Kennecott Canada Exploration Inc.

1997 GEOLOGICAL, GEOCHEMICAL, GEOPHYSICAL, AND DIAMOND DRILLING ASSESSMENT REPORT on the IRISHMAN CREEK OPTION

VOLUME 4

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Appendix XI

Petrographic Reports

Kennecott Canada Exploration Inc.
Irishman Creek Project - 1997

Samples for petrographic analysis

Sample	Drillhole	Northing	Easting	From	To	Description
VR 74215	97K-02	5458640	564220	50.60	50.80	Sphalerite veinlet, lesser galena. Subvertical vein within unaltered biotite quartzwacke. Peripherally does not show albitization/sericite alteration. Ideas on origin (ie late Cretaceous/ remobilized Proterozoic).
VR 74217	97K-03	5457870	5568000	297.26	297.32	Coarse subhedral white crystal (flake), is this feldspar? If so, note that they typically occur uppermost in a bed/turbidite sequence and appear to be associated with proximal detrital input. This would likely provide for retention of immature mineralogy, such as feldspar and suggests an environment of increased activity.
VR 74218	97K-03	5457870	5568000	504.52	504.56	Presence of white garnet? This sample is near upper contact of sulfide intersection. Thoughts on galena, clast replacement?
VR 74244	97K-03	5457870	5568000	568.05	568.17	Fine subrounded sphalerite, possibly strataform yet appears concentrated on one side of mineralized fracture:is this primary or epigenetic?
VR 74245	97K-03	5457870	5568000	507.25	507.30	Massive sphalerite, lesser galena intercalated with albitized metasediment. Is this fragment brecciation or clast? Does microscopic view of sulfides show a lineation which may suggest a strataform emplacement, or any textural characteristics for genesis?
VR 75451	97K-04	5457720	567910	229.31	229.37	Dark gray-blue coloration, is this actinolite alteration or remnant bedding? Light green altered biotite to chlorite, or muscovite development as well?
VR 75460	97K-04	5457720	567910	492.15	492.35	Tourmaline, on upper and lower contact, is lower fracture-facilitated and migration path for upper contact? Is core silicic as well as albitic?
VR 75461	97K-04	5457720	567910	500.88	501.07	Very hard, dark gray to black, tourmaline? Bed replacement? Note clast enclosed in quartz, is this tourmaline? Upper and lower contacts are bed parallel.
VR 75478	97K-04	5457720	567910	645.09	645.24	Nature of mineralization? Observe pyrrhotite and cotticule garnet (?) at base. Speculation on origin.
VR 75501	K97-03	5457870	5568000	60.12	60.20	Pink granules: garnet I assume or possibly k-spar? With albite/sericite fractures to what degree are they sericite? They are quite hard and appear to have a high albite component. Is matrix albitized or albitic/silicic?
VR 75502	K97-03	5457870	5568000	152.14	152.39	Submetallic, non-magnetic mineral: ilmenite or ??.

VR 75503	K97-02	5458640	564220	378.69	378.77	Coarse, subrounded dark gray fibrous to granular granules. They lack vitreous lustre, softness of biotite and decreased hardness often associated with alteration. MnO, actinolite?
VR 75506	K97-02	5458640	564220	660.99	661.09	Porphryoblastic biotite, pyrrhotite occupies similar sized sites either with biotite or alone. Can this be a pseudomorphic development or is chemistry not relational?
VR 75507	K97-02	5458640	564220	86.78	86.82	PA-1: Prismatic, hardness approx. 5, non-calcareous, silky lustre. Is this actinolite? This was suggested and appears to be a common interpretation. However I am somewhat confused as it is frequently noted hundreds of metres from a mafic source along with "biotite-chlorite-albite-actinolite" alteration.
VR 75508	K97-02	5458640	564220	347.39	347.47	PA-2: Is this weak to moderate tourmalinization? It is atypically hard and displays somewhat diffuse as opposed to sharp contacts in the quartzwacke.
VR 75566	K97-04	5457720	567910	877.16	877.2	Strong albitization, mottled styolitic texture: is this remnant bedding, actinolite or fine-felted tourmaline? Tourmaline occurs 1.5m downsection.
VR 75568	K97-04	5457720	567910	898.38	898.44	Banded quartzitic wacke and wacke, wacke beds composed of felted acicular tourmaline as replacement to argillaceous sediment. Why is tourmaline so bed-selective and why does albitization not affect these beds? Thoughts on this occurrence and possible implications.

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PETROGRAPHIC REPORT ON 2 THIN SECTIONS FROM MOVIE PROJECT

Report for: James Ryley — Invoice 970643
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VR75507A

PA-1: CALCITE ?VEIN WITH QUARTZ-BIOTITE-SERICITE-EPIDOTE-ACTINOLITE-GARNET-APATITE-SPHENE-OPAQUE ?WALLROCK AND/OR VEINS

Described as prismatic, hardness approximately 5, non-calcareous, silky lustre, possibly actinolite; noted hundreds of metres from a mafic source along with biotite-chlorite-albite-actinolite alteration. Hand sample is mainly carbonate (vigorous reaction to colc dilute HCl indicates calcite) with minor quartz and a dark green mafic mineral. The rock is not magnetic; there is no stained offcut for K-feldspar. Modal mineralogy in thin section is approximately:

Carbonate (mainly calcite)	60%
Quartz	30%
Biotite	3%
Sericite	3%
Epidote (zoisite/clinozoisite)	1%
Amphibole (?actinolite)	1%
Garnet	1%
Chlorite	<1%
Opaque	<1%
Sphene	<1%
Apatite	<1%

This slide consists mostly of coarse-grained calcite (subhedral to euhedral crystals that are optically continuous for up to 2.5 cm). Across one end of the section, there is a zone up to 1 cm thick of quartz-rich rock (?partly recrystallized Aldridge quartz wacke and/or partly quartz vein). Quartz is bimodal in size, with areas of fine-grained (<0.3 mm diameter, an- to subhedral) crystals that possibly represent altered wallrock, and areas of coarse, subhedral crystals up to 1.7 mm in diameter that likely represent veins.

Finer-grained quartz is mixed in places with interstitial garnet (skeletal subhedral crystals mainly less than 0.5 mm in diameter, but optically continuous for up to 2.5 mm) that is partly altered to fine-grained sericite and epidote-group mineral. Minor biotite (subhedral flakes to 0.1 mm) and patches of sericite (likely after former plagioclase feldspar) reinforce the impression that this material represents altered Aldridge sediment. The origin of the garnet, which is colourless and therefore possibly Mn-rich (this can only be proven by SEM/microprobe analysis on a polished thin section), is enigmatic but could be of exploration significance.

Coarse biotite (subhedral, commonly deformed medium brown flakes up to 1.5 mm diameter) is associated with the edges of the quartz-rich areas. In places there is minor subhedral amphibole up to 0.15 mm in diameter, with deep green pleochroism suggesting an actinolitic composition. Some biotite shows alteration to green biotite and/or chlorite (chlorite has anomalous blue, length-slow birefringence indicating moderate Fe:Fe+Mg, or F/M, ratio around 0.5-0.6); biotite is commonly associated with fine-grained masses of sericite that could be after former subhedral ?plagioclase crystals up to 0.25 mm in diameter, and subhedral crystals of Fe-poor epidote-group mineral (non-pleochroic; zoisite/clinozoisite, <0.3 mm in size). Fine-grained, sub- to anhedral opaque grains are less than 0.1 mm in diameter. Sphene forms sub- to euhedral crystals less than 50 microns in size, in places aggregating to about 0.1 mm across. Rare apatite forms euhedral prismatic crystals up to 0.2 mm long.

It is difficult to be sure of the relation between the calcite ?vein, quartz ?veining, minor amphibole and other minerals in this sample; in places the mafics (biotite, amphibole, epidote, garnet) appear to be part of a crushed matrix to quartz; elsewhere they appear interstitial to ?detrital quartz.

VR75508A

PA-2: PLAGIOCLASE-RICH (?ALBITIZED) LAYERED FINE QUARTZ-BIOTITE WACKE WITH LAYER-PARALLEL CONCENTRATIONS OF MUSCOVITE-?ALLANITE-SPHENE-RUTILE

Described as possible weak to moderate tourmalinization; hand specimen is a layered, dark to light grey sediment that is atypically hard and displays somewhat diffuse rather than sharp contacts with quartz wacke. The rock is not magnetic and shows no reaction to cold dilute HCl or stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz (detrital)	40-50%
Plagioclase (?albite)	25-35%
Biotite	10%
Muscovite, sericite	10%
Sphene, rutile	1-2%
?Allanite	1%
Chlorite (after biotite)	1%
Apatite	<1%
Zircon	<1%

This slide consists of alternating layers of coarser-grained (average 0.1-0.2 mm) and finer-grained (average about 50-100 microns) sediment; the coarser-grained layers are slightly enriched in biotite, causing the darker grey colour. In both layers, detrital quartz grains are anhedral to highly irreguluar in outline; the largest seen are just over 0.3 mm in diameter. Plagioclase feldspar is abundant, forming a "hash" of finer-grained, interstitial material that is rarely over 0.15 mm in diameter and only in places displays twinning. The relief appears to be negative compared to quartz and extinction angle on 010 is up to 12 degrees, suggesting an albitic composition. Relative proportions of albite and quartz are difficult to determine with precision; there may be more albite than estimated above. There does appear to be more albite than normal for Aldridge sediment, suggesting that the unusual hardness of this specimen is caused by significant albitization.

Biotite and muscovite form subhedral flakes up to 0.5 and almost 1 mm in diameter respectively; both appear to be partly porphyroblastic, likely formed during metamorphic recrystallization. The coarse muscovite crystals are possibly suggestive of former hydrothermal alteration; they are best developed or associated with unusual layer-parallel zones of ?allanite (Ce- and REE-bearing epidote that forms subhedral crystals up to 0.25 mm long, closely intergrown with minor sphene/rutile and surrounded by radiation-damaged chlorite and biotite). Outside these layer-parallel zones, muscovite is associated with clusters up to 0.2 mm across of sphene and rutile. Sphene crystals are subhedral and mainly less than 0.1 mm in diameter, commonly cored by dark brown ?rutile as rounded crystallites less than 25 microns in diameter. Chlorite associated with these layers (and replacing biotite away from the layers) has optical characteristics typical of low-Fe composition (very pale green, non-pleochroic, length-fast, non-anomalous birefringence; F/M may be around 0.4-0.5).

Minor apatite (subhedral crystals to 0.15 mm) and rare zircon (euhedra to 65 microns) are possibly detrital. Rare quartz veins (<0.1 mm thick) are subparallel to the layering.

This is not a tourmalinite; no tourmaline is detected in thin section. It appears to be albitized, and the presence of coarse porphyroblastic muscovite, in places associated with bedding-parallel concentrations of ?allanite, near the contacts between fine-grained and coarser sediment, may also be of exploration interest.

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PETROGRAPHIC REPORT ON 15 THIN SECTIONS FROM MOYIE PROJECT

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Dec. 19, 1997.

SUMMARY:

This is a suite of quartz wackes to fine silty wackes that range from unaltered (74215) or weakly muscovite/sericite-carbonate-epidote-chlorite altered (74217) to alkali feldspar (K-feldspar and/or albite-oligoclase; 75461, 75568) or calcic plagioclase (75460, 77501) altered, to intensely silicified or quartz--muscovite/sericite-epidote group mineral±chlorite, K-feldspar altered (74218, 74244, 75451, 75502, 75566) to weak tourmalinite (75503, 75568). Tourmaline forms <25% of these rocks, and is generally Fe-rich (green-brown, schorlitic), but is distinguished in 75568 by pale brown, more Mg-rich (intermediate dravite) composition that is of greater significance to exploration. In the latter (75568), it is also layered, rather than with the porphyroblastic texture of 75503 that may indicate a hornfelsed occurrence near a Moyie intrusive. Samples 75461 and 75566 do not contain tourmaline. Other samples thought to be albitic (75460, 75501, 75566, 75568) are either silicified, K-feldspathized, or contain anorthitic plagioclase; details are contained in the individual reports appended hereto.

Semi-massive to massive mineralization (74245, 75478) consists of 1-3 cm thick layers or ?veins of red-brown sphalerite with lesser galena and pyrrhotite plus variable quartz and clinozoisite (Fe-poor epidote) in variably quartz-clinozoisite-muscovite±Kspar-actinolite-sphene-chlorite-calcite altered wacke. It is not possible to determine if this mineralization is syngenetic or epigenetic from thin section examination. Note the apparent association between mineralization and clinozoisite (white in hand specimen; not garnet as thought in field examination). Pink to colourless sieve-textured garnet does occur (75451, trace; 75501, major; 75506, trace) but is not associated with mineralization.

The TiO_2-bearing mineral is predominantly sphene (with traces of rutile) for the suite up to 75501, but then changes to ilmenite (with generally subordinate sphene) for the rest of the suite to 75568. Minor ?allanite, or REE-bearing epidote-group mineral, is noted in a few samples (75461,75503) where crystals are coarse enough to suggest hydrothermal remobilization of REE.

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VR74215: QUARTZ-SPHALERITE±PYRRHOTITE-GALENA VEIN IN UNALTERED WACKE

Described as subvertical sphalerite-lesser galena veinlet within unaltered biotite quartz wacke; no albite/sericite alteration envelope; hand specimen shows trace magnetism and reaction to HCl along the vein. Traces of K-feldspar (long fractures parallel to bedding; not in the vein) are indicated by faint yellow stain in the etched slab. Modal mineralogy in polished thin section is approximately:

Quartz (mainly detrital; vein)	60%
Biotite	20%
Sericite	10%
Feldspar (?mainly plagioclase)	5%
Chlorite	1-2%
Epidote (?clinozoisite, allanite)	1-2%
Sphalerite	1-2%
Pyrrhotite	1%
Tourmaline	<1%
Galena, chalcopyrite	<1

Wallrock consists of fine (50-75 micron) subhedral quartz, likely recrystallized detrital grains, with interstitial white mica (sericite) as euhedral flakes to 50 microns and feldspar (mainly plagioclase although etched slab indicates minor Kspar) to 30 microns; there are abundant biotite "neocrysts" of up to 0.2 mm diameter. There are only traces of sulfides (pyrrhotite and sphalerite) in the walrock as very fine disseminated crystals to about 50 microns in diameter, in places concentrated along narrow fractures associated with chloritization of biotite and minor epidote. Chlorite forms flakes up to 0.1 mm in diameter that are pale green and have weak blue anomalous, length-slow birefringence, indicating moderate Fe:Fe+Mg or F/M ratio near 0.5. Epidote shows no discernible pleochroism and is likely Fe-poor (?clinozoisite). Scattered euhedral crystals of allanite (REE-bearing epidote) up to 0.1 mm in diameter contain minute sphalerite subhedra. Rare schorlitic tourmaline euhedra up to 0.15 mm long (green cores and brown rims are likely relict detrital and metamorphic overgrowths).

The vein consists of lenticular concentrations of sphalerite enclosing patches of pyrrhotite, and rare galena, in a gangue of quartz and minor biotite with selvages of epidote. Sphalerite forms subhedral crystals up to about 1.5 mm in diameter, with deep red-brown colour indicating moderate Fe content. Pyrrhotite forms subhedral crystals up to 1.2 mm in diameter, almost all contained within the sphalerite; rare chalcopyrite subhedra to 0.1 mm are associated with the pyrrhotite. Galena is confined around the outer margins of the sphalerite as irregularly-shaped masses up to 1 mm across. Rare pyrrhotite occurs at the selvage of the vein (separate from sphalerite); traces of chalcopyrite occur as fine inclusions in sphalerite at the selvage of the vein. I have seen similar veins in Lower Aldridge (Marysville outcrop) with biotite-only envelopes; fluid inclusions in them linked them to the Proterozoic mineralizing episode. Unfortunately, fluid inclusions appear absent from the quartz in this sample, so I am sorry that the thin section does not unequivocally answer your principal question: is the vein late Cretaceous/remobilized Proterozoic in origin. In my view it is unlikely that a petrographic analysis can resolve such a question, unless distinctive alteration or fluid inclusions are associated with such veining; possibly Pb isotopes would help, but they are an expensive solution.

VR74217: QUARTZ WACKE (QUARTZ-BIOTITE-MUSCOVITE; SERICITE-CARBONATE-EPIDOTE-CHLORITE ALTERATION); MUSCOVITE-RICH LAYER WITH BLASTIC ?SPHENE

Thin section is aimed at identifying coarse subhedral white crystal (?flakes), possibly ?feldspar; note that only minor parts of the crystals react to HCl, and most appear to be harder than steel. The rock is very slightly magnetic but shows no significant stain for K-feldspar. Modal mineralogy in thin section is approximately:

Quartz (detrital)	60%
Biotite	15%
Muscovite, sericite	15%
Carbonate (?mainly calcite)	5%
Opaques (?mainly pyrrhotite)	1-2%
Epidote	1-2%
Chlorite	1%
Sphene	<1%
Tourmaline	<1%
Apatite	<1%

The bulk of this section consists of normal Aldridge sediment (mainly detrital quartz with interstitial micas, minor opaques and scattered tourmaline). If there is any feldspar present, I cannot confidently identify it by relief difference against quartz. Quartz grains are subrounded to anhedral, and fall into two main size ranges: coarse grains of about 0.5 mm diameter, with distinct narrow (50 micron) overgrowths, and fine interstitial grains of about 50-100 micron grain size. Micas are principally biotite, as subhedral medium brown flakes up to about 0.25 mm in diameter, and white mica (muscovite and sericite respectively as euhedral ?detrital or metamorphic flakes to 0.5 mm and subhedral flakes to 50 microns that may reflect the alteration of ?former minor feldspathic material. In places carbonate (likely mostly calcite) appears to accompany sericite in replacing former feldspar. Opaques form scattered subhedral crystals up to 0.2 mm in diameter that appear to be mostly sulfides (likely pyrrhotite to judge by trace magnetism in hand specimen), locally associated with traces of 20-50 micron ?epidote and chlorite. Scattered euhedral ?detrital crystals of schorlitic tourmaline and apatite are up to 0.1 and 0.05 mm respectively.

A narrow (<1 mm thick) veinlet is composed of ?alkali feldspar as subhedra to 0.2 mm, likely mostly albitic but possibly including trace K-feldspar to judge by the faint yellow stain in hand specimen. Later carbonate (?mainly calcite) fracturing is found in and adjacent to the veinlet.

The white "crystals", which are unfortunately only barely cut in the thin section, appear to be aggregates of sphene that are present only in a fine-grained, muscovite-rich bed that is quite distinct from the normal, coarser-grained quartz-rich detritus described above. As such, it is likely that the apparent coarse size of the white "crystals" is due to metamorphic (porphyroblastic) growth from some precursor; their seive texture, visible with hand lens, is supportive of such an origin.

VR74218: INTENSELY EPIDOTE (?CLINOZOISITE)-QUARTZ-SPHENE ALTERED ROCK WITH PATCHES/VEINLETS OF GALENA-CHLORITE-PYRRHOTITE-RARE SPHALERITE

Grey-white, massive, strongly altered rock with wispy patches of blue-grey (sulfides, including galena and magnetic ?pyrrhotite) and lesser brown (biotite), from near upper contact of sulfide intersection. The rock is siliceous (harder than steel); white mineral may be ?garnet. There is no reaction to cold dilute HCl, and no stain for K-feldspar in the etched slab. Modal mineralogy in polished thin section is approximately:

Epidote (?clinozoisite)	65%
Quartz	30%
Galena	3%
Sphene	1%
Chlorite	<1%
Pyrrhotite	<1%
Sphalerite	tr

This slide consists mainly of epidote-group mineral as fine euhedral crystals, in places hosted by (poikilitically enclosed in) much larger crystals of quartz, or enclosed in a matrix of galena and minor pyrrhotite.

The epidote-group mineral forms euhedral to subhedral crystals up to 0.7 mm long that commonly show parallel extinction and have relatively low birefringence (first-order grey to slightly anomalous yellow-green); this is suggestive of clinozoisite. In places small subhedral to euhedral crystals of pale sphene up to 0.25 mm long are included in clinozoisite or in matrix galena or quartz. The abundance of sphene suggests derivation from an Aldridge sediment; the euhedral crystals and localization, especially along some of the sulfide-bearing fractures, suggests remobilization of TiO_2, and therefore very strong alteration.

The host quartz forms very large, mainly subhedral crystals that are optically continuous for up to 3 mm in diameter. The crystals are strained (strong undulose extinction that in places defines a lamellar texture) and contain abundant healed fractures evidenced by trails of pseudosecondary fluid inclusions.

Rare chlorite forms subhedral flakes to 0.25 mm diameter in rounded pseudomorphs after former ?mafic minerals up to 0.75 mm in size. Chlorite displays optical characteristics (very pale green colour, weakly to non-anomalous near-zero birefringence) suggestive of lower Fe content (F/M about ?0.4-0.5).

Galena occurs mainly in interstices between clinozoisite crystals, or in narrow (0.1 mm) fractures. The galena forms anhedral masses up to 1.5 mm in diameter, composed of smaller ?euhedral crystals (not individually discernible in polished section). Pyrrhotite forms subhedral crystals up to 0.5 mm long generally included in galena. Sphalerite is found as red-brown (moderate Fe) subhedra to 0.25 mm, only in some of the narrow fractures with galena.

VR74244: QUARTZ-SERICITE-ZOISITE-KSPAR-CHLORITE ALTERED FINE SILTSTONE WITH FRACTURES OF PYRRHOTITE-TOURMALINE-TRACE SPHALERITE-CHALCOPYRITE

Dark grey to greenish-buff, fine-grained altered sediment cut by a fracture oblique to bedding that contains pyrrhotite and reportedly fine subrounded sphalerite that may be ?stratiform but is concentrated along one side of the mineralized fracture. Minor Kspar is indicated by yellow stain in the etched slab, particularly in a fine-grained 3 cm thick bed and near the mineralized fracture; there is no reaction to cold dilute HCl; modal mineralogy in polished thin section is roughly:

Quartz (detrital, ?secondary)	50%
Sericite, muscovite	15%
Epidote-group (?zoisite)	10%
Pyrrhotite	10%
Biotite	5%
Tourmaline (dravite-schorl)	3-5%
K-feldspar (secondary)	3%
Chlorite (after biotite)	2%
Sphene, trace rutile	1%
Chalcopyrite, sphalerite	<1%

The wallrock consists of fine silt-sized (approximately 50 micron) quartz grains with lesser interstitial mica (mainly muscovite or sericite, but including variable proportions of biotite that is partly chloritized in places) to 75 microns, and significant pyrrhotite, epidote-group mineral, and tourmaline plus minor sphene. The quartz is likely mostly detrital, but some may be secondary, especially in and near the fracture system. Former plagioclase sites are replaced by the epidote-group mineral, and especially near the fracture/veinlet system, sericite and K-feldspar. The epidote-group mineral has anomalous blue birefringence, suggesting ?zoisite; it forms ragged to subhedral crystals mainly less than 1 mm in diameter. Tourmaline crystals are mainly less than 0.15 mm long, with pale brownish-green colour; abundance near the fracture system suggests it is mostly hydrothermal. Sphene forms mainly euhedral crystals up to 0.1 mm in diameter, rarely with euhedral rutile to 25 microns in their core. Pyrrhotite forms subhedra mainly <0.1 mm in diameter, closely associated with ?zoisite.

In the vein/fracture system, pyrrhotite forms sub- to anhedral crystals up to about 0.35 mm in diameter, rarely containing (?altered to) minor ?marcasite/pyrite as irregular aggregates up to 0.2 mm in diameter. The ?marcasite is localized along the interior of the mineralized fracture, possibly due to late-stage but still ?hypogene activity along a re-opening of the fracture. In places pyrrhotite and chalcopyrite "bleed off" the fracture system into the bedding, forming wispy bed-parallel laminae up to 0.2 mm thick, some containing minor sphalerite. Sphalerite is rare in the section, forming subhedral crystals up to 0.2 mm in diameter with red-brown colour (indicating moderate Fe content) that are closely associated with pyrrhotite and tourmaline in the quartz-vein mineralized fracture system. Tourmaline occurs as brownish-green euhedra to 0.25 mm long, probably of Fe-rich dravite-schorl composition (F/M perhaps ?0.6-0.7). Minor epidote-group mineral (blue anomalous birefringence suggests ?zoisite) forms subhedra to 0.1 mm in the fracture system. Both fresh brown biotite (euhedral flakes to 0.25 mm) and chloritized relics occur in and along the vein, and in places there are traces of sphene (some with cores of rutile) associated with the fractures, suggesting mobilization of TiO_2.

VR74245: MASSIVE SPHALERITE-GALENA-PYRRHOTITE WITH INTERCALATED QUARTZ-EPIDOTE(CLINOZOISITE/ZOISITE)-ACTINOLITE-SPHENE-CHLORITE-CARBONATE

Semi-massive sphalerite, lesser galena and pyrrhotite (rock is weakly magnetic) intercalated with white ?albitized metasediment (mainly harder than steel; no reaction to cold dilute HCl. Offcut not stained for K-feldspar; suggestion of a weak foliation/lineation evident in the sphalerite appears to be due to streaking by the saw blade. Modal mineralogy in polished thin section is approximately:

Sphalerite	65%
Quartz	20%
Galena	5%
Epidote-group (?Clinozoisite, zoisite)	5%
Pyrrhotite	1-2%
Amphibole (?actinolite)	1%
Sphene, trace rutile	1%
Chlorite (after biotite)	1%
Carbonate	<1%

Massive sphalerite layers are up to 2 cm thick, intercalated with wall-rock layers to 1 cm thick and lesser galena-rich lenses to 0.5 cm thick (internal to sphalerite layers). Galena-rich areas contain euhedral crystals of ?zoisite to 3 mm and quartz to 1 mm ; pyrrhotite appears to rim the silicate inclusions in the sulfides. Sphalerite masses show little internal structure (crystals appear to be subhedral and mainly less than 0.5 mm in size); there is no indication of lineation, unless it is perpendicular to the section. Minor pyrrhotite found along discontinuous stringers or layers, and at borders of massive sphalerite with wallrock, where it forms subhedral crystals up to 1 mm in size, could indicate former ?stratiform layering. However, the pyrrhotite (with galena) could also be considered to be along fractures in the sphalerite. Note that this distribution could be due to remobilization during deformation, since both galena and pyrrhotite deform more readily than sphalerite. In general, textural features for genetic hypotheses are not likely to be found microscopically in a rock that has undergone middle greenschist metamorphism/deformation; hand-specimen or outcrop-scales are more likely to preserve such features.

Altered wall-rock intercalations are similar to the quartz-epidote group mineral rich material described in VR74218; feldspar appears to be absent from this slide. Quartz crystals are mainly subhedral, up to about 0.5 mm in diameter, and show little evidence of strain (lack of undulose extinction, triple junctions indicating recrystallization and later annealing). Epidote-group mineral forms subhedral to euhedral crystals mostly interstitial to quartz and commonly associated with sphalerite/rare pyrrhotite. Epidote-group mineral crystals are less than 0.15 mm in diameter, mainly with anomalous yellow-green interference colours and lack of discernible pleochroism suggesting clinozoisite (Fe-poor epidote); near the margins of massive sphalerite, euhedral crystals to 0.3 mm long have anomalous blue interference colours, suggesting zoisite. In places along the margins of the massive sphalerite, sphene is important as euhedra to 0.2 mm in size, associated with the ?zoisite. Amphibole forms ragged crystals up to 0.7 mm long with deep green pleochroism suggesting actinolite (partly chloritized in places). Biotite, mostly interleaved or altered to chlorite, forms ragged flakes to 0.25 mm diameter. Rare carbonate is interstitial to quartz, forming anhedra less than 0.15 mm in size.

VR75451: QUARTZ-BIOTITE WACKE ALTERED PROGRESSIVELY TO MUSCOVITE, CHLORITE, ZOISITE/CLINOZOISITE, K-FELDSPAR, AND QUARTZ-ZOISITE

Bluish-grey, fine-grained, altered sediment, suggested to be due to ?actinolite; pale green due to ?sericite or chlorite. The rock is siliceous (harder than steel), weakly magnetic, does not react to cold dilute HCl but shows minor yellow stain for K-feldspar in certain layers. Modal mineralogy in polished thin section is approximately:

Quartz (detrital, secondary)	60%
Epidote-group (?zoisite/clinozoisite)	20%
Muscovite, sericite	10%
Biotite (partly chloritized)	5%
Pyrrhotite	2%
K-feldspar	1-2%
Sphene	1%
Garnet	<1%

The framework of the rock consists of subhedral quartz crystals, likely mostly detrital grains mainly less than 0.15 mm in diameter, but also mostly recrystallized and possibly added to by secondary quartz; it is hard to be sure at this grade of metamorphism unless the secondary quartz is distributed along obvious zones or fractures (some of which are present in this sample, up to 0.5 mm thick).

Interstitial to the quartz is abundant fine-grained epidote-group mineral and muscovite likely after the original feldspar content of the rock, or in other areas pale brown biotite, and rare garnet. The epidote-group mineral has no pleochroism and low, anomalous blue birefringence; it is likely zoisite, forming ragged to subhedral crystals mainly less than about 0.15 mm in diameter. Sericite forms subhedral flakes to 75 microns in diameter. Biotite occurs as ragged subhedra to 0.5 mm with a washed-out appearance due to partial chloritization and/or interleaving by muscovite (sericite). Chlorite displays optical characteristics (very pale green colour, weakly to non-anomalous near-zero birefringence) suggestive of moderate Fe content (F/M about ?0.5). Sphene forms small euhedral to subhedral crystals mainly less than 0.1 mm in diameter; garnet forms ragged sieve-textured crystals less than 1 mm across.

Disseminated pyrhotite is common throughout, mainly as sub- to anhedral crystals up to 0.5 mm in diameter, locally aggregating to 1 mm and closely associated with chloritized biotite, zoisite and sphene. Traces of chalcopyrite (to 0.1 mm) are found included in pyrrhotite.

Veinlets mainly less than 0.25 mm thick consist of zoisite and lesser sericite, with an inner envelope that contains minor K-feldspar (anhedral interstitial crystals to 75 microns). Blue-grey alteration envelopes around the veinlets are irregular and appear to be enriched in zoisite or clinozoisite; beyond this, musccovite/sericite and relict biotite appear to be more important, although zoisite is also present. The association of epidote (in this case zoisite or clinozoisite), sericite, sphene and garnet with sulfides is typical of alteration in the peripheral North Star Hill area near the Sullivan deposit.

VR75460: TOURMALINE-QUARTZ-ZOISITE VEIN WITH INNER K-SPAR AND OUTER ZOISITE-SERICITE ENVELOPES CUTTING QUARTZ-CALCIC PLAGIOCLASE WACKE

Tourmaline-bearing quartz vein about 1 cm thick in pale grey, fine-grained quartz-rich wacke; white alteration envelope up to almost 1 cm thick, with inner envelope containing minor yellow stain for K-feldspar; etched slab shows a selvage on one side of the vein rich in a blue-grey mineral (?zoisite as in 75451). The rock is not magnetic and shows no reaction to cold dilute HCl. Modal mineralogy in polished thin section is approximately:

Quartz (partly secondary)	75%
Epidote-group (?zoisite)	15%
Tourmaline (mainly vein)	5%
Sericite	3%
K-feldspar (secondary)	1%
Sphene	<1%
Pyrrhotite, trace galena	<1%
Carbonate	<1%
Rutile	<1%

Wallrock consists mainly of interlocking quartz and interstitial epidote-group mineral plus minor sericite and sphene, or further from the vein, calcic plagioclase takes the place of the epidote.

In the wallrock, quartz forms anhedral crystals mainly less than 0.3 mm in diameter with a recrystallized, partly overgrown look that suggests some of the quartz is secondary. Distal from the vein, finely twinned ?plagioclase has strong positive relief compared to quartz and is likely very calcic (possibly anorthite; this composition is likely secondary, and implies addition of calcium to the rock, as does the Fe-poor, Ca-rich epidote group mineral). Low, weakly blue anomalous birefringence suggests that the epidote-group mineral is zoisite, mostly present in the same sites as plagioclase, where it forms sub- to anhedral crystals mainly less than 0.1 mm in diameter but aggregating to 0.25 mm and associated with minor sericite and sphene. Both zoisite and sericite appear to form at the expense of (replace) plagioclase; this is responsible for the wide white envelope to the vein. An inner envelope contains minor K-feldspar as subhedral crystals less than 75 microns in size, that also occupy the interstices between quartz crystals and may take the place of plagioclase and sericite. Rare coarse tourmaline crystals are up to 0.4 mm long (brown cores with bluish rims suggests very Fe-rich composition, F/M possibly 0.8-0.9).

The vein consists of altnerate laminae of tourmaline and quartz on one side, and massive quartz with a selvage of zoisite on the other. The tourmaline is finely felted (euhedral crystals mainly less than 0.1 mm long, but in places elongated needles up to 0.5 mm). Quartz forms mainly coarse, anhedral to subhedral crystals that are optically continuous for up to 4.5 mm (poikilitically enclosing tourmaline crystals or free of tourmaline, in alternating layers). The colour, a medium brown with tinges of green, suggests fairly schorl-rich composition with F/M possibly near 0.7. Rare opaques in the vein include lath-like rutile to 0.75 mm long, mainly coated by sphene (implying mobilizaion of TiO_2), and minor pyrrhotite as subhedral crystals to 0.35 mm diameter associated with trace ?galena to 25 microns. The zoisite selvage consists of felted, radiating sheaf-like crystals up to 0.5 mm in diameter that are cut by narrow fractures of carbonate, likely late (?post-metamorphic).

VR75461: ALKALI FELDSPAR (KSPAR-ALBITE)-MUSCOVITE-CHLORITE ALTERED SEDIMENT CONTAINING MINOR TOURMALINE, CUT BY CALCITE-CHLORITE FRACTURES

Dark grey to blue-grey, fine-grained, very hard layer or ?bed replacement in coarser-grained, grey quartz-rich wacke. Late microfractures react to HCl; the rock is not magnetic but stains strongly for K-feldspar throughout. Modal mineralogy in polished thin section is approximately:

Quartz	35%
K-feldspar (?secondary)	35%
Muscovite (sericite)	15%
Plagioclase (?albite)	7%
Chlorite	3%
Rutile, sphene	1-2%
Carbonate	1-2%
Tourmaline	1%
Pyrrhotite	<1%
?Allanite	<1%

This is (in my experience) an unusual rock for the Aldridge. Although minor tourmaline is present in places, I would not characterize the rock as a "tourmalinite". It is composed mainly of alkali feldspar as a microcrystalline matrix that hosts relict ?detrital quartz grains, patches of muscovite/sericite, chlorite flakes, rutile, and ?allanite.

The feldspathic matrix consists largely of K-feldspar as sub- to anhedral crystals to 0.3 mm diameter, although in places subhedral crystals and partly replaced ?relics of twinned albite up to 0.2 mm in diameter are visible contained within the Kspar. Relief of the plagioclase below that of quartz and only slightly above that of Kspar, plus extinction on 010 near 17 degrees, suggests a composition near An_0. Quartz grains are generally sub- to anhedral, up to about 0.15 mm in size, and are poikilitically enclosed in the alkali feldspar matrix; the quartz may represent remnant detrital grains.

Irregular patches up to 0.35 mm across composed of mica (mainly ragged to subhedral muscovite up to 0.15 mm in diameter, or finer sericite of <50 microns diameter) are partially interstitial to the alkali feldspar crystals, or could represent ?altered plagioclase sites. The micaceous patches commonly include minor amounts of chlorite as subhedral flakes to 0.1 mm diameter, possibly after former ?biotite. Chlorite displays optical characteristics (pale green pleochroism, weakly to non-anomalous length-slow birefringence) suggestive of F/M about ?0.5, and is mixed with minor rutile, sphene and ?allanite as very fine subhedral crystals (5-15 microns) that aggregate to 0.25 mm in places. Scattered euhedral tourmaline crystals up to 0.15 mm long are greenish-brown, schorlitic (F/M possibly to 0.7) and could be mostly ?detrital. Allanite (?) crystals are up to 60 microns long associated with carbonate (mostly calcite subhedra to 0.1 mm) and chlorite-rich fracture zones or veins up to 0.5 mm thick.

Fine-grained pyrrhotite is rare, disseminated in the wallrock and mainly confined to fractures in the envelope; pyrrhotite is mostly sub- to anhedral and less than 0.5 mm in diameter, locally aggregating to 1 mm in the envelope. Rutile is the main TiO_2 mineral, forming subhedra to 35 microns, locally mixed with sphene (aggregates to 0.2 mm).

One possible explanation for this rock (to account for the Kspar) is that it represents a "granophyritized" sediment (generally found near a Moyie sill). The ?clast appears to be quartz-rutile rich.

VR75478: SPHALERITE-GALENA-PYRRHOTITE-QUARTZ-CLINOZOISITE ?LAYER OR VEIN IN QUARTZ-MUSCOVITE-CHLORITE-KSPAR ALTERED FINE QUARTZ WACKE

Sphalerite-galena-pyrrhotite ?layer or vein about 3 cm thick, thought to contain "coticule" (garnet-rich) layer or layers associated with the mineralization. However, the thin section shows that this is actually epidote (clinozoisite-zoisite) as in 74218, 44, 45 and 75451 and 60. The rock is magnetic but shows only trace ?reaction to cold dilute HCl, and trace stain for K-feldspar in the etched slab. Modal mineralogy in polished thin section is approximately:

Sphalerite	40%
Quartz (mainly detrital)	30%
Muscovite, sericite	10%
Chlorite	5%
Clinozoisite, zoisite	5%
Galena	5%
Pyrrhotite	3%
Sphene	<1%
K-feldspar (?secondary)	<1%
?Arsenopyrite	tr

The massive sulfide layer (or ?vein) consists of a central sphalerite layer about 1 cm thick that is mixed toward the edges with increasing amounts of galena and pyrrhotite. The sphalerite, which is red-brown in colour (moderate Fe content), forms sub- to euhedral crystals mainly less than 1 mm in diameter. Both galena and pyrrhotite are mainly interstitial to sphalerite, forming intergrown sub- to euhedral crystals rarely up to 1.5 mm in diameter that extend out into wallrock where they appear to replace interstices between quartz grains. Galena is semi-massive along one side of the sphalerite mass and mainly absent along the other margin; pyrrhotite occurs in both the sphalerite and the galena. Rare euhedral arsenopyrite is up to 0.5 mm across at the margins of the sphalerite; chalcopyrite is notably absent from the assemblage.

Irregular pockets up to 1 cm in size found along the margins of the sulfide layer/vein consist of aggregates of coarse, subhedral quartz to 3 mm and euhedral clinozoisite to 0.7 mm (likely the material tentatively identified as garnet in hand specimen examination), plus rare euhedral pale brown mica (muscovite/phlogopite).

Wallrock consists of a relatively fine-grained detrital quartz framework with interstitial micas (muscovite-sericite and chlorite, the latter possibly after ?biotite, plus clinozoisite/?zoisite). Quartz grains are mainly anhedral and rarely up to 0.6 mm long, in places polygonalized suggesting some secondary quartz activity. Muscovite forms subhedral flakes rarely over 0.1 mm in diameter; chlorite flakes are ragged subhedra to 0.3 mm associated with subhedral clinozoisite and ?zoisite to 0.1 mm and sparse sphene to 50 microns. Rare feldspar appears to be ?Kspar (subhedral, <0.1 mm). Chlorite displays optical characteristics (very pale green colour/no pleochroism, near-zero birefringence) suggestive of lower Fe content (F/M about ?0.4). There are no clear indications that the alteration minerals (likely replacing former interstitial detrital feldspars) are more concentrated near the sulfide layer/vein, as in an alteration envelope. However, there are also no clear indications in the sulfide mass of primary (syngenetic) textures either, so the origin of the sulfides remains enigmatic.

VR75501: SILICIFIED, CLINOZOISITE-CHLORITE FRACTURED, GARNET, BIOTITE CA-PLAGIOCLASE BEARING QUARTZ WACKE; CLOTS PYRRHOTITE-ZOISITE-SPHENE

Pale grey to buff-coloured altered wacke with pink ?garnet granules, brown biotite and white to pale greenish fracture envelopes that may be albite and ?minor sericite. The rock is not magnetic and shows no reaction to cold dilute HCl, and only trace stain for K-feldspar along the fracture envelopes in the etched slab. Modal mineralogy in polished thin section is approximately:

Quartz (partly secondary)	60%
Plagioclase (calcic)	10%
Garnet	10%
Clinozoisite, zoisite	10%
Chlorite	3-5%
Biotite	3%
Pyrrhotite	1-2%
Muscovite	1%
Sphene	<1%
K-feldspar (secondary)	<1%

Where least altered, the rock consists of an intergrown mosaic of quartz crystals with interstitial plagioclase, clinozoisite and biotite that in places hosts subhedral sieve-textured garnets. Much of the quartz appears to be secondary (abundant, sub- to euhedral polygonal crystals to 0.35 mm diameter that may have overgrown and partly obscured the original detrital quartz). Interstitial plagioclase forms small sub- to anhedral twinned crystals less than 0.1 mm in diameter, with extreme positive relief against quartz indicating very calcic composition (?possibly anorthite). As at the Fors occurrence, this is very likely a secondary composition; note the occurrence with Fe-poor, Ca-rich epidote (clinozoisite), which forms subhedral crystals to 0.2 mm also in interstices between quartz. Biotite forms scattered sub- to euhedral pale brown flakes up to 0.3 mm in diameter; muscovite or sericite appears to be confined to areas around "clots" as ragged subhedra to 50 microns.

In places the clinozoisite is concentrated in "clots" up to 2 mm across, associated with sulfides, sphene, muscovite and rare chlorite. Sphene forms mainly euhedral crystals up to 0.1 mm in diameter; chlorite forms ragged crystals with near-zero birefringence and virtually no colour (F/M probably 0.4), that in places clearly replace or interleave biotite. Garnet "crystals" are really ragged aggregates up to about 1.5 mm in diameter, of small granules or crystals to 0.5 mm diameter, that appear to replace the matrix between quartz grains. In a <1 cm thick zone crossing the slide, the garnets are associated with coarse subhedral secondary quartz to 2 mm, intergrown with clinozoisite to 0.5 mm, chloritized biotite to 1 mm, minor sphene and sulfides.

The fracture zones are characterized by increased clinozoisite or zoisite (not albite), forming interconnected subhedra mainly less than 0.1 mm in diameter, and with chloritization of biotite (these two minerals account for the pale green colour). Thus there is no albite in this sample and very little sericite.

Sulfides, mainly pyrrhotite as subhedral <0.5 mm crystals in irregularly-shaped aggregates up to 1.5 m across, are loosely associated with the zone of garnets in the middle of the slide, but not with the fracture zones. No base-metal sulfides are noted in the surface of the polished section.

VR75502: SILICIFIED, ALBITE/OLIGOCLASE-MINOR SERICITE-CALCITE-ZOISITE-RUTILE ALTERED/STOCKWORKED QUARTZ WACKE CUT BY CALCITE-ILMENITE VEIN

Pale grey, siliceous quartz wacke containing bladed submetallic non-magnetic mineral up to almost 1 cm in diameter, localized in a cm-thick carbonate vein (vigorous reaction to HCl). The rock is not magnetic and shows no stain for K-feldspar in the etched slab. Modal mineralogy in polished thin section is approximately:

Quartz (detrital and secondary)	65%
Plagioclase (?oligoclase-albite)	20%
Carbonate (vein)	10%
Sericite	2-3%
Ilmenite	1-2%
Rutile, sphene	<1%
?Zoisite	<1%
?Pyrite or marcasite	tr

The vein of interest in this sample consists mainly of coarse carbonate (likely all calcite to judge by the reaction in hand specimen), forming sub- to euhedral crystals that are optically continuous for over 1 cm and are characterized by bent twin lamellae (especially at the margins of the vein). The vein contains coarse bladed laths of ilmenite up to almost 1 cm long (broken in places along their length by ?remobilized calcite). In places the ilmenite is associated with smaller crystals (euhedra to 0.25 mm) of dark brown rutile and traces of sulfide as a lacey filigree of minute crystals to 10 microns (possibly pyrite or ?marcasite). I cannot recall seeing such an occurrence before in the Aldridge; the veining appears late (quartz veinlets are cut by the carbonate-ilmenite-rutile vein).

The wallrock consists principally of interlocked quartz and intersitial plagioclase feldspar plus minor sericite, traversed by numerous narrow veinlets composed of quartz and plagioclase in about the same proportions as the host. Quartz grains in the wallrock are <0.3 mm in size, predominantly subhedral to anhedral, and likely mostly originally detrital but partly recrystallized by silicification accompanying the stockwork of quartz-plagioclase veinlets. Interstitial feldspar crystals are sub- to anhedral and appear to have little or slightly negative relief compared to quartz, suggesting composition in the oligoclase-albite range; they show no twinning and are partly altered to fine sericite (5-30 micron flakes). Rutile and sphene form aggregates to 0.1 mm diameter composed of minute euhedra to 20 microns.

In the veinlets, quartz forms interlocking subhedra to 0.6 mm diameter with lesser subhedral twinned plagioclase (negative relief compared to quartz indicating albite-oligoclase composition). In places, especially near the major calcite vein, minor carbonate (?calcite) to 50 microns accompanies the narrow veinlets, and rare epidote-group mineral (?zoisite, with grey to blue anomalous birefringence) is also seen near the veinlets.

This appears to be a silicified, albite/oligoclase-minor sericite-calcite-rare zoisite altered and stockworked quartz wacke, cut by a major vein of calcite-ilmenite +/- rutile.

VR75503: WEAK TOURMALINITE (CLUSTERS OF SCHORL WITH MINOR CHLORITIZED BIOTITE-CLINOZOISITE/ALLANITE-ILMENITE, IN QUARTZ-PLAGIOCLASE MATRIX)

Described as containing coarse, subrounded dark gray fibrous to granular granules that lack vitreous luster, the softness of biotite and decreased hardnes generally associated with alteration: possibly could be ?MnO or actinolite. However, thin section analysis shows that they are **tourmaline** and thus this rock might be classed as a weak tourmalinite. The rock is not magnetic and shows only trace reaction to cold dilute HCl; there is no stain for K-feldspar in the etched slab. Modal mineralogy in polished thin section is approximately:

Quartz (partly secondary)	40%
Plagioclase (?oligoclase-albite)	35%
Tourmaline (schorlitic)	20%
Biotite (partly chloritized)	2-3%
Clinozoisite, ?allanite	1-2%
Ilmenite	1%
Sphene	tr

Tourmaline in this slide forms subhedral crystals rarely over 0.25 mm long, but commonly in irregular, rounded aggregates or "clots" to 1.5 mm diameter, or rarely lath-shaped ?pseudomorphs up to 2.5 mm long. Dark greenish-brown pleochroism (green cores, brown rims) indicates high Fe content (F/M perhaps as high as 0.8-0.9, i.e. schorl). In places minor brown biotite and colourless clinozoisite (Fe-poor epidote) are associated with the tourmaline clots, forming subhedral crystals to 0.3 mm and 0.1 mm respectively; there may be some ?allanite in place of clinozoisite locally. The biotite is commonly partly chloritized (subhedral flakes to 0.2 mm with optical characteristics such as pale green pleochroism and weakly anomalous birefringence indicating moderate Fe content, F/M around 0.5). Traces of sphene (to 30 microns) are associated with the chloritized biotite.

The clots of tourmaline contain or are closely associated with fine crystals of ilmenite as sub- to euhedra up to 0.1 mm in size. The form of the tourmaline clots is suggestive of replacement after ?biotite or some other mineral; the high F/M ratio could be indicative of recrystallization around a Moyie intrusive.

The matrix to the clots is difficult to be sure of, but most likely consists of interlocking quartz (subhedra to 0.3 mm diameter) and interstitial plagioclase feldspar (sub- to anhedra mainly less than 0.1 mm). Although the bulk of the quartz is likely originally detrital, it appears to be significantly recrystallized and may be partly to largely secondary. The plagioclase is difficult to quantify due to its slight (lower) relief difference compared to quartz, but it is commonly distinguished by incipient clay alteration. It may be about oligoclase-albite in composition, and could be in part secondary in origin. The proportions given above are estimated from the etched slab, in which quartz is grey and plagioclase is etched white.

VR75506: QUARTZ-?OLIGOCLASE WACKE, PARTLY SILICIFIED AND WITH BIOTITE-PYRRHOTITE-SPHENE/ILMENITE+/-CHALCOPYRITE-CARBONATE "CLOTS"

Pale grey siliceous sediment with clusters or porphyroblasts of biotite, some of which contain minor sulfides (mostly magnetic pyrrhotite). The rock shows no reaction to cold dilute HCl, and no stain for K-feldspar in the etched slab. Modal mineralogy in polished thin section is approximately:

Quartz (partly secondary)	50%
Plagioclase (?oligoclase)	40%
Biotite (partly chloritized)	5-7%
Pyrrhotite	1-2%
Sphene, ilmenite	1%
Apatite	<1%
Chalcopyrite	<1%
Carbonate	<1%

This sample is composed mainly of quartz and plagioclase (virtually indistinguishable except in etched slab, where quartz is grey and plagioclase etches white), hosting scattered clots of biotite (some with pyrrhotite) and a few sieve-like garnets.

Quartz grains are mostly subhedral and less than 0.2 mm in diameter; they likely represent detrital grains that have been partly to largely recrystallized by secondary quartz. This is especially obvious in and near the clots, in which coarse subhedral secondary quartz crystals are up to 0.75 mm in diameter. Plagioclase crystals are mainly not discernible in thin section due to lack of any twinning and identical relief compared to quartz. The plagioclase composition is thus probably about oligoclase (An_{20-30}). The etched slab indicates that they are generally somewhat finer than quartz, at about 0.1 mm in maximum diameter. In places their presence is indicated by minor alteration to incipient ?clay particles of a few microns diameter. Scattered medium brown crystals of biotite are also found interstitial to quartz/plagioclase as well as in the clots. Traces of ?apatite form minute sub-to euhedral crystals up to 20 microns in diameter between the silicates.

The clots contain subhedral to ragged biotite up to 1 mm in diameter and subhedral pyrrhotite to 0.5 mm, plus lesser sphene to 0.25 mm (in places containing subhedral ilmenite to 0.1 mm and traces of pyrrhotite to 50 microns). Minor garnet is associated with some of the sphene+/-ilmenite aggregates, or occurs as separate clusters of 50-100 micron subhedra, forming sieved aggregates up to 2 mm in diameter. Biotite is rarely altered to colourless (low Fe) chlorite, probably with F/M near 0.4. Rare chalcopyrite (subhedra to 0.15 mm) is included in pyrrhotite; rarely, carbonate as subhedra to 0.25 mm is associated with the sulfides/oxides in the clots.

The loose association between biotite and pyrrhotite probably relates to the increased availability of Fe in those sites compared to the general rock; this is commonly true of any altered rock, in which mafic sites are the usual hosts to sulfides and oxides. Thus in a sense the pyrrhotite is pseudomorphing the mafic sites, because of their unique chemistry (I'm not sure if this answers your question adequately).

VR75566: SILICIFIED, SERICITE-CLINOZOISITE ALTERED QUARTZ WACKE WITH FRACTURE ENVELOPES OF K-FELDSPAR

Pale to dark grey, altered rock with mottled texture (described as stylolitic); fracture envelopes contain minor secondary K-feldspar, indicated by pale yellow stain in etched slab. The rock is not magnetic and shows no reaction to cold dilute HCl. Modal mineralogy in polished thin section is approximately:

Quartz (partly secondary)	70%
Sericite (?after feldspar)	15%
Plagioclase	5%
Clinozoisite	5%
K-feldspar (secondary)	2-3%
Sphene/ilmenite	1-2%
Pyrite	<1%
Tourmaline (?detrital)	<1%
Zircon (?detrital)	tr

This sample consists mainly of quartz and interstitial sericite or sericitized/epidotized plagioclase, cut by fractures in which secondary K-feldspar is important.

In general, quartz forms anhedral, mainly detrital grains up to about 0.3 mm in diameter that are strongly strained rather than recrystallized (development of strong undulose extinction, lamellar structures instead of the polygonal crystals seen in some other samples in this suite). It is possible that at least part of the quartz is secondary. Interstitial areas are filled by sericite, epidote-group mineral, sphene and some relict plagioclase, suggesting that formerly more extensive plagioclase has been mostly replaced by the secondary minerals. Relict plagioclase shows ?negative relief against quartz, suggesting a composition near ?albite-oligoclase; it forms subhedral crystals or possibly detrital grains mainly less than 0.1 mm in diameter. However, the main alteration feature of this sample is not albitization but rather mainly sericitization, and minor K-feldspar. The reason for the dark mottling is not readily apparent in thin section, but may relate to variable abundances of the clinozoisite. The rock is not tourmalinized.

Sericite forms ragged subhedral flakes mainly less than about 50 microns in diameter. The epidote-group mineral has low, weakly anomalous birefringence that suggests a low Fe content (clinozoisite or zoisite). The crystals are generally anhedral and less than 0.2 mm in size, and are closely associated with sphene.

Throughout the slide, these fine sub- to euhedral crystals of sphene (aggregates to about 0.25 mm in diameter) are common, generally containing intergrown ilmenite (sub- to euhedral crystals to 0.1 mm in size). Rare sulfides include coarse euhedral pyrite crystals to 1.75 mm in diameter and traces of chalcopyrite as subhedra to 20 microns. There are rare very narrow (10-15 micron thick) fracture fillings of pyrite. Rare euhedral tourmaline crystals (greenish-brown, schorlitic, to 0.1 mm) and ?zircon crystals are up to 60 microns long, and are probably detrital.

VR75568: LAMINATED QUARTZ-POOR, K-FELDSPAR AND TOURMALINE-RICH WACKE; ILMENITE/SPHENE RICH INTERBEDS; MINOR MUSCOVITE-PLAGIOCLASE-EPIDOTE

Described as banded quartztitic wacke and wacke, wacke beds composed of felted acicular tourmaline as replacement of argillaceous sediment. Tourmaline is so bed-selective because of precisely the feature that you note: it can only form in argillaceous beds since it is such a highly aluminous mineral, and Al_2O_3 does not travel well in solution. In other words, the solution cannot dissolve or carry enough alumina to form tourmaline, and so the host rock must supply the alumina. Obviously a quartz-rich bed is ill-equipped to do so, but the argillaceous beds are well-equipped. In the Sullivan area, tourmaline and albite are mutually exclusive (albite always replaces tourmaline); however, in other areas such as Findlay Creek, the two commonly occur together. In this sample, the etched slab indicates extensive K-feldspar (probably secondary), especially in the quartz wacke layers:

K-feldspar (?secondary)	40%
Quartz	30%
Tourmaline	20%
Muscovite	5%
Plagioclase (relict)	1-2%
Ilmenite	1-2%
Epidote-group mineral	1%
Sphene	<1%

This sample consists largely of K-feldspar, not albite; even the usual quartz framework appears to be lacking, possibly partly replaced by the potassium feldspar. K-feldspar is likely mostly microcline to judge by the grid twinning; it forms mainly subhedral interlocking crystals of less than 0.2 mm diameter. Quartz varies from subordinate to major from layer to layer, inversely with K-feldspar; grain size is generally finer than the feldspar, in the 0.1 mm range. Strong grain size variations are noted from the coarse feldspathic layers to the finer quartz-rich layers.

Tourmaline is abundant, forming slender euhedra up to about 0.5 mm in length that are somewhat concentrated in certain layers up to 1.5 mm thick, notably associated with the coarse K-feldspar and with somewhat mor abundant plagioclase (subhedral, cloudy crystals to 0.2 mm). Note that this tourmaline, which is likely hydrothermal in origin, is pale brown (and uniform) in colour, the lack of colour/compositional zoning suggesting a non-detrital origin and the colour an F/M ratio near ?0.6, less Fe-rich than the commonly observed detrital tourmalines. In other thinner layers (less than 0.5 mm thick), marked by concentrations of ilmenite, tourmaline is also somewhat concentrated. Ilmenite forms small tabular subhedra up to 0.15 mm long, in part rimmed by sphene; it appears that these concentrations of ilmenite mark the ?bottoms of individual beds (the sites of heavy-mineral concentrations), whereas tourmaline is concentrated in the more argillaceous tops of beds just below the ilmenite laminae. There are no sulfides.

Muscovite forms euhedral flakes to about 0.15 mm diameter, possibly enriched in the same layers as tourmaline and tiny (30 micron) apatite euhedra. Minor amounts of epidote-group mineral (?zoisite or clinozoisite) form ragged anhedra to 0.1 mm in interstitial sites.

Appendix XII

Gravity Survey Procedures and Raw Data

SUMMARY REPORT

on a

GRAVITY SURVEY

conducted on the **PANDA AREA** of the

MOYIE PROJECT

Near Cranbrook, British Columbia

PROPERTY	:	SW of Cranbrook, British Columbia
	:	UTM Zone 11 Easting: 566000 - 569000
	:	UTM Zone 11 Northing: 5456000 - 5461000
SURVEY PERIOD	:	October 9 to October 12, 1997
WRITTEN FOR	:	Kennecott Canada Exploration Inc. 200 Granville Street, Suite 354 Granville Square Vancouver, British Columbia, V6C 1S4
WRITTEN BY	:	Tam Mitchell, AScT QUADRA SURVEYS 200 – 8191 River Road Richmond, British Columbia, V8X 3X9
GEOPHYSICAL INTERPRETATION	:	None
DATED	:	November 6, 1997

QUADRA SURVEYS

SUMMARY

An infill gravity survey was conducted in the Panda Basin portion of the Moyie area to further define an area of specific interest, which was identified in a 1996 gravity survey.

The property hosts a geological terrain known to be prospective for sedex type deposits. The purpose of the work was to define possible mineralized zones and geologic structures in the area.

The gravity survey was conducted primarily on foot on uncut lines over the target area. Gravity measurements were carried out using a Scintrex gravity meter. The station locations were obtained with a real time Trimble double differential GPS survey system. Inclinometer readings were taken at every station to a distance of 170 meters for terrain corrections.

The gravity data were corrected for the various influences to yield Bouguer gravity anomaly values. A very small calibration factor was applied to match observed gravity values obtained from the 1996 survey.

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Appendices

Illustrations

MAPS

INTRODUCTION

At the request of Kennecott Canada Exploration Inc. an infill gravity survey was conducted in, and proximal to, Panda Basin in the Moyie area, SW of Cranbrook BC. The purpose of the survey was to further define an area of specific interest which was identified in an August – September 1996 survey.

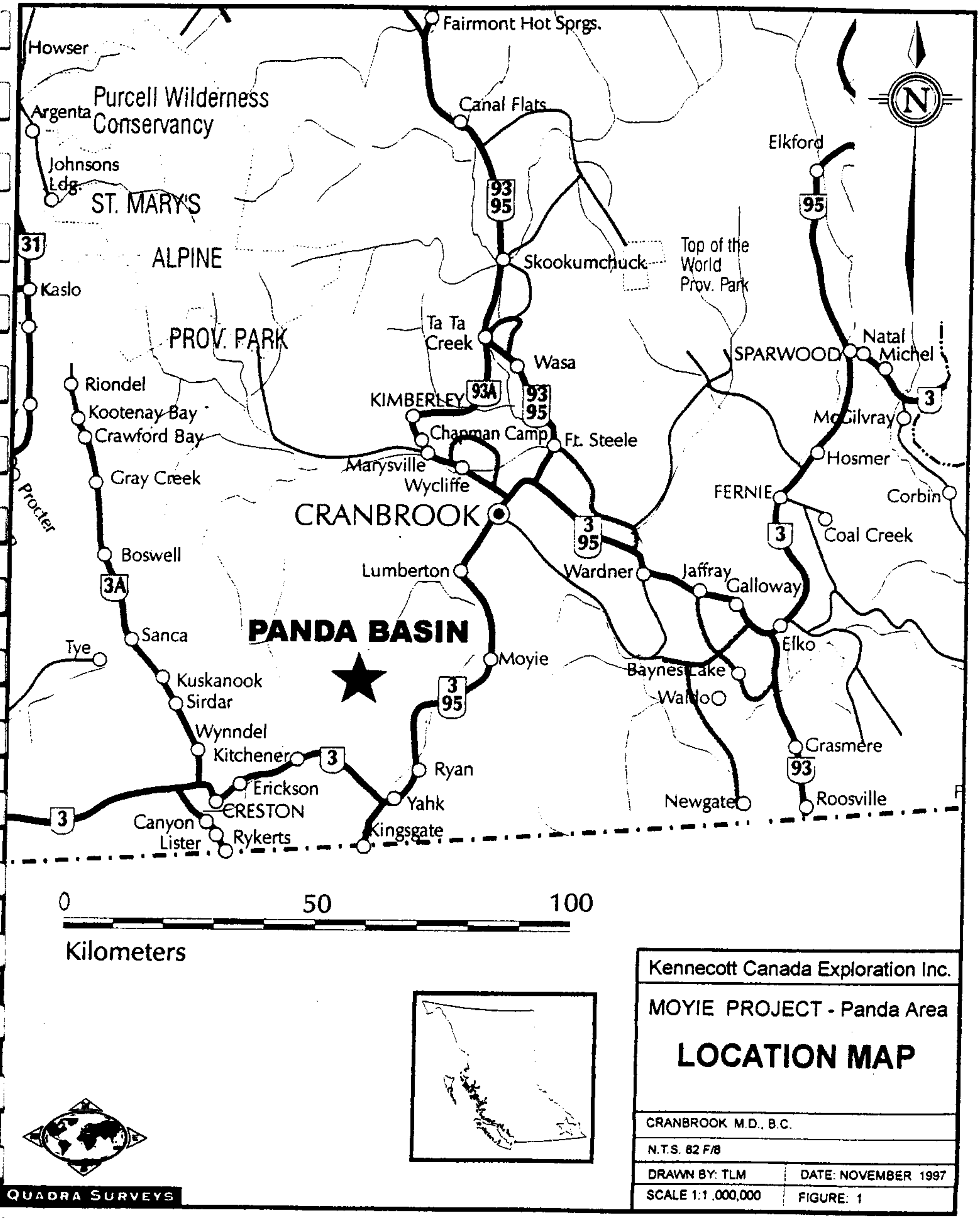
The survey was conducted by Tam Mitchell, AscT of Richmond, BC with the assistance of Zyoji Jackson of Cranbrook, BC. The crew was based at the Hastings Management field office at 3380 Wilks Road in Cranbrook. The exploration program was carried out under the field supervision of Steven Coombes of Kennecott Canada Exploration Inc.

The main purpose of the survey was to locate zones sedex type mineralization. Gravity surveying is a very effective tool in locating lead and zinc mineralization, particularly because of the high specific gravity of any sulphide mineralization especially that of lead.

LOCATION and ACCESS

The property is located to the South-West of Cranbrook approximately defined by UTM Zone 11; Easting: 566000 to 569000 and Northing: 5456000 to 5461000, see figure 1.

Access to the property was on the Lumberton logging road located approximately 10 km South of Cranbrook on Hwy. 95.


Fairmont Hot Sprgs.
Howser
Purcell Wilderness Conservancy
Argenta
Johnsons Ldg.
ST. MARY'S
ALPINE
PROV. PARK
Canal Flats
Elkford
93 95
95
31
Kaslo
Skookumchuck
Top of the World Prov. Park
Ta Ta Creek
Wasa
SPARWOOD
Natal
Michel
Riondel
Kootenay Bay
Crawford Bay
KIMBERLEY
93A
93 95
3
McGilvray
Chapman Camp
Ft. Steele
Marysville
Wycliffe
Hosmer
Gray Creek
Procter
CRANBROOK
FERNIE
Corbin
3 95
3
Coal Creek
Boswell
Lumberton
Wardner
Jaffray
Galloway
3A
Sanca
PANDA BASIN
Elko
Tye
Moyie
Baynes Lake
Kuskanook
Sirdar
Waldo
3 95
Wynndel
Kitchener
3
Grasmere
93
Ryan
Erickson
Yahk
Newgate
Roosville
3
CRESTON
Canyon
Lister
Rykerts
Kingsgate
0
50
100
Kilometers
Kennecott Canada Exploration Inc.
MOYIE PROJECT - Panda Area
LOCATION MAP
CRANBROOK M.D., B.C.
N.T.S. 82 F/8
DRAWN BY: TLM
DATE: NOVEMBER 1997
SCALE 1:1,000,000
FIGURE: 1
QUADRA SURVEYS

SURVEY PROCEDURE

All gravity readings were tied to the National Gravity Net by a gravity base station established in a 1996 gravity survey. The base is located at the Cranbrook field office at 3380 Wilks Road and is marked by a steel spike and identified by a wooden stake with an aluminum tag reading: "**Gravity Base –101**". Geographic coordinates for the station were derived by GPS measurements as **49° 32' 48.07384" N** and **115° 48' 44.86830" W** (see figure 2). The station has a **National Gravity Net value of 980688.13 ±0.02 mgal**. Field ties were also made to the nearest field base used for the GPS base station. A small calibration factor had to be applied to match the Scintrex gravity meter being used in the survey with the L&R gravity meters used in the 1996 survey, see appendix I.

All Survey locations were referenced to existing control points set in 1996 and the Real Time Kinematic GPS mode was used to define station locations.

Tam Mitchell, AScT, of Richmond BC, with the assistance of Zyoji Jackson of Cranbrook BC acquired the field data. A total of 37 stations were acquired during the 4 days of the survey.

Stations were accessible by 4 wheel drive, and for the most part, on foot on uncut lines. The survey was mildly hampered by inclement weather conditions, with two days of four having significant snowfall.

Inclinometer readings were taken on each gravity station with a Suunto inclinometer to provide inner zone terrain corrections in accordance with the Hammer Chart method. Zone B inclinometer readings were taken at 0, 90, 180 and 270 at a distance of 9.3 meters from the station. Zones C and D were shot at 0, 60, 120, 180, 240, and 300 degrees at distances of 35 and 112 meters respectively. Distances and angles were estimated.

INSTRUMENTATION

GRAVITY

The gravity readings were taken with a Scintrex CG-3 gravity meter (serial no. 10345) manufactured in Concord Ontario. The instrument has a world wide calibration range of over 7,000 mgal and a reading resolution of 0.005 mgal. This instrument features a sensor based on a fused quartz elastic system. The proof mass is balanced by a spring and a relatively small electrostatic restoring force. The position of the mass, which is sensed by a capacitative displacement transducer, is altered by a change in gravity. The inherent strength and elastic properties of the fused quartz together with stop limits around the proof mass permit the instrument to be operated without clamping. Instrument drift is considerably reduced by precise thermostatic control of the unit and software correction for residual effects. The instrument's tilt sensors are analog as well as electronic with a resolution of 1 arc second. Real time corrections for tilt errors can be automatically made for a range of ± 200 arc seconds. The entire gravity sensing mechanism is enclosed in a vacuum chamber to provide isolation from variations in atmospheric pressure. This extremely stable operating environment allows the long term drift of the sensor to be accurately predicted, and real time software correction reduces it to less than 0.02 mGals/day in theory. The unit can also automatically compensate for earth tides. The ETC is generated using the Longman formula (gravimetric factor 1.16).

SURVEYING

Station locations were surveyed using the Trimble Site Surveyor 4400 system with a Pacific Crest radio link. The system used was capable of post-processing rapid static measurements with an accuracy of ±5 mm +1ppm horizontal and ±1 cm + 1ppm vertical or real time data acquisition with an accuracy rating of ±1 cm +2ppm horizontal and ±2 cm + 2ppm vertical.

The Site Surveyor 4400 is based on Trimble's fourth generation real-time survey technology. Incorporating the latest Trimble real-time GPS engine code and solution alogrithms, the system provides very fast on-the-fly (OTF) initializations with the industry's most reliable position results. With this technology, average initialization times are cut in half. With advanced satellite signal acquisition and tracking, the ability to survey near trees is enhanced and downtime due to loss of signal minimized.

DATA REDUCTION and FORMULAE

The gravity data was processed by computer in the following manner:

g_o **Observed Gravity-** field observations corrected for earth tides and long term instrument drift were downloaded from electronic storage in the gravity meter and corrections made for instrument height and residual instrument drift. These values were then tied to the National Gravity Net.

g_{fa} **Free Air Effect-** Correction for relative distances of observation points from the centre of mass(earth). This calculation moves all stations to a common elevation datum and corrects for relative distances in distance from the source mass. The elevation datum used was CGVD 28 mean sea level. The formulae used was:

g_{fa}= -0.3086 mgal/m

g_{bs} **Bouger Slab Effect -** Correction for the relative differences in amounts of surface rock below gravity stations. This calculation requires that a mean density or rock type between the lowest and highest grid elevations be established. All stations are shifted to a common datum as in the free air effect except that the vertical change is through an assumed slab of the derived density. The elevation datum used was CGVD 28 mean sea level.

g_{bs}= 2*PI*.00667*σ mgal/m

Where σ = slab density (gm/cc)

g_t **Theoretical Gravity -** Yields correction for change of observed gravity with change in latitude which is due primarily to the rotation of the earth and the difference in earth's radius between the poles and the equator.

$g_t = g_e(1 + \alpha \sin^2 \theta + \beta \sin^2 2\theta)$

Where g_e = equatorial gravity = 978,031.85 mgal.

α = 0.005278895

β = -0.000023462

θ = Latitude

g_t **Terrain Correction-** corrections for variations caused by local terrain. The vertical component of the gravitational effect exerted by nearby hills, or not exerted by nearby valleys or gullies, will effect the net reading obtained on any one station. The overall effect on a given line profile or area will be a function of the station spacing relative to the frequency of terrain undulations. Areas were segmented using circular sectors in zones developed by Hammer (1939). Corrections were made for zones B, C, and D (covering an area from 2 to 170 meters from the station).

g_t was calculated from the following expression:

$$g_t = \Sigma\Phi\tau\sigma[r_o - r_i + (r_i^2 + z^2)^{1/2} - (r_o^2 + z^2)^{1/2}]$$

Where Φ = Sector angle (B = 90°, C & D = 60 °)

τ = gravitational constant = 0.00667

σ = average density (gm/cc)

r_o = outer sector radius (B=16.6, C=53.3, D=170)

r_i = inner sector radius (B=2, C=16.6, D=53.3)

z = elevation difference between sector and station.

g_{faa} **Free Air Anomaly:** is derived from the following formulae:

$g_{faa} = g_o - (g_l - 0.3086*E)$ = Free Air Anomaly

Where g_o = observed gravity

g_l = theoretical gravity

E = CGVD 28 elevation

g_{ba} **Bouguer Anomaly:** was derived from the following formulae:

$g_{ba} = g_b + g_{faa} + g_t$ = Bouguer Gravity

Where g_b = Bouguer gravity

g_{faa} = free air anomaly

g_t = terrain corrections

RESULTS & INTERPRETATION

The data was reduced to partial Bouguer gravity anomaly values. Terrain corrections have been applied to 170 meters. A density of 2.67 gm/cc was used throughout the survey. The partial Bouguer Gravity anomaly values spanned a range of 4.94 milligals from a low of –138.88 mgal to a high of -133.94 mgal. The mean partial Bouguer value was –135.91 ±1.40 mgal. The survey confirmed major and minor geologic trends in the area of interest.

SURVEY PRECISION

GRAVITY

Daily gravity loop ties were made to the base station –101 as follows:

Station	Loop Tie in mgal	Notes
-101	0.02	
-101	0.01	
-101	0.09	
-101	-0.04	

Repeat gravity readings were conducted on 5% of the stations read as follows:

Station	Repeat Accuracy - mgal
8501	-0.04
8503	-0.11

TIES TO 1996 SURVEY

The following ties were made to the 1996 Moyie gravity survey:

Station	1997 Observed G	1996 Observed G	Tie
11808	980535.69	980535.78	**0.09**
12309	980570.62	980570.77	**0.15**

LOCATION

The horizontal and vertical control for the survey was referenced to an existing control point. No traverses were required to conduct the survey. On every station location the GPS system was re-initialized to verify the accuracy of the recorded station location.

REFERENCES

LaCoste & Romberg Instruction Manual, Model G and D Gravity Meter, June 1989

Seigel, H.O.; ***A Guide to High Precision Land Gravimeter Surveys***, August 1995

Telford, W. M., Geldart, L. P., Sheriff, R. E., Keys, D. A.; ***Applied Geophysics***, 1982

Longman, I. M.; ***Journal of Geophysical Research,*** *Volume 64, No. 12;* ***Formulas for Computing the Tidal Accelerations Due to the Moon and Sun***, December 1959

Hammer, 1939; (Terrain Correction Model)

STATEMENT OF QUALIFICATIONS

I Thomas L. Mitchell, AScT, of the city of Richmond, Province of British Columbia, DO HEREBY CERTIFY THAT:

1. I am the owner of Quadra Surveys with office at 2-8640 Blundell Road, Richmond, British Columbia, V6R 1K1.

2. I am a graduate of BCIT, with a diploma in Surveying Technology (1977).

3. I am a geophysical surveyor, registered with the Association of Applied Science Technologists and Technicians of British Columbia.

4. I have practiced my profession in Africa, Canada, Japan and USA for 19 years.

5. This report is based on a gravity survey which I conducted.

6. I have no direct or indirect interest in the property nor do I expect to receive any.

Dated at Cranbrook, British Columbia, this 6th day of November, 1997.

APPENDIX I

Calibration

QUADRA SURVEYS

Kennecott Canada Exploration Inc.

Moyie Gravity Reduction Report

Instrumentation; Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997

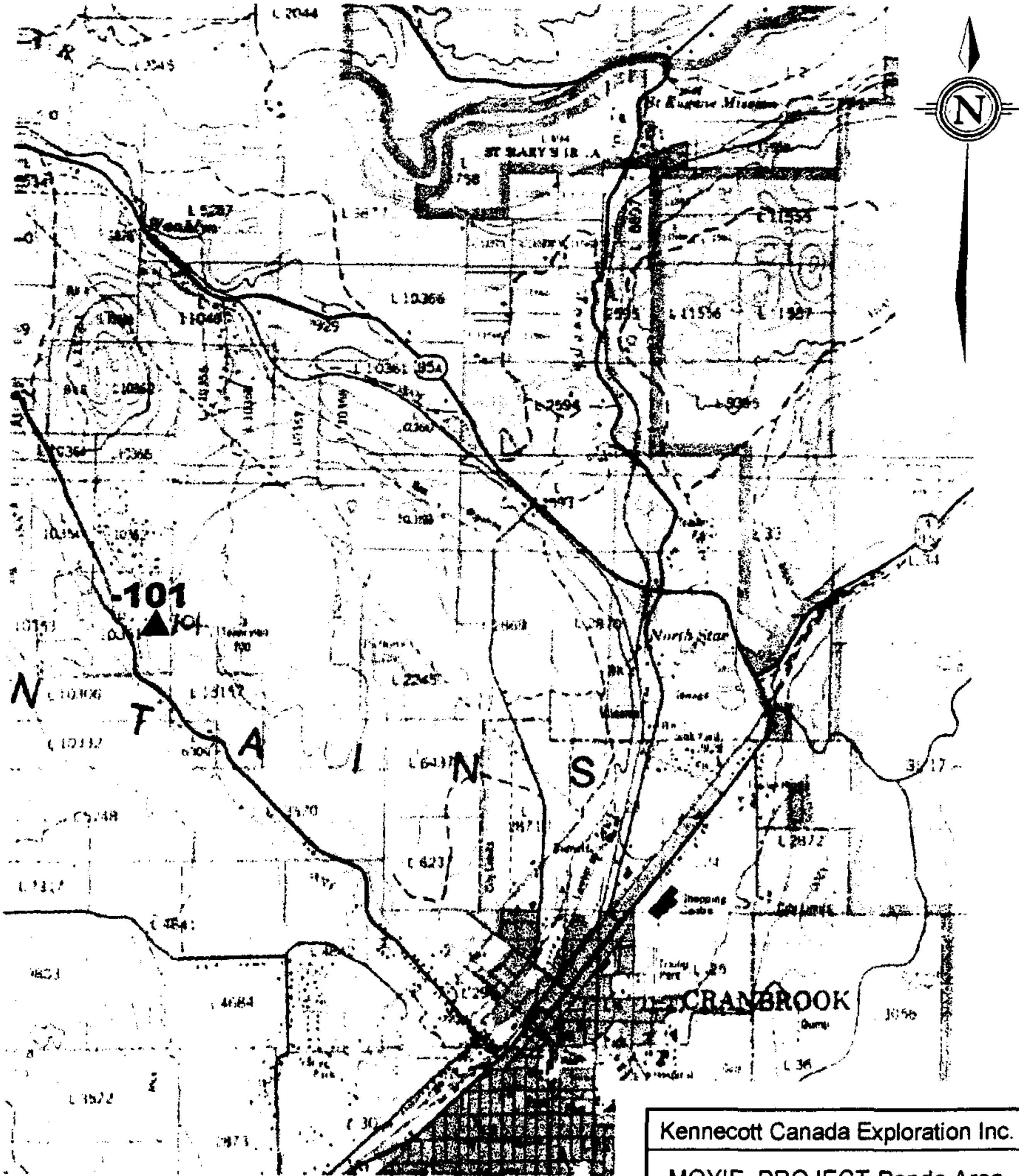
The following ties were conducted from Base -101 which has a value of 980688.13 mgal.
A small calibration difference was noted from the 1996 survey.
A linear calibration factor of .9992252 was derived from the following base ties and applied.

Tie to Base Station	1996 Observed Gravity	mgal Change From -101	1997 Observed Gravity	Tie to 1996	1997 Calibrated Observed Gravity	Tie to 1996
-107	**980647.33**	**40.87**	980647.26	-0.07	980647.29	-0.04
-106	**980522.66**	**165.55**	980522.58	-0.08	980522.71	0.05
			980522.46	-0.20	980522.59	-0.07
			980522.51	-0.15	980522.64	-0.02
			980522.45	-0.21	980522.58	-0.08
-105	**980522.67**	**165.58**	980522.55	-0.12	980522.68	0.01
			980522.46	-0.21	980522.58	-0.09
			980522.58	-0.09	980522.71	0.04
			980522.50	-0.17	980522.63	-0.04
-104	**980604.13**	**84.01**	980604.12	-0.01	980604.18	0.05
			980604.12	-0.01	980604.18	0.05
			980604.07	-0.06	980604.14	0.01
			980604.00	-0.13	980604.07	-0.06
			980604.12	-0.01	980604.18	0.05
			980604.14	0.01	980604.20	0.07
			980604.09	-0.04	980604.15	0.02
			980604.08	-0.05	980604.15	0.02
			980604.08	-0.05	980604.15	0.02
			Sum:	**-1.64**		**0.00**

APPENDIX II

Gravity & GPS Base Stations

QUADRA SURVEYS



Kennecott Canada Exploration Inc.

MOYIE PROJECT-Panda Area

GRAVITY BASE -101

CRANBROOK M.D., B.C.	
N.T.S. 82 F/1, 82 G/12	
DRAWN BY: TLM	DATE: NOVEMBER 1997
SCALE 1:50,000	FIGURE: 2

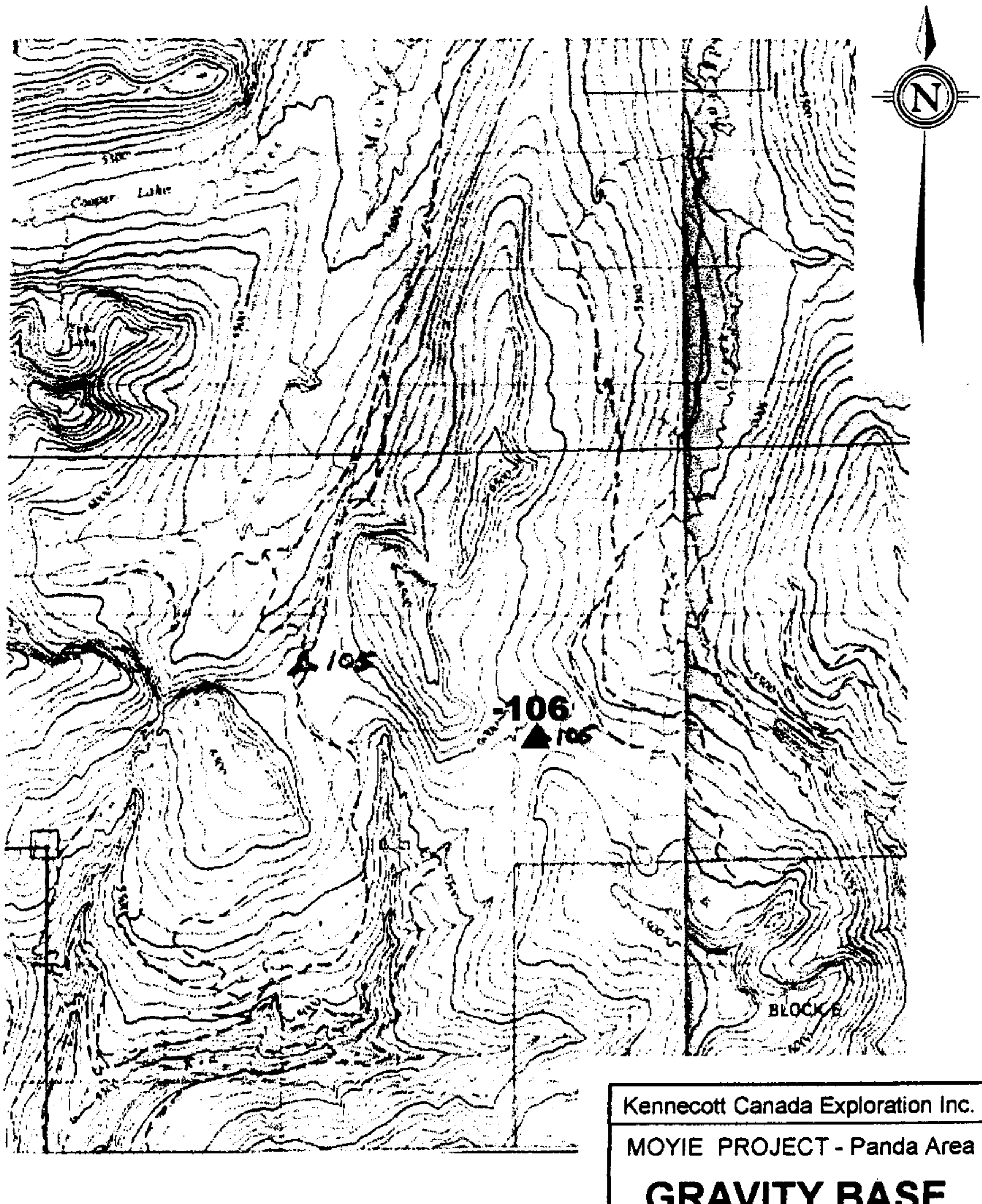
QUADRA SURVEYS

GRAVITY BASE -101

National Gravity Net Value: 980688.13 ±0.02 mgal

Northing: 49° 32' 48.07384"

Easting: -115° 48' 44.86830"



Kennecott Canada Exploration Inc.

MOYIE PROJECT - Panda Area

GRAVITY BASE -106

CRANBROOK M.D., B.C.

N.T.S. 82 F/8

DRAWN BY: TLM
DATE: NOVEMBER 1997

SCALE 1:50,000
FIGURE: 3

GPS BASE -106

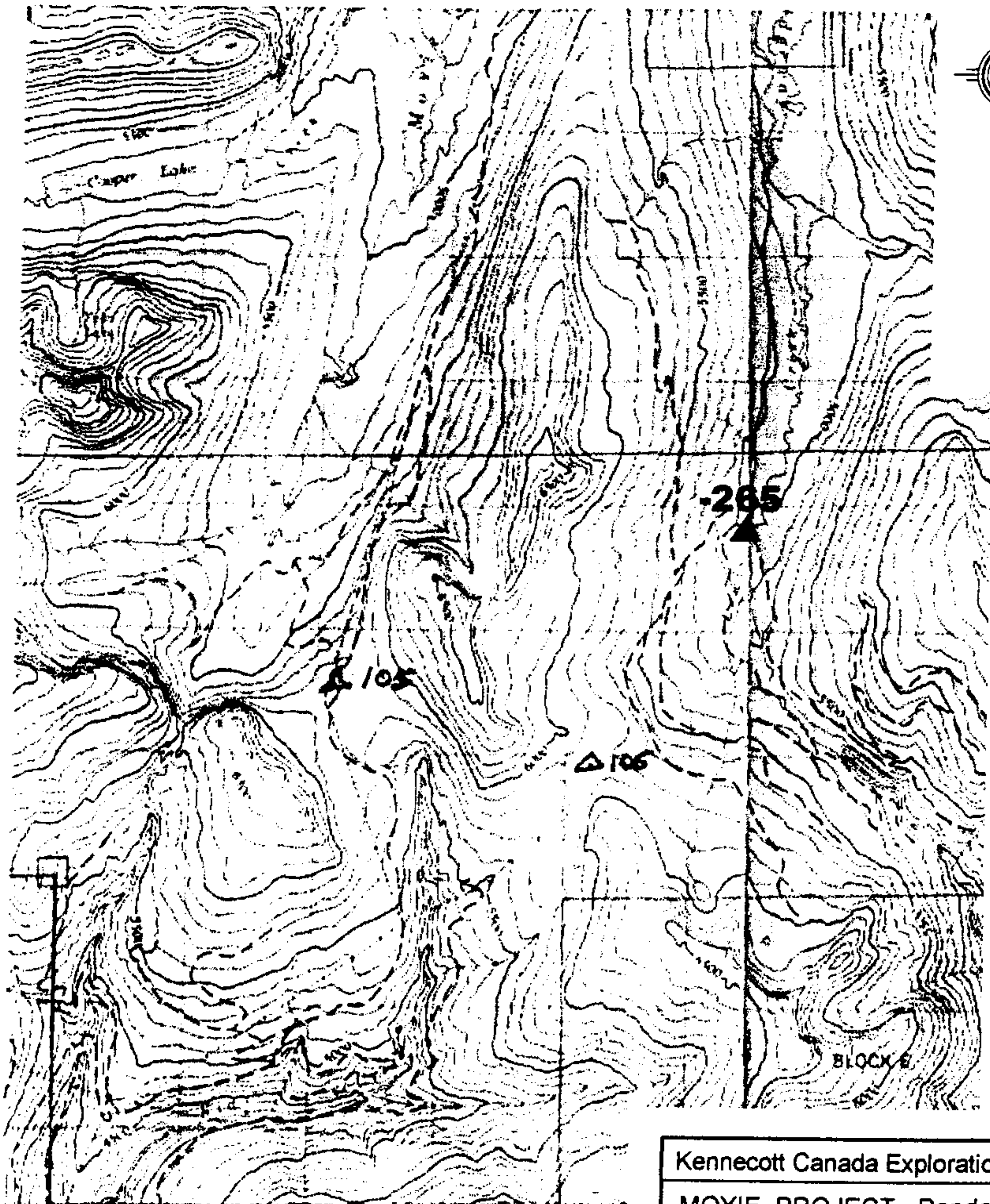
National Gravity Net Value: 980522.66 ±0.05 mgal

NAD 83 Northing: 49° 17' 02.20553"

NAD 83 Easting: -116° 05' 14.99081"

CGVD 28 Elevation: 1776.601

QUADRA SURVEYS



Kennecott Canada Exploration Inc.

MOYIE PROJECT - Panda Area

GPS BASE -265

CRANBROOK M.D., B.C.

N.T.S. 82 F/8

DRAWN BY: TLM | DATE: NOVEMBER 1997

SCALE 1:50,000 | FIGURE: 4

QUADRA SURVEYS

GPS BASE -265

NAD 83 Northing: 5461001.713 m

NAD 83 Easting: 567370.890 m

CGVD 28 Elevation: 1527.117 m

APPENDIX III

Partial Bouguer Anomaly Gravity Data Listing

Real Time GPS Station Locations and Elevation Calculations

Observed Gravity Values – Electronic Notes from Gravity Meter

Observed Gravity Data Reduction and Calculations

Inner Zone Terrain Corrections

QUADRA SURVEYS

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Basin Gravity Infill Survey

Partial Bouguer Anomaly Gravity Data Listing

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

Operator: Tam Mitchell

Density 2.67

Stn	NAD 83 Northing	NAD 83 Easting	WGS84 Latitude	WGS84 Longitude	CGVD28 Elev	Observed G	Theoretical Gravity	Terrain to 170m	Free Air Anomaly	Bouguer Anomaly
DDH K97-03	5457855.125	567984.552	49.2696749	-116.0654576	1829.934					
-265	5461001.713	567370.89	49.2980432	-116.0733619	1527.117	980570.65	981006.74	0.00	35.18	-135.70
-106	5459422.023	566362.102	49.2839458	-116.0874974	1776.601	980522.52	981005.48		65.30	-133.50
8501	5458427.835	567690.286	49.2748585	-116.0694052	1772.900	980521.54	981004.66	0.11	63.99	-134.28
8502	5457993.761	567810.591	49.2709411	-116.0678251	1809.722	980513.39	981004.31	0.13	67.56	-134.81
8503	5457695.191	567602.593	49.2682788	-116.0707344	1827.951	980508.22	981004.07	0.34	68.25	-135.95
8601	5458725.264	567489.084	49.2775558	-116.0721207	1750.992	980526.40	981004.90	0.14	61.85	-133.94
8602	5458210.291	567731.036	49.2728974	-116.0688819	1790.828	980517.62	981004.49	0.17	65.79	-134.43
8603	5457851.937	567984.779	49.2696462	-116.0654550	1830.341	980508.40	981004.20	0.26	69.05	-135.50
8604	5457676.741	567854.769	49.2680849	-116.0672716	1852.433	980503.30	981004.06	0.30	70.91	-136.07
8605	5457835.217	567518.919	49.2695474	-116.0718608	1841.248	980506.32	981004.19	0.51	70.34	-135.18
8606	5457936.497	567467.885	49.2704639	-116.0725452	1850.070	980504.88	981004.27	0.81	71.54	-134.66
8607	5458138.751	567342.955	49.2722968	-116.0742283	1849.231	980505.52	981004.43	0.39	71.76	-134.77
8608	5458090.635	567087.59	49.2718921	-116.0777464	1808.053	980512.32	981004.40	0.61	65.89	-135.82
8609	5458340.102	567198.585	49.2741236	-116.0761789	1809.285	980513.43	981004.60	0.10	67.17	-135.18
8610	5458467.26	567301.634	49.2752560	-116.0747410	1796.678	980516.77	981004.70	0.11	66.52	-134.41
8611	5458620.254	567378.074	49.2766236	-116.0736645	1771.364	980522.10	981004.82	0.16	63.92	-134.12
8612	5459016.193	567640.52	49.2801557	-116.0699898	1686.566	980538.90	981005.14	0.14	54.24	-134.34
8613	5458753.361	567956.448	49.2777567	-116.0656913	1684.655	980538.76	981004.92	0.18	53.72	-134.61
8701	5458694.669	566263.435	49.2774147	-116.0889745	1869.961	980501.49	981004.89	0.19	73.67	-135.38
8702	5458454.702	566384.61	49.2752433	-116.0873486	1881.021	980498.24	981004.70	0.27	74.02	-136.18
8703	5458152.342	566471.341	49.2725144	-116.0862066	1922.637	980487.83	981004.45	0.43	76.71	-138.01
8704	5457951.786	566515.158	49.2707058	-116.0856377	1940.672	980483.82	981004.29	0.30	78.42	-138.43
8705	5457630.738	566490.148	49.2678210	-116.0860348	1928.123	980486.53	981004.03	0.21	77.52	-138.02
8706	5457490.568	566656.011	49.2665423	-116.0837785	1925.482	980487.00	981003.92	0.35	77.28	-137.82
8707	5457284.774	566906.98	49.2646640	-116.0803636	1927.397	980486.27	981003.75	0.30	77.31	-138.06
8708	5457086.444	567209.079	49.2628470	-116.0762452	1884.688	980495.00	981003.59	0.83	73.03	-137.03
8709	5456826.923	567485.421	49.2604825	-116.0724913	1951.700	980480.80	981003.38	0.59	79.72	-138.08

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Basin Gravity Infill Survey

Partial Bouguer Anomaly Gravity Data Listing

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

Operator: Tam Mitchell

Density 2.67

Stn	NAD 83 Northing	NAD 83 Easting	WGS84 Latitude	WGS84 Longitude	CGVD28 Elev	Observed G	Theoretical Gravity	Terrain to 170m	Free Air Anomaly	Bouguer Anomaly
8710	5457007.495	567577.121	49.2620964	-116.0712006	1975.594	980475.55	981003.52	0.48	81.70	-138.88
8801	5458102.222	568256.946	49.2718669	-116.0616715	1783.610	980517.94	981004.39	0.26	63.97	-135.35
8802	5458317.962	568101.298	49.2738246	-116.0637742	1757.704	980523.83	981004.57	0.40	61.69	-134.59
8803	5458232.975	568441.57	49.2730223	-116.0591115	1738.926	980525.42	981004.50	1.56	57.55	-135.47
8804	5458020.228	568648.724	49.2710856	-116.0563006	1699.218	980533.15	981004.32	0.94	53.20	-136.00
8805	5457832.273	568617.099	49.2693987	-116.0567675	1738.391	980524.88	981004.17	0.75	57.18	-136.60
8806	5457424.656	568583.8	49.2657363	-116.0572950	1730.161	980525.62	981003.85	0.65	55.70	-137.25
8807	5457346.49	568451.661	49.2650481	-116.0591244	1754.813	980520.98	981003.78	0.63	58.73	-137.00
8808	5457255.524	568226.341	49.2642551	-116.0622365	1786.634	980514.44	981003.71	0.82	62.09	-137.01
11808	5459906.601	566365.142	49.2883038	-116.0873752	1706.538	980535.69	981005.87	0.48	56.46	-134.02
12309	5460974.918	567401.618	49.2977988	-116.0729438	1527.168	980570.62	981006.72	0.00	35.18	-135.70

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Partial Bouguer Anomaly Gravity Data Listing

Surveyed by: Quadra Surveys, June - July 1997

Simple Bouguer   Density   2.67

Stn	NAD 83 Northing	NAD 83 Easting	NAD 83 Latitude	NAD 83 Longitude	CGVD28 Elev	Calibrated to match 1996 Observed G	Theoretical Gravity	Terrain to 170m	Free Air Anomaly	Bouguer Anomaly
9701	5458167.727	567972.06	49.2724879	-116.0655762	1780.274	980519.55	981004.45	0.11	64.49	-134.61
9702	5460763.99	566264.667	49.2960262	-116.0886146	1771.119	980523.54	981006.56	0.19	63.55	-134.44
9703	5460360.556	566610.946	49.2923601	-116.0839198	1659.958	980544.82	981006.23	0.52	50.85	-134.37
9704	5459639.627	566718.664	49.2858643	-116.0825589	1652.702	980546.22	981005.65	0.24	50.59	-134.10
9705	5459857.943	566986.569	49.2877985	-116.0788389	1606.939	980555.32	981005.82	0.13	45.40	-134.28
9706	5460291.519	566820.478	49.2917163	-116.0810501	1596.800	980557.39	981006.17	0.28	43.99	-134.41
9707	5459846.014	567463.409	49.2876388	-116.0722846	1594.507	980558.77	981005.81	0.25	45.03	-133.14
9708	5458711.895	568414.692	49.2773328	-116.0593990	1636.646	980548.01	981004.88	0.10	48.20	-134.84
9709	5459796.489	567641.359	49.2871737	-116.0698463	1605.775	980556.27	981005.77	0.10	46.05	-133.53
9710	5460048.278	567743.813	49.2894269	-116.0683949	1615.198	980553.97	981005.97	0.43	46.46	-133.85
9711	5460544.134	568266.484	49.2938285	-116.0611235	1776.267	980521.45	981006.36	0.17	63.24	-135.35
9712	5459220.842	569331.608	49.2818069	-116.0467064	1848.091	980504.79	981005.29	0.40	69.82	-136.57
9713	5459160.939	569149.164	49.2812888	-116.0492249	1803.659	980513.52	981005.24	0.55	64.89	-136.38
9714	5458991.991	568792.525	49.2798096	-116.0541569	1637.333	980546.92	981005.11	0.39	47.09	-135.73
9715=22502	5461539.410	572537.390	49.3022876	-116.0022136	1901.729	980495.37	981007.12	0.63	75.12	-137.05
9716	5461554.850	572741.490	49.3024022	-115.9994038	1896.599	980496.70	981007.13	0.58	74.87	-136.78
9717	5461579.620	572940.680	49.3026012	-115.9966597	1887.229	980499.58	981007.15	0.32	74.83	-136.02
9718	5461763.090	572971.450	49.3042476	-115.9962031	1872.983	980503.02	981007.29	0.63	73.72	-135.23
9719	5461955.520	573027.390	49.3059716	-115.9953984	1856.492	980506.12	981007.45	0.83	71.58	-135.32
9720	5462132.280	573127.790	49.3075494	-115.9939852	1845.885	980508.94	981007.59	0.49	70.99	-135.07
9721=22503	5462342.710	573152.920	49.3094389	-115.9936010	1833.239	980511.40	981007.76	0.28	69.38	-135.47
9722	5462448.630	573379.540	49.3103643	-115.9904642	1814.598	980515.05	981007.84	0.39	67.19	-135.47
9723	5462552.820	573514.500	49.3112851	-115.9885886	1799.788	980518.03	981007.92	0.75	65.52	-135.12
9724	5462674.420	573689.530	49.3123577	-115.9861586	1779.371	980522.60	981008.02	0.51	63.69	-134.91
9725	5462768.780	573851.510	49.3131867	-115.9839130	1766.827	980525.25	981008.10	0.41	62.40	-134.89
9726	5463377.320	573908.880	49.3186529	-115.9830110	1714.078	980536.32	981008.58	0.21	56.70	-134.89
9727	5463651.590	574025.270	49.3211055	-115.9813588	1689.407	980541.19	981008.80	0.36	53.73	-134.95
9728	5459804.1	562939.72	49.2877444	-116.1344905	1669.197	980539.64	981005.82	0.61	48.94	-137.23

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Partial Bouguer Anomaly Gravity Data Listing

Surveyed by: Quadra Surveys, June - July 1997

Simple Bouguer Density 2.67

Stn	NAD 83 Northing	NAD 83 Easting	NAD 83 Latitude	NAD 83 Longitude	CGVD28 Elev	Calibrated to match 1996 Observed G	Theoretical Gravity	Terrain to 170m	Free Air Anomaly	Bouguer Anomaly
9729	5459987.46	563185.36	49.2893683	-116.1310839	1659.277	980544.37	981005.96	0.08	50.46	-135.13
9730	5460064.72	563510.26	49.2900294	-116.1266044	1654.114	980545.80	981006.02	0.28	50.24	-134.57
9731	5460455.3	563570.05	49.2935362	-116.1257201	1630.130	980551.42	981006.34	0.06	48.14	-134.20
9732	5460746.8	563696.21	49.2961448	-116.1239387	1622.754	980553.15	981006.57	0.06	47.37	-134.16
9733	5461062.66	563790.05	49.2989759	-116.1225977	1599.685	980557.61	981006.82	0.00	44.45	-134.55
9734	5461252.12	563856.78	49.3006730	-116.1216497	1587.994	980559.92	981006.97	0.02	43.00	-134.67
9735	5461520.73	564079.18	49.3030656	-116.1185479	1578.048	980561.92	981007.19	0.08	41.72	-134.78
9736	5461562.5	563954.23	49.3034543	-116.1202599	1569.862	980563.57	981007.22	0.03	40.81	-134.82
9737	5461661.13	563596.6	49.3043788	-116.1251630	1571.002	980562.73	981007.31	0.06	40.23	-135.49
9738	5461807.53	564131.26	49.3056396	-116.1177855	1564.109	980564.94	981007.42	0.06	40.21	-134.75
9739	5461465.8	564403.34	49.3025374	-116.1140983	1635.691	980550.51	981007.14	0.26	48.14	-134.63
9740	5467089.44	568771.42	49.3526396	-116.0530518	1524.698	980573.41	981011.63	0.33	32.31	-137.97
9741	5467152.65	569081.12	49.3531730	-116.0487770	1581.205	980562.56	981011.68	0.37	38.84	-137.72
9742	5467122.46	569296.75	49.3528770	-116.0458135	1638.196	980551.63	981011.65	0.31	45.53	-137.47
9743	5467092.607	571449.874	49.3523599	-116.0161759	1634.777	980554.88	981011.60	0.22	47.77	-134.94
9744	5466699.17	571452.48	49.3488212	-116.0162105	1676.463	980546.66	981011.29	0.19	52.73	-134.67
9745	5467122.006	569325.497	49.3528695	-116.0454179	1644.869	980550.08	981011.65	0.27	46.04	-137.75
9746	5467102.924	569437.489	49.3526852	-116.0438794	1676.303	980543.71	981011.63	0.44	49.38	-137.74
9747	5467130.964	570588.258	49.3528052	-116.0280312	1873.491	980505.18	981011.64	0.56	71.69	-137.38
9748	5467110.284	570923.643	49.3525803	-116.0234175	1760.255	980529.90	981011.62	0.22	61.49	-135.25
9749	5467076.575	571649.732	49.3521923	-116.0134273	1614.430	980559.01	981011.59	0.20	45.63	-134.82
9750	5466934.212	571982.707	49.3508768	-116.0088649	1564.110	980567.40	981011.47	0.45	38.61	-135.96
9751	5466233.658	570972.079	49.3446905	-116.0229068	1802.740	980521.40	981010.92	0.57	66.81	-134.34
9752	5466488.95	571316.454	49.3469464	-116.0181208	1721.096	980537.76	981011.12	0.43	57.77	-134.39
9753	5465384.665	572991.473	49.3368166	-115.9952652	1923.537	980493.52	981010.21	0.86	76.91	-137.46
9754	5465224.22	572827.215	49.3353932	-115.9975551	1881.742	980502.11	981010.08	0.59	72.73	-137.24
9755	5464955.995	572555.744	49.3330132	-116.0013401	1815.170	980516.33	981009.87	0.41	66.62	-136.09
9756	5464697.914	572272.381	49.3307257	-116.0052864	1852.161	980508.82	981009.67	0.31	70.73	-136.21

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Partial Bouguer Anomaly Gravity Data Listing

Surveyed by: Quadra Surveys. June - July 1997

Simple Bouguer   **Density   2.67**

Stn	NAD 83 Northing	NAD 83 Easting	NAD 83 Latitude	NAD 83 Longitude	CGVD28 Elev	Calibrated to match 1996 Observed G	Theoretical Gravity	Terrain to 170m	Free Air Anomaly	Bouguer Anomaly
9757	5466369.224	573794.476	49.3455748	-115.9840313	2029.959	980471.90	981011.00	0.24	87.35	-139.55
9758	5466132.948	573649.232	49.3434673	-115.9860743	2012.042	980476.13	981010.81	0.44	86.24	-138.46
9759	5465816.609	573517.093	49.3406382	-115.9879515	1989.430	980481.51	981010.55	0.42	84.90	-137.29
9760	5463586.863	567514.804	49.3212780	-116.0709455	1488.942	980579.23	981008.82	0.10	29.90	-136.61
9761	5463250.395	568010.579	49.3181968	-116.0641816	1501.747	980576.42	981008.54	0.00	31.32	-136.72
9762	5463033.797	568453.079	49.3161993	-116.0581309	1539.773	980569.34	981008.36	0.17	36.14	-135.98
9763	5462794.3	569297.261	49.3139500	-116.0465588	1612.612	980555.14	981008.16	0.14	44.63	-135.67
9764	5463096.691	569728.739	49.3166206	-116.0405702	1607.745	980555.21	981008.40	0.12	42.96	-136.82
9765	5463283.444	568441.393	49.3184459	-116.0582488	1513.514	980574.16	981008.57	0.00	32.66	-136.70
9766	5459251.331	564053.194	49.2826570	-116.1192691	1785.658	980520.91	981005.36	0.06	66.60	-133.15
9767	5459060.037	564371.748	49.2809030	-116.1149203	1761.386	980525.74	981005.20	0.08	64.10	-132.91
9768	5459306.518	564463.394	49.2831102	-116.1136207	1751.880	980527.71	981005.40	0.12	62.94	-132.98
9769	5458335.2	564540.661	49.2743659	-116.1127151	1693.671	980537.94	981004.62	0.22	55.99	-133.31
9770	5457653.392	564572.393	49.2682303	-116.1123889	1645.012	980546.37	981004.07	0.34	49.95	-133.78
9771	5457268.111	564153.443	49.2648091	-116.1182089	1596.277	980554.25	981003.76	0.20	43.10	-135.31
9772	5458394.389	564367.27	49.2749165	-116.1150890	1735.324	980530.16	981004.67	0.48	61.01	-132.69
9773	5458658.492	564133.289	49.2773165	-116.1182630	1786.432	980519.45	981004.88	0.95	65.86	-133.09
9774	5457839.582	563512.93	49.2700159	-116.1269210	1768.988	980520.36	981004.23	0.34	62.04	-135.57
9775	5458163.274	563749.184	49.2729026	-116.1236221	1818.494	980512.08	981004.49	0.44	68.78	-134.26
9776	5458457.815	563834.361	49.2755429	-116.1224043	1892.829	980496.41	981004.72	0.29	75.82	-135.69
9777	5458501.317	563643.895	49.2759540	-116.1250156	1894.682	980496.87	981004.76	0.28	76.81	-134.92
9778	5458573.629	563291.888	49.2766409	-116.1298430	1882.431	980500.21	981004.82	0.23	76.30	-134.10
9779	5458786.738	565702.318	49.2783033	-116.0966729	1762.828	980524.75	981004.97	0.14	63.78	-133.34
9780	5458562.107	565463.403	49.2763086	-116.0999940	1730.925	980530.80	981004.79	0.16	60.17	-133.35
9781	5458227.1	565115.474	49.2733327	-116.1048314	1671.283	980541.82	981004.53	0.34	53.05	-133.62
9782	5458112.815	565283.056	49.2722869	-116.1025465	1660.861	980544.02	981004.43	0.13	52.13	-133.58
9783	5457903.769	565728.604	49.2703590	-116.0964566	1718.519	980532.43	981004.26	0.10	58.51	-133.69
9784	5457927.692	565026.069	49.2706493	-116.1061089	1618.622	980551.30	981004.29	0.31	46.53	-134.28

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Partial Bouguer Anomaly Gravity Data Listing

Surveyed by: Quadra Surveys, June - July 1997

Simple Bouguer Density 2.67

Stn	NAD 83 Northing	NAD 83 Easting	NAD 83 Latitude	NAD 83 Longitude	CGVD28 Elev	Calibrated to match 1996 Observed G	Theoretical Gravity	Terrain to 170m	Free Air Anomaly	Bouguer Anomaly
9785	5458497.752	562838.609	49.2760052	-116.1360860	1751.075	980525.23	981004.77	1.03	60.85	-134.07
9786	5458886.563	562871.174	49.2794989	-116.1355772	1774.045	980521.21	981005.08	0.49	63.60	-134.41
9787	5459140.842	562837.125	49.2817894	-116.1360054	1819.691	980512.51	981005.28	0.30	68.78	-134.53
9788	5458597.21	563206.179	49.2768619	-116.1310175	1873.551	980502.26	981004.84	0.30	75.59	-133.75
9789	5458317.38	563219.301	49.2743437	-116.1308813	1847.777	980506.96	981004.62	0.17	72.57	-134.02
9790	5458083.461	563157.589	49.2722462	-116.1317666	1829.576	980508.89	981004.43	0.29	69.07	-135.36
11103	5467161.815	570276.593	49.3531187	-116.0323166	1923.378	980493.90	981011.67		75.78	-139.44
12008	5457951.375	562747.803	49.2711003	-116.1374200	1714.028	980532.00	981004.33		56.62	-135.17
12301	5459185.193	568630.07	49.2815655	-116.0563571	1660.512	980542.93	981005.26		50.10	-135.70
12307	5459560.832	567965.267	49.2850183	-116.0654328	1625.873	980551.14	981005.57		47.31	-134.62
21102	5460047.2	562897.99	49.2899352	-116.1350260	1704.008	980535.07	981006.01		54.91	-135.76
23703	5465630.8	573204.368	49.3390047	-115.9922899	1960.447	980487.54	981010.41		82.12	-137.24

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Real Time Station Locations and Elevation Calculations

Instrumentation: Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, October 1997

			Latitude			Longitude West					Corrected	
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev	Notes
Proposed												
1	5457983	567812										Proposed Stns
2	5458201	567729										Proposed Stns
3	5458446	567669										Proposed Stns
4	5458032	568312										Proposed Stns
5	5458269	568497										Proposed Stns
6	5458340	568128										Proposed Stns
7	5458731	567979										Proposed Stns
8	5458046	568713										Proposed Stns
9	5457770	568587										Proposed Stns
10	5457491	568635										Proposed Stns
11	5457196	568933										Proposed Stns
12	5457006	568657										Proposed Stns
13	5457163	568150										Proposed Stns
14	5457334	568408										Proposed Stns
15	5456798	567550										Proposed Stns
16	5457066	567198										Proposed Stns
17	5457286	566902										Proposed Stns
18	5457476	566674										Proposed Stns
19	5457677	566466										Proposed Stns
20	5458325	567219										Proposed Stns
21	5458124	567342										Proposed Stns
22	5457900	567450										Proposed Stns
23	5457703	567569										Proposed Stns

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

.Real Time Station Locations and Elevation Calculations

Instrumentation: Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, October 1997

			Latitude			Longitude West					Corrected	
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev	Notes
Possible equipment / weather problems, repeat values on following day to be used												
-106	5459411.606	566343.051	49	17	1.87516	116	5	15.93993	1756.046	-13.57	1756.046	Redone
-265	5461001.706	567370.887	49	17	52.9552	116	4	24.10286	1527.777	-13.56	1527.777	Redone
8501	5458428.485	567689.735	49	16	29.51173	116	4	9.88566	1772.858	-13.59	1772.858	Redone
8502	5457993.979	567810.42	49	16	15.39498	116	4	4.17865	1809.671	-13.6	1809.671	Redone
DDH9703	5457854.994	567984.685	49	16	10.82521	116	3	55.64079	1829.875	-13.6	1829.875	Redone
8503	5457693.722	567602.51	49	16	5.756	116	4	14.64895	1827.975	-13.6	1827.975	Redone
-106	5459422.023	566362.102	49	17	2.20502	116	5	14.99081	1776.601	-13.57	1776.601	
-265	5461001.713	567370.89	49	17	52.95544	116	4	24.10272	1527.127	-13.56	1527.117	
12309	5460974.918	567401.618	49	17	52.07566	116	4	22.59765	1527.178	-13.56	1527.168	
11808	5459906.601	566365.142	49	17	17.89373	116	5	14.55075	1706.548	-13.56	1706.538	
8601	5458725.264	567489.084	49	16	39.20082	116	4	19.63468	1750.972	-13.59	1750.992	
8501	5458427.835	567690.286	49	16	29.49045	116	4	9.85877	1772.88	-13.59	1772.900	
8602	5458210.291	567731.036	49	16	22.43048	116	4	7.97486	1790.798	-13.6	1790.828	
8502	5457993.761	567810.591	49	16	15.38784	116	4	4.17033	1809.692	-13.6	1809.722	
DDH K97-03	5457855.125	567984.552	49	16	10.8295	116	3	55.6473	1829.904	-13.6	1829.934	
8603	5457851.937	567984.779	49	16	10.72618	116	3	55.63799	1830.311	-13.6	1830.341	
8604	5457676.741	567854.769	49	16	5.1056	116	4	2.17787	1852.403	-13.6	1852.433	
8503	5457695.191	567602.593	49	16	5.80353	116	4	14.64397	1827.921	-13.6	1827.951	
8605	5457835.217	567518.919	49	16	10.37065	116	4	18.69898	1841.218	-13.6	1841.248	
8606	5457936.497	567467.885	49	16	13.67021	116	4	21.16266	1850.04	-13.6	1850.070	
8607	5458138.751	567342.955	49	16	20.26844	116	4	27.22179	1849.201	-13.6	1849.231	
8608	5458090.635	567087.59	49	16	18.8116	116	4	39.88703	1808.023	-13.6	1808.053	
8609	5458340.102	567198.585	49	16	26.84507	116	4	34.24386	1809.265	-13.59	1809.285	
8610	5458467.26	567301.634	49	16	30.92143	116	4	29.06754	1796.658	-13.59	1796.678	
8611	5458620.254	567378.074	49	16	35.84485	116	4	25.19205	1771.344	-13.59	1771.364	

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Real Time Station Locations and Elevation Calculations

Instrumentation: Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, October 1997

			Latitude			Longitude West					Corrected	
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev	Notes
8612	5459016.193	567640.52	49	16	48.56036	116	4	11.9633	1686.556	-13.58	1686.566	
8613	5458753.361	567956.448	49	16	39.92416	116	3	56.48859	1684.635	-13.59	1684.655	
-106	5459422.023	566362.102	49	17	2.20502	116	5	14.99081	1776.601	-13.57	1776.601	
8701	5458694.669	566263.435	49	16	38.69288	116	5	20.30817	1869.951	-13.58	1869.961	
8702	5458454.702	566384.61	49	16	30.87576	116	5	14.45484	1881.011	-13.58	1881.021	
8703	5458152.342	566471.341	49	16	21.05188	116	5	10.34373	1922.617	-13.59	1922.637	
8704	5457951.786	566515.158	49	16	14.54099	116	5	8.29555	1940.652	-13.59	1940.672	
8705	5457630.738	566490.148	49	16	4.15572	116	5	9.7251	1928.093	-13.6	1928.123	
8706	5457490.568	566656.011	49	15	59.55221	116	5	1.60253	1925.452	-13.6	1925.482	
8707	5457284.774	566906.98	49	15	52.79023	116	4	49.3091	1927.357	-13.61	1927.397	
8708	5457086.444	567209.079	49	15	46.24936	116	4	34.48255	1884.648	-13.61	1884.688	
8709	5456826.923	567485.421	49	15	37.73692	116	4	20.96852	1951.65	-13.62	1951.700	
8710	5457007.495	567577.121	49	15	43.54713	116	4	16.32229	1975.544	-13.62	1975.594	
-106	5459422.023	566362.102	49	17	2.20502	116	5	14.99081	1776.601	-13.57	1776.601	
8801	5458102.222	568256.946	49	16	18.72085	116	3	42.01745	1783.58	-13.6	1783.610	
8802	5458317.962	568101.298	49	16	25.76865	116	3	49.58709	1757.674	-13.6	1757.704	
8803	5458232.975	568441.57	49	16	22.8801	116	3	32.80135	1738.896	-13.6	1738.926	
8804	5458020.228	568648.724	49	16	15.90814	116	3	22.68206	1699.188	-13.6	1699.218	
8805	5457832.273	568617.099	49	16	9.83524	116	3	24.36295	1738.361	-13.6	1738.391	
8806	5457424.656	568583.8	49	15	56.65074	116	3	26.26207	1730.121	-13.61	1730.161	
8807	5457346.49	568451.661	49	15	54.17316	116	3	32.84792	1754.773	-13.61	1754.813	
8808	5457255.524	568226.341	49	15	51.31845	116	3	44.05156	1786.594	-13.61	1786.634	

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Real Time Station Locations and Elevation Calculations

Instrumentation; Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, June - July 1997

16-Jun

Name	Northing	Easting	Latitude dd	mm	ss.sssss	Longitude dd	mm	ss.sssss	Elev	GSD95W	Corrected Elev
-106	5459422.02	566362.10	49	17	2.20553	-116	5	14.99081	1776.60	-13.57	1776.601
9701	5458167.73	567972.06	49	16	20.95657	-116	3	56.07421	1780.24	-13.60	1780.274
9702	5460763.99	566264.67	49	17	45.69443	-116	5	19.01240	1771.14	-13.55	1771.119
9703	5460360.56	566610.95	49	17	32.49630	-116	5	2.11132	1659.97	-13.56	1659.958
9704	5459639.63	566718.66	49	17	9.11144	-116	4	57.21218	1652.70	-13.57	1652.702
9705	5459857.94	566986.57	49	17	16.07469	-116	4	43.82013	1606.94	-13.57	1606.939
9706	5460291.52	566820.48	49	17	30.17865	-116	4	51.78040	1596.81	-13.56	1596.800

17-Jun

Name	Northing	Easting	Latitude dd	mm	ss.sssss	Longitude dd	mm	ss.sssss	Elev	GSD95W	Corrected Elev
9707	5459846.01	567463.41	49	17	15.49960	-116	4	20.22456	1594.51	-13.57	1594.507
9708	5458711.90	568414.69	49	16	38.39808	-116	3	33.83649	1636.63	-13.59	1636.646
9709	5459796.49	567641.36	49	17	13.82523	-116	4	11.44655	1605.78	-13.57	1605.775
9710	5460048.28	567743.81	49	17	21.93690	-116	4	6.22170	1615.20	-13.57	1615.198
9711	5460544.13	568266.48	49	17	37.78242	-116	3	40.04464	1776.27	-13.57	1776.267
9712	5459220.84	569331.61	49	16	54.50496	-116	2	48.14296	1848.07	-13.59	1848.091
9713	5459160.94	569149.16	49	16	52.63980	-116	2	57.20973	1803.64	-13.59	1803.659
12301	5459185.19	568630.07	49	16	53.63572	-116	3	22.88556	1660.49	-13.59	1660.512
9714	5458991.99	568792.53	49	16	47.31445	-116	3	14.96499	1637.31	-13.59	1637.333
12307	5459560.83	567965.27	49	17	6.06571	-116	3	55.55811	1625.86	-13.58	1625.873

18-Jun

Suspect Name	Northing	Easting	Latitude dd	mm	ss.sssss	Longitude dd	mm	ss.sssss	Elev	GSD95W	Corrected Elev
-107	5465068.53	580786.59	49	19	58.76819	-115	53	16.97580	1126.37	-13.79	1126.367
9715	5461539.41	572537.39	49	18	8.23536	-116	0	7.96906	1901.92	-13.60	1901.729
9716	5461554.85	572741.49	49	18	8.64790	-115	59	57.85383	1896.78	-13.61	1896.599
9717	5461579.62	572940.68	49	18	9.36432	-115	59	47.97487	1887.40	-13.62	1887.229
9718	5461763.09	572971.45	49	18	15.29149	-115	59	46.33114	1873.15	-13.62	1872.983
9719	5461955.52	573027.39	49	18	21.49786	-115	59	43.43427	1856.66	-13.62	1856.492
9720	5462132.28	573127.79	49	18	27.17781	-115	59	38.34683	1846.06	-13.62	1845.885
9721	5462342.71	573152.92	49	18	33.98008	-115	59	36.96362	1833.41	-13.62	1833.239
9722	5462448.63	573379.54	49	18	37.31148	-115	59	25.67120	1814.77	-13.62	1814.598
9723	5462552.82	573514.50	49	18	40.62640	-115	59	18.91900	1799.96	-13.62	1799.788
9724	5462674.42	573689.53	49	18	44.48771	-115	59	10.17079	1779.54	-13.62	1779.371
9725	5462768.78	573851.51	49	18	47.47227	-115	59	2.08662	1766.99	-13.63	1766.827
9726	5463377.32	573908.88	49	19	7.15030	-115	58	58.83947	1714.24	-13.63	1714.078
9727	5463651.59	574025.27	49	19	15.97970	-115	58	52.89185	1689.57	-13.63	1689.407

19-Jun Geoid

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Real Time Station Locations and Elevation Calculations

Instrumentation: Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, June - July 1997

			Latitude			Longitude					Corrected
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev
-105	5459848.40	563995.15	49	17	16.91991	-116	7	11.89748	1777.16	-13.56	1777.159
21102	5460047.20	562897.99	49	17	23.76673	-116	8	6.09346	1704.00	-13.57	1704.008
9728	5459804.10	562939.72	49	17	15.87990	-116	8	4.16562	1669.19	-13.57	1669.197
9729	5459987.46	563185.36	49	17	21.72576	-116	7	51.90221	1659.27	-13.57	1659.277
9730	5460064.72	563510.26	49	17	24.10594	-116	7	35.77566	1654.11	-13.56	1654.114
9731	5460455.30	563570.05	49	17	36.73026	-116	7	32.59226	1630.13	-13.56	1630.130
9732	5460746.80	563696.21	49	17	46.12133	-116	7	26.17935	1622.76	-13.55	1622.754
9733	5461062.66	563790.05	49	17	56.31313	-116	7	21.35174	1599.70	-13.55	1599.685
9734	5461252.12	563856.78	49	18	2.42268	-116	7	17.93903	1588.01	-13.54	1587.994
9735	5461520.73	564079.18	49	18	11.03599	-116	7	6.77260	1578.07	-13.54	1578.048
9736	5461562.50	563954.23	49	18	12.43561	-116	7	12.93553	1569.88	-13.54	1569.862
9737	5461661.13	563596.60	49	18	15.76360	-116	7	30.58694	1571.02	-13.54	1571.002
9738	5461807.53	564131.26	49	18	20.30264	-116	7	4.02792	1564.13	-13.54	1564.109
9739	5461465.80	564403.34	49	18	9.13477	-116	6	50.75388	1635.71	-13.54	1635.691

20-Jun

			Latitude			Longitude					Corrected
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev
-104	5469919.01	568662.34	49	22	41.16172	-116	3	14.63578	1375.88	-13.56	1375.884
9740	5467089.44	568771.42	49	21	9.50244	-116	3	10.98639	1524.70	-13.56	1524.698
9741	5467152.65	569081.12	49	21	11.42281	-116	2	55.59731	1581.21	-13.56	1581.205
9742	5467122.46	569296.75	49	21	10.35730	-116	2	44.92865	1638.19	-13.57	1638.196
9743	5467153.17	571396.61	49	21	10.47929	-116	1	0.83388	1632.65	-13.60	1632.688
9744	5466699.17	571452.48	49	20	55.75645	-116	0	58.35781	1676.42	-13.60	1676.463

23-Jun

			Latitude			Longitude					Corrected
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev
-104	5469919.01	568662.34	49	22	41.16121	116	3	14.63578	1375.88	-13.56	1375.884
9743	5467092.61	571449.87	49	21	8.49558	116	0	58.23315	1634.74	-13.60	1634.777
9745	5467122.01	569325.50	49	21	10.33034	116	2	43.50440	1644.86	-13.57	1644.869
9746	5467102.92	569437.49	49	21	9.66664	116	2	37.96566	1676.29	-13.57	1676.303
11103	5467161.82	570276.59	49	21	11.22729	116	1	56.33987	1923.36	-13.58	1923.378
9747	5467130.96	570588.26	49	21	10.09879	116	1	40.91240	1873.47	-13.58	1873.491
9748	5467110.28	570923.64	49	21	9.28912	116	1	24.30305	1760.23	-13.59	1760.255

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Real Time Station Locations and Elevation Calculations

Instrumentation; Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, June - July 1997

24-Jun

			Latitude			Longitude					Corrected
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev
-104	5469919.01	568662.34	49	22	41.16121	116	3	14.63578	1375.88	-13.56	1375.884
9749	5467076.58	571649.73	49	21	7.89210	116	0	48.33810	1614.39	-13.60	1614.430
9750	5466934.21	571982.71	49	21	3.15632	116	0	31.91360	1564.06	-13.61	1564.110
9751	5466233.66	570972.08	49	20	40.88584	116	1	22.46464	1802.71	-13.59	1802.740
9752	5466488.95	571316.45	49	20	49.00693	116	1	5.23477	1721.07	-13.59	1721.096

25-Jun

			Latitude			Longitude					Corrected
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev
-104	5469919.01	568662.34	49	22	41.16121	116	3	14.63578	1375.88	-13.56	1375.884
23703	5465630.80	573204.37	49	20	20.41706	115	59	32.24372	1960.39	-13.62	1960.447
9753	5465384.67	572991.47	49	20	12.53970	115	59	42.95463	1923.48	-13.62	1923.537
9754	5465224.22	572827.22	49	20	7.41559	115	59	51.19853	1881.69	-13.61	1881.742
9755	5464956.00	572555.74	49	19	58.84760	116	0	4.82427	1815.13	-13.60	1815.170
9756	5464697.91	572272.38	49	19	50.61268	116	0	19.03118	1852.13	-13.59	1852.161
9757	5466369.22	573794.48	49	20	44.06918	115	59	2.51260	2029.89	-13.63	2029.959
9758	5466132.95	573649.23	49	20	36.48244	115	59	9.86737	2011.97	-13.63	2012.042
9759	5465816.61	573517.09	49	20	26.29765	115	59	16.62532	1989.36	-13.63	1989.430

26-Jun

			Latitude			Longitude					Corrected
Name	Northing	Easting	dd	mm	ss.sssss	dd	mm	ss.sssss	Elev	GSD95W	Elev
-104	5469919.01	568662.34	49	22	41.16121	116	3	14.63578	1375.88	-13.56	1375.884
9760	5463586.86	567514.80	49	19	16.60077	116	4	15.40397	1488.96	-13.54	1488.942
9761	5463250.40	568010.58	49	19	5.50846	116	3	51.05381	1501.77	-13.54	1501.747
9762	5463033.80	568453.08	49	18	58.31736	116	3	29.27115	1539.78	-13.55	1539.773
9763	5462794.30	569297.26	49	18	50.22008	116	2	47.61152	1612.61	-13.56	1612.612
9764	5463096.69	569728.74	49	18	59.83401	116	2	26.05276	1607.75	-13.56	1607.745
9765	5463283.44	568441.39	49	19	6.40516	116	3	29.69577	1513.52	-13.55	1513.514

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Real Time Station Locations and Elevation Calculations

Instrumentation; Trimble RTK 4400 SSI Surveyor

Surveyed by: Quadra Surveys, June - July 1997

30-Jun

Name	Northing	Easting	Latitude dd	mm	ss.sssss	Longitude dd	mm	ss.sssss	Elev	GSD95W	Corrected Elev
-105	5459848.40	563995.15	49	17	16.91940	116	7	11.89748	1777.16	-13.56	1777.159
9761	5459251.33	564053.22	49	16	57.56500	116	7	9.36766	1785.67	-13.57	1785.677
9766	5459251.33	564053.19	49	16	57.56502	116	7	9.36872	1785.65	-13.57	1785.658
9767	5459060.04	564371.75	49	16	51.25066	116	6	53.71311	1761.37	-13.58	1761.386
9768	5459306.52	564463.39	49	16	59.19664	116	6	49.03435	1751.87	-13.57	1751.880
9769	5458335.20	564540.66	49	16	27.71723	116	6	45.77437	1693.64	-13.59	1693.671
9770	5457653.39	564572.39	49	16	5.62904	116	6	44.60021	1644.97	-13.60	1645.012
9771	5457268.11	564153.44	49	15	53.31281	116	7	5.55190	1596.23	-13.61	1596.277
9772	5458394.39	564367.27	49	16	29.69950	116	6	54.32041	1735.29	-13.59	1735.324
9773	5458658.49	564133.29	49	16	38.33938	116	7	5.74676	1786.41	-13.58	1786.432
9774	5457839.58	563512.93	49	16	12.05711	116	7	36.91545	1768.95	-13.60	1768.988
9775	5458163.27	563749.18	49	16	22.44940	116	7	25.03965	1818.46	-13.59	1818.494
9776	5458457.82	563834.36	49	16	31.95432	116	7	20.65556	1892.80	-13.59	1892.829
9777	5458501.32	563643.90	49	16	33.43434	116	7	30.05621	1894.65	-13.59	1894.682
9778	5458573.63	563291.89	49	16	35.90729	116	7	47.43484	1882.40	-13.59	1882.431

01-Jul

Name	Northing	Easting	Latitude dd	mm	ss.sssss	Longitude dd	mm	ss.sssss	Elev	GSD95W	Corrected Elev
-106	5459422.02	566362.10	49	17	2.20502	116	5	14.99081	1776.60	-13.57	1776.601
9779	5458786.74	565702.32	49	16	41.89199	116	5	48.02242	1762.82	-13.58	1762.828
9780	5458562.11	565463.40	49	16	34.71100	116	5	59.97850	1730.92	-13.58	1730.925
9781	5458227.10	565115.47	49	16	23.99766	116	6	17.39288	1671.26	-13.59	1671.283
9782	5458112.82	565283.06	49	16	20.23295	116	6	9.16733	1660.84	-13.59	1660.861
9783	5457903.77	565728.60	49	16	13.29248	116	5	47.24384	1718.50	-13.59	1718.519
9784	5457927.69	565026.07	49	16	14.33746	116	6	21.99219	1618.60	-13.59	1618.622

02-Jul

Name	Northing	Easting	Latitude dd	mm	ss.sssss	Longitude dd	mm	ss.sssss	Elev	GSD95W	Corrected Elev
-105	5459848.40	563995.15	49	17	16.91940	116	7	11.89748	1777.16	-13.56	1777.149
12008	5457951.38	562747.80	49	16	15.96123	116	8	14.71193	1713.99	-13.61	1714.028
9785	5458497.75	562838.61	49	16	33.61878	116	8	9.90966	1751.05	-13.60	1751.075
9786	5458886.56	562871.17	49	16	46.19605	116	8	8.07807	1774.03	-13.59	1774.045
9787	5459140.84	562837.13	49	16	54.44192	116	8	9.61933	1819.68	-13.58	1819.691
9788	5458597.21	563206.18	49	16	36.70272	116	7	51.66300	1873.53	-13.59	1873.551
9789	5458317.38	563219.30	49	16	27.63726	116	7	51.17285	1847.75	-13.60	1847.777
9790	5458083.46	563157.59	49	16	20.08617	116	7	54.35963	1829.55	-13.60	1829.576

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

SCINTREX V5.0 AUTOGRAV / Field Mode R4.4
Ser No: 10345.
Line: 1009. Grid: 0. Job: 1. Date: 97/10/09 Operator: 777.
GREF.: 0. mGals Tilt x sensit.: 271.4
GCAL.1: 5861.733 Tilt y sensit.: 287.4
GCAL.2: 0. Deg.Latitude: 49.5
TEMPCO.: -0.1355 mGal/mK Deg.Longitude: 115.7
Drift const.: 0.17 GMT Difference: 6.hr
Drift Correction Start Time: 23:33:43 Cal.after x samples: 12
Date: 97/07/15 On-Line Tilt Corrected = "*"

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4208.249 *	0	-4	-5	-0.8	0	60	0	8:41:26
-265	4090.689 *	0.1	12	11	-1	-0	60	0	12:04:05
-265	4090.7 *	0.1	7	11	-1	-0	60	0	12:05:35
8501	4041.552 *	0.1	-11	8	-0.9	-0	60	5	12:34:32
8502	4033.377 *	0.1	31	49	-1	-0	60	0	12:47:09
8503	4028.293 *	0.1	20	19	-1.1	-0.1	60	0	13:56:24
-101	4208.27 *	0.1	-5	3	-0.9	-0.1	60	0	17:16:38

SCINTREX V5.0 AUTOGRAV / Field Mode R4.4
Ser No: 10345.
Line: 1010. Grid: 0. Job: 1. Date: 97/10/10 Operator: 777.
GREF.: 0. mGals Tilt x sensit.: 271.4
GCAL.1: 5861.733 Tilt y sensit.: 287.4
GCAL.2: 0. Deg.Latitude: 49.5
TEMPCO.: -0.1355 mGal/mK Deg.Longitude: 115.7
Drift const.: 0.17 GMT Difference: 6.hr
Drift Correction Start Time: 23:33:43 Cal.after x samples: 12
Date: 97/07/15 On-Line Tilt Corrected = "*"

Station	Grav.	SD.	Tilt x	Tilt y	Temp	E.T.C	Dur	# Rej	Time
-101	4208.343 *	0	8	25	-0.8	0	60	0	7:58:40
-106	4042.657 *	0	-5	16	-1.2	0	60	0	10:57:56
12309	4090.747 *	0.1	-16	6	-1	0	60	8	11:24:10
11808	4055.803 *	0	-6	10	-1	0	60	0	11:46:41
8601	4046.508 *	0.1	25	0	-1	0	60	0	12:01:34
8501	4041.625 *	0.1	7	27	-1.1	0	60	4	12:10:10
8602	4037.734 *	0.1	-2	20	-1.1	-0	60	2	12:20:49
8502	4034.933 *	8.5	0	-43	-1.2	-0	60	0	12:30:36
8603	4028.525 *	0	13	-28	-1.1	-0	60	16	13:05:42
8604	4023.417 *	0	-14	41	-1.2	-0	60	0	13:25:41
8503	4028.293 *	0.1	6	22	-1.2	-0	60	6	13:53:21
8605	4026.45 *	0.3	8	38	-1.2	-0.1	60	2	14:11:54

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

8606	4025.005	*	0.1	20	19	-1.2	-0.1	60	0	14:29:31
8607	4025.633	*	0	22	16	-1.2	-0.1	60	0	15:01:20
8608	4032.458	*	0.4	58	25	-1.3	-0.1	60	3	15:24:41
8609	4033.568	*	0.1	45	21	-1.4	-0.1	60	1	15:50:22
8610	4036.912	*	0.3	20	35	-1.4	-0.1	60	1	16:05:56
8611	4042.239	*	0	13	4	-1.4	-0.1	60	0	16:19:49
8612	4059.061	*	0	-11	14	-1.4	-0.1	60	3	16:43:38
8613	4058.924	*	0	8	25	-1.4	-0.1	60	0	17:01:11
-106	4042.579	*	0	7	-6	-1.2	-0.1	60	2	18:29:05
-101	4208.436	*	0	-12	-3	-0.9	-0.1	60	1	20:06:45

SCINTREX V5.0 AUTOGRAV / Field Mode R4.4
Ser No: 10345.
Line: 1011. Grid: 0. Job: 1. Date: 97/10/11 Operator: 777.
GREF.: 0. mGals Tilt x sensit.: 271.4
GCAL.1: 5861.733 Tilt y sensit.: 287.4
GCAL.2: 0. Deg.Latitude: 49.5
TEMPCO.: -0.1355 mGal/mK Deg.Longitude: 115.7
Drift const.: 0.17 GMT Difference: 6.hr
Drift Correction Start Time: 23:33:43 Cal.after x samples: 12
Date: 97/07/15 On-Line Tilt Corrected = "*"

Station	Grav.		SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4208.379	*	0	-9	6	-0.9	0	60	0	8:33:14
-106	4042.646	*	0.3	-33	-15	-1	0	60	1	11:46:08
8701	4021.609	*	0.1	-13	8	-1	0	60	1	12:34:16
8702	4018.347	*	0	22	10	-1.1	0	60	0	12:53:00
8703	4007.952	*	0.1	7	0	-1.1	-0	60	3	13:18:04
8704	4003.916	*	0.1	0	9	-1.2	-0	60	2	13:35:28
8705	4006.633	*	0.1	-28	13	-1.2	-0	60	4	13:55:18
8706	4007.096	*	0.1	-10	20	-1.2	-0	60	0	14:15:05
8707	4006.365	*	0.1	6	3	-1.1	-0.1	60	5	14:35:41
8708	4015.109	*	0.3	-24	12	-1.2	-0.1	60	0	14:56:34
8709	4000.902	*	0.3	0	32	-1.2	-0.1	60	0	15:26:34
8710	3995.643	*	0.1	-5	11	-1.2	-0.1	60	0	15:48:07
-106	4042.596	*	0.1	2	11	-1.3	-0.1	60	2	17:27:02
-101	4208.378	*	0	-17	1	-0.8	-0.1	60	0	19:16:46

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation: Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

SCINTREX V5.0   AUTOGRAV / Field Mode   R4.4
Ser No: 10345.
Line: 1012. Grid: 0. Job: 1. Date: 97/10/12 Operator: 777.
GREF.: 0. mGals   Tilt x sensit.: 271.4
GCAL.1: 5861.733   Tilt y sensit.: 287.4
GCAL.2: 0.   Deg.Latitude: 49.5
TEMPCO.: -0.1355 mGal/mK   Deg.Longitude: 115.7
Drift const.: 0.17   GMT Difference: 6.hr
Drift Correction Start Time: 23:33:43   Cal.after x samples: 12
Date: 97/07/15   On-Line Tilt Corrected = "*"

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4208.405 *	0	-6	6	-0.8	0	60	1	8:27:42
-106	4042.683 *	0.1	-12	13	-0.7	0	60	1	12:04:14
8801	4038.08 *	0.1	4	11	-0.8	0	60	4	13:20:01
8802	4043.993 *	0.2	15	-56	-0.8	-0	60	0	13:38:45
8803	4045.573 *	0	50	-4	-0.9	-0	60	3	14:21:12
8804	4053.282 *	0.1	16	25	-1	-0.1	60	0	15:02:47
8805	4045.019 *	0.4	138	16	-1.1	-0.1	60	0	15:43:25
8806	4045.737 *	0.2	18	28	-1.1	-0.1	60	0	16:28:50
8807	4041.101 *	0	10	7	-1.1	-0.1	60	4	16:51:24
8808	4034.559 *	0	-9	24	-1.1	-0.1	60	4	17:15:54
-106	4042.667 *	0.1	-15	-2	-1.2	-0.1	60	0	18:45:55
-101	4208.36 *	0	-19	10	-0.7	-0	60	0	21:53:42

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation: Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997
Operator: Tam Mitchell

Gravity Field Values

Jun-16

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4193.003	0.02	5	-4	-0.96	0.01	60	1	8:17:19
-106	4027.498	0.208	-34	-17	-0.76	0.052	60	0	12:53:15
9701	4024.319	0.03	-4	-8	-0.94	0.02	60	1	14:17:15
9702	4028.307	0.032	10	5	-0.84	-0.002	60	0	15:05:53
9703	4049.596	0.064	-24	7	-0.87	-0.015	60	0	15:34:12
9704	4051.003	0.019	1	5	-0.85	-0.033	60	0	16:18:06
9705	4060.101	0.021	0	-5	-0.9	-0.043	60	2	16:47:36
9706	4062.194	0.021	11	4	-0.91	-0.052	60	0	17:19:06
-101	4193.051	0.026	-9	2	-0.83	-0.055	60	0	21:04:22

Jun-17

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4192.996	0.018	12	5	-1.03	-0.001	60	3	8:11:10
-106	4027.312	0.018	-6	0	-1.07	0.065	60	1	10:19:03
9707	4063.5	0.025	3	-6	-1.04	0.084	60	0	11:46:07
9708	4052.743	0.02	-6	1	-1.15	0.084	60	1	12:11:28
9709	4060.995	0.016	3	2	-1.16	0.078	60	6	12:53:10
9710	4058.696	0.015	-6	3	-1.19	0.069	60	0	13:23:29
9711	4026.13	0.133	-20	1	-1.16	0.054	60	0	14:01:46
9712	4009.462	0.03	-15	-10	-1.19	0.035	60	0	14:41:12
9713	4018.205	0.051	6	-7	-1.28	0.024	60	0	15:01:02
12301	4047.62	* 0.128	4	1	-1.27	0.006	60	0	15:33:53
9714	4051.624	0.041	20	14	-1.21	-0.007	60	0	15:55:49
12307	4055.83	* 0.036	0	4	-1.2	-0.021	60	2	16:23:26
-101	4192.918	0.02	7	-8	-1.15	-0.076	60	1	19:04:18

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation: Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997
Operator: Tam Mitchell

Gravity Field Values

Jun-18

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4192.899	0.024	6	6	-1.13	-0.012	60	0	8:18:23
-107	4152.039	0.029	-19	16	-1.1	0.035	60	0	9:32:08
9715	4000.021	0.021	1	6	-1.13	0.086	60	1	11:10:16
9716	4001.356	0.026	-2	4	-1.32	0.093	60	0	11:31:02
9717	4004.237	0.029	2	-1	-1.21	0.097	60	0	11:47:29
9718	4007.672	0.03	0	2	-1.27	0.099	60	0	11:57:41
9719	4010.784	0.041	-5	-6	-1.28	0.1	60	18	12:07:51
9720	4013.613	0.028	2	2	-1.29	0.101	60	0	12:16:04
9721	4016.075	0.024	7	3	-1.27	0.102	60	0	12:34:40
9722	4019.726	0.022	-9	6	-1.27	0.101	60	0	12:48:55
9723	4022.718	0.068	-26	4	-1.31	0.1	60	13	12:57:13
9724	4027.287	0.029	-5	14	-1.31	0.098	60	2	13:08:51
9725	4029.943	0.03	1	7	-1.32	0.096	60	0	13:18:33
9726	4041.018	0.046	-4	5	-1.32	0.091	60	20	13:38:42
9727	4045.902	0.082	1	10	-1.31	0.088	60	0	13:48:00
-101	4192.977	0.049	8	6	-1.05	0.042	60	3	15:20:53

Jun-19

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4192.863	0.014	14	9	-1.17	-0.032	60	5	8:19:16
-105	4027.113	0.015	6	7	-1.45	0.086	60	0	11:19:12
21102	. 4039.67	* 0.030	10	7	-1.33	0.11	60	1	12:21:57
9728	4044.249	0.155	-30	-15	-1.42	0.114	60	0	12:54:43
9729	4048.966	0.029	-23	24	-1.48	0.115	60	0	13:16:11
9730	4050.398	0.014	4	-12	-1.5	0.11	60	1	13:49:23
9731	4056.022	0.017	-13	-2	-1.47	0.106	60	0	14:05:54
9732	4057.781	0.014	70	-10	-1.49	0.101	60	0	14:22:17
9733	4062.222	0.064	24	15	-1.49	0.091	60	9	14:43:29
9734	4064.528	0.041	14	-23	-1.49	0.072	60	5	15:21:12
9735	4066.532	0.074	30	5	-1.46	0.054	60	0	15:49:34
9736	4068.174	0.138	2	30	-1.55	0.043	60	3	16:06:03
9737	4067.331	0.345	16	-45	-1.55	0.027	60	2	16:27:40
9738	4069.547	0.133	57	16	-1.56	0.007	60	0	16:55:49
9739	4055.101	0.018	13	-12	-1.58	-0.037	60	2	18:01:50
9732	4057.72	0.025	41	-8	-1.6	-0.05	60	0	18:22:51
21102	. 4039.63	* 0.018	4	1	-1.6	-0.064	60	0	18:50:50
-105	4027.128	0.024	3	17	-1.52	-0.078	60	0	19:26:01
-100	4192.807	0.031	-7	14	-1.23	-0.077	60	0	23:09:41

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation: Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997
Operator: Tam Mitchell

Gravity Field Values

Jun-20

GCAL.1:	5861.733	Tilt y sensit.:	274.8
GCAL.2:	0.	Deg.Latitude:	49.5
TEMPCO.:	-0.1355 mGal/mK	Deg.Longitud[redacted]	in error
Drift const.:	0.24	GMT Difference:	6.hr

Drift Correction Start -Time: 07:35:59 Cal.after x samples: 12
Date: 97/06/20 On-Line Tilt Corrected = "*"

			Remo	Redo	
Stn	Time	Grav	Tides	Tides	Grav
-101	10:01:39	4196.2	0.07	-0.03	4196.3
-104	11:13:38	4112.2	0.06	0.019	4112.3
9740	12:16:36	4081.3	0.06	0.063	4081.5
9741	12:57:22	4070.4	0.07	0.093	4070.6
9742	13:47:14	4059.5	0.08	0.112	4059.7
9743	15:37:04	4063.1	0.1	0.116	4063.3
9744	16:13:37	4054.5	0.1	0.103	4054.7
10704	16:36:02	4064	0.09	0.092	4064.2
10703	16:44:36	4067.1	0.09	0.086	4067.3
10702	16:50:03	4069.1	0.09	0.083	4069.3
10701	16:56:51	4072.2	0.08	0.08	4072.4
-104	17:20:48	4112.2	0.08	0.064	4112.4
-101	18:13:35	4196.4	0.05	0.028	4196.5

23-Jun

Station	Time	Grav.
-101	9:58:42	4196.8
-104	11:09:59	4112.7
9743	12:10:01	4063.5
9740	13:01:10	4082
9741	13:33:54	4071.1
9745	14:28:34	4058.7
9746	15:13:27	4052.3
11103	16:59:14	. 4002.42
9747	17:30:21	4013.7
9748	17:55:31	4038.5
9743	18:31:35	4063.4
-104	19:51:18	4112.7
-100	20:37:20	4196.8

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation; Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997
Operator: Tam Mitchell

Gravity Field Values

24-Jun

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time	
-101	4196.761	0.013	0	1	-0.46	-0.073	60	0	8:36:03	
-104	4112.756	0.013	1	4	-0.47	-0.064	60	1	1:13:43	Calculated Value
9743	4063.423	0.022	-5	1	-0.39	-0.029	60	0	11:58:26	from below
9749	4067.546	0.015	11	33	-0.44	-0.017	60	0	12:22:16	
9750	4075.999	0.201	-9	-22	-0.29	0.013	60	1	13:22:18	
9743	4063.512	0.022	-11	22	-0.37	0.036	60	3	14:10:22	
9744	4055.2	0.06	14	5	-0.48	0.043	60	0	14:27:07	
9751	4029.911	0.016	-2	-5	-0.54	0.058	60	0	15:09:00	
9752	4046.297	0.015	5	2	-0.59	0.07	60	0	16:09:11	
9743	4063.364	0.019	-6	-6	-0.59	0.07	60	0	16:31:41	
104	4112.747	0.017	12	8	-0.37	0.066	60	0	17:19:13	
-101	4196.804	0.027	7	14	-0.65	0.048	60	3	18:16:50	

Battery falure reset clock below, used difference between value read at -101at 0:06:41
and at 18:16:50 to calculate a check at -104

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-104	4102.253	0.019	1	2	-0.47	-0.064	60	4	1:10:57
-104	4102.248	0.025	1	3	-0.47	-0.064	60	1	1:12:18
-104	4102.247	0.013	1	4	-0.47	-0.064	60	1	1:13:43
-101	4186.295	0.035	7	-16	-1.42	-0.064	60	0	0:06:41
	10.509								

25-Jun

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4196.771	0.023	15	-13	-0.35	-0.05	60	0	8:33:05
-104	4112.761	0.015	3	-6	-0.43	-0.056	60	0	10:13:50
23703	3995.95	* 0.038	-2	11	-0.35	-0.031	60	0	12:39:27
9753	4002.018	0.118	3	22	-0.35	-0.018	60	0	13:19:58
9754	4010.609	0.029	4	6	-0.32	-0.008	60	1	13:46:24
9755	4024.86	0.304	24	-18	-0.24	0.005	60	1	14:22:17
9756	4017.344	0.27	-58	9	-0.41	0.029	60	4	15:35:45
23703	3996.12	* 0.038	-7	0	-0.26	0.043	60	0	17:12:38
9757	3980.395	0.024	2	7	-0.33	0.042	60	1	17:28:16
9758	3984.627	0.033	-10	0	-0.35	0.041	60	0	17:39:35
9759	3990.044	0.036	6	-1	-0.36	0.038	60	2	18:11:25
-104	4112.75	0.024	-3	10	-0.23	0.016	60	0	19:27:43
-101	4196.802	0.025	-8	1	-0.19	-0.01	60	0	20:28:39

26-Jun

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation; Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997
Operator: Tam Mitchell

Gravity Field Values

-101	4196.772	0.015	10	20	-0.34	-0.024	60	0	9:08:34
-104	4112.768	0.025	-8	1	-0.31	-0.034	60	1	10:36:51
9760	4087.756	0.028	-1	-6	-0.35	-0.038	60	0	11:54:03
9761	4085.067	0.214	41	-15	-0.35	-0.035	60	2	12:54:22
9762	4077.983	0.047	18	3	-0.34	-0.027	60	1	13:56:06
9763	4063.804	0.179	7	0	-0.31	-0.009	60	0	15:18:41
9764	4063.895	0.126	-13	22	-0.33	0	60	0	16:02:24
9765	4082.852	0.043	-22	-25	-0.3	0.008	60	3	16:47:18
9760	4087.921	0.022	-2	4	-0.29	0.013	60	0	17:38:22
-104	4112.867	0.085	-11	42	-0.21	0.014	60	0	18:14:42
-101	4196.932	0.044	2	16	-0.18	0.001	60	1	19:49:37

30-Jun

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4196.97	0.02	114	92	-0.75	0.041	60	2	8:53:37
-101	4196.904	0.019	-4	2	-0.74	0.042	60	0	8:55:42
-101	4196.905	0.026	8	5	-0.74	0.043	60	0	8:57:02
-105	4031.372	0.04	1	3	-0.76	0.078	60	0	10:40:11
-105	4031.369	0.036	-17	3	-0.76	0.078	60	0	10:41:47
-104	4031.297	0.037	-22	-3	-0.86	0.079	2	0	10:51:57
-105	4031.351	0.03	-4	9	-0.86	0.079	60	1	10:52:24
9766	4029.545	0.026	7	5	-0.68	0.079	60	1	11:43:38
9766	4029.546	0.032	18	7	-0.68	0.079	60	0	11:45:37
9766	4029.546	0.02	2	6	-0.68	0.079	60	0	11:47:00
9767	4034.389	0.015	2	4	-0.76	0.077	60	0	11:58:54
9767	4034.387	0.017	1	0	-0.75	0.077	60	0	12:00:16
9767	4034.388	0.019	-10	-9	-0.74	0.077	60	0	12:02:10
9768	4036.441	0.063	-23	15	-0.78	0.072	60	0	12:26:11
9768	4036.394	0.046	-44	-3	-0.76	0.07	60	0	12:32:02
9768	4036.393	0.037	-44	-11	-0.77	0.07	60	4	12:33:34
9769	4046.629	0.026	-3	4	-0.73	0.063	60	0	12:54:56
9769	4046.626	0.017	-4	2	-0.72	0.063	60	1	12:56:14
9770	4055.025	0.206	40	7	-0.7	0.057	60	0	13:10:55
9770	4055.089	0.127	89	-4	-0.7	0.056	60	6	13:12:52
9771	4062.957	0.046	3	9	-0.7	0.053	60	0	13:20:29
9771	4062.951	0.018	2	13	-0.7	0.052	60	0	13:23:04
9772	4038.836	0.032	-7	-3	-0.71	0.038	60	0	13:52:25
9772	4038.843	0.035	-16	-8	-0.7	0.037	60	7	13:54:04
9773	4028.121	0.066	-15	3	-0.69	0.026	60	2	14:15:55
9773	4028.125	0.044	1	15	-0.68	0.025	60	5	14:18:20
9794	4029.073	0	26	-1	-0.65	0.001	1	0	15:05:08
9774	4029.055	0.015	0	3	-0.66	0	60	1	15:05:53

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation; Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997
Operator: Tam Mitchell

Gravity Field Values

9774	4029.06	0.014	3	2	-0.65	-0.001	60	2	15:09:07
9775	4020.757	0.026	-1	10	-0.71	-0.006	60	0	15:16:38
9775	4020.756	0.013	5	17	-0.7	-0.006	60	1	15:18:07
9776	4005.07	0.055	13	13	-0.78	-0.017	60	1	15:39:51
9776	4005.089	0.034	7	24	-0.75	-0.019	60	0	15:43:41
9777	4005.555	0.117	3	5	-0.75	-0.031	60	0	16:07:40
9777	4005.556	0.035	-3	4	-0.74	-0.032	60	2	16:09:34
9778	4008.872	0.021	-7	6	-0.85	-0.037	60	7	16:23:35
9778	4008.882	0.017	3	16	-0.83	-0.038	60	1	16:25:14
-105	4031.3	0.023	-11	0	-0.74	-0.067	60	0	18:03:08
-105	4031.309	0.019	-3	5	-0.73	-0.067	60	0	18:04:35
-101	4197.001	0.016	-1	1	-0.62	-0.072	60	1	19:22:07
-101	4196.993	0.023	0	3	-0.63	-0.072	60	0	19:24:36
-101	4196.988	0.019	2	3	-0.64	-0.072	60	0	19:26:15

1-Jul

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4196.938	0.025	-9	18	-0.85	0.015	60	0	8:31:47
9760	4088.05	0.032	9	2	-0.76	0.087	60	3	10:53:21
-106	4031.336	0.035	-14	9	-0.76	0.094	60	1	11:24:17
9779	4033.455	0.054	-7	6	-0.72	0.093	60	3	12:42:19
9780	4039.518	0.08	-18	6	-0.77	0.091	60	22	12:48:42
9781	4050.53	0.016	2	0	-0.75	0.087	60	0	13:06:12
9782	4052.747	0.024	-12	7	-0.76	0.085	60	0	13:13:10
9783	4041.138	0.027	-11	9	-0.77	0.07	60	3	13:49:56
9784	4060.045	0.022	14	9	-0.71	0.059	60	1	14:14:23
-106	4031.315	0.162	-21	5	-0.54	-0.051	60	0	17:30:12
9760	4088.002	0.013	-15	2	-0.57	-0.061	60	3	17:54:44
-101	4197.005	0.018	-1	20	-0.57	-0.078	60	0	19:12:25

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Values - Electronic Notes from Gravity Meter

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, June - July 1997

Operator: Tam Mitchell

Gravity Field Values

2-Jul

Station	Grav.	SD.	Tilt x	Tilt y	Temp.	E.T.C.	Dur	# Rej	Time
-101	4196.959	0.009	1	0	-0.83	-0.016	60	0	8:17:23
-105	4031.413	0.025	-5	-2	-0.87	0.05	60	0	9:56:18
12008	4040.75	* 0.011	6	-8	-0.77	0.078	60	0	10:46:23
9785	4034.027	0.239	-23	-20	-0.85	0.107	60	2	12:35:10
9786	4029.949	0.062	-2	15	-0.94	0.104	60	4	13:10:46
9787	4021.23	0.072	-92	-21	-0.88	0.093	60	0	13:54:25
9788	4010.969	0.03	-11	11	-0.83	0.045	60	0	15:27:15
9789	4015.682	0.042	3	-11	-0.87	0.033	60	3	15:45:15
9790	4017.637	0.04	-8	6	-0.86	0.017	60	2	16:09:32
12008	4040.72	* 0.026	-20	-10	-0.92	-0.018	60	0	17:03:29
-105	4031.389	0.017	3	4	-0.86	-0.04	60	0	17:41:20
-101	4197.035	0.013	-8	-2	-0.74	-0.079	60	0	19:24:42

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Gravity Survey

Observed Gravity Data Reduction and Calculations

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

Operator: Tam Mitchell

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Uncalibrated Observed Gravity	Notes	
-101	4208.249	8:41:26	0.54	4208.42	0.00	4208.42	976479.71	980688.13	-101	
-265	4090.7	12:05:35	0.53	4090.86	-0.01	4090.85	976479.71	980570.56	-265	
8501	4041.552	12:34:32	0.57	4041.73	-0.01	4041.72	976479.71	980521.43	8501	
8502	4033.377	12:47:09	0.58	4033.56	-0.01	4033.55	976479.71	980513.26	8502	
8503	4028.293	13:56:24	0.43	4028.43	-0.01	4028.42	976479.71	980508.13	8503	
-101	4208.27	17:16:38	0.54	4208.44	-0.02	4208.42	976479.71	980688.13	-101	Loop Tie 0.02
					-0.18					
-101	4208.343	7:58:40	0.54	4208.51	0.00	4208.51	976479.62	980688.13	-101	
-106	4042.657	10:57:56	0.57	4042.83	-0.02	4042.81	976479.62	980522.43	-106	
12309	4090.747	11:24:10	0.6	4090.93	-0.03	4090.91	976479.62	980570.53	12309	
11808	4055.803	11:46:41	0.57	4055.98	-0.03	4055.95	976479.62	980535.57	11808	
8601	4046.508	12:01:34	0.57	4046.68	-0.03	4046.65	976479.62	980526.27	8601	
8501	4041.625	12:10:10	0.56	4041.80	-0.03	4041.77	976479.62	980521.39	8501	-0.04
8602	4037.734	12:20:49	0.55	4037.90	-0.03	4037.87	976479.62	980517.49	8602	
8502	4034.933	12:30:36	0.57	4035.11	-0.03	4035.08	976479.62	980514.70	8502	High SD in G Meter (do not use)
8603	4028.525	13:05:42	0.51	4028.68	-0.04	4028.64	976479.62	980508.26	8603	
8604	4023.417	13:25:41	0.52	4023.58	-0.04	4023.54	976479.62	980503.16	8604	
8503	4028.293	13:53:21	0.49	4028.44	-0.04	4028.40	976479.62	980508.02	8503	-0.11
8605	4026.45	14:11:54	0.49	4026.60	-0.05	4026.56	976479.62	980506.18	8605	
8606	4025.005	14:29:31	0.53	4025.17	-0.05	4025.12	976479.62	980504.74	8606	
8607	4025.633	15:01:20	0.57	4025.81	-0.05	4025.76	976479.62	980505.38	8607	
8608	4032.458	15:24:41	0.53	4032.62	-0.06	4032.57	976479.62	980512.19	8608	
8609	4033.568	15:50:22	0.52	4033.73	-0.06	4033.67	976479.62	980513.29	8609	

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Gravity Survey

Observed Gravity Data Reduction and Calculations

Instrumentation: Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, October 1997

Operator: Tam Mitchell

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Uncalibrated Observed Gravity	Notes
8610	4036.912	16:05:56	0.53	4037.08	-0.06	4037.02	976479.62	980516.64	8610
8611	4042.239	16:19:49	0.56	4042.41	-0.06	4042.35	976479.62	980521.97	8611
8612	4059.061	16:43:38	0.55	4059.23	-0.06	4059.17	976479.62	980538.79	8612
8613	4058.924	17:01:11	0.53	4059.09	-0.07	4059.02	976479.62	980538.64	8613
-106	4042.579	18:29:05	0.56	4042.75	-0.08	4042.67	976479.62	980522.29	-106
-101	4208.436	20:06:45	0.54	4208.60	-0.09	4208.51	976479.62	980688.13	-101 Loop Tie 0.09
-101	4208.379	8:33:14	0.54	4208.55	0.00	4208.55	976479.58	980688.13	-101
-106	4042.646	11:46:08	0.52	4042.81	0.00	4042.81	976479.58	980522.39	-106
8701	4021.609	12:34:16	0.5	4021.76	0.00	4021.76	976479.58	980501.34	8701
8702	4018.347	12:53:00	0.53	4018.51	0.00	4018.51	976479.58	980498.09	8702
8703	4007.952	13:18:04	0.47	4008.10	0.00	4008.10	976479.58	980487.68	8703
8704	4003.916	13:35:28	0.54	4004.08	0.00	4004.08	976479.58	980483.66	8704
8705	4006.633	13:55:18	0.53	4006.80	0.00	4006.80	976479.58	980486.38	8705
8706	4007.096	14:15:05	0.53	4007.26	0.00	4007.26	976479.58	980486.84	8706
8707	4006.365	14:35:41	0.54	4006.53	0.00	4006.53	976479.58	980486.11	8707
8708	4015.109	14:56:34	0.53	4015.27	0.00	4015.27	976479.58	980494.85	8708
8709	4000.902	15:26:34	0.52	4001.06	0.00	4001.06	976479.58	980480.64	8709
8710	3995.643	15:48:07	0.54	3995.81	0.00	3995.81	976479.58	980475.39	8710
-106	4042.596	17:27:02	0.56	4042.77	0.00	4042.77	976479.58	980522.35	-106
-101	4208.378	19:16:46	0.54	4208.54	0.01	4208.55	976479.58	980688.13	-101 Loop Tie 0.01
					0.07				
-101	4208.405	8:27:42	0.54	4208.57	0.00	4208.57	976479.56	980688.13	-101
-106	4042.683	12:04:14	0.59	4042.87	0.01	4042.88	976479.56	980522.44	-106

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Gravity Survey

Observed Gravity Data Reduction and Calculations

Instrumentation; Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, October 1997
Operator: Tam Mitchell

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Uncalibrated Observed Gravity	Notes
8801	4038.08	13:20:01	0.5	4038.23	0.01	4038.25	976479.56	980517.81	8801
8802	4043.993	13:38:45	0.45	4044.13	0.02	4044.15	976479.56	980523.71	8802
8803	4045.573	14:21:12	0.45	4045.71	0.02	4045.73	976479.56	980525.29	8803
8804	4053.282	15:02:47	0.53	4053.45	0.02	4053.47	976479.56	980533.03	8804
8805	4045.019	15:43:25	0.5	4045.17	0.02	4045.19	976479.56	980524.75	8805
8806	4045.737	16:28:50	0.55	4045.91	0.02	4045.93	976479.56	980525.49	8806
8807	4041.101	16:51:24	0.53	4041.26	0.02	4041.29	976479.56	980520.85	8807
8808	4034.559	17:15:54	0.53	4034.72	0.03	4034.75	976479.56	980514.31	8808
-106	4042.667	18:45:55	0.57	4042.84	0.03	4042.87	976479.56	980522.43	-106
-101	4208.36	21:53:42	0.54	4208.53	0.04	4208.57	976479.56	980688.13	-101 Loop Tie -0.04

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Data Reduction and Calculations

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, June - July 1997

Panda Basin Area

16-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4193.00	8:17:19	0.53	4193.17	0	4193.17	976494.96	980688.13	980688.13
-106	4027.50	12:53:15	0.46	4027.64	-0.02	4027.62	976494.96	980522.58	Tie -.08 mGal
9701	4024.32	14:17:15	0.5	4024.47	-0.02	4024.45	976494.96	980519.42	
9702	4028.31	15:05:53	0.56	4028.48	-0.03	4028.45	976494.96	980523.41	
9703	4049.60	15:34:12	0.57	4049.77	-0.03	4049.74	976494.96	980544.71	
9704	4051.00	16:18:06	0.56	4051.18	-0.03	4051.15	976494.96	980546.11	
9705	4060.10	16:47:36	0.58	4060.28	-0.03	4060.25	976494.96	980555.21	
9706	4062.19	17:19:06	0.54	4062.36	-0.04	4062.32	976494.96	980557.28	
-101	4193.05	21:04:22	0.53	4193.21	-0.05	4193.17	976494.96	980688.13	Loop Tie -.05 mGal

17-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4193.00	8:11:10	0.52	4193.16	0	4193.16	976494.97	980688.13	
-106	4027.31	10:19:03	0.55	4027.48	0.01	4027.49	976494.97	980522.46	
9707	4063.50	11:46:07	0.58	4063.68	0.02	4063.70	976494.97	980558.67	
9708	4052.74	12:11:28	0.55	4052.91	0.02	4052.93	976494.97	980547.90	
9709	4061.00	12:53:10	0.57	4061.17	0.03	4061.20	976494.97	980556.17	
9710	4058.70	13:23:29	0.56	4058.87	0.03	4058.90	976494.97	980553.87	
9711	4026.13	14:01:46	0.57	4026.31	0.04	4026.35	976494.97	980521.32	
9712	4009.46	14:41:12	0.56	4009.63	0.04	4009.67	976494.97	980504.64	
9713	4018.21	15:01:02	0.55	4018.37	0.04	4018.41	976494.97	980513.38	
12301	4047.62	15:33:53	0.58	4047.80	0.05	4047.85	976494.97	980542.82	Tie Or
9714	4051.62	15:55:49	0.54	4051.79	0.05	4051.84	976494.97	980546.81	
12307	4055.83	16:23:26	0.58	4056.01	0.05	4056.06	976494.97	980551.03	Tie
-101	4192.92	19:04:18	0.51	4193.08	0.08	4193.16	976494.97	980688.13	Loop Tie -.08

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Data Reduction and Calculations

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, June - July 1997

18-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4192.90	8:18:23	0	4192.90	0	4192.90	976495.23	980688.13	
-107	4152.04	9:32:08	0	4152.04	-0.01	4152.03	976495.23	980647.26	
9715	4000.02	11:10:16	0	4000.02	-0.03	3999.99	976495.23	980495.22	
9716=225	4001.36	11:31:02	0	4001.36	-0.03	4001.33	976495.23	980496.56	
9717	4004.24	11:47:29	0	4004.24	-0.03	4004.21	976495.23	980499.44	
9718	4007.67	11:57:41	0	4007.67	-0.03	4007.64	976495.23	980502.87	
9719	4010.78	12:07:51	0	4010.78	-0.04	4010.74	976495.23	980505.97	
9720	4013.61	12:16:04	0	4013.61	-0.04	4013.57	976495.23	980508.80	
21=22503	4016.08	12:34:40	0	4016.08	-0.04	4016.04	976495.23	980511.27	
9722	4019.73	12:48:55	0	4019.73	-0.04	4019.69	976495.23	980514.92	
9723	4022.72	12:57:13	0	4022.72	-0.05	4022.67	976495.23	980517.90	
9724	4027.29	13:08:51	0	4027.29	-0.05	4027.24	976495.23	980522.47	
9725	4029.94	13:18:33	0	4029.94	-0.05	4029.89	976495.23	980525.12	
9726	4041.02	13:38:42	0	4041.02	-0.05	4040.97	976495.23	980536.20	
9727	4045.90	13:48:00	0	4045.90	-0.06	4045.84	976495.23	980541.07	
-101	4192.98	15:20:53	0	4192.98	-0.08	4192.90	976495.23	980688.13	Loop Tie .08

19-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4192.86	8:19:16		4192.86	0	4192.86	976495.27	980688.13	
-105	4027.11	11:19:12	0	4027.11	0.01	4027.12	976495.27	980522.39	
21102	4039.67	12:21:57	0	4039.67	0.01	4039.68	976495.27	980534.95	
9728	4044.25	12:54:43	0	4044.25	0.01	4044.26	976495.27	980539.53	
9729	4048.97	13:16:11	0	4048.97	0.02	4048.99	976495.27	980544.26	
9730	4050.40	13:49:23	0	4050.40	0.02	4050.42	976495.27	980545.69	
9731	4056.02	14:05:54	0	4056.02	0.02	4056.04	976495.27	980551.31	
9732	4057.78	14:22:17	0	4057.78	0.02	4057.80	976495.27	980553.07	
9733	4062.22	14:43:29	0	4062.22	0.02	4062.24	976495.27	980557.51	
9734	4064.53	15:21:12	0	4064.53	0.02	4064.55	976495.27	980559.82	
9735	4066.53	15:49:34	0	4066.53	0.02	4066.55	976495.27	980561.82	
9736	4068.17	16:06:03	0	4068.17	0.03	4068.20	976495.27	980563.47	
9737	4067.33	16:27:40	0	4067.33	0.03	4067.36	976495.27	980562.63	
9738	4069.55	16:55:49	0	4069.55	0.03	4069.58	976495.27	980564.85	
9739	4055.10	18:01:50	0	4055.10	0.03	4055.13	976495.27	980550.40	
9732	4057.72	18:22:51	0	4057.72	0.04	4057.76	976495.27	980553.03	Tie -.04
21102	4039.63	18:50:50	0	4039.63	0.04	4039.67	976495.27	980534.94	Tie -.01
-105	4027.13	19:26:01	0	4027.13	0.04	4027.17	976495.27	980522.44	Tie +.05
-101	4192.81	23:09:41	0	4192.81	0.05	4192.86	976495.27	980688.13	Loop Tie -0.05

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Data Reduction and Calculations

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys. June - July 1997

20-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.262	10:01:39	0	4196.26		4196.26	976491.87	980688.13	
-104	4112.254	11:13:38	0	4112.25		4112.25	976491.87	980604.12	
9740	4081.46	12:16:36	0	4081.46		4081.46	976491.87	980573.33	
9741	4070.609	12:57:22	0	4070.61		4070.61	976491.87	980562.47	
9742	4059.66	13:47:14	0	4059.66		4059.66	976491.87	980551.53	
9743	4063.279	15:37:04	0	4063.28		4063.28	976491.87	980555.14	
9744	4054.72	16:13:37	0	4054.72		4054.72	976491.87	980546.59	
10704	4064.184	16:36:02	0	4064.18		4064.18	976491.87	980556.05	
10703	4067.266	16:44:36	0	4067.27		4067.27	976491.87	980559.13	
10702	4069.292	16:50:03	0	4069.29		4069.29	976491.87	980561.16	
10701	4072.384	16:56:51	0	4072.38		4072.38	976491.87	980564.25	
-104	4112.381	17:20:48	0	4112.38	-0.13	4112.25	976491.87	980604.12	
-101	4196.471	18:13:35	0	4196.47	-0.21	4196.26	976491.87	980688.13	Tie 0.21

The above loop was redone due to large gravity misclosure.

23-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.80	9:58:42	0.53	4196.97	0	4196.97	976491.16	980688.13	
-104	4112.74	11:09:59	0.54	4112.91	0	4112.91	976491.16	980604.07	
9743	4063.46	12:10:01	0.57	4063.63	0	4063.63	976491.16	980554.79	
9740	4082.01	13:01:10	0.56	4082.18	0	4082.18	976491.16	980573.34	
9741	4071.13	13:33:54	0.55	4071.30	0	4071.30	976491.16	980562.46	
9745	4058.68	14:28:34	0.46	4058.82	-0.01	4058.81	976491.16	980549.97	
9746	4052.27	15:13:27	0.56	4052.45	-0.01	4052.44	976491.16	980543.60	
11103	4002.42	16:59:14	0.57	4002.60	-0.01	4002.59	976491.16	980493.75	
9747	4013.74	17:30:21	0.47	4013.89	-0.01	4013.88	976491.16	980505.04	
9748	4038.47	17:55:31	0.52	4038.63	-0.01	4038.62	976491.16	980529.78	
9743	4063.42	18:31:35	0.57	4063.59	-0.01	4063.58	976491.16	980554.74	Tie -.05
-104	4112.69	19:51:18	0.56	4112.86	-0.02	4112.84	976491.16	980604.00	Tie -.07
-101	4196.82	20:37:20	0.53	4196.99	-0.02	4196.97	976491.16	980688.13	Loop Tie -.02

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Data Reduction and Calculations

Instrumentation; Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys, June - July 1997

24-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.76	8:36:03	0.53	4196.92	0	4196.92	976491.21	980688.13	
-104	4112.76		0.53	4112.92	-0.01	4112.91	976491.21	980604.12	
9743	4063.42	11:58:26	0.53	4063.59	-0.01	4063.58	976491.21	980554.79	
9749	4067.55	12:22:16	0.56	4067.72	-0.02	4067.70	976491.21	980558.91	
9750	4076.00	13:22:18	0.37	4076.11	-0.02	4076.09	976491.21	980567.30	
9743	4063.51	14:10:22	0.53	4063.68	-0.03	4063.65	976491.21	980554.86	
9744	4055.20	14:27:07	0.55	4055.37	-0.03	4055.34	976491.21	980546.55	
9751	4029.91	15:09:00	0.58	4030.09	-0.03	4030.06	976491.21	980521.27	
9752	4046.30	16:09:11	0.56	4046.47	-0.04	4046.43	976491.21	980537.64	
9743	4063.36	16:31:41	0.55	4063.53	-0.04	4063.49	976491.21	980554.70	Tie -.09
104	4112.75	17:19:13	0.53	4112.91	-0.04	4112.87	976491.21	980604.08	Tie -.04
-101	4196.80	18:16:50	0.53	4196.97	-0.05	4196.92	976491.21	980688.13	LoopTie -.05

25-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.771	8:33:05	0.53	4196.93	0	4196.93	976491.20	980688.13	
-104	4112.761	10:13:50	0.57	4112.94	0	4112.94	976491.20	980604.14	
23703	3995.95	12:39:27	0.53	3996.11	-0.01	3996.10	976491.20	980487.30	
9753	4002.018	13:19:58	0.53	4002.18	-0.01	4002.17	976491.20	980493.37	
9754	4010.609	13:46:24	0.53	4010.77	-0.01	4010.76	976491.20	980501.96	
9755	4024.86	14:22:17	0.5	4025.01	-0.02	4024.99	976491.20	980516.19	
9756	4017.344	15:35:45	0.5	4017.50	-0.02	4017.48	976491.20	980508.68	
23703	3996.12	17:12:38	0.55	3996.29	-0.03	3996.26	976491.20	980487.46	Tie +.16
9757	3980.395	17:28:16	0.55	3980.56	-0.03	3980.53	976491.20	980471.73	
9758	3984.627	17:39:35	0.56	3984.80	-0.03	3984.77	976491.20	980475.97	
9759	3990.044	18:11:25	0.45	3990.18	-0.03	3990.15	976491.20	980481.35	
-104	4112.75	19:27:43	0.57	4112.93	-0.04	4112.89	976491.20	980604.09	Tie -.05
-101	4196.802	20:28:39	0.53	4196.97	-0.04	4196.93	976491.20	980688.13	Tie -.04

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Data Reduction and Calculations

Instrumentation: Scintrex CG3 Gravity Meter No.10345
Surveyed by: Quadra Surveys, June - July 1997

26-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.772	9:08:34	0.53	4196.94	0	4196.94	(Did not use this portion of loop)		
-104	4112.768	10:36:51	0.56	4112.94	0	4112.94	976491.14	980604.08	
9760	4087.756	11:54:03	0.51	4087.91	-0.01	4087.90	976491.14	980579.04	
9761	4085.067	12:54:22	0.51	4085.22	-0.03	4085.19	976491.14	980576.33	
9762	4077.983	13:56:06	0.52	4078.14	-0.04	4078.10	976491.14	980569.24	
9763	4063.804	15:18:41	0.5	4063.96	-0.06	4063.90	976491.14	980555.04	
9764	4063.895	16:02:24	0.47	4064.04	-0.07	4063.97	976491.14	980555.11	
9765	4082.852	16:47:18	0.51	4083.01	-0.08	4082.93	976491.14	980574.07	
9760	4087.921	17:38:22	0.56	4088.09	-0.09	4088.00	976491.14	980579.14	Tie 0.10
-104	4112.867	18:14:42	0.57	4113.04	-0.1	4112.94	976491.14	980604.08	LoopTie 0.10
-101	4196.932	19:49:37	0.53	4197.10		4197.10	(Did not use this portion of loop)		

Note: Had battery problem so used loop tie at -104

30-Jun

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.905	8:57:02	0.53	4197.07	0	4197.07	976491.06	980688.13	
-105	4031.351	10:52:24	0.53	4031.51	-0.02	4031.49	976491.06	980522.55	
9766	4029.546	11:47:00	0.62	4029.74	-0.02	4029.72	976491.06	980520.78	
9767	4034.388	12:02:10	0.61	4034.58	-0.02	4034.56	976491.06	980525.62	
9768	4036.393	12:33:34	0.52	4036.55	-0.03	4036.52	976491.06	980527.58	
9769	4046.626	12:56:14	0.55	4046.80	-0.03	4046.77	976491.06	980537.83	
9770	4055.06	13:10:55	0.55	4055.23	-0.03	4055.20	976491.06	980546.26	
9771	4062.951	13:23:04	0.58	4063.13	-0.04	4063.09	976491.06	980554.15	
9772	4038.843	13:54:04	0.55	4039.01	-0.04	4038.97	976491.06	980530.03	
9773	4028.125	14:18:20	0.56	4028.30	-0.04	4028.26	976491.06	980519.32	
9774	4029.055	15:05:53	0.54	4029.22	-0.05	4029.17	976491.06	980520.23	
9775	4020.756	15:18:07	0.57	4020.93	-0.05	4020.88	976491.06	980511.94	
9776	4005.089	15:43:41	0.54	4005.26	-0.05	4005.21	976491.06	980496.27	
9777	4005.556	16:09:34	0.55	4005.73	-0.06	4005.67	976491.06	980496.73	
9778	4008.882	16:25:14	0.58	4009.06	-0.06	4009.00	976491.06	980500.06	
-105	4031.309	18:04:35	0.51	4031.47	-0.07	4031.40	976491.06	980522.46	Tie -.09
-101	4196.988	19:26:15	0.53	4197.15	-0.08	4197.07	976491.06	980688.13	Loop Tie .08

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Observed Gravity Data Reduction and Calculations

Instrumentation: Scintrex CG3 Gravity Meter No.10345

Surveyed by: Quadra Surveys. June - July 1997

1-Jul

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.938	8:31:47	0.54	4197.10	0	4197.10	976491.03	980688.13	
9760	4088.05	10:53:21	0.53	4088.21	-0.01	4088.20	976491.03	980579.23	
-106	4031.336	11:24:17	0.51	4031.49	-0.01	4031.48	976491.03	980522.51	
9779	4033.455	12:42:19	0.53	4033.62	-0.03	4033.59	976491.03	980524.62	
9780	4039.518	12:48:42	0.53	4039.68	-0.03	4039.65	976491.03	980530.68	
9781	4050.53	13:06:12	0.56	4050.70	-0.03	4050.67	976491.03	980541.70	
9782	4052.747	13:13:10	0.53	4052.91	-0.03	4052.88	976491.03	980543.91	
9783	4041.138	13:49:56	0.57	4041.31	-0.03	4041.28	976491.03	980532.31	
9784	4060.045	14:14:23	0.53	4060.21	-0.04	4060.17	976491.03	980551.20	
-106	4031.315	17:30:12	0.54	4031.48	-0.06	4031.42	976491.03	980522.45	Tie -.06
9760	4088.002	17:54:44	0.54	4088.17	-0.06	4088.11	976491.03	980579.14	Tie -.09
-101	4197.005	19:12:25	0.52	4197.17	-0.07	4197.10	976491.03	980688.13	Loop Tie 0.07

1-Jul

Station	Meter Reading mGal	Time	IH	IH Corr. mGal	Drift	Drift Corr. mGal	Base Shift	Observed Gravity	Notes
-101	4196.959	8:17:23	0.53	4197.12	0	4197.12	976491.01	980688.13	
-105	4031.413	9:56:18	0.54	4031.58	-0.01	4031.57	976491.01	980522.58	
12008	4040.75	10:46:23	0.56	4040.92	-0.02	4040.90	976491.01	980531.91	
9785	4034.027	12:35:10	0.31	4034.12	-0.03	4034.09	976491.01	980525.10	
9786	4029.949	13:10:46	0.5	4030.10	-0.03	4030.07	976491.01	980521.08	
9787	4021.23	13:54:25	0.53	4021.39	-0.03	4021.36	976491.01	980512.37	
9788	4010.969	15:27:15	0.57	4011.14	-0.04	4011.10	976491.01	980502.11	
9789	4015.682	15:45:15	0.58	4015.86	-0.05	4015.81	976491.01	980506.82	
9790	4017.637	16:09:32	0.49	4017.79	-0.05	4017.74	976491.01	980508.75	
12008	4040.72	17:03:29	0.56	4040.89	-0.06	4040.83	976491.01	980531.84	Tie -.07
-105	4031.389	17:41:20	0.53	4031.55	-0.06	4031.49	976491.01	980522.50	Tie -.08
-101	4197.035	19:24:42	0.53	4197.20	-0.08	4197.12	976491.01	980688.13	Loop Tie .08

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Inner Zone Terrain Corrections

Surveyed by Quadra Surveys

	Inclinometer Readings in Deg to Terrain Correction Zc																Zone-B				Zone-C						Zone-D						B, C, & D	
Stn	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	Ter Cor	Stn
-265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.00	-265
8501	0	5	0	8	0	5	3	0	8	8	0	5	3	0	8	8	.000	.004	.000	.009	.000	.004	.001	.000	.009	.009	.000	.011	.004	.000	.029	.029	0.11	8501
8502	0	7	0	8	0	7	5	0	8	7	0	7	5	0	8	7	.000	.007	.000	.009	.000	.007	.004	.000	.009	.007	.000	.022	.011	.000	.029	.022	0.13	8502
8503	0	0	0	0	0	7	5	0	0	0	0	20	20	0	0	0	.000	.000	.000	.000	.000	.007	.004	.000	.000	.000	.000	.167	.167	.000	.000	.000	0.34	8503
12309	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.00	12309
11808	0	12	0	5	0	12	12	0	16	16	0	12	12	0	16	16	.000	.020	.000	.004	.000	.020	.020	.000	.035	.035	.000	.063	.063	.000	.110	.110	0.48	11808
8601	0	8	0	4	0	8	7	0	7	7	0	8	7	0	7	7	.000	.009	.000	.003	.000	.009	.007	.000	.007	.007	.000	.029	.022	.000	.022	.022	0.14	8601
8602	0	9	0	10	0	8	8	0	8	7	0	8	8	0	8	7	.000	.012	.000	.014	.000	.009	.009	.000	.009	.007	.000	.029	.029	.000	.029	.022	0.17	8602
8603	0	5	0	6	0	7	5	0	8	7	0	9	9	0	17	8	.000	.004	.000	.006	.000	.007	.004	.000	.009	.007	.000	.036	.036	.000	.123	.029	0.26	8603
8604	0	7	0	12	0	9	7	0	10	10	0	9	7	0	13	15	.000	.007	.000	.020	.000	.011	.007	.000	.014	.014	.000	.036	.022	.000	.074	.097	0.30	8604
8605	0	10	0	8	0	10	10	0	8	8	0	20	23	0	8	8	.000	.014	.000	.009	.000	.014	.014	.000	.009	.009	.000	.167	.215	.000	.029	.029	0.51	8605
8606	0	15	0	14	0	14	14	0	12	12	0	25	27	0	12	12	.000	.028	.000	.025	.000	.027	.027	.000	.020	.020	.000	.250	.287	.000	.063	.063	0.81	8606
8607	0	10	0	14	0	12	12	0	11	14	0	14	10	0	11	14	.000	.014	.000	.025	.000	.020	.020	.000	.017	.027	.000	.085	.044	.000	.054	.085	0.39	8607
8608	0	0	0	0	0	0	0	0	0	0	15	25	20	12	0	8	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.097	.250	.167	.063	.000	.029	0.61	8608
8609	0	6	0	0	0	6	7	0	3	3	0	6	7	0	7	7	.000	.006	.000	.000	.000	.005	.007	.000	.001	.001	.000	.016	.022	.000	.022	.022	0.10	8609
8610	0	0	0	0	0	8	8	0	0	0	0	8	8	0	6	6	.000	.000	.000	.000	.000	.009	.009	.000	.000	.000	.000	.029	.029	.000	.016	.016	0.11	8610
8611	0	11	0	10	0	8	6	0	10	8	0	8	6	0	7	8	.000	.017	.000	.014	.000	.009	.005	.000	.014	.009	.000	.029	.016	.000	.022	.029	0.16	8611
8612	7	0	0	0	0	7	7	0	6	6	0	8	10	0	6	7	.007	.000	.000	.000	.000	.007	.007	.000	.005	.005	.000	.029	.044	.000	.016	.022	0.14	8612
8613	0	6	0	0	0	6	6	0	5	5	0	13	9	0	7	7	.000	.006	.000	.000	.000	.005	.005	.000	.004	.004	.000	.074	.036	.000	.022	.022	0.18	8613
8701	5	5	5	8	5	8	7	5	8	8	5	8	9	10	0	5	.004	.004	.004	.009	.004	.009	.007	.004	.009	.009	.011	.029	.036	.044	.000	.011	0.19	8701
8702	0	0	7	10	0	10	12	0	7	8	0	12	15	0	5	8	.000	.000	.007	.014	.000	.014	.020	.000	.007	.009	.000	.063	.097	.000	.011	.029	0.27	8702
8703	0	15	0	16	0	10	13	0	15	15	0	8	10	0	15	15	.000	.028	.000	.031	.000	.014	.023	.000	.031	.031	.000	.029	.044	.000	.097	.097	0.43	8703
8704	0	12	0	12	0	9	9	0	11	11	0	7	7	0	13	14	.000	.020	.000	.020	.000	.011	.011	.000	.017	.017	.000	.022	.022	.000	.074	.085	0.30	8704
8705	0	10	0	8	0	7	7	0	8	7	0	7	7	0	12	11	.000	.014	.000	.009	.000	.007	.007	.000	.009	.007	.000	.022	.022	.000	.063	.054	0.21	8705
8706	10	0	12	0	0	9	7	0	12	13	0	8	7	0	15	16	.014	.000	.020	.000	.000	.011	.007	.000	.020	.023	.000	.029	.022	.000	.097	.110	0.35	8706
8707	0	15	0	9	0	9	9	0	8	10	0	9	9	0	12	13	.000	.028	.000	.012	.000	.011	.011	.000	.009	.014	.000	.036	.036	.000	.063	.074	0.30	8707
8708	0	24	0	16	0	20	20	0	13	15	0	22	22	0	15	14	.000	.059	.000	.031	.000	.052	.052	.000	.023	.031	.000	.199	.199	.000	.097	.085	0.83	8708
8709	0	17	0	10	0	12	12	0	19	18	0	12	11	0	19	18	.000	.035	.000	.014	.000	.020	.020	.000	.048	.043	.000	.063	.054	.000	.152	.137	0.59	8709
8710	0	17	0	10	0	17	15	0	9	9	0	17	15	0	12	11	.000	.035	.000	.014	.000	.039	.031	.000	.011	.011	.000	.123	.097	.000	.063	.054	0.48	8710
8801	0	10	0	0	0	12	10	0	0	0	0	17	10	0	7	7	.000	.014	.000	.000	.000	.020	.014	.000	.000	.000	.000	.123	.044	.000	.022	.022	0.26	8801

KENNECOTT CANADA EXPLORATION INC.

1997 Panda Infill Gravity Survey

Inner Zone Terrain Corrections

Surveyed by Quadra Surveys

	Inclinometer Readings in Deg to Terrain Correction Zc															
Stn	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6
8802	0	7	0	0	0	5	5	0	5	0	0	20	20	7	5	5
8803	0	28	0	28	0	25	25	0	27	27	0	25	25	0	27	27
8804	0	25	0	8	0	23	23	0	10	10	0	23	23	0	18	18
8805	0	18	18	0	0	18	16	0	18	18	0	18	16	18	17	0
8806	0	10	15	0	0	7	10	0	10	10	10	17	17	15	10	17
8807	0	12	5	0	0	9	9	0	5	5	10	22	22	7	5	15
8808	0	10	5	0	0	12	10	0	10	10	10	16	13	14	23	23

	Zone-B				Zone-C						Zone-D						B, C, & D	
Stn	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	Ter Cor	Stn
8802	.000	.007	.000	.000	.000	.004	.004	.000	.004	.000	.000	.167	.167	.022	.011	.011	0.40	8802
8803	.000	.073	.000	.073	.000	.079	.079	.000	.090	.090	.000	.250	.250	.000	.287	.287	1.56	8803
8804	.000	.062	.000	.009	.000	.068	.068	.000	.014	.014	.000	.215	.215	.000	.137	.137	0.94	8804
8805	.000	.038	.038	.000	.000	.043	.035	.000	.043	.043	.000	.137	.110	.137	.123	.000	0.75	8805
8806	.000	.014	.028	.000	.000	.007	.014	.000	.014	.014	.044	.123	.123	.097	.044	.123	0.65	8806
8807	.000	.020	.004	.000	.000	.011	.011	.000	.004	.004	.044	.199	.199	.022	.011	.097	0.63	8807
8808	.000	.014	.004	.000	.000	.020	.014	.000	.014	.014	.044	.110	.074	.085	.215	.215	0.82	8808

KENNECOTT CANADA EXPLORATION INC.

1997 Moyle Gravity Infill Survey

Inner Zone Terrain Corrections

Surveyed by: Quadra Surveys, June - July 1997

	Inclinometer Readings in Deg to Terrain Correction Zones																Zone-B				Zone-C						Zone-D						B, C, & D	
Stn	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	Ter Cor	Stn
9701	0	0	4	10	5	5	5	7	0	0	0	5	5	0	10	4	.000	.000	.003	.014	.004	.004	.004	.007	.000	.000	.000	.011	.011	.000	.044	.007	0.11	9701
9702	0	5	0	0	0	5	9	4	8	8	0	8	12	0	9	7	.000	.004	.000	.000	.000	.004	.011	.002	.009	.009	.000	.029	.063	.000	.036	.022	0.19	9702
9703	0	10	6	0	0	15	15	0	12	10	1	15	14	0	18	14	.000	.014	.006	.000	.000	.031	.031	.000	.020	.014	.000	.097	.085	.000	.137	.085	0.52	9703
9704	0	0	0	0	0	9	5	0	9	7	0	15	9	0	10	8	.000	.000	.000	.000	.000	.011	.004	.000	.011	.007	.000	.097	.036	.000	.044	.029	0.24	9704
9705	9	10	5	3	7	0	7	10	4	0	0	7	7	2	7	2	.012	.014	.004	.001	.007	.000	.007	.014	.002	.000	.000	.022	.022	.002	.022	.002	0.13	9705
9706	7	16	0	10	12	0	10	8	10	0	0	8	12	8	7	8	.007	.031	.000	.014	.020	.000	.014	.009	.014	.000	.000	.029	.063	.029	.022	.029	0.28	9706
9707	5	16	14	5	5	10	13	7	14	6	6	4	11	0	6	5	.004	.031	.025	.004	.004	.014	.023	.007	.027	.005	.016	.007	.054	.000	.016	.011	0.25	9707
9708	5	0	9	0	0	7	5	0	5	8	0	4	7	0	6	5	.004	.000	.012	.000	.000	.007	.004	.000	.004	.009	.000	.007	.022	.000	.016	.011	0.10	9708
9709	7	0	0	5	0	10	10	0	0	0	0	7	9	0	3	0	.007	.000	.000	.004	.000	.014	.014	.000	.000	.000	.000	.022	.036	.000	.004	.000	0.10	9709
9710	15	3	5	25	3	8	12	8	18	15	3	10	7	10	10	12	.028	.001	.004	.062	.001	.009	.020	.009	.043	.031	.004	.044	.022	.044	.044	.063	0.43	9710
9711	0	0	0	0	0	0	7	0	0	0	0	12	10	7	8	0	.000	.000	.000	.000	.000	.000	.007	.000	.000	.000	.000	.063	.044	.022	.029	.000	0.17	9711
9712	0	0	14	13	8	5	12	13	10	0	8	10	9	11	15	7	.000	.000	.025	.022	.009	.004	.020	.023	.014	.000	.029	.044	.036	.054	.097	.022	0.40	9712
9713	0	0	0	16	0	10	10	11	20	15	10	18	14	4	13	10	.000	.000	.000	.031	.000	.014	.014	.017	.052	.031	.044	.137	.085	.007	.074	.044	0.55	9713
9714	5	8	17	0	0	7	3	10	13	6	15	0	8	4	6	18	.004	.009	.035	.000	.000	.007	.001	.014	.023	.005	.097	.000	.029	.007	.016	.137	0.39	9714
9715	4	3	25	8	3	17	15	2	15	10	3	15	16	3	17	15	.003	.001	.062	.009	.001	.039	.031	.001	.031	.014	.004	.097	.110	.004	.123	.097	0.63	9715
9716	3	22	0	11	3	15	18	0	12	16	0	12	16	0	16	15	.001	.052	.000	.017	.001	.031	.043	.000	.020	.035	.000	.063	.110	.000	.110	.097	0.58	9716
9717	5	10	5	15	5	13	10	3	6	12	0	12	5	4	5	16	.004	.014	.004	.028	.004	.023	.014	.001	.005	.020	.000	.063	.011	.007	.011	.110	0.32	9717
9718	5	23	5	15	5	17	14	5	20	11	7	15	10	5	22	7	.004	.055	.004	.028	.004	.039	.027	.004	.052	.017	.022	.097	.044	.011	.199	.022	0.63	9718
9719	5	35	2	22	5	25	20	4	21	20	10	15	5	5	20	15	.004	.101	.001	.052	.004	.079	.052	.002	.057	.052	.044	.097	.011	.011	.167	.097	0.83	9719
9720	4	15	2	14	4	13	13	3	15	17	3	10	10	6	18	12	.003	.028	.001	.025	.002	.023	.023	.001	.031	.039	.004	.044	.044	.016	.137	.063	0.49	9720
9721	3	8	3	8	3	11	5	3	10	10	8	12	5	4	13	7	.001	.009	.001	.009	.001	.017	.004	.001	.014	.014	.029	.063	.011	.007	.074	.022	0.28	9721
9722	6	20	4	10	5	15	12	4	10	10	5	10	7	7	13	12	.006	.045	.003	.014	.004	.031	.020	.002	.014	.014	.011	.044	.022	.022	.074	.063	0.39	9722
9723	7	22	5	16	7	22	15	5	18	12	5	20	15	3	18	13	.007	.052	.004	.031	.007	.063	.031	.004	.043	.020	.011	.167	.097	.004	.137	.074	0.75	9723
9724	8	18	5	10	8	18	10	7	15	10	10	15	6	8	15	10	.009	.038	.004	.014	.009	.043	.014	.007	.031	.014	.044	.097	.016	.029	.097	.044	0.51	9724
9725	3	13	3	8	3	5	10	5	20	12	0	8	5	7	17	15	.001	.022	.001	.009	.001	.004	.014	.004	.052	.020	.000	.029	.011	.022	.123	.097	0.41	9725
9726	5	10	0	5	5	10	10	0	10	7	7	6	6	0	13	5	.004	.014	.000	.004	.004	.014	.014	.000	.014	.007	.022	.016	.016	.000	.074	.011	0.21	9726
9727	6	8	4	15	5	13	7	5	12	8	4	12	10	5	13	10	.006	.009	.003	.028	.004	.023	.007	.004	.020	.009	.007	.063	.044	.011	.074	.044	0.36	9727
9728	0	0	0	14	0	13	6	0	3	11	13	25	14	0	8	15	.000	.000	.000	.025	.000	.023	.005	.000	.001	.017	.074	.250	.085	.000	.029	.097	0.61	9728
9729	0	0	0	5	0	0	0	0	0	6	5	0	0	0	0	12	.000	.000	.000	.004	.000	.000	.000	.000	.000	.005	.011	.000	.000	.000	.000	.063	0.08	9729
9730	0	0	14	20	0	12	12	0	13	15	0	3	10	0	7	10	.000	.000	.025	.045	.000	.020	.020	.000	.023	.031	.000	.004	.044	.000	.022	.044	0.28	9730
9731	0	0	0	14	0	0	2	5	8	5	0	0	0	0	0	7	.000	.000	.000	.025	.000	.000	.001	.004	.009	.004	.000	.000	.000	.000	.000	.022	0.06	9731
9732	0	0	0	10	0	0	3	2	6	0	0	0	4	4	6	3	.000	.000	.000	.014	.000	.000	.001	.001	.005	.000	.000	.000	.007	.007	.016	.004	0.06	9732
9733	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.00	9733
9734	0	0	0	0	0	0	0	0	6	5	0	0	0	0	5	2	.000	.000	.000	.000	.000	.000	.000	.000	.005	.004	.000	.000	.000	.000	.011	.002	0.02	9734

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Inner Zone Terrain Corrections

Surveyed by: Quadra Surveys, June - July 1997

	Inclinometer Readings in Deg to Terrain Correction Zones																Zone-B				Zone-C						Zone-D						B, C, & D	
Stn	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	Ter Cor	Stn
9735	0	0	6	6	0	0	7	7	7	7	0	0	5	5	5	5	.000	.000	.006	.006	.000	.000	.007	.007	.007	.007	.000	.000	.011	.011	.011	.011	0.08	9735
9736	0	0	0	10	0	0	0	0	3	5	0	0	0	0	3	5	.000	.000	.000	.014	.000	.000	.000	.000	.001	.004	.000	.000	.000	.000	.004	.011	0.03	9736
9737	0	0	7	3	0	0	7	5	3	0	0	0	6	7	3	0	.000	.000	.007	.001	.000	.000	.007	.004	.001	.000	.000	.000	.016	.022	.004	.000	0.06	9737
9738	0	0	0	5	0	0	0	0	7	8	0	0	0	0	6	8	.000	.000	.000	.004	.000	.000	.000	.000	.007	.009	.000	.000	.000	.000	.016	.029	0.06	9738
9739	15	0	0	12	0	0	10	6	8	12	0	10	8	0	10	10	.028	.000	.000	.020	.000	.000	.014	.005	.009	.020	.000	.044	.029	.000	.044	.044	0.26	9739
9740	0	0	18	19	0	0	10	7	8	14	0	0	11	5	9	15	.000	.000	.038	.041	.000	.000	.014	.007	.009	.027	.000	.000	.054	.011	.036	.097	0.33	9740
9741	5	5	12	19	5	3	10	5	5	15	5	5	15	5	6	15	.004	.004	.020	.041	.004	.001	.014	.004	.004	.031	.011	.011	.097	.011	.016	.097	0.37	9741
9742	0	0	10	8	0	0	10	10	9	9	0	0	10	13	10	13	.000	.000	.014	.009	.000	.000	.014	.014	.011	.011	.000	.000	.044	.074	.044	.074	0.31	9742
9743	0	0	8	8	0	0	10	6	8	7	0	0	10	9	10	9	.000	.000	.009	.009	.000	.000	.014	.005	.009	.007	.000	.000	.044	.036	.044	.036	0.22	9743
9744	4	4	10	6	4	4	12	3	5	0	6	5	13	9	2	0	.003	.003	.014	.006	.002	.002	.020	.001	.004	.000	.016	.011	.074	.036	.002	.000	0.19	9744
9745	0	0	0	10	0	0	10	10	5	0	0	0	10	11	8	15	.000	.000	.000	.014	.000	.000	.014	.014	.004	.000	.000	.000	.044	.054	.029	.097	0.27	9745
9746	12	8	10	0	15	16	3	0	12	15	10	15	8	0	15	6	.020	.009	.014	.000	.031	.035	.001	.000	.020	.031	.044	.097	.029	.000	.097	.016	0.44	9746
9747	0	0	20	20	0	0	18	17	17	17	0	0	13	8	20	10	.000	.000	.045	.045	.000	.000	.043	.039	.039	.039	.000	.000	.074	.029	.167	.044	0.56	9747
9748	0	0	10	15	0	0	10	8	10	5	0	0	8	7	10	10	.000	.000	.014	.028	.000	.000	.014	.009	.014	.004	.000	.000	.029	.022	.044	.044	0.22	9748
9749	0	14	0	5	0	12	10	0	5	3	10	10	0	0	8	5	.000	.025	.000	.004	.000	.020	.014	.000	.004	.001	.044	.044	.000	.000	.029	.011	0.20	9749
9750	0	18	15	0	0	10	18	0	13	12	0	10	15	0	13	12	.000	.038	.028	.000	.000	.014	.043	.000	.023	.020	.000	.044	.097	.000	.074	.063	0.45	9750
9751	0	8	10	18	8	20	10	0	20	10	10	2	8	17	18	8	.000	.009	.014	.038	.009	.052	.014	.000	.052	.014	.044	.002	.029	.123	.137	.029	0.57	9751
9752	0	12	16	0	10	10	3	17	13	0	10	12	0	16	12	2	.000	.020	.031	.000	.014	.014	.001	.039	.023	.000	.044	.063	.000	.110	.063	.002	0.43	9752
9753	20	0	20	0	20	20	0	0	20	15	18	20	0	0	20	16	.045	.000	.045	.000	.052	.052	.000	.000	.052	.031	.137	.167	.000	.000	.167	.110	0.86	9753
9754	0	20	0	14	0	16	15	0	15	10	0	17	15	0	15	15	.000	.045	.000	.025	.000	.035	.031	.000	.031	.014	.000	.123	.097	.000	.097	.097	0.59	9754
9755	0	10	12	0	0	0	0	0	15	15	8	17	18	0	0	7	.000	.014	.020	.000	.000	.000	.000	.000	.031	.031	.029	.123	.137	.000	.000	.022	0.41	9755
9756	0	0	0	0	0	0	0	0	0	0	0	3	20	15	10	0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004	.167	.097	.044	.000	0.31	9756
9757	0	10	0	7	0	10	10	0	10	10	0	13	10	0	6	8	.000	.014	.000	.007	.000	.014	.014	.000	.014	.014	.000	.074	.044	.000	.016	.029	0.24	9757
9758	0	15	0	3	0	15	13	0	18	12	0	15	13	13	10	0	.000	.028	.000	.001	.000	.031	.023	.000	.043	.020	.000	.097	.074	.074	.044	.000	0.44	9758
9759	0	14	0	5	0	10	10	0	16	13	0	14	12	0	15	12	.000	.025	.000	.004	.000	.014	.014	.000	.035	.023	.000	.085	.063	.000	.097	.063	0.42	9759
9760	5	0	0	3	5	0	0	3	0	0	7	10	0	5	0	5	.004	.000	.000	.001	.004	.000	.000	.001	.000	.000	.022	.044	.000	.011	.000	.011	0.10	9760
9761	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.00	9761
9762	0	13	0	10	0	8	10	9	8	0	0	3	7	10	7	0	.000	.022	.000	.014	.000	.009	.014	.011	.009	.000	.000	.004	.022	.044	.022	.000	0.17	9762
9763	8	5	3	5	0	8	10	0	3	6	0	8	10	0	3	6	.009	.004	.001	.004	.000	.009	.014	.000	.001	.005	.000	.029	.044	.000	.004	.016	0.14	9763
9764	0	0	0	0	0	0	0	0	0	0	0	10	10	0	6	5	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.044	.044	.000	.016	.011	0.12	9764
9765	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.00	9765
9766	0	0	0	0	0	0	0	0	0	5	0	5	5	0	7	5	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004	.000	.011	.011	.000	.022	.011	0.06	9766
9767	0	7	0	8	0	3	5	6	7	10	5	0	5	0	4	3	.000	.007	.000	.009	.000	.001	.004	.005	.007	.014	.011	.000	.011	.000	.007	.004	0.08	9767
9768	0	0	0	5	8	10	6	6	2	6	4	7	5	6	2	6	.000	.000	.000	.004	.009	.014	.005	.005	.001	.005	.007	.022	.011	.016	.002	.016	0.12	9768

KENNECOTT CANADA EXPLORATION INC.

1997 Moyie Gravity Infill Survey

Inner Zone Terrain Corrections

Surveyed by: Quadra Surveys, June - July 1997

	Inclinometer Readings in Deg to Terrain Correction Zones																Zone-B				Zone-C						Zone-D						B, C, & D	
Stn	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	Ter Cor	Stn
9769	0	0	0	0	3	7	13	3	0	5	3	10	13	5	3	10	.000	.000	.000	.000	.001	.007	.023	.001	.000	.004	.004	.044	.074	.011	.004	.044	0.22	9769
9770	20	4	5	7	3	9	14	11	8	5	5	5	8	5	14	12	.045	.003	.004	.007	.001	.011	.027	.017	.009	.004	.011	.011	.029	.011	.085	.063	0.34	9770
9771	4	15	4	10	3	8	4	4	15	10	0	5	5	10	8	0	.003	.028	.003	.014	.001	.009	.002	.002	.031	.014	.000	.011	.011	.044	.029	.000	0.20	9771
9772	0	18	5	5	2	13	17	10	0	10	4	15	17	12	5	10	.000	.038	.004	.004	.001	.023	.039	.014	.000	.014	.007	.097	.123	.063	.011	.044	0.48	9772
9773	7	7	10	15	12	6	12	8	5	15	22	3	8	8	18	33	.007	.007	.014	.028	.020	.005	.020	.009	.004	.031	.199	.004	.029	.029	.137	.408	0.95	9773
9774	5	0	4	17	5	5	12	5	5	14	5	8	15	14	0	5	.004	.000	.003	.035	.004	.004	.020	.004	.004	.027	.011	.029	.097	.085	.000	.011	0.34	9774
9775	18	14	8	8	15	2	12	12	0	10	11	5	15	12	3	10	.038	.025	.009	.009	.031	.001	.020	.020	.000	.014	.054	.011	.097	.063	.004	.044	0.44	9775
9776	5	0	0	10	7	9	0	8	9	7	3	12	2	10	14	8	.004	.000	.000	.014	.007	.011	.000	.009	.011	.007	.004	.063	.002	.044	.085	.029	0.29	9776
9777	0	14	0	10	0	12	7	12	12	0	0	13	4	10	10	2	.000	.025	.000	.014	.000	.020	.007	.020	.020	.000	.000	.074	.007	.044	.044	.002	0.28	9777
9778	0	5	10	7	7	2	10	10	5	7	7	2	9	10	5	10	.000	.004	.014	.007	.007	.001	.014	.014	.004	.007	.022	.002	.036	.044	.011	.044	0.23	9778
9779	10	8	0	2	0	13	5	7	0	5	3	4	7	8	0	5	.014	.009	.000	.001	.000	.023	.004	.007	.000	.004	.004	.007	.022	.029	.000	.011	0.14	9779
9780	10	0	0	4	10	7	3	5	6	4	2	10	8	5	6	4	.014	.000	.000	.003	.014	.007	.001	.004	.005	.002	.002	.044	.029	.011	.016	.007	0.16	9780
9781	8	0	5	10	10	5	0	10	10	10	16	15	7	3	7	0	.009	.000	.004	.014	.014	.004	.000	.014	.014	.014	.110	.097	.022	.004	.022	.000	0.34	9781
9782	0	12	0	0	0	7	3	5	3	5	5	5	0	9	5	7	.000	.020	.000	.000	.000	.007	.001	.004	.001	.004	.011	.011	.000	.036	.011	.022	0.13	9782
9783	0	0	0	0	5	5	5	0	0	0	6	0	5	7	7	6	.000	.000	.000	.000	.004	.004	.004	.000	.000	.000	.016	.000	.011	.022	.022	.016	0.10	9783
9784	9	0	8	0	7	10	10	0	0	8	8	16	10	10	7	0	.012	.000	.009	.000	.007	.014	.014	.000	.000	.009	.029	.110	.044	.044	.022	.000	0.31	9784
9785	0	28	0	30	0	20	25	0	20	20	0	22	25	0	12	17	.000	.073	.000	.081	.000	.052	.079	.000	.052	.052	.000	.199	.250	.000	.063	.123	1.03	9785
9786	0	16	0	8	6	19	19	5	0	7	0	21	15	5	4	10	.000	.031	.000	.009	.005	.048	.048	.004	.000	.007	.000	.182	.097	.011	.007	.044	0.49	9786
9787	8	10	10	8	10	15	5	11	5	13	11	10	0	11	0	5	.009	.014	.014	.009	.014	.031	.004	.017	.004	.023	.054	.044	.000	.054	.000	.011	0.30	9787
9788	15	3	5	10	8	10	0	5	12	6	9	13	6	5	10	6	.028	.001	.004	.014	.009	.014	.000	.004	.020	.005	.036	.074	.016	.011	.044	.016	0.30	9788
9789	0	6	8	8	0	6	11	7	5	0	1	7	11	5	0	7	.000	.006	.009	.009	.000	.005	.017	.007	.004	.000	.000	.022	.054	.011	.000	.022	0.17	9789
9790	10	5	10	3	10	8	8	8	5	4	10	10	6	7	0	14	.014	.004	.014	.001	.014	.009	.009	.009	.004	.002	.044	.044	.016	.022	.000	.085	0.29	9790

Appendix XIII

Bore Hole Geophysical Logging Procedures and Results

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KOMEX INTERNATIONAL LTD.
ENVIRONMENTAL AND ENGINEERING CONSULTANTS

October 28, 1997

OUR FILE: KI97-4688

Kennecott Canada Inc.
Granville Square
#354 - 200 Granville St.
Vancouver, B.C.

Attention: Andrew Cole
Project Geophysicist

Dear Mr. Cole:

Re: ***Geophysical Logging of the K9702 and K9703 Boreholes, Moyie Creek, B.C.***

We are pleased to provide a formal letter to follow up the delivery of preliminary logs on September 26, 1997.

Background

Kennecott Canada Inc. is conducting base metal exploration in the Moyie Creek area of southeastern British Columbia. As part of this program, Komex International Ltd. geophysically logged two drilled and cored boreholes, K9702 and K9703. Geophysical logging provides the advantages of continuous objective data collection with no missing sections; the identification of features in the borehole not visible in the core to the naked eye; and the ability to identify features up to a half meter away, but not necessarily intersecting the borehole. Logging services included magnetic susceptibility, induction conductivity, and natural gamma. The specific objective of the program was to identify and resolve significant intersections.

Field Techniques

All field work was performed from September 22 to September 24, 1997. Data were collected with a portable hand cranked winch with 1,000 m of four conductor cable. All logging depths are referenced to ground surface. All logs were run in K9703. Only susceptibility and natural gamma logs were run in K9702. The logging tools included the Geonics Ltd. EM39S magnetic susceptibility probe, the EM39G gamma ray probe, and the EM39 borehole conductivity probe.

The EM39S is a new two coil susceptibility tool specifically designed to measure magnetic susceptibilities over a large dynamic range, including at very low values commonly associated with soils and sedimentary environments. The resolution of the EM39S is approximately the intercoil spacing, or 50 cm. Although the thickness of features smaller than 50 cm cannot be precisely resolved, they can still be "seen" if they are of significant susceptibility contrast. The instrument response is generally independent of the borehole diameter. 90% of the instrument response is from earth materials within a radius of 30 cm from the borehole axis. The response of materials from 5 to 25 cm from the borehole axis is roughly uniform. The operating frequency is 39.2 kHz. Data are recorded as 10^{-3} SI units. The instrument is described in detail by McNeill et. al. (1996).

The EM39G counts naturally emitted gamma rays of all energy levels using a scintillation counter. The detector is a thallium activated sodium iodide crystal 2.5 cm in diameter and 6.5 cm in length. The probe counts radiation from material in a sphere of a radius of approximately 20 cm. Data are recorded as raw counts per second (cps) with a time constant of 1 second. The influence of earth materials falls off with the square root of distance from the tool.

The EM39 electromagnetic conductivity tool is described in detail by McNeill (1986). It is very similar in design to the EM39S magnetic susceptibility probe. The intercoil spacing is 50 cm, providing a vertical resolution of approximately 50 cm. Borehole effects are negligible. Formation or annular material within a radius of 18 cm from the probe contributes very little to the measured conductivity. The peak response occurs 32 cm from the borehole. The operating frequency is 39.2 kHz. Data is output as apparent conductivity in millisiemens/meter (mS/m).

Results

The results are described in the accompanying log plots. The logs are presented on a 1:500 vertical scale. No filtering has been applied other than a 9 point boxcar to the natural gamma data in order to mute statistical fluctuations. Some minor block shifting of the susceptibility data has been applied in order to remove some negative values in the very low susceptibility host rock.

The host rock is generally characterized by very low susceptibility values (less than 1 X 10^{-3} SI), low conductivity values (less than 10 mS/m), and high gamma counts (greater than 150 cps). Significant intersections exhibit high magnetic susceptibilities and/or high electrical conductivities. Zones of low gamma counts (less than 100 cps are probably igneous intrusions.

Conclusions

1. Probable intersections are clearly identified by elevated magnetic susceptibilities and/or electrical conductivities. Igneous intrusions are indicated by zones of low gamma counts.

2. Numerous intersections were identified in the accompanying log plots, particularly in K9702.

3. Borehole magnetic susceptibility, conductivity, and natural gamma logging appear to be appropriate techniques for identifying significant intersections in the Moyie Creek area. Other logging services which may be considered in the future include self potential, induced polarization, temperature, borehole orientation, and borehole magnetometer surveys.

If you have any further questions, please do not hesitate to contact the undersigned.

References

McNeill, J.D. 1986. Borehole Conductivity Meter Theory of Operation. Technical Note TN-6. Geonics Limited, Mississauga, Ontario, Canada.

McNeill, J.D., Hunter, J.A., Bosnar, M. 1996. Applications of a borehole induction magnetic susceptibility logger to shallow lithological mapping: Journal of Environmental and Engineering Geophysics, v. 0, no. 2 (January 1996), pp. 77-90.

Yours truly,

Komex International Ltd.

Paul Bauman, M.Sc., P.Eng.

Appendix XIV

UTEM Survey Prccedures and Results

UTEM-3 BOREHOLE

&

SURFACE SURVEY

Logistics Report

ON THE

MOYIE PROJECT

BH K97-03 : UTM Collar Coordinates: 567984 E, 5457855 N

NELSON MINING DIVISION, B.C.

FOR

KENNECOTT CANADA EXPLORATION INC.

SURVEY BY

SJ GEOPHYSICS LTD.

October, 1997

REPORT BY

Rolf Krawinkel
SJ Geophysics Ltd.

TABLE OF CONTENTS

SJ Geophysics Ltd./S.J.V. Consultants Ltd. 11762 - 94th Ave., Delta, B.C. Canada
Tel (604) 582-1100 fax (604) 589-7466 E-mail sydv@istar.ca

INTRODUCTION

A large loop time domain electromagnetic (UTEM-3) surface and borehole survey was completed by SJ Geophysics Ltd., for Kennecott Canada Exploration Inc., on the Moyie Project, during the period of October 9 to October 19, 1997. The Moyie Project consisted of one borehole (k97-03), UTM collar coordinates 567984 E, 5457855 N, located in the Nelson Mining Division of B.C., Canada.

The purpose of the survey was to evaluate the conductive response and possible extent of massive sulphide intersections in the borehole.

DESCRIPTION OF UTEM SYSTEM.

UTEM is an acronym for "University of Toronto ElectroMagnetometer". The system was developed by Dr. Y. Lamontagne (1975) while he was a graduate student of that University.

The following is a short description of the UTEM system used in the field. A paper (A time-domain EM system measuring the step response of the ground) by G.F. West, J.C. Macnae and Y. Lamontagne, giving a more complete description with an overview of interpretations is located in Appendix IV.

The field procedure consists of first laying out a large loop, which can vary in size from less than 100M X 100M to more than 2Km X 2Km, of single strand insulated wire and energizing it with current from a transmitter which is powered by a 2.5 kW motor generator. During a surface survey the lines are generally oriented perpendicular to one side of the loop and surveying can be performed both inside and outside the loop. For borehole survey the sensor coil is placed down the borehole measuring the axial component of the electromagnetic field from a minimum of 2 separate loops.

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The transmitter loop is energized with a precise triangular current waveform at a carefully controlled frequency (30.97 Hz for this survey). The receiver system includes a sensor coil and backpack portable receiver module which has a digital recording facility. The time synchronization between transmitter and receiver is achieved through quartz crystal clocks in both units which are accurate to about one second in 50 years.

The receiver sensor coil measures the vertical, horizontal, or axial magnetic component of the electromagnetic field and responds to its time derivative. Since the transmitter current waveform is triangular, the receiver coil will sense a perfect square wave in the absence of geologic conductors. Deviations from a perfect square wave are caused by electrical conductors which may be geologic or cultural in origin. The receiver stacks any pre-set number of cycles in order to increase the signal to noise ratio.

The UTEM receiver gathers and records 10 channels of data at each station occupied. The higher number channels (7-8-9-10) correspond to short time or high frequency while the lower number channels (1-2-3) correspond to long time or low frequency. Therefore, poor or weak conductors will respond on channels 10, 9, 8, 7 and 6. Progressively better conductors will give responses on progressively lower number channels as well. For example, massive, highly conducting sulfides or graphite will produce a response on all ten channels.

The Borehole system consists of a normal surface UTEM-3 transmitter and receiver along with special receiver coil (1 1/4" in diameter). The coil is connected to the receiver trough a controller and fibre optic cable.

FIELD WORK

Rolf Krawinkel and Zoran Dujakovic, geophysicists with SJ Geophysics Ltd., and the equipment mobilized from Vancouver to Cranbrook by truck on October 9, 1997. Andrew Cole, geophysicist and representative of Kennecott Canada Exploration Inc. as well as Kenji Jackson, a young helper, were available to provide the orientation, assistance in laying out and picking up wire, and preparing a surface line. The drive to the site (approx. 40 km) required about 1.5 hours due to road conditions.

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Upon arrival on site there was fresh snow covering the whole area which hindered the placing (and repairing) of the loops. The first loop took more than two days to complete at which time a problem was discovered with the signal interconnection between the receiver and the down hole probe. A replacement fiber optic cable and controller (signal decoder) were obtained the following day from the manufacturers: Lamontagne Geophysics Ltd., of Kingston, Ontario. The equipment problem caused the loss of one day. The first and largest loop (loop1) was used to survey both the borehole (k97-03) and a surface line (L1000E), and then it was used as a basis to form the four smaller subsequent loops by bisecting in two directions.

The borehole was surveyed from five loops and the surface line was completed in two halves, in a period of 11days comprised of two mobilization days, three strictly looping days, five production (survey) days, and one down day.

DATA PRESENTATION

The results of the 1997 UTEM survey (Appendix V), are presented on 5 data sections of the measured total field (axial component) normalized to the calculated primary field, for the borehole. Together with 10 Vectorplot sections of the primary field. The surface line results are presented as 2 normalizations of the secondary field as obtained by subtracting out Ch1 response. A plan map showing loop locations is also included (Plate G1).

Legends for the UTEM data sections are also attached (Appendix II).

In order to reduce the field data, the theoretical primary field of the loop must be computed at each station. The normalization of the data is as follows:

Surface data

a) For Channel 1:

% Ch.1 anomaly = (Ch.1 - PC) X 100//PT/

Where:

PC is the calculated primary field in the direction of the component from the loop at the occupied station

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Ch.1 is the observed amplitude of Channel 1

PT is the calculated total field

b) For remaining channels (n = 2 to 9)

% Ch.n anomaly = (Ch.n - Ch.1) X 100/Ni

where:

Ch.n is the observed amplitude of Channel n (2 to 9)

N is Ch1 for Ch1 normalized

N is PT for primary field normalized

I is the data station for continuous normalized (each reading normalized by different primary field)

I is the station below the arrow on the data sections for point normalized (each reading normalized by the same primary field)

Subtracting channel 1 (Ch.1) from the remaining channels eliminates the topographic errors from all the data except channel 1.

If there is a response in channel 1 from a conductor then this value must be added to do a proper conductivity determination from the decay curves. Therefore channel 1 should not be subtracted indiscriminately.

The data from each line is plotted on at least 2 separate sections consisting of a continuous normalized section and a point normalized section. Additional point normalized data sections were produced where more than one conductor is present on the same line. Point normalization data is the absolute secondary field at a "gain setting" related to the normalization point. The data is usually point normalize over the central part of the crossover anomaly to aid in interpretation.

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Borehole data

a) For all channels

% Ch.n anomaly = (Ch.n) x 100//PT/

Where:

PT is the calculated primary field in the direction of the component from the loop at the occupied station

Ch.n is the observed amplitude of Channel n

The calculated primary field is plotted along with the total field to compare so the direction of the anomaly can be compared to the primary field. This also allows easy visualization of any location problems of the loops and boreholes.

R. Krawinkel

Rolf Krawinkel, B.Sc.

Geophysicist

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APPENDIX I

STATEMENT OF QUALIFICATIONS

I, Rolf Krawinkel, of 3219 Wellington Avenue, Vancouver, British Columbia, hereby certify that.

1) I am a graduate from the University of British Columbia 1981, receiving a Bachelor of Science in (Hon.) Astronomy and Geophysics.
2) I have been engaged in mining and mining exploration since 1979.

Rolf Krawinkel, B.Sc.

Geophysicist

APPENDIX II

Legend

UTEM SYSTEM MEAN DELAY TIME

Channel Number	Delay Time(msec)	Symbol
1	12.8	|
2	6.4	\
3	3.2	/
4	1.6	□
5	0.8	Σ
6	0.4	∡
7	0.2	⁊
8	0.1	×
9	0.05	△
10	0.025	◇

Base Frequency = 31 Hz

APPENDIX III

Production Sheets

Location	Moyie				
Survey	UTEM3	Equipment	UTEM3, Borehole		
N.T.S.					
Latitude		Longitude		Hole: K97-03	
Survey Dates	Oct. 1997			UTM: 567984E 5457855N 1835m	
Project Geologist	Andrew Cole, geophysicist			Helpers:	
SJGL Crew	Rolf Krawinkel-RK			Andrew Cole-AC	
	Zoran Dujakovic-ZD			Kenji Jackson-KJ	

DATE	Discription	Property	Grid	RX	Loop	Line	From	to	Dist.	RX Op	Coil	Other	Comments
09-Oct	Mob day									RK,ZD	AC,KJ		Leave Vancouver at 9am, long drive to Cranbrook, arrive at 9:30pm, eat, unpack
10-Oct	looping	Moyie			1					RK,ZD	AC,KJ		Start laying loop1, several inches of snow, steep, do not complete the loop
11-Oct	looping	Moyie			1					RK,ZD	AC,KJ		Finish laying wire, two breaks, fix last break at 5:40pm
12-Oct	survey	Moyie			1	1000E	2000N	3100N	1100	RK	ZD	AC,KJ	Few hours to fix loop, setup dummy (work), borehole system didn't work, head off to do surface line 1000E. Rolf checked out probes by oscilloscope in evening. Zoran worked on data.
13-Oct	stand by	Moyie								RK,ZD			Spent a day in Cranbrook, playing with data, buying some miscellaneous items and fixing the truck
14-Oct	survey				1	K97-03	0	730	730	RK,ZD		AC,KJ	Picked up new equipment at the airport at 12:30 and than surveyed BH K97-03. Late finish. AC and KJ put some more wire
15-Oct	survey	Moyie			1	1000E	2000N	1150N	850	RK	ZD	AC,KJ	Finished surface survey, AC and KJ prepared loops for tomorrow
16-Oct	survey	Moyie			2	K97-03	0	730	730	RK	ZD	KJ	very nice day: good weather, good loops, surveyed down and up and picked up some wire. AC worked in office
					3	k97-03	730	0	730	ZD	RK	KJ	
17-Oct	survey	Moyie			4	k97-03	0	730	730	RK	ZD	KJ	some problems with both loops as an animal passed through last night, we finish the survey, another late night: no plots until after midnight. AC worked in office
					5	k97-03	730	0	730	ZD	RK	KJ	
18-Oct	looping	Moyie										RK,ZD,KJ	picked up all wire and moved all equipment back to Cranbrook. AC went back to Vancouver
19-Oct	Mob day									RK, ZD			Mob from Cranbrook to Vancouver. Got vancouver at 12pm

APPENDIX IV

A time domain EM system measuring

the step response of the ground.

GEOPHYSICS, VOL. 49, NO. 7 (JULY 1984); P. 1010–1026, 26 FIGS.

A time-domain EM system measuring the step response of the ground

G. F. West*, J. C. Macnae*‡, and Y. Lamontagne‡

ABSTRACT

A wide-band time-domain EM system, known as UTEM, which uses a large fixed transmitter and a moving receiver has been developed and used extensively in a variety of geologic environments. The essential characteristics that distinguish it from other systems are that its system function closely approximates a step-function response measurement and that it can measure both electric and magnetic fields. Measurement of step rather than impulse response simplifies interpretation of data amplitudes, and improves the detection of good conductors in the presence of poorer ones. Measurement of electric fields provides information about lateral conductivity contrasts somewhat similar to that obtained by the gradient array resistivity method.

INTRODUCTION

This article describes the design of the UTEM system and its development at the Geophysics Laboratory of the University of Toronto by Y. Lamontagne and G. F. West from 1971 to 1979. UTEM is a wideband, time-domain, ground EM system with a step-function system response. It was designed to try to achieve the sensitivity and interpretability necessary to handle problems of deep exploration, conductive environments, and a variety of terrain conditions, in an economically viable manner. As with most EM systems, effective exploration for massive sulfide ores was the principal objective. The method was conceived in 1971, and the first UTEM I instrument was operational in 1972. It was an analog electronic system, and was used in a number of surveys which have been described by Lamontagne (1975). An improved UTEM II which incorporated a digital recording system was then designed and constructed at the University of Toronto with financial aid from a consortium of mining companies. It was first used in 1976. To fall 1980, about 1000 line-km had been surveyed with the system from 144 loops in 35 areas. UTEM III, which is a microprocessor-controlled system with expanded capabilities, is now produced commercially by Lamontagne Geophysics Ltd. Some of the field results obtained using the UTEM II system have been described in Lamontagne et al. (1977, 1980), Macnae (1977, 1980, 1981), Lodha (1977), and Podolsky and Slankis (1979). Data from all three UTEM systems are identical insofar as geophysical characteristics are concerned. The differences affect only data noise levels and operational convenience. Some of the noise rejection features of UTEM III are discussed by Macnae et al. (1984).

THE UTEM SYSTEM

Design philosophy

UTEM uses a large, fixed, horizontal transmitter loop as its source. The field of the loop is mapped in the quasi-static zone with the receiver system; the vertical component of the magnetic field is always measured, and in some circumstances the horizontal magnetic and electric field components may be measured as well (Figure 1). The size of the transmitter loop depends on the prospecting problem; loops may range from about 2 km × 1 km in resistive terrain to 300 m × 300 m in a conductive area. Lines are typically surveyed to a distance of 1.5 to 2 times the loop dimensions.

The large loop transmitter-field mapping receiver configuration was chosen in order to give the system the deepest possible exploration for orebody sized conductors, without sacrificing the ability to resolve shallower structures (depth < 50 m). This dictates a very large transmitter moment, and makes an extended source desirable. The virtue of an extended source is that the coupling between the source and a receiver or the source and a nearby conductive zone is not so many orders of magnitude larger than the coupling to a distant receiver or deep target as is the case with a confined source.

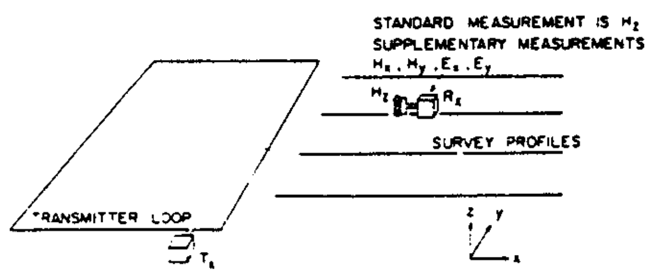

FIG. 1. Schematic layout of a UTEM survey.

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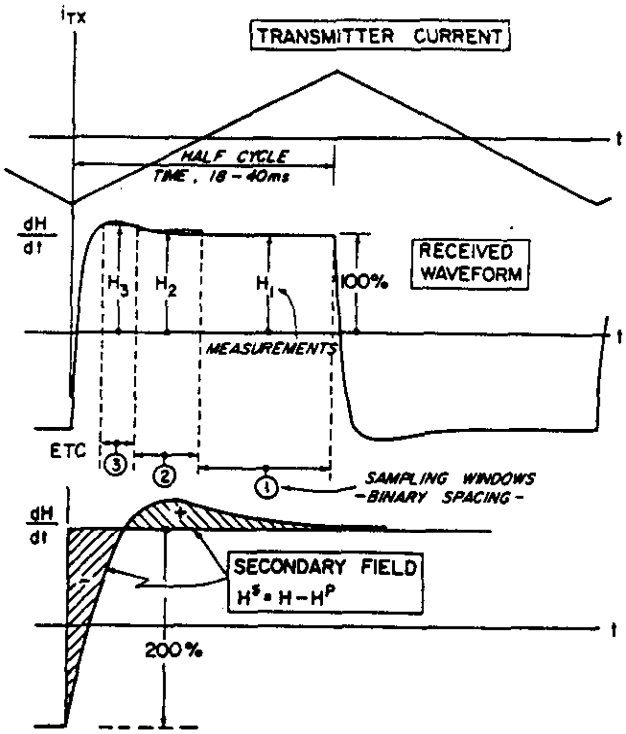

FIG. 2. Transmitted and received UTEM waveforms. Note that the measurement channels are numbered from the latest to the earliest. Sampling is repeated, with due regard to sign, in every half-cycle.

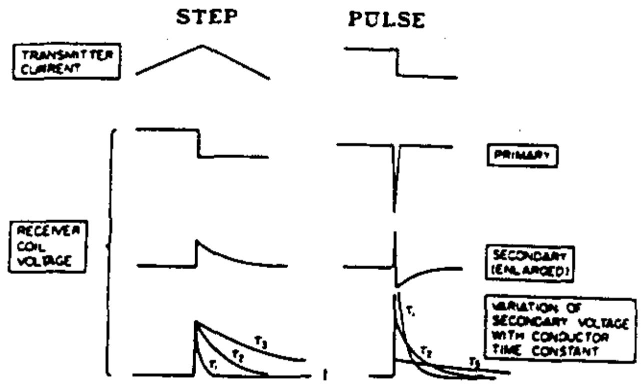

FIG. 3. Comparison of transient signals in step and pulse type systems.

Given a large transmitter and a large *Tx-Rx* separation, it is inevitable that induction in extensive conductive overburden and in large formational conductors will contribute more to the response than with a small scale system. Also, as the separation becomes larger it becomes increasingly likely that the system will be responding to several nearby conductors at once. However, a fixed transmitter-moving receiver system offers a basis for separating the signal contributions from the various conductors and resolving the geometry of deep-seated conductors. At any time instant, the magnetic field of the current system induced in the ground is a potential field (within the quasi-static zone), and if it is mapped on a profile or over a surface, there is a firm theoretical basis for separating it into parts and estimating the current systems which caused it. When the transmitter and hence the eddy current system move for each observation, it is more difficult to find a theoretical basis for stripping of responses into component parts.

There are negative aspects to using a fixed transmitter method. In addition to the aforementioned enhancement of anomalies due to formational conductors, the transmitter can be positioned badly for induction in small plate-like conductors, and a large good conductor can screen a smaller, shorter time-constant conductor which lies behind it. For these reasons it may be desirable to have survey coverage from more than one transmitter location.

The UTEM II transmitter passes a low-frequency current of precise triangular waveform through the transmitter loop. The magnetic field is sensed with a coil, which responds to the time derivative of the local magnetic field, so in "free space" a precise square-wave voltage would be induced in the receiver. In the presence of conductors the waveform is substantially distorted. The UTEM receiver measures this distortion by determining amplitudes at 10 delay times (actually, averages over time windows) which are spaced in a binary geometric progression between the waveform transitions. The sample scheme is shown in Figure 2. Note that the UTEM channel numbers are conventionally numbered in reverse order of time. This is because the latest time measurement often serves as a reference to which the other measurements are compared, whereas the number of earlier time measurements which can be made accurately may change if base period or instrument bandwidth is altered. The base frequency of the system is selectable, usually about 30 or 15 Hz (25 or 12.5 Hz in countries with 50 Hz power). A common practice is to set the base frequency (adjustable in 0.1 percent steps) about 0.5 Hz from a subharmonic of the power line in order that power line interference can be detected by slow beating in the data. The base frequency is usually set low enough that all ground response has nearly vanished by the end of the half-cycle. When this is the case, the UTEM system determines the step response of the ground in the time range 25μs to 12.8 ms (30 Hz base frequency).

Time-domain systems

Time-domain systems have some advantage over frequency-domain systems in that simultaneous measurement is easier to achieve over the whole spectrum and, at the same time, it is possible to check the phase synchronization of the transmitter and receiver time bases. Most time-domain systems employ an on-off type of transmitter current and confine all measurements to the off period, as this automatically separates the secondary from the primary field. However, when a coil is used as a sensor, the time derivative of the signal is observed. Thus, if the transmitter loop is energized with a step current, it is the impulse response of the ground which is observed.

When prospecting for conductive mineral deposits, it is generally more desirable for interpretation purposes to observe the step response than any other time response. The reason for this lies in the characteristics of eddy current decay. For the step

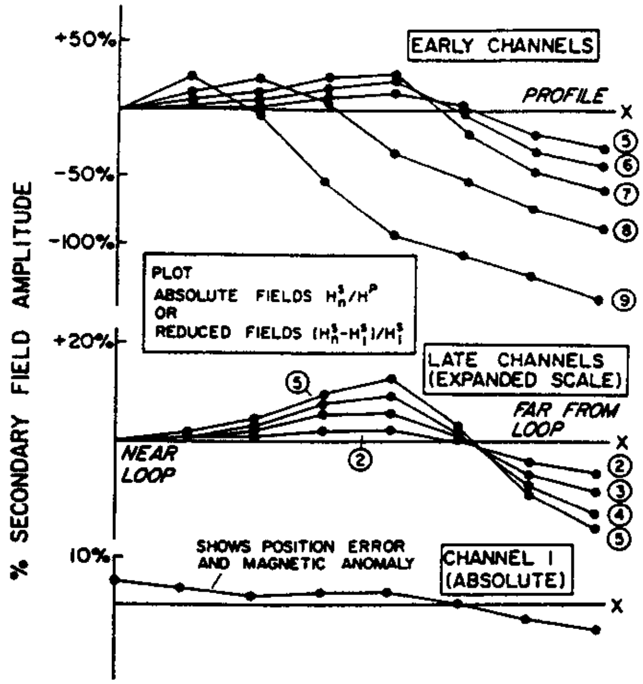

FIG. 4. Standard presentation of UTEM vertical component magnetic field data.

response, the early-time limit of response is identical to the frequency-domain inductive limit, and for a simple conductor in free space this is a function of geometry alone. For the impulse response, the early time limit is scaled from the step response limit by the inverse of the transient decay time constant (Figure 3). Thus, the decay rate must first be determined in order to interpret amplitude information in terms of geometry. This may present little difficulty in simple cases, but when complex or overlapping responses are observed it can be a serious problem. Also, even in the case of the step response, overburden anomalies which generally are of short time constant have early time amplitudes which are very much larger than the anomalies of target conductors with long time constant. Any further amplification caused by measuring the impulse rather than step response is clearly undesirable.

Although a system with a step response is usually desirable for interpretation purposes, the UTEM system is only one implementation of such a system. In fact a system using a magnetometer receiver with a square-wave transmitter instead of an induction coil (referred to as MSW system in the following sections) would have an identical system response. The foregoing rationale of the interpretational advantages of step response does not consider the other important factors which enter the design of actual systems such as signal-to-noise (S/N) efficiency and transmitter-sensor design constraints which in fact guide the choice of the actual transmitter waveform and sensor used. This is a complex topic discussed by Lamontagne et al. (1980). For example, the UTEM III system actually uses a modified triangular transmitter waveform and deconvolution in the receiver to improve its S/N performance but has a system response identical to the UTEM I and UTEM II systems (Macnae et al., 1984), i.e., a square-wave response. Thus the UTEM I/II systems, the conceptual MSW system, and the UTEM III system all make identical measu. they excite the ground differently. To avoi discussions in this paper of actual induced c in the ground will be limited to the UTEM sy: triangular waveform and to the MSW system.

The sampling scheme of Figure 2 was chose: all measuring time is utilized and time scalin ments is permitted. In the frequency dom. sponses may be characterized by dimensionl the form

$$\theta_f = \sigma\mu\omega L^2,$$

which demonstrates that scale changes of . quency or (length)² are equivalent to one an gous parameter for the time domain is

$$\theta_t = \sigma\mu L^2/t.$$

In interpreting frequency-domain data, it is pare observed frequency response data w model response data. This is convenient bec necessity of rescaling the model data for al physical scale lengths that might be encou cases. The same sort of scaling is possible data, but only if the system function of the ap discontinuity response. If this is not the case, the apparatus has a characteristic ramp sh response curves cannot be rescaled in time t as this would imply rescaling the shut-off different from that used by the apparatus.

To ensure that time scaling can readily l that have been sampled and averaged over a also necessary that the window widths be pro after the discontinuity. UTEM has such sam noted that time scaling may only be applied lous responses which are short enough so as in the interval between the two successive tra which form the square wave.

Data presentation

Because the field intensity falls off rapic distance from the transmitter loop, it is c normalize the secondary field observations One suitable normalizing factor is the pri netic field signal (H_z^p). If the positions of th and the receiver are known reasonably accur value of H_z^p may be employed. If the ground by late time, the channel 1 measurement is H_z^p. Normal survey data plotting practice procedures.

Figure 4 is an example of a standard plc dary vertical magnetic field data (H_z^s). Cha secondary field (Ch 1-H_z^p)/H_z^p (where H_z^p is t mary field) and all other channels are nor [(Ch n-Ch 1)/Ch 1] to correct for any positi tion of H^p and also to remove the effect o anomalies (for further details see Lamontagn channels on the example plot show a crosso ly, indicative of a concentration of (changi as will be discussed. The amplitude vari number indicates that these induced currents time. A small component of response appears to have persisted to Ch 1 and, for quantitative analysis, it should be remembered that the data reduction process will have caused subtraction of this amount from profiles of Ch 2-Chn. On the early-time channels, the migration of crossover location from one channel to another indicates that the secondary current flow at these times is not fixed in geometry, a characteristic which is indicative of an extensive conductor (here extensive overburden) rather than a localized conductor such as that responsible for the late time crossovers.

Since at any delay time, the secondary field is a potential field, interpretation of geometrically fixed current systems is best performed using absolute secondary fields normalized by the primary field intensity at a single point rather than continuously along the profile. Although only one case presented in this paper has this absolute or "point normalization," recent routine field practice is to point normalize all survey profiles exhibiting discrete anomalies, in order to simplify interpretation.

Horizontal magnetic field measurements may be made by reorienting the receiver coil. Normalization is done using the vertical primary magnetic field (calculated or vertical Ch 1 measurement). Unfortunately, horizontal field measurements frequently suffer a somewhat higher noise level than vertical fields, due to the predominantly horizontal orientation of sferic interference.

The electric field waveform is, like the voltage from the coil sensor, a square wave if the ground is very resistive. It is distorted in much the same way as the coil signal when the ground is conductive. Electric field observations are usually plotted as E_i/E_T^p—the observed channel voltage between the electrodes divided by the maximum expected late time voltage between electrodes at the observation point in any horizontal direction, i.e., $E_T^p = (E_x^{p2} + E_y^{p2})^{1/2}$. "Expected" here refers to the electric field produced by a loop on a laterally uniform, resistive half-space. This normalization facilitates intercomparison of x and y component data. The geologic noise level in electric field data is usually high, so plotting on expanded scales is rarely justified. All channel data are usually plotted on the same axes, as shown in Figure 5.

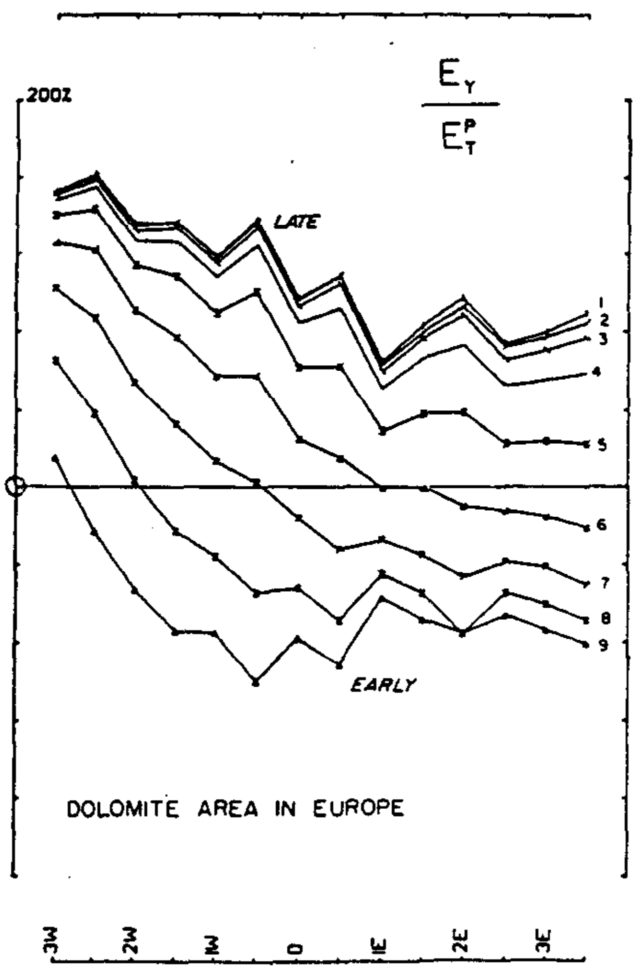

FIG. 5. Standard presentation of electric field data. The observed component is normalized to the total primary electric field of the transmitter loop.

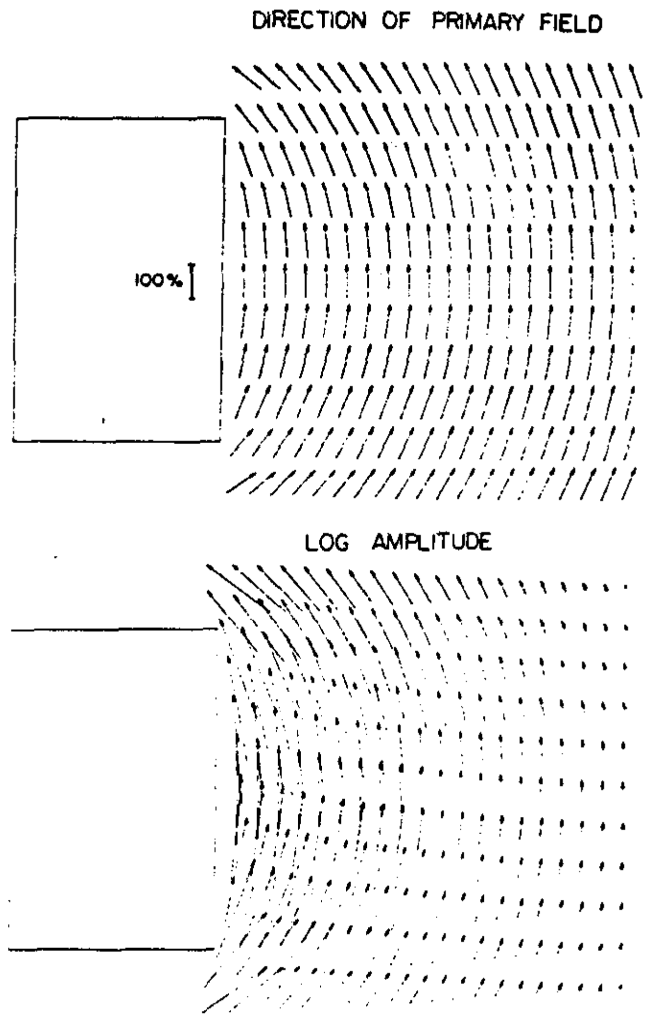

FIG. 6. Vector plots of late time electric field. (a) Direction information only. (b) Showing direction and intensity of the primary field.

The reference state for electric field data is usually described as a "laterally uniform, resistive half-space," rather than free space. By resistive is meant a case where all inductive transients have died out. The free-space electric field of a horizontal loop is horizontal, so introduction of a resistive half-space does not affect the field. However, for any other orientation of the transmitter loop or the earth-air interface, the free-space electric field will be directed across the interface and a strong distortion of the field will occur. Since the conductivity of air is virtually zero, the earth-air interface almost always has a high conductivity ratio, even if the earth is resistive in terms of induction. The charge which arises on the interface essentially doubles the vertical component of the E field in the air near the boundaries and annuls the vertical component in the ground. Thus the E field in the ground is (almost always) virtually horizontal. The nomenclature for the reference state serves to remind one that the earth-air interface has an important role in the physics of

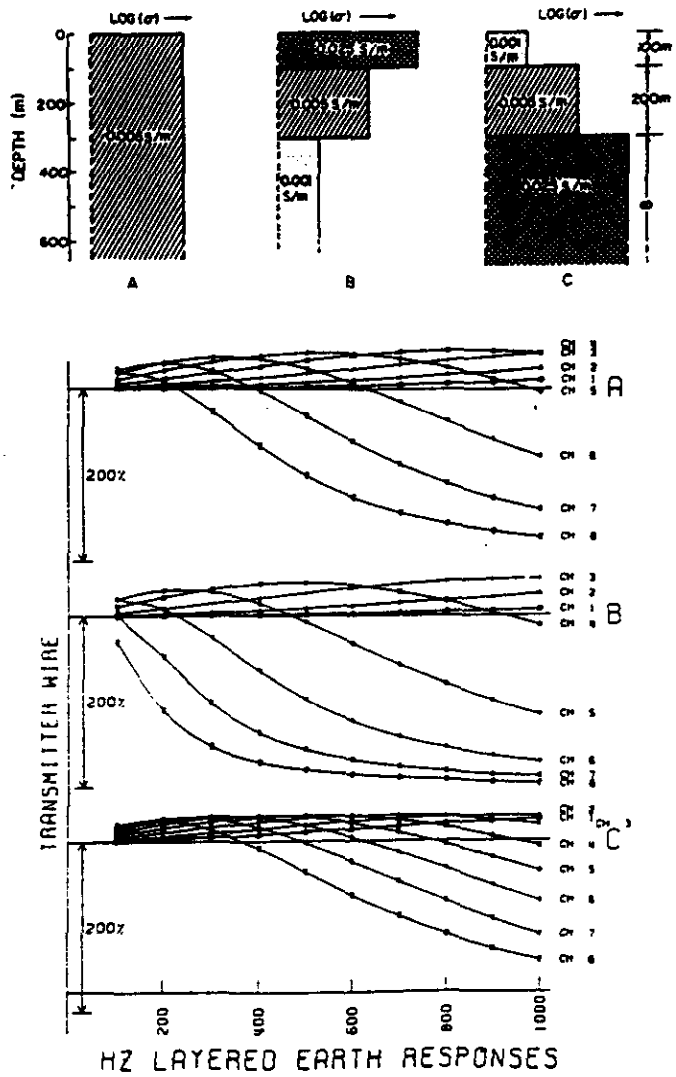

FIG. 7. UTEM layered earth response.

the electric field and is always assumed to be
lateral inhomogeneity or induction is permittec
model.

The electric field of a heterogeneous, condu
normally become constant at late time, as the
vanish. At the same time, the rate of change c
becomes constant. However, the observed lat
usually found to be different from the free-s
resistive half-space value, due to lateral inhor
earth's conductivity structure. The late-tim
around a loop greatly resembles what mig
gradient resistivity survey. The field weaves
around the more resistive areas and through th
tive ones. A vector display of the late-time E fi
ing reflection of the *relative* conductivity of va
ground. It is impractical to plot the unnorm
since the true field intensity falls off rapidly
distance from the loop. The lengths of the pl
therefore proportioned to the normalized fie
for profile plots. Vector plots of the free-space r
shown in Figure 6. Examples of field data
following section.

Errors caused by the presence of EM r
geometrical control are discussed for the magn
in Lamontagne (1975). For the electric (E) ca
measurement and sources of error are discuss
of Macnae (1981). As in the dc resistivity met
features can seriously distort local electric
conductivity contrasts such as overburden p
lithological changes can have quite large eff
tude of measured E fields.

INTERPRETATION

We shall describe briefly the responses fr
simple geologic models and how these can
interpreted.

Layered earth responses

The problem of EM induction in a layere
treated in the literature, particularly for frequ
tems (e.g., Wait, 1962). Time-domain cases
studied for some specific problems, for exam
sheet was solved by Maxwell (1891) and the
is discussed by Nabighian (1979). A general, l
tion for UTEM geometry and waveforms w
tagne (1975). Figure 7 shows three exampl
sponses for different layer conductivities. Fig
examples of a thin layer at different depths.
common characteristics of layered earth res
of the anomalous profiles are generally
broader at later times. The migration of cro
with positive lobes toward the loop and ne
from the loop, seems to indicate that th
system is migrating away from the loop.
behavior described by Nabighian (1979)
smoke ring.

If the UTEM system employed a magne
and a square current waveform in the tra
ring analogy would be exact, as the crossov

the position of the main current concentrations. However, the UTEM receiver is a coil which is sensitive only to dH/dt, and thus to the rate of change of induced and transmitter loop current. Thus the moving pattern of crossovers is actually indicating outward migration of *changes* in the induced current pattern. Toward the end of each half-cycle, the induced current system at any point in the survey area tends to a constant value, as indicated by the electric field measurements, but this steady current is invisible to the coil receiver.

When interpreting UTEM magnetic field data, it can often be simpler to think of the data in terms of the magnetometer receiver, square-wave transmitter current (MSW) analogy. Because the analogy is *exact* for a linear process like EM induction, there is no approximation in using it. It is very convenient to think of the field measurements of secondary signal at any delay time as describing the Biot-Savart magnetic field of a changing and decaying (analogous) induced current system. However, when electric field data are being analyzed and compared with magnetic field (dH/dt) data, it is necessary to revert to the true picture of the induced currents (or take a time derivative of the E data) to maintain a consistent relationship. UTEM magnetic field data are usually symbolized as H^s_{z1} (alphabetic subscript = component direction, superscript = p primary, s secondary, T total, numeric subscript = channel number) to accord with the magnetometer analogy; and in most discussions of simple induction, it is the time history of the *analogous* induced current which is described.

An important feature of layered earth H^s_z data is the early-time limit of continuously normalized H^s_{z1}/H^p_z data. If the ground is sufficiently conductive near the surface, the early-time secondary field data at points remote from the transmitter loop will approach -200 percent; i.e., one finds that the voltage in the receiver coil has had insufficient time to change from the steady value attained at the end of the previous half-cycle (Figure 2). This situation may be pictured in the magnetometer-square wave current analogy as an induced current system forming near the surface of the ground under the transmitter loop such as prevents the total (analogous) magnetic field from entering into the ground anywhere except very close to the transmitter wire. The -200 percent anomaly thus represents response at the inductive limit.

Finite thin plate in free space

A convenient modeling method for thin finite plate conductors in free space is the integral equation solution of Annan (1974). Annan computed the best set of polynomial eigenpotentials of order 4, and used these to represent the induced current flow in the plate as a sum of 15 "eigencurrents." The solution for the eigencurrents themselves is quite complicated, but needs only to be done once for a plate of given width to length ratio. After that, any induced current system can be described in terms of 15 coefficients in the eigenpotential summation. The secondary field at a receiver can then be simply computed in terms of these induced eigencurrents. One great advantage of Annan's method is that each eigencurrent has a frequency or time-domain response identical to a simple loop circuit. Thus the solution for a broad frequency range or many time windows is very easy to calculate. Routines for simple, interactive application of Annan's algorithms to a number of EM systems have been programmed by Dyck (Dyck et al., 1980).

Examples of type curves generated with Annan's solution may be found in Lodha (1977) and Lamontagne et al. (1980). Figure 9 shows the results of a set of computed UTEM type curves for the geometry shown in Figure 10. Also shown in Figure 10 is the geometry of the primary magnetic field, which controls the nature of induction in the plate. For the zero dip case, the primary field is mostly perpendicular to the plate. The induction in the plate tends to cancel this field at early times, leading to a negative H_z anomaly directly over the plate. Positive shoulders on each side show the secondary magnetic field of the "forward (analogous) current" near the front edge of the plate nearest the loop and the "reverse current" near the rear edge. The normalization scheme used in plotting this data is to divide the total secondary field by the calculated primary field at the measuring point. It has the undesirable effect of making asymmetric a secondary anomaly that is symmetric in terms of absolute amplitude by increasing the relative amplitude away from the loop. In fact, the absolute secondary amplitude of the positive shoulder near the loop is usually larger than the one on the side away from the loop. As the dip of the plate is increased, the positive shoulder moves away, and by the time a 30-degree dip is reached the reverse crossover is off the end of the plotted line. From dips of 30 to 135 degrees, the anomaly maintains a basic shape in the form of a simple crossover. The amplitude

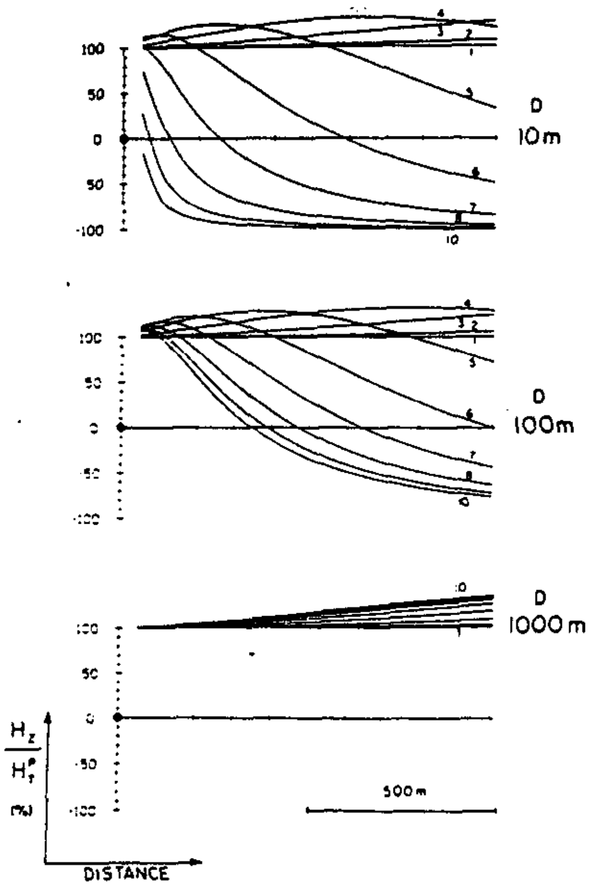

FIG. 8. Hz response of a thin horizontal sheet at various depths. The conductivity-thickness of the sheet is 2 S. The front of the transmitter loop is at the origin of coordinates.

does vary somewhat, however, being controlled by the primary field component normal to the plate which becomes a smaller and smaller fraction of the total field as the plate rotates from 30 to 150 degrees (Figure 10). The case at a dip of 150 degrees shows a very interesting behavior. The primary field can be seen to be *down* in the upper half of the plate and *up* in the lower half. The result of this is that the anomaly changes location and amplitude dramatically. For a very small plate, an anomaly could conceivably disappear completely. This phenomenon has been discussed by Bosschart (1964) for the Turam method. For a large planar conductor, howev always present since a curving primary field r where, except in the special case when a vert located directly under the center of a horizc loop. The 165-degree dip case of Figure 9 sho crossover on the edge of the conductor far frc normal crossover is very small, due in par induction at the near edge as shown in Figur large primary field used as a divisor for norma

The electric field anomaly generated by a p

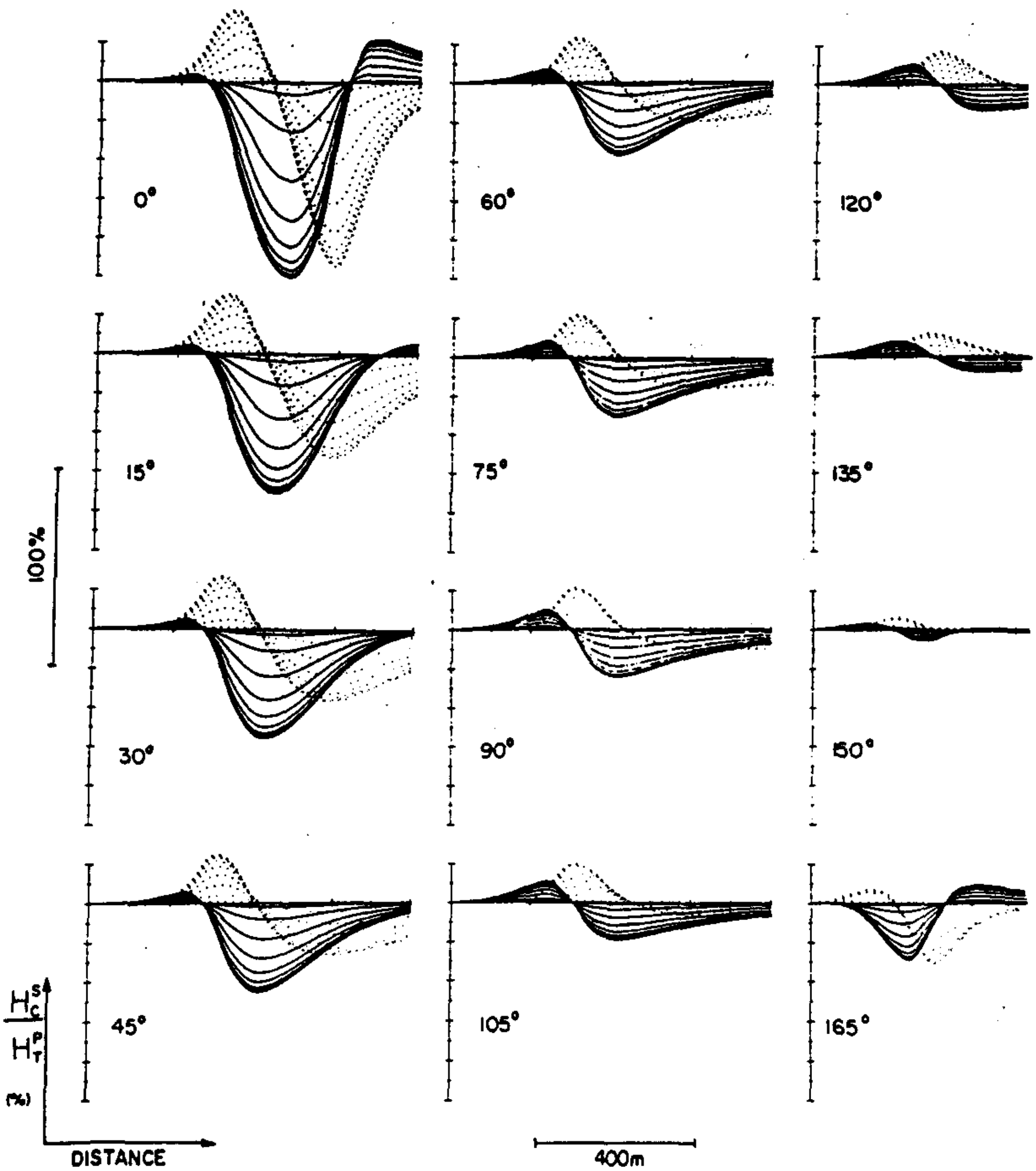

FIG. 9. UTEM H_x (solid) and H_z (dotted) profiles over a dipping plate (continuous normalization). (Geometry shc

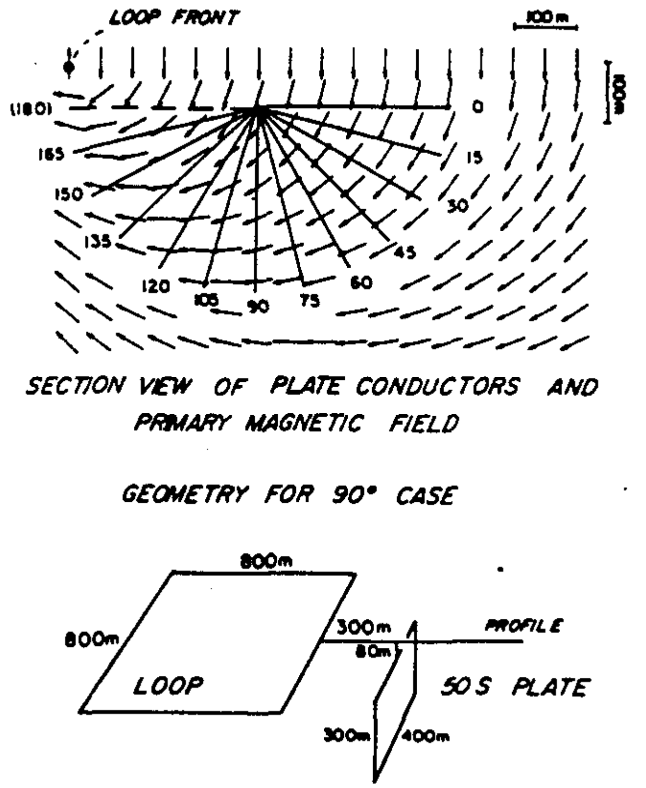

FIG. 10. Geometry and dimensions of the models shown in Figure 9. Also shown is the configuration of the primary field in the vicinity of the target conductor.

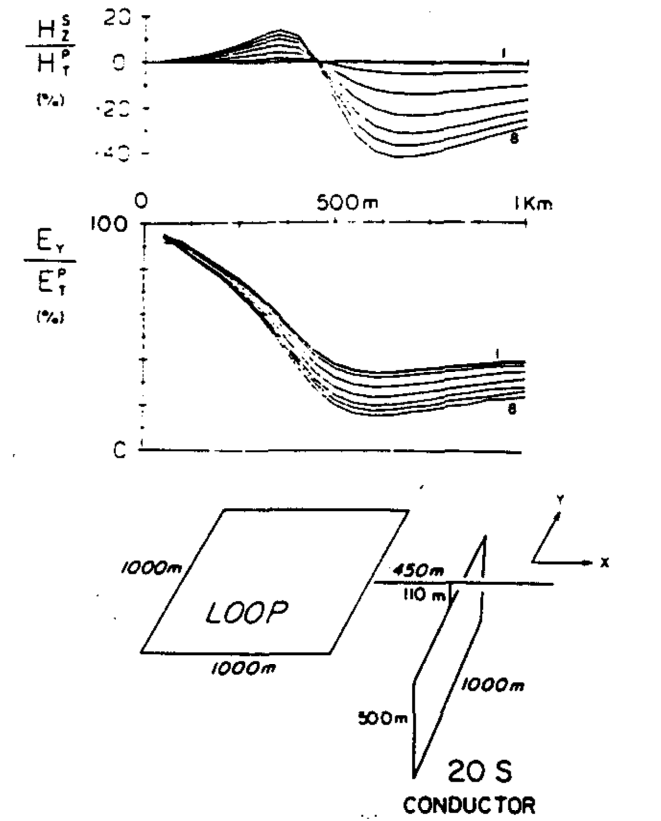

FIG. 11. Scale model UTEM secondary magnetic H_z^s and total electric E_y data over a vertical plate conductor.

a resistive half-space is caused by charge on the plate as well as eddy currents flowing in it, and is affected by the earth-air interface. Annan's algorithm does not determine the charge distribution, so analog scale modeling methods were employed to produce type profiles. Figure 11 shows an example for a vertical plate. The longitudinal electric field is greatly reduced over the body at all times (i.e., there is a strong reduction in the late time limit). The dynamic (time-varying) part of the anomaly has the same time variation as the magnetic field but has a different geometrical pattern. The electric field is highly vulnerable to distortion by any conductivity contrast and the intensity of the static, late-limit anomaly over a conductor may therefore be reduced by any stratification between the conductor and the surface.

Other simple anomaly shapes

A set of simple schematic models is shown in Figure 12, for each of which the main features of the vertical magnetic field are sketched. The set of sketches was derived from quantitative scale model experiments by Lamontagne (1975). For the simple models illustrated where the host rock is completely nonconducting, the general anomaly shape for one body remains quite constant for the whole time range. The changes in anomaly from one channel to another are mostly in the amplitude and smoothness of the anomalies.

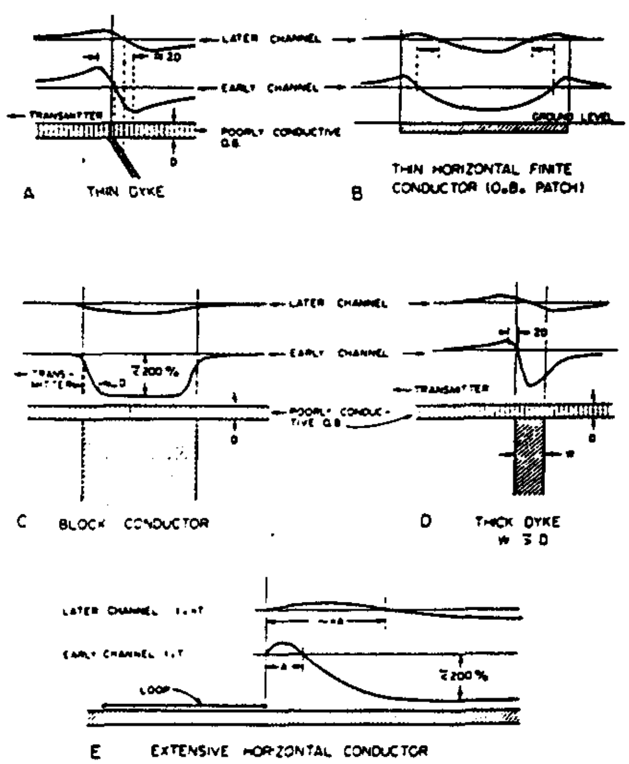

FIG. 12. The form of continuously normalized UTEM H_z^s anomalies over some simple shapes. All conductors are in free space.

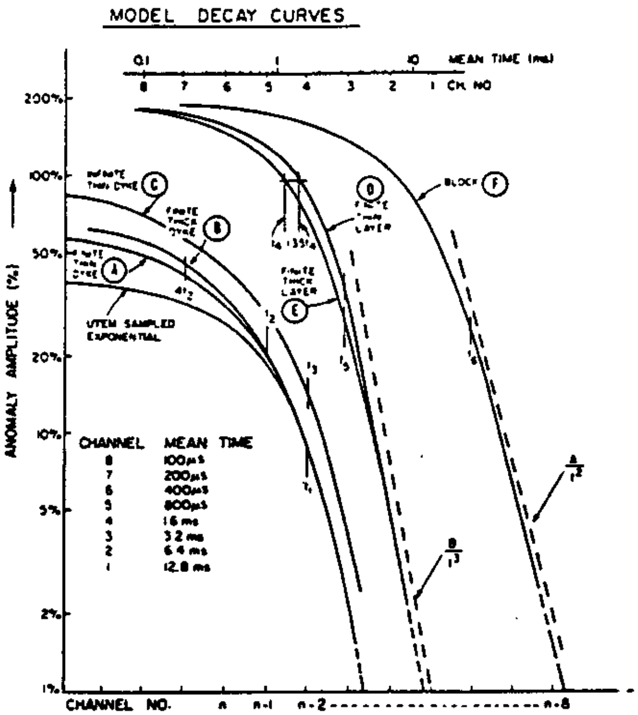

FIG. 13. The amplitude decay curves for the simple models of Figure 12. Mean sampling times are given for a base frequency of 30 Hz. The curve *UTEM sampled exponential* is a calculated function included for comparison. Lamontagne (1975) gives simple approximation formulas for interpreting target conductance from reference times $t_1, \ldots, t_6$ determined by translational curve matching.

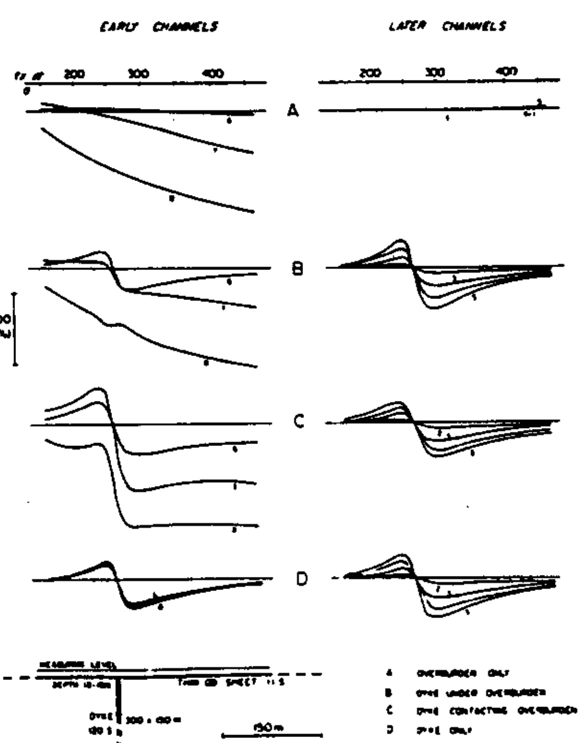

FIG. 14. Scale model UTEM H_z^s profiles over a conductive thin dike with overburden present.

Thin dike.—A conductive, steeply dippi
crossover shape similar to the plate mode
point where the anomaly changes sign indi
the top edge of the conductor. The anomali
to be broader and shifted slightly downdip
times. The inductive decay rate of the an
cussed in a following section.

Surface horizontal finite conductor.—A
ductor of limited dimensions (not extend
produces an anomaly consisting of a low
with large positive shoulders near its
become rounded at later times and migrat
of the conductor. Note that the thin horiz
Figure 9 has a fairly deep location and th
tion of the crossover points is less evident,

Shallow block conductor.—This type of c
negative anomaly over its top having an
200 percent at early times. An importar
block-like conductor is the absence of la
anomalies. The amplitude of the positive s
1/10 of the central negative, in contrast t
layer where the shoulders have amplitu
central negative. The sharpness of the cro
can be used as an indication of depth of
anomaly is called a top anomaly and is
current pattern flowing around the top of

Thick dike.—As might be expected, th
case between a block and a thin dike
tabular body is of the same order as its de
cases the response is a combination of cros
aly due to vertical and horizontal curre
anomaly being more evident on the early-
crossover anomaly on later-time chann
decay rates results from the different scal
flows, the top anomaly being controlled
dike, and the crossover by the depth exten

Extensive horizontal conductors.—All
stricted lateral extent give rise to locali
simply change amplitude with time (ap
sponse of a very large conductor such as
12e is included for comparison. In this c
rents are not confined and they migrate h

Time response of simple free-space mod
example decay plots of log anomaly amp
(channel number). The responses shown
UTEM sampled step responses that are
interpretation of actual field data when
lous response has effectively vanished at
ing by lateral translation of the graphs
cases, as previously discussed. The appl
decays to interpretation is discussed b
including the use of characteristic param
ductance. A significant point to note is t
finite bodies eventually exhibits exponen
whereas induction in infinite features t
inverse power law (Kaufman, 1978). There
and F, the very late portion of the de
show an exponential behavior if measur
tivity.

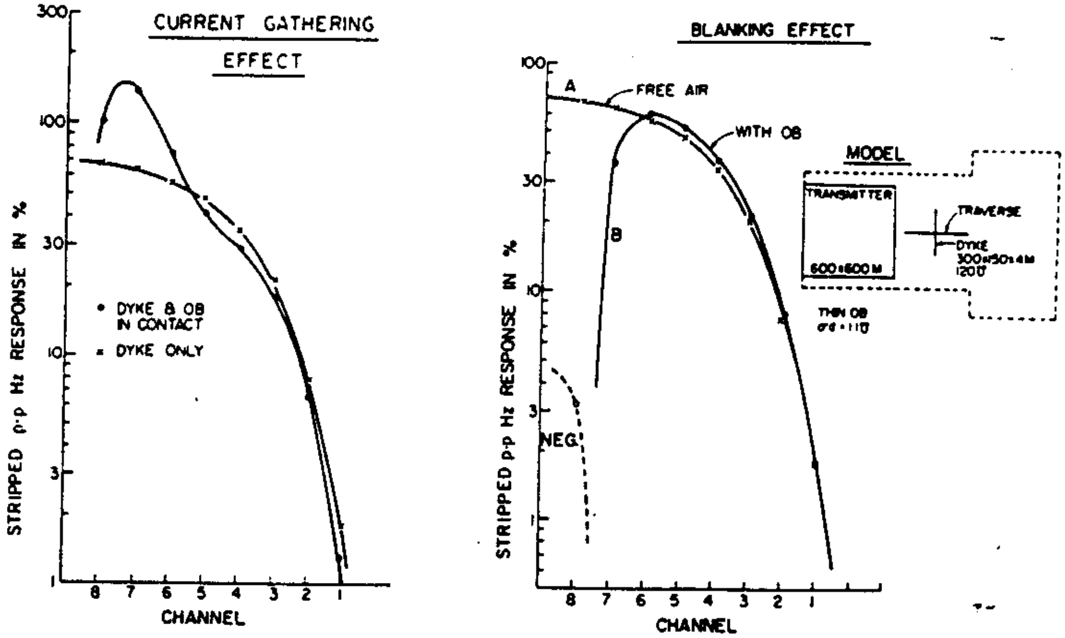

FIG. 15. Decay plots for the H_z^x anomalies of Figure 14.

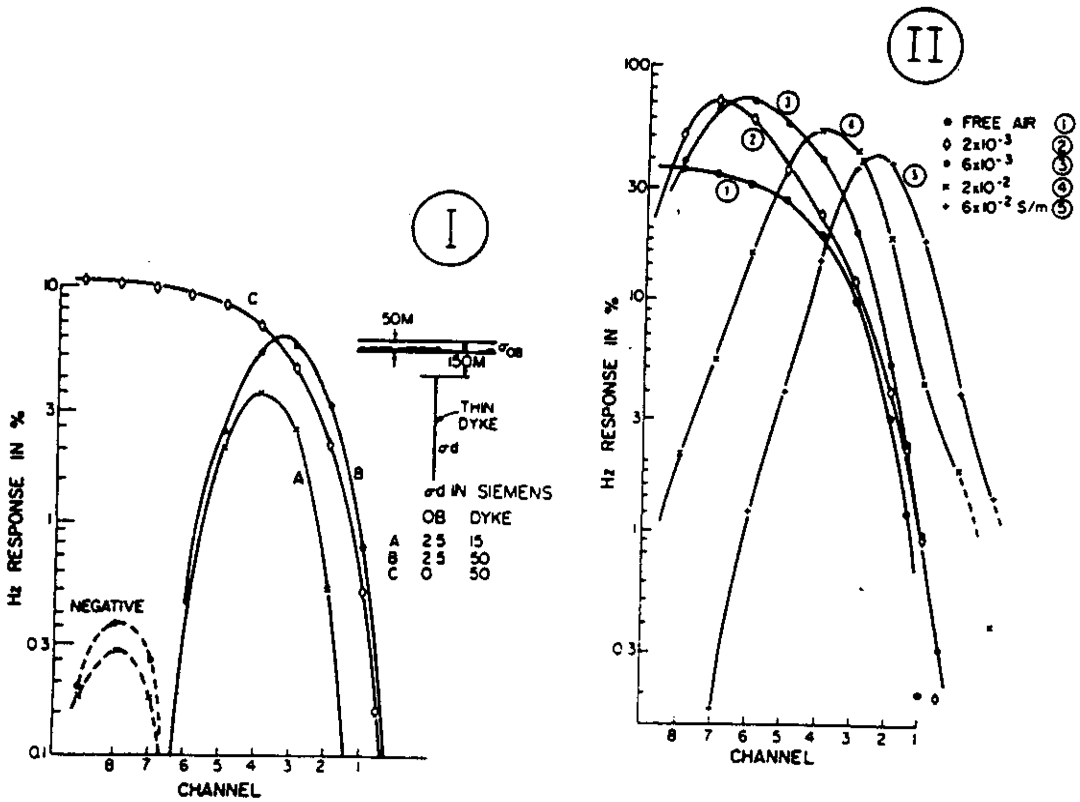

FIG. 16. Decay plots of H_z^x anomalies over a thin dike (I) under a conductive overburden and (II) in a conductive half-space.

Overburden effects

We will restrict the discussion of overburden and host-rock effects to the case of a simple vertical finite dike conductive target, which was studied by Lamontagne (1975) using a scale model. Conductive overburden cover can modify the responses of underlying conductors in two main ways. Let us consider a dike target whose response in free space is given in Figure 14d. If overburden is now placed over this target conductor, the resultant response (Figure 14b) is not just the sum of the overburden and dike response. At early times it can be seen that there is very little response from the dike. This is because the magnetic field (MSW analogy) has not yet penetrated the overburden, and it leads to the name "overburden blanking" for this characteristic. At later times (Ch 6-1), when we can see from Figure 14a that the field has completely penetrated the overburden layer, the dike and overburden response (14b) is virtually indistinguishable from that of the dike alone (14d). The time decay pattern of the peak-to-peak amplitude of the crossover is plotted in Figure 15. It clearly shows the blanking effect of the overburden at early times (right-hand figure). The minute negative response at earliest time is present only when the overburden extends under the loop, and i the complicated way in which the field fi.. target.

A second effect occurs when the dike is with the overburden. The results are quit where the dike was not in contact (Figu regionally induced (analogous) current flc has been "gathered" or "channeled" int higher conductivity. This accounts for crossover anomalies at early times. Becaus the dike greatly exceeds that of the overb current gathering is virtually independe: extent. The gathering effect at early times tor" remaining attached to the overburd dike was removed was found to be over 8(complete dike. At later times, when the (a in the overburden has migrated away (i.e.. current is no longer time-varying), the resp identical to that of the dike alone. Tl response is plotted on Figure 15, and i hancement at early times a slight attenuat: intermediate times can be seen.

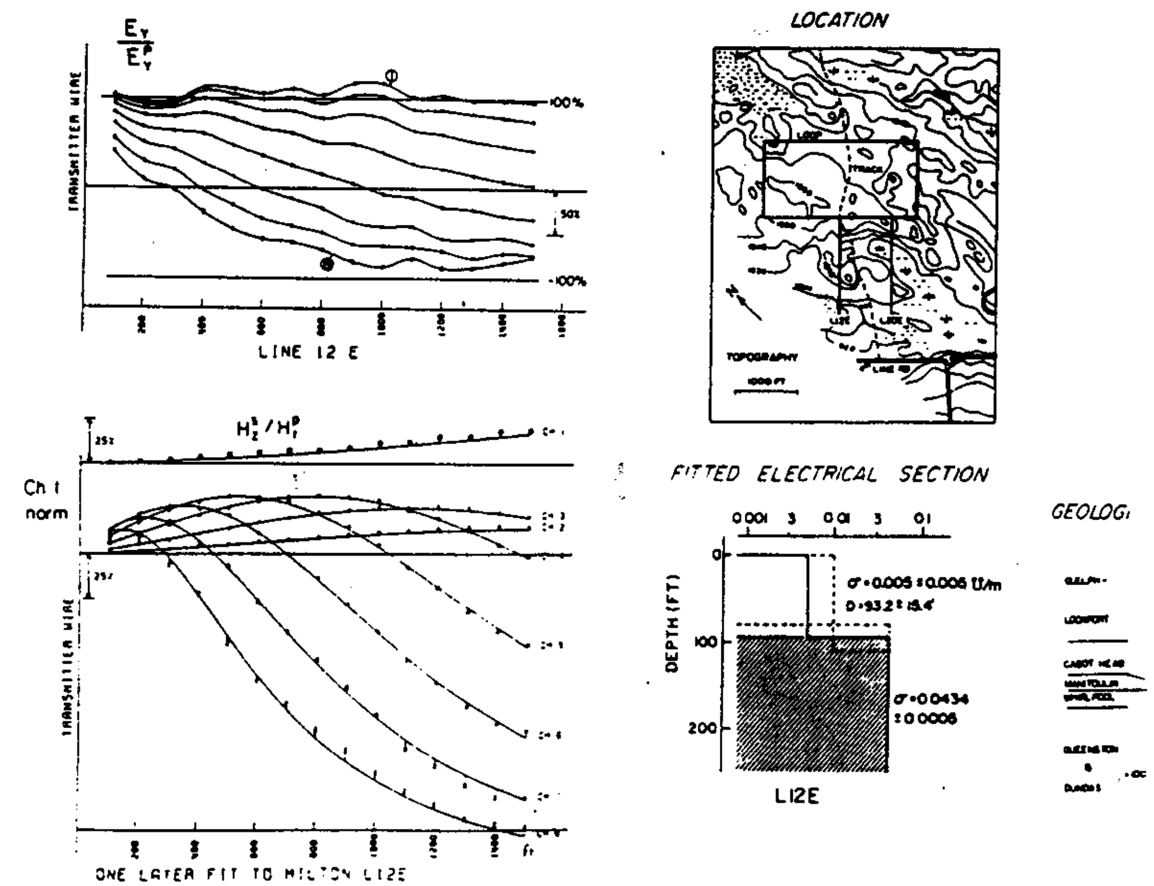

FIG. 17. Field example of E_y and H_z^s data from a well-stratified earth. The electrical section was obtained fr data. The curves on the H_z^s graph are the theoretical model; the points are the field data. The bottom axis is geologic section is from nearby gas drilling exploration.

where and much less on average. It is mostly humus or thin glacial soil. Surface water is fresh, and likely quite resistive (> 100 Ωm). Figure 17 shows some of the data with a layer and half-space model fitted to it by iterative minimization of squared error. Also shown is a stratigraphic section from a well a few kilometers distant. The dolomite layer is too resistive for its conductivity to be determined by data whose earliest time sample is at 100 μs. (The survey was done with UTEM I.) At first glance, the data look just like that for any conductive earth, as the early-time data at the end of profiles have the usual strong negative anomaly, and there is a regular outward progression of crossovers as time progresses (decreasing channel number). However, the resistive surface layer does reveal itself in the limited approach of the early time curves to −200 percent anomaly. The convergence of E_y at late time to 100 percent of the primary field confirms the excellent lateral homogeneity of the site.

Thomas Township, Northern Ontario

This site has become an interesting te methods, and a new grid has been cut a hawk Lake geophysical test range. It is a has many of the geometrical and electric massive sulfide body. It is covered by 83 conductive overburden. It was found o. EM and has been intersected by two boreh

A UTEM II survey with 30 Hz base f out on 6 lines of length 2200 ft and transmitter loops to the north and south o shows a profile across the middle of the con

At 50 μs (Ch 9), the regionally induced only 500 ft from the loop. The field ha overburden at the target site. From 100 μs 8-6), a crossover response is observed over

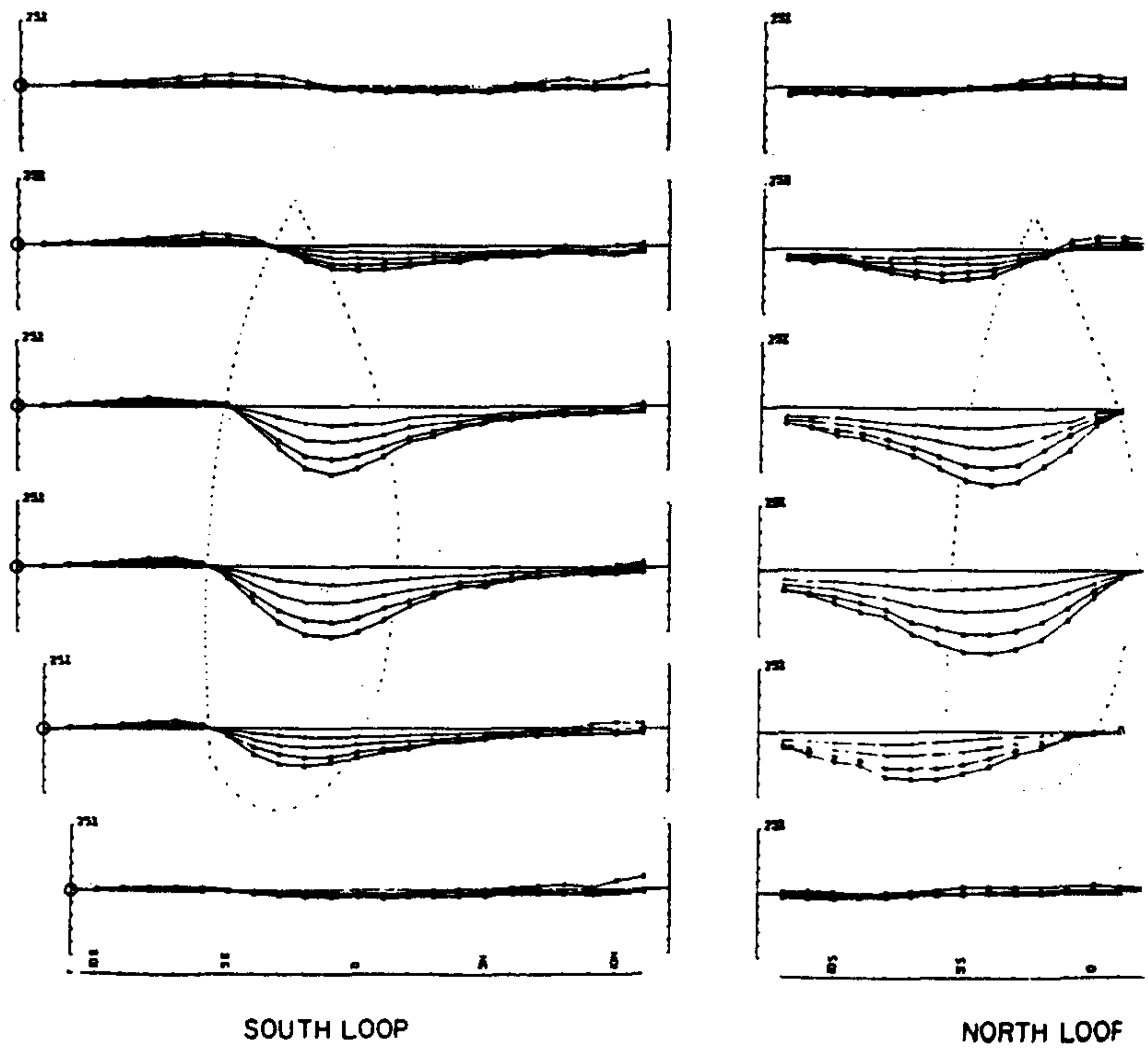

FIG. 19. Later time H_z^s profiles (Ch 5-2) outline the perimeter of the conductor.

Host rock effects

Figure 16 II shows the time variation in response of a 60 S vertical plate located in a half-space. The results were calculated by Lamontagne (1975) by Fourier transformation of the frequency-domain numerical modeling of Lajoie and West (1976). At early times the response is reduced from the free-air response: this corresponds to blanking by the conductive region above the target. At later times the response is enhanced indicating that the regional (analogous) current in the host rock is being gathered into the plate at these times. For poorly conducting host rock, the response at late times is close enough to the free-space response that simple interpretation of the target using a plate in free-space model is valid. For the higher host conductivities (case 4, 5) this is no longer the case.

FIELD RESULTS

Milton, Ontario

This area was surveyed to demonstrate what data from a conductive, well-stratified earth looks like. The area is one where 650 m of flat-lying Paleozoic sediments overlie the Precambrian basement. The predominant member of the stratigraphy is a uniform and thick sequence of shale. Other beds are mostly resistive calcareous and sandstone formations. The survey area is covered by a mixed forest and marshy streams, with occasional outcrops. The top of the bedrock is a dolomite formation which is everywhere more than 20 m thick. Topographic relief is minor (< 10 m), with occasional rough spots near outcrop. Overburden is probably less than 10 m every-

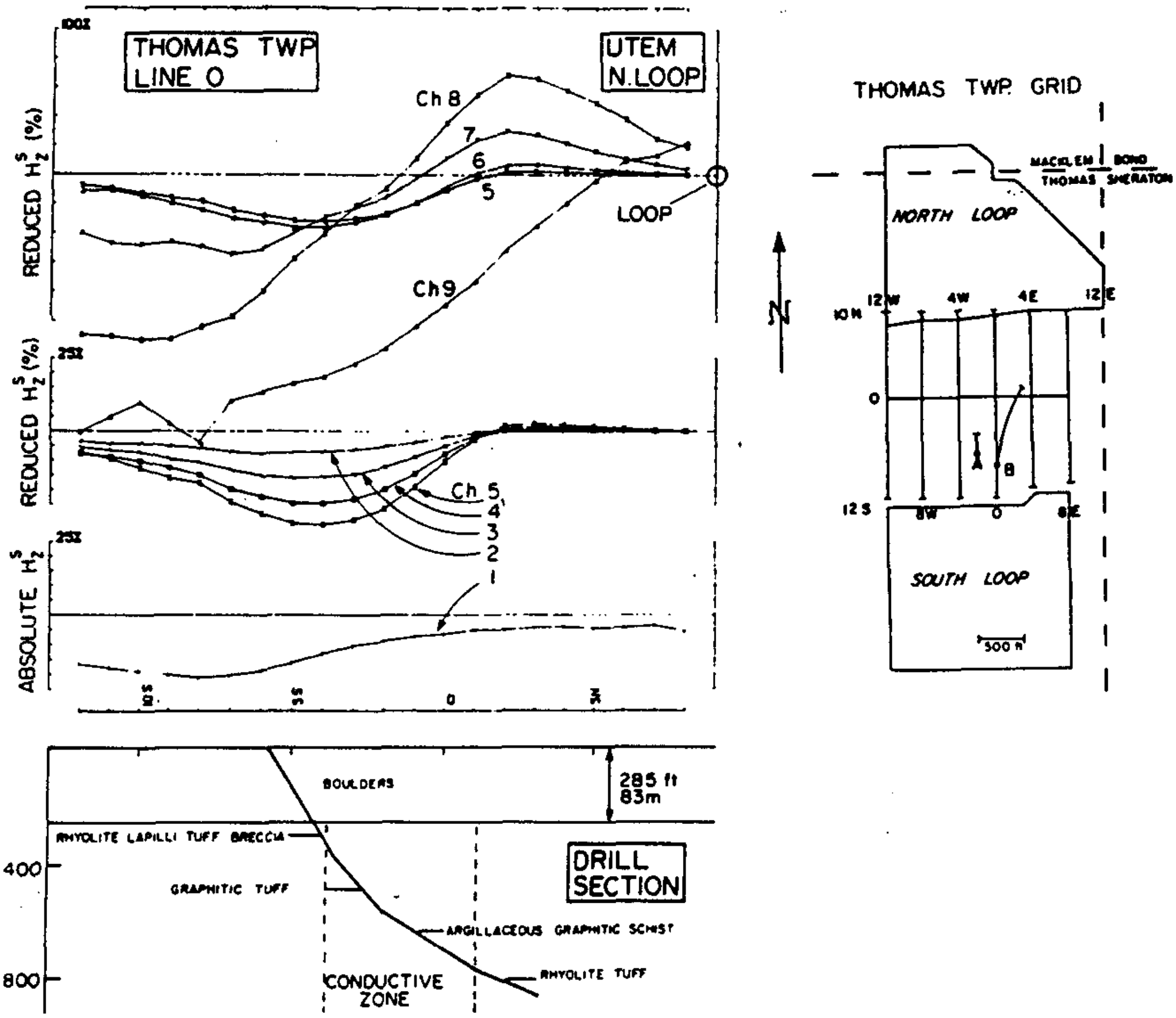

FIG. 18. A profile of H_z^s data from the north transmitter loop across the Thomas Twp test site. A map of the survey is included (different scale).

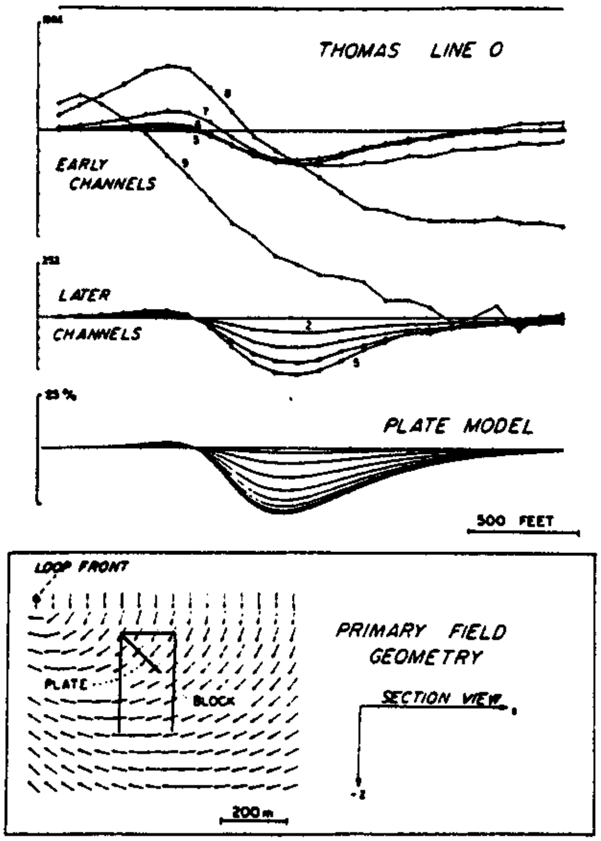

FIG. 20. Comparison of H_z^s data from the south transmitter loop with a free-space plate model. The configuration of the primary field is also shown.

500 μs the response changes to an asymmetric negative anomaly which decays much more slowly than the crossover response. The early-time crossover response is a current gathering or channeling anomaly where the (analogous) anomalous current flows along the length of the zone, while the longer time constant response is a local induction anomaly, where induced currents flow in a vortex within the target conductor.

Figure 19 shows a map of all the late-time profiles. They clearly delineate the edge of the target body. Figure 20 shows how a rectangular plate model can be found which models the observed results from one transmitter loop quite accurately, but which has to be rotated in order to match the results from the other loop. The late-time induced (analogous) current system in the actual conductor appears to be a tightly defined normal current in the front upper (near-loop) edge of the conductor with a more diffuse, return current deep in the rear of the body. A survey with the transmitter loop located on the other side of the body was similarly fitted by a plate dipping away from that loop, indicating the conductor to be a thick zone in which currents can flow in a variety of directions.

Electric fields were measured at the Thomas site. The late time vector map is shown in Figure 21, along with a rough numerical model. The conductive zone shows very clearly, although its edge is ill defined. Figure 22 shows a profile of the longitudinal component of electric field over the body. The field intensity is almost constant from channel 6 onward, and the main feature of the response is the aforementioned broad reduction in the field strength over the conductor. It is helpful, when looking at E field profiles, to imagine a plot on the same axes of the negative of the observed channel 1 response. This is the value the field starts from at the half-cycle transition. Even as early as 50 μs (Ch 9), the electric field has made most of its polarity reversal. In fact, between the loop to the target body it has overshot, while from the target body outwards it is changing relatively slowly. The time changes in E are actually very similar to those in H. There are two dominant decay times, a short one corresponding to the overburden and the channeling target response (Ch 8-6) and a long one corresponding to the local induction response (Ch 5-1). Also, these two E-field responses have a different geometrical form corresponding with the different forms of the magnetic anomalies. The scaled up version of the E data in Figure 22 shows the slowly decaying anomaly. Considerable noise is apparent in the data at this magnification.

Bedrock conductor beneath overburden

Figure 23 shows the measured secondary H_z fields at a site in Australia. The slow outward migration of the early-time channels and the −200 percent early-time limit away from the transmitter loop are characteristics of the response of a near-surface conductive weathered layer. This layer has a total conductance of about 4 S.

Around station 210W a more local superimposed crossover anomaly is evident which is fixed in location. This feature is evident over a great strike length. When the visually estimated overburden response is stripped from the anomaly and the peak-to-peak crossover response is plotted on a decay plot (Figure 26), the characteristics of early time blanking, time delay, and enhancement are clearly displayed. Corresponding to the model data of Figure 16, the early time blanking attenuates the local anomaly as the (analogous) magnetic field has not had time to penetrate the weathered layer. At intermediate times (Ch 5, 4) the response lies above a fitted free-space, half-plane conductor decay curve. This is partly an amplitude enhancement from current gathering and partly due to a small delay in time while the (analogous) magnetic field penetrates the near-surface conductor. It is not clear whether any of the L400S response can be identified as due to local induction. Nevertheless, the plotted induction curve for a half-plane in free space serves as a useful reference and establishes an upper limit on the conductance of the feature (7S in this case).

On two survey lines about 1 km away, the same local feature is observed, but the response has changed to one of longer time constant. As shown in Figure 24, a clear response persists through channels 2 and 1. These data are replotted with "point normalization" on Figure 25 to show the absolute secondary field. Absolute normalization preserves the true anomaly shape, but has the disadvantage of scaling up strongly those anomalies which lie near the transmitter. The stripped peak-to-peak response is plotted in decay form in Figure 26 and clearly shows the difference in time constant at the two locations.

The increase in time constant seen on line 600N is very significant, since little change is seen in the background response and only a lesser change in the blanking time. It indicates that the L600N late-time response is due to local induc-

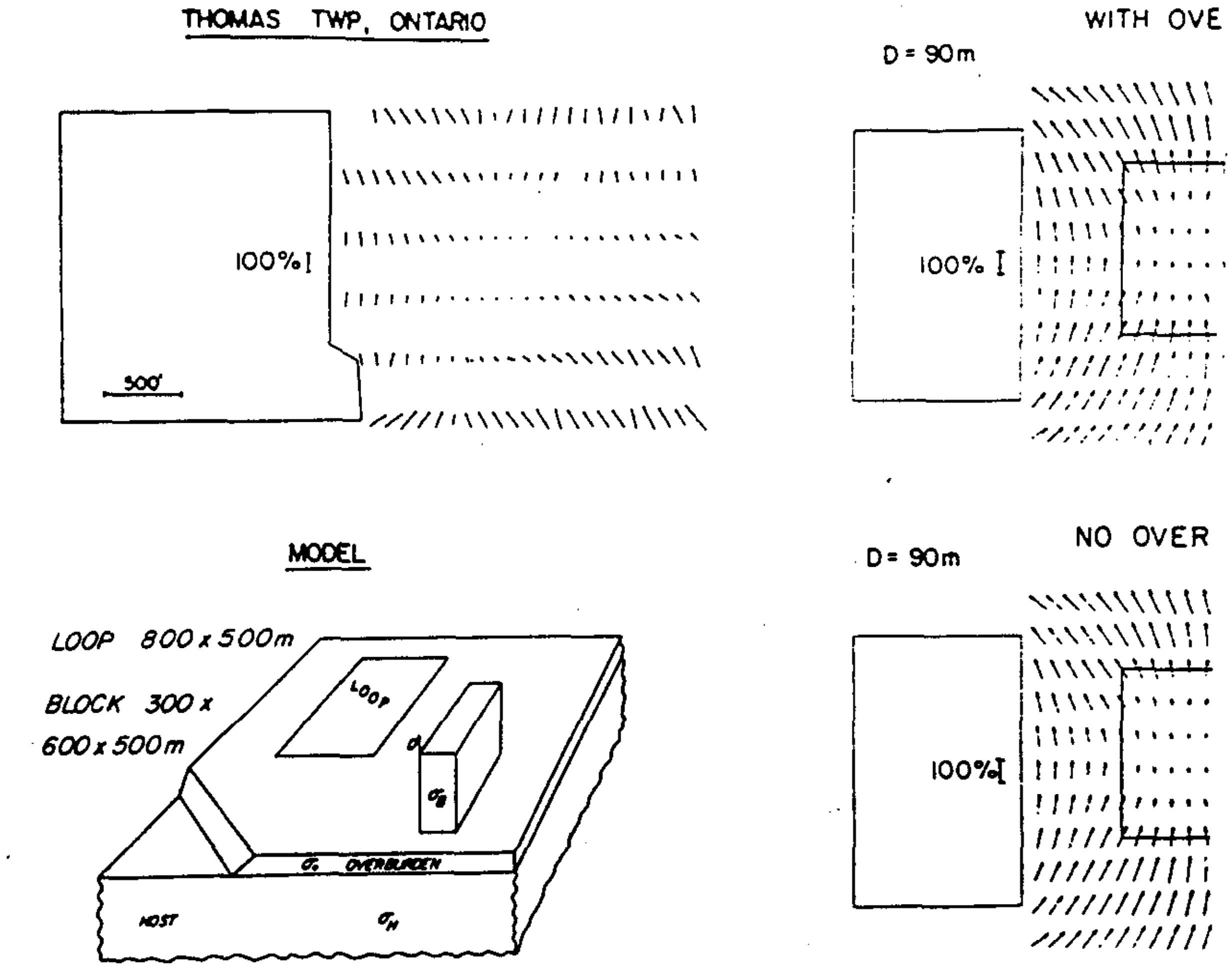

FIG. 21. Vector map of the late-time E field at Thomas Twp. A block model is included for comparison. The exa
where $\sigma_B \gg \sigma_O \gg \sigma_H \gg \sigma_{AIR}$.

tion. Model fitting of the decay, taking into account the limited strike extent of the long time constant response, leads to an interpretation of this feature as a local thickening of the half-plane conductor. The local conductance needed to produce the longer time constant is 120 S in contrast to the 7 S maximum of the rest of the bedrock conductor.

Drilling indicated that the extensive conductor was a 50 m thick calc-silicate zone containing both carbonates and sulfide lenses within a talc-sericite host. The locally more conductive part consisted chiefly of nearly massive noneconomic sulfides.

CONCLUSIONS

Experience with UTEM demonstrates that a wideband, time-domain EM system which measures the step response of the ground is electronically feasible and practical. Considerable field and modeling experience has shown that it is simple to use the amplitude information from such a system to aid significantly in interpretation. In our opinion the step response has a significant advantage over the impulse resp
and interpretation of good conductors in the
ones. Electric field data measured with the s
independent information about lateral cond
and may be a useful aid in interpretation.

ACKNOWLEDGMENTS

Development of the UTEM system and i
capability was funded from a number of sou
developed with support from the National Re
Canada. UTEM II instrumentation was supp
Ltd., *Texasgulf Inc.*, and *Cominco Ltd.*, wit
studies funded by a consortium of compa
Aquitaine, Asarco, Cominco, Geoterrex, Gu
Newmont, Noranda, Phelps Dodge, Selco,
sources, Texasgulf, and Umex. Graduate stu
tagne, G. Lodha, J. Macnae, and M. Vallée, w
project received stipendary and computing

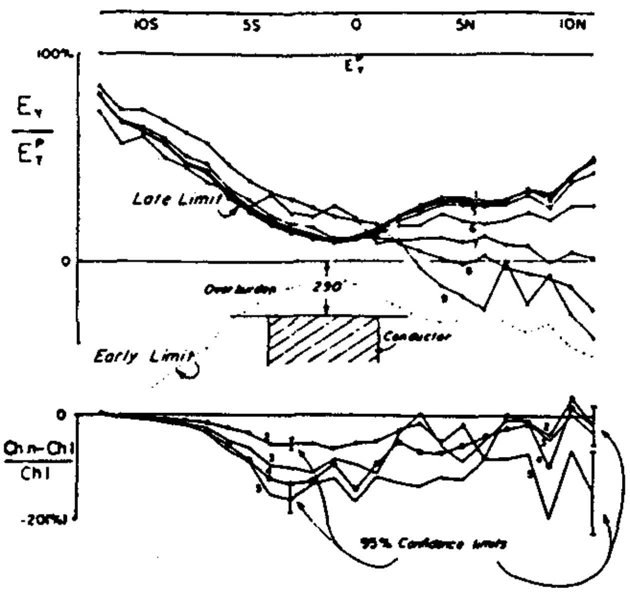

FIG. 22. Thomas Twp E_y data for line 0 from the south transmitter loop. The expanded scale data on the lower axes show that a very weak dynamic E field anomaly is associated with the main H_z^s late time response (Ch 5-1).

Natural Sciences and Engineering Research Council of Canada and the University of Toronto. All this assistance is gratefully acknowledged. We also thank an anonymous reviewer for a very careful, helpful review.

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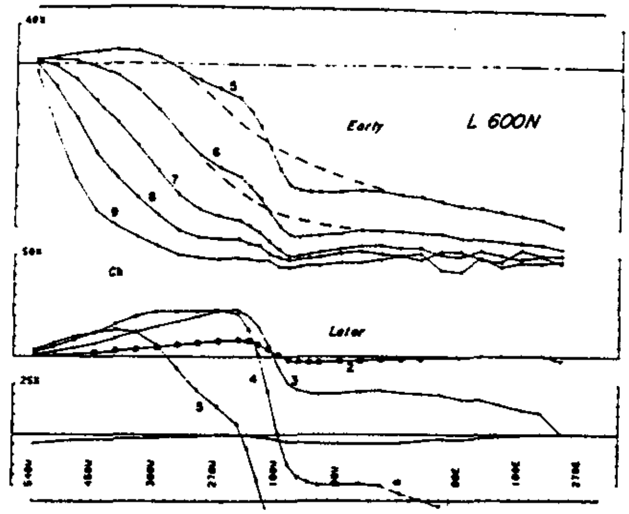

FIG. 24. H_z^s data on line 600N 1 km away from the previous figure showing a time decay of the local anomaly lasting to much later times. Remeasurement of the profile at 13 Hz gave virtually identical profiles (shifted one channel) with no visible Ch 1 anomaly.

Bosschart, R. A., 1964, Analytical interpretation of fixed source electromagnetic data: Doctoral thesis, Univ. of Delft.
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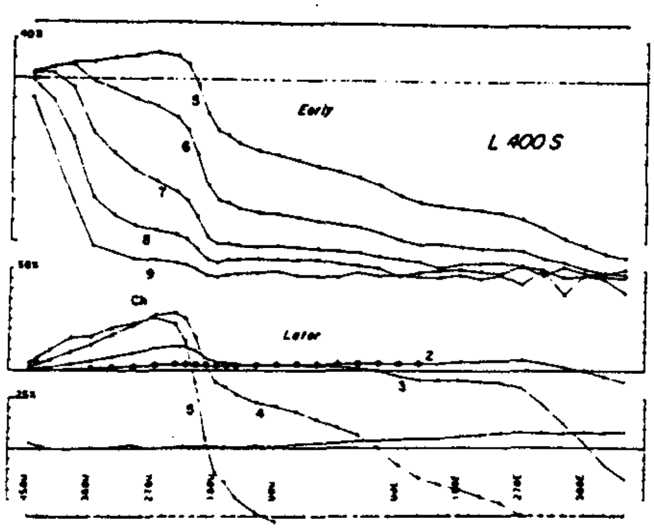

FIG. 23. H_z^s data from New South Wales showing the migrating crossovers of the overburden near the loop and a local anomaly around station 210 W. (Survey frequency 26 Hz.)

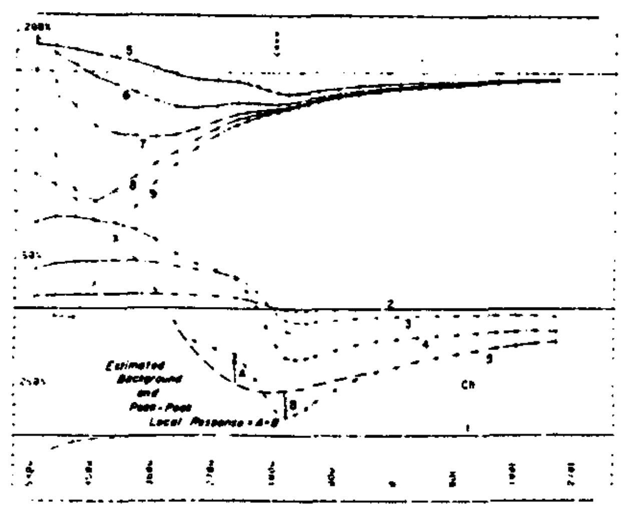

FIG. 25. Point normalized H_z^s from line 600N. The local secondary fields have been normalized to the constant primary field at station 210W and show how stripped peak-to-peak local anomaly amplitude is estimated.

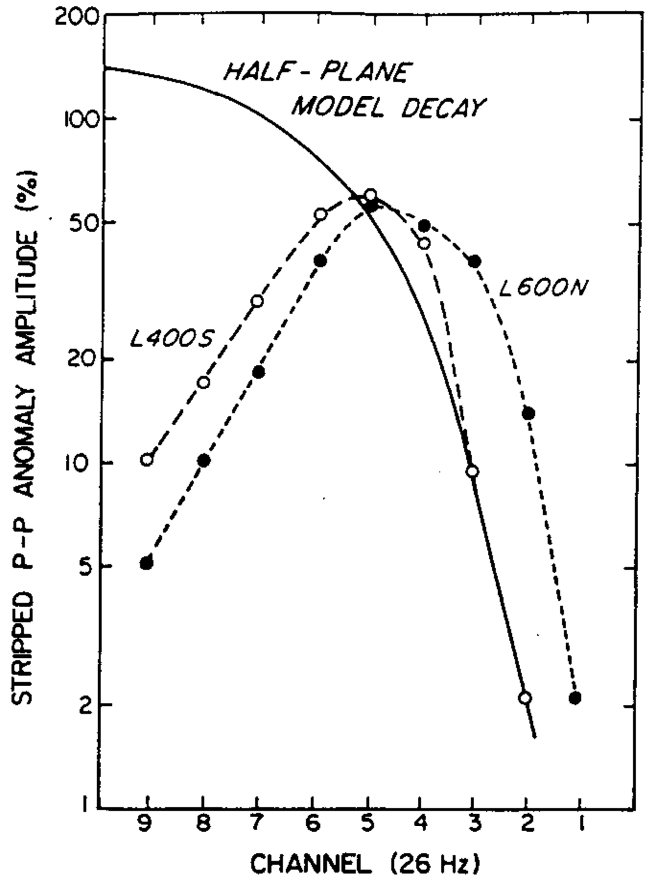

FIG. 26. Amplitude decay plot of stripped anomaly on lines 400S and 600N of the New South Wales survey.

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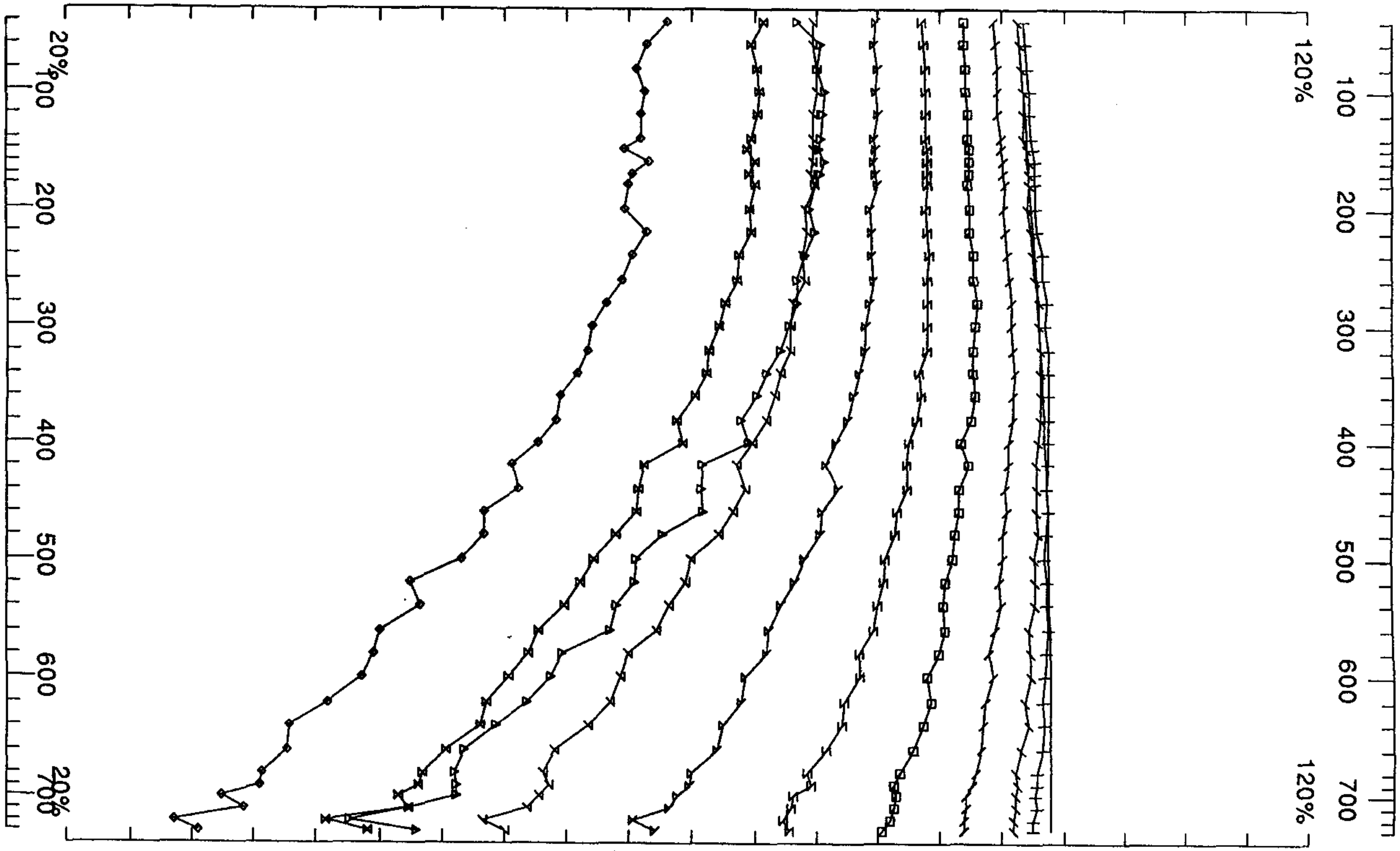
APPENDIX V

Data Sections



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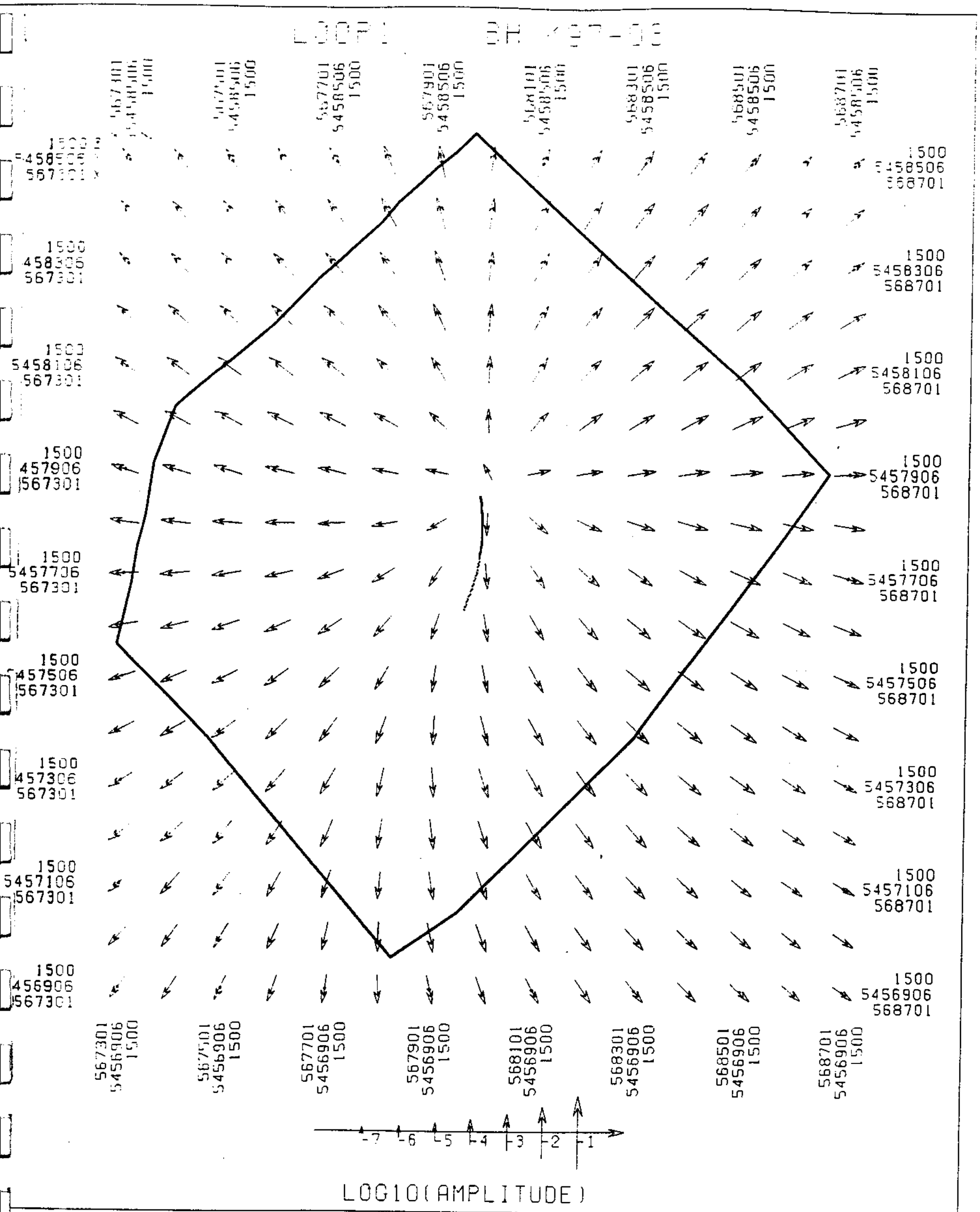
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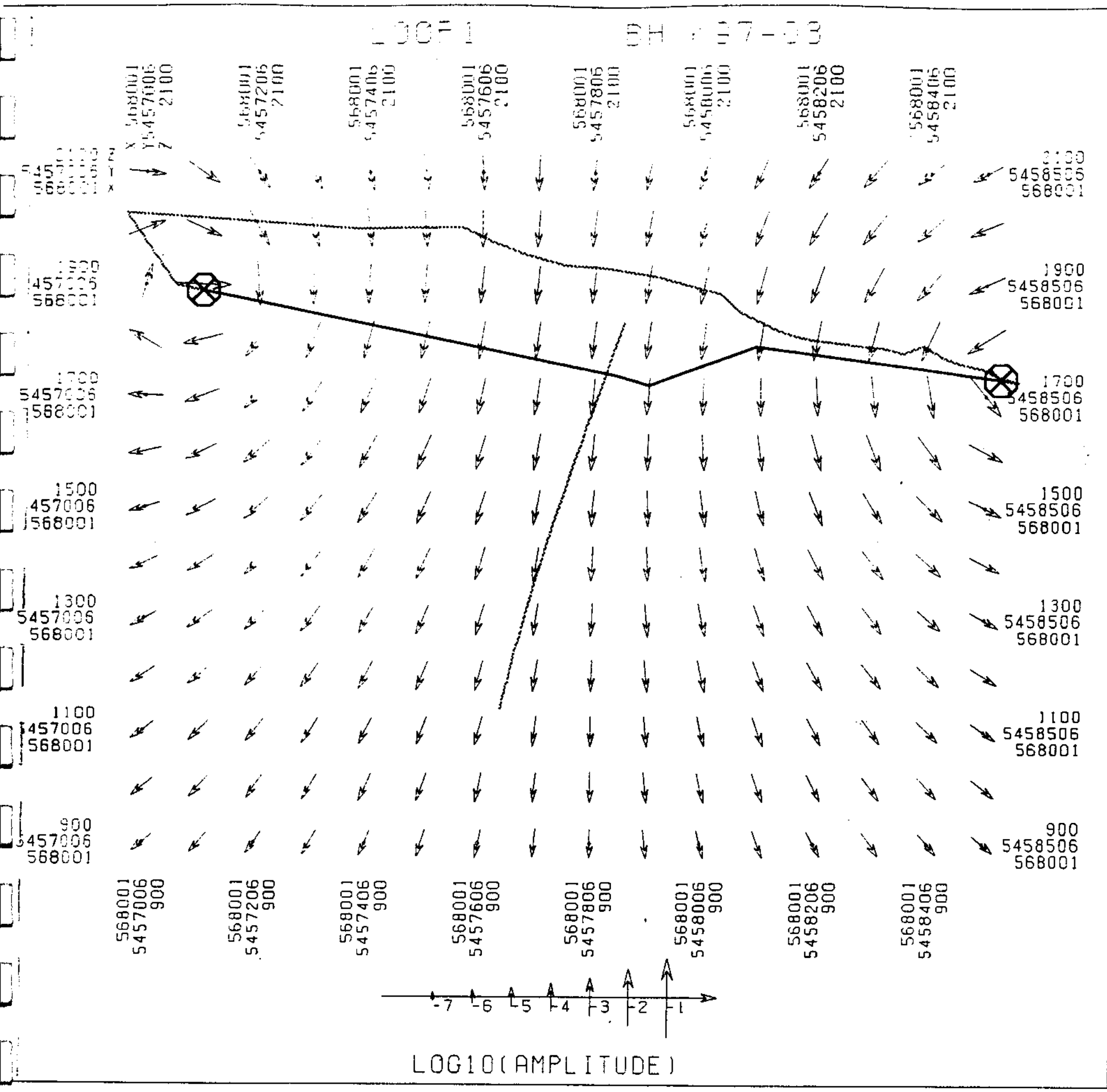

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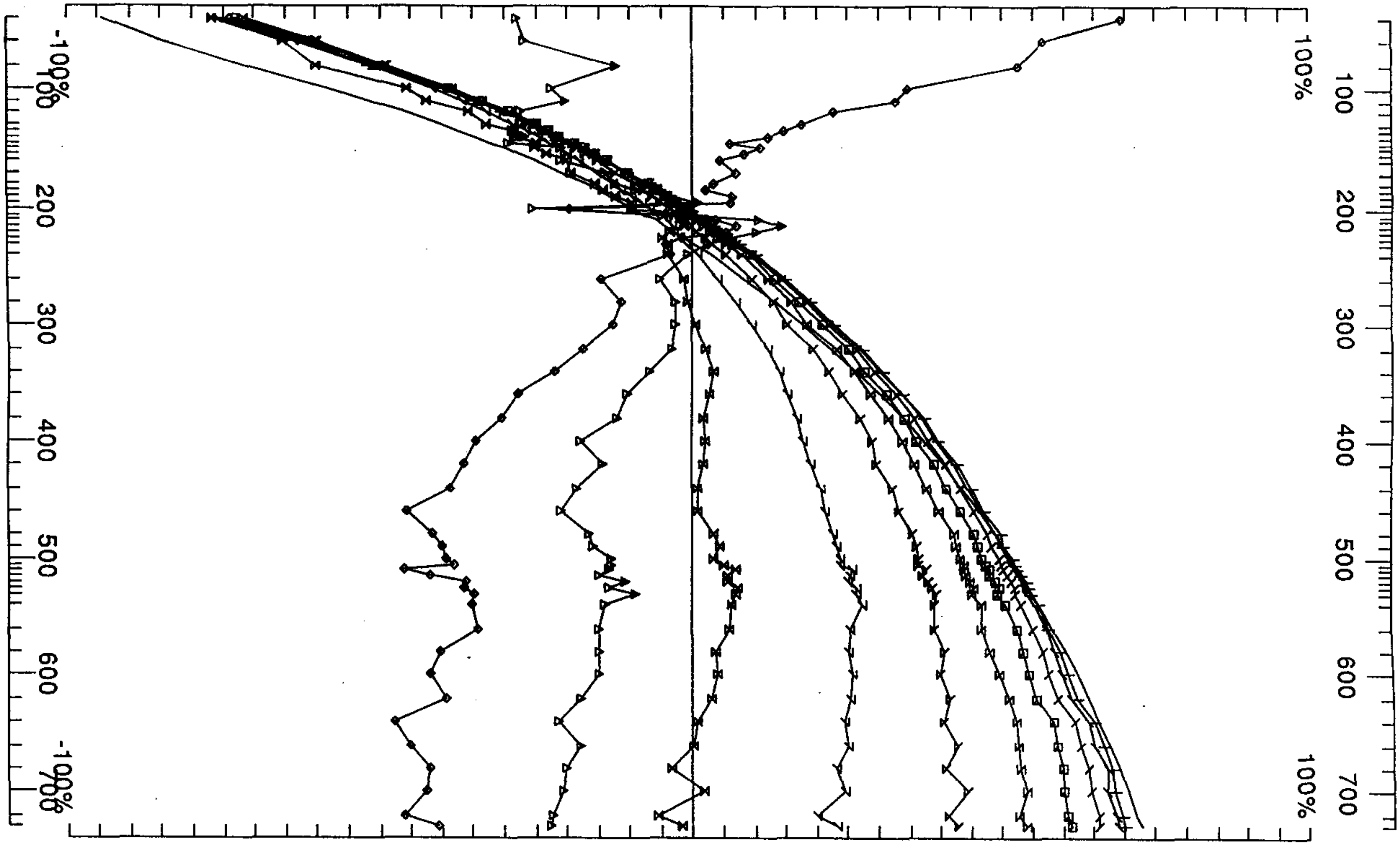

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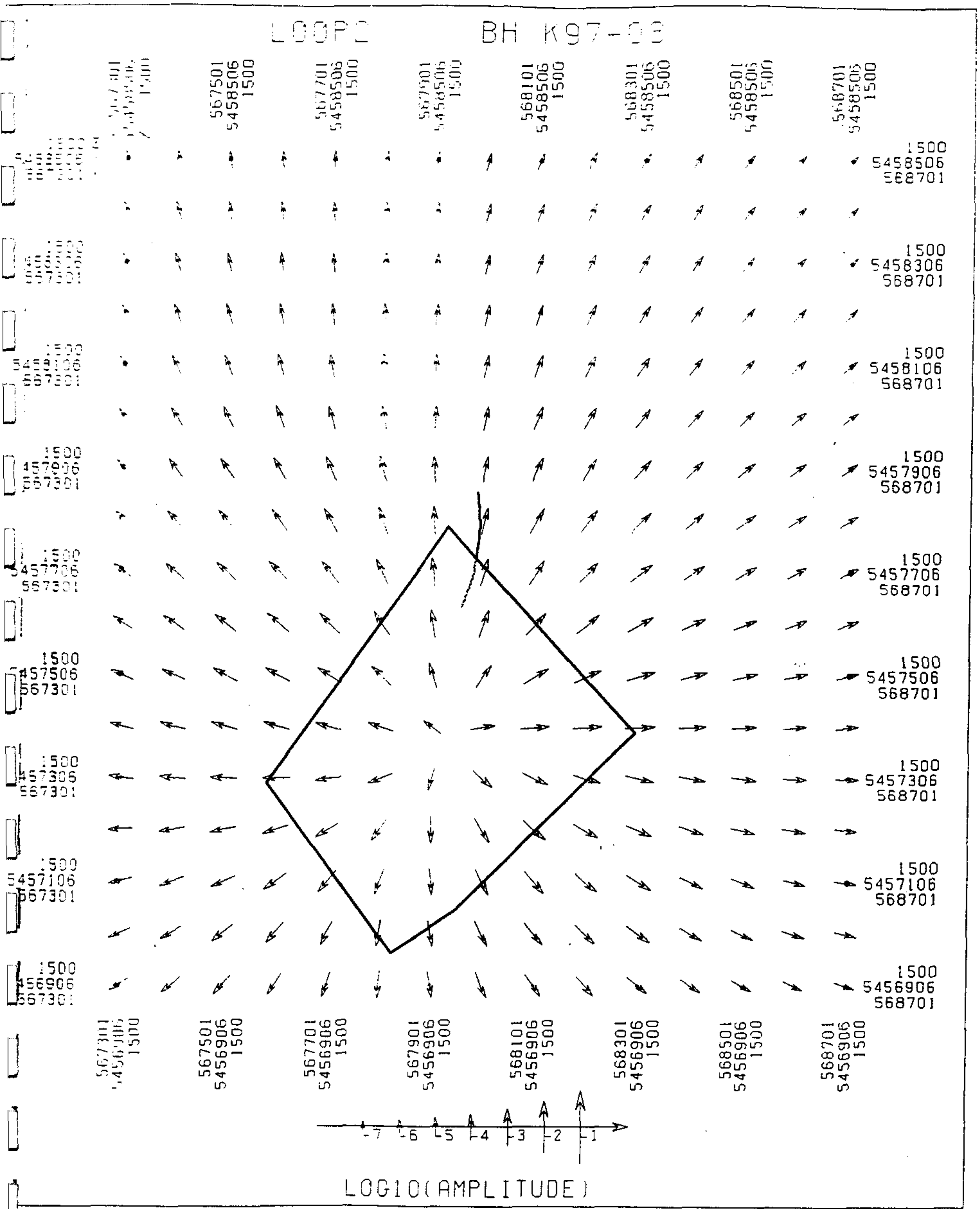
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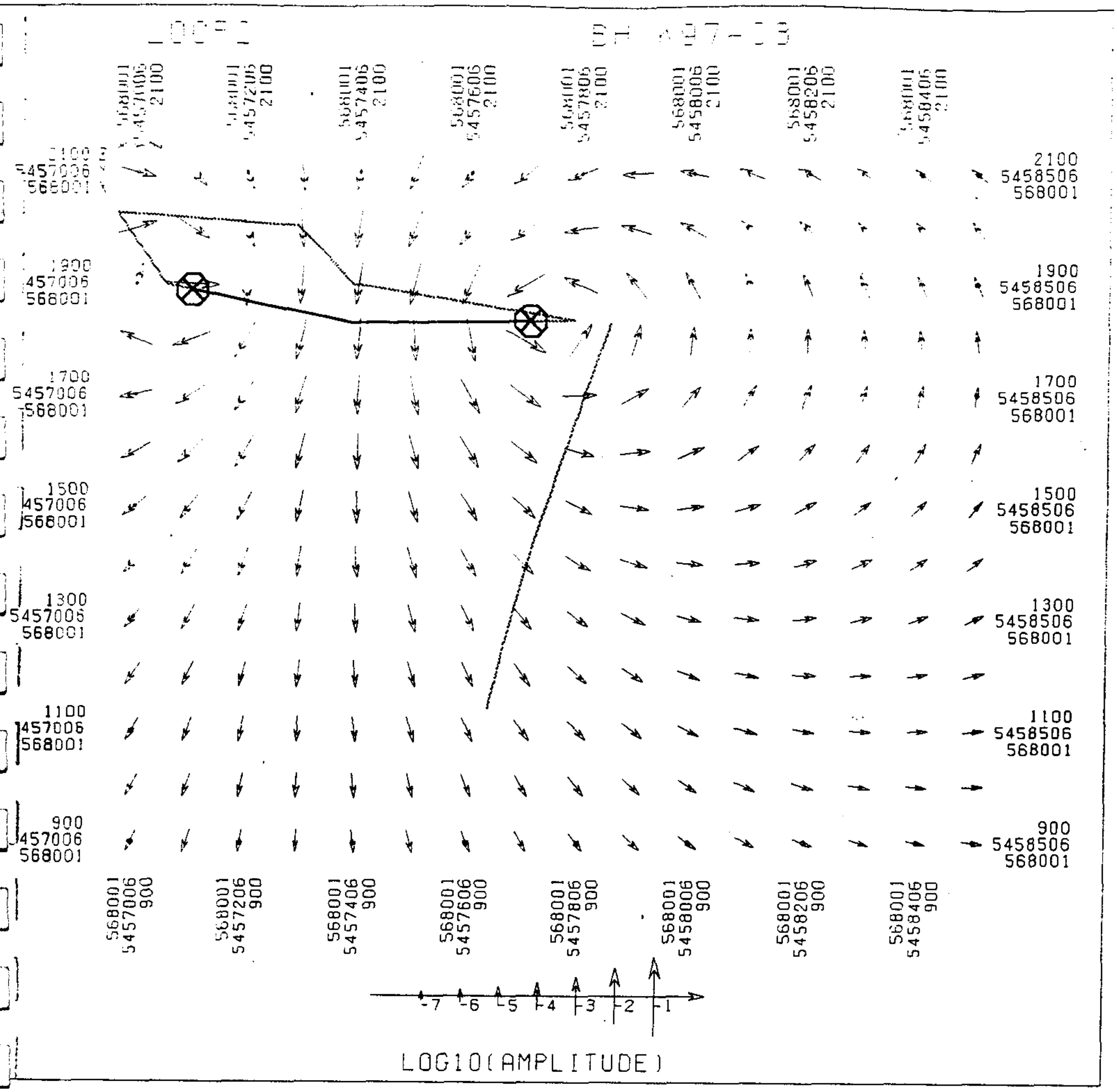
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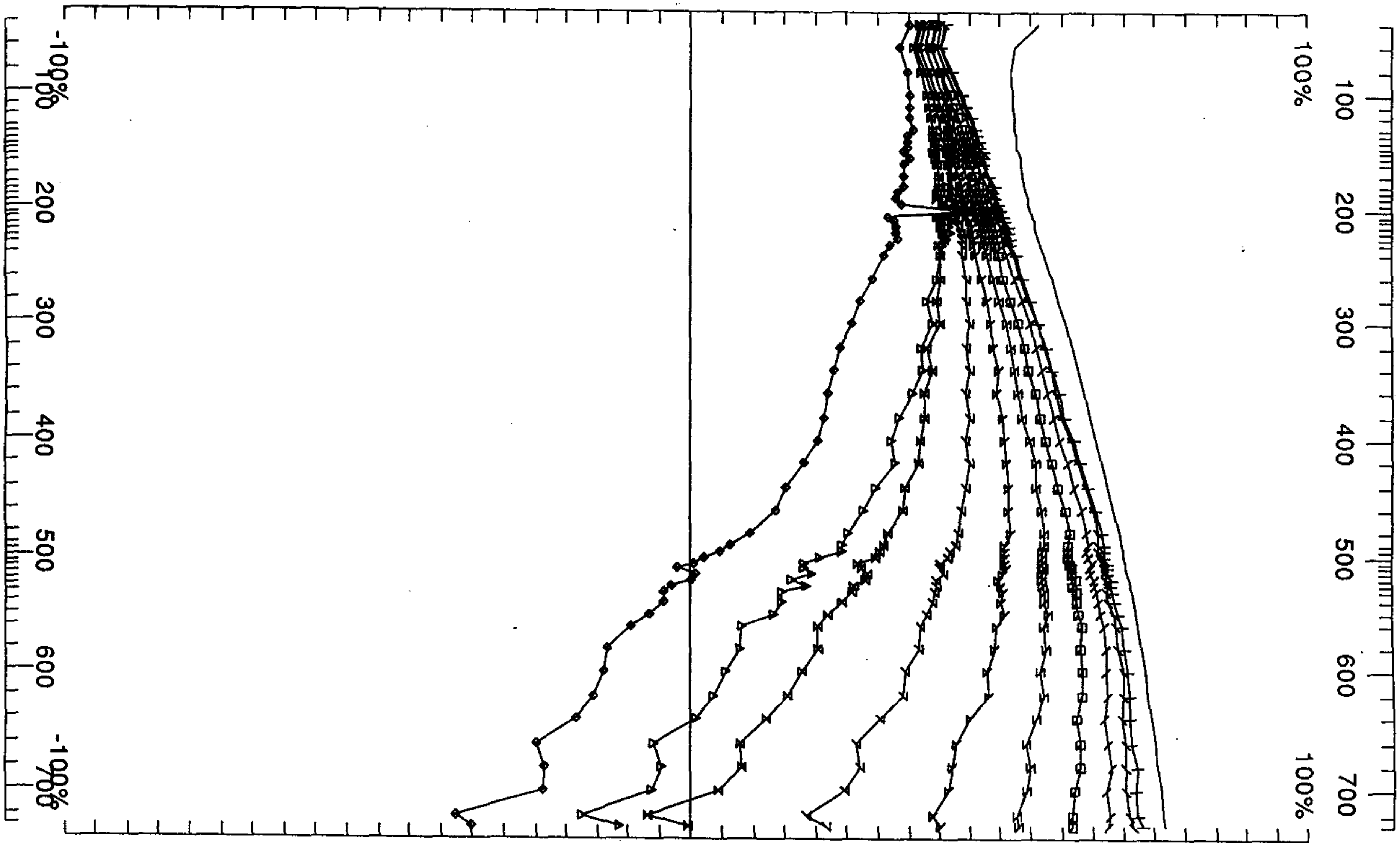

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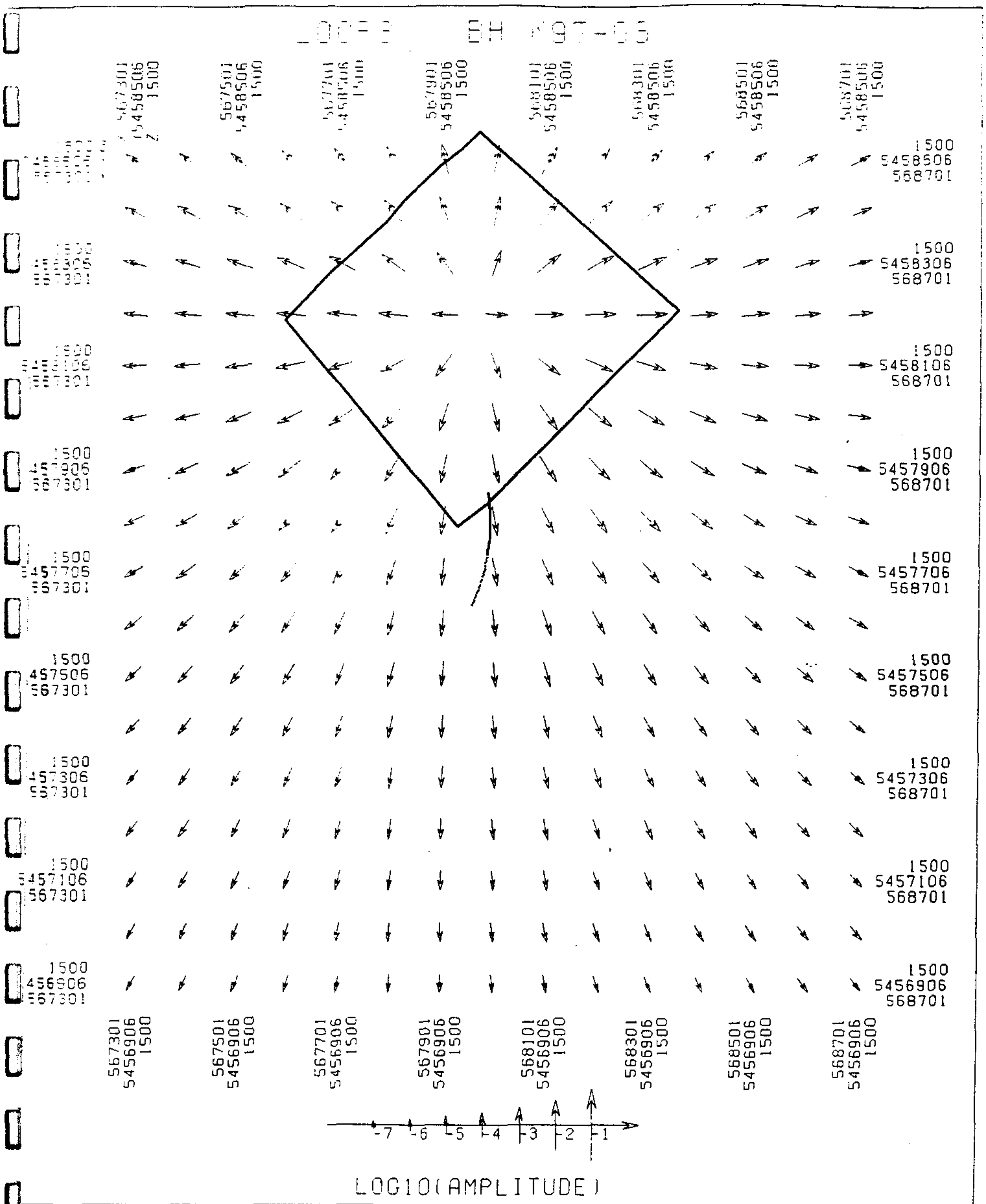

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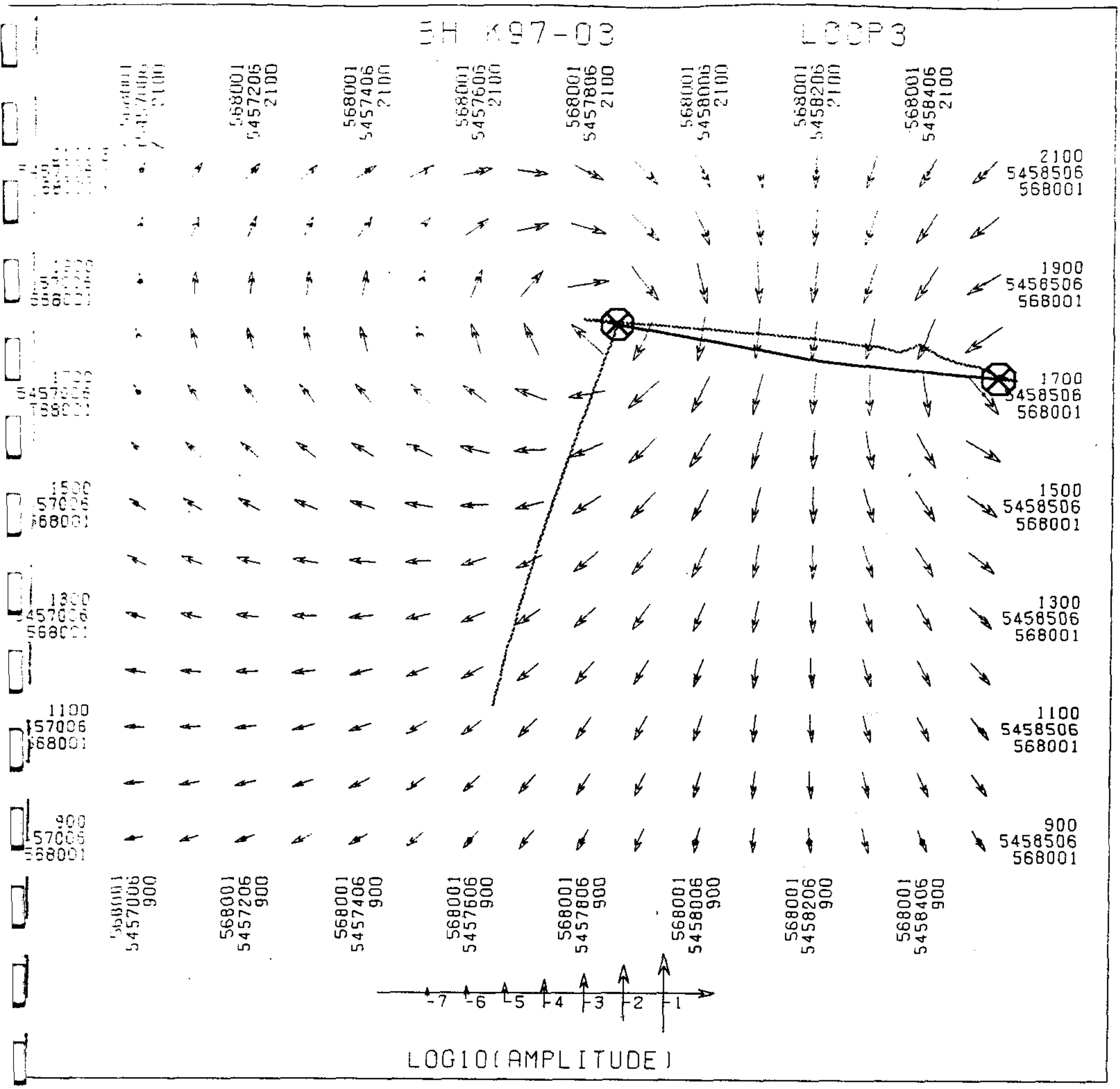
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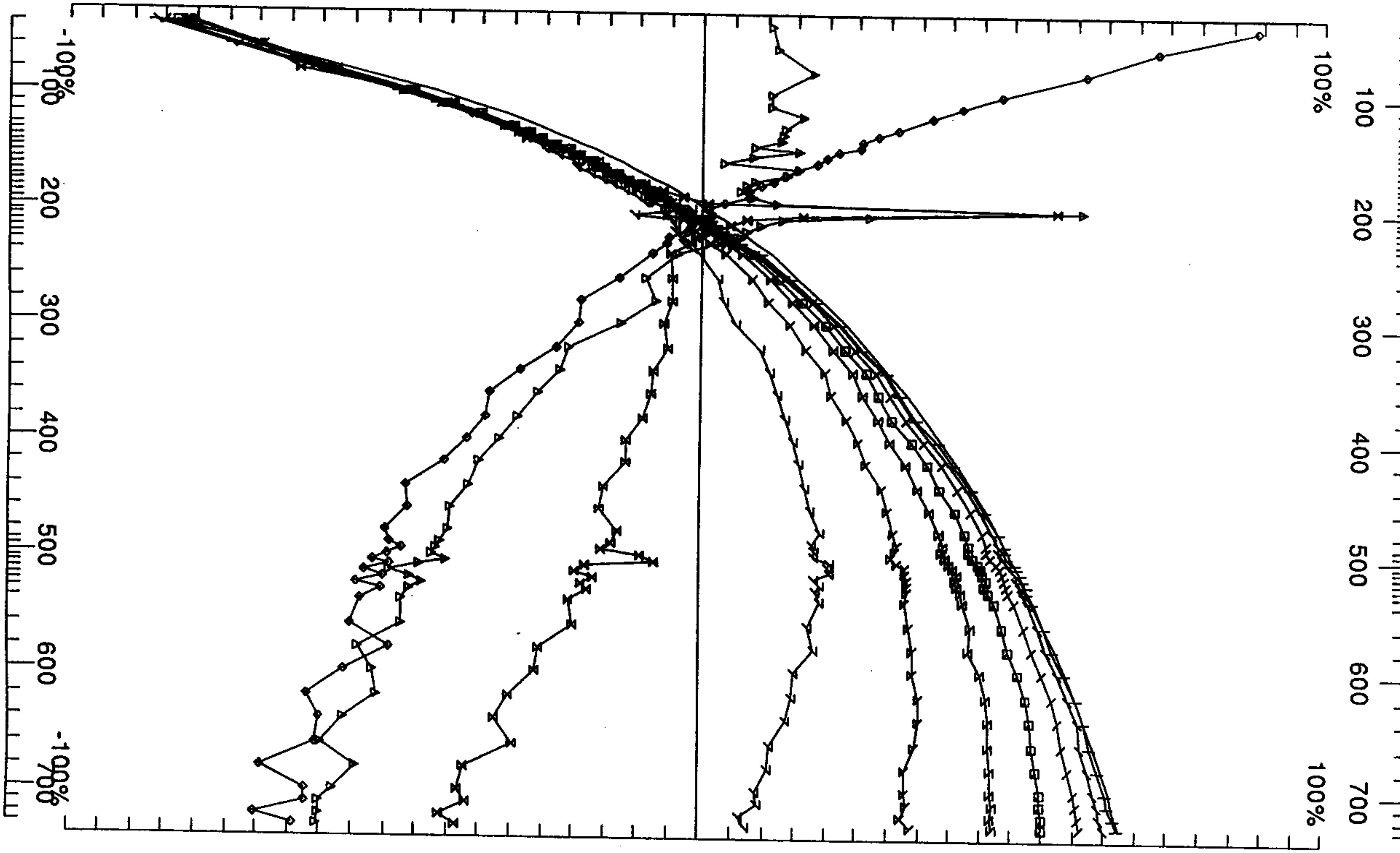

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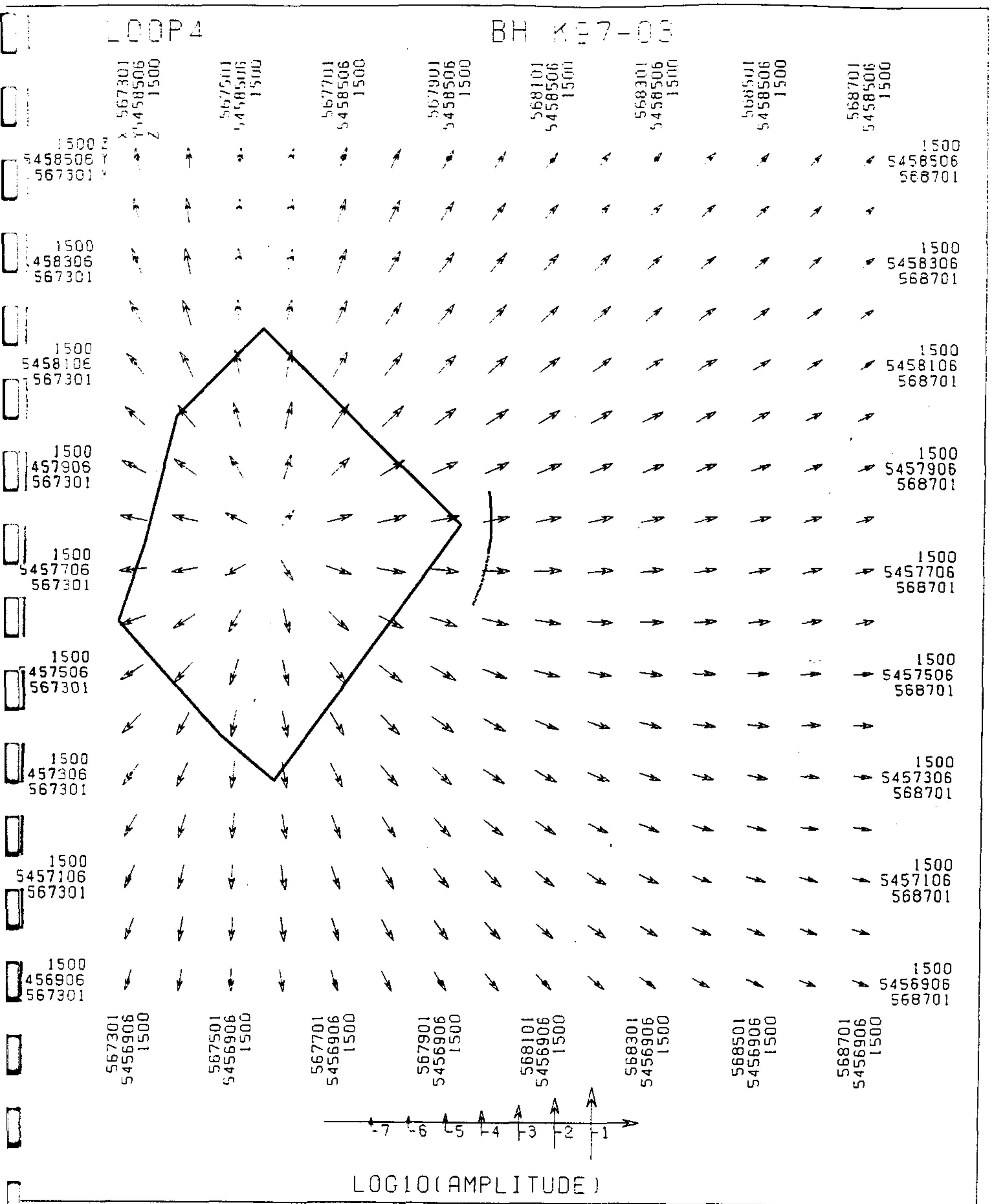
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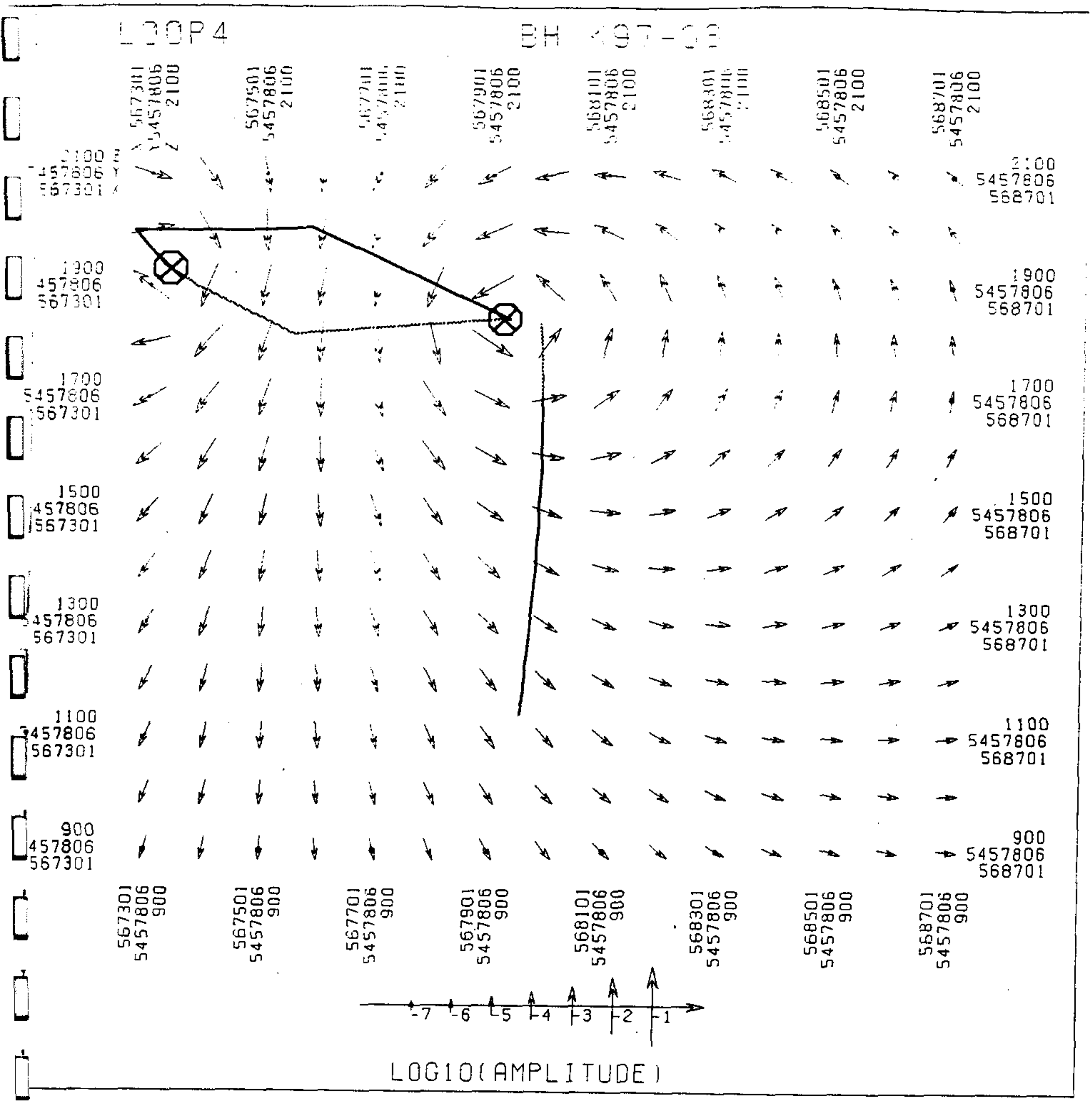
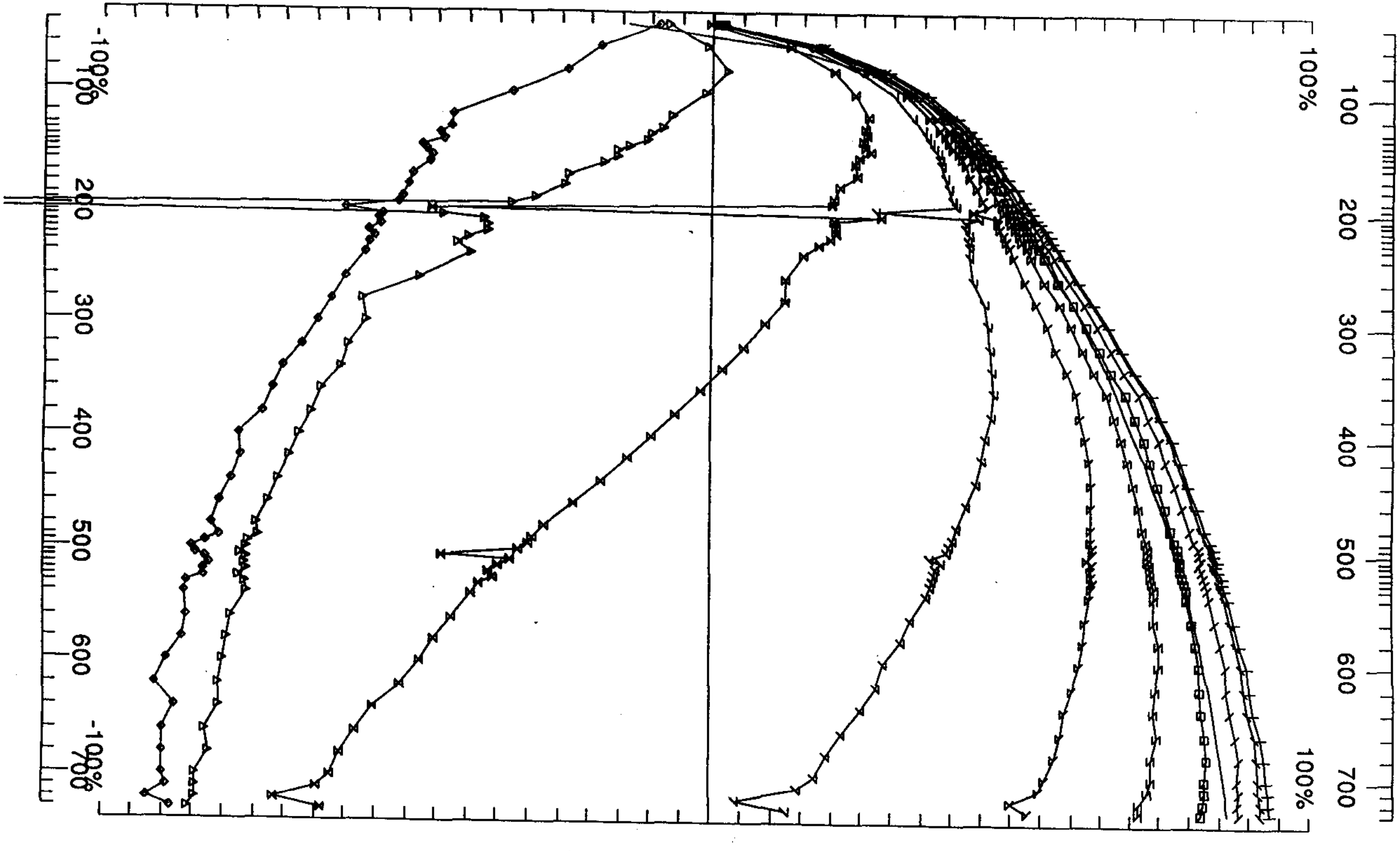
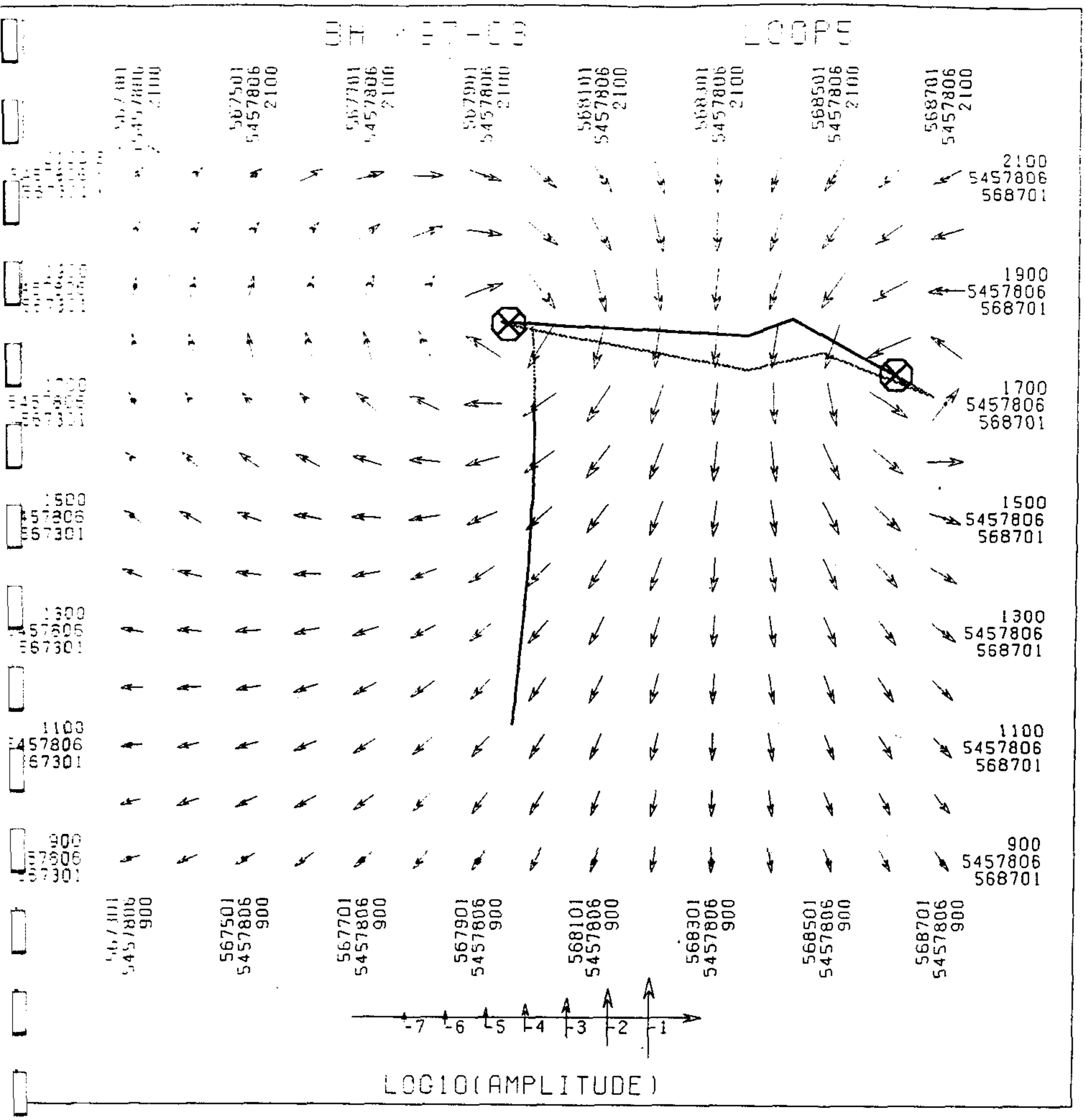
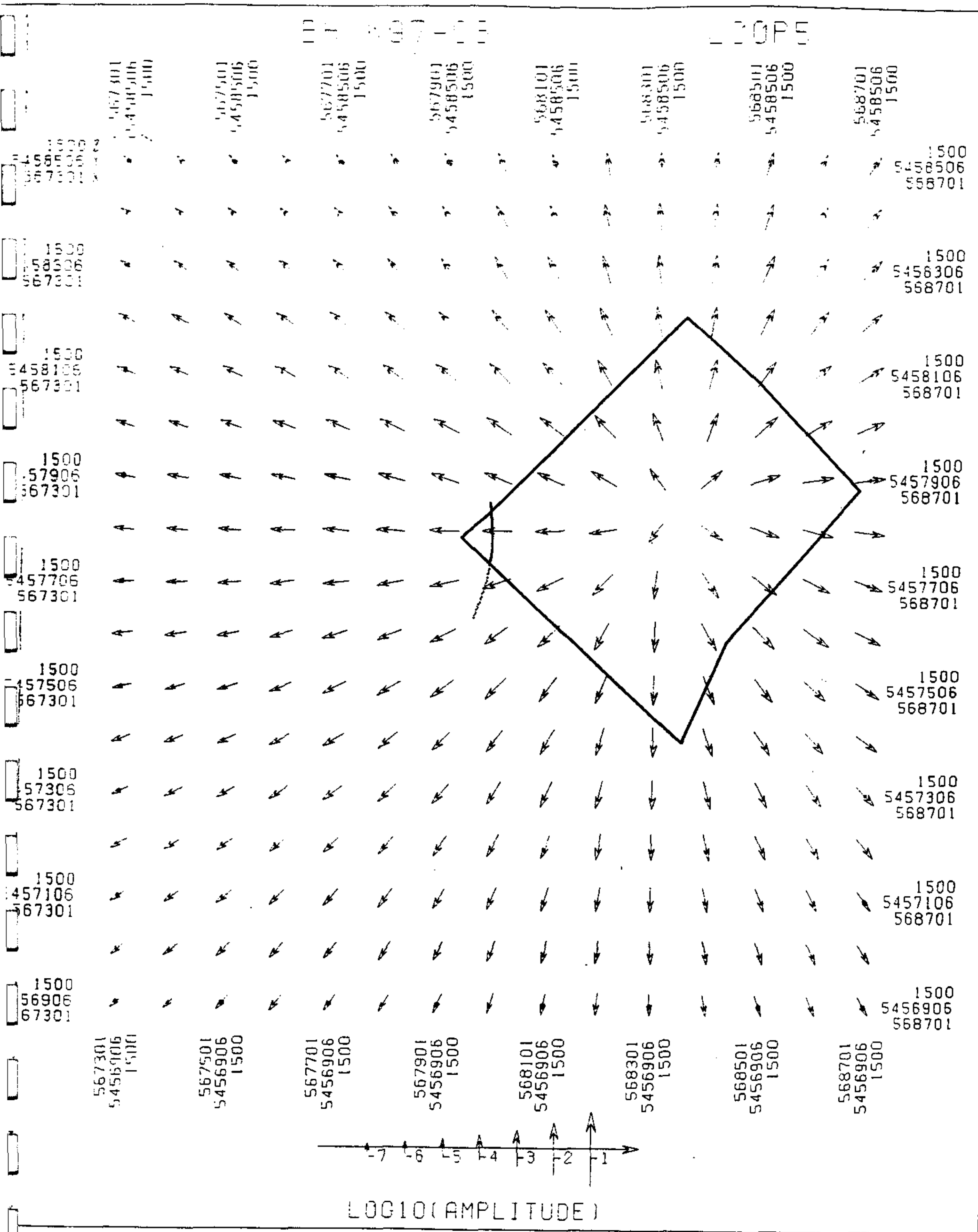
568301
5456906
1500
568501
5456906
1500
568701
5456906
1500
-7
-6
-5
-4
-3
-2
-1
LOG10(AMPLITUDE)


LOOP4
BH
567301 5457806 2100
567501 5457806 2100
567901 5457806 2100
568101 5457806 2100
568501 5457806 2100
568701 5457806 2100
2100 5457806 568701
1900 5457806 567301
1900 5457806 568701
1700 5457806 567301
1700 5457806 568701
1500 5457806 567301
1500 5457806 568701
1300 5457806 567301
1300 5457806 568701
1100 5457806 567301
1100 5457806 568701
900 5457806 567301
900 5457806 568701
567301 5457806 900
567501 5457806 900
567701 5457806 900
567901 5457806 900
568101 5457806 900
568301 5457806 900
568501 5457806 900
568701 5457806 900
-7 -6 -5 -4 -3 -2 -1
LOG10(AMPLITUDE)



Loop: 5 Hole: k97-03 Compt: Axial	Total, Chn/|Hp| Contin. Norm at depth of 0 m Base Freq. 30.974 Hz	BHUTEM Survey at: MOYIE PROJECT For: KENNECOTT CANADA EXPLORATION INC. **SJ GEOPHYSICS LTD.** Job 9750 Surveyed : 17/10/97 Reduced : 19/10/97 Plotted : 21/10/97


LOOP
2100
5457806
568701
1900
5457806
568701
1700
5457806
568701
1500
5457806
568701
1300
5457806
568701
1100
5457806
568701
900
5457806
568701
567501
5457806
2100
568701
5457806
2100
567501
5457806
900
567701
5457806
900
567901
5457806
900
568101
5457806
900
568301
5457806
900
568501
5457806
900
568701
5457806
900
-7
-6
-5
-4
-3
-2
-1
LOG10(AMPLITUDE)



1500
5458506
568701
1500
5458306
568701
1500
5458106
568701
1500
5457906
568701
1500
5457706
568701
1500
5457506
568701
1500
5457306
568701
1500
5457106
568701
1500
5456906
568701
567501
5456906
1500
567701
5456906
1500
567901
5456906
1500
568101
5456906
1500
568301
5456906
1500
568501
5456906
1500
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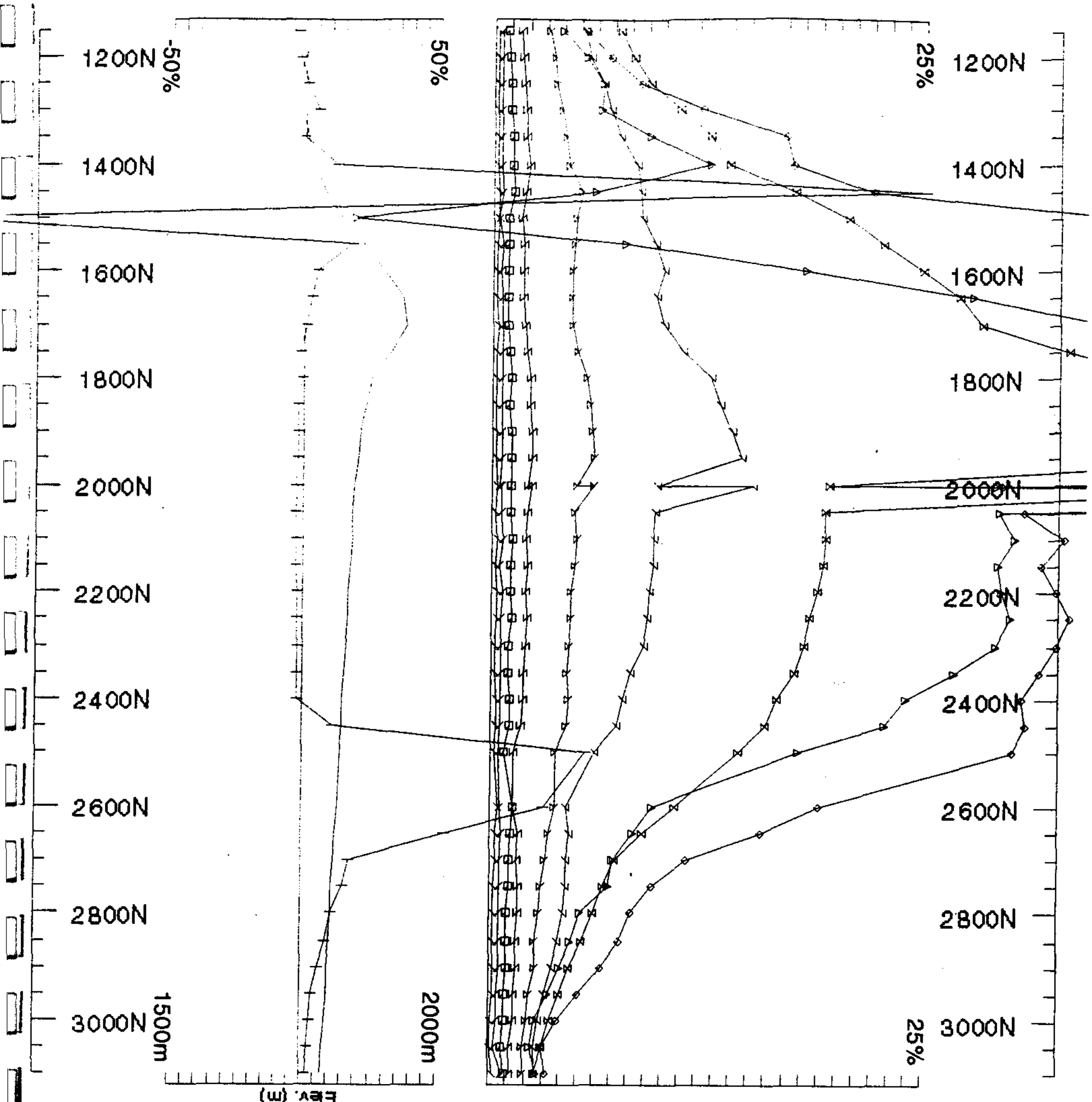
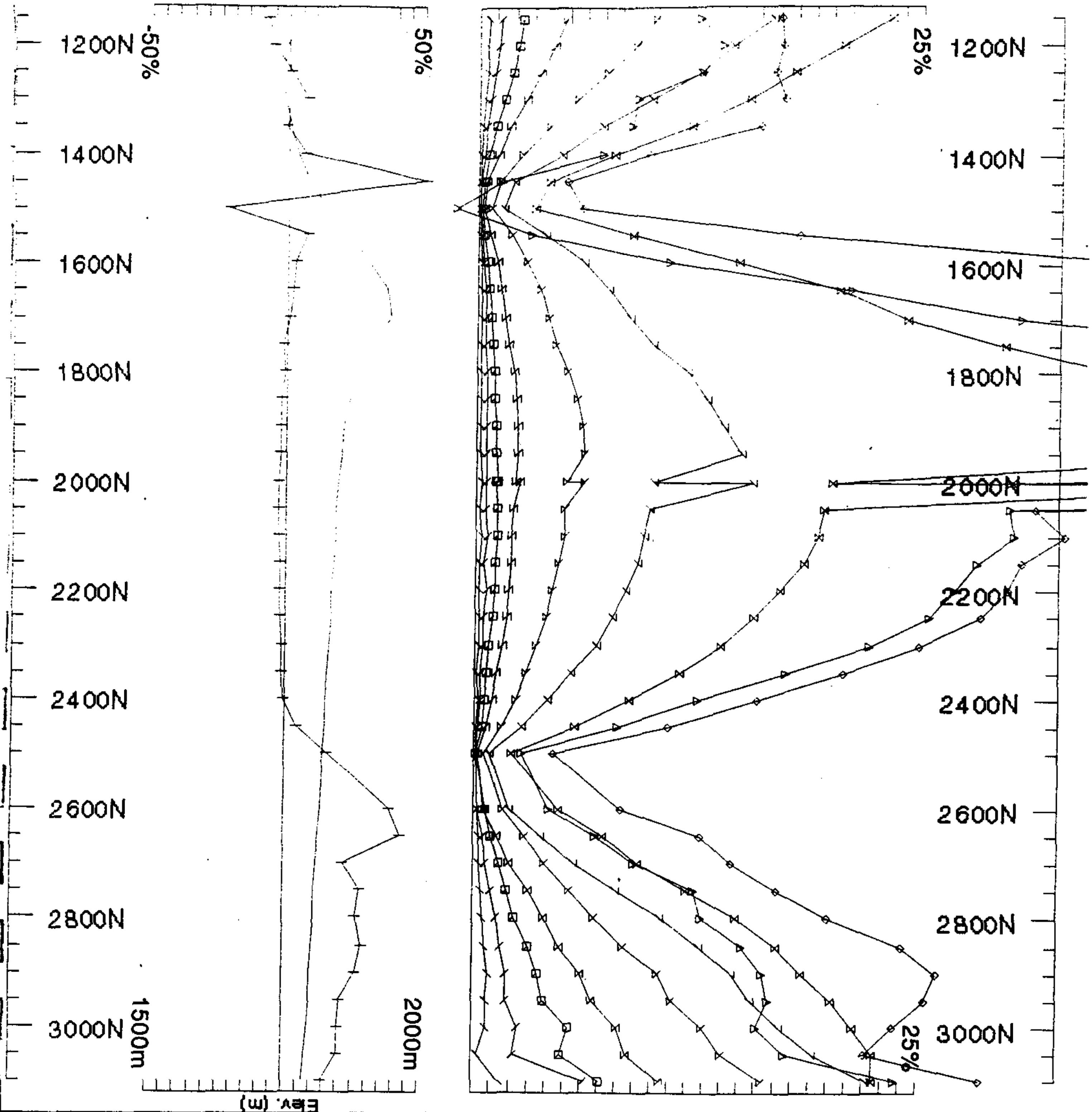
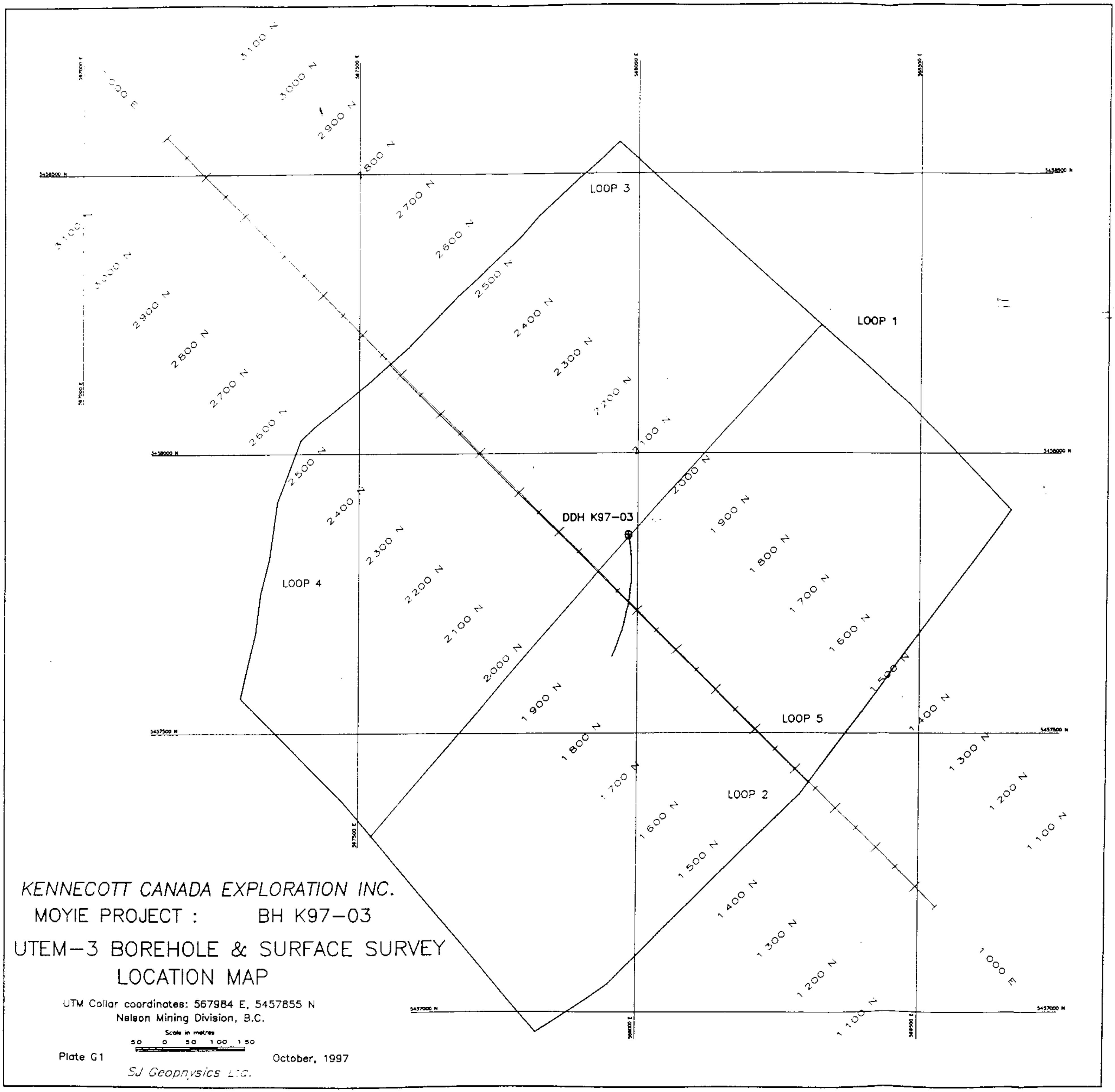
5456906
1500
-7
-6
-5
-4
-3
-2
-1
LOG10(AMPLITUDE)



Loop: 1	Secondary, (Chn - Ch1)/lHpl	BHUTEM Survey at: MOYIE PROJECT For: KENNECOTT
Hole: 1000E	Point Norm.at stn 2100	
Compt: Axial	Base Freq. 30.974 Hz	SJ GEOPHYSICS LTD. Job 9750 Surveyed: 12/10/9 Reduced: 18/10/91 Plotted: 23/10/9



Loop: 1	Secondary, (Chn - Ch1)/IHpl	BHUTEM Survey at: MOYIE PROJECT
Hole: 1000E	Contin. Norm at depth of 0 m	For: KENNECOTT
Compt: Axial	Base Freq. 30.974 Hz	SJ GEOPHYSICS LTD. Job 9750 Surveyed: 12/10/9 Reduced: 18/10/9 Plotted: 23/10/9


LOOP 1
LOOP 2
LOOP 3
LOOP 4
LOOP 5
DDH K97-03
3100 N
3000 N
2900 N
2800 N
2700 N
2600 N
2500 N
2400 N
2300 N
2200 N
2100 N
2000 N
1900 N
1800 N
1700 N
1600 N
1500 N
1400 N
1300 N
1200 N
1100 N
1000 E
KENNECOTT CANADA EXPLORATION INC.
MOYIE PROJECT : BH K97-03
UTEM-3 BOREHOLE & SURFACE SURVEY
LOCATION MAP
UTM Collar coordinates: 567984 E, 5457855 N
Nelson Mining Division, B.C.
Scale in metres
50 0 50 100 150
Plate G1
October, 1997
SJ Geophysics Ltd.