**STATE OF ALASKA**

**DEPARTMENT OF NATURAL RESOURCES**

**DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS**

Tony Knowles, *Governor*

John T. Shively, *Commissioner*

Milton A. Wiltse, *Director and State Geologist*

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BEDROCK GEOLOGY OF THE RUBY/POORMAN MINING DISTRICT, ALASKA

By
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# BEDROCK GEOLOGY OF THE RUBY/POORMAN MINING DISTRICT, ALASKA

by

C.C. Puchner,[1] G.M. Smith,[2] R.W. Flanders,[3] D.E. Crowe,[4] and S.C. McIntyre[5]

## INTRODUCTION

The Ruby/Poorman mining district is located south of the village of Ruby on the Yukon River (figs. 1, 2). The authors mapped the district in 1984 as part of a regional exploration program conducted by the Anaconda Minerals Company. Reconnaissance geologic mapping by Mertie and Harrington (1924) and Cass (1959) had suggested that the Ruby/Poorman area was geologically similar to the Kaiyuh Mountains (fig. 2), where precious metal-rich, carbonate-hosted polymetallic mineralization occurs at the Illinois Creek Mine and the Waterpump Creek prospect. In addition, the occurrence of a schist-hosted lead-silver bearing gossan (Thomas, 1964) and numerous placer gold deposits suggested potential for other types of precious metal-bearing lode deposits in the Ruby/Poorman area.

Although the mapping had previously been exhibited at a poster session and described (Smith and Puchner, 1985a; Smith and Puchner, 1985b), the map has not been readily available to the public. In response to continuing interest in mineral exploration in Alaska, the State of Alaska's Division of Geological and Geophysical Surveys selected the Ruby/Poorman area in 1997 for a regional airborne magnetic and electromagnetic survey. In a collaborative effort, this map is being published together with the results of the geophysical survey to aid mineral exploration of the area.

## REGIONAL GEOLOGICAL FRAMEWORK

The Ruby/Poorman district forms a part of a broad, nearly continuous belt of metamorphic rocks extending from the east-central Brooks Range to at least the Poorman area. This uplift has been referred to as the Aniak-Ruby geanticline (Cady and others, 1955) and the Ruby geanticline (Miller and others, 1959). The metamorphic rocks coring the uplift comprise the Ruby terrane of Jones and others (1987) and Silberling and others (1994). Lithologies of the Ruby terrane include pelitic schist, quartzite, marble, metavolcanic and meta-igneous rocks, and gneiss with metamorphic grades from lower greenschist and blueschist to amphibolite facies (Gemuts and others, 1983).

Fossil and radiometric ages for the protoliths of the rocks of the Ruby terrane are few, but include: (1) early Middle Ordovician conodonts in the Kaiyuh Mountains (Nulato Quadrangle; Patton and others, 1994), (2) Late Ordovician to Late Mississippian coral in the Ruby/Poorman area (this study), (3) Middle Devonian conodonts in the Kokrines Hills (Melozitna Quadrangle; Patton and others, 1994), and (4) a uranium-lead age of 390 ± 12 m.y. (Devonian) on zircon from augen orthogneiss in the Tanana Quadrangle (Patton and others, 1987). In the southeastern Ruby and northwestern Medfra quadrangles, similar metamorphic lithologies (attributed to the Nixon Fork terrane by Silberman and others, 1979a) are overlain by unmetamorphosed Permian rocks (Patton and Dutro, 1979) and yield some Paleozoic and Precambrian potassium-argon and uranium-lead ages: (1) potassium-argon ages ranging

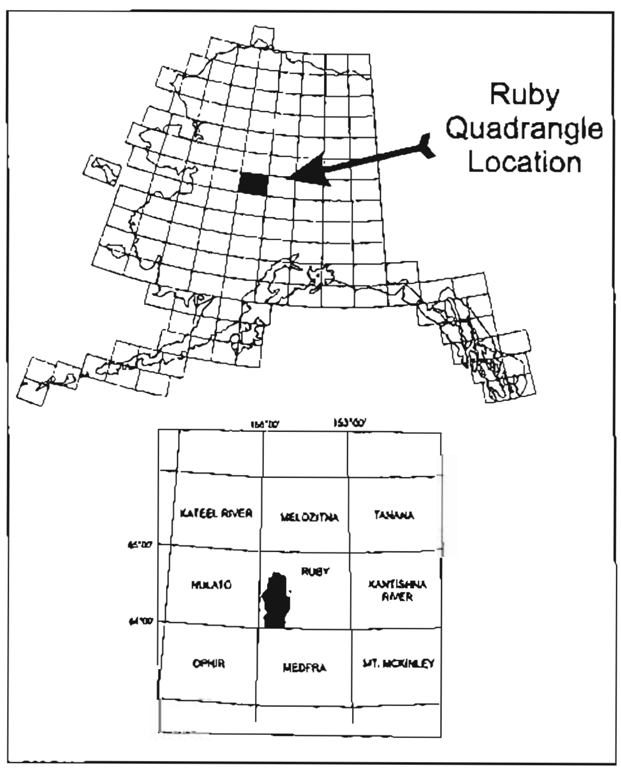


Figure 1. *Location of the study area and the Ruby Quadrangle.*

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from 296 to 921 m.y., including 921 ± 25 m.y. and 663 ± 20 m.y. on a sheared diorite intrusion and adjacent wall rocks, respectively, in the southeastern Ruby quadrangle (Silberman and others, 1979a), (2) a potassium-argon age of 697 ± 20 m.y. on a quartz-potassium feldspar porphyry from the same area (Dillon and others, 1985), and (3) uranium-lead ages of 850 and 1,265 m.y. on zircons from felsic metavolcanic rocks in the northeastern Medfra and southeastern Ruby quadrangles (Dillon and others, 1985). Dillon and others (1985) interpret a greenschist facies metamorphic event at 390 ± 40 m.y. from their uranium-lead data, which is the same age as the augen gneiss from the Ruby terrane in the Tanana Quadrangle reported by Patton and others (1987). These data suggest that the protoliths of the metamorphic rocks of the Ruby/Poorman area are mid-Paleozoic or older, possibly including rocks of Precambrian age, which may have undergone Devonian metamorphism.

Metamorphic rocks of the Ruby terrane are flanked to the northwest and southeast by an assemblage of sedimentary, mafic volcanic rocks, and mafic intrusive rocks. On the northwest side of the Ruby terrane, these rocks have been assigned to the Angayucham terrane (see fig. 2) and to the southeast, to either the Tozitna terrane or the Innoko terrane (Jones and others, 1987; Silberling and others, 1994). All three terranes include graywacke, chert, shale, limestone and basalt. The Angayucham and Tozitna terranes are also abundantly intruded by gabbro and diabase (Dover, 1994; Patton and others, 1977; Patton and others, 1994) and are, locally, structurally overlain by ultramafic-mafic complexes (Patton and others, 1977). Fossil ages of the sedimentary rocks in all three terranes are similar, ranging from Devonian to Jurassic, but most of the ages range from Mississippian to Permian (Bird, 1977; Brosgé and others, 1969; Chapman and others, 1985; Dover, 1994; Hitzman and others, 1982; Jones and others, 1984; Murchey and Harris, 1985; Patton and others, 1977; Patton and others, 1980; Patton and Miller, 1973; Plafker and others, 1978).

Patton and others (1994) argue that the lithologic assemblages flanking the Ruby terrane are one and same (their Angayucham-Tozitna terrane) and represent an obducted ophiolitic suite with a root zone in the Koyukuk basin, noting similarities in the lithologies, thrust panels, and stacking order on either side of the Ruby terrane. Dover (1994) assigns the rocks to the northwest of the Ruby terrane to the Kanuti assemblage (Angayucham terrane of others) and those to the southeast to the Tozitna assemblage (Tozitna terrane). He argues that the latter assemblage is not derived from a root zone in the Koyukuk basin, but is of local origin, citing similarities to, and possible interfingering with, underlying and adjacent stratigraphy.

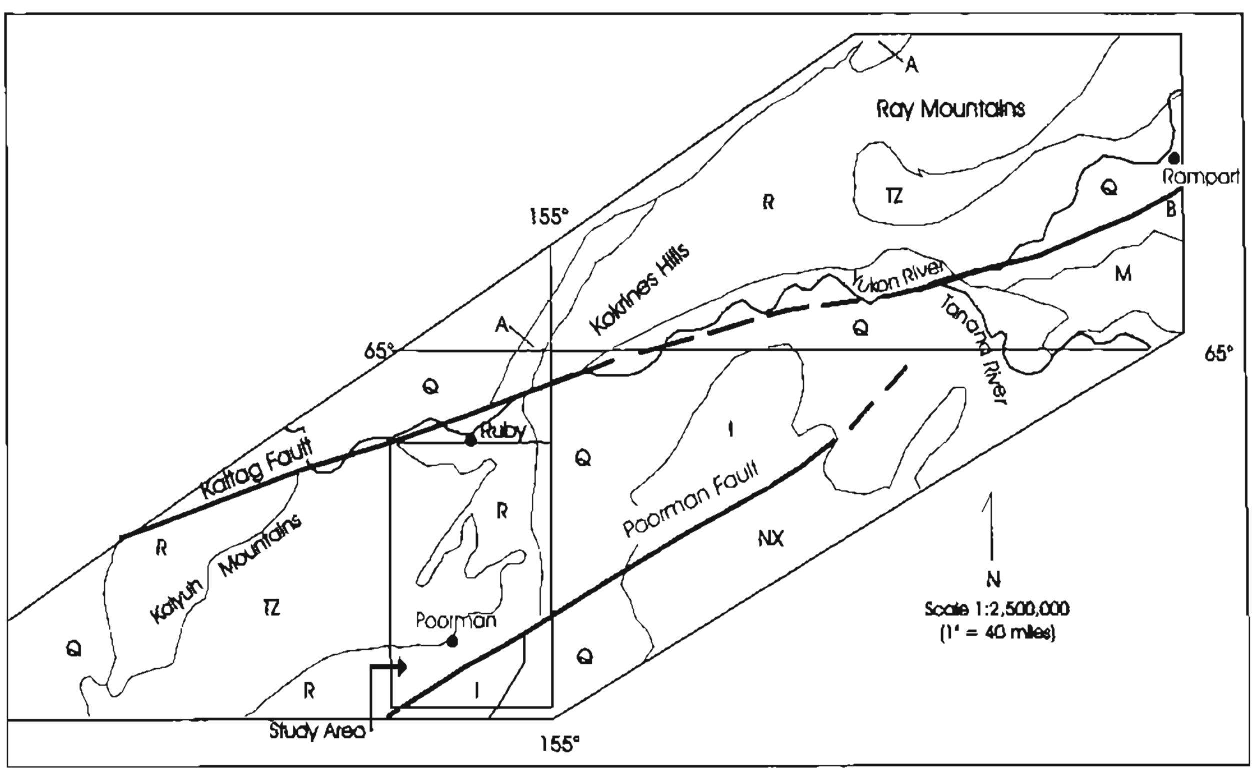


Figure 2. *Terrane map of a portion of west-central Alaska, showing study area, modified after Silberling and others (1994). Terrane abbreviations: A - Angayuchum, R - Ruby, TZ - Tozitna, I - Innoko, NX - Nixon Fork, B - Baldry, and M - Manley; A - Mesozoic and Cenozoic overlap rocks.*

# GEOLOGY OF THE RUBY/POORMAN MINING DISTRICT

## INTRODUCTION/METHODOLOGY

Regional geologic mapping in the Ruby/Poorman district was carried out at a scale of 1:63,360 over a period of two months in 1984. The Ruby/Poorman district has less than 1,000 feet of relief, is extensively vegetated, and is buried by extensive eolian deposits derived from the Yukon River floodplain to the north, hence the area mapped has far less than one percent outcrop and rubblecrop combined. Therefore, the primary method of mapping was stream traverse, where cobble and boulder lithologies were noted and the sparse rubble and outcrop accessible from the stream courses were mapped. This effort was supplemented by helicopter hopping into areas of rubble or outcrop large enough to land in, and observation of rock chips in soil sample pits. Traverse coverage of the area is shown in figure 3 (on sheet); areas of outcrop and exposed rubble are noted on the geologic map. More detailed descriptions of the map units and their relationships follow. To facilitate the discussion the units are described from the base of the structural sequence.

## MAP UNITS AND GEOLOGIC RELATIONSHIPS

### LITHOTECTONIC TERRANES

**Ruby terrane**

PzpCsg SCHIST AND GNEISS — The structurally lowest unit in the Ruby/Poorman area consists of pelitic schist with lesser quartzofeldspathic gneiss and foliated greenstone. This unit is exposed in a northeast-trending antiform centered on Scow Mountain (T11S, R17E). The schist is medium- to coarse-grained with hand specimen mineralogy of quartz ± muscovite ± chlorite ± biotite ± graphite ± garnet ± staurolite. Staurolite indicates amphibolite facies metamorphism. Coarse-grained muscovite ± biotite-quartz-feldspar orthogneiss (table 1) is present in the Straight Creek area (T12S, R17E). Lenses of foliated plagioclase-actinolite(?)-chlorite greenstone, probably retrograded amphibolite, is common but volumetrically minor.

PzpCs PELITIC SCHIST — Fine- to medium-grained pelitic schist composed of quartz-muscovite ± chlorite ± graphite. The unit cores a northeast-southwest elongate antiform in the VABM Gold area (T14S, R18E). Metamorphic quartz segregations are common in the schist. The mineralogy indicates greenschist facies metamorphism.

The unit is geographically isolated from the higher-grade schist terrane to the north (PzpCsg); consequently, the relative age of their respective protoliths is unknown. Cretaceous and Tertiary potassium-argon ages (this study, table 2) probably reflect a thermal event associated with granite (TKg) intrusion. Both schist units are assigned a Devonian and older, possibly including Precambrian, age based on the radiometric, fossil, and stratigraphic evidence in the surrounding region previously cited.

Pzrm MARBLE — Medium- to coarse-grained marble which crops out prominently at the village of Ruby and several miles to the east along the Yukon River. The hand specimen mineralogy is calcite with minor phlogopite(?), pyrite, and diopside(?). The foliation and bedding in the marble projects beneath a phyllite unit (Pzrp) at Ruby, suggesting the marble underlies the phyllite unit. Mertie and Harrington (1924) reported localities east of Ruby where marble beds appear to be intercalated in garnet schist (PzpCsg?), but they suggest that the contacts could be structural. The base of the Pzrm unit is not exposed in the area mapped.

Pzrml MARBLE AND LIMESTONE — Medium- to coarse-grained calcitic marble and recrystallized limestone cropping out in the Tamarack Bluff area (T15 and 16S, R18E). Bedding and possible sedimentary breccias are preserved locally where metamorphic recrystallization is incomplete. Coral fossils collected from the unit indicate an age between Late Ordovician and Late Mississippian (table 3). The limestone underlies a phyllite unit (Pzrp, described below) in the Tamarack Bluff area, but whether or not the contact is depositional or if the stratigraphic section is upright is unknown. The base of the unit is not exposed. Based on lithologic similarity and the same structural position relative to Pzrp (described below), the marble is tentatively correlated to Pzrm.

Pzrp PHYLLITE AND QUARTZITE — Graphitic phyllite with minor interbedded graphitic quartzite, which are locally upgraded to graphite schist and graphitic quartz-mica schist. The unit occurs throughout the district from the Yukon River to the Poorman area and is well exposed along the Yukon River immediately to the east of Ruby. At this locality, graphitic quartzite comprises up to 50 percent of the unit, an unusually high percentage and probably the reason for the significant amount of outcrop there. Where the unit is exposed near granitic intrusive rocks (TKg), well-developed andalusite porphyroblasts are present.

Generally consistent minor folds with northeast-trending axes and southeast- dipping axial planes suggest transport of the rocks to the northwest, providing the section is upright. In contrast, foliation in the underlying schists (PzpCs and PzpCsg) strikes either northwest, dipping both northeast and southwest, or northeast, dipping both northwest and southeast, suggesting the Ruby phyllite is allochthonous with respect to the underlying schists, as does the contrast in metamorphic grade.

Because the unit has not yielded fossils of any kind and its contacts with the rocks commonly below it (PzpCs and PzpCsg) and above it (Pzts and Pztp) appear structural, neither the absolute nor the relative age of the unit is known. However, based on a structural position above Pzml, a late Paleozoic age is tentatively assigned.

**Tozitna terrane**

Pzts,Pztp SLATE, SILTSTONE, CHERT, GRAYWACKE, AND LIMESTONE (Pzts) and PHYLLITE, SCHIST, METAGRAYWACKE, METACHERT, GREENSTONE, AND MARBLE (Pztp) — These units, which include siltstone, mudstone, shale, fine-grained to conglomeratic graywacke, chert, limestone, and mafic volcanic rocks and their metamorphic equivalents, are widespread in the district and are distinguished by deformation and metamorphic grade. The lower grade unit, Pzts, consists of green, black, and tan siltstone intercalated with gray to green, fine-grained to conglomeratic graywacke with lesser white to green chert and limestone. A higher-grade unit, Pztp, includes phyllite and fine-grained quartz-muscovite-chlorite schist intercalated with metagraywacke, recrystallized chert, greenstone, and rare marble. These higher-rank rocks commonly have at least three cleavages whose intersections are co-linear and produce long slender "pencils" upon fracturing. Two fossil collections from limestones within the mapped area are both of Devonian age (table 3). Both units are widely intruded by dominantly sill-form mafic intrusive bodies (MzPzmi).

In general, these lithologic assemblages are similar to those described for the Rampart group at the type locality near the village of Rampart (Mertie, 1937) and included in the Tozitna terrane (Silberling and Jones, 1984). Moreover, like the Rampart group elsewhere, the units contain voluminous mafic intrusive rocks (Dover, 1994). In contrast, graywacke is more abundant in the Ruby/Poorman area and mafic volcanic rocks less abundant than in the Rampart area. Dover (1994) describes a metaclastic sequence, dominantly quartz wacke, between the Rampart assemblage (defined as the Rampart group and the mafic intrusive rocks together) and underlying schists in the southern Tanana Quadrangle. At one time (Dover and Miyaoka, 1985), this metaclastic sequence was tentatively included in the Rampart assemblage. The sequence contains limestone of Devonian age (Dover, 1994). A similar and probably correlative Devonian clastic sequence (phyllite and graywacke of the Slate Creek thrust panel) is described by Patton and others (1994) in the Tozitna-Angayucham terrane. Based on the abundance of graywacke and the presence of Devonian limestone in the Ruby/Poorman area, the Pzts and Pztp units probably contain rocks equivalent to both the Rampart group and the Devonian clastic rocks described elsewhere in the Tozitna terrane. Fossil collections in the Ruby/Poorman and adjacent areas of the Tozitna terrane suggest a mid to late Paleozoic age for the Pzts and Pztp units.

Because the mafic intrusive rocks described below (MzPzmi) do not show intrusive relationships to any map units other than the sedimentary rocks (Pzts) of the Tozitna terrane, they were intruded into the Tozitna terrane elsewhere, then the Tozitna assemblage (MzPzmi and Pzts) was tectonically emplaced into its present position. Bedding to cleavage intersections indicate folds about northeast-striking axes and imply transport from either the northwest or the southeast. The transport direction cannot be determined without knowing whether or not the rocks are right side up. Essentially the same relationships between mafic intrusive rocks, the Rampart group, and underlying schist have been observed in the southern Tanana Quadrangle (Jones and others, 1984).

The contrast in metamorphic grade between units Pzts and Pztp and their distribution suggests two thrust panels, a lower panel of higher grade rocks (Pztp) overridden by the lower grade unit (Pzts) or, alternatively the higher grade assemblage was produced by tectonism along the sole of the fault bringing the Tozitna terrane over the Ruby terrane.

MzPzmi INTERMEDIATE TO MAFIC INTRUSIVE ROCKS — Of these rocks, fine- to medium-grained gabbro is the most commonly occurring lithology. Pyroxenite, orthopyroxene gabbro, and, rarely, varieties with minor free quartz occur (note that these rocks are quartz normative, shown in table 1). Where exposed in outcrop, the intrusive bodies are generally sill-form.

The age of these intrusive rocks is very poorly documented. One sample of hornblende-bearing gabbro hosted in the Rampart group from the Tozitna terrane north of the village of Rampart (fig. 2) yielded a Triassic potassium-argon age of 205 ± 6 m.y. (Brosgé and others, 1969).

**Innoko terrane**

MDc CHERT AND SLATE — This unit contains thin-banded red, green, and gray chert with minor thin interbeds of slate. The unit and that described immediately below (Pg) were originally defined and mapped in the southernmost Ruby Quadrangle by Chapman and Patton (1979), who collected Devonian, probable Mississippian, and Mississippian radiolaria from the cherts. These rocks extend through the northwestern Medfra Quadrangle (Patton and others, 1980) into the Ophir Quadrangle where they have been assigned to the Innoko terrane (Chapman and others, 1985). The Innoko terrane is another lithologic assemblage of deep oceanic affinity that is allochthonous with respect to metamorphic basement rocks (Patton and Moll, 1982).

This unit, consisting almost entirely of chert in the study area, bears little resemblance to any of the geologic units mapped in the area between Ruby and Poorman and is separated from them by coincident topographic, Landsat, and magnetic (U.S. Geological Survey, 1976) linears. This evidence suggests a major fault between the area underlain by this unit and that described below (Pg) and the Ruby/Poorman district to the north. This fault was first recognized and named the Poorman fault by Gemuts and others (1983) and appears to be a major southwest-northeast strike-slip fault similar to the Kaltag (Patton and Tailleur, 1977; Patton and others, 1984) and related faults.

Pg GRAYWACKE CONGLOMERATE AND MUDSTONE — The unit consists of fine- to medium-grained graywacke with lesser graywacke conglomerate (basalt, andesite, shale, chert, quartzite and chert clasts) and gray to green mudstone. Chapman and Patton (1979) collected probable Permian fossils from the unit (table 3). Like the chert and slate unit (MDc) probable correlative rocks of the Innoko terrane have been recognized and mapped in the Ophir Quadrangle (Chapman, and others, 1985).

## OVERLAP ASSEMBLAGES

**Intrusive Rocks**

TKg GRANITE — Medium- to coarse-grained, equigranular to porphyritic granite composed of anhedral quartz, anhedral to euhedral potassium feldspar, anhedral plagioclase, and subhedral biotite. In the Ruby/Poorman area, granite intrudes rocks of both the Ruby (Pzrp and PzpCsg) and Tozitna (Pzts) terranes, cropping out in a large stock in the Monument Rocks area (T13S, R17E) and as smaller bodies in Birch Creek (T12S, R17E), along Long Creek between the mouths of Midnight and Greenstone creeks (T14S, R16E), and in Glacier Creek (T16S, R18E). The potassium feldspar is dominantly orthoclase with lesser microcline, and the plagioclase ranges in composition from oligoclase to albite (Mertie and Harrington, 1924). Samples from the Monument Rocks and Birch Creek plutons yielded potassium-argon ages of 65.5 ± 3.3 m.y. and 65.2 ± 2.0 m.y. (table 2).

**Volcanic and Sedimentary Rocks**

TKv VOLCANIC ROCKS, SILTSTONE AND SANDSTONE — The unit consists of porphyritic basalt, andesite, and lesser rhyolite flows, tuffs, and breccias intercalated with minor siltstone and sandstone (Chapman and Patton, 1979; Eakin, 1914; Mertie and Harrington, 1924). The unit is widespread south of the Poorman fault in the Medfra Quadrangle and is exposed in the area mapped along the South Fork of the Sulatna River, where it consists almost exclusively of feldspar and pyroxene porphyritic basalt and/or andesite. Silberman and others (1979b) determined a whole rock potassium-argon age of 62.9 ± 2.8 m.y. on a sample of basalt from an area approximately four miles west of the southeast corner of the map area.

Table 1. *Major oxide analyses and CIPW Norms, Ruby/Poorman mining district*

| Map unit | TKv | TKg | TKg | MzPzmi | MzPzmi | Pztp | Pzp€sg |
|---|---|---|---|---|---|---|---|
| Map symbol | 1 | 2 | 1 | 3 | 4 | 5 | 6 |
| Location | T11S, R16E | T12S, R17E | T13S, R17E | T13S, R18E | T13S, R16E | T12S,R17E | T12S,R17E |
| Field no. | 84-RF-69 | 84-RF-23 | RF-Ruby-1 | 84-GS-50 | 84-GS-93 | 84-RF-96 | 84-GS-61 |
| Rock type | Basalt | Biotite Granite | Biotite Granite | Hornblende Pyroxene Gabbro | Hornblende Pyroxene Gabbro | Foliated Greenstone | Muscovite Biotite Garnet Orthogneiss |
| | | | | **Major Oxide Analyses (weight percent)[a]** | | | |
| $SiO_2$ | 42.90 | 73.60 | 74.60 | 51.50 | 50.80 | 48.00 | 75.30 |
| $TiO_2$ | 3.68 | 0.18 | 0.16 | 0.83 | 1.72 | 1.33 | 0.14 |
| $Al_2O_3$ | 14.00 | 14.00 | 13.80 | 5.84 | 14.20 | 15.30 | 12.80 |
| $Fe_2O_3$ | 3.30 | 0.44 | 0.41 | 2.43 | 2.20 | 2.60 | 0.88 |
| FeO | 7.60 | 0.60 | 0.90 | 6.50 | 9.20 | 7.70 | 0.30 |
| CaO | 8.61 | 0.72 | 1.04 | 16.90 | 10.10 | 8.93 | 0.57 |
| MgO | 4.34 | 0.23 | 0.32 | 13.30 | 5.83 | 8.13 | 0.23 |
| MnO | 0.14 | 0.01 | 0.03 | 0.16 | 0.18 | 0.18 | 0.01 |
| $Na_2O$ | 4.06 | 3.44 | 3.55 | 0.85 | 2.05 | 1.84 | 2.57 |
| $K_2O$ | 1.65 | 5.73 | 5.10 | 0.11 | 0.65 | 0.03 | 6.56 |
| $P_2O_5$ | 0.71 | 0.05 | 0.05 | 0.06 | 0.17 | 0.12 | 0.03 |
| LOI | 8.39 | 0.77 | 0.31 | 1.54 | 2.85 | 5.85 | 0.62 |
| Total | 99.38 | 99.77 | 100.27 | 100.02 | 99.95 | 100.01 | 100.01 |
| | | | | **CIPW norms[b]** | | | |
| Quartz | - - | 29.71 | 31.26 | 1.71 | 5.42 | 3.84 | 33.76 |
| Orthoclase | 9.75 | 33.86 | 30.14 | 0.65 | 3.84 | 0.18 | 38.77 |
| Albite | 22.41 | 29.11 | 30.04 | 7.19 | 17.35 | 15.57 | 21.75 |
| Anorthite | 15.10 | 3.25 | 4.83 | 11.80 | 27.63 | 33.40 | 2.63 |
| Nepheline | 6.47 | - - | - - | - - | - - | - - | - - |
| Corundum | - - | 0.95 | 0.67 | - - | - - | - - | 0.51 |
| Diopside | 18.60 | - - | - - | 57.15 | 17.60 | 8.19 | - - |
| Hypersthene | | 1.03 | 2.13 | 14.74 | 18.42 | 26.41 | 0.57 |
| Olivine | 5.25 | - - | - - | - - | - - | - - | - - |
| Magnetite | 4.78 | 0.64 | 0.20 | 3.52 | 3.19 | 3.77 | 0.59 |
| Ilmenite | 6.99 | 0.34 | 0.30 | 1.58 | 3.27 | 2.53 | 0.27 |
| Hematite | - - | - - | - - | - - | - - | - - | 0.47 |
| Apatite | 1.64 | 0.12 | 0.12 | 0.14 | 0.39 | 0.28 | 0.07 |
| Plagioclase Composition | An 40 | An 10 | An 14 | An 62 | An 61 | An 68 | An 11 |

[a]Analyses by X-Ray Laboratories, Don Mills, Ontario, Canada
[b]Calculated using Igpet 2.3 for McIntosh by Terra Softa, Inc.
- - = None.

Table 2. *$^{40}$K-$^{40}$Ar Radiometric ages, Ruby/Poorman mining district*

| Map symbol | Location | Field no. | Mineral | K (wt. %) | $^{40}$Ar (rad) (scc/g x $10^{-5}$) | %$^{40}$Ar (rad) | Age (m.y.) | Map unit (rock type) |
|---|---|---|---|---|---|---|---|---|
| 1[1] | T13S, R17E | RF-Ruby-1 | Biotite | 5.62 | 1.43 | 87.1 | 65.5 ± 3.3 | TKg (biotite granite) |
| | | | | 5.63 | 1.49 | 89.2 | | |
| | | | | 5.64 | | | | |

| Map symbol | Location | Field no. | Mineral | $K_2O$ (wt. %) | Sample wt. (g) | $^{40}$Ar (rad) x $10^{-11}$ (mol/g) | $^{40}$Ar (rad) x $10^{-3}$ / $^{40}$K | %$^{40}$Ar (rad) | Age (m.y.) | Map unit (rock type) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2[2] | T12S, R17E | 84-RF-23 | Biotite | 8.487<br>8.447<br>mean 8.467 | 0.1133 | 80.9070 | 3.8568 | 87.38 | 65.2 ± 2.0 | TKg (biotite granite) |
| 3[2] | T10S, R18E | 84-GS-1 | Biotite | 7.920<br>7.917<br>mean 7.919 | 0.0959 | 71.7374 | 3.6565 | 75.42 | 61.9 ± 1.9 | Pzp€sg (staurolite-mica-garnet-schist) |
| | | | Muscovite | 7.893<br>7.887<br>mean 7.890 | 0.1022 | 84.7099 | 4.3334 | 82.46 | 73.1 ± 2.2 | |
| 4[2] | T11S, R18E | 84-SM-2 | Muscovite | 9.470<br>9.500<br>9.500<br>mean 9.490 | 0.1339 | 99.4043 | 4.2277 | 91.20 | 71.3 ± 2.1 | Pzp€sg (gneiss) |

Constants: $\lambda e + \lambda' e = 0.581 \times 10^{-10}$/yr, $\lambda_\beta = 4.962 \times 10^{-10}$/yr. $^{40}$K/K total = $1.167 \times 10^{-4}$ mol/mol.

[1]Analyzed by Teledyne Isotopes, 50 Van Buren Ave., Westwood, NJ 07675.

[2]Analyzed by D. L. Turner, Geochronology Laboratory, University of Alaska, Fairbanks.

Table 3. *Fossils, Ruby/Poorman mining district*

| Map symbol | Location | Field no. | Identification/Comments | Identified by (Reference) | Age | Map unit |
|---|---|---|---|---|---|---|
| (1) | T15S, R18E | 84-GS-37 | Syringoporoid coral, indet., strongly recrystallized and sheared | W.J. Sando | Late Ordovician to Early Permian | Pzrml |
| (2) | T16S, R18E | 84-GS-48 | Syringopora sp. | W.J. Sando | Late Ordovician to Late Mississippian | Pzrml |
| (3) | T11S, R17E | 84-GS-9 | Conodont fauna: Polygnathus serotinus, Belodella resima, Panderodus sp. indet., indet. S. elements, C.A.I. 5.0-6.0 | T.R. Carr | Late Early to early-Middle Devonian | Pzts |
| (4) | T12S, R16E | 12 AE-1 | Cladopora sp., fragments of crinoid columns, possibly referable to the genus Melocrinus | Edwin Kirk (Eakin, 1914) | Devonian | Pzts |
| (5) | T17S, R18E | N/A | Nodosinellids, Tetrataxis, and bryozoan and echinoderm debris | A.K. Armstrong, R.C. Douglas, and J.T. Dutro, Jr. (Chapman and Patton, 1979) | Permian (?) | Pg |
| (6) | T16S, R18E | N/A | Radiolarians: Cyrtisphaeratenium with Holocciscus (2 samples) | B.K. Holdsworth D.L. Jones (Chapman and Patton, 1979) | Devonian | MDc |
| | | N/A | Paronaella (1 sample) | | probably Mississippian | MDc |
| | | N/A | Paronaella with Neohagiastrids (1 sample) | | Late(?) Mississippian | MDc |

N/A = not available

## GEOLOGIC AND TECTONIC DISCUSSION

Although limited age control exists for the geologic units and exposure is extremely poor, a basic geologic history for the Ruby/Poorman area can be inferred from the geologic studies presented here. The probable sequence of events and evidence for them are as follows:

(1) Deposition of pelitic sediments and their subsequent metamorphism to greenschist and amphibolite facies to produce the pelitic schist units (PzpCs and PzpCsg) of the Ruby terrane.

(2) Tectonic transport of graphitic phyllite and quartzite (Pzrp) into the area from either the northwest or the southeast along faults that are locally demonstrably low angle (contact relationships in Crooked Creek: T12S, R17E). Contrasting metamorphic grade and foliation attitudes suggest that Pzrp is allochthonous with respect to PzpCs and PzpCsg. The marbles and recrystallized limestones (Pzrm and Pzrml) may have been emplaced with Pzrp, or alternatively, they may be a part of the basement schist complex (PzpCs and PzpCsg).

(3) Tectonic transport of the Tozitna terrane into the area from either the northwest or the southeast. Contacts with the underlying Pzrp unit and topography in Grant Creek (T13S, R18E) suggest a low-angle contact. Because mafic intrusive rocks (MzPzmi) exhibit intrusive contacts exclusively with sedimentary and volcanic components of the Tozitna terrane (Pzts and Pztp), their intrusion had to occur elsewhere and the Tozitna terrane must be allochthonous with respect to Pzrp. For the sake of simplification, transport directions for both the Tozitna terrane (Pzts and Pztp) and Pzrp on the cross sections are shown from southeast to northwest.

(4) Gentle open folding about northeast-southwest axes with klippe of the Tozitna terrane preserved in synforms.

(5) Intrusion of granite and uplift along a north-south axis, hence the north-south orientation of the upland between Ruby and Poorman, and strike-slip movement along the Kaltag fault, juxtaposing Angayucham and Ruby terrane rocks, and the Poorman fault, bringing the Innoko terrane against the Ruby terrane. Given that the Ruby/Poorman area is bounded to the north by the Kaltag fault and on the south by the Poorman fault, it is likely that some of the contacts mapped are high angle faults, but the exposure is not sufficient to determine which ones are.

## ECONOMIC GEOLOGY

### INTRODUCTION

Two types of mineralization are known in the Ruby/Poorman district: placer gold deposits, locally with accessory cassiterite, and a single occurrence of schist-hosted, silver-rich galena-bearing gossan (Eakin, 1914). Placer gold has been mined in the district almost continuously since 1907, with the total production through 1995 estimated at 477,000 oz (14,835 kg) of refined gold (Bundtzen and others, 1995). Sufficient cassiterite is present in some placer concentrates that an unknown but modest amount has been produced and shipped to refiners (K. Tryck and T. Bundtzen, personal commun.).

### PLACER GOLD DEPOSITS

Significant historical and present-day placer gold mining is restricted to two general areas: (1) in the streams arranged peripherally around the granite stock in the Monument Rocks area (of which the major producers have been Long and Trail creeks), and (2) in the vicinity of Poorman (including Spruce, Poorman, and Tamarack creeks).

Most of the placer gold deposits in the Monument Rocks area contain accessory cassiterite (Mertie, 1936). Given the ubiquitous global association of tin mineralization with highly evolved granites, which the TKg plutons appear to be (high silica and corundum normative) (fig. 4), the cassiterite was almost certainly derived from lode mineralization directly associated with the granite stock. Given that the granites do not exhibit alkalinity/oxidation states of intrusions generally associated with gold mineralization (fig. 5) and that intrusion-related gold and tin mineralization seldom occur together, the arrangement of the gold placers around the Monument Rocks pluton is surprising. The mafic intrusive rocks of the Tozitna terrane appear to be gold favorable (fig. 5). Perhaps they provided a source of high background gold, which the hydrothermal cell produced by granite emplacement remobilized and concentrated.

In the Poorman area, rhyolite porphyry in the bedrock in an underground placer mine at Poorman (Mertie, 1936) and granite cropping out in Glacier Creek (T16S, R18E) approximately six miles to the east, suggesting that a larger granite body might underlie the Poorman area of the Ruby/Poorman mining district also. Again, perhaps there is a spatial relation between gold mineralization and granite plutons.

### BEAVER CREEK PROSPECT

At the Beaver Creek prospect (T10S, R17E) two northeast-striking zones of silver-rich galena-bearing gossan in quartz-muscovite schist (PzpCsg) have been outlined by trenching. The gossan varies from massive and earthy to siliceous with abundant cellular boxworks. Both types of gossan contain remnant primary galena in a gossan matrix with minor anglesite and cerussite. Trench mapping by Thomas (1964) shows both zones to be controlled by premineral faults with strike northeasterly and dip steeply to the northwest, essentially parallel to the schistosity. The northwestern zone has an apparent strike length of 300 ft (91.5 m) and varies from 3 to 10 ft (0.9 to 3.05 m) in width. The highest grade channel sample assayed 6.2 percent lead, less than 0.03 percent zinc, less than 0.02 percent copper, and 1.44 oz per ton (49.4 g/tonne) silver over a width of 6.6 ft (2 m) as calculated from Thomas (1964).

The southeastern of the two zones has an apparent strike length of 500 ft (152 m) and ranges from 0.5 to 6 ft (0.15 to 1.8 m) in width. The highest grade channel sample across the zone assayed 8.55 percent lead, 1.27 percent zinc, 0.03 percent copper, and 14.93 oz per ton (511.9 g/tonne) silver as calculated from Thomas (1964).

Since 1964, the trenches have slumped and bedrock is no longer exposed. However, blocks of float exhibit crosscutting relationships between the gossan and wall rock schistosity, and clay envelopes in schist around gossanous silica veins. These observations suggest that the mineralization could be epigenetic.

## DISCUSSION

The occurrence of gold and cassiterite in placer deposits of the region strongly suggests that lode deposits of gold and tin are likely to be discovered in the Ruby/Poorman mining district. Because tin deposits nearly always occur in and immediately adjacent to granites, the logical areas to explore for tin mineralization are the granite stocks.

The spatial association of gold placers with the Monument Rocks pluton suggests lode gold mineralization could occur near the granite plutons. Areas where mafic intrusive rocks might, based on their alkalinity/oxidation state, provide country rock with a high background gold content might prove more likely to host lode gold

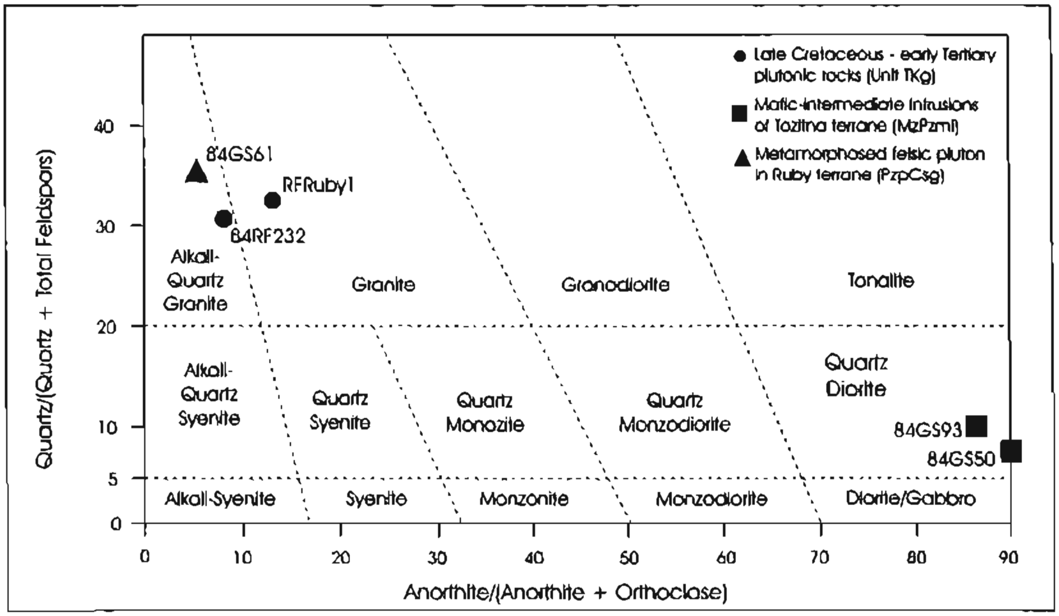


Figure 4. *Normative QAPF diagram, after Streckheisen and LeMaitie (1979), of plutonic and metaplutonic rocks from the Ruby/Poorman mining district. Data from table 1.*

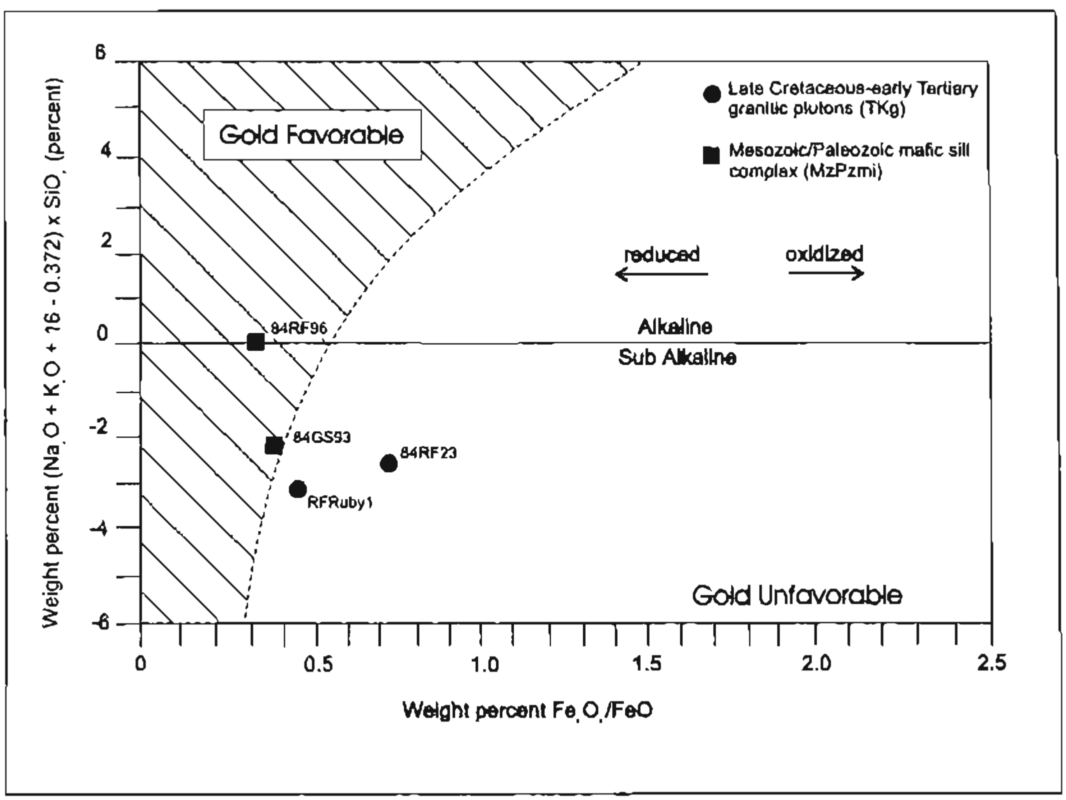


Figure 5. *Gold favorability of igneous rocks, Ruby/Poorman mining district, after Leveille, Newberry, and Bull, 1988.*

mineralization. Likewise, the Beaver Creek prospect is probably not the only occurrence of lead-silver mineralization in the district. Given that the occurrence appears epigenetic and is localized near the trace of a major fault, the trace and environs of other such structures are worthy of prospecting. Given the possibility that the Beaver Creek occurrence is a remobilized, syngenetic massive sulfide, the area underlain by the host schist should be considered as an exploration target.

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