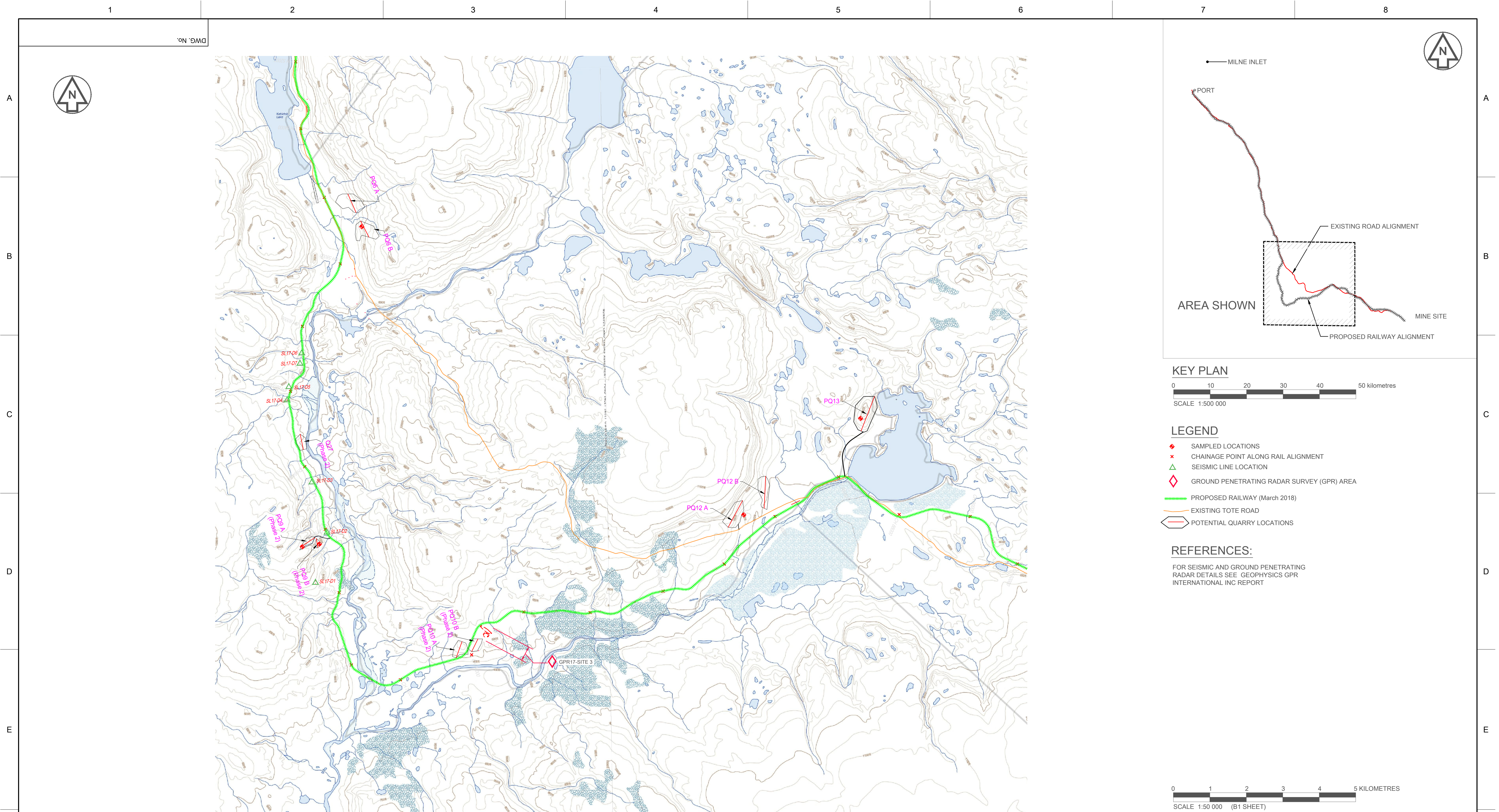
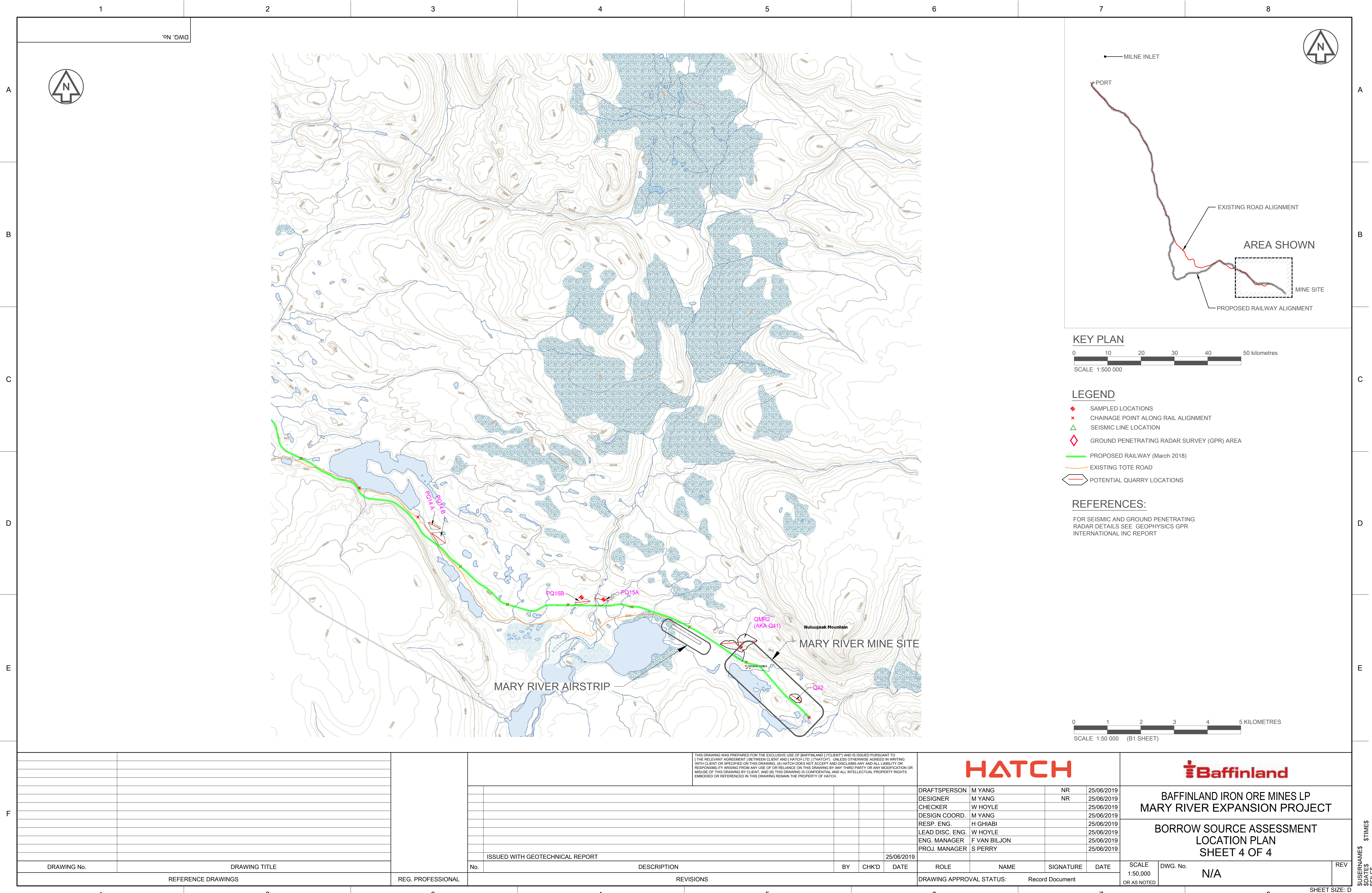


[illegible]



Appendix B

Laboratory Test Results



SGS Canada Inc.

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Hatch LTD

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Phone: 905-374-5200
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ABA - Modified Sobek

09-January-2019

Date Rec. : 20 December 2018
LR Report: CA15343-DEC18
Reference: PO#

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Q1	6: Q5	7: Q24	8: QMR2	9: PQ4B	10: PQ5B	11: PQ6B	12: PQ12A	13: PQ13	14: PQ15A	15: PQ15B
Paste pH	07-Jan-19	08:23	09-Jan-19	17:29	9.74	9.25	8.19	9.53	8.19	8.27	8.18	8.81	9.14	9.28	9.13
Fizz Rate [---]	07-Jan-19	08:23	09-Jan-19	10:26	1	1	4	1	4	4	4	4	1	1	1
Sample weight [g]	07-Jan-19	08:23	09-Jan-19	10:26	1.97	1.98	1.97	1.98	2.00	1.99	2.03	2.00	2.01	2.01	2.01
HCl Added [mL]	07-Jan-19	08:23	09-Jan-19	10:26	20.00	20.00	80.00	20.00	82.00	99.20	95.00	74.00	20.00	20.00	20.00
HCl [Normality]	07-Jan-19	08:23	09-Jan-19	10:26	0.10	0.10	0.50	0.10	0.50	0.50	0.50	0.50	0.10	0.10	0.10
NaOH [Normality]	07-Jan-19	08:23	09-Jan-19	10:26	0.10	0.10	0.50	0.10	0.50	0.50	0.50	0.50	0.10	0.10	0.10
NaOH to pH=8.3 [mL]	07-Jan-19	08:23	09-Jan-19	10:26	15.47	15.37	3.14	18.28	5.33	4.88	2.84	4.43	17.84	18.06	17.76
Final pH	07-Jan-19	08:23	09-Jan-19	10:26	1.15	1.15	1.62	0.94	1.52	1.57	1.84	1.80	0.72	0.97	0.78
NP [t CaCO3/1000 t]	07-Jan-19	08:23	09-Jan-19	10:26	12	12	975	4.3	958	1185	1135	870	5.4	4.8	5.6
AP [t CaCO3/1000 t]	09-Jan-19	10:26	09-Jan-19	10:27	0.62	0.62	0.62	0.62	0.62	0.62	0.62	1.25	0.62	0.62	0.62
Net NP [t CaCO3/1000 t]	09-Jan-19	10:26	09-Jan-19	10:27	10.9	11.1	975	3.68	958	1184	1134	868	4.78	4.18	4.98
NP/AP [ratio]	09-Jan-19	10:26	09-Jan-19	10:27	18.5	18.9	1561	6.94	1546	1911	1831	696	8.71	7.74	9.03
Sulphur (total) [%]	02-Jan-19	12:36	07-Jan-19	16:49	< 0.005	0.006	0.020	0.005	< 0.005	0.006	< 0.005	0.032	< 0.005	< 0.005	< 0.005
Acid Leachable SO4-S [%]	07-Jan-19	16:49	07-Jan-19	16:49	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sulphide [%]	03-Jan-19	13:17	07-Jan-19	16:49	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	< 0.02	< 0.02	< 0.02
Carbon (total) [%]	02-Jan-19	12:36	07-Jan-19	16:49	0.106	0.048	11.0	0.033	11.4	11.3	11.1	11.2	0.070	0.032	0.050
Carbonate [%]	03-Jan-19	10:39	04-Jan-19	14:18	0.145	< 0.025	52.9	0.070	50.9	54.0	52.0	42.1	0.105	0.035	0.100



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ABA - Modified Sobek

LR Report :

CA15343-DEC18

*NP (Neutralization Potential)

= $50 \times (N \text{ of HCL} \times \text{Total HCL added} - N \text{ NaOH} \times \text{NaOH added})$

Weight of Sample

*AP (Acid Potential) = % Sulphide Sulphur $\times$ 31.25

*Net NP (Net Neutralization Potential) = NP-AP

NP/AP Ratio = NP/AP

*Results expressed as tonnes CaCO₃ equivalent/1000 tonnes of material

Samples with a % Sulphide value of <0.02 will be calculated using a 0.02 value.

Chris Sullivan



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21-June-2019

Hatch LTD

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Date Rec. : 05 June 2019
LR Report: CA15104-JUN19
Reference: Job# H/353004/221 1534,
PCCR 4091

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: PQ4A	6: PQ9A	7: PQ9B	8: PQ5A
Paste pH [no unit]	17-Jun-19	08:35	18-Jun-19	10:56	8.15	8.00	7.95	8.19
Fizz Rate [no unit]	17-Jun-19	08:35	18-Jun-19	10:56	4	4	4	4
Sample weight [g]	17-Jun-19	08:35	21-Jun-19	10:22	2.02	2.00	2.01	1.98
HCl Added [mL]	17-Jun-19	08:35	21-Jun-19	10:22	80.80	81.50	79.00	77.50
HCl [Normality]	17-Jun-19	08:35	21-Jun-19	10:22	0.50	0.50	0.50	0.50
NaOH [Normality]	17-Jun-19	08:35	21-Jun-19	10:22	0.50	0.50	0.50	0.50
NaOH to pH=8.3 [mL]	17-Jun-19	08:35	21-Jun-19	10:22	4.66	4.67	2.98	4.65
Final pH [no unit]	17-Jun-19	08:35	21-Jun-19	10:22	1.48	1.51	1.64	1.55
NP [t CaCO3/1000 t]	17-Jun-19	08:35	21-Jun-19	10:22	942	960	946	920
AP [t CaCO3/1000 t]	21-Jun-19	14:43	21-Jun-19	10:22	0.62	0.62	0.62	0.62
Net NP [t CaCO3/1000 t]	21-Jun-19	14:43	21-Jun-19	10:22	942	960	945	919
NP/AP [ratio]	21-Jun-19	14:43	21-Jun-19	10:22	1520	1549	1525	1484
Sulphur (total) [%]	14-Jun-19	09:01	17-Jun-19	11:12	0.023	0.012	0.010	0.011
Acid Leachable SO4-S [%]	14-Jun-19	09:01	17-Jun-19	11:12	0.02	< 0.02	< 0.02	< 0.02
Sulphide [%]	17-Jun-19	11:04	17-Jun-19	11:12	< 0.02	< 0.02	< 0.02	< 0.02
Carbon (total) [%]	14-Jun-19	09:01	17-Jun-19	11:12	11.4	10.7	11.0	11.0
Carbonate [%]	17-Jun-19	09:36	17-Jun-19	11:12	49.6	50.0	53.1	51.7
Weight [g]	---	---	---	---	953	944	1098	1098

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LR Report : CA15104-JUN19

$$\begin{aligned} & \text{*NP (Neutralization Potential)} \\ & = 50 \times (\text{N of HCL} \times \text{Total HCL added} - \text{N NaOH} \times \text{NaOH added}) \\ & \text{-----} \\ & \text{Weight of Sample} \end{aligned}$$

$$\text{*AP (Acid Potential)} = \% \text{ Sulphide Sulphur} \times 31.25$$

$$\text{*Net NP (Net Neutralization Potential)} = \text{NP} - \text{AP}$$

$$\text{NP/AP Ratio} = \text{NP/AP}$$

*Results expressed as tonnes CaCO₃ equivalent/1000 tonnes of material

Samples with a % Sulphide value of <0.02 will be calculated using a 0.02 value.



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Hatch LTD

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Phone: 905-374-5200
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11-January-2019

Date Rec. : 20 December 2018
LR Report: CA15344-DEC18

Copy: #1

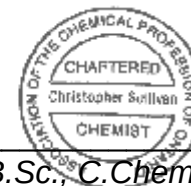
CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Q1	6: Q5	7: Q24	8: QMR2	9: PQ4B	10: PQ5B	11: PQ6B	12: PQ12A	13: PQ13	14: PQ15A	15: PQ15B
Silver [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Aluminum [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	76000	76000	3000	39000	3700	2900	3000	9000	57000	86000	69000
Arsenic [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	1.1	0.6	< 0.5	0.6	0.6	< 0.5	< 0.5	2.0	1.9	0.9	0.9
Barium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	750	650	13	150	14	12	12	51	270	1200	1900
Beryllium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	1.8	2.3	0.11	1.6	0.11	0.11	0.11	0.25	2.0	1.9	1.2
Bismuth [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	0.09	0.33	< 0.09	0.09
Calcium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	9200	7000	360000	3700	380000	370000	340000	200000	1800	8500	4300
Cadmium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	0.03	0.03	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	0.03	0.05	0.07
Cobalt [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	2.4	4.1	0.57	2.0	0.66	0.50	0.52	2.7	1.7	7.0	3.2
Chromium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	92	80	4.8	99	3.3	2.1	2.3	4.6	98	83	75
Copper [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	2.7	6.4	0.9	4.2	1.2	1.1	1.2	6.2	3.4	3.2	3.5
Iron [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	11000	16000	2100	10000	2600	2000	2300	5300	14000	28000	17000
Potassium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	33000	34000	1800	20000	2300	1700	1900	9900	53000	41000	47000
Lithium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	28	31	5	10	6	5	5	27	28	28	19
Magnesium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	3700	7200	14000	4800	5000	17000	25000	120000	5500	9800	6400
Manganese [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	230	230	72	190	110	70	68	150	130	520	240
Molybdenum [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	6.2	6.7	0.5	11	0.2	0.1	0.2	0.8	8.3	6.4	7.8
Sodium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	33000	28000	220	9500	210	220	220	390	10000	30000	16000
Nickel [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	25	9.6	3.8	8.5	4.0	3.3	3.0	4.6	5.1	17	5.9
Phosphorus [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	110	280	64	85	110	40	38	130	58	400	240

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Q1	6: Q5	7: Q24	8: QMR2	9: PQ4B	10: PQ5B	11: PQ6B	12: PQ12A	13: PQ13	14: PQ15A	15: PQ15B
Lead [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	52	24	0.91	8.8	1.4	0.95	0.75	4.8	22	20	28
Antimony [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Selenium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Tin [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	250	170	310	27	290	390	350	67	28	160	98
Titanium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	700	1300	170	660	210	160	160	330	660	1800	1400
Thallium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	0.65	0.48	0.06	0.28	0.03	0.03	< 0.02	0.18	0.92	0.72	0.50
Uranium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	3.1	2.4	0.42	2.7	0.47	0.37	0.42	1.0	5.2	1.9	2.2
Vanadium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	8	21	4	11	5	5	4	12	5	27	15
Yttrium [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	5.4	5.5	1.9	7.9	2.6	1.4	1.5	3.3	11	7.1	6.4
Zinc [µg/g]	09-Jan-19	13:24	10-Jan-19	10:15	26	35	2.8	21	3.2	3.5	2.7	3.8	17	59	39

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20-June-2019

Hatch LTD

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Date Rec. : 05 June 2019
LR Report: CA15105-JUN19
Reference: Job# H/353004/221 1534,
 PCCR 4091

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: PQ4A	6: PQ9A	7: PQ9B	8: PQ5A
Silver [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	< 1	< 1	< 1	< 1
Aluminum [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	2600	4000	3200	3500
Arsenic [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	2.6	1.5	0.84	0.80
Barium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	9.3	18	12	16
Beryllium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	0.074	0.11	0.10	0.11
Bismuth [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	0.12	< 0.09	< 0.09	< 0.09
Calcium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	350000	320000	360000	360000
Cadmium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	0.087	0.036	0.023	< 0.02
Cobalt [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	0.70	0.83	0.67	0.69
Chromium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	2.2	3.0	2.6	2.5
Copper [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	7.3	2.7	2.6	1.6
Iron [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	2400	2800	2300	3000
Potassium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	1600	3100	2000	2000
Lithium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	4.1	6.6	8.1	5.4
Magnesium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	4600	18000	13000	5200
Manganese [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	91	69	130	140
Molybdenum [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	< 0.1	0.18	0.12	< 0.1
Sodium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	140	150	150	140
Nickel [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	3.1	3.9	3.7	4.1
Phosphorus [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	34	76	25	48
Lead [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	10	3.1	3.4	2.1
Antimony [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	< 0.8	< 0.8	< 0.8	< 0.8
Selenium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	< 0.7	< 0.7	< 0.7	< 0.7
Tin [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	< 6	< 6	< 6	< 6
Strontium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	270	210	270	280
Titanium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	170	230	190	220
Thallium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	0.042	0.043	0.064	0.032
Uranium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	0.40	0.52	0.49	0.47
Vanadium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	3.9	4.9	4.2	4.8
Yttrium [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	2.0	1.6	1.5	2.1
Zinc [µg/g]	17-Jun-19	18:41	17-Jun-19	11:55	37	14	11	6.6

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LR Report : CA15105-JUN19

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SFE 3:1 ratio 24hr (MEND) prefilter pH

11-January-2019

Date Rec. : 20 December 2018
LR Report: CA15345-DEC18

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Q1	6: Q5	7: Q24	8: QMR2	9: PQ4B	10: PQ5B
Sample weight [g]	03-Jan-19	07:42	07-Jan-19	10:34	250	250	250	250	250	250
Volume D.I. Water [mL]	03-Jan-19	07:42	07-Jan-19	10:34	750	750	750	750	750	750
Final pH	04-Jan-19	16:07	08-Jan-19	14:22	9.40	8.92	8.80	9.06	8.79	9.34
pH [no unit]	07-Jan-19	15:50	09-Jan-19	14:41	9.16	8.01	8.47	9.03	8.44	8.34
Alkalinity [mg/L as CaCO ₃]	07-Jan-19	15:50	09-Jan-19	14:41	28	32	28	37	26	26
Conductivity [uS/cm]	07-Jan-19	15:50	09-Jan-19	14:41	68	79	106	126	81	81
Chloride [mg/L]	08-Jan-19	14:25	09-Jan-19	12:46	3	4	11	4	8	7
Sulphate [mg/L]	08-Jan-19	14:32	09-Jan-19	12:46	2	< 2	6	< 2	< 2	< 2
Mercury [mg/L]	09-Jan-19	16:05	10-Jan-19	08:46	< 0.00001	< 0.00001	< 0.00001	0.00018	< 0.00001	< 0.00001
Silver [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.771	0.420	0.196	0.445	0.235	0.149
Arsenic [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.0011	0.0003	< 0.0002	0.0013	< 0.0002	< 0.0002
Barium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00454	0.00277	0.00151	0.00193	0.00075	0.00074
Boron [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.009	0.022	0.085	0.026	0.047	0.059
Beryllium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.000008	0.000017	< 0.000007	0.000012	< 0.000007	< 0.000007
Bismuth [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	< 0.000007	0.000010	< 0.000007	< 0.000007	0.000032	0.000020
Calcium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	3.33	4.37	11.2	3.84	10.5	7.92



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SFE 3:1 ratio 24hr (MEND) prefilter pH

LR Report :

CA15345-DEC18

Analysis	1: Analysis Start Date	2: Analysis Start Time Completed	3: Analysis Date Completed	4: Analysis Time	5: Q1	6: Q5	7: Q24	8: QMR2	9: PQ4B	10: PQ5B
Cadmium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	< 0.000003	0.000003	0.000009	0.000009	< 0.000003	< 0.000003
Cobalt [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.000044	0.000034	< 0.000004	0.000069	0.000007	0.000109
Chromium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00017	0.00015	0.00022	0.00007	0.00035	0.00023
Copper [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00038	0.00637	0.00876	0.00048	0.00091	0.00041
Iron [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.105	0.079	0.008	0.061	< 0.007	< 0.007
Potassium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	7.36	6.41	1.96	15.4	2.14	1.35
Lithium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.0126	0.0047	0.0042	0.0061	0.0038	0.0024
Magnesium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.496	1.29	4.08	1.14	1.62	3.33
Manganese [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00320	0.00137	0.00002	0.00147	0.00002	< 0.00001
Molybdenum [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00039	0.00174	0.00111	0.00345	0.00156	0.00052
Sodium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	5.96	6.07	1.24	8.84	0.96	0.84
Nickel [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Lead [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00079	0.00010	0.00006	0.00022	0.00002	< 0.00001
Antimony [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.0004	0.0004	0.0003	0.0004	0.0003	0.0003
Selenium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	< 0.00004	0.00011	0.00006	0.00049	< 0.00004	< 0.00004
Tin [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00022	0.00015	0.00022	0.00022	0.00012	0.00009
Strontium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.0153	0.00593	0.129	0.00681	0.111	0.111
Titanium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00719	0.00332	0.00074	0.00449	0.00005	< 0.00005
Thallium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.000009	< 0.000005	0.000006	0.000008	< 0.000005	0.000005
Uranium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00963	0.00121	0.000046	0.00818	0.000048	0.000022
Vanadium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00314	0.00370	0.00047	0.00618	0.00065	0.00049
Tungsten [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.00017	0.00024	0.00004	0.00045	0.00022	0.00022
Yttrium [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	0.000079	0.000110	0.000005	0.000163	0.000003	< 0.000002
Zinc [mg/L]	07-Jan-19	12:44	11-Jan-19	14:03	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002

Analysis	11: PQ6B	12: PQ12A	13: PQ13	14: PQ15A	15: PQ15B
Sample weight [g]	250	250	250	250	250



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SFE 3:1 ratio 24hr (MEND) prefilter pH

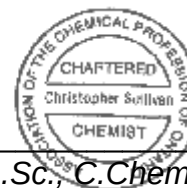
LR Report :

CA15345-DEC18

Analysis	11: PQ6B	12: PQ12A	13: PQ13	14: PQ15A	15: PQ15B
Volume D.I. Water [mL]	750	750	750	750	750
Final pH	9.21	8.34	8.17	8.61	8.35
pH [no unit]	8.51	9.32	7.97	7.78	7.51
Alkalinity [mg/L as CaCO ₃]	29	88	39	22	46
Conductivity [uS/cm]	100	272	90	50	109
Chloride [mg/L]	9	35	2	1	2
Sulphate [mg/L]	< 2	3	< 2	< 2	< 2
Mercury [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00002
Silver [mg/L]	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	0.128	0.026	0.448	1.06	0.389
Arsenic [mg/L]	0.0004	0.0010	0.0016	0.0010	0.0005
Barium [mg/L]	0.00080	0.00269	0.00194	0.00801	0.00920
Boron [mg/L]	0.078	0.071	0.033	0.041	0.035
Beryllium [mg/L]	< 0.000007	< 0.000007	0.000034	0.000020	0.000015
Bismuth [mg/L]	0.000051	< 0.000007	0.000027	< 0.000007	0.000012
Calcium [mg/L]	8.69	9.20	4.98	0.21	7.25
Cadmium [mg/L]	0.000021	0.000004	0.000007	0.000007	< 0.000003
Cobalt [mg/L]	0.000015	0.000052	0.000055	0.000099	0.000202
Chromium [mg/L]	0.00110	0.00011	0.00004	0.00023	0.00006
Copper [mg/L]	0.00097	0.00110	0.00198	0.00299	0.01076
Iron [mg/L]	0.016	0.007	0.190	0.353	0.139
Potassium [mg/L]	1.49	6.58	13.4	10.3	16.9
Lithium [mg/L]	0.0030	0.0239	0.0035	0.0019	0.0013
Magnesium [mg/L]	4.36	22.1	1.84	0.236	1.16
Manganese [mg/L]	0.00005	0.00007	0.00192	0.00610	0.00740
Molybdenum [mg/L]	0.00230	0.00301	0.00068	0.00095	0.00198
Sodium [mg/L]	1.15	6.10	2.68	4.41	2.57
Nickel [mg/L]	< 0.0001	0.0004	< 0.0001	0.0002	< 0.0001
Lead [mg/L]	< 0.00001	0.00002	0.00018	0.00019	0.00039

Analysis	11: PQ6B	12: PQ12A	13: PQ13	14: PQ15A	15: PQ15B
Antimony [mg/L]	0.0002	0.0003	0.0005	0.0005	0.0005
Selenium [mg/L]	< 0.00004	0.00009	0.00007	0.00006	0.00010
Tin [mg/L]	0.00051	0.00008	0.00008	0.00040	0.00033
Strontium [mg/L]	0.108	0.0498	0.00497	0.00093	0.00928
Titanium [mg/L]	0.00048	0.00006	0.00346	0.0189	0.00650
Thallium [mg/L]	< 0.000005	0.000171	0.000013	0.000011	< 0.000005
Uranium [mg/L]	0.000035	0.000127	0.00250	0.000184	0.00161
Vanadium [mg/L]	0.00052	0.00198	0.00045	0.00398	0.00119
Tungsten [mg/L]	0.00017	0.00020	0.00074	0.00013	0.00026
Yttrium [mg/L]	0.000005	0.000019	0.000639	0.000139	0.000229
Zinc [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002

Chris Sullivan



Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical



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Hatch LTD

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Canada, L2E 7J7
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SFE 3:1 ratio 24hr (MEND) prefilter pH

17-June-2019

Date Rec. : 05 June 2019
LR Report: CA15106-JUN19

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: PQ4A	6: PQ9A	7: PQ9B	8: PQ5A
Sample weight [g]	11-Jun-19	07:22	12-Jun-19	08:25	250	250	250	250
Volume D.I. Water [mL]	11-Jun-19	07:22	12-Jun-19	08:25	750	750	750	750
Final pH [no unit]	12-Jun-19	08:02	12-Jun-19	08:25	9.15	9.10	9.23	9.22
pH [no unit]	12-Jun-19	16:19	13-Jun-19	16:28	8.43	8.50	8.68	8.35
Alkalinity [mg/L as CaCO ₃]	12-Jun-19	16:19	13-Jun-19	16:28	25	32	29	26
Conductivity [uS/cm]	12-Jun-19	16:19	13-Jun-19	16:28	77	118	86	75
Chloride [mg/L]	12-Jun-19	14:31	14-Jun-19	16:42	6	15	7	6
Sulphate [mg/L]	12-Jun-19	14:26	15-Jun-19	13:54	2	2	2	< 2
Mercury [mg/L]	13-Jun-19	11:49	13-Jun-19	11:38	0.00001	< 0.00001	< 0.00001	0.00001
Silver [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.266	0.184	0.122	0.254
Arsenic [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.0002	0.0002	< 0.0002	0.0002
Barium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00202	0.00192	0.00265	0.00211
Boron [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.053	0.156	0.303	0.044
Beryllium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Bismuth [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Calcium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	9.13	11.3	8.47	9.70
Cadmium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.000003	< 0.000003	< 0.000003	< 0.000003
Cobalt [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.000021	0.000059	0.000009	0.000016
Chromium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00038	0.00017	0.00021	0.00037

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: PQ4A	6: PQ9A	7: PQ9B	8: PQ5A
Copper [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.0003	0.0003	< 0.0002	0.0003
Iron [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.007	< 0.007	< 0.007	< 0.007
Potassium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	1.75	2.40	1.55	1.80
Lithium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.0031	0.0055	0.0059	0.0030
Magnesium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	1.41	5.07	3.14	1.54
Manganese [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00007	0.00011	0.00015	0.00003
Molybdenum [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00033	0.00056	0.00036	0.00034
Sodium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.88	1.58	1.21	0.89
Nickel [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.0001	0.0004	< 0.0001	< 0.0001
Lead [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00001	0.00001	0.00001	0.00001
Antimony [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Selenium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00008	0.00014	0.00005	0.00008
Tin [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.00006	0.00008	< 0.00006	< 0.00006
Strontium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.110	0.104	0.0905	0.111
Titanium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.00005	< 0.00005	< 0.00005	0.00014
Thallium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.000005	0.000007	0.000023	< 0.000005
Uranium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.000042	0.000071	0.000026	0.000048
Vanadium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00084	0.00054	0.00044	0.00058
Tungsten [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	0.00006	0.00011	0.00005	0.00008
Yttrium [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.000002	< 0.000002	0.000003	0.000003
Zinc [mg/L]	13-Jun-19	11:20	14-Jun-19	11:52	< 0.002	< 0.002	< 0.002	< 0.002

Chris Sullivan

Chris Sullivan, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety





Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for: *Environmental -Analytical*

Project Number/ LIMS No. *Custom XRD/MI4500-JAN19*

Sample Receipt: *January 2, 2019*

Sample Analysis: *January 9, 2019*

Reporting Date: *January 15, 2019*

Instrument: BRUKER AXS D8 Advance Diffractometer

Test Conditions: Co radiation, 40 kV, 35 mA
Regular Scanning: Step: 0.02°, Step time: 1s, 2θ range: 3-80°

Interpretations : PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.

Detection Limit : 0.5-2%. Strongly dependent on crystallinity.

Contents:

- 1) Method Summary
- 2) Quantitative XRD Results
- 3) XRD Pattern(s)

Kim Gibbs, H.B.Sc., P.Geo.
Senior Mineralogist

Huyun Zhou, Ph.D., P.Geo.
Senior Mineralogist

ACCREDITATION: SGS Minerals Services Lakefield is accredited to the requirements of ISO/IEC 17025 for specific tests as listed on our scope of accreditation, including geochemical, mineralogical and trade mineral tests. To view a list of the accredited methods, please visit the following website and search SGS Canada - Minerals Services - Lakefield: <http://palcan.scc.ca/SpecsSearch/GLSearchForm.do>.



Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Minerals Services is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativeness of any goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted.



Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

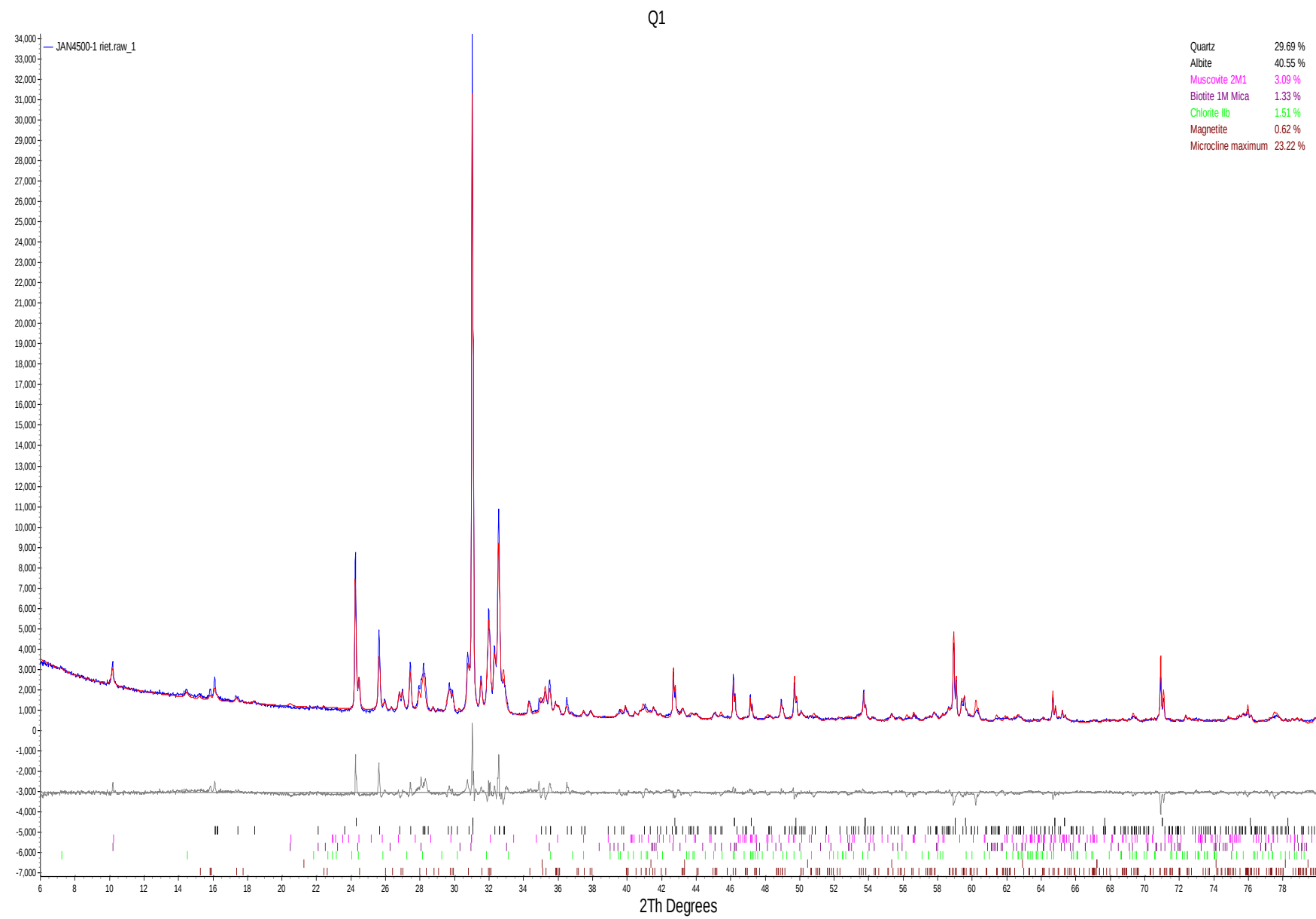
Mineral/Compound	Q1 JAN4500-01 (wt %)	Q5 JAN4500-02 (wt %)	Q24 JAN4500-03 (wt %)	QMR2 JAN4500-04 (wt %)	PQ4B JAN4500-05 (wt %)	PQ5B JAN4500-06 (wt %)	PQ6B JAN4500-07 (wt %)	PQ12A JAN4500-08 (wt %)	PQ13 JAN4500-09 (wt %)	PQ15A JAN4500-10 (wt %)	PQ15B JAN4500-11 (wt %)
Quartz	29.7	30.7	1.1	65.8	1.1	0.5	0.8	1.7	41.4	26.1	34.8
Albite	40.6	32.7	-	12.3	-	-	-	-	11.4	28.7	18.9
Muscovite	3.1	4.9	-	6.7	0.0	-	-	-	5.5	8.4	10.4
Biotite	1.3	2.5	-	3.7	-	-	-	-	0.7	8.9	4.6
Chlorite	1.5	2.7	-	1.2	-	-	-	-	2.4	0.2	0.0
Magnetite	0.6	0.3	-	0.3	-	0.4	0.4	-	0.8	1.1	0.6
Microcline	23.2	23.3	-	9.9	-	-	-	-	36.9	24.1	29.8
Hematite	-	0.9	-	0.1	-	0.1	0.2	0.8	-	-	-
Diopside	-	1.3	-	-	-	-	-	-	-	-	-
Lepidocrocite	-	0.6	-	-	-	-	-	-	-	0.8	-
Calcite	-	-	90.6	-	98.7	86.6	80.6	0.1	0.6	1.1	0.4
Ankerite	-	-	5.2	-	-	12.3	5.1	-	0.1	0.6	0.3
Dolomite	-	-	3.1	-	0.2	-	12.9	91.5	0.2	0.1	0.2
Sanidine	-	-	-	-	-	-	-	6.0	-	-	-
TOTAL	100	100	100	100	100	100	100	100	100	100	100

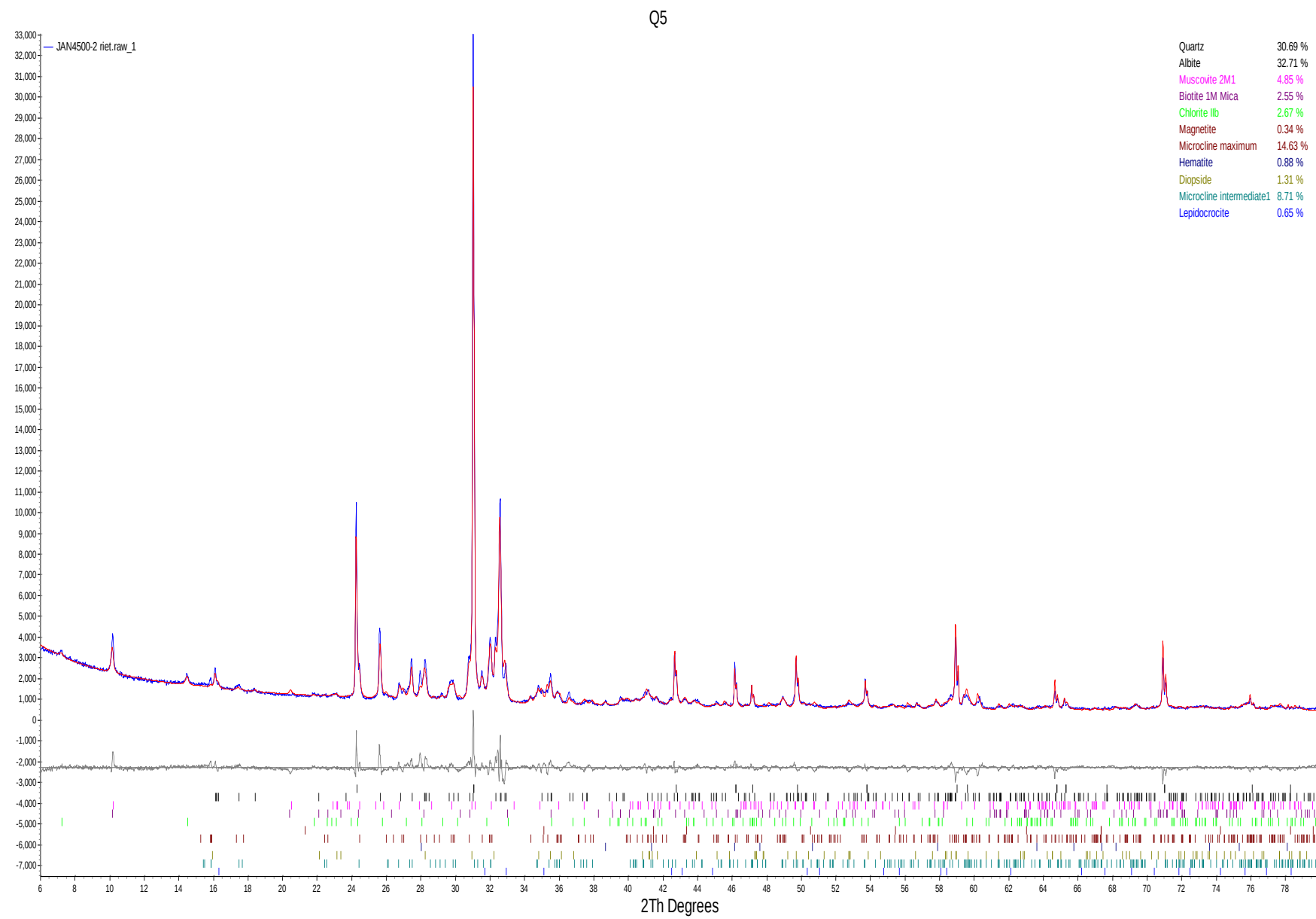
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

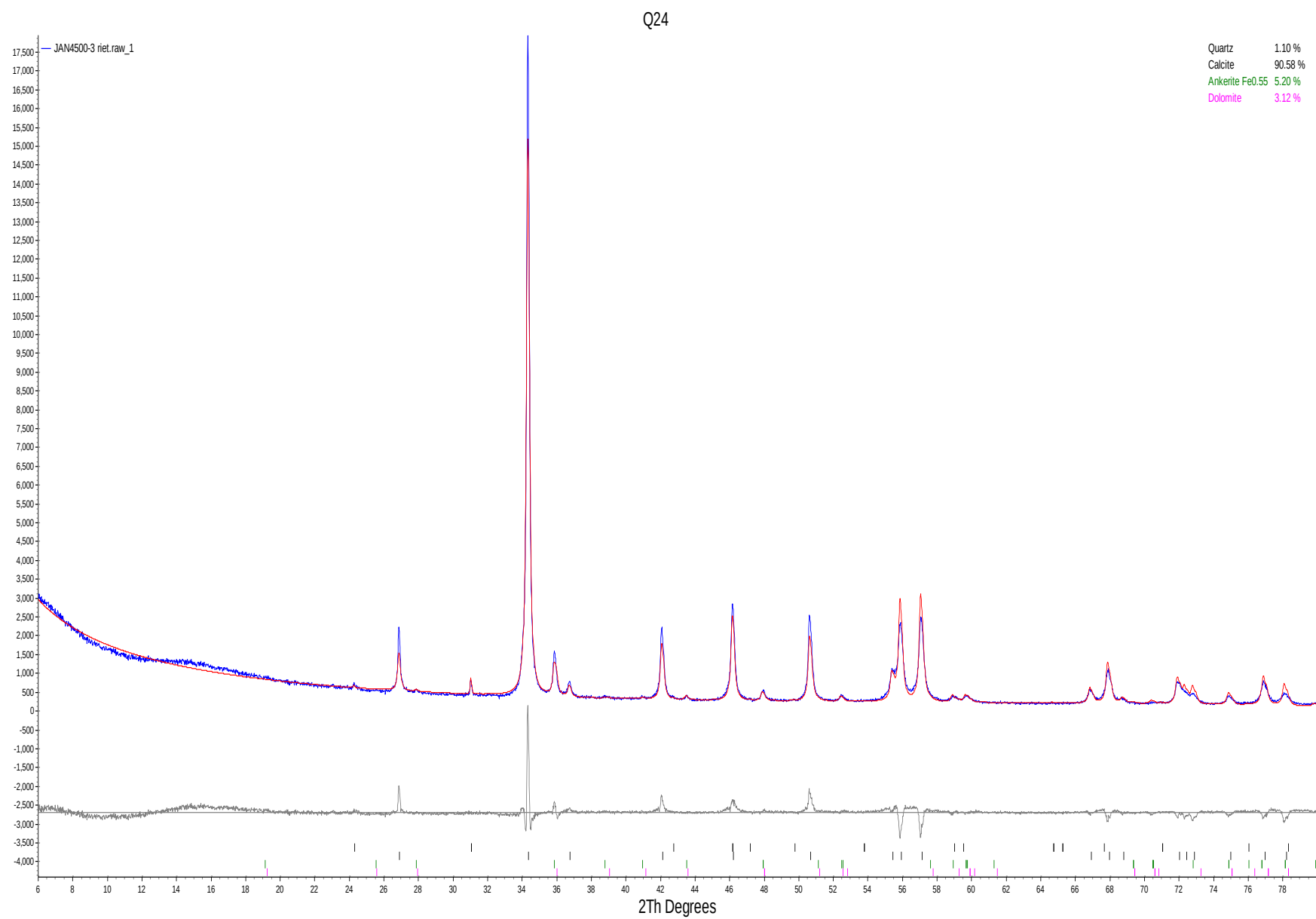
Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

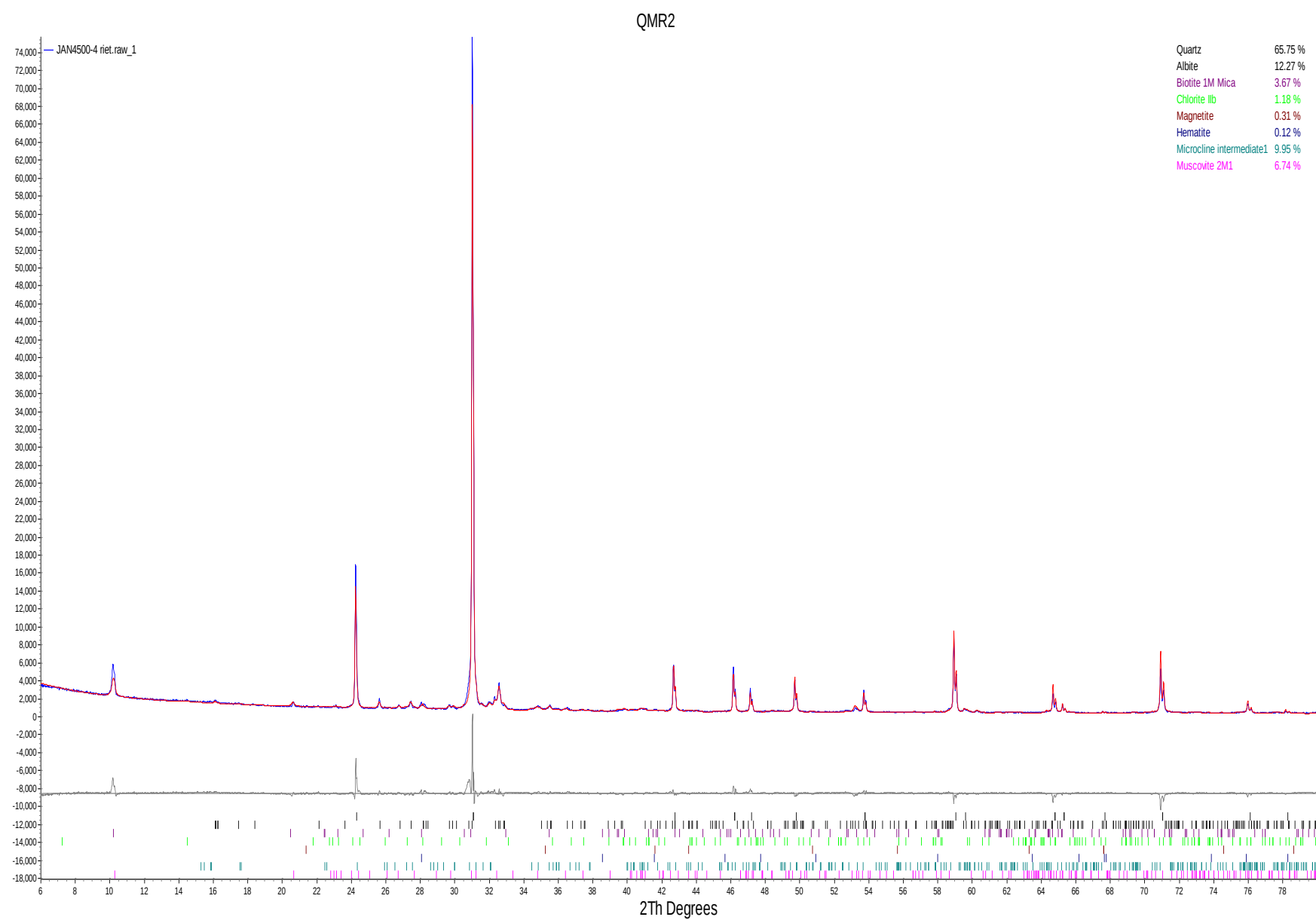
The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

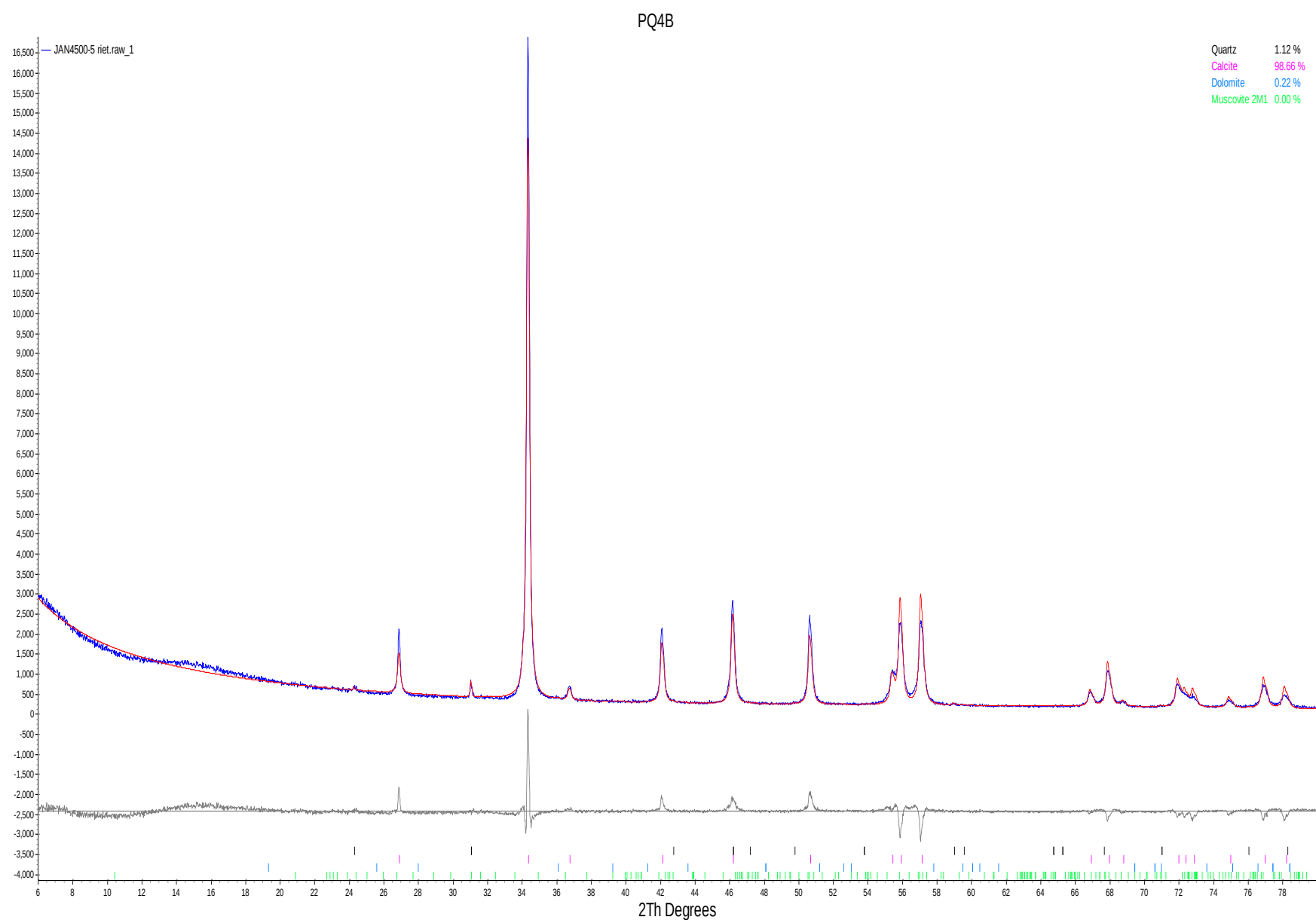
Mineral/Compound	Formula
Quartz	SiO ₂
Albite	NaAlSi ₃ O ₈
Muscovite	KAl ₂ (AlSi ₃ O ₁₀)(OH) ₂
Biotite	K(Mg,Fe) ₃ (AlSi ₃ O ₁₀)(OH) ₂
Chlorite	(Fe,(Mg,Mn) ₅ ,Al)(Si ₃ Al)O ₁₀ (OH) ₈
Magnetite	Fe ₃ O ₄
Microcline	KAlSi ₃ O ₈
Hematite	Fe ₂ O ₃
Diopside	CaMgSi ₂ O ₆
Lepidocrocite	FeOOH
Calcite	CaCO ₃
Ankerite	CaFe(CO ₃) ₂
Dolomite	CaMg(CO ₃) ₂
Sanidine	KAlSi ₃ O ₈

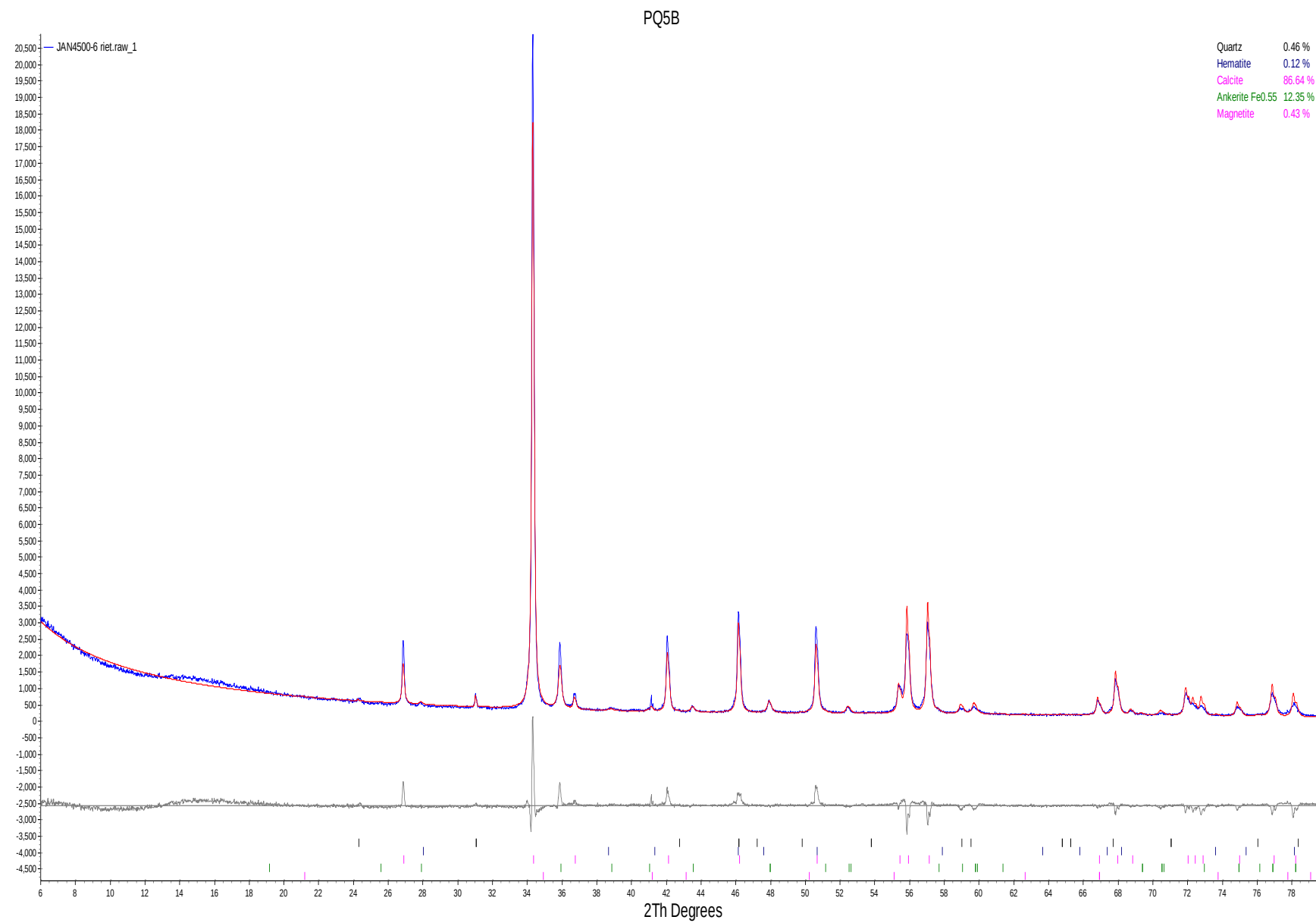


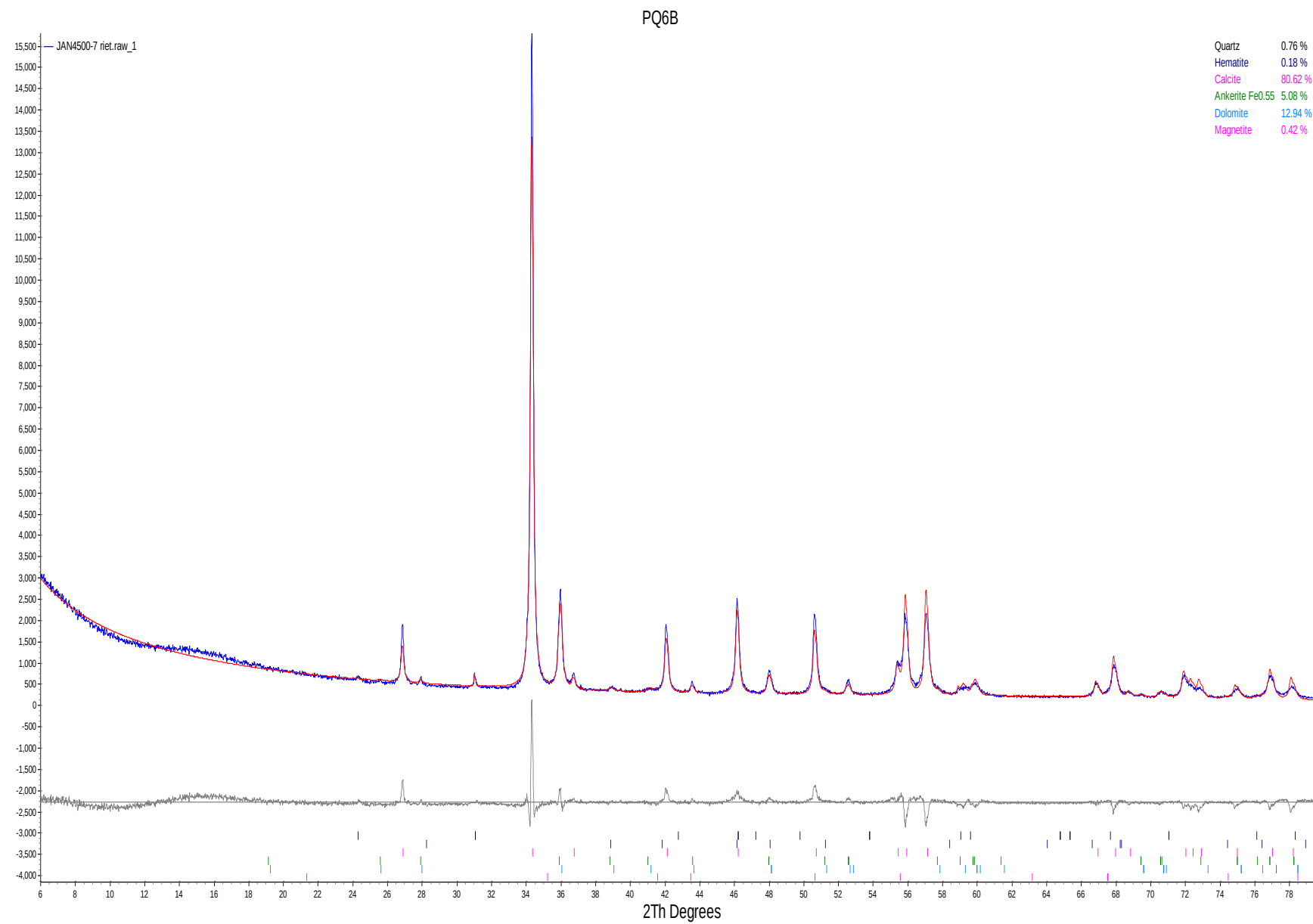


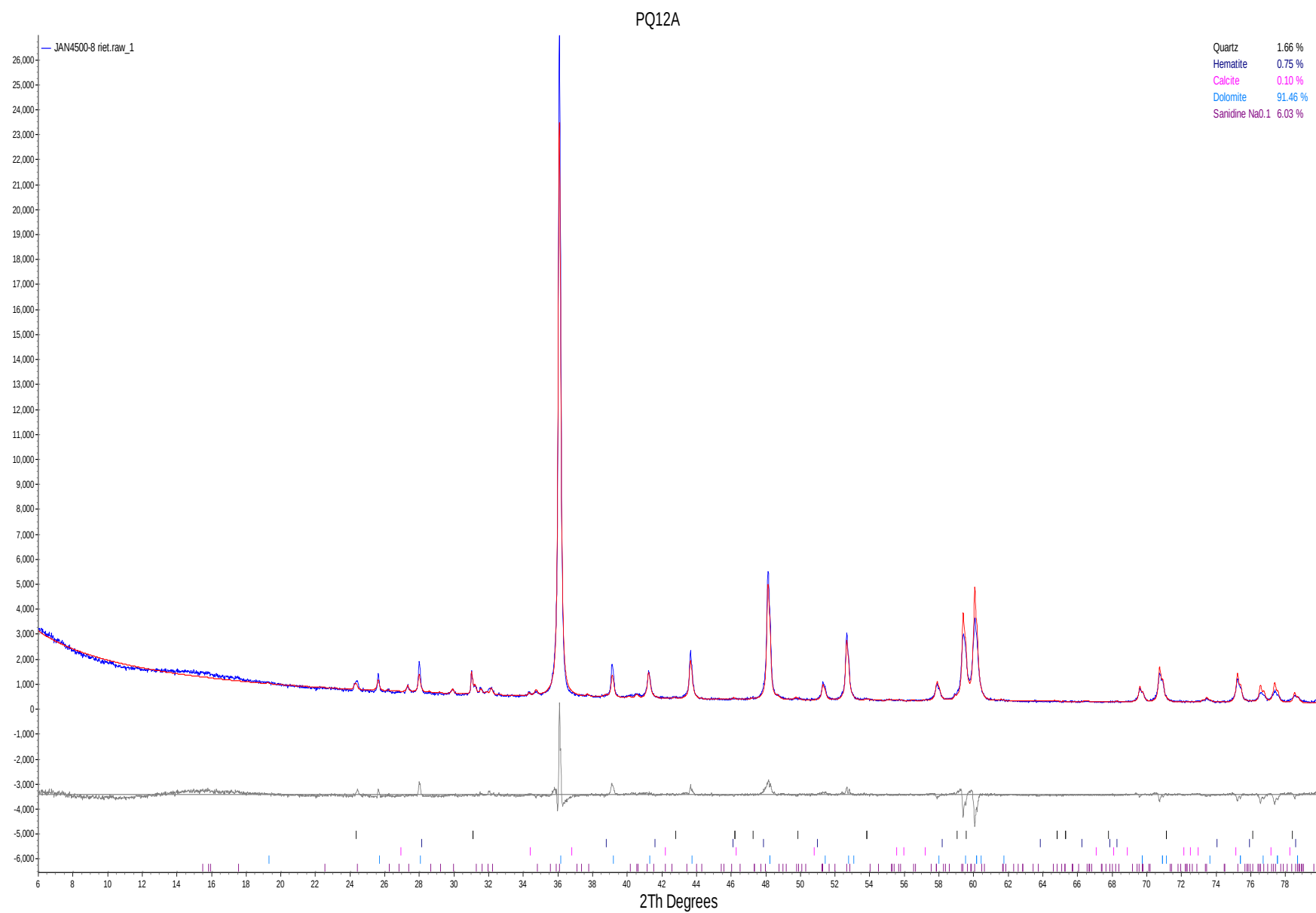




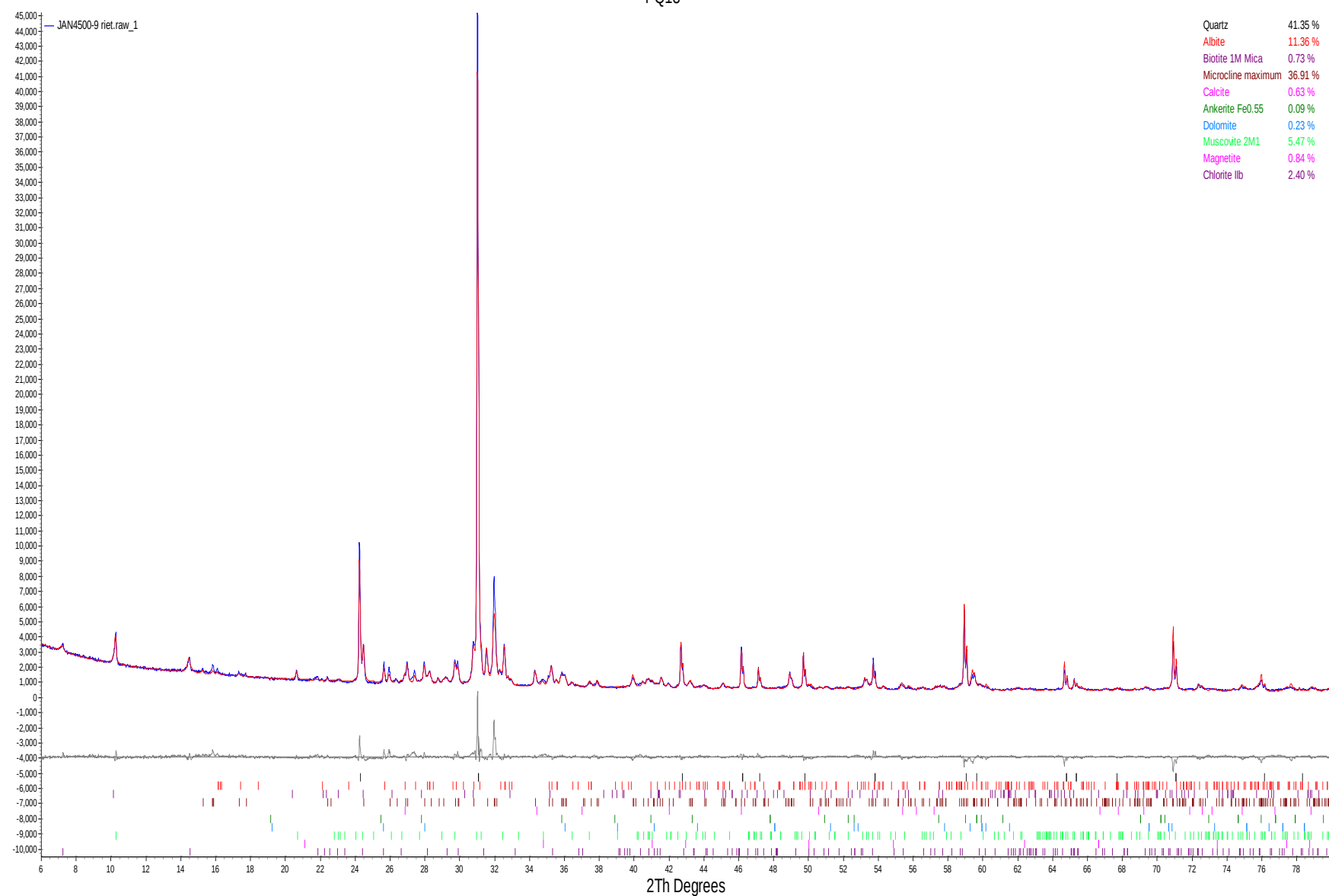






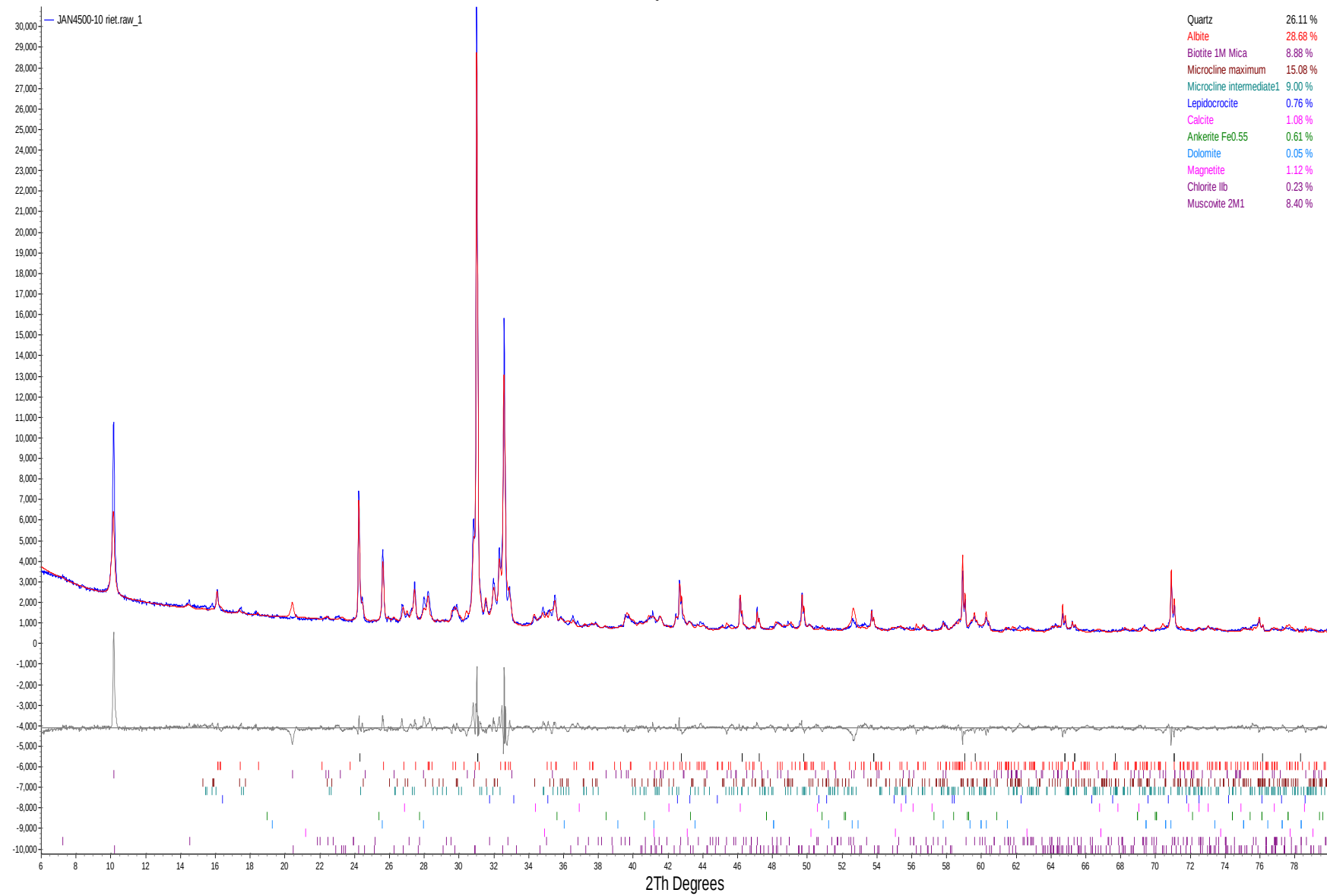


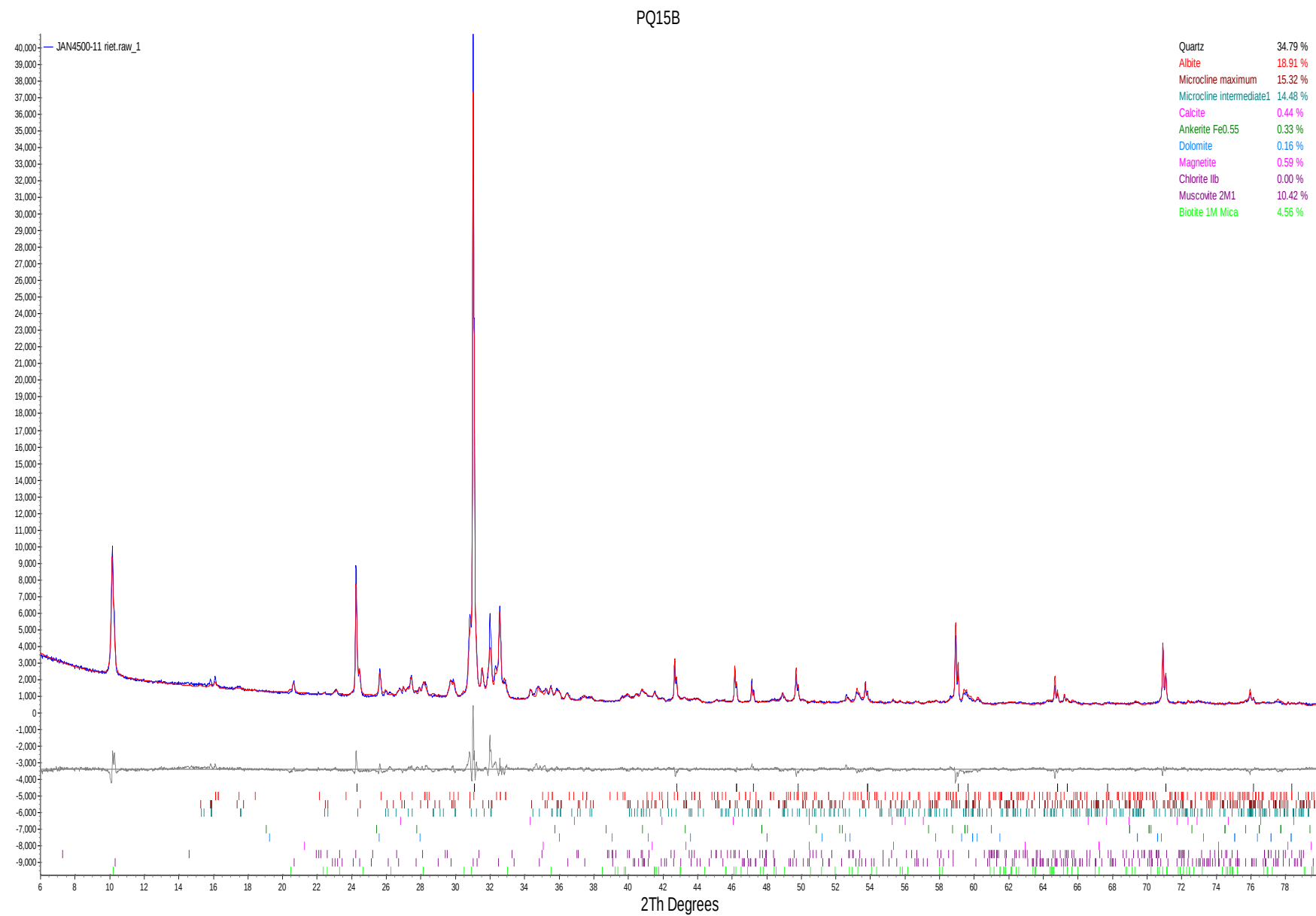
PQ13





PQ15A







Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for: Environmental -Analytical
Project Number/ LIMS No. Custom XRD/MI4502-JUN19
Sample Receipt: June 10, 2019
Sample Analysis: June 10, 2019
Reporting Date: June 11, 2019

Instrument: BRUKER AXS D8 Advance Diffractometer
Test Conditions: Co radiation, 40 kV, 35 mA
Regular Scanning: Step: 0.02°, Step time: 1s, 2θ range: 3-80°
Interpretations : PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit : 0.5-2%. Strongly dependent on crystallinity.

Contents:
1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

Kim Gibbs, H.B.Sc., P.Geo.
Senior Mineralogist

Huyun Zhou, Ph.D., P.Geo.
Senior Mineralogist

ACCREDITATION: SGS Minerals Services Lakefield is accredited to the requirements of ISO/IEC 17025 for specific tests as listed on our scope of accreditation, including geochemical, mineralogical and trade mineral tests. To view a list of the accredited methods, please visit the following website and search SGS Canada - Minerals Services - Lakefield: <http://palcan.scc.ca/SpecsSearch/GLSearchForm.do>.



Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Minerals Services is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativeness of any goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted.

Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Report Prepared for:

Mineral/Compound	PQ4A JUN4502-01 (wt %)	PQ9A JUN4502-02 (wt %)	PQ9B JUN4502-03 (wt %)	PQ5A JUN4502-04 (wt %)
Quartz	0.9	2.6	2.0	1.2
Calcite	98.5	83.0	89.5	96.9
Muscovite	0.6	0.6	0.8	1.0
Dolomite	-	12.4	4.7	0.6
Ankerite	-	1.6	3.0	0.3
TOTAL	100	100	100	100

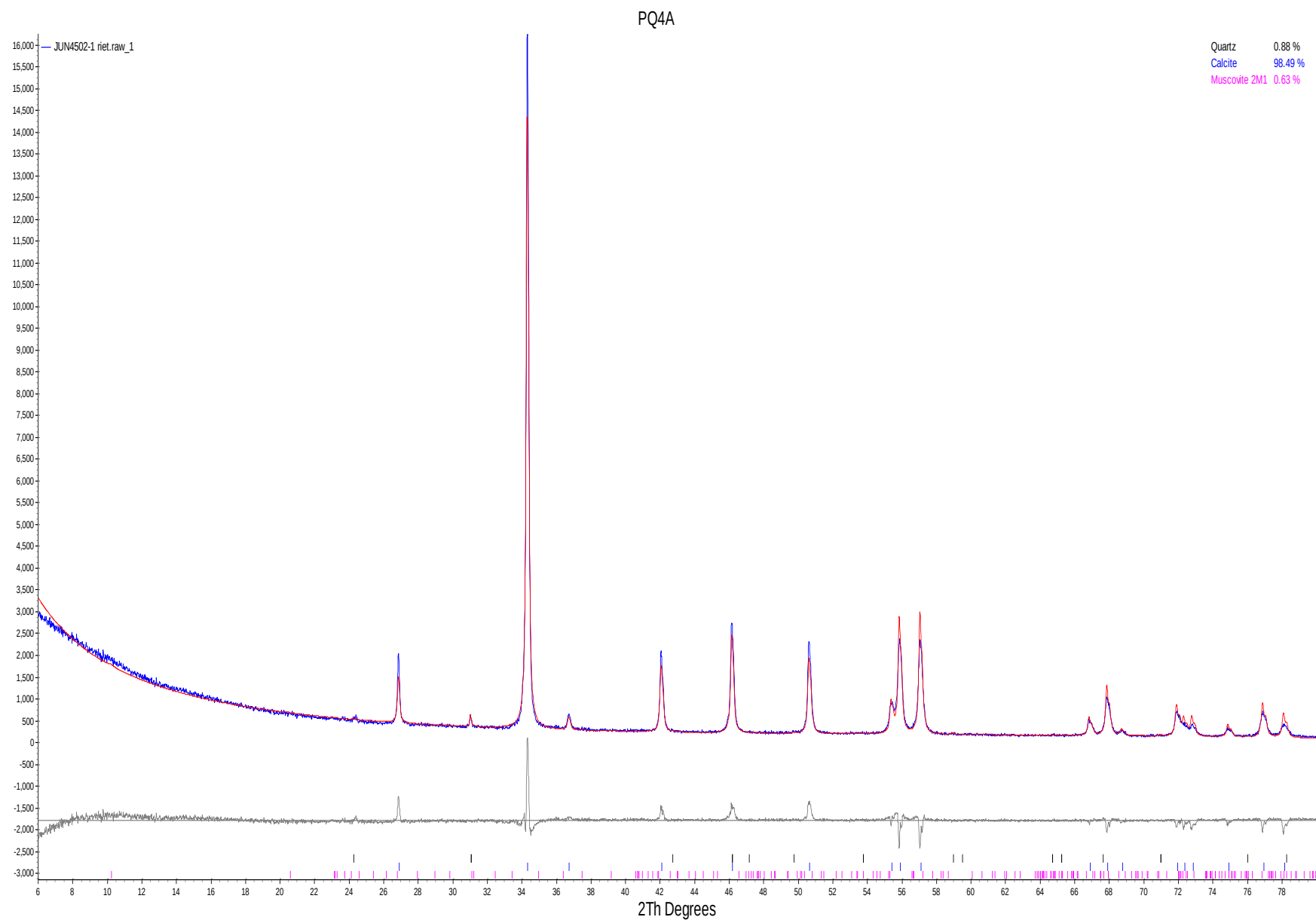
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

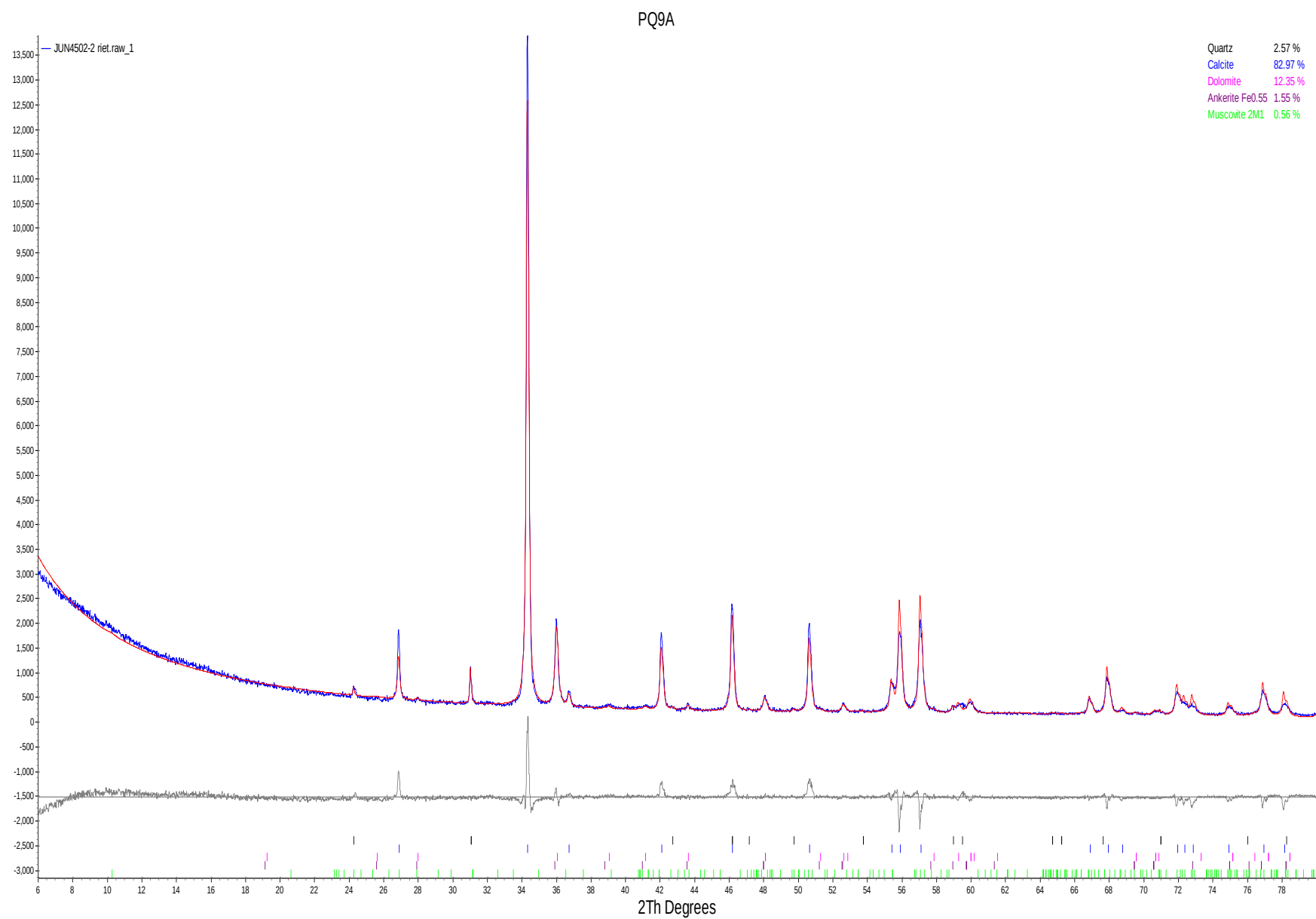
Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

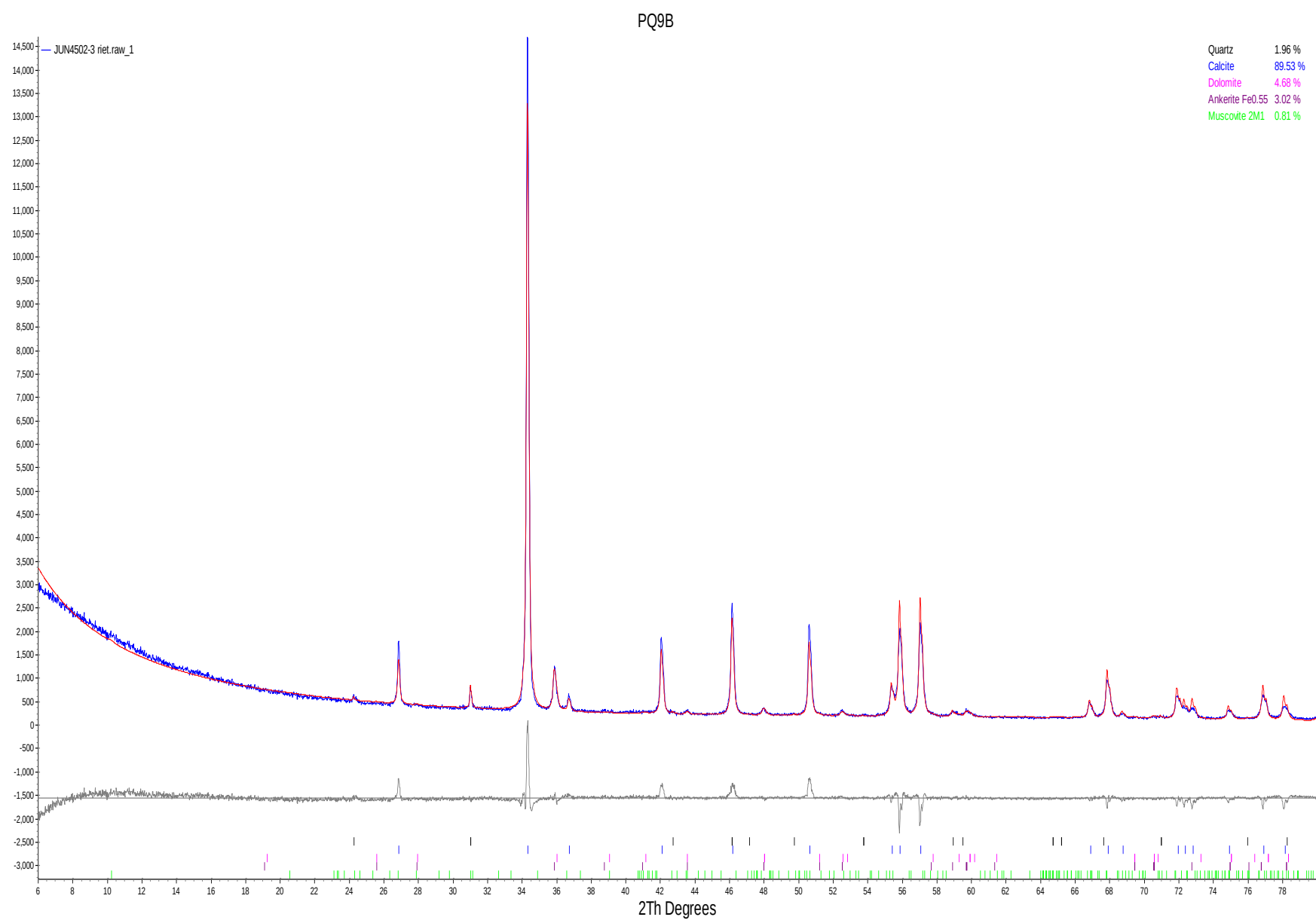
The weight percent quantities indicated have been normalized to a sum of 100%.

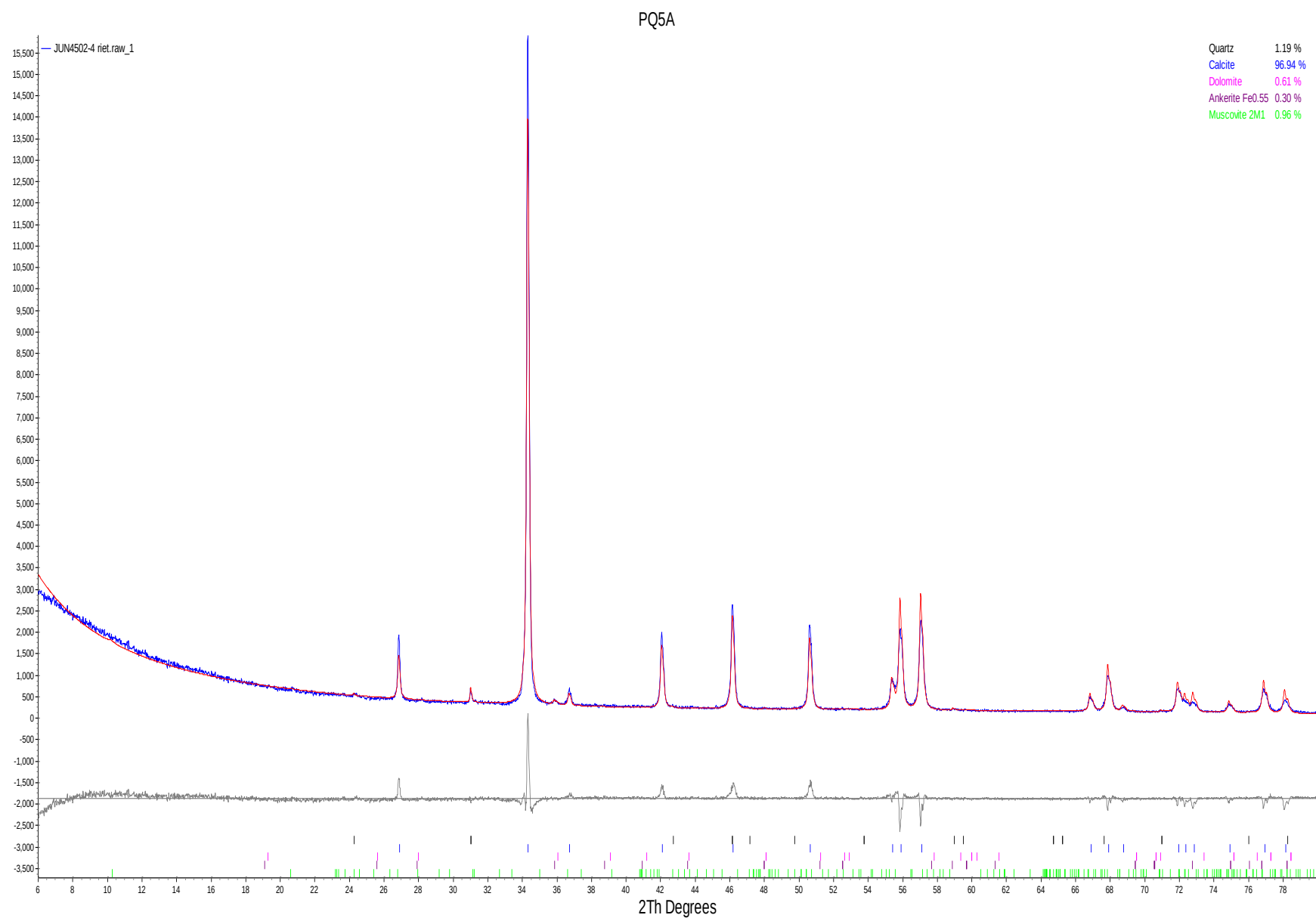
The quantity of amorphous material has not been determined.

Mineral/Compound	Formula
Quartz	SiO ₂
Calcite	CaCO ₃
Muscovite	KAl ₂ (AlSi ₃ O ₁₀)(OH) ₂
Dolomite	CaMg(CO ₃) ₂
Ankerite	CaFe(CO ₃) ₂











ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ6B	01	lump	perpendicular	76	42.00	0.55	63.75	4064.15	16000	8096	1.99	1.12	2.22	24.5	48.81
	02	lump	perpendicular	63	43.00	0.68	58.73	3449.18	7500	3795	1.10	1.08	1.18	24.0	26.41
	03	lump	perpendicular	79	46.00	0.58	68.02	4626.91	20000	10120	2.19	1.15	2.51	24.5	53.59
	04	lump	perpendicular	85	45.00	0.53	69.79	4870.10	13000	6578	1.35	1.16	1.57	24.5	33.09
	05	lump	perpendicular	94	36.00	0.38	65.64	4308.61	14000	7084	1.64	1.13	1.86	24.5	40.28
	06	lump	perpendicular	75	25.00	0.33	48.86	2387.30	16000	8096	3.39	0.99	3.36	21.0	71.22
	07	lump	perpendicular	72	29.00	0.40	51.56	2658.50	12000	6072	2.28	1.01	2.32	23.0	52.53
	08	lump	perpendicular	100	28.00	0.28	59.71	3565.04	25000	12650	Non-conforming, invalid D/W ratio				
	09	lump	perpendicular	101	51.00	0.50	80.98	6558.40	12500	6325	0.96	1.24	1.20	24.5	23.63
	10	lump	perpendicular	103	45.00	0.44	76.82	5901.41	1700	860	0.15	1.21	0.18	24.5	3.57
	11	lump	perpendicular	73	46.00	0.63	65.39	4275.50	24000	12144	2.84	1.13	3.20	24.5	69.59
	12	lump	perpendicular	70	37.00	0.53	57.43	3297.66	12000	6072	1.84	1.06	1.96	24.0	44.19
	13	lump	perpendicular	67	61.00	0.91	72.14	5203.68	18000	9108	1.75	1.18	2.06	24.5	42.88
	14	lump	perpendicular	84	66.00	0.79	84.02	7058.78	18000	9108	1.29	1.26	1.63	24.5	31.61
	15	lump	perpendicular	65	30.00	0.46	49.83	2482.80	11000	5566	2.24	1.00	2.24	21.0	47.08

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ15A	01	lump	parallel	73	37	0.51	58.64	3438.99	26000.00	13156.00	3.83	1.07	4.11	24	91.81
	02	lump	perpendicular	66	51	0.77	65.47	4285.69		Non-conforming, invalid failure plane					
	03	lump	perpendicular	65	40	0.62	57.54	3310.39	30000.00	15180.00	4.59	1.07	4.88	24	110.05
	04	lump	parallel	42	33	0.79	42.01	1764.69	17000.00	8602.00	4.87	0.92	4.51	21	102.36
	05	lump	perpendicular	73	56	0.77	72.15	5204.96	44000.00	22264.00	4.28	1.18	5.04	24.5	104.80
	06	lump	parallel	58	40	0.69	54.35	2953.89	16000.00	8096.00	2.74	1.04	2.85	24	65.78
	07	lump	perpendicular	91	51	0.56	76.87	5909.05	30000.00	15180.00	2.57	1.21	3.12	24.5	62.94
	08	lump	parallel	64	51	0.80	64.47	4155.82	22000.00	11132.00	2.68	1.12	3.00	24.5	65.63
	09	lump	perpendicular	77	53	0.69	72.08	5196.05	55000.00	27830.00	5.36	1.18	6.31	24.5	131.22
	10	lump	perpendicular	75	49	0.65	68.40	4679.11	31000.00	15686.00	3.35	1.15	3.86	24.5	82.13
	11	lump	perpendicular	54	43	0.80	54.37	2956.44	24000.00	12144.00	4.11	1.04	4.27	24	98.58
	12	lump	parallel	60						Non-conforming, failure before testing					
	13	lump	perpendicular	67	50	0.75	65.31	4265.32	26000.00	13156.00	3.08	1.13	3.48	24.5	75.57
	14	lump	parallel	48	31	0.65	43.53	1894.56	25000.00	12650.00	6.68	0.94	6.27	21	140.22
	15	lump	perpendicular	62	58	0.94	67.66	4578.53	26000.00	13156.00	2.87	1.15	3.29	24.5	70.40

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
Q24	1	lump	perpendicular	69	111	1.61	98.75	9751.66	29000	14674	1.50	1.36	2.04	24.5	36.87
	2	lump	perpendicular	82	98	1.20	101.15	10231.66	24000	12144	1.19	1.37	1.63	24.5	29.08
	3	lump	perpendicular	77	103	1.34	100.49	10097.97	38000	19228	1.90	1.37	2.61	24.5	46.65
	4	lump	perpendicular	67	113	1.69	98.18	9639.61	18000	9108	0.94	1.35	1.28	24.5	23.15
	5	lump	parallel	68	112	1.65	98.47	9696.91		Non-conforming, invalid failure plane					
	6	lump	perpendicular	57	123	2.16	94.48	8926.60	30000	15180	1.70	1.33	2.26	24.5	41.66
	7	lump	parallel	72	108	1.50	99.50	9900.62	17000	8602	0.87	1.36	1.18	24.5	21.29
	8	lump	parallel	72	108	1.50	99.50	9900.62	24000	12144	1.23	1.36	1.67	24.5	30.05
	9	lump	parallel	45	135	3.00	87.95	7734.86	22000	11132	1.44	1.29	1.86	24.5	35.26
	10	lump	perpendicular	51	129	2.53	91.52	8376.57	18000	9108	1.09	1.31	1.43	24.5	26.64
	11	lump	parallel	85	95	1.12	101.40	10281.32	26000	13156	1.28	1.37	1.76	24.5	31.35
	12	lump	perpendicular	70	110	1.57	99.01	9803.86	6000	Non-conforming, invalid failure plane					
	13	lump	parallel	87	93	1.07	101.50	10301.69	24000	Non-conforming, invalid failure plane					
	14	lump	parallel	68	112	1.65	98.47	9696.91	26000	Non-conforming, invalid failure plane					
	15	lump	parallel	60	120	2.00	95.75	9167.24	29000	14674	1.60	1.34	2.14	24.5	39.22
	16	lump	parallel	55	125	2.27	93.56	8753.45	18000	9108	1.04	1.33	1.38	24.5	25.49
	17	lump	parallel	60	120	2.00	95.75	9167.24	30000	15180	1.66	1.34	2.22	24.5	40.57

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ12A	1	lump	perpendicular	61	39	0.64	55.04	3029.01	43000	21758	7.18	1.04	7.50	24.00	172.40
	2	lump	perpendicular	83	62	0.75	80.94	6552.03	47000	23782	Maximum load exceeded				
	3	lump	perpendicular	84	52	0.62	74.58	5561.46	48000	24288	4.37	1.20	5.23	24.50	107.00
	4	lump	perpendicular	82	65	0.79	82.38	6786.31	54000	27324	Maximum load exceeded				
	5	lump	perpendicular	72	32	0.44	54.16	2933.52	17000	8602	2.93	1.04	3.04	24.00	70.38
	6	lump	perpendicular	72	31	0.43	53.31	2841.85	19000	9614	3.38	1.03	3.48	23.00	77.81
	7	lump	perpendicular	77	38	0.49	61.04	3725.47	33000	16698	4.48	1.09	4.90	24.50	109.81
	8	lump	perpendicular	71	34	0.48	55.44	3073.57	17000	8602	2.80	1.05	2.93	24.00	67.17
	9	lump	perpendicular	79	28	0.35	53.07	2816.38	22000	11132	3.95	1.03	4.06	23.00	90.91
	10	lump	perpendicular	90	38	0.42	65.99	4354.44	29000	14674	3.37	1.13	3.82	24.50	82.56
	11	lump	perpendicular	46	36	0.78	45.92	2108.47	29000	14674	6.96	0.96	6.70	21.00	146.15
	12	lump	parallel	42	42	1.00	47.39	2245.98	22000	11132	4.96	0.98	4.84	21.00	104.08
	13	lump	perpendicular	72	39	0.54	59.79	3575.23	37000	18722	5.24	1.08	5.68	24.00	125.68
	14	lump	parallel	40	32	0.80	40.37	1629.73	23000	11638	7.14	0.91	6.49	19.00	135.68
	15	lump	parallel	39	38	0.97	43.44	1886.92	17000	8602	4.56	0.94	4.28	21.00	95.73

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ4B	01	lump	perpendicular	69	33	0.48	53.84	2899.14	6000	3036	Non-conforming, invalid failure plane				
	02	lump	perpendicular	89	34	0.38	62.07	3852.79	16000	8096	2.10	1.10	2.32	24.50	51.48
	03	lump	perpendicular	87	30	0.34	57.65	3323.13	1000	506	0.15	1.07	0.16	24.00	3.65
	04	lump	perpendicular	105	33	0.31	66.42	4411.74	6000	3036	0.69	1.14	0.78	24.50	16.86
	05	lump	perpendicular	68	32	0.47	52.64	2770.55	8000	4048	1.46	1.02	1.50	23.00	33.60
	06	lump	perpendicular	59	44	0.75	57.49	3305.30	20000	10120	3.06	1.06	3.26	24.00	73.48
	07	lump	perpendicular	96	42	0.44	71.65	5133.66	20000	10120	1.97	1.18	2.32	24.50	48.30
	08	lump	perpendicular	55	38	0.69	51.59	2661.05	12000	6072	2.28	1.01	2.31	23.00	52.48
	09	lump	perpendicular	60	33	0.55	50.21	2520.99	10000	5060	2.01	1.00	2.01	23.00	46.16
	10	lump	perpendicular	55	42	0.76	54.23	2941.16	12000	6072	2.06	1.04	2.14	24.00	49.55
	11	lump	perpendicular	94	43	0.46	71.74	5146.39	34000	17204	3.34	1.18	3.93	24.50	81.90
	12	lump	perpendicular	54	40	0.74	52.44	2750.17	20000	10120	3.68	1.02	3.76	23.00	84.63
	13	lump	perpendicular	96	47	0.49	75.79	5744.81	8000	4048	Non-conforming, invalid failure plane				
	14	lump	perpendicular	49	36	0.73	47.39	2245.98	22000	11132	4.96	0.98	4.84	21.00	104.08
	15	lump	perpendicular	55	35	0.64	49.51	2450.96	12000	6072	Non-conforming, invalid failure plane				

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ5B	01	lump	perpendicular	65	30	0.46	49.83	2482.80	14000	7084	2.85	1.00	2.85	21.00	59.92
	02	lump	perpendicular	85	41	0.48	66.61	4437.20	20000	10120	2.28	1.14	2.59	24.50	55.88
	03	lump	perpendicular	41	35	0.85	42.74	1827.08	16000	8096	4.43	0.93	4.13	21.00	93.05
	04	lump	perpendicular	62	32	0.52	50.26	2526.09	12000	6072	2.40	1.00	2.41	23.00	55.29
	05	lump	perpendicular	73	36	0.49	57.85	3346.04	20000	10120	3.02	1.07	3.23	24.00	72.59
	06	lump	perpendicular	50	30	0.60	43.70	1909.84	18000	9108	4.77	0.94	4.49	21.00	100.15
	07	lump	perpendicular	85	53	0.62	75.74	5735.89	21000	10626	1.85	1.21	2.23	24.50	45.39
	08	lump	perpendicular	84	57	0.68	78.08	6096.22	14000	7084	1.16	1.22	1.42	24.50	28.47
	09	lump	perpendicular	94	55	0.59	81.13	6582.59	19000	9614	1.46	1.24	1.82	24.50	35.78
	10	lump	perpendicular	96	54	0.56	81.24	6600.42	18000	9108	Non-conforming, invalid failure plane				
	11	lump	perpendicular	70	40	0.57	59.71	3565.04	10000	5060	1.42	1.08	1.54	24.00	34.06
	12	lump	perpendicular	44	51	1.16	53.45	2857.12	16000	8096	Non-conforming, invalid failure plane				
	13	lump	perpendicular	38	57	1.50	52.51	2757.81	14000	7084	2.57	1.02	2.63	23.00	59.08
	14	lump	parallel	75	41	0.55	62.57	3915.18	8000	4048	1.03	1.11	1.14	24.50	25.33
	15	lump	perpendicular	43	42	0.98	47.95	2299.45	12000	6072	2.64	0.98	2.59	21.00	55.45

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
QMR2	01	lump	perpendicular	69	30	0.43	51.34	2635.58	44000.00	22264.00	8.45	1.01	8.55	23.00	194.29
	02	lump	perpendicular	55	39	0.71	52.26	2731.08	18000.00	9108.00	3.33	1.02	3.40	23.00	76.70
	03	lump	perpendicular	82	38	0.46	62.99	3967.38	42000.00	21252.00	5.36	1.11	5.94	24.50	131.24
	04	lump	perpendicular	79	45	0.57	67.28	4526.33	33000.00	16698.00	3.69	1.14	4.22	24.50	90.38
	05	lump	perpendicular	79	45	0.57	67.28	4526.33	33000.00	16698.00	3.69	1.14	4.22	24.50	90.38
	06	lump	perpendicular	86	38	0.44	64.51	4160.91	29000.00	14674.00	3.53	1.12	3.95	24.50	86.40
	07	lump	perpendicular	72	33	0.46	55.00	3025.19	26000.00	13156.00	4.35	1.04	4.54	24.00	104.37
	08	lump	perpendicular	83	40	0.48	65.02	4227.12	20000.00	10120.00	2.39	1.13	2.69	24.50	58.65
	09	lump	perpendicular	86	30	0.35	57.31	3284.93	40000.00	20240.00	6.16	1.06	6.55	24.00	147.88
	10	lump	perpendicular	85	30	0.35	56.98	3246.73	28000.00	14168.00	4.36	1.06	4.63	24.00	104.73
	11	lump	perpendicular	101	44	0.44	75.22	5658.23	34000.00	17204.00	3.04	1.20	3.65	24.50	74.49
	12	lump	perpendicular	63	30	0.48	49.06	2406.40	30000.00	15180.00	6.31	0.99	6.25	21.00	132.47
	13	lump	perpendicular	59	35	0.59	51.28	2629.22	39000.00	19734.00	7.51	1.01	7.59	23.00	172.63
	14	lump	perpendicular	58	37	0.64	52.27	2732.35	30000.00	15180.00	5.56	1.02	5.67	23.00	127.78
	15	lump	perpendicular	71	30	0.42	52.08	2711.98	22000.00	11132.00	4.10	1.02	4.18	23.00	94.41

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program
 Date : March.3,2019
 Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
Q5	01	lump	perpendicular	51	43	0.84	52.84	2792.19	8000	4048	1.45	1.03	1.49	23.00	33.34
	02	lump	perpendicular	83	37	0.45	62.53	3910.08	17000	8602	2.20	1.11	2.43	24.50	53.90
	03	lump	perpendicular	104	35	0.34	68.08	4634.55	23000	11638	2.51	1.15	2.89	24.50	61.52
	04	lump	perpendicular	67	38	0.57	56.94	3241.64	24000	12144	3.75	1.06	3.97	24.00	89.91
	05	lump	perpendicular	66	41	0.62	58.70	3445.36	10000	5060	1.47	1.07	1.58	24.00	35.25
	06	lump	perpendicular	59	34	0.58	50.54	2554.10	10000	5060	1.98	1.00	1.99	23.00	45.57
	07	lump	parallel	70	38	0.54	58.20	3386.79	9000	4554	1.34	1.07	1.44	24.00	32.27
	08	lump	parallel	59	35	0.59	51.28	2629.22	16000	8096	3.08	1.01	3.11	23.00	70.82
	09	lump	parallel	43	35	0.81	43.77	1916.21	24000	12144	6.34	0.94	5.97	21.00	133.09
	10	lump	parallel	38	37	0.97	42.31	1790.16	18000	9108	5.09	0.93	4.72	21.00	106.84
	11	lump	perpendicular	40	38	0.95	43.99	1935.31	17000	8602	4.44	0.94	4.20	21.00	93.34
	12	lump	perpendicular	52	38	0.73	50.16	2515.90	16000	8096	3.22	1.00	3.22	23.00	74.01
	13	lump	perpendicular	60	32	0.53	49.44	2444.60	24000	12144	4.97	0.99	4.94	21.00	104.32
	14	lump	perpendicular	58	40	0.69	54.35	2953.89	20000	10120	Non-conforming, invalid failure plane				
	15	lump	parallel	47	45	0.96	51.89	2692.88	16000	8096	3.01	1.02	3.06	23.00	69.15

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
Q15B	01	lump	perpendicular	75	65	0.87	78.78	6206.99	66000	33396	Maximum load exceeded				
	02	lump	perpendicular	100	73	0.73	96.41	9294.57	26000	13156	1.42	1.34	1.90	24.50	34.68
	03	lump	perpendicular	75	75	1.00	84.63	7161.91	26000	13156	1.84	1.27	2.33	24.50	45.01
	04	lump	perpendicular	53	77	1.45	72.08	5196.05	24000	12144	2.34	1.18	2.76	24.50	57.26
	05	lump	perpendicular	96	69	0.72	91.84	8433.87	22000	11132	1.32	1.31	1.74	24.50	32.34
	06	lump	perpendicular	42	71	1.69	61.62	3796.77	20000	10120	2.67	1.10	2.93	24.50	65.30
	07	lump	parallel	73	74	1.01	82.93	6877.98	19000	9614	1.40	1.26	1.76	24.50	34.25
	08	lump	parallel	74	45	0.61	65.11	4239.85	27000	13662	3.22	1.13	3.63	24.50	78.95
	09	lump	perpendicular	55	36	0.65	50.21	2520.99	29000	14674	5.82	1.00	5.83	23.00	133.88
	10	lump	parallel	75	47	0.63	66.99	4488.13	22000	11132	2.48	1.14	2.83	24.50	60.77
	11	lump	perpendicular	62	39	0.63	55.49	3078.67	38000	19228	6.25	1.05	6.55	24.00	149.89
	12	lump	perpendicular	76	40	0.53	62.21	3870.61	10000	5060	1.31	1.10	1.44	24.50	32.03

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program
Date : March.3,2019
Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ13	01	lump	parallel	92	60	0.65	83.83	7028.22	53000	26818	Maximum load exceeded				
	02	lump	perpendicular	74	45	0.61	65.11	4239.85	42000	21252	5.01	1.13	5.65	24.50	122.80

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1
5. Due to the high strength of rock and limited sub-samples, only 2 tests were possible.



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project H/353004 - PCCR4091, Propose Quarry Sampling & Lab Testing Program

Date : March.3,2019

Test By: RS & XZ

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
Q1	01	lump	parallel	66	52	0.79	66.10	4369.72	20000	10120	2.32	1.13	2.63	24.50	56.74
	02	lump	perpendicular	63	44	0.70	59.41	3529.39	32000	16192	4.59	1.08	4.96	24.00	110.11
	03	lump	parallel	99	70	0.71	93.93	8823.47	12000	6072	0.69	1.33	0.91	24.50	16.86
	04	lump	perpendicular	81	32	0.40	57.45	3300.21	29000	14674	4.45	1.06	4.73	24.00	106.71
	05	lump	perpendicular	60	33	0.55	50.21	2520.99	29000	14674	5.82	1.00	5.83	23.00	133.88
	06	lump	perpendicular	73	62	0.85	75.91	5762.63	26000	13156	2.28	1.21	2.75	24.50	55.93
	07	lump	parallel	59	37	0.63	52.72	2779.46	37000	18722	6.74	1.02	6.90	23.00	154.92
	08	lump	perpendicular	102	46	0.45	77.29	5973.99	40000	20240	3.39	1.22	4.12	24.50	83.01
	09	lump	parallel	69	45	0.65	62.88	3953.37	34000	17204	4.35	1.11	4.82	24.50	106.62
	10	lump	perpendicular	96	36	0.38	66.33	4400.28	38000	19228	4.37	1.14	4.96	24.50	107.06
	11	lump	parallel	72	38	0.53	59.02	3483.55	28000	14168	4.07	1.08	4.38	24.00	97.61
	12	lump	perpendicular	71	57	0.80	71.78	5152.76	54000	27324	Maximum load exceeded				
	13	lump	perpendicular	82	35	0.43	60.45	3654.17	30000	15180	4.15	1.09	4.52	24.50	101.78
	14	lump	perpendicular	81	35	0.43	60.08	3609.60	30000	15180	Non-conforming, invalid failure plane				
	15	lump	perpendicular	58	38	0.66	52.97	2806.20	32000	16192	5.77	1.03	5.92	23.00	132.71

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2018
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project Mary River Quarry Samples
Date : June 5.2019
Test By: EM & JS

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ4A	01	lump	perpendicular	85	36	0.43	62.63	3922.05	5000	2530.00	0.65	1.11	0.71	24.5	15.80
	02	lump	perpendicular	86	35	0.40	61.60	3794.09	7000	3542.00	0.93	1.10	1.03	24.5	22.87
	03	lump	perpendicular	60	49	0.82	61.25	3751.05	7500	3795.00	1.01	1.10	1.11	24.5	24.79
	04	lump	perpendicular	68	61	0.90	72.37	5236.77	8000	4048.00	0.77	1.18	0.91	24.5	18.94
	05	lump	perpendicular	96	30	0.31	60.40	3647.80	9000	4554.00	Non-conforming, D/W < 0.33				
	06	lump	perpendicular	114	53	0.47	87.80	7708.33	5000	2530.00	0.33	1.29	0.42	24.5	8.04
	07	lump	perpendicular	124	46	0.37	84.91	7209.40	10000	5060.00	0.70	1.27	0.89	24.5	17.20
	08	lump	perpendicular	72	21	0.30	44.38	1969.79	7500	3795.00	Non-conforming, D < 30 mm				
	09	lump	perpendicular	105	36	0.34	69.27	4797.80	6500	3289.00	0.69	1.16	0.79	24.5	16.80
	10	lump	perpendicular	105	30	0.29	63.21	3995.77	4000	2024.00	Non-conforming, D/W < 0.33				
	11	lump	perpendicular	82	31	0.38	56.90	3237.34	4000	2024.00	0.63	1.06	0.66	24	15.00
	12	lump	perpendicular	60	33	0.54	50.16	2515.72	6000	3036.00	1.21	1.00	1.21	23	27.76
	13	lump	perpendicular	46	33	0.71	43.73	1912.21	5000	2530.00	1.32	0.94	1.25	21	27.78
	14	lump	perpendicular	60	61	1.01	68.07	4633.18	8000	4048.00	0.87	1.15	1.00	24.5	21.41
	15	lump	perpendicular	41	37	0.89	44.14	1948.76	2000	1012.00	0.52	0.95	0.49	21	10.91
	16	lump	perpendicular	87	31	0.35	58.31	3399.48	3000	1518.00	0.45	1.07	0.48	24	10.72
	17	lump	perpendicular	81	31	0.38	55.91	3126.09	4000	2024.00	0.65	1.05	0.68	24	15.54
	18	lump	perpendicular	72	32	0.44	54.08	2924.63	4000	2024.00	0.69	1.04	0.72	24	16.61
	19	lump	perpendicular	47	30	0.64	42.64	1818.43	6000	3036.00	1.67	0.93	1.55	21	35.06

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2019
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project Mary River Quarry Samples
Date : June 5.2019
Test By: EM & JS

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ5A	01	lump	parallel	76	69	0.91	81.60	6658.98	6000	3036	0.46	1.25	0.57	24.5	11.17
	02	lump	perpendicular	60	54	0.91	64.29	4132.76	8000	4048	0.98	1.12	1.10	24.5	24.00
	03	lump	perpendicular	123	85	0.69	115.62	13369.09	4000	2024	0.15	1.46	0.22	24.5	3.71
	04	lump	perpendicular	81	30	0.37	55.51	3081.00	3500	1771	0.57	1.05	0.60	24.0	13.80
	05	lump	perpendicular	98	30	0.31	61.07	3729.73	4500	2277	Non-conforming, D/W < 0.33				
	06	lump	perpendicular	56	35	0.62	49.46	2446.30	5000	2530	1.03	1.00	1.03	21.0	21.72
	07	lump	parallel	49	47	0.96	54.10	2926.83	5500	2783	0.95	1.04	0.99	24.0	22.82
	08	lump	perpendicular	44	38	0.88	46.02	2117.81	6000	3036	1.43	0.96	1.38	21.0	30.10
	09	lump	perpendicular	74	44	0.59	63.99	4094.55	4000	2024	0.49	1.12	0.55	24.5	12.11
	10	lump	perpendicular	91	46	0.50	72.78	5297.32	3500	1771	0.33	1.18	0.40	24.5	8.19
	11	lump	perpendicular	72	33	0.46	54.57	2977.78	2500	1265	0.42	1.04	0.44	24.0	10.20
	12	lump	perpendicular	96	36	0.37	66.41	4410.35	7500	3795	0.86	1.14	0.98	24.5	21.08
	13	lump	perpendicular	99	60	0.61	87.08	7583.40	5900	2985	0.39	1.28	0.51	24.5	9.65
	14	lump	perpendicular	81	32	0.40	57.82	3342.66	2000	1012	Non-conforming, D/W < 0.33				
	15	lump	perpendicular	85	49	0.58	73.13	5347.52	8000	4048	0.76	1.19	0.90	24.5	18.55
	16	lump	perpendicular	55	38	0.69	51.82	2685.59	4000	2024	0.75	1.02	0.77	23.0	17.33
	17	lump	perpendicular	108	60	0.55	90.54	8196.61	22000	11132	1.36	1.31	1.77	24.5	33.27
	18	lump	perpendicular	57	51	0.89	60.62	3675.12	32000	16192	4.41	1.09	4.80	24.5	107.94
	19	lump	perpendicular	47	31	0.67	43.04	1852.17	6000	3036	Non-conforming, D/W < 0.33				
	20	lump	perpendicular	48	31	0.65	44.04	1939.83	4500	2277	Non-conforming, D/W < 0.33				
	21	lump	perpendicular	45	41	0.92	48.51	2353.24	4000	2024	0.86	0.99	0.85	21.0	18.06
	22	lump	perpendicular	45	34	0.76	44.11	1945.72	11000	5566	2.86	0.95	2.70	21.0	60.07

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2019
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project Mary River Quarry Samples
Date : June 5.2019
Test By: EM & JS

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ9A	01	lump	perpendicular	100	36.00	0.36	67.70	4583.62	6000	3036	0.66	1.15	0.76	24.5	16.23
	02	lump	perpendicular	85	31.50	0.37	58.39	3409.07	1700	860	0.25	1.07	0.27	24.0	6.06
	03	lump	perpendicular	60	31.50	0.53	49.06	2406.40	5000	2530	1.05	0.99	1.04	21.0	22.08
	04	lump	perpendicular	95	35.00	0.37	65.07	4233.48	10000	5060	1.20	1.13	1.35	24.5	29.28
	05	lump	perpendicular	90	49.00	0.54	74.93	5614.94	16000	8096	1.44	1.20	1.73	24.5	35.33
	06	lump	perpendicular	55	36.00	0.65	50.21	2520.99	5000	2530	1.00	1.00	1.01	23.0	23.08
	07	lump	perpendicular	90	34.00	0.38	62.42	3896.08	10000	5060	1.30	1.10	1.44	24.5	31.82
	08	lump	perpendicular	100	33.00	0.33	64.82	4201.65	14000	7084	1.69	1.12	1.89	24.5	41.31
	09	lump	perpendicular	100	34.00	0.34	65.79	4328.98	12000	6072	1.40	1.13	1.59	24.5	34.36
	10	lump	perpendicular	80	32.00	0.40	57.09	3259.46	4000	2024	0.62	1.06	0.66	24.0	14.90
	11	lump	perpendicular	85	33.00	0.39	59.76	3571.41	5000	2530	0.71	1.08	0.77	24.0	17.00
	12	lump	perpendicular	90	47.00	0.52	73.39	5385.76	4500	2277	0.42	1.19	0.50	24.5	10.36
	13	lump	perpendicular	70	31.00	0.44	52.56	2762.91	5000	2530	0.92	1.02	0.94	23.0	21.06
	14	lump	perpendicular	105	32.00	0.30	65.41	4278.05	6000	3036	Non-conforming, D/W < 0.33				
	15	lump	perpendicular	70	31.50	0.45	52.99	2807.47	6500	3289	1.17	1.03	1.20	23.0	26.94
	16	lump	perpendicular	100	31.50	0.32	63.33	4010.67	3500	1771	0.44	1.11	0.49	24.5	10.82
	17	lump	perpendicular	110	32.50	0.30	67.47	4551.79	8000	4048	Non-conforming, D/W < 0.33				
	18	lump	perpendicular	120	35.00	0.29	73.13	5347.56	12000	6072	Non-conforming, D/W < 0.33				
	19	lump	perpendicular	80	31.50	0.39	56.64	3208.54	3000	1518	0.47	1.06	0.50	24.0	11.35
	20	lump	perpendicular	102	33.44	0.33	65.90	4342.83	6000	3036	0.70	1.13	0.79	24.5	17.13

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2019
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1



ASTM D-5731-08 Determination of Point Load Strength Index of Rock and Application to Rock Strength Classifications.

Point Load Test Results Summary

Project : Mary River Quarry Samples
Date : June 5.2019
Test By: EM & JS

Proposed Quarry Location	Sample	Test Type	Loading Relative to Bedding	W (W1+W2)/2	D	D/W	Equiv. Diameter D _e , mm	Diameter Squared D _e ² , mm ²	Pressure at break (kPa)	(P) Point Load Newtons	Uncorrected Point Load Strength Index (Is) mPa	Correction Factor (F)	Corrected Point Load Strength Index (Is50)	Correlation Factor (K)	ASTM Generalized UCS (mPa)
PQ9B	01	lump	perpendicular	75.2	36	0.48	58.63	3437.31	6000	3036	0.88	1.07	0.95	24.0	21.20
	02	lump	perpendicular	79.5	38	0.47	61.61	3795.81	8000	4048	1.07	1.10	1.17	24.5	26.13
	03	lump	parallel	41.5	32	0.76	40.93	1675.00	4000	2024	1.21	0.91	1.10	19.0	22.96
	04	lump	perpendicular	71.35	36	0.51	57.49	3304.94	3500	1771	0.54	1.06	0.57	24.0	12.86
	05	lump	perpendicular	56.24	30	0.53	46.36	2148.91	4500	2277	1.06	0.97	1.02	21.0	22.25
	06	lump	perpendicular	73.23	31	0.42	53.61	2874.54	5000	2530	0.88	1.03	0.91	23.0	20.24
	07	lump	perpendicular	43.44	31	0.70	41.12	1690.80	5500	2783	1.65	0.92	1.51	19.0	31.27
	08	lump	perpendicular	83.54	38	0.46	63.69	4056.78	6000	3036	0.75	1.12	0.83	24.5	18.34
	09	lump	perpendicular	70.22	41	0.59	60.82	3699.62	4000	2024	0.55	1.09	0.60	24.5	13.40
	10	lump	perpendicular	79.43	33	0.41	57.43	3297.93	3500	1771	0.54	1.06	0.57	24.0	12.89
	11	lump	perpendicular	60.6	31	0.51	48.86	2387.26	2500	1265	0.53	0.99	0.52	21.0	11.13
	12	lump	perpendicular	61	31	0.50	48.77	2378.94	7500	3795	1.60	0.99	1.58	21.0	33.50
	13	lump	perpendicular	52.89	32	0.61	46.66	2177.14	5900	2985	1.37	0.97	1.33	21.0	28.80
	14	lump	perpendicular	100.49	50	0.50	80.37	6460.03	2000	1012	0.16	1.24	0.19	24.5	3.84
	15	lump	perpendicular	83.45	37	0.45	63.07	3978.03	8000	4048	1.02	1.11	1.13	24.5	24.93
	16	lump	perpendicular	87.78	54	0.62	78.03	6088.90	4000	2024	0.33	1.22	0.41	24.5	8.14
	17	lump	perpendicular	75.74	51	0.68	70.43	4960.58	22000	11132	2.24	1.17	2.62	24.5	54.98
	18	lump	perpendicular	91.31	53	0.58	78.35	6138.45	32000	16192	2.64	1.22	3.23	24.5	64.63
	19	lump	perpendicular	97.2	36	0.37	67.15	4509.73	6000	3036	0.67	1.14	0.77	24.5	16.49
	20	lump	perpendicular	92.8	43	0.47	71.65	5133.86	4500	2277	0.44	1.18	0.52	24.5	10.87
	21	lump	perpendicular	72.6	39	0.53	59.81	3577.29	4000	2024	0.57	1.08	0.61	24.0	13.58
	22	lump	perpendicular	65.7	47	0.72	62.86	3950.84	11000	5566	1.41	1.11	1.56	24.5	34.52
	23	lump	perpendicular	96.12	49	0.51	77.52	6008.99	6000	3036	0.51	1.22	0.62	24.5	12.38
	24	lump	perpendicular	76.88	32	0.41	55.82	3115.71	17000	8602	2.76	1.05	2.90	24.0	66.26
	25	lump	perpendicular	84.22	40	0.48	65.69	4314.99	3000	1518	0.35	1.13	0.40	24.5	8.62
	26	lump	perpendicular	82.36	31	0.38	57.39	3293.75	13000	6578	2.00	1.06	2.12	24.0	47.93
	27	lump	perpendicular	65	46	0.71	61.62	3797.02	20000	10120	2.67	1.10	2.93	24.5	65.30
	28	lump	perpendicular	79.12	36	0.46	60.57	3668.87	6000	3036	0.83	1.09	0.90	24.5	20.27
	29	lump	perpendicular	85	33	0.39	59.74	3569.24	8000	4048	1.13	1.08	1.23	24.0	27.22
	30	lump	perpendicular	64.22	44	0.69	60.21	3624.72	11000	5566	1.54	1.09	1.67	24.5	37.62
	31	lump	perpendicular	77	36	0.47	59.78	3573.51	11000	5566	1.56	1.08	1.69	24.0	37.38
	32	lump	perpendicular	67	32	0.47	51.99	2702.50	18000	9108	3.37	1.02	3.43	23.0	77.51
	33	lump	perpendicular	98	33	0.33	63.71	4058.98	20000	10120	2.49	1.12	2.78	24.5	61.08
	34	lump	perpendicular	107	59	0.55	89.65	8037.89	20000	10120	1.26	1.30	1.64	24.5	30.85
	35	lump	perpendicular	75.2	58	0.77	74.36	5529.38	14000	7084	1.28	1.20	1.53	24.5	31.39
	36	lump	perpendicular	88	64	0.72	84.48	7137.21	18000	9108	1.28	1.27	1.62	24.5	31.27
	37	lump	perpendicular	110	65	0.59	95.12	9047.56	26000	13156	1.45	1.34	1.94	24.5	35.63
	38	lump	perpendicular	105	60	0.57	89.56	8021.34	35000	17710	2.21	1.30	2.87	24.5	54.09
	39	lump	perpendicular	60	40	0.66	54.93	3017.55	33000	16698	5.53	1.04	5.77	24.0	132.81
	40	lump	perpendicular	90	60	0.67	82.92	6875.43	37000	18722	2.72	1.26	3.42	24.5	66.71

Notes:

1. All samples tested were irregular lumps as per ASTM D-5731-08 Fig. 3 / Type D
2. Samples were stored to preserve natural moisture contents before testing. Tests were at natural moisture content.
3. Most recent calibration of point load tester on April 24, 2019
4. Strength conversion factor K determined as per ASTM D-5731-08 / Table 1

PHYSICAL PROPERTY TESTING OF BALLAST AGGREGATE

QMR2, Diabase, Q1 Materials

Project # TB152049

Prepared for:

Hatch Ltd.
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Attention: Ralph Serluca

Prepared by:

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14 February 2019

1.0 Introduction

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood) is pleased to present the results of laboratory testing conducted on a Ballast Stone received in our Wood Burlington, Ontario laboratory on 04 October 2018. It is understood that a representative Hatch Ltd. sampled the material in October 2018.

2.0 Methodology

Testing of the ballast stone included the following:

- ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
- ASTM C88 Soundness of Aggregates by use of Magnesium Sulphate
- ASTM C29 Bulk Density ("Unit Weight") and Voids in Aggregate
- ASTM C127 Relative Density (Specific Gravity) and Absorption of Coarse Aggregates
- ASTM C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

3.0 Results

Results of the composite sieve analysis are presented in Enclosures 1 to 3. Each sample was crushed with the use of a sledge hammer in order to meet the grading requirements, provided by the client, referencing 2.2.12, Table 25 Fill-Rail Ballast.

Parameters and results for the remaining tests on the ballast aggregate are provided in Tables 1 through 4.



Table 1: Determination of weighted percent loss of aggregate after five cycles
ASTM C88 Soundness of Aggregates by Use of Magnesium Sulphate¹

Sample Identification	Sieve Fraction (mm)	Initial Sample Mass (g)	Percent Passing After Test (%)	Weighted Percentage of Mass Loss (%)	
				Per Fraction	Total ⁴
S346-18	- 37.5 + 19 ²	1539.6	4.5	2.0	3
QMR2	+ 37.5 ^{3,2}	2019.9	1.6	0.8	
S347-18	- 37.5 + 19 ²	1533.9	1.0	0.4	1
Diabase	+ 37.5 ^{3,2}	2060.5	0.9	0.4	
S348-18	- 37.5 + 19 ²	1507.5	1.1	0.5	1
Q1	+ 37.5 ^{3,2}	2035.4	0.4	0.2	

¹ Previously used Magnesium Sulphate solution

² Section 12.1.5 was not recorded, no distress in any particles was visible

³ 37.5mm fraction tested only

⁴ Final number rounded to the nearest whole number

Table 2: Determination of the bulk density
ASTM C29 Bulk Density ("Unit Weight") and Voids in Aggregate

Sample Identification	Loose Density (kg/m ³)	Jigging Density (kg/m ³)	Voids in Loose Aggregate (%)	Voids in Rodded Aggregate (%)
S346-18 QMR2	1351	1516	50	44
S347-18 Diabase	1417	1639	52	44
S348-18 Q1	1307	1533	50	42

Table 3: Determination of the relative density and absorption
ASTM C127 Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

Sample Identification	Relative Density (OD)	Relative Density (SSD)	Absorption (%)
S346-18 QMR2	2.728	2.740	0.42
S347-18 Diabase	2.930	2.950	0.68
S348-18 Q1	2.630	2.636	0.21

Table 4: Determination of resistance to degradation using the Los Angeles testing machine.
ASTM C535 Resistance to Degradation of large-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

Sample Identification	Maximum Aggregate Size used (mm)	Grading Designation	Sample Loss (%)
S346-18 QMR2	37.5	2	21.2
S347-18 Diabase	37.5	2	17.8
S348-18 Q1	37.5	2	23.2

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If you have any questions with regards to the results of the testing conducted, please do not hesitate to contact the undersigned at your convenience.

Yours truly,

Wood Environment & Infrastructure Solutions,

a Division of Wood Canada Limited

Reviewed by,



Kristen Hand
Soils & Aggregate Laboratory Supervisor



Ognjenko Lazic
Asphalt & Concrete Laboratory Supervisor

kh:OL
Enclosure (3)

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

ASTM C136

Enclosure: 1
Report Date: 26 October 2018
Project No.: TB152049

Client: Hatch Ltd.
Sample Source: QMR 2 - 1&2
Date Sampled: September 2018
Sampled by: Client
Sample Type: Rail Ballast Aggregate, Type 25 Fill
Specification: Section 2.2.12

Lab No: S346-18
Date Received: 04 October 2018
Date Tested: 19 October 2018
Lab Technician: J. Wood

SIEVE SIZES (mm)	100	90.0	75.0	63	50	37.5	25.0	19	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
SPECIFICATIONS	100.0	100.0	100.0	100.0	95-100	35-70	0-15	-	0-5	-	-	-	-	-	-	-	-
% PASSING	100.0	100.0	100.0	100.0	98.5	50.0	6.2	5.2	3.8	1.5	0.0	-	-	-	-	-	-

