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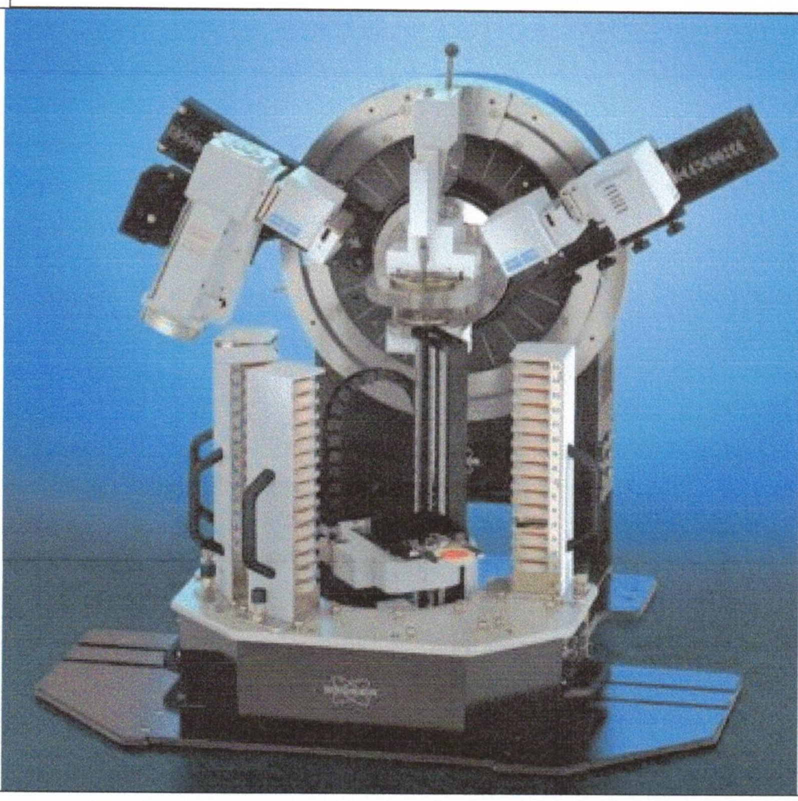
Customer Name: Mr. K. Nageswara Rao.
Customer Address: Critical Minerals Trackers, Mineral Exploration and Geo Solution, #Concourse, No 406,7-1-58/CC/406, Opp Lal Bungalow, Greenland's, Hyderabad -500016 India.
Customer Ref : P37/NB/2025
Lab ID : G2296-21

Dates of Sample Analysis :05/09/2025
Date of Reporting :08/09/2025

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.

Prepared by: Nagaraj Singh
Verified by: Satyanarayana

Sample G2296-21 (P37/NB/2025)

Summary

Sample G2296-21: WDXRF bulk oxides (Bruker S8 Tiger 4 kW) and XRD (Bruker D8 Advance) major phases reconciled. Reported crystallinity = 80.4% and amorphous fraction = 19.6% respectively. XRD major phases (reported as percent of crystalline): Quartz 42.71%, Kaolinite 38.73%, K�feldspar 18.56%. These were converted to absolute wt% of the whole sample (table below) assuming phase% are relative to the crystalline fraction.

WDXRF data

Oxide	Wt % (measured)
SiO2	73.48
Al2O3	12.76
Fe2O3	3.99
TiO2	1.6
K2O	2.27
CaO	0.24
MgO	0.17
P2O5	0.09
LOI	4.94

XRD phases — absolute wt% (scaled to crystallinity)

Mineral phase (reported % of crystalline)	Absolute wt% of sample (calculated)	Representative formula
Quartz (42.71% of crystalline)	34.34	SiO_2
Kaolinite (38.73% of crystalline)	31.14	$Al_2Si_2O_5(OH)_4$
K-feldspar (18.56% of crystalline)	14.92	$KAlSi_3O_8$ (approx.)

Stoichiometric conversions (mineral → oxide equivalents)

Mineral	Formula	Mol. mass (g/mol)	Major oxide wt% (per 100 g mineral)	Notes
Kaolinite	Al2Si2O5(OH)4	258.157	Al2O3: 39.495 ; SiO2: 46.548 ; H2O: 13.957	Contributes Al2O3, SiO2 and structural H2O (LOI).
Quartz	SiO2	60.084	SiO2: 100.00	Pure silica.

K?feldspar (approx.)	KAlSi3O8	278.328	K2O: 16.922 ; Al2O3: 18.317 ; SiO2: 64.762	Approximate oxide split from KAlSi3O8.

Predicted oxide contributions from crystalline phases (wt% of whole sample)

Oxide	Measured (WDXRF)	From Quartz	From Kaolinite	From K-feldspar	Total predicted (wt%)
SiO2	73.48	34.34	14.49	9.66	58.50
Al2O3	12.76	0.00	12.30	2.73	15.03
K2O	2.27	0.00	0.00	2.53	2.53
Fe2O3	3.99	0.00	0.00	0.00	0.00
TiO2	1.60	0.00	0.00	0.00	0.00
LOI	4.94	0.00	4.35	0.00	4.35

Predicted totals, residuals and inferred amorphous composition

Oxide	Measured (wt%)	Predicted crystalline (wt%)	Residual (Meas – Pred, wt%)
SiO2	73.48	58.50	14.98
Al2O3	12.76	15.03	-2.27
K2O	2.27	2.53	-0.26
Fe2O3	3.99	0.00	3.99
TiO2	1.60	0.00	1.60
LOI	4.94	4.35	0.59

Inferred amorphous fraction = 19.60% of sample. Positive residuals are allocated to this amorphous fraction. Below are residuals normalized to the amorphous mass (i.e., percent of the 19.60% amorphous).

Oxide	Residual (wt% of sample)	Inferred % of amorphous (residual/19.6×100)
SiO2	14.98	76.44
Fe2O3	3.99	20.36
TiO2	1.60	8.16
LOI	0.59	3.03
CaO	0.24	1.22
ZrO2	0.21	1.07
MgO	0.17	0.87
P2O5	0.09	0.46
Na2O	0.08	0.41
BaO	0.06	0.31
SO3	0.05	0.26
PbO	0.04	0.20
Cr2O3	0.01	0.05
MnO	0.01	0.05

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NiO	0.01	0.05
ZnO	0.01	0.05
K2O	-0.26	-0.26
Al2O3	-2.27	-2.27

Interpretation & final justification

• The XRD-identified crystalline phases (quartz, kaolinite, K⍰feldspar) explain the majority of SiO2 and a substantial part of Al2O3 and K2O. Predicted LOI from kaolinite partially explains measured LOI (measured LOI = 4.94 wt%). Residual LOI and minor oxide mismatches are allocated to the amorphous fraction and minor/trace phases.

• The high SiO2 (73.48 wt%) and dominant quartz (absolute 34.34 wt%) indicate a siliciclastic or sand-rich material with significant feldspar and clay components. Kaolinite (absolute 31.14 wt%) indicates weathering or hydrothermal alteration of feldspars/silicates.

• Probable origin: sedimentary (weathered siliciclastic) or felsic/arkosic detrital source; volcanic origin unlikely as a primary source.

Minor / secondary phases likely present

- Minor amorphous silica (opal or volcanic glass relics) in amorphous fraction
- Iron oxyhydroxide coatings (goethite/ferrihydrite) accounting for Fe2O3 ~3.99%
- Clay-smectite or interstratified clays as subordinate components
- Accessory heavy minerals: zircon (ZrO2 ~0.21%), rutile/ilmenite (TiO2 ~1.60%)
- Feldspar alteration products (sericite, illite) as weathering products

Commercial implications & recommendations

• Commercial uses: high⍰SiO2 material suitable for silica sand uses (glass, foundry sand) depending on grain size and impurities; kaolinite component useful for ceramics and fillers. K⍰feldspar indicates potential for ceramic flux applications (glazes).
• Recommendations: particle size analysis, mineral liberation studies, SEM⍰EDS mapping and Rietveld with an internal standard to refine amorphous content and phase proportions. If silica sand use is intended, evaluate heavy⍰mineral and iron oxide content for brightness.

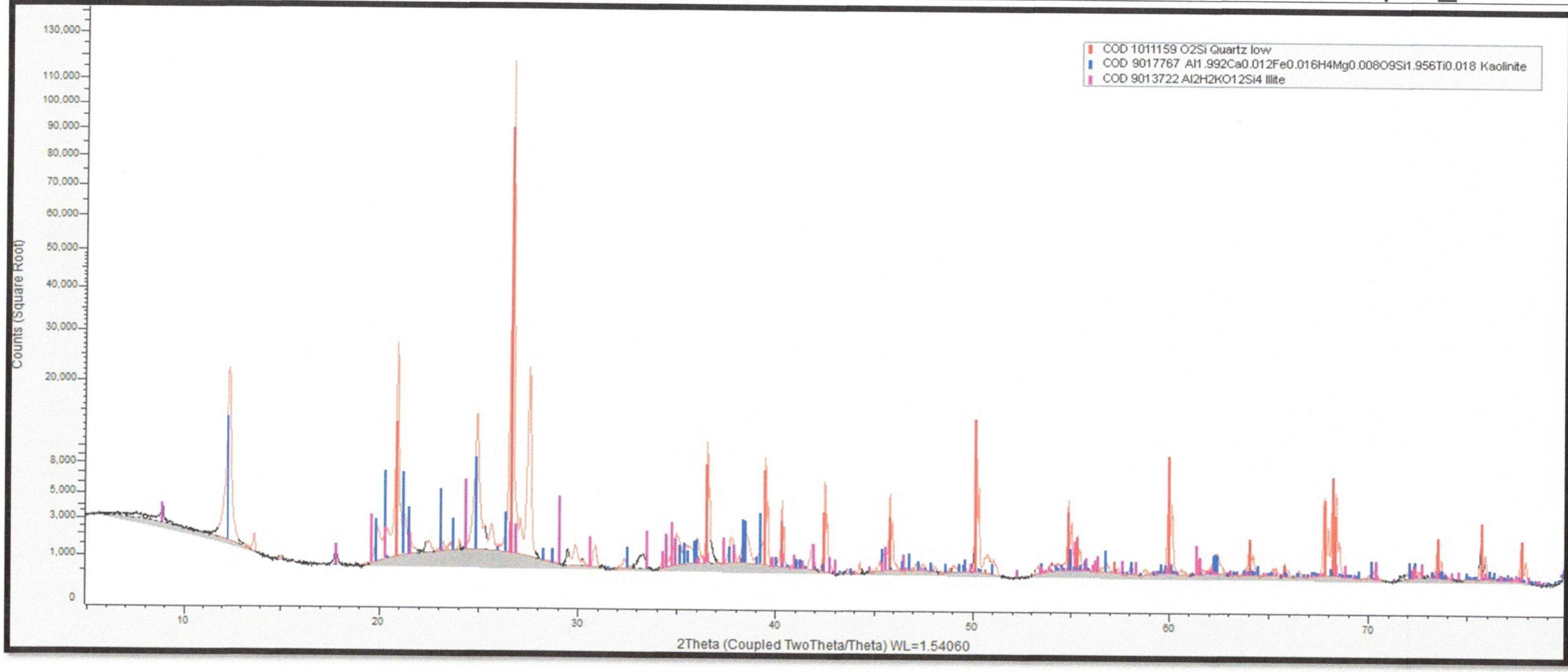
Final concise results

• XRD major phases (absolute wt% of sample): Quartz 34.34 wt%, Kaolinite 31.14 wt%, K⍰feldspar 14.92 wt%. Crystallinity = 80.4%, Amorphous = 19.6%.
• Bulk WDXRF (wt%): SiO2 73.48, Al2O3 12.76, K2O 2.27, Fe2O3 3.99, LOI 4.94.
• Interpretation: sedimentary/weathered siliciclastic material (arkosic to quartz⍰rich) with potential industrial uses for silica sand, ceramics, and feldspar flux, subject to beneficiation.

G2296-21

P37/NB/2025

XRD Scan Report_1 of 2



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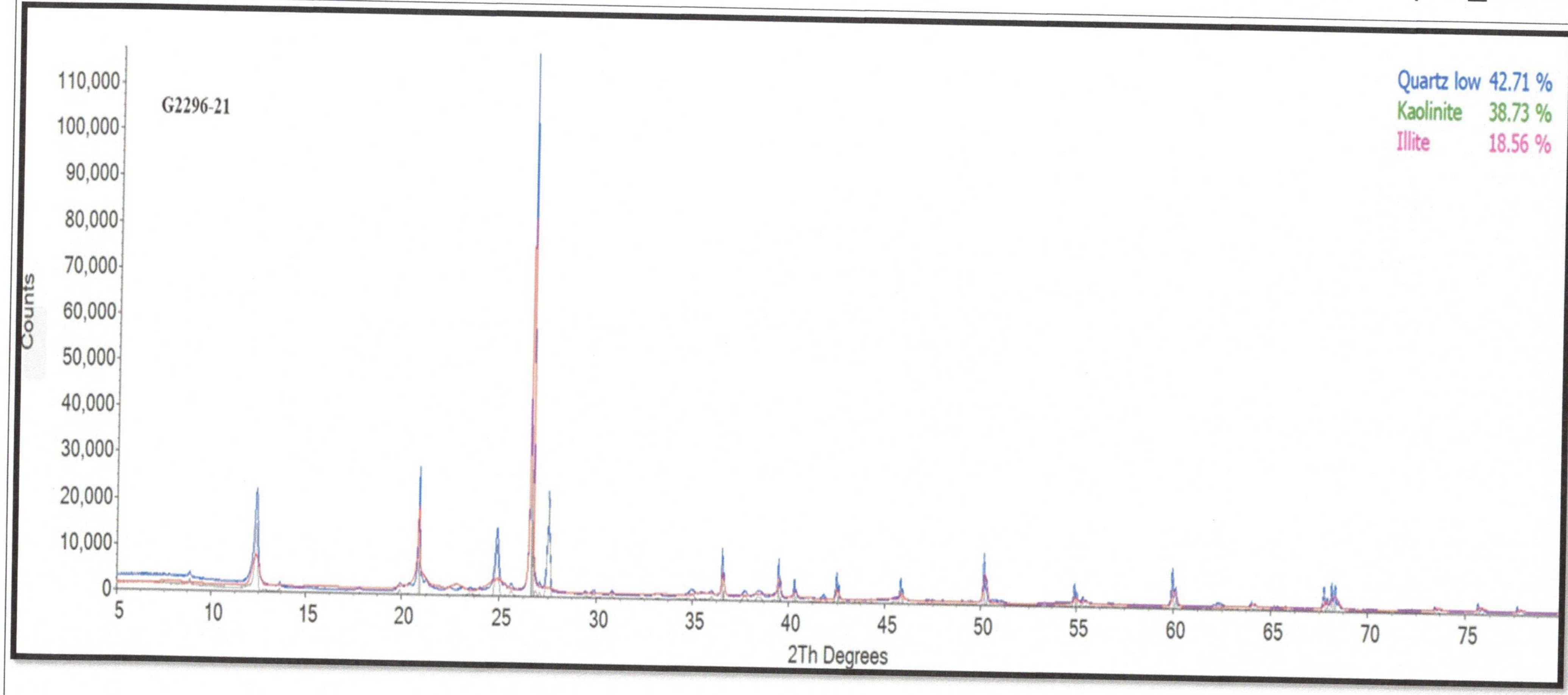

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Customer Ref : P38/NB/2025
Lab ID : G2296-22

Dates of Sample Analysis :05/09/2025
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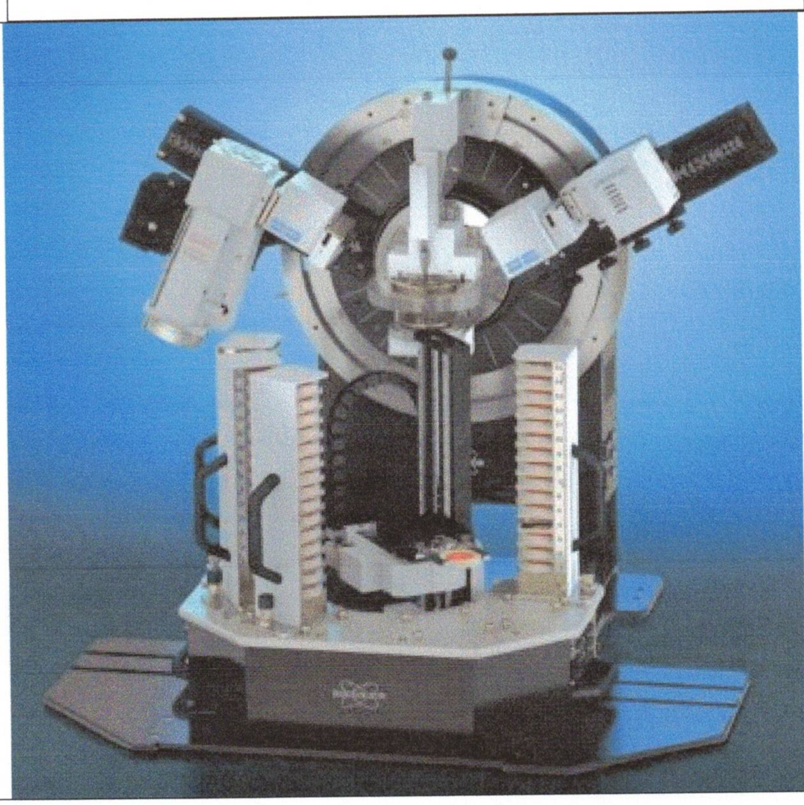
1.60 KW POWDER X RAY DIFRACTOMETER METHOD



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Sample G2296-22 (P38/NB/2025)

Summary

Sample G2296-22: WDXRF (Bruker S8 Tiger 4 kW) bulk oxide dataset reconciled with XRD (Bruker D8 Advance) major phases. Reported crystallinity = 81.60% → inferred amorphous fraction = 18.40%. Major XRD phases (reported as % of crystalline): Goethite 38.0%, Kaolinite 21.5%, Quartz 14.6%, Calcite 18.56% (scaled to crystallinity).

WDXRF data

Oxide	Wt % (measured)
Fe2O3	33.49
SiO2	42.71
Al2O3	9.24
CaO	2.00
TiO2	0.80
K2O	0.59
LOI	9.83

XRD major phases — absolute wt% (scaled to crystallinity)

Mineral phase	Wt % (sample)	Representative formula
Goethite (38.00% of crystalline)	33.46	FeO(OH)
Kaolinite (21.50% of crystalline)	18.93	Al2Si2O5(OH)4
Quartz (14.60% of crystalline)	12.85	SiO2
Calcite (18.56% of crystalline)	16.34	CaCO3

Stoichiometric conversions (mineral → oxide equivalents)

Mineral	Formula	Mol. mass (g/mol)	Major oxide wt% (per 100 g mineral)	Notes
Kaolinite	Al2Si2O5(OH)4	258.157	Al2O3: 39.495 ; SiO2: 46.548 ; H2O: 13.957	Contributes Al2O3, SiO2 and structural H2O (LOI).
Goethite	FeO(OH)	88.851	Fe2O3 equiv: 89.862 ; H2O: 10.138	Hydroxy-iron oxide; contributes Fe2O3 equivalent and LOI.
Calcite	CaCO3	100.086	CaO: 56.029 ; CO2: 43.971	Contributes CaO and CO2 (LOI).
Quartz	SiO2	60.084	SiO2: 100.00	Pure silica.

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Predicted oxide contributions from crystalline phases (wt% of whole sample)

Oxide	Measured (WDXRF)	From Kaolinite	From Goethite	From Calcite	From Quartz
Al2O3	9.24	7.48	0.00	0.00	0.00
SiO2	42.71	8.81	0.00	0.00	12.86
Fe2O3	33.49	0.00	30.07	0.00	0.00
CaO	2.00	0.00	0.00	9.16	0.00
LOI	9.83	0.00	3.39	7.19	0.00
TiO2	0.80	0.00	0.00	0.00	0.00

Predicted totals, residuals and inferred amorphous composition

Oxide	Measured (wt%)	Predicted crystalline (wt%)	Residual (Meas – Pred, wt%)
Al2O3	9.24	7.48	1.76
SiO2	42.71	21.67	21.04
Fe2O3	33.49	30.07	3.42
CaO	2.00	9.16	-7.16
LOI	9.83	13.22	-3.39
TiO2	0.80	0.00	0.80

Inferred amorphous fraction = 18.40% of sample. Positive residuals attributed to amorphous fraction. Residuals normalized to the amorphous mass (percent of the 18.40% amorphous) are below.

Oxide	Residual (wt% of sample)	Inferred % of amorphous (residual/18.4×100)
SiO2	21.04	114.34
Fe2O3	3.42	18.58
Al2O3	1.76	9.58
TiO2	0.80	4.35
K2O	0.59	3.21
P2O5	0.41	2.23
MgO	0.27	1.47
BaO	0.19	1.03
MnO	0.17	0.92
Na2O	0.07	0.38
SO3	0.04	0.22
V2O5	0.04	0.22
SrO	0.03	0.16
ZrO2	0.03	0.16
Cr2O3	0.02	0.11
LOI	-3.39	-3.39
CaO	-7.16	-7.16

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Interpretation, origin assessment & commercial implications

Interpretation:

- The sample is Fe?rich (Fe_2O_3 = 33.49 wt%) with significant SiO_2 (42.71 wt%) and moderate LOI (9.83 wt%).
- Scaled goethite explains a large portion of measured Fe_2O_3; kaolinite contributes Al_2O_3 and structural water; calcite explains CaO and part of LOI; quartz contributes to SiO_2.

Origin assessment:

- The mineral assemblage (goethite + kaolinite + quartz + calcite) is consistent with a ferruginous weathering profile (laterite/pedogenic horizon) with some carbonate input or mixing. A volcanic or meteoritic origin is unlikely based on mineralogy.

Commercial implications:

- Iron: Fe_2O_3 ~33.5% — material may be suitable for iron oxide pigment production or as a concentrate after beneficiation; not direct feed for blast?furnace without upgrading.
- Kaolinite: possible use in ceramics/fillers if iron is reduced; requires beneficiation for high?brightness applications.
- Quartz and calcite: potential uses in silica sand and lime markets depending on grain size and purity.

Minor / secondary phases likely present

- Hematite, lepidocrocite or ferrihydrite (fine Fe-phases)
- Anatase/rutile/ilmenite (Ti-bearing phases)
- Amorphous/allophane aluminosilicates in amorphous fraction
- Smectite/interstratified clays as minor components
- Apatite or phosphate minerals (P_2O_5 ~0.41%)

Final concise results

- Scaled XRD major phases (wt% of sample): Goethite 33.46%, Kaolinite 18.93%, Quartz 12.86%, Calcite 16.34% (sum = 81.60%). Crystallinity = 81.60%, Amorphous = 18.40%.
- Bulk WDXRF (wt%): Fe_2O_3 33.49, SiO_2 42.71, Al_2O_3 9.24, TiO_2 0.80, LOI 9.83.
- Interpretation: ferruginous/regolith material (lateritic/pedogenic) with industrial mineral potential and targetable Fe/Ti heavy minerals after beneficiation.

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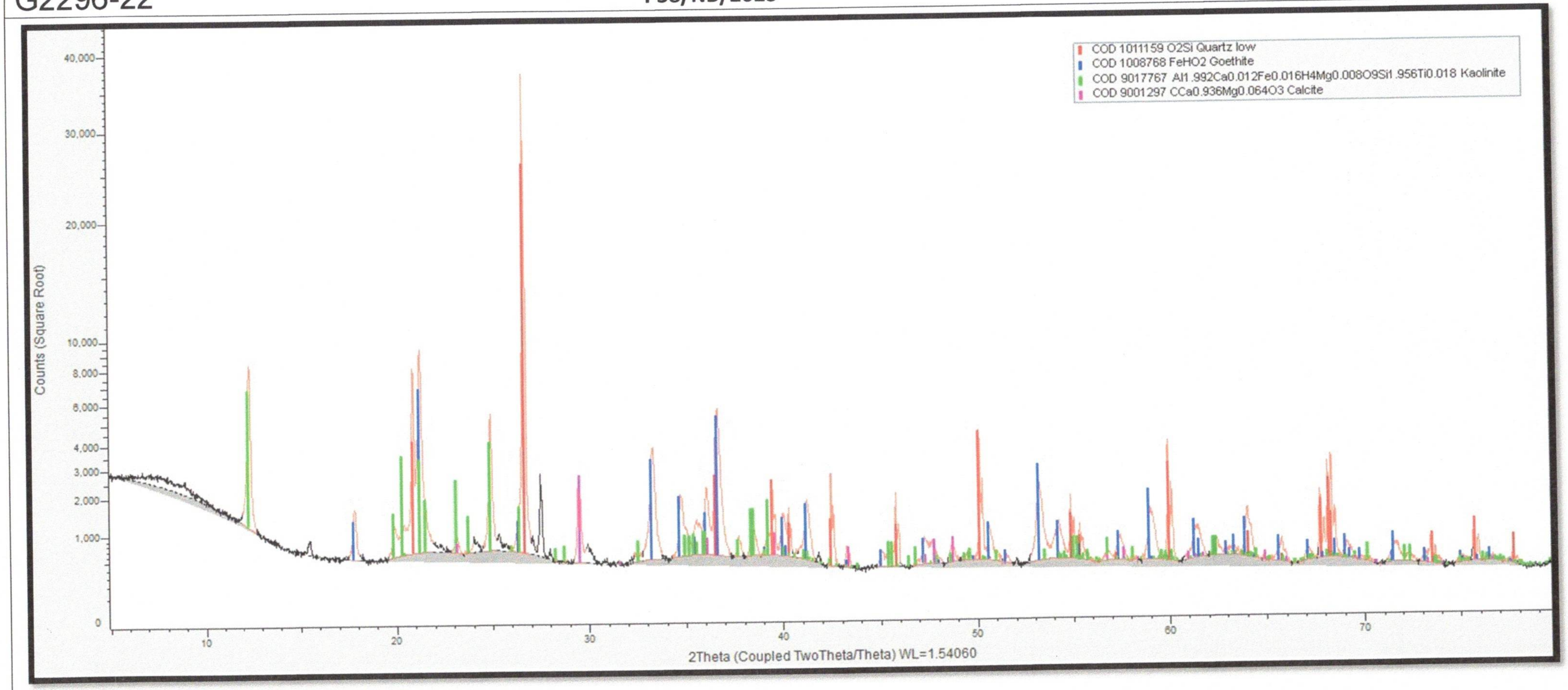
BRUKER D8 ADVANE XRD TEST DATA

G2296-22

P38/NB/2025

XRD Scan Report_1 of 2



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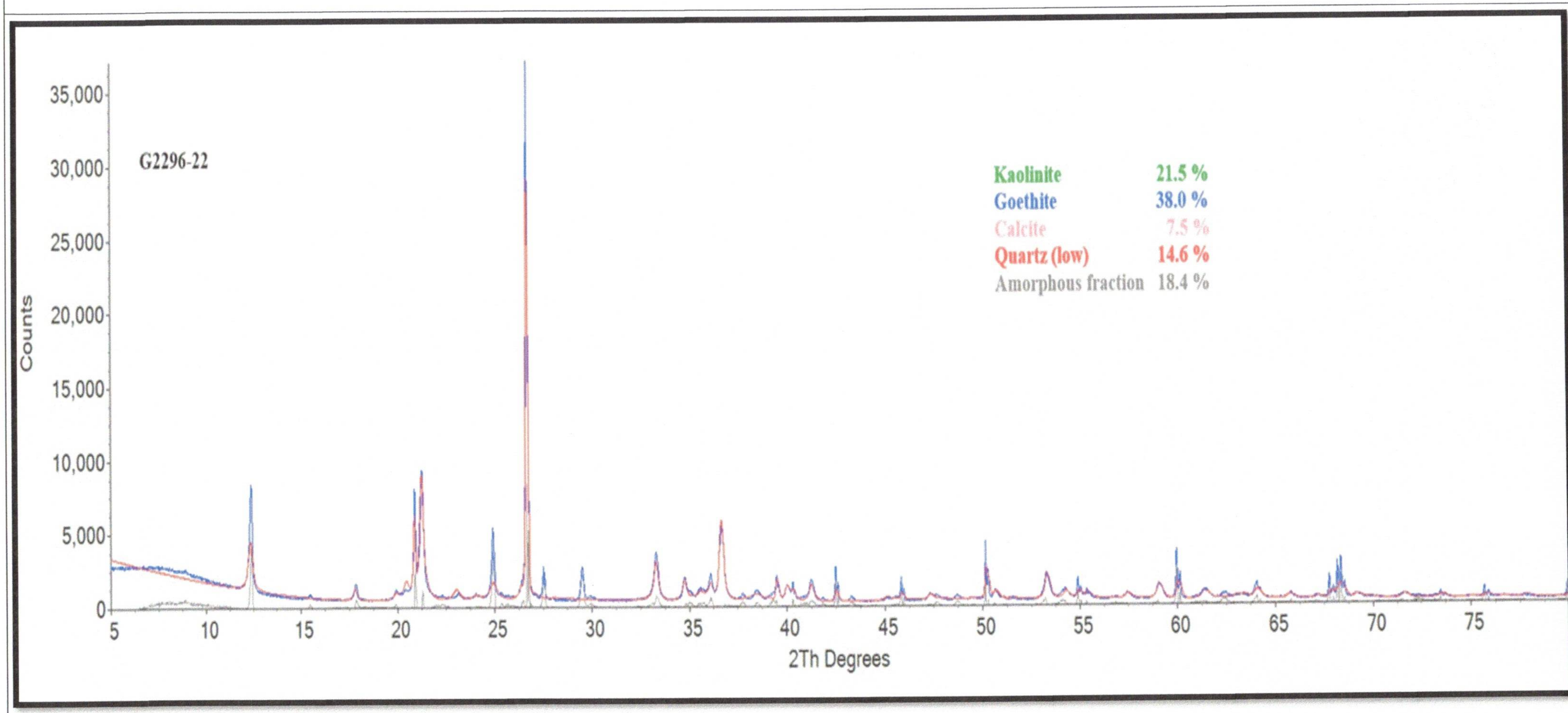
G2296-22 | **P38/NB/2025** | XRD Scan Report_2 of 2



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Dates of Sample Analysis :05/09/2025
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MINERALOGY TEST REPORT

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Sample G2296-16 (T34/NB/2025/04)

Expert XRD–XRF Report

Instruments:

- WDXRF: Bruker S8 Tiger Series 2, 4 kW
- XRD: Bruker D8 Advance, 1.6 kW

WDXRF Oxide Composition

Oxide	wt%	Oxide	wt%
Al2O3	8.33	MnO	0.11
BaO	<0.05	Na2O	0.08
CaO	0.21	P2O5	<0.05
Cr2O3	<0.05	SiO2	64.68
Fe2O3	19.00	SO3	<0.05
K2O	1.37	SrO	<0.05
MgO	0.09	TiO2	0.64
V2O5	<0.05	ZrO2	0.05
HfO2	<0.05	PbO	<0.05
CuO	<0.05	ZnO	<0.05
NiO	<0.05	LOI	5.29
Total	**100.00**		

Major XRD Phases

Phase	Formula	wt% (crystalline fraction)	Absolute wt% (normalized to bulk)
Quartz (low)	SiO2	43.45	35.80
Kaolinite	Al2Si2O5(OH)4	21.21	17.49
Goethite	FeO(OH)	17.43	14.37
Vaterite	CaCO3	0.31	0.26
Total crystalline	–	82.40	68.0
Amorphous content	–	17.60	17.6

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Stoichiometric Oxide Contributions from Crystalline Phases

Oxide	From Quartz	From Kaolinite	From Goethite	From Vaterite	Total Predicted	WDXRF Measured	Residual → Amorphous
SiO2	35.80	9.03	0.00	0.00	44.83	64.68	+19.85
Al2O3	0.00	7.47	0.00	0.00	7.47	8.33	+0.86
Fe2O3*	0.00	0.00	14.37	0.00	14.37	19.00	+4.63
CaO	0.00	0.00	0.00	0.15	0.15	0.21	+0.06
CO2 (LOI)	0.00	0.00	0.00	0.11 (in LOI)	0.00	5.29 (total LOI)	0.00
Others (K2O, TiO2, trace oxides)	0.00	0.00	0.00	0.00	0.00	2.24	2.24

*Goethite contributes FeO(OH); converted to Fe2O3 equivalent.

Amorphous Content (17.6%)

Likely constituents of the amorphous fraction:

- Amorphous silica / opaline SiO2 (major, explains excess SiO2).
- Poorly crystalline Fe-oxyhydroxides (ferrihydrite, hydrated goethite).
- Minor alumino-silicate gels / altered kaolinite

Suggested Minor/Secondary Phases

- **Smectite/illite group clays** (not resolved in XRD).
- **Ferrihydrite** (nanocrystalline Fe-oxyhydroxide).
- **Amorphous silica** (opal-A, chalcedony precursor).
- **Accessory Ti/Zr oxides** (rutile, zircon traces suggested by XRF TiO2, ZrO2).

Expert Interpretation & Origin

- High **SiO2 (64.7%)**, **moderate Fe2O3 (19.0%)**, and presence of kaolinite suggest a **lateritic/siliciclastic sedimentary origin**.
- Not meteoritic (absence of Ni/Co-rich phases, chondritic textures).
- Not volcanic glass dominated (but some amorphous SiO2 could reflect secondary silica).
- Most consistent with **weathering of arkosic/sandstone material** enriched in quartz and kaolinite, with iron oxyhydroxide precipitation.

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Potential Commercial Uses

Component	Possible Applications
Quartz (high-purity SiO2)	Glass, ceramics, foundry sand, silica flour
Kaolinite	Ceramics, paper coating, refractories, catalysts
Goethite (iron oxyhydroxide)	Pigments (yellow ochre), precursor to Fe ores
Amorphous silica	Pozzolanic cement additive, fillers, industrial silica
Trace Ti/Zr oxides	Pigments, ceramics, potential Ti/Zr recovery (if concentrated)

Final Justification (Results)

The combined **XRF–XRD analysis** shows that crystalline phases (82.4%) account for the bulk chemistry but leave **~17.6% amorphous fraction**, largely silica- and Fe-rich, consistent with weathering-derived opaline silica and ferrihydrite. The sample represents a **silica-rich, ferruginous clay/quartz mixture** typical of sedimentary–lateritic environments. Potential industrial uses include **ceramics, silica products, and pigment/iron recovery**.

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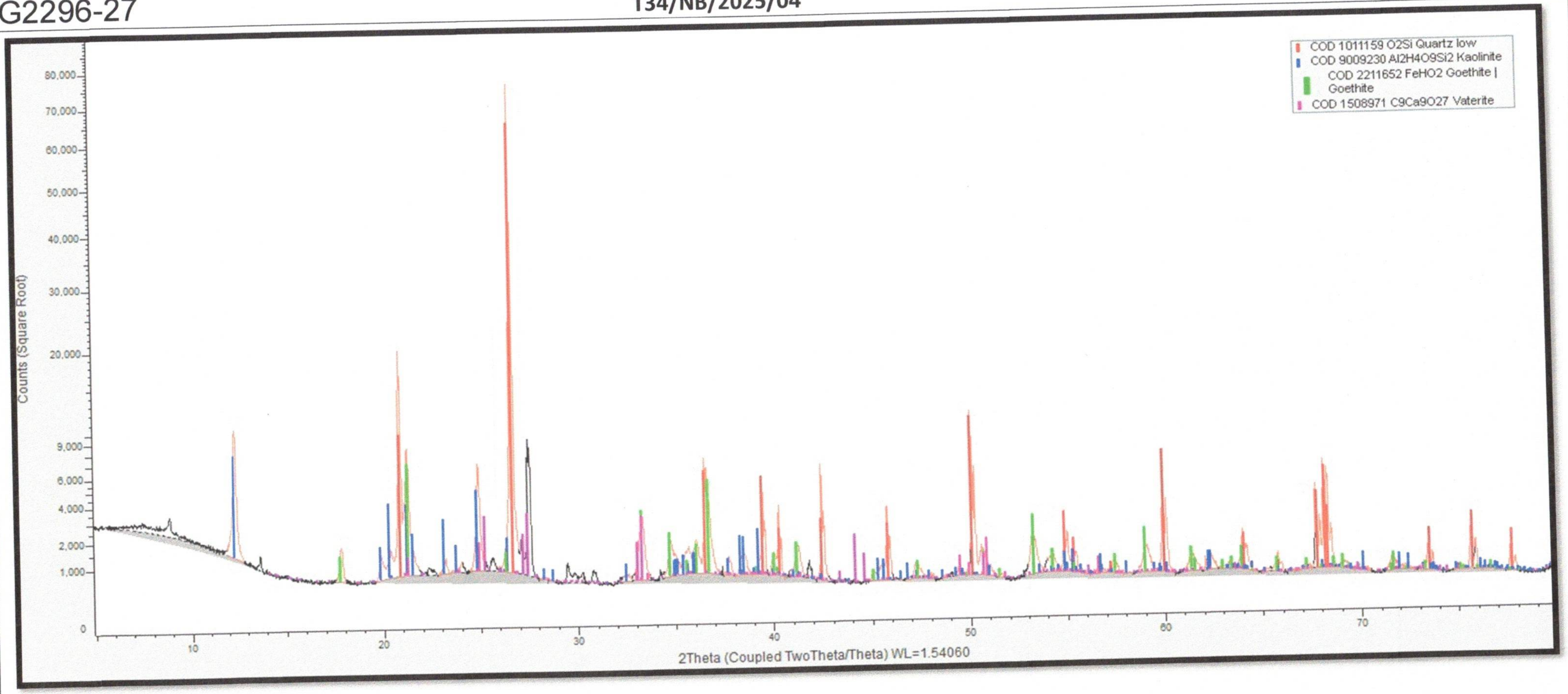
BRUKER D8 ADVANE XRD TEST DATA

G2296-27

T34/NB/2025/04

XRD Scan Report_1 of 2



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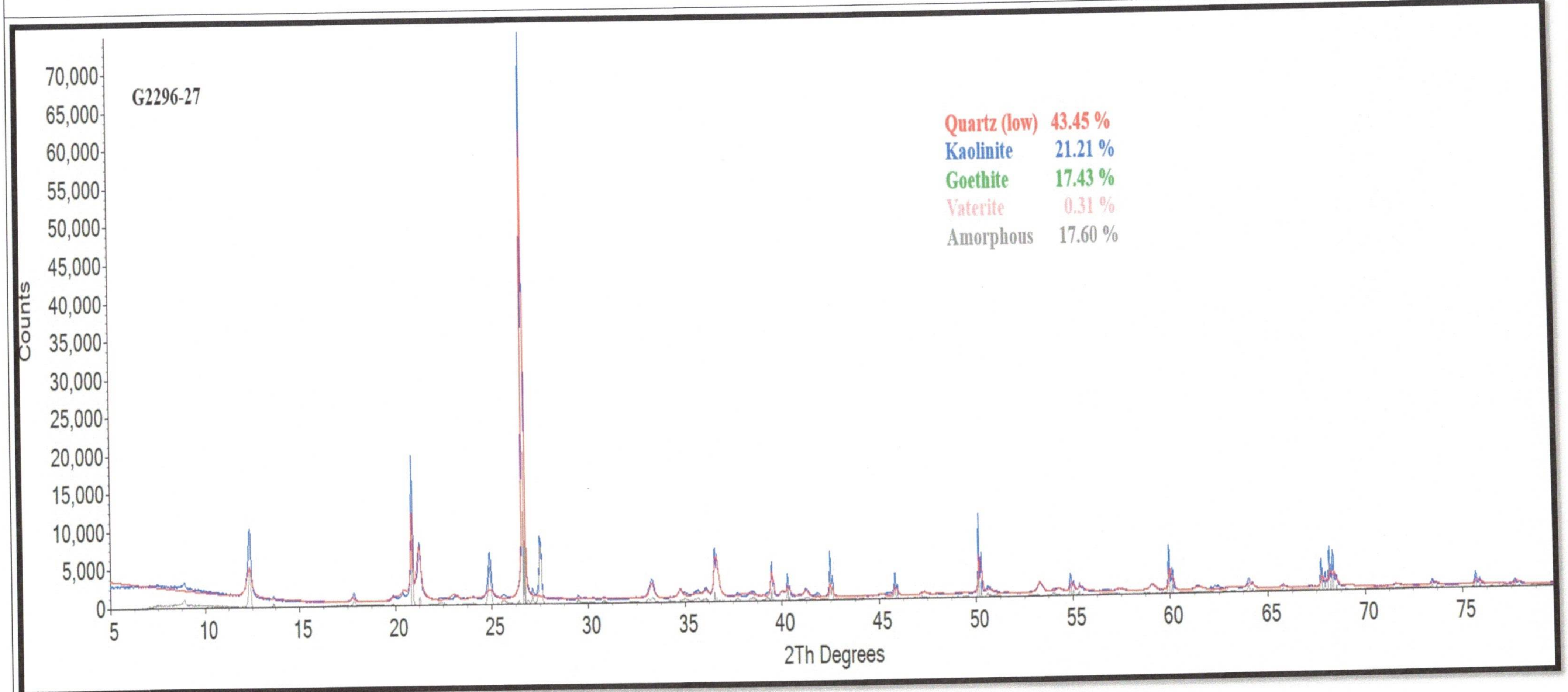

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