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Government of South Australia
Department for Energy and Mining

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Francesco Colombi[1], Laura Jackson[1], Gabriele Baldassarre[2] and Anita Parbhakar-Fox[1]

1 Mine Waste Transformation through Characterisation (MIWATCH), W.H. Bryan Mining Geology Research Centre, Sustainable Minerals Institute (SMI), The University of Queensland
2 Department of Environmental, Land and Infrastructure Engineering, Torino, Italy

January 2025

Report Book 2024/00036

Department for Energy and Mining
Level 4, 11 Waymouth Street, Adelaide
GPO Box 618, Adelaide SA 5001
Phone +61 8 8463 3000
Email dem.minerals@sa.gov.au
dem.petroleum@sa.gov.au
www.energymining.sa.gov.au

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Preferred way to cite this publication
Colombi F, Jackson L, Baldassarre G and Parbhakar-Fox A 2025. *Secondary prospectivity of South Australia's mine waste: Kanmantoo Cu, Au and Ag mine*, Report Book 2024/00036. Department for Energy and Mining, South Australia, Adelaide.

Cover
View from the old tailings storage facility toward the new at Kanmantoo Mine. (Photograph courtesy Carmen Krapf)

Sustainable Minerals Institute

Secondary Prospectivity of South Australia's Mine Waste: Kanmantoo Cu, Au & Ag mine

Case Study Report for the Geological Survey of South Australia

Reporting Date: 19/09/2024

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[1] QS World University Rankings and the Performance Ranking of Scientific Papers for World Universities (2019)

[2] The University of Queensland is ranked third in the world for mining and mineral engineering, 2018 Shanghai Rankings by subject

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Acknowledgements

The SMI and MIWATCH staff are thanked for their assistance in the project (project management, field assistance, sample preparation and report reviewing). This study has been funded by the Geological Survey of South Australia's (GSSA) 'Critical Minerals South Australia' project.

GSSA's Carmen Krapf, Adrian Fabris and Bronwyn Camac are thanked for the management and support of the project. Moira Coffey for site organisation, logistics, access permission and site supervision during sampling. Glenn Norris and Caitlin Rowett (Hillgrove Resources) are thanked for providing access to the Kanmantoo mine site and tailings as well as hosting the MIWATCH team during the sampling.

Carmen Krapf and Peter Keller (GSSA) are thanked for their extensive review of this report.

The SMI MLA lab staff, Sietronics and Adelaide Microscopy are acknowledged for the analytical services and support. Holly Cook helped with the sampling.

We acknowledge the traditional owners on which this study was conducted.

Executive summary

The MIWATCH group previously prepared a desktop review of the mine waste features at various locations in South Australia, examining the potential for critical metals for the Department for Energy and Mining. The desktop study highlighted potential opportunities of the mine waste features and prospectivity for critical metals at the Kanmantoo mine. In this study tailings at the Kanmantoo mine were sampled and the geochemical and mineralogical characteristics of the samples were assessed to determine the critical metal/mineral potential.

The Kanmantoo mine is located ~44 km SE of Adelaide. The Kanmantoo mine is characterized by copper-gold-(silver) deposits within metasediments of the Tapanappa Formation, part of the early Cambrian Kanmantoo Group. Historic mining of copper at Kanmantoo began in 1846. The site holds a significant amount of tailings, subdivided between the new and old tailings storage facilities.

In total, 74 tailings samples were collected at this site. Mineralogically, the samples are dominated by quartz, garnet, biotite, magnetite and chlorite, with trace contents of staurolite, andalusite, muscovite-illite and pyrite (in addition to amorphous phases and iron oxides).

Positive correlations exist between Ni and Co, Fe and Cu, Mn and Fe with REE, and Mg with Rb. Spatially, the highest concentrations of Cu, Bi, Co and Mn are located in the old tailings storage facility and in the SW-S side of the new tailings storage facility.

Mineral chemistry investigations confirm endowment of several critical metals in garnets and iron sulfides. The former displays the highest concentrations of Zr (2.2 %), Bi (2.3 %), Ti (3.6 %) and Mn (4.9 %). While the highest concentrations of Cu, Ni and Co are in iron sulfides (mean: 946 ppm, 772 ppm and 2,236 ppm respectively).

Future studies should focus on continuing to characterise the uncovered, unrehabilitated tailings which may represent an ongoing acid and metalliferous drainage (AMD) risk.

High concentrations of garnet (up to 65 wt.%) were measured in the sampled tailings, with staurolite and andalusite as minor phases. Heavy mineral sand potential should be further explored within the tailings at Kanmantoo. In addition, after sulfide extraction a garnet-rich product could be concentrated and used in the manufacturing industry (e.g., blasting media and/or abrasives). Alternatively, if sulfides are not remined, in-situ leaching for either sulfide passivation or bioleaching could be explored for the tailings to prevent any future AMD generation.

Texturally, the Kanmantoo sulfides are complex and partly oxidised. Therefore, any future metallurgical work could be complicated, requiring a degree of comminution and separation techniques to create sulfide steams for processing. Conventional methods may need to be adapted to recover fine-size sulfides (*p80* < 70 µm). Innovative techniques to cost-effectively valorise this potential resource should be explored in future metallurgical studies.

1. Introduction

1.1 Project aims and objectives

A desktop review was undertaken by MIWATCH to identify the critical metal potential of mine waste features at various locations in South Australia for the Department for Energy and Mining (Jackson et al., 2023). High-ranking potential sites for critical metals from the desktop study are listed in Table 1.

The focus of this report has been to sample tailings at the Kanmantoo mine, assess the geochemical and mineralogical characteristics and determine critical metals potential to inform secondary prospectivity investigations.

Table 1. *Mine waste sites with high critical metal potential in South Australia (from Jackson et al., 2023).*

Site	Owner/Operator	Waste type(s)	Primary commodity	Mine waste target element/s	Sampled
Mount Gunson/ West Lagoon	A & MJ Musolino Pty Ltd./Minister for Environment and Water	• Tailings	Cu, Ag, Co	Cu-Co-Ag-Bi-Au-Zn	Y
Port Pirie REE	DEM	• Tailings	REE, U	REE	**Y**
Burra	Regional Council of Goyder	• Tailings	Cu, DOL	Cu-(Co-Ni-Zn-Au-Mo-U-REE)	N
Mount Grainger	DEM	• Tailings	Au	Au-(Bi-Mn-Cu-Pb-Zn-Co-As-Ag-Ba-Te-Hg-Sb)	N
Alma and Victoria	Minister for Environment and water	• Tailings	Au	Au-(Ag-As-Bi-Cu-Co-Fe-Mn-Mo-Pb)	Y
Paratoo	Gawler Craton Resources Pty Ltd.	• Waste rock/overburden	Cu, REE	Cu-(Au-REE)	Y
Moonta	Minister for Environment and Water	• Tailings	Cu, Ag, Au	Cu-(Co-Au-Zn-Pb-Ag-S)	N
Challenger	Barton Gold (Care and maintenance)	• Tailings	Au, Ag	Au-As-Bi-(Ag-Co-Ni-Cu-Te-Be)	Y
Dome Rock	Bush Heritage Australia	• Waste rock	Cu, Au, Co	Cu-(Co-Au-U)	N
Iron Knob	SIMEC	• Waste rock	Fe	Mn	N
Iron Monarch	SIMEC	• Waste rock	Fe	Mn	N
Iron Prince	SIMEC	• Waste rock	Fe	Mn	N
Brukunga	DEM	• Tailings • Waste rock • Sludge	S	(Cu-As-Ag-Co)	Y
Kanmantoo	**Hillgrove Resources Ltd**	**• Historic & modern tailings**	**Cu, Au**	**Cu-(Co-Ni-REE-Sc)**	**Y**

1.2 Site Description

1.2.1 Location

Geological Domain: Delamerian Orogen / Eastern Stansbury Basin (Kanmantoo Trough)

Co-ordinates:
Zone 54
Universal Transverse Mercator (UTM): Easting: 318180.71, Northing: 6114951.5
Decimal degrees: Latitude: -35.091852°, Longitude: 139.005394°
Degrees, minutes, seconds: Latitude: 35° 5'30.67"S, Longitude: 139° 0'19.42"E

The Kanmantoo mine is located ~44 km SE of Adelaide (Figure 1) and it is associated with multiple copper-gold-(silver) deposits within metasediments of the Tapanappa Formation, part of the early Cambrian Kanmantoo Group.

Figure 1. *Regional location map for the Kanmantoo mine site.*

1.2.2 Overview of mining operation

Operating Company: Hillgrove Resources Ltd

Mined Commodities: Copper, gold ± silver

Mining Method: Previously an open cut copper gold mine, now progressing to an underground operation.

Depth of Mining (Open Pit): 363 m (main pit aka "Giant Pit")

2. Geology and History

2.1 Kanmantoo deposit Geology

The Kanmantoo Group sediments were rapidly deposited over a period of 8 ± 5 Myr, based on a maximum depositional age zircon U-Pb dating of the Sellick Hill Tuff (522 ± 2 Ma) near the top of the underlying Normanville Group (Jenkins et al. 2002), and a minimum depositional age from zircon U-Pb dating of the earliest syn-deformational magmatic intrusion (514 ± 3 Ma) provided by Foden et al. (2006). This latter age defines the onset of the Delamerian Orogeny, which terminated sedimentation in the Kanmantoo Trough and resulted in regional metamorphism and three deformation events (Figure 2; Table 2). Orogenesis is proposed to have lasted ~24 Myr, terminating at 490 ± 3 Ma with rapid uplift, cooling and extension associated with post-tectonic magmatism (Foden et al. 2006). Peak metamorphism associated with orogenesis is proposed to have occurred at 512 ± 22 Ma (Hammerli et al. 2014) and in the Kanmantoo deposit area, metamorphosed the Kanmantoo Group to amphibolite facies (Pollock et al. 2018).

The site contains multiple orebodies (grey polygons in Figure 3; high Cu zones in Figure 4). Mineralisation consists of predominantly of chalcopyrite, pyrrhotite and magnetite ± minor primary and secondary pyrite (Seccombe et al. 1985). However, the method of mineralisation remains controversial, with interpretations divided between syn-sedimentary, syn-metamorphic and post-peak metamorphism/orogenic models (Table 3).

Table 2. *Summary of deformation events and resulting features associated with the Delamerian Orogeny. Adapted from geological summary provided by Pollock et al. (2018), based on studies by Talbot (1964), Offler and Fleming (1968), Preiss, (1987), Mancktelow (1990) and Belperio et al. (1998).*

Deformation Event	Resulting S-fabric	Resulting Folding
D_1	S_1: Regional slaty cleavage	F_1: Major upright folds
D_2 (peak metamorphism)	S_2: Weak crenulation overprinting S_1	F_2: Weak folds (e.g. Kanmantoo syncline)
D_3	S_3: Weak crenulation (restricted to the eastern Mount Lofty range)	F_3: Open folds

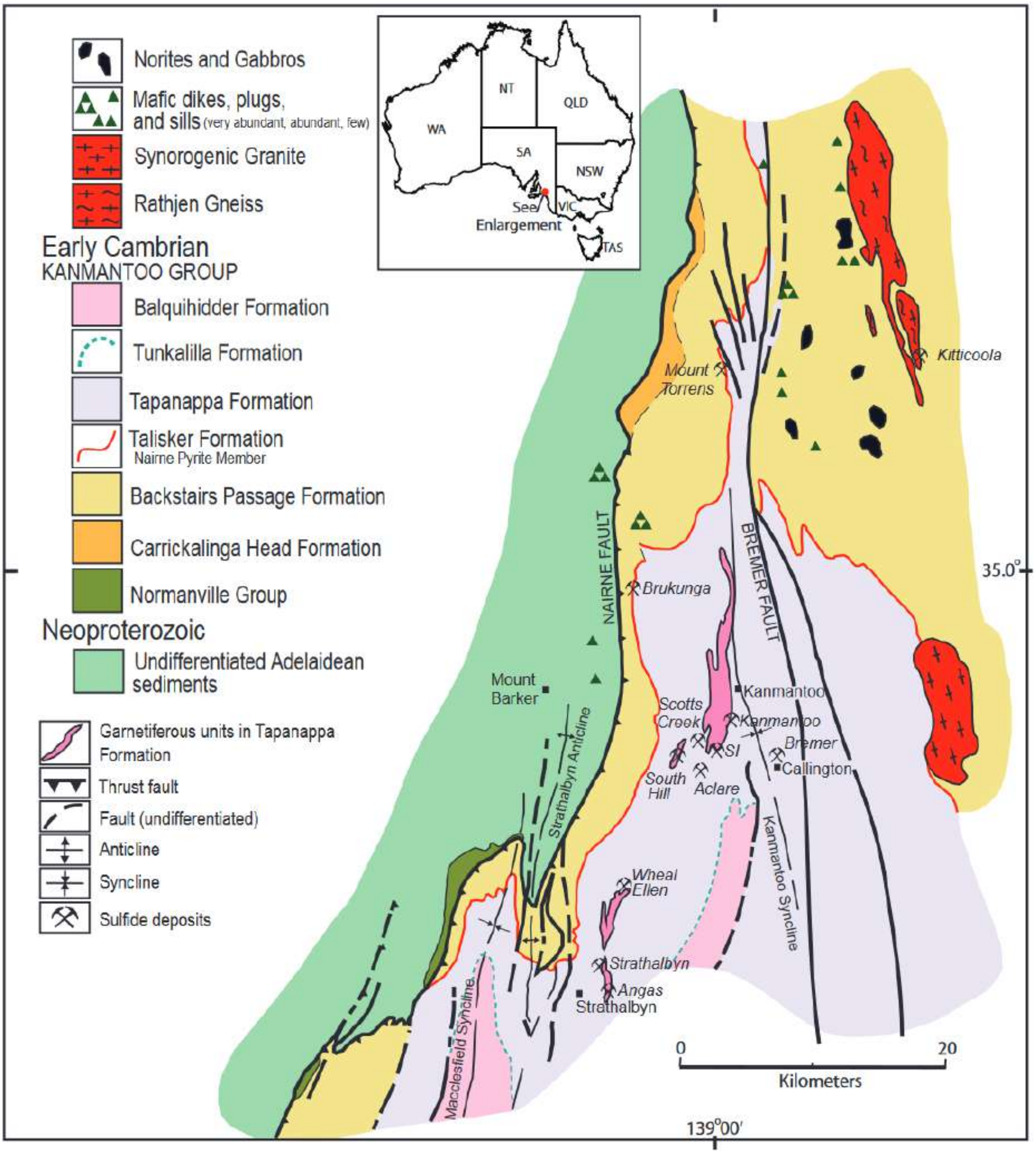

Figure 2. *Regional geologic map of the Kanmantoo region after Pollock et al. (2018).*

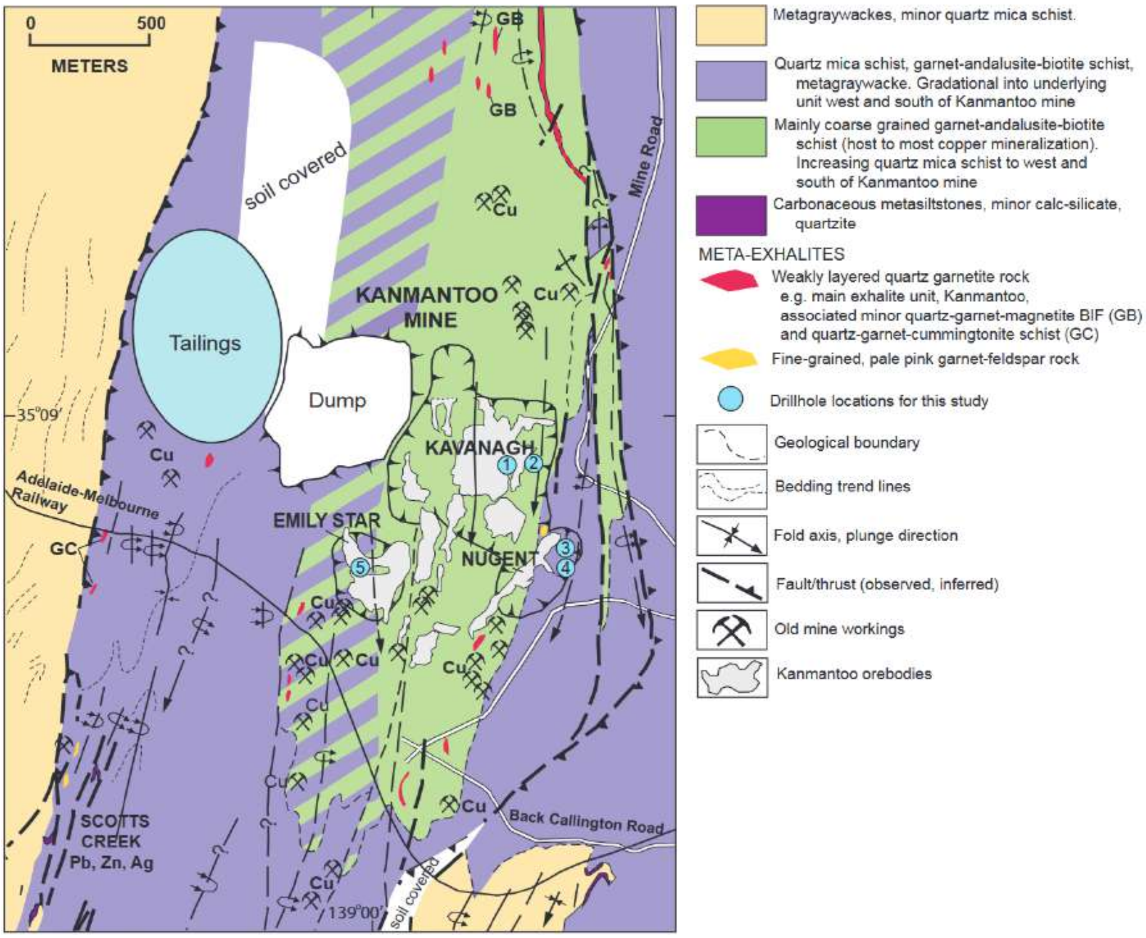

Figure 3. *Geological map of the Kanmantoo deposit area after Pollock et al. (2018). Note only the new tailings dump established by Hillgrove Resources is shown. Numbered drillholes do not correspond to present report.*

Table 3. *Summary of proposed genetic models and associated references for the Kanmantoo deposit. Adapted after discussion by Pollock et al. (2018).*

Genetic Model	Processes	References
Syn-sedimentary	Sulphide mineralisation from hydrothermal processes at/below the seafloor. Deposits then variably remobilised to varying degrees during later metamorphism.	Verwoerd and Cleghorn (1975), Seccombe et al. (1985), Parker (1986), Spry et al. (1988), Both (1990), Belperio et al. (1998), Toteff, (1999), Burtt (2008), Pollock et al. (2018)
Syn-metamorphic	Mineralisation occurred during peak metamorphism.	Thompson (1975), Parker (1986), Solomon and Groves (1994), Gum (1998), Oliver et al. (1998), Schiller (2000), Burtt (2008)
Post-peak metamorphism / orogenic	Ore-bearing fluids derived from orogenic granite towards the end of the Delamerian Orogeny	Foden et al. (1999), Focke et al. (2009), Schmidt Mumm et al. (2009), Tedesco (2009), Wilson (2009), Arbon (2011), Lyons (2012)

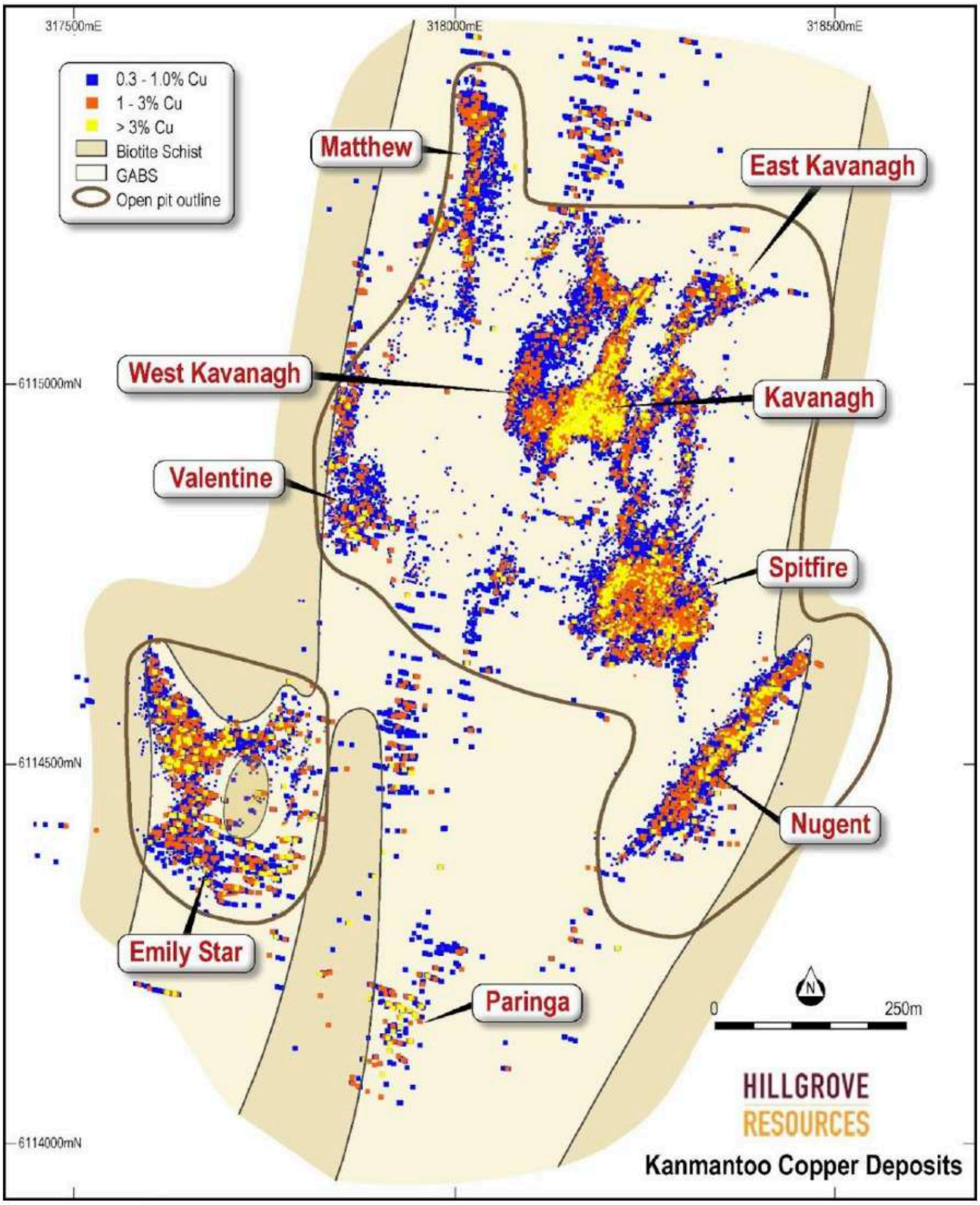

Figure 4. *Copper grades from drillholes collected across the Kanmantoo mine area after Hillgrove Resources (2022). GABS = garnet-andalusite-biotite schist.*

2.2 Mining, processing history and status

A summary of the history of mining activity at Kanmantoo is provided in Table 4 and the evolution of the site and location of the tailings dams, waste rock dump and open pits are shown in Figure 5. Although mining at the site began in the late 1800's, the site can be considered in two stages: (1) the "old" open pit mine, operated by Kanmantoo Mines Limited from 1970-1976; and (2) the reactivation of the mine from 2011-2024 by Hillgrove Resources.

Although open pit mining by Hillgrove Resources has ceased, the site remains active, with the company intending to begin underground operations to extract deeper mineralisation associated with the Kavanagh (Giant Pit) and potentially other proximal deposits (Wallace, 2021). The site currently contains two tailings dams, the old dam from mining activities from 1970-1976 (old tailings storage facility), and a new dam constructed by Hillgrove Resources adjacent to the western end of the waste rock dump (new tailings storage facility; Figure 5).

Table 4. *Summary of the history of activity of Kanmantoo mine, unless otherwise referenced, information is adapted from the summary provided in Hillgrove (2020).*

Time	Activity
1846	Onset of mining activity in the Kanmantoo area.
1874	Mining at Kanmantoo ceased due to global drop in copper prices.
1874 - 1960's	Intermittent prospecting in the Kanmantoo area. In the late 1960's a joint venture between North Broken Hill Ltd. and Broken Hill South Ltd. discovered the main deposit.
1970	Start of open pit mining of the Kavanagh deposit, over the workings of earlier mines. Operations were conducted by Kanmantoo Mines Limited, a joint venture between North Broken Hill Ltd, Broken Hill South Ltd., Electrolytic Zinc Co. of Australia Ltd. and Ravenrock Investments Ltd.
1976	Kanmantoo Mines Limited ceased mining operations due to low copper prices. At the time of closure, production was 4.05 Mt of ore with an average of 1% Cu (Seccombe et al. 1985). The site contained an open pit, processing plant infrastructure, a waste rock dump and tailings dam (referred to herein as the "Old waste rock dump" and "Old tailings dam", respectively).
1985	~65% of the original tailings dam covered with soil to support growth of indigenous and imported grasses, trees and shrubs (Agnew, 1988).
1988	Former processing plant on site repurposed by Neutrog for fertiliser manufacturing.
2003	Hillgrove Resources began exploration program in Kanmantoo area.
2010 - 2019	Hillgrove Resources took over the site in 2010 recommenced mining at existing open pit over the Kavanagh deposit (renamed the pit from "Kavanagh Pit" to the "Giant Open Pit" or "Giant Pit"). Two additional pits named Emily Star and Nugent were also created and were later backfilled with waste rock after extracting the available resource. A new tailings dam was added which slightly overlaps the western edge of old waste rock dump. The old tailings dam was left intact. After extracting the economically viable resource within the open pit, mining at the site ceased in May 2019.
Current Status	Hillgrove Resources continue processing of stockpiles. Underground mining is being planned from the base of the Giant Pit (Wallace, 2021). The current tailings dam is now in care and maintenance, while the old tailings dam has not been disturbed per Hillgrove Resources' licence conditions for the site.

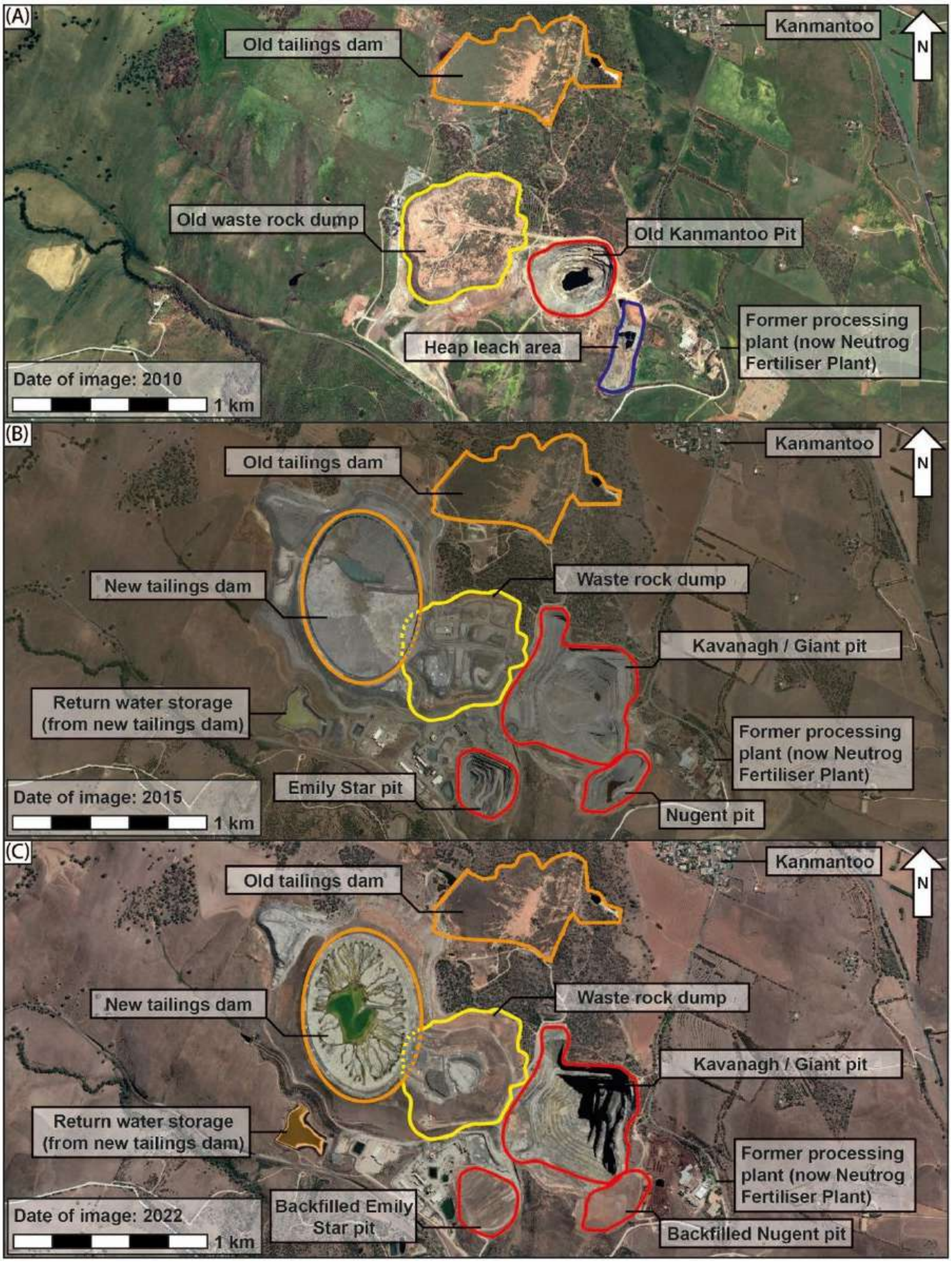

Figure 5. *Comparison of Kanmantoo mine infrastructure following original mine closure, reactivation and current state in care and maintenance. (A) Site in 2010, following initial mine closure but prior to reactivation. (B) Site in 2015 during active mining operations. (C) Site in 2022 after ceasing active mining. All satellite imagery from Google Earth. Boundaries for all labelled infrastructure after Hillgrove (2020).*

2.3 Previous data and studies

2.3.1 CSIRO Minesite Rehabilitation Research Program (PhD thesis)

Limited geochemical analysis was conducted on the old tailings dam by Agnew (1998) as part of a study assessing the formation of hardgrounds within tailings deposits. Four drillholes were collected in the Kanmantoo old tailings dam and their locations are shown in Figure 6, however no significant cementations/hardgrounds were found. Table 5 provides a summary of key characteristics including mineralogy, grain sizes and pH, while Tables 6 and 7 provide the results from geochemical analyses collected from cores 1, 3 and 4 (core 2 was not analysed).

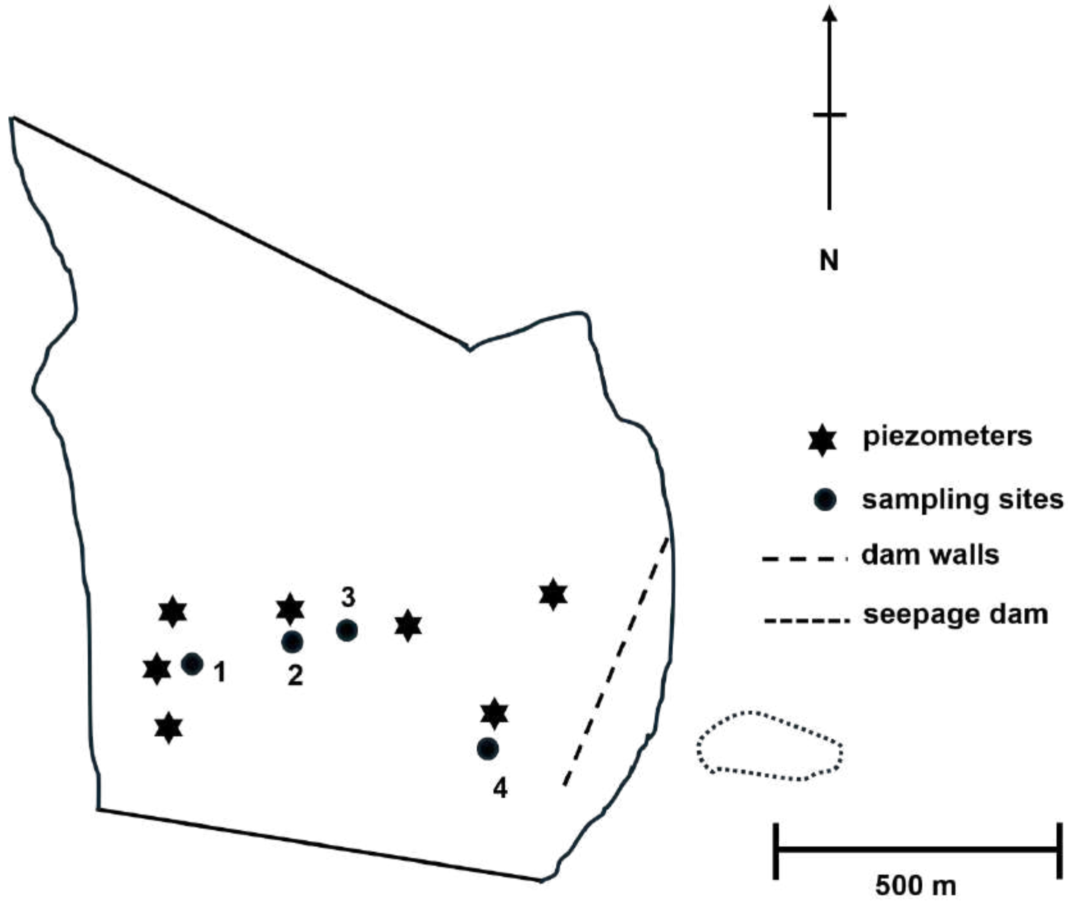

Figure 6. *Sampling locations in the old tailings dam after Agnew (1998).*

Table 5. *Characteristics of the old tailings dam after summary and results from Agnew (1998).*

Characteristics	Summary
Dam	Old tailings dam (at time of sampling, only one dam was present at the site) – on crest with two rock walls covered with soil and native vegetation. Total area is ~ 19.4 Ha.
Waste to ore ratio	5:1
Mineralogy	Sulphide minerals: 0.5-1% pyrite Gangue minerals: quartz, phlogopite, muscovite, clinochlore, almandine, andalusite, hercynite, magnetite, magnesite and minor calcite. Secondary minerals: samples at depth contained jarosite, halite and sylvite (not in large enough quantities to develop cementing characteristics).
Tailings grain size distribution	Coarse sand = 4 to 36% Fine sand = 60% Silt = 1 to 27% Clay = 1 to 6%
pH	3-5 (no trend with depth)
Type of cement	No cements
Surface cover	Soil cover (no surface salts)

Table 6. *X-ray fluorescence (XRF) results from the old tailings dam by Agnew (1988).*

Component	Site 1 (50-60 cm)	Site 1 (2.5-2.6 m)
SiO_2 (%)	42.7	59.7
Al_2O_3 (%)	12.1	14.4
Fe_2O_3 (%)	42.2	20.6
Fe (%)	29.5	14.4
MnO (%)	0.80	0.44
MgO (%)	1.50	2.41
CaO (%)	0.16	0.18
K_2O (%)	0.48	1.42
TiO_2 (%)	0.42	0.51
P_2O_5 (%)	0.11	0.13
SO_3 (%)	2.34	3.29
S (%)	0.94	1.32
Ba (ppm)	40	120
Ce (ppm)	60	70
Co (ppm)	30	135
Cr (ppm)	71	90
Cu (ppm)	560	1240
Ga (ppm)	15	15
La (ppm)	30	40
Ni (ppm)	15	35
Pb (ppm)	b.d.l	10
Rb (ppm)	25	85
Sr (ppm)	5	10
Th (ppm)	b.d.l	15
U (ppm)	b.d.l	10
V (ppm)	145	70
Y (ppm)	60	35
Zn (ppm)	155	220
Zr (ppm)	125	140

Sb (ppm)	b.d.l	b.d.l
Cd (ppm)	b.d.l	b.d.l
As (ppm)	15	5

b.d.l. = below detection limit

Table 7. *Kanmantoo tailings solute concentrations (1:5 batch leaching) after Agnew (1988).*

Component (ppm)	Site 1			Site 3				Site 4	
	57 cm	130 cm	260 cm	57 cm	109 cm	125 cm	333 cm	40 cm	130 cm
Al	3.0	6.8	451.8	99	643	837	509	1.1	3.5
Ca	29.0	235	24.7	275	403	832	189	185	287
Co	<0.1	<0.1	23.3	1.32	2.64	3.44	67.1	<0.1	13
Cu	16.3	25.2	280	123	200	190	292	5.2	33.5
Fe	<0.1	<0.1	15.3	1.00	3.9	11.1	27.6	<0.1	23
K	3.0	1.8	7.6	1.29	<0.1	0.81	25.5	19.9	105
Mg	9.6	13.8	232	106	342	448	1325	22.7	150
Mn	4.8	7.4	6.79	33.3	70.7	80.6	47.3	4.71	95
Na	11	11	12.2	6.61	12.2	8.51	8.79	49.89	60
Ni	<0.1	<0.1	7.94	<0.1	0.76	0.98	24.7	<0.1	3.5
S	71.0	270	1414	659	2376	2939	3320	206	600
Zn	13.2	<0.1	3.05	0.8	1.39	1.52	13.9	<0.1	2.5

2.3.2 Tailings Assessment by Hillgrove Resources

Assessment and analysis of tailings was also undertaken prior to Hillgrove Resources reopening the site (Hillgrove Resources, 2020 and references therein). The tailings storage facility (TSF) has been designed according to an integrated waste landform (IWL) concept, which uses waste rock to contain the tailings. Table 8 provide a summary of information regarding the waste rock, including its generation, disposal and potential for acidity generation. Geochemical test work derived from a bench-scale metallurgical work revealed the potentially acid forming (PAF) nature of the tailings, due to the presence of naturally reactive sulfides (e.g., marcasite; Table 9). TSF underdrainage samples were measured for major and minor ions for the period between 2012 and 2019. The mineralogy of the tailings solids indicated an enrichment in Ag, Bi and Se, which was not detected in the liquor (Table 10).

Table 8. *Waste rock inventory after Hillgrove Resources (2020). NAF = non-acid forming, PAF = potentially acid forming, IWL = integrated waste landform.*

Material Moved	Mt
Open pit waste rock production	
NAF production	19.7
PAF production	47.6
Total waste	**67.3**
Waste Rock Use other than in IWL	
Emily Star pit - backfill	8.5
O'Neil/Nugent pit - backfill	7.2
PAF estimated from Underground to end of mine life	
PAF waste rock to be used in underground backfill or placed at base of Giant Pit	0.3
NAF usage to end of mine life (as at May 2019)	
Already used for rehabilitation and other construction	11.1
Stockpiled for rehabilitation	4.1
Required for rehabilitation of site including IWL cover	1.5
Indicative excess stockpiled NAF	2.6

Table 9. *Acid base analysis and net-acid-generation results for tailings samples after Hillgrove Resources (2020) and references therein.*

MC	Total-S	SO_4-S	Sulphide-	CO_3-C	ANC	NAPP	NAG	NAG-pH	Classification
(% w/w)	%	%	%	%	Kg H_2SO_4/tonne				
20.5	0.80	0.03	0.78	0.01	9	16	13	3.6	PAF

Source: (Campbell, 2007a) MC = Moisture content; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; PAF = Potential-Acid Formation; NAG = Net-Acid Generation.

Table 10. *Tailings liquor analysis after Hillgrove Resources (2020) and references therein.*

Major-Ions (mg/L)								
Na	K	Mg	Ca	Cl	SO_4	HCO_3	CO_3	OH
379	322	110	577	547	2614	26	<1	<1
Minor-Ions (mg/L)								
Fe	Cu	Ni	Zn	Co	Al	Cd	Pb	Cr
74	19.6	0.2	0.84	0.6	0.24	0.0002	0.001	<0.01
Hg	As	Sb	Bi	Se	B	Mo	P	F
<0.0001*	<0.001	0.00014*	<0.000005*	0.0030*	0.04*	0.00009*	0.1*	0.2*
Ag	Ba	Sr	Tl	V	Sn	U	Th	Mn
<0.00001*	0.059*	0.38*	0.00006*	<0.01*	<0.0001*	0.00013*	<0.000005*	0.72*

Source: Average of quarterly underdrainage samples 2012 to 2019 where available (*otherwise Campbell, 2007a).

3. Opportunities for mine waste

3.1 Critical metal potential

Recently, garnet sands, particularly almandine ($Fe_3Al_2(SiO_4)_3$) and pyrope ($Mg_3Al_2(SiO_4)_3$) have been proposed as a potential unconventional source of scandium and rare earth elements, as scandium can readily substitute into the mineral lattice (Klimpel et al., 2021). This is particularly relevant for tailings at Kanmantoo mine, as the surrounding country rock is a garnet-andalusite-biotite schist (Figure 3), with a composition strongly favouring almandine and pyrope (Figure 7). The trace element composition of unmineralized Kanmantoo Group metasediments has been studied previously, however scandium was not among the suite of elements analysed (Hammerli et al., 2016).

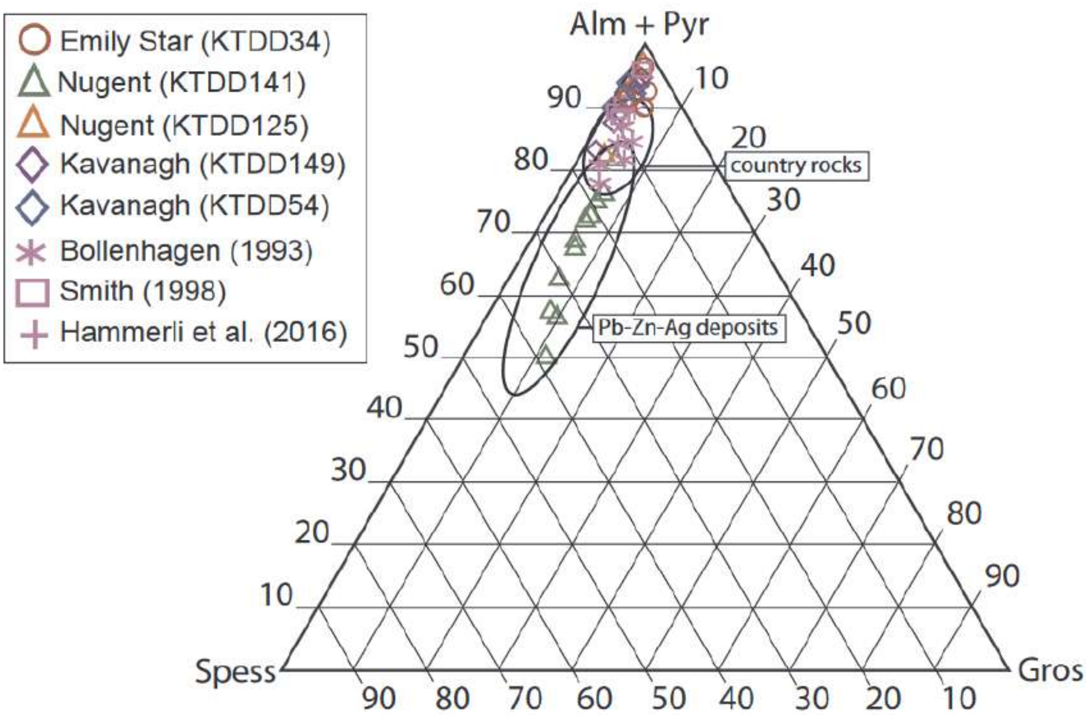

Figure 7. *Ternary plot of average garnet composition for individual samples from the Kanmantoo deposit and country rock schist. Figure after Pollock et al. (2018) and including data from Bollenhagen (1993), Smith (1998) and Hammerli et al. (2016). Alm = almandine, Pyr = pyrope, Spess = spessartine, Gros = grossular.*

4. Materials and Methods

4.1 Sample collection

The Kanmantoo Cu mine site was visited by the UQ staff in collaboration with the Geological Survey of South Australia (GSSA) in March 2024 for the purpose of collecting mine waste samples from the tailings. The main targets sampled include the old (Figure 8a) and new (Figure 8b) tailings storage facilities. Previous information on the old tailings storage facility were collected by p-XRF analysis by Agnew (1998). In this study, metals such as Cu, Zn, Zr and Co reported relatively high levels.

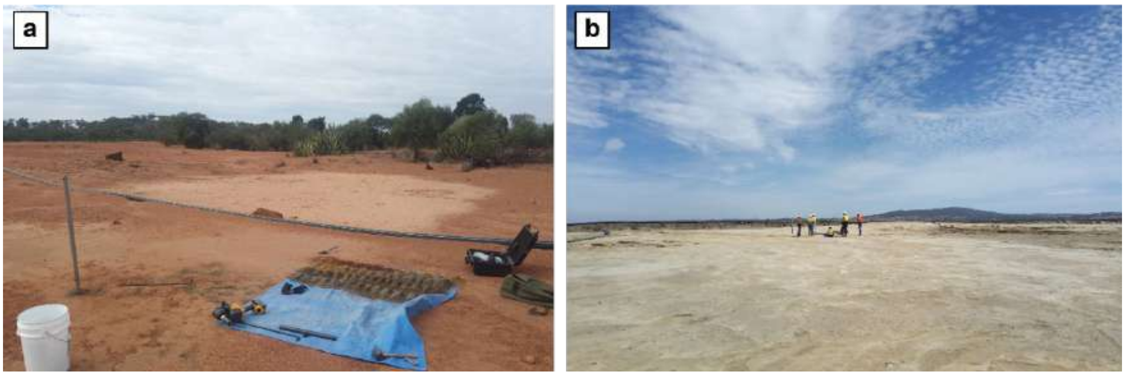

Figure 8. *Tailings storage facilities at Kanmantoo: a) old tailings storage facility; b) new tailings storage facilities.*

Five auger holes were drilled into the new tailings storage facility (Figure 9). Samples were collected to a maximum depth of 5 m. Holes were drilled around the tailings storage facility, to provide complete coverage of the tailings storage facility and to avoid the centre because of the potential instability associated with water pooling within the tailings storage facility. Five holes were drilled using a manual drilling method in the old tailings facility due to the denser subsurface material present in this area. Samples were collected to a maximum depth of 5.9 m. In total, 74 samples from 10 auger holes were collected (Figure 9; *Appendix A*). A visual catalogue of the samples and facies descriptions are given in *Appendix B*. The colour of the tailings collected from the old tailings storage facility exhibited greater variability throughout the vertical profile compared to those obtained from the new tailings storage facility (Figure 10). A summary of the sample collected is shown in Table 11.

Tailings from each hole of the two tailings storage facilities were logged, photographed, and subsampled based on different facies characteristics. To ensure quality standards were met, Certified Reference Material (CRM) OREAS 162 and 522 were inserted at a rate 1:15, in addition to those inserted by ALS (blanks and standards). Duplicates during the analysis of the samples and quality check results can be seen in the certificates (*Appendix C*).

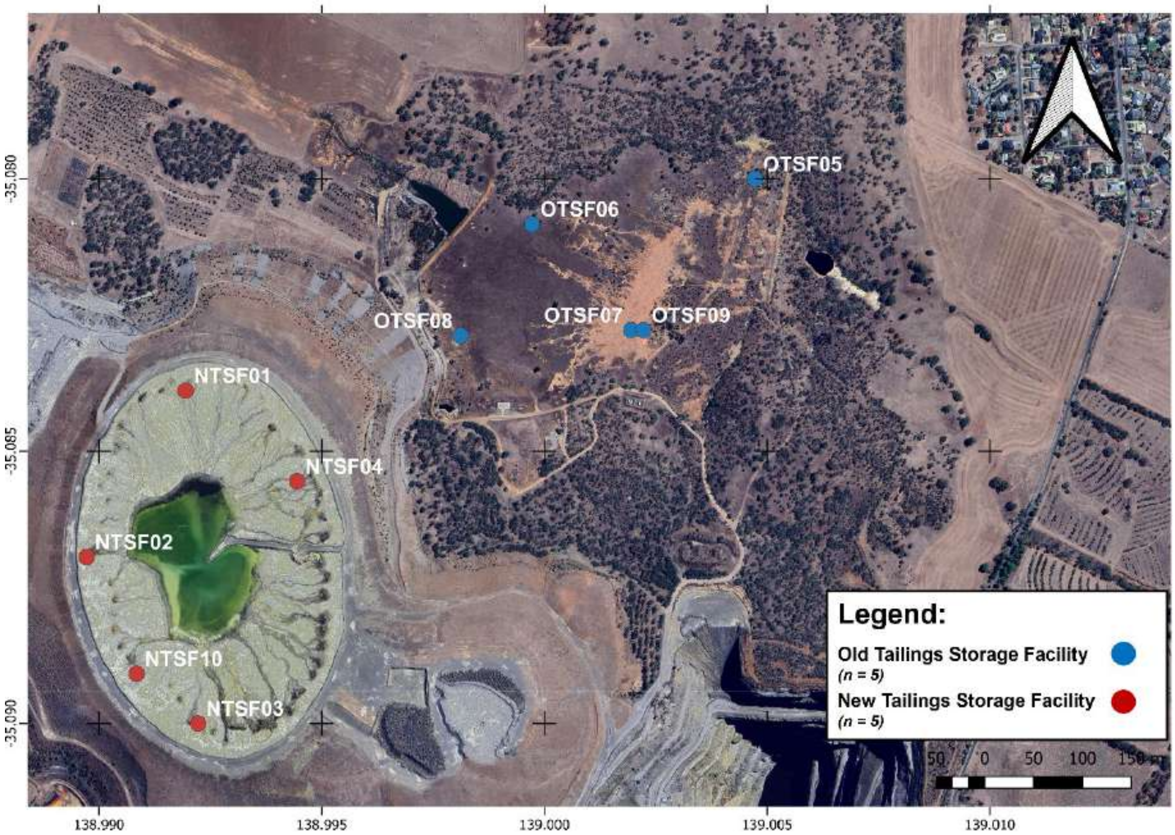

Figure 9. *Location of samples collected from the old tailings storage facility (blue dots) and the new tailings storage facility (red dots).*

Figure 10. Tailings samples from the a) new tailings storage facility and (b) the old tailings storage facility.

Table 11. Summary of samples collected from the two tailings storage facilities.

Hole number	Sample type	Number of samples
Hole 1	Tailings	7
Hole 2	Tailings	10
Hole 3	Tailings	9
Hole 4	Tailings	4
Hole 5	Tailings	11
Hole 6	Tailings	5
Hole 7	Tailings	10
Hole 8	Tailings	4
Hole 9	Tailings	8
Hole 10	Tailings	6
Total samples		74

After collection, the samples were brought to the Australian Laboratory Service (ALS) in Adelaide, where they were prepared for analysis. Wet samples were dried for at least 24 hours in an oven at 60 °C. Samples were then coarse crushed to 70 % passing 2 mm, then 250 g of the material were split and pulverised to 85 % passing 75 µm. Barren quartz was used to clean the crusher and pulveriser after each sample, to avoid contamination between samples. The pulverised portion was used for geochemical assaying and bulk mineralogy measurements, whilst the coarse rejects were used for in-situ mineralogical and mineral chemistry studies.

4.2 Geochemical assay

The prepared pulps were submitted to ALS Geochemistry for analysis using two different techniques. For ME-MS61 analysis, 0.25 g of pulps were digested in a combination of four acids namely HCl (hydrochloric acid), HNO_3 (nitric acid), HF (hydrofluoric acid) and $HClO_4$ (perchloric acid). The solution was then analysed for a full suite of major and trace elements by inductively coupled plasma mass spectrometry (ICP-MS). Lithium borate fusion (ALS ME-MS81) was used to determine concentrations of elements known to be refractory using traditional acid digests (e.g., REE, Zr, etc.), as certified in *Appendix C*. Fused beads were prepared by mixing lithium borate flux with 2 g of the pulverised sample. The bead is dissolved in acid prior to analysis by ICP-MS. Pulps (~30 g for better results) were pressed and analysed for the determination of Si, Ti and Zr by p-XRF (pXRF-34. A summary of element suites for each method and their detection limits is given in Table 12.

Table 12. *Analytical suited used and their limit of detection range (ALS Global).*

ME-MS61	**Analyte**	**Ag (ppm)**	**Al (%)**	**As (ppm)**	**Ba (ppm)**	**Be (ppm)**	**Bi (ppm)**	**Ca (%)**	**Cd (ppm)**	**Ce (ppm)**	**Co (ppm)**
	Lower LOD	0.01	0.01	0.2	10	0.05	0.01	0.01	0.02	0.01	0.01
	Upper LOD	100	50	10,000	10,000	1,000	10,000	50	1,000	500	10,000
	Analyte	**Cr (ppm)**	**Cs (ppm)**	**Cu (ppm)**	**Fe (%)**	**Ga (ppm)**	**Ge (ppm)**	**Hf (ppm)**	**In (ppm)**	**K (%)**	**La (ppm)**
	Lower LOD	1	0.05	0.2	0.01	0.05	0.05	0.1	0.005	0.01	0.5
	Upper LOD	10,000	500	10,000	50	10,000	500	500	500	10	10,000
	Analyte	**Li (ppm)**	**Mg (%)**	**Mn (ppm)**	**Mo (ppm)**	**Na (%)**	**Nb (ppm)**	**Ni (ppm)**	**P (ppm)**	**Pb (ppm)**	**Rb (ppm)**
	Lower LOD	0.2	0.01	5	0.05	0.01	0.1	0.2	10	0.5	0.1
	Upper LOD	10,000	50	100,000	10,000	10	500	10,000	10,000	10,000	10,000
	Analyte	**Re (ppm)**	**S (%)**	**Sb (ppm)**	**Sc (ppm)**	**Se (ppm)**	**Sn (ppm)**	**Sr (ppm)**	**Ta (ppm)**	**Te (ppm)**	**Th (ppm)**
	Lower LOD	0.002	0.01	0.05	0.1	1	0.2	0.2	0.05	0.05	0.01
	Upper LOD	50	10	10,000	10,000	1,000	500	10,000	100	500	10,000
	Analyte	**Ti (%)**	**Tl (ppm)**	**U (ppm)**	**V (ppm)**	**W (ppm)**	**Y (ppm)**	**Zn (ppm)**	**Zr (ppm)**		
	Lower LOD	0.005	0.02	0.1	1	0.1	0.1	2	0.5		
	Upper LOD	10	10,000	10,000	10,000	10,000	500	10,000	500		
ME-MS81	**Analyte**	**Ba (ppm)**	**Ce (ppm)**	**Cr (ppm)**	**Cs (ppm)**	**Dy (ppm)**	**Er (ppm)**	**Eu (ppm)**	**Ga (ppm)**	**Gd (ppm)**	**Hf (ppm)**
	Lower LOD	0.5	0.1	10	0.01	0.05	0.03	0.02	0.1	0.05	0.1
	Upper LOD	10,000	10,000	10,000	10,000	1,000	1,000	1,000	1,000	1,000	1,000
	Analyte	**Ho (ppm)**	**La (ppm)**	**Lu (ppm)**	**Nb (ppm)**	**Nd (ppm)**	**Pr (ppm)**	**Rb (ppm)**	**Sm (ppm)**	**Sn (ppm)**	**Sr (ppm)**
	Lower LOD	0.01	0.1	0.01	0.1	0.1	0.02	0.2	0.03	1	0.1
	Upper LOD	1,000	10,000	1,000	2,500	10,000	1,000	10,000	1,000	10,000	10,000
	Analyte	**Ta (ppm)**	**Tb (ppm)**	**Th (ppm)**	**Tm (ppm)**	**U (ppm)**	**V (ppm)**	**W (ppm)**	**Y (ppm)**	**Yb (ppm)**	**Zr (ppm)**
	Lower LOD	0.1	0.01	0.05	0.01	0.05	5	1	0.1	0.03	2
	Upper LOD	2,500	1,000	1,000	1,000	1,000	10,000	10,000	10,000	1,000	10,000
pXRF-34	**Analyte**	**Si (%)**	**Ti (%)**	**Zr (ppm)**							
	Lower LOD	0.5	0.1	5							
	Upper LOD	47	60	50,000							

4.3 X-ray diffractometry (XRD)

Ten samples with the highest Ag, Bi, Co, S, Fe and Mn values were chosen for further mineralogy studies (Table 13). They were sent to Sietronics Laboratory Services (ACT) for X-ray diffraction (XRD) analysis. Specimens are initially ground to a powder using a ring mill or hand-grinded using mortar and pestle. A 2 g sub-sample is then split off and micronized using a McCrone® mill with agate beads and ethanol, then dried. Each sample was accurately weighed and spiked with 20 wt.% corundum for determination of amorphous or poorly diffracting material. The resultant homogenous powders were back-pressed into sample holders.

Table 13. *Samples selected for XRD and MLA mineralogical investigations.*

Sample	Sample type	Tailings facies	Rationale
KA07	New Tailings	Hole 1	High Co and Mn across Hole 1
KA12	New Tailings	Hole 2	High Co, Al and Mn
KA22	New Tailings	Hole 3	High Cu and Co
KA33	Old Tailings	Hole 5	Highest Bi across all samples
KA35	Old Tailings	Hole 5	Highest Ag and Fe across all samples, high Bi
KA51	Old Tailings	Hole 7	Highest Co and S across all samples
KA53	Old Tailings	Hole 7	Highest Mn across all samples
KA62	Old Tailings	Hole 8	High Ag, Co and Ni
KA65	Old Tailings	Hole 9	High Bi and Mn
KA77	New Tailings	Hole 10	High Mn and Co

4.4 Mineral liberation analysis (MLA)

Automated mineralogy tools such as the mineral liberation analyser (MLA), Quantitative Evaluation of Minerals by Scanning electron microscopy (QEMSCAN) and the Tescan TIMA uniquely combine back scattered electron (BSE) image analysis, X-ray mineral identification and advanced imaging and pattern recognition analysis to produce classified mineralogy outputs (Parbhakar-Fox & Lottermoser, 2015). Primary applications of these technologies have been to collect modal mineralogy data through point counting methods, and to characterise target mineral phases in terms of their size, shape, liberation characteristics and mineral associations.

The 10 samples most endowed in Ag, Cu, Co, Ni, Bi, As, In, Mn, Fe, Sc, and S (Table 13) were analysed at the Sustainable Minerals Institute, University of Queensland MLA lab. As there was a wide range of particle sizes present, MLA samples were prepared using the vertical mounting method. For this type of mount the sample is mixed in a mould with graphite and epoxy, cured then sectioned and remounted in the standard 30 mm round mould. Once the vertical mount has cured the surface is then ground back and polished to give a high-quality finish prior to carbon coating.

The XBSE measurement mode (which uses a combination of backscattered electrons and X-rays to identify phases present in the sample) was used to provide information of the relative abundance of the minerals in the sample and identify potential hosts of key elements.

Due to a wide range of particle sizes, measurements were undertaken using two approaches: the first without setting a minimum particle size and setting the maximum particles measured to 30,000 (this method can be used for modal mineralogy but did not measure the full sample section); the second measurement was done to image to the full particle section and capture the coarse particles (for this measurement a minimum particle size was set to exclude fine particulates, this measurement should not be used for modal mineralogy). A site-specific mineral reference library was developed for these samples. All results were processed in-house using Dataview software.

4.5 Laser ablation ICPMS (LA-ICP-MS)

Laser ablation analyses was carried out at Adelaide Microscopy, University of Adelaide, using a RESOlution-SE laser platform, equipped with an ATL 193 nm excimer laser and S155 large format sample cell, coupled to an Agilent 8900 quadrupole ICP-MS. The laser operating parameters were optimized for sulfide analysis using a fluence of ~3 J/cm^2, and 5 Hz laser repetition rate. Samples were ablated in an atmosphere of pure helium flowing through the sample cell at a rate of ~ 0.38 L/min and immediately mixed with ~ 1 L/min argon in the exit funnel before flowing on to the ICP-MS. The ICP-MS instrument was optimized to maximise sensitivity on mid- to high-masses, production of molecular oxide interferences (i.e., 232Th16O+/232Th+) and doubly charged ion interferences (i.e., 140Ce++/140Ce+), with both interferences maintained at levels < 0.2 %.

Many element isotopes were measured to capture the trace element contents of the targeted minerals and to reveal minerals other than the target that might be ablated during analysis, e.g., as mineral inclusions or in minerals adjacent to the target. For each spot analysis, the background signal is recorded for 30 seconds, then the laser is turned on and the targeted mineral is ablated while the ICP-MS collects data for each element for ~40 seconds.

During spot analysis, the material analysed was typically dominated by the targeted mineral. Element signals that show no changes, gradual smooth changes, or changes consistent with chemical zonation are interpreted to be chemically bound into the target mineral structure. However, lasering through evenly distributed 'invisible' micro-inclusions may also show no or gradual changes in the signal and are therefore indistinguishable from 'true' chemical substitution into the mineral structure. Both types of occurrences are referred to as refractory. Elements that have signals with discrete, sharp changes in the laser signal, and can sometimes reach a sufficient level to dilute target major element signals are interpreted as being hosted in mineral inclusions or in minerals adjacent to the target.

To calculate concentrations, the average of the signal over the time interval of interest is calibrated against reference standards STDGL3 (a sulfide-rich glass for primary calibration for quantifying siderophile and chalcophile elements after Danyushevsky et al. 2011) and glass GSD-1G (USGS).

The laser spot size used for mineral grains of interest was 24 µm, while 50 µm and 64 µm were used for GSD-1G and NIST1612 primary standard glasses, respectively. Data reduction was performed using the LADR software package (Norris Scientific). In total 329 laser ablation spot analyses passed quality control and filtering (n= 314 spots in garnet, n = 12 spots in pyrite, n = 3 spots in pyrrhotite).

5. Results

5.1 Bulk geochemistry

Bulk-rock geochemical data from the Kanmantoo new tailings storage facility show that the tailings are relatively enriched in critical metals such as **Bi**, **Cu**, **Mn**, **Co**, **In, Te** and **Se** often >10 times the average crustal abundance (Figure 11). Similarly, bulk-rock geochemical data from the Kanmantoo old tailings storage facility reveal an enrichment in metal(loid)s such as **Ag, As, Cu, Mn, Co, Bi, In, Se, Te** and **W** (Figure 12).

Statistical parameters for bulk-rock composition of the sampled waste from both tailings storage facilities are summarised in Figures 13 and 14 and Table 14. The new tailings storage facility contains maximum concentrations of abundant critical metals, such as Mn (3,880 ppm), Co (128 ppm), Cu (1,085 ppm) Bi (88.6 ppm) and Rb (134 ppm). The old tailings storage facility is relatively enriched in the same metals, with maximum concentrations of 6,730 ppm for Mn, 131 ppm for Co, 447 ppm for Bi, 2,700 ppm for Cu and 166 ppm for Rb.

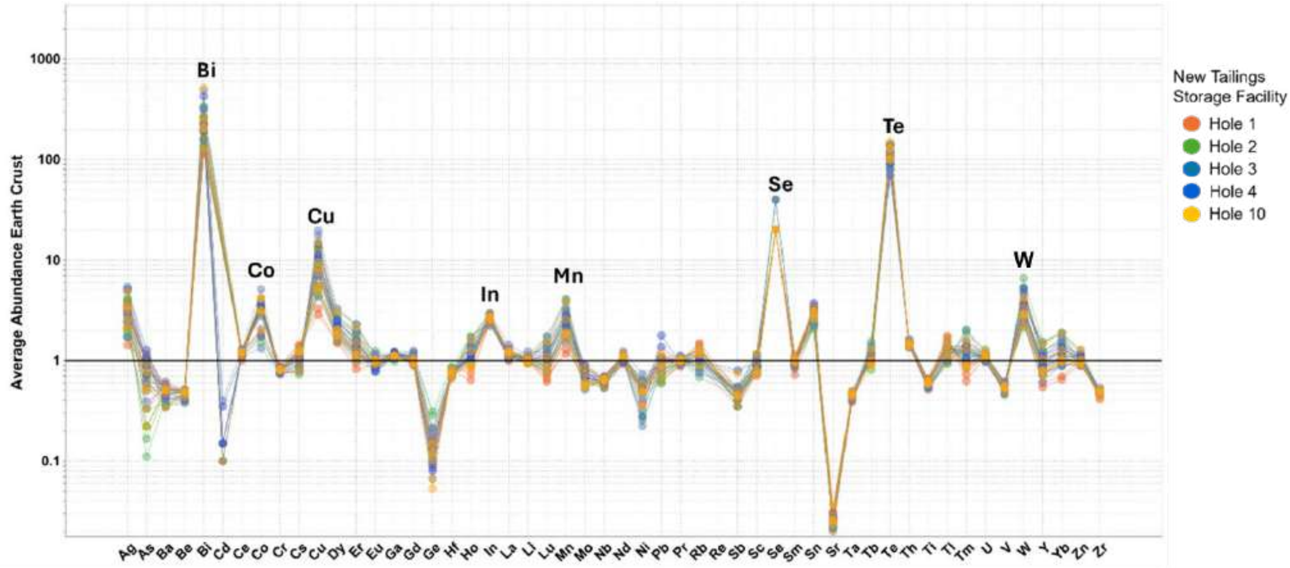

Figure 11. *Bulk chemistry summary for the sampled new tailings storage facility at Kanmantoo (n=36) compared to average crustal abundance values (Levinson, 1974).*

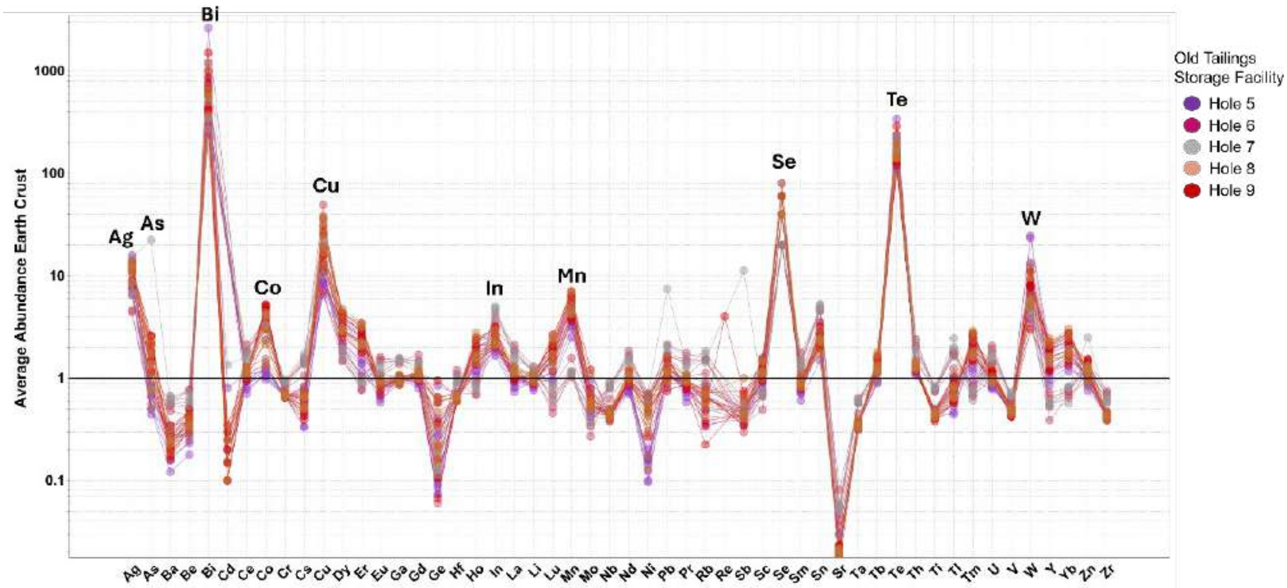

Figure 12. *Bulk chemistry summary for the sampled old tailings storage facility at Kanmantoo (n=38) compared to average crustal abundance values (Levinson, 1974).*

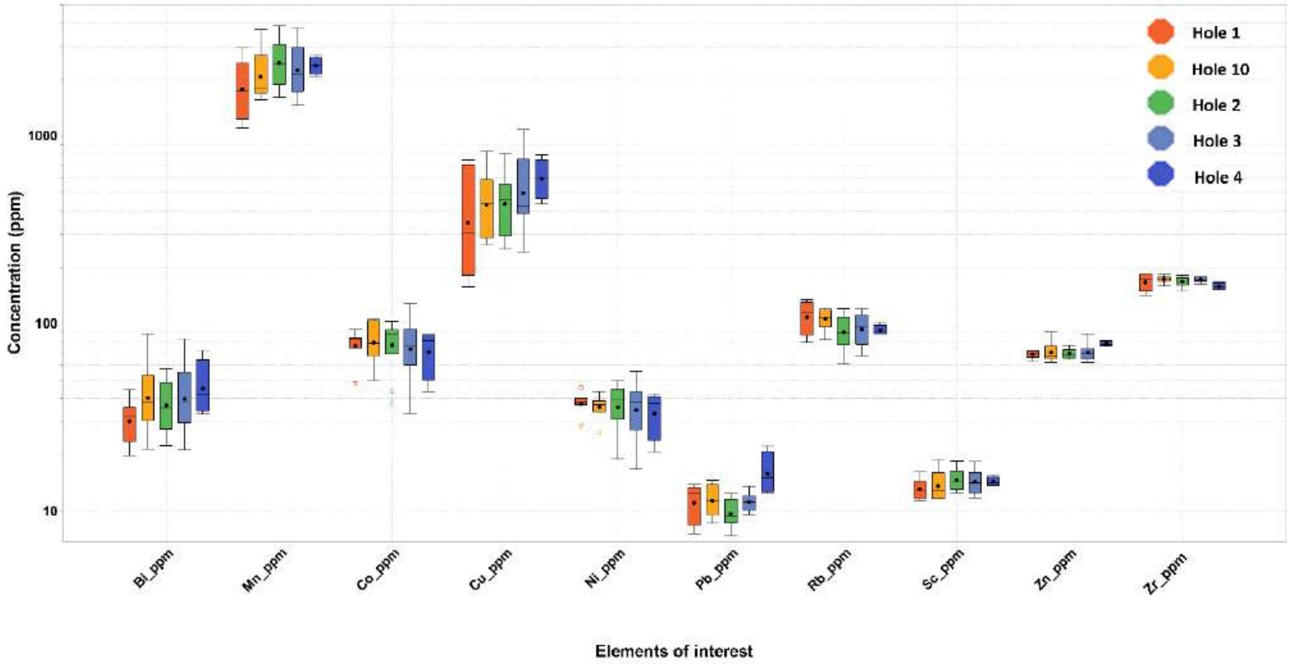

Figure 13. *Tukey boxplot for selected elements measured in the new tailings storage facility.*

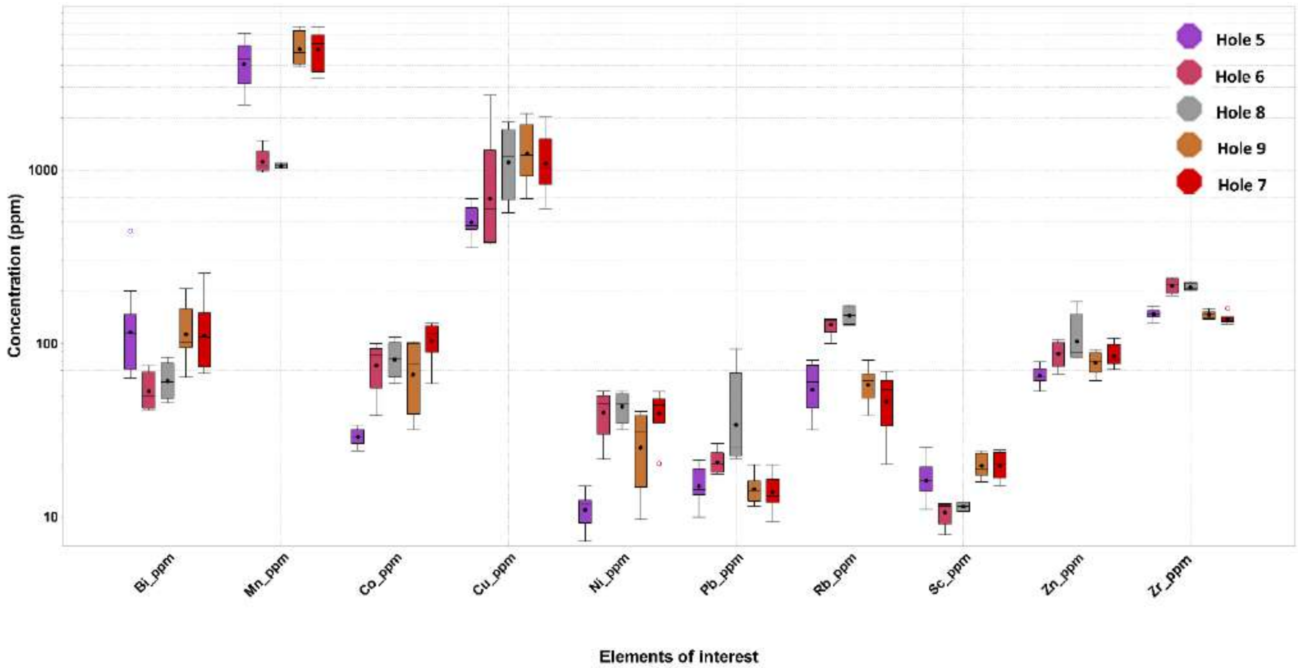

Figure 14. *Tukey boxplot for selected elements measured in the old tailings storage facility.*

__Table 14.__ Summary statistics for selected elements measured in Kanmantoo tailings (n = 74).

	Al (ptc)	Ag (ppm)	As (ppm)	Bi (ppm)	Co (ppm)	Cu (ppm)	S (ptc)	Fe (ptc)	Mn (ppm)	Mg (ppm)	P (ppm)	In (ppm)	Ni (ppm)	Sc (ppm)	Pb (ppm)	Rb (ppm)	Zn (ppm)	Zr (ppm)	LREE (ppm)	HREE (ppm)
New Tailings Storage Facility (n = 36)																				
Minimum	6.1	0.1	0.2	20	33	157	0.4	9	1,110	24	520	0.2	17	11	7.4	61	62	142	134	34
Maximum	7.7	0.4	2.3	89	128	1,085	1.2	16	3,880	1.3	660	0.3	56	19	22	134	90	184	180	86
Mean	6.6	0.2	1.3	40	79	491	0.8	12	2,290	1.7	591	0.3	37	14	11	99	71	168	157	56
Median	6.6	0.2	1.3	35	82	439	0.8	12	2,135	1.5	590	0.3	38	14	11	101	69	169	158	53
Old Tailings Storage Facility (n = 38)																				
Minimum	5.2	0.3	0.8	41	24	356	0.2	9.8	973	0.9	450	0.2	7.3	7.9	9.4	20	53	130	98	33
Maximum	8.0	1.1	40	447	131	2,700	1.7	22	6,730	2.4	850	0.5	53	25	93	166	174	240	279	128
Mean	6.8	0.7	3.1	111	71	986	0.8	16	3,902	1.3	568	0.3	30	17	18	74	81	161	158	76
Median	6.8	0.7	1.5	95	80	796	0.6	16	4,165	1.1	520	0.2	34	17	15	62	78	147	144	78

The downhole plots in Figures 15 to 18 display correlations of selected elements for specific holes at Kanmantoo. In these profiles, Cu shows a strong correlation with Fe and S. Cobalt is also correlated with S, though to a lesser degree, particularly in hole 4 and hole 6, which are from the new and old tailings storage facilities, respectively (Figures 15-16). Iron follows a similar downhole pattern to Al, Mn, Bi and REE's, with a stronger correlation for HREE than REE (Figures 17-18). Bismuth also shows similar downhole trends to Fe and S (*Appendix D*). In addition, magnesium and K are correlated with Rb (*Appendix D*).

Geochemical correlations in ioGAS were further investigated through correlation matrices for specific elements in tailings samples from the old and new tailings storage facilities (Tables 15 and 16). The correlation diagrams, illustrated in Figure 19, reveal notable geochemical associations, including but not limited to Mg-Rb, LREE-Zr, Ni-Co-S and Fe-Al-Mn-Cu-Sc-Bi-Zn. These associations suggest possible mineralogical compositions within the weathered tailings. Sulfides are a potential host of Cu, Co and Ni (Table 15; Figures 19; 20a-b-c-d). Rare earth elements such as Sc and particularly HREE are associated with Fe, Al and Mn, suggesting silicates (e.g., garnets) may be a potential host (Table 15; Figures 19, 20e-f). In contrast, LREE are strongly associated with zirconium (Table 15; Figures 19, 20g). The strong correlation between Rb with Mg (and K) may be associated with the presence of Rb within the layered structure of micas, such as biotite (Figure 20h; *Appendix D*).

Bulk-rock geochemical data obtained from the Kanmantoo old tailings storage facility are presented as a correlation matrix in Table 16. The accompanying correlation diagrams, depicted in Figure 21, highlight significant geochemical associations, such as Mg-P-Rb-Zr-LREE, Co-Ni-Zn and Fe-Mn-HREE-Sc-Bi. The lower correlation observed for Fe and Cu with S suggests post-depositional weathering of sulfides (Table 16, Figures 21, 22a-c). The high correlation of REE with Mn and Fe suggests that these elements occur associated with Mn and Fe minerals (Table 16; Figures 21, 22e-f). Downhole correlation trends for the selected elements are similar to those identified in the new tailings storage facility, except for the positive correlation of Fe with Bi (Figure 22b), and the lack of correlation between Fe and Cu. Overall, bivariate plots results are consistent with downhole geochemical data.

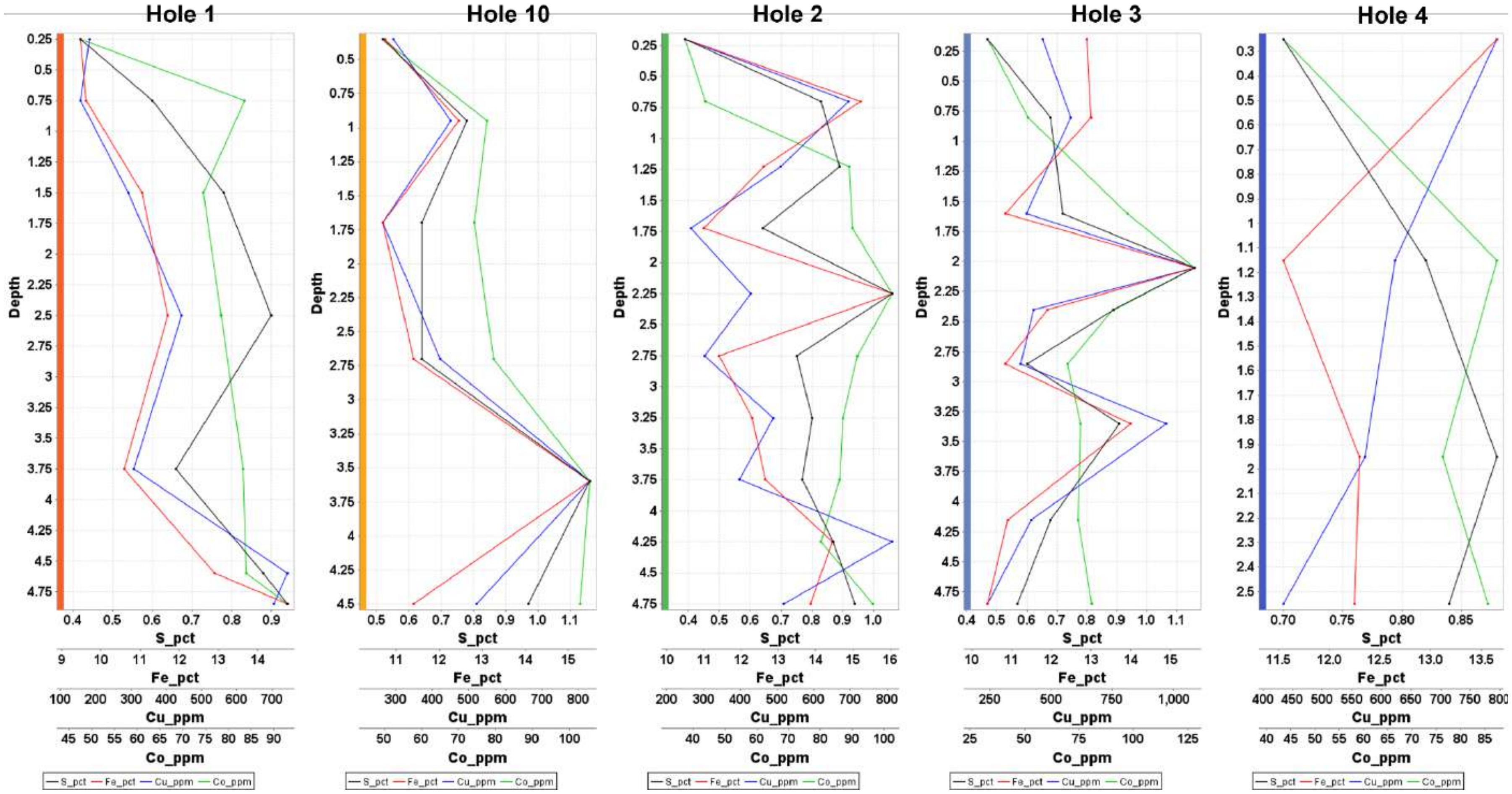

Figure 15. *Downhole plots of S (%), Fe (%), Cu (ppm) and Co (ppm) in tailings samples from the Kanmantoo new tailings storage facility against depth.*

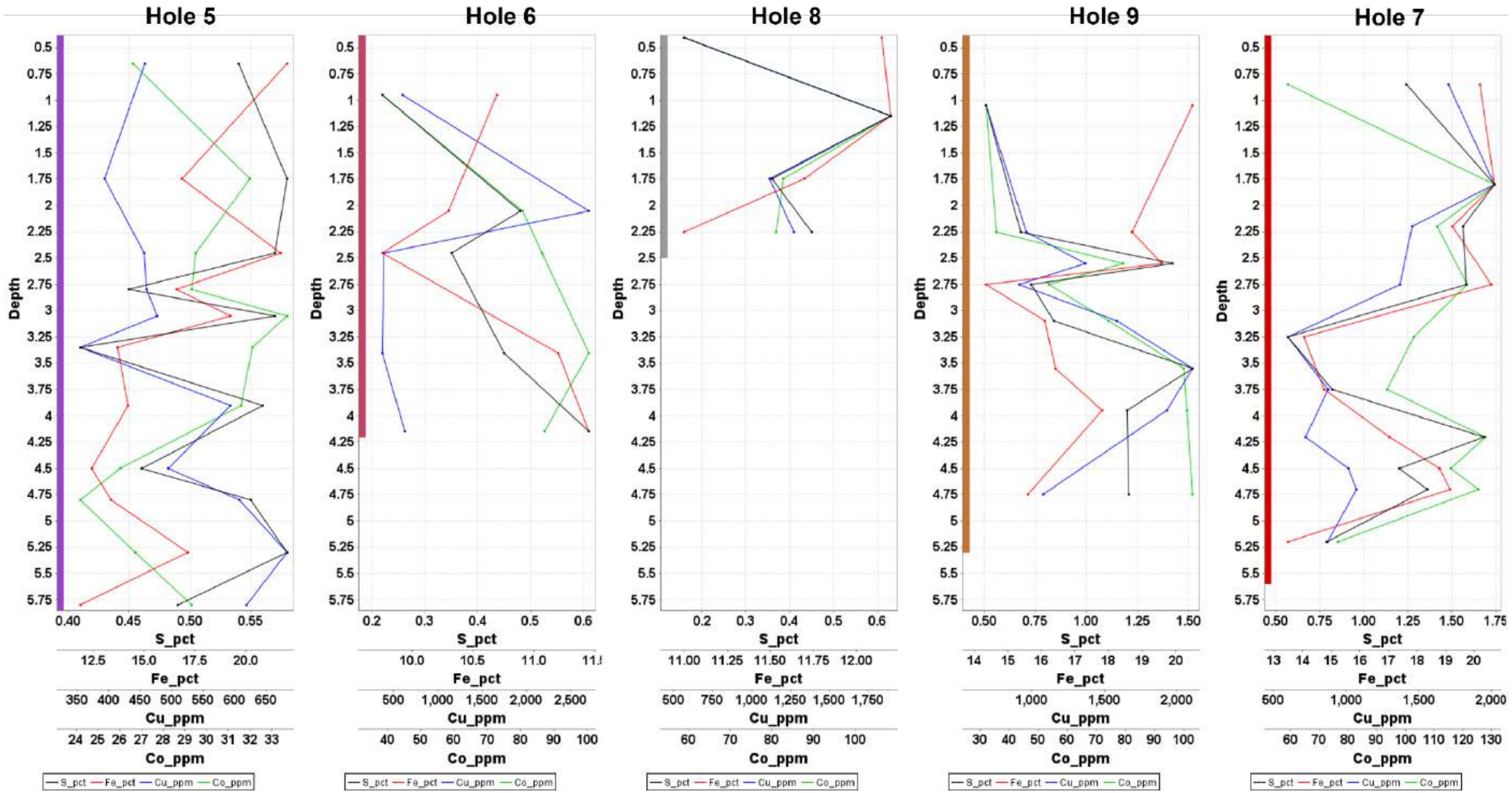

Figure 16. *Downhole plots of S (%), Fe (%), Cu (ppm) and Co (ppm) in tailings samples from the Kanmantoo old tailings storage facility against depth.*

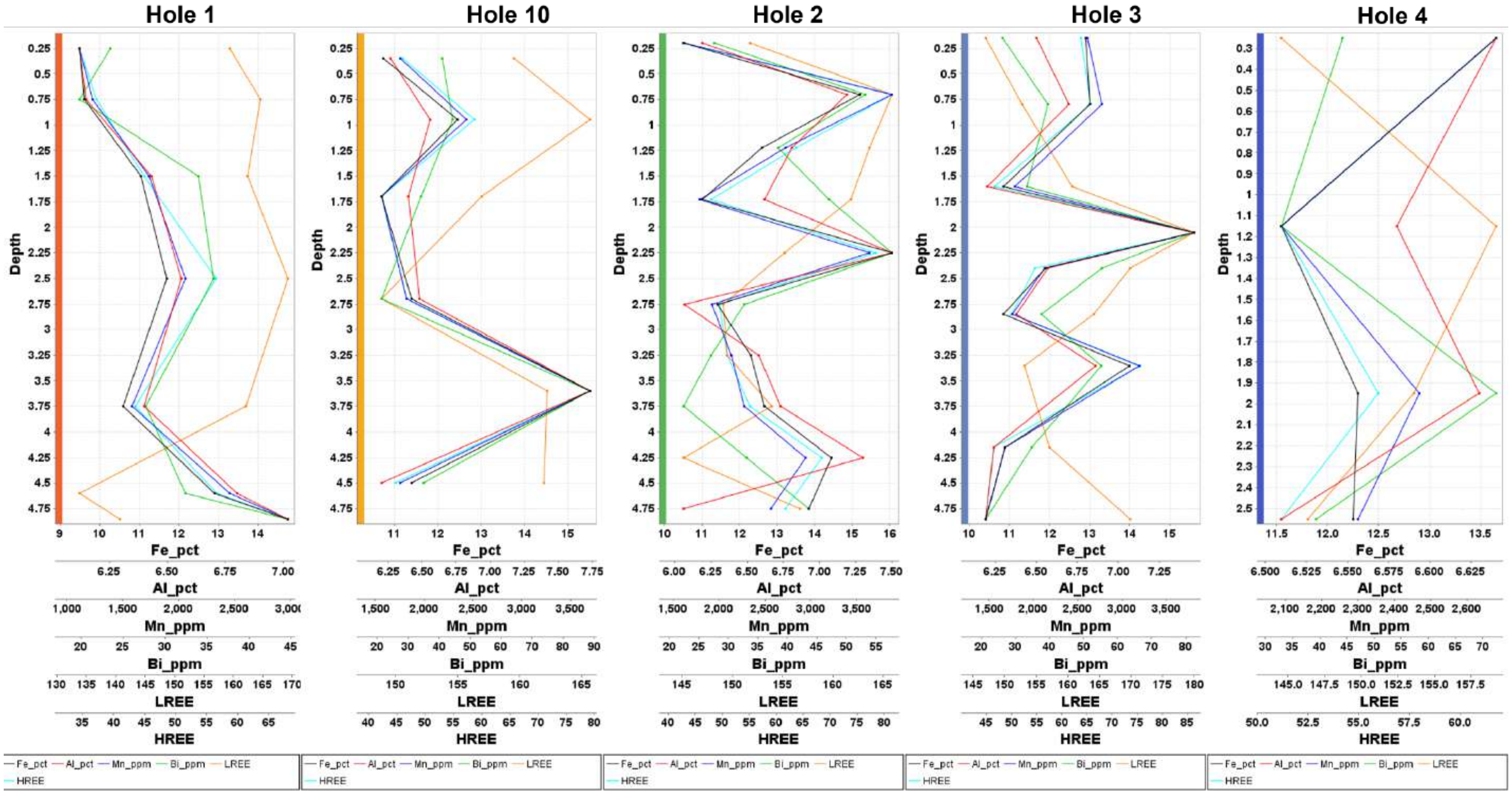

__Figure 17.__ Downhole plots of Fe (%), Al (%), Mn (ppm), Bi (ppm), LREE (ppm) and HREE (ppm) in tailings samples from the Kanmantoo new tailings storage facility against depth.

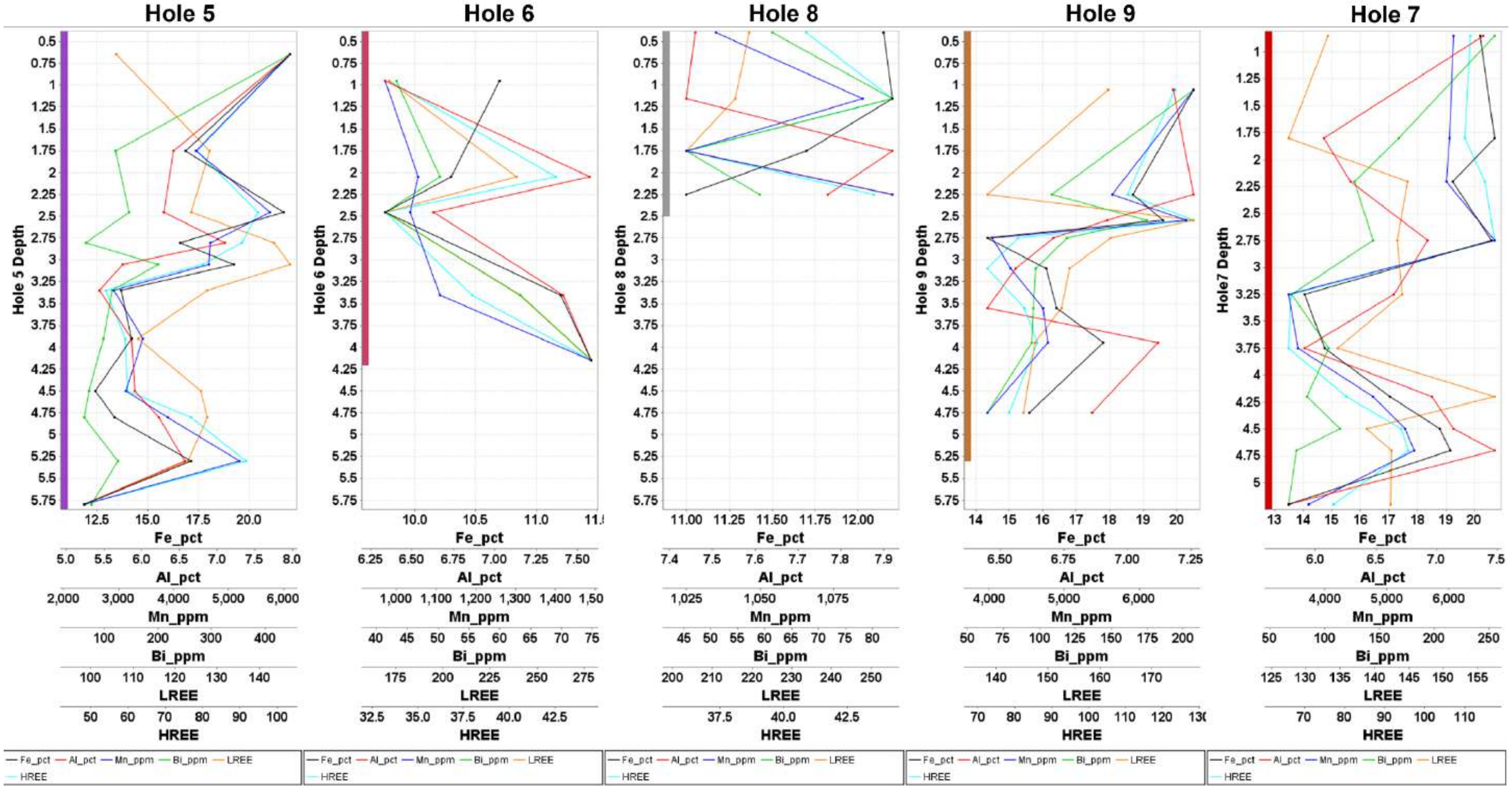

Figure 18. *Downhole plots of Fe (%), Al (%), Mn (ppm), Bi (ppm), LREE (ppm) and HREE (ppm) in tailings samples from the Kanmantoo old tailings storage facility against depth.*

Table 15. *Correlation matrix for selected elements measured in the Kanmantoo new tailings storage facility (n=36).*

	Bi	Co	Cu	S	Fe	Mn	Mg	Al	P	Ni	Sc	Rb	Zn	Zr	LREE	HREE
Bi	1.00															
Co	0.37	1.00														
Cu	0.62	0.25	1.00													
S	**0.70**	**0.74**	0.69	1.00												
Fe	0.66	0.27	**0.80**	**0.74**	1.00											
Mn	**0.72**	0.21	**0.81**	**0.71**	**0.98**	1.00										
Mg	-0.50	-0.01	-0.77	-0.46	-0.78	-0.79	1.00									
Al	0.68	0.30	**0.72**	0.68	**0.86**	**0.87**	-0.49	1.00								
P	0.55	0.19	0.08	0.30	0.28	0.36	-0.01	0.44	1.00							
Ni	0.27	**0.93**	0.07	0.55	0.08	0.05	0.22	0.21	0.24	1.00						
Sc	**0.72**	0.18	**0.78**	0.66	**0.94**	**0.97**	-0.69	**0.91**	0.41	0.07	1.00					
Rb	-0.51	-0.32	-0.78	-0.68	-0.85	-0.82	**0.85**	-0.56	-0.05	-0.13	-0.71	1.00				
Zn	**0.75**	0.41	0.54	0.61	0.50	0.53	-0.26	0.63	0.48	0.41	0.57	-0.34	1.00			
Zr	0.09	0.00	-0.35	-0.16	-0.32	-0.21	0.33	-0.21	0.50	0.11	-0.18	0.41	-0.03	1.00		
LREE	0.28	0.27	-0.14	0.12	-0.15	-0.06	0.25	-0.01	0.53	0.32	-0.03	0.25	0.16	**0.83**	1.00	
HREE	**0.71**	0.22	**0.82**	**0.70**	**0.96**	**0.99**	-0.79	**0.86**	0.34	0.06	**0.97**	-0.81	0.52	-0.16	0.01	1.00

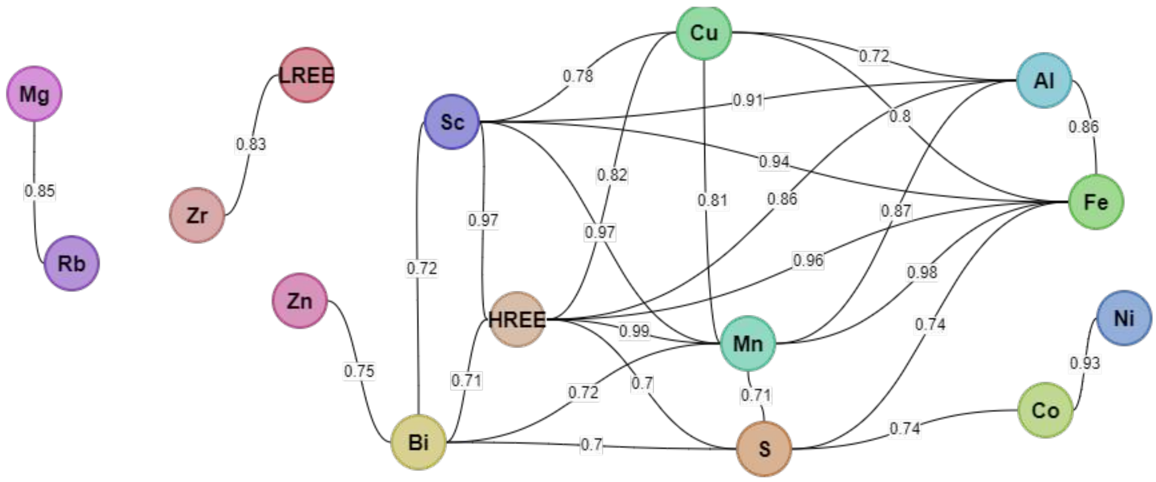

Figure 19. *Correlation diagram (r > 0.7) for selected elements measured in the Kanmantoo new tailings storage facility (n=36). Diagram plotted in EzCorrGraph (Campos & Licht, 2021).*

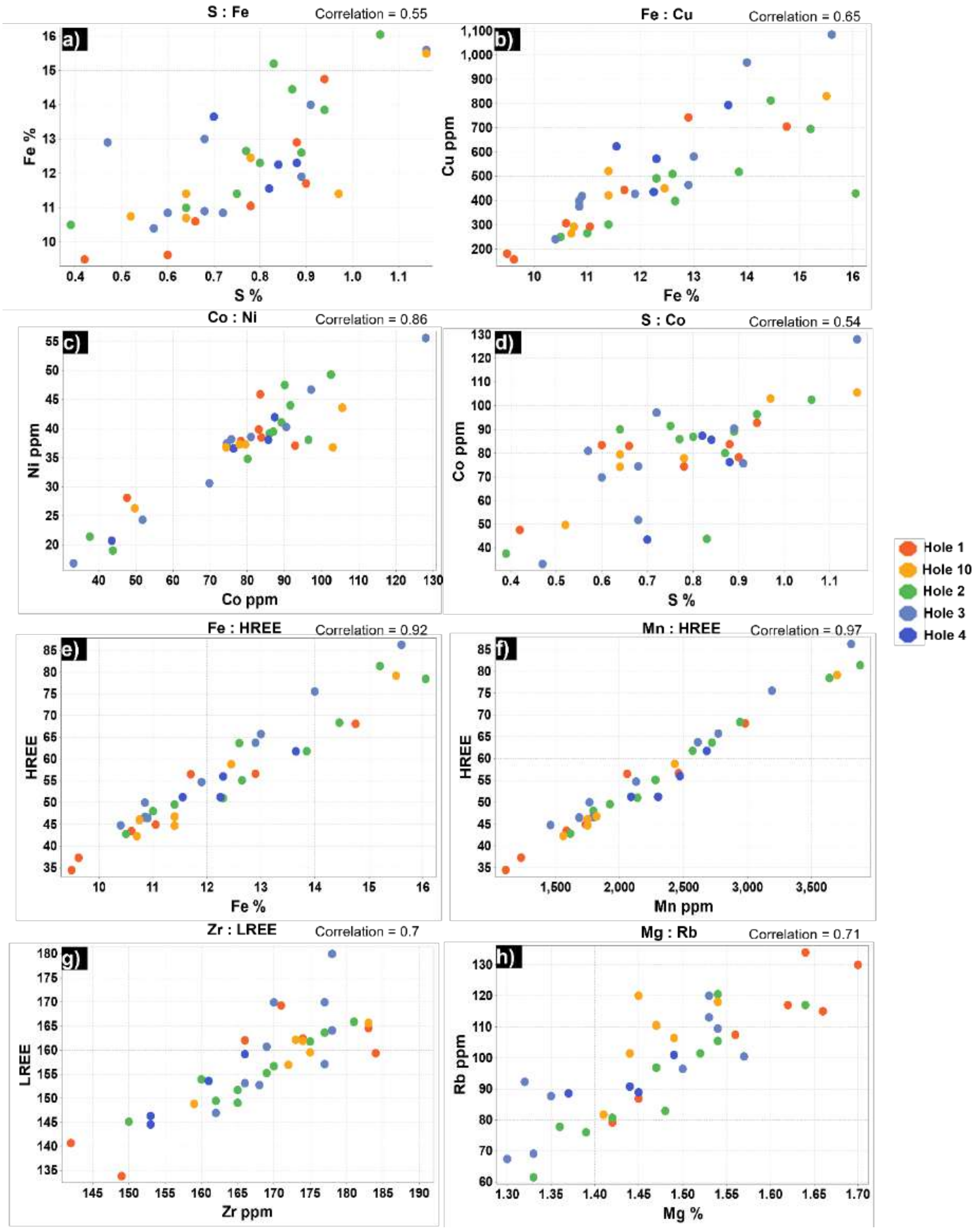

Figure 20. *Bivariate plots for select elements for the Kanmantoo new tailings storage facility (n = 36); a): S (%) vs. Fe (%); b) Fe (%) vs. Cu (ppm); c): Co (ppm) vs. Ni (ppm); d): S (%) vs. Co (ppm); e): Fe (%) vs. HREE (ppm); f): Mn (ppm) vs. HREE (ppm); g): Zr (ppm) vs. LREE (ppm); h): Mg (%) vs. Rb (ppm).*

Table 16. *Correlation matrix for selected elements measured in the Kanmantoo old tailings storage facility (n=38).*

	Bi	Co	Cu	S	Fe	Mn	Mg	Al	P	Ni	Sc	Rb	Zn	Zr	LREE	HREE
Bi	1.00															
Co	-0.23	1.00														
Cu	-0.02	0.53	1.00													
S	0.18	0.67	0.53	1.00												
Fe	**0.71**	0.04	0.11	0.59	1.00											
Mn	0.62	0.00	0.10	0.64	**0.95**	1.00										
Mg	-0.43	0.18	0.06	-0.49	-0.73	-0.86	1.00									
Al	0.13	0.29	0.26	-0.01	0.03	-0.10	0.52	1.00								
P	-0.27	0.18	0.10	-0.40	-0.55	-0.69	**0.91**	0.63	1.00							
Ni	-0.39	**0.92**	0.54	0.44	-0.26	-0.29	0.47	0.40	0.46	1.00						
Sc	0.67	0.10	0.22	0.64	**0.93**	**0.95**	-0.72	0.10	-0.52	-0.16	1.00					
Rb	-0.56	0.11	0.03	-0.54	-0.85	-0.91	**0.94**	0.42	**0.85**	0.43	-0.79	1.00				
Zn	-0.36	0.60	0.39	0.14	-0.35	-0.40	0.52	0.39	0.39	**0.70**	-0.32	0.49	1.00			
Zr	-0.43	0.12	0.03	-0.45	-0.69	-0.80	**0.91**	0.45	**0.94**	0.41	-0.69	**0.90**	0.42	1.00		
LREE	-0.37	0.32	0.22	-0.24	-0.54	-0.63	**0.83**	0.59	**0.89**	0.56	-0.48	**0.80**	0.53	**0.89**	1.00	
HREE	0.60	0.05	0.18	0.64	**0.92**	**0.98**	-0.78	0.01	-0.59	-0.21	**0.97**	-0.84	-0.33	-0.72	-0.51	1.00

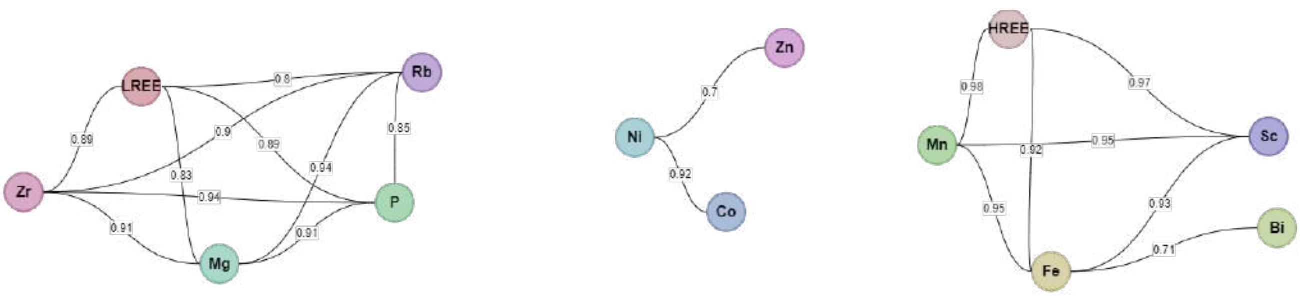

Figure 21. *Correlation diagram (r > 0.7) for selected elements measured in the Kanmantoo new tailings storage facility (n=38). Diagram plotted in EzCorrGraph (Campos & Licht, 2021).*

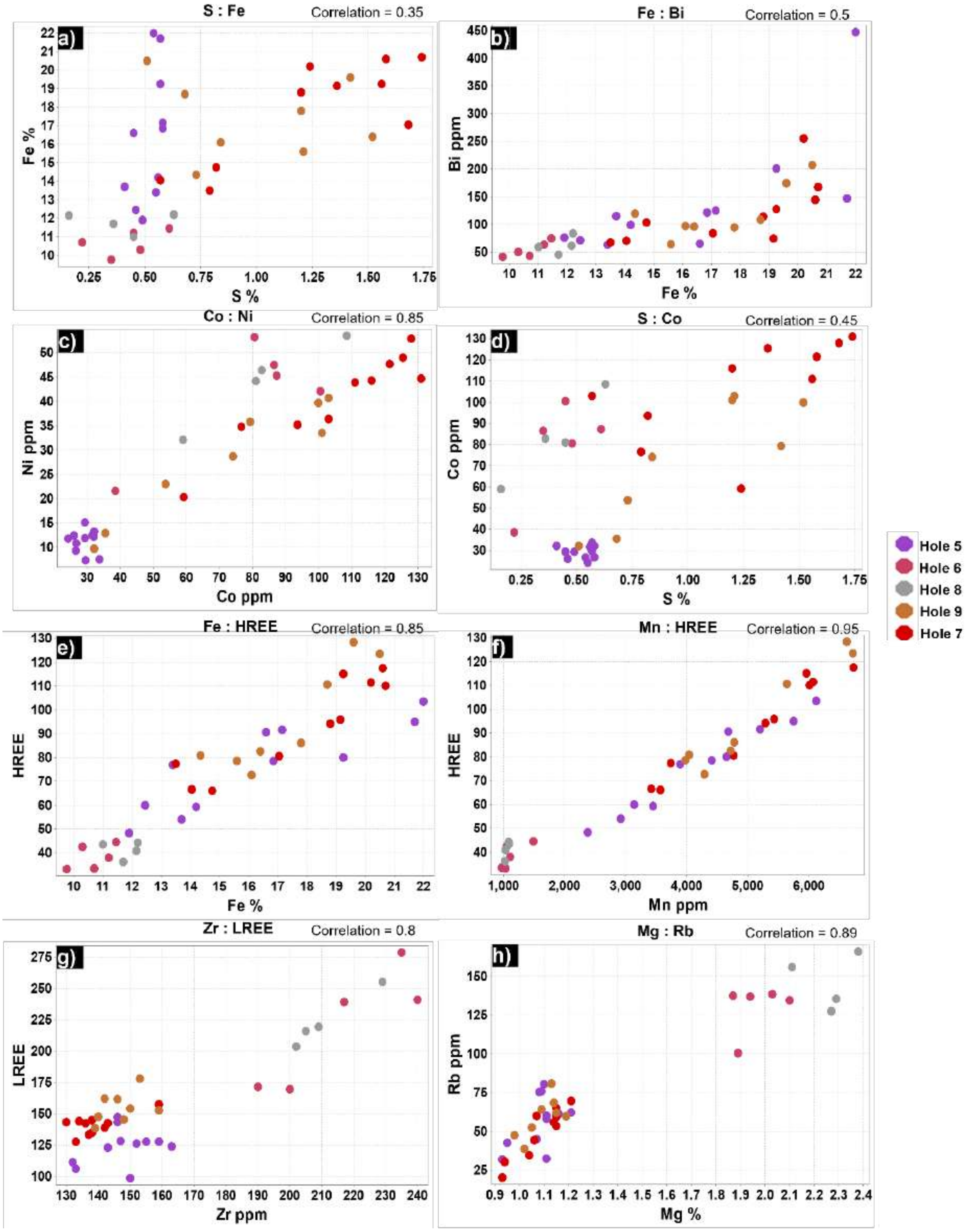

Figure 22. *Bivariate plots for select elements for the Kanmantoo new tailings storage facility (n = 38); a): S (%) vs. Fe (%); b) Fe (%) vs. Bi (ppm); c): Co (ppm) vs. Ni (ppm); d): S (%) vs. Co (ppm); e): Fe (%) vs. HREE (ppm); f): Mn (ppm) vs. HREE (ppm); g): Zr (ppm) vs. LREE (ppm); h): Mg (%) vs. Rb (ppm).*

Spatial plots for the Kanmantoo site (Figures 23 to 26) reveal differing distribution trends between the new and old tailings storage facilities. The old tailings storage facility shows notably higher concentrations of most analysed metals. Copper concentration reaches up to 2,700 ppm (hole 6), Mn concentration is up to 6,730 ppm (hole 7), and Bi values are up to 447 ppm (hole 5).

In contrast, the new tailings storage facility exhibits lower concentrations of most metals of interest compared to the old tailings storage facility, except for Cu and Co. Copper concentrations reach up to 1,085 ppm (hole 3), and cobalt concentrations are up to 128 ppm (hole 3).

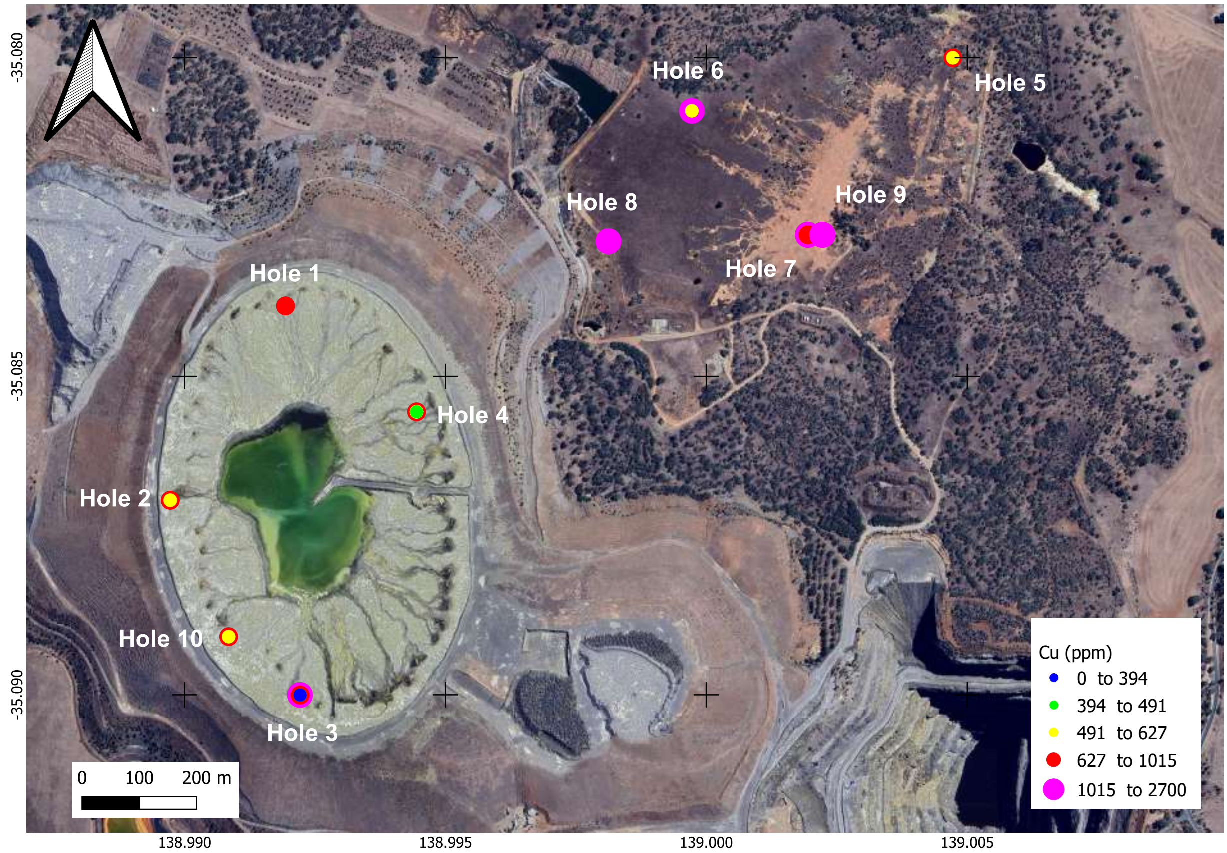

Figure 23. *Spatial distribution of highest Cu values (ppm) across the Kanmantoo mine site.*

Figure 24. *Spatial distribution of highest Mn values (ppm) across the Kanmantoo mine site.*

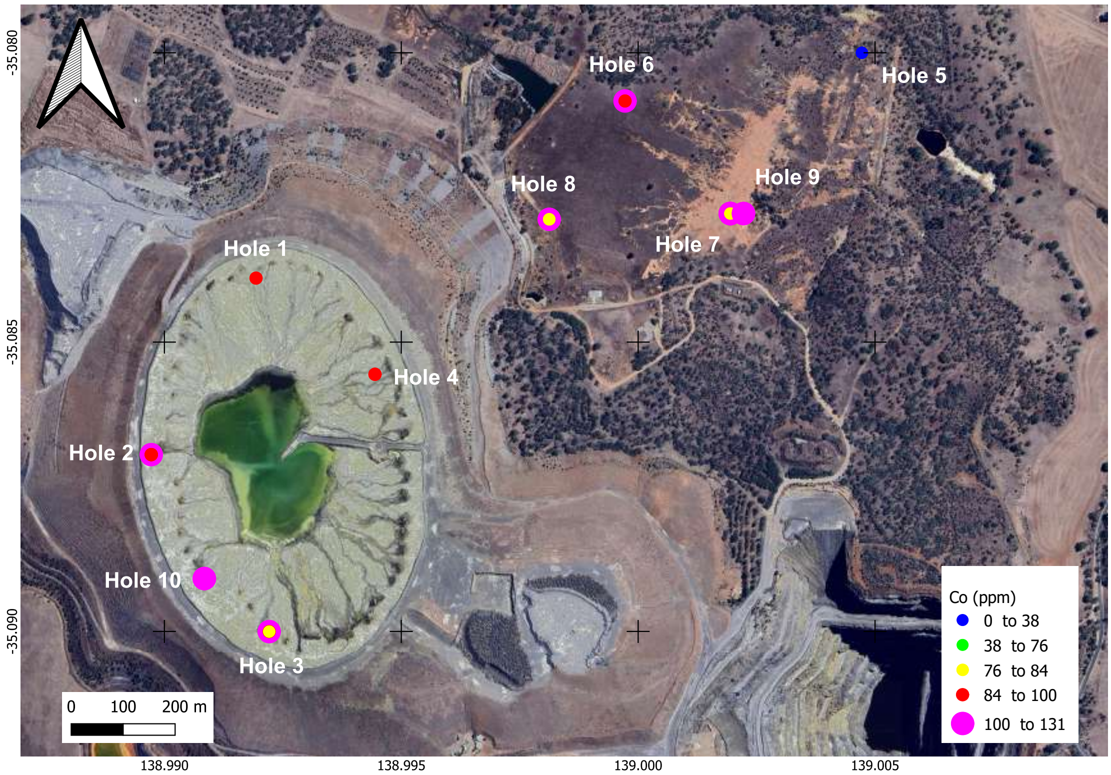

Figure 25. *Spatial distribution of highest Co values (ppm) across the Kanmantoo mine site.*

Figure 26. *Spatial distribution of highest Bi values (ppm) across the Kanmantoo mine site.*

5.2 Mineralogy

5.2.1 Bulk mineralogy

Of the 74 samples analysed from the Kanmantoo tailings, 10 were selected for extended mineralogical analyses and included 4 tailings from the new tailings storage facility and 6 tailings from the old tailings storage facility. These were chosen as they were high in Cu, Bi, Co and Mn. Quantitative phase analysis indicated that the mineralogy of the Kanmantoo tailings from the new tailings storage facility is mainly composed of **quartz** (34 – 38 wt.%, mean: 36 wt.%), **almandine** (25 – 28 wt.%, mean: 26.3 wt.%), **biotite** (7 – 10 wt.%, mean: 8 wt.%) and **magnetite** (1 – 18 wt.%, mean: 5.3 wt.%; Figure 27; Table 17; *Appendix E*). Minor phases include muscovite-illite, chlorite, andalusite, staurolite, pyrite, chalcocyanite and hematite.

The tailings from the old tailings storage facility have a slight different mineral composition, with mineralogy dominated by **almandine** (5 – 51 wt.%, mean: 35.2 wt.%), **quartz** (25 – 37 wt.%, mean: 28.8 wt.%), **biotite** (1 – 17 wt.%, mean: 9 wt.%) and **chlorite** (4 – 11 wt.%, mean: 5.7 wt.%). (Figure 27; Table 18; *Appendix E*). Minor phases include magnetite, muscovite-illite, andalusite, jarosite, staurolite, goethite, mixed layer clay, pyrite, chalcocyanite and hematite.

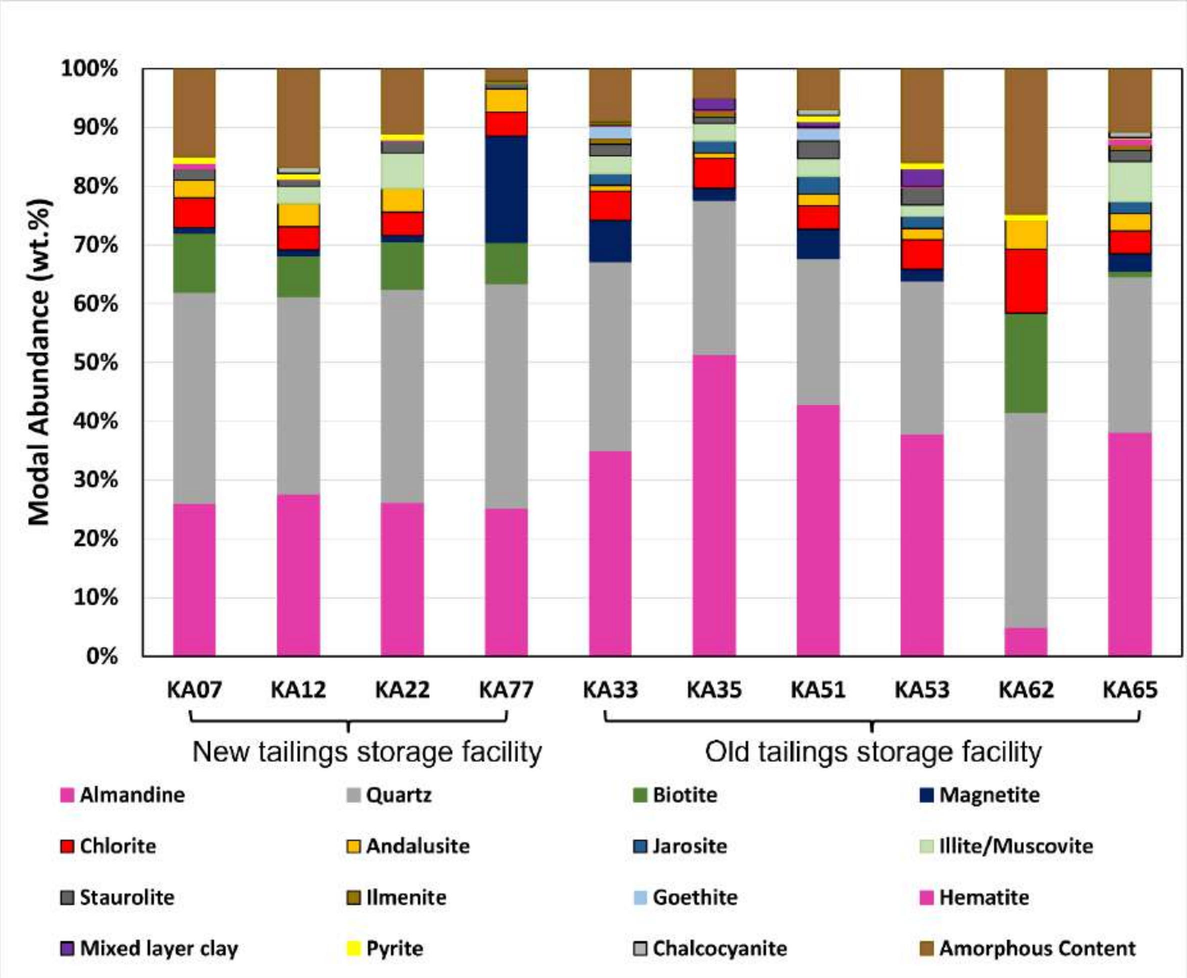

Figure 27. *Modal mineralogy as determined by XRD of Kanmantoo mine waste (new tailings storage facility: n=4; old tailings storage facility: n=6).*

Table 17. *Summary statistics for mineral phases quantified by XRD for the new tailings storage facility (n = 4).*

Mineral (wt. %)	Minimum	Maximum	Mean	Median
Quartz	34	38	36	36
Almandine	25	28	26.3	26
Biotite	7	10	8	7.5
Magnetite	1	18	5.3	1
Muscovite/illite	3	6	4.5	4.5
Chlorite	4	5	4.3	4
Andalusite	3	4	3.8	4
Staurolite	1	2	1.5	1.5
Pyrite	0.2	1	0.8	1
Chalcocyanite	0.2	1	0.6	0.6
Hematite	0.2	1	0.5	0.2
Amorphous material	2	17	11.3	13

Table 18. *Summary statistics for mineral phases quantified by XRD for the old tailings storage facility (n = 6).*

Mineral (wt. %)	Minimum	Maximum	Mean	Median
Almandine	5	51	35.2	38.5
Quartz	25	37	28.8	26.5
Biotite	1	17	9	9
Chlorite	4	11	5.7	5
Magnetite	2	7	3.8	3
Muscovite/illite	2	7	3.6	3
Andalusite	1	5	2.3	2
Jarosite	2	3	2.2	2
Staurolite	1	3	2.2	2
Goethite	2	2	2	2
Mixed layer clay	0.2	3	1.6	1.5
Pyrite	0.2	1	0.7	1
Chalcocyanite	0.2	1	0.7	1
Hematite	0.2	1	0.4	0.2
Amorphous material	5	25	12.2	10

5.2.2 In-situ mineralogy

The modal mineralogy results were analysed by splitting the dataset into two groups, represented by the tailings collected in the new tailings storage facility (n= 4) and the tailings collected in the old tailings storage facility (n=6).

The MLA results indicate that the tailings from the new tailings storage facility are primary characterized by the presence of **garnet** (33.8 to 40 wt.%; mean: 37.1 wt.%; Table 19) and **quartz** (32.8 to 35.8 wt.%; mean: 33.9 wt.%). The third mineral in abundance is represented by **silicate agglomerate** (9.3 to 13.3 wt.%; mean: 10.7 wt.%). Minor phases include biotite, andalusite, staurolite, Fe oxides, kaolinite-pyrophyllite and chlorite (Figure 28). Trace amounts of ilmenite, pyrrhotite, pyrite, muscovite-illite and jarosite are also detected (Figure 29; Table 19).

By contrast, the MLA results indicate that the tailings from the old tailings storage facility are primary characterized by the presence of **garnet,** which also displays a much wider range (8.2 to 65.6 wt.%; mean: 45.1 wt.%; Figure 30; Table 20). The second dominant mineral is **quartz** (15.2 to 35.2 wt.%; mean: 25.4 wt.%), followed by **biotite** (0.2 to 25.5 wt.%; mean: 4.9 wt.%), **silicate agglomerate** (6.1 to 14.1 wt.%; mean: 10.3 wt.%) and **chlorite** (0.3 to 11.1 wt.%; mean: 2.3 wt.%). Minor phases include andalusite, staurolite and Fe oxides (Figure 28). Trace amounts of kaolinite-pyrophyllite, muscovite-illite, jarosite, ilmenite, pyrite, pyrrhotite and apatite are also detected (Figure 31; Table 20).

Table 19. *Summary statistics for mineral phases quantified by MLA in tailings from the new tailings storage facility (n = 4).*

Mineral (wt. %)	Minimum	Maximum	Mean	Median
Garnet	33.8	40	37.1	37.3
Quartz	32.8	35.8	33.9	33.5
Silicate agglomerate	9.3	13.3	10.7	10.2
Biotite	5	7	6	6.1
Andalusite	3.4	4	3.7	3.7
Staurolite	2.9	3.8	3.3	3.3
Fe oxide	0.6	1.2	0.8	0.7
Kaolinite-pyrophyllite	0.6	1.4	1	1.1
Chlorite	0.5	1.2	0.8	0.7
Ilmenite	0.4	0.5	0.5	0.5
Pyrrhotite	0.4	0.7	0.5	0.5
Pyrite	0.2	0.4	0.3	0.3
Muscovite-Illite	0.3	0.7	0.5	0.4
Jarosite	0.3	0.3	0.3	0.3
Apatite	0.1	0.1	0.1	0.1
Plagioclase	0.1	0.1	0.1	0.1
Orthoclase	b.d.l	0.1	0.1	0.1

b.d.l. = below detection limit

Table 20. *Summary statistics for mineral phases quantified by MLA in tailings from the old tailings storage facility (n = 6).*

Mineral (wt. %)	Minimum	Maximum	Mean	Median
Garnet	8.2	65.6	45.1	53.9
Quartz	15.2	35.2	25.4	24.4
Biotite	0.2	25.5	4.9	1.1
Silicate agglomerate	6.1	14.1	10.3	10.5
Chlorite	0.3	11.1	2.3	0.6
Andalusite	1.1	4	2	1.5
Staurolite	1.9	3.6	3	3.2
Fe oxide	1.4	6.4	3.2	2.8
Kaolinite-pyrophyllite	0.2	0.8	0.4	0.4
Muscovite-Illite	0.1	1	0.3	0.2
Jarosite	b.d.l	0.8	0.3	0.1
Ilmenite	0.3	0.7	0.5	0.5
Pyrite	b.d.l	0.7	0.3	0.2
Pyrrhotite	b.d.l	0.3	0.1	0.1
Apatite	b.d.l	0.3	0.1	0.1
Schwertmannite	b.d.l	0.1	0.1	0.1
Plagioclase	b.d.l	0.2	0.1	0.1
Orthoclase	b.d.l	0.1	b.d.l	b.d.l

b.d.l. = below detection limit

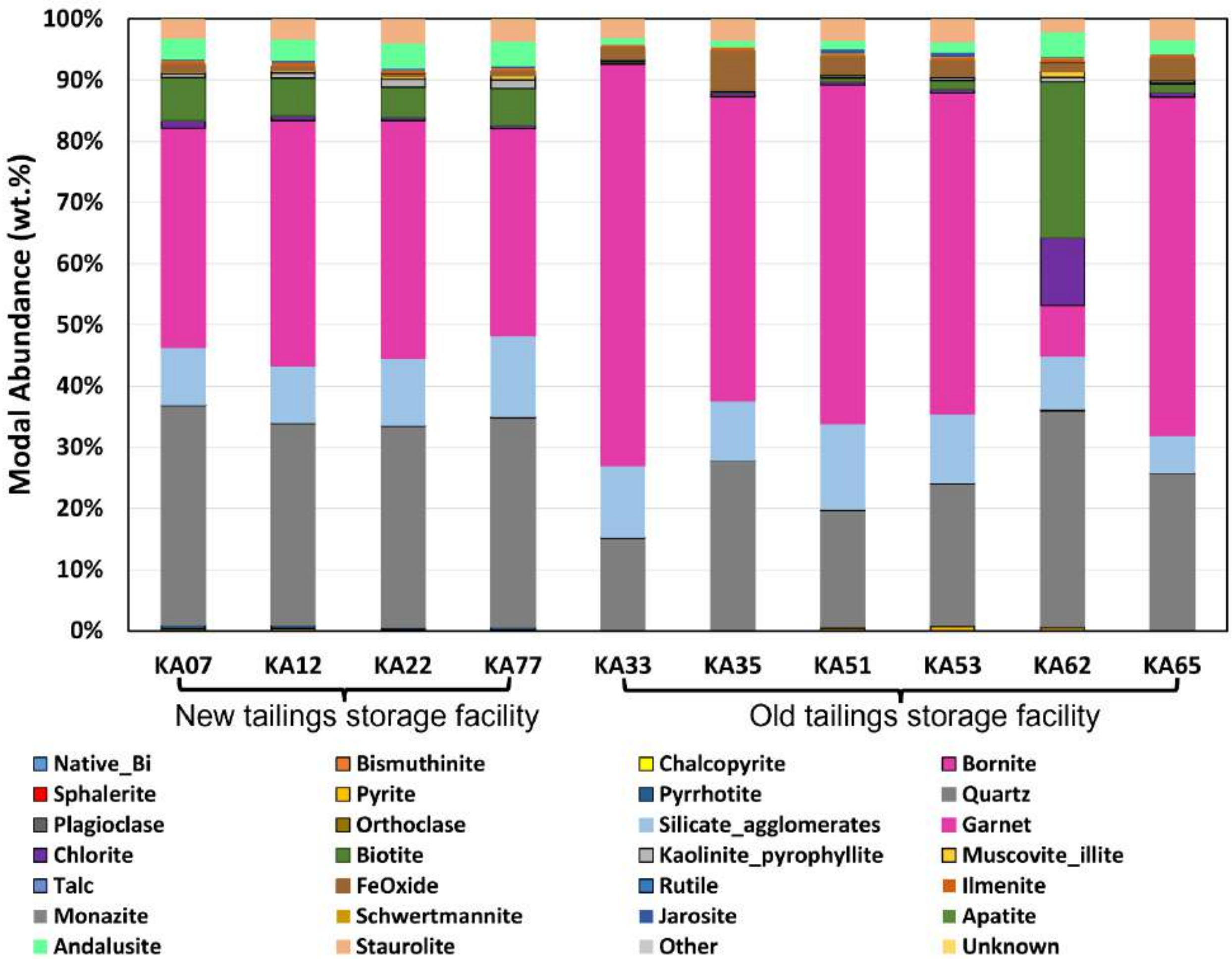

Figure 28. *Modal mineralogy as determined by MLA of Kanmantoo tailings (new tailings storage facility: n = 4; old tailings storage facility: n= 6).*

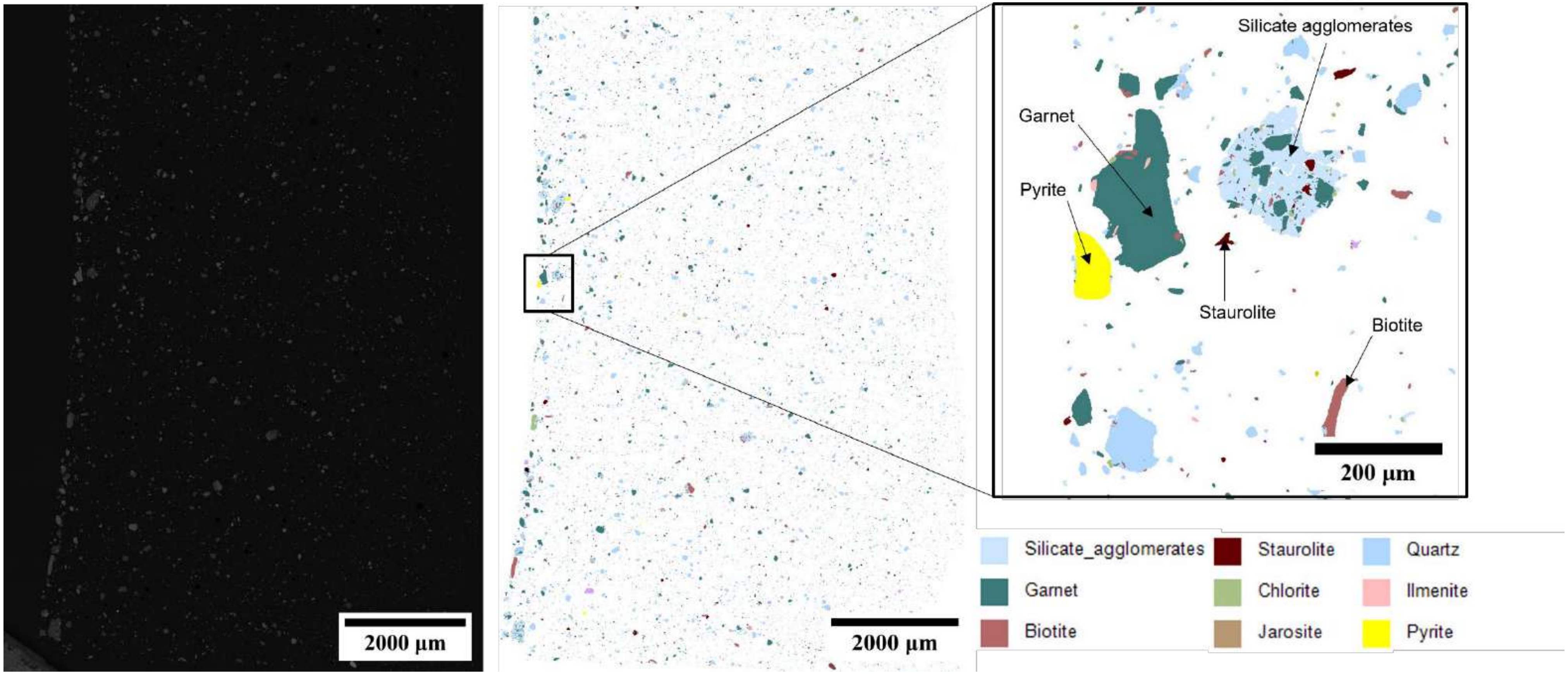

Figure 29. *BSE and classified mineralogy image for tailings sample KA07 as determined by MLA. Major phases include garnet (35.8 wt.%), quartz (35.8 wt.%), silicate agglomerates (9.4 wt.%), biotite (7 wt.%), andalusite (3.4 wt.%) and staurolite (2.9 wt.%). Minor phases include Fe oxides (1.2 wt.%), chlorite (1.2 wt.%), kaolinite-pyrophyllite (0.6 wt.%), pyrrhotite (0.6 wt.%) and pyrite (0.3 wt.%).*

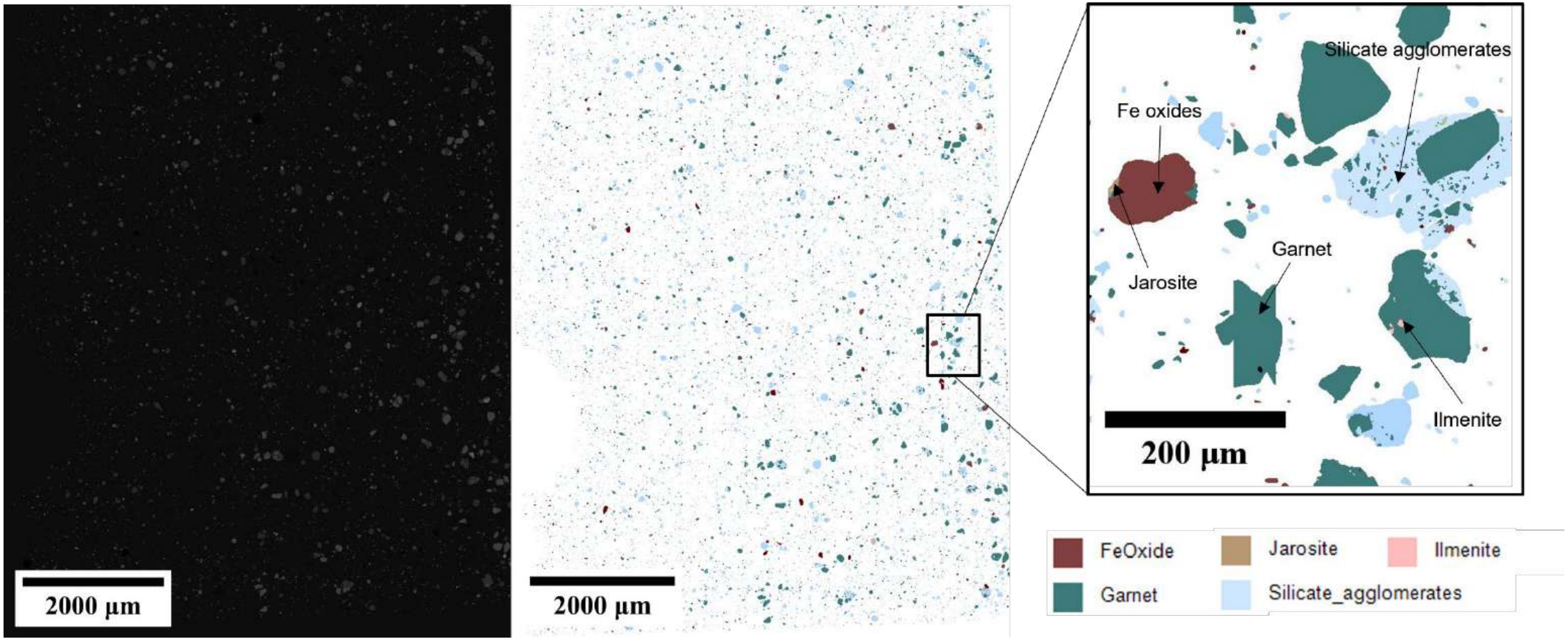

Figure 30. *BSE and classified mineralogy image for tailings sample KA35 as determined by MLA. Major phases include garnet (49.7 wt.%), quartz (27.8 wt.%), silicate agglomerates (9.7 wt.%), Fe oxides (6.4 wt.%), staurolite (3.3 wt.%) and andalusite (1.1 wt.%). Minor phases include chlorite (0.6 wt.%), ilmenite (0.5wt.%) and kaolinite-pyrophyllite (0.2 wt.%).*

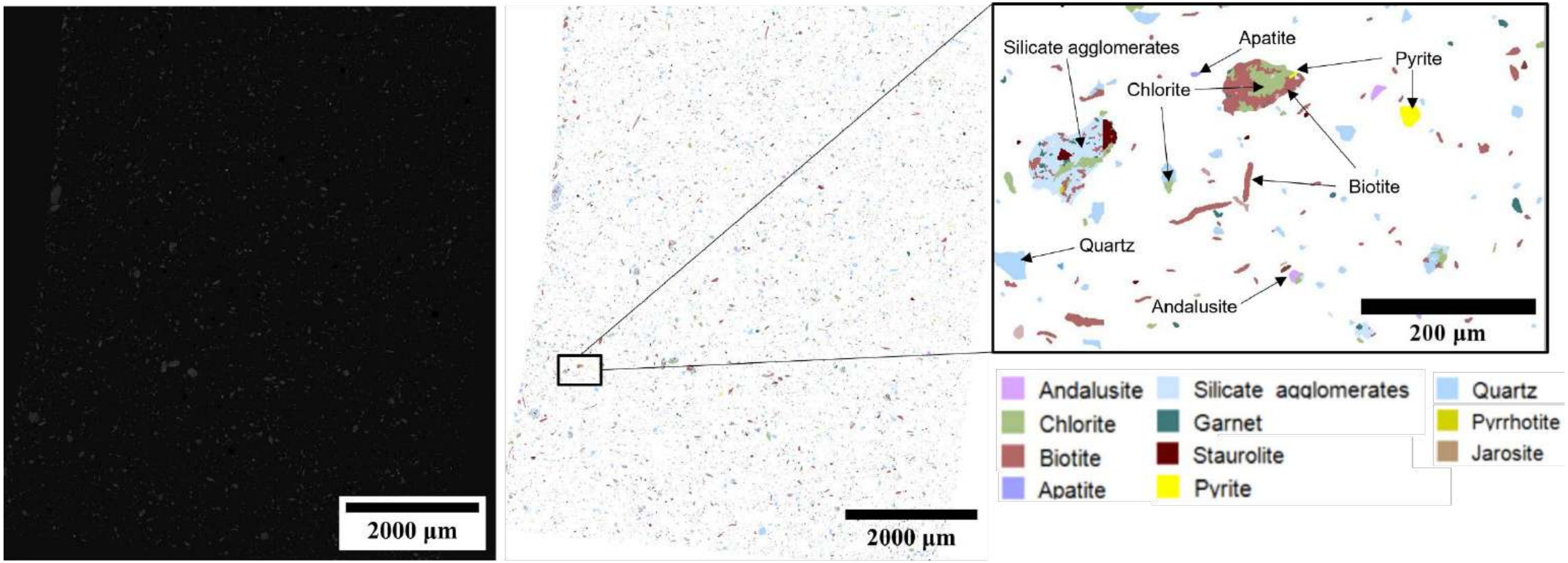

Figure 31. *BSE and classified mineralogy image for tailings sample KA62 as determined by MLA. Major phases include quartz (35.2 wt.%), biotite (25.5 wt.%), chlorite (11.1 wt.%), silicate agglomerates (8.8 wt.%), garnet (8.2 wt.%), andalusite (4 wt.%), staurolite (1.9 wt.%) and Fe oxides (1.4 wt.%). Minor phases include muscovite-illite (0.9 wt.%), kaolinite-pyrophyllite (0.8 wt.%), ilmenite (0.6 wt.%), pyrite (0.5 wt.%), apatite (0.3 wt.%) and pyrrhotite (0.2 wt.%).*

5.2.3 Particle size distribution

Pyrite, silicates (e.g., garnet) and Fe oxides from tailings were further investigated for particle size distribution. Even though sulfides (pyrite) are not as abundant as the silicates or Fe oxides in the Kanmantoo tailings, they were still targeted for further investigation due to their potential to host critical metals.

Analysis of particle size distribution show that pyrite *p80* from the new tailings storage facility ranged between 20 and 90 µm (Figure 32). Whereas the particle size distribution of pyrite *p80* from the old tailings storage facility ranged between 11 and 55 µm (Figure 33). Garnet in the new tailings storage facility displays a *p80* ranging between 43 and 65 µm (Figure 34). By contrast, in the old tailings storage facility garnet shows a *p80* characterized by a wider range, between 23 and 83 µm (Figure 35). Iron oxides in the new tailings storage facility had *p80* ranging between 25 and 101 µm (Figure 36). In the old tailings storage facility Fe oxides are characterized by *p80* ranging from 25 to 41 µm (Figure 37).

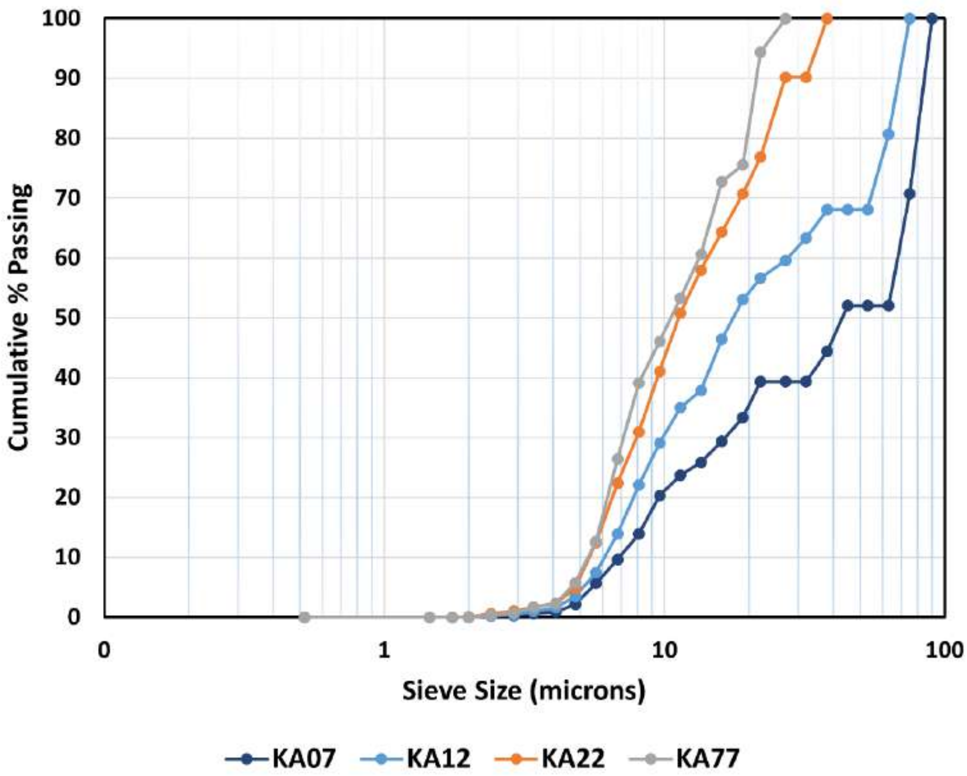

Figure 32. *Particle size distribution for pyrite from the new tailings storage facility (n=4).*

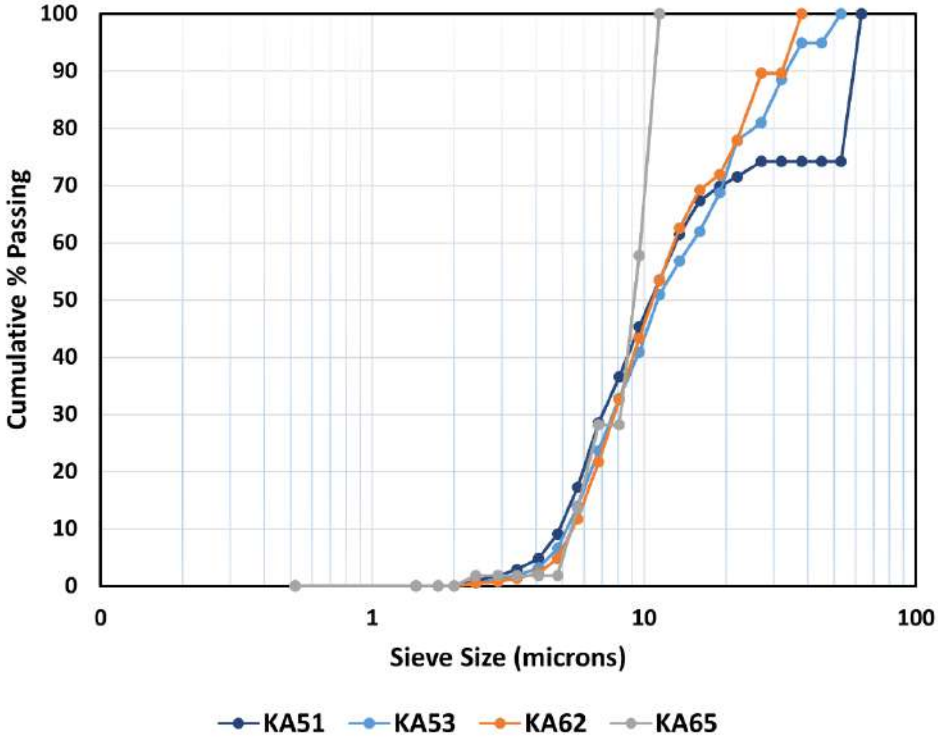

Figure 33. *Particle size distribution for pyrite from the old tailings storage facility (n=4).*

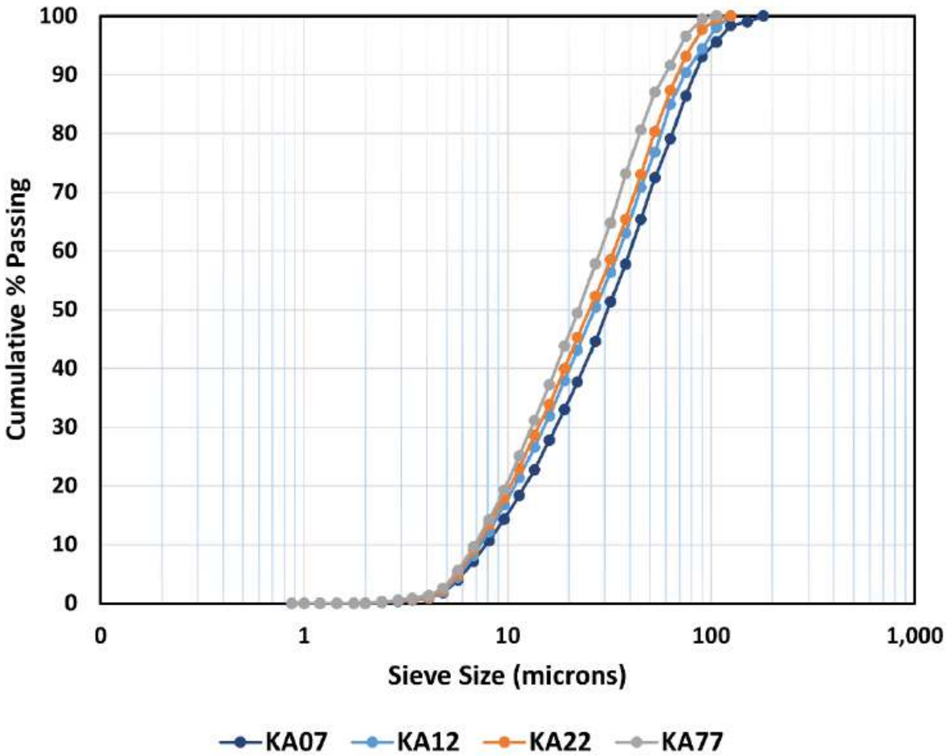

Figure 34. *Particle size distribution for garnet from the new tailings storage facility (n=4).*

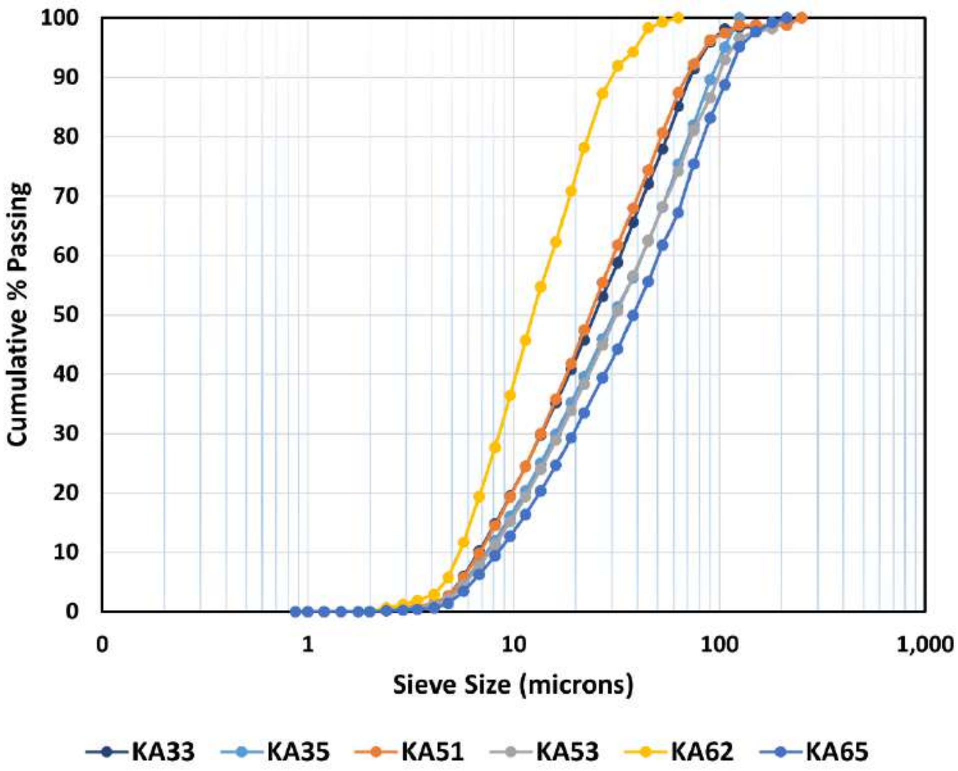

Figure 35. *Particle size distribution for garnet from the old tailings storage facility (n=6).*

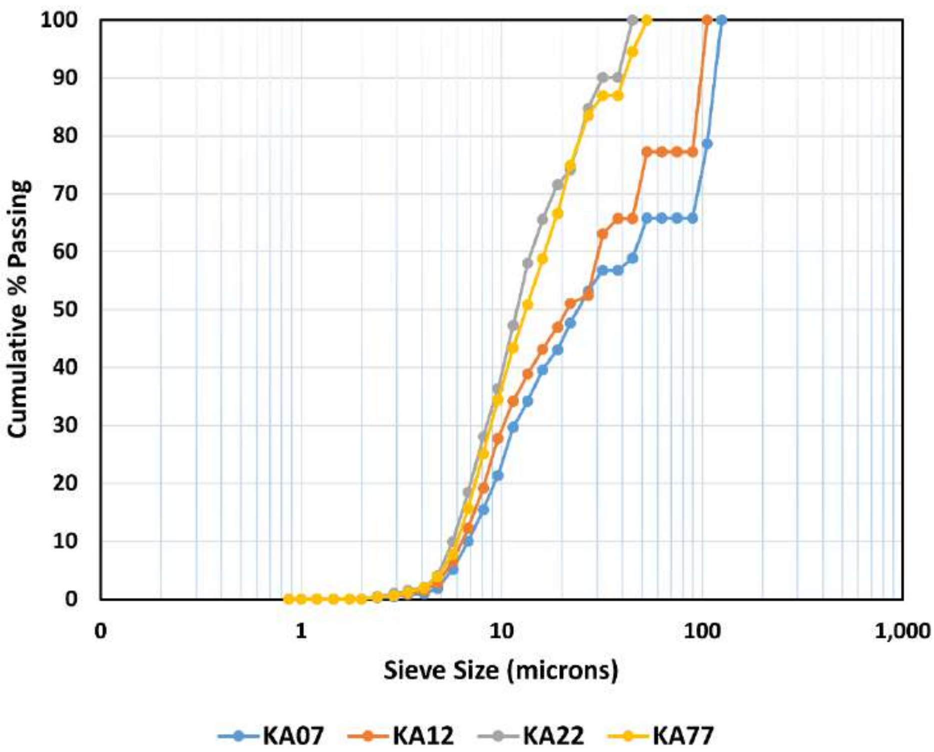

Figure 36. *Particle size distribution for garnet from the new tailings storage facility (n=4).*

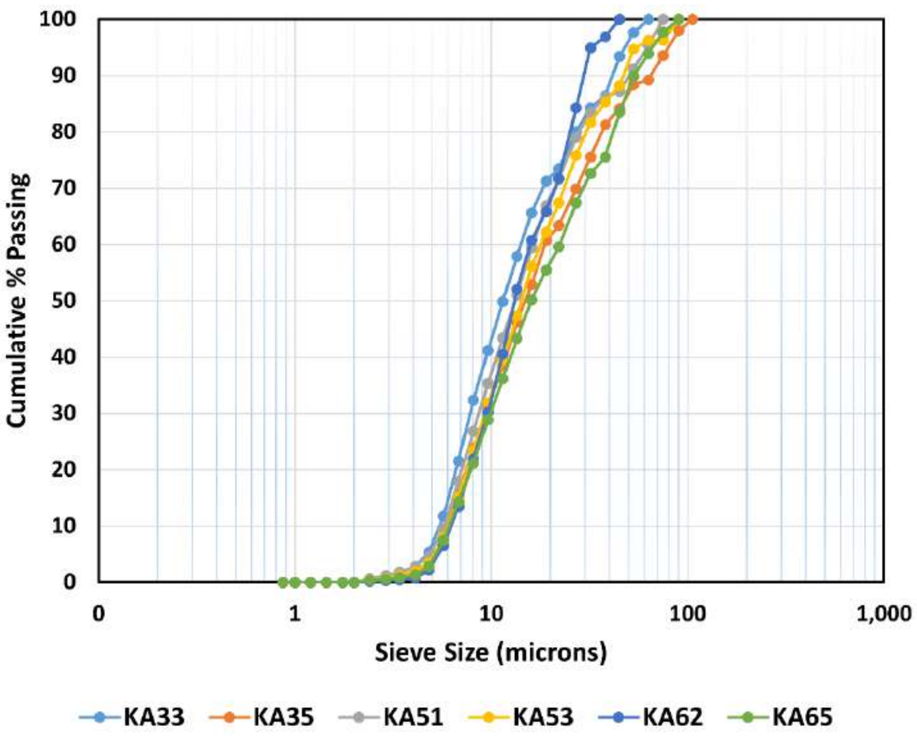

Figure 37. *Particle size distribution for garnet from the old tailings storage facility (n=6).*

5.2.4 Mineral associations

Mineral associations indicate that pyrite from the new tailings storage facility is often liberated (i.e., free surfaces: pyrite: 86–90%; Figure 38). Garnet within the new tailings storage facility is also liberated (free surfaces: 79-83%; Figure 40). Also, Fe oxides are liberated in the new tailings storage facility (free surfaces: pyrite: 76-85%; Figure 42). Where locked, pyrite tends to associate with silicate agglomerates; minor associations are quartz and garnet (Figure 38). Similarly, garnet has major associations with silicate agglomerates and minor associations with quartz (Figure 40). In turn, Fe oxides mainly associated with silicate agglomerates, minor associations are with quartz and garnet (Figure 42).

Pyrite, garnet and Fe oxides within Kanmantoo old tailings storage facility are almost entirely liberated (free surfaces: pyrite: 83-97%; garnet: 75-83%; ankerite: 76-90%; Figures 39-41-43). Pyrite is mostly associated with silicate aggregates and garnet (Figure 39). Garnet is mainly associated with silicate aggregates and quartz. Garnet in the KA62 sample shows minor association with biotite and chlorite (Figure 41). Iron oxides mostly associated with silicate aggregates and garnet, with minor association with quartz (Figure 42).

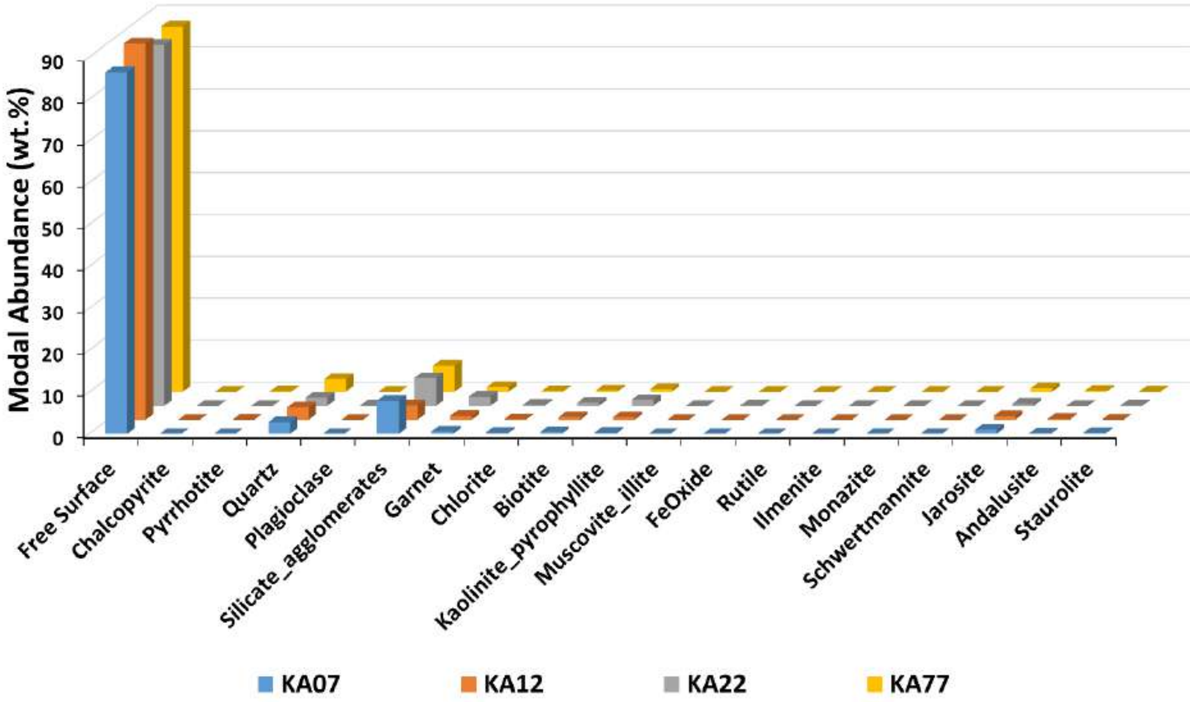

Figure 38. *Pyrite mineral association for new tailings storage facility as determined by MLA (n=4).*

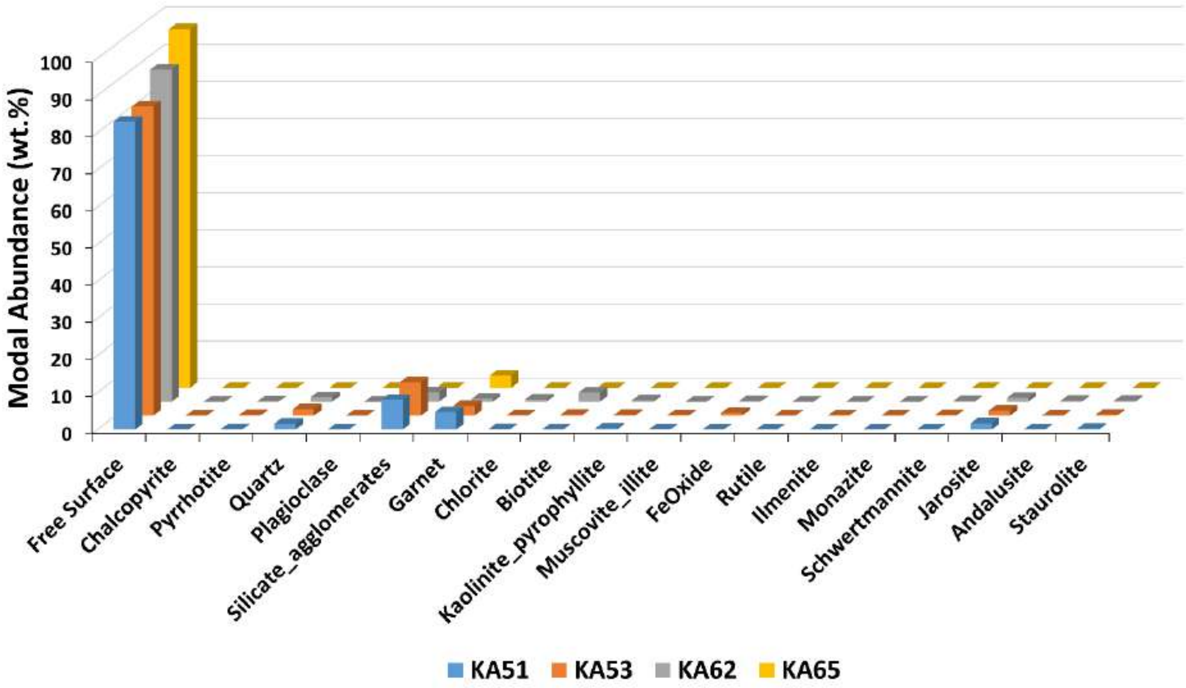

Figure 39. *Pyrite mineral association for old tailings storage facility as determined by MLA (n=3).*

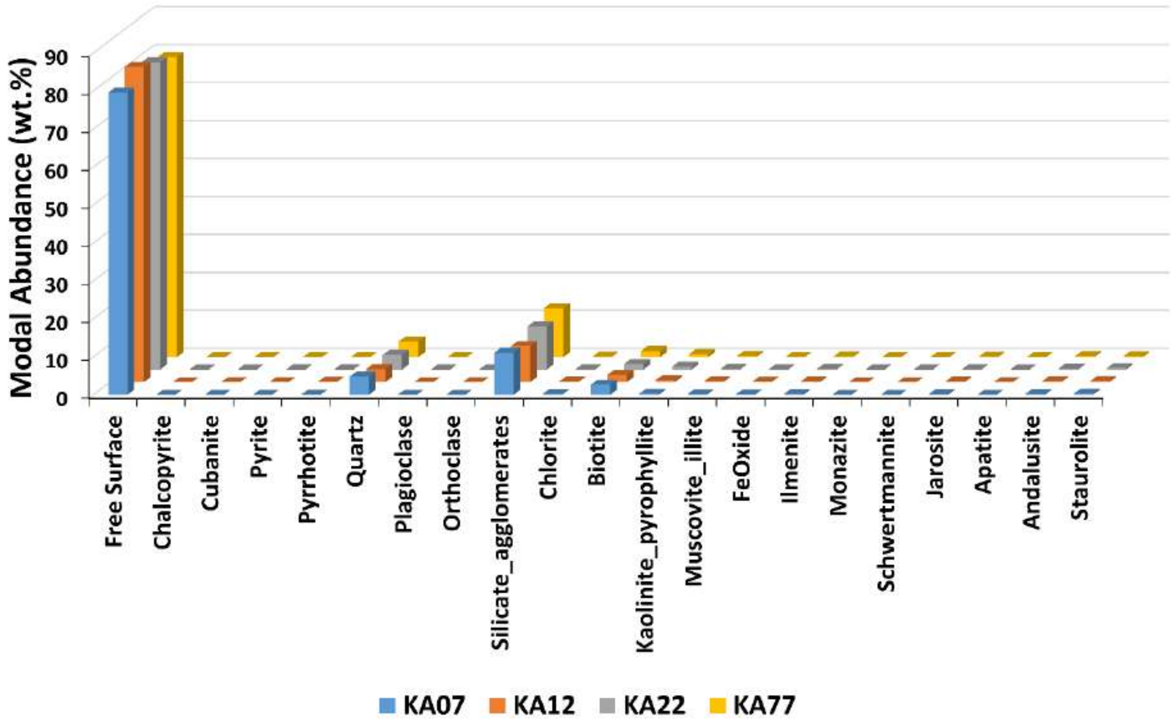

Figure 40. *Garnet mineral association for new tailings storage facility as determined by MLA (n=4).*

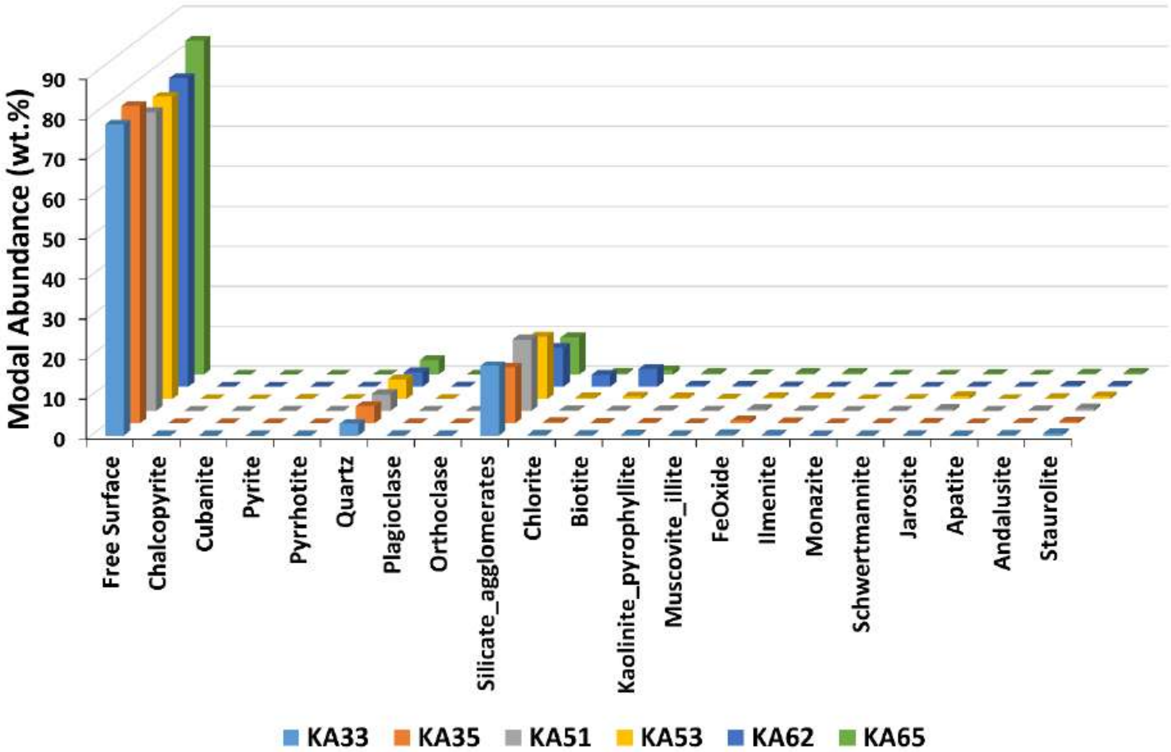

Figure 41. *Garnet mineral association for old tailings storage facility as determined by MLA (n=6).*

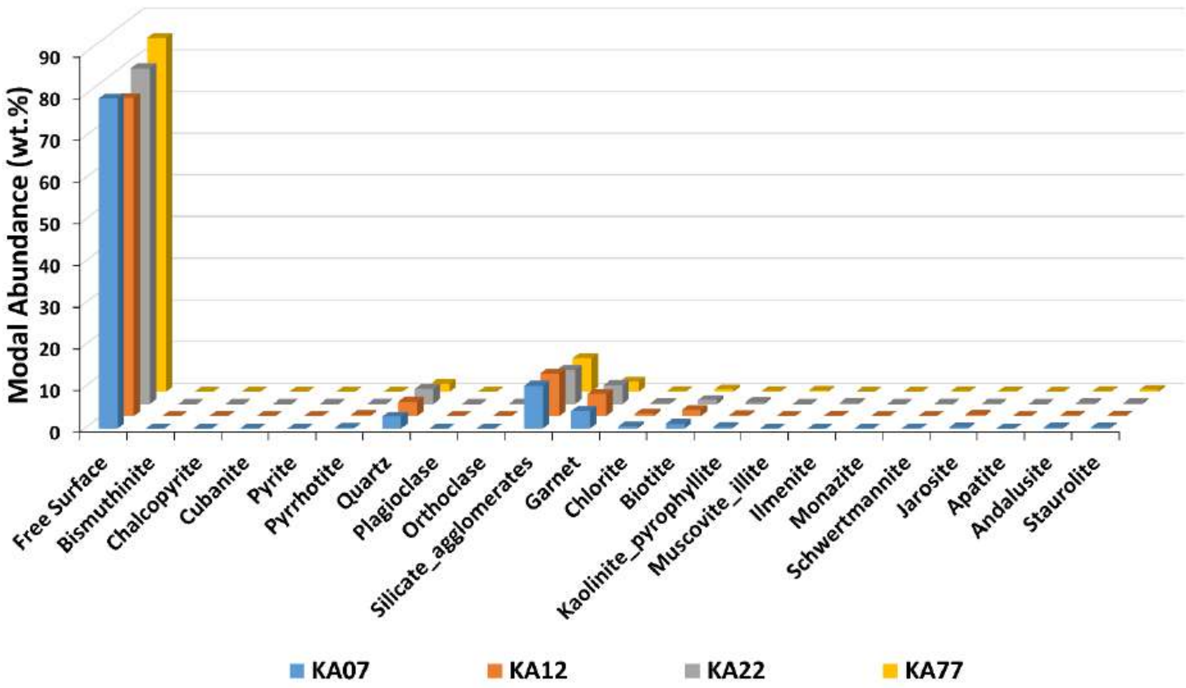

Figure 42. *Iron oxides mineral association for new tailings storage facility as determined by MLA (n=4).*

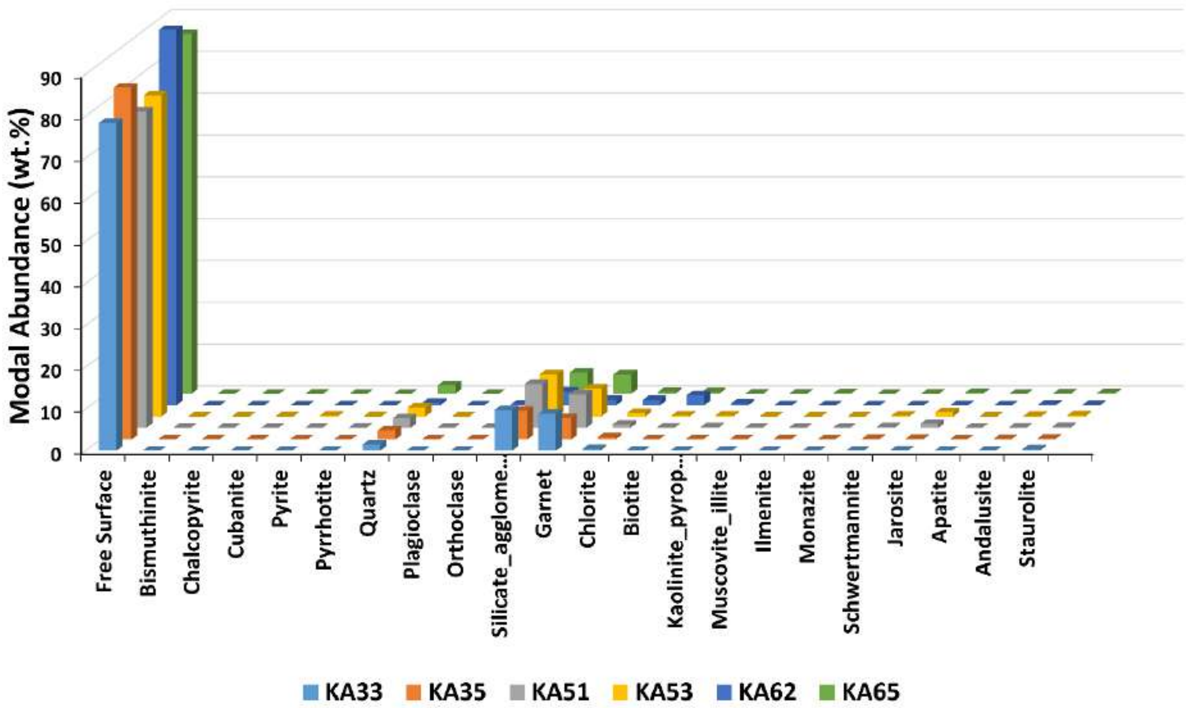

Figure 43. *Iron oxides mineral association for old tailings storage facility as determined by MLA (n=6).*

5.3 Mineral chemistry

5.3.1 Compositional variations

Mineral chemistry of garnet and iron sulfides from 5 tailings samples (KA07, KA12, KA35, KA53 and KA62) was investigated by LA-ICP-MS to assess the distribution of metals such as Mn, critical metals (Co, Bi, Zr, Ti) and REE's.

LA-ICP-MS results indicate that garnet has the highest Mn concentration among samples analysed (mean values: 14,057 ppm; Figure 44; Table 21). In addition, garnet displays the highest concentrations of Zr (22,328 ppm), Bi (23,115 ppm) and Ti (36,963 ppm) (Figure 44; Table 21).

Iron sulfides, including pyrite and pyrrhotite, show the highest concentrations of Cu (8,845 ppm), Ni (1,668 ppm) and Co (3,983 ppm) (Figure 44; Table 21).

Given the small particle size of iron oxides, the identification by LA-ICP-MS resulted in poor signal acquisition. Therefore, the discussion below focuses on garnets and iron sulfides.

Table 21. *Statistical summary of concentrations for selected trace elements for LA-ICP-MS analyses (n=329), garnet (n=314), iron sulfide (n=15).*

Mineral phase	^{90}Zr (ppm)	^{209}Bi (ppm)	^{66}Zn (ppm)	^{65}Cu (ppm)	^{60}Ni (ppm)	^{59}Co (ppm)	^{49}Ti (ppm)	^{55}Mn (ppm)
Garnet (n = 314)								
Minimum	1.21	0.01	2.9	0.24	0.09	9.6	26.9	5,486
Maximum	22,328	23,115	52.4	801	30.7	96	36,963	49,927
Mean	623	592	19.1	70.1	3.9	38	3,163	14,057
Median	3	0.2	15.1	0.2	0.2	28	120	11,150
Iron sulfide (n = 15)								
Minimum	0.01	0.36	0.63	1.16	1.91	11.99	2.00	3.70
Maximum	5.3	123	24.5	8,445	1,668	3,983	639	135
Mean	1.1	19.4	5.6	946	772	2,236	135	39
Median	0.2	2.4	3.3	53	720	2,468	59.5	25

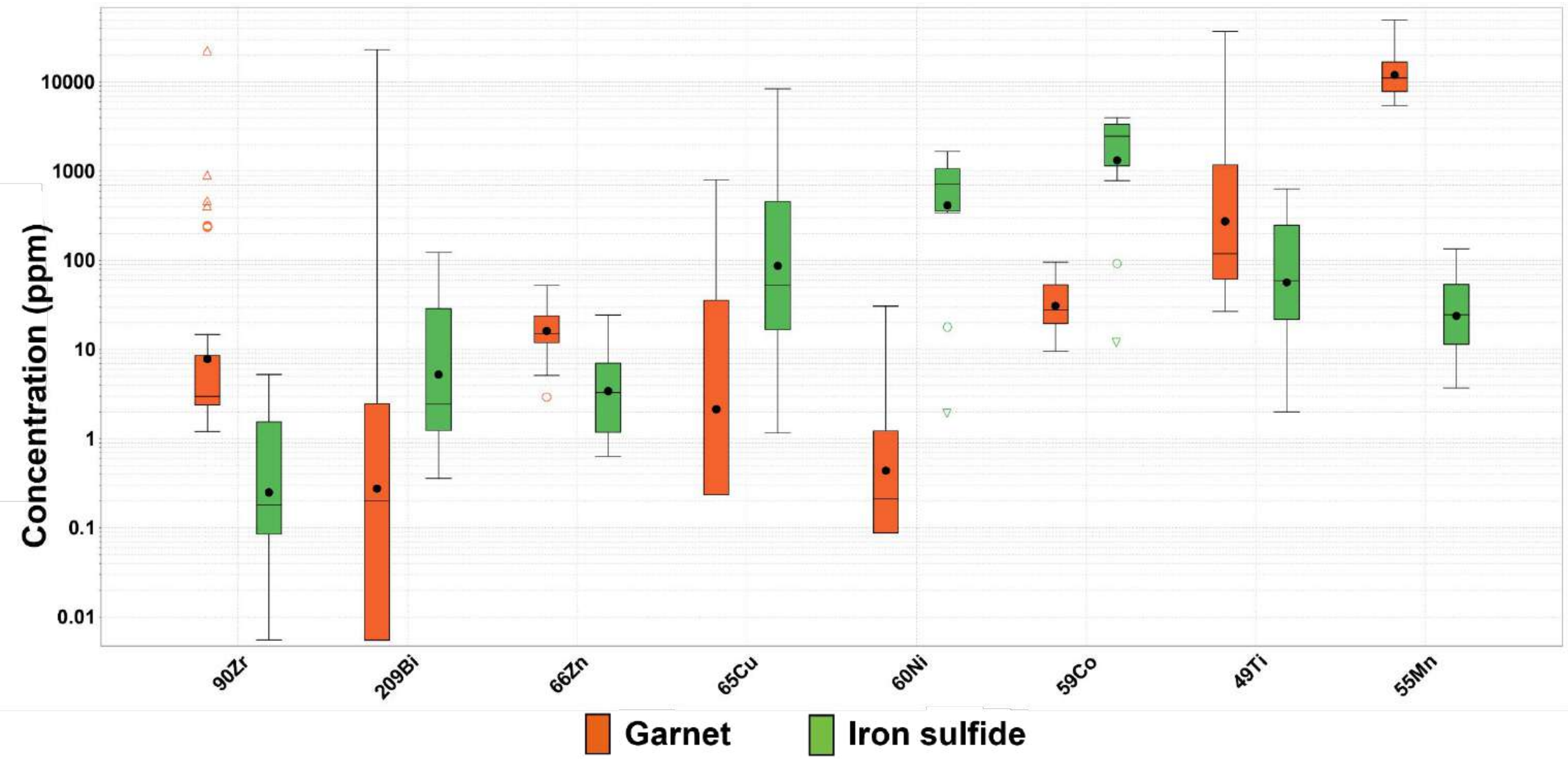

Figure 44. *Tukey log-plot summarising concentrations of Zr, Bi, Zn, Cu, Ni, Co, Ti and Mn in garnet and iron sulfide (n=329).*

5.3.2 Deportment mode

The LA-ICP-MS analysis of garnet displays trace element compositional variations within individual crystals. Specifically, the results for garnet sample KA07_gnt-49 indicate that LREE (La, Ce, Pr Nd, Sm, Eu), HREE (Gd, Tb, Dy, Y), Th and U are elevated throughout the mineral matrix (Figure 45). A different garnet compositional pattern is shown from LA-ICP-MS analyses of samples KA35_gnt-56 and KA35_gnt-09, which indicate that elements such as Zr, U, Hf, Th, Ti and Bi exist as micro-inclusions, as evidenced by their peak-shape patterns (Figures 46-47). Correlation matrixes for selected elements from the garnet LA-ICP-MS dataset reveals complex geochemical associations of P and Pb with LREE and HREE (Tables 22-23; Figures 48-49).

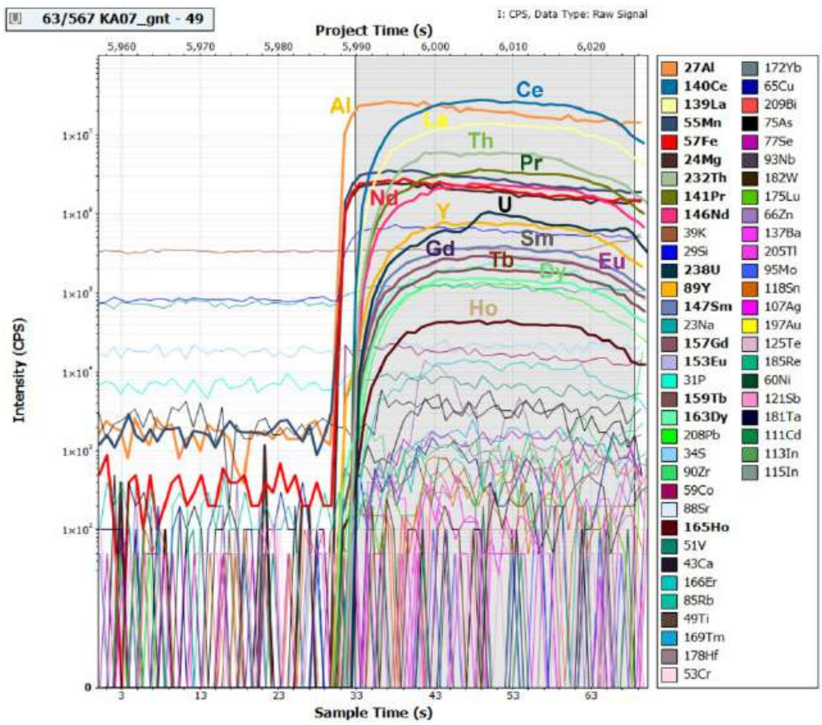

Figure 45. *LA-ICP-MS pattern for garnet KA07_gnt-49 (1,035 ppm Y; 14,938 ppm La, 30,070 ppm Ce; 3,211 ppm Pr; 12,465 ppm Nd; 2,309 ppm Sm; 466 ppm Eu; 1,739 ppm Gd; 169 ppm Tb; 522 ppm Dy; 6,043 ppm Th; 763 ppm U).*

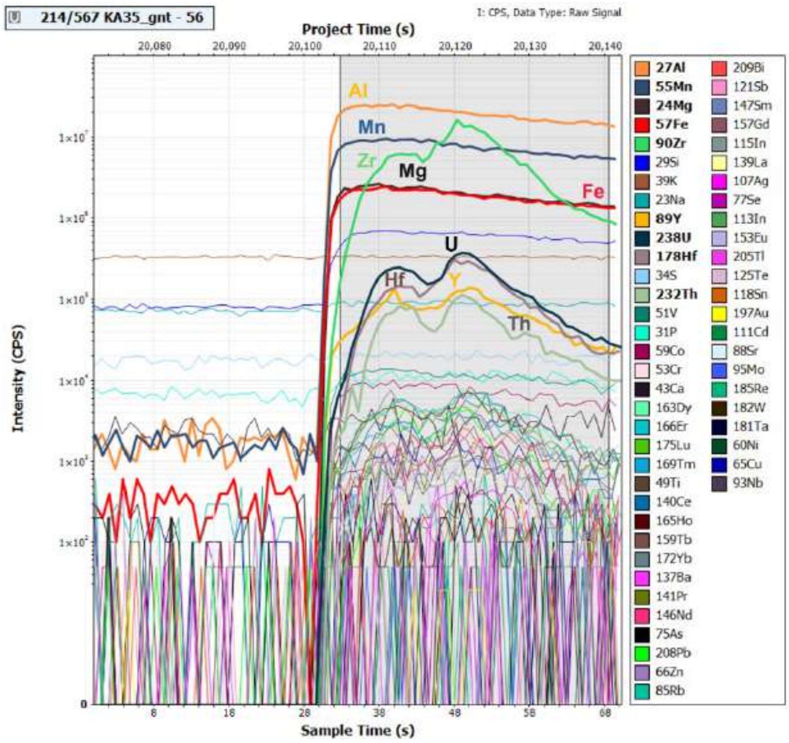

Figure 46. *LA-ICP-MS pattern for garnet KA35_gnt-56 (22,327 ppm Zr; 210 ppm U; 70 ppm Th; 523 ppm Hf).*

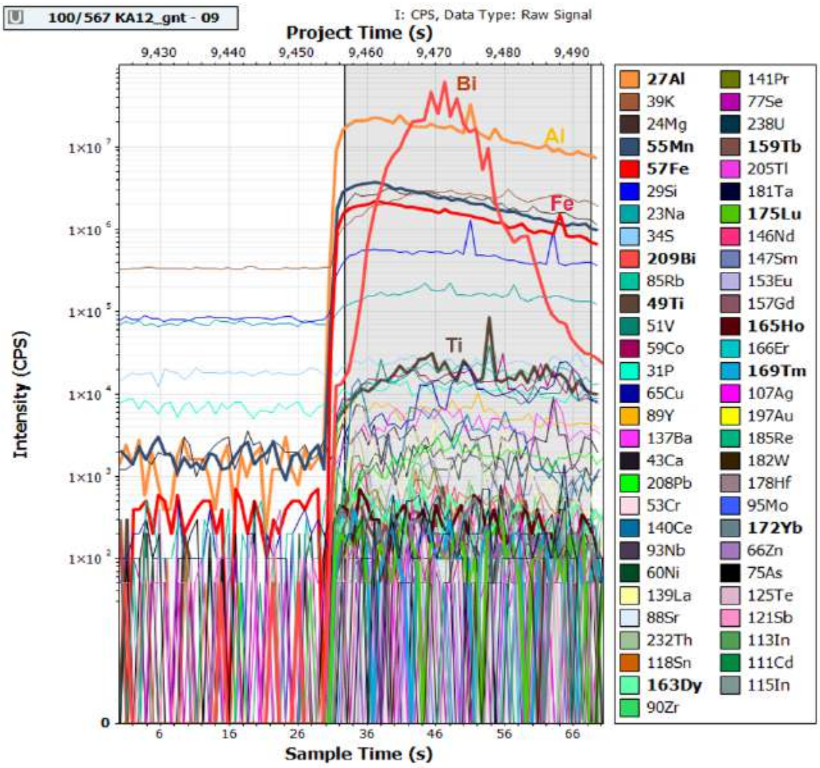

Figure 47. *LA-ICP-MS pattern for garnet KA12_gnt-09 (23,115 ppm Bi; 1,246 ppm Ti).*

Table 22. *Correlation matrix (R > 0.7) for selected metals and trace elements measured in garnet from the new tailings storage facility (n=127).*

	^{27}Al	^{57}Fe	^{209}Bi	^{208}Pb	^{31}P	^{139}La	^{140}Ce	^{141}Pr	^{146}Nd	^{147}Sm	^{153}Eu	^{157}Gd	^{159}Tb	^{163}Dy
^{27}Al	1.00													
^{57}Fe	0.27	1.00												
^{209}Bi	-0.13	-0.42	1.00											
^{208}Pb	-0.51	-0.39	-0.02	1.00										
^{31}P	-0.48	-0.30	-0.03	**0.99**	1.00									
^{139}La	-0.52	-0.45	-0.04	**0.99**	**0.98**	1.00								
^{140}Ce	-0.52	-0.37	-0.04	**0.99**	**0.99**	**1.00**	1.00							
^{141}Pr	-0.60	-0.37	-0.04	**0.99**	**0.99**	**1.00**	**1.00**	1.00						
^{46}Nd	-0.58	-0.36	-0.03	**0.99**	**0.98**	**1.00**	**1.00**	**1.00**	1.00					
^{147}Sm	-0.50	-0.34	-0.03	**0.99**	**0.98**	**1.00**	**1.00**	**1.00**	**1.00**	1.00				
^{153}Eu	-0.50	-0.35	-0.03	**0.99**	**0.98**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	1.00			
^{157}Gd	-0.50	-0.36	-0.03	**1.00**	**0.99**	**0.99**	**1.00**	**1.00**	**1.00**	**1.00**	**0.99**	1.00		
^{159}Tb	-0.50	-0.41	-0.03	**0.99**	**0.97**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.98**	**0.99**	1.00	
^{163}Dy	-0.45	-0.51	-0.05	**0.85**	**0.81**	**0.89**	**0.85**	**0.81**	**0.81**	**0.81**	**0.81**	**0.82**	**0.89**	1.00

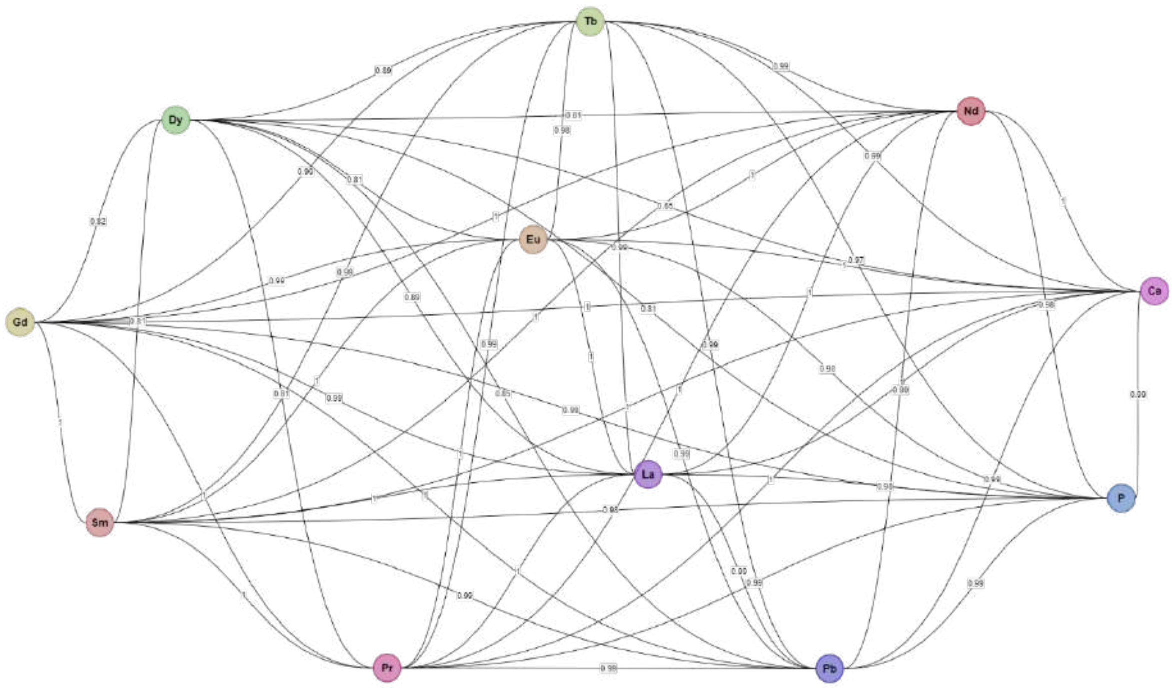

Figure 48. *Correlation diagram (r > 0.7) for selected metals and trace elements measured in Kanmantoo garnet (n=127) from the new tailings storage facility. Diagram plotted in EzCorrGraph (Campos & Licht, 2021).*

Table 23. *Correlation matrix (R > 0.7) for selected metals and trace elements measured in garnet from the old tailings storage facility (n=187).*

	^{27}Al	^{57}Fe	^{209}Bi	^{208}Pb	^{31}P	^{139}La	^{140}Ce	^{141}Pr	^{146}Nd	^{147}Sm	^{153}Eu	^{157}Gd	^{159}Tb	^{163}Dy
^{27}Al	1.00													
^{57}Fe	0.33	1.00												
^{209}Bi	-0.58	-0.23	1.00											
^{208}Pb	-0.16	-0.17	0.14	1.00										
^{31}P	-0.09	-0.32	0.00	0.43	1.00									
^{139}La	-0.03	-0.11	-0.05	**0.97**	0.40	1.00								
^{140}Ce	-0.04	-0.11	-0.04	**0.97**	0.40	**1.00**	1.00							
^{141}Pr	-0.02	-0.11	-0.06	**0.98**	0.40	**1.00**	**1.00**	1.00						
^{46}Nd	-0.04	-0.10	-0.04	**0.97**	0.40	**1.00**	**1.00**	**1.00**	1.00					
^{147}Sm	-0.06	-0.12	-0.02	**0.97**	0.41	**1.00**	**1.00**	**1.00**	**1.00**	1.00				
^{153}Eu	-0.06	-0.14	-0.03	**0.97**	0.40	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	1.00			
^{157}Gd	-0.07	-0.21	-0.04	**0.95**	0.46	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**	1.00		
^{159}Tb	-0.10	-0.49	-0.07	0.50	0.52	0.56	0.54	0.54	0.51	0.52	0.55	0.68	1.00	
^{163}Dy	-0.09	-0.50	-0.07	0.08	0.42	0.11	0.09	0.09	0.08	0.10	0.13	0.29	**0.89**	1.00

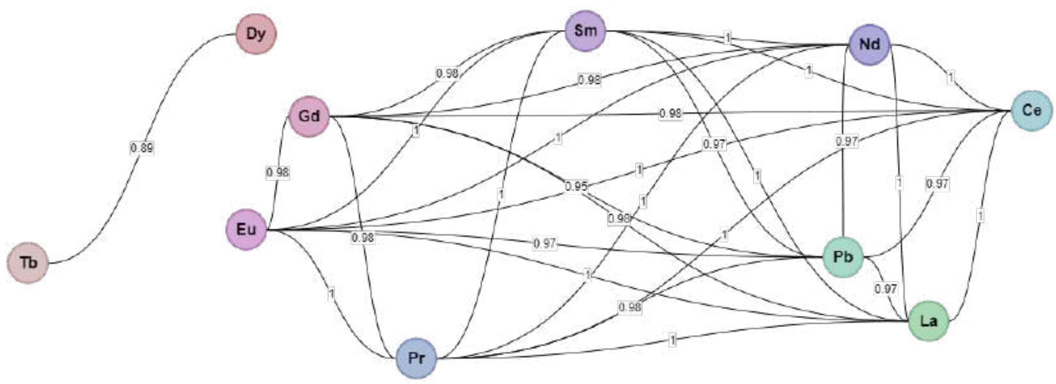

Figure 49. *Correlation diagram (r > 0.7) for selected metals and trace elements measured in Kanmantoo garnet (n=187) from the old tailings storage facility. Diagram plotted in EzCorrGraph (Campos & Licht, 2021).*

Compositional patterns obtained from LA-ICP-MS analysis of iron sulfides display trace element compositional variations within individual crystals. The compositional pattern for pyrrhotite sample KA07_pyh-01 shows elevated concentrations of Co and Ni throughout the mineral matrix (Figure 50). A correlation matrix for the pyrrhotite LA-ICP-MS dataset shows a geochemical association involving Cu-Zr-Bi-Zn-Ti-Mn (Table 24; Figure 52). The compositional pattern for pyrite sample KA62_py-02 shows elevated concentrations of Co, Ni, Cu throughout the mineral matrix and a spike in Ti (Figure 51). A correlation matrix for the pyrite LA-ICP-MS dataset shows a complex geochemical association involving Cu-Zr-Ni-Bi-Zn-Ti-Mn (Table 25; Figure 53).

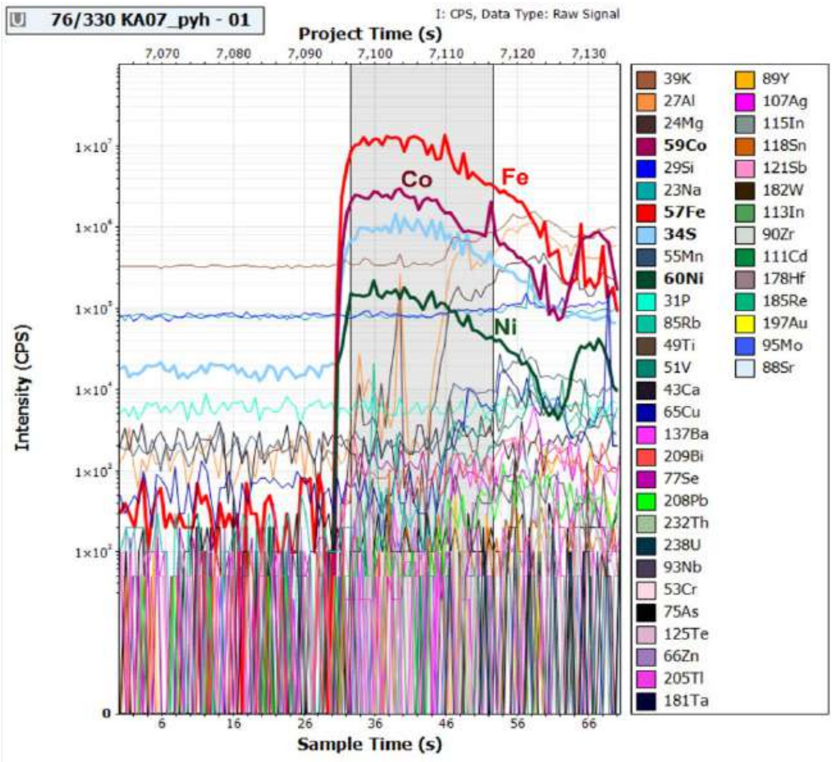

Figure 50. *LA-ICP-MS pattern for pyrrhotite KA07_pyh-01 (3,371 ppm Co; 1,000 ppm Ni).*

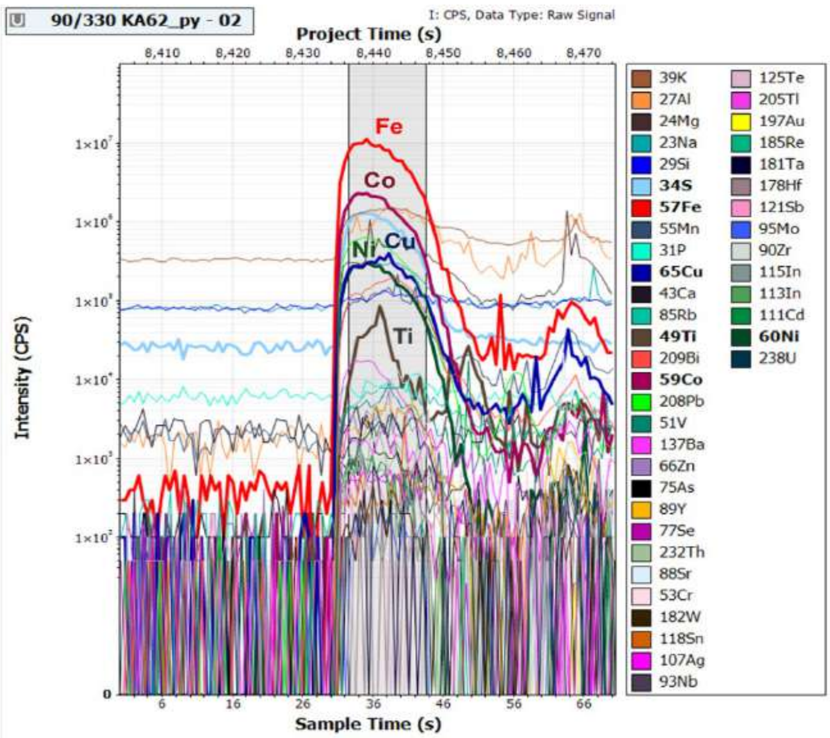

Figure 51. *LA-ICP-MS pattern for pyrite KA62_py-02 (640 ppm Ti; 2,468 ppm Co; 1,578 ppm Ni; 1,802 ppm Cu).*

Table 24. Correlation matrix (R > 0.7) for selected metals and trace elements measured in Kanmantoo iron sulfides from the new tailings storage facility (n=8).

	^{90}Zr	^{209}Bi	^{66}Zn	^{65}Cu	^{60}Ni	^{59}Co	^{49}Ti	^{55}Mn
^{90}Zr	1.00							
^{209}Bi	**0.81**	1.00						
^{66}Zn	0.60	0.80	1.00					
^{65}Cu	**0.76**	0.32	0.07	1.00				
^{60}Ni	**0.99**	**0.75**	0.54	**0.75**	1.00			
^{59}Co	0.24	0.25	0.25	-0.01	0.35	1.00		
^{49}Ti	0.64	**0.97**	**0.82**	0.09	0.57	0.20	1.00	
^{55}Mn	0.31	**0.78**	0.53	-0.10	0.21	0.01	**0.87**	1.00

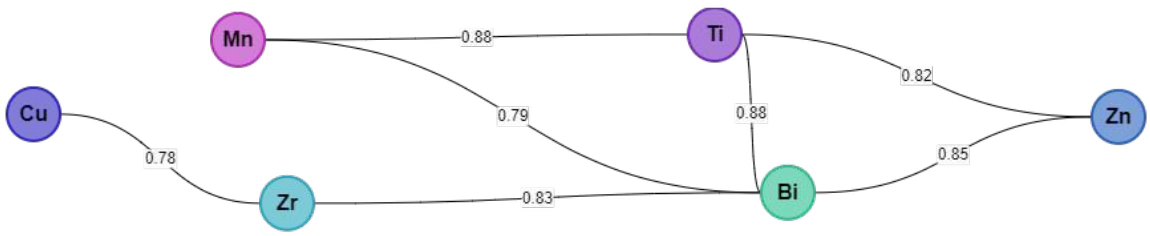

Figure 52. *Correlation diagram (r > 0.7) for selected metals and trace elements measured in Kanmantoo iron sulfides (n=8) from the new tailings storage facility. Diagram plotted in EzCorrGraph (Campos & Licht, 2021).*

Table 25. Correlation matrix (R > 0.7) for selected metals and trace elements measured in Kanmantoo iron sulfides from the old tailings storage facility (n=7).

	^{90}Zr	^{209}Bi	^{66}Zn	^{65}Cu	^{60}Ni	^{59}Co	^{49}Ti	^{55}Mn
^{90}Zr	1.00							
^{209}Bi	**0.81**	1.00						
^{66}Zn	0.60	0.80	1.00					
^{65}Cu	**0.76**	0.32	0.07	1.00				
^{60}Ni	**0.99**	**0.75**	0.54	**0.75**	1.00			
^{59}Co	0.24	0.25	0.25	-0.01	0.35	1.00		
^{49}Ti	0.64	**0.97**	**0.82**	0.09	0.57	0.20	1.00	
^{55}Mn	0.31	**0.78**	0.53	-0.10	0.21	0.01	**0.87**	1.00

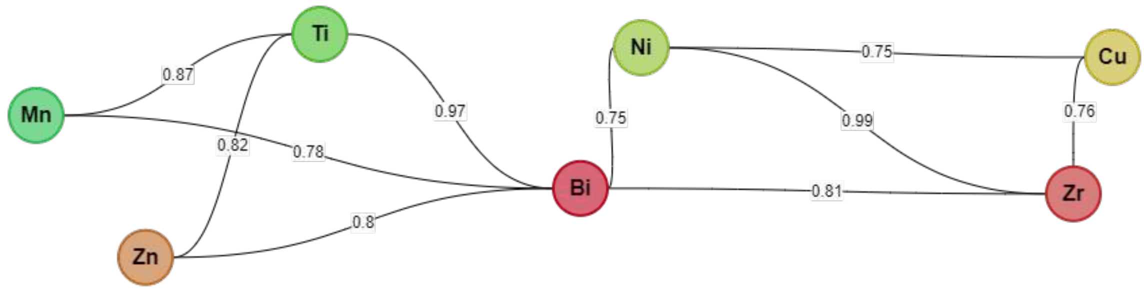

Figure 53. *Correlation diagram (r > 0.7) for selected metals and trace elements measured in Kanmantoo iron sulfides (n=7) from the old tailings storage facility. Diagram plotted in EzCorrGraph (Campos & Licht, 2021).*

6. Summary

The Kanmantoo mine is a copper-gold-(silver) deposit located approximately 44 km SE of Adelaide. The Kanmantoo tailings were sampled in March 2024, and 74 samples (36 tailings samples from the new tailings storage facility and 38 tailings samples from the old tailings storage facility) were collected in total for geochemical analysis.

Based on the bulk chemical assay of the tailings, Cu is the most enriched base metal, followed by Bi, Co and Mn. **Copper and Bi have been identified as being present in the Kanmantoo tailings at concentrations greater than 10 times the average crustal abundance** (Table 26).

The old tailings storage facility is more enriched than the new tailings storage facility, with higher concentrations of Cu, Co, Bi and Mn.

- Ten samples enriched with Cu, Co, Bi, Mn were chosen for extended mineralogical analyses.
- X-ray diffraction and MLA analysis show that the Kanmantoo tailings samples from the new tailings storage facility contain (in order of abundance) quartz, garnet, biotite and magnetite. Minor phases include muscovite-illite, chlorite, andalusite, staurolite, pyrite, chalcocyanite and hematite.
- The mineralogy of the Kanmantoo tailings samples from the old tailings storage facility contain (in order of abundance) garnet, quartz, biotite and chlorite. Minor phases include magnetite, muscovite-illite, andalusite, jarosite, staurolite, goethite, mixed-layer clay, pyrite, chalcocyanite and hematite.
- Laser ablation-ICP-MS analysis show that garnet is the main host for critical and base metals in the Kanmantoo tailings.
- Compositional characterization of garnet grains reveals an endowment with Mn, Zr, Bi and Ti. In addition, garnet grains in Kanmantoo tailings are also hosts of a suit of REE, in particular LREE, including La, Ce, Pr, Nd.
- Compositional characterization of pyrite grains reveals they are endowed with Ni, Co and Cu.

Table 26. *Summary statistics for critical and base metals abundant in Kanmantoo (n=74).*

	Cu (ppm)	Co (ppm)	Bi (ppm)	Mn (ppm)
	n = 74			
Minimum	157	24.2	19.8	973
Maximum	2,700	131	447	6,730
Mean	745	75	76	3,118
Median	617	80	131	3,150
Crustal abundance *	60	25	0.0085	950
Times higher than average crustal abundance	12X	3X	8941X	3X

6.1 Critical mineral tenor

The summary statistics for critical, high-tech metals and rare earth elements listed by Geoscience Australia are shown in Tables 27 and 28, respectively, for all Kanmantoo tailings samples. **Relative to crustal abundance, average concentrations of As, Bi and Cu are more than ten times higher than their respective average crustal abundances** (Table 27). Summary statistics for REEs indicate that the average concentrations of REEs do not exceed crustal abundance values (Table 28).

Table 27. *Summary statistics for critical and base metals from Kanmantoo tailings (n=74).*

Element	Min.	Max.	Mean	SD	Crustal abundance (Rumble, 2021)
Ag (ppm)	0.1	1.1	0.5	0.3	0.075
Al (%)	5.2	8	6.7	0.6	8.23
As (ppm)	0.2	40.3	**2.2**	4.6	0.004
Be (ppm)	0.5	2.17	1.2	0.3	2.8
Bi (ppm)	19.8	447	**76**	64.8	0.0085
Co (ppm)	24.2	131	75	29.5	25
Cr (ppm)	65	96	76.2	8.3	102
Cu (ppm)	157	2,700	**745**	508	60
Ga (ppm)	12.9	23.5	16.6	2.5	19
Ge (ppm)	0.1	1.4	0.3	0.3	1.5
Hf* (ppm)	3.3	6.6	4.4	0.7	3
In (ppm)	0.2	0.5	0.3	0.1	0.25

Li (ppm)	15.3	26	20.4	2.0	20
Mg (%)	0.9	2.4	1.4	0.3	2.3
Mn (ppm)	973	6,730	3,118	1,653	950
Nb* (ppm)	8.2	19	12.5	2.8	20
Ni (ppm)	7.3	55.6	33.3	13.2	84
Sb (ppm)	0.1	2.2	0.1	0.3	0.2
Sc (ppm)	7.9	25.3	15.6	3.9	22
Sn (ppm)	3	10.5	5.8	1.6	2.3
Ta* (ppm)	0.7	1.5	1.0	0.2	2
Ti (%)	0.2	0.5	0.3	0.1	0.57
W (ppm)	3.2	36.8	8.6	6.1	1.25
Zn (ppm)	53	174	76.0	16.2	70
Zr* (ppm)	130	240	164.6	24.1	165

**data from ME-MS81 analysis*

Table 28. *Summary statistics for rare earth elements from Kanmantoo tailings (n=74).*

Element	Min.	Max.	Average	SD	Crustal abundance (Rumble, 2021)
Ce (ppm)	42.5	128.0	71.0	14.3	66.5
Dy (ppm)	4.4	14.2	7.6	2.4	5.2
Er (ppm)	2.2	9.6	4.9	2.0	3.5
Eu (ppm)	0.7	1.9	1.1	0.2	2
Gd (ppm)	4.3	9.1	5.8	0.8	6.2
Ho (ppm)	0.8	3.3	1.7	0.6	1.3
La (ppm)	22.0	63.0	35.4	7.3	39
Lu (ppm)	0.2	1.3	0.6	0.3	0.8
Nd (ppm)	19.8	51.9	30.2	5.9	41.5
Pr (ppm)	4.8	14.4	8.1	1.6	9.2
Sm (ppm)	3.6	10.6	5.9	1.1	7.05
Tb (ppm)	0.7	1.6	1.1	0.2	1.2
Tm (ppm)	0.3	1.4	0.7	0.3	0.52

6.2 Recommendations

- Based on this study, and considering the crustal abundance values, the main metals that could be further studied for their recovery potential in the Kanmantoo tailings are Cu and Bi. Copper is associated with iron sulfides, whereas Bi is associated with garnets. Additionally, mineral chemistry revealed Zr, Ti and REE's enrichment in garnet and Co endowment in iron sulfides.
- Further investigations into the garnet chemistry across the two TSFs at Kanmantoo are recommended to identify the mineral association with Bi, Ti, Zr and REE using electron microprobe analysis. This analysis was beyond the scope of this study.
- Given the association of Zr with garnet in the tailings, experimental studies (e.g., high tension and magnetic separation) should focus on the recovery of zircon as by-product from other heavy minerals such as garnet (Rao et al., 2024).
- Given the associattion of Ti and REE's with garnet in the tailings, the economic potential of heavy mineral sands (including staurolite and andalusite) within the tailings warrants further exploration (Mudd et al., 2016). It is worth noting that garnet sand may also be an unconventional resource for REEs (Klimpel et al., 2021).
- In this study, tailings were sampled to a depth of 6 m to examine the critical metal tenor. Sampling of the full thickness and additional in-depth characterisation of the tailings will better elucidate the grades and deportment of metals of the tailings at Kanmantoo, and also predict with more precision, models of grades and tonnages (Blannin et al., 2023).
- If deeper sampling reveals higher content of pyrite, then conventional flotation could be used as the *p80* (between 20 and 90 µm) of the sampled waste indicates pyrite falls within a suitable range (Whitworth et al., 2022).
- Biotite is distinctively high in some samples (KA62: 25 wt.%). Biotite is associated with rubidium (Rb). Although Rb is not considered a critical element, ion exchange leaching could be proposed to extract Rb from biotite (Zhengwei et al., 2023), resulting in the simultaneous extraction of Rb and recovery of mica minerals for other applications.
- Given the high average As concentration in the tailings (Table 27), sequential extractions and leaching tests should be conducted to evaluate the acid metalliferous drainage (AMD) potential of the tailings (Ruiz-Sanchez et al., 2023).
- In addition to the findings of the current project scope, it is important to consider the geo-environmental properties of the tailings and assess their potential environmental risks. Standard environmental testing such as synthetic precipitation leaching procedure (SPLP) or extraction methods such as the toxicity characteristic leaching procedure (TCLP) in addition to sequential extraction procedures are highly recommended to determine the presence of hazardous elements in the leachates.

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Appendix A

Kanmantoo sample information.

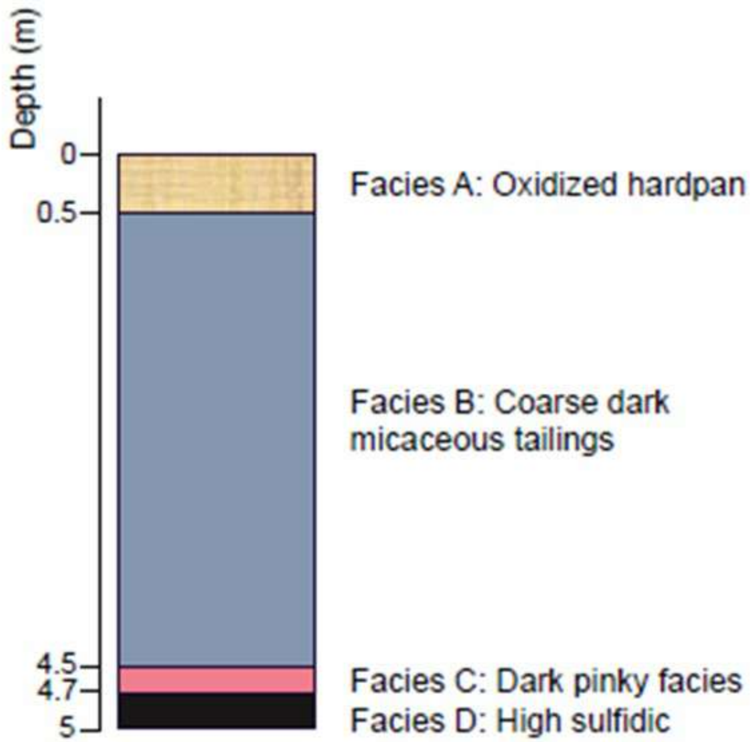
Sample ID	Sample type	Hole number	longitude	latitude	Depth from (m)	Depth to (m)
000	standard (OREAS 162)	–	–	–	–	–
KA1	New tailings	KA01	138.9919	-35.0839	0	0.5
KA2	New tailings	KA01	138.9919	-35.0839	0.5	1
KA3	New tailings	KA01	138.9919	-35.0839	1	2
KA4	New tailings	KA01	138.9919	-35.0839	2	3
KA5	New tailings	KA01	138.9919	-35.0839	3	4.5
KA6	New tailings	KA01	138.9919	-35.0839	4.5	4.7
KA7	New tailings	KA01	138.9919	-35.0839	4.7	5
KA8	New tailings	KA02	138.9897	-35.0869	0	0.4
KA9	New tailings	KA02	138.9897	-35.0869	0.4	1
KA10	New tailings	KA02	138.9897	-35.0869	1	1.45
KA11	New tailings	KA02	138.9897	-35.0869	1.45	2
KA12	New tailings	KA02	138.9897	-35.0869	2	2.5
KA13	New tailings	KA02	138.9897	-35.0869	2.5	3
KA14	New tailings	KA02	138.9897	-35.0869	3	3.5
KA15	New tailings	KA02	138.9897	-35.0869	3.5	4
KA16	New tailings	KA02	138.9897	-35.0869	4	4.5
KA17	New tailings	KA02	138.9897	-35.0869	4.5	5
KA18	standard (OREAS 522)	–	–	–	–	–
KA19	New tailings	KA03	138.9922	-35.0900	0	0.3
KA20	New tailings	KA03	138.9922	-35.0900	0.3	1.3
KA21	New tailings	KA03	138.9922	-35.0900	1.3	1.9
KA22	New tailings	KA03	138.9922	-35.0900	1.9	2.2
KA23	New tailings	KA03	138.9922	-35.0900	2.2	2.6
KA24	New tailings	KA03	138.9922	-35.0900	2.6	3.1
KA25	New tailings	KA03	138.9922	-35.0900	3.1	3.6
KA26	New tailings	KA03	138.9922	-35.0900	3.6	4.7
KA27	New tailings	KA03	138.9922	-35.0900	4.7	5
KA28	standard (OREAS 162)	–	–	–	–	–
KA29	New tailings	KA04	138.9944	-35.0855	0	0.5
KA30	New tailings	KA04	138.9944	-35.0855	0.5	1.8
KA31	New tailings	KA04	138.9944	-35.0855	1.8	2.1
KA32	New tailings	KA04	138.9944	-35.0855	2.1	3
KA33	Old tailings	KA05	139.0047	-35.08	0	1.3
KA34	Old tailings	KA05	139.0047	-35.08	1.3	2.2
KA35	Old tailings	KA05	139.0047	-35.08	2.2	2.7
KA36	Old tailings	KA05	139.0047	-35.08	2.7	2.9
KA37	Old tailings	KA05	139.0047	-35.08	2.9	3.2
KA38	Old tailings	KA05	139.0047	-35.08	3.2	3.5
KA39	Old tailings	KA05	139.0047	-35.08	3.5	4.3
KA40	Old tailings	KA05	139.0047	-35.08	4.3	4.7

KA41	Old tailings	KA05	139.0047	-35.08	4.7	4.9
KA42	Old tailings	KA05	139.0047	-35.08	4.9	5.7
KA43	Old tailings	KA05	139.0047	-35.08	5.7	5.9
KA44	standard (OREAS 522)	–	–	–	–	–
KA45	Old tailings	KA06	138.9997	-35.0808	0	1.9
KA46	Old tailings	KA06	138.9997	-35.0808	1.9	2.2
KA47	Old tailings	KA06	138.9997	-35.0808	2.2	2.7
KA48	Old tailings	KA06	138.9997	-35.0808	2.7	4.1
KA49	Old tailings	KA06	138.9997	-35.0808	4.1	4.2
KA50	Old tailings	KA07	139.0019	-35.0827	0	1.7
KA51	Old tailings	KA07	139.0019	-35.0827	1.7	1.9
KA52	Old tailings	KA07	139.0019	-35.0827	1.9	2.5
KA53	Old tailings	KA07	139.0019	-35.0827	2.5	3
KA54	Old tailings	KA07	139.0019	-35.0827	3	3.5
KA55	Old tailings	KA07	139.0019	-35.0827	3.5	4
KA56	Old tailings	KA07	139.0019	-35.0827	4	4.4
KA57	Old tailings	KA07	139.0019	-35.0827	4.4	4.6
KA58	Old tailings	KA07	139.0019	-35.0827	4.6	4.8
KA59	Old tailings	KA07	139.0019	-35.0827	4.8	5.6
KA60	standard (OREAS 162)	–	–	–	–	–
KA61	Old tailings	KA08	138.9981	-35.0828	0	0.8
KA62	Old tailings	KA08	138.9981	-35.0828	0.8	1.5
KA63	Old tailings	KA08	138.9981	-35.0828	1.5	2
KA64	Old tailings	KA08	138.9981	-35.0828	2	2.5
KA65	Old tailings	KA09	139.0022	-35.0827	0	2.1
KA66	Old tailings	KA09	139.0022	-35.0827	2.1	2.4
KA67	Old tailings	KA09	139.0022	-35.0827	2.4	2.7
KA68	Old tailings	KA09	139.0022	-35.0827	2.7	2.8
KA69	Old tailings	KA09	139.0022	-35.0827	2.8	3.4
KA70	Old tailings	KA09	139.0022	-35.0827	3.4	3.7
KA71	Old tailings	KA09	139.0022	-35.0827	3.7	4.2
KA72	Old tailings	KA09	139.0022	-35.0827	4.2	5.3
KA73	New tailings	KA10	138.9908	-35.0890	0	0.7
KA74	New tailings	KA10	138.9908	-35.0890	0.7	1.2
KA75	New tailings	KA10	138.9908	-35.0890	1.2	2.2
KA76	New tailings	KA10	138.9908	-35.0890	2.2	3.2
KA77	New tailings	KA10	138.9908	-35.0890	3.2	4
KA78	New tailings	KA10	138.9908	-35.0890	4	5
KA79	standard (OREAS 522)	–	–	–	–	–

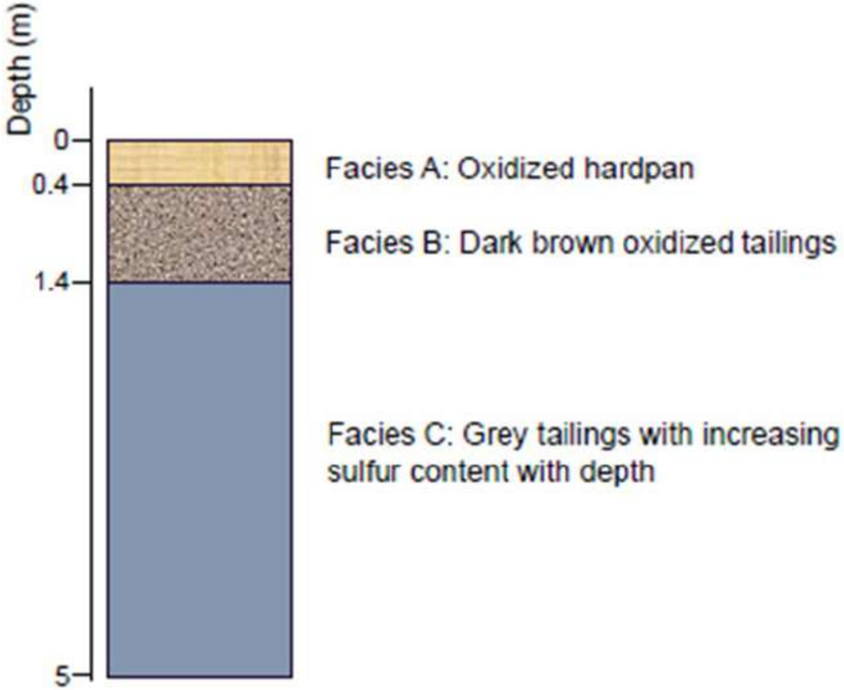
Appendix B

Tailings facies and location.

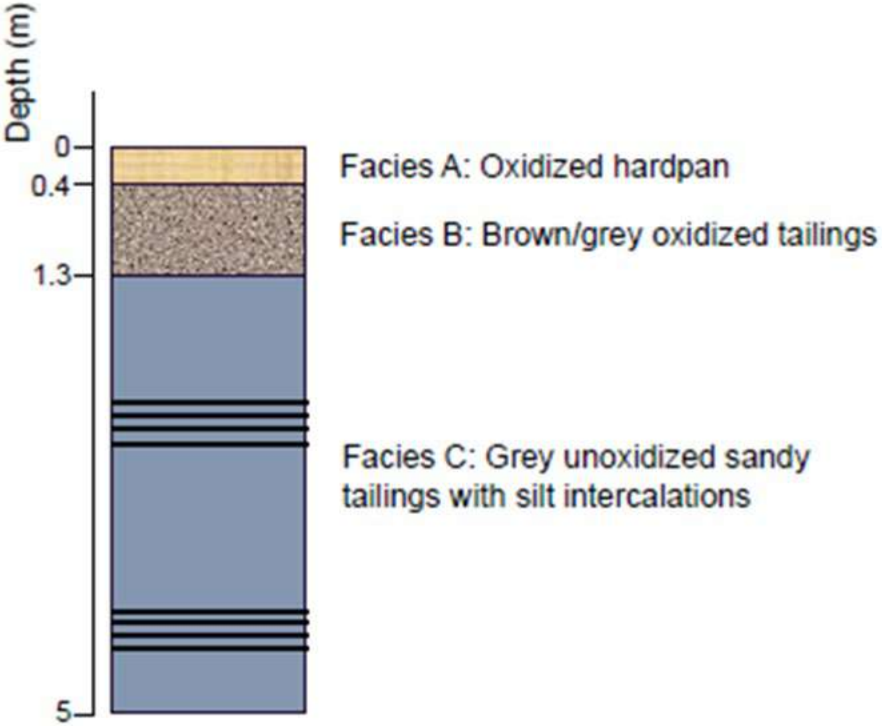
HOLE 1


Depth (m)
0
0.5
4.5
4.7
5
Facies A: Oxidized hardpan
Facies B: Coarse dark micaceous tailings
Facies C: Dark pinky facies
Facies D: High sulfidic

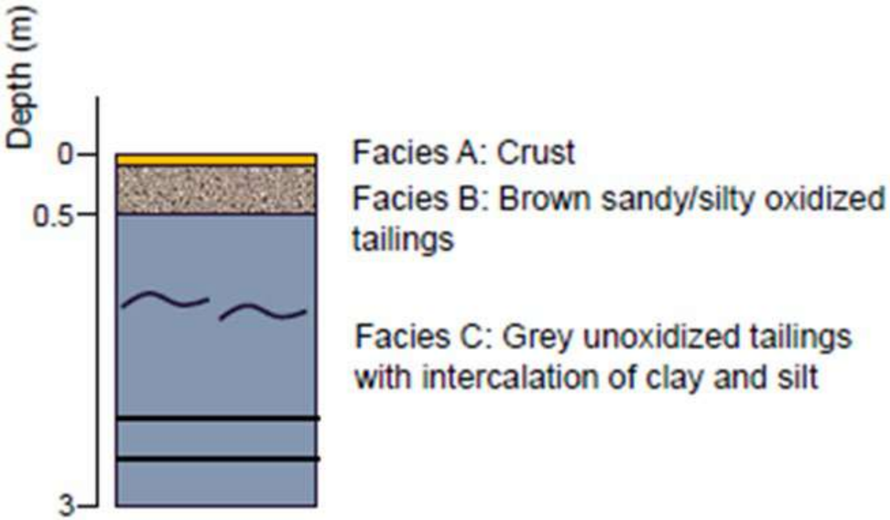
HOLE 2


Depth (m)
0
0.4
1.4
5
Facies A: Oxidized hardpan
Facies B: Dark brown oxidized tailings
Facies C: Grey tailings with increasing sulfur content with depth

HOLE 3

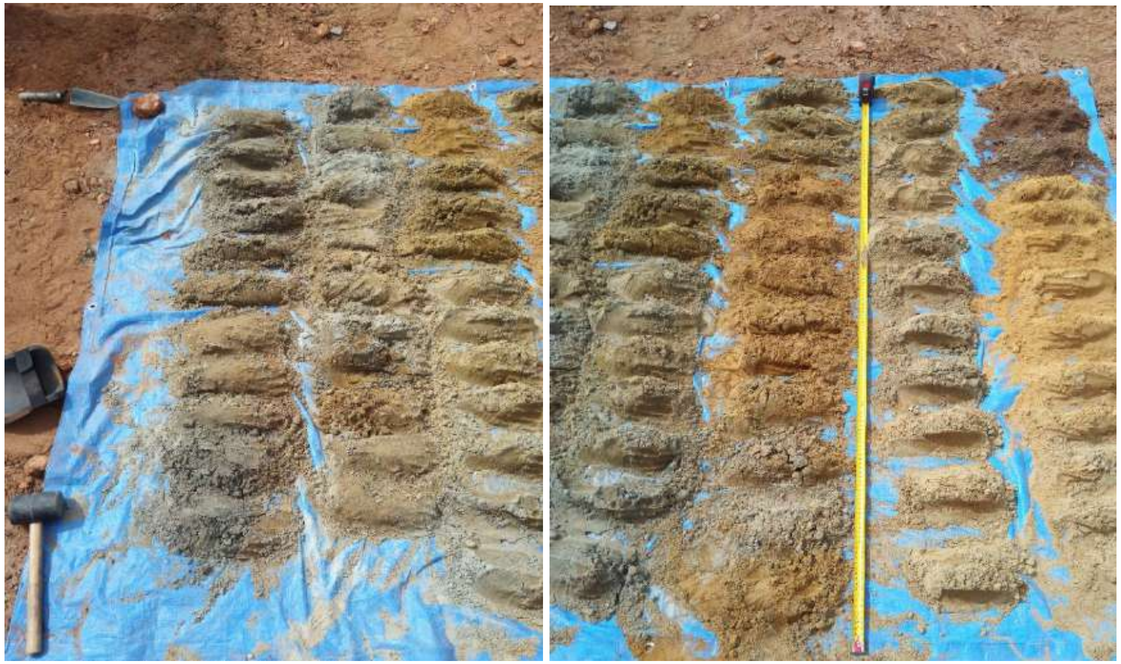

Depth (m)
0
0.4
1.3
5
Facies A: Oxidized hardpan
Facies B: Brown/grey oxidized tailings
Facies C: Grey unoxidized sandy tailings with silt intercalations

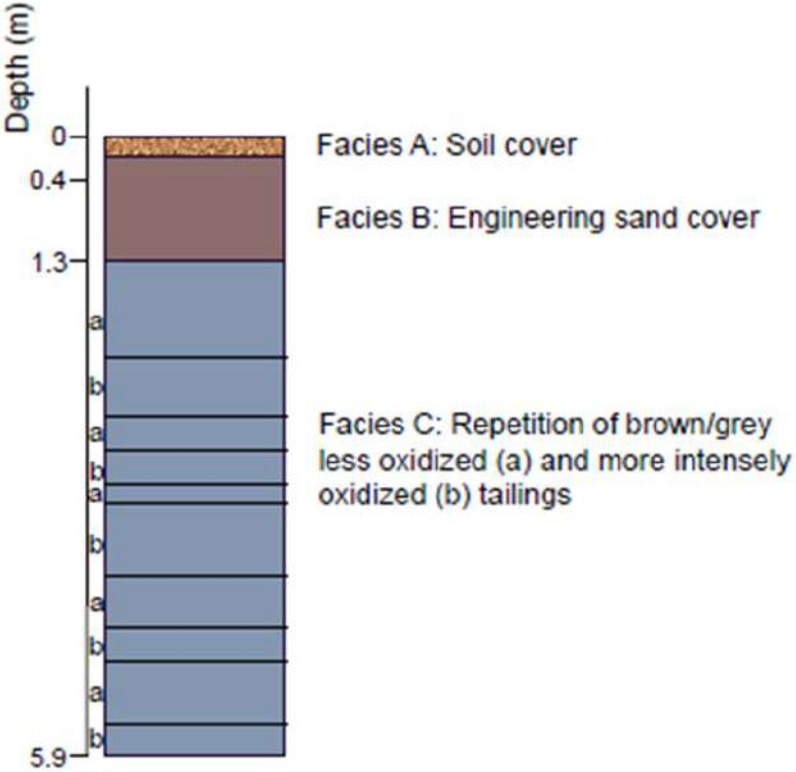
HOLE 4



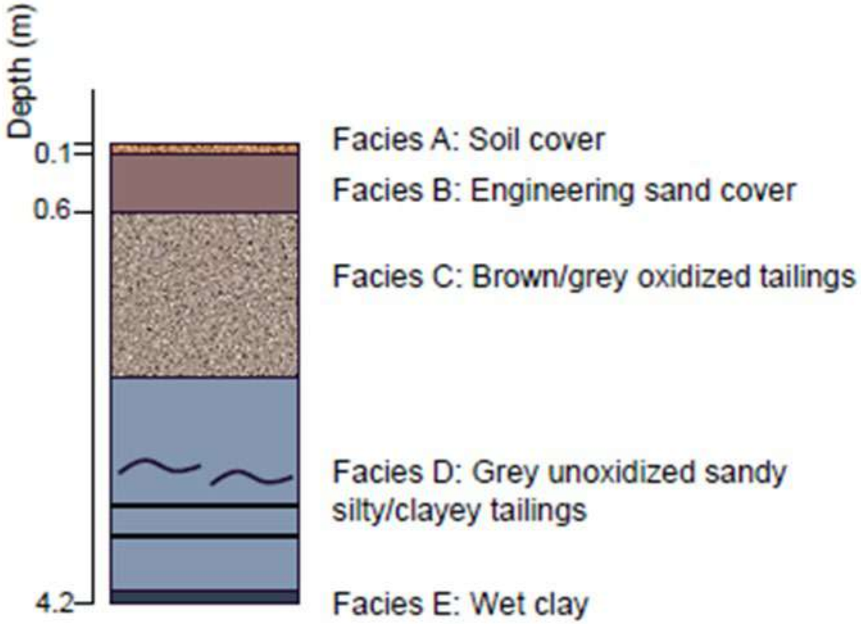
Depth (m)
0
0.5
3
Facies A: Crust
Facies B: Brown sandy/silty oxidized tailings
Facies C: Grey unoxidized tailings with intercalation of clay and silt

HOLE 5



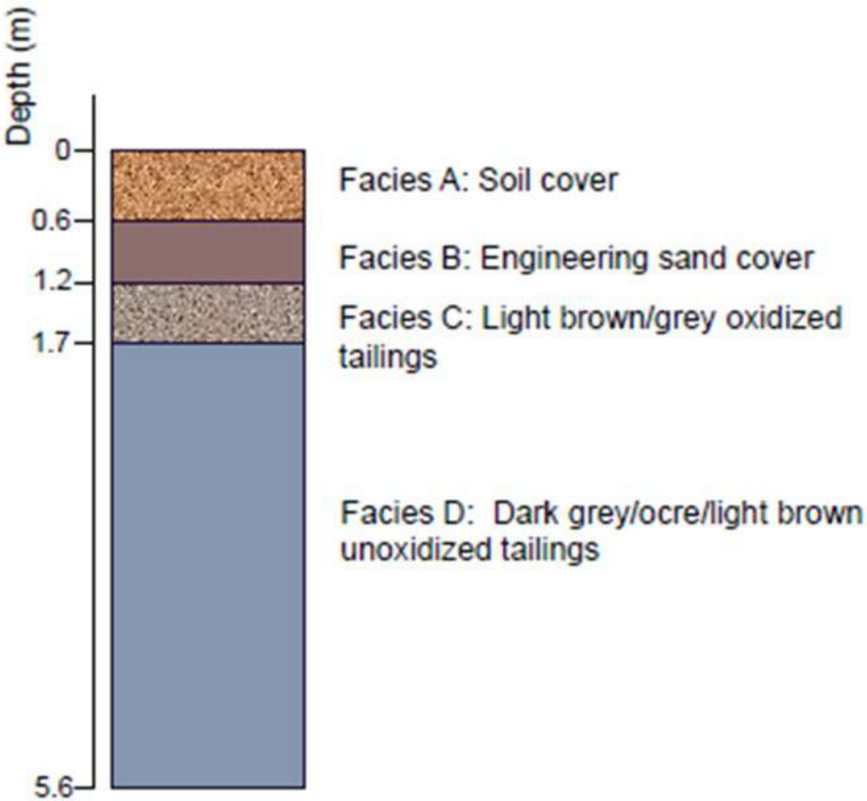

Depth (m)
0
0.4
1.3
5.9
a
b
a
b
a
b
a
b
a
b
Facies A: Soil cover
Facies B: Engineering sand cover
Facies C: Repetition of brown/grey less oxidized (a) and more intensely oxidized (b) tailings

HOLE 6

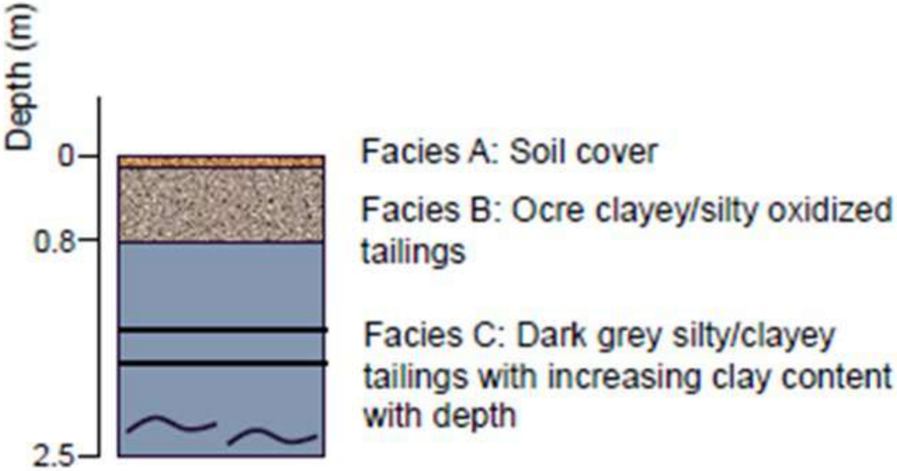


Depth (m)
0.1
0.6
4.2
Facies A: Soil cover
Facies B: Engineering sand cover
Facies C: Brown/grey oxidized tailings
Facies D: Grey unoxidized sandy silty/clayey tailings
Facies E: Wet clay

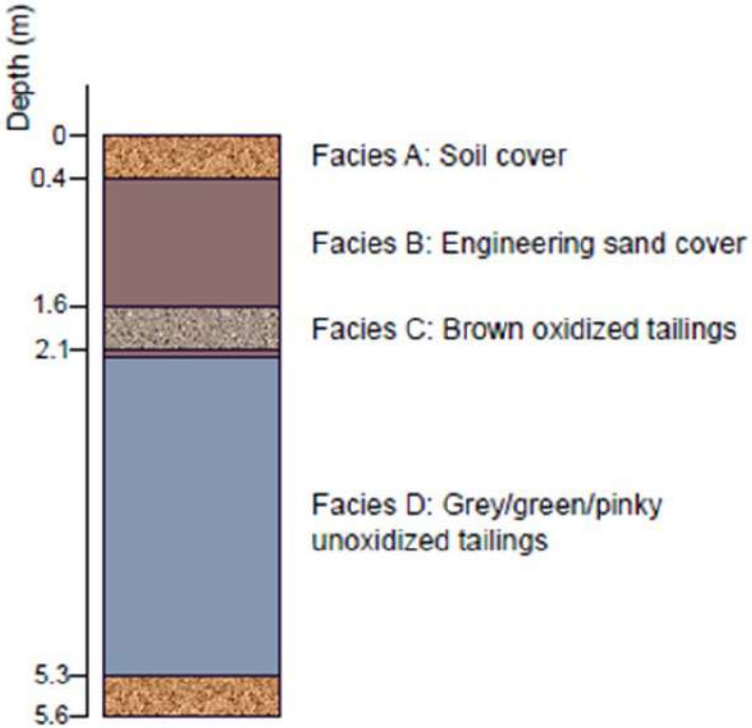
HOLE 7


Depth (m)
0
0.6
1.2
1.7
5.6
Facies A: Soil cover
Facies B: Engineering sand cover
Facies C: Light brown/grey oxidized tailings
Facies D: Dark grey/ocre/light brown unoxidized tailings

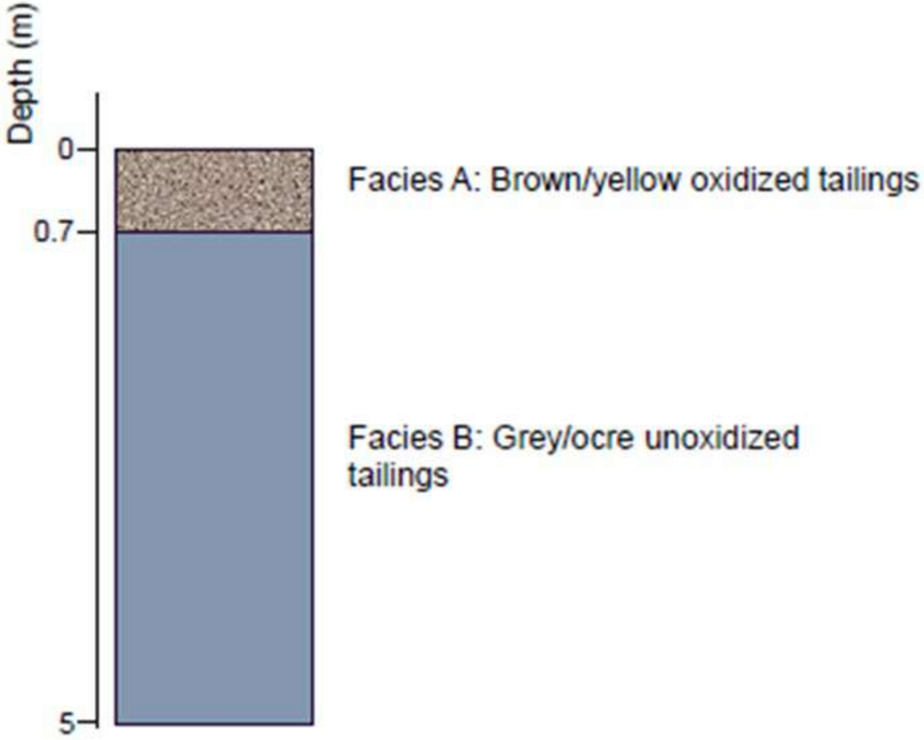
HOLE 8


Depth (m)
0
0.8
2.5
Facies A: Soil cover
Facies B: Ocre clayey/silty oxidized tailings
Facies C: Dark grey silty/clayey tailings with increasing clay content with depth

HOLE 9


Depth (m)
0
0.4
1.6
2.1
5.3
5.6
Facies A: Soil cover
Facies B: Engineering sand cover
Facies C: Brown oxidized tailings
Facies D: Grey/green/pinky unoxidized tailings

HOLE 10


Depth (m)
0
0.7
5
Facies A: Brown/yellow oxidized tailings
Facies B: Grey/ocre unoxidized tailings

Appendix C

Whole-rock geochemistry results.

SAMPLE DESCRIPTION	ME-MS61 Ag ppm	ME-MS61 Al %	ME-MS61 As ppm	ME-MS61 Ba ppm	ME-MS61 Be ppm	ME-MS61 Bi ppm	ME-MS61 Ca %	ME-MS61 Cd ppm	ME-MS61 Ce ppm	ME-MS61 Co ppm	ME-MS61 Cr ppm	ME-MS61 Cs ppm	ME-MS61 Cu ppm
000	3.13	0.86	1120	10	0.32	6.85	8.96	0.08	21.5	652	18	0.19	7610
KA1	0.12	6.12	1.3	230	1.31	23.5	0.2	<0.02	66.8	47.6	89	4.35	181.5
KA2	0.1	6.15	1.8	240	1.4	19.8	0.18	<0.02	66	83.5	86	4.17	157.5
KA3	0.15	6.43	2.1	210	1.35	34	0.19	<0.02	65.1	74.4	85	3.78	293
KA4	0.19	6.56	1.9	200	1.33	35.8	0.19	0.02	63.8	78.3	79	3.43	443
KA5	0.15	6.4	1.1	230	1.39	27.7	0.17	<0.02	64.5	83.1	80	3.72	307
KA5R	0.14	6.35	2.6	220	1.31	24	0.17	<0.02	63.8	79.5	78	3.61	321
KA6	0.27	6.8	1.8	170	1.25	32.4	0.16	<0.02	57.5	83.8	73	2.68	743
KA7	0.28	7.02	1	160	1.12	44.6	0.16	<0.02	61.6	92.9	73	2.42	705
KA8	0.13	6.19	1.6	210	1.18	27.6	0.16	<0.02	66.5	37.6	83	3.93	251
KA9	0.29	7.19	1.9	140	1.06	53.2	0.19	<0.02	66.3	43.8	74	2.51	695
KA10	0.21	6.81	1.7	180	1.36	38.5	0.2	0.03	65	89.2	81	3.06	509
KA11	0.12	6.62	1.4	210	1.42	47.1	0.17	<0.02	69	90.1	83	3.8	266
KA12	0.22	7.5	1.2	150	1.22	57.7	0.19	0.02	64.5	102.5	78	2.56	429
KA13	0.14	6.07	0.4	200	1.35	32.7	0.17	<0.02	53	91.6	82	3.07	302
KA14	0.18	6.58	0.4	200	1.29	27.1	0.17	<0.02	63.4	87	83	3.18	491
KA15	0.17	6.73	0.3	200	1.32	22.4	0.16	<0.02	62.3	86	80	3.06	398
KA16	0.28	7.3	0.6	150	1.27	33.1	0.17	0.03	58.2	80.1	77	2.31	813
KA17	0.23	6.06	0.2	160	1.15	43.6	0.15	0.02	50.2	96.5	79	2.18	518
KA18	3.18	0.86	1140	10	0.32	7.03	8.86	0.08	22.4	650	19	0.19	7650
KA19	0.23	6.5	1.6	170	1.09	26.2	0.16	<0.02	58.4	33.2	75	2.82	464
KA20	0.22	6.7	1.7	170	1.22	39.6	0.18	0.02	59.1	51.8	78	2.72	581
KA20R	0.24	6.01	1.8	150	1.2	38.5	0.16	0.02	49.3	46.6	73	2.31	593
KA21	0.17	6.2	1	200	1.42	33.4	0.17	<0.02	60.2	97.2	81	3.38	399
KA22	0.38	7.46	1.8	140	1.37	82.4	0.18	0.08	62.1	128	76	2.33	1085

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb
	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
000	8.06	2.68	0.16	0.7	1.395	0.16	11.8	8.9	5.42	1340	3.37	0.02	1.1
KA1	9.49	18.4	0.19	2.4	0.242	2.1	34.2	19.2	1.64	1110	1.34	0.08	13.9
KA2	9.62	18.15	0.18	2.6	0.241	2.09	33.2	20	1.7	1230	1.01	0.08	13.9
KA3	11.05	17.9	0.21	2.4	0.245	1.88	32.7	20.6	1.66	1735	1.09	0.07	13.5
KA4	11.7	17.15	0.24	2.3	0.254	1.71	31.8	20.6	1.56	2060	0.99	0.08	12.5
KA5	10.6	18.3	0.19	2.2	0.265	1.94	32.5	19.6	1.62	1585	0.9	0.07	13.6
KA5R	10.65	17.85	0.18	2.1	0.259	1.86	32	19.3	1.57	1705	0.97	0.07	13.2
KA6	12.9	16.5	0.2	2	0.271	1.42	27.9	19.4	1.45	2460	1.08	0.05	11.1
KA7	14.75	16.4	0.23	2.1	0.285	1.22	31.2	19	1.42	2980	0.99	0.04	10.8
KA8	10.5	17.7	0.2	2.2	0.236	1.9	33.4	18.8	1.54	1615	1.26	0.07	13.2
KA9	15.2	14.75	0.43	2.2	0.236	1.24	33.3	20.2	1.36	3880	0.95	0.05	10.6
KA10	12.6	15.95	0.21	2.2	0.238	1.57	32.1	22.2	1.47	2720	1.16	0.06	11.4
KA11	11	18.4	0.18	2.3	0.254	1.85	34.5	20.5	1.64	1795	0.77	0.06	13.5
KA12	16.05	15.75	0.47	2.6	0.243	1.25	31.6	21.3	1.42	3640	0.89	0.05	11
KA13	11.4	17.25	0.15	2.2	0.244	1.68	25.5	20.2	1.48	1925	1	0.06	12.7
KA14	12.3	17.2	0.2	2.3	0.288	1.7	31.7	19.7	1.54	2140	0.86	0.06	12.8
KA15	12.65	17.2	0.2	2.1	0.249	1.63	31.2	19.4	1.52	2280	0.86	0.05	12.6
KA16	14.45	15.85	0.32	2.5	0.27	1.24	29.1	19.7	1.39	2940	1.2	0.04	10.8
KA17	13.85	16.75	0.19	2.1	0.267	1.32	25.8	18.8	1.33	2570	0.86	0.05	12.1
KA18	8.28	2.62	0.08	0.7	1.37	0.16	11.6	9.2	5.31	1360	3.43	0.01	1.1
KA19	12.9	16.1	0.2	2.3	0.222	1.49	29.8	24.8	1.32	2610	1.02	0.07	11.7
KA20	13	15.65	0.29	2.2	0.231	1.44	29.4	20.1	1.35	2770	1.06	0.06	11.2
KA20R	12.3	15.4	0.13	2.1	0.226	1.3	24	19	1.2	2660	1.2	0.05	10.8
KA21	10.85	16.75	0.1	2.4	0.239	1.78	28.9	21.1	1.5	1795	0.8	0.06	12.9
KA22	15.6	16.3	0.32	2.2	0.3	1.2	31	22.7	1.3	3810	1.2	0.05	10.8

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
000	13.8	190	347	4.3	<0.002	4.16	15.9	1.5	<1	0.5	15.8	0.09	0.05
KA1	28.1	590	13.8	134	<0.002	0.42	0.1	11.3	1	7.1	11.9	0.97	0.12
KA2	45.9	600	13.4	130	<0.002	0.6	0.07	11.7	1	6.7	11	0.97	0.1
KA3	37.1	600	12.9	115	<0.002	0.78	0.09	12.5	1	6.5	10.6	0.96	0.11
KA4	37.9	580	12.6	107.5	<0.002	0.9	0.08	13.7	1	6.3	11.4	0.91	0.1
KA5	39.9	590	10.6	117	<0.002	0.66	0.09	12.9	1	6.2	10.6	0.98	0.11
KA5R	39.1	580	10.4	113	<0.002	0.67	0.07	12.9	1	5.9	10	0.93	0.11
KA6	38.5	520	8.4	86.9	<0.002	0.88	0.11	14.4	1	4.6	8.1	0.78	0.11
KA7	37.1	550	7.6	79.2	<0.002	0.94	0.07	16.3	1	4.4	7.5	0.79	0.14
KA8	21.4	580	12.4	120.5	<0.002	0.39	0.08	12.6	1	6.6	10.4	0.92	0.1
KA9	19	620	9.7	77.8	<0.002	0.83	0.1	18	2	4.6	8.1	0.82	0.14
KA10	41.1	600	11.5	96.9	<0.002	0.89	0.1	14.9	1	5.3	9.4	0.83	0.12
KA11	47.5	600	11.8	117	<0.002	0.64	0.07	13.2	1	6.3	10.4	0.96	0.12
KA12	49.3	630	8.8	80.7	<0.002	1.06	0.11	18.5	1	4.5	8.3	0.83	0.11
KA13	44	580	10.3	82.9	<0.002	0.75	0.1	12.7	1	6.1	9	0.91	0.09
KA14	39.5	610	9.2	105.5	<0.002	0.8	0.08	14	1	5.3	9.6	0.92	0.09
KA15	39.2	590	8.2	101.5	<0.002	0.77	0.09	14.7	1	5	8.7	0.91	0.08
KA16	34.8	590	7.4	76	<0.002	0.87	0.09	15.9	1	4.1	8	0.83	0.12
KA17	38.1	580	8.8	61.5	<0.002	0.94	0.09	13.7	2	4.7	8.5	0.88	0.09
KA18	13.4	200	334	4.3	<0.002	4.18	16.25	1.5	<1	0.5	15.4	0.09	<0.05
KA19	16.8	570	10.4	92.3	<0.002	0.47	0.1	15.2	1	6.4	9.9	0.86	0.1
KA20	24.3	590	10.4	87.7	<0.002	0.68	0.1	15.1	1	5.5	9.1	0.81	0.07
KA20R	22.8	540	10	64	<0.002	0.65	0.11	14.1	1	5.2	8	0.81	0.1
KA21	46.7	590	12.1	96.5	<0.002	0.72	0.09	12.2	1	6.7	9.5	0.94	0.08
KA22	55.6	610	11.2	67.4	<0.002	1.16	0.11	18.4	2	4.8	8.2	0.84	0.14

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Ba	Ce	Cr	Cs
	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
000	1.68	0.027	5.32	1	7	0.6	6.9	28	25.4	12.6	23.6	26	0.2
KA1	14.45	0.377	0.79	3	83	4.2	16.3	66	82.5	242	73	113	4.53
KA2	14.25	0.376	0.76	3.2	80	3.6	17.9	71	84.6	249	74.6	114	4.46
KA3	14.4	0.363	0.69	3.1	78	4.8	22.4	71	82.9	223	73.2	111	4.08
KA4	13.95	0.337	0.61	3	74	4.3	27.2	72	79.8	210	74.9	109	3.91
KA5	14.4	0.363	0.67	3.1	79	3.8	22.4	63	78.2	245	72.4	105	3.83
KA5R	14.05	0.354	0.65	3.1	76	4.5	23.8	64	76.8	244	73.9	111	3.95
KA6	13.4	0.305	0.47	2.7	66	4.8	31.3	70	68.1	177.5	60.2	95	2.92
KA7	14.25	0.293	0.42	3	63	6.1	37.9	68	72.4	152	64	97	2.45
KA8	14	0.356	0.7	2.8	77	5.3	22.7	66	78.9	222	69.7	106	3.98
KA9	14.3	0.304	0.46	2.8	61	9.9	46.3	65	78.3	150.5	74.3	101	2.61
KA10	14.05	0.33	0.56	3.1	69	4.3	33.8	75	79	197	74	108	3.5
KA11	14.7	0.363	0.66	3.3	79	3.2	25.7	72	80.1	227	73.8	109	4.01
KA12	14.65	0.314	0.45	3.5	65	5.4	44.8	77	85.3	151.5	70.3	98	2.89
KA13	11.6	0.35	0.61	3	78	4.3	21.6	69	76.9	213	67.2	103	3.74
KA14	14.45	0.353	0.57	3	75	4	27.1	65	80.3	204	67.3	105	3.43
KA15	14.1	0.345	0.54	3	76	4.4	29.3	67	82.8	212	70.3	109	3.45
KA16	14.2	0.308	0.42	2.9	65	8	37.6	72	75.7	157.5	65.6	102	2.7
KA17	10.8	0.32	0.45	2.9	72	7.9	27.6	66	76.5	173.5	71.2	107	2.84
KA18	1.73	0.027	5.4	1	7	0.6	6.9	29	25.6	13.2	24.3	25	0.18
KA19	13.45	0.32	0.52	2.6	69	7.3	34	62	80.4	183.5	65.8	103	3.31
KA20	13.15	0.321	0.5	2.7	69	6.7	32.7	69	77.3	178.5	69.2	103	3.2
KA20R	10.65	0.294	0.48	2.5	66	5.9	28.9	67	73.9	180.5	68.2	107	3.13
KA21	13.15	0.36	0.66	3.1	79	3.6	21.6	67	75.8	220	74.3	110	4.08
KA22	13.45	0.303	0.45	3.2	64	5.2	44.2	88	80.3	146	78.2	104	2.7

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Dy	Er	Eu	Ga	Gd	Hf	Ho	La	Lu	Nb	Nd	Pr	Rb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
000	1.87	0.84	0.76	2.7	2.92	0.85	0.33	12.1	0.07	1.48	11.7	2.82	3.7
KA1	4.56	2.31	1.1	21.9	4.93	4.75	0.77	35.1	0.36	14.9	30.9	8.2	140
KA2	4.55	2.67	1.18	21.9	5.77	4.85	0.9	36.2	0.33	15.25	32.4	8.1	145.5
KA3	5.15	3.29	1.09	22.3	5.37	5.15	1.19	36.3	0.37	15.05	32.3	8.18	127.5
KA4	6.09	3.82	1.18	22.5	6.27	4.48	1.24	40.1	0.45	14.15	32.1	8.47	113.5
KA5	5.36	3.22	1.14	22.5	5.91	4.57	1.07	36.4	0.31	14.4	30.9	8.47	127.5
KA5R	6.29	3.13	1.42	22.7	5.69	4.77	1.25	36.2	0.52	14.5	32.1	8.19	126
KA6	6.23	4.18	1.1	21.5	5.22	3.54	1.44	29.9	0.59	11.8	25.9	7.18	91
KA7	7.69	5.28	1.19	20.7	5.25	3.7	1.67	31	0.64	11.7	26.5	7.51	84.3
KA8	4.78	2.95	0.93	21.5	5.24	4.49	1.14	33.2	0.43	13.8	28.9	7.92	122.5
KA9	9.34	6.51	1.14	21.1	6.43	5.08	2.07	36.6	0.86	11.6	32.4	8.64	84.3
KA10	7.37	4.5	1.06	22	6.16	4.56	1.73	36.8	0.68	12.95	31.4	8.13	106
KA11	5.47	3.44	1.13	23.2	5.59	4.64	1.24	36.1	0.38	14.5	30.9	8.59	125
KA12	8.46	5.27	1.16	21	6.36	4.29	2.08	33.3	0.76	11.8	30.5	8.24	78.6
KA13	5.75	3.56	1.08	22.3	5.23	4.52	1.23	33.3	0.48	13.05	28.5	7.68	116.5
KA14	6.09	3.39	0.97	20.9	5.25	4.58	1.33	32.8	0.43	12.85	30.2	7.45	104
KA15	6.45	4.07	1.14	21.9	5.89	4.11	1.34	33.4	0.43	13.1	29.3	8.31	113
KA16	7.29	4.76	1.18	22	5.67	3.99	1.65	31.8	0.58	12.5	27.2	7.93	80.9
KA17	7.13	4.73	1.5	22.1	6.02	4.56	1.68	34.7	0.52	12.3	29.5	8.01	85.7
KA18	2.07	0.84	0.85	3	2.38	0.87	0.31	12.9	0.07	1.78	12.2	3.21	5.8
KA19	7.3	4.45	1.12	22.2	5.21	4.37	1.65	32.5	0.6	12.75	29.9	7.41	103
KA20	7.44	5.29	0.95	22.1	5.44	4.16	1.62	33.9	0.72	12.35	29.6	7.99	98.8
KA20R	7.19	5.17	0.98	23.2	5.63	4.44	1.62	34.8	0.69	12.55	30.2	7.76	94.4
KA21	5.09	3.13	1.08	22.3	5.88	4.47	1.26	35.2	0.44	13.6	30.4	8.19	119.5
KA22	9.91	6.44	1.36	22.8	6.78	4.92	2	43.1	0.87	11.55	34.8	9.21	79.7

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Sm	Sn	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
000	2.64	1.3	17.8	0.2	0.3	1.96	0.11	1.03	15	1	8.4	0.43	32
KA1	6.18	9.6	11.4	1.4	0.83	14.95	0.3	3.36	100	5.5	23.4	1.94	184
KA2	6.35	7.6	11.6	1.3	0.83	14.8	0.35	3.79	135	4.6	25.6	2.08	183
KA3	6	7.9	13.2	1.3	0.95	15.05	0.45	3.58	104	5.6	30.6	2.96	174
KA4	6.22	7.6	14.1	1.2	0.98	15.65	0.6	3.68	264	6.6	39.7	3.61	171
KA5	6.85	7.7	9.4	1.2	0.99	15.5	0.42	3.73	117	5.5	29.3	2.79	166
KA5R	6.52	6.6	10.2	1.3	0.93	15.75	0.54	3.44	122	5.9	31.9	3.34	173
KA6	4.32	4.6	8.4	1.1	0.96	13.65	0.59	3.14	82	6.4	39	3.62	149
KA7	5.24	5.6	8.3	1	1.08	14.1	0.74	3.16	78	7.5	46.4	4.59	142
KA8	5.84	7.2	11.4	1.3	0.73	14.85	0.42	3.2	91	6.5	29.7	2.67	165
KA9	6.37	5.7	9.3	1	1.13	14.8	0.95	3.36	95	11.8	54.9	5.66	181
KA10	6.11	7.3	11.7	1.1	1.2	15	0.64	3.83	84	5.5	42.9	4.62	177
KA11	5.71	7.6	10.8	1.3	0.99	15.65	0.49	3.78	99	3.7	32.8	3.16	175
KA12	5.38	5.6	10.6	1	1.39	15.05	0.91	3.98	76	6.3	53.9	5.71	169
KA13	6.08	7.7	10.7	1.1	0.89	14.5	0.51	3.43	91	4.5	33.9	3.17	165
KA14	5.51	6.7	10	1.1	1	14.6	0.56	3.26	88	4.8	35	3.18	162
KA15	5.6	6.3	9.4	1.2	1.02	15.2	0.61	3.59	90	5.6	37.5	3.67	160
KA16	5.76	5.6	9.2	1	1.13	14.55	0.67	3.4	80	11.5	47.5	4.79	150
KA17	5.77	5.8	10.4	1.1	1.08	15.15	0.61	3.57	89	10.2	41.8	4.23	170
KA18	3.17	0.7	15.6	0.2	0.36	1.85	0.09	1.18	42	1.3	9.5	0.52	33
KA19	5.02	9.2	10.8	1.1	0.94	13.45	0.6	2.87	93	9.4	43.7	4.51	162
KA20	5.68	8.1	9	1	0.98	14.65	0.63	3.25	95	8.4	44.9	4.17	168
KA20R	5.48	7.4	11.2	1.2	1.08	14.55	0.72	3.22	87	9.1	47.1	4.33	170
KA21	5.69	8.7	11.4	1.2	0.99	15.2	0.46	3.72	92	5.1	32.6	2.64	169
KA22	6.51	7.8	10.3	1	1.31	15.75	0.98	4.06	230	7.9	59.2	5.59	178

SAMPLE	pXRF-34	pXRF-34	pXRF-34
DESCRIPTION	Si	Ti	Zr
	ppm	ppm	ppm
000			
KA1	25.8	0.3	178
KA2	27	0.3	166
KA3	26.5	0.3	166
KA4	26.5	0.3	154
KA5	26.2	0.4	162
KA5R	26.8	0.3	160
KA6	22	0.3	139
KA7	26.7	0.3	153
KA8	26.9	0.3	166
KA9	23.8	0.3	164
KA10	25.3	0.3	176
KA11	27.2	0.3	159
KA12	25.6	0.3	152
KA13	26.1	0.3	159
KA14	26.6	0.3	164
KA15	27.2	0.3	154
KA16	27.3	0.3	156
KA17	27.7	0.3	173
KA18			
KA19	25.4	0.3	159
KA20	25.4	0.3	181
KA20R	25.3	0.3	174
KA21	26.6	0.3	166
KA22	26.5	0.3	171

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
KA23	0.2	6.57	2	200	1.4	55.5	0.2	<0.02	67.6	90.5	85	3.63	427
KA24	0.17	6.38	0.9	210	1.31	37.7	0.2	0.02	66.6	69.8	81	3.57	376
KA25	0.36	6.86	1.1	150	1.25	55.1	0.18	0.03	55.1	75.7	74	2.38	970
KA26	0.22	6.24	0.7	210	1.36	34.7	0.18	0.02	63.3	74.5	82	3.57	418
KA26R	0.16	5.91	1	200	1.32	29.5	0.18	<0.02	58	70.5	78	3.39	385
KA27	0.12	6.19	0.6	230	1.43	21.2	0.14	<0.02	57.5	81	87	3.38	241
KA28	1.22	3.83	499	230	0.7	8.64	3.56	<0.02	140.5	550	30	0.62	9010
KA29	0.35	6.64	2.3	170	1.14	44.2	0.23	0.07	59.7	43.5	78	2.93	794
KA30	0.25	6.58	1.6	200	1.45	33	0.19	0.03	62.5	87.4	84	3.4	623
KA31	0.25	6.63	1.9	190	1.41	72.4	0.22	0.03	60.2	76.3	81	3.21	572
KA32	0.21	6.51	1.3	190	1.4	39.3	0.19	<0.02	57.8	85.7	81	3.09	435
KA32R	0.2	6.89	1.2	200	1.41	38.2	0.2	0.02	63.1	86.7	83	3.19	470
KA33	0.63	7.97	1.5	70	0.68	447	0.15	<0.02	44	26.6	68	1.01	458
KA34	0.62	6.42	1.5	100	0.82	121.5	0.12	0.02	48.5	32	66	1.6	394
KA35	1.11	6.29	0.9	50	0.5	147	0.14	0.03	55.4	29.5	67	1	457
KA36	0.9	7.11	1.4	110	0.97	65.1	0.14	<0.02	62.3	29.3	69	2.02	461
KA37	0.91	5.75	0.9	70	0.65	201	0.16	0.16	65.7	33.7	67	1.3	477
KA38	0.56	5.44	0.9	120	0.76	115	0.15	<0.02	52.6	32.1	67	2.07	356
KA39	0.52	5.87	1.2	110	0.82	99.1	0.13	<0.02	50.8	31.6	66	1.87	594
KA40	0.52	5.91	1.4	130	0.95	71.2	0.12	<0.02	53.7	26	65	2.46	495
KA41	0.48	6.23	1.2	120	1.08	63	0.14	<0.02	53.9	24.2	67	2.31	608
KA42	1.01	6.57	0.9	110	0.83	125	0.18	<0.02	51.9	26.7	65	1.8	683
KA42R	0.79	6.51	1	120	1.09	114.5	0.17	<0.02	54.7	28.1	67	1.95	526
KA43	0.53	5.24	0.8	140	1.07	76.3	0.13	<0.02	40.4	29.3	66	2.48	619
KA44	3.34	0.85	1100	10	0.32	7.19	8.64	0.1	23.6	653	18	0.22	7510

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb
	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
KA23	11.9	17.55	0.19	2.3	0.264	1.76	33.5	20.9	1.53	2130	1.18	0.06	13
KA24	10.85	17.35	0.16	2.3	0.255	1.84	32.6	20.4	1.53	1765	0.99	0.06	13
KA25	14	16.15	0.26	2.3	0.293	1.27	27.4	20.8	1.33	3190	0.99	0.05	11.3
KA26	10.9	18.35	0.15	2.3	0.272	1.8	31.3	19.8	1.54	1685	1.08	0.07	13.3
KA26R	10.25	16.85	0.13	2.1	0.258	1.72	28.8	18.7	1.48	1515	0.96	0.07	12.5
KA27	10.4	18.5	0.15	2.3	0.258	1.9	29	19.1	1.57	1460	0.87	0.06	14
KA28	23.6	15.45	0.2	3	0.227	2.76	163.5	17.1	1.05	3940	194.5	0.63	5.8
KA29	13.65	16.55	0.2	2.2	0.262	1.44	29.7	20.7	1.37	2680	1.18	0.09	11.7
KA30	11.55	18	0.14	2.3	0.292	1.75	30.9	21.6	1.49	2090	1.23	0.07	13.2
KA31	12.3	17.4	0.13	2.4	0.271	1.63	29.8	21.3	1.44	2470	1.36	0.07	12.7
KA32	12.25	17.25	0.12	2.2	0.241	1.6	29	21	1.45	2300	1.04	0.07	12.2
KA32R	12.85	16.65	0.13	2.1	0.239	1.67	32	21.4	1.53	2400	0.9	0.07	12
KA33	22	13.2	1.27	2.1	0.258	0.53	22.6	22.1	1.11	6120	1.04	0.06	7.6
KA34	16.85	14.9	0.5	2	0.226	0.86	24.7	18.1	1.07	4410	0.79	0.04	9.2
KA35	21.7	14.8	0.94	2.2	0.234	0.49	28.4	16.6	0.93	5750	0.64	0.02	8.1
KA36	16.6	14.75	0.41	2	0.265	0.94	30.8	15.3	1.11	4680	0.94	0.04	8.6
KA37	19.25	15.55	0.61	2	0.203	0.66	33.1	16.1	0.95	4650	0.69	0.03	8.9
KA38	13.7	15.15	0.13	1.9	0.192	1.02	26.9	17.2	1.21	2920	0.63	0.05	9.6
KA39	14.2	15.45	0.11	1.8	0.182	0.94	25.6	18.3	1.16	3450	0.67	0.05	9.9
KA40	12.45	14.8	0.15	2	0.207	1.2	27.5	17.9	1.1	3140	0.81	0.05	9.9
KA41	13.4	14.6	0.14	2	0.195	1.16	27.2	19.4	1.08	3890	0.82	0.05	9.5
KA42	17.15	14.2	0.43	2.1	0.251	0.91	26.4	20.8	1.11	5200	1.19	0.06	9.1
KA42R	15.75	15.65	0.32	2.3	0.219	0.99	27.7	21.9	1.11	4290	1.17	0.1	9.5
KA43	11.9	15.4	0.11	2.1	0.167	1.22	21.3	19	1.09	2380	1.45	0.1	10.1
KA44	8.23	2.5	0.09	0.7	1.435	0.16	11.9	9.1	5.17	1330	3.45	0.01	1

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA23	40.3	590	13.6	113	<0.002	0.89	0.11	14.1	1	6.2	10.3	0.94	0.09
KA24	30.6	590	12.1	120	<0.002	0.6	0.09	13.3	1	5.9	10.2	0.95	0.08
KA25	38.2	600	9.8	69.1	<0.002	0.91	0.1	17.1	2	4.5	8.2	0.88	0.12
KA26	37.5	580	12	109.5	<0.002	0.68	0.09	12.9	1	6.3	11.2	0.95	0.1
KA26R	35.3	550	12	104.5	<0.002	0.65	0.1	11.8	1	6	10.9	0.91	0.08
KA27	38.6	590	9.6	100.5	<0.002	0.57	0.08	11.8	1	5.9	9.8	1	0.07
KA28	73.4	880	13.5	82.6	0.094	2.41	7.7	11.5	3	8.4	195	0.42	1.06
KA29	20.7	580	22.3	88.6	<0.002	0.7	0.16	15.5	1	7.5	10.3	0.84	0.11
KA30	42	600	13.2	101	<0.002	0.82	0.09	13.9	1	6.7	10.6	0.96	0.1
KA31	36.6	610	17.1	90.8	<0.002	0.88	0.1	14.3	1	6.9	10.4	0.91	0.14
KA32	38.1	590	12.6	88.9	<0.002	0.84	0.08	13.7	1	6.1	9.9	0.91	0.09
KA32R	37.1	600	12.8	101	<0.002	0.86	0.09	14.2	1	5.8	9.8	0.89	0.1
KA33	9.3	570	20.4	32.4	<0.002	0.54	0.1	25.3	3	3	7.1	0.63	0.34
KA34	12.2	510	14.4	45	<0.002	0.58	0.08	17.2	2	4.6	7.1	0.7	0.15
KA35	7.3	540	13.3	31.8	<0.002	0.57	0.08	19.4	4	4.8	5.2	0.65	0.21
KA36	11.9	520	10	60.2	<0.002	0.45	0.09	18.4	2	4.9	8.2	0.7	0.11
KA37	7.5	500	15.2	42.6	<0.002	0.57	0.1	16.2	3	5.6	6.9	0.68	0.17
KA38	13.2	470	14	62.1	<0.002	0.41	0.07	12.4	2	5.4	7.7	0.74	0.14
KA39	12.5	490	14.4	61.2	<0.002	0.56	0.07	14.6	2	4.3	7.1	0.72	0.16
KA40	12.4	500	14.1	80.4	<0.002	0.46	0.1	14.1	2	4.7	8.3	0.73	0.13
KA41	11.8	490	13.4	75.4	<0.002	0.55	0.1	14.8	2	4.5	7.6	0.72	0.14
KA42	10.8	540	21.4	58.2	<0.002	0.58	0.08	19.7	2	4.7	11.1	0.72	0.22
KA42R	13	510	19.8	64.5	<0.002	0.5	0.1	17.4	2	4.9	14	0.73	0.18
KA43	15.1	470	19	75.9	<0.002	0.49	0.09	11.1	2	6.3	11.3	0.76	0.15
KA44	13	190	342	4.4	<0.002	4.04	16.95	1.6	<1	0.5	15.8	0.09	<0.05

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Ba	Ce	Cr	Cs
	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA23	14.3	0.352	0.68	3.1	77	4.3	26.8	76	78.4	224	76.9	115	4.03
KA24	14.55	0.361	0.66	2.9	78	3.9	23.9	67	79.6	218	73.5	108	3.96
KA25	13.45	0.311	0.48	3.1	65	7.2	36.3	72	82.6	168	69	101	2.83
KA26	14.15	0.356	0.64	3	79	4.8	22.6	71	89	229	70.8	109	3.92
KA26R	12.95	0.341	0.61	2.8	77	4.1	20.1	68	76.4	230	72.1	110	4.09
KA27	13.2	0.37	0.65	3	83	3.5	18.4	62	79.5	262	76.6	123	4.16
KA28	7.36	0.344	0.29	41.9	159	136	18.6	31	116	>10000	175.5	42	0.67
KA29	13.6	0.318	0.51	2.7	70	7.9	33.2	81	77.2	203	65.8	103	3.23
KA30	13.75	0.353	0.64	3.1	78	5.5	25.6	76	81.3	217	73.2	107	3.69
KA31	13.35	0.345	0.63	3.1	76	5	28.3	76	82.8	193	69.7	106	3.54
KA32	12.7	0.341	0.59	2.9	77	5.3	26.1	79	79.5	192	67.1	108	3.52
KA32R	14.05	0.355	0.56	2.9	77	4.9	28.2	81	75.3	195	67.2	105	3.42
KA33	13.1	0.23	0.21	2.6	57	18.2	60.6	59	74.3	66.2	46.8	88	1.04
KA34	11.1	0.26	0.34	2.3	64	10.4	41.5	68	71.4	109	57.6	88	1.84
KA35	12.05	0.246	0.2	2.3	76	36.8	59.3	53	73.3	51.6	56.3	84	0.97
KA36	12.6	0.261	0.36	2.4	61	12.1	51.1	79	67.8	108	64.9	91	2.17
KA37	11.5	0.258	0.24	2.3	78	35.1	47.2	65	68.6	71.6	65.9	86	1.41
KA38	11.2	0.285	0.39	2.2	71	20	29.2	61	67	120.5	56.9	87	2.26
KA39	11.25	0.278	0.35	2.3	70	8.5	33.8	65	66.8	114.5	50.1	91	1.92
KA40	11.4	0.284	0.46	2.2	65	7.5	33.9	62	69.7	130	56.5	87	2.64
KA41	11.55	0.277	0.42	2.2	63	5.7	41.2	72	76.4	127	56	88	2.53
KA42	12.75	0.266	0.34	2.4	65	10.2	54.3	64	74.1	102.5	55.5	87	1.89
KA42R	12.6	0.271	0.36	2.4	65	9.4	45.5	86	77.1	116.5	55.6	90	2.05
KA43	10.5	0.28	0.46	2.1	71	11.3	25.7	74	74.1	145.5	42.5	86	2.59
KA44	1.8	0.024	5.5	1	7	0.6	7	28	26.1	12.3	22.4	22	0.19

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Dy	Er	Eu	Ga	Gd	Hf	Ho	La	Lu	Nb	Nd	Pr	Rb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA23	7.01	3.82	1.26	23.1	5.85	4.42	1.38	37.9	0.62	14.05	32.9	8.87	138
KA24	6.15	3.45	1.19	22.9	5.59	4.74	1.22	36.2	0.45	14.3	33	8.4	126
KA25	8	5.7	1.41	22.5	6.04	4.57	1.84	32.7	0.74	12.2	29.8	7.87	92
KA26	5.76	3.1	1.28	22.2	5.78	5.11	1.13	35	0.4	14.15	30.2	8.12	128.5
KA26R	5.42	2.78	1.32	22.6	5.46	4.4	0.98	34.8	0.34	14.45	31.1	8.59	131
KA27	5.09	2.85	1.14	23.9	6.52	4.85	1.15	38.3	0.39	15	31.9	9.01	132.5
KA28	3.46	2.33	1.96	16.9	4.71	3.22	0.8	236	0.41	6.78	31.6	11.5	83.1
KA29	7.48	4.33	1.04	22.3	5.42	3.91	1.43	31.5	0.56	12.95	27.8	7.8	100.5
KA30	5.83	3.29	1.08	20.9	5.58	4.3	1.29	35.3	0.42	13.3	30.6	8.13	120.5
KA31	6.81	3.93	1.01	22.4	5.27	4.2	1.37	34	0.52	13.05	30.3	7.94	112
KA32	6.6	3.5	0.93	22.3	4.85	3.99	1.28	33.4	0.5	12.9	26.9	7.65	105.5
KA32R	6.18	3.93	1.22	23	5.88	4.02	1.29	34.8	0.53	13.6	28.4	8.11	107.5
KA33	11.15	8.07	0.75	17.7	5.01	3.64	2.74	24	0.96	8.25	20.5	5.39	37.1
KA34	9.05	6.41	1.12	20.3	5.01	3.89	2.02	29.1	0.81	10.3	23.4	6.79	63.1
KA35	10.65	7.75	0.89	19.3	5.25	4.2	2.47	27.9	0.94	8.51	22.2	6.75	31.6
KA36	9.74	7.21	0.95	19.4	5.8	3.76	2.32	32.6	0.99	10.05	26.5	7.04	62.1
KA37	9.07	6.02	0.93	21.7	5.78	3.89	2.11	33.4	0.82	9.53	28.5	7.48	44.4
KA38	5.92	3.83	0.83	21.2	4.7	3.91	1.4	29.3	0.5	10.75	25.2	6.3	70.8
KA39	6.58	3.96	0.7	22.1	4.99	3.56	1.42	24.4	0.58	10.1	20.9	5.87	60.6
KA40	6.57	4.29	0.94	20.4	4.87	4.21	1.61	28.1	0.73	11.15	24.5	6.37	85
KA41	8.36	5.41	1.04	20.7	5.45	4.08	1.83	28.4	0.71	10.7	24.4	6.61	83.9
KA42	9.82	6.7	0.97	21	5.43	3.68	2.42	27.2	0.84	9.56	23	6.13	60
KA42R	9.25	6.09	0.98	21.1	5.18	3.39	2.06	28.6	0.75	10.5	22.4	6.32	65.8
KA43	5.42	3.2	0.87	20.7	4.29	3.89	1.28	22	0.47	10.3	19.8	4.8	85.2
KA44	1.65	0.86	0.84	2.9	2.74	1	0.25	12	0.1	1.45	12.1	2.8	3.7

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Sm	Sn	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA23	6.19	9	10.2	1.2	0.99	15.55	0.53	3.56	95	5.4	36.6	3.73	170
KA24	6.23	6.7	11.1	1.1	0.88	15.4	0.45	3.47	133	5.6	34.1	3.23	178
KA25	6.33	6.6	9.1	1	1.22	15.15	0.76	3.56	80	8.2	52.2	5.1	166
KA26	5.94	8	13.4	1.1	0.89	15.2	0.41	3.61	99	5.6	32.1	2.67	177
KA26R	5.15	7.4	12.8	1.2	0.88	15	0.44	3.71	106	4.9	28.5	2.87	174
KA27	6.43	6.7	10.4	1.3	1.06	16.3	0.46	4.03	114	5.9	31	2.79	177
KA28	4.22	12.1	253	0.6	0.71	9.02	0.32	45.7	228	152	22.1	1.91	126
KA29	5.2	9.7	11.2	1	0.96	14.45	0.67	3.17	88	10.9	42.2	4.12	153
KA30	5.3	7.8	9.6	1.1	0.92	14.95	0.51	3.39	90	6.3	35.6	3.34	166
KA31	5.39	8	10.5	1.1	1	14.8	0.67	3.2	86	5.5	37.8	3.87	161
KA32	5.51	8.5	9.4	1	1.01	14.25	0.59	3.36	93	6.5	34.5	3.22	153
KA32R	5.19	6.7	9.1	1.1	0.93	13.9	0.58	3.26	91	6.3	35.5	3.75	158
KA33	3.64	4.3	7.2	0.8	1.34	13.4	1.16	2.98	72	20.4	70.2	7.86	133
KA34	5.1	6.4	7.9	0.9	1.13	12.6	0.72	2.79	86	13.6	53.1	5.29	147
KA35	4.57	7.7	5.3	0.7	1.39	11.8	0.93	2.5	88	38	64.3	6.55	163
KA36	5.56	6	9	0.9	1.11	13.1	1.02	2.71	73	14.3	61.8	6.42	146
KA37	5.23	8.6	8.2	0.8	1.03	11.55	0.83	2.82	94	37.8	54.5	5.63	146
KA38	4.39	8.9	9.1	0.9	0.81	11.5	0.54	2.65	80	22.8	37.1	3.9	155
KA39	4.29	6	7.5	0.9	0.83	11.1	0.64	2.73	83	10	40.4	4.9	132
KA40	4.76	6.1	8.3	0.9	1.04	11.6	0.59	2.63	80	8.5	41	4.11	152
KA41	5.75	6.9	9.5	0.9	1.12	11.7	0.83	2.6	108	7.6	53.4	5.22	159
KA42	4.73	8.7	11.3	0.8	1.36	13.2	0.99	2.85	81	12.4	63.2	6.27	143
KA42R	4.32	8.2	14	0.9	1.35	12.5	0.85	2.77	81	10.5	54.5	5.87	140
KA43	4.27	11	11.2	0.9	0.84	10.65	0.46	2.38	81	11.7	33.1	3.52	150
KA44	1.94	1	15.7	0.1	0.34	1.96	0.1	1.12	14	1	8.5	0.6	37

SAMPLE	pXRF-34	pXRF-34	pXRF-34
DESCRIPTION	Si	Ti	Zr
	ppm	ppm	ppm
KA23	26.7	0.3	162
KA24	27.2	0.3	167
KA25	25.9	0.3	161
KA26	27	0.3	151
KA26R	27.6	0.3	155
KA27	26.5	0.4	154
KA28	17.3	1.1	119
KA29	24.8	0.3	142
KA30	26.5	0.3	162
KA31	26.8	0.3	148
KA32	26.4	0.3	146
KA32R	26.9	0.3	157
KA33	24.3	0.2	160
KA34	25.5	0.3	150
KA35	26	0.3	162
KA36	26.3	0.3	154
KA37	26.4	0.3	173
KA38	27.6	0.3	152
KA39	26.4	0.3	142
KA40	27.3	0.3	162
KA41	28.6	0.3	159
KA42	24.9	0.3	142
KA42R	26.7	0.3	152
KA43	29.6	0.3	152
KA44			

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
KA45	0.32	6.34	1	210	1.22	43.3	0.14	<0.02	60.5	38.5	78	3.18	601
KA46	0.46	7.57	1.5	230	2.14	50.3	0.18	0.05	108.5	80.6	92	4.2	2700
KA46R	0.35	7.06	1	230	1.62	46.7	0.18	0.02	95.2	98.3	84	4.34	939
KA47	0.31	6.63	0.9	230	1.44	41.5	0.17	0.03	82.3	86.5	78	4.24	391
KA48	0.45	7.41	1.3	230	1.62	63.3	0.2	0.04	113	100.5	85	4.46	377
KA49	0.63	7.58	1.6	270	2.17	74.8	0.33	0.04	125	87.3	89	4.63	627
KA50	0.86	7.39	4.7	80	0.85	255	0.17	0.06	59.9	59.2	66	1.43	1705
KA51	0.9	6.07	2.1	70	0.96	167.5	0.15	0.05	37.5	131	65	1.18	2020
KA52	0.92	6.29	3.3	80	1.02	127.5	0.15	0.03	49.5	111	68	1.39	1455
KA53	0.81	6.93	2.8	70	0.96	144.5	0.16	0.07	55.2	121.5	68	1.28	1370
KA54	0.53	6.65	2.6	120	1.38	70.4	0.12	0.02	66.2	103	70	2.1	601
KA55	0.81	5.91	1.5	110	1.12	103.5	0.12	0.02	56.5	93.6	66	1.97	877
KA56	0.75	6.96	4	100	1.4	84	0.15	0.03	72.7	128	71	1.87	722
KA57	0.96	7.14	2	90	1.17	114	0.15	0.04	63.9	116	69	1.88	1015
KA58	0.81	7.48	4.6	90	1.2	74.5	0.16	0.03	65.9	125.5	67	1.67	1070
KA59	0.61	5.78	3.8	130	1.28	67.4	0.12	<0.02	47.6	76.6	67	2.21	871
KA59R	0.83	7.14	4.2	90	1.19	77.3	0.16	0.05	64.9	127	67	1.71	1100
KA60	1.34	3.93	496	350	0.71	9.36	3.57	<0.02	154	575	29	0.67	9330
KA61	0.5	7.46	1.4	240	1.51	61.5	0.13	<0.02	92.6	59	93	4.07	568
KA62	1.06	7.44	40.3	240	1.84	83.7	0.17	0.27	88.6	108.5	87	4.35	1895
KA63	0.47	7.92	0.9	280	1.7	45.5	0.17	<0.02	89.4	82.8	96	5.15	1115
KA64	0.6	7.77	1.5	260	2.02	59	0.19	<0.02	109.5	81	93	4.83	1270
KA65	0.98	7.18	3.1	80	0.73	207	0.15	<0.02	67.9	32.1	67	1.56	684
KA66	0.88	7.26	1.3	90	0.98	108.5	0.15	<0.02	59.4	35.5	67	1.6	961
KA67	0.71	6.92	2	80	0.85	174.5	0.16	0.02	58.8	79.3	67	1.49	1370

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb
	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
KA45	10.7	15.7	0.09	2.1	0.294	1.87	30.1	20.7	1.89	973	0.56	0.08	12.6
KA46	10.3	21.9	0.25	3.1	0.429	2.14	53.4	23.5	1.94	1055	0.73	0.07	16.5
KA46R	10.4	21.8	0.23	3	0.308	2.1	47.1	22.3	2	1025	0.48	0.07	16.7
KA47	9.76	20.7	0.18	2.7	0.248	2.02	39.5	21.7	1.87	1035	0.51	0.07	16.2
KA48	11.2	23.5	0.33	3.3	0.302	2.12	53.8	22.4	2.1	1110	0.41	0.07	17.6
KA49	11.45	21.8	0.32	3.6	0.362	2.12	62.8	26	2.03	1490	0.83	0.23	16.3
KA50	20.2	13.4	1.42	2	0.313	0.65	29.9	23.1	1.06	6070	1.18	0.05	8.2
KA51	20.7	14.25	0.98	2.1	0.321	0.51	16	22.7	0.93	6010	1.81	0.04	8.2
KA52	19.25	13.65	0.54	1.9	0.266	0.65	22.3	19.2	0.94	5960	0.84	0.03	8.1
KA53	20.6	12.95	0.57	2	0.294	0.59	25.9	21.4	1.04	6730	1.03	0.03	7.8
KA54	14.05	15.8	0.16	1.8	0.2	1.08	32.4	18.9	1.21	3420	0.77	0.05	9.7
KA55	14.75	15.15	0.1	1.8	0.225	0.95	26.8	17.9	1.15	3570	0.76	0.04	9.3
KA56	17.05	15.7	0.24	2.1	0.227	0.97	36	22.7	1.15	4770	0.94	0.04	9.7
KA57	18.8	14.85	0.86	2	0.229	0.83	31.3	19.5	1.14	5290	0.87	0.04	8.7
KA58	19.15	13.85	0.89	2	0.214	0.79	32.6	18.8	1.15	5430	0.73	0.04	8.5
KA59	13.5	14.4	0.16	1.8	0.208	1.13	21.4	17.5	1.07	3740	0.8	0.05	9.4
KA59R	18.9	14	0.34	2	0.225	0.77	31.3	18.6	1.09	5300	0.79	0.04	8.6
KA60	24.4	15.65	0.3	3.2	0.247	2.85	174	17.6	1.05	3940	199	0.64	6.2
KA61	12.15	22.5	0.17	3	0.395	2.07	45.8	23.4	2.27	1035	0.76	0.1	16.6
KA62	12.2	22.1	0.21	2.7	0.498	2.12	41.5	24.3	2.29	1085	0.66	0.11	15.6
KA63	11.7	23	0.19	2.8	0.481	2.53	44.2	24.8	2.38	1025	0.59	0.1	18.2
KA64	11	23.1	0.27	3.3	0.459	2.33	52.1	23.9	2.11	1095	0.53	0.11	16.9
KA65	20.5	13.4	0.91	2	0.287	0.7	34	18.4	0.98	6720	0.86	0.03	8
KA66	18.7	14.05	0.51	2	0.297	0.8	29.8	20	1.05	5640	0.88	0.04	8.5
KA67	19.6	12.9	0.97	2.1	0.214	0.7	27.5	20.9	1.02	6620	0.77	0.04	7.9

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA45	21.6	660	17.8	100.5	<0.002	0.22	0.07	7.9	1	6.9	13.4	0.91	0.16
KA46	53.2	790	20.3	137	<0.002	0.48	0.08	11.6	2	9.2	20.7	1.18	0.16
KA46R	49.5	750	19.2	141	<0.002	0.42	0.06	11.3	1	8.7	17.2	1.23	0.1
KA47	47.5	710	18.7	137.5	<0.002	0.35	0.07	10.6	1	7.1	15.6	1.18	0.12
KA48	42.1	850	20.9	134.5	<0.002	0.45	0.06	11.6	1	9.8	17.6	1.29	0.15
KA49	45.3	820	26.6	138.5	<0.002	0.61	0.13	12	1	9.2	30.5	1.16	0.23
KA50	20.3	520	20	44.4	0.002	1.24	0.14	23.7	3	3.9	8.8	0.67	0.29
KA51	44.7	510	19.3	20.2	<0.002	1.74	0.12	24.6	3	4.3	8.5	0.66	0.24
KA52	43.9	510	13.1	30.3	<0.002	1.56	0.09	22.9	3	4.2	7.5	0.64	0.19
KA53	47.7	520	15.7	34.6	<0.002	1.58	0.09	23.8	3	4	6.9	0.64	0.23
KA54	36.4	480	11.2	69.6	<0.002	0.57	0.1	15.3	1	5.3	6.9	0.75	0.13
KA55	35.2	450	13	59.4	<0.002	0.82	0.08	15.1	2	6.4	6.3	0.73	0.13
KA56	52.9	520	15.2	65.1	<0.002	1.68	0.15	17.5	2	5.6	7.5	0.75	0.15
KA57	44.3	530	13.4	55.8	<0.002	1.2	0.09	20.1	3	4.7	7.6	0.69	0.17
KA58	49	540	9.4	53.4	<0.002	1.36	0.1	20.4	2	4.3	6.7	0.67	0.12
KA59	34.8	470	12.5	60	<0.002	0.79	0.07	17.4	2	4.4	8.8	0.73	0.14
KA59R	49.9	530	9.3	51.8	<0.002	1.36	0.1	20.5	2	4.4	7.1	0.69	0.17
KA60	75.2	880	13.8	87.4	0.103	2.46	8.43	12.2	3	9.3	195.5	0.45	1.21
KA61	32.1	720	21.9	127.5	<0.002	0.16	0.1	10.8	1	9	22.4	1.2	0.17
KA62	53.5	710	93.1	135.5	<0.002	0.63	2.25	10.9	2	10.3	19.1	1.13	0.23
KA63	46.4	780	25.3	166	<0.002	0.36	0.09	12.2	1	10.5	19.8	1.25	0.16
KA64	44.2	810	25.7	156	<0.002	0.45	0.11	12.2	2	9.7	21.6	1.23	0.23
KA65	9.7	540	15	47.5	<0.002	0.51	0.09	24.1	3	4.5	7.5	0.65	0.19
KA66	12.9	520	14.2	52.5	<0.002	0.68	0.08	22.8	3	4	8	0.67	0.19
KA67	35.8	540	20	38.7	<0.002	1.42	0.08	23.7	4	3.4	6.8	0.65	0.2

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Ba	Ce	Cr	Cs
	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA45	11.8	0.42	0.56	2.7	82	6.2	11.7	67	78.3	204	77.4	102	4.07
KA46	20.6	0.448	0.79	5.6	90	7.2	19.3	97	110	239	109	108	4.35
KA46R	18.3	0.445	0.8	4.3	85	7.3	15.8	84	111.5	238	90.7	106	4.27
KA47	15.95	0.429	0.75	3.9	84	5.2	16.4	82	97.3	230	75.8	103	4.16
KA48	21.1	0.465	0.82	4.8	90	8.4	16.3	89	117	239	109.5	109	4.47
KA49	24.4	0.441	0.77	5.2	84	7.9	21.6	106	123	265	128	109	4.41
KA50	13.5	0.229	0.27	2.7	57	11.9	67.5	71	72	81.6	59.8	86	1.44
KA51	11.8	0.217	0.26	3.1	58	13.9	57.8	82	74.2	74.7	56.4	91	1.34
KA52	12.05	0.232	0.29	2.9	64	12.1	61.8	81	69	81.6	65.4	92	1.46
KA53	12.1	0.229	0.26	2.8	64	12.3	63.2	76	70.2	67.8	64.4	89	1.32
KA54	11.4	0.277	0.4	3.1	68	9.8	36.2	98	64.7	128	64.6	95	2.18
KA55	10.6	0.266	0.38	2.8	70	16.4	35.3	77	64.1	114.5	60.5	92	2.03
KA56	13.1	0.273	0.37	3.2	69	11.6	48.6	108	75.2	101	69.9	91	1.71
KA57	13.1	0.252	0.33	3	66	16.5	56.1	81	72.1	88.9	62.8	90	1.71
KA58	13.45	0.246	0.32	3.7	60	12.3	58.2	103	71.5	85.1	63.5	87	1.72
KA59	10.1	0.264	0.45	2.8	65	4.5	36.5	78	64.6	147.5	64.1	96	2.44
KA59R	13.35	0.245	0.32	3.6	63	13.5	56.9	106	70.3	97	63	87	1.68
KA60	7.87	0.343	0.31	46.3	155	143.5	20.1	31	123	>10000	165	42	0.64
KA61	19.5	0.455	0.73	4.2	90	8.4	16.2	83	100	241	99	119	4.36
KA62	17.9	0.435	1.1	4.5	90	8.6	18	174	95.6	248	97.3	117	4.59
KA63	17	0.479	0.9	3.9	99	6.1	15.5	86	98.6	284	91.7	118	5.25
KA64	22.3	0.459	0.87	5	93	7	17.9	91	112	283	116	125	4.98
KA65	13.4	0.238	0.29	2.6	65	19.5	73.2	61	73.3	79.8	72.3	94	1.56
KA66	13.25	0.242	0.31	2.6	61	8.6	61.9	72	70.2	98.7	61.4	95	1.76
KA67	12.55	0.235	0.29	2.8	60	7.7	66.3	67	75.7	95	79	94	1.7

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Dy	Er	Eu	Ga	Gd	Hf	Ho	La	Lu	Nb	Nd	Pr	Rb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA45	4.53	2.18	1.32	24.6	5.83	5.05	0.85	39.2	0.26	16.8	33.1	8.56	126.5
KA46	6.27	2.89	1.92	26.3	7.94	5.65	1.12	53.7	0.31	17.85	46.7	11.95	143.5
KA46R	5.07	2.54	1.55	26.5	7.1	6.13	0.77	45.2	0.31	17.4	39.3	10.2	142
KA47	4.42	2.47	1.25	24.4	6.21	5	0.83	37.3	0.35	17.05	33.5	8.63	136.5
KA48	5.55	2.15	1.84	28.2	7.86	6.24	1.02	55.8	0.23	18	44.5	12.6	141
KA49	6.22	2.92	1.74	26.5	9.12	6.61	1.08	63	0.42	17.3	51.9	14.4	143.5
KA50	11.75	8.31	1.02	19.1	5.91	3.55	2.69	29.8	1.04	8.85	25.6	6.43	44.2
KA51	12.3	7.98	0.82	18.5	6.54	3.72	2.7	28.1	1.06	8.78	23.7	6.46	44.6
KA52	13.2	8.6	1.09	20.4	6	4.04	2.84	32.7	1.32	9.22	27.4	7.49	51.5
KA53	12.7	9.54	0.98	18.7	5.94	3.3	2.96	31.4	1.1	8.36	26.9	7.61	39.6
KA54	7.56	4.97	1.04	22.2	5.95	3.46	1.73	32.7	0.76	10.8	26.6	7.36	73
KA55	8.14	4.98	1	21.5	5.14	3.26	1.62	30	0.59	10.9	25.5	7.38	70.1
KA56	9.15	6.29	1.08	21.4	6.04	4.32	2.11	35.2	0.8	10.6	32	8.02	66.3
KA57	10.35	7.17	0.97	20.3	5.6	3.69	2.4	31	0.89	9.36	26	7.28	55.4
KA58	10.55	7.15	1.16	19	5.81	3.84	2.47	31.8	1	9.27	26.9	7.26	52
KA59	8.65	6.08	0.98	21.6	5.07	3.72	1.9	32.1	0.79	10.55	27.3	7.38	84.1
KA59R	10.75	7.08	1.06	18.9	5.25	3.85	2.32	31.5	0.97	8.69	26.5	7.55	55.6
KA60	3.48	2.1	1.93	17	3.95	3.04	0.77	225	0.38	6.72	29.1	10.65	84.1
KA61	5.2	2.61	1.66	29.4	7.29	5.78	0.95	50.5	0.34	17.85	41.7	10.85	137
KA62	5.93	2.86	1.38	27.9	7.24	5.58	1.03	48.6	0.4	17.45	42.5	11.1	151.5
KA63	4.61	2.44	1.3	28.9	6.53	5.69	0.9	45.4	0.3	19	40.4	10.6	165
KA64	5.89	2.64	1.5	28.1	7.84	6.23	1.04	59.5	0.44	19	47.6	13.55	168
KA65	12.55	9	1.12	20.3	6.25	4.26	2.98	36.5	1.22	8.95	30.6	8.94	47.3
KA66	10.95	8.66	1.05	22	5.63	3.49	2.69	31.7	1.09	9.61	25.6	7.47	55.8
KA67	14.2	9.62	1.16	19.4	6.79	4.03	3.32	40.4	1.26	8.82	34.9	9.03	51.5

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Sm	Sn	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA45	6.07	12.8	15.6	1.2	0.84	15.15	0.32	3.76	100	8.8	22.4	2.04	190
KA46	7.89	12.4	20	1.3	1.21	20.7	0.4	6.34	103	8.9	28.1	2.25	217
KA46R	6.99	10	17.2	1.3	1.06	17.7	0.36	4.7	103	8.3	23.6	1.91	208
KA47	6.82	7.2	15.1	1.3	0.87	14.7	0.33	3.89	97	5.8	22	1.94	200
KA48	8.77	12.4	16.6	1.4	1.04	20.4	0.36	4.94	106	9.6	25.4	2.21	240
KA49	10.55	13.2	30.7	1.3	1.22	23.9	0.41	5.59	91	9.8	29.8	2.43	235
KA50	4.69	6.2	9.9	0.7	1.39	13	1.31	2.86	72	12.8	76.9	8.1	137
KA51	5.51	6.1	7.4	0.7	1.48	12.45	1.2	3.08	75	15.7	75.7	7.67	133
KA52	4.74	6.4	7.4	0.7	1.45	12.9	1.18	3.42	79	13.7	78.2	8.32	138
KA53	6.03	5.8	8	0.7	1.39	12.6	1.29	3.17	80	13.5	80.2	8.31	130
KA54	5.75	6.6	8.1	0.9	1.08	12.3	0.7	3.51	82	11.6	45.7	4.09	134
KA55	5.15	9.2	6.9	0.9	1.03	11.6	0.73	2.98	81	18.1	44.5	4.49	138
KA56	5.2	8	7.5	0.9	1.21	12.65	0.92	3.53	80	13.3	54.6	5.48	159
KA57	5.14	5.5	8.8	0.8	1.33	12.85	1.04	3.31	80	18.1	63.9	7.09	142
KA58	6.08	4.3	7.7	0.7	1.36	13.1	1.08	3.86	74	13.8	65.7	6.59	143
KA59	5.38	6.4	11.2	0.9	1.12	12.05	0.82	3.16	80	5.2	53	5	136
KA59R	5.96	6.3	7.7	0.8	1.4	12.85	1.01	3.76	78	15	65.3	6.19	147
KA60	4.69	11.4	247	0.4	0.62	8.49	0.28	43.4	182	148	19.4	1.83	120
KA61	8.33	11.6	22.6	1.4	1.09	19.3	0.36	4.73	111	10	27.9	2.43	209
KA62	7.79	16	23.7	1.4	1.06	18.7	0.38	4.99	112	11.3	30.1	2.49	205
KA63	7.65	13.2	20.3	1.4	0.84	17	0.29	4.38	116	6.5	25.1	1.71	202
KA64	9.26	13.8	22.3	1.5	1.16	23.1	0.36	5.38	125	8.5	29.6	2.39	229
KA65	5.84	6.9	8.4	0.7	1.52	13.8	1.33	3.01	88	22.1	86.8	8.08	146
KA66	5.54	4.7	8.6	0.8	1.37	13.05	1.14	2.95	86	9.4	77.2	7.53	139
KA67	6.67	4.3	8.3	0.7	1.62	13.95	1.38	3.05	86	9.8	87.9	9.09	153

SAMPLE	pXRF-34	pXRF-34	pXRF-34
DESCRIPTION	Si	Ti	Zr
	ppm	ppm	ppm
KA45	25.1	0.4	202
KA46	24.1	0.4	219
KA46R	25.2	0.4	207
KA47	26.3	0.4	196
KA48	24.2	0.4	233
KA49	27.1	0.4	238
KA50	23.6	0.2	154
KA51	22.4	0.2	151
KA52	25.3	0.2	148
KA53	23.2	0.2	141
KA54	28.5	0.3	136
KA55	28.1	0.3	131
KA56	27.2	0.3	160
KA57	26.8	0.3	147
KA58	27.2	0.2	155
KA59	27.2	0.3	138
KA59R	26.7	0.2	153
KA60	17.6	1.1	125
KA61	25.5	0.4	214
KA62	25	0.4	196
KA63	25.9	0.4	188
KA64	26	0.4	217
KA65	24.6	0.3	147
KA66	24.9	0.3	145
KA67	25.4	0.3	160

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
KA68	0.6	6.71	4.4	140	1.23	119.5	0.12	0.02	70.6	53.7	73	2.33	910
KA69	0.78	6.56	3.1	110	0.97	97.2	0.13	0.03	73.7	74.1	70	2.05	1585
KA70	0.83	6.45	3.8	100	1.04	96	0.14	0.05	64.8	99.9	66	2	2110
KA71	0.86	7.12	2.5	100	0.96	94.6	0.14	0.05	63	101	70	1.92	1930
KA72	0.9	6.86	2.5	110	1.11	64.1	0.14	0.07	59.3	103	66	1.95	1080
KA72R	0.9	6.96	3.2	110	0.99	70.9	0.14	0.11	64.4	110	66	1.95	1280
KA73	0.18	6.27	1.4	210	1.31	41.1	0.16	<0.02	69.1	49.7	81	3.87	293
KA74	0.25	6.56	0.9	210	1.36	44.4	0.22	<0.02	72.9	77.9	82	3.65	450
KA75	0.15	6.4	0.4	220	1.44	34.2	0.17	<0.02	66.9	74.3	84	3.72	265
KA76	0.22	6.48	0.6	210	1.38	21.4	0.15	<0.02	63.6	79.5	80	3.39	421
KA77	0.34	7.73	1.7	150	1.4	88.6	0.22	0.02	68	105.5	80	2.35	831
KA78	0.24	6.2	1	190	1.21	35.1	0.14	<0.02	68.6	103	80	2.87	521
KA79	1.19	3.9	484	380	0.7	8.47	3.53	<0.02	131.5	543	30	0.59	9210
KA48R	0.37	7.38	1.3	230	1.59	59.3	0.21	<0.02	98.8	83	85	3.97	349

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb
	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
KA68	14.35	15.7	0.22	1.8	0.216	1.26	33.8	18.4	1.13	4040	1.06	0.04	10
KA69	16.1	16.3	0.35	2	0.241	0.94	36.4	22.5	1.14	4290	0.91	0.03	9.9
KA70	16.4	14.95	0.24	2.1	0.226	0.94	32.2	21.5	1.09	4720	1.65	0.04	9.7
KA71	17.8	14.45	0.7	1.9	0.242	0.91	31.4	20.3	1.19	4780	0.78	0.04	8.9
KA72	15.6	14	0.3	1.8	0.204	0.97	29.3	20.5	1.15	3980	0.84	0.06	9
KA72R	16.45	13.95	0.23	2	0.226	0.93	31.2	20	1.16	4450	0.87	0.05	8.7
KA73	10.75	16.7	0.1	2.4	0.237	1.84	33.8	19.4	1.45	1750	1.26	0.08	13.3
KA74	12.45	16.35	0.18	2.3	0.262	1.72	34.7	20.8	1.47	2430	0.86	0.1	12.7
KA75	10.7	16.7	0.08	2.4	0.253	1.9	31.8	20	1.54	1560	0.86	0.06	13.3
KA76	11.4	16.75	0.19	2.1	0.273	1.72	31.2	19.1	1.49	1820	0.91	0.05	12.9
KA77	15.5	16.4	0.22	2.2	0.294	1.34	34.6	22.2	1.41	3700	1.1	0.06	11
KA78	11.4	16.95	0.15	2.2	0.27	1.67	34.4	18.7	1.44	1750	0.82	0.06	12.6
KA79	23.2	15.1	0.28	2.8	0.207	2.76	158	17.1	1.03	3850	195	0.63	5.6
KA48R	10.6	22.1	0.19	3.1	0.262	2.11	51.3	22.4	2.04	1090	0.48	0.08	16.2

SAMPLE	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
DESCRIPTION	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te
	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA68	23	480	14.3	80.8	<0.002	0.73	0.11	17.4	2	4.8	11	0.79	0.16
KA69	28.7	500	13.8	68.4	<0.002	0.84	0.13	19	2	5.9	6.8	0.76	0.14
KA70	39.7	520	16.6	64.2	<0.002	1.52	0.2	18.5	2	4.9	7.3	0.74	0.16
KA71	33.5	510	12	59.8	<0.002	1.2	0.09	18	2	4.8	7.9	0.68	0.14
KA72	40.7	480	11.6	61.9	<0.002	1.21	0.09	16	2	4.6	8.2	0.69	0.14
KA72R	42.1	510	11.6	61.1	<0.002	1.3	0.08	17.6	2	4.7	8	0.68	0.13
KA73	26.3	590	13.6	120	<0.002	0.52	0.09	12.8	1	6.8	10.7	0.97	0.13
KA74	37.3	610	14.6	110.5	<0.002	0.78	0.1	15.2	1	6.2	13.8	0.94	0.1
KA75	36.8	600	11.1	118	<0.002	0.64	0.09	11.7	1	5.9	9.4	0.99	0.13
KA76	37.3	560	8.6	106.5	<0.002	0.64	0.08	12.9	1	5.4	8.6	0.91	0.11
KA77	43.6	660	9.9	81.7	<0.002	1.16	0.15	18.8	1	5.2	9.6	0.85	0.15
KA78	36.8	570	11.5	101.5	<0.002	0.97	0.09	11.6	1	6.1	9.8	0.89	0.1
KA79	69.1	890	12.6	78.6	0.092	2.43	7.53	11.1	2	8	188.5	0.4	1.05
KA48R	36	850	19	130.5	<0.002	0.43	0.09	10.6	1	8.4	16.1	1.14	0.13

DESCRIPTION	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Ba	Ce	Cr	Cs
	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA68	13	0.279	0.48	2.4	71	8.4	43.2	89	64.5	139	75.5	101	2.54
KA69	13.4	0.27	0.38	2.6	72	16.2	47.7	78	70.8	103	69.1	96	2.06
KA70	12.55	0.27	0.38	2.6	67	9.6	49	86	73.8	106.5	67.5	90	2.05
KA71	12.4	0.262	0.34	2.4	68	14.3	47.3	81	66.3	111.5	66.2	92	1.98
KA72	12	0.258	0.36	2.5	63	7.4	41.7	93	65.1	127.5	64.9	91	2.1
KA72R	12.05	0.259	0.37	2.6	60	8.4	47.3	81	68	121.5	73.7	98	2.22
KA73	14.75	0.354	0.72	2.9	77	4.3	23	66	82.4	216	72.2	113	4.15
KA74	15.45	0.35	0.64	3.2	73	5.1	31	72	81	214	74.1	110	3.81
KA75	14.85	0.366	0.65	3.1	77	3.4	20.8	69	81.5	228	70.4	109	3.93
KA76	14.45	0.337	0.57	3	74	4.1	24.2	66	71.8	215	66.6	107	3.56
KA77	14.65	0.329	0.48	3.3	67	6.3	44.5	90	85.7	144.5	73	103	2.73
KA78	13.55	0.345	0.52	2.8	71	4.4	24.2	62	76.4	198	73.6	105	3.11
KA79	6.85	0.344	0.27	39.7	151	124.5	17.9	31	111.5	>10000	171.5	40	0.7
KA48R	18.85	0.469	0.74	4.1	89	6.5	14.9	87	106	258	110.5	107	4.43

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Dy	Er	Eu	Ga	Gd	Hf	Ho	La	Lu	Nb	Nd	Pr	Rb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA68	9.28	6.21	1.18	21.4	5.3	3.33	1.86	36.7	0.76	11	29.8	8.55	86.7
KA69	8.57	5.82	1.23	21.8	5.54	4.37	1.71	35.6	0.62	10.2	29.3	7.94	67.7
KA70	9.11	6.21	0.97	21.9	6.09	3.81	1.99	34.8	0.85	10.05	29.3	7.71	66.7
KA71	8.92	5.99	1.16	21.5	5.32	3.51	2.16	33.6	0.86	9.35	28	7.99	61.5
KA72	8.54	6.17	1.14	21.7	5.54	4.08	1.9	32.7	0.72	10.45	28.6	7.63	67.6
KA72R	10.95	6.83	1.21	23.7	6.11	3.86	2.2	37.6	0.87	10.25	32.5	8.56	69.9
KA73	5.45	3.21	1.24	23.5	4.86	4.8	1.11	36.7	0.43	14.25	30.5	8.22	127
KA74	6.14	4.27	1.14	22.8	5.71	5.05	1.47	37.1	0.55	13.4	32.8	8.5	121
KA75	5.15	2.92	1.2	22.1	5.09	4.42	1.05	35.4	0.36	14.25	30.8	8.17	123.5
KA76	5.99	3.18	1.1	23.3	5.55	4.12	1.08	33.3	0.48	13.45	29.3	7.73	118
KA77	9.39	6.05	1.22	21.5	5.39	4.56	1.96	36.7	0.78	11.8	31.2	8.58	84.7
KA78	5.44	3.51	1.19	22.6	5.11	4.42	1.02	36.8	0.41	13.75	30.4	8.25	111
KA79	3.39	2.01	1.67	16.9	3.98	3.07	0.73	235	0.3	7	29.7	10.8	83.9
KA48R	4.88	2.18	1.59	26.9	7.15	6.26	0.84	55.4	0.26	18.2	48.3	12.5	146.5

SAMPLE	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
DESCRIPTION	Sm	Sn	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
KA68	5	5.9	12.2	0.9	1.16	13.3	0.85	2.62	91	10.2	55.3	5.42	142
KA69	5.37	7.1	7.1	0.9	1.07	12.15	0.78	2.61	95	18.8	49.4	4.72	150
KA70	6.23	6.7	7.3	0.9	1.07	12.55	0.8	2.98	84	10.7	56.9	5.63	159
KA71	5.23	5.7	9.5	0.8	1.2	12.6	0.89	2.66	84	15.7	60.3	5.78	140
KA72	4.83	7	10.9	0.8	1.03	13.1	0.78	3.01	80	9.5	54.2	5.24	148
KA72R	6.63	6.3	9.4	0.9	1.22	14.45	0.91	3.29	86	9.9	59.5	6.22	148
KA73	5.84	7.7	11.5	1.1	0.87	14	0.45	3.12	96	5.2	31.6	2.91	175
KA74	6.29	7.6	15.6	1.1	0.9	15.5	0.62	3.52	92	6	41	3.83	183
KA75	5.9	7.6	12.2	1.1	0.83	15.15	0.43	3.54	93	3.8	28.4	3.15	172
KA76	5.28	6.7	9.4	1.1	0.82	14.55	0.4	3.45	94	5.4	31.7	3.09	159
KA77	6.09	6.3	10	1	1.17	14.55	0.74	3.56	86	7.4	53.4	5.69	173
KA78	6.59	6.5	11	1.1	0.98	13.95	0.42	3.33	94	5.2	30	2.94	174
KA79	3.89	11	251	0.5	0.67	8.71	0.26	45.4	194	149	20.2	2.08	122
KA48R	9.71	12.2	17.2	1.4	1.07	20.7	0.28	4.93	107	7.9	24.7	1.87	238

SAMPLE	pXRF-34	pXRF-34	pXRF-34
DESCRIPTION	Si	Ti	Zr
	ppm	ppm	ppm
KA68	27.6	0.3	134
KA69	27.7	0.3	140
KA70	27.4	0.3	161
KA71	26.5	0.3	150
KA72	27.8	0.3	143
KA72R	26.4	0.3	139
KA73	25.8	0.3	169
KA74	27.5	0.3	165
KA75	28.5	0.3	156
KA76	28.3	0.3	158
KA77	26.9	0.3	178
KA78	28.3	0.3	179
KA79	17.8	1.1	124
KA48R	25.1	0.4	228

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Account: UNIQUE

CERTIFICATE AD24070918

Project: Kanmantoo tailings
P.O. No.: 4280008539
This report is for 89 samples of Tailings submitted to our lab in Adelaide, SA, Australia on 15-MAR-2024.
The following have access to data associated with this certificate:

FRANCESCO COLOMBI	LAURA JACKSON	ANITA PARBHAKAR-FOX

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
PUL-23	Pulv Sample - Split/Retain
BAG-01	Bulk Master for Storage
BAG-21	Raw Sample in a new bag
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LEV-01	Waste Disposal Levy
LOG-22	Sample login - Rcd w/o BarCode
DRY-22	Drying - Maximum Temp 60C
LOG-24	Pulp Login - Rcd w/o Barcode
OA-HSUL10	Handling of High Sulphide Samples
TRA-21	Transfer sample

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-MS61	48 element four acid ICP-MS	
ME-MS81	Lithium Borate Fusion ICP-MS	ICP-MS
pXRF-34	pXRF - Si, Ti & Zr Add on Package	PXRF

This is the Final Report and supersedes any preliminary report with this certificate number.Results apply to samples as submitted.All pages of this report have been checked and approved for release.
***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

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Brisbane QLD 4053
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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
Analyte	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOD	0.01	0.01	0.2	10	0.05	0.01	0.01	0.02	0.01	0.1	1	0.05	0.2	0.01	0.05
STANDARDS															
CGL 208															
Target Range - Lower Bound															
Upper Bound															
EMOG-17	66.2	4.53	578	510	1.75	5.43	1.90	19.00	46.2	762	53	6.99	8160	4.87	11.85
EMOG-17	66.3	4.56	571	660	1.82	5.73	1.85	19.15	47.8	769	54	7.15	8230	4.89	10.95
EMOG-17	69.6	4.66	575	970	1.81	5.57	1.97	19.85	46.3	766	58	6.42	8290	4.90	11.75
Target Range - Lower Bound	60.9	4.18	522	310	1.60	5.31	1.72	18.15	42.9	686	49	6.56	7750	4.42	10.75
Upper Bound	74.5	5.13	638	440	2.06	6.51	2.12	22.2	52.5	838	62	8.12	8910	5.42	13.25
GBM321-8	2.87	7.22	58.3	1140	1.50	1.54	3.79	1.70	110.0	27.8	151	3.84	3670	5.61	20.1
GBM321-8	2.86	7.28	55.2	1110	1.47	1.12	3.78	1.66	107.0	27.3	141	3.65	3650	5.47	19.75
Target Range - Lower Bound	2.60	6.40	50.2	930	1.27	1.12	3.33	1.53	99.0	24.0	125	3.44	3380	4.98	18.65
Upper Bound	3.20	7.84	61.8	1280	1.66	1.39	4.10	1.91	121.0	29.6	155	4.32	3890	6.10	22.9
MP-2a															
MP-2a															
Target Range - Lower Bound															
Upper Bound															
MRCA-21	8.13	7.67	20.0	1290	2.75	1.44	1.79	2.04	99.7	31.2	46	11.95	971	3.36	19.95
MRCA-21	7.81	7.42	17.9	1190	2.56	2.93	1.71	2.05	100.0	29.7	41	11.30	908	3.13	19.05
Target Range - Lower Bound	7.57	6.83	17.2	1050	2.51	1.39	1.58	1.99	92.7	28.0	38	10.75	877	3.05	18.75
Upper Bound	9.27	8.37	21.4	1440	3.17	1.73	1.96	2.47	113.5	34.4	49	13.25	1010	3.75	23.0
OREAS 120															
OREAS 120															
OREAS 120															
Target Range - Lower Bound															
Upper Bound															
OREAS 20a															
OREAS 20a															
Target Range - Lower Bound															
Upper Bound															
OREAS 460															
Target Range - Lower Bound															
Upper Bound															

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
Analyte	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOD	0.05	0.1	0.005	0.01	0.5	0.2	0.01	5	0.05	0.01	0.1	0.2	10	0.5	0.1
STANDARDS															
CGL 208															
Target Range - Lower Bound															
Upper Bound															
EMOG-17	0.19	1.9	0.882	1.63	24.0	26.9	0.95	735	1110	1.09	14.7	7570	790	7280	109.5
EMOG-17	0.08	1.8	0.886	1.64	24.6	26.9	0.91	749	1085	1.10	14.6	7560	790	7230	110.0
EMOG-17	0.17	1.8	0.926	1.67	23.6	26.7	0.95	753	1105	1.12	14.7	7710	820	7350	108.5
Target Range - Lower Bound	0.06	1.6	0.823	1.49	20.7	23.9	0.86	670	997	0.99	12.7	6820	700	6570	98.9
Upper Bound	0.30	2.2	1.015	1.85	26.4	29.7	1.08	830	1220	1.23	15.7	8330	880	8030	121.0
GBM321-8	0.16	3.8	0.074	2.14	56.4	11.4	1.86	830	64.4	2.24	11.1	2290	1010	2060	174.5
GBM321-8	0.16	3.6	0.067	2.14	54.8	11.4	1.82	806	62.4	2.20	11.2	2270	990	2040	167.5
Target Range - Lower Bound	0.12	3.3	0.064	1.87	49.0	9.8	1.61	715	57.9	1.93	9.5	2020	880	1845	153.0
Upper Bound	0.36	4.3	0.092	2.31	61.0	12.4	1.99	885	70.9	2.38	11.9	2480	1100	2250	187.0
MP-2a															
MP-2a															
Target Range - Lower Bound															
Upper Bound															
MRCA-21	0.15	1.9	0.121	2.88	53.1	61.4	0.73	8130	23.9	2.04	15.2	963	890	901	172.0
MRCA-21	0.14	1.8	0.113	2.74	54.1	57.7	0.68	7800	23.7	1.89	14.4	915	830	862	161.0
Target Range - Lower Bound	0.07	1.5	0.103	2.58	49.0	54.7	0.65	7330	22.5	1.79	12.9	849	770	816	154.5
Upper Bound	0.31	2.1	0.137	3.18	61.0	67.3	0.82	8970	27.7	2.21	15.9	1040	970	998	189.5
OREAS 120															
OREAS 120															
OREAS 120															
Target Range - Lower Bound															
Upper Bound															
OREAS 20a															
OREAS 20a															
Target Range - Lower Bound															
Upper Bound															
OREAS 460															
Target Range - Lower Bound															
Upper Bound															

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method / Analyte / Units / LOD	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1
STANDARDS															
CGL 208															
Target Range - Lower Bound															
Upper Bound															
EMOG-17	0.305	3.17	778	8.1	6	2.4	198.0	0.90	1.15	11.05	0.312	2.12	3.1	71	3.4
EMOG-17	0.308	3.13	789	8.1	6	2.5	201	0.93	1.28	10.65	0.310	2.15	2.9	70	4.0
EMOG-17	0.308	3.33	790	7.7	6	2.5	207	0.90	1.35	11.15	0.324	2.09	3.1	75	3.5
Target Range - Lower Bound	0.286	2.91	643	7.2	4	2.2	184.5	0.78	1.10	10.35	0.285	1.89	2.8	67	3.3
Upper Bound	0.354	3.57	869	9.0	9	3.2	226	1.08	1.46	12.65	0.359	2.61	3.7	84	4.7
GBM321-8	<0.002	0.40	1.78	20.1	1	2.9	293	0.76	<0.05	18.45	0.671	1.26	2.2	139	3.9
GBM321-8	<0.002	0.40	1.61	19.3	<1	2.9	293	0.80	0.06	17.40	0.665	1.21	2.1	134	3.0
Target Range - Lower Bound	<0.002	0.33	1.40	16.7	<1	2.7	258	0.64	<0.05	16.00	0.591	1.01	2.0	123	2.9
Upper Bound	0.005	0.43	2.01	20.7	2	3.9	316	0.92	0.15	19.55	0.733	1.41	2.6	153	4.1
MP-2a															
MP-2a															
Target Range - Lower Bound															
Upper Bound															
MRCA-21	0.012	0.43	27.2	9.4	1	4.7	175.5	1.14	0.11	15.00	0.369	1.20	3.9	65	11.3
MRCA-21	0.012	0.41	24.9	8.7	1	4.5	165.5	1.05	0.15	15.60	0.354	1.12	4.1	59	10.4
Target Range - Lower Bound	0.008	0.38	22.8	8.0	<1	4.3	156.5	0.98	<0.05	13.95	0.328	0.97	3.7	57	9.3
Upper Bound	0.018	0.49	31.0	10.0	3	5.7	191.5	1.30	0.23	17.05	0.412	1.37	4.8	71	12.9
OREAS 120															
OREAS 120															
OREAS 120															
Target Range - Lower Bound															
Upper Bound															
OREAS 20a															
OREAS 20a															
Target Range - Lower Bound															
Upper Bound															
OREAS 460															
Target Range - Lower Bound															
Upper Bound															

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32 Shand Street
Stafford
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INDOOROOPILLY QLD 4068

Finalized Date: 23-APR-2024
Account: UNIQUE

Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
Analyte	Y	Zn	Zr	Ba	Ce	Cr	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho	La
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
LOD	0.1	2	0.5	0.5	0.1	5	0.01	0.05	0.03	0.02	0.1	0.05	0.05	0.01	0.1
STANDARDS															
CGL 208				1110	98.9	63	16.90	6.82	3.85	1.24	27.8	7.63	3.68	1.33	45.1
Target Range - Lower Bound				935	83.9	41	14.75	5.70	3.32	1.11	23.3	6.41	3.15	1.16	39.2
Upper Bound				1145	103.0	67	18.05	7.08	4.12	1.40	28.7	7.95	3.97	1.44	48.2
EMOG-17	16.6	7530	68.2												
EMOG-17	16.2	7500	63.8												
EMOG-17	16.0	7530	64.4												
Target Range - Lower Bound	14.3	6800	55.6												
Upper Bound	17.7	8320	76.4												
GBM321-8	38.3	1095	149.5												
GBM321-8	37.5	1095	136.0												
Target Range - Lower Bound	33.7	961	117.5												
Upper Bound	41.4	1180	160.5												
MP-2a															
MP-2a															
Target Range - Lower Bound															
Upper Bound															
MRCA-21	17.6	856	60.1												
MRCA-21	16.9	807	60.2												
Target Range - Lower Bound	15.6	740	50.5												
Upper Bound	19.2	908	69.5												
OREAS 120				1035	45.4	50	0.71	2.72	1.48	0.98	10.1	3.11	6.43	0.50	20.9
OREAS 120				1045	48.1	49	0.71	2.39	1.36	1.14	11.4	3.40	6.56	0.44	22.4
OREAS 120				1005	45.9	43	0.71	2.63	1.60	1.06	10.5	3.11	7.27	0.53	21.7
Target Range - Lower Bound				875	41.6	35	0.65	2.11	1.24	0.91	9.5	2.69	5.32	0.42	18.9
Upper Bound				1070	51.0	59	0.81	2.69	1.58	1.15	11.9	3.39	6.62	0.54	23.3
OREAS 20a															
OREAS 20a															
Target Range - Lower Bound															
Upper Bound															
OREAS 460				844	1835	415	3.84	21.4	6.11	23.2	28.1	50.4	11.85	2.91	1355
Target Range - Lower Bound				727	1620	349	3.30	17.75	5.38	20.4	23.8	45.0	10.55	2.48	1230
Upper Bound				889	1980	437	4.06	21.8	6.64	25.0	29.3	55.1	13.05	3.06	1505

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Project: Kanmantoo tailings

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Lu ppm 0.01	ME-MS81 Nb ppm 0.05	ME-MS81 Nd ppm 0.1	ME-MS81 Pr ppm 0.02	ME-MS81 Rb ppm 0.2	ME-MS81 Sm ppm 0.03	ME-MS81 Sn ppm 0.5	ME-MS81 Sr ppm 0.1	ME-MS81 Ta ppm 0.1	ME-MS81 Tb ppm 0.01	ME-MS81 Th ppm 0.05	ME-MS81 Tm ppm 0.01	ME-MS81 U ppm 0.05	ME-MS81 V ppm 5	ME-MS81 W ppm 0.5
							STANDARDS									
CGL 208		0.48	14.15	40.5	10.55	92.7	7.52	7.4	1350	1.0	1.15	21.1	0.55	13.55	91	32.9
Target Range - Lower Bound		0.44	11.55	33.9	8.82	79.3	6.60	4.7	1140	0.8	0.97	18.50	0.46	11.50	73	27.2
Upper Bound		0.56	14.20	41.7	10.80	97.4	8.14	7.3	1395	1.3	1.21	22.7	0.59	14.20	102	34.4
EMOG-17																
EMOG-17																
EMOG-17																
Target Range - Lower Bound																
Upper Bound																
GBM321-8																
GBM321-8																
Target Range - Lower Bound																
Upper Bound																
MP-2a																
MP-2a																
Target Range - Lower Bound																
Upper Bound																
MRCA-21																
MRCA-21																
Target Range - Lower Bound																
Upper Bound																
OREAS 120		0.29	8.30	19.6	5.03	96.3	4.10	1.4	135.5	0.7	0.45	5.45	0.25	41.4	31	1.9
OREAS 120		0.22	8.42	20.6	5.44	84.9	3.90	1.2	137.5	0.6	0.46	5.67	0.18	38.8	23	0.6
OREAS 120		0.28	8.61	20.7	4.82	86.9	3.96	1.4	132.0	0.7	0.43	5.88	0.25	38.9	31	0.6
Target Range - Lower Bound		0.18	7.24	17.1	4.49	78.1	3.34	<0.5	114.0	0.4	0.39	4.86	0.17	36.7	12	<0.5
Upper Bound		0.24	8.96	21.1	5.53	95.9	4.14	2.1	140.0	0.8	0.49	6.05	0.23	44.9	34	2.1
OREAS 20a																
OREAS 20a																
Target Range - Lower Bound																
Upper Bound																
OREAS 460		0.53	752	838	247	79.8	105.0	15.8	318	14.1	4.82	116.5	0.69	4.21	262	5.0
Target Range - Lower Bound		0.46	628	739	220	67.3	96.3	13.9	274	12.2	4.35	104.5	0.62	3.74	235	3.8
Upper Bound		0.58	768	903	268	82.7	117.5	18.1	336	15.2	5.33	127.5	0.78	4.68	299	6.3

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Y ppm 0.1	ME-MS81 Yb ppm 0.03	ME-MS81 Zr ppm 1	pXRF-34 Si % 0.5	pXRF-34 Ti % 0.1	pXRF-34 Zr ppm 5
STANDARDS							
CGL 208		41.5	3.33	140			
Target Range - Lower Bound		34.7	2.99	117			
Upper Bound		42.6	3.72	145			
EMOG-17							
EMOG-17							
EMOG-17							
Target Range - Lower Bound							
Upper Bound							
GBM321-8							
GBM321-8							
Target Range - Lower Bound							
Upper Bound							
MP-2a					30.8	<0.1	144
MP-2a					30.4	<0.1	142
Target Range - Lower Bound					24.5	<0.1	102
Upper Bound					37.9	0.2	166
MRCA-21							
MRCA-21							
Target Range - Lower Bound							
Upper Bound							
OREAS 120		12.9	1.39	275			
OREAS 120		12.9	1.18	256			
OREAS 120		13.3	1.49	316			
Target Range - Lower Bound		10.9	1.18	229			
Upper Bound		13.5	1.50	282			
OREAS 20a					30.2	0.5	308
OREAS 20a					30.2	0.4	298
Target Range - Lower Bound					23.6	0.2	237
Upper Bound					36.7	0.8	369
OREAS 460		63.2	3.97	478			
Target Range - Lower Bound		53.9	3.49	424			
Upper Bound		66.1	4.33	520			

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method Analyte Units LOD	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05
								STANDARDS								
OREAS 507		1.28	7.60	47.7	1120	2.45	1.78	1.78	0.65	73.4	8.2	44	11.05	6300	3.21	19.05
OREAS 507		1.37	7.24	47.3	1070	2.42	1.84	1.64	0.65	75.8	7.9	44	11.40	5980	3.06	18.20
OREAS 507		1.30	7.90	44.5	1150	2.54	1.80	1.87	0.67	71.3	7.4	45	11.15	6410	3.20	19.40
Target Range - Lower Bound		1.20	6.68	41.8	930	2.25	1.59	1.53	0.60	63.0	7.0	38	9.76	5780	2.81	18.20
Upper Bound		1.48	8.18	51.6	1280	2.86	1.97	1.89	0.78	77.0	8.8	49	12.05	6660	3.45	22.4
OREAS-100a																
OREAS-100a																
OREAS-100a																
Target Range - Lower Bound																
Upper Bound																
RTS-3a																
RTS-3a																
Target Range - Lower Bound																
Upper Bound																
								BLANKS								
BLANK		<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	<0.2	<0.01	0.10
BLANK		<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	<0.01	<0.1	2	<0.05	0.2	<0.01	0.07
BLANK		<0.01	<0.01	<0.2	<10	<0.05	0.01	<0.01	0.02	<0.01	<0.1	<1	<0.05	0.4	<0.01	0.06
BLANK		<0.01	<0.01	<0.2	<10	<0.05	0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	<0.2	<0.01	0.05
BLANK		<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	0.01	<0.1	<1	<0.05	1.1	<0.01	0.05
Target Range - Lower Bound		<0.01	<0.01	<0.2	<10	<0.05	<0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	<0.2	<0.01	<0.05
Upper Bound		0.02	0.02	0.4	20	0.10	0.02	0.02	0.04	0.02	0.2	2	0.10	0.4	0.02	0.10
BLANK																
BLANK																
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BLANK																
Target Range - Lower Bound																
Upper Bound																

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Finalized Date: 23-APR-2024
Account: UNIQUE

Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1
STANDARDS																
OREAS 507		0.19	1.9	0.147	3.13	36.2	50.8	0.72	360	114.0	2.10	12.7	16.5	880	38.3	164.0
OREAS 507		0.15	2.0	0.149	3.02	36.0	48.5	0.65	346	110.5	2.05	12.9	15.6	820	37.9	166.0
OREAS 507		0.16	1.9	0.155	3.25	34.9	51.7	0.72	364	114.5	2.17	13.2	15.0	900	37.2	163.0
Target Range - Lower Bound		0.07	1.7	0.130	2.75	30.0	44.8	0.63	310	102.5	1.88	11.2	14.3	770	32.9	146.5
Upper Bound		0.31	2.3	0.170	3.39	37.8	55.2	0.79	390	125.5	2.32	14.0	17.9	970	41.3	179.5
OREAS-100a																
OREAS-100a																
OREAS-100a																
Target Range - Lower Bound																
Upper Bound																
RTS-3a																
RTS-3a																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK		0.06	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05	<0.01	<0.1	0.2	<10	<0.5	<0.1
BLANK		<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1
BLANK		<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1
BLANK		<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1
BLANK		<0.05	<0.1	<0.005	<0.01	<0.5	0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1
Target Range - Lower Bound		<0.05	<0.1	<0.005	<0.01	<0.5	<0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1
Upper Bound		0.10	0.2	0.010	0.02	1.0	0.4	0.02	10	0.10	0.02	0.2	0.4	20	1.0	0.2
BLANK																
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BLANK																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method / Analyte / Units / LOD	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1
STANDARDS															
OREAS 507	0.084	0.75	5.02	8.5	4	4.6	214	1.03	0.60	14.50	0.352	0.92	4.2	63	8.2
OREAS 507	0.080	0.70	5.09	8.6	4	4.6	210	1.06	0.76	14.75	0.332	0.92	3.5	61	8.1
OREAS 507	0.082	0.79	4.91	8.1	4	5.3	229	1.06	0.66	14.20	0.368	0.93	3.6	66	9.5
Target Range - Lower Bound	0.075	0.66	4.47	7.5	2	4.3	195.0	0.97	0.54	12.50	0.310	0.77	3.6	58	7.8
Upper Bound	0.096	0.82	6.17	9.3	6	5.7	239	1.29	0.80	15.30	0.390	1.09	4.6	73	10.8
OREAS-100a															
OREAS-100a															
OREAS-100a															
Target Range - Lower Bound															
Upper Bound															
RTS-3a															
RTS-3a															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK	<0.002	<0.01	<0.05	0.1	<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1
BLANK	<0.002	<0.01	<0.05	0.1	<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1
BLANK	<0.002	<0.01	<0.05	0.1	<1	<0.2	<0.2	<0.05	<0.05	0.01	<0.005	0.02	<0.1	<1	<0.1
BLANK	<0.002	<0.01	<0.05	0.1	<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1
BLANK	<0.002	<0.01	<0.05	<0.1	<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1
Target Range - Lower Bound	<0.002	<0.01	<0.05	<0.1	<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1
Upper Bound	0.004	0.02	0.10	0.2	2	0.4	0.4	0.10	0.10	0.02	0.010	0.04	0.2	2	0.2
BLANK															
BLANK															
BLANK															
BLANK															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															

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Finalized Date: 23-APR-2024
Account: UNIQUE

Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
Analyte	Y	Zn	Zr	Ba	Ce	Cr	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho	La
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
LOD	0.1	2	0.5	0.5	0.1	5	0.01	0.05	0.03	0.02	0.1	0.05	0.05	0.01	0.1
STANDARDS															
OREAS 507	16.2	161	63.2												
OREAS 507	16.1	157	63.8												
OREAS 507	16.0	166	63.9												
Target Range - Lower Bound	13.9	143	53.9												
Upper Bound	17.2	179	74.1												
OREAS-100a				432	481	42	2.70	23.9	15.25	3.79	20.0	22.1	14.10	4.93	260
OREAS-100a				424	472	42	2.74	23.2	14.55	3.79	20.7	20.2	14.55	4.81	267
OREAS-100a				418	439	37	2.46	20.7	13.95	3.76	18.0	20.7	13.55	4.27	240
Target Range - Lower Bound				388	417	28	2.51	20.8	13.40	3.32	17.3	21.2	13.20	4.32	234
Upper Bound				475	509	52	3.09	25.6	16.40	4.10	21.3	26.0	16.20	5.30	286
RTS-3a															
RTS-3a															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK	<0.1	<2	<0.5												
BLANK	<0.1	<2	<0.5												
BLANK	<0.1	<2	<0.5												
BLANK	<0.1	<2	<0.5												
BLANK	<0.1	<2	<0.5												
Target Range - Lower Bound	<0.1	<2	<0.5												
Upper Bound	0.2	4	1.0												
BLANK				0.7	0.1	<5	0.01	<0.05	<0.03	<0.02	<0.1	<0.05	<0.05	0.01	0.1
BLANK				3.1	<0.1	<5	<0.01	<0.05	<0.03	<0.02	0.1	<0.05	<0.05	<0.01	<0.1
BLANK				5.9	0.1	<5	<0.01	<0.05	<0.03	<0.02	0.2	<0.05	<0.05	<0.01	<0.1
BLANK				<0.5	<0.1	<5	0.02	0.05	0.03	0.02	0.1	0.07	<0.05	0.02	0.1
BLANK				3.7	<0.1	<5	<0.01	<0.05	<0.03	<0.02	0.1	<0.05	<0.05	<0.01	<0.1
BLANK				0.8	0.1	<5	<0.01	<0.05	<0.03	<0.02	0.1	<0.05	<0.05	0.01	0.2
Target Range - Lower Bound				<0.5	<0.1	<5	<0.01	<0.05	<0.03	<0.02	<0.1	<0.05	<0.05	<0.01	<0.1
Upper Bound				1.0	0.2	10	0.02	0.10	0.06	0.04	0.2	0.10	0.10	0.02	0.2

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description (Method / Analyte / Units / LOD)	ME-MS81 Lu ppm 0.01	ME-MS81 Nb ppm 0.05	ME-MS81 Nd ppm 0.1	ME-MS81 Pr ppm 0.02	ME-MS81 Rb ppm 0.2	ME-MS81 Sm ppm 0.03	ME-MS81 Sn ppm 0.5	ME-MS81 Sr ppm 0.1	ME-MS81 Ta ppm 0.1	ME-MS81 Tb ppm 0.01	ME-MS81 Th ppm 0.05	ME-MS81 Tm ppm 0.01	ME-MS81 U ppm 0.05	ME-MS81 V ppm 5	ME-MS81 W ppm 0.5
STANDARDS															
OREAS 507															
OREAS 507															
OREAS 507															
Target Range - Lower Bound															
Upper Bound															
OREAS-100a	2.05	45.0	154.0	47.2	261	24.6	9.5	35.3	3.4	3.43	50.5	2.23	132.5	70	11.0
OREAS-100a	2.40	44.9	154.0	47.3	254	25.4	9.7	37.3	3.6	3.70	49.9	2.22	134.5	44	10.3
OREAS-100a	1.77	40.3	137.5	43.0	235	22.7	9.3	32.6	3.0	3.43	47.1	2.05	123.0	42	9.4
Target Range - Lower Bound	2.02	39.6	136.5	42.4	235	21.2	7.9	31.9	3.2	3.41	46.4	2.07	121.5	25	9.3
Upper Bound	2.50	48.6	167.5	51.8	288	26.0	10.9	39.2	4.2	4.19	56.8	2.55	148.5	49	12.5
RTS-3a															
RTS-3a															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
BLANK															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	0.01	<0.05	0.1	0.02	<0.2	0.06	<0.5	0.1	0.1	0.01	<0.05	<0.01	<0.05	<5	0.6
BLANK	<0.01	0.06	0.1	<0.02	0.6	<0.03	1.2	0.2	0.1	<0.01	<0.05	<0.01	<0.05	7	<0.5
BLANK	<0.01	<0.05	<0.1	<0.02	<0.2	<0.03	<0.5	<0.1	<0.1	<0.01	<0.05	<0.01	<0.05	<5	0.5
BLANK	0.02	<0.05	<0.1	0.04	<0.2	0.03	<0.5	0.2	0.1	0.06	<0.05	0.03	<0.05	<5	0.5
BLANK	<0.01	<0.05	<0.1	<0.02	0.3	0.10	0.5	<0.1	<0.1	<0.01	<0.05	<0.01	<0.05	5	<0.5
BLANK	<0.01	0.06	0.1	<0.02	<0.2	0.04	<0.5	0.1	<0.1	0.01	<0.05	0.01	<0.05	8	<0.5
Target Range - Lower Bound	<0.01	<0.05	<0.1	<0.02	<0.2	<0.03	<0.5	<0.1	<0.1	<0.01	<0.05	<0.01	<0.05	<5	<0.5
Upper Bound	0.02	0.10	0.2	0.04	0.4	0.06	1.0	0.2	0.2	0.02	0.10	0.02	0.10	10	1.0

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Project: Kanmantoo tailings

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method	ME-MS81	ME-MS81	ME-MS81	pXRF-34	pXRF-34	pXRF-34
Analyte	Y	Yb	Zr	Si	Ti	Zr
Units	ppm	ppm	ppm	%	%	ppm
LOD	0.1	0.03	1	0.5	0.1	5
STANDARDS						
OREAS 507						
OREAS 507						
OREAS 507						
Target Range - Lower Bound						
Upper Bound						
OREAS-100a	139.0	15.00	544			
OREAS-100a	142.0	14.40	545			
OREAS-100a	129.0	12.75	516			
Target Range - Lower Bound	127.5	13.40	511			
Upper Bound	156.5	16.40	626			
RTS-3a				18.4	0.3	88
RTS-3a				18.3	0.3	100
Target Range - Lower Bound				14.1	<0.1	56
Upper Bound				22.4	0.6	100
BLANKS						
BLANK						
BLANK						
BLANK						
BLANK						
BLANK						
Target Range - Lower Bound						
Upper Bound						
BLANK	<0.1	<0.03	<1			
BLANK	<0.1	<0.03	2			
BLANK	0.1	<0.03	<1			
BLANK	<0.1	<0.03	<1			
BLANK	<0.1	<0.03	1			
BLANK	0.2	<0.03	2			
Target Range - Lower Bound	<0.1	<0.03	<1			
Upper Bound	0.2	0.06	2			

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05
							DUPLICATES									
ORIGINAL		0.31	8.06	22.2	770	1.39	0.16	1.46	0.04	23.7	30.4	2	0.78	1180	3.80	20.1
DUP		0.30	9.44	22.6	790	1.39	0.19	1.58	0.04	28.5	29.4	2	0.87	1195	3.92	19.40
Target Range - Lower Bound		0.28	8.30	21.1	710	1.27	0.16	1.43	<0.02	24.8	28.3	<1	0.73	1145	3.66	18.70
Upper Bound		0.33	9.20	23.7	850	1.51	0.19	1.61	0.06	27.4	31.5	3	0.92	1230	4.06	20.8
KA8																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA20R		0.24	6.01	1.8	150	1.20	38.5	0.16	0.02	49.3	46.6	73	2.31	593	12.30	15.40
DUP		0.27	6.25	1.8	160	1.28	42.7	0.17	0.02	48.6	50.9	80	2.44	635	13.15	16.50
Target Range - Lower Bound		0.23	5.81	1.5	130	1.13	38.6	0.15	<0.02	46.5	46.2	72	2.21	592	12.10	15.10
Upper Bound		0.28	6.45	2.1	180	1.35	42.6	0.18	0.04	51.4	51.3	81	2.54	636	13.35	16.80
KA26R																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA28																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA39																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA42																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA44																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Stafford
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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method / Analyte / Units / LOD	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1
DUPLICATES															
ORIGINAL	0.27	2.4	0.085	2.84	10.6	12.4	1.34	1055	4.76	3.81	6.1	2.8	1820	11.8	48.8
DUP	0.14	2.5	0.080	2.86	13.2	12.4	1.40	1055	4.86	3.77	6.1	2.4	1870	12.2	57.1
Target Range - Lower Bound	0.14	2.2	0.073	2.70	10.8	11.6	1.29	997	4.52	3.59	5.7	2.3	1740	10.9	50.2
Upper Bound	0.27	2.7	0.092	3.00	13.0	13.2	1.45	1115	5.10	3.99	6.5	2.9	1950	13.1	55.7
KA8															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA20R	0.13	2.1	0.226	1.30	24.0	19.0	1.20	2660	1.20	0.05	10.8	22.8	540	10.0	64.0
DUP	0.13	2.2	0.242	1.36	24.6	20.4	1.27	2880	1.28	0.06	11.3	24.4	580	10.6	61.9
Target Range - Lower Bound	0.07	1.9	0.217	1.25	22.6	18.5	1.16	2630	1.13	0.04	10.4	22.2	520	9.3	59.7
Upper Bound	0.19	2.4	0.251	1.41	26.0	20.9	1.31	2910	1.35	0.07	11.7	25.0	600	11.3	66.2
KA26R															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA28															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA39															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA42															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA44															
DUP															
Target Range - Lower Bound															
Upper Bound															

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1
	DUPLICATES															
ORIGINAL		0.023	0.90	0.59	8.0	1	1.5	712	0.36	0.16	1.72	0.378	0.43	1.2	175	1.2
DUP		0.025	0.89	0.61	9.1	1	1.5	759	0.36	0.16	2.19	0.374	0.44	1.2	168	1.1
Target Range - Lower Bound		0.021	0.84	0.51	8.0	<1	1.2	699	0.29	0.10	1.85	0.352	0.38	1.0	162	1.0
Upper Bound		0.027	0.95	0.70	9.1	2	1.8	772	0.43	0.22	2.06	0.400	0.49	1.4	181	1.3
KA8																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA20R		<0.002	0.65	0.11	14.1	1	5.2	8.0	0.81	0.10	10.65	0.294	0.48	2.5	66	5.9
DUP		<0.002	0.70	0.12	14.1	1	5.7	8.6	0.87	0.12	10.95	0.317	0.51	2.7	71	6.4
Target Range - Lower Bound		<0.002	0.63	0.06	13.3	<1	5.0	7.7	0.75	<0.05	10.25	0.285	0.44	2.4	64	5.6
Upper Bound		0.004	0.72	0.17	14.9	2	5.9	8.9	0.93	0.17	11.35	0.326	0.55	2.8	73	6.7
KA26R																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA28																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA39																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA42																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA44																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Project: Kanmantoo tailings

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
	Analyte	Y	Zn	Zr	Ba	Ce	Cr	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho	La
	Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	LOD	0.1	2	0.5	0.5	0.1	5	0.01	0.05	0.03	0.02	0.1	0.05	0.05	0.01	0.1
DUPLICATES																
ORIGINAL		17.7	100	89.6												
DUP		21.3	99	93.0												
Target Range - Lower Bound		18.4	93	84.0												
Upper Bound		20.6	106	98.6												
KA8					222	69.7	106	3.98	4.78	2.95	0.93	21.5	5.24	4.49	1.14	33.2
DUP					230	74.8	116	4.25	5.24	3.46	1.04	23.9	5.27	4.65	1.20	38.9
Target Range - Lower Bound					214	68.5	100	3.90	4.71	3.01	0.92	21.5	4.94	4.29	1.10	34.1
Upper Bound					238	76.0	122	4.33	5.31	3.40	1.05	23.9	5.57	4.85	1.24	38.0
KA20R		28.9	67	73.9												
DUP		28.9	73	91.4												
Target Range - Lower Bound		27.4	65	76.0												
Upper Bound		30.4	76	89.3												
KA26R					230	72.1	110	4.09	5.42	2.78	1.32	22.6	5.46	4.40	0.98	34.8
DUP					234	74.4	108	3.93	6.03	2.94	1.38	21.8	5.70	4.42	1.02	38.7
Target Range - Lower Bound					220	69.5	99	3.80	5.39	2.69	1.26	21.0	5.25	4.14	0.94	34.8
Upper Bound					244	77.0	119	4.22	6.06	3.03	1.44	23.4	5.91	4.68	1.06	38.7
KA28																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA39					114.5	50.1	91	1.92	6.58	3.96	0.70	22.1	4.99	3.56	1.42	24.4
DUP					127.0	54.4	91	2.00	6.93	4.23	1.04	22.9	4.58	3.78	1.54	26.5
Target Range - Lower Bound					114.0	49.5	81	1.85	6.37	3.86	0.81	21.3	4.50	3.44	1.40	24.1
Upper Bound					127.5	55.0	101	2.07	7.14	4.33	0.93	23.7	5.07	3.90	1.56	26.8
KA42																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA44					12.3	22.4	22	0.19	1.65	0.86	0.84	2.9	2.74	1.00	0.25	12.0
DUP					11.2	22.8	23	0.18	1.70	0.76	0.92	2.8	2.46	0.75	0.26	11.9
Target Range - Lower Bound					10.7	21.4	16	0.17	1.54	0.74	0.82	2.6	2.42	0.78	0.23	11.3
Upper Bound					12.8	23.8	29	0.20	1.81	0.88	0.94	3.1	2.78	0.97	0.28	12.6

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Project: Kanmantoo tailings

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Lu ppm 0.01	ME-MS81 Nb ppm 0.05	ME-MS81 Nd ppm 0.1	ME-MS81 Pr ppm 0.02	ME-MS81 Rb ppm 0.2	ME-MS81 Sm ppm 0.03	ME-MS81 Sn ppm 0.5	ME-MS81 Sr ppm 0.1	ME-MS81 Ta ppm 0.1	ME-MS81 Tb ppm 0.01	ME-MS81 Th ppm 0.05	ME-MS81 Tm ppm 0.01	ME-MS81 U ppm 0.05	ME-MS81 V ppm 5	ME-MS81 W ppm 0.5
								DUPLICATES								
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA8		0.43	13.80	28.9	7.92	122.5	5.84	7.2	11.4	1.3	0.73	14.85	0.42	3.20	91	6.5
DUP		0.46	15.05	31.2	8.63	127.5	6.48	8.7	12.0	1.2	0.97	15.40	0.45	3.18	180	8.3
Target Range - Lower Bound		0.41	13.65	28.4	7.84	118.5	5.82	7.1	11.0	1.1	0.80	14.30	0.40	2.98	124	6.5
Upper Bound		0.48	15.20	31.7	8.71	131.5	6.50	8.8	12.4	1.4	0.90	15.95	0.47	3.40	147	8.3
KA20R																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA26R		0.34	14.45	31.1	8.59	131.0	5.15	7.4	12.8	1.2	0.88	15.00	0.44	3.71	106	4.9
DUP		0.45	14.60	32.4	8.13	130.5	5.77	8.0	14.9	1.1	0.97	15.15	0.49	3.79	201	9.9
Target Range - Lower Bound		0.37	13.75	30.1	7.92	124.0	5.16	6.8	13.1	1.0	0.87	14.25	0.43	3.51	141	6.5
Upper Bound		0.42	15.30	33.4	8.80	137.5	5.76	8.6	14.6	1.3	0.98	15.90	0.50	3.99	166	8.3
KA28																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA39		0.58	10.10	20.9	5.87	60.6	4.29	6.0	7.5	0.9	0.83	11.10	0.64	2.73	83	10.0
DUP		0.66	10.55	23.5	6.17	65.4	4.38	8.2	8.2	0.9	0.98	11.35	0.59	2.61	84	9.5
Target Range - Lower Bound		0.58	9.76	21.0	5.70	59.7	4.09	6.2	7.4	0.8	0.85	10.60	0.57	2.49	74	8.8
Upper Bound		0.66	10.90	23.4	6.34	66.4	4.58	8.0	8.3	1.0	0.96	11.85	0.66	2.85	93	10.7
KA42																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA44		0.10	1.45	12.1	2.80	3.7	1.94	1.0	15.7	0.1	0.34	1.96	0.10	1.12	14	1.0
DUP		0.15	1.28	11.8	2.91	4.5	3.23	0.8	15.3	0.1	0.33	2.05	0.09	1.02	16	1.7
Target Range - Lower Bound		0.11	1.25	11.3	2.69	3.7	2.43	<0.5	14.6	<0.1	0.31	1.85	0.08	0.97	9	0.8
Upper Bound		0.14	1.48	12.6	3.02	4.5	2.74	1.0	16.4	0.2	0.36	2.16	0.11	1.17	21	1.9

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Y ppm 0.1	ME-MS81 Yb ppm 0.03	ME-MS81 Zr ppm 1	pXRF-34 Si % 0.5	pXRF-34 Ti % 0.1	pXRF-34 Zr ppm 5
DUPLICATES							
ORIGINAL							
DUP							
Target Range - Lower Bound							
Upper Bound							
KA8		29.7	2.67	165			
DUP		33.0	2.91	174			
Target Range - Lower Bound		29.7	2.62	160			
Upper Bound		33.0	2.96	179			
KA20R							
DUP							
Target Range - Lower Bound							
Upper Bound							
KA26R		28.5	2.87	174			
DUP		31.5	2.76	160			
Target Range - Lower Bound		28.4	2.64	158			
Upper Bound		31.6	2.99	176			
KA28					17.3	1.1	119
DUP					17.6	1.1	122
Target Range - Lower Bound					15.2	0.9	103
Upper Bound					19.7	1.3	138
KA39		40.4	4.90	132			
DUP		41.7	4.13	141			
Target Range - Lower Bound		38.9	4.26	129			
Upper Bound		43.2	4.77	144			
KA42					24.9	0.3	142
DUP					25.1	0.3	147
Target Range - Lower Bound					22.0	0.2	125
Upper Bound					28.0	0.4	164
KA44		8.5	0.60	37			
DUP		8.9	0.59	36			
Target Range - Lower Bound		8.2	0.54	34			
Upper Bound		9.2	0.65	39			

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method / Analyte / Units / LOD	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05
DUPLICATES															
KA52	0.92	6.29	3.3	80	1.02	127.5	0.15	0.03	49.5	111.0	68	1.39	1455	19.25	13.65
DUP	0.91	7.44	3.8	80	1.03	125.0	0.16	0.03	64.1	112.0	68	1.49	1475	19.95	13.35
Target Range - Lower Bound	0.86	6.51	3.2	60	0.92	120.0	0.14	<0.02	54.0	106.0	64	1.32	1415	18.60	12.80
Upper Bound	0.97	7.22	3.9	100	1.13	132.5	0.17	0.04	59.7	117.0	72	1.56	1515	20.6	14.25
KA56															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA57															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA70															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA71															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA75															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA77	0.34	7.73	1.7	150	1.40	88.6	0.22	0.02	68.0	105.5	80	2.35	831	15.50	16.40
DUP	0.33	7.54	1.7	150	1.39	61.5	0.21	0.03	66.6	102.5	88	2.34	816	15.10	16.35
Target Range - Lower Bound	0.31	7.24	1.4	130	1.28	71.3	0.19	<0.02	63.9	98.7	79	2.18	794	14.55	15.50
Upper Bound	0.36	8.03	2.0	170	1.51	78.8	0.24	0.04	70.7	109.5	89	2.51	853	16.10	17.25
KA79															
DUP															
Target Range - Lower Bound															
Upper Bound															

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1
DUPLICATES																
KA52		0.54	1.9	0.266	0.65	22.3	19.2	0.94	5960	0.84	0.03	8.1	43.9	510	13.1	30.3
DUP		1.24	2.0	0.277	0.74	31.7	20.2	1.10	6140	1.02	0.03	8.1	45.2	530	14.2	47.8
Target Range - Lower Bound		0.77	1.8	0.253	0.65	25.2	18.5	0.96	5740	0.83	0.02	7.6	42.1	480	12.5	37.0
Upper Bound		1.01	2.1	0.290	0.74	28.9	20.9	1.08	6360	1.03	0.04	8.6	47.0	560	14.8	41.1
KA56																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA57																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA70																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA71																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA75																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA77		0.22	2.2	0.294	1.34	34.6	22.2	1.41	3700	1.10	0.06	11.0	43.6	660	9.9	81.7
DUP		0.24	2.3	0.297	1.30	34.1	21.7	1.37	3630	1.16	0.06	11.0	46.3	620	9.8	79.2
Target Range - Lower Bound		0.16	2.0	0.276	1.24	32.1	20.7	1.31	3480	1.02	0.05	10.4	42.5	600	8.9	76.3
Upper Bound		0.30	2.5	0.315	1.40	36.6	23.2	1.47	3850	1.24	0.07	11.7	47.4	680	10.8	84.6
KA79																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1
							DUPLICATES									
KA52		<0.002	1.56	0.09	22.9	3	4.2	7.5	0.64	0.19	12.05	0.232	0.29	2.9	64	12.1
DUP		<0.002	1.60	0.23	22.0	3	4.1	7.2	0.64	0.16	12.80	0.240	0.29	2.9	64	11.9
Target Range - Lower Bound		<0.002	1.49	0.10	21.2	2	3.7	6.8	0.56	0.12	11.80	0.219	0.25	2.7	60	11.0
Upper Bound		0.004	1.67	0.22	23.7	4	4.6	7.9	0.72	0.23	13.05	0.253	0.33	3.1	68	13.0
KA56																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA57																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA70																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA71																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA75																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA77		<0.002	1.16	0.15	18.8	1	5.2	9.6	0.85	0.15	14.65	0.329	0.48	3.3	67	6.3
DUP		<0.002	1.13	0.18	18.3	1	5.2	9.3	0.83	0.14	14.30	0.323	0.47	3.2	67	6.0
Target Range - Lower Bound		<0.002	1.08	0.10	17.5	<1	4.7	8.8	0.75	0.09	13.75	0.305	0.42	3.0	63	5.6
Upper Bound		0.004	1.21	0.23	19.6	2	5.7	10.1	0.93	0.20	15.20	0.347	0.53	3.5	71	6.7
KA79																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description / Method	ME-MS61	ME-MS61	ME-MS61	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81	ME-MS81
Analyte	Y	Zn	Zr	Ba	Ce	Cr	Cs	Dy	Er	Eu	Ga	Gd	Hf	Ho	La
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
LOD	0.1	2	0.5	0.5	0.1	5	0.01	0.05	0.03	0.02	0.1	0.05	0.05	0.01	0.1
DUPLICATES															
KA52	61.8	81	69.0												
DUP	65.3	83	69.2												
Target Range - Lower Bound	60.3	76	63.4												
Upper Bound	66.8	88	74.8												
KA56															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA57				88.9	62.8	90	1.71	10.35	7.17	0.97	20.3	5.60	3.69	2.40	31.0
DUP				96.5	63.7	92	1.83	11.25	7.26	0.96	19.9	6.10	3.79	2.55	31.7
Target Range - Lower Bound				87.6	60.0	81	1.67	10.20	6.82	0.90	19.0	5.51	3.50	2.34	29.7
Upper Bound				97.8	66.5	101	1.87	11.40	7.61	1.03	21.2	6.19	3.98	2.61	33.0
KA70				106.5	67.5	90	2.05	9.11	6.21	0.97	21.9	6.09	3.81	1.99	34.8
DUP				110.0	66.4	88	1.88	9.07	6.52	1.06	21.1	5.75	4.09	2.09	34.9
Target Range - Lower Bound				102.5	63.5	80	1.86	8.59	6.02	0.94	20.3	5.57	3.70	1.93	33.0
Upper Bound				114.0	70.4	98	2.07	9.59	6.71	1.09	22.7	6.27	4.20	2.15	36.7
KA71															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA75															
DUP															
Target Range - Lower Bound															
Upper Bound															
KA77	44.5	90	85.7												
DUP	43.4	95	82.0												
Target Range - Lower Bound	41.7	86	77.1												
Upper Bound	46.2	99	90.6												
KA79															
DUP															
Target Range - Lower Bound															
Upper Bound															

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Lu ppm 0.01	ME-MS81 Nb ppm 0.05	ME-MS81 Nd ppm 0.1	ME-MS81 Pr ppm 0.02	ME-MS81 Rb ppm 0.2	ME-MS81 Sm ppm 0.03	ME-MS81 Sn ppm 0.5	ME-MS81 Sr ppm 0.1	ME-MS81 Ta ppm 0.1	ME-MS81 Tb ppm 0.01	ME-MS81 Th ppm 0.05	ME-MS81 Tm ppm 0.01	ME-MS81 U ppm 0.05	ME-MS81 V ppm 5	ME-MS81 W ppm 0.5
								DUPLICATES								
KA52																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA56																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA57		0.89	9.36	26.0	7.28	55.4	5.14	5.5	8.8	0.8	1.33	12.85	1.04	3.31	80	18.1
DUP		1.07	8.76	26.9	7.68	56.7	4.97	6.2	7.4	0.8	1.36	13.00	0.96	3.24	81	18.3
Target Range - Lower Bound		0.92	8.56	25.0	7.09	53.0	4.77	5.1	7.6	0.7	1.27	12.25	0.94	3.06	71	16.8
Upper Bound		1.04	9.56	27.9	7.87	59.1	5.34	6.6	8.6	0.9	1.42	13.60	1.06	3.49	90	19.6
KA70		0.85	10.05	29.3	7.71	66.7	6.23	6.7	7.3	0.9	1.07	12.55	0.80	2.98	84	10.7
DUP		0.89	10.15	29.3	7.65	69.7	5.80	6.3	7.5	0.9	1.29	12.65	0.91	2.75	82	10.5
Target Range - Lower Bound		0.82	9.55	27.7	7.28	64.6	5.68	5.7	6.9	0.8	1.11	11.90	0.80	2.67	74	9.6
Upper Bound		0.92	10.65	30.9	8.08	71.8	6.35	7.3	7.9	1.0	1.25	13.30	0.91	3.06	92	11.6
KA71																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA75																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA77																
DUP																
Target Range - Lower Bound																
Upper Bound																
KA79																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Finalized Date: 23-APR-2024
Account: UNIQUE

Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Y ppm 0.1	ME-MS81 Yb ppm 0.03	ME-MS81 Zr ppm 1	pXRF-34 Si % 0.5	pXRF-34 Ti % 0.1	pXRF-34 Zr ppm 5
			DUPLICATES				
KA52							
DUP							
Target Range - Lower Bound							
Upper Bound							
KA56					27.2	0.3	160
DUP					27.0	0.3	152
Target Range - Lower Bound					23.9	0.2	135
Upper Bound					30.3	0.4	177
KA57		63.9	7.09	142			
DUP		65.5	6.79	150			
Target Range - Lower Bound		61.4	6.56	138			
Upper Bound		68.0	7.32	154			
KA70		56.9	5.63	159			
DUP		57.0	5.65	157			
Target Range - Lower Bound		54.0	5.33	149			
Upper Bound		59.9	5.95	167			
KA71					26.5	0.3	150
DUP					26.4	0.3	154
Target Range - Lower Bound					23.3	0.2	132
Upper Bound					29.6	0.4	172
KA75					28.5	0.3	156
DUP					28.5	0.3	169
Target Range - Lower Bound					25.2	0.2	141
Upper Bound					31.9	0.4	184
KA77							
DUP							
Target Range - Lower Bound							
Upper Bound							
KA79					17.8	1.1	124
DUP					17.5	1.1	123
Target Range - Lower Bound					15.4	0.9	106
Upper Bound					19.9	1.3	141

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
	Units	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOD	0.01	0.01	0.2	10	0.05	0.01	0.01	0.02	0.01	0.1	1	0.05	0.2	0.01	0.05
DUPLICATES																
KA48R		0.37	7.38	1.3	230	1.59	59.3	0.21	<0.02	98.8	83.0	85	3.97	349	10.60	22.1
DUP		0.42	7.40	1.2	230	1.61	61.8	0.21	<0.02	102.5	84.6	85	4.08	348	10.60	22.8
Target Range - Lower Bound		0.37	7.01	1.0	200	1.47	57.5	0.19	<0.02	95.6	79.5	80	3.77	336	10.05	21.3
Upper Bound		0.42	7.77	1.5	260	1.73	63.6	0.23	0.04	105.5	88.1	90	4.28	361	11.15	23.6

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1
		DUPLICATES														
KA48R		0.19	3.1	0.262	2.11	51.3	22.4	2.04	1090	0.48	0.08	16.2	36.0	850	19.0	130.5
DUP		0.18	3.2	0.272	2.10	50.6	22.4	2.04	1095	0.45	0.08	16.9	37.4	850	20.5	130.5
Target Range - Lower Bound		0.12	2.9	0.249	1.99	47.9	21.1	1.93	1035	0.39	0.07	15.6	34.7	800	18.3	124.0
Upper Bound		0.25	3.4	0.285	2.22	54.0	23.7	2.15	1150	0.54	0.09	17.5	38.7	900	21.2	137.0

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1
DUPLICATES																
KA48R		<0.002	0.43	0.09	10.6	1	8.4	16.1	1.14	0.13	18.85	0.469	0.74	4.1	89	6.5
DUP		<0.002	0.44	0.08	10.9	1	8.8	16.6	1.21	0.14	19.60	0.472	0.80	4.4	89	7.3
Target Range - Lower Bound		<0.002	0.40	<0.05	10.1	<1	8.0	15.3	1.07	0.08	18.25	0.442	0.69	3.9	84	6.3
Upper Bound		0.004	0.47	0.10	11.4	2	9.2	17.4	1.28	0.19	20.2	0.499	0.85	4.6	94	7.5

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QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5	ME-MS81 Ba ppm 0.5	ME-MS81 Ce ppm 0.1	ME-MS81 Cr ppm 5	ME-MS81 Cs ppm 0.01	ME-MS81 Dy ppm 0.05	ME-MS81 Er ppm 0.03	ME-MS81 Eu ppm 0.02	ME-MS81 Ga ppm 0.1	ME-MS81 Gd ppm 0.05	ME-MS81 Hf ppm 0.05	ME-MS81 Ho ppm 0.01	ME-MS81 La ppm 0.1
DUPLICATES															
KA48R	14.9	87	106.0												
DUP	15.4	88	111.5												
Target Range - Lower Bound	14.3	81	100.0												
Upper Bound	16.0	94	117.5												

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Lu ppm 0.01	ME-MS81 Nb ppm 0.05	ME-MS81 Nd ppm 0.1	ME-MS81 Pr ppm 0.02	ME-MS81 Rb ppm 0.2	ME-MS81 Sm ppm 0.03	ME-MS81 Sn ppm 0.5	ME-MS81 Sr ppm 0.1	ME-MS81 Ta ppm 0.1	ME-MS81 Tb ppm 0.01	ME-MS81 Th ppm 0.05	ME-MS81 Tm ppm 0.01	ME-MS81 U ppm 0.05	ME-MS81 V ppm 5	ME-MS81 W ppm 0.5
								DUPLICATES								
KA48R																
DUP																
Target Range - Lower Bound																
Upper Bound																

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

Sample Description	Method / Analyte / Units / LOD	ME-MS81 Y ppm 0.1	ME-MS81 Yb ppm 0.03	ME-MS81 Zr ppm 1	pXRF-34 Si % 0.5	pXRF-34 Ti % 0.1	pXRF-34 Zr ppm 5
DUPLICATES							
KA48R							
DUP							
Target Range - Lower Bound							
Upper Bound							

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Project: Kanmantoo tailings

QC CERTIFICATE OF ANALYSIS AD24070918

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

REEs may not be totally soluble in this method.
Applies to Method: ME-MS61

ACCREDITATION COMMENTS

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist
Applies to Method: ME-MS61

LABORATORY ADDRESSES

Processed at ALS Perth located at 31 Denninup Way, Malaga, Australia. Processed at ALS Perth Sample Preparation at 79 Distinction Road, Wangara, WA, Australia
Applies to Method: pXRF-34

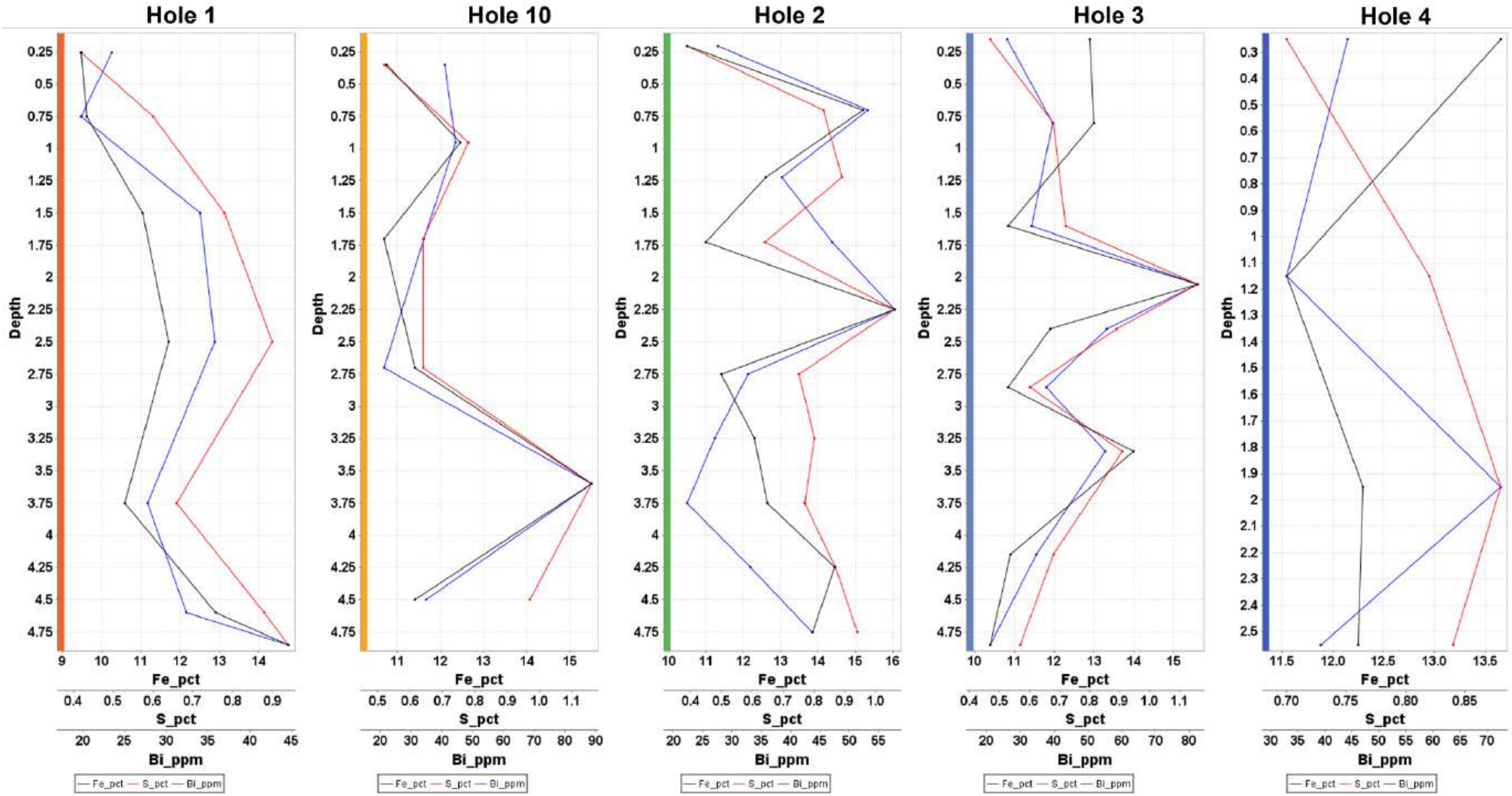
Processed at ALS Adelaide located at Unit 1, 1 Burma Road, Pooraka, Adelaide, SA, Australia.
Applies to Method:

BAG-01	BAG-21	DRY-22	LEV-01
LOG-22	LOG-24	OA-HSUL10	PUL-23
PUL-QC	SPL-21	TRA-21	WEI-21

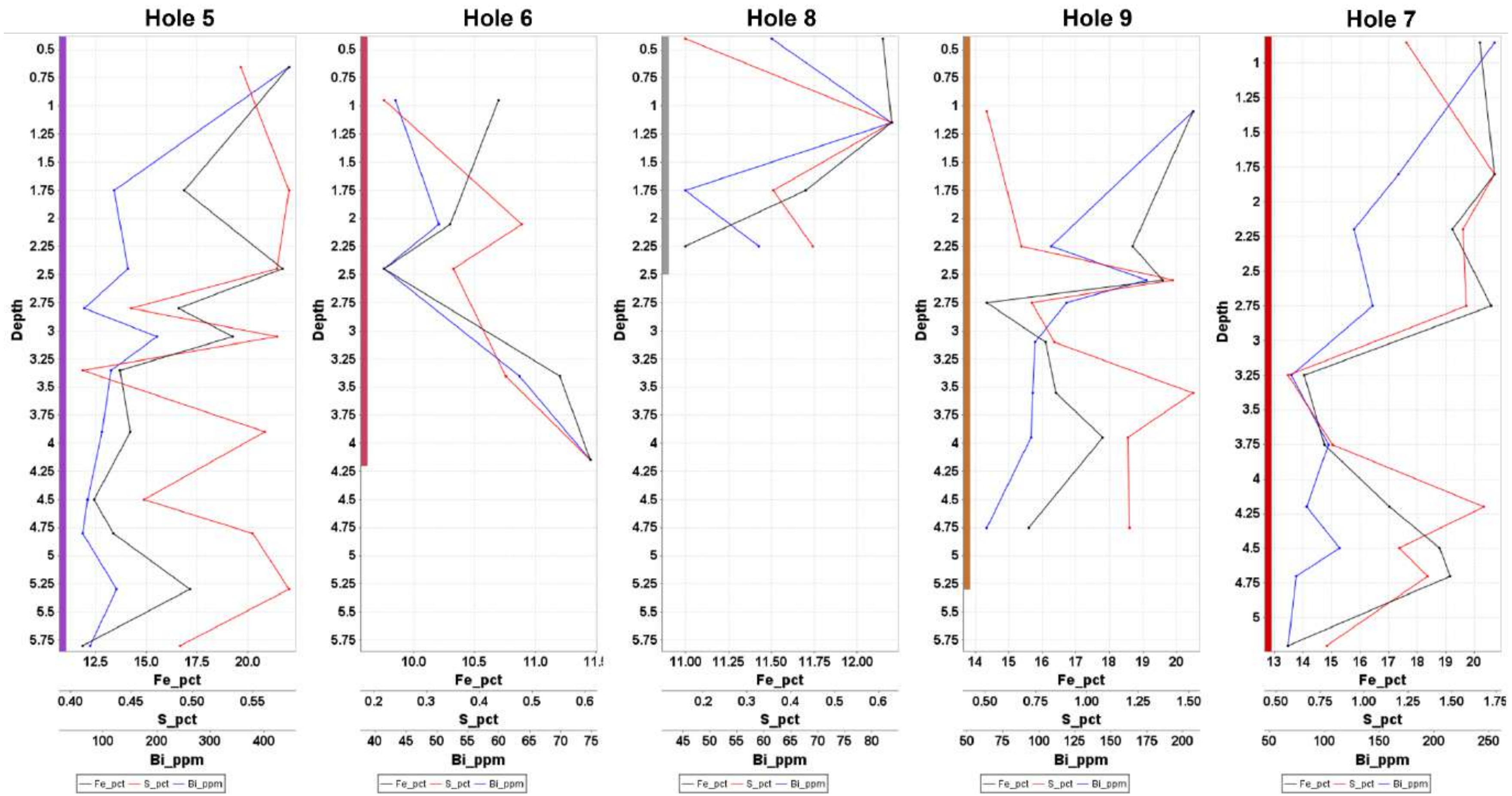
Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 23 Pineapple Street, Zillmere, QLD, 4034, Australia
Applies to Method: ME-MS61 ME-MS81

Appendix D

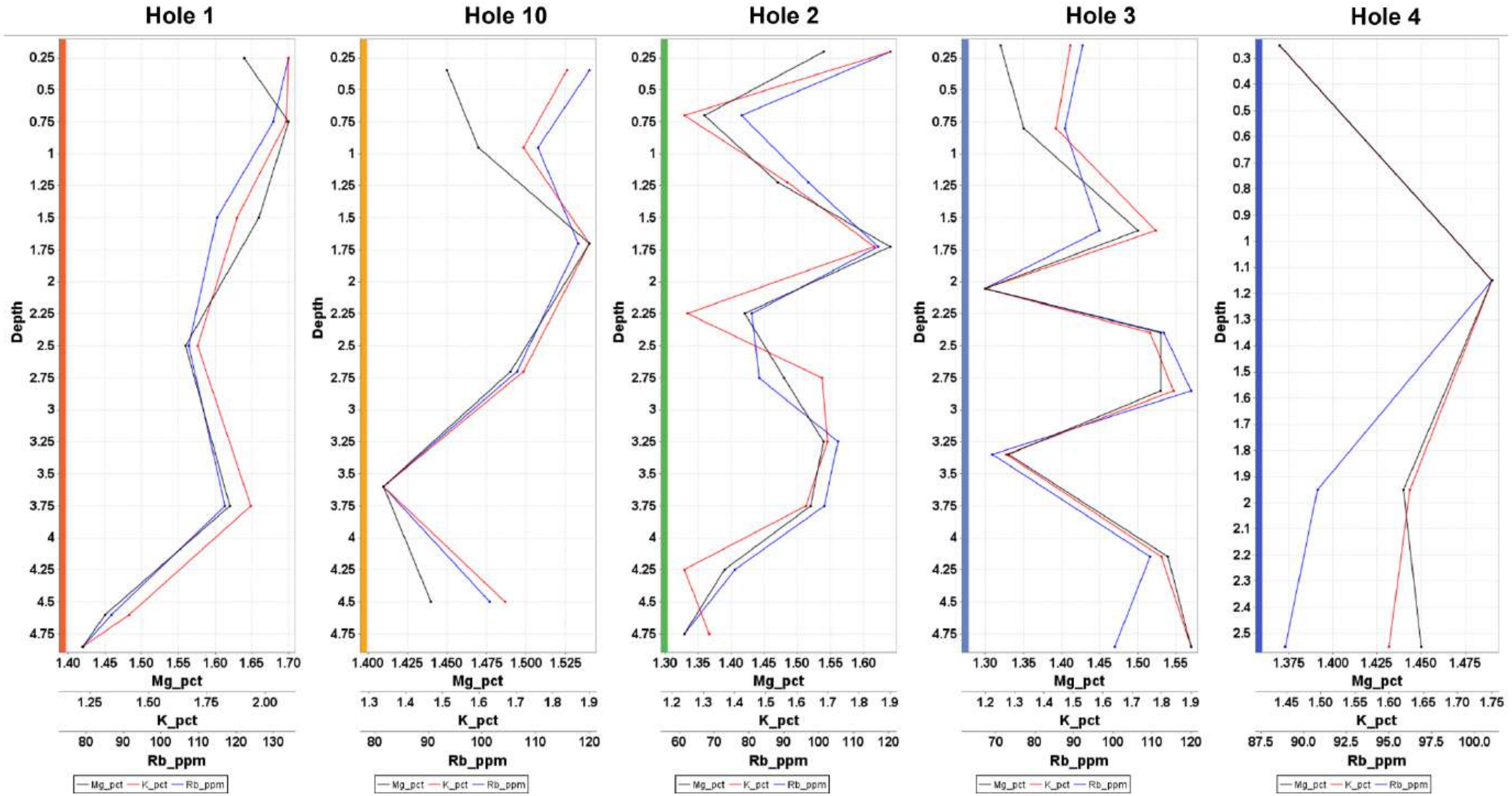
Downhole plots.



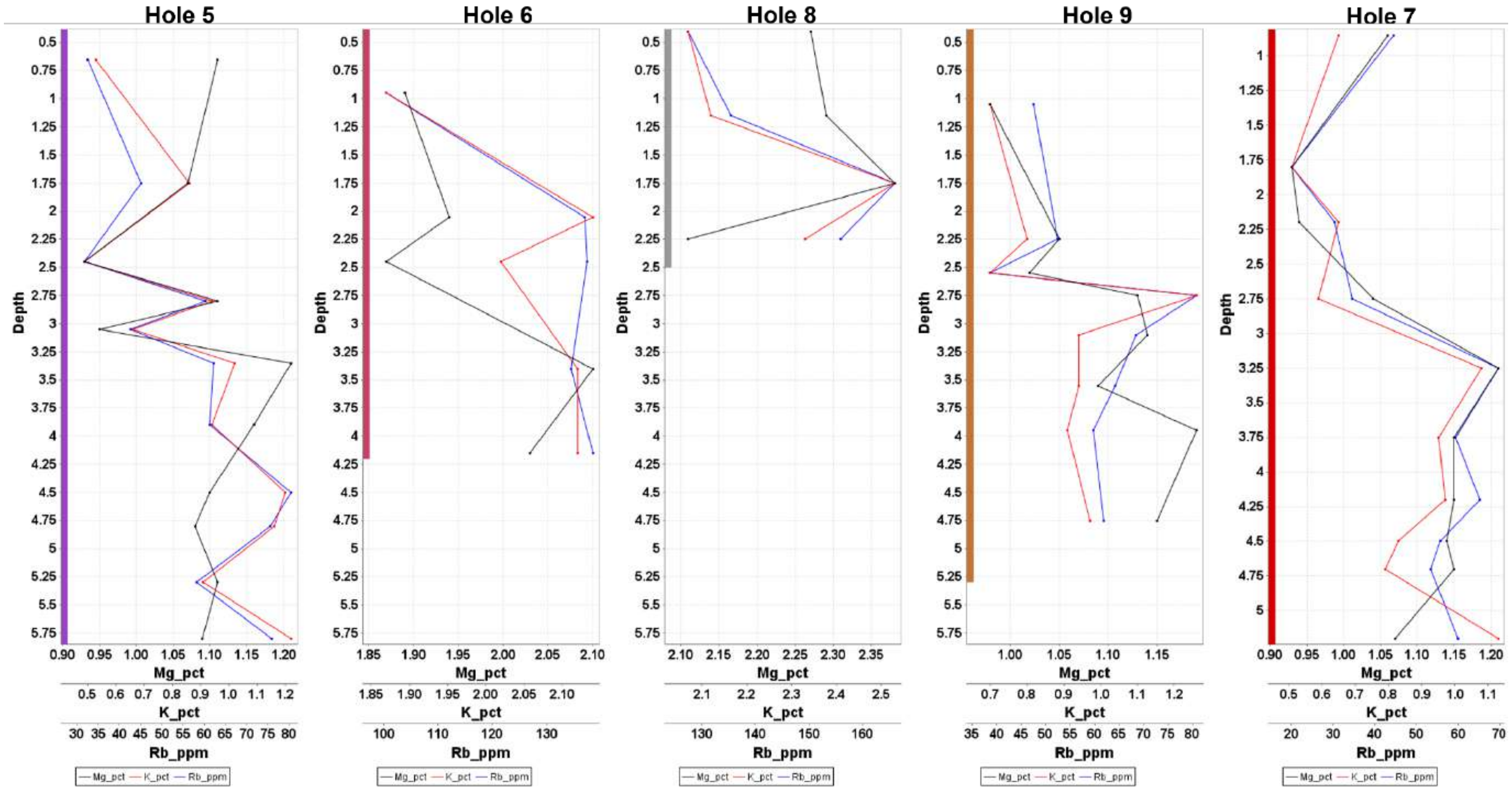
Downhole plots of Fe (%), S (%) and Bi (ppm) in tailings samples from the Kanmantoo new tailings storage facility against depth.



Downhole plots of Fe (%), S (%) and Bi (ppm) in tailings samples from the Kanmantoo old tailings storage facility against depth.



Downhole plots of Mg (%), K(%) and Rb (ppm) in tailings samples from the Kanmantoo new tailings storage facility against depth.



Downhole plots of Mg (%), K(%) and Rb (ppm) in tailings samples from the Kanmantoo old tailings storage facility against depth.

Appendix E

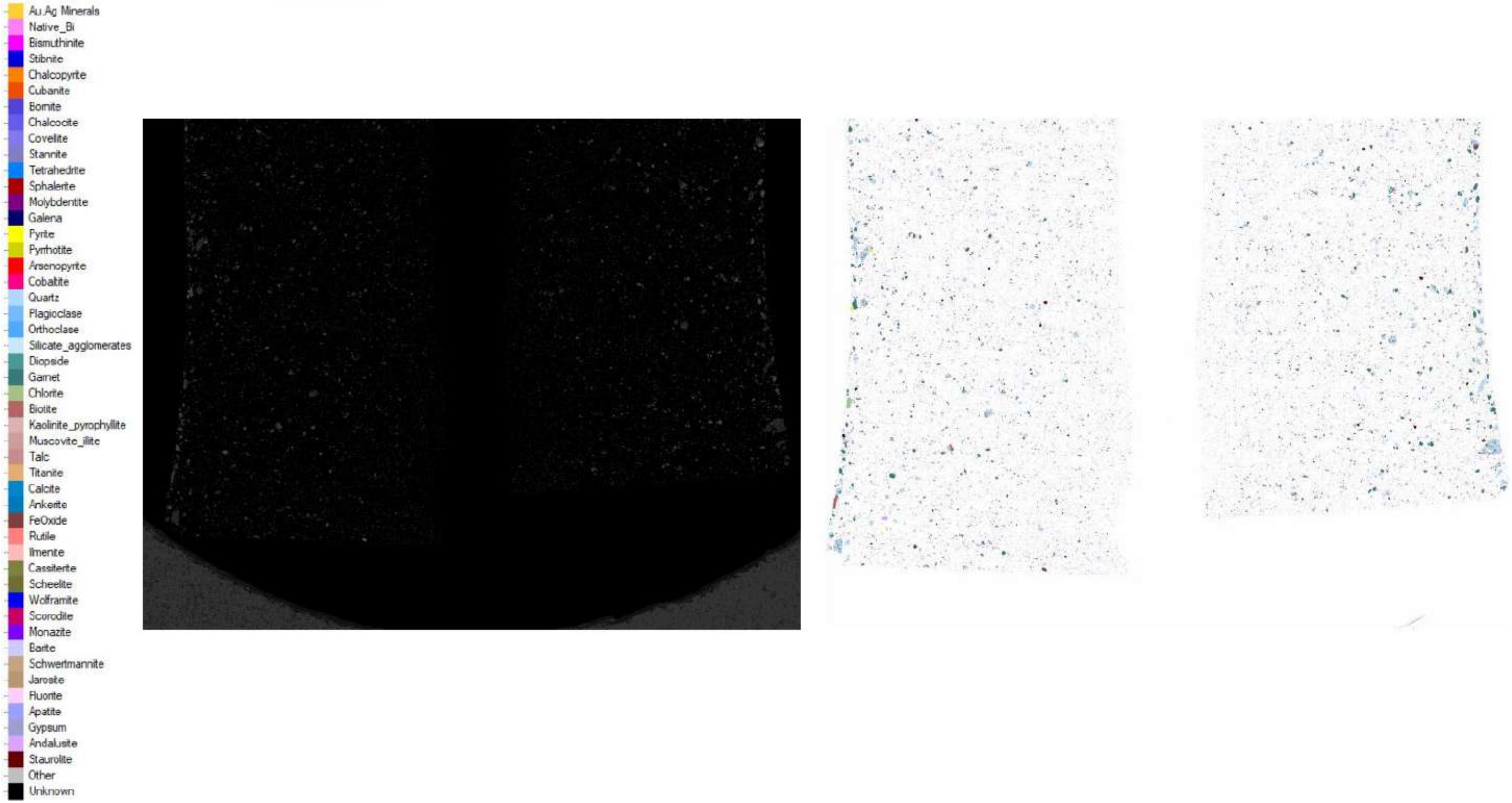
X-ray diffraction results.

Mineral (wt. %)	KA07	KA12	KA22	KA77	KA33	KA35	KA51	KA53	KA62	KA65
Almandine	26	28	26	25	35	51	43	38	5	39
Quartz	36	34	36	38	32	26	25	26	37	27
Biotite	10	7	8	7					17	1
Magnetite	1	1	1	18	7	2	5	2	ND	3
Chlorite	5	4	4	4	5	5	4	5	11	4
Andalusite	3	4	4	4	1	1	2	2	5	3
Jarosite					2	2	3	2		2
Illite/Muscovite		3	6		3	3	3	2		7
Staurolite	2	1	2	1	2	1	3	3		2
Ilmenite					1	1	0.2			1
Goethite					2		2			
Hematite	1	0.2	0.2	ND	0.2	0.2	0.2	0.2	ND	1
Mixed layer clay					0.2	2	1	3		
Pyrite	1	1	1	0.2	0.2	ND	1	1	1	0.2
Chalcocyanite		1		0.2	0.2		1			1
Alunite, natro	<0.5									
Chalcopyrite						<0.5				
Expanding clay								<0.5		
Potassium feldspar	<0.5									
Rutile	<0.5									
Amorphous Content	15	17	11	2	9	5	7	16	25	11

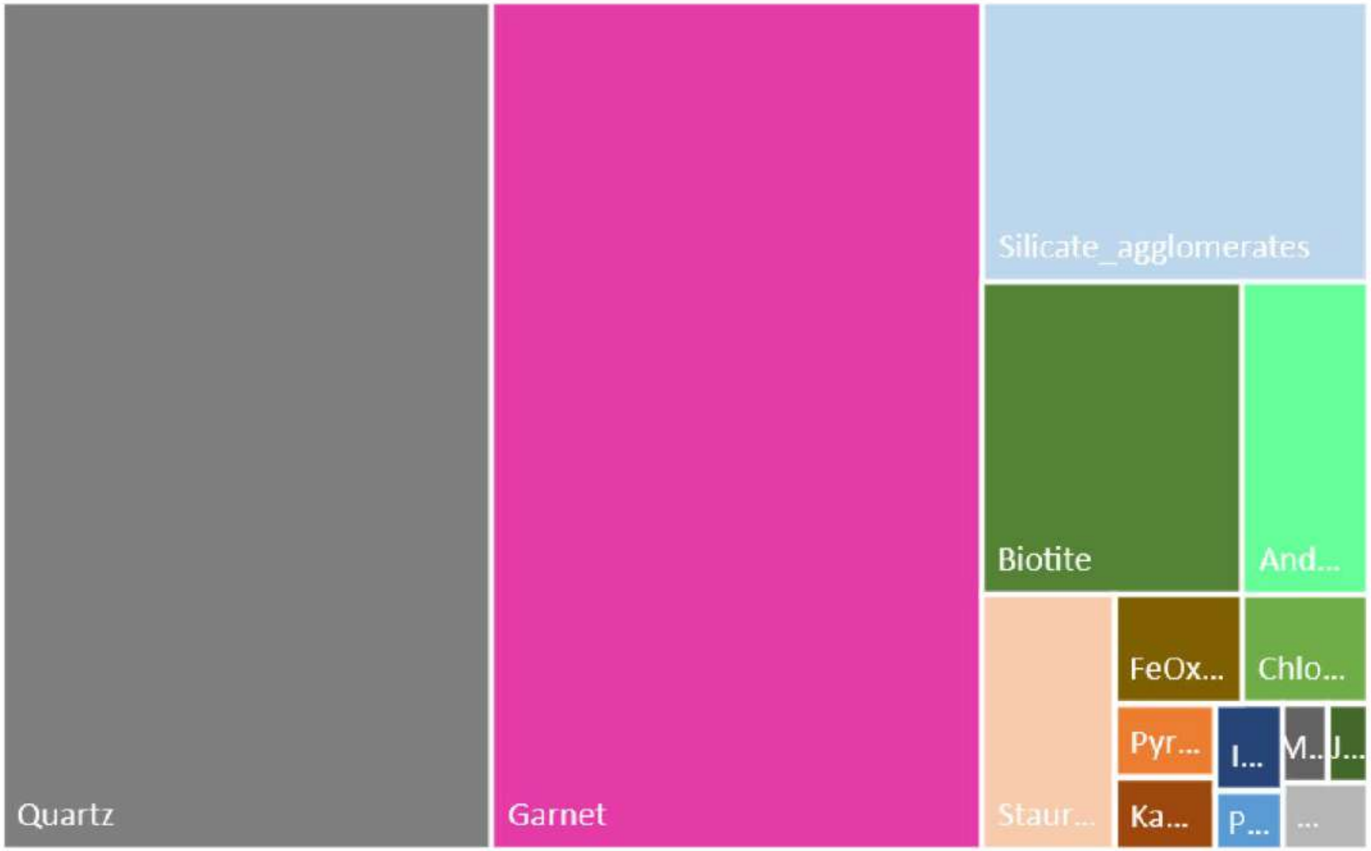
Appendix F

Kanmantoo MLA images for LA-ICP-MS.

KA07 new tailings storage facility

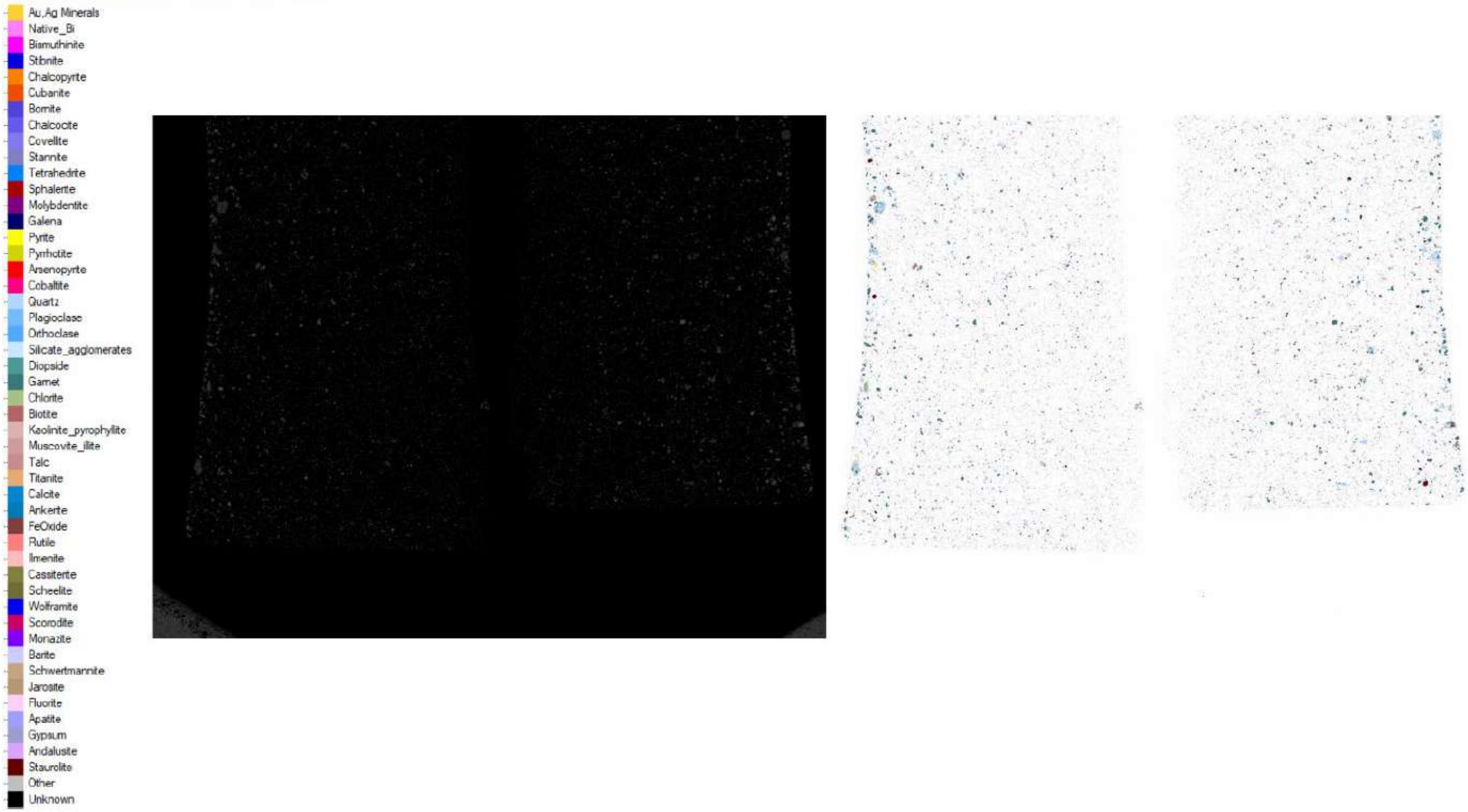


KA07 new tailings storage facility

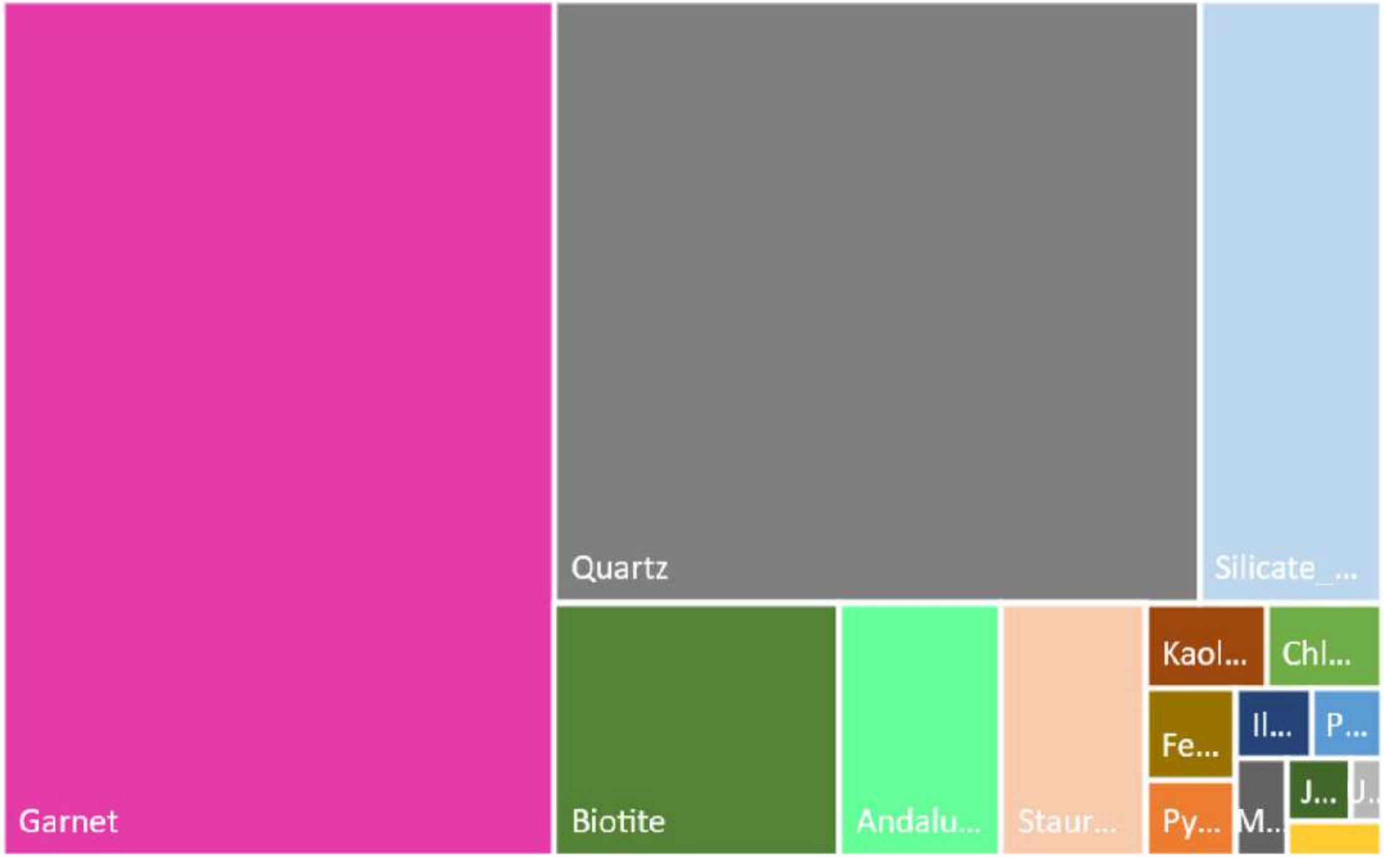


KA12 new tailings storage facility

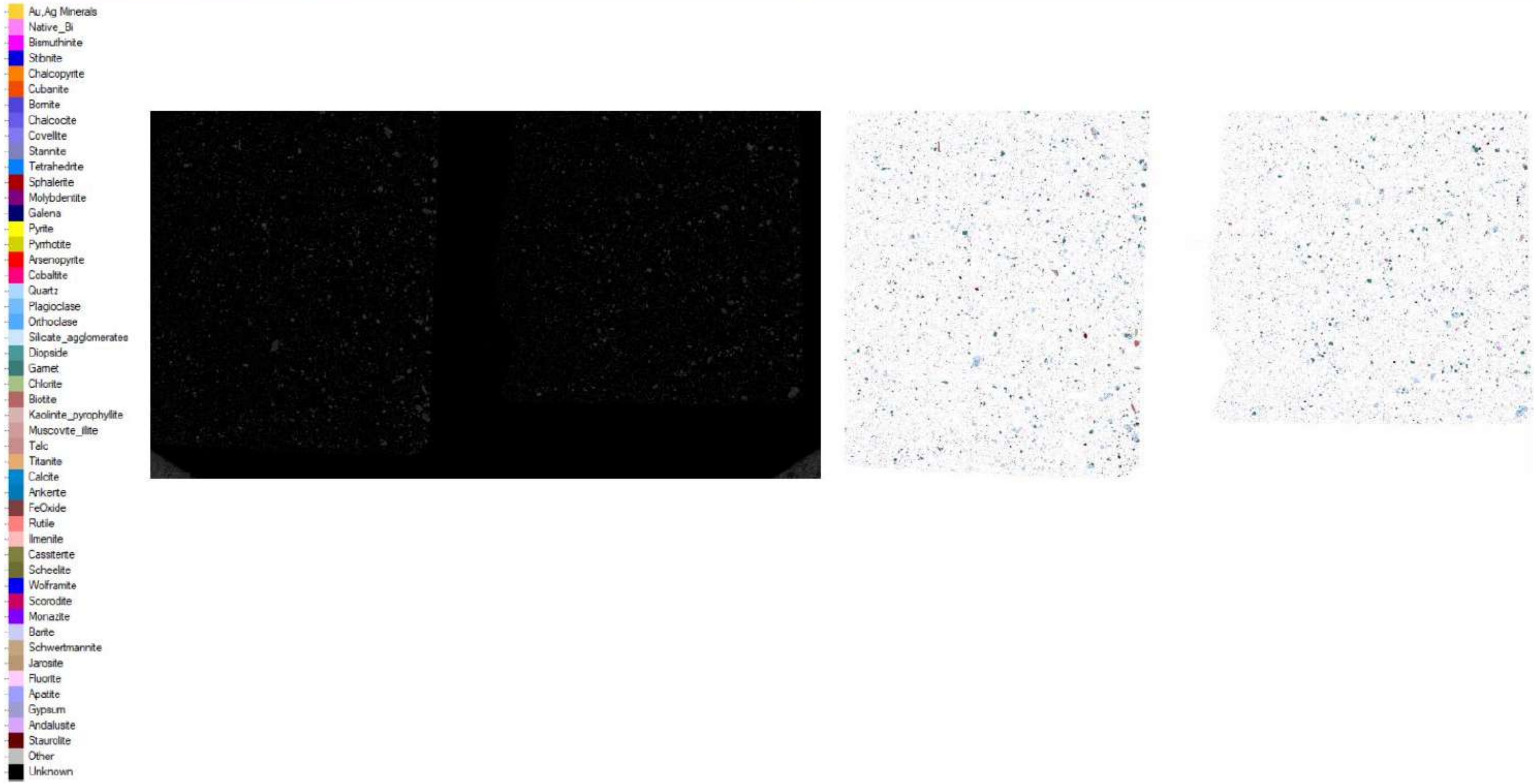
The University of Queensland
Australia



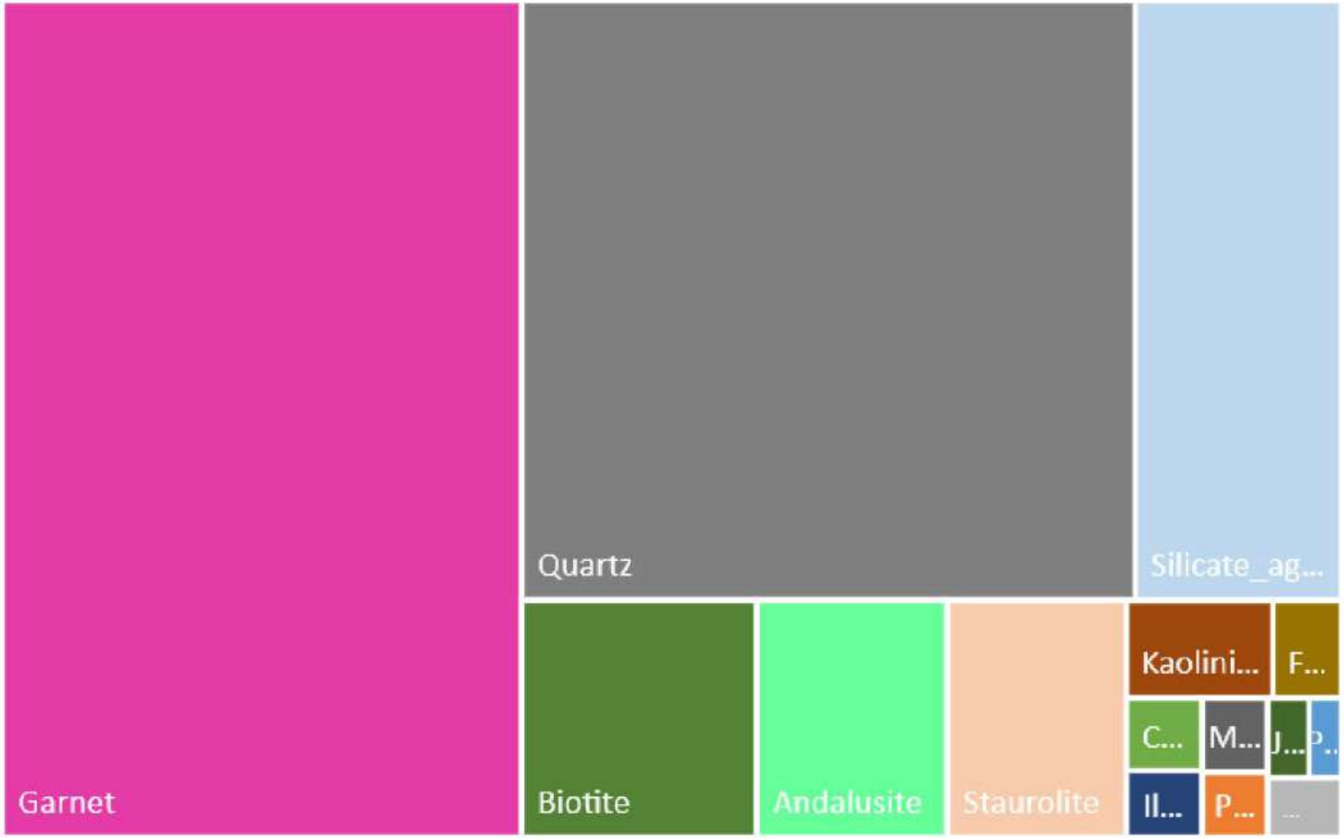
KA12 new tailings storage facility



KA22 new tailings storage facility



KA22 new tailings storage facility



KA77 new tailings storage facility

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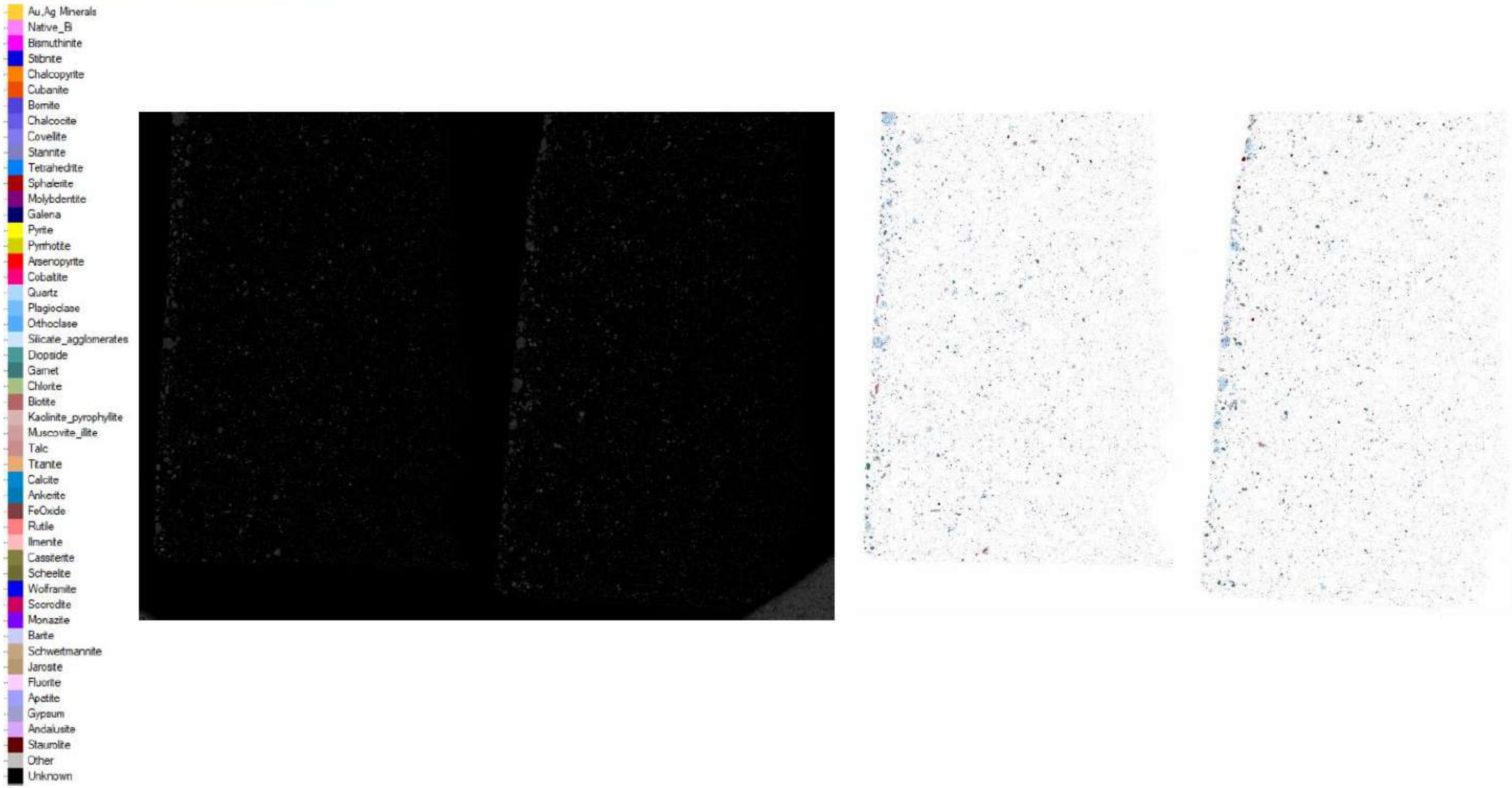
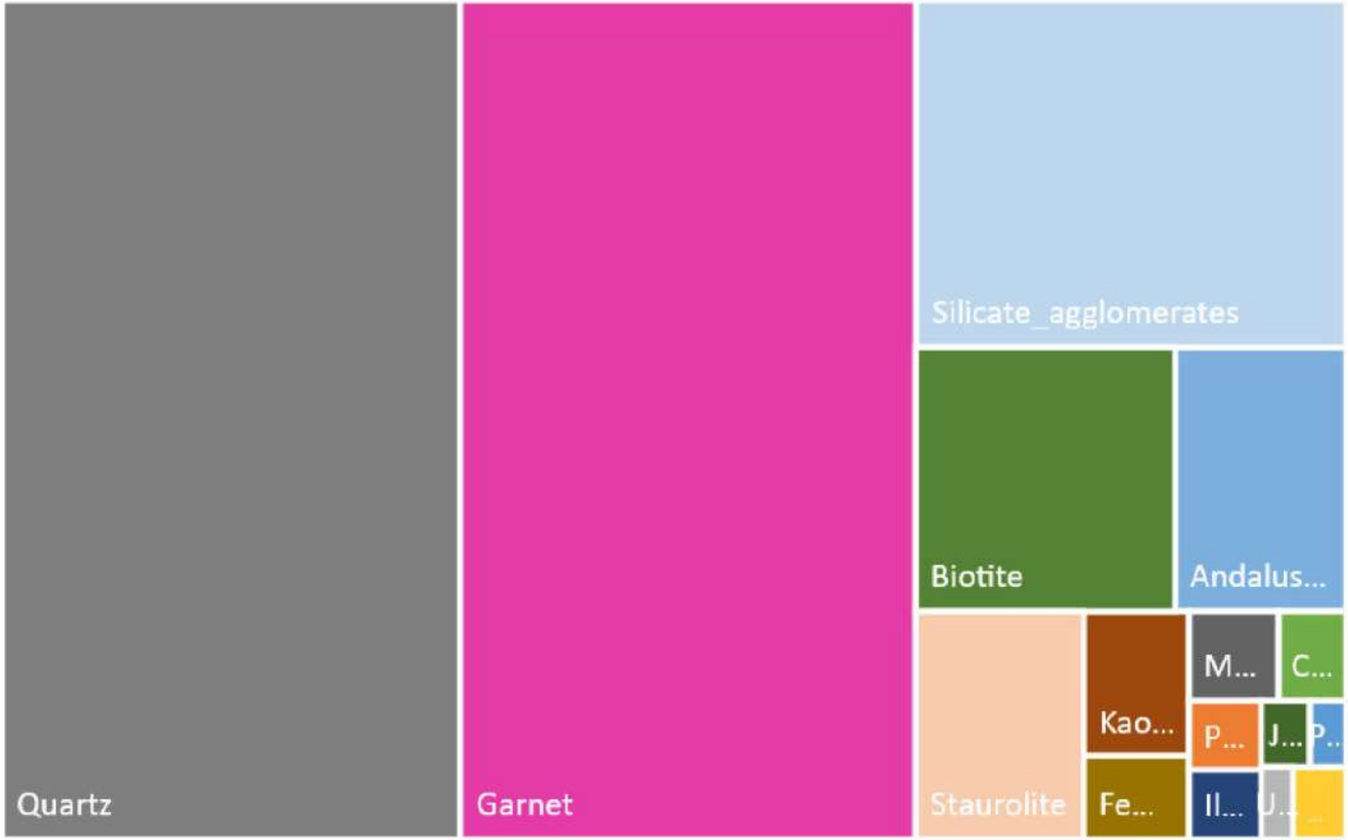


KA77 new tailings storage facility



KA33 old tailings storage facility

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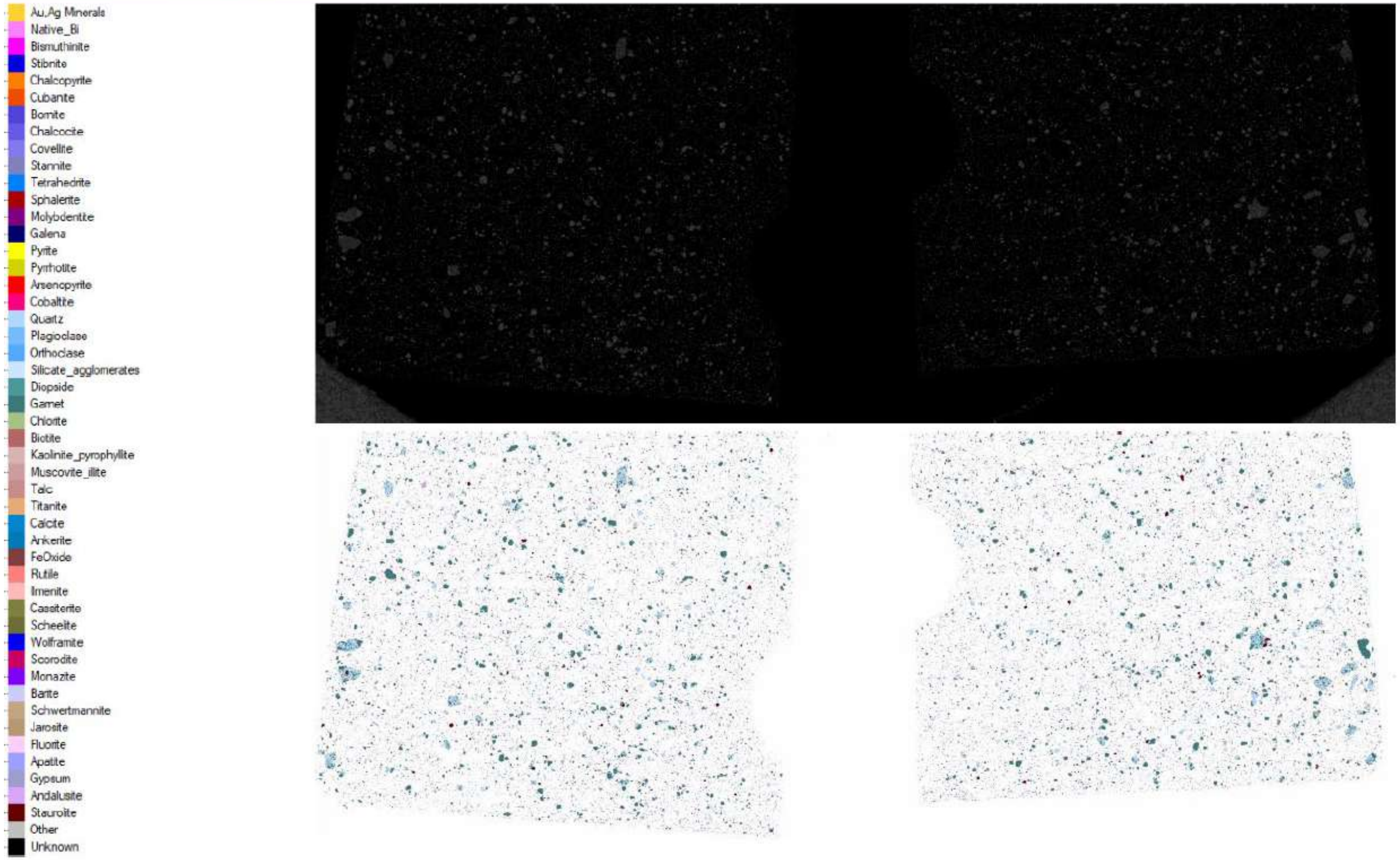
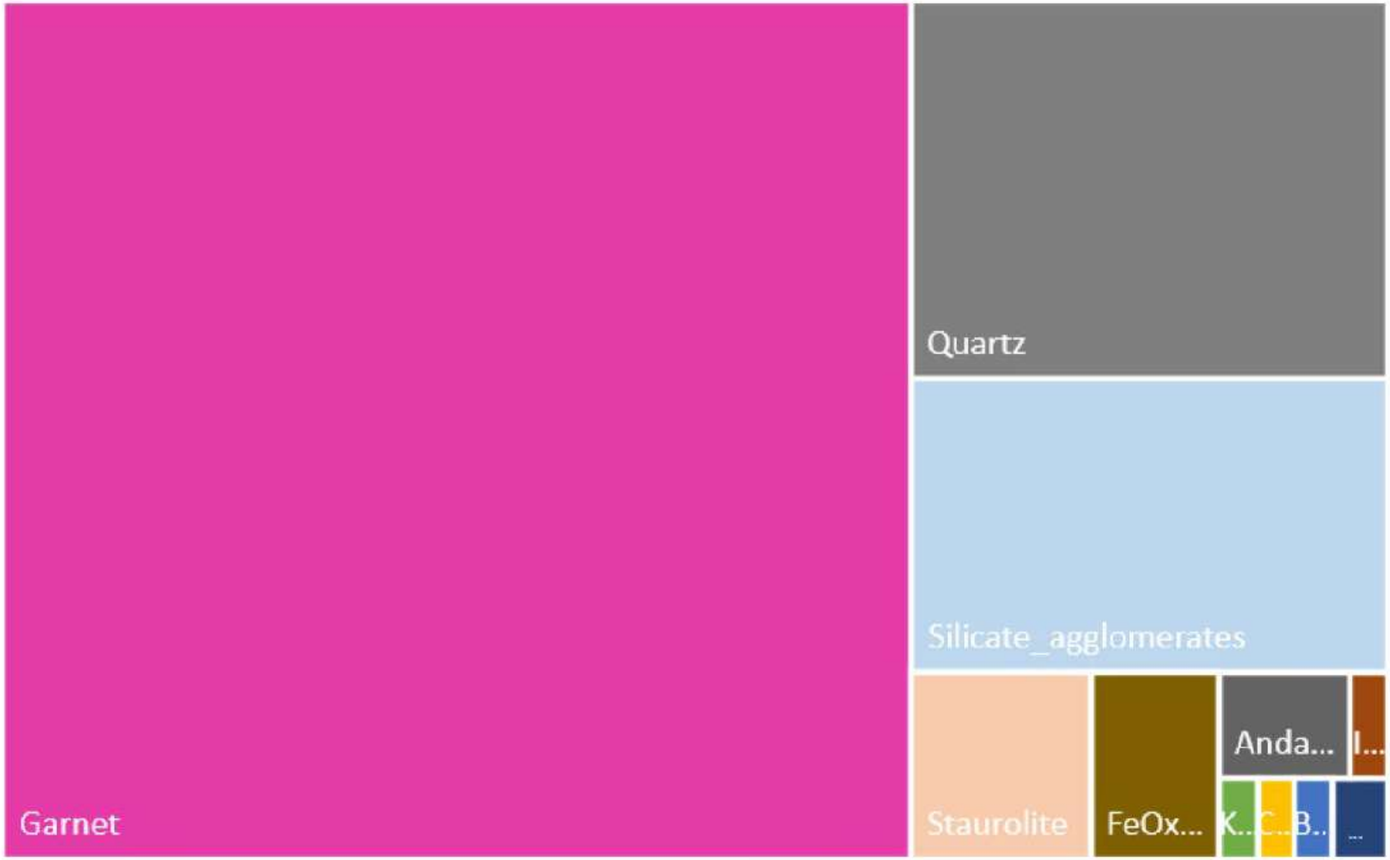


KA33 old tailings storage facility



KA35 old tailings storage facility

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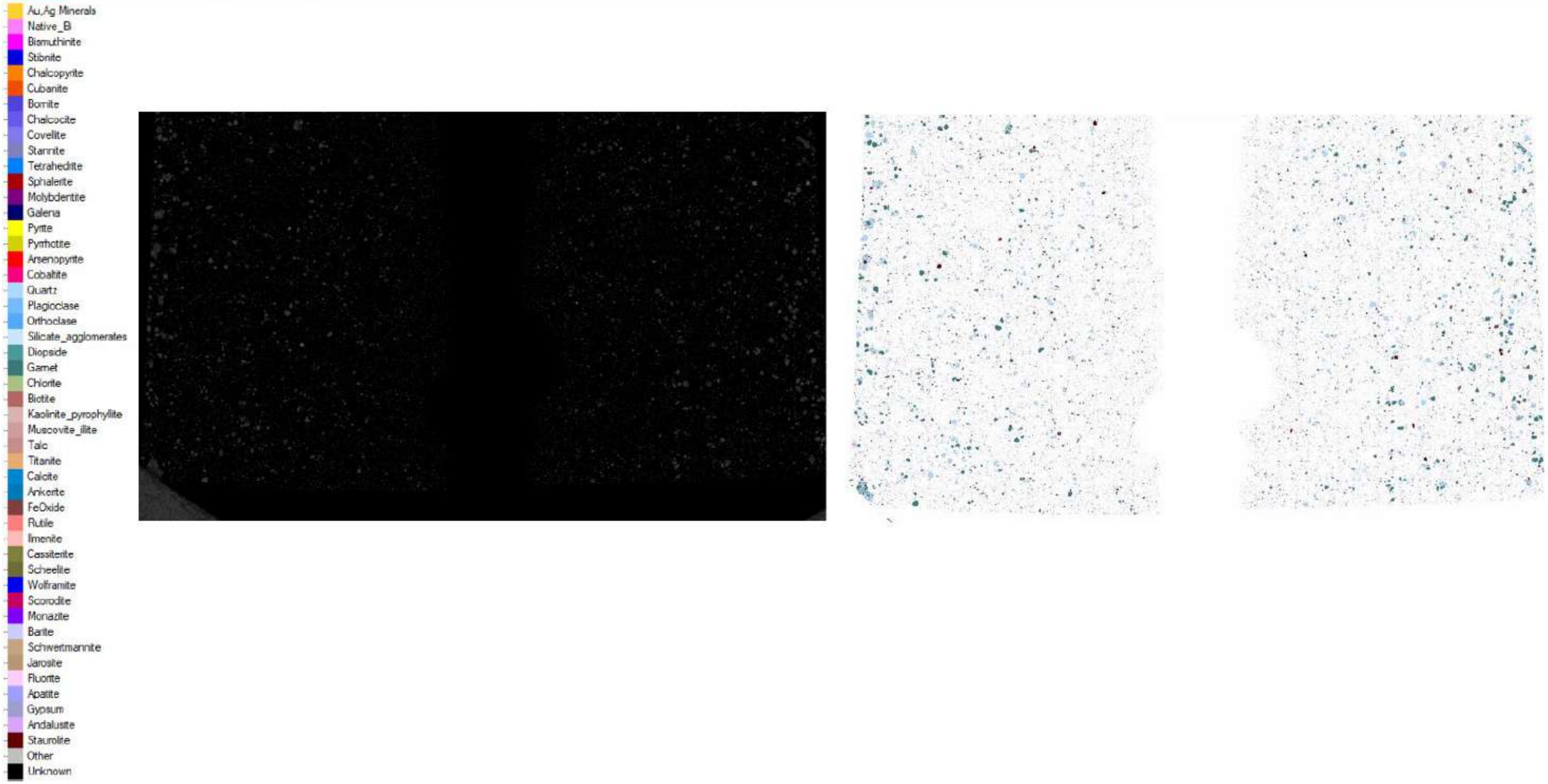
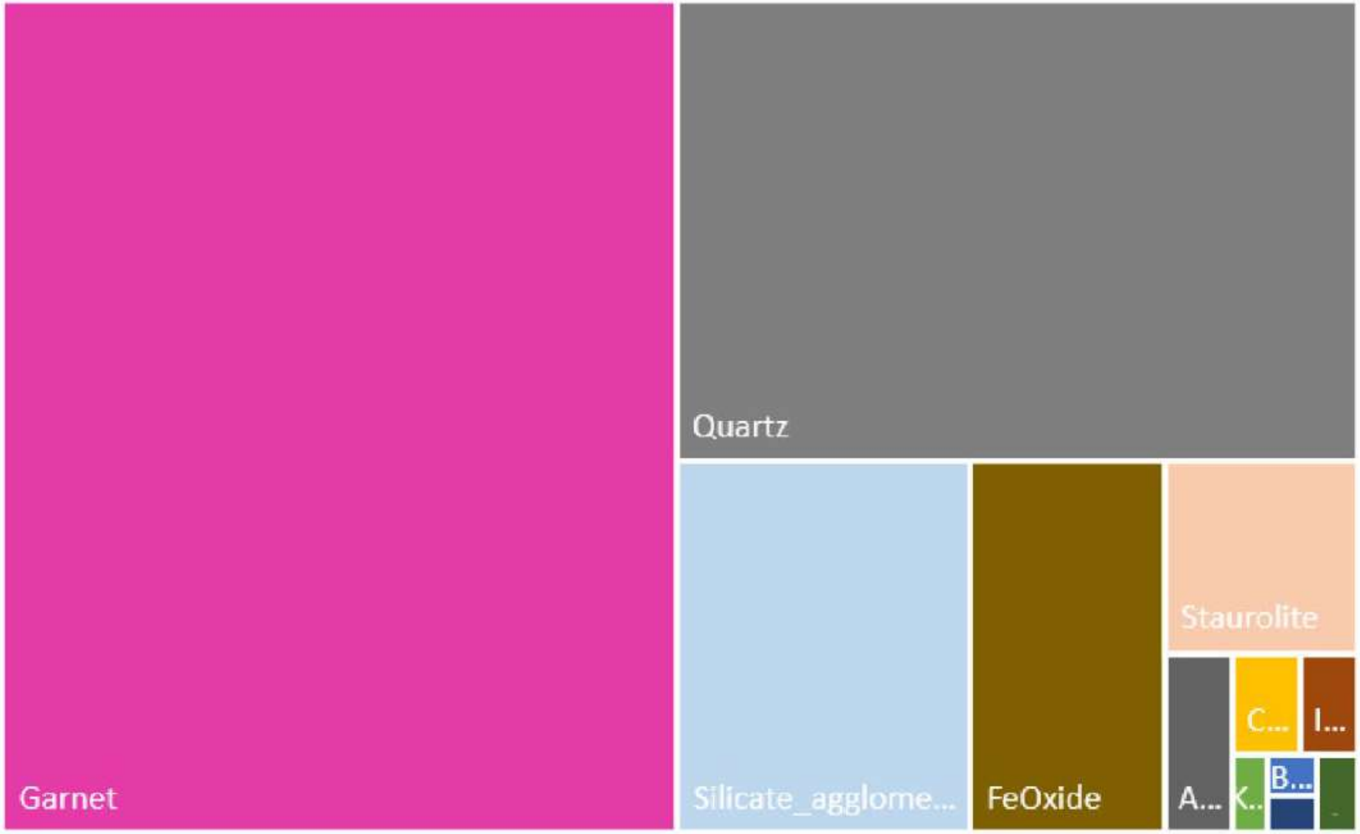
AUSTRALIA



KA35 old tailings storage facility



KA51 old tailings storage facility

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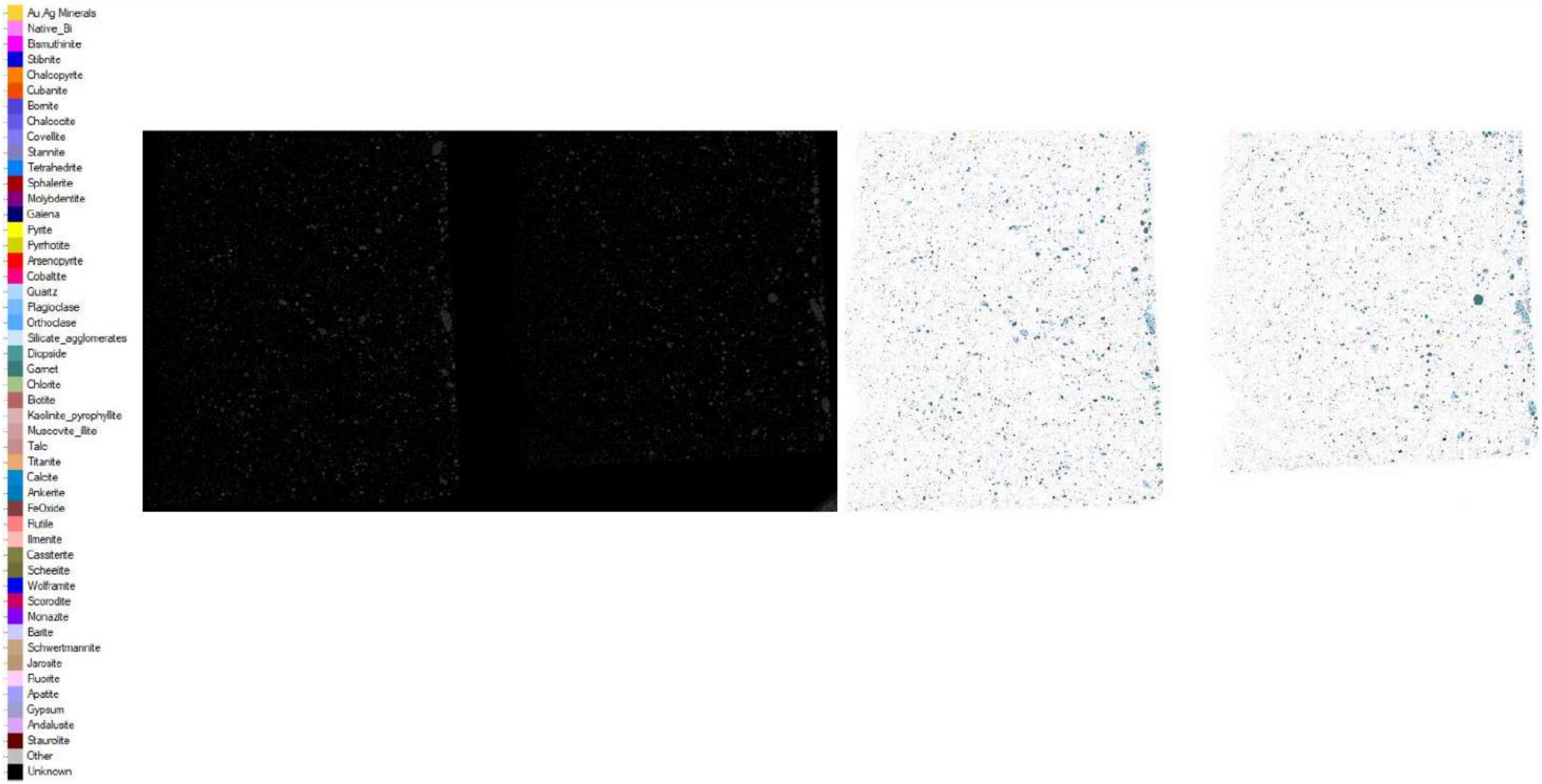

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CREATE CHANGE

KA51 old tailings storage facility

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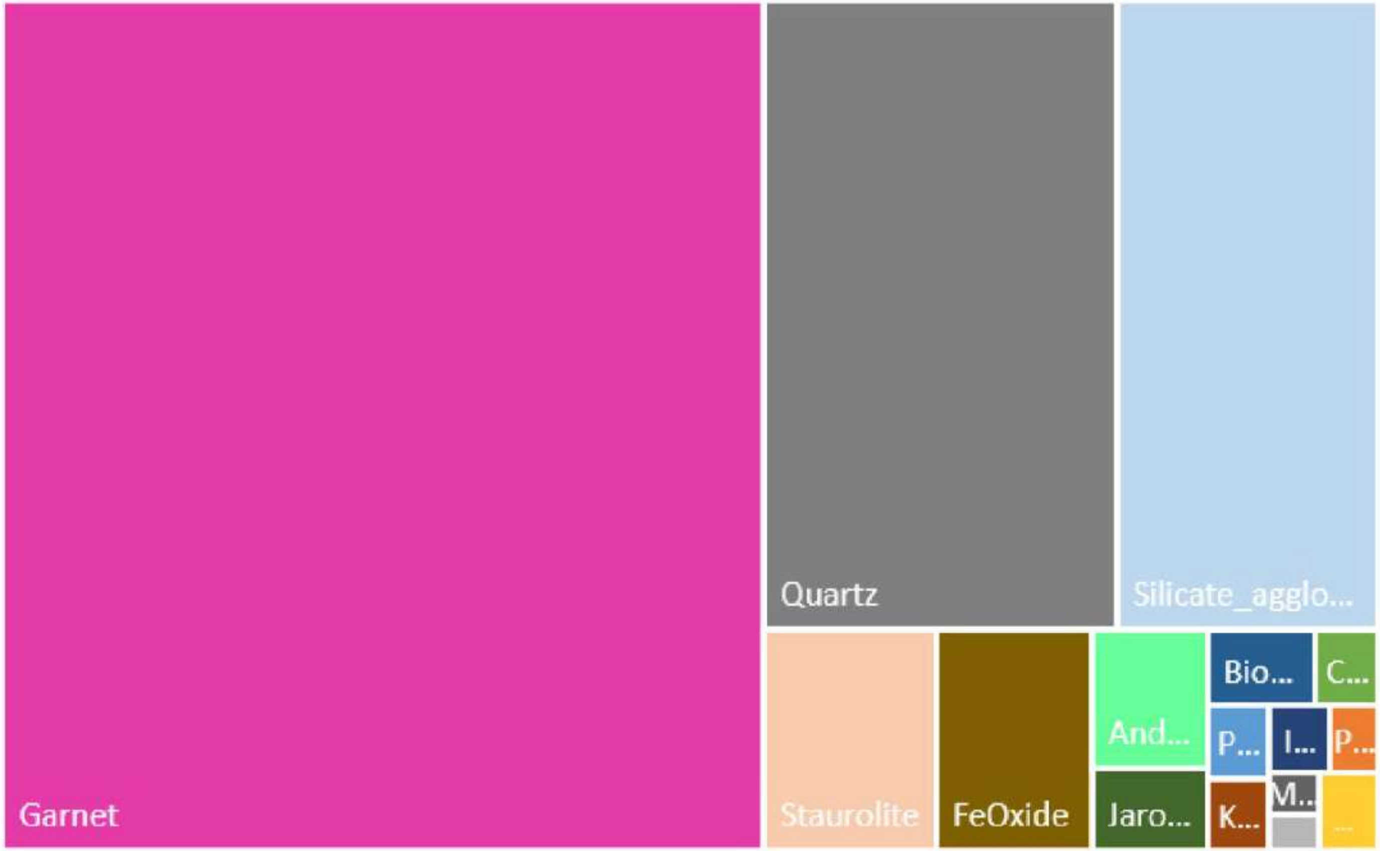

KA53 old tailings storage facility

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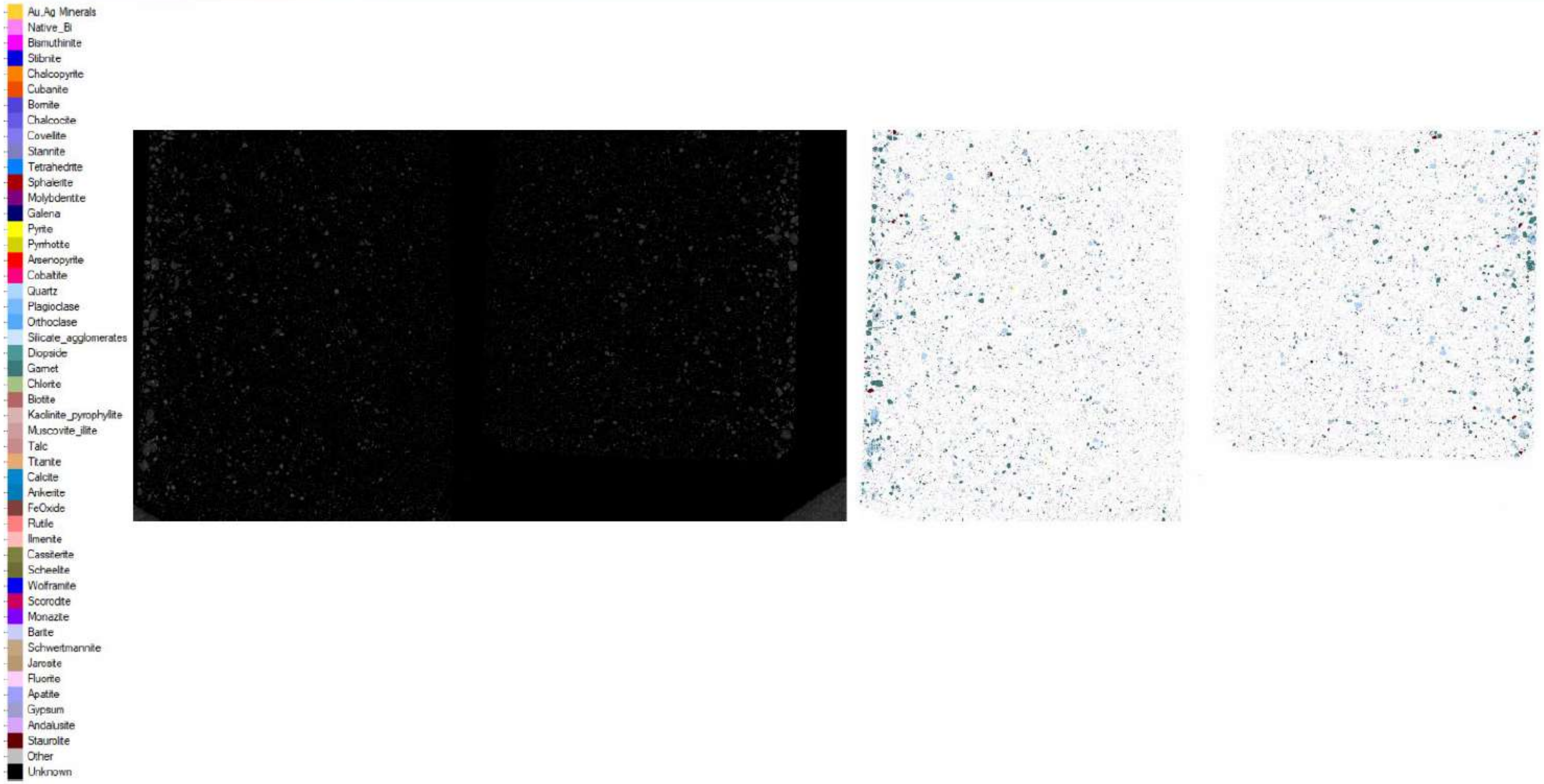
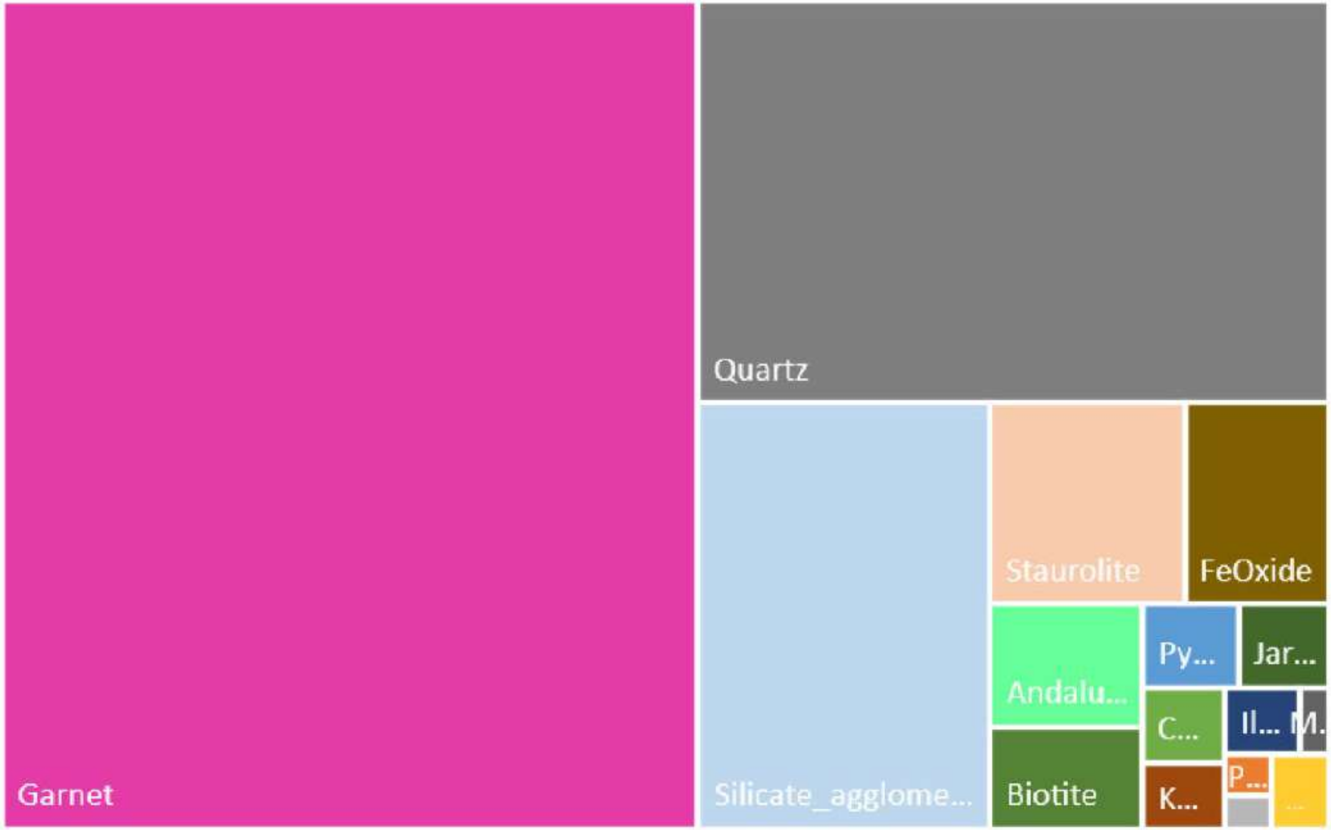
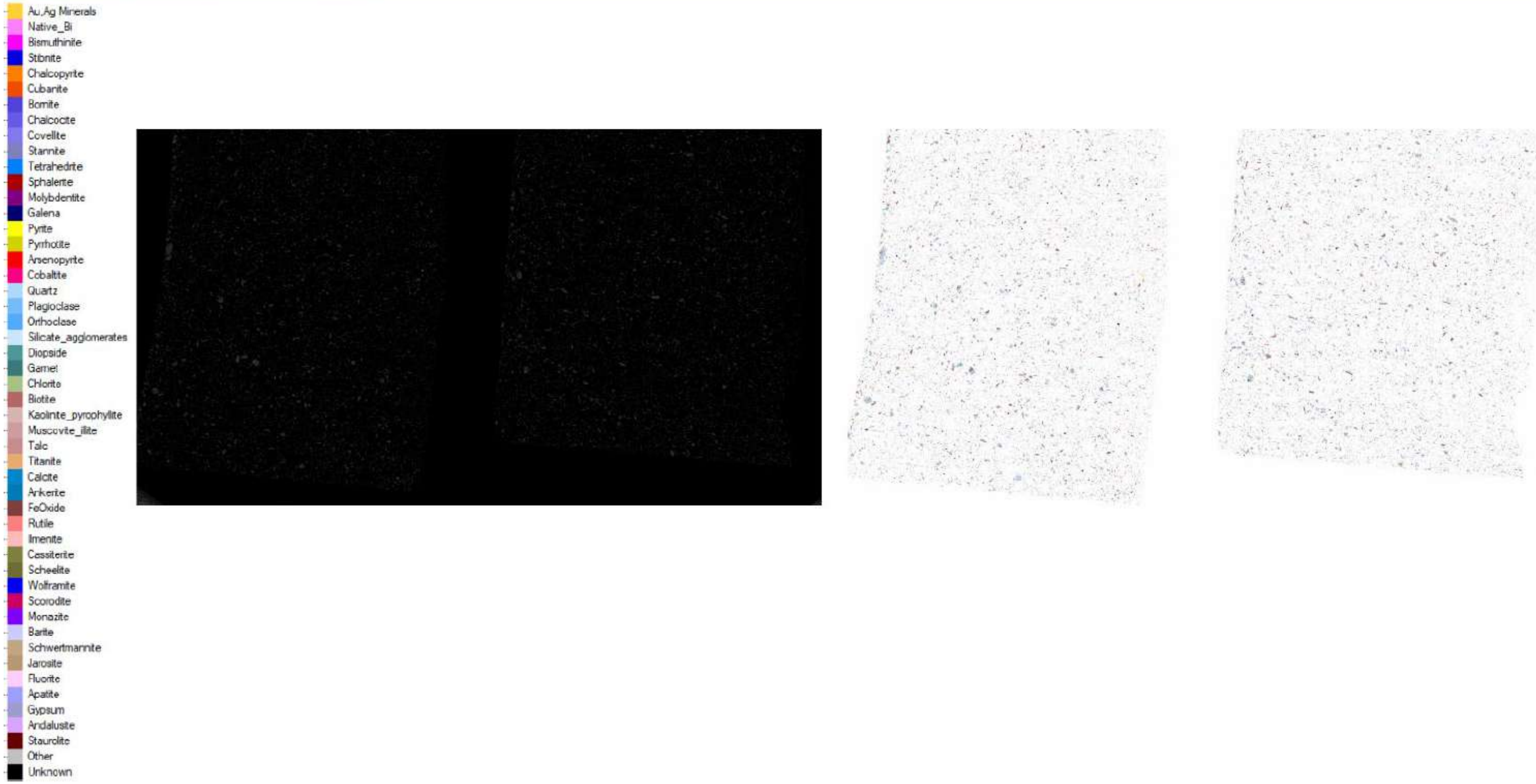


KA53 old tailings storage facility



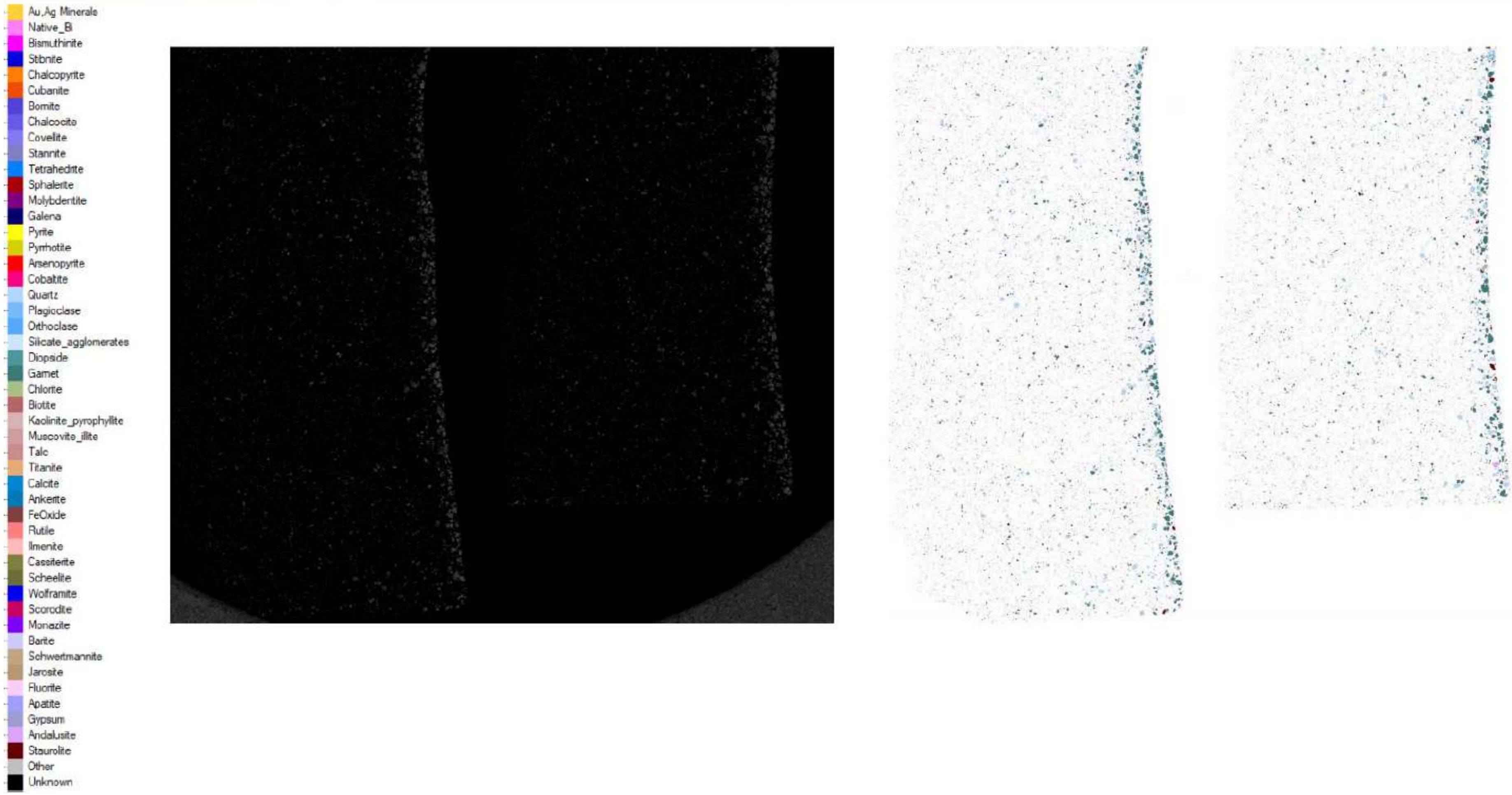
KA62 old tailings storage facility

The University of Queensland
Australia

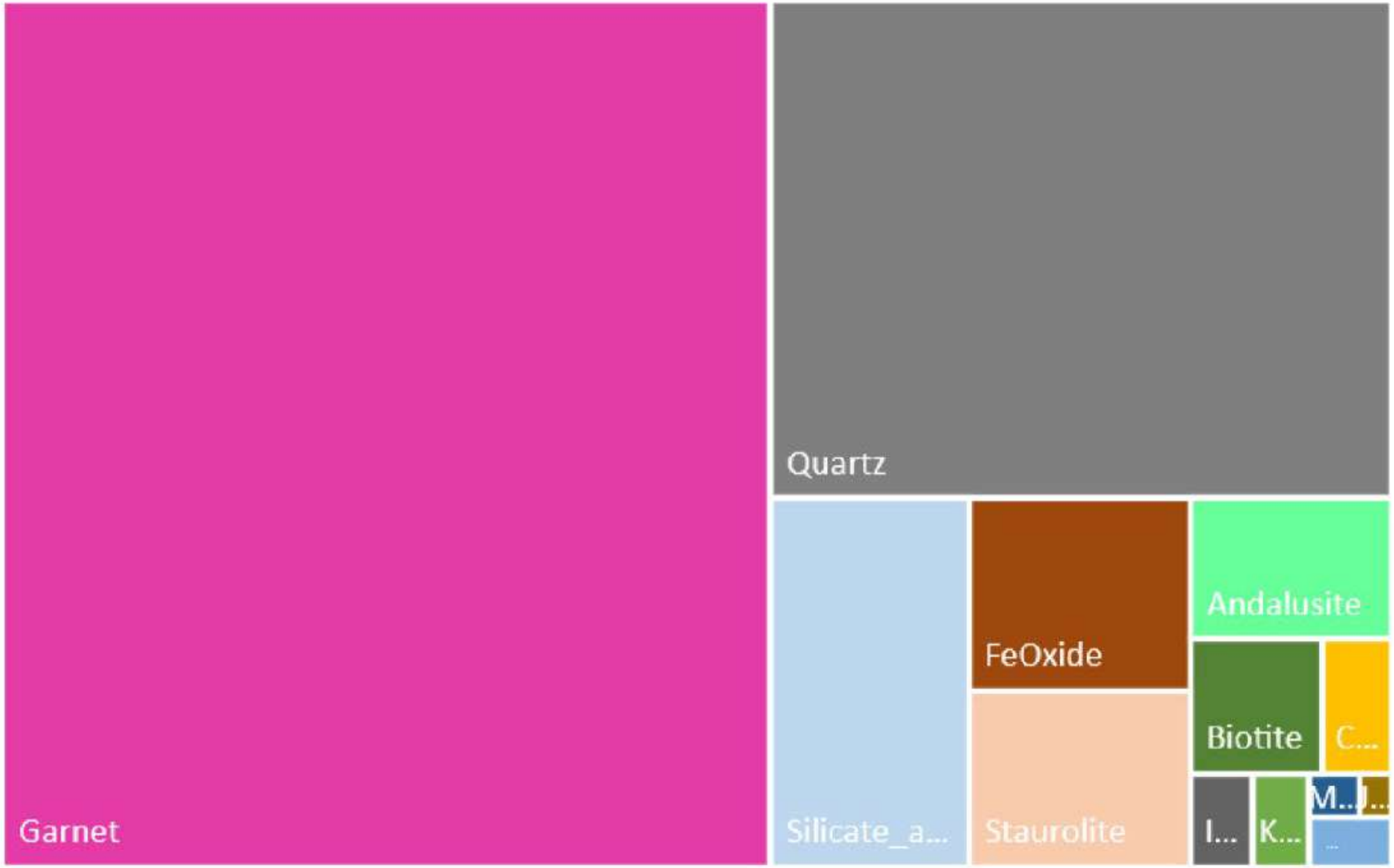


KA62 old tailings storage facility

KA65 old tailings storage facility



KA65 old tailings storage facility



Appendix G

MLA results.

Mineral (wt%)	KA07	KA12	KA22	KA77	KA33	KA35	KA51	KA53	KA62	KA66
Garnet	35.83	40.04	38.8	33.84	65.58	49.71	55.37	52.45	8.19	55.34
Quartz	35.84	32.87	32.82	34.12	15.16	27.83	18.95	23.1	35.16	25.65
Silicate agglomerates	9.38	9.32	11.03	13.25	11.74	9.7	14.08	11.32	8.77	6.06
Biotite	7.02	6.1	4.97	6.06	0.25	0.18	0.71	1.42	25.45	1.49
Staurolite	2.93	3.1	3.79	3.41	2.83	3.28	3.26	3.55	1.87	3.23
Andalusite	3.38	3.47	4.04	4	1.17	1.08	1.37	1.7	4.03	2.35
Fe oxides	1.2	0.7	0.6	0.77	2.01	6.41	2.92	2.65	1.37	3.55
Chlorite	1.19	0.84	0.49	0.54	0.25	0.61	0.41	0.57	11.09	0.76
Kaolinite-pyrophyllite	0.63	0.88	1.28	1.35	0.27	0.23	0.38	0.49	0.76	0.44
Ilmenite	0.5	0.45	0.44	0.45	0.33	0.51	0.34	0.45	0.65	0.48
Muscovite-illite	0.32	0.42	0.43	0.71	0.05	0.05	0.18	0.18	0.97	0.18
Pyrite	0.34	0.42	0.23	0.21	b.d.l	b.d.l	0.39	0.73	0.47	b.d.l
Pyrrhotite	0.65	0.57	0.38	0.45	b.d.l	b.d.l	0.27	0.17	0.25	0.01
Jarosite	0.28	0.34	0.3	0.28	0.03	0.09	0.8	0.68	0.14	0.11
Plagioclase	0.05	0.05	0.05	0.1	0.09	0.02	0.1	0.07	0.19	0.07
Apatite	0.08	0.09	0.06	0.06	b.d.l	0.01	0.03	0.05	0.26	0.04
Monazite	0.01	0.01	0.01	0.02	b.d.l	b.d.l	0.01	0.01	0.02	0.01
Schwertmannite	0.02	0.02	0.03	0.02	0.02	0.08	0.11	0.11	0.03	0.03
Orthoclase	0.05	0.04	0.05	0.06	0.01	0.01	0.02	0.03	0.1	0.04
Chalcopyrite	0.02	0.01	0.01	0.01	b.d.l	b.d.l	0.03	0.03	0.01	0.01
Bornite	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	0.02	b.d.l	b.d.l	b.d.l
Sphalerite	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	0.01	b.d.l
Talc	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	0.01	0.01	b.d.l
Rutile	b.d.l	b.d.l	0.01	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	0.01	b.d.l
Native Bi	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	0.01	b.d.l	b.d.l
Bismuthinite	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	0.01	b.d.l	b.d.l	b.d.l
Other	0.13	0.06	0.05	0.07	0.03	0.03	0.07	0.08	0.08	0.03
Unkown	0.14	0.16	0.12	0.2	0.15	0.16	0.15	0.14	0.1	0.1

b.d.l = below detection limit

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Contact details

Dr Francesco Colombi
W.H. Bryan Mining and Geology Research Centre, SMI
M +61 0490208185
E f.colombi@uq.edu.au
W smi.uq.edu.au

Dr Laura Jackson
W.H. Bryan Mining and Geology Research Centre, SMI
M +61 0437214070
E laura.jackson@uq.edu.au
W smi.uq.edu.au

Mr Gabriele Baldassarre
Department of Environmental, Land and Infrastructure Engineering, DIATI
M +39 3386490302
E gabriele_baldassarre@polito.it

Dr Anita Parbhakar-Fox
W.H. Bryan Mining and Geology Research Centre, SMI
T +61 7 33655941
M +61 0400850831
E a.parbhakarfox@uq.edu.au
W smi.uq.edu.au

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