Investigation of the Rois Malk Epithermal Gold System, Republic of Palau

U.S. GEOLOGICAL SURVEY BULLETIN 1872

U.S. DEPARTMENT OF THE INTERIOR

March 3, 1849

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By W. R. MILLER, J. J. RYTUBA, M. A. ARNOLD, and T. L. VERCOUTERE

Detailed geological and geochemical investigations of the Rois Malk area, Republic of Palau, resulted in the identification of an epithermal gold system in a 1.5 x 1 km area

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By W.R. Miller, J.J. Rytuba, M.A. Arnold, *and* T.L. Vercoutere

Abstract

Detailed geological and geochemical investigations of the Rois Malk area on the Island of Babelthuap, Republic of Palau, resulted in the identification of more than 100 mineralized veins, shear zones, and brecciated areas in a 1.5×1 kilometer area. Most of the veins contained anomalous amounts of gold, as much as 13 parts per million. The study area is underlain by Eocene(?) basalt and basaltic andesite flows and flow breccia which have undergone deep lateritic weathering.

The veins and shear zones range in width from less than a centimeter to several meters and strike northeast to northwest with steep dips. The longest vein extends over 500 meters along trend. It is likely that veins continue beyond the study area, but are obscured by dense jungle and intense weathering. The veins show typical comb quartz textures and open-space fillings. Shear zones exhibiting multiple stages of brecciation contain rock cemented by quartz and iron and manganese oxides. Sulfides associated with the mineralization are pyrite, sphalerite, chalcopyrite, and galena. Gold occurs as native gold, electrum, and Au-Ag telluride; elements associated with gold include Mo, Te, Bi, Pb, Ag, Cu, Zn, and As.

The most effective sample medium for geochemical exploration is stream sediments: gold is a diagnostic pathfinder element followed in effectiveness by Te, Zn, Pb, and Cu. Heavy-mineral concentrates from stream sediments are also useful, particularly for determination of the mineralogy. Bottom sediment samples collected from coastal mangrove swamps are effective in rapid detection of onshore mineralization adjacent to mangrove swamp and coast.

The results of this study suggest that the Rois Malk system is similar to the top of other productive epithermal vein systems and may represent the lower levels of an enargite-gold subtype epithermal system. Tonnages of known enargite-type deposits elsewhere in the world range from 0.2 to 11 million metric tons and gold grades from 3 to 18 parts per million. The vein system at Rois Malk warrants further surface exploration and drilling. The methods used in this study can be used to evaluate other parts of Palau as well as other areas with similar environments particularly in the western Pacific.

INTRODUCTION

The Republic of Palau occupies the westernmost part of the Caroline Islands, 1,500 km southwest of Guam (fig. 1). Babelthuap is the largest of Palau's 200 islands, and the Rois Malk area is located in the southeastern part of this island. Palau has a tropical humid climate characterized by small seasonal variations. Rainfall is abundant throughout the year; mean annual rainfall is around 380 cm, with the maximum occurring in July and a minimum in February through March (U.S. Army, 1956).

A 10-day geologic reconnaissance of the Republic of Palau in spring 1985 by a team of USGS scientists resulted in the identification of a large epithermal gold system having anomalously high gold contents at the surface (Rytuba and others, 1985). The gold system was in an area previously prospected by the Japanese, but in 1938–39 it was considered to be of no commercial interest. The mineralized system occurs on Babelthuap Island and is named after a prominent hill within the study area called Rois Malk.

In spring 1986, detailed geological, geochemical, and geophysical follow-up studies of the Rois Malk area were carried out by a team of USGS scientists. This report is the result of these studies. Both trips were funded by the Office of Territorial and International Affairs and the U.S. Geological Survey.

The Rois Malk area lies on a northwest-trending ridge which contains the prominent hill of Rois Malk. The top of Rois Malk is 104 m in elevation and is the highest point in the study area. The ridge is characterized by moderate to steep slopes dissected by dendritic drainages which slope away to the southwest and to the northeast to the seacoast. During World War II, the Japanese heavily fortified this ridge with numerous trenches.

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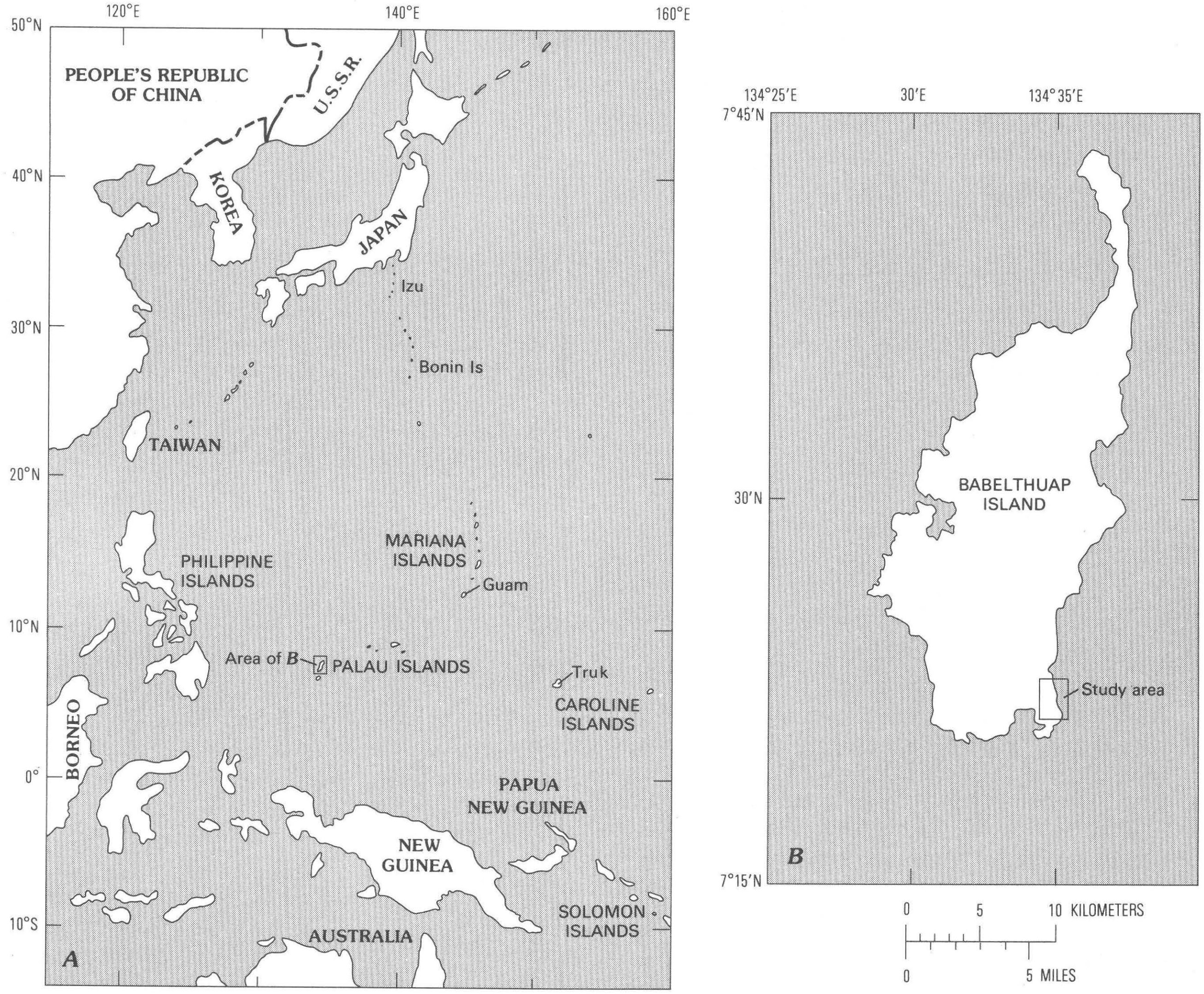

Figure 1. Index map showing location of *A*, Palau and *B*, Rois Malk study area.

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REGIONAL GEOLOGIC SETTING

The Palau arc is an intra-oceanic island arc-trench system which separates the Pacific and Philippine plates in the western Pacific Ocean (fig. 2). It is the southernmost of a series of arc-trench systems which include the Yap, Mariana, and Bonin-Izu systems. More than 200 islands lie along the 350-km length of the Palau arc, but only four of the islands along the northern part of

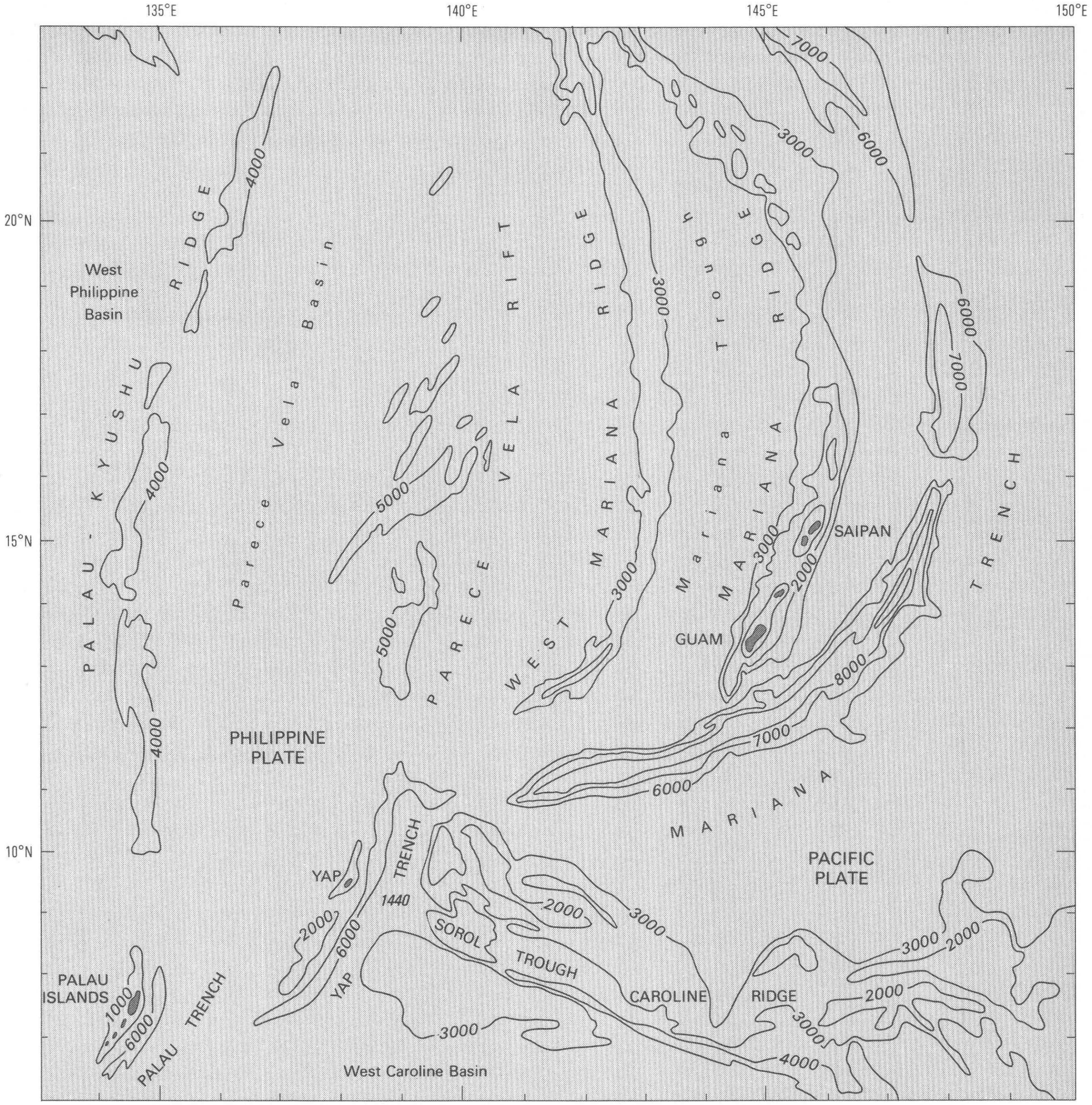


Figure 2. Geologic map of the western Pacific showing Palau, Yap, and Mariana arc-trench systems. Depth contour interval 1,000 m.

the arc are composed primarily of volcanic rocks. Babelthuap, the largest island of the Palau group, contains the oldest volcanic rocks exposed in the arc, and these are likely Eocene in age. The youngest volcanic rocks, of middle Miocene age, are also exposed in Babelthuap as well as in three islands immediately to the south. Most of the islands in Palau are composed of Miocene to Pliocene carbonate rocks representing uplifted marine reef deposits.

Volcanic activity in the Palau arc has been episodic; major pulses of volcanism occurred in the early to middle Oligocene and the early Miocene. Volcanism ceased along the Palau arc at about 20–25 million years ago, but episodic volcanism has continued to the recent along the Mariana and Bonin-Izu arcs. Tectonic activity along the Palau arc is very limited; seismic activity has been concentrated along the volcanically active arcs to the north of Palau. Magnitude 4.5 or greater earthquakes have been recorded along the central part of the Palau arc, but other parts of the arc have been essentially aseismic in historic times.

The Palau trench is well developed offshore of the northern part of the arc, where ocean depths consistently exceed 6,000 m (fig. 2). In the southern part of the arc-trench system, the trench is less well defined and less than 6,000 m in depth. The deepest trenches in the region occur offshore of the active Mariana arc, where ocean depths generally exceed 8,000 m with local areas exceeding 9,000 m.

Extending northward from the Palau arc is the Palau-Kyushu ridge. It transects the Philippine plate into two distinct basins: the west Philippine basin and the Parece Vela basin. Formation of the Palau-Kyushu ridge began in the early Tertiary, at about the same time of formation as the west Philippine basin (Karig and Moore, 1975). As volcanic activity along the Palau-Kyushu ridge ceased at about 25 million years ago, opening of Parece Vela basin was initiated. Rifting associated with opening of the basin resulted in subsidence of the Palau-Kyushu ridge and its eventual submergence. Volcanic activity subsequently began along the Mariana ridge at about 20 million years ago and continued as back-arc basin spreading continued in the Parece Vela basin. The evolution of the Palau-Kyushu ridge, Parece Vela basin, and Mariana ridge has provided the basis for a generally accepted model of intra-oceanic arc and back-arc basin development (Hawkins and others, 1984). An important part of the model has been the recognition of extension and crustal spreading outward of the extinct arc. This area subsequently becomes the back-arc basin when the volcanic activity is initiated along the new arc.

The chemical evolution of magmas along the arcs in the western Pacific shows a systematic progression from early boninites and associated arc-tholeiites, to dominance by arc-tholeiites and finally calc-alkaline lavas (Hawkins and others, 1984). In some arcs the progression ends with shoshonites, but this is not typically the case in the Palau, Yap, Marianas, and Bonin systems.

Boninites, characterized by low concentrations of high field strength elements and high concentrations of magnesium, nickel, and chromium, characterize the earliest phase of volcanism on Yap, Guam, Truk, and Bonin. These lavas are derived from peridotites depleted by a previous episode of melting. Melting of the mantle wedge under hydrous conditions occurs early in the fore-arc development (Hawkins and others, 1984). Because of these restricted conditions of formation and limited source, the volume of boninites in the arcs is small. Until this study, evidence for the boninitic phase of volcanism on Palau was absent. As for the second evolutionary stage, voluminous island arc tholeiite lavas characterize most of the volcanic rocks in the arc systems. These are followed in arc development by calc-alkaline lavas, which are generally the last phase of volcanic activity in the arc. The Palau arc follows the pattern of development of other arcs in the western Pacific.

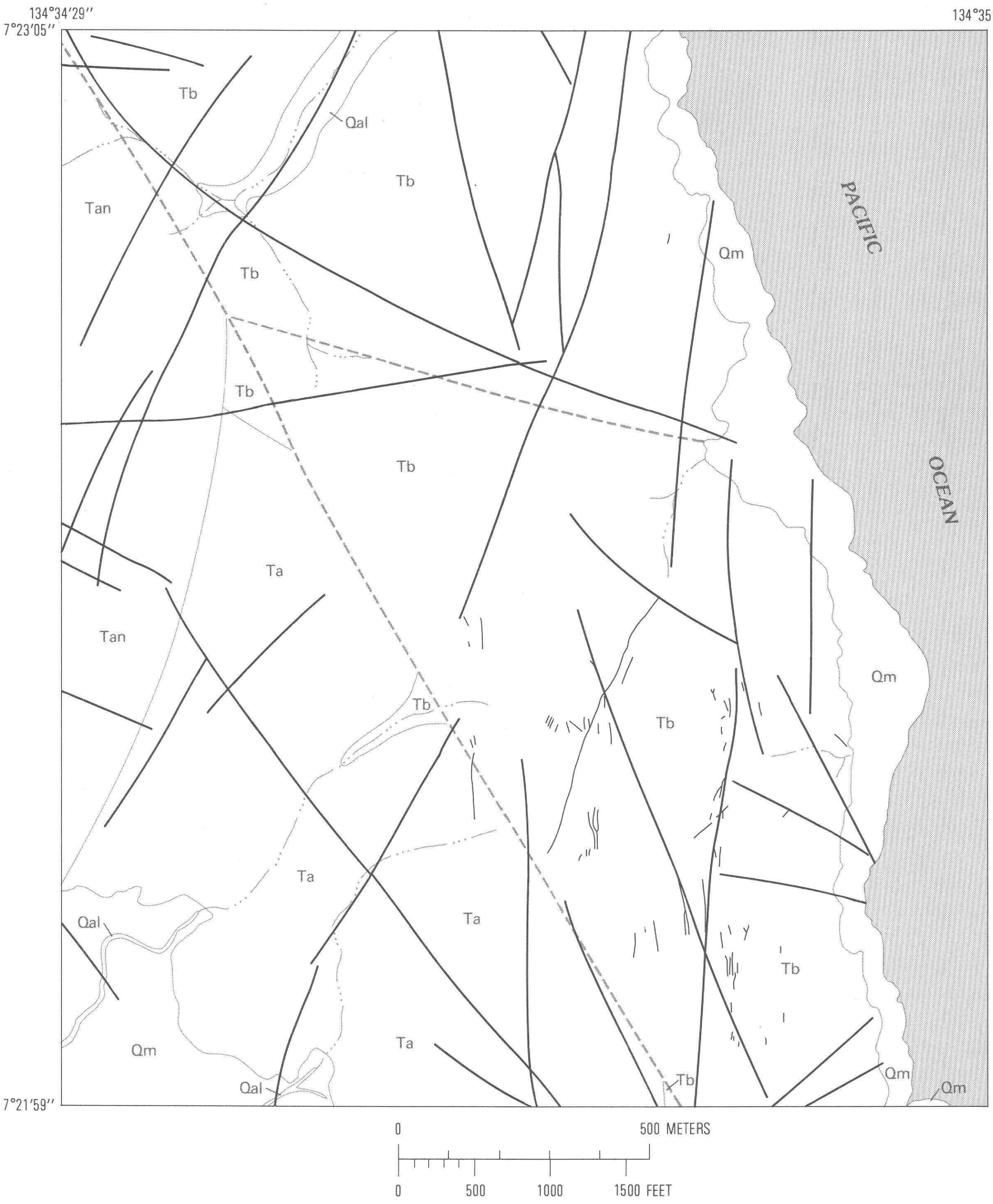
GEOLOGY OF THE ROIS MALK STUDY AREA

Two formations occur within the Rois Malk study area, the Babelthuap and Airai Formations (pl. 1). The Babelthuap Formation consists of basalt and basaltic andesite flows and flow breccias. Massive outcrops of weakly to strongly propylitically altered flows and flow breccias occur along the coast on the east side of the study area, and smaller outcrops occur in the central and western parts of the study area. In most parts of the study area, the Babelthuap Formation is intensely weathered to laterite. The original igneous texture of the rock is sometimes destroyed, but many remnant outlines of pyroxene and feldspar phenocrysts are present. The flows are typically massive and have a vesicular texture. Flow breccias consist of large angular blocks up to 1 m in width. The attitude of the flows was not discernible within the study area. Petrographically the flows consist of phenocrysts of clinopyroxene (augite) and plagioclase in a devitrified glass groundmass. Vesicles within the flows are filled with zeolites which include laumontite, prehnite, and pumpellyite. Fine-grained quartz veinlets are locally present.

The west side of the study area consists of the Airai Formation in fault contact with the older Babelthuap Formation. The fault trends northwest and dips at a high angle. The formation consists of interbedded, weakly consolidated shales and shaly siltstones and pebble conglomerate. Local organic-rich horizons occur and contain abundant pyrite. No veins or mineralized shear zones cut the Airai Formation, and it is considered to be postmineralization in age.

A small outcrop of porphyritic dacite (less than 1 m^2 and too small to indicate on pl. 1) occurs in the south part of the study area. It is chemically distinct from the Babelthuap flows and is probably intrusive into the Babelthuap Formation.

Because of poor exposures, only a few faults could be mapped with certainty in the study area. Several right lateral faults with displacements of several meters offset vein VR–1, strike N. 65° E., and dip at high angles. These faults probably extend throughout the study area. Several linear features cut across the study area and show up particularly well on aerial photographs. These strike N. 20° E. and extend for up to 2 km along strike (fig. 3). On the surface the linear features separate massive outcrops of Babelthuap flows from intensely weathered flows and laterite developed from the Babelthuap Formation. If the linear features are faults, then the juxtaposition of



EXPLANATION

Quaternary

Qal **Alluvium**

Qm **Mangrove swamp deposits**

Tertiary

Ta **Airai Formation**

Tb **Babelthuap Formation**

Tan **Ngarsul Member of Aimeliic Formation**

Approximate contact

Fault

Vein

Lineations

Figure 3. Distribution of linear features in the Rois Malk study area.

differently weathered rock formations suggests that the faults are recent in age and may have substantial offset. The significance of these possible faults is important in evaluating the mineralization because they would displace the veins and shear zones. Further detailed work including trenching is required to evaluate these structures.

TECHNIQUES FOR COLLECTION, PREPARATION, AND ANALYSIS

Media sampled include rocks (veins, lateritic rock, and bedrock), soils, stream sediments, heavy-mineral concentrates (from stream sediments), and mangrove sediments. The techniques for collection, preparation, and analysis of samples of each medium are discussed herein.

Rocks

Samples of rocks included veins, lateritic rock hosting the veins, and bedrock. Lateritic rock is more properly a soil, but because the original rock textures are usually preserved and samples are treated similarly to rock in preparation and analyses, it is included with rocks. Surface exposures of rocks vary from rare nearly fresh exposures to more common weathered rock. Bedrock material was collected by compositing several samples from about a 1 m^2 area. Vein samples were collected by compositing several samples along the vein or by channel sampling across the vein.

Rock and vein samples were dried, crushed, and pulverized using ceramic plates to less than 0.15 mm, and split. One split was analyzed with a six-step, d.c.-arc semiquantitative emission spectrography method for 31 elements. A second split was analyzed by atomic absorption spectroscopy for Au, Te, As, Zn, Cd, Bi, and Sb. A detailed description of vein and rock samples appears in appendix A. A complete listing of chemical analyses of vein samples appears in appendix B, table 15. The analytical procedures and the limits of determination of the analytical methods also appear in appendix B. A third split was analyzed by Kevex X-ray emission spectrography. In addition, scanning electron microscopy (SEM) techniques were used to study polished sections and fragments of veins.

Trenches and Road Cuts

Several trenches were dug with a backhoe across the zone of mineralization to better determine the nature and extent of the vein system. In particular, country rocks adjacent to the veins were sampled to determine whether gold and associated elements were present outward from the veins into the country rock. Attempts to sample below the zone of intense weathering and oxidation were unsuccessful because the zone of lateritic weathering extends beyond the 3-m limit of the backhoe. Because of inaccessibility and limited time, only a limited number of trenches were completed, and these were sited primarily with respect to access rather than geologic interest. Further sampling by trenching in the mineralized area is warranted.

In addition to backhoe trenches, fortification trenches constructed by the Japanese during World War II were cleared of loose material and vegetation and sampled. These are generally less than 2 m deep but provided good exposures of mineralized shear zones and veins that were not exposed on the ground surface. Road cuts were also cleared and sampled along an old Japanese road which extends across the southern part of the vein system.

The locations of backhoe trenches, fortification trenches, and road cuts (referred to as channels) are shown by letter designation on plate 1. Complete chemical analyses are listed in appendix B, table 16.

Soils

Soil samples consisted of approximately 0.5 kg of material collected about 15 cm below the surface. Soils are generally lithosols with no well-developed horizons. All soil samples were oven dried at 120 °C for approximately 12 hours, lightly crushed, pulverized, and chemically analyzed in the same manner as the rock samples. A detailed description of soil samples makes up appendix C. For complete chemical analyses of soil samples, see appendix B, tables 17 and 18.

Stream Sediments and Heavy-Mineral Concentrates

Stream-sediment samples consisted of approximately 1–2 kg of composited sediment. These samples were oven dried at 120 °C for approximately 12 hours, sieved to less than 0.18 mm (minus 80 mesh), and chemically analyzed in the same manner as the rock samples. A complete listing of chemical analyses of stream sediments is shown in appendix B, table 19.

Heavy-mineral-concentrate samples were collected by compositing and panning 5–7 kg of stream sediment in the field to obtain the heavy-mineral concentrates. These concentrate samples were air dried, sieved to less than 1 mm (minus 18 mesh), and the magnetite removed with a

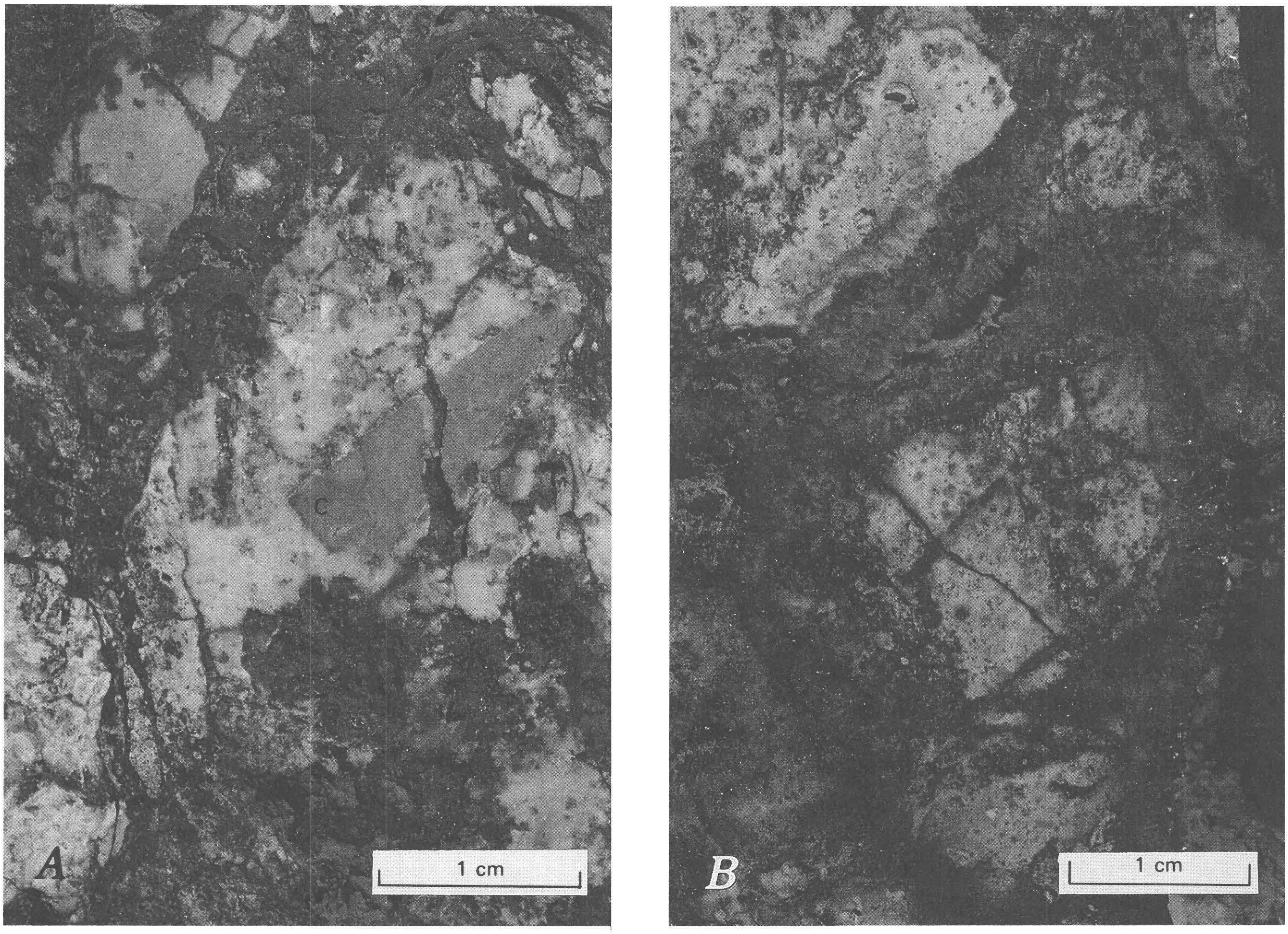


Figure 4. Clast-supported breccia. *A*, Breccia (PM 216) from VB–2 brecciated area showing clast C, which is an intensely altered dacite containing native silver. The surrounding quartz is unmineralized. *B*, Breccia (PM 145) from VB–3 brecciated area, showing clasts of intensely altered propylitic basalt surrounded by comb quartz and vugs.

hand magnet. The remaining concentrate was separated using bromoform (specific gravity 2.86) into a light and heavy fraction, and the light fraction discarded. The heavy-mineral fraction was separated electromagnetically with a Frantz isodynamic separator with a forward slope of 15° and a side slope of 20° at 0.6 amperes. The magnetic fraction at 0.6 amperes contained primarily pyroxenes, amphiboles, and spinel minerals; it was discarded. The remaining nonmagnetic fraction was split. One split was hand ground to less than 0.015 mm in an agate mortar and analyzed with a six-step d.c.-arc semiquantitative emission spectrographic technique for 31 elements. The other split was used for mineralogic studies of individual grains with a conventional binocular microscope and X-ray emission spectrography with a scanning electron microscope (SEM). A complete listing of chemical analyses of heavy-mineral concentrates is shown in appendix B, table 20.

Mangrove Sediments

Mangrove sediment samples were collected by boat on the ocean side of mangrove swamps along the southeastern and eastern coast of Babelthuap Island from the Rois Malk study area to south of the village of Melekeok. The samples were collected by driving a 4-cm-diameter PVC pipe into bottom sediments during high tide. The core samples consisted of approximately 15 cm of organic-rich, fine-grained sediments and calcareous debris. The samples were dried in an oven at 80 °C, ashed in a furnace at 500 °C for 18–24 hours to remove the organic material, and sieved to less than 0.18 mm. This fraction was analyzed with a six-step d.c.-arc semiquantitative emission spectrographic technique for 31 elements and by atomic absorption spectroscopy for Au, Te, As, Zn, Cd, Bi, and Sb. Appendix D gives detailed description of mangrove sediment samples.

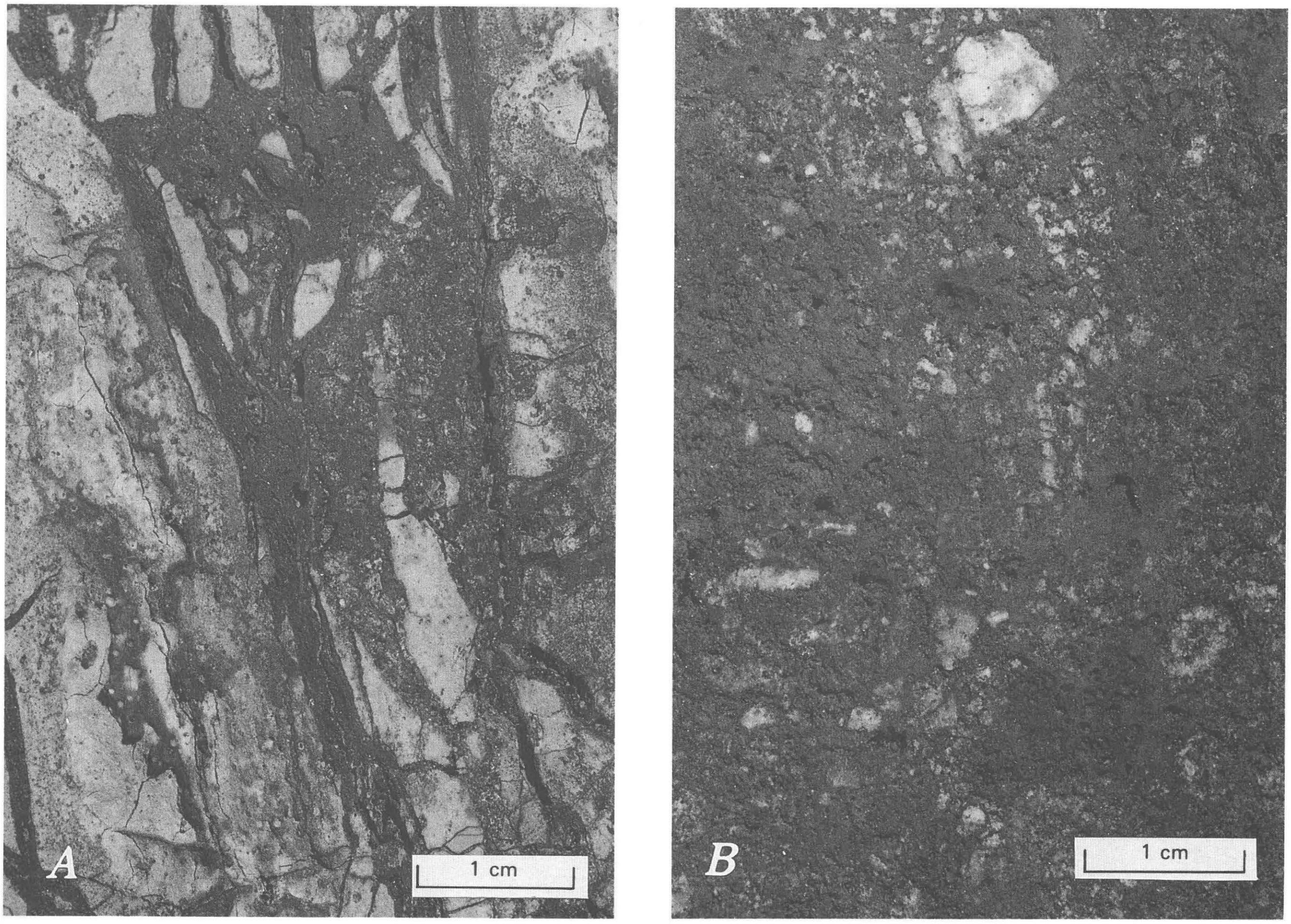


Figure 5. Matrix-supported breccias from brecciated area VB–2 showing iron oxide after sulfide. *A*, siliceous matrix; *B*, iron-oxide matrix.

All samples for chemical analyses by emission spectrography and atomic absorption spectroscopy were prepared and analyzed by the USGS laboratory in Denver, Colorado, under the supervision of J.B. McHugh, R.T. Hopkins, and R.M. O'Leary.

MINERAL SYSTEM

Veins and silicified and mineralized shear zones ranging in width from a few centimeters to several meters were mapped over an area 1.5 km by 1 km in the Rois Malk study area (pl. 1). The veins consist of quartz with varying amounts of sulfides or iron oxides after sulfides. Mineralized shear zones consist of brecciated rock cemented by quartz and iron oxides after sulfides and vary from clast-supported (fig. 4) to matrix-supported breccia (fig. 5). The veins display continuity along their strike length with some veins as much as 500 m in length.

The surface manifestations of the veins and mineralized shear zones generally are poor. The intense weathering with subsequent development of laterite, along with the presence of locally dense jungle vegetation, masks the outcrops. Three types of exposures of veins and shear zones can be seen: in areas of laterite cleared of vegetation, the veins and shear zones form subtle resistant ribs rising above the surface. Iron and manganese oxides are generally concentrated at the surface exposure of veins. These often look similar to manganese-iron oxide coatings and veinlets developed during laterite formation, but can be distinguished from them by the presence of quartz crystals often showing good comb textures. Exposures of the veins are best displayed on the walls of numerous fortification trenches made during World War II; finally, in the dense jungle, outcrops of veins and shear zones are scarce and restricted to occasional resistant outcrops of weathered quartz or silicified and iron- and manganese-encrusted

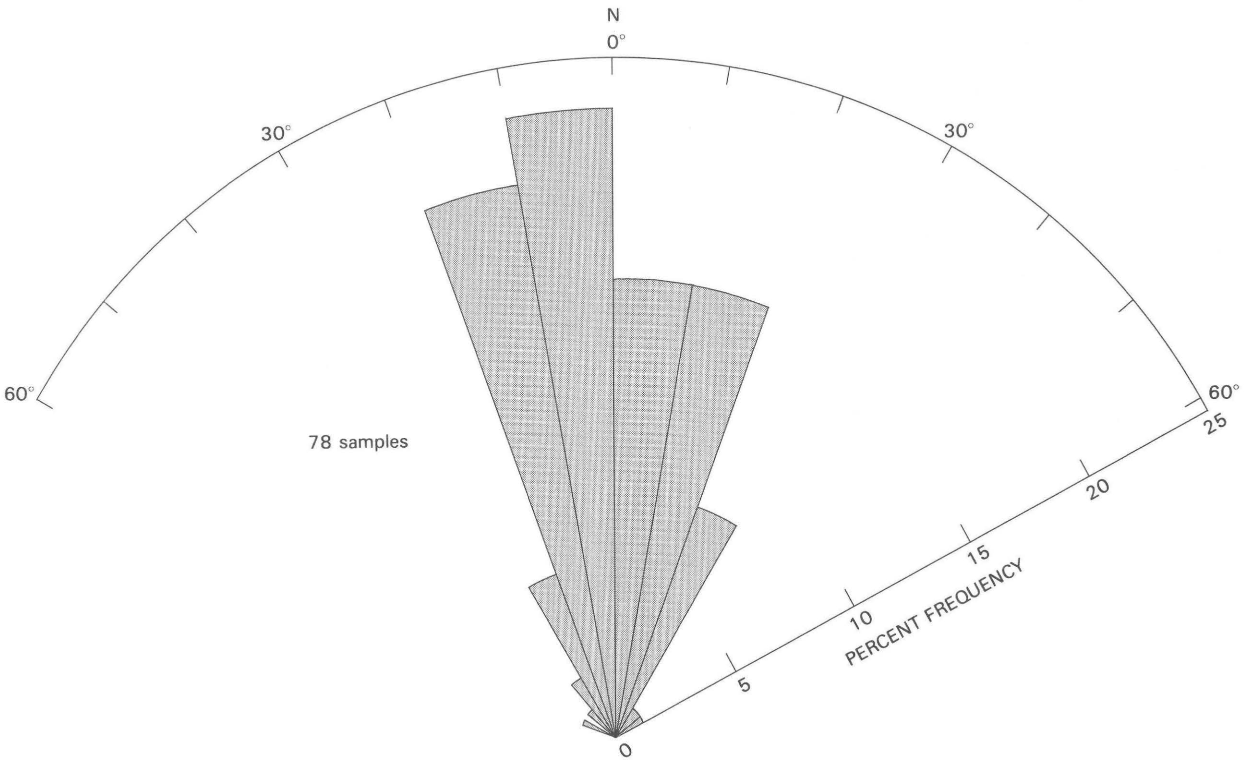


Figure 6. Frequency distribution of mineralized veins and shear zones in the Rois Malk study area.

breccias. The distribution of veins as shown on plate 1 likely only reflects a fraction of the total veins in the mineralized zone. Indications are that the vein system continues to the north and possibly west of the study area.

The veins have two preferred orientations, north-northwest and north-northeast, but display a continuum between the two preferred orientations. Vein and shear zone orientations are shown in figure 6. Veins of the two orientations are probably contemporaneous with similar textures and morphology. No crosscutting relationships could be documented, possibly because of poor exposure. Where veins of the two orientations intersect, the number of veins increases and spacing between individual veins decreases to locally form a stockwork of veins.

A frequency plot of veins containing high gold content, from 0.7 to 5.8 ppm, shows that veins and mineralized shear zones with high gold contents strike N. 20° E., N. to N. 10° W., and N. 30° to 35° W. (fig. 7). Although many veins and shear zones in the study area trend from N. to N. 20° E., only a few of these veins contain greater than 0.7 ppm gold. Highest gold content occurs in veins and shear zones trending N. 10° W. and N. 30° W.

Hydrothermal Alteration

Porphyritic basalts and basaltic andesites of the Babelthuap Formation have been subjected to a weak to moderately strong propylitic alteration. The basalts are partly altered to an assemblage of chlorite ± calcite ± epidote. In strongly propylitized samples, calcic plagioclase has been altered to a more sodic phase, generally albite. Laumontite is locally present and occurs both in the groundmass and vesicles within the basalt. Coarse-grained epidote with crystals up to several centimeters in length occurs only in quartz veins which cut the basalts. Chemical changes accompanying increasing degrees of propylitization include increase of MgO, CO_2, Ba, and Fe_2O_3 total (see samples JP 19, PR 33, PR 37 in table 1), and decrease in K_2O, CaO, and Sr.

Sericite is the main hydrothermal alteration mineral present in veins and mineralized shear zones, as well as in country rock adjacent to the veins, and occurs as fine-grained intergrowths with quartz and as coatings on fracture surfaces. The intense weathering in the mineralized area generally precludes identification of sericite in hand samples, but X-ray diffraction is effective in defining areas of sericite alteration. The basalts and basaltic andesites of the Babelthuap Formation have low

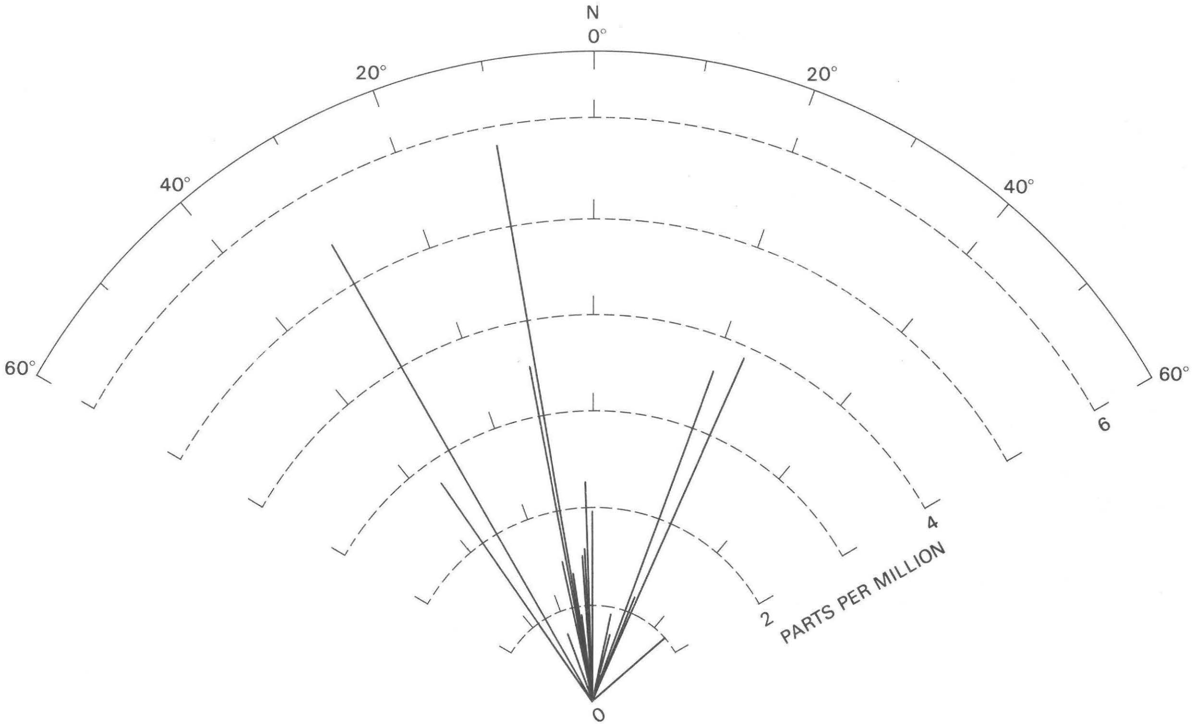


Figure 7. Frequency distribution of mineralized veins and shear zones with gold content from 0.7 to 5.8 ppm.

initial potassium content, from 0.32 to 0.47 percent (table 1). In mineralized samples containing sericite, K_2O content increases to as much as 2.9 percent. The potassium metasomatism is accompanied by increases in rubidium content of up to 50 ppm compared to 7 or less ppm in unaltered basalts. Geochemical analysis for rubidium proved to be effective in delineating the amount of sericite alteration in veins and adjacent country rocks. (See section, "Veins and Shear Zones.")

In intensely weathered samples which are also mineralized, sericite is destroyed and the alteration assemblage consists of kaolinite, gibbsite, ± dickite, and nacrite. Quartz is present in both weathered and unweathered hydrothermally altered samples. Whether all kaolinite is the result of weathering or whether some is part of the original hydrothermal alteration assemblage is not known. In highly weathered, mineralized samples, all major element cations (K_2O, Na_2O, CaO, MgO) are depleted and Fe_2O_3 (total) and Al_2O_3 are increased relative to less weathered, mineralized samples (table 1, PR 28–1 versus JP 20). Because of the mineralogic and chemical changes caused by weathering, it is not possible to delineate the original extent of potassic alteration associated with the hydrothermal event.

Veins and Shear Zones

VS–1 Vein

The VS–1 vein (pl. 1) has the longest strike length continuity, 500 m, of the veins mapped in the mineralized zone. It likely continues further to the north and south but is covered by dense jungle vegetation. The vein strikes N. 20°–30° E. and is generally steeply dipping, ranging from 80° SE. to 80° NW. Its width ranges from 0.3 to 2 m, and in trench P (fig. 8) the vein was observed to pinch and swell with depth, narrowing from 0.6 m at the surface to a few centimeters at 1 m depth, and then widening again with increasing depth. In trench H (fig. 9) two small (1- to 3-cm-wide) siliceous iron-oxide veins were exposed on either side of the VS–1 vein. Typically the VS–1 vein forms a resistant ridge in areas cleared of vegetation, rising several centimeters above the surrounding laterite. Massive quartz makes up the west side of the vein, and brecciated and sheared country rock cemented by varying amounts of quartz, manganese oxides, and iron oxides after sulfides forms the eastern part of the vein. In the oxidized parts of the vein, iron

Table 1. Major and minor element chemistry of the Babelthuap Formation

[Samples normalized and recalculated volatile free for major element oxides; <, less than. All major oxides in percent. All minor elements in ppm, except marked with * is in ppb (Au); leaders (--), not determined]

Description--	Fresh	Fresh	Weak propylitic	Weak propylitic	Strong propylitic	Weathered	Laterite-mineralized	Mineralized	Mineralized
Sample No.--	PT 106	PT 113	JP 19	PR 33	PR 37	PR 45	PR 28-1	PR 25	JP 20
SiO_2	54.0	51.2	52.4	53.3	50.8	52.6	47.4	63.9	55.96
Al_2O_3	20.2	18.3	16.4	16.7	17.5	19.2	30.5	20.9	13.37
Fe_2O_3T	7.66	9.44	8.78	8.7	9.8	9.6	19.2	13.6	26.74
MgO	4.45	7.33	8.2	7.3	10.7	9.6	.49	.39	.3
CaO	9.66	10.27	10.3	10.1	7.9	2.73	.11	.13	.02
Na_2O	2.70	2.3	2.6	2.9	2.4	3.0	<0.2	<.2	.09
K_2O	0.32	.37	.47	.05	.06	.05	<0.3	.03	2.93
TiO_2	0.63	0.54	.53	.64	.59	.72	1.01	.73	.59
H_2O+	--	--	3.52	3.81	5.37	7.04	.48	7.06	--
H_2O-	--	--	1.20	.75	.97	2.54	3.63	1.55	--
CO_2	--	--	.43	.35	4.4	.55	.90	1.0	--
Cl	--	--	20	50	150	80	140	100	--
F	--	--	100	200	200	<100	<100	<100	--
Ba	41	48	19	51	138	314	49	52	347
Co	20	50	70	30	34	36	220	60	<5
Cr	62	124	406	348	518	682	1,028	940	747
Cu	88	94	76	57	3	48	219	1,876	157
Ni	34	84	138	121	190	248	729	432	17
Rb	<5	<5	<5	4	7	1	0	2	33
Sc	30	30	50	--	--	--	--	--	100
Sr	210	181	232	228	90	172	17	18	14
V	200	200	300	--	--	--	--	--	300
Y	13	16	15	15	11	22	5	3	7
Zn	69	84	68	77	139	587	203	281	38
Zr	46	40	39	33	19	24	20	15	49
Hg	--	--	.07	.06	.07	1.9	1.8	.58	--
Au*	21	4	2	80	8	90	4	--	300
Te	.08	.08	<.02	--	--	--	--	--	6.8
P_2O_5	.06	.06	.04	.06	.04	.02	.04	.02	.024
MnO_2	.14	.17	.18	.16	.25	.09	1.2	.32	0

oxide pseudomorphs after pyrite and sphalerite are present. In the unoxidized parts of the vein, pyrite up to 1 mm in diameter and sphalerite up to 3 mm in diameter are distributed throughout the vein.

Gold concentrations along the strike of the vein vary considerably, from 0.08 to 3.9 ppm (0.0023–0.12 oz per ton); the central part of the vein contains the higher values. The highest Au content is from a 2-m channel sample (PT 117) containing 3.9 ppm Au. Copper and Zn concentrations range from 0.015 to 0.5 percent and 0.003 to 1.0 percent, respectively, and are typically low in the oxidized parts of the vein and high where sulfides are still present. Lead (<50 ppm) and Ag (≤3 ppm) contents are low throughout the vein. The range in Te content is relatively restricted ranging from 0.4 to 6.9 ppm; the Te:Au ratios range from 69 to 1.25, with the lowest ratios occurring in the central part of the vein.

The country rock is locally silicified to 0.5 m on either side of the vein as in trench H (fig. 9). Channel samples of country rock away from the vein contain low Au content, ranging from 0.001 to 0.006 ppm, and very low Te content of <20 to 20 ppb. In trench P (fig. 8), country rock adjacent to the vein on the east side also contained low Au (0.003 ppm) and Te (1.15 ppm) contents. However, the westernmost sample in the trench, PM 271, which includes moderate to intense stockwork veining, contained 0.014 ppm Au and 0.56 ppm Te. The easternmost sample, PM 276, contained elevated Zn, Y, and B but no veining was observed.

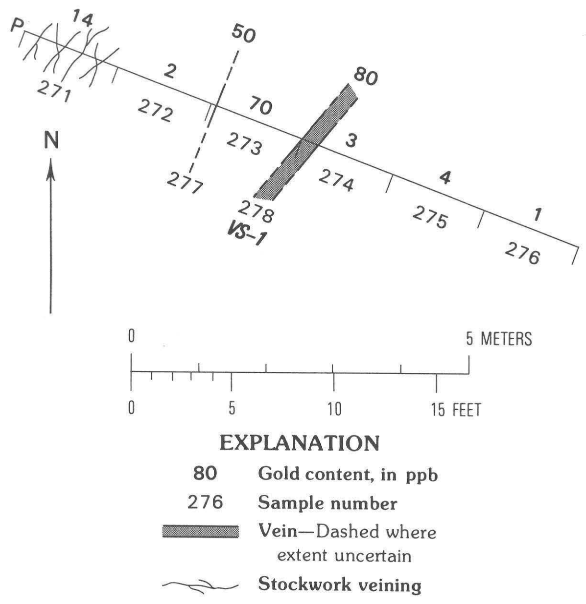


Figure 8. Plan view of backhoe trench P showing veins and gold content. Sample numbers have PM prefix. Gold content of samples determined by atomic absorption.

VR–1 and 2 Veins

The VR–1 vein (pl. 1) is one of the westernmost veins mapped in the mineralized zone. It strikes from N. 13° E. to N. 13° W. and has a strike length of 400 m before dense vegetation obscures its north and south ends. It generally has a high-angle dip along its length, dipping 74° E. in its northernmost extent in trench Q (pl. 1) and 85° to the east in the central part exposed in trench I (pl. 1). The vein varies in width from 0.3 to 1.4 m and consists of sheared and brecciated country rock cemented by varying amounts of quartz, iron (up to 10 percent), and minor manganese oxides (up to 0.20 percent). No remnant sulfides are presently found in the vein. Secondary copper minerals are locally present in the more silicified parts of the vein. The surficial expression of the vein is marked by a ridge which extends above the surrounding laterite for up to 0.3 m. Near trench I (pl. 1), the VR–1 vein is a single vein at the surface, but at depth within the trench, VR–1 consists of three silicified zones separated by sheared and brecciated country rock with abundant iron and manganese oxides (fig. 10). VR–2, a vein which splays off from vein VR–1 near the southern part of the vein where trench I is located, varies in width from 0.3 to 0.5 m. Vein VR–2 strikes N. 15° W. and consists of a silicified zone within sheared and brecciated country rock. Like VR–1, it forms a resistant ridge above the surrounding laterite.

Several right lateral faults offset vein VR–1; their individual displacements range from 2 to 5 m. Total offset along the length of the vein is about 35 m. The faults are high angle and generally strike N. 65° E. Vertical displacement likely has accompanied lateral movement, but poor exposure precludes documenting this. The faults are not altered or mineralized, and they are considered to be postmineralization in age.

Gold concentrations of channel samples across vein VR–1 range from 0.47 to 3.3 ppm (0.014–0.1 oz per ton) with the highest value occurring in a 0.3-m channel sample (PT 130 B) in the central part of the vein (pl. 1). Gold contents are highest in the more silicified part of the vein as compared to parts of the vein consisting of sheared and brecciated country rock cemented by iron and manganese oxides. In trench I (fig. 10), exposures of the vein along part of the trench wall consist of three silicified zones containing 0.021, 0.72, and 0.91 ppm Au separated by sheared country rock. The country rocks between the vein exposures are intensely weathered, and a channel sample across the 1.2-m total exposure zone (fig. 10) contained 0.47 ppm Au and 1.17 ppm Te. Channel samples of the country rock exposed in other parts of the trench have very low Au contents, ranging from 0.001 to 0.006 ppm. Adjacent to vein VR–1, Au contents increase to 0.012–0.017 ppm. Tellurium content increases to 0.57 ppm as compared to less than 0.02 to 0.3 ppm in country rock away from the vein. No other elements are present in anomalous concentrations in the country rock.

In the vein, Ag content is locally high, 20 ppm, along the northern part of the vein, and Te content is high along the length of the vein, ranging from 1.7 to 10.4 ppm; the Te:Au ratio ranges from 0.85 to 15.6. Base-metal content is generally low: Pb ranges from 15 to 700 ppm; Cu, 115–3,000 ppm; and Zn, 1–300 ppm. Boron content is anomalously high along the entire length of the vein, at 10–50 ppm, which is the highest B content measured in veins within the study area. Arsenic and rubidium contents are consistently anomalous, with ranges of 5–50 ppm and 10–35 ppm, respectively.

The VR–1 vein is characterized by high gold, arsenic, and boron contents and low barium, zinc, and cadmium contents. Anomalous contents of rubidium indicate introduction of potassium during the alteration process. Because the vein is exposed at nearly the same elevation along its strike, variation in the gold content may indicate the magnitude of lateral variation in gold content to be expected in the vein.

The VR–2 vein (pl. 1), which splays off the VR–1 vein, has lower Au concentrations, 0.06–0.07 ppm, but similarly high contents of B and As and low contents of Ba, Zn, and Cd contents as the VR–1 vein. Tellurium content is similar to that of vein VR–1, but Te:Au ratios are considerably higher in VR–2 because of the low Au content in the vein.

A comparison of surface channel samples of vein

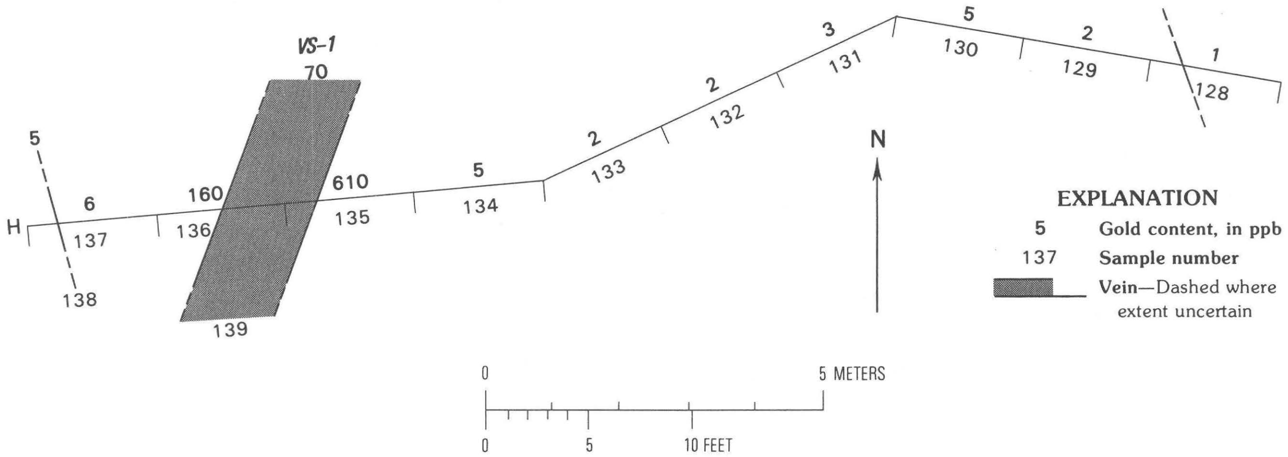


Figure 9. Plan view of backhoe trench H showing veins and gold content. Sample numbers have PA prefix. Gold content of samples determined by atomic absorption.

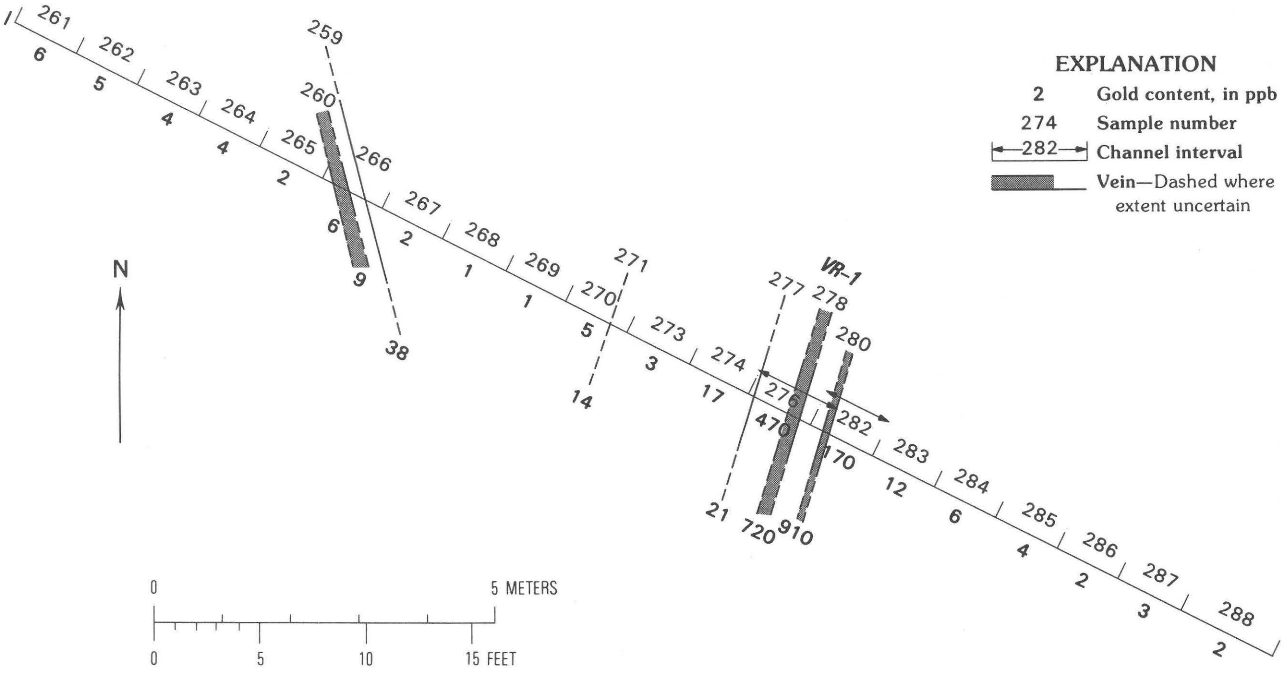


Figure 10. Plan view of backhoe trench I showing veins and gold content. Sample numbers have PT prefix. Gold content of samples determined by atomic absorption.

VR–1 to the sample taken in trench Q (also on VR–1, fig. 11) provides a basis for evaluating the gold content of VR–1 as a function of depth. Surface channel samples of the vein taken adjacent to the area of trench Q contained 0.66 and 0.5 ppm gold as compared to 1.45 ppm in the vein at a depth of 1.5 m. The apparent increase in gold content with depth suggests that gold may be depleted in surface samples because of weathering processes. However, the decrease could also be explained by initial variation in gold content of the vein. Further sampling is necessary to document the effect of weathering on gold content.

VT Veins

A group of 14 veins and mineralized shear zones exposed over a 58-m-wide zone comprise the VT veins (pl. 1). The veins are well exposed in five, 1–2-m-deep trenches which trend perpendicular to the veins (fig. 12). These trenches were originally constructed by the Japanese in the early 1940's as part of the defense fortification of the Rois Malk area. Excellent exposures of the mineralized zones and country rock are revealed on the trench walls after clearing of vegetation and slope wash. Between the trenches the veins are poorly exposed on the

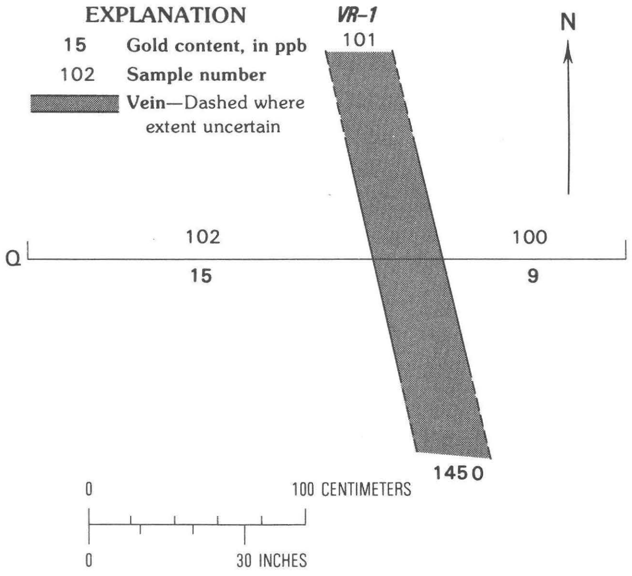


Figure 11. Plan view of backhoe trench Q showing veins and gold content. Sample numbers have JR prefix. Gold content of samples determined by atomic absorption.

surface, and only a few veins could be projected along the strike length of the veins. The discontinuous nature of the veins suggests that the veins represent high-level branching in a vein system that likely coalesces at depth.

The veins and mineralized shear zones range in width from a few centimeters to 0.76 m, strike northerly, and dip at a high angle. (See appendix A for detailed descriptions.) The veins consist of massive quartz typically displaying a comb texture. The mineralized shear zones contain less quartz and are cemented by iron and manganese oxides. A boxwork texture of iron oxides after sulfides is preserved in the more silicified parts of the shear zones and more massive parts of the quartz veins.

High gold and tellurium contents are generally restricted to the veins and shear zones with Au ranging from 0.005 to 0.96 ppm and Te from 0.35 to 8.3 ppm. In comparison to the entire study area, the concentrations of Zn, Cr, V, Cu, and Co in the VT veins are generally high.

The vein with highest Au content, 0.96 ppm, occurs at the east end of trench A. It is 0.76 m wide and consists of a shear zone containing massive quartz. Vugs up to 3 cm wide are common in the vein and are lined with well-formed quartz crystals. Boxwork texture of iron oxides after sulfides occurs in the more massive parts of the vein. Base-metal contents are high; the low Ag content (3 ppm) likely reflects leaching during weathering and oxidation. Although the vein cannot be traced along the surface, it probably extends to the south to the locality of sample PT 110 (pl. 1). The vein at this latter location consists of massive silica; it strikes N. 10° W., as does the vein of sample PT 228, and contains 1.32 ppm Au and 4.88 ppm Te. Both veins (sample localities PT 228 and PT 110) contain anomalous Rb (53 and 23 ppm, respectively), and country rock adjacent to them also contains anomalous Rb.

The country rock between the veins and mineralized shear zones generally has low gold content, less than 0.010 ppm. However, in a few areas the gold content of the host rocks is anomalously high. In the central part of trench D, the host rocks between the veins contain from 0.021 to 0.09 ppm Au, 1.2 to 4.2 ppm Te, and 0.07 to 0.2 percent Cu. A more restricted area of country rock within trenches A, B, and C contains anomalously high Au, up to 0.30 ppm, and up to 0.15 percent Cu. The anomalous trace-metal contents of the country rocks suggest that mineralization has spread out into the country rocks from the veins, but it is also possible that weathering has redistributed copper into the country rocks. Further work in this zone is warranted to test whether mineralization has spread into the country rock at depth, where weathering and oxidation are less intense.

Although good exposures are present in the trenches, potassic alteration minerals associated with the veins and shear zones were not visible probably because of intense weathering. X-ray diffraction indicated that sericite is locally present and was probably more abundant prior to weathering. Anomalous contents of Rb in the veins and shear zones, up to 53 ppm, as well as in host rocks adjacent to the veins, up to 40 ppm, indicate that potassium metasomatism occurred in and adjacent to the veins.

VA Veins

The VA veins (pl. 1) are a group of closely spaced veins which are best exposed along the Japanese road in the southern part of the study area. The veins range in width from 1 cm to more than a meter, trend northeast to northwest, and dip nearly vertically. The intensity of veining is greatest and is well exposed along the road, but the intensity decreases southward of the road, where the veins narrow to silicified fracture zones. The silicified fractures contain only low gold values. These fractures are covered by jungle but appear to be pinching out southward.

Along trend, veins may narrow, swell, or bifurcate. Some of the veins contain comb quartz and open-space cavities usually lined with quartz crystals (fig. 13). These veins generally contain the highest Au, Ag, and Te values.

Zones of silicification or iron oxides after sulfides are common both within veins and within country rock adjacent to veins. Mineralized brecciated zones cemented with silica or iron oxides after sulfides also occur.

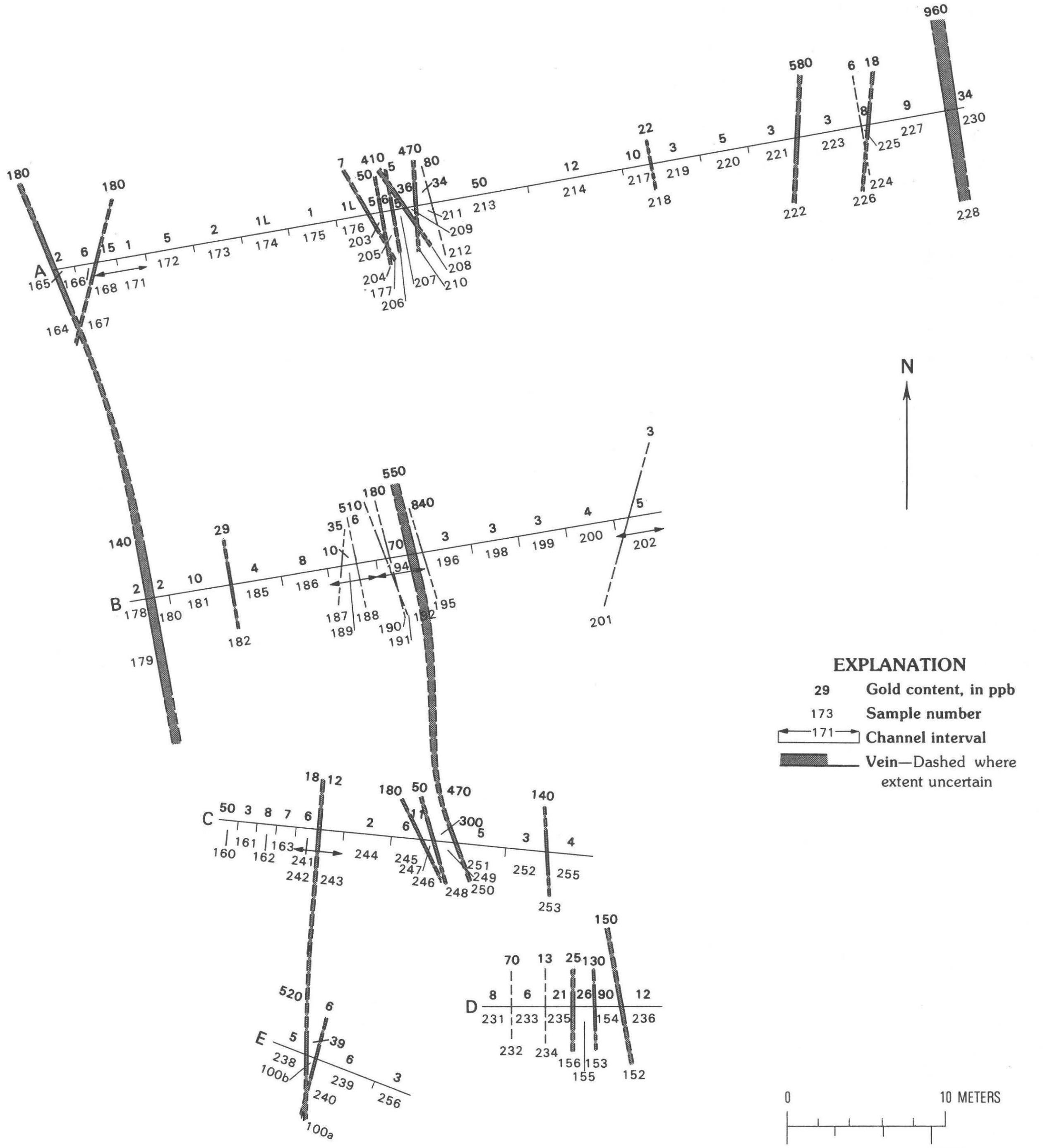


Figure 12. Plan view of fortification trenches A, B, C, D, and E showing veins, shear zones, and gold content. Sample numbers have a PT prefix. Gold content of samples determined by atomic absorption.

Between some of the veins exposed in road cuts, moderate stockwork veining was observed. Gold values are highest in the veins and decrease in the stockwork veining and lateritic country rock. Tellurium values are generally high in the veins, and are locally high in the stockwork veining and country rocks adjacent to the veins. Channel samples taken from road cut O (pl. 1; fig. 14), which included stockwork veining, contain from 0.005 to 0.16 ppm Au and 0.48 to 6.26 ppm Te.

Channel samples were collected from trench N, a 1.5-m-deep Japanese fortification trench (fig. 15), which intersects a 50-cm VA vein (pl. 1). The vein consists of

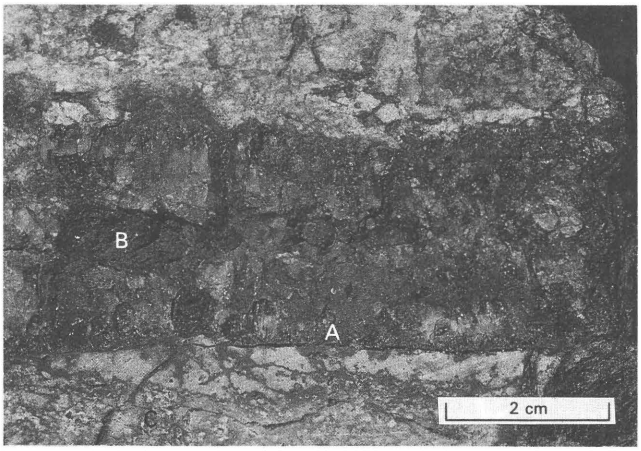


Figure 13. Vein sample (PM 225) with comb quartz (A) bordering an iron oxide after sulfide core (B). The vein is within lateritic country rock (C).

massive rose-colored comb quartz, open-space cavities, and iron oxide after sulfides. Pyrite and arsenopyrite are present in the less oxidized parts of the vein. PM 267, a channel sample collected across the vein, contained 0.22 ppm Au, 5.7 ppm Te, and 2,000 ppm Cr. Samples collected across the laterite with numerous quartz and iron-oxide stringers on either side of the vein contained 0.017–0.028 ppm Au, and 4.15–4.4 ppm Te. Channel samples of the country rock away from the vein and stringers were low in Au (<0.001–0.003 ppm), Mn (30–50 ppm), Co (<5 ppm), Ni (7–20 ppm), and Zn (<5–10 ppm), whereas Te was still high (0.63–3.28 ppm).

Road cuts G, K, L, M, and O (pl. 1) are located along the Japanese road which intersects many of the VA veins. In road cut G (fig. 16) no veins or mineralized shear zones were exposed, although a few small (less than 1-cm-wide) iron-oxide stringers were present. Channel samples across the road cut contained Au (0.001–0.002 ppm), Te (0.03–0.23 ppm), Mn (700–3,000 ppm), Cr (300–2,000 ppm), and Zn (100–160 ppm).

Road cut K (fig. 16) intersects no mineralized veins or iron-oxide stringers although several small unmineralized quartz-epidote fracture fillings were exposed across the the road cut. Calcium (2–5 percent), Mg (1.5–2 percent), Sr (300 ppm), and Y (15–20 ppm) values were higher across this road cut than in any of the other trenches or road cuts sampled, whereas Au (<0.001–0.002 ppm) and Te (20 ppm) were low. The chemistry from road cut K indicates a different rock type than the Babelthuap Formation which underlies much of the Rois Malk area. Road cut K cuts through a small ridge which may represent a dike. Rock sample PM 132 taken 10 m north of road cut K along this ridge was a relatively unweathered andesitic-dacite porphyry, and is probably the same rock type as that in road cut K but which now is laterite.

Road cut L intersects a 60-cm-wide quartz vein and several smaller siliceous veins and iron-oxide stringers (fig. 17). The vein trends north to east and forms a low ridge for 125 m. The vein is predominantly massive quartz with some sulfides and iron oxide after sulfides; it contains open-space cavities lined with comb quartz. A 10-cm-wide zone containing iron oxides after sulfides is present on both sides of the vein. Channel samples away from the vein contained <0.001–0.004 ppm Au and 0.020-0.95 ppm Te. A channel sample (PM 152) across the vein contained 0.2 ppm Au, 4.98 ppm Te, 0.7 ppm Ag, 200 ppm Ba, 130 ppm Zn, and 50 ppm Pb. Vein sample PA 113 collected from the northern end of this vein, 50 m from the road cut (pl. 1), contained 5.8 ppm Au, 1 ppm Ag, 7.7 ppm Te, 150 ppm Pb, 170 ppm Zn, 20 ppm Mo, 10 ppm As, and 3 ppm Bi.

Road cut M (fig. 17) intersects six 1- to 10-cm-wide veins varying from narrow iron-oxide stringers to quartz with iron oxide after sulfide cores. Samples from these veins contained 0.016–1.47 ppm Au, <0.5–10 ppm Ag, 0.87-13 ppm Te, 220–240 ppm Zn, 0.1–11 ppm Cd, 100–1,000 ppm Cu, 15–1,500 ppm Co, 300–>5,000 ppm Mn, and <20–500 ppm Ba.

Road cut O intersects several veins and areas of stockwork veining (fig. 14). The road cut exposure is more intensely veined than other road cuts in the southern portion of the Rois Malk area. The veins trend north-south and are steeply dipping to the east. Open-space cavities, comb quartz, and abundant pyrite are usually present in the veins. Generally the country rock adjacent to the veins contains abundant limonite and hematite after sulfides with small (less than 1-cm-wide) quartz stringers. These veins contain 0.006–0.99 ppm Au, <5–5 ppm Ag, 4.72–9.6 ppm Te, 50–700 ppm Cu, and 5–140 ppm Zn. In addition, sample PM 225 contained 170 ppm As and 190 ppm Sb.

Brecciated Areas

VB–1, 2, and 3 Brecciated Areas

Brecciated areas occur along silicified shear and fracture zones, veins, and as isolated pods. Many of these areas exhibit multiple stages of brecciation. That some of these areas contain breccia clasts of propylitized basalt suggests that the brecciation postdates the propylitization of the basalt, which probably occurred regionally during a late stage of volcanic activity.

Breccia area VB–1 (pl. 1) is located approximately 60 m east of the southern end of vein VS–1. This 30×100-m zone crops out as a ridge along a north-south-trending linear shear or fracture zone. Several 0.5- to 2-m-wide veins border or are included in this breccia

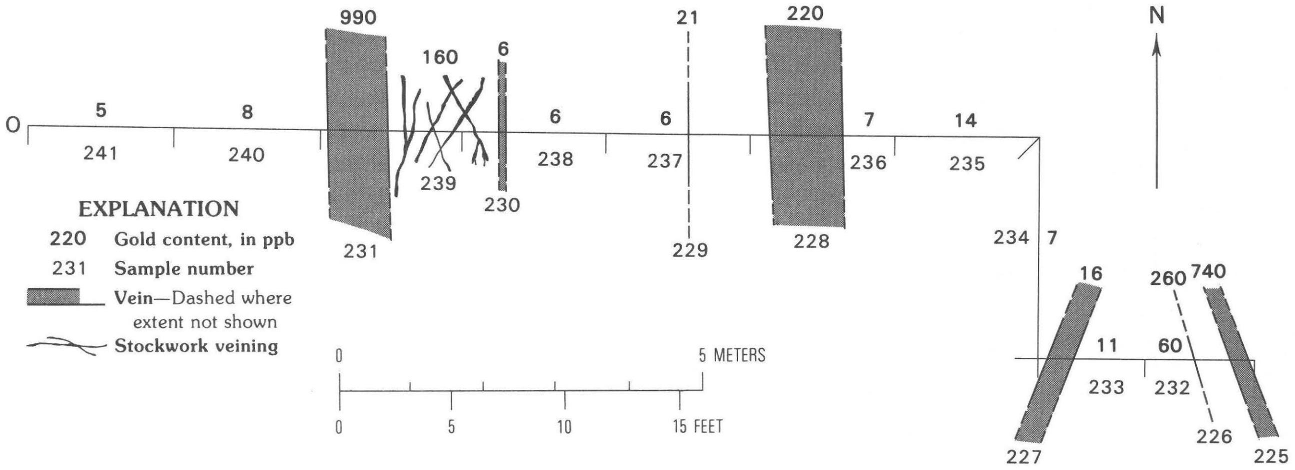


Figure 14. Plan view of road cut O showing veins and gold content. Sample numbers have PM prefix. Gold content of samples determined by atomic absorption.

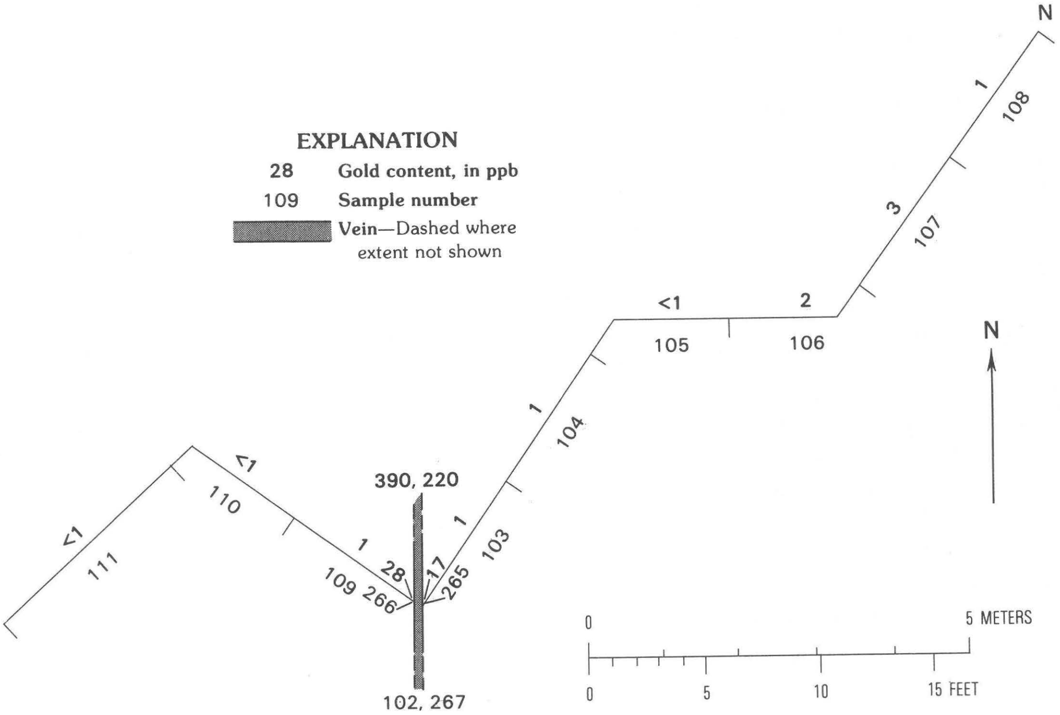


Figure 15. Plan view of fortification trench N showing veins and gold content. Sample numbers have PM prefix. Gold content of samples determined by atomic absorption.

zone. The breccia clasts are generally small (1 mm to 1 cm), with the breccias being both clast and matrix supported. Iron oxide after sulfides is common. Pyrite and arsenopyrite are present in the less weathered samples. Samples from VB–1 contain as much as 1.58 ppm Au, 150 ppm As, and 20 ppm Mo. Contents of Mn, Co, and Ni from this area are low.

VB–2 is a 30×40–m brecciated area located approximately 200 m east of VB–1 (pl. 1). VB–2 exhibits multiple stages of brecciation and contains both rounded and angular fragments (1 to 10 cm in size). The breccias are both clast and matrix supported. SEM techniques revealed native Ag in sample PM 216 (fig. 4*A*), within a clast of possible andesitic dacite that had been silicified and mineralized prior to brecciation. The surrounding quartz is not mineralized. Within the brecciated area,

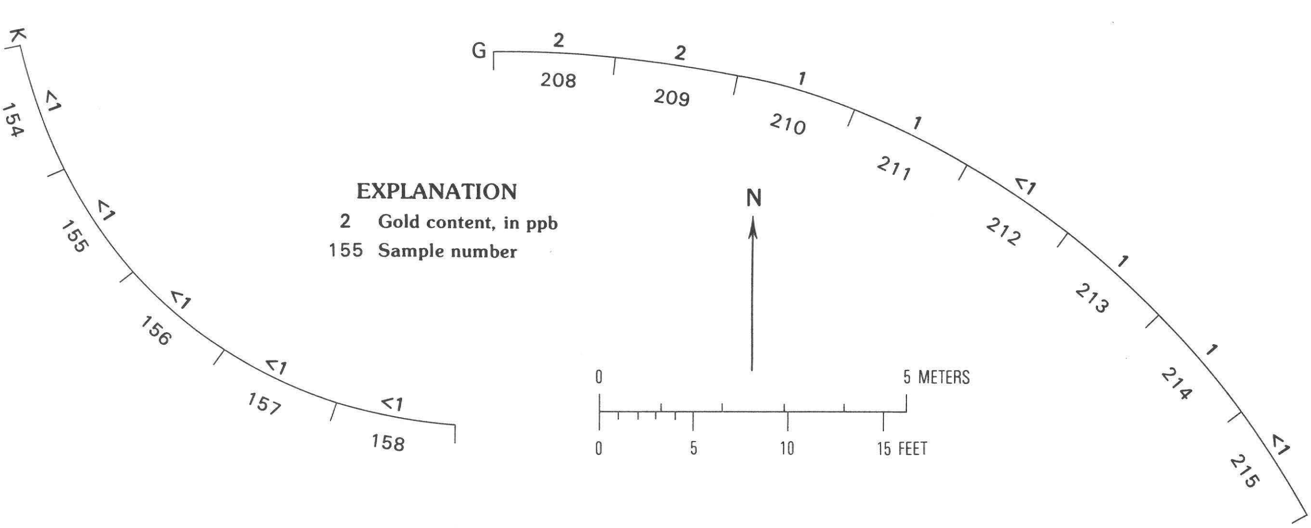


Figure 16. Plan views of road cuts G and K showing gold content. Sample numbers have PM prefix. Gold content of samples determined by atomic absorption. See plate 1 for map relation between road cuts.

clasts from all stages of brecciation contain abundant pyrite. Much of the breccia is cemented by quartz or iron oxides after sulfides, in some places with boxwork textures (fig. 18). Open-space cavities and comb quartz are present in some places. Samples from VB–2 contained as much as 0.18 ppm Au, 1.5 ppm Ag, 6.22 ppm Te, 1,000 ppm Cu, 150 ppm Pb, 4 ppm Bi, and 20 ppm As.

VB–3 is a 4×20–m brecciated area located approximately 100 m north of VB–2 (pl. 1). VB–3 crops out as a widening of a vein and exhibits multiple stages of brecciation. All clasts contain pyrite. Open-space cavities lined with comb quartz are also present. Sample PM 135 consists of quartz and intensely altered basalt cemented by silica and iron oxides after sulfides (fig. 4*B*). This sample contains 1.05 ppm Au, 0.5 ppm Ag, and 15.6 ppm Te.

These brecciated areas contain low to moderate precious- and base-metal values at the surface, but the possibility exists for more significant mineralization at depth below the zone of weathering.

GEOCHEMISTRY OF THE VEIN SYSTEM

Samples of vein material were collected in order to determine the economic significance of veins in terms of precious- and base-metal contents and to determine the geochemical signatures or suites of elements associated with the veins.

Generation of Statistics and Maps

Statistical parameters and computer-generated point-plot maps showing distribution of elements for the vein samples were prepared using the computer mapping program within the USGS–STATPAC system (Van Trump and Miesch, 1977). For the map plots approximately 20 percent of the samples are considered anomalous and divided into four classes at approximately the 97.5th, 95th, 90th, and 80th percentile. An additional class was added at the 60th percentile in order to show samples with elevated values. The use of the five percentiles has the advantage of approximately doubling the number of samples of each class beginning from most anomalous to least anomalous. Occasionally because a high percentage of samples fall in only a few intervals for an element, an anomalous class may be missing. Also because of the high background concentrations for gold and tellurium in veins within the study area, the ranges for the lower anomalous intervals of these elements are decreased.

The results of the chemical analyses of 151 samples of vein material are summarized on table 2. The complete set of chemical data is shown in appendix B. The distributions of selected elements are shown on plates 2 and 3 and are discussed below.

Epithermal Suite (Au, Ag, Te, Bi, As, and Hg)

In epithermal precious-metal deposits, Au is commonly associated with Ag, As, Sb, Hg, Se, and Te (Tooker, 1985). In veins at Rois Malk, Au is positively correlated (in order of importance) with Mo, Te, Bi, Pb, Ag, Cu, Zn, and As (table 3). This suite of elements is indicative of epithermal precious-metal mineralization.

Gold values in veins at Rois Malk range from 0.005 to 13 ppm with a geometric mean of 0.16 ppm (table 2). Gold is usually immobile in the weathering environment;

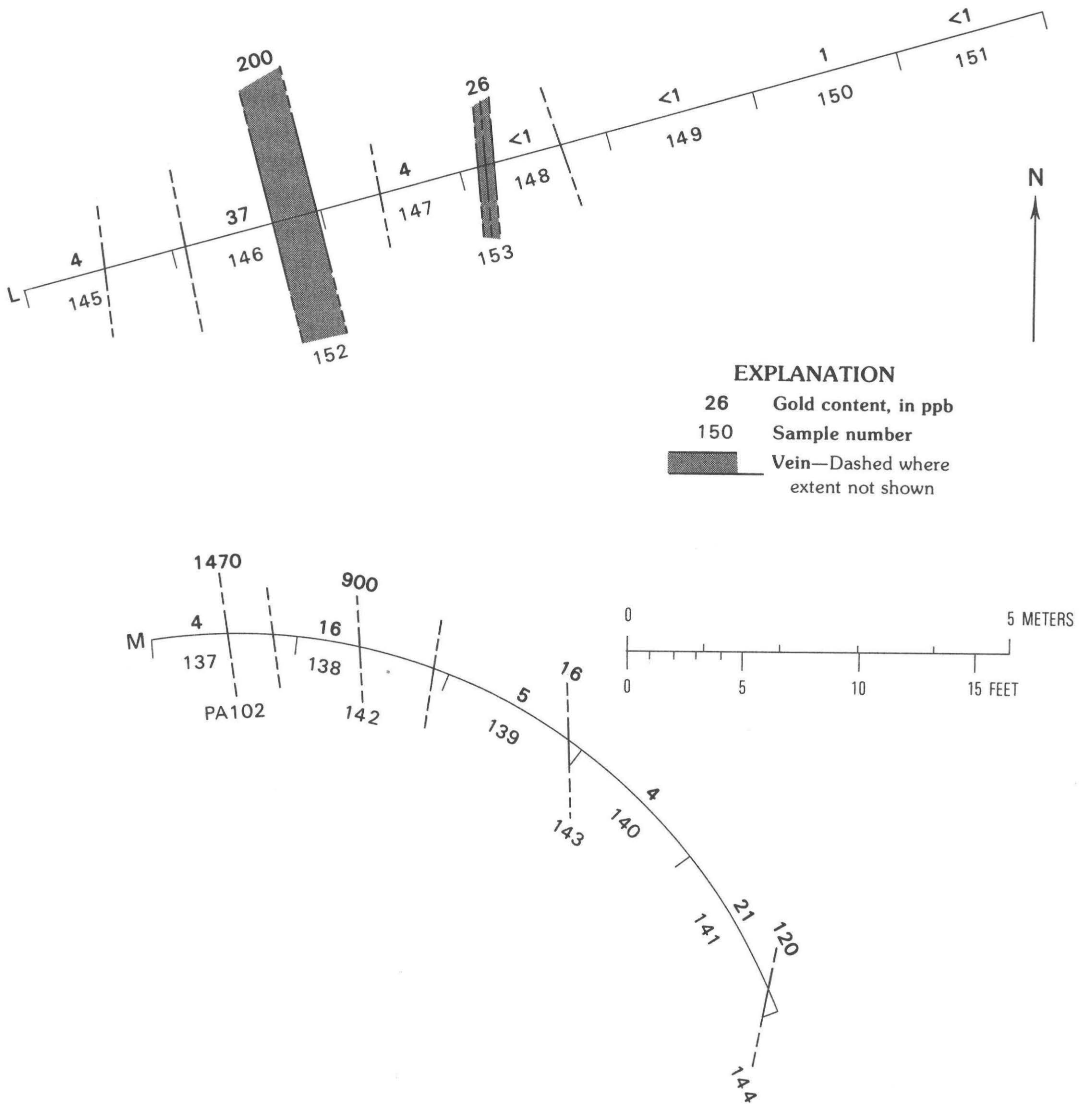


Figure 17. Plan views of road cuts L and M showing veins and gold content. Sample numbers have PM prefix. Gold content of samples determined by atomic absorption. See plate 1 for map relation between road cuts.

therefore these values probably reflect primary values of the veins. Anomalous gold values occur in veins throughout the study area and indicate the large size of the area of mineralization (pl. 2). The highest gold values are in veins containing open-space cavities lined with comb quartz. The highest concentration occurs in the extreme northeastern part of the study area. Based on SEM study, the gold is often fine grained (1 to 20 micrometers) and occurs as native gold, electrum (fig. 19), and tellurides (fig. 20). Although veins exposed near the top of the hill called Rois Malk are about 100 m higher than along the coast, there seems to be no correlation of gold content with depth in system. The highest gold content is from a vein along the coast, but other veins higher in the system also contain high gold contents. The values of gold in veins decrease significantly in the extreme southeastern part of the system where the veins pinch out into fractures. The system may extend to the west and particularly to the north of the study area where anomalous values of gold in veins are still present.

Silver values in veins at Rois Malk range from less than 0.5 to 30 ppm with a geometric mean of 0.67 ppm (table 2). Anomalous concentrations of silver in veins occur throughout the study area, particularly in the central and eastern parts and north of the VT veins (pl. 1). Argentite occurring on pyrite and native silver was detected by SEM techniques (fig. 21). Silver is moderately mobile in the weathering environment and forms cerargyrite, AgCl. Silver at Rois Malk has been

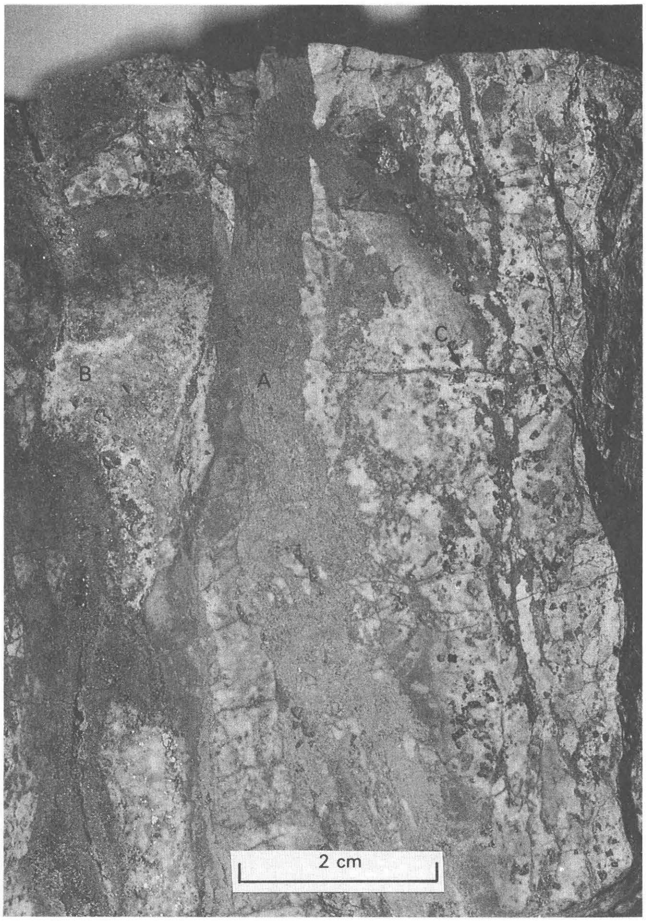


Figure 18. Photograph of breccia sample from the VB–2 brecciated area showing Fe-oxide after sulfide (A), pyrite-rich clasts (B), and pyrite clasts (C).

Table 2. Summary of chemical data for 151 vein samples, Rois Malk area, Palau

[All values in ppm except where noted; leaders (--), insufficient data for calculation]

Element	Valid analyses	Minimum	Maximum	Geometric mean
Emission spectrographic analysis				
Fe (pct.)	151	1.5	20	7.27
Mg (pct.)	144	<.02	1.5	0.084
Ca (pct.)	16	<.05	0.7	--
Ti (pct.)	151	.01	0.5	0.13
Mn	141	20	>5,000	299
Ag	61	<0.5	30	0.67
B	63	<10	50	8.07
Ba	70	<20	1,000	27.9
Co	104	<5	2,000	16.2
Cr	151	20	3,000	358
Cu	151	30	5,000	411
Mo	31	<5	100	--
Ni	144	<5	500	32.0
Pb	125	<10	700	24.0
Sc	148	<5	>100	31.7
V	151	20	1,000	189
Y	32	<10	30	--
Zr	120	<10	30	13.3
Atomic absorption analyses				
As	76	<10	300	11.4
Zn	148	<5	[1]>2,000	79.8
Cd	71	<0.1	>100	0.16
Bi	67	<1	25	0.93
Sb	6	<2	190	--
Au	151	0.005	13	0.16
Te	151	0.020	18.6	3.19

[1] Maximum value of >10,000 ppm was obtained by a separate emission spectrographic analysis.

mobilized and partially lost from the veins, although some has been reprecipitated as AgCl and AgI. Cerargyrite and iodargyrite occurring as coatings on pyrite were detected by SEM techniques in several of the vein samples (figs. 22 and 23) and are thought to be secondary. Silver can also be associated with manganese and iron oxides, but this does not appear to be common at Rois Malk.

Tellurium values in veins at Rois Malk range from 0.02 to 18.6 ppm with a geometric mean of 3.19 ppm (table 2). The highest values for Te in veins generally occur in the eastern half of the study area where Te correlates with Au (pl. 2). In the western part of the study area Te content of veins is lower. Tellurium in veins at Rois Malk is correlated (in order of importance) with Bi, Au, Ag, Cu, and Cr (table 3). These elements except for Cr are generally associated with epithermal precious-metal deposits. The presence of a gold-silver telluride (fig. 20) explains the correlation of Au with Ag and Te. The mobility of Te in the weathering environment is considered to be low (Wedepohl, 1969–78), so Te values in veins probably reflect original contents. The elevation shown in table 3 approximates the level of the system; the higher the elevation, the higher in the system. Tellurium contents in veins tend to decrease toward the coast (pl. 2), suggesting lower Te values lower in the system (table 3).

Bismuth values in veins at Rois Malk range from less than 1 to 25 ppm with a geometric mean of 0.93 ppm (table 2). These values are low compared to Bi values associated with many epithermal precious-metal deposits found in the Western United States, but bismuth in veins from Rois Malk is correlated with gold and tellurium. Anomalous values for bismuth in veins occur throughout the study area, but the highest values occur in the southern part of the study area associated with the VA veins (pl. 2). In the extreme southeastern part of the study area, veins pinch out to fractures with resulting decrease in bismuth content. Bismuth content of veins also decreases in the extreme eastern part of the study area.

Arsenic values in veins at Rois Malk range from less than 10 to 300 ppm with a geometric mean of 11.4 ppm (table 2). These values are not high compared to epithermal deposits found in the Western United States (Tooker, 1985) and at Lihir Island, Papua New Guinea, where As values can reach more than 1,000 ppm (P. Morrissey, oral commun., 1986). Even so, arsenic in veins at Rois Malk is correlated with gold and therefore related to the gold mineralization. In addition considerable arsenic may have been lost from the veins in the intense weathering environment.

Anomalous values of As in veins occur throughout the study area, particularly the VB–1 brecciated area and along the VS–1 vein (pls. 1, 2). Anomalous values of As in veins also occur in the northern and western parts of the study area.

Thallium and mercury concentrations were determined for 24 samples selected from vein samples with a range in gold contents and depths in the system. The results are summarized in table 4. Thallium and mercury concentrations of veins from the Rois Malk area are low compared to epithermal precious-metal deposits in the Western United States (Silberman and Berger, 1985), but thallium is correlated with gold. Mercury does not correlate with gold possibly because the original mercury content of surface veins at Rois Malk has been lost due to the later intense chemical weathering.

Base-Metal Suite (Cu, Pb, Zn, Cd, and Mo)

The chalcophile elements Cu, Pb, Zn, Cd, and Mo are often associated with epithermal deposits. At Rois Malk this suite of elements is present in veins at wide ranges of concentrations.

Copper values in veins at Rois Malk range from 30 to 5,000 ppm with a geometric mean of 411 ppm (table 2). The elevated geometric mean indicates the abundance of Cu in the vein system. Of the base metals, Cu content of veins at Rois Malk is the highest. Copper is intermediate in mobility, and some of the Cu has probably been lost from the veins during oxidation and weathering. The highest values of Cu occur in veins from the central part of the study area (pl. 3). Localized highs in veins occur at and to the north of the VT veins and along the VS–1 vein. Minor chalcopyrite and bornite are observed in some of the veins.

Lead values in veins at Rois Malk range from less than 10 to 700 ppm with a geometric mean of 24 ppm (table 2). The mobility of lead in the weathering environment is low, and therefore lead content probably reflects original values in veins. Localized high values of lead in veins occur in the west-central part of the study area and in the VT veins. Lead values decrease to the south. The VB–2 brecciated area contains elevated concentrations of lead. Minor galena is observed in quartz and within pyrite in veins along the coast.

Zinc in veins at Rois Malk is correlated particularly with manganese and copper (table 3). The mobility of zinc in the weathering environment is high and is controlled by adsorption onto iron and particularly onto manganese oxides. This affinity of manganese oxide to adsorp zinc explains the high correlation of zinc with manganese at Rois Malk (table 3) and indicates that part of the zinc has been mobilized and then stabilized by manganese oxides.

Zinc content of veins ranges from less than 5 to greater than 10,000 ppm (by spectrographic analysis) with a geometric mean of 79.8 ppm (table 2). Considerable Zn has been lost due to its mobility in the intense weathering environment. Anomalous values of Zn in veins occur mainly in the central part of the study area (pl. 3). The northern part of the VS–1 vein, where sulfides are still locally present, and the VT vein system contain the highest values for Zn. Veins from the northern, southern, and western parts of the study area are low in zinc. Sphalerite is observed in veins along the coast (fig. 24) and in the VS–1 vein.

Cadmium is commonly associated with Zn at a Zn:Cd ratio of 500:1 (Wedepohl, 1969–78) but this ratio can vary considerably. The Zn:Cd ratio at Rois Malk is approximately 1,000:1, possibly indicating that Cd is more mobile than Zn.

Cadmium values of veins at Rois Malk range from less than 0.1 to greater than 100 ppm with a geometric mean of 0.16 ppm (table 2). The two most anomalous values of Cd (and also Zn) occur along the northern part of the VS–1 vein where some sulfides are still present in the vein (compare pls. 2 and 3). The veins in the eastern part of the study area are low in Cd concentrations, except along the coast. The veins in the southern and western part of the area are also low in Cd contents. The distribution of Cd in veins at Rois Malk is similar to that of Zn.

In veins at Rois Malk, base-metal elements are associated with the gold mineralization. Moderate to low values of Pb and Zn and high values of Cu are associated with the veins. The high values of Cu suggest a porphyry-copper system at depth in the center of the study area, but no conclusive evidence of hypabyssal rocks was noted in the study area to support this hypothesis.

Table 3. Correlation matrix using logged data for 151 vein samples

[Number below the 1.0 diagonal is the number of valid pairs; leaders (--), insufficient data for calculation]

	Fe	Mg	Ca	Ti	Mn	Ag	B	Ba	Co	Cr	Cu	Mo
Fe	1.0	-.35	-.21	-.19	-.14	-.07	-.08	-.23	-.03	.07	.26	-.28
Mg	144	1.0	.07	.34	.17	.12	.16	.09	-.02	.06	.12	.20
Ca	16	16	1.0	.23	.34	-.20	-.34	.37	.19	-.54	-.16	-.12
Ti	151	144	16	1.0	.19	-.11	.31	-.06	.11	.28	-.15	.11
Mn	141	134	14	141	1.0	-.12	-.14	.27	.71	.37	.23	-.06
Ag	61	58	10	61	53	1.0	.14	-.08	.09	-.01	.26	.16
B	63	63	9	63	58	34	1.0	-.11	.13	-.08	-.06	.45
Ba	70	70	8	70	60	40	39	1.0	.53	-.06	.11	-.28
Co	104	99	13	104	94	47	40	43	1.0	.24	.26	-.39
Cr	151	144	16	151	141	61	63	70	104	1.0	.25	-.12
Cu	151	144	16	151	141	61	63	70	104	151	1.0	.04
Mo	31	31	4	31	31	14	19	17	10	31	31	1.0
Ni	144	138	16	144	134	59	60	68	103	144	144	28
Pb	125	120	16	125	117	55	59	61	86	125	125	28
Sc	148	141	14	148	139	58	60	67	102	148	148	30
V	151	144	16	151	141	61	63	70	104	151	151	31
Y	32	31	3	32	22	14	12	17	26	32	32	2
Zr	120	116	16	120	112	49	54	59	84	120	120	25
As	76	73	7	76	72	31	35	39	40	76	76	27
Zn	148	141	16	148	138	59	61	69	102	148	148	30
Cd	71	70	11	71	61	39	36	40	65	71	71	11
Bi	67	63	7	67	66	33	35	36	41	67	67	21
Sb	6	5	0	6	6	3	3	3	2	6	6	3
Au	151	144	16	151	141	61	63	70	104	151	151	31
Te	151	144	16	151	141	61	63	70	104	151	151	31

Mafic Suite (Mn, Co, Cr)

Manganese in veins at Rois Malk is correlated with Co and Cr (table 3). Manganese values in veins at Rois Malk range from 20 to greater than 5,000 ppm with a geometric mean of 299 ppm, Co from less than 5 to greater than 5,000 ppm with a mean of 16.2 ppm, and Cr from 20 to 2,000 ppm with a geometric mean of 358 ppm (table 2). Localized high values of Mn, Co, and Cr occur in the central and eastern parts of the study area, particularly the VT veins (pl. 3). These elements are low to intermediate in mobility in the weathering environment, and probably represent original vein contents. Manganese oxides are ubiquitous throughout the study area and locally coat the inside of open-space cavities and cement some of the breccias. The late nature of the manganese oxides and correlation of Mn with Co and Cr suggest that Co and Cr were precipitated with manganese oxides from low-temperature fluids during the late stage of formation of the veins. Generally, siliceous veins do not contain high concentrations of Cr and Co. High values of Co and Cr, particularly in the VT vein (≤700 ppm Co and ≤3,000 ppm Cr), suggest localized imprint of elements associated with mafic rock onto the vein geochemistry. These elements may have been derived as contamination of mafic host rock or from underlying mafic host rock associated with the mineralization.

Ni	Pb	Sc	V	Y	Zr	As	Zn	Cd	Bi	Sb	Au	Te
-.11	-.12	.13	-.04	.14	-.23	-.01	.04	-.16	.17	-.01	.05	.00
.12	.10	-.01	.03	.04	.13	.04	.23	.25	-.06	-.52	.07	.10
.19	-.00	.47	-.05	--	-.14	-.17	.22	.05	.73	--	-.31	-.62
.35	.01	.54	.44	-.27	.64	.01	-.05	-.08	-.10	-.27	-.41	-.18
.70	.16	.42	.15	.16	.01	-.22	.42	.12	.26	-.09	-.16	-.06
.02	.11	-.24	.05	-.02	-.03	.09	-.12	.05	.20	-1.0	.33	.30
-.16	.21	.13	.11	.37	.19	-.29	-.03	-.05	-.17	-1.0	.17	.13
.43	.17	.34	-.09	.41	.14	-.22	.23	.48	.20	.89	-.19	-.37
.63	.12	.38	.08	.20	.04	-.36	.17	.51	.02	--	-.14	-.10
.45	.05	.45	.40	-.18	-.05	-.32	.17	-.03	.10	.20	-.12	.22
.28	.18	.14	.12	.09	-.29	-.08	.40	.11	.36	-.10	.28	.27
.06	.32	-.14	-.05	1.0	.29	.29	.26	.02	.29	-.24	.58	.09
1.0	.04	.54	.33	.07	.09	-.41	.39	.21	.07	.14	-.32	-.20
120	1.0	.06	.11	.32	-.07	-.01	.33	.40	.18	-.24	.37	.07
141	122	1.0	.52	-.15	.25	-.06	.31	.13	.08	-.02	-.30	-.14
144	125	148	1.0	.03	.18	-.03	.24	-.04	-.03	-.52	-.08	.08
32	22	31	32	1.0	-.12	-.07	.28	.31	-.01	--	.18	-.10
116	100	118	120	27	1.0	.20	-.18	-.22	.19	-.80	-.21	-.14
70	67	74	76	13	56	1.0	-.11	-.18	-.05	.16	.22	-.03
141	122	145	148	31	117	74	1.0	.40	.21	-.04	.24	.05
69	60	68	71	23	57	32	71	1.0	-.08	1.0	.10	-.15
64	59	65	67	10	46	45	66	30	1.0	.02	.43	.58
6	5	6	6	3	4	6	5	2	6	1.0	-.20	.12
144	125	148	151	32	120	76	148	71	67	6	1.0	.47
144	125	148	151	32	120	76	148	71	67	6	151	1.0

Conclusions About the Vein System

The veins at Rois Malk have a geochemical signature indicative of epithermal precious-metal deposits found throughout the world. In addition, high copper values occur with the veins and may indicate the presence of a porphyry-copper system at depth. Some of the veins locally contain high concentrations of Mn, Co, and Cr which have been derived from mafic rock.

The mean Au content of surface veins at Rois Malk is 0.16 ppm, well below economic level, but channel samples across several veins do reach ore-grade levels (up to 0.38 oz per ton). Drilling and further testing are required to determine whether sufficient grades and volume are present in the subsurface to warrant economic development.

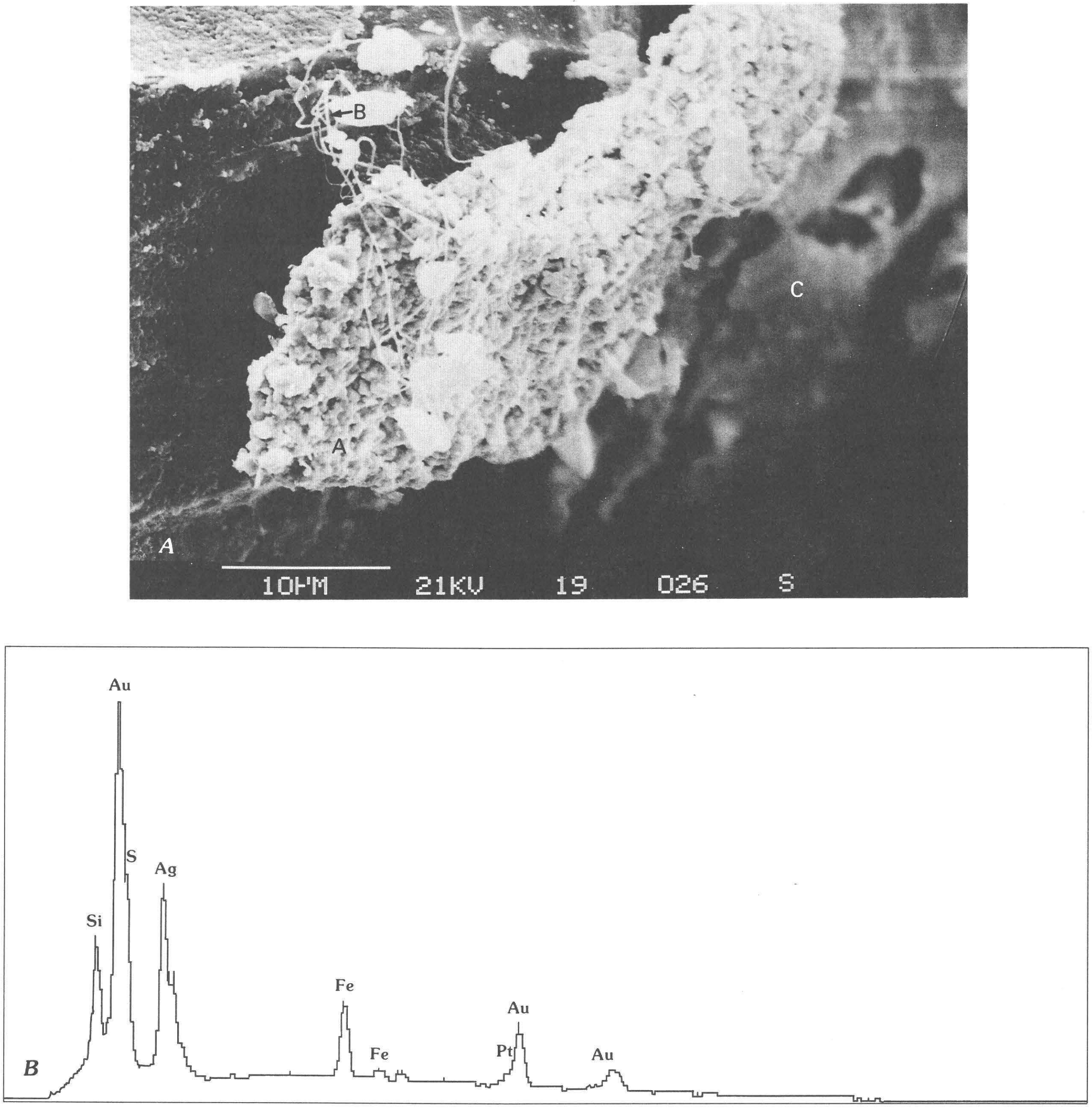


Figure 19. Electrum in vein sample PT 291. *A*, Photomicrograph of sample showing electrum (A) and fine pyrite wire (B), on the edge of a pyrite grain (C). Bar scale is 10 micrometers. *B*, X-ray emission spectrum of electrum from vein sample PT 291. Height of a peak is a qualitative measure of concentration.

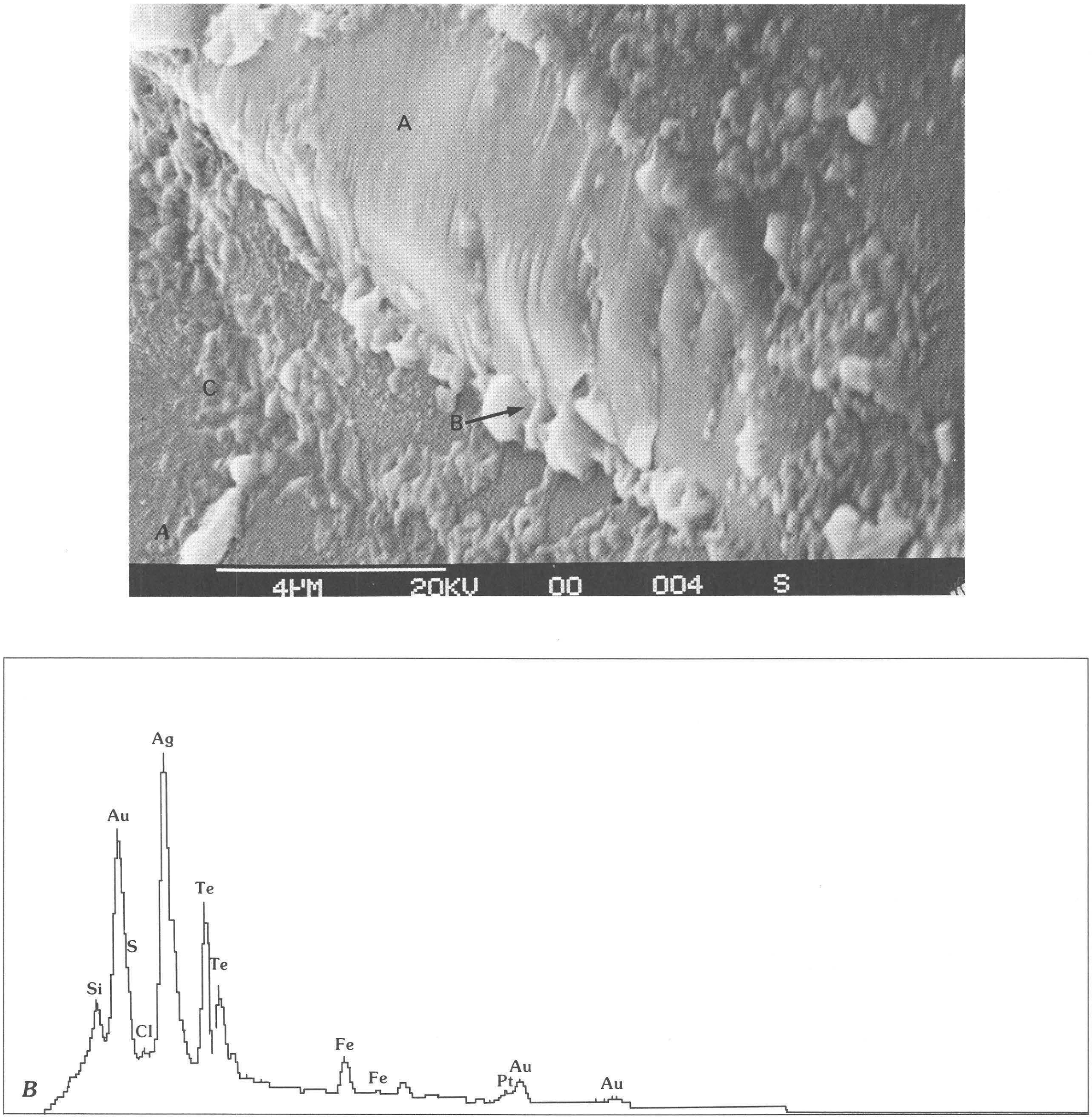


Figure 20. Gold-silver telluride in vein sample PT 291. *A*, Photomicrograph of sample showing gold-silver telluride (A), surrounded by chalcopyrite crystals (B), in a pyrite grain (C). Bar scale is 4 micrometers. *B*, X-ray emission spectrum of gold-silver telluride from vein sample PT 291. Height of a peak is a qualitative measure of concentration.

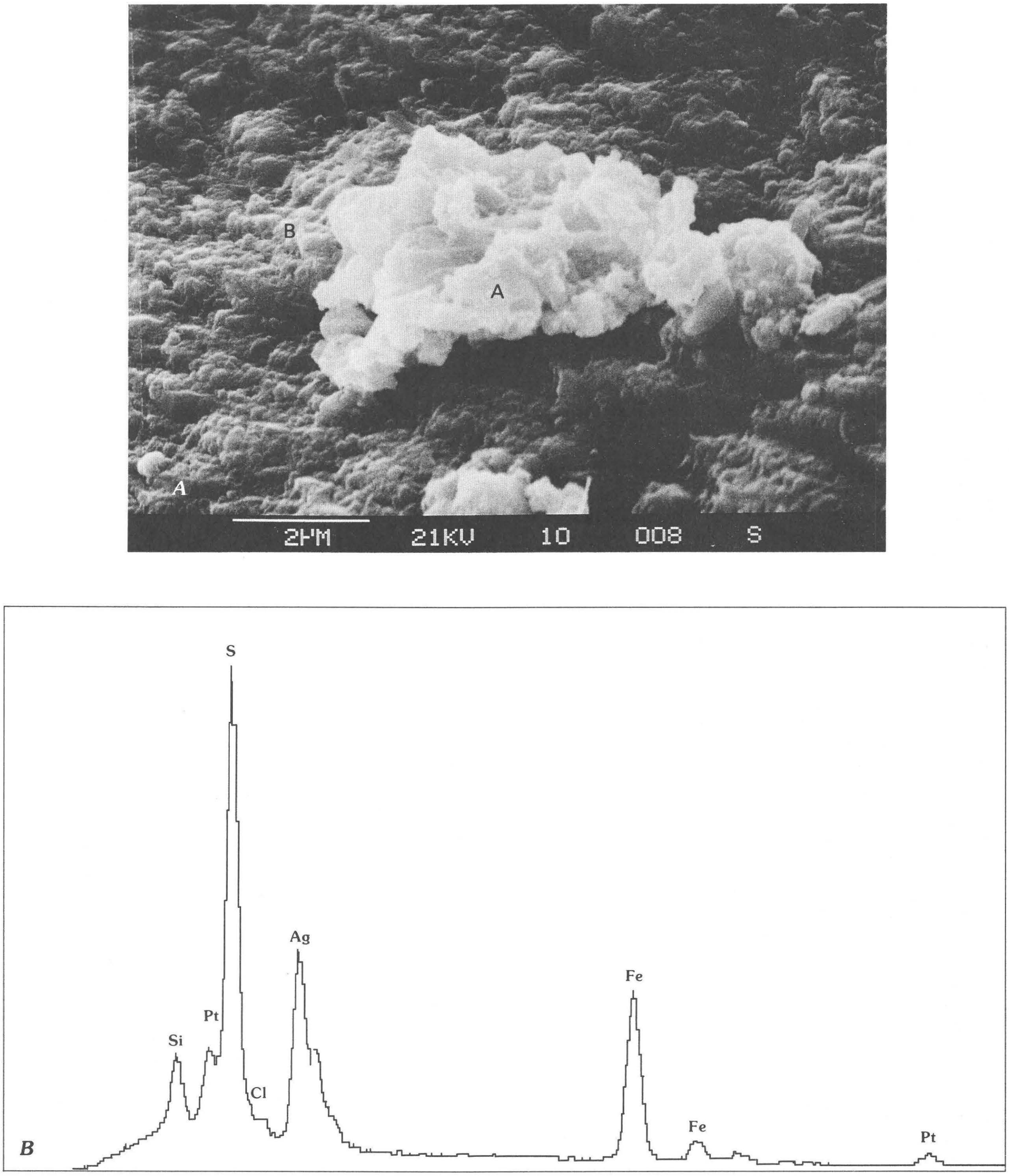


Figure 21. Argentite in vein sample PT 291. *A*, Photomicrograph of sample showing argentite, Ag_2S (A) on pyrite (B). Bar scale is 2 micrometers. *B*, X-ray emission spectrum of argentite from vein sample PT 291. Height of a peak is a qualitative measure of concentration.

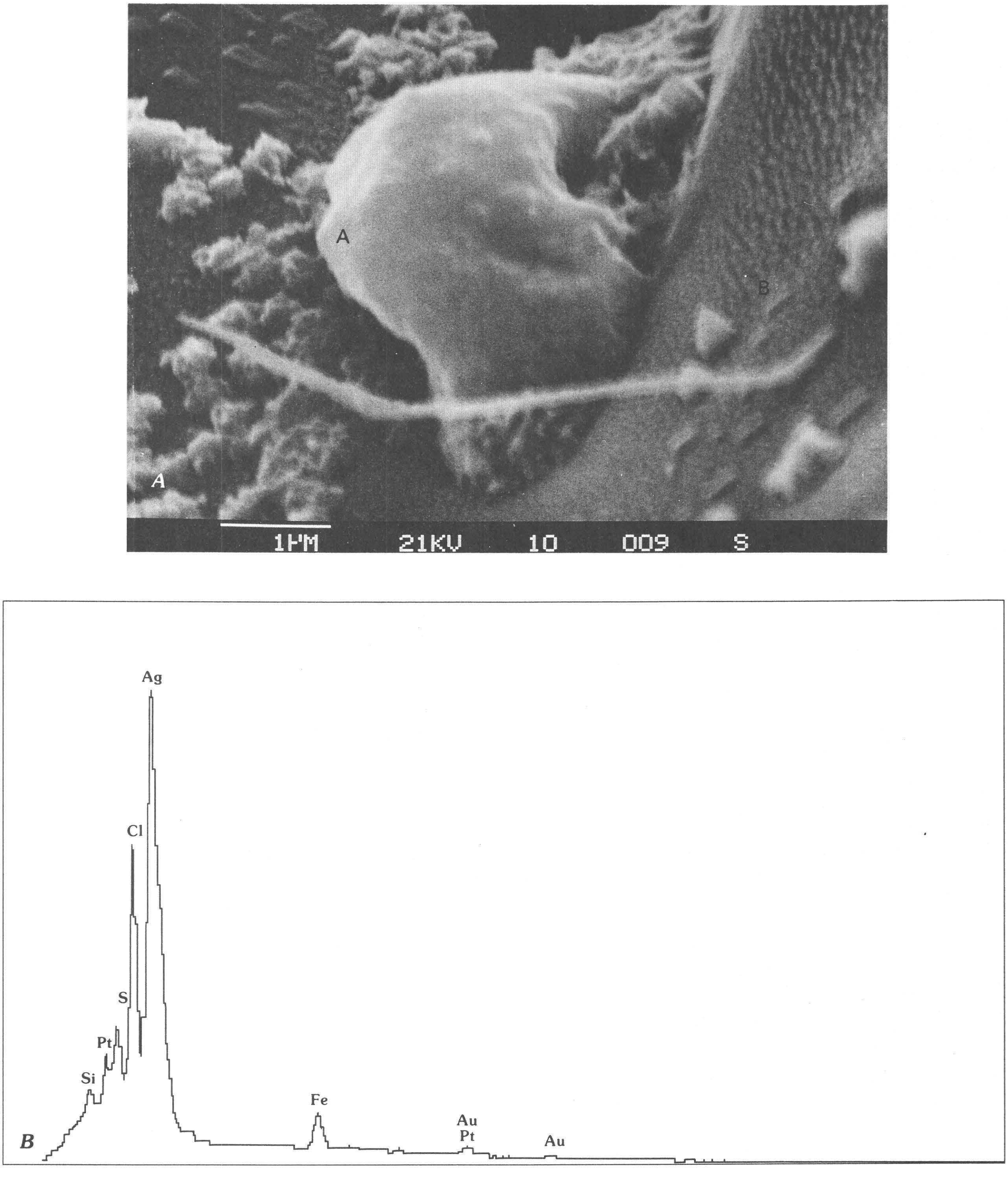


Figure 22. Cerargyrite in vein sample PT 291. *A*, Photomicrograph of sample showing cerargyrite, AgCl (A) on a pyrite grain (B). Note pyrite wire in the foreground. Bar scale is 1 micrometer. *B*, X-ray emission spectrum of cerargyrite from vein sample PT 291. Height of a peak is a qualitative measure of concentration.

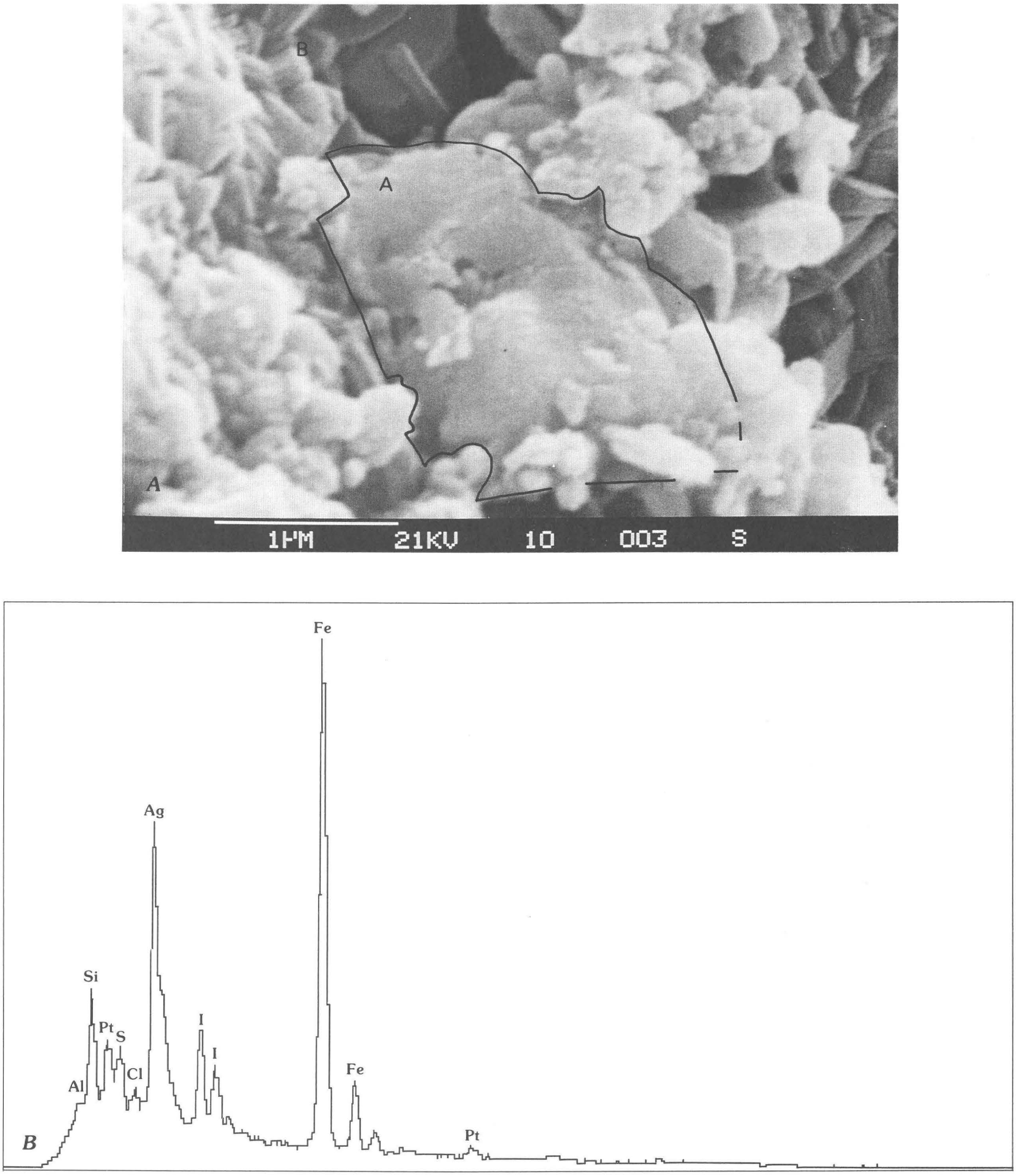


Figure 23. Iodyrite in vein sample PT 291. *A*, Photomicrograph of sample showing iodyrite, AgI (A), on pyrite with Fe-oxide and FeS_2 overgrowths (B). Bar scale is 1 micrometer. *B*, X-ray emission spectrum of iodyrite from vein sample PT 291. Height of a peak is a qualitative measure of concentration.

Table 4. Comparison of average thallium and mercury contents with ranges of gold contents and elevation

[Tl and Hg are in ppm. Each value of Tl and Hg represents the average of four vein samples]

	Tl	Hg
Gold content of veins:		
Au (>3.5 ppm)	0.22	0.07
Au (0.05 to 1.0 ppm)	.07	.10
Au (0.1 to 0.3 ppm)	.04	.06
Approximate elevation of vein:		
90 m	0.10	0.06
50 m	.09	.02
10 m	.09	.07

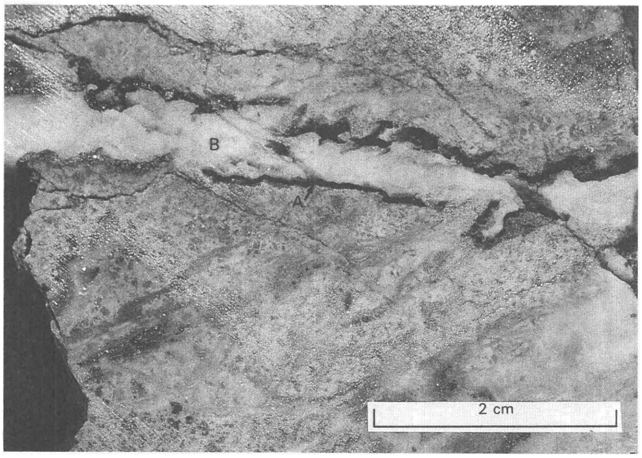


Figure 24. Vein sample PM 201A showing sphalerite (A) bordering quartz-epidote center (B).

MEDIA FOR GEOCHEMICAL EXPLORATION

Because we know that precious-metal mineralization has taken place at Rois Malk, we can test several geochemical media for their efficacy in detecting mineralized rock in the tropical humid environment of Palau. The media tested include stream sediments, heavy-mineral concentrates derived from stream sediments, soils, and mangrove sediments. The results of this testing can be important for future mineral exploration on other parts of Palau and similar areas in the western Pacific and tropical islands elsewhere in the world.

Table 5. Summary of chemical data for 16 stream-sediment samples, Rois Malk area

[All values in ppm except where noted; leaders (--), insufficient data for calculation]

Element	Valid analyses	Minimum	Maximum	Geometric mean
Emission spectrographic analysis				
Fe (pct.)	16	2	5	3.22
Mg (pct.)	16	0.07	2	0.95
Ca (pct.)	16	0.05	2	0.58
Ti (pct.)	16	0.2	0.5	0.30
Mn	16	70	1,000	450
B	10	<10	20	8.78
Ba	3	<20	20	--
Co	15	<5	70	45.4
Cr	15	200	>5,000	1,270
Cu	16	30	100	55.7
Ni	16	50	200	120
Pb	7	<10	30	9.65
Sc	16	20	30	29.3
Sr	1	<100	200	--
V	16	150	300	217
Y	14	<10	15	11.1
Zr	16	20	30	23.3
Atomic absorption analyses				
As	1	<10	10	--
Zn	15	50	640	92.1
Cd	1	<0.1	5	--
Au	16	.001	0.130	0.007
Te	16	.002	1.0	0.010

Stream Sediments and Heavy-Mineral Concentrates

Stream sediments are the most common medium used for geochemical exploration. They reflect the geology of the drainage basin above the sample site, as modified by terrain and climate, and include both clastic and hydromorphic material.

The Rois Malk area lies along a northwest-trending ridge with drainages coming off all sides of the ridge. Relief from the top of Rois Malk hill to the coast is 100 m in a distance of 200 m. Therefore, the gradients for most streams are high. Samples of stream sediments were collected from 16 sites, mainly from single-branched or unbranched drainages. The less than 0.18-mm (minus-80-mesh) fraction of stream sediments was chemically analyzed, and the results summarized in table 5. The complete listing of chemical analyses is shown in appendix B, table 19.

Five sediment samples from streams that clearly drain the mineralized area all contain anomalous amounts of metals (fig. 25). Six sediment samples from streams that drain mostly unmineralized terrain are barren (fig. 25). Another three stream-sediment samples were collected west of Ngerkesou about 10 km north of

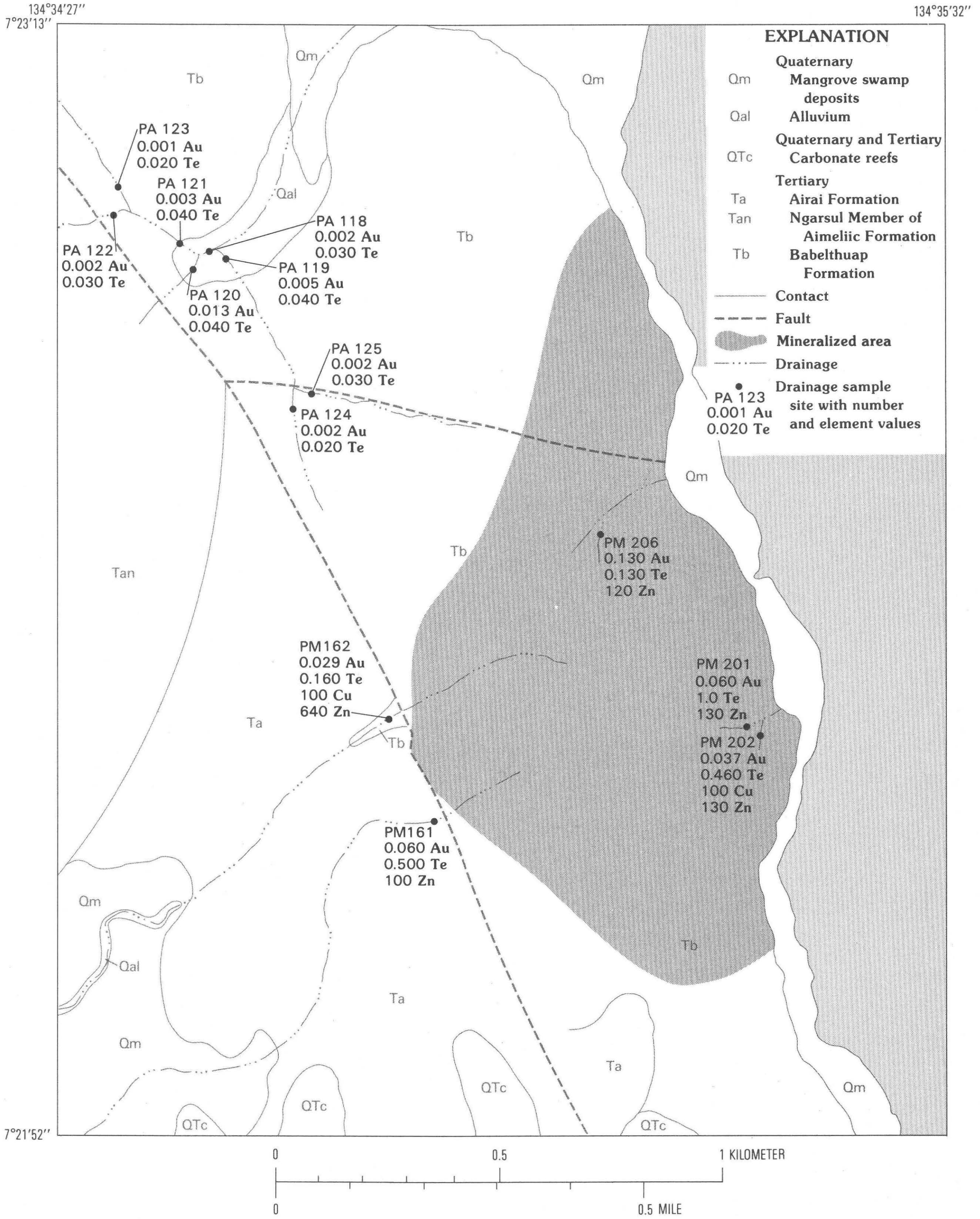


Figure 25. Significant concentrations, in ppm, of Au, Te, Cu, and Zn in the less than 0.18-mm fraction of stream sediments from the Rois Malk study area and vicinity.

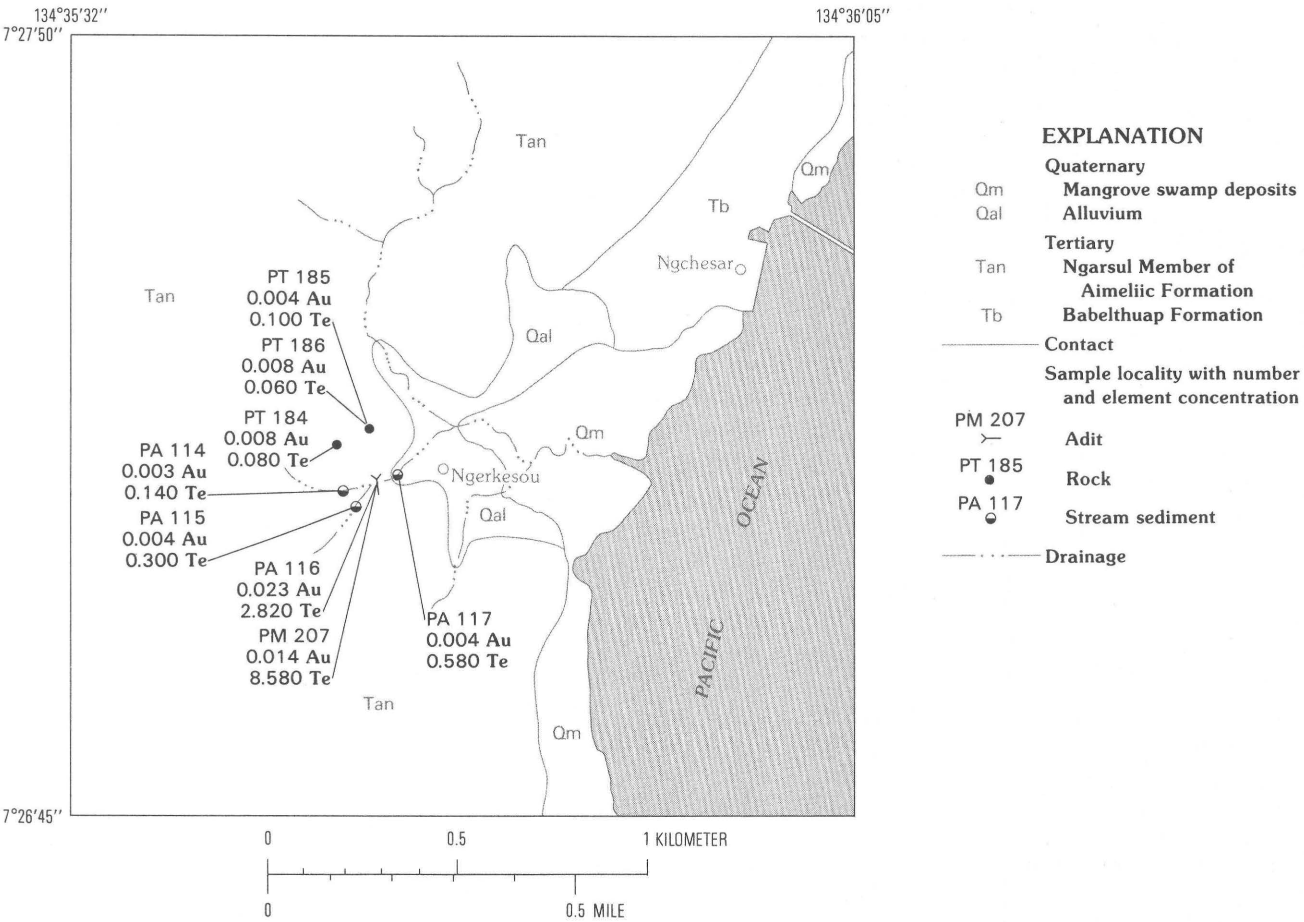


Figure 26. Concentrations, in ppm, of Au and Te in stream sediments, rock samples, and adit samples from the Ngerkesou area.

Table 6. Comparison of maximum value/background value for selected trace metals in the less than 0.18-mm fraction of 16 stream sediments

Element	Valid analyses	Minimum	Maximum	Background	Maximum/ Background
Au[1]	16	1	130	2	65
Te	16	20	1,000	30	33.3
Cu[2]	16	30	100	50	2
Pb	7	10	30	7	4.3
Zn	16	50	640	80	8

[1] Minimum, maximum, and background values for Au and Te in ppb.

[2] Minimum, maximum, and background values for Cu, Pb, and Zn in ppm.

Rois Malk (fig. 26). The ratio of observed value of an element to its background value in the suite Au, Te, Cu, Pb, and Zn clearly indicates that Au and Te are the most enriched metals followed by Zn, Pb, and Cu (table 6). Chemical analyses of the <0.18-mm (minus-80-mesh) fraction of stream sediments from small drainages for this metal suite are an effective medium for precious- and base-metal exploration on Babelthuap Island.

The three stream-sediment samples collected west of Ngerkesou about 10 km north of Rois Malk (fig. 26) contain anomalous values for Te but for no other element (fig. 26). The three small streams drain areas underlain by the Ngarsul Member of the Aimeliic Formation, which is younger than the Babelthuap Formation which hosts the vein system at Rois Malk. Rocks cut by the three drainages have been pyritized, and

Table 7. Summary of emission spectrographic analysis chemical data for 13 heavy-mineral-concentrate samples, Rois Malk area, Palau

[All values in ppm except where noted]

Element	Valid analyses	Minimum	Maximum	Geometric mean
Fe (pct.)	13	3	7	4.44
Mg (pct.)	13	1	7	3.19
Ca (pct.)	13	2	10	6.40
Ti (pct.)	12	0.15	>2	0.25
Mn	13	300	700	576
Ag	4	<1	500	--[1]
Au	2	<20	700	--
Cd	3	<50	200	--
Co	11	<10	150	30.5
Cr	10	1,500	10,000	7,880
Cu	13	20	10,000	170
Mo	1	<10	15	--
Ni	13	70	200	130
Pb	4	<20	100	--
Sc	13	20	70	58.8
V	13	150	700	219
Zn	4	<500	15,000	--
Zr	4	<20	200	--

[1] Leaders (--), insufficient data for calculation.

several shallow exploration adits have been made, probably by the Japanese. This area has probably been subjected to the same processes of mineralization as occurred at Rois Malk, but mineralization here was less intense and at a higher level than at Rois Malk. This also implies that the mineralization of Rois Malk area took place after that of the Ngarsul Member of the Aimeliic Formation. The area between Rois Malk and Ngerkesou is considered to have potential for precious-metal mineralization similar to Rois Malk.

Samples of heavy-mineral concentrates were collected from the same sites in the Rois Malk area as the stream sediments. Heavy-mineral concentrates mainly represent mineralogy of the drainage basin above the sample site with common rock-forming light minerals, such as plagioclase, removed.

The results of the chemical analyses are summarized in table 7. A complete listing of the chemical analyses is shown in appendix B, table 20. Because of the resistant nature of concentrates and the difficulty of putting these minerals in solution, only emission spectrographic analyses were performed on the heavy-mineral concentrates. Spectrographic analyses are not as sensitive for many elements as atomic adsorption analyses (appendix B, table 14), but the concentrating effect of this geochemical medium increases the background values for many trace and minor elements.

The most important pathfinder elements for detecting mineralization products are Cu and Ag followed by Au and Zn (table 8). Copper and silver were detected in four out of five of the samples taken from streams draining the mineralized area (fig. 27). Gold was detected in two out of the five samples. The highest value for Au is 700 ppm, which is much higher than gold values in stream sediment and is due to the concentrating effect of the medium. Gold determinations of heavy-mineral concentrates are more inconsistent than those of stream sediments because of the smaller amount of sample used for the spectrographic analysis (5 mg vs. 10 g).

Heavy-mineral concentrates also can be used to determine the various minerals present using optical and scanning electron microscope (SEM) techniques. Samples from the mineralized area contained pyrite, chalcopyrite, sphalerite, galena, and gold as well as pyroxene, amphibole, zircon, and chromite (fig. 28). Concentrate samples from the unmineralized area contained pyrite, pyroxene, amphibole, zircon, and chromite (fig. 28). It is obvious from the mineralogy which streams are draining areas affected by the mineralization. The determination of the mineralogy of heavy-mineral concentrates allows an added dimension to the interpretation.

Soils

Soils in the study area are generally reddish brown, well-drained, ferruginous latosols developed over indurated but deeply weathered basaltic to andesitic rocks. Zones of silicification commonly stand out as discontinuous ribs 10–30 cm above the surrounding surface. Two traverses using soil samples were conducted in the study area. The first was a traverse across the vein system, and the second was a detailed traverse in the western part of the study area.

East-West Soil Traverse

An east-west soil sample traverse across the vein system was conducted at approximately one sample per 25 m (fig. 29). The traverse mostly follows an old Japanese road and therefore deviates somewhat from east-west. The samples consisted mostly of red and brown clay and weathered rock collected between 10 and 30 cm depth. No obvious soil horizons are present. Table 9 is a summary of the chemical analyses. Sample site descriptions appear in appendix C, and complete chemical analyses are listed in appendix B, table 17.

The most important pathfinder elements for the precious-metal mineralization are Au, Te, and Zn (fig. 30). These elements display similar patterns; however, sample PM 166 with the highest Te content (1.82 ppm) was taken east of the VA veins (fig. 29) in what is considered an unmineralized area.

Table 8. Comparison of maximum value/background value for selected trace metals in 13 heavy-mineral concentrates

[Minimum, maximum, and background values in ppm]

Element	Valid analyses	Minimum	Maximum	Background	Maximum/ Background
Au	2	<20	700	<20	>35
Ag	4	<1	50	<1	>50
Cu	13	20	10,000	50	200
Pb	4	<20	100	<20	> 5
Zn	4	<500	15,000	<500	>30
Co	11	<10	150	20	7.5
Cd	3	<50	200	<50	> 4

Samples PM 180, 181, and 178 contained the highest Au values (0.110, 0.040, and 0.024 ppm, respectively). PM 180 and 181 occur west of vein VS–1 and away from any known veins. Sample PM 180 contained 100 ppm Cu and 0.12 ppm Te. Sample PM 181 contained 100 ppm Cu and 0.02 ppm Te. These two samples occur west and downslope from vein VS–1. The anomalous gold content is probably due to soil moving downslope from the mineralized veins above. Another less likely possibility is the presence of unrecognized mineralized stringers or veins in the country rock.

Sample PM 178 occurs on the west side of the VB–1 area and contained the only detected values for Ba (30 ppm) and B (30 ppm) in the soil samples. Barium and boron must have been introduced during the formation of the VB–1 veins. Other anomalous elements at this site are 300 ppm Cu, 0.88 ppm Te, 30 ppm Pb, and 85 ppm Zn. These Pb, Cu, and Zn values are the highest values in the traverse.

Detailed Soil Traverse

A detailed soil traverse (10-m intervals) consisting of two traverse lines perpendicular to each other was conducted along the western boundary of the study area (J, pl. 1). The traverse crosses the Oikull fault, which brings the Babelthuap Formation in contact with the Airai Formation. The soils were collected in a manner similar to that of the first traverse. Several soils in this traverse have well-developed horizons with a definite color change from red to yellow at around 20 cm. Table 10 summarizes the chemical analyses. Sample site descriptions are shown in appendix C, and a complete listing of chemical analyses is shown in appendix B, table 18.

Anomalous Au and Te contents of the soil samples do not correspond to locations of veins (figs. 31 and 32), but generally increase toward the fault, which is downslope from most of the sample sites. Such increase may indicate soil movement. Chromium and vanadium contents of the soils are high (table 10), probably reflecting the basaltic bedrock.

Sample PM 183, collected from a small vein, contains the only detected values for Ba (100 ppm) and Y (70 ppm) and must reflect introduced Ba and Y during the formation of the vein. Other anomalous elements at this site include Co (100 ppm), Mn (3,000 ppm), Cu (150 ppm), and Zn (350 ppm). Sample site PM 192, lying 3 m upslope from a main vein, contained 0.004 ppm Au, compared to sample site PM 193, 7 m downslope, whose sample contained 0.012 ppm Au. The slope gradient varies from 15° to 20°. This increase in gold content indicates that some of the gold is being transported downslope mechanically, which should be taken into account when soils are utilized for geochemical exploration.

Based on the results of these two traverses, soils can be used as a sample media for detailed geochemical exploration in the Rois Malk area. Pathfinder elements, in order of importance, are Au, Te, Zn, Cu, Co, and Pb. Only a few values of Ba, B, and Y were detected, but in each case, these elements were associated with the presence of veins. The possibility of mechanical transport downslope of gold and other ore-related elements in soils must be considered when interpreting soil data.

Backhoe trench F (pl. 1), sited near the detailed soil traverse, also crosses the Oikull fault (fig. 33). A 15-cm-wide limonitic zone is present at the fault. On the Airai Formation side of this zone is a 3-cm-wide siliceous vein containing iron oxide after sulfides. Sample PM 262 collected from this vein contained 0.22 ppm Au and 2.18 ppm Te. Sample PM 261 collected from the limonitic zone contained 0.008 ppm Au and 0.29 ppm Te.

The geochemistry changes dramatically across the fault: the Babelthuap Formation side is higher in Mn, Cu, Co, Zn, but lower in Au, Te, and B (table 11).

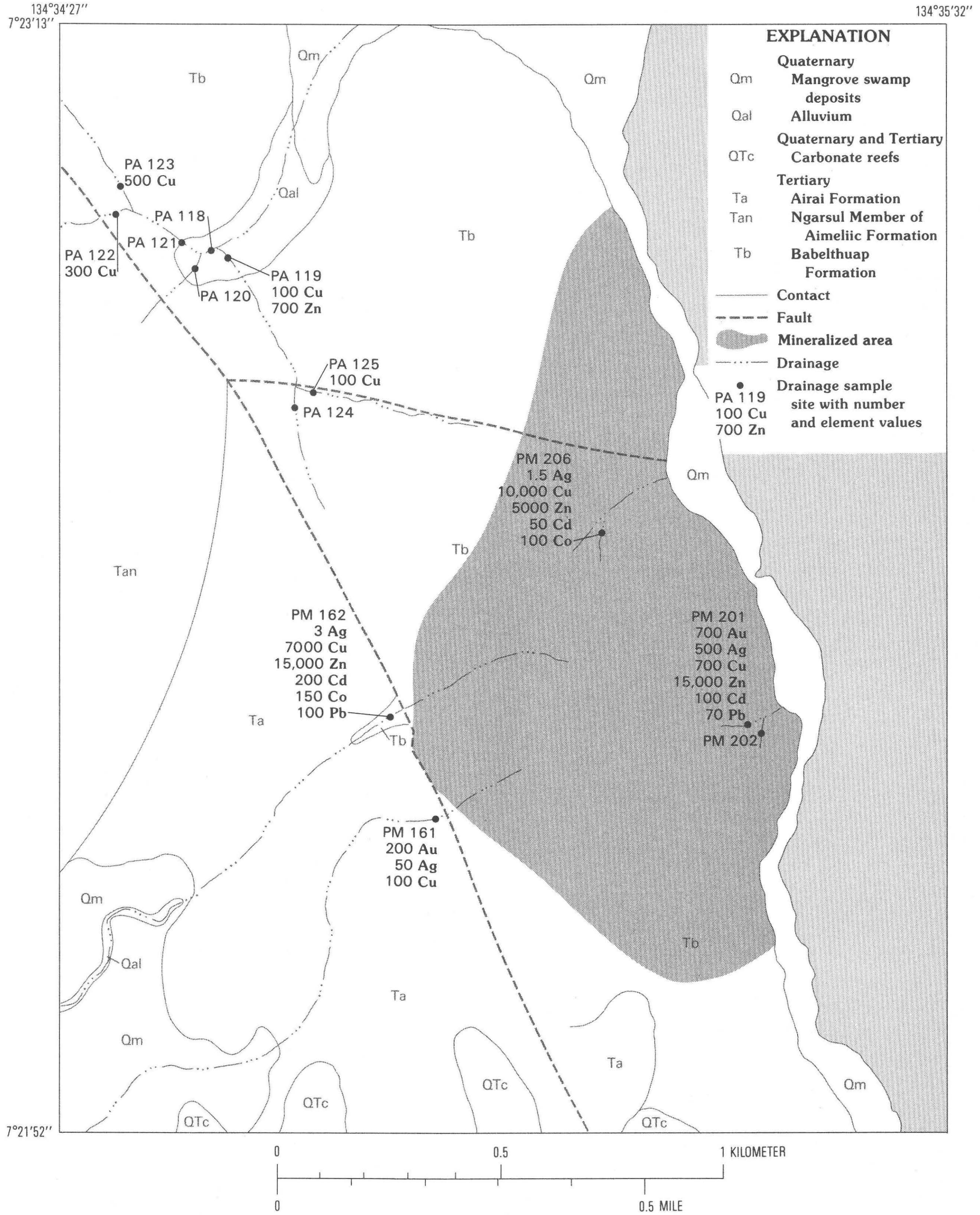


Figure 27. Significant concentrations, in ppm, of Au, Ag, Cu, Zn, Cd, Co, and Pb in heavy-mineral concentrates from the Rois Malk study area and vicinity.

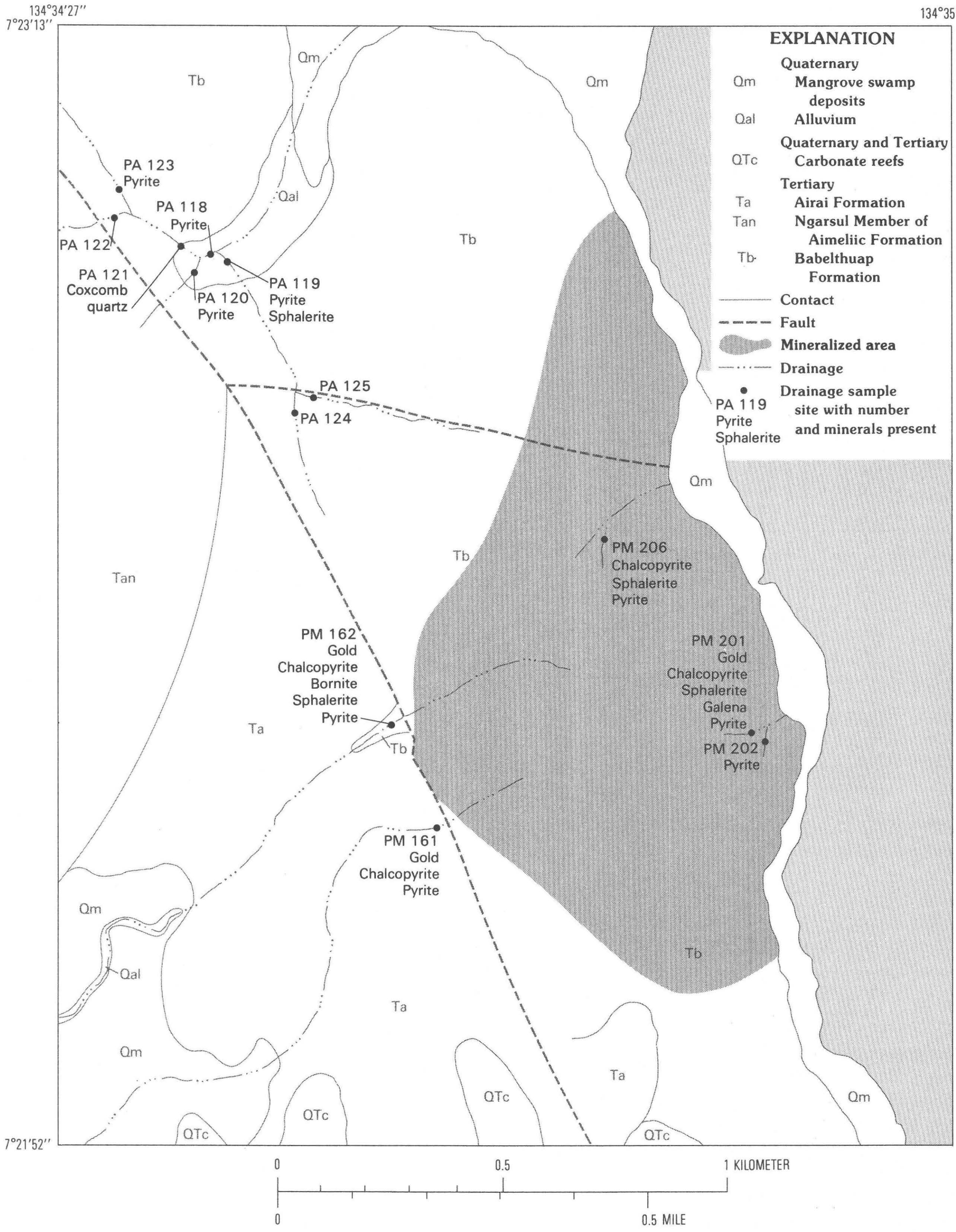


Figure 28. Selected minerals present in heavy-mineral concentrates from the Rois Malk study area and vicinity.

Table 9. Summary of chemical data for an east-west soil traverse across the Rois Malk area

[All data ppm except where noted]

Element	Valid analyses	Minimum	Maximum	Geometric mean
		Spectrographic analysis		
Fe (pct.)	20	3	10	4.91
Mg (pct.)	20	0.02	0.2	0.076
Ti (pct.)	20	0.3	0.5	0.41
Mn	20	100	2,000	509
B	1	<10	30	--[1]
Ba	1	<20	30	--
Co	17	< 5	150	21.5
Cr	20	150	1,000	453
Cu	20	30	300	91.8
Ni	20	30	300	107
Pb	5	<10	30	--
Sc	20	30	70	44.4
V	20	150	500	249
Y	3	<10	50	--
Zr	20	20	30	28.8
		Atomic absorption analyses		
Zn	20	5	85	22.1
Cd	7	<0.1	0.2	--
Au	19	<0.001	0.110	0.006
Te	20	0.020	1.82	0.017

[1] Leaders (--), insufficient data for calculation.

Mangrove Sediments

Mangrove coast and swamps are well developed around the Island of Babelthuap. Of the 160 km of coastline, 125 km are bounded by mangrove swamps which vary in width from a few tens of meters to a kilometer. The low-energy environment characteristic of the intertidal zone within the mangrove coast and swamp is conducive to trapping very fine grained sediment, retaining it in and among the dense mangrove root system. This sediment was sampled by coring, and then chemically analyzed to test its effectiveness as a medium indicating mineralized rock on land adjacent to the mangrove coast and swamp. Sediments are contributed from three main sources: (1) land mass adjacent to the mangrove coast (largest source); (2) supply by littoral currents; and (3) organic and carbonate remains of biota within the mangrove community. Mangrove sediments consist of silt, clay, and organic and carbonate remains. Samples were ashed prior to chemical analyses to decrease the effects of the organic and carbonate remains of biota.

Core samples of sediment within the mangrove coasts and swamps were taken by inserting a polyvinyl chloride pipe of 4 cm diameter into the sediment to a depth of 1 m. Recovered core samples ranged from a few centimeters to nearly a meter in length. A few of the longer core samples were split: one-half was panned to make a heavy-mineral concentrate, which was then used for optical identification of sediment mineralogy.

Two sets of mangrove sediments were collected (fig. 34), one set in November 1985 and the second set in March 1986. Sample descriptions of these two sets form appendix D, and results of the chemical analyses for Au and Te are shown on figure 35.

Gold values of mangrove sediment samples from the coastal area surrounding Rois Malk hill on the southeast part of Babelthuap (fig. 35) range from 0.001 to 0.10 ppm, and Te contents range from <0.020 ppm to 2.1 ppm. Gold and tellurium values are highest in the coastal areas immediately adjacent to the zone of gold mineralization on Rois Malk, particularly the southeast and northeast parts of the area.

Core samples from the mangrove coast on the east side of Babelthuap extending from just north of Rois Malk to Melekeok village were taken at approximately 1 km intervals (fig. 34). Gold values of these samples range from 0.001 to 0.008 ppm, and Te values range from <0.020 to 0.13 ppm. The Au and Te values are considerably lower than those measured in mangrove sediments adjacent to the known mineralized area at Rois Malk. One sample taken off the coast of Ngernerecherakl contained slightly anomalous Au (0.008 ppm) and Te (0.060 ppm) and may indicate the occurrence of mineralization on the adjacent land area. The high Te value (0.10 ppm) of a sample near Ngerkesou probably reflects mineralization in the vicinity of the exploration workings present west of the town. Chromium values of many of the samples exceed 2,000 ppm. Chromium spinel probably derived from the Babelthuap Formation was observed optically in concentrates prepared from some of the mangrove sediment samples. The possibility exists for offshore accumulations of economic chromite placers, but proof of this would require further testing.

Collection and analysis of sediment within the intertidal zone of the mangrove coastal environment constitute an effective reconnaissance method for rapidly determining the precious-metal potential of land areas adjacent to the coast. Mangrove coastal environments are common elsewhere in the Pacific, and mangrove sediments could thus be sampled as a first step in an exploration program for precious metals.

Summary on the Effectiveness of Geochemical Media

Stream sediments, heavy-mineral concentrates, mangrove sediments, and soils were tested as sample

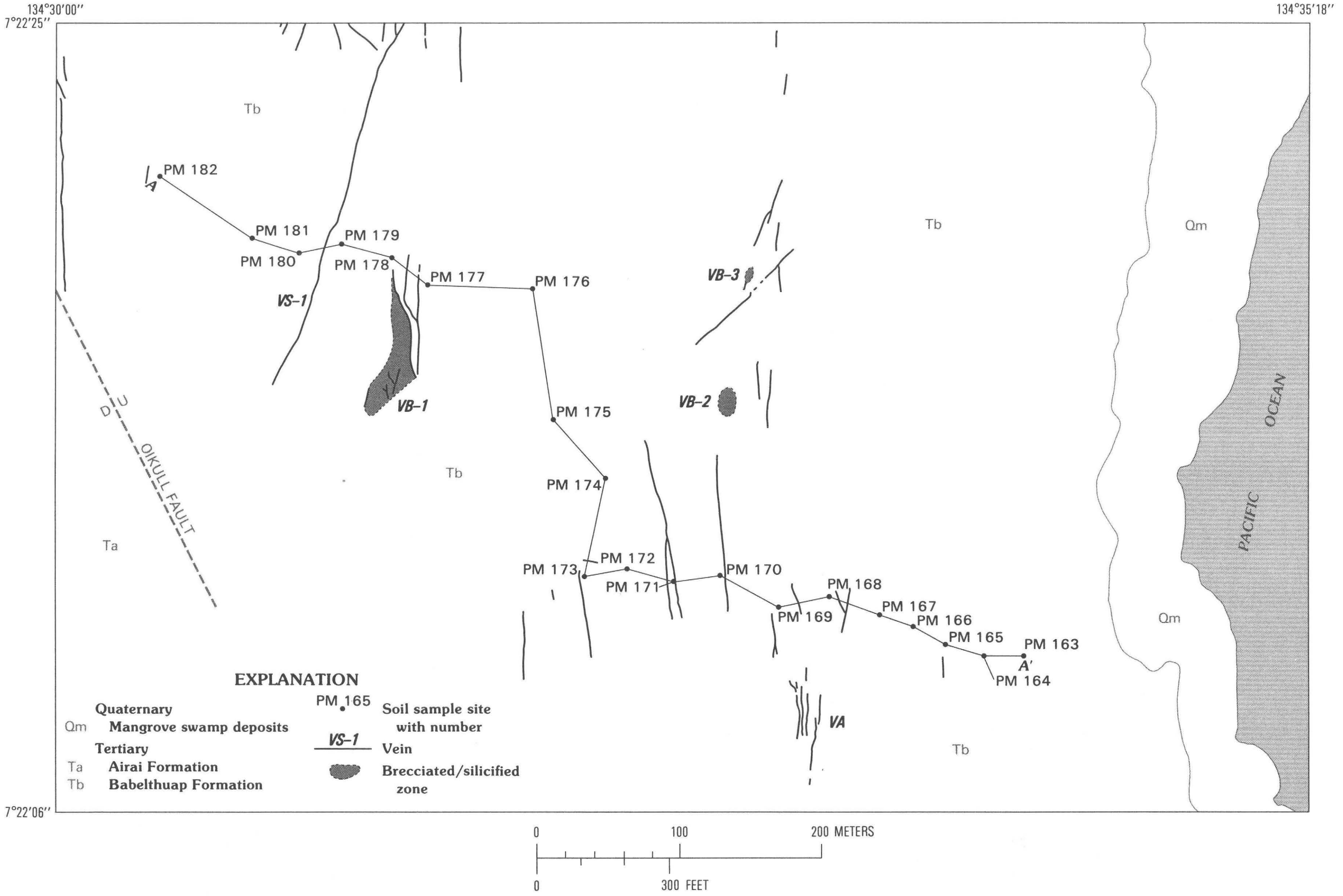


Figure 29. Map showing soil sample sites from east-west traverse *A-A'* across the Rois Malk study area. On fault, U, upthrown side; D, downthrown side.

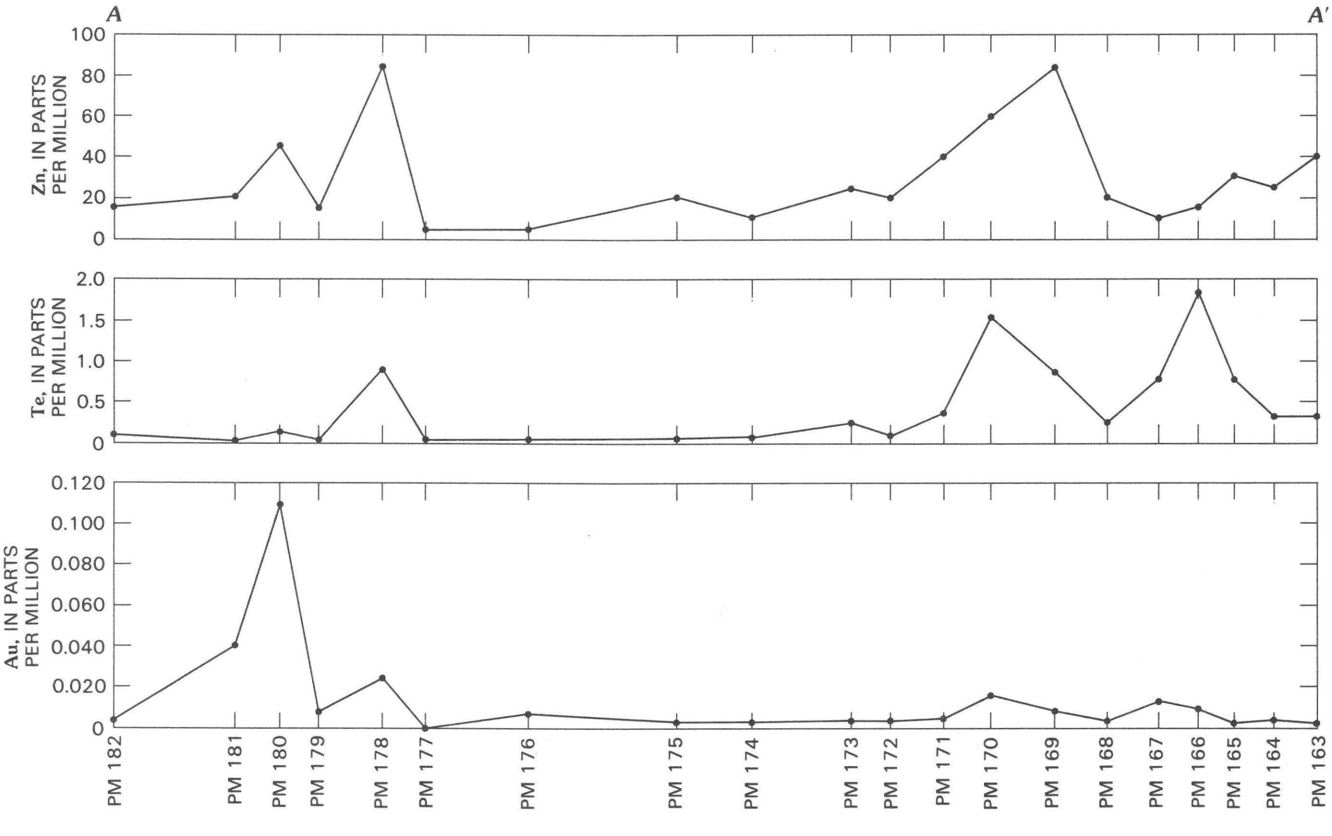


Figure 30. Gold, tellurium, and zinc concentrations from an east-west soil traverse across the Rois Malk study area. East is to the right.

media to be used for detection of precious-metal mineralization at Rois Malk. The most effective medium is the <18 mm fraction of sediments from small streams. Gold is the most diagnostic pathfinder element followed by tellurium, zinc, lead, and copper. Heavy-mineral concentrates derived from stream sediments are an effective medium, both for chemical analysis and for determining the mineralogy. Native gold, pyrite, chalcopyrite, bornite, sphalerite, and galena were all detected in heavy-mineral concentrates from small streams draining mineralized areas at Rois Malk.

The use of mangrove sediments is effective in detecting onshore mineralization adjacent to mangrove swamp and coast, and this medium can be used for rapid reconnaissance of adjacent onshore areas. Gold and tellurium are the most effective pathfinder elements for detecting the mineralization. Soils can be used for detailed geochemical surveys, but care must be exercised in the interpretation of soil geochemistry when soils are collected on slopes. It seems evident at Rois Malk that gold and other ore-related elements can be mechanically transported downslope.

These sample media tested at Rois Malk can be used for geochemical exploration in other parts of Palau as well as other areas with similar environments, particularly in the western Pacific.

Table 10. Summary of chemical data of a detailed soil traverse, Rois Malk

[All values in ppm except where noted; leaders (--), insufficient data]

Element	Valid analyses	Minimum	Maximum	Geometric mean
Spectrographic analysis				
Fe (pct.)	18	2	20	5.95
Mg (pct.)	18	0.02	0.1	0.046
Ti (pct.)	18	0.15	0.5	0.34
M	18	20	3,000	112
B	3	<10	10	--
Ba	1	<20	100	--
Co	8	<5	150	6.12
Cr	18	100	2,000	500
Cu	18	30	150	80.4
Mo	4	<5	20	--
Ni	18	30	150	47.9
Pb	3	<10	20	--
Sc	18	20	50	29.7
V	18	150	500	287
Y	1	<10	70	--
Zr	18	15	30	26.0
Atomic absorption analyses				
As	7	<10	20	6.80
Zn	17	<5	350	18.6
Cd	1	<0.1	0.1	--
Au	18	0.003	0.090	0.014
Te	18	0.040	1.0	0.330

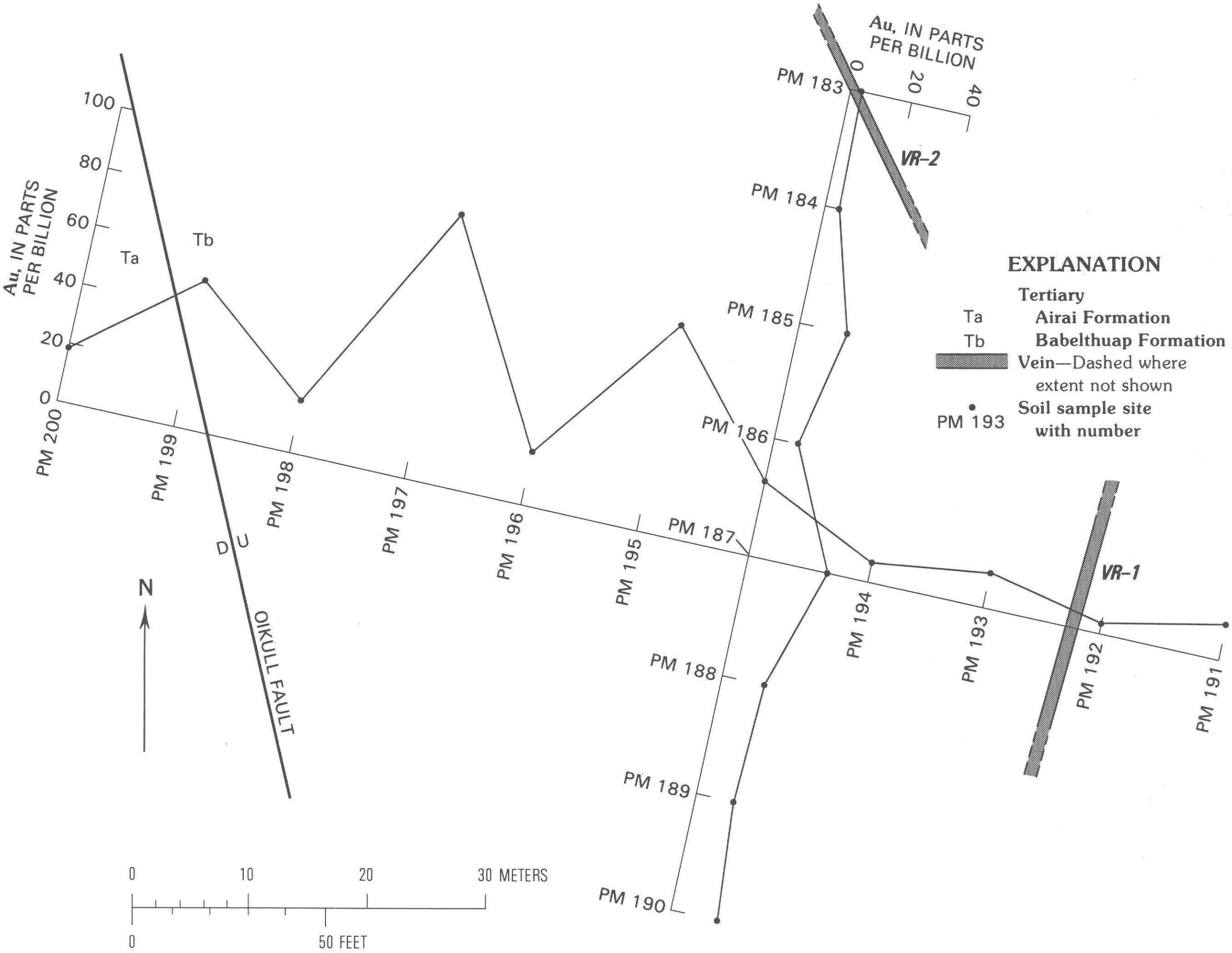


Figure 31. Detailed soil traverse (pl. 1, J) and gold concentrations from the western side of the Rois Malk study area. On fault, U, upthrown side; D, downthrown side.

INTERPRETATION AND CONCLUSIONS

The epithermal vein system in the Rois Malk study area has similarities to other productive epithermal vein districts present in the circum-Pacific region. The size of the mineralized area, the number and extent of veins, and the chemistry of the mineralized zones are comparable to those of many districts that have had significant precious-metal production and by-product base-metal production.

In the Rois Malk study area, more than 100 veins and mineralized shear zones are distributed over an area 1×1.5 km in size. The veins and shear zones range from a few centimeters to several meters in width and are locally continuous along strike for distances up to 600 m. The number and distribution of veins observed in the study area (pl. 1) only represent part of the vein system. Undoubtedly, many of the veins and shear zones continue along strike for distances greater than shown on plate 1, but dense vegetation and intense lateritic weathering obscure the vein outcrops. It is also likely that additional veins are present in the Rois Malk study area, but they are similarly obscured by vegetation and weathering. The limited number of trenches sited in the study area successfully exposed veins and shear zones. Additional trenches should be sited in order to delineate veins which do not crop out, and to determine the extent and gold contents: the trenching should be located perpendicular to the north-south trend of the vein system and should be focused in areas where veins and shear zones as currently shown on plate 1 are most numerous.

All the veins and shear zones sampled within the Rois Malk study area contain anomalous concentrations of Au, usually from 0.1 to 1 ppm, and a few outcropping veins contain ore-grade Au values, 1.5 to 13 ppm. Because of intense weathering and oxidation, it is not certain that surface samples reflect the original gold contents of the veins and shear zones. It is possible that during weathering and laterite development, gold contents have been depleted relative to the original gold

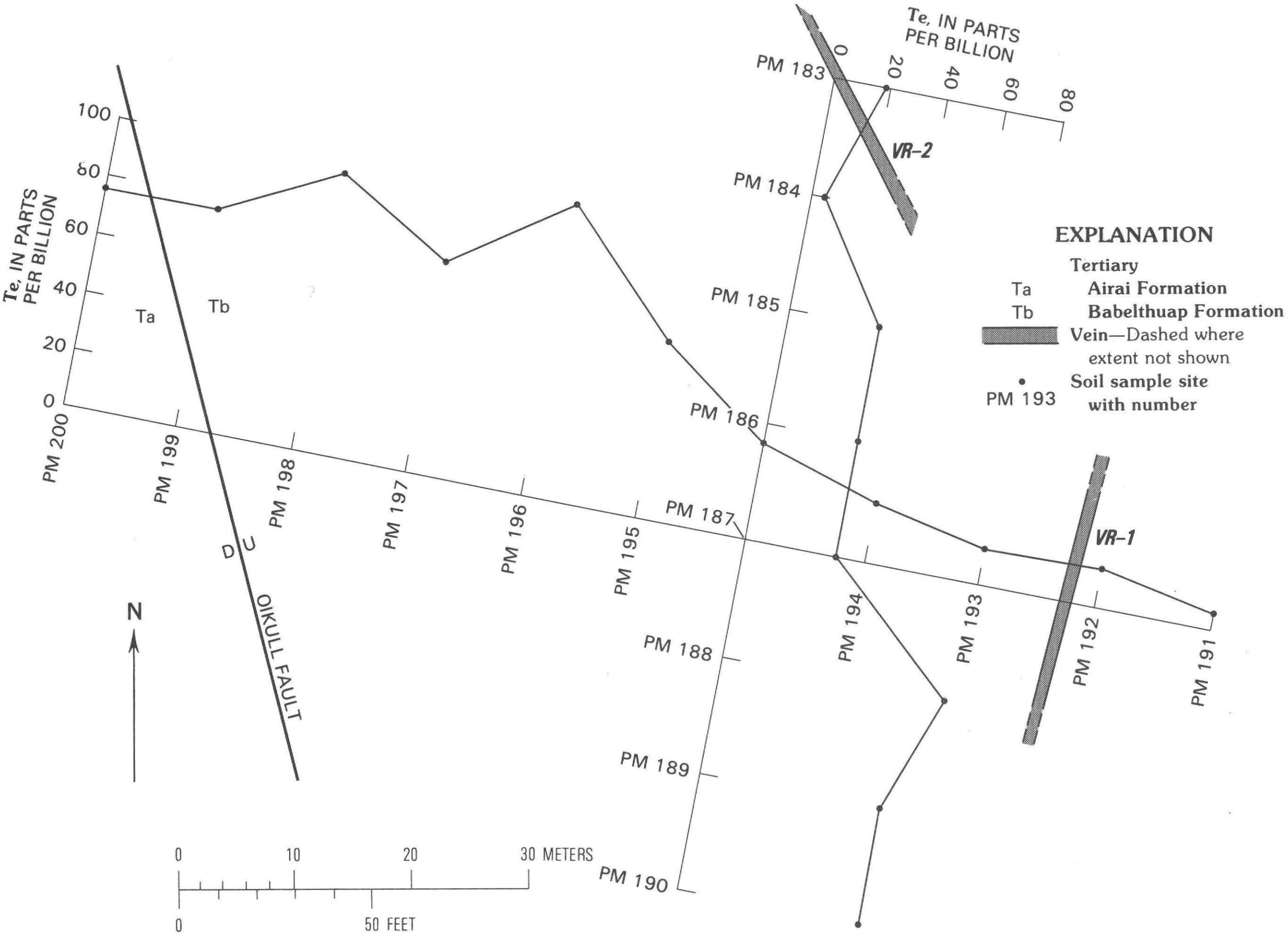


Figure 32. Detailed soil traverse (pl. 1, J) and tellurium concentrations from the western side of the Rois Malk study area. On fault, U, upthrown side; D, downthrown side.

contents of the veins and shear zones. It is clear that weathering and oxidation have reduced the original copper, zinc, and silver contents of the veins and shear zones. To test whether gold values vary with the extent of weathering, drilling to encounter unweathered and unoxidized portions of veins is necessary. The depth of weathering in the Rois Malk area is unknown, but backhoe trenches to 2½ m were still in deeply weathered country rock. The weathering probably extends tens of meters below the surface.

This study has focused on surface exposures and some limited trenching to very shallow depths. The lateral persistence of veins and shear zones indicates that they continue at depth. Drilling is necessary to evaluate the subsurface extent and grade of the veins and shear zones. On the basis of the texture of the veins and shear zones, geochemistry, and alteration mineralogy, the level of exposures present at the Rois Malk area is suggestive of the upper part of a productive zone of a vein system. Outcrops of veins carrying in excess of 0.1 oz per ton may represent the top of local ore shoots developed along segments of the vein. Although extensive weathering precludes adequate characterization of the alteration assemblage, the presence of sericite and chlorite-epidote assemblages suggests that the veins are exposed in or adjacent to narrow zones of argillic to advanced-argillic alteration. Near-surface acid alteration consisting of kaolinite-alunite-quartz likely formed at a higher level than present exposures and is now eroded from the area. Similarly, any surface manifestations of a hot-spring system have been removed by erosion. A hypothetical cross section through the Rois Malk study area (fig. 36) suggests a possible subsurface configuration of the vein system. Epithermal vein systems are typically productive over a vertical interval ranging from 100 to 200 m. Ore

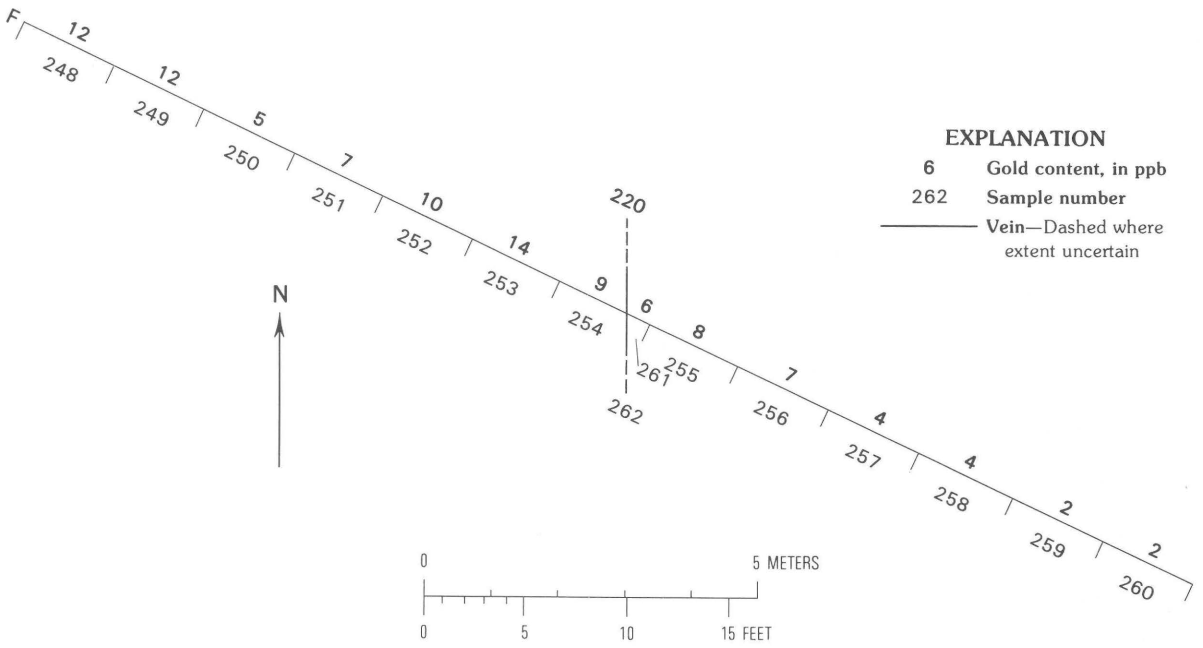


Figure 33. Plan view of backhoe trench F showing veins and gold content. Sample numbers have PM prefix. Gold content of samples determined by atomic absorption.

Table 11. Comparison of ranges of selected elements in channel samples from trench F between the Babelthuap Formation and the Airai Formation

[Values in ppm except for Au and Te in ppb]

	Au	Te	Zn	Cu	Co	Mn	B
Babelthuap Formation--	2-9	20-140	30-65	50-150	5-70	100-1,000	<10
Airai Formation--	5-14	420-780	<5-15	30-70	<5-5	20-30	10-15

grades tend to drop abruptly at the top and base of the productive zone even though veins and shear zones may extend above and below the productive zone.

Because no subsurface data are available and intense weathering obscures much of the alteration mineralogy, a conceptual model for the mineral system cannot be assigned with any certainty. However, on the basis of the limited surface evidence from alteration mineralogy and geochemistry, we speculate that the epithermal vein system is similar to the *deeper* levels of an enargite-gold subtype to the quartz-adularia (Sado) subtype (Ashley, 1982; Cox and Singer, 1986). The enargite-gold systems are characterized by high copper, arsenic, and gold in the upper parts of the vein system and contain increasing amounts of base metals and decreasing amounts of enargite and sulfosalts with depth. Tellurium is present throughout the system, and gold tellurides occur along with native gold. Pyrite, enargite, chalcopyrite, sphalerite, and silver-bearing sulfosalts also occur in the ore, with chalcopyrite replacing enargite as the dominant copper mineral with depth. The geochemistry of the Rois Malk oxidized vein systems is consistent with the original primary sulfide minerals being of the deeper levels of the enargite-gold subtype, where chalcopyrite dominates over enargite. All the vein systems are characterized by the presence of anomalous concentrations of gold, tellurium, and copper. Silver, arsenic, and zinc also are locally anomalous along parts of vein systems and were likely higher in concentration and more widespread prior to oxidation and weathering

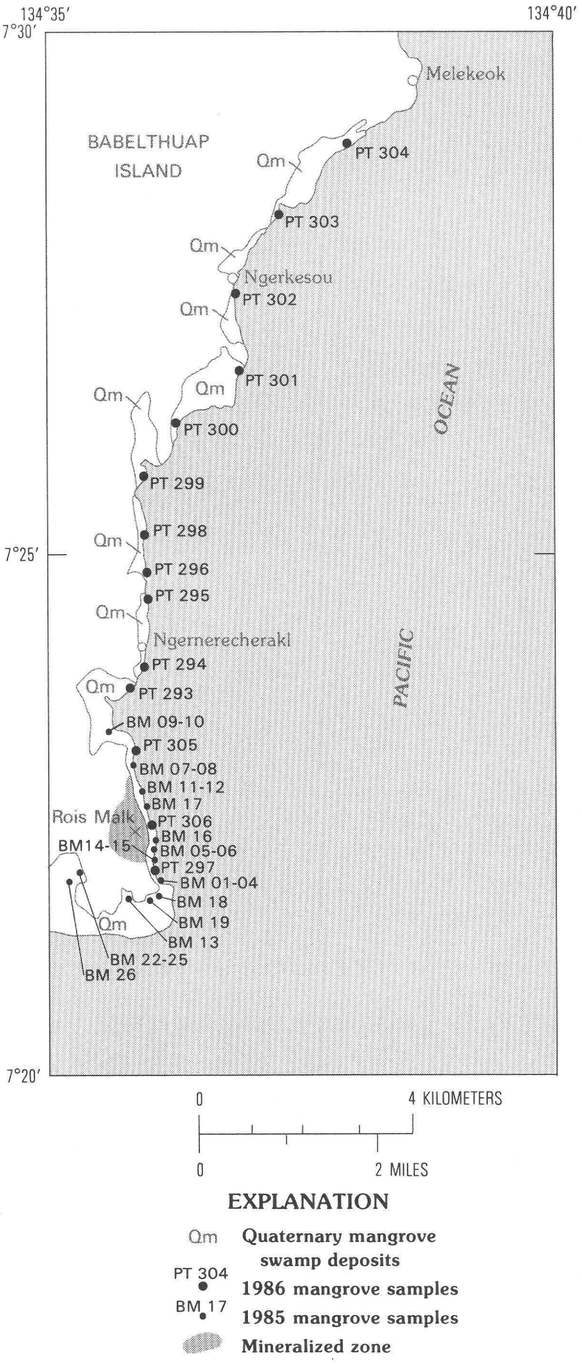


Figure 34. Location of sample sites for sediments taken from mangrove coast and swamp along the eastern and southern coast of Babelthuap.

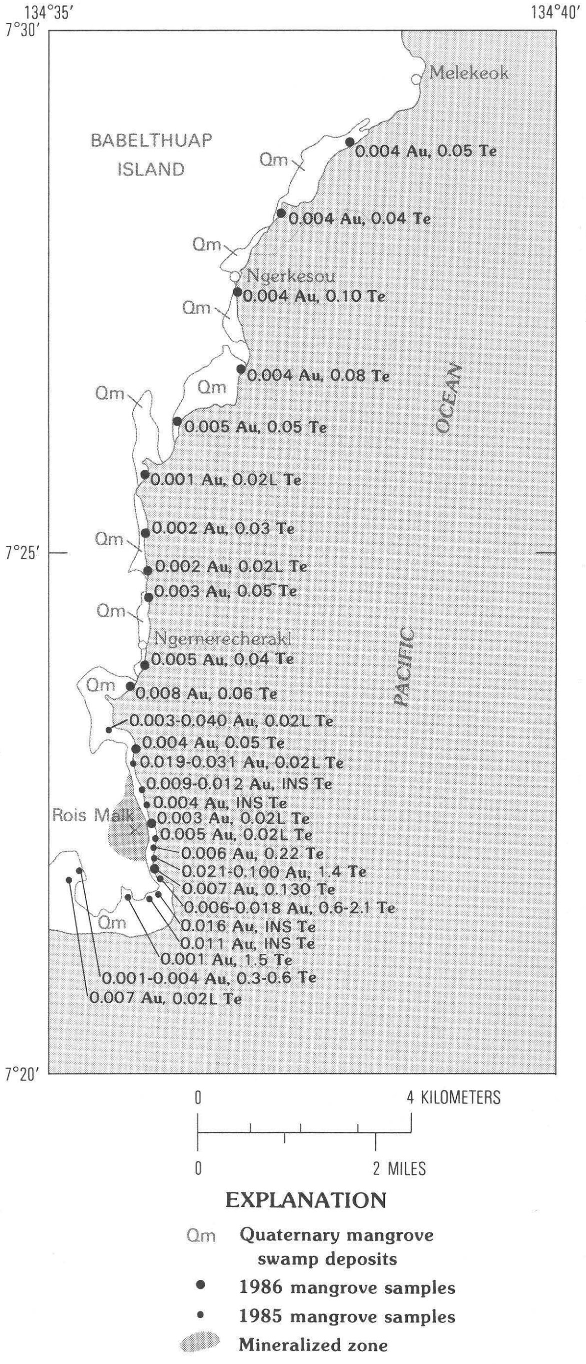


Figure 35. Gold and tellurium contents (ppb) of sediments from cores taken in mangrove coast and swamp environments. INS, insufficient sample for analysis; L, less than.

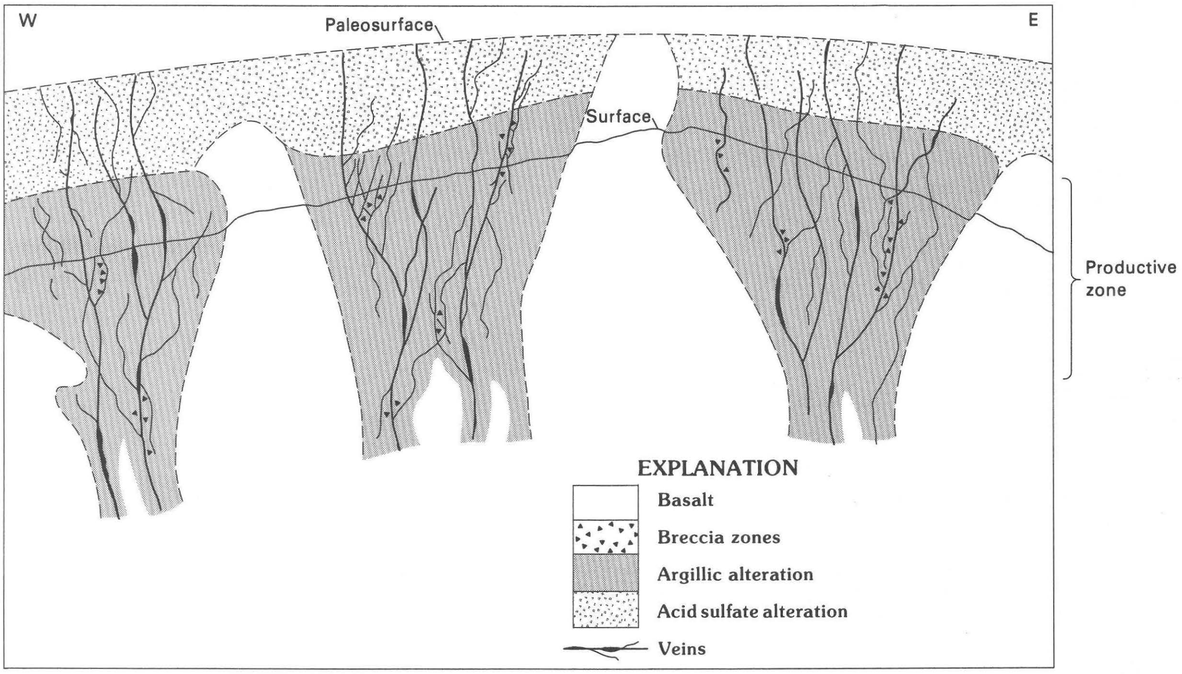


Figure 36. Schematic cross section through the vein system in the Rois Malk study area. Dashed lines are hypothetical contacts and paleosurface.

of the primary sulfides. Veins in enargite-gold systems tend to show typical replacement textures with brecciated country rock cemented by silica and sulfides. Veins have a vuggy and porous texture, and comb structures and crustified banding are common. Breccia pipes and pods of brecciated country rock often host ore. The schematic cross section (fig. 36) shows that breccia zones may be present at depth in the Rois Malk study area. Surface samples from the VB brecciated areas indicate that multiple brecciation and silicification episodes have occurred at Rois Malk. The possibility exists that the epithermal vein system at Rois Malk is the top part of a porphyry-copper system similar to the OK Tedi deposit in Papua, New Guinea (Davies, 1978), although no hypabyssal intrusive rock was observed at Rois Malk to support this hypothesis.

Estimates of the potential size of any orebody that may be discovered in the Rois Malk study area are speculative because of the lack of subsurface information. Drilling in the more intensely veined areas is therefore necessary for any more accurate assessments. However, ore grade and tonnage models based on known productive deposits can be used to define the possible size and grade of an orebody that may be discovered by subsurface drilling. For epithermal vein systems of the enargite-alunite subtype, the tonnage of known orebodies ranges from 0.2 to 11 million t (metric tons), and the gold grades can range from 3 to 18 ppm (0.1 to 0.6 oz/t), silver grades from 2 to 130 ppm, and copper from 0.05 to 5 percent (Cox and Singer, 1986). Tonnage and grade distributions are shown in figures 37–40.

The vein system in the Rois Malk study area warrants further surface exploration and subsurface drilling. The geochemistry and distribution of vein and shear zones reported in this study can be used as a basis to define several areas within the Rois Malk area that warrant further trenching, surface sampling, and drilling.

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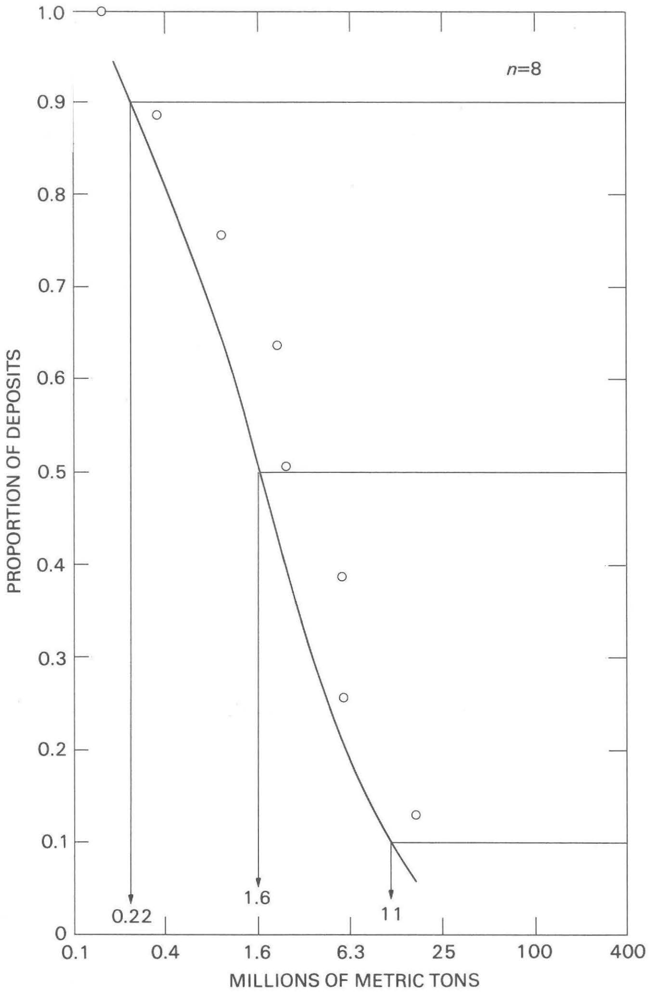

Figure 37. Range in size of productive epithermal gold vein deposits of the enargite subtype, from Cox and Singer (1986).

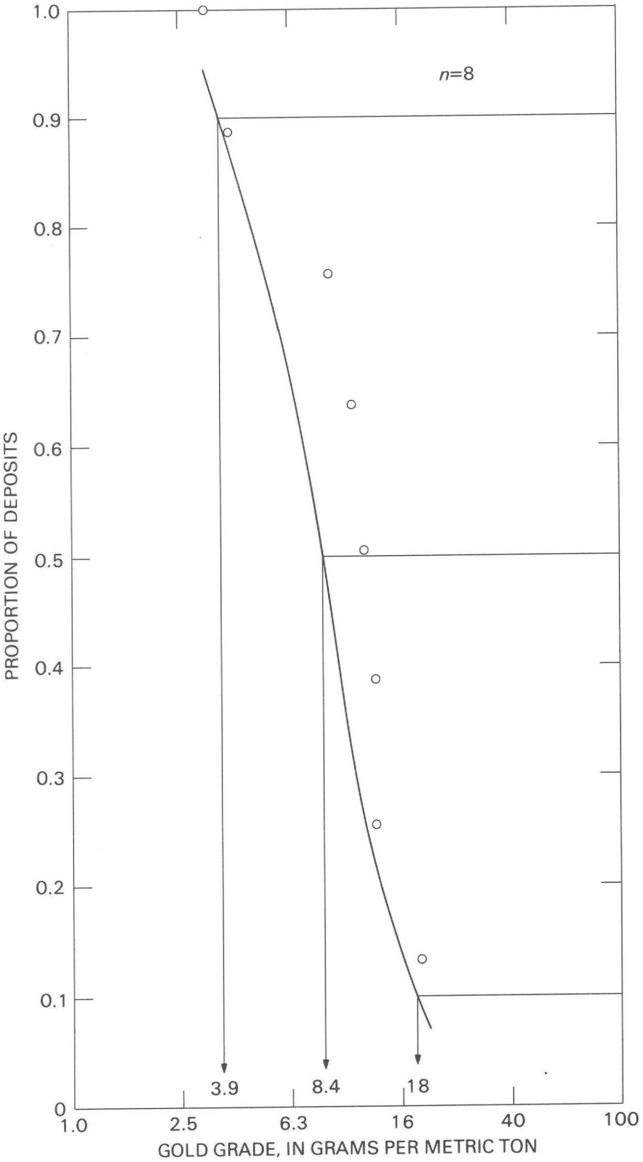

Figure 38. Range of gold grades in productive epithermal gold vein deposits of the enargite subtype, from Cox and Singer (1986).

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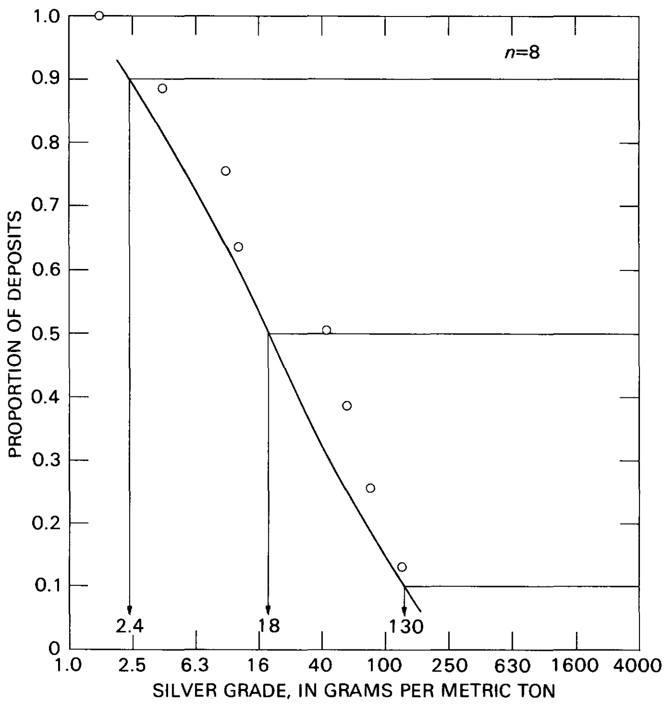

Figure 39. Range of silver grades in productive epithermal gold vein deposits of the enargite subtype, from Cox and Singer (1986).

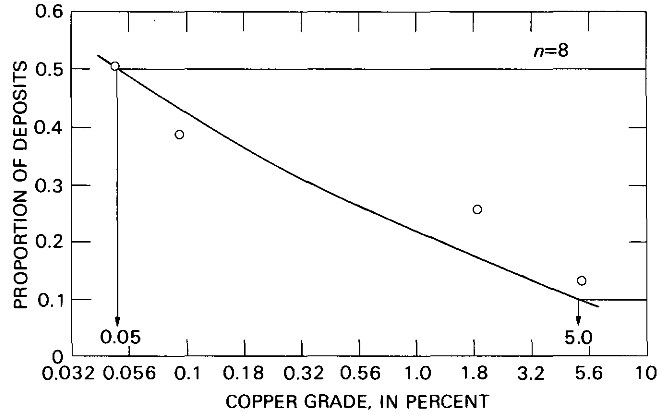

Figure 40. Range of copper grades in productive epithermal gold vein deposits of the enargite subtype, from Cox and Singer (1986).

APPENDIXES A–D

APPENDIX A. Description of Vein, Rock, and Channel Samples, Rois Malk Study Area

Table 12. Description of vein and rock samples from the Rois Malk study area

[S, sulfide; Ox, oxide after sulfide; Om, oxides of manganese; P, pyrite, when known; Sp, sphalerite, when known; L, laterite; B, fresh basalt; Bp, propylitic basalt; La, laterite formed vein; Si, silicified or quartz bearing; Su, sulfide cemented; Bx, breccia; gs, grab sample or composited grab sample; --, no data or not present; x, present]

Sample No.	Vein name	Strike	Dip	Vein width (cm)	Vein mineralogy Quartz	Vein mineralogy Sulfide/oxide	Channel width (cm)	Host rock	Vein type	Comments
PA 101	--	N. 10° W.	80°-90° E.	30	x	S	30	L	Si	Several parallel stringers.
PA 102	VA	N. 4° W.	80°-90° E.	6	x	Ox	6	L	Si	
PA 103	--	N 12° W.	--	10	x	X, Ox	10	L	Si	Open space, comb quartz.
PA 104	--	N. 5° E.	--	30	x	Ox	30	L	Si	
PA 105	--	N. 20° W.	--	30	x	Ox	30	L	Si, Su	
PA 106	--	--	--	150	x	Ox	gs	L	Si, Su	
PA 107	--	--	--	--			gs	L	--	Quartz surface rubble.
PA 108	--	N. 10° W.	--	10	x	Ox	10	L	Si	
PA 109	--	N. 1° E.	--	60	x	Ox	60	L	--	
PA 110	--	--	--	300	x	Ox	300	L	--	
PA 111	--	--	--	30	x	Ox	30	L	--	
PA 112	--	N. 70° W.	--	30	x	Ox	30	L	Si	
PA 113	--	--	--	20	x	Ox	20	L	Si	Comb quartz.
PA 126	VB-1	N. 2° E.	--	100	x	X, Ox	100	L	Si	Many parallel stringers.
PA 127	--	--	--	--	x	X, Ox	100	L	Si	Zone of stringers.
PA 138	--	N. 15° E.	--	--	--	Ox	gs	L	Ox	Fe oxide stringers.
PA 139	VS-1	N. 25° E.	90° E.	100	x	S, Ox	100	L	Si	Several stringers and stockwork.
PA 140	--	N. 10° E.	--	100	x	S, Ox	gs	L	Si	Grab sample from shaft tailings.
PA 141	--	N. 25° E.	--	30	x	Ox	30	L	Si	
PA 142	--	N. 15° E.	--	40	x	Ox, P	40	L	Si	
PA 143	--	N. 15° E.	--	30	x	Ox	30	L	Si	
PA 144	--	N. 15° E.	--	80	x	Ox	80	L	Si	
PM 101	--	N. 20° E.	--	30	x	Ox, Om	30	L	Si	Vugs.
PM 102	--	N. 10° E.	85° E.	50	x	S, Ox	50	L	Si, Su	
PM 116	--	N. 5° W.	--	30	x	Ox	30	L	Si	Veinlets.
PM 117	VB-1	N. 10° E.	--	>30	x	Ox	30	L	Bx	Comb quartz, vugs.
PM 118	VB-1	N. 5° W.	--	100	x	Ox	100	L	Bx	
PM 119	VB-1	N. 20° E.	82° E.	25	x	Ox	25	L	Bx	
PM 120	VB-1	N. 38° W.	80° E.	60	x	Ox	60	L	Bx	Vugs.
PM 121	--	N. 20° E.	--	--	x		gs	L		Radiating quartz.
PM 122	--	N. 1° E..	--	30	x	Ox	30	L	Si	Vugs.
PM 124	--	N. 20° E.	--	25	x	Ox	25	L	Si	
PM 125	--	N. 12° W.	--	15	x	Ox	15	L	Si	Three parallel veins.
PM 126	VB-2	N. 20° E.	--	--	x	Ox		L	Bx	Vugs.
PM 127	--	N. 15° W.	--	--	x	Ox		L	Si	Comb quartz.
PM 131	--	N. 10° W.	--	60	x	Ox, S	60	L	Si	Vugs.
PM 133	--	N. 28° E.	--	25	x	Ox	25	L	Bx	
PM 134	--	N. 40° E.	74° E.	15	x	Ox	15	L	Si	
PM 135	VB-3	N. 50° E.	--	100	x	S, Ox	100	L	Bx	
PM 136	--	--	--	10	x	Ox	10	L	Si	
PM 142	--	N. 7° W.	--	5	x	Ox	5	L	Si	
PM 143	--	--	--	15	x	Ox	15	L	Si	
PM 144	--	--	--	3	x	Ox	3	L	Si	

PM 152	--	N. 10° W.	--	60	x	S, Ox	60	L	Si	
PM 153	--	--	--	--	x	Ox	gs	L	--	Several 1 cm stringers.
PM 201A	--	--	--	--	x	Sp	gs	--	Si	Float in drainage.
PM 204	--	N. 35° W.	--	40	x	S, Ox	40	BP	Si	
PM 205	--	N. 35° W.	--	40	x	S, Ox	40	BP	Si	
PM 216	VB-2	--	--	--	x	Ox	gs	L	Bx	
PM 217	VB-2	--	--	--	x	Ox	gs	L	Bx	
PM 218	VB-2	--	--	--	x	Ox	gs	L	Bx	
PM 219	VB-2	--	--	--	--	--	gs	L	Bx	Laterite.
PM 220	VB-2	--	--	--	x	Ox	gs	L	Bx	Stockwork.
PM 225	VA	N. 1° E.	85°	20	x	S, Ox	20	L	Si	Comb quartz.
PM 226	VA	N. 1° E.	85°	10	x	Ox	10	L	Si	Comb quartz.
PM 227	VA	N. 1° E.	85°	50	x	Ox	50	L	Si	
PM 228	VA	N. 1° E.	85°	100	x	Ox	100	L	Si	
PM 229	VA	N. 1° E.	85°	8	x	Ox	8	L	Si	
PM 230	VA	N. 1° E.	85°	10	x	Ox	10	L	Si	
PM 231	VA	N. 1° E.	85°	--	x	Ox	50	L	Si	Stockwork.
PM 242	--	--	--	--	x	P, S, Ox	gs	L	Si	Abundant pyrite.
PM 244	--	N. 3° E.	--	10	x	Ox, S	10	L	Si	Comb quartz, vugs.
PM 245	--	N. 20° E.	5° E.	100	x	Ox	100	L	Si	Stockwork.
PM 246	--	--	--	100	x	Ox	100	L	Si	
PM 262	--	N. 14° E.	75° W.	3	x	Ox	3	L	Si	
PM 263	--	--	--	100	x	Ox	100	L	Si	Several veinlets.
PM 264	--	--	--	40	x	S, P, Ox	40	L	Si	Pink quartz.
PM 265	--	--	--	--	x	Ox	28	--	Si	Country rock adjacent to vein PM 267. Contains Fe-oxide and silica stringers.
PM 266	--	--	--	--	x	Ox	30	--	Si	Country rock adjacent to vein PM 267. Contains Fe oxide and silica stringers.
PM 267	--	N. 2° W.	80° W.	46	x	P, Ox	46	L	Si	
PM 269	--	N. 1° E.	--	30	x	S, Ox	30	L	Si	Comb quartz.
PM 270	--	--	--	--	--	Ox	gs	L	Si	Tight fractures.
PM 278	VS-1	N. 20° E.	80° E.	60		S, Ox	60	L	Si	
PM 280	--	N. 30° E.	--	--	x	Ox		L		
PM 281	--	--	--	--	x	Sp, Ox	gs	--	Si	Float.
PM 282	--	--	--	--	x	Ox	gs	L	Si	Shaft tailings.
PM 283	VB-1	--	--	100	x	S, Ox	100	L	Bx	
PM 284	VB-1	--	--	50	x	Ox	50	L	Bx	
PM 285	VB-1	--	--	100	--		100	L	Bx	Blue clay?
PM 286	VB-1	--	--	50	x	S, Ox, P	50	L	Bx	
PT 100A	--	N. 1° E.	75° W.	18	x	S	18	L	Si, Su	Discrete 2.5 cm vein of quartz with 15 cm of sulfide next to quartz, some brecciation.
PT 100B	--	N. 1° E.	75° W.	18	--	--	46	L		Sample of PT 100A plus surrounding rock.
PT 101A	--	N. 2° E.	75° E.	--	x	S	35	L	Su, Si	Two discrete veins 5 cm apart. One dominantly sulfide, the other is a quartz vein.
PT 102	--	--	--	10	x	S	gs	L	Si, Su	Abundant.
PT 103A	--	N. 5° W.	80° E.	25	x	P	21	L	Si, Su	Abundant vugs and open fractures with quartz. Blue-green specks.
PT 103B	--	--	--	2	x	--	6	--	Si veinlet	This is adjacent to PT 103A.
PT 105A	--	N. 5° W.	80°-85° W.	>30	x	Ox	gs	Bp	--	Vein may be in a fault zone.
PT 105C	--	N. 10° E.	75°-85° E.	>30	x	P	gs	Bp	--	
PT 107	--	--	--	10	x	S, Ox	10	L	--	
PT 108	--	--	--	--	x	Ox	gs	--	Si	Float.
PT 109	--	--	--	25	x	S	gs	L	--	Frothy quartz in open vugs.

Table 12. Description of vein and rock samples—Continued

Sample No.	Vein name	Strike	Dip	Vein width (cm)	Vein mineralogy		Channel width (cm)	Host rock	Vein type	Comments
					Quartz	Sulfide/oxide				
PT 110	--	N. 10° W.	85° W.	30	x	Ox	30	L	Si	White quartz in vugs.
PT 111	--	--	--	--	x	Ox	gs	--	Si zone	Silicified zone rather than discrete vein.
PT 112	--	--	--	--	x	Ox	gs	Bp	Si	Quartz crystals in open cavities. Float sample from creek.
PT 114	--	--	--	--	x	Ox	gs	L	Si	Float samples from creek.
PT 115	VS-1	N. 31° E.	85°-90° E.	60	x	Ox, Om	60	L	Si	Breccia zone more than vein.
PT 116	VS-1	N. 28° E.	85°-90° E.	75	x	Ox, Om	75	L	Bx, Si	Quartz stringers. Blue-green specks.
PT 117	VS-1	N. 24° E.	70° E.	200	x	Ox	200	L	Si	Blue-green mineral in northwestern 5 cm of vein. Blue-green specks.
PT 118	VS-1	--	--	46	x	P, Sp	46	L	Si	Good fresh material. This is from an old trench a few feet deep. Quartz is massive.
PT 119	--	--	--	46	x	P, Sp	46	L	Si	Quartz in vugs and in stringers.
PT 120	VS-1	--	>30	--	x	Sp, P	gs	L	Si	Quartz is massive.
PT 121	VS-1	--		--	x	P	gs	L	Si	
PT 122	--	--	--	--	x	--	gs	--	Si	Rock cut by sulfide and quartz veins.
PT 123	--	--	--	--	--	Ox	gs	L	Bx-Su	Sulfide cemented breccia, now oxidized.
PT 124	--	--	--	--	--	Ox	gs	L	Su	Mn oxides in fractures.
PT 125	--	--	--	--	--	--	gs	--	--	Float.
PT 126	VR-1	N. 10° W.	85°-90° W.	107	x	Ox	107	L	Su	Mostly a sulfide vein before oxidation Minor quartz. Blue-green stain.
PT 127	VR-1	N. 10° W.	85° W.	122	x	Ox	122	L	Su	Not much silicification.
PT 130B	VR-1	N. 15° E.	85° W.	168	x	Ox	30	L	Bx, Si	Comb quartz in vugs. Blue-green stain
PT 131	--	N. 15° W.	85° W.	30	x	Ox	30	L	Si, Su	Oxides after sulfides in vein at intersection with vein PT 130.
PT 132	--	--	--	15	x	Ox	46	L	Si, Su	Resistant zone is 56 cm wide, quartz and oxides zone only 15 cm wide.
PT 136	VS-1	--	--	--	x	P	gs	L	Si	Fine-grained pyrite disseminated through massive quartz. Float sample from creek.
PT 137	VS-1	--	--	30	x	Ox, P	30	L	Su, Si	Oxides 5 mm x 5 mm, vein mostly oxides, probably sphalerite; quartz in vugs.
PT 139	--	--	--	--	x	Ox	gs	L	Su, Si	Quartz in vugs.
PT 140	VS-1	--	--	--	x	Ox	gs	L	Si	Selected samples from surface.
PT 141	VS-1	--	--	--	x	Ox	gs	L	Si	Selected samples from surface. Same vein as PT 141, south side of road. Friable quartz.
PT 142	VS-1	--	--	--	x	Ox	--	L	Su, Si	Very weathered. Friable quartz. Blue-green stain.
PT 143	--	N. 5° W.	85° W.	15-30	x	Ox	15-30	L	Su, Si	Resistant, silicified, quartz in vugs.
PT 144	--	--	--	--	x	--	gs	L	Si	
PT 145	VR-1	--	--	--	x	--	--	L	Bx, Si	Float.
PT 147	--	--	--	--	--	Om	--	L	La	May be lateritically formed.
PT 148	--	--	--	--	x	Om	gs	L	La, Si	
PT 152	--	N. 10° W.	65° E.	20	x	Ox	20	L	Bx	
PT 153	--	N. 10° W.	70° E.	8	--	Ox	23	L	Bx, Su	Blue-green stain.
PT 167	--	N. 15° E.	75°-80° E.	10	x	Ox	10	L	Si	

PT 177	--	N. 30° W.	85° W.	12	x	Ox	12	L	Si	Fe staining along contacts, comb quartz.
PT 190	--	N. 20° W.	60° E.	5	x	Ox, Om	5	L	Si	
PT 191	--	N. 15° W.	80° E.	5	x	Om	20	L	Si	Channel 20 cm wide to include another small vein.
PT 208	--	N. 35° W.	85° E	15	x	--	15	L	Si	Several quartz stringers.
PT 210	--	N. 5° W.	85° E.	15	x	Ox	15	L	Si, Su	
PT 222	--	N. 3° E.	--	25	x	Ox	25	L	Si, Su	Abundant oxides after sulfides.
PT 228	--	N. 10° W.	80° E.	76	x	Ox	76	L	Su, Si	Vugs lined with quartz + oxides. Blue-green stain.
PT 246	--	N. 27° W.	90°	5	x	--	5	L	Si	Silica invaded adjacent country rock. Blue-green stain.
PT 250	--	N. 20° W.	75° E.	25	x	--	25	L	Si	
PT 253	--	N. 3° W.	77° W.	10	x	Ox	10	L	Si, Su	
PT 257	--	N. 27° W.	85° E.	15	x	Ox	15	L	Si	Blue-green stain.
PT 259	--	N. 15° W.	35° E.	8	x	Ox	8	L	Si, Su	
PT 278	VR-1	N. 13° E.	85° E.	20	x	Ox	20	L	Si	Blue-green specks.
PT 280	VR-1	N. 13° E.	85° E.	8	x	Ox	8	L	Si	Looks like silicified country rather than quartz vein.
PT 290	--	N. 15° E.	85° E.	2	x	--	2	Bp	Si	White quartz crystals.
PT 291	--	--	--	--	--	--	gs	L	Si(?)	Float.
PT 292	--	--	--	--	--	--	gs	--	--	
PT 307	--	N. 25° W.	85° E.	10	x	--	10	L	Si	Exposed in pit.
PT 308	--	--	--	--	--	--	30	--	--	
PT 309	--	N. 4° E.	85° E.	30	x	Ox	30	L		Several resistant zones.
PT 310	--	--	--	--	--	--	30	--	--	
PT 311	VS-1	--	--	30	x	--	30	L	Bx, Si	
PT 312	--	--	--	--	x	--	--	--	Si	
PT 313	--	N. 3° E.	85° E.	60	x	Ox	60	L	Si	Blue-green specks.
PT 314	--	N. 3° E.	85° E.		x	Ox	gs	L	Si	
PT 315	--	N. 3° E.	84° E.	182	x	--	182	L	Bx, Si	Part of vein is breccia.
PT 317	--	N. 7° E.	85° W.	60	x	--	60	L		Blue-green specks.
PT 318	--	N. 0° E.	84° W.	60	x	Ox	60	L	Su, Si	Resistant ribs of quartz.
PT 320	--	N. 10° E.	85° E.	25	x	--	25	L	Si	Resistant ribs of quartz.
PT 321	--	N. 15° E.	85° E.	30	x	Ox	30	L	Su, Si	
PT 322	--	N. 50° W.	84° E.	10	x	--	10	L	Si	
PT 324	--	N. 10° E.	85° W.	10-60	x	Ox, Om	gs	L		Botryoidal MnO vein.
PT 326	--	--	--	5	x	Ox		L	Su, Si	
JR 100	--	--	--	--	--	--	91	L	--	
JR 101	VR-1	N. 13° W.	74° E.	32	x	Ox	32	L	Si	Massive quartz.
JR 102	--	--	--	--	--	--	152	L	--	
JR 103	--	--	--	--	x	--	gs	--	Si	

Table 13. Description of channel samples from trenches, Rois Malk study area

Sample No.	Channel length (cm)	Trench No.	Comments
PT 154	152	D	Wall rock between veins.
PT 155	122	D	
PT 157	122	D	
PT 159	122	D	
PT 160	122	C	Contains some quartz-oxide veins.
PT 161	122	C	
PT 162	122	C	
PT 163	122	C	Contains some quartz veins.
PT 165	122	A	Minor quartz veinlets.
PT 166	122	A	Do.
PT 168	122	A	Do.
PT 171	304	A	
PT 172	304	A	Very faint quartz stringers.
PT 173	304	A	
PT 174	304	A	
PT 175	304	A	
PT 176	213	A	Several deeply weathered quartz stringers.
PT 178	91	B	
PT 180	91	B	
PT 181	396	B	Contains two 1 cm wide quartz veins.
PT 185	304	B	
PT 186	304	B	
PT 189	304	B	Sample excludes veins PT 187 and 188.
PT 194	304	B	Sample excludes veins PT 190, 191, and 192.
PT 196	304	B	
PT 198	304	B	
PT 199	304	B	
PT 200	304	B	
PT 202	304	B	Sample excludes vein PT 201.
PT 203	61	A	
PT 205	61	A	
PT 207	61	A	
PT 209	61	A	
PT 211	91	A	
PT 213	610	A	Transported soil (slide).
PT 214	610	A	
PT 217	182	A	
PT 219	304	A	
PT 220	304	A	
PT 221	304	A	
PT 223	396	A	
PT 225	46	A	
PT 227	488	A	
PT 230	30	A	
PT 231	183	D	
PT 233	213	C	
PT 235	152	D	
PT 236	244	D	
PT 238	213	E	
PT 239	396	E	
PT 241	304	C	Includes veins PT 242 and 24
PT 244	304	C	
PT 245	183	C	
PT 247	61	C	
PT 249	122	C	
PT 251	304	C	
PT 252	260	C	
PT 255	274	C	
PT 256	244	E	
PT 261	100	I	
PT 262	100	I	
PT 263	100	I	
PT 264	100	I	
PT 265	100	I	
PT 266	100	I	Contains samples PT 259 and 260.
PT 267	100	I	
PT 268	100	I	
PT 269	100	I	
PT 270	100	I	
PT 273	100	I	
PT 274	100	I	
PT 276	100	I	Contains samples PT 277, 278 279, 280, and 281.
PT 282	100	I	Contains Fe-oxide veinlets.
PT 283	100	I	
PT 284	100	I	
PT 285	100	I	
PT 286	100	I	
PT 287	100	I	
PT 288	100	I	
PA 128	200	H	
PA 129	200	H	
PA 131	200	H	
PA 132	200	H	
PA 133	200	H	
PA 134	200	H	
PA 135	200	H	
PA 136	200	H	
PA 137	200	H	
PM 103	200	N	
PM 104	200	N	
PM 105	200	N	
PM 106	200	N	
PM 107	200	N	
PM 108	200	N	
PM 109	200	N	
PM 110	200	N	
PM 111	200	N	
PM 137	200	M	
PM 138	200	M	
PM 139	200	M	
PM 140	200	M	
PM 141	200	M	
PM 145	200	L	
PM 146	200	L	
PM 147	200	L	
PM 148	200	L	
PM 149	200	L	
PM 150	200	L	
PM 151	200	L	
PM 154	200	K	
PM 155	200	K	
PM 156	200	K	
PM 157	200	K	
PM 158	200	K	
PM 208	200	G	
PM 209	200	G	
PM 210	200	G	
PM 211	200	G	
PM 212	200	G	
PM 213	200	G	
PM 214	200	G	
PM 215	200	G	
PM 232	200	O	
PM 233	200	O	
PM 234	200	O	
PM 235	200	O	
PM 236	200	O	
PM 237	200	O	
PM 238	200	O	
PM 239	200	O	
PM 240	200	O	
PM 241	200	O	
PM 248	150	F	
PM 249	150	F	
PM 250	150	F	
PM 251	150	F	
PM 252	150	F	
PM 253	150	F	
PM 254	150	F	
PM 255	150	F	
PM 256	150	F	
PM 257	150	F	
PM 258	150	F	
PM 259	150	F	
PM 260	150	F	
PM 271	150	P	
PM 272	150	P	
PM 273	150	P	
PM 274	150	P	
PM 275	150	P	
PM 276	150	P	

APPENDIX B. Chemical Data for Vein, Channel, Soil, Stream-Sediment, and Heavy-Mineral Concentrates, Rois Malk Study Area

Each sample was analyzed by R.T. Hopkins for 31 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The elements analyzed and their lower limits of determination are listed in table 14. Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, ... Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, ... The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level and plus or minus two reporting intervals at the 96 percent confidence level (Motooka and Grimes, 1976). The results of these analyses are shown in table 15. In addition, gold and tellurium were determined in each sample by J.B. McHugh and antimony, arsenic, bismuth, cadmium, and zinc (A–Z method) by R.M. O'Leary using atomic-absorption spectroscopy.

A brief description of these procedures follows. *Gold*: A 10-gram sample is roasted for 1 hour at 700 °C; gold is then extracted with hydrobromic acid–0.5 percent bromine solution and MIBK (methyl isobutyl ketone). Flame atomic-absorption spectroscopy is used to determine gold to 0.05 ppm detection limit; samples below this limit are determined by electrothermal atomic-absorption spectroscopy using background correction to 0.001 ppm detection limit (O'Leary and Meier, 1986). *Tellurium:* Te is extracted from a 5-gram sample with hydrobromic–2 percent bromine solution and MIBK. Ascorbic acid is used to reduce iron interference. Flame atomic-absorption spectroscopy is used to determine tellurium to 0.02 ppm detection limit (O'Leary and Meier, 1986). *A–Z Method*: The metals of interest are solubilized from a 1.0-gram sample with hydrochloric-hydrogen peroxide solution and extracted with Aliquat 336–MIBK. Flame atomic-absorption spectroscopy is used to determine these metals. Limits of detection are Sb 2 ppm, As 10 ppm, Bi 1 ppm, Cd 0.1 ppm, and Zn 5 ppm (O'Leary and Viets, 1986).

Tables 15–20 list results of analyses for samples. Data are arranged so that column 1 contains the USGS-assigned sample numbers. Columns 2 and 3 are the sample localities in UTM–N and UTM–E (Universal Transverse Mercator, zone 53). Columns in which element headings show the letter "s" before the element symbol are emission spectrographic analyses; "aa" indicates atomic-absorption analyses. "P" or "T" after the element symbol in the "aa" columns indicates partial or total digestion of the sample for that element. Note: Values determined for the major elements (Fe, Mg, Ca, and Ti) are given in weight percent; all others are given in parts per million (micrograms/gram).

Table 14. Limits of determination for the spectrographic analysis based on a 10-mg sample

[Spectrographic limits of determination for heavy-mineral-concentrate samples are based on a 5-mg sample, and are therefore two reporting intervals higher than the limits given for rocks and stream sediments]

Elements	Lower determination limit	Upper determination limit
	Percent	
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

Table 15. Chemical data for 151 vein samples from the Rois Malk area

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown]

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
JR101	815,131.13	453,750.94	10.0	.15	<.05	.150	2,000	<.5	N	N	15	<20
JR103	815,131.13	453,750.94	10.0	.10	N	.070	150	N	N	N	<10	<20
PA101	814,604.44	454,200.31	7.0	.50	<.05	.200	700	<.5	N	N	N	N
PA102	814,494.13	454,284.31	5.0	.15	<.05	.200	3,000	<.5	N	N	<10	150
PA103	814,445.25	454,311.88	7.0	<.02	N	.020	70	5.0	N	N	N	N
PA104	814,314.69	454,312.19	5.0	.07	<.05	.200	500	N	N	N	N	N
PA105	814,876.06	453,577.50	20.0	.02	<.05	.070	500	N	N	N	N	N
PA106	814,895.94	453,634.94	15.0	.07	<.05	.200	70	N	N	N	N	N
PA107	814,901.88	453,660.69	20.0	.07	<.05	.200	70	N	N	N	N	N
PA108	814,853.31	453,794.19	10.0	.10	N	.100	20	N	N	N	10	<20
PA109	814,578.25	454,246.44	7.0	.07	<.05	.100	500	7.0	N	N	<10	100
PA110	814,572.75	454,206.56	5.0	.07	<.05	.200	1,000	N	N	N	N	N
PA111	814,572.50	454,200.94	10.0	.07	<.05	.150	500	N	N	N	N	N
PA112	814,585.56	454,140.06	20.0	<.02	N	.150	150	1.5	N	N	N	N
PA113	814,571.81	454,132.06	5.0	.07	<.05	.100	50	1.0	N	<10	15	70
PA126	814,794.06	453,999.00	7.0	.07	N	.200	3,000	1.0	N	N	N	100
PA138	814,815.81	453,954.63	7.0	.07	N	.500	300	N	N	N	N	N
PA139	814,817.31	453,942.88	20.0	.07	N	.100	>5,000	2.0	N	N	N	300
PA140	814,942.94	454,038.63	7.0	.02	<.05	.100	70	2.0	N	N	10	30
PA141	814,951.38	453,917.69	15.0	<.02	<.05	.300	700	N	N	N	N	<20
PA142	814,964.13	453,908.50	15.0	.02	<.05	.070	>5,000	N	N	N	N	300
PA143	814,969.19	453,906.56	15.0	.02	<.05	.150	150	N	N	N	N	N
PA144	814,969.19	453,901.31	20.0	.02	<.05	.070	>5,000	.5	N	N	N	300
PM101	815,192.75	454,140.88	15.0	.07	<.05	.200	50	N	N	N	N	<20
PM102	814,537.50	454,338.38	10.0	.05	<.05	.100	150	1.5	N	N	N	20
PM116	814,686.69	454,079.31	5.0	.02	<.05	.200	1,000	N	N	N	N	N
PM117	814,725.50	454,005.06	7.0	.07	<.05	.100	30	<.5	N	N	<10	20
PM118	814,781.81	453,987.06	7.0	.03	<.05	.070	50	N	N	N	10	N
PM119	814,711.38	453,989.69	7.0	.10	<.05	.100	30	N	N	N	<10	50
PM120	814,701.94	453,982.50	7.0	.05	<.05	.070	30	N	N	N	15	N
PM121	814,827.69	454,284.81	7.0	.15	<.05	.100	150	N	N	N	N	100
PM122	814,721.31	454,273.19	5.0	.15	<.05	.200	150	N	N	N	N	<20
PM124	814,711.25	454,284.06	5.0	.10	<.05	.150	700	N	N	N	<10	N
PM125	814,652.00	454,241.13	5.0	.15	<.05	.200	3,000	N	N	N	N	<20
PM126	814,693.75	454,244.19	20.0	.30	N	.070	150	N	N	N	N	N
PM127	814,559.63	454,343.50	5.0	.15	N	.015	2,000	5.0	N	N	10	50
PM131	814,520.00	454,140.06	7.0	.15	<.05	.070	50	7.0	N	N	15	50
PM133	814,402.75	454,304.88	7.0	.15	<.05	.030	30	N	N	N	<10	N
PM134	814,350.00	454,303.38	10.0	.20	<.05	.200	1,000	N	N	N	N	N
PM135	814,782.69	454,266.13	10.0	.20	<.05	.100	150	.5	N	N	N	30
PM136	814,615.31	454,066.19	3.0	.10	N	.100	300	N	N	N	N	N
PM142	814,493.13	454,287.19	3.0	.10	<.05	.070	>5,000	10.0	N	N	15	500
PM143	814,492.00	454,289.75	5.0	.15	N	.300	300	N	N	N	N	N
PM144	814,490.44	454,292.25	7.0	.20	<.05	.150	700	.7	N	N	N	200
PM152	814,519.75	454,140.19	5.0	.15	<.05	.070	100	N	N	N	15	100

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
JR101	N	10	N	10	1,000	1,500	N	15	N	20	700	N	50	15
JR103	N	N	N	N	500	1,000	N	7	N	15	150	N	50	N
PA101	N	N	N	50	1,000	500	N	N	N	150	30	N	50	N
PA102	N	<10	N	500	700	500	N	N	N	100	15	N	70	N
PA103	N	N	N	10	150	500	N	N	N	15	10	N	10	N
PA104	N	N	N	30	300	700	N	N	N	50	10	N	30	N
PA105	N	N	N	70	500	50	N	<5	N	50	10	N	20	N
PA106	N	N	N	<5	200	150	N	N	N	30	70	N	30	N
PA107	N	N	N	N	1,000	100	N	N	N	30	20	N	50	N
PA108	N	N	N	N	150	300	N	5	N	5	10	N	30	N
PA109	N	30	N	15	1,500	700	N	N	N	20	N	N	50	N
PA110	N	N	N	30	700	150	N	N	N	200	30	N	50	N
PA111	N	N	N	30	1,500	200	N	N	N	70	<10	N	50	N
PA112	N	10	N	15	700	1,500	N	N	N	50	15	N	50	N
PA113	N	N	N	<5	150	100	N	20	N	10	150	N	20	N
PA126	N	N	N	70	300	500	N	N	N	150	50	N	50	N
PA138	N	N	N	7	200	150	N	N	N	70	10	N	50	N
PA139	<1	N	N	300	300	1,000	N	N	N	70	200	N	70	N
PA140	N	N	N	5	300	300	N	N	N	10	15	N	15	N
PA141	N	N	N	20	150	300	N	N	N	150	20	N	70	N
PA142	N	N	N	150	150	500	N	N	N	50	<10	N	50	N
PA143	<1	N	N	15	150	700	N	N	N	50	<10	N	50	N
PA144	<1	N	N	100	100	700	N	N	N	30	15	N	50	N
PM101	N	N	N	N	500	200	N	N	N	<5	20	N	30	N
PM102	N	N	N	<5	1,000	500	N	N	N	15	15	N	15	N
PM116	N	N	N	70	500	100	N	N	N	150	<10	N	50	N
PM117	N	N	N	N	150	300	N	20	N	10	15	N	15	N
PM118	N	N	N	N	500	700	N	N	N	5	10	N	20	N
PM119	N	N	N	N	150	300	N	10	N	5	15	N	20	N
PM120	N	N	N	N	200	200	N	N	N	10	10	N	30	N
PM121	N	N	N	20	700	500	N	N	N	30	20	N	20	N
PM122	N	N	N	5	300	300	N	N	N	70	10	N	30	N
PM124	N	N	N	30	500	300	N	N	N	150	20	N	30	N
PM125	N	N	N	70	700	200	N	N	N	150	10	N	50	N
PM126	N	N	N	20	1,000	500	N	N	N	30	50	N	30	N
PM127	N	N	N	10	200	300	N	N	N	15	10	N	<5	N
PM131	N	N	N	N	150	200	N	N	N	10	50	N	7	N
PM133	N	N	N	N	20	700	N	7	N	<5	N	N	20	N
PM134	N	N	N	50	500	1,500	N	N	N	150	10	N	50	N
PM135	N	<10	N	<5	700	300	N	N	N	20	70	N	50	N
PM136	N	N	N	15	300	70	N	N	N	20	N	N	30	N
PM142	N	N	N	1,500	300	1,000	N	N	N	200	N	N	50	N
PM143	N	N	N	20	200	100	N	N	N	30	N	N	50	N
PM144	N	N	N	15	300	500	N	N	N	30	20	N	70	N
PM152	N	N	N	10	150	200	N	<5	N	10	50	N	10	N

Table 15. Chemical data for 151 vein samples—Continued

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
JR101	N	300	N	N	300	15	N	50	300	.6	5	8	1.450	10.40
JR103	N	200	N	N	N	<10	N	30	70	N	2	2	.230	5.14
PA101	N	150	N	N	<200	15	N	N	180	N	N	N	.100	4.38
PA102	N	200	N	10	<200	30	N	N	220	1.1	4	N	1.470	13.00
PA103	N	70	N	N	N	<10	N	20	50	N	2	10	.500	5.98
PA104	N	200	N	N	N	20	N	N	20	N	N	N	.017	2.74
PA105	N	300	N	15	200	10	N	30	65	N	N	N	.020	.36
PA106	N	200	N	<10	N	30	N	20	35	N	N	N	.036	1.50
PA107	N	200	N	N	N	20	N	N	5	N	N	N	.045	1.16
PA108	N	100	N	10	N	20	N	160	40	N	1	N	.280	2.80
PA109	N	200	N	N	<200	30	N	N	130	.2	25	N	1.970	18.60
PA110	N	150	N	N	200	30	N	N	110	N	N	N	.050	3.36
PA111	N	200	N	N	<200	15	N	N	170	.1	1	N	.060	8.10
PA112	N	150	N	N	<200	15	N	N	90	N	10	N	.150	11.40
PA113	N	200	N	N	200	15	N	10	170	N	3	N	5.800	7.70
PA126	N	200	N	N	<200	20	N	N	130	.2	N	N	.006	1.02
PA138	N	500	N	N	N	30	N	N	45	N	N	N	.005	.06
PA139	N	150	N	20	<200	10	N	20	130	.7	N	N	.070	.85
PA140	N	200	N	<10	N	10	N	20	30	N	N	N	.260	6.55
PA141	N	200	N	10	300	20	N	N	25	.5	N	N	.006	.06
PA142	N	100	N	20	500	N	N	N	35	7.9	N	N	.033	.54
PA143	N	150	N	10	200	20	N	N	170	.1	N	N	.027	.08
PA144	N	50	N	15	200	10	N	N	75	4.2	N	N	.033	.02
PM101	N	70	N	N	N	<10	N	10	10	N	2	N	.140	5.39
PM102	N	150	N	<10	<200	10	N	N	70	.1	N	N	.390	4.58
PM116	N	200	N	N	N	20	N	N	45	N	N	N	.036	2.01
PM117	N	150	N	N	N	20	N	60	40	N	1	N	.200	6.67
PM118	N	200	N	N	N	10	N	10	30	N	N	N	.060	3.78
PM119	N	150	N	N	N	15	N	50	15	N	N	N	.320	2.55
PM120	N	150	N	<10	<200	10	N	150	130	N	N	N	.130	6.02
PM121	N	150	N	N	<200	<10	N	N	85	N	N	N	.030	6.38
PM122	N	150	N	N	N	10	N	N	50	N	N	N	.140	8.24
PM124	N	150	N	N	<200	10	N	N	120	.1	N	N	.039	4.72
PM125	N	200	N	N	<200	20	N	N	170	.2	N	N	.025	2.95
PM126	N	100	N	N	<200	<10	N	N	75	N	1	N	.180	5.15
PM127	N	100	N	N	N	N	N	N	35	.3	2	N	.530	5.24
PM131	N	150	N	N	<200	10	N	N	130	N	N	N	.240	2.21
PM133	N	150	N	N	N	N	N	20	60	N	N	N	.060	2.84
PM134	N	200	N	10	200	20	N	N	190	N	N	N	.023	6.90
PM135	N	150	N	N	<200	15	N	10	100	N	2	N	1.050	15.60
PM136	N	300	N	N	N	20	N	<10	35	N	N	N	.025	3.58
PM142	N	150	N	15	200	15	N	N	240	11.0	N	N	.900	4.15
PM143	N	300	N	<10	200	30	N	N	220	.2	N	N	.016	.87
PM144	N	300	N	N	200	20	N	N	220	.1	N	N	.120	4.60
PM152	N	150	N	N	<200	<10	N	N	130	.1	N	N	.200	4.98

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
PM153	814,520.44	454,144.31	5.0	.15	<.05	.300	>5,000	1.5	N	N	20	1,000
PM201A	814,886.75	454,554.31	1.5	.15	.15	.070	150	.7	N	N	10	500
PM204	814,932.44	454,544.19	5.0	.50	.10	.100	300	5.0	N	N	N	N
PM205	814,910.88	454,572.00	15.0	.03	<.05	.015	150	1.0	N	N	N	N
PM216	814,692.13	454,252.44	15.0	.07	<.05	.150	70	N	N	N	N	<20
PM217	814,692.25	454,251.13	20.0	.03	<.05	.070	700	N	N	N	N	N
PM218	814,693.25	454,250.56	20.0	.05	<.05	.070	150	N	N	N	N	<20
PM219	814,694.13	454,252.50	3.0	.05	<.05	.200	1,000	1.5	N	N	N	N
PM220	814,693.56	454,253.44	10.0	.10	<.05	.150	700	<.5	N	N	N	70
PM225	814,462.81	454,316.56	5.0	.10	<.05	.100	70	2.0	N	N	N	150
PM226	814,462.88	454,316.13	5.0	.10	<.05	.150	30	N	N	N	N	100
PM227	814,462.31	454,313.31	3.0	.07	<.05	.200	300	N	N	N	N	N
PM228	814,466.19	454,307.56	5.0	.07	<.05	.200	1,000	N	N	N	N	N
PM229	814,465.94	454,305.44	7.0	.07	<.05	.300	1,000	N	N	N	N	N
PM230	814,465.63	454,301.06	3.0	.20	<.05	.300	50	N	N	N	<10	150
PM231	814,465.56	454,297.13	5.0	<.02	N	.010	200	5.0	N	N	N	N
PM242	814,483.56	454,319.00	7.0	.03	<.05	.070	30	1.5	N	N	N	50
PM244	814,432.25	454,310.56	15.0	.03	N	.050	50	7.0	N	N	10	<20
PM245	814,347.25	454,306.44	5.0	.10	<.05	.300	700	N	N	N	N	N
PM246	814,337.88	454,317.44	7.0	.05	<.05	.300	700	N	N	N	N	N
PM262	814,917.63	453,715.19	7.0	.15	.05	.200	30	N	N	N	15	50
PM263	814,656.56	454,186.38	3.0	.15	<.05	.200	1,500	N	N	N	N	N
PM264	814,537.69	454,338.75	15.0	.02	<.05	.030	70	N	N	N	N	<20
PM269	814,559.56	454,333.88	7.0	.03	<.05	.030	1,000	3.0	N	<10	10	50
PM270	814,381.63	454,419.50	7.0	.50	.05	.300	1,000	N	N	N	N	N
PM278	815,189.13	454,139.19	20.0	.10	N	.200	30	N	N	N	N	70
PM280	814,781.06	454,432.06	3.0	.20	.05	.100	300	3.0	N	N	<10	70
PM281	814,751.50	454,503.94	1.5	.70	.07	.100	500	1.5	N	N	10	200
PM282	814,942.94	454,038.63	7.0	.03	<.05	.100	100	2.0	N	N	N	70
PM283	814,714.19	453,982.25	10.0	.03	<.05	.070	20	<.5	<200	N	N	<20
PM284	814,767.31	454,007.19	10.0	.07	<.05	.050	20	N	N	N	10	70
PM285	814,765.13	453,995.38	3.0	.05	<.05	.200	20	N	N	N	N	N
PM286	814,764.19	453,992.38	10.0	.05	<.05	.150	20	N	N	N	N	30
PT100A	814,965.38	454,292.44	7.0	.03	<.05	.050	1,500	N	N	N	<10	N
PT100B	814,965.38	454,292.44	5.0	.10	<.05	.200	>5,000	1.5	N	N	10	100
PT101A	814,971.50	454,296.38	10.0	.10	<.05	.150	500	N	N	N	10	<20
PT102	815,002.00	454,308.88	7.0	.03	<.05	.050	200	N	N	N	N	N
PT103A	814,942.88	454,290.00	10.0	.10	<.05	.100	2,000	3.0	N	N	10	70
PT103B	814,942.88	454,290.00	7.0	.10	<.05	.300	150	N	N	N	15	N
PT105A	814,910.06	454,296.06	10.0	.30	.05	.100	300	2.0	N	N	15	<20
PT105C	814,910.06	454,296.06	5.0	1.00	.05	.200	500	1.5	N	N	<10	N
PT107	814,933.75	454,332.06	5.0	.15	.50	.200	1,500	N	N	N	<10	N
PT108	814,911.50	454,405.94	7.0	.20	.10	.070	200	3.0	N	N	10	<20
PT109	814,976.88	454,394.19	5.0	.10	<.05	.070	1,000	10.0	N	N	20	20
PT110	814,981.25	454,376.88	10.0	.07	<.05	.050	70	7.0	N	N	20	30

Table 15. Chemical data for 151 vein samples—Continued

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
PM153	N	N	N	150	700	300	N	N	N	500	30	N	70	N
PM201A	N	N	N	<5	300	50	20	15	N	10	70	<100	<5	N
PM204	N	N	N	10	500	500	N	N	N	30	15	N	20	N
PM205	N	N	N	10	150	700	N	N	N	20	20	N	7	N
PM216	N	N	N	7	700	700	N	N	N	20	100	N	30	N
PM217	N	N	N	70	700	1,000	N	N	N	50	30	N	30	N
PM218	N	N	N	10	700	700	N	N	N	10	50	N	30	N
PM219	N	N	N	70	700	500	N	N	N	150	150	N	50	N
PM220	N	N	N	50	500	700	N	N	N	15	20	N	20	N
PM225	N	N	N	<5	300	500	N	N	N	10	<10	300	30	N
PM226	N	N	N	N	500	150	N	N	N	10	N	N	30	N
PM227	N	N	N	15	700	150	N	N	N	150	<10	N	50	N
PM228	N	N	N	70	1,000	200	N	N	N	100	10	N	50	N
PM229	N	N	N	100	700	150	N	N	N	150	10	N	50	N
PM230	N	N	N	N	30	50	N	N	N	7	<10	N	30	N
PM231	N	10	N	30	50	700	N	N	N	7	<10	N	7	N
PM242	N	N	N	<5	500	200	N	N	N	7	10	N	20	N
PM244	N	15	N	<5	150	1,500	N	N	N	10	10	N	20	N
PM245	N	N	N	30	500	700	N	N	N	150	<10	N	30	N
PM246	N	N	N	70	500	700	N	N	N	150	15	N	50	N
PM262	N	N	N	N	300	100	N	N	N	20	10	N	30	N
PM263	N	N	N	70	1,000	1,000	N	N	N	150	20	N	50	N
PM264	N	N	N	<5	1,000	500	N	N	N	30	<10	N	20	N
PM269	N	15	N	10	50	200	N	N	N	20	20	N	7	N
PM270	N	N	N	70	300	150	N	N	N	100	10	N	30	N
PM278	N	N	N	N	700	100	N	N	N	7	<10	N	30	N
PM280	N	N	N	7	300	1,000	N	30	N	30	500	N	15	N
PM281	N	N	150	<5	150	200	<20	10	N	30	700	N	10	N
PM282	N	N	N	N	300	200	N	5	N	7	15	N	30	N
PM283	N	N	N	N	200	500	N	15	N	<5	20	N	30	N
PM284	N	N	N	10	70	500	N	N	N	10	70	N	15	N
PM285	N	N	N	N	700	150	N	N	N	100	<10	N	30	N
PM286	N	N	N	N	700	300	N	5	N	5	15	N	15	N
PT100A	N	N	N	150	1,000	700	N	N	N	50	<10	N	30	N
PT100B	N	N	N	700	700	1,000	N	N	N	200	30	N	50	N
PT101A	N	N	N	70	2,000	2,000	N	N	N	150	50	N	70	N
PT102	N	N	N	10	500	300	N	N	N	30	10	N	30	N
PT103A	N	N	N	70	700	1,500	N	N	N	50	150	N	70	N
PT103B	N	N	N	20	2,000	700	N	N	N	100	20	N	100	N
PT105A	N	<10	N	15	500	700	N	N	N	30	70	N	20	N
PT105C	N	N	N	10	500	500	N	N	N	50	10	N	30	N
PT107	N	N	N	100	50	200	N	N	N	150	10	N	70	N
PT108	N	<10	N	10	200	500	N	N	N	30	20	N	20	N
PT109	N	N	N	100	200	500	N	N	N	20	50	N	20	N
PT110	N	N	N	N	150	300	N	5	N	5	70	N	10	N

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PM153	N	300	N	20	300	30	N	N	250	3.2	N	N	.026	4.52
PM201A	N	30	N	N	700	20	N	20	560	43.0	N	N	.140	.34
PM204	N	150	N	N	300	20	N	10	220	.1	N	N	.250	7.55
PM205	N	150	N	N	500	N	N	90	220	.5	N	N	2.700	4.74
PM216	N	150	N	N	N	15	N	N	20	N	N	N	.042	6.10
PM217	N	150	N	N	<200	N	N	20	100	N	4	N	.120	6.28
PM218	N	70	N	N	<200	N	N	<10	45	N	1	N	.045	4.03
PM219	N	200	N	<10	N	15	N	N	45	.1	N	N	.011	3.39
PM220	N	100	N	N	N	10	N	N	55	N	1	N	.026	6.22
PM225	N	100	N	15	<200	15	N	170	70	N	2	190	.740	7.45
PM226	N	150	N	<10	N	20	N	10	5	N	N	N	.260	7.62
PM227	N	200	N	15	<200	20	N	N	60	.3	N	N	.016	4.72
PM228	N	200	N	15	<200	20	N	N	140	.2	N	N	.220	6.36
PM229	N	200	N	20	<200	20	N	N	85	N	N	N	.021	6.68
PM230	N	200	N	N	N	30	N	N	15	N	N	N	.006	5.62
PM231	N	20	N	N	N	N	N	N	10	N	5	N	.990	9.60
PM242	N	500	N	<10	N	N	N	N	35	N	2	N	.150	4.20
PM244	N	70	N	15	<200	<10	N	N	145	.1	12	N	2.200	8.60
PM245	N	200	N	N	<200	20	N	N	80	N	N	N	.024	5.42
PM246	N	200	N	N	N	20	N	N	20	N	N	N	.010	2.98
PM262	N	200	N	N	N	30	N	N	20	N	N	N	.220	2.18
PM263	N	200	N	N	N	20	N	N	20	N	N	N	.020	1.76
PM264	N	200	N	N	<200	N	N	20	80	N	2	N	.150	4.74
PM269	N	150	N	N	N	N	N	<10	50	.5	8	N	5.400	10.90
PM270	N	200	N	N	<200	30	N	N	70	N	N	N	.050	1.94
PM278	N	150	N	N	N	15	N	30	10	N	2	N	.080	5.55
PM280	N	200	N	N	<200	15	N	60	270	2.1	2	N	.600	2.68
PM281	N	70	N	N	10,000	10	N	10	340	54.0	N	N	.110	1.10
PM282	N	300	N	N	N	10	N	10	45	N	N	N	.030	6.65
PM283	N	200	N	N	N	10	N	130	10	N	N	N	.430	4.37
PM284	N	100	N	N	200	<10	N	20	170	.1	N	N	1.580	5.41
PM285	N	200	N	10	N	20	N	N	30	N	N	N	.051	1.88
PM286	N	100	N	N	N	15	N	N	5	N	N	N	.024	4.12
PT100A	N	200	N	N	N	<10	N	10	65	.1	N	N	.520	4.60
PT100B	N	300	N	10	200	20	N	N	180	.2	N	N	.039	2.00
PT101A	N	1,000	N	<10	700	10	N	10	620	2.1	3	N	.430	8.52
PT102	N	200	N	N	200	N	N	10	130	.2	3	N	.090	11.20
PT103A	N	700	N	N	300	<10	N	N	280	2.6	3	N	.510	8.44
PT103B	N	700	N	N	300	20	N	<10	210	.6	N	N	.120	2.14
PT105A	N	200	N	N	300	10	N	30	220	.3	3	N	.660	10.60
PT105C	N	200	N	N	<200	15	N	N	100	N	1	N	.420	5.62
PT107	N	300	N	N	<200	15	N	N	100	.6	N	N	.015	1.16
PT108	N	200	N	N	300	10	N	N	210	.5	2	N	.100	6.42
PT109	N	100	N	N	<200	10	N	N	120	.4	1	N	.430	6.62
PT110	N	70	N	N	200	10	N	N	150	N	2	N	1.320	4.88

Table 15. Chemical data for 151 vein samples—Continued

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
PT111	815,131.19	454,341.38	10.0	.30	.15	.200	5,000	10.0	N	N	15	70
PT112	815,236.69	454,296.63	7.0	1.00	.05	.150	700	15.0	N	N	10	N
PT114	815,159.38	454,379.50	7.0	.10	.05	.030	>5,000	20.0	N	N	15	700
PT115	815,186.06	454,136.94	20.0	.05	<.05	.100	2,000	1.5	N	N	N	20
PT116	815,156.06	454,105.50	10.0	.10	<.05	.150	1,500	N	N	N	<10	150
PT117	815,137.38	454,091.81	15.0	.07	<.05	.070	50	N	N	N	<10	<20
PT118	815,091.19	454,069.75	15.0	.03	<.05	.050	100	3.0	N	N	N	<20
PT119	815,078.25	454,063.75	5.0	.03	<.05	.070	100	2.0	N	N	15	<20
PT120B	815,060.75	454,055.25	5.0	1.00	<.05	.100	1,000	2.0	N	N	15	<20
PT121	815,041.06	454,045.44	5.0	.03	<.05	.100	70	1.0	N	N	15	30
PT122	815,041.13	454,045.38	5.0	.15	<.05	.300	70	N	N	N	10	150
PT123	815,036.25	454,067.50	10.0	<.02	<.05	.070	70	N	N	N	N	<20
PT124	815,258.94	454,130.94	5.0	.50	<.05	.500	2,000	N	N	N	15	<20
PT125	815,350.13	454,153.13	5.0	.70	.05	.300	1,000	N	N	N	15	20
PT126	815,148.69	453,750.94	10.0	.20	<.05	.150	50	20.0	N	N	15	<20
PT127	815,106.75	453,752.19	3.0	.07	<.05	.300	300	5.0	N	N	10	N
PT130B	814,922.94	453,730.19	5.0	.10	<.05	.150	20	5.0	N	N	10	20
PT131	814,899.13	453,727.50	7.0	.10	<.05	.300	30	N	N	N	15	30
PT132	814,931.00	453,723.50	7.0	.15	<.05	.200	100	N	N	N	15	30
PT136	814,860.75	453,956.88	3.0	.30	.05	.150	300	N	N	N	<10	<20
PT137	814,908.06	453,970.75	10.0	.50	<.05	.200	1,000	N	N	N	10	<20
PT139	815,097.75	453,595.06	7.0	.07	<.05	.150	70	N	N	N	10	<20
PT140	814,810.19	453,937.81	15.0	.02	N	.030	200	1.5	N	N	N	N
PT141	814,771.50	453,924.19	10.0	.05	<.05	.100	100	N	N	N	<10	N
PT142	814,717.00	453,897.13	3.0	.07	<.05	.100	200	N	N	N	10	<20
PT143	814,719.25	453,882.19	5.0	.05	<.05	.100	2,000	10.0	N	N	10	150
PT144	814,693.94	453,813.69	7.0	.07	<.05	.150	200	N	N	N	<10	<20
PT145	814,804.19	453,728.31	5.0	.15	<.05	.070	70	N	N	N	15	N
PT149	815,651.63	453,953.25	2.0	<.02	<.05	.200	1,000	N	N	N	N	N
PT152	814,971.94	454,310.88	7.0	.03	<.05	.300	5,000	3.0	N	N	N	<20
PT153	814,972.25	454,304.88	10.0	.15	<.05	.150	1,500	N	N	N	<10	70
PT167	815,021.19	454,273.56	7.0	.03	<.05	.070	1,000	1.5	N	N	10	100
PT177	815,023.56	454,291.88	5.0	.03	<.05	.300	1,000	N	N	N	10	N
PT190	814,999.88	454,296.50	7.0	.07	<.05	.150	>5,000	7.0	N	N	15	200
PT191	814,999.94	454,298.69	7.0	.07	<.05	.150	500	.7	N	N	15	N
PT208	815,024.13	454,297.19	7.0	.15	<.05	.300	1,000	1.5	N	N	20	50
PT210	815,024.31	454,300.06	10.0	.10	<.05	.150	700	1.5	N	N	20	70
PT222	815,028.50	454,324.63	10.0	.10	<.05	.100	500	<.5	N	N	20	20
PT228	815,030.25	454,338.75	5.0	.15	<.05	.200	1,500	3.0	N	N	20	150
PT246	814,983.06	454,299.44	10.0	.03	<.05	.300	1,500	3.0	N	N	N	<20
PT250	814,983.19	454,304.25	15.0	.10	<.05	.200	300	N	N	N	N	30
PT253	814,983.44	454,310.94	5.0	.03	<.05	.070	700	N	N	N	15	N
PT257	815,155.19	453,719.13	3.0	.10	<.05	.200	3,000	N	N	N	20	500
PT259	814,917.31	453,732.25	5.0	.15	<.05	.150	70	N	N	N	20	100
PT278	814,912.56	453,745.19	3.0	.15	<.05	.300	20	N	N	N	50	70

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
PT111	N	10	N	50	700	1,000	N	N	N	100	700	N	30	N
PT112	N	N	N	20	2,000	1,000	N	N	N	150	30	N	30	N
PT114	N	N	N	2,000	1,000	5,000	N	N	N	500	50	N	>100	N
PT115	N	N	N	100	500	200	N	N	N	30	30	N	30	N
PT116	N	N	N	15	700	300	N	N	N	20	15	N	50	N
PT117	N	N	N	N	200	300	N	20	N	15	70	N	30	N
PT118	N	N	>500	70	70	3,000	N	N	N	50	30	N	10	N
PT119	N	N	N	5	50	300	N	5	N	<5	<10	N	15	N
PT120B	N	N	>500	70	300	5,000	N	7	N	50	20	N	20	N
PT121	N	N	N	20	300	200	N	15	N	30	30	N	15	N
PT122	N	N	N	N	150	200	N	N	N	<5	15	N	30	N
PT123	N	N	N	N	150	300	N	<5	N	<5	20	N	7	N
PT124	N	N	N	100	1,000	500	N	N	N	200	15	N	30	N
PT125	N	N	N	50	1,000	500	N	N	N	100	10	N	30	N
PT126	N	<10	N	<5	700	3,000	N	10	N	20	50	N	30	N
PT127	N	N	N	10	200	700	N	N	N	30	100	N	30	N
PT130B	N	N	N	N	300	200	N	N	N	<5	150	N	20	N
PT131	N	N	N	N	500	500	N	N	N	15	30	N	30	N
PT132	N	N	N	5	200	500	N	N	N	20	20	N	30	N
PT136	N	N	N	15	700	500	N	10	N	30	15	N	20	N
PT137	N	N	N	50	100	700	N	N	N	50	<10	N	20	N
PT139	N	N	N	N	300	150	N	15	N	10	15	N	20	N
PT140	N	N	N	10	150	700	N	N	N	20	50	N	30	N
PT141	N	N	N	<5	500	500	N	N	N	30	30	N	30	N
PT142	N	N	N	10	700	200	N	N	N	50	20	N	30	N
PT143	N	N	N	200	300	700	N	7	N	70	50	N	30	N
PT144	N	N	N	10	300	500	N	N	N	30	30	N	50	N
PT145	N	<10	N	N	150	700	N	30	N	7	15	N	30	N
PT149	N	N	N	100	200	30	N	N	N	50	N	N	30	N
PT152	N	N	N	200	1,000	2,000	N	N	N	200	50	N	70	N
PT153	N	N	N	70	1,500	2,000	N	N	N	70	20	N	70	N
PT167	N	N	N	20	1,500	700	N	N	N	100	50	N	50	N
PT177	N	N	N	50	500	200	N	N	N	150	50	N	70	N
PT190	N	N	N	300	1,000	1,000	N	N	N	300	300	N	70	N
PT191	N	N	N	50	700	700	N	N	N	100	50	N	70	N
PT208	N	N	N	150	1,000	700	N	N	N	100	70	N	70	N
PT210	N	N	N	70	1,000	700	N	N	N	50	70	N	70	N
PT222	N	N	N	20	1,000	700	N	N	N	50	70	N	70	N
PT228	N	N	N	15	200	300	N	N	N	15	700	N	70	N
PT246	N	N	N	150	3,000	1,500	N	N	N	150	70	N	70	N
PT250	N	N	N	70	2,000	3,000	N	N	N	150	50	N	100	N
PT253	N	N	N	70	700	500	N	N	N	70	10	N	50	N
PT257	N	N	N	70	300	200	N	N	N	50	150	N	30	N
PT259	N	N	N	N	200	500	N	N	N	15	10	N	30	N
PT278	N	N	N	N	150	150	N	N	N	10	150	N	30	N

Table 15. Chemical data for 151 vein samples—Continued

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PT111	N	300	N	20	700	20	N	N	460	.8	6	N	3.000	6.22
PT112	N	200	N	N	<200	10	N	N	110	N	N	N	.150	3.52
PT114	<100	500	N	20	500	10	N	10	350	21.0	1	N	.450	4.90
PT115	N	70	N	N	<200	10	N	20	15	N	2	N	.240	6.25
PT116	N	200	N	10	<200	10	N	20	100	.4	2	N	.180	6.90
PT117	N	150	N	N	<200	N	N	10	85	N	2	N	3.900	4.95
PT118	N	50	N	N	>10,000	10	N	10	>2,000	>100.0	N	N	3.600	4.23
PT119	N	150	N	N	200	10	N	<10	50	.2	1	N	.440	7.92
PT120B	N	150	N	N	>10,000	10	N	N	>2,000	>100.0	N	N	1.180	6.26
PT121	N	150	N	N	500	15	N	20	140	.7	1	N	.230	3.36
PT122	N	300	N	N	N	30	N	30	40	.2	N	N	.340	5.17
PT123	N	50	N	N	N	N	N	10	20	N	N	N	.120	1.16
PT124	N	200	N	15	500	30	N	N	160	.3	N	N	.017	.68
PT125	N	200	N	N	200	20	N	N	130	N	N	N	.024	1.31
PT126	N	300	N	N	N	<10	N	40	85	N	6	N	.660	10.30
PT127	N	200	N	N	N	20	N	10	50	N	3	N	.500	6.94
PT130B	N	500	N	N	N	20	N	40	55	N	1	N	3.300	2.82
PT131	N	300	N	N	N	30	N	20	10	N	1	N	.070	3.25
PT132	N	200	N	N	<200	20	N	30	100	N	1	N	.060	1.75
PT136	N	200	N	N	200	15	N	10	120	.2	1	N	1.090	9.28
PT137	N	150	N	15	200	20	N	<10	190	N	N	N	.070	3.19
PT139	N	300	N	N	N	20	N	30	15	N	1	N	1.960	3.88
PT140	N	300	N	20	200	<10	N	130	120	.1	1	N	.250	2.87
PT141	N	300	N	N	N	15	N	10	35	N	N	N	.070	3.36
PT142	N	300	N	N	<200	20	N	40	90	.1	N	N	.100	.40
PT143	N	150	N	N	N	20	N	50	35	.5	N	N	.310	3.19
PT144	N	200	N	N	N	15	N	70	30	N	N	N	.250	4.76
PT145	N	100	N	N	N	N	N	40	45	N	2	N	.700	3.93
PT149	N	150	N	<10	N	20	N	N	10	N	N	N	.015	.02
PT152	N	200	N	N	200	15	N	10	220	.1	N	N	.150	3.62
PT153	N	300	N	N	200	10	N	10	210	.2	4	N	.130	9.12
PT167	N	300	N	N	<200	10	N	N	110	.1	N	N	.180	2.34
PT177	N	200	N	N	N	20	N	N	40	N	N	N	.007	.34
PT190	N	300	N	10	500	15	N	10	460	3.1	N	N	.510	3.61
PT191	N	500	N	N	500	10	N	<10	390	.9	N	N	.180	4.12
PT208	N	300	N	<10	500	20	N	N	350	.7	N	N	.410	6.94
PT210	N	200	N	N	300	15	N	N	270	.7	2	N	.470	5.50
PT222	N	500	N	N	700	10	N	10	700	1.7	1	N	.580	8.60
PT228	N	300	N	<10	700	20	N	30	820	1.8	2	N	.960	13.00
PT246	N	500	N	N	<200	20	N	N	170	.8	3	N	.180	5.64
PT250	N	1,000	N	N	700	15	N	20	650	1.9	4	N	.470	8.34
PT253	N	150	N	N	<200	<10	N	20	150	.1	1	N	.140	8.76
PT257	N	200	N	N	N	20	N	N	25	.1	N	N	.240	.66
PT259	N	200	N	N	N	20	N	N	40	N	1	N	.038	2.50
PT278	N	300	N	N	N	30	N	30	5	N	N	N	.720	1.74

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
PT280	814,911.31	453,748.69	5.0	.15	<.05	.300	50	N	N	N	30	50
PT290	815,898.13	454,183.13	3.0	1.50	.70	.300	>5,000	N	N	N	<10	300
PT291	815,874.81	454,203.06	3.0	.20	<.05	.200	150	10.0	300	10	30	20
PT307	815,068.25	454,004.25	10.0	.20	N	.300	1,500	.5	N	N	10	<20
PT309	814,991.75	454,026.19	10.0	.20	<.05	.300	100	<.5	N	N	20	70
PT311	815,015.13	454,023.44	5.0	.10	<.05	.200	70	N	N	N	15	20
PT313	814,918.94	454,041.31	7.0	.07	<.05	.200	300	N	N	N	N	70
PT314	814,943.19	454,038.50	7.0	.03	<.05	.200	50	30.0	N	N	<10	70
PT315	814,939.81	454,041.63	5.0	.05	N	.150	1,000	.7	N	N	<10	150
PT317	814,937.13	454,029.00	15.0	.10	<.05	.200	50	N	N	N	15	70
PT318	814,940.50	454,014.13	15.0	.10	N	.200	50	N	N	N	20	<20
PT320	814,947.56	453,990.63	15.0	.07	N	.200	150	5.0	N	N	N	20
PT321	814,946.69	453,980.13	10.0	<.02	N	.300	20	N	N	N	N	N
PT322	814,948.06	453,965.38	20.0	.03	N	.070	500	N	N	N	N	<20
PT324	814,945.69	453,944.81	20.0	.07	<.05	.070	>5,000	3.0	N	N	N	200
PT326	814,938.44	453,894.88	15.0	.05	N	.200	150	N	N	N	N	N

Table 15. Chemical data for 151 vein samples—Continued

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
PT280	N	N	N	N	150	300	N	N	N	5	70	N	30	N
PT290	N	N	N	70	300	700	N	N	N	150	30	N	30	N
PT291	N	N	N	N	100	700	N	100	N	10	200	N	15	N
PT307	N	N	N	100	500	1,000	N	10	N	100	30	N	50	N
PT309	N	N	N	5	200	500	N	10	N	15	10	N	50	N
PT311	N	N	N	N	700	150	N	15	N	20	<10	N	30	N
PT313	N	N	N	N	500	150	N	5	N	5	50	N	30	N
PT314	N	N	N	10	300	150	N	N	N	20	15	N	20	N
PT315	N	N	N	70	300	300	N	5	N	20	30	N	50	N
PT317	N	N	N	N	500	300	N	5	N	10	15	N	50	N
PT318	N	N	N	N	150	300	N	20	N	7	10	N	50	N
PT320	N	N	N	7	100	200	N	N	N	30	<10	N	70	N
PT321	N	N	N	N	100	700	N	N	N	30	15	N	30	N
PT322	<1	N	N	20	300	300	N	N	N	50	<10	N	50	N
PT324	<1	N	N	300	50	300	N	N	N	50	70	N	50	N
PT326	<1	N	N	20	150	500	N	N	N	30	<10	N	50	N

Sample	Sr-ppm	V-ppm	W-ppm	Y-ppm	Zn-ppm	Zr-ppm	Th-ppm	As-ppm	Zn-ppm	Cd-ppm	Bi-ppm	Sb-ppm	Au-ppm	Te-ppm
	s	s	s	s	s	s	s	aa	aa	aa	aa	aa	aa	aa
PT280	N	300	N	15	N	20	N	80	N	N	1	2	.910	3.75
PT290	150	200	N	20	<200	10	N	N	200	5.4	N	N	.110	.13
PT291	N	150	N	15	N	20	N	300	70	.2	4	2	13.000	13.90
PT307	N	200	N	N	N	20	N	30	95	N	1	N	.110	5.98
PT309	N	300	N	N	500	20	N	30	310	.1	2	N	.210	5.32
PT311	N	200	N	N	N	10	N	20	20	N	1	N	.080	3.37
PT313	N	300	N	N	N	<10	N	30	10	N	2	N	.130	8.78
PT314	N	300	N	N	N	<10	N	20	10	N	1	N	.060	9.62
PT315	N	300	N	<10	<200	15	N	20	90	.5	N	N	.050	4.64
PT317	N	200	N	N	<200	20	N	80	25	N	2	N	.180	2.70
PT318	N	200	N	N	<200	20	N	50	100	N	2	N	.160	5.48
PT320	N	200	N	10	300	10	N	60	320	N	N	N	.210	1.53
PT321	N	300	N	N	N	20	N	10	25	N	2	N	.080	5.82
PT322	N	150	N	15	500	<10	N	10	400	.2	N	N	.030	.34
PT324	N	150	N	30	700	<10	N	30	630	3.5	N	N	3.500	.62
PT326	N	200	N	20	300	20	N	N	310	.1	N	N	.060	.03

Table 16. Chemical data for 163 channel samples from the Rois Malk area

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown]

Sample	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-pp s
JR100	7.0	.07	<.05	.30	300	2.0	N	N	10	N	N	N
JR102	5.0	.15	N	.50	200	N	N	N	N	N	N	N
PA127	5.0	.10	N	.30	3,000	1.0	N	N	N	100	N	N
PA128	5.0	.07	N	.50	300	N	N	N	N	N	N	N
PA129	3.0	.07	N	.50	300	N	N	N	N	N	N	N
PA130	5.0	.07	N	.50	150	N	N	N	N	N	N	N
PA131	5.0	.10	N	.30	150	N	N	N	N	N	N	N
PA132	5.0	.07	N	.30	100	N	N	N	N	N	N	N
PA133	5.0	.07	N	.30	100	N	N	N	N	N	N	N
PA134	7.0	.10	N	.50	200	N	N	N	N	N	N	N
PA135	10.0	.15	N	.30	1,500	.5	N	N	<10	150	N	N
PA136	10.0	.15	N	.50	500	N	N	N	<10	20	N	N
PA137	3.0	.07	N	.30	200	N	N	N	N	N	N	N
PM103	3.0	.10	<.05	.50	20	N	N	N	10	N	N	N
PM104	3.0	.15	<.05	.30	30	N	N	N	N	N	N	N
PM105	2.0	.07	<.05	.50	30	N	N	N	N	N	N	N
PM106	1.5	.05	N	.30	30	N	N	N	N	N	N	N
PM107	3.0	.07	N	.50	70	N	N	N	10	N	N	N
PM108	3.0	.07	<.05	.50	50	N	N	N	<10	N	N	N
PM109	3.0	.10	<.05	.50	150	N	N	N	N	N	N	N
PM110	3.0	.07	<.05	.50	70	N	N	N	10	N	N	N
PM111	3.0	.07	<.05	.50	70	N	N	N	<10	N	N	N
PM137	3.0	.07	<.05	.30	200	N	N	N	<10	N	N	N
PM138	3.0	.10	<.05	.30	5,000	N	N	N	10	70	N	N
PM139	3.0	.07	<.05	.30	300	N	N	N	<10	N	N	N
PM140	3.0	.10	N	.50	200	N	N	N	10	N	N	N
PM141	3.0	.10	<.05	.30	200	N	N	N	10	50	N	N
PM145	5.0	.30	<.05	.50	1,000	N	N	N	N	N	N	N
PM146	5.0	.20	<.05	.30	1,000	N	N	N	10	<20	N	N
PM147	3.0	.20	<.05	.30	1,500	N	N	N	<10	20	N	N
PM148	3.0	.20	<.05	.30	3,000	N	N	N	N	100	N	N
PM149	5.0	.30	<.05	.50	700	N	N	N	N	20	N	N
PM150	5.0	.50	.07	.50	1,500	N	N	N	N	50	N	N
PM151	5.0	.30	<.05	.30	1,000	N	N	N	N	N	N	N
PM154	3.0	2.00	2.00	.30	700	N	N	N	10	N	N	N
PM155	3.0	2.00	3.00	.30	1,000	N	N	N	<10	N	N	N
PM156	5.0	1.50	5.00	.30	1,000	N	N	N	N	N	N	N
PM157	3.0	1.50	2.00	.30	1,000	N	N	N	N	N	N	N
PM158	3.0	2.00	3.00	.30	1,000	N	N	N	N	N	N	N
PM208	7.0	.20	<.05	.50	3,000	N	N	N	N	<20	N	N
PM209	7.0	.15	<.05	.50	1,000	N	N	N	N	N	N	N
PM210	7.0	.10	<.05	.50	700	N	N	N	N	N	N	N
PM211	7.0	.07	<.05	.50	1,000	N	N	N	N	N	N	N
PM212	5.0	.10	<.05	.30	1,500	N	N	N	N	<20	N	N
PM213	7.0	.15	<.05	.30	3,000	N	N	N	N	100	N	N

Sample	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s
JR100	N	7	700	700	N	N	N	100	150	N	50	N	N
JR102	N	N	200	100	N	N	N	30	30	N	30	N	N
PA127	N	70	200	500	N	N	N	100	50	N	50	N	N
PA128	N	<5	300	70	N	N	N	50	<10	N	50	N	N
PA129	N	<5	300	100	N	N	N	50	N	N	30	N	N
PA130	N	<5	300	150	N	N	N	50	<10	N	30	N	N
PA131	N	<5	300	100	N	N	N	30	<10	N	30	N	N
PA132	N	N	200	70	N	N	N	30	<10	N	30	N	N
PA133	N	N	200	70	N	N	N	50	<10	N	30	N	N
PA134	N	10	300	100	N	N	N	50	10	N	50	N	N
PA135	N	100	300	700	N	N	N	50	150	N	70	N	N
PA136	N	20	700	300	N	N	N	50	50	N	50	N	N
PA137	N	N	300	70	N	N	N	50	10	N	30	N	N
PM103	N	N	150	70	N	N	N	30	<10	N	30	N	N
PM104	N	N	150	100	N	N	N	30	N	N	30	N	N
PM105	N	N	100	30	N	N	N	50	N	N	30	N	N
PM106	N	N	70	30	N	N	N	50	N	N	30	N	N
PM107	N	N	150	50	N	N	N	50	N	N	30	N	N
PM108	N	<5	150	70	N	N	N	50	N	N	30	N	N
PM109	N	5	100	100	N	N	N	100	N	N	30	N	N
PM110	N	<5	150	150	N	N	N	100	N	N	30	N	N
PM111	N	5	150	150	N	N	N	150	N	N	50	N	N
PM137	N	20	200	150	N	N	N	100	<10	N	50	N	N
PM138	N	200	200	200	N	N	N	100	N	N	50	N	N
PM139	N	7	150	70	N	N	N	70	<10	N	50	N	N
PM140	N	20	200	70	N	N	N	100	<10	N	50	N	N
PM141	N	10	200	200	N	N	N	100	<10	N	50	N	N
PM145	N	70	700	100	N	N	N	150	30	N	50	N	N
PM146	N	70	700	200	N	N	N	100	70	N	30	N	N
PM147	N	20	700	150	N	N	N	100	20	N	50	N	N
PM148	N	70	300	150	N	N	N	100	15	N	50	N	N
PM149	N	50	700	150	N	N	N	100	N	N	50	N	N
PM150	N	100	700	150	N	N	N	150	50	N	70	N	N
PM151	N	100	500	150	N	N	N	150	N	N	70	N	N
PM154	N	70	300	30	N	N	N	150	N	N	30	N	300
PM155	N	50	200	150	N	N	N	150	N	N	30	N	300
PM156	N	50	500	100	N	N	N	100	N	N	50	N	300
PM157	N	50	200	100	N	N	N	100	N	N	30	N	300
PM158	N	50	300	70	N	N	N	150	<10	N	30	N	300
PM208	N	100	2,000	150	N	N	N	200	30	N	70	N	N
PM209	N	70	1,000	150	N	N	N	200	<10	N	70	N	N
PM210	N	70	1,000	150	N	N	N	200	10	N	70	N	N
PM211	N	70	1,500	200	N	N	N	300	<10	N	70	N	N
PM212	N	70	700	150	N	N	N	150	N	N	70	N	N
PM213	N	150	1,000	200	N	N	N	300	N	N	100	N	N

Table 16. Chemical data for 163 channel samples—Continued

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
JR100	200	N	N	<200	30	N	N	70	.1	--	N	.009	.10
JR102	200	N	<10	<200	30	N	N	20	N	--	N	.015	.12
PA127	300	N	N	<200	30	N	N	130	N	--	N	.002	.98
PA128	300	N	N	N	30	N	N	30	N	--	N	.001	.02
PA129	500	N	N	N	30	N	N	30	N	--	N	.002	<.02
PA130	300	N	N	N	30	N	N	20	N	--	N	.005	<.02
PA131	200	N	N	N	30	N	N	15	N	--	N	.003	<.02
PA132	200	N	<10	N	30	N	N	10	N	--	N	.002	<.02
PA133	150	N	N	N	30	N	N	15	N	--	N	.002	<.02
PA134	200	N	N	N	30	N	N	20	N	--	N	.005	<.02
PA135	300	N	15	<200	20	N	N	30	.1	--	N	.610	.90
PA136	300	N	<10	<200	30	N	N	85	N	--	N	.160	.41
PA137	200	N	N	N	30	N	N	50	N	--	N	.006	.06
PM103	200	N	<10	N	50	N	N	N	N	--	N	.001	3.28
PM104	300	N	15	N	30	N	N	N	N	--	N	.001	2.88
PM105	300	N	<10	N	50	N	N	N	N	--	N	<.001	1.22
PM106	300	N	<10	N	50	N	N	N	N	--	N	.002	1.84
PM107	300	N	<10	N	50	N	N	5	N	--	N	.003	.79
PM108	300	N	<10	N	50	N	N	10	N	--	N	.001	.87
PM109	300	N	<10	N	50	N	N	5	N	--	N	.001	1.00
PM110	300	N	N	N	50	N	N	10	N	--	N	<.001	.59
PM111	300	N	<10	N	70	N	N	5	N	--	N	<.001	.63
PM137	200	N	<10	200	30	N	N	130	N	--	N	.004	.23
PM138	300	N	15	<200	30	N	N	150	3.6	--	N	.016	1.54
PM139	300	N	<10	200	50	N	N	85	N	--	N	.005	.50
PM140	300	N	N	<200	50	N	N	60	N	--	N	.004	.35
PM141	300	N	<10	<200	50	N	N	80	N	--	N	.021	1.68
PM145	200	N	15	200	30	N	N	85	.4	--	N	.004	.18
PM146	300	N	30	300	30	N	N	135	1.2	--	N	.037	2.03
PM147	300	N	10	200	20	N	N	125	.3	--	N	.004	1.00
PM148	200	N	<10	<200	30	N	N	75	.4	--	N	<.001	.95
PM149	200	N	<10	<200	50	N	N	50	N	--	N	<.001	.06
PM150	300	N	10	N	30	N	N	40	N	--	N	.001	.13
PM151	200	N	15	<200	30	N	N	50	N	--	N	<.001	.02
PM154	300	N	20	N	30	N	N	65	N	--	N	<.001	.02
PM155	200	N	20	N	30	N	N	50	N	--	N	<.001	.02
PM156	200	N	20	N	30	N	N	35	N	--	N	<.001	.02
PM157	200	N	15	N	20	N	N	60	N	--	N	<.001	.02
PM158	200	N	15	N	30	N	N	50	N	--	N	<.001	.02
PM208	200	N	N	<200	20	N	N	90	.3	--	N	.002	.23
PM209	300	N	N	<200	30	N	N	90	N	--	N	.002	.14
PM210	300	N	N	<200	30	N	N	65	N	--	N	.001	.10
PM211	300	N	<10	<200	30	N	N	100	N	--	N	.001	.03
PM212	300	N	<10	<200	20	N	N	100	N	--	N	<.001	.11
PM213	300	N	<10	<200	30	N	N	160	N	--	N	.001	.08

Sample	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s
PM214	7.0	.10	<.05	.30	700	N	N	N	N	<20	N	N
PM215	3.0	.07	<.05	.30	1,000	N	N	N	N	100	N	N
PM232	3.0	.10	<.05	.30	50	N	N	N	10	150	N	N
PM233	5.0	.10	<.05	.30	150	N	N	N	15	<20	N	N
PM234	3.0	.10	<.05	.50	200	N	N	N	N	N	N	N
PM235	5.0	.20	<.05	.50	500	N	N	N	<10	N	N	N
PM236	3.0	.07	<.05	.30	1,000	<.5	N	N	N	N	N	N
PM237	5.0	.10	<.05	.50	500	N	N	N	N	N	N	N
PM238	3.0	.15	.05	.30	500	N	N	N	N	N	N	N
PM239	3.0	.10	<.05	.30	300	N	N	N	15	50	N	N
PM240	5.0	.15	<.05	.30	1,500	N	N	N	<10	<20	N	N
PM241	3.0	.07	<.05	.30	1,000	N	N	N	N	N	N	N
PM248	5.0	.05	N	.30	20	N	N	N	<10	N	N	N
PM249	3.0	.10	N	.50	30	N	N	N	10	N	N	N
PM250	3.0	.10	N	.30	20	N	N	N	15	N	N	N
PM251	3.0	.10	N	.50	30	N	N	N	10	N	N	N
PM252	3.0	.10	N	.50	30	N	N	N	10	N	N	N
PM253	2.0	.07	<.05	.30	20	N	N	N	10	N	N	N
PM254	3.0	.10	N	.30	30	N	N	N	10	N	N	N
PM255	3.0	.03	N	.50	100	N	N	N	N	N	N	N
PM256	5.0	.10	N	.50	700	N	N	N	N	<20	N	N
PM257	5.0	.07	N	.50	150	N	N	N	N	N	N	N
PM258	5.0	.07	N	.50	1,000	N	N	N	N	N	N	N
PM259	5.0	.07	N	.50	700	N	N	N	N	N	N	N
PM260	5.0	.10	N	.50	150	N	N	N	N	N	N	N
PM265	5.0	.20	<.05	.30	30	N	N	N	15	200	N	N
PM266	3.0	.15	<.05	.30	30	N	N	N	15	100	N	N
PM267	15.0	.02	<.05	.05	50	N	N	N	N	<20	N	N
PM271	5.0	.03	N	.30	200	N	N	N	N	N	N	N
PM272	5.0	.10	N	.50	500	N	N	N	N	N	N	N
PM273	7.0	.20	N	.30	150	N	N	N	<10	N	N	N
PM274	5.0	.15	N	.30	150	N	N	N	10	20	N	N
PM275	5.0	.03	N	.50	200	N	N	N	N	N	N	N
PM276	7.0	.05	N	.30	200	N	N	N	<10	N	N	N
PT148	2.0	.10	.15	.15	300	N	N	N	N	N	N	N
PT154	7.0	.07	<.05	.30	3,000	N	N	N	15	N	N	N
PT155	7.0	.07	N	.30	5,000	N	N	N	10	<20	N	N
PT157	5.0	.03	<.05	.30	1,500	N	N	N	<10	N	N	N
PT159	5.0	.02	N	.30	1,000	N	N	N	<10	N	N	N
PT160	5.0	.05	<.05	.30	1,500	N	N	N	N	<20	N	N
PT161	7.0	.07	<.05	.30	3,000	N	N	N	10	<20	N	N
PT162	5.0	.05	<.05	.30	1,000	N	N	N	10	N	N	N
PT163	5.0	.10	<.05	.30	1,500	N	N	N	10	N	N	N
PT165	3.0	.07	N	.30	700	N	N	N	10	N	N	N
PT166	3.0	.10	<.05	.30	300	N	N	N	10	<20	N	N

Table 16. Chemical data for 163 channel samples—Continued

Sample	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s
PM214	N	70	700	150	N	N	N	200	<10	N	70	N	N
PM215	N	70	300	150	N	N	N	150	10	N	50	N	N
PM232	N	N	700	150	N	N	N	20	<10	N	30	N	N
PM233	N	15	200	100	N	N	N	50	<10	N	30	N	N
PM234	N	15	300	200	N	N	N	100	N	N	30	N	N
PM235	N	20	300	200	N	N	N	100	10	N	50	N	N
PM236	N	70	500	200	N	N	N	150	10	N	30	N	N
PM237	N	50	300	150	N	N	N	150	<10	N	50	N	N
PM238	N	15	50	100	N	N	N	50	<10	N	30	N	N
PM239	N	20	150	300	N	N	N	30	N	N	30	N	N
PM240	N	70	200	300	N	N	N	70	<10	N	30	N	N
PM241	N	150	150	200	N	N	N	70	<10	N	30	N	N
PM248	N	<5	300	50	N	N	N	30	<10	N	30	N	N
PM249	N	5	500	70	N	N	N	50	N	N	30	N	N
PM250	N	<5	300	50	N	N	N	50	N	N	30	N	N
PM251	N	<5	300	50	N	N	N	70	<10	N	30	N	N
PM252	N	<5	300	50	N	N	N	70	N	N	30	N	N
PM253	N	N	500	30	N	N	N	70	N	N	30	N	N
PM254	N	N	500	100	N	N	N	100	N	N	30	N	N
PM255	N	5	300	70	N	N	N	100	<10	N	30	N	N
PM256	N	7	500	100	N	N	N	150	30	N	50	N	N
PM257	N	7	200	50	N	N	N	100	N	N	50	N	N
PM258	N	70	300	100	N	N	N	150	<10	N	50	N	N
PM259	N	70	200	150	N	N	N	150	10	N	50	N	N
PM260	N	10	300	100	N	N	N	150	N	N	50	N	N
PM265	N	N	150	150	N	N	N	10	N	N	30	N	N
PM266	N	N	100	50	N	N	N	7	N	N	30	N	N
PM267	N	N	2,000	300	N	N	N	20	N	N	20	N	N
PM271	N	N	700	200	N	N	N	150	N	N	50	N	N
PM272	N	15	2,000	200	N	N	N	150	10	N	50	N	N
PM273	N	N	1,500	200	N	N	N	150	N	N	50	N	N
PM274	N	N	200	150	N	N	N	30	N	N	30	N	N
PM275	N	N	100	100	N	N	N	20	N	N	30	N	N
PM276	N	<5	100	150	N	N	N	30	<10	N	50	N	N
PT148	N	70	300	30	<20	N	N	30	N	N	15	N	N
PT154	N	150	1,000	2,000	N	N	N	200	30	N	70	N	N
PT155	N	100	1,000	2,000	N	N	N	200	70	N	70	N	N
PT157	N	70	700	300	N	N	N	150	10	N	70	N	N
PT159	N	70	500	200	N	N	N	150	<10	N	50	N	N
PT160	N	70	700	500	N	N	N	150	20	N	70	N	N
PT161	N	200	1,000	700	N	N	N	150	70	N	70	N	N
PT162	N	70	700	500	N	N	N	100	50	N	70	N	N
PT163	N	70	500	500	N	N	N	100	20	N	70	N	N
PT165	N	70	500	200	N	N	N	100	30	N	70	N	N
PT166	N	10	700	200	N	N	N	100	30	N	70	N	N

Sample	V-ppm	W-ppm	Y-ppm	Zn-ppm	Zr-ppm	Th-ppm	As-ppm	Zn-ppm	Cd-ppm	Bi-ppm	Sb-ppm	Au-ppm	Te-ppm
	s	s	s	s	s	s	aa	aa	aa	aa	aa	aa	aa
PM214	300	N	N	<200	30	N	N	75	N	--	N	.001	.17
PM215	300	N	N	N	30	N	N	80	N	--	N	<.001	.10
PM232	300	N	N	N	30	N	40	20	N	--	N	.060	6.26
PM233	300	N	<10	N	30	N	N	25	.1	--	10	.011	3.05
PM234	300	N	N	N	50	N	N	15	.1	--	N	.007	2.34
PM235	300	N	N	N	50	N	N	65	N	--	N	.014	3.84
PM236	200	N	N	N	30	N	N	70	.2	--	N	.007	2.78
PM237	300	N	15	N	30	N	N	20	N	--	N	.006	1.48
PM238	300	N	N	N	30	N	N	25	N	--	N	.006	1.56
PM239	200	N	<10	N	20	N	N	15	N	--	N	.160	5.88
PM240	300	N	15	<200	30	N	N	70	.9	--	N	.008	2.36
PM241	300	N	N	N	30	N	N	40	N	--	N	.005	.48
PM248	300	N	N	N	30	N	N	5	N	--	N	.012	.59
PM249	300	N	N	N	30	N	N	N	N	--	N	.012	.64
PM250	300	N	N	N	30	N	N	N	N	--	N	.005	.42
PM251	300	N	N	N	30	N	N	N	N	--	N	.007	.50
PM252	300	N	N	N	30	N	N	N	N	--	N	.010	.78
PM253	300	N	N	N	30	N	N	N	N	--	N	.014	.68
PM254	300	N	N	N	30	N	N	15	N	--	N	.009	.46
PM255	300	N	N	<200	30	N	N	40	N	--	N	.008	.14
PM256	300	N	<10	N	30	N	N	55	N	--	N	.007	.02
PM257	300	N	<10	N	30	N	N	55	N	--	N	.003	.06
PM258	300	N	N	N	30	N	N	65	N	--	N	.004	.05
PM259	300	N	<10	N	30	N	N	50	N	--	N	.002	.05
PM260	300	N	<10	<200	30	N	N	30	N	--	N	.002	.06
PM265	300	N	N	N	20	N	N	5	N	--	N	.017	4.40
PM266	300	N	<10	N	30	N	60	15	N	--	N	.028	4.15
PM267	200	N	N	N	10	N	N	65	N	--	N	.220	5.70
PM271	300	N	N	N	30	N	N	90	N	--	N	.014	.56
PM272	300	N	<10	<200	30	N	N	50	N	--	N	.002	.68
PM273	300	N	N	<200	30	N	N	130	N	--	N	.070	1.27
PM274	300	N	<10	N	50	N	N	25	N	--	N	.003	1.15
PM275	300	N	<10	N	50	N	N	20	N	--	N	.004	.12
PM276	300	N	10	<200	30	N	N	110	N	--	N	.001	.10
PT148	150	N	N	N	15	N	N	25	N	--	N	.002	.09
PT154	500	N	N	200	20	N	N	230	.1	--	N	.090	4.20
PT155	500	N	N	200	20	N	N	100	.8	--	N	.026	1.28
PT157	300	N	N	<200	30	N	N	200	.1	--	N	.003	.34
PT159	200	N	N	<200	20	N	N	110	N	--	N	.003	.06
PT160	300	N	N	200	30	N	N	190	.2	--	N	.050	2.60
PT161	300	N	N	<200	30	N	N	160	.4	--	N	.003	.54
PT162	300	N	<10	<200	30	N	N	145	.6	--	N	.008	.40
PT163	300	N	<10	<200	30	N	N	120	.2	--	N	.007	1.55
PT165	300	N	<10	300	30	N	N	150	N	--	N	.002	.18
PT166	500	N	<10	300	30	N	N	130	N	--	N	.006	.23

Table 16. Chemical data for 163 channel samples—Continued

Sample	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s
PT168	5.0	.10	N	.30	300	N	N	N	15	N	N	N
PT171	3.0	.10	N	.30	150	N	N	N	10	N	N	N
PT172	3.0	.10	N	.30	70	N	N	N	<10	N	N	N
PT173	5.0	.05	N	.30	1,000	N	N	N	N	<20	N	N
PT174	5.0	.02	N	.30	700	N	N	N	N	N	N	N
PT175	5.0	<.02	N	.30	700	N	N	N	N	N	N	N
PT176	5.0	.05	N	.30	3,000	N	N	N	<10	<20	N	N
PT178	5.0	.05	<.05	.30	700	N	N	N	10	N	N	N
PT180	5.0	.05	<.05	.30	1,000	N	N	N	10	N	N	N
PT181	5.0	.05	<.05	.30	1,500	N	N	N	N	<20	N	N
PT185	7.0	.07	N	.30	500	N	N	N	N	N	N	N
PT186	5.0	.07	N	.30	700	N	N	N	N	N	N	N
PT189	3.0	.10	<.05	.30	700	N	N	N	15	<20	N	N
PT194	5.0	.10	<.05	.30	300	N	N	N	10	<20	N	N
PT196	7.0	.05	<.05	.30	700	N	N	N	N	<20	N	N
PT198	7.0	.05	N	.50	1,000	N	N	N	N	N	N	N
PT199	7.0	.05	N	.30	1,000	N	N	N	N	N	N	N
PT200	7.0	.07	N	.30	500	N	N	N	N	N	N	N
PT202	7.0	.05	N	.30	1,000	N	N	N	10	N	N	N
PT203	7.0	.10	<.05	.50	150	N	N	N	20	<20	N	N
PT205	3.0	.10	<.05	.50	100	N	N	N	20	N	N	N
PT207	5.0	.15	N	.50	500	N	N	N	30	20	N	N
PT209	5.0	.15	<.05	.50	2,000	N	N	N	50	20	N	N
PT211	10.0	.15	<.05	.30	500	N	N	N	20	70	N	N
PT213	7.0	.07	<.05	.30	3,000	N	N	N	N	30	N	N
PT214	7.0	.07	<.05	.50	500	N	N	N	N	N	N	N
PT217	7.0	.10	<.05	.50	700	N	N	N	15	N	N	N
PT219	5.0	.07	N	.50	500	N	N	N	N	N	N	N
PT220	5.0	.05	N	.50	500	N	N	N	N	N	N	N
PT221	5.0	.10	N	.70	500	N	N	N	10	N	N	N
PT223	7.0	.10	N	.50	300	N	N	N	10	N	N	N
PT225	5.0	.07	<.05	.30	300	N	N	N	20	N	N	N
PT227	3.0	.07	N	.30	300	N	N	N	<10	N	N	N
PT230	5.0	.15	<.05	.50	300	<.5	N	N	30	70	N	N
PT231	7.0	.07	N	.30	700	N	N	N	<10	N	N	N
PT233	5.0	.03	<.05	.50	1,000	N	N	N	<10	N	N	N
PT235	5.0	.03	<.05	.50	2,000	N	N	N	N	N	N	N
PT236	5.0	.02	N	.50	700	<.5	N	N	N	N	N	N
PT238	5.0	.07	<.05	.50	1,000	N	N	N	N	N	N	N
PT239	5.0	.10	N	.50	700	N	N	N	10	N	N	N
PT241	5.0	.07	<.05	.30	2,000	N	N	N	<10	N	N	N
PT244	7.0	.07	<.05	.50	3,000	N	N	N	<10	N	N	N
PT245	5.0	.05	<.05	.30	1,500	.5	N	N	10	N	N	N
PT247	3.0	.10	<.05	.30	3,000	1.0	N	N	20	20	N	N
PT249	7.0	.07	<.05	.30	2,000	1.0	N	N	10	<20	N	N

Sample	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s
PT168	N	<5	700	300	N	N	N	30	20	N	50	N	N
PT171	N	N	150	100	N	N	N	30	10	N	30	N	N
PT172	N	N	150	70	N	N	N	30	<10	N	30	N	N
PT173	N	100	700	150	N	N	N	150	<10	N	70	N	N
PT174	N	70	1,000	150	N	N	N	200	15	N	70	N	N
PT175	N	70	700	100	N	N	N	150	10	N	70	N	N
PT176	N	200	1,000	300	N	N	N	200	50	N	70	N	N
PT178	N	70	700	150	N	N	N	100	10	N	70	N	N
PT180	N	70	700	300	N	N	N	150	30	N	70	N	N
PT181	N	70	700	300	N	N	N	200	10	N	70	N	N
PT185	N	15	1,000	200	N	N	N	150	15	N	70	N	N
PT186	N	15	700	200	N	N	N	100	10	N	70	N	N
PT189	N	15	500	300	N	N	N	100	20	N	50	N	N
PT194	N	10	700	700	N	N	N	100	30	N	70	N	N
PT196	N	10	500	200	N	N	N	150	30	N	70	N	N
PT198	N	70	1,500	150	N	N	N	150	<10	N	70	N	N
PT199	N	70	700	200	N	N	N	200	<10	N	70	N	N
PT200	N	15	500	150	N	N	N	100	<10	N	70	N	N
PT202	N	70	700	150	N	N	N	150	10	N	70	N	N
PT203	N	N	700	200	N	N	N	150	10	N	70	N	N
PT205	N	N	200	150	N	N	N	100	<10	N	50	N	N
PT207	N	20	150	200	N	N	N	150	<10	N	70	N	N
PT209	N	70	700	700	N	N	N	200	300	N	70	N	N
PT211	N	50	700	500	N	N	N	100	20	N	70	N	N
PT213	N	300	1,000	500	N	N	N	150	70	N	70	N	N
PT214	N	20	700	150	N	N	N	150	10	N	70	N	N
PT217	N	70	700	200	N	N	N	150	<10	N	70	N	N
PT219	N	10	700	300	N	N	N	100	15	N	50	N	N
PT220	N	N	500	150	N	N	N	70	20	N	50	N	N
PT221	N	7	500	150	N	N	N	100	30	N	70	N	N
PT223	N	N	500	150	N	N	N	100	15	N	70	N	N
PT225	N	N	500	200	N	N	N	150	15	N	50	N	N
PT227	N	7	150	150	N	N	N	70	50	N	30	N	N
PT230	N	5	700	300	N	N	N	100	100	N	50	N	N
PT231	N	15	1,000	200	N	N	N	150	<10	N	70	N	N
PT233	N	15	700	300	N	N	N	150	<10	N	70	N	N
PT235	N	70	1,000	700	N	N	N	150	10	N	70	N	N
PT236	N	70	2,000	500	N	N	N	200	15	N	70	N	N
PT238	N	70	1,000	200	N	N	N	200	10	N	70	N	N
PT239	N	50	500	150	N	N	N	150	<10	N	70	N	N
PT241	N	70	500	300	N	N	N	150	10	N	70	N	N
PT244	N	150	700	300	N	N	N	200	<10	N	100	N	N
PT245	N	70	700	300	N	N	N	150	30	N	70	N	N
PT247	N	100	700	700	N	N	N	200	70	N	70	N	N
PT249	N	150	1,500	1,500	N	N	N	200	150	N	70	N	N

Table 16. Chemical data for 163 channel samples—Continued

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PT168	300	N	<10	<200	30	N	N	80	N	--	N	.015	1.31
PT171	200	N	<10	N	30	N	N	25	N	--	N	.001	.12
PT172	200	N	<10	N	50	N	N	15	N	--	N	.005	.08
PT173	300	N	<10	<200	30	N	N	110	.1	--	N	.002	.02
PT174	300	N	N	<200	30	N	N	170	N	--	N	<.001	.02
PT175	300	N	<10	<200	20	N	N	120	N	--	N	.001	<.02
PT176	200	N	N	<200	30	N	N	60	N	--	N	<.001	<.02
PT178	200	N	N	N	20	N	N	85	N	--	N	.002	.22
PT180	300	N	<10	300	30	N	N	240	.8	--	N	.002	.48
PT181	300	N	<10	<200	20	N	N	200	.5	--	N	.010	1.43
PT185	300	N	N	<200	30	N	N	140	.1	--	N	.004	.10
PT186	300	N	N	<200	20	N	N	75	.1	--	N	.008	.06
PT189	300	N	<10	<200	30	N	N	90	N	--	N	.010	.55
PT194	300	N	N	300	20	N	N	300	.5	--	N	.070	1.75
PT196	300	N	N	500	20	N	N	230	.8	--	N	.003	.25
PT198	300	N	N	<200	30	N	N	110	.4	--	N	.003	.14
PT199	200	N	N	<200	30	N	N	110	.4	--	N	.003	.26
PT200	300	N	N	<200	20	N	N	120	.2	--	N	.004	.22
PT202	300	N	N	200	30	N	N	240	.5	--	N	.005	.34
PT203	300	N	<10	<200	30	N	N	40	N	--	N	.005	.14
PT205	300	N	<10	200	30	N	N	60	N	--	N	.006	.10
PT207	300	N	15	<200	30	N	N	150	.2	--	N	.005	.26
PT209	500	N	<10	300	30	N	N	270	.4	--	N	.036	1.75
PT211	700	N	<10	300	30	N	N	350	.4	--	N	.034	3.82
PT213	300	N	N	<200	50	N	N	50	1.1	--	N	.050	2.80
PT214	300	N	N	<200	30	N	N	90	.1	--	N	.012	.44
PT217	300	N	N	<200	30	N	N	120	.2	--	N	.010	.30
PT219	300	N	<10	<200	30	N	N	90	.1	--	N	.003	.52
PT220	200	N	N	N	30	N	N	450	.1	--	N	.005	.03
PT221	300	N	<10	300	30	N	N	150	.1	--	N	.003	.20
PT223	300	N	N	200	30	N	N	75	N	--	N	.003	.47
PT225	300	N	N	<200	30	N	N	60	.1	--	N	.008	.72
PT227	300	N	N	500	30	N	N	100	N	--	N	.009	.15
PT230	500	N	N	500	30	N	N	220	N	--	N	.034	1.62
PT231	300	N	N	200	20	N	N	100	N	--	N	.008	.44
PT233	300	N	N	<200	30	N	N	130	.3	--	N	.006	.14
PT235	300	N	N	200	30	N	N	380	1.3	--	N	.021	1.73
PT236	300	N	<10	700	30	N	N	80	.2	--	N	.012	.16
PT238	300	N	N	<200	30	N	N	100	.1	--	N	.005	.20
PT239	300	N	N	<200	30	N	N	25	.3	--	N	.006	.03
PT241	300	N	<10	<200	30	N	N	170	N	--	N	.006	.43
PT244	300	N	N	<200	30	N	N	40	N	--	N	.002	<.02
PT245	300	N	N	<200	30	N	N	170	.4	--	N	.006	.14
PT247	300	N	<10	<200	20	N	N	90	N	--	N	.011	.84
PT249	700	N	N	700	20	N	N	400	.4	--	N	.300	4.24

Sample	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s
PT251	7.0	.07	N	.50	1,500	N	N	N	<10	<20	N	N
PT252	5.0	.05	<.05	.30	1,000	N	N	N	N	N	N	N
PT255	10.0	.05	<.05	.50	700	N	N	N	N	N	N	N
PT256	5.0	.05	<.05	.50	1,000	N	N	N	N	<20	N	N
PT261	3.0	.07	<.05	.50	100	N	N	N	N	N	N	N
PT262	5.0	.05	<.05	.50	150	N	N	N	<10	N	N	N
PT263	5.0	.07	N	.50	150	N	N	N	<10	N	N	N
PT264	5.0	.07	<.05	.50	70	N	N	N	<10	N	N	N
PT265	5.0	.07	<.05	.70	100	N	N	N	10	N	N	N
PT266	3.0	.15	<.05	.30	500	.5	N	N	15	20	N	N
PT267	3.0	.15	<.05	.30	100	N	N	N	15	N	N	N
PT268	3.0	.15	N	.50	150	N	N	N	15	N	N	N
PT269	5.0	.15	<.05	.50	100	N	N	N	15	N	N	N
PT270	3.0	.15	<.05	.30	150	N	N	N	15	N	N	N
PT273	5.0	.15	<.05	.50	200	N	N	N	20	N	N	N
PT274	5.0	.15	<.05	.50	150	N	N	N	20	N	N	N
PT276	3.0	.15	<.05	.30	70	N	N	N	30	50	N	N
PT282	3.0	.10	<.05	.30	70	N	N	N	15	<20	N	N
PT283	7.0	.15	<.05	.30	500	N	N	N	20	N	N	N
PT284	5.0	.15	N	.30	150	N	N	N	15	N	N	N
PT285	3.0	.20	<.05	.50	200	N	N	N	10	N	N	N
PT286	3.0	.15	N	.30	150	N	N	N	10	N	N	N
PT287	7.0	.20	<.05	.50	700	N	N	N	15	50	N	N
PT288	3.0	.20	N	.50	150	N	N	N	<10	N	N	N
PT292	3.0	.30	<.05	.50	200	N	N	N	15	N	N	N
PT308	5.0	.15	<.05	.30	3,000	N	N	N	10	N	N	N
PT310	5.0	.20	N	.50	150	N	N	N	15	100	N	N
PT312	3.0	.15	<.05	.30	150	N	N	N	50	<20	N	N

Table 16. Chemical data for 163 channel samples—Continued

Sample	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s
PT251	N	100	1,000	300	N	N	N	200	30	N	70	N	N
PT252	N	100	500	150	N	N	N	150	20	N	70	N	N
PT255	N	70	1,000	300	N	N	N	200	<10	N	70	N	N
PT256	N	70	700	100	N	N	N	200	<10	N	70	N	N
PT261	N	N	500	300	N	N	N	200	<10	N	50	N	N
PT262	N	5	500	300	N	N	N	200	10	N	70	N	N
PT263	N	10	700	200	N	N	N	200	<10	N	50	N	N
PT264	N	N	700	150	N	N	N	150	10	N	50	N	N
PT265	N	<5	700	300	N	N	N	200	10	N	70	N	N
PT266	N	50	500	500	N	N	N	150	15	N	50	N	N
PT267	N	5	300	200	N	N	N	100	10	N	50	N	N
PT268	N	7	200	200	N	N	N	70	15	N	30	N	N
PT269	N	5	200	200	N	N	N	70	15	N	30	N	N
PT270	N	<5	200	150	N	N	N	30	30	N	50	N	N
PT273	N	<5	300	150	N	N	N	30	30	N	50	N	N
PT274	N	<5	300	300	N	N	N	70	50	N	50	N	N
PT276	N	N	200	150	N	N	N	30	150	N	30	N	N
PT282	N	N	200	200	N	N	N	50	70	N	30	N	N
PT283	N	5	1,000	300	N	N	N	70	150	N	50	N	N
PT284	N	N	700	150	N	N	N	30	30	N	50	N	N
PT285	N	N	150	150	N	N	N	20	<10	N	30	N	N
PT286	N	<5	500	150	N	N	N	30	<10	N	30	N	N
PT287	N	15	500	200	N	N	N	30	30	N	30	N	N
PT288	N	<5	200	100	N	N	N	20	N	N	30	N	N
PT292	N	10	1,000	500	N	N	N	150	150	N	30	N	N
PT308	N	100	700	700	N	N	N	200	10	N	50	N	N
PT310	N	N	200	200	N	N	N	70	<10	N	50	N	N
PT312	N	N	500	150	N	N	N	100	15	N	30	N	N

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PT251	300	N	N	N	30	N	N	240	.1	--	N	.005	.17
PT252	200	N	N	<200	20	N	N	120	N	--	N	.003	.05
PT255	300	N	N	500	30	N	N	95	N	--	N	.004	.58
PT256	200	N	N	<200	30	N	N	200	.2	--	N	.003	<.02
PT261	200	N	<10	N	30	N	N	20	N	--	N	.006	.07
PT262	300	N	<10	N	30	N	N	20	N	--	N	.005	.03
PT263	300	N	N	N	30	N	N	30	N	--	N	.004	.05
PT264	300	N	N	N	30	N	N	10	N	--	N	.004	.07
PT265	300	N	N	N	30	N	N	10	N	--	N	.002	.08
PT266	300	N	N	N	30	N	N	20	N	--	N	.006	.65
PT267	300	N	N	N	30	N	N	5	N	--	N	.002	.06
PT268	300	N	N	N	30	N	N	65	N	--	N	.001	.07
PT269	500	N	N	<200	30	N	N	10	N	--	N	.001	.10
PT270	500	N	<10	<200	30	N	N	10	N	--	N	.005	.20
PT273	300	N	<10	<200	30	N	N	10	N	--	N	.003	.30
PT274	300	N	<10	<200	30	N	N	35	N	--	N	.017	.57
PT276	300	N	<10	N	30	N	10	25	N	--	N	.470	1.17
PT282	500	N	N	<200	30	N	N	20	N	--	N	.170	1.54
PT283	500	N	<10	<200	30	N	N	25	N	--	N	.012	.58
PT284	300	N	N	N	30	N	N	10	N	--	N	.006	.12
PT285	300	N	N	N	30	N	N	10	N	--	N	.004	.06
PT286	150	N	N	N	30	N	N	5	N	--	N	.002	.04
PT287	300	N	N	N	30	N	N	15	.1	--	N	.003	.09
PT288	300	N	<10	N	30	N	N	5	N	--	N	.002	<.02
PT292	200	N	20	<200	30	N	N	45	.1	--	N	.035	.06
PT308	300	N	N	<200	20	N	<10	100	.1	--	N	.019	.71
PT310	300	N	<10	500	30	N	N	200	N	--	N	.019	1.28
PT312	300	N	N	<200	30	N	20	75	.1	--	N	.007	1.37

Table 17. Chemical data for an east-west soil traverse across the Rois Malk area

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown]

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
PM163	814,518	454,480	5	.15	<.05	.3	700	N	N	N	N	N	N
PM164	814,517	454,449	5	.10	<.05	.3	500	N	N	N	N	N	N
PM165	814,525	454,418	5	.15	<.05	.3	1,500	N	N	N	N	N	N
PM166	814,538	454,393	5	.07	<.05	.5	1,500	N	N	N	N	N	N
PM167	814,547	454,365	3	.07	<.05	.3	150	N	N	N	N	N	N
PM168	814,560	454,330	5	.07	N	.5	200	N	N	N	N	N	N
PM169	814,552	454,288	5	.07	<.05	.3	1,500	N	N	N	N	<20	N
PM170	814,574	454,243	3	.05	<.05	.5	1,000	N	N	N	N	N	N
PM171	814,570	454,206	7	.10	<.05	.3	700	N	N	N	N	N	N
PM172	814,580	454,167	5	.20	N	.5	1,000	N	N	N	N	<20	N
PM173	814,574	454,136	5	.15	N	.5	1,000	N	N	N	N	N	N
PM174	814,639	454,151	5	.07	<.05	.5	200	N	N	N	N	N	N
PM175	814,671	454,101	10	.02	<.05	.5	2,000	N	N	N	N	<20	N
PM176	814,772	454,094	5	.10	N	.5	200	N	N	N	N	N	N
PM177	814,776	454,014	3	.07	N	.5	150	N	N	N	N	N	N
PM178	814,793	453,988	5	.10	N	.3	1,500	N	N	N	30	30	N
PM179	814,808	453,942	7	.05	N	.5	100	N	N	N	N	N	N
PM180	814,798	453,913	3	.05	N	.3	150	N	N	N	N	N	N
PM181	814,807	453,879	7	.07	N	.5	1,000	N	N	N	N	<20	N
PM182	814,852	453,804	5	.03	N	.5	200	N	N	N	N	N	N

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
PM163	N	N	70	700	50	N	N	N	100	<10	N	50	N
PM164	N	N	50	700	50	N	N	N	100	10	N	50	N
PM165	N	N	100	500	30	<20	N	N	100	<10	N	50	N
PM166	N	N	70	300	70	N	N	N	150	<10	N	50	N
PM167	N	N	5	150	150	N	N	N	100	N	N	50	N
PM168	N	N	10	700	70	N	N	N	150	N	N	50	N
PM169	N	N	100	1,000	150	N	N	N	150	15	N	70	N
PM170	N	N	20	500	70	N	N	N	100	<10	N	50	N
PM171	N	N	30	1,000	150	N	N	N	150	10	N	50	N
PM172	N	N	70	700	200	N	N	N	150	N	N	50	N
PM173	N	N	70	500	100	N	N	N	150	<10	N	50	N
PM174	N	N	15	700	50	N	N	N	150	N	N	50	N
PM175	N	N	150	700	200	N	N	N	300	N	N	70	N
PM176	N	N	5	300	100	N	N	N	100	<10	N	30	N
PM177	N	N	N	150	70	N	N	N	50	N	N	30	N
PM178	N	N	N	150	300	N	N	N	50	30	N	30	N
PM179	N	N	<5	200	70	N	N	N	30	N	N	30	N
PM180	N	N	5	700	100	N	N	N	70	10	N	30	N
PM181	N	N	100	700	100	N	N	N	150	N	N	50	N
PM182	N	N	10	300	70	N	N	N	100	N	N	30	N

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PM163	N	200	N	15	N	30	N	N	40	.1	N	N	.002	.29
PM164	N	200	N	15	N	30	N	N	25	N	N	N	.003	.28
PM165	N	200	N	50	N	30	N	N	30	.1	N	N	.002	.77
PM166	N	300	N	N	N	30	N	N	15	.1	N	N	.009	1.82
PM167	N	300	N	N	N	30	N	N	10	N	N	N	.012	.76
PM168	N	300	N	<10	N	30	N	N	20	N	N	N	.003	.24
PM169	N	300	N	<10	N	20	N	N	85	.1	N	N	.008	.84
PM170	N	300	N	N	N	30	N	N	60	.1	N	N	.015	1.52
PM171	N	300	N	N	N	30	N	N	40	N	N	N	.004	.34
PM172	N	150	N	N	N	30	N	N	20	N	N	N	.003	.06
PM173	N	300	N	N	N	30	N	N	25	N	N	N	.003	.21
PM174	N	300	N	N	N	30	N	N	10	N	N	N	.002	.03
PM175	N	300	N	<10	N	30	N	N	20	N	N	N	.002	.04
PM176	N	200	N	N	N	30	N	N	5	N	N	N	.006	.03
PM177	N	150	N	N	N	30	N	N	5	N	N	N	<.001	.02
PM178	N	500	N	N	N	30	N	<10	85	.2	N	N	.024	.88
PM179	N	200	N	N	N	30	N	N	15	N	N	N	.007	.03
PM180	N	200	N	N	N	30	N	N	45	.2	N	N	.110	.12
PM181	N	300	N	N	N	30	N	N	20	N	N	N	.040	.02
PM182	N	200	N	N	N	20	N	N	15	N	N	N	.003	.10

Table 18. Chemical data from a detailed soil traverse, Rois Malk area

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown]

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
PM183	814,930	453,729	20	.07	<.05	.20	3,000	N	N	N	N	100	N
PM184	814,927	453,728	3	.05	<.05	.30	100	N	N	N	<10	N	N
PM185	814,923	453,727	3	.07	<.05	.50	100	N	N	N	<10	N	N
PM186	814,920	453,726	2	.05	<.05	.50	20	N	N	N	10	N	N
PM187	814,916	453,724	5	.05	N	.50	20	N	N	N	10	N	N
PM188	814,913	453,723	7	.05	<.05	.50	70	N	N	N	<10	N	N
PM189	814,910	453,722	5	.05	<.05	.50	30	N	N	N	<10	N	N
PM190	814,905	453,720	5	.05	<.05	.50	70	N	N	N	<10	N	N
PM191	814,909	453,741	3	.02	<.05	.50	1,500	N	N	N	N	N	N
PM192	814,912	453,736	5	.10	<.05	.30	150	N	N	N	<10	N	N
PM193	814,913	453,732	5	.02	<.05	.50	100	N	N	N	N	N	N
PM194	814,915	453,728	5	.07	N	.50	200	N	N	N	N	N	N
PM195	814,918	453,720	15	.05	N	.30	30	N	N	N	<10	N	N
PM196	814,919	453,716	7	.05	N	.30	70	N	N	N	<10	N	N
PM197	814,921	453,712	5	.05	N	.30	100	N	N	N	10	N	N
PM198	814,922	453,708	20	.03	N	.15	150	N	N	N	N	N	N
PM199	814,924	453,705	10	.03	N	.15	200	N	N	N	N	N	N
PM200	814,926	453,700	7	.03	N	.20	150	N	N	N	N	N	N

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
PM183	N	N	100	500	150	N	N	N	150	20	N	50	N
PM184	N	N	N	200	70	N	N	N	50	N	N	50	N
PM185	N	N	<5	200	100	N	N	N	50	<10	N	30	N
PM186	N	N	N	300	30	N	N	N	70	N	N	30	N
PM187	N	N	N	300	70	N	7	N	50	N	N	30	N
PM188	N	N	N	700	70	N	N	N	50	<10	N	30	N
PM189	N	N	N	700	50	N	N	N	50	<10	N	30	N
PM190	N	N	N	1,000	70	N	N	N	50	<10	N	30	N
PM191	N	N	150	100	150	N	N	N	50	N	N	30	N
PM192	N	N	<5	500	100	N	N	N	30	N	N	30	N
PM193	N	N	N	300	100	N	N	N	70	<10	N	30	N
PM194	N	N	7	500	100	N	N	N	50	N	N	30	N
PM195	N	N	N	700	100	N	<5	N	50	15	N	30	N
PM196	N	N	5	2,000	70	N	<5	N	50	<10	N	30	N
PM197	N	N	10	300	50	N	10	N	30	N	N	20	N
PM198	N	N	10	2,000	100	N	20	N	30	15	N	30	N
PM199	N	N	15	1,000	70	N	7	N	30	N	N	20	N
PM200	N	N	10	700	100	N	<5	N	30	<10	N	20	N

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PM183	N	150	N	70	1,000	15	N	N	350	.1	N	N	.003	.18
PM184	N	200	N	<10	N	30	N	N	60	N	N	N	.004	.04
PM185	N	200	N	N	N	30	N	N	20	N	N	N	.016	.30
PM186	N	300	N	N	N	30	N	N	5	N	N	N	.008	.31
PM187	N	200	N	N	N	30	N	N	5	N	N	N	.027	.31
PM188	N	300	N	N	N	30	N	10	15	N	N	N	.014	.77
PM189	N	300	N	N	N	30	N	10	5	N	N	N	.012	.62
PM190	N	300	N	<10	N	30	N	10	10	N	N	N	.015	.62
PM191	N	300	N	<10	N	30	N	N	20	N	N	N	.012	.05
PM192	N	300	N	N	N	20	N	N	15	N	N	N	.004	.13
PM193	N	200	N	<10	N	30	N	N	25	N	N	N	.012	.12
PM194	N	300	N	<10	N	30	N	N	25	N	N	N	.007	.20
PM195	N	300	N	N	N	30	N	N	20	N	N	N	.070	.60
PM196	N	300	N	N	N	30	N	N	40	N	N	N	.018	1.00
PM197	N	300	N	N	N	30	N	10	N	N	N	N	.090	.72
PM198	N	500	N	<10	<200	15	N	20	10	N	N	N	.018	.95
PM199	N	500	N	N	<200	20	N	10	10	N	N	N	.050	.74
PM200	N	500	N	N	<200	20	N	10	240	N	N	N	.018	.74

Table 19. Chemical data for 16 stream-sediment samples, Rois Malk area

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown]

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
PA114	824,850	455,725	5	2.00	2.00	.5	1,000	N	N	N	10	<20	N
PA115	824,820	455,737	3	1.00	.30	.3	500	N	N	N	10	<20	N
PA117	824,875	455,787	3	1.00	.20	.5	500	N	N	N	10	<20	N
PA118	815,991	453,186	3	1.00	1.00	.3	500	N	N	N	N	<20	N
PA119	815,984	453,199	5	1.00	.30	.3	500	N	N	N	20	<20	N
PA120	815,986	453,150	3	1.00	.30	.3	500	N	N	N	10	<20	N
PA121	816,000	453,150	3	1.00	.70	.3	200	N	N	N	N	<20	N
PA122	816,116	452,968	3	1.00	.70	.3	300	N	N	N	N	N	N
PA123	816,139	452,944	3	2.00	2.00	.3	500	N	N	N	N	20	N
PA124	815,698	453,364	3	.70	.30	.3	500	N	N	N	10	<20	N
PA125	815,703	453,375	3	1.50	1.50	.3	500	N	N	N	N	20	N
PM161	814,725	453,674	2	.07	.05	.2	70	N	N	N	N	N	N
PM162	814,978	453,609	3	1.00	.70	.3	500	N	N	N	10	20	N
PM201	814,887	454,554	3	1.00	1.00	.2	700	N	N	N	20	<20	N
PM202	814,884	454,570	5	1.00	1.50	.3	700	N	N	N	20	N	N
PM206	815,357	454,181	3	1.50	.70	.3	700	N	N	N	10	<20	N

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
PA114	N	N	70	700	100	N	N	N	100	15	N	30	N
PA115	N	N	20	200	70	<20	N	N	70	10	N	30	N
PA117	N	N	50	200	70	N	N	N	100	<10	N	30	N
PA118	N	N	50	5,000	30	N	N	N	100	<10	N	30	N
PA119	N	N	70	700	50	N	N	N	150	<10	N	30	N
PA120	N	N	50	1,000	30	N	N	N	150	<10	N	30	N
PA121	N	N	70	1,000	50	N	N	N	100	N	N	30	N
PA122	N	N	50	5,000	50	N	N	N	150	N	N	30	N
PA123	N	N	50	5,000	30	N	N	N	150	<10	N	30	N
PA124	N	N	50	700	70	N	N	N	150	N	N	30	N
PA125	N	N	70	5,000	50	N	N	N	150	N	N	30	N
PM161	N	N	<5	500	30	<20	<5	N	50	20	N	20	N
PM162	N	N	50	1,000	100	N	N	N	100	20	N	30	N
PM201	N	N	50	1,000	70	N	N	N	150	30	N	30	N
PM202	N	N	70	1,500	100	N	N	N	150	20	N	30	N
PM206	N	N	70	>5,000	70	N	N	N	200	15	N	30	N

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Cd-ppm aa	Bi-ppm aa	Sb-ppm aa	Au-ppm aa	Te-ppm aa
PA114	N	200	N	15	N	30	N	N	65	N	N	N	.003	.14
PA115	N	150	N	<10	N	20	N	N	55	N	N	<2	.004	.30
PA117	N	200	N	10	N	30	N	N	50	N	N	<2	.004	.58
PA118	N	200	N	10	<200	20	N	N	70	N	N	<2	.002	.03
PA119	N	200	N	15	<200	30	N	N	85	N	N	N	.005	.04
PA120	N	200	N	10	N	20	N	N	80	N	N	N	.013	.04
PA121	N	300	N	10	N	30	N	N	80	N	N	<2	.003	.04
PA122	N	300	N	15	<200	20	N	N	70	N	N	N	.002	.03
PA123	N	200	N	10	N	20	N	N	75	N	N	N	.001	.02
PA124	N	300	N	15	N	20	N	N	75	N	N	N	.002	.02
PA125	N	200	N	10	N	20	N	N	85	N	N	N	.002	.03
PM161	N	200	N	<10	N	20	N	10	100	N	N	<2	.060	.50
PM162	200	200	N	10	500	30	N	N	640	5.0	N	N	.029	.16
PM201	N	200	N	15	200	20	N	--	--	--	--	--	.060	1.00
PM202	<100	300	N	15	<200	30	N	N	130	N	N	N	.037	.46
PM206	N	200	N	10	<200	20	N	N	120	N	N	N	.130	.13

Table 20. Chemical data for 13 heavy-mineral concentrates, Rois Malk area

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown]

Sample	Utm-n	Utm-e	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s
PA118	815,991	453,186	5	3.0	7	.15	700	N	N	N
PA119	815,984	453,199	3	5.0	7	.15	700	N	N	N
PA120	815,986	453,150	3	3.0	5	.15	500	N	N	N
PA121	816,000	453,150	3	5.0	10	.15	700	N	N	N
PA122	816,116	452,968	5	5.0	10	.15	700	N	N	N
PA123	816,139	452,944	5	7.0	10	.15	700	N	N	N
PA124	815,698	453,364	3	5.0	10	.15	700	N	N	N
PA125	815,703	453,375	5	5.0	7	.30	700	N	N	N
PM161	814,725	453,674	5	1.0	2	>2.00	300	50.0	N	200
PM162	814,978	453,609	7	3.0	5	.30	500	3.0	N	N
PM201	814,887	454,554	7	2.0	5	.30	500	500.0	N	700
PM202	814,884	454,570	3	2.0	7	.70	500	N	N	N
PM206	815,357	454,181	7	1.5	5	.15	500	1.5	N	N

Sample	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s
PA118	N	N	N	N	N	50	>10,000	30	N	N	N
PA119	N	N	N	N	N	20	10,000	50	N	N	N
PA120	N	N	N	N	N	15	10,000	30	N	N	N
PA121	N	N	N	N	N	20	10,000	50	N	N	N
PA122	N	N	N	N	N	50	>10,000	300	N	N	N
PA123	N	N	N	N	N	50	10,000	500	N	N	N
PA124	N	N	N	N	N	20	7,000	20	N	N	N
PA125	N	N	N	N	N	50	>10,000	100	N	N	N
PM161	N	<50	N	N	N	N	7,000	100	N	15	N
PM162	<20	N	N	N	200	150	3,000	7,000	N	N	N
PM201	N	N	N	N	100	50	1,500	700	N	N	N
PM202	N	N	N	N	N	<10	7,000	30	N	N	N
PM206	<20	N	N	N	50	100	10,000	10,000	N	N	N

Sample	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
PA118	150	N	N	70	N	N	300	N	N	N	N	N
PA119	150	N	N	70	N	N	200	N	N	700	N	N
PA120	150	N	N	70	N	N	200	N	N	N	N	N
PA121	100	N	N	70	N	N	200	N	N	N	N	N
PA122	150	N	N	70	N	N	200	N	N	N	<20	N
PA123	150	N	N	70	N	N	200	N	N	N	20	N
PA124	100	N	N	70	N	N	200	N	N	N	N	N
PA125	200	N	N	70	N	N	300	N	N	N	N	N
PM161	70	20	N	50	N	N	700	N	N	N	200	N
PM162	200	100	N	50	N	N	150	N	N	15,000	20	N
PM201	100	70	N	50	N	N	150	N	N	15,000	<20	N
PM202	70	<20	N	70	N	N	200	N	N	N	50	N
PM206	200	20	N	20	N	N	150	N	N	5,000	N	N

APPENDIX C. Description of Soil Samples from the Rois Malk Study Area

Sample No.	Depth of sample (cm)	Description
Twenty soil samples collected along east-west traverse of Rois Malk area		
PM 163	30	Red to brown clay, some rock fragments.
PM 164	30	Red to orange clay.
PM 165	30	Do.
PM 166	30	Do.
PM 167	30	Red to orange clay, FeO clasts, rock fragments.
PM 168	30	Red to orange clay,limonite, 2 meters from vein.
PM 169	30	Red to brown clay, limonite, FeO clasts.
PM 170	30	Red to brown clay, MnO, limonite, 3 meters from vein.
PM 171	25	Red to brown clay, laterite clasts, 4 meters from vein.
PM 172	30	Red to brown clay, laterite clasts.
PM 173	15	Red to brown clay.
PM 174	15	Red to brown clay, limonite, FeO clasts.
PM 175	15	Red to brown clay.
PM 176	30	Red to brown clay, minor limonite.
PM 177	15	Do.
PM 178	20	Yellow to brown clay, abundant limonite.
PM 179	30	Yellow clay, limonite, siliceous clasts.
PM 180	15	Red to brown clay.
PM 181	15	Red to brown clay, bauxitic residue.
PM 182	25	Do.
Eighteen soil samples from detailed traverse on the west side of the Rois Malk study area		
PM 183	15	Yellow clay, next to vein.
PM 184	13	Red to brown clay, bauxitic residue.
PM 185	15	Red to brown clay, limonite, laterite clasts.
PM 186	10	Yellow to brown clay, siliceous residue.
PM 187	25	Yellow to brown clay, rock fragments.
PM 188	25	Yellow to brown clay, bauxitic residue.
PM 189	25	Yellow to brown clay, small Fe-Ox veinlet clasts.
PM 190	25	Yellow to brown clay, bauxitic residue.
PM 191	25	Red to brown clay, siliceous residue.
PM 192	15	Red to brown clay.
PM 193	15	Red to brown clay, laterite clasts.
PM 194	20	Red to brown clay, limonite.
PM 195	18	Red to brown clay, quartz and Fe-Ox veinlets.
PM 196	20	Red to brown clay, siliceous residue.
PM 197	20	Yellow clay.
PM 198	20	Do.
PM 199	13	Do.
PM 200	20	Do.

APPENDIX D. Description of Mangrove Sediment Samples from the Eastern Side of Babelthuap Island

Sample No.	Core length (cm)	Sediment description
BM 1	8	Organic-rich, black, fine- to medium-sandy sediment.
BM 2	30	Black, fine to coarse sand with some gravel and rock fragments.
BM 3	30	Organic-rich, black, medium to coarse sand with some root material.
BM 4	<10	Organic-rich, fine-grained sediment.
BM 5	30	Organic-rich, black sand and silt.
BM 6	23	Organic-rich, black sand with abundant root material.
BM 7	<10	Sand and silt.
BM 8	25	Black sand with some shell fragments.
BM 9	<10	Coarse sand.
BM 10	<10	Organic-rich, fine-grained sediment.
BM 11	<10	Organic-rich, coarse sand with root material.
BM 12	23	Black, fine to coarse sand with shell fragments and root material.
BM 13	<10	Organic-rich, fine-grained sediment.
BM 14	<10	Do.
BM 15	<10	Do.
BM 16	<10	Do.
BM 17	<10	Coarse sand with shell and coral fragments.
BM 18	13	Organic-rich, black, fine sand with abundant roots.
BM 19	10	Black, fine sand and mud.
BM 20	8	Organic-rich, black, fine-grained sediment.
BM 21	<10	Organic-rich, fine-grained sediment with abundant roots.
BM 22	13	Organic-rich, fine-grained sediment.
BM 23	10	Do.
BM 24	15	Do.
BM 25	6	Do.
BM 26	15	Do.
PT 293	18	Brown to black, organic-rich, fine-grained sediment with roots.
PT 294	8	Sandy, fine-grained sediment.
PT 295	10	Do.
PT 296	13	Shelly, fine-grained sediment.
PT 297	15	Sandy, fine-grained sediment.
PT 298	15	Do.
PT 299	18	Do.
PT 300	20	Do.
PT 301	18	Organic-rich, fine-grained sediment.
PT 302	30	Do.
PT 303	18	Do.
PT 304	20	Do.
PT 305	18	Do.
PT 306	15	Coarse carbonate sand and shell fragments.

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