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KERR:

THE GEOLOGY AND EVOLUTION OF A DEFORMED PORPHYRY Cu-Au DEPOSIT

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ABSTRACT

The Kerr Cu-Au deposit is located in the highly mineralized Sulphurets district in northwestern British Columbia. Exploration on the deposit since 1985 by Western Canadian Mining and Placer Dome Inc. has outlined a geological resource of 135 million tonnes of 0.76% Cu and 0.34 g/t Au.

Kerr is a strongly altered and deformed Early Jurassic (195-200 Ma) porphyry deposit. Mineralization is related to a northerly trending pyritic zone of porphyritic, potassic monzonite intrusions in Late Triassic Stuhini Group sedimentary and volcaniclastic rocks. Intense alteration and deformation of these rocks commonly makes identification of protoliths difficult to impossible. A combination of careful relogging of drill core, petrography and lithogeochemical study has improved protolith identification and led to a clearer understanding of the deposit.

Alteration and mineralization are characterized primarily by variable amounts of sericite, chlorite, quartz, anhydrite, pyrite and chalcopyrite. The strongest Cu-Au mineralization is associated with a core of chlorite-bearing alteration and quartz stockworks. Strong sericitic (phyllic) alteration with quartz and disseminated pyrite flanks the core zone. Postmineral dikes include 195 Ma

feldspar megacrystic and aphanitic andesite types.

Original Cu-Au mineralization at Kerr was cupola-like, related to the upper parts of a relatively shallow, long-lived monzonitic intrusive hydrothermal system. Regional compressive deformation was subsequently focused in the resulting low competency alteration zone. There has been significant local remobilization of original mineralization during later intrusive, structural and metamorphic events.

Kerr has characteristics in common with other porphyry systems in the Sulphurets district, and with some documented Philippine deposits.

LOCATION AND TOPOGRAPHIC SETTING

The Kerr deposit is located 60 km north of Stewart, in northwestern British Columbia, latitude 56° 28' north, longitude 130° 16' west, NTS 104B/8W (Figure 1). The property lies within the Iskut River area, at the headwaters of Sulphurets Creek, and just above the toe of the Sulphurets Glacier. Access is by helicopter.

The northerly trending deposit is exposed across a broad northeasterly trending ridge with steep flanks (Figure 2). The southern side drops down to the Sulphurets Glacier; the northern side is an amphitheatre-shaped basin whose lower slopes are filled with landslide debris from the steep rock walls above. Drainage from this basin flows into Sulphurets Creek, which joins the Unuk River 15 km to the west. The deposit is exposed between 1150 and 1750 m elevations.

HISTORY

Exploration work in the district around Kerr dates back to the late 1800's, when placer Au prospecting was conducted on Sulphurets Creek. Interest in the hard rock source for placer accumulations centred around the Brucejack and Sulphurets areas, east and north of Kerr, respectively, until 1982 when the Kerr claims were staked by the Alpha Joint Venture. Reconnaissance soil geochemistry across the Kerr gossan in 1983 produced anomalous Au values that encouraged

Brinco Limited to option the property in 1984. Brinco conducted a small soil geochemical program in 1984, and drilled three diamond drill holes in 1985. In 1987, Brinco sold all of its exploration properties, including a 70% interest in the Kerr Property, to Western Canadian Mining Corporation, and the Alpha Joint Venture sold its 30% interest to Sulphurets Gold Corporation. That same year, exploration for high grade Au veins similar to those of Brucejack Lake was conducted through a program of mapping, trenching, induced polarization and diamond drilling (14 holes). Induced polarization results led to the placement of two drill holes in a large zone of anomalously high chargeability and low resistivity. Compilation of the results of that program led the project manager, John Kowalchuk, to suggest that the property hosted a porphyry system. Forty-two additional diamond drill holes were drilled in 1988 and 1989. All work by Brinco and Western Canadian Mining was conducted under the direction of R. Hewton.

Placer Dome Inc. acquired the property late in 1989 through the purchase of all shares of Sulphurets Gold Corporation. A 73-hole diamond drill program was conducted by Placer Dome in 1990. A second short program to twin ten previously-drill holes with poor recovery was conducted in 1992, and all past drill holes were relogged. To date, a total of 26,159.5 m have been drilled on the Kerr property. Most drill holes into the Kerr deposit dip moderately eastward.

REGIONAL GEOLOGY

The Kerr deposit lies within Stikinia, an accreted terrane of Triassic and Jurassic volcanic arcs resting on upper Paleozoic basement and overlain by Jurassic basinal sedimentary rocks. All of these elements are present in the Sulphurets district with the exception of upper Paleozoic basement (Figure 3).

Upper Triassic and lower Jurassic volcanic arcs are composed of mafic to felsic volcanics, arc-derived clastics, and intervolcanic marine sediments. The upper Triassic Stuhini Group has been described by Lewis (1992) as containing two major subdivisions, a lower dominantly sedimentary division, and an upper dominantly volcanic and volcaniclastic division. Stratigraphic markers within the lower sedimentary sequence have been recognized by Lewis (1993) on the Kerr property.

The lower Jurassic Hazelton Group overlies the Stuhini Group along a regional unconformity. Within the Hazelton Group, coarse basal sedimentary rocks are overlain by a lower volcanic/volcaniclastic sequence with extreme facies changes, an upper felsic volcanic-pyroclastic unit (Mt. Dilworth formation), and an uppermost marine sedimentary sequence containing subaqueous mafic volcanic flows. The upper contact of the Hazelton Group with the overlying middle to upper Triassic Bowser Lake Group is gradational. Rocks of the Bowser Lake

Group consist of basinal mudstone, sandstone and conglomerate.

Four episodes of plutonism are recognized by Anderson (1989) in the area, two of which are genetically linked to volcanic rocks of the district. The Late Triassic Stikine plutonic suite generally intrudes areas of thick volcanic accumulations in the Stuhini Group. The Early Jurassic (189-195 Ma) Texas Creek plutonic suite is most commonly associated with the Hazelton Group, but also intrudes rocks of the Stuhini Group, as at Kerr. The Mitchell Intrusions shown on Figure 3 belong to the Texas Creek plutonic suite.

Structural geology of the district around Kerr is dominated by east-southeasterly directed Cretaceous compression. The McTagg anticlinorium, which exposes Stuhini Group rocks in its core, and the Sulphurets thrust, which passes within 1.5 km of the hangingwall of Kerr, are manifestations of that event. A regional Early Jurassic (Toarcian) unconformity described by Anderson and Thorkelson (1990) has been suggested as evidence of an earlier structural event, but little evidence of deformation has been encountered to date (Lewis, 1992).

GEOLOGY OF THE KERR DEPOSIT

The Kerr deposit has been referred to as a porphyry-type deposit since 1987, but strong surface weathering and intense alteration and deformation have hampered efforts to understand the system. In 1990, D. Bridge began work on the Kerr deposit that led him to believe that mineralization was localized around one or more previously unrecognized monzonite intrusions. In 1992, Placer Dome Inc. geological staff relogged all of the available drill core, developed a new geological model, and came to a similar conclusion.

Alteration at Kerr was produced by a relatively shallow, long-lived hydrothermal system generated by intrusion of monzonite into bedded country rocks of the Stuhini Group. Subsequent regional deformation along the Sulphurets thrust was diverted into the area of Kerr because pre-existing structures and intense alteration provided a zone of low competency along which compression was easily accommodated.

The surface expression of the deposit is a large, strongly leached, schistose, pyritic gossan. Soil geochemistry shows elevated to anomalous Au values over the deposit, and a halo of anomalous Cu values. Induced polarization detects high chargeability and low resistivity over the deposit.

Surface geological detail is limited by the highly weathered nature of exposed rocks, and as a result, geology can best be represented on level plans and cross-sections. The northern, deeper portion of the deposit has retained much of the original spatial relationships of the porphyry system. In the southern, higher levels, deformation has reduced the deposit to panels of alteration and mineralization which bear little resemblance to a porphyry system.

Deformation at Kerr has made identification of original lithologies difficult. Alteration is therefore the principal defining factor of the geological model, and rock types have been reduced to three basic categories: premineral volcanic and sedimentary rocks of the Stuhini Group, mineralizing monzonite, and postmineral intrusions.

Stuhini Group, *et al.*

The majority of volcaniclastic and sedimentary rocks belonging to the Stuhini Group within the deposit are highly schistose. Undeformed sedimentary rocks, observed largely in the footwall in the northern sector, consist primarily of coarse conglomerate, siltstone, mudstone and minor greywacke. Conglomerate contains siliceous or cherty clasts which are not found in volcaniclastics.

Undeformed volcaniclastic rocks are exposed just east of Kerr Peak, but are not present within the deposit. Outcrops near the peak exhibit variable grain size and sorting characteristics, ranging from sandy tuffs to coarse volcanic conglomerate with boulders up to 1 m in diameter. All except the coarsest units are well-bedded, and minor interbedded mudstone is present.

Within the deposit, volcaniclastics are generally recognized by the presence of strongly flattened clasts (Figure 4a). During core logging, sedimentary rocks were distinguished from volcaniclastics by the presence of siliceous clasts and a granular texture. Those criteria, however, are far from diagnostic, and perhaps are not even valid. Sedimentary and volcanic rocks have therefore been included together on Figure 5.

Within the core of the deposit, deformation is commonly so intense that a protolith cannot be assigned. In these cases, 'sericite schist' or 'strongly chloritized rock' are the most appropriate terms. For simplicity's sake, these intensely deformed areas are not delineated on plans and sections.

Monzonite Porphyry

Monzonite intrusions are plagioclase-hornblende-biotite porphyries with common apatite microphenocrysts (Figure 4b). Coarse plagioclase and hornblende phenocrysts are 1-3 mm long, 1-3% tabular biotite is less than 1 mm, and anhedral to subhedral apatite may reach 0.6 mm in diameter. Apatite is the most resistant to alteration, but euhedral grains are rare. Primary hornblende and biotite do not occur. Euhedral to anhedral hornblende is pseudomorphed by fine-grained chlorite and/or sericite combined with oriented patches and stringers of fine titanium oxides. Biotite is completely pseudomorphed by muscovite or fine-grained chlorite, titanium oxides and opaques; it is rarely recognizable in hand specimen. Plagioclase phenocrysts are variably altered to sericite and have diffuse boundaries. In hand specimen, strongly flattened, sericitized plagioclase phenocrysts are translucent green. The groundmass mineralogy in these porphyries outside of the stronger alteration zones is dominated by fine sericite, plagioclase and minor quartz.

Where alteration and deformation are intense, identification of monzonite may hinge on the recognition of plagioclase or hornblende phenocrysts alone. Several intrusive phases appear to be present, but cannot be distinguished clearly by their mineralogy. Breccias are inferred to be present, especially around the margins of the main intrusion, where flattened clasts are observed in plagioclase and/or hornblende phyric schists. Whole rock lithogeochemistry (below) indicates that all rocks that have been identified macroscopically as monzonite are of similar chemical composition.

Monzonite is probably part of the "Mitchell Intrusions" (Figure 3), which belong to the Early Jurassic Texas Creek plutonic suite. This age is inferred from the close relationship between monzonite and porphyritic dikes described below.

Monzonite appears on plans and sections (Figure 5) to be most abundant in the lower reaches of the deposit, but it is also the suspected protolith for much of the strongly altered material in the upper central portions (Figure 6). Strong pervasive alteration in the deposit area precludes petrographic or chemical classification into alkalic or calcalkalic suites; it is best described simply as potassic monzonite.

Postmineral Intrusions

A large area of barren intrusive rocks occurs in the southeastern corner of the deposit, as shown on the 1500 m level plan, Figure 5. Textural varieties include plagioclase porphyry (locally crowded) and intrusive breccia. Hornblende and/or augite phenocrysts are evident locally. Alteration, which is locally texturally-destructive, includes pervasive chlorite, epidote, sericite and carbonate. K-feldspar is a primary component in the groundmass of some porphyries. The nature of these rocks, their alteration, and their relationship to the deposit have not been studied in detail; the contact between them and mineralizing monzonite is probably a fault. The postmineral age relationship for some of these intrusions is based on lithogeochemical similarities with cross-cutting intrusions within the deposit. However, other intrusive bodies included in this category may be pre or synmineral.

Plagioclase hornblende porphyry dikes and intrusions are most abundant in the southern half of the deposit. These porphyries are mineralogically and petrographically similar to the host monzonite, but they are generally massive and barren or only weakly mineralized. They are inferred to be late phases of the same magma that generated the mineralizing monzonite intrusion. Whole rock lithogeochemistry shows a higher Na content for these dikes relative to monzonite.

All plagioclase hornblende porphyries contain about 20% feldspar and 10% chlorite-altered hornblende phenocrysts, minor apatite microphenocrysts, and are strongly sericitic. Common texturally-destructive alteration is characterized by abundant green sericite with disseminated pyrite and minor chalcopyrite. Less altered specimens (Figure 4c) contain grey sericite, very little sulphide, stronger pervasive carbonate, and are weakly to moderately magnetic. Thin section work indicates at least two compositional populations: an andesitic variety containing 20% plagioclase and 10% hornblende phenocrysts in a plagioclase-dominant groundmass, and a quartz monzonitic variety containing 20% plagioclase and 4% hornblende phenocrysts in a K-feldspar/plagioclase groundmass.

Variable alteration of plagioclase hornblende porphyries in close proximity to each other can be attributed to different ages of intrusion during the waning stages of hydrothermal alteration. A U-Pb zircon date of 197 $\pm$ 3.0 Ma, obtained from a syenodiorite dike belonging to this suite (Bridge, 1993), effectively dates the decline of the hydrothermal system.

Albite megacrystic porphyry occurs as several dikes which intrude the deposit along generally north-south trends. The principal dike (Figure 5) cuts across the deposit at an acute angle, from the hangingwall in the south to the footwall in the north. It is interpreted to have intruded along a pre-existing structure that has undergone renewed movement evidenced by local offsets and by deformation and gouge along some contacts. The main dike varies in thickness from 0.5 to 15 m, and is weakly to moderately magnetic. Megacrystic porphyry is barren of mineralization, except for minor sulphides along its margins within the deposit.

Megacrystic porphyry contains up to 2% euhedral albite megacrysts, which are commonly 1-3 centimetres in diameter (Figure 4d). The groundmass generally contains 15-20% indistinct 2-5 mm plagioclase phenocrysts. Phenocrysts and groundmass are strongly sericitized; local carbonate, fine chlorite $\pm$ hematite are also present. Megacrysts are most abundant toward the centre of the dike. Highly flattened, aligned plagioclase phenocrysts define a contact-parallel foliation along contacts and in narrow dikes which are free of megacrysts.

A U-Pb zircon date of 195 $\pm$ 1.5 Ma was obtained by Bridge (1992) from a texturally similar hyalophane (Ba-rich K-feldspar) megacrystic dike on the west side of the deposit. Hyalophane megacrystic dikes intrude along east-west trends, but are probably of similar age to northerly trending albite megacrystic dikes described here. The 195 Ma age date for these rocks places an upper limit on the timing of mineralization and the age of the structures which they intrude. Both appearance and age correlate these dikes with "Premier porphyry" dikes of the Texas Creek plutonic suite (Anderson, 1989).

Aphanitic andesite dikes are common throughout the deposit. These highly altered dikes are massive, dark green, and composed of fine-grained plagioclase, chlorite, ilmenite and sericite. Correlation between cross-sections is difficult, especially since many strike east-west. These dikes generally cross-cut schistosity, but many folded dikes have been observed on surface (J. Payne, unpub, 1989; Bridge, 1993). Payne observed andesite dikes to grade into plagioclase hornblende porphyries described above, and suggested that there may be several ages of intrusion.

Eocene dikes are not shown on the accompanying illustrations because they are too small to depict at this scale. They are narrow (up to 3 m wide) and intrude the deposit along the general northerly foliation trend. A K-Ar age date of 51.5 $\pm$ 2 Ma has been obtained by Bridge (1992, 1993).

Eocene dikes are composed of highly variable amounts of biotite, fine-grained plagioclase, chlorite, tremolite/actinolite, quartz and K-feldspar. Quartz and K-feldspar phenocrysts are common; biotite occurs as phenocrysts locally. Coarse white carbonate and possible barite occur as local amygdules, especially along contacts.

Variable mineralogy has resulted in variable compositions for Eocene dikes. Bridge (1993), Payne (unpub, 1992) and Wells (unpub, 1993) each describe different Eocene dikes, reporting kersantite, andesite and monzonite compositions, respectively.

ALTERATION

Alteration zonation is most evident in the northern sector of the deposit, but is poorly defined in the south (Figure 6). A combination of elevation differences within the porphyry system and postmineral structural disruption in the south are probably responsible for this effect.

Abundant pervasive sericite occurs throughout the deposit, but is accompanied by chlorite in the core of the main monzonite intrusion and in much of its upper and peripheral zones. Within monzonite, chlorite is restricted to replacements of mafic minerals in the sericite-chlorite zone. Outward from this core alteration, strong texturally destructive chlorite-sericite zone alteration contains more pervasive chlorite than sericite.

Yellow and grey sericite alteration types occur peripheral to the above two chlorite-bearing types. Yellow sericite characterizes the northern sector, but grey sericite dominates in the south. Grey sericite alteration also occurs in much of the upper core of the deposit, surrounding and locally mixed with strong chlorite-sericite alteration. Unlike peripheral areas where intensity of alteration is variable, grey sericite in the upper core is typically intense and texturally destructive.

Sericite-Chlorite

Pervasive sericite-chlorite alteration affects primarily monzonite and lesser amounts of volcanic rocks. Although strongly altered, protolith characteristics such as phenocrysts or rock fragments are still visible in pale to medium green coloured rocks (Figure 4b). Thin section examinations reveal that up to 35% fine-grained plagioclase may be present with abundant fine-grained green sericite and chlorite. Sericite is commonly twice as abundant as chlorite. In drill core, zones of pale green sericite-dominant alteration are common. Patchy quartz is present in amounts varying from 5-15%. Pyrite content is generally less than 10%. Original phenocrysts of hornblende alter to chlorite, biotite alters to sericite/muscovite, and plagioclase alters to pale green sericite.

Chlorite-Sericite (+/- Anhydrite)

Dark green, pervasive chlorite-dominant alteration occurs around the margins of the main monzonite intrusion. It most commonly occurs between sericite-chlorite and intense grey sericite zones (Figure 6), and may represent an alteration front. Chlorite-sericite alteration (Figures 4e, 4k) is texturally destructive, but probably overprints both monzonite and volcaniclastic rocks. Up to 60% dark chlorite is accompanied by up to 30% sericite. Patchy quartz (5-15%) may locally represent dismembered veins. Anhydrite is most visible as white to pink coarsely crystalline veins up to several centimetres wide (Figure 4e), but may also occur as pervasive concentrations locally up to 40%. Some original plagioclase is typically still present. Pyrite content is only 1-7%. Where present, primary biotite phenocrysts have been replaced by chlorite. Apatite grains up to 15 mm are locally present in some of the most strongly altered zones. There is no evidence to indicate that any of this chlorite is altered hydrothermal biotite.

Grey Sericite

Pervasive grey sericite alteration (Figures 4a, 4f) affects rocks throughout the southern portion of the deposit and within the core of the northern section (Figure 6). These rocks are characterized by 40-60% grey sericite with 5-10% quartz and 0-7% chlorite. Fine-grained plagioclase is commonly present in amounts varying from 20-50%. Original porphyritic and volcaniclastic textures are locally still visible, but alteration and deformation can be so strong that rocks are commonly best described as sericite or quartz-sericite schist. Where grey sericite alteration accompanies stockwork mineralization, the quartz content (exclusive of veins) may rise to 35%, and very little plagioclase is present. The pyrite content of this alteration type can be as high as 15%, especially in volcaniclastic rocks.

Yellow Sericite

Pervasive yellow sericite alteration (Figures 4g, 4h) is a peripheral assemblage affecting only the Stuhini Group. It is most abundant in the northern portion of the deposit, primarily in the footwall below the main stockwork zone. Yellow sericite alteration has the lowest average Cu grade of all the pervasive alteration types because it is largely confined to the periphery of the deposit.

Only 5-15% original plagioclase is present; 30-60% yellow sericite, 10-20% quartz, and 10-20% pyrite are characteristic. Yellow sericite commonly forms a matrix that wraps around 1-2 mm rounded quartz, giving these rocks an augen-like, granular appearance. Green sericite commonly occurs in minor amounts as a replacement of selected clasts, and can vary from pale olive green to various bright green hues (Figure 4g). Scanning electron microprobe analyses indicate that all sericites (grey, yellow and green) contain fine-grained rutile inclusions, but that pale olive green sericite is also chromium-bearing.

Yellow sericite alteration gradually weakens with depth in the footwall area of sections 10500 and 10600 N. As alteration and deformation weaken, pervasive sericite changes from yellow to green, and gradually disappears as sedimentary textures become clear. This, plus the presence of quartz-rich coarse sandstone in this poorly altered area, has led to the suggestion that yellow sericite is a selective alteration of sedimentary rocks (versus grey sericite alteration of more immature volcaniclastics). This empirical correlation is based solely on systematic drill core study.

Anhydrite, Gypsum and Rubble

Anhydrite veining is most commonly associated with chlorite-bearing alteration types, but there are several occurrences in grey sericite, and one occurrence (in the extreme north) in yellow sericite with crackled quartz stockwork. It is characteristic of texturally destructive chlorite-sericite alteration, and of the upper portions of sericite-chlorite altered monzonite. Anhydrite veins locally carry minor chalcopyrite.

During deformation, anhydrite was remobilized into irregular veinlets that post-date all other vein types. These veinlets form cross-cutting networks or parallel sets which may cut across or parallel foliation (Figures 4f, 4l). In the upper reaches of the deposit, down to a maximum of about 250 m, anhydrite has altered to gypsum. Consequent volumetric expansion and subsequent leaching of highly soluble gypsum by groundwater has resulted in large areas of voids and broken rock called "rubble." Core recovery in these zones is poor, and geological detail is often lacking, but rubble probably represents areas of pre-existing hydrothermal anhydrite.

Anhydrite and gypsum are distributed within and around the upper reaches of the main monzonite intrusion (Figure 7). The footwall of the deposit hosts the most continuous anhydrite-bearing zone. At depth in the extreme north, anhydrite, gypsum and rubble occur in two parallel zones that roughly coincide with zones of sericite-chlorite altered monzonite.

MINERALIZATION

The Kerr deposit is a pyrite-rich Cu-Au system which has been defined primarily by its Cu content. Drilling has delineated the lateral extent of mineralization along most of the length of the deposit, but the northern and southern limits, and the maximum depth extent have not yet been defined. The estimated geological resource, calculated in 1991, is 135 million tonnes of 0.76% Cu and 0.34 g/t Au.

The most important mineralization type is quartz stockwork, which drapes over the main monzonite intrusion and extends a considerable distance down the eastern side, along the footwall of the deposit (Figure 7). Section 10400 N illustrates this relationship. Moving north from section 10400 N, stockwork crosses from the footwall to the hangingwall; this relationship is illustrated on the 1200 m level plan. In the southern sector of the deposit, illustrated by section 9700 N and the 1500 m level plan, a second stockwork zone appears west of the main one, between 9650 N and 9750 N. Deformation is strong in this area and lithologies are so difficult to trace that it is not known whether the western stockwork is a separate "hangingwall" zone, or whether it has been structurally separated from the main eastern stockwork. Schistose rocks between the two zones are among the most strongly foliated rocks in the deposit area.

Deformation of mineralized quartz veins has resulted in segregation of sulphides into interstices between granular recrystallized quartz, resulting in a 'crackled' texture (Figures 4i, 4j). Chalcopyrite also occurs as fracture fillings in an earlier generation of coarse vein pyrite. Drill intersections of individual veins vary from 1 cm to 7 m. Narrow veins and veinlets are commonly highly contorted, as shown in Figures 4h and 4k.

The mineralogy of quartz stockwork veins is variable, and may contain any combination of pyrite, chalcopyrite, bornite, tetrahedrite, tennantite or rare enargite. Thin films of secondary digenite/chalcocite are also present, but are only locally significant near the surface. Small (less than 1 mm) flakes of crystalline (primary?) covellite are locally abundant, especially in rubbled zones and near-surface areas. Strong chloritic and siliceous alteration forms a broad halo around the high grade footwall zone in the northern sector, but intense stockwork in the south is hosted by grey sericite schist.

In addition to crackled quartz stockwork, mineralization is hosted by several other types of veinlets. Figures 4g, 4h, 4k and 4l illustrate some of the various vein types and their relationships. A detailed study of vein character, paragenesis and distribution has not been done, but the main types observed are:

1. py $\pm$ qtz,ser,minor cpy	predeformation
2. qtz $\pm$ py,carb,anh,ser,chl,cpy	predeformation
3. anh $\pm$ cpy	predeformation
4. carb $\pm$ minor cpy,bn	syn/postdeformation
5. qtz + carb,chl,cpy	postdeformation

anh=anhydrite, bn=bornite, carb=carbonate, chl=chlorite, cpy=chalcopyrite, py=pyrite, qtz=quartz, ser=sericite.

Chlorite-bearing alteration types host the greatest variety of vein types. Postdeformation vein sets are most commonly superimposed on, or in the vicinity of, crackled quartz stockworks (Figure 4k).

Mineralization grading over 0.4% Cu is generally located within or adjacent to crackled quartz stockwork (Figure 8). The main exceptions occur in the northern sector, where significant tonnages of non-stockwork mineralization grading over 0.4% Cu occur in monzonite at depth below the stockwork, in strongly chlorite-sericite altered rubble above the stockwork, and in yellow sericite altered volcano-sedimentary rocks above and below the stockwork. All mineralization grading over 1.0% Cu occurs within stockwork.

Within the population of stockwork mineralized rocks grading over 0.4% Cu, subtle grade controls are exerted by rock type and alteration. Monzonite and strongly chloritized rocks exhibit the highest average grades of 0.8% Cu and 0.35 g/t Au, followed by volcanics and grey sericite schist with similar averages of about 0.7% Cu and 0.35 g/t Au. Yellow sericite altered rocks are less well mineralized, averaging about 0.6% Cu and 0.23 g/t Au.

The Au:Cu ratio (g/t:%) for all rocks grading over 0.4% Cu ranges up to 10.92, but the average value is 0.4. A positive correlation between Cu and Au is illustrated on Figure 9. Most of the high Au values with little/no associated Cu are from yellow sericite altered rocks in the footwall of the northern portion of the deposit. Not only do these rocks have a high background of about 100 ppb Au, but there are several significant intersections grading over 1.0 g/t Au. It is not known at this time what relationship this area has to the main Cu deposit.

The 1500 m level plan (Figure 8) shows a linear concentration of Au values over 0.5 g/t along the footwall of the megacrystic porphyry dike (Figure 5), and along a northeasterly trending appendage to that zone around 9600 N. Both are believed to be the result of remobilization and concentration of Au values along structures. The structure which guided emplacement of the megacrystic dike is a defined structure, but the northeasterly arm is an assumed structure that has not been mapped.

Molybdenum has not been analyzed throughout the entire deposit. Available values are most commonly less than 100 ppm, but range up to 423 ppm. Molybdenite is associated with chloritic alteration on sections 9700 N and 10500 N, in footwall and hangingwall areas, respectively. In sections north of 9700 N, molybdenite occurrences move progressively out of chloritic zones into peripheral yellow sericite altered rocks below monzonite. In sections north of 10500 N, occurrences move progressively into yellow sericite alteration above monzonite.

STRUCTURE

The Kerr deposit occurs within a major northerly trending structural zone with strong foliation and widespread shearing. Early brittle structures are masked by subsequent intrusion, alteration and deformation, and poor core recovery commonly characterizes the most strongly deformed zones. For these reasons, few structures are recognized within the deposit. The only specific structure that is reasonably well-defined is the one into which the megacrystic albite porphyry dike has intruded. This structure cross-cuts the mineralized zone, and is a sharp footwall to mineralization in the northern sector.

Delineation of several northerly trending faults mapped on surface by Payne (unpub, 1989) was attempted on cross-sections, but it was not possible to trace those structures in drill holes for more than 150 m depth. One possible cross-cutting structure is suggested by offsets in alteration patterns and monzonite distribution on level plans in the area of the Au zone described above. Unfortunately, there was little evidence in drill core to permit its delineation.

Peter Lewis (unpub, 1992) has observed that the deposit is defined on surface by irregular, sharp alteration contacts, not by structures, and that mapped northerly to northeasterly trending faults do not greatly offset stratigraphy. There is, however, in his estimation, approximately 800 m or more of displacement between the hangingwall and footwall of the deposit. This displacement took place during a single east-southeasterly directed compressive episode during which strain was preferentially accommodated by altered rocks. This interpretation is based on the observation that all deformation post-dates alteration.

Major deformation probably occurred during regional Cretaceous compression and development of the nearby Sulphurets thrust. A K-Ar age date of 124 $\pm$ 4 Ma (Bridge, 1993) from sericite schist within the Kerr deposit supports an Early Cretaceous event.

WHOLE ROCK LITHOGEOCHEMISTRY

Whole rock geochemical analyses were conducted by the Geological Survey of Canada in 1990, and by Placer Dome in 1992 and 1993. A total of 423

Geological Survey of Canada samples give complete lithogeochemical signatures for eleven drill holes. Placer Dome analyzed 58 samples chosen from specific sites in order to develop chemical signatures for known rock types and confirm many tentative protolith identifications.

Verification of the cogenetic nature of highly altered rocks through identification of two conserved (immobile) elements is a well documented technique (Pearce, 1990; Stanley and Russell, 1989). Examination of the relationships between the oxides of nine major elements (Al, Ca, Fe, K, Mg, Na, P, Si and Ti) has determined that Al_2O_3 and TiO_2 are conserved constituents at Kerr, except within zones of strongest chlorite and most intense quartz stockwork. Na_2O and K_2O are the most useful of the mobile elements. Al_2O_3/TiO_2 ratios combined with K_2O/Na_2O ratios and careful sample descriptions, have permitted reasonably confident differentiation of the main lithologies in the deposit.

Plots of Al_2O_3/TiO_2 ratios versus K_2O/Na_2O ratios (Figure 10) illustrate how lithogeochemistry has added confidence to the identification of the central monzonite intrusion in the Kerr deposit. Sixteen samples of visually distinguishable monzonite all plot within a narrow range of Al_2O_3/TiO_2 ratios, between 37 and 46. K_2O/Na_2O ratios, however, show a spread between zero and 100, reflecting variable Na depletion down to 0.04 weight percent. Postmineral dikes and intrusions, however, show opposed relationships; Al_2O_3/TiO_2 ratios are variable and reflect a higher TiO_2 content, and K_2O/Na_2O ratios are consistently low, reflecting a much higher Na_2O content. The difference between TiO_2 content in monzonite and postmineral intrusions probably reflects Ti phase fractionation in the parent magma.

Down-hole plots of Al_2O_3/TiO_2 ratios, K_2O and Na_2O content were created for each of the drill holes with continuous Geological Survey of Canada data. Figure 11 is an illustration of one such plot for drill hole K88-18, located at 10230 N, 9600 E. Although data points are few, trends shown for this hole are similar to those of the data package as a whole. The following observations are made:

1. Monzonite shows a consistent Al_2O_3/TiO_2 ratio of about 40. K_2O content is variable within a range of 1.5-5.0 weight percent. Na_2O content is consistently less than 0.25 weight percent.

2. The lower stockwork zone in grey sericite altered rocks exhibits a signature almost identical to the upper monzonite zone, and can be inferred to have a monzonite protolith.

3. Most postmineral dikes are clearly distinguished by high Na_2O content and relatively low Al_2O_3/TiO_2 ratios.

4. Yellow sericite altered rocks at the bottom of the hole exhibit low Al_2O_3/TiO_2 ratios typical of volcaniclastic or sedimentary rocks.

Discussion of chemical gains and losses during alteration is limited by the fact that all samples come from within the altered area. In many cases, it is not possible to comment on gains and losses of K, since similar high K levels occur in all rocks throughout the hydrothermal system. However, there has clearly been a loss of Na. Stockwork-mineralized monzonite displays significant enrichment of SiO_2 and Fe_2O_3, lesser K_2O enrichment, and depletion of MgO, CaO and Na_2O. Rocks adjacent to stockwork commonly show enrichment of MgO, CaO and Na_2O.

DISCUSSION AND CONCLUSIONS

The geologic history of the Kerr porphyry deposit begins with intrusion of one or more phases of monzonite into sedimentary and volcaniclastic rocks of the Stuhini Group (Table 1). Hydrothermal alteration and mineralization were then developed in a broad area in the upper and peripheral zones of the main intrusion. Pervasive alteration is zoned from sericite-chlorite in the main intrusion, to strong chlorite-sericite around the edge of the intrusion, to grey and yellow sericite peripheries. Anhydrite veining occurs in an area that drapes over the main monzonite and overlaps most pervasive alteration types, but the deep core of the intrusion is anhydrite free. Mineralization occurs in veinlets and disseminations, but the best grades are associated with an area of particularly abundant stockwork veins and veinlets that roughly coincides with the most intense pervasive alteration. Plagioclase hornblende porphyries, dated at 197 Ma, intruded while the hydrothermal system was still weakly active. Megacrystic porphyries intruded after alteration and mineralization were complete, at about 195 Ma.

Major deformation occurred during a period of southeasterly directed Cretaceous compression. Strongly altered rocks of the porphyry system were intensely foliated and locally sheared. The pervasive alteration overprint is so complete that original mineralogy is questionable, and protoliths are commonly unrecognizable. Within the main stockwork, intense deformation resulted in widespread recrystallization and folding of veins, and the whole zone was flattened. During recrystallization of the stockwork, some quartz, all carbonate, and some Cu was remobilized and subsequently deposited as chalcopyrite in veinlets which are locally observed to be offset by continued deformation. Many of the aphanitic andesite dikes are cross-cut by these veinlets. The distribution of Au values indicates that Au was locally redistributed along some structures. Anhydrite was mobilized into hairline fractures that postdate the development of foliation. Later hydration of anhydrite to gypsum, and subsequent dissolution of gypsum, transformed large volumes of rock into zones of rubble. Intrusion of Eocene dikes is the youngest event on the property.

Many aspects are still poorly understood, the most important of which is the character of alteration. A chloritic core with a phyllic halo is not typical of British Columbia porphyry deposits. It does not readily fit either alkalic or calcalkalic models because the chemistry of the system is transitional between the two. One way of attempting to relate Kerr to current British Columbia models is to suggest that chlorite is secondary after hydrothermal biotite. However, if remnant primary biotite phenocrysts are observed in various stages of alteration in chloritized intrusive rocks, there should also be remnant hydrothermal biotite, but none has been observed.

The possibility of original K-feldspar flooding and later alteration to sericite is also a matter for debate. K-feldspar was detected by Geological Survey of Canada microprobe analyses and has been observed as alteration in intrusive rocks above the hangingwall stockwork zone in the southern sector. Most of these intrusions have been designated as postmineral in the current discussion, but that correlation is preliminary, and further studies could prove otherwise.

If K-feldspathization did occur, it seems odd that none of it has survived in the core of the deposit. However, widespread elevated K_2O values suggest that there has been significant K enrichment at Kerr, and the main K-bearing mineral phase currently present is sericite. Since sericitic alteration is cross-cut by the 195 Ma megacrystic dikes, sericitization must have occurred in Early Jurassic time, long before Cretaceous deformation. Sericite therefore probably represents a late stage of porphyry alteration, resulting from the interaction between magmatic and meteoric fluids.

Kerr is not the only deformed porphyry deposit in the area. To the north, the Mitchell-Sulphurets ridge features the Main Copper, Sulphurets Gold and McQuillan zones. These are related to potassic monzonite to quartz syenite intrusions and are all probably fairly high level systems. Sulphurets Gold, with its strongly deformed porphyry zones along the Raewyn fault zone, has some similarities with Kerr. Most notable are: (1) a wide zone of pyrite-sericite alteration; (2) Cu-Au values associated with strongly deformed and altered monzonitic intrusions and volcanic wallrocks; and (3) proximal zones of chlorite, sericite, carbonate and local albite alteration. Sericite alteration at Sulphurets clearly overprints earlier and widespread K-feldspar alteration.

Chlorite generally accounts for only a small percentage of core alteration in Cordilleran porphyry deposits. It occurs most commonly in association with epidote and carbonate as a peripheral alteration in propylitic zones. Similar alteration assemblages can be found, however, in descriptions of some Philippine deposits (Sillitoe and Gappe, 1984), where sericite-clay-chlorite (SCC) alteration is the principal alteration associated with ore. SCC alteration overprints original K-silicate alteration assemblages of hydrothermal biotite or K-feldspar, and is overprinted by later sericitic alteration. SCC alteration preserves original textures and most likely corresponds to the deep sericite-chlorite assemblage at Kerr. The chlorite content of SCC alteration increases as zones of K-silicate alteration are approached. This could be analogous to the presence of strong chlorite-sericite alteration at Kerr, although the presence of K-silicate alteration has not been demonstrated. The Tirad Cu-Au porphyry (Trudu and Bloom, 1988) contains all three alteration stages, which represent a change from magma-dominated to meteoric-dominated fluids with time. Au and Cu precipitation occurred throughout the life of the hydrothermal system, but was dependant upon an abundant, long-lived magmatic source.

Similarities in physical characteristics between Kerr and some Philippine deposits suggests similar evolutionary histories. K-silicate alteration is therefore assumed to have been the initial alteration stage at Kerr, which developed as a high level hydrothermal system with abundant meteoric water input.

In conclusion, the Kerr deposit is associated with porphyritic monzonitic intrusions within a northerly trending structural zone in Stuhini volcaniclastic and sedimentary rocks. Cupola-like Cu-Au porphyry mineralization with widespread K-silicate alteration was probably associated with one or more of these early intrusive phases. Significant local remobilization of original porphyry mineralization has taken place. The timing of many of these events and the nature of the original porphyry system still pose many questions.

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REFERENCES

Anderson, R. G., 1989: A Stratigraphic, Plutonic, and Structural Framework for the Iskut River Map Area, Northwestern British Columbia, *In* Current Research, Part E, *Geological Survey of Canada*, Paper 89-1E, p145-154.

Anderson, R. G. and Thorkelson, D. J., 1990: Mesozoic Stratigraphy and Setting for Some Mineral Deposits in Iskut River Map Area, Northwestern British Columbia, *In* Current Research, Part E, *Geological Survey of Canada*, Paper 90-1F, p131-139.

Bridge, D. A., 1992: The Kerr Poly-Deformed Copper-Gold Porphyry Deposit, Sulphurets Gold Camp, *Mineral Deposit Research Unit Iskut River Project - Annual Technical Report - Year 2*, p9.1-9.9.

Bridge, D. A., and Godwin, C. I., 1992: Preliminary Geology of the Kerr Copper-(Gold) Deposit, Northwestern British Columbia (104B/8), *In* Geological Fieldwork 1991, *B. C. Ministry of Energy, Mines* *and Petroleum Resources*, Paper 1992-1, p513-516.

Bridge, D. A., 1993: The Deformed Early Jurassic Kerr Porphyry Cu(-Au) Deposit, Sulphurets Gold Camp, Northwestern British Columbia - An Update, *Mineral Deposit Research Unit Iskut River Metallogeny Project - Annual Report, Year 3*, p2.1-2.13.

Henderson, J. R., *et al.*, 1992: Stratigraphy and Structure of the Sulphurets Area, British Columbia, *In* Current Research, Part A, *Geological Survey of Canada*, Paper 92-1A, p323-335.

Lewis, P. D., 1992: Structural Evolution of the Iskut River Area: Preliminary Results, *Mineral Deposit Research Unit Iskut River Project - Annual Technical Report - Year 2*, p2.1-2.23.

Lewis, P. D., 1993: Stratigraphic and Structural Setting of the Iskut River Area, *Mineral Deposit Research Unit Iskut River Metallogeny Project - Annual Report, Year 3*, p1.1-1.5.

Macdonald, A. J., *et al.*, 1993: The Iskut River Area, Northwestern British

Columbia Canada: An Application of Research in Metallogenesis to Enhance Exploration Success, *Mineral Deposit Research Unit Iskut River Metallogeny Project - Annual Report, Year 3*, p7.1-7.37.

Pearce, T. H., 1990: Getting the Most from Your Data: Applications of Pearce Element Ratio Analysis, *In* Theory and Application of Pearce Element Ratios to Geochemical Data Analysis, ed. by J. K. Russell, C. R. Stanley, *Geological Association of Canada Short Course Notes No. 8*, p99-130.

Sillitoe, R. H. and Ciceron, A. A., 1985: Geological Characteristics and Evolution of a Gold-Rich Porphyry Copper Deposit at Guinaoang, Luzon, Philippines, *In* Asian Mining '85, *Institute of Mining and Metallurgy*, p15-26.

Sillitoe, R. H. and Gappe, I. M., 1984: Philippine Porphyry Copper Deposits: Geologic Setting and Characteristics, *CCOP Technical Publication 14*, 89p.

Stanley, C. R. and Russell, J. K., 1989: Petrologic Hypotheses Testing with Pearce Element Ratio Diagrams: Derivation of Diagram Axes, *Contributions to Mineralogy and Petrology*, Volume 103, p78-89.

Trudu, A. G. and Bloom, M. S., 1988: A Genetic Model for the Origin of Hypogene Gold in Porphyry Copper Systems: The Tirad Porphyry Copper-Gold Deposit (Guinaoang, NW Luzon, Philippines), *Bicentennial Gold 88*, Melbourne, p211-216.

Figure Captions

Figure 1. Location of the Kerr deposit relative to Triassic-Jurassic Stikinia and Quesnellia volcanic terranes in British Columbia.

Figure 2. Surface expression of the Kerr deposit.

Figure 3. Regional geology modified from R. V. Kirkham, unpub, (1992), Henderson, *et al.* (1992) and Lewis (1993).

Figure 4. a. Schistose fragmental volcaniclastic. KS-74, 57.0 m

b. Sericite-chlorite altered plagioclase and biotite porphyritic monzonite with early pyrite-sericite veinlet. KS-121, 286.2 m

c. Relatively weakly altered plagioclase and hornblende porphyritic postmineral dike. KS-89, 75.2 m

d. Albite megacrystic porphyry dike. KS-127, 274.5 m

e. Chloritized monzonite with coarse anhydrite. KS-123, 154.5 m *(anh=anhydrite)*

f. Grey sericite altered volcaniclastic(?) with early anhydrite and late gypsum veinlets and boudinaged quartz vein. KS-74, 300.5 m *(anh=anhydrite, gyp=gypsum, qtz=quartz)*

g. Yellow and green sericite alteration of sedimentary(?) rock. Quartz-pyrite veinlets host minor tetrahedrite, chalcopyrite, and rare specularite. Green sericite patches were probably original clasts. KS-92, 84.0 m

h. Yellow sericite alteration of sedimentary(?) rock with contorted quartz-carbonate-pyrite-chalcopyrite-tetrahedrite veinlet(s) with chlorite halo(s). Contorted vein or veins cut both foliation and parallel veinlets of similar composition. KS-93, 74.5 m

i. Portion of a crackled quartz-chalcopyrite vein, showing distinctive networking sulphide distribution. KS-74, 193.6 m

j. Photomicrograph of a portion of a crackled quartz-bornite-pyrite-tennantite vein showing distribution of Cu minerals between recrystallized quartz grains. Courtesy of Jeff Harris. KS-98, 355.7 m *(bn=bornite, py=pyrite, qtz=quartz, tnt=tennantite)*

k. Contorted crackled quartz-pyrite veins in strong chlorite-sericite alteration. Late quartz-chlorite-chalcopyrite veinlets are responsible for Cu grades in this interval. KS-139, 72.6 m

l. Strongly chloritized monzonite hosts six episodes of veining: (1)

pyrite-sericite(-chalcopyrite), (2) carbonate(-chalcopyrite-bornite), (3) pyrite-sericite-chlorite, (4) quartz(-chlorite-pyrite-chalcopyrite), (5) quartz-carbonate-chalcopyrite(-chlorite), and (6) gypsum. KS-87, 178.7 m

Figure 5. Distribution of major lithologies in plan and section.

Figure 6. Distribution of major pervasive alteration zones in plan and section.

Figure 7. Distribution of crackled quartz stockwork, anhydrite and gypsum veining, and rubble in plan and section.

Figure 8. Generalized distribution of Cu and Au in plan and section.

Figure 9. Scatterplot of Au versus Cu for all Kerr assays. The correlation coefficient for this data set of 10,077 values is 0.44.

Figure 10. Lithogeochemical signatures of (a) known intrusive rocks and (b) volcanic and sedimentary rocks and rocks of unknown protolith. Note that several of the samples in (b) that have not been assigned protoliths fall within the range

of monzonite shown in (a). The authors have been hesitant to reinterpret protolith based purely on lithogeochemical data. However, some drill intercepts that were not originally logged as monzonite were changed on the basis of a combination of lithogeochemical signature and macroscopic and petrographic characteristics. Further detailed studies may delineate more monzonite than is now known.

Figure 11. Whole rock lithogeochemistry of drill hole K88-18. Consistent Al_2O_3/TiO_2 ratios in the 115-170 m interval mirror the pattern of the upper monzonite interval, and suggest that the lower grey sericite zone may also be monzonite. Below 180 m, lower and somewhat variable Al_2O_3/TiO_2 ratios are typical of peripheral sedimentary rocks. The lowest K_2O values and the highest Na_2O values occur in postmineral dikes. In the upper mineralized interval (10-80 m), where monzonite textures are still visible, Au values imperfectly follow the same general pattern of Cu values. In the lower, well mineralized interval (115-170 m), where alteration and intense deformation have destroyed original protolith textures, the relationship between Cu and Au, although generally positive, is poorly defined. Erratic high antimony values are consistent with the interpretation that the Kerr porphyry system was probably shallow. Arsenic values up to 1300 ppm show a similar distribution to that of antimony.

TABLE 1
GEOLOGIC EVOLUTION OF THE KERR Cu-Au DEPOSIT

Age (Ma)	Event
52	Intrusion of Eocene lamprophyre dikes (monzonite, andesite, kersantite).
124	Regional compression and development of the Sulphurets Thrust.
195	Intrusion of postmineral feldspar-megacrystic dikes.
197	Intrusion of late syn to postmineral plagioclase-hornblende dikes.
±200-197	Intrusion of monzonite (Texas Creek Suite) and development of mineralizing hydrothermal system.
±235-208	Deposition of Stuhini Group volcaniclastics and sediments.

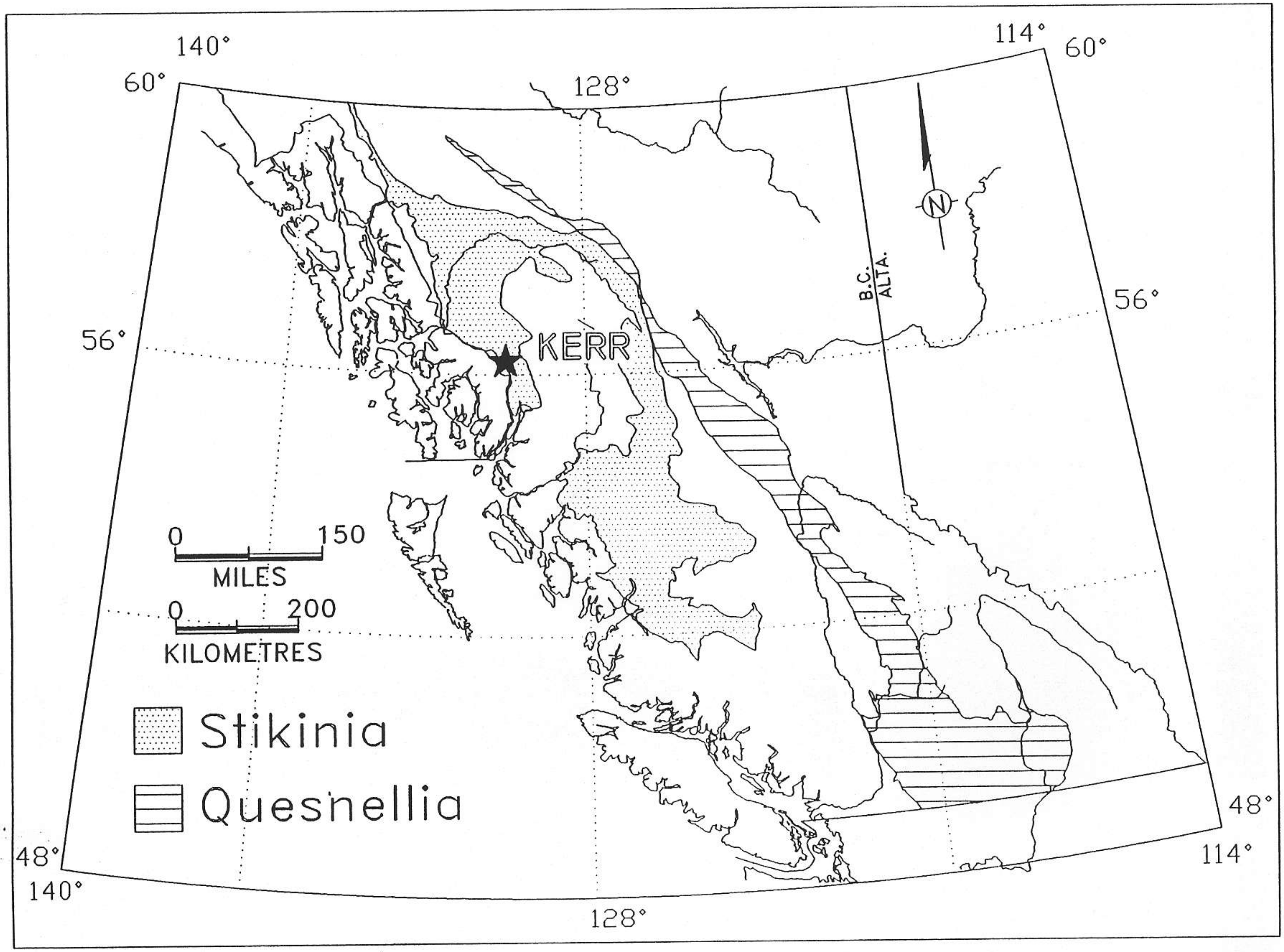
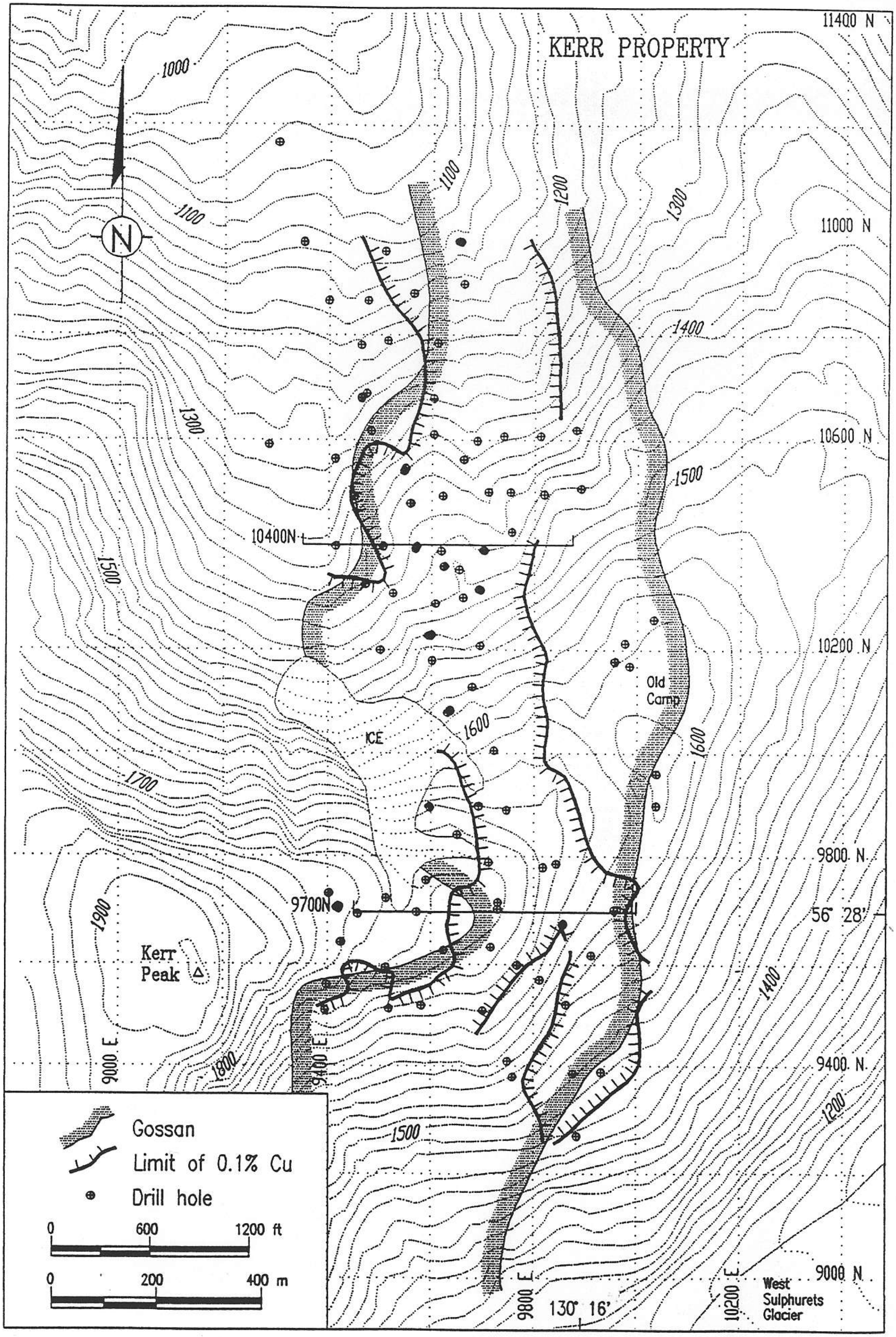
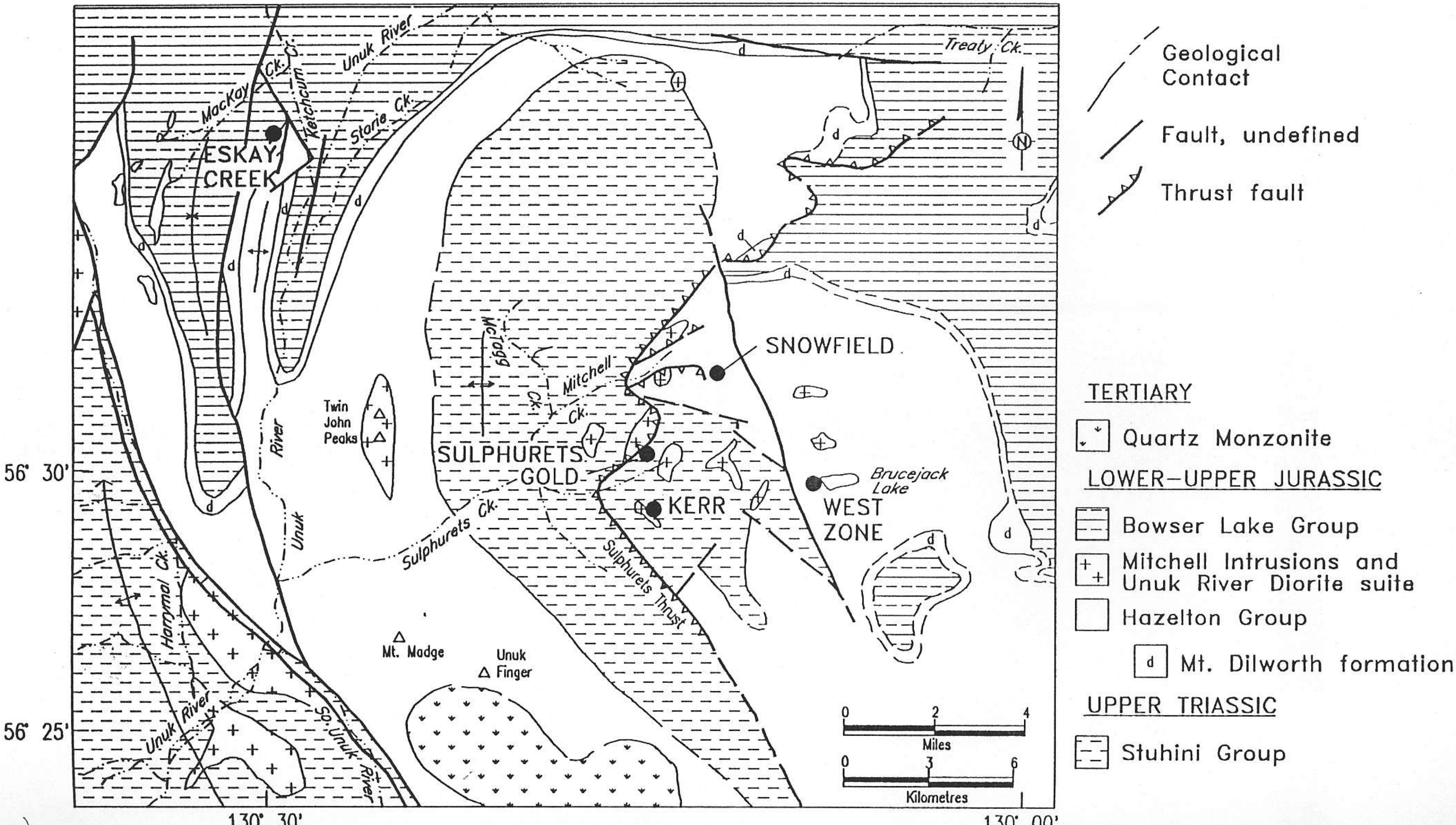

140°
60°
128°
114°
60°
56°
56°
KERR
B.C.
ALTA.
N
0
150
MILES
0
200
KILOMETRES
Stikinia
Quesnellia
48°
48°
140°
114°
128°

Fig. 1

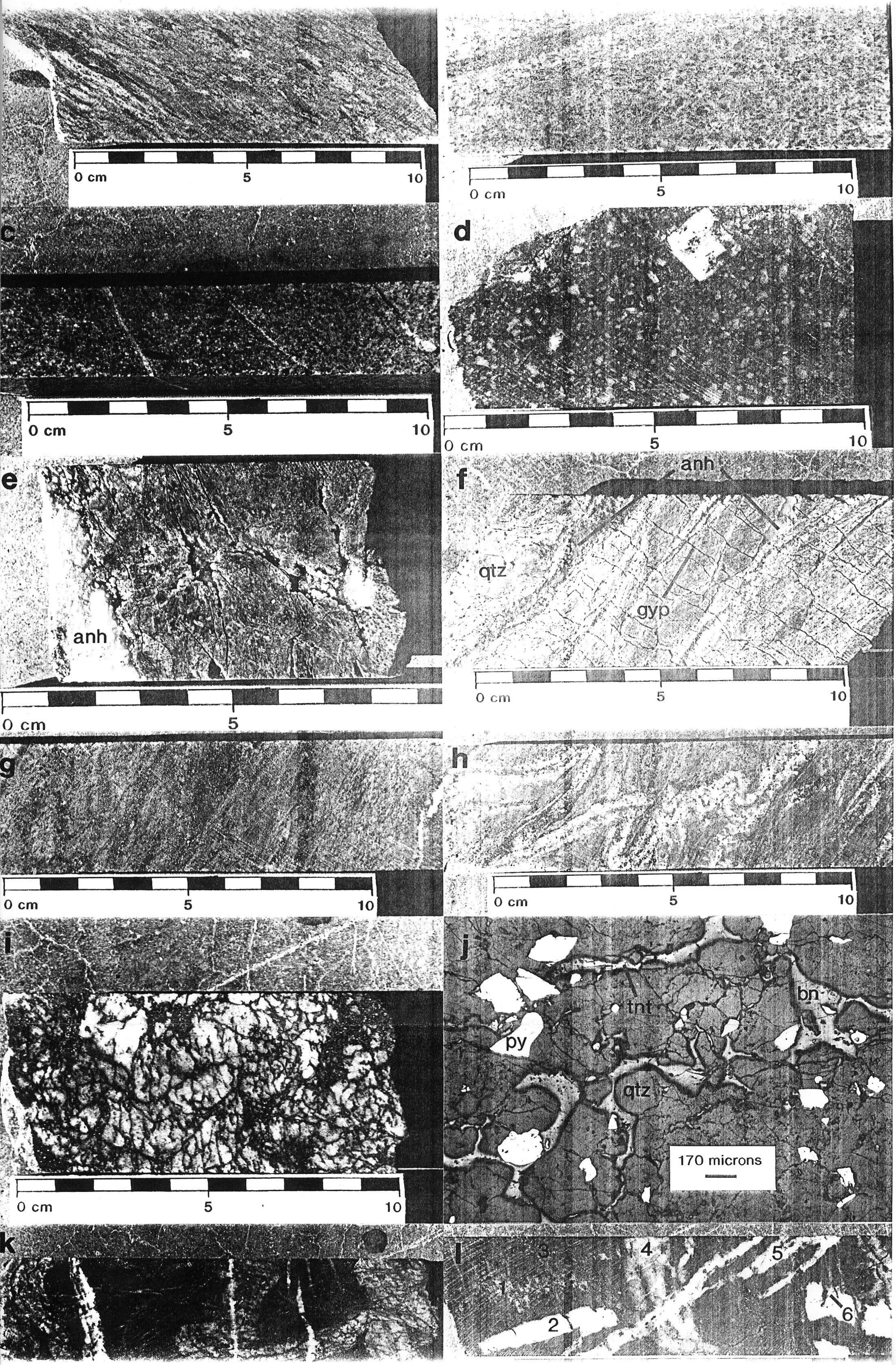


KERR PROPERTY
11400 N
11000 N
10600 N
10400N
10200 N
9800 N
9700N
56° 28'
9400 N
9000 N
9000 E
9400 E
9800 E
10200 E
130° 16'
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
ICE
Old Camp
Kerr Peak
West Sulphurets Glacier
N
Gossan
Limit of 0.1% Cu
Drill hole
0
600
1200 ft
0
200
400 m

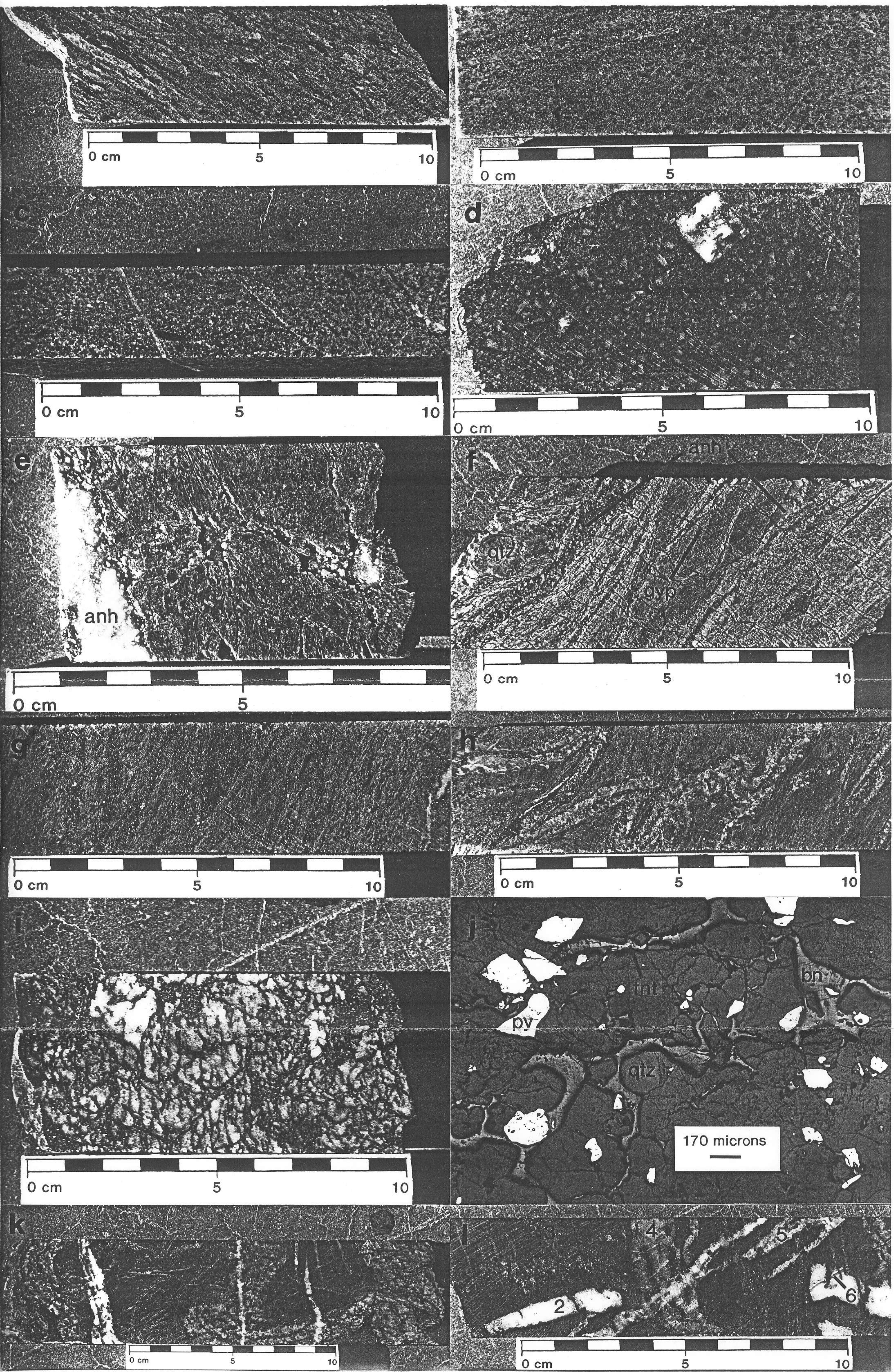
2



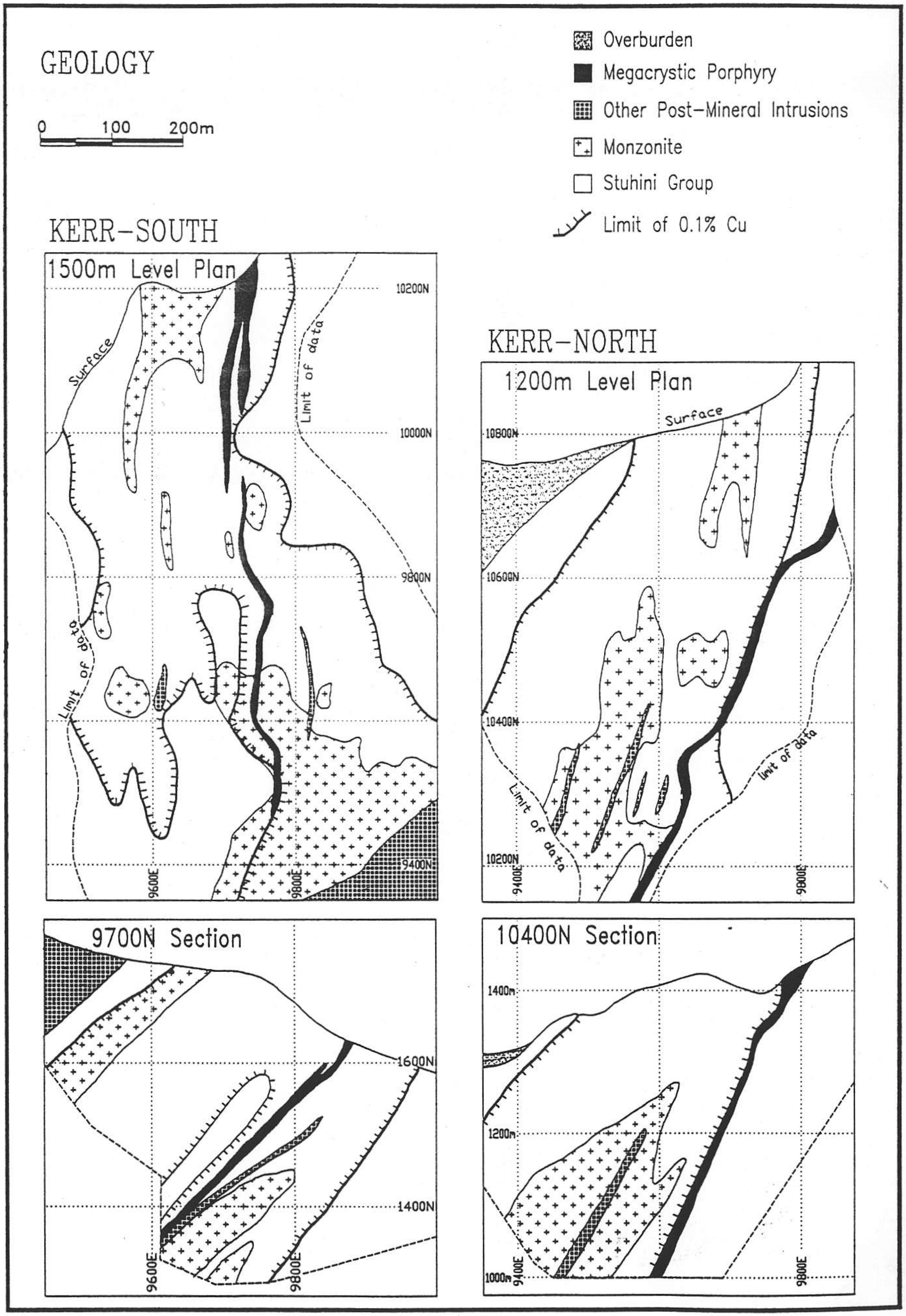
Geological Contact
Fault, undefined
Thrust fault
TERTIARY
Quartz Monzonite
LOWER–UPPER JURASSIC
Bowser Lake Group
Mitchell Intrusions and Unuk River Diorite suite
Hazelton Group
d Mt. Dilworth formation
UPPER TRIASSIC
Stuhini Group
ESKAY CREEK
SNOWFIELD
SULPHURETS GOLD
KERR
WEST ZONE
Brucejack Lake
Twin John Peaks
Mt. Madge
Unuk Finger
Unuk River
MacKay Ck.
Ketchum Ck.
Storie Ck.
Treaty Ck.
McTagg Ck.
Mitchell Ck.
Sulphurets Ck.
Sulphurets Thrust
Harrymel Ck.
So. Unuk River
N
Miles
0 2 4
Kilometres
0 3 6
56° 30'
56° 25'
130° 30'
130° 00'



0 cm
5
10
0 cm
5
10
c
d
0 cm
5
10
0 cm
5
10
e
anh
0 cm
5
f
anh
qtz
gyp
0 cm
5
10
g
h
0 cm
5
10
0 cm
5
10
i
0 cm
5
10
j
tnt
bn
py
qtz
170 microns
k
l
1
2
3
4
5
6



0 cm
5
10
c
d
e
anh
f
anh
qtz
gyp
g
h
i
j
tnt
bn
py
qtz
170 microns
k
l
2
4
5
6



GEOLOGY
0 100 200m
Overburden
Megacrystic Porphyry
Other Post-Mineral Intrusions
Monzonite
Stuhini Group
Limit of 0.1% Cu
KERR-SOUTH
1500m Level Plan
Surface
Limit of data
Limit of data
10200N
10000N
9800N
9400N
9600E
9800E
KERR-NORTH
1200m Level Plan
Surface
10800N
10600N
10400N
10200N
Limit of data
Limit of data
9400E
9800E
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1600N
1400N
9600E
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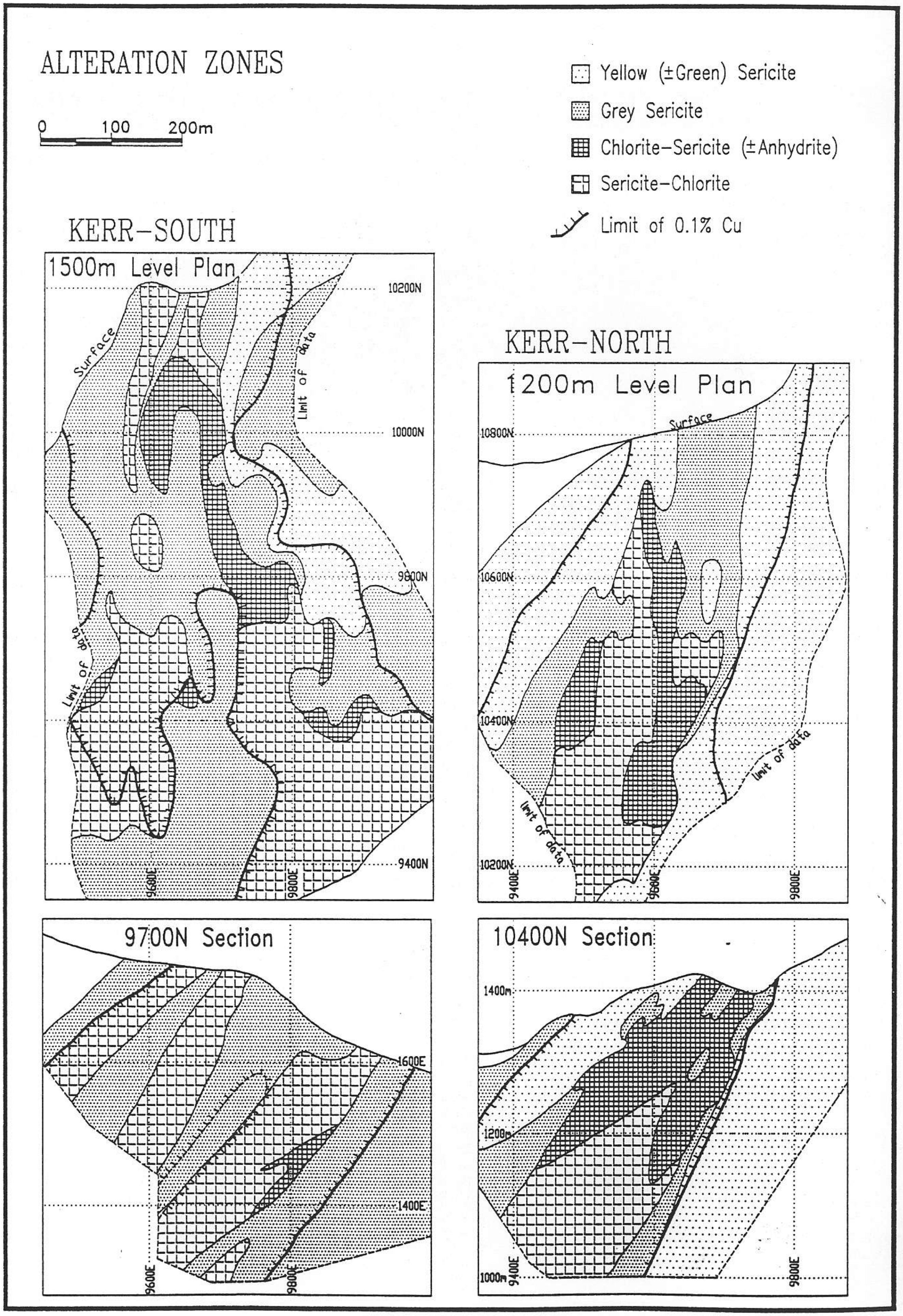
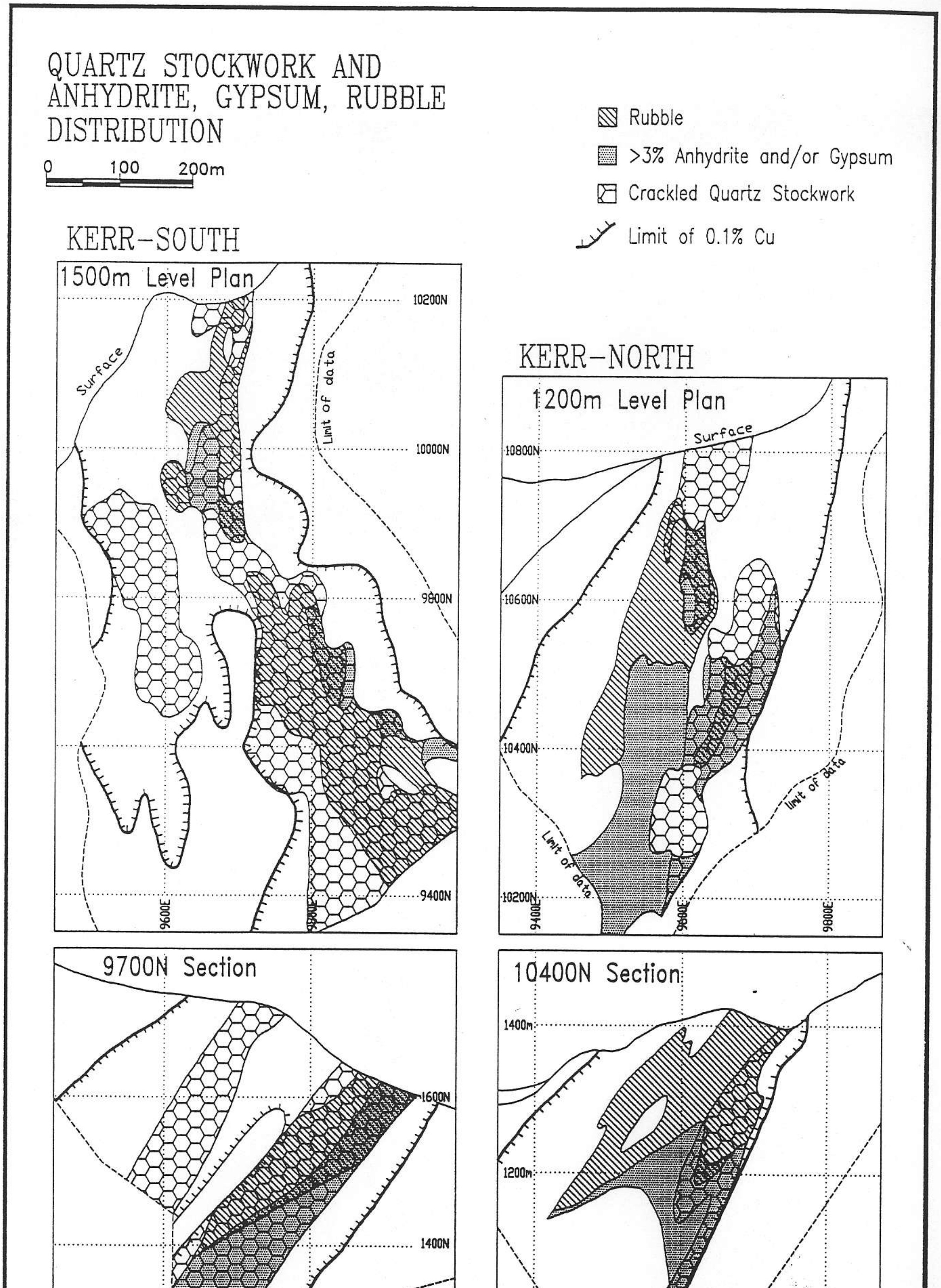
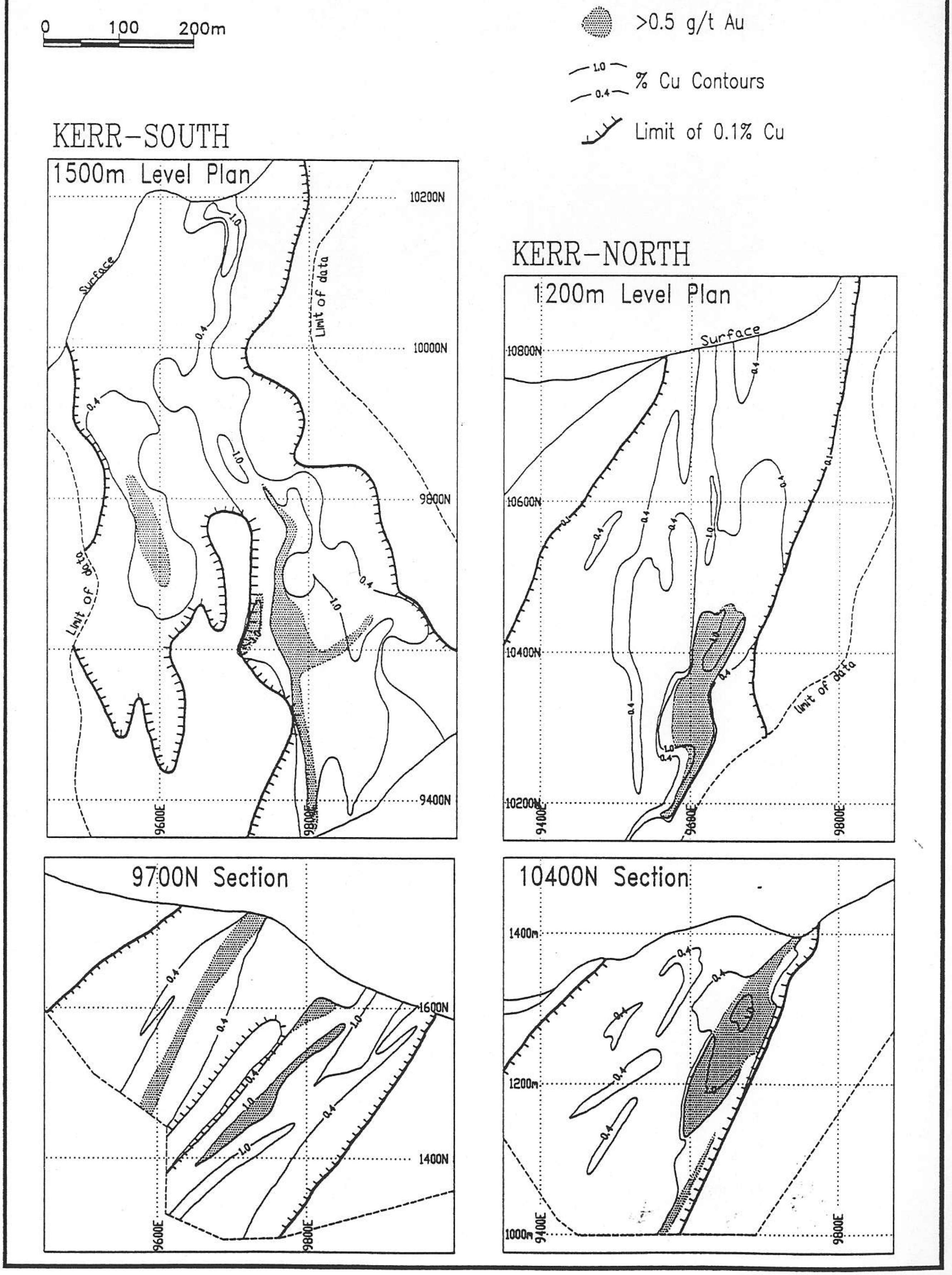
10400N Section
1400m
1200m
1000m
9400E
9800E

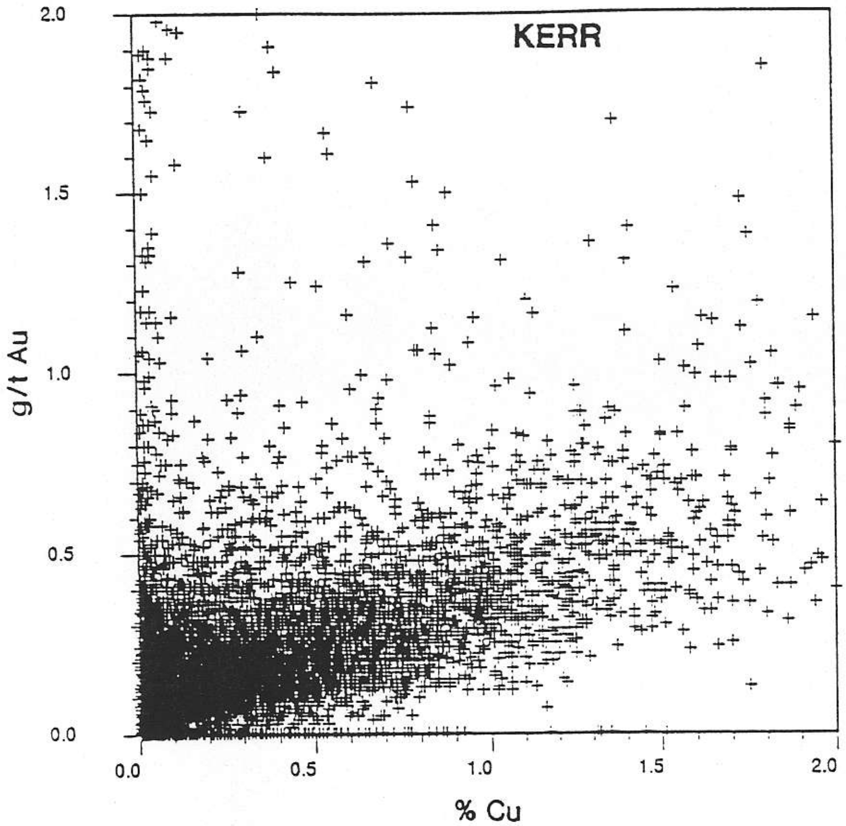


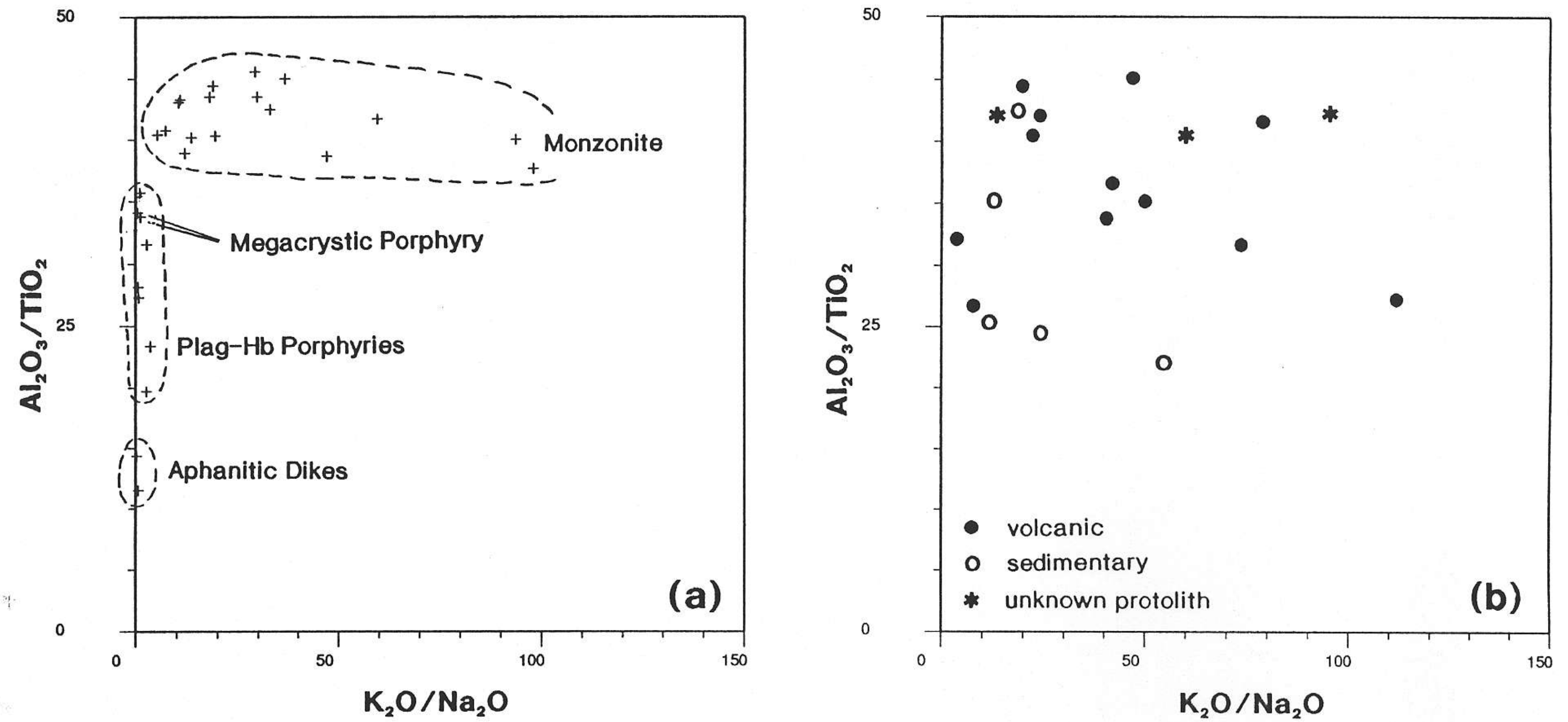
ALTERATION ZONES
0 100 200m
Yellow (±Green) Sericite
Grey Sericite
Chlorite–Sericite (±Anhydrite)
Sericite–Chlorite
Limit of 0.1% Cu
KERR–SOUTH
1500m Level Plan
10200N
10000N
9800N
9400N
9600E
9800E
Surface
Limit of data
KERR–NORTH
1200m Level Plan
10800N
10600N
10400N
10200N
9400E
9600E
9800E
Surface
Limit of data
9700N Section
1600E
1400E
9600E
9800E
10400N Section
1400m
1200m
1000m
9400E
9800E


QUARTZ STOCKWORK AND
ANHYDRITE, GYPSUM, RUBBLE
DISTRIBUTION
0 100 200m
Rubble
>3% Anhydrite and/or Gypsum
Crackled Quartz Stockwork
Limit of 0.1% Cu
KERR-SOUTH
1500m Level Plan
Surface
Limit of data
10200N
10000N
9800N
9400N
9600E
9800E
KERR-NORTH
1200m Level Plan
Surface
10800N
10600N
10400N
10200N
Limit of data
Limit of data
9400E
9600E
9800E
9700N Section
1600N
1400N
9600E
9800E
10400N Section
1400m
1200m
1000m
9400E
9800E

COPPER AND GOLD DISTRIBUTION




KERR
g/t Au
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
% Cu


50
25
0
0
50
100
150
Al_2O_3/TiO_2
K_2O/Na_2O
Monzonite
Megacrystic Porphyry
Plag-Hb Porphyries
Aphanitic Dikes
(a)
volcanic
sedimentary
unknown protolith
(b)

LITHOGEOCHEMICAL PROFILES
DRILLHOLE K88-18