HASHEMITE KINGDOM OF JORDAN

MINISTRY OF ENERGY AND MINERAL RESOURCES

BASE METALS PROJECT

FOR

SUMR AL TAIYBA MOUNTAINS AREA

Draft Updated Report

Natural Resources Studies Directorate

Prospecting Studies Division

Aug 2024

2024

CONTENTS

TABLES..v
List of Abbreviations vi
ABSTRACT..vii
1. INTRODUCTION 1
1.1. Background..1
1.2. Location and Access 1
1.3. Previous studies 2
1.4. Purpose of the study 4
2. GEOLOGY OF THE STUDY AREA..6
3. FIELD WORK..8
3.1 Reconnaissance Trips...8
3.2 Trenches & Boreholes..8
4. Geophysical Studies 12
5. Surface Geochemical Analysis – Rock Samples...................................14
5.1 Sampling & Lab analysis..17
6. RESULTS and DISCUSSION 18
(MODELING and INTERPRETATION) 18
6.1 The Results of zone No. 01..19
6.2 The Results of zone No. 02..32
6.3 The Results of zone No. 03..39
6.4 The Results of zone No. 04..44
6.5 Geochemical Interpretation of Sumr Al Taiyba Area 50
6.6 Economic Elements 57
7. CONCLUSION 58
8. APPENDICES..61
8.1 APPENDIX A 61
8.1.1 TABLES 61
8.1.2 MAPS...68
8.2 APPENDIX B..70
8.2.1 Trenches Informative Data...70
8.2.2 ICP_Result 71
8.2.3 XRF Results...72
8.2.4 XRD Results 73

TABLES

Figure 1: Location of the Study Area 2
Figure 2: Distribution of Previous Survey Samples (BRGM). 3
Figure 3: Catchments and Weak Zones in the Study Area 5
Figure 4: Geology of The Study Area 6
Figure 5: Distribution of Ahaymir Rock Unit 7
Figure 6: Workflow in Field 9
Figure 7: Digitized Trench Using Arc_ Map 10.6v 10
Figure 8: Borehole Location in the Weak Zone Based Tan Angle 11
Figure 9: Geophysical Resistivity Survey, ERT method. 12
Figure 10: Correlation matrix for Surface Geochemical analysis rocks. 16
Figure 11: Weak Zone 01, Digitized & ICP Zn in Trench 01 19
Figure 12: Weak Zone 01, Digitized & ICP Zn in Trench 02 20
Figure 13: Weak Zone 01, Digitized & ICP Zn in Trench 03 21
Figure 14: Alteration Correlation in the Weak Zone 01 22
Figure 15: Weak Zone 01, Digitized Trench 11 23
Figure 16: Correlation Matrix for Chemical Analysis of Zone No. 1 29
Figure 17: Borehole Lithological Log vs Chemical Analysis 31
Figure 18: Correlation between Borehole Log and Excavated Trench 32
Figure 19: Weak Zone 02, Digitized Trench 07 33
Figure 20: Weak Zone 02, Digitized Trench 08 34
Figure 21: Weak Zone 02, Digitized Trench 09 35
Figure 22: Weak Zone 02, Digitized Trench 10 36
Figure 23: Alteration Correlation in the Weak Zone 02 37
Figure 24: Correlation Matrix for Chemical Analysis of Zone No. 2 38
Figure 25: Weak Zone 03, Digitized & ICP Zn in Trench 04 40
Figure 26: Weak Zone 03, Digitized & ICP Zn in Trench 05 41
Figure 27: Alteration Correlation in the Weak Zone 03 42
Figure 28: Correlation Matrix for Chemical Analysis of Zone No. 3 43
Figure 29: Weak Zone 04, Digitized & ICP Zn in Trench 06A 45
Figure 30: Weak Zone 04, Digitized & ICP Zn in Trench 06B 46
Figure 31: Weak Zone 04, Digitized & ICP _Zn in Trench 06C 47
Figure 32: Dipping Direction Trench 06A & Trench 06B_06C 48
Figure 33: Correlation Matrix for Chemical Analysis of Zone No. 4 49
Figure 34: Lithological section of Fz01-BH5 borehole 52
Figure 35: Elemental correlation coefficient. 54
Figure 36: Anomalies of Zn, Ba, Pb, Li & Cu 56

Table 1: Array parameters for ERT Resistivity method. 13
Table 2: ICP-MS Analysis for requested group of elements. 14
Table 3: Composite elements of the Rhyolite Rock asset. 15
Table 4: Composite elements of the altered layer rock asset. 15
Table 5: Shared elements in the two-rock asset. 15
Table 6: The Background pathfinder elements. 17
Table 7: XRF analysis for the following oxides: 17
Table 8: ICP-MS analysis for the following elements 17
Table 9: XRD analysis to determine the following type of minerals group 17
Table 10: ICP Results of Base Metals & REE for Weak Zone 01 30
Table 11: ICP Results of Base Metals & REE For Trench 11 30
Table 12: ICP Results of Base Metals & REE for Weak Zone 02 39
Table 13: ICP Results of Base Metals & REE in the Weak Zone 03 44
Table 14: ICP Results of pathfinder elements Trench 06A 49

List of Abbreviations

A	Area bearing (Influence Area)
Ce	Cerium
Cs	Cesium
E	East
Fig.	Figure
GIS	Geographic Information System
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
km	Kilometer
km^2	Square Kilometer
La	Lanthanum
Lu	Lutetium
m	Meter
m^2	Square Meter
m^3	Cubic Meter
Max.	Maximum
mg/kg	Milligram Per Kilogram
Min.	Minimum
mm/year	Millimeter Per Year
N	North
Nd	Neodymium
NGMP	National Geological Mapping Project
No.	Number
NRA	Natural Resources Authority
ppm	Part Per Million
REEs	Rare Earth Element(s)
St.D.	Standard Deviation
S	South
TD	Total Depth
AM	Ahaymir Volcanic Suit
UTM	Universal Transverse Mercator
W	West

ABSTRACT

Over the last five years, the Ministry of Energy and Mineral Resources (MEMR) has initiated several mineral resources exploration projects, including Phosphate, Potash, REE, Gold, and base metals. These projects result from geological and geochemical studies conducted by the Natural Resources Studies Directorate (NRSD) of MEMR in collaboration with various global agencies across the country.

A geochemical survey of basement rocks in southern Jordan was conducted by the Geochemical Survey Division (MEMR) in collaboration with the French Geological Survey (BRGM). A final report was published in 1994. Geochemical anomalies were identified in several areas in the Wadi Araba, including the Sumr Al Taiyba Mountains, known as the ARAGEO-2 anomaly by BRGM, which were recommended for follow-up.

The study area is located in Wadi Araba, approximately 230 km south of Amman along the Dead Sea-Aqaba Road. It can be accessed via dirt roads and is about 9 km south of Bir-Mathkour village. The study area covers 6.5 km2, in addition, the area has been divided into 42 catchment areas.

Extensive studies were conducted on the pre-determined four designated zones in catchment areas one and two by excavating trenches. A total of thirteen trenches were excavated, in addition, three boreholes were drilled, and necessary samples were collected and sent to the MEMR lab for analysis. After collecting and analyzing 185 samples, it was discovered that the levels of Zn (max. 2380 ppm and background 435 ppm), Pb (max. 547.7 ppm and background 44 ppm), and Li (max. 381.7 ppm and background 63 ppm) had significantly increased. Furthermore, there was an increase in the results within acceptable percentages of elements such as Cu, Ni, V, Sr, Cr, Cs, Ba, Sn, and Y.

Consequently, this project is currently open for private-sector partnerships and investments, making it a promising area for interested parties to explore. As of the time of writing this report, further exploration is still needed and waiting for the final report of the geochemical survey and their recommendations related to the rest catchment areas. Private sector individuals and companies are welcome to explore potential investment opportunities.

1. INTRODUCTION

1.1. Background

In response to the accelerating global competition in the production of precious, base metals, and REE. The Jordanian Government represented by the Ministry of Energy and Mineral Resource (MEMR) has adopted a new strategy that targets expanding various types of metals exploration as well as optimal utilization of mineral resources. Accordingly, several of mineral resources exploration projects were launched in the last five years included Phosphate, Potash, REE, Gold, and base metals based on the results of Geological and geochemical studies that are implemented by MEMR represented by Natural Resources Studies Directorate (NRSD) and other global agencies over the country.

Based on the regional geochemical survey carried out by BRGM, which identified the Sumr Al Taiyba Mountains area "ARAGEO-2 anomaly" as a potential target for the presence of gold and base metals mineralization, this follow-up geochemical survey, which began on 10/16/2022, aimed to continue the work on tracing the source of geochemical anomalies and identifying them more precisely to study and evaluate them by a joint team consist of geological and geochemical surveyors as well as prospecting and geophysical geologists.

1.2. Location and Access

The study area is located in Wadi Araba, about 230 km south of Amman along the Dead Sea-Aqaba road and about 9 km south of Bir-Mathkour village and can be accessed via dirt roads (Fig. 1).

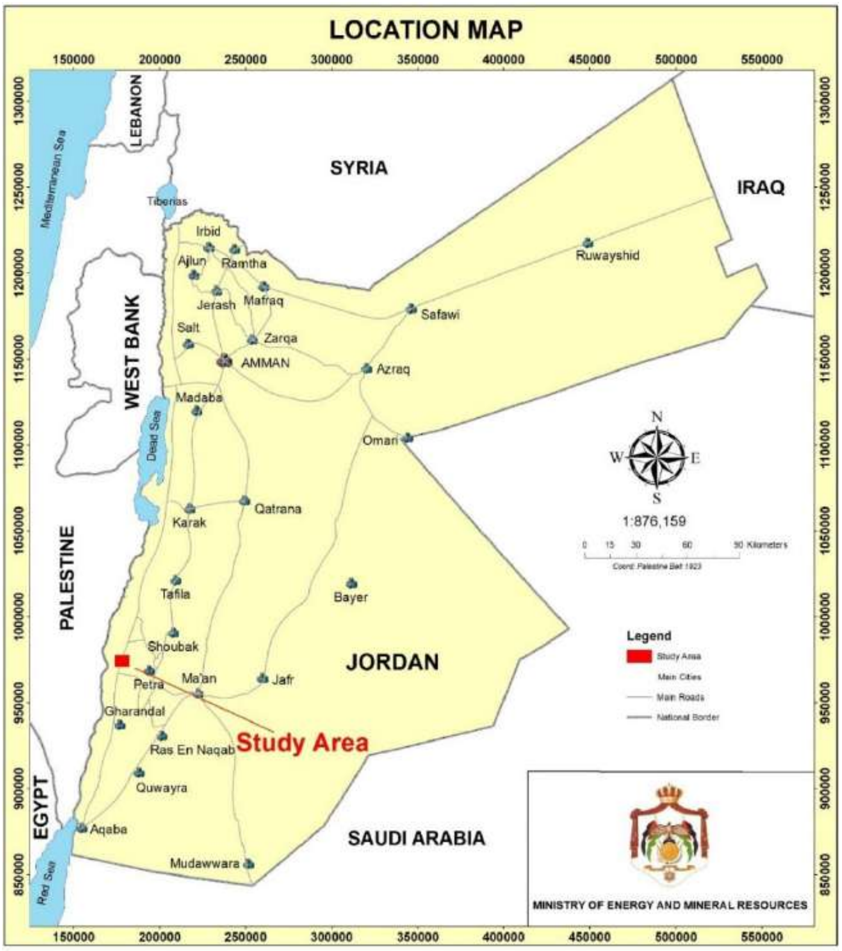


Figure 1: Location of the Study Area

1.3. Previous studies

The Geochemical Survey Division (MEMR) in collaboration with the French Geological Survey (BRGM) have conducted a regional survey of the basement rocks in southern Jordan in 1994.

The objective of the survey was to identify areas with abnormal concentrations of elements that are indicative of mineralization using stream sediments and heavy mineral concentrates.

The released final report has recommended several areas been identified as geochemical anomalies. One of these anomalous areas located in Wadi Araba region called the Sumr Al Taiyba Mountains were defined ARAGEO-2 anomaly according to BRGM.

BRGM collected seventeen (17) stream sediment samples and five (5) heavy mineral concentrates from the second-order streams within the study area with a sampling density of about 4 samples/km² (Fig. 2).

The study area "ARAGEO-2" contains anomalous concentrations of zinc and lead, in addition to shows of gold (Appendix A). The presence of such elements associated with concentrations above the common "background" makes the area potential for economic mineralization and should be studied in detail.

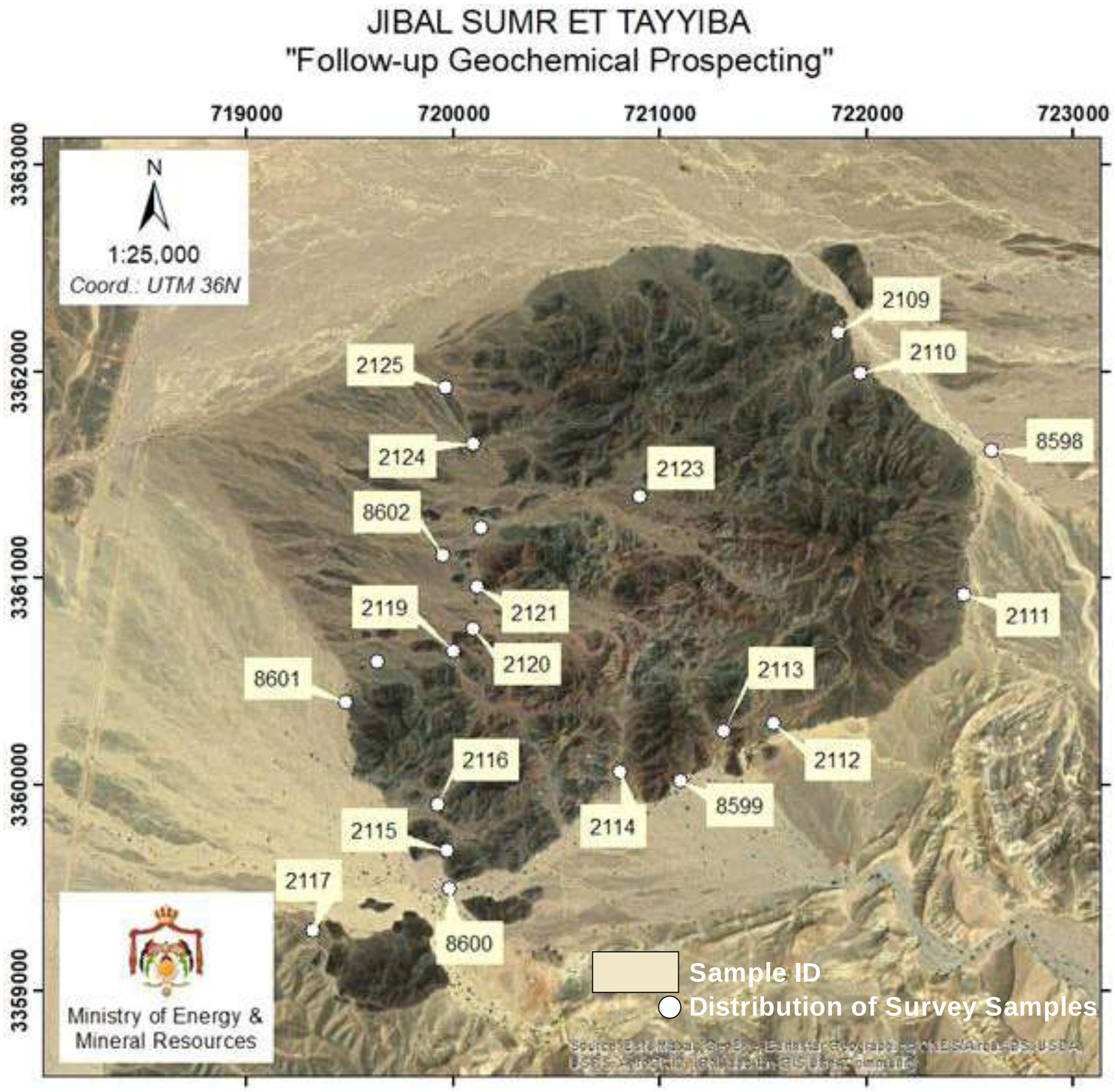


Figure 2: Distribution of Previous Survey Samples (BRGM).

1.4. Purpose of the study

Integrated studies to explore the components, the environmental condition and the major source of Precious, Base metals and REE in Sumr Al Taiyba mountains with a limited area equivalent to 6.5 km2. Therefore, based on regional results of BRGM data, the geochemical and prospecting studies were launched.

In the Geochemical survey, the Sumr Al Taiyba area was divided into 42 catchments. The following types of group samples including stream, heavy & rocks were collected and subjected to certain kinds of analysis including ICP-MS, XRF, and thin section in the MEMR lab in addition to AAS for gold investigation in the SGS Canadian lab to determine the concentrations and anomalies certain type of elements called pathfinder. The pathfinder elements are group of elements including precious and base metals produced over long series of sulfidation minerlization process. The recent layout results of Geochemical survey in the study area, total of four alteration (weak) zones contain distinguishing values of pathfinder elements that were determined in the catchment areas 01 & 02 (Fig. 3).

As a follow-up of integration studies, Prospecting studies were commenced on 5 Feb 2023 in the catchment areas 01, 02, and 10 including trench excavation and drilling boreholes to determine the following requirements:

- Measure the strike, dip & dip direction of the alteration layers in the weak zones.
- Define the type of pathfinder elements deposited along the zones in addition to their level values.
- Determine the mineralization type.

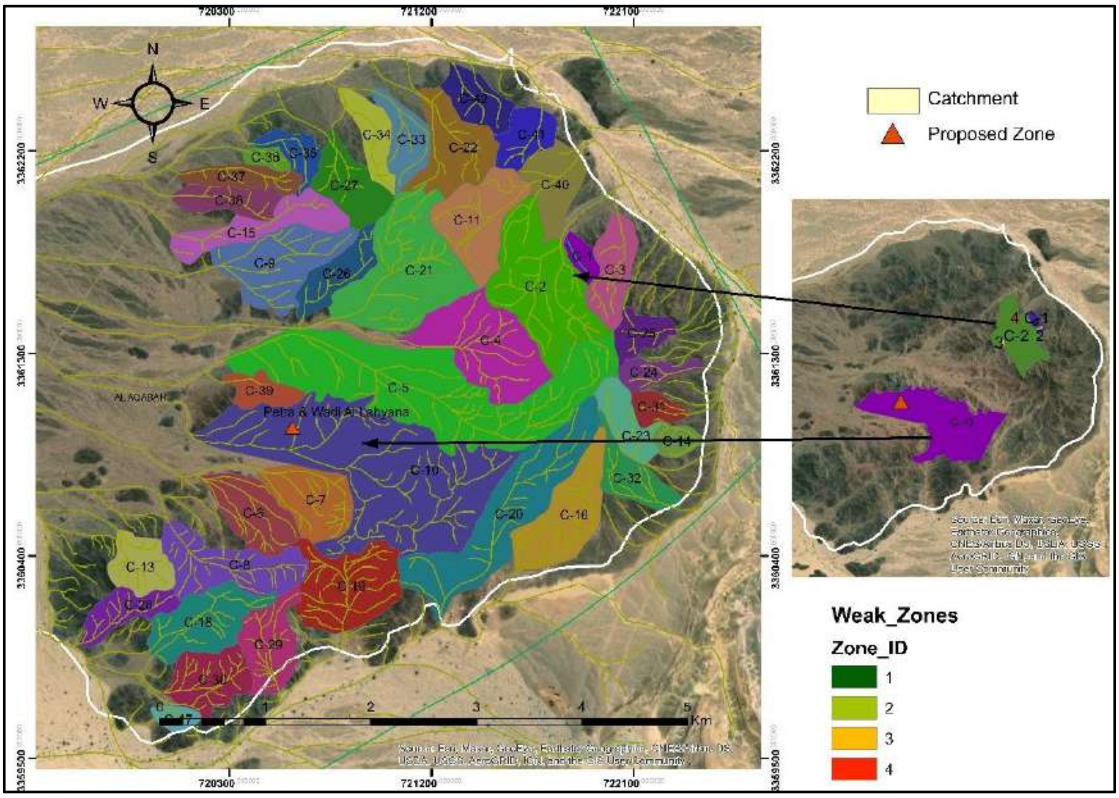


Figure 3: Catchments and Weak Zones in the Study Area

2. GEOLOGY OF THE STUDY AREA

From a geological point of view, the Sumr Al Taiyba Mountains consist entirely of Pre-Cambrian rhyolite volcanic rocks “AM” surrounded by sediments of Pleistocene and Quaternary alluvial and flood plains (Fig. 4). On the south, it is structurally bordered by Cretaceous sedimentary rock units consisting of sandstone, limestone, argillites, marl, phosphate, and chert.

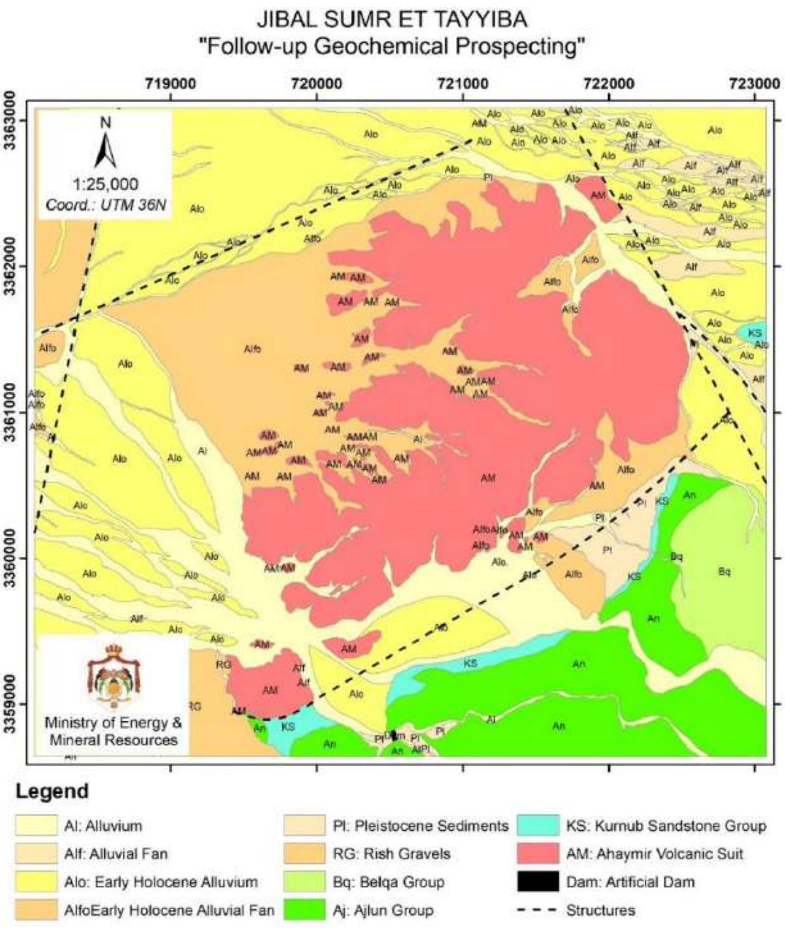


Figure 4: Geology of The Study Area

The main faults, which are believed to follow the Dead Sea Transform Fault System “DSTF”, surround the AM from all sides forming a semi-circular shape with peaks concave towards the west where the general inclination (Fig. 5). Thus, it is likely that there are complex structures within the study area that need a detailed study.

The closest exposure of the same rock unit “AM” is located about 6 km to the east in Wadi Abu-Khusheiba.

The lowest altitude in the study area is about 175 m a.m.s.l in the west, while the highest altitude is about 400 m a.m.s.l in the east, with a height difference of about 225 m. The study area is divided into two parts: one half has a floodplain terrain with an intricate network of streams, while the other half is mountains with rhyolite volcanic rocks of the AM. In the southeastern corner, there are Cretaceous sedimentary rocks of the Kurnub Sandstone Formation "KS", and carbonate formations belong to the Ajloun and Balqa Groups. The slope is generally gentle in most of the area of about 4o and reaches its maximum on the slopes of the high mountains.

The study area is part of geological map sheet Petra & Wadi AlLahyana scaled 1:50,000. According to the map, Ahaymir group was divided into four members (Fig. 5) including Al Bayda (Quartz-Feldspar Porphyry), Mufarqida Conglomerate, Musaymir Effusive and Qusayb Rhyolite where Qusayb Rhyolite member is the most one predominant in the study area. Furthermore, diabase and andesite rocks are embedded in between over the study area.

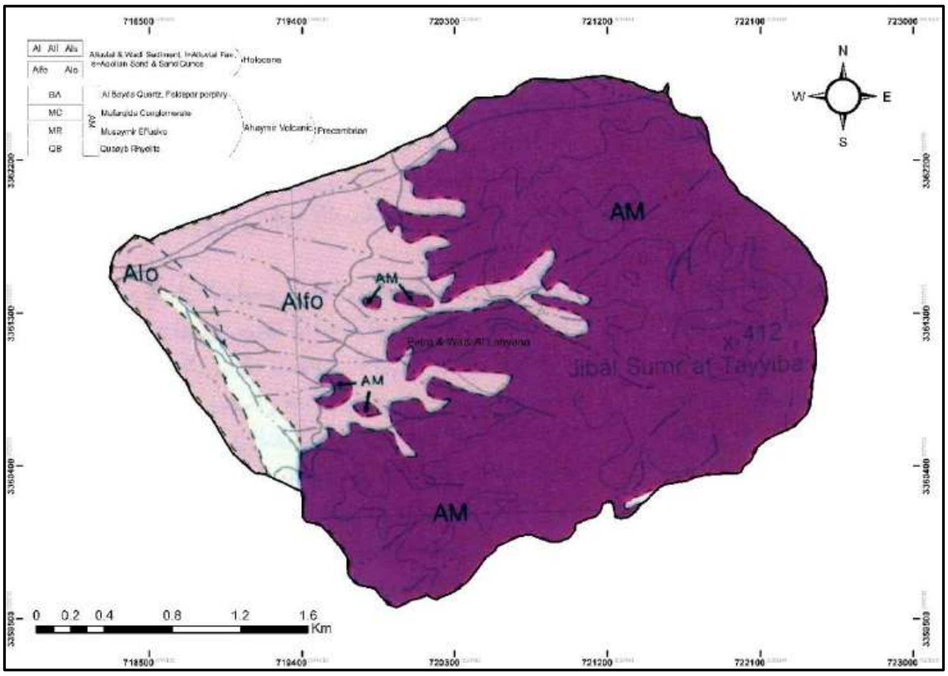


Figure 5: Distribution of Ahaymir Rock Unit

3. FIELD WORK

3.1 Reconnaissance Trips

Driven by the Ministry of Energy and Mineral Resources' mandate to optimize mineral resource exploitation and attract investors, the prospecting studies division initiated exploration activities in the Sumr Al Taiyba study area (covers 6.5 km^2).

Initial reconnaissance trips in November 2022 (in collaboration with the geochemical division) aimed to identify zones of weakness indicative of potential mineralization. These zones included fracture zones filled with residual fluids from the final crystallization of Auhimr Suite igneous rocks (Araba Complex), fault zones, and igneous dykes. Subsequent trips, guided by updated geochemical survey results, further refined potential exploration zones.

Trenching and pit excavation identified promising locations, and subsequent sample analysis led to the selection of drilling sites. These operations and their outcomes will be elaborated upon in subsequent sections.

3.2 Trenches & Boreholes

As mentioned above, a total of four zones were determined in catchment areas 01 and 02 in addition to another proposed altered zone was determined in catchment no. 10. Trenches and drilling boreholes are prospecting methods were utilized to obtain further information regarding the pathfinder elements within alteration layers extend along the weak zones.

The trenches were excavated perpendicular to the strike of the weak zones to expose as much as possible of alteration layers that are occured over there. Along the trench, the footwall and the hanging wall are the main structural features used to indicate the start and end of alteration occurrences. By using millimeter paper, the lithology and structure features of the trenches were documented with the following details (Fig. 6, Trench 03 is an example):

- Distinguishing in the draw between the alteration layer and the mother rock layer (Rhyolite).
- The strike, dip, and dip direction of alteration layers.
- Shows of exposed base metals or any related alteration minerals.
- Start and End of the trench.
- Sample's location

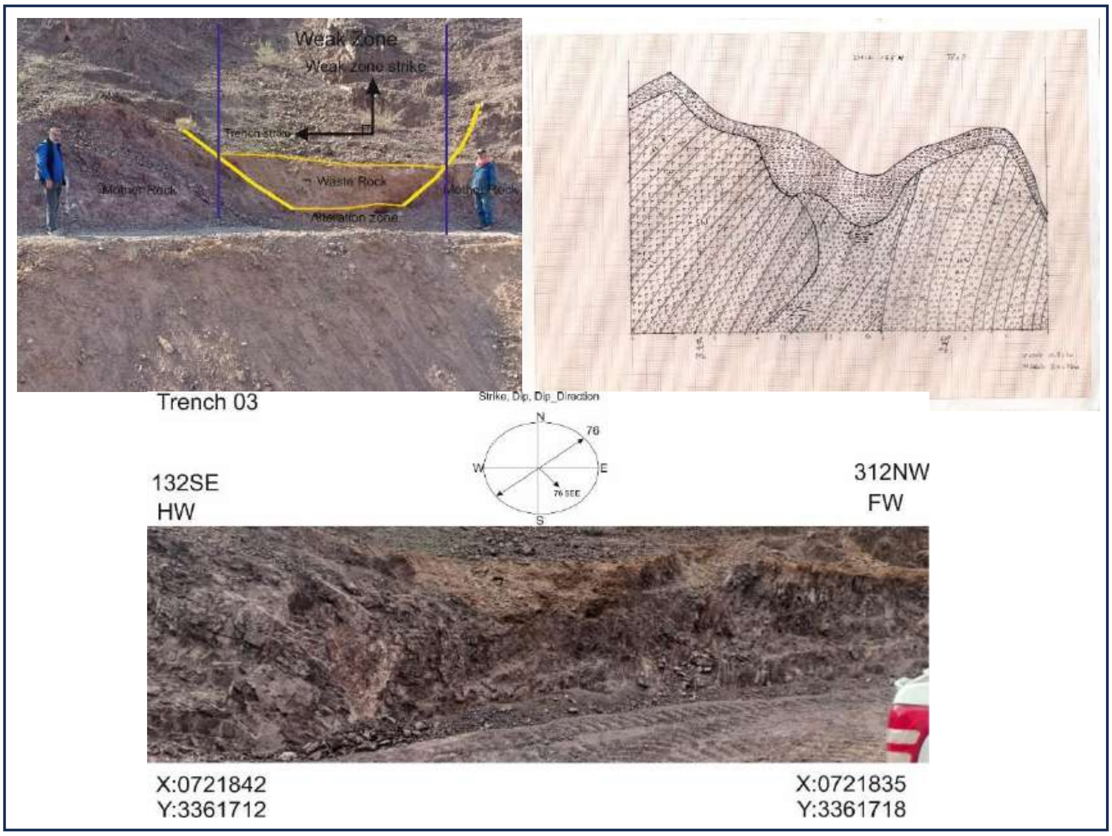


Figure 6: Workflow in Field

Using Arc-Map in digitizing the drawn trench in order to declare the following parameters (Fig. 7, Trench 03 is an example):

- Lithology type & structure features.
- Length and depth of the altered layer.
- Define the pathfinder elements results by PPM.
- Strike, Dip, Dip Direction of the altered zones.

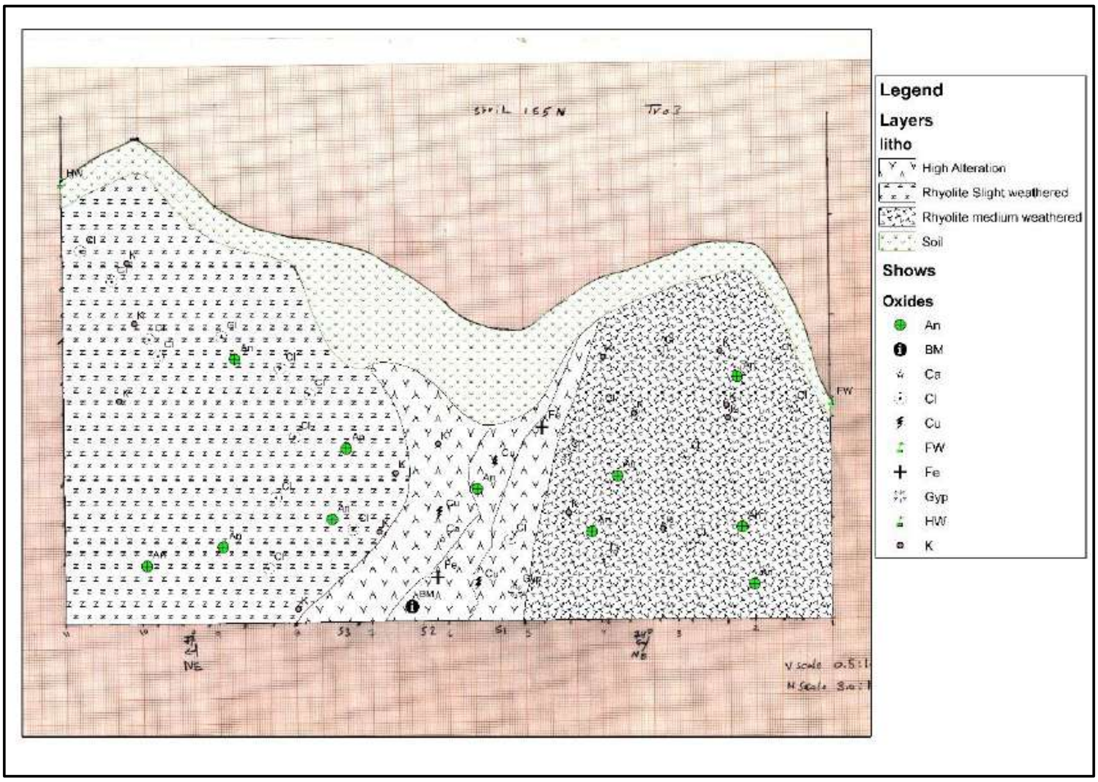


Figure 7: Digitized Trench Using Arc_ Map 10.6v

Ultimately, the Arc-Map will use to link the altered layer to define the outcome of the strike, Dip, and Dip Direction for a particular group of drawn trenches over certain weak zones. The second phase is drilling borehole to explore the subsurface extension of the altered zone. The borehole location is determine according to the dip direction of altered layer whereas the separated distance between the rig location and the weak zone is measured according the maximum penetration depth of the rig. That distance is measured based on the tan angle the dip-altered layer multiply to the maximum penetration depth of the rig (Fig. 8, Zone 01 is an example).

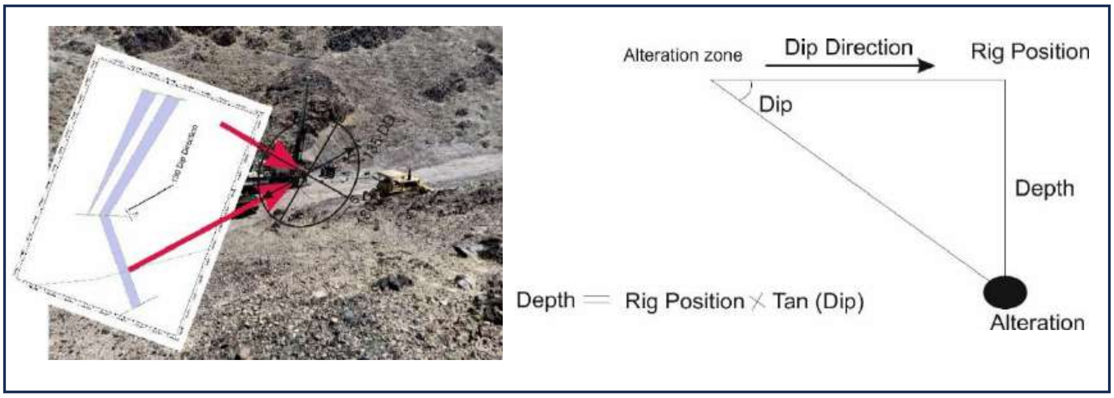


Figure 8: Borehole Location in the Weak Zone Based Tan Angle

4. Geophysical Studies

In respond to the irregular shape topography of the study area and incompatible status for the predominant rock in the study area to the altered layer in term of their physical characteristics in term of the bulk density, texture and shape, geophysical resistivity survey was implemented using ERT method that has variety arrays to proceed. Three different arrays were carried out included (Fig. 9):

- Winner Schlumberger
- Dipole – Pole
- Pole - Pole

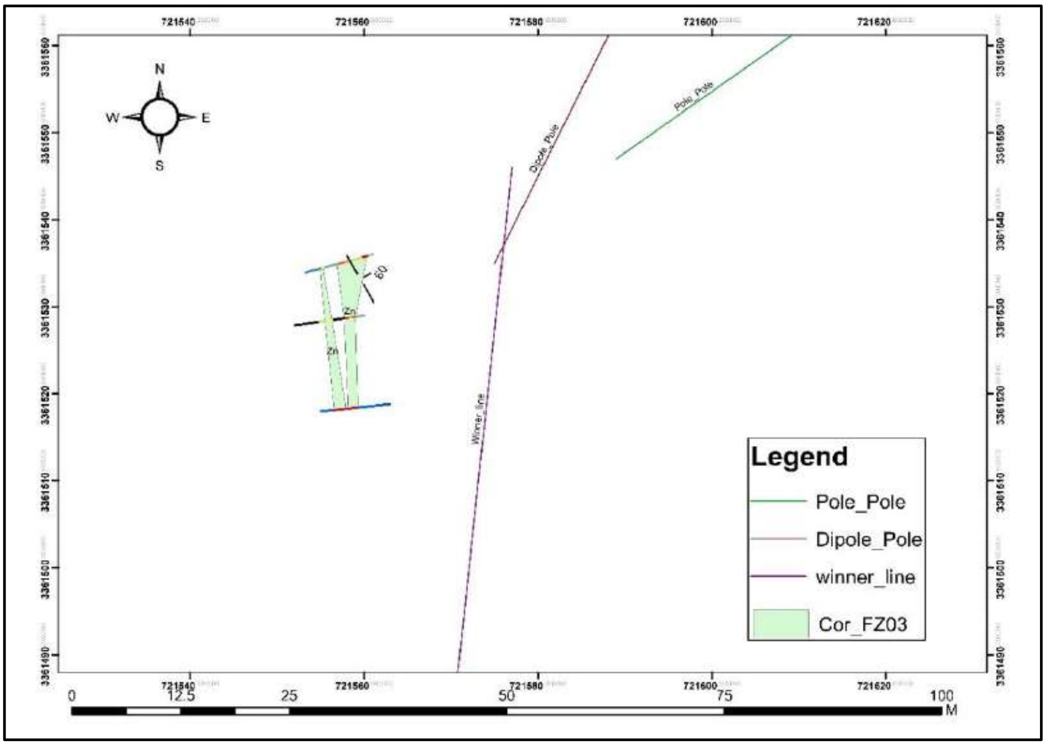


Figure 9: Geophysical Resistivity Survey, ERT method.

Each of array –that are mentioned above - was used according to the certain parameters to obtain the optimal resolution for the target layer including the electrode spacing, the length of array and the rate of penetration Table No. 01. The largest penetrated depth is 54 m using pole –pole whereas the highest penetrated depth resolution is 26 m using Pol-pole with spacing electrode 1 m. Remarkably, the geophysical report contains the subsurface models with interpretations will be enclosed with this report after received the final layout from the geophysical team.

Table 1: Array parameters for ERT Resistivity method.

Type of Array	# of Array	Electrode Spacing	Length of array	Rate of penetration depth	Penetrated depth
Winner Schlumberger	1	2 m	64 m	16%	~10 m
Diploe - Pole	1	2 m	64 m	40%	~25 m
Pole - Pole	1	2 m	64 m	85%	~54 m
Pole - Pole	1	1 m	31 m	85%	26 m

5. Surface Geochemical Analysis – Rock Samples

According to the surface geochemical survey analysis for the total of 64 collected rock samples the composite elements of the predominant Rhyolite rocks over the study area have been identified than the composite elements of the altered layer using Correlation matrix statistical analysis for assets requested 34 of elements Table 02.

Table 2: ICP-MS Analysis for requested group of elements.

Be	**Cd**	**Co**	**Cs**	**Cu**	**Ga**	**Li**	**Ni**	**Pb**	**Sr**
V	**Zn**	**Hf**	**Mo**	**Nb**	**Sb**	**Sn**	**W**	**Zr**	**Ce**
Dy	**Gd**	**Ho**	**La**	**Nd**	**Pr**	**Sc**	**Sm**	**Y**	**Yb**
Rb	**Cr**	**Ti**	**Ba**						

The correlation matrix is statistical analysis method to figure out the relation between two groups of assets. If the correlation value close to +1 between two type of element, the co-existence for them in the same mineral is high potential and vice versa for correlation value equal -1. In the (Fig. 10) revealed total of 18 analyzed elements are associated to the predominant Rhyolite rock (mother rock) Table 03, whereas total of 13 analyzed elements are associated to the altered layer Table 04. Remarkably, Zirconium and Copper are the main elements composite for the Rhyolite rocks and altered layer rocks, respectively; and both of element were used in the correlation matrix to explore the rest of component for the two asset rock by their correlation value which is restricted between +1 , -1). So far, two element from the composite elements of the two group assets are included in the both assets Sn and Y Table 05.

Table 3: Composite elements of the Rhyolite Rock asset.

Zr	**Rb**	**Be**	**Ga**	**Hf**	**Mo**	**Nb**	**Sn**	**W**	**Ce**
Dy	**Gd**	**La**	**Nd**	**Pr**	**Sm**	**Y**	**Yb**		

Table 4: Composite elements of the altered layer rock asset.

Cu	**Zn**	**Li**	**Pb**	**Sr**	**V**	**Cr**	**Ni**	**Ba**	**Co**
Cs	**Sn**	**Y**							

Table 5: Shared elements in the two-rock asset.

Sn	**Y**

Corresponding to the Table 04, the composite elements of the altered rocks asset have been entitled pathfinder elements to track the sulfidation minerals in term of their type, strike, Dip, Dip-direction and settled depth. Furthermore, the background of the pathfinder elements of the altered rock was extracted from the overall surface rock geochemical analysis. The pathfinder elements background ppm were used to find out their potential high value which is considered indices into certain type of sulfidation mineralization process (Table 06).

	Bi_ppm	Rb_ppm	Be_ppm	Cd_ppm	Co_ppm	Cr_ppm	Cs_ppm	Cu_ppm	Ga_ppm	Li_ppm	Ni_ppm	Pb_ppm	Sr_ppm	V_ppm	Zn_ppm	Hf_ppm	Mo_ppm	Nb_ppm	Sb_ppm	Sn_ppm	W_ppm	Zr_ppm	Ce_ppm	Dy_ppm	Gd_ppm	Ho_ppm	La_ppm	Nd_ppm	Pr_ppm	Sc_ppm	Sm_ppm	Y_ppm	Yb_ppm	Ba_ppm
Bi_ppm	1																																	
Rb_ppm	#DIV/0!	1																																
Be_ppm	#DIV/0!	-0.48574	1																															
Cd_ppm	#DIV/0!	#DIV/0!	#DIV/0!	1																														
Co_ppm	#DIV/0!	-0.42462	0.157165	#DIV/0!	1																													
Cr_ppm	#DIV/0!	0.141024	-0.36366	#DIV/0!	-0.11663	1																												
Cs_ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1																											
Cu_ppm	#DIV/0!	-0.29203	-0.08608	#DIV/0!	-0.20514	0.057523	#DIV/0!	1																										
Ga_ppm	#DIV/0!	-0.82644	0.388282	#DIV/0!	0.497119	-0.11918	#DIV/0!	-0.1744	1																									
Li_ppm	#DIV/0!	-0.14409	-0.09503	#DIV/0!	0.173868	-0.10489	#DIV/0!	0.002377	0.143773	1																								
Ni_ppm	#DIV/0!	0.087089	0.042499	#DIV/0!	0.131254	0.716725	#DIV/0!	0.006226	0.120002	0.000541	1																							
Pb_ppm	#DIV/0!	0.16833	-0.00302	#DIV/0!	-0.07141	-0.18326	#DIV/0!	-0.00702	-0.27523	0.614961	-0.1097	1																						
Sr_ppm	#DIV/0!	0.613747	-0.10741	#DIV/0!	0.478972	-0.01814	#DIV/0!	-0.00121	-0.01967	0.28164	0.052957	0.049832	1																					
V_ppm	#DIV/0!	0.438594	-0.10394	#DIV/0!	0.466174	-0.08488	#DIV/0!	-0.01482	0.018174	0.172695	-0.11554	0.169169	0.765249	1																				
Zn_ppm	#DIV/0!	-0.70809	-0.08991	#DIV/0!	0.089754	-0.13463	#DIV/0!	0.03395	0.038063	0.853583	-0.06117	0.716499	0.056847	0.605128	1																			
Hf_ppm	#DIV/0!	0.254973	0.104416	#DIV/0!	-0.02116	0.157375	#DIV/0!	-0.1074	0.551753	-0.25252	0.10386	-0.53432	-0.46693	-0.36269	-0.19248	1																		
Mo_ppm	#DIV/0!	0.054858	0.401947	#DIV/0!	0.02128	-0.24821	#DIV/0!	-0.06372	0.254101	0.187405	-0.04828	-0.12838	-0.06203	-0.07848	-0.06371	0.10912	1																	
Nb_ppm	#DIV/0!	-0.3075	0.038006	#DIV/0!	0.19854	0.150078	#DIV/0!	-0.13562	0.707179	-0.10581	0.026631	-0.42063	-0.18729	-0.08677	-0.00211	0.844873	0.074484	1																
Sb_ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1															
Sn_ppm	#DIV/0!	-0.47047	0.275322	#DIV/0!	0.003283	-0.27268	#DIV/0!	-0.05009	0.29582	-0.08311	-0.19182	0.22319	-0.25018	-0.21853	0.04755	0.289124	0.132473	0.22954	#DIV/0!	1														
W_ppm	#DIV/0!	-0.43022	0.353005	#DIV/0!	0.237653	-0.11559	#DIV/0!	-0.23084	0.579422	-0.35826	0.003908	-0.45407	-0.52565	-0.44536	-0.27121	0.686142	0.148078	0.540356	#DIV/0!	0.411565	1													
Zr_ppm	#DIV/0!	0.516592	0.214653	#DIV/0!	0.009971	-0.00654	#DIV/0!	-0.04922	0.599282	-0.45433	-0.30931	-0.45212	-0.43239	-0.34117	-0.36268	0.974907	0.196306	0.834609	#DIV/0!	0.309407	0.684751	1												
Ce_ppm	#DIV/0!	-0.59391	0.107158	#DIV/0!	-0.03019	-0.02363	#DIV/0!	-0.17953	0.314065	-0.28998	-0.00629	-0.205	-0.30107	-0.26706	-0.20935	0.491936	0.003105	0.299935	#DIV/0!	0.141582	0.379902	0.49954	1											
Dy_ppm	#DIV/0!	0.259174	-0.0566	#DIV/0!	-0.11881	-0.02949	#DIV/0!	-0.03901	0.075613	-0.21103	-0.17714	-0.14399	-0.13632	-0.11893	-0.10158	0.228919	-0.05297	0.249928	#DIV/0!	-0.04996	0.058595	0.208862	0.091231	1										
Gd_ppm	#DIV/0!	-0.89441	0.603754	#DIV/0!	0.38146	-0.38163	#DIV/0!	-0.18191	0.729571	0.085264	0.088154	-0.1737	-0.07302	-0.00921	-0.00932	0.438408	0.383756	0.385162	#DIV/0!	0.33233	0.487473	0.570399	0.425128	-0.07664	1									
Ho_ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1								
La_ppm	#DIV/0!	-0.56553	0.053506	#DIV/0!	0.079017	-0.00878	#DIV/0!	-0.22641	0.434217	-0.31221	-0.03778	-0.23057	-0.50478	-0.45103	-0.20451	0.594502	0.022779	0.540672	#DIV/0!	0.425119	0.750935	0.600264	0.603117	0.165781	0.309616	#DIV/0!	1							
Nd_ppm	#DIV/0!	-0.28696	0.018943	#DIV/0!	0.077602	0.019906	#DIV/0!	-0.23128	0.473867	-0.30325	0.011512	-0.28892	-0.46103	-0.39951	-0.20377	0.687227	0.01992	0.621517	#DIV/0!	0.348602	0.72207	0.699661	0.705606	0.189964	0.38664	#DIV/0!	0.964778	1						
Pr_ppm	#DIV/0!	-0.29632	0.018689	#DIV/0!	0.178954	0.030076	#DIV/0!	-0.20935	0.617995	-0.25405	0.034548	-0.34849	-0.36472	-0.27918	-0.13588	0.771693	0.022374	0.7708	#DIV/0!	0.335846	0.706693	0.779662	0.670919	0.213521	0.464838	#DIV/0!	0.899318	0.959562	1					
Sc_ppm	#DIV/0!	#DIV/0!	-0.09964	#DIV/0!	0.495942	-0.07211	#DIV/0!	-0.03436	0.054819	0.146211	-0.10019	0.041809	0.872261	0.962059	0.406404	-0.34674	-0.06582	-0.06442	#DIV/0!	-0.18824	-0.39789	-0.32645	-0.26301	-0.10415	-0.014	#DIV/0!	-0.40767	-0.36035	-0.24838	1				
Sm_ppm	#DIV/0!	-0.76946	0.479837	#DIV/0!	0.310059	-0.26777	#DIV/0!	-0.32275	0.734399	-0.08571	0.070507	-0.2366	-0.18413	-0.1598	-0.15548	0.551123	0.303686	0.467756	#DIV/0!	0.365742	0.620784	0.65422	0.696146	0.030801	0.885874	#DIV/0!	0.616775	0.691737	0.716586	-0.12003	1			
Y_ppm	#DIV/0!	0.686019	0.045026	#DIV/0!	0.006677	0.106983	#DIV/0!	-0.015	0.495131	-0.31923	0.071836	-0.51985	-0.55302	-0.47041	-0.28372	0.904345	0.069486	0.768312	#DIV/0!	0.259729	0.762767	0.865867	0.538439	0.173019	0.372669	#DIV/0!	0.711001	0.7784	0.833153	-0.45502	0.530354	1		
Yb_ppm	#DIV/0!	0.563115	0.659247	#DIV/0!	0.116248	-0.41199	#DIV/0!	-0.13542	0.361984	0.100629	0.095002	-0.15307	-0.14812	-0.16075	-0.16611	0.226195	0.57441	0.052747	#DIV/0!	0.272376	0.38204	0.374445	0.068855	-0.09761	0.779526	#DIV/0!	0.089321	0.111773	0.108408	-0.14628	0.608564	0.175795	1	
Ba_ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.007498	#DIV/0!	0.646891	#DIV/0!	0.517088	0.118438	0.527042	#DIV/0!	#DIV/0!	0.563022	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-0.44036	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1

Figure 10: Correlation matrix for Surface Geochemical analysis rocks.

Table 6: The Background pathfinder elements.

Pathfinder element	Cu	Zn	Li	Pb	Sr	V	Cr	Ni	Ba
Background	923 ppm	435 ppm	63 ppm	44 ppm	95 ppm	55 ppm	332 ppm	166 ppm	217 ppm
Pathfinder element	**Co**	**Cs**	**Sn**	**Y**					
Background	22 ppm	5 ppm	11 ppm	87 ppm					

5.1 Sampling & Lab analysis

The sampling was carried out according to the standard criteria that is relied mainly on the description lithology that separates between the Rhyolite rock and altered rocks. Total of 142 samples were collected from total of 15 excavated trenches as well as 53 samples were collected from three drilled borehole

During the Prospecting activities, the selected samples were subjected into set of chemical analyses included XRF, ICP-MS and XRD instruments that were proceeded in the MEMR lab; the requested chemical sets are included in following tables below Table No. 07, 08, and 09.

Table 7: XRF analysis for the following oxides:

Fe2O3 Wt.%	MnO Wt.%	TiO2 Wt.%	CaO Wt.%	CuO Wt.%	K2O Wt.%	SO3 Wt.%	SiO2 Wt.%	Al2O3 Wt.%	MgO Wt.%	Na2O Wt.%

Table 8: ICP-MS analysis for the following elements

Be	**Cd**	**Co**	**Cs**	**Cu**	**Ga**	**Li**	**Ni**	**Pb**	**Sr**
V	**Zn**	**Hf**	**Mo**	**Nb**	**Sb**	**Sn**	**W**	**Zr**	**Ce**
Dy	**Gd**	**Ho**	**La**	**Nd**	**Pr**	**Sc**	**Sm**	**Y**	**Yb**
Rb	**Cr**	**Ti**	**Ba**						

Table 9: XRD analysis to determine the following type of minerals group

Major	Minor	Traces

6. RESULTS and DISCUSSION (MODELING and INTERPRETATION)

The identified four zones in the catchment 01, 02 were intensively examined utilizing excavated trenches whereas drilling boreholes will carry out based on trenches parameters and geophysical survey data. The most layout data was covered in the identified zones :

- Digitize trenches on millimeter paper.
- Determine the strike, dip, and dip direction of each trench
- Expressing ICP-MS data for the pathfinder elements over the digitized trenches.
- Determine the extension, strike, dip, and dip direction of the alteration layers over the weak zone according to the excavated trenches.
- Expressing ICP-MS data of the alteration layers over the weak zone using ARC-map.
- Define the pathfinder element using the Correlation matrix method for each zone.
- Define the background and maximum values for the ICP results for each weak zone.
- Explore the predominant minerals in the alteration layers using XRD analysis.
- The aforementioned points have been discussed in detail for each zone separately.
- All chemical results details have been enclosed in the appendix B.

6.1 The Results of zone No. 01

The four trenches were excavated and one borehole was drilled. The alteration layers were identified and distinguished than the mother rock (Rhyolite) in the digitized millimeter paper in addition to the length of each layer. The ICP results for the pathfinder elements are representing the main function of indication into the alteration zone. Therefore, the Zinc was nominated in the four weak zones to represent the rest of the pathfinder elements on the digitized millimeter paper as well as used to correlate the altered layer over the weak zone. In the following Figures (11, 12, and 13), the alterations were distinguished using Zn values in ppm as well as their depth and length in meter unit.

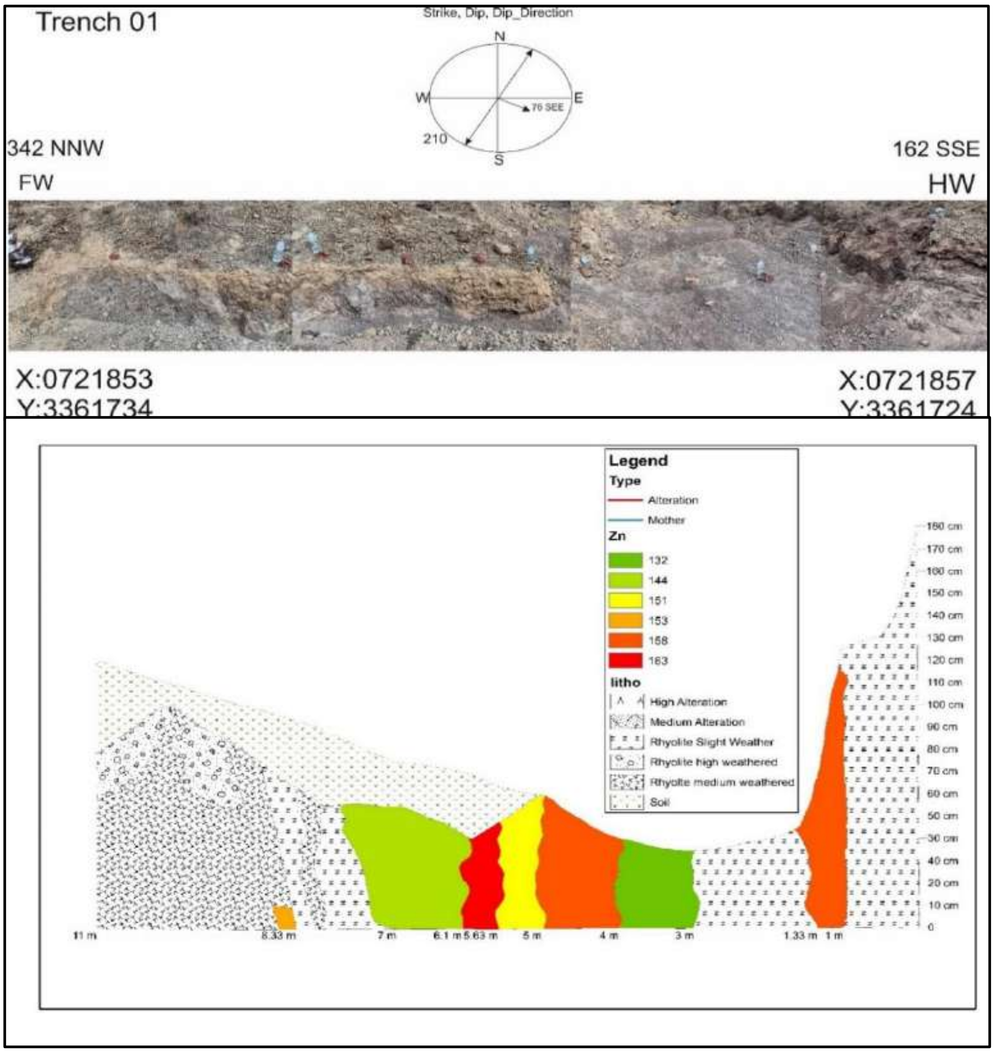


Figure 11: Weak Zone 01, Digitized & ICP Zn in Trench 01

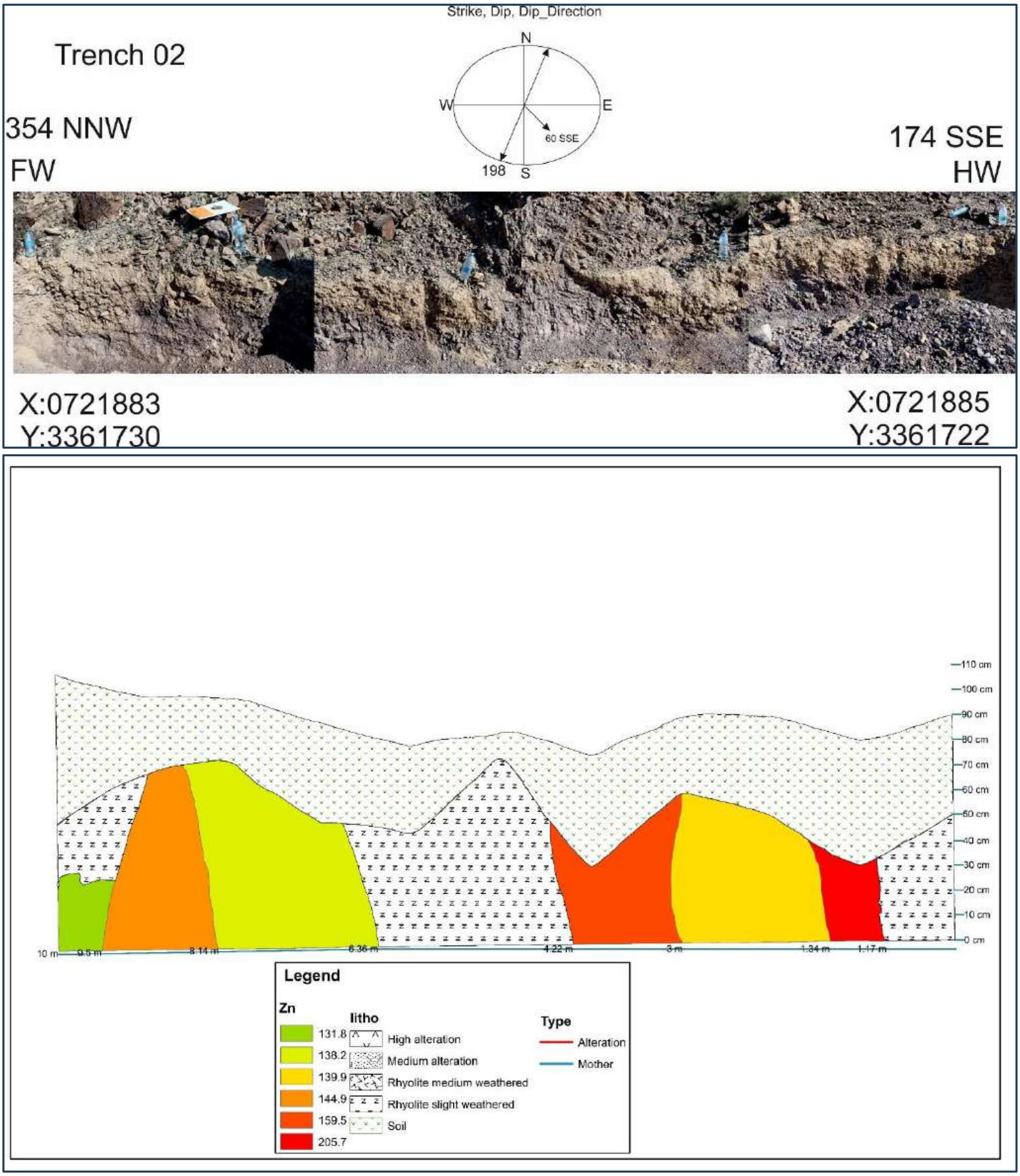


Figure 12: Weak Zone 01, Digitized & ICP Zn in Trench 02

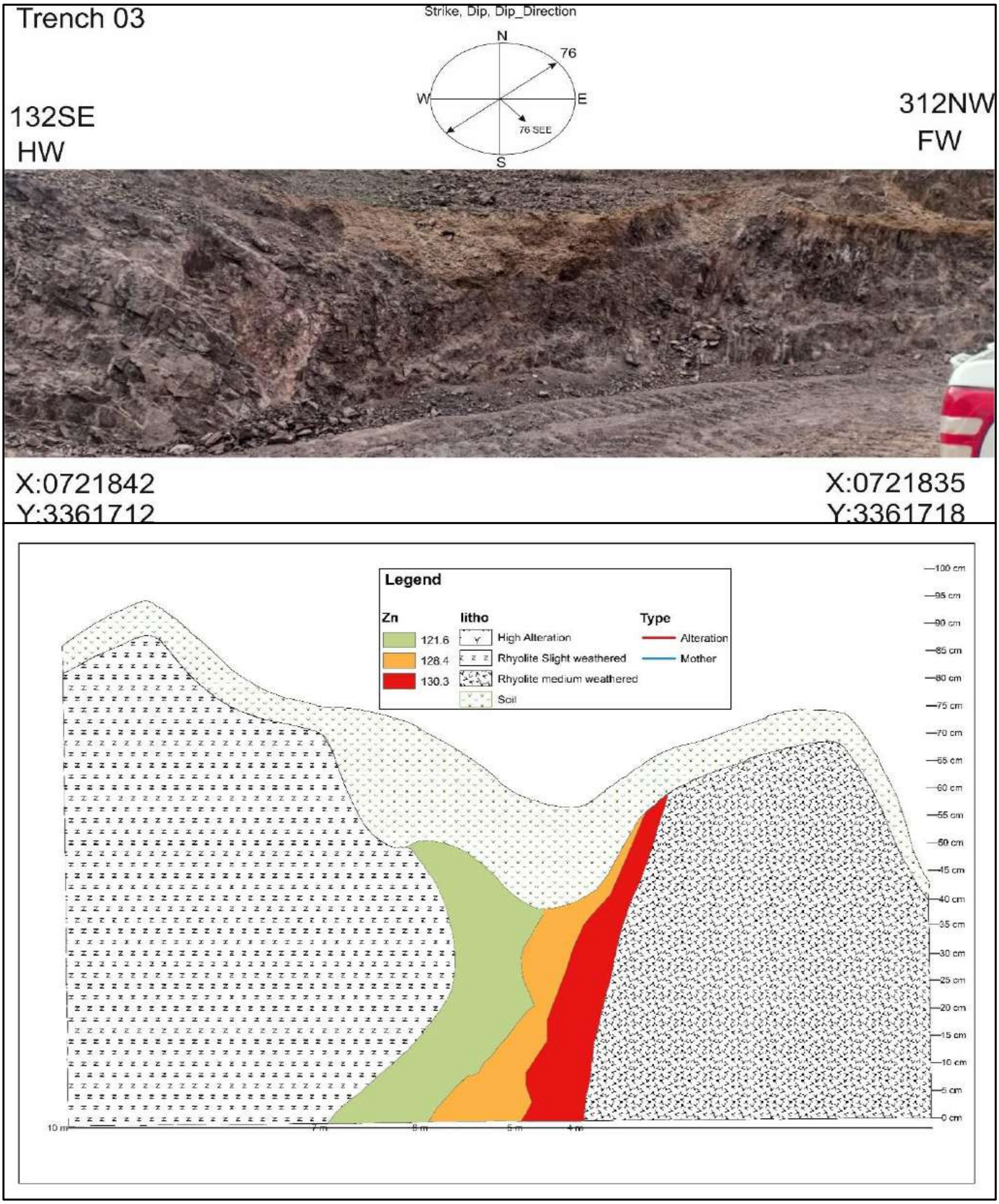


Figure 13: Weak Zone 01, Digitized & ICP Zn in Trench 03

Based on the Alteration results, the correlation links Trench 01, Trench 02, and Trench 03 together reveal to an alteration zone dipping toward the south-east of the study area (Fig. 14).

Meanwhile, for further investigation in the weak zone 01, Trench labelled 11 was excavated (Fig. 14).

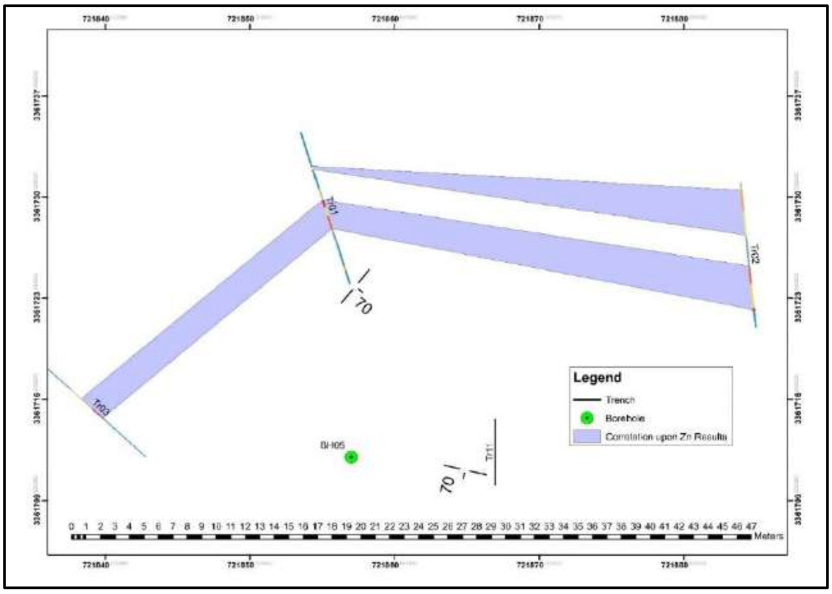


Figure 14: Alteration Correlation in the Weak Zone 01

Trench no. 11 is dipping toward the southwest and crossing the main correlation in the weak zone 01. Recently, it was digitized in millimeter paper revealed on total of five alteration layers that were sampled and sent to the MEMR lab. The sample results of Trench 11 were represented on the digitized millimeter paper (Fig. 15).

On the other hand, based on the zinc correlation over weak zone 01 (Fig. 14), the borehole was drilled to a total depth of 43 meters accompany with sampling. Based on the lithology description and chemical analysis results for total of 43 collected samples , the alteration layer was encountered at depth 10 m and continued to depth 20 m.

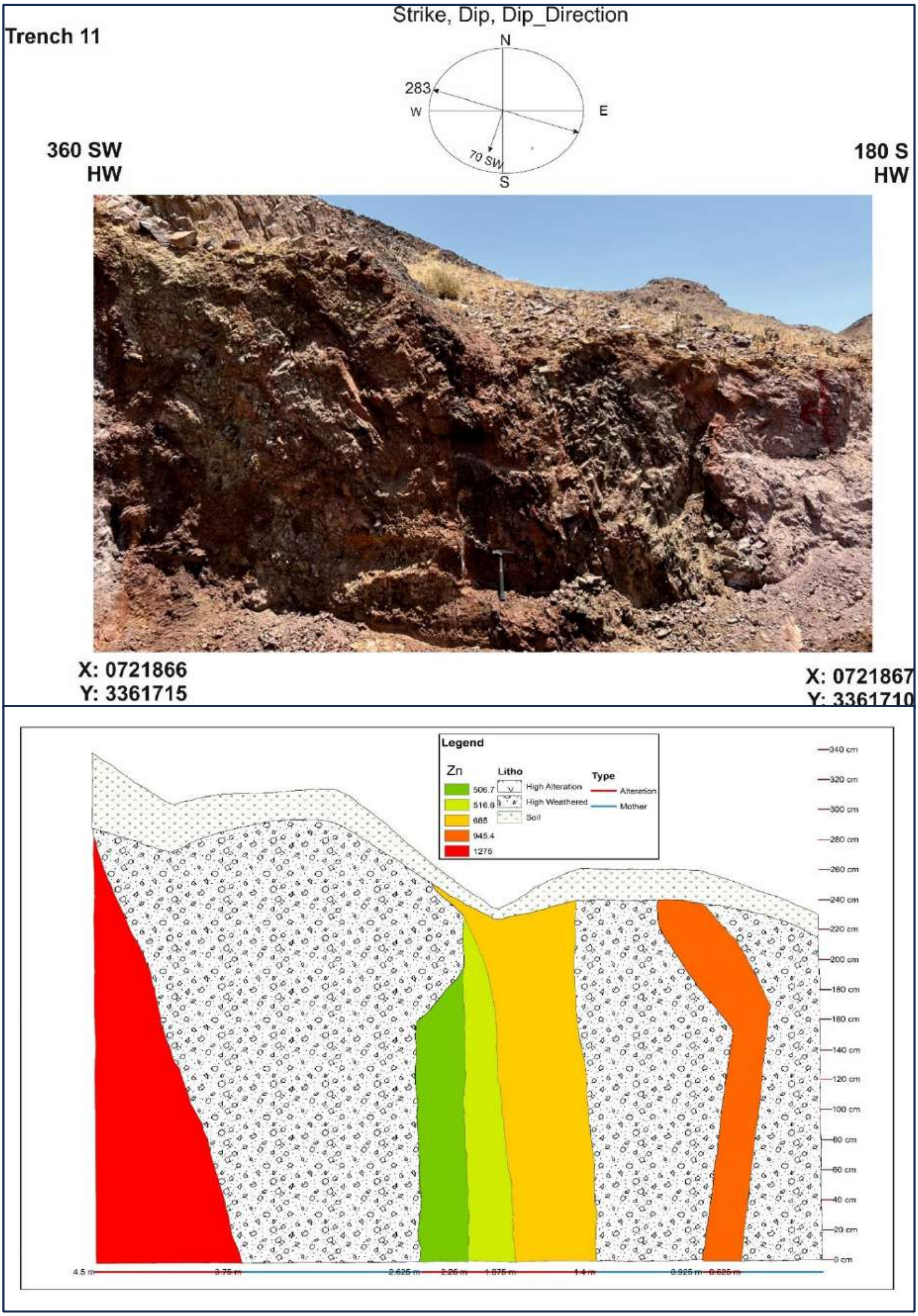


Figure 15: Weak Zone 01, Digitized Trench 11

The pathfinder elements over the weak zone have been determined using the Correlation matrix. The correlation matrix of Zone 01 (Fig. 16) shows the elements that have emerged during the alteration process and apart than the mother rock elements.

According to the correlation value for the following elements Zinc (Zn), copper (Cu), and Zirconium (Zr) the pathfinder elements and mother rock have been known. The pathfinder elements in zone 01 are Zn, Cu, Li, Ni, Pb, Sr, V, Y. Mother rock elements: Zr, Be, Cd, Co, Cs, Mo, Nb, Sb, Sn,W, Sm,Yb.

	Be(ppm)	Cd(ppm)	Co(ppm)	Cs(ppm)	Cu(ppm)	Ga(ppni)	Li(ppm)	Ni(ppm)	Pb(ppm)	Sr(ppm)	V(ppm)
Be(ppm)	1										
Cd(ppm)	0.277831	1									
Co(ppm)	0.056735	0.167827	1								
Cs(ppm)	-0.41261	0.421663	-0.1591	1							
Cu(ppm)	-0.53477	-0.84508	-0.0936	-0.35365	1						
Ga(ppni)	0.909229	0.252523	-0.05109	-0.30791	-0.52202	1					
Li(ppm)	-0.03275	0.002889	-0.27119	-0.29791	0.180837	0.056586	1				
Ni(ppm)	-0.48423	-0.66449	0.010426	-0.2647	0.85623	-0.46014	0.150929	1			
Pb(ppm)	-0.48413	-0.52272	-0.09995	0.122516	0.444491	-0.32211	-0.49815	0.415805	1		
Sr(ppm)	-0.58581	-0.27197	-0.09338	-0.01147	0.633671	-0.57105	0.298236	0.702987	0.193533	1	
V(ppm)	-0.67456	-0.61366	-0.36959	0.259297	0.620332	-0.5595	-0.03414	0.550674	0.664327	0.530818	1
Zn(ppm)	-0.17819	-0.09248	0.10724	-0.35532	0.373161	-0.18414	0.5543	0.318269	-0.22383	0.710888	0.148332
Hf(ppm)	-0.16338	-0.59519	0.051596	-0.27122	0.455116	-0.20935	-0.52798	0.440354	0.648649	0.183371	0.428139
Mo (ppm)	0.246602	0.992897	0.162171	0.418322	-0.83196	0.237907	0.019821	-0.65154	-0.48519	-0.26753	-0.59503
Nb(ppm)	0.341301	0.990994	0.207623	0.30841	-0.83652	0.301573	0.035282	-0.64958	-0.56685	-0.27665	-0.684
Sb(ppm)	-0.27961	0.581503	0.196947	0.214785	-0.13979	-0.3434	0.229781	0.030973	-0.3159	0.57517	-0.18455
Sn(ppm)	0.310129	0.998024	0.186669	0.374784	-0.84411	0.282533	0.008894	-0.66582	-0.53317	-0.27748	-0.64119
W(ppm)	0.252802	0.887062	0.54449	0.261055	-0.69869	0.205061	-0.06074	-0.5493	-0.48403	-0.175	-0.66075
Zr(ppm)	0.242947	0.89875	0.236441	0.358904	-0.7592	0.187676	-0.2584	-0.53248	-0.29517	-0.187	-0.51149
Ce(ppm)	0.656783	0.081946	0.020032	-0.64582	-0.06552	0.662799	0.474825	0.023101	-0.3694	-0.0405	-0.4269
Dy(ppm)	-0.24616	-0.99703	-0.19179	-0.42041	0.832318	-0.21053	-0.00154	0.666474	0.526032	0.28384	0.616331
Gd(ppm)	0.397692	0.970848	0.181416	0.234146	-0.80116	0.353813	0.056545	-0.61036	-0.55175	-0.21875	-0.6696
Ho(ppm)											
La(ppm)	0.553765	0.472597	-0.03309	-0.19736	-0.3713	0.65171	0.430853	-0.30244	-0.49726	0.010695	-0.47743
Nd(ppm)	0.704075	0.28792	0.02093	-0.48515	-0.28147	0.772106	0.35374	-0.24571	-0.40838	-0.09779	-0.5226
Pr(ppm)	0.461905	-0.30111	-0.10969	-0.67943	0.268637	0.543441	0.498394	0.166787	-0.15324	0.073408	-0.13708
Sc(ppm)											
Sm(ppm)	0.501822	0.89469	0.164237	0.049249	-0.74849	0.489604	0.189636	-0.58935	-0.56597	-0.2811	-0.7405
Y(ppm)	0.322615	-0.32102	-0.02198	-0.35106	0.205287	0.26621	-0.41127	0.303123	0.430802	0.172048	0.171836
Yb(ppm)	0.355807	0.981999	0.163057	0.29724	-0.83025	0.313477	-0.00593	-0.64898	-0.51234	-0.27878	-0.65421

	Zn(ppm)	Hf(ppm)	Mo (ppm)	Nb(ppm)	Sb(ppm)	Sn(ppm)	W(ppm)	Zr(ppm)	Ce(ppm)	Dy(ppm)	Gd(ppm)	Ho(ppm)	La(ppm)	Nd(ppm)	Pr(ppm)	Sc(ppm)	Sm(ppm)	Y(ppm)	Yb(ppm)
Zn(ppm)	1																		
Hf(ppm)	-0.01324	1																	
Mo (ppm)	-0.08745	-0.60846	1																
Nb(ppm)	-0.04064	-0.56767	0.981159	1															
Sb(ppm)	0.544427	-0.28355	0.575435	0.59251	1														
Sn(ppm)	-0.07084	-0.57396	0.989041	0.996275	0.582428	1													
W(ppm)	0.07869	-0.52947	0.879425	0.895769	0.618425	0.893901	1												
Zr(ppm)	-0.08139	-0.18683	0.882642	0.904822	0.590496	0.908621	0.802473	1											
Ce(ppm)	0.286994	-0.25271	0.102607	0.156377	-0.00805	0.115321	0.11407	-0.01466	1										
Dy(ppm)	0.100029	0.590241	-0.98995	-0.9884	-0.58284	-0.99506	-0.88842	-0.89678	-0.04885	1									
Gd(ppm)	0.024561	-0.52422	0.96126	0.986067	0.609137	0.981228	0.875398	0.908288	0.265307	-0.96179	1								
Ho(ppm)												1							
La(ppm)	0.370555	-0.52116	0.479543	0.507802	0.310412	0.494013	0.476607	0.312981	0.715849	-0.4276	0.589422		1						
Nd(ppm)	0.34418	-0.28925	0.295547	0.355659	0.108447	0.325014	0.327008	0.209386	0.841513	-0.24559	0.455899		0.932883	1					
Pr(ppm)	0.404443	-0.18103	-0.28202	-0.23952	-0.23024	-0.27435	-0.18539	-0.44649	0.798993	0.336244	-0.15013		0.599956	0.731314	1				
Sc(ppm)																1			
Sm(ppm)	0.056999	-0.61835	0.895661	0.927896	0.501194	0.910193	0.829432	0.766208	0.447049	-0.88217	0.946143		0.680246	0.591324	0.110395		1		
Y(ppm)	0.027103	0.660723	-0.34341	-0.28807	-0.17162	-0.29451	-0.27439	-0.0227	0.290498	0.361275	-0.16191		0.068965	0.26089	0.260821		-0.17391	1	
Yb(ppm)	-0.05889	-0.49514	0.970577	0.991634	0.576523	0.990008	0.861621	0.933281	0.163085	-0.97909	0.990174		0.492232	0.359001	-0.25109		0.923583	-0.20764	1

Figure 16: Correlation Matrix for Chemical Analysis of Zone No. 1

Using the background elements concentration of the Rocks that were collected from the surface during the geochemical survey, the ICP results (ppm) for the pathfinder elements over Trenches 01, 02, and 03 have been classified into the background and maximum value for each element to define the dimensions of the altered zone, see (Table 10).

Table 10: ICP Results of Base Metals & REE for Weak Zone 01

	Cu	**Zn**	**Li**	**Ni**	**Pb**	**Sr**	**V**
Background (ppm)	923	435	63	166	44	95	55
Max. (ppm)	20.5	205.7	17.8	210.6	28.9	224.7	12.8
	Y						
Background (ppm)	87						
Max. (ppm)	83.5						

- Based on the table 01, the base metals exceeded their background values are: Ni, Sr.

Furthermore, five samples selected randomly earlier from Trench 11 and sent to the Jordan Atomic Energy Commission (JAEC) lab for analysis. The ICP (Table 11) results showing interest values that are indicated into alteration zone has certain strike, dip & dip direction embedded in the trench 11.

Table 11: ICP Results of Base Metals & REE For Trench 11

	Cu	**Zn**	**Li**	**Ni**	**Pb**	**Sr**	**V**
Background (ppm)	933	427	60	130	45	95	55
Max. (ppm)	80	1318	225	72	78	140	190
	Y	**Ba**					
Background (ppm)	49	220					
Max. (ppm)	19	12664					

- Based on the Table 11, the base metals exceeded their background concentration are: Zn, Li, Pb, Sr, and V.

Ultimately, the XRD results have showed the major minerals deposited along the alteration layer extends over this zone "Quartz, Feldspar" and traces of "Muscovite, Hematite and Clay".

The borehole labeled no. 05 (Fig. 14) was determined after confirmed the final layout of the dip direction and direction of the alteration layer from the excavated trenches in the zone 01 – the determine borehole location was explained in the methodology section - The total depth of the drilled borehole is 43m and the altered layer was encountered based on the lithology description and ICP results of the pathfinder elements from depth 9 m and finished at depth 22m (Fig. 17).

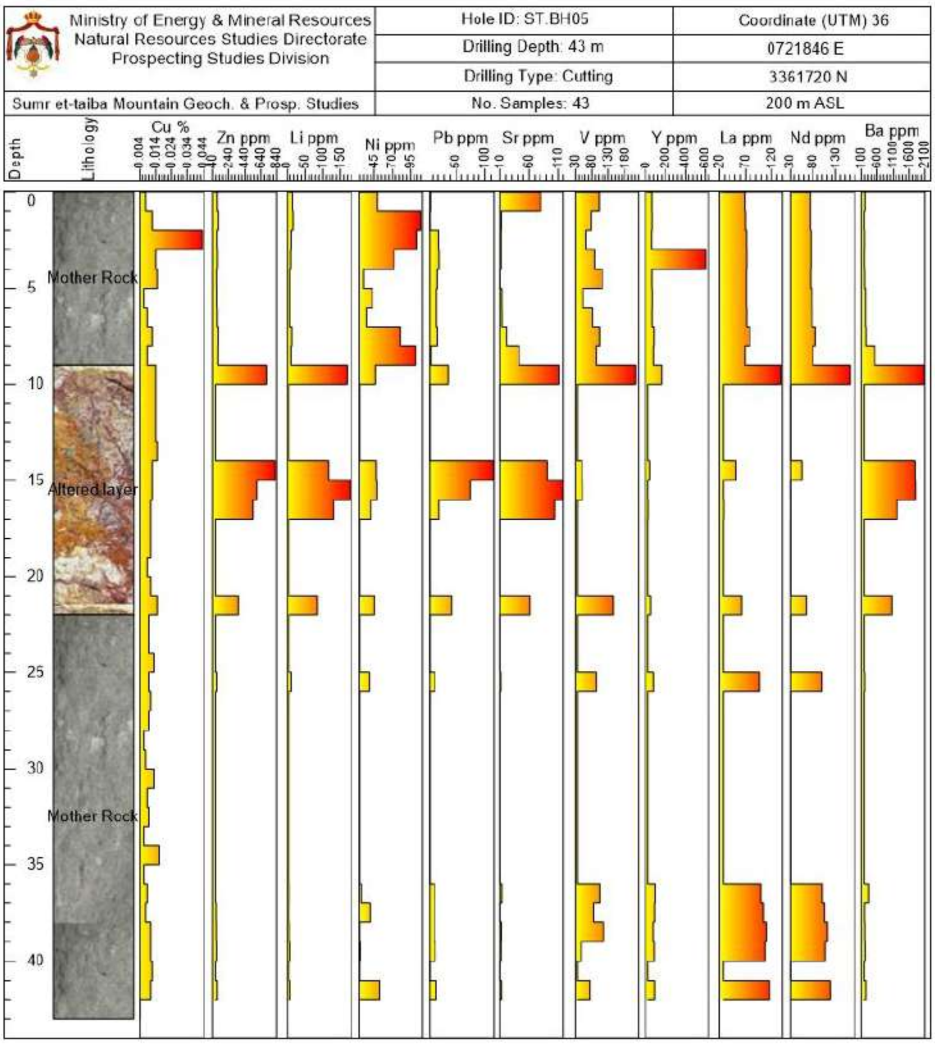


Figure 17: Borehole Lithological Log vs Chemical Analysis

The thickness of altered layer has increased when moved toward the dip direction of the altered zone 01 (Fig. 18). Remarkably, the level values of pathfinder elements have increased along the dip direction of the altered layer.

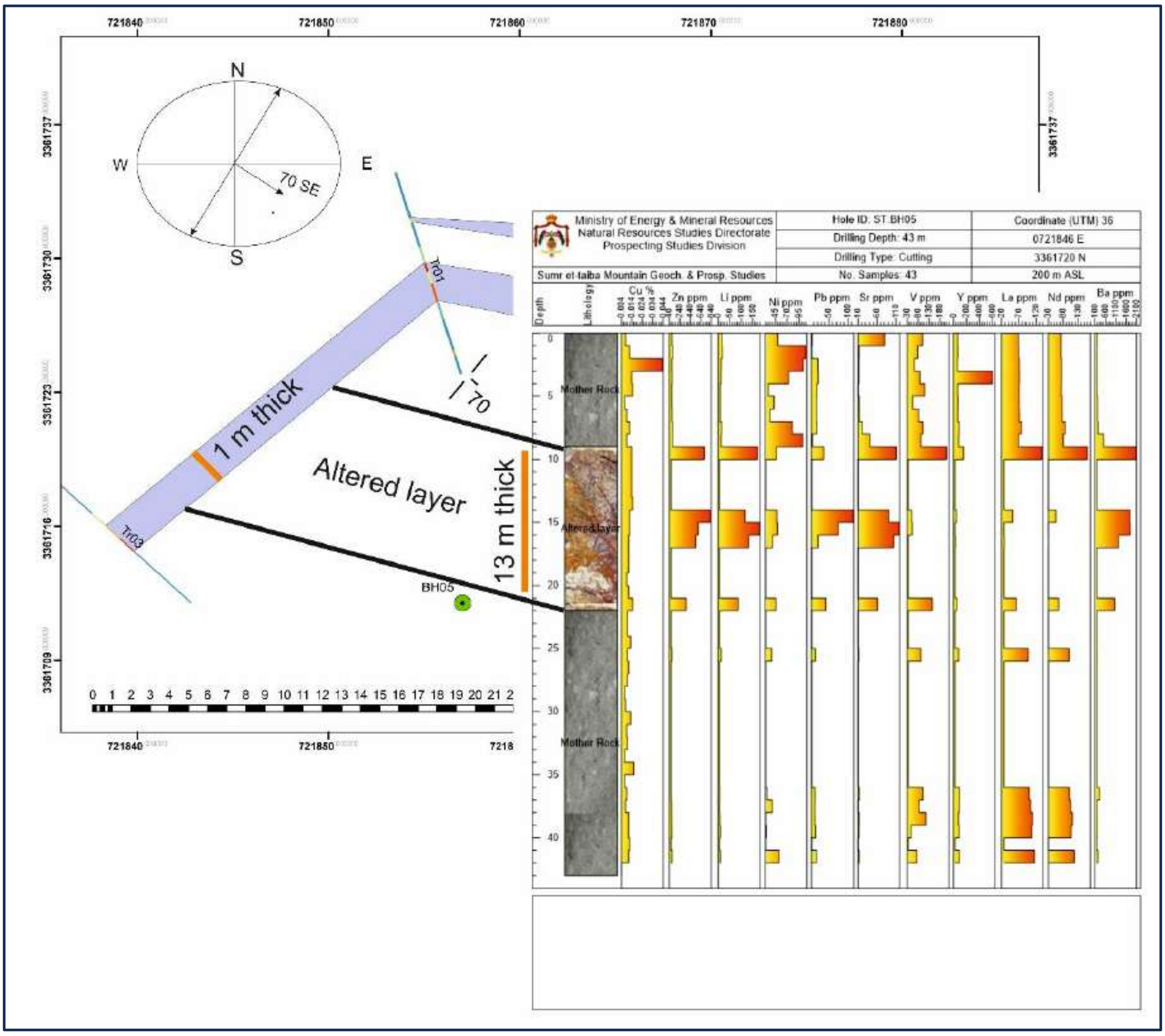


Figure 18: Correlation between Borehole Log and Excavated Trench

6.2 The Results of zone No. 02

In the weak zone 02 four trenches were excavated. Each one was digitized on millimeter paper in addition to the structural measurements were documented (Fig. 19, 20, 21, 22). The chemical results were received included the following analysis ICP, XRF & XRD. The Zinc element was used to represent the rest of the pathfinder elements on millimeter paper as well as to correlate the altered layer over the weak zone.

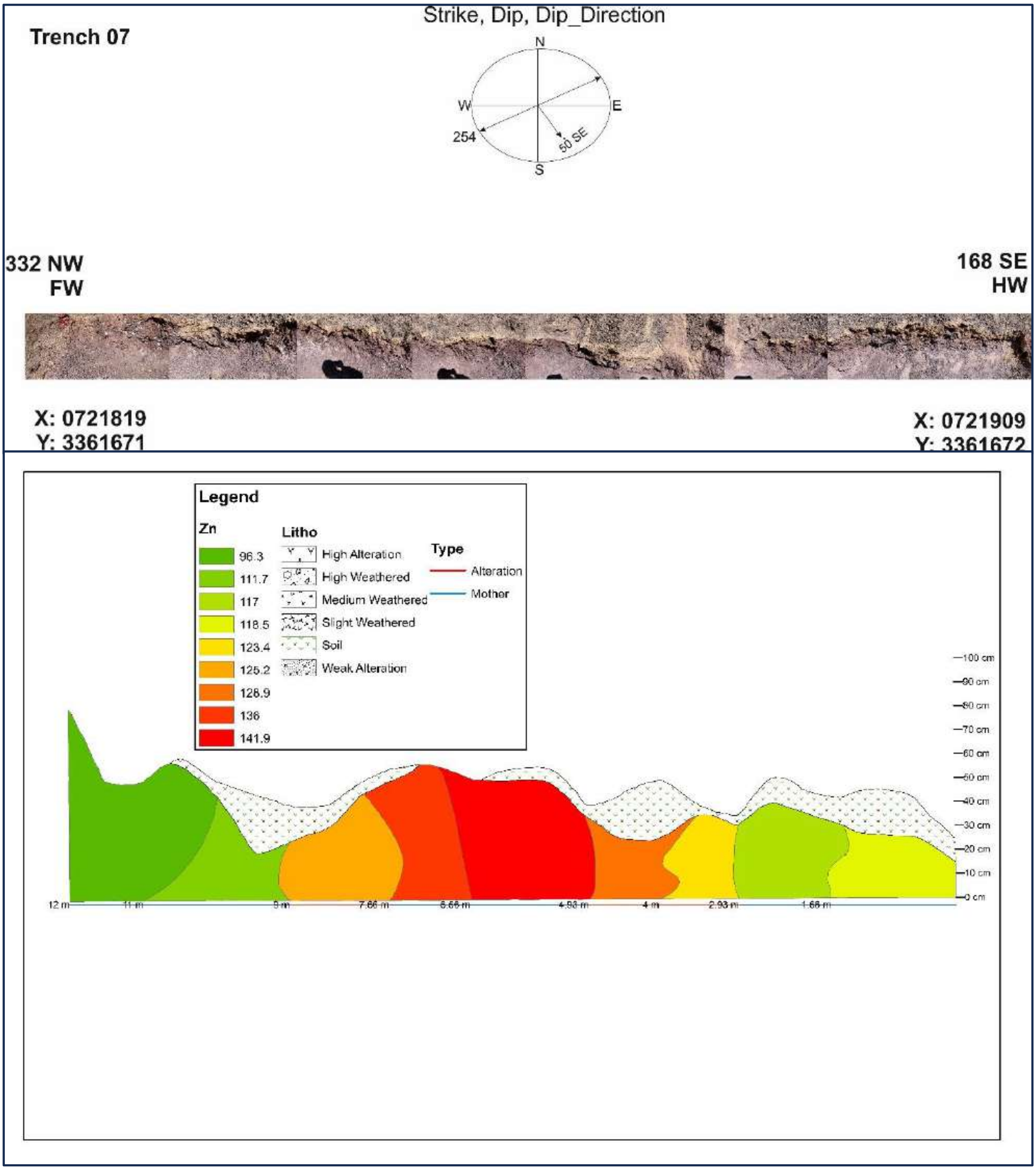


Figure 19: Weak Zone 02, Digitized Trench 07

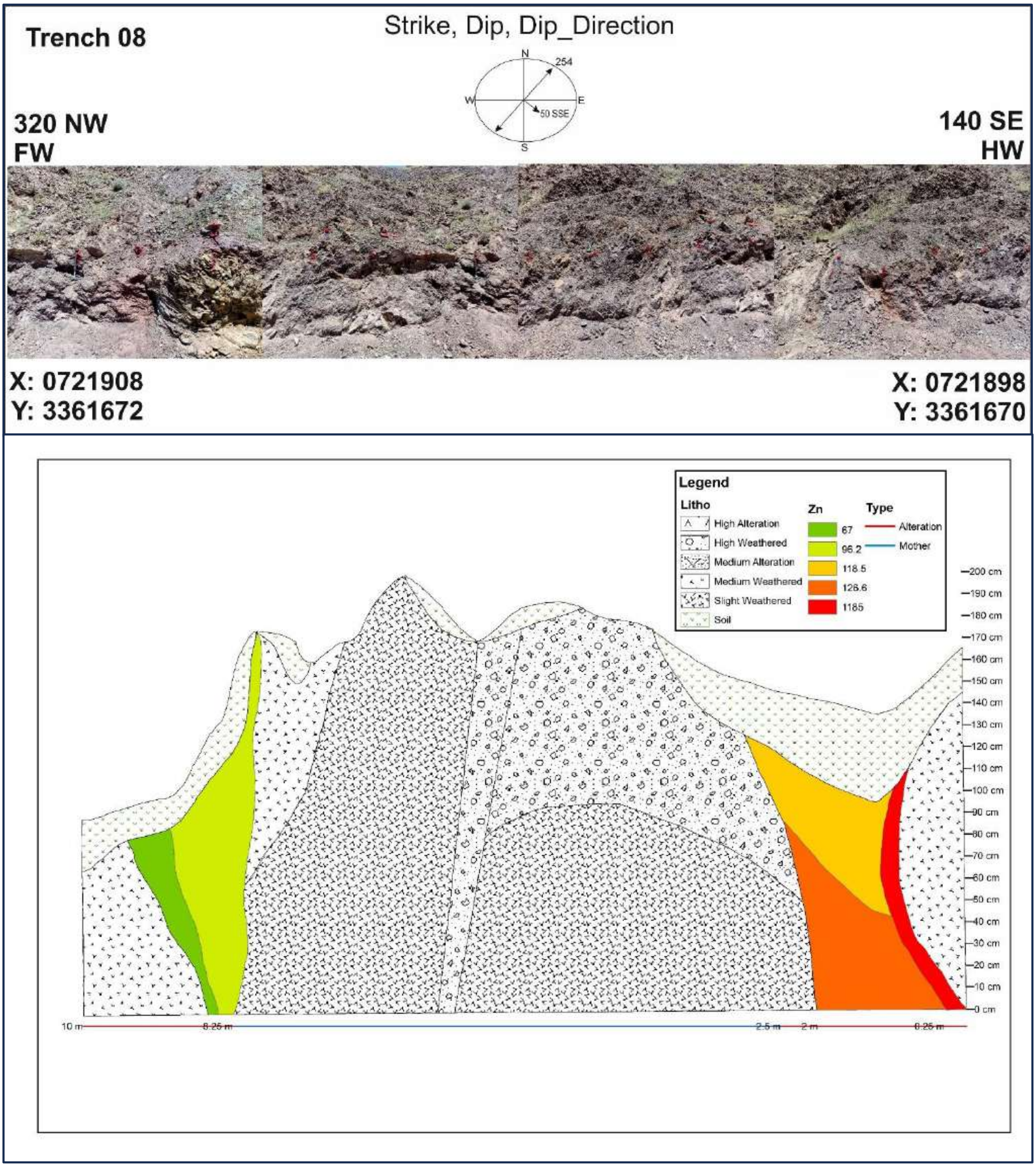


Figure 20: Weak Zone 02, Digitized Trench 08

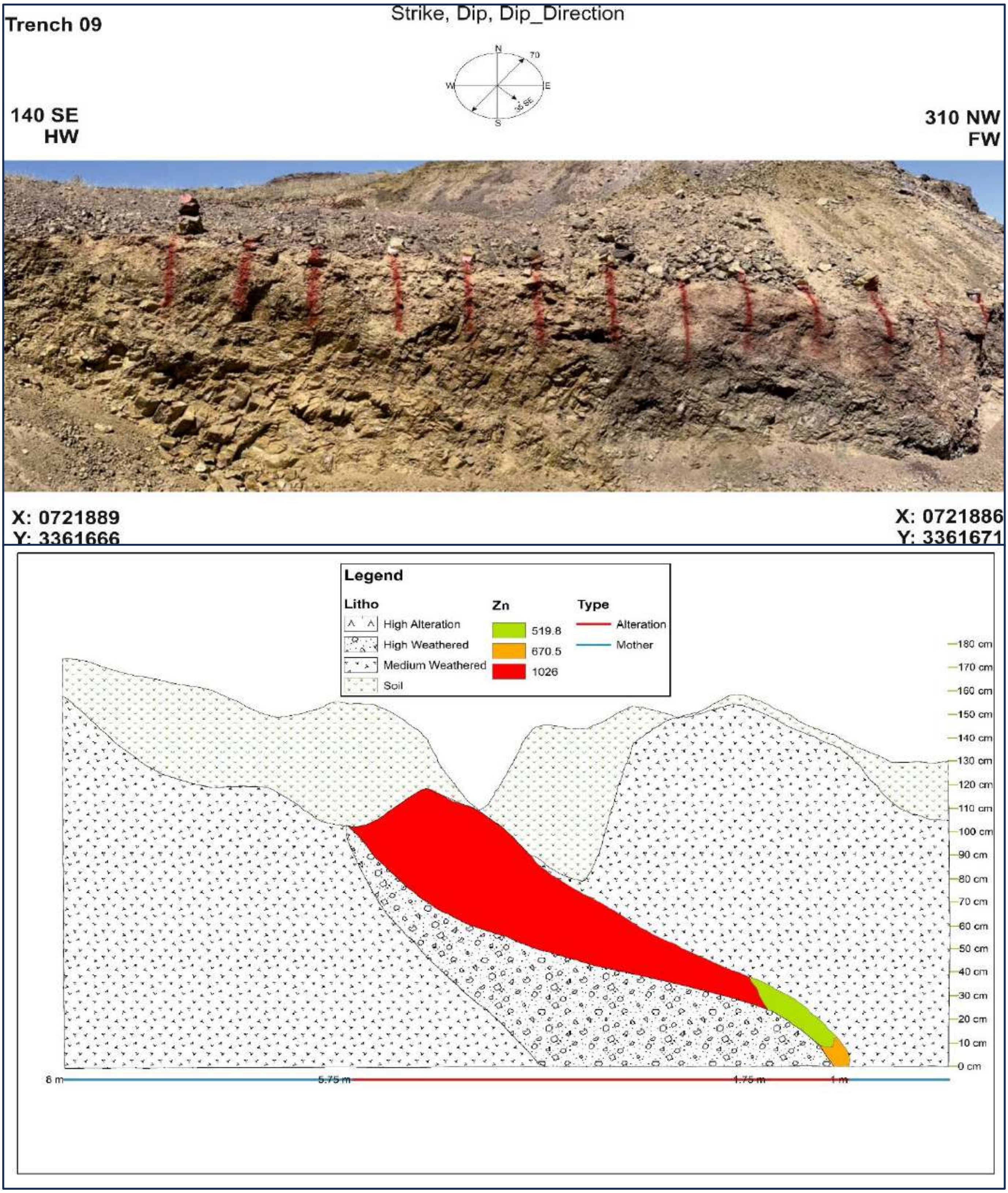


Figure 21: Weak Zone 02, Digitized Trench 09

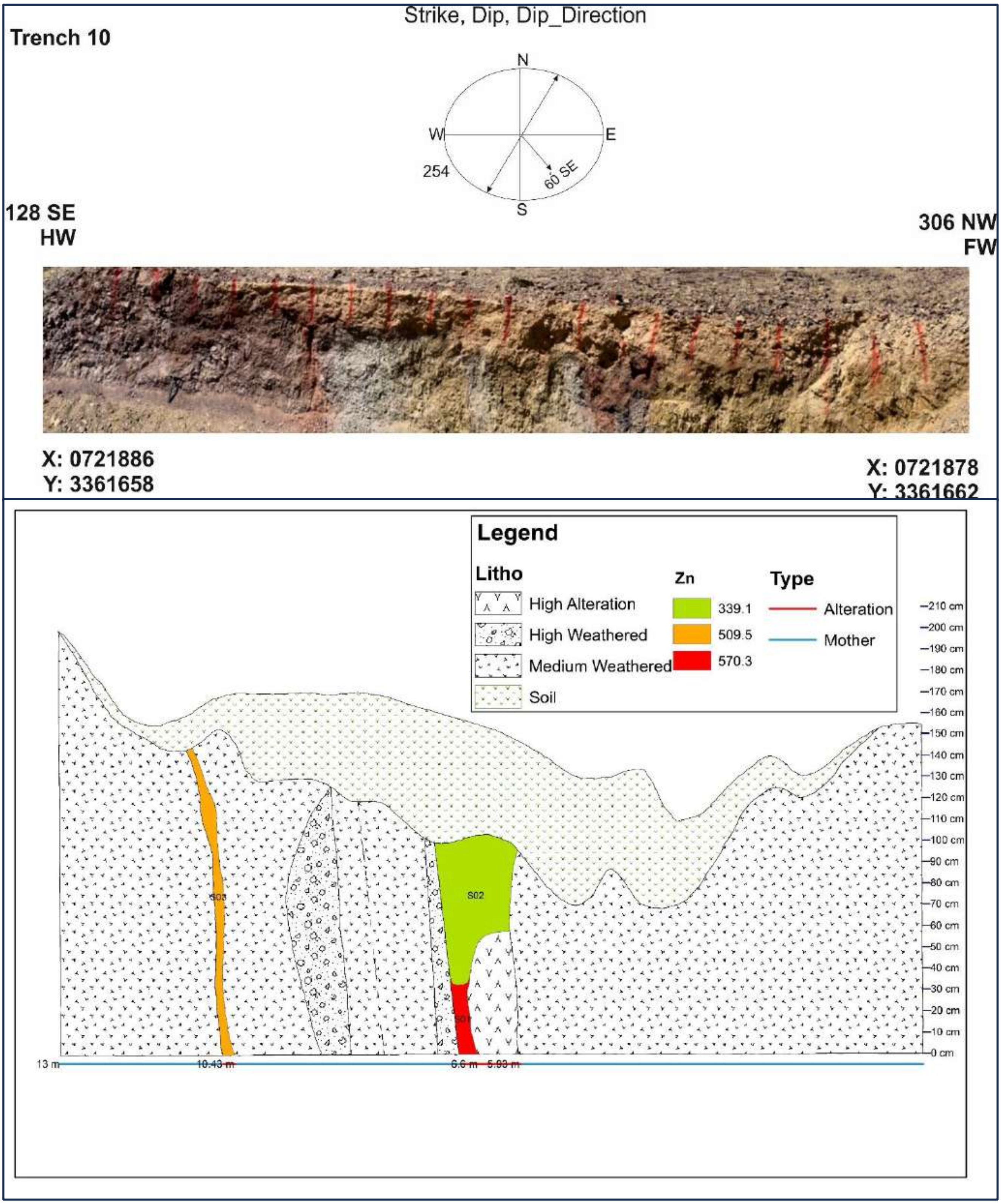


Figure 22: Weak Zone 02, Digitized Trench 10

The correlation of altered layer over the weak zone 02 was conducted by using Zn element as indication for the rest pathfinder element over the weak zone 02. The correlated altered layer has final layout of structural measurements including the Strike, Dip & Dip direction (Fig. 23).

The XRD results have showed the major minerals deposited along the alteration layer extends over this zone “Anorthite, Feldspar (Albite, Microcline)" and minor of "Augite", Furthermore traces of "Quartz, Hematite and Gypsum".

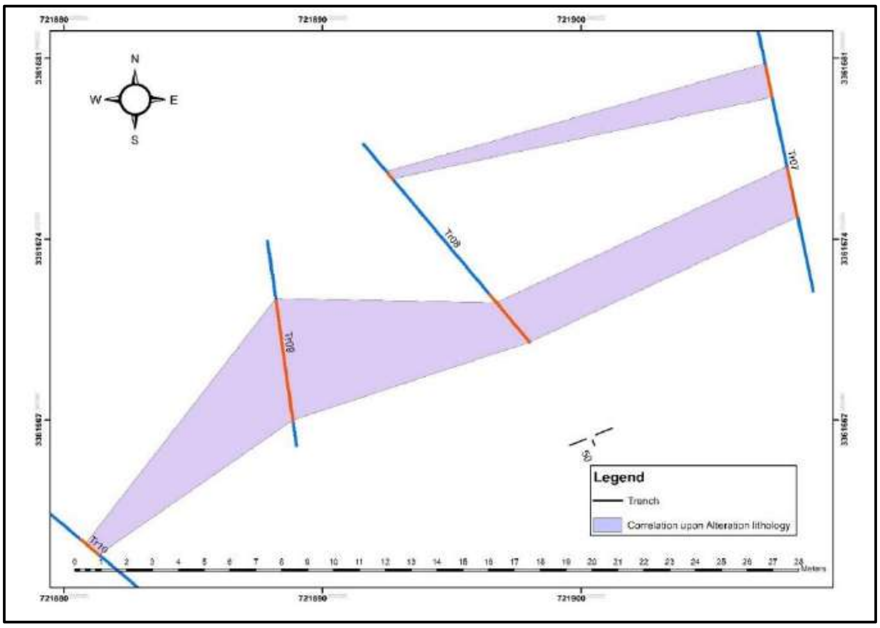


Figure 23: Alteration Correlation in the Weak Zone 02

Moreover, the pathfinder elements of the alteration layer over the weak zone 02 was figured out using Correlation matrix. Due to total of 18 elements were received their ICP results from MEMR lab instead of 34 elements were planned to receive that issue had occurred in respond to the periodic maintenance that was implemented for the ICP tool in the MEMR lab. The correlation matrix among 18 elements of ICP results, the pathfinder & mother elements were determined (Fig. 24):

The pathfinder elements: Zn, Cu, Ni, Pb, Cr, Ba, Li, Sr, and Y.

The mother rock elements: Zr.

	Co(ppm)	Cu(ppm)	Ga(ppni)	Li(ppm)	Ni(ppm)	Pb(ppm)	Sr(ppm)	Zn(ppm)	Nb(ppm)	Sn(ppm)	W(ppm)	Zr(ppm)	Ce(ppm)	La(ppm)	Nd(ppm)	Y(ppm)	Cr(ppm)	Ba(ppm)
Co(ppm)	1																	
Cu(ppm)		1																
Ga(ppni)	0.989478		1															
Li(ppm)	-0.10972	0.616284	-0.20483	1														
Ni(ppm)	-0.02957	0.556907	0.085589	0.595983	1													
Pb(ppm)	0.143067	0.966462	0.13373	0.607716	0.570984	1												
Sr(ppm)	-0.00502		0.114451	-0.56778	0.315869	-0.59649	1											
Zn(ppm)	-0.56946	0.956628	-0.4885	0.660962	0.616335	0.901971	0.780117	1										
Nb(ppm)	-0.17545		-0.25916	0.362315	-0.00428	0.784534	-0.92767	-0.67352	1									
Sn(ppm)	-0.54041		-0.56687	0.040042	0.278469	0.724927	-0.61436	-0.24265	0.852773	1								
W(ppm)	-0.56623		-0.66157	0.462542	-0.29513	0.384879	-0.8129	-0.28455	0.853344	0.813524	1							
Zr(ppm)	-0.51748	-0.7163	-0.45842	-0.71439	-0.76729	-0.67145	0.725302	-0.78781	-0.6811	-0.31134	-0.25341	1						
Ce(ppm)	-0.60242		-0.65678	0.06406	-0.02362	0.530407	-0.65044	-0.14859	0.820615	0.943099	0.908001	-0.15479	1					
La(ppm)	-0.62004		-0.70231	0.365068	-0.20871	0.417746	-0.76174	-0.22172	0.846599	0.867954	0.992121	-0.20604	0.949807	1				
Nd(ppm)	-0.54153		-0.62698	0.398877	-0.17074	0.504777	-0.82244	-0.33225	0.903115	0.882643	0.989827	-0.32264	0.93865	0.992587	1			
Y(ppm)	-0.87461		-0.90855	0.21274	-0.00528	0.262523	-0.44526	0.139961	0.624279	0.849116	0.869652	0.104357	0.899822	0.912126	0.873259	1		
Cr(ppm)	0.742644	0.298011	0.827854	0.269339	0.767246	0.32872	0.508852	0.24865	-0.46628	-0.47126	-0.8372	-0.36869	-0.6247	-0.80863	-0.76537	-0.80622	1	
Ba(ppm)	0.850241	0.88324	0.875956	0.655618	0.722961	0.934246	0.288171	0.863864	-0.46733	-0.75619	-0.76714	-0.78594	-0.88179	-0.82621	-0.76022	-0.93124	0.402261	1

Figure 24: Correlation Matrix for Chemical Analysis of Zone No. 2

Using the background elements concentration of the Rocks that were collected from the surface during the geochemical survey. The ICP results (ppm) for the pathfinder elements over the Trenches 07, 08, 09, 10 have been classified into background and maximum value for each element in order to figure out the dimensions of the altered zone, see (Table no. 12).

Table 12: ICP Results of Base Metals & REE for Weak Zone 02

	Zn	**Cu**	**Pb**	**Cr**	**Ba**	**Li**	**Sr**	**Y**
Background (ppm)	427	933	44	154	220	60	95	49
Max.	1185	226	148	205	927	132	247	64

Based on the table 12, the base elements exceeded their background concentration are:

Zn, Pb, Cr, Ba, Li, Y and Sr.

6.3 The Results of zone No. 03

In this zone total of three trenches were excavated, trench no. 04 and 05 were digitized and represented by Zinc element as indication for the rest pathfinder elements (Fig. 25, Fig. 26), whereas the trench no. 12 has been digitized and samples for chemical analysis were collected and sent to MEMR lab.

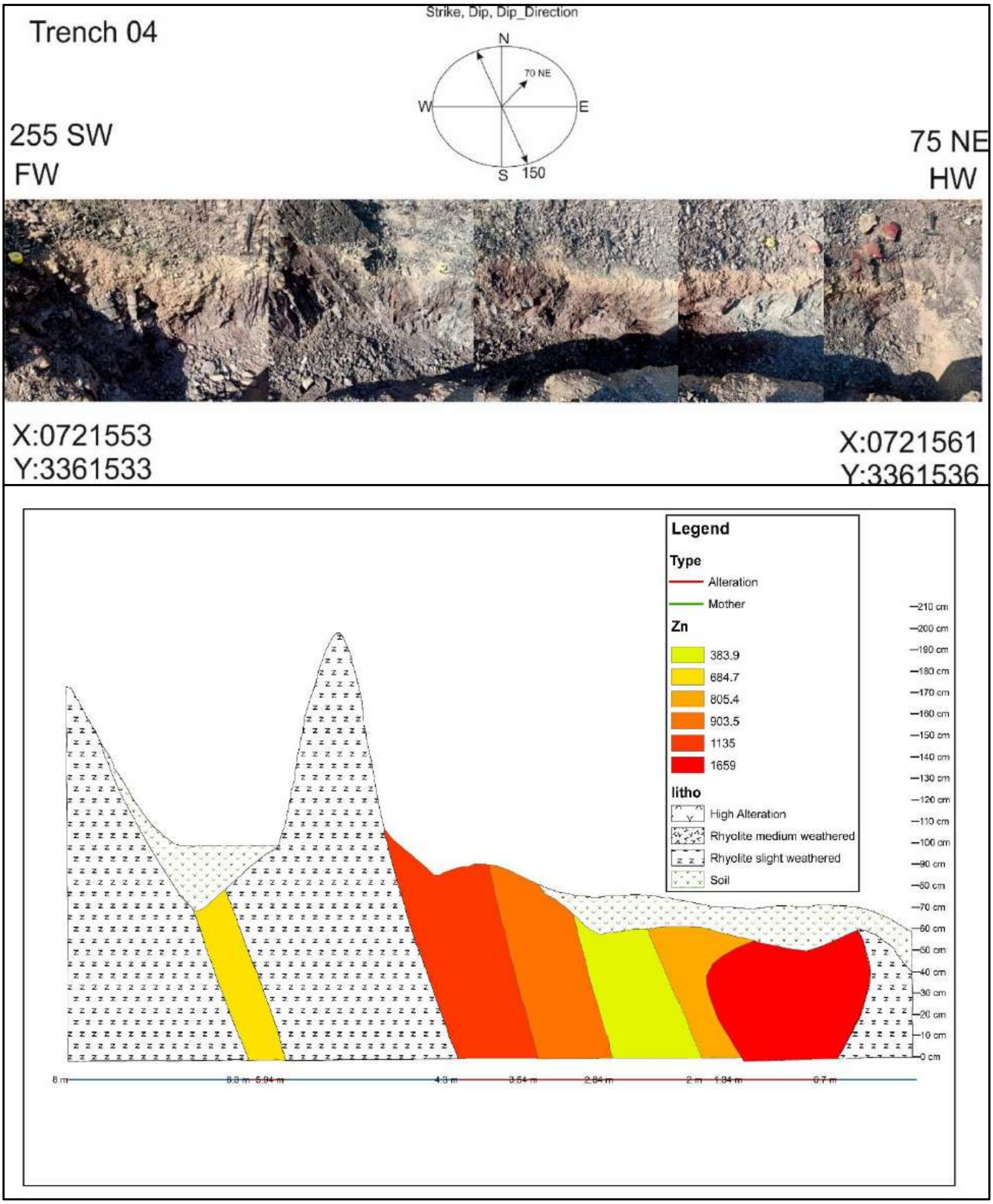


Figure 25: Weak Zone 03, Digitized & ICP Zn in Trench 04

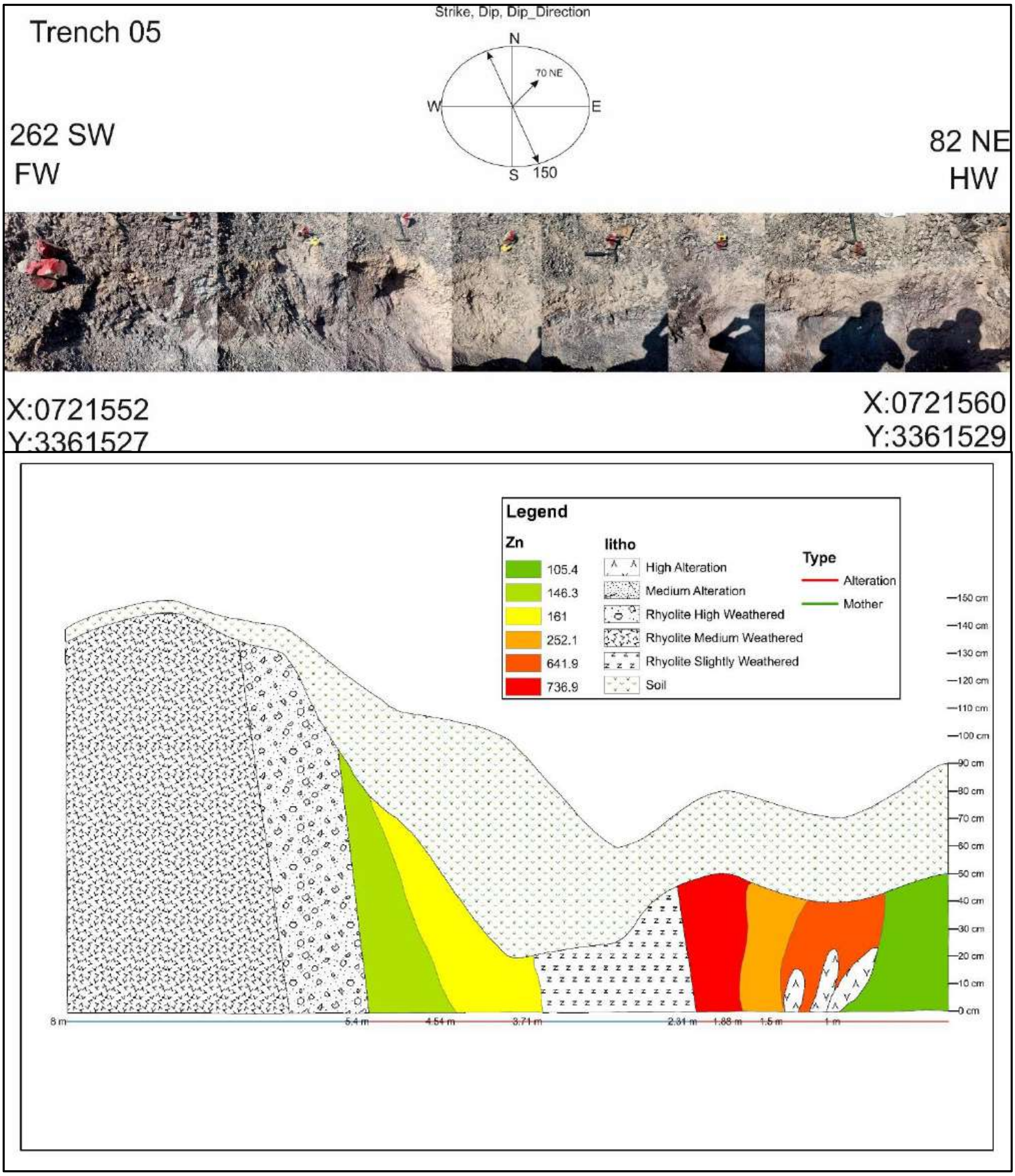


Figure 26: Weak Zone 03, Digitized & ICP Zn in Trench 05

The correlation links the trenches 04, 05 and 12 dipping toward north east of the study area (Fig. 27). The correlation was established based on the ICP-Zn in ppm that represented the rest of the pathfinder elements.

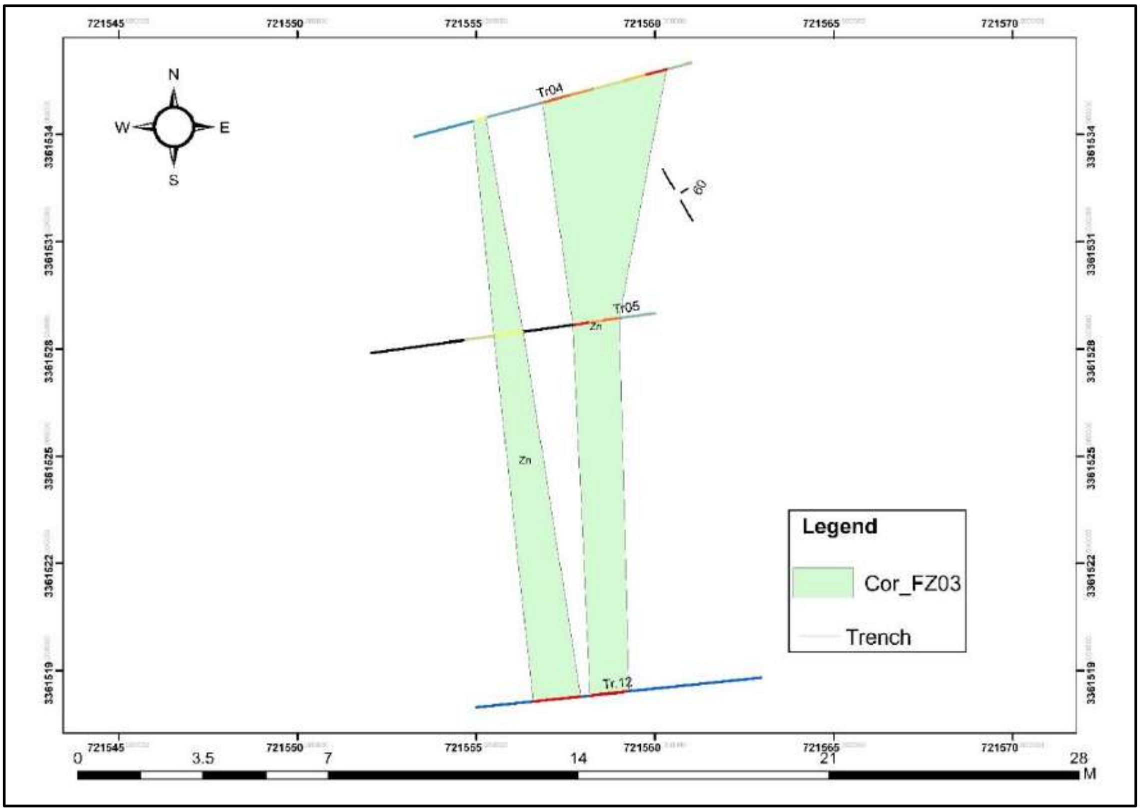


Figure 27: Alteration Correlation in the Weak Zone 03

The pathfinder elements have been determined in the weak zone 03 using similar workflow series in the weak zone 01 & weak zone 02.

The pathfinder elements were determined using 31 elements instead of 34 elements recommended ICP-MS to analyze in respond to the periodic maintenance for the MEMR lab equipment.

According to the (Fig. 28), the pathfinder elements are Zn, Cu, Co, Cs, Li, Pb, Sr, V, Sn, and Ba.

Whereas mother rock elements are Zr, Be, Hf, Mo, Nb, W, Gd, La, Nd, Pr, Sm, and Yb.

	Be(ppm)	Cd(ppm)	Co(ppm)	Cs(ppm)	Cu(ppm)	Ga(ppni)	Li(ppm)	Ni(ppm)	Pb(ppm)	Sr(ppm)	V(ppm)	Zn(ppm)
Be(ppm)	1											
Cd(ppm)		1										
Co(ppm)	0.148862		1									
Cs(ppm)	0.223229		0.535606	1								
Cu(ppm)	-0.12321		-0.11873	0.272207	1							
Ga(ppni)	0.536341		0.10434	-0.15389	0.002909	1						
Li(ppm)	0.307632		0.805128	0.837719	0.050745	0.154191	1					
Ni(ppm)	0.229421		0.737249	0.086029	-0.04585	0.356181	0.448951	1				
Pb(ppm)	0.134516		0.258413	0.811553	0.727005	0.106214	0.589298	0.061154	1			
Sr(ppm)	-0.34454		0.731582	0.545025	0.069097	-0.26951	0.681978	0.334	0.367843	1		
V(ppm)	-0.19467		0.868146	0.592199	-0.0931	-0.54052	0.785914	0.288722	0.264149	0.879088	1	
Zn(ppm)	-0.11117		0.891922	0.665775	0.134912	-0.01972	0.870442	0.524293	0.48947	0.883838	0.950878	1
Hf(ppm)	0.09031		-0.71722	-0.84727	-0.03954	0.406699	-0.8851	-0.09971	-0.54675	-0.82698	-0.8807	-0.88081
Mo (ppm)	-0.4542		-0.22923	-0.11978	-0.00939	-0.21761	-0.20136	-0.3679	-0.03883	-0.14494	-0.01153	-0.13155
Nb(ppm)	0.11866		-0.70444	-0.83735	-0.01601	0.417737	-0.87084	-0.06057	-0.53444	-0.82613	-0.87713	-0.86971
Sn(ppm)	-0.02543		-0.42724	-0.05473	0.90887	0.156875	-0.32084	-0.13668	0.48139	-0.30203	-0.42374	-0.23042
W(ppm)	0.184304		-0.40978	-0.6876	-0.13788	0.358984	-0.80317	0.268726	-0.56221	-0.73434	-0.72768	-0.74688
Zr(ppm)	0.093146		-0.77306	-0.85025	-0.04578	0.090122	-0.89353	-0.38564	-0.56085	-0.84109	-0.87236	-0.89413
Ce(ppm)	0.214238		-0.59346	-0.80178	-0.11317	0.467576	-0.81378	-0.03982	-0.54209	-0.74928	-0.83605	-0.8208
Dy(ppm)	0.121532		0.220018	-0.01759	0.037436	0.079326	0.175306	0.271836	-0.11003	-0.08034	0.171597	0.192769
Gd(ppm)	0.190103		-0.50301	-0.75352	-0.17266	0.479481	-0.66512	-0.24515	-0.49443	-0.67302	-0.69944	-0.69163
La(ppm)	0.217543		-0.55069	-0.7233	-0.17638	0.450098	-0.74964	-0.12425	-0.50282	-0.74118	-0.78762	-0.79617
Nd(ppm)	0.231212		-0.54581	-0.78357	-0.19153	0.466478	-0.76567	-0.10018	-0.55561	-0.74483	-0.79391	-0.79856
Pr(ppm)	0.218058		-0.5453	-0.78369	-0.20794	0.448971	-0.77123	-0.10316	-0.56548	-0.74664	-0.78987	-0.80364
Sc(ppm)	-0.04817		0.913702	0.698553	-0.17203	-0.42504	0.808067	0.35101	0.300377	0.875844	0.942981	0.914198
Sm(ppm)	0.344887		-0.24812	-0.47392	-0.16612	0.61356	-0.51613	0.089498	-0.32077	-0.58603	-0.58667	-0.52762
Y(ppm)	0.015311		-0.76729	-0.84173	0.030242	0.33175	-0.85107	-0.29011	-0.47687	-0.79245	-0.85075	-0.85768
Yb(ppm)	0.073456		-0.52218	-0.76756	-0.21804	0.354369	-0.8259	-0.0336	-0.59433	-0.64692	-0.74802	-0.77215
Rb(ppm)	0.276422		-0.37264	0.357268	0.521917	0.512785	0.043305	-0.44761	0.656884	-0.25914	-0.39827	-0.2018
Cr(ppm)	-0.05131		0.847884	0.267984	-0.18871	-0.15506	0.507619	0.811607	-0.0005	0.627324	0.717254	0.698745
Ba(ppm)	0.524117		0.4262	0.18037	0.161867	0.344576	0.054644	0.46585	0.066027	0.095388	-0.05333	0.096186

	Hf(ppm)	Mo (ppm)	Nb(ppm)	Sb(ppm)	Sn(ppm)	W(ppm)	Zr(ppm)	Ce(ppm)	Dy(ppm)	Gd(ppm)	Ho(ppm)
Be(ppm)											
Cd(ppm)											
Co(ppm)											
Cs(ppm)											
Cu(ppm)											
Ga(ppni)											
Li(ppm)											
Ni(ppm)											
Pb(ppm)											
Sr(ppm)											
V(ppm)											
Zn(ppm)											
Hf(ppm)	1										
Mo (ppm)	0.06893	1									
Nb(ppm)	0.993867	-0.00685	1								
Sn(ppm)	0.360605	0.027685	0.379767		1						
W(ppm)	0.8588	-0.07019	0.871133		0.245667	1					
Zr(ppm)	0.997453	0.062854	0.995236		0.379192	0.844839	1				
Ce(ppm)	0.963959	-0.02404	0.961191		0.294535	0.868599	0.955017	1			
Dy(ppm)	-0.09108	-0.34824	-0.0285		-0.02374	0.024429	-0.04709	-0.19427	1		
Gd(ppm)	0.856774	0.234365	0.828645		0.204172	0.685771	0.852147	0.909005	-0.26338	1	
La(ppm)	0.88184	0.232802	0.852217		0.213931	0.794494	0.864479	0.9317	-0.35076	0.943694	
Nd(ppm)	0.920379	0.116757	0.904063		0.210922	0.831864	0.909175	0.97266	-0.25696	0.95863	
Pr(ppm)	0.918457	0.146578	0.898136		0.194004	0.830186	0.90604	0.96715	-0.27072	0.959195	
Sc(ppm)	-0.90354	-0.10248	-0.90729		-0.49285	-0.67511	-0.91362	-0.809	0.024877	-0.70032	
Sm(ppm)	0.70943	0.101109	0.686749		0.205633	0.739797	0.68251	0.811619	-0.32239	0.838888	
Y(ppm)	0.968954	0.199316	0.955346		0.40278	0.743337	0.975562	0.923567	-0.14405	0.889781	
Yb(ppm)	0.907502	0.066684	0.885267		0.173788	0.834254	0.888349	0.935747	-0.26976	0.861623	
Rb(ppm)	0.048371	0.142471	0.030496		0.527825	-0.08918	0.037373	0.072425	-0.36515	0.146384	
Cr(ppm)	-0.47315	-0.16596	-0.45668		-0.38361	-0.13243	-0.57682	-0.4064	0.164294	-0.4744	
Ba(ppm)	-0.04581	-0.87815	-0.07534		0.076467	0.277276	-0.0936	0.106826	-0.29381	0.011813	

	La(ppm)	Nd(ppm)	Pr(ppm)	Sc(ppm)	Sm(ppm)	Y(ppm)	Yb(ppm)	Rb(ppm)	Cr(ppm)	Ti(ppm)	Ba(ppm)
Be(ppm)											
Cd(ppm)											
Co(ppm)											
Cs(ppm)											
Cu(ppm)											
Ga(ppni)											
Li(ppm)											
Ni(ppm)											
Pb(ppm)											
Sr(ppm)											
V(ppm)											
Zn(ppm)											
Hf(ppm)											
Mo (ppm)											
Nb(ppm)											
Sn(ppm)											
W(ppm)											
Zr(ppm)											
Ce(ppm)											
Dy(ppm)											
Gd(ppm)											
La(ppm)	1										
Nd(ppm)	0.984148	1									
Pr(ppm)	0.987107	0.998647	1								
Sc(ppm)	-0.72829	-0.7564	-0.74948	1							
Sm(ppm)	0.842013	0.84281	0.843185	-0.47699	1						
Y(ppm)	0.870608	0.902779	0.902483	-0.91549	0.652905	1					
Yb(ppm)	0.869666	0.903708	0.91171	-0.69477	0.81454	0.863158	1				
Rb(ppm)	0.182118	0.100301	0.094901	-0.26318	0.245349	0.105081	0.011151	1			
Cr(ppm)	-0.42292	-0.4148	-0.40631	0.729674	-0.23112	-0.57672	-0.3085	-0.63626	1		
Ba(ppm)	0.319354	0.204939	0.204079	0.260487	0.527018	-0.21533	0.086961	0.227593	0.259498		1

Figure 28: Correlation Matrix for Chemical Analysis of Zone No. 3

Using the background concentration ppm of the pathfinder elements that were extracted from the geochemical survey Table 05, the base elements exceed the background limit are Zn, Cu, Co, Cs, Li, Pb, Sr, V, and Sn.

Table 13: ICP Results of Base Metals & REE in the Weak Zone 03

	Zn	Cu	Co	Cs	Li	Pb	Sr	V	Sn	Dy
Background (ppm)	427	933	10	5	60	44	95	55	6	17
Max. (ppm)	1659	1587	35	37	183	94	325	202	34	14
	Rb	**Ba**								
Background (ppm)	230	220								
Max. (ppm)	204	227								

The XRD has not analyzed for weak zone in respond to the similarity results to the weak zone 01 and zone 02 in term of alteration lithology characteristics.

In this zone, the Pathfinder elements are recorded values have more tendency toward anomaly values. In this zone and long over the direction of the altered layer, geophysical survey by resistivity method was conducted to figure out its dimension in the subsurface.

6.4 The Results of zone No. 04

Three trenches were excavated labeled Trenches 06A, 06B, and Tr06C. They have revealed two of alteration layer dipping within different direction.

The trenches have been digitized and represented according to pathfinder ICP-Zn element data, to clarify the alteration layer in term of strike, dip, dip direction & lithology (Fig. 29, Fig. 30, and Fig. 31).

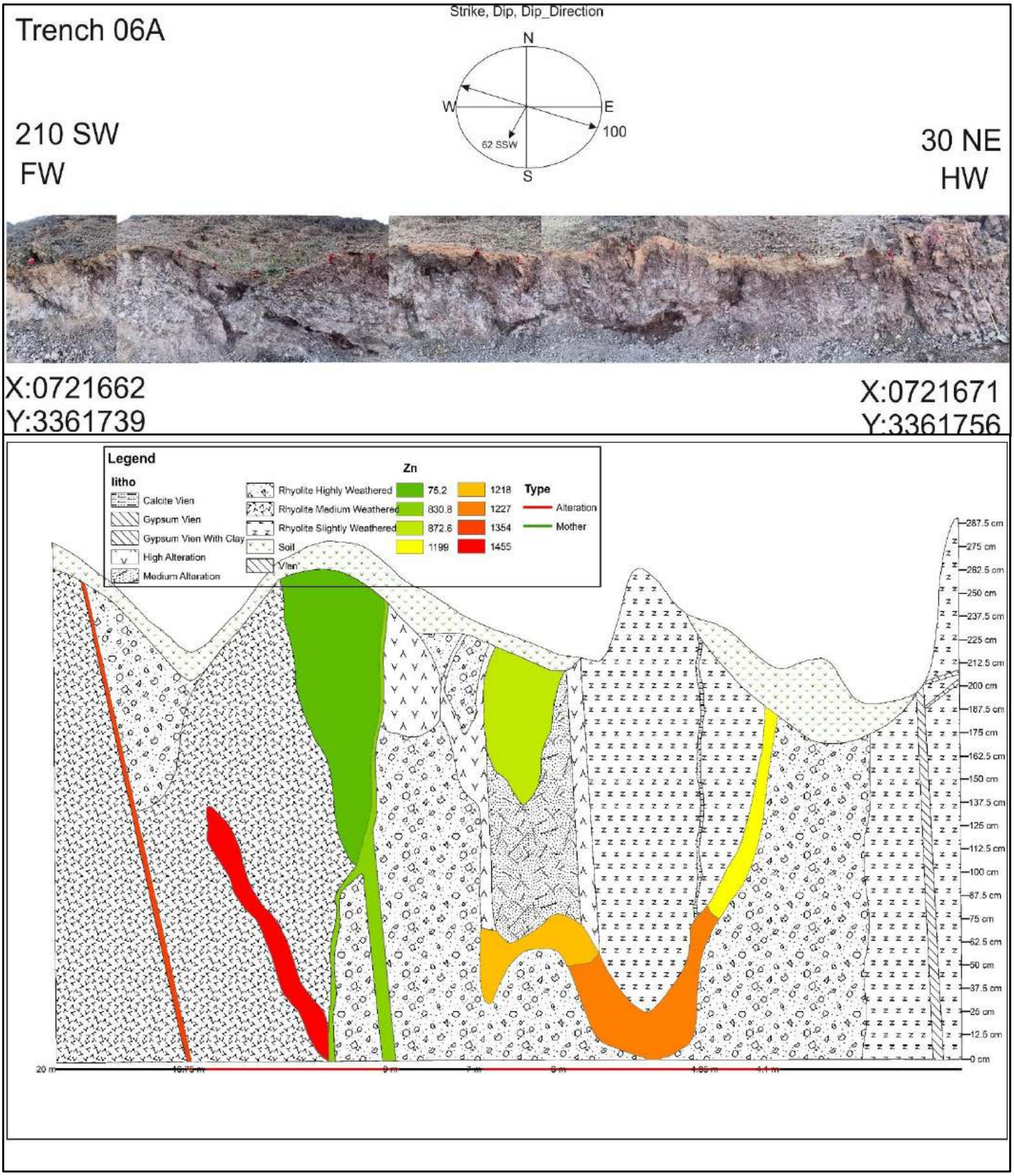


Figure 29: Weak Zone 04, Digitized & ICP Zn in Trench 06A

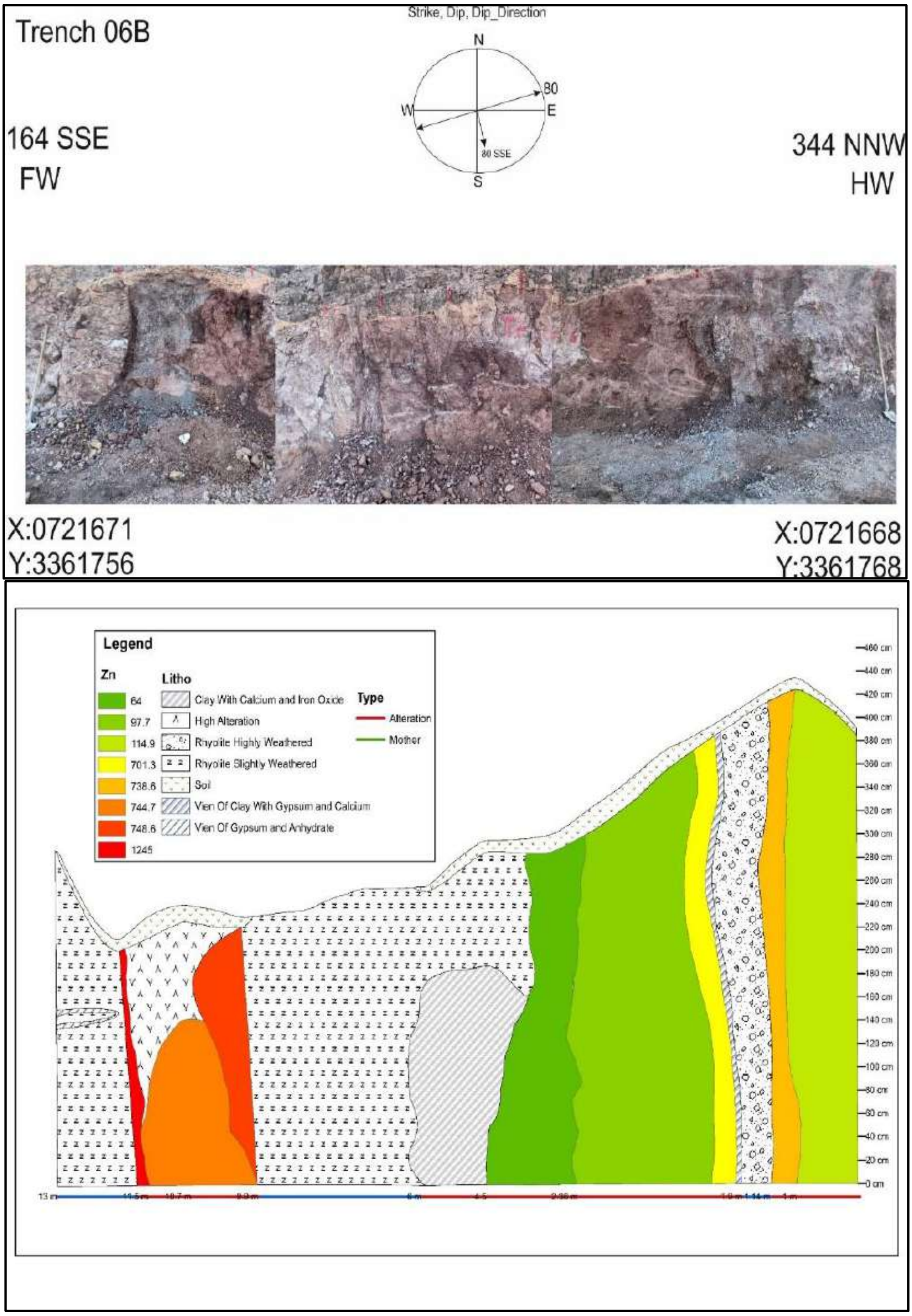


Figure 30: Weak Zone 04, Digitized & ICP Zn in Trench 06B

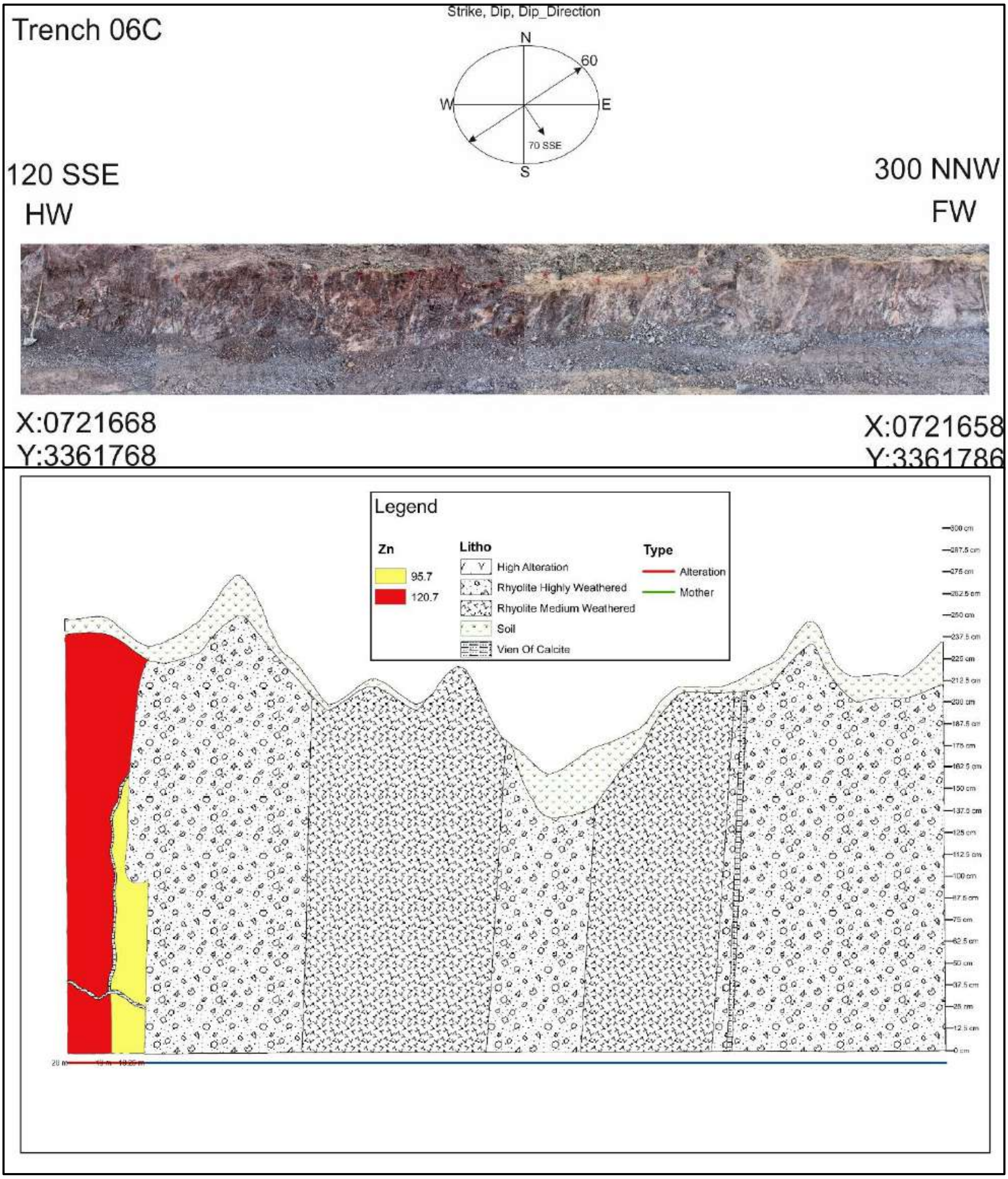


Figure 31: Weak Zone 04, Digitized & ICP _Zn in Trench 06C

As mentioned in above, those trenches have revealed into two different dipping direction where Trench 06A has dipping direction to the southwest of the study area whereas Trenches 06B and 06C have dipping direction to the southeast of the study area (Fig. 32).

The Boreholes labeled BH07 and BH08 were projected close to the Trenches 06A and 06B, respectively, corresponding to the dip direction. The proposed boreholes will be drilled until encountered the altered layer accompany with sampling.

The pathfinder elements were identified for the weak zone 04 using correlation matrix by gathering the ICP results of the excavated trenches.

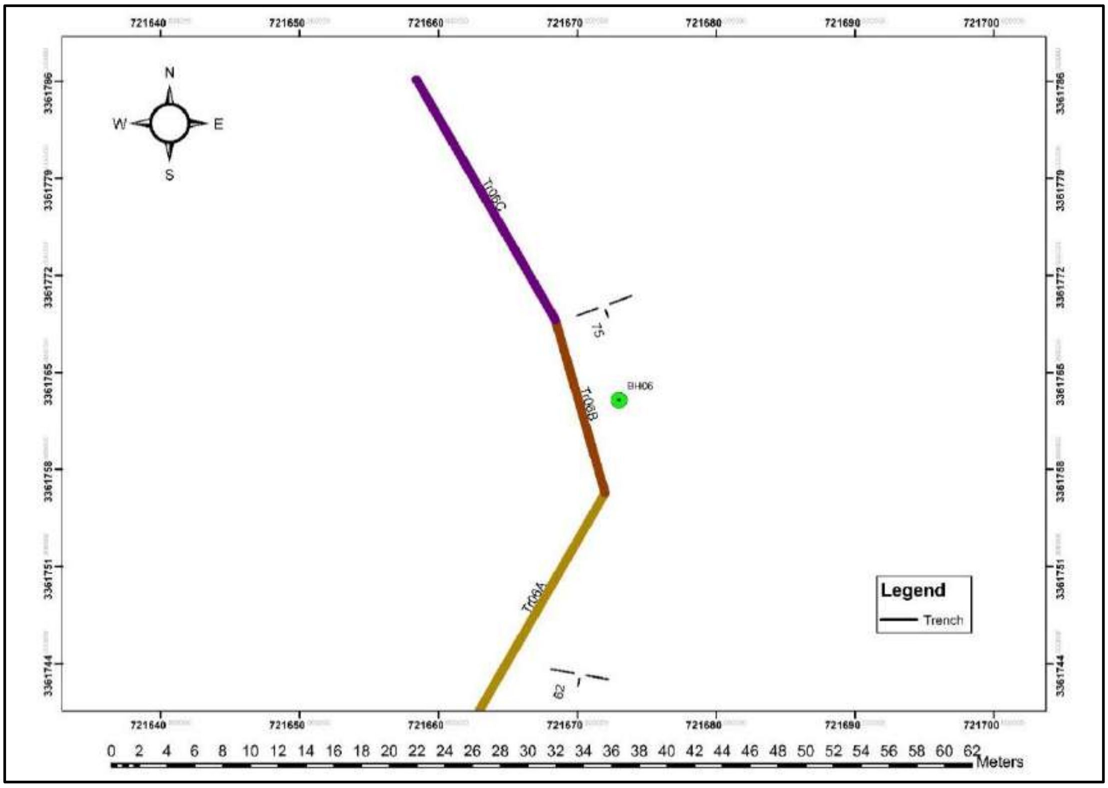


Figure 32: Dipping Direction Trench 06A & Trench 06B_06C

The Pathfinder elements have been determined based on the eight analyzed ICP results instead of 34 recommended elements ICP analyses. That attributed to the same reasons were encountered MEMR lab directorate for the samples zone labeled 03.

According to the correlation matrix of the zone 04 (Fig. 33), the pathfinder elements are: Cu, Zn, Ba, Pb, Li, Ni, and Cr.

Whereas the only element represents the mother rock in respond to the shortages in ICP-analysis is Zr.

	Cu(ppm)	Li(ppm)	Ni(ppm)	Pb(ppm)	Zn(ppm)	Zr(ppm)	Cr(ppm)	Ba(ppm)
Cu(ppm)	1							
Li(ppm)	0.361504	1						
Ni(ppm)	0.089636	0.692263	1					
Pb(ppm)	0.586947	0.817397	0.615888	1				
Zn(ppm)	0.386633	0.957395	0.763314	0.83389	1			
Zr(ppm)	-0.31525	-0.80215	-0.68568	-0.51361	-0.74647	1		
Cr(ppm)	0.041457	0.487426	0.898544	0.575243	0.582015	-0.42669	1	
Ba(ppm)	0.037122	0.267784	0.506464	0.165765	0.245113	-0.63841	0.492825	1

Figure 33: Correlation Matrix for Chemical Analysis of Zone No. 4

The Chemical Results ICP for trench 06A are given in the Table 14:

Table 14: ICP Results of pathfinder elements Trench 06A

	Cu	Zn	Ba	Pb	Li	Ni	Cr
Background (ppm)	933	427	220	44	60	130	154
Max. (ppm)	281.6	1455	1686	88	333	107	309

The pathfinder elements are recorded values exceeded limit their background is: Zn, Ba, Pb, Li, and Cr.

Regarding XRD analysis, the results were obtained in the weak zone01 has been represented to this zone as well due to the similarity of alteration characteristics.

6.5 Geochemical Interpretation of Sumr Al Taiyba Area

6.5.1 Introduction

The mountains of Sumr Al Taiyba consist of composite volcanos, which composed of acidic lava flows (Rhyolite), pyroclastic deposits like ignimbrites, Breccia & Tuff, mudflow (lahar) deposits and lava domes. Pyroclastic rocks are the most common rocks in the study area. The host rocks (composite volcanoes) Intersected by dykes rich in basic & ultrabasic components. Chemical anomalies are concentrated within diabase dykes, and the most important anomalies in this area are zinc, barium, lead, copper, lithium and zirconium, in addition to the presence of some other elements: such as scandium and cerium.

The diabase deposits which included by terrain in study area are emplaced varies. While traditional models set porphyry development in the root zones of upstanding calc-alkaline stratovolcanoes (Composite Volcanoes) and mineralization must be outcropped by considerable later uplift and erosion, many quality porphyry base metals and intrusion related ore deposits do not occur in association with related volcanic rocks. In addition, mineralization and volatiles may have been concentrated by retention within the magma chamber and concentrate in apophyses localized on major structures or adjacent subsidiary dilatant structural sites (Balaram & Sawant, 2022).

High sulphidation epithermal ore deposits display characteristic alteration, which aids target generation, and in some instances evolve to host marginal and overprinting lower sulphidation ores, which display improved metallurgy and metal grades.

6.5.2 Indicator minerals

The indicator minerals, which provide information of source magma chemistry, including crystallization temperatures, degree of fractionation, water content, and oxidation state. Indicator minerals have become important in the exploration of gold, diamond, rare earth elements (REE), platinum group elements (PGE), base metals, and lithium deposits in the past four decades and now. The most important indicator minerals in the study area are hematite, rutile, zircon, apatite, pyrite, sphlerite, magnetite, galena, clay minerals, zeolites & titanite. These minerals are resistant to weathering and so end up in the soil, till, or stream sediments, indicating their presence in the bedrock of a specific type of mineralization, hydrothermal alteration, or lithology, and these minerals are increasingly targeted in mineral exploration studies (Balaram & Sawant, 2022).

6.5.3 Pathfinder Elements

During exploration studies, pathfinder elements together with indicator minerals provide a means to evaluate large areas for their mineral potential by eliminating likely barren areas from the areas under consideration. The most important significant elements in the study area that appear strongly like zinc (Zn), zirconium (Zr), lead (Pb) , and barium (Ba), in addition to other elements such as REE, W, Hf, Nb, Co, V, Sr & Ni. The Fig. 34 shows the main chemical elements and their anomalies with rocks changes in Sumr Al Taiyba area.

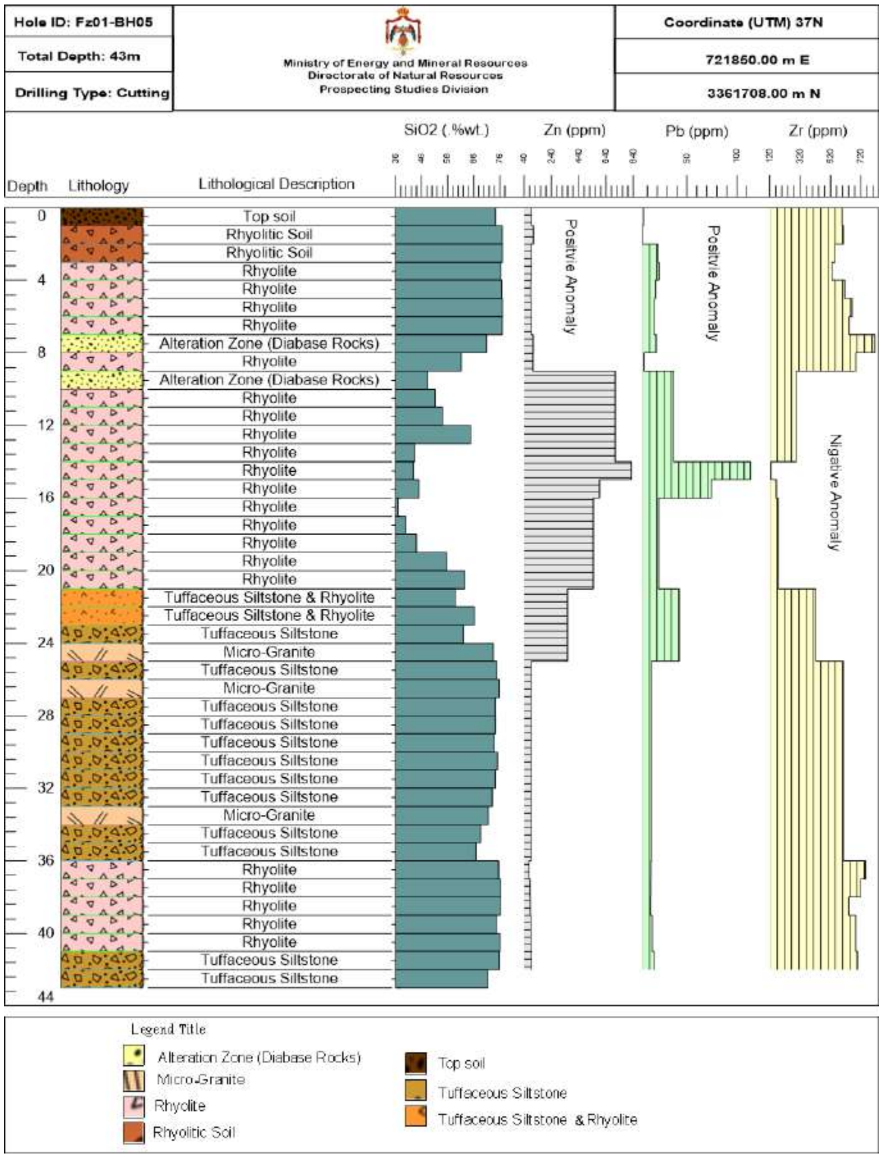


Figure 34: Lithological section of Fz01-BH5 borehole shows the main chemical elements and their anomalies with rock changes

Geochemical anomalies are geochemical features different from what is considered normal. They can be the result of unusual or uncommon processes concentrating particular elements (e.g. an ore-forming process, weathering and element dispersion from an unusual element concentration such as an ore body. Traditionally, geochemical anomalies have been identified by setting threshold values, which mark the upper and lower limits of normal variation for a particular population of data. Values within the threshold values are referred to as background values and those above or below as anomalies.

In mineral exploration, interest is generally in positive anomalies, on the assumption that ore deposits and their weathering have increased element abundances above normal crustal levels. However, negative anomalies can also be important, for example, where they reflect depletion in some elements during host rock alteration accompanying ore formation. Based on the foregoing, we will summarize chemical anomalies and determine interrelationships in the study area as follows:

6.5.3.1 Negative anomalies

Among the most important chemical elements that showed a negative anomaly in Sumr Al Taiyba region are Zirconium (Zr), in addition to other elements like LREE (Cerium (Ce), Lanthanum (La), Neodymium (Nd), Praseodymium (Pr) & Samarium (Sm)), some HREE like Yttrium (Y) , potassium (K), Hafnium (Hf), Tungsten (W), Niobium (Nb) and tin (Sn).

6.5.3.2 Positive anomalies

Zinc (Zn), lead (Pb), Copper (Cu), lithium (Li) and barium (Ba) are considered, respectively, among the most important positive anomalies indicating the presence of the ore body, in addition to other elements such as Titanium (Ti), cobalt (Co), vanadium (V), strontium (Sr), nickel (Ni) & some HREE like scandium (Sc).

The Fig. 35 below shows the nature of relationships between the positive and negative anomalous chemical elements (Cu, Sr, Ba, K, Cs, Li, Zr, Hf, Nb, Ti, La, Ce, Pb, Ga & Zn) in diabase dikes.

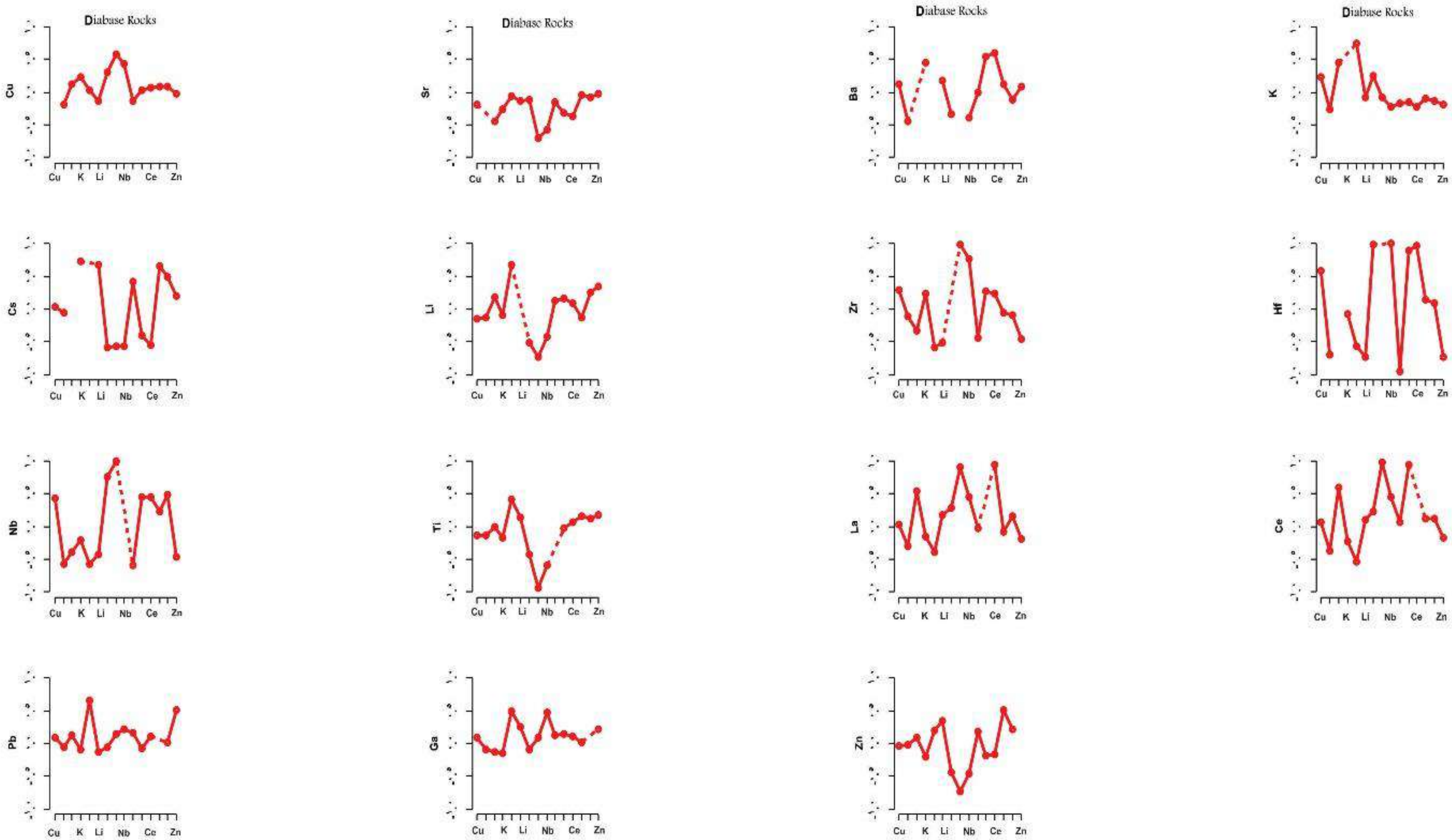
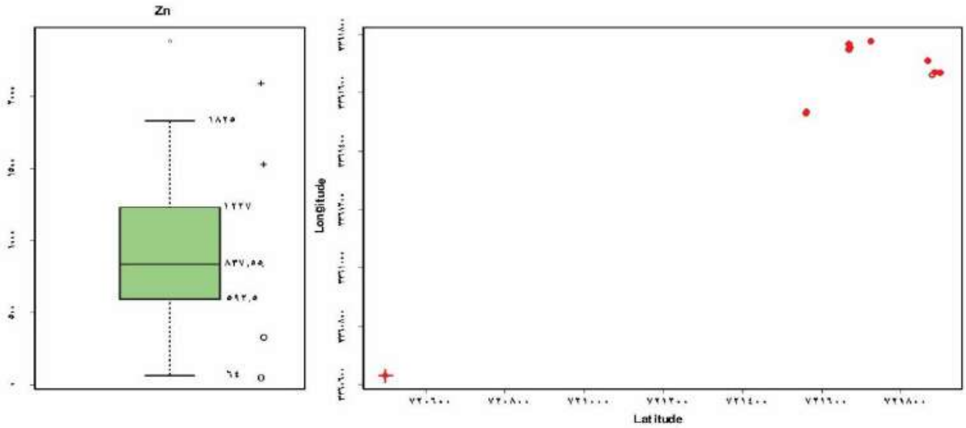
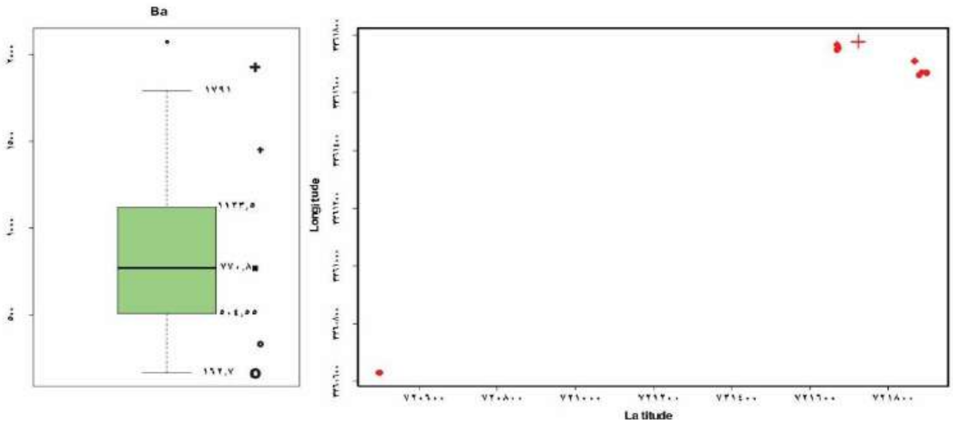
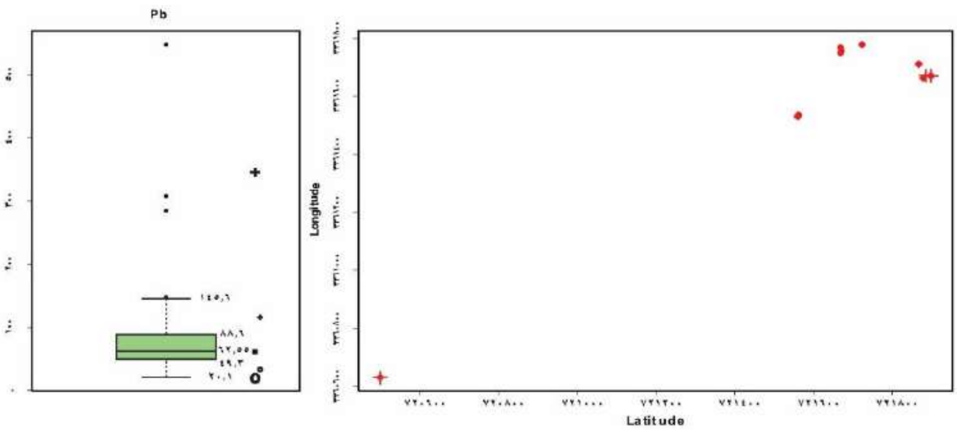


Figure 35: Elemental correlation coefficient to Cu, Sr, Ba, K, Cs, Li, Zr, Hf, Nb, Ti, La, Ce, Pb, Ga & Zn in diabase dikes.

Fig. 36 also shows the prevailing trend that takes us towards the ore body in the study area based on diabase samples for Zn, Pb, Ba, Cu and Li. The above-mentioned element anomaly plot showed strong anomalies for Pb, Cu and Zn, with less strong anomalies for Li and Ba, noting that the prevailing direction of the anomaly in the region is toward the northeast of Sumr Al Taiyba Mountains, noting that research is still ongoing to determine the center of mineralization in the study area.







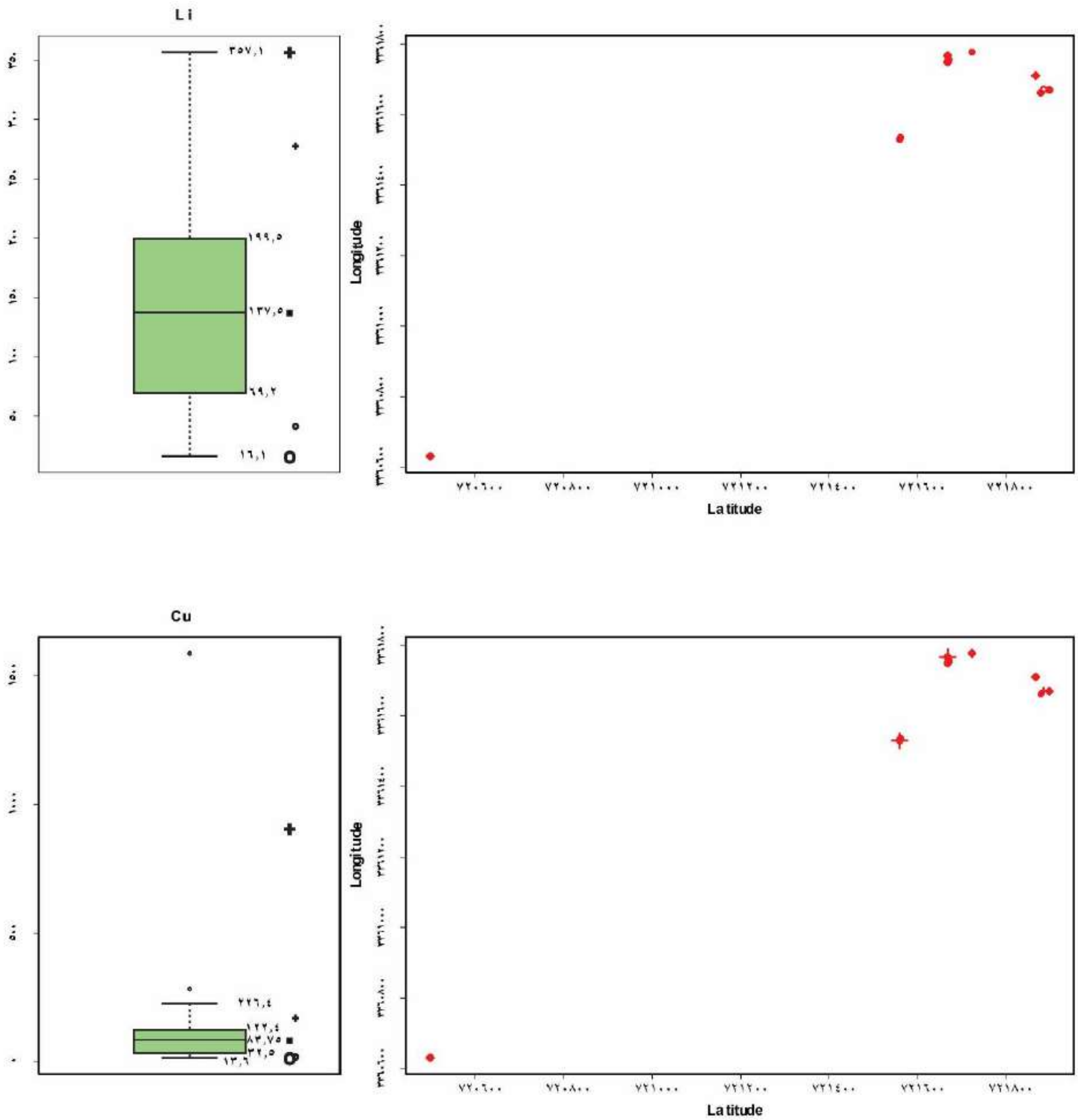


Figure 36: Anomalies of Zn, Ba, Pb, Li & Cu plot of latitude vs. longitude reflecting theirs distributions.

6.6 Economic Elements

Barium is considered an economically viable element, as the element is characterized by its high concentrations in the diabase dikes separating it, with relatively high concentrations in the host rocks, as the average element in the region reaches 837 ppm, with the highest value for this element in the region reaching 1791ppm (0.17 wt. %). Similar to barium, zinc has very high concentrations, which have reached 1825 ppm (0.18 wt. %) in the diabase dikes up to this moment, with an average of 837.5 ppm. Lithium is also considered an economically viable element in the diabase dikes, with the highest value of the element reaching approximately 357 ppm, noting that the average concentrations of the element in samples are equal to 137.5 ppm. As for zirconium, its concentrations in the study area, within the host rocks, reached 1083 (0.10 wt. %) ppm, with an average of 727 ppm, which are relatively high concentrations when compared it to its concentrations in different places of Jordan.

7. CONCLUSION

The mountains of Sumr Al Taiyba consist of composite volcanos, which composed of acidic lava flows (Rhyolite), pyroclastic deposits like ignimbrites, Breccia & Tuff, mudflow (lahar) deposits and lava domes Intersected by dykes rich in basic & ultrabasic components. Chemical anomalies are concentrated within diabase dykes, and the most important anomalies in this area are zinc, barium, lead, copper, lithium and zirconium, in addition to the presence of some other elements: such as scandium and cerium.

Such this discovered kind of alteration layers' interest with strike, dip and dip direction as well as remarkable concentration of pathfinder elements are indicating into vast subsurface mineralization taken place within certain environment of epithermal sulfidation process that is divided into high sulfidation, intermediate sulfidation and low sulfidation.

According to the ICP results of the requested elements, included precious base and rare earth elements in the four weak zones, the alteration layers deposited in the weak zone 03 and weak zone 04 are recorded the highest values. In addition to the altered layer deposited along the strike trench 11.

Generally, hematite, rutile, apatite, pyrite, magnetite, ilmenite, clay minerals, halite, gypsum, zeolites, corundum &

titanite are the most lithified indicators encountered in the alteration layers as they are playing major proves for alteration process occurred within particular condition of halo oxidation which is resulted by low to intermediate epithermal sulfidation process. Moreover, this type of discovered pathfinder elements that were mentioned above are well guidance for low epithermal mineralization deposited long over 300 m with varieties of thicknesses.

Based on the explored of pathfinder elements in each weak zone by using correlation matrix, the following pathfinder elements included Zn, Cu, Li, Pb, Sr, V, Cr and Ba are the most predominant type in the four weak zones, whereas the following pathfinder elements included Co, Cs, Sn, and Y are less common in the four weak zones. Remarkably, the weak zone 03 and weak zone 04 are recorded interesting values of the pathfinder elements.

The most important chemical elements that showed a negative anomaly in Sumr Al Taiyba region are Zr, in addition to other elements like LREE (Ce, La, Nd, Pr & Sm), K, Hf, W, Nb, Sn & some HREE like Y.

Zn, Pb, Cu, Li & Ba are considered, respectively, among the most important positive anomalies indicating the presence of ore body, in addition to other elements such as Ti, Co, V, Sr, Ni & some HREE like Sc.

Presence of Pb, Cu and Zn, with less strong anomalies for Li and Ba, indicate that the prevailing direction of the anomaly in the region is toward the northeast of Sumr Al Taiyba Mountains, noting that the research is still ongoing to determine the center of mineralization in the study area.

Ba, Zn, Zr & Li are considered among the most important elements that may be economically viable in the study area.

Sumr Al Taiyba has to subject into further of developed prospecting studies including Geophysical studies, tilted angle of core drilling, advance chemical analysis and alteration anomaly extraction in remote sensing in order to figure out the main source of alteration layer as well as the subsurface bodies of mineralization ore.

8. APPENDICES

8.1 APPENDIX A

8.1.1 TABLES

Appendix 1: Results of stream sediment samples and HMC (BRGM).

S_ID	X_UTM	Y_UTM	Type	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	MnO	TiO_2	P
2109	721863	3362188	SS	84.4	8.9	4.6	4.5	1.3	3.6	0.1	0.72	1764
2110	721970	3361991	SS	103	12.7	11.4	5.5	2.4	4.9	0.3	2.19	2795
2111	722476	3360920	SS	73	8.6	4.1	11.9	1.6	3.5	0.1	0.68	2206
2112	721549	3360293	SS	81.2	9.8	5.5	7	1.5	4.1	0.1	1.16	2831
2113	721310	3360257	SS	91.4	9.6	2.9	4.8	0.4	4.9	0.1	0.26	527
2114	720804	3360062	SS	93.1	10.3	3.1	3.4	0.6	5.2	0.1	0.34	597
2115	719967	3359680	SS	76.9	8.6	3.2	2.5	0.5	-0.1	0.1	0.29	477
2116	719921	3359901	SS	74.7	7.1	3.2	3.8	0.3	3	0.1	0.24	403
2117	719318	3359288	SS	80.6	2.3	1.6	7.5	0.2	1.4	0	0.11	1066
2118	719632	3360593	SS	74.8	7.7	3.7	2.9	0.4	2.9	0.1	0.29	435
2119	720001	3360646	SS	70.4	8.3	4.6	2.5	1	3.2	0.1	0.56	774
2120	720098	3360754	SS	71.2	8.7	5	2.4	1.2	3.1	0.1	0.58	1011
2121	720114	3360958	SS	73.3	8	5.4	2.8	0.8	3.4	0.1	0.91	1379
2122	720136	3361245	SS	69.6	8.6	6.3	4.2	1.8	3.6	0.2	1.07	1758
2123	720903	3361394	SS	76.8	7.8	4.8	2.9	0.8	3.1	0.1	0.56	948
2124	720093	3361650	SS	76	7.8	5.4	2.5	1	3.4	0.1	0.74	1208
2125	719959	3361925	SS	82.8	9.5	3.5	2.8	0.9	3.6	0.1	0.39	614
8598	722605	3361620	HMC	45.7	1	10.3	20.6	3.5	0.3	0.2	2.31	61503
8599	721101	3360017	HMC	85.4	0.8	3.6	7.4	0.8	0.3	0	0.41	3561
8600	719979	3359495	HMC	80.9	0.7	4.7	7	0.7	0.3	0	0.46	4098
8601	719478	3360400	HMC	83.3	0.9	3.8	7.1	0.7	0.4	0.1	0.54	3392
8602	719951	3361108	HMC	66.1	3.3	21	3.5	1.7	0.9	0.5	8.7	2442
S_ID	Li	Be	B	V	Cr	Co	Ni	Cu	Zn	As	Sr	Y
2109	28	6	32	42	25	14	25	16	206	-31	105	68
2110	57	9	37	125	31	23	34	35	477	-34	142	91
2111	27	4	32	40	24	18	29	14	168	-6	193	52
2112	20	5	32	64	38	14	26	16	134	1	195	68
2113	14	5	32	20	11	10	20	10	97	-26	92	75
2114	19	5	30	24	12	9	21	20	113	-33	83	74
2115	-2	6	37	28	7	-3	10	6	126	46	5	61
2116	12	6	36	21	12	15	25	5	116	83	73	68
2117	5	2	36	16	13	14	26	24	41	33	54	24
2118	17	6	35	30	15	16	27	5	188	78	52	74
2119	28	5	33	54	20	19	30	8	237	100	64	60
2120	31	6	31	61	32	18	32	14	289	100	67	60
2121	16	5	31	66	16	20	31	12	172	92	67	65
2122	22	5	31	87	32	22	43	15	308	111	78	61
2123	15	7	34	49	24	19	33	9	207	81	51	77
2124	16	6	35	53	20	19	29	13	208	97	49	75
2125	21	6	37	35	12	-4	9	19	166	-16	87	70
8598	11	2	48	224	133	18	98	32	241	60	639	56
8599	5	1	41	49	28	8	35	23	76	54	110	21
8600	5	1	59	56	28	20	44	17	105	78	101	27
8601	6	1	47	42	23	24	45	12	98	71	132	23
8602	18	3	41	485	49	46	70	25	687	104	91	50

S_ID	Nb	Mo	Ag	Sn	Ba	La	Ce	W	Pb	Bi	Zr	Au
2109	44	12	0.6	21	271	69	146	22	39	30	784	
2110	74	19	0.5	30	511	105	228	40	124	14	917	5
2111	34	16	0.8	28	403	49	128	22	35	28	575	
2112	48	18	0.4	24	436	73	170	30	44	8	822	
2113	45	14	0.6	20	337	73	172	31	34	57	809	
2114	46	15	0.4	22	368	75	170	27	39	20	779	
2115	42	-4	-0.4	5	227	60	144	64	39	-25	628	
2116	52	5	1.4	25	333	62	153	68	50	-21	854	
2117	20	0	1.2	20	224	25	63	49	37	-1	317	
2118	53	7	1.2	25	145	71	175	68	56	-3	830	
2119	47	7	1.2	27	302	58	144	79	76	6	633	
2120	47	7	1.2	25	304	60	143	80	100	9	615	
2121	55	8	1.4	26	227	63	163	76	63	10	776	
2122	49	6	1.4	30	310	53	132	79	61	-9	685	
2123	57	7	1.4	28	180	69	167	76	61	-3	915	5
2124	58	7	1.3	29	152	76	178	79	63	14	889	
2125	43	-4	-0.7	7	203	67	147	39	27	13	732	
8598	36	0	0.1	4	4376	50	59	29	104	-8	146	
8599	21	6	0.2	19	488	28	31	27	53	-8	935	
8600	28	17	1.1	26	698	34	42	32	52	-18	1658	
8601	26	18	1.3	34	342	35	52	28	56	-10	1298	
8602	99	28	0.6	35	265	67	129	48	81	-43	2020	

Appendix 2: Summary of catchment & sub-catchment areas and the number of proposed samples within the study area.

CATCHMENT AREAS

Catchment ID	Priority	BRGM Results (ppm)			Area (sq.m)	No. of Samples		Notes
		Au	Pb	Zn		SS*	HMC*	
C-1	A	5	123	477	53542	2	2	Zn, Pb, (Au) anomalies
C-2	A	5	123	477	101691	4	2	Zn, Pb, (Au) anomalies
C-3	A	5	123	477	74271	3	2	Zn, Pb, (Au) anomalies
C-4	A	5	61	207	173625	5	5	Zn, Pb, (Au) anomalies
C-5	B	-	61	308	458458	4	2	Zn, Pb anomalies
C-6	B	-	100	289	93069	3	1	Zn, Pb anomalies
C-7	B	-	100	289	97133	1	1	Zn, Pb anomalies
C-8	B	-	76	237	125321	2	1	Zn, Pb anomalies
C-9	B	-	63	208	140435	2	2	Zn, Pb anomalies
C-10	C	-	63	172	512066	3	1	Pb anomaly & high Zn background
C-11	D	-	39	206	124213	1	0	Zn anomaly
C-12	D	-	39	206	42483	1	0	Zn anomaly
C-13	D	-	56	188	62301	1	1	High Zn & Pb background
C-14	D	-	35	168	26468	0	0	Rock sampling prospecting
C-15	D	-	27	166	91815	2	0	Moderate Zn & low Pb background
C-16	D	-	44	134	128326	2	0	Zn & Pb shows
C-17	D	-	39	126	19544	0	0	Rock sampling prospecting
C-18	D	-	50	116	113072	2	1	Zn show & high Pb background
C-19	D	-	39	113	145440	2	1	Zn show & high Pb background
C-20	D	-	34	97	235055	2	2	Zn show & moderate Pb background
C-21	E	-	-	-	228064	1	1	Close to gold shows
C-22	E	-	-	-	109409	1	0	Close to gold shows
C-23	E	-	-	-	57319	1	1	Close to gold shows
C-24	E	-	-	-	32737	1	1	Close to gold shows
C-25	E	-	-	-	41172	1	1	Close to gold shows
C-26	E	-	-	-	62352	1	0	Close to Zn & Pb anomalies
C-27	E	-	-	-	79401	1	0	Close to Zn & Pb anomalies
C-28	E	-	-	-	55710	1	1	Close to Zn & Pb anomalies
C-29	E	-	-	-	86044	1	1	Close to Zn & Pb anomalies
C-30	E	-	-	-	83557	1	1	Close to Pb anomaly
C-31	F	-	-	-	27856	0	0	Rock sampling prospecting

C-32	F	-	-	-	61454	0	0	Rock sampling prospecting
C-33	F	-	-	-	60093	0	0	Rock sampling prospecting
C-34	F	-	-	-	54304	0	0	Rock sampling prospecting
C-35	F	-	-	-	37651	0	0	Rock sampling prospecting
C-36	F	-	-	-	16857	0	0	Rock sampling prospecting
C-37	F	-	-	-	49843	0	0	Rock sampling prospecting

Continue

C-38	F	-	-	-	53243	0	0	Rock sampling prospecting
C-39	F	-	-	-	37758	0	0	Rock sampling prospecting
C-40	F	-	-	-	86403	0	0	Rock sampling prospecting
C-41	F	-	-	-	52725	1	0	Rock sampling prospecting
C-42	F	-	-	-	57160	0	0	Rock sampling prospecting
					Sum	53	31	

*SS: stream sediment samples, *HMC: heavy mineral concentrates.

أحواض التصريف المائي الثانوية (Subcatchment)						
Catchment ID	Priority	BRGM Results (ppm)			Area (sq.m)	Notes
		Au	Pb	Zn		
C-1A	A	5	123	477	29238	Zn, Pb, (Au) anomalies
C-2A	A	5	123	477	20750	Zn, Pb, (Au) anomalies
C-2B	A	5	123	477	45883	Zn, Pb, (Au) anomalies
C-2C	A	5	123	477	14590	Zn, Pb, (Au) anomalies
C-3A	A	5	123	477	26249	Zn, Pb, (Au) anomalies
C-3B	A	5	123	477	10543	Zn, Pb, (Au) anomalies
C-4A	A	5	61	207	16922	Zn, Pb, (Au) anomalies
C-4B	A	5	61	207	22089	Zn, Pb, (Au) anomalies
C-4C	A	5	61	207	30456	Zn, Pb, (Au) anomalies
C-4D	A	5	61	207	39067	Zn, Pb, (Au) anomalies
C-5A	B	-	61	308	341856	Zn, Pb anomalies
C-5B	B	-	61	308	206772	Zn, Pb anomalies
C-5C	B	-	61	308	108049	Zn, Pb anomalies
C-6A	B	-	100	289	33531	Zn, Pb anomalies
C-6B	B	-	100	289	19458	Zn, Pb anomalies
C-8A	B	-	76	237	50799	Zn, Pb anomalies
C-9A	B	-	63	208	31723	Zn, Pb anomalies
C-10A	C	-	63	172	318250	Pb anomaly & high Zn background
C-10B	C	-	63	172	153237	Pb anomaly & high Zn background
C-15A	D	-	27	166	44689	Moderate Zn & low Pb background
C-16A	D	-	44	134	70289	Zn & Pb shows
C-18A	D	-	50	116	59196	Zn show & high Pb background
C-19A	D	-	39	113	71202	Zn show & high Pb background
C-20A	D	-	34	97	114654	Zn show & moderate Pb background

Appendix 3: Results of the orientation survey stream sediment samples in the laboratories of JAEC and MEMR.

- JAEC laboratory

هيئة الطاقة الذرية الأردنية															
ID	**Ba**	**Bi**	**Cd**	**Co**	**Cr**	**Cu**	**La**	**Li**	**Mo**	**Ni**	**Pb**	**Y**	**Zn**	**Zr**	**Th**	**U**
ST-S-1	528.29	<18.29	<1.81	78.03	<105.89	93.38	<50.62	<136.20	<36.96	41.25	98.18	53.72	411.57	474.57	55.90	7.00
ST-S-1a	479.38	<18.29	<1.81	74.86	<105.89	85.04	<50.62	<136.20	<36.96	40.06	<71.93	49.58	426.19	432.76	<8.75	<4.78
ST-S-2	491.52	<18.29	<1.81	73.52	<105.89	93.26	51.34	<136.20	<36.96	40.40	<71.93	57.41	391.58	500.03	8.96	<4.78
ST-S-2a	482.69	<18.29	<1.81	64.36	<105.89	85.09	<50.62	<136.20	<36.96	36.51	<71.93	56.00	424.21	489.50	<8.75	<4.78
ST-S-3	471.79	<18.29	<1.81	<37.38	<105.89	49.98	65.06	<136.20	<36.96	27.03	72.92	65.69	419.30	560.11	9.88	<4.78
ST-S-3a	460.87	<18.29	<1.81	<37.38	<105.89	49.42	57.30	<136.20	<36.96	27.22	72.34	59.44	403.94	497.04	11.46	<4.78
ST-S-4	580.86	<18.29	<1.81	<37.38	<105.89	45.33	73.41	<136.20	<36.96	<26.31	99.80	74.43	413.40	606.57	13.66	6.15
ST-S-4a	551.30	<18.29	<1.81	<37.38	<105.89	46.49	72.85	<136.20	<36.96	<26.31	84.56	69.19	406.33	571.06	9.06	4.89
ST-S-5	599.00	<18.29	<1.81	<37.38	<105.89	45.69	78.28	<136.20	<36.96	<26.31	103.81	75.59	423.63	618.82	10.42	5.36
ST-S-5a	438.75	<18.29	<1.81	<37.38	<105.89	54.63	60.85	<136.20	<36.96	26.62	<71.93	59.81	404.52	501.68	<8.75	<4.78
ST-S-6	512.49	<18.29	<1.81	<37.38	<105.89	42.77	83.46	<136.20	<36.96	<26.31	77.94	77.60	441.10	640.10	11.30	5.67
ST-S-6a	465.72	<18.29	<1.81	<37.38	<105.89	40.20	72.05	<136.20	<36.96	<26.31	77.93	67.72	418.72	545.20	<8.75	<4.78
ST-S-7	545.70	<18.29	<1.81	56.52	<105.89	85.79	67.62	<136.20	<36.96	33.98	89.16	67.29	656.73	582.04	8.80	<4.78
ST-S-7a	644.48	<18.29	<1.81	47.90	<105.89	80.15	86.02	<136.20	<36.96	<26.31	152.16	69.73	541.85	607.66	<8.75	<4.78
ST-S-8	808.05	<18.29	<1.81	51.66	<105.89	94.26	84.19	<136.20	<36.96	28.85	163.02	72.45	591.02	630.60	10.47	5.11
ST-S-8a	469.57	<18.29	<1.81	52.32	105.97	83.78	55.30	<136.20	<36.96	28.15	83.45	56.30	592.42	486.46	<8.75	<4.78

- MEMR laboratory

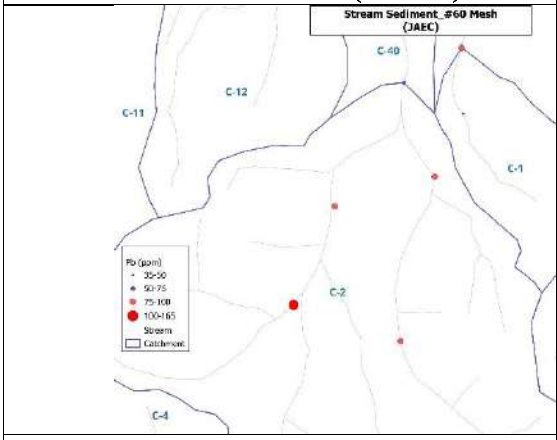
MEMR Laboratory																							
#	**S.ID**	**Co_ppm**	**Cs_ppm**	**Cu_ppm**	**Ga_ppm**	**Li_ppm**	**Ni_ppm**	**Pb_ppm**	**Sr_ppm**	**V_ppm**	**Zn_ppm**	**Hf_ppm**	**Zr_ppm**	**Ce_ppm**	**Dy_ppm**	**Gd_ppm**	**La_ppm**	**Nd_ppm**	**Pr_ppm**	**Sc_ppm**	**Sm_ppm**	**Y_ppm**	**Yb_ppm**
1	ST-S-1	35.3	5.1	58.2	25.5	40.4	82	88.3	139.3	270.6	346.6	8.7	369.7	115.4	21.4	21.9	50.8	53.7	15.9	10.7	17.2	45.5	5.7
2	ST-S-1a	32.3	2.5	58.8	23.8	38.6	88.8	66.3	144.8	237.5	369.3	7.7	333.2	110.1	6	20	49.3	52.2	15.1	10.6	16.4	40.7	5.2
3	ST-S-2	31.5	2.5	60.5	26.3	37.7	72.9	69.3	137.2	236.5	333.1	9.3	384.2	112.9	10.3	21.5	52.1	55.1	15.8	10.4	17.8	47.2	5.7
4	ST-S-2a	27.1	2.5	48.1	22.3	35.8	74.1	51.5	115.3	205.2	351.4	8.4	364.4	106.2	9.1	18.9	48.2	50.4	13.8	9.2	15.6	44.7	5.3
5	ST-S-3	14.4	5.8	36.5	22.2	37.5	62.8	69.1	96.8	96.7	340.8	9.5	412.6	130.1	12.3	17.2	58.2	57.4	15.3	6.1	14	51.2	5.4
6	ST-S-3a	13.9	5.6	34.7	19.3	35	48.3	65.5	99.7	97.3	338.4	8.4	368.4	120.3	11.3	16	53.5	53.5	14.4	6.1	12.9	46.3	2.5
7	ST-S-4	12.2	6.6	30.7	10.9	41.9	61.2	88.4	83.6	77.7	348.2	11.5	485.9	151.4	16	19.4	67.4	65.9	17.8	2.5	15.2	61.2	6.4
8	ST-S-4a	14	6.2	33.8	22.2	44.2	48	100.5	92.4	79.7	371.5	9.5	411.8	145.1	13.2	17.7	63.6	63	16.3	5.4	14	52.1	5.5
9	ST-S-5	13.2	6.5	30.8	22.7	41.4	38.5	90.1	82.9	80.1	348	11.3	482.4	151	15.4	19.1	65.8	64.7	17.3	2.5	14.9	59.6	6.2
10	ST-S-5a	14.2	5.5	35	19.8	36	50.9	59	100.7	93.9	336.5	8.5	369.4	120.2	11.6	16.1	52.3	53.1	14.3	6.1	12.9	46	2.5
11	ST-S-6	16.3	6.7	35.5	17.2	49.5	101.9	69.1	83.3	56.8	348.9	11.3	477.7	154.6	14.5	18.1	68.5	66.7	18.1	2.5	14.7	58.9	6.1
12	ST-S-6a	10.8	6.3	26.6	20.7	42.1	40.9	65.5	81.3	59.2	349.5	10.1	433.4	102.7	12.4	16.4	64.5	62.6	17.2	2.5	14	54.4	5.6
13	ST-S-7	25.8	7.8	61.8	24.9	37.6	75.8	100.9	108.5	188.6	576.2	11	438.3	143.2	12	21.4	62.7	63.8	17	9	18.1	52.5	6.1
14	ST-S-7a	18.4	8.1	54.3	23.9	27.2	68	146.2	85.3	167.5	465.6	11.3	473	181	7	22.4	80	79.4	21.4	6.8	20.1	58.1	6.8
15	ST-S-8	21.9	8.5	58.5	25.5	31	72.4	160.2	89.8	177.8	490.5	11.7	507.2	182.6	6.4	24.4	79.3	76.8	21.5	7.2	19.6	60.1	7.1
16	ST-S-8a	21.5	7.1	54.7	21.6	32	78.1	81.2	97.1	165.3	505.9	9.2	387.9	129.9	12	18.7	58.1	58.6	15.7	8.2	17.2	47.6	5.4

8.1.2 MAPS

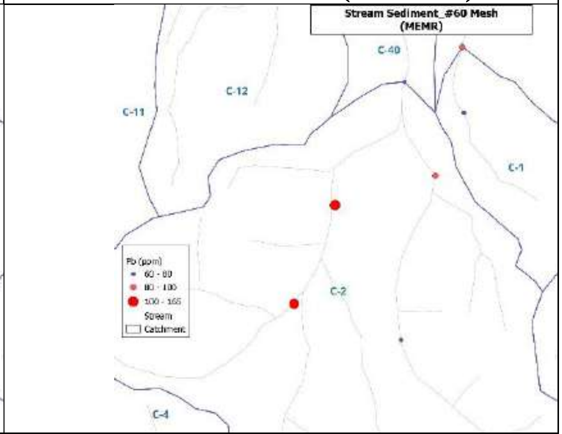
Appendix 4: Maps of Pb, Zn, and Cu results from JAEC & MEMR laboratories.

- **Pb maps**

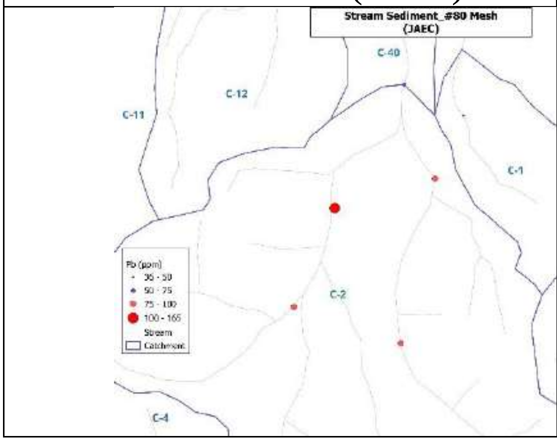
#60 Mesh (JAEC)



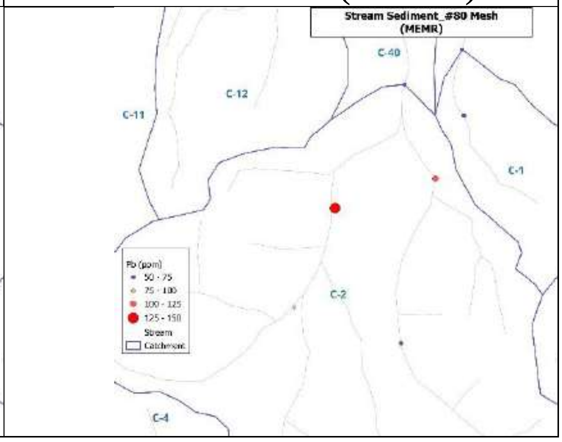
#60 Mesh (MEMR)



#80 Mesh (JAEC)

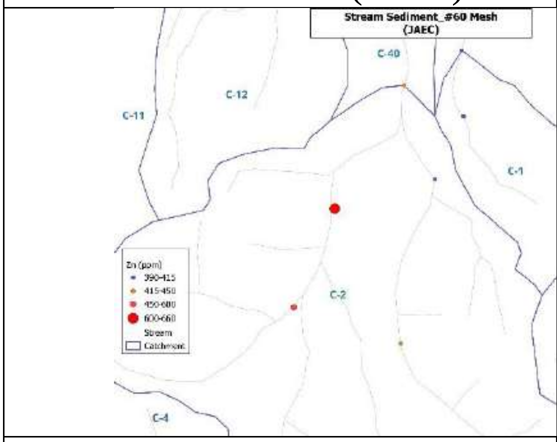


#80 Mesh (MEMR)

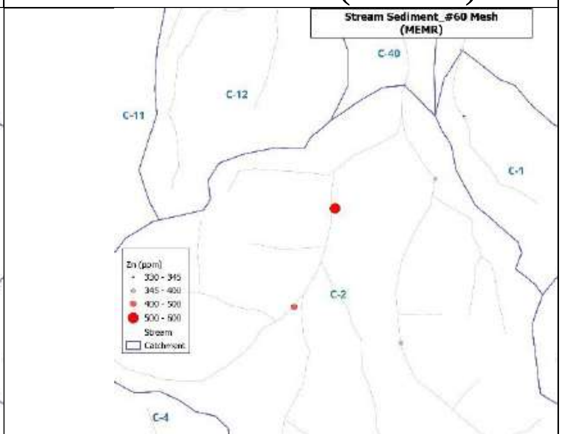


- **Zn maps**

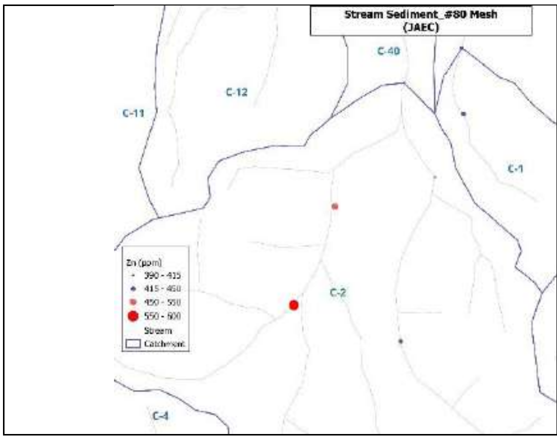
#60 Mesh (JAEC)

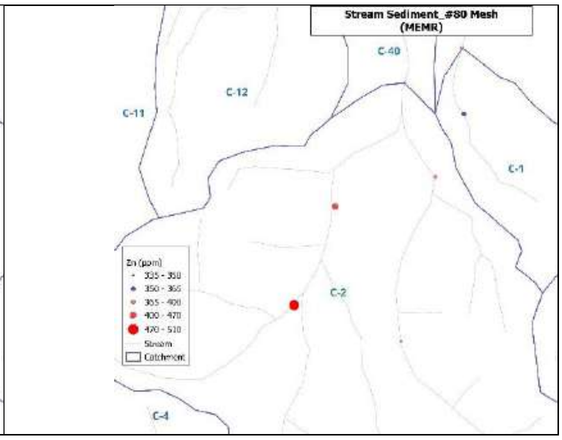


#60 Mesh (MEMR)



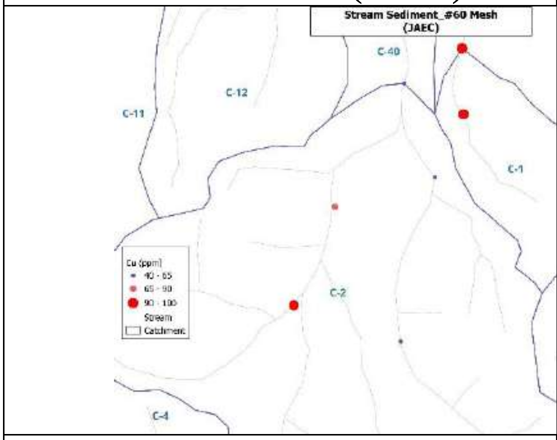
#80 Mesh (JAEC)	#80 Mesh (MEMR)



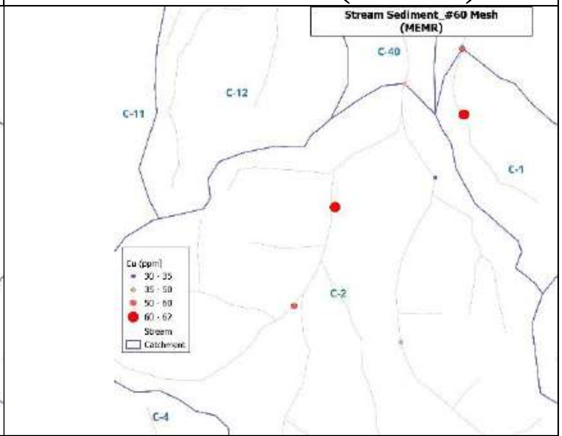


- **Cu maps**

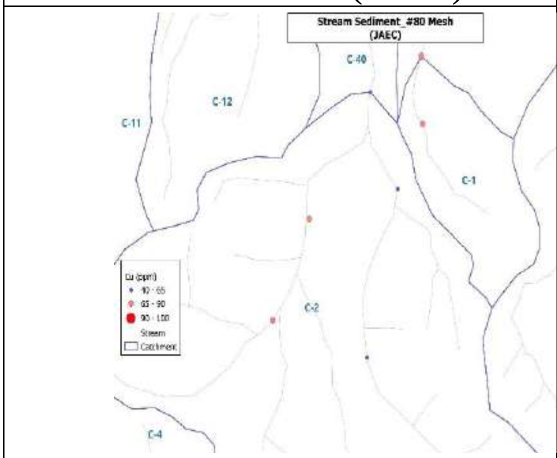
#60 Mesh (JAEC)



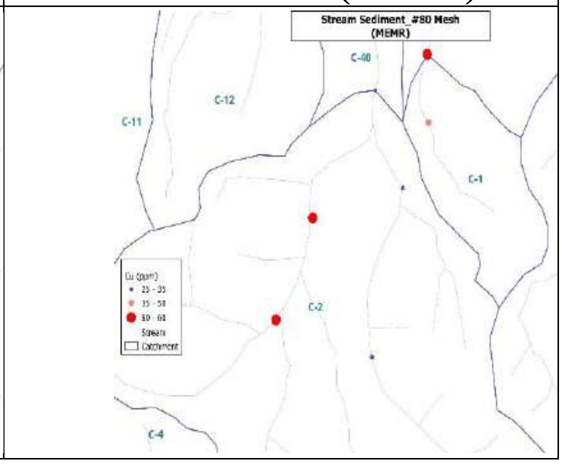
#60 Mesh (MEMR)



#80 Mesh (JAEC)



#80 Mesh (MEMR)



8.2 APPENDIX B

8.2.1 Trenches Informative Data

one +A3:Y62n	X	Y	Z	TR. ID	T.R Dimension: Trench Line	Wall Type	Direction	Coordinates: X	Y	Z	T.L.(m)	T.D(m)	Overburden(cm): Min	Max	Trench drilling info.: Start	End	Drilling Activity	Altration Zone: From	To	Width	Intesity	Type	Style	Mineralization	Altration Orientation: Strike	Dip	Dip Direction	Geologist
1	721838	3361722	276	Tr. 01	Start Point	Hang wall	162 SSE	721857	3361724	279	11	1	0.1	0.4	1/26/2023	1/30/2023	hammar & Track loader	1	1.33	0.33	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate	210	76	SEE	Ezaldeen & Alaa
																		3	4	1	medium	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
																		4	5	1	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
																		5	5.63	0.63	medium	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
					End Point	Foot wall	342 NNW	721853	3361734	278								5.63	6.1	0.47	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
																		6.1	7	0.9	medium	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
																		8.33	8.56	0.23	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
				Tr. 02	Start Point	Hang wall	174 SSE	721885	3361722	281	10	1	0.1	0.5	1/24/2023	1/25/2023	hammar & Track loader	1.17	1.34	0.62	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate	198	60	SEE	Ezaldeen & hamidi
																		3	4.22	1.25	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate				
																		6.36	8.14	1.78	medium	propylitic	oxidation halos	fe-mn, sulfide, carbonate, black mineral, calcite				
					End Point	Foot wall	354 NNW	721883	3361730	280								8.14	9.5	1.36	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, salt				
				Tr. 03	Start Point	Foot wall	312 NW	721835	3361718	277	10	5.5	0.3	1.5	30-Jan-23	1/31/2023	Track loader	4	5	1	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, copper, epidote	76	76	SSE	Ezaldeen & Alaa
																		5	6	1	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, copper, epidote				
					End Point	Hang wall	132 SE	721842	3361712	278								6	7	1	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, copper, epidote				
				Tr.11	Start Point	Hang wall	180 S	721867	3361710	278	5.4	2.5	0	0.1	20-Jun-23	6/20/2023	Track loader	0	3.1	3.1	strong	propylitic	oxidation halos	fe-mn, clay, sulfides, sulfer	283	70	SW	Alaa, Ez
					End Point	Foot wall	360N	721866	3361715	276																		
2	721891	3361666	274	Tr.07	Start Point	Hang wall	168 SSE	721909	3361672	278	12	1	0	0.25	10-Apr-23	4/12/2023	Hammar	3	4	1	Slightly	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite	254	50	SE	Azmi
					End Point	Foot wall	332 NNW	71906.486	3361683.7	278								4	5	1	Strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, Blue mineral	254	50	SE	
				Tr.08							10	2	0	0.4	2-May-23	2-May-23	Track loader	0	0.25	0.25	Medium	propylitic	oxidation halos	Gypsum, Carbonate	254	50	SE	Ali Al Smadi, Alaa, Ez
					Start Point	Hang wall	140 SE	721898	3361670	250								0.25	1.6	1.35	strong	propylitic	oxidation halos	Carbonate, Caly	254	50	SE	
																		8.275	8.425	0.15	Strong	propylitic	oxidation halos	Clay	230	50	SSE	
					End Point	Foot wall	320 NW	721891.58	3361677.7	250								8.425	8.525	0.1	strong	propylitic	oxidation halos	Carbonate, Clay	230	50	SSE	
				Tr.09	Start Point	Foot wall	232 NNW	721886	3361671	280	8	1.75	0	0.65	6-Jun-23	7-Jun-23	Track loader	0.95	1.1	0.15	strong	propylitic	oxidation halos	fe-mn, carbonate	250	35	SE	Alaa, Azmi
					End Point	Hang wall	172 SSE	721889	3361666	280																		
				Tr.10	Start Point	Foot wall	214 NW	721878	3361662	283	13	2	0	0.6	6-Jun-23	7-Jun-23	Track loader	5.9	6.83	0.93	strong	propylitic	oxidation halos	fe-Mn, Carbonate	254	60	SE	Alaa, Alaa, Qasim
					End Point	Hang wall	130SE	721886	3361658	281								9.3	9.5	0.2	strong	propylitic	oxidation halos	Fe-Mn, Clay	254	60	SE	
3	721553	3361516	294	Tr. 04	Start Point	Hang wall	75 NE	721561	3361536	296	8	1	0	0.3	6-Feb-23	8-Feb-23	hammer	1.34	2	0.66	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, copper, epidote	150	70	NE	Azmi
																		2	2.84	0.84	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, calcite				
																		3.54	4.3	0.76	strong	propylitic	oxidation halos	e-mn, sulfide, carbonate, chlorite, calcite, salt, gypsu				
					End Point	Foot wall	255 SW	721553	3361533	297								5.94	6.3	0.36	strong	propylitic	oxidation halos	fe-mn, sulfide, carbonate, chlorite, copper, epidote				
				Tr. 05	Start Point	Hang wall	82 NE	721560	3361529	296	8	1.4	0.05	0.7	13/02/2023	15/02/2023	hammer	0	1	1	Strong	propylitic	oxidation halos	fe-mn, sulfide, calcite, black minerals.	150	70	NE	Jawal & Ez
																		1	1.5	0.5	Strong	propylitic	oxidation halos	fe-mn, sulfide, calcite.				
																		1.5	1.88	0.38	Strong	propylitic	oxidation halos	fe-mn, sulfide, calcite.				
																		1.88	2.31	0.43	Strong	propylitic	oxidation halos	fe-mn, sulfide, calcite, copper				
					End Point	Foot wall	262 SW	721552	3361527	297								3.71	4.54	0.83	medium	propylitic	oxidation halos	fe-mn, sulfide, calcite, carbonate				
																		4.54	5.4	0.86	strong	propylitic	oxidation halos	fe-mn, sulfide, calcite.				
4	721671	3361756	275	Tr. 06A	Start Point	Hang wall	30 NE	721671	3361756	275	20	2.8	0.15	0.45	27/02/2023	27/02/2023	Track loader	4.1	4.85	0.75	strong	propylitic	oxidation halos	fe-mn, sulfide, calcite, gypsum, BM	100	62	SSW	Jawal & Ez
																		6	7	1	strong	propylitic	oxidation halos	fe-mn, sulfide, gypsum, Anhydrite.				
																		9	10	1	strong	propylitic	oxidation halos	fe-mn, sulfide, gypsum, calcite, BM.				
																		11.5	12.5	1	strong	propylitic	oxidation halos	fe-mn, sulfide, gypsum, calcite.				
																		13	13.35	0.35	strong	propylitic	oxidation halos	fe-mn, sulfide, gypsum.				
					End Point	Foot wall	210 SW	721662	3361739	278								13.35	15	1.65	medium	propylitic	oxidation halos	Carbonate				
																		15.95	16.75	0.8	strong	propylitic	oxidation halos	Sulfides, calcite				
																		17	17.15	0.15	strong	propylitic	oxidation halos	sulfides.				
				Tr. 06B	Start Point	Foot wall	344 NNW	721668	3361768	275	13	4.35	0.1	0.15	13/02/2023	15/02/2023	Track loader	0	1	1	strong	propylitic	oxidation halos	Calcite, carbonate				
																		1	1.4	0.4	strong	propylitic	oxidation halos	sulfides, calcite.				
																		1.9	2.36	0.46	strong	propylitic	oxidation halos	sulfides, calcite.				
																		2.36	4.5	2.14	strong	propylitic	oxidation halos	sulfides, iron oxide, calcite				
					End Point	Foot wall	164 SSE	721671	3361756	275								4.5	6	1.5	strong	propylitic	oxidation halos	sulfides, iron oxide, calcite				
																		9.9	10.7	0.8	strong	propylitic	oxidation halos	sulfides, iron oxide, calcite				
																		10.7	11.5	0.8	strong	propylitic	oxidation halos	sulfides, iron oxide, calcite				
																		11.5	11.7	0.2	strong	propylitic	oxidation halos	sulfides, iron oxide, calcite	80	80	SSE	Jawal & Ez
				Tr. 06C	Start Point	Foot wall	300 NNW	721658	3361786	275	20	2.75	0.8	0.38	28/02/2023	28/02/2023	Track loader	18.25	19	0.75	strong	propylitic	oxidation halos	manganise oxides, Iron oxides, Calcite.	60	70	SSE	Jawal & Ez
					End Point	Hang wall	120 SSE	721668	3361768	275								19	20	1	strong	propylitic	oxidation halos	manganise oxides, Iron oxides, Calcite.				
				Tr. 06D	Start Point	Foot wall	200NNW	721669	3361750	275					2/13/2023	2/15/2023	Track loader	4	7	3	strong	propylitic	oxidation halos	manganise oxides, Iron oxides, Calcite.				
					End Point	Hang wall	110 SE	721667	3361765	275	15	6	0	0.5				12	15	3	strong	propylitic	oxidation halos	manganise oxides, Iron oxides, Calcite.				Ali Al Smadi

8.2.2 ICP_Result

ID	From	To	Diff	Lab	Be(ppm)	Cd(ppm)	Co(ppm)	Cs(ppm)	Cu(ppm)	Ga(ppm)	Li(ppm)	Ni(ppm)	Pb(ppm)	Sr(ppm)	V(ppm)	Zn(ppm)	Hf(ppm)	Mo (ppm)	Nb(ppm)	Sb(ppm)	Sn(ppm)	W (ppm)	Zr (ppm)	Ce(ppm)	Dy(ppm)	Gd(ppm)	Ho(ppm)	La(ppm)	Nd(ppm)	Pr(ppm)	Sc(ppm)	Sm(ppm)	Y(ppm)	Yb(ppm)	Rb(ppm)	Cr (ppm)	Ti	Ba
S.T.Tr02-01	1.17	1.34	0.17	memr	4.7	1	16.8	5	20.5	23.5	13.9	210.6	24.9	224.7	12.8	205.7	16	5	40.2	16.2	5	89.4	513.4	188.8	15.1	11.4	5	87.5	85.2	26.1	5	12.9	79.1	5				
S.T.Tr02-02	1.34	3	1.66	memr	4.9	1	19.4	5	15.3	23.2	8.8	79.8	25	17.2	8.5	139.9	16.4	5	40.5	8.2	5	78.8	490	159	13.7	9	5	70.1	70.8	21.7	5	11.4	69.8	5				
S.T.Tr02-03	3	4.22	1.22	memr	6	1	17.3	5	12.6	26.2	12	88.4	23.3	24.2	12.4	159.5	15.9	5	38	5	5	66.4	480.4	181.8	14.5	9.8	5	79.5	80.8	25	5	12.5	73.6	5				
S.T.Tr02-04	4.22	6.36	2.14	memr	6.2	1	19.7	5	15	27	9.3	176.2	25.2	13.2	8	114.4	15.8	5	40.3	5	5	70.5	485.6	195.2	14.8	10.2	5	80.7	82.6	25.4	5	13.2	78.3	5				
S.T.Tr02-05	6.36	8.14	1.78	memr	6.8	1	15.1	5	10.7	28	8.2	70.4	25.3	13.3	8.7	138.2	16.3	5	39.2	5	5	64.1	494.8	186.4	15.6	10.6	5	86.4	88.7	26.8	5	13.5	83.5	5				
S.T.Tr02-06	8.14	9.5	1.36	memr	6.4	1	14.7	5	11.5	28.1	10.1	72	26	22.5	10.4	144.9	15.5	5	38.4	5	5	50.4	444.1	195.7	15.4	10.5	5	89.8	91.9	27.7	5	13.6	78.9	5				
S.T.Tr02-07	9.5	10	0.5	memr	6.2	1	11.8	5	14.8	27.3	12.7	70.6	24.3	27.9	9.3	131.8	14.4	5	34.4	5	5	46.2	399.7	195.4	14.8	10.2	5	87.4	88.1	27.4	5	13.5	74.8	5				
ST.Tr01.S01	1	1.33	0.33	memr	6.7	5	17.1	6.2	6.6	28.3	11.3	35.8	18.6	16.2	5	157.5	15.6	7.2	124.3	10.9	22.9	158.6	837.7	190.2	5	19.9	5	89.6	90.9	23.6	5	18.5	73.8	8.6				
ST.Tr01.S02	3	4	1	memr	7.2	5	18.8	5	6	27.2	8.5	37.1	18	13.8	5	132.5	15	7	120.3	10.8	22.3	169.7	794.8	194.1	5	20.2	5	86	86.6	23.1	5	18.5	80.8	8.5				
ST.Tr01.S03	4	5	1	memr	6.6	5	19.5	5.9	8.6	27.7	10.9	35.9	18.3	18.5	5.1	158	13.5	7.2	118.6	10.7	22.4	196.7	721.6	186.9	5	19.4	5	98.6	97.5	26	5	18.9	72.9	8.1				
ST.Tr01.S04	5	5.63	0.63	memr	6.3	5	16.9	5.7	8.2	26.7	12.4	49.1	20.7	24.3	7.1	151.2	13.7	7.7	115.0	10.5	21.8	150.7	728.1	207.3	5	19.9	5	93.6	93.7	25.3	5	19	74.1	8.2				
ST.Tr01.S05	5.63	6.1	0.47	memr	6.6	5	20.2	5.9	9.3	27.8	11.4	38.7	21.8	22.4	6.5	163.1	13.2	7.3	118.5	10.7	22.5	202.1	712.8	203.1	5	20.2	5	93.1	93.5	27.9	5	21.4	77.1	8.4				
ST.Tr01.S06	6.1	7	0.9	memr	6.6	5	14.4	5.6	8.4	27	11	54.6	19.1	18.5	5.1	143.6	13	7.4	120.7	10.8	21.7	148.2	702.4	193.4	5	19.1	5	88.6	88.4	26.1	5	20.6	71.2	8.3				
ST.Tr01.S07	8.33	8.56	0.23	memr	6.2	5	17.2	5	7	27.5	17.8	50	17.5	16	5	153.3	11.1	7.4	120.7	10.9	21.9	170.3	589.3	201	5	18.7	5	93.6	91.6	26.8	5	20.6	65.6	7.9				
ST.Tr03.S01	4	5	1	memr	5.9	5	21.7	7.3	6.7	26.7	5.2	47.9	28.9	17.5	7.1	130.3	15.9	7.5	115.5	10.6	22.1	213.7	843.2	179.6	5	18.7	5	85.3	85.7	22.7	5	18.5	77.3	8.2				
ST.Tr03.S02	5	6	1	memr	5.6	5	11.8	8.9	8.2	26.1	10.1	66.3	26.9	35.4	10.6	128.4	15.7	7.3	113.2	10.7	21.9	99.7	835.9	174.5	5	19.2	5	84.5	82.8	21.9	5	18.2	78.3	8.6				
ST.Tr03.S03	6	7	1	memr	5	5	15.7	14.7	7.5	24.5	8.7	42	22.7	39.9	11.2	121.6	12.6	7.3	99.3	10.3	20.2	153	666.8	153.6	5	15.6	5	80	71	19.9	5	14.5	66.9	7.2				
ST.S01	-	-		memr	5	5	32.9	36.3	29.9	13.3	215.7	73.5	55.1	142.2	191.9	1179.4	5	7.9	27.3	7.5	17.1	34.4	160.9	45.6	9.6	14.9	5	22.5	26.8	7.2	24.6	9.4	19.1	5				
ST.S02	-	-		memr	5	5	29.4	34.6	26.3	26	313.8	70.1	44	218.3	152.5	1113.5	5	7.6	24.6	7.5	17	32.1	155	39.2	10.2	14.4	5	23.3	25.7	6.3	23.4	8.7	17.6	5				
A03.S01	X:0718227	Y:3346895		memr	5	5	23.2	12.6	66	22.8	10.4	81	10.4	57.4	7.2	10	5	7.4	28.4	8.3	20.7	194.5	30.9	15.9	12	5	5	7.5	6.6	2.1	5	1.2	5	5				
A03.S02	X:0718190	Y:3346858		memr	5	5	17.8	10	24.2	18.6	6.8	45.1	10.9	150.7	7	20.8	5	7.2	16.9	7.6	18.5	163.2	65.5	175.6	8.2	6.4	5	36.5	27.6	7	5	3.6	5	5				
A03.S03	X: 0718183	Y: 3346771		memr	5	5	32.8	6.5	10.6	9.8	12	57.5	5	45.2	5	21.9	5	7.4	14.7	8	18.6	283.2	33.8	7.5	5	5	5	3.4	2.5	0.8	5	0.7	5	5				
ST-Tr04-S01	0	0.7	0.7	memr	6.8	5	15.5	6.3	9.9	27.5	20.5	95	15.6	21.4	13.4	174.1	21.4	5	51.4	5	11.8	78.8	821.7	156.2	14.1	16.8	5	69.7	71.5	21.4	5	17.2	69.6	7.5	147.1	87		
ST-Tr04-S02	0.7	1.34	0.64	memr	3.4	5	35.5	14.8	14.2	19	108.1	144.6	23.3	325.1	202.1	1659	5	5.6	5.8	5	5.3	11.5	130.1	68.6	11.2	12.8	5	30.1	35.2	9.5	26.9	9.2	14.8	5	104.2	389.4		
ST-Tr04-S03	1.34	2	0.66	memr	5.7	5	19	37	16.2	27.8	113.6	77.2	56.3	179.4	88.8	805.4	5	6	5	5	5.5	9.4	103	65.4	8.1	12.1	5	36.1	34.2	9.2	17.8	10.1	11.6	5	184.8	102.2		
ST-Tr04-S04	2	2.84	0.84	memr	4.5	5	9	9	14.5	23.7	53.7	64.3	26.6	62.3	64.7	383.9	16	6.4	38.1	5	8.6	27.4	626.7	109.8	13.4	14.8	5	40.7	48	13.9	5	9.6	61.9	6.2	132.7	80		
ST-Tr04-S05	2.84	3.54	0.7	memr	6.6	5	22.4	33.5	36.4	27.8	129.8	98.5	58.7	168.8	96	903.5	5	5	5.2	5	5.1	9.1	108.4	67.2	8.4	12.2	5	34.9	35.9	10.2	19.6	11	13.1	5	173.6	159.3		
ST-Tr04-S06	4.3	5.94	1.64	memr	7.3	5	13.7	7.6	9.3	29.4	14.9	169.4	18.8	15.7	11.2	157	21.6	5	52.2	5	12.2	76.2	797.8	159.8	10.3	15.6	5	70.6	69.2	20.6	5	16.5	60.8	7.1	140	225.3		
ST-Tr04-S07	5.94	6.3	0.36	memr	8.7	5	19	11.3	13	38.3	107.4	81.4	33.4	48.8	45.5	684.7	16.6	5.1	39.3	5	10.2	33.1	634.3	144.1	14.3	18.4	5	69.6	71.3	20.8	7.5	17.7	59.1	6.2	176.1	20.4		
ST-Tr04-S08	6.3	8	1.7	memr	7.3	5	16.8	8	16.1	29	14.6	149.2	19.9	15.4	16.3	136.1	20.2	5	53.4	5	12.3	94.5	773.2	170.2	12.1	16.9	5	79.2	80.2	23.7	5	18.2	63.9	6.9	147.8	190		
ST-Tr04-S09	3.54	4.3	0.76	memr	9.3	5	32.6	37.3	19	21.1	183.1	132	53.3	175.8	148.5	1135	5	5.2	6.4	5	5.7	11.2	150.4	74.7	11.1	13.2	5	38.8	40.1	11.4	23.4	9.9	17	5	147.2	307.8		
ST-Tr05.S01	0	1	1	memr	5	5	9.4	5.5	9.2	24.8	12.7	52	25.4	20.3	26.9	105.4	19.7	9.2	41.7	5	11.4	49.1	733.9	148.5	5	19.2	5	93.2	81.8	25.2	5	18.3	78.7	7	171.7	51.2		
ST-Tr05.S02	1	1.5	0.5	memr	7.9	5	16.2	20.8	13.6	26.8	127.9	76.2	45.6	103.8	71.5	641.9	11.7	5	25.6	5	8.4	19.5	422	108.8	8.6	14.7	5	52.7	54.3	15.2	10.9	12.4	41.3	5	154.6	72.2		
ST-Tr05.S03	1.5	1.88	0.38	memr	5.2	5	7.7	6.9	207.6	21.8	39.9	54.6	24	114.1	33.5	252.1	14.6	5	33.9	5	9.3	23.1	555.2	111.9	11.9	14	5	51.4	53	15.2	5	3.6	54.7	5.4	144.2	40.1		
ST-Tr05.S04	1.88	2.31	0.43	memr	5.9	5	11.5	28.5	1587	26.4	72.8	76.8	93.7	111.3	41.2	736.9	13.9	5.6	32.5	5	34.2	27.7	527.4	109.6	10.1	14.2	5	47	47.6	13.2	5.7	12.1	53.5	5.4	203.9	36.2		
ST-Tr05.S05	3.71	4.54	0.83	memr	6.5	5	10	5	15.6	28.3	16.5	102.3	21.2	89.2	8	161	22.1	5.2	53.6	5	12.2	51.3	831.3	181.2	5	18.2	5	81.1	80.1	24	5	18.9	77.2	8	169.3	98.2		
ST-Tr05.S06	4.54	5.4	0.86	memr	6.7	5	12.2	5	10.8	27.8	19	49.2	28.9	99.6	7.4	146.3	21.6	5	51.8	5	11.8	63	815.1	187.5	5	19.5	5	85.7	86.8	26.1	5	20	79.4	8.1	161	30.5		
ST-3A				JAEC	3	5	37		72	54	203	48	60	65	171	1003	4	5	24	5	5		160	53	4	5	5	26	30	7	18	6	19			83	12664	
ST-4A				JAEC	4	5	38		80	30	225	44	64	52	167	1318	3	5	16	5	5		141	46	3	5	5	22	26	6	15	5	17			83	11736	
ST-5				JAEC	3	5	37		49	30	99	72	78	140	162	1030	4	5	15	5	5		139	45	3	4	5	21	24	6	15	6	15			95	10616	
ST-6				JAEC	3	5	33		64	49	95	45	52	69	182	1039	4	5	14	5	5		137	42	4	5	5	20	24	6	17	5	18			77	11918	
ST-7				JAEC	3	5	38		13	53	141	44	49	80	190	1057	4	5	15	5	5		145	44	4	5	5	21	25	6	18	6	17			71	11708	
S.T.Tr 06A-1	4.1	4.85	0.75	MEMR					32.9		165.5	78.4	60.2			1199							349.8													155.9		695.5
S.T.Tr 06A-2	6	7	1	MEMR					75.6		234.9	99.1	86.6			1227							168													286		1251
S.T.Tr 06A-3	9	10	1	MEMR					27		258.5	107	78.4			1218							185.3													308.6		1434
S.T.Tr 06A-4	11.5	12.5	1	MEMR					27.6		235.6	62.4	62			872.6							145.8													69.2		494.2
S.T.Tr 06A-5	13	13.35	0.35	MEMR					42.4		162.4	31.1	53.9			830.8							398.7													51.7		342.4
S.T.Tr 06A-6	13.35	15	1.65	MEMR					2.7		20.1	15.6	20.5			75.2							612													45.7		123.8
S.T.Tr 06A-7	15.95	16.75	0.8	MEMR					124.8		310.7	52	88.6			1455							244.4													65		380.7
S.T.Tr 06A-8	17	17.15	0.15	MEMR					84.6		332.8	46.8	78.2			1354							231.3													77.4		462
S.T.Tr 06B-1	0	1	1	MEMR					**3.2**		**19.8**	**13.6**	**26.5**			**114.9**							**659.1**													**39.1**		**253.4**
S.T.Tr 06B-2	1	1.4	0.4	MEMR					**14.3**		**170.5**	**55.3**	**26.4**			**738.6**							**111**													**68.4**		**1199**
S.T.Tr 06B-3	1.9	2.36	0.46	MEMR					**48.9**		**150.9**	**65.5**	**23.3**			**701.3**							**131.8**													**88.1**		**1080**
S.T.Tr 06B-4	2.36	4.5	2.14	MEMR					**13.8**		**38**	**14.3**	**17.7**			**97.7**							**493.4**													**23.8**		**767.5**
S.T.Tr 06B-5	4.5	6	1.5	MEMR					**24**		**23.2**	**18.9**	**21.5**			**64**							**370.8**													**22.4**		**1173**
S.T.Tr 06B-6	9.9	10.7	0.8	MEMR					281.6		146.4	33.4	78.2			748.6							275.3													64.5		828.3
S.T.Tr 06B-7	10.7	11.5	0.8	MEMR					33.9		200.9	42.1	63.1			744.7							151.2													81.1		1686
S.T.Tr 06B-8	11.5	11.7	0.2	MEMR					55.2		240.5	52.7	52.6			1245							178.8													104.8		1003
S.T.Tr 06C-1	18.25	19	0.75	MEMR					16.4		18.5	24.8	34.5			95.7							657.6													44.3		561.8
S.T.Tr 06C-2	19	20	1	MEMR					9.8		18.3	24.9	34.7			120.7							735.8													60		393.5
S.T.Tr 06D-1	0	3	3	MEMR					26.9		230.1	95.6	54			1000							168.4													255.8		616.2
S.T.Tr 06D-2	3	5	2	MEMR					48.9		82.9	93.6	42.5			859.1							401.4													267.6		514.9
S.T.Tr 06D-3	5	6	1	MEMR					121.8		18.1	133.1	38.8			153.1							776.5													657.9		175.2
S.T.Tr 06D-4	6	7	1	MEMR					19.6		18.6	81	28.7			116.2							727													319.2		366.5
S.T.Tr 06D-5	7	8	1	MEMR					22.4		43.9	82	28			297.2							469.4													329		478
S.T.Tr 06D-6	8	10	2	MEMR					35.9		18.2	81.2	28.9			107							351.7													171		557
S.T.Tr 06D-7	10	12	2	MEMR					197.7		58.5	103.8	53.2			672.3							546.3													345.4		384.5
S.T.Tr 06D-8	12	13	1	MEMR					23.2		13.6	152.3	27.7			155.5							698.7													774.2		177.9
S.T.Tr 06D-9	13	15	2	MEMR					16.8		9.7	87.3	41.6			152.1							856.9													434.9		207.9
S.T.Tr 06D-10	8	10	2	MEMR					20.8		7.7	73	13.4			73.5							87.2													157.3		555.5
S.T.Tr 08-1	0	2	2	MEMR					**55.1**		**21.9**	**56.5**	**25.8**			**183.4**							**169.1**													**97.8**		**162.7**
S.T.Tr 08-2	2	4	2	MEMR					**62.2**		**51.8**	**71.2**	**33.5**			**236**							**182.3**													**114.8**		**317.7**
S.T.Tr 08-3	4	6	2	MEMR					**93.5**		**16.1**	**82.9**	**20.1**			**109.4**							**241.6**													**117.8**		**488.5**
S.T.Tr 08-4	6	8	2	MEMR					**146.2**		**37.2**	**74.2**	**307.8**			**1384**							**249.9**													**91.1**		**620.2**
S.T.Tr 08-5	8	9	1	MEMR					**96.7**		**51.6**	**72.6**	**79.3**			**844.3**							**396.1**													**131.2**		**431.4**
S.T.Tr 08-6	9	10	1	MEMR					**6.2**		**11.9**	**44.8**	**25.2**			**129.6**							**618.3**													**122.8**		**279.7**
S.T.Tr 08-7	10	12	2	MEMR					**6.1**		**9.8**	**41.2**	**19.9**			**120.9**							**578.1**													**109**		**73.8**

8.2.3 XRF Results

S.ID.	From	To	Fe2O3 Wt.%	MnO Wt.%	TiO2 Wt.%	CaO Wt.%	K2O Wt.%	SO3 Wt.%	SiO2 Wt.%	Al2O3 Wt.%	MgO Wt.%	Na2O Wt.%	L.O.I Wt.%
ST-TR01- S01	1	1.33	3.15	<0.050	0.21	0.33	4.48	0.035	76.07	10.48	0.5	3.15	1.34
ST-TR01- S02	3	4	2.98	<0.050	0.2	0.48	4.31	0.029	76.29	10.32	0.31	3.62	1.22
ST-TR01- S03	4	5	3.05	<0.050	0.21	0.44	4.52	0.018	76.09	10.51	0.49	3.25	1.2
ST-TR01- S04	5	5.63	3.07	<0.050	0.22	0.64	4.32	0.045	76.13	10.14	0.5	3.11	1.6
ST-TR01- S05	5.63	6.1	3.16	<0.050	0.21	0.44	4.51	0.071	75.98	10.29	0.47	3.19	1.45
ST-TR01- S06	6.1	7	2.92	< 0.050	0.21	0.47	4.61	0.021	76.08	10.36	0.39	3.31	1.33
ST-TR01- S07	8.33	8.56	3.03	< 0.050	0.2	0.53	4.6	0.013	75.9	10.38	<0.28	3.68	1.16
S.T. Tr02-S# 01	1.17	1.34	3.59	<0.050	0.22	2.36	3.54	< 0.060	74.68	8.54	0.5	2.61	3.91
S.T. Tr02-S# 02	1.34	3	2.88	< 0.050	0.19	1.57	3.84	< 0.060	76.51	9.08	0.77	2.77	2.36
S.T. Tr02-S# 03	3	4.22	2.93	0.062	0.22	2.02	3.92	< 0.060	74.4	9.52	0.79	2.97	3.16
S.T. Tr02-S# 04	4.22	6.36	3	0.053	0.2	1.64	3.98	< 0.060	75.08	9.92	0.48	3.41	2.23
S.T. Tr02-S# 05	6.36	8.14	2.91	0.057	0.2	1.32	4.28	< 0.060	75.18	10.11	0.65	3.28	2.02
S.T. Tr02-S# 06	8.14	9.5	2.95	< 0.050	0.21	1.3	4.3	< 0.060	75.09	10.06	0.7	2.68	2.65
S.T. Tr02-S# 07	9.5	10	3	0.066	0.21	1.67	4.21	< 0.060	74.56	10.02	0.54	2.92	2.79
ST-Tr03- S01	4	5	3.05	<0.050	0.21	0.31	4.95	0.083	76.43	10.48	0.29	2.9	1.06
ST-Tr03- S02	5	6	2.86	< 0.050	0.2	1.16	4.7	0.091	74.9	10.12	0.59	2.25	2.89
ST-Tr03- S03	6	7	2.96	< 0.050	0.2	1.42	5.11	1.02	72.88	9.79	0.69	1.72	3.87
ST-S01	-	-	11.05	0.3	1.96	2.71	3.76	0.52	39.5	15.21	8.91	2.19	12.37
ST- S02	-	-	11.02	0.33	1.95	3.91	4.11	0.085	40.7	15.05	10.49	1.49	9.76
A03-S01	-	-	0.71	0.073	0.036	0.58	5.41	0.019	73.61	14.29	0.31	3.31	1.41
A03- S02	-	-	0.59	<0.050	0.85	0.44	4.62	0.05	72.93	14.09	<0.28	4.09	1.27
A03- S03	-	-	0.3	<0.050	0.029	0.48	1.86	0.022	88.49	5.93	<0.28	1.54	0.94
S.T.Tr 04- 1	0	0.7	3.04	0.058	0.21	2.17	4.06	0.22	73.44	9.88	0.34	3.76	2.61
S.T.Tr 04- 2	0.7	1.34	10.37	0.22	1.77	5.16	3.20	0.16	45.63	15.27	8.65	1.44	6.77
S.T.Tr 04- 3	1.34	2	8.95	0.33	1.22	16.51	5.90	0.005	32.97	10.25	6.39	0.17	16.36
S.T.Tr 04- 4	2	2.84	3.58	0.46	0.26	9.31	4.17	0.073	60.16	8.43	2.19	1.54	9.51
S.T.Tr 04- 5	2.84	3.54	8.62	0.27	1.29	12.97	6.29	0.040	37.30	11.29	7.00	0.34	13.53
S.T.Tr 04- 6	4.3	5.94	3.08	0.05	0.20	0.53	5.21	0.069	75.40	10.41	0.28	3.26	1.40
S.T.Tr 04- 7	5.94	6.3	5.70	0.16	0.60	0.90	4.87	0.052	67.69	11.55	2.78	2.64	2.66
S.T.Tr 04- 8	6.3	8	3.14	0.05	0.20	0.72	4.24	0.23	75.59	10.28	<0.28	4.05	1.20
S.T.Tr 04- 9	3.54	4.3	9.58	0.34	1.62	4.93	5.19	0.10	44.80	13.63	9.56	0.93	8.10
S.T Tr 05-01	0	1	3.67	0.052	0.18	0.81	5.32	0.14	75.67	10.23	0.42	1.88	1.62
S.T Tr 05-02	1	1.5	6.21	0.17	0.77	5.77	4.33	2.23	55.80	11.16	3.93	1.99	7.30
S.T Tr 05-03	1.5	1.88	2.87	0.18	0.26	8.11	4.48	3.90	59.96	8.58	1.45	1.48	8.68
S.T Tr 05-04	1.88	2.31	4.17	0.15	0.45	4.93	5.92	2.91	61.76	9.64	2.69	0.63	6.59
S.T Tr 05-05	3.71	4.54	3.04	0.051	0.20	1.21	4.39	0.76	73.82	10.14	0.53	3.28	2.56
S.T Tr 05-06	4.54	5.4	2.90	< 0.050	0.19	2.03	4.31	1.23	72.27	9.80	0.52	<0.34	3.52
S.T.Tr 06A-1	4.1	4.85	8.68	0.47	0.97	2.96	3.74	2.47	51.3	10.96	7.85	1.63	8.01
S.T.Tr 06A-2	6	7	11.26	0.51	1.44	2.8	3.33	1.78	42.2	12.73	12.73	1.15	8.8
S.T.Tr 06A-3	9	10	10.35	0.47	1.45	3.97	3.81	1.15	42.12	12.71	12.97	1.07	8.87
S.T.Tr 06A-4	11.5	12.5	7.83	0.34	1.35	8.94	2.69	10	32.9	10.71	8.01	1.06	15.14
S.T.Tr 06A-5	13	13.35	7.19	0.3	1.1	1.55	3.15	4.75	56.68	12.04	4.64	3.27	4.75
S.T.Tr 06A-6	13.35	15	2.72	0.054	0.18	2.06	4.2	0.95	72.4	10.23	0.38	3.38	3.33
S.T.Tr 06A-7	15.95	16.75	10.07	0.6	2.01	3.41	1.94	1.27	46.82	14.05	9.33	3.02	6.77
S.T.Tr 06A-8	17	17.15	10.75	0.6	2.37	1.9	2.42	0.13	45.83	15.8	9.94	2.78	6.68
S.T.Tr 06B-1	0	1	2.81	0.077	0.19	2.56	4.21	1	71.58	9.52	0.68	2.49	4.76
S.T.Tr 06B-2	1	1.4	9.2	0.65	1.36	12.38	3.66	0.33	36.78	12.01	7.36	1.49	14.41
S.T.Tr 06B-3	1.9	2.36	8.05	0.56	1.21	15.24	4.77	0.23	34.82	11.45	6.8	0.72	15.77
S.T.Tr 06B-4	2.36	4.5	2.92	0.41	0.17	10.18	5.72	0.12	61.68	8.05	0.99	<0.34	9.63
S.T.Tr 06B-5	4.5	6	2.31	1.76	0.1	19.61	4.49	0.23	47.46	5.75	1	<0.34	17.2
S.T.Tr 06B-6	9.9	10.7	7.55	0.49	1.24	9.5	3.86	1.95	45.02	11.36	5.86	1.36	11.1
S.T.Tr 06B-7	10.7	11.5	9.9	0.45	2.09	4.56	4.21	0.97	42.74	16.14	8.1	2.03	7.82
S.T.Tr 06B-8	11.5	11.7	8.63	0.42	2.13	3.35	3.5	1.18	44.08	15.52	9.5	2.62	8.06
S.T.Tr 06C-1	18.25	19	2.51	0.84	0.16	7.95	5.16	0.087	64.26	8.6	0.79	1.04	8.61
S.T.Tr 06C-2	19	20	2.81	0.27	0.18	4.69	4.86	1	68.77	9.29	0.61	1.81	5.71
ST.Tr 6D-1	0	3	7.49	0.38	2.05	6.40	5.55	0.53	41.14	15.14	9.86	0.34	11.60
ST.Tr 6D-2	3	5	6.76	0.23	1.25	5.79	4.51	0.28	50.05	12.93	4.89	0.34	12.39
ST.Tr 6D-3	5	6	4.33	0.058	0.21	1.13	5.51	0.06	73.70	10.71	0.35	1.67	2.32
ST.Tr 6D-4	6	7	3.22	0.13	0.19	3.54	6.96	0.06	71.83	9.60	0.65	0.34	4.40
ST.Tr 6D-5	7	8	3.03	0.33	0.36	13.44	5.05	0.084	55.13	8.14	1.84	0.34	13.06
ST.Tr 6D-6	8	10	2.78	2.90	0.11	25.20	3.30	0.27	38.00	4.69	0.49	0.34	21.42
ST.Tr 6D-7	10	12	6.59	0.20	0.84	2.18	5.74	0.11	63.55	12.24	2.75	1.47	4.26
ST.Tr 6D-8	12	13	4.64	0.10	0.21	2.87	4.05	0.06	71.88	9.98	0.40	2.79	3.02
ST.Tr 6D-9	13	15	3.83	0.093	0.19	1.46	5.10	0.06	74.50	10.24	0.44	1.64	2.48
ST.Tr 6D-10	8	10	1.03	1.39	0.059	47.10	0.95	0.26	9.92	1.63	0.27	0.34	36.91
ST.Tr8-1	0	2	9.37	0.16	2.83	5.53	0.41	2.95	46.98	11.06	7.65	0.34	11.56
ST.Tr8-2	2	4	14.13	0.22	2.83	7.28	1.07	0.16	45.37	10.53	7.44	0.64	9.30
ST.Tr8-3	4	6	13.59	0.22	4.03	6.90	1.87	ND	46.24	15.25	4.75	2.57	3.21
ST.Tr8-4	6	8	14.81	0.50	4.07	5.56	3.91	ND	43.01	13.96	4.72	2.34	5.83
ST.Tr8-5	8	9	9.56	0.24	2.46	3.95	3.62	1.36	55.76	12.04	3.80	1.86	4.42
ST.Tr8-6	9	10	3.46	0.05	0.22	1.27	5.05	0.34	75.81	9.97	0.28	1.82	1.42
ST.Tr8-7	10	12	3.25	0.05	0.20	2.72	3.71	2.29	70.40	9.57	0.30	2.81	4.34

8.2.4 XRD Results

Sample ID	From	To	Phase Identification			Uncertainty (if required)
			Major	Minor	Trace	
Tr0l-S1	1	1.33	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Hematite	NA
Tr0l-S2	3	4	Quartz, Feldspar(Albite, Microcline)	-	Hematite, Clay	NA
Tr0l-S3	4	5	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Hematite, Clay	NA
Tr01-S4	5	5.63	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Hematite, Clay	NA
Tr01-S5	5.63	6.1	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Hematite	NA
Tr0l-S6	6.1	7	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Clay	NA
Tr0l-S7	8.33	8.56	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Clay	NA
T03-S1	4	5	Quartz, Feldspar(Albite, Microcline)	-	-	NA
T03-S2	5	6	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Hematite	NA
T03-S3	6	7	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Gypsum, Hematite	NA
ST-S0l	-	-	This sample is amorphous			NA
ST-S02	-	-	Feldspar(Microcline, Orthoclase), Hematite, Augite, Faujasite	Chlorite, calcite	-	NA
A03-S1	-	-	Quartz, Feldspar(Albite, Microcline, Orthoclase)	-	Muscovite	NA
A03-S2	-	-	Quartz, Feldspar(Albite, Microcline)		Muscovite	NA
A03-S3	-	-	Quartz	Feldspar(Albite, Microcline, Orthoclase)	Muscovite	NA
ST.Tr6-10	-	-	Calcite		Quartz	NA
ST.BH3-5	-	-	Quartz, Feldspar(Albite, Microcline)		Hematite	NA
ST.Tr8-4	-	-	Anorthite, Feldspar(Albite, Microcline)	Augite	Quartz, Hematite	NA
ST.Tr8-6	-	-	Feldspar(Albite, Microcline), Quartz		Gypsum, Hematite	NA