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GEOLOGIC REPORT NO. 10

Geology of the Bluff Area, Solomon Quadrangle, Seward Peninsula, Alaska

By

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Juneau, Alaska
June, 1965

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GEOLOGY OF THE BLUFF AREA, SOLOMON QUADRANGLE, SEWARD PENINSULA, ALASKA

By G. Herreid

INTRODUCTION

The mining camp of Bluff is on the south coast of the Seward Peninsula, 50 miles east of Nome. The present investigation was prompted mainly by the description in U.S. Geological Survey Bulletin 722 of mineralized schist bands in the area. It seemed possible to the writer that these might be rich enough in gold to mine with a modern open pit operation. Field work was done from June 19 to July 5, 1964 by the author, capably assisted by Michael Mitchell. The work was much facilitated by the generous hospitality of Mr. and Mrs. Milton Morgan, John Novak, and Wayne Chambers, prospectors and miners at Bluff. Thanks are due also to Gene Farland for flying mail and supplies, and to other Bluff miners for their assistance.

GEOLOGY

Much of the northwestern part of the Seward Peninsula is underlain by lower Paleozoic and possibly older limestone and slate. These rocks are flanked on the southeast by marble and schist which, because of similar lithology before metamorphism, are generally considered to be of about the same age. These metamorphic rocks underlie most of the Seward Peninsula. Farther east, Cretaceous graywacke of the Koyukuk geosyncline laps onto this metamorphic terrain and has been deformed along with the underlying metamorphics in a belt of north-trending folds. At Bluff the folds trend north also, although they may be much older, and the bedrock is schist and marble. The gold lodes and placers in the Bluff area are located near a marble-schist contact zone.

Between Eldorado Creek and Koyana Creek a large recumbent fold is present, here called the Bluff anticline, which is overturned to the east and plunges north at approximately 18°. East and west of this central area the schist-marble contact is only slightly undulatory and the schist overlies the marble. Interbedding of marble and schist at the contact at Koyana Creek indicates that these rocks are in depositional contact with one another. The schist is probably younger than the marble.

In general, the highlands and coastal bluffs are underlain by marble which supports little or no vegetation, and the lowlands are underlain by schist which is tundra-covered and has little or no outcrop. However, in some low-lying covered areas, for example along the west side of Daniels Creek and in Upper Basin Creek, scattered marble float and occasional outcrops indicate marble bedrock. In these areas the marble-schist contact has no surface expression.

The marble, which crops out along much of the coast, dips northward under the schist. Inland it is only exposed in areas where folding and faulting bring it to the surface. The regional geologic maps of the U.S. Geological Survey and air photo and visual observations by the author indicate that the country surrounding the map area for several miles is almost entirely underlain by schist. It is probably of genetic significance that the gold-producing creeks drain alluvial basins underlain by both marble and schist.

Lithology

In general the schist is composed of lenticular layers of quartz up to 2 mm thick, sheathed by foliated greenish gray muscovite-chlorite layers. These micaceous layers are invariably crenulated, generally in a rude irregular manner, but where quartz layers are thin or lacking, the rock becomes more phyllitic and the crenulations are regular on a fine scale. Where chlorite predominates, the schist is soft and dark greenish-gray. Limy schist is present near the marble contacts just west of Koyana Creek. One specimen of schist in this area contains about 10% zoisite.

In the placer cuts on Daniels Creek, subangular boulders weathered to a moderate yellowish brown are fairly common. These range from schist, predominantly composed of quartz separated by micaceous layers, to slightly foliated quartzite with fine scattered white mica on foliation surfaces. This rock lies between mica schist and black marble on Daniels Creek about 800 feet below the old mill, and between mica schist and light gray marble on the east edge of the Eskimo Lode at the upper edge of the bluff along the coast. In thin section a piece of schistose quartzite from Daniels Creek is seen to consist of about 5% aligned sericite flakes and 95% equant to slightly elongated quartz grains (to 0.4 mm long) with sutured borders. The rock apparently originated either as a slightly impure sandstone or as a quartzose replacement before or during metamorphism. Smith (1910, p.58) attributes quartz rock found at the marble-schist contacts to replacement of the marble. He mentions gradations from pure marble to pure quartz. Such gradations were not found at Bluff.

Similar quartzite is present on the east side of the headwaters of Lost Creek at an elevation of 480 feet, both as float and in place in the marble. In a prospect pit at sample site 30, quartz layers up to a few inches thick run parallel to the layering of the marble across a width of 10 feet. A grab sample of quartz contained 0.1 ounces gold per ton, 0.33 ounces silver per ton, less than 0.1% lead, and a trace each of copper and zinc. It is unlikely that chert would contain this much gold and silver. Geochemical soil samples indicate a moderate lead anomaly in the pit and no anomalies in the marble uphill from the pit (geochemical samples 30, 30a, 30b; Table 1). From this locality to 1020 feet in elevation on the ridge, scattered patches of white quartz talus are present. At elevation 1020 similar rock crops out, but interbedded with the marble. The rock here and at sample site 30 is bone white, fine-grained, granular quartzite, and appears to be a recrystallized sandstone.

Marble ranges from layered dark gray carbonaceous rock near the schist contacts at Bluff and Koyana Creek to conspicuously crystalline white rock in the marble hills north of Bluff. The marble in the hills along the coast between Bluff and Koyana Creek is mainly light gray banded rock, intermediate between the two.

Typical dark gray marble is present at beach level on the east side of the Idaho lode. This rock is medium-grained,rudely-foliated marble with foliation surfaces a dull dark gray due to concentration of carbonaceous material. Crenulation of the foliation surfacesdefines a rude lineation parallel to the direction of regional folding. On surfaces broken across the foliation, the rock is a medium-dark gray due to the presence of colorless calcite grains between the carbonaceous layers. The contact with the schist of the Idaho lode is sharp within 1/4" or less, and is isoclinally folded with a fold amplitude of a few feet.

In the coastal cliffs, east of Grizzly Creek the marble is a medium gray, medium-grained, strongly-crenulated rock. Bedding planes 2-3 feet apart are present, as well as banding on a smaller scale. Occasional parallel and crosscutting white calcite veins up to a few inches thick are present. Deformed white calcite veins are common in the medium gray marble, generally constituting less than 5% of the rock. These tend to be somewhat coarser-grained than the gray marble matrix, and are generally irregular, elongated globs, occasionally in the form of isolated folds. At points 1/4 mile east and 1/8 mile southwest (unit A, figure 5) of the mouth of Koyana Creek, the marble contains up to 50% of similar deformed white calcite veinlets.

The marble in the hills inland from Bluff is generally a medium-grained rock weathering light gray to very light gray. Faint grayish banding parallel to the rude foliation is present in places. Foliation is generally only crudely displayed so that the attitude of the rock is not apparent in many outcrops. No minor folds were seen, but crenulations are generally present on foliation surfaces.

The impression was gained that the very light gray marble north of Bluff, in the core of the Bluff anticline, has developed by recrystallization from medium to dark gray marble.

The interbedding of marble and schist at the contact on Koyana Creek and the parallelism or near-parallelism of composition banding and foliation attitudes in the two rocks indicates that they are in conformable contact and have been subjected to the same folding. At the Bluff lodes the foliation in places crosscuts the marble schist contact (e.g. west side of Idaho lode at top of Bluff). Such structures are typical in the axial zones of flowage type folds. It was probably this feature, along with the complex fold structures, that made Brooks (1908) believe that the schist of the lodes was an altered intrusive.

Structure

All foliation and bedding attitudes, minor fold axes, and crenulations have been plotted on a sterographic net (figure 2). The grouping of fold axes and crenulations in one region on the net indicates a fair parallelism of fold axes over the entire map area. The map area is therefore a single structural domain in which cylindroidal folding is approximated. The average plunge of axes, as visually estimated from the plot, is 18° N. If the map is viewed looking downward toward the north at an 18° angle, the approximate profile of the fold is seen. This profile, corrected for differences in topography on the geologic map, indicates that the marble hills north of Bluff are the outcrop of a bulging fold overturned to the east. This great recumbent fold in an area of otherwise gently undulating structure is an indication that the rocks behaved more plastically than in the surrounding area. It seems likely that this plasticity was due to higher temperature or greater water content localized in the area of the fold. Such conditions would also be conducive to mobility of ore bearing fluids.

The concentration of poles of foliation and bedding reflects the predominance of flat dips, both in the fold and along the coast to the east and west of the fold.

Minor structures consisting of small folds and crenulations are widely present. The folding of composition banding on a scale of a few inches is present in possibly 5-10% of the outcrops with attitudes obscured by poor exposures in many of these. Crenulations are present on most foliation surfaces in marble and are ubiquitous on phyllitic partings in marble and in the schist. Minor folds and crenulations parallel one another where both are present in a single outcrop and statistically are roughly parallel throughout the area, as noted above. They are the result of movements that were pervasive throughout the region during folding, movements which also resulted in the major folds in the area. Where folds of intermediate scale have been recognized they plunge northerly, about parallel to the minor folds. These intermediate folds have been mapped at the Bluff lodes (figure 4), along the coast line a mile west of Ryan Creek, and 900 feet east of Koyana Creek. The folds at the latter locality are several feet in amplitude and are overturned to the west (axial plane N45W, 55° NE dip). Lack of exposures along much of the schist-marble contact and lack of strong composition banding elsewhere reduces the possibility of recognizing intermediate-sized folds in the map area.

Block faulting in the Grizzly Creek area has elevated the marble over an area of about 1/2 mile square. A V-shaped salient in the center of this block has dropped down along faults that run along Grizzly Creek and the next creek to the east.

GEOCHEMISTRY

Because of the lack of surface drainage in the valleys underlain by marble, only 3 stream sediment samples were taken in the map area (see Table 1). A line of soil samples (1-11) taken across the Bluff lodes does not show any anomalies. Another line, taken west of Daniels Creek, shows a single lead anomaly (sample 12) adjacent to Daniels Creek. The origin of this anomaly could be similar to sample site 10, a prospect pit with no visible sulfides and with low gold values in quartz. The single high zinc value (#11A) was also taken in a prospect pit with no visible sulfides.

The gold lodes carry from 800 parts per million (0.08%) to 16% arsenic, and the possibility exists that arsenic soil anomalies are associated with gold in the area.

MINERAL DEPOSITS

Gold placers and lode deposits of gold-arsenopyrite and cinnabar are present in the map area. The first discovery was of placer gold at the mouth of Daniels Creek in September, 1899 (Brooks, 1908). Outcropping lode deposits on the bluff east of Daniels Creek were located soon after. Claim posts on the edge of the bluff and also in the lode area 4,000 feet to the north have the date 1900 carved on them. Cinnabar is present in the placers and has been found as small lode pockets on Swede Gulch.

Placer gold has been mined on Daniels Creek, Eldorado Creek and Swede Gulch. Placer prospects are known on Ryan and Koyana creeks, and evidence of prospecting was found on Grizzly Creek and the creek east of it.

During our visit to the area, Wayne Chambers was dredging on Eldorado Creek with a small dredge. Milton Morgan and John Novak, representing the Auric Offshore Mining Company, were making preparations for offshore dredging with a patented underwater suction device operated from an amphibious vessel.

Daniels Creek

Daniels Creek has been mined on both the modern channel and on a buried channel on the west side. From appearances, the buried channel was mined first. It is a narrow steep-side gorge (20-30 feet deep by about 10 feet wide) in marble bedrock whose walls were, before burial, deeply etched and rounded by subaerial weathering. The bedrock is fine-grained medium light to a very light gray marble with up to 5% of its volume composed of parallel and crosscutting white calcite veinlets less than 1/4 inch thick. These stand up in relief on surfaces etched by weathering. Some composition banding of marble parallel to foliation was observed, and also occasional crinkled phyllitic layers and diffuse pale reddish gray (iron rich) layers parallel to the banding of the marble. Occasional tiny grains of limonitized sulfide along phyllitic layers represent the only sign of mineralization in the area. Rounded pieces of limonitized float of unknown origin up to several inches across are common in the creek gravel and in panned concentrates from Daniels Creek. Some contain pyrite(?) cores and one was found to contain 11% lead.

The fault that cuts across the upper part of the mined area brings black marble in contact with white marble. Red iron stain and some brecciation are present along the fault. Only a little mining has been done above the fault. Limonitized sheared marble along the fault assays .03 ounces of gold per ton and .03 ounces of silver, a value of $1.08 per ton.

Above the upper extent of mining, the buried channel is hidden beneath the gently inclined west side slopes of Daniels Creek. In this area, a residual soil mantle four to five feet thick is composed of angular blocks of white marble in a brown soil. The buried channel is cut in black marble which is overlain by this mantle of white marble debris. Evidently, downhill creep has brought surficial material down the slope from the white marble area west of the fault (see figure 3). The slope is consistent and drops about 15 feet in 100 feet. Further south on the west side of the creek where the slope is five or less feet in 100, well-developed soil horizons with a clay layer a few inches below the surface are present. This slope is probably too flat for active creep to take place.

Brooks (1908, p. 293) believed that the gold was derived from the schist near the marble contact. He pointed out that the Bluff lodes which run along the east side of the creek and cross it 3500 feet from the beach are the logical source of the gold. However, placer mining stopped a little above the fault, 1000 feet below this intersection. This suggests some complexity in the origin of the placer, but no other likely source of gold is present in the area. It is interesting to note that gold can be panned from the soil mantle along both the east limit of the placer cut below the schist and the west limit of the creek on the side where only marble is present. The occasional phyllitic layers in the marble appear to be poorly mineralized and insufficient in amount to be an important source of gold. No evidence was seen to support the suggestion by Cathcart (1922) that Daniels Creek is cut along a mineralized schist layer from which it derived its gold. Study of figure 3 indicates that this could only be true on lower Daniels Creek, as most of the creek is underlain by marble.

Some gold may have come from the cross fault itself, but it seems unlikely that this is a sufficient source for all the gold on Daniels Creek.

The Bluff lodes crop out on the bluff a thousand feet east of the mouth of Daniels Creek and extend northward to cross Daniels Creek about 3500 feet above its mouth (see figures 3 and 4). At present the only exposures are along the sea cliffs, but in the past many shafts have been sunk, mainly in the area where the lodes cross Daniels Creek. The "lodes" as the term has been used by Cathcart (1922), refers to bands of quartz-mica schist, only part of which appear to contain significant amounts of ore minerals.

The only outcropping sulfide showing seen along the Bluff lodes is on the Idaho lode, about six feet above beach level. This showing consists of a roughly horizontal lens of solid arsenopyrite and pyrite about four feet wide by 20 feet long. At the west end it is covered by a talus slide and at the east end it pinches down to a quartz vein one foot wide. The sulfide lens and quartz vein appear to plunge very gently north into the hill. The surrounding rocks are much folded and crenulated. This showing may be localized along a north-plunging fold hinge of moderate size.

The portions of the Idaho lode and the Seagull and Eskimo lodes in the sea cliff exposures consist of moderately iron-stained quartz mica schist. A representative grab sample (D, Table 2) across the 20 foot width of the Seagull lode at the top of the bluff assayed $14.70 per ton.

The northward extension of the lodes has been traced for 4700 feet across a covered area by a series of shallow shafts and trenches, now mostly sloughed in. The dumps show variously: barren looking vein quartz, barren schist, moderately limonitized schist, and in some of the diggings north of the old mill, highly oxidized sulfide. Scheelite can be panned from some of the sulfide material. Table 2 gives analyses and descriptions of samples taken on the more favorable looking dumps and on some of the lean ones. There appears to be a considerable quantity of $1-$2 ore along with an unknown amount of $6-$14 ore. Trenching and more detailed sampling will be necessary to adequately sample this zone.

Koyana Creek

Nine hundred feet east of Koyana Creek, banded schist contains numerous quartz veins. The quartz veins are parallel to the schistosity, of rather irregular shape, mainly less than one inch wide, and have been folded with the schist. The amplitude of the folds is generally 1-2 inches. Limonitized sulfides (?) make sparsely scattered spots along the veins. About 500 feet east of Koyana Creek in the vicinity of an old adit (Cathcart, 1922, p. 188) a number of crosscutting quartz-arsenopyrite veins are present. These fill joints six inches to two feet apart, which pinch out along their strike and are present over a wide area, but have an appreciable sulfide content only near the old adit. The largest exposed vein is four inches wide and about 10 feet long, with solid pyrite and arsenopyrite in places and with scattered sulfides in quartz elsewhere. The adit was apparently driven to intersect this vein.

These two types of veins, parallel and crosscutting, have been called respectively older and younger by Smith (1910, p. 90). Also present in the area are veins intermediate between the parallel veins and the tabular crosscutting veins. One exposed on the beach just east of Koyana Creek is 3 inches wide, irregularly shaped, and crosscuts the schist at a moderate angle. A sketch of it is shown in figure 5, upper left hand corner. Quartz from this vein assays 0.01 ounces per ton of gold (Table 3, #5), the same as the enclosing schist (Table 3, #7).

The data in Table 3 indicate that the older quartz veins carry little more precious metal than the schist and that the younger arsenopyrite-bearing veins are richer. The values in the schist near the marble contact are high enough to account for the presence and location of the gold placers.

Swede Gulch

Swede Gulch has been placer mined for gold in a cut that extends 600 feet north from the edge of the bluff. A prominent gin pole and a cabin in poor repair remain from the mining operation. Cinnabar was present in the placer, and lode cinnabar showings have been prospected.*

The sketch map (figure 6) shows part of the area. A 4' x 6' shaft has been sunk about 20 feet in pink marble. This pink marble shows up in the shaft, in the trench east of the shaft, and down the face of the bluff. Assays indicate that the pink color is due to iron and not cinnabar. Breccia ore containing tan-weathering marble clasts cemented by white calcite and cinnabar was seen on a small dump. No showings of ore are present in the shaft or were seen elsewhere in place. Evidently the dump material was hand picked from small pockets. A patch of snow on the bluff face may have covered the showings described by Anderson.

Locally the fine-grained medium gray marble from the placer cut has fractures and breccia filled with white calcite and pink-stained calcite similar to some of the iron-stained marble found at A and B in figure 6.

Analysis of pink carbonate fracture and breccia filling with a Lemaire type S-1 mercury detector indicates a mercury content of about one part per million in two samples from the area. Barren-appearing light gray marble showed no mercury. Microscopic examination of crushed vein material indicates that the coloration is mainly due to limonite. Evidently trace amounts of cinnabar were introduced with the limonite. For this reason, limonite may be a guide to ore in this area.

*"Bluff Cinnabar Deposit - At the mouth of Swede Creek about 1 1/2 miles east of Bluff, a cinnabar lode has been prospected with two short tunnels and a few small shafts. Equipment for working and retorting the ore was shipped in several years ago and is still idle on the beach. The two tunnels apparently were begun in pockets of ore, but most of their lengths are in barren limestone. The cinnabar occurs in limestone beds exposed on a cliff overlooking Bering Sea. Several beds in the limestone as much as 10 feet wide are stained by hematite to a color very similar to that of the cinnabar ore. Assays of these zones varied from 0.04% to 0.14% Hg. and they cannot be considered as possible ore. Adjacent to the portal of the easternmost tunnel is a small pocket of ore, exposed only on the cliff face. An 18-inch chip sample across this kidney assayed 6.76% Hg. A 7-foot chip sample across the same kidney and into lower grade ore on both sides assayed 2.36% Hg. Channel samples would probably give somewhat lower values. The kidney is not more than 7 feet long and does not justify more than hand prospecting. The deposit, however, has not yet been thoroughly sampled." (Anderson, 1946, p. 33).

ORIGIN OF MINERAL DEPOSITS AND THEIR RELATION TO MAJOR STRUCTURES

The placers and placer prospects on Koyana, Daniels, and Eldorado Creeks and Swede Gulch all lie on or near the band of schist that has been infolded with and now underlies the marble of the Bluff anticline. The placer deposits are probably all associated with nearby lode deposits. The lack of placer gold discoveries elsewhere in the map area and the surrounding region emphasizes the close association of mineral deposits with the band of schist. This spatial association suggests a structural control of gold (and cinnabar) mineralization by the Bluff anticline.

Quartz-sulfide veins in the area occur only in schist and consist of two types: small folded veins up to a few inches wide, and larger tabular veins up to one or two feet wide, called respectively older and younger quartz veins by Smith (1910, p. 90-92). The older veins parallel the foliation of the schist and are probably a synkinematic segregation of quartz liberated by the breakdown of silicate minerals during metamorphism. The younger veins generally occupy joints or faults that crosscut the foliation, and are often subperpendicular to the regional axis of folding. They formed after folding ceased.

The younger veins often contain gold and visible amounts of arsenopyrite and pyrite, whereas the older veins contain only occasional rusty specks which may represent limonitized sulfide grains. The older veins are common in the schist, whereas the younger veins are not.

Veins which appear to be intermediate between the two types are present. These are a few inches wide, crosscut the foliation slightly, and are partly folded. The younger veins are apparently the latest members of a series of veins whose emplacement began while metamorphism was still in progress.

Deformed and tabular calcite veins in the marble are probably the equivalent of the early and late quartz veins in the schist. They are not mineralized.

SUMMARY & SUGGESTIONS FOR PROSPECTING

1. The known lode deposits are located along the margins of the band of schist that extends from Koyana Creek to Eldorado Creek. The placer gold deposits have been found along the same belt.

2. Gold deposits ranging in value from $1 to $2 per ton appear to be present over widths as great as several hundred feet. The arsenic content of this material ranges from 800 parts per million (0.08%) in the lowgrade to several percent in some of the veins.

3. The presence of disseminated gold ore assaying $14.70 per ton over a width of 20 feet on the Eskimo lode suggests that economic gold concentrations may be present in widths suitable for open pit mining. This ore carries 1.6% arsenic.

4. Much of the schist band is covered with shallow surficial deposits and tundra. Arsenic anomalies in the soil and small drainages should provide an effective guide to covered gold deposits along the schist belt.

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Table 1

Geochemical Analyses in Bluff Region

Sample No.	Copper (ppm)	Lead (ppm)	Zinc (ppm)	Depth	Soil Sample	Float or soil type	Location
1	25	15	125	6"	X	Brown clay	Sample line acros Bluff lodes
1A	25	35	110	6"	X	" "	"
2	20	35	115	6"	X	" "	"
3	15	15	50	12"	X	" "	"
4	35	35	85	6"	X	" "	"
5	35	35	80	12"	X	" "	"
6*	50	30	130	6"	X	" "	"
7	65	30	140	6"	X	" "	"
7A	50	45	140	6"	X	" "	"
8	40	25	90	6"	X	" "	"
8A	25	35	105	12"	X	" "	"
9	30	15	75	12"	X	" "	"
9A	30	20	70	12"	X	" "	"
10	45	15	60	6"	X	Red brown clay	"
10A	40	10	115	6"	X	Brown clay	"
11	35	25	110	6"	X	" "	"
12	75	120	170	18"	X	Gray marble	Sample line west of Daniels Creek
13	25	20	60	12"	X	wh. M. w/red stain	"
14*	10	15	45	18"	X	wh. M., bn. clay	"
15	30	15	60	18"	X	Black M., bn. clay	"
16	25	20	55	18"	X	Brown soil	"
17	100	35	90	18"	X	Wh. M., gy.-gn clay	"
18	65	50	95	18"	X	Gy.-bn. clay	"
19	60	20	90	18"	X	Blue clay	"
19A	50	20	75	18"	X	Blue clay	"
20*	25	20	65	12"	X	Wh.-gy. M., bn. clay	"
21	45	30	95	18"	X	Wh.-gy. M. w/Fe stain, bn. clay	"
22	50	10	115	6"	X	Bn. clay	Sch. area W of Bluff

Table 1 (Continued)

Sample No.	Copper (ppm)	Lead (ppm)	Zinc (ppm)	Depth	Soil Sample	Float or soil type	Location
23	35	20	105	6"	X	Brown Clay	Sch. area W. of Bluf.
24*	20	15	90	6"	X	" "	"
25	15	10	110	6"	X	" "	"
26	65	50	145	6"	X	" "	"
27	30	40	140	3'	X	Lt. gy. M., bn.soil	Karst pit on Basin Creek
28	60	20	135	3'	X	"	"
29	45	20	125	3'	X	"	"
30	50	250	160	5'	X	Red powder in prospect pit	Pit on wh. qtz. laye: in lt. gy marble
30A	15	15	65	6"	X	Lt. gy. M. rubble slope	100' E of 30
30B	35	5	65	6"	X	"	200' E of 30
31	10	0	55	6"	X	Lt. gy. M. wh. qtz. rubble	
32	30	40	140	6"	X	Lt. gy. M. w/ red stain	100' W of Pit A
32A	25	35	200	6"	X	"	Pit A (figure 5)
32B	20	20	145	6"	X	"	50' E of Pit A
32C	30	40	145	6"	X	"	100'E of Pit A
33	25	15	90			90% sch, 5% vein qtz, 5% marble	Koyana Creek
34	20	15	90			Sch. 5% vein qtz. bedrock is marble	Grizzly Creek
35	30	15	95			Lt. gy. marble, sch.	Creek E of Grizzly Creek

Samples 33, 34, and 35 are stream sediment samples.

*Duplicate samples analyzed by Rocky Mountain Geochemical Laboratories:

6	65	50	120
14	15	10	30
20	35	20	50
24	25	15	50

qtz - quartz
Sch - schist
M - marble
bn - brown
Lt gy - ligh gray
wh - whit

Table 2

Assays of the Bluff lodes

	Au oz/t	Ag oz/t	Value $	Cu %	Pb %	Zn %	As %	
A*	0.18	0.35	6.75**	Tr	nil	nil	16.5	Idaho lode at beach, chip sample across 4 ft. pod of arsenopyrite, pyrite & greenish yellow oxidation product. Pod exposed for length of 20 ft. Qual. X-ray spec-Major: As,S,Fe; Trace: Al,Si,K, Ca,Ti,Ni,Ag(?).
B	0.19	0.16	6.85	Tr	nil	nil		Idaho lode at beach, chip sample across 1 ft. qtz. vein. No free milling gold.
	.30	.26	10.83	(repeat sample)				
C	0.01	0.55	.98	.01	tr	tr		Seagull lode, halfway up bluff; grab sample of qtz. rich zone in moderately limonitized schist.
D	0.42	0.45	14.70	.01	.01	tr	1.6	Seagull lode, at top of bluff; grab sample across 20 ft. weathered schist.
E	0.02	0.32	1.15	nil	nil	nil		Calcite veinlets, selected chip sample across 30 ft. on N wall of sea cave.
F	0.02	0.26	1.03	nil	nil	nil		Chip sample of narrow rusty zone along minor fault in dark gray marble, E side of Idaho lode.
G	0.02	0.18	1.04	tr	tr	nil		Vein qtz on old dump of old shaft (10' deep).
H	tr	0.15	.19	tr	nil	tr		Old dump beside 10 ft. shaft. Black marble and schist present, schist sampled.
I	2.76	1.49	98.52	0.1	nil	nil	17.3	Dump beside old shaft with hand hoist. Strong iron stain, blocks of oxidized arsenopyrite (sampled). Scheelite(?) panned.

Table 2 (Continued)

J	0.05	0.29	2.12	0.1	tr	0.1		Dump at old 10-15' shaft, moderate iron stain, no sulfide on dump. Tracks from mill lead here, were never installed.
K	0.03	0.66	1.90	nil	nil	tr		Barren looking schist beside old 10 ft. shaft.
L	0.06	0.65	2.93	0.2	nil	0.1		Rusty dump by 3 prospect pits at schist-marble contact. No sulfides on dump.
M	0.16	1.57	7.52	0.1	0.1	tr		Dump by caved pit, schist fragments and red fines panned, no colors.
N	0.20	0.36	7.26	0.1	tr	nil		Nonsulfide material from old dump.
O	0.23	0.63	8.86	0.1	0.1	tr	2.3	Oxidized sulfides from small pile on dump.
P	0.04	0.33	1.82	tr	nil	nil		6' deep pit on bright red stained calcite cemented marble breccia. About on strike of Daniels fault. No sulfide mineralization.
Q	0.03	0.03	1.08					Limonitized marble shear zone, traces of sulfide and free gold.

* Letters refer to location on Fig. 3
** Au $35/oz Ag $1.29/oz As not included.

Table 3

Chip samples taken along coast near Koyana

Sample No.	Gold (oz/T)	Silver (oz/T)	Lead (%)	Copper (%)	Zinc (%)	Arsenic (%)	Value (Silver at $1.29/oz.)	
1	.32	.24	nil		nil	17.1	$11.51	Qtz-Asp vein near old adit (younger quartz vein)
2	.04	.18	tr	nil	tr	.8	1.63	Boudined qtz vein at portal of old adit.
3	.03	.16	.1	tr	nil	.2	1.25	700' chip at 10' intervals - qtz (mainly olde qtz veins)
4	.07	.65	nil	nil	tr	.08	3.16	700' chip at 10' intervals - schist
5	.01	.29	tr	nil	nil		.72	Crosscutting deformed vein
6			nil	nil	tr			Schist with parallel (early) qtz veinlets
7	.01	.25	nil	tr	tr		.67	Schist without qtz.

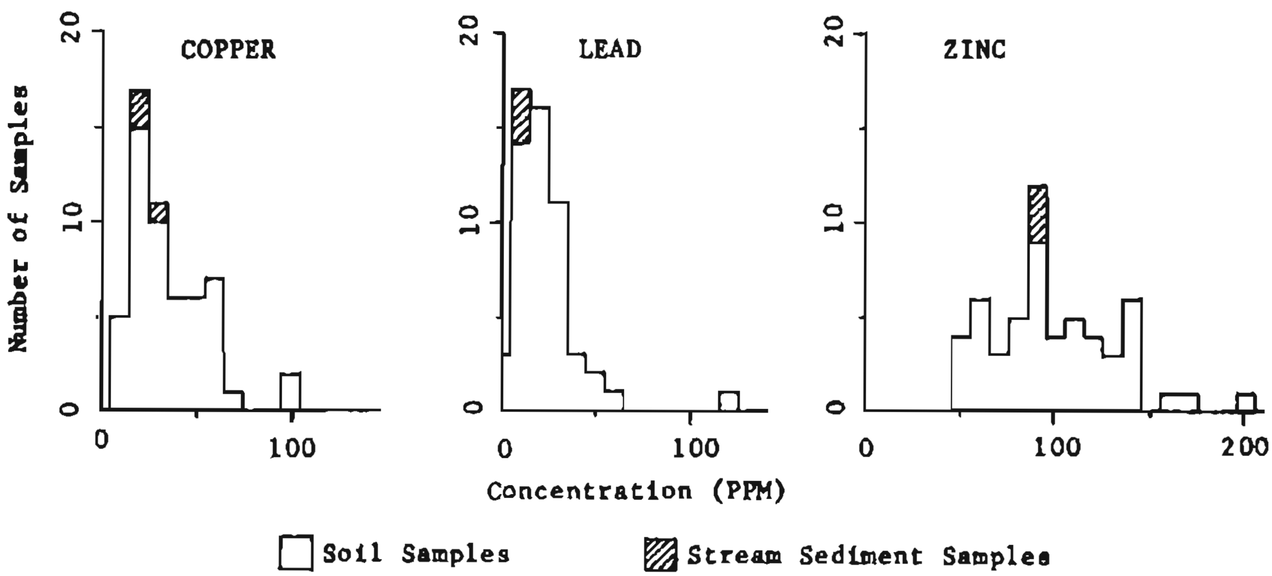


Figure 1. Graphical summary of geochemical data.

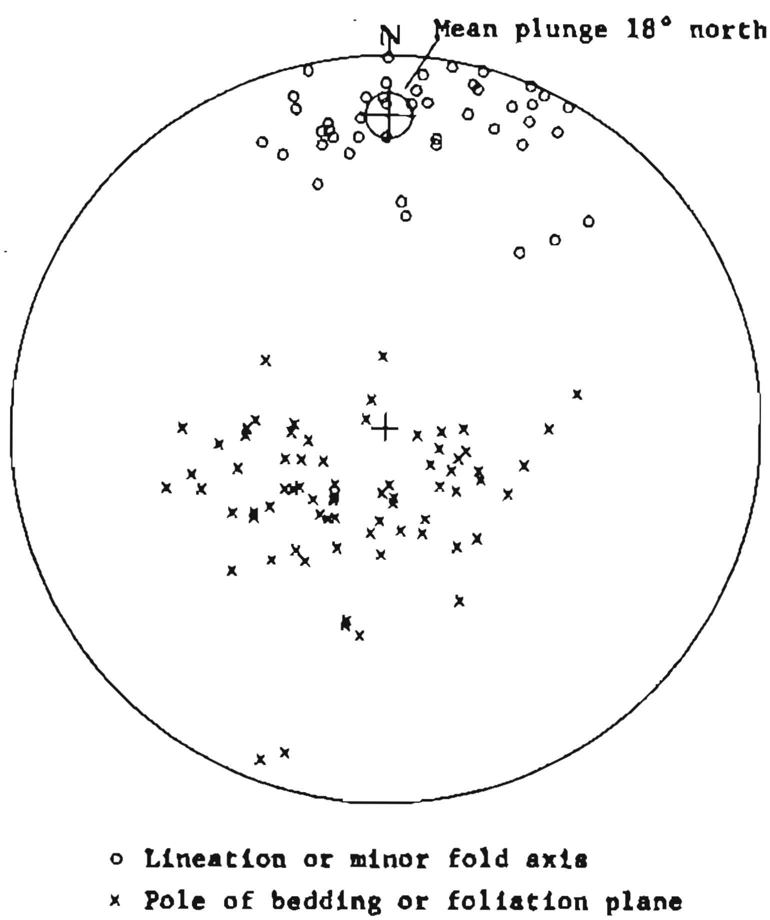
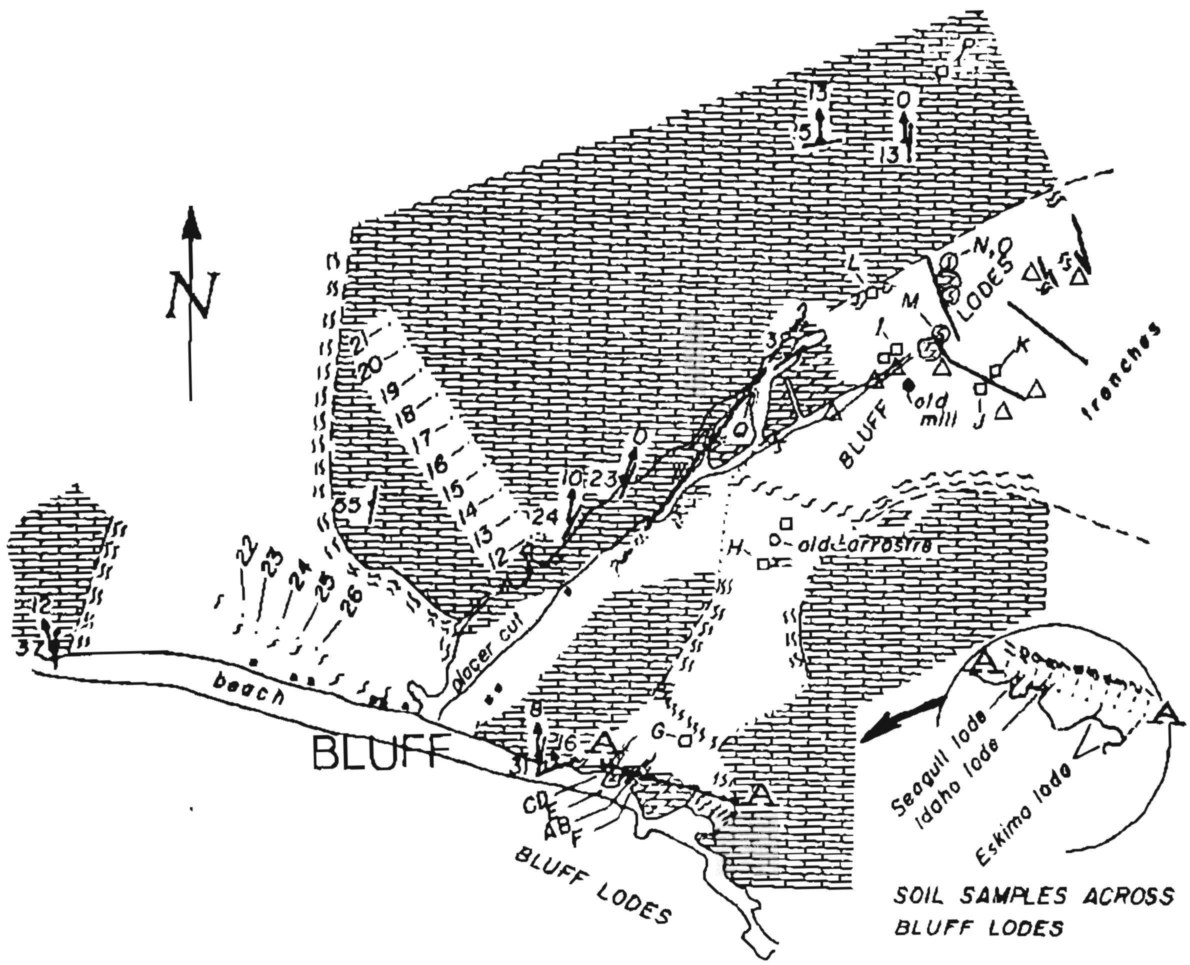


Figure 2. Lower hemisphere, equal area projection of all measured attitudes in the map area.

Figure 3

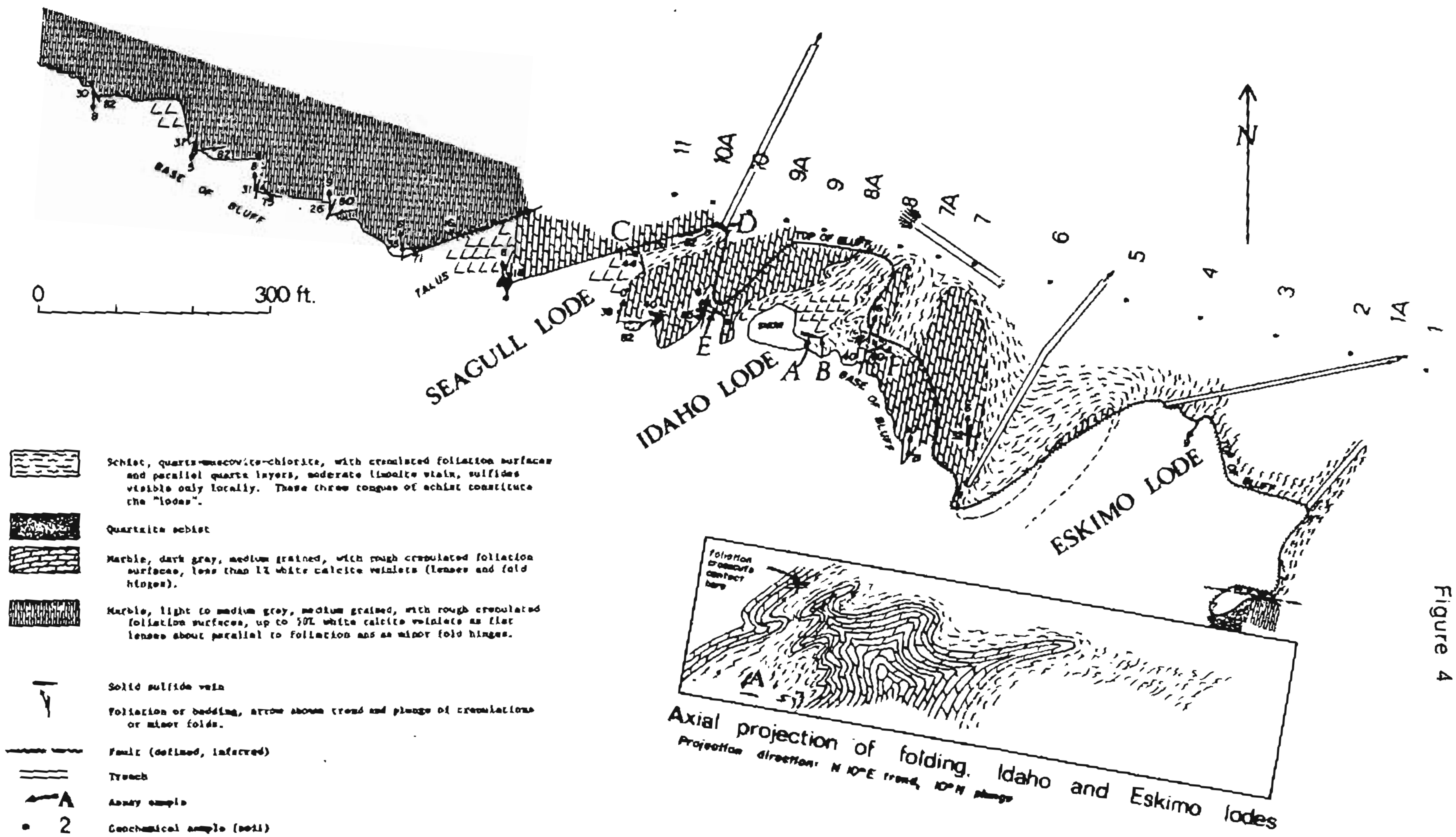


GEOLOGIC MAP OF THE DANIELS CREEK AREA

0 1000 2000 3000 FEET

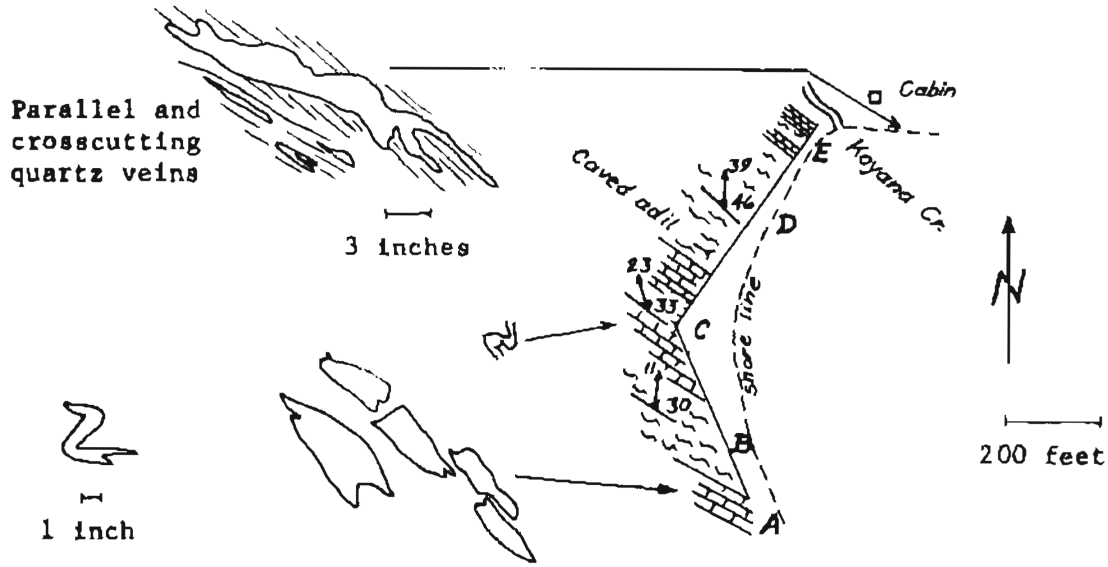
Cover	Red iron stained marble
Schist	Arsenopyrite pod
Quartzite schist	Foliation, bedding
Dark gray marble	Fault
Light to medium gray marble	Pit or shaft
	Geochemical soil sample
House	Assay sample

Figure 4



The Bluff lodes east of Daniels Creek

Marble-schist contact west of Koyana Creek - Figure 5



Profiles of small deformed calcite veins, looking north

Geological sketch map
Figure 5

A Marble, medium gray, medium grained with prominent white calcite boudins, hinges, and lenses.

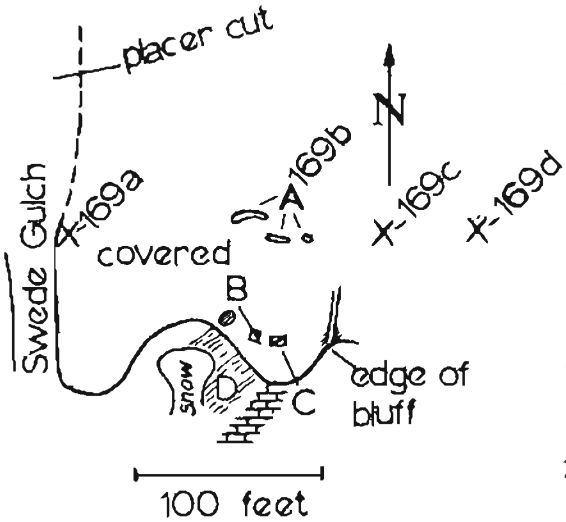
B Limy sericite-chlorite schist, yellow brown weathering, light gray on fresh surface. Calcite and quartz lenses and boudins.

C Black marble, with 1-2% white calcite rods. Phyllitic surfaces and a granular look due to white calcite grains scattered through rock. Marks fingers black. Similar in appearance to black marble at Bluff.

D Sericite-chlorite schist, slightly limy, medium greenish gray, about 5% vein quartz. Quartz veins up to a foot or more wide crosscut the schistosity at considerable angles, but are boudined. This suggests the veins were emplaced fairly late in the period of metamorphic deformation. In places, especially around these late kinematic veins, the rock is strongly rust stained. Smaller quartz veins, parallel to the schistosity and presumably synkinematic, have sheaves of green chlorite associated with them.

Old adit driven on a late kinematic vein. Selected chips of vein quartz near the adit (Table II, #2) assay 0.04 oz./T gold.

E Black limy schist interlayered with sericite-chlorite schist.



A Cream to medium gray marble.

B Ore pile next to old blacksmith shop. Breccia ore: tan weathered clasts with white calcite-cinnabar filling.

C 4' x 6' vertical shaft, about 20 feet deep, collared in white marble; from 1 foot to bottom pink marble (0.7% Fe, nil H_2S).

D Pink marble to depth of more than 60 feet.

X Soil sample

Exposed pink marble

Exposed cream to medium gray marble

Geochemical Analyses

	Cu (ppm)	Pb (ppm)	Zn (ppm)	Hg* Scale Units	Hg(ppm) (approx.)
169a	25	35	200	1.1	2.2
169b	20	20	145	0.35	.7
169c	30	40	145	0.55	1.1
169d	30	40	140	+20	+40
C (pink marble from shaft at C)				4.5	9

* Analyzed in field with Lemaire type S-1 mercury analyzer.

Figure 6. Geological sketch map of Swede Gulch cinnabar prospect