Spatial Analysis and Systematics of Discrete Extensional Structures in the Vicinity of the Kanmantoo Cu-Au Mineral Deposit, South Australia.

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ABSTRACT

The Kanmantoo Cu-Au deposit, situated 55 km south-east of Adelaide is hosted in the Tapanappa Formation of the Kanmantoo Trough. Recent evidence supports an epigenetic mineralising model for the deposit with respect to the Delamerian Orogeny of ~514 to 490 ±3 Ma. The Delamerian deformation event is the oldest portion of the Tasmanides, a 20 000 km orogenic belt along the eastern palaeo-pacific margin of Gondwana. Mineralisation of the Kanmantoo deposit has been linked with post-Delamerian multi-phase extension in east dipping normal faults. The final stages of extension resulted in non-mineralised north dipping normal faults and proximal discrete fracturing. Structural analysis of geology centred on the Kanmantoo deposit has classified a systematic set of extensional fracturing, developed in- the Kanmantoo Deposit and in the region and surrounding the deposit for >5 km radius. The fracture set trends east-west and dip steeply to the north with a recorded mean orientation of 75/359°. Fractures are characteristically not offset by shearing, strike for tens of metres, have variable frequency, and alterations influence by fluid migration. Petrographic and geochemical analysis (SEM)in this study has defined a regionally distributed fracture hosted albitic alteration, which is relatively enriched in Na, Ca, Al and depleted in Fe, Mg and K. A late stage extensional setting is supported for the development of the discrete sub-vertical fracturing.

Keywords: Kanmantoo copper gold deposit, Delamerian Orogeny, Extension, Fractures, Joints, Albite alteration.

Table of Contents

1. INTRODUCTION

This paper is focused towards a systematic record of late stage extensional structures and their spatial distribution in the vicinity of the Kanmantoo deposit. Further, geochemical alteration surrounding the investigated structures has been studied with the aim to identify possible chemical relationships of newly formed minerals and wall rock alteration associated with this fracture system to the mineralising system of the Kanmantoo deposit.

1.1. Tectonic and Structural Evolution

1.1.1. TASMANIDES

Along the eastern margins of Gondwana in the Neoproterozoic (~750 Ma) a large 20,000 km orogenic belt, developed in relation to the breakup of the supercontinent Rodinia (Glen, 2005). The early stages of the orogenic zone involved the dispersion of the supercontinent, change of passive to active margins (subduction), and the opening of the Proto-Pacific Ocean (Foden *et al.*, 2006). This extensive system broadly defines the global Pan African orogenic event found in present locations such as Eastern Australia, New Zealand, West Antarctica, South Africa, and Western Argentina (Glen, 2005; Foden *et al.*, 2006). The Eastern Australian portion of this belt is referred to as the Tasmanides (Glen, 2006), which is spatially comprised of five orogenic belts that stretch 4,000 km from Cape York (Queensland) in the north to Heazelwood (Tasmania) in the south. The five spatial separated belts get younger from west to east and south to north, following a generalised accretion model (Glen, 2005). The five zones: Delamerian, Lachlan, New England, Thomson and North Queensland, represent complete tectonic cycles of extended periods of sedimentation and igneous activity in intercontinental sag basins and terminated by rapid deformational events (Glen, 2005). The deformation of the thick sedimentary sequences was caused by subduction related collision and terrane accretion due to ridge-push forces that commenced around 540-525 Ma (Glen, 2005; Foden *et al.* 2006), and mostly occurs over multiple phases . Deformation of the Tasmanides ceased in the Mesozoic due to the breakup of Gondwana and the change into an extensional regime (Coney, 1990), which has largely continued to today.

1.1.2. DELAMERIAN OROGENY

The oldest part of the Tasmanides, the Delamerian Orogenic belt, defines rock units that have undergone multiphase Mid-Late Cambrian to Early Ordovician deformation (Glen, 2005). This orogenic belt encompasses the Glenelg Complex (Western Victoria), Wonaminta Block (Western NSW), Heazelwood Complex (Tasmania), and the Adelaide Rift Complex (Eastern South Australia) which separates the Pre-Cambrian cratons in the west from the remaining Tasmanides belts in the east. Referred to as the outboard units (Glen, 2006), the Glenelg, Wonaminta and Heazelwood Complexes are characterised by small rift basins, Neoproterozoic alkaline magmatic rifting and mafic-ultramafic convergent magmatism at ~520 Ma.

The Adelaide Rift Complex (Inboard unit) of Eastern South Australia is a North-South trending sedimentary unit that Stretches 1100km from Peake and Denison inliers in far north to the western tip of Kangaroo Island (Preiss, 1987). Geochronological studies by Foden *et al.* (2002) on the earliest syntectonic granites (Rathjen Gneiss) show the Delamerian Orogeny commencing at 514 ± 3 Ma, driven by ridge-push forces relating to the westward dipping subduction tectonism. After short multiphase deformation of ~24 M.yr., the collisional environment was reversed due to subduction related slab roll back at 490 ± 3 Ma resulting in rapid uplift, cooling, extension and post tectonic magmatism (Foden *et al.*, 2006). Eastward slab roll back was theorised by Foden *et al.* (2006) to be caused by the newly subducting slab as it reached the 650 km transition zone of mantle discontinuity, and losing most of its negative buoyancy. The resultant rapid upper plate exhumation and extension would imply an influx of hot asthenosphere as a possible source for the post tectonic magmatism (Foden *et al.*, 2006).

The Delamerian Orogeny has been linked to the Ross Orogeny in Western Antarctica, as both deformation events terminate at 490 ± 3 Ma with synchronous late magmatic and terminal cooling histories (Foden *et al.*, 2006). However, the Ross

Orogeny started 25 M.yr. before the onset of the Delamerian, which was still in a stage of rifting mostly situated in the Kanmantoo Trough (eastern flanks of the Adelaide Fold Belt). The sedimentation of the 7-8 km thick Kanmantoo Trough was extremely rapid, developing in only 8 M.yr., which would have required a high rate of subsidence and sediment supply (Haines *et al.*, 2001). Supporting evidence of southerly derived sediments include, geochronology of detrital zircons, close proximity, lack of western sources, and current directions in Basal turbidite sequence in the Kanmantoo Trough (Haines *et al.* 2001; Foden *et al.*, 2006). Between 540–514 ± 3 Ma the Ross Orogeny experienced rapid tectonic shortening and erosion which may have provided the high depositional rates of the Kanmantoo Trough.

1.1.3. KANMANTOO TROUGH

The Kanmantoo Trough (Figure 1) is a 7-8 km thick group of clastic rich immature sediments (sandstones, arkoses, and pelites) that formed in a major extensional fault controlled rift basin in the Cambrian (Burtt, 2003). Three transgressive-regressive depositional phases developed the sedimentary sequences. These formed in a tectonic jog related to an East-West strike-slip fault along the Pacific margin segments of Gondwana (Flöttmann *et al.*, 1998). Sedimentation was rapid, with dating of the basal Normanville group tuff horizon constraining maximum age of deposition at 522 ± 2 Ma (Foden *et al.*, 2006), which cessed at 514 ± 3 Ma by the reversal of tectonic regimes and onset of the Delamerian Orogeny. The orogenic compressional forces were directed in a south-east to north-west trend that inverted the extensional faulting into west-verging fold thrust belts (Burtt, 2003; Foden *et al.* 2006). Magmatism that also occurred in association with the earlier extensional regime included basalts and dolerites (Flöttmann *et al.*, 1998) as well as syn-Delamerian I- and S-Type Granites (Foden *et al.*, 1999).

The resultant deformation developed in multiple phases (Preiss, 1995), with three main episodes recognised, D_1 to D_3. The earliest deformation phase, D_1, involved a series of west verging thrusts that developed a schistosity (S_1) sub-parallel to compositional sedimentary layering (S_0) (Preiss, 1995). This early fabric was mostly destroyed by later deformation and is only visible in the growth of porphyroblasts

(Oliver *et al.*, 1998; Tedesco, 2008). The D_2 and D_3 deformation overprints D_1 with North-South and North-northwest (respectively) trending upright to steeply inclined folds that plunge shallowly south (Preiss, 1995). Fabrics were also developed with an axial plane foliation and crenulated cleavage, S_2 and S_3 (Burtt, 2003).

The Kanmantoo group is characterised by Buchan style metamorphism of high temperature and low pressure that range from chlorite to sillimanite grade (Sandiford *et al.*, 1990). Buchan style metamorphism relates to deep basement weaknesses with concurrent syn- to post tectonic magmatism (Burtt, 2003). Oliver *et al.* (1998) place peak metamorphic conditions at the Kanmantoo region at 350-450^{o}C for the biotite zones and 600–650^{o}C Sillimanite zone, which is supported by sillimanite metapelites in the Mt. Lofty Ranges indicating peak conditions of 550-600^{o}C and Pressures of 300-500 MPa (Sandiford *et al.*, 1995).

The orogeny was short lived and terminated by slab roll back. The resulting extensions lead to mantle upwelling between the subducting slab and orogen (Foden at al., 2002). 493-480 Ma post tectonic bimodal magmatism, characterised by A-type granites and mafic intrusives, occurs in the Kanmantoo trough and has been theorised to relate to this late stage heating event and rapid uplift (Foden *et al.*, 2006; Tedesco, 2008). The combination of late stage magmatism and extensional uplift has been found to closely relate to and control the mineralising event at the Kanmantoo deposit by Wilson (2009) and Tedesco (2008).

The Delamerian Orogeny has also been the driving force of other major mineralised deposits in the Adelaide Fold Belt and the Kanmantoo Trough (Preiss and Robertson, 2003). The Adelaide fold belt is host to abundant Vein Au (Bird In Hand), Cu-Au associated with porphyries (Burra), syn-sedimentary Cu, diamond and various Zn-Pb style (Angas, Strathalbyn, and Beltana) mineralised deposits. The Kanmantoo Trough mineralisations are significantly linked with orogenic deformation and magmatic activity (Burtt 2003), with abundant Cu, Au, Zn, Pb and Ag-rich deposits. Larger mineral deposits in the Kanmantoo Trough include:

- Angas Zn-Pb-Au-Ag Sedimentary Exhalative (SEDEX),
- Aclare Zn-Pb-Au-Ag Sedimentary Exhalative (SEDEX),
- Bremer discordant Cu stockwork deposit,

- Strathalbyn structurally modified stratiform Cu-Pb-Au,
- Wheal Ellen structurally modified Zn-Pb-Ag-Au SEDEX; and
- Kanmantoo discordant Cu-Au stockwork (Burtt, 2003).

1.2. Kanmantoo Deposit

1.2.1. HOST LITHOLOGIES

The Kanmantoo mine is hosted by the Tapanappa Formation, part of the Cambrian Kanmantoo group of clastic immature sediments in the Kanmantoo Trough (Burtt, 2003). The Tapanappa Formation was deposited in mid-sequence and represents a period of rapid sedimentation of marine shelf sediments (Schiller, 2000). The Formation is comprised of a thick turbiditic sequences of sediments, the majority of which are coarse grained greywacke, which grades-up to fine grained laminated siltstones (Burtt, 2003). This Formation was subsequently affected by the Delamerian Orogeny and developed into metapelites and metapsammites (Schiller, 2000). The Kanmantoo deposit is hosted in the relatively Fe-rich garnet-andalusite-biotite (GAB) schist, a 6km long lens that extents along strike (Schiller, 2000). Smaller lenses of GAB schist found regionally also host mineralisation (Aclare, Wheal Ellen and Angus). The host unit is consistent with the amphibolite facies Buchan style metamorphism, according to garnet-in and andalusite + staurolite-in isograds of Dymoke and Sandiford (1992). The GAB schist is surrounded by variations of this unit (Figure 2), Quartz-mica-andalusite, garnet-biotite and major quartz-mica-feldspar schist (Schiller, 2000).

The host rock of the Kanmantoo Mineralisation has a dominant fabric that relates to the D_2 deformation event, the schistosity (S_2) is fairly consistent through the Kanmantoo region with small bends on a local scale (Schiller, 2000). Foliation (S_2) trends north-south and dips steeply to the east (Schiller, 2000), though some have argued the structure and fabric in the mine represent the later D_3 event (Nero, 1993; Oliver *et al.*, 1998; Tedesco, 2008; Wilson, 2009).

1.2.2. STRUCTRAL CONTROL

Structurally, the deposit is hosted in part of the Kanmantoo syncline, an upright synform that trends north-south and shallowly plunges (15^{o}) south (Schiller, 2000). Two major normal faults occur in the region, the Bremer fault in the west and the Kanmantoo fault northeast of the mine (Schiller, 2000), both trend north-south and are sub-vertical. (Figure 2) Structural studies by Schiller (2000) and Wilson (2009) show an increase in deformation on a local scale of the deposit, supporting the suggestions of a dilatational feature associated with the mineralisation. Four stages of deformation have been recognised at mine scale by Wilson (2009), the oldest structures relate to reactivation of east dipping compressional fault planes with normal movement. The further three stages oscillate between extensional-compressional-extensional, with the earliest stage of extensional faulting coincident with the main stage of mineralisation (Wilson, 2009). The mineralised east dipping extensional faults post date all other faulting in the area, and are supported by insitu monazite dating of ~492 ±9 Ma relating to late stage extensional mineralisation (Wilson ,2009).

1.2.3. ALTERATION

Alteration occurs on two scales in relation to the Kanmantoo deposit, regional metasomatism and local mine scale chloritic alteration (Burtt, 2003). Regional metasomatism with increasing metamorphic grade (greenschist to amphibolite facies) corresponds to metapelitic schist becoming ^{18}O depletion (Oliver *et al.*, 1998). Associated with this is a mass transfer of fluids resulting in a 1km wide altered zone around the Kanmantoo mineralisation with distinct Fe, and Al enrichment and depletion of Ca and Na. The interpretation by Oliver *et al.* (1998) suggests that the alteration might reflect equilibration of metapelites with a second external fluid source from a crystallising magma at depth. Tedesco (2008) supported this alteration with geochemical studies indicating Fe, Mn, S, Au, Ag and Cu enrichment of the metapelites on a deposit scale.

Mine scale alteration of the GAB schist to the garnet-chlorite±biotite schist has a strong relationship with the Copper mineralisation (Schiller, 2000), including the addition of Si, Mn, Mg, S, and Cu but a depletion of the alkalis (Na and K). Wilson (2009) shows that chlorite alteration was initiated concurrently with continuing garnet growth in the mineralised extensional faults, which have been dated to occur in post peak metamorphic conditions (~492 Ma). These early stages of chlorite alteration are indicative for the transition from compressional to extensional settings, though not sure if the mineralisation was already associated with the change in stress patterns (Wilson, 2009).

1.2.4. MINERALISATION

The Cu-Au sulphide mineralisation is currently one of the largest base metal mineral deposit in the Kanmantoo group (Abbot, 2005). Between 1970 and 1976 the Kanmantoo open cut mine yielded 4.05Mt of ore at ~1% Cu, ~0.07 g/t Au, ~3G/t Ag (Burtt, 2003), with a estimated 34.4Mt of ore still left underground at 0.9% Cu and 0.2 g/t Au (Hillgrove, 2007). The ore body is hosted in the lode schists of garnet-biotite-chlorite and garnet-chlorite-chalcopyrite (Schiller, 2000). The ore body has developed in pipe like bodies with podiform lenses, parallel to S_2 and discordant with relic bedding (S_0) (Abbot, 2005). Copper mineralisation occurs as disseminated copper grains in altered rock and as discrete veins/veinlets which are very irregular and diffuse. Vein dimensions are commonly ~10mm thick and extended for ~1m (Schiller, 2000). The highest grades of copper ore in the deposit are associated with dense sulphide rich veins of varying size running sub-parallel to each other.

Other than the main ore body of Kanmantoo there are also several smaller pipe-like satellite deposits, the majority are orientated similarly to the main ore body-

- The South-Eastern lode is slightly oblique to S_2 and deeply plunging
- O'Neil lode is very discordant with S_2 striking Northeast and tabular in form.
- Paringa and Emily Star lodes are generally parallel to S_2, but much more structurally complex than the other zones with a series of faults and shear

zone intersecting each other which has created a high mineralised zone (Stephens, 2004).

Mineralisation is unlikely to have formed from syngenetic processes as proposed by Belperio *et al.* (1998), Toteff (1999), Abbott *et al.* (2005) and Spry *et al.* (1988) from there geochemical and structural studies. Geochemical, geochronological and structural studies suggest mineralisation to be epigenetic utilising late stage orogenic shear zones and post orogenic extensional structures (Tedesco, 2008; Wilson, 2009; Flocke *et al.*, 2009; Schiller, 2000). Dating of the insitu monazites in early stage chlorite alteration of mineralised shear zones revealed ages of~ 492 Ma (Wilson, 2009), relating to post tectonic magmatism and extension.

1.3. Previous Work on Extensional Structures

Schiller (2000) mapped several prominent extensional fracures south of the main mineralisation of the Kanmantoo mine area, with characteristics of continuous strike (over tens of metres, east-west trend, steeply north dipping), associated with slight topographic rise in outcrop, and with mineral infill of quartz, albite and tourmaline. These structures also occurred as sheeted zones of closely spaced sub-parallel fractures (~5cm apart) over an approximate distance of one metre (Schiller, 2000). The fracturing is generally described as mode 1 with no apparent differential movement and offset related to them, though a single fracture set was recorded to have differential movement with very minor kink-like folds and movement of the schistosity; this would make the fractures minor normal faults (Schiller, 2000). The fluids migrating into the joints/fractures were suggested to be metasomatic, relating to the mineralisation of Kanmantoo after peak metamorphism. Further structural studies by Stephens (2004) recorded planar extension veins in the Kanmantoo Mine and surrounding area. The veins are described as late stage, east-west striking, steeply dipping, very planar veins that infill jointing, common on the western side of the pit and generally not mineralised (Stephens, 2004).

More recent work on the structure and timing of the Kanmantoo mineralisation by Wilson (2009) and Focke *et al.* (2009) recorded similar late stage extensional fractures within and regionally surrounding the deposit. These studies hinted at their importance in relation to the structural timing of the late stage post-peak deformation mineralisation of the Kanmantoo deposit.

2. METHODS

2.1. Structural

Field work was conducted to provide structural analysis of the extensional fracturing surrounding the Kanmantoo Cu-Au mineral deposit on a regional scale (Figure 2). The Kanmantoo deposit is located 55 km south east of Adelaide, South Australia. The project brief was to first focus on the structure and geology in a ~3 km radius of the Kanmantoo mine, though the area subsequently expanded further regionally as the extent of the fracturing was realised. With assistance from Hillgrove Resources (Lease holders) access was granted to the Kanmantoo mine, surrounding tenements and public land to map and analysis the geology. Public road cuttings were also used when land access was not available. The vast majority of the geology in the study area is covered in alluvium, soil and ferricrete, leaving sparsely distributed weathered outcrop and man-made road/rail cuttings.

Field studies focused on the discrete extensional fracture and veins that are found in majority of outcrop, recording location (GPS with mean error of ± 5m), orientation (structure was measure for dip and dip direction), rock lithology, fracture appearance/vein fill, density and spacing of the structures, structural relationships, and other visual anomalies associated with the structures. Compass reading were corrected for the study area with positive declination of 6^{o} (Geosciences Australia, 2009).

2.2. Geochemistry

2.2.1. SAMPLE DESCRIPTION

Sampling was conducted on both the field area outcrop and the diamond drill core provided by Hillgrove Resources to collect representative samples of the fractures and their alteration. Sampling of the rock outcrop became difficult to collect an intact representative sample due to the weathering effects on the outcrop; weathering likely would have altered the geochemistry of the fracture and country rock, skewing results. Two regional outcrop samples were collected from both the garnet-andalusite-biotite schist, KTH001, and the quartz-mica-feldspar schist, KTH002. To overcome the outcrop weathering issue and to help in regional to mine comparisons, 4 representative sample were collected from the diamond drill core in closer relationship with the mineralisation. Care had to be taken in selecting the samples from the core to best match the appearance and orientation of the altered fractures compared to what was seen in the outcrop. These drill core samples also had to be picked from below the 20-30 m depth weathering zone (Klinger D., Personal communication, 2009). The location of the 6 samples analyses can be seen in Figure 3 and in Table 1.

2.2.2. PETROGRAPHY

For geochemical analysis of the altered fractures, samples were prepared with both a standard thin section with cover slide and a 200 micron polished thin section centred over the fracture. Petrography was performed with a petrographic microscope and a scanning electron microscope to develop an understanding on the effects of the alteration associated with the fracturing on the country rock.

2.2.3. RELATIVE ELEMENTAL MAPPING

Due to the discrete nature of the fractures and alteration in the rock samples a unique analysis technique was developed using the Philips XL20 Scanning Electron Microscope with integrated EDAX DX4 Energy Dispersive X-ray and Image Analyser, to do a basic "insitu whole rock major element micro-analycal maps" on the country rock and the alteration haloes associated with the fractures. Samples of the bleached altered fractures where prepared as carbon coated 200 micron polished thin sections. A transect (~20mm long) of ~15-20 electron back scatter multi-field maps was produced using the EDAX Genesis system covering a country rock-altered fracture-country rock transect path, which is visualised in Figure 4. The multi-element maps were taken with the electron beam set at 20 kv with spot 6, along a fixed transect line with the multi-fields distributed higher and more frequent in the alteration fracture than unaltered country rock. The multi-field maps were based on 200 x magnifications electron backscatter image of the various mineral assemblages and relative elemental data on significant elements including O, Na, Mg, Al, Si, P, S, K, Ca, Ti, Mn, Fe, and Cu. The EDAX scanning was taken at low levels with map resolution set at 256 x 200, dwellus at 200, ROIs at 14, and frames rate at 64, these mapping setting could be increased to give a better overall map resolution and detection limits. The resultant maps dimensions are 1.6x1.29mm, with a covered area of ~2mm^2.

Using the petrography and SEM elemental analysis results, graphs of the relative compositions were plotted to support what has been recorded from the petrographic descriptions of the fractures and related alteration. To find bulk changes in the rocks chemistry as it develops across the altered fracture, to hopefully define a source or timing of the fractures in relationship with the mineralisation and previous research.

3. RESULTS

3.1. Structural

Dip/dip direction measurement were recorded for this study.

3.1.1. GEOLOGY

Structural elements were recorded in all rock types in the study area, with the most abundant lithology being the quartz-mica-feldspar schist described in detail by Schiller (2000). The study area has a north to south trending schistosity that dips steeply east. The schistosity is fairly constant on a regional scale, with slight kinks and bends on an outcrop scale. For this reason, the schistosity in the study site was observed, but only recorded occasionally in the outcrop (Foliation recorded at 71/106°, 55/075°, 68/071° in regional observations).

3.1.2. FRACTURE DESCRIPTION

The defining characteristic of the investigated extensional fractures are their consistent strike and steep dip. The fractures sit in rock with a predominate north-south fabric (bedding, foliation and faults) the studied fracture sets trend east-west cross cutting the foliation in the outcrops. The cross cutting trend of the fractures make them stand out in the rock and help weather the outcrops further. The fractures or joints are discrete planes that cut close to perpendicular to the foliation and can be traced for tens of metres along strike in outcrop (Figure 5). Opening of the fractures by ~1-5 mm is common, where the fracture surfaces have lost cohesion, split, and been infilled with secondary minerals, which is common in extensionally formed tensile structures.

This type of fracturing could be classified as mode I jointing (Price and Cosgrove, 1991), as it shows no apparent offset or shear displacement and just exhibits dilation. Very little to no offset was recorded for these extensional planes on a meso-scale. The east-west trending fractures are also seen to intersect other structures in the rocks with no apparent displacement such as quartz veins along foliation. Earlier forming quartz veining (of variable orientations) are cut through and overprinted by the east-west fracturing, and in highly fractured areas the slightly differing orientated east-west fracturing interact with no apparent offset to each other. The best examples of the fracture interactions are viewed in the more recently exposed (North-South) road cuttings. Figure 6 shows a road cutting along the Princes Highway (0320861 E, 6113802 N) the largest and clearest section. Some slight movement and offset was recorded along strike of one fracture, but this may be related to weathering effects as meteoric fluids and surface movements have caused the rocks to locally lose cohesion along the fracture plane and fall away from each other, as seen in Figure 7. Evaluating any shear displacement that happened on a micro-scale is difficult, as the fluids which ran through the structures have altered and destroyed the mineral fabric of the country rock close to the fracture surface.

The thin 1-2 mm veins are not open, create slight surface irregularities (or say they are weathered out) in rock, and usually occur in tight grouping sets, and because of the tight grouping of veins it can drastically increase an areas fracture density (# of fractures per m). The discrete nature of these structures facilitates the definition of their strike extent and even allows their detection in weathered, moss covered outcrop. The more pronounced fractures with distinct alteration halos vary more in size, due to fracture aperture and alteration width. Fracture aperture is typically around 1-5 mm, but can be up to ~10mm, aperture increases the weathering effects to the steeply dipping fractures eroding the vein material and developing a furrow. Increased weathering develops fracture surface, where there is loss of fracture cohesion altogether and one half splits away entirely, the fracture surfaces are the most visually prominent structure. The alteration halos of the fractures are a defining feature and make them considerably effortless to observe from a distance. Greatly ranging in thickness from 1-40 mm+ (average ~15 mm) the alteration halos undulate along fracture strike as evidence for fluid migration along the structures and fluid wall-rock interactions causing chemical and mineralogical changes in the rocks. Recorded in some cases, the alteration halo is uneven across the fracture, developing thicker on side. 90% of fractures recorded looked to have interaction with fluid sources, those fractures with no visible vein material show iron stained fracture surfaces, very smooth and planar, which also hints at fluid involvement. No morphological features were observed on the fracture surfaces such as rib-marks or plumose-marks, though unsure if this is due to none present, obscured weathered surfaces, or fluid movement.

The quartz infilled east-west trending structures usually have little to no alteration of the fractures wall-rock, which is similar to sulphide-rich infilled fractures observered. The quartz infill fractures (Figure 8) are ~5 mm thick, closed, typically form planar fracture surfaces from weathering processes, surfaces are highly iron stained and typically still covered in patches of the quartz vein material. The sulphide rich infill material observed in fractures within the Kanmantoo mine has been weathered away leaving small patches of decomposing sulphide material (Figure 9); these fractures are also sometimes high in silica which preserves the vein material.

3.1.3. FRACTURE ORIENTATION

A total of 1126 fracture planes were measured in the study area on field outcrops and within the area of the Kanmantoo mine. A highly consistent orientation and dip direction is evident from the summary plot in Figure 10. All fractures trend east-west at 345^o to 015° with 63% having a dip direction of 000 ±15° or 90% orientated 000 ±30 degrees. Figure 10 also shows the continuity of dip angle of the structures, with 90% of the recorded structures having a dip angle $\geq 60^o$ and furthermore dips in a northerly direction. Due to the consistent trend of the majority of the structures a slight rotation (±20) of the strike becomes a prominent quality, which could lead to the development of differing fracture sets or patterns. Orientation data was subdivided into different zones of the field area in relation to the Kanmantoo deposit; Figure 11 displays the subdivisions. The subdivided zones are described below:

- East-west: when divided into east and west sectors, Figure 12, there is no change in mean fracture orientation. The resultant means of $76/359^o$ (west) and 74/359^o (east) are highly comparable with the All Fracture mean (Figure 10) of 75/359^o.

- Quadrants: dividing the data into compass quadrants, Figure 13, fracture orientation can be seen to change slightly. The north-west and north-east sectors have highly comparable means with All Fracture mean, 75/359^o, of Figure 10. The northern quadrants orientation means are 75/356^o (NW) and 73/356^o (NE). The most noticeable change in fracture orientation in this data distribution is in the southern sectors. There is a clockwise rotation of the mean dip direction in the southern zone of 78/004^o (SW) and 74/002^o (SE).

- North-South: dividing the field data into 5 sectors from north to south, Figure 14, the mean orientation can be seen to change, especially the structures dip direction. There is a clockwise rotation of the mean resultant dip direction from 41/352^o in the regional north sector to 70/005^o in the regional south sector. The dip angle also seems to change significantly as well in the different sectors, with dip angle decreasing in the more regional sectors.

- Mine to regional: The sectors are divided into concentric circles surrounding the mine to observe any orientation changes spreading from the central mine deposit, Figure 15. The central sector, mine area, has a narrow range of strike orientation as seen in the rose diagram and a mean resultant orientation of 79/005^o. Moving outwards into the next sector (mine surround) the mean dip direction is rotated anticlockwise to 70/356^o, this is equivalent to the mean orientation of 75/359^o of all data. The outer sector, away from the mine, is the regional area with a mean fracture orientation of 72/001^o. The dip direction of this sector has been rotated clockwise with respect to the previous mine surround sector and is comparable with the sector closest to the mine.

- Fracture Infill: Structural data has been divided with respect to the generalised vein infill of the fractures. Figure 16, shows the distribution of the types of infill. The sulphide-rich fractures mapped from the pit wall have a small sample size and a resultant mean orientation of 77/009^o, Figure 16. The quartz filled veins, which are scattered throughout the region have a more diverse orientation range than most data sub-sets but at the same time a comparable mean orientation of 71/003^o. The most abundant fracture infill material, the mean orientation of this data set, 72/358^o, reflects the overall fracture orientation as it contains 90% of the data.

Figure 17 shows a mean fracture orientation distribution map of all north dipping fractures, using neighbourhood statistics software (ArcMap). This software outputs values (mean, range) for each data point based on the locations value and that of surrounding neighbouring values (ArcGis, 2008). Overall, Figure 17 shows only minimal variation of the fracture orientation throughout the study area. The area closely surrounding the mineral deposit has a very consistent dip direction mean of ~343^o to 005^o which slightly increases outwards radially to 005^o - 030^o dip direction. In the more regional areas of Figure 17, the strike is rotated anticlockwise towards a more north-south dip direction of ~355°, comparable with immediate mine area.

The dip of the fracturing is also largely constant over the study site, as shown in Figure 18. There is no substantial change in mean fracture dip within a radius of 3 km of the Kanmantoo deposit, with steeply dipping fractures ranging from ~60-88^o. The most noticeable change in dip across the study site occurs in the northern area; ~5 km north from the Kanmantoo deposit dip shallows out to ~40^o, and continuing into the northwest region dip significantly shallows out to sub-horizontal. The shallow dips also relate to anticlockwise rotation of dip direction, with fracturing in the area orientated in a north to north-east trend, dipping in a westerly direction.

3.1.4. FRACTURE FREQUENCY

Frequency of fracturing was recorded as an expression of the density of structures at a location over one metre intervals. It is also averaged over the frequency of fracturing in the immediately surrounding outcrops, as to determine regional scale fracture-frequency trends. The extensional fracturing in the study area was observed to have inconsistent spacing and frequency on a local (outcrop) to a regional scale. On a local scale, the fracturing looked to have no continuous arrangement of fracturing in rock, ranging from evenly spaced, tightly grouped, to uneven distribution, as displayed in Figure 19. Though, the majority of fracture spacing consists of tightly grouped fracture sets usually consisting of 3-4 structures or fractures per metre. The fracture sets are usually a composite of the fine closed ~1mm fractures and the more prominent and altered open fractures that regularly form the planar fracture surfaces. It is a rare occurrence to find a singular extensional fracture in the rocks, and when observed can be related to the minor and sparse outcrop of the area.

Fracture frequency ranges from very sparse (one fracture per two metres, 0.5 f/m) to a dense (15 fractures per metre, 15 f/m) and displayed as both absolute data (Figure 20) and mean fracture density (Figure 21). From the data recorded on the fracture frequency map, Figure 20, generalised patterns can be recognised. Regionally, the northern section appears to have low density (0.5-4 f/m) fracturing when compared with the southern regions, which has a distinctly higher average density of 5-9 f/m. Outer regional data is not conclusive due to the limited recorded locations. Closer to the deposit the southern areas appear to have consistently higher fracture density than the north and two to three high density trends can be traced running through the deposit. There is a high density north-south trend on the western flanks of the deposit highlighted by an 11-15 f/m fracture density, a north-east trend in the southern zone and a north-west trend to the east of the deposit.

Trends in fracture frequency are more noticeable in the mean frequency plot (Figure 21) and frequency range plot of Figure 22, averaging a closely spaced data set and producing a fracture frequency mean of 4.5 f/m. Frequency trends include:

- The northern section of the study site has a slightly lower fracture frequency than the southern sections
- Increased frequency of fractures close to the deposit especially in the southern zones
- A zone of higher frequency on the northeast zone, close to the deposit
- A vague north-south trend of higher mean density fracturing
- All high density fracturing, ≥11 f/m close to deposit
- Mineral deposit lies within a zone that is comparable with the overall mean of 4.5 f/m

3.1.5. DISTRIBUTION OF FRACTURES

The different types of east-west trending structures are present in the majority of outcrop in the study area. The different lithologies of the area appear to have no affect on fracture distribution, with no significant changes in fracture orientation, appearance and frequency. Though in one location (0317469 E, 6113077 N) with a visible lithologic boundary (from the deposit hosting GAB schist to the QMF schist), fracturing was recorded to increase from rock type A to rock type B across the boundary. The boundary was marked by a thick weathered infill fracture (78/015°), Figure 23. The larger recognised and inferred structures that trend north-south in the study area also appear to have little effect on fracture distribution, with fractures occurring across the structural domains, though no first hand interactions of faulting and fracturing was observed. In some cases fracture aperture or frequency was seen to increase close to known mineralised areas, such as in the Paringa mineralised zone (south-west of mine pit). A thicker (~10 cm) extensional fracture was observed trending across old near surface mine workings and an increase of fracture frequency close to similar disused mine shafts.

3.1.6 ALTERATION SURROUNDING EXTENSIONAL FRACTURES

With east-west fracturing occurring in most of the outcrop observed, the difference in fracture infill distribution becomes important in relations with deposit mineralisation. Fractures were classified by different infill chemistry observations, with sulphide rich, quartz rich and bleached altered infill fractures. Non-infill structures (no visible infill or fluid-wall rock interaction) are also occasionally observed in regional outcrop, trending east-west these fractures are non planar, vague and appear more like cracks relating to weathering processes.

Figure 24, shows the fracture distribution in the study area in respect to infill mineral (sulphide-rich, quartz rich veins, bleached alteration veins). Sulphide-rich and sulphide +silica-rich infilled fractures are only observed within the main mineralised zone of the Kanmantoo deposit. Unlike the bleached altered fractures, which are not represented in the pit walls of the mine.

The bleached infill fractures (classified in field by colourations and visual observations) are commonly found throughout most outcrops in the study area. Surrounding the mineral deposit these fractures are the dominant extension related structures and become increasingly infrequent and irregularly distributed in areas more distal to the deposit. The extent of the altered extensional fractures can be observed in the northern sectors of the study area, with increasing variation density, strike, dip and substantial barren road cuttings in the north-east north-west corners. Exceptions to this observation is in the north-east sector where a small patch of outcrop was recorded with east-west trending fractures of medium frequency past a barren zone of rock closer to the deposit.

Unlike the northern zones decreasing abundance of extensional fractures, the southern zone appears to continue the structural trends of the mineral deposit. East-west trending structures at medium density are found in the majority of outcrops recorded, with both quartz and bleached infill. The quartz filled fractures appear to dominate sections of the southern zone, such as the road outcrops along the south-eastern freeway and majority of outcrops found in the south-east section, Figure 24. The bleached infill fractures are still present in the rock with the quartz infill, but in low frequency and infrequently distributed. The south-west zone of the study site appears to be an exception which is dominated by the sodic altered fractures and could relate to a fluid flow trend of the mineralising system.

3.2. Geochemical

Fluid migration along the extensional fractures in the study area has developed differential fracture infill mineralogy and chemical alterations due to fluid-fracture wall rock interactions. Observational differences exist in the fractures infill mineralogy/chemistry, which may be related to the timing, fluid source or proximity to the Kanmantoo deposit. The most abundant type of fracture infill/alteration found in the study area is the bleached/pale alteration; these discrete altered fractures were sampled so as to classify the alteration type.

3.2.1. PETROGRAPHY

3.2.1.1. Unaltered Country Rock

The samples analysed are from the GAB schist and the QMF schist that are found throughout the study area and a sourced from outcrop and diamond drill core (Table 1).

The GAB schist is characterised by the coarse andalusite porphyroblasts, abundant garnet crystals and a dominate schist fabric. The groundmass is medium well formed quartz grains with minor feldspars (more in outcrop sample, KTH001, away from mine). The rock fabric is formed by elongated needle-like biotite crystals that are tightly grouped and orientated along the S_2 schistosity, minor muscovite crystals are closely associated with biotite but less aligned with the fabric. The biotite fabric has a close relationship with the large garnet crystals (0.05 to 0.5 mm), with the biotite fabric occasionally looking to be consuming the garnet when in contact. The biotite schist also wraps around the large porphyroblasts of andalusite, as it is deflected around. The andalusite porphyroblasts are ~3-6 mm long in samples, elongated along the biotite fabric. Accessory minerals in the GAB schist are staurolite, illmenite, apatite, allanite, rutile, plus minor zircon and monazite.

The QMF schist has a groundmass dominated by fine to medium course grain quartz, making up >60% of the rocks mass with additional feldspar and plagioclase in the groundmass. The rocks fabric is a low to moderate schistosity make up of biotite grains, with minor muscovite. The biotite grains are less elongated along the fabric lineation and not as tightly grouped together as in the GAB schist, the muscovite crystals are not as closely aligned with the fabric (S_2). Accessory minerals in the QMF schist are illmenite, allanite, rutile, garnet, with minor zircon, and monazite.

The unaltered mineralogy is comparable and consistent across the samples analysed (Figure 25), except for sample KTH003, that contains a quartz vein which trends parallel with the schistosity of the sample.

3.2.1.2. Altered Fracture

Mineral and chemical alterations are closely associated with fracturing that cuts through the centre of the KTH001-KTH007 samples. Fluid migration along the fractures has developed a central vein (~1 mm thick) surrounded by an alteration halo (~10mm thick). The edges of the alteration halos are evident in a thin section by the removal of the majority of the schist fabric, as seen in Figure 26. More noticeable in the GAB schist samples due to the dominance of the schist, the biotite fabric thins out towards the central vein which trends perpendicular to the fabric (S_2). Quartz dominates groundmass remains with the occasional fine biotite grain. Associated with the loss of biotite is the lack of garnet crystals close to the central vein, only occurring in close proximity to the remaining biotite grains. The loss of biotite (high in Ti) fabric also appears to slightly increase to volume of titanium-rich oxides (illmenite and rutile) in the altered halos. Moving out from the central vein and congregating along the eradicated fabric trends are very fine grain veins in between the quartz crystals, the texture appears to be recrystallised fluids. Closer to the central vein quartz becomes less abundant and finer grained, replaced by more feldspar (mostly plagioclase). In this zone, finer fractures spread out from the central vein, though the majority lack infilling minerals. The central fracture veins are comprised mostly of feldspars, plagioclase and K-feldspar, chlorite and minor fine grain quartz crystals (Figure 27). The minerals crystals in the central vein area are large, have well formed boundaries and mostly lack any form of orientation/arrangement. The well formed feldspar crystals in the veins appear to be orientated perpendicular to fracture development, from the repeated twinning orientation in the majority of crystals. Sample specific observations are:

- KTH001- Alteration vein is made up of feldspars with K, Na rich feldspar core moving out to a K-feldspar rim and then followed by plagioclase outer rim (Figure 28)
- KTH002- Altered vein has an albite core to a K feldspar (orthoclase) rim, also tabular well developed chlorite crystals with no orientation. Surrounded by sodium rich plagioclase. Small apatite minerals occurring in the alteration halo.
- KTH003- Central altered vein has Zinc/Lead sulphides and pyrite crystals in the middle, as well as chlorite. Surrounded by Na-rich feldspar (albite) and which move out to a Fe-rich plagioclase (Ca, Na). Fracture, vein and alteration overprint quartz vein in sample, with alteration moving through gap in quartz crystals
- KTH004- Large well formed grain growth in central vein, K-feldspar makes up majority of central vein material surrounded by plagioclase
- KTH007- No central vein material in this sample, only alteration halo. The alteration halo has a rim of chlorite mineral surrounding the outside of alteration zone, abundant apatite within alteration zone.
- KTH008- Differs from the other samples due to its high iron-rich alteration. Central vein made up of Fe-rich pyrite, quartz, chlorite, chloritoid, and K-feldspar.

3.2.2. GEOCHEMISTRY OF VEINS AND ALTERATION

The Scanning Electron Microscopy was used on the thin section samples to map the element variations across the fractures and their surrounding alteration halo. Data was then normalised to the unaltered rock elements maps on the far extremities of the transects taken in each sample. The normalising of the major element data was used to negate some of the problems that would develop in the data due to the map dimensions, grain size, and mineralogy of the individual element maps in the transects, thus producing more consistent data.

3.2.2.1. KTHOO1

The normalised data for this sample, Figure 29, show a relative enrichment/ depletion of various elements at 200x magnification. The spidergram graphs (Figure 29) show a clear relationship between the visually bleached alteration zone (spot 6–20) and significant changes in the relative element concentrations normalised to the unaltered rock distal to the fracture (fld0001, fld0022, fld0023). The most prominent chemical changes across the fracture are the enrichment of Na with a 20x increase, as well as significant enrichments in Ce, (10x) and Cu, (~100x). Minor enrichments of O, Ca, Al, and Mn are closely associated with the centre of the fracture. Minor element depletion in Mg and Fe can be linked closely to the alteration surrounding the fracture. The other elements such as Si and Ti, show minor fluctuation in levels that can be slightly related to the fracture, but more likely related to the mineralogy (element rich mineral grain distorting overall trend) of the maps spectrum (Figure 30). Phosphorous and S values also spike (1x) in relation to the grain size and abundance of phosphorous-rich mineral grains in the relative map (Figure 29).

Lower magnification (25x) analysis of the fracture alteration show similar trends in enrichment and depletions as shown in Figure 31, K1M1-K1M3. Though not normalised to unaltered rock, the data shows enrichments of Na, Ca and Al towards the fracture, and depletions of Fe, K, and Mg. Data from Figure 32 (K1L1-K1L4), developed over a different transect in the sample gives similar results. Relative enrichments of Na, Ca, Ce (large allanite crystals in K1L4) and Al (large andalusite porphyroblasts in K1L3-K1L4 maps) are shown across the fracture which cuts across the middle of map K1L2. Elements depleted associated this section are Fe, K and to some extent Mg.

3.2.2.2. KTH002

The normalised spidergrams for KTH002, Figure 33, are representative of a thick ~15mm alteration halo surrounding an extensional fracture (Figure 34). The elemental spidergrams of KTH002 show increased element variability across the transect due to the multiple micro-veins that splay off the central vein, though relative trends still exist. The chemical alteration shows relative enrichments of Na, Al, and O, but is most noticeable for its depletions in Mg, Ca and Fe. Sharp peaks and troughs mark the fractures surface with Mg, Cu, Ce, Ti, Si, and K all depleted, this can be related to the slight difference in mineralogy at the centre of the alteration/fracture. A trend of enriched/depletion occurs in the data (left of fracture line) with closely associated relative enrichment of Na, Mg, Al, P, S, K, Ce, Mn, Fe, and Cu and depletion in O, Si, and Ti, highlighted by the Al and Si opposing relationship which make the edge of the fractures alteration.

3.2.2.3. KTH003

The spidergram graphs of Figure 35, are comparable with a ~2 mm central vein and ~10mm less defined alteration halo, the transect also crosses a separate vein (spot 12, Figure 36) that is marked by sharp spikes in the data. The central vein (spot 6) is relatively depleted slightly in Mn, Mg, Ti, Fe, and K. Slight enrichments of Na, Al, K, Ca and Ce occur at the edge of the alteration halo (spot 4) and continue to rise across the fracture until the relatively spikes relating to analysis spot 12. Significant enrichments of Na, S, Ce and Fe related to the mineralogy in fld0012.

3.2.2.4. KTH004

The altered fracture of sample KTH004 (Figure 37) includes a 1mm central vein surrounded by a ~10mm undulating alteration halo. The middle of the fracture's alteration (spot 8, in Figure 38) is closely associated with relative enrichment and depletions of the various elements recorded. The alteration is significantly enriched the Na, with the central vein peaking at almost 200x the sodium levels of unaltered rock. Other significant enrichments include Al (2x), S (60x), P (20x), and Ca (4x) that corresponds highly with the central vein. There are also associated depletions of Mg, Si, Fe and a slight associated depletion of Mn that relate to the central vein/fracture. The relative elemental concentrations appear asymmetrical trending across the fracture, with more elements retaining or increasing their levels in analysis maps >spot 8.

3.2.2.5. KTH007

Sample KTH007 represents one half of an altered extensional fracture, the fracture's surface/face is highlighted in Figure 39, as the planar edge of the thin section. Visually, the alteration begins at the fracture's face and continues out to analysis spot 8, which corresponds to noticeable changes in elemental concentrations (Figure 40). The edge of the alteration halo corresponds with relative enrichments in Mg, S, Ti, P, Ce, Mn, Fe, and Cu which sharply drop off to depleted levels moving in the alteration zone. Iron, Mg, K and Mn continue to have depleted levels progressing towards the fractures face. Significant enrichments of Na, and Al starts at normalised unaltered levels and continue to increase towards the fracture face. Sodium significantly continues to rise towards the central vein, increasing relatively 6x the normalised value. Sharp rises in relative S (2x) values in the spidergram is resultant of singular sulphide-rich minerals in the alteration zone, in comparison to very poor S content country rock.

3.2.2.6. KTH008

The normalised spidergram graphs of sample KTH008 (Figure 41) are characterised by sharp changes of relative enrichment/depletion closely associated with the central vein that cuts through the sample. High levels of enrichment in the vein of Mg (4x), Ce (2x), Mn (8x) and Fe (3x) are followed by relative depletions in the elements on either side of the vein/fracture. This pattern is also reversed with relative depletion of Na, Al, Si, K, and Ti closely associated with the fractures centre, followed by enrichment of these elements on either side of the fracture. The high value of S and Fe (Spot 7) at the edge of the central vein corresponds to a large pyrite grain, Figure 42.

4. INTERPRETATION AND DISCUSSION

4.1. Structure Classification

The discrete extensional structures surrounding the Kanmantoo deposit are referred to as fracturing in this paper; this is a broad term encompassing structures that have developed by brittle failure such as faults, joints and sealed (veins) joints (Ramsey & Huber, 1987; Price & Cosgrove, 1991). Jointing refers to fractures of geological origin occurring either singularly or more frequently in a set or a system, but showing no visible movement parallel to the surface of discontinuity (Mandl, 2005). The structures studied in the field area, show no visible signs of shear displacement either on an outcrop scale or in the thin sections analysed as in Figure 43. Schiller's (2000) structural study does correspond with this observation, recording many east-west trending regional fractures sets with no significant displacement, except for small zone where shear displacement was described with respect to the schist fabric (S_2). This small displacement could be related to a localised increase in the extensional stress field.

From the extensive fracture data collected in the study area, the structure can be classified as part of the fundamental fracture mode (I), where relative displacement of the fracture faces (surface) only occurs normal to the facture front, thus opening or dilation of the fracture faces (Mandl, 2005) (Figure 44). Mode I fracturing develop in stress conditions below shear failure and with tensile dilation parallel with the least principal stress axes, σ_3 (Price and Cosgrove, 1991). Of the structures recorded in the field area, dilation of the fracturing is typically mm to cm scale. Fracture length is difficult to assess due to the sparse outcrop, though fracture strike can be traced across outcrops for tens of metres. Extensional fracturing in the mine pit is observered striking across the benches height and width (Figure 45).

The structures can also be classified as a systematic set (Price and Cosgrove, 1991). Extensional fractures are considered systematic when they occur in a set where the structures in the set are parallel or sub-parallel with each other. The majority of structural analyses are sub-parallel to each other, with dip of the fracturing highly comparable to a mean of 75^{o} ±15^{o} and dip direction of 000 ±30^{o} (east-west striking). The slight variations in the orientation of the discrete fracturing (dip/dip directions) could be related to changes in the stress field that affected structure development (faulting in the vicinity of Kanmantoo mine) in the post-Delamerian extensional regime. Wilsons (2009) study showed that there was a rotation of stresses that developed different orientated faulting in a switching compressional-extensional regime. These constantly changing stress fields could have continued into the late stages of extension where the discrete fracturing has developed. Though not as great as the changes in faulting (normal/thrust faults) and fault orientation seen by Wilson (2009), the discrete fracturing does rotate a fair bit, especially in the north area of the field area.

The variation of fracture frequency seen in the study area is highlighted by a general increase of fractures per m in close vicinity to the Kanmantoo mineralisation, Figure 20. In this area fracture density appears to have a fracture density of 8-15 f/m compared to the fracture frequency mean of 4-5 f/m. The increase of the discrete fracturing around the mineralisation supports the theorised dilatational jog or oblique transtensional jog (Flocke *et al.* 2009), which would cause an increase of structural deformation. Structural studies by Wilson (2009), Burtt (2003), and Stephens (2004) showed an increase of faulting and structures, (Figure 2) in close vicinity to the Kanmantoo mineralisation which further support the theory of the jog or damaged zone. Variations of fracture frequency also shows a continuation of increased fracture frequency towards the southern areas of the study area but only an average fracture frequency in the northern areas, evidence which may support a southern continuation of fracturing and fluid migration.

4.2. Geochemistry

The extensional fracturing in the study area was subjected to hydrothermal alteration, with fluid migrating along the dilating structure, during or directly following the rocks tensile failure/propagation. The systematic fracture set recorded in the study area has three broad styles of infill mineralogy, sulphide-rich, silica-rich and bleached altered fractures. The sulphide-rich fractures are only observed in the mine pits walls and benches, quartz infilled fractures are also present in this zone, though no bleached altered fracture are present. The east-west trending sulphide infilled fractures in the mine are not exceedingly mineralised, as described by Wilson (2009) and Stephens (2004). Silica-rich infilled structures are observered in the majority of areas and orientations. East-west trending quartz infilled fractures look to be enriched in Fe, due to the increased/prominent iron staining on exposed fracture surfaces. The bleached alteration fractures are distributed throughout the study area and can be related to fluid migration concurrent with mineralisation at the Kanmantoo mine.

The bleached alteration fractures have been analysed for the elemental changes across the fracture in an effort to understand the geochemistry. The SEM-EDAX produced data that is highly relative to the mineralogy, grain size and textures of the samples. As the areas mapped using the SEM EDAX system are ~2mm^2 each at 200x magnification and single mineral grain range from 10-50% of the mapped area, analysis results are highly subjective to the field of view. Though this analysis technique was used to record bulk chemical changes insitu across discrete fractures and is supported by petrographic observations.

The bleached fractures were found to have a relative enrichment of Na, Al, ± Ca, and relative depletions of Fe, Mg, and ± P, K. The mineralogy of the samples reflects these enrichments/depletions, with the central vein/fracture surfaces dominated by sodium (and calcium) rich plagioclase as well as K-feldspars and a chlorite rich core (Figure 27). The alteration halo surrounding the central vein has a similar feldspar dominated mineralogy and the other dominant feature in the halo is the destruction of the biotite schist fabric (S_2). These geochemical and mineralogical alterations are similar to features of joints forming in the late stage cooling phases of granitic gneiss in Lavertezzo, Switzerland (Ramsey and Huber, 1987) and steeply dipping extensional fractures in the Newark Basin, New Jersey (Herman, 2009). Ramsey and Huber (1987) describe bleached jointing as a result of hydrothermally active fluids migrating through the dilated joints in late stage cooling of igneous and metamorphic rocks. The bleached alteration caused by the fluids destroys/transforms the biotite minerals into orthoclase feldspar and a thin central chlorite vein. Albite rich feldspars infill the earliest group of sub-vertical extensional fractures in the Newark Basin, with crystalline growth aligning perpendicular to the fracture plane (Herman, 2009). This is similar to what is seen in the Kanmantoo samples. The relative elemental analysis also recorded sharp peaks of Cu and S in and adjacent to the central vein, indicating a possible relationship with the main Kanmantoo Cu-Au mineralising fluids.

Oliver *et al's.* (1998) study on fluid flow and metasomatism of the Kanmantoo deposit showed a distinct enrichment of Fe, Cu and S in the mineralised zone at the expensive of depletion of Na and Ca. During ore formation various elements (O, Ca, Na, Sr, S, Cu and Fe) where transported and focused in the deposit at a 100m to >1km regional scale. Though in the mineralised veining Na, Ca and Sr were removed by the fluid phase on a >10 m scale (Oliver *et al.*, 1998).

Tedesco's (2009) analysis on the orogenic model for the Kanmantoo deposit on a local scale supports Oliver et al (1998) results (on a regional scale) with bulk comparative geochemistry and geochemical modelling. Alteration trends in the deposit show an enrichment of Fe, Cu, S, Mn, Au and Ag when compared with the original sedimentary lithologies (Tedesco, 2009). Geochemical modelling of the fluids resulting in mineralisation at Kanmantoo was conducted by Tedesco (2009) at estimated mineralising conditions of 370-385^{o}C and pressures of 280-320 MPa based on TitaniQ thermometry fluid inclusion analysis. Flow through model showed the enrichment of sulphides, copper minerals and chlorite close to the deposit, which decreases as the fluid moves distal to the deposit and returns to an original unaltered country rock composition (Tedesco, 2009). A large spike in feldspar composition slightly distal (stages 9-11 in Figure 46) from the mineralised zone was dismissed by Tedesco (2009) as a modelling error, but could be related to the composition and fluid flow in the extensional fractures regionally surrounding the Kanmantoo deposit. The fractures are also subject to chemical weathering from meteoric fluids which could be a significant problem in comparatively mapping alteration.

4.3. Relationship to Kanmantoo Deposit

There are multiple aspects of the structures recorded in this study that suggest development from post-Delamerian extensional uplift tectonism. However the Kanmantoo Trough might have been subjected to younger (<490 Ma) tectonic activities developed from outside neighbouring sources. After the end of the Delamerian Orogeny and subsequent magmatism relating to extensional uplift, minimal tectonic activity has been recorded to have affected the Adelaide Orogenic Belt. The British Empire Granites and related magmatic intrusions in the North-East of the Adelaide fold Belt (Arkaroola) have been dated at ~440 Ma, a thermal pulse that has developed post Delamerian (Elburg et al, 2003). Hydrothermal activity leading to the development of Beltana's Willemite deposit (100km South-west of Arkaroola) has been date at ~435 Ma (K-Ar dating), a very sillimar age, though not necessary related to the British empire granites (Groves *et al.*, 2003). These thermal tectonic activities have been theorised to be related to the Lachlan Fold Belt, of Ordovician to Carboniferous age on the eastern side of the Adelaide Fold Belt. Deformation on the western provinces of the Lachlan Fold Belt has been dated (Ar-Ar dating of micas) at 440 Ma which corresponds with the ages of tectonism recorded in the northeast sector of the Adelaide Fold Belt (Foster *et al.* 2001; Elburg et al, 2003). The Breakup and extension of the Australian and Antarctica sections of Gondwana in the Cretaceous, produced dominant north-south faulting (Miller *et al.* 2002), though east-west jointing is recorded in relationship with the Delamerian and western Lachlan boundary, which is very distal from the Kanmantoo deposit.

The difference in alteration fluids migrating through the extensional fracturing is also key evidence for a post-Delamerian fracture development. The abundantly distributed albitic alterated fracturing is recorded throughout the study area except for the pit walls. If fracture development occurred in conjunction with the possible

~440 Ma age, fracturing and albitic alteration would overprint the mineralisation and surrounding geology.

Structural and geochemical evidence supports a post Delamerian extensional origin for the discrete fracturing studied. The major indication of post Delamerian development is that the fractures cross cut all D_1 to D_3 structures and foliation (S_2) on a mine and regional scale. Orientation and growth of the fractures also suit the stress field related to the localised oblique transtensional jog theorised by (Flocke *et al.* 2009). Orientation of the fractures can be related to the last phase of deformation (described by Wilson, 2009) of the Delamerian Orogeny (Figure 47-48). Wilson (2009) described four stages of deformation relating to the mineralisation and the fault population of the Kanmantoo deposit. The four stages of deformation cycle through compression and extensional stages, with mineralisation only developing in east dipping normal faults (relating to the first extension phase). The last stage of principal stress reversal resulted in north dipping normal faulting surrounding the mineralisation which post date all other deformation in the area (Wilson, 2009). These structures relate to an extensional regime which post dates the Delamerian Orogeny at ~490 ±3 Ma. The north dipping faults are also closely associated with high frequency fracturing; with multiple fractures around the faults, with spacing's of 5 to 8 cm (Wilson, 2009).

The regional trend of distribution and extent of the east-west fracturing may provide evidence towards the theory of Kanmantoo trough mineralisation held by Flocke *et al.* (2009). This involves a north-south fluid mineralising corridor that includes the deposits of Kanmantoo, Alcare, Bremer, Wheal Ellen, Angas, and Strathalbyn. The Northern section of the study area shows inconsistencies in fracture frequency, orientation and extent with increased distance from the centralised Kanmantoo deposit. Extensional fracturing in the north appears to terminates with large sectors in the north-west and north-east containing no east-west structures or albitic alteration. The direct opposite can be implied about the southern regions of the study site with a continuation of the albitic alteration in fractures and similar fracture frequency and orientation found up to 7km south from the deposit. Further interpretations of these distal regional trends must be limited due to the increased distances between observations.

5. CONCLUSION

A discrete systematic fracture set has been recorded in the vicinity of the Kanmantoo Cu-Au mineralised deposit. The Fracture set trends east-west, dip steeply to the north, striking tens of metres, and show a fairly consistent structural frequency. The fractures, which show no visible signs of shear, cross cut the foliation (S_2) that formed due to the Delamerian Orogeny of 514-490 ±3 Ma (Foden *et al.*, 2006). Fluid migration along the dilation structures was found to develop three broad alteration types; albite (feldspar), silica, sulphide-rich veining. Albitic altered fracturing is the most abundant and wide spread, with relative geochemical analysis showing enrichments of Na, Al and Ca and depletions of Fe, Mg and K. The relative geochemistry and petrography of the altered fractures have been linked with late stage extensional cooling and fluid flow-through model of Tedesco (2009).

Data from this study supports the development of systematic fracturing relating to post-Delamerian extension at ~490 Ma. Termination of the Delamerian Orogeny related to slab roll back resulted in uplift and extension (Foden *et al.* 2009); with the youngest structures observered north dipping normal faults (Wilson, 2009).

To completely understand the systematic fracture set and its relationship with the Kanmantoo deposit, further work must be conducted on-

- Confining the full regional extent of the east-west trending fractures and related alterations;
- Oxygen isotope analysis on the fractures alteration to deduce fluid origin; and
- Similar structurally mineralised deposits for comparative discrete altered fracturing.

6. ACKNOWLEDGEMENTS

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8. FIGURE CAPTIONS

Figure 1. Location of the Kanmantoo Trough, in relations with other major South Australia geological provinces.

Figure 2. A 1 : 50 000 scale geology map, localised around the Kanmantoo Cu-Au deposit, South Australia (Source: Schiller (2000), Abbot (2005)).

Figure 3. Location of samples KTH001-KTH008 from diamond drill core and outcrop.

Figure 4. KTH001 Example of the geochemical analysis transect taken across the altered fractures.

Figure 5. QMF schist outcrop, with fractures (red) continuing through outcrop and cross cutting foliation (S_2) (grey), fracture surfaces have formed due to weathering processes.

Figure 6. Road cutting showing the systematic fracture sets, steeply dipping north, central fracture has increased ~20cm alteration halo.

Figure 7. The two main bleached altered fracture types found in the study site (QMF schist), cross cutting the foliation (S_2). Discrete 1mm vein (left) showing no significant dilation. Open 3mm fracture (right) with 15mm bleached alteration.

Figure 8. Quartz infilled extensional fractures. (a) planar east-west fracture surface with residual quartz material left on surface (b) small outcrop showing closely spaced fracturing with ~20mm thick quartz veining

Figure 9. Sulphide-rich planar fracturing observered in the deposits pit wall, the central vein material has been highly weathered away, leaving little remnant material and slight alteration.

Figure 10. Stereonets of the complete recorded structural data. Shows systematic characteristics with a mean principal orientation of $75/359^o$.

Figure 11. Schematic diagrams of division of structural data (a) east-west (b) compass quadrants (c) north to south and (d) mine to regional.

Figure 12. Stereonets of East-West division.

Figure 28. SEM image of central vein of KTH001, displaying the mineralogical alteration of the country rock to fracture faces.

Figure 29. Sample KTH001- Elemental spidergrams of fracture transect through the alteration halo and central vein; normalised to unaltered rock.

Figure 30. Elemental maps of KTH001 fracture transect- showing the mineralogy and element concentration of analysis spots along transect.

Figure 31. Relative element graphs of major enrichment/depletion associations in maps K1M1-K1M3 at 25x magnification. A transect across the centralised fracture and alteration from a larger field of view.

Figure 32. Relative element graphs of major enrichment/depletion associations in maps K1L1-K1L4 at 25x magnification. A transect across the centralised fracture and alteration from a larger field of view.

Figure 33. Sample KTH002- Elemental spidergrams of fracture transect through the alteration halo and central vein; normalised to unaltered rock.

Figure 34. Elemental maps of KTH002 fracture transect- showing the mineralogy and element concentration of analysis spots along transect.

Figure 35. Sample KTH003- Elemental spidergrams of fracture transect through the alteration halo and central vein; normalised to unaltered rock.

Figure 36. Elemental maps of KTH003 fracture transect- showing the mineralogy and element concentration of analysis spots along transect.

Figure 37. Sample KTH004- Elemental spidergrams of fracture transect through the alteration halo and central vein; normalised to unaltered rock.

Figure 38. Elemental maps of KTH004 fracture transect- showing the mineralogy and element concentration of analysis spots along transect.

Figure 39. Sample KTH007- Elemental spidergrams of fracture transect through the alteration halo and central vein; normalised to unaltered rock.

Figure 40. Elemental maps of KTH007 fracture transect- showing the mineralogy and element concentration of analysis spots along transect.

Figure 41. Sample KTH008- Elemental spidergrams of fracture transect through the alteration halo and central vein; normalised to unaltered rock.

Figure 42. Elemental maps of KTH008 fracture transect- showing the mineralogy and element concentration of analysis spots along transect.

Figure 43. Image and sketch of extensional fracture cutting through the GAB schist in the pit wall. Fracture is infilled with sulphides that have weathered away leaving fracture surface. Fracture also cuts through a thin north trending quartz vein that shows no visible signs of offset or shear in relations with the later stage fracturing.

Figure 44. Mohr stress circle showing the difference in dilation, shear and shear-dilation and with tensile dilation parallel with the least principal stress axes, σ_3 (Sourced from Price and Cosgrove, 1991).

Figure 45. Continuous sub vertical fracturing present in the western walls of the mine pit. Fractures are observed to continue from the pit floor to the surface ~100+m high. Fractures cut across all visible structure.

Figure 46. Flow through model by Tedesco (2009) at 370^{o} and 300 MPa. Model of fluid composition from the Kanmantoo mineralising deposit spreading out distally to normalise with country rock composition. Anomalous spike in feldspar enrichment, dismissed by Tedesco, could relate to albite altered fractures.

Figure 47. Diagram showing mean fracture dip direction trends of the study area, no representation of fracture frequency.

Figure 48. Diagram showing mean fracture dip direction trends of the study area, no representation of fracture frequency. Colour difference in strike of general fracture trends.

9. TABLES

SAMPLES ANALYSED						
Sample Number	Easting	Northing	Rock Type	Source	Depth	Orientation (D / DD)
KTH001	317948	6116295	garnet-andalusite-biotite schist	outcrop	0m	86 / 352
KTH002	316566	6114966	quartz-mica-feldspar schist	outcrop	0m	71 / 168
KTH003	318408	6114415	garnet-andalusite-biotite schist	diamond drill core	95.3m	80 / 345
KTH004	318210	6114340	garnet-andalusite-biotite schist	diamond drill core	12.8m	79 / 169
KTH007	317782	6114507	quartz-mica-feldspar schist	diamond drill core	54.6m	82 / 350
KTH008	318434	6115095	garnet-andalusite-biotite schist	diamond drill core	148.9m	76 / 002

Table 1. Samples Analysed- the location, rock type, source and orientation of the 6 samples used for geochemical analysis.

10. FIGURES

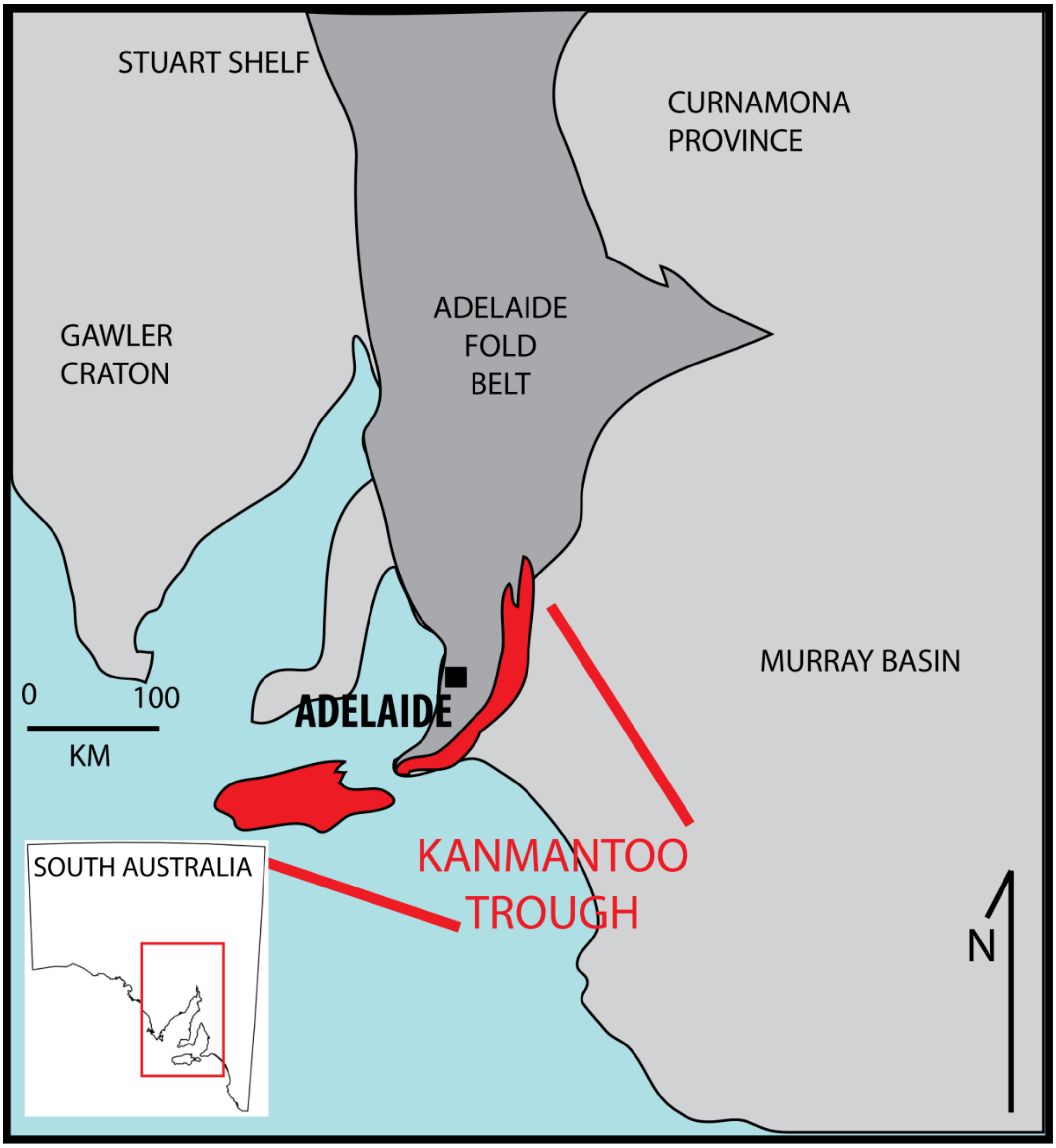
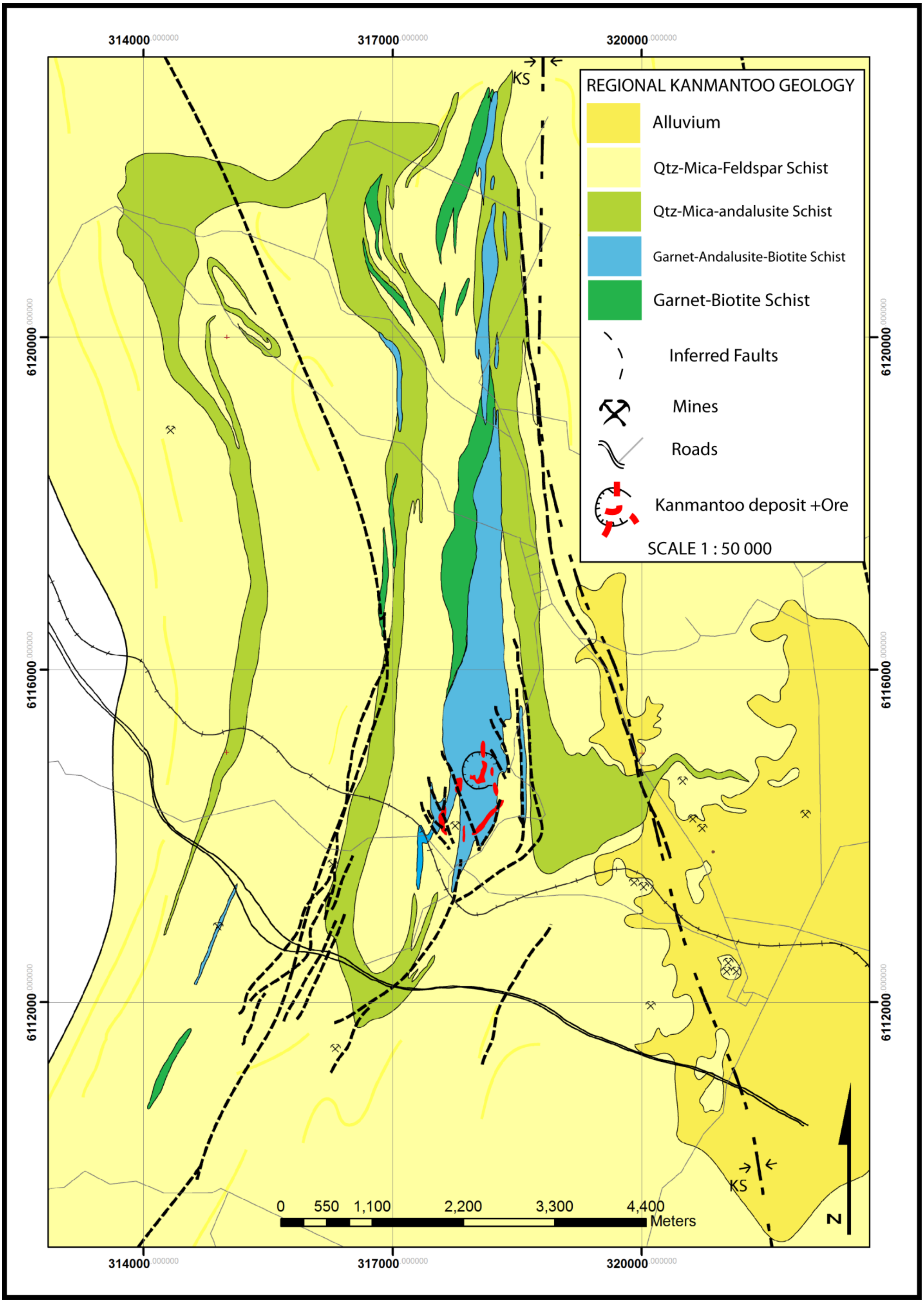
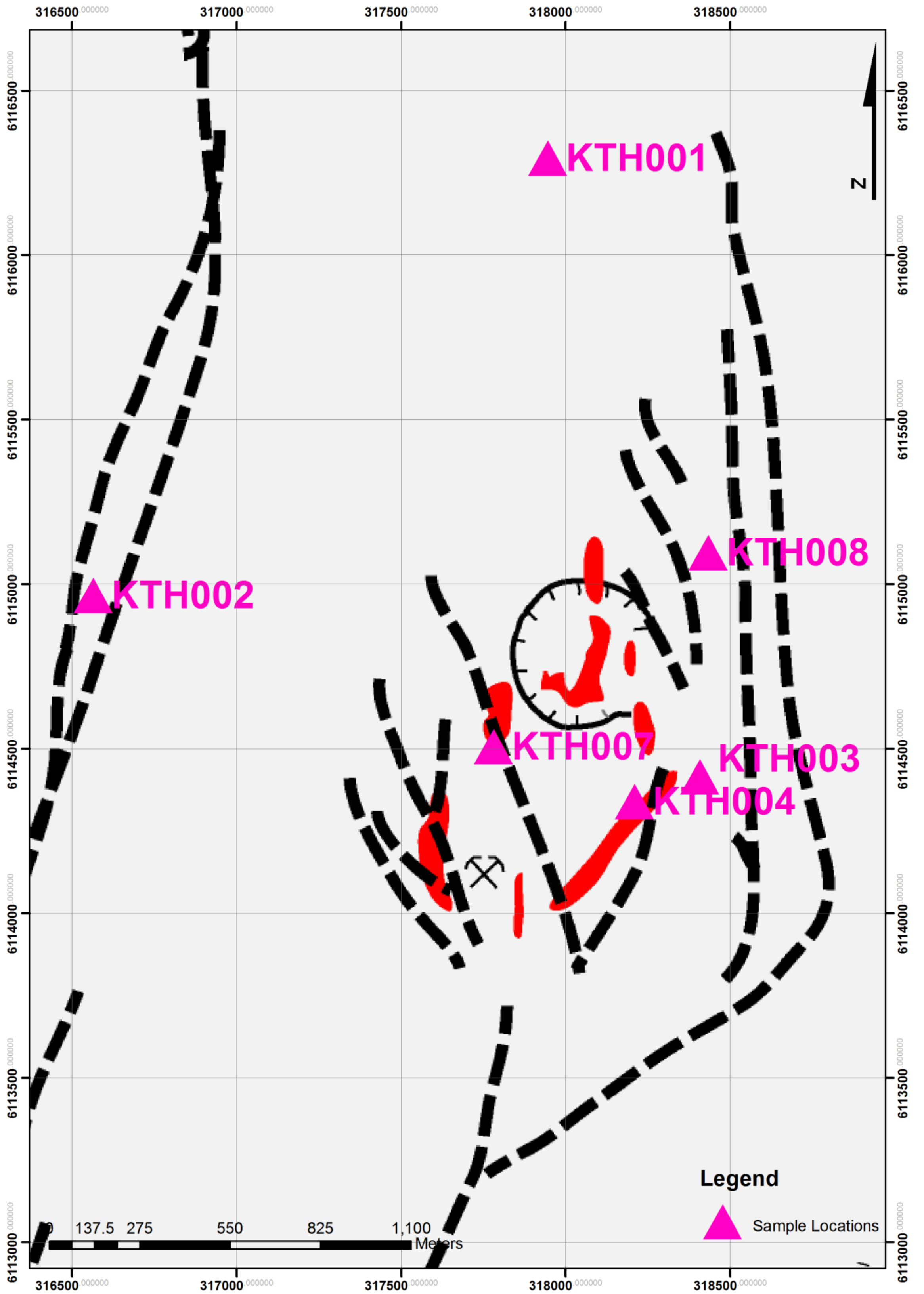


Figure 1



314000
317000
320000
6120000
6116000
6112000
KS
REGIONAL KANMANTOO GEOLOGY
Alluvium
Qtz-Mica-Feldspar Schist
Qtz-Mica-andalusite Schist
Garnet-Andalusite-Biotite Schist
Garnet-Biotite Schist
Inferred Faults
Mines
Roads
Kanmantoo deposit +Ore
SCALE 1 : 50 000
0 550 1,100 2,200 3,300 4,400
Meters
N

Figure 2



316500
317000
317500
318000
318500
6116500
6116000
6115500
6115000
6114500
6114000
6113500
6113000
N
KTH001
KTH008
KTH002
KTH007
KTH003
KTH004
Legend
Sample Locations
0
137.5
275
550
825
1,100
Meters

Figure 3

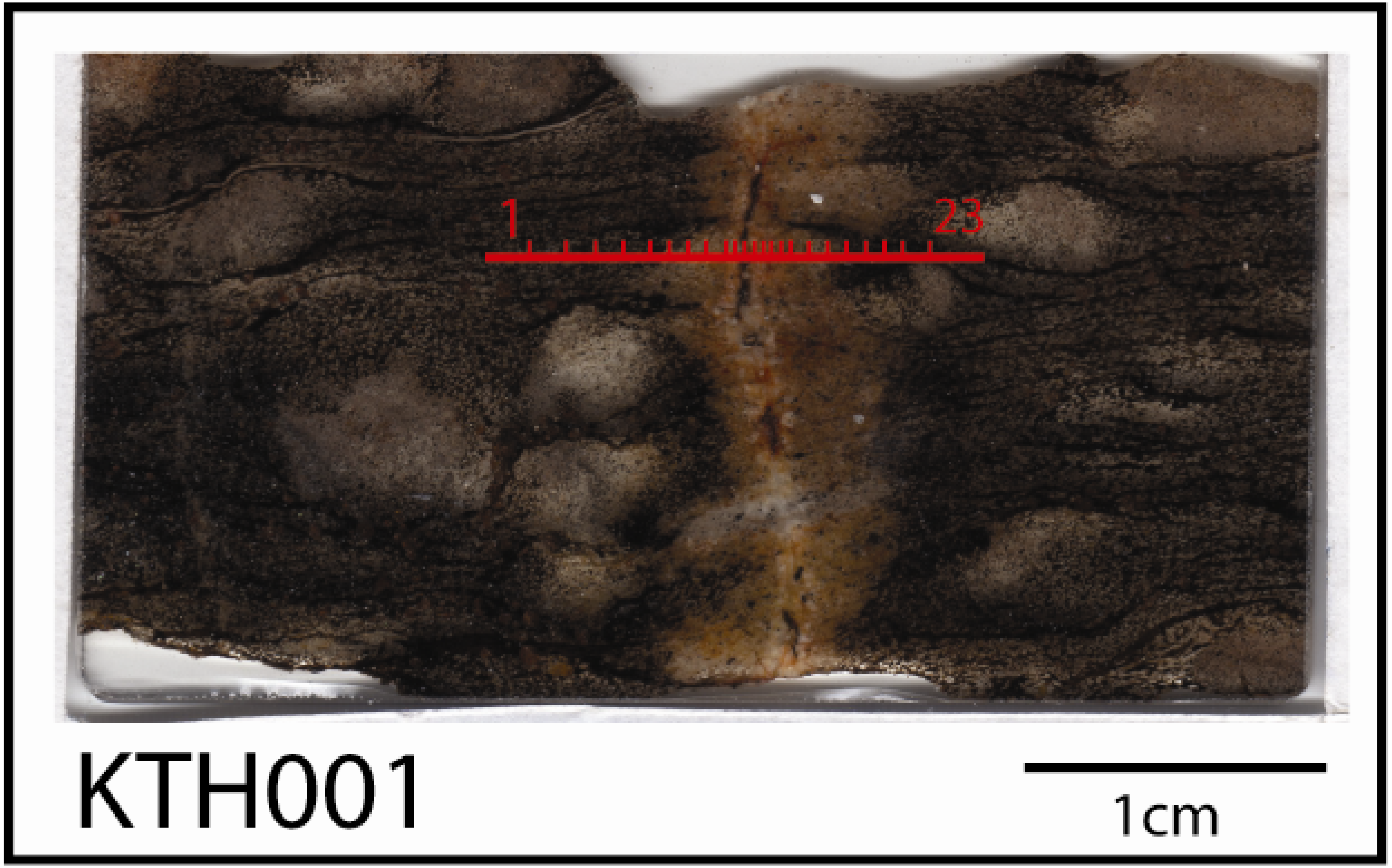
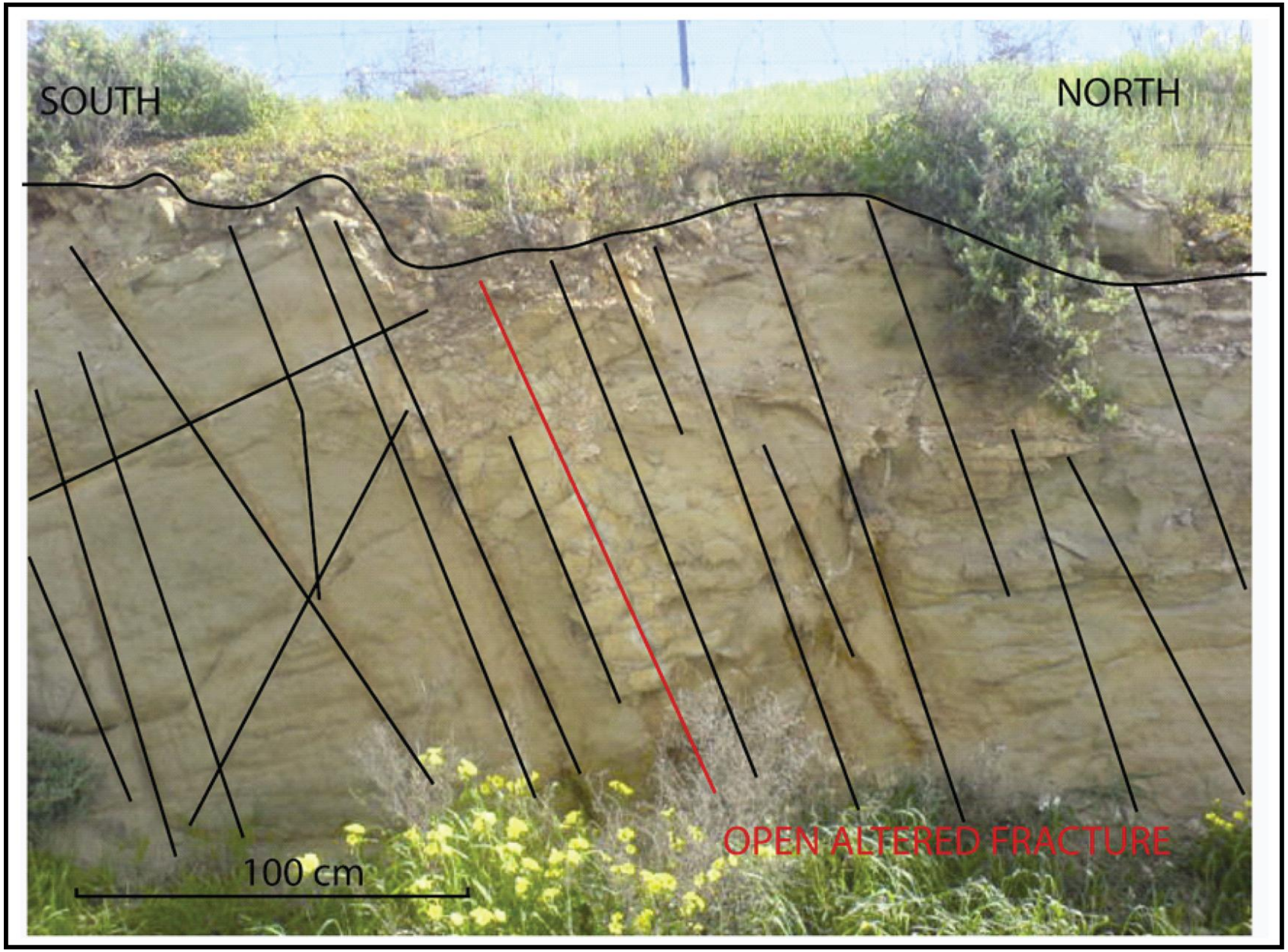


Figure 4

Figure 5



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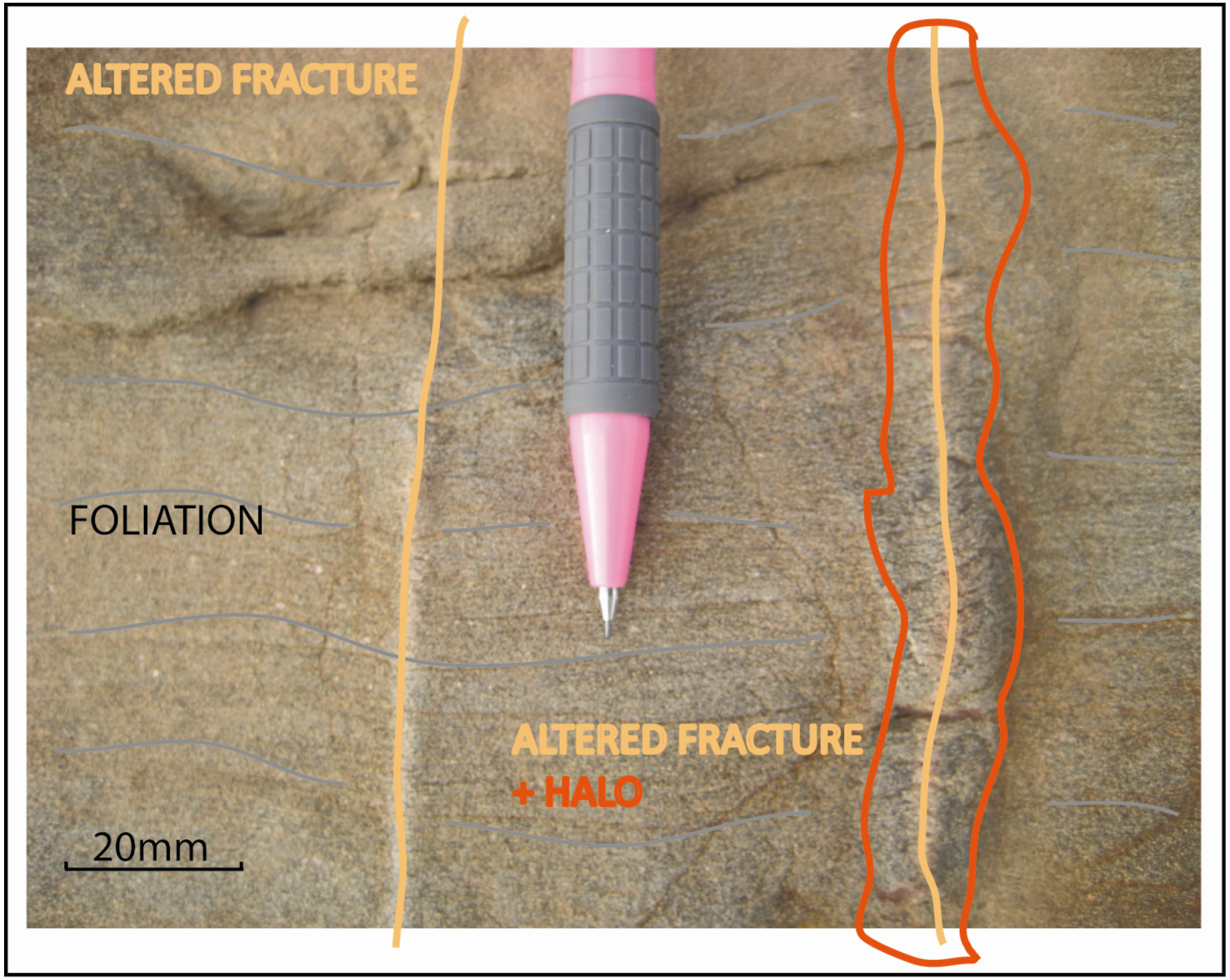


Figure 7

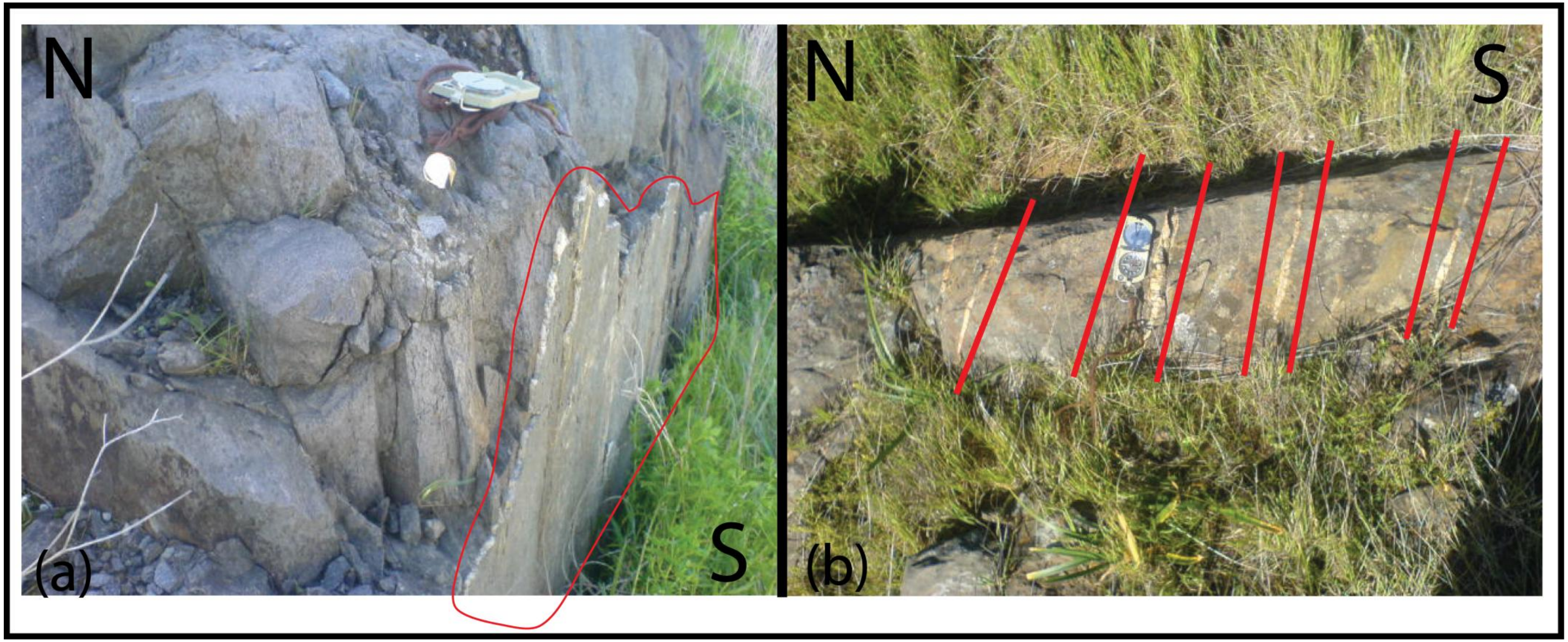


Figure 8

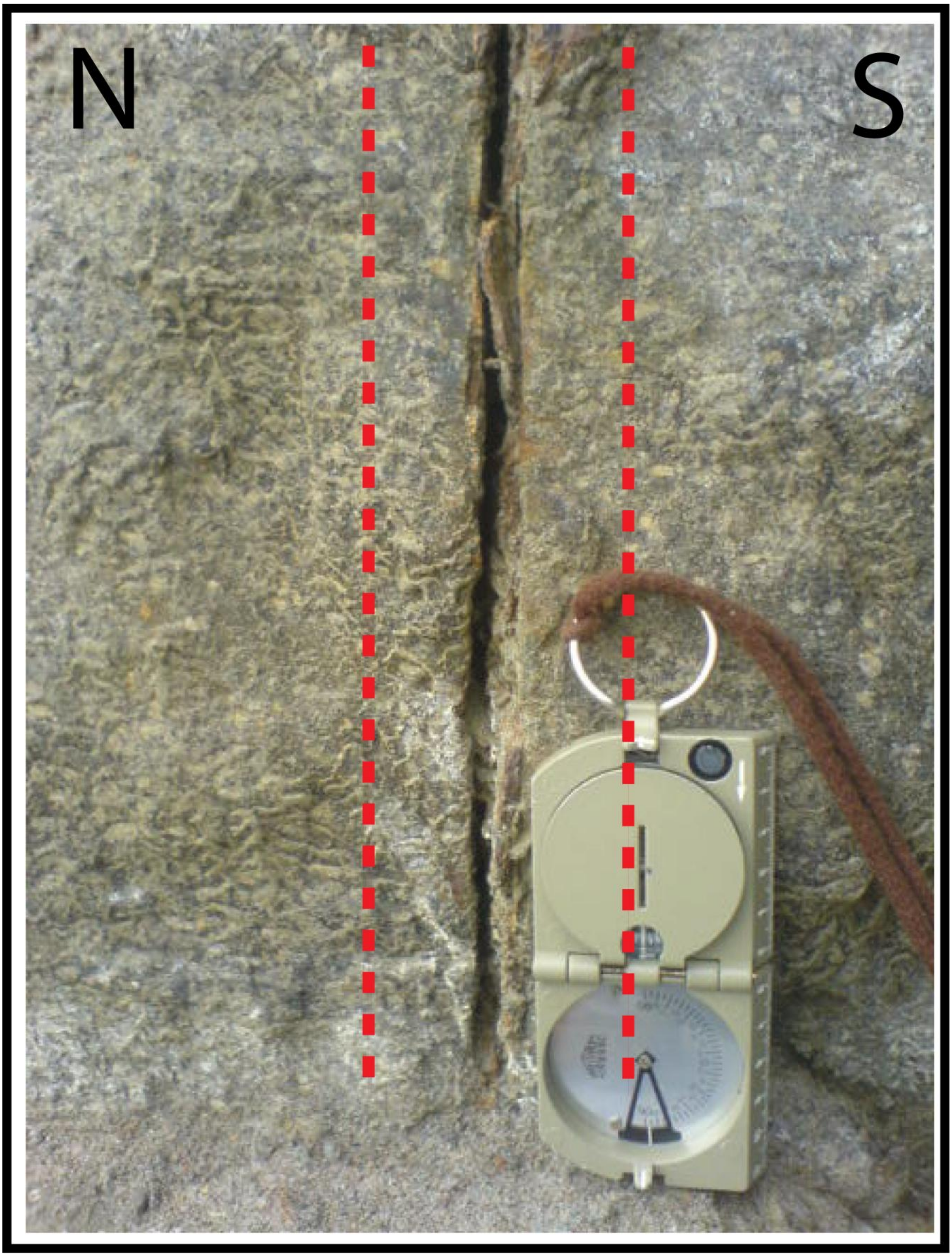
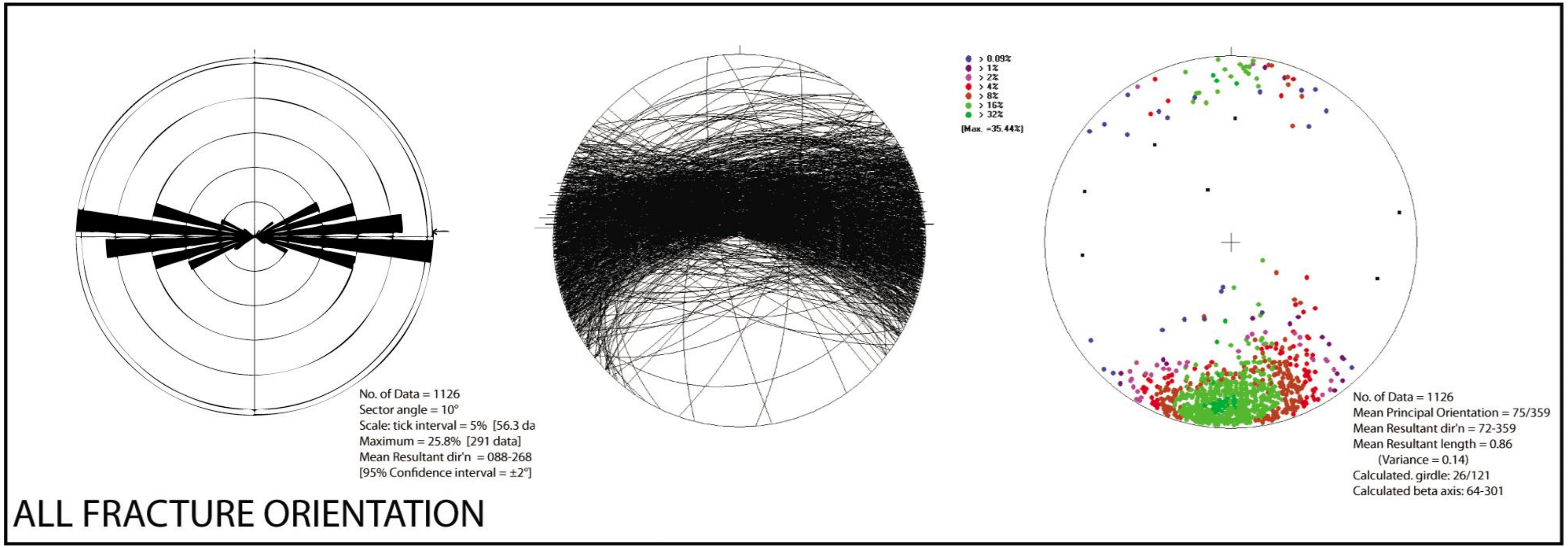


Figure 9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Mean Resultant dir'n = 088-268
[95% Confidence interval = ±2°]
> 0.09%
> 1%
> 2%
> 4%
> 8%
> 16%
> 32%
[Max. =35.44%]
No. of Data = 1126
Mean Principal Orientation = 75/359
Mean Resultant dir'n = 72-359
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(Variance = 0.14)
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ALL FRACTURE ORIENTATION

Figure 10

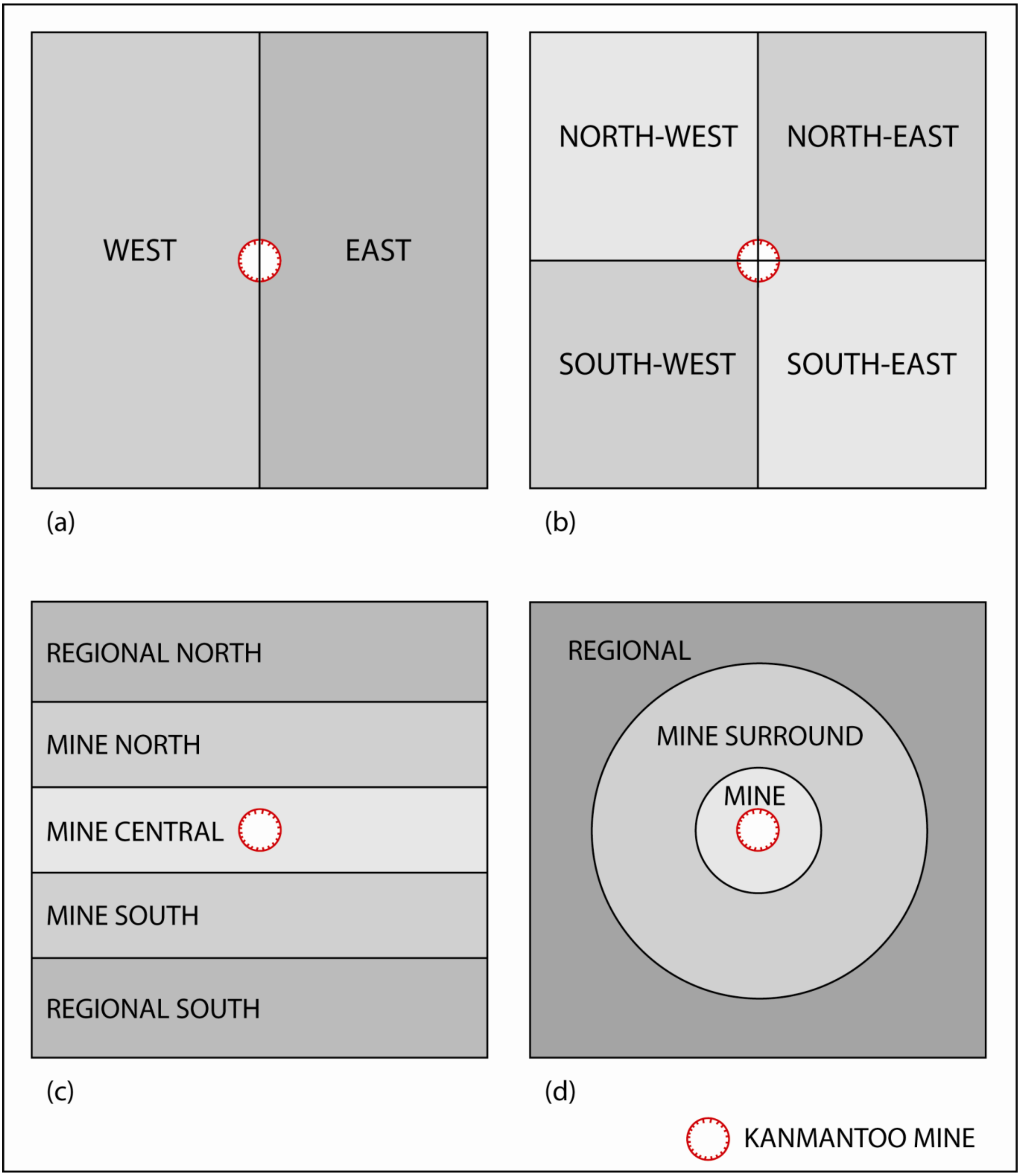
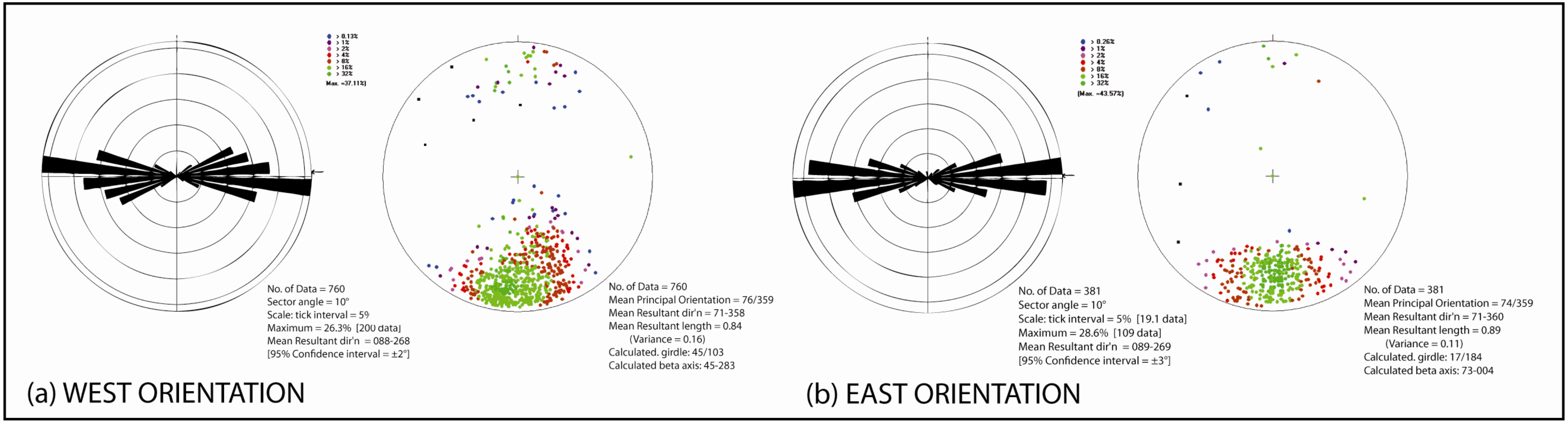

WEST
EAST
(a)
NORTH-WEST
NORTH-EAST
SOUTH-WEST
SOUTH-EAST
(b)
REGIONAL NORTH
MINE NORTH
MINE CENTRAL
MINE SOUTH
REGIONAL SOUTH
(c)
REGIONAL
MINE SURROUND
MINE
(d)
KANMANTOO MINE

Figure 11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Mean Resultant dir'n = 71-358
Mean Resultant length = 0.84
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Calculated beta axis: 45-283
(a) WEST ORIENTATION
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> 2%
> 4%
> 8%
> 16%
> 32%
(Max. =43.57%)
No. of Data = 381
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[95% Confidence interval = ±3°]
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Mean Resultant dir'n = 71-360
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(Variance = 0.11)
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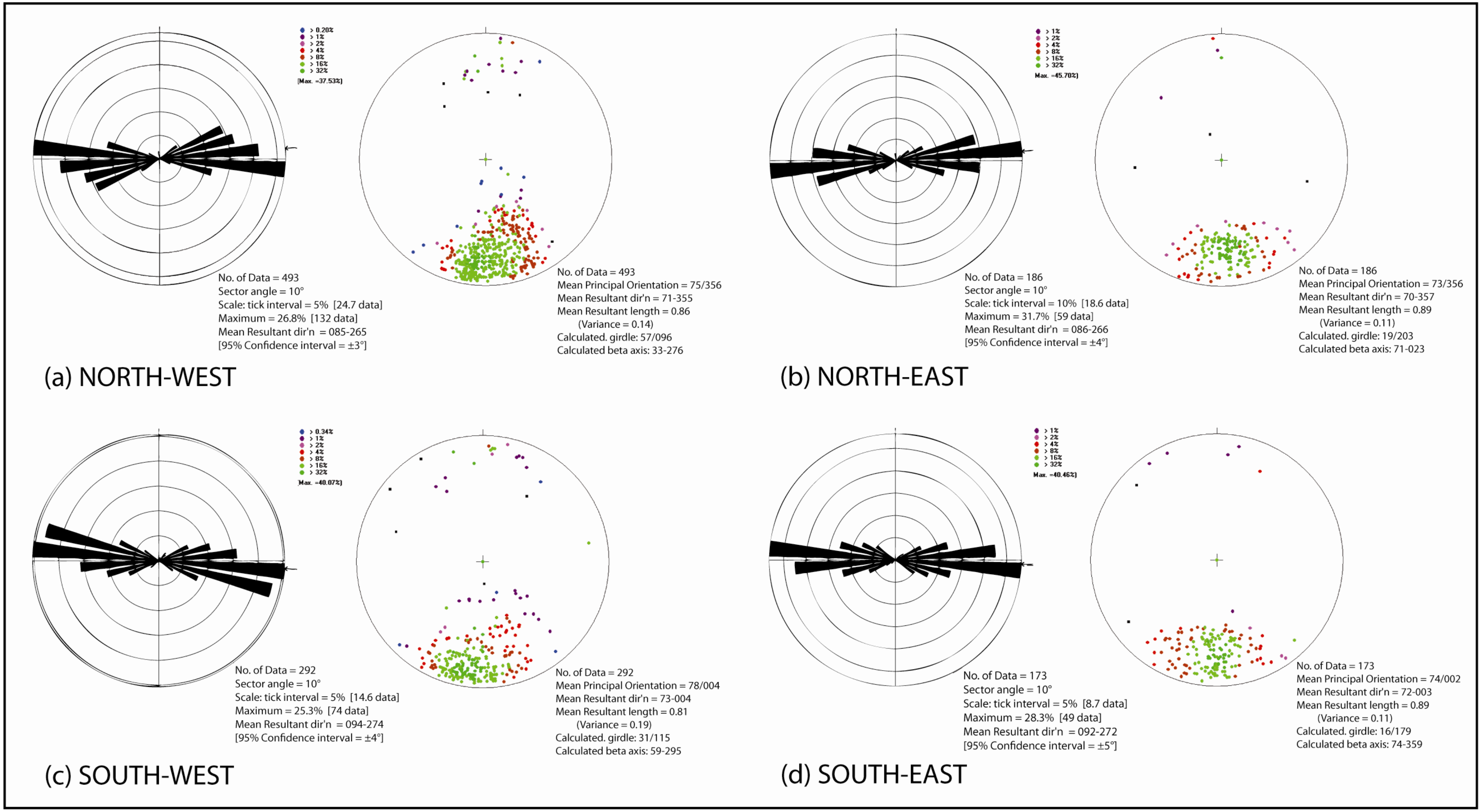
Calculated beta axis: 73-004
(b) EAST ORIENTATION

Figure 12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Mean Resultant dir'n = 70-357
Mean Resultant length = 0.89
(Variance = 0.11)
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Calculated beta axis: 71-023
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[95% Confidence interval = ±4°]
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(c) SOUTH-WEST
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[95% Confidence interval = ±5°]
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Mean Resultant dir'n = 72-003
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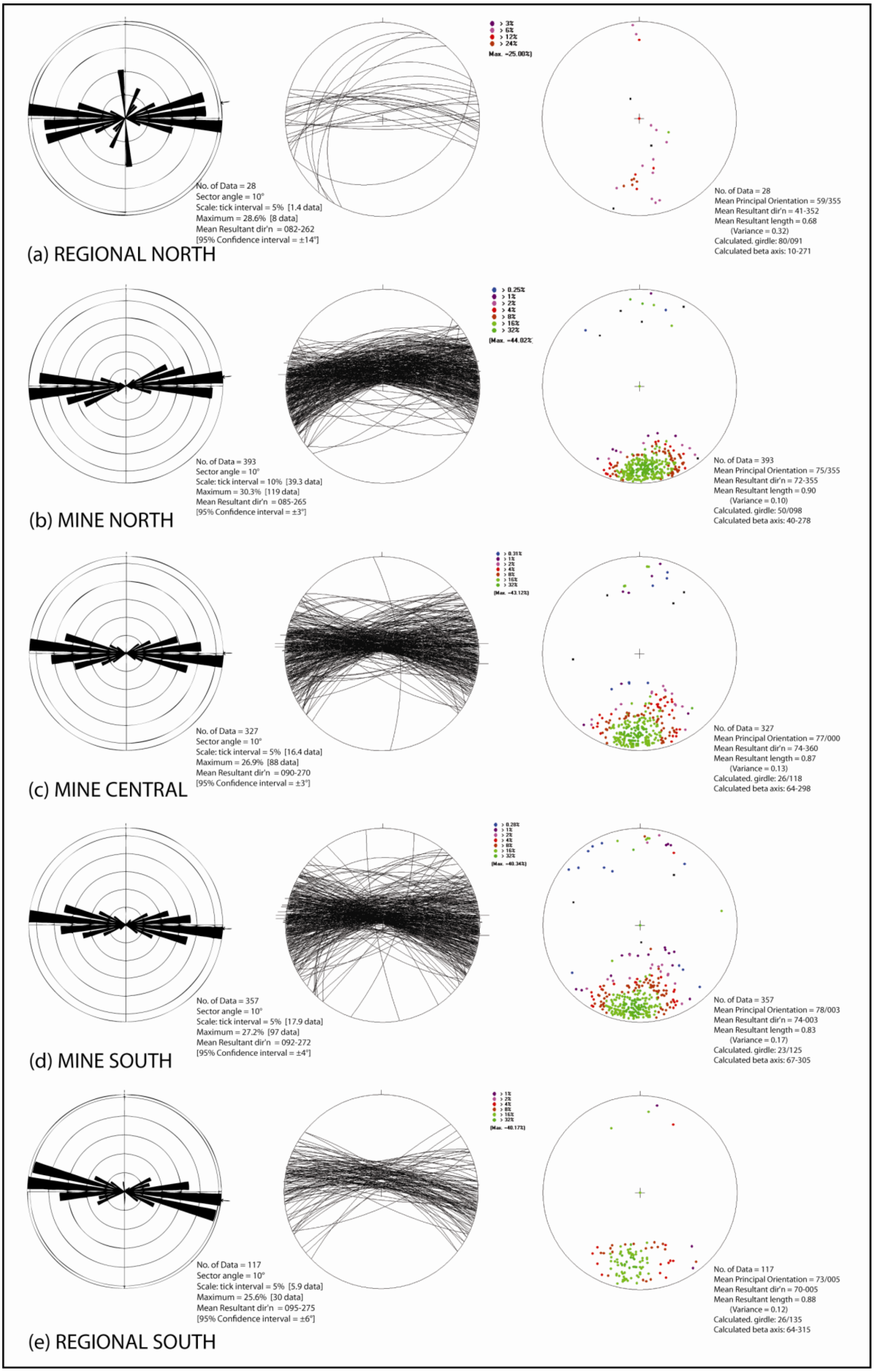
Calculated beta axis: 74-359
(d) SOUTH-EAST

Figure 13



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> 6%
> 12%
> 24%
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[95% Confidence interval = ±14°]
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Mean Resultant length = 0.68
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Calculated beta axis: 10-271
(a) REGIONAL NORTH
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> 4%
> 8%
> 16%
> 32%
Max. =44.02%
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[95% Confidence interval = ±3°]
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Mean Resultant dir'n = 72-355
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(Variance = 0.10)
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Calculated beta axis: 40-278
(b) MINE NORTH
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[95% Confidence interval = ±3°]
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Mean Principal Orientation = 77/000
Mean Resultant dir'n = 74-360
Mean Resultant length = 0.87
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Calculated beta axis: 64-298
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Sector angle = 10°
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[95% Confidence interval = ±4°]
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Mean Resultant dir'n = 74-003
Mean Resultant length = 0.83
(Variance = 0.17)
Calculated. girdle: 23/125
Calculated beta axis: 67-305
(d) MINE SOUTH
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Maximum = 25.6% [30 data]
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[95% Confidence interval = ±6°]
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Mean Principal Orientation = 73/005
Mean Resultant dir'n = 70-005
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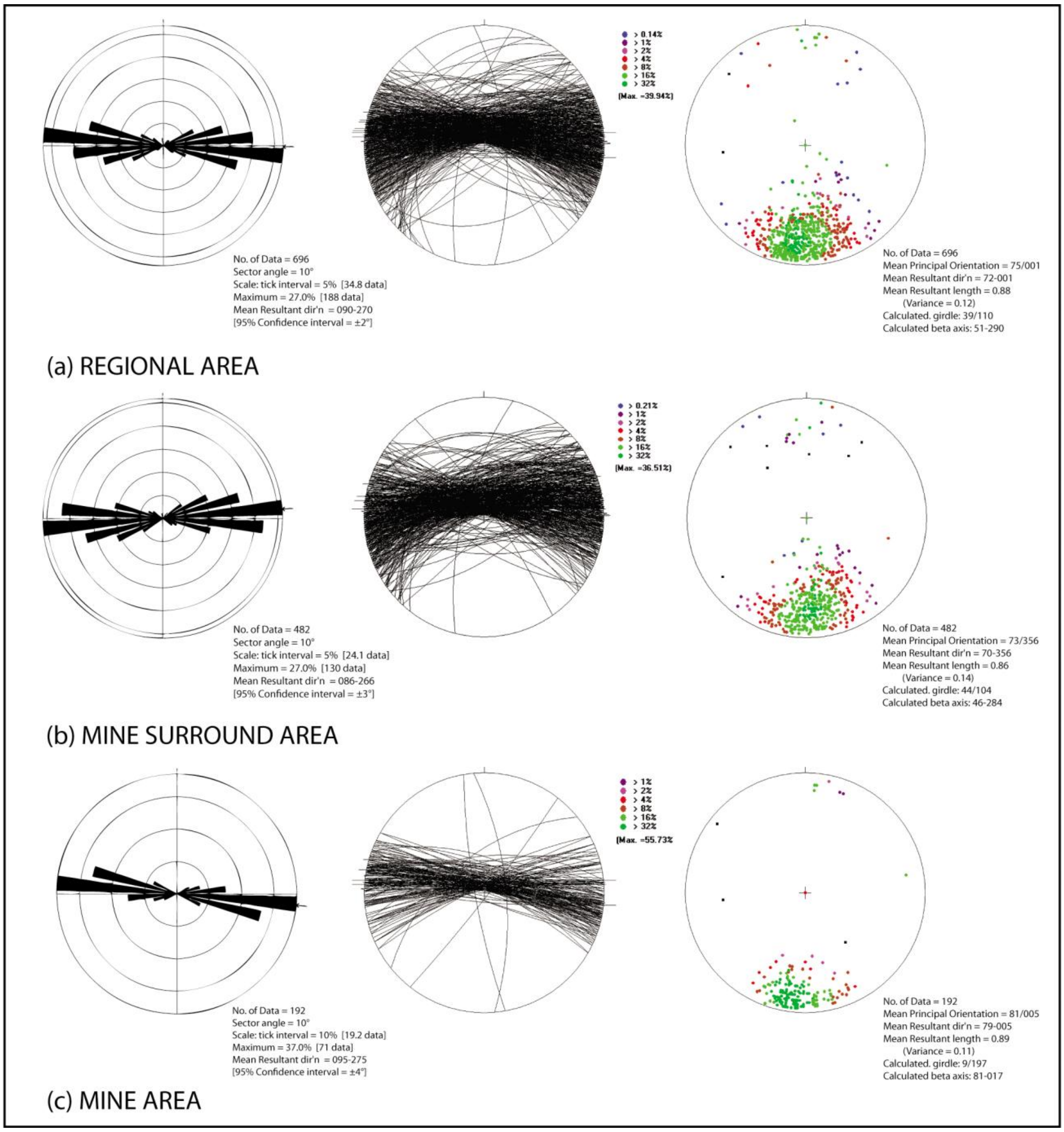
Calculated beta axis: 64-315
(e) REGIONAL SOUTH

Figure 14



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> 1%
> 2%
> 4%
> 8%
> 16%
> 32%
(Max. =39.94%)
No. of Data = 696
Sector angle = 10°
Scale: tick interval = 5% [34.8 data]
Maximum = 27.0% [188 data]
Mean Resultant dir'n = 090-270
[95% Confidence interval = ±2°]
No. of Data = 696
Mean Principal Orientation = 75/001
Mean Resultant dir'n = 72-001
Mean Resultant length = 0.88
(Variance = 0.12)
Calculated. girdle: 39/110
Calculated beta axis: 51-290
(a) REGIONAL AREA
> 0.21%
> 1%
> 2%
> 4%
> 8%
> 16%
> 32%
(Max. =36.51%)
No. of Data = 482
Sector angle = 10°
Scale: tick interval = 5% [24.1 data]
Maximum = 27.0% [130 data]
Mean Resultant dir'n = 086-266
[95% Confidence interval = ±3°]
No. of Data = 482
Mean Principal Orientation = 73/356
Mean Resultant dir'n = 70-356
Mean Resultant length = 0.86
(Variance = 0.14)
Calculated. girdle: 44/104
Calculated beta axis: 46-284
(b) MINE SURROUND AREA
> 1%
> 2%
> 4%
> 8%
> 16%
> 32%
(Max. =55.73%)
No. of Data = 192
Sector angle = 10°
Scale: tick interval = 10% [19.2 data]
Maximum = 37.0% [71 data]
Mean Resultant dir'n = 095-275
[95% Confidence interval = ±4°]
No. of Data = 192
Mean Principal Orientation = 81/005
Mean Resultant dir'n = 79-005
Mean Resultant length = 0.89
(Variance = 0.11)
Calculated. girdle: 9/197
Calculated beta axis: 81-017
(c) MINE AREA

Figure 15

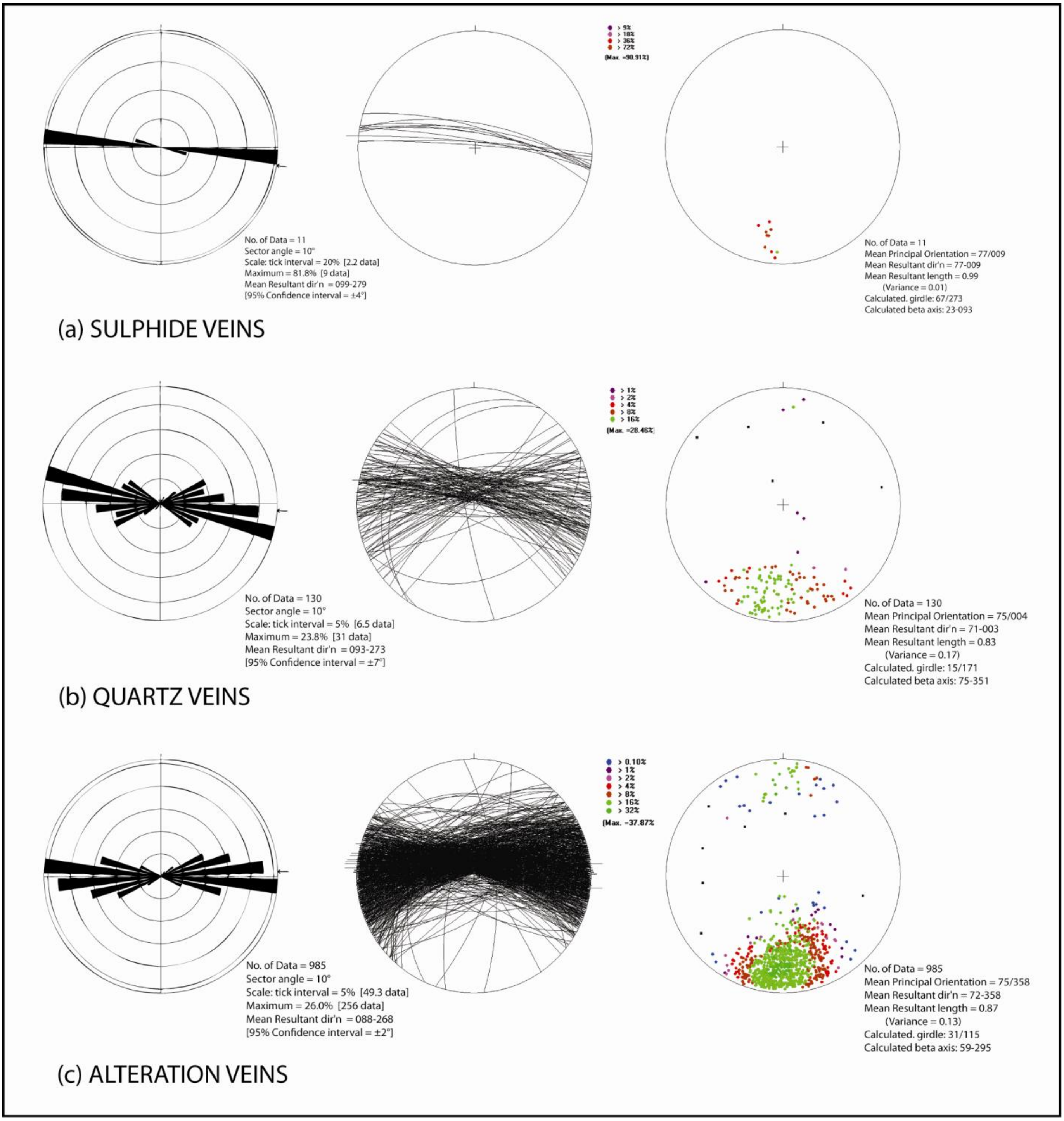
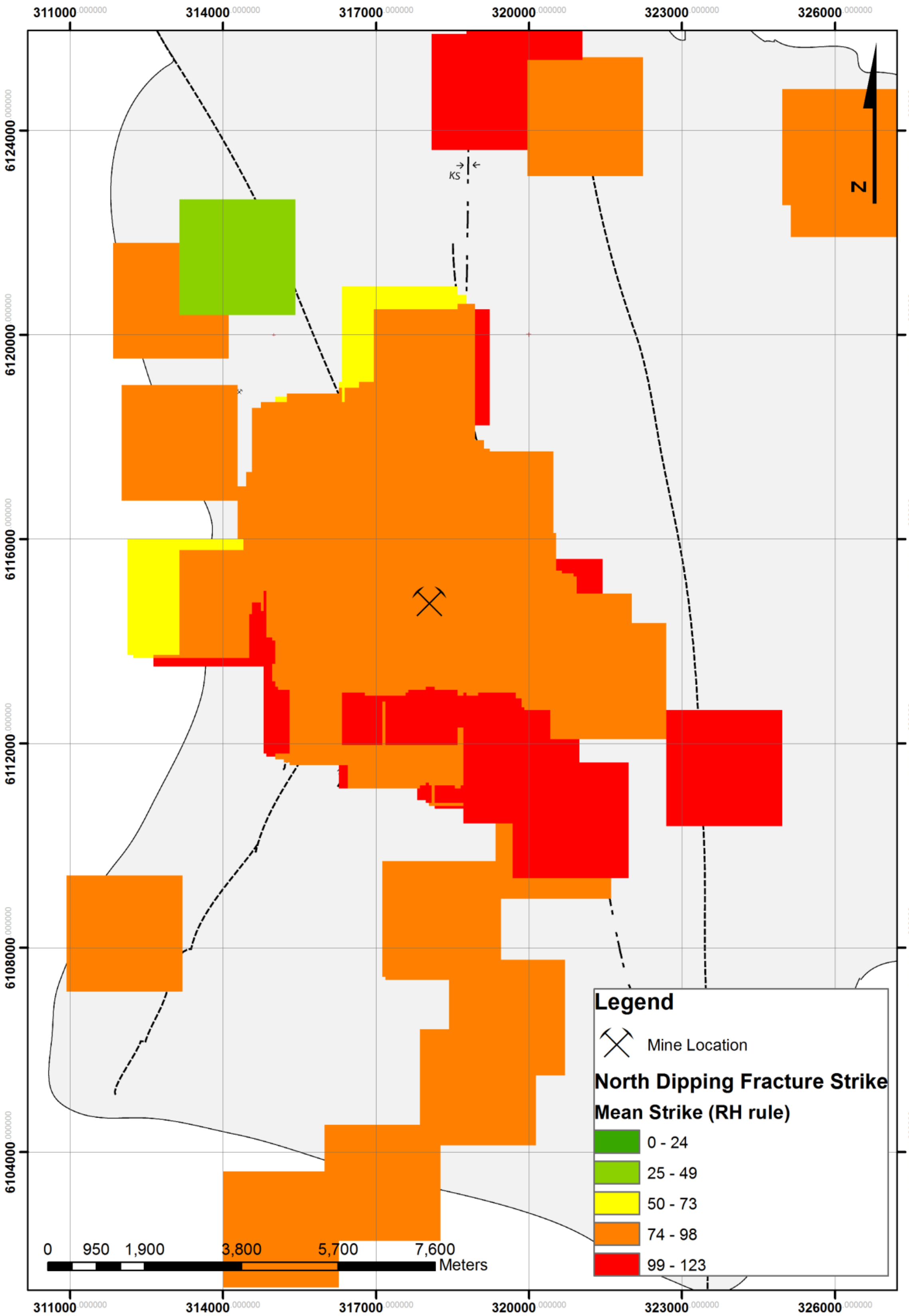

> 9%
> 18%
> 36%
> 72%
(Max. =90.91%)
No. of Data = 11
Sector angle = 10°
Scale: tick interval = 20% [2.2 data]
Maximum = 81.8% [9 data]
Mean Resultant dir'n = 099-279
[95% Confidence interval = ±4°]
No. of Data = 11
Mean Principal Orientation = 77/009
Mean Resultant dir'n = 77-009
Mean Resultant length = 0.99
(Variance = 0.01)
Calculated. girdle: 67/273
Calculated beta axis: 23-093
(a) SULPHIDE VEINS
> 1%
> 2%
> 4%
> 8%
> 16%
[Max. =28.46%]
No. of Data = 130
Sector angle = 10°
Scale: tick interval = 5% [6.5 data]
Maximum = 23.8% [31 data]
Mean Resultant dir'n = 093-273
[95% Confidence interval = ±7°]
No. of Data = 130
Mean Principal Orientation = 75/004
Mean Resultant dir'n = 71-003
Mean Resultant length = 0.83
(Variance = 0.17)
Calculated. girdle: 15/171
Calculated beta axis: 75-351
(b) QUARTZ VEINS
> 0.10%
> 1%
> 2%
> 4%
> 8%
> 16%
> 32%
(Max. =37.87%
No. of Data = 985
Sector angle = 10°
Scale: tick interval = 5% [49.3 data]
Maximum = 26.0% [256 data]
Mean Resultant dir'n = 088-268
[95% Confidence interval = ±2°]
No. of Data = 985
Mean Principal Orientation = 75/358
Mean Resultant dir'n = 72-358
Mean Resultant length = 0.87
(Variance = 0.13)
Calculated. girdle: 31/115
Calculated beta axis: 59-295
(c) ALTERATION VEINS

Figure 16



Legend
Mine Location
North Dipping Fracture Strike
Mean Strike (RH rule)
0 - 24
25 - 49
50 - 73
74 - 98
99 - 123
0 950 1,900 3,800 5,700 7,600
Meters
KS
N
311000
314000
317000
320000
323000
326000
6124000
6120000
6116000
6112000
6108000
6104000

Figure 17

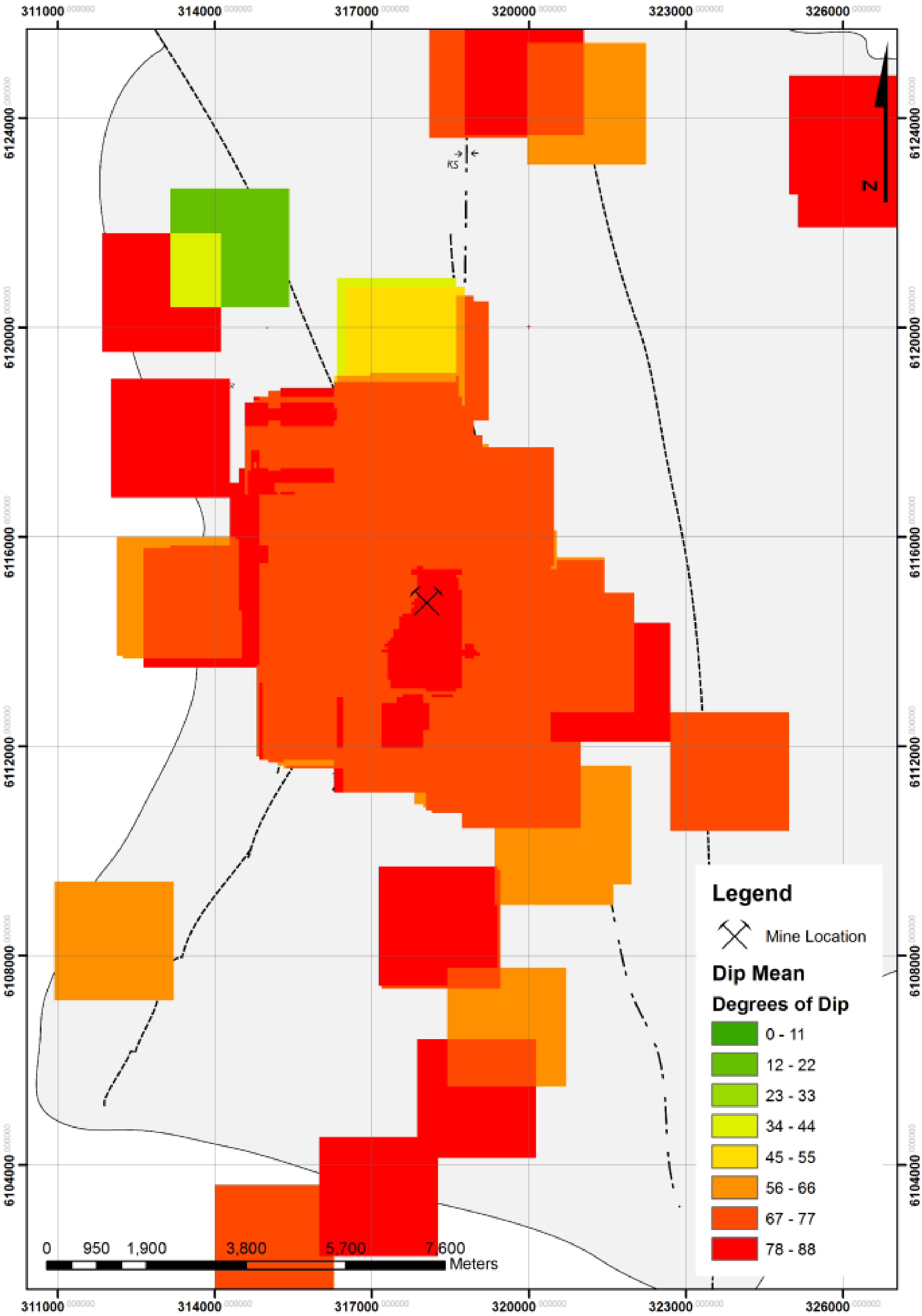

311000
314000
317000
320000
323000
326000
6124000
6120000
6116000
6112000
6108000
6104000
KS
N
Legend
Mine Location
Dip Mean
Degrees of Dip
0 - 11
12 - 22
23 - 33
34 - 44
45 - 55
56 - 66
67 - 77
78 - 88
0 950 1,900 3,800 5,700 7,600
Meters

Figure 18

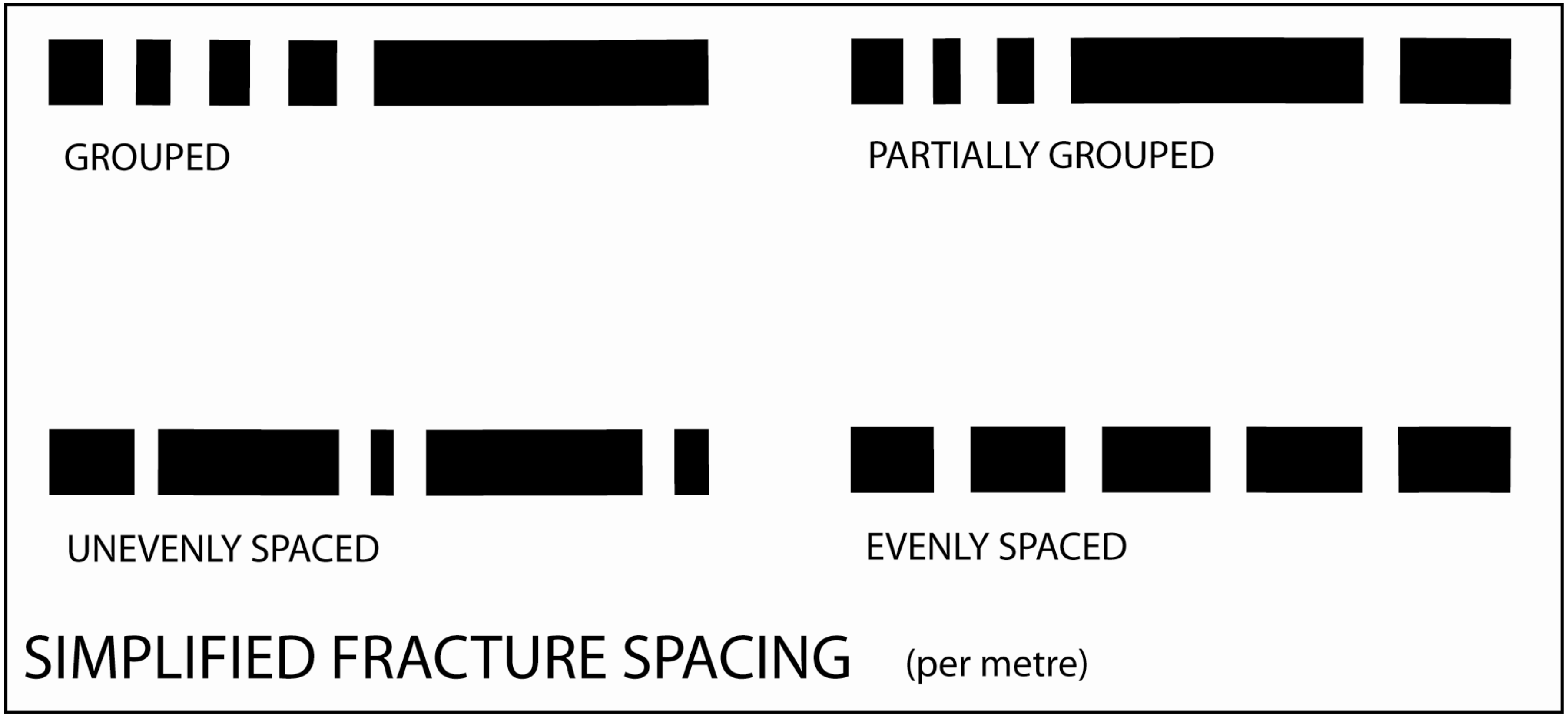

GROUPED
PARTIALLY GROUPED
UNEVENLY SPACED
EVENLY SPACED
SIMPLIFIED FRACTURE SPACING (per metre)

Figure 19

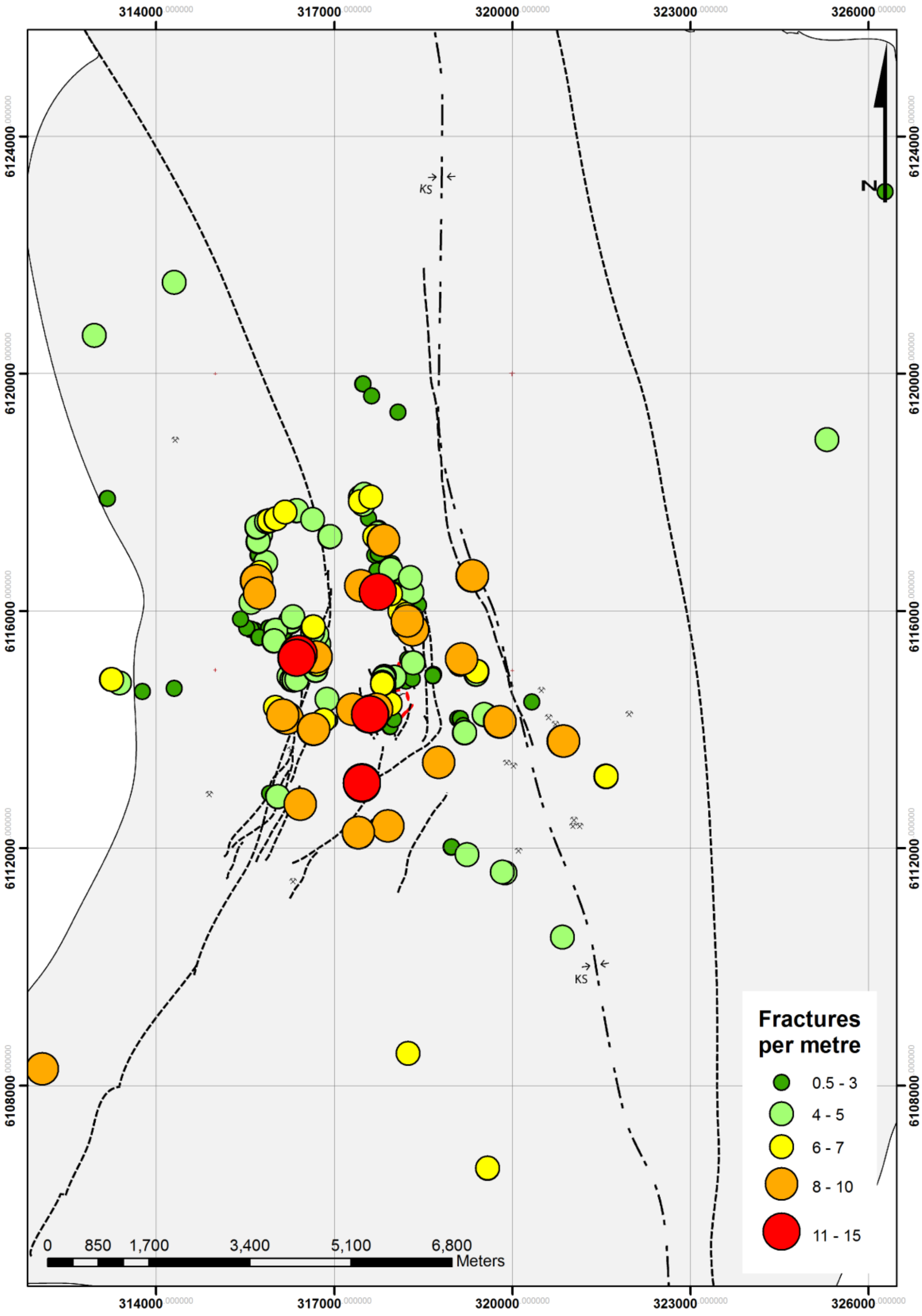

314000
317000
320000
323000
326000
6124000
6120000
6116000
6112000
6108000
KS
N
Fractures per metre
0.5 - 3
4 - 5
6 - 7
8 - 10
11 - 15
0
850
1,700
3,400
5,100
6,800
Meters

Figure 20

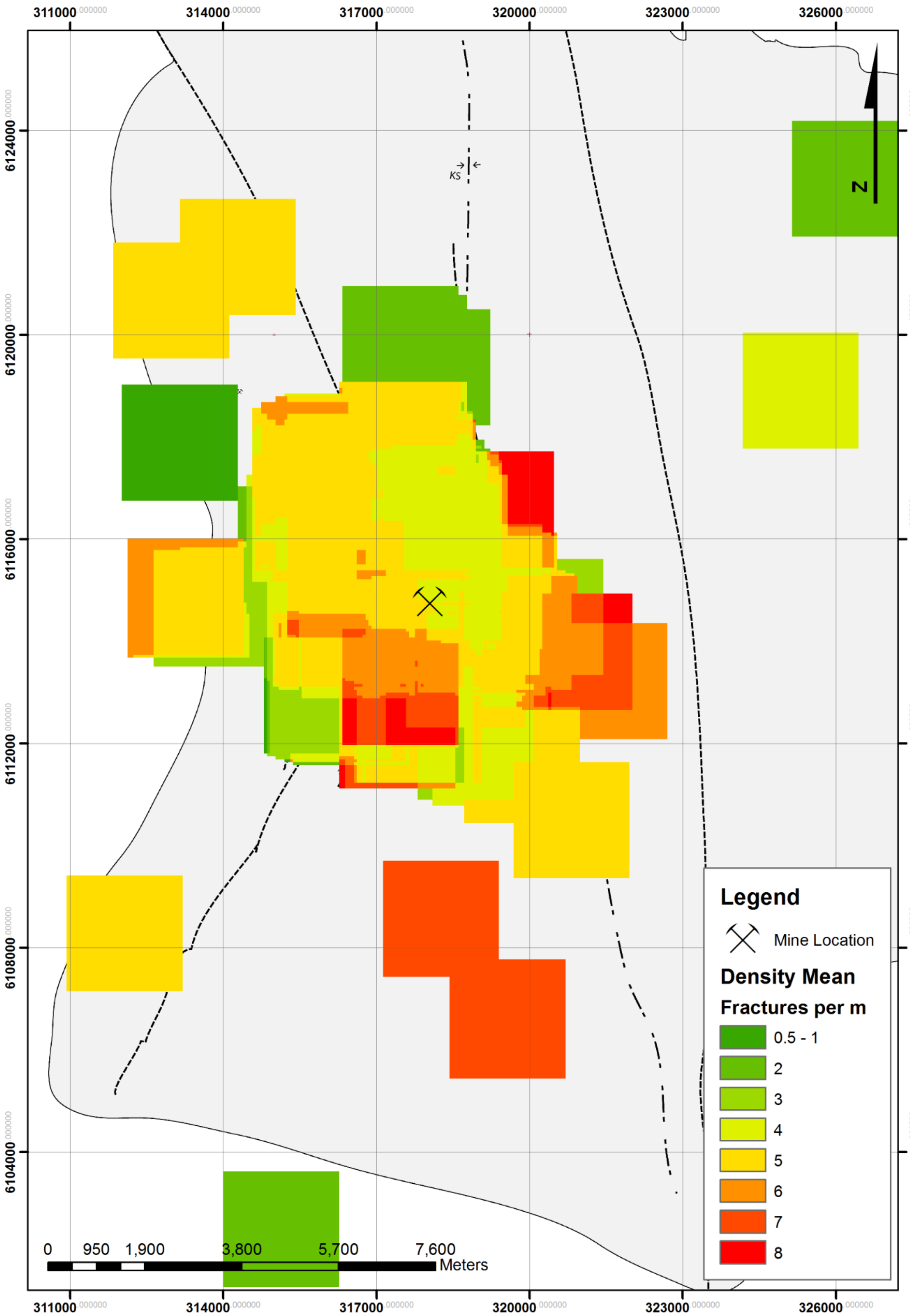
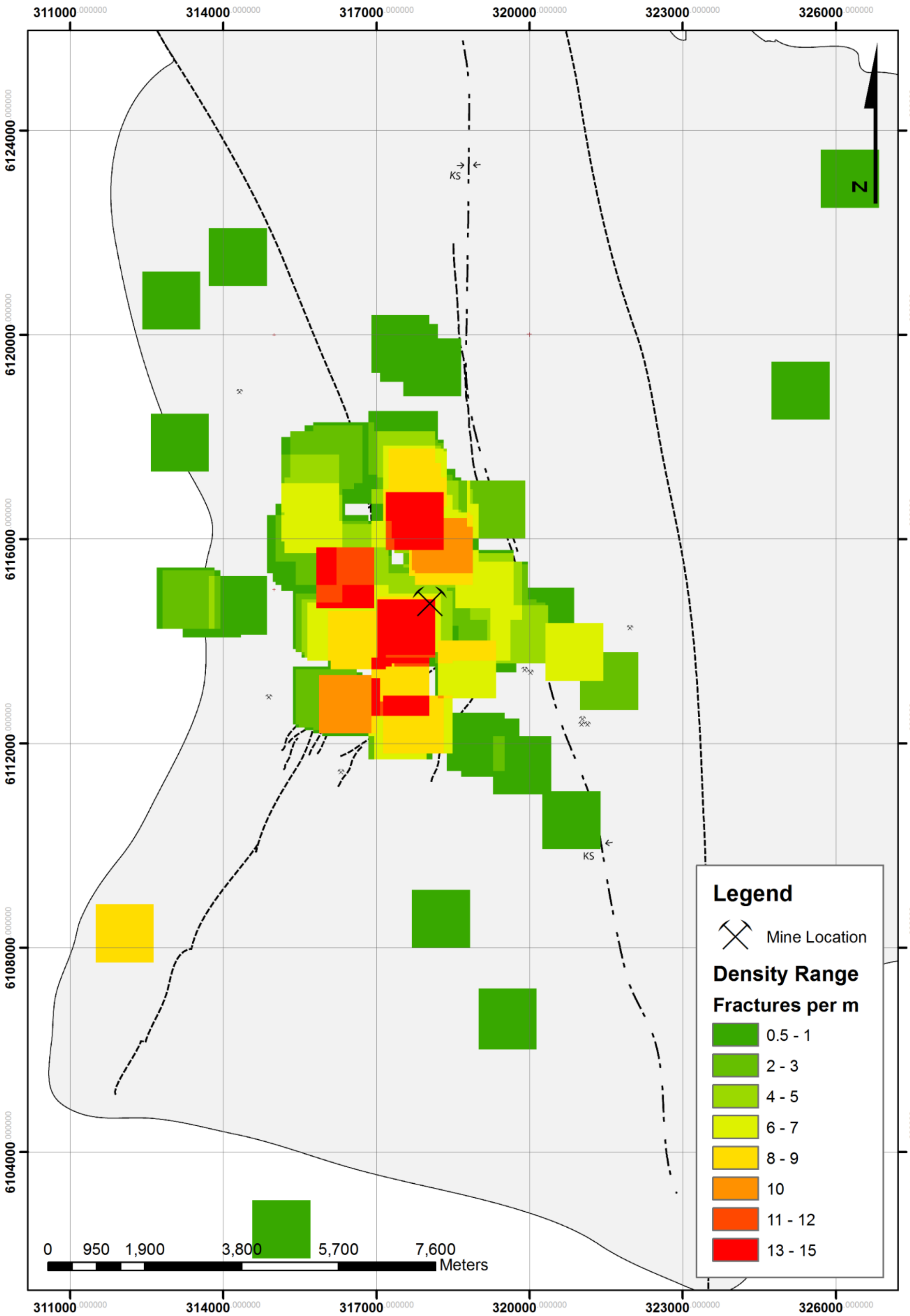

311000
314000
317000
320000
323000
326000
6124000
6120000
6116000
6112000
6108000
6104000
KS
N
Legend
Mine Location
Density Mean
Fractures per m
0.5 - 1
2
3
4
5
6
7
8
0
950
1,900
3,800
5,700
7,600
Meters

Figure 21



311000
314000
317000
320000
323000
326000
6124000
6120000
6116000
6112000
6108000
6104000
KS
KS
N
Legend
Mine Location
Density Range
Fractures per m
0.5 - 1
2 - 3
4 - 5
6 - 7
8 - 9
10
11 - 12
13 - 15
0
950
1,900
3,800
5,700
7,600
Meters

Figure 22

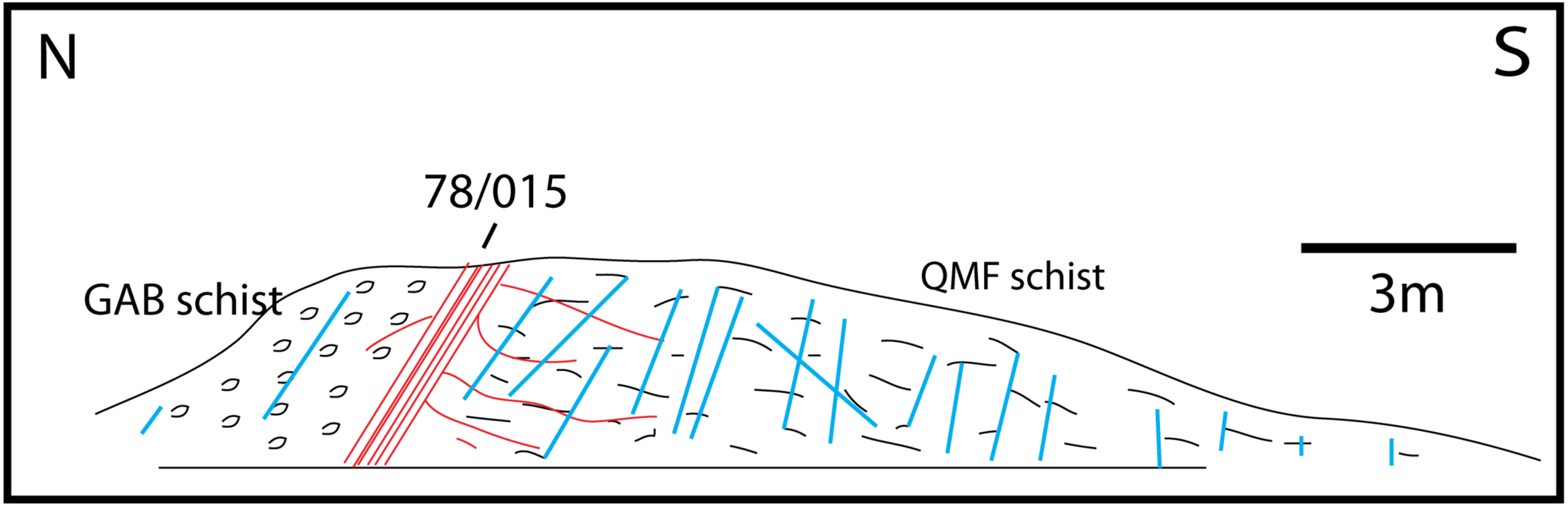
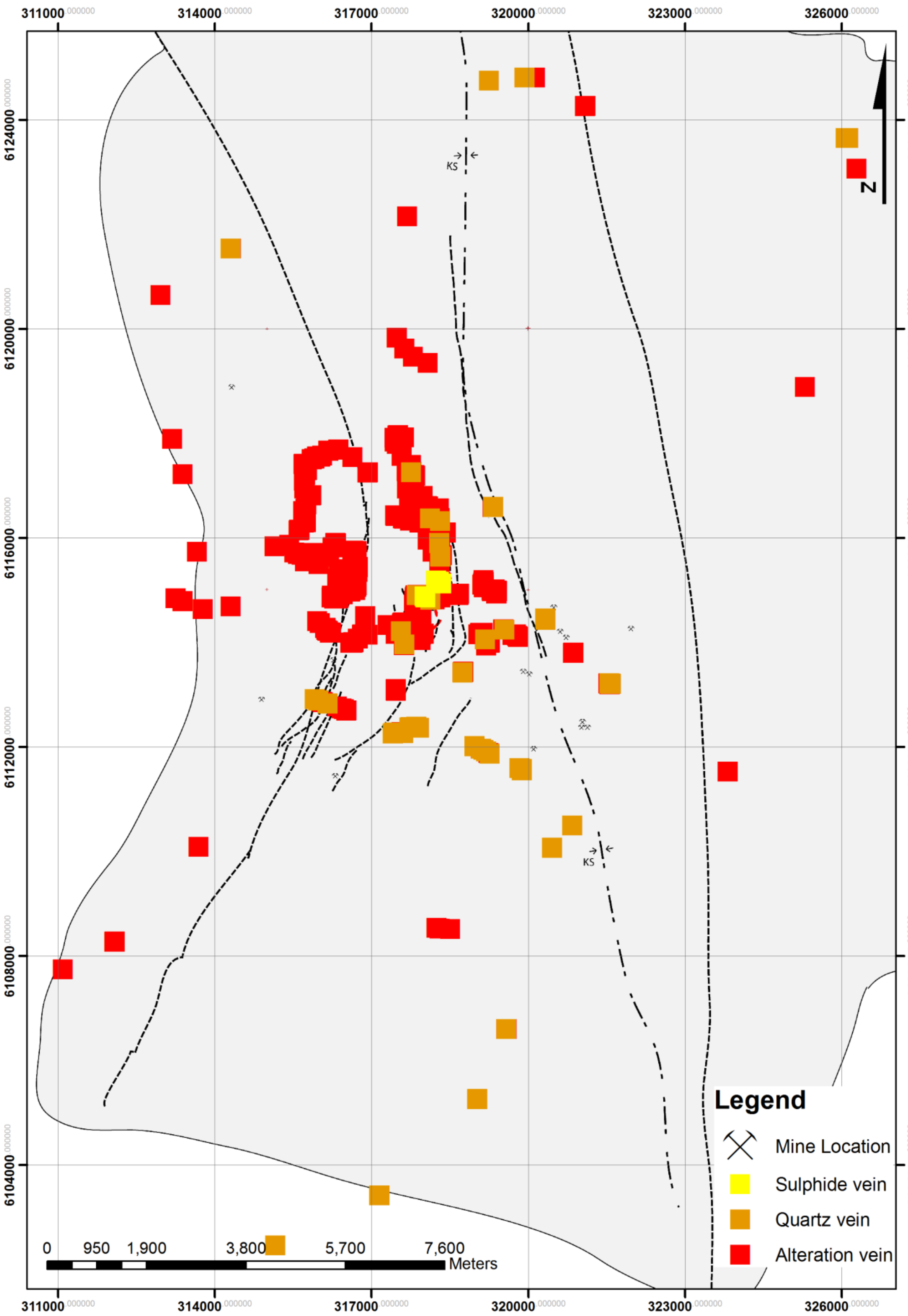


Figure 23



311000
314000
317000
320000
323000
326000
6124000
6120000
6116000
6112000
6108000
6104000
KS
KS
N
Legend
Mine Location
Sulphide vein
Quartz vein
Alteration vein
0
950
1,900
3,800
5,700
7,600
Meters

Figure 24

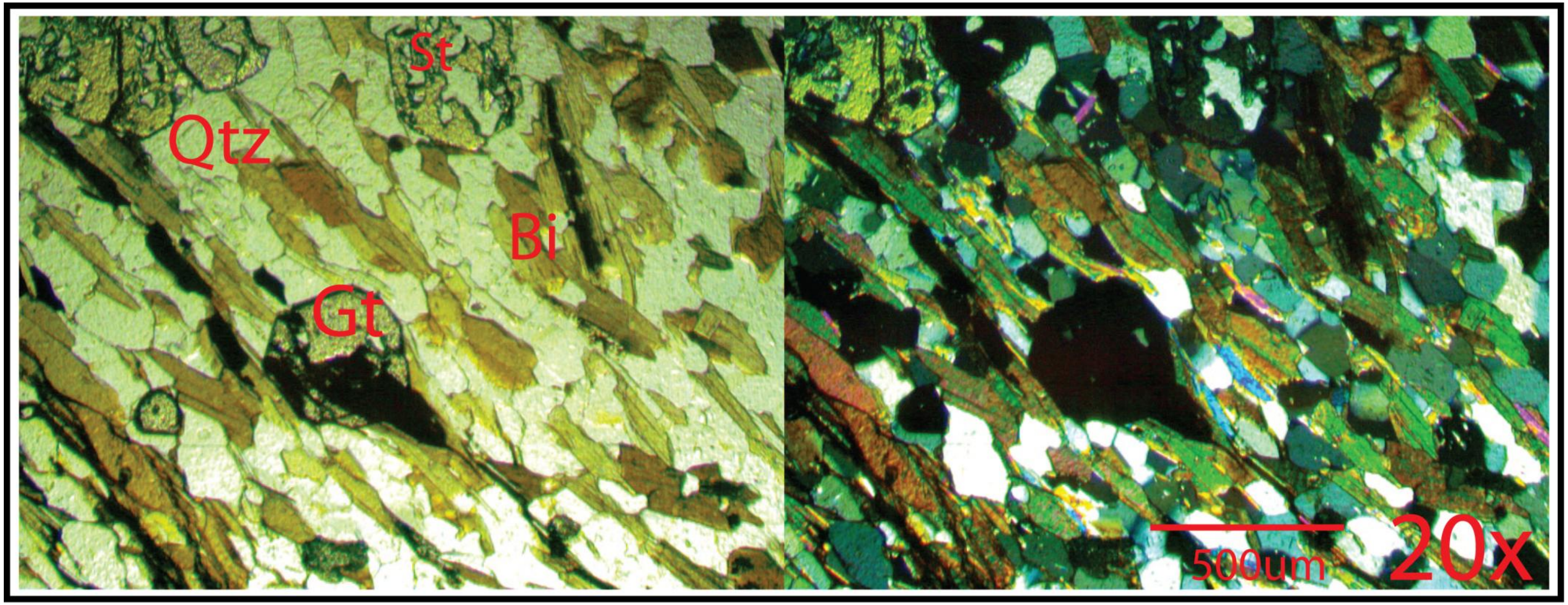


Figure 25

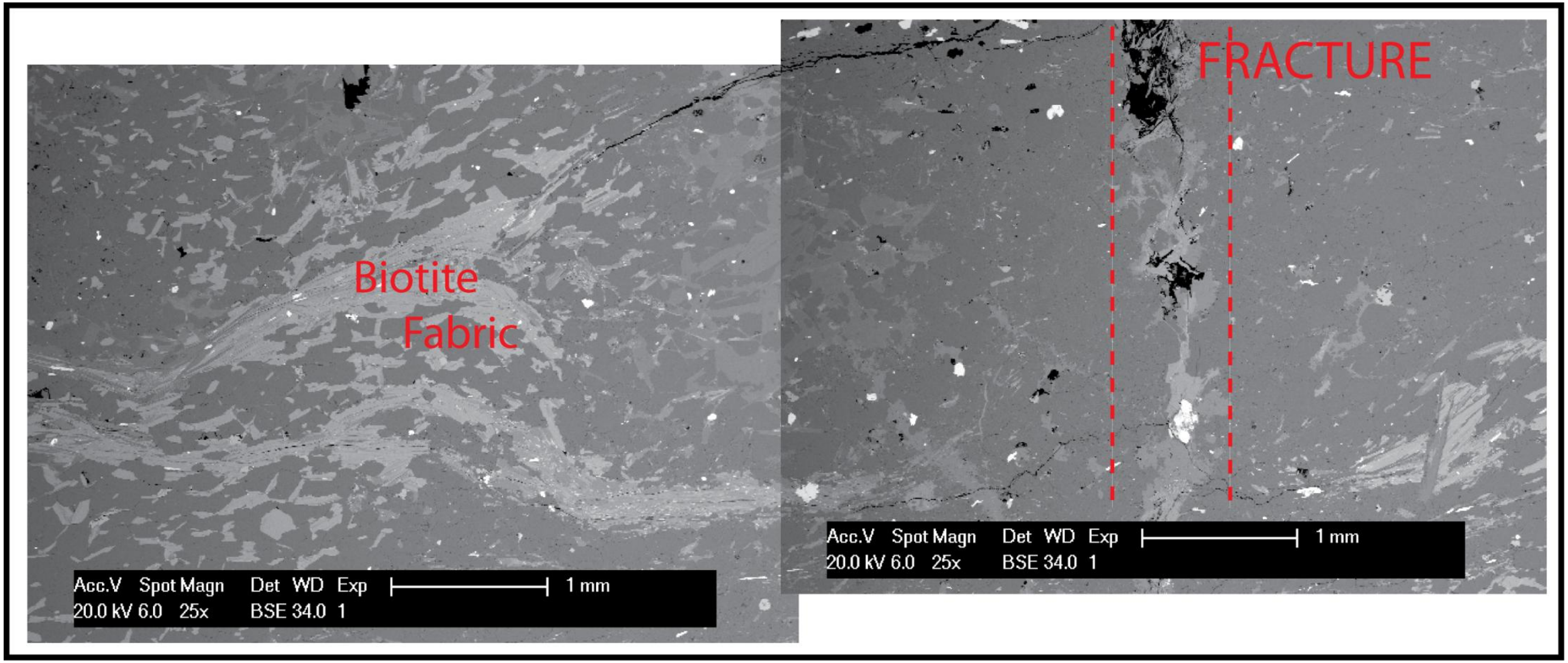

Biotite
Fabric
Acc.V Spot Magn Det WD Exp 1 mm
20.0 kV 6.0 25x BSE 34.0 1
FRACTURE
Acc.V Spot Magn Det WD Exp 1 mm
20.0 kV 6.0 25x BSE 34.0 1

Figure 26

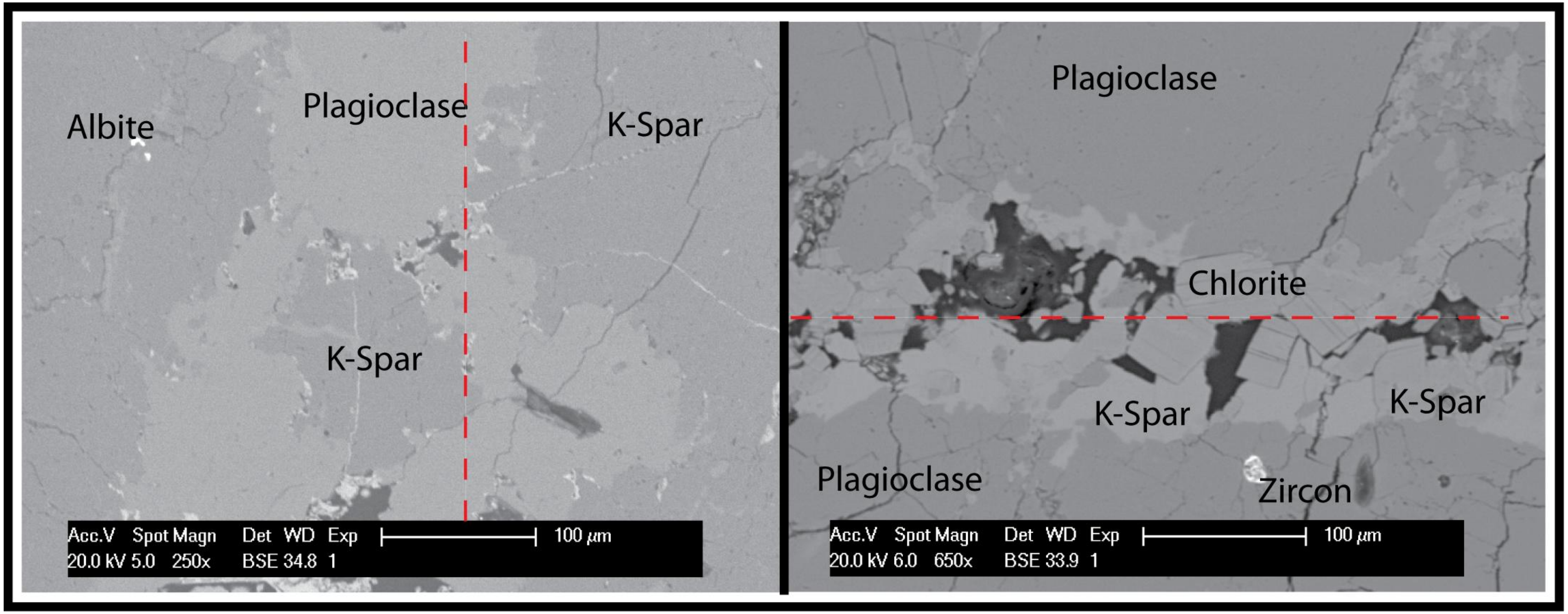

Albite
Plagioclase
K-Spar
K-Spar
Acc.V Spot Magn Det WD Exp 100 µm
20.0 kV 5.0 250x BSE 34.8 1
Plagioclase
Chlorite
K-Spar
K-Spar
Plagioclase
Zircon
Acc.V Spot Magn Det WD Exp 100 µm
20.0 kV 6.0 650x BSE 33.9 1

Figure 27

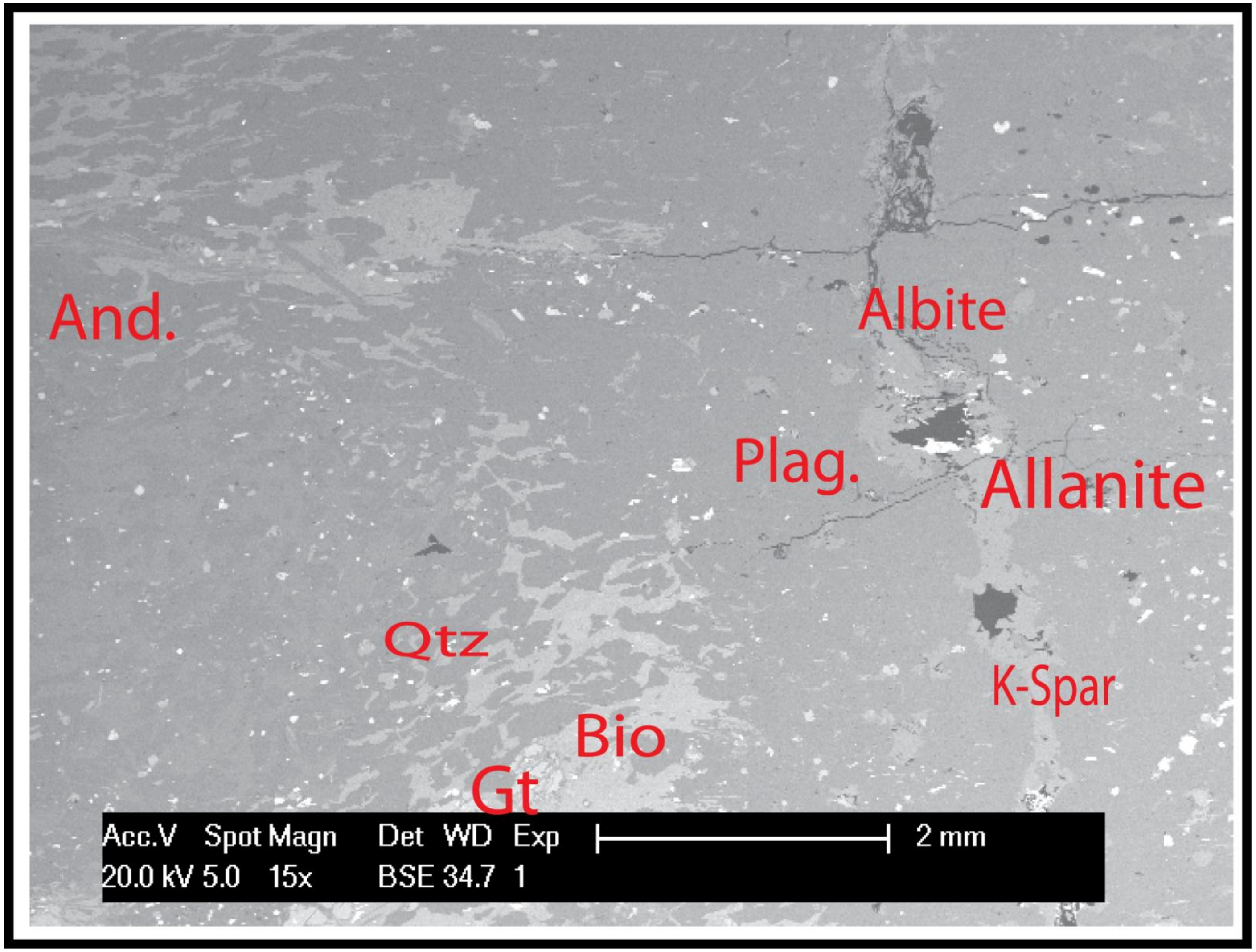

And.
Albite
Plag.
Allanite
Qtz
K-Spar
Bio
Gt
Acc.V Spot Magn Det WD Exp
20.0 kV 5.0 15x BSE 34.7 1
2 mm

Figure 28

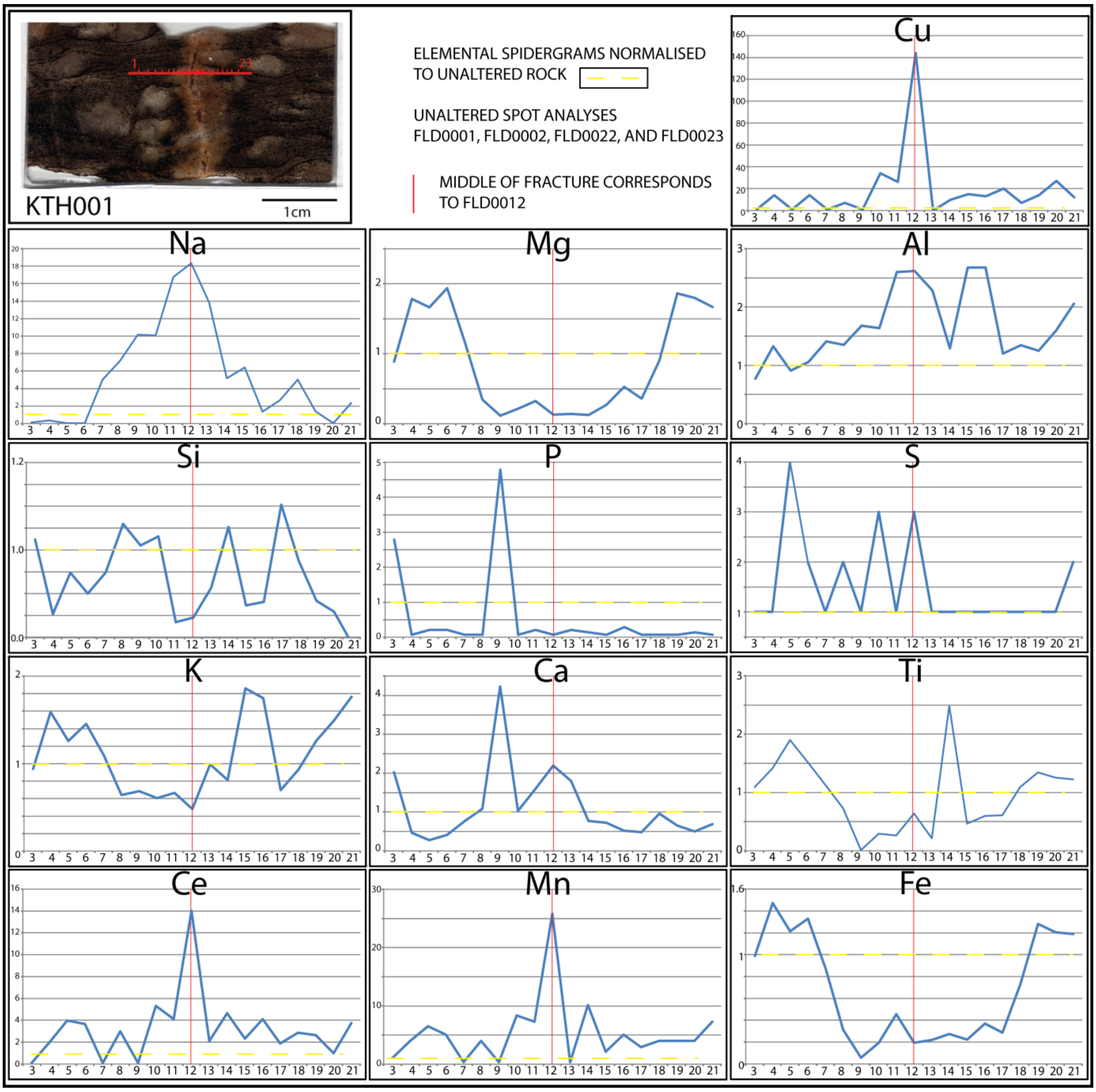

KTH001
1cm
ELEMENTAL SPIDERGRAMS NORMALISED TO UNALTERED ROCK
UNALTERED SPOT ANALYSES FLD0001, FLD0002, FLD0022, AND FLD0023
MIDDLE OF FRACTURE CORRESPONDS TO FLD0012
Cu
Na
Mg
Al
Si
P
S
K
Ca
Ti
Ce
Mn
Fe

Figure 29

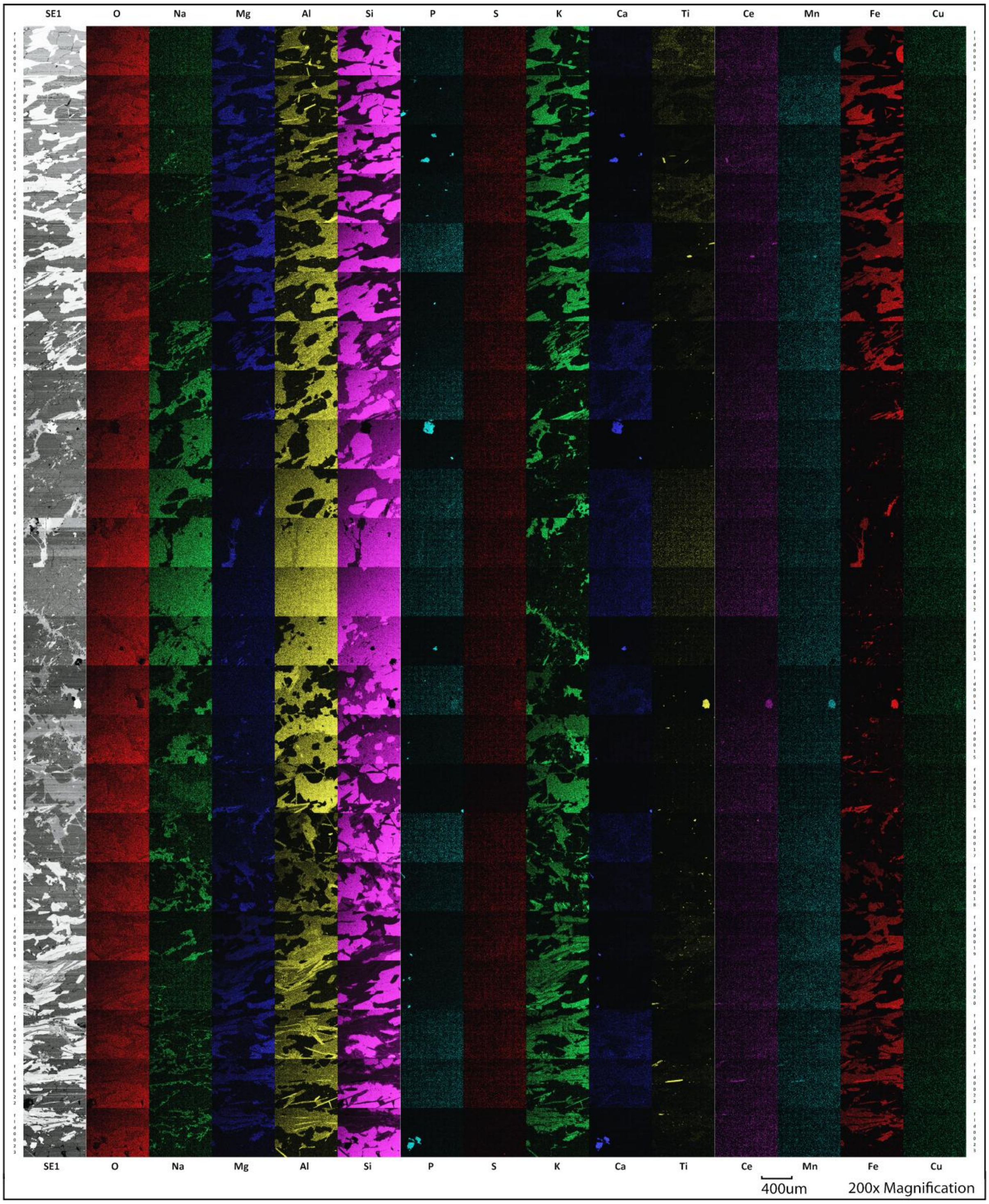
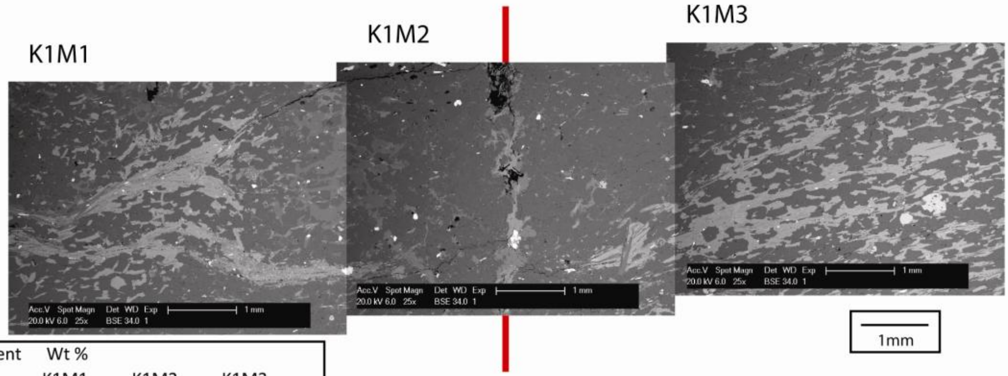
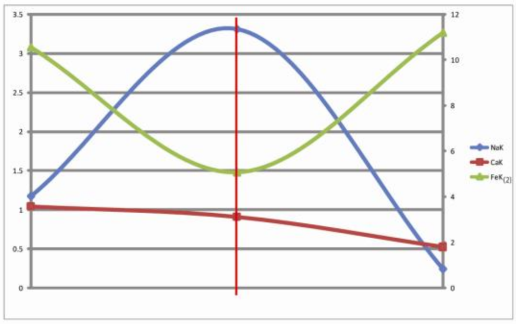


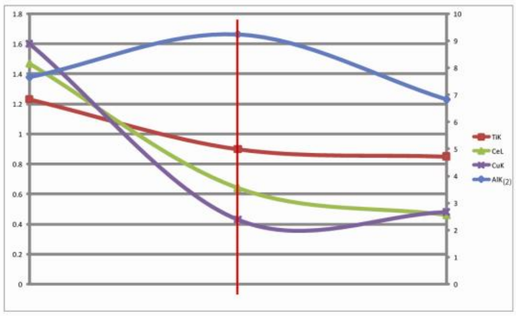
Figure 30

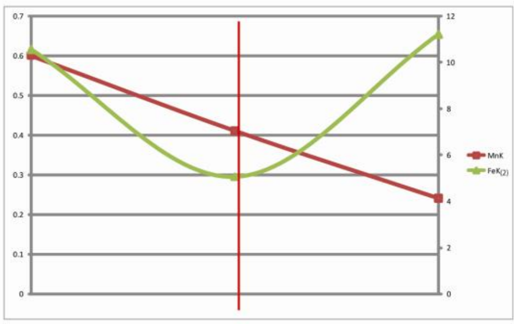
KTH001

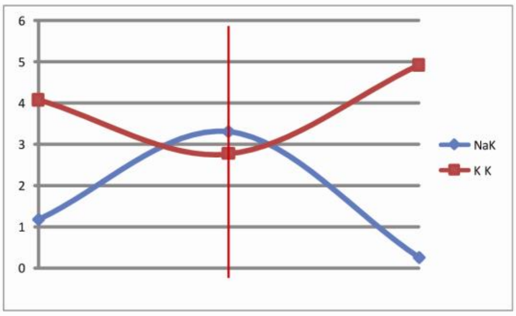


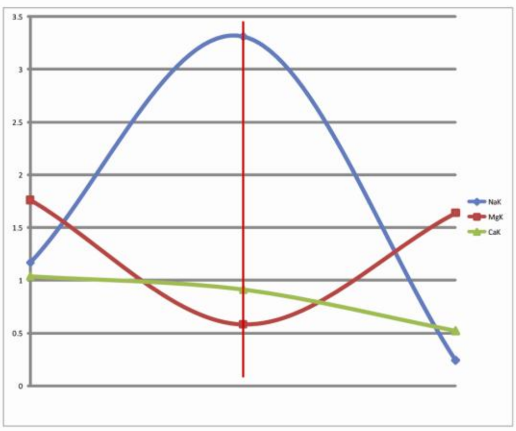
Element	Wt %		
	K1M1	K1M2	K1M3
O K	20.21	25.62	23.49
NaK	1.17	3.31	0.24
MgK	1.76	0.58	1.64
AlK	7.65	9.24	6.83
SiK	48.66	49.96	49.01
P K	0.01	0.17	0.14
S K	0.01	0.01	0.01
K K	4.06	2.76	4.91
CaK	1.04	0.91	0.52
TiK	1.23	0.9	0.85
CeL	1.47	0.64	0.46
MnK	0.6	0.41	0.24
FeK	10.54	5.06	11.19
CuK	1.6	0.43	0.48
Total	100	100	100







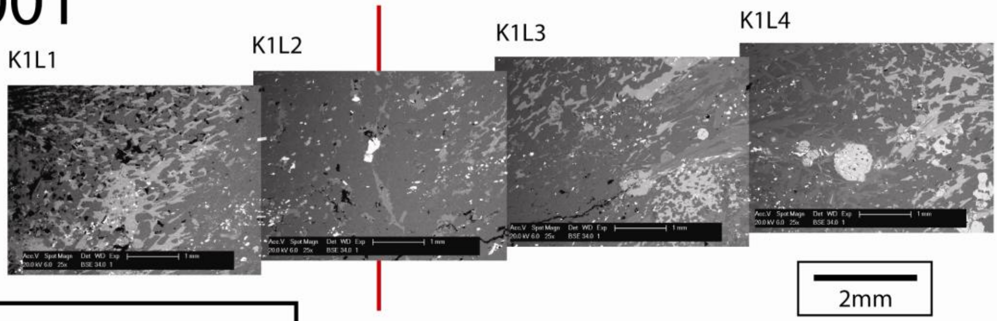




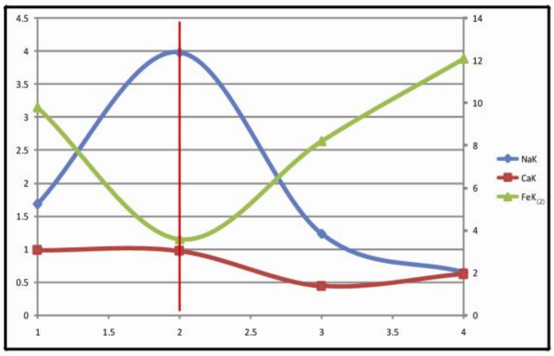
(2) Secondary (right) Axis

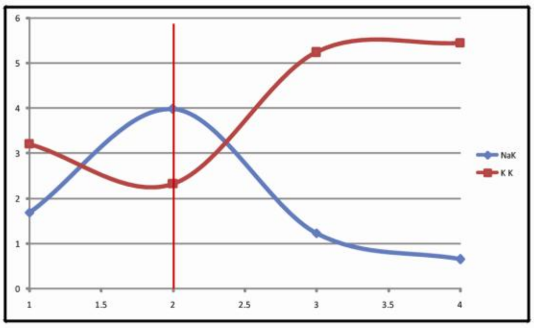
Figure 31

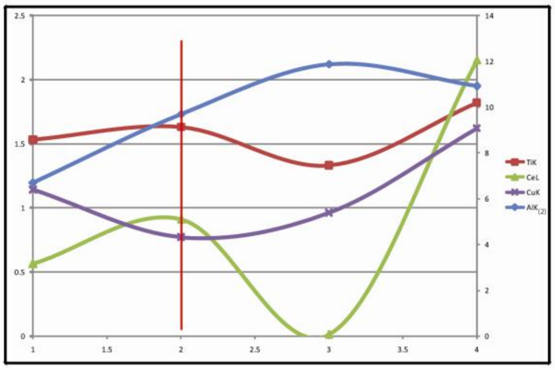
KTH001

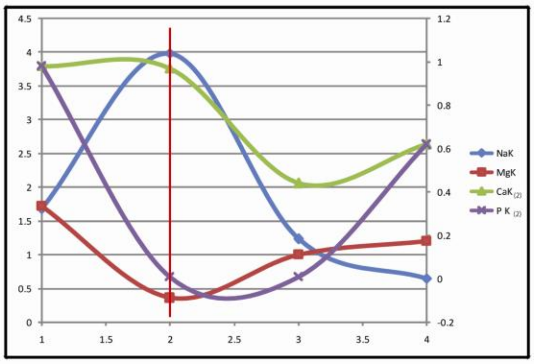


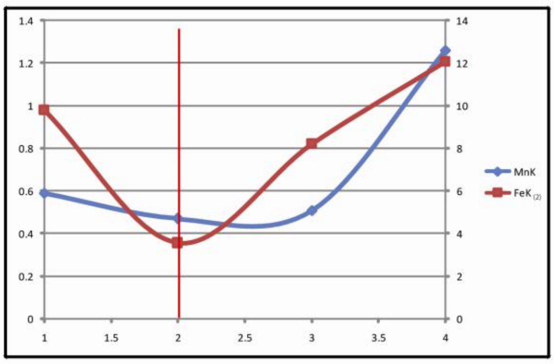
Element	K1L1	K1L2	K1L3	K1L4
	Wt %			
O K	23.62	26	24.34	18.43
NaK	1.68	3.98	1.23	0.65
MgK	1.72	0.36	1	1.2
AlK	6.69	9.69	11.87	10.91
SiK	47.51	49.32	44.88	43.09
P K	0.98	0.01	0.01	0.62
S K	0.01	0.01	0.01	0.12
K K	3.2	2.32	5.24	5.44
CaK	0.98	0.97	0.44	0.62
TiK	1.53	1.63	1.33	1.82
CeL	0.56	0.91	0.01	2.15
MnK	0.59	0.47	0.51	1.26
FeK	9.8	3.57	8.21	12.08
CuK	1.14	0.77	0.96	1.62
Total	100	100	100	100











(2) Secondary (right) Axis

Figure 32

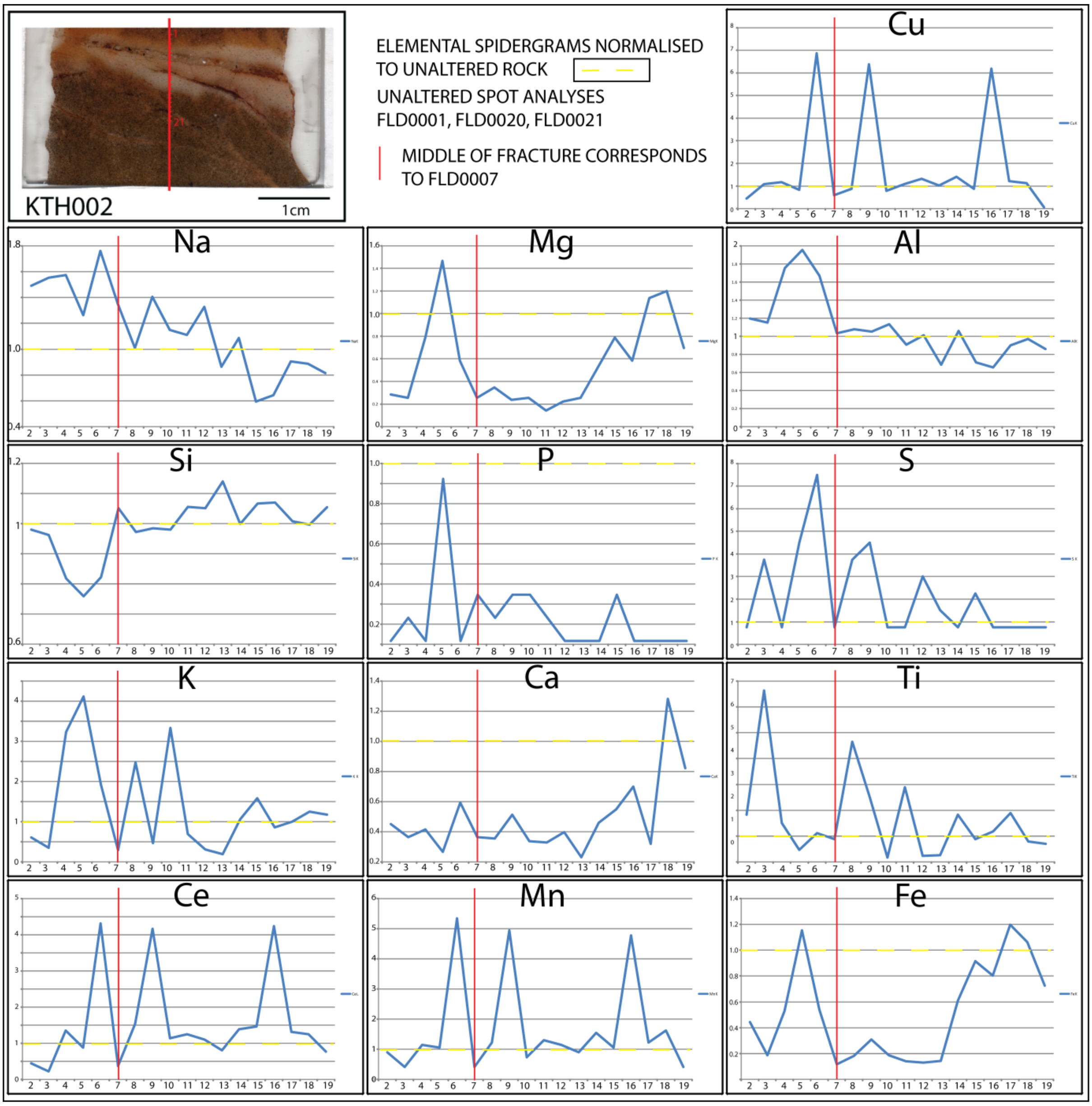

KTH002
1cm
ELEMENTAL SPIDERGRAMS NORMALISED TO UNALTERED ROCK
UNALTERED SPOT ANALYSES FLD0001, FLD0020, FLD0021
MIDDLE OF FRACTURE CORRESPONDS TO FLD0007
Cu
Na
Mg
Al
Si
P
S
K
Ca
Ti
Ce
Mn
Fe

Figure 33

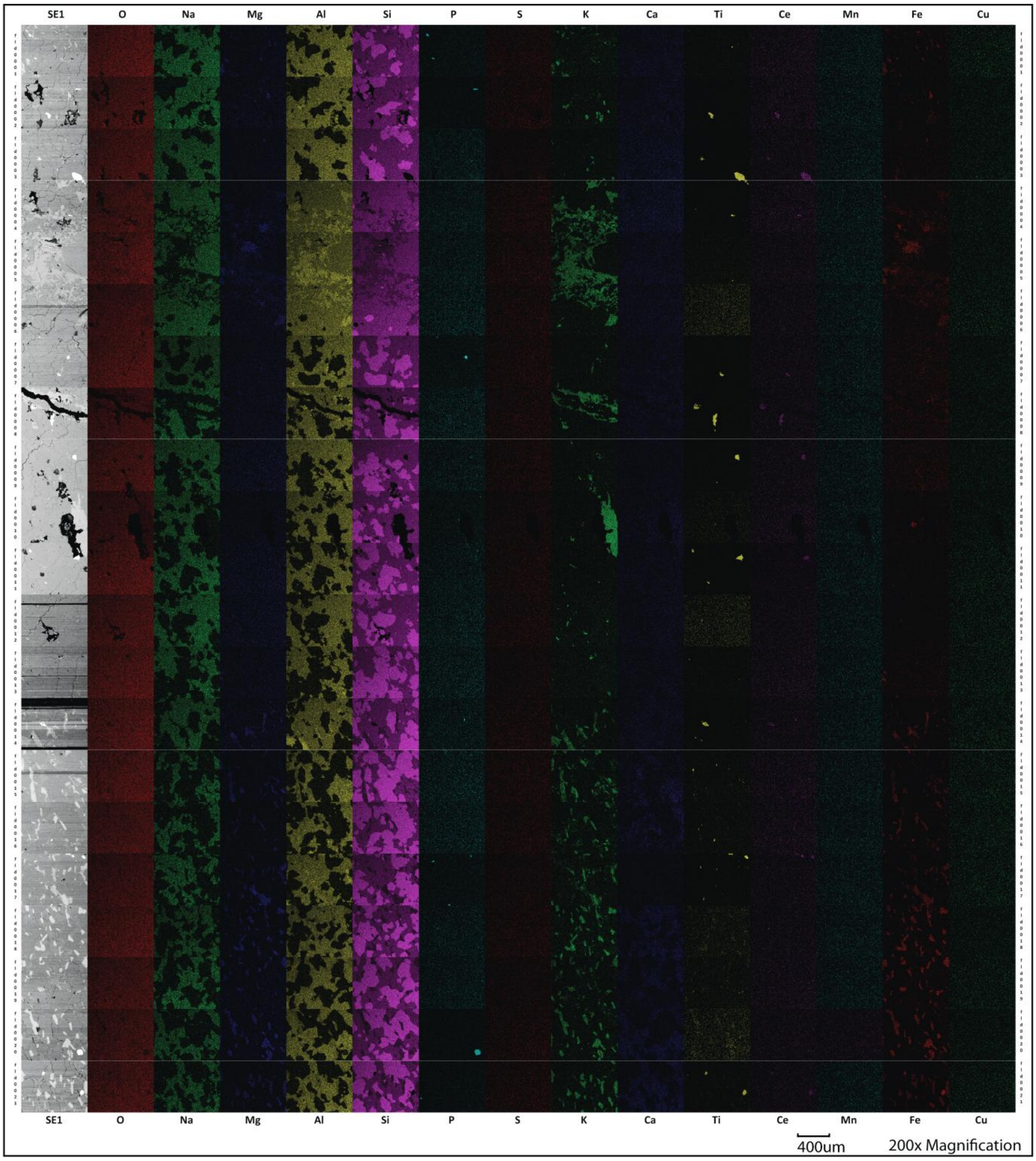
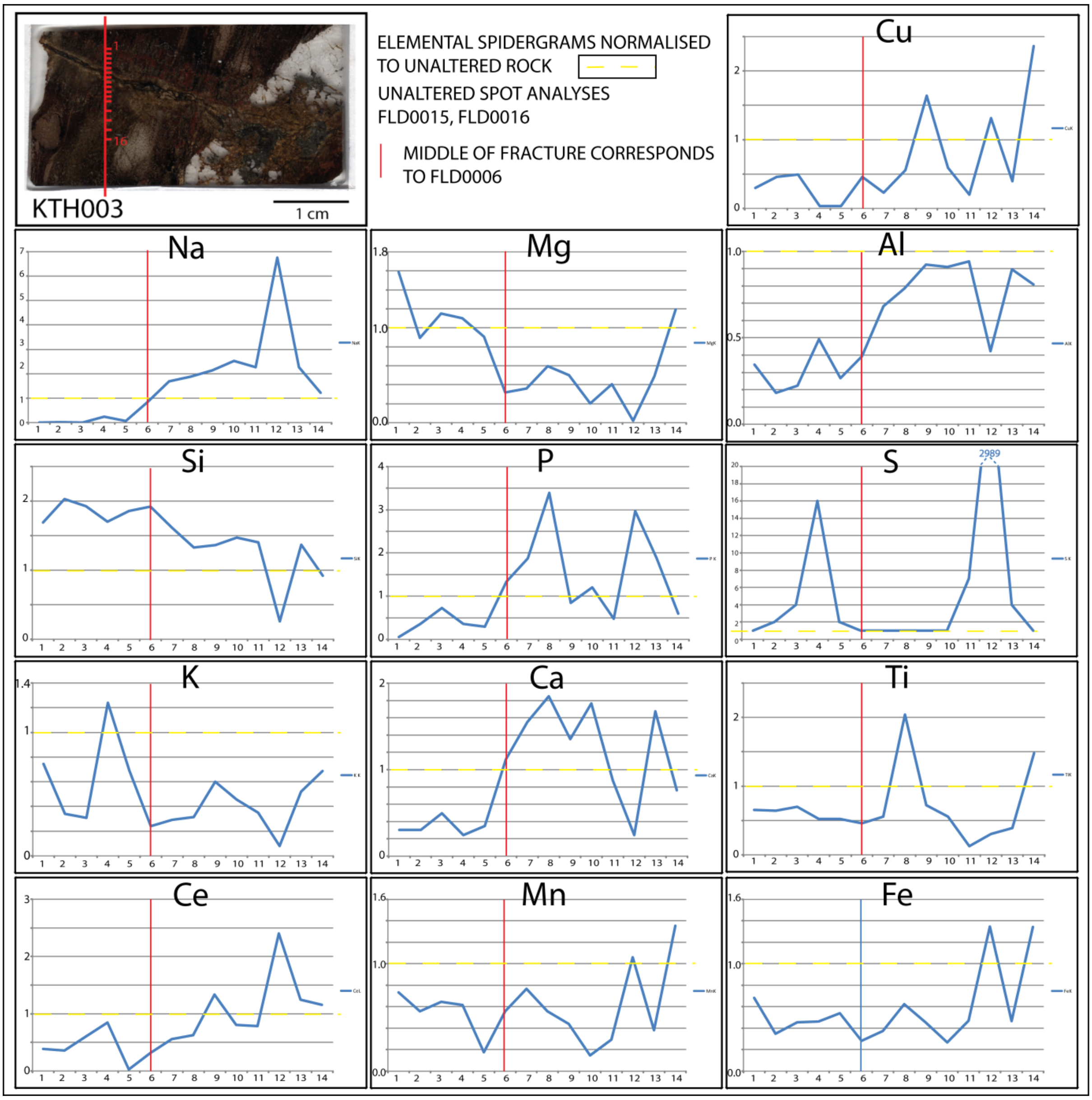


Figure 34



KTH003
1 cm
ELEMENTAL SPIDERGRAMS NORMALISED TO UNALTERED ROCK
UNALTERED SPOT ANALYSES FLD0015, FLD0016
MIDDLE OF FRACTURE CORRESPONDS TO FLD0006
Cu
Na
Mg
Al
Si
P
S
2989
K
Ca
Ti
Ce
Mn
Fe

Figure 35

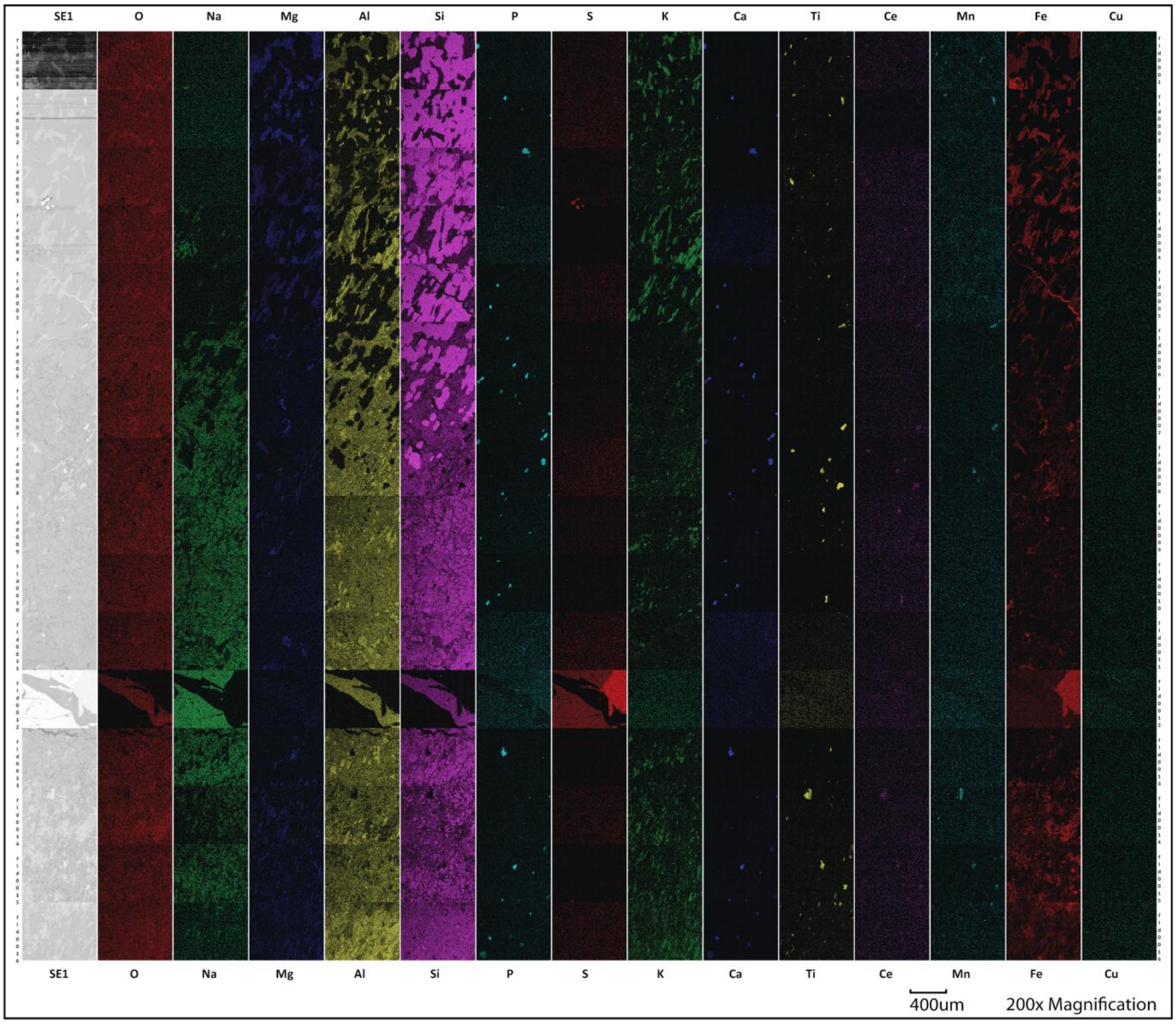


Figure 36

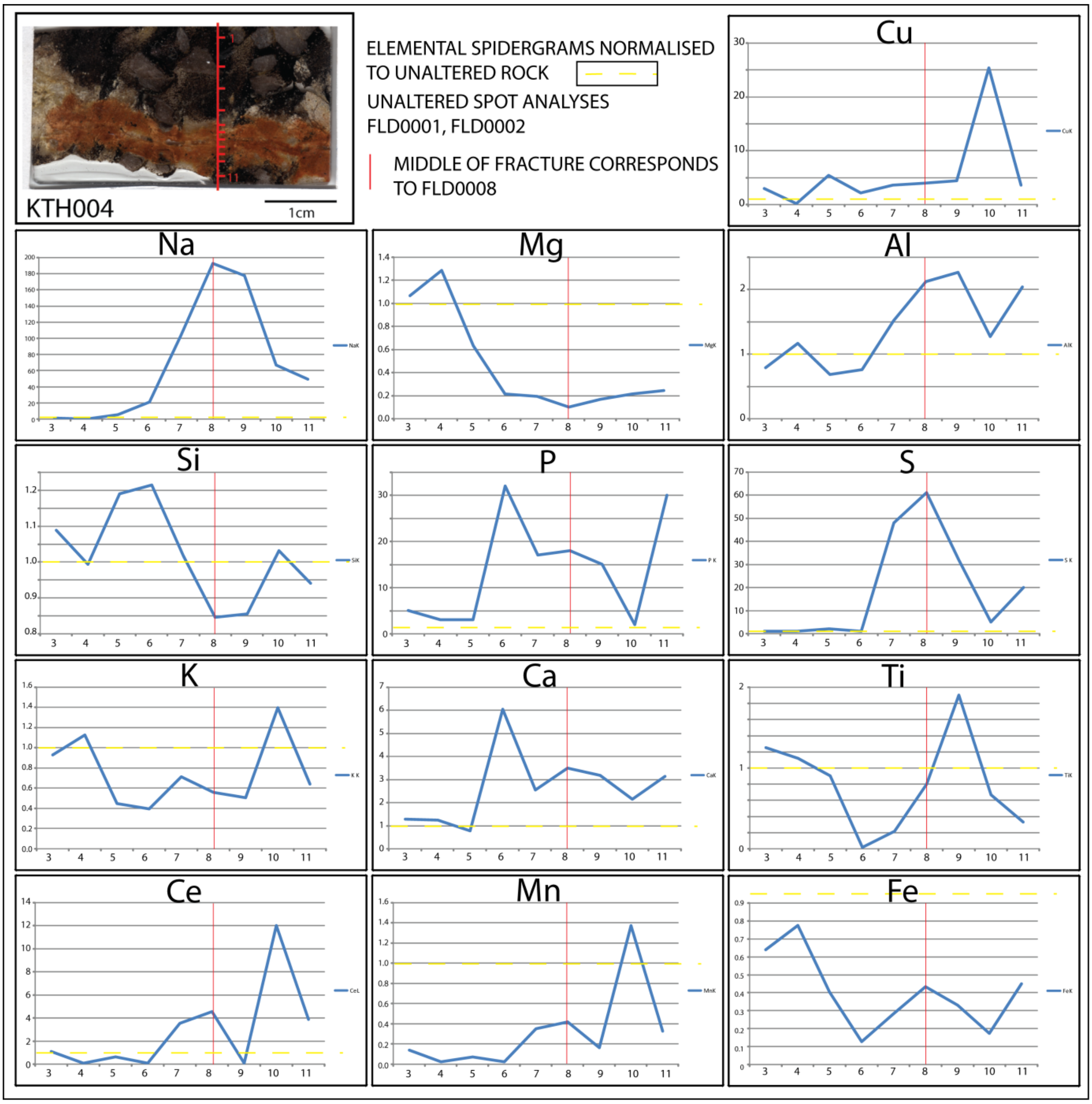

KTH004
1cm
ELEMENTAL SPIDERGRAMS NORMALISED TO UNALTERED ROCK
UNALTERED SPOT ANALYSES FLD0001, FLD0002
MIDDLE OF FRACTURE CORRESPONDS TO FLD0008
Cu
Na
Mg
Al
Si
P
S
K
Ca
Ti
Ce
Mn
Fe

Figure 37

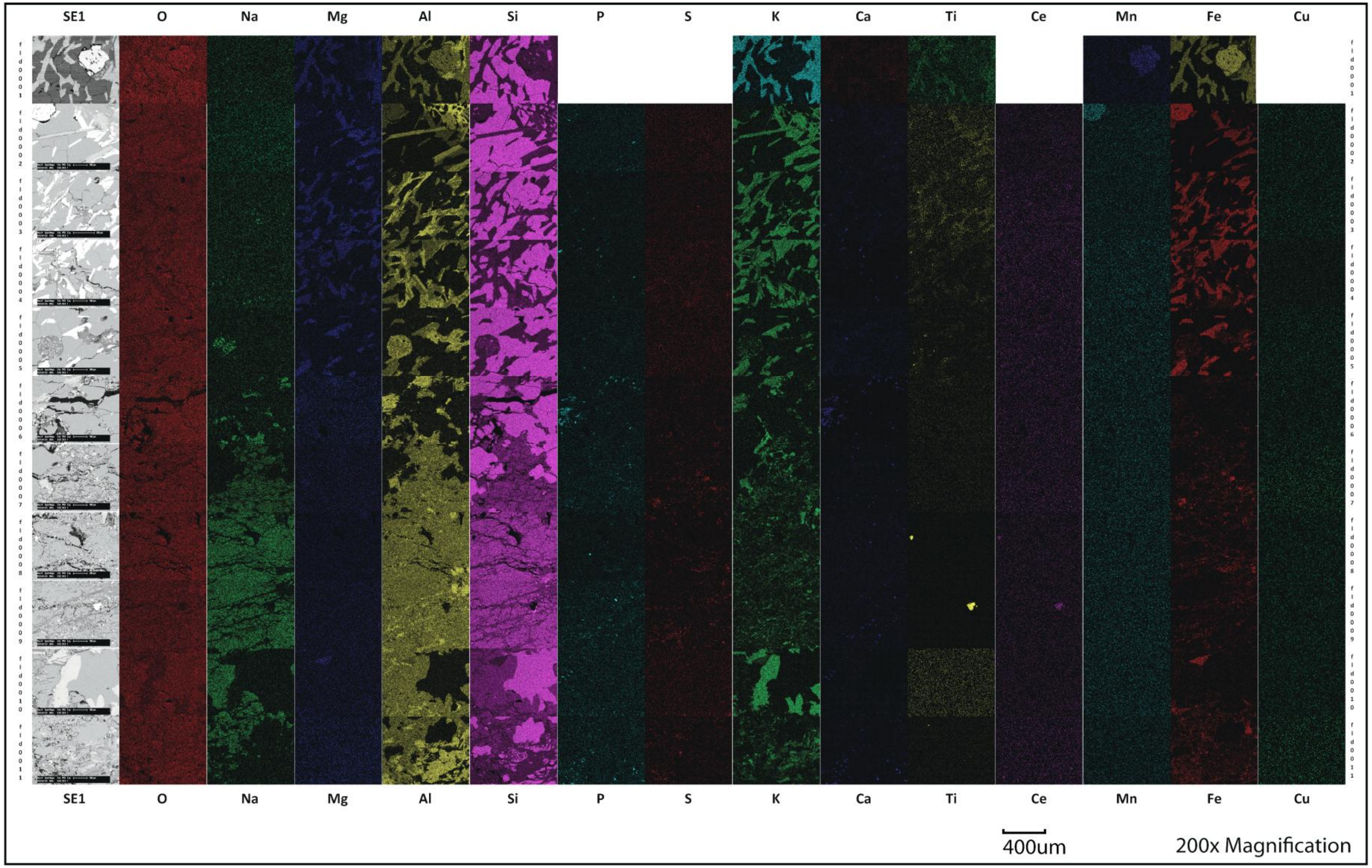


Figure 38

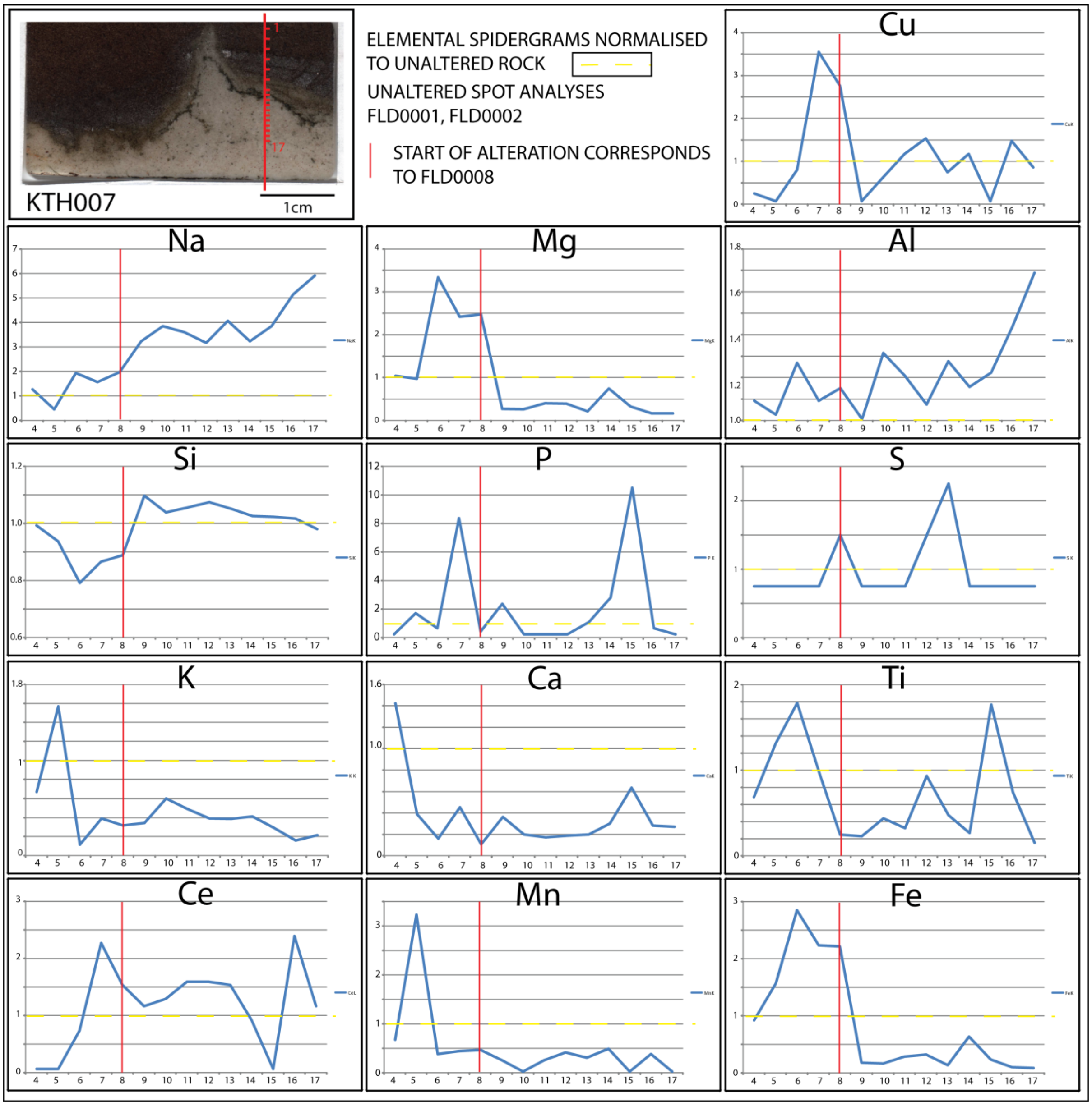

KTH007
1cm
ELEMENTAL SPIDERGRAMS NORMALISED TO UNALTERED ROCK
UNALTERED SPOT ANALYSES FLD0001, FLD0002
START OF ALTERATION CORRESPONDS TO FLD0008
Cu
Na
Mg
Al
Si
P
S
K
Ca
Ti
Ce
Mn
Fe

Figure 39

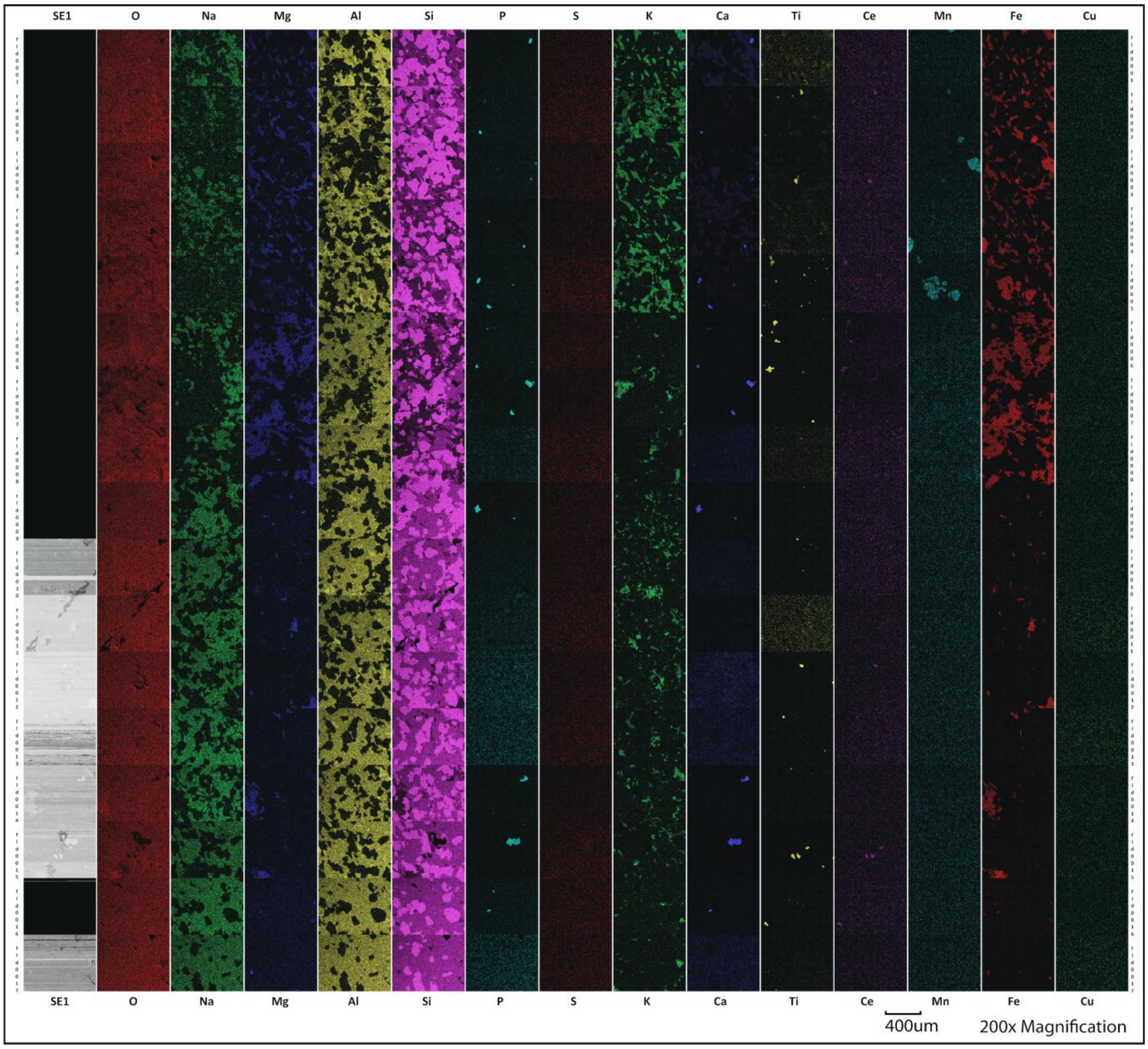
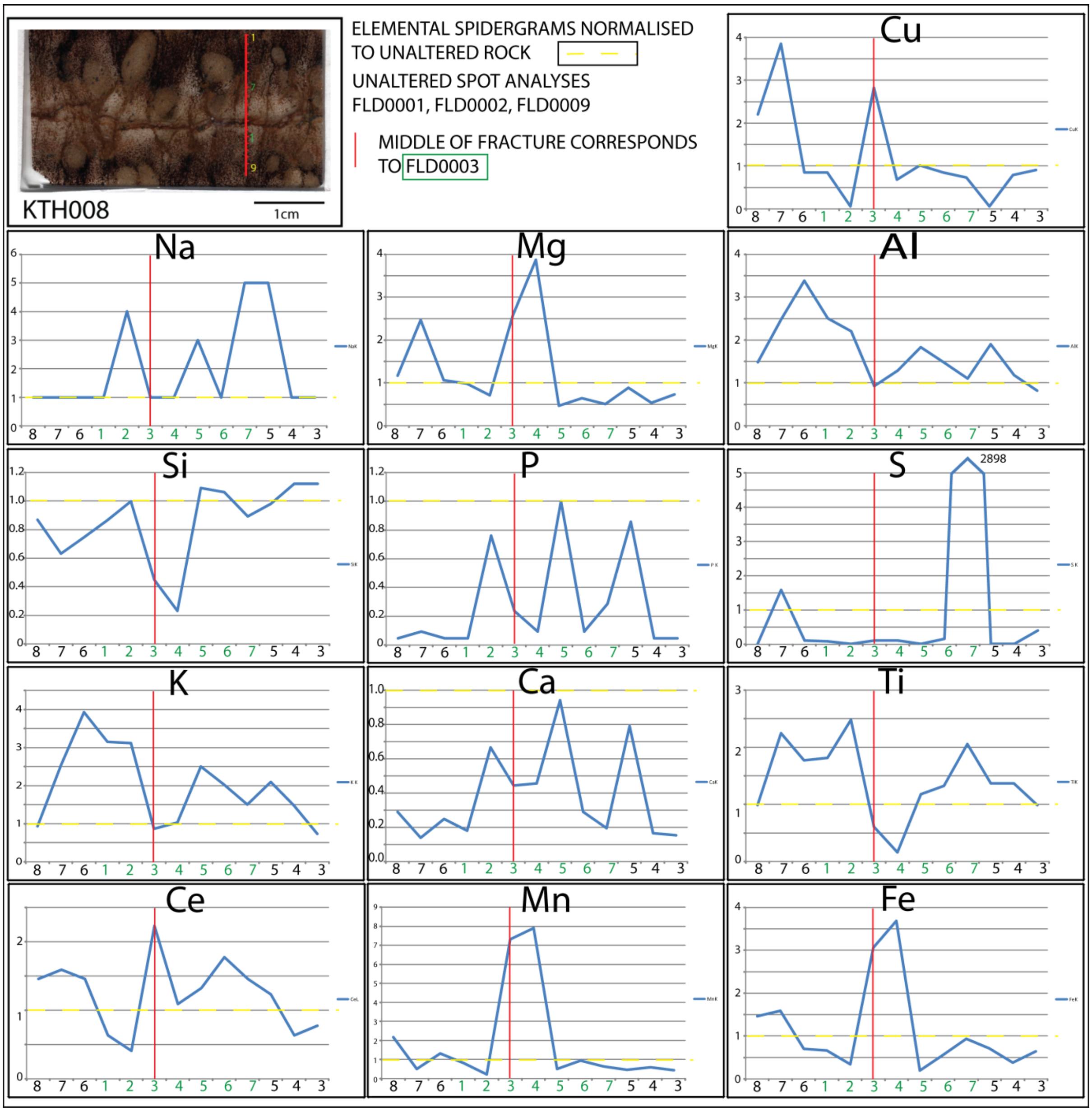


Figure 40



ELEMENTAL SPIDERGRAMS NORMALISED TO UNALTERED ROCK
UNALTERED SPOT ANALYSES FLD0001, FLD0002, FLD0009
MIDDLE OF FRACTURE CORRESPONDS TO FLD0003
KTH008
1cm
Cu
Na
Mg
Al
Si
P
S
2898
K
Ca
Ti
Ce
Mn
Fe

Figure 41

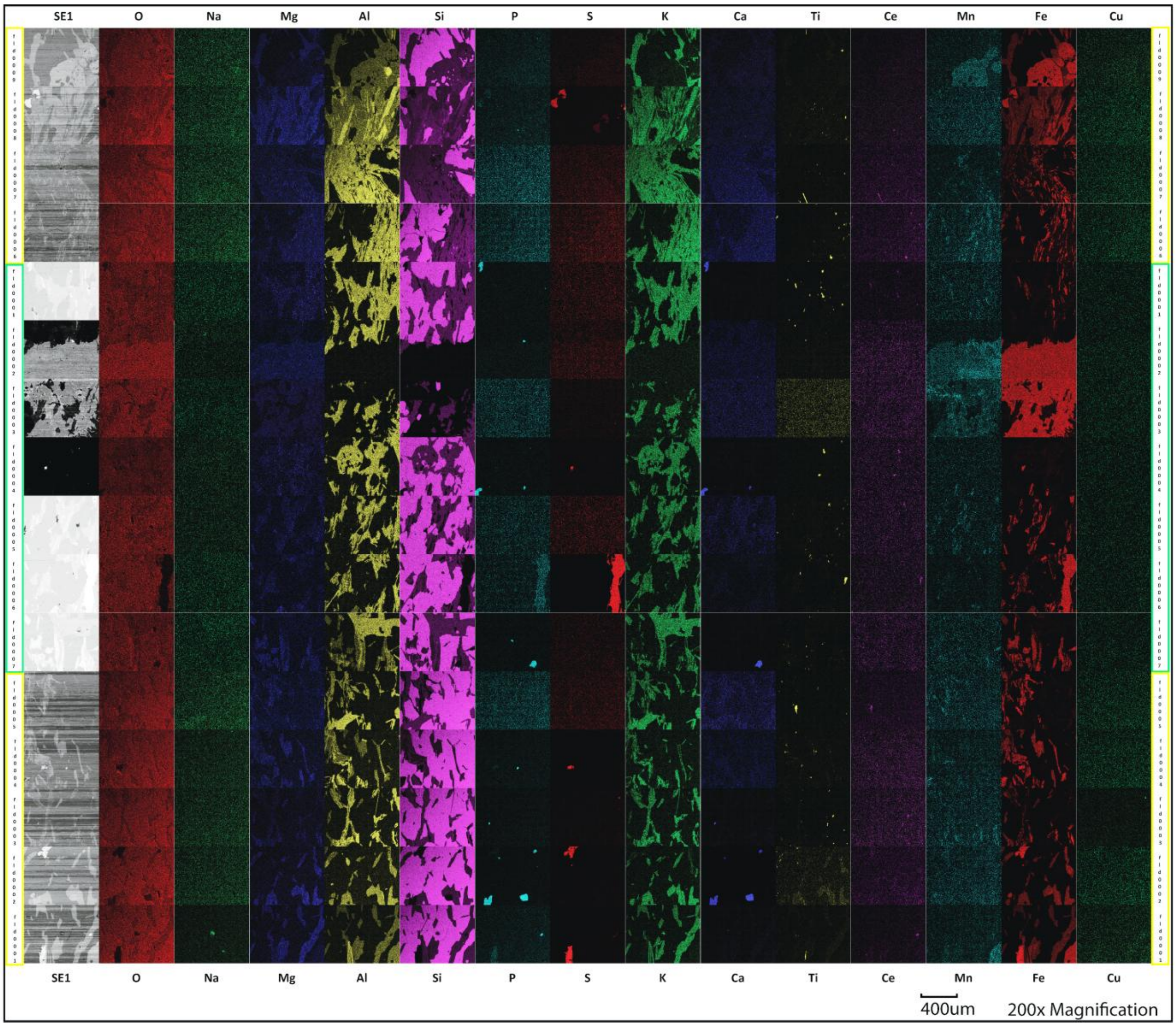


Figure 42

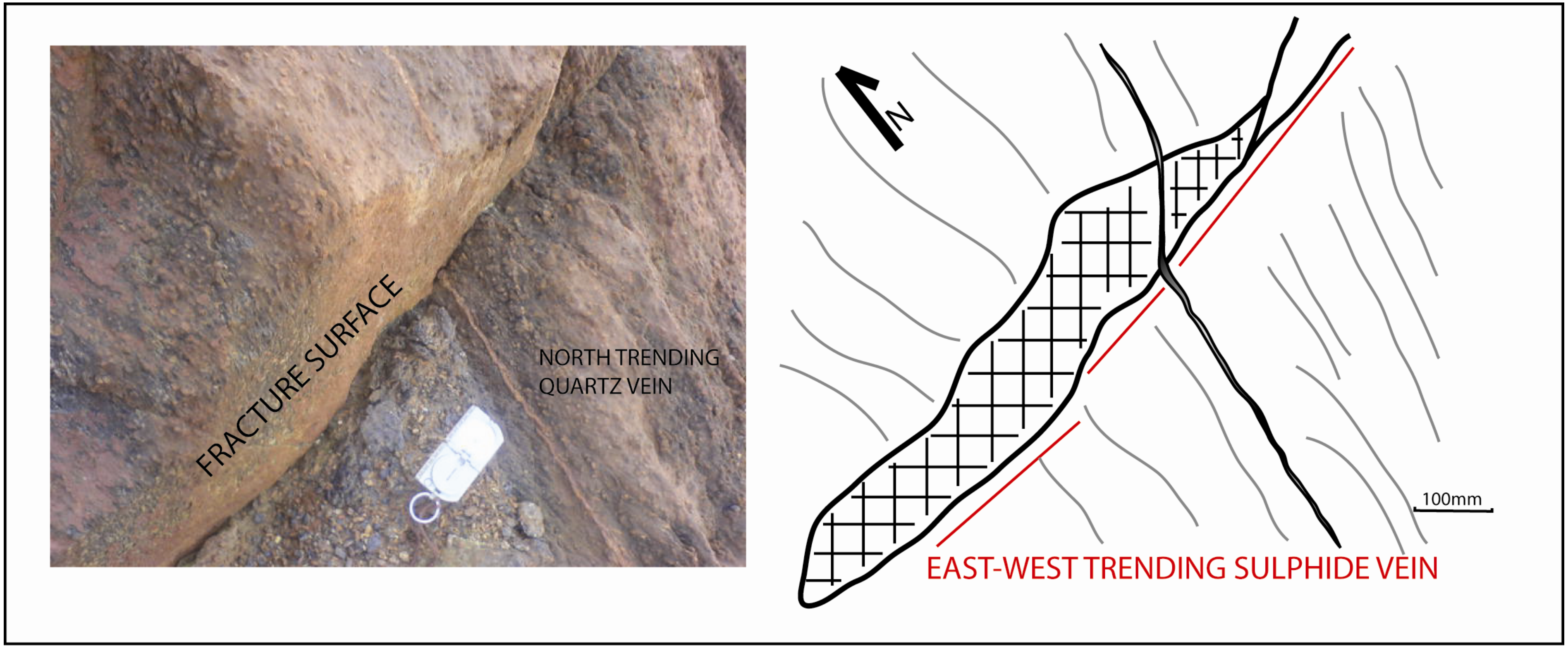

FRACTURE SURFACE
NORTH TRENDING
QUARTZ VEIN
N
100mm
EAST-WEST TRENDING SULPHIDE VEIN

Figure 43

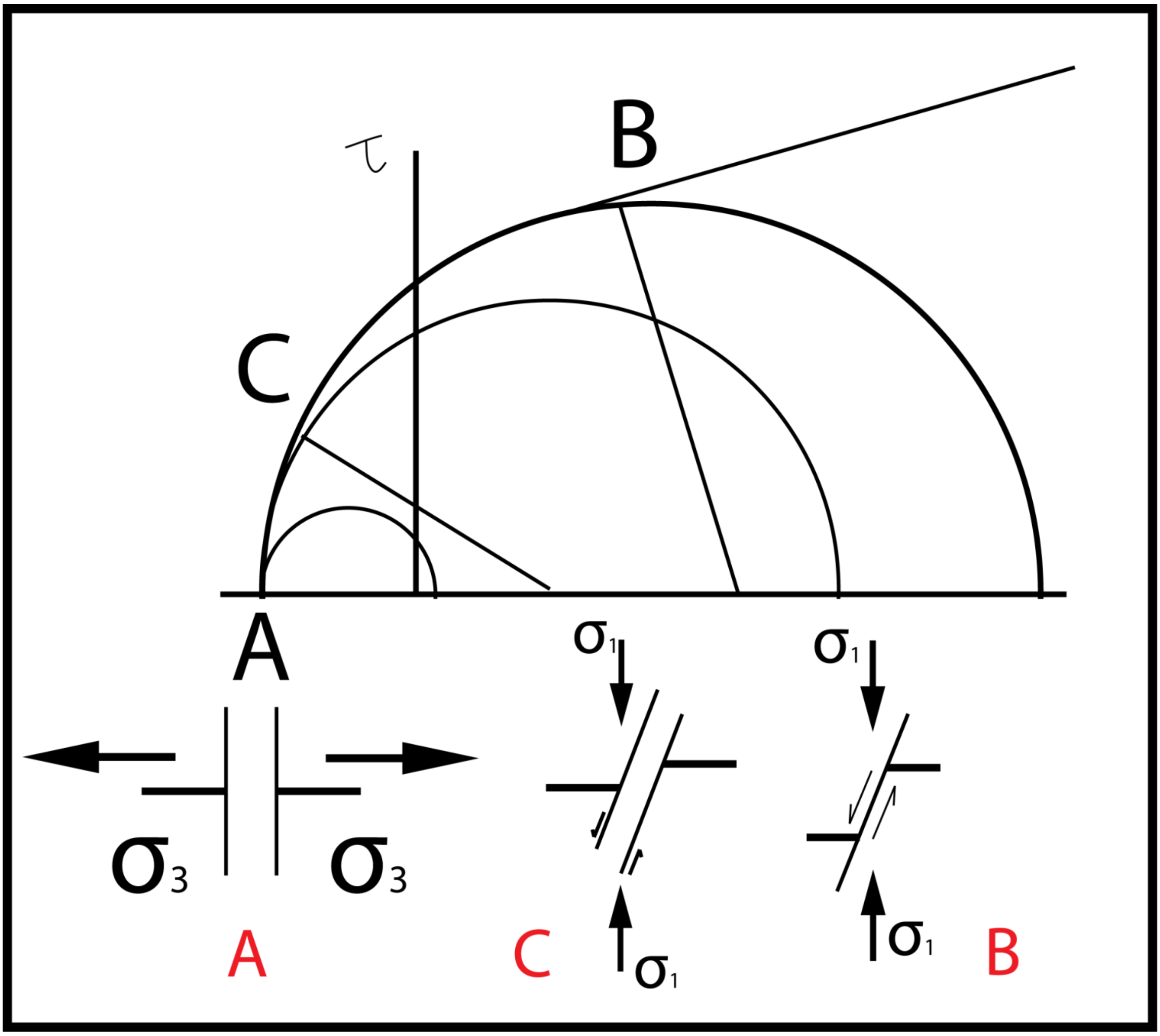


Figure 44

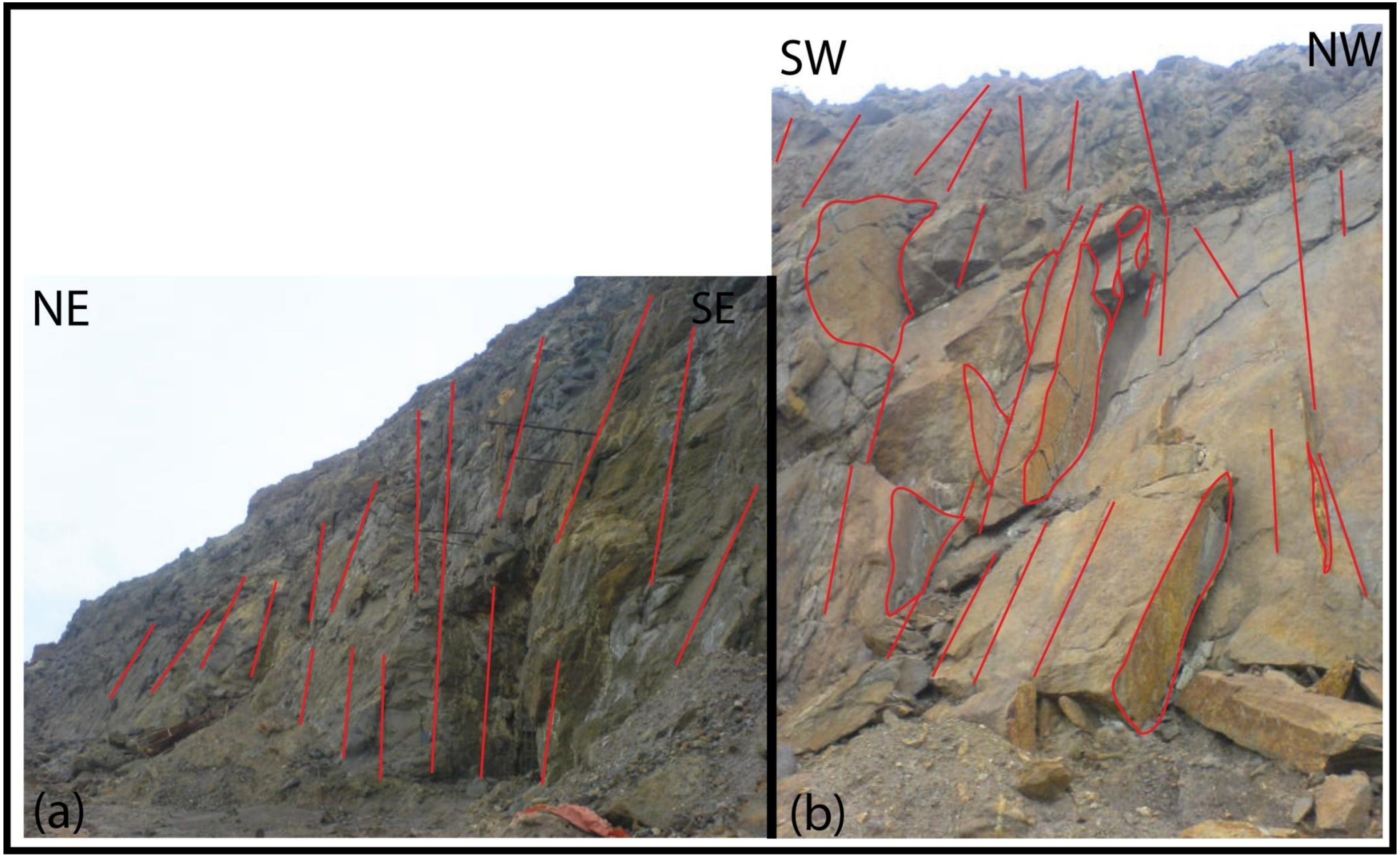
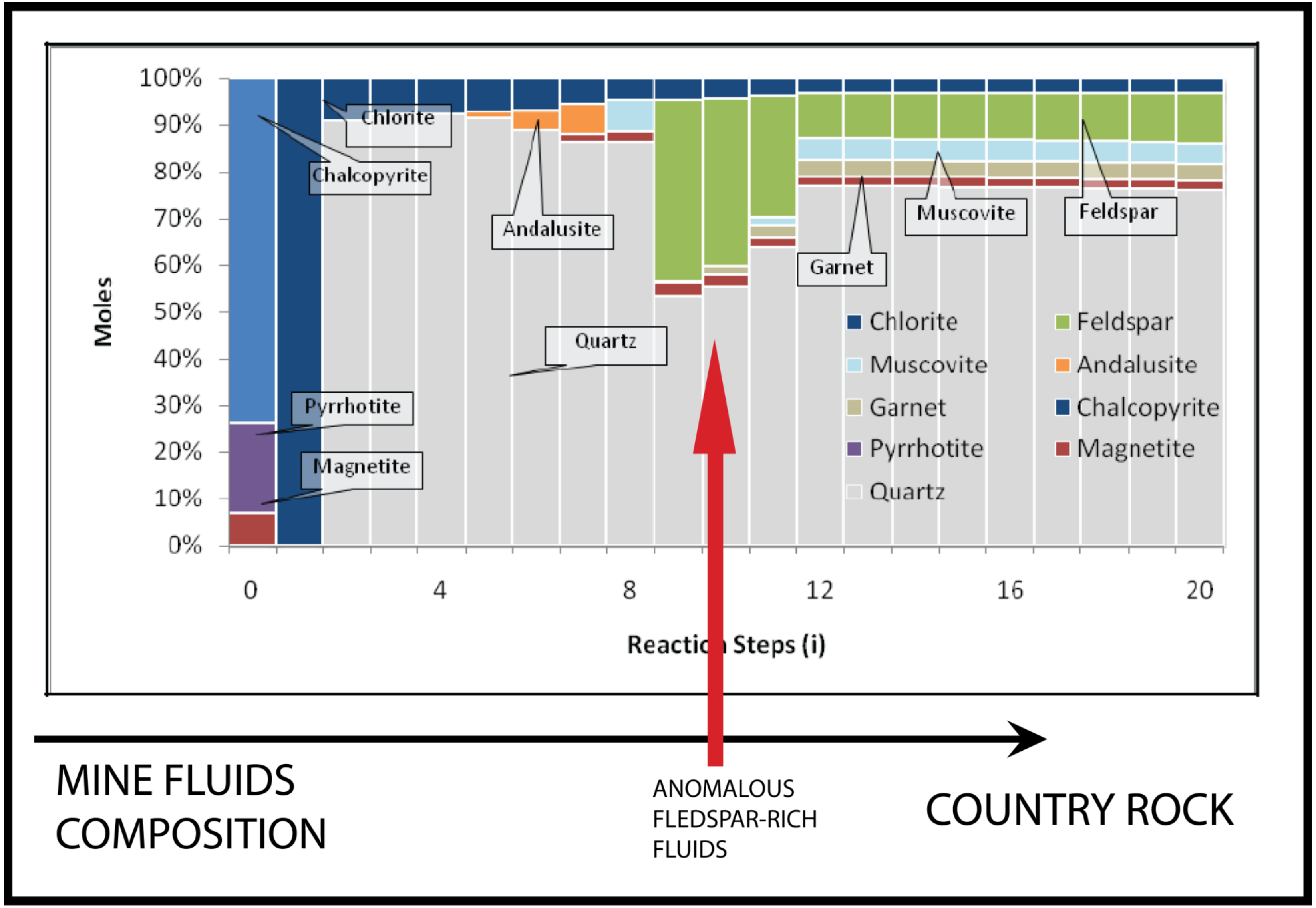


Figure 45



100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Moles
Chlorite
Chalcopyrite
Andalusite
Garnet
Muscovite
Feldspar
Quartz
Pyrrhotite
Magnetite
Chlorite
Feldspar
Muscovite
Andalusite
Garnet
Chalcopyrite
Pyrrhotite
Magnetite
Quartz
0
4
8
12
16
20
Reaction Steps (i)
MINE FLUIDS COMPOSITION
ANOMALOUS FLEDSPAR-RICH FLUIDS
COUNTRY ROCK

Figure 46


KS
KS
N
Legend
Mine Location
North Dipping Fracture Strike
Mean Strike (RH rule)
25 - 49
50 - 73
74 - 98
99 - 123
0
950
1,900
3,800
5,700
7,600
Meters

Figure 47

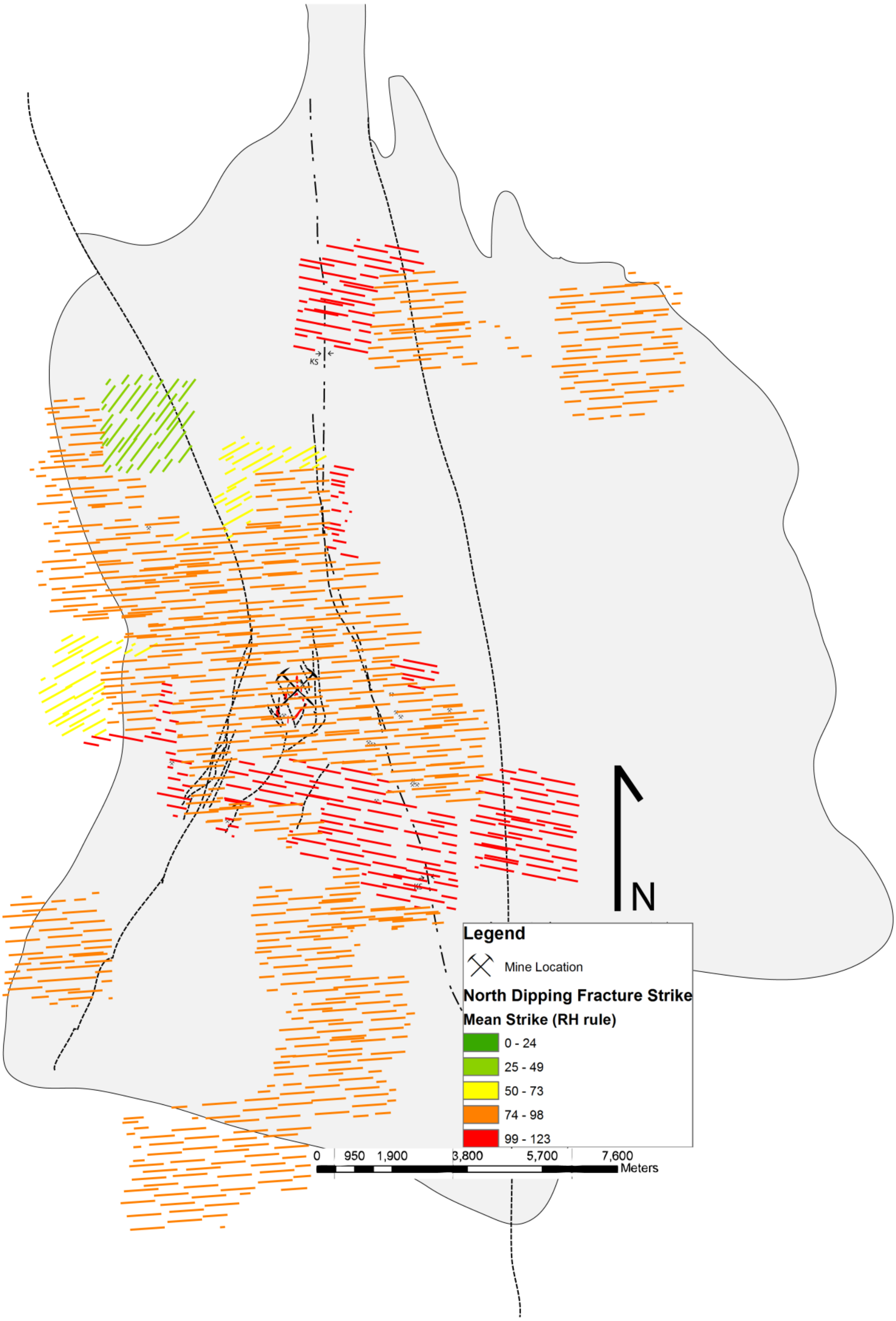

N
Legend
Mine Location
North Dipping Fracture Strike
Mean Strike (RH rule)
0 - 24
25 - 49
50 - 73
74 - 98
99 - 123
0
950
1,900
3,800
5,700
7,600
Meters

Figure 48

11. APPENDIX 1

Appendix 1: Structural Field Data

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
318109	6115992	GABs	92	78	2	7	Alteration	planar surface, altered surface- smooth and discoloured, 3/30cm fracture set
318110	6115993	GABs	64	82	334	5	Alteration	less planar surface, a rough smooth surface
317946	6116297	GABs	85	84	355		Alteration	vein fracture with 1mm opening and a 4mm alteration halo, typical looking cream inner to red outer colour, very discrete and thin fractures (picture taken)
317947	6116294	GABs	79	76	349	7	Alteration	vein fracture with 1mm opening , weathered infill and a 3mm alteration halo, typical looking cream inner to red outer colour, very discrete and thin fractures
317948	6116295	GABs	82	86	352	7	Alteration	part of a vein fracture set of 4 over 20cm, though all very discrete 2 with no gaps and appear as a alteration lineation, larger 'red' most likely iron enriched alteration halo into GABs, foliation in the outcrop is typical North-south trending steep east dipping
317948	6116287	GABs	80	85	350	3	Alteration	a very prominent singular vein fracture, not open but has infill, alteration halo 6mm thick, high level of quartz veining in the area most as un-orientated, few have same orientation in extensional strike, one quartz vein noted thick 80mm
317949	6116288	GABs	78	75	348	7	Alteration	discrete set of fractures of 5 over 50cm or a population of 7/m
317950	6116289	GABs	75	80	345	2	Alteration	prominent singular subvertical vein fracture with ~5mm alteration halo, this intersects with a north dipping (5cm) quartz vein
317951	6116290	GABs	78	75	348	4	Alteration	6mm alteration halo (similar colour ironstained with 'cream' inner vein material), not open more a vein
317949	6116696	GABs	67	71	337	4	Alteration	planar surface, iron stained surface

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317921	6116294	GABs	74	82	344		Alteration	alterated vein fracture similar colour, hal averages ~5mm but up to 16mm in some bit where it pushes along foliation lines it looks like, thinner alteation lineations run subparallel with fracture as a fracture set and looks to be related to folded thin quartz veining
317918	6116292	GABs	81	86	351		Alteration	a fine singular discrete fracture almost a alteration 'lineation' typical colour seen in all alteration
317918	6116289	GABs	87	78	357		Alteration	vein fracture with ~6mm alteration, seen to continue in interupted outcrop for +4m, continous fracture
317788	6116392	GABs	81	83	351		Alteration	singluar fine 1mm alteration vein fracture
317794	6116403	GABs	69	74	339		Alteration	planar fracture surface with alteration on surface and low alteration halo
317795	6116404	QMFs	72	85	342		Alteration	fracture set of prominent fracture surface and fracture vein with 2mm alteration halo
317669	6116403	QMFs	78	79	348		Alteration	open fracture ~2mm with large alteration halo of around 30mm, could have been faulted and offset but more likely rock outcrop have become loose
317638	6116403	QMFs	74	72	344		Alteration	fracture surface, having a prominent crest that looks to be more resistant to weathering
317609	6116371	QMFs	76	82	346		Alteration	open fracture ~3mm with a typical looking alteration 3mm on each side
317610	6116372	QMFs	77	87	347		Alteration	high density fracture set fractures are open with no/low alteration halo, looks to have 'fluid' contained in fracture
317603	6116371	QMFs	64	72	334		Alteration	open fracture with 6mm alteration halo
317463	6116415	QMFs	65	76	335		Alteration	slightly open fracture with no alteration visable
317450	6116425	QMFs	68	81	338	9	Alteration	slightly open fracture with 6mm alteration halo, iron red alteration, look to be evenly spaced fractures ~10cm a fracture set of 5 (5/50cm), with middle of set fracture having a larger alteration halo
317620	6116360	QMFs	69	84	339		Alteration	subvertical fracture surface, altered fracture but no halo
318112	6116391	GABs					Alteration	no fracture system seen in discontinous GABs outcrop, outcrop and foliation trending N-S, minimum quatz veining

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
318119	6116371	GABs	84	66	354		Alteration	open fracture,gap ~5mm, continous for metres, weathered out alteration
318120	6116372	GABs	64	82	334		quartz	quartz veins in the area, smae general trend as NE fracture systems
318114	6116372	GABs	87	82	357		Alteration	fracture surfaces (planar surface), iron staining, surface altered -smooth and guessing by red/brown colour change that it is by iron rich fluids
318114	6116372	GABs	85	55	355		Alteration	" " " " " "
318265	6116134	GABs	71	74	341		Alteration	fracture surface, altered surface-(red/brown) iron staining
318266	6116135	GABs	77	67	347		Alteration	fracture surface developed from fracture with ~2mm gap, weathered surface but altered, red/brown colour of alteration halo of about ~4mm
318207	6116176	GABs					Alteration	a large GABs boulder seen with alteration fracture but boulder not insitu, boulder highly fracture with typical fractures the cream colour soft inner which grade out to the red/brown iron alteration
318352	6115664	GABs					Alteration	large GABs outcrop with no visable E-W trending fracture sets seen
318324	6115680	GABs	14	70	284	10	Alteration	discrete lineations in rock, thin rock crest lineations could be slight fractures, counted a distrubition of 4/20cm in rock, thick quartz veining also visible in the same orientation
318318	6115633	GABs	72	74	342	6	quartz	discrete lineations structures, no alteration, highly fractured area 9/~2m with quartz vein (some ~15cm thick) 3/2m trending in same orientation
318319	6115634	GABs	79	78	349	2	quartz	also north-south quartz veining along rock weakness the foliation, looks to be highly structurally developed
318309	6115638	GABs	60	71	330		Alteration	discrete fractures ~1mm open rock gap, no infill of alteration, surfaces/alteration halo of what i have discribed as iron stained rock due to the red colour surrounding the fracture comapred with the 'normal' state of the rock

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
318310	6115639	GABs	71	78	341		Alteration	" " " " " "
318311	6115640	GABs	82	85	352		Alteration	" " " " " "
318312	6115641	GABs	67	73	337		quartz	thin quartz vein
318303	6115546	GABs	72	78	342		Alteration	fracture surfaces (planar surface), iron staining, surface altered -smooth and guessing by red/brown colour change that it is by iron rich fluids
318304	6115547	GABs	70	64	340		Alteration	" " " " " "
318305	6115548	GABs	69	67	339		Alteration	fracture in rock, gap of ~2mm, this area is close to suface old copper workings, a small mineralised zone
318300	6115509	GABs	75	74	345		Alteration	fracture surface, but not abudant in this outcrop, or as it seems in this area compared with other more fractured areas
318079	6115961	GABs					Alteration	no fracture or E-W structure recorded
318174	6115734	GABs	95	79	5		Alteration	planar surface and altered fracture, fracture has 1mm gap with small/slight (not heavily) oxidised (red colour) alteration
318232	6115829	GABs	78	86	348	10	Alteration	high fracture zone 4/30cm or 2/15cm, fine fractures with no gap and low iron rich alteration, quartz veins present nearby
318260	6115840	GABs	86	78	356		Alteration	weathered' discontinous fracture surfaces, slightly visible iron alteration on surface and halo
318312	6115877	GABs	66	80	336	0.5	Alteration	very discrete vague fracture surfaces in outcrop but very barren of fracture looking structure, quartz veining in outcrop present
318313	6115878	GABs	66	77	336		Alteration	
318306	6115882	GABs	85	61	355	1	Alteration	large 'iron' altered smooth fracture surface, area only consists of fracture surfaces not intact fractures 'lines'
318296	6115897	GABs	86	66	356	1	Alteration	" " " "

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								" "
318297	6115898	GABs	75	78	345	0.5	Alteration	" " " " " "
318298	6115899	GABs	80	66	350	0.5	quartz	" " " " ", quartz veining developed along surface plane as well
318247	6115939	GABs	86	85	356	0.5	Alteration	" " " " ", smooth fractures, sparse distrubtion with ~1 every 3m
318262	6115946	GABs	63	59	333		Alteration	large fracture surface, looks very weathered and rough surface
318257	6115951	GABs	79	74	349	3	Alteration	4/2m similar fracture surfaces, no intact fractures seen
318244	6115952	GABs	80	64	350	1	Alteration	large 'iron' altered smooth fracture surface,3 similar over ~4m, area only consists of fracture surfaces not intact fractures 'lines'
318228	6115960	GABs	82	78	352		Alteration	large outcrop with vague east-west trending fracture structures that cut across n-s trending schist foliation, quzrtz veining along foliation
318227	6115926	GABs	110	75	20	3	Alteration	fractures and fracture surfaces present in outcrop, about 5/2m fractures have 1mm gap, weather iron rich alteration and halo
318227	6115927	GABs	89	72	359		Alteration	continous fracture surface, alteration iron rich surface
318216	6115928	GABs	85	79	355		Alteration	" " "
318213	6115937	GABs	75	68	345	7	Alteration	3/50cm fractures, 2mm gap in fracture slighlty altered surfaces and halo into rock
317738	6116321	QMFs	60	74	330	10	Alteration	road outcrop, non gapped fractures, red/cream alteration halo ~20mm, high fractured area, dense fracture sets
317739	6116322	QMFs	85	71	355	10	Alteration	" " " " ", 10/1m
317738	6116321	QMFs	86	78	356	15	Alteration	" "

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								" " ", 8/25cm
317751	6116323	QMFs	82	81	352	10	Alteration	road outcrop, non gapped fractures, red/cream alteration halo ~20mm, high fractured area, dense fracture sets 4/20cm
317758	6116327	QMFs	54	53	324	10	Alteration	road outcrop, non gapped fractures, red/cream alteration halo ~20mm, high fractured area, dense fracture sets 2/10cm
317759	6116328	QMFs	75	72	345	10	Alteration	
317564	6114219	GABs	104	81	14		Alteration	north-south trending foliation, high fractured area, weathered outcrop, gap of ~3mm, alteration rich in iron (dark red colour)
317565	6114220	GABs	86	85	356		Alteration	
317566	6114221	GABs	96	76	6		Alteration	
317567	6114222	GABs	106	85	16		Alteration	" " " " "
317568	6114223	GABs	92	87	2		Alteration	
317569	6114224	GABs	101	79	11		Alteration	" " " " "
317564	6114214	GABs	105	84	15		quartz	old copper workings, thick (30cm) quartz vein/structure, mineralisation directly linked to structure, rock surrounding fractured by same orientated structures
317565	6114215	GABs	94	86	4		Alteration	typical fracture surface and fracture next to larger mineralised structure above
317556	6114214	GABs	95	86	5		Alteration	large fracture surface directly next to mineralisation
317557	6114215	GABs	104	81	14		Alteration	large fracture surface directly next to mineralisation
317576	6114210	GABs	91	80	1		Alteration	this area looks highly weathered and broken up from the mining process
317575	6114217	GABs	66	80	336	8	Alteration	associated with the beleived mineralisation, direct area high fracture?(e-w trending structures), typical looking fractures and fracture surfaces
317589	6114197	GABs	97	84	7		Alteration	2 close fractures, weathered out middle part creating a ~10cm gap, small amount of iron rich

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								alteration
317589	6114197	GABs	84	82	354		Alteration	
317590	6114198	GABs	76	83	346		Alteration	a close by fracture surface
317608	6114240	GABs	86	86	356		Alteration	
317609	6114241	GABs	86	84	356		Alteration	2 close fractures, weathered out middle part creating a ~7cm gap, small amount of iron rich alteration
317607	6114246	GABs	84	84	354	14	Alteration	high fracture density area, fracture set of 4/30cm, does look a bit like positive flower structure in rock but could judt look like it, typical looking fractures
317608	6114247	GABs	86	84	356	14	Alteration	" " " " "
317609	6114248	GABs	84	86	354	14	Alteration	fracture gaps of ~2mm to 4mm " " " "
317610	6114249	GABs	85	84	355	14	Alteration	" " " " "
317604	6114253	GABs	86	86	356	14	Alteration	fracture, 2mm gap, uneven alteration halo, thicker on 'footwall', iron rich alteration
317606	6114260	GABs	73	85	343	7	Alteration	prominent raised altered fracture
317607	6114261	GABs	85	86	355	8	Alteration	Fracture set, 4/20cm, positive flower-like fracture
317608	6114262	GABs	84	87	354	8	Alteration	
317607	6114279	GABs	75	84	345	0.5	Alteration	fracture with alteration halo, 2mm fracture gap with ~10mm alteration halo (red/Cream colour), fracture distrubtion 1/3m, photo taken, sample taken KMH006
317608	6114305	GABs	75	87	345	0.5	Alteration	" " " " "
317611	6114326	GABs	86	84	356	2	Alteration	fracture, 5mm gap, alteration halo ~10mm, typical looking fracture (red/cream colour), sample taken of alteration material (inner cream material) KMH007
317588	6114354	GABs	70	84	340	2	Alteration	altered fracture surface, planar surface, iron rich alteration, a less fractured area than above

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317587	6114366	GABs	66	82	336	2	Alteration	
317596	6114380	GABs	83	80	353	2	Alteration	2 open fractures, 5mm gap, no or very little alteration associated with the fracture, elongated andalusite crystals
317608	6114387	GABs	84	86	354	2	Alteration	2 open fractures, 5mm gap, no or very little alteration associated with the fracture, elongated andalusite crystals
317606	6114365	GABs	79	80	349	3	Alteration	normal' looking fractures, no alteration but open with 3mm gap and distrubtion of 7/5m
317312	6114335	GABs	68	85	338	3	Alteration	vague fracture looking structures, next to old workings eg mineralised zone
317313	6114336	GABs	62	74	332	3	Alteration	
317314	6114337	GABs	85	86	355	8	Alteration	typical looking fracture with similar cream/red alteration, a high fracture zone with around 8/1m structures
312082	6108272	QMFs	72	61	342	7	Alteration	14/20m - high degree of fracturing
312083	6108273	QMFs	66	65	336	5	Alteration	
312084	6108274	QMFs	66	60	336	7	Alteration	
312085	6108275	QMFs	99	84	9	4	Alteration	
312086	6108276	QMFs	102	62	12	6	Alteration	
312087	6108277	QMFs	99	64	9	10	Alteration	
312088	6108278	QMFs	74	56	344	9	Alteration	
313181	6117893	QMFs	101	87	11	0.5	Alteration	2 fracture seen in road side outcrop 20m apart, low density, with slight ironstained altered halo ~10mm, not 'typical alteration'
313182	6117894	QMFs	86	84	356	0.5	Alteration	large fracture surface
312965	6120645	QMFs	79	83	349	5	Alteration	high to medium density of fracturing with no alteration or iron staining on fracture surfaces, look more like jointing that extensional fracturing, foliation is 161/55e
325299	6118882	QMFs				4	Alteration	road side north-south trending outcrop does have e-w trending subvertical fracturing, look like jointing again no alteration seen
326281	6123064	QMFs	81	80	351	2	Alteration	vague very low density extensional orientated structure in road side outcrop with no alteration or veining

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
326125	6123651	QMFs	292	88	382		quartz	quartz veining in extensional orientated planar fracturing ~5mm thick, area dominated by structural jointing along foliation
326079	6123651	QMFs	76	82	346		quartz	no extensional looking fracturing
321089	6124260	QMFs	268	82	178		Alteration	small outcrop on roadside, planar alteration fracturing and veining, alteration mostly confined in fracture as vein, 1-2mm some have a 3mm halo
321090	6124261	QMFs	95	64	5		Alteration	
321091	6124262	QMFs	86	52	356		Alteration	
321092	6124263	QMFs	96	69	6		Alteration	very planar altered surfaces, high iron stained (photos taken)
321093	6124264	QMFs	94	60	4		Alteration	
321094	6124265	QMFs	97	65	7		Alteration	
321095	6124266	QMFs	92	66	2		Alteration	
320129	6124804	QMFs					Alteration	large continous road cutting along bremer creek with no east-west trending fracturing, dominated by north-south? Jointing and cracks
319929	6124804	QMFs	266	88	176		Alteration	iron stained semi planar structure
319930	6124805	QMFs	106	88	16		quartz	quartz infill in extensional fractures, low density area
319929	6124804	QMFs	270	78	180		quartz	
319930	6124805	QMFs	246	25	156		quartz	shallow south dipping structure with no alteration
319248	6124746	QMFs	108	74	18		quartz	extensional fracture vein infill with quartz
323817	6111528	QMFs	111	85	21		Alteration	slight alteration, iron stained semi planar structures
323818	6111529	QMFs	64	76	334		Alteration	
323819	6111530	QMFs	109	72	19		Alteration	
323820	6111531	QMFs	114	72	24		Alteration	
323821	6111532	QMFs	95	75	5		Alteration	
323822	6111533	QMFs	98	66	8		Alteration	
316595	6113994	QMFs	108	74	18	0.5	Alteration	extensional fracturing with alteration halos, low density with around 3/1m
316596	6113995	QMFs	110	85	20	0.5	Alteration	
316597	6113996	QMFs	91	82	1	0.5	Alteration	thick (one side 10mm) alteration halo on planar fracture surface

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316598	6113997	QMFs	117	83	27	0.5	Alteration	
316599	6113998	QMFs	96	78	6	1	Alteration	a rough planar surface
316600	6113999	QMFs	102	65	12	1	Alteration	
316628	6113994	QMFs	67	52	337	2	Alteration	low density fracturing 2/1m, a similar density, highly weathered and broken up fracture surfaces, alteration present
316629	6113995	QMFs	61	61	331	1	Alteration	
316630	6113996	QMFs	109	81	19	2	Alteration	
316631	6113997	QMFs	100	70	10	0.5	Alteration	
316632	6113998	QMFs	98	75	8	1	Alteration	
316650	6114002	QMFs	112	84	22	9	Alteration	mostly area consists of alterated surfaces and veining, no/low/thin alteration halos
316651	6114003	QMFs	84	81	354	9	Alteration	alterated lineation in rock
316652	6114004	QMFs	109	84	19	9	Alteration	
316653	6114005	QMFs	102	82	12	9	Alteration	an intact vein fracture with a large ~10mm alteration halo
316654	6114006	QMFs	88	87	358	9	Alteration	a high density fracture set of very thin discrete fractures with alteration fluid infill, 4/30cm
316655	6114007	QMFs	116	80	26	9	Alteration	
316656	6114008	QMFs	110	80	20	9	Alteration	
316657	6114009	QMFs	108	86	18	9	Alteration	
316742	6114077	QMFs	46	65	316	2	Alteration	low density fracturing, no alteration, area dominated by shallow dipping fracturing
316743	6114078	QMFs	46	60	316	2	Alteration	
316819	6114148	QMFs	98	82	8	2	Alteration	low density area of fracturing, and low aleration of fracture surfaces
316820	6114149	QMFs	121	75	31	2	Alteration	
316821	6114150	QMFs	111	75	21	4	Alteration	
316822	6114151	QMFs	105	82	15	4	Alteration	
316823	6114152	QMFs	71	60	341	4	Alteration	
316824	6114153	QMFs	44	45	314	7	Alteration	a bit further east is a section of shallow dipping, slighlty more north striking fracturing that has increased density to high grade 6-7/1m
316825	6114154	QMFs	42	38	312	7	Alteration	
316826	6114155	QMFs	38	48	308	7	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316827	6114156	QMFs	44	40	314	7	Alteration	
316923	6114149	QMFs	66	30	336	2	Alteration	shallow dipping, low density fracturing
316924	6114150	QMFs	86	20	356	2	Alteration	
316877	6114507	QMFs	98	74	8	2	Alteration	low density fracturing, alteration fluid confined to veins and fracture surfaces (no alteration halos), thin 1-2mm veins
316878	6114508	QMFs	100	70	10	5	Alteration	fracture set of 4 in tight grouping
316879	6114509	QMFs	91	82	1	5	Alteration	
316223	6114187	QMFs	86	70	356	2	Alteration	low density fracturing, though fracturing grouped together 4-5 fractures in sets
316224	6114188	QMFs	92	75	2	2	Alteration	
316225	6114189	QMFs	74	35	344	2	Alteration	shallow dipping fractures as well present
316203	6114188	QMFs	110	35	20	8	Alteration	a zone of high fracturing with multiple orientations, shallow e-w as well as ne-sw steep dipping fracturing
316204	6114189	QMFs	60	60	330	8	Alteration	no offsetting with other interacting fractures, noted random orientated quartz veins that have been boudingared
316205	6114190	QMFs	121	40	31	8	Alteration	
316206	6114191	QMFs	77	75	347	8	Alteration	
316160	6114223	QMFs	128	50	38	6	Alteration	shallow dipping e-w fracturing, with high-medium density fracturing
316161	6114224	QMFs	101	65	11	6	Alteration	
316162	6114225	QMFs	76	49	346	6	Alteration	
316163	6114226	QMFs	91	81	1	6	Alteration	looks to be a very defromed area with 'random' orientated fracturing dominated by the shallow dipping, also seen is boudingaded quartz veins
316164	6114227	QMFs	94	75	4	5	Alteration	extensional fracturing with low/none alteration halos , fluids contained in veins and as altered fracture surfaces
316165	6114228	QMFs	74	70	344	4	Alteration	fracture surfaces are less smooth planar, more rough and undulating (could be weathering), fractures form sets that have high density 4-5/60cm (over ~5m) but low density outside of fracture set
316137	6114240	QMFs	66	55	336	8	Alteration	high fracture density zone 8/1m, but very discrete

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								thin fracturing thin veining and surfaces with ~2mm alteration halos
316138	6114241	QMFs	121	80	31	8	Alteration	
316137	6114240	QMFs	91	70	1	8	Alteration	
316114	6114279	QMFs	79	55	349	5	Alteration	low density area , with fracture sets of high density of 3-5 fractures in a set- set of 5/1m, though have no alteration halos and fracture surfaces dont have high alteration, rough planar surfaces
316115	6114280	QMFs	306	76	216	5	Alteration	
316116	6114281	QMFs	304	64	214	5	Alteration	
316117	6114282	QMFs	86	85	356	5	Alteration	
316118	6114283	QMFs	90	68	0	5	Alteration	
316119	6114284	QMFs	122	84	32	5	Alteration	
316120	6114285	QMFs	76	72	346	5	Alteration	
316011	6114370	QMFs	88	74	358	5	Alteration	low density, fractures developing into fracture sets of 4-5, low alteration which could be due to low amounts of fluids moving through fluids
316012	6114371	QMFs	95	84	5	4	Alteration	fracture set density 6/2m
316013	6114372	QMFs	109	36	19	3	Alteration	fracture set density of 5/2m, seperate set
316014	6114373	QMFs	64	82	334	6	Alteration	another fracture set with increasing density into an old road cutting or working striking along foliation
315959	6114411	QMFs	109	78	19	3	Alteration	low density fracturing, slight alteration on fracture surfaces
314305	6114694	QMFs	104	87	14	2	Alteration	small road outcrop with fracture surfaces very rough and weathered, altered iron stained
314306	6114695	QMFs	94	78	4	2	Alteration	low to medium density 6/5m
313386	6117212	QMFs					Alteration	loose boulders on road side with vague altered structure as iron stained fracture surface but not sure of orientation, close to freeway so have to confirm with that work
314308	6121534	GABs	34	24	304	5	quartz	shallow westerly dipping planar structures, no alteration present, quartz covering fracture surface
314309	6121535	GABs	25	37	295	5	Alteration	alteration present in these one, similar alteration with small alteration halo, density of area is medium to low of 1-7/m
314308	6121534	GABs	30	16	300	5	quartz	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317485	6119827	QMFs	66	34	336	2	Alteration	shallow westerly dipping planar structures, low to slightly iron stained fracture surfaces
317486	6119828	QMFs	41	41	311	2	Alteration	low density but hard to tell due to low levels of outcrop
317632	6119621	QMFs	76	60	346	2	Alteration	low amount of structure in rock, low density of 1/3m to 3/1m, sparsly distrubed, low degree of altered surfaces, look more like jointing than fracturing
317633	6119622	QMFs	71	48	341	2	Alteration	
317632	6119621	QMFs	74	56	344	2	Alteration	
317797	6119467	QMFs	92	72	2		Alteration	large outcrop roadside,with no real structure present, vague moderately west dipping structure, quartz veining in no orientation, no alteration in fracture
318075	6119349	QMFs +GABs	103	71	13	2	Alteration	discrete altered vein fracture and fracture surfaces, visible for +6m, low density fracturing, alteration surface of typical nature
317679	6122151	QMFs					Alteration	small outcrop on roadside, few vague shallow west dipping fractures, with no alteration
319322	6116584	QMFs	226	69	136		Alteration	altered fracture veins and surfaces, alteration halos present in some, normal looking alteration,
319323	6116585	QMFs	90	74	0		Alteration	
319324	6116586	QMFs	86	70	356		Alteration	
319325	6116587	QMFs	85	64	355		Alteration	
319326	6116588	QMFs	92	63	2		Alteration	
319327	6116589	QMFs	96	73	6		Alteration	
319328	6116590	QMFs	82	66	352		Alteration	
319329	6116591	QMFs	88	75	358	6	Alteration	iron stained alteration halos on some fracturing up to ~40mm thick, density high with 4-8/m of large prominent fracture, many more discrete <1mm vein fractures
319330	6116592	QMFs	91	74	1	6	Alteration	
320861	6113802	QMFs	92	68	2	8	Alteration	high density fracturing in area, dominated by subvertical, north dipping altered fracturing
320862	6113803	QMFs	90	75	0	10	Alteration	denisty of 7-8/m to 12/m, with zones 3-8/m or visually prominent fracturing of 4/m (from a distance)

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
320863	6113804	QMFs	80	66	350	10	Alteration	
320864	6113805	QMFs	78	66	348	10	Alteration	fracture have developed into loose sets, of larger prominent fractures developing as a smooth planar fracture surface
320865	6113806	QMFs	94	76	4	10	Alteration	
320866	6113807	QMFs	76	70	346	10	Alteration	
317723	6112372	QMFs	108	74	18	0.5	quartz	quartz covered fracture surface, smooth and planar, low density of 1/2m
317724	6112373	QMFs	102	81	12	0.5	quartz	
317751	6112380	QMFs	94	75	4	0.5	quartz	quartz covered fracture surface, smooth and planar, low density of 1/2m, fracture can be traced 20m+ along strike
317752	6112381	QMFs	101	80	11	0.5	quartz	
317761	6112369	QMFs	93	75	3	0.5	quartz	quartz covered fracture surface, smooth and planar, low density of 1/2m
317762	6112370	QMFs	101	86	11	0.5	quartz	
317761	6112369	QMFs	73	85	343	0.5	quartz	
317859	6112391	QMFs	68	76	338	3	quartz	quartz covered fracture surface, smooth and planar, medium to low density of 3/m
317860	6112392	QMFs	94	63	4	3	quartz	
317859	6112391	QMFs	88	84	358	5	quartz	do get fracture density increases with tight fracture sets (a tight group of fracturing of the same orientation) fracture set of 4/60cm
317908	6112371	QMFs	84	69	354	2	quartz	low density area, fracture surfaces
317908	6112371	QMFs	246	72	156	5	quartz	
317909	6112372	QMFs	98	85	8	8	quartz	a fracture set of 5/30cm of same orientation
320327	6114461	QMFs	124	83	34	3	quartz	quartz veins fracture set of 5/2m, veins are ~10mm thick
320328	6114462	QMFs	73	46	343	3	quartz	smooth planar fracture surface, slight iron stained alteration with small 1mm alteration
320330	6114434	QMFs	123	74	33		quartz	quartz veins, average size 20-30mm thich some thicker
319876	6111582	QMFs	111	80	21	4	quartz	quartz veins of 10-30mm thickness, medium density of fracturing at 4/m, very planar and straight veining compared to other orientated quartz veins which snake

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319877	6111583	QMFs	55	87	325	4	quartz	
319876	6111554	QMFs	118	66	28		quartz	planar quartz veins
319877	6111555	QMFs	113	75	23		quartz	
319876	6111554	QMFs	121	81	31		quartz	
319831	6111594	QMFs	121	72	31	5	quartz	planar quartz veins, thickness of 3-20mm, medium denisty fracturing of 5/1m
319832	6111595	QMFs	107	76	17	5	quartz	
319833	6111596	QMFs	116	70	26	5	quartz	
319834	6111597	QMFs	128	77	38	5	quartz	
319835	6111598	QMFs	106	68	16	5	quartz	
319261	6111875	QMFs	123	73	33		quartz	planar quartz veining
319237	6111887	QMFs	90	75	0	4	Alteration	altered planar surfaces with no alteration halos, medium to low fracture density
319238	6111888	QMFs	84	68	354	4	Alteration	
319237	6111887	QMFs	92	81	2	4	Alteration	
319194	6111913	QMFs	104	83	14		quartz	quartz covered and altered fracture surfaces, no alteration halo, smooth planar surfaces
319195	6111914	QMFs	106	82	16		quartz	
319196	6111915	QMFs	118	63	28		quartz	
319197	6111916	QMFs	88	70	358		quartz	
319198	6111917	QMFs	64	62	334		quartz	
319199	6111918	QMFs	91	82	1		quartz	
319141	6111944	QMFs	100	57	10		quartz	quartz covered fracture surface, no alteration halo, massive n-s trending east dipping shear fault zone in area
319142	6111945	QMFs	96	68	6		quartz	
318125	6114809	GABs	66	83	336		quartz	rough planar quartz veins,
318126	6114810	GABs	62	83	332		quartz	
318030	6114858	GABs	94	87	4		sulphide	planar smooth fracture surfaces, alteration fluid looks to be a sulphide rich fluid, proper ore fluid, fractures are continous up pit walls top to bottom, ~100m+ up dip and ~50m+ strike, density of extensional? Fracturing (prominent) 1 every 50cm or 4/m (classed as medium density)
318014	6114877	GABs	96	84	6	4	quartz-sulphide	fracture vein with no alteration halos, veins look to

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								be filled with a quartz rich sluphide vein, that has weathered out on fracture surface to leave behind iron/weathered sulphide vein surface
318015	6114878	GABs	95	87	5	4	Alteration	
318016	6114879	GABs	97	84	7	4	Alteration	
318318	6114852	GABs	110	77	20	3	Alteration	continous fracture surfaces, slighlty altered surface definate fluid movement, surfaces have been weathered to dark black 'iron stained' surface with no alteration halo
318319	6114853	GABs	120	75	30	3	Alteration	
318318	6114852	GABs	116	76	26	3	Alteration	density medium of 3/m, fractures have developed rough planar surfaces, highly weathered
318319	6114853	GABs	100	85	10	3	Alteration	
318320	6114854	GABs	112	79	22	3	Alteration	
318321	6114855	GABs	120	82	30	3	Alteration	
318671	6114926	GABs	101	88	11	3	Alteration	rough planar fracture surfaces, medium denisty fo 3/m, slight iron stained
318672	6114927	GABs	106	87	16	3	Alteration	
318673	6114928	GABs	85	82	355	3	Alteration	
318674	6114929	GABs	85	81	355	3	Alteration	
318664	6114902	GABs	110	89	20	3	Alteration	rough planar fracture surfaces, medium denisty fo 3/m, slight iron stained
318665	6114903	GABs	103	83	13	3	Alteration	
318666	6114904	GABs	95	88	5	3	Alteration	
318667	6114905	GABs	91	86	1	3	Alteration	
317880	6114908	GABs	76	85	346		Alteration	vague fracture structures in rock, structures are very undulating and are non planar
317881	6114909	GABs	104	85	14		Alteration	
317866	6114899	GABs	97	88	7	3	quartz	rough planar fracture visible over 4m+, highly weather outcrop but can see slight alteration halo of fracture, surrounding rock has 3 more fractures but are non planar and discontinous (photo taken)
317867	6114900	GABs	103	85	13	3	quartz	quartz vein of ~10cm thick
317846	6114894	GABs	86	65	356	3	Alteration	rough planar surface, medium density area 3/m
317847	6114895	GABs	98	80	8	4	Alteration	rough planar surface with altered surface and ~20mm alteration halo (both sides), medium

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								density 4/m
317848	6114896	GABs	104	88	14	4	Alteration	discrete fracture veins surounding more prominent fracture surfaces
317849	6114897	GABs	96	81	6	5	Alteration	in area around 2 out of 9 extensional fractures and veins, has developed into prominent fracture surface visible from 5m+ distance
317836	6114875	GABs	103	80	13	5	Alteration	rough planar structure iron stained fracture surface, with medium density of ~5/m
317837	6114876	GABs	102	86	12	5	Alteration	
317838	6114877	GABs	92	75	2	5	Alteration	
317839	6114878	GABs	100	86	10	5	Alteration	
317831	6114854	GABs	97	81	7	4	Alteration	similar structure of nearby area, rough planar fractures, iron stained alteration
317832	6114855	GABs	101	81	11	4	Alteration	
317833	6114856	GABs	76	62	346	4	Alteration	
317834	6114857	GABs	99	88	9	4	Alteration	
317835	6114858	GABs	76	87	346	5	Alteration	
317836	6114859	GABs	102	81	12	5	Alteration	typical looking fracture alteration fractures in highly weather outcrop
317814	6114796	GABs	99	81	9	5	Alteration	similar looking structure and density of larger area, rough planar structures of medium density 5/m
317815	6114797	GABs	100	83	10	5	Alteration	
317816	6114798	GABs	104	81	14	5	Alteration	
317813	6114767	GABs	88	80	358	7	Alteration	thick altered veins above old mine workings (deep shaft), alteration looks like the typical alteration explained before, yellow cream inner vein out to red iron stained alteration halo, a 20mm halo
317814	6114768	GABs	102	76	12	7	Alteration	
317815	6114769	GABs	88	85	358	7	Alteration	a very thick 20cm vein of alteration, area of slighlty higher fracturing density, high of 7/m
317816	6114770	GABs	95	84	5	7	Alteration	
317817	6114757	GABs	91	79	1	4	Alteration	typical looking fracture vein, with small fine ~1mm alteration halo, fluid movement looks to be confined inside veins
317839	6114757	GABs	95	84	5	4	Alteration	rough-to-smooth planar fractures, weathered surface creating a rough surface with smooth

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								unweathered patches on surface
317840	6114758	GABs	101	84	11	4	Alteration	density similar to area of 4/m
317841	6114759	GABs	100	87	10	4	Alteration	
318209	6114815	GABs	88	75	358	2	Alteration	pit wall cutting, fracture surfaces looks clean, slight alteration
318210	6114816	GABs	91	86	1	2	Alteration	a fracture surface with a ~30mm alteration halo (photo taken), an iron-orange colour alteration, fracture is open about 5mm, fracture density was observed to be ~6/10m
318509	6108519	QMFs					Alteration	loose non-insitu boulders with some fracturing and veining in rocks
318303	6108525	QMFs	90	79	0		Alteration	prominent fracturing but highly weathered (a smooth but broken up fracture surface), a highly altered fracture with ~20mm alteration halo (high fe staining)
318304	6108526	QMFs	95	69	5		Alteration	
318305	6108527	QMFs	89	76	359		Alteration	
318246	6108537	QMFs	88	75	358	7	Alteration	large stained fracture surface, with quartz veins been intersecting and perpendicularlly moving into rock, fracture surface has a surface area of around 2msquare
318247	6108538	QMFs	90	80	0	7	Alteration	medium to high density fractured area of 7/m
318248	6108539	QMFs	86	85	356	7	Alteration	no alteration halos
313692	6110088	pyrite member					Alteration	north-south trending pyrite member
311088	6107746	QMFs					Alteration	small roadside outcrop with no structures seen
317150	6103416	QMFs	104	88	14		quartz	thin extensional related quartz veining, no alteration halo, noted that as the quartz vein has been weathered away on the fracture surface to leave an iron stained alteration
317151	6103417	QMFs	84	80	354		quartz	
317152	6103418	QMFs	100	85	10		quartz	
317153	6103419	QMFs	46	75	316		quartz	
317154	6103420	QMFs	51	85	321		quartz	
315156	6102460	QMFs	84	60	354	2	quartz	thin extensional related quartz veining 2-5mm, no alteration halo, noted that as the quartz vein has been weathered away on the fracture surface to

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								leave an iron stained alteration
315157	6102461	QMFs	92	86	2	2	quartz	hard to judge but low degree of density
315156	6102460	QMFs	108	65	18	2	quartz	
319022	6105259	QMFs	66	75	336		Alteration	a fracture with a 15mm alteration halo
319023	6105260	QMFs	102	75	12		quartz	quartz vein 2-4mm thick
319024	6105261	QMFs	100	85	10		quartz	quartz vein 4mm thick
319025	6105262	QMFs	96	83	6		quartz	quartz vein
319026	6105263	QMFs	101	85	11		quartz	quartz vein
319583	6106602	QMFs	78	60	348	7	Alteration	high density fracturing of 7/m to medium density of 5/m in area, fracture has a 15mm alteration halo
319584	6106603	QMFs	89	62	359	7	Alteration	
319585	6106604	QMFs	82	55	352	7	quartz	also in area are south dipping quartz veins
319586	6106605	QMFs	88	70	358	7	Alteration	
320455	6110070	QMFs	281	85	191		quartz	5-10mm quartz infill fracturing with no alteration halo, weathered away quartz veining on fracture surface has left an iron stained alteration
320456	6110071	QMFs	296	76	206		quartz	
320457	6110072	QMFs	276	80	186		quartz	
320458	6110073	QMFs	96	66	6		quartz	
319095	6111969	QMFs	98	68	8		Alteration	smooth planar 'iron stained' surfaces, the dominate looking structure in area apart from n-s striking east dipping foliation,
319096	6111970	QMFs	100	65	10		quartz	a continous fracture over strike of 20m+, there is quartz veining along same orientation ~2mm thick
319097	6111971	QMFs	128	71	38		quartz	a quartz vein fracture surface that is smooth planar
318972	6112014	QMFs	108	66	18	3	quartz	quartz veining ~10mm thick in area, a medium to low density of vein fracturing of 3/m
318973	6112015	QMFs	101	64	11	3	quartz	
318974	6112016	QMFs	94	65	4	3	quartz	fracturing apears in the outcrop as veins and rough planar fracture surfaces
318975	6112017	QMFs	97	65	7	3	quartz	
318976	6112018	QMFs	108	67	18	3	quartz	
317437	6112279	QMFs	110	74	20	7	quartz	fracture veins infill of quartz veins, ~10mm thick
317438	6112280	QMFs	84	72	354	7	quartz	a quartz vein with small ~6mm red alteration halo, in this outcrop there is a increased in fracturing

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								due to the very fine discrete fracture veins of ~1mm thick in the same orientation as fracture structure in the area (photo)
317439	6112281	QMFs	86	85	356	7	quartz	quartz vein, can be seen along strike for 10m+ with red alteration halo of ~15mm
317410	6112259	QMFs	115	86	25	9	quartz	very thin fracture veins of 1mm with a 10mm alteration halo, very discrete and high density of fracturing
317411	6112260	QMFs	103	80	13	9	quartz	
317412	6112261	QMFs	101	72	11	9	quartz	rock outcrop full of very discrete fracture veins less than 1mm thick, no opening gap, visible as a small alteration vein and halo
317413	6112262	QMFs	100	84	10	9	quartz	vein material looks to be high in quartz but having thin 1mm alteration halo, discrete fracturing is 'sandwitched' between larger similar orientated quartz veins
317554	6112266	QMFs	93	75	3	3	Alteration	altered fracture surfaces, area is of medium density of 3/m of prominent fracturing, but a high density of the thin 1mm discrete fracture veins with typical looking fracture and halo
317555	6112267	QMFs	98	76	8	3	Alteration	
317556	6112268	QMFs	101	83	11	3	Alteration	
317585	6112265	QMFs	106	83	16		Alteration	typical looking fracture with alteration, coloured with cream-orange inner vein to red alteration halo, halo are ~5mm thick (photo)
317586	6112266	QMFs	115	68	25		Alteration	
317605	6112266	QMFs	76	81	346		quartz	quartz veining infilling extensional fracturing, could be an area of change of fluid fracturation
317606	6112267	QMFs	74	75	344		quartz	
317607	6112268	QMFs	97	56	7		quartz	
317608	6112269	QMFs	102	74	12		quartz	
317579	6112287	QMFs	88	68	358		Alteration	typical looking alteartion fracturing with ~15mm alteration halos, but does look to have quartz vein material cover on the surface
317580	6112288	QMFs	83	84	353		Alteration	
317581	6112289	QMFs	90	71	0		Alteration	
317582	6112290	QMFs	105	74	15		Alteration	the fracture surfaces are very planar, but rough

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								planar with an altered surface and a thin 4mm alteration halo
317583	6112291	QMFs	104	75	14		Alteration	
318334	6115120	GABs	107	70	17	4	sulphide	continous fracture surface, looks to be fluid related to mineralisation, sulphide rich with 15-20mm alteration
318335	6115121	GABs	93	84	3	4	sulphide	semi-planar fracture, undulating and very rough, no alteration or fluid movement looks to have moved through it, this fracture is in the middle of 4 vaguely non-planar similar orienatated fractures
318336	6115122	GABs	92	65	2	4	quartz	thin 2mm undulating, non-planar quartz vein
318337	6115123	GABs	113	81	23	4	quartz	a thin continous fracture vein 20m+ along strike, fracture has a 2-3mm alteration halo
318338	6115124	GABs	102	68	12	4	quartz	a continous fracture surface with no visible alteration, slight iron staining from weathering
318334	6115120	GABs	100	76	10	4	Alteration	a continous fracture next to above with alteration on surface which tell us of fluid movement through fracture
318329	6115132	GABs	100	64	10	3	Alteration	slight alteration on fracture surface with a ~15mm alteration halo, part of a fracture set of 7/4m, which is about low to medium density
318330	6115133	GABs	87	71	357	3	Alteration	
318331	6115134	GABs	101	79	11	3	Alteration	
318332	6115135	GABs	102	67	12	3	Alteration	fracture cuts straight through a 15cm quartz vein of 28/76n with no displacement
318313	6115145	GABs	103	81	13		Alteration	fracture set, very rough planar surfaces which look to have had low to no fluid movement through it
318314	6115146	GABs	103	69	13		Alteration	
318315	6115147	GABs	102	71	12		Alteration	
318316	6115148	GABs	102	72	12		Alteration	
318317	6115149	GABs	115	69	25		Alteration	
318312	6115146	GABs	113	64	23	3	Alteration	continous fracture surface, rough planar clean cutting fracture and fracture surfaces, a slight vein material present on fracture surface
318313	6115147	GABs	110	58	20	3	Alteration	density of area is around 1-4/m, a medium density
318314	6115148	GABs	175	69	85	3	Alteration	no displacement when fractures intersect

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
318304	6115159	GABs	91	73	1		Alteration	clean cutting rough planar fractures, looks to have had minium fluid movement into fractures
318305	6115160	GABs	91	76	1		Alteration	
318306	6115161	GABs	102	64	12		Alteration	does no displace/offseta quartz vein that intersects it of 300/71s
318286	6115157	GABs	100	66	10		sulphide	observed in rock are some subvertical fracture veins that have orientated along foliation close to hinge of mine fold, these fractures veins have an alteration halo of ~15-20mm, vein infill looks to be high sulphide which would make sense close to the mineralisation
318287	6115158	GABs	100	82	10		sulphide	
318288	6115159	GABs	101	73	11		sulphide	no alteration halos on fracture, fractures are in the form of 2mm veins, vein material has been weathered out
318289	6115160	GABs	99	75	9	2	sulphide	density of fracturing is low to medium of abouit 2/m
318238	6115183	GABs	100	75	10	2	sulphide	low fluid movement through vein but hard to tell, because if the vein material is high in sulphides it would weather out very quickly and maybe only leave a slight iron staining from small alteration halo on fracture surface
318239	6115184	GABs	100	75	10	2	sulphide	rough planar clean cutting fracture, density of prominent fracturing is low of about 2/m
318240	6115185	GABs	98	71	8	2	sulphide	weathered fracture surface with patchy bits of high sulphide vein material left on surface
316158	6112831	QMFs	77	62	347	3	quartz	quartz filled fracture with no alteration halo, low density of fracturing around 4/2m
316159	6112832	QMFs	82	62	352	3	quartz	a rough undulating non-planar fracture surface
316160	6112833	QMFs	87	80	357	3	quartz	
316070	6112856	QMFs	73	74	343	2	Alteration	planar fractures in rock with very little alteration/ fluid flow through fracture, sligh iron staining, density low of around 2/m
316048	6112863	QMFs	77	56	347	2	Alteration	smooth planar 'iron stained' fracture surfaces, prominent fracture
316049	6112864	QMFs	120	62	30	2	Alteration	density of fracturing is low to medium of about 2/m
316050	6112865	QMFs	80	88	350	4	Alteration	part of a fracture set of 4 in close proximity

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316051	6112866	QMFs	97	84	7	4	Alteration	a proper looking altered fracture vein with cream interior of vein to thin red colour alteration halo
316052	6112867	QMFs	121	72	31	4	Alteration	a planar fracture surface
315980	6112890	QMFs	102	74	12	3	Alteration	planar fracture surfaces, altered, medium to low fracture density of 2-3/m, fractures are very continous along strike for 20m+ and around 10m+ down dip
315981	6112891	QMFs	135	86	45	3	quartz	
315982	6112892	QMFs	102	78	12		quartz	quartz vein
315983	6112893	QMFs	103	84	13		quartz	an altered fracture surface, concluded from high degree of iron staining compared to the surrounding rock surfaces away from the fracturing
315916	6112919	QMFs	126	81	36	0.5	quartz	fractures with slight iron stained surfaces, low fracture density area of 1/2m
315916	6112919	QMFs	121	66	31	0.5	quartz	
315917	6112920	QMFs	87	78	357	0.5	quartz	low density fracturing of 1/2m, looks to be quartz veining in fracture infill, the fracture surfaces are iron stained with small fine patches of quartz infill, small quartz bits have cream/orange colour which makes it appear as 'typical' alteration, no alteration halos, fractures are continous allong strike 15m+
316340	6112776	QMFs	91	65	1	0.5	Alteration	fractures appear to cut straight through a fold in the rock (fold noticed from foliation)
316429	6112741	QMFs	94	35	4	10	Alteration	close area dominated by shallow dipping fractures with a large ~50mm alteration halo, with an increase of density to very high at 10/m
316470	6112724	QMFs	104	74	14		Alteration	an altered fracture surface, concluded from high degree of iron staining compared to the surrounding rock surfaces away from the fracturing,
316471	6112725	QMFs	66	50	336		Alteration	continous fracture along strike for 10m+, fracture is open with a 1mm gap and has a 15mm alteration halo
316520	6112699	QMFs	101	86	11	2	Alteration	a low density area of the outcrop, not much 'extensional' fracturing or structure, iron stained fracture surfaces that are common of the area
316521	6112700	QMFs	76	75	346	2	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
321537	6113217	QMFs	72	64	342		Alteration	unaltered surface
321538	6113218	QMFs	46	83	316		Alteration	planar slighlty altered (iron stained) fracture surface
321539	6113219	QMFs	78	69	348		Alteration	
321540	6113220	QMFs	68	81	338		Alteration	all fractures in the area are planar surfaces with only a slight iron stained alteration on the surfaces
321541	6113221	QMFs	68	72	338		Alteration	
321556	6113216	QMFs	105	86	15		quartz	undulating non-planar quartz veining of around 5mm thick
321557	6113217	QMFs	83	75	353		quartz	a planar 'iron stained' surface
321558	6113218	QMFs	66	81	336		quartz	
321559	6113219	QMFs	62	85	332		quartz	
321574	6113215	QMFs	107	88	17	4	quartz	quartz covered fracture surface
321575	6113216	QMFs	74	66	344	4	quartz	very smooth planar fracture surface, no alteration halo on fracture, slight iron staining
321576	6113217	QMFs	71	75	341	4	quartz	medium fracture density of 4/1m
321577	6113218	QMFs	67	68	337	4	quartz	fracture surface intersecting thin quartz veins that are running 128/65n, fracture cuts clean through veins
321579	6113204	QMFs	93	83	3	6	quartz	quartz cover fracture surfaces
321580	6113205	QMFs	63	75	333	6	quartz	iron stained' fracture surfaces
321581	6113206	QMFs	77	65	347	6	quartz	fracture surface with discrete 1mm alteration halo
321582	6113207	QMFs	56	85	326	6	quartz	medium density fracturing in area of 6/m, area dominated by the more nne fracturing
321583	6113208	QMFs	66	84	336	6	quartz	
321558	6113201	QMFs	90	82	0		Alteration	mostly all planar fracture, but show little signs of fluid movement thorughout the fracturing only slight iron staining on fracture surfaces, no true alteration surface or fluids
321559	6113202	QMFs	87	83	357		Alteration	
321560	6113203	QMFs	59	70	329		Alteration	
321561	6113204	QMFs	107	82	17		Alteration	
321562	6113205	QMFs	121	88	31		Alteration	
321563	6113206	QMFs	80	81	350		Alteration	
319322	6116584	QMFs	226	69	136	8	Alteration	high density fracturing in rock from 4-8/m,

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								dominated by the 'typical' north dipping altered fractures
319323	6116585	QMFs	90	74	0	8	Alteration	fractures in area have had fluid movement through, with altered fractures and alteration halos, some thick up to ~10-40mm
319324	6116586	QMFs	92	70	2	8	Alteration	
319325	6116587	QMFs	85	64	355	8	Alteration	
319326	6116588	QMFs	92	63	2	8	quartz	quartz veining along similar orientation
319327	6116589	QMFs	96	73	6	8	quartz	
319328	6116590	QMFs	82	66	352	8	Alteration	
319329	6116591	QMFs	88	75	358	8	Alteration	
319330	6116592	QMFs	91	74	1	8	Alteration	
320861	6113802	QMFs	92	68	2	8	Alteration	altered fractures of high fracture density from 7-8/m of prominent fracturing to 12/m to include the small discrete 1mm fracture veining, altered fractures have a ~20mm alteration
320862	6113803	QMFs	90	75	0	8	Alteration	
320863	6113804	QMFs	80	66	350	4	Alteration	noted that not all fracture structures have fluid movement, have altered ratio 1:2 over a 1m section,
320864	6113805	QMFs	78	66	348	3	Alteration	fracturing density of prominent fracturing of high 17/5m, prominent fractures develop continous planar surfaces 4m+ over strike, smaller thin 1-2mm altered veins in between creating a sort of repeating fracture set
320865	6113806	QMFs	76	70	346	3	Alteration	
320866	6113807	QMFs	94	76	4	4	Alteration	
320844	6110500	QMFs	100	61	10	5	quartz	quartz infill in extensional fractures, medium density fracturing of around 5/m, planar surface are slighlty altered which could be residue from waethered away quartz infill
320845	6110501	QMFs	106	58	16	5	quartz	
320846	6110502	QMFs	110	61	20	5	quartz	
312082	6108272	QMFs	72	61	342	2	Alteration	typical looking' altered fracture veins and fracture surfaces, majority of altered fractures with ~15mm alteration halo

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
312083	6108273	QMFs	66	65	336	2	Alteration	fractures are less subvertical in area
312084	6108274	QMFs	66	60	336	2	Alteration	a high fracture area far away from the mine, prominent fracture density of 14/10m medium density, around 1/m
312085	6108275	QMFs	99	84	9	2	Alteration	
312086	6108276	QMFs	102	62	12	2	Alteration	
312087	6108277	QMFs	99	64	9	2	Alteration	
312088	6108278	QMFs	74	56	344	2	Alteration	
317975	6116794	GABs	91	68	1	2	Alteration	highly weathered outcrop, structurally dominated by altered fracture surfaces, fracture density of 2/m, low to medium density
317976	6116795	GABs	86	78	356	2	Alteration	
317977	6116796	GABs	72	84	342	2	Alteration	
317978	6116797	GABs	81	68	351	2	Alteration	
317979	6116798	GABs	95	84	5	2	Alteration	
317963	6116631	GABs	97	73	7	1	Alteration	large outcrop has infrequenty low density fracturing 1/m, thin altered fracture veins
317964	6116632	GABs	71	71	341	1	Alteration	
317965	6116633	GABs	90	70	0	1	Alteration	
317966	6116634	GABs	96	70	6	1	Alteration	
318040	6116579	QMFs	95	76	5	0.5	Alteration	unaltered fracture surface, area of low density fracturing from 1/2m to 1/10m
318055	6116603	GABs	96	73	6	1	Alteration	low density fracturing of 1/m, low degree of alteration, slight iron staining on fracture surface
318056	6116604	GABs	86	49	356	1	Alteration	
318057	6116605	GABs	69	43	339	1	Alteration	
318058	6116606	GABs	95	68	5	1	Alteration	
318080	6116600	GABs	95	65	5	2	Alteration	low density fracturing 2/m, fracture surfaces have be altered 'iron stained'
318081	6116601	GABs	88	68	358	2	Alteration	
318082	6116602	GABs	88	65	358	2	Alteration	
318210	6116530	GABs	82	78	352		Alteration	area dominated by smooth planar fracturing surfaces, fracture surfaces are altered and fractures veins are still present with small alteration halos, fractures can be traces into

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								neighbouring outcrop along strike for 20-30m+
318211	6116531	GABs	97	71	7		Alteration	
318212	6116532	GABs	89	70	359		Alteration	
318213	6116533	GABs	91	82	1		Alteration	
318214	6116534	GABs	101	80	11		Alteration	
318282	6116543	GABs	101	86	11	2	Alteration	low density fracturing of 2/m, with altered fracture veins and surfaces
318283	6116544	GABs	91	75	1	2	Alteration	
318284	6116545	GABs	86	72	356	2	Alteration	
318285	6116546	GABs	77	81	347	2	Alteration	
318287	6116561	GABs	95	78	5	5	Alteration	an increase fracture area of medium denisty of 5/m, typical alteration in fractures
318288	6116562	GABs	85	71	355	5	Alteration	
318300	6116371	GABs	60	80	330	3	Alteration	low density fracturing area of 3/m, fracture surfaces are rough planar and slightly weathered
318301	6116372	GABs	61	81	331	3	Alteration	
318302	6116373	GABs	69	86	339	3	Alteration	
318303	6116374	GABs	108	87	18	3	Alteration	
318304	6116375	GABs	80	70	350	3	Alteration	
318305	6116313	GABs	51	85	321	4	Alteration	low to medium density fracturing 3-4/m, fractures are altered mostly reckonised as altered fracture surfaces
318306	6116314	GABs	84	66	354	4	Alteration	
318307	6116315	GABs	84	72	354	4	Alteration	
318308	6116316	GABs	85	75	355	4	Alteration	
318309	6116317	GABs	87	75	357	4	Alteration	
318310	6116318	GABs	86	68	356	4	quartz	fracture infill of quartz 15-20mm thick
318311	6116319	GABs	51	80	321	4	quartz	
318414	6116091	GABs	78	69	348	2	Alteration	prominent fracture density of 1-2/m, most structure has developed into altered fracture surface with small thin alteration halo, the fracture surfaces are very smooth and planar which leads us to believe that they have been altered by vein material that clean cuts the rock unit and creates a

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								very smooth surface in the very rough quartz schist and especially GABs
318415	6116092	GABs	66	70	336	2	Alteration	
318416	6116093	GABs	81	70	351	2	Alteration	
318417	6116094	GABs	87	76	357	2	Alteration	
318418	6116095	GABs	106	60	16	2	Alteration	typical' looking altered fracture vein with cream-orange inner to red-orange halo, also noted that the foliation is similar to known with north-south strike and steep east dip
318419	6116096	GABs	86	70	356	2	Alteration	
318420	6116097	GABs	66	68	336	2	Alteration	
318421	6116098	GABs	87	74	357	2	Alteration	
318422	6116099	GABs	73	70	343	2	Alteration	
318045	6116532	GABs	81	69	351	1	Alteration	altered fractures with 'red' alteration halos ~20mm, fractures are seen to cut throughsome quartz veinlets that are striking in a north-south trend
318046	6116533	GABs	81	70	351	1	Alteration	
318047	6116534	GABs	82	78	352	1	Alteration	(photo taken), low fracture density of 1/m
318048	6116535	GABs	78	74	348	1	Alteration	
318049	6116536	GABs	76	62	346	1	Alteration	
317940	6116593	GABs	98	68	8	1	Alteration	low density fracturing of 1/m, fractures apear to be highly altered as fracture surfaces and fracture veins, typical looking alteration with 10-25mm alteration halo
317941	6116594	GABs	98	70	8	1	Alteration	
317942	6116595	GABs	96	71	6	1	Alteration	
317943	6116596	GABs	98	76	8	1	Alteration	
317944	6116597	GABs	93	69	3	1	Alteration	
317945	6116598	GABs	91	68	1	2	Alteration	
317882	6116593	GABs	95	70	5	2	Alteration	low density fracturing of 1-2/m, altered fractures
317883	6116594	GABs	100	71	10	2	Alteration	
317884	6116595	GABs	91	76	1	2	Alteration	
317885	6116596	GABs	95	81	5	2	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317722	6116672	GABs	92	75	2	3	Alteration	low to medium fracture density 2-3/m, altered fractures
317723	6116673	GABs	96	84	6	3	Alteration	
317724	6116674	GABs	91	83	1	3	Alteration	
317725	6116675	GABs	97	76	7	3	Alteration	
317682	6116938	QMFs	61	80	331	0.5	Alteration	low density fracturing 3/15m or 1/5m, no alteration present on fracture surfaces
317683	6116939	QMFs	101	78	11	0.5	Alteration	
317684	6116940	QMFs	76	80	346	0.5	Alteration	
317740	6116961	QMFs	90	65	0	3	Alteration	weathered small outcrop, low density fracturing of 2-3/m, farcturing less than prominent, small fracture veins present in rock
317741	6116962	QMFs	88	60	358	3	Alteration	
317742	6116963	QMFs	92	64	2	3	Alteration	
317811	6117146	QMFs	85	74	355	3	Alteration	small patchy outcrop, low density fracturing 2-3/m, small zones of fracture sets with greater alteration with small 5mm alteration
317812	6117147	QMFs	95	85	5	3	Alteration	
317813	6117148	QMFs	71	79	341	3	Alteration	
317814	6117149	QMFs	96	77	6	3	Alteration	
317815	6117150	QMFs	104	85	14	3	Alteration	
317816	6117151	QMFs	70	76	340	3	Alteration	
317831	6117184	QMFs	100	79	10	9	Alteration	tight grouping fracture set in outcrop, high density fracturing 9/m, typical alteration on fracture surfaces and veins
317832	6117185	QMFs	100	84	10	9	Alteration	
317833	6117186	QMFs	97	87	7	9	Alteration	
317834	6117187	QMFs	98	80	8	9	Alteration	(photo taken)
317835	6117188	QMFs	94	76	4	9	Alteration	
317815	6117195	QMFs	91	60	1	5	Alteration	alteration fluid in veins 'typical' looking alteration, overall medium density fracturing with high zones of density relating to tight fracture sets, density 5/m
317816	6117196	QMFs	87	70	357	5	Alteration	
317817	6117197	QMFs	90	75	0	5	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317818	6117198	QMFs	89	71	359	5	Alteration	structure is visible in rock outcrop either as discrete 1-4mm veins with 10mm alteration halos or more noticable as clean cutting smooth planar fracture surfaces
317819	6117199	QMFs	102	77	12	5	Alteration	
317820	6117200	QMFs	84	71	354	5	Alteration	
317821	6117201	QMFs	97	76	7	5	Alteration	
317758	6117254	QMFs with banded GABs	51	80	321	2	quartz	northeast trending quartz veining 40mm thick
317759	6117255	QMFs with banded GABs	101	78	11	2	Alteration	low density fracturing in large 'structurally barren' outcrop, fractures are have has fluid movement and have been altered with 15mm alteration halo
317760	6117256	QMFs with banded GABs	97	83	7	2	Alteration	
317761	6117257	QMFs with banded GABs	110	60	20	2	Alteration	(photo taken)
317762	6117258	QMFs with banded GABs	76	60	346	2	Alteration	
317763	6117259	QMFs with banded GABs	96	85	6	2	Alteration	
317685	6117251	QMFs	91	86	1	7	Alteration	high density fracturing 1/20cm, though fracturing is non-planar and undulating very vague, no alteration on fracturing, hard to get a reading off fracturing
317677	6117276	QMFs	102	79	12	3	Alteration	rough planar surface
317678	6117277	QMFs	78	53	348	3	Alteration	smooth planar fracture surfaces, fracture has been altered with small thin alteration halo
317679	6117278	QMFs	97	84	7	3	Alteration	
317680	6117279	QMFs	81	72	351	3	Alteration	area has medium density fracturing, though the majority of fracturing are rough semi-planar structures which hint at low/no fluid flow in fracturing
317681	6117280	QMFs	91	76	1	3	Alteration	altered fracture surface, smooth planar, can trace fracture along strike for 30m+
317736	6117303	QMFs	66	85	336	5	Alteration	medium to high density fracturing 4-5/m, rough planar structures
317737	6117304	QMFs	77	88	347	5	Alteration	
317738	6117305	QMFs	113	83	23	5	Alteration	
317739	6117306	QMFs	97	80	7	4	Alteration	medium density fracturing 3-4/m
317740	6117307	QMFs	73	76	343	4	Alteration	
317741	6117308	QMFs	76	56	346	4	Alteration	smooth planar fracture surfaces, surface apears

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								altered with small alteration halo
317755	6117388	QMFs	85	79	355	3	Alteration	prominent planar fracture surfaces, medium density fracturing 2-3/m
317756	6117389	QMFs	95	75	5	3	Alteration	
317757	6117390	QMFs	100	80	10	3	Alteration	
317579	6117561	QMFs	280	74	190	1	Alteration	no alteration in south dipping fracture
317580	6117562	QMFs	106	74	16	1	Alteration	rough planar surface, very low density fracturing in area, structure in rock looks to have no real fluid movement in them, structure are vague looks more like joints
317488	6117791	QMFs	54	64	324	5	Alteration	medium to high density fracturing 4-5/m, smooth planar structures, altered surfaces with ~20mm alteration halos
317489	6117792	QMFs	60	72	330	5	Alteration	
317490	6117793	QMFs	66	65	336	5	Alteration	
317491	6117794	QMFs	87	85	357	5	Alteration	
317442	6117839	QMFs	98	86	8	6	Alteration	a high density fractured area, noted about 6/m, fractures are slightly altered with thin alteration halos
317443	6117840	QMFs	103	85	13	6	Alteration	
317442	6117911	QMFs	66	55	336	5	Alteration	a planar altered fracture surface that is continous over 15m+ along strike, area is of medium to high (fracture set increasing density) density fracturing
317443	6117912	QMFs	69	82	339	5	Alteration	
317444	6117913	QMFs	68	59	338	5	Alteration	
317445	6117914	QMFs	70	88	340	5	Alteration	
317446	6117915	QMFs	66	64	336	5	Alteration	highly altered fracture surface (photo taken)
317447	6117916	QMFs	74	50	344	5	Alteration	highly altered fracture surface
317500	6117954	QMFs	110	79	20	5	Alteration	medium to high density fracturing of 4-5/m, due to the difference in striking in some of the smaller thin fracture veins, they intersect each other, but do not offset each other, no movement other than the slight opening, looks to have happened close together timewise
317501	6117955	QMFs	111	74	21	5	Alteration	
317502	6117956	QMFs	67	82	337	5	Alteration	this area seems to be dominated by th northeast

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								trending fracturing
317503	6117957	QMFs	69	81	339	5	Alteration	
317504	6117958	QMFs	81	79	351	5	Alteration	
317505	6117959	QMFs	71	50	341	5	Alteration	
317506	6117960	QMFs	62	64	332	5	Alteration	
317507	6117961	QMFs	80	43	350	5	Alteration	
317508	6117962	QMFs	70	61	340	5	Alteration	
317620	6117919	QMFs	66	67	336	6	Alteration	infrequent high density fracturing 5-6/m, mostly forming fracture sets, fractures are smooth planar fracture surfaces that have been altered
317621	6117920	QMFs	93	85	3	6	Alteration	
316321	6115897	QMFs	88	78	358		Alteration	no planar structure seen in north-south trending pyrite member
316306	6115896	QMFs	86	60	356	5	Alteration	medium density fracturing, with tight grouping fracture sets of 5/40cm, altered fracture surfaces
316307	6115897	QMFs	272	74	182	5	Alteration	
316308	6115898	QMFs	88	65	358	5	Alteration	
316258	6115812	QMFs	65	85	335	4	Alteration	medium density fracturing in area of 3-4/m, fractures are rough planar as the altered surfaces of the fractures have been highly weathered
316259	6115813	QMFs	83	84	353	4	Alteration	
316260	6115814	QMFs	76	72	346	4	Alteration	
316261	6115815	QMFs	83	75	353	4	Alteration	though some of the fracture surfaces are still smooth planar due to the altered fluids that moved through the fractures gaps
316262	6115816	QMFs	86	75	356	4	Alteration	
316263	6115817	QMFs	66	75	336	4	Alteration	
316264	6115818	QMFs	86	84	356	4	Alteration	
316265	6115819	QMFs	69	63	339	4	Alteration	
316181	6115681	QMFs	72	48	342	3	Alteration	medium denisty fracturing in area, 3/m, weathering has degraded the outcrop on where it is hard to spot the small thin fracturing veining which could be view in this kind of rock, mostly fracturing is view as altered fracture surfaces
316182	6115682	QMFs	69	50	339	3	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316183	6115683	QMFs	74	64	344	3	Alteration	
316184	6115684	QMFs	65	54	335	3	Alteration	
316185	6115685	QMFs	56	56	326	3	Alteration	
316186	6115686	QMFs	68	35	338	3	Alteration	
316187	6115687	QMFs	77	42	347	3	Alteration	
316152	6115645	QMFs	96	78	6	3	Alteration	medium denisty altered fracturing 3/m
316153	6115646	QMFs	100	80	10	3	Alteration	
316154	6115647	QMFs	97	81	7	3	Alteration	
316155	6115648	QMFs	70	70	340	3	Alteration	
316156	6115649	QMFs	98	63	8	3	Alteration	
316012	6115666	QMFs	98	45	8	4	Alteration	medium density altered fracturing 4/m, mostly all are noted as fracture surfaces, due to the slightly different strike some of these fractures intesect but do not offset each other
316013	6115667	QMFs	76	45	346	4	Alteration	
316014	6115668	QMFs	80	46	350	4	Alteration	
316015	6115669	QMFs	90	46	0	4	Alteration	
316016	6115670	QMFs	106	74	16	4	Alteration	
316017	6115671	QMFs	116	76	26	4	Alteration	
315894	6115707	QMFs	94	78	4	3	Alteration	still medium density fracturing of 2-3/m, fracture surfaces and outcrop looks to the highly weathered and covered in moss which makes observations hard, altered fractured surfaces are still smooth planar but have been weathered to for a cracked broken surface
315895	6115708	QMFs	92	60	2	3	Alteration	
315896	6115709	QMFs	100	78	10	3	Alteration	
315897	6115710	QMFs	92	86	2	3	Alteration	
315898	6115711	QMFs	110	86	20	3	Alteration	
315730	6115547	QMFs	91	73	1	3	Alteration	medium density fracturing of 2-3/m, (photo taken) with density increases due to fracture sets which tends to be an increase in the small discrete 1mm fracture veins, density increases to 17/m, larger fractures though seem to have more/increased alteration

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
315731	6115548	QMFs	97	82	7	3	Alteration	
315732	6115549	QMFs	102	87	12	3	Alteration	
315733	6115550	QMFs	104	85	14	3	Alteration	
315734	6115551	QMFs	99	85	9	3	Alteration	
315735	6115552	QMFs	111	80	21	3	Alteration	
315662	6115673	QMFs	98	84	8	2	Alteration	low to medium density fracturing in outcrop, 1-2/m, fracturing is rough planar with low alteration on surfaces
315594	6115686	QMFs	101	85	11	2	Alteration	altered fracture surfaces and fracture veins of low to medium density of 1-2/m (photo taken)
315595	6115687	QMFs	98	86	8	2	Alteration	
315596	6115688	QMFs	94	86	4	2	Alteration	
315597	6115689	QMFs	96	80	6	2	Alteration	
315598	6115690	QMFs	86	82	356	2	Alteration	
315526	6115713	QMFs	101	88	11	2	Alteration	altered fracture surfaces and fracture veins of low to medium density of 1-2/m
315142	6115833	pyrite member					Alteration	north-south trending pyrite member
315427	6115864	QMFs	92	86	2	2	Alteration	patchy outcrop but noted fracture density at 2/m, low to medium density
315987	6115492	QMFs	104	85	14	4	Alteration	medium density fracturing of 3-4/m, dominated by altered fracture surfaces
315988	6115493	QMFs	97	81	7	4	Alteration	
315989	6115494	QMFs	104	80	14	4	Alteration	
315990	6115495	QMFs	48	45	318	4	Alteration	
315991	6115496	QMFs	101	83	11	4	Alteration	
315602	6116139	QMFs	81	80	351	4	Alteration	medium fracture density of 3-4/m, both altered fracture surfaces and thin discrete fracture veins, alteration seems to be low
315617	6116150	QMFs	89	88	359		Alteration	altered fracture surfaces and discrete fracture veins, fracture surfaces are all smooth planar altered surfaces with ~20mm alteration halo, alteration halo is noted as being a thin wavy sometime slightly uneven mineral/colour change in the rock surrounding a fracture, fluids have been forced into fracture walls and interacted with the mineralogy

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
315618	6116151	QMFs	81	85	351		Alteration	
315619	6116152	QMFs	81	75	351		Alteration	
315620	6116153	QMFs	98	82	8		Alteration	
315621	6116154	QMFs	97	70	7		Alteration	
315622	6116155	QMFs	88	80	358		Alteration	
315623	6116156	QMFs	105	84	15		Alteration	
315699	6116284	QMFs	97	82	7	5	Alteration	medium to high fracture density of 4-5/m, altered fractures
315700	6116285	QMFs	84	74	354	5	Alteration	
315701	6116286	QMFs	90	86	0	5	Alteration	
315702	6116287	QMFs	99	74	9	5	Alteration	
315703	6116288	QMFs	86	62	356	5	Alteration	
315704	6116289	QMFs	100	82	10	5	Alteration	
315705	6116290	QMFs	81	72	351	5	Alteration	
315745	6116297	QMFs	106	71	16	9	Alteration	a high density fractured area of 8-9/m, most of the fracturing in the area consists of the very fine discrete 1-2mm altered fracture veining, that appear as a thin vein lineation and when not open (no gap) appear to be slighty more weather resistant
315746	6116298	QMFs	107	75	17	9	Alteration	
315747	6116299	QMFs	97	86	7	9	Alteration	these fractures interect but do not offset thin quartz veining ~5mm thick along same orientation as foliation that is 226/60e
315695	6116506	QMFs	85	85	355	8	Alteration	still high density fracturing, of ~7/m which does increase in small areas due to tight grouping fracture set to 10/m
315696	6116507	QMFs	88	78	358	8	Alteration	
315697	6116508	QMFs	101	80	11	8	Alteration	
315698	6116509	QMFs	84	80	354	8	Alteration	
315736	6116555	QMFs	90	66	0	3	Alteration	fractures are altered with small 4mm alteration halo in the fracture wall, it lloks to be in this outcrop that not all of the fracturing structure has had fluid movement involvement, it was noted that only around 1 in 3 of the fracture surfaces in the area have a very smooth planar surface with

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								'typical' looking alteration- red iron stain with slight cream-orange colour on surface
315737	6116556	QMFs	96	86	6	3	Alteration	
315738	6116557	QMFs	97	84	7	3	Alteration	
315749	6116639	QMFs	81	70	351	6	Alteration	similar fracturing with high to medium fracture density with alteration
315750	6116640	QMFs	81	84	351	6	Alteration	
315751	6116641	QMFs	76	83	346	6	Alteration	
315752	6116642	QMFs	80	82	350	6	Alteration	
315843	6116809	QMFs	79	80	349	4	Alteration	medium density fractures, 4/m with low degree of alteration on the fracture surfaces
315844	6116810	QMFs	66	86	336	4	Alteration	
315845	6116811	QMFs	61	86	331	4	Alteration	
315846	6116812	QMFs	97	82	7	4	Alteration	
315847	6116813	QMFs	90	82	0	4	Alteration	
315848	6116814	QMFs	97	75	7	4	Alteration	
315717	6116937	QMFs	78	74	348	3	Alteration	medium density fracturing with 3/m, with low degree of alteration in the fractures
315718	6116938	QMFs	79	58	349	3	Alteration	
315719	6116939	QMFs	74	54	344	3	Alteration	
315720	6116940	QMFs	100	63	10	3	Alteration	
315721	6116941	QMFs	78	60	348	3	Alteration	
315722	6116942	QMFs	87	76	357	3	Alteration	
315723	6116943	QMFs	298	60	208	3	Alteration	a few infrequent south dipping altered fractures that have formed fracture sets
315724	6116944	QMFs	277	86	187	3	Alteration	
315725	6116945	QMFs	299	83	209	3	Alteration	
315709	6117091	QMFs	69	82	339	2	Alteration	medium density fracturing 2-3/m (photo taken), slight alteration in fractures
315710	6117092	QMFs	88	70	358	2	Alteration	
315711	6117093	QMFs	82	70	352	2	Alteration	
315712	6117094	QMFs	80	64	350	2	Alteration	
315713	6117095	QMFs	81	78	351	2	Alteration	
315714	6117096	QMFs	86	76	356	2	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
315715	6117097	QMFs	83	84	353	2	Alteration	
315716	6117162	QMFs	72	56	342	5	Alteration	medium to high fracture density of 3-5/m, fractures occur as smooth planar altered fractured surfaces
315717	6117163	QMFs	86	79	356	5	Alteration	
315718	6117164	QMFs	86	75	356	5	Alteration	
315719	6117165	QMFs	79	81	349	5	Alteration	
315720	6117166	QMFs	84	65	354	5	Alteration	
315721	6117167	QMFs	83	70	353	5	Alteration	
315722	6117168	QMFs	71	79	341	5	Alteration	
315723	6117169	QMFs	69	80	339	5	Alteration	
315724	6117170	QMFs	71	84	341	5	Alteration	
315725	6117171	QMFs	78	79	348	5	Alteration	
315729	6117201	QMFs	66	83	336	4	Alteration	(photo taken), medium denisty altered fracturing
315730	6117202	QMFs	87	86	357	4	Alteration	
315731	6117203	QMFs	70	84	340	4	Alteration	
315763	6117293	QMFs	66	80	336	4	Alteration	medium density fracturing, altered surfaces
315764	6117294	QMFs	70	85	340	4	Alteration	
315765	6117295	QMFs	110	86	20	4	Alteration	
315702	6117408	QMFs	70	73	340	5	Alteration	medium to high fracture density of 3-5/m, fractures occur as smooth planar altered fractured surfaces
315703	6117409	QMFs	78	87	348	5	Alteration	
315704	6117410	QMFs	76	85	346	5	Alteration	
315705	6117411	QMFs	66	84	336	5	Alteration	
315706	6117412	QMFs	82	76	352	5	Alteration	
315707	6117413	QMFs	96	79	6	5	Alteration	
315859	6117501	QMFs	79	68	349	5	Alteration	medium to high fracture density of 3-5/m, fractures occur as smooth planar altered fractured surfaces
315860	6117502	QMFs	96	60	6	5	Alteration	
315861	6117503	QMFs	289	72	199	5	Alteration	
315862	6117504	QMFs	79	86	349	5	Alteration	
315863	6117505	QMFs	101	88	11	5	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
315905	6117515	QMFs	86	80	356	4	Alteration	medium density fracturing, few in the area are actuall smooth/rough planar structures, most of the fractures appear to be rough undulating non-planar fractures that are vague to see
315906	6117516	QMFs	107	84	17	6	Alteration	
315907	6117517	QMFs	91	66	1	6	Alteration	
315908	6117518	QMFs	75	79	345	6	Alteration	
315909	6117519	QMFs	95	74	5	6	Alteration	
315960	6117550	QMFs	80	82	350		Alteration	medium to high fracture density of 5-6/m, fractures occur as smooth planar altered fractured surfaces
315961	6117551	QMFs	84	76	354		Alteration	
315962	6117552	QMFs	78	73	348		Alteration	
315963	6117553	QMFs	97	85	7		Alteration	
316020	6117552	QMFs	57	72	327	6	Alteration	medium to high fracture density of 5-6/m, fractures occur as smooth planar altered fractured surfaces, area close to old mine workings, hinting at mineralising fluid
316021	6117553	QMFs	66	74	336	6	Alteration	
316022	6117554	QMFs	66	73	336	6	Alteration	
316023	6117555	QMFs	51	71	321	6	Alteration	
316057	6117569	pyrite member					Alteration	
316175	6117663	QMFs	77	69	347	6	Alteration	medium to high fracture density of 5-6/m, fractures occur as smooth planar altered fractured surfaces
316176	6117664	QMFs	67	67	337	6	Alteration	
316177	6117665	QMFs	66	76	336	6	Alteration	
316178	6117666	QMFs	83	84	353	6	Alteration	
316364	6117683	QMFs	67	82	337	4	Alteration	medium denisty fracturing of 3-4/m
316365	6117684	QMFs	75	78	345	4	Alteration	
316366	6117685	QMFs	76	87	346	4	Alteration	
316367	6117686	QMFs	72	86	342	4	Alteration	
316368	6117687	QMFs	81	79	351	4	Alteration	
316369	6117688	QMFs	85	63	355	4	Alteration	
316637	6117539	QMFs	103	81	13	4	Alteration	medium denisty fracturing of 3-4/m

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316638	6117540	QMFs	96	70	6	4	Alteration	
316925	6117246	QMFs	111	86	21	4	Alteration	medium denisty fracturing of 3-4/m, fractures appear to have been altered by fluid with small alteration halos
316926	6117247	QMFs	113	60	23	4	Alteration	
316927	6117248	QMFs	76	80	346	4	Alteration	
316928	6117249	QMFs	98	70	8	4	Alteration	
316929	6117250	QMFs	88	81	358	4	Alteration	
316930	6117251	QMFs	97	80	7	4	Alteration	
313769	6114638	QMFs	101	86	11	3	Alteration	small outcrop looks to have a medium degree of fracture density at 3/m, fractures have been altered in 'typical looking alteration style with thin alteration halos, outcrop also havs non-planar non altered fracturing which would increase the fracture density if included
313770	6114639	QMFs	96	69	6	3	Alteration	
313385	6114783	QMFs	69	74	339	4	Alteration	outcrop has altered fracture surfaces and closed fracture veins, alteration halo in fracture walls are about 10mm thick, medium density fracturing of 2-4/m
313386	6114784	QMFs	68	60	338	4	Alteration	
313387	6114785	QMFs	82	80	352	4	Alteration	
313388	6114786	QMFs	61	50	331	4	Alteration	
313249	6114839	QMFs	66	64	336	6	Alteration	outcrop has high density fracturing of up to 6/m, majority of fracturing in area is the discrete 2mm fracture veins with ~5mm alteration halo, 'typical looking alteration in fracturing
313250	6114840	QMFs	58	66	328	6	Alteration	
313251	6114841	QMFs	61	71	331	6	Alteration	
313252	6114842	QMFs	74	67	344	6	Alteration	
313253	6114843	QMFs	51	55	321	6	Alteration	
313657	6115732	pyrite member					Alteration	
319761	6114158	QMFs	97	88	7	5	Alteration	altered fracture surfaces with thin 2mm alteration halos, outcrop has a medium to high fracture denisty of 5/m
319762	6114159	QMFs	94	84	4	5	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319763	6114160	QMFs	91	64	1	5	Alteration	
319764	6114161	QMFs	80	64	350	5	Alteration	
319718	6114148	QMFs	83	58	353	6	Alteration	a tight grouping fracture set, fractures appear to be heavy altered with the typical looking alteration +halo, alteration halos are ~30-40mm thick, fractures are continous and can be traced over 10m+
319719	6114149	QMFs	84	59	354	6	Alteration	
319720	6114150	QMFs	93	58	3	7	Alteration	fracture density is high at 6-7/m
319721	6114151	QMFs	86	81	356	7	Alteration	
319722	6114152	QMFs	80	60	350	7	Alteration	
319723	6114153	QMFs	94	61	4	7	Alteration	
319724	6114154	QMFs	75	71	345	7	Alteration	
319725	6114155	QMFs	95	61	5	7	Alteration	
319702	6114146	QMFs	95	76	5	3	Alteration	medium density fracturing in outcrop of 3/m , fractures appear to have a low degree of alteration on the surfaces with no/low alteration halos
319703	6114147	QMFs	95	68	5	3	Alteration	
319704	6114148	QMFs	88	64	358	3	Alteration	
319545	6114245	QMFs	94	66	4	5	Alteration	high to medium density fracturing at 4-5/m, the 'typical' red/cream colouration of the alteration noted on fracture surfaces
319546	6114246	QMFs	84	86	354	5	quartz	a 30mm quartz vein that is subparallel with the altered fractures
319523	6114249	QMFs	92	71	2	5	Alteration	altered fracture surfaces that can be traced along strike for 40m+, alteration surfaces have a cream/orange/red colouration with 10-30mm alteration halos
319524	6114250	QMFs	92	81	2	5	Alteration	
319525	6114251	QMFs	94	71	4	5	Alteration	
319526	6114252	QMFs	114	76	24	5	Alteration	fracture density of the outcrop is 4-5/m, medium density
319527	6114253	QMFs	91	75	1	5	Alteration	
319145	6115150	GABs	76	74	346	3	Alteration	medium density fracturing of 3/m, typical altered fracturing
319146	6115151	GABs	75	71	345	3	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319147	6115152	GABs	80	78	350	3	Alteration	
319148	6115153	GABs	86	82	356	3	Alteration	
319134	6115116	GABs	77	75	347	4	Alteration	3-4/m fracture density, medium density, altered fracture surfaces with ~30mm alteration halos, outcrop look to have 2 separate fracture orientations, ne-sw and n-e
319135	6115117	GABs	86	76	356	4	Alteration	quartz veining along the foliation n-s trending
319136	6115118	GABs	46	76	316	4	Alteration	
319137	6115119	GABs	88	64	358	4	Alteration	
319138	6115120	GABs	51	77	321	4	Alteration	
319139	6115121	GABs	78	73	348	4	Alteration	
319124	6115100	GABs	85	78	355	5	Alteration	medium to high density with 4-5/m, fractures are altered with smooth planar surfaces with 10-20mm alteration halos
319125	6115101	GABs	85	76	355	5	Alteration	
319153	6115093	GABs	51	70	321		Alteration	old mine workings with extensional fracturing noticed in mine shaft walls
319154	6115094	GABs	83	70	353		Alteration	
319152	6115051	GABs	66	86	336		Alteration	altered fracture surfaces, smooth and planar yet appear weathered
319153	6115052	GABs	82	86	352		Alteration	
319154	6115053	GABs	92	86	2		Alteration	
319309	6114973	GABs	74	68	344	2	Alteration	altered fracture surfaces with thin 2-5mm alteration halo in fracture walls, smooth and planar yet appear weathered, fracture density is low with 1-2/m
319310	6114974	GABs	87	75	357	2	Alteration	
319311	6114975	GABs	72	74	342	2	Alteration	
319312	6114976	GABs	75	80	345	2	Alteration	
319313	6114977	GABs	56	62	326	2	Alteration	
319301	6114997	GABs	106	75	16		Alteration	altered fracture surfaces, smooth and planar yet appear weathered
319302	6114998	GABs	81	86	351		Alteration	
319303	6114999	GABs	65	84	335		Alteration	
319304	6115000	GABs	76	85	346		Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319305	6115001	GABs	78	70	348		Alteration	
317619	6113950	QMFs	84	56	354		Alteration	red coloured 'iron stained' altered fracture surfaces
317620	6113951	QMFs	282	87	192		Alteration	red coloured 'iron stained' altered fracture surfaces, with 5mm alteration halo
317621	6113952	QMFs	111	84	21		Alteration	red coloured 'iron stained' altered fracture surfaces, with 5mm alteration halo
317622	6113953	QMFs	275	81	185		Alteration	
317623	6113954	QMFs	291	83	201		Alteration	red coloured 'iron stained' altered fracture surfaces, with 2mm alteration halo
317624	6113955	QMFs	108	78	18		Alteration	
317625	6113956	QMFs	108	76	18		Alteration	
317626	6113957	QMFs	90	60	0		Alteration	red/cream coloured 'iron stained' altered fracture surfaces, with 15mm alteration halo
317627	6113958	QMFs	100	66	10		Alteration	red/cream coloured 'iron stained' altered fracture surfaces, with 10mm alteration halo
317628	6113959	QMFs	108	87	18		Alteration	red/cream coloured 'iron stained' altered fracture surfaces, with 5mm alteration halo
317629	6113960	QMFs	100	74	10		Alteration	red/cream coloured 'iron stained' altered fracture surfaces, very smooth and planar surface
317630	6113961	QMFs	106	74	16		Alteration	
317631	6113962	QMFs	106	74	16		Alteration	red/cream coloured 'iron stained' altered fracture surfaces, with 15mm alteration halo
317632	6113963	QMFs	350	81	260		quartz	a thin planar 4mm quartz vein
317633	6113964	QMFs	218	86	128		quartz	thick 10cm quartz vein
316713	6115083	QMFs	70	58	340	3	Alteration	iron stained altered smooth planar surfaces, medium denisty
316714	6115084	QMFs	68	65	338	3	Alteration	
316715	6115085	QMFs	64	62	334	3	Alteration	
316715	6115100	QMFs	90	69	0	6	Alteration	iron stained altered smooth planar surfaces
316716	6115101	QMFs	72	78	342	6	Alteration	high fracture density of 6/m, dominated by the thin altered fracture veins that appear more resistant to weathering, folitaion is still similar to what is expected of strike north-south dipping steeply east
316694	6115219	QMFs	96	76	6	8	Alteration	high fracturing in outcrop, 8/m, still fracturing made up of altered fracture smooth planar fracture surfaces and fine discrete inrock fracture veins with

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								small alteration halos 1-5mm thick
316695	6115220	QMFs	90	78	0	8	Alteration	
316709	6115273	QMFs	72	45	342	4	Alteration	medium density fracturing in this outcrop
316710	6115274	QMFs	74	79	344	4	Alteration	
316729	6115344	QMFs	283	87	193		Alteration	fracturing in outcrop appears as discrete fracture veins in rock and planar slightly altered fracture surfaces, fracture surfaces are not as prominent in this outcrop form distance
316730	6115345	QMFs	85	68	355		Alteration	
316731	6115346	QMFs	69	82	339		Alteration	
316732	6115347	QMFs	241	69	151		Alteration	
316739	6115436	QMFs	277	88	187	4	Alteration	altered fracture surfaces, medium density
316740	6115437	QMFs	54	81	324	4	Alteration	
316741	6115438	QMFs	96	79	6	4	Alteration	
316710	6115598	QMFs	101	69	11	4	Alteration	
316711	6115599	QMFs	65	75	335	4	Alteration	
316712	6115600	QMFs	65	60	335	4	Alteration	altered fracture surfaces, medium density
316713	6115601	QMFs	85	60	355	4	Alteration	
316714	6115602	QMFs	81	44	351	4	Alteration	
319351	6115005	GABs	86	65	356		Alteration	altered 'iron stained' planar fracture surfaces
319352	6115006	GABs	77	56	347		Alteration	
319353	6115007	GABs	86	67	356		Alteration	
319354	6115008	GABs	81	70	351		Alteration	
319355	6115009	GABs	76	75	346		Alteration	
319356	6115010	GABs	81	68	351		Alteration	
319396	6114985	GABs	71	64	341		Alteration	altered 'iron stained' planar fracture surfaces, fractures can be traced along strike for 10m+
319397	6114986	GABs	71	58	341		Alteration	
319405	6114977	GABs	87	76	357	6	Alteration	fractures appear to be highly altered, mostly as fracture surfaces with 10-15mm alteration halo, fractures can be traces in outcrop over strike of 20m+
319406	6114978	GABs	84	62	354	5	Alteration	
319407	6114979	GABs	71	60	341	5	Alteration	fracture density is medium to high at 4-5/m

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319387	6114927	GABs	86	70	356	4	Alteration	fractures appear to be highly altered, mostly as fracture surfaces with 10-15mm alteration halo
319388	6114928	GABs	88	67	358	4	Alteration	
319389	6114929	GABs	91	70	1	4	Alteration	
319390	6114930	GABs	95	66	5	4	Alteration	
319391	6114931	GABs	83	55	353	4	Alteration	
319392	6114932	GABs	91	65	1	4	Alteration	
319393	6114933	GABs	80	64	350	4	Alteration	
319394	6114934	GABs	78	68	348	4	Alteration	
319144	6115190	GABs	86	72	356	8	Alteration	high density fracturing of 8/m, with the majority of altered fracturing appearing as smooth and rough planar surfaces
317466	6114164	GABs	70	71	340		Alteration	rough planar altered fracture surface, most fractures are open 1-3mm and have a 15mm alteration halo in the fracture walls
317467	6114165	GABs	51	56	321		Alteration	large prominent altered fracture surface, typical colourisation of cream/orange/red
317468	6114166	GABs	289	83	199		Alteration	large prominent altered fracture surface, fracture has a 50mm alteration halo in the fracture walls
317469	6114167	GABs	98	81	8		Alteration	
317470	6114168	GABs	93	77	3		Alteration	
317471	6114169	GABs	106	84	16		Alteration	rough planar altered fracture surface, fracture is open 3mm and has a 15mm alteration halo in the fracture wall
319046	6114158	QMFs	96	81	6		Alteration	weathered fractures planar surface, weathering has caused patches of alteration to be weathered off the fracture face
319047	6114159	QMFs	90	81	0		Alteration	
319048	6114160	QMFs	91	85	1		Alteration	a continous altered fractures surface and fracture vein
319049	6114161	QMFs	92	84	2		Alteration	a prominent planar fracture in outcrop which looks to have no alteration present, quartz veining along foliation
319080	6114182	QMFs	86	76	356	2	Alteration	a smooth fracture surface with a low altered surface
319081	6114183	QMFs	81	86	351	2	Alteration	a 'iron stained' fracture surface with small 10mm alteration halo

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319082	6114184	QMFs	89	79	359	2	Alteration	
319083	6114185	QMFs	92	74	2	2	Alteration	low density fracturing of 1-2/m seen in a patchy outcrop
319119	6114178	QMFs	86	76	356	3	Alteration	medium density fracturing of 2-3/m, typical looking smooth planar fracture surfaces and fracture veins, with low alteration, fracture surfaces are highly iron stained
319120	6114179	QMFs	82	81	352	3	Alteration	
319121	6114180	QMFs	85	86	355	3	Alteration	
319122	6114181	QMFs	85	78	355	3	Alteration	
319123	6114182	QMFs	78	81	348	3	Alteration	
319124	6114183	QMFs	91	84	1	3	Alteration	
319125	6114184	QMFs	81	74	351	3	Alteration	
319126	6114185	QMFs	86	83	356	3	Alteration	
319173	6114060	QMFs	86	74	356	3	Alteration	medium density fracturing of 2-3/m dominated by well defined smooth planar fracture surfaces, fracture surfaces are typically iron stained
319174	6114061	QMFs	85	74	355	3	Alteration	
319175	6114062	QMFs	91	79	1	3	quartz	there is also present north-east striking thin 2mm quartz veining
319262	6113995	QMFs	91	84	1		Alteration	prominent smooth planar fracturing, slighty altered in fracturing, outcrop is highly weathered
319263	6113996	QMFs	93	86	3		Alteration	
319264	6113997	QMFs	91	80	1		Alteration	
319265	6113998	QMFs	86	78	356		Alteration	
319266	6113999	QMFs	101	85	11		Alteration	
319267	6114000	QMFs	71	81	341		Alteration	
319196	6113943	QMFs	90	85	0	4	Alteration	medium density fracturing, 3-4/m, fractures are slightly altered with colouration of red/cream on fracture surfaces and in thin fracture veins
319197	6113944	QMFs	95	81	5	4	Alteration	
319198	6113945	QMFs	91	79	1	4	Alteration	
319804	6114109	QMFs	82	72	352	4	Alteration	altered fracturing in outcrop, smooth planar fracture surfaces, medium density of 4/m
319805	6114110	QMFs	77	76	347	4	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
319806	6114111	QMFs	93	63	3	4	Alteration	
319807	6114112	QMFs	101	58	11	4	Alteration	
319790	6114125	QMFs	87	71	357	8	Alteration	highly altered fracture smooth planar surfaces, are continously fractures which can be traces in the spotty outcrop over strike of 20m+
319791	6114126	QMFs	79	65	349	8	Alteration	fracture surfaces are highly altered and iron stained with ~20mm alteration halos in fracture walls, fracture density is high with 8/m fracturing
319792	6114127	QMFs	81	66	351	8	Alteration	
319793	6114128	QMFs	86	61	356	8	Alteration	
318744	6113426	QMFs	130	81	40	4	quartz	smooth planar fracturing, slighty altered with iron stained surface
318745	6113427	QMFs	145	81	55	4	Alteration	discrete fracture set with slight alteration
318746	6113428	QMFs	113	84	23	4	quartz	undulating non-planar fracturing with quartz veining infill
318747	6113429	QMFs	106	86	16	4	Alteration	
318748	6113430	QMFs	115	83	25	4	Alteration	an altered smooth planar fracture, typical alteraion colourisation of red/cream
318749	6113431	QMFs	114	87	24	4	Alteration	
318750	6113432	QMFs	117	76	27	4	Alteration	a large continous fracture, fracture is weathered but has not been altered
318751	6113433	QMFs	116	65	26	4	Alteration	a large planar altered surfaces, with thin 5mm alteration halo
318752	6113434	QMFs	98	82	8	4	Alteration	a large planar altered surfaces, with smooth altered surface with similar alteration colourisation red/cream
318753	6113435	QMFs	95	81	5	4	Alteration	
318754	6113436	QMFs	223	82	133	4	Alteration	a less prominent fracture with no alteration
318755	6113437	QMFs	235	86	145	4	Alteration	slightly altered fracture surface
318756	6113438	QMFs	100	79	10	4	Alteration	
318757	6113439	QMFs	245	86	155	4	Alteration	
318758	6113440	QMFs	102	80	12	4	Alteration	discrete altered fracture, slightly open with 'typical' cream/red alteration colourisation with ~5mm alteration halo
318759	6113441	QMFs	105	71	15	4	Alteration	
318760	6113442	QMFs	103	72	13	10	alteration/quartz	discrete altered fracture, slightly open with 'typical'

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								cream/red alteration colourisation with ~5mm alteration halo, quartz veining 10mm thick parallel with folitaion 194/71e
317469	6113077	GABs	115	78	25	8	Alteration	thick alteration vein, highly weathered, 17cm thick alteration, seperates the GABs fram the quartz mica schist, alteration veins shoot off the large vein along the n-s east dipping foliation
317469	6113078	GABs	110	84	20	9	Alteration	fracture vein, open with 1mm gap, with varying width of alteration halo of 3-20mm, typical alteration colourasation cream/orange/red
317469	6113079	GABs	295	79	205	8	Alteration	thin 1mm alteration vein, high fracture density of 14/m of mostly the discrete thin altered fracture veins
317469	6113080	GABs	288	82	198	8	Alteration	thin fracture vein with 10-15mm alteration halo
317469	6113081	GABs	120	88	30	10	Alteration	large prominent fracture, highly altered with ~20mm alteration halo
317469	6113082	GABs	110	86	20	9	Alteration	altered fracture vein with 15mm alteration halo, typical looking, the GABs unit in the north of the outcrop appear to have a lower altered fracture density compared to the high density fracturing in the southern quartz mica schist unit
317469	6113083	GABs	115	84	25	8	Alteration	a closed altered fracture vein with thin 5mm alteration halo, high density fracturing
317469	6113084	GABs	239	87	149	7	Alteration	a closed altered fracture vein with thin 2mm alteration halo, high density fracturing
317469	6113085	QMFs	243	64	153	7	Alteration	thin discrete alteration veins, in area the horizontal vein that come off the large alteration vein has weathered into loose clay material
317469	6113086	QMFs	238	70	148	10	Alteration	
317469	6113087	QMFs	116	86	26	14	Alteration	a closed altered fracture vein with thin 2mm alteration halo, high density fracturing
317469	6113088	QMFs	111	88	21	12	Alteration	a closed altered fracture vein with thin 3mm alteration halo, high density fracturing
317469	6113089	QMFs	120	86	30	14	Alteration	a closed altered fracture vein with thin 3mm alteration halo, high density fracturing of 14/m
317469	6113090	QMFs	114	67	24	10	Alteration	
317469	6113091	QMFs	132	84	42	11	Alteration	open discrete fracturing with 20mm alteration halo
317469	6113092	QMFs	265	76	175	14	Alteration	open discrete fracturing with 20mm alteration halo

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317469	6113093	QMFs	274	83	184	10	Alteration	a closed altered fracture vein with thin 25mm alteration halo, high density fracturing
317469	6113094	QMFs	109	84	19	14	Alteration	
317469	6113095	QMFs	273	85	183	13	Alteration	
317469	6113096	QMFs	255	84	165	11	Alteration	a closed altered fracture vein with thin 30mm alteration halo, high density fracturing
317469	6113097	QMFs	99	84	9	15	Alteration	open 5mm discrete fracturing with 30mm alteration halo
317469	6113099	QMFs	114	85	24	9	Alteration	a closed altered fracture vein with thin 25mm alteration halo, high density fracturing
317469	6113101	QMFs	103	84	13	10	Alteration	
317469	6113103	QMFs	106	87	16	10	Alteration	a closed altered fracture vein with thin 40mm alteration halo, high density fracturing
317469	6113105	QMFs	101	82	11	10	Alteration	
317469	6113107	QMFs	199	72	109	10	Alteration	very thick 70mm alteration fracture
317469	6113109	QMFs	88	82	358	10	Alteration	typical looking alteration fracture vein with a light cream/white interior of the vein which changes into a brown/red colourisation in the alteration halo in the fracture walls
317469	6113111	QMFs	120	80	30	11	Alteration	
317469	6113113	QMFs	99	83	9	14	Alteration	a open fracture, 10mm with 70mm alteration halo
317759	6116327	QMFs	66	62	336	4	Alteration	continous fracturing, low alteration fracturing with thin 2mm alteration halos, medium density
317760	6116328	QMFs	95	80	5	4	Alteration	
317763	6116329	QMFs	69	62	339		Alteration	discrete alteration fracture veining with ~5mm alteration vein, low degree of alteration
317764	6116330	QMFs	94	65	4		Alteration	
317765	6116331	QMFs	60	70	330		Alteration	
316346	6115162	QMFs	70	64	340		Alteration	smooth planar altered fracturing, dominate fracture orientation in this outcrop, smooth red/brown coloured alteration on fracture surfaces
316347	6115163	QMFs	110	76	20		Alteration	a more spares orientated fracture sets but not as smooth planar as before
316348	6115164	QMFs	75	86	345		Alteration	
316242	6114895	QMFs	70	88	340	4	Alteration	small discrete altered fracture veins, low alteration, medium density fracturing

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316243	6114896	QMFs	59	85	329	4	Alteration	iron stained alteration on fracture surfaces
316238	6114855	QMFs	84	85	354		Alteration	
316239	6114856	QMFs	68	49	338		Alteration	
316240	6114857	QMFs	84	85	354		Alteration	
316287	6114836	QMFs	54	45	324	4	Alteration	altered iron stained fracture surfaces, medium density 4/m
316288	6114837	QMFs	55	60	325	4	Alteration	
316289	6114838	QMFs	55	66	325	4	Alteration	
316319	6114832	QMFs	101	80	11	4	Alteration	smooth altered planar fracture surfaces, fracture veins have 1mm opening with a 5mm alteration halo, typical looking colourisation
316320	6114833	QMFs	85	78	355	4	Alteration	small discrete altered fracture veins, low alteration, medium density fracturing
316321	6114834	QMFs	79	83	349	4	Alteration	
316322	6114835	QMFs	96	86	6	4	Alteration	
316323	6114836	QMFs	126	80	36	4	Alteration	
316369	6114839	QMFs	110	78	20	4	Alteration	typical looking alteration fractures of medium density
316370	6114840	QMFs	71	69	341	4	Alteration	
316371	6114841	QMFs	60	68	330	4	Alteration	
316451	6114912	QMFs	114	74	24		Alteration	iron stained alteration on fracture surfaces
316452	6114913	QMFs	64	70	334		Alteration	
316453	6114914	QMFs	65	55	335		Alteration	
316566	6114966	QMFs	258	71	168		Alteration	typical looking fracture veining with alteration, fracture has a 30mm alteration veins in fracture walls, though it uneven as the fluid looks to have pushed in along foliation schist
316567	6114967	QMFs	281	71	191		Alteration	
316568	6114968	QMFs	260	65	170		Alteration	a closed fracture vein with small 2mm alteration halo
316593	6114969	QMFs	90	81	0		Alteration	not well developed non planar fractures in outcrop
316594	6114970	QMFs	257	71	167		Alteration	a smooth fracture surface with a low altered surface
316595	6114971	QMFs	92	65	2		Alteration	
316596	6114972	QMFs	255	67	165		Alteration	open 1mm alteration fracture with typical 15mm

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								alteration halo
316688	6114993	QMFs	81	59	351	4	Alteration	medium density fracturing 4/m, altered fractures
316689	6114994	QMFs	84	57	354	4	Alteration	
316690	6114995	QMFs	61	55	331	4	Alteration	
316691	6114996	QMFs	59	55	329	4	Alteration	
316708	6115056	QMFs	99	55	9	3	Alteration	2-3/m medium density fracturing, smooth planar fracture surfaces
317946	6114433	GABs	102	86	12	6	Alteration	highly altered fracturing, with thick alteration halo of 70mm
317947	6114434	GABs	103	86	13	6	Alteration	
317956	6114477	GABs	94	84	4	3	Alteration	typical looking altered fracturing, slightly open 1-2mm open fracturing, medium density fracturing of 2-3/m fracture vein and surfaces
317957	6114478	GABs	120	75	30	3	Alteration	
317958	6114479	GABs	94	88	4	3	Alteration	
317906	6114610	GABs	94	79	4	3	Alteration	a prominent and continous fracturing, slighty altered (iron stained' with altered fracture surfaces, medium density fracturing 2-3/m
316717	6115743	QMFs	113	70	23		Alteration	smooth altered planar fracture surfaces, typical colouration cream/orange/red alteration
316718	6115744	QMFs	108	77	18		Alteration	
316719	6115745	QMFs	104	80	14		Alteration	
316649	6115753	QMFs	74	52	344	3	Alteration	slight iron staining on fracture surfaces, medium density of 2-3/m
316650	6115754	QMFs	79	69	349	3	Alteration	
316651	6115755	QMFs	95	74	5	3	Alteration	
316646	6115725	QMFs	106	80	16	7	Alteration	increase of fracture density to high density at 7/m, area dominated by altered fracture density
316647	6115726	QMFs	99	78	9	7	Alteration	
316648	6115727	QMFs	272	56	182	7	Alteration	
316649	6115728	QMFs	256	69	166	7	Alteration	
316650	6115729	QMFs	232	56	142	7	Alteration	
316651	6115730	QMFs	264	79	174	7	Alteration	
316652	6115731	QMFs	94	82	4	7	Alteration	
316653	6115732	QMFs	81	75	351	7	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
316637	6115636	QMFs	86	52	356	4	Alteration	medium density fracturing, low alteration in fracturing veins and in fracture surfaces
316638	6115637	QMFs	100	85	10	4	Alteration	
316639	6115638	QMFs	101	22	11	4	Alteration	
316640	6115639	QMFs	265	70	175	4	Alteration	
316641	6115640	QMFs	100	57	10	4	Alteration	
316642	6115641	QMFs	100	20	10	4	Alteration	
316565	6115374	QMFs	290	79	200		Alteration	fine discrete altered fracturing in rock
316419	6115397	QMFs	94	74	4		Alteration	open 1mm alteration fracture with typical 15mm alteration halo
316420	6115398	QMFs	84	68	354		Alteration	
316377	6115354	QMFs	98	87	8	3	Alteration	medium density altered fracturing with a slight increse with tight grouping fracture sets
316378	6115355	QMFs	99	73	9	3	Alteration	
316379	6115356	QMFs	55	65	325	3	Alteration	
316403	6115286	QMFs	279	78	189		Alteration	outcrop dominated by south dipping fracturing, smooth planar altered fracturing
316400	6115271	QMFs	112	86	22	15	Alteration	high density fracturing with tight grouping fracture sets with 15/m+, dominated by smooth planar alteration fracture surfaces and discrete fracture veins
316401	6115272	QMFs	105	84	15	15	Alteration	alteration is the typical colourisation that is seen the majority of places, the light cream/yellow central vein material which move out the the orange/red/brown alteration halo
316402	6115273	QMFs	106	81	16	15	Alteration	
316368	6115206	QMFs	55	50	325	15	Alteration	
316369	6115207	QMFs	128	86	38	15	Alteration	still high density fracturing of 15/m+
316370	6115208	QMFs	55	49	325	15	Alteration	
316371	6115209	QMFs	104	74	14	15	Alteration	
316372	6115210	QMFs	70	61	340	15	Alteration	
316373	6115211	QMFs	69	62	339	15	Alteration	
317596	6114380	GABs	93	80	3	4	Alteration	open planar fracture, slight altertion on fracture surface, medium to low alteration
317608	6114387	GABs	94	86	4	3	Alteration	open planar fracture, slight altertion on fracture surface, medium to low alteration

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317606	6114365	GABs	89	80	359	3	Alteration	open planar fracture, slight altertion on fracture surface, medium to low alteration of 2-3/m
317712	6114335	GABs	78	85	348	8	Alteration	fracturing surrounding an old mine working, fractures have been altered with typical looking colourisation
317713	6114336	GABs	72	74	342	8	Alteration	a high fractured zone of the outcrop of 8/m
317714	6114337	GABs	95	86	5	8	Alteration	
317912	6114283	GABs	91	87	1	2	Alteration	low density fracturing in outcrop, fracture has undergone low to no alteration, no visible signs
317935	6114223	GABs	100	84	10		Alteration	weathered altered fracturing, planar fracture surface that has been weather and roughed up
317934	6114129	GABs	99		9	2	Alteration	dominated by small discrete fracture veins, 1-2/m low to medium density fracturing, fractures are altered with iron stained fracture surfaces and thin alteration halos
317935	6114130	GABs	95	85	5	2	Alteration	
317936	6114131	GABs	106	84	16	2	Alteration	
317937	6114132	GABs	99	83	9	2	Alteration	
317938	6114133	GABs	109	82	19	2	Alteration	
317939	6114134	GABs	100	88	10	2	Alteration	
317921	6114088	GABs	95	76	5	3	Alteration	open 2-4mm discrete fracturing with 10mm alteration halo, low to medium density of 1-3/m
317922	6114089	GABs	99	83	9	3	Alteration	
317942	6114048	GABs	89	85	359	3	Alteration	altered planar fracture surfaces, iron stained surfaces and discrete thin 2mm fracture veins, medium density of 2-3/m
317943	6114049	GABs	71	82	341	3	Alteration	
318002	6114168	GABs	96	79	6	3	Alteration	planar altered fracture of low to medium density of 2-3/m,
318003	6114169	GABs	104	84	14	3	Alteration	open 3mm discrete fracture vein with typical colouration alteration
318004	6114170	GABs	100	86	10	3	Alteration	
317940	6116328	GABs	100	88	10	3	Alteration	planar altered fractures, smooth surfaces with thin alteration halos, medium density fracture 2-3/m
317941	6116329	GABs	94	88	4	3	Alteration	
317942	6116330	GABs	93	86	3	3	Alteration	

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
317564	6114219	GABs	114	81	24		Alteration	fracture surfaces are highly iron stained cause by weathering of the low altered fracture surfaces, fractures are open with 3mm
317565	6114220	GABs	96	85	6		Alteration	
317566	6114221	GABs	106	76	16		Alteration	
317567	6114222	GABs	116	85	26		Alteration	
317568	6114223	GABs	102	87	12		Alteration	
317569	6114224	GABs	111	79	21		Alteration	
317564	6114214	GABs	115	84	25		quartz	next to old copper workings, fracture infill with quartz veining, thick at 30cm
317556	6114214	GABs	105	86	15		Alteration	large prominent fracture, altered with ~20mm alteration halo, fracture is closely associtated with a small mineralised zone (old mine shaft)
317557	6114215	GABs	114	81	24		Alteration	
317558	6114216	GABs	104	80	14		Alteration	
317576	6114210	GABs	101	80	11	3	Alteration	slighlty altered fracture surfaces closely realted to small mineralisation, medium fracture density
317575	6114217	GABs	76	80	346	4	Alteration	slighlty altered fracture surfaces closely realted to small mineralisation, medium fracture density
317589	6114195	GABs	107	84	17		Alteration	large fracture surface, smooth and planar, slightly altered
317590	6114196	GABs	94	82	4		Alteration	
317589	6114195	GABs	86	83	356		Alteration	
317608	6114240	GABs	96	86	6		Alteration	prominent smooth planar fracturing, slighty altered in fracturing, outcrop is highly weathered
317609	6114241	GABs	96	84	6		Alteration	
317607	6114246	GABs	275	84	185	5	Alteration	tight grouping fracture set in outcrop, medium density fracturing 5/m, typical alteration on fracture surfaces and veins, fracture set forms an interesting 'flower structure'
317608	6114247	GABs	276	84	186	5	Alteration	
317609	6114248	GABs	94	86	4	5	Alteration	
317610	6114249	GABs	95	86	5	5	Alteration	
317604	6114253	GABs	96	86	6		Alteration	planar fracture with alteration +halo (halo has uneven distrubtion being thicker in the footwall
317606	6114260	GABs	103	85	13	3	Alteration	planar altered fractures, smooth surfaces with thin

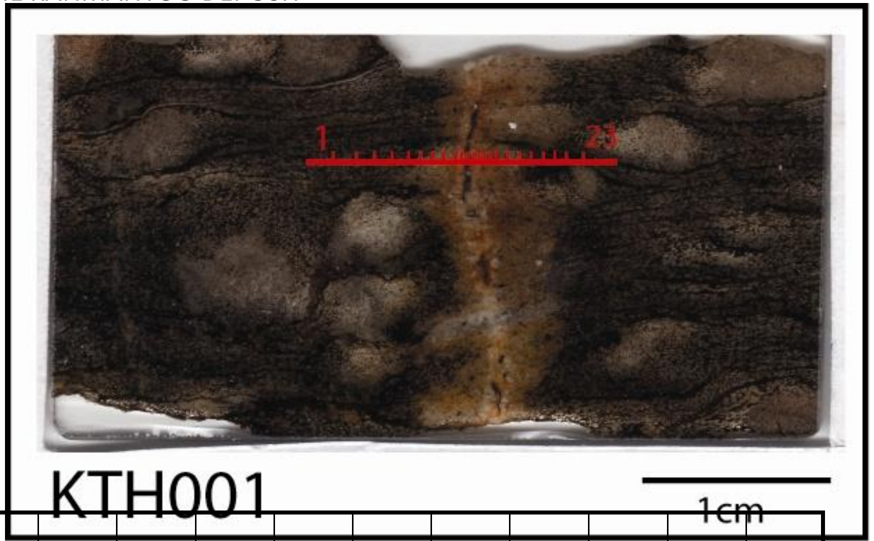
EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
								alteration halos, medium density fracture 2-3/m
317607	6114261	GABs	94	87	4	3	Alteration	
317607	6114279	GABs	85	84	355	4	Alteration	fracture with alteration, typical looking with 10mm thick alteration halo, medium density fracturing
317608	6114305	GABs	85	87	355	3	Alteration	fracture with alteration, typical looking with 10mm thick alteration halo, medium density fracturing
317611	6114326	GABs	96	84	6	4	Alteration	fracture with alteration, typical looking with 10mm thick alteration halo, medium density fracturing
317588	6114354	GABs	80	84	350	4	Alteration	iron stained alteration on fracture surfaces, medium density fracturing
317587	6114366	GABs	76	82	346	3	Alteration	fracture with alteration, typical looking with 10mm thick alteration halo, medium density fracturing
318174	6115734	GABs	105	79	15	4	Alteration	planar fracture veining which has been exposed to a planar fracture surface, has thin alteration halo
318232	6115829	GABs	88	86	358	7	Alteration	medium to high fracture denisty of 4-9/m with tight grouping fracture sets increasing the overall density
318260	6115840	GABs	96	78	6	3	Alteration	altered planar fracture surfaces, iron stained surfaces and discrete thin 2mm fracture veins, medium density of 2-3/m
318312	6115877	GABs	76	80	346		Alteration	non planar fracturing, undulating surfaces with low alteration present
318313	6115878	GABs	76	77	346		Alteration	smooth prominent fracture surface, altered iron stained fractures
318306	6115882	GABs	95	61	5	4	Alteration	smooth prominent fracture surface, altered iron stained fractures, medium density fracturing
318296	6115897	GABs	96	66	6		quartz	quartz vein material found on planar iron stained fracture surface
318297	6115898	GABs	85	78	355		quartz	
318298	6115899	GABs	86	66	356		quartz	
318247	6115939	GABs	96	85	6	2	Alteration	smooth prominent fracture surface, altered iron stained fractures, low density fracturing
318262	6115946	GABs	73	59	343	3	Alteration	rough planar fracture surfaces, medium denisty fo 3/m, slight iron stained
318257	6115951	GABs	89	74	359	3	Alteration	medium density fracturing of 2-3/m, planar altered fracture surfaces of similar orientation
318244	6115952	GABs	90	64	0	2	Alteration	low to medium density fracturing of 1-2/m, planar altered fracture surfaces of similar orientation

EASTING	NORTHING	ROCK TYPE	STRIKE	DIP	DIP DIRECTION	FREQUENCY /m	VEIN MATERIAL	NOTES
318228	6115960	GABs	87	78	357		Alteration	non planar fracturing, undulating surfaces with low alteration present
318227	6115926	GABs	120	75	30	3	Alteration	altered planar fracture surfaces, iron stained surfaces and discrete thin 2mm fracture veins, medium density of 2-3/m
318227	6115927	GABs	99	72	9	4	Alteration	a iron stained continous fracture surface, medium density
318216	6115928	GABs	95	79	5	3	Alteration	a iron stained continous fracture surface, medium density
318213	6115937	GABs	85	68	355	5	Alteration	medium density fracture set of 5/m, open planar altered fracture with 5mm alteration halo
317738	6116321	GABs	70	69	340	5	Alteration	thin discrete alteration veins, typical colourisation alteration vein and alteration halo ~10mm thick, high density area of 10/m, which is due to the tight grouping dicrete fracture veins
317739	6116322	GABs	95	74	5	5	Alteration	
317740	6116323	GABs	96	82	6	5	Alteration	
317751	6116323	GABs	92	81	2	6	Alteration	smooth prominent fracture surface, altered iron stained fractures, high to medium density fracturing, 5-6/m
317758	6116327	GABs	64	53	334	4	Alteration	smooth prominent fracture surface, altered iron stained fractures, medium density fracturing

12. APPENDIX 2

Appendix 2.1:
Relative element analysis

2.1.1. KTH001



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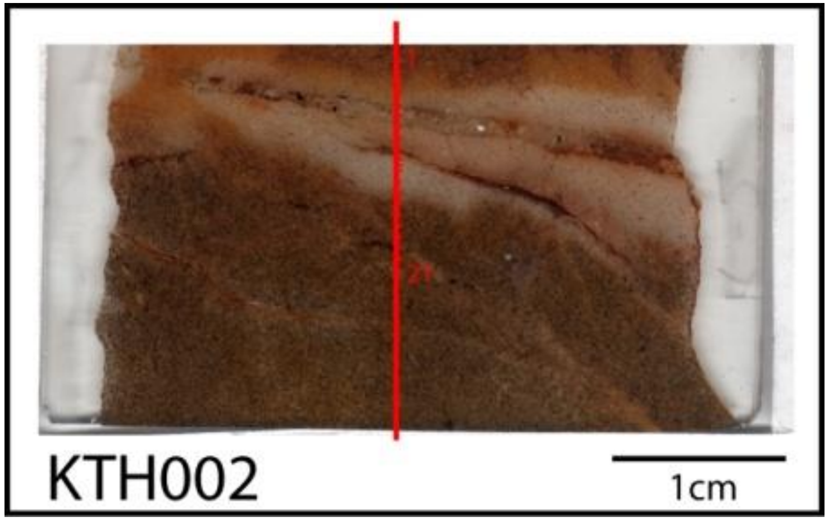
O	24.9	23.97	25.03	23.22	24.14	23.73	25.21	26.81	27.88	26.93	26.68	25.96	27.31	26.88	26.74	26.49	27.33	25.94	24.60	24.70	24.13	25.18	26.0
Na	0.01	0.01	0.04	0.12	0.01	0.01	1.79	2.56	3.63	3.60	6.00	6.55	4.95	1.85	2.29	0.48	0.95	1.79	0.50	0.01	0.84	0.72	0.71
Mg	0.86	1.33	1.09	2.20	2.05	2.39	1.43	0.42	0.14	0.26	0.40	0.16	0.17	0.15	0.33	0.65	0.44	1.12	2.30	2.22	2.06	1.55	1.20
Al	3.82	5.08	4.11	7.07	4.84	5.65	7.52	7.19	8.96	8.71	13.86	13.93	12.16	6.87	14.26	14.25	6.40	7.18	6.65	8.49	10.96	6.75	5.66
Si	57.4	51.32	54.05	45.06	50.08	47.56	50.05	55.94	53.35	54.44	44.12	44.63	48.21	55.57	46.12	46.55	58.28	51.51	46.65	45.37	41.64	49.68	52.7
P	0.01	0.06	0.39	0.01	0.03	0.03	0.01	0.01	0.67	0.01	0.03	0.01	0.03	0.02	0.01	0.04	0.01	0.01	0.01	0.02	0.01	0.03	0.47
S	0.01	0.01	0.01	0.01	0.04	0.02	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
K	2.86	4.58	3.48	5.89	4.66	5.38	4.07	2.37	2.54	2.25	2.47	1.78	3.67	3.01	6.89	6.48	2.59	3.45	4.67	5.51	6.53	4.07	3.31
Ca	0.05	0.33	1.08	0.25	0.15	0.22	0.41	0.58	2.25	0.55	0.85	1.17	0.96	0.41	0.39	0.28	0.26	0.51	0.35	0.27	0.37	0.26	1.49
Ti	0.26	0.64	0.75	0.97	1.30	1.04	0.77	0.50	0.01	0.20	0.18	0.44	0.15	1.70	0.32	0.41	0.42	0.75	0.92	0.86	0.84	1.35	0.49
Ce	0.01	0.18	0.01	0.18	0.36	0.33	0.01	0.27	0.01	0.48	0.37	1.26	0.19	0.42	0.21	0.37	0.17	0.26	0.24	0.09	0.34	0.18	0.01
Mn	0.01	0.05	0.03	0.11	0.18	0.14	0.01	0.11	0.01	0.23	0.20	0.71	0.01	0.28	0.06	0.14	0.08	0.11	0.11	0.11	0.20	0.06	0.01
Fe	9.70	12.47	9.93	14.79	12.19	13.36	8.74	3.15	0.58	1.96	4.59	1.95	2.20	2.76	2.24	3.73	2.87	7.29	12.88	12.09	11.95	10.12	7.89
Cu	0.01	0.01	0.01	0.14	0.01	0.14	0.01	0.07	0.01	0.34	0.26	1.44	0.01	0.10	0.15	0.13	0.20	0.07	0.14	0.27	0.12	0.04	0.01

2.1.2. KTH002



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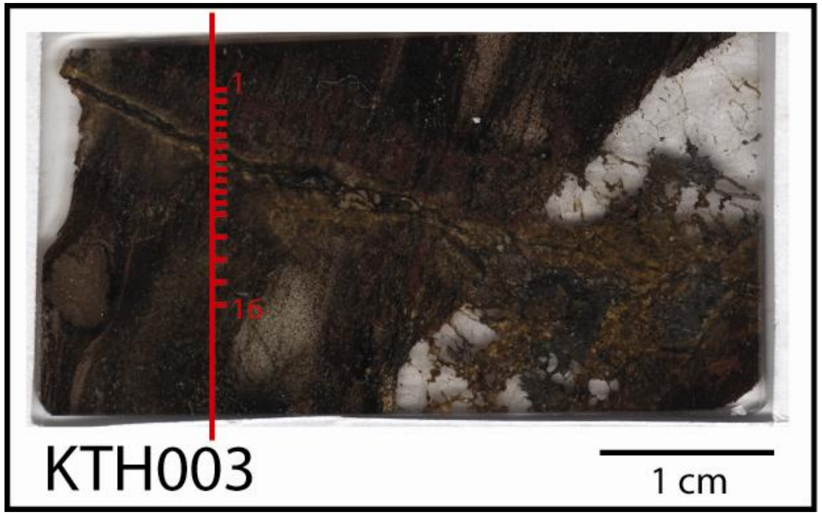
O	4.77	4.88	4.93	4.76	4.68	4.59	4.90	4.85	4.66	4.80	4.87	4.89	4.91	4.82	4.74	4.56	4.73	4.64	4.77	4.65	4.58
Na	6.08	6.27	6.54	6.62	5.31	7.40	5.68	4.24	5.91	4.83	4.67	5.58	3.63	4.57	2.49	2.70	3.80	3.73	3.42	3.20	3.32
Mg	4.00	2.18	1.94	6.07	11.29	4.49	1.94	2.67	1.82	1.94	1.09	1.70	1.94	4.00	6.07	4.49	8.74	9.22	5.34	8.86	10.19
Al	5.24	5.24	5.06	7.71	8.59	7.33	4.53	4.73	4.62	4.98	3.98	4.44	3.01	4.65	3.11	2.88	3.95	4.26	3.77	3.99	3.93
Si	4.71	4.72	4.63	3.94	3.65	3.96	5.06	4.68	4.74	4.72	5.08	5.06	5.49	4.81	5.14	5.15	4.85	4.80	5.08	4.89	4.84
P	1.61	1.61	3.23	1.61	12.90	1.61	4.84	3.23	4.84	4.84	3.23	1.61	1.61	1.61	4.84	1.61	1.61	1.61	1.61	38.71	1.61
S	1.82	1.82	9.09	1.82	10.91	18.18	1.82	9.09	10.91	1.82	1.82	7.27	3.64	1.82	5.45	1.82	1.82	1.82	1.82	1.82	3.64
K	2.14	2.16	1.24	11.60	14.77	6.87	1.03	8.87	1.68	11.96	2.46	1.11	0.68	3.79	5.68	3.06	3.57	4.49	4.22	4.44	4.19
Ca	3.99	3.84	3.09	3.54	2.26	5.05	3.09	3.01	4.37	2.86	2.79	3.39	1.96	3.92	4.67	5.95	2.71	10.93	7.01	10.63	10.93
Ti	1.80	5.46	19.92	4.50	1.38	3.32	2.63	13.97	7.54	0.48	8.64	0.69	0.76	5.46	2.63	3.53	5.67	2.35	2.07	1.52	5.67
Ce	4.49	1.42	0.71	4.37	2.83	13.93	1.18	4.96	13.46	3.66	4.01	3.54	2.60	4.49	4.72	13.70	4.25	4.01	2.48	2.13	3.07
Mn	3.43	2.70	1.23	3.43	3.19	16.18	1.23	3.68	14.95	2.21	3.92	3.43	2.70	4.66	3.19	14.46	3.68	4.90	1.23	2.21	3.43
Fe	5.58	3.58	1.51	4.28	9.33	4.35	0.94	1.47	2.50	1.51	1.13	1.03	1.15	4.93	7.40	6.49	9.69	8.61	5.87	8.63	10.02
Cu	2.41	1.20	2.94	3.21	2.27	18.98	1.60	2.41	17.65	2.14	2.94	3.61	2.81	3.88	2.41	17.11	3.34	3.07	0.13	4.01	1.87

2.1.3. KTH003



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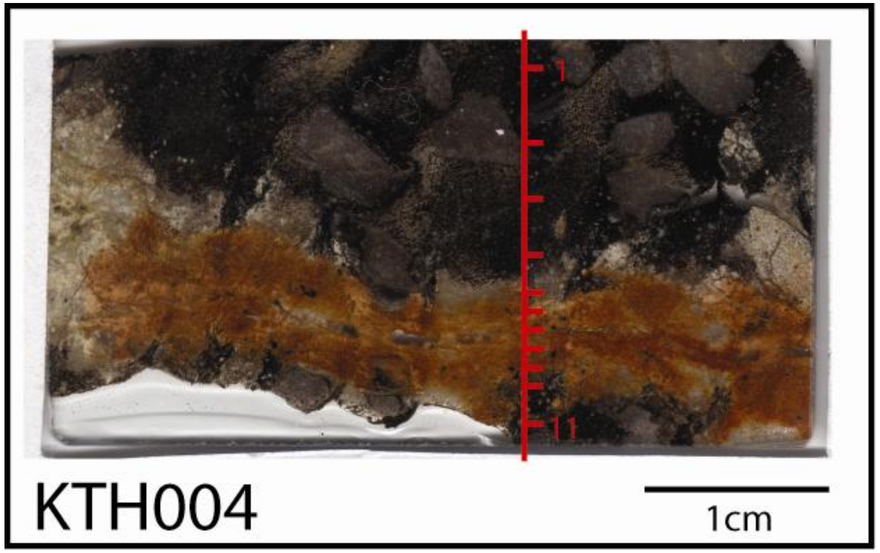
O	22.94	24.42	23.86	23.44	23.59	23.93	23.21	22.06	22.43	23.68	22.83	8.2	22.81	19.52	19.85	23.43
Na	0.01	0.03	0.01	0.53	0.16	1.88	3.78	4.23	4.82	5.66	5.08	15.16	5.08	2.75	4.25	0.24
Mg	2.35	1.32	1.7	1.63	1.34	0.47	0.53	0.88	0.74	0.3	0.6	0.03	0.72	1.76	1.26	1.7
Al	6.14	3.24	3.97	8.8	4.75	7.03	12.21	14.05	16.51	16.26	16.83	7.56	15.99	14.46	14.01	21.77
Si	51.15	61.51	58.39	51.56	56.34	58.16	49.05	40.3	41.39	44.63	42.53	7.87	41.47	27.9	32.39	28.37
P	0.01	0.06	0.12	0.06	0.05	0.22	0.31	0.56	0.14	0.2	0.08	0.49	0.31	0.1	0.13	0.2
S	0.01	0.02	0.04	0.16	0.02	0.01	0.01	0.01	0.01	0.01	0.07	29.89	0.04	0.01	0.01	0.01
K	1.72	0.78	0.71	2.86	1.59	0.55	0.67	0.72	1.38	1.05	0.8	0.18	1.2	1.58	1.38	3.24
Ca	0.26	0.26	0.43	0.21	0.3	0.97	1.34	1.6	1.17	1.53	0.76	0.21	1.45	0.66	1.23	0.5
Ti	0.59	0.58	0.63	0.47	0.47	0.41	0.5	1.85	0.65	0.5	0.11	0.27	0.35	1.34	1	0.81
Ce	0.17	0.16	0.27	0.38	0.01	0.14	0.25	0.28	0.6	0.36	0.35	1.08	0.56	0.52	0.52	0.38
Mn	0.25	0.19	0.22	0.21	0.06	0.19	0.26	0.19	0.15	0.05	0.1	0.36	0.13	0.46	0.47	0.21
Fe	14.34	7.31	9.53	9.69	11.33	5.9	7.82	13.1	9.54	5.6	9.81	28.31	9.78	28.25	23.01	19.05
Cu	0.09	0.14	0.15	0.01	0.01	0.14	0.07	0.17	0.5	0.18	0.06	0.4	0.12	0.72	0.5	0.11

2.1.4. KTH004



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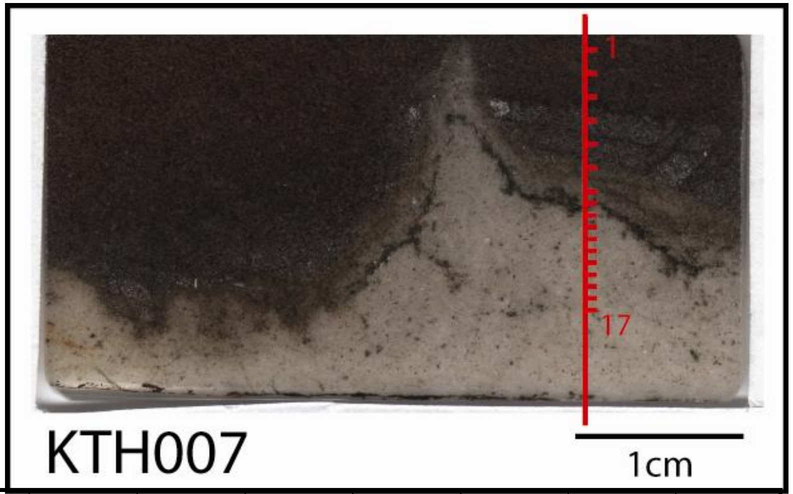
O	22.34	24.88	25.21	25.14	26.26	27.36	26.29	26.12	26.95	25.02	26.33
Na	0.01	0.05	0.04	0.01	0.17	0.63	3.12	5.78	5.32	2	1.48
Mg	1.36	0.76	1.13	1.36	0.67	0.23	0.21	0.11	0.18	0.23	0.26
Al	5.97	7.84	5.46	8.08	4.74	5.26	10.53	14.68	15.65	8.8	14.07
Si	47.72	53.62	55.17	50.38	60.3	61.56	51.49	42.91	43.34	52.3	47.68
P	0.01	0.01	0.05	0.03	0.03	0.32	0.17	0.18	0.15	0.02	0.3
S	0.01	0.01	0.01	0.01	0.02	0.01	0.48	0.61	0.32	0.05	0.2
K	4.48	3.66	3.79	4.58	1.81	1.6	2.89	2.26	2.05	5.69	2.6
Ca	0.28	0.16	0.28	0.27	0.17	1.33	0.56	0.77	0.7	0.47	0.69
Ti	0.64	0.38	0.64	0.57	0.46	0.01	0.11	0.41	0.97	0.34	0.17
Ce	0.01	0.17	0.1	0.01	0.06	0.01	0.32	0.41	0.01	1.08	0.35
Mn	0.56	0.3	0.06	0.01	0.03	0.01	0.15	0.18	0.07	0.59	0.14
Fe	16.66	8.1	7.92	9.59	5	1.59	3.51	5.38	4.1	2.16	5.56
Cu	0.01	0.09	0.15	0.01	0.27	0.11	0.18	0.2	0.22	1.27	0.18

2.1.6. KTH007



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O	23.96	23.64	23.39	24.23	23.09	23.38	23.45	23.42	25.91	25.78	25.28	25.35	25.78	25.09	25.92	25.59	25.65
Na	1.52	0.63	0.99	1.32	0.46	2.02	1.63	2.04	3.37	4.01	3.75	3.3	4.25	3.37	4.01	5.38	6.18
Mg	0.99	1.14	1.3	1.18	1.11	3.82	2.76	2.83	0.3	0.29	0.45	0.44	0.23	0.85	0.37	0.18	0.18
Al	8.58	7.02	7.08	8.25	7.76	9.58	8.25	8.7	7.6	9.93	9.13	8.12	9.64	8.74	9.24	10.89	12.77
Si	53.92	54.68	53.73	53.72	50.72	42.8	46.82	48.04	59.36	56.14	57.07	58.11	56.85	55.51	55.3	55.05	53.03
P	0.09	0.02	0.03	0.01	0.08	0.03	0.39	0.02	0.11	0.01	0.01	0.01	0.05	0.13	0.49	0.03	0.01
S	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.01	0.01
K	1.91	5.4	2.28	2.13	5.01	0.37	1.24	1.01	1.09	1.91	1.56	1.24	1.23	1.32	0.93	0.51	0.69
Ca	3.74	0.71	2.36	3.23	0.88	0.36	1.03	0.24	0.82	0.45	0.39	0.42	0.45	0.68	1.44	0.64	0.61
Ti	0.37	0.56	0.65	0.36	0.69	0.94	0.52	0.13	0.12	0.23	0.17	0.49	0.25	0.14	0.93	0.39	0.08
Ce	0.17	0.11	0.21	0.01	0.01	0.12	0.37	0.25	0.19	0.21	0.26	0.26	0.25	0.15	0.01	0.39	0.19
Mn	0.16	0.3	0.7	0.26	1.25	0.15	0.17	0.18	0.1	0.01	0.1	0.16	0.12	0.19	0.01	0.15	0.01
Fe	4.43	5.64	7.09	5.27	8.95	16.29	12.77	12.67	1.02	0.94	1.65	1.84	0.76	3.64	1.36	0.56	0.49
Cu	0.16	0.15	0.18	0.04	0.01	0.13	0.58	0.45	0.01	0.1	0.19	0.25	0.12	0.19	0.01	0.24	0.14

2.1.6. KTH008

9 point spots
vein transect

Element	Wt %														
	fld0009	fld0008	fld0007	fld0006	fld0001	fld0002	fld0003	fld0004	fld0005	fld0006	fld0007	fld0005	fld0004	fld0003	fld0002	fld0001
O	21.64	21.81	24.94	25.29	24.79	18.33	17.64	25.13	24.09	20.06	23.61	26.71	25.79	26.61	25.61	23.43
Na	0.01	0.01	0.01	0.01	0.04	0.01	0.01	0.03	0.01	0.05	0.05	0.01	0.01	0.01	0.01	0.01
Mg	1.05	2.21	0.95	0.88	0.64	2.31	3.47	0.42	0.58	0.46	0.8	0.48	0.66	0.48	0.69	0.95
Al	6.78	11.37	15.47	11.45	10.09	4.26	5.89	8.39	6.71	5.02	8.69	5.41	3.77	4.84	2.8	4.13
Si	44.56	32.44	38.24	44.46	51.12	23.03	11.91	55.95	54.41	45.7	50.18	57.4	57.42	58.92	56.46	52.77
P	0.01	0.02	0.01	0.01	0.16	0.05	0.02	0.21	0.02	0.06	0.18	0.01	0.01	0.03	0.6	0.02
S	0.01	0.97	0.07	0.05	0.01	0.07	0.07	0.01	0.1	9.84	0.01	0.01	0.25	0.07	0.47	1.35
K	1.91	5.15	7.96	6.39	6.32	1.76	2.1	5.07	4.12	3.05	4.26	3.01	1.5	2.66	1.88	2.3
Ca	0.21	0.1	0.18	0.13	0.48	0.32	0.33	0.68	0.21	0.14	0.57	0.12	0.11	0.17	1.9	0.06
Ti	0.42	0.95	0.75	0.77	1.05	0.26	0.07	0.5	0.56	0.87	0.58	0.58	0.42	0.5	0.41	0.44
Ce	0.32	0.35	0.32	0.14	0.09	0.49	0.24	0.29	0.39	0.32	0.27	0.14	0.17	0.23	0.21	0.13
Mn	0.87	0.2	0.53	0.33	0.09	2.92	3.16	0.2	0.38	0.26	0.19	0.24	0.18	0.22	0.09	0.24
Fe	21.84	23.75	10.45	9.94	5.13	45.72	54.98	2.94	8.27	14.03	10.62	5.75	9.57	5.15	8.76	14.18
Cu	0.39	0.68	0.15	0.15	0.01	0.5	0.12	0.18	0.15	0.13	0.01	0.14	0.16	0.13	0.13	0.01

Appendix 2.2: Normalised relative element data

2.2.1. KTH001

Normalised to unaltered analysis spots fld0001, fld0002 & fld0022

	fld003	fld004	fld005	fld006	fld007	fld008	fld009	fld010	fld011	fld012	fld013	fld014	fld015	fld016	fld017	fld018	fld019	fld020	fld021
O	1.00	0.93	0.96	0.95	1.01	1.07	1.11	1.08	1.07	1.04	1.09	1.07	1.07	1.06	1.09	1.04	0.98	0.99	0.96
Na	0.11	0.34	0.03	0.03	5.01	7.16	10.15	10.07	16.78	18.32	13.85	5.17	6.41	1.34	2.66	5.01	1.40	0.03	2.35
Mg	0.88	1.78	1.66	1.94	1.16	0.34	0.11	0.21	0.32	0.13	0.14	0.12	0.27	0.53	0.36	0.91	1.86	1.80	1.67
Al	0.77	1.33	0.91	1.06	1.41	1.35	1.68	1.63	2.60	2.61	2.28	1.29	2.68	2.67	1.20	1.35	1.25	1.59	2.06
Si	1.02	0.85	0.95	0.90	0.95	1.06	1.01	1.03	0.84	0.85	0.91	1.05	0.87	0.88	1.10	0.98	0.88	0.86	0.79
P	2.79	0.07	0.21	0.21	0.07	0.07	4.79	0.07	0.21	0.07	0.21	0.14	0.07	0.29	0.07	0.07	0.07	0.14	0.07
S	1.00	1.00	4.00	2.00	1.00	2.00	1.00	3.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00
K	0.94	1.59	1.26	1.45	1.10	0.64	0.69	0.61	0.67	0.48	0.99	0.81	1.86	1.75	0.70	0.93	1.26	1.49	1.76
Ca	2.03	0.47	0.28	0.41	0.77	1.09	4.23	1.03	1.60	2.20	1.80	0.77	0.73	0.53	0.49	0.96	0.66	0.51	0.69
Ti	1.09	1.42	1.90	1.52	1.12	0.73	0.01	0.29	0.26	0.64	0.22	2.48	0.47	0.60	0.61	1.09	1.34	1.26	1.23
Ce	0.11	2.00	4.00	3.67	0.11	3.00	0.11	5.33	4.11	14.00	2.11	4.67	2.33	4.11	1.89	2.89	2.67	1.00	3.78
Mn	1.09	4.00	6.55	5.09	0.36	4.00	0.36	8.36	7.27	25.82	0.36	10.18	2.18	5.09	2.91	4.00	4.00	4.00	7.27
Fe	0.99	1.47	1.21	1.33	0.87	0.31	0.06	0.20	0.46	0.19	0.22	0.27	0.22	0.37	0.29	0.73	1.28	1.20	1.19
Cu	1.00	14.00	1.00	14.00	1.00	7.00	1.00	34.00	26.00	144.00	0.00	10.00	15.00	13.00	20.00	7.00	14.00	27.00	12.00

2.2.2. KTH002

Normalised to unaltered analysis spots fld0001, fld0020 & fld0021

	fld0002	fld0003	fld0004	fld0005	fld0006	fld0007	fld0008	fld0009	fld0010	fld0011	fld0012	fld0013	fld0014	fld0015	fld0016	fld0017	fld0018	fld0019
O	1.05	1.06	1.02	1.00	0.98	1.05	1.04	1.00	1.03	1.04	1.05	1.05	1.03	1.02	0.98	1.01	0.99	1.02
Na	1.49	1.56	1.58	1.26	1.76	1.35	1.01	1.41	1.15	1.11	1.33	0.86	1.09	0.59	0.64	0.90	0.89	0.81
Mg	0.28	0.25	0.79	1.47	0.58	0.25	0.35	0.24	0.25	0.14	0.22	0.25	0.52	0.79	0.58	1.14	1.20	0.69
Al	1.20	1.15	1.76	1.96	1.67	1.03	1.08	1.05	1.13	0.91	1.01	0.69	1.06	0.71	0.66	0.90	0.97	0.86
Si	0.98	0.96	0.82	0.76	0.82	1.05	0.97	0.98	0.98	1.06	1.05	1.14	1.00	1.07	1.07	1.01	1.00	1.05
P	0.12	0.23	0.12	0.92	0.12	0.35	0.23	0.35	0.35	0.23	0.12	0.12	0.12	0.35	0.12	0.12	0.12	0.12
S	0.75	3.75	0.75	4.50	7.50	0.75	3.75	4.50	0.75	0.75	3.00	1.50	0.75	2.25	0.75	0.75	0.75	0.75
K	0.60	0.35	3.23	4.12	1.91	0.29	2.47	0.47	3.33	0.69	0.31	0.19	1.06	1.58	0.85	0.99	1.25	1.18
Ca	0.45	0.36	0.42	0.27	0.59	0.36	0.35	0.51	0.34	0.33	0.40	0.23	0.46	0.55	0.70	0.32	1.28	0.82
Ti	1.82	6.65	1.50	0.46	1.11	0.88	4.66	2.52	0.16	2.88	0.23	0.25	1.82	0.88	1.18	1.89	0.78	0.69
Ce	0.44	0.22	1.35	0.88	4.32	0.37	1.54	4.17	1.13	1.24	1.10	0.80	1.39	1.46	4.24	1.32	1.24	0.77
Mn	0.89	0.41	1.14	1.05	5.35	0.41	1.22	4.95	0.73	1.30	1.14	0.89	1.54	1.05	4.78	1.22	1.62	0.41
Fe	0.44	0.19	0.53	1.15	0.54	0.12	0.18	0.31	0.19	0.14	0.13	0.14	0.61	0.92	0.80	1.20	1.07	0.73
Cu	0.44	1.06	1.16	0.82	6.87	0.58	0.87	6.39	0.77	1.06	1.31	1.02	1.40	0.87	6.19	1.21	1.11	0.05

2.2.3. KTH003

Normalised to unaltered analysis spots fld0015 & fld0016

	fld0001	fld0002	fld0003	fld0004	fld0005	fld0006	fld0007	fld0008	fld0009	fld0010	fld0011	fld0012	fld0013	fld0014
O	1.06	1.13	1.10	1.08	1.09	1.11	1.07	1.02	1.04	1.09	1.05	0.38	1.05	0.90
Na	0.00	0.01	0.00	0.24	0.07	0.84	1.68	1.88	2.15	2.52	2.26	6.75	2.26	1.22
Mg	1.59	0.89	1.15	1.10	0.91	0.32	0.36	0.59	0.50	0.20	0.41	0.02	0.49	1.19
Al	0.34	0.18	0.22	0.49	0.27	0.39	0.68	0.79	0.92	0.91	0.94	0.42	0.89	0.81
Si	1.68	2.02	1.92	1.70	1.85	1.91	1.61	1.33	1.36	1.47	1.40	0.26	1.37	0.92
P	0.06	0.36	0.73	0.36	0.30	1.33	1.88	3.39	0.85	1.21	0.48	2.97	1.88	0.61
S	1.00	2.00	4.00	16.00	2.00	1.00	1.00	1.00	1.00	1.00	7.00	2989.00	4.00	1.00
K	0.74	0.34	0.31	1.24	0.69	0.24	0.29	0.31	0.60	0.45	0.35	0.08	0.52	0.68
Ca	0.30	0.30	0.50	0.24	0.35	1.12	1.55	1.85	1.35	1.77	0.88	0.24	1.68	0.76
Ti	0.65	0.64	0.70	0.52	0.52	0.45	0.55	2.04	0.72	0.55	0.12	0.30	0.39	1.48
Ce	0.38	0.36	0.60	0.84	0.02	0.31	0.56	0.62	1.33	0.80	0.78	2.40	1.24	1.16
Mn	0.74	0.56	0.65	0.62	0.18	0.56	0.76	0.56	0.44	0.15	0.29	1.06	0.38	1.35
Fe	0.68	0.35	0.45	0.46	0.54	0.28	0.37	0.62	0.45	0.27	0.47	1.35	0.47	1.34
Cu	0.30	0.46	0.49	0.03	0.03	0.46	0.23	0.56	1.64	0.59	0.20	1.31	0.39	2.36

2.2.4. KTH004

Normalised to unaltered analysis spots fld0001 & fld0002

	fld0003	fld0004	fld0005	fld0006	fld0007	fld0008	fld0009	fld0010	fld0011
O	1.07	1.06	1.11	1.16	1.11	1.11	1.14	1.06	1.12
Na	1.33	0.33	5.67	21.00	104.00	192.67	177.33	66.67	49.33
Mg	1.07	1.28	0.63	0.22	0.20	0.10	0.17	0.22	0.25
Al	0.79	1.17	0.69	0.76	1.52	2.13	2.27	1.27	2.04
Si	1.09	0.99	1.19	1.21	1.02	0.85	0.86	1.03	0.94
P	5.00	3.00	3.00	32.00	17.00	18.00	15.00	2.00	30.00
S	1.00	1.00	2.00	1.00	48.00	61.00	32.00	5.00	20.00
K	0.93	1.13	0.44	0.39	0.71	0.56	0.50	1.40	0.64
Ca	1.27	1.23	0.77	6.05	2.55	3.50	3.18	2.14	3.14
Ti	1.25	1.12	0.90	0.02	0.22	0.80	1.90	0.67	0.33
Ce	1.11	0.11	0.67	0.11	3.56	4.56	0.11	12.00	3.89
Mn	0.14	0.02	0.07	0.02	0.35	0.42	0.16	1.37	0.33
Fe	0.64	0.77	0.40	0.13	0.28	0.43	0.33	0.17	0.45
Cu	3.00	0.20	5.40	2.20	3.60	4.00	4.40	25.40	3.60

2.2.5. KTH007

Normalised to unaltered analysis spots fld0001 & fld0002

	fld0004	fld0005	fld0006	fld0007	fld0008	fld0009	fld0010	fld0011	fld0012	fld0013	fld0014	fld0015	fld0016	fld0017
O	1.02	0.98	0.99	0.99	0.99	1.09	1.09	1.07	1.07	1.09	1.06	1.10	1.08	1.08
Na	1.26	0.44	1.93	1.56	1.95	3.22	3.83	3.58	3.15	4.06	3.22	3.83	5.14	5.90
Mg	1.03	0.97	3.34	2.41	2.48	0.26	0.25	0.39	0.38	0.20	0.74	0.32	0.16	0.16
Al	1.09	1.03	1.27	1.09	1.15	1.01	1.31	1.21	1.07	1.28	1.16	1.22	1.44	1.69
Si	0.99	0.94	0.79	0.87	0.89	1.10	1.04	1.05	1.07	1.05	1.03	1.02	1.02	0.98
P	0.21	1.71	0.64	8.36	0.43	2.36	0.21	0.21	0.21	1.07	2.79	10.50	0.64	0.21
S	0.75	0.75	0.75	0.75	1.50	0.75	0.75	0.75	1.50	2.25	0.75	0.75	0.75	0.75
K	0.67	1.57	0.12	0.39	0.32	0.34	0.60	0.49	0.39	0.38	0.41	0.29	0.16	0.22
Ca	1.42	0.39	0.16	0.45	0.11	0.36	0.20	0.17	0.19	0.20	0.30	0.63	0.28	0.27
Ti	0.68	1.31	1.78	0.99	0.25	0.23	0.44	0.32	0.93	0.47	0.27	1.77	0.74	0.15
Ce	0.06	0.06	0.73	2.27	1.53	1.16	1.29	1.59	1.59	1.53	0.92	0.06	2.39	1.16
Mn	0.67	3.23	0.39	0.44	0.47	0.26	0.03	0.26	0.41	0.31	0.49	0.03	0.39	0.03
Fe	0.92	1.56	2.85	2.23	2.22	0.18	0.16	0.29	0.32	0.13	0.64	0.24	0.10	0.09
Cu	0.24	0.06	0.80	3.55	2.76	0.06	0.61	1.16	1.53	0.73	1.16	0.06	1.47	0.86

2.2.5. KTH008

Normalised to unaltered analysis spots fld0001, fld0002, & fld009

	fld0008	fld0007	fld0006	fld0001	fld0002	fld0003	fld0004	fld0005	fld0006	fld0007	fld0005	fld0004	fld0003
O	0.92	0.93	1.06	1.07	1.05	0.78	0.75	1.07	1.02	0.85	1.00	1.13	1.09
Na	1.00	1.00	1.00	1.00	4.00	1.00	1.00	3.00	1.00	5.00	5.00	1.00	1.00
Mg	1.17	2.46	1.06	0.98	0.71	2.58	3.87	0.47	0.65	0.51	0.89	0.54	0.74
Al	1.48	2.49	3.39	2.51	2.21	0.93	1.29	1.84	1.47	1.10	1.90	1.18	0.82
Si	0.87	0.63	0.75	0.87	1.00	0.45	0.23	1.09	1.06	0.89	0.98	1.12	1.12
P	0.05	0.10	0.05	0.05	0.76	0.24	0.10	1.00	0.10	0.29	0.86	0.05	0.05
S	0.02	1.59	0.11	0.08	0.02	0.11	0.11	0.02	0.16	16.13	0.02	0.02	0.41
K	0.94	2.54	3.92	3.15	3.11	0.87	1.03	2.50	2.03	1.50	2.10	1.48	0.74
Ca	0.29	0.14	0.25	0.18	0.66	0.44	0.46	0.94	0.29	0.19	0.79	0.17	0.15
Ti	0.99	2.24	1.77	1.82	2.48	0.61	0.17	1.18	1.32	2.06	1.37	1.37	0.99
Ce	1.45	1.59	1.45	0.64	0.41	2.23	1.09	1.32	1.77	1.45	1.23	0.64	0.77
Mn	2.18	0.50	1.33	0.83	0.23	7.30	7.90	0.50	0.95	0.65	0.48	0.60	0.45
Fe	1.46	1.59	0.70	0.67	0.34	3.06	3.68	0.20	0.55	0.94	0.71	0.39	0.64
Cu	2.21	3.85	0.85	0.85	0.06	2.83	0.68	1.02	0.85	0.74	0.06	0.79	0.91