وزارة الطاقة والثروة المعدنية

فلزات القاعدة والعناصر الأرضية النادرة في وادي مبارك

2025

Ministry of Energy and Mineral Resources

The Hashemite Kingdom Of Jordan

WADI MUBARAK

"PROPOSED AREA FOR INVESTMENT OPPORTUNITY"

"Base Metals & REEs"

"Brief"

Geology and Mining Directorate

Geological and Geochemical Surveys Division

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CONTENT

TABLES

FIGURES

APPENDICES

1. OVERVIEW

1.1. Objective

The aim is to open the area for private sector investment for exploration as it has been identified through a previous regional geochemical survey as containing significant anomalies indicating the presence of zinc and lead, along with elevated values of niobium, tin, and REEs.

1.2. Area of Interest

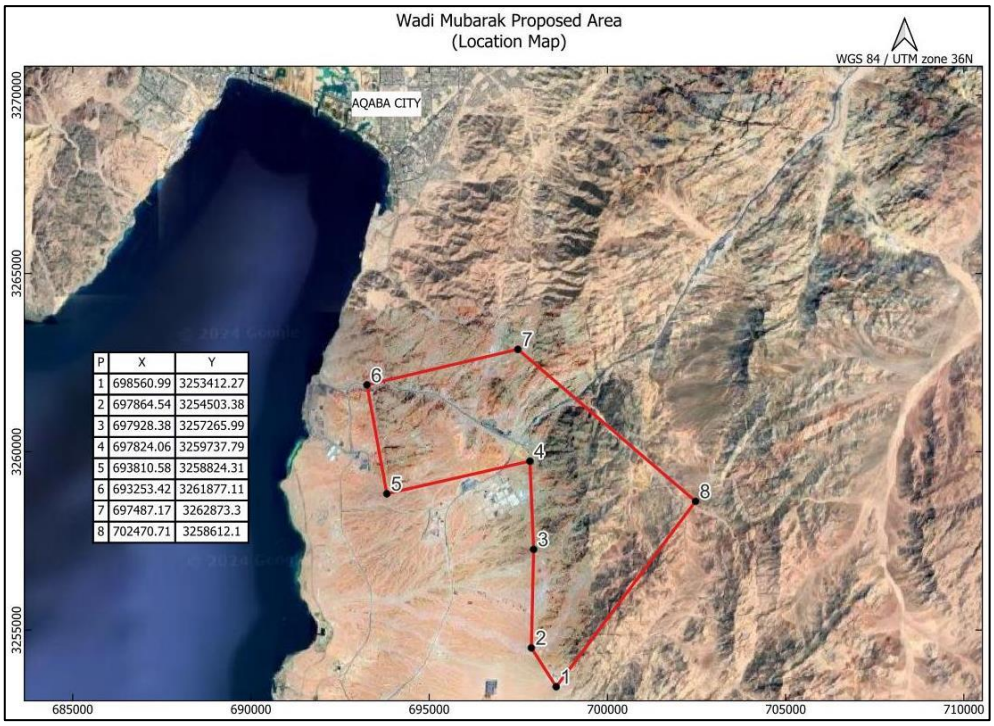
The proposed area is located in the Aqaba Governorate region, about 6 km southeast of the city of Aqaba, and encompassing approximately 36 km^2 (Table-1) (Fig. 1).

Its proximity to infrastructures such as tarmac roads, power lines, and the Aqaba port, enhances the project's development potential.

High mountains with rugged surfaces form the prominent terrain element with wide, deeply incised valleys. Elevations range from 77m to 1026m a.m.s.l (Fig. 2).

Table 1: Wadi Mubarak proposed investment area coordinates.

P	X (WGS 84 / UTM 36N)	Y (WGS 84 / UTM 36N)
1	698561	3253412
2	697865	3254503
3	697928	3257266
4	697824	3259738
5	693811	3258824
6	693253	3261877
7	697487	3262873
	702471	3258612



P	X	Y
1	698560.99	3253412.27
2	697864.54	3254503.38
3	697928.38	3257265.99
4	697824.06	3259737.79
5	693810.58	3258824.31
6	693253.42	3261877.11
7	697487.17	3262873.3
8	702470.71	3258612.1

Figure 1: Location map of Wadi Mubarak proposed area.

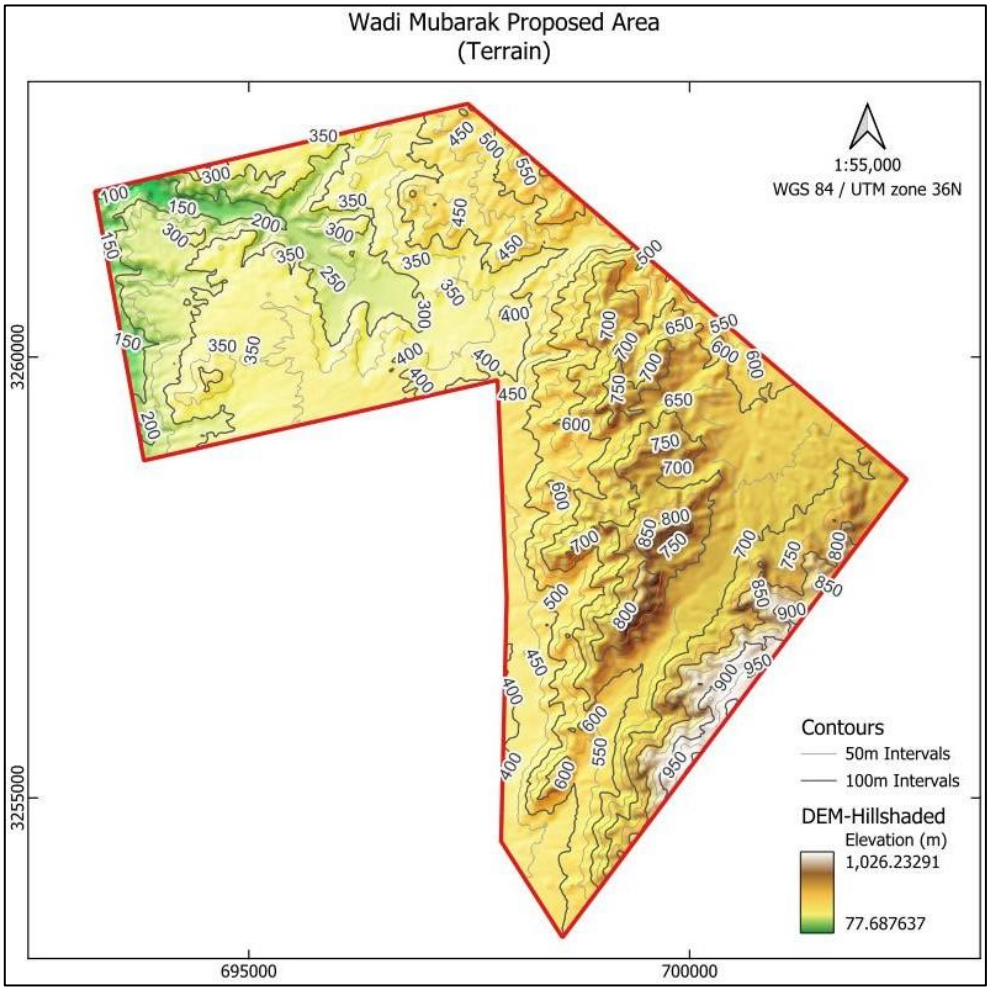


Figure 2: DEM and elevations of Wadi Mubarak proposed area.

1.3. Previous Work

A regional geochemical survey was conducted on the basement igneous rocks in the southern part of the Kingdom by the Geochemical Survey Division (formerly part of the Natural Resources Authority), in cooperation with the French Geological Survey (BRGM). The survey involved collecting samples of stream sediments and heavy minerals.

This survey, reported in 1994, identified several areas in the Aqaba and Wadi Araba regions that contained elements at above-normal concentrations, known as geochemical anomalies.

These elements included zinc, lead, copper, and other elements, which suggest the presence of mineralized zones.

The study recommended continued exploration in these anomaly areas in detail, including the proposed Wadi Mubarak area.

2. REGIONAL BACKGROUND

2.1. Geological Setting

The proposed area is underlain by basement igneous rocks, which are considered the northernmost extension of the Arabian-Nubian Shield, with some small and scattered sedimentary rock units of the Salib Arkoses Sandstone Formation, Kurnub Sandstone Group, and Na'ur Limestone Formation (Fig. 3).

The igneous rocks are primarily represented by the Yutum Granite suite and the Ruman Granodiorite suite, which has a geochemical profile rich in iron group elements with a more potassic fringe of an alkaline tendency (BRGM, 1994).

The Yutum suite contains outcrops of the Abu Jeddah granite and the intruding Imran monzogranite units, while the Ruman suite consists of the Sabil granodiorite unit, which shows Ba enrichment.

The area is interspersed with acidic and basic dykes with a dominant NE-SW direction, and other secondary directions, especially NW-SE and E-W.

The area is strongly influenced by structures associated with the Dead Sea Transform Fault System (DSTFS), which formed in the Miocene, as well as by Precambrian faults that contributed to the opening of the Red Sea and the submergence of the Aqaba Gulf by water near the end of the Miocene.

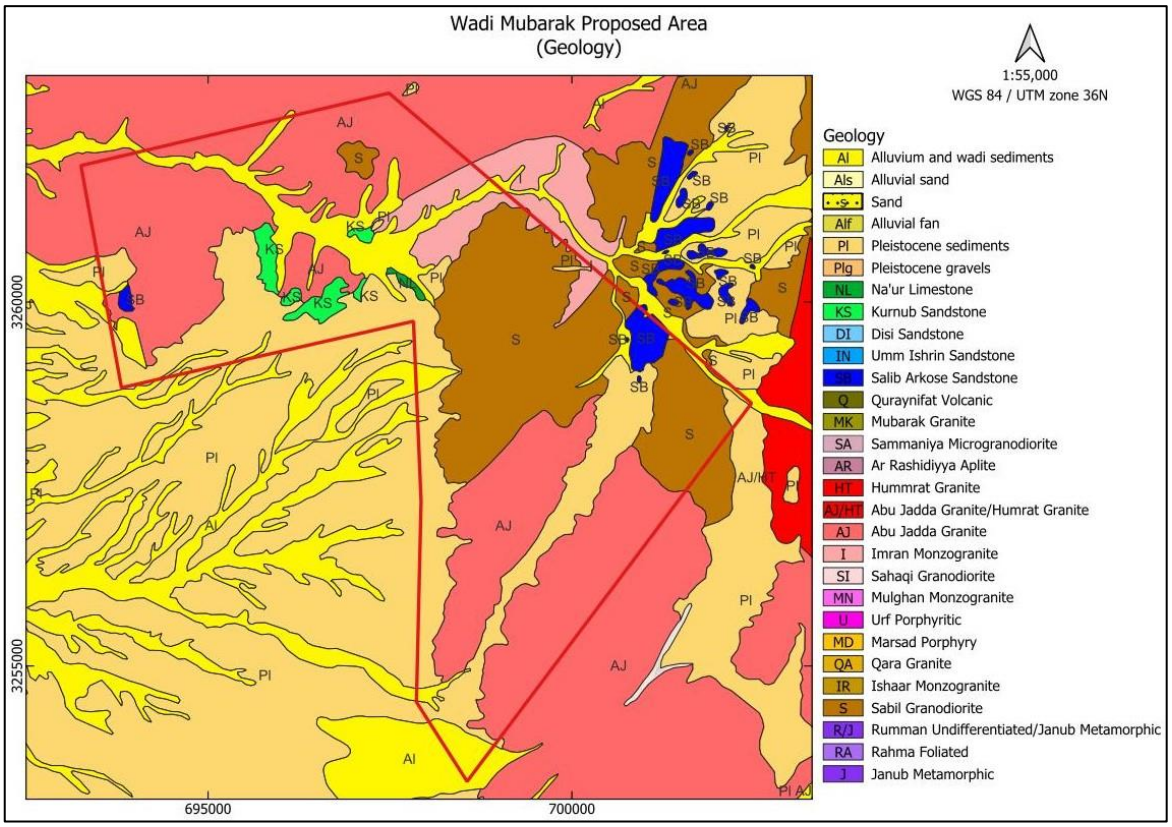


Figure 3: Geology of Wadi Mubarak proposed area. *Legend includes units other than those within the area's boundaries*.

2.2. Geochemical Survey Results

2.2.1. Survey Results

The Wadi Mubarak proposed area was surveyed by collecting stream sediment (SS) samples (Appendix 1).

The results from the BRGM regional geochemical survey provide valuable insights into the mineral potential of the proposed investment area (Table 2).

The survey identified significant geochemical anomalies that highlight prospective zones for mineral exploration (Fig. 4).

- **Zinc and Lead**

Zinc and lead values up to 337 ppm and 75 ppm, respectively, were observed in stream sediment samples within the Abu Jeddah granite and Sabil granodiorite units in the northern, central and southern parts of the area.

The elevated Pb values are likely related to alkaline differentiation within the granite, where Zn values correlate with high Cr, V, Fe_2O_3, and TiO_2values characterize the basic rocks, i.e., is related to the lithology.

- **REEs, Niobium, and Tin**

Yttrium, Cerium, and Lanthanum, as proxies for REEs, elevated values up to 137 ppm, 399 ppm, and 150 ppm, respectively, were observed in stream sediment samples in association with anomalous Phosphorous values within the Abu Jeddah granite and Imran monzogranite units in the northern and southern parts of the area.

Niobium elevated values up to 105 ppm were observed in association with REEs (Fig. 5) within the Abu Jeddah granite and Imran monzogranite units in the northern and southern parts of the area.

Tin elevated values up to 54 ppm were detected in stream sediment samples within the Sabil granodiorite unit in the central part of the area.

Elevated P, Nb, Ce, Sn, and Bi possibly reflecting the presence of more evolved alkaline rocks.

Table 2: Summary statistics of BRGM base metals, REEs, Nb, and Sn results.

	SS (ppm)							
	Zn	**Pb**	**Cu**	**Y**	**La**	**Ce**	**Nb**	**Sn**
Min.	22.0	2.0	5.0	9.0	18.0	35.0	16.0	9.0
Max.	337.0	75.0	34.0	137.0	150.0	399.0	105.0	54.0
Range	315.0	73.0	29.0	128.0	132.0	364.0	89.0	45.0
Mean	112.6	35.7	16.2	27.5	51.1	102.8	33.4	22.9
St. Dev.	66.9	21.5	7.5	24.4	25.0	66.3	19.7	9.3
Qr1	88.8	31.0	11.0	19.8	39.8	77.0	23.8	17.0
Qr2	110.5	42.0	17.0	25.0	49.0	95.5	31.5	24.0
Qr3	148.3	64.5	23.3	36.5	59.0	114.8	41.8	29.0
Skew.	1.4	-0.2	0.2	2.6	1.7	2.2	1.6	0.9
kurt.	1.9	-1.0	-0.9	7.4	3.1	5.6	2.5	0.7
$CI_{95\%}$	96.3-129.0	30.4-40.9	14.4-18.1	21.5-33.5	45.0-57.2	86.6-119.1	28.5-38.2	20.7-25.2

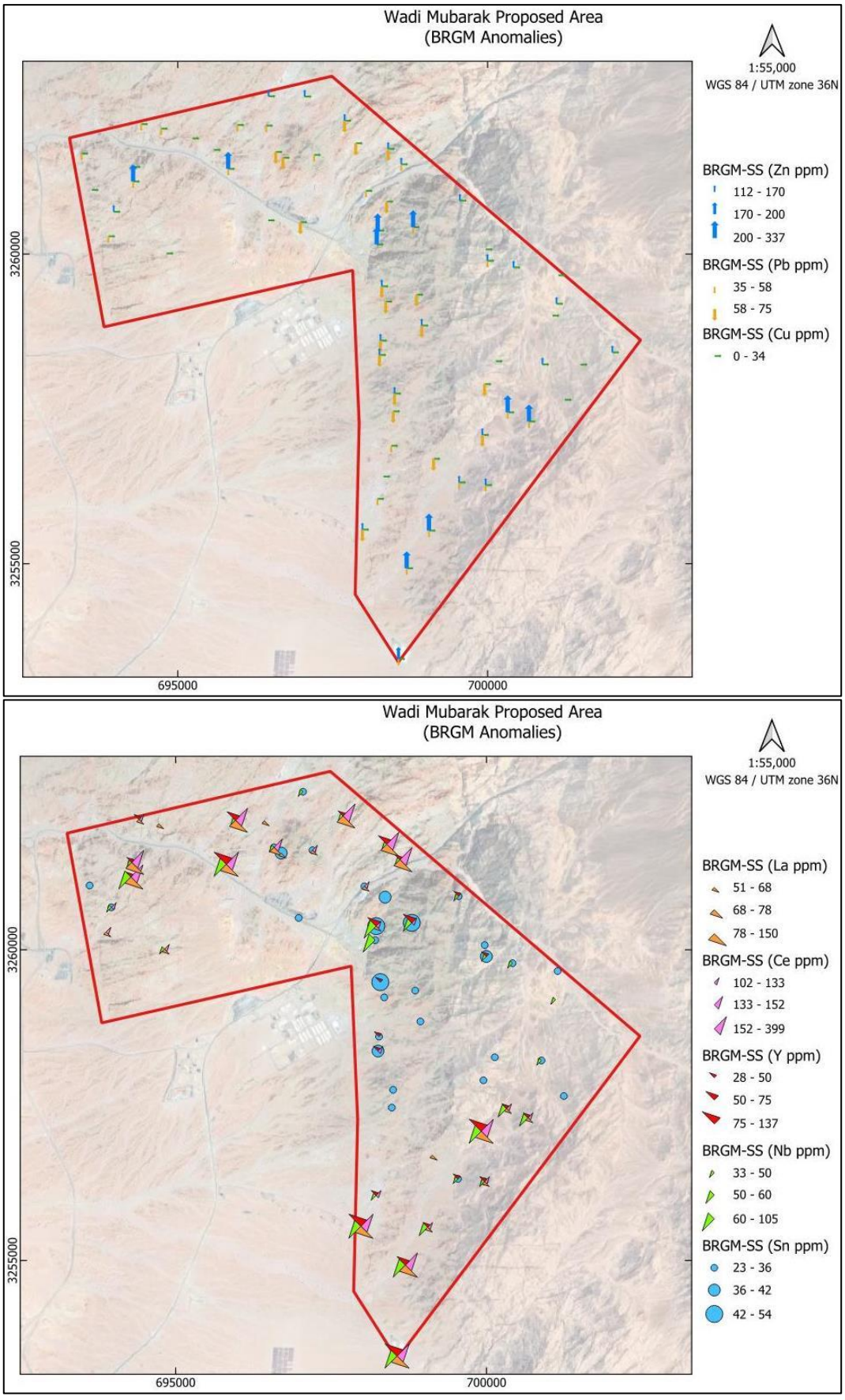


Figure 4: BRGM elevated concentrations in SS samples.

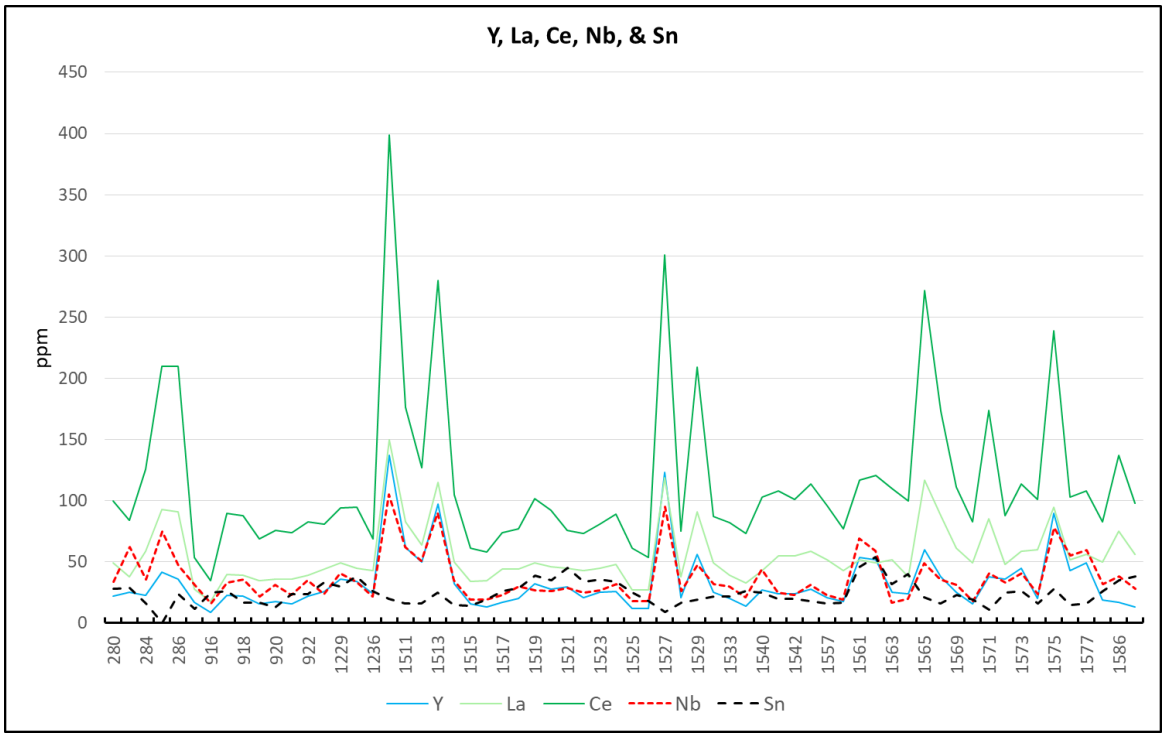


Figure 5: Direct relationship between REEs and Nb, where Sn behaves differently.

2.2.2. Anomaly Areas

The survey results were mapped to identify three anomalous areas (Fig. 6), which are outlined as follows:

- **Anomaly-1 (northern part)**

This area exhibits anomalous REEs and Nb concentrations along with elevated values of Zn and Pb within the Abu Jeddah granite and Imran monzogranite units.

- **Anomaly-2 (central part)**

This area exhibits anomalous concentrations of Sn, Nb, and Zn with elevated Pb values within the Sabil granodiorite unit.

- **Anomaly-3 (southern part)**

This area exhibits anomalous REEs, Nb, and Zn concentrations along with elevated values of Pb within the Abu Jeddah granite unit.

The identified anomalies were found to be largely inconsistent with those identified by BRGM, although the identification of REEs, niobium and tin was consistent, possibly due to the way the data were interpreted (Fig. 7).

These anomalous areas represent the primary targets for further prospecting and exploration works.

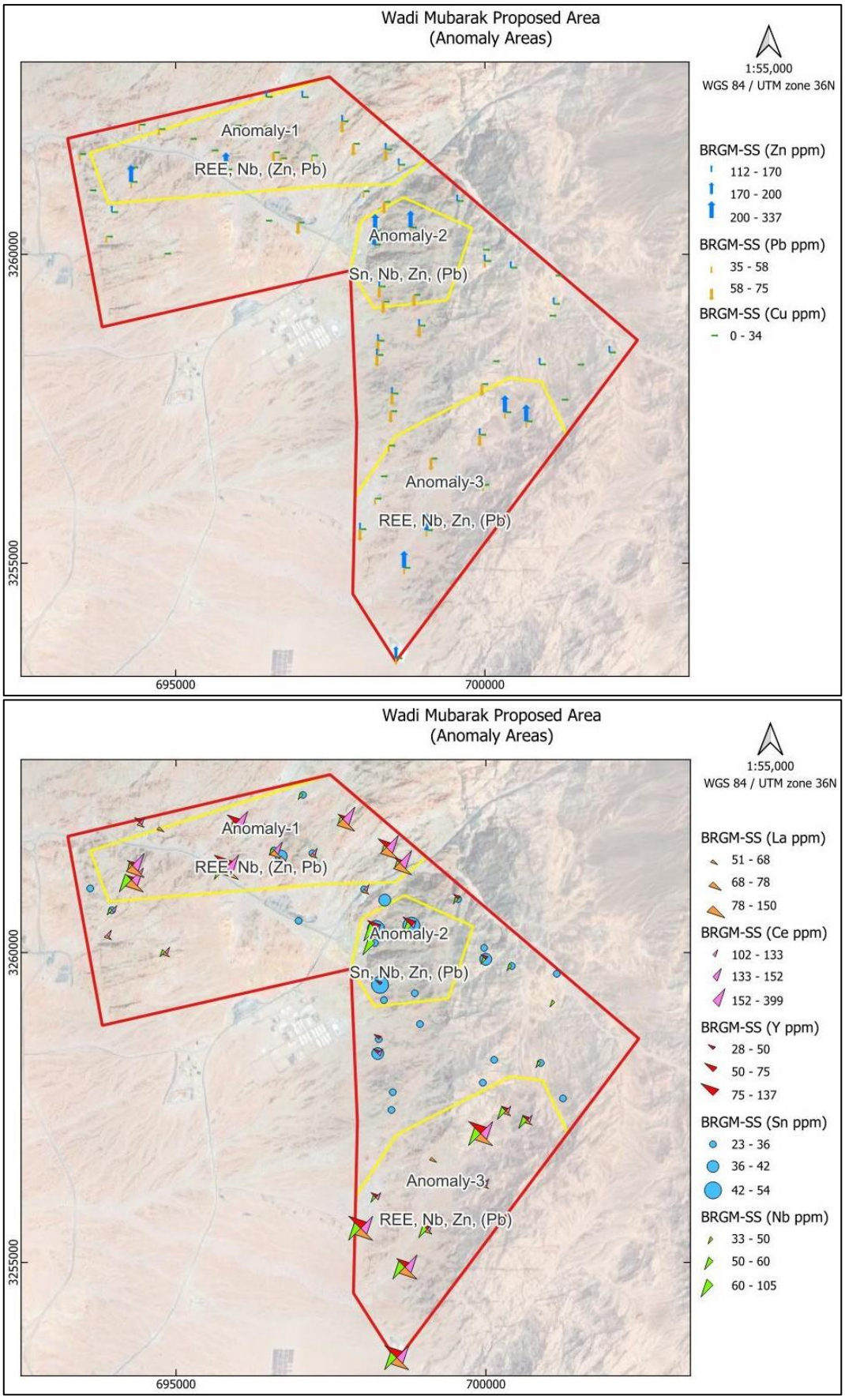


Figure 6: Anomaly areas identified in Wadi Imran proposed area.

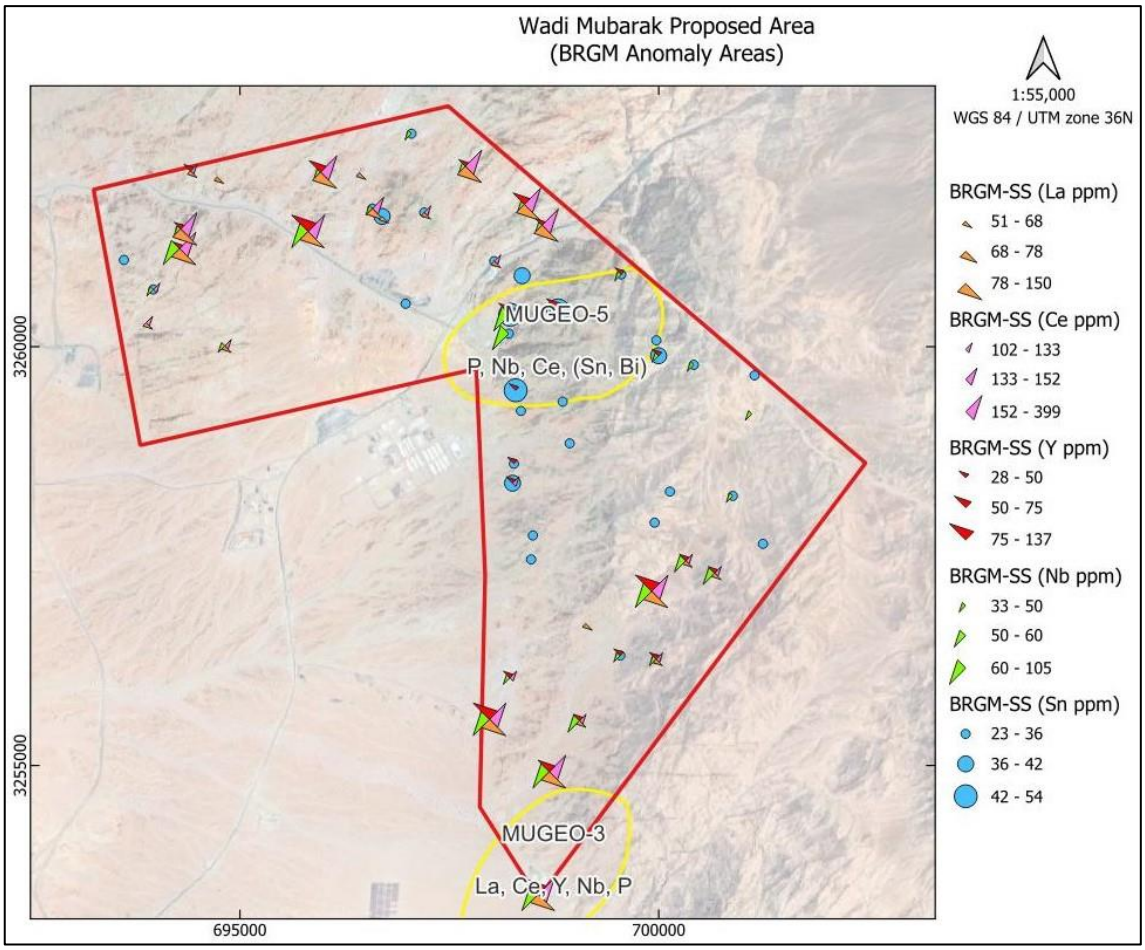


Figure 7: Anomaly areas identified by the BRGM in Wadi Mubarak proposed area.

3. REFERENCES

BRGM. (1994). Geochemical and Mineral Exploration of Aqaba-Araba Complex, *Ministry of Energy & Mineral Resources, Amman, Jordan. Internal Report.*

4. APPENDICES

Appendix 1: Analysis results of BRGM's stream sediment (SS) samples.

SS	X	Y	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	MnO	TiO2	P	Zn	Pb	Cu	Y
SID	WGS84/UTM36N	WGS84/UTM36N	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
280	697049	3262545	53.5	11.7	12.1	7.7	2.9	1.8	0.2	2.77	4355	127	18	18	22
283	698211	3260157	34.6	8.4	33.8	9.0	3.7	0.9	0.4	11.08	13897	311	12	24	25
284	694820	3260011	67.4	12.4	10.3	4.4	1.6	2.1	0.2	1.91	2641	103	9	20	23
285	694280	3261173	60.2	9.3	38.3	4.6	1.5	1.7	0.4	5.92	3301	298	35	17	42
286	694293	3261408	78.0	15.7	11.3	5.9	1.5	3.0	0.2	1.60	2948	108	18	15	36
312	702015	3258413	50.6	10.6	17.6	10.0	4.9	1.1	0.2	4.13	5281	149	23	30	17
916	701145	3259658	118.2	2.9	5.8	2.1	0.7	0.4	0.1	0.90	1296	39		8	9
917	700420	3259785		12.2	12.8	8.0	3.4	1.7	0.2	2.67	3965	124	8	30	23
918	701113	3259198	69.5	11.9	17.1	8.3	3.0	1.8	0.2	3.11	3939	132	8	24	22
919	701050	3259007	73.9	12.4	9.4	7.6	2.7	2.1	0.2	1.67	2818	93	2	24	16
920	701501	3258216	71.6	12.2	13.8	7.3	2.7	1.9	0.2	2.24	3144	111	7	21	18
921	700135	3258271	85.7	12.8	8.9	6.5	2.6	2.2	0.2	1.70	3137	85	3	18	16
922	700886	3258219	71.4	12.2	13.5	8.6	3.6	1.7	0.2	2.90	4927	119	10	27	22
923	701246	3257647	59.8	12.4	11.1	6.0	3.3	2.0	0.2	2.23	4311	106	31	24	26
1229	699554	3260864	52.7	10.5	17.0	7.8	3.8	1.5	0.3	4.16	6986	156	33	22	36
1235	699999	3259893	60.2	11.2	14.7	7.6	4.0	1.5	0.2	3.00	4690	142	44	23	34
1236	699973	3260077	61.3	12.8	10.0	5.7	3.5	1.8	0.1	1.89	4369	104	26	23	24
1509	698563	3253462	51.5	10.2	18.6	5.9	2.6	1.6	0.3	4.26	4320	183	40	16	137
1511	698695	3254926	51.1	10.9	21.0	7.5	4.3	1.2	0.3	4.98	6333	216	40	26	62
1512	699055	3255535	50.5	10.6	20.9	8.5	5.1	1.1	0.3	5.10	6875	214	41	31	50
1513	697981	3255551	71.9	12.1	9.0	3.5	1.0	2.3	0.3	1.18	1376	130	68	7	97
1514	698224	3256048	57.9	11.3	4.5	3.0	1.6	2.7	0.1	0.92	1193	81	38	14	32
1515	698319	3256408	60.5	10.2	4.6	3.2	1.4	2.2	0.1	0.72	1195	57	31	10	16

1516	698446	3256905	58.9	10.5	7.0	3.5	2.2	1.9	0.1	1.42	2068	80	36	16	13
1517	698478	3257461	60.9	11.6	8.2	4.2	2.3	2.0	0.1	1.64	2713	100	68	17	17
1518	698499	3257747	53.3	10.9	13.6	5.2	2.7	1.6	0.2	3.26	2969	151	62	23	20
1519	698256	3258371	56.9	11.7	11.9	5.8	3.2	1.6	0.1	1.89	3753	115	69	23	32
1520	698272	3258604	57.2	12.0	11.8	6.1	3.0	1.7	0.1	1.68	3715	119	75	25	28
1521	698293	3259480	46.0	12.1	14.5	9.1	4.6	1.0	0.2	2.89	6761	140	73	32	30
1522	698356	3259234	58.2	12.0	8.5	5.4	2.5	1.9	0.1	1.62	3493	96	70	18	21
1523	698854	3259345	53.3	11.2	10.1	6.5	3.3	1.7	0.2	1.96	4551	110	73	21	25
1524	698938	3258847	50.2	10.4	15.2	6.1	2.7	1.6	0.2	2.93	4400	157	75	22	26
1525	696979	3260514	83.8	4.3	2.5	1.1	0.5	0.9	0.1	0.54	1729	31	64	5	12
1526	696460	3260546	71.8	11.5	4.0	2.1	1.2	3.1	0.1	0.87	2472	43	28	8	12
1527	695814	3261377	44.3	6.3	35.1	2.1	1.0	1.3	0.4	5.82	2798	301	51	10	123
1528	695587	3261684	77.9	7.7	5.0	1.5	0.8	2.0	0.1	1.11	1630	55	25	7	21
1529	695963	3262086	62.4	10.3	13.3	2.6	1.2	2.5	0.2	1.97	2297	108	42	15	56
1530	695238	3261869	65.1	12.1	8.4	4.3	1.8	2.6	0.1	1.85	3223	88	31	26	25
1533	693448	3261624	66.4	12.8	8.9	4.3	2.1	2.6	0.2	2.15	4867	86	40	16	20
1539	693616	3261037	104.7	4.7	3.3	1.6	0.3	0.9	0.1	0.61	1211	22	25	7	14
1540	693967	3260684	82.9	5.3	13.5	2.4	0.7	1.0	0.2	2.73	1728	119	31	10	27
1541	693881	3260288	69.2	11.3	4.8	3.1	0.9	2.5	0.1	0.89	1647	68	51	13	24
1542	694731	3262027	61.5	11.9	6.9	3.8	1.7	2.8	0.1	1.38	3385	89	54	15	24
1544	694410	3262100	66.2	10.9	10.0	3.5	1.6	2.2	0.2	2.31	2937	108	50	11	28
1557	696428	3262075	68.9	11.5	5.6	2.6	1.1	3.1	0.1	0.83	1581	58	38	7	21
1558	696466	3262550	69.7	11.6	3.6	2.2	1.1	3.0	0.1	0.68	1428	122	33	7	18
1561	698227	3260382	35.3	7.6	36.1	9.0	4.7	0.8	0.5	11.53	22554	337	40	22	54
1562	698799	3260435	40.1	8.5	29.3	9.4	4.6	1.0	0.4	8.75	22773	244	40	22	52
1563	698037	3261022	80.8	11.6	6.8	3.3	1.5	2.1	0.1	1.16	2706	92	57	10	25
1564	698370	3260848	80.1	12.4	3.0	3.7	1.6	2.4	0.1	1.19	2721	105	72	11	24
1565	698397	3261700	56.5	10.0	21.3	4.3	1.8	1.9	0.2	2.59	3219	140	65	11	60
1566	698608	3261451	60.6	11.6	13.4	4.3	2.2	2.2	0.2	2.84	3099	157	45	14	38

1569	697201	3261603	66.6	11.4	10.1	4.1	1.9	2.4	0.2	1.48	3256	96	56	14	25
1570	697873	3261790	65.4	13.1	4.9	2.4	1.1	3.7	0.1	0.96	1390	64	66	8	16
1571	697693	3262155	56.3	11.4	16.0	2.7	1.3	3.0	0.2	2.30	2009	146	75	11	38
1572	699542	3256313	49.7	13.7	12.8	5.7	4.3	1.9	0.2	3.03	5042	148	49	34	36
1573	699970	3256270	50.1	13.4	14.9	6.1	4.6	1.8	0.2	3.67	5008	167	46	32	45
1574	699129	3256694	70.3	13.5	7.1	2.8	1.5	2.3	0.1	1.02	2125	94	73	10	20
1575	699917	3257080	60.7	13.8	8.5	4.1	2.3	2.8	0.3	1.62	1250	126	73	22	90
1576	700325	3257445	51.0	11.3	19.1	6.8	4.3	1.5	0.3	4.34	5598	206	45	25	43
1577	700669	3257297	49.0	10.6	22.6	7.2	4.5	1.3	0.4	5.33	6483	252	44	27	49
1578	699952	3257900	72.3	12.3	8.7	4.5	2.3	2.0	0.1	1.47	2873	104	61	16	19
1586	696582	3261650	66.2	11.1	8.2	3.8	2.1	2.3	0.2	1.82	1977	86	70	16	17
1587	696698	3261557	67.5	10.3	7.4	4.0	2.3	2.1	0.1	1.43	1710	71	72	16	13
SS	**La**	**Ce**	**Nb**	**Sn**	**Li**	**Be**	**V**	**Cr**	**Co**	**Ni**	**As**	**Sr**	**Ba**	**W**	**Zr**
SID	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
280	49	100	34	28	34	4	270	74	36	54	73	344	352	46	194
283	38	84	62	29	20	1	805	23	58	49	77	374	390	58	241
284	59	126	36	16	26	4	178	36	16	43	65	283	418	53	272
285	93	210	75		24	3	735	245	25	57	57	209	357	47	615
286	91	210	47	24	45	6	170	29	16	41	88	248	510	66	377
312	28	54	31	12	30	2	415	227	41	82	13	377	453	25	251
916	18	35	16	25	7	1	120	56	18	29		121	91		381
917	40	90	33	26	27	2	261	65	23	55	17	423	456	24	298
918	39	88	36	17	29	2	358	115	20	46	1	401	528	19	329
919	35	69	22	17	29	3	174	53	13	35		381	584	20	226
920	36	76	31	13	26	2	270	86	16	38	16	380	518	25	280
921	36	74	23	24	31	3	171	53	15	44	13	361	481	24	214
922	39	83	35	24	29	2	279	98	25	68	15	365	472	27	268
923	44	81	24	33	27	3	184	73	34	65	32	356	499	22	204
1229	49	94	41	30	34	2	314	91	23	47	48	374	483	46	237

1235	45	95	34	38	22	2	297	105	31	58	79	373	479	50	264
1236	43	69	22	26	26	2	154	61	30	53		426	514	34	199
1509	150	399	105	20	25	3	370	131	28	78	75	250	310	42	568
1511	83	176	62	16	22	3	460	151	40	63	83	305	425	48	619
1512	64	127	51	16	21	2	472	214	48	70	130	310	447	56	569
1513	115	280	90	25	16	7	89	100	10	26	99	105	207	62	1152
1514	50	105	35	15	20	4	55	62	11	31	30	173	189	26	537
1515	34	61	19	14	19	3	48	29	5	23	10	268	259	31	157
1516	35	58	19	19	28	3	121	57	15	39	36	307	316	28	215
1517	44	74	23	26	30	3	160	68	22	46	86	300	380	55	274
1518	44	77	30	29	26	2	332	128	31	60	73	328	382	66	895
1519	49	102	27	39	26	3	238	151	32	54	90	375	432	70	989
1520	46	92	26	35	25	3	235	218	31	51	121	401	449	72	503
1521	45	76	29	45	23	2	262	105	49	82	111	461	472	78	227
1522	43	73	25	34	25	3	146	61	27	49	89	366	482	69	195
1523	45	81	27	36	24	3	177	97	33	64	125	361	457	72	206
1524	48	89	32	34	26	2	333	119	36	60	131	323	415	78	286
1525	27	61	18	25	9	2	38	18	14	27	90	82	102	55	173
1526	27	54	18	18	20	3	53	15	12	23		151	286	7	122
1527	119	301	95	9	27	3	719	232	22	47		101	263	20	868
1528	38	75	26	17	23	3	88	35	8	21	3	122	270	18	212
1529	91	209	48	19	27	3	224	91	13	45	10	193	392	16	299
1530	49	87	32	22	45	4	158	45	17	40	30	218	441	20	191
1533	39	82	30	22	40	4	183	51	19	46	27	319	626	24	163
1539	33	73	21	26	9	2	48	19	16	22	16	105	196	24	216
1540	43	103	44	25	10	2	281	96	24	33	30	111	225	35	310
1541	55	108	25	20	25	4	79	17	7	16	61	194	381	67	213
1542	55	101	23	20	42	4	131	24	14	30	50	232	503	58	192
1544	59	114	31	18	20	3	205	62	11	32	63	264	418	57	230

1557	52	96	23	16	26	4	88	43	6	30	39	180	361	51	173
1558	43	77	19	17	28	4	61	30	4	27	44	218	464	59	168
1561	52	117	69	46	16	2	795	19	50	40	129	296	397	92	374
1562	49	121	59	54	19	2	595	22	46	40	148	294	475	100	347
1563	52	110	17	32	18	3	164	50	12	22	146	253	694	114	252
1564	38	100	20	40	18	5	183	57	14	23	168	264	773	116	261
1565	117	272	49	21	17	2	342	71	12	31	87	269	659	84	532
1566	88	173	36	16	18	2	310	89	12	37	77	304	596	91	323
1569	61	111	31	23	23	3	217	53	11	34	111	283	531	98	239
1570	49	83	18	19	21	3	93	15	2	12	38	320	649	81	154
1571	85	174	41	11	20	4	291	79	7	24	51	245	449	68	389
1572	48	88	33	25	32	3	327	80	38	69	77	422	387	77	254
1573	59	114	41	26	31	3	400	97	41	72	73	407	364	81	278
1574	60	101	24	16	35	4	142	53	1	26	69	365	365	89	264
1575	95	239	78	28	38	6	191	33	19	52	82	225	211	83	496
1576	52	103	55	15	23	2	431	139	33	61	119	354	408	106	336
1577	56	108	60	16	23	2	521	180	40	65	139	317	426	122	281
1578	50	83	32	26	34	3	163	45	13	39	144	321	443	125	235
1586	75	137	38	35	25	3	161	23	25	53	113	364	276	87	202
1587	56	98	28	38	25	3	149	24	26	52	122	325	265	86	165

Note: *The sample locations are inaccurate as the shift can be up to a hundred meters from the actual location due to the methods adopted for conducting the regional survey in the 1990s.*