Appendix 2 Petrographic examination reports

Englobe
325, DE L'ESPINAY STREET
QUEBEC (QC) G1L 2J2
Phone : 418-647-1402

PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 5
Type: 5-14 mm

Date: 06-12-2016
Sample: 1
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #5 consists of particles from a sedimentary rock. The facies observed is a fine to medium grain calcitic dolostone. Carbonate veins, mainly form of dolomite, have been observed in some aggregates. Particles with a greater concentration of clay minerals were also identified. The color of the particles is light to medium grey. The form of the particles are predominantly flattened and lengthened. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 2.0 mm (arenite to lutite). Strength of the particles are medium to good. The hardness is medium (4^{δ}) for the dolomitic limestone and medium to low for the argillaceous dolomite ($\approx 3^{\delta}$).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 129 was calculated for the sample and is equivalent to a "good to fair" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1 %). The sulfur content (S_{total}) is 0.3080 %.

Petrographic observations on polished thin section

The composition of the sedimentary rocks varies according to the conditions of depostition. In order to facilitate the counts of the different facies observed on the polished thin section, Table 2 presents the number of occurrences of these facies as well as their particularities. Please note that the distinction of these facies can only be done with a microscope.

Generally, the sample consists of approximately 50 % dolomite and 30 % calcite. Rounded grains of quartz as well as crystalline carbonate veins were observed in the aggregates. The opaque minerals observed represent 5 to 10 % and consist of pyrite and iron oxides. The size of the fragments is generally less than 2.0 mm (arenite to lutite). The pyrite crystals are framboidal and cubic in shape and generally have a size of less than 0.2 mm.

Figures 1 and 2 show photomicrographs of the sample.

Mathilde Koné, tech.
Realized by 2016-09-01

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 2016-09-22

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325, DE L'ESPINAY STREET
QUEBEC (QC) G1L 2J2
Phone : 418-647-1402

PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 5
Type: 5-14 mm

Date: 06-12-2016
Sample: 1
Sampling: Client*

Summary

The coarse aggregate from Site #5 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of sedimentary rock (dolostone) with a PN of 129 is judged to have a good to fair physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good to fair physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1 %). The sulfur content (S_{total}) is 0.3080 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

Mathilde Koné, tech.
Realized by 2016-09-01

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 2016-09-22

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 5
Type: 5-14 mm

Date: 06-12-2016
Sample: 1
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm % retained 14 mm	% passing 14 mm % retained 10 mm	% passing 10 mm % retained 5 mm
Grain-size proportion (%)	14.0	57.4	27.1
Weighted % of the fraction used (%)	14.2	58.3	27.5

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Calcitic dolostone	1	70.6	10.0	86.5	50.4	92.3	25.4
Argillaceous calcitic dolostone	3	29.4	12.5	13.5	23.6	7.7	6.4
Cumulative petrographic numbers			22.6		74.0		31.7
Percentage of petrographic quality classification	Good : 83.1 %		Fair : 16.9 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 129							

Table 2 : Petrographic facies observed in thin section

MICROSCOPE OBSERVATIONS				
Polished thin section with 16 aggregates (LM-187A and LM-187B)				
Facies	Limestone $CaCO_3$ (> 90%)	Dolimitic limestone $CaCO_3$ (50-90%)	Calcitic dolostone $CaMg(CO_3)_2$ (50-90%)	Dolostone $CaMg(CO_3)_2$ (> 90%)
# of particles	2		14	
observations	Fine grain limestone (calcilutite)		Dolomitic sandstone	

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

**: The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

δ: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

β: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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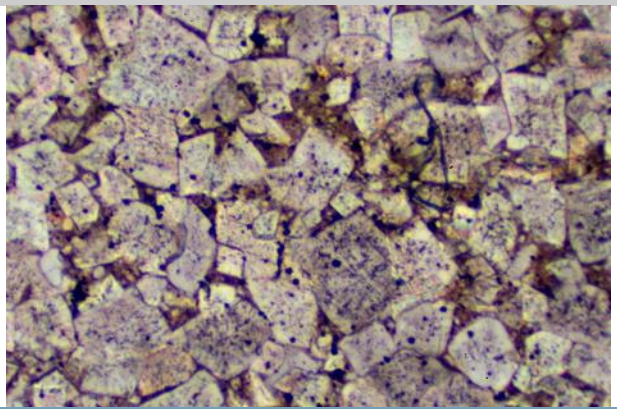
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

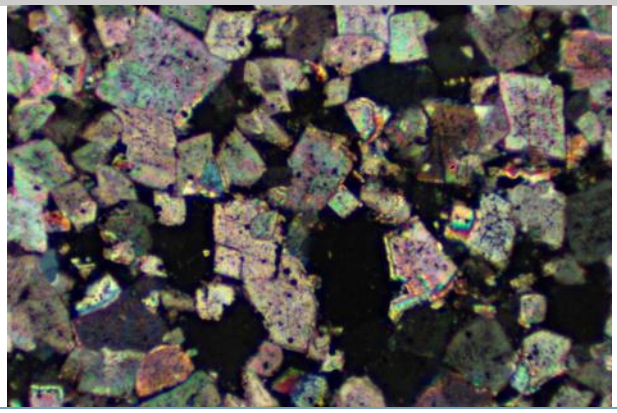
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 5
Type: 5-14 mm

Date: 06-12-2016
Sample: 1
Sampling: Client*

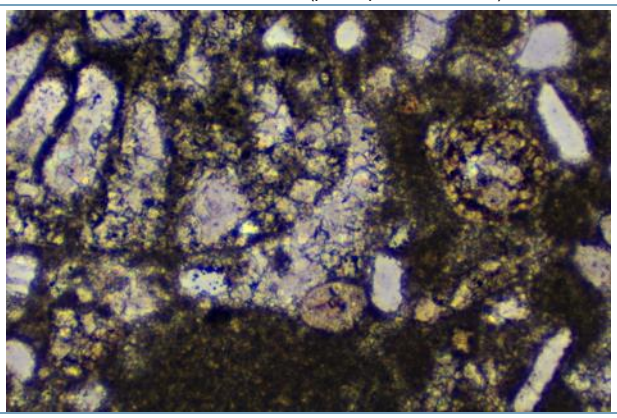
MICROSCOPIC PHOTOGRAPHY



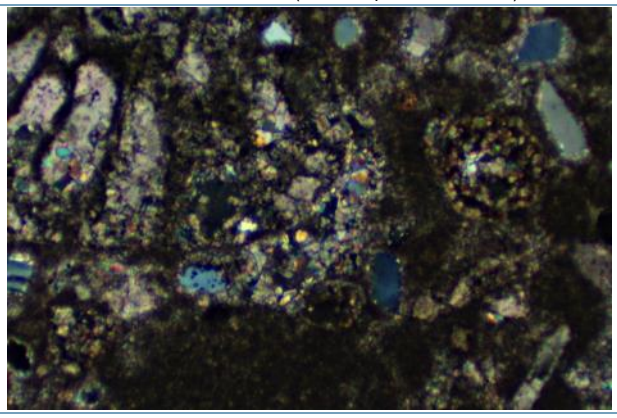
1A: Calcitic dolostone (plane polar view 40X)



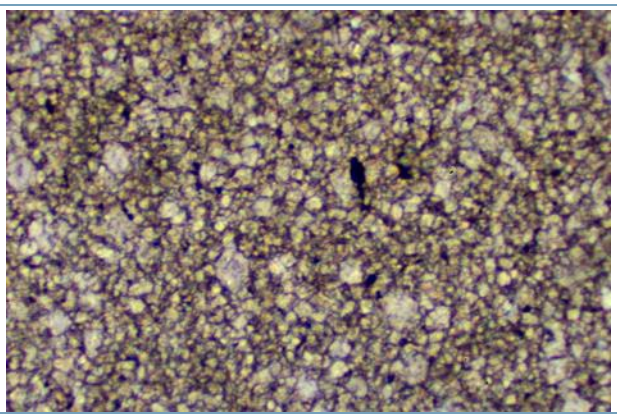
1B: Calcitic dolostone (crossed polars view 40X)



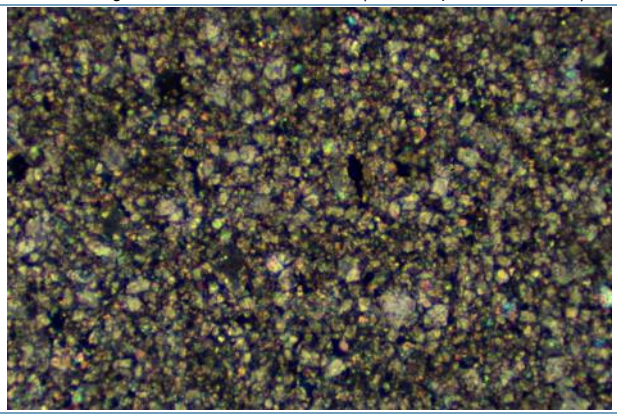
1C: Fine grain fossiliferous limestone (plane polar view 40X)



1D: Fine grain fossiliferous limestone (crossed polars view 40X)



1E: Calcitic dolostone (plane polar view 40X)



1F: Calcitic dolostone (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

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Realized by 2016-09-01

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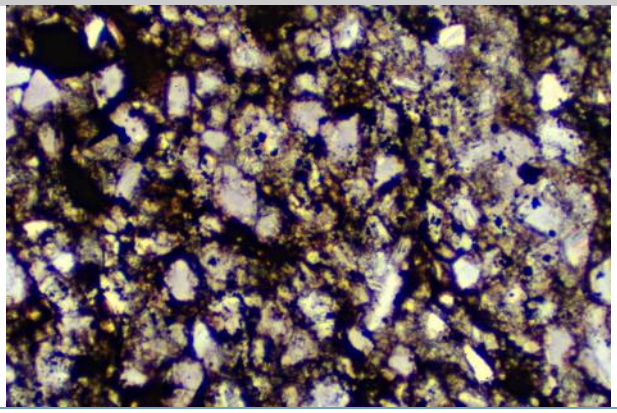
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

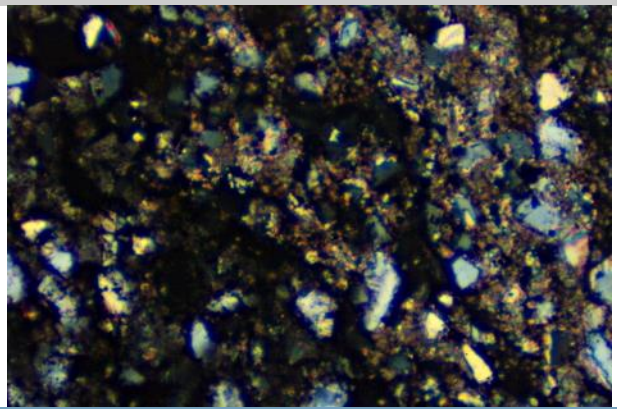
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 5
Type: 5-14 mm

Date: 06-12-2016
Sample: 1
Sampling: Client*

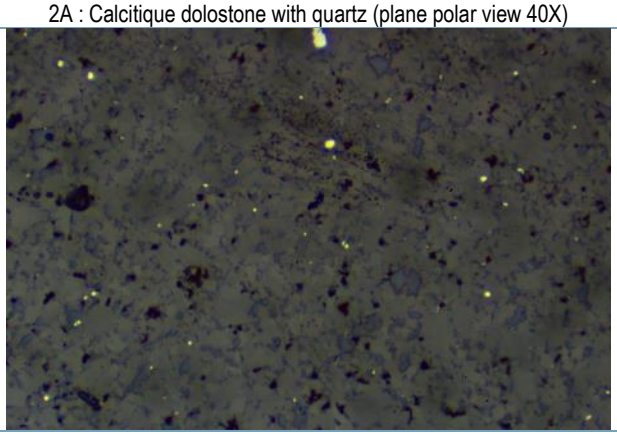
MICROSCOPIC PHOTOGRAPHY



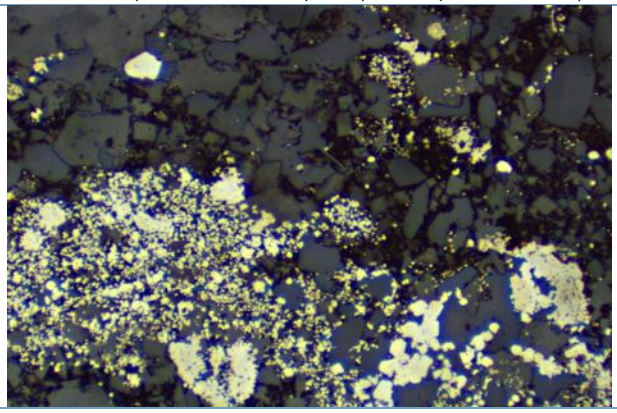
2A : Calcitique dolostone with quartz (plane polar view 40X)



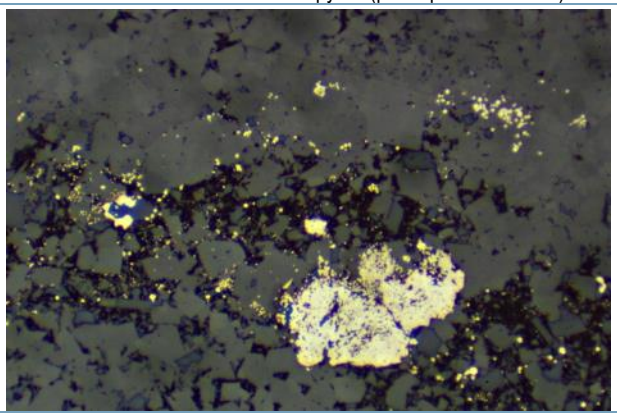
2B : Calcitique dolostone with quartz (crossed polars view 40X)



2C : Disseminated framboidal pyrite (plane polar view 40X)



2D : Framboidal and cubic pyrite (plane polar view 40X)



2E : Framboidal and cubic pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 2016-09-01

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 11
Type: 5-14 mm

Date: 06-12-2016
Sample: 5
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #11 consists of particles from a sedimentary rock. The facies observed is a fine grain limestone. Carbonate crystals have been observed in cladding or veins in some particles. Particles with a greater concentration of clay minerals were also identified. The color of the particles is light to medium grey. The form of the particles are predominantly flattened and lengthened. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 1/16 mm (arenite to lutite). Strength of the particles is good. The hardness is medium (4-5$^{\delta}$) for the limestone and medium to low for the argillaceous limestone (≈ 3$^{\delta}$).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 105 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.3095 %.

Petrographic observations on polished thin section

The composition of the sedimentary rocks varies according to the conditions of deposition. In order to facilitate the counts of the different facies observed on the polished thin section, Table 2 presents the number of occurrences of these facies as well as their particularities. Please note that the distinction of these facies can only be done with a microscope.

Generally, the sample consists of approximately 70 % calcite and 30 % dolomite. Rounded quartz grains as well as crystalline carbonate or quartz veins were observed in the aggregates. Alignments of clay minerals or opaque minerals were observed in 4 particles (out of 24).The opaque minerals observed represent 2 to 5 % and consist of pyrite and iron oxides. The size of the fragments is generally less than 2.0 mm (arenite to lutite). The pyrite crystals are framboidal and cubic in shape and generally have a size of less than 0.5 mm.

Figures 1 and 2 show photomicrographs of the sample.

Mathilde Koné, tech.
Realized by 2016-12-05

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 2016-12-06

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Phone : 418-647-1402

PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 11
Type: 5-14 mm

Date: 06-12-2016
Sample: 5
Sampling: Client*

Summary

The coarse aggregate from Site #11 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of sedimentary rock (limestone) with a PN of 105 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.3095 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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Realized by 2016-12-05

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 2016-12-06

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 11
Type: 5-14 mm

Date: 06-12-2016
Sample: 5
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm % retained 14 mm	% passing 14 mm % retained 10 mm	% passing 10 mm % retained 5 mm
Grain-size proportion (%)	11.0	29.1	51.3
Weighted % of the fraction used (%)	12.0	31.8	56.1

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Limestone	1	80.8	9.7	96.9	30.9	97.8	54.9
Argillaceous limestone	2	19.2	4.6	3.1	2.0	2.2	2.5
Cumulative petrographic numbers			14.3		32.8		57.4
Percentage of petrographic quality classification	Good : 91.8 %		Fair : 8.2 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 105							

Table 2 : Petrographic facies observed in thin section

MICROSCOPE OBSERVATIONS				
Polished thin section with 24 aggregates (LM-188A and LM-188B)				
Facies	Limestone $CaCO_3$ (> 90%)	Dolimitic limestone $CaCO_3$ (50-90%)	Calcitic dolostone $CaMg(CO_3)_2$ (50-90%)	Dolostone $CaMg(CO_3)_2$ (> 90%)
# of particles	13	4	7	
observations	Fine grain limestone (calcilutite)	Calcitic sandstone	Dolomitic sandstone	

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

**: The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

δ: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

β: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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Realized by 2016-12-05

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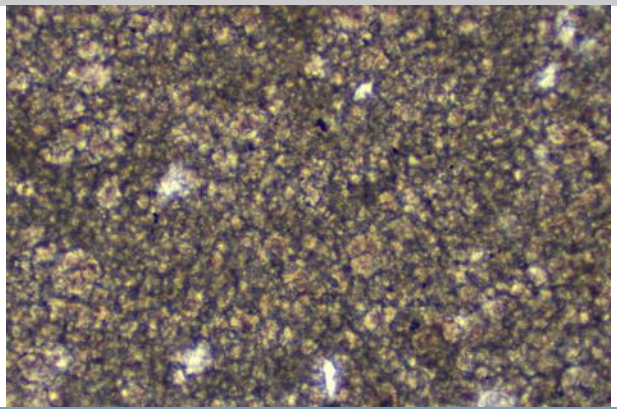
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

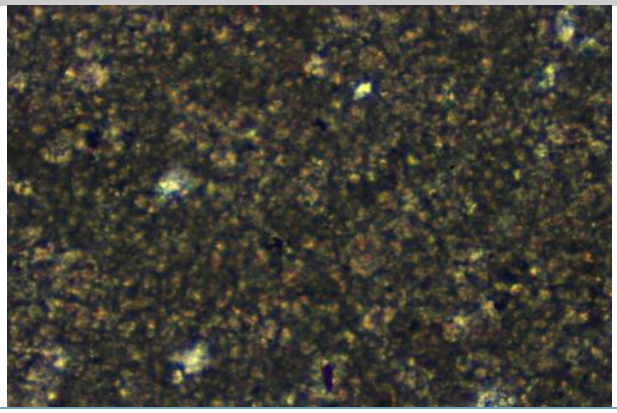
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 11
Type: 5-14 mm

Date: 06-12-2016
Sample: 5
Sampling: Client*

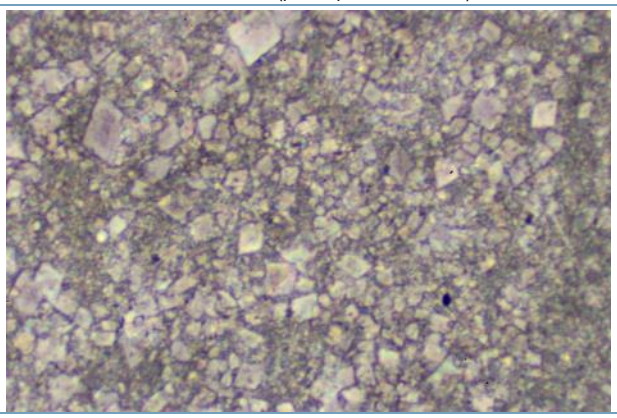
MICROSCOPIC PHOTOGRAPHY



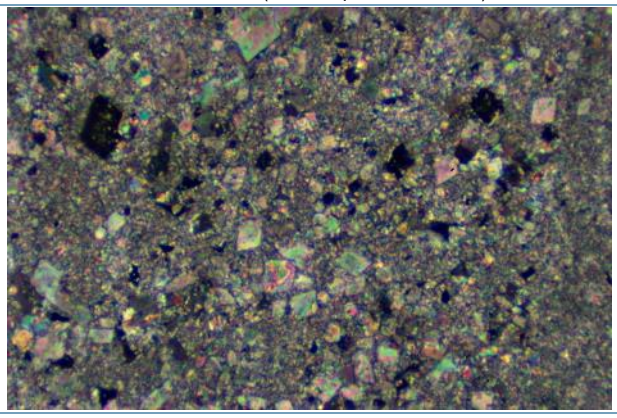
1A: Limestone (plane polar view 40X)



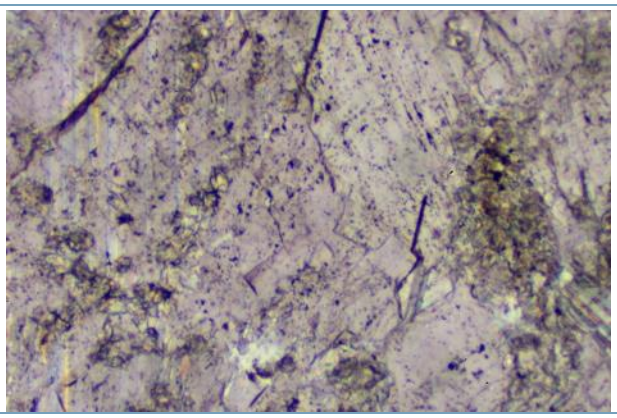
1B: Limestone (crossed polars view 40X)



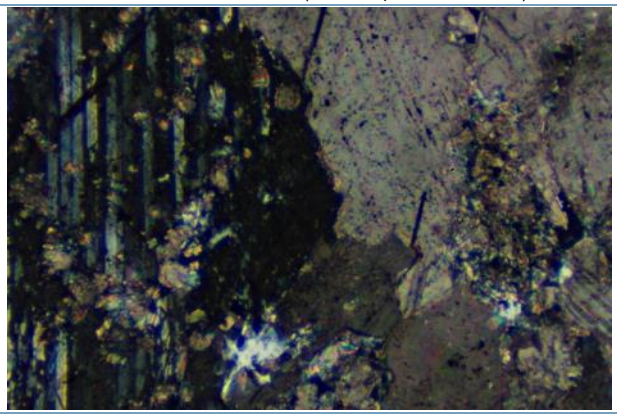
1C: Dolomitic limestone (plane polar view 40X)



1D: Dolomitic limestone (crossed polars view 40X)



1E: Carbonate crystals (plane polar view 40X)



1F: Carbonate crystals (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 2016-12-05

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 2016-12-06

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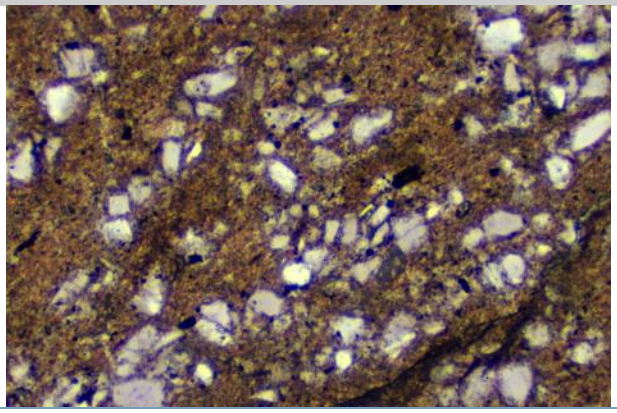
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

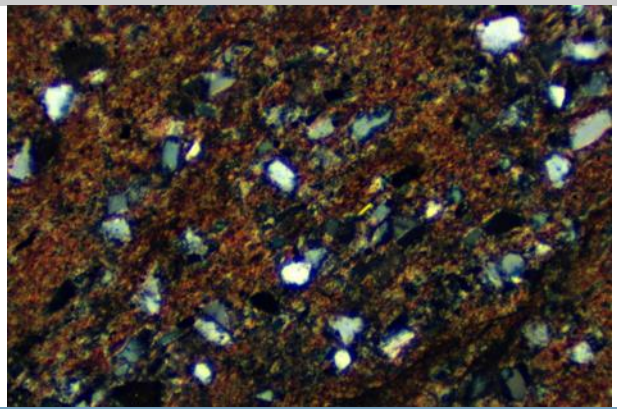
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 11
Type: 5-14 mm

Date: 06-12-2016
Sample: 5
Sampling: Client*

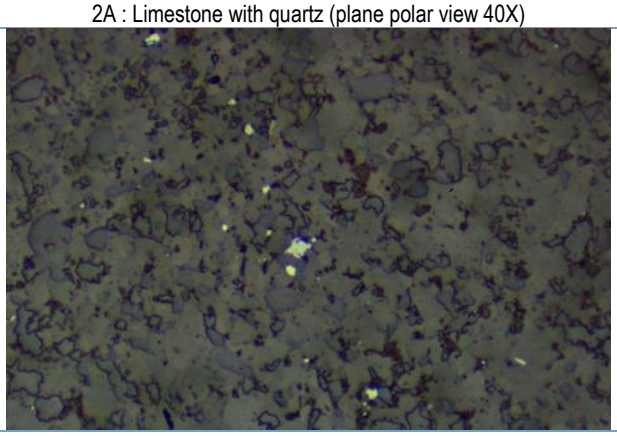
MICROSCOPIC PHOTOGRAPHY



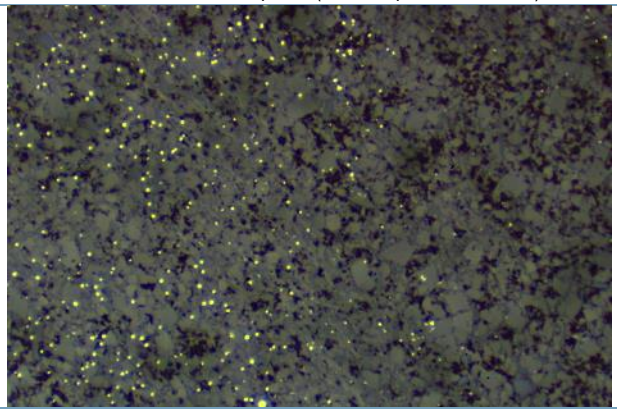
2A : Limestone with quartz (plane polar view 40X)



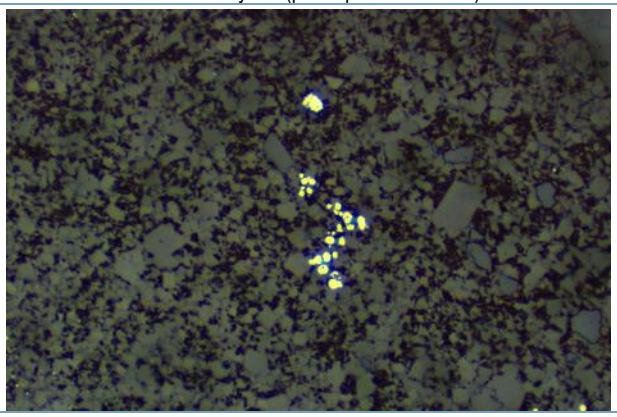
2B : Limestone with quartz (crossed polars view 40X)



2C : Iron oxydes (plane polar view 40X)



2D : Pyrite (plane polar view 40X)



2E : Framboidal pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 2016-12-05

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 14
Type: 5-14 mm

Date: 06-12-2016
Sample: 7
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #14 consists of particles from a sedimentary rock. The facies observed is a fine grain fossiliferous limestone. Carbonate crystals, mostly dolomite, have been observed in cladding or veins in some particles. Particles with a greater concentration of clay minerals were also identified. The color of the particles is medium grey. The form of the particles are predominantly cubic and flattened. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 3 mm (arenite to lutite). Strength of the particles is good. The hardness is medium (≈4^{δ}) for the limestone and medium to low for the argillaceous limestone (≈ 3^{δ}).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 106 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.2270 %.

Petrographic observations on polished thin section

The composition of the sedimentary rocks varies according to the conditions of deposition. In order to facilitate the counts of the different facies observed on the polished thin section, Table 2 presents the number of occurrences of these facies as well as their particularities. Please note that the distinction of these facies can only be done with a microscope.

The sample consists of fossils fragments of in a fine-grained carbonate matrix. Crystalline carbonate veins were observed in the aggregates. The dolomitic facies is characterized by the presence of dolomite (idiomorphic) crystals in a fine-grained matrix. The opaque minerals observed represent 5 to 10 % and consist of pyrite. The size of the fragments is generally less than 3.0 mm (arenite to lutite). The pyrite crystals are framboidal and cubic in shape and generally have a size of less than 0.5 mm.

Figures 1 and 2 show photomicrographs of the sample.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 14
Type: 5-14 mm

Date: 06-12-2016
Sample: 7
Sampling: Client*

Summary

The coarse aggregate from Site #14 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of sedimentary rock (limestone) with a PN of 106 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.2270 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 14
Type: 5-14 mm

Date: 06-12-2016
Sample: 7
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm	% passing 14 mm	% passing 10 mm
	% retained 14 mm	% retained 10 mm	% retained 5 mm
Grain-size proportion (%)	5.5	35.4	55.3
Weighted % of the fraction used (%)	5.7	36.6	57.7

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Limestone	1	90.3	5.1	91.2	33.4	97.5	56.2
Argillaceous limestone	2	9.7	1.1	8.8	6.4	2.5	2.9
Cumulative petrographic numbers			6.2		39.9		59.1
Percentage of petrographic quality classification	Good : 93.0 %		Fair : 7.0 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 106							

Table 2 : Petrographic facies observed in thin section

MICROSCOPE OBSERVATIONS				
Polished thin section with 19 aggregates (LM-189A and LM-189B)				
Facies	Limestone $CaCO_3$ (> 90%)	Dolimitic limestone $CaCO_3$ (50-90%)	Calcitic dolostone $CaMg(CO_3)_2$ (50-90%)	Dolostone $CaMg(CO_3)_2$ (> 90%)
# of particles	13	2		4
observations	Fine grain Limestone - fossiliferous and / or argillaceous	Sandstone limestone - With quartz rounded grains		Idiomorphic dolomite crystals

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

**: The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

δ: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

β: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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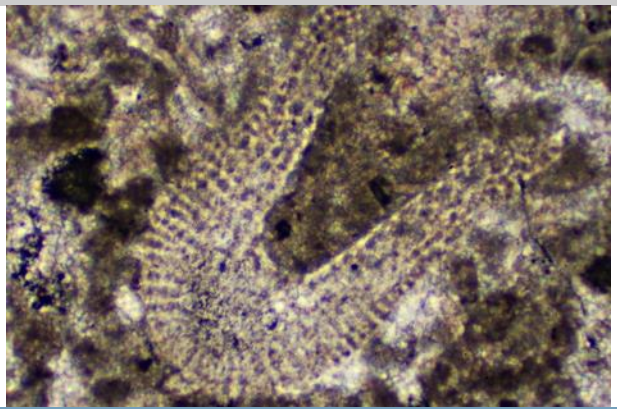
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

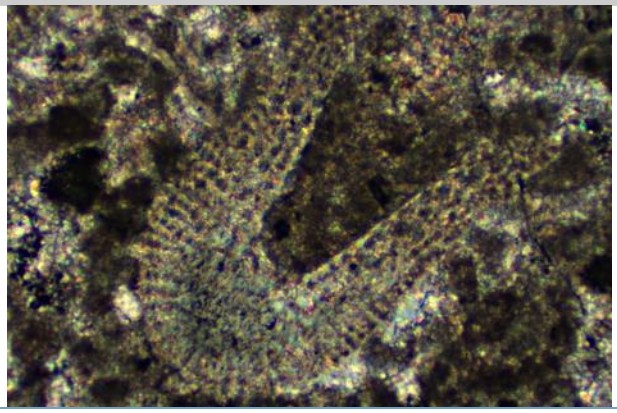
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 14
Type: 5-14 mm

Date: 06-12-2016
Sample: 7
Sampling: Client*

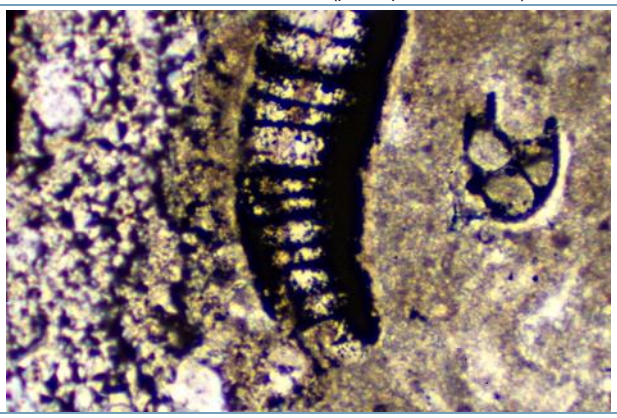
MICROSCOPIC PHOTOGRAPHY



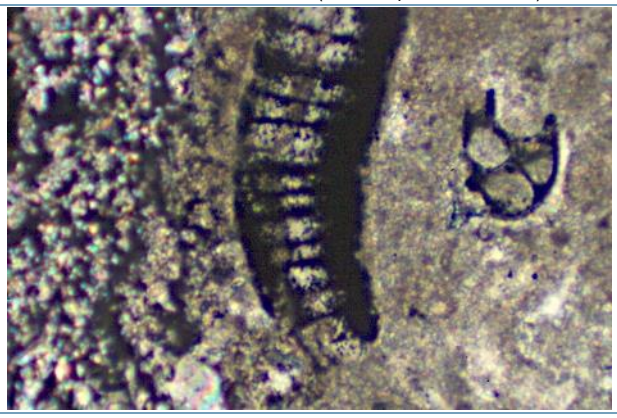
1A: Fossiliferous limestone (plane polar view 40X)



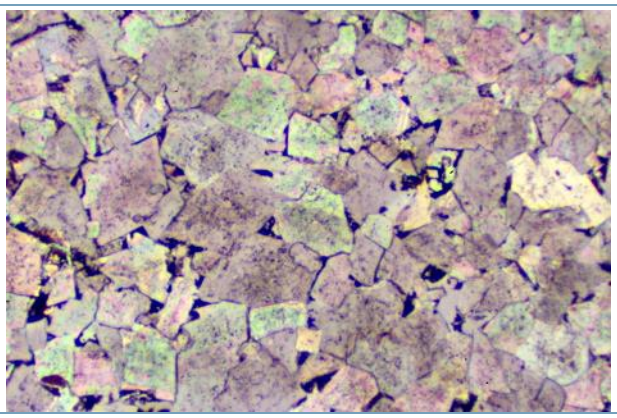
1B: Fossiliferous limestone (crossed polars view 40X)



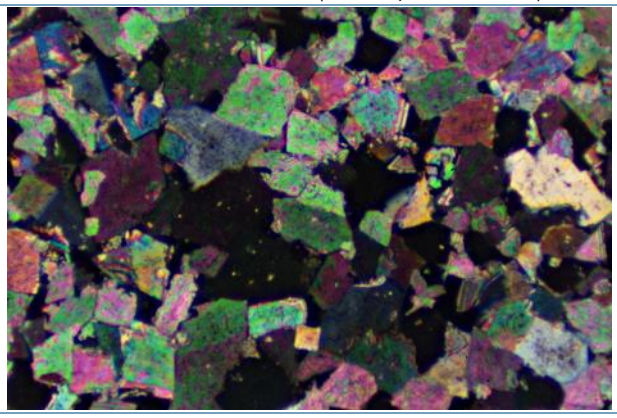
1C: Fossiliferous limestone (plane polar view 40X)



1D: Fossiliferous limestone (crossed polars view 40X)



1E: Cristalline dolostone (plane polar view 40X)



1F: Cristalline dolostone (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

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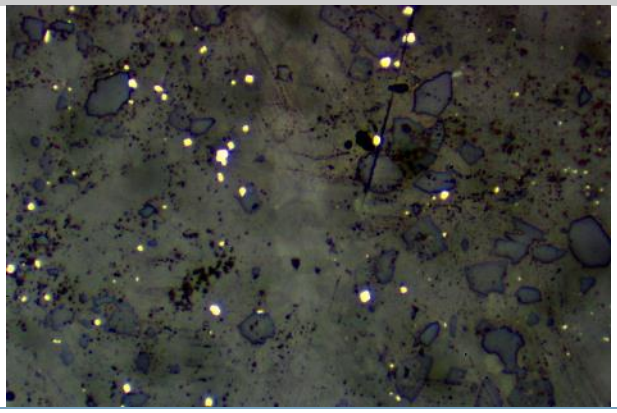
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

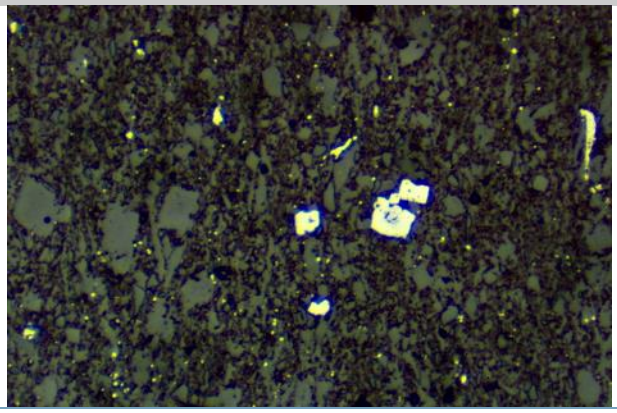
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 14
Type: 5-14 mm

Date: 06-12-2016
Sample: 7
Sampling: Client*

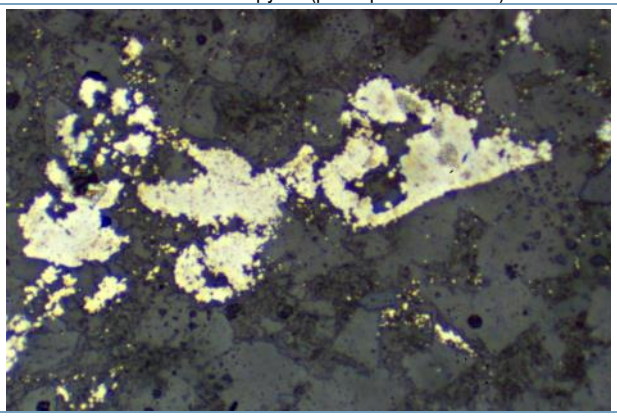
MICROSCOPIC PHOTOGRAPHY



2A : Framboidal pyrite (plane polar view 40X)



2B : Framboidal and cubic pyrite (plane polar view 40X)



2C : Framboidal and cubic pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 17
Type: 5-14 mm

Date: 06-12-2016
Sample: 9
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #17 consists of particles from a sedimentary rock. The facies observed is a fine grain fossiliferous and crystalline calcitic dolostone. Particles with a greater concentration of clay minerals were also identified. The color of the particles is light grey. The form of the particles are predominantly cubic and flattened. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 5.0 mm (rudite, arenite to lutite). Strength of the particles is good. The hardness is medium (≈4^{δ}) for the limestone and medium to low for the argillaceous limestone (≈ 3^{δ}).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 106 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.1320 %.

Petrographic observations on polished thin section

The sample consists of approximately 85 % dolomite and 15 % carbonated clasts. Areas containing idiomorphic crystals of dolomite in a carbonaceous micritic matrix were observed in 5 particles (out of 8). The opaque minerals observed represent 1 to 5 % and consist of pyrite and iron oxides. The size of the fragments is generally less than 5.0 mm (rudite to arenite). The pyrite crystals are framboidal and cubic in shape and generally have a size of less than 1.5 mm.

Thin sections LM-190A and LM-190B are showing 8 aggregates.

Figures 1 and 2 show photomicrographs of the sample.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 17
Type: 5-14 mm

Date: 06-12-2016
Sample: 9
Sampling: Client*

Summary

The coarse aggregate from Site #17 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of sedimentary rock from (dolomite) with a PN of 106 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.1320 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 17
Type: 5-14 mm

Date: 06-12-2016
Sample: 9
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm	% passing 14 mm	% passing 10 mm
	% retained 14 mm	% retained 10 mm	% retained 5 mm
Grain-size proportion (%)	2.2	37.3	51.4
Weighted % of the fraction used (%)	2.4	41.0	56.5

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Calcitic dolostone	1	98.0	2.4	90.0	36.9	97.5	55.1
Argillaceous calcitic dolostone	2	2.0	0.1	10.0	8.2	2.5	2.8
Cumulative petrographic numbers			2.5		45.1		58.0
Percentage of petrographic quality classification	Good : 95.2 %		Fair : 4.8 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 106							

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

**: The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

$^{\delta}$: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

$^{\beta}$: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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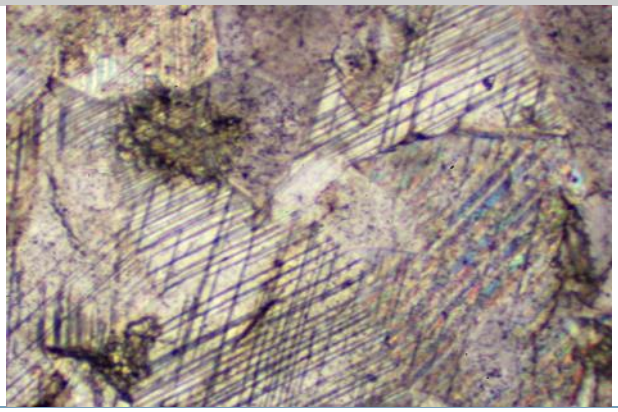
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

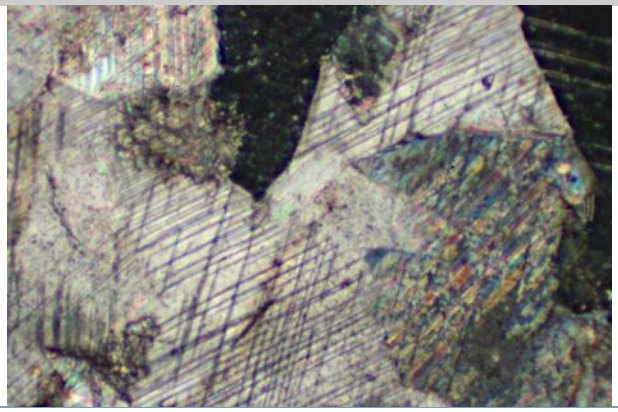
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 17
Type: 5-14 mm

Date: 06-12-2016
Sample: 9
Sampling: Client*

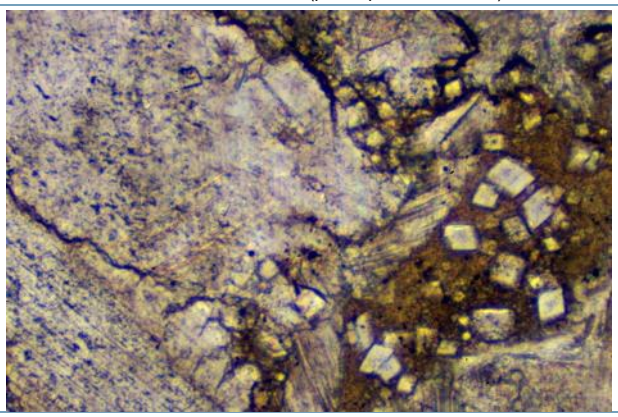
MICROSCOPIC PHOTOGRAPHY



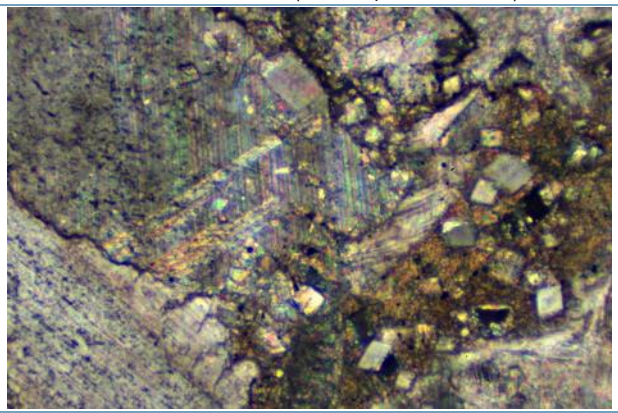
1A: Calcitic dolostone (plane polar view 40X)



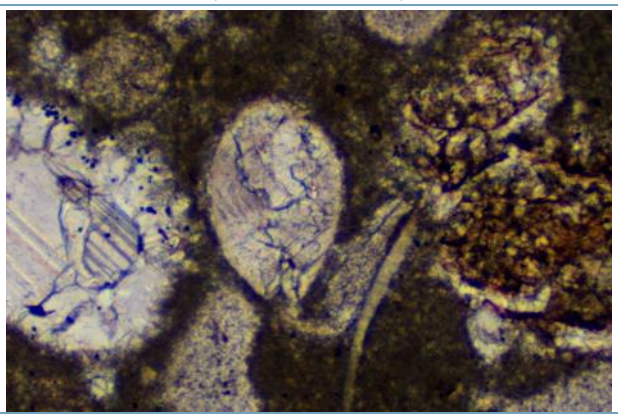
1B: Calcitic dolostone (crossed polars view 40X)



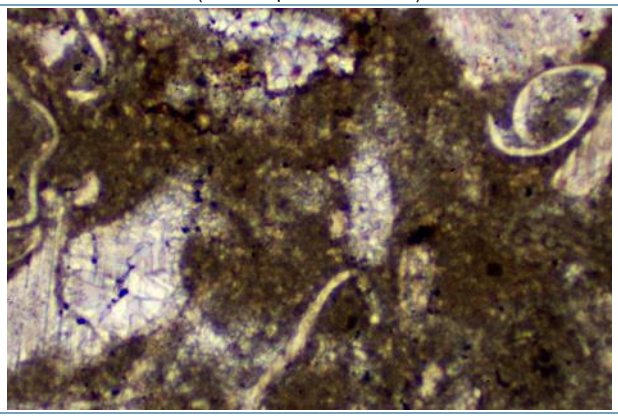
1C: Calcitic dolostone with dolomite in a micritic matrix (plane polar view 40X)



1D: Calcitic dolostone with dolomite in a micritic matrix (crossed polars view 40X)



1E: Clast of fossiliferous limestone (plane polar view 40X)



1F: Clast of fossiliferous limestone (plane polar view 40X)

Figure 1 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 2016-12-05

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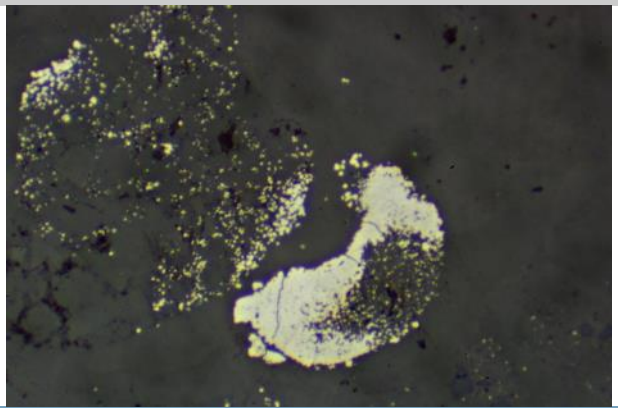
325, DE L'ESPINAY STREET
QUEBEC (QC) G1L 2J2
Phone : 418-647-1402

PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

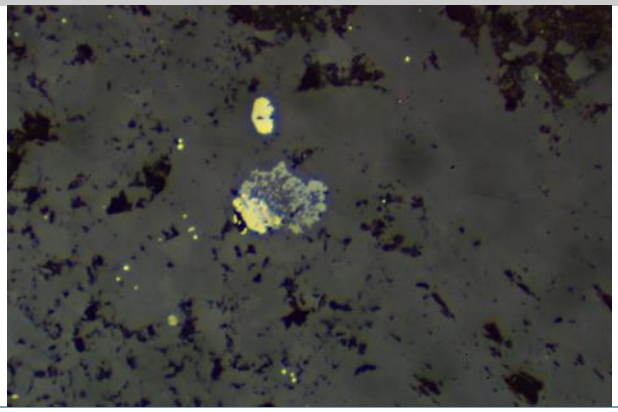
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 17
Type: 5-14 mm

Date: 06-12-2016
Sample: 9
Sampling: Client*

MICROSCOPIC PHOTOGRAPHY



2A : Framboidal pyrite (plane polar view 40X)



2B : Pyrite and iron oxides (plane polar view 40X)

Figure 2 : Microphotographs of the sample

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Realized by 2016-12-05

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 19
Type: 5-14 mm

Date: 28-09-2016
Sample: 25
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #19 consists of particles from a volcanic rock. The facies observed is a basalt. The color of the particles is greenish to pinkish grey. The pinkish particles shows a slight oxidation of the hematite (iron oxide). The form of the particles are predominantly cubic. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 3.0 mm (medium to fine phaneritic). Strength of the particles is very good and the hardness is about 7 to 8$^{\delta}$).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 100 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Volcanic rocks may contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Traces of pyrite were observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.0339 %.

Petrographic observations on polished thin section

The sample consists of approximately 70 % to 80 % plagioclases, 10 % to 15 % pyroxene and 5 % olivine. The opaque minerals observed represent less than 1 % and consist mostly in iron oxides (hematite, ilmenite, magnetite) and traces of pyrite. The size of the fragments is generally less than 3.0 mm and the form varies from idiomorphic to xenomorphic.

Thin sections LM-197A and LM-197B are showing 18 aggregates.

Figures 1 and 2 show photomicrographs of the sample.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 19
Type: 5-14 mm

Date: 28-09-2016
Sample: 25
Sampling: Client*

Summary

The coarse aggregate from Site #19 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of volcanic rock (basalt) with a PN of 100 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Volcanic rocks may contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Traces of pyrite were observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.0339 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 19
Type: 5-14 mm

Date: 28-09-2016
Sample: 25
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm	% passing 14 mm	% passing 10 mm
	% retained 14 mm	% retained 10 mm	% retained 5 mm
Grain-size proportion (%)	2.3	24.3	56.9
Weighted % of the fraction used (%)	2.8	29.1	68.1

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Basalt	1	100	2.8	100	29.1	100	68.1
Cumulative petrographic numbers			2.8		29.1		68.1
Percentage of petrographic quality classification	Good : 100 %		Fair : 0 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 100							

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

** The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

δ: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

β: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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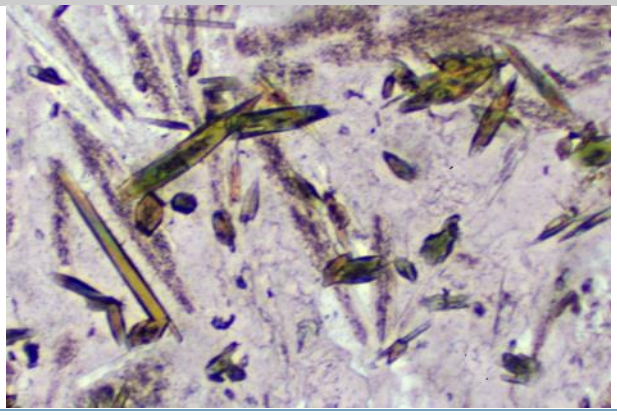
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

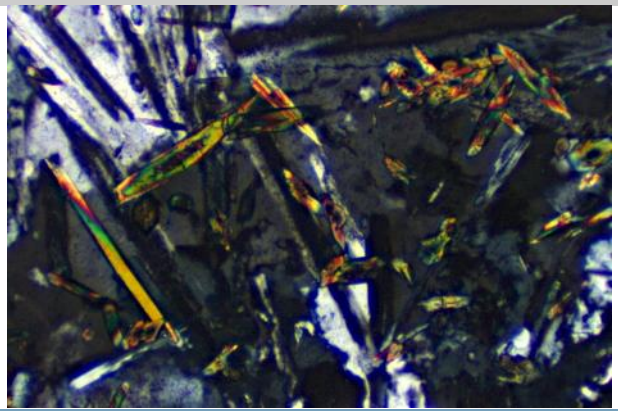
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 19
Type: 5-14 mm

Date: 28-09-2016
Sample: 25
Sampling: Client*

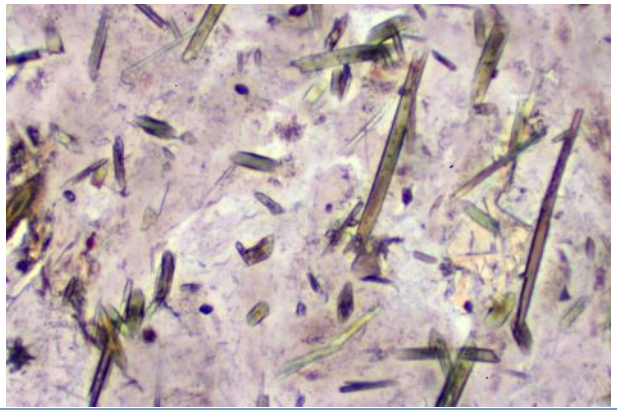
MICROSCOPIC PHOTOGRAPHY



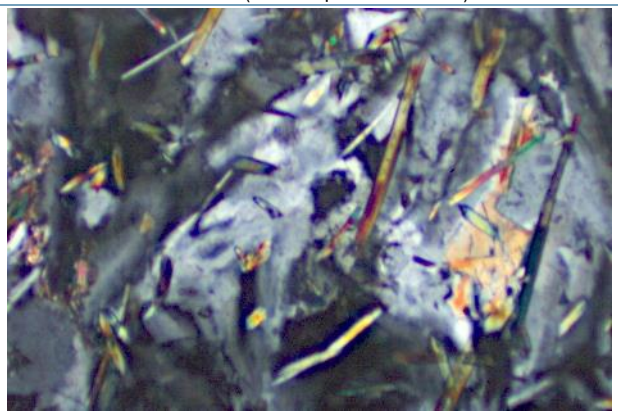
1A: Basalt (plane polar view 40X)



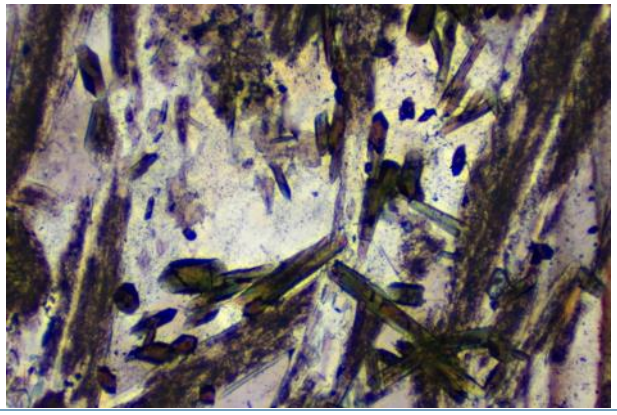
1B: Basalt (crossed polars view 40X)



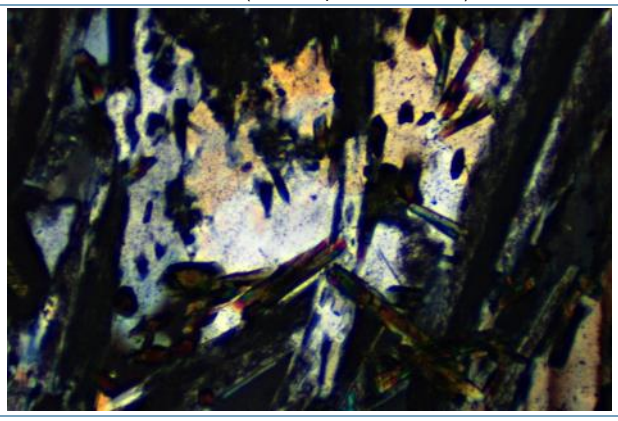
1C: Basalt (plane polar view 40X)



1D: Basalt (crossed polars view 40X)



1E: Basalt (plane polar view 40X)



1F: Basalt (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

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Realized by 15-09-2016

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Verified and approved by Date : 28-09-2016

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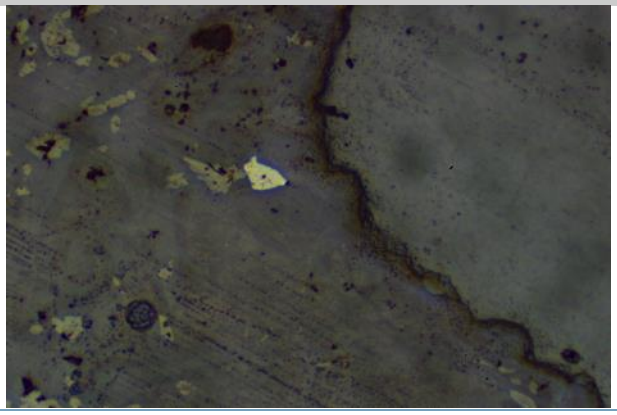
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

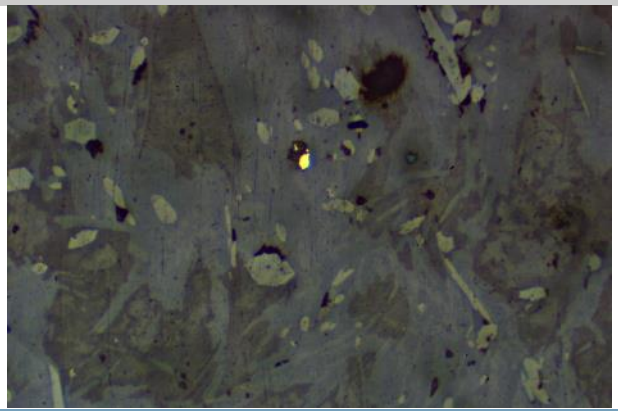
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 19
Type: 5-14 mm

Date: 28-09-2016
Sample: 25
Sampling: Client*

MICROSCOPIC PHOTOGRAPHY



2A : Iron oxides (plane polar view 40X)



2B : Pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 15-09-2016

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 22
Type: 5-14 mm

Date: 06-12-2016
Sample: 11
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #22 consists of particles from a sedimentary rock. The facies observed is a fine grain dolomitic limestone. The color of the particles varies from medium gray to chamois. The form of the particles are predominantly flattened and elongated. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 5.0 mm (rudite, arenite to lutite). Strength and the hardness of the particles are low to medium ($\approx 3^{\delta}$).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 100 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.0965 %.

Petrographic observations on polished thin section

The sample consists of carbonaceous matrix composed of approximately 60 % calcite and 35 % dolomite, with big crystals of dolomite. Rounded quartz grains were observed in some aggregates (slightly sandstone). The opaque minerals observed represent 1 to 3 % and consist of pyrite. The size of the fragments is generally less than 2.0 mm (arenite to lutite). The pyrite crystals are framboidal and cubic in shape and generally have a size of less than 0.5 mm.

Thin sections LM-191A and LM-191B are showing 14 aggregates.

Figures 1 and 2 show photomicrographs of the sample.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 22
Type: 5-14 mm

Date: 06-12-2016
Sample: 11
Sampling: Client*

Summary

The coarse aggregate from Site #22 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of sedimentary rock (limestone) with a PN of 100 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.0965 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 22
Type: 5-14 mm

Date: 06-12-2016
Sample: 11
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm	% passing 14 mm	% passing 10 mm
	% retained 14 mm	% retained 10 mm	% retained 5 mm
Grain-size proportion (%)	1.9	28.7	59.6
Weighted % of the fraction used (%)	2.1	31.8	66.1

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Dolomitic limestone	1	100	2.1	100	31.8	100	66.1
Cumulative petrographic numbers			2.1		31.8		66.1
Percentage of petrographic quality classification	Good : 100 %		Fair : 0 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 100							

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

** The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

δ: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

β: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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Realized by 2016-12-05

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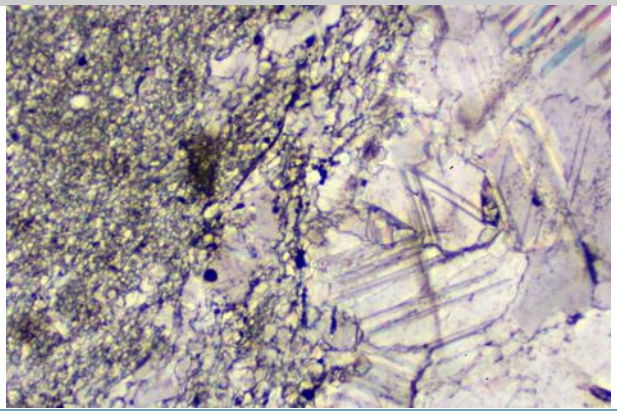
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

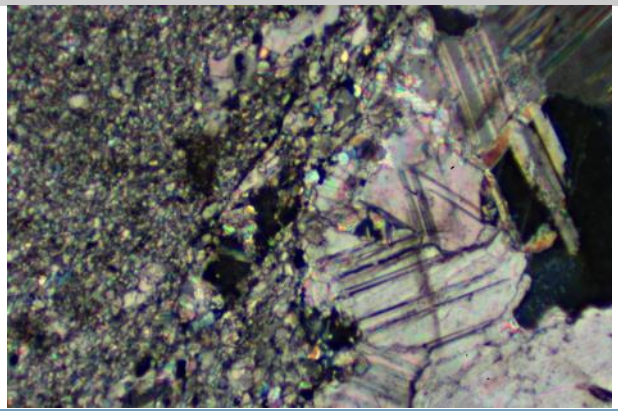
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 22
Type: 5-14 mm

Date: 06-12-2016
Sample: 11
Sampling: Client*

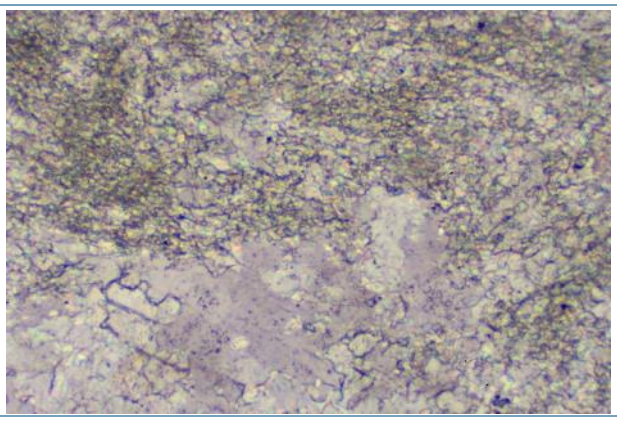
MICROSCOPIC PHOTOGRAPHY



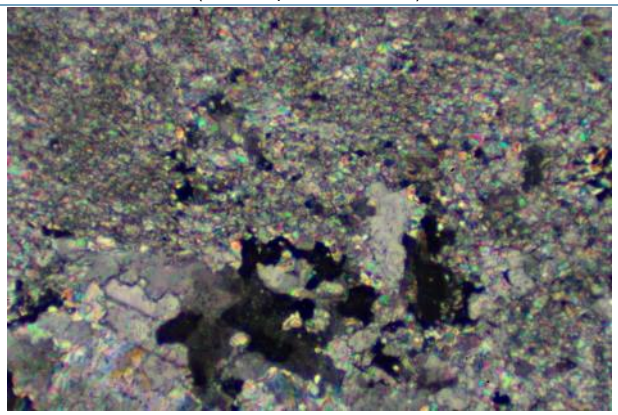
1A: Dolomitic limestone with dolomite crystals (plane polar view 40X)



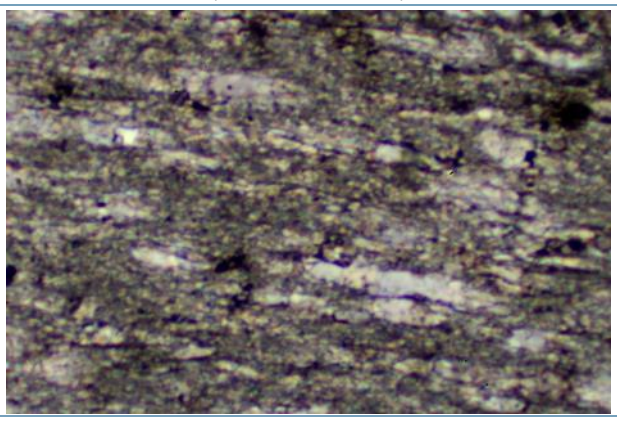
1B: Dolomitic limestone with dolomite crystals (crossed polars view 40X)



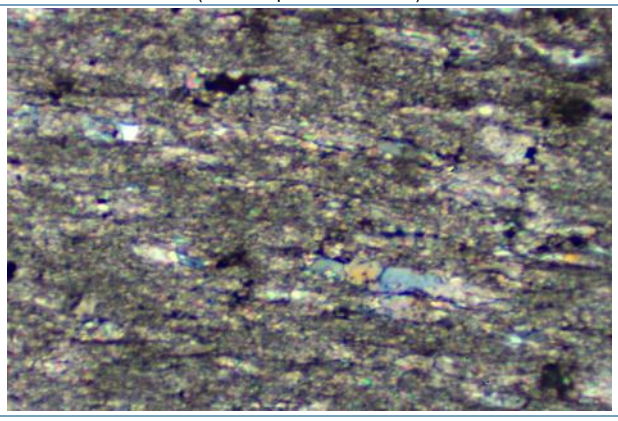
1C: Dolomitic limestone with dolomite crystals (plane polar view 40X)



1D: Dolomitic limestone with dolomite crystals (crossed polars view 40X)



1E: Dolomitic limestone with quartz grains (plane polar view 40X)



1F: Dolomitic limestone with quartz grains (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

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Realized by 2016-12-05

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 2016-12-06

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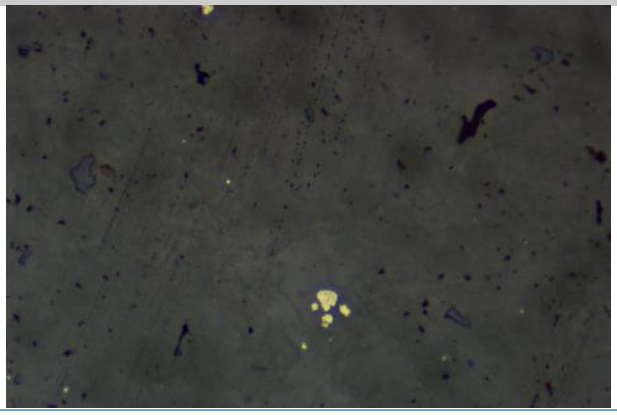
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

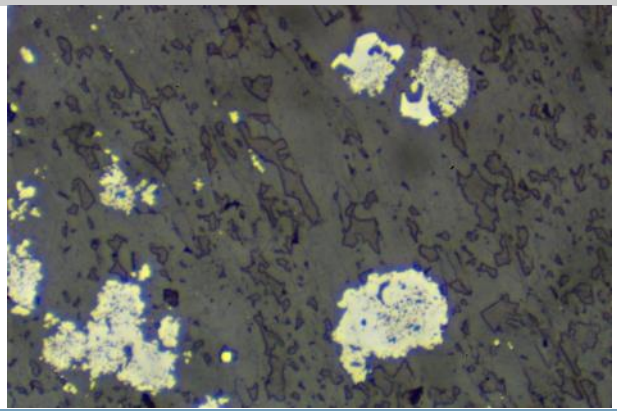
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 22
Type: 5-14 mm

Date: 06-12-2016
Sample: 11
Sampling: Client*

MICROSCOPIC PHOTOGRAPHY



2A : Framboidal pyrite (plane polar view 40X)



2B : Pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 2016-12-05

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Verified and approved by Date : 2016-12-06

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 23
Type: 5-14 mm

Date: 06-12-2016
Sample: 13
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #22 consists of particles from a sedimentary rock. The facies observed is a crystalline calcitic dolostone. Particles showing some schistosity were also observed. The color of the particles is light gray. The form of the particles are predominantly cubic and elongated. The angularity of the particles varies from angular to subangular. The grain size is usually lower than 5.0 mm (rudite, arenite to lutite). Strength of the particles are medium to good. The hardness of the particles is medium ($\approx 4^{\delta}$) and medium to low for the particles showing schistosity ($\approx 3^{\delta}$).

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note $^{\beta}$ on page 3), a PN of 110 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.1050 %.

Petrographic observations on polished thin section

The sample consists of two kind of textures dolostone: a dolostone with coarse sub idiomorphic crystals and a dolostone with idiomorphic crystals in a carbonaceous micritic matrix. Size of the grains varies from 0.5 to more than 5.0 mm for the first type of dolostone and between 0.1 and 0.5 mm for the second one. Fossils have been observed in clasts of the coarse dolostone. The opaque minerals observed represent 1 to 5 % and consist of pyrite. The pyrite crystals are framboidal and cubic in shape and generally have a size of less than 0.5 mm.

Thin sections LM-192A and LM-192B are showing 19 aggregates.

Figures 1 and 2 show photomicrographs of the sample.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 23
Type: 5-14 mm

Date: 06-12-2016
Sample: 13
Sampling: Client*

Summary

The coarse aggregate from Site #23 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of sedimentary rock (dolostone) with a PN of 110 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Sedimentary rocks often contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Pyrite is the only iron sulfur observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.1050 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 23
Type: 5-14 mm

Date: 06-12-2016
Sample: 13
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm % retained 14 mm	% passing 14 mm % retained 10 mm	% passing 10 mm % retained 5 mm
Grain-size proportion (%)	3.6	22.3	52.5
Weighted % of the fraction used (%)	4.6	28.4	67.0

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Calcitic dolostone	1	80.0	3.7	90.4	25.7	91.9	61.5
Calcitic dolostone (with schistosity)	2	20.0	1.8	9.6	5.5	8.1	10.8
Cumulative petrographic numbers			5.5		31.2		72.4
Percentage of petrographic quality classification	Good : 87.4 %		Fair : 12.6 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 110							

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

**: The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

$^{\delta}$: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

$^{\beta}$: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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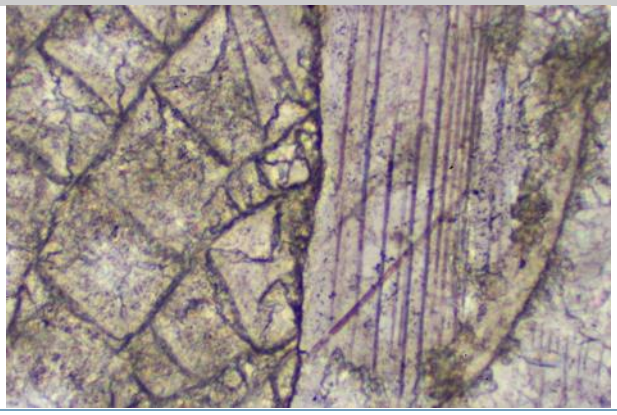
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

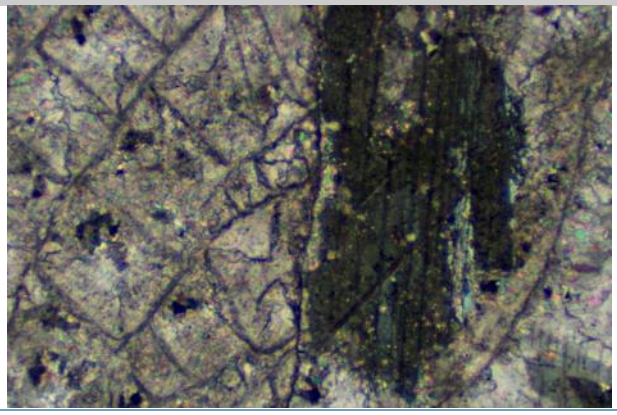
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 23
Type: 5-14 mm

Date: 06-12-2016
Sample: 13
Sampling: Client*

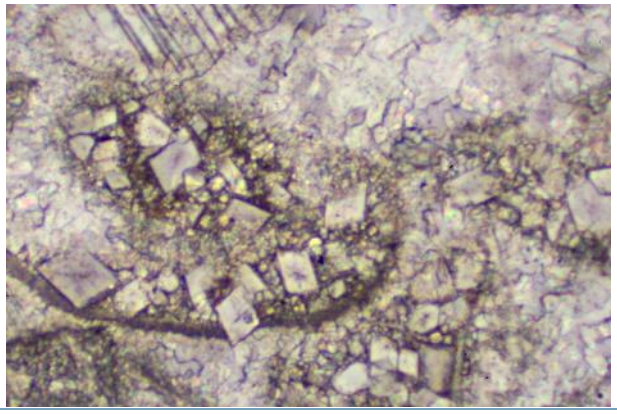
MICROSCOPIC PHOTOGRAPHY



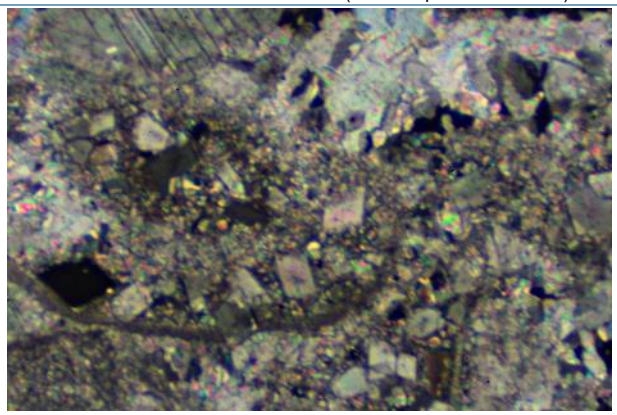
1A: Calcitic dolostone with fossils (plane polar view 40X)



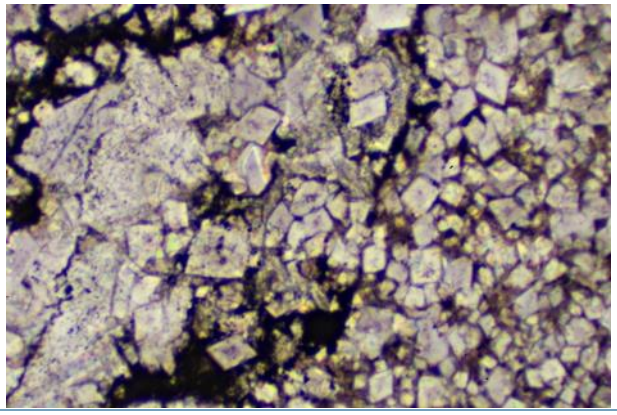
1B: Calcitic dolostone with fossils (crossed polars view 40X)



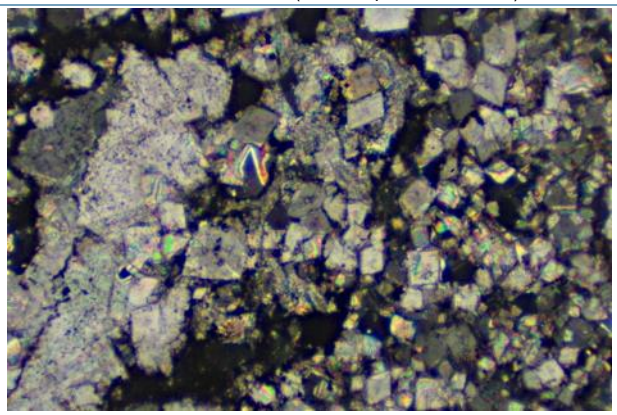
1C: Calcitic dolostone (plane polar view 40X)



1D: Calcitic dolostone (crossed polars view 40X)



1E: Calcitic dolostone (plane polar view 40X)



1F: Calcitic dolostone (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

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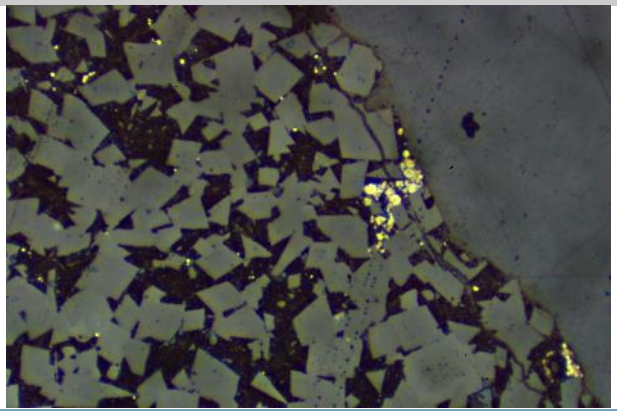
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

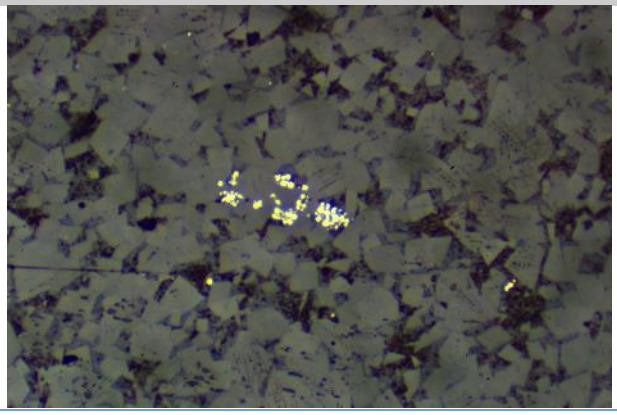
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 23
Type: 5-14 mm

Date: 06-12-2016
Sample: 13
Sampling: Client*

MICROSCOPIC PHOTOGRAPHY



2A : Framboidal pyrite (plane polar view 40X)



2B : Framboidal pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 26
Type: 5-14 mm

Date: 28-09-2016
Sample: 19
Sampling: Client*

Petrographic analysis of aggregates

Generality

The sample consists of a crushed aggregate composed of sieves fractions between 5 mm to 14 mm. Coating on the aggregate consisted of silt/clay, which was completely removed by washing.

To complete the characterization, two thins sections have been prepared and analyzed.

Geology of the aggregate

According to observations made on the sample, the coarse aggregate from source #26 consists of particles from a volcanic rock. The facies observed is a basalt. The color of the particles is greenish to pinkish grey. The pinkish particles shows a strong oxidation of the hematite (iron oxide). Crystalline carbonates and/or quartz veins were observed in some aggregates. The form of the particles are predominantly cubic. The angularity of the particles varies from angular to subangular. The grain size is usually of imperceptible size (aphanitic). Strength of the particles is good to medium and the hardness is about 5^{δ}.

Petrographic quality

In accordance with the methods in use in the aggregates engineering industry, the sample was classified according to the petrographic number (PN). Using standard petrographic quality coefficients for the different quality classifications of each rock type (see note β on page 3), a PN of 100 was calculated for the sample and is equivalent to a "good" rating. Table 1 on page 3 shows the results obtained in the determination of the petrographic number.

Alkali-aggregates and others deleterious substances

Volcanic rocks may contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Traces of pyrite were observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.0399 %.

Petrographic observations on polished thin section

The sample consists of approximately 75 % to 85 % plagioclases, 10 % to 15 % pyroxene and 1 % to 2 % olivine and chlorite. Quartz or carbonate veins frequently intersect the basalt. The opaque minerals observed represent 2 % to 10 % and consist mostly in iron oxides (hematite, ilmenite, magnetite) and traces of pyrite. The size of the fragments is generally less than 2.0 mm and the form varies from idiomorphic to xenomorphic.

Thin sections LM-193A and LM-193B are showing 14 aggregates.

Figures 1 and 2 show photomicrographs of the sample.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 26
Type: 5-14 mm

Date: 28-09-2016
Sample: 19
Sampling: Client*

Summary

The coarse aggregate from Site #26 consists of crushed particles of sieves fractions between 5 mm to 14 mm composed of volcanic rock (basalt) with a PN of 100 is judged to have a good physical-mechanical quality, in a petrographic point of view, for concrete production.

In the present state of knowledge and according to the petrographic observations carried out on the sample supplied by the client, the aggregate has good physico-mechanical and chemical characteristics for use in cement concrete. In addition, no deleterious substances were identified in the sample.

According to these facts, the aggregate can be used in concrete.

Volcanic rocks may contains minerals that are likely to react with the alkali present in portland cement. Therefore, if the aggregate has not been subjected to an assessment of the alkali-aggregate reaction in accordance with the test methods and criteria prescribed by standard CSA A23.1, it is recommended to proceed with such an assessment, at least annually. In addition, depending on the results obtained during these tests, it is recommended to refer to the CSA A23.2-28A standard in order to verify the use of cementitious additives necessary to counter the reactivity of the aggregates.

Traces of pyrite were observed in the sample. The determination of the sulfur content (S_{total}) by chemical analysis shows that the content meets the requirement of the European standard NF EN 1260+A1: 2008 in presence of pyrite (max 1%). The sulfur content (S_{total}) is 0.0399 %.

Table A2.2 of CSA A23.2-15A (14) suggests a PN limit of 125 to manufacture C1, C2 and F1 concrete. This standard also stipulates that it is not appropriate to reject a coarse aggregate based only on its PN value. Such decisions should only be made after review of other physical test data obtained in the context of a comprehensive test program or based on field performance history. In addition, it is essential that physical test results meet the requirements of CSA A23.1 and BNQ 2560-114.

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PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 26
Type: 5-14 mm

Date: 28-09-2016
Sample: 19
Sampling: Client*

Table 1 : Petrographic number result

Sample			
	% passing 20 mm	% passing 14 mm	% passing 10 mm
	% retained 14 mm	% retained 10 mm	% retained 5 mm
Grain-size proportion (%)	7.8	39.6	49.8
Weighted % of the fraction used (%)	8.0	40.7	51.2

Petrographic number result (PN)							
Petrographic facies	Factor	% retained 14 mm	PN	% retained 10 mm	PN	% retained 5 mm	PN
Basalt	1	100	8.0	100	40.7	100	51.2
Cumulative petrographic numbers			8.0		40.7		51.2
Percentage of petrographic quality classification	Good : 100 %		Fair : 0 %		Poor : 0 %		Deleterious : 0 %
Petrographic number result (PN): 100							

Notes: Sieve sizes: 20 mm, 14 mm, 10 mm, 5 mm.

*: Sampling and transport were performed by a client representative.

** The PN is shown for information purposes only, because according to the standard, fine aggregate do not have a PN.

δ: On Mohs' hardness scale : 1=weak (talc) to 10=very hard (diamond).

β: PN multiplier : 1 : good, 3 : fair, 6 : poor et 10 : deleterious.

Limitation of the characterization :

- Please note that the observations contained in this document were realized on the sample transmitted by the client. No validation with respect to the representativeness of the sample was performed.
- All identifications were made using standard visual diagnosis and basic geological techniques.
- The comments and observations in this report are based on the petrographic analysis performed as per standards CSA A23.2-15A and ASTM C295. The conclusions consist of a professional opinion based on the results of a visual examination, the recognition of mineral phases by microscopy and experience acquired by previous studies and current practices.

For microphotographs:

- The width of the photomicrograph is 2 mm if the magnification is 40X and 1 mm if the magnification is 100X.

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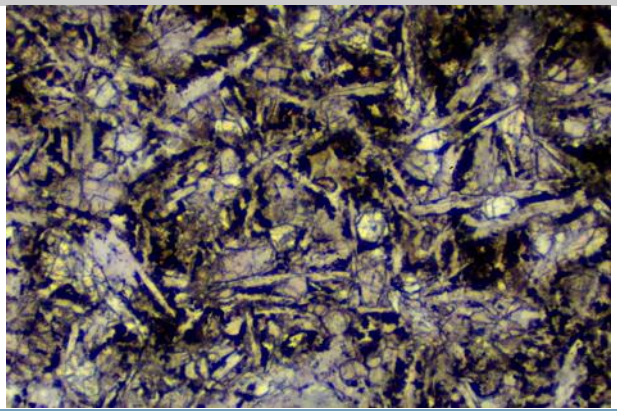
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

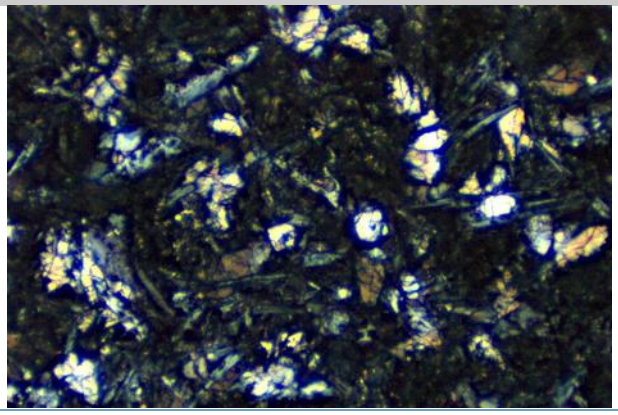
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 26
Type: 5-14 mm

Date: 28-09-2016
Sample: 19
Sampling: Client*

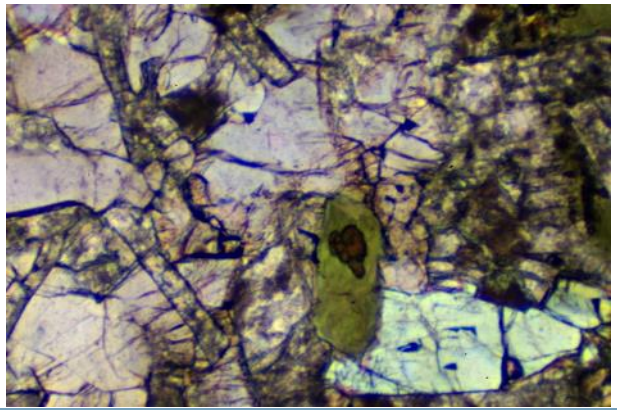
MICROSCOPIC PHOTOGRAPHY



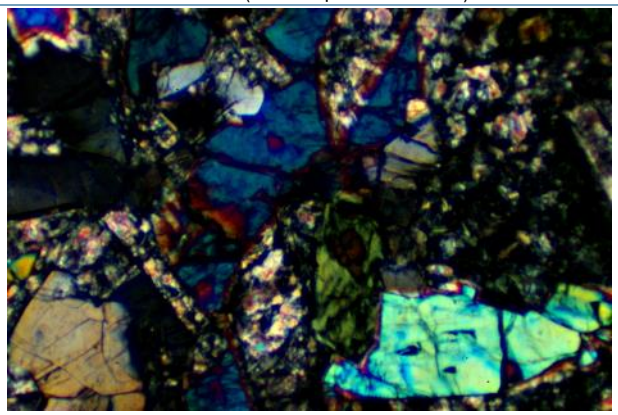
1A: Basalt (plane polar view 40X)



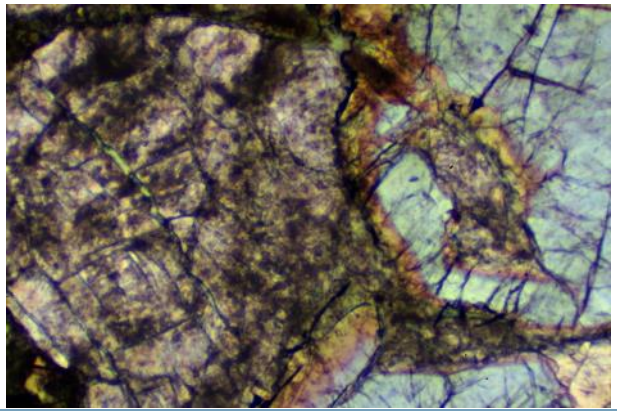
1B: Basalt (crossed polars view 40X)



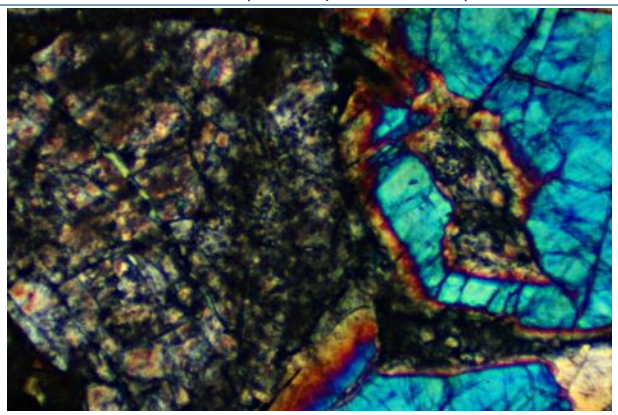
1C: Basalt (plane polar view 40X)



1D: Basalt (crossed polars view 40X)



1E: Basalt (plane polar view 40X)



1F: Basalt (crossed polars view 40X)

Figure 1 : Microphotographs of the sample

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Realized by 15-09-2016

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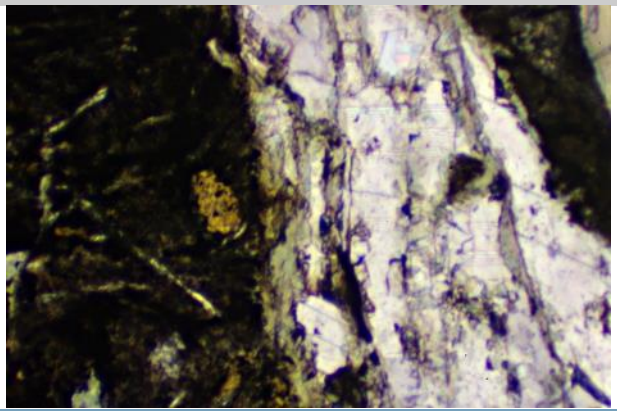
PETROGRAPHIC EXAMINATION REPORT
(CSA A23.2-15A Method A)

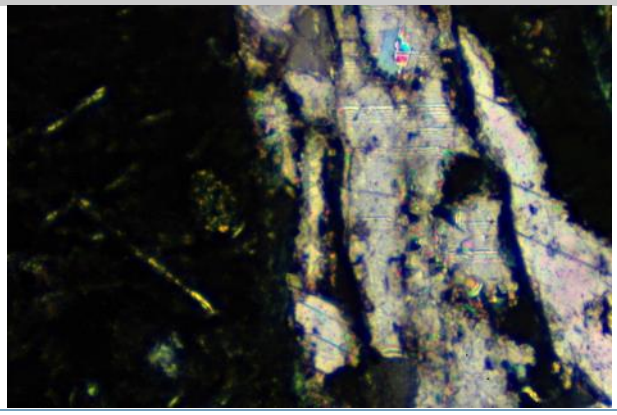
Client : ACRGTQ
Project: P-0009583-0-05-500
Source #: 26
Type: 5-14 mm

Date: 28-09-2016
Sample: 19
Sampling: Client*

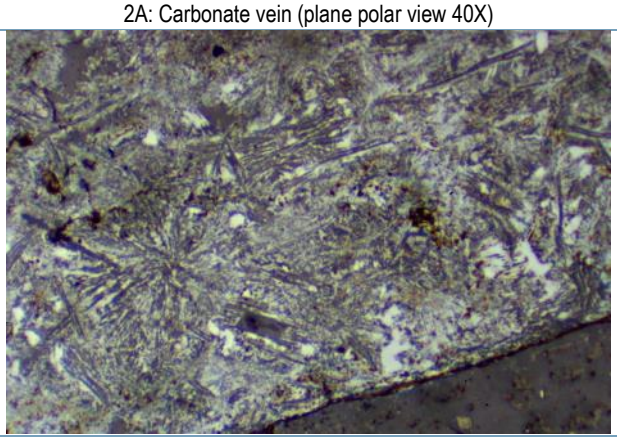
MICROSCOPIC PHOTOGRAPHY



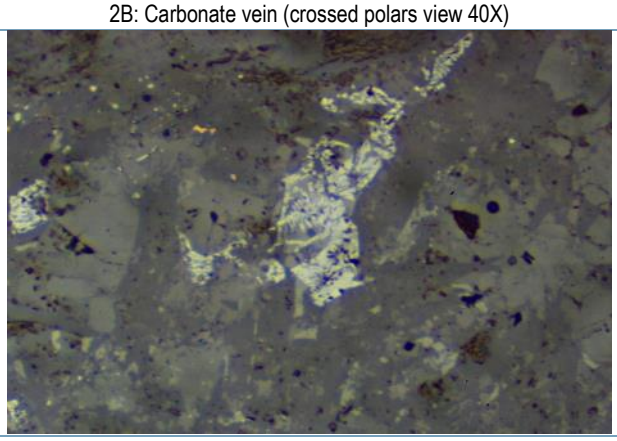
2A: Carbonate vein (plane polar view 40X)



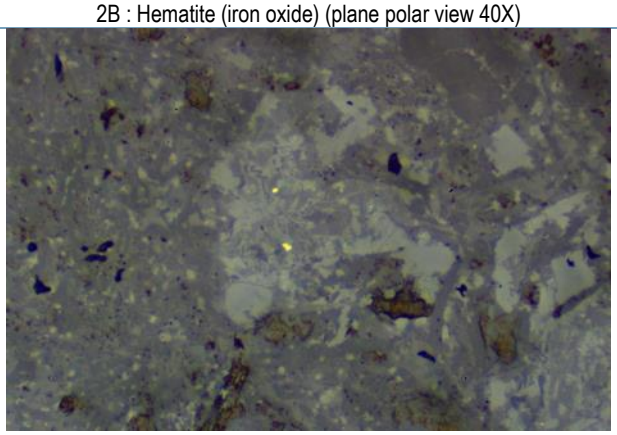
2B: Carbonate vein (crossed polars view 40X)



2B : Hematite (iron oxide) (plane polar view 40X)



2D : Iron oxides (plane polar view 40X)



2E : Pyrite (plane polar view 40X)

Figure 2 : Microphotographs of the sample

Mathilde Koné, tech.
Realized by 15-09-2016

Sofie Tremblay, géo. M. Sc.
Verified and approved by Date : 28-09-2016