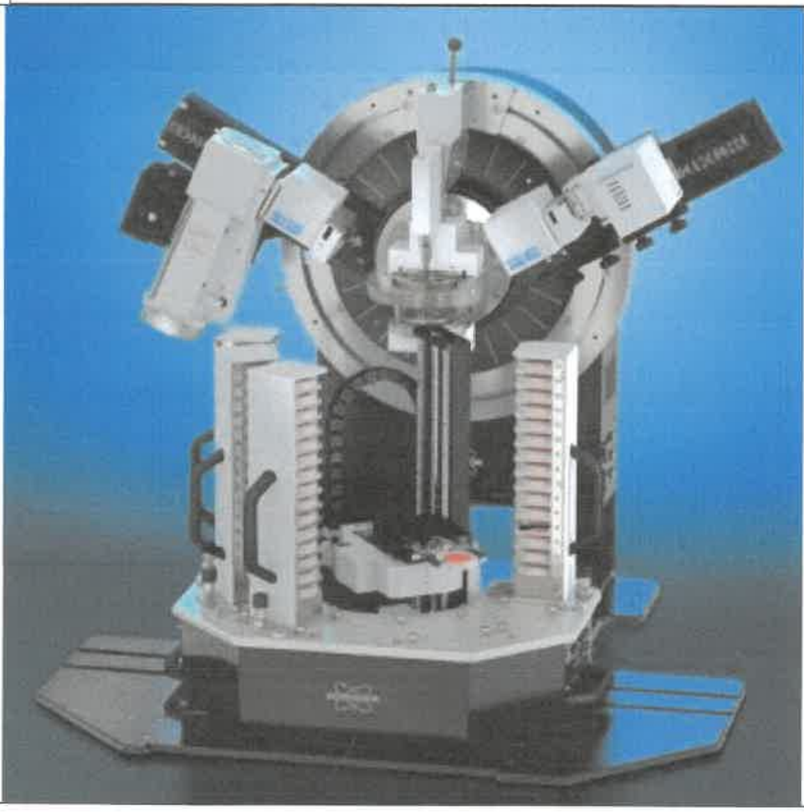
Customer Name: Mr. K. Nageswara Rao.
Customer Address: Critical Minerals Trackers, Mineral Exploration and Geo Solution, #Concourse, No 406,7-1-58/CC/406, Opp. Lal Bungalow, Greenland's, Hyderabad -500016 India.
Customer Ref : CMT/011/75/2025
Lab ID : G2803-4
Date of Sample Analysis :17/10/2025
Date of Reporting :23/10/2025

MINERALOGY TEST REPORT

1.60 KW POWDER X RAY DIFRACTOMETER METHOD



INTRODUCTION: X-ray diffraction (XRD) and petrology studies are both valuable techniques used in geology and materials science for analysing minerals and rocks, but they serve different purposes and offer unique advantages. Here's how XRD is superior to petrology studies in certain aspects. XRD excels in identifying crystalline minerals present in a sample. It provides precise information about the crystal structure and lattice parameters of minerals, which can be challenging to ascertain solely through petrological observations. XRD allows for quantitative analysis of mineral phases present in a sample, providing accurate estimates of mineral composition based on peak intensities. Petrology studies, while descriptive, may not always provide quantitative data on mineral abundance. XRD is highly sensitive and can detect trace amounts of minerals present in a sample, even at concentrations as low as a few percent. Powder Diffraction (XRD) Database, contains a comprehensive collection of more than 6000 diffraction patterns for various materials. Researchers use this resource for identifying unknown substances, confirming crystal structures, and conducting material characterization. Shiva Analyticals team has decades of experience on XRD studies. Accurate chemical assay coupled with reliable mineralogy information is vital in resource characterisation.

Sample Code: G2803-4 (CMT/011/75/2025)

Instruments: WDXRF – Bruker S8 Tiger Series 2 (4 kW); XRD – Bruker D8 Advance (1.6 kW).
2θ Scan Range: 5–80° | Crystallinity: 68.40% | Amorphous: 31.60% |

Bulk Oxides by WDXRF:

Oxide	Wt.%
Al2O3	12.05
BaO	<0.05
CaO	11.41
Cr2O3	0.16
Fe2O3	12.11
K2O	0.77
MgO	13.03
MnO	0.10
Na2O	1.89
P2O5	0.27
SiO2	45.26
SO3	<0.05
SrO	<0.05
TiO2	2.00
V2O5	<0.05
ZrO2	<0.05
HfO2	<0.05
CuO	<0.05
NiO	0.06
PbO	<0.05
ZnO	<0.05
LOI	0.74

Mineral Phases by XRD:

Sl.no	Mineral Phase	Chemical Formula	XRD Wt.%	XRD Crystalline Wt % (XRD Wt.% ×0.684)	Molecular Weight (g/mol)
1	Diopside	$CaMgSi_2O_6$	0.73	0.50	216.55
2	Hedenbergite	$CaFeSi_2O_6$	24.67	16.87	248.09
3	Augite	$(Ca,Mg,Fe)Si_2O_6$	0.38	0.26	236.35
4	Forsterite	Mg_2SiO_4	6.54	4.47	140.69
5	Qandilite	Mg_2TiO_4	0.55	0.38	179.98
6	Hydrogarnet	$Ca_3Al_2(OH)_{12}$	1.04	0.71	358.30
7	Aegirine augite	$(Na,Ca)(Fe,Mg)Si_2O_6$	0.27	0.18	239.50
9	Anorthite	$CaAl_2Si_2O_8$	3.6	2.46	278.21

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10	Chromite	$FeCr_2O_4$	0.46	0.31	223.84
11	Quartz	SiO_2	2.24	1.53	60.08
Sl.no	**Mineral Phase**	**Chemical Formula**	**XRD Wt.%**	**(XRD Wt.% ×0.684)**	**Molecular Weight (g/mol)**
12	Ankerite	$Ca(Fe,Mg)(CO_3)_2$	0.48	0.33	206.39
13	Muscovite 2M1	$KAl_2(AlSi_3O_{10})(OH)_2$	1.9	1.30	398.30
14	Clinochlore	$(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$	6.63	4.53	595.22
15	Lizardite-1T	$Mg_3Si_2O_5(OH)_4$	8.54	5.84	277.11
16	Periclase	MgO	0.72	0.49	40.30
17	Fassaite	$(Ca,Mg,Al)(Si,Al)_2O_6$	0.71	0.49	236.35
18	Labradorite An65	$(Ca,Na)(Al,Si)_4O_8$	10.29	7.04	271.81
19	Magnetite	Fe_3O_4	5.14	3.52	231.53
20	Aegirine	$NaFeSi_2O_6$	0.87	0.60	231.00
21	Jadeite	$NaAlSi_2O_6$	0.19	0.13	201.20
22	Phlogopite	$KMg_3(AlSi_3O_{10})(OH)_2$	1.08	0.74	419.25
23	Andesine An50	$(Na,Ca)(Al,Si)_4O_8$	22.97	15.71	268.62
Total			**100**	**68.40**	

Stoichiometric Comparison Table:

Oxides	XRF (wt%)	XRD crystallinity (wt%)	Amorphous (wt%)
SiO2	45.26	30.26	15.00
Al2O3	12.05	9.16	2.89
Fe2O3	12.11	9.33	2.78
MgO	13.03	7.49	5.54
CaO	11.41	8.59	2.82
Na2O	1.89	1.34	0.55
K2O	0.77	0.18	0.59
TiO2	2.00	0.25	1.75
Cr2O3	0.16	0.11	0.05
CO2	0.00	0.15	-0.15
H2O	0.00	1.53	-1.53
Traces	1.32	0.00	1.32

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Interpretation

- The analyzed sample is a mafic-ultramafic rock characterized by high SiO_2 (45.26%), MgO (13.03%), Fe_2O_3 (12.11%), CaO (11.41%), and Al_2O_3 (12.05%), with minor alkalis and trace elements indicating a plagioclase and Ca-pyroxene-rich composition.
- XRD analysis reveals dominant Hedenbergite, Diopside, Forsterite, Labradorite, and Andesine, along with secondary hydrous and alteration phases such as Clinochlore, Lizardite, Phlogopite, Hydrogarnet, and Ankerite, reflecting low-grade hydrothermal or metamorphic overprint.
- The rock exhibits partial crystallinity with a significant amorphous fraction particularly in SiO_2, MgO, TiO_2, and Fe_2O_3, suggesting the presence of fine-grained or glassy silicates from rapid cooling or alteration. Minor accessory phases, including magnetite, chromite, and Ti-bearing minerals, host trace metals like Cr, V, and Ni.
- Overall, the sample represents a partially crystalline, plagioclase- and pyroxene-dominated mafic-ultramafic rock with evidence of secondary alteration and significant amorphous material

Suggested minor/Secondary mineral phases

The amorphous fraction is primarily glassy interstitial silicates with secondary alteration products (serpentine, chlorite, hydrogarnet) and minor Ti/Fe-bearing phases.

Potential commercial uses

Component	Application
High MgO	Forsterite and pyroxenes provide high-temperature stability for furnace linings and refractory bricks
High CaO	Calcium-rich phases like plagioclase and ankerite can react with CO_2 for mineral carbonation
High SiO_2 and Al_2O_3	Suitable for ceramic tiles, porcelain, and specialty glass production
Pyroxene, Olivine, Diopside	Hard silicate minerals can be ground for abrasive powders or fillers in construction and polymers
Forsterite, Clinochlore	Mg-bearing minerals can be processed to obtain magnesium oxide or other Mg-based products

Probable origin assessment

The sample likely represents a mafic-ultramafic cumulate formed from a mantle-derived, Mg- and Ca-rich magma, as indicated by dominant Ca-pyroxenes, plagioclase, and forsterite. The significant amorphous fraction (31.60%) suggests rapid cooling or partial devitrification, while the presence of clinochlore, lizardite, hydrogarnet, and ankerite points to low-grade hydrothermal or metamorphic alteration. Minor spinel and Fe-Ti oxides hosting Cr, Ni, and Ti indicate crystallization from a metal-bearing mafic melt.

Final Results

- Rock Type and Composition: The sample is a mafic-ultramafic rock, rich in SiO_2 (45.26%), MgO (13.03%), Fe_2O_3 (12.11%), CaO (11.41%), and Al_2O_3 (12.05%), dominated by Ca-pyroxenes, plagioclase, and forsterite.

- Crystallinity and Amorphous Content: XRD shows partial crystallinity (68.40%) with a significant amorphous fraction (31.60%), mainly consisting of glassy silicates and poorly crystalline Mg-, Fe-, and Ti-bearing phases.
- Secondary/Alteration Phases: Presence of clinochlore, lizardite, hydrogarnet, and ankerite indicates low-grade hydrothermal or metamorphic alteration.
- Accessory Minerals: Minor spinel, magnetite, and Fe-Ti oxides host trace metals like Cr, Ni, Ti, and V, reflecting a metal-bearing mafic melt origin.
- The rock likely formed as a mantle-derived mafic-ultramafic cumulate with subsequent alteration

Stoichiometric Oxide Table

Mineral Name	Mineral Formula	XRD	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	Cr2O3	CO2	H2O
Diopside	$CaMgSi_2O_6$	0.50	0.28	0.00	0.00	0.09	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Hedenbergite	$CaFeSi_2O_6$	16.87	7.54	0.00	4.77	0.00	4.56	0.00	0.00	0.00	0.00	0.00	0.00
Augite	$(Ca,Mg,Fe)Si_2O_6$	0.26	0.10	0.00	0.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Forsterite	Mg_2SiO_4	4.47	1.91	0.00	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Qandilite	Mg_2TiO_4	0.38	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Hydrogarnet	$Ca_3Al_2(OH)_{12}$	0.71	0.00	0.24	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.07
Aegirine augite	$(Na,Ca)(Fe,Mg)Si_2O_6$	0.18	0.11	0.00	0.04	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Anorthite	$CaAl_2Si_2O_8$	2.46	1.07	0.81	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00
Chromite	$FeCr_2O_4$	0.31	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
Quartz	SiO_2	1.53	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ankerite	$Ca(Fe,Mg)(CO_3)_2$	0.33	0.00	0.00	0.05	0.07	0.06	0.00	0.00	0.00	0.00	0.15	0.00
Muscovite 2M1	$KAl_2(AlSi_3O_{10})(OH)_2$	1.30	0.60	0.45	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.15
Clinochlore	$(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$	4.53	1.35	0.78	0.50	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.53
Lizardite01T	$Mg_3Si_2O_5(OH)_4$	5.84	2.55	0.00	0.00	2.55	0.00	0.00	0.00	0.00	0.00	0.00	0.74
Periclase	MgO	0.49	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fassaite	$(Ca,Mg,Al)(Si,Al)_2O_6$	0.49	0.14	0.20	0.00	0.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Labradorite An65	$(Ca,Na)(Al,Si)_4O_8$	7.04	3.65	2.05	0.00	0.00	1.04	0.30	0.00	0.00	0.00	0.00	0.00
Magnetite	Fe_3O_4	3.52	0.00	0.00	3.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aegirine	$NaFeSi_2O_6$	0.60	0.31	0.00	0.19	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Jadeite	$NaAlSi_2O_6$	0.13	0.05	0.03	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
Phlogopite	$KMg_3(AlSi_3O_{10})(OH)_2$	0.74	0.33	0.14	0.00	0.15	0.00	0.00	0.08	0.00	0.00	0.00	0.04
Andesine An50	$(Na,Ca)(Al,Si)_4O_8$	15.71	8.74	4.46	0.00	0.00	1.63	0.88	0.00	0.00	0.00	0.00	0.00
	Total	**68.40**	**30.26**	**9.16**	**9.33**	**7.49**	**8.59**	**1.34**	**0.18**	**0.25**	**0.11**	**0.15**	**1.53**

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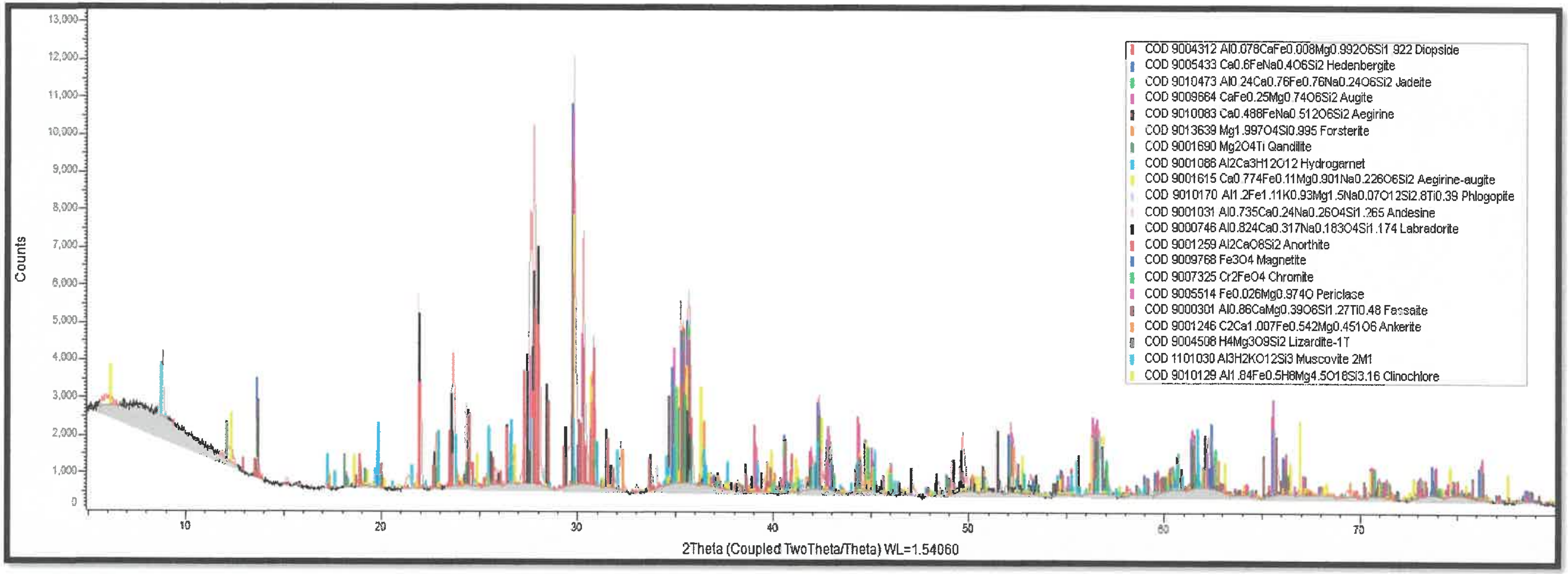
BRUKER D8 ADVANCE XRD TEST DATA

G2803-4 | CMT/011/75/2025 | XRD Scan Report_1 of 2



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BRUKER D8 ADVANCE XRD TEST DATA

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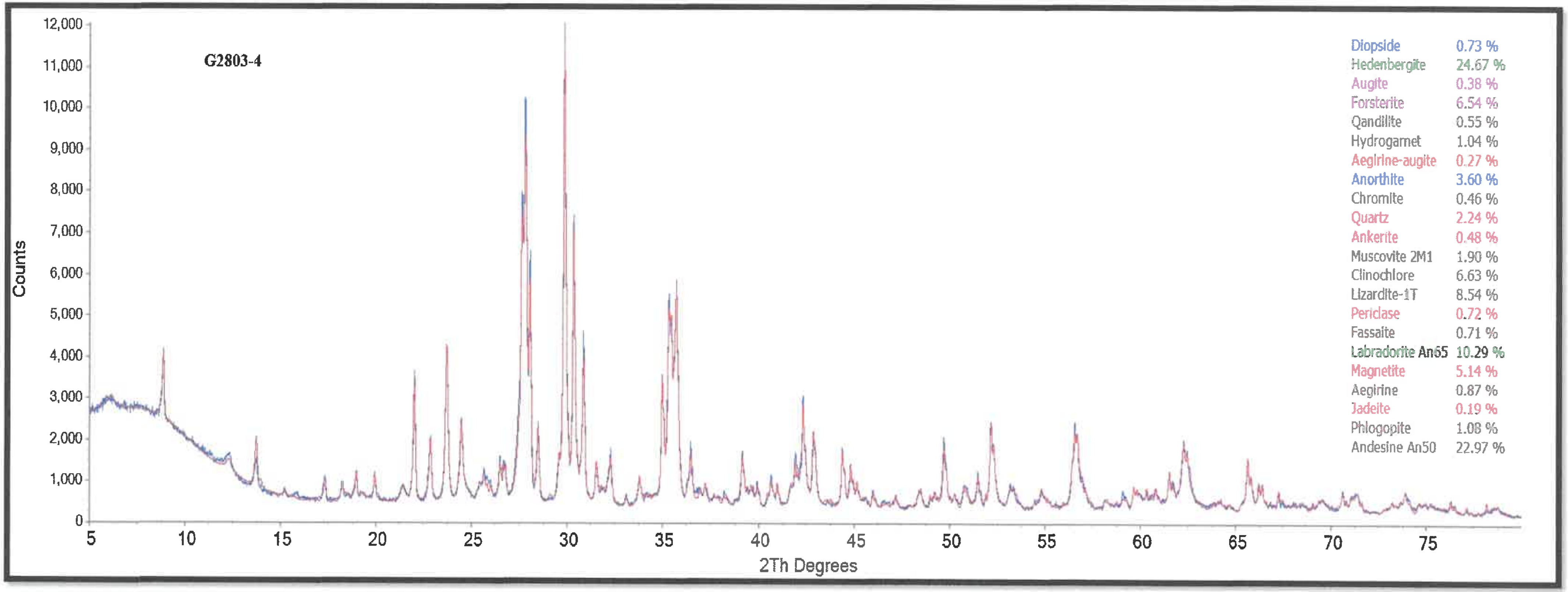

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