	977 1252	40 140
WEAVER	SKY HIGH #2 Amended Location Notice	AMC70223	977 1252	41 142
WEAVER	SKY HIGH #3 Amended Location Notice	AMC70224	977 1252	42 144
WEAVER	SKY HIGH #4 Amended Location Notice	AMC 70225	977 1252	43 146

[illegible]469 PAGE 247

[illegible]	SIX [illegible] #5 Amended Location Notice	[illegible]	[illegible] [illegible]	[illegible]
WEAVER	GREY MARE #1	AMC78214	1252	[illegible]
WEAVER	GREY MARE #2	AMC78215	1252	[illegible]
WEAVER	GREY MARE #3	AMC78216	1252	154
WEAVER	GREY MARE #4	AMC78217	1252	[illegible]
WEAVER	GREY MARE #5	AMC78218	1252	[illegible]
WEAVER	PONCHO VILLA #1 Amended Location Notice	AMC78220	[illegible] 1252	[illegible]
WEAVER	PONCHO VILLA #2 Amended Location Notice	[illegible]	[illegible] 1252	[illegible]
KIRKLAND	JACK OF DIAMOND #1	[illegible] AMC113559	[illegible]	[illegible]
KIRKLAND	JACK OF DIAMOND #2	AMC78212 AMC113560	[illegible]	[illegible]
KIRKLAND	JACK OF DIAMOND #3	AMC78213 AMC113561	1321	[illegible]
WEAVER	GREEN ROCK #1 Amended Location Notice	AMC24730	1148 1290	473 565
WEAVER	RED ROCK #1 Amended Location Notice Amended Location Notice	AMC24731	1143 1148 1290	[illegible] 472 567
WEAVER	BLACK ROCK #1 Amended Location Notice	AMC24732	1148 1290	[illegible] [illegible]
WEAVER	CRAZY HORSE O. K.	AMC101990	1290	[illegible]
WEAVER	CRAZY HORSE TOKAY	AMC101991	1290	[illegible]
WEAVER	CRAZY HORSE #1	AMC101992	1290	553
WEAVER	CRAZY HORSE #2	AMC101993	1290	555
WEAVER	CRAZY HORSE #3.	AMC101994	1290	557
WEAVER	CRAZY HORSE #4	AMC101995	1290	559
WEAVER	BLACK DIKE NO. 1 Amended Location Notice	AMC74727	Book of Mines 153 1063	17 712
WEAVER	BLACK DIKE EXTENSION NO. 1 Amended Location Notice	AMC74730	Book of Mines 158 1063	560 713

[illegible]	[illegible] SION NO. 2	[illegible]	[illegible]	[illegible]
[illegible]	BLACK DIKE [illegible] SION NO. 3	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] SION NO. 4	[illegible]	113	335
	Amended Location Notice		1065	714
[illegible]	BLACK DIKE EXTENSION NO. 5	[illegible]118942	1339	36
[illegible]	RIM ROCK NO. 1	[illegible]82149	Book of Mines 1[illegible]4	[illegible]

TOGETHER WITH the Mineral Lease No. 31009, dated January 21, 1975, which expires January 20, 1995, all as revealed by the Records of the State Land Department concerning the "Kachina Doll #1 Mining Claim".

1469 249

BRASDA TITLE SERVICE

(602) 995-3276 ~~4760 Falcon Drive - Falcon Field Mesa, Arizona 85205 (602) 832-0373~~ 2740 W. Lawrence Lane Phoenix, Arizona 85021

September 20, 1982

Mr. Ansel Slome
West Beroy, Inc.
450 N. Roxbury Dr.
Beverly Hills, California 90210

RE: Continuation of Certificate of Title No. 46, First Amendment D. C. Layton, et ux, et al Kachina Doll #1 Mining Claim, et al, Kirkland and Weaver Mining Districts, Yavapai County, Arizona

Dear Mr. Slome

After completion of a search of the records of the various offices of the County of Yavapai, State of Arizona, The Arizona State Land Department located in Phoenix, Arizona, and the Bureau of Land Management located in Phoenix, Arizona, from April 19, 1982, at 7:30 A. M. through and including September 1, 1982, at 7:30 A. M., it is my opinion that the title to the within described unpatented Lode Mining Claims located in the Kirkland and Weaver Mining Districts in Township 10 and 12 North, Range 5 West, G&SRB&M, Yavapai County, Arizona, as more fully described in said Certificate of Title No. 46, First Amendment, are free and clear of all encubrances and liens, SUBJECT ONLY TO THE ITEMS SET FORTH IN SAID CERTIFICATE AS MODIFIED BY THE CHANGES SET FORTH BELOW:

The Bureau of Land Management Serial Numbers to the following described Lode Mining Claims is hereby changed to read as follows:

NAME OF CLAIM	BLM SERIAL NO.
SKY HIGH #1	AMC78222
SKY HIGH #2	AMC78223
SKY HIGH #3	AMC78224
SKY HIGH #4	AMC78225
SKY HIGH #5	AMC78226

TITLE TO ALL OF THE MINING CLAIMS LISTED IN CERTIFICATE NO. 46, FIRST AMENDMENT IS VESTED AS FOLLOWS:

Delbert C. Layton, also known as D. C. Layton, and Priscilla A. Layton, husband and wife, as to an undivided ½ interest, and Bar BM Livestock, Inc., a Nevada Corporation, as to an undivided ½ interest, as to all claims, EXCEPT THE KACHINA DOLL #1.

The State of Arizona, as to the fee title, Delbert C. Layton and Priscilla A. Layton, husband and wife, as to the Lessee's Interest under that certain Mineral Lease No. 31009 dated January 21, 1975, wherein the State Land Department, is the Lessor, and Margaret E. Titus, Bud Rains and Frank Yellowhorse, are the lessees, for the purpose of extracting and shipping ore and mineral substances from and under the parcel described in Notice of Location, type A., dated October 23, 1974, recorded October 23, 1974, in Book of Official Records 937 at page 566 of the records of Yavapai County, Arizona; Term: Expires January 20, 1995, and thereafter the Lessees Interest therein was assigned to Delbert C. Layton, a married man, by Certificate of Assignment dated June 22, 1982 and attached to said lease, all as more fully set forth by instruments contained in the records of the State Land Department, as to the KACHINA DOLL #1 MINING CLAIM.

THE FOLLOWING EXCEPTIONS ARE HEREBY ADDED OR CHANGED AS FOLLOWS:

1A. Annual Assessment work for the year 1983, an encumbrance upon said mining claims, as affected by ARS 27-208, et seq.

1. Exception No. 1 of Certificate of Title No. 46, First Amendment, is hereby deleted.

11. Exception No. 11 of Certificate No. 46, First Amendment, is hereby modified to include the following assignment of the lessees' interest:

Certificate of Assignment attached to said lease dated July 1, 1982, wherein the Lessees' Interest therein was assigned to Anschultz Corporation, as to an undivided 1/6 interest, Anthrust, Inc., as to an undivided 1/3 interest, Phillips Petroluem Company, as to an undivided 1/3 interest, AGT Development Corporation, as to an undivided 1/16 interest, Connecticutt Mutual Life Insurance Company, as to an undivided 1/16 interest, and Huron Petroluem Corporation, as to an undivided 1/24 interest.

NOTE: An application to assign an undivided ½ interest in Mineral Lease No. 31009 to Bar BM Livestock, Inc., a Nevada Corporation, is being processed by the Arizona State Land Office. The state is presently holding up this assignment for the following items:

a) A bond in the amount of $2,000.00 in favor of the State of Arizona.

b) Bar BM Livestock, Inc, a Nevada Corporation, to qualify to do business in the State of Arizona.

NOTE: The rental on Mineral Lease No. 31009 is paid through January 20, 1983.

IN WITNESS WHEREOF, I hereby sign this Continuation of Certificate of Title No. 46 this 17 day of September, 1982.

BRASDA TITLE SERVICE

Bernard W. Brasda, Owner

BRASDA TITLE SERVICE

(602) 995-3276 ~~4760 Falcon Drive — Falcon Field Mesa, Arizona 85205 (602) 832-0273~~ 2740 W. Lawrence Lane Phoenix, Arizona 85051

September 20, 1982

Mr. Ansel Slome
West Beroy, Inc.
450 N. Roxbury Dr.
Beverly Hills, California 90210

Jim Buida

RE: Continuation of Certificate of Title No. 46, First Amendment ~~D. C. Layton, et ux, et al~~ Kachina Doll #1 Mining Claim, et al, Kirkland and Weaver Mining Districts, Yavapai County, Arizona

Dear Mr. Slome

After completion of a search of the records of the various offices of the County of Yavapai, State of Arizona, The Arizona State Land Department located in Phoenix, Arizona, and the Bureau of Land Management located in Phoenix, Arizona, from April 19, 1982, at 7:30 A. M. through and including September 1, 1982, at 7:30 A. M., it is my opinion that the title to the within described unpatented Lode Mining Claims located in the Kirkland and Weaver Mining Districts in Township 10 and 12 North, Range 5 West, G&SRB&M, Yavapai County, Arizona, **as more fully described** in said Certificate of Title No. 46, First Amendment, are free and clear of all encubrances and liens, SUBJECT ONLY TO THE ITEMS SET FORTH IN SAID CERTIFICATE AS MODIFIED BY THE CHANGES SET FORTH BELOW:

The Bureau of Land Management Serial Numbers to the following described Lode Mining Claims is hereby changed to read as follows:

NAME OF CLAIM	BLM SERIAL NO.
SKY HIGH #1	AMC78222
SKY HIGH #2	AMC78223
SKY HIGH #3	AMC78224
SKY HIGH #4	AMC78225
SKY HIGH #5	AMC78226

TITLE TO ALL OF THE MINING CLAIMS LISTED IN CERTIFICATE NO. 46, FIRST AMENDMENT IS VESTED AS FOLLOWS:

Delbert C. Layton, also known as D. C. Layton, and Priscilla A. Layton, husband and wife, as to an undivided ½ interest, and Bar BM Livestock, Inc., a Nevada Corporation, as to an undivided ½ interest, as to all claims, EXCEPT THE KACHINA DOLL #1.

The State of Arizona, as to the fee title, Delbert C. Layton and Priscilla A. Layton, husband and wife, as to the Lessee's Interest under that certain Mineral Lease No. 31009 dated January 21, 1975, wherein the State Land Department, is the Lessor, and Margaret E. Titus, Bud Rains and Frank Yellowhorse, are the lessees, for the purpose of extracting and shipping ore and mineral substances from and under the parcel described in Notice of Location, type A., dated October 23, 1974, recorded October 23, 1974, in Book of Official Records 937 at page 566 of the records of Yavapai County, Arizona; Term: Expires January 20, 1995, and thereafter the Lessees Interest therein was assigned to Delbert C. Layton, a married man, by Certificate of Assignment dated June 22, 1982 and attached to said lease, all as more fully set forth by instruments contained in the records of the State Land Department, as to the KACHINA DOLL #1 MINING CLAIM.

THE FOLLOWING EXCEPTIONS ARE HEREBY ADDED OR CHANGED AS FOLLOWS:

1A. Annual Assessment work for the year 1983, an encumbrance upon said mining claims, as affected by ARS 27-208, et seq.

1. Exception No. 1 of Certificate of Title No. 46, First Amendment, is hereby deleted.

11. Exception No. 11 of Certificate No. 46, First Amendment, is hereby modified to include the following assignment of the lessees' interest:

Certificate of Assignment attached to said lease dated July 1, 1982, wherein the Lessees' Interest therein was assigned to Anschultz Corporation, as to an undivided 1/6 interest, Anthrust, Inc., as to an undivided 1/3 interest, Phillips Petroluem Company, as to an undivided 1/3 interest, AGT Development Corporation, as to an undivided 1/16 interest, Connecticutt Mutual Life Insurance Company, as to an undivided 1/16 interest, and Huron Petroluem Corporation, as to an undivided 1/24 interest.

NOTE: An application to assign an undivided ½ interest in Mineral Lease No. 31009 to Bar BM Livestock, Inc., a Nevada Corporation, is being processed by the Arizona State Land Office. The state is presently holding up this assignment for the following items:

a) A bond in the amount of $2,000.00 in favor of the State of Arizona.

b) Bar BM Livestock, Inc, a Nevada Corporation, to qualify to do business in the State of Arizona.

NOTE: The rental on Mineral Lease No. 31009 is paid through January 20, 1983.

IN WITNESS WHEREOF, I hereby sign this Continuation of Certificate of Title No. 46 this 17 day of September, 1982.

BRASDA TITLE SERVICE

Bernard W. Brasda, Owner

Will trade for gold stock shares

Sec. 35 + 36 T 37N R55E

BRASDA TITLE SERVICE

~~4760 Falcon Drive Falcon Field~~
~~Mesa Arizona 85205~~
~~(602) 832-0372~~

2740 W. Lawrence Lane
Phoenix, Arizona 85021
(602)995-3276

November 12, 1981

Mr. Doug Petersen
Peterson Realty
Wickenburg, Arizona

RE: BTS No. 46
Bud Raims, et al,
Kachina Doll #1 Mining Claim, et al,
in the Kirkland and Weaver Mining
Districts, Yavapai County, Arizona

Dear Mr. Petersen

After completion of a search of the records of the various offices of the County of Yavapai, State of Arizona, The Arizona State Land Department located at Phoenix, Arizona and the Bureau of Land Management located at Phoenix, Arizona, from the inception of the records through and including November 2, 1981 at 7:30 A. M., it is my opinion that the title to the unpatented lode mining claims located in the Kirkland and Weaver Mining Districts in Townships 10 and 12 North, Range 5 West, G&SRB&M, Yavapai County, Arizona, described below are free and clear of all encumbrances and liens; SUBJECT ONLY TO THE ITEMS LISTED BELOW:

MINING DISTRICT	NAME OF CLAIM	BLM SERIAL NO.	NOTICE OF LOCATION BOOK OF OFFICIAL RECORDS	PAGE
WEAVER	KACHINA DOLL #1	AMC No. Not Required	937	596
WEAVER	VICTORIA #1 Amended Location Notice	AMC78215	924 1287	913 763
WEAVER	VICTORIA #2	AMC98902	1287	765
WEAVER	VICTORIA #3	AMC98903	1287	767
WEAVER	VICTORIA #4	AMC98904	1287	769
WEAVER	THUNDER HILL Amended Location Notice	AMC78227	923 941	945 750
WEAVER	SKY HIGH #1 Amended Location Notice	AMC70222	977 1252	40 140
WEAVER	SKY HIGH #2 Amended Location Notice	AMC70223	977 1252	41 142
WEAVER	SKY HIGH #3 Amended Location Notice	AMC70224	977 1252	42 144
WEAVER	SKY HIGH #4 Amended Location Notice	AMC70225	977 1252	43 146

WEAVER	SKY HIGH #5	AMC70226	977	44
	Amended Location Notice		1252	148
WEAVER	GREY MARE #1	AMC78214	1252	150
WEAVER	GREY MARE #2	AMC78215	1252	152
WEAVER	GREY MARE #3	AMC78216	1252	154
WEAVER	GREY MARE #4	AMC78217	1252	156
WEAVER	GREY MARE #5	AMC78218	1252	158
WEAVER	PONCHO VILLA #1	AMC78220	926	991
	Amended Location Notice		1252	136
WEAVER	PONCHO VILLA #2	AMC78221	926	992
	Amended Location Notice		1252	138
KIRKLAND	JACK OF DIAMOND #1	AMC78211	863	337
	Amended Location Notice		896	600
	Amended Location Notice		1321	657
KIRKLAND	JACK OF DIAMOND #2	AMC78212	863	338
	Amended Location Notice		893	661
	Amended Location Notice		1321	659
KIRKLAND	JACK OF DIAMOND #3	AMC78213	863	339
	Amended Location Notice		893	662
	Amended Location Notice		1321	661
WEAVER	GREEN ROCK #1	AMC24730	1148	473
	Amended Location Notice		1290	565
WEAVER	RED ROCK #1	AMC24731	1143	881
	Amended Location Notice		1148	472
	Amended Location Notice		1290	567
WEAVER	BLACK ROCK #1	AMC24732	1148	471
	Amended Location Notice		1290	563
WEAVER	CRAZY HORSE O.K.	AMC101990	1290	549
WEAVER	CRAZY HORSE TOKAY	AMC101991	1290	551
WEAVER	CRAZY HORSE #1	AMC101992	1290	553
WEAVER	CRAZY HORSE #2	AMC101993	1290	555
WEAVER	CRAZY HORSE #3	AMC101994	1290	557
WEAVER	CRAZY HORSE #4	AMC101995	1290	559

WEAVER	BLACK DIKE NO. 1	AMC74727	Book of Mines 153	17
	Amended Location Notice		1063	712
WEAVER	BLACK DIKE EXTENSION NO. 1	AMC74730	Book of Mines 158	560
	Amended Location Notice		= 1063	713
WEAVER	BLACK DIKE EXTENSION NO. 2	AMC74731	Book of Mines 158	561
WEAVER	BLACK DIKE EXTENSION NO. 3	AMC74732	Book of Mines 158	562
WEAVER	BLACK DIKE EXTENSION NO. 4	AMC74733	113	335
	Amended Location Notice		1063	714
WEAVER	BLACK DIKE EXTENSION NO. 5	AMC118942	1339	56
WEAVER	RIM ROCK NO. 1	AMC82449	Book of Mines 154	550

TITLE TO THE ABOVE DESCRIBED MINING CLAIMS IS VESTED AS FOLLOWS:

THE STATE OF ARIZONA as to the fee title and MARGARET E. TITUS, BUD RAINES AND FRANK YELLOWHORSE, as Lessees under that certain Mineral Lease No. 31009 dated January 21, 1975 wherein the State Land Department is the Lessor and Margaret E. Titus, Bud Rains and Frank Yellowhorse are the Lessees, for the purpose of extracting and shipping ore and mineral substances from and under the parcel described in Notice of Location, Type A dated October 23, 1974 and recorded October 23, 1974 in Book of Official Records 937 at page 566 of the records of Yavapai County, Arizona; Term: Expires January 20, 1995 and all as revealed by the records of the State Land Office as to the KACHINA DOLL #1 Mining Claim. (See Exhibit "B" for the terms of this lease and a metes and bounds description and plat of said claim)

Bud Rains, a single man, as to an undivided ¼ (one-fourth) interest, David L. Beasley and his wife on August 5, 1974 as to an undivided ¼ (one fourth) interest and D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided ½ (one-half) interest as to the VICTORIA NO. 1 Mining Claim;

Bud Rains, a single man, as to an undivided ¼ (one-fourth) interest, Frank Yellowhorse as to an undivided ¼ (one-fourth) interest and D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided ½ (one-half) interest as to the VICTORIA #2, VICTORIA #3 and VICTORIA #4 Mining Claims;

Bud Rains, a single man, as to an undivided $\frac{1}{4}$ (one-fourth) interest, Margaret E. Titus, a single woman, as to an undivided $\frac{1}{4}$ (one-fourth) interest and D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided $\frac{1}{2}$ (one-half) interest as to the THUNDER HILL Mining Claim;

Bud Rains, a single man, and Margaret E. Titus, a single woman, as to an undivided $\frac{1}{4}$ (one-fourth) interest, John Tauss and Susan Tauss, husband and wife, as to an undivided $\frac{1}{4}$ (one-fourth) interest and D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided $\frac{1}{2}$ (one-half) interest in the SKY HIGH #1, SKY HIGH #2, SKY HIGH #3, SKY HIGH #4 and SKY HIGH #5 Mining Claims;

Delbert Layton and Priscilla Layton, husband and wife, Bud Rains, a single man and Margaret Titus, a single woman, as to the GREY MARE #1, GREY MARE #2, GREY MARE #3, GREY MARE #4 and GREY MARE #5 Mining Claims;

Bud Rains, a single man and Margaret E. Titus, a single woman, as to an undivided $\frac{1}{2}$ (one-half) interest and D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided $\frac{1}{2}$ (one-half) interest as to the PONCHO VILLA #1, PONCHO VILLA #2 and BLACK DIKE EXTENSION #5 Mining Claims;

D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided $\frac{1}{2}$ (one-half) interest and Frank Yellowhorse and his wife on February 11, 1980 as to an undivaded $\frac{1}{2}$ (one-half) interest as to the JACK OF DIAMOND #1, JACK OF DIAMOND #2 and JACK OF DIAMOND #3 Mining Claims;

Bud Rains, a single man, as to an undivided $\frac{1}{2}$ (one-half) interest and D. C. Layton and Priscilla A. Layton, husband and wife, as to an undivided $\frac{1}{2}$ (one-half) interest as to the GREEN ROCK #1, RED ROCK #1, BLACK ROCK #1, BLACK DIKE #1, BLACK DIKE EXTENSION NO. 1, BLACK DIKE EXTENSION NO. 2, BLACK DIKE EXTENSION NO. #3 and BLACK DIKE EXTENSION NO. 4 Mining Claims;

Bud Rains, a single man, as to an undivided $\frac{1}{2}$ (one-half) interest, Margaret E. Titus, a single woman, as to an undivided $\frac{1}{4}$ (one-fourth) interest and Frank Yellowhorse and his wife on March 27, 1980 as to an undivided $\frac{1}{4}$ (one-fourth) interest as to the CRAZYHORSE O. K., CRAZY HORSE TOKAY, CRAZY HORSE #1, CRAZY HORSE #2, CRAZY HORSE #3, CRAZY HORSE #4 and RIM ROCK NO. 1 Mining Claims.

SUBJECT TO THE FOLLOWING EXCEPTIONS:

1. Annual Assessment work for the year 1982, an encumbrance upon said mining claims, as affected by ARS27-203, et seq.

2. Annual Assessment work for the year 1981, an encumbrance upon said mining claims, as affected by ARS27-203, et seq.

3. The rights of the United States of America and the State of Arizona as set forth in the general mining laws concerning minerals and mining of mineral deposits and lodes.

4. Any items, circumstances, boundary conflicts, overstaking of claims or other matters which an inspection of the area where these claims are located would reveal.

5. Right of Way No. 3693N through the $E\frac{1}{2}SE\frac{1}{4}$ of Section 14, Township 10 North, Range 5 West, G&SRB&M in favor of Mountain States Telephone and Telegraph, Term: Indefinite. (KACHINA DOLL #1)

6. Right of Way No. 1984N through the $E\frac{1}{2}$ of Section 14, Township 10 North, Range 5 West, G&SRB&M in favor of Arizona Public Service Company, Term: Indefinite (KACHINA DOLL #1)

7. Plat of existing Lode Mining Claim showing the location of the VICTORIA #1 Mining Claim within Section 14, Township 10 North, Range 5 West, (See Exhibit "A" for copy of Plat) recorded October 17, 1979 in Book of Official Records 1252 at page 161 of the records of Yavapai County, Arizona.

8. Plat of existing Lode Mining Claim showing the location of the THUNDERHILL Mining Claim within Sections 13, 14, 23 and 24 of Township 10 North, Range 5 West (See Exhibit "A" for copy of Plat) recorded October 17, 1979 in Book of Official Records 1252 at page 162 of the records of Yavapai County, Arizona.

9. Plat of existing Lode Mining Claims showing the location of the CRAZY HORSE GROUP in Sections 22, 23, 24, 25, 26 and 27 in Township 10 North, Range 5 West (See Exhibit "A" for copy of Plat) recorded April 8, 1980 in Book of Official Records 1290 at page 561 of the records of Yavapai County, Arizona.

10. Plats of Mining Lode Claims filed in the records of the Bureau of Land Management Offices located in Phoenix, Arizona, showing the location of various claims being considered herein. (See Exhibit "G" for copies)

11. The terms and conditions of the lease between the State of Arizona as lessor and Margaret E. Titus, Bud Rains and Frank Yellowhorse, as lessees described above. (KACHINA DOLL #1) (SEE EXHIBIT "B")

12. The rights of HARMCO, INC. A Delaware Corporation, and ANSCHULTZ CORPORATION, A Kansas Corporation under Non-Competitive Oil and Gas Lease No. 63159, dated April 26, 1979 wherein the State of Arizona, acting by and through its State Land Department, is the lessor and the Anschultz Corporation, a Kansas Corporation, is the lessee, Term: 5 years, expiring April 25, 1983 and thereafter the lessees interest therein was assigned to HARMCO, Inc., a Delaware Corporation, as to an undivided $\frac{1}{2}$ (one-half) interest and The Anschultz Corporation, a Kansas Corporation, as to an undivided $\frac{1}{2}$ (one-half) interest as revealed by the records of the State Land Office.

NOTE: The mineral lease wherein Bud Rains, Margaret E. Titus and Frank Yellowhorse are the lessees leases all mineral substances to these lessees, however, the lease described above leases oil and gas substances to The Anschultz Corporation, A Kansas Corporation and NARMCO, Inc., a Delaware Corporation. Oil and Gas Deposits are mineral substances and therefore this lease conflicts with the Mineral Lease being considered herein.

13. The rights of Bud Rains as revealed by the Amended Location Notices on the JACK OF DIAMOND #1, JACK OF DIAMOND #2, JACK OF DIAMOND #3 Mining Claims recorded September 3, 1980 in Book of Official Records 1321 at pages 657, 659 and 661, wherein Bud Rains signed as a locator. (See Location Notices in Exhibit "A" and Deed to Frank Yellowhorse in Exhibit "D")

14. The rights of the spouses of Charles Potter and Jack Harley on August 21, 1973 being the date of the Notices of Location recorded in Book of Official Records 863 at pages 337, 338 and 339 on the JACK OF DIAMOND #1, JACK OF DIAMOND #2 and JACK OF DIAMOND #3 Mining Claims. (See deed to G. Mahon in Exhibit "E")

15. The rights of the spouses of Stewart W. Warden and Cecil E. Testors on June 12, 1978 being the date of the Location Notices recorded in the Book of Official Records 1148 at pages 471, 472 and 473 on the GREEN ROCK #1, RED ROCK #1 and BLACK ROCK #1 Mining Claims. (See deed to Bud Rains in Exhibit "F")

16. Failure to record an AFFADAVIT OF LABOR PERFORMED AND MATERIALS FURNISHED for the period from September 1, 1975 through August 31, 1976. (RIM ROCK #1, BLACK DIKE EXTENSION #1, BLACK DIKE EXTENSION #2, BLACK DIKE EXTENSION #3, BLACK DIKE EXTENSION #4, JACK OF DIAMOND #1, JACK OF DIAMOND #2, JACK OF DIAMOND #3, VICTORIA #1, THUNDERHILL #1, PONCHO VILLA #1 and PONCHO VILLA #2)

17. Mortgage dated May 9, 1979 between Bud E. Rains, as mortgagor and Delbert C. Layton, as mortgagee, to secure the sum of $4,550.00 and other sums payable thereunder, as revealed by Prommissory Note attached to Quit Claim Deed recorded August 3, 1979. (see Exhibit "H" for a copy of this instrument)

18. Item numbers 1 thru 17, Inclusive, are encumbrances and affect the title to the lode mining claims described herein. Items 1 and 3 thru 11, Inclusive, above run with the title to the claims and cannot be removed. Items 3, 12, 13, 14, 15, 16 and 17 can be removed by proper curative action.

EXHIBIT "A" ****See this exhibit for a complete description of the above described unpatented lode and placer mining claims, as more fully set forth in the Location Notices recorded on each of the above described claims.

EXHIBIT "B" attached is the State Lease and related instruments on the KACHINA DOLL Mine.

EXHIBIT "C" attached is a copy of the Oil and Gas Lease No. 63159 in Item

12 above.

EXHIBIT "D" attached is a copy of the Deed from Bud Rains to Frank Yellowhorse described in item 13 above.

EXHIBIT "E" attached is a copy of the Deed from Potter to Mohan described in Item 14 above.

EXHIBIT "F" attached is a copy of the Deed from Worden and Teeters to Rains described in Item 15 above.

EXHIBIT "G" attached are the plats described in Item 10 above.

EXHIBIT "H" attached is a copy of the Quitclaim Deed evidencing the the mortgage described in Item 17 above.

IN WITNESS WHEREOF, I hereby sign this certificate this 12th day November, 1981.

ERASDA TITLE SERVICE

[signature]

[illegible] W. [illegible], Owner

Notes on back side of Assay Sheet # 3931-33

Rim Rock # 1 and 2

Black Extension # 2 & 3

Black # 3 -

Filcher & Fry#

Chas. Rice Rock # 3

'Black Dike # 4, 5, & 8

3001-33

Shop No. 1265 ... File No. ...

VALUES
Latest Quotation

1 oz. Gold ...
1 oz. Silver ...
1 lb. Copper ...
1 lb. Lead ...
1 lb. Zinc ...

THIS CERTIFIES
Samples submitted for assay contain as follows:

Date 19 SEPT 1961

CHAS A DIEHL

Arizona Assay Office

Phone Alpine 3-4001

815 North First Street
Phoenix, Arizona
P. O. Box 1148

MR. CHAS. MUNSEY

Short Ton ... 2000 Lbs.
Short Ton Unit ... 20 Lbs.
Long Ton ... 2240 Lbs.
Long Ton Unit ... 22.4 Lbs.

MARKS	SILVER PER TON Ozs.	Tenths	VALUE PER TON	GOLD PER TON Ozs.	100ths	VALUE PER TON	TOTAL VALUE PER TON of Gold & Silver	PERCENTAGE LEAD	REMARKS
#1	3	8	$3.23		.42	$14.70		7.60	
#2		4	.36		.26	$ 9.10		8.80	
#3	2	1	$1.90	3	.20	$112.00		0.40	

Paid

Charges $ 16.50 PAID

Assayer Chas. A. Diehl
Chas. A. Diehl
Reg. No. 682

ANDY CHUKA, PRINT

DEPARTMENT OF MINERAL RESOURCES
State of Arizona
MINE OWNER'S REPORT

Date: October 8, 1962

1. Mine: Black Dike
2. Location: Sec. Twp. Range. Nearest Town: Yarnell Distance: 2 miles
   Direction: SE Nearest R.R.: Santa Fe Distance: 9 miles
   Road Conditions: Good
3. Mining District and County: Weaver District - Yavapai County
4. Former Name of Mine: Same
5. Owner: Earl R. Edwards, John L. Meyer, Charles Munsey, etal. By contract purchase
   Address: Box 160, Peoria, Arizona
6. Operator: Same
   Address:
7. Principal Minerals: Gold, Silver and Lead
8. Number of Claims: Lode 13 Patented Unpatented
   Placer Patented Unpatented
9. Type of Surrounding Terrain: Rough
10. Geology and Mineralization: Monsonite formation with fissure veins, also penetrated by rhyolite dikes
11. Dimension and Value of Ore Body: Unknown

Please give as complete information as possible and attach copies of engineer's reports, shipment returns, maps, etc. if you wish to have them available in this Department's files for inspection by prospective leasors or buyers.

(over)

12. Ore "Blocked Out" or "In sight": Unknown

Ore Probable: Considered to be large ore body

13. Mine Workings—Amount and Condition: Shaft 450 feet deep, in good condition

	No.	Feet	Condition
Shafts	1	450	Good
	2	40 ft.	Good
Raises			approximately 200 feet of open cut work
Tunnels			
Crosscuts		Some	
Stopes			Has been considerable stoping

14. Water Supply: Unknown

15. Brief History: Uhknown

16. Remarks:

17. If Property for Sale, List Approximate Price and Terms: $15,000 - $5000.00 down

18. Signature: John L Meyer

IRON KING ASSAY OFFICE
ASSAY CERTIFICATE

BOX 247 — PHONE 632-7410
HUMBOLDT, ARIZONA 86329

REGISTERED ASSAYER CERTIFICATE NO. 2978 WALTER G. STATLER Date Signed...... ARIZONA, U.S.A.

ASSAY MADE FOR
David Green-Lee
Box 332
Yarnell, Az. 85362

March 5, 1981

REF. NO.	DESCRIPTION	oz/ton Au	oz/ton Ag	/	% Fe	% Pb	% Zn	% Cu
6-17	#1	0.486	1.21			Nil		
-18	#2	2.126	3.20			4.98		
-19	3	0.538	0.94			0.62		
-20	4	0.014	1.93			0.24		
-21	5	0.002	0.66					
-22	6	0.055	0.68					
-23	7	1.750	0.41					

CHARGES $78.75

ASSAYER ____________

IRON KING ASSAY OFFICE

ASSAY CERTIFICATE

BOX 247 — PHONE 632-7410
HUMBOLDT, ARIZONA 86329

REGISTERED ASSAYER
CERTIFICATE NO. 2978
WALTER G. STAPLER
Date Signed 3/19/78
ARIZONA, U.S.A.

ASSAY MADE FOR
David Green-Lee
Yarnell, Ariz.

March 19, 1978

REF. NO.	DESCRIPTION	oz/ton Au	oz/ton Ag		% Fe	% Pb	% Zn	% Cu
~~6-2~~	~~Black Dike Extn. #1bench~~	~~.882~~	~~0.76~~			~~0.70~~		

ASSAYER ______

CHARGE ~~$8.50 paid~~

IRON KING ASSAY OFFICE
ASSAY CERTIFICATE

BOX 247 — PHONE 632-7410
HUMBOLDT, ARIZONA 86329

REGISTERED ASSAYER CERTIFICATE NO. 2798 WALTER G. STATLER Date Signed 9/1/77 ARIZONA, U.S.A.

Y
E

David Green-lee
P.O. Box 332
Yarnell, Ariz.

Sept. 1, 1977

F. O.	DESCRIPTION	oz/ton Au	oz/ton Ag		% Fe	% Pb	% Zn	% Cu
-6	#1 Ext. #1, Back Xcut	1.042	12.86			40.90		
-7	#2 " " "	1.238	11.60			37.50		
-8	#3 " " "	4.02	4.18			12.90		

GES ______________ ASSAYER ______________

IRON KING ASSAY OFFICE
ASSAY CERTIFICATE

BOX 247 — PHONE 632-7410
HUMBOLDT, ARIZONA 86329

REGISTERED ASSAYER CERTIFICATE NO. 2978 WALTER STATLER Date Signed 4/5/77 ARIZONA, U.S.A.

ASSAY MADE FOR
David Green-Lee
P.O. Box Box 332
Yarnell, Ariz. 85362

Black Dike Enterprise

May 5, 1977

REF. NO.	DESCRIPTION	oz/ton Au	oz/ton Ag		% Fe	% Pb	% Zn	% Cu
4-27-17	#1	3.190	0.41					
-18	#2	.98	0.50					
-19	#3	1.118	1.105			0.70		

CHARGES ____________

ASSAYER ____________

IRON KING ASSAY OFFICE

ASSAY CERTIFICATE

BOX 14 — PHONE 632-7410

HUMBOLDT, ARIZONA 86329

REGISTERED ASSAYER
CERTIFICATE NO. 2978
WALTER G. STATLER
Date Signed 5/27
ARIZONA, U.S.A.

ASSAY MADE FOR

DAVID GREEN*LEE
P.O. Box 332
Yarnell, Ariz. 85362

May 27, 1976

DESCRIPTION	oz/ton Au	oz/ton Ag		% Fe	% Pb	% Zn	% Cu
Ref no							
5-24-16 ~~xx2~~ #1	.866	0.63					
5-24-17 #2	Tr	0.40					

CHARGES $12.00 paid

ASSAYER____________________

THE ORIGIN OF GOLD-BEARING QUARTZ VEINS IN PRECAMBRIAN ROCKS NEAR WICKENBURG, ARIZONA

by Anne Marie Fischer

THE ORIGIN OF GOLD-BEARING QUARTZ VEINS IN PRECAMBRIAN ROCKS NEAR WICKENBURG, ARIZONA

by

Anne Marie Fischer

A Thesis Submitted to the Faculty of the

DEPARTMENT OF GEOSCIENCES

In partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCES

In the Graduate College

THE UNIVERSITY OF ARIZONA

1 9 8 4

ACKNOWLEDGMENTS

I would like to acknowledge Amoco Minerals for financial support and geochemical analyses, and the land owners, Mrs. Thompson, Mr. Campbell, and Mr. Housley, for their cooperation. I would like to thank my family and friends who acted as field assistants, Rudy Fischer, Marie Fischer, Nancy Riggs and Andrew Arnold, and my advisor, Dr. Guilbert, for their support and patience during all phases of this project.

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ABSTRACT

A considerable number of gold deposits occur in Precambrian rocks in central Arizona, recognizing that they might be either syngenetic to their host rocks or introduced into them, the purpose of this study has been to determine the origin of the gold-bearing quartz vein contents and the role of the Precambrian host rocks and host rock environments in their formation. Detailed geologic mapping, structural analysis, and petrography were employed in the detailed study of three small selected areas that contain previously mined quartz veins in Precambrian host rocks. Results obtained from study of fluid inclusions and a K-Ar date were of limited use.

It is concluded that the Precambrian rocks of this study are part of a 1770 to 1820 m.y. old greenstone belt with lithologies, stratigraphy, and mineralization similar to those of Archean greenstone belts. The gold-bearing veins are not undisturbed exhalites. The multi-stage model proposed for the origin of the veins involves subeconomic Precambrian gold concentration and Laramide epithermal reconcentration to economic levels.

CHAPTER 1

INTRODUCTION

Gold production from deposits in the Bradshaw Mountains and Vulture Mountains in central Arizona began in the 1860's as placer mining. Only the Vulture Mine proved productive as a lode deposit before 1900; lode vein mines in this area were successfully developed early in the twentieth century only until general closure of the district by gold economics before and during the Great Depression. Recent geologic studies have identified the host rocks of many of the deposits in the Wickenburg area as Precambrian in age, the Vulture Mine and the Octave Mine being two important examples. Production from the Wickenburg area totals approximately 24,000 kilograms of gold, some percentage of which might have been localized by Precambrian lithotectonic phenomena.

The purpose of this study was to determine the origin of gold-bearing quartz veins to the Precambrian rocks of the Wickenburg area through the use of detailed geologic mapping, structural analysis, petrography, fluid inclusion studies, and isotopic dating. The study was instigated in part because although early authors generally ascribed gold deposits in the area to mid-Tertiary volcanic processes, many of the mined occurrences actually occur not in Tertiary volcanic outcrops but in Precambrian basement rocks. Thus association with Tertiary processes is not assured, and possible new genetic models for this area might apply. The geologic environment in which the

Wickenburg gold deposits are found is similar enough to gold deposits of the Canadian and South African Archean greenstone belts to suggest such a study. Accepted models of formation of gold deposits in Archean greenstones include a primary Precambrian syn-sedimentary exhalative origin (Ridler, 1976) and Precambrian burial-metamorphic secretion (Kerrich and Fryer, 1978) or metamorphic secretion (Boyle, 1979; Zimmerman, 1983). In contrast to most Archean greenstone terranes, the presence of both Laramide granodiorite stocks and mid-Tertiary volcanic rocks in central Arizona requires the consideration of gold ores as original Precambrian segregations, as Proterozoic gold deposits hydrothermally remobilized during the Laramide or Oligocene-Pliocene, or as essentially 'new' Mesozoic-Cenozoic deposits derived elsewhere and emplaced in the Precambrian rocks of the region. Exploration for unexposed gold deposits in Precambrian rocks in central Arizona depends upon determination of the origin of known deposits and understanding the source of their economic metals. This study is designed to shed some light on the role which the Precambrian host rocks played in the formation of these deposits.

Method

Many geologic tools were used during this study. Twenty-one prospects in the general vicinity of Wickenburg were visited in order to determine their suitability for this project. Of these, fifteen were determined to be of little use due to poor exposure, inaccessibility, or the nature of their host rocks; their characteristics are listed in the Appendix, Table 1. Three areas, each of which contain two of the prospects, were chosen for detailed study (Fig. 1). Detailed geologic mapping was undertaken during October and November 1982, to define local stratigraphy, mineralization, alteration and structure. Sixty-two geochemical samples, including vein material, alteration material, and non-mineralized background material, were analyzed by fire assay for Au, Ag, Pb, Zn and Cu. The results are compiled in the Appendix, Table 2. A petrographic study of 36 thin sections was undertaken to determine protolithologies, metamorphic and alteration effects, and vein and alteration mineralogies mapped. Structural data were analyzed to determine local structural fabric and the relationship of quartz veins to metamorphic foliation. A K-Ar date on sericite from the alteration envelope associated with quartz veins established the timing of mineralization. Fluid inclusion studies aided in determining environments of formation of the quartz veins.

Organization

This paper concentrates on information pertinent to determination of the origin of the gold-bearing quartz veins. Past production of the mines in the area, and a summary of early investigations and the regional geology, are presented as background. Data are presented in three parts. First, lithologic characteristics are described in outcrop, in hand sample, and microscopically. Second, structural data including the orientation of metamorphic foliation and the orientation and relationship of quartz veins to that foliation are presented. Third, mineralization and alteration are described in outcrop, in thin section, through fluid inclusion studies, and through the use of

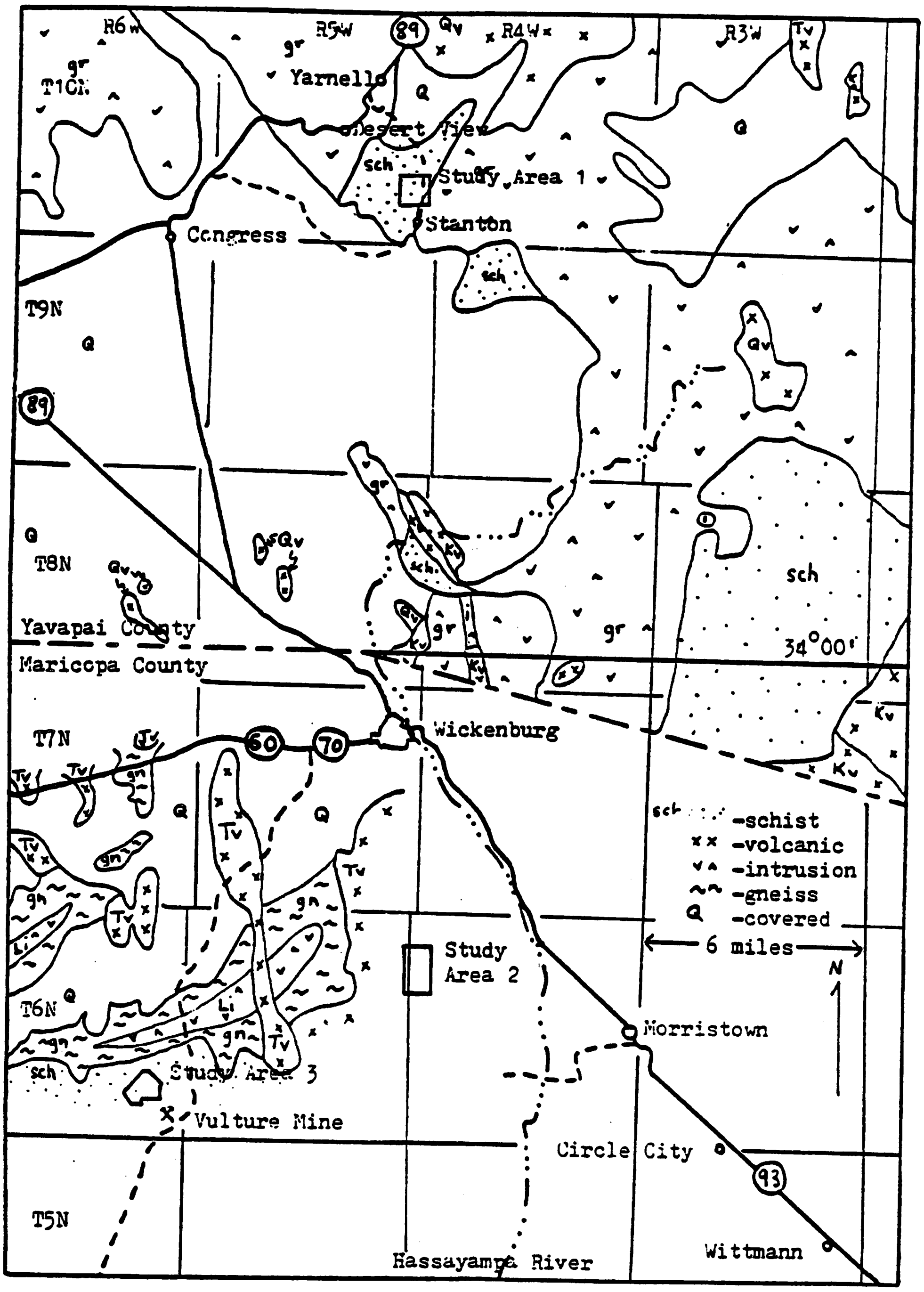

Fig. 1. Location map of study areas and generalized geologic map. Geology from Ariz. Bur. Mines, 1958, Geologic Map of Yavapai County, Arizona, and Rehrig, Shafiqullah, and Damon, 1980.

isotopic dating. Finally, a geologic interpretation is presented which calls on a combination of data from this and past studies.

The results of this project show that the Precambrian rocks in central Arizona are part of a 1770 to 1820 m.y. old greenstone belt with lithologies, stratigraphy, and mineralization similar to those of Archean greenstones. It was determined that the gold-bearing quartz veins in Proterozoic rocks of this study are not generally of an exhalative origin. The model proposed for their formation involves Precambrian sub-economic gold concentration by metamorphic or sedimentary processes and later Laramide epithermal reconcentration to economic levels.

Early Investigations

There have been many past reports on mining activity in the general vicinity of this study area; most were focused on the Vulture Mine. Wheeler (1872), Penfield (1881), Moore (1902), Purlington (1907), Hutchinson (1911), Hafer (1911), Dinsmore (1911), Defty (1912), McClintock (1928), and Thompson (1930) are the early authors on the subject. Metzger (1938) included a production and brief geological description of all of the gold producing mines of that time in a U.S. Bureau of Mines report on gold mining and milling in the Wickenburg area.

About 50% of the gold produced in the area has come from only two mines, the Octave Mine and the Vulture Mine. The Octave Mine, in the southern Weaver Mountains, exploited a quartz vein in granite and produced about 440,000 metric tons of ore containing gold, silver, lead, and copper (Arizona Bureau of Geology and Mineral Technology, confidential files, 1983). Gold and silver production was over $2,000,000 from 1900 to 1905 according to Wilson (1967) but this figure may be too high.

The Vulture Mine, the most productive one in the area, is located in the Vulture Mountains. It has been described (Wilson, 1967) as a vein system that occupies a fault zone. The hanging wall is partly granite-porphyry and partly schist; the footwall is schist. Near the vein, sericite is abundant. The Vulture vein strikes slightly north of west and dips 45° N, parallel to the metamorphic foliation in the footwall. The Vulture Mine produced a total of 9,380 kilograms of gold from 1866 to 1917 (Wilson, 1967). It has been the target of several reinterpretive exploration ventures in recent years.

CHAPTER 2

REGIONAL GEOLOGICAL HISTORY

Precambrian Rocks

Precambrian rocks crop out in a northwest-trending belt in central Arizona (Fig. 2), and have been described in detail by Anderson, et al. (1971), Anderson and Blacet (1972), Bouley and Hodder (1976), DeWitt (1976), and Donnelly and Hahn (1981). The Precambrian rocks in this study area are correlated with those described by these authors as part of the Yavapai Series, a provincial time-stratigraphic unit representing the interval from 1770 $\pm$ 10 to 1820 m.y. (Anderson, et al., 1971). The Big Bug Group of the Yavapai Series includes the Green Gulch Volcanics, Spud Mountain Volcanics, and Iron King Volcanics in the Cleator Belt and the Mayer District (Fig. 3; Donnelly and Hahn, 1981). The Green Gulch Volcanics is a sequence of basaltic and rhyolitic flows and rhyolitic to andesitic tuffaceous rocks. The lower unit of the Spud Mountain Volcanics is characterized by volcanic breccia, and the upper unit is composed of bedded andesitic tuffaceous rocks. The Iron King Volcanics consists of a lower and an upper unit; the lower unit comprises pillow and amygdaloidal andesitic and basaltic flows with interbedded sediments and rhyolitic flows and tuffs. The upper sequence is mixed mafic and rhyolitic tuffaceous rocks.

The Texas Gulch Formation is stratigraphically above and distinct from units in the Yavapai Series. Field relationships indicate the age of this formation to be less than that of other Yavapai units

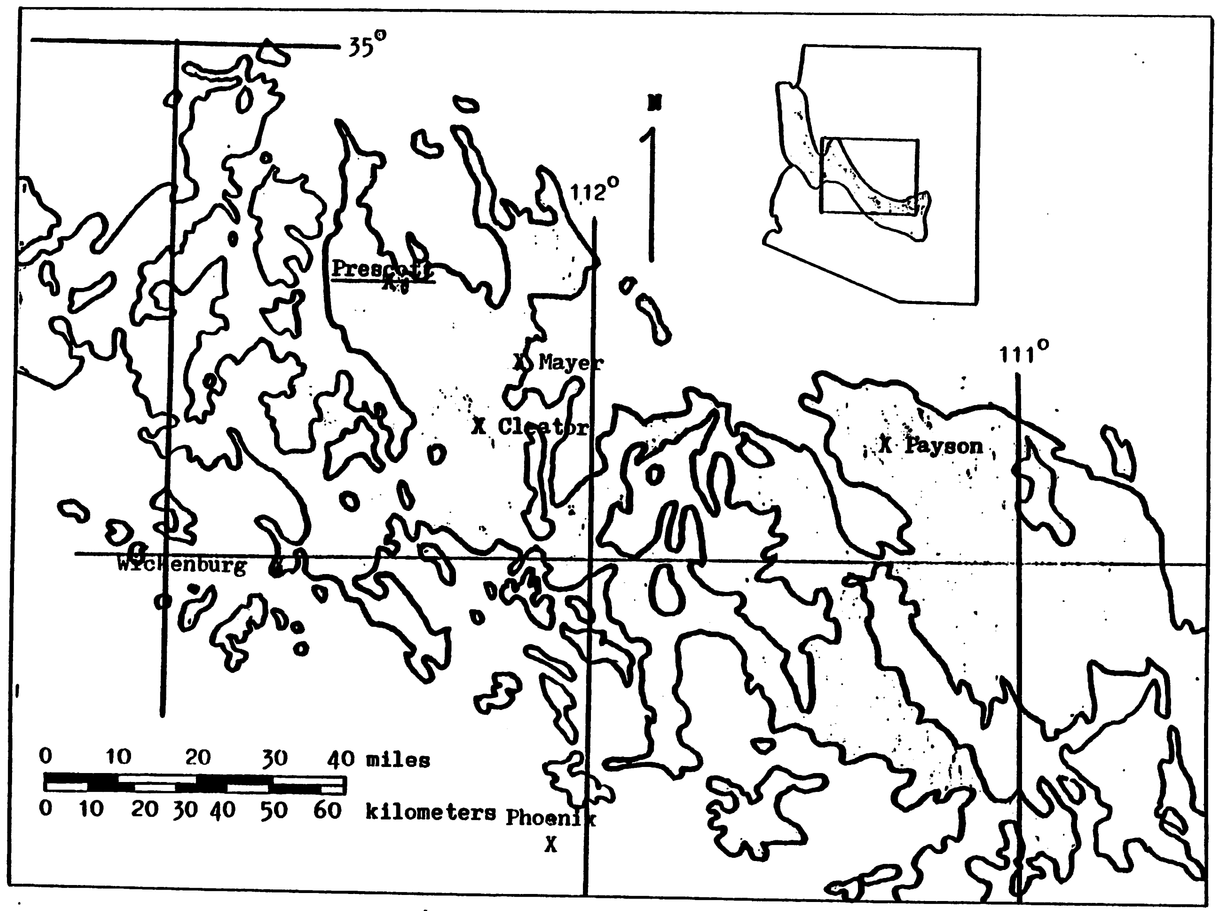

Fig. 2. Geologic map showing distribution of Precambrian rocks in central Arizona. Inset shows area included. After Donnelly and Hahn (1981).

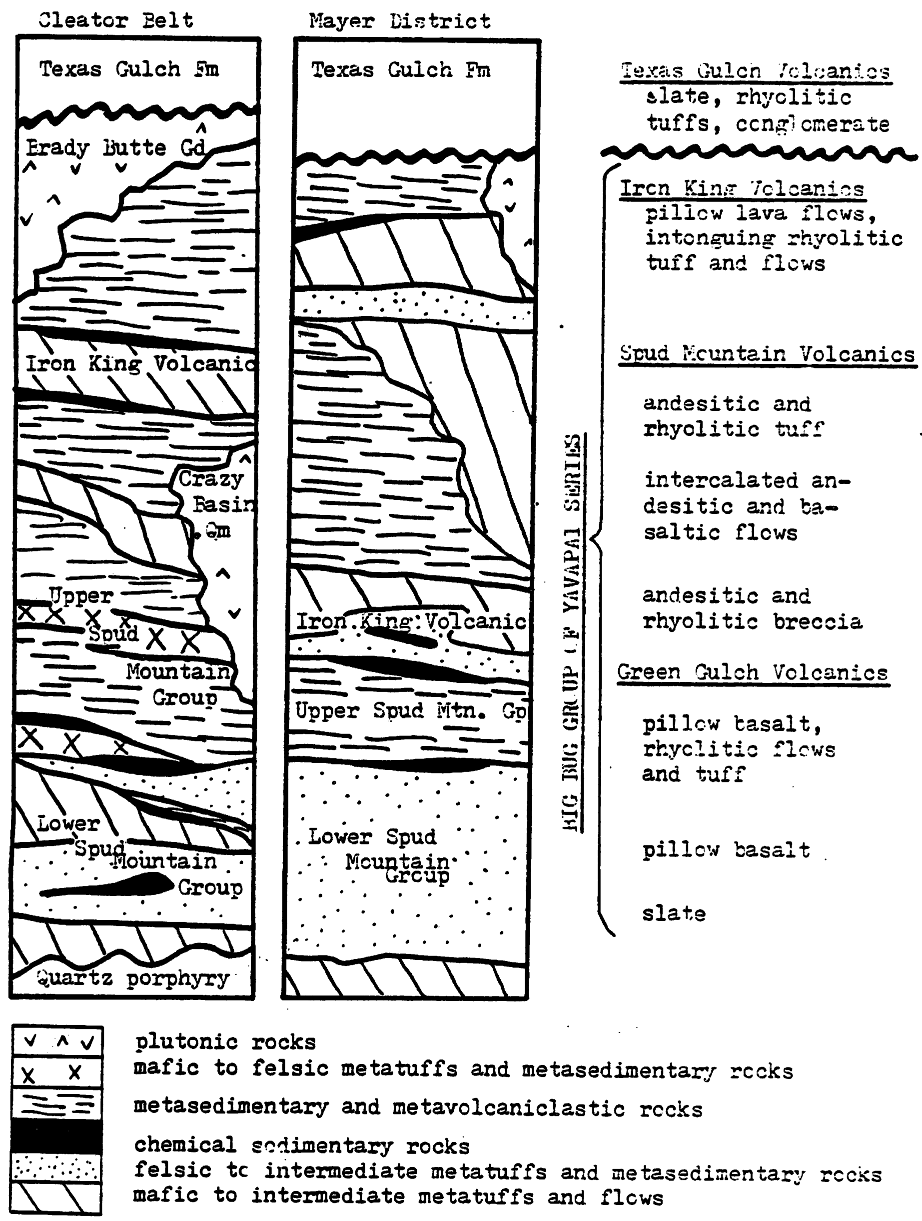

Fig. 3. Generalized stratigraphic columns from the Cleator Belt and the Mayer District (Donnelly and Hahn, 1981) and a descriptive stratigraphic column of the Big Bug Group of the Yavapai Series.

and thus younger than 1770 ± 10 m.y. The Texas Gulch Formation in the Poland Junction - Prescott area is composed of rhyolitic tuff and purple slate (Anderson and Blacet, 1972).

The presence of Precambrian intrusive rocks in and near the study areas of this report is well documented. The Big Bug Group includes large masses and dikes of quartz prophyry in the Spud Mountain Volcanics and Iron King Volcanic units; gabbro dikes occur in the Iron King Volcanics (Anderson and Blacet, 1972). A coarse-grained, porphyritic granite crops out along U.S. Highway 60-70 west of Wickenburg and between the Vulture Mountains and Caballeros Peaks (Fig. 1; Rehrig, et al., 1980). A Precambrian gneissic granite forms much of the basement northwest of the Vulture Mine (Rehrig, et al., 1980).

Phanerozoic Rocks

The Phanerozoic rocks of the region are composed only of Tertiary volcanic and intrusive rocks. A geochronologic study of the Tertiary rocks of the Vulture Mountains has established the presence of the Eocene Wickenburg Batholith (Fig. 1), dated at 68.4 m.y., that intrude the Precambrian basement (Rehrig, et al., 1980). Tertiary volcanic rocks lie directly on both Precambrian basement and on eroded surfaces of this Tertiary pluton. The composition of the volcanic succession progressed from calc-alkaline to alkaline during the Miocene epoch from 26 to 16 m.y. ago (Rehrig, et al., 1980). Rock types within the volcanic succession include vitrophyre, ashflow tuff, welded tuff, breccia, agglomerate, and volcanic flows. North-northwest striking porphyritic dikes intrude these volcanic rocks, and a 13.5-m.y.-old basalt flow overlies all of these rocks in angular unconformity. Listric normal faulting occurred in the Vulture Mountains during the interval 25-15 m.y. before present (Rehrig, et al., 1980).

Studies undertaken 65 kilometers northeast of the Vulture Mountains in the Bradshaw Mountains revealed similar geological histories. The late Cretaceous or early Tertiary Crown King granodiorite is found to intrude Precambrian rocks near Crown King (DeWitt, 1976). A granodiorite stock at Walker was dated at 64 m.y. (Anderson and Blacet, 1972), and one near Big Bug Creek was dated at 70 m.y. (Anderson, 1968). Tertiary rhyolitic dikes were intruded parallel to metamorphic foliation. Late Tertiary basaltic dikes were intruded perpendicular to metamorphic foliation and are considered to be feeder dikes to flat-lying basalt flows near Crown King (DeWitt, 1976). The Hickey Formation on Mingus Mountain is composed of late Miocene-early Pliocene basalt flows (Anderson and Blacet, 1972).

CHAPTER 3

LITHOLOGY, STRUCTURE, AND MINERALIZATION

Three areas appropriate to the goals of this study of precious metal habitat were chosen for detailed study (Fig. 1). To preserve consistency, each area will be described in terms of location, lithology, structure, mineralization, and alteration. A cohesive interpretation of the Wickenburg vicinity incorporating these descriptions will be presented in a separate chapter.

General Lithologic Characteristics

The Precambrian rocks in all of the areas studied have undergone greenschist to amphibolite facies metamorphism. A lithologic distinction between mafic schist and felsic schist has been made in the field and on the accompanying maps. 'Mafic schist' includes mineralogically similar lithologies of diverse origin including metavolcanic flows, fine- to coarse-grained metasedimentary rocks, and chemical sediments. 'Felsic schist' units contain metacherts, metavolcanic tuffs, and metasedimentary protolithologies. The Precambrian granite which occurs in the Paydirt area (Fig. 4, located in back pocket) is coarse-grained and locally foliated.

Phanerozoic rocks in the thesis area are principally Tertiary volcanic rocks and dikes. Laramide age granitic rocks of about 65 m.y. (Rehrig, Shafiqullah, and Damon, 1980) occur in Area 1 at Stanton (Fig. 1). These younger plutonic units are distinguished from Precambrian granites by their fresh, non-foliated, relatively fine-grained nature. Pegmatite dikes which occur in the Morristown area (Study Area 2) are presumed to be related to the intrusion of Laramide stocks.

General Structural Characteristics

A distinct foliation caused by alignment of mineral grains is apparent in all of the rocks classified as Precambrian schist. In felsic schist, muscovite and sericite grains are aligned; in mafic schist biotite, chlorite, hornblende, and sericite show alignment.

General Alteration and Mineralization

The description of alteration and mineralization is limited to occurrences in Precambrian rather than younger rocks in order to eliminate consideration of assured involvement of Tertiary mineralization. The gold-bearing quartz veins in Area 1 (Stanton) will be described in detail; mineralization occurrences in Areas 2 and 3 (Morristown and Paydirt) will be described only generally. Quartz veins and mineralized shear zones are generally concordant to metamorphic foliation in each of the study areas, but locally as much as 10° of discordance between vein walls and metamorphic foliation was observed (Figs. 5, 6, 7).

Area 1, Stanton

Location

Area 1 is located in the southern portion of the Weaver Mountains, T10N R5W Sec 25, in Yavapai County (Fig. 1). It is 22 kilometers due north of Wickenburg and 0.8 kilometers north of the town of

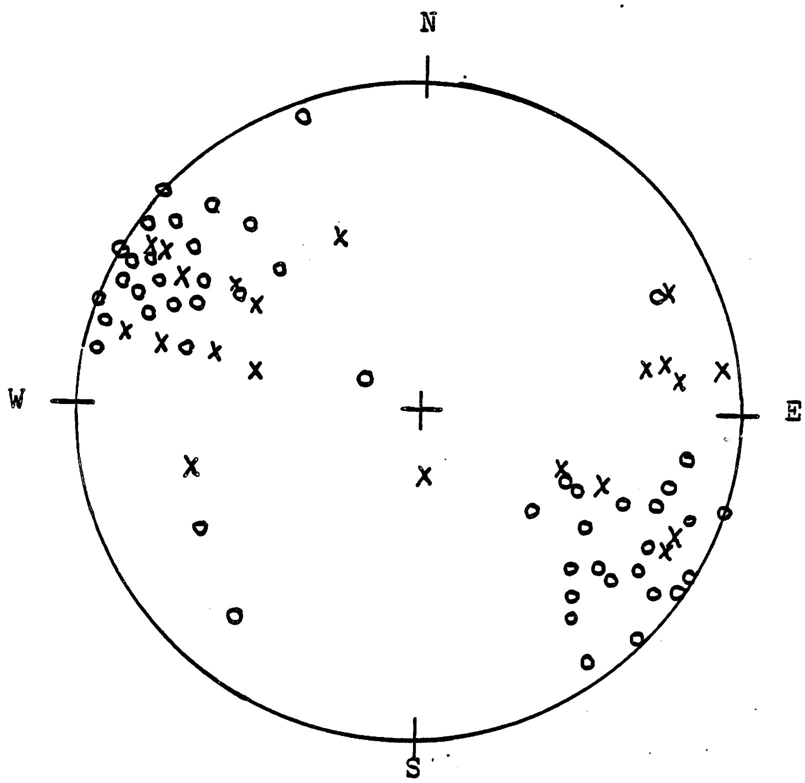

Fig. 5. Stereoplot of poles to metamorphic foliation (o) and quartz veins (x) from Study Area 1 near Stanton, Arizona.

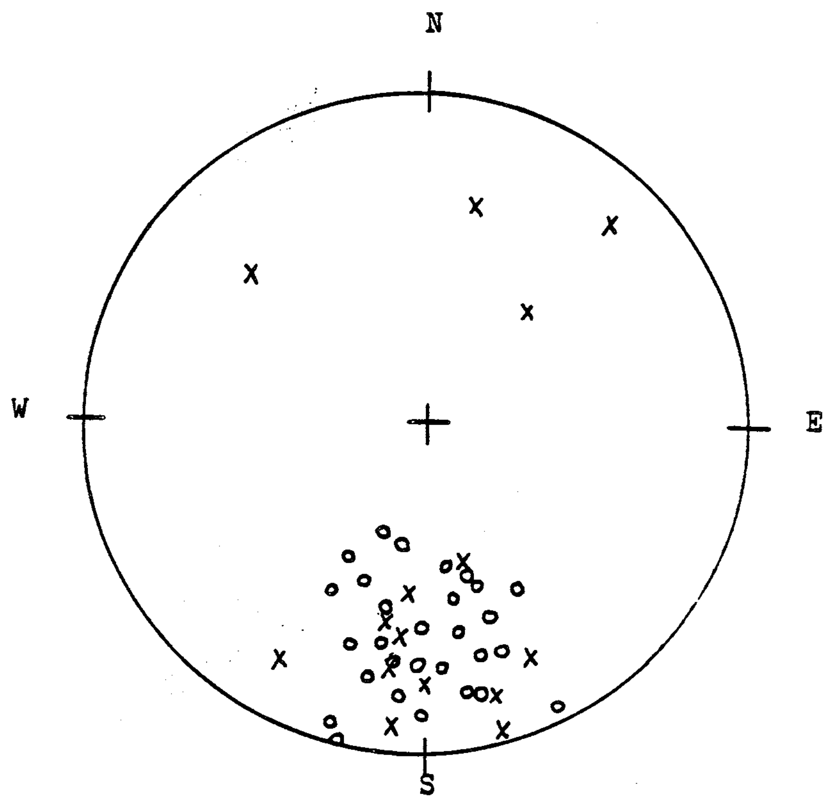

Fig. 6. Stereoplot of poles to metamorphic foliation (o) and quartz veins (x) from Study Area 2 near Morristown, Arizona.

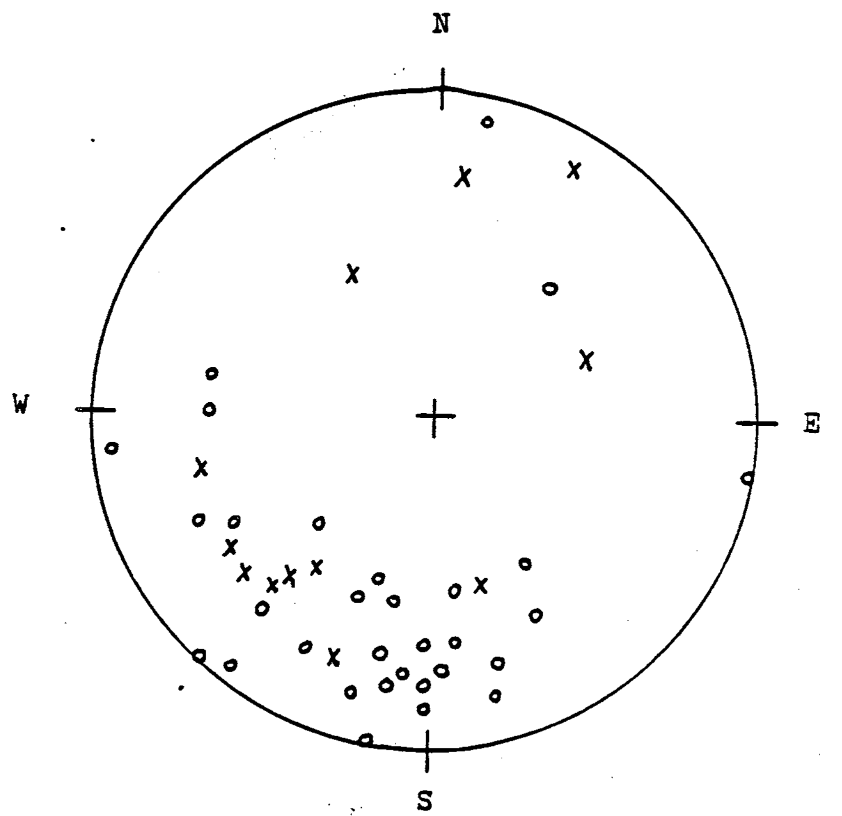

Fig. 7. Stereoplot of poles to metamorphic foliation (o) and quartz veins (x) from Study Area 3 near the Paydirt Mine, Arizona.

Stanton, Arizona. Access is by graded dirt road east from Highway 89, 4 kilometers northeast of Congress and 0.8 kilometers southwest of Yarnell. The terrain of Area 1 is rugged (Fig. 8). Elevation ranges from 1071 meters in Antelope Creek to 1255 meters on the hilltops along the western margins of the map area.

Numerous small prospect pits and trenches are evidence of past mining activity. When runoff permits, placer activity is ongoing along both Antelope and Indian Creeks. The Lucky Johnnie and Katie gold mine is located near the eastern margin of the field area. The Red Metal Mine, in the center of the east half of sec 25 T10N R5W, produced 21.3 metric tons of ore between 1923 and 1941. From this ore, a recorded 227 kilograms of copper (0.53%), 1,450 grams of silver (33.9 ppm), and 341 grams of gold (7.9 ppm) were recovered.

Lithology

Precambrian rocks in Area 1 near Stanton are exposed both in washes and along ridges. 'Mafic schist' protolithologic terms are used for these rocks. The well-exposed basalt in Antelope Creek lacks relict textures or structures. It is dark grey to greenish grey in color and is iron-oxide stained on weathered surfaces. Gradational changes from massive non-foliated basalt to basalt with a pronounced schistosity occur over distances on the order of one meter. Massive basalt is resistant and forms steep walls in washes; schistose basalt is friable. Phenocrysts of aligned labradorite and quartz are apparent in thin section. The groundmass is mostly aligned secondary chlorite and lesser calcite. Pyrite occurs microscopically in veinlets and as

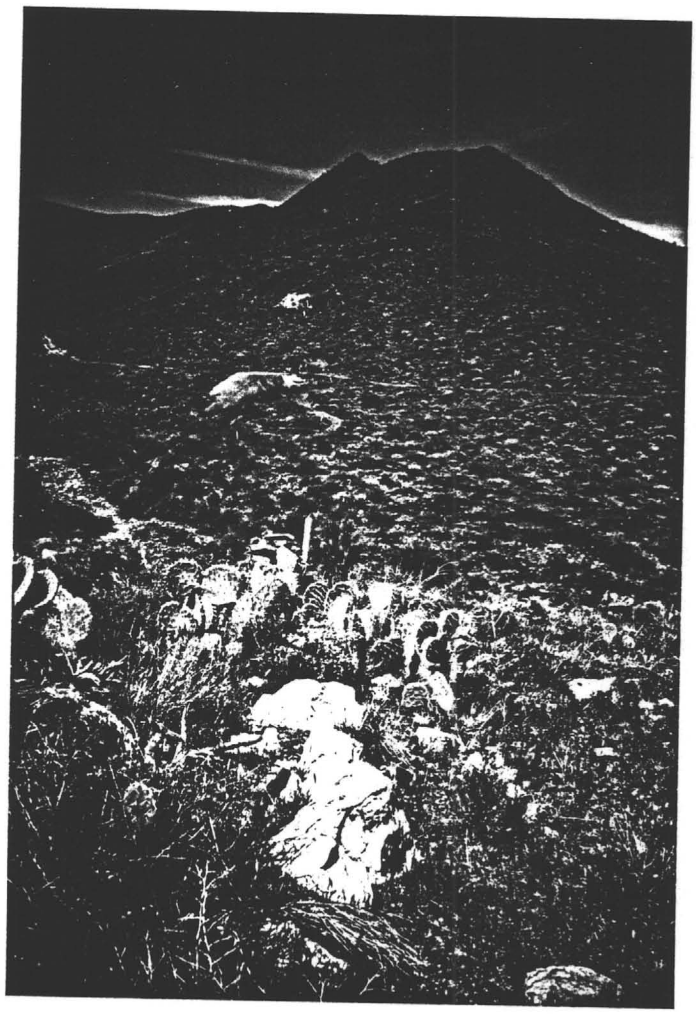

Fig. 8. Topography of Study Area 1 from white quartz vein in foreground trending into the Red Metal Mine approximately 450 meters north.

minor euhedral crystals. Basaltic rocks extend parallel to metamorphic foliation in Antelope Creek and probably under the alluvium to the east, where it crops out at the Lucky Johnnie and Katie Mine.

Fine-, medium-, and coarse-grained sediments are exposed along Indian Creek from near the confluence of Antelope Creek northwest to the boundary of the field area. Intercalated siltstone, sandstone, and conglomerate comprise 600 meters perpendicular to metamorphic foliation. Relict sedimentary structures are manifested in distinct size differentiations between silts, sands, and pebbles, but no definitive facing-direction indicators were found. Stretching parallel to foliation is common and extreme, with distension of as much as 10 to 1 in some cobbles. Clast lithologies within the conglomerates include chert, granite, and mafic volcanic rocks. The conglomerate units contain silt layers and gradational silt-sand-pebble units. Some sandstone units are homogeneous across 10 meters perpendicular to foliation. These sandstones contain quartz grains up to 2 mm in diameter and relict plagioclase grains now altered to clay. The siltstone, sandstone, and groundmass of the conglomerate are dark grey to greenish grey in color, with light reddish grey clasts.

Two types of oxide-facies banded-iron-formation, magnetite-hematite-rich and chert-rich, occur within the sediment pile. The magnetite-hematite-rich banded iron formations are discontinuous units about 0.5 meters thick consisting of thin, 5-mm-to-less-than-1-mm-thick alternating beds of magnetite and hematite with minor chert. Relict soft sedimentary deformation structures are preserved as sandstone-siltstone flame structures protruding into iron formations. The magnetite-hematite-rich iron formations weather to black resistant units. Oxidation at some localities has resulted in the formation of pervasive surficial iron-oxides. Chert-rich banded iron formations consist of silica layers with thin hematite or magnetite horizons. Microscopic load features and grain size differentiation between layers is apparent upon petrographic examination. These thin resistant beds are dark red hematite-stained in color and are more common than the magnetite-hematite-rich type.

Exposures of felsic schist in the study area near Stanton are confined to limited areas in the western half of the map area. Felsic schist occurs as narrow, discontinuous bands within mafic schist, and as one fairly continuous unit seven meters thick. This main unit parallels metamorphic foliation and extends northward from the southern boundary of the area continuously for about 1100 meters. These rocks are light tan to orange in color. They contain quartz phenocrysts less than 3 mm in diameter and minor biotite in a fine-grained felsic groundmass. Iron oxides and minor talc occur on weathered surfaces.

Another type of foliated felsic rock occurs as silica lenses within mafic schist. An exposure of this lithology occurs about 150 meters west of the main felsic schist body. It crops out in three locations, the largest of which is 335 meters long parallel to foliation. The other two exposures are smaller lenses along strike. Petrographic examination of these rocks reveals their chert protolithology; they are composed of intergrown microscopic quartz grains with minor iron oxide staining, and they exhibit an aligned sericite and chlorite overprint.

Rich Hill, just east of the study area, is composed of the granite that extends into the field area on the eastern boundary. The rock is generally resistant but weathers along fractures into large rounded boulders. The granite is composed of 1-3 mm diameter quartz grains, potassium feldspar, and minor biotite, and hornblende in a fine-grained groundmass of quartz, potassium feldspar, and plagioclase feldspar. Pervasive fractures in the rock obscure individual potassium feldspar grains. Biotite is bleached light green. Iron-oxide-stained groundmass surrounds each hornblende crystal.

Tertiary volcanic rocks capping the hills on the western boundary of the study area are dark grey to black and extremely fine-grained. They are fresh and weakly banded parallel to the contact with Precambrian schist. Minor amounts of hydrous iron-oxides occur on weathered surfaces in these Tertiary volcanic rocks.

Structure

Metamorphic foliation in the Precambrian schist of the Stanton area is well defined. The orientation of foliation averages about N 30° E and dips from 70° NW to 70° SE (Fig. 5). Evidence of extension is present. The only horizons within the schist which are competent enough to retain evidence of folding are the magnetite-hematite-rich facies of the banded iron formations (Fig. 9) and the conformable silica lenses (Fig. 10). Both of these units exhibit isoclinal folds with limbs parallel to local metamorphic foliation. Similar folds (Ramsay, 1967) are evidence of shear in a direction parallel to metamorphic foliation. Stretched-pebble conglomerates and fine-grained

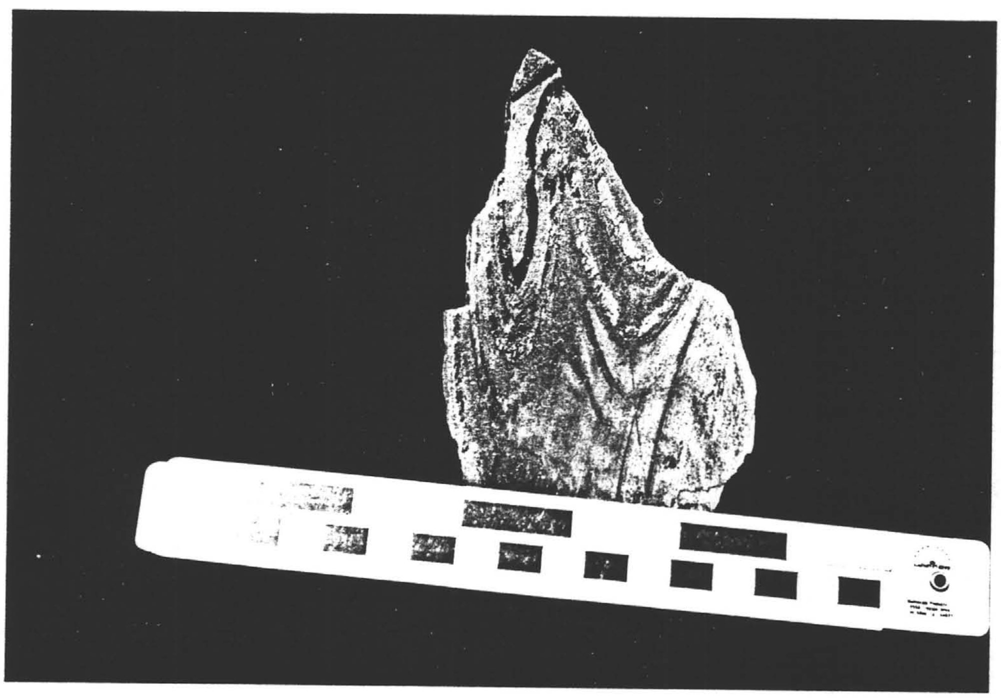

Fig. 9. Slab of folded banded iron formation from Study Area 1 near Stanton, Arizona.

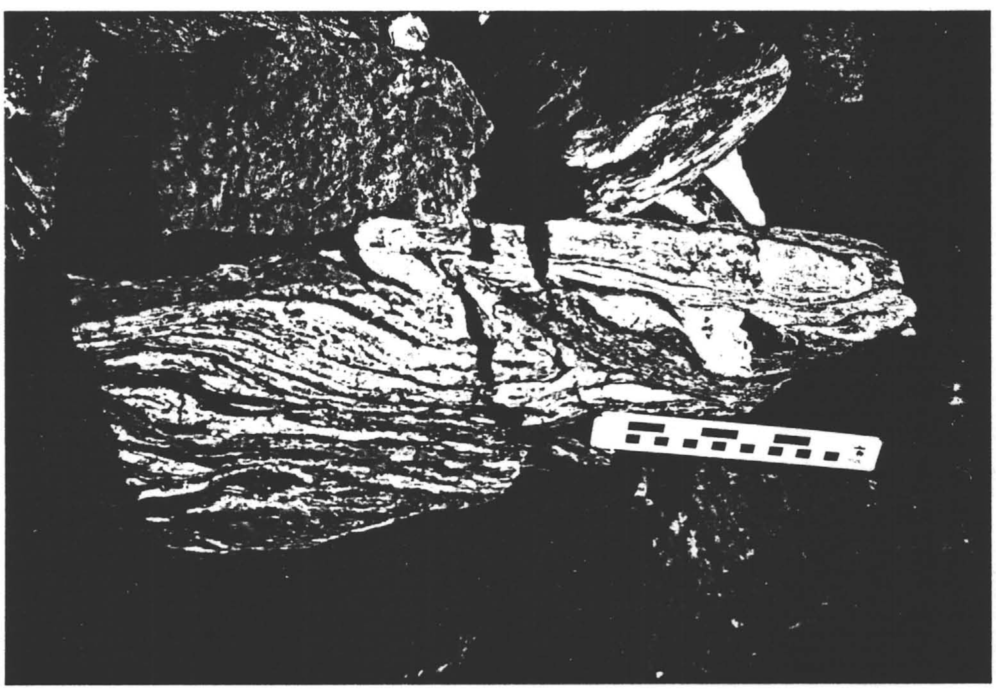

Fig. 10. Folded silica lens from the Lucky Johnnie and Katie Mine near Stanton, Arizona.

sediments smeared parallel to foliation provide additional evidence of shear parallel to metamorphic foliation. The felsic schist units parallel the trend of metamorphic foliation. However, the mafic schist-felsic schist contact may vary by as much as 15^{o} from local foliation orientation. The contact is clear and best defined in the field by the contrast of dark mafic schist against light felsic schist. As the contact of the felsic unit is approached, thin horizons of felsic schist become increasingly common within the mafic schist.

The Laramide granite-Precambrian schist contact is covered by Quaternary alluvium. It is inferred to occur at a break in slope below the distinctive granite cliffs.

The Tertiary volcanic rock-Precambrian schist contact is defined by an abrupt change in metamorphic grade of the rocks. In many locales, Precambrian sediments are in contact with local Tertiary basal volcanic breccia, making the distinction unclear; however, the Tertiary rocks are fresh and non-foliated, and the Precambrian rocks are schistose.

Mineralization and Alteration

Mineralization and alteration in the Stanton area are described morphologically, mineralogically, petrographically, through fluid inclusion study, and through isotopic dating. The poorly exposed veins are visible as rare resistant white quartz outcrops. Numerous pits and trenches delineate the location of the veins where they are covered. They split from single, one-meter-wide veins to four or five parallel veinlets about 10 cm wide.

The mineralogy of the veins is simple; their modal composition is 92% milky white quartz, 4% ankerite, 2% euhedral tourmaline, 1% pyrite. In some specimens up to 5 vol.% pyrite occurs as blebs and stringers. Minor euhedral quartz occurs in vugs.

Rare quartz microveinlets are visible upon microscopic examination of the vein material. The veinlets show cross-cutting and en echelon relationships. Also apparent in thin section is the occurrence of minor individual muscovite grains and hematite along quartz boundaries, and calcite within quartz.

The results of a vein-quartz fluid inclusion study carried out in the University of Arizona Fluid Inclusion Laboratory indicate two distinct homogenization temperatures, one around 215°C and one around 355°C. An average freezing point depression of -7.9°C corresponding to approximately 12% NaCl equivalent was obtained from these samples (Fig. 11).

The quartz veins are contained within a 10-meter-wide alteration zone. Exposure of the alteration zone is good where the quartz veins are exposed and ranges from clear to indistinct in other areas. The envelopes are easily distinguishable as friable, bleached, and iron-oxide-stained zones in the dark mafic schist; it is difficult to discern alteration in the felsic schist.

Mineralogical determination is best made petrographically. Alteration mineralogy is 30% quartz, 30% sericite, 20% chlorite, and 20% hematite, calcite, tourmaline, and biotite. Most of the sericite is physically and optically aligned parallel to metamorphic foliation; some occurs as unoriented fine-grained aggregates. Cross-cutting

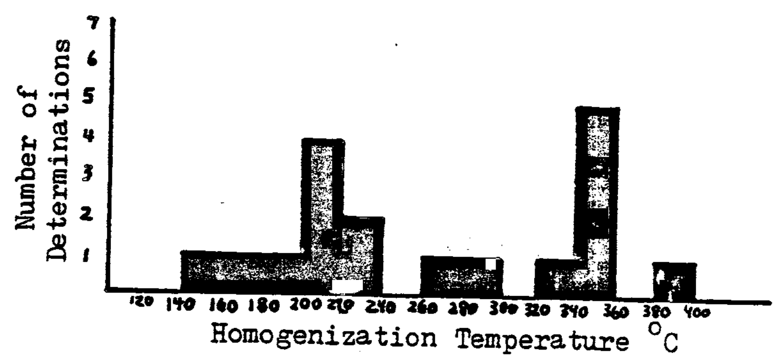

Fig. 11. Fluid inclusion data representing uncorrected fluid inclusion filling temperatures from vein quartz from Study Area 1 near Stanton, Arizona.

quartz micro-veinlets occur; the earlier veinlets are finer grained than the later veinlets by a factor of 10. Minor hematite veinlets cross-cut quartz veinlets. A K-Ar date from the Laboratory of Isotope Geochemistry, University of Arizona, on sericite from the alteration zone gave a 430 ± 10 m.y. age.

Area 2, Morristown

Location

Area 2 is located 8 kilometers due south of Wickenburg and 8 kilometers west of Morristown in the eastern portion of the Vulture Mountains (sec 7 T6N R4W) in Maricopa County (Fig. 1). Access is by Gates Road west from Highway 89 0.8 kilometers south of Morristown graded to the Hassayampa River. The quality of the road deteriorates on the west side of the Hassayampa River, but it is passable with a two-wheel drive vehicle in dry weather. Elevation ranges from 800 meters on a hilltop to 689 meters in washes along the southern and eastern area boundaries.

Evidence of past mining activity is mainly abandoned workings. Pegmatites were exploited in the northwest corner of the map area (Fig. 12, located in back pocket) and in the Dove Mine in the NW1/4 SW1/4 sec 7 T6N R4W. The El Centenillo Mine, located near the southwest margin of the map area, recorded production of gold, copper, and calcium. The Mammoth Spar Mine in the central portion of the area has a recorded production of fluorspar. Most of the workings in the area are grouped in the Hope Mining Claims, formerly Garcia Mines, which produced gold in the 1930's (J.D. Campbell, 1982, pers. comm.).

Lithology

Exposure of Precambrian rocks is fair to good in topographically low parts of the Morristown area (Fig. 12). Hornblende schist is exposed in the northern portion of the map area. It is blue-grey in outcrop; some iron-oxide staining occurs on weathered surfaces. It is composed of 50 to 90% fine-grained hornblende with minor quartz, muscovite, and calcite aligned to produce schistosity.

Chlorite schist also occurs in low-lying areas but is confined to the southern and northeastern portions of the map area. It is greenish-grey in color, and weathered surfaces show some iron-oxide staining. The chlorite schist here is composed of aligned, fine-grained biotite, chlorite, and feldspar. The contact between chlorite schist and hornblende schist is gradational.

A small portion of Field Area 2 contains relatively fresh intercalated sandstone and siltstone. The sandstone units comprise about 10% of the rock and average about four centimeters thick. Evidence of recrystallization was observed in the sands, which are now composed mostly of quartz with minor feldspar and chlorite. The siltstones are friable and contain chlorite and undifferentiated clays. Regional metamorphic foliation parallels the bedding planes.

Banded iron formations occur in the south central portion of the map area. They are discontinuous and thin at less than 0.75 meters wide. Chert-rich formations exhibit laminated magnetite and hematite with zones high in silica, are resistant to weathering, and are dark red to black in color. The magnetite-hematite-rich units grade laterally into chert-rich units. Chert-rich banded iron formations exhibit alternating bands of dark iron-oxides with light silica. Their appearance in outcrop is striped, with banding at the centimeter scale.

Isolated lenses of ferruginous chert occur in the southern portion of the map area. They are up to 1.5 meters wide and 25 meters long and trend parallel to metamorphic foliation. The rocks are composed of silica colored by hematite and magnetite. They are deep red in color and exhibit compositional banding. Ferruginous chert lenses are resistant to weathering and form distinctive low ridges.

Felsic schist comprises about 20% of the Precambrian rocks described in the Morristown area. This muscovite schist is exposed as a well-defined band in the north central portion of the study area. Small isolated outcrops of felsic schist also occur in the southern half of the area. The felsic schist ranges from bluish-silver to pinkish-silver in color. The rock contains up to 80% muscovite, with lesser biotite altering to chlorite along cleavage, quartz, garnet, and iron oxides. The surfaces of outcrops exhibit a distinctive mica sheen. Pink weathered surfaces are common and are the result of a higher iron-oxide content.

Phanerozoic rocks are represented by unzoned pegmatite dikes and volcanic rocks. Pegmatite dikes occur in the northern half of the map area, the largest is 5 meters wide and 200 meters in continuous length. Most other pegmatite occurrences are small isolated outcrops or float; mineralogy is typically quartz, potassium feldspar, and muscovite with pervasive iron-oxide staining.

Volcanic rocks are restricted to topographic highs. Both volcanic flows and dikes up to 30 meters thick are found in the study area. The dacitic rocks are comprised of fresh plagioclase and minor quartz in a light purple fine-grained silicic groundmass. In many of the washes, an undulating contact between fresh volcanic rocks and the Precambrian rocks below is visible as an iron-oxide-stained, clay-rich baked regolith zone in schist.

Structure

In the Morristown area, metamorphic foliation is uniformly oriented at east-west with a 60^{o} N dip (Fig. 6). The limbs of isoclinal folds in silica lenses, and therefore the indicated direction of shear, parallels metamorphic foliation. The felsic schist-mafic schist contact is clear, and the general trend of the felsic units is parallel to foliation. A clearly depositional contact exists between Tertiary volcanic rocks and Precambrian schists.

Pegmatites which have been mined for feldspar in the northwest corner of the map area are oriented N 45^{o} W, dipping at 45^{o} SW, an orientation discordant to metamorphic foliation. The largest and most continuous of the pegmatites, exposed in the Dove Mine, is oriented N 5^{o} E 82^{o} SE. This pegmatite is discordant to both metamorphic foliation and other measurable pegmatites in the map area. Most of the pegmatites in the area are exposed only as float, and quantitative orientations are therefore unattainable.

The Tertiary dikes in the area are oriented approximately east-west and are vertical, corresponding to the local metamorphic foliation.

Mineralization and Alteration

Mineralization within the Morristown area occurs as shear zones parallel to metamorphic foliation mainly within felsic schist. The two-meter-wide zone of clay-rich, iron-oxide stained gouge is the only evidence of alteration in the area.

Area 3, Paydirt

Location

Area 3, located 0.8 kilometers north of the Vulture Mine Property, sec 25 T6N R6W, is 17 kilometers southwest of Wickenburg at the southern margin of the Vulture Mountains in Maricopa County (Fig. 1). Access is by graded road to the Paydirt Mine which leads west off of the Vulture Mine Road about 2.2 kilometers south of the Vulture Mine entrance.

The topography is gentle and rolling except for a few steep hills. Elevation ranges from 707 meters on a hilltop to 646 meters in the wash at the southeast corner of the area. Extensive mining and prospecting have occurred in the historical and recent past. The Paydirt Mine, now a small open pit, has a recorded production of 11.3 metric tons of ore containing 182 kilograms (0.8%) of copper and 370 grams (16.3 ppm) of gold from the mid 1960's. Informal sources state that the mine produced gold and silver up until late 1982 (Housley, 1982, pers. comm.). The Red Cloud Mine in the northeast portion of the study area has recorded production of gold and iron from 108 meters of drifts on 3 levels (Metzger, 1938). The central portion of the map area has seen geological examinations in 1963 and 1965. Current exploration is evidenced by fresh roads, sample locations, and prospect pits and trenches.

Lithology

Poor exposure due to alluvial cover obscures lithologic relationships and makes protolithologic determinations difficult in Area 3 near the Paydirt Mine. Mafic schist occurs in low areas in the northern and western portions of the study area (Fig. 13, located in back pocket). The schist is typically dark bluish to greenish-grey in color. The composition of the mafic schist grades from hornblende with minor plagioclase to biotite-muscovite schist. An intermediate composition of the end members is represented by a hornblende-biotite schist.

Felsic schist is confined to a small area in the southwest portion of Area 3. It is light in color and exhibits a distinctive mica sheen due to muscovite on weathered surfaces. The felsic schist contains muscovite, quartz, biotite, and potassium feldspar.

A schist intermediate between mafic and felsic schist is composed of alternating felsic and mafic units which are from 2 centimeters to 2 meters thick. However, the composition of the intermediate felsic units is slightly more mafic than the main body of the felsic schist. Similarly, the mafic schist contained in the intermediate unit is slightly more felsic than the main mafic schist formation.

The granite which crops out at the Paydirt Mine is continuous along the western margin of the study area. It is composed of 40% fine-grained groundmass, 35% quartz, 20% orthoclase, and 5% plagioclase with minor muscovite and tourmaline. This granite grades into a foliated sub-gneissic granite which is exposed as an isolated outcrop in the northwest quadrant of the map area. This Precambrian intrusive rock is light in color and forms low hills.

Volcanic rocks form distinct ridges surrounding the central low of the study area near the Paydirt Mine. The volcanic rocks are grouped as a single unit on the field map (Fig. 13), but different types can be distinguished. Quartz andesite flows are exposed in the southern portion of the study area, and quartz andesite dikes occur as elongate ridges to the north and east. These rocks are purple and contain plagioclase phenocrysts in fine-grained tuffaceous groundmass. On the western boundary of the map area, a high, distinctively white hill is formed by an erosion-resistant silicified volcanic unit. The unit contains 5% quartz phenocrysts, relict plagioclase, and minor biotite in a fine-grained silica groundmass. Basaltic dikes occur in the southern portion of the study area. The dikes are from 1-3 meters in width and are black in color. Mineralogical zoning in the basaltic dikes is defined by plagioclase-rich centers. The basaltic dikes cut both mafic schist and volcanic rocks.

Structure

The strike of metamorphic foliation in the Paydirt Study Area is variable from N 25° E to N 35° W, and the dip ranges from 50° NE to vertical (Fig. 7). Tertiary dikes in the area trend N 45° W. The dikes are generally concordant with metamorphic foliation.

Generally, lithologic contacts are poorly exposed in the Paydirt Study Area. The contact between Precambrian granite and Tertiary volcanic rocks is defined by gross lithologic differences and degree of freshness. The contact between Precambrian granite and Precambrian mafic schist is also defined by lithologic differences, although the Precambrian felsic schist-Precambrian granite contact is more complex. In some locations, the distinction between gneissic granite and quartz-rich muscovite schist is difficult to make. Felsic schist is defined as rock which is clearly schistose and does not contain potassium feldspar. The contact between Tertiary volcanic rocks and Precambrian schist is extremely undulatory suggesting accumulation of volcanic rocks on topography of moderate relief. Pods of mafic schist on the order of meters in width project into the Tertiary volcanic rocks. The mafic schist-felsic schist contact does not conform to metamorphic foliation.

Mineralization and Alteration

Two types of mineralization occur within Area 3, iron-oxide-rich shear zones near the northern margin of the area and quartz veins in Precambrian granite in the southwestern portion of the area. The vertical shear zones containing iron-oxide stained gouge are pervasively fractured, and vein material is found only as float. The Red Cloud Mine is an example of this type of deposit. The country rock includes felsic schist composed of quartz porphyroblasts, biotite, and plagioclase feldspar and mafic schist composed of hornblende, chlorite, calcite, and biotite. The stopes, shafts, and adits demonstrate that the trend of mineralization is approximately east-west and vertical. Alteration includes weak argillization, iron-oxide staining, and extensive fracturing. Mineralization occurs as minor quartz veins and breccia.

In the southwest portion of the area, northwest from the Paydirt Mine, quartz veins occur along a northwest-trending shear zone in Precambrian granite. The veins consist almost entirely of milky, euhedrally terminated quartz crystals with iron-stained silica-filled vugs. Up to 2% pyrite occurs in the veins as fine-grained euhedral cubes in some locations. A 7-10 meter-wide alteration zone surrounds the veins. In this zone, pervasive iron-oxide stained fractures and weak argillization of potassium feldspar phenocrysts within the granite occur parallel to the veins. At the Paydirt Mine, hematite-stained gouge pods, epidote, and chlorite are common. The most-intense alteration and best-defined veins occur near the Paydirt Mine. This mineralization grades into a poorly defined, iron-oxide-stained shear zone to the northwest where it is covered by Tertiary volcanic rocks.

CHAPTER 4

DISCUSSION

The following section first establishes that the central Arizona metavolcanic and metasedimentary succession is a lithotectonic greenstone belt, with many similarities to Archean greenstone belts in general. Next, greenstone belt gold deposits are classified as exhalative or remobilized exhalative, metamorphic, or epithermal. Theoretical models of formation and characteristics of these deposit types are then compared to a summary of characteristics of mineralization occurrences in the Wickenburg area. Finally, a multistage model of formation for the Wickenburg deposits is presented.

The Precambrian rocks of central Arizona have been described as a greenstone belt (Anderson and Silver, 1976; Donnelly and Hahn, 1981) and have many collective similarities to lithologic units in Archean greenstone terranes. The 'Yavapai greenstone belt' exhibits a characteristic greenschist to amphibolite facies metamorphic overprint upon volcanic and sedimentary units, as well as associated Precambrian granitic stocks (Windley, 1977).

Comparison of a stratigraphic column of a typical Archean greenstone belt (Windley, 1977) and a generalized column from this study area in central Arizona (Fig. 14) reveals additional similarities. The basalt-andesite-dacite cycle of the calc-alkaline volcanic group is present in Arizona, as are the conglomerates, sandstones, shales, cherts, and banded iron formations of the sedimentary group.

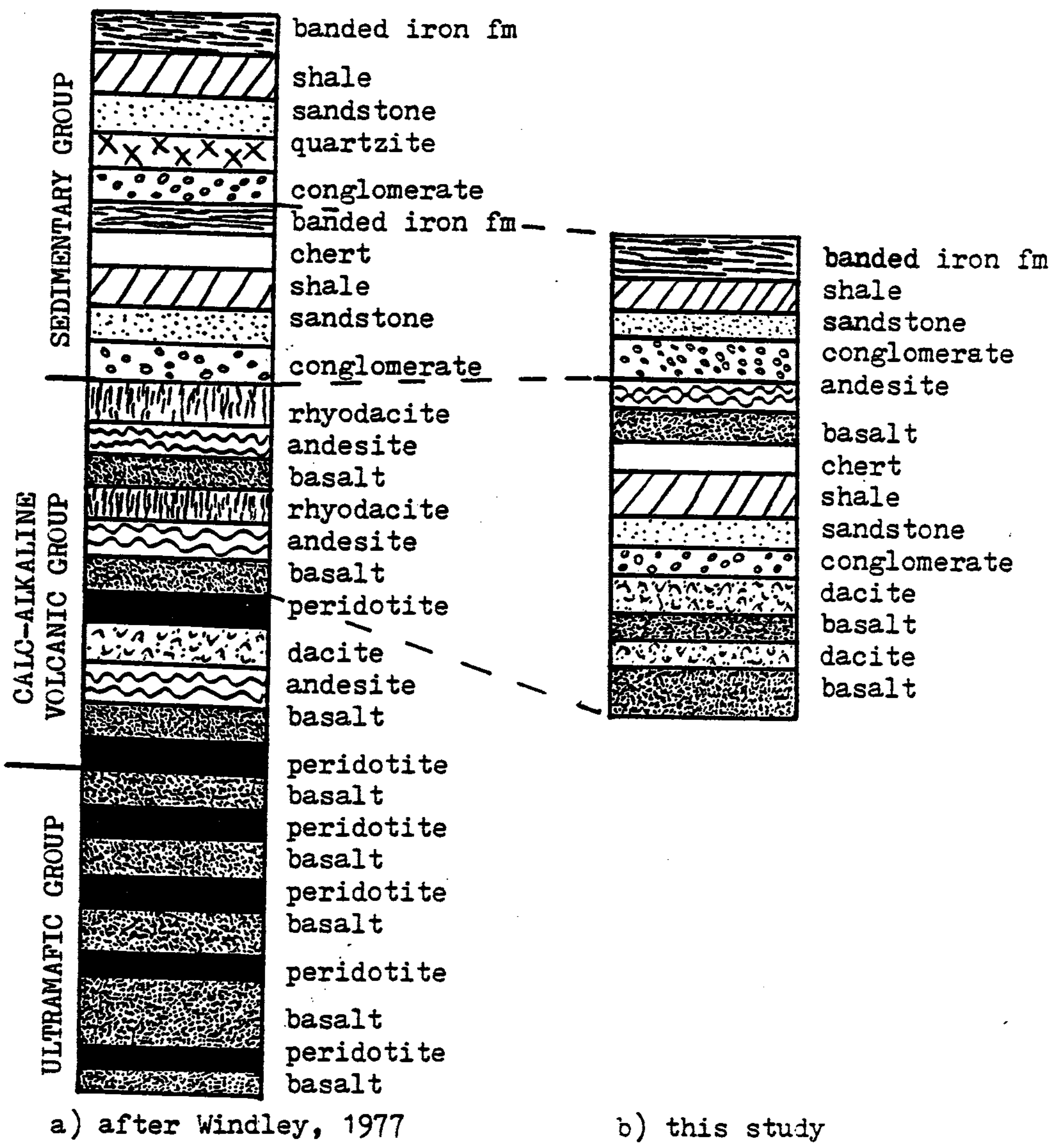

Fig. 14. Greenstone belt stratigraphy. Comparison of a stratigraphic column of (a) a typical Archean greenstone belt, after Windley (1977), and (b) a generalized stratigraphic column from Study Area 1 near Stanton, Arizona.

As pointed out by Donnelly and Hahn (1981), basal ultramafic rocks are absent. It appears that the central Arizona greenstones are comparable to the upper calc-alkaline volcanic group and the sedimentary group of Windley's (1977) idealized Archean greenstone column.

Gold deposits in greenstone belts can be categorized as exhalative, remobilized exhalative, metamorphic, or epithermal. Exhalites such as are found at the Kerr-Addison Mine or the Horne Mine in the Abitibi greenstone belt are taken to represent chemical sediments of volcanogenic origin (Ridler, 1976). Plastic flow of gold-rich horizons during later folding episodes may result in relocation of gold such as at Homestake, South Dakota, which is considered to be the type example of mobilized auriferous exhalites. Sawkins and Rye (1974) listed nine requisites to this type of deposit: 1) the presence of iron-rich metasediments; 2) their conformable nature; 3) the great lateral extent of ore; 4) the gold-pyrite-arsenopyrite-quartz assemblage; 5) the absence of zoning in orebodies; 6) their association with metavolcanic rocks; 7) the absence of demonstrably related plutonic rocks; 8) the presence of more chlorite than sericite in alteration assemblages; 9) the presence of metamorphic textures in ore as suggested by textural relationships between sulfide minerals and between sulfide and silicate minerals.

Metamorphism is the common factor in the second model discussed which describes the genesis of gold deposits in greenstones. The pervasive greenschist to amphibolite facies metamorphism typical of greenstone belts indicates that an important fluid and heat source has been operative. Metamorphic secretion models assume that gold and gangue elements are mobilized and deposited during superimposed metamorphic events (Boyle, 1979) or burial metamorphism (Kerrich and Fryer, 1978). In these models, gold is released when the rocks in which it is contained are subjected to conditions of regional metamorphism accompanying intrusion of an igneous body or burial metamorphism during continued greenstone belt accumulation. Pressures of around 10 kbar and temperatures from 350^{o} to 500^{o} C trigger the release of gold as well as copper, lead, zinc, silver, and silica which form hydrothermal solutions with the water and other volatiles released contemporaneously. The solutions migrate following decreasing pressure pathways and are precipitated as quartz veins in dilatant zones (Boyle, 1979). A metamorphic secretion model was proposed to explain the origin of the Dome Mine in the Abitibi greenstone belt (Kerrich and Fryer, 1978). In this model, about 5 weight percent structural water is released by the basaltic rocks at the greenschist-amphibolite transition around 450^{o} to 500^{o} C. These fluids leach silica, gold, arsenic, sulfur, and other elements from the rocks through which they flow and form reservoirs of metamorphic-dehydration fluids under impermeable layers. If the total pressure of these solutions is greater than the confining strength of the trapping rocks, cracks can be formed. Solutions can flow through these cracks and deposit veins. If these solutions reach the surface in a submarine environment, there is the possibility of the precipitation of chemical sediments physically indistinguishable from those of volcanogenic origin.

An epithermal model describing genesis of gold deposits is discussed below. A simplified epithermal model assumes that a magmatic heat source drives a convective cell in which water is heated. The source of this water has been argued to be meteoric, oceanic, connate, metamorphic, or magmatic (White, 1981). Buchanan (1981) classified ore minerals, gangue minerals, and alteration assemblages according to depth within a given epithermal system and also emphasized the role of episodic boiling due to pressure buildup and rapid pressure release. Characteristically, elements such as Au, As, Sb, Hg, Tl, B, and minor Ag precipitate near the surface and are associated with quartz, calcite, pyrite, and minor fluorite and barite. Higher temperatures and pressures deeper in the system cause precipitation of Ag, base metals, Se, Te, and Bi with quartz, adularia, sericite, pyrite, and lesser calcite, chlorite, and fluorite. Laramide stocks and mid-Tertiary volcanic rocks within the Yavapai greenstone belt may represent a shallow heat source resulting in deposition of gold in veins.

Windley (1977) notes that the most important gold mineralization in greenstone belts occurs near granitic plutons and decreases into the greenstones. He reasons that these stocks provided heat sources to mobilize gold in the country rocks, making it available for transfer into veins, shear zones, and other dilatant features. Background gold values obtained in this Wickenburg study average 0.68 ppm (Appendix, Table 2); these rocks presumably could represent a gold source for similar deposits.

A simplified model for the formation of gold deposits in greenstones which combines the three models discussed earlier is presented in Fig. 15. An existing volcano-sedimentary pile possibly containing

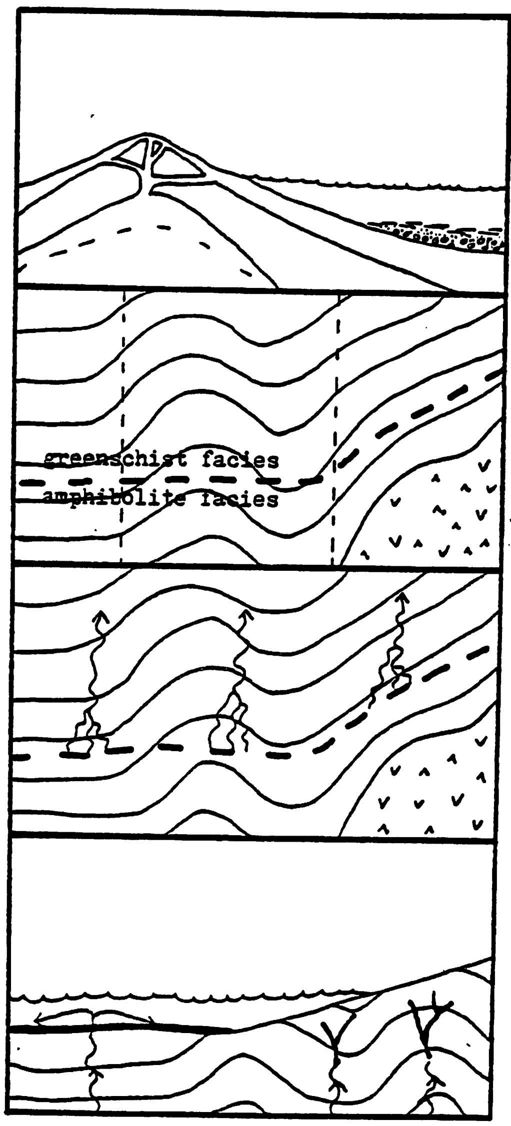

Fig. 15. Model for formation of gold deposits in greenstone belts.

sedimentary gold concentrations (Fig. 15a) experiences an increased thermal gradient during burial, folding, or because of intrusion (Fig. 15b). The greenschist-amphibolite transition (Kerrich and Fryer, 1978) or an intrusive event triggers the release of hydrothermal fluids (Fig. 15c). Elements such as Si, Au, Fe, As, S, as well as Mn, Ti, Cu, Pb, Zn, Co, and Ag can be leached from the rocks (Fripp, 1976) and held in solution by hydrothermal fluids. If the thermal gradient is sufficient to allow the solution to reach the surface, gold-bearing exhalites may be formed. If deposition occurs below the surface, veins are formed (Fripp, 1976). Later intrusions of plutons could reconcentrate economically important elements.

Resultant gold deposits are gold-bearing exhalites or veins produced either by metamorphic secretion or contemporary intrusion of plutons. Later intrusive events may produce an epithermal overprint.

The following is a summary of characteristics of mineralization occurrences in the areas studied in this project which can be classified as either quartz veins or shear zones. Quartz veins in mafic schist in Study Area 1 and in Precambrian granite in Study Area 3 range from single one-meter-wide veins to four or five parallel 10 cm-wide veinlets. The veins are straight, generally concordant to metamorphic foliation and cross lithologic boundaries within the metasedimentary pile. The veins are composed of 92% milky white quartz with minor ankerite, tourmaline, pyrite, and vugs with euhedral quartz crystals indicating open-space-filling. A distinct 7-10 meter-wide alteration zone generally surrounds the veins. The zone is bleached and iron-oxide-stained and is composed of 40% silica, 40% sericite, and 20%

combined hematite, calcite, tourmaline, and biotite in varying proportions. Shear zones occur within felsic schist in Areas 2 and 3. These two-meter-wide clay-rich, iron-oxide-stained gouge zones are generally concordant to local metamorphic foliation.

The mineralized occurrences studied in this project do not fit neatly into any of the categories which have been discussed. The following section describes first those characteristics which support and then those that oppose assignment to the three models which were presented; first an exhalative or remobilized exhalative model, second a metamorphic model, and finally an epithermal model. Some aspects of the deposits in central Arizona support an exhalative origin; for example, their stratigraphy and the presence of exhalites in the succession as represented by banded iron formations. However, geochemical analyses of banded iron formations resulted in gold values which averaged only 0.20 ppm (Appendix, Table 2).

Most of the evidence contradicts an exhalite model according to the criteria outlined by Sawkins and Rye (1974): 1) the veins are not folded as are the banded iron formations; 2) the veins exhibit open-space-filling textures, not metamorphic textures; 3) the veins cross stratigraphy; 4) sericite is dominant over chlorite in alteration; 5) ore values are spotty; 6) plutonic rocks are common; 7) no arsenic-bearing minerals were found. This evidence demonstrates that the gold-bearing quartz veins in the Wickenburg area are not of an undisturbed exhalative origin.

There is supportive evidence for the metamorphic secretion model in the areas studied in Arizona. The greenschist-amphibolite facies transition is present, for example, in Study Area 2 (Fig. 12), where it was mapped as a gradational contact between chlorite schist and hornblende schist. The background gold values in the area are relatively high at an average of 0.68 ppm (Appendix, Table 2) and could represent a possible nearby gold source. The upper peak of homogenization temperatures obtained from fluid inclusion studies (Fig. 11) is in agreement with the temperature of around 350° to 360° C obtained by Kerrich and Fryer (1978) in their study of the Dome Mine.

Evidence against the metamorphic secretion model also exists in the study area. An example is the well-defined, relatively low temperature alteration halo which is out of equilibrium with the country rock. Also, open-space-filling textures in the veins point toward deposition at shallower depths.

Some field evidence supports an epithermal origin for mineralization in this study. The abundance of nearby granitic stocks and Tertiary volcanic rocks may represent a local heat source. The veins in the study areas exhibit typical epithermal open-space-filling textures, milky quartz, and a well-defined quartz-calcite-sericite-chlorite alteration assemblage.

Fluid inclusion data do not support a simple epithermal model. The 355° C uncorrected homogenization temperature is well above average epithermal temperatures of around 240° C (Buchanan, 1981). Temperature corrections for pressure of +100° C for 1 kbar and +220° C for 2 kbar (Lemmlein and Klevstov, 1961) would raise the homogenization temperatures even more. The high temperature peak in the raw data would fall somewhere between 450° and 575° C. However, pressure correction of the lower peak at 215^{0} would raise it into the typical epithermal range. Generally, epithermal deposits have a salinity of less than 3 weight percent NaCl (Buchanan, 1981), but the salinity of the veins in this study is around 12 weight percent NaCl equivalent.

The data obtained in this study is in part contradictory. For example, veins with epithermal mineralogy, open-space-filling textures, and low-temperature alteration haloes are contained not in mid-Tertiary volcanic rocks but in a Precambrian metasedimentary pile such as at Katharine, Arizona or Reymert, Arizona (Wilson, 1983). The results of fluid inclusion studies show two uncorrected homogenization temperature peaks. The salinity value of 12 weight percent NaCl equivalent obtained in this study is higher than typical epithermal salinities. It is unlikely that the K-Ar date of 430 m.y. from sericite from the alteration halo documents a previously unrecorded Cambrian hydrothermal event in central Arizona; it is more probable that sample contamination is the cause of this questionable date. For example, young low-potassium sericite produced during a Laramide hydrothermal event may not have been fully separated from high-potassium Precambrian orthoclase contained in the country rocks. A K-Ar date on this mixture would produce a date intermediate between the two end-members. It could also be that sericite was formed during a Precambrian hydrothermal event at low temperature and also during a Laramide event. When a mixture of this young and old sericite was analyzed, a hybrid date would be the result. Radiogenic argon loss during a later hydrothermal event could also result in the questionable date.

The fluid inclusion data seem to support a multistage model. The multiple peaks (Fig. 11) can represent the result of necking of primary fluid inclusions by a secondary thermal event. However, they may also represent evidence for an early high temperature sub-economic gold concentration by metamorphic secretion and later Laramide epithermal concentration. The hybrid K-Ar date also indicates two thermal events.

These contradictory data suggest a multistage model for the veins. Viljoen, Saager, and Viljoen (1969) proposed a multistage model for the Steynsdorp gold deposits in the Barberton Mountain Land, South Africa. Initial sub-economic gold concentrations were produced as a result of biological or sedimentary processes. Later intrusion resulted in the deposition of economic gold-bearing quartz veins which those authors maintain should be classified as pseudohydrothermal.

Model

The following multistage model is presented to describe the genesis of gold-bearing quartz veins in Precambrian greenstones near Wickenburg, Arizona. Gold was initially concentrated at low levels during the Precambrian greenschist to amphibolite facies metamorphic event around 1770 to 1820 m.y. Metamorphic secretion at this time leached gold, possibly from Precambrian exhalites or gold-bearing conglomerates in the succession and deposited it as sub-economic gold-quartz veins in dilatant zones.

Granodiorite stocks intruded the rocks containing low level gold concentrations during the Laramide. The increased thermal gradient associated with the intrusion of stocks triggered the release of fluids contained in the greenstones. These fluids leached gold and other elements as they passed through the country rocks following low pressure pathways. The effects of both Precambrian greenschist-amphibolite facies metamorphism and the intrusion of granitic stocks in the Laramide are preserved in the rocks. It is probable that both of these events influenced the deposition of gold in central Arizona. The secondary epithermal concentration of gold produced gold-bearing quartz veins with characteristics of both metamorphic secretion and epithermal deposits.

Conclusions

1) The Precambrian greenschist to amphibolite facies rocks of central Arizona represent a 1770 to 1820 m.y.-old greenstone belt with many similarities to Archean greenstone terranes.

2) Although Precambrian chemical sediments exist in the area, the gold-bearing quartz veins are not undisturbed or folded volcanogenic sediments.

3) A multistage model of formation is proposed involving early sub-economic concentration of elements by sedimentary or metamorphic processes and later epithermal reconcentration to economic levels during intrusion of Laramide plutons.

Suggestions for Further Study

Because of the longevity of gold exploitation in the area and the gold deposits exposed at the surface, it is probable that there are additional unexposed gold deposits in the area. Exploration efforts should be concentrated in the greenstones near Laramide pluton-Precambrian greenstone contacts. Comparison of mineralogically similar veins in host rocks of different age could shed more light on the role the country rocks play in gold concentration. It would also be useful to undertake additional geologic mapping to untangle stratigraphic and structural history.

APPENDIX

Table 1. List of prospects visited.

Banker Group - 1
Location: SE 1/4 NE 1/4 sec 31 T6N R5W
Mineralization: none visible
Host rocks: Tertiary volcanic rocks
Exposure: poor, 8 meter deep shaft in gravel cover, no outcrop
Access: very poor, marginal two-wheel drive

Benjamin - 2
Location: C E 1/2 SW 1/4 sec 2 T8N R3W
Mineralization: iron-oxide stained gouge zone
Host rocks: sub-gneissic granite
Exposure: poor
Access: four-wheel drive

Black Hawk - 3
Location: SE 1/4 sec 3 T8N R3W
Mineralization: iron-stained quartz vein and gouge in shear zone
Host rocks: Precambrian gneissic granite
Exposure: fair
Access: four-wheel drive

Dead Engineer - 4
Location: NE 1/4 NE 1/4 sec 12 T5N R6W
Mineralization: minor quartz veins and breccia in iron-stained silica
Host rocks: Precambrian hornblende schist
Exposure: small area of fair outcrop and vertical shaft about 200 meters deep
Access: graded road

El Centenillo - 5
Location: SE 1/4 SW 1/4 SW 1/4 sec 7 T6N R4W
Mineralization: shear zone
Host rocks: Precambrian schist and Tertiary volcanic rocks
Exposure: fair
Access: poor

El Tigre - 6
Location: NW 1/4 NW 1/4 sec 20 T6N R4W
Mineralization: N 75° W 75° NE shear zone containing black calcite and hematite stain
Host rocks: mafic schist
Exposure: poor
Access: marginal two-wheel drive

Table 1. continued.

Electra - 7
- Location: E 1/2 E 1/2 SW 1/4 sec 8 T8N R3W
- Mineralization: N 20^{o} W 70^{o} SW shear zone with minor hematite staining
- Host rocks: sub-gneissic granodiorite and Tertiary volcanic rocks
- Exposure: poor
- Access: good two-wheel drive

Finance Group - 8
- Location: NW 1/4 NE 1/4 NW 1/4 sec 29 T6N R5W
- Mineralization: shear zone? approximately EW with silicification
- Host rocks: possibly Precambrian schist
- Exposure: good in nearby washes, but very poor near 10 meter deep shaft
- Access: marginal two-wheel drive

Golden State Claims - 9
- Location: N 1/2 NE 1/4 sec 17 T8N R3W
- Mineralization: horizontal shear zones containing minor quartz, calcite, and gouge
- Host rocks: granodiorite
- Exposure fair
- Access: fair

Golden State and San Francisco Claims - 10
- Location: NW 1/4 SW 1/4 SW 1/4 sec 9 T8N R3W
- Mineralization: N 30^{o} W 65^{o} SW trending shear zone; dump contains molybdenite, azurite, bornite, and hematite
- Host rocks: granodiorite
- Exposure: poor
- Access: fair

Hope (formerly Garcia) - 11
- Location: SE 1/4 NW 1/4 sec 7 T6N R4W
- Mineralization: EW trending quartz and calcite veins with minor hematite stain
- Host Rocks: Precambrian schist
- Exposure: good
- Access: marginal two-wheel drive in dry weather

Leviathan - 12
- Location: C sec 35 T10N R5W
- Mineralization: large quartz vein trending EW 35^{o} N
- Host rocks: silicified Tertiary? Precambrian?
- Exposure: excellent, large working mine
- Access: controlled

Table 1. continued.

Lucky Cuss - 13
Location: E 1/2 sec 22 T6N R7W
Mineralization: N 45^{0} E vertical shear zone, hematite stained quartz
Host rocks: Precambrian sub-gneissic granite
Exposure: good
Access: good two-wheel drive

Lucky Johnnie and Katie - 14
Location: C SE 1/4 sec 25 T10N R5W
Mineralization: hematite stained quartz veins
Host rocks: Precambrian schist
Exposure: poor except in 23 x 12 x 8 meter cut
Access: good two-wheel drive

Newsboy, Pitt - 15
Location: SE 1/4 SW 1/4 NW 1/4 sec 22 T6N R4W
Mineralization: iron-stained volcanic breccia
Host rocks: Tertiary volcanic rocks? Precambrian schist nearby
Exposure: good in 30 x 45 x 23 meter open pit and in washes
Access: good two-wheel drive in dry weather

Paydirt - 16
Location: NE 1/4 SE 1/4 NW 1/4 sec 26 T6N R6W
Mineralization: quartz veins and argillized gouge zone
Host rocks: Precambrian granite
Exposure: good, small open pit
Access: good graded road

Queen of Sheba - 17
Location: SW 1/4 SW 1/4 sec 8 T6N R4W
Mineralization: breccia with copper-oxides and minor quartz with hematite staining
Host rocks: Tertiary volcanic rocks
Exposure: mostly covered by recent bulldozing
Access: two-wheel drive in dry weather

Red Cloud - 18
Location: N 1/2 NW 1/4 sec 25 R6W T6N
Mineralization: breccia and iron-stained shear zone N 80^{0} E vertical
Host rocks: Precambrian mafic schist
Exposure: mostly covered by dump, outcrop in small adits and creek bottom
Access: poor, four-wheel drive required

Red Twister Claims - 19
Location: SW 1/4 SW 1/4 sec 25 T10N R5W
Mineralization: quartz veins
Host rocks: Precambrian mafic schist
Exposure: Excellent
Access: good

Table 1. continued.

South Vulture - 20

Location:	SW 1/4 NW 1/4 SW 1/4 sec 1 T5N R6W
Mineralization:	bleached, argillized, iron-stained shear zone trending N 10° E 75° SE and breccia
Host rocks:	Tertiary silicic volcanic rocks
Exposure:	good, two shallow shafts
Access:	good graded county road

Table 2. Results of geochemical analyses.

Sample Number	Au ppm	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Sample Description
1	5.60	18.00	76.0	18.0	149.0	conglomerate
2	0.80	2.80	40.0	17.0	130.0	sediments
4	0.40	1.20	45.0	9.0	87.0	alteration near banded iron formation
7	0.80	1.10	30.0	5.0	27.0	vein
8	0.60	0.90	46.0	14.0	181.0	alteration-vein 7
9	1.20	1.20	32.0	11.0	98.0	alteration-vein 7
10	0.50	0.70	25.0	13.0	102.0	basalt
13	0.50	1.10	51.0	16.0	123.0	folded vein
16	0.10	2.40	43.0	46.0	167.0	folded calcite vein
18	0.20	0.60	30.0	12.0	72.0	alteration-vein 19
19	0.20	0.30	29.0	13.0	27.0	vein
20	0.30	0.40	24.0	12.0	61.0	alteration-vein 19
21	0.30	0.90	44.0	11.0	134.0	alteration-vein 22
22	0.20	0.40	22.0	6.0	27.0	vein
23	0.30	0.60	28.0	11.0	110.0	alteration-vein 22
24	0.05	1.50	214.0	15.0	188.0	alteration-vein 25
25	1.90	19.90	1,580.0	6.0	54.0	vein
26	0.20	1.10	85.0	15.0	109.0	alteration-vein 25
27	0.30	3.00	60.0	57.0	122.0	breccia
28	0.10	2.30	14.0	30.0	82.0	breccia
29	0.40	1.30	54.0	22.0	663.0	alteration-vein 30

Table 2. continued.

Sample Number	Au ppm	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Sample Description
30	0.40	2.21	76.0	295.0	338.0	vein
31	0.05	43.60	649.0	13.0	70.0	Rich Hill granite
32	0.40	1.20	26.0	20.0	42.0	altered zone
33	0.70	3.60	60.0	8.0	43.0	altered zone
103	0.10	0.70	77.0	11.0	17.0	ferruginous chert
105	0.10	0.60	43.0	11.0	64.0	hornblende schist
107	0.20	0.60	61.0	14.0	107.0	muscovite schist
111	0.20	2.20	129.0	12.0	36.0	silicic banded iron formation
112	0.60	1.30	181.0	21.0	135.0	alteration-vein 113
113	0.30	1.90	25.0	196.0	93.0	vein
114	0.05	24.30	362.0	66.0	118.0	alteration-vein 113
118	0.05	2.50	150.0	10.0	100.0	muscovite schist
119	0.05	0.70	94.0	10.0	107.0	schist with veins
123	2.10	83.80	1,119.0	9.0	91.0	vein and gouge
124	0.05	1.30	17.0	9.0	59.0	alteration-vein 123
127	0.70	1.70	50.0	18.0	232.0	veins
128	0.05	0.60	49.0	10.0	110.0	alteration-vein 127
131	0.10	0.80	155.0	23.0	44.0	banded iron formation
140	0.05	0.80	13.0	8.0	14.0	chert
201	0.05	0.50	13.0	6.0	38.0	hornblende schist
205	0.05	0.40	10.0	9.0	56.0	chlorite schist
209	0.05	0.30	15.0	7.0	40.0	muscovite schist
210	0.05	0.10	13.0	7.0	141.0	muscovite schist

Table 2. continued.

Sample Number	Au ppm	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Sample Description
211	0.70	2.60	5,487.0	77.0	134.0	quartz veins in muscovite schist
212	0.20	1.80	443.0	105.0	346.0	wall rock-vein 213
213	0.30	3.00	84.0	13.0	72.0	quartz vein
215	0.05	1.60	53.0	50.0	182.0	breccia in pegmatite
216	0.05	1.20	116.0	13.0	141.0	wall rock-vein 217
217	1.90	3.20	48.0	406.0	134.0	vein
218	0.20	2.60	36.0	53.0	262.0	wall rock-vein 217
222	0.05	3.80	30.0	23.0	66.0	vein
223	0.05	0.50	98.0	6.0	144.0	wall rock-vein 222
224	2.30	9.20	142.0	794.0	289.0	sulfide-bearing vein
225	0.70	5.30	242.0	50.0	247.0	wall rock-vein 224
226	0.20	2.00	35.0	11.0	60.0	vein
227	0.05	0.80	13.0	12.0	8.0	wall rock-vein 226
228	0.05	0.30	11.0	7.0	9.0	altered volcanic rock
229	0.10	2.50	244.0	34.0	65.0	gneissic granite
231	0.30	0.50	40.0	11.0	83.0	altered zone-Paydirt
232	0.30	0.70	9.0	15.0	181.0	gouge-Paydirt
233	0.70	1.60	97.0	21.0	33.0	gouge-Paydirt

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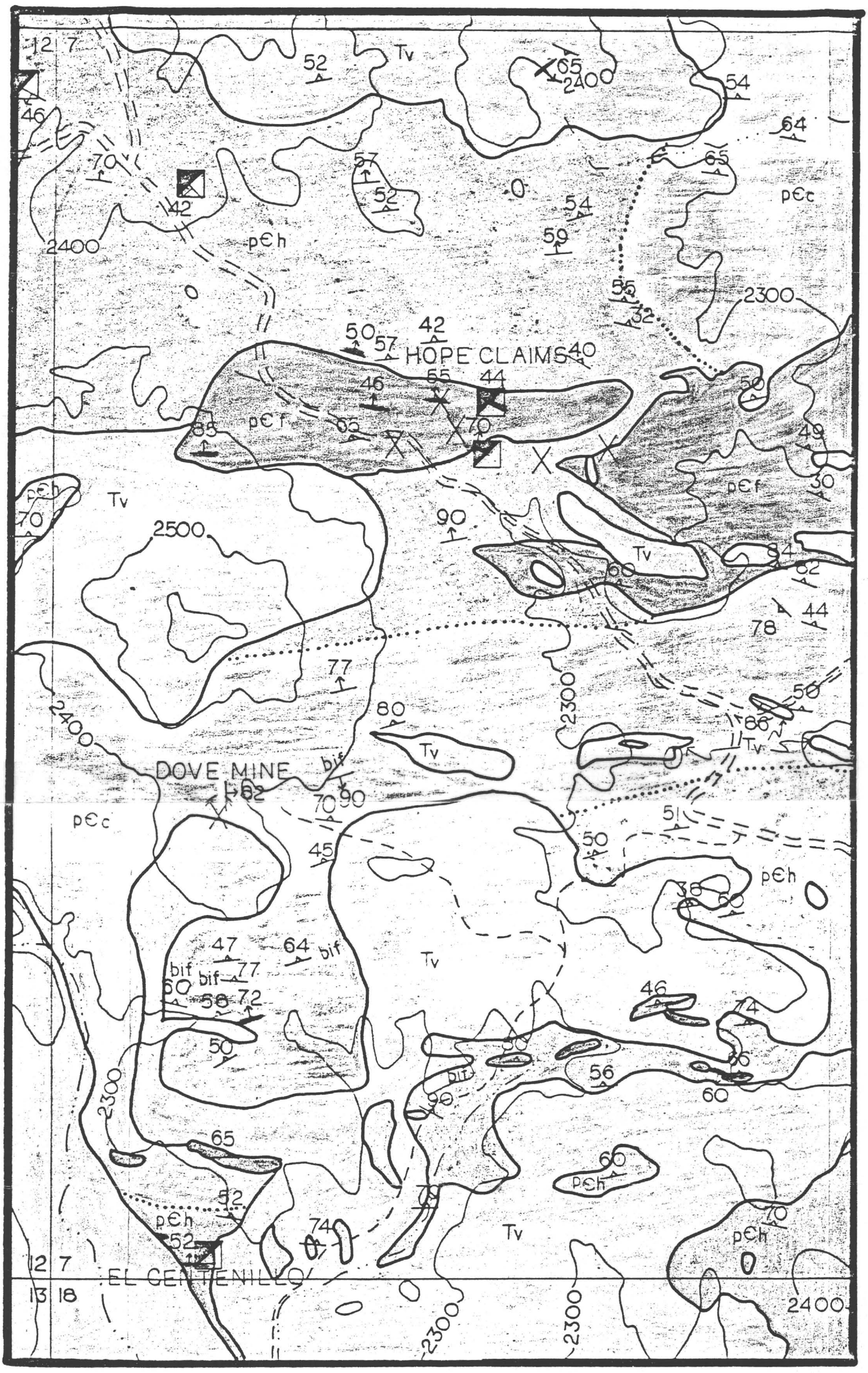
GEOLOGIC MAP OF STUDY AREA 2,

WEST OF MORRISTOWN, ARIZONA

Geology by A. Fischer; October - December, 1982 contour interval: 100 feet

scale 1:6000 — 0, 500, 1000, 1500 feet; 0, 100, 200, 300, 400 meters



EXPLANATION

- Tv – Tertiary Volcanic Rocks and Dikes, Undifferentiated - includes dacite dikes and flows.
- p – Tertiary Pegmatite Dikes - simple unzoned pegmatite dikes composed of quartz, potassium feldspar, and muscovite.
- pЄh – Precambrian Hornblende Schist - hornblende schist with minor quartz, muscovite, and calcite.
- pЄc – Precambrian Chlorite Schist - biotite-chlorite schist with minor feldspar.
- pC – Precambrian Ferruginous Chert - silica lenses with hematite and magnetite
- pЄf – Precambrian Felsic Schist - muscovite schist with minor biotite, chlorite, quartz and garnet.
- 71 – orientation of strike and dip of metamorphic foliation
- p 67 – orientation of strike and dip of pegmatite dike
- 57 – orientation of strike and dip of quartz vein
- bif 23 – orientation of strike and dip of banded iron formation
- – contact
- .... – gradational contact
- X – prospect pit
- – shaft
- – open pit mine

N

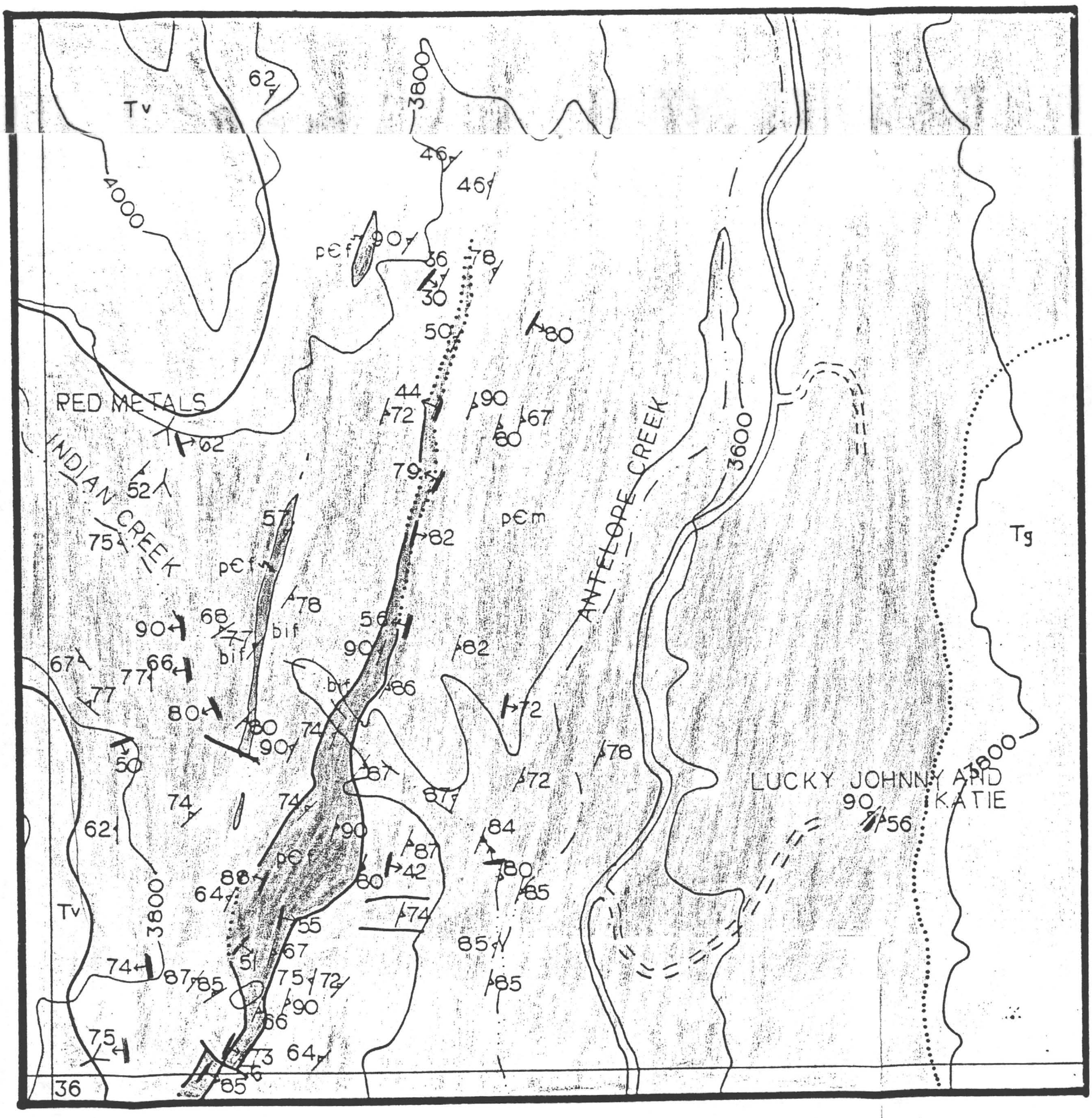
Fig. 12. Geologic map of Study Area 2, west of Morristown, Arizona.

GEOLOGIC MAP OF STUDY AREA I, NEAR STANTON, ARIZONA

EXPLANATION

- Tv – Tertiary Volcanic Rocks - basaltic/andesitic volcanic rocks
- Tg – Laramide Porphyritic Granite - quartz and orthoclase with minor biotite and hornblende in a fine-grained groundmass of quartz, orthoclase, and plagioclase
- pЄm – Precambrian Mafic Schist - metabasalt and basaltic metasediments; intercalated shale, sandstone and conglomerate, including banded iron formation
- pЄf – Precambrian Felsic Schist - quartz biotite schist and silica lenses
- bif - banded iron formation
- 77 - orientation of strike and dip of metamorphic foliation
- 56 - orientation of strike and dip of quartz vein
- contact
- covered contact
- fault
- adit

N



Geology by A. Fischer, October - December, 1982

contour interval: 100 feet   scale 1:6000

0 500 1000 1500 feet

0 100 200 300 400 meters

Fig. 4. Geologic map of Study Area 1, near Stanton, Arizona.

GEOLOGIC MAP OF STUDY AREA 3 PAYDIRT, SOUTH OF WICKENBURG, ARIZONA.

EXPLANATION

Tv — Tertiary Dikes and Volcanic Rocks, Undifferentiated - includes quartz andesite flows, quartz andesite dikes, dacite flows, and basaltic dikes.

p€m — Precambrian Mafic Schist - gradational from hornblende-plagioclase schist to biotite-muscovite schist.

p€f — Precambrian Felsic Schist - muscovite-quartz-biotite-potassium feldspar schist.

p€g — Precambrian Granite - porphyritic granite containing quartz, orthoclase, and plagioclase with minor muscovite and tourmaline in a fine-grained groundmass grading to foliated subgneissic granite of similar composition.

72 / 31 — orientation of strike and dip of metamorphic foliation

q — orientation of strike and dip of quartz vein

— contact

— inferred contact

X — prospect pit

— adit

— shaft

Geology by A. Fischer, October-December, 1982

contour interval: 100 feet

scale: 1:6000

0 500 1000 1500 feet

0 100 200 300 400 meters

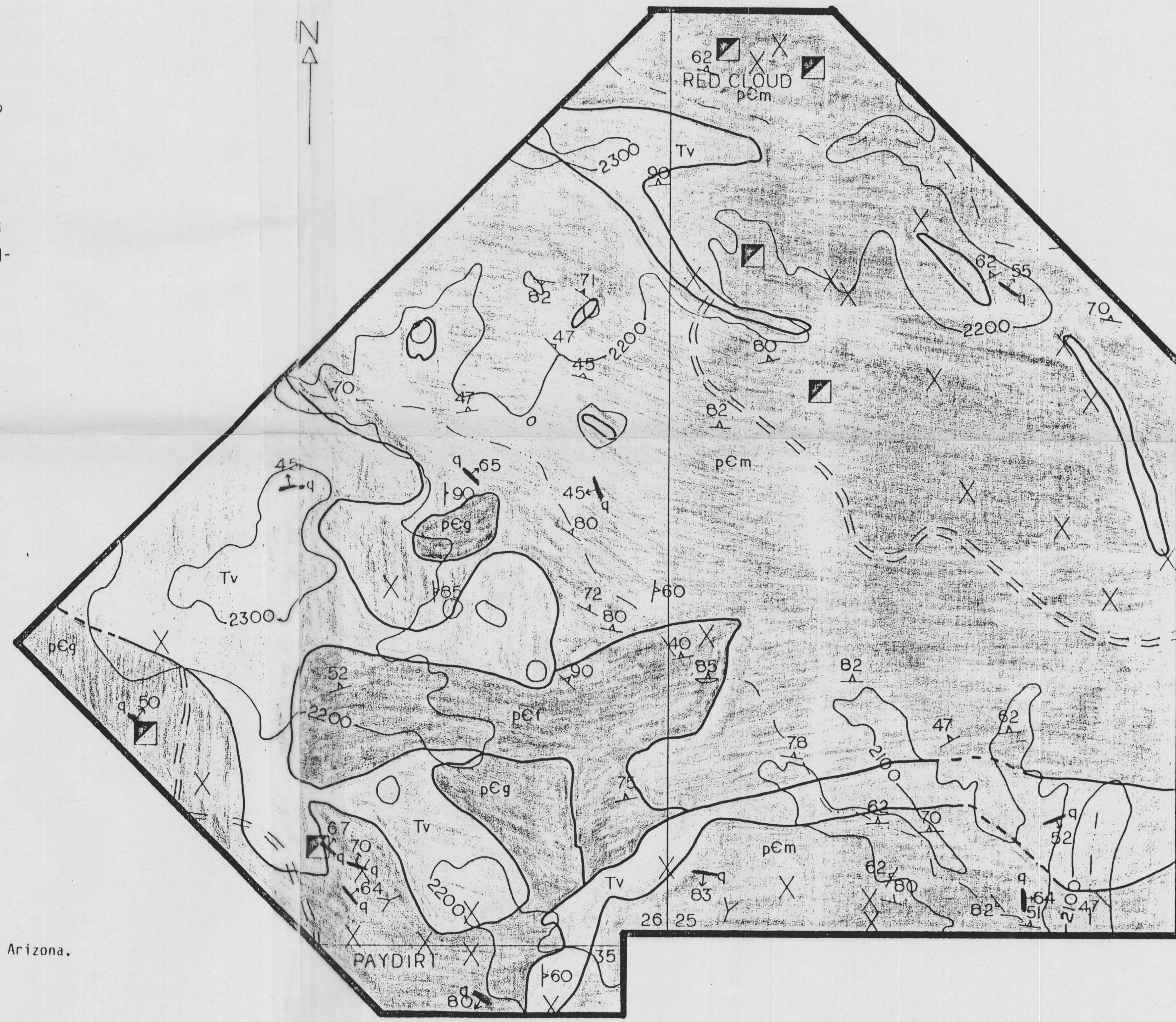


Fig. 13. Geologic map of Study Area 3, Paydirt, south of Wickenburg, Arizona.

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