Detailed Geological Study of Three Precious Metal Prospects in Marquette County and One in Gogebic County, Michigan

by

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ABSTRACT

Three precious metal prospects in Marquette County, Michigan (Bjork Lundeen, Ford, and Peppin) were geologically mapped at a scale of 1:2400 to 1:1200. One site (Marenisco Prospect) in Gogebic County, Michigan was mapped at a scale of 1:600. These areas were chosen because of their varied geologic settings. The data obtained from these three prospects combined with previous studies can provide a base to develop an understanding of the regional geologic setting of precious metal mineralization in northern Michigan.

The Bjork Lundeen prospect is located about 1.0 mile west of Callahan's Ropes Gold Mine. The bedrock consists of variably altered Archean pillowed basalts. Pyrite is found as fine disseminations throughout the basalts and in greater concentrations in association with a northwest-southeast trending quartz vein. An old test shaft and a trench expose parts of the mineralized quartz vein, but geologic relationships in the immediate vicinity are obscure due to the lack of outcrop. Vein quartz contains irregular layers of massive pyrite with intergrown subhedral to euhedral tourmaline and individual euhedral pyrite cubes.

The Ford prospect is located about 3.1 miles northeast of the Ropes Gold Mine. The bedrock consists of fine-grained clastic Archean sediments cut by two east-west trending, altered, mafic sills. The age of these sills is uncertain, but we suggest that they are Archean. This Archean rock package is unconformably overlain by the Lower Proterozoic Goodrich Quartzite which strikes east-west and dips 65 degrees north. A few very small Keweenawan diabase dikes cut the Archean rocks. The Archean Rocks have undergone an intense penetrative deformation exhibited by crenulated and fine anastomosing foliations, folded quartz lenses, and micro and macro faulting. A number of 'old prospects are located along one of the northwest trending faults which cuts the Archean sediment unit and a mafic sill. This prospected area is centered on closely spaced quartz veins containing variable amounts of pyrite. Pyrite is abundant in the country rock associated with these quartz veins.

The Peppin prospect is located about 3.5 miles northwest of the Ropes Gold Mine. The bedrock consists of an Archean granodiorite intruded by three felsic dikes and a few aplite dikes. It also contains one mafic unit which is either a dike or a roof pendant. The origin of this mafic unit is uncertain, but textural evidence supports an intrusive origin. An old shaft was sunk on a 2.5 foot wide quartz vein which is sandwiched between two foliated mafic layers. These mafic layers contain more pyrite than the quartz vein. A trench uncovers another quartz vein which is located at the contact between a sheared felsic dike, a foliated mafic layer, and the granodiorite rock. Pyrite is disseminated throughout the quartz vein and the granodiorite adjacent to the vein.

The Marenisco prospect is located about 4.5 miles north of the town of Marenisco. The bedrock consists of an Archean biotite schist intruded by biotite leucogranites and quartz monzonite dikes which are probably Archean in age and one Keweenawan diabase dike. An old shaft was sunk on a "metalliferous" belt described by A.P. Swineford in 1883. No belt was observed during this investigation, therefore, any further study should involve subsurface work.

The mineralization at all three Marquette prospects is epigenetic. Anomalous concentrations of gold are hosted by pyrite-bearing quartz veins, and the localization of these veins is dependent on earlier formed structures. The main non-metallic alteration minerals include quartz, sericite, and chlorite. The rock types, structure, and occurrence of quartz veins with minor sulfides indicate that the Marquette County prospects studied here deserve further consideration by industry.

INTRODUCTION

Detailed geologic mapping of Bjork Lundeen, Ford, Peppin and Marenisco precious metal prospects was part of a collaborative project between the Geological Survey Division of the Michigan Department of Natural Resources and the Department of Geology and Geological Engineering at Michigan Technological University. The data obtained from these prospects combined with other recent studies (Johnson et. al., 1986; Owens and Bornhorst, 1985; Shepeck, 1985; and Rossellf 1983) can provide a base to develop a better understanding of the geologic setting of precious metal mineralization in northern Michigan.

The following data were collected during the summer and fall of 1985 and include field work, megascopic hand descriptions, and gold and silver assays. Each of the four prospects will be described separately.

ACKNOWLEDGEMENTS

This project has been funded by the Geological Survey Division of the Department of Natural Resources of Michigan and by the Department of Geology and Geological Engineering, Michigan Technological University. Bob Reed, Michigan Geological Survey-Lansing office, provided old geological data. Assistants in the field were Paul Raether, Greg Lynas, Jennifer Daniels and William Swenor. We thank all private and commercial landowners for access to their lands.

PROSPECTS IN MARQUETTE COUNTY

REGIONAL GEOLOGY

The bedrock geology of Marquette County is complex and includes a wide variety of rock types ranging in age from Archean to Middle Proterozoic (Morgan and DeCristoforof 1980; Puffet, 1974). The prospects, studied in Marquette County, are located north of the east-west trending Great Lakes tectonic zone of Sims (1980) and consist of Archean granite and greenstone. A thick succession of Archean volcanic rocks, about 2.7 b.y. old are intruded by Archean mafic to felsic dikes and granite plutons. The volcanic rocks consist of interbedded pillowed basalt lava flows and felsic pyroclastic deposits and volcaniclastic sediments, termed the Mona Schist, and dacitic to latitic agglomerates, tuffs, and lavas, termed the Kitchi Schist. Many of these rocks were subaqueously deposited. An 8 km long by 1 km wide serpentinite body, the Deer Lake Peridotite, is discordant with the Kitchi Schist and was probably structurally emplaced (Rossell, 1983). A sliver of schistose rock, which also may have been structurally emplaced within the Deer Lake Peridotite (Shepeck, 1985), hosts gold and silver mineralization being extracted at Callahan's Ropes Gold Mine. The volcanic rocks are cross-cut by gabbro and then rhyolite dikes (Owens and Bornhorstf 1985). This was followed by an episode of regional granitic plutonism perhaps synchronous with regional Archean deformation and metamorphism (rhyolite dikes and granites may be part of the same event). Following an extended period of erosion and/or non-deposition, a thick succession of dominantly clastic transgressive-regressive sediments were deposited on the edge of a stable craton margin during .Early Proterozoic time. These Early Proterozoic sediments and the Archean rocks are cross-cut by diabase dikes and sills. The region was deformed during the Penokean (1.8-1.9 b.y. old) orogeny which produced N70W trending foliationf foldsr and shear zones (Klasner, 1978) and low to high grade metamorphic rocks (James, 1955). The Penokean orogeny was followed by another extended period of erosion and/or non-deposition. Around 1.1 b.y. ago E-W trending diabase dikes were emplaced and were associated with the Middle Proterozoic (Keweenawan) Mid-Continent rift system. The Precambrian bedrock is overlain by Pleistocene glacial deposits.

BJORK LUNDEEN PROSPECT

LOCATION AND WORK METHODS

The Bjork Lundeen prospect is located about 1.0 mile (1.61 km) west of Callahan's Ropes Gold Mine in the southwestern corner of the Negaunee SW, 7.5' quadrangle, section 30r T.48N., R.27W. (Figure 1). The prospect was geologically mapped at a scale of 1:2400. Outcrops were mapped using the compass and pace method on an east-west trending baseline with north-south traverse lines, spaced 100 feet apart. The geologic map includes the location of a shaft, trenches and test pits used in previous prospecting.

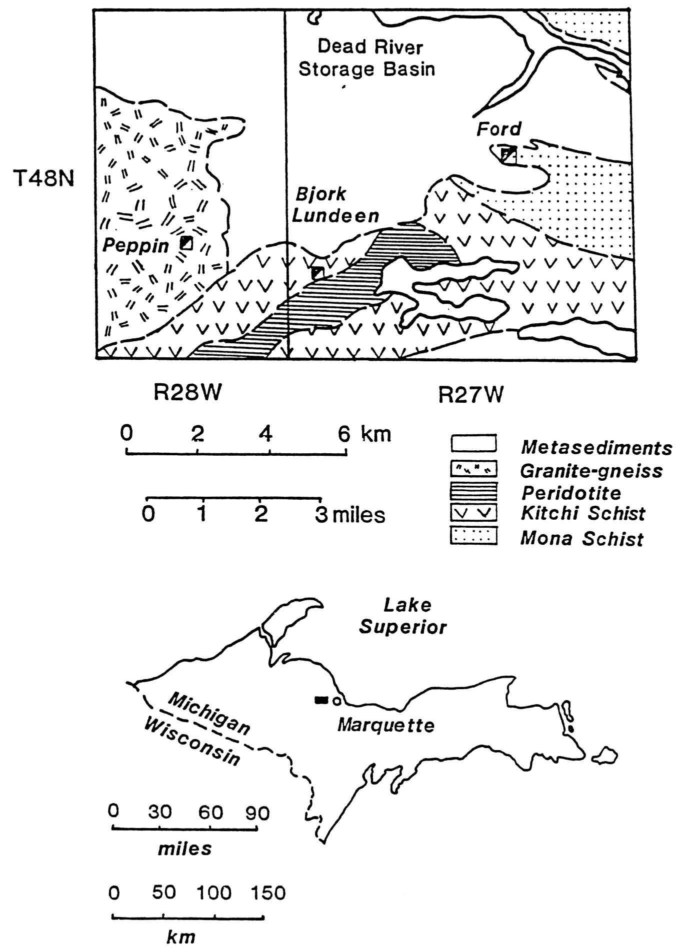

Figure 1. Regional geology and location map of Ford, Bjork Lundeen and Peppin prospects, T.48N., R.27W. to 28W. (modified from Morgan and DeCristoforo, 1980).

PREVIOUS WORK

The study area is included within the Negaunee SW geologic quadrangle map at a scale of 1:24000 by Clark et. al. (1975). A geologic map, an outcrop map, and a short unpublished report were completed in 1936 as part of a gold exploration project by the Norgan Gold Mining Company.

UNIT DESCRIPTIONS

The bedrock at the Bjork Lundeen prospect consists of a succession of pillowed basalt lava flows, probably about 2.7 b.y. old based on regional stratigraphic correlation (Morgan and DeCristoforo, 1980), with one occurence of interflow sediments. These rocks have been metamorphosed to the greenschist facies.

Pillowed Basalt

The dominant lithologic unit at the Bjork Lundeen prospect is a succession of pillowed basalt lava flows of undetermined thickness. Outcrops are usually small with little relief. Pillow structures are most evident on some of the larger outcrops where preferential weathering reveals ellipsoidal-shaped pillows averaging about 1.0 foot long. Pillow orientations were difficult to determine, but an approximate attitude in one location is N80W with a vertical dip and the stratigraphic top to the south.

This unit is a massive, greenish grey to medium grey, very fine- to medium-grained basalt. The groundmass consists of variable amounts of dark green chlorite, dark green (1-2mm) fibrous amphibole, light green plagioclase, euhedral to subhedral magnetites and disseminated sulfides (pyrite). Quartz is present in the interpillow voids,

Metasediment

One small (probable) outcrop of metasediment was found 600 feet from the shaft at the Bjork Lundeen prospect (Plate I). Weathering to a brown color, the metasediment is a very fine-grained rock with alternating lmm-lcm wide grey and black beds. Grey beds contain anhedral quartz, possibly feldspar and very fine-grained biotite, whereas, the black beds are too fine-grained to distinguish minerals in hand specimen. The single outcrop is interpreted as a thin Archean sediment interbedded with the pillowed basalt lava flows.

STRUCTURE

Foliations are poorly developed in the pillowed basalts but occasional zones of foliated chlorite strike N55-65W and dip 76 degrees to the north and to the south. Lack of outcrop and variation in bedrock type made it difficult to define the structure in the area. In one outcrop a small scale fault was indicated by a three inch linear area of positive relief offset in a dextral sense. A few outcrops were very altered and layered in zones up to two feet wide, with attitudes of N55W 76N. We tentatively interpret these as zones of shearing.

MINERALIZATION

Historical Activity

The Bjork-Lundeen prospect has been and is currently being explored for gold mineralization. Several trenches, pits, and one shaft make up the old workings at the site. These workings were noted in a 1936 unpublished report by the Norgan Gold Mining Company and are probably pre-1936. Diamond drilling was reported by the company and more recently drilling was done by Cheveron. Vein and disseminated mineralization are present at Bjork Lundeen.

Vein Mineralization

Veins at the Bjork Lundeen prospect are dominantly composed of quartz. The largest quartz vein is about 50 inches wide and of an undetermined length. It trends N60W and dips 70SW. Adjacent to the vein, the pillowed basalt is relatively more foliated than elsewhere. The foliation may be indicative of a shear zone. The large vein is composed of milky-white, massive, vitreous quartz, recrystallized quartz granules, massive pyrite and tourmaline. The pyrite and black, subhedral to euhedral, 2mm to 1cm tourmaline are intergrown forming alternating tourmaline-rich or pyrite-rich layers with quartz-rich layers. Smaller veins are scattered throughout the area and have curved outcrop traces which suggest that they may have been folded. These veins are composed of massive white quartz.

Disseminated Mineralization

Disseminated pyrite is present in small amounts (up to 10%) in some of the pillowed basalts. It is more prevalent in the basalts in the western end of the mapped area*

GOLD AND SILVER ASSAY DATA

Four samples were analyzed for gold and one for silver (Table 1). The highest values of gold and silver were found in the shaft quartz vein material. The extremely high values may not be representative, but could be due to “nugget effect” during sampling. The other samples were at or below the detection limit for gold.

FORD PROSPECT

LOCATION AND WORK METHODS

The Ford prospect is located approximately 3.1 miles (5.0km) northeast of Callahan1s Ropes Gold Mine in Marquette County, Michigan in the NE 1/4 of section 15 and NW 1/4 of section 14, T.48.N., R.27W. (Fig. 1). The Ford Prospect was geologically mapped at a scale of 1:1200. North-south traverse lines were surveyed by the compass and tape method every 100 feet along a 200 foot, east-west trending baseline. All outcrops, shafts, trenches, and pits were mapped by the compass and pace method. Some of the smaller outcrops were combined with larger outcrops, a few were exaggerated in size, and clusters of small outcrops were mapped as one large outcrop.

PREVIOUS WORK

Clark et. al. (1975) mapped the study area at a scale of 1:24000 as part of the Negaunee SW geologic quadrangle map. According to their geologic map, the area consists of the Archean Nealy Creek Member of the

Mona Schist, a clastic sediment and/or recrystallized tuff. The Nealy Creek Member is cut by two metadiabase intrusives which are shown as either Archean or Early Proterozoic in age. One of the intrusions is shown to be in fault contact with the Goodrich Quartzite of Early Proterozoic age.

Table 1: Gold and Silver Assays for Bjork Lundeen Detection limit Au 0.001 ppm and Ag 0.5 ppm Sample locations are given in Figure 2. Gold and silver analyses were done by Nuclear Activation Services Limited, Hamiliton, Ontario, Canada.

SAMPLE	GOLD PPM	OZ/TON	SILVER PPM
(1) CB-BL-3	0.022	0.0006	--
(2) BLQ	0.001	--	--
(3) BLSQ	94	2.74	80
	100	2.92	--
(4) BL-13	0.001	--	--

CB-BL-3	Grab sample of schistose country rock taken near the shaft.
BLQ	Grab sample of a quartz vein in the basalt in the northwest part of the mapped area.
BLSQ	Grab sample of the quartz vein from the dump rock near the shaft.
BL-13	Grab sample of basalt from the southeast part of the mapped area.

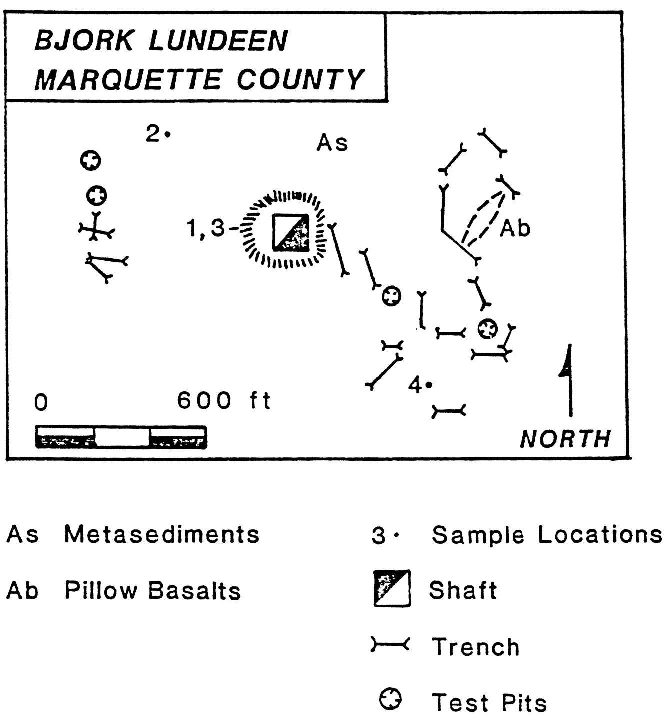

Figure 2. Simplified map of the Bjork Lundeen prospect with the sample locations of the gold and silver assays given in Table 1 (CTR. of W1/2, S30, T.48N., R.27W.).

UNIT DESCRIPTIONS

The bedrock geology of the Ford prospect consists of an Archean clastic sediment intruded by two Archean gabbros. These rocks are variably foliated, faulted and metamorphosed to greenschist facies. One of the Archean gabbro intrusives is unconformably overlain by an Early Proterozoic quartzite. Three small Middle Proterozoic (Keweenawan) diabase dikes cut the Archean rocks.

Nealy Creek Member of the Mona Schist

The Nealy Creek Member of the Mona Schist was named by Puffett (1974). The Nealy Creek Member in the mapped area has an apparent thickness of at least 650 to 700 feet, but it is steeply dipping and extensively deformed. To the east of the Ford Prospect in the Negaunee quadrangle, the Nealy Creek Member has a maximum thickness of about 3000 feet (Puffet, 1974). Outcrops of this unit are abundant in the area forming rounded knobs and high cliff faces. Within the mapped area the unit is conformable with two east-west trending, mafic intrusions.

The Nealy Creek Member is generally a grey, very fine-grained clastic sediment. It is thinly foliated and in places it has a slaty cleavage. Most minerals are too fine to be identified with a hand lens except for small (0.5mm to 1mm) rounded quartz grains and layered silicates (sericite and chlorite). Occasionally, small (0.5mm to 1mm) laths of feldspar are visible. Finely disseminated pyrite is scattered throughout the unit causing a rust brown stain on the weathered surfaces.

Foliations and what appears to be a metamorphic layering obscure bedding, but at two localities contrasting lithologies show a strike of N80W and dip of approximately 78 degrees north.

Metagabbro Intrusives

Two unnamed, east-west trending, vertically dipping metagabbro intrusives occur in the northern and southern portions of the mapped area (Plate II). The northern and southern metagabbro intrusives are 100 to 250 feet and 300 to 350 feet thick, respectively. Contacts with the Nealy Creek Member are obscure, but the general trend of the intrusives is parallel to the bedding attitudes of the Nealy Creek Member. This suggests that these intrusives are sills. Intense foliations in the rocks at the contacts suggests that they may be sheared. The contact of the northern intrusive with the Goodrich Quartzite was mapped as an erosional unconformity.

The intrusives are dark green to greenish grey and fine- to coarse-grained metagabbros. They are composed of greenish-white plagioclase intergrown with green amphiboles, chlorite, and disseminated pyrite (1mm average) which is scattered throughout the unit. The pyrite is relatively more abundant in schistose zones within the metagabbro. In the northern intrusive secondary alteration takes the form of silicification and potassic alteration which is found along the contact between the metagabbro and the Goodrich Quartzite. Silicification and carbonatization is the alteration observed in the southern intrusive.

Goodrich Quartzite

The Goodrich Quartzite was mapped by Clark et. al. (1975) and is part of the Early Proterozoic Marquette

Supergroup. It crops out in the northern part of the mapped area and is over 200 feet thick. Outcrops of this unit are few and tend to form small rounded knobs. Bedding strikes east-west and dips 65 degrees north. The contact between the Goodrich Quartzite and the metagabbro intrusive shows no evidence of faulting and is interpreted as an erosional unconformity.

The Goodrich Quartzite is a matrix supported quartz-clast conglomerate at its base and grades upward into a white, purple, and black, fine- to medium-grained, finely-laminated to thick-bedded, quartzite. Clasts in the conglomerate are mostly milky white quartz with lesser amounts of iron formation, and minor black slate chips. The quartzite is composed of fine- to coarse-, poorly sorted, subangular quartz grains with lesser amounts of feldspar.

Keweenawan Diabase Dikes

There are three small (average 3 feet, wide by 3 feet long) Keweenawan diabase dikes in the area. Based on correlation with other unmetamorphosed dikes in the region, these dikes are presumed to be about 1.1 b. y. old (Keweenawan) and are related to Mid-Continental rift magmatism. They are distinquished by their unmetamorphosed and magnetic character. The dikes strike approximately east-west and dip 80 degrees north to vertical. One diabase dike intrudes the Nealy Creek Member, and two intrude the southern metagabbro intrusive. The Keweenawan diabase is black, fine- to medium-grained and is composed of small (1-2mm) plagioclase laths and pyroxene grains.

STRUCTURE

Evidence for deformation within the study area include foliation, faults, possible shear zones, small scale folds, and an apparent metamorphic layering. The rocks in the area have a variable schistosity which typically strikes N65-80W or N50-80E and dips 65 north to vertical. In the northern part of the area attitude of schistosity is different (N38W, 75 W and N85W, 72 S) due to a nearby inferred fault. In the west part of the area, the foliation has been folded, and it shows a well developed crenulation cleavage. A planar foliation, slaty cleavage, was observed in localized areas of the sediment. This may be the result of compositional differences, though, in one area the planar foliation is being interpreted as a fault. In some localities, the foliation is anastomosing which may be a result of shearing.

In parts of the sediment unit, an apparent metamorphic layering was observed. At a glance, the layering looks like small scale crossbedding, but one layer can be seen cutting across another one. No large folds were recognized in the mapped area, though, some small quartz veins are interpreted as being folded and boudined.

Four north-northwest trending faults offset the southern metagabbro intrusive. A similar oriented fault is indicated by a zone of well-developed schistosity in the northern metagabbro intrusive. One north-northeast trending fault is indicated by topography and by zones of slaty cleavage. A well-developed schistosity is prevalent throughout the Nealy Creek Member. In the metagabbro. intrusives, well-developed schistose zones range in size from 1 inch up to 20 feet wide. Near the contact between the metagabbro intrusives and the Nealy Creek Member, the rocks are intensely foliated. We interpret these relatively well-developed schistose areas as zones of shearing. The age of faulting and shearing is equivocal, but we suggest that it is Archean.

MINERALIZATION

The Ford prospects were named by Kelly (1936, unpublished Norgan Gold Mining Company Reports) because the mineral rights were once held by the Ford Motor Company. The prospect consists of three shafts, test pits, and trenches. Most of the exploration activity was centered on a large (20 feet wide by 450 feet long) composite quartz vein which was emplaced along a north-northwest trending fault (Plate III). Vein and disseminated types of mineralization are observed in the area.

Vein Mineralization

Veins are dominantly composed of quartz and range in size from about 0.5inches to 20 feet thick. Most of the veins are a few inches wide. The heavily prospected vein strikes N45W, dips 75S, ranges in size from 2 to 20 feet wide and extends for more than 450 feet. In places the quartz vein surrounds large fragments of altered metababbro. This may represent a mineralized fault breccia. The quartz is milky white and contains a small amount of sulfide minerals (pyrite), and thin wisps of a light-green layered silicate. Vugs containing euhedral white quartz crystals are present in the vein.

Disseminated Mineralization

Disseminated sulfides are present in minor amounts in all of the rocks in the area, but are relatively more abundant in the country rock adjacent to the large quartz vein. Disseminated sulfides are also abundant in shear zones within the metagabbro intrusives.

GOLD AND SILVER ASSAY DATA

Eight samples were analyzed for gold and three for silver (Table 2). Five samples contained gold at or below the detection limits (0.001 ppm). The highest gold contents (although below a reasonable background level at 0.01 ppm) were from the prospected area near the northwest shaft. Both samples contain disseminated sulfides and marginally confirm the potential of gold in association with the north-northwest trending, prospected fault zone. The three silver assays were below the detection limit of 0.5 ppm Ag.

PEPPIN PROSPECT

LOCATION AND WORK METHODS

The Peppin prospect is located approximately 3.5 miles (5.6 km) northwest of Callahan's Ropes Gold Mine in Marquette County, Michigan and is within the SE 1/4 of section 22 and the SW 1/4 of section 23, T.48N., R.28W. (Fig. 1). The Peppin Prospect was geologically mapped at a scale of 1:1200. North-south traverse lines were located 100 feet apart along an east-west trending baseline by the compass and pace method and the compass and tape method. The map includes the location of the outcrops, the trenches, and the shaft.

Table 2: Gold and Silver Assays for Ford Prospects Detection limit Au 0.001 ppm and Ag 0.5 ppm Sample locations are shown in Figure 3. Analyses by Nuclear Activation Services Limited, Hamilton, Ontario, Canada.

SAMPLE		GOLD PPM	OZ/TON	SILVER PPM
(5)	FCSD	0.001 0.003	-- --	-- 0.5
(6)	FSH-2	0.006	0.0002	0.5
(7)	FS-40	0.001	--	--
(8)	FS-2	0.001	--	--
(9)	FS-7	0.001	--	--
(10)	FS-39	0.004	--	--
(11)	FSH-1	0.001	--	0.5
(12)	FSH-3	0.001	--	--

FCSD Grab sample of gabbro from southwest shaft.
FSH-2 Grab sample of gabbro from northwest shaft.
FS-40 Grab sample of gabbro from eastern shaft.
FS-2 Grab sample of gabbro from eastern map section.
FS-7 Grab sample of gabbro schist, part of fault.
FS-39 Grab sample of metasediment near northwest shaft.
FSH-1 Grab sample of quartz from northwest shaft
FSH-3 Grab sample of quartz from southwest shaft

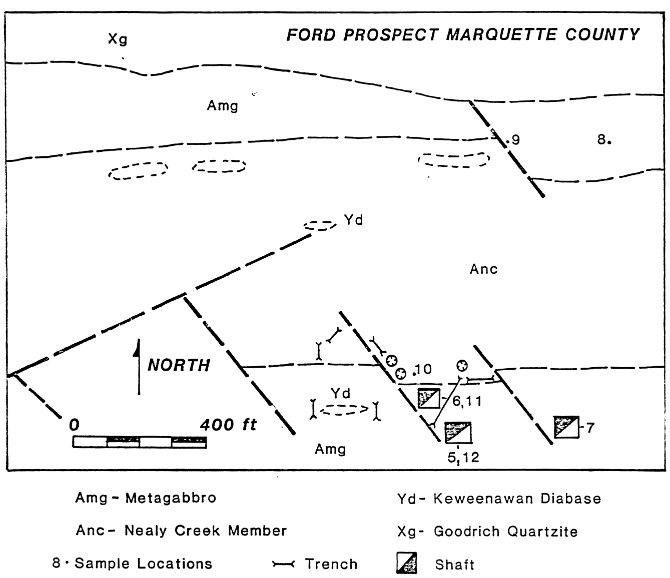

Figure 3. Simplified map of the Ford prospect with the sample locations of the gold and silver assays given in Table 2 (SE1/4, NE1/4, S15 and W1/2, SW1/4, NW1/4, S14, T.48N., R.27W.).

PREVIOUS WORK

The Peppin prospect area .is shown by Bodwell (1972) on a 1:62500 regional geologic map. The prospect was discussed briefly in an unpublished geologic report prepared for the Norgan Gold Mining Company.

UNIT DESCRIPTIONS

The bedrock geology at the Peppin prospect area consists of an Archean granodiorite which is part of a large composite pluton, and it contains five pods of mafic rock which Kelly (1936 unpublished report) suggested were roof pendants of greenstone. The origin of the mafic rocks is uncertain. The granodiorite and one of the mafic pods are intruded by felsic dikes.

Granodiorite

Granodiorite is the dominant lithology in the study area. The unit consists of pink to grey, fine- to medium-grained granodiorite composed of mostly equigranular to inequigranular feldspar and quartz crystals with about 15% biotite/chlorite. In hand sample plagioclase appears to be more abundant than potassium feldspar. Minor sulfides are disseminated throughout the rock and small (avg. 2mm) sulfide masses were observed in the granodiorite adjacent to the quartz veins. In some areas the granodiorite is stained an orange color.

Randomly oriented, small (1 to 5 inches wide), pink, fine-grained, aplite dikes intrude the granodiorite and are included as part of this unit. They are composed mostly of equigranular quartz and feldspar with approximately 5% biotite and no visible opaques.

At a few localities there are 1 to 3 foot wide exposures of a fine-grained, dark green, mafic schist mapped as part of the granodiorite. The dominant foliation in these mafic rocks has a N70-80E trend and is defined by thin layers of chlorite and quartz + feldspar. The foliation has been folded forming a well developed crenulation cleavage. The origin of this mafic rock is uncertain, but it may be due deformation and metamorphism of the granodiorite.

Mafic Intrusives

Within the mapped area there are two mafic intrusives that trend northeasterly and easterly. The northern intrusive is approximately 10 feet wide, and the lateral continuity is unknown. The central mafic intrusive forms a gently rounded and fairly extensive hill 100 to 150 feet wide and 1000 feet long which is probably its minimum dimensions. A contact between the mafic intrusive and the granodiorite was not observed, consequently, the field relationships are inconclusive.

Both intrusives are dark green, and fine- to medium-grained amphibolites composed of plagioclase, amphibole, chlorite, and less than 5% quartz. Disseminated sulfides are present in both intrusives.

In the Norgan Gold Mining Company unpublished reports, it was suggested the these mafic rocks were roof pendants of greenstone. The field evidence cannot refute this idea, but we suggest that it is equally possible that they are intrusive dikes. Textural evidence suggests an intrusive origin. If intrusive, these mafic rocks are probably Archean or Early Proterozoic in age.

Felsic Dikes

There are three unnamed west-northwest trending felsic dikes which are located in the southern part of the mapped area. They intrude the granodiorite and the central mafic intrusive. The felsic dikes range from 5 to 10 feet wide and vary from 40 to 550 feet long. Contacts are gradational with both the granodiorite and the central mafic intrusive.

The felsic dikes are massive to layered, grey, very fine-grained rocks. Most of the grains were too small to be identified in hand specimen, but in the coarser samples feldspar, quartz, biotite, and pyrite were observed.

STRUCTURE

The Peppin Prospect is located in Archean intrusive rocks which are sheared and possibly faulted. Folding in the area was not recognized. The dominant structure consists of zones, usually a few feet wide, of a well-foliated granodiorite with a well-developed crenulation cleavage. Two ages of deformation are shown by the crenulation cleavage and we interpret these zones as due to shearing. The first foliation trends N80W or N80E dips 63-78N. At a few localities interlocking quartz grains form poorly defined bands trending in the same direction as the foliated zones. Swamps in the southern half of the area trend west-northwest and in the northern half to the northeast. The swamps could be due to differential erosion along shear zones.

Only one N40W trending fault was recognized in an area where the felsic dike appeared to be drag folded. Additional faults maybe present in the granodiorite as indicated by bleached areas in the granodiorite.

MINERALIZATION

The Peppin prospect was explored in the early 1930s by the Norgan Gold Mining Company who sunk a shaft and dug trenches on two quartz veins. They reported (unpublished report) gold contents of 0.75 oz. and 0.05 oz. per ton. The largest veins in the mapped area are spacially associated with a felsic dike and sheared granodiorite. The veins are up to 2.5 feet wide and are composed of massive, white, sometimes sugary quartz with occasional orange staining and minor wisps of layered silicates (chlorite and/or sericite). Pyrite makes up about 1% of the vein in the trench and occurs as a globular masses (avg. 2mm) and as singular euhedral crystals intergrown with the quartz. Pyrite also occurs as disseminations in the granodiorite adjacent to the veins.

GOLD AND SILVER ASSAY DATA

Eight samples were analyzed for gold and two for silver (Table 3). Four samples contained gold at or below the detection limit (0.001 ppm) and both of the silver assay values were below the detection limit (0,5 ppm). The highest gold values were obtained on the granodiorite samples located near the trench.

Table 3: Gold and Silver Assays for Peppin Prospect Detection limit Au 0.001 ppm and Ag 0.5 ppm Sample locations are in Figure 4. Analyses were done by Nuclear Activation Services Limited, Hamilton, Ontario, Canada.

SAMPLE	GOLD PPM	OZ/TON	SILVER PPM
(13) PA-8	0.004	--	--
(14) PTQ	0.004	--	0.5
(15) PA-22	0.001	--	--
(16) PA-23	0.001	--	--
(17) PA-20	0.001	--	--
(18) PA-24	0.033	0.001	--
(19) PA-21	0.009	--	--
(20) PCRSH	0.001	--	--

PA-8	Grab sample of quartz from northern granodiorite outcrop.
PTQ	Grab sample of quartz from trench.
PA-22	Grab sample of quartz from shaft.
PA-23	Grab sample of felsic dike at trench.
PA-20	Grab sample of felsic dike in the south-west part of the mapped area.
PA-24	Grab sample of granodiorite at trench.
PA-21	Grab sample of granodiorite in the south-west part of the mapped area.
PCRSH	Grab sample of mafic schist at shaft.

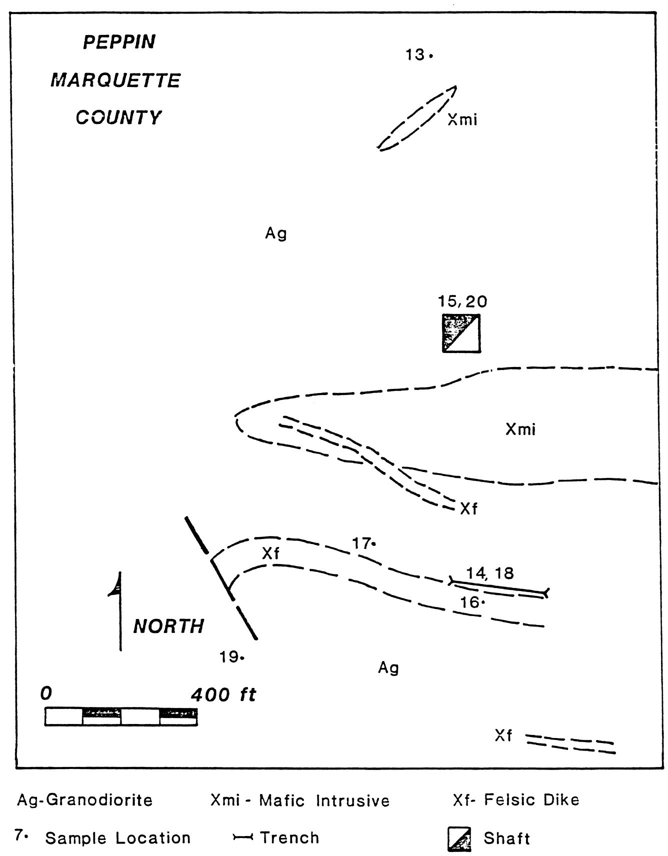

Figure 4. Simplified map of the Peppin prospect with the sair.ple locations of the gold and silver assays given in Table 3 (W1/4, SW1/4, S23, and E1/2, SE1/4, S22, T.48N., R28W.)

MARENISCO PROSPECT

The regional geology described for Marquette County is not applicable to the Marenisco Prospect which, is located in Gogebic County. The reader should refer to Sims et. Al. (1984) for applicable regional geology.

BRIEF OVERVIEW OF REGIONAL GEOLOGY

The Marenisco prospect is located in Gogebic County in the northwestern end of the Upper Peninsula of Michigan. The prospect is located within the granite-greenstone terrane of Sims (1980). This terrane consists of Archean metavolcanic and metasedimentary rocks which were intruded by granitic rocks. This Archean rock assemblage is unconformably overlain by Early Proterozoic sedimentary rocks of the Marquette Range Supergroup (Sims et. al., 1984). The bedded rocks are complexly folded and faulted by two different deformational events: in Late Archean and in Early Proterozoic time.

LOCATION AND WORK METHODS

The Marenisco prospect area is located in Gogebic County, Michigan approximately 4.2 miles (6.7 km) north of Marenisco in section 28, T.47N., R.43W. (Figure 5). The Marenisco area was geologically mapped at a scale of 1:600. Using the compass and pace method, outcrops and the location of the one shaft were mapped from traverse lines spaced at 50 foot intervals on a N45W baseline. Clusters of small autcrops are shown as one large outcrop on the geologic map.

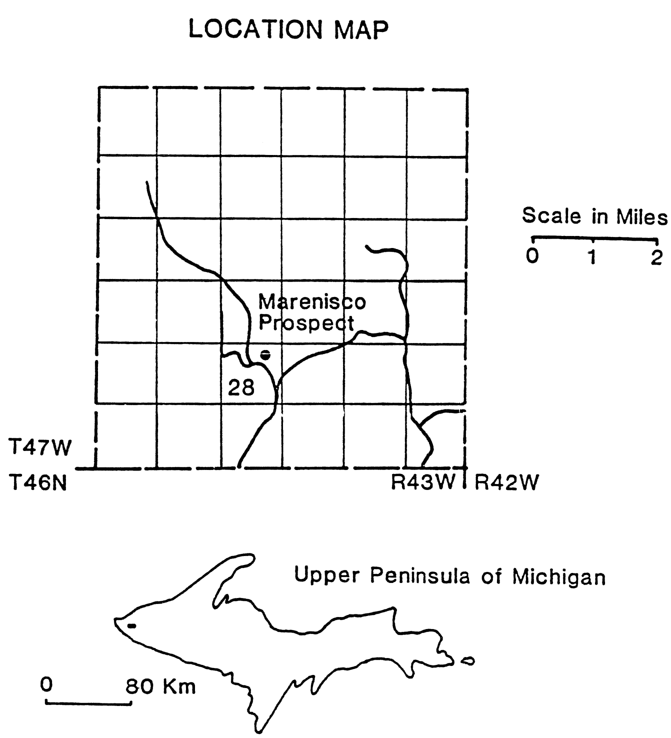

Figure 5. Location map of the Marenisco prospect in section 28, T.47N., R.43W., Gogebic County, Michigan.

PREVIOUS WORK

The geology of the Marenisco-Watersmeet areas has been included in a number of studies: Fritts (1969), Trent (1973), Prinz (1981), and Sims et. al., (1984). The site was also mentioned in the 1936 Norgan Gold Mining Company unpublished reports.

UNIT DESCRIPTIONS

The Marenisco prospect is located between the Presque Isle and the Prospector Creek faults in Archean schistose rocks which were intruded by the Puritan Batholith (Fig. 6). The Presque Isle Fault separates the Early Proterozoic Palms Formation from the Archean schistose rocks which had been previously interpreted as Palms Formation by Trent (1973).

In the immediate vicinity of the Marenisco Prospectr the bedrock consists of an Archean biotite schist intruded by east-west trending, small, Archean, felsic dikes and a Keweenawan diabase dike.

Biotite Schist

Biotite schist is the dominant lithology in the mapped area and its thickness is not known. Outcrop size is variable ranging from small knobs with low relief to larger knobs forming rounded cliff faces.

The unit consists of a greenish grey to dark grey, fine-grained, typically massive, biotite schist. The biotite schist exhibits a fine layering (1mm-1cm thick) which consists of alternating quartz-feldspar rich zones and biotite rich zones. It contains 1 to 5% very fine disseminated sulfides which are relatively more abundant in the rock taken from piles of rock near the shaft. Adjacent to the Keweenawan diabase dike, the schist contains abundant dark green, 2mm, acicular amphiboles and relatively abundant sulfides. Minor amounts of carbonate are present throughout the unit. Small, white to grey, vitreous quartz pods and veins along with white biotite leucogranite and quartz monzonite dikelets cut this rock unit. This unit is Archean in age (Sims et. al., 1984), but its protolith is unclear.

Biotite Leucogranite to Quartz Monzonite Dikes

The biotite leucogranite named by Sims et. al., (1984) intrudes the biotite schist and forms small, irregular shaped diklets (avg. 2 inches wide). The dikes are white with black specks, fine-grained biotite leucogranites. Also intruding the biotite schist are quartz monzonite dikes ranging in size from approximately two inches up to fourteen inches thick and of uncertain length. The dikes are white to orange fine- to medium-grained quartz monzonites.

Plagioclase, potassium feldspar, and quartz make up 95 to 97% of the dikes with up to 3% biotite in the leucogranites and small amount of sericite in the quartz monzonites. Very fine, disseminated pyrite is present in minor amounts. The age of the dikes is uncertain, but they are probably Archean in age.

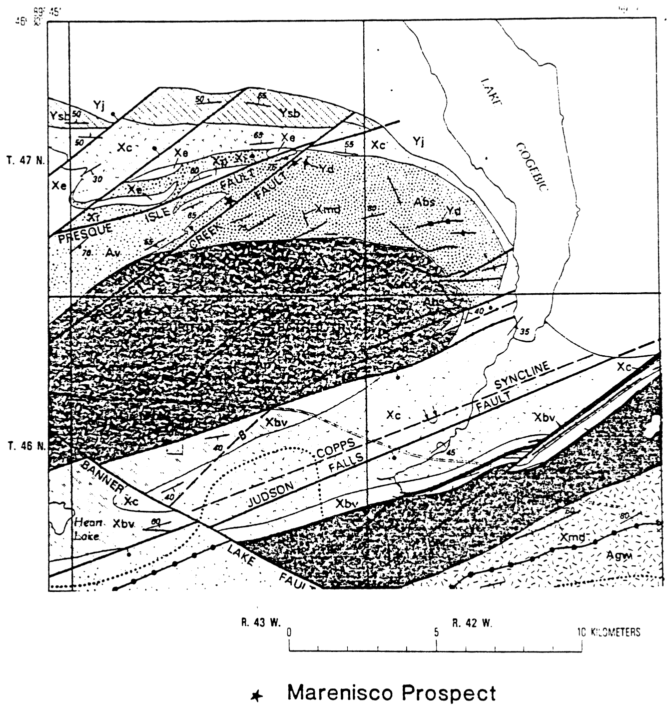

Figure 6a. Regional geologic map of the Marenisco-Watersmeet area showing the location of the Marenisco prospect (taken from Sims et. al., 1984).

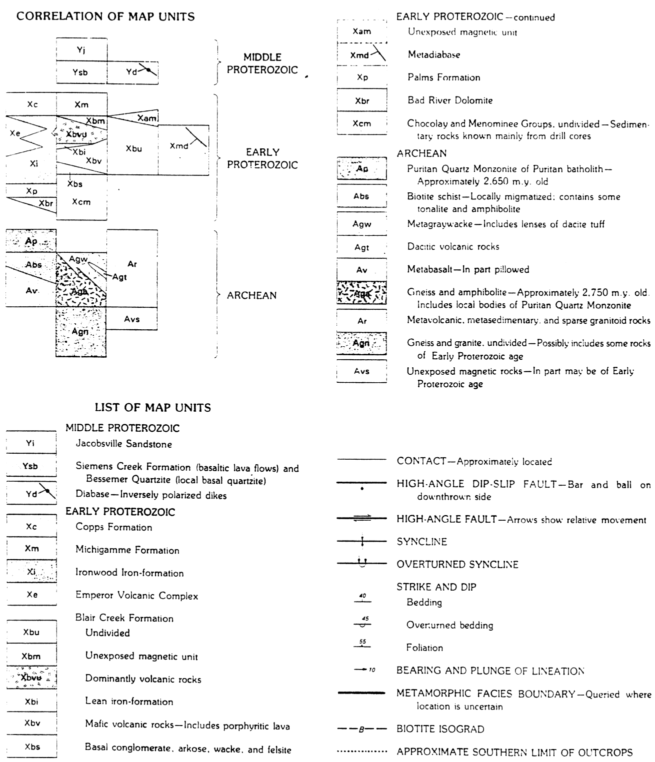

Figure 6b. Correlation of map units and symbols used in Figure 6a.

Keweenawan Diabase Dikes

An unmetamorphosed, relatively magnetic, diabase dike of probable Keweenawan age intrudes the Archean biotite schist. The dike consists of a dark grey, fine-grained, diabase composed of mostly plagioclase (2mm laths) and intergrown (2mm) pyroxene. It has a thin chilled margin containing sparse euhedral, 2mm, amphiboles. The contact between the Keweenawan diabase dike and the Archean biotite schist is sharp and strikes N75E, dips 55E. This dike is probably Middle Proterozoic (Keweenawan) in age and is related to Mid-Continent rift magmatism.

STRUCTURE

The Marenisco prospect is located between the east-northeast trending Presque Isle and the Prospector Creek faults (Figure 6). The Presque Isle fault separates Early Proterozoic rocks to the north from the Archean rocks to the south (Sims et. al., 1984).

In the immediate vicinity of the prospect the biotite schist is foliated (foliation strikes N45E with an average dip of 70 degrees SE). Thin layering described previously strikes slightly more easterly, N45-65E, dips 63-75 SE.

The rocks found in piles next to the shaft are intensely pyritized, silicified, and foliated, thus they are intensely deformed. The shaft area at the Marenisco prospect was interpreted by Swineford (1936, unpublished report of the Norgan Gold Mining Company) as part of a metalliferous belt with an easterly strike, dipping 75 degrees south. No such belt was observed during this investigation.

MINERALIZATION

The only reported exploration in the vicinity of the Marenisco prospect was reported by Kelly (1936, unpublished report of the Norgan Gold Mining Company report) who quoted A. P. Swineford of the Summit Exploring, Mining and Manufacturing Company (1883). The company sunk a shaft of at least 15 feet deep in what he called a belt of dark chloritic schist with abundant free quartz and iron pyrite. Swineford reported anomalous gold and silver contents.

GOLD AND SILVER ASSAY DATA

Two samples were analyzed for gold and one sample for silver (Table 4). Both samples have similar gold contents which are at background levels.

Table 4: Gold and Silver Assays for Marenisco Prospect Detection Limit for Au 0.001 ppm and Ag 0.5 ppm. Sample locations are shown in Figure 7. Analyses by Nuclear Activation Services Limitedf Hamilton, Ontario, Canada.

SAMPLE	GOLD PPM	AG PPM
(21) CB-M-1-2	0.008	<0.5
(22) CB-M-12	0.007	--

CB-M-1-2 Grab sample of rock from piles near shaft.

CB-M-12 Grab sample of biotite schist near shaft.

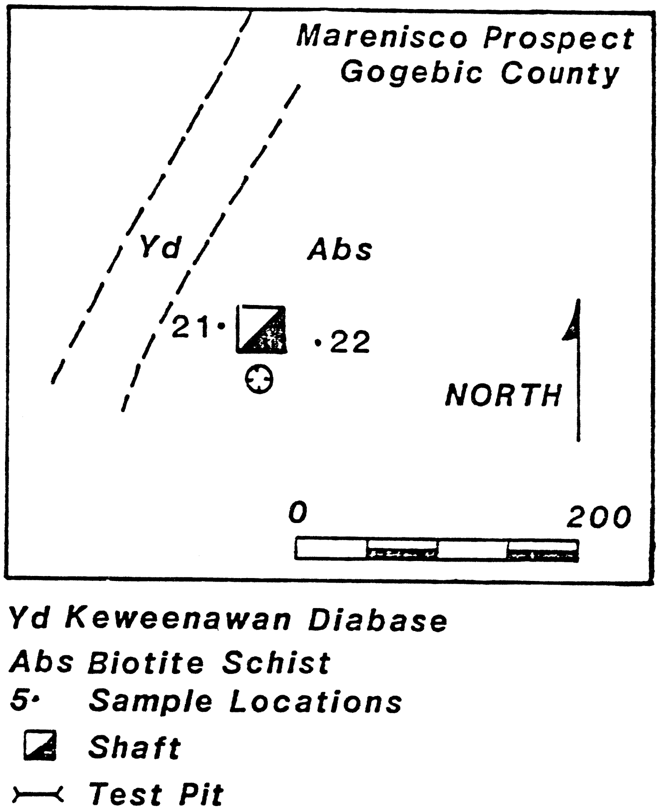

Figure 7. Simplified map of the Marenisco prospect with the sample locations of the gold and silver assays given in Table 4 (NE1/4, SW1/4, NE1/4, S28, T.47N., R.43W.).

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