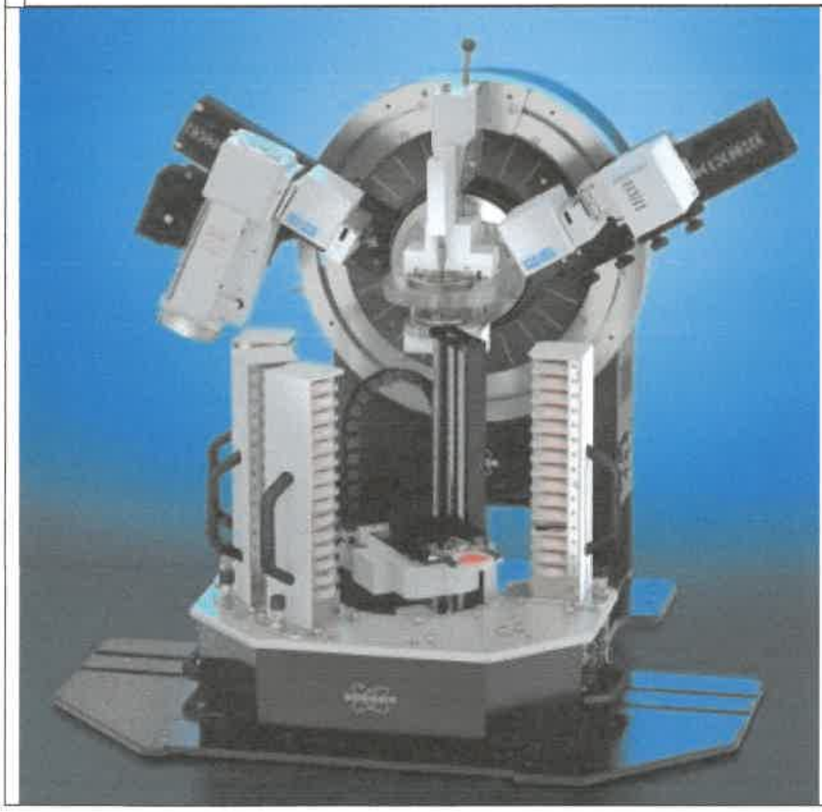
Customer Name: Mr. K. Nageswara Rao.
Customer Address: Critical Minerals Trackers, Mineral Exploration and Geo Solution, #Concourse, No 406,7-1-58/CC/406, Opp. Lal Bungalow, Greenland's, Hyderabad -500016 India.
Customer Ref : CMT/011/29/2025
Lab ID : G2803-3
Date of Sample Analysis :17/10/2025
Date 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: G2803-3(CMT/011/29/2025)

Instruments: WDXRF – Bruker S8 Tiger Series 2 (4 kW); XRD – Bruker D8 Advance (1.6 kW).
2θ Scan Range: 5–80° | Crystallinity: 64.20% | Amorphous: 35.80% |

Bulk Oxides by WDXRF:

Oxide	Wt.%
Al2O3	10.34
BaO	<0.05
CaO	10.24
Cr2O3	0.24
Fe2O3	11.83
K2O	0.62
MgO	16.07
MnO	0.12
Na2O	1.49
P2O5	0.21
SiO2	43.92
SO3	<0.05
SrO	<0.05
TiO2	1.61
V2O5	<0.05
ZrO2	<0.05
HfO2	<0.05
CuO	<0.05
NiO	0.09
PbO	<0.05
ZnO	<0.05
LOI	3.04

Mineral Phases by XRD:

Sl.no	Mineral Phase	Chemical Formula	XRD Wt.%	XRD Crystalline Wt % (XRD Wt.% ×0.642)	Molecular Weight (g/mol)
1	Diopside	$CaMgSi_2O_6$	4.96	3.18	216.55
2	Hedenbergite	$CaFeSi_2O_6$	1.78	1.14	248.09
3	Aegirine	$NaFeSi_2O_6$	0.64	0.41	231.00
4	Augite	$(Ca,Na)(Mg,Fe)Si_2O_6$	10.87	6.98	236.35
5	Olivine	$(Mg,Fe)_2SiO_4$	0.8	0.51	153.31
6	Enstatite	$MgSiO_3$	3.06	1.96	100.39
7	Pigeonite	$(Ca,Mg,Fe)Si_2O_6$	2.7	1.73	226.50

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Sl.no	Mineral Phase	Chemical Formula	XRD Wt.%	(XRD Wt.% ×0.642)	Molecular Weight (g/mol)
8	Labradorite	$(Ca,Na)(Al,Si)_4O_8$	19.86	12.75	271.81
9	Andesine An50	$(Na,Ca)(Al,Si)_4O_8$	11.89	7.63	268.62
10	Forsterite	Mg_2SiO_4	2.84	1.82	140.69
11	Chayesite	$K(Mg,Fe)_4Fe^{3+}Si_{12}O_{30}$	3.66	2.35	1040.72
12	Chlorite	$(Mg,Fe)_3(Si,Al)_4O_{10}(OH)_8$	4.84	3.11	595.22
13	Analcime	$NaAlSi_2O_6{\cdot}H_2O$	2.57	1.65	220.15
14	Magnetite	Fe_3O_4	0.72	0.46	231.53
15	Magnesioferrite	$MgFe_2O_4$	0.68	0.44	200.00
16	Titanite	$CaTiSiO_5$	2.89	1.86	197.76
17	Hydrogarnet	$Ca_3Al_2(SiO_4)_{3-x}(OH)_{4x}$	1.85	1.19	414.37
18	Lizardite	$Mg_3Si_2O_5(OH)_4$	0.6	0.39	277.11
19	Antigorite	$Mg_3Si_2O_5(OH)_4$	4.13	2.65	300.77
20	Phillipsite-Ca	$Ca_3(Si_{10}Al_6)O_{32}{\cdot}12H_2O$	2.15	1.38	1043.9
21	Illite	$KAl_2(Si_3Al)O_{10}(OH)_2$	12.46	8.00	398.31
22	Quartz	SiO_2	4.05	2.60	60.08
Total			**100**	**64.20**	

Stoichiometric Comparison Table:

Oxides	XRF (wt%)	XRD crystallinity (wt%)	Amorphous (wt%)
SiO2	43.92	30.63	13.29
Al2O3	10.34	8.89	1.45
Fe_2O_3	11.83	3.38	8.45
MgO	16.07	9.17	6.90
CaO	10.24	6.35	3.89
Na2O	1.49	1.18	0.31
K2O	0.62	1.04	-0.42
TiO2	1.61	0.72	0.89
H2O	0.00	2.83	-2.83
Traces	3.88	0.00	3.88

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Interpretation

- Bulk geochemistry reveals dominance of SiO_2 (43.92 wt%), MgO (16.07 wt%), Fe_2O_3 (11.83 wt%), and CaO (10.24 wt%), with minor alkalis (Na_2O 1.49 wt%, K_2O 0.62 wt%) and trace oxides.
- XRD identifies primary crystalline phases dominated by plagioclase (Labradorite 19.86 wt%, Andesine 11.89 wt%) and clinopyroxenes (Augite 10.87 wt%, Diopside 4.96 wt%), alongside olivine, enstatite, and minor titanite.
- Secondary hydrous minerals, including serpentine-group phases (Antigorite, Lizardite), chlorite, chayesite, phillipsite, and illite, account for alteration features.
- Stoichiometric comparison between XRF and XRD indicates 35.80 wt% of the sample is amorphous or poorly crystalline, particularly enriched in Fe and Mg, reflecting post-magmatic hydration and minor oxidation.
- The data suggest a mafic-ultramafic protolith that has undergone low-grade metamorphic alteration, with primary igneous minerals partially preserved. These findings provide insights into the mineralogical evolution, alteration processes, and potential secondary mineral formation in Mg- and Fe-rich silicate rocks.

Suggested minor/Secondary mineral phases

- The sample contains a significant amorphous fraction (35.80 wt%), representing non-crystalline or poorly crystalline material.
- This fraction is enriched in SiO_2, Fe_2O_3, MgO, and CaO, reflecting contributions from glassy silicates, secondary Fe-oxides, and hydrous Mg-Ca silicates such as serpentine and chlorite.
- The presence of these amorphous phases indicates post-magmatic alteration and low-grade hydration, consistent with the observed LOI of 3.04 wt%.

Potential commercial uses

Mineral / Oxide	Potential Commercial Uses
MgO / Olivine / Serpentine / Chlorite	Refractories, Mg metal and MgO production, CO_2 sequestration, ceramics
CaO / Plagioclase / Diopside / Titanite	Cement and lime production, glass and ceramic raw materials
SiO_2 / Quartz / Amorphous silica	Glass manufacture, fillers in polymers and paints, and catalyst supports
Fe_2O_3 / Magnetite / Magnesioferrite	Iron pigments, minor iron extraction, and catalysts
Na_2O / K_2O / Feldspars (Andesine, Labradorite)	Ceramics, glass, industrial fillers
Hydrous / Clay minerals (Illite, Phillipsite, Hydrogarnet)	Ceramics, soil conditioners, zeolite applications, and lightweight aggregates
Trace / Minor oxides (TiO_2, ZrO_2, etc.)	Pigments, catalyst supports, specialty ceramics

Probable origin assessment

The sample is derived from a mafic-ultramafic igneous protolith, dominated by plagioclase and pyroxenes. Subsequent low-grade hydrothermal alteration produced hydrous minerals (serpentine, chlorite, phillipsite, illite) and a significant amorphous fraction (35.80 wt%), reflecting hydration and partial oxidation. Overall, it represents a magmatic rock modified by secondary alteration processes.

Final Results:

- Bulk Geochemistry: The sample is mafic-ultramafic, dominated by SiO_2 (43.92 wt%), MgO (16.07 wt%), Fe_2O_3 (11.83 wt%), and CaO (10.24 wt%), with minor Na_2O, K_2O, and trace elements. LOI (3.04 wt%) indicates water in hydrous phases
- Primary Mineralogy (XRD): Dominated by plagioclase feldspars (Labradorite, Andesine) and clinopyroxenes (Augite, Diopside, Hedenbergite), along with olivine, enstatite, and minor titanite, confirming a magmatic origin.
- Secondary Minerals and Hydrous Phases: Presence of serpentine-group minerals (Antigorite, Lizardite), chlorite, chayesite, phillipsite, illite, and hydrogarnet reflects post-magmatic alteration, including hydration and low-grade metamorphism.
- Amorphous Fraction: Approximately 37.6 wt% of the sample is amorphous, enriched in Si, Fe, Mg, and Ca, likely comprising glassy silicates, secondary Fe-oxides, and hydrous Mg-Ca silicates, indicating element mobility during alteration.
- The rock is a primary mafic-ultramafic igneous protolith modified by serpentinization, chloritization, and clay formation.

Stoichiometric Oxide Table

Mineral Name	Chemical Formula	XRD wt%	SiO2	Al2O3	Fe_2O_3	MgO	CaO	Na2O	K2O	TiO2	H2O
Diopside	$CaMgSi_2O_6$	3.18	1.76	0.00	0.00	0.59	0.83	0.00	0.00	0.00	0.00
Hedenbergite	$CaFeSi_2O_6$	1.14	0.51	0.00	0.32	0.00	0.31	0.00	0.00	0.00	0.00
Aegirine	$NaFeSi_2O_6$	0.41	0.22	0.00	0.13	0.00	0.00	0.06	0.00	0.00	0.00
Augite	$(Ca,Na)(Mg,Fe)Si_2O_6$	6.98	0.49	0.00	0.58	3.65	2.16	0.10	0.00	0.00	0.00
Olivine	$(Mg,Fe)_2SiO_4$	0.51	0.21	0.00	0.05	0.25	0.00	0.00	0.00	0.00	0.00
Enstatite	$MgSiO_3$	1.96	1.18	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00
Pigeonite	$(Ca,Mg,Fe)Si_2O_6$	1.73	0.94	0.00	0.22	0.31	0.26	0.00	0.00	0.00	0.00
Labradorite	$(Ca,Na)(Al,Si)_4O_8$	12.75	7.88	3.76	0.00	0.00	0.76	0.35	0.00	0.00	0.00
Andesine An50	$(Na,Ca)(Al,Si)_4O_8$	7.63	4.24	2.15	0.00	0.00	0.81	0.43	0.00	0.00	0.00
Forsterite	Mg_2SiO_4	1.82	0.74	0.00	0.00	1.08	0.00	0.00	0.00	0.00	0.00
Chayesite	$K(Mg,Fe)_4Fe^{3+}Si_{12}O_{30}$	2.35	1.05	0.00	0.92	0.15	0.00	0.00	0.23	0.00	0.00
Chlorite	$(Mg,Fe)_3(Si,Al)_4O_{10}(OH)_8$	3.11	0.98	0.56	0.35	0.94	0.00	0.00	0.00	0.00	0.28
Analcime	$NaAlSi_2O_6{\cdot}H_2O$	1.65	0.90	0.39	0.00	0.00	0.00	0.24	0.00	0.00	0.12
Magnetite	Fe_3O_4	0.46	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00
Magnesioferrite	$MgFe_2O_4$	0.44	0.00	0.00	0.35	0.09	0.00	0.00	0.00	0.00	0.00
Titanite	$CaTiSiO_5$	1.86	0.58	0.00	0.00	0.00	0.56	0.00	0.00	0.72	0.00
Hydrogarnet	$Ca_3Al_2(SiO_4)_{3-x}(OH)_{4x}$	1.19	0.31	0.28	0.00	0.00	0.47	0.00	0.00	0.00	0.13
Lizardite	$Mg_3Si_2O_5(OH)_4$	0.39	0.17	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.05
Antigorite	$Mg_3Si_2O_5(OH)_4$	2.65	1.16	0.00	0.00	1.16	0.00	0.00	0.00	0.00	0.33
Phillipsite-Ca	$Ca_3(Si_{10}Al_6)O_{32}{\cdot}12H_2O$	1.38	0.61	0.18	0.00	0.00	0.19	0.00	0.00	0.00	0.40
Illite	$KAl_2(Si_3Al)O_{10}(OH)_2$	8.00	4.10	1.57	0.00	0.00	0.00	0.00	0.81	0.00	1.52
Quartz	SiO_2	2.60	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		**64.20**	**30.63**	**8.89**	**3.38**	**9.17**	**6.35**	**1.18**	**1.04**	**0.72**	**2.83**

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Verified by: Satyanarayana

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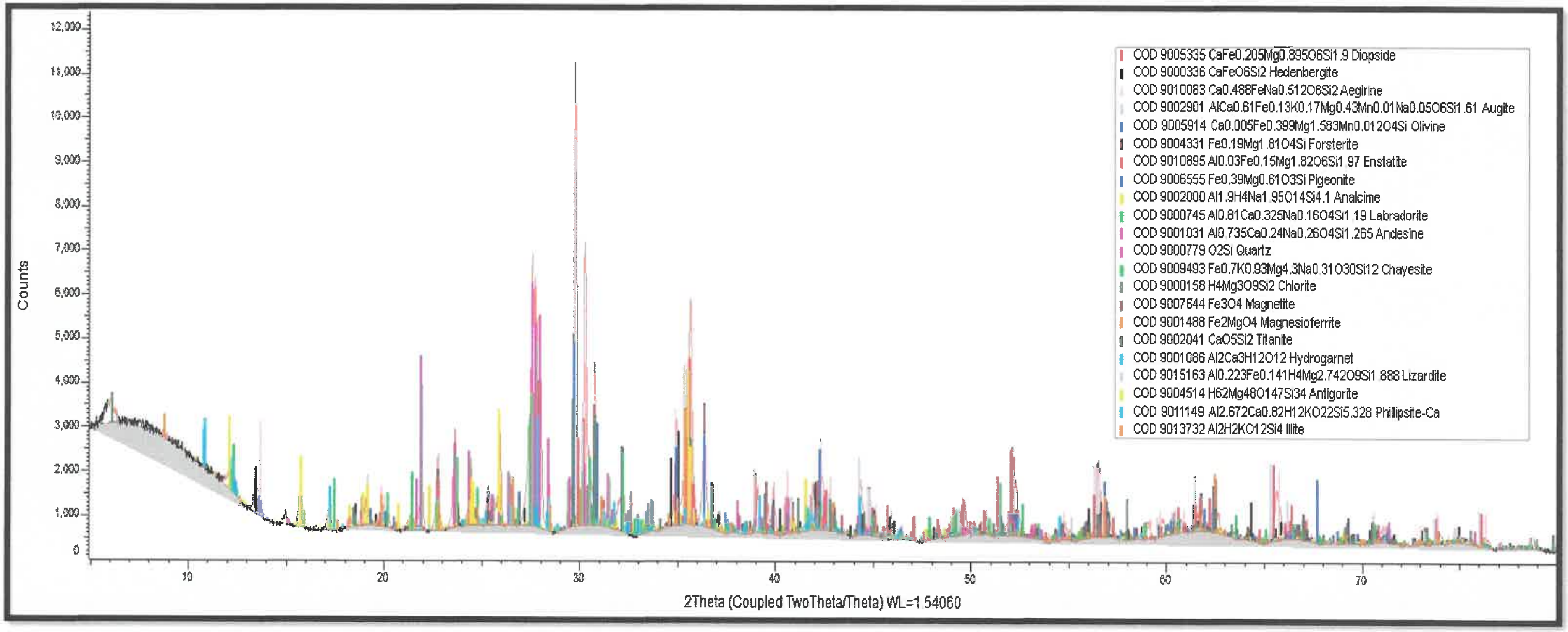
BRUKER D8 ADVANCE XRD TEST DATA

G2803-3	CMT/011/29/2025	XRD Scan Report_1 of 2



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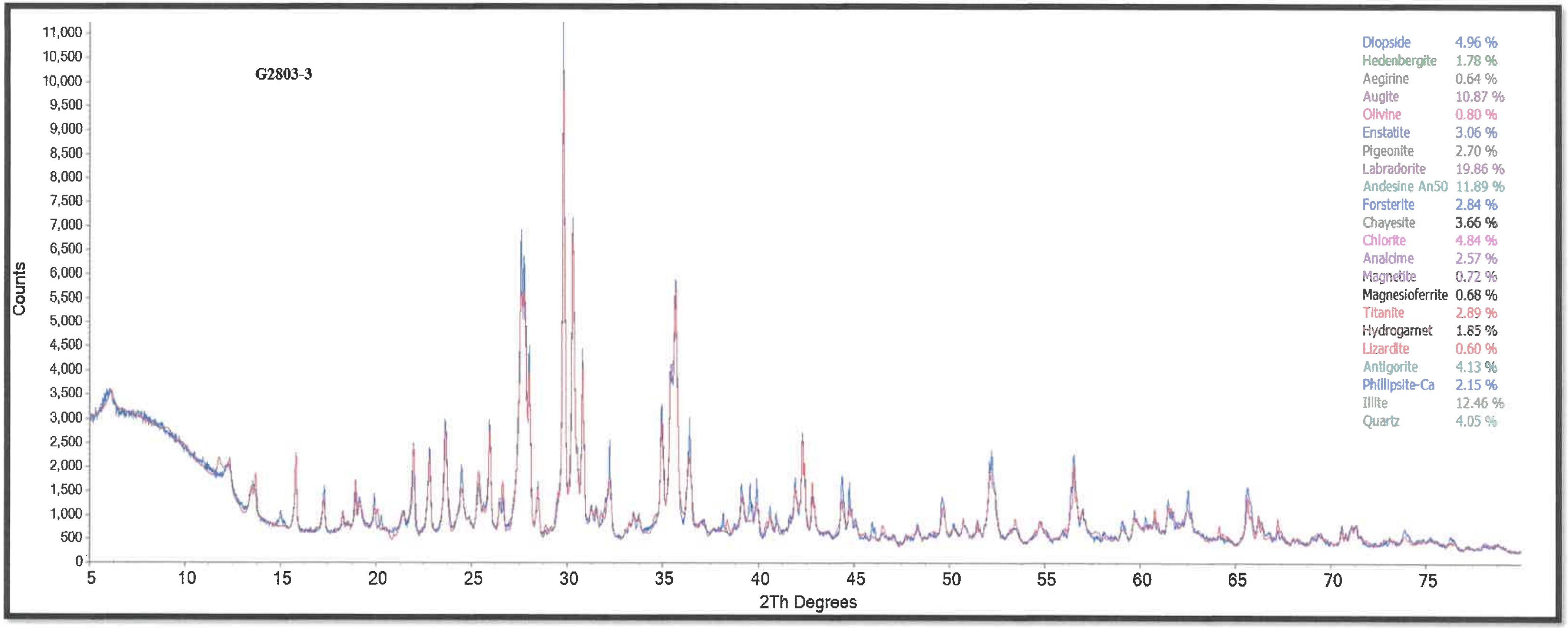
BRUKER D8 ADVANCE XRD TEST DATA

G2803-3	CMT/011/29/2025	XRD Scan Report_2 of 2



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