وزارة الطاقة والثروة المعدنية

الذهب

و

الزنك

Report on the geological exploration activities conducted in Wadi Araba, Southern Jordan

(Finan area)

Introduction:

This report summarizes the geological exploration activities conducted in Wadi Araba, Southern Jordan, focusing on lithium, gold, and zinc, the study covers two areas illustrated in Figure 1. Area 3 located in the Finan region, about 25 km southwest of the city of Tafila within the Feynan and Shoubak geological panels scale 1:50,000 in the area of Jabal Zureik Al-Mirad, in the northwestern part of the Wadi Araba area and can be reached through the road to the villages of Qureigra - Feynan via the Wadi Araba Dead Sea - Aqaba road and the area of the exploration area is about 35.7 km. Area 4 is located west of Finan. A total of 448 geochemical samples (lithogeochemical and stream samples) were collected from both areas. Three types of fraction sizes were collected and sieved: "-20/80", "-80", and "-20 mesh" for Heavy Mineral Concentrates (HMC).

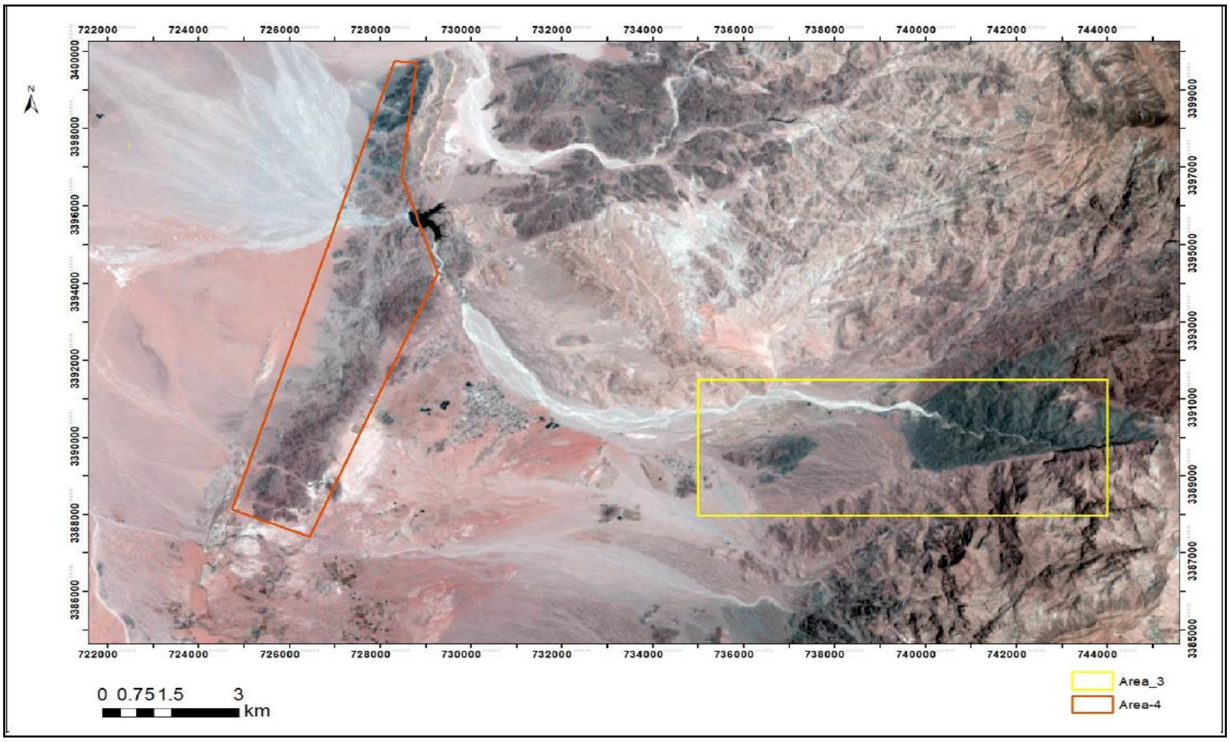

Figure 1. Areas of interest for lithium and associated minerals exploration (area 3, area 4)

The project aims to assess the economic potential of these regions for mineral extraction, particularly for lithium and associated elements, as well as gold and zinc.

Geological Background

- The region is dominated by Neo-Proterozoic rocks (603-572 Ma) comprising syenogranite and Ghuweir Volcanic Suite basaltic rocks.
- These rocks belong to the calc-alkaline series, characterized by high aluminum and potassium oxide content and low titanium and iron oxides.
- Key geological structures include the Wadi Araba and Salawan faults, which govern the area's tectonic and structural framework.
- Bimodal volcanism and extensional tectonics have created conditions favorable for pegmatite formation; however, the pegmatite development in these regions remains immature.

Exploration Results

1. Gold (Area 3):

Target Locations:
Gold anomalies were identified in Area 3, particularly near quartz and calcite veins. The anomalies are associated with hydrothermal alterations in quartz-rich environments.

Key Samples:

- Rk2011: Gold anomalies in quartz veins.
- Rk2041: Similar indications of gold mineralization.
- Ss1033: Heavy mineral concentrate (H.M.C.) showing significant traces of gold.

Field Observations:

- Large quartz crystals with evidence of hydrothermal alterations were observed, creating a conducive environment for gold deposition.
- The most promising sites are located within coordinates: E741000 to E744200 and N3390000 to N3392000.

Recommendations:

1. Conduct detailed geochemical studies on identified sites.
2. Utilize advanced drilling techniques to confirm and quantify gold deposits.

---

2. Zinc (Area 4):

Target Locations:
Zinc anomalies were detected in Area 4, especially along fault zones between Minshar Monzogranite and Abu Saq'a schist.

Key Samples:

- Rk2051: Zinc concentration of 6,770 ppm.
- Rk2058: Zinc concentration of 1,001 ppm.
- Rk2071: Zinc concentration of 337.2 ppm.

Field Observations:

- Zinc is associated with lead and hydrothermal mineral intrusions.
- Evidence of mineralized fault systems and veins, with quartz and feldspar crystals observed in promising locations.

Recommendations:

1. Implement intensive geochemical mapping and spectral analysis (ICP-OES) to refine target zones.
2. Design exploratory drilling programs to determine the economic feasibility of zinc extraction.

Analytical QA/QC

The QA/QC program employed several strategies to ensure the accuracy and reliability of the data. It included collecting 16 field duplicate samples for stream sediment analysis, accounting for 24.5% of the total samples, and 6 duplicates for rock samples, representing 12.8%, with non-pulp duplicates analyzed. Three Certified Reference Materials (CRMs) listed in table 4 were carefully selected for the lithium exploration program to represent the expected styles and grades of pegmatite mineralization. These CRMs were "blindly" inserted into the sample stream at a rate of 1 CRM for every 20 samples for both stream sediments and rock samples, with sequential numbering used to ensure proper tracking and maintain the integrity of the process. Additionally, blank samples sourced from barren or un-mineralized Glass Sands and Limestone were included in the QA/QC process. These blank materials were inserted into the sample stream at approximately 1 blank for every 21 samples. Limestone blanks were placed in standard sample bags, numbered, and sequentially incorporated into the sample sequence to enhance the program's robustness.

TABLE 1:
CERTIFIED REFERENCE MATERIALS CODE USED FOR ACCURACY PURPOSES

CRM Code	Principal Certified Value		Mineralization Style
OREAS750	0.23% Li	16.5 ppm La	Pegmatite Deposit
OREAS752	0.707% Li	1.88 ppm La	Pegmatite Deposit
OREAS753	1.02% Li	0.37 ppm La	Pegmatite Deposit

QA/QC ANALYSIS

The QA/QC analysis employed multiple measures to ensure the precision and accuracy of sampling, preparation, and assay procedures. Certified Reference Materials (CRMs) were used to monitor analytical performance, with 14 samples from three CRMs (OREAS_750, OREAS_752, and OREAS_753) analyzed. CRMs were inserted at a 6.7% rate, and the results for OREAS_750 and OREAS_752 showed good precision within 2 standard deviations (SD) of accepted values. However, two samples of CRM 753 were identified as outliers, attributed to potential mislabeling or laboratory errors. Regular batch-by-batch monitoring of standards is recommended to maintain accuracy.

Blanks were included in the sample stream at an 8% rate to detect contamination. Seventeen blank samples returned lithium assay results below the detection limit (1 ppm), except one outlier (RK2080) at 26.48 ppm Li, traced to the use of limestone instead of Glass Sands. This led to the discontinuation of limestone as a blank material, confirming the effectiveness of the operating procedures.

Duplicate samples were employed to evaluate sampling variance, homogeneity, and assay precision. Results showed a strong correlation between duplicate pairs for stream and heavy mineral concentrate (H.M.C.) samples, while rock samples displayed higher variance due to local random variation, as expected. These findings highlight the reliability of the QA/QC procedures, with some recommendations for refinement.

Results and Interpretation

The interpretation of the ICP results supports the sound selection of two sampling size methods and their corresponding grain size fractions in relation to the Wadi Araba basements. This is evident through the combination of cluster analysis, which produced a lithogeochemical map aligning closely with the existing geological mapping. The -20/+80 mesh fraction and -80 mesh fraction both prove to be effective for the targeted areas, with the -20/+80 mesh fraction showing slightly higher concentrations (Figures 2 and 3).

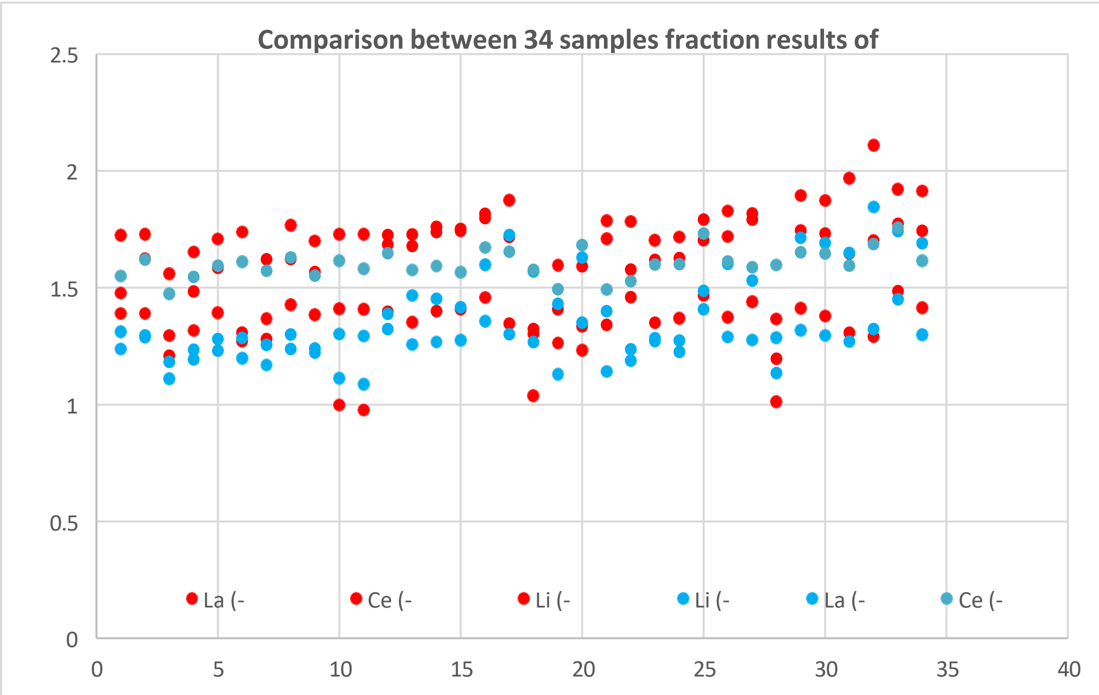

Figure 2: Fraction -20/80 more effective than -80 mesh

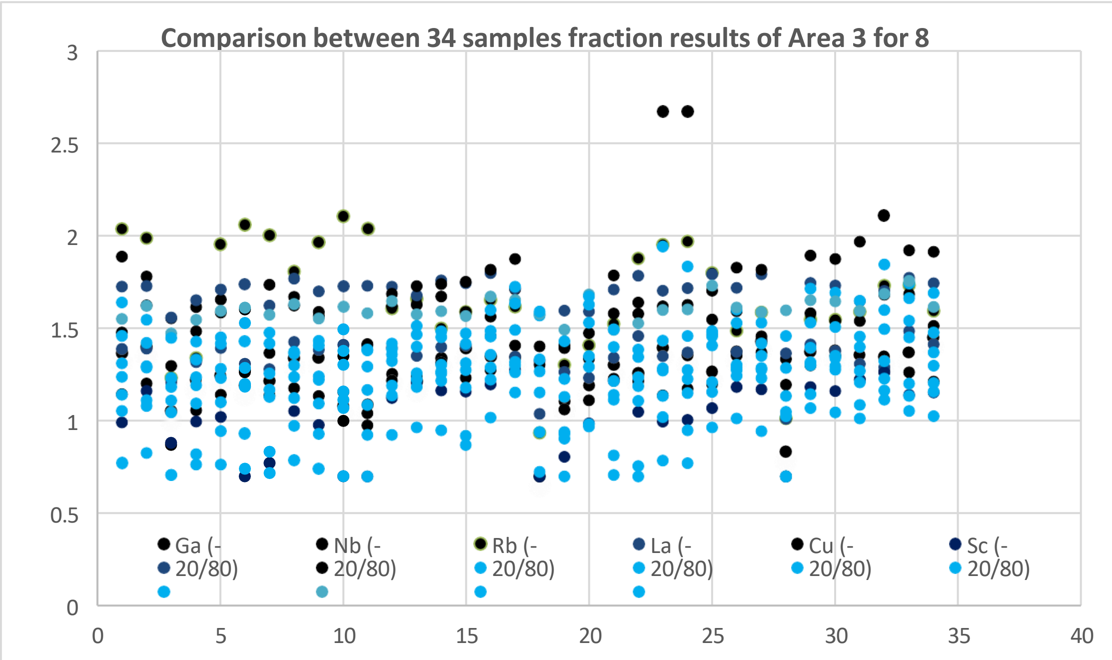

Figure 3: Fraction -20/80mesh populated higher results than fraction -80 mesh, Cu return the higher value in fraction -20/80mesh

The key results for the targeted areas are summarized as follows in Tables2 to 7 and

- The area is geologically and structurally suitable for exploration, with some evidence of pegmatite present. However, pegmatite development is not yet mature enough to generate significant minerals such as quartz, potassium feldspar, albite, and muscovite. Typical accessory minerals identified include biotite, garnet, tourmaline, and apatite.
- The ICP geochemical results did not show any evidence of spodumene pegmatite in either area. However, spodumene pegmatites are not known to exist in the region. Pegmatite development is limited to barren quartz-albite types. Thus, the area is not suitable for exploration of lithium-cesium-tantalum (LCT) deposits.
- In Area 3, stream sediment ICP_OES results for lithium (Li) showed a maximum of 128.8 ppm, with a background concentration of 28 ppm. The highest results were 162.8 ppm for rock samples and 90.3 ppm for H.M.C. samples (Tables2,3, and 4).

TABLE 2:

- **ELEMENTS AND ANALYTICAL RANGES OF STREAM SAMPLES FOR ARGETEST METHOD Gar03 Ext (Area 3)**

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Ag	< 0.5	Ta	5 - 9.8	Co	1 - 44.95	P %	.02-0.38
Ga	5- 44.5	Te	< 5	Cr	1 - 363.8	Pb	2 - 133.1
Hf	5-8.7	Tb	< 5	Cu	1 - 469.3	S %	.01-0.11
In	< 5	Th	5 - 53	Fe %	.01- 8.37	Sb	< 5
Yb	< 5	U	< 5	K %	.01-3.29	Sn	< 5
Lu	< 5	Al %	.01-7.68	La	1 - 53.75	Sr	1 - 482.6
Nb	5 -25.5	As	1-3.86	Li	1 - 128.8	Ti %	.01-0.87
Rb	5 -127.2	Ba	1 - 3341	Mg %	.01- 4.54	V	1 - 207
Se	< 5	Be	2 - 3.6	Mn	2 - 1589	W	< 5
Ce	5 -125.2	Bi	< 5	Mo	1 - 21.5	Zn	1 - 832.1
Sc	5 -19.8	Ca %	.01-12.05	Na %	0.01- 3.01	Zr	1 - 932.6
Tl	< 5	Cd	1.08	Ni	1 - 95.5		

TABLE 3:

ELEMENTS AND ANALYTICAL RANGES OF H.M.C FOR ARGETEST METHOD Gar03 Ext and FA03 (Area 3)

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Au	.005 - .037	Hf	<0.5	Co	1 - 47.01	P %	.01 - .24
Ag	<0.5	Te	<0.5	Cr	1 - 317.1	Pb	2 - 105.4
Sc	5 - 18.3	Tb	<0.5	Cu	1 - 1908	S %	.01 - .51
Th	5 - 93.1	In	<0.5	Fe %	.01 -27.57	Sb	<0.5
Rb	5 -67.5	Tl	<0.5	K	0.01 -1.88	Sn	<0.5
Nb	5 -80.9	Al %	.01 - 6.43	La	1 - 111.6	Sr	1 - 458.2
Yb	5 - 11.5	As	<1	Li	1 - 90.3	Ti %	.01 - 1.27
U	<0.5	Ba	1 - 9817	Mg %	.01 - 3.69	V	1 - 535.1
Se	<0.5	Be	2 - 5.46	Mn	2 - 1603	W	<0.5
Ce	5 - 347.4	Bi	<0.5	Mo	1 - 20.33	Zn	1 - 174.2
Ta	<0.5	Ca %	.01 - 6.65	Na %	.01 - 2.12	Ga	5 - 32.1
Lu	<0.5	Cd	<1	Ni	1 - 67.6	Zr	1 - 973.2

TABLE 4:

ELEMENTS AND ANALYTICAL RANGES OF ROCK SAMPLES FOR ARGETEST METHOD Gar03 Ext and FA03 (Area 3)

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Au	0.005 -.207	Hf	5 -8.4	Co	1 - 51.1	P %	.01 - .41
Ag	<0.5	Te	<5	Cr	1- 315.9	Pb	2 - 114
Sc	5 -22.5	Tb	<5	Cu	1 - 3865	S %	.01 - 1.26
Th	5 - 19.4	In	<5	Fe %	.01 - 8.29	Sb	<5
Rb	5 - 143	Tl	<5	K %	.01 - 4.52	Sn	<5
Nb	5 - 28.5	Al %	.01 - 8.73	La	1 - 43.08	Sr	1 - 658.1
Yb	5 - 5.3	As	1 - 5.37	Li	1 - 162.8	Ti %	.01 - 1.08
U	<5	Ba	1 - 4891	Mg %	.01 - 5.36	V	1 - 251.8
Se	<5	Be	2 - 7.36	Mn	2 - 4065	W	<5
Ce	5 - 84.2	Bi	<5	Mo	1 - 14.12	Zn	1 - 496.4
Ta	<5	Ca %	.01 - 22.5	Na %	.01 - 3.85	Ga	5 - 26.2
Lu	<5	Cd	<1	Ni	1 - 145.9	Zr	1 - 451.1

- In Area 4, multiple types of granite were observed, with results showing 28.68 ppm of Li in stream sediment (background of 9.88 ppm), 22.53 ppm in H.M.C., and 29.62 ppm in chip rock samples (Tables5, 6, and 7).

TABLE 5:

ELEMENTS AND ANALYTICAL RANGES OF ROCK SAMPLES FOR ARGETEST METHOD Gar03 ext (area 4)

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Ag	<0.5	Ta	< 5	Co	1 - 28.05	P	.01 -.58
Ga	5 - 103.4	Te	< 5	Cr	1 -480	Pb	2 - 389.1
Hf	%	Tb	< 5	Cu	1 - 3528	S %	.01 - 1.68
In	< 5	Th	5 - 38.4	Fe %	.01 - 4.42	Sb	< 5
Yb	< 5	U	< 5	K %	.01 - 5.26	Sn	5 - 14.34
Lu	< 5	Al %	0.01 - 8.11	La	1 - 406.8	Sr	1 - 900.1
Nb	5 - 47	As	1 - 77.29	Li	1 - 29.62	Ti %	.01 - .46
Rb	5 - 147.7	Ba	1 - 6998	Mg %	.01 - 2.9	V	1 - 98.49
Se	< 5	Be	2 - 32.32	Mn	2 - 2570	W	< 5
Ce	5 - 796.9	Bi	< 5	Mo	1 - 114.7	Zn	1 - 6770
Sc	5 - 22	Ca %	.01 - 33.44	Na %	.01 - 3.96	Zr	1 - 404.1
Tl	5 - 249.5	Cd	1 - 3.14	Ni	1 - 85.03		

TABLE 6:

ELEMENTS AND ANALYTICAL RANGES OF STREAM SAMPLES FOR ARGETEST METHOD Gar03 Ext (area 4)

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Ga	5 -104	Ta	< 5	Co	1 - 43.84	P	.01 - 0.5
Ag	< 0.5	Te	5 - 307.3	Cr	1 - 277.6	Pb	2 - 118.6
Hf	5 - 41.8	Tb	< 5	Cu	2 - 257.7	S %	.01 - .1
In	< 5	Th	5 - 193.4	Fe %	.01 - 6.08	Sb	< 5
Yb	< 5	U	5 - 40.2	K	.01 - 31	Sn	< 5
Lu	< 5	Al %	.01 - 7.09	La	1 - 57.97	Sr	682.3
Nb	5 - 35.1	As	1 - 65.8	Li	1 - 28.68	Ti %	.01 - 1.55
Rb	5 - 976.3	Ba	1 - 9539	Mg %	.01 - 23.22	V	1 - 173.9
Se	5 - 8.9	Be	2 - 11.74	Mn	2 - 1015	W	< 5
Ce	5 - 353.1	Bi	< 5	Mo	1 - 21.28	Zn	1 - 303.7
Sc	5 - 20.4	Ca%	.01 - 37.17	Na %	.01 - 3.19	Zr	1 - 382.4
Tl	< 5	Cd	1 - 1.38	Ni	1 - 71.16		

TABLE 7:

ELEMENTS AND ANALYTICAL RANGES OF H.M.C. SAMPLES FOR ARGETEST METHOD Gar03 Ext and FA03 (area 4)

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Au	<.005	Lu	<5	Cd	<1	Ni	1 - 58.95
Ag	.5 -1.47	Hf	5 - 79.8	Co	1 - 187.9	P	.01 - .27
Ga	5 - 110.3	Te	<5	Cr	1 - 504.1	Pb	2 - 136.6
Sc	5 - 20.4	Tb	<5	Cu	1 - 122.67	S %	.01 - .22
Th	5 - 307.3	In	<5	Fe %	.01 - 51.34	Sb	<5
Rb	5 -95.7	Tl	<5	K %	.01 - 3.33	Sn	<5
Nb	5 - 179.1	Al %	.01 - 4.99	La	1 - 448.7	Sr	1 - 406.5
Yb	<5	As	1 - 65.8	Li	1 - 22.53	Ti %	.01 - 9.44
U	<5	Ba	334- 9539	Mg %	.01 - 1.3	V	1 - 766.9
Se	<5	Be	2 - 11.32	Mn	471 - 8540	W	<5
Y	<5	Bi	<5	Mo	1 - 34.02	Zn	1 - 730.7
Ce	5 - 976.3	Ca %	.01 - 4.32	Na %	.01 - 2.62	Zr	1 - 925.9
Ta	<5						

- Neither area exhibited any anomalies for lithium or associated elements (Cs, Ta).

  In Area 3, anomalous gold (Au) targets were identified, particularly in samples Rk2011 and Rk2041, as well as the H.M.C. sample Ss1033. These samples originated from quartz or calcite veins.

- In Area 4, the most significant findings were evidence of mineralized intrusions for zinc (Zn) with lead (Pb). Rock samples Rk2051 (Zn 6,770 ppm), Rk2058 (Zn 1,001 ppm), and Rk2071 (Zn 337.2 ppm) were collected from the fault zone between the Minshar monzogranite and Abu Saq'a schist .

Conclusions and Recommendations

- Cluster analysis of the "-20/80" fraction size revealed slightly higher concentrations for certain elements compared to the "-80" fraction.
- The sediment cover in the areas is relatively weak due to the region's morphology and low rainfall. As a result, heavy mineral concentration sampling showed limited success.
- No anomalies were detected for lithium or associated elements such as cesium (Cs) or tantalum (Ta) in either area.
- Although the area appears geologically and structurally suitable, and some evidence of grano-pegmatite was found, pegmatite development has not reached maturity or developed sufficiently to produce fertile pegmatites.
- Area 3 shows potential for precious metal exploration, with preliminary results indicating promising targets for gold. Detailed geochemical prospecting is recommended for these areas.
- A significant zinc anomaly was detected in Area 4, warranting further follow-up with stream and lithogeochemical analysis to assess its potential.
