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Gold in panned concentrates from southern Alamance County, Central North Carolina

by

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Introduction

The Major Hill-Sutphin area of gold mineralization, identified by this panned concentrate survey, is in the Carolina slate belt in central North Carolina. It is located in an area where several small gold prospects were worked in the past and where small scale gold panning in the streams may have been widespread and is carried on to a limited extent today; however we have found no reference to past or present gold production in the geologic literature. The area is partly or wholly within part of the Snow Camp-Major Hill hydrothermal alteration system, a major zone of siliceous and high-alumina hydrothermal alteration of the type known to have contained minable gold ores at other localities in the slate belt. Part of the alteration system near the Snow Camp pyrophyllite mine was described by Schmidt (1985b).

Studies to define the Major Hill-Sutphin mineralized zone, and in particular the stream sediment sampling program described here, are part of a larger research project testing applications of satellite remote sensing to mineral exploration. Consequently, many persons have been involved in developing the ideas that led to the selection of this area for evaluation by stream sediment sampling; these included especially R.G. Schmidt and T.L. Klein of the U.S. Geological Survey and Carmen Anton-Pacheco and Alba Payás of the Instituto Geologico y Minero de España, Madrid, Spain. In addition, those whose field mapping helped lead to the evaluation program include particularly Elizabeth H. Hughes of the U.S. Geological Survey, who carried out detailed mapping in the area in 1985. Additional map data were collected by Alba Payás, Pablo Gumiel, and Carmen Anton-Pacheco of the Instituto Geologico y Minero de España and M.J. Kingston and L.C. Rowan of the U.S. Geological Survey.

Studies of the pyrophyllite deposit at the Snow Camp mine and the much more extensive associated hydrothermal alteration began with a brief visit in November, 1979, followed by several more visits by Schmidt, Klein, and others in subsequent years. Examination of a variety of maps and images made by processing Landsat multispectral scanner and thematic mapper data led to the conclusion that the total area of hydrothermal alteration was probably much greater than formerly suspected. Field studies proved this to be so, and the desirability of detailed mapping and stream sediment sampling were realized. Partial mapping was carried out in 1985 and the sampling survey described here was conducted in April and June, 1986. The stream sediment sampling survey was designed to be completed in a very few days and to test as large an area as possible, hence sampling was confined to sites close to public roads. As a result, a large area northwest, west, and south of Sutphin, near the center of our study and partly surrounded by drainages yielding gold in panned concentrates, remains untested in this first-stage study.

Results of all phases of the survey are still incomplete, but some of the partial results, taken together, may be of interest to explorationists, and therefore the decision was made to make them available in this preliminary form.

Sampling procedures used

Panned concentrates were made following a standardized procedure using a 14 inch gold pan. Each sample consisted of a pan roughly level-full, approximately 5-6 kg dry weight or a volume of 0.004 m^3 (or 0.005 yd^3). Wet samples weigh 7-8 kg per pan. Stream sediments were generally panned in the stream where they were taken; soils were placed in plastic sacks and carried to convenient streams for processing. The resulting concentrates were placed in plastic bags and returned to the laboratory for drying and examination under the microscope. Each stream sediment analysis shown on tables 3-6 was made on the concentrate from one pan.

All soil samples for analysis by emission spectrograph were composites of 10-15 separate samples taken over an area 10-20 meters in diameter. In plowed fields, the samples were dug at the surface and in forested areas they were taken from the A_2 horizon beneath the organic-rich surficial material. Large rock chips were rejected in the field and small pebbles screened out in the laboratory before analysis.

Rock chip samples from outcrops and prospect dumps each consisted of 8-15 separate fragments 2-3 cm in diameter. Weathered rinds were removed wherever possible. It is important to consider the composite nature of the samples collected in judging the significance of the analyses of the prospect dump samples.

Regional geology

The Carolina slate belt is a complex area of late Precambrian to Cambrian volcanosedimentary, epiclastic, and volcanic rocks extending 650 km from central Georgia to southern Virginia. In the Snow Camp region it is 60 km wide and consists of intermediate metavolcanic rocks with lesser areas of mudstone, and of fewer felsic and mafic metavolcanic rocks. Several granitic plutons and subvolcanic porphyry dikes of probably widely different ages intrude the slate belt rocks in this area.

Hydrothermal alteration

Many large zones of intense hydrothermal alteration are present in the Carolina slate belt in North Carolina as described by Schmidt (1985a), Klein and Schmidt (1985), and Sexauer (1983). These zones are typically several kilometers in dimension, and have undergone extensive leaching of alkalis and introduction of silica in parts of the systems. Sericitization is widespread but in some areas the mica is paragonite. Peripheral areas may have undergone much propylitic alteration but we have not distinguished this from the pervasive greenschist facies regional metamorphism. In the most intensely altered parts of some of the systems, lenses, pods, and pipes of alumina-rich minerals mixed with quartz have formed. Many of these have been exploited for their pyrophyllite and pyrophyllite-andalusite rock.

The metals gold, silver, copper, molybdenum, tin, and arsenic occur in small amounts in many of the altered zones in North Carolina, but only gold has been found in minable quantity. The occurrence of other metal deposits associated with this type of alteration in other parts of the world was discussed by Schmidt (1985a). Presence of this type of alteration is considered favorable for gold exploration in this region (Carpenter and Allard, 1982, Schmidt, 1982, 1985a, p. 29-49, Klein and Schmidt, 1985).

The Snow Camp alteration system is a very large one, extending northeastward 13 km, and it is several km wide. The most altered rocks are resistant to weathering and tend to form hills and monadnocks. The width of alteration is not well defined because the eastward extent along several narrow shear zones is not yet known. The most intensely altered parts of the system have been almost entirely replaced by quartz forming quartz granofels, in places accompanied by pyrophyllite, andalusite, and pyrite. Siliceous breccias containing magnetite or specular hematite are widespread, mostly on the east side of the quartz granofels hills. Narrow sheared zones, commonly hydrothermally altered and containing small amounts of sulfide extend northeastward from the quartz-granofels hills along lineaments for several kilometers. Brecciation at the Braxton gold prospect may be associated with such a zone.

Pyrophyllite/andalusite and sericite are the main mineral commodities that have been produced in the map area. Several prospects for metallic minerals have been located though none are recorded in geologic literature, and it is believed that most of these were for gold. Silver and/or copper was mined from a small deposit just outside the map area to the north, and an area 3 km west of the map was prospected for copper (Carpenter, 1976).

Not much is known about the way that gold occurs in the mapped area, but it is assumed to be similar to the gold occurrences at Pilot Mountain, Randolph County, NC. There, gold has been mined especially from fracture zones and quartz veins but is also dispersed widely in siliceous and quartz-sericite altered volcanic rocks. Gold has been detected by fire-assay analyses from unnamed shafts east of Major Hill (sample 6140) where it occurs in masses of iron oxide boxworks in white vein quartz, and at the Braxton prospect where it is in iron oxide taken from a narrow brecciated zone. Visible gold was not noted in the samples submitted from these prospects.

The source of gold in the panned concentrates is probably both veins and widespread disseminations within drainage basins in the zone of intense hydrothermal alteration, but may be restricted to veins and shears outside of the big alteration zone. All of the gold particles seen are less than 2 mm in size. Unfortunately, the east boundary of the alteration is less well defined in the area where panned concentrates contained gold near Major Hill, than in other parts of the perimeter.

Stream sediment sampling program

A program of collecting stream sediments and panned concentrates was designed to test the mineral potential, especially the gold potential of the entire Snow Camp alteration system. In April and June, 1986, it was possible for John D'Agostino to carry out sampling in part of the sites selected and the samples collected tested drainages from all parts of the system. In addition to stream sediments, soils from some of the gold prospects and adjacent to the prospects were concentrated by panning. Results of microscopic examination of the panned concentrates are shown on the accompanying map and in tables 3-6. Visual identification of the andalusite and gahnite was confirmed by E.J. Dwornik using the scanning electron microscope. Chemical analyses of the sediments have not been completed and will be reported later.

Discussion of results

Though our sampling program is far from complete and the data in hand have been collected for a variety of purposes, the spectrographic, panned concentrate, and fire assay analyses presented in Tables 1-6 do represent a considerable amount of geochemical information, and can be interpreted in a tentative fashion.

Visible gold in panned concentrates and gold detected in fire assay results is distinctly limited to an area north and east of Major Hill. Most of the gold-bearing samples so far taken are from within the intensely hydrothermally altered zone; samples 70c and 72c and the Braxton prospect (sample 6064) are east of this zone, but may be related to narrow zones of altered rock along northeast-trending shears. The andalusite in sample 70c suggests hydrothermal alteration within that drainage basin, though we have not been aware of any there. The complete absence of visible gold from any concentrate in the southwest half of the intensely altered zone was a surprise to us and a result that we consider very significant, though at present unexplained.

Metal values other than gold in rocks and soils from restricted narrow shear zones and from the large main zone of hydrothermal alteration seem to show no particular trends. Small but anomalous amounts of molybdenum (3-12 ppm), tin (5-19 ppm), arsenic (140-370 ppm) are present in many of these samples throughout the area (tables 1 and 2), but, except for molybdenum, are lacking in the samples from the gold-bearing prospects (samples 6140 and 6064).

Significant silver analyses (3-21 ppm) were obtained from three samples, number 1966, sulfide-bearing quartz-sericite rock along a shear, and from gossan samples from the two prospects (numbers 6140 and 6044).

Conclusions

The occurrence of visible gold in 7 of the panned stream sediment concentrates from this rather clearly delimited area, together with analyses of samples taken from the dumps of old prospects suggest that the Major Hill-Sutphin area is favorable for further economic mineral evaluation. The close association of these indications with a very large area of hydrothermal alteration of the silica-rich high-alumina type is considered to further favor the area.

References cited

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Table 1. Analyses by emission spectrograph and fire assay of hydrothermally altered rock and ore.

Field No.	6120R	6139R	1966R	1890R	6154R	6140R	6064R
Lab. No.	W-235364	W-235365	W-234328	W-233725	W-235367	W-235366	W-235363
SI %	> 34	> 34	> 34	> 34	> 34	> 34	> 34
AL %	21	21	18	14	17	1.2	2.3
FE %	4.1	3.7	2.5	4.0	3.4	19	2.3
MG %	1.5	0.71	0.42	1.7	0.48	0.081	0.13
CA %	2.9	3.1	0.95	1.9	0.023	0.022	0.014
NA %	6.4	4.0	> 6.8	4.1	0.11	0.026	0.012
K %	4.0	4.1	3.1	1.7	4.1	0.48	0.59
TI %	0.64	0.26	0.36	0.36	0.35	0.050	0.11
P %	0.16	0.078	< 0.068	0.13	< 0.068	< 0.068	< 0.068
MN %	0.11	0.078	0.041	0.23	0.044	0.0054	0.016
AG PPM	0.28	0.33	3.7	0.29	0.18	21	21
AS PPM	150	< 100	190	< 100	370	< 100	< 100
AU PPM	< 6.8	< 15	< 6.8	< 6.8	< 6.8	54	< 15
B PPM	9.0	17	4.6	< 3.2	26	< 6.8	5.0
BA PPM	1300	1200	730	540	690	110	91
BE PPM	3.2	2.9	1.3	2.1	4.0	< 1.0	< 1.0
CE PPM	130	< 43	90	< 43	< 43	130	< 43
CO PPM	8.8	1.3	1.4	3.8	< 1.0	120	< 1.0
CR PPM	2.3	1.2	2.6	11	1.2	5.2	< 1.0
CU PPM	22	7.1	27	9.6	8.7	710	24
EU PPM	3.8	4.0	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2
GA PPM	29	33	26	17	27	< 1.5	5.1
GE PPM	< 4.6	4.9	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6
LA PPM	77	36	48	32	< 10	< 22	26
MO PPM	1.5	1.2	3.5	1.2	12	3.0	1.9
NB PPM	11	14	12	11	11	7.0	< 6.8
ND PPM	79	50	55	< 68	< 32	< 32	< 32
NI PPM	17	6.0	7.1	7.8	5.9	42	2.5
PB PPM	20	19	150	28	30	29	27
SC PPM	11	11	8.6	12	9.4	2.7	2.5
SN PPM	9.5	6.2	7.1	4.9	7.6	< 4.6	< 4.6
SR PPM	370	200	260	310	48	13	3.0
V PPM	62	13	11	37	24	31	17
Y PPM	26	31	19	30	18	< 1.5	2.5
YB PPM	5.6	9.6	5.5	5.4	3.9	< 0.15	0.84
ZN PPM	53	42	340	130	< 10	54	32
ZR PPM	210	280	240	140	250	21	48
THE FOLLOWING ANALYSES BY FIRE ASSAY							
AU PPM	< .05	< .05		< .075	< .05	92	11

The following elements are present in less than the threshold amounts indicated (in ppm): Bi, 10; Cd, 32; Dy, 22; Er, 4.6; Gd, 32; Hf, 15 or 150; Hg, 6.8; In, 10; Ir, 15; Li, 68, but for some an unresolved interference made results unreliable; Lu, 15; Os, 15; Pd, 1.0; Pr, 100; Pt, 2.2; Re, 10; Rh, 2.2; Ru, 2.2; Sb, 6.8; Sm, 10; Ta, 320; Tb, 32; Th, 46; Tl, 10; Tm, 4.6; U, 220 or 460; W, 15.

Determined in laboratories of U.S. Geological Survey. Emission spectrograph analyses by C. J. Skeen and W. B. Crandall; A. F. Dorrzapf, project leader. Fire assay by Roosevelt Moore; P. J. Aruscavage, project leader.

Description of samples (see attached page).

Table 1: Description of samples

6120	One-half-meter wide probably sheared zone in andesitic fragmental volcanic rocks; trends northeastward. Quartz-sericite-pyrite alteration in zone is intense.
6139	Several-meter wide sheared zone in andesitic volcanic rocks, trends N. 75°E. Quartz-sericite-pyrite alteration is present.
1966	Much fractured gray quartz-sericite-pyrite rock in major drainage-enhanced lineament. Exposed part of altered zone perhaps one meter wide, boundaries covered by overburden.
1890	Pyritic quartz-sericitic schist in large boulders blasted from pipeline trench, on edge of major drainage-enhanced lineament.
6154	Quartz-sericite-pyrite altered rock from N. 30°E. trending zone in intermediate volcanic rocks. Zone is perhaps 10 m wide, and is exposed for 30 m along trend.
6140	Rock from prospect dumps east of Major Hill. Sample consisted of vein quartz boxworks and iron oxide gossan from oxidized quartz-sulfide veins. Prospect pits trend N. 70°W.
6064	Rock from Braxton prospect dump, mostly oxidized quartz-pyrite cemented breccias from N. 50 E. fractured zone. Breccia fragments are 2-5 cm.

Table 2. Analyses by emission spectrograph of composite samples of lower A-horizon soils and two of deep saprolites (1568 and 1569).

Field No.	792E	1573E	1568	1569	1834E	1835E
Lab. No.	W-228845	W-228854	W-228852	W-228853	W-230670	W-230671
SI %	> 34	> 34	> 34	> 34	> 34	> 34
AL %	5.1	9.0	15	20	7.3	10
FE %	2.8	3.1	5.0	4.9	5.2	2.1
MG %	0.13	0.072	0.26	0.26	0.090	0.12
CA %	0.26	0.055	0.013	0.015	0.10	0.049
NA %	0.22	0.29	0.075	0.46	0.31	0.080
K %	0.90	0.81	2.2	5.1	0.59	1.9
TI %	0.44	0.69	0.23	0.54	0.81	0.52
P %	< 0.068	< 0.068	0.12	0.16	< 0.068	0.073
MN %	0.080	0.0067	0.098	0.030	0.020	0.013
AG PPM	0.23	0.11	0.38	0.14	0.15	1.1
AS PPM	160	< 100	260	140	< 100	< 100
AU PPM	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8	< 6.8
B PPM	14	13	6.3	12	9.0	10
BA PPM	180	270	460	1700	260	600
BE PPM	3.5	< 1.0	5.6	2.4	< 1.0	< 1.0
CE PPM	< 43	< 43	250	130	< 43	< 43
CO PPM	7.4	1.2	7.7	9.9	1.2	1.5
CR PPM	6.7	37	< 1.0	73	28	21
CU PPM	4.8	40	24	140	42	20
DY PPM	< 22	< 22	< 22	< 22	< 22	39
ER PPM	< 4.6	< 4.6	< 4.6	< 4.6	< 4.6	7.7
EU PPM	< 2.2	< 2.2	< 2.2	4.4	< 2.2	< 2.2
GA PPM	9.1	11	34	21	12	12
LA PPM	32	< 10	64	120	29	29
LI PPM	< 68	< 68	< 68	< 68	< 68	200
MO PPM	3.1	7.3	5.3	5.3	2.3	1.1
NB PPM	21	17	34	11	14	16
ND PPM	40	< 32	130	140	72	< 68
NI PPM	11	13	12	12	7.9	9.0
PB PPM	27	26	50	50	21	14
SC PPM	3.1	8.1	7.7	11	7.7	6.8
SM PPM	< 10	< 10	18	< 10	< 10	< 10
SN PPM	6.9	7.5	19	6.2	4.8	< 4.6
SR PPM	34	150	32	450	290	55
V PPM	35	81	39	92	100	60
Y PPM	26	17	70	20	13	12
YB PPM	4.5	2.6	16	4.7	2.6	2.2
ZN PPM	21	< 10	62	< 10	< 10	< 10
ZR PPM	610	160	1600	240	200	190

The following elements are present in less than the threshold amounts indicated (in ppm): Bi, 10; Cd, 32; Er, 4.6; Gd, 32; Hf, 15 or 150; Hg, 6.8; In, 10; Ir, 15; Lu, 15; Os, 15; Pd, 1.0; Pr, 100; Pt, 2.2; Re, 10; Rh, 2.2; Ru, 2.2; Sb, 6.8; Sm, 10; Ta, 320; Tb 32; Th, 46; Tl, 10; Tm, 4.6; U, 220 or 460; W, 15.

Determined in laboratories of U.S. Geological Survey. Emission spectrograph analyses by C. J. Skeen, Z. A. Brown, J. D. Fletcher, and W. B. Crandell; A. F. Dorrzapf, project leader.

Description of samples (see attached sheet).

Table 2: Description of samples

792	Soil from area of devitrified glassy rhyolite bedrock; part of rock hydrothermally altered along microfractures.
1573	Soil from area of sugary quartz granofels; quartz content very high.
1568	Clay-rich saprolite from north wall, deeply-cut access grade to Snow Camp pyrophyllite mine. Two-meter channel sample.
1569	Clay-rich saprolite from south wall, deeply-cut access grade to Snow Camp pyrophyllite mine. Two-meter channel sample.
1834	Soil from area with much float of hydrothermally altered rock. Present are pyrophyllite quartz rock, chloritoid-bearing slate, and siliceous breccia rock with a black matrix.
1835	Soil from area of quartz granofels, some with traces of pyrophyllite and some with casts and stains resulting from oxidation of small amounts of pyrite.

Table 3. Panned stream sediment concentrates containing visible gold.

Sample Number	Specular Hematite	Bright Blue Gahnite	Andalusite G = Gray	Sulfides Py=pyrite Ph=pyrrhotite Ch=chalcopy.	Oxidized pyrite cubes; limonite nodules 1/	"Brown Balls" 2/	Vein quartz chips	Epidote	X indicates present; S, sparse; C, common; blank indicates looked for but not found COMMENTS
6C	X			Py	X	X	X	X	3 particles of gold noted
45C				Py				X	2 particles of gold noted
47C	X	X	X		X		X	X	23 particles of gold noted
48C	X	X	G				X	X	35 particles of gold noted
57C	X	S						X	1 particle of gold noted
70C	X		X	Py, Ph	X	X	S	C	15 particles of gold noted
72C	X			Ch, Py	X	X	X	X	35 particles of gold noted

1/ Grains we call "limonite nodules" are solid iron oxide.
2/ "Brown balls" are mineral or lithic grains armored with iron oxide.

Table 4. Panned stream sediment concentrates, no visible gold noted

Sample Number	Specular Hematite	Bright Blue Gahnite	Andalusite B = Blue Gray G = Gray	Sulfides Py=pyrite Ph=pyrrhotite Ch=chalcopy.	Oxidized pyrite cubes; limonite nodules 1/	"Brown Balls" 2/	Vein quartz chips	Epidote	X indicates present; S, sparse; C, common blank indicates looked for but not found COMMENTS
1C							X	X	
2C	X						X	C	
3C							X		
4C							X	S	
8C					X		X		
19C	X	X		Ch, Py, Ph 3/	X	X	X	X	More sulfide grains here than other streams in study
35C								X	
37C								X	
39C						X	X		
41C		S	S(B)					X	
43C						X		S	
60C								X	
62C								C	
64C				Py, Ph				X	
66C		X	B	Py			X	C	
68C								S	
74C						X	X	X	
76C				Py	X		X	X	
79C	X					X		S	
81C									
82C							X	X	

1/ Grains we call "limonite nodules" are solid iron oxide.
2/ "Brown balls" are mineral or lithic grains armored with iron oxide.
3/ Other sulfides noted: bornite, arsenic-bearing pyrite.

(cont'd)

Table 4 (cont'd).

Sample Number	Specular Hematite	Bright Blue Gahnite	Andalusite B = Blue Gray G = Gray	Sulfides Py=pyrite Ph=pyrrhotite Ch=chalcopy.	Oxidized pyrite cubes; limonite nodules 1/	"Brown Balls" 2/	Vein quartz chips	Epidote	X indicates present; S, sparse; C, common blank indicates looked for but not found COMMENTS
85C					X				
87C							X	X	
89C							X	X	
91C					X	X	X		
93C									
95C		X	B					X	
98C									
99C		X			X		X	X	
102C				Py			X	X	
104C								X	
107C					X			X	
110C							X		
112C							X	X	Sparse black opaques (magnetite)
114C		S	S(G)				X	X	Sparse black opaques
117C	X				X			S	Tiny magnetite grains
119C				Cp(s)	X		X	X	Ilmenite present
121C	C				S		X		
123C	X							X	
125C	S					X		X	Quartz crystals in sample
127C	S								

1/ Grains we call "limonite nodules" are solid iron oxide.
2/ "Brown balls" are mineral or lithic grains armored with iron oxide.
3/ Other sulfides noted: bornite, arsenic-bearing pyrite.

Table 5. Panned soil sample concentrates containing visible gold

Sample Number	Specular Hematite	Bright Blue Gahnite	Andalusite B = Blue Gray G = Gray	Sulfides Py=pyrite Ph=pyrrhotite Ch=chalcopy.	Oxidized pyrite cubes; limonite nodules 1/	"Brown Balls" 2/	Vein quartz chips	Epidote	X indicates present; S, sparse; C, common blank indicates looked for but not found COMMENTS
14D									
15D								X	2 particles of gold
16D				Py	X				5 particles of gold
17D	X			Py	X			X	6 particles of gold
51D	X	X	G		X	X	X		5 particles of gold
54D	X			Py	X	X	X	S	1 particle of gold

1/ Grains we call "limonite nodules" are solid iron oxide.
2/ "Brown balls" are mineral or lithic grains armored with iron oxide.

Table 6. Panned soil sample concentrates, no visible gold noted

Sample Number	Specular Hematite	Bright Blue Gahnite	Blue Gray Andalusite	Sulfides Py=pyrite Ph=pyrrhotite Ch=chalcopy.	Oxidized pyrite cubes; limonite nodules1/	"Brown Balls"2/	Vein quartz chips	Epidote	X indicates present; S, sparse; C, common blank indicates looked for but not found COMMENTS
9D							X	X	
10D				Py				S	
11D								X	
12D	X				X			C	
20D						X		X	
21D					X	X			
22D						X			
24D					X	X			
25D					X		X		
27D	X				X	X			
28D					X	X			
29D						X			
30D	X				X				
32D	X				X	X			
33D					X	X	X		
34D					X	X			
49D		S	S						
50D					X	X	X	X	
52D					X		X		
53D	X	X	X		X	X	X	X	
55D					X	X	X		
58D	X				C				
77D					X	X	X		
100D							X	S	
108D	X					X	X	X	

1/ Grains we call "limonite nodules" are solid iron oxide.
2/ "Brown balls" are mineral or lithic grains armored with iron oxide.