Canadian Metals Inc.

Characterization Study of the Langis Silica Deposit
NTS: 22B11, Matapedia Region, Quebec, CANADA

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Effective Date: December 06, 2013

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Report to:

CANADIAN METALS INC.

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GLOSSARY

UNITS OF MEASURE

Coefficient of Uniformity	Cu
degree	°
degrees Celsius	°C
gram	g
hectare (10,000 m^2)	ha
kilogram	kg
kilometre	km
kilowatt	kW
less than	<
metre	m
microns	µm
millilitre	mL
millimetre	mm
million	M
million tonnes	Mt
minute (time)	min
parts per million	ppm
percent	%
pound(s)	lb
pounds per square inch	psi
revolutions per minute	rpm
square metre	m^2
tonne (1,000 kg) (metric ton)	t
volt	V

1.0 SUMMARY

The Langis Silica Property (the Property) is located in the eastern Matapedia Region of Quebec, near the towns of Amqui and Matane, in gently folded Appalachian terrain. The Property is controlled 100% by Canadian Metals Inc., a public company listed on the Canadian National Stock Exchange (CNSX) since August 1, 2013 under the symbol CME:CNX, and hereinafter referred to as CMI.

The Property covers a geologically-mapped area of highly siliceous sandstone of economic interest as a potential source of silica sand for an, as yet, undetermined market. It is the site of a small non-operating sandstone quarry that was explored and operated briefly during the 1980's. Historic documentation concerning the exploration phase was used in the preparation of this Report. There is no production phase documentation publicly available.

The Property is actively being explored by CMI. A broad area of highly siliceous sandstone has been outlined by government mapping and by the existing quarry and the recent drilling completed by CMI in September, 2013. Core lengths from three of the drill holes, as well as selected sandstone blocks from the quarry, were sampled and sent for geochemical and physical analyses in order to characterize the sandstone and, as a result, to suggest potential economic uses. This Characterization Study of the Langis Silica Deposit is the reason for this Technical Report.

1.1 PROPERTY DESCRIPTION AND LOCATION, ACCESSIBILITY, OWNERSHIP AND HISTORY

The Property consists of four map-designated claims (CDCs) covering a total area of 227.62 ha. It is located in the Matapedia Region of the Gaspe Peninsula of Quebec in northeast Langis Township within the Regional Municipality (MRC) of Matapedia. The Property is held 100% by Canadian Metals Inc.

The Property is located in gently rolling, forested Appalachian terrain. The area experiences a cool humid continental climate with warm summers and cold snowy winters. The Property is easily road accessible via paved provincial Highway 195 and a gravel road in good condition. It is 20km by road via Highway 195 from the town of Amqui, which is on Highway 132 and is the administrative centre of the Matapedia Regional Municipality (MRM). It is also accessible via Highway 195 from Highway 132 at the port of Matane, a distance of 40km. Amqui is served by rail (CNR) and Matane is a tidewater seaport.

The nearest source of a continuous substantial flow of fresh water is a stream 1.8km ESE of the present Langis quarry. High voltage transmission lines cross the Property 300m south of the existing quarry.

The first known examination and comprehensive report on the potential economic value of the sandstones of Langis and Tessier Townships was done by R. A. Marleau for Uniquartz Inc. in 1979. In 1982 an extensive diamond drilling program was completed on the Langis and neighbouring Tessier sandstone prospects. A total of 3,993' (1,215.5m) was drilled in twenty-two drill holes, twelve of which, totalling 2,135' (649.9m), were completed on the Langis Deposit.

Subsequently extensive physical and geochemical testing was completed on the drill core in order to determine the physical and geochemical characteristics of the sandstones. This testing comprised over 10,000' of drill core in sample lengths of 10'. Additionally two bulk samples of 2.5 tonnes each were taken. A total historic tonnage of 27.6 million mt at average grades of 0.11% Fe2O3 and 0.41% Al2O3 was calculated and published. There is no mention anywhere of the SiO2 grade. In 1985 Uniquartz Inc. revised the Langis Indicated Resource tonnage and grade to 25.5 million mt at average grades of 0.12% Fe2O3 and 0.41% Al2O3 - no mention of SiO2 grade. It should be noted that the estimate was completed prior to adoption of the current standards embodied in NI 43-101 and therefore the results cannot be relied upon. The stated indicated resources are likely similar to the current standards for indicated resources. A Qualified Person has not done sufficient work to classify the historical estimate as current mineral resources or mineral reserves. The issuer is not treating the historical estimate as current mineral resources or mineral reserves as defined in sections 1.2 and 1.3 NI 43-101 and the historical estimate should not be relied upon.

There is no further reference to development or production from the Langis deposit after 1985. At some point thereafter a quarrying operation was begun. From remaining evidence it consisted of the quarrying of several hundred thousand tonnes of sandstone, plus a loading and crushing facility, and other surface installations.

1.2 GEOLOGICAL SETTING AND MINERALIZATION

The Matapedia Region forms part of the Appalachian Province which stretches from Alabama to Newfoundland. The portion of this that hosts the rocks pertinent to this Report is known as the Connecticut Valley – Gaspé Synclinorium (CVGS). These rocks were folded, faulted, intruded, and weakly metamorphosed during the Appalachian Orogeny.

The CVGS rocks of Matapedia-Gaspe subregion include the Siluro-Devonian-aged Chaleurs Group. The lower stratigraphic section of the Chaleurs Group is comprised of green shale of the Awantjish Formation overlain

by white to pink quartz arenite of the Val Brillant Formation. The quartz arenite (a siliceous sandstone) of the Val Brillant Formation is highly siliceous and occurs as thick white layers, and locally, pink to mauve layers which result from hematite discolouration.

On the Property, Val Brillant sandstone forms a prominent remnant of formerly more extensive sandstone cover. It is up to 60m in thickness and sits conformably upon green shales of the Awantjish Formation. The quarry exposes a 20 to 30m thickness of the Lower White Member of the Val Brillant sandstone. This is the siliceous sandstone targeted by CMI. In the quarry the target sandstone forms a gently south-dipping monocline. It is a highly siliceous sandstone of multi-cyclic origins and largely purged of impurities. On the Property the sandstone forms a lobe measuring approximately 1,700m long by 250 to 500m wide. Within this area the existing quarry covers an unsurveyed area of approximately 90m X 90m.

The 1982-83 work revealed the following physical characteristics for the Val Brillant Sandstone (the Sandstone):

- Quartz grains varied from 0.1mm to 0.54mm diameter;
- Uniformity coefficient is 1.72, meaning that this fine quartz is well-sorted;
- Sphericity range in the quartz grains was 0.67 to 0.80 (high);
- Roundness or angularity factor of quartz grains varied from 0.37 to 0.90;
- Point of fusion of Val Brillant Sandstone was 1,700oC;
- Thermal shock testing showed that the Sandstone was suitable for production of ferrosilicium;
- Refractoriness testing demonstrated that the Sandstone could probably be used as foundry sand.

1.3 EXPLORATION, SAMPLING AND ANALYTICAL PROCEDURE

The 2013 drilling program conducted at the Property had two initial objectives: to obtain a representative bulk sample of the sandstone for geochemical and physical characterization. Consequently, over a period of five days, a total of nine NQ-diameter diamond drill holes were drilled for a total core length of 456m. The drill pattern is designed for future calculation of a mineral resource, consisted of three sections of three holes each forming an approximately 100m square pattern

The core was logged based upon subtle stratigraphic compositional changes. Three drill holes, PL-13-01, 02 and 05, were selected as representative of the target sandstone. They were logged and sampled in 3m intervals unless

stratigraphic contacts dictated otherwise. The other six holes were logged but not sampled.

Upon completion of the drilling, it was decided by CMI to limit the 2013 work program to the Characterization Study in order to define potential end uses of the Langis sandstone before continuing further. This implied limiting the sampling to three representative drill holes and, as a result, not completing a resource calculation at this time.

From the three holes sampled, half of the core was retained and placed back in the core box, respecting the original orientation and position. The other half was split again (quartered), with one quarter bagged for geochemical assay and the other quarter bagged for physical testing. A total of 41 sample lengths totaling 105.5m of drill core were prepared. Additionally, a total of 12 Lower White Sandstone samples, including 9 from whole (unsplit) drill core, as well as 3 sawn sandstone cubes selected from the quarry, were prepared and shipped specifically for thermal shock testing. All drill core and rock samples were shipped securely to the CTMP laboratory located in Thetford Mines, Quebec.

1.4 MINERAL PROCESSING AND METALLURGICAL TESTING

A general characterization study of the Langis silica deposit was conducted with laboratory tests to provide information for its chemical, physical and thermal properties. This information can then be used to help determine which end use the silica can be suitable for.

Chemical properties of the core samples were analyzed by X-ray fluorescence (XRF) for the major oxides and trace elements.

Chemical and physical properties of silica sand below 600 microns were evaluated after undergoing desliming, attrition and magnetic separation processes.

Based on the preliminary test work by CTMP laboratory, the basic properties of the Langis sandstone indicates it has potential to be a usable source of silica. The impurities contained in the core samples are about 1% with a silica grade in the order of 98.55% SiO_2 and a loss on ignition ranging from 0.3% to 0.5%. When corrected for loss on ignition incurred during high temperature lump silica applications, the ore averages 98.95% SiO_2, with major oxide impurities in the order of 0.14% Fe_2O_3, 0.48% Al_2O_3 and 0.05% TiO_2.

Thermal shock tests on twelve representative lump samples reveal that this material has relatively strong cementation, making it a potential source for lump silica applications in high temperature furnaces.

For applications requiring silica sand grains, it was shown that a significant amount of impurities can be eliminated with the removal of fine sand below 100 microns. The residual sand may then average 99.44% SiO_2, with major oxide impurities in the order of 0.05% Fe_2O_3, 0.20% Al_2O_3 and 0.03% TiO_2.

With attrition, iron oxides and clays can be scrubbed from the surface of the sand grains thereby producing a cleaner silica sand averaging 99.56% SiO_2, with major oxide impurities in the order of 0.03% Fe_2O_3, 0.16% Al_2O_3 and 0.03% TiO_2.

High intensity magnetic separation removed a very small fraction of magnetic material with the objective of reducing the Fe_2O_3 content to below 0.03%, however the average impurities content in the sand product was left relatively unchanged.

Physical characteristics of the silica sand were evaluated with respect to particle size distribution, AFS grain fineness numbers, coefficient of uniformity, roundness, sphericity and crush resistance.

The SiO_2 content was calculated from the sum of the assayed results of ten major oxides, twenty four trace elements and loss on ignition, by the x-ray fluorescence (XRF) method. This is a typical method of analysis for a silica deposit such as Langis and was used as an indicator for the purpose of this characterization study. However, in determining such low levels of oxide impurities, this method has shown that there is an issue of accuracy which is evident in the variance of oxide impurities concentration and the margin of error as reported by CTMP from samples analyzed in triplicate.

1.5 CONCLUSIONS AND RECOMMENDATIONS

Geological mapping and historic exploration drilling have outlined a large lobe of highly siliceous Lower White Sandstone of the Val Brillant Formation on CMI's Langis Property. Historical exploration drilling and attendant historical geochemical and physical analyses indicate the potential for an economic silica sand deposit of more than 25 Mt contained within this lobe.

GENIVAR supervised a nine-hole, 456m drilling program at Langis in September 2013. Of these, three representative drill holes were sampled and analyzed at CTMP laboratory in order to characterize the silica sand for potential economic end usages. They hosted the following silica drill intersections:

- PL-13-01: 98.65% SiO_2 over 30.28m (including 98.69% SiO_2 over 28.95m)
- PL-13-02: 98.70% SiO_2 over 41.2m
- PL-13-05: 98.22% SiO_2 over 27.0m (including 99.10% SiO_2 over 22.0m)

The other six holes were logged and remain unsampled. They display similar highly siliceous intersections with similar thicknesses to the three sampled drill holes. If the six holes were sampled and analyzed using similar procedures, an inferred silica sand resource tonnage could then be calculated.

Based on the chemical, physical and thermal properties observed from the test work at CTMP, by crushing and screening to -120+20 mm lump particles, the Property may be a potential source for the production of ferrosilicon. Further crushing to -25+5 mm particles can also make it a potential source as a flux agent for base metal smelting.

Crushing to -600 microns and deslining the -100 microns fines as well as attrition, size classification, dewatering and drying can be considered to provide a potential source of glass sand, foundry sand and other uses like abrasive sand, sodium silicate, silicon carbide. Magnetic separation may be used to further reduce the iron content for some glass sand applications. Further testing to determine extent of iron impurities removal is recommended. The material was also tested for frac sand and based on an initial evaluation, the presence of many clusters as well as the issue with the grains' roundness should be considered as a stumbling block for its potential as a source of frac sand. Further tests are recommended to better evaluate this product by a specialized frac sand laboratory. Depending upon the potential user requirements for a specific silica sand product, more detailed tests would be required to determine process design criteria.

The potential quantity and grade of silica material within the Property is in the range of 15 to 28 million tonnes at 98.1% to 99.2% SiO_2 based on the assumptions of a specific gravity of 2.65, strike length range of 600 to 800 m, width of 275 to 325 m and a thickness of 30 to 40 m. It should be noted that the potential quantity and grade is conceptual in nature, that there has been insufficient exploration to define a mineral resource and that it is uncertain if further exploration will result in the target being delineated as a mineral resource.

It is the authors' opinion that additional expenditures are warranted in order to advance the project to the level of economic assessment. The recommended work program includes the following items:

- Deposit delineation to the level of an Indicated Resource, including geochemical analysis of the six remaining holes, the drilling and geochemical analysis of ten additional holes (NQ-diameter core), and permitting and cutting. This program is estimated to cost $120,000 to $140,000;

- Validation of the silica deposit for the production of ferrosilicon by testing bulk samples with potential customers. The quantities of bulk samples

would vary based on the customers' requirements. Cost of collecting such bulk samples is estimated at $50,000 to $100,000;

- Initiating an economic study for a quarrying operation. The cost of this work is estimated at $60,000.

The total cost of these recommended expenditures is between $230,000 and $300,000.

2.0 INTRODUCTION

This Technical Report entitled Characterization Study of the Langis Silica Deposit (the Deposit), was prepared for Canadian Metals Inc. (CMI), with a corporate office located at 1200 Avenue McGill College, suite 1240, Montreal, Quebec, H3B 4G7, by GENIVAR Inc. (GENIVAR), with a corporate office at 1600 Blvd. Rene Levesque West, 16th Floor, Montreal, QC H3H 1P9.

It was prepared at the request of CMI in order to characterize the Deposit in terms of possible uses and potential economic value of a silica sand end product. It describes the Langis Silica Property (Property), the geology of the Property and project area, the current exploration drilling program, the results of physical and geochemical testing, and provides conclusions and recommendations for additional work. No engineering costing or market studies are provided herein.

This report makes use of Quebec Ministry of Natural Resources (QMNR) files describing the geology of the Langis Property area, as well as “GM” files sourced from the SIGEOM database describing past recorded work on the Langis Property. It is also reliant upon physical and geochemical characterization studies of comparable silica sand projects, and the physical and geochemical results from Langis samples as supplied by the Centre de Technologie et de Plasturgie (CTMP) laboratory..

One of the authors of this report, John Charlton, P. Geo. of GENIVAR accompanied by Etienne Forbes, P. Geo. of GeoForbes Services Inc. visited the Property on August 22, 2013. During that visit they examined the existing quarry, loading and crushing foundations and other infrastructure remnants, Langis waste piles, the forested area adjacent to the quarry where drilling was anticipated, and a comparable quarry located one kilometre east of the Langis quarry.

Mr. Forbes managed the diamond drilling program described herein on behalf of GENIVAR. He was also responsible for core logging, sampling, and coordinating bush clearing and surveying operations on the site. On his second visit of September 21, 2013, Mr. Charlton visited the core logging and sampling facility used by Mr. Forbes and reviewed the drill core from the current exploration program, the sampling technique, QA/QC procedures, and sample shipping coordination with the laboratory doing the analytical work.

Mr. Mireno Dhe Paganon, P. Eng. of GENIVAR coordinated and supervised laboratory test work with the CTMP laboratory.

3.0 RELIANCE ON OTHER EXPERTS

John Charlton, P. Geo. has relied a upon information concerning mineral claims, as disclosed in Section 4.0 on the QMNR, GESTIM website. He has also relied upon Etienne Forbes, P. Geo. to manage the drilling program, complete the core logging and sampling, and ship the samples to the CTMP laboratory. Mireno Dhe Paganon, P. Eng., has relied upon laboratory geochemical and physical test results supplied by the CTMP laboratory of Thetford Mines, Quebec.

GENIVAR has reviewed and analyzed data and reports provided by CMI, together with publicly available data, and CTMP laboratory test results, drawing its own conclusions augmented by direct field examination.

This report includes technical information, which required subsequent calculations to derive subtotals, totals and weighted averages. Such calculations inherently involve a degree of rounding and consequently introduce a margin of error. Where these occur, the QPs do not consider them to be material.

GENIVAR has relied on third party information prepared by non-qualified persons relating to permitting aspects of the Property. This information has been provided by MRC of Matapedia and the MNRQ as disclosed in subsection 4.6.

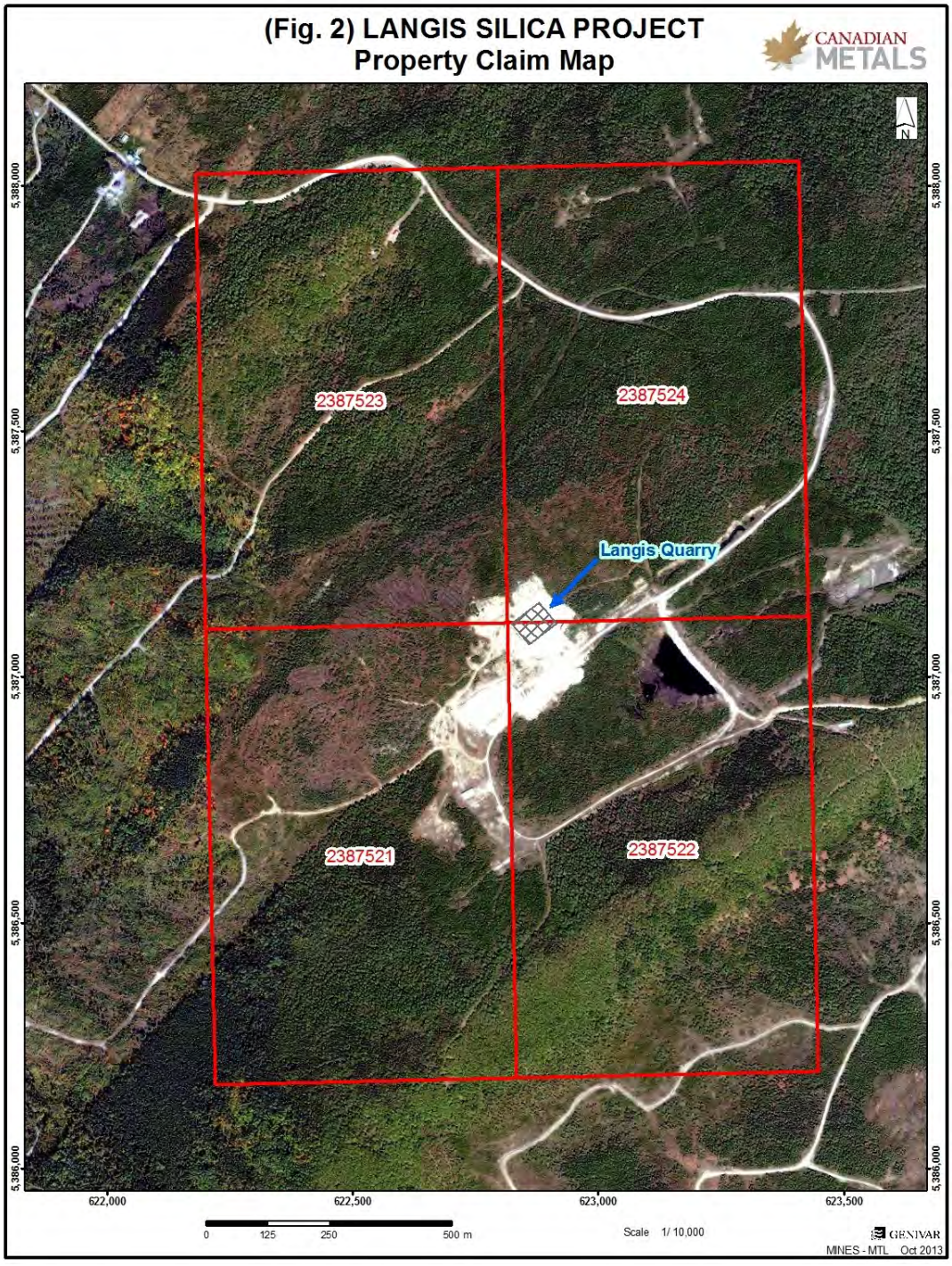
4.0 PROPERTY DESCRIPTION AND LOCATION

4.1 LOCATION

The Property consists of four map-designated claims (CDCs) covering a total area of 227.62 ha. It is located in the Matapedia Region of the Gaspe Peninsula of Quebec (Figure 1) in northeastern Langis Township within the Regional Municipality (MRC) of Matapedia (Figure 2). It is within NTS map sheet 22B11. The geographic centre of the Property is at approximately latitude 48° 37' 30" N and longitude 67° 20' 00" W. The Property covers parts of Ranges VI and VII of Langis Township.

Figure 1: General Project Location

Figure 2: Property Map



4.2 MINERAL DISPOSITIONS

Table 1: Mineral Dispositions

Claim #	Area (ha)	Acquisition Date	Expiry Date	Renewal Fee ($)
2387521	56.91	2013/07/12	2015/07/11	54.25
2387522	56.91	2013/07/12	2015/07/11	54.25
2387523	56.90	2013/07/12	2015/07/11	54.25
2387524	56.90	2013/07/12	2015/07/11	54.25

4.3 TENURE RIGHTS

The four claims comprising the Langis Property are owned 100% by 9285-3696 Quebec Inc., which is a wholly owned subsidiary of Canadian Metals Inc. All are map-designated claims with common acquisition and expiry dates (Table 1). Each requires an exploration expenditure value of minimum $1,200 in order to be renewed. Cash in lieu of work is optional. The renewal fee for each claim is $54.25.

4.4 ROYALTIES AND RELATED INFORMATION

The Property is held 100% by Canadian Metals Inc. Production from the Property is subject to a 3% net smelter return (NSR) payable to 9285-3696 Quebec Inc. It is also subject to a 7% Net Profits Interest (NPI) payable to 9285-3696 Quebec Inc.

4.5 ENVIRONMENTAL LIABILITIES

There are no known environmental liabilities currently affecting the Property.

4.6 PERMITS

All the work done this fall on the Property was performed on crown lands which are considered public and is located in an area managed by the MRC of Matapedia.

A request for a tree cutting permit was sent to the MRNQ at their Rimouski office and was forwarded by them to the MRC office located in Amqui, Quebec.

The permit was received prior to start wood cutting and drilling.

In the case that work results and economic studies would be positive, CMI could apply for an exclusive mining lease as described herein.

In the province of Quebec, companies must obtain a surface-mining lease (*bail exclusif* or BEX) before operating an industrial silica sand quarry. This lease can be obtained by presenting an application for exclusive lease for mining surface mineral substances and attaching the following items:

- A map indicating the boundaries of the land in question;
- A map at a scale no less than 1: 5,000 indicating the boundaries and the adjoining territory of 150m, including name and layout of public roads, existing and planned access roads, waterways or lakes, shaft sites and the location and nature of any construction, campsite, or recreational establishment;
- A report describing the nature, scope and value of the deposit;
- A report stipulating the intended use of the substance to be mined, the target markets, and the anticipated production rate;
- A report describing the proposed mining method; and

Payment of the rental fee, which is proportional to the duration of the lease.

4.7 OTHER RELEVANT FACTORS

GENIVAR is not aware of any other significant factors or risks affecting access, title or the right or ability to perform work on the Property.

5.0 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 SITE TOPOGRAPHY, ELEVATION AND VEGETATION

The Property is located in gently rolling Appalachian terrain. A set of elongate hills oriented NNE dominates the topography. These are transected along the northeast by the valley of the Matane River. In the Property area and immediate surroundings elevations range from a high of 279m to a low of 90m along the river. In the area of interest around the quarry there is a gentle incline from the access road at 240m up to just over 250m proceeding across the hill toward the northwest.

The Property is largely forest covered. It is a mixed forest of hardwoods such as maple, poplar, and birch mixed with conifers such as white spruce, white pine, and cedar. Locally there are areas of second or third growth dominated by alders and other low bushes.

5.2 ACCESS

The Property is easily road accessible via paved provincial Highway 195 and a gravel road in good condition. The Property is 20km by road (Highway 195) from the town of Amqui which is on Highway 132 and is the administrative centre of the Matapedia Regional Municipality (MRM). It is also accessible via Highway 195 from Highway 132 at the town of Matane, a distance of 40km. The Langis gravel access road runs southeast from Highway 195, from a point 5km to the east of the village of St. Vianney. From this intersection it is 2.5km to the existing quarry on the Langis Property.

Amqui is served by the CNR and has a train station with passenger services.

Accessibility to the Property may be hampered by winter snow accumulation, however access to the Property is available year round if required.

5.3 CLIMATE

The closest climate data collection site is the Mont Joli airport, which is located 64km straight west of the Property. Mont Joli climate is somewhat modified due

to the seashore location, the most obvious difference being stronger winds. Climate data for Mont Joli is shown below.

Table 2: Climate Data for Mont-Joli

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	13 (55)	12.4 (54.3)	20 (68)	29.1 (84.4)	31.4 (88.5)	33.3 (91.9)	35.9 (96.6)	33.3 (91.9)	32.2 (90)	26.7 (80.1)	21.8 (71.2)	16.7 (62.1)	35.9 (96.6)
Average high °C (°F)	−7.8 (18)	−6.5 (20.3)	−0.9 (30.4)	5.4 (41.7)	13.5 (56.3)	19.8 (67.6)	22.7 (72.9)	21.3 (70.3)	16 (61)	9.1 (48.4)	2.4 (36.3)	−4.6 (23.7)	7.5 (45.5)
Daily mean °C (°F)	−12.3 (9.9)	−10.9 (12.4)	−5 (23)	1.6 (34.9)	8.5 (47.3)	14.4 (57.9)	17.5 (63.5)	16.2 (61.2)	11.4 (52.5)	5.3 (41.5)	−0.7 (30.7)	−8.3 (17.1)	3.1 (37.6)
Average low °C (°F)	−16.7 (1.9)	−15.2 (4.6)	−9 (16)	−2.3 (27.9)	3.4 (38.1)	9 (48)	12.2 (54)	11.1 (52)	6.7 (44.1)	1.5 (34.7)	−3.8 (25.2)	−12 (10)	−1.3 (29.7)
Record low °C (°F)	−33.3 (−27.9)	−31.1 (−24)	−29.4 (−20.9)	−19.9 (−3.8)	−12.2 (10)	−1.1 (30)	0.8 (33.4)	1.8 (35.2)	−5 (23)	−8.4 (16.9)	−18.3 (−0.9)	−30.6 (−23.1)	−33.3 (−27.9)
Precipitation mm (inches)	79.8 (3.142)	59.1 (2.327)	69.4 (2.732)	63.3 (2.492)	84 (3.31)	73.5 (2.894)	84.6 (3.331)	89.1 (3.508)	77.8 (3.063)	83.9 (3.303)	77.7 (3.059)	86.7 (3.413)	928.9 (36.571)

Source: Environment Canada[5]

The Property experiences a cool humid continental climate with warm summers and cold winters. Average July high temperature (Mont Joli) is 22.7 °C, with an average low of 12.2 °C. Average January high temperature (Mont Joli) is -7.8 °C, with an average low of -16.7 °C. The spring-summer-fall period begins in early May and ends in the latter part of October. Winter conditions normally endure from early November through to late April. Precipitation is moderate and is fairly evenly distributed throughout the year. Snowfall accumulations of up to 3m are common by mid-March.

5.4 INFRASTRUCTURE

The Property is 20km by paved road from Amqui. CN Rail passes through Amqui connecting it to the ports of Rimouski and Campbellton, New Brunswick. A rail siding would need to be permitted and built at Amqui in order to ship silica product by rail.

The Property is 40km by paved road from the port of Matane. Matane is presently considered to be the most likely trans-shipment point for the potential silica product. These transportation alternatives will require researching in the

next phase of work. The road into the existing quarry area from the paved highway appears to be in good condition and possibly capable of handling heavy truck traffic, although upgrading may be required.

The town of Amqui has a population of approximately 6,300, while the town of Matane has a population of approximately 14,500. There are several smaller villages in the area of the Property such as St. Vianney, St. Tharcisius, Saint-Rene-de-Matane, Lac au Saumon and Val Brillant. There is an adequate skill set locally available for the operation of a silica quarry.

The nearest source of a continuous substantial flow of fresh water is a stream called Riviere Tamagodi 1.8 km to the east-southeast of the present Langis quarry. This stream flows northeastward into the Matane River. The Matane River flows northward into the St. Lawrence estuary.

High voltage transmission lines cross the Property 300m south of the existing quarry. A transformer substation is already installed 400m southwest of the existing quarry.

At the southwest corner of the existing quarry, foundations for a loading and crushing facility, installed by an earlier operator, appear to be in good condition. Also about 400m southwest of the existing quarry there is a 25m X 12m finished concrete floor which could be suitable for erection of a new building. There is adequate flat area for storage of waste rock from a quarrying operation.

6.0 HISTORY

Geological mapping and exploration of the Langis area of the Matapedia Region began with the investigations of Logan in 1844 and his assistant Murray in 1846. A. P. Low visited the area in 1884, followed by Ells in 1885, and by L. W. Bailey and W. McInnes in 1884-85, the latter work resulting in the first geological map of the region (1888). Later, during the period 1928-31 F. J Alcock and G. W. Crickney surveyed the area as part of a larger regional mapping effort. Following up on that work, J. W. Laverdière and L. G. Morin concentrated specifically on the Langis area. A general geological map of the Matapedia-Matane region was completed by E. Aubert de la Rue in 1941 (RG 009). Still later, H. W. McGerrigle completed geological work in the area as part of his compilation of the Geological Map of the Gaspé Peninsula (1953).

Mapping the Region Rimouski-Matapedia, J. Beland touched on the area in 1960 (RP 430). Subsequently detailed geological mapping of the Cuoq-Langis Area of Matane and Matapedia Counties was completed by N. C. Ollerenshaw in 1961 and 1967 (RG121). This is the most comprehensive geological mapping of the Property area. Synthesis of the area into Gaspe regional geology was completed by Slivitsky et al (1991). Stratigraphy was reinterpreted and integrated into the Appalachian geology by Brisebois and Morin (2003).

The first known examination and comprehensive report on the sandstones of Langis and Tessier Townships was done by R. A. Marleau (1979) for Uniquartz Inc. (GM 36008). This work on the Val Brillant Sandstone was entitled a “Comparative study in regard to other commercial silica/sands of northeastern America”.

During the summer/autumn of 1982 an extensive diamond drilling program was completed on Langis and neighbouring Tessier sandstone occurrences. A total of 3,993’ (1,215.5 m) was drilled in twenty-two drill holes, twelve of which, totalling 2,135’ (649.9 m), were completed on the Langis deposit. The drilling was supervised by R. A. Marleau of Services Geotechniques Shickshocks Inc (SGS) for Uniquartz Inc. (GM 36008).

Subsequently extensive physical and geochemical testing was completed on the drill core in order to determine the physical and geochemical characteristics of the sandstones of the Langis and Tessier deposits. This testing comprised over 10,000’ of drill core in sample lengths of 10’. Additionally two (2) bulk samples were taken, each weighing more than 2.5 tonnes. A total historic tonnage of 27.6 million mt at average grades of 0.11% Fe_2O_3 and 0.41% Al_2O_3 was calculated

and published. Oddly, there is no mention anywhere of the SiO_2 grade. This was classified as an Indicated Reserve. *This resource is historic in nature and does not meet the requirements for Resource categorization as set out in NI 43-101.*

In 1985, Pierre Labrecque working for Uniquartz Inc. (GM 42388), revised the Langis Indicated Resource tonnage and grade to 25.5 million mt at average grades of 0.12% Fe_2O_3 and 0.41% Al_2O_3. *This resource is historic in nature and does not meet the requirements for Resource categorization as set out in NI 43-101.* Again, there is no mention of SiO_2 grade.

There is no further reference to development or production from the Langis deposit after 1985. At some point thereafter a quarrying operation was begun. From remaining evidence it consisted of the quarrying of several hundred thousand tonnes (no volume estimate is made here) of sandstone, a loading and crushing facility, and other surface installations. Several elongate piles of crushed waste rock remain to the west of the quarry.

7.0 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGY

The Matapedia Region forms part of the Appalachian geological Province which stretches from Alabama, in the southeast USA, to Newfoundland. The portion of this Province that hosts the rocks pertinent to this Report is known as the Connecticut Valley – Gaspe Synclinorium (CVGS). These rocks were folded, faulted, intruded, and weakly metamorphosed during what is generally known as the Appalachian Orogeny. In Matapedia the Appalachian Orogeny is comprised of three main orogenic episodes:

1) The Taconic Orogeny in late Ordovician time, when a volcanic island arc collided with the pre-existing Laurentia landmass as the Iapetus Ocean closed;

2) The Acadian Orogeny of mid-Devonian time, whence the micro-continents Avalonia and Baltica abutted the accreted margins of the Laurentian continental mass;

3) The Alleghenian Orogeny in the Permo-Carboniferous, when the continent of Gondwana accreted onto and joined with Laurentia to form Pangea.

The latter phase is of minor importance in Matapedia and Gaspe. However, a fourth phase, known as the Salinian (Silurian in age) is interpreted to have been a significant tectonic event in this region.

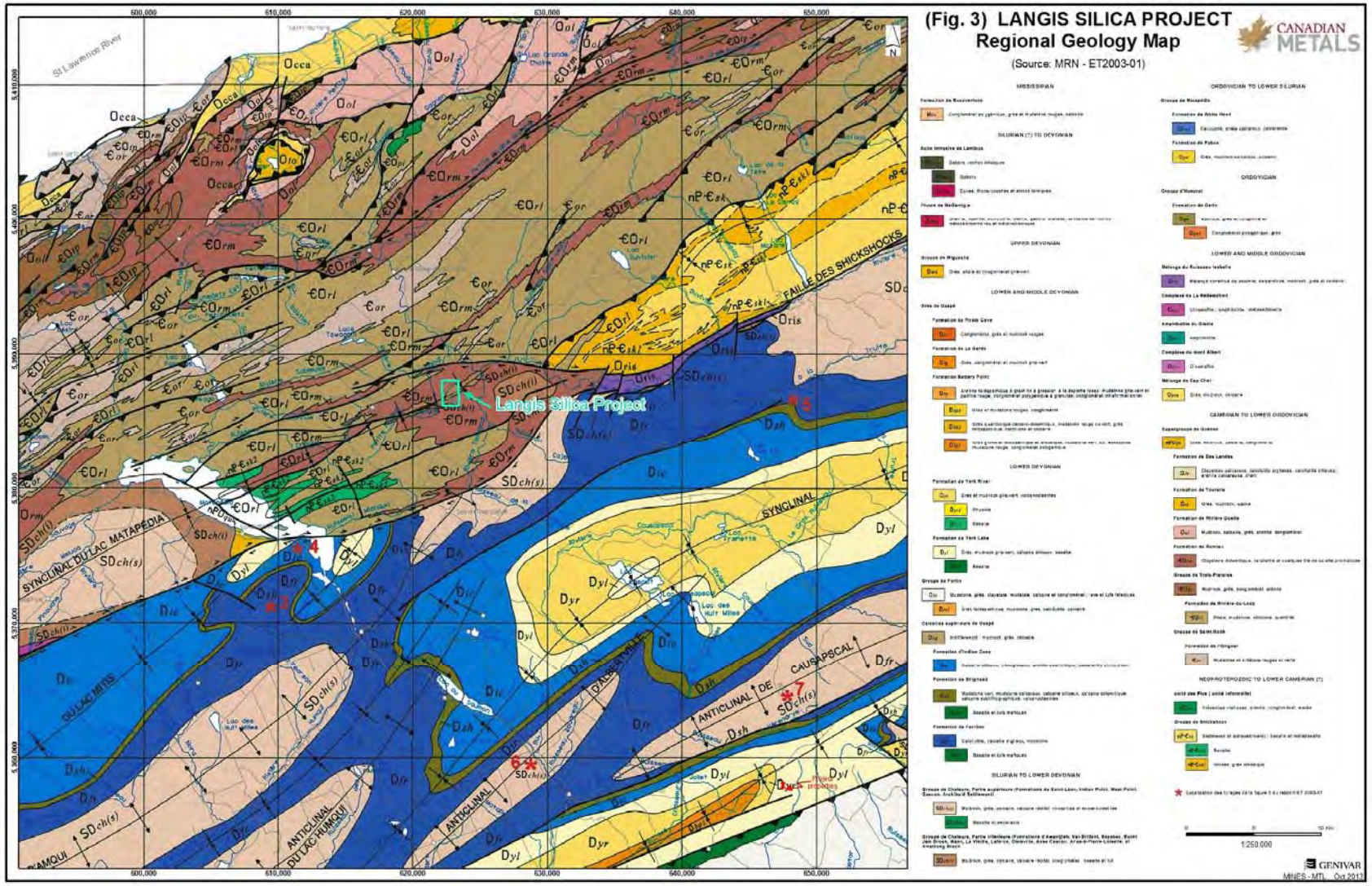
The CVGS rocks of Matapedia-Gaspe are of Ordovician-Siluro-Devonian ages. They are comprised of wacke and conglomerates of the Cabano Group (Ordovician to Silurian in age), overlain by the Siluro-Devonian rocks of the Chaleurs Group, which are overlain concordantly to locally discordantly by Devonian limestone and sandstone of the Gaspe Group. The north contact of the CVGS is a discordant, tectonic contact with Cambro-Ordovician rocks to the north.

The stratigraphy of the Chaleurs Group is, from bottom to top, the green shale of the Awantjish Formation, the white to pink quartz arenite of the Val Brillant Formation, the limestone of the Sayabec Formation, and the mudstone and siltstone of the Saint-Leon Formation.

The quartz arenite of the Val Brillant Formation is highly siliceous. It appears as thick (up to several metres) white layers, and locally, pink to mauve layers which result from hematite discolouration. The grains are medium-fine, well-rounded, and welded together with silica cement (GM 57849). Total thickness is usually 40 to 60 m. It is the target siliceous sandstone at the Langis Project and surrounding area.

The Val Brillant Formation forms two distinct north and south arms. The north arm extends 97 km from Mont Comi, just south of Mont Joli, to Lac Matane. It is affected by thrust faulting and lateral faulting. The south arm is exposed along a 40 km strike length from Esprit-Saint and Grand Lac Neigette. NE-SW oriented synclines and anticlines characterise this area.

Figure 3: Regional Geology



7.2 PROJECT GEOLOGY

The Siluro-Devonian Val Brillant sandstone forms a prominent remnant of a formerly more extensive sandstone cover. It averages approximately 60m in thickness and sits conformably upon green shales of the Awantjish Formation, which sits unconformably upon dolomitic claystone and calcilutite of the Ordovician Romieu Formation. The Val Brillant sandstone is conformably overlain by a 10m thick layer of arenaceous dolomite which transitions into true dolomite at the top. These formations are interpreted to form the core of a shallow syncline that extends southeast to Lac Matapedia and is truncated to the northeast by the Shickshock Fault at the Matane River (ET 2003-01).

Evidence of a syncline is not obvious in the walls of the Langis Quarry. The quarry exposes a 20 to 30m thickness of Val Brillant sandstone, the silica sand source targeted by the Langis Project. In the quarry the Val Brillant sandstone forms a gently (-5^{o} to -10^{o}) south-dipping monocline.

During the author's (J. D. Charlton, P. Geo.) visit the following geologic features were noted at Langis:

- In the quarry an unbroken succession of uniform thick pink-beige sandstone strata of up to 2m thickness, separated by thin purple-stained hematite interfaces;
- In the quarry a 1.5m thick section of thinner sandstone layers with more obvious red to purple hematite staining, as illustrated below;
- An extensive "hump" of unblasted, non-sandstone rock in the centre of the quarry;
- In the quarry sub-vertical faults cutting the sandstone strata as in photo below; faults are oriented north-south and NE-SW, the latter exhibiting near-horizontal slickensides (strike-slip faults).
- In the forested area to the east of the quarry, thin to no overburden cover with frequent outcrops of sandstone and arenaceous dolomite.

Figure 4: NE Corner of Langis Quarry Showing Vertical Fault With Slickensides on East Wall

The Val Brillant sandstone in the Langis-Tessier area is comprised of an Upper Sandstone, an Intermediate Sandstone, a Red Layered Sandstone (noted only in the Tessier area), and a Lower Sandstone.

Upper Sandstone: is pale greyish-white with local pink patches. It is fine grained and formed of thin beds (maximum 0.6m) that are characterized by laminae and cross-bedding. The grey colour signifies a higher clay content that that of the Intermediate Sandstone. It is 10 – 15m thick.

Intermediate Sandstone: is a 12 – 20m thick unit that is locally absent in the Langis area. It is composed entirely of quartz grains with sparse hematite held together by silica cement. It is medium-grained, with well-rounded to sub-rounded grains and has a white sugary appearance. Finer grained layers are interstratified. Individual beds are up to 2m in thickness. Sporadic pink colouration is not necessarily indicative of an abundance of iron, but is normally caused by occurrences of particles of hematite. Bedding planes and fractures are commonly marked by paper-thin layers of hematite originating from circulation of subterranean water.

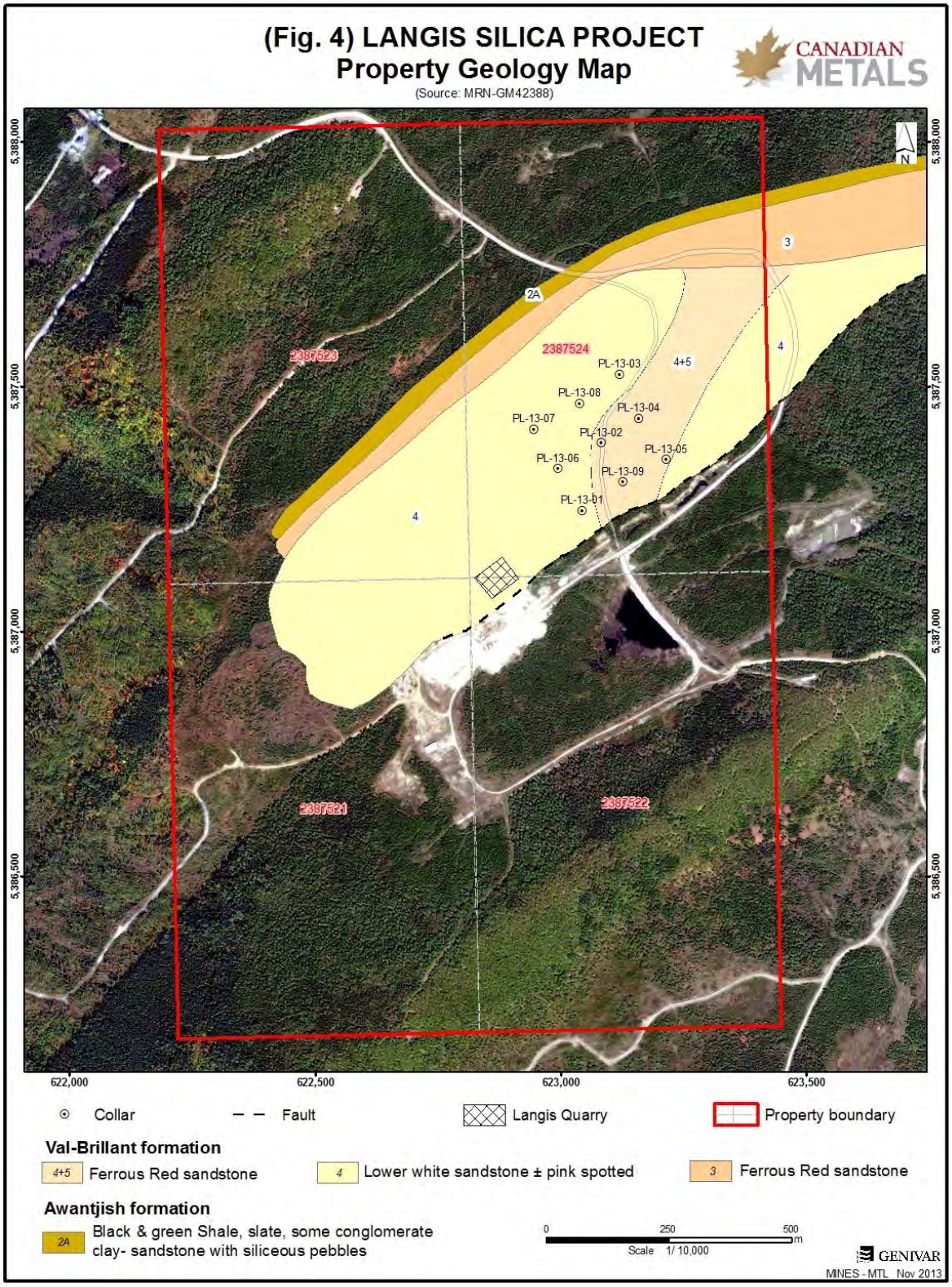
Figure 5: Thin Iron-Enriched Beds Within Lower White Sandstone

Lower White Sandstone: is 13–20m in thickness. It is generally fine-grained and exhibits less pink discolouration than the Intermediate Sandstone. In the Langis area, the Lower Sandstone is up to 60m in thickness where it abuts the east-west fault along the southern sandstone limit. It is comprised of sandstone beds from a few centimetres up to 0.5m in thickness (Figure 4 and Figure 5). It is more compacted than the Upper and Intermediate Sandstones.

The Val Brillant Sandstone is of multi-cyclic origins, having been derived from older sandstones situated to the north. It formed in a marine, well-oxygenated environment along an active but stable Silurian seashore.

At the Property the target sandstone covers an oblong surface area measuring approximately 1,700m long by 250 to 500m wide on the Property. Within this area the existing quarry covers an area of approximately 90m X 90m (Figure 6). The south contact of the sandstone oblong is truncated by a fault (RG 121). As shown in the upper photo on previous page, the sandstone exposed in the northeast corner of the quarry reaches about 25m in thickness. On the west side of the quarry the exposed sandstone is about 10m in thickness.

Figure 6: Property Geology



7.3 MINERALIZATION

The Val Brillant Sandstone is on average composed of 92% quartz grains, 6-7% silica cement (+ minor alumina and hematite cement),

In *1982-83* extensive physical and geochemical testing was completed on the drill core in order to determine the physical and geochemical characteristics of the sandstones of the Langis and Tessier deposits. This testing comprised over 10,000' of drill core in sample lengths of 10'. Additionally two (2) bulk samples were taken, each weighing more than 2.5 tonnes.

The 1982-83 work revealed the following physical characteristics for the Val Brillant Sandstone in the vicinity of the Langis and Tessier deposits:

- Quartz grains from Langis and Tessier vary from 0.1 mm to 0.54 mm diameter
- Uniformity coefficient at Langis and Tessier is 1.72, meaning that this fine sand is well-sorted
- Sphericity range in Val Brillant Sandstone (not from Langis or Tessier) is 0.67 to 0.80, which is high
- Roundness or angularity factor (again from Val Brillant Sandstone outside of Langis and Tessier area) varies from 0.37 to 0.90
- Point of fusion of Val Brillant Sandstone is 1,700^{o}C
- Thermal shock testing showed that the Val Brillant Sandstone is suitable for production of ferrosilicium
- Refractoriness testing demonstrated inconclusively that the Val Brillant Sandstone could be used as foundry sand.

It was concluded from this work that the sandstone could be easily purified and that the treated sand could then be utilized as foundry sand or for the manufacture of coloured, or with reduction in iron content, transparent, glass. Because of high resistance to thermal shock, it was suggested that it was also useable for the manufacture of ferrosilicium.

8.0 DEPOSIT TYPES

The following description of silica-rich rocks is sourced from the British Columbia Mineral Deposit Profiles.

Silica-rich Rocks, R07

by Z.D. Hora, Retired, British Columbia Geological Survey, Victoria, B.C., Canada

IDENTIFICATION

SYNONYMS: High silica quartzite, quartz sandstone, silica rock silicastone.

COMMODITIES: Silica sand, lump silica.

EXAMPLES (British Columbia (MINFILE #) - Canada/International): Golden (082N001), (082N043), Longworth (093H038), Bridesville (082ESW144) – Selkirk, Manitoba, Badgley Island, Ontario, St. Canut, Quebec; Oriskany sandstone, Pennsylvania and West Virginia, St.Peter sandstone, Illinois and Missouri.

GEOLOGICAL CHARACTERISTICS

CAPSULE DESCRIPTION: Uniform, massive beds of siliceous sediments, such as sandstone and chert, or their metamorphic equivalents, like quartzite. These beds are commonly formed in sedimentary sequences, although some cherts can be found with volcanic rocks. They have high silica contents with very limited impurities, usually under 1%.

TECTONIC SETTINGS: Siliceous sediments formed on a shallow continental shelf or deposited in inland seas, large lacustrine basins or rift zones on the continent. Cherts form in oceanic environments associated with island arcs and spreading centers. Quartzites found in orogenic belts of all ages.

DEPOSITIONAL ENVIRONMENT/GEOLOGICAL SETTING: Siliceous sediments deposited into a low energy environment slowly sinking or stagnant sedimentary basin. Source area has to be rich in siliceous sedimentary, igneous or metamorphic rocks to provide a steady supply of well sorted and weathered clastic material to estuaries along the shoreline. Weathering conditions before and during transportation should be able to separate resistant quartz from less stable feldspars, hornblende and pyroxenes, transporation will separate the clay

minerals and mica with heavy minerals from the silica particles. Cherts form in oceanic environments near and distal to spreading centres and rift zones and along volcanic belts as exhalative deposits. They can also form as biogenic and/or chemical precipitates of selica gel in an oceanic environment.

AGE OF MINERALIZATION: Precambrian to Tertiary. modern protolithic facies on the seafloor.

HOST/ASSOCIATED ROCK TYPES: Siliceous sediments are found with a wide spectrum of clastic and carbonate rocks, including coal and associated with clay deposits. Cherts are found with felsic to mafic and ultramafic volcanics and associated greywacke and shale. Quartzites and metamorphic cherts are found with the metamorphic equivalents of the rocks listed previously.

DEPOSIT FORM: The siliceous sediments occur as metres thick beds that can extend more than tens of kilometres, while the chert beds may be up to several tens of metres thick and laterally extend for hundreds of metres but are frequently discontinuous.

TEXTURE/STRUCTURE: Silica-rich sediments typically have uniform grain size, may be well lithified or friable, and can be layered, cross bedded or massive beds. Massive or rhythmically bedded chert is found sometimes with argillaceous interbeds and soft sediment deformation features. Quartzites as metamorphosed equivalents of sandstones or cherts usually display the structure of the original rock.

ORE MINERALOGY [Principal and subordinate]: Quartz; chert can also have other forms of amorphous and microcrystalline silica.

GANGUE MINERALOGY [Principal and subordinate]: Siliceous sediments can contain clay minerals, pyrite, mica and minor heavy minerals (rutile, sphene, ilmenite, zircon, etc.). Cherts can contain clay minerals, hematite, manganese oxides, pyrite; rhodonite, rhodochrosite, calcite, barite.

ALTERNATE MINERALOGY: Fractures can have secondary Fe - Mn hydroxides and/or calcium carbonate.

WEATHERING: Usually weather resistant, resulting in morphological highs. Only some friable sandstones result in depressions.

ORE CONTROLS: Source terrains that minimize impurities and despositional environments that includes long or repeated transportation with intensive wear of particles which includes separation from other silicates like feldspars for example. This may occur both by physical as well as chemical weathering.

GENETIC MODELS: Siliceous sediments form on the shallow continental shelf and in inland seas or large lacustrine basins with a relatively low energy environment and a steady supply of well sorted silica sand. After the deposition, the accumulated sediment will be cemented by compaction, a minor clay component, or introduced secondary silica. Cherts form in deep water oceanic environment with hydrothermal activity and abundance of radiolarians suggest oceanic upwelling that enriches water in nutrients., or recrystallized under metamorphic conditions.

ASSOCIATED DEPOSIT TYPES: Siliceous sediments - building stone; cherts - Sedex and VMS deposits, marine diatomite.

COMMENTS: Crystalline silica in dust form is considered a carcinogenic health hazard. Mineral processing of alaskite feldspar rocks can produce a very high purity (10 to 200 ppm impurities) silica co-product.

EXPLORATION GUIDES

GEOCHEMICAL SIGNATURE: In general more than 98% silica with traces of other elements.

GEOPHYSICAL SIGNATURE: Only where contrast with host rocks is significant.

OTHER EXPLORATION GUIDES: Look for resistant ridges and outcrops and absence of impurities in hand sample visible to the naked eye.

ECONOMIC FACTORS

TYPICAL GRADE AND TONNAGE: Each use has its very specific requirement for the particle size and shape, physical strength and permissible amounts of different impurities. For lump silica the concerns are purity, sizing of crushed rock (fracture and bedding density) and contamination by Ca, Fe, Mn, Ti, Al, Na and K minerals or graphite and silica sand they are friability and size of silica particles and contamination by Fe, Mn and Al minerals and refractory minerals of Al, Zr, Cr. Generally silica contents have to be 98% with significant impurities removable by processing. Which depend on the end use. Even high purity orthoquartzite usually contains minute titanium minerals which are detrimental for silicon metal (even at 0.2% TiO2). Also, even trace of Ca can make silica unacceptable for specific end uses. Lasca grade silica may contain impurities in ppm only. Such contaminants may be absent in oceanic cherts. Individual deposits range from 1 million tonnes to 100 million tonnes.

ECONOMIC LIMITATIONS: While some very specific silica raw materials may be relatively expensive, the basic types of silica sand or lump silica are low priced, bulk commodities sensitive to transportation costs. For its main uses, silica sand from sandstones has a number of substitutes and their use depends on local or

regional availability. Silica is available as a co-product or by-product of feldspar and residual kaolin mining and is produced locally from dune and beach sands. Foundry sand can be substituted by some other minerals, like olivine, for example.

END USES: Most silica is used in the form of sand to manufacture glass products and as foundry sand. In North America, about one third is used in glass and one-fifth as foundry sand. The remaining silica is divided among a multitude of metallurgical and chemical uses, including cement, ceramics, fillers and blasting sand. Very high quality silica is being used for a long list of synthetic silicas and silicon chemicals, silicon metal, ferrosilicon and silicon carbide, cultured silica crystals and silica glass. Silica sand for hydraulic fracturing has to be well rounded and to withstand very high pressures when pumped into oil and gas wells to enhance the recovery. The past widespread use of fine grained silica rocks was to make acid refractory bricks (dinas) used in iron metallurgy. These silica rocks were termed “dinas rock”.

IMPORTANCE: In the year 2000 Canadian production was 2.0 million tonnes and the United States produced 28.5 million tones annually. Cement, glass and ceramics are unthinkable without silica, so is the use as a foundry sand. Most of other applications are less visible, but equally important for industrial societies.

9.0 EXPLORATION

Exploration at the Property mainly consisted in the diamond drilling described in Item 10.0 Drilling.

In addition, to complete the metallurgical testing, nine whole core samples and three block samples collected from the wall of the quarry, were provided for the thermal shock testing. The three block samples for thermal shock tests were located some 180m south-southwest from diamond drill hole PL-13-01. A handheld GPS with ±5 m accuracy was used to locate the samples.

Etienne Forbes P. Geo visually selected samples in the quarry based on specific parameters from the *Centre de Technologie Minérale et de Plasturgie inc.* (CTMP). Among the parameters considered during sampling were: size, form, cleanliness, and fracturing. The preparation of the samples was conducted at the core logging facility (core shack) of GeoForbes Services located in Lac-au-Saumon, Quebec.

Table 3: Locations of Thermal Shock Test Samples

Sample #	UTM Nad 83, zone 19U		Description
	Easting	Northing	
P175879	622923	5387146	White sandstone
P175880	622903	5387133	White sandstone
P175882	622879	5387147	Pinkish-white sandstone

Results of these tests are discussed in detail in Item 13 Mineral Processing and Metallurgical Testing.

10.0 DRILLING

10.1 DRILLING PROGRAM

The 2013 drilling program conducted on the Property had one principal objective, that is to obtain a representative bulk sample of quartzitic sandstone for petrological and metallurgical characterizations.

Les Forages Dibar Inc./André Roy from Ste-Anne-des-Monts, Quebec was commissioned to complete nine NQ diamond drill holes. This program was performed from September 16 to 20, 2013.

Drilling sites were first located with a handheld GPS with ± 5m accuracy. A total of nine diamond drill holes were drilled for 456 linear meters. Drill pattern consisted of three sections with three holes per section. Lines and holes spacing were approximately 100m. The area tested consisted in a square of 200 x 200m or four hectares (Figure 7).

All holes were drilled vertically allowing intersection of the geological units at a high angle, thus obtaining sample length very close or equal to true thickness.

Figures Figure 8 to Figure 10 are generalized geological cross-sections.

Figure 7: Drill Hole Location Map

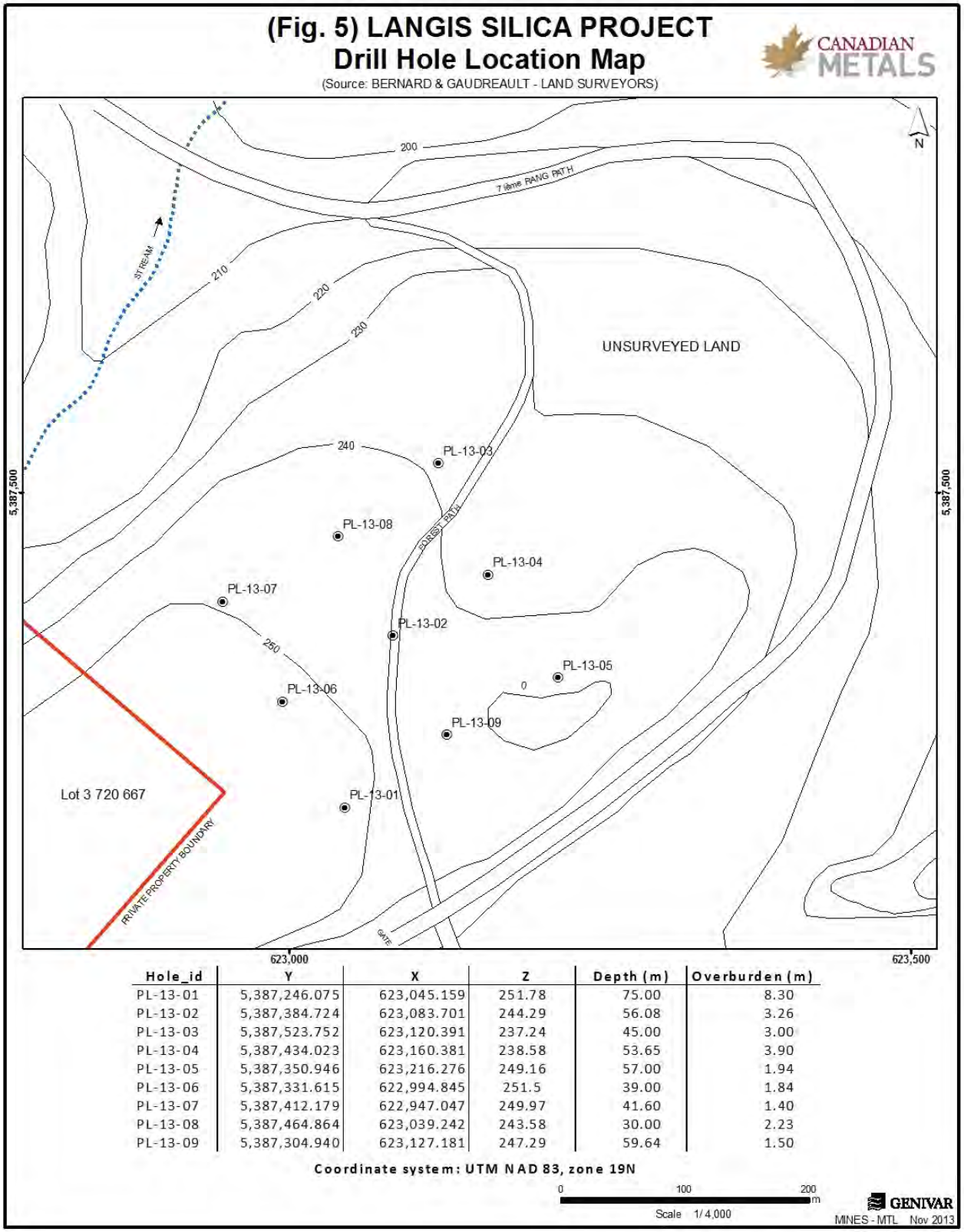


Figure 8: Drill Hole Geological Cross-Section

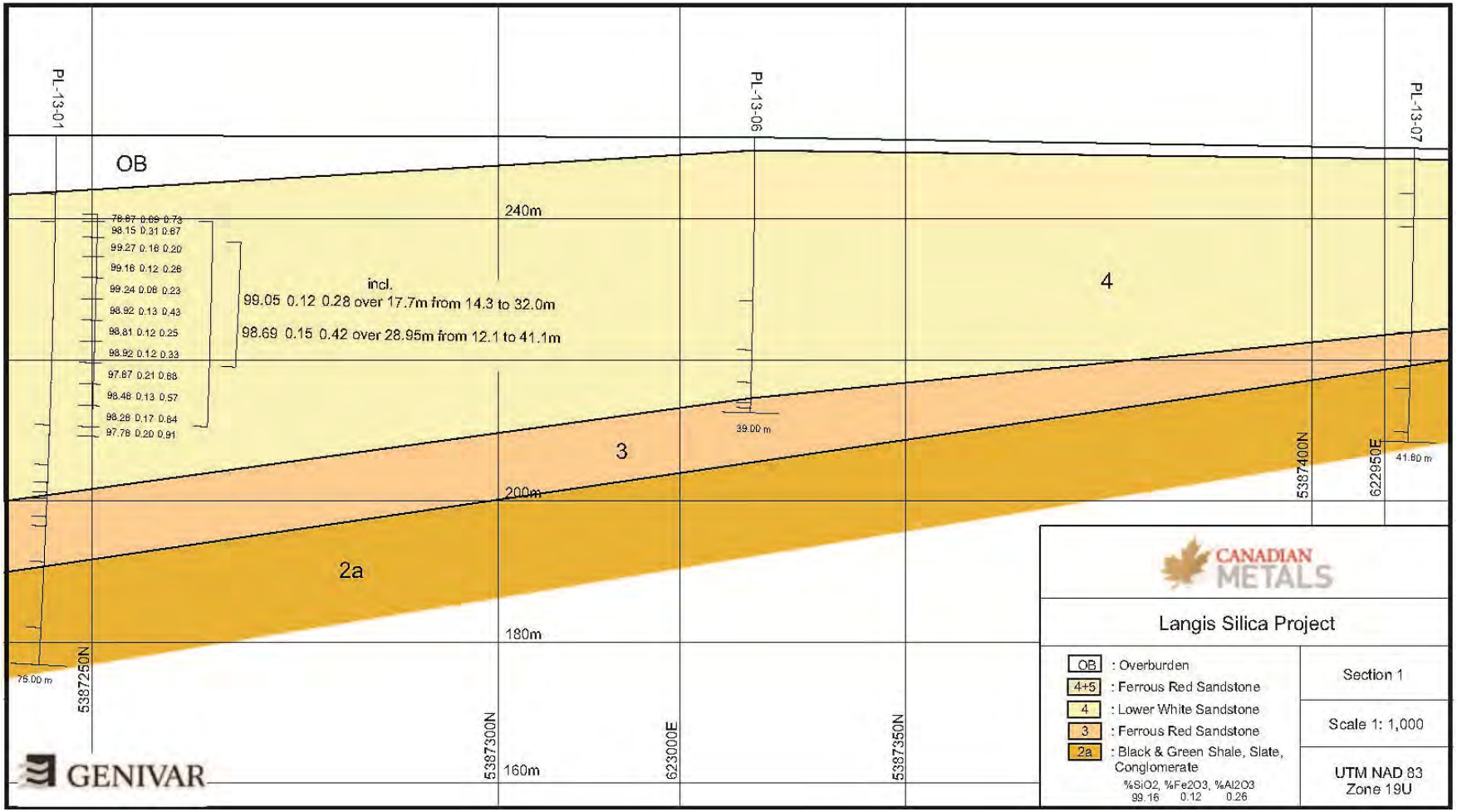


Figure 9: Drill Hole Geological Cross-Section

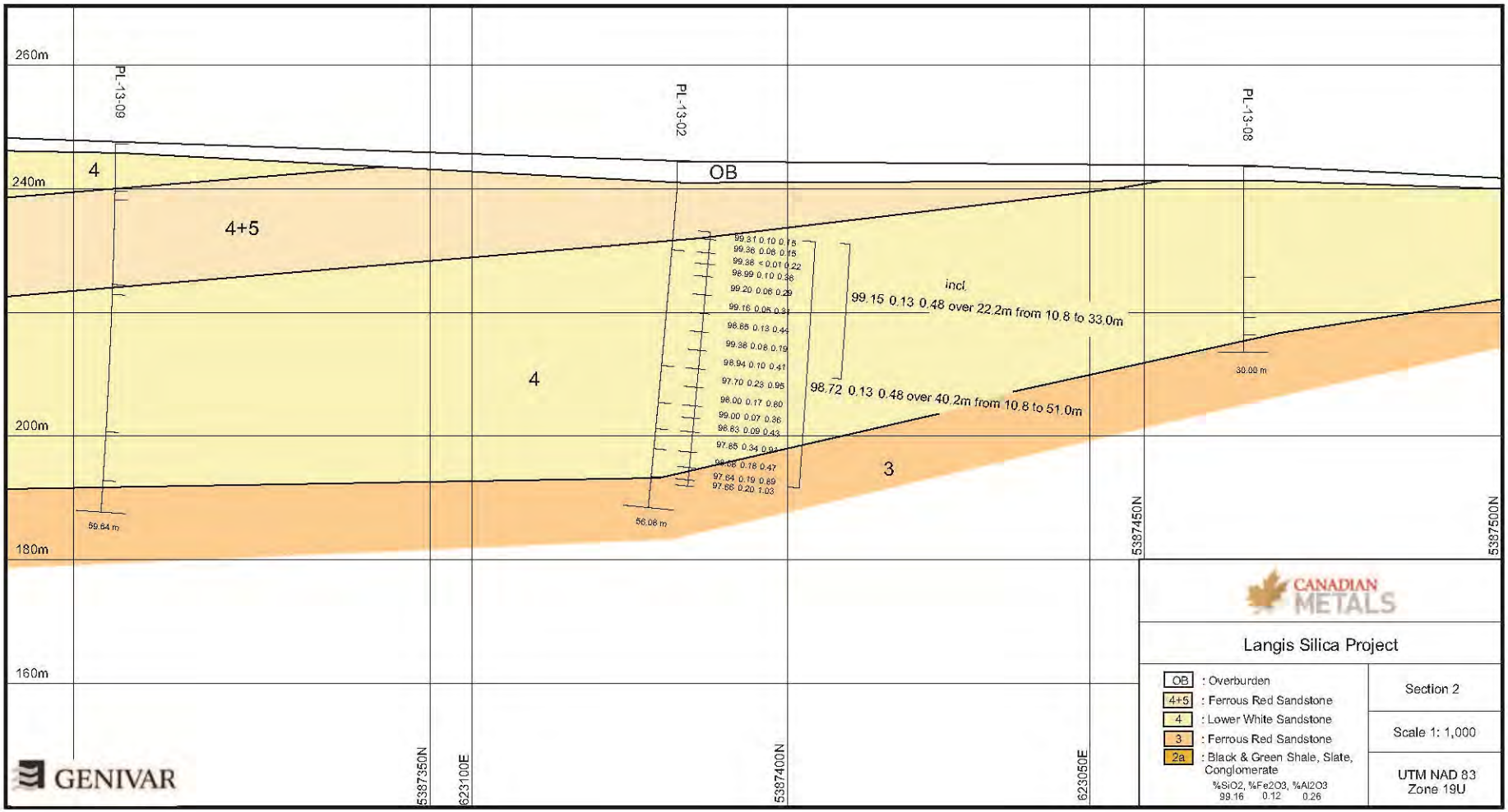
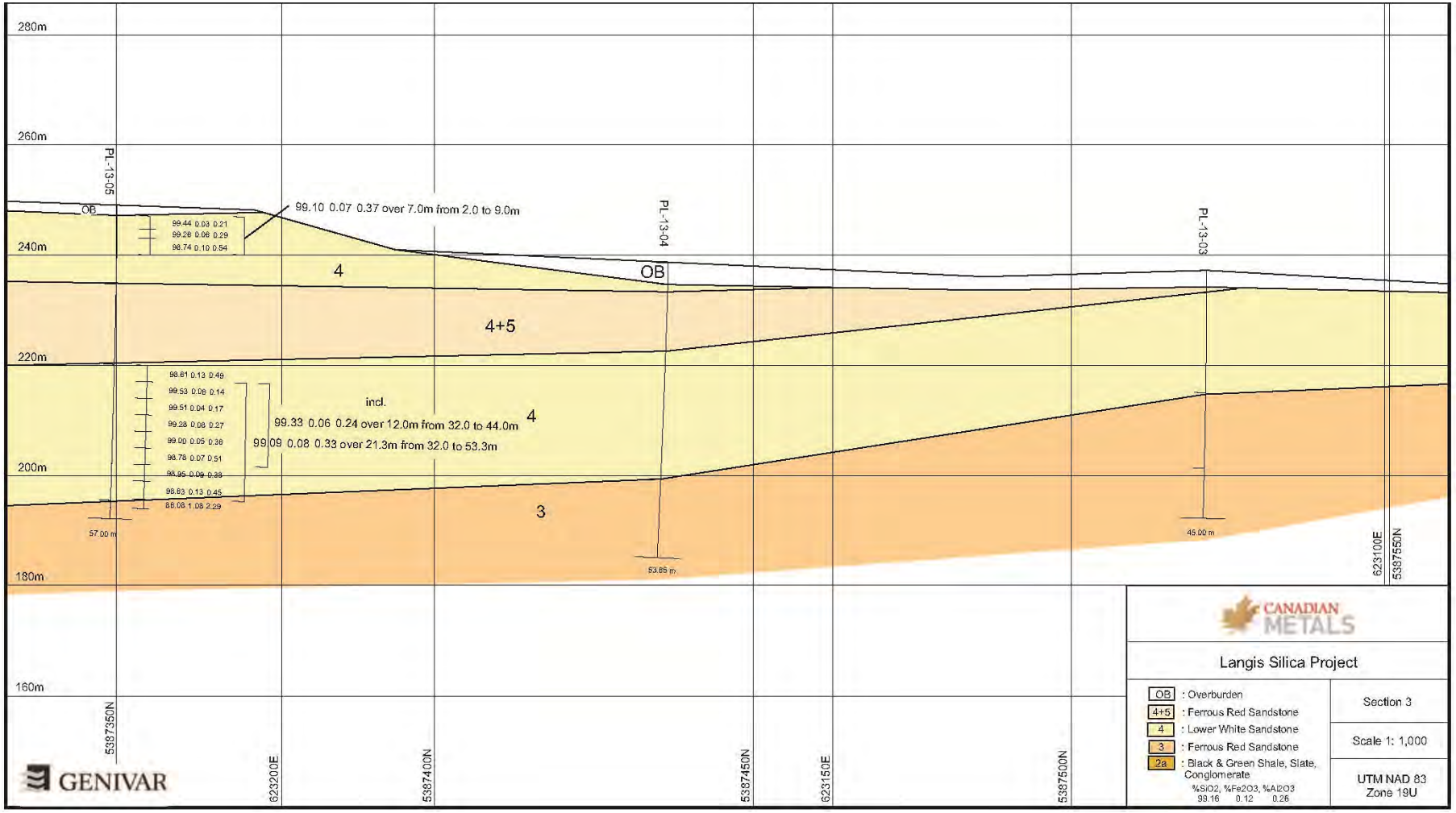


Figure 10: Drill Hole Geological Cross Section



10.1.1 SURVEYING

COLLAR SURVEY

Bernard & Gaudreault, Arpenteurs-Géomètres Inc. which have their office in Amqui, Quebec, were commissioned for surveying diamond drill hole collars. Surveying was conducted on October 16th, 2013 using a Trimble R8 Mobile RTK GPS and a second Trimble R8 model 3 GPS at the base station located on a known reference station (geodesic station # 78KS131). The level of accuracy of the method is in the millimeter range for X and Y axis and in the centimeter range for the elevation (Z axis).

DOWNHOLE SURVEY

All holes were surveyed for inclination and bearing using a Flexit downhole survey tool with two measurements, one at the beginning and one at the end of each hole. Survey data was entered in the core logging database.

Table 4: Drill Hole Information

Hole #	UTM Nad 83 Coordinate			Alt.	Dip	Total hole length in meter			Total length of QZ sandstone in meter		
	Zone	Easting	Northing	m	°	From	To	Length	From	To	Length
PL-13-01	19U	623045	5387246	251.8	-90	0.0	75.0	75.0	12.2	41.0	28.8
									46.6	49.2	2.6
PL-13-02	19U	623084	5387385	244.3	-90	0.0	56.1	56.1	3.3	33.0	29.7
									39.0	43.3	4.3
									46.5	51.0	4.5
PL-13-03	19U	623120	5387524	237.2	-90	0.0	45.0	45.0	3.0	22.2	19.2
PL-13-04	19U	623160	5387434	238.6	-90	0.0	53.7	53.7	16.0	46.0	30.0
PL-13-05	19U	623216	5387351	249.2	-90	0.0	57.0	57.0	1.9	14.4	12.5
									29.0	53.6	24.6
PL-13-06	19U	622995	5387332	251.5	-90	0.0	39.0	39.0	1.8	23.1	21.3
									30.1	34.7	4.6
PL-13-07	19U	622947	5387412	250.0	-90	0.0	41.6	41.6	1.4	6.4	5.0
									11.2	26.1	14.9
PL-13-08	19U	623039	5387465	243.6	-90	0.0	30.0	30.0	2.2	27.2	25.0
PL-13-09	19U	623127	5387305	247.3	-90	0.0	59.6	59.6	1.5	7.7	6.2
									9.1	22.8	13.7
									24.4	46.6	22.2

10.1.2 SUMMARY OF DRILLING RESULTS

The center of the drilled area was physically located some 350m north-east of the former St-Vianney (now Langis) silica quarry on the top of the small hill. This area was mapped as white ± spotty quartz sandstone (unit 5) and red ferrous sandstone (Unit 4+5) of the Val Brillant formation. This was also confirmed by authors during a site visit prior the program started.

Holes PL-13-01 to 09 intercepted a gently dipping white ± spotty quartz sandstone beds of several meters and up to 30-40 m in thickness. Table 5 below summarizes the %SiO2-%Fe_2O_3-%Al_2O_3 composite grades calculated from the CTMP whole rock analysis.

Table 5: %SiO2 %Fe2O3 %Al2O3 Composit Grades of DDHS PL 13 01, 02 and 05

Hole #	From	To	Length	SiO_2	Fe_2O_3	Al_2O_3
	m	m	m	%	%	%
PL-13-01	12.10	41.05	28.95	98.69	0.15	0.42
incl.	14.30	32.00	17.70	99.05	0.12	0.28
incl.	14.30	23.00	8.70	99.22	0.11	0.23
PL-13-02	10.80	51.00	40.20	98.72	0.13	0.48
incl.	10.80	33.00	22.20	99.15	0.08	0.29
PL-13-05	2.00	9.00	7.00	99.10	0.07	0.37
	32.00	53.30	21.30	99.09	0.08	0.32
incl.	32.00	44.00	12.00	99.33	0.06	0.24

10.1.3 CORE LOGGING PROCEDURE

All core logging was conducted by Etienne Forbes, P. Geo. at the Lac-au-Saumon core logging facility following procedures further described herein.

At reception, all core boxes were opened and placed in order on the logging table. All meterage wood blocks were verified to control core box numbers and any possible mistakes done during drilling procedures.

Then, start and end intervals of core inside each core box were measured and recorded on a Microsoft Excel® sheet for future reference. All core boxes were tagged with an aluminium tape marked with the hole and box numbers with start and end intervals.

The recovery and Rock Quality Designation (RQD) were measured. This was followed with geoscientist photographing the core boxes and describing the geological units in term of colour, grain size, bedding angle to core axis, alteration

and accessory minerals. These descriptive data were directly entered into the Geotic® Software.

Exclusively for holes PL-13-01, 02 and 05, samples were prepared following procedure described in the following sub-item.

10.1.4 SAMPLING APPROACH

Sampling approach was discussed by the GENIVAR geoscientists and engineers, involved in the preparation of this NI-43-101 technical report before the drilling program started.

Sample length was based upon both geological contacts and on the whiteness of the quartzitic sandstone. Numbered sample tags were placed at the beginning of each sample together with distinctive red arrows on the core marking the beginning and end intervals.

Thus mineralized core samples, generally in sections of 3.0m (median) but locally as short as 1.0m and as long as 3.3m, were prepared by an employee of Geoforbes Services inc. at the core shack.

Core boxes were received at the GeoForbes Services Inc. logging facility located in Lac-au-Saumon some 35 km by road to the project during the drilling program. At reception, they were securely placed inside the facility before logging and sampling procedures. The facility was always locked when unoccupied.

Core samples of holes PL-13-01, 02 and 05 were split in half along the long axis by a hydraulic-powered core splitter. Half of the core samples was retained and placed back into the core box, respecting the original orientation and position, whereas the other half was split again - one for the geochemical assay and one for the bulk sample devoted to the metallurgical tests. Sample tags were also stapled to the bottom of the core tray at the start of each sample**,** so that each sample could be relocated following future handling, transportation and storage.

A total of forty-one samples totaling 105.5 m of core were prepared. This length represents 56.1% of the total core length for these three holes and 23.1% of the whole drilling length.

A total of twelve samples representing nine from core samples (approximately 48 mm diameter x 96 mm long) and three from the surface of the quarry (approximately 100mm x 100mm x 100mm cubes) were prepared for thermal shock testing.

All samples were securely bagged and taped with adhesive tape before being placed in large Fabrene bags (rice bags) and tied with a security numbered

plastic zip-tie before shipping. A list of sample numbers shipped was included in one of the rice bags for laboratory verification.

No aspect of sample preparation was conducted by an employee, officer, director or associate of CMI.

10.1.5 RELIABILITY OF CORE SAMPLING

Core samples are considered very reliable and representative of the high grade silica deposit present in the area tested by drilling because of the homogeneity of the sequence, which minimizes the risks of sample biases and because the core recovery was excellent.

10.2 QP'S OPINION

It is GENIVAR's opinion that the drilling and logging procedures put in place by the logging geologist meet acceptable industry standards and that the information is reliable and can be used for geological and resource modeling.

11.0 SAMPLES PREPARATION, ANALYSES AND SECURITY

11.1 SAMPLE PREPARATION

All rice bags were shipped by Expedibus from the Lac-au-Saumon terminus to the CTMP laboratory in Thetford Mines, Quebec. All samples were received in good standing by the laboratory. The latter sent a list of received samples in conformity with the list of samples shipped

11.2 ANALYTICAL PROCEDURE

The samples from rice bags were processed by CTMP using the following steps:

- Primary crushing to 5 – 10 mm with a Denver $3^{1/4}$'' x $4^{1/2}$'' Jaw crusher;
- Secondary crushing to –5 mm with a Denver 12'' Gyratory crusher;
- Tertiary crushing to 0.5 – 1.0 mm with a Denver 10'' x 6'' Roll crusher

Samples for geochemical analysis by XRF (X-Ray Fluorescence) were prepared by producing fused samples for major oxides and pressed samples for trace elements. The CTMP laboratory is not an accredited laboratory however employed acceptable procedures per the following steps:

- Samples prepared by crushing to 0.5 – 1.0 mm were split into ±50 g and then pulverized to -75 µm with a Retsch PM400 grinding mill;
- The samples were then heated in a Lindberg Blue M furnace at 1000°C for one hour to incur loss on ignition;
- For fused samples, 0.6 g was used with 6 g of flux (50% lithium borate, 50% lithium metaborate). This mixture was fused together for 20 minutes in a Claisse M4-30 gas fusion fluxer;
- For pressed samples, 8 g was used with 2 g of binder (Cereox). This mixture was pressed for 1 minute in a 12 tonne Carver 4350 L press;
- Both fused and pressed samples were analyzed using the XRF (X-Ray Fluorescence) method with a 4 kW Bruker model S8 Tiger WDXRF (wavelength dispersive) analyzer under the supervision of Jacques Fiset, Chemist at the CTMP laboratory. As detailed in CTMP's report (Appendix A), the method used by the Bruker analyzer allows for the analysis of

major oxide concentrations generally from 0.01% to 100%, with detection limits as listed in Table 6. The standards used are certified reference materials and the documentation provided indicates the concentrations however no certificates were included. The procedure used at CTMP consists of varying the conditions of the analyzer with the verification sample provided by Bruker (BRSTG2). At the beginning of each day three quality control samples (QC_GEOMAJ-01, QC_GEOMAJ-02, QC_GEOMAJ-03) are analyzed and a green light indicates that the results are within the allowable tolerances. To validate this method two samples provided with the standards (GEOMAJ-16 and GEOMAJ-06) were used. The concentrations of these standard samples are listed in CTMP's report.

Table 6: Whole Rock XRF Reporting Limits for CTMP

Oxide	Detection Limits	
	Min. (%)	Max. (%)
SiO_2	0,40	100,00
Al_2O_3	0,04	90,00
Fe_{total} as Fe_2O_3	0,01	40,00
TiO_2	0,01	8,00
Na_2O_3	0,02	11,00
MgO	0,02	100,00
P_2O_5	0,01	20,00
SO_3	0,05	55,00
K_2O	0,05	15,00
CaO	0,02	100,00
MnO	0,01	0,80

Samples for metallurgical tests were processed using the following steps:

- Crushing to 0.5–1.0 mm as per above procedure, then split in two. One half was used for the physical characterization tests which was further divided into 2 kg samples for further processing;
- Screening through 30 mesh on a Gilson screen (F100 -600µm);
- Washing for 5 minutes on a 106µm Sweco screen;
- Vacuum filter both overs and unders with a Whatman 114, 25µm filter, then dry and weighed separately;
- For the composite sample representing PL-13-05, the material passing 600 µm and retained on 100 µm was split into 4 samples to perform 4 separate attrition tests. The remaining material was used for particle size distribution and XRF analysis;

- The material passing 100 µm was pulverized and analyzed by XRF as per the method described earlier;
- Samples were diluted to 75% solids by weight (950g of silica with 320g of water) for a total of 750ml in a 1000ml rectangular container;
- Attrition in a Metso flotation machine converted to an attrition scrubber at 1000 rpm for 1, 3, 5, and 10 minutes;
- Material after attrition was then washed on a 106µm screen (small diameter) fitted with a vacuum plate. The fractions retained on the screen and on the filter (Whatman 114, 25µm) were dried and weighed. A sub-sample of the material retained on 106 µm was analyzed for particle size distribution and the remaining was pulverized and analyzed by XRF. The -106 µm material recovered on the filter was pulverized and analyzed by XRF;
- For the composite samples representing PL-13-01 and 02, they were prepared in the same way except the attrition time was 5 minutes.
- For the 3 composite samples, the washed product retained on 106 µm was then then passed through a wet high intensity magnetic separator (WHIMS) Outotec model 3x4L. At 30% solids by weight the slurry passed through a bed of ½'' balls set at a current of 5.9 amperes, producing a magnetic field of approximately 20 kGauss. Bothe the magnetic and non-magnetic fractions were filtered, dried and weighed. A sub-sample of the non-magnetic material was analyzed for particle size distribution and another was pulverized and analyzed by XRF. The magnetic material was pulverized and analyzed by XRF;

Samples for analysis of roundness and sphericity were taken from the final non-magnetic material after 5 minutes of attrition, from composite samples PL-13-01 and PL-13-05. Three size fractions were prepared as -20+40, -30+50 and -40+70 mesh, typical for frac sand fractions. Photomicrographs of these fractions were used to analyze roundness and sphericity. Samples with better results for roundness and sphericity were chosen to conduct crush resistance tests. Fractions -20+40 and -30+50 were tested with a hydraulic press. Pressure was increased successively from 4000 psi to 8000 psi in 1000 psi intervals. After each test the sample was screened to determine the percentage of fines. The tests conducted for the evaluation of roundness and sphericity and crush resistance are as per the procedures set in ISO 13503-2:2006 (API RP 19C).

For thermal shock resistance, 12 samples were provided by CMI. 3 samples from each drill core (approximately 2'' diameter x 4'' long), as well as 3 samples taken from the surface of the quarry (approximately 4"x4''x4'' cubes) were used. Each were heated in a Lindberg Blue M furnace at 1000°C for 20 to 50 minutes, then cooled to room temperature. Loss on ignition was calculated based on the

samples weight before and after thermal shock. Light mechanical breakages were observed. The cooled samples were then screened on 12.5 mm screen opening and the percentage of particles larger than 12.5 mm was determined.

At no time was an employee of CMIGENIVAR involved in the analytical process.

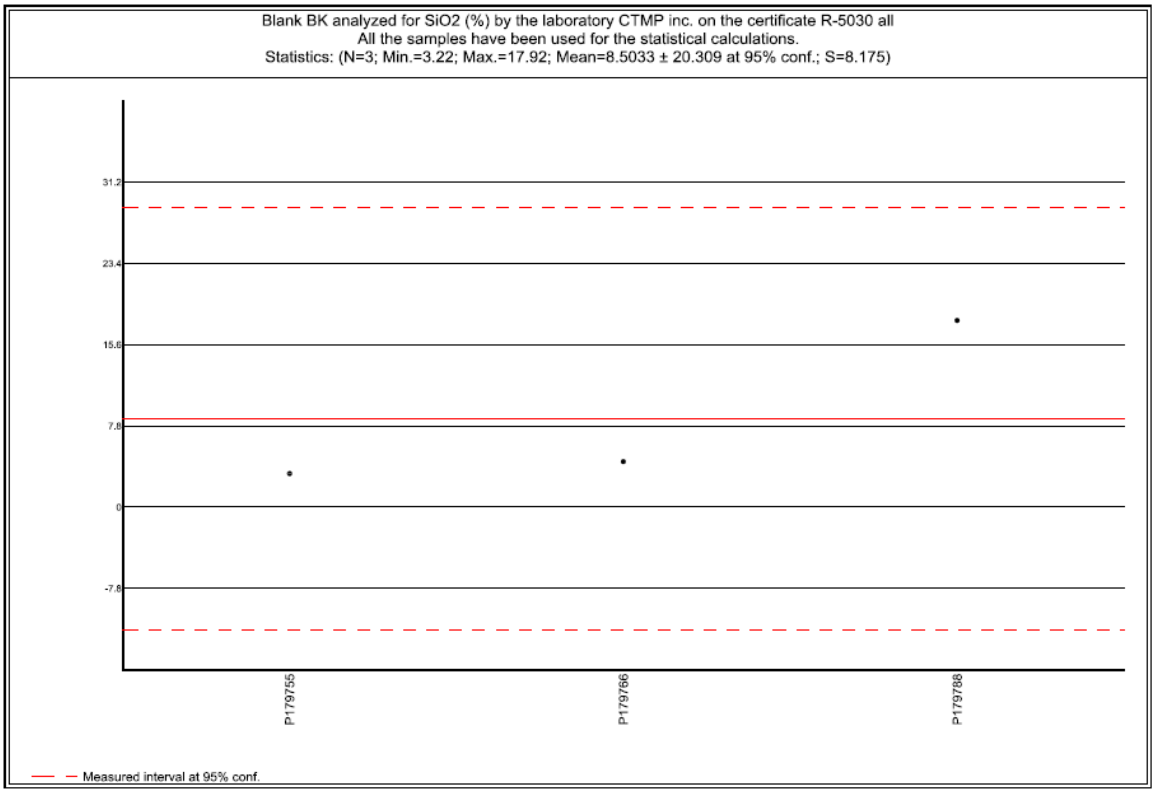
11.3 QA/QC

QAQC at this stage included the insertion in the sample stream of three blank samples and four standard samples for a total of forty-eight (48) samples, e.g. 15% of independent check samples. Blank samples consisted of white marble granulates. Standard samples consisted in silica sand collected from a pile located in the vicinity of the St-Vianney quarry.

11.3.1 BLANKS

A total of three blank samples were inserted in the sample stream. Blanks consisted in white marbles supposed to not contain or contain a very low quantity of silica. Figure 11 below shows that SiO_2 measured in all samples varies from 3.22 to 17.92% (P179788). Considering the high deviation of sample # P179788 it would be crucial to perform a reanalysis confirming any contamination during the first assay procedures.

Figure 11: Analyzed %SiO_2 in Blank Samples



11.3.2 DUPLICATES

Independent duplicate samples were not inserted at this stage by GENIVAR geologist.

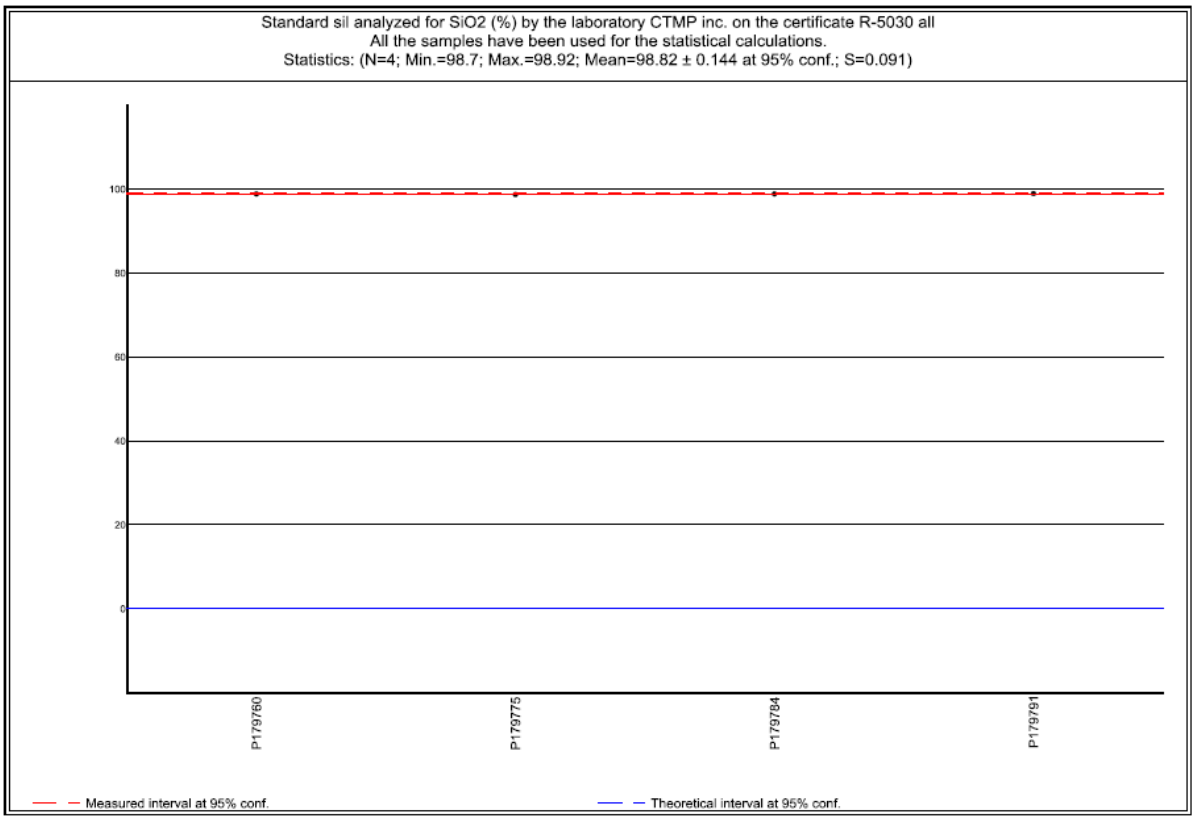
CTMP performed one duplicate assay for major-elements. Sample P179781 and P179781-R return SiO2 tenor of 98.68% and 98.67% respectively.

Duplicates sampling and assaying at a rate of 3-5% should be applied in the next core sampling program.

11.3.3 STANDARDS

A total of four standard samples were randomly inserted in the sample stream by the logging geologist during sampling procedure and were submitted for major and multi-elements assaying. Figure 12 below shows the very low variation of silica content in the silica sand used.

Figure 12: Silica Content in the Silica Sand Used



11.4 QP'S OPINION

It is the authors's opinion that sample preparation, security, and analytical procedures put in place by logging geologist and laboratory were adequate for a program at this stage and meet acceptable industry standards. The information can be used for geological resource modeling. The X-ray fluorescence (XRF) method is appropriate for detection of major chemical impurities, however in determining very low levels of oxide impurities contained in the Langis deposit, the XRF method employed by CTMP laboratory has shown that there is an issue of accuracy, therefore it is recommended to use other methods of analysis such as ICP-MS during future test work.

12.0 DATA VERIFICATION

12.1 VERIFICATION PROCEDURE

Six samples from the 3 drill cores were selected to carry out chemical analysis in triplicate at Centre de Technologie Minerale et de Plasturgie (CTMP) which is not an accredited laboratory. The selected samples are distributed as a function of the length of each drill core and at different depths. Table 7 lists the samples analyzed for the major oxides, loss on ignition and trace elements in triplicate. The results of the chemical analysis by XRF are within the limits of acceptability at this stage. The biggest variances for the oxide impurities are with Fe_2O_3 and Al_2O_3

Table 7: Chemical Composition of Selected Samples in Triplicate

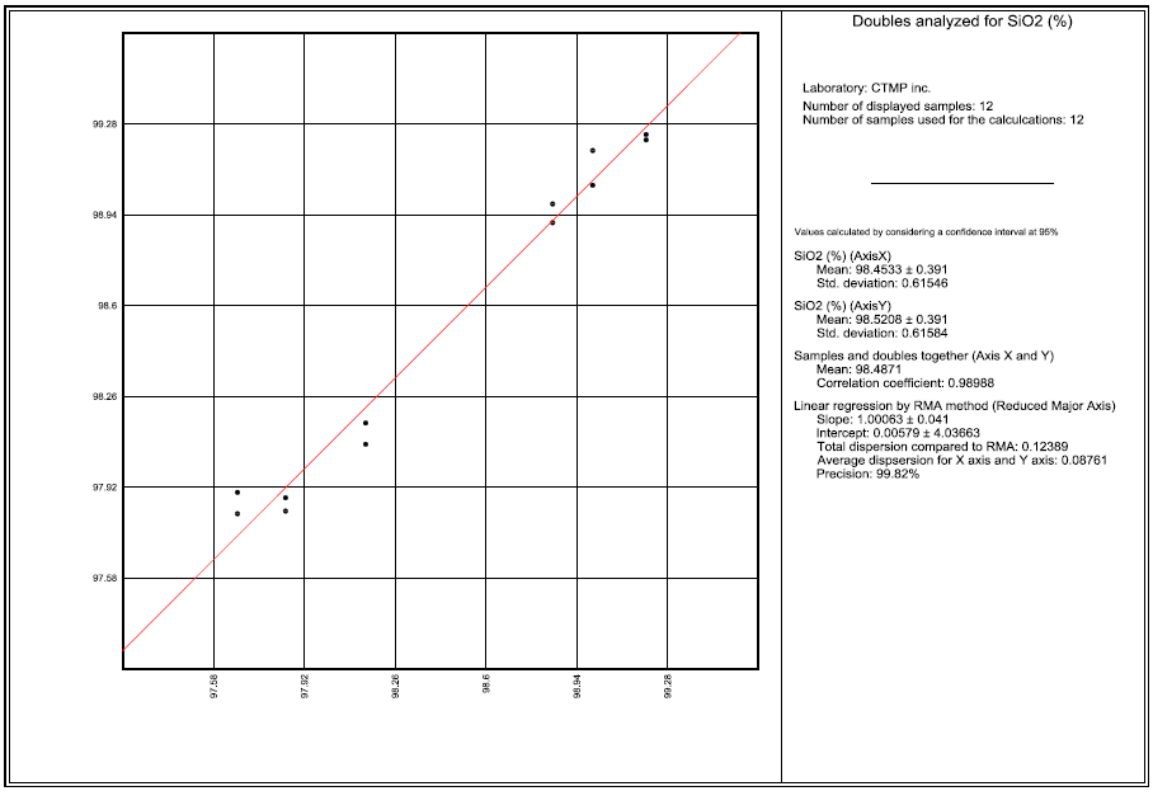
Samples	SiO2 (1) (%)	MgO (%)	CaO (%)	Fe2O3 (%)	Al2O3 (%)	MnO (%)	Na2O (%)	K2O (%)	TiO2 (%)	SO3 (%)	P2O5 (%)	P.A.F. (%)	Traces (%)	Total (%)
P179752-a	98,15	0,16	0,07	0,31	0,67	0,01	0,03	0,16	0,04	< 0,01	0,01	0,37	0,02	100,00
P179752-b	98,08	0,16	0,07	0,32	0,69	0,01	0,03	0,16	0,05	< 0,01	0,01	0,39	0,03	100,00
P179752-c	98,16	0,17	0,07	0,30	0,66	0,01	0,05	0,16	0,05	< 0,01	0,01	0,33	0,03	100,00
P179761-a	97,78	0,16	0,33	0,21	0,68	0,01	0,11	0,11	0,06	0,03	0,01	0,48	0,03	100,00
P179761-b	97,82	0,16	0,33	0,21	0,66	0,01	0,08	0,11	0,07	< 0,01	0,01	0,51	0,03	100,00
P179761-c	97,90	0,15	0,33	0,20	0,70	0,01	0,08	0,10	0,07	< 0,01	0,01	0,42	0,03	100,00
P179770-a	99,20	0,03	0,01	0,06	0,29	0,01	0,03	0,07	0,04	< 0,01	< 0,01	0,24	0,02	100,00
P179770-b	99,24	0,03	0,01	0,08	0,28	0,01	0,02	0,07	0,04	< 0,01	0,01	0,19	0,02	100,00
P179770-c	99,22	0,04	0,02	0,07	0,31	0,01	0,04	0,07	0,04	< 0,01	0,01	0,15	0,02	100,00
P179772-a	98,84	0,08	0,02	0,13	0,44	0,01	0,05	0,06	0,05	< 0,01	0,01	0,28	0,03	100,00
P179772-b	98,91	0,09	0,02	0,13	0,40	0,01	0,05	0,06	0,05	< 0,01	0,01	0,24	0,03	100,00
P179772-c	98,98	0,08	0,02	0,12	0,41	0,01	0,04	0,06	0,05	< 0,01	0,01	0,19	0,03	100,00
P179780-a	97,85	0,16	0,06	0,34	0,91	0,01	0,03	0,16	0,08	< 0,01	0,01	0,37	0,02	100,00
P179780-b	97,83	0,17	0,06	0,36	0,86	0,01	0,04	0,16	0,08	< 0,01	0,01	0,40	0,02	100,00
P179780-c	97,88	0,17	0,06	0,34	0,90	0,01	0,03	0,16	0,08	< 0,01	0,01	0,34	0,02	100,00
P179794-a	99,00	0,10	0,02	0,05	0,36	0,01	0,12	0,04	0,04	< 0,01	0,01	0,23	0,02	100,00
P179794-b	99,05	0,10	0,01	0,07	0,39	0,01	0,05	0,04	0,04	< 0,01	< 0,01	0,22	0,02	100,00
P179794-c	99,18	0,08	0,01	0,05	0,35	0,01	0,03	0,03	0,04	< 0,01	0,01	0,19	0,02	100,00

'(1) 100-others

Based on these results the standard deviations are listed in CTMP's report Appendix A and are not pooled to include detection limits, precision, accuracy, repeatability and reproducibility. However, as reported by CTMP, the margin of error for each oxide content was calculated as the product of 1.96 (95% confidence interval) and the average standard deviations.

This data was also entered in the Geotic database as doubles analyzed for SiO_2 and a correlation plot, Figure 13 generated satisfactory results.

Figure 13: Correlation Plot of Doubles Analyzed for SiO_2



12.2 QP'S OPINION

Based on the results shown from the analysis of selected samples, the data provided is within acceptable limits and thus adequate for this stage of the study. However, from the relative uncertainty with which the XRF method of analysis was employed at CTMP it is recommended to use other methods of analysis such as ICP-MS during future test work.

13.0 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 INTRODUCTION

GENIVAR was mandated to conduct a general characterization study of the Property in order to evaluate it as a source of usable silica. A laboratory test plan was recommended that would provide information for its chemical, physical and thermal properties. This information can then be used to help determine which end use the silica can be suitable for. The major uses of silica can be categorized based on the particle size requirements, i.e. lump silica (350mm down to 2 or 3mm), silica sand (2mm down to 74 microns) and ground silica (below 75 microns).

13.2 LABORATORY TEST PLAN

The Centre de Technologie Minerale et de Plasturgie (CTMP) in Thetford Mines, QC was chosen by CMI to performed laboratory test work on three drill core samples of quartz ore taken from the Langis deposit. CTMP is not an accredited laboratory.

One half of the drill cores were used for testing, which comprises two phases:

Phase 1

For *chemical properties*, X-ray fluorescence (XRF) was used to analyse the major oxides and trace elements of 48 samples taken from 1/4 of the drill cores.

Phase 2

Chemical and physical properties were evaluated on three core samples which were homogenized and crushed and screened to finer than 600 microns. A classification/desliming step was then performed by washing the sand with spray water on a vibrating screen deck with 106 microns opening. Attrition scrubbing was performed on the washed sand to remove more ferrous and clay inlays. The scrubbed sand was washed again on a vibrating screen deck with 106 microns opening and then passed through a high intensity magnetic separator to remove maximum ferromagnetic particles. Chemical analysis by XRF and particle size distribution was performed between each step. Grain shape evaluation for roundness and sphericity as well as crush resistance tests were also conducted.

Thermal properties were evaluated by conducting thermal shock tests on a total of 12 lump samples. Three samples taken from each drill core (approximately 48mm diameter x 96mm long), as well as three samples taken from the surface of the quarry (approximately 100mm x 100mm x 100mm cubes) were used to conduct thermal shock tests. Each sample was introduced in a pre-heated oven at 1000°C and held there for a minimum of 15 minutes, then cooled to room temperature. Light mechanical breakages were observed. The cooled samples were then screened on 12.5 mm screen opening and the percentage of particles larger than 12.5 mm was determined. Above 80% larger than 12.5 mm demonstrates good resistance to thermal shock.

Figures Figure 14 and Figure 15 are generalized flowcharts of the processing steps performed for phase 2.

Figure 14: Test Plan for Lump Silica Applications

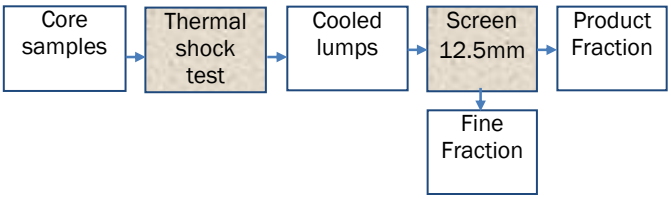
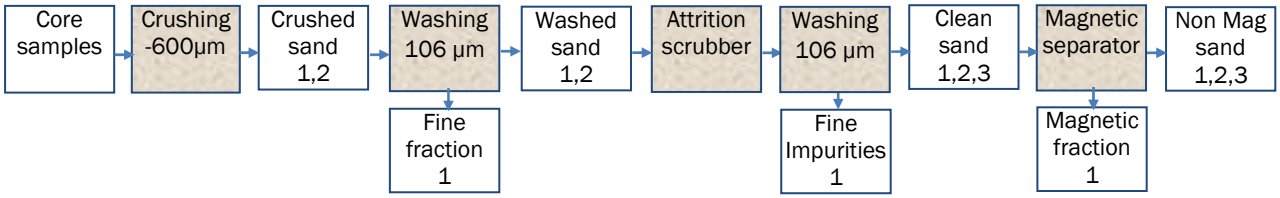


Figure 15: Test Plan for Silica Sand Applications



Analytical procedures applied:

- XRF chemical analysis
- Size distribution (grain size, AFS fineness)
- Roundness, Sphericity

13.3 CHARACTERIZATION OF LUMP SILICA

The criteria for evaluating the deposit as a source of lump silica for high temperature applications are chemical composition, thermal shock resistance and lump size.

Silicon metal production requires lump silica to be very pure with at least 99.5% silica (SiO_2), while specifications for iron oxide (Fe_2O_3) impurities range from 0.05% to 0.10%, alumina (Al_2O_3) from 0.10% to 0.20% and titanium dioxide (TiO_2) up to 0.006%, CaO and MgO impurities must be no more than 0.2% and P and As must be avoided. Resistance to thermal shock is critical and the product should retain at least 80% on a 12.5 mm screen after undergoing thermal shock. The lump silica must not degrade during handling and transportation and is generally 25 to 350 mm in size.

Ferrosilicon production requires silica (SiO_2) content to be at least 98.7%, while specifications for iron oxide (Fe_2O_3) impurities should be maximum 0.3%, alumina (Al_2O_3) 0.6%, titanium dioxide (TiO_2) 0.05%, CaO and MgO 0.2% and P_2O_5 0.1%. Requirements for thermal shock resistance are the same as above.

As a fluxing agent for smelting base-metal ores, the silica sand reacts with iron and basic oxides to form a silicate slag. The silica content of the flux should be as high as possible because silica is the active slagging ingredient. Iron, alumina and other oxide impurities are not critical except that they reduce the percentage of available silica. Silica flux particles are generally 5 to 25 mm in size.

13.3.1 CHEMICAL COMPOSITION

Chemical analyses of the composite samples, using the XRF method and per the detection limits as reported by CTMP laboratory, are summarized in Table 8. The average silica grade for the three drill core samples, including loss on ignition (LOI) between 0.3% and 0.5%, is 98.55%.

Table 8: Chemical Analysis of Langis Silica (Including L.O.I.)

		Minimum	Average composite analysis		
		Detection Limit	PL-13-01	PL-13-02	PL-13-05
SiO_2	%	0,40	98,65	98,70	98,22
Fe_2O_3	%	0,01	0,15	0,13	0,14
Al_2O_3	%	0,04	0,44	0,50	0,48
TiO_2	%	0,01	0,05	0,05	0,04
MgO	%	0,02	0,09	0,10	0,23
CaO	%	0,02	0,11	0,05	0,20
MnO	%	0,01	0,01	0,01	0,01
Na_2O	%	0,02	0,06	0,04	0,06
K_2O	%	0,05	0,07	0,08	0,07
SO_3	%	0,05	<0,05	<0,05	<0,05
P_2O_5	%	0,01	<0,01	<0,01	<0,01
L.O.I.	%	-	0,30	0,30	0,52

For industrial applications requiring high temperature metallurgical grade lump silica, the LOI compounds are vaporized and typically extracted to dust collection

systems. The remaining compounds are therefore in concentrations relative to the remaining mass. The chemical analyses for the composite samples, corrected for LOI, are summarized in Table 9. The average silica grade then becomes 98.95% SiO_2, 0.14% Fe_2O_3, 0.48% Al_2O_3 and 0.05% TiO_2. This correction for LOI would not be used for sand applications where the silica is not subjected to high temperatures.

Table 9: Chemical Analysis of Langis Silica (Excluding L.O.I.)

		Minimum	Average composite analysis		
		Detection Limit	PL-13-01	PL-13-02	PL-13-05
SiO_2	%	0,40	99,00	99,04	98,76
Fe_2O_3	%	0,01	0,15	0,13	0,14
Al_2O_3	%	0,04	0,44	0,50	0,49
TiO_2	%	0,01	0,05	0,05	0,05
MgO	%	0,02	0,09	0,10	0,23
CaO	%	0,02	0,11	0,05	0,21
MnO	%	0,01	0,01	0,01	0,01
Na_2O	%	0,02	0,06	0,04	0,06
K_2O	%	0,05	0,07	0,08	0,07
SO_3	%	0,05	<0,05	<0,05	<0,05
P_2O_5	%	0,01	<0,01	<0,01	<0,01
L.O.I.	%	-	-	-	-

13.3.2 THERMAL SHOCK TEST

A critical aspect of characterizing lump silica for high temperature applications is its resistance to thermal shock. Nine samples from drill cores and three samples from the surface were provided for thermal shock resistance tests. Thermal shock evaluation was based on the "SKW" procedure, in which the sample is introduced into a furnace at 1000^0C for at least 15 minutes, after cooling and light mechanical breakage it is screened at 12.5 mm and the percentage retained is determined. A result of more than 80% demonstrates the material has a high resistance to thermal shock. Results from thermal shock analyses of the twelve samples indicate an average value of 95.1%, demonstrating a relatively strong cementation suitable for lump quartz. Depending on the specific producer of ferrosilicon, further detailed tests would be required.

Based on the test work at CTMP, the Langis silica deposit can meet the requirements for the production of ferrosilicon as well as a flux agent for base metal smelting. The chemical composition of this material, however, does not meet the requirements for the production of silicon metal which requires a higher purity silica.

13.4 CHARACTERIZATION OF SILICA SAND

Sand samples were prepared by crushing the drill cores through a primary jaw crusher, a secondary gyratory crusher and a tertiary roll crusher to finer than 600 µm. The -600 µm homogenized head feed was then processed through a classification/desliming step, an attrition step and a magnetic separation step. Table 10 summarizes the grade and weight recovery of silica (SiO_2) and the major oxide impurities (Fe_2O_3, Al_2O_3, TiO_2) after each process step. The concentration levels of the other oxide impurities contained in the sand product are listed in CTMP's laboratory report (Appendix B, Table B7). For the purpose of this characterization study only the three major oxide impurities are taken into consideration as they determine the quality of most silica sand applications. Appendix B lists the general chemical and physical specifications for different uses of silica.

Table 10: Grade and Weight Recovery of Sand After Each Process Step

Operation Step	Head Feed	Classification		Attrition		Magnetic Separation	
Valuable product	-600 µm	-600 +106µm product		-600 +106µm attritioned		-600 +106µm non-magnetic	
Sample PL-13-01							
Wt Recovery overall (%)	100	75,49		74,04		73,77	
Wt. Recovery per step (%)	100	75,49		98,08		99,64	
Component	Grade (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)
SiO_2	99,03	99,39	75,78	99,58	98,09	99,56	99,66
Fe_2O_3	0,09	0,05	35,48	0,03	89,99	0,03	75,13
Al_2O_3	0,40	0,21	42,64	0,15	94,56	0,16	98,39
TiO_2	0,04	0,03	50,66	0,03	95,03	0,03	98,58
Sample PL-13-02							
Wt Recovery overall (%)	100	77,78		76,13		75,96	
Wt. Recovery per step (%)	100	77,78		97,87		99,77	
Component	Grade (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)
SiO_2	98,91	99,46	78,06	99,53	97,91	99,47	99,78
Fe_2O_3	0,09	0,05	40,24	0,02	77,97	0,04	86,64
Al_2O_3	0,47	0,19	42,23	0,17	88,77	0,15	98,39
TiO_2	0,06	0,03	48,84	0,02	89,32	0,03	98,36
Sample PL-13-05							
Wt Recovery overall (%)	100	84,87		83,21		73,99	
Wt. Recovery per step (%)	100	84,87		98,05		88,92	
Component	Grade (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)
SiO_2	99,01	99,46	84,96	99,58	98,08	99,20	88,93
Fe_2O_3	0,08	0,05	60,90	0,05	93,00	0,01	56,30
Al_2O_3	0,32	0,20	71,82	0,15	89,43	0,17	88,09
TiO_2	0,04	0,03	70,62	0,05	96,58	0,02	86,94
Average							
Wt Recovery overall (%)	100	78,13		76,55		75,91	
Wt. Recovery per step (%)	100	78,13		97,98		99,16	
Component	Grade (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)	Grade (%)	Recovery (%)
SiO_2	98,98	99,44	78,38	99,56	98,01	99,41	99,21
Fe_2O_3	0,09	0,05	40,80	0,03	85,49	0,03	60,50
Al_2O_3	0,40	0,20	46,20	0,16	91,29	0,16	95,50
TiO_2	0,05	0,03	52,84	0,03	93,02	0,03	94,60

13.4.1 CLASSIFICATION/DESLIMING

The initial classification step removed the -106 µm fines by washing the material on a 150 mesh Sweco screen. This step alone can remove approximately 22% of the material from the head feed. The resulting product contains considerably less impurities thereby producing a higher purity silica sand averaging 99.44% SiO_2. The average iron oxides content was reduced from 0.09% to 0.05% Fe_2O_3, while the average alumina content dropped from 0.40% to 0.20% Al_2O_3 and titanium dioxide from 0.05% to 0.03% TiO_2. As this process is considered more of a desliming step, it is typically performed by hydrocyclones and is a critical step in the purification of silica sand. It also prepares cleaner sand for subsequent steps.

13.4.2 ATTRITION

Attrition tests were conducted on core sample PL-13-05 to evaluate the effect of attrition residence time. The optimal residence time was then used for samples Pl-13-01 and PL-13-02. The objective of attrition scrubbing is to loosen and disperse coatings of iron oxides, clay minerals and other cementing materials from the sand grain surfaces.

Table 11 shows the distribution of silica and the major oxide impurities for different attrition times on sample PL-13-05. There is an overall increase in silica grade with increasing attrition time. Increasing the attrition time to 10 minutes did not significantly improve the removal of impurities. Taking into account the relative uncertainty with the analysis method, it can be concluded that the removal of iron oxide and titanium oxide impurities were not significantly affected by attrition time. This can be explained by the fact that much of the iron and titanium oxides may be finely disseminated in the silica. On the other hand, the alumina content decreased with attrition time, from 0.19% at 1 minute to 0.13% at 10 minutes.

Table 11: Distribution of +106µm Product at Different Attrition Times

Residence Time	1 minute		3 minutes		5 minutes		10 minutes	
Weight Recovery (%)	98,22		98,12		98,05		98,18	
Component	Grade (%)	Dist'n (%)	Grade (%)	Dist'n (%)	Grade (%)	Dist'n (%)	Grade (%)	Dist'n (%)
SiO_2	99,54	98,24	99,57	98,13	99,58	98,08	99,63	98,19
Fe_2O_3	0,03	94,31	0,03	91,57	0,05	93,00	0,04	95,94
Al_2O_3	0,19	96,05	0,18	95,23	0,15	89,43	0,13	96,30
TiO_2	0,03	97,07	0,03	95,60	0,05	96,58	0,03	95,75

It was agreed to establish an attrition time of 5 minutes as optimal for samples PL-13-1 and PL-13-02. As shown in Table 10, after 5 minutes of attrition and desliming at 106 µm the silica grade for the three composite samples increased from an average 99.44% to 99.56% SiO_2. It was also observed that the average iron oxides content was reduced from 0.05% to 0.03%, the average alumina content was reduced from 0.20% to 0.16%, while the average content of titanium dioxide was left unchanged.

The weight recovery of the product after attrition and desliming averages 98%.

Particle size distributions were analyzed for the +106µm product at different attrition times. As indicated in CTMP's report, there is very little change in particle size distributions with AFS grain fineness numbers ranging from 63 to 67.

13.4.3 MAGNETIC SEPARATION

Wet high intensity magnetic separation (WHIMS) was conducted on the clean deslimed sand attritioned for 5 minutes. The final non-magnetic material contained an average silica grade of 99.41% SiO_2, while the impurities content in

the sand range from 0.01% to 0.04% Fe_2O_3, and 0.15% to 0.17% Al_2O_3 and 0.02% to 0.03% TiO_2. The average impurities content therefore was left relatively unchanged. Nevertheless, a small fraction of magnetic material (less than 1%) was removed indicating that further reduction of iron oxide impurities from the silica sand can be achieved. Again the lack of conclusive results to indicate an improvement in the silica grade by the removal of a small fraction of magnetic impurities can be attributed to the relative uncertainty with which the XRF method was used by CTMP in determining such low levels of oxides. Validation of this step by other methods of analysis is recommended.

13.4.4 PARTICLE SIZE DISTRIBUTION

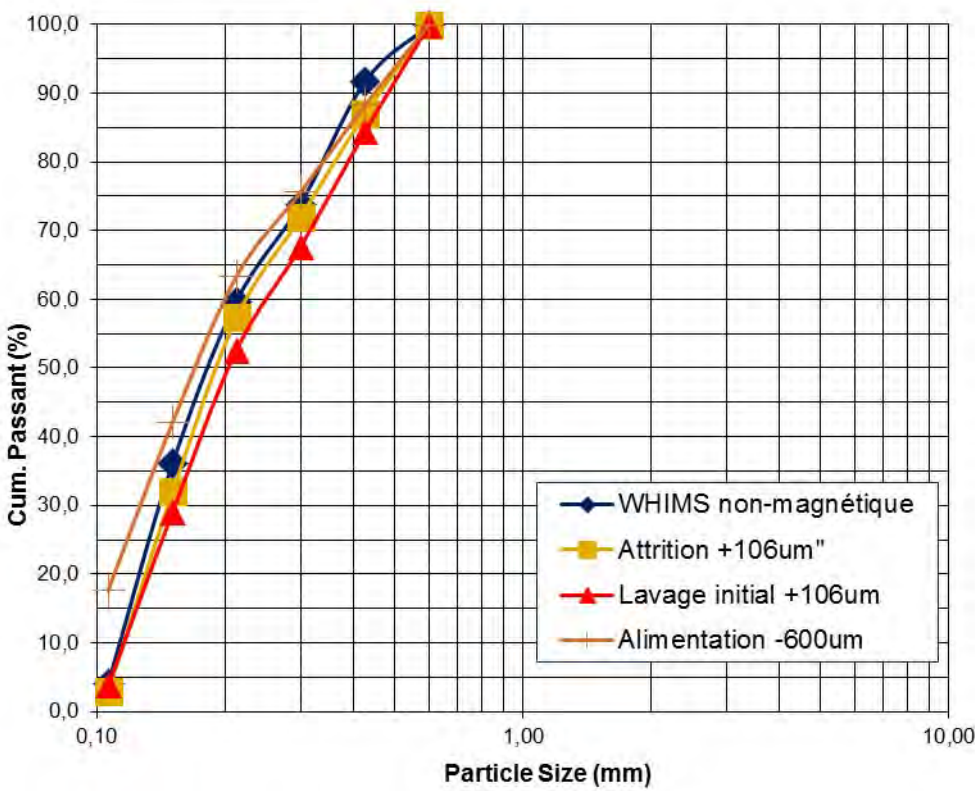
Grain size distribution is an important physical characteristic in determining whether it is applicable to many silica sand uses. The average particle size distributions of the three composite samples, after each process step, are listed in Table 12. It is noted that the size distributions are fairly close for the three composite samples, therefore only the average is illustrated in this analysis. The particle size distributions for samples PL-13-01 (Envoi 1), PL-13-02 (Envoi 2) and PL-13-05 (Envoi 3), after each process step, are included in Appendix B of the CTMP's report. As noted earlier, the classification/desliming step represents the removal of approximately 20% of the head feed. The average AFS grain fineness number is thus reduced from 79 to 66. The average coefficient of uniformity (C_u), which is a measure of grain sorting or uniformity, was calculated to be 2.11, indicating the sand is fairly well sorted. As the value of C_u increases, the material becomes less sorted or uniform. After the initial classification at 106 µm the particle size distribution becomes slightly finer after undergoing attrition and magnetic separation, and becomes a little more uniform with lower Cu values.

Table 12: Average Size Distribution of Sand After Each Process Step

Operation Step		Head Feed	Classification	Attrition	Magnetic Separation
		-600 µm	-600+106µm product	-600+106µm attritioned	-600+106µm non-mag
(US series)	(mm)	(% Passing)	(% Passing)	(% Passing)	(% Passing)
20	0,850	100,00	100,00	100,00	100,00
30	0,600	99,94	99,85	99,87	99,90
40	0,425	88,24	84,37	86,98	91,68
50	0,300	75,59	67,66	71,95	73,86
70	0,212	63,31	52,58	57,29	59,68
100	0,150	41,99	28,93	31,93	36,04
140	0,106	17,69	3,78	2,89	4,11
Pan					
AFS Grain Fineness No.		79	66	68	71
Cu Coefficient of Uniformity		-	2,11	1,91	1,82

A graphical representation of the particle size distributions for each process step is illustrated in Figure 16.

Figure 16: Size Distribution of Sand After Each Process Step



13.4.5 ROUNDNESS AND SPHERICITY

An important physical characteristic for frac sands and foundry sands, is roundness and sphericity of the grains. The core samples were broken down to liberate the individual grains and then screened for various size fractions. Three size fractions were prepared (20/40 mesh, 30/50 mesh and 40/70 mesh) which represent typical sizes of frac sand used as proppants for hydraulic fracturing. A visual analysis of 20 randomly chosen grains for each size fraction was performed based on comparison to the Krumbien & Sloss chart as outlined in the ISO 13503-2 (API RP 19C) standard. Results are shown in Table 13. These observations indicate the roundness of the sand grains averages between 0.3 and 0.5 and thus can be considered sub-angular to sub-rounded, while the sphericity averages between 0.6 and 0.7 and can be considered medium to high sphericity. For frac sand the requirement is 0.6 for both roundness and sphericity, therefore the issue will be roundness even though sphericity may be acceptable. Foundry sand requirements are sub-angular to rounded grains to allow a certain degree of permeability; therefore this product can be applicable to foundry sand based on its grain shape.

Table 13: Roundness and Sphericity of Different Size Fractions

Product	Attrition 10 min, before WHIMS			Attrition 5 min, after WHIMS			Breakage after heating, Attrition 5 min		
Fraction	20/40	30/50	40/70	20/40	30/50	40/70	20/40	30/50	40/70
Roundness	0,4	0,5	0,4	0,4	0,5	0,4	0,3	0,4	0,4
Sphericity	0,6	0,7	0,6	0,7	0,7	0,6	0,7	0,6	0,7

Figures Figure 17 to Figure 20 are photo illustrations of some of the sand fractions evaluated. There are some nice round and spherical sand grains but there are also many angular grains with inclusions and pre-fractures. In addition, there is a significant amount of agglomerates of finer particles (clusters) which, when subjected to high pressures, will tend to break into finer particles.

13.4.6 CRUSH RESISTANCE

Crush resistance tests are used to evaluate frac sand. Tests were conducted on the 20/40 mesh and 30/50 mesh fractions of the product after 5 minutes of attrition and magnetic separation and as per ISO 13503-2 (API RP 19C) standard. Results for the 20/40 product showed 26.3% fines at 4000 psi and 32.5% fines at 5000 psi. The 30/50 product showed 21.7% fines at 2000 psi and 40.1% fines at 4000 psi. The API requirement for 20/40 frac sand is 14% fines at 6000 psi. The high amount of fines generated from the crush resistance test can be explained by the presence of agglomerates (clusters) and the angular grains that tend to break apart into fines under high pressures.

Figure 17: 20/40 Mesh Fraction, Attritioned for 10 Minutes, No WHIMS

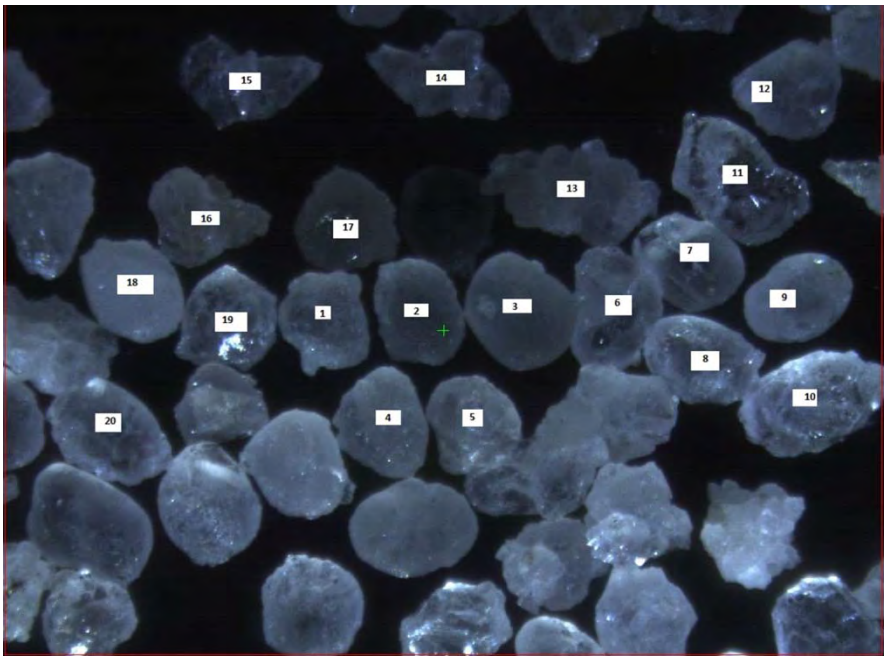


Figure 18: 30/50 Mesh Fraction, Attritioned for 10 Minutes, No WHIMS

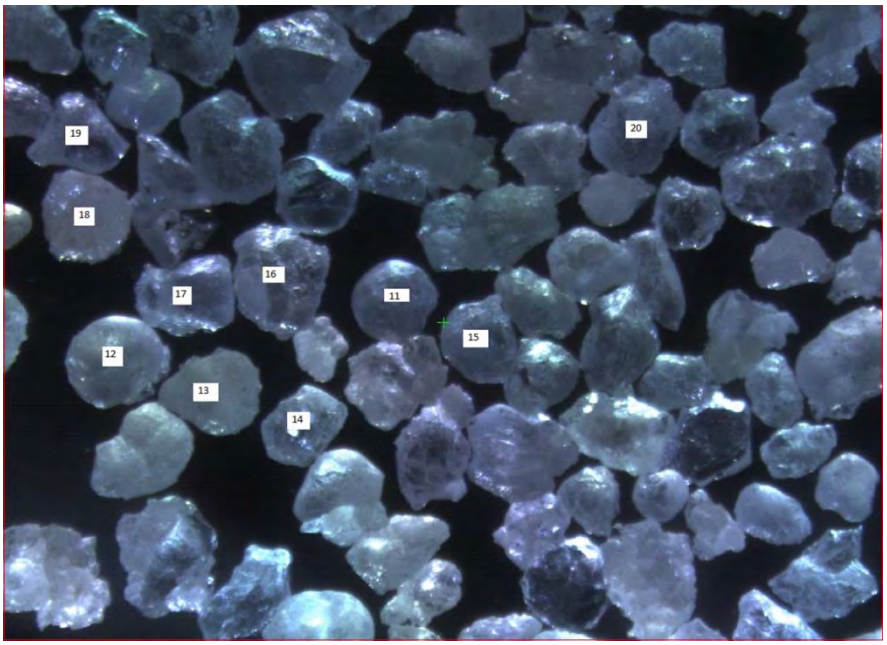


Figure 19: 20/40 Mesh Fraction, Attritioned for 5 minutes, Non-Magnetics After WHIMS

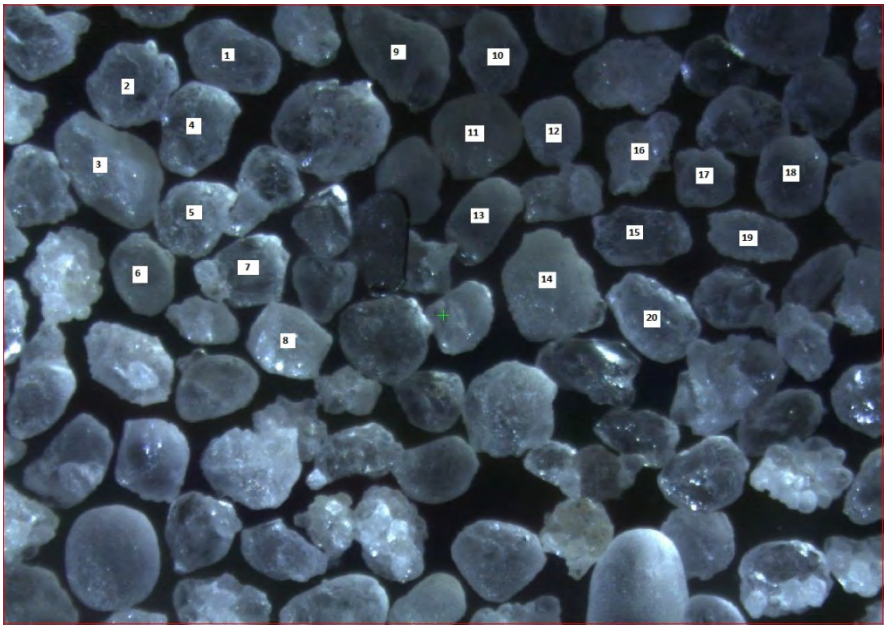
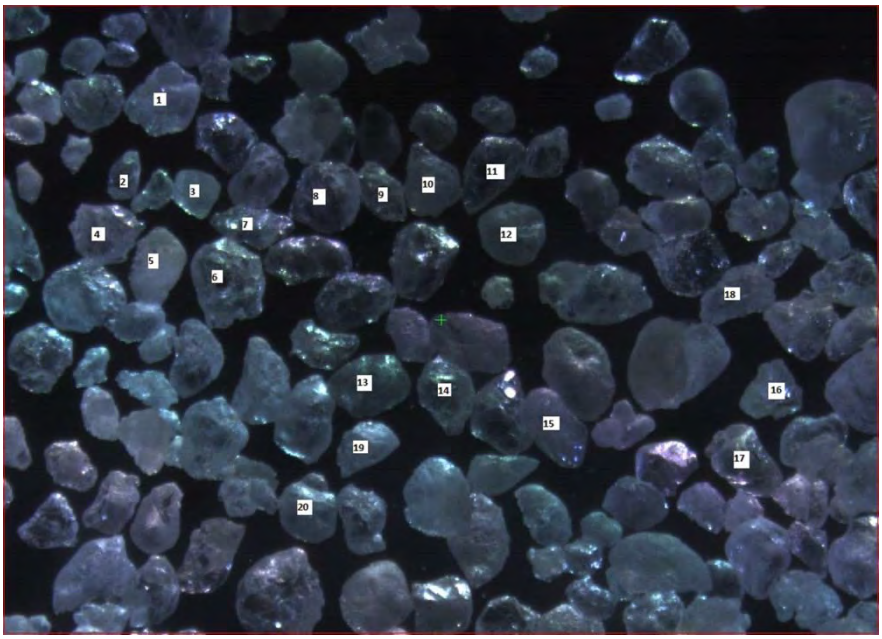


Figure 20: 40/70 Mesh Fraction, Attritioned for 5 minutes, Non-Magnetics After WHIMS



13.4.7 FRAC SAND

Evaluation of the material for hydraulic fracturing sand (frac sand) includes, among other requirements, silica grade, size fraction, roundness, sphericity and crush resistance. Most frac sands contain at least 99% SiO_2, therefore the sand from Langis can meet this requirement. Typical size fractions are designated as 6/12, 8/16, 12/20, 16/30, 20/40, 30/50, 40/70, 70/140 and 90% of the sand should lie within those mesh ranges. Samples were evaluated for roundness and sphericity on 20/40, 30/50 and 40/70 fractions. API requirements are at least 0.6 for both roundness and sphericity. The roundness of the Langis sand will be an issue as it lies between 0.3 and 0.5, while its sphericity is acceptable at 0.6 to 0.7. Crush resistance tests of the 20/40 and 30/50 fractions indicate the Langis sand will not meet API requirements. The crushing strength of the sand was lowered due to the presence of agglomerates (clusters), as evidenced from the photomicrographs. Common in sandstone formations, these clusters are typically broken down through attrition and sometimes removed as a coarse fraction +1 to 2 mm after impact crushing. Further tests are recommended to better evaluate this product by a specialized Frac sand laboratory for a suite of API tests including detailed evaluation of roundness and sphericity, crush resistance, acid solubility, turbidity, conductivity, etc.

13.4.8 GLASS SAND

The criteria for evaluating the deposit as a source of glass sand are chemical composition, size distribution and trace contaminant levels. Chemical control of

the glass batch is of primary importance and as silica sand is the major constituent of the batch composition, it must have a high level of uniformity. The silica content is very important, however it is not the main issue, rather, it is the non-silica contaminants that determine the quality. The principal contaminants include iron, alumina and titania. Other contaminants like calcium, magnesium are present in lesser amounts. Iron oxide (Fe_2O_3) impurities will lead to tinted or opaque glass. Alumina (Al_2O_3) provides greater chemical durability and lower coefficient of expansion, while too much alumina increases the viscosity of the glass, making it difficult to melt and work, and also decreases the transparency of the glass. Titania (TiO_2) colors glass and is more difficult to neutralize than iron. Other impurities such as lime in the form of calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)$) are to be avoided. It is preferable to use lime-free sand and add raw limestone to the glass batch as required rather than rely on daily analyses for lime content. Magnesia (MgO) content up to 1% in sand is generally causes little trouble in glassmaking.

The chemical composition of the silica sand will vary depending on the glass making user. For clear flat glass the silica (SiO_2) content in most glass sands should exceed 99%. The iron content in the form of Fe_2O_3 should be uniform and less than 0.035%, while alumina (Al_2O_3) should be maximum 0.10% and titania (TiO_2) should be maximum 0.02%. For colored container glass the silica (SiO_2) content should be at least 98.9%, while both Fe_2O_3 and Al_2O_3 should be maximum 0.15% and TiO_2 should be maximum 0.10%.

The grain size distribution is controlled simply but screening the coarse and the fine fractions. Again it depends on the end user, however, it should generally pass 20 mesh (0.83 mm) and no more than 5% should pass 150 mesh (0.100 mm). Excessive fines in the sand are undesirable because they tend to carry impurities, cause dusting that can be lost with the flue gases and can also cause foaming in the tanks.

Residual moisture is also considered a contaminant with typical levels requiring less than 0.1% moisture. A drying step will therefore be required if the Langis deposit is to be considered a potential source of glass sand.

Based on the results from the test work the chemical composition of the sand after undergoing attrition and magnetic separation ranges from 99.20% to 99.56% SiO_2, while the impurities range from 0.01% to 0.04% Fe_2O_3, 0.15% to 0.17% Al_2O_3 and 0.02% to 0.03% TiO_2. The particle size distribution lies within the typical target range of 20 to 150 mesh. This demonstrates that the Langis sand could be a potential source of glass sand. It is recommended however to conduct more detailed tests specific to the potential glass making user. If further removal of contaminant minerals is required, flotation techniques to either float the impurities from the glass sand product or to float the clean sand from the impurities can be tested.

13.4.9 FOUNDRY SAND

Molding sand used in foundries should consist of uniform-sized sub-angular to rounded grains of silica. Silica (SiO_2) content can range from 88% to 99%, while oxide impurities can vary greatly. Grain sizes generally lie between 75 and 850 microns, with typical AFS grain fineness numbers between 55 and 65 and the bulk of the sand preferably retained on three adjacent sieves.

Based on the results from the test work the chemical composition and grain shape with respect to roundness and sphericity will qualify the Langis sand as a potential source of foundry sand. Magnetic separation will not be required and suitable sand may be produced even without attrition. The issue will be the particle size distribution as the AFS numbers produced from the prepared samples (average 66 after initial desliming) are somewhat higher than the normal range for typical foundry sands. This can be adjusted by classifying the sand at a coarser size in order to meet the specific needs of the potential foundry. Again depending on the foundries, the sand must satisfy further specifications such as refractoriness, permeability, bond strength, acid demand value, moisture, pH and turbidity. Therefore further tests are recommended to satisfy the requirements of potential end users.

13.4.10 OTHER USES

ABRASIVE SAND

The silica at Langis mey be used as abrasive sand in sandblasting applications. General requirements for the silica is that it should be clean and free of adhering clay or coatings of iron oxide and it should not generate dust during handling. The silica (SiO_2) content should be high (up to 99%) so that little waste results from minerals too soft to be effective. Rounded and angular sand grains are typically used for these applications. Detailed tests specific to abrasive sand users will be required.

SODIUM SILICATE

This silica sand may be a potential for the manufacture of sodium silicate. It should contain 99% SiO_2 and less than 0.1% iron, less than 1% alumina (Al_2O_3) and less than 0.5% combine lime and magnesia. Grain sizes should be between 140 and 850 microns. Sodium silicate is used as a chemical agent for detergents, catalysts, pigments, adhesives, paper making, fabrication of calcium and aluminum silicates. It is also be used in the flotation process for the recovery of fine graphite, as it acts as a quartz depressant and slime dispersant. Industrial production is based on fusing silica sand with either sodium carbonate or sodium sulphate and reducing agent such as carbon, at about 1200-1400^{o}C.

Silicon Carbide

This silica sand may also be a potential for the manufacture of silicon carbide. It should contain 99% SiO_2 while iron oxide and alumina should each be less than 0.1%. All sand should be larger than 150 microns. Silicon carbide is generally used as an abrasive, but also used as a refractory. Industrial production is based on melting silica sand and coke in an electric arc furnace at $+2200^0$C.

Ground Silica

It may be possible to produce ground silica, or silica flour with the silica sand from Langis. It will however incur high capital costs for equipment to dry, grind (to below 75 microns), classify and package the fine powder. The general requirements are chemical purity, lack of color or tint (iron oxide must be very low) and particle size. Silica flour has multiple applications such as an abrasive additive in soaps, paints, foundry work, glass, ceramic and clay production. More detailed tests will be required by the potential end user.

13.5 Summary and Conclusion

Based on the preliminary test work by CTMP, basic chemical, physical and thermal properties of the Langis sandstone indicates it has potential to be a usable source of silica. The impurities contained in the core samples are about 1% with a silica grade in the order of 98.55% SiO2 and a loss on ignition ranging from 0.3% to 0.5%. When corrected for loss on ignition incurred during high temperature lump silica applications, the ore averages 98.95% SiO_2, 0.14% Fe_2O_3, 0.48% Al_2O_3 and 0.05% TiO_2.

Thermal shock tests on twelve representative lump samples reveal that this material has relatively strong cementation, making it a potential source for lump silica applications in high temperature furnaces.

For applications requiring silica sand grains it can be shown that a significant amount of impurities can be eliminated with the removal of fine sand below 100 microns. The residual sand then averages 99.44% SiO_2, 0.05% Fe_2O_3, 0.20% Al_2O_3 and 0.03% TiO_2.

With attrition, iron oxides and clays can be scrubbed from the surface of the sand grains thereby producing a cleaner silica sand averaging 99.56% SiO_2, 0.03% Fe_2O_3, 0.16% Al_2O_3 and 0.03% TiO_2.

High intensity magnetic separation removed a very small fraction of magnetic material with the objective of reducing the Fe_2O_3 content to below 0.03%, however the average impurities content in the sand product was left relatively unchanged.

Physical characteristics of the silica sand were evaluated with respect to particle size distribution, AFS grain fineness numbers, coefficient of uniformity, roundness, sphericity and crush resistance.

It should be noted that the SiO_2 content was calculated from the sum of the assayed results of ten major oxides, twenty four trace elements and loss on ignition, by the x-ray fluorescence (XRF) method. This is a normal method of analysis for a silica deposit such as Langis and was used as an indicator for the purpose of this characterization study. However, in determining such low levels of oxide impurities, this method has shown that there is an issue of accuracy which is evident in the variance of impurities concentration and the basic margin of error as reported by CTMP from the samples analyzed in triplicate.

Based on the chemical, physical and thermal properties observed from the test work at CTMP, by crushing and screening to -120+20 mm lump particles, the Langis silica deposit may be a potential source for the production of ferrosilicon. Further crushing to -25+5 mm particles will also make it a potential source as a flux agent for base metal smelting. The chemical composition of this material, however, does not meet the requirements for the production of silicon metal.

Crushing to -600 microns and deslining the -100 microns fines as well as attrition, size classification, dewatering and drying can be considered to provide a potential source of glass sand, foundry sand and other uses like abrasive sand, sodium silicate, silicon carbide. The material was also tested for frac sand and based on an initial evaluation, the presence of many clusters as well as the issue with the grains' roundness should be considered a stumbling block for its potential as a source of frac sand. Further tests are recommended to better evaluate this product by a specialized frac sand laboratory.

14.0 MINERAL RESOURCE ESTIMATES

No new mineral resource estimates have been made at this time.

14.1 PREVIOUS ESTIMATES

A total historic tonnage of 27.6 million mt at average grades of 0.11% Fe2O3 and 0.41% Al2O3 was calculated and published for the Langis Deposit in 1983 (GM 40477). There is no mention of the SiO2 grade. This was classified as an Indicated Reserve. This resource is historic in nature and does not meet the requirements for Resource categorization as set out in NI 43-101.

In 1985, Pierre Labrecque working for Uniquartz Inc. (GM 42388), revised the Langis Deposit Indicated Resource to 25.5 million mt at average grades of 0.12% Fe2O3 and 0.41% Al2O3. This resource is historic in nature and does not meet the requirements for Resource categorization as set out in NI 43-101. There is no mention of SiO2 grade.

It should be noted that the estimate was completed prior to adoption of the current standards embodied in NI 43-101 and therefore the results cannot be relied upon. The stated indicated resources are likely similar to the current standards for indicated resources.

15.0 MINERALS RESERVE ESTIMATES

This Section is not applicable to the present mandate for the Langis Project.

16.0 MINING METHODS

This Section is not applicable to the present mandate for the Langis Project.

17.0 RECOVERY METHODS

17.1 PROCESS DESCRIPTION

This Section is not applicable to the present mandate for the Langis Project.

18.0 PROJECT INFRASTRUCTURE

This Section is not applicable to the present mandate for the Langis Project.

19.0 MARKET STUDIES AND CONTRACTS

This Section is not applicable to the present mandate for the Langis Project.

20.0 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

This Section is not applicable to the present mandate for the Langis Project.

21.0 CAPITAL AND OPERATING COSTS

This Section is not applicable to the present mandate for the Langis Project.

22.0 ECONOMIC ANALYSIS

This Section is not applicable to the present mandate for the Langis Project.

23.0 ADJACENT PROPERTIES

A group of five (5) claims, adjacent on the west to the Langis Property, is held by private company 9285-3696 Quebec Inc. A group of seven (7) claims, adjacent on the east to the Langis Property, is held by multiple owners.

This latter group of 7 claims includes two (2) claims held by Kevick Lavergne-Rousseau. The former Tessier silica quarry is situated on them. A drilling program conducted by Uniquartz Inc. in 1981 permitted the calculation of a historic, non-43-101-compliant resource estimate of 5.3 Mt of silica (silica grade not listed), and containing at 0.12% Fe2O3 and 0.73% Al2O3 as impurities. This deposit sits 800m east of the Langis Property boundary.

Located 4.3 km east of the Langis Property is the Colline Tortue Property. It consists of nine (9) contiguous claims held by private corporation 9285-3696 Quebec Inc. A work program conducted in 1981 by Uniquartz Inc including geological mapping, sampling and exploratory drilling (three DDHs for 224.3m) resulted in a calculation of a historic, non-43-101-compliant resource estimate of approximately 96 Mt of silica (silica grade not provided).

In both the Tessier and Colline Tortue cases, no Qualified Person has verified the historic resource information.

24.0 OTHER RELEVANT DATA AND INFORMATION

There is no other information deemed to be relevant to this Report.

25.0 INTERPRETATIONS AND CONCLUSIONS

25.1 GEOLOGY

Geological mapping and historic exploration drilling have outlined a large lobe of highly siliceous Lower White Sandstone of the Val Brillant Formation, part of the Chaleurs Group, extending over an area of 250 – 400 m in width by 1.2 km in length on CMI's Langis Property.

Historical exploration drilling and attendant geochemical and physical analyses and testing demonstrated the potential for an economic silica sand deposit of more than 25 Mt at the Langis Silica Project.

As a result CMI decided that a Characterization Study, designed to define the physical and geochemical attributes of the target Lower White Sandstone, would be the initial step necessary in identifying the economic potential at the Langis Silica Project. Consequently GENIVAR supervised a 9-hole drilling program at Langis (total 456m). From this 3 representative drill holes were sampled and analyzed. The 3 holes hosted the following drill intersections:

- PL-13-01: 98.65% SiO2 over 30.28 m (including 98.69% SiO2 over 28.95 m)
- PL-13-02: 98.70% SiO2 over 41.2 m
- PL-13-05: 98.22% SiO2 over 27.0 m (including 99.10% SiO2 over 22.0 m)

These intersections were sent to the CTMP laboratory, using the sampling protocol explained in Sections 9.0 and 10.0, for geochemical analyses and definition of physical characteristics.

The other 6 holes were logged but remain unsampled. They display similar highly siliceous intersections with similar thicknesses to the 3 drill holes that were sampled. If they were sampled and analyzed using similar procedures, an inferred silica sand resource tonnage could be calculated.

25.2 METALLURGY

Laboratory test work conducted by CTMP provided basic information for the chemical, physical and thermal properties of the Langis deposit. This characterization study demonstrates the potential of high purity silica sandstone that may be suitable for some end uses.

The impurities contained in the core samples provided are about 1%, with a silica grade of 98.55% and a loss on ignition of 0.36%. When corrected for loss on ignition incurred in high temperature lump silica applications, the silica grade averages 98.95%. Thermal shock tests also reveal that this material has relatively strong cementation, making it suitable for lump silica applications in high temperature furnaces.

Desliming and attrition scrubbing can produce a silica sand averaging 99.56% SiO_2, 0.03% Fe_2O_3, 0.16% Al_2O_3 and 0.03% TiO_2.

High intensity magnetic separation can remove a very small portion of magnetic material however there was no significant reduction in the concentration of Fe_2O_3 and other impurities.

Physical characteristics of the sand with respect to particle size distribution, AFS grain fineness number, coefficient of uniformity, roundness, sphericity and crush resistance were reported.

The XRF method of analysis was used to provide the estimated concentrations of oxide impuriteies and trace elements. The SiO2 content was calculated from the sum of the assayed results. This is a normal method of analysis for s silica deposit such as Langis and was used as an indicator for the purpose of this characterization study. However there are relative uncertainties with which this method is used in determining such low levels of impurities. As such, it would be interesting to confirm the purity of this silica with more accurate procedures.

Based on these results the Langis silica deposit may be a potential source for the production of ferrosilicon as well as a flux agent for base metal smelting. It is the intention of CMI to advance the project based upon pilot scale testing for ferrosilicon.

26.0 RECOMMENDATIONS

The potential quantity and grade of silica material within the Property is in the range of 15 to 28 million tonnes at 98.1% to 99.2% SiO_2 based on the assumptions of a specific gravity of 2.65, strike length range of 600 to 800 m, width of 275 to 325 m and a thickness of 30 to 40 m. It should be noted that the potential quantity and grade is conceptual in nature, that there has been insufficient exploration to define a mineral resource and that it is uncertain if further exploration will result in the target being delineated as a mineral resource.

It is the authors' opinion that additional expenditures are warranted in order to advance the project to the level of economic assessment. The recommended work program includes the following items:

- Deposit delineation to the level of an Indicated Resource, including geochemical analysis of the six remaining holes, the drilling and geochemical analysis of ten additional holes (NQ-diameter core), and permitting and cutting. This program is estimated to cost $120,000 to $140,000;

- Validation of the silica deposit for the production of ferrosilicon by testing bulk samples with potential customers. The quantities of bulk samples would vary based on the customers' requirements. Cost of collecting such bulk samples is estimated at $50,000 to $100,000;

- Initiating an economic study for a quarrying operation. The cost of this work is estimated at $60,000.

The total cost of these recommended expenditures is between $230,000 and $300,000.

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28.0 CERTIFICATE OF QUALIFIED PERSONS

I, John D. Charlton, P. Geo., of Saint-Lazare, Quebec do hereby certify:

- I am Director, Geology and Mining with GENIVAR Inc. with a business address at 1600 blvd Rene-Lévesque, 16th Floor, Montréal, Québec H3H 1P9.
- This certificate applies to the technical report entitled Characterization study of the Langis Silica Deposit (the "Technical Report").
- I am a graduate of the University of Western Ontario (1973). I am a member in good standing of Order of Quebec Geologists (OGQ #0443). My relevant experience includes 38 years of experience in exploration and operations, including review of the Hope's Advance Iron Ore Project of Oceanic Iron Ore Corp. I am a "Qualified Person" for the purposes of National Instrument 43-101 (the "Instrument").
- My most recent personal inspection of the Property was August 14, 2013.
- I am responsible for all completed Sections of the Technical Report.
- I am independent of Canadian Metals Inc. as defined by Section 1.5 of the Instrument.
- I have no prior involvement with the Property that is the subject of the Technical Report.
- I have read the Instrument and the sections of the Technical Report that I am responsible for have been prepared in compliance with the Instrument.
- As of the date of this certificate, to the best of my knowledge, information, and belief, the sections of the Technical Report that I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Signed and dated this 6th day of December, 2013 in Montreal, Quebec.

"Original document signed and sealed by John D. Charlton, P.Geo."

John D. Charlton, P. Geo.
Director, Geology and Mining

GENIVAR Inc.

I, Mireno Dhe Paganon, Eng., of Kirkland, Quebec do hereby certify:

- I am Process Engineer with GENIVAR Inc. with a business address at 1600 blvd Rene-Lévesque, 16th Floor, Montréal, Québec H3H 1P9.
- This certificate applies to the technical report entitled Characterization study of the Langis Silica Deposit (the "Technical Report").
- I am a graduate of Metallurgical Engineering at McGill University of Montreal, Quebec (1991). I am a member in good standing of Ordre des Ingénieurs du Québec (OIQ #118862). My relevant experience includes 22 years of process engineering in mineral processing, sand and aggregate, chemical, food and pharmaceutical industries. I am a "Qualified Person" for the purposes of National Instrument 43-101 (the "Instrument").
- I have not visited the project site.
- I am responsible for section 13.0 and parts of sections 1.0, 11.0, 12.0, 25.0 and 26.0.
- I am independent of Canadian Metals Inc. as defined by Section 1.5 of the Instrument.
- I have no prior involvement with the Property that is the subject of the Technical Report.
- I have read the Instrument and the sections of the Technical Report that I am responsible for have been prepared in compliance with the Instrument.
- As of the date of this certificate, to the best of my knowledge, information, and belief, the sections of the Technical Report that I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Signed and dated this 6th day of December, 2013 in Montreal, Quebec.

"Original document signed and sealed by Mireno Dhe Paganon, Eng."

Mireno Dhe Paganon, Eng.
Process Engineer
GENIVAR Inc.

APPENDIX A

CTMP LABORATORY REPORT

Centre de technologie minérale et de plasturgie inc. (CTMP)
671, boulevard Frontenac Ouest, porte 7C
Thetford Mines (Québec) G6G 1N1
Téléphone : (418) 338-6410 Télécopieur : (418) 338-9584
ctmp@cegepth.qc.ca – www.ctmp.ca

RAPPORT D'ANALYSE

Projet : **Silica Matane (Langis) - Canadian Metal (CME)**

Numéro proposition : **R-5030 & R-5136**

Client : Canadian Metals
1200, avenue Mc Gill College, bureau 1240
Montréal (Québec) Canada H3B 4G7
Att : M. Stéphane Leblanc

Personne contact : Mireno Dhe Paganon / Claire Hayek (GENIVAR Inc.)

Représentant du CTMP : Alexandre-Sacha Leblond / Mathieu Brousseau

Date : 27/11/2013

Table des matières

Annexe

1. Demande du client

Canadian Metal (CME) entend exploiter un dépôt de silice localisé au sud de Matane afin de produire un grade dont la qualité lui permettra de se qualifier pour des utilisations dans l'industrie du verre, en fonderie, en transformation de ferrosilicium ou comme sable de fracturation.

Genivar agit comme aviseur technique auprès de CME pour le projet Langis. CME a mandaté le Centre de technologie minérale et de plasturgie inc. (CTMP) pour réaliser la caractérisation du dépôt Langis et d'évaluer le potentiel de purification de la silice.

2. Méthodes de travail utilisés par le CTMP

Phase 1 : Analyse géochimique

Préparation préliminaire des échantillons :

Pour les analyses géochimiques, 48 sacs numérotés ont été expédiés par le client. Les 48 échantillons ont été préparés individuellement par les étapes suivantes :

Les échantillons ont été concassés individuellement au concasseur à mâchoire :

- Marque : Denver
- Modèle : Crusher
- Dimension : 3¼''x4½''

Produit : granulats de 5-10 mm

Photo #01 – Concasseur à mâchoire Denver

La totalité du matériel concassé à l'étape précédente a été concassé une deuxième fois au concasseur giratoire :

- Marque : Denver
- Modèle : Gyratory crusher
- Dimension : 12''

Résultat : granulats de 0-5 mm

Photo #02 – Concasseur giratoire Denver

La totalité du produit de l'étape précédente a été concassé individuellement une troisième fois au concasseur à rouleaux :

- Marque : Denver
- Modèle : Roll crusher
- Dimension : 10''x6'' Rolls

Résultat : granulats de 1000-500 µm

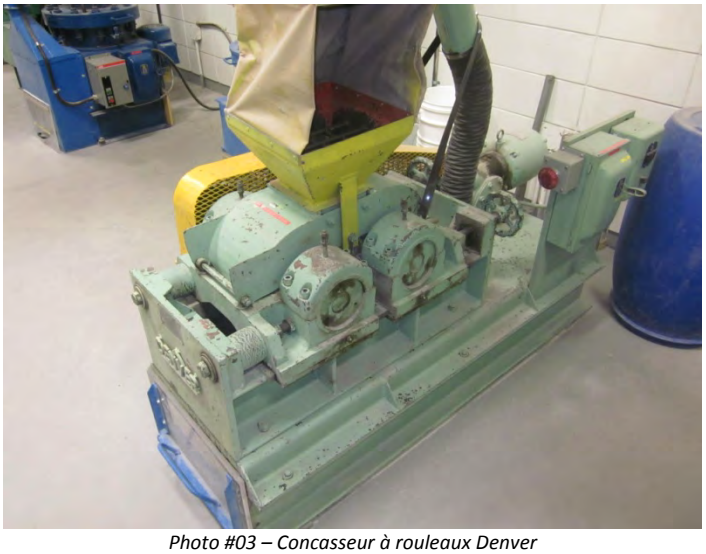


Photo #03 – Concasseur à rouleaux Denver

Préparation des pastilles d'analyse :

Pour les 48 échantillons, des pastilles d'analyses ont été préparées pour les analyses géochimiques par fluorescence X (XRF). Deux types de pastilles ont été préparés :

- Pastilles fusionnées pour les oxydes majeurs;
- Pastilles pressées pour les métaux en traces.

Voici les étapes de préparation :

Les produits de l'étape préliminaire ont été séparés dans un séparateur (splitter) et ensuite pulvérisés (±50g) à 600µm :

- Marque : Retsch
- Modèle : PM400

Résultat : particules de 75µm et moins

Photo #04 – Pulvérisateur Retsch

Les échantillons sont ensuite chauffés dans un four à 1000°C durant une heure pour effectuer une perte au feu :

- Marque : Lindberg Blue M
- Modèle : Box furnace

Photo #05 – Four Linberg Blue M – Box Furnace

Pour produire les pastilles fusionnées, un échantillon de poudre pulvérisé préalablement brassé (0,6g) a été prélevé. Ensuite, 6g de fondant (50% borate de lithium, 50% métaborate de lithium) a été ajouté. Ce mélange a été fusionné 20 minutes au Fluxeur :

- Marque : Claisse
- Modèle : M4-30 Gas fusion

Produit : pastilles fusionnées utilisées au XRF pour les oxydes majeurs

Photo #06 – Fluxeur Claisse M4-30 Gas fusion

Photo #07 – Pastille fusionnée

Pour produire les pastilles pressées, un échantillon de poudre pulvérisé préalablement homogénéisé (8g) a été prélevé, puis mélangé à 2g de liant (Cereox). Ce mélange a été pressé sur une presse de 12 tonnes pendant une minute :

- Marque : Craver
- Modèle : 4350.L

Produit : pastilles pressées utilisées au XRF pour les métaux en trace.

Photo #08 – Presse 12T Carver 4350.L

Photo #09 – Pastille pressée

Analyse géochimique :

Pour les 48 échantillons, les deux types de pastilles ont été analysés au XRF (Fluorescence à rayon X) :

- Marque : Bruker
- Modèle : S8 Tiger
- Type : WDXRF (Wavelenth dispersive)
- Puissance : 4 kW

Photo #10 – XRF Bruker S8 Tiger

Les résultats de ces analyses nous permettent de quantifier la teneur en métal totale dans le minerai. L'appareil convertit automatiquement par calcul cette teneur élémentaire en teneur en oxyde majeur et en métaux en trace. À titre d'exemple, le fer (Fe) est convertit en sa forme la plus abondante : l'hématite (Fe_2O_3). S'il y a de la magnétite (Fe_3O_4) en présence, celle-ci a été ramené sous forme hématite.

La procédure utilisée pour vérifier l'appareil XRF avant une analyse sur l'étendue en concentrations d'oxydes majeurs de 0,01 à 100% a été développée par Bruker. Tel qu'indiqué dans les deux tableaux suivants, avec la courbe de calibration et les standards de calibration actuels, les seuils de détection sont au mieux de 0,01%.

Tableau: Seuil de détection des oxydes majeurs

Oxyde	Étendue	
	Min. (%)	Max. (%)
Na_2O	0,02	11,00
MgO	0,02	100,00
Al_2O_3	0,04	90,00
SiO_2	0,4	100,00
P_2O_5	0,01	20,00
SO_3	0,05	55,00
K_2O	0,05	15,00
CaO	0,02	100,00
TiO_2	0,01	8,00
MnO	0,01	0,80
$Fe_2O_{3\,(t)}$	0,01	40,00

Tableau: Seuil de détection des éléments traces

Élément / composé	Teneur	
	Min (ppm)	Max (ppm)
Sc	1,6	60
V	1,4	340
Cr	3,3	24000
Co	2,2	700
Ni	1,5	2640
Cu	4,7	5400
Zn	3,8	1310
Ga	0,7	400
As	2,9	330
Rb	0,9	1300
Sr	0,9	1650
Y	6,5	800
Zr	4,9	550
Nb	0,6	700
Mo	1	700
Sn	3,1	1300
Sb	1,7	122
Cs	4,7	260
Ba	5	4000
La	5,2	1340
Ce	4	2230
Pb	1,5	5500
Th	12,6	1003
U	1,5	650

Les standards utilisés sont des matériaux de référence certifiée (MRC). La méthode utilisée consiste à vérifier l'état de l'appareil avec le standard de vérification BRSTG2 (voir composition et tolérance en Annexe F). Ensuite, avant chaque série de tests XRF, la dérive de la courbe de calibration a été vérifiée avec trois standards de contrôle de qualité : QC_GEOMAJ-01, QC_GEOMAJ-02 et QC_GEOMAJ-03. Les concentrations de ces échantillons témoins sont fournies dans le tableau qui suit. Une tolérance visée pour chaque élément doit être rencontrée afin de pouvoir passer à l'analyse des échantillons.

Tableau: Composition des témoins MRC de calibration

	QC_GEOMAJ-01	QC_GEOMAJ-02	QC_GEOMAJ-03
Oxyde :	Rock	Feldspar	Sillimanite
SiO2	64.890	29.208	34.840
Al2O3	16.567	8.035	58.800
TiO2	0.823	0.411	1.830
Fe2O3	4.857	4.619	2.060
Mn3O4	0.092	0.440	0.030
CaO	2.542	31.613	0.140
MgO	0.864	18.900	0.100
Na2O	3.149	2.023	0.050
K2O	5.320	4.032	0.180
P2O5	0.370	0.088	0.100
SO3	0.062	T	0.070
SUM	99.42	99.37	98.20
L.O.I.	2.82	31.8	0

Pour valider la courbe de calibration sur le bas de la courbe, l'échantillon MRC GEOMAJ-15 a été utilisé. L'échantillon GEOMAJ-06 a été sélectionné en début de projet comme témoin représentatif de la silice brute et a permis de confirmer la précision d'analyse. La composition de ces deux témoins est fournie au tableau qui suit.

Tableau: Composition des standards MRC

	GEOMAJ-15	GEOMAJ-06
Oxyde :	Silica	Sediment
SiO2	99.880	91.526
Al2O3	0.036	2.924
TiO2	0.017	0.216
Fe2O3	0.012	3.974
Mn3O4	T	0.134
CaO	0.006	0.721
MgO	T	0.124
Na2O	T	0.041
K2O	0.005	0.134
P2O5	T	0.062
SO3	T	0.021
SUM	99.96	99.88
L.O.I.	0.1	2.88

Des 48 échantillons (96 pastilles), six échantillons ont été effectués en triplicata afin d'évaluer la répétabilité des manipulations décrites à la section 2 et de mesure du XRF.

L'erreur de mesure sur les 18 pastilles fusionnées et 18 pastilles pressées est présentée aux pages 20 à 22.

Phase 2 : Caractérisation physique de la silice

Séparation et récupération de la silice :

Pour chaque carotte, les sacs d'échantillons pour les essais ont été mélangés, donnant trois échantillons. Chacun de ces échantillons a été concassé et broyé suivant la même méthode qu'en Phase 1. Ceux-ci ont été divisés en deux : une moitié pour les essais de caractérisation physique et l'autre moitié pour en réserve.

La portion retenue pour les essais de caractérisation physique a été mélangée et ensuite divisée en sacs de 2 kg pour être soumis aux étapes de traitement suivantes.

Détermination du temps de contact à l'attriteur :

Le temps optimum d'attrition a été déterminé à partir de l'échantillon 3.

- Prendre deux sacs et les tamiser à sec sur le tamis Gilson de 30 mesh (600µm).

Photo #11 – Tamis Gilson

- Laver le -600 µm pendant 5 minutes à l'eau sur un tamis Sweco 150 mesh (106 µm).

Photo #12 – Tamis Sweco

- Filtrer (Whatman 114, 25 µm) le contenu de chaque chaudière sur une plaque syphon et ensuite sécher et peser séparément les fractions retenues et passantes;

Photo #13 – Plaque filtrante

Du matériel passant 600 µm et retenu 106 µm (-600, +106 µm), réserver la masse requise de silice pour quatre essais d'attrition. Avec le matériel excédentaire, effectuer la distribution granulométrique et pulvériser le reste au Retsch pour analyse XRF;

- Pulvériser au Retsch la totalité de la fraction passante 100 µm et analyser au XRF;

- Séparer en quatre le matériel passant 600 µm et retenu 100 µm (-600, +106 µm) pour quatre essais d'attrition indépendants;

- Préparer le mélange de pulpe 75% s/s (i.e. 950g de silice dans 320g d'eau) totalisant un volume de pulpe de 750 ml dans le contenant rectangulaire de 1 litre;

- Mélanger avec l'appareil de flottation Metso à 1000 rpm avec l'hélice marine pendant différents temps de contact : 1, 3, 5 et 10 min, indépendamment.

Photo #14 – Cellule d'attrition Metso

On a procédé à un second lavage à l'eau pendant 1 minute sur un petit tamis 150 mesh (106µm) disposé sur une plaque syphon. Les fractions retenues sur la toile et sur le filtre (Whatman 114, 25 µm) ont été séchées et pesées. Un sous-échantillon représentatif de la fraction retenue sur la toile a été analysé pour la granulométrie et le reste a été pulvérisé au Retsch avant d'être passé au XRF. La fraction récupérée sur le filtre a été entièrement pulvérisée puis analysée au XRF.

Purification de la silice par des étapes de traitement successives:

Un temps d'attrition optimal de 5 minutes a été établi en 1.1. Les envois 1 et 2 ont été traités suivant la même procédure. La totalité de chaque envoi a été traitée suivant les étapes 1 à 8 décrites précédemment, sauf l'étape 7 qui consistait en une série d'attritions de 5 minutes.

Ensuite, pour enlever les oxydes de fer, le produit lavé retenu à 106µm a été repulpé et passé dans un séparateur magnétique humide à haute intensité (WHIMS) Outotec (modèle 3x4L). À 30% s/s, la pulpe s'écoulait bien sur un lit de billes d'acier AISI 420-C de ½ po. Avec cette taille de billes et un courant de 5.9 ampères, un champ magnétique d'environ 20 kGauss a été généré.

Photo #15 – Séparateur magnétique WHIMS

Chaque fraction a ensuite été filtrée (Whatman 114, 25 µm), séchée puis pesée. Un sous-échantillon représentatif de la fraction non-magnétique a été analysé pour la granulométrie et un autre échantillon a été pulvérisé au Retsch avant d'être passé au XRF. La fraction magnétique a été entièrement pulvérisée puis analysée au XRF.

Phase 2 : Analyse de sphéricité et de rondeur

Analyse de sphéricité et de rondeur avant concassage et broyage

Des morceaux de carottes ont été prélevés aléatoirement et passés au four à 1000°C pendant 15 minutes (Four Lindberg Blue M, Box furnace). Ensuite, les morceaux ont été refroidis dans l'eau pendant environ 2 heures.

Photo #16 –Échantillons à 1000°C

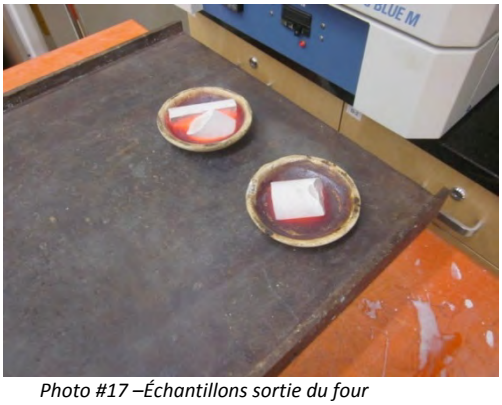


Photo #17 –Échantillons sortie du four

Les particules ont été libérées à l'aide de légers chocs mécaniques. Le produit a été attrité pendant 5 minutes, tamisé et séparé en fractions suivantes :

- -20/+40 mesh;
- -30/+50 mesh;
- -40/+70 mesh.

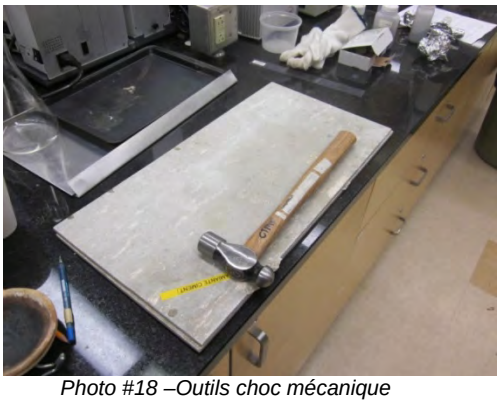


Photo #18 –Outils choc mécanique

Photo #19 –Libération des particules

Pour chacune de ces fractions, des photographies par microscopie optique ont été prises pour analyser la rondeur et la sphéricité des particules.

Analyse de sphéricité et de rondeur après purification de la silice

Pour cette analyse, nous avons prélevé nos échantillons dans le produit non-magnétique attrité 5 minutes après la séparation magnétique de l'envoi #1 et #3.

Les deux échantillons ont été tamisés individuellement et séparés en fractions suivantes :

- -20/+40 mesh;
- -30/+50 mesh;
- -40/+70 mesh.

Pour chacune de ces fractions de l'envoi #1 et #3, des photographies par microscopie optique ont été prises pour analyser la rondeur et la sphéricité des particules.

Phase 3 : Essai de résistance thermique de la silice

Traitement thermique des échantillons

Pour l'essai de résistance thermique de la silice, 12 échantillons ont été expédiés par le client. Trois de ces échantillons sont des blocs de surface de 4 pouces cube de dimension. Les 9 autres sont des sections de carottes de forage d'environ 2 pouces de diamètre et 4 pouces de long.

Les 12 échantillons ont été insérés individuellement dans un four à 1000°C pour une durée entre 20 et 50 minutes et, ensuite, refroidis à l'air ambiant. Le four utilisé est :

- Marque : Lindberg Blue M
- Modèle : Box furnace

Photo #20 – Four Linberg Blue M – Box Furnace

Choc mécanique et perte au feu:

Un calcul de poids a été fait avant et après le traitement thermique au four. La perte au feu a été calculée avec ces données.

Photo #21 –Échantillon section de carotte à 1000°C

Photo #22 –Échantillon section de carotteen refroidissement

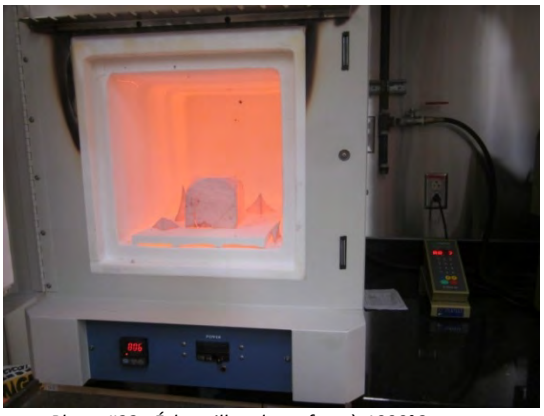


Photo #23 –Échantillon de surface à 1000°C

Photo #24 –Échantillon de surface en refroidissement

Chaque échantillon a subi un léger choc mécanique manuel. Ensuite, l'échantillon a été passé au tamis 12.5 mm afin de calculer le pourcentage de particules passantes pour l'analyse de l'essai.

Phase 4 : Essai pour sable de fractionnement (norme Frac Sand API 19C)

Suite aux analyses de rondeur et de la sphéricité, les fractions ayant les meilleurs résultats sont sélectionnées pour l'essai de résistance à l'écrasement.

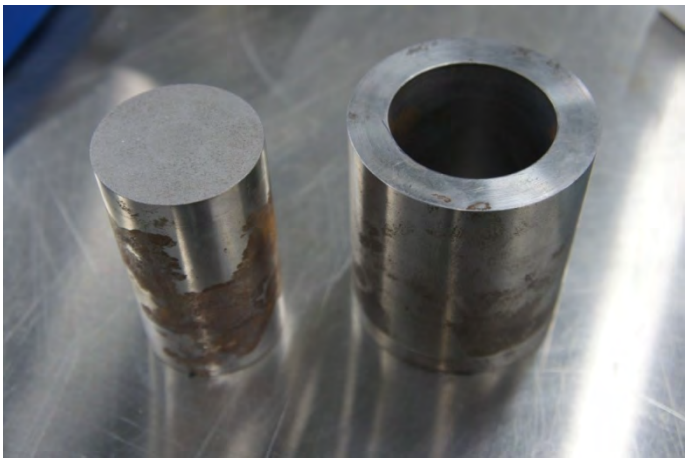


Photo #25 – Cellule de compression

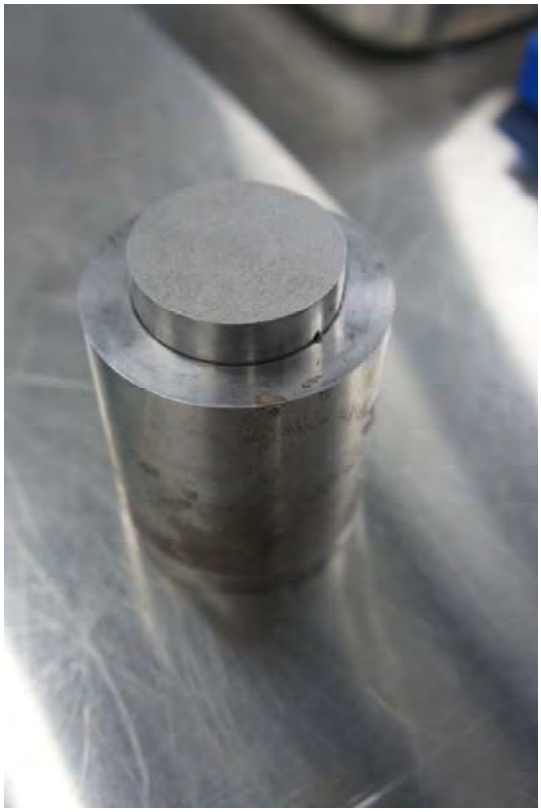


Photo #26 – Cellule de compression

Photo #27 –Presse hydaulique

Essai de résistance à l'écrasement (Crush resistance test) :

Les fractions 20/40 et 30/50 du produit non-magnétique attrité 5 minutes de l'envoi #3 ont été testées sur une presse hydraulique. La pression a été augmentée par étapes successives de 4000 psi à 8000 psi avec des intervalles de 1000 psi. Après chaque essai, un tamisage a été effectué pour calculer le pourcentage de particules broyées passant sur le tamis inférieur de la fraction testée.

Essais autres pour le sable de fractionnement :

Les tests suivant l'essai de résistance à l'écrasement ont été annulés, puisque les résultats de l'essai de résistance à l'écrasement étaient négatifs.

3. Résultats

L'analyse suivante est faite en fonction des données brutes de laboratoire présentes dans les annexes A à E.

Phase 1 : Analyse géochimique

Résultats des oxydes majeurs

Les valeurs suivantes ont été obtenues à partir des analyses XRF des pastilles fusionnées. Les résultats sont en **annexe A**.

Tableau 1 : Analyse d'oxydes majeurs pour les 18 échantillons

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179751	76,67	4,43	6,30	0,69	0,73	0,02	0,05	0,04	0,05	0,37	0,01	9,72	0,03	99,10
P179752	98,15 a	0,16	0,07	0,31	0,67	0,01	0,03	0,16	0,04	< 0,01	0,01	0,37	0,02	100,00
P179753	99,27 a	0,02	0,02	0,16	0,20	0,01	0,03	0,06	0,04	< 0,01	< 0,01	0,17	0,02	100,00
P179754	99,16 a	0,03	0,02	0,12	0,26	0,01	0,08	0,07	0,03	< 0,01	0,01	0,19	0,02	100,00
P179755	3,22	0,53	51,56	0,22	0,43	0,01	0,04	0,10	0,03	0,07	0,01	41,89	0,03	98,14
P179756	99,24 a	0,01	0,10	0,06	0,23	0,01	0,03	0,05	0,04	< 0,01	< 0,01	0,21	0,02	100,00
P179757	98,92 a	0,08	0,02	0,13	0,43	0,01	0,02	0,07	0,05	< 0,01	0,01	0,24	0,02	100,00
P179758	98,81 a	0,03	0,31	0,12	0,25	0,01	0,03	0,04	0,04	< 0,01	< 0,01	0,34	0,02	100,00
P179759	98,92 a	0,07	0,03	0,12	0,33	0,01	0,19	0,05	0,04	< 0,01	0,01	0,21	0,02	100,00
P179760	98,83 a	0,08	0,02	0,16	0,42	0,01	0,03	0,05	0,06	< 0,01	0,01	0,30	0,03	100,00
P179761	97,67 a	0,16	0,33	0,21	0,68	0,01	0,11	0,11	0,06	0,03	0,01	0,48	0,03	99,86
P179762	98,46 a	0,13	0,11	0,13	0,57	0,01	0,03	0,06	0,06	< 0,01	0,01	0,33	0,02	99,90
P179763	98,26 a	0,16	0,09	0,17	0,64	0,01	0,03	0,06	0,07	< 0,01	0,01	0,37	0,02	99,87
P179764	97,76 a	0,27	0,12	0,20	0,91	0,01	0,04	0,06	0,06	< 0,01	0,01	0,49	0,02	99,93
P179765	99,31 a	0,01	0,03	0,10	0,15	0,01	0,03	0,05	0,03	< 0,01	< 0,01	0,24	0,03	100,00
P179766	4,37	0,49	51,84	0,35	0,82	0,01	0,04	0,24	0,05	0,16	0,01	41,00	0,02	99,40
P179767	99,36 a	< 0,01	0,06	0,06	0,15	< 0,01	0,03	0,05	0,04	< 0,01	< 0,01	0,23	0,02	100,00
P179768	99,38 a	< 0,01	0,02	< 0,01	0,22	0,01	0,03	0,07	0,03	< 0,01	< 0,01	0,22	0,02	100,00
P179769	98,99 a	0,06	0,02	0,10	0,36	0,01	0,01	0,08	0,05	< 0,01	< 0,01	0,29	0,03	100,00
P179770	99,20 a	0,03	0,01	0,06	0,29	0,01	0,03	0,07	0,04	< 0,01	< 0,01	0,24	0,02	100,00
P179771	99,16 a	0,04	0,01	0,05	0,31	0,01	0,04	0,06	0,04	< 0,01	0,01	0,25	0,02	100,00
P179772	98,85 a	0,08	0,02	0,13	0,44	0,01	0,05	0,06	0,05	< 0,01	0,01	0,28	0,02	100,00
P179773	99,38 a	< 0,01	0,01	0,08	0,19	0,01	0,02	0,05	0,04	< 0,01	< 0,01	0,20	0,02	100,00
P179774	98,94 a	0,06	0,01	0,10	0,41	0,01	0,03	0,08	0,05	< 0,01	0,01	0,27	0,03	100,00

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179775	98,70 a	0,09	0,03	0,09	0,44	0,01	0,04	0,05	0,06	< 0,01	< 0,01	0,33	0,02	99,84
P179776	97,70 a	0,27	0,09	0,23	0,95	0,01	0,06	0,09	0,05	< 0,01	0,01	0,45	0,02	99,91
P179777	98,00 a	0,20	0,06	0,17	0,80	0,01	0,05	0,10	0,06	< 0,01	0,01	0,42	0,02	99,88
P179778	99,00 a	0,06	0,05	0,07	0,36	< 0,01	0,03	0,05	0,05	< 0,01	0,01	0,25	0,02	99,93
P179779	98,83 a	0,08	0,06	0,09	0,43	0,01	0,02	0,06	0,06	< 0,01	0,01	0,27	0,02	99,92
P179780	97,85 a	0,16	0,06	0,34	0,91	0,01	0,03	0,16	0,08	< 0,01	0,01	0,37	0,02	100,00
P179781	98,68 a	0,10	0,07	0,18	0,47	0,01	0,04	0,09	0,06	< 0,01	0,01	0,27	0,02	100,00
P179781-R	98,67 a	0,09	0,07	0,19	0,49	0,01	0,04	0,08	0,06	< 0,01	0,01	0,27	0,02	100,00
P179782	97,64 a	0,24	0,19	0,19	0,89	0,01	0,15	0,18	0,07	< 0,01	0,01	0,41	0,02	100,00
P179783	97,66 a	0,26	0,07	0,20	1,03	0,01	0,04	0,15	0,08	< 0,01	0,01	0,47	0,02	100,00
P179784	98,83 a	0,08	0,02	0,11	0,45	0,01	0,04	0,05	0,06	< 0,01	0,01	0,32	0,02	100,00
P179785	99,44 a	0,02	0,02	0,03	0,21	0,01	0,02	0,04	0,03	< 0,01	< 0,01	0,16	0,02	100,00
P179786	99,26 a	0,05	0,02	0,06	0,29	0,01	0,02	0,04	0,04	< 0,01	< 0,01	0,19	0,02	100,00
P179787	98,74 a	0,15	0,03	0,10	0,54	0,01	0,03	0,06	0,04	< 0,01	< 0,01	0,29	0,02	100,00
P179788	17,92	0,56	44,30	0,30	0,94	0,01	0,04	0,23	0,05	0,04	0,01	35,41	0,03	99,81
P179789	98,61 a	0,15	0,13	0,13	0,49	0,01	0,03	0,06	0,04	< 0,01	< 0,01	0,33	0,02	100,00
P179790	99,53 a	< 0,01	0,02	0,06	0,14	0,01	0,02	0,03	0,03	< 0,01	0,01	0,13	0,02	100,00
P179791	98,92 a	0,08	0,02	0,11	0,39	0,01	0,04	0,05	0,05	< 0,01	0,01	0,30	0,02	100,00
P179792	99,51 a	< 0,01	0,01	0,04	0,17	0,01	0,04	0,03	0,03	< 0,01	< 0,01	0,14	0,02	100,00
P179793	99,28 a	0,04	0,01	0,08	0,27	0,01	0,03	0,03	0,04	< 0,01	< 0,01	0,19	0,02	100,00
P179794	99,00 a	0,10	0,02	0,05	0,36	0,01	0,12	0,04	0,04	< 0,01	0,01	0,23	0,02	100,00
P179795	98,78 a	0,13	0,06	0,07	0,51	0,01	0,04	0,04	0,04	< 0,01	0,01	0,29	0,02	100,00
P179796	98,95 a	0,09	0,07	0,09	0,38	0,01	0,04	0,04	0,04	< 0,01	0,01	0,26	0,02	100,00
P179797	98,63 a	0,13	0,08	0,13	0,45	0,01	0,13	0,06	0,05	< 0,01	0,01	0,29	0,03	100,00
P179798	86,08 a	2,39	2,69	1,08	2,29	0,02	0,05	0,45	0,13	0,02	0,01	4,79	0,00	100,00

Les valeurs des oxydes majeurs peuvent être séparées en trois groupes :

- Le premier groupe comporte les échantillons ayant une faible teneur en SiO_2. Pour ces échantillons on observe une haute teneur en CaO et une grande perte au feu. Nous pouvons évaluer ces échantillons comme une intrusion de carbonate dans le sol.

  Voici les échantillons concernés :

- **P179755**
- **P179766**
- **P179788**

- Le deuxième groupe comporte les échantillons ayant une teneur en SiO_2 moins élevée que la majorité des échantillons. Pour ces échantillons on observe une teneur légèrement plus élevée en MgO, CaO, Fe_2O_3, Al_2O_3, SO_3 et une perte au feu plus élevée que la majorité des échantillons, mais plus bas que le premier groupe.

  Voici les échantillons concernés :
  - **P179751**
  - **P179798**

- Le troisième groupe comporte la majorité des échantillons, qui ont une teneur très élevée en SiO_2. Pour ces échantillons on observe une teneur légère en Fe_2O_3 et Al_2O_3.

  Voici les échantillons concernés :

- **P179752**	- **P179769**	- **P179784**
- **P179753**	- **P179770**	- **P179785**
- **P179754**	- **P179771**	- **P179786**
- **P179756**	- **P179772**	- **P179787**
- **P179757**	- **P179773**	- **P179789**
- **P179758**	- **P179774**	- **P179790**
- **P179759**	- **P179775**	- **P179791**
- **P179760**	- **P179776**	- **P179792**
- **P179761**	- **P179777**	- **P179793**
- **P179762**	- **P179778**	- **P179794**
- **P179763**	- **P179779**	- **P179795**
- **P179764**	- **P179780**	- **P179796**
- **P179765**	- **P179781**	- **P179797**
- **P179767**	- **P179782**	
- **P179768**	- **P179783**	

Résultats des métaux en traces

Les valeurs suivantes ont été obtenues à partir des analyses XRF des pastilles pressées. Les résultats sont en **annexe A**.

Tableau 2 : Analyse des éléments en traces pour les 18 échantillons

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179751	4	4	56	< 2	7	6	4	1	36	< 1	25	52	5	6	< 3	13	< 5	14	10	< 4	7	< 13	3	ND
P179752	< 2	6	82	< 2	5	< 5	4	1	10	< 1	12	43	6	6	3	11	< 5	20	10	< 4	4	< 13	3	ND
P179753	< 2	2	76	< 2	3	< 5	< 4	1	7	< 1	11	53	6	6	4	12	< 5	13	11	< 4	3	< 13	3	ND
P179754	< 2	3	32	< 2	4	< 5	< 4	1	4	< 1	14	60	7	6	4	13	< 5	16	11	< 4	4	< 13	3	ND
P179755	39	5	< 3	< 2	6	8	6	2	3	1	170	11	2	6	< 3	8	5	13	15	< 4	9	< 13	4	ND
P179756	< 2	< 2	33	< 2	3	< 5	< 4	1	< 3	< 1	11	55	6	6	3	12	< 5	14	11	< 4	2	< 13	3	ND
P179757	< 2	3	37	< 2	4	< 5	< 4	2	6	< 1	15	46	6	6	3	13	< 5	13	11	< 4	7	< 13	3	ND
P179758	< 2	3	37	< 2	4	< 5	< 4	1	< 3	< 1	13	65	8	6	4	13	< 5	13	11	< 4	4	< 13	3	ND
P179759	< 2	4	34	< 2	4	5	< 4	1	3	< 1	18	73	7	6	< 3	12	< 5	13	11	< 4	5	< 13	3	ND
P179760	< 2	6	48	< 2	5	< 5	< 4	1	6	1	14	113	11	6	5	13	< 5	17	11	< 4	5	< 13	3	ND
P179761	< 2	5	44	< 2	5	5	< 4	1	3	1	37	78	8	6	4	12	< 5	28	11	4	6	< 13	3	NA
P179762	< 2	4	52	< 2	3	< 5	< 4	2	< 3	< 1	20	52	7	6	< 3	12	< 5	21	11	< 4	5	< 13	3	NA
P179763	< 2	3	59	< 2	3	< 5	< 4	1	3	< 1	20	71	8	6	5	14	< 5	16	11	< 4	6	< 13	3	NA
P179764	< 2	2	24	< 2	4	< 5	< 4	1	< 3	< 1	29	38	5	6	3	12	< 5	19	10	< 4	6	< 13	3	NA
P179765	< 2	2	37	< 2	3	< 5	< 4	1	< 3	< 1	8	104	9	6	3	14	< 5	13	11	< 4	2	< 13	3	ND
P179766	39	6	< 3	< 2	< 2	5	8	1	< 3	5	164	4	2	6	< 3	9	5	13	14	< 4	6	< 13	4	ND
P179767	< 2	3	68	< 2	5	< 5	< 4	1	< 3	< 1	7	43	6	6	4	13	< 5	15	11	< 4	< 2	< 13	3	ND
P179768	< 2	4	32	< 2	3	< 5	< 4	1	< 3	< 1	8	39	5	6	< 3	12	< 5	13	11	< 4	2	< 13	3	ND
P179769	< 2	3	77	< 2	6	< 5	< 4	1	4	< 1	13	111	11	6	4	13	< 5	17	11	< 4	3	< 13	3	ND
P179770	< 2	3	45	< 2	3	< 5	< 4	1	< 3	< 1	15	52	6	6	< 3	12	< 5	16	11	< 4	3	< 13	3	ND
P179771	< 2	4	45	< 2	2	< 5	< 4	1	< 3	< 1	24	57	7	6	3	11	< 5	14	11	< 4	4	< 13	3	ND
P179772	< 2	5	66	< 2	5	< 5	< 4	1	< 3	< 1	31	88	9	6	3	12	6	13	11	< 4	6	< 13	3	ND
P179773	< 2	3	75	< 2	2	< 5	< 4	1	< 3	< 1	11	53	7	6	3	12	< 5	14	11	< 4	2	< 13	3	ND
P179774	< 2	4	58	< 2	4	< 5	< 4	1	4	< 1	20	38	5	6	4	13	< 5	15	11	< 4	5	< 13	3	ND
P179775	< 2	4	42	< 2	4	< 5	< 4	1	< 3	< 1	15	91	9	6	< 3	12	6	18	11	< 4	4	< 13	3	NA
P179776	< 2	5	12	< 2	3	< 5	< 4	2	< 3	< 1	21	57	7	6	5	13	< 5	22	10	< 4	5	< 13	3	NA
P179777	< 2	3	27	< 2	4	< 5	< 4	2	4	1	19	68	8	6	3	13	< 5	20	11	< 4	5	< 13	3	NA
P179778	< 2	4	36	< 2	3	< 5	< 4	1	< 3	< 1	11	38	5	6	4	13	8	16	11	< 4	< 2	< 13	3	NA
P179779	< 2	5	41	< 2	3	< 5	< 4	1	< 3	< 1	12	43	6	6	5	12	< 5	13	11	5	3	< 13	3	NA
P179780	< 2	7	57	< 2	5	< 5	4	1	< 3	1	22	30	6	6	4	12	5	22	10	5	6	< 13	3	NA

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179781	< 2	4	38	< 2	3	< 5	< 4	1	3	< 1	18	26	4	6	5	13	< 5	20	11	< 4	3	< 13	3	NA
P179782	< 2	7	51	< 2	4	< 5	4	2	3	1	25	27	5	6	4	14	< 5	26	10	5	4	< 13	3	NA
P179783	< 2	6	42	< 2	6	< 5	< 4	2	4	1	21	36	6	6	4	12	< 5	23	10	< 4	4	< 13	3	NA
P179784	< 2	4	42	< 2	4	< 5	< 4	1	< 3	< 1	16	61	7	6	5	13	< 5	16	11	< 4	5	< 13	3	NA
P179785	< 2	2	17	< 2	3	< 5	< 4	1	4	< 1	10	97	9	6	3	13	< 5	15	11	< 4	2	< 13	3	NA
P179786	< 2	3	32	< 2	3	< 5	< 4	1	4	< 1	14	46	6	6	5	13	10	16	11	< 4	3	< 13	3	NA
P179787	< 2	5	15	< 2	3	< 5	< 4	1	4	< 1	14	39	5	6	4	11	< 5	17	11	< 4	4	< 13	3	NA
P179788	32	8	< 3	< 2	3	< 5	8	2	< 3	5	144	< 6	2	6	< 3	9	10	13	14	< 4	4	< 13	4	NA
P179789	< 2	5	66	< 2	4	< 5	< 4	1	< 3	< 1	9	72	8	6	3	12	< 5	13	11	< 4	< 2	< 13	3	NA
P179790	< 2	3	42	< 2	4	< 5	< 4	1	< 3	< 1	9	48	6	6	5	12	< 5	13	11	< 4	2	< 13	3	NA
P179791	< 2	5	41	< 2	3	< 5	< 4	1	< 3	< 1	16	54	7	6	4	13	< 5	16	11	< 4	4	< 13	3	NA
P179792	< 2	2	27	< 2	3	< 5	< 4	0	< 3	< 1	10	73	8	6	3	12	< 5	13	11	< 4	2	< 13	3	NA
P179793	< 2	3	48	< 2	3	< 5	< 4	1	< 3	< 1	12	36	5	6	4	15	< 5	13	11	< 4	3	< 13	3	NA
P179794	2	2	35	< 2	3	< 5	< 4	1	< 3	< 1	15	35	5	6	4	13	8	14	11	< 4	5	< 13	3	NA
P179795	< 2	5	21	< 2	3	< 5	< 4	1	4	< 1	27	69	7	6	4	13	< 5	15	11	< 4	9	< 13	3	NA
P179796	< 2	3	34	< 2	3	< 5	< 4	1	< 3	< 1	30	74	8	6	5	13	< 5	13	11	< 4	6	< 13	3	NA
P179797	< 2	4	49	< 2	3	< 5	< 4	1	3	< 1	15	69	8	6	4	12	< 5	15	11	< 4	4	< 13	3	NA
P179798	2	17	84	< 2	8	6	7	3	< 3	12	28	28	7	6	3	12	5	62	9	15	8	< 13	3	NA

Dans cette analyse, il y a présence de certains éléments en trace à des teneurs plus grandes que 100 ppm, comme Yttrium (Y) sur les échantillons P179761, P179765 et P179769 et du Strontium (Sr) dans les échantillons P179755, P179766 et P179788. Cependant, pour l'ensemble des métaux en traces, il n'y a aucune donnée marquante.

Résultats des triplicatas :

Les valeurs suivantes ont été obtenues à partir des analyses XRF des pastilles fusionnées et pressées supplémentaires. Les résultats sont en **annexe A**.

Voici les tableaux des résultats pour les triplicatas des oxydes majeurs :

Tableau 3 : Triplicatas effectués pour évaluer l'erreur de mesure

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179752-a	98,15 (1)	0,16	0,07	0,31	0,67	0,01	0,03	0,16	0,04	< 0,01	0,01	0,37	0,02	100,00
P179752-b	98,08 (1)	0,16	0,07	0,32	0,69	0,01	0,03	0,16	0,05	< 0,01	0,01	0,39	0,03	100,00
P179752-c	98,16 (1)	0,17	0,07	0,30	0,66	0,01	0,05	0,16	0,05	< 0,01	0,01	0,33	0,03	100,00
P179761-a	97,78 (1)	0,16	0,33	0,21	0,68	0,01	0,11	0,11	0,06	0,03	0,01	0,48	0,03	100,00
P179761-b	97,82 (1)	0,16	0,33	0,21	0,66	0,01	0,08	0,11	0,07	< 0,01	0,01	0,51	0,03	100,00
P179761-c	97,90 (1)	0,15	0,33	0,20	0,70	0,01	0,08	0,10	0,07	< 0,01	0,01	0,42	0,03	100,00
P179770-a	99,20 (1)	0,03	0,01	0,06	0,29	0,01	0,03	0,07	0,04	< 0,01	< 0,01	0,24	0,02	100,00
P179770-b	99,24 (1)	0,03	0,01	0,08	0,28	0,01	0,02	0,07	0,04	< 0,01	0,01	0,19	0,02	100,00
P179770-c	99,22 (1)	0,04	0,02	0,07	0,31	0,01	0,04	0,07	0,04	< 0,01	0,01	0,15	0,02	100,00
P179772-a	98,84 (1)	0,08	0,02	0,13	0,44	0,01	0,05	0,06	0,05	< 0,01	0,01	0,28	0,03	100,00
P179772-b	98,91 (1)	0,09	0,02	0,13	0,40	0,01	0,05	0,06	0,05	< 0,01	0,01	0,24	0,03	100,00
P179772-c	98,98 (1)	0,08	0,02	0,12	0,41	0,01	0,04	0,06	0,05	< 0,01	0,01	0,19	0,03	100,00
P179780-a	97,85 (1)	0,16	0,06	0,34	0,91	0,01	0,03	0,16	0,08	< 0,01	0,01	0,37	0,02	100,00
P179780-b	97,83 (1)	0,17	0,06	0,36	0,86	0,01	0,04	0,16	0,08	< 0,01	0,01	0,40	0,02	100,00
P179780-c	97,88 (1)	0,17	0,06	0,34	0,90	0,01	0,03	0,16	0,08	< 0,01	0,01	0,34	0,02	100,00
P179794-a	99,00 (1)	0,10	0,02	0,05	0,36	0,01	0,12	0,04	0,04	< 0,01	0,01	0,23	0,02	100,00
P179794-b	99,05 (1)	0,10	0,01	0,07	0,39	0,01	0,05	0,04	0,04	< 0,01	< 0,01	0,22	0,02	100,00
P179794-c	99,18 (1)	0,08	0,01	0,05	0,35	0,01	0,03	0,03	0,04	< 0,01	0,01	0,19	0,02	100,00

Le tableau 4 présente les écarts types et la marge d'erreur calculée comme le produit de 1,96 (intervalle de confiance à 95%) et de la moyenne des écarts-type pour un oxyde donné.

Tableau 4 : Écarts-type et calcul de la marge d'erreur

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179752	0,044	0,006	0,000	0,010	0,015	0,000	0,012	0,000	0,006	NA	0,000	0,031	0,006	0,000
P179761	0,061	0,006	0,000	0,006	0,020	0,000	0,017	0,006	0,006	NA	0,000	0,046	0,000	0,000
P179770	0,020	0,006	0,006	0,010	0,015	0,000	0,010	0,000	0,000	NA	0,000	0,045	0,000	0,000
P179772	0,070	0,006	0,000	0,006	0,021	0,000	0,006	0,000	0,000	NA	0,000	0,045	0,000	0,000
P179780	0,025	0,006	0,000	0,012	0,026	0,000	0,006	0,000	0,000	NA	0,000	0,030	0,000	0,000
P179794	0,093	0,006	0,012	0,021	0,000	0,047	0,006	0,000	NA	NA	0,021	0,000	0,000	0,000
Moyenne	0,052	0,006	0,003	0,011	0,016	0,008	0,009	0,001	0,002	NA	0,003	0,033	0,001	0,000
Marge d'erreur	0,102	0,011	0,006	0,021	0,032	0,015	0,018	0,002	0,005	NA	0,007	0,064	0,002	NA

Ainsi, une teneur d'oxyde de fer à 300 ppm serait exprimée comme suit : 0,03±0,021%. On constate que la marge d'erreur est assez grande sur les impuretés aux concentrations mesurées. L'**annexe A** présente les seuils de détection de l'appareil pour une calibration standard :

- SiO_2 : 0,40 – 100,00%;
- Fe_2O_3 : 0,01 – 40,00%;
- Al_2O_3 : 0,04 – 90,00%;
- TiO_2 : 0,01 – 8,00%.

Voici les tableaux des résultats pour les triplicatas des métaux en traces :

Tableau 5 : Triplicatas sur les éléments en traces

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179752-a	< 2	6	82	< 2	5	< 5	4	1	10	< 1	12	43	6	6	3	11	4	20	10	< 4	4	< 13	3	NA
P179752-b	< 2	4	113	< 2	5	< 5	< 4	1	10	< 1	12	43	6	6	4	13	4	21	10	< 4	4	< 13	3	NA
P179752-c	< 2	4	97	< 2	6	< 5	< 4	2	11	< 1	12	44	6	6	4	14	4	19	10	< 4	5	< 13	3	NA
P179761-a	< 2	5	44	< 2	5	5	< 4	1	3	1	37	78	8	6	4	12	4	28	11	4	6	< 13	3	NA
P179761-b	< 2	3	48	< 2	6	< 5	< 4	2	< 3	1	37	78	8	6	4	14	4	25	11	< 4	8	< 13	3	NA
P179761-c	< 2	5	47	< 2	4	5	< 4	1	3	1	37	78	9	6	4	14	4	29	11	7	7	< 13	3	NA
P179770-a	< 2	3	45	< 2	3	< 5	< 4	1	< 3	< 1	15	52	6	6	< 3	12	4	16	11	< 4	3	< 13	3	NA
P179770-b	< 2	4	44	< 2	3	< 5	< 4	1	< 3	< 1	16	53	7	6	3	11	4	16	11	< 4	2	< 13	3	NA
P179770-c	< 2	4	35	< 2	4	< 5	< 4	1	< 3	< 1	16	52	6	6	3	13	4	13	11	< 4	4	< 13	3	NA
P179772-a	< 2	5	66	< 2	5	< 5	< 4	1	< 3	< 1	31	88	9	6	3	12	6	13	11	< 4	6	< 13	3	NA
P179772-b	< 2	4	65	< 2	4	< 5	< 4	1	< 3	< 1	30	87	10	6	4	13	6	13	11	< 4	7	< 13	3	NA
P179772-c	< 2	4	65	< 2	5	< 5	< 4	1	4	< 1	31	87	9	6	< 3	13	4	13	11	< 4	6	< 13	3	NA
P179780-a	< 2	7	57	< 2	5	< 5	4	1	< 3	1	22	30	6	6	4	12	5	22	10	5	6	< 13	3	NA
P179780-b	< 2	6	55	< 2	3	< 5	4	2	3	1	22	30	6	6	4	13	7	24	10	< 4	6	< 13	3	NA
P179780-c	2	7	62	< 2	5	< 5	< 4	2	3	< 1	21	30	6	6	4	11	5	25	10	< 4	5	< 13	3	NA
P179794-a	2	2	35	< 2	3	< 5	< 4	1	< 3	< 1	15	35	5	6	4	13	8	14	11	< 4	5	< 13	3	NA
P179794-b	< 2	3	30	< 2	3	< 5	< 4	1	< 3	< 1	15	34	4	6	3	12	4	15	11	< 4	4	< 13	3	NA
P179794-c	< 2	4	32	< 2	4	< 5	< 4	1	3	< 1	15	34	5	6	4	12	8	14	11	< 4	4	< 13	3	NA

Tableau 6 : Écart type et marge d'erreur sur les métaux en trace

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179752	NA	1,155	15,503	NA	0,577	NA	NA	0,577	0,577	NA	0,000	0,577	0,000	0,000	0,577	1,528	0,000	1,000	0,000	NA	0,577	NA	0,000	NA
P179761	NA	1,155	2,082	NA	1,000	0,000	NA	0,577	0,000	0,000	0,000	0,000	0,577	0,000	0,000	1,155	0,000	2,082	0,000	2,121	1,000	NA	0,000	NA
P179770	NA	0,577	5,508	NA	0,577	NA	NA	0,000	NA	NA	0,577	0,577	0,577	0,000	0,000	1,000	0,000	1,732	0,000	NA	1,000	NA	0,000	NA
P179772	NA	0,577	0,577	NA	0,577	NA	NA	0,000	NA	NA	0,577	0,577	0,577	0,000	0,707	0,577	1,155	0,000	0,000	NA	0,577	NA	0,000	NA
P179780	NA	0,577	3,606	NA	1,155	NA	0,000	0,577	0,000	0,000	0,577	0,000	0,000	0,000	0,000	1,000	1,155	1,528	0,000	NA	0,577	NA	0,000	NA
P179794	NA	1,000	2,517	NA	0,577	NA	NA	0,000	NA	NA	0,000	0,577	0,577	0,000	0,577	0,577	2,309	0,577	0,000	NA	0,577	NA	0,000	NA
Moyenne	NA	0,840	4,965	NA	0,744	0,000	0,000	0,289	0,192	0,000	0,289	0,385	0,385	0,000	0,310	0,973	0,770	1,153	0,000	2,121	0,718	NA	0,000	NA
Marge d'erreur	NA	1,647	9,732	NA	1,458	NA	NA	0,566	0,377	NA	0,566	0,754	0,754	NA	0,608	1,907	1,509	2,260	NA	4,158	1,408	NA	NA	NA

Phase 2 : Caractérisation physique de la silice

Les données brutes associées à cette section sont présentées à l'Annexe B.

Détermination du temps de contact à l'attriteur

Les essais d'optimisation de temps d'attrition ont été réalisés sur l'envoi 3. Le temps optimal obtenu a été appliqué pour l'envoi 1 et 2. Le tableau 7 montre la distribution des oxydes pour différents temps d'attrition. La distribution d'un oxyde est calculée comme un ratio des produits teneur et %poids par rapport à l'alimentation : %distribution = cC/c0C0 . Ainsi, le pourcentage de distribution de la silice dans la fraction +106 µm représente une récupération, alors que le pourcentage de distribution des impuretés (Fe2O3, Al2O3, TiO2) dans le produit représente un taux d'enlèvement (ou taux de récupération) dans le rejet. Lorsque le temps d'attrition augmente entre 1 et 5 minutes, on voit que le pourcentage d'élimination des oxydes de fer et d'aluminium (i.e. récupération de ces oxydes sur la fraction -106 µm) augmente. Un temps d'attrition de 10 minutes ne donne pas d'amélioration signification dans l'élimination des impuretés. En tenant compte de l'erreur de mesure présentée au tableau 4, on peut conclure que l'enlèvement des oxydes de fer et d'aluminium n'est pas affecté par le temps d'attrition. Ceci s'explique par le fait que ces minéraux sont finement disséminés dans toute la matrice de silice. Par contre, on peut conclure que les teneurs d'alumine diminuent lorsque le temps d'attrition augmente : il passe de 0,19% (1 minute) à 0,13% (10 minutes).

Le tableau 8 montre que le temps de contact dans l'attriteur n'a pas d'incidence sur la distribution granulométrique du produit +106µm.

Il a été convenu de fixer un temps d'attrition de 5 minutes comme temps de séjour optimal pour l'étape d'attrition. Les essais d'attrition pour les Envois 1 et 2 ont donc été effectués avec un temps de contact de 5 minutes.

Purification de la silice par des étapes successives de traitement

Le tableau 9 montre le sommaire de distribution des oxydes à chaque étape de traitement. Pour une étape donnée, plus la distribution de la silice dans le produit est grande (i.e. récupération), plus l'opération est efficace à enlever les oxydes d'impureté. Conséquemment, la distribution du Fe_2O_3, du Al_2O_3 et du TiO_2 dans le produit sera plus faible. En moyenne, 76,2% du matériel concassé et passant sur une toile de 600 µm (F100-600µm) se retrouve dans le produit final (non-magnétique -600,+106µm), à une teneur moyenne de 99,4%. Après séparation magnétique, le produit non-magnétique contient une teneur moyenne d'oxyde de fer de 0.03% (300 ppm), de 0,16% d'oxyde d'aluminium et de 0,03% d'oxyde de titane. Au cumulatif, il reste en moyenne 26,9% du Fe_2O_3, 34,9% du Al_2O_3 et 50,6% du TiO_2 initialement présent dans l'alimentation F100-600µm.

En éliminant la fraction fine -106 µm, après l'étape de lavage initiale il ne reste en moyenne que 40,80% du Fe_2O_3, 46.20% du Al_2O_3 et 52.84% du TiO_2 initial. Ainsi, les teneurs moyennes des impuretés dans le matériel concassé -600 µm peuvent être réduites de 0,09% à 0,05% pour l'oxyde de fer, de 0,40% à 0,20% pour l'oxyde d'aluminium et de 0,05%

à 0,03% pour l'oxyde de titane. Un procédé de lavage efficace permettra donc d'alléger les étapes subséquentes. C'est étape est critique pour l'enlèvement des impuretés. Les résultats obtenus à partir de l'Envoi 3 diffèrent des autres envois à cause que les résultats d'analyse de cet envoi découlent de l'étape de détermination du temps de contact. En effet, comme le montrent les Figues 2-4B, les pourcentages de distribution des impuretés dans le produit sont plus élevés que pour les deux autres envois. Ceci s'explique par le fait que, pour un même temps de lavage, un lavage humide sur un tamis vibrant de 8'' (Section 1.1.1.2) est moins efficace que sur tamis Sweco de 36''.

L'étape d'attrition permet de détacher et disperser des impuretés et argiles cimentées à la surface des grains de sable. Le tableau 9 montre que l'étape d'attrition permet une augmentation de la teneur en silice d'une moyenne de 99,43% à 99,56% SiO_2. Les teneurs moyennes en impuretés après attrition peuvent être réduites de 0,05% à 0,03% pour l'oxyde de fer et de 0,20% à 0,16% pour l'oxyde d'aluminium. Les Figures 1-3B indiquent que cette étape est néanmoins très peu efficace à l'enlèvement des particules d'oxyde.

L'étape de séparation magnétique à haute intensité humide (WHIMS) permet une récupération spécifique de l'oxyde de fer. Le tableau 9 et les Figures 1-3B montrent qu'une petite fraction de matériel magnétique a été éliminée. La teneur moyenne après séparation magnétique indique 99.41% SiO_2 et, à l'intérieur de la marge d'erreur sur les mesures, les teneurs d'impuretés sont demeurées inchangées. Néanmoins, tout porte à croire que cette étape est critique à l'obtention d'une teneur en oxyde de fer en-dessous de 300 ppm. Une nouvelle calibration du XRF pour des teneurs en impuretés inférieures aux limites de détection actuelles serait nécessaire pour évaluer la performance de la séparation magnétique avec plus de précision.

Le tableau 10 et la Figure 5 montrent que les étapes de traitement ont très peu d'incidence sur la distribution granulométrique du produit. On remarque sur la Figure 5 C une baisse du coefficient d'uniformité (D_{60}/D_{10}) du premier lavage vers la séparation magnétique. La Figure 5A permet de constater que ceci est principalement dû au fait que la proportion de particule D_{60} diminue de grosseur avec l'avancement dans les étapes de traitement à cause d'un effet de cisaillement. Le cisaillement n'influence cependant pas la sphéricité des particules de silice, car l'indice AFS demeure inchangé entre les étapes.

Tableau 7 : Distribution des oxydes dans le produit +106µm après différents temps d'attrition

Temps d'attrition	Fraction	Poids (g)	Teneur (%)				Distribution (% basé sur feed Calc)					Ratio d'enrichissement	
			SiO_2	Fe_2O_3	Al_2O_3	TiO_2	Poids (%)	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	Fe_2O_3	Al_2O_3
1 min	+106 µm	928,74	99,54	0,03	0,19	0,03	98,22	98,24	94,31	96,05	97,07		
	-106 µm	16,82	98,72	0,10	0,42	0,05	1,78	1,76	5,69	3,95	2,93	3,20	2,22
	Feed (calc)	945,56	99,53	0,031	0,189	0,030	100,00	100,00	100,00	100,00	100,00		
	Feed (assayed)		99,46	0,05	0,20	0,03							
3 min	+106 µm	929,12	99,57	0,03	0,18	0,03	98,12	98,13	91,57	95,23	95,60		
	-106 µm	17,82	98,76	0,12	0,47	0,06	1,88	1,87	8,43	4,77	4,40	4,48	2,53
	Feed (calc)	946,94	99,55	0,027	0,185	0,026	100,00	100,00	100,00	100,00	100,00		
	Feed (assayed)		99,46	0,05	0,20	0,03							
5 min	+106 µm	928,32	99,58	0,05	0,15	0,05	98,05	98,08	93,00	89,43	96,58		
	-106 µm	18,49	97,87	0,17	0,89	0,08	1,95	1,92	7,00	10,57	3,42	3,58	5,41
	Feed (calc)	946,81	99,54	0,047	0,164	0,046	100,00	100,00	100,00	100,00	100,00		
	Feed (assayed)		99,46	0,05	0,20	0,03							
10 min	+106 µm	924,20	99,63	0,04	0,13	0,03	98,18	98,19	95,94	96,30	95,75		
	-106 µm	17,09	99,15	0,08	0,27	0,06	1,82	1,81	4,06	3,70	4,25	2,23	2,04
	Feed (calc)	941,29	99,62	0,036	0,133	0,026	100,00	100,00	100,00	100,00	100,00		
	Feed (assayed)		99,46	0,05	0,20	0,03							

Tableau 8 : Distribution granulométrique dans les produits +106µm après différents temps d'attrition

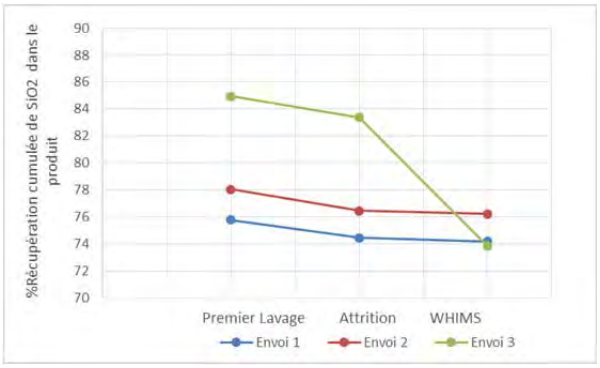
Cummulé passant (%)				
	Temps d'attrition			
Dimension	1 min	3 min	5 min	10 min
No.30	99,8	99,9	99,9	99,7
No. 40	85,0	86,5	82,8	81,6
No.50	68,9	71,0	65,1	63,3
No.70	53,8	55,7	49,8	48,0
No.100	28,2	29,3	25,8	24,8
No.140	3,6	3,7	3,4	3,2
Panne	0,0	0,0	0,0	0,0
AFS:	66,1	67,2	63,8	62,8

Tableau 9 : Distribution des oxydes dans le produit à chaque étape de traitement

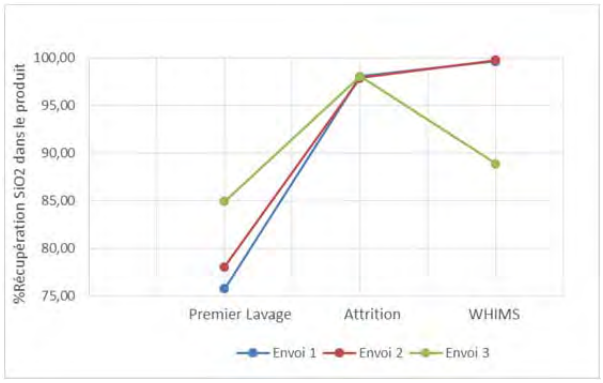
		Alimentation	Premier lavage			Attrition			Séparation Magnétique		
		-600 µm	-600 + 106µm			+106µm			Non-magnétique		
Envoi 1											
Fraction massique (%)	Alim.Étape		75,49			98,08			99,64		
	Alim. Initiale	100	75,49			74,04			73,75		
Oxyde		Teneur (%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)
SiO_2		99,03	99,39	75,78	75,78	99,58	98,09	74,46	99,56	99,66	74,18
Fe_2O_3		0,09	0,05	35,48	35,48	0,03	89,99	20,88	0,03	75,13	20,81
Al_2O_3		0,40	0,21	42,64	42,64	0,15	94,56	29,87	0,16	98,39	31,75
TiO_2		0,04	0,03	50,66	50,66	0,03	95,03	49,68	0,03	98,58	49,50
Envoi 2											
Fraction massique (%)	Alim.Étape		77,78			97,87			99,77		
	Alim. Initiale	100	77,78			76,13			75,96		
Oxyde		Teneur (%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)
SiO_2		98,91	99,46	78,06	78,06	99,53	97,91	76,45	99,47	99,78	76,23
Fe_2O_3		0,09	0,05	40,24	40,24	0,02	77,97	15,75	0,04	86,64	31,43
Al_2O_3		0,47	0,19	42,23	42,23	0,17	88,77	36,98	0,15	98,39	32,56
TiO_2		0,06	0,03	48,84	48,84	0,02	89,32	31,87	0,03	98,36	47,70
Envoi 3											
Fraction massique (%)	Alim.Étape		84,87			98,05			88,92		
	Alim. Initiale	100	84,87			83,21			73,99		
Oxyde		Teneur (%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)
SiO_2		99,01	99,46	84,96	84,96	99,58	98,08	83,39	99,20	88,93	73,87
Fe_2O_3		0,08	0,05	60,90	60,90	0,05	93,00	53,74	0,01	56,30	10,62
Al_2O_3		0,32	0,20	71,82	71,82	0,15	89,43	52,81	0,17	88,09	53,22
TiO_2		0,04	0,03	70,62	70,62	0,05	96,58	41,04	0,02	86,94	41,04
Moyenne Arithmétique											
Oxyde		Teneur (%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)
SiO_2		98,98	99,44	79,60	79,60	99,56	98,03	78,10	99,41	96,12	74,76
Fe_2O_3		0,09	0,05	45,54	45,54	0,03	86,99	30,12	0,03	72,69	20,95
Al_2O_3		0,40	0,20	52,23	52,23	0,16	90,92	39,89	0,16	94,96	39,18
TiO_2		0,05	0,03	56,71	56,71	0,03	93,64	40,86	0,03	94,63	46,08
Moyenne Cumulative											
Fraction massique (%)	Alim.Étape		78,13			97,98			99,16		
	Alim. Initiale	100	78,13			76,55			75,91		
Oxyde		Teneur (%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)	Teneur (%)	Distribution instantanée (%)	%Distribution Cumulée(%)
SiO_2			99,43	78,38	78,38	99,56	98,01	76,89	99,41	99,21	76,20
Fe_2O_3			0,05	40,80	40,80	0,03	85,49	20,86	0,03	60,50	26,87
Al_2O_3			0,20	46,20	46,20	0,16	91,29	36,09	0,16	95,50	34,94
TiO_2			0,03	52,84	52,84	0,03	93,02	45.03	0,03	94,60	50,57

Tableau 10 : Distributions et indices granulométriques à chaque étape de traitement

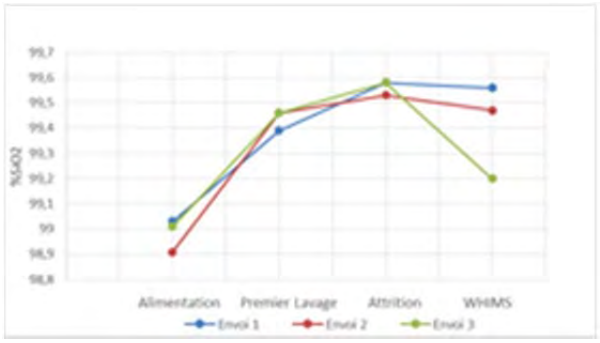
Cummulé passant (%)																
Dimension	-600µm				-600, +106 Alimentant attrition				+106 Produit Attrité				Produit Démagnétisé			
(U.S.A series)	Envoi 1	Envoi 2	Envoi 3	Moyenne	Envoi 1	Envoi 2	Envoi 3	Moyenne	Envoi 1	Envoi 2	Envoi 3	Moyenne	Envoi 1	Envoi 2	Envoi 3	Moyenne
No.30	100,0	100,0	99,9	99,9	99,8	99,8	99,9	99,8	99,9	99,8	99,9	99,9	99,8	99,9	99,9	99,9
No. 40	89,9	92,0	82,8	88,2	86,7	81,7	84,7	84,4	88,9	89,2	82,8	87,0	90,2	90,1	94,8	91,7
No.50	78,6	83,0	65,1	75,6	71,4	63,5	68,0	67,7	74,9	75,9	65,1	72,0	77,0	77,8	66,8	73,9
No.70	67,4	72,8	49,8	63,3	56,7	48,4	52,6	52,6	60,2	61,9	49,8	57,3	62,6	64,8	51,7	59,7
No.100	47,9	52,3	25,8	42,0	32,1	26,8	27,9	28,9	34,2	35,7	25,8	31,9	38,1	39,0	31,0	36,0
No.140	24,8	24,8	3,4	17,7	3,8	2,7	4,8	3,8	2,2	3,0	3,4	2,9	4,5	3,0	4,9	4,1
Panne	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AFS:	85,0	88,0	63,8	78,9	68,0	63,3	66,1	65,8	69,6	70,8	63,8	68,1	72,7	72,6	68,0	71,1
CU:	--				1,97	2,20	2,16	2,1	1,87	1,76	2,10	1,9	1,64	1,75	2,06	1,8



A : Récupération cumulée dans le produit

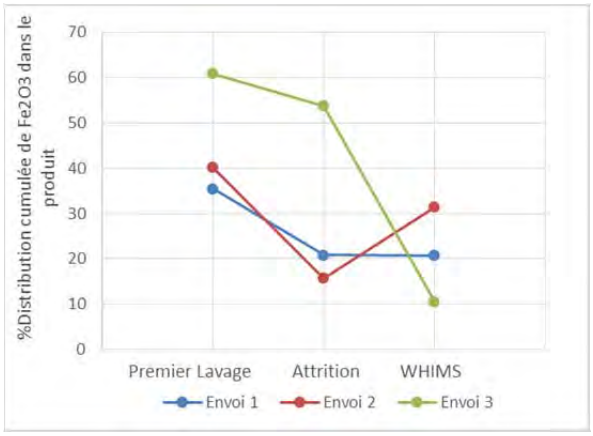


B : Récupération instantanée dans le produit

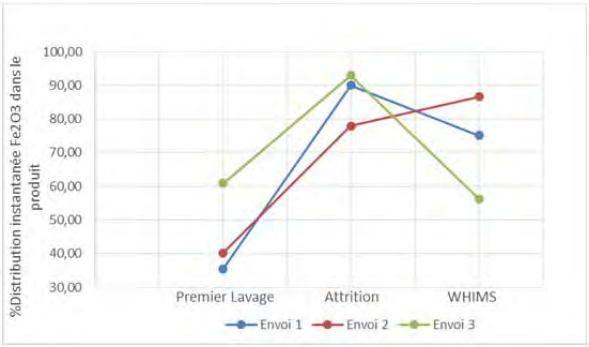


C : Teneur analysée dans le produit

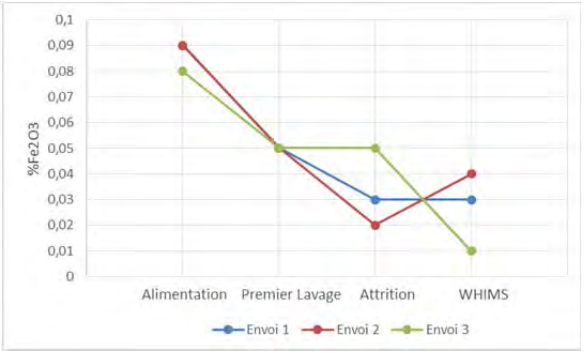
Figure 1 : Performance de purification du SiO_2 dans le produit



A : %Distribution cumulé du Fe_2O_3 dans le produit



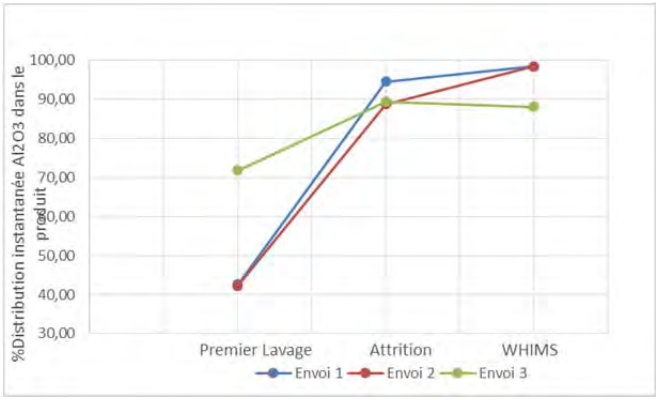
B : %Distribution instantanée en Fe_2O_3 dans le produit



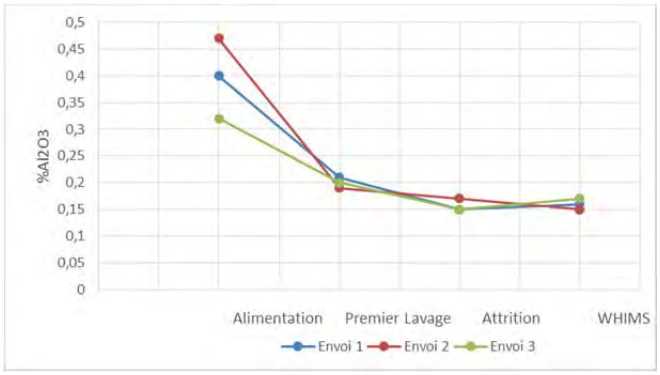
C : Teneur en Fe_2O_3 analysée dans le produit

Figure 2 : Performance d'épuration du Fe_2O_3 dans le produit

A : %Distribution cumulé du Al_2O_3 dans le produit

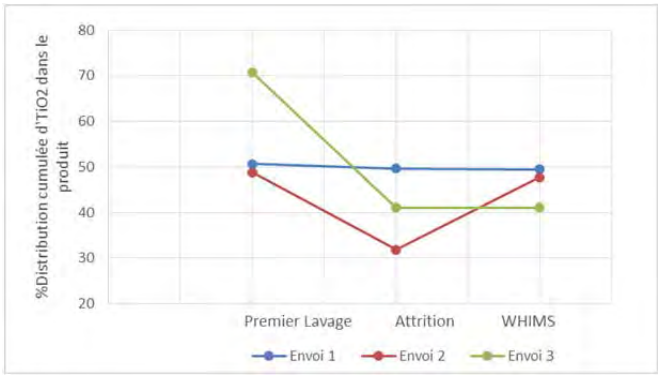


B : %Distribution instantanée en Al_2O_3 dans le produit

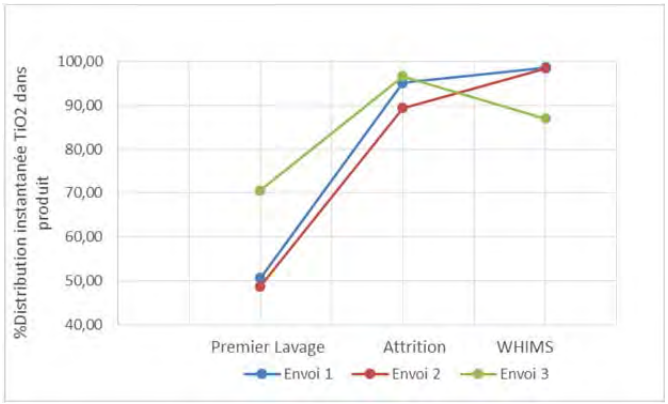


C : Teneur en Al_2O_3 analysée dans le produit

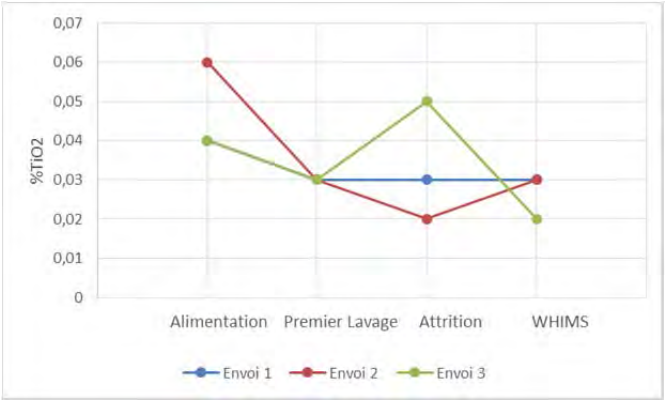
Figure 3 : Performance d'épuration du Al_2O_3 dans le produit



A : %Récupération instantanée en TiO_2 dans le produit

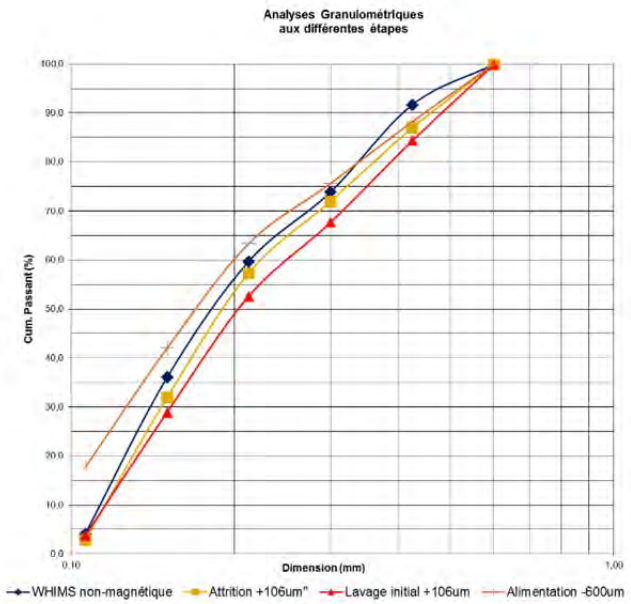


B : %Récupération instantanée en TiO_2 dans le produit

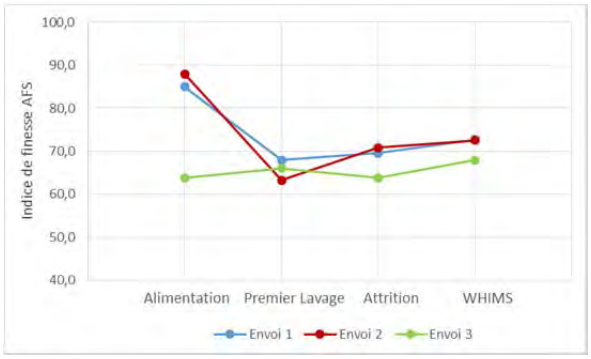


C : Teneur en TiO_2 analysée dans le produit

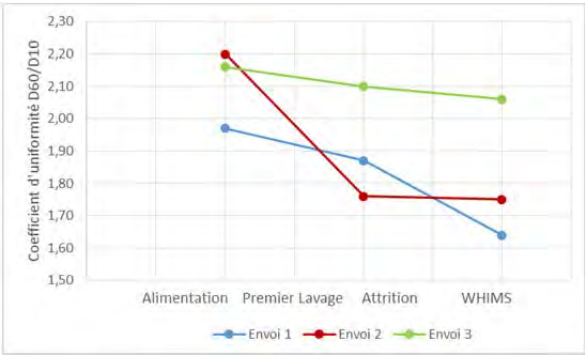
Figure 4 : Performance d'épuration du TiO_2 dans le produit



A : %Cumulé passant selon l'étape de traitement



B : Évolution de l'indice AFS d'une étape à l'autre



C : Évolution du coefficient d'uniformité (D_{60}/D_{10})

Figure 5 : Distribution granulométrique du produit aux différentes étapes

Résultats de l'analyse de sphéricité et de rondeur avant et après concassage et broyage (norme Frac Sand API 19C):

Trois essais d'analyse visuelle de sphéricité et de rondeur ont été effectués pour mieux observer les différents types de préparation des grains de silice. Voici les trois types de préparation dans lesquelles nous avons échantillonné les fractions analysées :

- Échantillon avant concassage, traité thermiquement et attrité 5 minutes;
- Échantillon après concassage, attrité 10 minutes sans séparation magnétique au WHIMS;
- Échantillon après concassage, attrité 5 minutes et Non-magnétique après la séparation magnétique au WHIMS;

Les essais suivants ont été réalisés en fonction de la norme sur les sables de fractionnement API 19C. Une analyse visuelle a été effectuée sur 20 particules aléatoires de chaque fraction selon la charte visuelle suivante :

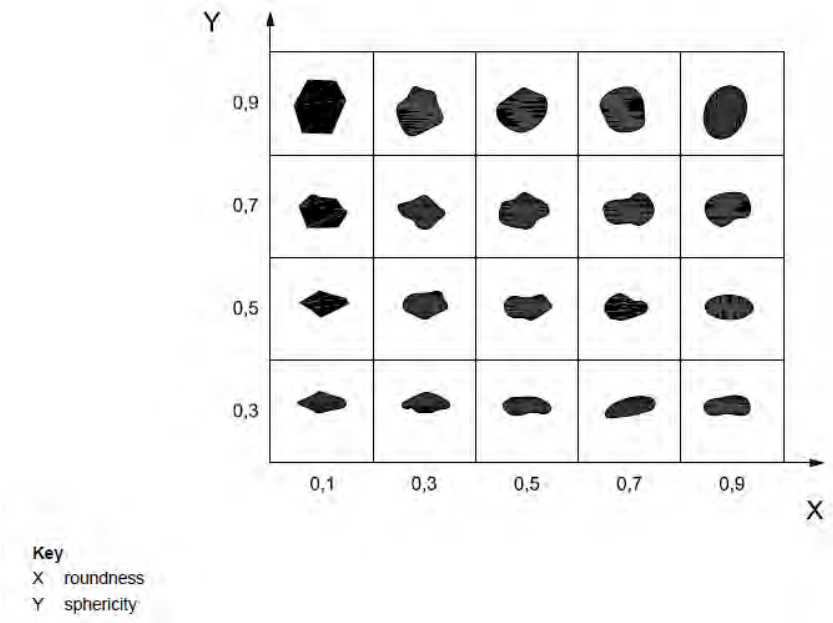


Figure 5 — Chart for visual estimation of sphericity and roundness

Voici les résultats pour la sphéricité et rondeur avant et après concassage et broyage (Voir **Annexe D**) :

Tableau 11 : Sphéricité et rondeur pour différentes classes granulométriques

	Produit	**Attrité 10 min. envoi #3 avant WHIMS**			**Non-magnétique attrité 5 min. après WHIMS**			**Traitement thermique avant concassage attrité 5 min.**		
	Fraction	**20/40**	**30/50**	**40/70**	**20/40**	**30/50**	**40/70**	**20/40**	**30/50**	**40/70**
Rondeur	**X**	0,4	0,5	0,4	0,4	0,5	0,4	0,3	0,4	0,4
Sphéricité	**Y**	0,6	0,7	0,6	0,7	0,7	0,6	0,7	0,6	0,7

Phase 3 : Essai de résistance thermique de la silice

Pour l'essai de résistance thermique, nous avons respecté la norme SKW. Pour l'ensemble des tests, les fractions retenues sur le tamis 12.5 mm sont toutes plus élevées que 80%. Les essais sont tous positifs. Les données de laboratoire sont présent à l'**annexe C**.

Résultats essai choc thermique:

Voici les résultats pour les essais de choc thermique.

Tableau 12 : Distributions granulométriques pour différents échantillons

Echantillon	Type échantillon	Fraction + 12,5 mm (g)	Fraction - 12,5 mm (g)	Fraction + 12,5 mm (%)	Fraction - 12,5 mm (%)	durée calcination (min)
P175880	bloc	2506,5	175,92	93,4	6,6	20,0
P175877	carotte	373,12	43,07	89,7	10,3	20,0
P175822	bloc	2496,40	161,17	93,9	6,1	45,0
P175881	bloc	2574,60	42,92	98,4	1,6	85,0
P175876	carotte	377,79	41,96	90,0	10,0	31,0
P175878	carotte	404,09	14,85	96,5	3,5	25,0
P175856	carotte	430,47	1,43	99,7	0,3	32,0
P175854	carotte	381,08	47,78	88,9	11,1	25,0
P175855	carotte	408,36	21,02	95,1	4,9	45,0
P175852	carotte	429,73	1,42	99,7	0,3	50,0
P175851	carotte	404,80	16,74	96,0	4,0	50,0
P175853	carotte	416,68	2,40	99,4	0,6	50,0

Résultats perte au feu:

Voici les résultats de perte au feu pour les essais de choc thermique :

Tableau 13 : Perte au feu des différents échantillons

Echantillon	Type échantillon	poids départ (g)	poids final (g)	LOI (%)
P175880	bloc	2687,4	2685,3	0,1
P175877	carotte	418,3	418,23	0,0
P175822	bloc	2671,3	2661,5	0,4
P175881	bloc	------	2717,8	------
P175876	carotte	424,1	423,4	0,2
P175878	carotte	420,8	419,6	0,3
P175856	carotte	432,6	432,0	0,1
P175854	carotte	430,3	430,0	0,1
P175855	carotte	431,3	430,1	0,3
P175852	carotte	432,5	431,4	0,3
P175851	carotte	423,3	421,9	0,3
P175853	carotte	420,2	419,2	0,2

Phase 4 : Essai pour sable de fractionnement

Pour les essais pour les sable de fractionnement, un seul test a été réalisé; celui de résistance à l'écrasement. Les essais ont été effectués sur les fractions 20/40 et 30/50 du produit non-magnétique attrité 5 minutes de l'envoi #3. Les résultats de ce test ont été négatifs et nous avons abandonné les tests des étapes suivantes. Les données de laboratoire sont présentes dans l'**annexe E.**

Voici les tableaux des résultats:

Tableau 14 : Fractions granulométriques du produit non-magnétique

A : Produit : N-mags whims 5.9A envoie #3 attrite 5 min Pr20-40

Essai	load on cell (lb force)	load on cell (psi)	stress on sand (psi)	poids départ (g)	Fraction + 50 (g)	Fraction - 50 (g)	Fraction + 50 (%)	Fraction - 50 (%)
1	12566	426	4000	37,08	27,20	9,73	73,7	26,3
2	15708	533	5000	37,08	24,94	12,00	67,5	32,5

B : Produit : N-mags whims 5.9A envoie #3 attrite 5 min Pr30-50

Essai	load on cell (lb force)	load on cell (psi)	stress on sand (psi)	poids départ (g)	Fraction + 70 (g)	Fraction - 70 (g)	Fraction + 70 (%)	Fraction - 70 (%)
1	12566	426	4000	32,49	19,44	13,01	59,9	40,1
2	6283	213	2000	32,49	25,38	7,04	78,3	21,7

4. Conclusions

Les analyses géochimiques permettent de constater que la majorité des échantillons ont une teneur élevé en SiO2 et on observe une teneur légère en Fe2O3 et Al2O3. Nous avons aussi évalué les métaux en traces, dont les valeurs sont négligeables.

Un procédé constitué d'un tamisage à 600 µm, d'une première étape de lavage à l'eau sur une toile de 106µm, d'une étape d'attrition de 5 minutes, d'une seconde étape de lavage à l'eau sur toile 106µm et d'une séparation magnétique humide à haute intensité permet une récupération de 76,2% silice à une teneur moyenne de 99.4%. Au total, à la suite de ces étapes de traitement, c'est en moyenne 73,1% de l'oxyde de fer, 65,1% de l'oxyde d'aluminium et 49,4% de l'oxyde de titane qui ont étés enlevés du matériel alimenté (F100-600µm). Après séparation magnétique, le produit non-magnétique contient une teneur moyenne d'oxyde de fer de 0.03% (300 ppm), de 0,16% d'oxyde d'aluminium et de 0,03% d'oxyde de titane. Une calibration à faibles teneurs en impureté et une seconde analyse des pastilles au XRF serait nécessaire pour confirmer la performance de cette chaîne de traitement. Les pourcentages de distributions instantanés indiquent que l'étape de lavage initiale est la plus performante pour enlever les impuretés. C'est aussi cette étape qui rejette le plus de particule fine probablement à cause du sur-concassage. Il serait intéressant de refaire cette expérience en incorporant une étape de tamisage sur une toile de 600 µm entre le concasseur giratoire et le concasseur à rouleaux. Cette étape permettrait non-seulement d'évaluer le taux de recyclage au concassage, mais aussi de mieux balancer la chaîne de traitement de la silice.

Pour les tests de sable de fractionnement selon la norme API 19C, les données sont négatives. Le test de sphéricité et de rondeur a donné des valeurs moyennes assez faibles. Le deuxième test de sable de fractionnement, la résistance à l'écrasement, nous permis de valider le résultat négatif de l'analyse de sphéricité et de rondeur. L'optimisation de la température et du temps de séjour dans le four pourrait permettre de réduire la formation d'agrégats non-sphérique.

L'essai de choc thermique ont été concluant pour l'ensemble des échantillons puisque le passant 12.5mm a été plus élevé que l'exigence de 80%.

5. Signatures

En signant ci-dessous, le Centre de technologie minérale et de plasturgie Inc. (CTMP) valide les données et le rapport d'analyse ci-dessus.

5 déc. 2013

Alexandre-Sacha Leblond Ing.
Chargé de projets – secteur minéral
Centre de technologie minérale et de plasturgie Inc.

Date

05-12-2013

Mathieu Brousseau Ing. Jr.
Chargé de projets – secteur minéral
Centre de technologie minérale et de plasturgie Inc.

Date

Annexe A

Données des essais
d’analyses géochimiques

Centre de technologie minérale et de plasturgie inc. (CTMP)
671, boulevard Frontenac Ouest, porte 7C
Thetford Mines (Québec) G6G 1N1
Téléphone : (418) 338-6410 Télécopieur : (418) 338-9584
ctmp@cegepth.qc.ca – www.ctmp.ca

Analyse géochimique - Oxydes majeurs

No. Projet: R-5030
Titre: Silica Matane (Langis)
Client: Canadian Metals
1200, avenue Mc gill College, bureau 1240
Montréal, Qc., H3B 4G7, Canada
a/s: M. Stéphane LEBLANC

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179751	76,67	4,43	6,30	0,69	0,73	0,02	0,05	0,04	0,05	0,37	0,01	9,72	0,03	99,10
P179752	98,15 a	0,16	0,07	0,31	0,67	0,01	0,03	0,16	0,04	< 0,01	0,01	0,37	0,02	100,00
P179753	99,27 a	0,02	0,02	0,16	0,20	0,01	0,03	0,06	0,04	< 0,01	< 0,01	0,17	0,02	100,00
P179754	99,16 a	0,03	0,02	0,12	0,26	0,01	0,08	0,07	0,03	< 0,01	0,01	0,19	0,02	100,00
P179755	3,22	0,53	51,56	0,22	0,43	0,01	0,04	0,10	0,03	0,07	0,01	41,89	0,03	98,14
P179756	99,24 a	0,01	0,10	0,06	0,23	0,01	0,03	0,05	0,04	< 0,01	< 0,01	0,21	0,02	100,00
P179757	98,92 a	0,08	0,02	0,13	0,43	0,01	0,02	0,07	0,05	< 0,01	0,01	0,24	0,02	100,00
P179758	98,81 a	0,03	0,31	0,12	0,25	0,01	0,03	0,04	0,04	< 0,01	< 0,01	0,34	0,02	100,00
P179759	98,92 a	0,07	0,03	0,12	0,33	0,01	0,19	0,05	0,04	< 0,01	0,01	0,21	0,02	100,00
P179760	98,83 a	0,08	0,02	0,16	0,42	0,01	0,03	0,05	0,06	< 0,01	0,01	0,30	0,03	100,00
P179761	97,67 a	0,16	0,33	0,21	0,68	0,01	0,11	0,11	0,06	0,03	0,01	0,48	0,03	99,86
P179762	98,46 a	0,13	0,11	0,13	0,57	0,01	0,03	0,06	0,06	< 0,01	0,01	0,33	0,02	99,90
P179763	98,26 a	0,16	0,09	0,17	0,64	0,01	0,03	0,06	0,07	< 0,01	0,01	0,37	0,02	99,87
P179764	97,76 a	0,27	0,12	0,20	0,91	0,01	0,04	0,06	0,06	< 0,01	0,01	0,49	0,02	99,93
P179765	99,31 a	0,01	0,03	0,10	0,15	0,01	0,03	0,05	0,03	< 0,01	< 0,01	0,24	0,03	100,00
P179766	4,37	0,49	51,84	0,35	0,82	0,01	0,04	0,24	0,05	0,16	0,01	41,00	0,02	99,40
P179767	99,36 a	< 0,01	0,06	0,06	0,15	< 0,01	0,03	0,05	0,04	< 0,01	< 0,01	0,23	0,02	100,00
P179768	99,38 a	< 0,01	0,02	< 0,01	0,22	0,01	0,03	0,07	0,03	< 0,01	< 0,01	0,22	0,02	100,00
P179769	98,99 a	0,06	0,02	0,10	0,36	0,01	0,01	0,08	0,05	< 0,01	< 0,01	0,29	0,03	100,00
P179770	99,20 a	0,03	0,01	0,06	0,29	0,01	0,03	0,07	0,04	< 0,01	< 0,01	0,24	0,02	100,00
P179771	99,16 a	0,04	0,01	0,05	0,31	0,01	0,04	0,06	0,04	< 0,01	0,01	0,25	0,02	100,00
P179772	98,85 a	0,08	0,02	0,13	0,44	0,01	0,05	0,06	0,05	< 0,01	0,01	0,28	0,02	100,00
P179773	99,38 a	< 0,01	0,01	0,08	0,19	0,01	0,02	0,05	0,04	< 0,01	< 0,01	0,20	0,02	100,00

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179774	98,94 [a]	0,06	0,01	0,10	0,41	0,01	0,03	0,08	0,05	< 0,01	0,01	0,27	0,03	100,00
P179775	98,70 [a]	0,09	0,03	0,09	0,44	0,01	0,04	0,05	0,06	< 0,01	< 0,01	0,33	0,02	99,84
P179776	97,70 [a]	0,27	0,09	0,23	0,95	0,01	0,06	0,09	0,05	< 0,01	0,01	0,45	0,02	99,91
P179777	98,00 [a]	0,20	0,06	0,17	0,80	0,01	0,05	0,10	0,06	< 0,01	0,01	0,42	0,02	99,88
P179778	99,00 [a]	0,06	0,05	0,07	0,36	< 0,01	0,03	0,05	0,05	< 0,01	0,01	0,25	0,02	99,93
P179779	98,83 [a]	0,08	0,06	0,09	0,43	0,01	0,02	0,06	0,06	< 0,01	0,01	0,27	0,02	99,92
P179780	97,85 [a]	0,16	0,06	0,34	0,91	0,01	0,03	0,16	0,08	< 0,01	0,01	0,37	0,02	100,00
P179781	98,68 [a]	0,10	0,07	0,18	0,47	0,01	0,04	0,09	0,06	< 0,01	0,01	0,27	0,02	100,00
P179781-R	98,67 [a]	0,09	0,07	0,19	0,49	0,01	0,04	0,08	0,06	< 0,01	0,01	0,27	0,02	100,00
P179782	97,64 [a]	0,24	0,19	0,19	0,89	0,01	0,15	0,18	0,07	< 0,01	0,01	0,41	0,02	100,00
P179783	97,66 [a]	0,26	0,07	0,20	1,03	0,01	0,04	0,15	0,08	< 0,01	0,01	0,47	0,02	100,00
P179784	98,83 [a]	0,08	0,02	0,11	0,45	0,01	0,04	0,05	0,06	< 0,01	0,01	0,32	0,02	100,00
P179785	99,44 [a]	0,02	0,02	0,03	0,21	0,01	0,02	0,04	0,03	< 0,01	< 0,01	0,16	0,02	100,00
P179786	99,26 [a]	0,05	0,02	0,06	0,29	0,01	0,02	0,04	0,04	< 0,01	< 0,01	0,19	0,02	100,00
P179787	98,74 [a]	0,15	0,03	0,10	0,54	0,01	0,03	0,06	0,04	< 0,01	< 0,01	0,29	0,02	100,00
P179788	17,92	0,56	44,30	0,30	0,94	0,01	0,04	0,23	0,05	0,04	0,01	35,41	0,03	99,81
P179789	98,61 [a]	0,15	0,13	0,13	0,49	0,01	0,03	0,06	0,04	< 0,01	< 0,01	0,33	0,02	100,00
P179790	99,53 [a]	< 0,01	0,02	0,06	0,14	0,01	0,02	0,03	0,03	< 0,01	0,01	0,13	0,02	100,00
P179791	98,92 [a]	0,08	0,02	0,11	0,39	0,01	0,04	0,05	0,05	< 0,01	0,01	0,30	0,02	100,00
P179792	99,51 [a]	< 0,01	0,01	0,04	0,17	0,01	0,04	0,03	0,03	< 0,01	< 0,01	0,14	0,02	100,00
P179793	99,28 [a]	0,04	0,01	0,08	0,27	0,01	0,03	0,03	0,04	< 0,01	< 0,01	0,19	0,02	100,00
P179794	99,00 [a]	0,10	0,02	0,05	0,36	0,01	0,12	0,04	0,04	< 0,01	0,01	0,23	0,02	100,00
P179795	98,78 [a]	0,13	0,06	0,07	0,51	0,01	0,04	0,04	0,04	< 0,01	0,01	0,29	0,02	100,00
P179796	98,95 [a]	0,09	0,07	0,09	0,38	0,01	0,04	0,04	0,04	< 0,01	0,01	0,26	0,02	100,00
P179797	98,63 [a]	0,13	0,08	0,13	0,45	0,01	0,13	0,06	0,05	< 0,01	0,01	0,29	0,03	100,00
P179798	86,08 [a]	2,39	2,69	1,08	2,29	0,02	0,05	0,45	0,13	0,02	0,01	4,79	0,00	100,00

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Analyse géochimique - Métaux en traces

No. Projet: R-5030
Titre: Silica Matane (Langis)
Client: Canadian Metals
1200, avenue Mc gill College, bureau 1240
Montréal, Qc., H3B 4G7, Canada
a/s: M. Stéphane LEBLANC

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179751	4	4	56	< 2	7	6	4	1	36	< 1	25	52	5	6	< 3	13	< 5	14	10	< 4	7	< 13	3	ND
P179752	< 2	6	82	< 2	5	< 5	4	1	10	< 1	12	43	6	6	3	11	< 5	20	10	< 4	4	< 13	3	ND
P179753	< 2	2	76	< 2	3	< 5	< 4	1	7	< 1	11	53	6	6	4	12	< 5	13	11	< 4	3	< 13	3	ND
P179754	< 2	3	32	< 2	4	< 5	< 4	1	4	< 1	14	60	7	6	4	13	< 5	16	11	< 4	4	< 13	3	ND
P179755	39	5	< 3	< 2	6	8	6	2	3	1	170	11	2	6	< 3	8	5	13	15	< 4	9	< 13	4	ND
P179756	< 2	< 2	33	< 2	3	< 5	< 4	1	< 3	< 1	11	55	6	6	3	12	< 5	14	11	< 4	2	< 13	3	ND
P179757	< 2	3	37	< 2	4	< 5	< 4	2	6	< 1	15	46	6	6	3	13	< 5	13	11	< 4	7	< 13	3	ND
P179758	< 2	3	37	< 2	4	< 5	< 4	1	< 3	< 1	13	65	8	6	4	13	< 5	13	11	< 4	4	< 13	3	ND
P179759	< 2	4	34	< 2	4	5	< 4	1	3	< 1	18	73	7	6	< 3	12	< 5	13	11	< 4	5	< 13	3	ND
P179760	< 2	6	48	< 2	5	< 5	< 4	1	6	1	14	113	11	6	5	13	< 5	17	11	< 4	5	< 13	3	ND
P179761	< 2	5	44	< 2	5	5	< 4	1	3	1	37	78	8	6	4	12	< 5	28	11	4	6	< 13	3	NA
P179762	< 2	4	52	< 2	3	< 5	< 4	2	< 3	< 1	20	52	7	6	< 3	12	< 5	21	11	< 4	5	< 13	3	NA
P179763	< 2	3	59	< 2	3	< 5	< 4	1	3	< 1	20	71	8	6	5	14	< 5	16	11	< 4	6	< 13	3	NA
P179764	< 2	2	24	< 2	4	< 5	< 4	1	< 3	< 1	29	38	5	6	3	12	< 5	19	10	< 4	6	< 13	3	NA
P179765	< 2	2	37	< 2	3	< 5	< 4	1	< 3	< 1	8	104	9	6	3	14	< 5	13	11	< 4	2	< 13	3	ND
P179766	39	6	< 3	< 2	< 2	5	8	1	< 3	5	164	4	2	6	< 3	9	5	13	14	< 4	6	< 13	4	ND
P179767	< 2	3	68	< 2	5	< 5	< 4	1	< 3	< 1	7	43	6	6	4	13	< 5	15	11	< 4	< 2	< 13	3	ND
P179768	< 2	4	32	< 2	3	< 5	< 4	1	< 3	< 1	8	39	5	6	< 3	12	< 5	13	11	< 4	2	< 13	3	ND
P179769	< 2	3	77	< 2	6	< 5	< 4	1	4	< 1	13	111	11	6	4	13	< 5	17	11	< 4	3	< 13	3	ND
P179770	< 2	3	45	< 2	3	< 5	< 4	1	< 3	< 1	15	52	6	6	< 3	12	< 5	16	11	< 4	3	< 13	3	ND
P179771	< 2	4	45	< 2	2	< 5	< 4	1	< 3	< 1	24	57	7	6	3	11	< 5	14	11	< 4	4	< 13	3	ND
P179772	< 2	5	66	< 2	5	< 5	< 4	1	< 3	< 1	31	88	9	6	3	12	6	13	11	< 4	6	< 13	3	ND
P179773	< 2	3	75	< 2	2	< 5	< 4	1	< 3	< 1	11	53	7	6	3	12	< 5	14	11	< 4	2	< 13	3	ND
P179774	< 2	4	58	< 2	4	< 5	< 4	1	4	< 1	20	38	5	6	4	13	< 5	15	11	< 4	5	< 13	3	ND
P179775	< 2	4	42	< 2	4	< 5	< 4	1	< 3	< 1	15	91	9	6	< 3	12	6	18	11	< 4	4	< 13	3	NA
P179776	< 2	5	12	< 2	3	< 5	< 4	2	< 3	< 1	21	57	7	6	5	13	< 5	22	10	< 4	5	< 13	3	NA
P179777	< 2	3	27	< 2	4	< 5	< 4	2	4	1	19	68	8	6	3	13	< 5	20	11	< 4	5	< 13	3	NA
P179778	< 2	4	36	< 2	3	< 5	< 4	1	< 3	< 1	11	38	5	6	4	13	8	16	11	< 4	< 2	< 13	3	NA
P179779	< 2	5	41	< 2	3	< 5	< 4	1	< 3	< 1	12	43	6	6	5	12	< 5	13	11	5	3	< 13	3	NA
P179780	< 2	7	57	< 2	5	< 5	4	1	< 3	1	22	30	6	6	4	12	5	22	10	5	6	< 13	3	NA

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179781	< 2	4	38	< 2	3	< 5	< 4	1	3	< 1	18	26	4	6	5	13	< 5	20	11	< 4	3	< 13	3	NA
P179782	< 2	7	51	< 2	4	< 5	4	2	3	1	25	27	5	6	4	14	< 5	26	10	5	4	< 13	3	NA
P179783	< 2	6	42	< 2	6	< 5	< 4	2	4	1	21	36	6	6	4	12	< 5	23	10	< 4	4	< 13	3	NA
P179784	< 2	4	42	< 2	4	< 5	< 4	1	< 3	< 1	16	61	7	6	5	13	< 5	16	11	< 4	5	< 13	3	NA
P179785	< 2	2	17	< 2	3	< 5	< 4	1	4	< 1	10	97	9	6	3	13	< 5	15	11	< 4	2	< 13	3	NA
P179786	< 2	3	32	< 2	3	< 5	< 4	1	4	< 1	14	46	6	6	5	13	10	16	11	< 4	3	< 13	3	NA
P179787	< 2	5	15	< 2	3	< 5	< 4	1	4	< 1	14	39	5	6	4	11	< 5	17	11	< 4	4	< 13	3	NA
P179788	32	8	< 3	< 2	3	< 5	8	2	< 3	5	144	< 6	2	6	< 3	9	10	13	14	< 4	4	< 13	4	NA
P179789	< 2	5	66	< 2	4	< 5	< 4	1	< 3	< 1	9	72	8	6	3	12	< 5	13	11	< 4	< 2	< 13	3	NA
P179790	< 2	3	42	< 2	4	< 5	< 4	1	< 3	< 1	9	48	6	6	5	12	< 5	13	11	< 4	2	< 13	3	NA
P179791	< 2	5	41	< 2	3	< 5	< 4	1	< 3	< 1	16	54	7	6	4	13	< 5	16	11	< 4	4	< 13	3	NA
P179792	< 2	2	27	< 2	3	< 5	< 4	0	< 3	< 1	10	73	8	6	3	12	< 5	13	11	< 4	2	< 13	3	NA
P179793	< 2	3	48	< 2	3	< 5	< 4	1	< 3	< 1	12	36	5	6	4	15	< 5	13	11	< 4	3	< 13	3	NA
P179794	2	2	35	< 2	3	< 5	< 4	1	< 3	< 1	15	35	5	6	4	13	8	14	11	< 4	5	< 13	3	NA
P179795	< 2	5	21	< 2	3	< 5	< 4	1	4	< 1	27	69	7	6	4	13	< 5	15	11	< 4	9	< 13	3	NA
P179796	< 2	3	34	< 2	3	< 5	< 4	1	< 3	< 1	30	74	8	6	5	13	< 5	13	11	< 4	6	< 13	3	NA
P179797	< 2	4	49	< 2	3	< 5	< 4	1	3	< 1	15	69	8	6	4	12	< 5	15	11	< 4	4	< 13	3	NA
P179798	2	17	84	< 2	8	6	7	3	< 3	12	28	28	7	6	3	12	5	62	9	15	8	< 13	3	NA

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Ananlyse géochimique - Triplicatas oxydes majeurs

No. Projet: R-5030
Titre: Silica Matane (Langis)
Client: Canadian Metals
1200, avenue Mc gill College, bureau 1240
Montréal, Qc., H3B 4G7, Canada
a/s: M. Stéphane LEBLANC

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179752-a	98,15 (1)	0,16	0,07	0,31	0,67	0,01	0,03	0,16	0,04	< 0,01	0,01	0,37	0,02	100,00
P179752-b	98,08 (1)	0,16	0,07	0,32	0,69	0,01	0,03	0,16	0,05	< 0,01	0,01	0,39	0,03	100,00
P179752-c	98,16 (1)	0,17	0,07	0,30	0,66	0,01	0,05	0,16	0,05	< 0,01	0,01	0,33	0,03	100,00
P179761-a	97,78 (1)	0,16	0,33	0,21	0,68	0,01	0,11	0,11	0,06	0,03	0,01	0,48	0,03	100,00
P179761-b	97,82 (1)	0,16	0,33	0,21	0,66	0,01	0,08	0,11	0,07	< 0,01	0,01	0,51	0,03	100,00
P179761-c	97,90 (1)	0,15	0,33	0,20	0,70	0,01	0,08	0,10	0,07	< 0,01	0,01	0,42	0,03	100,00
P179770-a	99,20 (1)	0,03	0,01	0,06	0,29	0,01	0,03	0,07	0,04	< 0,01	< 0,01	0,24	0,02	100,00
P179770-b	99,24 (1)	0,03	0,01	0,08	0,28	0,01	0,02	0,07	0,04	< 0,01	0,01	0,19	0,02	100,00
P179770-c	99,22 (1)	0,04	0,02	0,07	0,31	0,01	0,04	0,07	0,04	< 0,01	0,01	0,15	0,02	100,00
P179772-a	98,84 (1)	0,08	0,02	0,13	0,44	0,01	0,05	0,06	0,05	< 0,01	0,01	0,28	0,03	100,00
P179772-b	98,91 (1)	0,09	0,02	0,13	0,40	0,01	0,05	0,06	0,05	< 0,01	0,01	0,24	0,03	100,00
P179772-c	98,98 (1)	0,08	0,02	0,12	0,41	0,01	0,04	0,06	0,05	< 0,01	0,01	0,19	0,03	100,00
P179780-a	97,85 (1)	0,16	0,06	0,34	0,91	0,01	0,03	0,16	0,08	< 0,01	0,01	0,37	0,02	100,00
P179780-b	97,83 (1)	0,17	0,06	0,36	0,86	0,01	0,04	0,16	0,08	< 0,01	0,01	0,40	0,02	100,00
P179780-c	97,88 (1)	0,17	0,06	0,34	0,90	0,01	0,03	0,16	0,08	< 0,01	0,01	0,34	0,02	100,00
P179794-a	99,00 (1)	0,10	0,02	0,05	0,36	0,01	0,12	0,04	0,04	< 0,01	0,01	0,23	0,02	100,00
P179794-b	99,05 (1)	0,10	0,01	0,07	0,39	0,01	0,05	0,04	0,04	< 0,01	< 0,01	0,22	0,02	100,00
P179794-c	99,18 (1)	0,08	0,01	0,05	0,35	0,01	0,03	0,03	0,04	< 0,01	0,01	0,19	0,02	100,00

'(1) 100-autres

Écart type et marge d'erreur

Échantillons	SiO_2 (%)	MgO (%)	CaO (%)	Fe_2O_3 (%)	Al_2O_3 (%)	MnO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	SO_3 (%)	P_2O_5 (%)	P.A.F. (%)	Total Traces (%)	Total (%)
P179752	0,044	0,006	0,000	0,010	0,015	0,000	0,012	0,000	0,006	NA	0,000	0,031	0,006	0,000
P179761	0,061	0,006	0,000	0,006	0,020	0,000	0,017	0,006	0,006	NA	0,000	0,046	0,000	0,000
P179770	0,020	0,006	0,006	0,010	0,015	0,000	0,010	0,000	0,000	NA	0,000	0,045	0,000	0,000
P179772	0,070	0,006	0,000	0,006	0,021	0,000	0,006	0,000	0,000	NA	0,000	0,045	0,000	0,000
P179780	0,025	0,006	0,000	0,012	0,026	0,000	0,006	0,000	0,000	NA	0,000	0,030	0,000	0,000
P179794	0,093	0,006	0,012	0,021	0,000	0,047	0,006	0,000	NA	NA	0,021	0,000	0,000	0,000
Moyenne	0,052	0,006	0,003	0,011	0,016	0,008	0,009	0,001	0,002	NA	0,003	0,033	0,001	0,000
Marge d'erreur	0,102	0,011	0,006	0,021	0,032	0,015	0,018	0,002	0,005	NA	0,007	0,064	0,002	NA

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Ananlyse géochimique - Triplicatas métaux en traces

No. Projet: R-5030
Titre: Silica Matane (Langis)
Client: Canadian Metals
1200, avenue Mc gill College, bureau 1240
Montréal, Qc., H3B 4G7, Canada
a/s: M. Stéphane LEBLANC

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179752-a	< 2	6	82	< 2	5	< 5	4	1	10	< 1	12	43	6	6	3	11	4	20	10	< 4	4	< 13	3	NA
P179752-b	< 2	4	113	< 2	5	< 5	< 4	1	10	< 1	12	43	6	6	4	13	4	21	10	< 4	4	< 13	3	NA
P179752-c	< 2	4	97	< 2	6	< 5	< 4	2	11	< 1	12	44	6	6	4	14	4	19	10	< 4	5	< 13	3	NA
P179761-a	< 2	5	44	< 2	5	5	< 4	1	3	1	37	78	8	6	4	12	4	28	11	4	6	< 13	3	NA
P179761-b	< 2	3	48	< 2	6	< 5	< 4	2	< 3	1	37	78	8	6	4	14	4	25	11	< 4	8	< 13	3	NA
P179761-c	< 2	5	47	< 2	4	5	< 4	1	3	1	37	78	9	6	4	14	4	29	11	7	7	< 13	3	NA
P179770-a	< 2	3	45	< 2	3	< 5	< 4	1	< 3	< 1	15	52	6	6	< 3	12	4	16	11	< 4	3	< 13	3	NA
P179770-b	< 2	4	44	< 2	3	< 5	< 4	1	< 3	< 1	16	53	7	6	3	11	4	16	11	< 4	2	< 13	3	NA
P179770-c	< 2	4	35	< 2	4	< 5	< 4	1	< 3	< 1	16	52	6	6	3	13	4	13	11	< 4	4	< 13	3	NA
P179772-a	< 2	5	66	< 2	5	< 5	< 4	1	< 3	< 1	31	88	9	6	3	12	6	13	11	< 4	6	< 13	3	NA
P179772-b	< 2	4	65	< 2	4	< 5	< 4	1	< 3	< 1	30	87	10	6	4	13	6	13	11	< 4	7	< 13	3	NA
P179772-c	< 2	4	65	< 2	5	< 5	< 4	1	4	< 1	31	87	9	6	< 3	13	4	13	11	< 4	6	< 13	3	NA
P179780-a	< 2	7	57	< 2	5	< 5	4	1	< 3	1	22	30	6	6	4	12	5	22	10	5	6	< 13	3	NA
P179780-b	< 2	6	55	< 2	3	< 5	4	2	3	1	22	30	6	6	4	13	7	24	10	< 4	6	< 13	3	NA
P179780-c	2	7	62	< 2	5	< 5	< 4	2	3	< 1	21	30	6	6	4	11	5	25	10	< 4	5	< 13	3	NA
P179794-a	2	2	35	< 2	3	< 5	< 4	1	< 3	< 1	15	35	5	6	4	13	8	14	11	< 4	5	< 13	3	NA
P179794-b	< 2	3	30	< 2	3	< 5	< 4	1	< 3	< 1	15	34	4	6	3	12	4	15	11	< 4	4	< 13	3	NA
P179794-c	< 2	4	32	< 2	4	< 5	< 4	1	3	< 1	15	34	5	6	4	12	8	14	11	< 4	4	< 13	3	NA

Écart type et marge d'erreur

Échantillons	Sc (PPM)	V (PPM)	Cr (PPM)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Ga (PPM)	As (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Nb (PPM)	Mo (PPM)	Sn (PPM)	Sb (PPM)	Cs (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Pb (PPM)	Th (PPM)	U (PPM)	Zr (PPM)
P179752	NA	1,155	15,503	NA	0,577	NA	NA	0,577	0,577	NA	0,000	0,577	0,000	0,000	0,577	1,528	0,000	1,000	0,000	NA	0,577	NA	0,000	NA
P179761	NA	1,155	2,082	NA	1,000	0,000	NA	0,577	0,000	0,000	0,000	0,000	0,577	0,000	0,000	1,155	0,000	2,082	0,000	2,121	1,000	NA	0,000	NA
P179770	NA	0,577	5,508	NA	0,577	NA	NA	0,000	NA	NA	0,577	0,577	0,577	0,000	0,000	1,000	0,000	1,732	0,000	NA	1,000	NA	0,000	NA
P179772	NA	0,577	0,577	NA	0,577	NA	NA	0,000	NA	NA	0,577	0,577	0,577	0,000	0,707	0,577	1,155	0,000	0,000	NA	0,577	NA	0,000	NA
P179780	NA	0,577	3,606	NA	1,155	NA	0,000	0,577	0,000	0,000	0,577	0,000	0,000	0,000	0,000	1,000	1,155	1,528	0,000	NA	0,577	NA	0,000	NA
P179794	NA	1,000	2,517	NA	0,577	NA	NA	0,000	NA	NA	0,000	0,577	0,577	0,000	0,577	0,577	2,309	0,577	0,000	NA	0,577	NA	0,000	NA
Moyenne	NA	0,840	4,965	NA	0,744	0,000	0,000	0,289	0,192	0,000	0,289	0,385	0,385	0,000	0,310	0,973	0,770	1,153	0,000	2,121	0,718	NA	0,000	NA
Marge d'erreur	NA	1,647	9,732	NA	1,458	NA	NA	0,566	0,377	NA	0,566	0,754	0,754	NA	0,608	1,907	1,509	2,260	NA	4,158	1,408	NA	NA	NA

Annexe B

Données des essais de caractérisation physique

B.1 : Matériel Concassé

Détail de la distribution granulométrique du matériel concassé pour l'Envoi 1

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	AFS calculation	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No. 8	2,360	1,66	1,4	1,4	98,6	7	10
No. 12	1,700	1,11	0,9	2,3	97,7	8	7
No. 16	1,180	1,27	1,1	3,4	96,6	12	13
No. 20	0,850	1,70	1,4	4,8	95,2	16	23
No. 30	0,600	4,74	4,0	8,8	91,2	20	79
No. 40	0,425	11,14	9,3	18,1	81,9	30	279
No. 50	0,300	12,57	10,5	28,6	71,4	40	420
No. 70	0,212	12,53	10,5	39,0	61,0	50	523
No. 100	0,150	20,75	17,3	56,4	43,6	70	1214
No. 140	0,106	25,00	20,9	77,3	22,7	100	2089
Panne		27,22	22,7	100,0	0,0	140	3184
						Sum:	7841
TOTAL		119,69	100,0			AFS:	78

Détail de la distribution granulométrique du matériel concassé pour l'Envoi 2

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No. 8	2,360	2,3	2,1	2,1	97,9	7	14,7
No. 12	1,700	1,1	1,0	3,1	96,9	8	8,3
No. 16	1,180	1,9	1,8	4,9	95,1	12	21,3
No. 20	0,850	2,5	2,3	7,2	92,8	16	36,8
No. 30	0,600	5,9	5,4	12,6	87,4	20	108,8
No. 40	0,425	12,2	11,3	23,9	76,1	30	338,9
No. 50	0,300	13,0	12,0	36,0	64,0	40	480,7
No. 70	0,212	11,9	11,0	47,0	53,0	50	550,1
No. 100	0,150	16,6	15,3	62,3	37,7	70	1072,7
No. 140	0,106	19,9	18,4	80,7	19,3	100	1840,9
Panne		20,9	19,3	100,0	0,0	140	2702,8
						Sum:	7175,9
TOTAL		108,26	100,0			AFS:	71,8

Détail de la distribution granulométrique du matériel concassé pour l'Envoi 3

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No. 8	2,360	3,14	2,6	2,6	97,4	7	18,2
No. 12	1,700	1,79	1,5	4,1	95,9	8	11,8
No. 16	1,180	2,63	2,2	6,3	93,7	12	26,1
No. 20	0,850	3,64	3,0	9,3	90,7	16	48,2
No. 30	0,600	6,48	5,4	14,6	85,4	20	107,2
No. 40	0,425	10,59	8,8	23,4	76,6	30	262,8
No. 50	0,300	10,82	9,0	32,3	67,7	40	358,0
No. 70	0,212	10,55	8,7	41,1	58,9	50	436,4
No. 100	0,150	18,29	15,1	56,2	43,8	70	1059,1
No. 140	0,106	26,52	21,9	78,1	21,9	100	2193,9
Panne		26,43	21,9	100,0	0,0	140	3061,1
						Sum:	7582,9
TOTAL		120,88	100,0			AFS:	75,8

B.2 : Matériel d'alimentation de la chaîne de traitement, -600µm

Détail de la distribution granulométrique du matériel d'alimentation (-600µm) pour l'Envoi 1

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,02	0,0	0,0	100,0	20	0
No. 40	0,425	15,28	10,1	10,1	89,9	30	302
No.50	0,300	17,07	11,3	21,4	78,6	40	450
No.70	0,212	17,11	11,3	32,6	67,4	50	564
No.100	0,150	29,50	19,5	52,1	47,9	70	1362
No.140	0,106	34,97	23,1	75,2	24,8	100	2307
Panne		37,62	24,8	100,0	0,0	140	3475
TOTAL		151,57	100,0			Sum:	8462
						AFS:	85

Détail de la distribution granulométrique du matériel d'alimentation (-600µm) pour l'Envoi 2

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant		
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,04	0,0	0,0	100,0	20	1
No. 40	0,425	9,80	8,0	8,0	92,0	30	239
No.50	0,300	11,05	9,0	17,0	83,0	40	359
No.70	0,212	12,58	10,2	27,2	72,8	50	511
No.100	0,150	25,29	20,5	47,7	52,3	70	1437
No.140	0,106	33,86	27,5	75,2	24,8	100	2749
Panne		30,55	24,8	100,0	0,0	140	3472
TOTAL		123,17	100			Sum:	8768
						AFS:	88

Détail de la distribution granulométrique du matériel d'alimentation (-600µm) pour l'Envoi 3

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,21	0,2	0,2	99,8	20	3
No. 40	0,425	17,84	14,2	14,4	85,6	30	427
No.50	0,300	18,35	14,6	29,0	71,0	40	585
No.70	0,212	15,81	12,6	41,6	58,4	50	630
No.100	0,150	23,54	18,8	60,4	39,6	70	1314
No.140	0,106	21,06	16,8	77,2	22,8	100	1679
Panne		28,6	22,8	100,0	0,0	140	3195
TOTAL		125,44	100,0			Sum:	7833
						AFS:	78

B.3 : Produit du premier lavage, -600µm,+106µm

Détail de la distribution granulométrique du produit du premier lavage (-600µm, +106 µm) pour l'Envoi 1

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant		
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.20	0,850					USA	
No.30	0,600	0,17	0,2	0,2	99,8	20	3
No. 40	0,425	14,16	13,2	13,3	86,7	30	395
No.50	0,300	16,39	15,3	28,6	71,4	40	610
No.70	0,212	15,82	14,7	43,3	56,7	50	736
No.100	0,150	26,37	24,5	67,9	32,1	70	1718
No.140	0,106	30,42	28,3	96,2	3,8	100	2831
Panne		4,1	3,8	100,0	0,0	140	537
TOTAL		107,45	100,0			Sum:	6831
						AFS:	68
						D10:	0,114
						D60:	0,225
						C.U.:	1,97

Détail de la distribution granulométrique du produit du premier lavage (-600µm, +106 µm) pour l'Envoi 2

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.20	0,850					USA	
No.30	0,600	0,21	0,2	0,2	99,8	20	4
No. 40	0,425	19,92	18,1	18,3	81,7	30	543
No.50	0,300	19,99	18,2	36,5	63,5	40	727
No.70	0,212	16,65	15,1	51,6	48,4	50	757
No.100	0,150	23,79	21,6	73,2	26,8	70	1513
No.140	0,106	26,54	24,1	97,3	2,7	100	2412
Panne		2,9	2,7	100,0	0,0	140	374
TOTAL		110,04	100,0			Sum:	6329
						AFS:	63
						D10:	0,123
						D60:	0,27
						C.U.:	2,20

Détail de la distribution granulométrique du produit du premier lavage (-600µm, +106 µm) pour l'Envoi 3

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.20	0,850					USA	
No.30	0,600	0,11	0,1	0,1	99,9	20	2
No. 40	0,425	16,03	15,1	15,3	84,7	30	454
No.50	0,300	17,69	16,7	32,0	68,0	40	669
No.70	0,212	16,30	15,4	47,4	52,6	50	770
No.100	0,150	26,22	24,8	72,1	27,9	70	1734
No.140	0,106	24,38	23,0	95,2	4,8	100	2304
Panne		5,1	4,8	100,0	0,0	140	675
TOTAL		105,83	100,0			Sum:	6608
						AFS:	66
						D10:	0,248
						D60:	0,122
						C.U.:	2,16

B.4 : Produit de l'attrition de 5 min, +106µm

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 1

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.20	0,850					USA	
No.30	0,600	0,14	0,1	0,1	99,9	20	2
No. 40	0,425	17,00	11,0	11,1	88,9	30	329
No.50	0,300	21,80	14,1	25,1	74,9	40	563
No.70	0,212	22,70	14,6	39,8	60,2	50	732
No.100	0,150	40,25	26,0	65,8	34,2	70	1818
No.140	0,106	49,65	32,0	97,8	2,2	100	3204
Panne		3,42	2,2	100,0	0,0	140	309
TOTAL		155,0	100,0			Sum:	6957
						AFS:	70
						D10:	0,114
						D60:	0,213
						C.U.:	1,87

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 2

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.20	0,850					USA	
No.30	0,600	0,19	0,2	0,2	99,8	20	4
No. 40	0,425	10,60	10,6	10,8	89,2	30	318
No.50	0,300	13,30	13,3	24,1	75,9	40	532
No.70	0,212	14,00	14,0	38,1	61,9	50	701
No.100	0,150	26,11	26,1	64,3	35,7	70	1830
No.140	0,106	32,71	32,7	97,0	3,0	100	3274
Panne		3,01	3,0	100,0	0,0	140	422
TOTAL		99,9	100,0			Sum:	7080
						AFS:	71
						D10:	0,114
						D60:	0,2
						C.U.:	1,76

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 3

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,14	0,1	0,1	99,9	20	2
No. 40	0,425	19,18	17,1	17,2	82,8	30	512
No.50	0,300	19,88	17,7	34,9	65,1	40	708
No.70	0,212	17,22	15,3	50,2	49,8	50	767
No.100	0,150	26,90	24,0	74,2	25,8	70	1677
No.140	0,106	25,11	22,4	96,6	3,4	100	2236
Panne		3,86	3,4	100,0	0,0	140	481
TOTAL		112,29	100,0			Sum:	6384
						AFS:	64
						D10:	0,126
						D60:	0,265
						CU:	2,1

B.5 : Produit non-magnétique

Détail de la distribution granulométrique du produit non-magnétique pour l'Envoi 1

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.20	0,850					USA	
No.30	0,600	0,38	0,2	0,2	99,8	20	3
No. 40	0,425	24,17	9,7	9,8	90,2	30	290
No.50	0,300	32,98	13,2	23,0	77,0	40	527
No.70	0,212	36,07	14,4	37,4	62,6	50	721
No.100	0,150	61,20	24,5	61,9	38,1	70	1712
No.140	0,106	84,27	33,7	95,5	4,5	100	3368
Panne		11,16	4,5	100,0	0,0	140	624
TOTAL		250,23	100,0			Sum:	7245
						AFS:	72,4
						D10:	0,122
						D60:	0,2
						C.U.:	1,64

Détail de la distribution granulométrique du produit non-magnétique pour l'Envoi 2

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,11	0,1	0,1	99,9	20	2
No. 40	0,425	12,41	9,8	9,9	90,1	30	295
No.50	0,300	15,47	12,3	22,2	77,8	40	491
No.70	0,212	16,44	13,0	35,2	64,8	50	652
No.100	0,150	32,56	25,8	61,0	39,0	70	1807
No.140	0,106	45,38	36,0	97,0	3,0	100	3598
Panne		3,74	3,0	100,0	0,0	140	415
TOTAL		126,11	100			Sum:	7260
						AFS:	72,6
						D10:	0,114
						D60:	0,2
						C.U.:	1,75

Détail de la distribution granulométrique du produit non-magnétique pour l'Envoi 3

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
U.S.A series	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,44	0,1	0,1	99,9	20	1
No. 40	0,425	36,38	5,1	5,2	94,8	30	0
No.50	0,300	198,15	28,0	33,2	66,8	40	1121
No.70	0,212	106,65	15,1	48,3	51,7	50	754
No.100	0,150	145,81	20,6	69,0	31,0	70	1444
No.140	0,106	192,62	27,3	96,2	3,8	100	2725
No.200	0,075	22,05	3,1	99,3	0,7	140	437
No.270	0,075	1,81	0,3	99,6	0,4	200	51
Panne		2,86	0,4	100,0	0,0	270	109
TOTAL		706,77	100,0			Sum:	6798
						AFS:	67,98
						D10:	0,126
						D60:	0,26
						cu	2,06

B.6 : Produit de l'attrition +106µm – Incidence du temps de contact

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 3, 1min

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,17	0,2	0,2	99,8	20	3
No. 40	0,425	16,61	14,8	15,0	85,0	30	444
No.50	0,300	18,06	16,1	31,1	68,9	40	644
No.70	0,212	16,95	15,1	46,2	53,8	50	756
No.100	0,150	28,70	25,6	71,8	28,2	70	1791
No.140	0,106	27,58	24,6	96,4	3,6	100	2459
Panne		4,08	3,6	100,0	0,0	140	509
TOTAL		112,15	100,0			Sum:	6607
						AFS:	66

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 3, 3min

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,07	0,1	0,1	99,9	20	1
No. 40	0,425	14,72	13,4	13,5	86,5	30	403
No.50	0,300	16,98	15,5	29,0	71,0	40	620
No.70	0,212	16,78	15,3	44,3	55,7	50	766
No.100	0,150	28,84	26,3	70,7	29,3	70	1843
No.140	0,106	28,10	25,7	96,3	3,7	100	2566
Panne		4,04	3,7	100,0	0,0	140	516
TOTAL		109,53	100,0			Sum:	6716
						AFS:	67

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 3, 5min

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,14	0,1	0,1	99,9	20	2
No. 40	0,425	19,18	17,1	17,2	82,8	30	512
No.50	0,300	19,88	17,7	34,9	65,1	40	708
No.70	0,212	17,22	15,3	50,2	49,8	50	767
No.100	0,150	26,90	24,0	74,2	25,8	70	1677
No.140	0,106	25,11	22,4	96,6	3,4	100	2236
Panne		3,86	3,4	100,0	0,0	140	481
TOTAL		112,29	100,0			Sum:	6384
						AFS:	64
						D10:	0,126
						D60:	0,265
						CU:	2,1

Détail de la distribution granulométrique du produit d'attrition (+106 µm) pour l'Envoi 3, 10min

Dimension	Dimension	poids retenu	poids retenu	Cum. Retenu	Cum. Passant	Calcul AFS	
(U.S.A series)	(mm)	(g)	(%)	(%)	(%)	Previous Sieve	Product
No.30	0,600	0,29	0,3	0,3	99,7	20	6
No. 40	0,425	18,77	18,1	18,4	81,6	30	544
No.50	0,300	18,91	18,3	36,7	63,3	40	731
No.70	0,212	15,87	15,3	52,0	48,0	50	767
No.100	0,150	24,00	23,2	75,2	24,8	70	1623
No.140	0,106	22,31	21,6	96,8	3,2	100	2155
Panne		3,36	3,2	100,0	0,0	140	454
TOTAL		103,51	100,0			Sum:	6280
						AFS:	63

B7 : Compositions chimiques XRF aux différentes étapes de traitement

Suivi de la composition chimique aux différentes étapes de traitement pour les trois envois (attrition 5min)

	Évolution de la composition du produit											
	Alimentation -600µm avant lavage			-600,+106µm avant attrition			+106µm après attrition			Non-magnétique après WHIMS		
Oxyde	Envoi 1	Envoi 2	Envoi 3	Envoi 1	Envoi 2	Envoi 3	Envoi 1	Envoi 2	Envoi 3	Envoi 1	Envoi 2	Envoi 3
SiO_2	99,03	98,91	99,01	99,39	99,46	99,46	99,58	99,53	99,58	99,56	99,47	99,20
Fe_2O_3	0,09	0,09	0,08	0,05	0,05	0,05	0,03	0,02	0,05	0,03	0,04	0,01
Al_2O_3	0,40	0,47	0,32	0,21	0,19	0,20	0,15	0,17	0,15	0,16	0,15	0,17
TiO_2	0,04	0,06	0,04	0,03	0,03	0,03	0,03	0,02	0,05	0,03	0,03	0,02
MgO	0,08	0,08	0,11	0,02	0,01	0,04	<0,01	0,02	<0,01	0,01	0,01	0,05
CaO	0,04	0,02	0,02	0,03	0,01	0,02	0,02	0,01	0,01	0,02	0,01	0,01
MnO	0,01	0,01	0,01	0,01	0,01	0,01	<0,01	0,01	0,01	<0,01	0,00	<0,01
Na_2O	0,03	0,04	0,16	0,05	0,03	0,02	0,06	0,08	0,04	0,04	0,09	0,04
K_2O	0,05	0,08	0,05	0,04	0,04	0,03	0,03	0,05	0,03	0,03	0,05	0,05
SO_3	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,02	0,00	<0,01
P_2O_5	0,01	0,01	0,01	0,01	0,01	0,01	<0,01	<0,01	<0,01	0,01	0,00	0,01
P.A.F.	0,22	0,23	0,19	0,17	0,16	0,15	0,10	0,09	0,13	0,11	0,15	0,12

		Évolution de la composition du rejet							
	-600,-106µm avant attrition			-106µm après attrition			Magnétique après WHIMS		
Oxyde	Envoi 1	Envoi 2	Envoi 3	Envoi 1	Envoi 2	Envoi 3	Envoi 1	Envoi 2	Envoi 3
SiO_2	97,86	97,88	98,77	98,65	97,64	97,87	95,30	94,92	93,47
Fe_2O_3	0,28	0,26	0,18	0,17	0,26	0,17	2,76	2,71	2,56
Al_2O_3	0,87	0,91	0,44	0,44	0,99	0,89	0,73	1,08	0,87
TiO_2	0,09	0,11	0,07	0,08	0,11	0,08	0,12	0,22	0,22
MgO	0,23	0,20	0,11	0,12	0,24	0,30	0,39	0,40	1,84
CaO	0,09	0,03	0,06	0,09	0,03	0,05	0,08	0,09	0,14
MnO	0,01	0,01	0,01	0,01	0,01	0,01	0,07	0,11	0,07
Na_2O	0,01	0,04	0,06	0,07	0,04	0,06	0,08	0,10	0,13
K_2O	0,11	0,15	0,04	0,08	0,17	0,06	0,06	0,09	0,09
SO_3	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	0,00
P_2O_5	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02
P.A.F.	0,44	0,40	0,25	0,28	0,50	0,50	0,40	0,27	0,59

B8 : Distribution et récupération des oxydes aux différentes étapes

Distribution et récupération des oxydes découlant du premier lavage sur un tamis Sweco 106µm

Fraction	Poids (g)	Contenu (%)				Distribution instantanée (% basé sur feed Calc)					Distribution Cumulée (%)					Ratio d'enrichissement	
		SiO2	Fe2O3	Al2O3	TiO2	Poids (%)	SiO2	Fe2O3	Al2O3	TiO2	Poids initial (%)	SiO2	Fe2O3	Al2O3	TiO2	Fe2O3	Al2O3
Envoi 1																	
+106 µm	9387	99,39	0,05	0,21	0,03	75,49	75,78	35,48	42,64	50,66	75,49	75,78	35,48	42,64	50,66		
-106 µm	3048	97,86	0,28	0,87	0,09	24,51	24,22	64,52	57,36	49,34	24,51	24,22	64,52	57,36	49,34	2,63	2,34
Feed (calc)	12435	99,01	0,106	0,372	0,045	100,00	100,00	100,00	100,00	100,00	100,00						
Feed (assayed)		99,03	0,09	0,40	0,04												
Envoi 2																	
+106 µm	9387	99,46	0,05	0,19	0,03	77,78	78,06	40,24	42,23	48,84	77,78	78,06	40,24	42,23	48,84		
-106 µm	2681	97,88	0,26	0,91	0,11	22,22	21,94	59,76	57,77	51,16	22,22	21,94	59,76	57,77	51,16	2,69	2,60
Feed (calc)	12068	99,11	0,097	0,350	0,048	100,00	100,00	100,00	100,00	100,00	100,00						
Feed (assayed)		98,91	0,09	0,47	0,06												
Envoi 3																	
+106 µm	4661	99,46	0,05	0,20	0,03	84,87	84,96	60,90	71,82	70,62	84,87	84,96	60,90	71,82	70,62		
-106 µm	831	98,77	0,18	0,44	0,07	15,13	15,04	39,10	28,18	29,38	15,13	15,04	39,10	28,18	29,38	2,58	1,86
Feed (calc)	5492	99,36	0,070	0,236	0,036	100,00	100,00	100,00	100,00	100,00	100,00						
Feed (assayed)		99,01	0,08	0,20	0,03												

Distribution et récupération des oxydes découlant du deuxième lavage sur un tamis Sweco 106µm, suivant une attrition de 5 min

Fraction	Poids (g)	Contenu (%)				Distribution instantanée (% basé sur feed Calc)					Distribution Cumulée (%)					Ratio d'enrichissement	
		SiO2	Fe2O3	Al2O3	TiO2	Poids (%)	SiO2	Fe2O3	Al2O3	TiO2	Poids initial (%)	SiO2	Fe2O3	Al2O3	TiO2	Fe2O3	Al2O3
Envoi 1																	
+106 µm	8081	99,58	0,03	0,15	0,03	98,08	98,09	89,99	94,56	95,03	74,04	74,46	20,88	29,87	49,68		
-106 µm	159	98,65	0,17	0,44	0,08	1,92	1,91	10,01	5,44	4,97	25,96	25,54	79,12	59,64	52,79	5,20	2,83
Feed (calc)	8240	99,56	0,033	0,156	0,031	100,00	100,00	100,00	100,00	100,00							
eed (assayed)		99,39	0,05	0,21	0,03												
Envoi 2																	
+106 µm	8056	99,53	0,02	0,17	0,02	97,87	97,91	77,97	88,77	89,32	76,13	76,45	15,75	36,98	31,87		
-106 µm	175	97,64	0,26	0,99	0,11	2,13	2,09	22,03	11,23	10,68	23,87	23,55	84,25	63,02	68,13	10,36	5,28
Feed (calc)	8231	99,49	0,025	0,187	0,022	100,00	100,00	100,00	100,00	100,00	100,00						
eed (assayed)		99,46	0,05	0,19	0,03												
Envoi 3																	
+106 µm	928	99,58	0,05	0,15	0,05	98,05	98,08	93,00	89,43	96,58	83,21	83,39	53,74	52,81	103,86		
-106 µm	18	97,87	0,17	0,89	0,08	1,95	1,92	7,00	10,57	3,42	16,79	16,61	46,26	47,19	-3,86	3,58	5,41
Feed (calc)	947	99,54	0,047	0,164	0,046	100,00	100,00	100,00	100,00	100,00	100,00						
eed (assayed)		99,46	0,05	0,20	0,03												

Distribution et récupération des oxydes découlant de la séparation magnétique WHIMS

Fraction	Poids (g)	Contenu (%)				Distribution instantanée (% basé sur feed Calc)					Distribution Cumulée (%)					Ratio d'enrichissement	
		SiO2	Fe2O3	Al2O3	TiO2	Poids (%)	SiO2	Fe2O3	Al2O3	TiO2	Poids initial (%)	SiO2	Fe2O3	Al2O3	TiO2	Fe2O3	Al2O3
Envoi 1																	
Non-mag	7967,00	99,56	0,03	0,16	0,03	99,64	99,66	75,13	98,39	98,58	73,77	74,18	20,81	31,75	49,50		
Mag	28,66	95,30	2,76	0,73	0,12	0,36	0,34	24,87	1,61	1,42	26,23	25,82	79,19	68,25	50,50	69,37	4,50
Feed (calc)	7995,66	99,54	0,040	0,162	0,030	100,00	100,00	100,00	100,00	100,00	100,00						
Feed (assayed)		99,58	0,03	0,15	0,03												
Envoi 2																	
Non-mag	8025,00	99,47	0,04	0,15	0,03	99,77	99,78	86,64	98,39	98,36	75,96	76,23	31,43	30,76	50,97		
Mag	18,27	94,92	2,71	1,08	0,22	0,23	0,22	13,36	1,61	1,64	24,04	23,77	68,57	69,24	57,10	58,83	7,10
Feed (calc)	8043,27	99,46	0,046	0,152	0,030	100,00	100,00	100,00	100,00	100,00	100,00						
Feed (assayed)		99,53	0,02	0,17	0,02												
Envoi 3																	
Non-mag	8025,00	99,20	0,01	0,17	0,02	99,77	99,79	63,18	98,85	97,56	83,02	83,17	11,92	59,72	36,35		
Mag	18,27	93,47	2,56	0,87	0,22	0,23	0,21	36,82	1,15	2,44	16,98	16,83	88,08	40,28	63,65	56,89	5,07
Feed (calc)	8043,27	99,19	0,016	0,172	0,020	100,00	100,00	100,00	100,00	100,00	100,00						
Feed (assayed)		99,58	0,05	0,15	0,05												

B9 : Compositions chimiques XRF pour différents temps d'attrition

Suivi de la composition chimique pour différents temps d'attrition (envoi 3)

		Composition suivant le deuxième lavage après différents temps d'attrition							
	Alimentation	1 min		3 min		5 min		10 min	
Oxyde	+106µm	+106µm	-106µm	+106µm	-106µm	+106µm	-106µm	+106µm	-106µm
SiO_2	99,4566667	99,54	98,72	99,565	98,76	99,575	97,87	99,625	99,15
Fe_2O_3	0,05	0,03	0,1	0,025	0,12	0,045	0,17	0,035	0,08
Al_2O_3	0,19666667	0,185	0,42	0,18	0,47	0,15	0,89	0,13	0,27
TiO_2	0,03	0,03	0,05	0,025	0,06	0,045	0,08	0,025	0,06
MgO	0,05	0,02	0,16	0,01	0,14	<0,01	0,30	<0,01	0,08
CaO	0,03	0,02	0,05	0,03	0,04	0,01	0,05	0,01	0,04
MnO	<0,01	<0,01	0,01	<0,01	0,01	<0,01	0,01	<0,01	0,01
Na_2O	0,02	0,06	0,14	0,04	0,04	0,04	0,06	0,05	0,04
K_2O	0,03	0,03	0,05	0,03	0,04	0,03	0,06	0,03	0,04
SO_3	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
P_2O_5	<0,01	<0,01	0,01	<0,01	0,01	<0,01	0,01	<0,01	<0,01
P.A.F.	0,15	0,18	0,29	0,13	0,31	0,13	0,50	0,11	0,23

Annexe C

Données des essais de sphéricité et de rondeur

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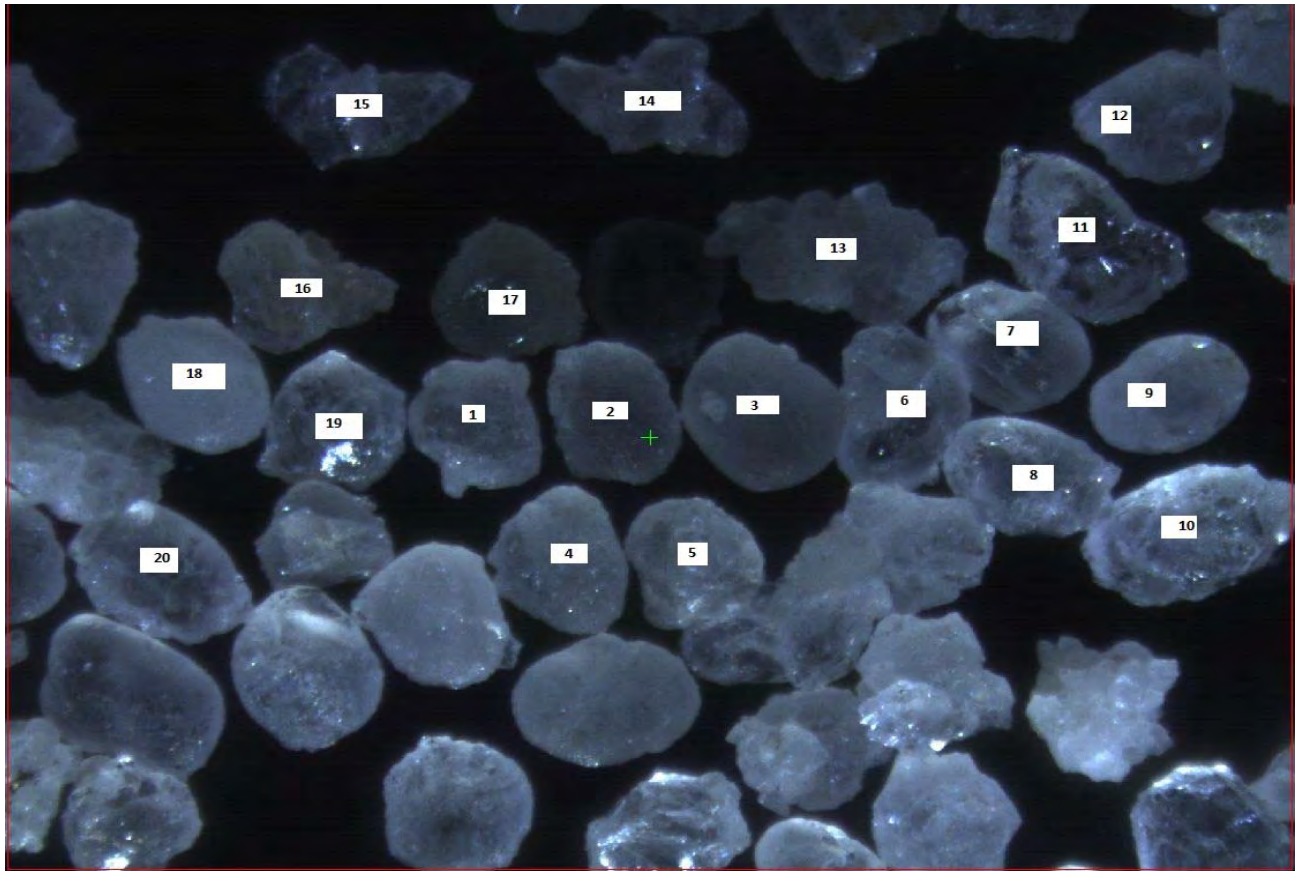
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

Attrité, 10 miné, envoi 3
Produit : Produit 20-40
Photos : Pr20-40Ph12-5X-A

Particule																																				moy	
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20			
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,5	0,7	0,5	0,9	0,7	0,9	0,5	0,7	0,5	0,7	0,7	0,7	0,7	0,9	0,3	0,5	0,9	0,7	0,3	0,7	0,3	0,3	0,3	0,9	0,3	0,3	0,3	0,3	0,1	0,5	0,3	0,5	0,5	0,7	0,5	0,7	0,3	0,7	0,3	0,5	0,4	0,6

X : rondeur Y : sphéricité



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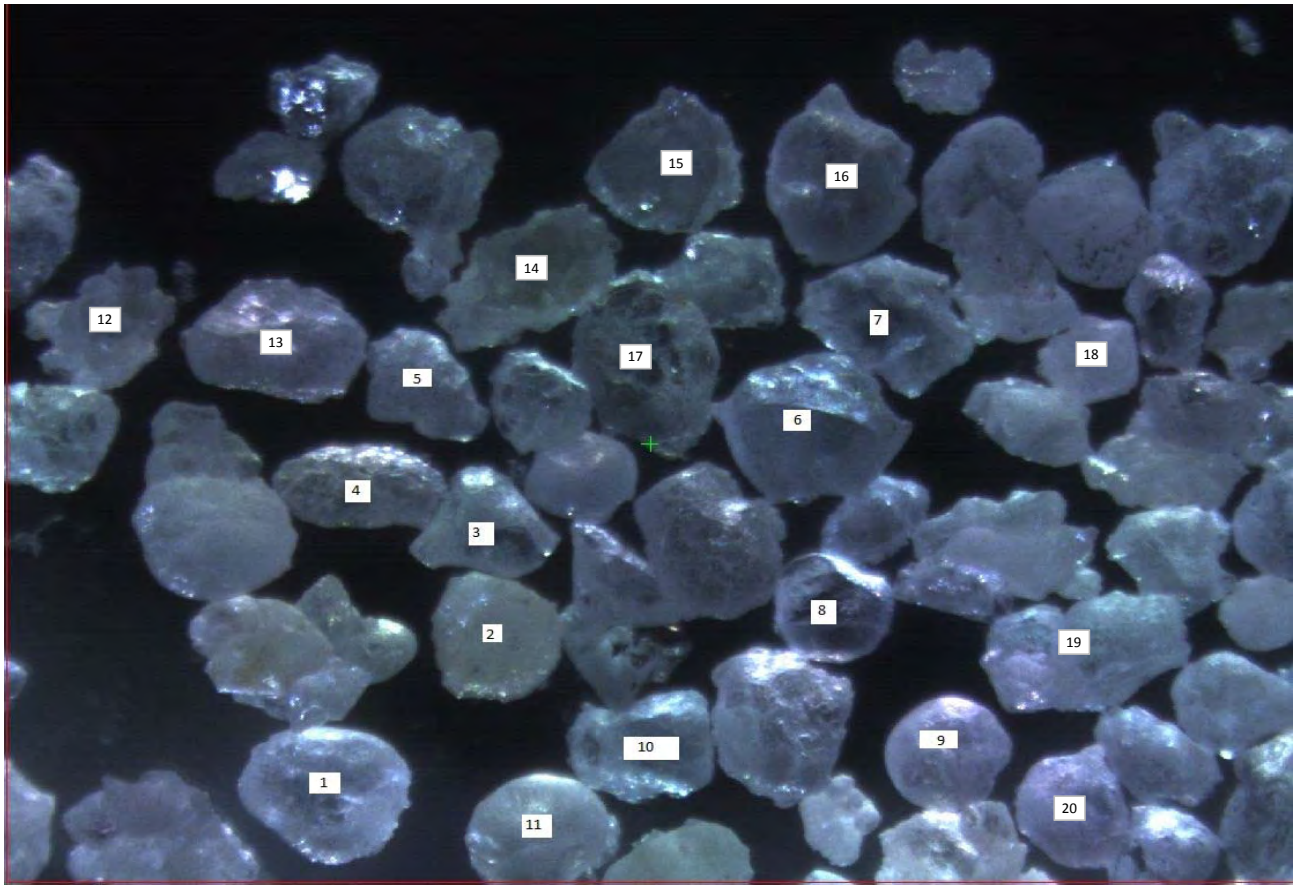
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

Attrité, 10 miné, envoi 3
Produit : Produit 30-50
Photos : Pr30-50Ph12-5X-A, Pr30-50Ph12-5X-C

Particule																																					
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,5	0,7	0,5	0,9	0,3	0,5	0,5	0,3	0,3	0,5	0,5	0,7	0,1	0,5	0,5	0,9	0,7	0,9	0,5	0,5	0,7	0,9	0,1	0,7	0,5	0,7	0,5	0,5	0,5	0,9	0,5	0,7	0,5	0,7	0,3	0,9	0,3	0,3	0,7	0,9	0,5	0,7

X : rondeur Y : sphéricité



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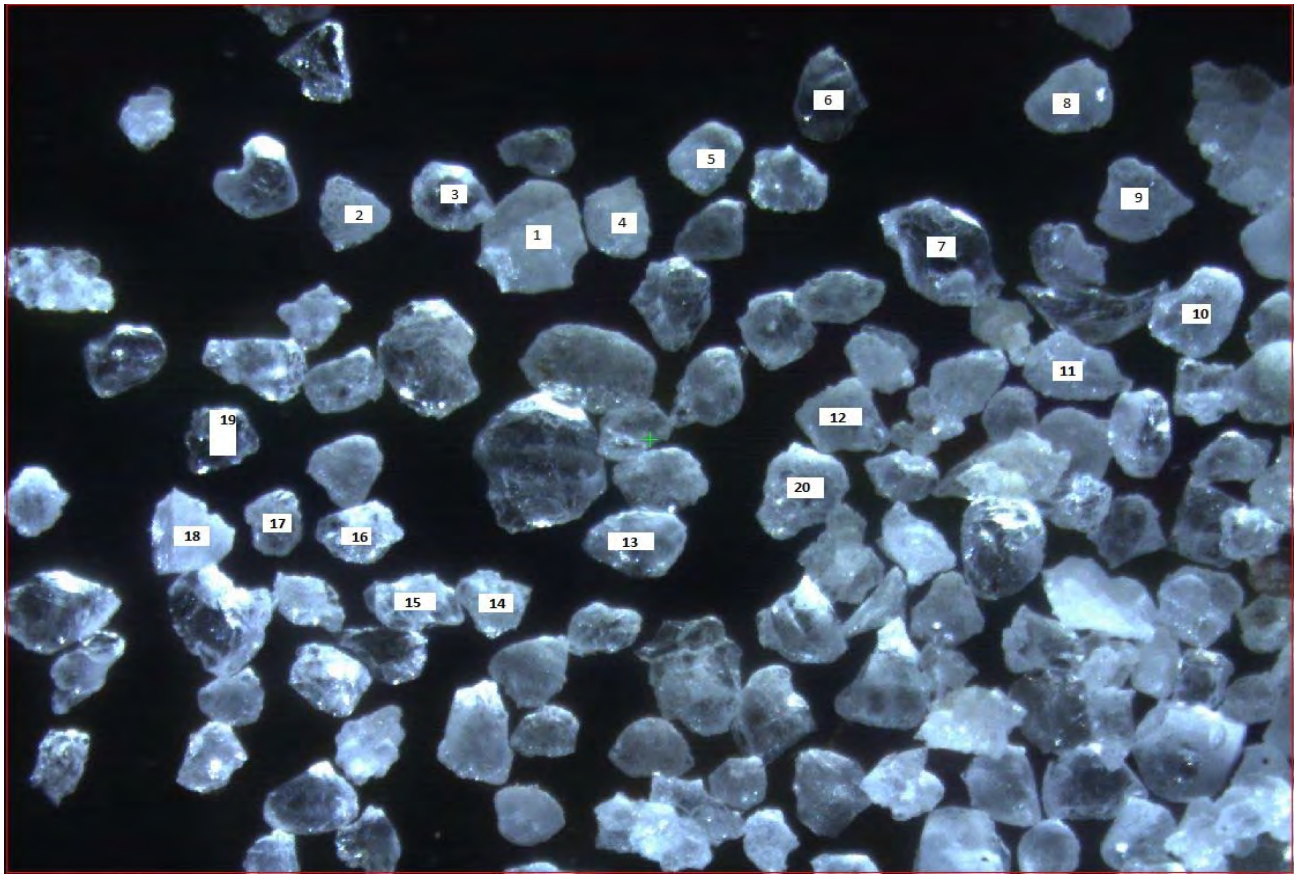
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

Attrité, 10 miné, envoi 3
Produit : Produit 40-70
Photos : Pr40-70Ph12-5X-A

Particule																																							
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,1	0,7	0,3	0,5	0,5	0,9	0,5	0,7	0,5	0,7	0,3	0,5	0,1	0,5	0,5	0,9	0,5	0,7	0,5	0,7	0,5	0,5	0,3	0,5	0,5	0,7	0,3	0,5	0,3	0,5	0,3	0,5	0,7	0,7	0,3	0,7	0,5	0,7	0,5	0,7	0,4	0,6

X : rondeur Y : sphéricité



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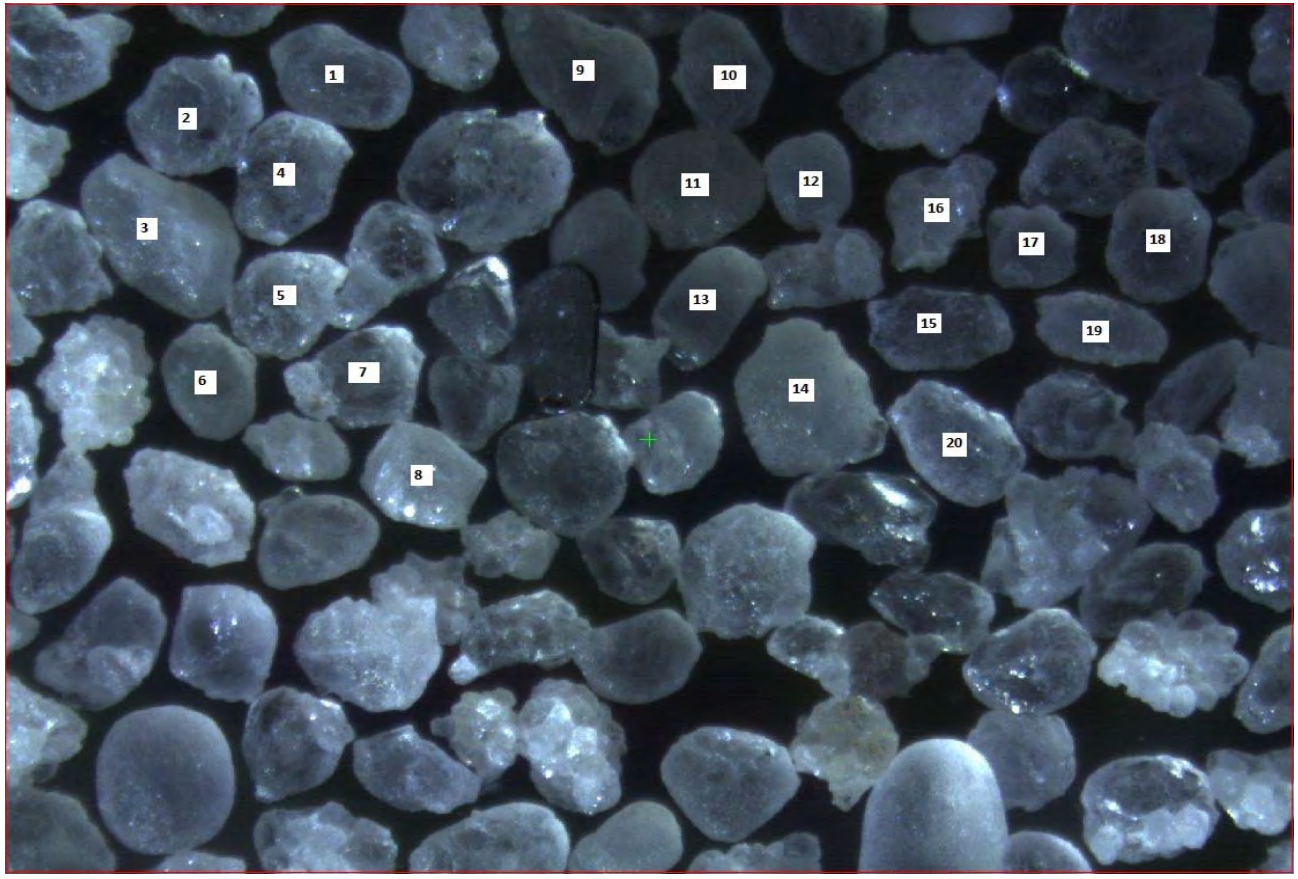
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

2013-11-14 Sphericity and roundness
Produit : Produit 20-40
Photos : N-mags whims 5.9A envoie #3 attrite 5 min Pr20-40(12,5X)-2

Particule																																					
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,7	0,7	0,5	0,9	0,3	0,5	0,3	0,7	0,5	0,9	0,5	0,7	0,1	0,7	0,1	0,7	0,7	0,5	0,3	0,7	0,7	0,9	0,7	0,9	0,7	0,7	0,3	0,7	0,3	0,7	0,1	0,5	0,3	0,7	0,5	0,9	0,5	0,7	0,7	0,7	0,4	0,7

X : rondeur Y : sphéricité



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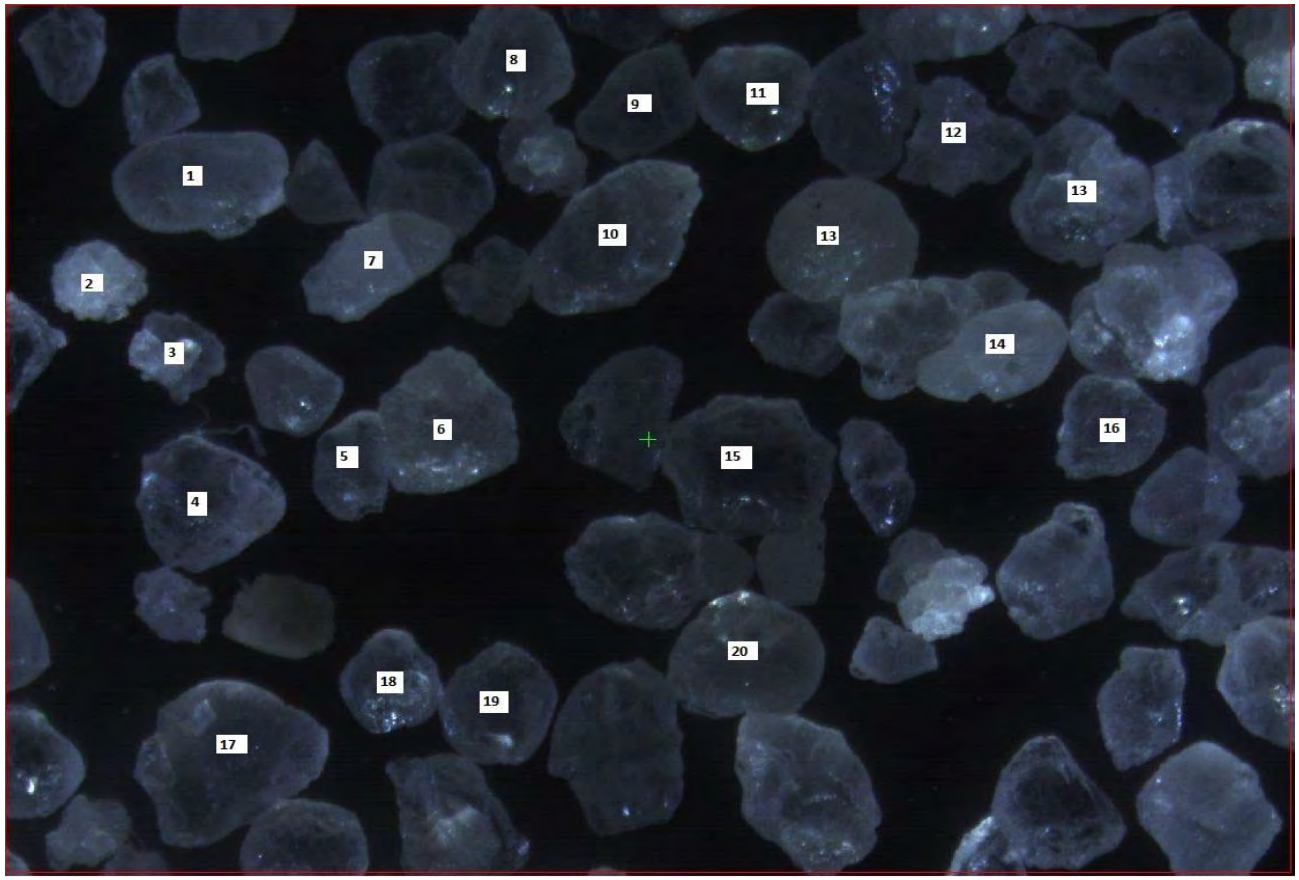
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

2013-11-14 Sphericity and roundness
Produit : Produit 30-50
Photos : N-mags whims 5.9A envoie #3 attrite 5 min Pr30-50(12,5X-2)

Particule																																							
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,7	0,7	0,5	0,9	0,3	0,7	0,5	0,7	0,7	0,5	0,5	0,7	0,5	0,5	0,7	0,9	0,5	0,5	0,5	0,5	0,7	0,9	0,1	0,5	0,5	0,7	0,7	0,5	0,3	0,7	0,3	0,7	0,5	0,7	0,7	0,9	0,7	0,9	0,7	0,9	0,5	0,7

X : rondeur Y : sphéricité



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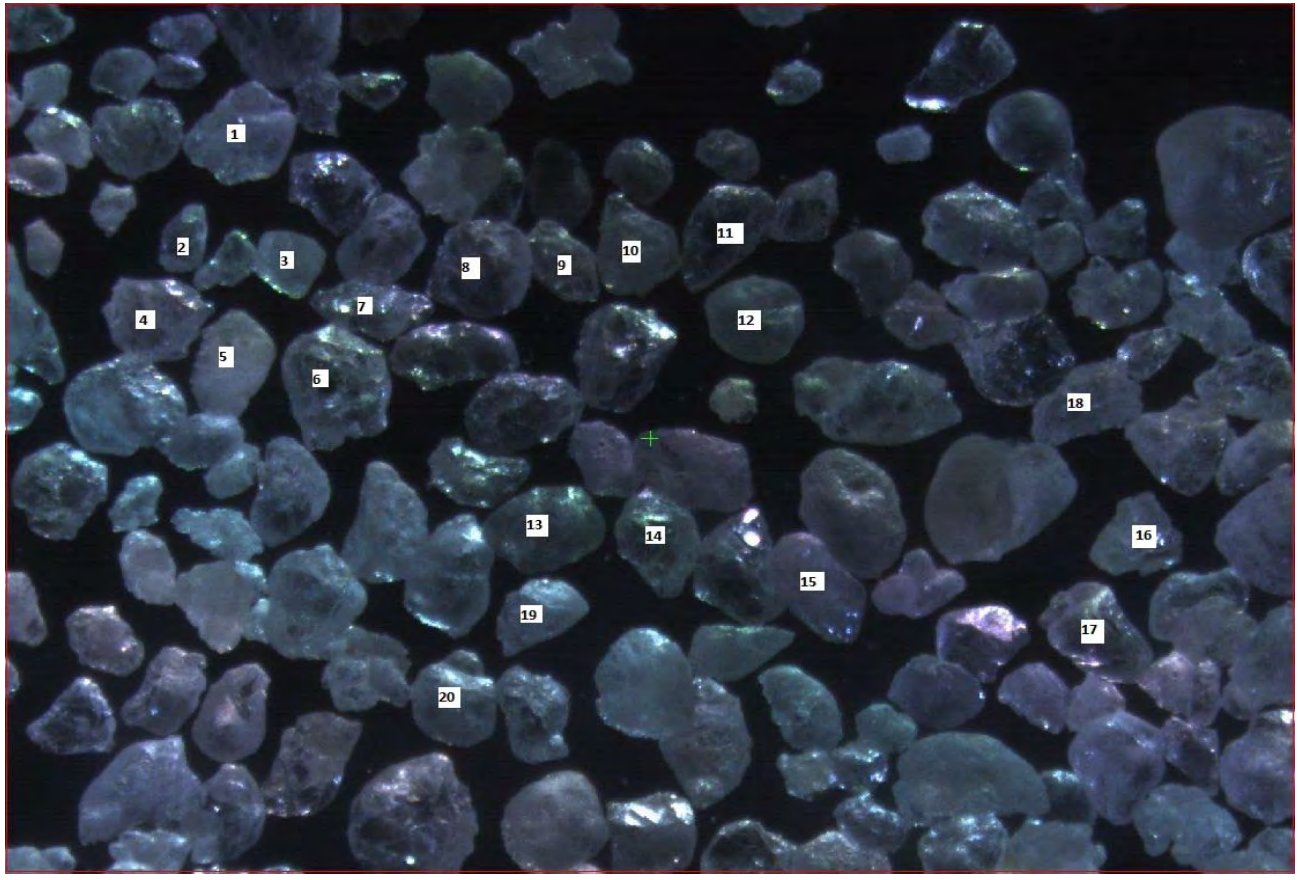
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

2013-11-14 Sphericity and roundness
Produit : Produit 40-70
Photos : N-mags whims 5.9A envoie #3 attrite 5 min Pr40-70(12,5X-1)

Particule																																							
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,3	0,7	0,3	0,5	0,5	0,7	0,3	0,7	0,3	0,5	0,3	0,7	0,3	0,3	0,5	0,9	0,5	0,5	0,3	0,7	0,3	0,5	0,7	0,9	0,7	0,7	0,5	0,5	0,5	0,5	0,3	0,5	0,5	0,5	0,3	0,5	0,3	0,5	0,5	0,7	0,4	0,6

X : rondeur Y : sphéricité



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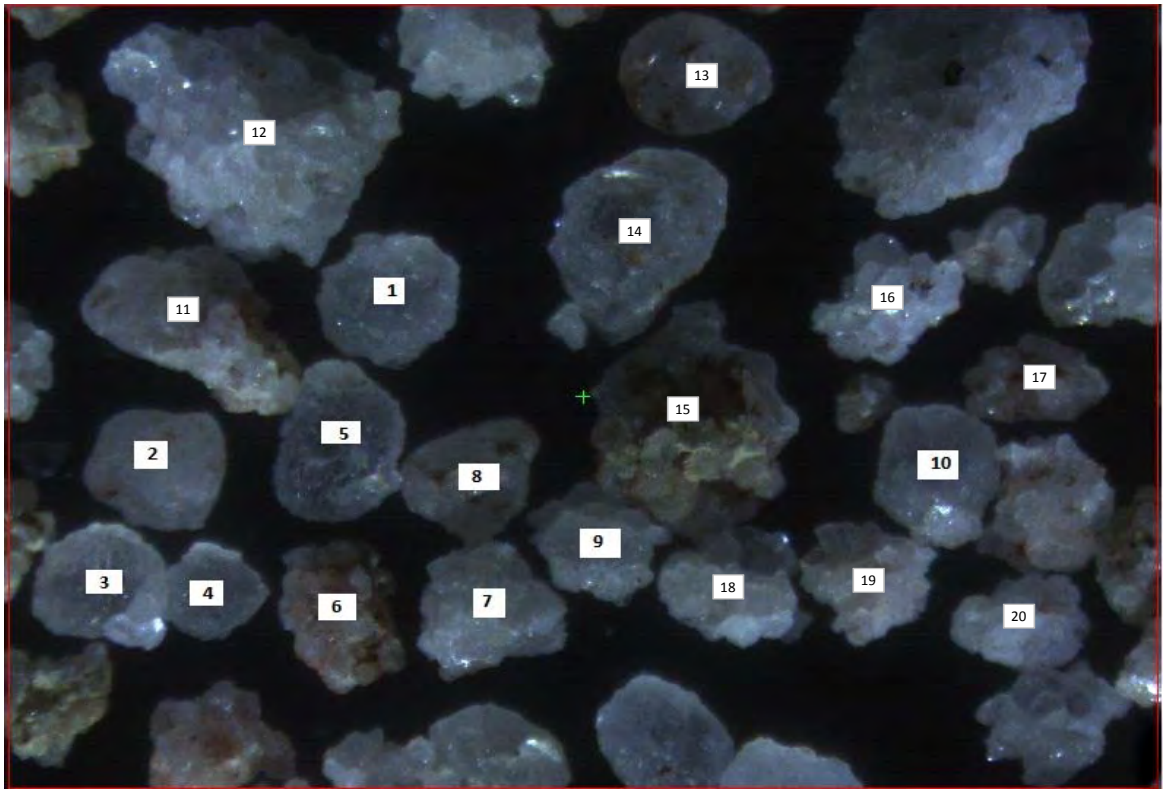
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

Thermique + attrition 5 min.
Produit : Produit 20-40
Photos : Pr20-40Ph12-5X-01

Particule																																							
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,5	0,9	0,5	0,9	0,5	0,7	0,5	0,7	0,5	0,7	0,1	0,5	0,1	0,5	0,3	0,7	0,1	0,7	0,3	0,7	0,5	0,3	0,3	0,7	0,9	0,9	0,5	0,7	0,1	0,7	0,1	0,5	0,3	0,5	0,3	0,7	0,1	0,7	0,3	0,7	0,3	0,7

X : rondeur Y : sphéricité



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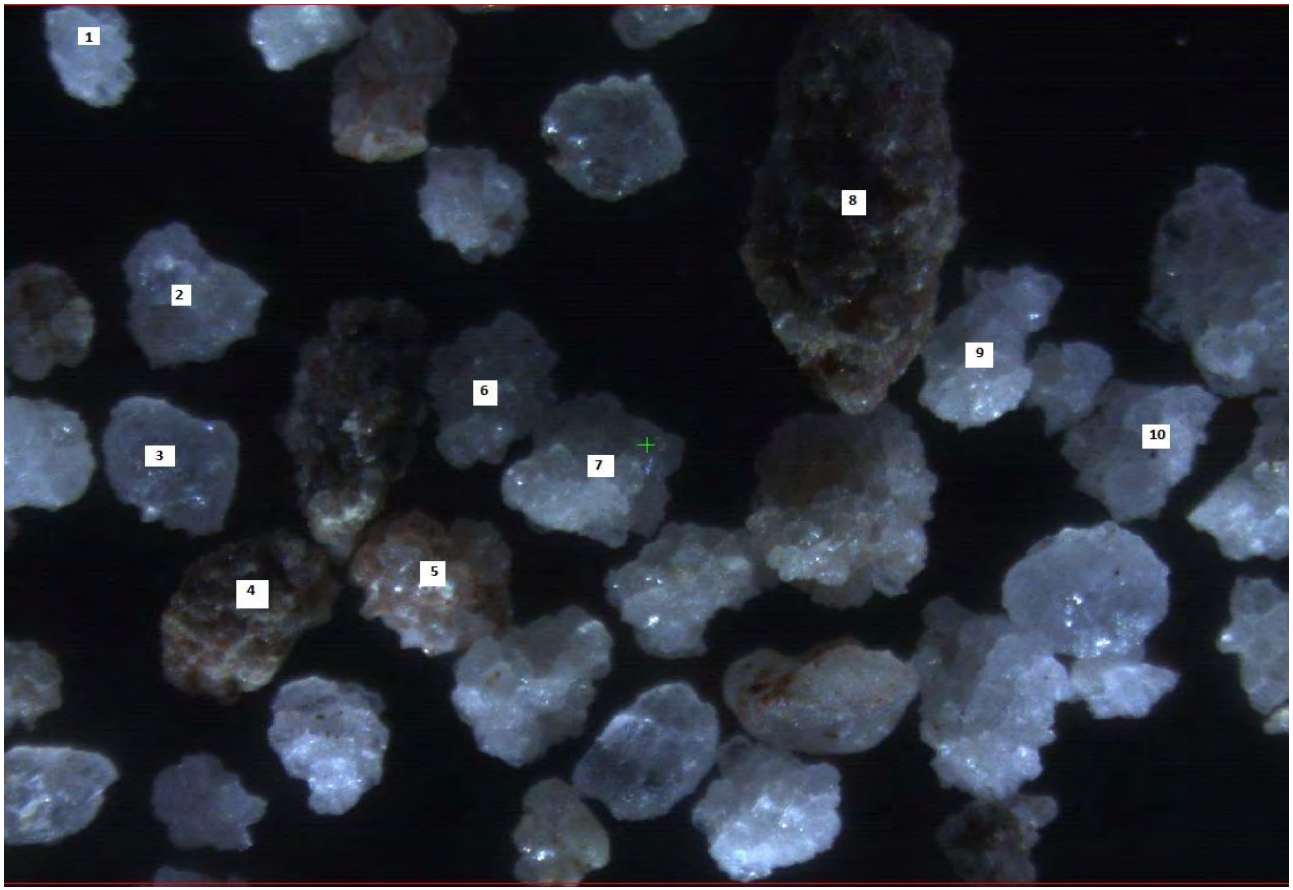
Essai de sphéricité et de rondeur

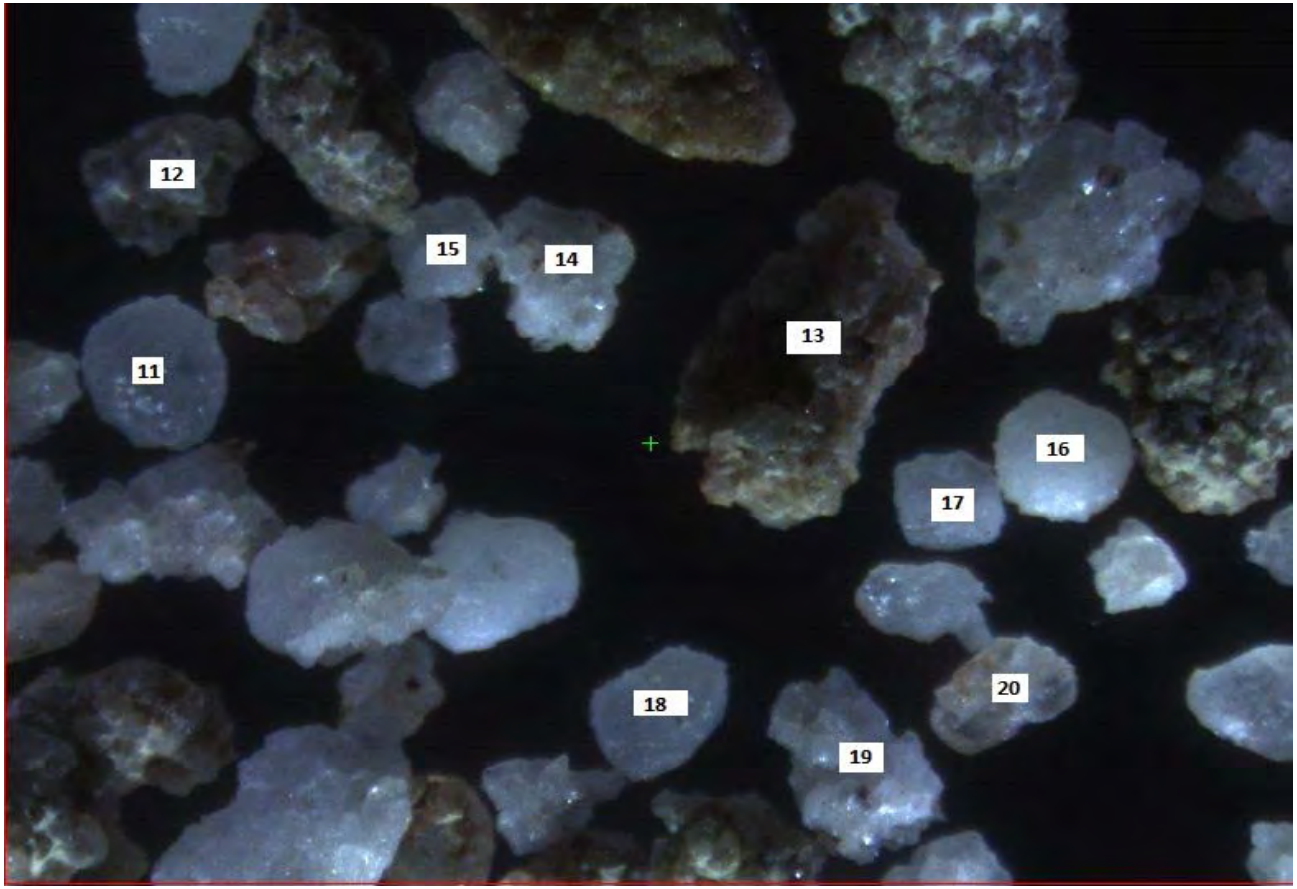
Selon la norme API RP 19C

Thermique + attrition 5 min.
Produit : Produit 30-50
Photos : Pr30-50Ph12-5X-01

Particule																																			
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20		moy	
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,3	0,5	0,1	0,5	0,3	0,5	0,3	0,5	0,1	0,7	0,1	0,7	0,3	0,7	0,1	0,3	0,3	0,3	0,1	0,3	0,7	0,9	0,1	0,5	0,1	0,3	0,5	0,7	0,5	0,7	0,9	0,9	0,7	0,9	0,7	0,7	0,1	0,5	0,7	0,5	0,4	0,6

X : rondeur Y : sphéricité




12
15
14
13
11
16
17
18
20
19

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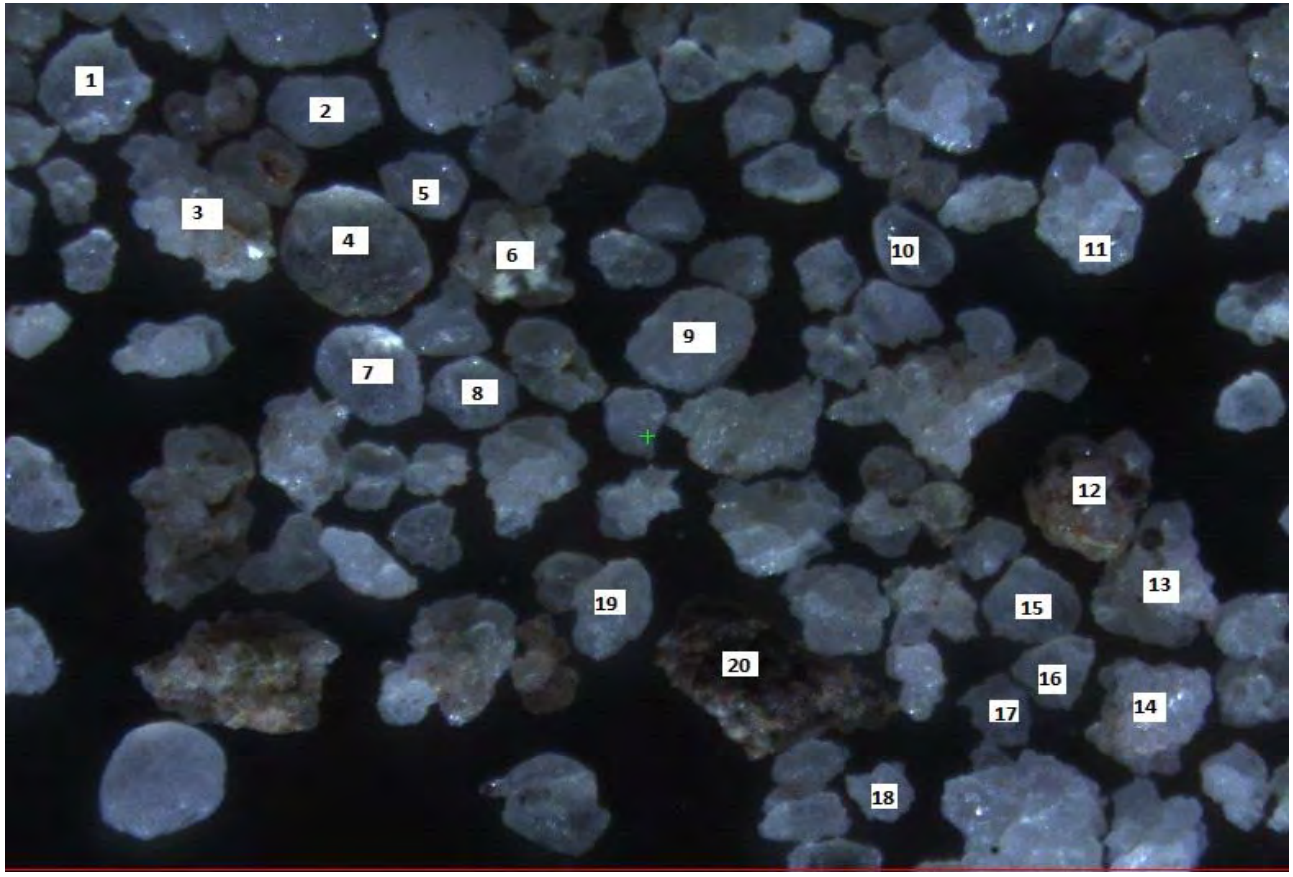
Essai de sphéricité et de rondeur

Selon la norme API RP 19C

Thermique + attrition 5 min.
Produit : Produit 40-70
Photos : Pr40-70Ph12-5X-01

Particule																																		moy	
No.1		No.2		No.3		No.4		No.5		No.6		No.7		No.8		No.9		No.10		No.11		No.12		No.13		No.14		No.15		No.16		No.17		No.18		No.19		No.20			
X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
0,3	0,7	0,5	0,5	0,1	0,3	0,7	0,9	0,5	0,9	0,1	0,7	0,7	0,9	0,7	0,9	0,7	0,7	0,7	0,7	0,5	0,5	0,3	0,5	0,1	0,5	0,1	0,5	0,5	0,9	0,5	0,7	0,3	0,5	0,3	0,5	0,5	0,7	0,1	0,5	0,4	0,7

X : rondeur Y : sphéricité



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Essai de sphéricité et de rondeur

Selon la norme API RP 19C

Sommaire des résultats

	Produit	Attrité 10 min. envoi #3 avant WHIMS			Non-magnétique attrité 5 min. après WHIMS			Traitement thermique avant concassage attrité 5 min.		
	Fraction	20/40	30/50	40/70	20/40	30/50	40/70	20/40	30/50	40/70
Rondeur	X	0,4	0,5	0,4	0,4	0,5	0,4	0,3	0,4	0,4
Sphéricité	Y	0,6	0,7	0,6	0,7	0,7	0,6	0,7	0,6	0,7

Annexe D

Données des essais de choc thermique

Centre de technologie minérale et de plasturgie inc. (CTMP)
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ctmp@cegepth.qc.ca – www.ctmp.ca

Essai de Choc thermique

Selon la norme SKW

No. Projet: R-5030

Titre: Silica Matane (Langis)

Client: Canadian Metals
1200, avenue Mc gill College, bureau 1240
Montréal, Qc., H3B 4G7, Canada
a/s: M. Stéphane LEBLANC

Date: 2013-11-11

Résistance au choc thermique

Echantillon	Type échantillon	Fraction + 12,5 mm (g)	Fraction - 12,5 mm (g)	Fraction + 12,5 mm (%)	Fraction - 12,5 mm (%)	durée calcination (min)
P175880	bloc	2506,5	175,92	93,4	6,6	20,0
P175877	carotte	373,12	43,07	89,7	10,3	20,0
P175822	bloc	2496,40	161,17	93,9	6,1	45,0
P175881	bloc	2574,60	42,92	98,4	1,6	85,0
P175876	carotte	377,79	41,96	90,0	10,0	31,0
P175878	carotte	404,09	14,85	96,5	3,5	25,0
P175856	carotte	430,47	1,43	99,7	0,3	32,0
P175854	carotte	381,08	47,78	88,9	11,1	25,0
P175855	carotte	408,36	21,02	95,1	4,9	45,0
P175852	carotte	429,73	1,42	99,7	0,3	50,0
P175851	carotte	404,80	16,74	96,0	4,0	50,0
P175853	carotte	416,68	2,40	99,4	0,6	50,0

Calcination à 1000 degrés celsius

Perte au feu (LOI)

Echantillon	Type échantillon	poids départ (g)	poids final (g)	LOI (%)
P175880	bloc	2687,4	2685,3	0,1
P175877	carotte	418,3	418,23	0,0
P175822	bloc	2671,3	2661,5	0,4
P175881	bloc	------	2717,8	------
P175876	carotte	424,1	423,4	0,2
P175878	carotte	420,8	419,6	0,3
P175856	carotte	432,6	432,0	0,1
P175854	carotte	430,3	430,0	0,1
P175855	carotte	431,3	430,1	0,3
P175852	carotte	432,5	431,4	0,3
P175851	carotte	423,3	421,9	0,3
P175853	carotte	420,2	419,2	0,2

Annexe E

Données des essais de résistance à l'écrasement

Centre de technologie minérale et de plasturgie inc. (CTMP)
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Téléphone : (418) 338-6410 Télécopieur : (418) 338-9584
ctmp@cegepth.qc.ca – www.ctmp.ca

Essai de résistance à l'écrasement (Crush test)

Selon la norme API RP 19C

No. Projet: R-5136 (R-5030)
Titre: Silica Matane (Langis)
Client: Canadian Metals
1200, avenue Mc gill College, bureau 1240
Montréal, Qc., H3B 4G7, Canada
a/s: M. Stéphane LEBLANC

Produit : N-mags whims 5.9A envoie #3 attrite 5 min Pr20-40

Essai	load on cell (lb force)	load on cell (psi)	stress on sand (psi)	poids départ (g)	Fraction + 50 (g)	Fraction - 50 (g)	Fraction + 50 (%)	Fraction - 50 (%)
1	12566	426	4000	37,08	27,20	9,73	73,7	26,3
2	15708	533	5000	37,08	24,94	12,00	67,5	32,5

Produit : N-mags whims 5.9A envoie #3 attrite 5 min Pr30-50

Essai	load on cell (lb force)	load on cell (psi)	stress on sand (psi)	poids départ (g)	Fraction + 70 (g)	Fraction - 70 (g)	Fraction + 70 (%)	Fraction - 70 (%)
1	12566	426	4000	32,49	19,44	13,01	59,9	40,1
2	6283	213	2000	32,49	25,38	7,04	78,3	21,7

Calculs

Supposons qu'on veut appliquer une force de 15 708 lbs avec la presse

Force(psi) presse = 15 708 lbs ÷ aire cylindre presse
Force(psi) presse = 15 708 lbs ÷ 29.465 po^2
Force (psi) presse = 533

Force(psi) échant. = Force (lbs) presse ÷ aire cylindre échant.
Force(psi) échant. = 15 708 lbs po^2 ÷ 3.1416 po^2
Force (psi) échant. = 5000

Presse
diamétre cylindre presse = 6.125 po
Aire cylindre presse = 29,465 po^2

diamètre cylindre échantillon = 2 po
aire cylindre échantillon = 3.1416 po^2

Bulk density = qty matériel (g) ÷ volume cylindre (cm^3)

Bulk density (Pr 20/40) = 21,81 ÷ 14,53 = 1,50 g/cm^3

Bulk density (Pr 30/50) = 1,32 g/cm^3

$m_p = 24.7 \times \rho_{bulk}$ (Norme API 19C, p. 25)

masse (Pr 20/40) (cylindre) = 24,7 x bulk density = 24,7 X 1,50 = 37,08 g

masse (Pr 20/40) (cylindre) = 32,49 g

Annexe F

Composition du matériel de référence BRSTG2

S8 Analytical Acceptance Test

Instrument#: 6610 **Site:** Centre de Technologie Minerale

S8-Check

This measurement tests all relevant parameters of the basic instrument configuration. The glass sample STG2 in a 34 mm sample holder has to be measured as "Control sample" using "S8-Check-Vac34"

Note

Use this method for stability check or precision check.

	Measurement of glass-sample STG2 at Bruker AXS Karlsruhe	Measurement of glass-sample STG2 after installation	max. deviation Bruker AXS / Installed system
Sample	S8-Check-STG		
Date	4/17/2012 2:45:49 PM		
Measurement	S8-Check-Vac34		
Calibration	S8-Check-Vac34		
Operator	Admin		
Na_2O	13.8	13,8	**± 0.5**
Al_2O_3	1.19	1,19	**± 0.03**
SiO_2	71.6	71,7	**± 1.5**
CaO	5.00	5,00	**± 0.2**
Fe_2O_3	0.0597	0,0598	**± 0.002**
Sb_2O_3	0.58	0,58	**± 0.02**

Conclusion:
The above mentioned Spectrometer System passed this Analytical Acceptance Test.

Signatures: Site Date 23 mai 2012.

(Customer representative) (Bruker AXS representative)

APPENDIX B

GENERAL CHEMICAL AND PHYSICAL REQUIRMENTS OF SILICA

General chemical and physical specifications for different uses of silica

Possible Uses	Candidate Category	SiO_2 Min (%)	Fe_2O_3 Max (%)	Al_2O_3 Max (%)	TiO_2 Max (%)	LOI Max (%)	Particle size (mm)	Notes with respect to test results received for the Langis Silica
Candidate Category: **A** = Candidate, **B** = Potential Canadidate with further processing, **C** = Non-Candidate								
Lump Silica								
Silicon Metal[1][2][3][6]	C	99.5	0.10	0.20	0.006	<0,04	50 - 100	TiO_2 requirement too low for Langis
Silicon Chemical[1][2]	C	99.8	0.05	0.10	0.005		10 - 90	TiO_2 requirement too low for Langis
Ferrosilicon[1][2][3][6]	A	98.7	0.30	0.60	0.05		20 - 120	Good for Langis
Flux agent in smelting[1][2][3]	A	90.0 - 95.0	1.5	1.5			5 - 25	Good for Langis
Silica Sand								
Glass sand (colored)[1][2]	A	98.9	0.15	0.15	0.10		0.100 - 0.500	Good for Langis
Glass sand (clear)[1][2][4][5][9]	B	99.5	0.035	0.10	0.02		0.100 - 0.500	Close, but need further treatment to reduce Fe_2O_3, Al_2O_3, TiO_2
Glass sand (flat)[1][2][4][5][9]	C	99.5	0.007	0.20	0.02		0.100 - 0.500	Fe_2O_3 too high in Langis snad
Fiberglass (insulation)[1][2][5]	A	98.1	0.50	0.52	0.05		0.100 - 0.400	Good for Langis
Fiberglass (fabrics)[1][2]	A	99.2	0.04	0.60	0.05		0.100 - 0.400	Good for Langis
Foundry sand[1][2][4][7][9]	B	88.0 - 99.0	Variable	Variable	Variable		0.080 - 0.850	Potential for Langis. R & S okay. 0.4% Max L.O.I. AFS to be adjusted.
Frac sand[1][2][3][4][9]	B						0.400 - 0.850	Potential for low quality frac sand. R&S and crush resistance not good.
Silicon carbide (SiC)[1][2][3]	B	99.3 - 99.7	0.03 - 0.20	0.08 - 0.25			0.150	Potential for Langis. Need to reduce Fe_2O_3.
Sodium silicate[1][2][3]	B	99.4	0.05	0.20	0.05		0.150 - 0.840	Potential for Langis. Check <0.05% CaO & MgO
Other uses								
Abrasive Sand[4]	B	78 - 99	0.05				0.420 - 0.850	Good for Langis for sand blasting Grade No. 1.
Silica Flour[3][4]	C	99.3	0.05	0.06	0.013		<0.075	Al2O3, TiO2 are too high in Langis sand; check for lack of color; refractive index; <0.01% CaO & MgO
Golf Course Sand[8][9]	B						0.100 - 1.000	Potential for Langis. Check for Color; BD 1.25 to 1.4 g/cm3, capillary pore space 15 to 25%; hydraulic conductivity 24 to 43 cm/h; water retention 11.9 to 18.6 cm/m

Notes:

1. This table illustrates general recommended limits for the composition and grading of silica for different potential uses. There are no specific industry-wide specifications or requirments for the quality of silica sand. Chemical and physical specifications are mostly dictated by end users.

2. Further laboratory tests will be required for more detailed physical characterizations such as ***refractoriness*** and ***permeability*** for foundry sand, as well as ***crush resistance*** and ***acid solubility*** for frac sand.

Sources:

(1) Jacob J-L.; Les Ressources Quebecoises en Silice
(2) Sidex; Exploring for Silica in Quebec
(3) Dumont M.; Canadian Minerals Yearbook 2006
(4) McLaws I.J.; Uses and Specifications of Silica Sand
(5) McLaws I.J.; Silica Sands in the Fort McMurray area, Alberta
(6) Zayed A.M.; Review on the Current Quality Standards of Quartz and Silicon Feedstock for High-Tech Industries
(7) Dawson M.; Silica Sand Foundry Requirements and Classification
(8) Murdoch C.L., Hensley D.L.; Physical Properties of Hawaiian Golf Course Sands
(9) GWP Consultants; A Study of Silica Sand Quality and End Uses in Surrey and Kent