



**DORFNER ANZAPLAN: EVALUATION OF A QUARTZITE  
DEPOSIT IN CANADA FOR THE IDENTIFICATION  
OF POTENTIAL APPLICATIONS  
*-SUMMARY***

*APRIL 25, 2016*



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# Project Background

- The Silicon Ridge Property hosts two significant quartzite units, named “G” and “H”, as detailed in the 2014 NI 43-101 technical report by Geologica Groupe-Conseil.
- The quartzite deposit is described to consist of 98% to 99% quartz with traces of biotite, muscovite, hematite, fuchsite and ilmenite commonly associated.
- **Rogue wanted to determine if the high grade silica on the Silicon Ridge Property could be suitable for commercial applications, similar to the nearby Sitec mine** (*see Appendix*).
- In October 2015, cooperation between Rogue and Dorfner ANZAPLAN (“ANZAPLAN”) started with the site visit of Dr. Haus on the Silicon Ridge property accompanied by Rogue’s Senior V.P. and QP, Eddy Canova, Géo (OGQ403).
- Based on that visit, Rogue sent three PQ and three NQ drill cores to ANZAPLAN. The PQ drill cores were subjected to processing tests, targeting the evaluation of the suitability of the quartz as feedstock for silicon applications.
- The present report summarizes the results of chemical and mineralogical analyses of the quartz sample as well as processing test results of the PQ drill cores.
- During mineralogical investigations inclusions of hematite, ilmenite, muscovite, sillimanite, zircon and rutile were identified in quartz. Mineral and fluid inclusions were characterized by optical microscopy on four selected samples.

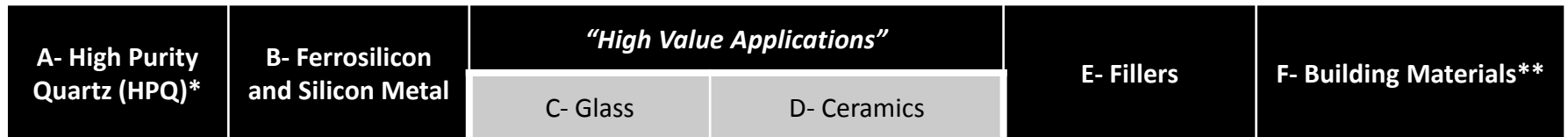


# ANZAPLAN: an Industry Leader

- Dorfner is a leading European industrial minerals producer with more than a hundred years of experience in processing high quality raw materials.
- ANZAPLAN has been founded in 1985 to become the most independent venture within the Dorfner group of companies.
- Today, ANZAPLAN is a specialist in the industrial and strategic minerals businesses, providing a one-stop shopping solution across all phases of the economic evaluation and process development of industrial minerals projects - with technological expertise from its own laboratories, test center and pilot plant processing facilities including analytical and engineering services covering a first evaluation of the deposit up to a full engineering of the processing plant.
- In April, 2016 the Rogue management team visited the ANZAPLAN facilities in Hirschau, Germany.



# For context- Overview of potential commercial markets



*The main focus for ANZAPLAN's analysis.*  
To determine if the Silicon Ridge material could be suitable for commercial applications.

*...Some attention...*

\* = a very small volume market, currently well serviced by existing suppliers.

\*\* = straightforward market, reject material can be sold as similar to aggregate.



# Analysis overview

- All three PQ drill core samples were split into five sub-samples (in total 15 samples). Each sub-sample was crushed individually to < 80 mm and classified into fractions 20 – 40 mm and 40 – 80 mm and < 20 mm.
- 3 Fractions resulted:
  - The undersized fraction < 20 mm was further crushed and ground into fractions 0.1 – 0.3 mm and < 0.1 mm. These two fractions were further beneficiated with the target of **high value applications** such as glass or ceramics.
  - 20 – 40 mm and 40 – 80 mm were subjected to optical sorting tests, targeting application of quartz as feedstock for **metallurgical grade (MG-) silicon** and respectively, **ferrosilicon** production.

Source: The ANZAPLAN study- “Evaluation of a Quartzite Deposit in Canada for the Identification of Potential Application”, April 2016



## Findings- *the “G” quartzite unit (general)*

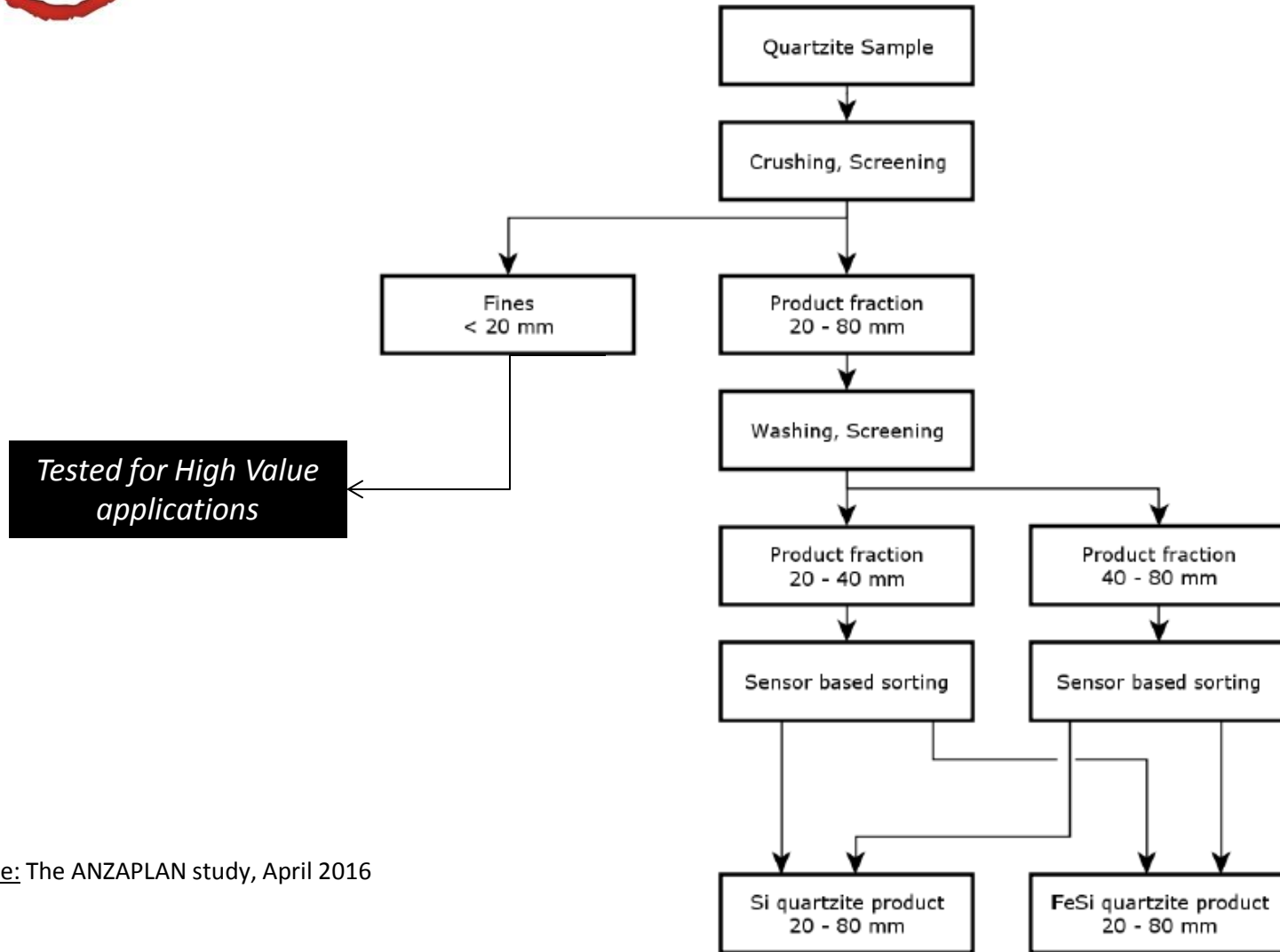
- With such a large extent of quartzite, there are differences in yield across samples and there is the ***opportunity to selectively produce*** from across the quartzite.
  - At Sitec, it is reported that selective production has led to a 30+ year low grade stockpile which is only now being further processed, with new additional optical sorter units, drawing on recently-installed line power.
- Industry-proven physical ***beneficiation processes can improve the material*** and upgrade a larger percentage of the deposit into a marketable product.
- After beneficiation, almost 80% of the deposit should be suitable for ferrosilicon and high value applications, with the remainder likely in demand as Filler or Building Materials (*this does not consider selective production*).

Source:

1) Bâtisseurs d'Avenir - Mine SITEC - 20150626 – TVCO: <https://www.youtube.com/watch?v=l8SzkwJnr0>



# Analysis- *Silicon applications*

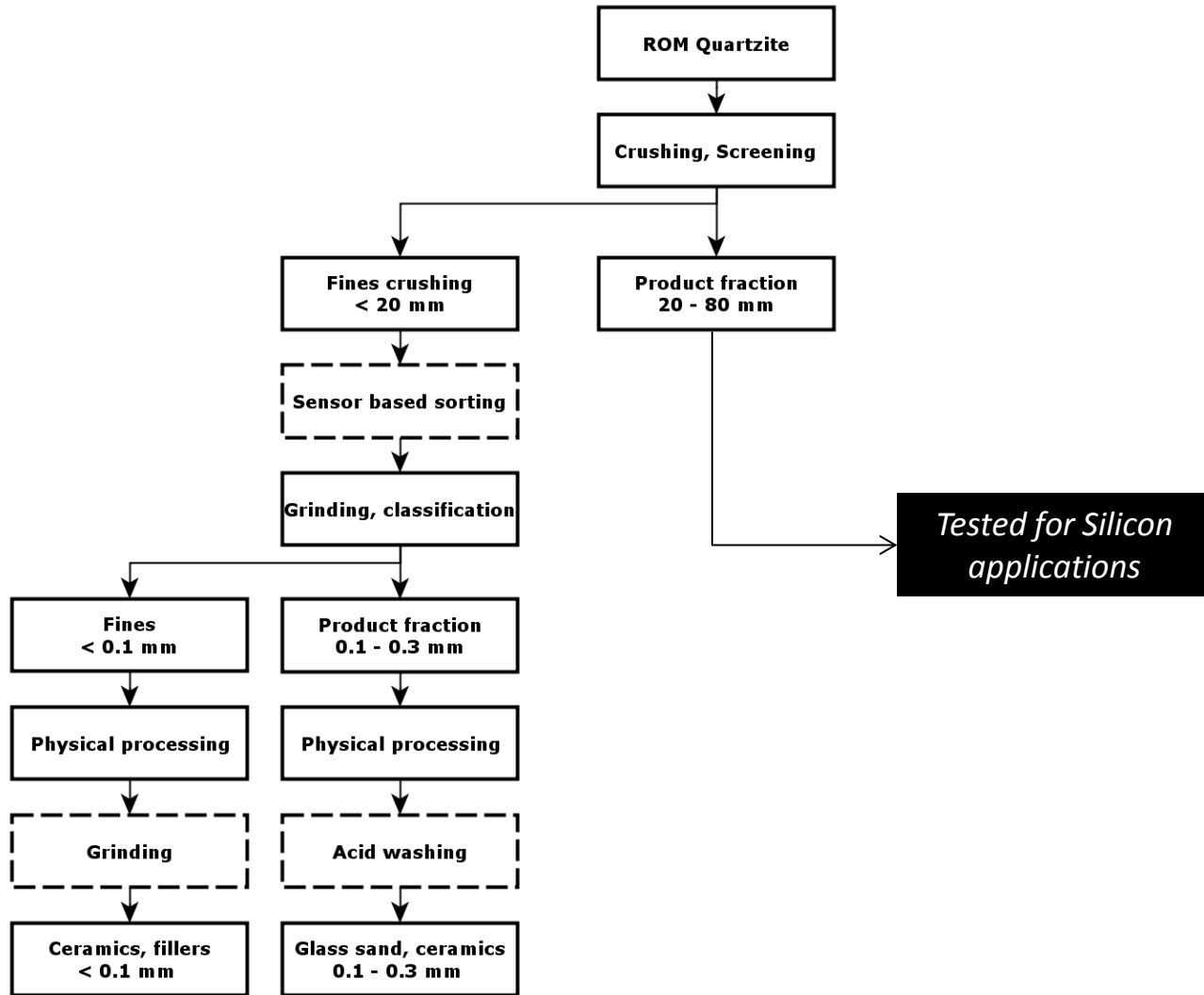


Source: The ANZAPLAN study, April 2016





# Analysis- *High Value Applications*



Source: The ANZAPLAN study, April 2016

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# Findings- *High Value Applications*

**Table 1:** High value application potential of drill core sample A (GF 15-60; 38 – 97 m), sample B (GF 15-60; 118 – 138 m), sample C (GF 15-62; 35 - 56 m) and sample D (GF 15-62; 56 – 84 m) and optical sorting reject fraction of PQ 15-60 after full processing.

	Container glass (colored)	Container glass (clear)	Float glass (window, automotive)	Fiberglass (insulation)	Fiberglass (fabrics)	Borosilicate glass, pyrex	White float glass, opal glass, crystal glass	Solar glass	Borofloat	Quartz powder	Engineered stone	Silicon carbide	Fused silica	Sodium/ Potassium silicate
Sample A	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sample B	x	x	x	x	x	x	x			x	x	x	x	x
Sample C	x	x	x	x	x	x				x	x	x	x	x
Sample D	x	x	x	x	x	x	x	x		x	x	x	x	x
PQ 15-60 EI	x		x	x	x	x				x		x		x

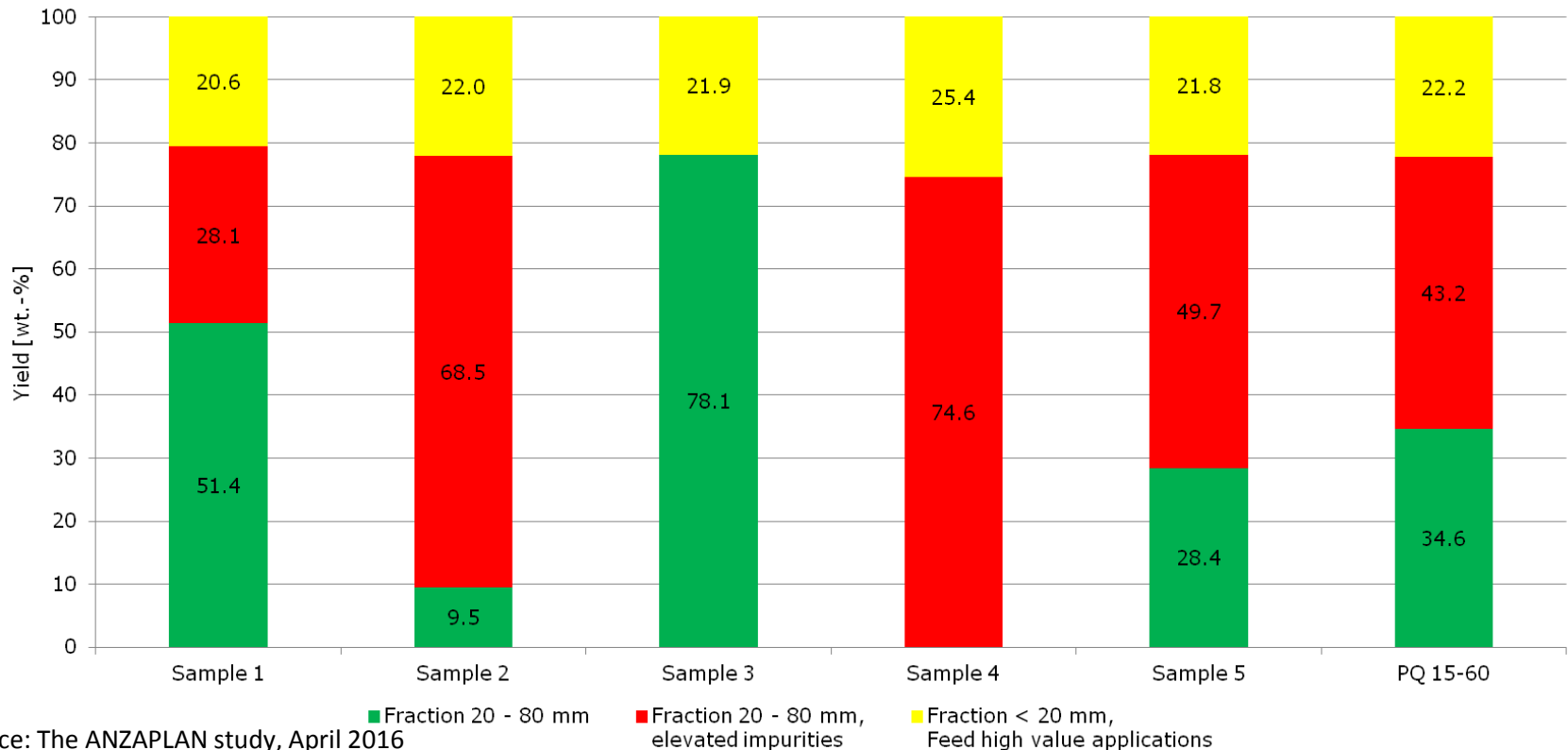
- Acid washing after flotation of sample A resulted in a further reduction of iron.
- After magnetic separation fraction < 0.1 mm has good potential for application in ceramics (body and glazes) as well as fillers in paint and coatings, sealants, silicone rubber and epoxy.



# Findings- *Potential for Selective Production*

- Differences in yield of different sections within the drill core demonstrate the potential of selective mining and blending between different sections to increase the yield of product meeting the typical specifications in ferrosilicon production.

**Figure 1:** Yield distribution of samples 1 – 5 of PQ 15-60 (first five bars, left) and cumulative for PQ 15-60 (right), based on chemical consumption after optical sorting

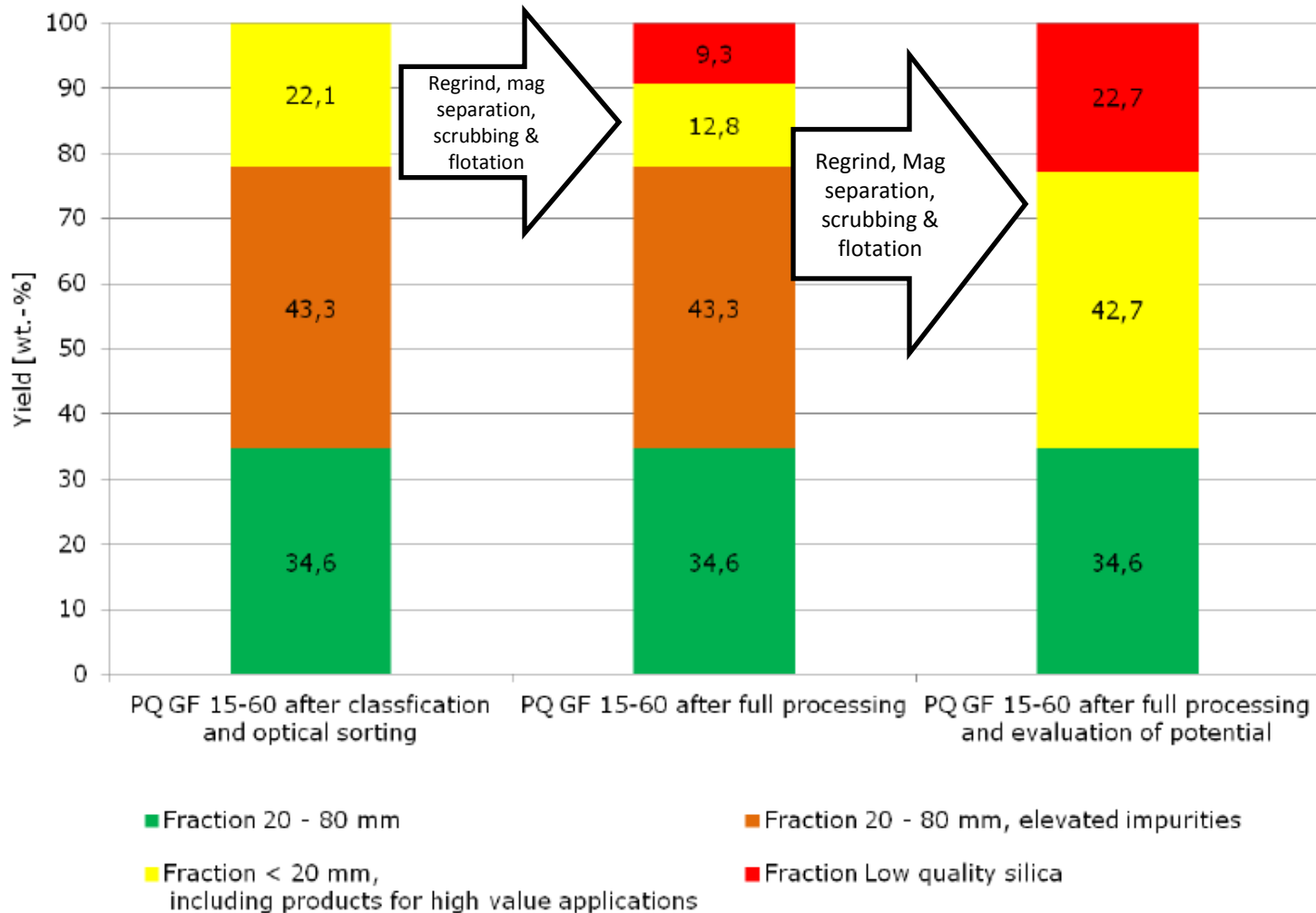


Source: The ANZAPLAN study, April 2016



# Findings- *Results of Beneficiation*

**Figure 2:** Mass distribution of PQ GF 15-60 after various stages

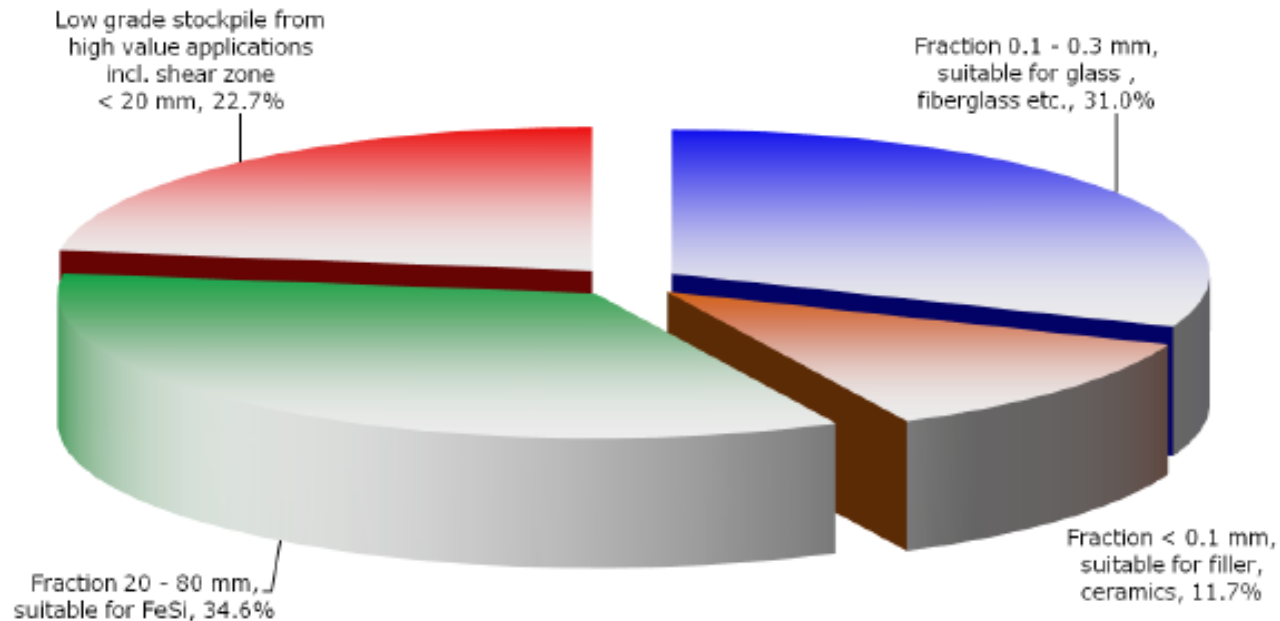




# Findings- *Example Mass Balance*

- A mass balance illustrating the processing results for drill core PQ GF 15-60 is shown in Figure 3.
- In total 35% of the sample (fraction 20 – 80 mm) is suitable for FeSi application and an additional 43% fulfill the requirements for high value applications (fractions <0.1 mm and 0.1 – 0.3 mm).
- This represents the split of material if the ***entire quartzite unit was processed***
  - i.e. no selective mining

**Figure 3:** Mass balance of PQ GF 15-60 after processing



Source: The ANZAPLAN study, April 2016



# Conclusion

- **ANZAPLAN determined that the high grade silica on the Silicon Ridge property could be suitable for various commercial applications.**
- ANZAPLAN recommends Rogue continues to de-risk the Project, proceeding on its work with Met-Chem Canada Inc. (“Met-Chem”) in Montreal for a 43-101 Resource calculation (in June) and Preliminary Economic Assessment (in September).
- ANZAPLAN proposes to support Met-Chem indicating recoveries to support the interpretation of technical results with regard to resource estimation.

Source: The ANZAPLAN study, April 2016



# Recommendations

- In order to evaluate the full potential of Silicon Ridge, ANZAPLAN also recommends:
  - **A market study** and discussing specific characteristics of products with potential customers. Target of these discussions will be to evaluate the market potential of the different products as well as estimated product sales prices.
  - **A detailed bulk sample** for use in marketing. For discussion with potential customers, sample production is recommended, including the following approach. Blast samples should be taken representing a typical chemical composition calculated from drill core analyses and ANZAPLAN's processing results. It is advised to process these samples into (ferro)silicon grade for inspection at (ferro)silicon smelters. In order to improve the overall product yield, non-(ferro) silicon qualities should be processed into glass and ceramic grade qualities for inspection at glass and ceramic manufacturers, as well as demand from the filler industry identified during market study.
- Based on these results, pricing and supply opportunities can be discussed with potential clients. Together with transportation costs the PEA can be finalized, building the basis for a detailed business plan.

Source: The ANZAPLAN study, April 2016



# APPENDIX





# The Neighbouring Sitec Mine

- Sitec Quartz Inc. operates quartzite deposits 4km to the south-west of the Silicon Ridge property, which are mined by open pit method and annual production is 200,000 to 250,000 tons per year.
- Sitec mines the quartzite and does an initial crush, screens and sorts 4” material, for:
  - Elkem Metal Canada Inc. in Chicoutimi for ferrosilicon
  - Silicium Québec in Bécancour, for MG-silicon
- A second crushing of the material, screens and sorts
  - 3/8” to 3/4” for foundries and
  - a fine fraction, <3/8” is sent to Cambria Quartz Stone Surfaces in Minnesota, USA, for *quartz filler, engineered stone* countertops
- Sitec has two seasons of operation: with the quarry operating from May to November, and the processing operating all year round.
- **Rogue wanted to determine if the Silicon Ridge material could be suitable for commercial applications, similar to Sitec.**

## Sources:

- 1) Informe Affaires Sagueny – Lac-Saint-Jean, October 2013-Volume 4, Numero 11, La mine SITEC, une valeur sûre pour Elkem, pages 26 and 27.
- 2) Bâtisseurs d'Avenir - Mine SITEC - 20150626 – TVCO: <https://www.youtube.com/watch?v=l8SzkwJnr0>
- 3) Le Charlevoisien: Sitec: cinquante ans d'exploitation minière, Juillet 27, 2012;  
<http://www.lecharlevoisien.com/actualites/economie/229226/sitec-cinquante-ans-dexploitation-miniere>



## Drill core detail

- ANZAPLAN received different drill cores from Rogue, nearly 7000 kg in total
- All drill cores originate from Quartzite unit “G” (cf. Figure 6).
- Three combinations of drill cores were received, each containing a PQ drill core (85 mm diameter, cf. Figure 4) and a quarter of a paired NQ drill core (47.6 mm diameter, cf. Figure 5).
- The pairing of the drill cores is listed in Table 2.
- The PQ drill cores were used for processing tests, while NQ drill cores were subjected to chemical analyses.

***Table 2-*** *Drill core combinations of PQ (85 mm) and NQ (47.6 mm) cores.*

<b><u>PQ drill core</u></b>	<b><u>NQ drill core</u></b>
GF 15 -53	GF 15 -39
GF 15-60	GF 15-42
GF 15-62	GF 15-46



## Drill core detail (cont'd)

**Figure 4:** *Picture of PQ drill core GF15-60; drilling depth 55 -59 m*

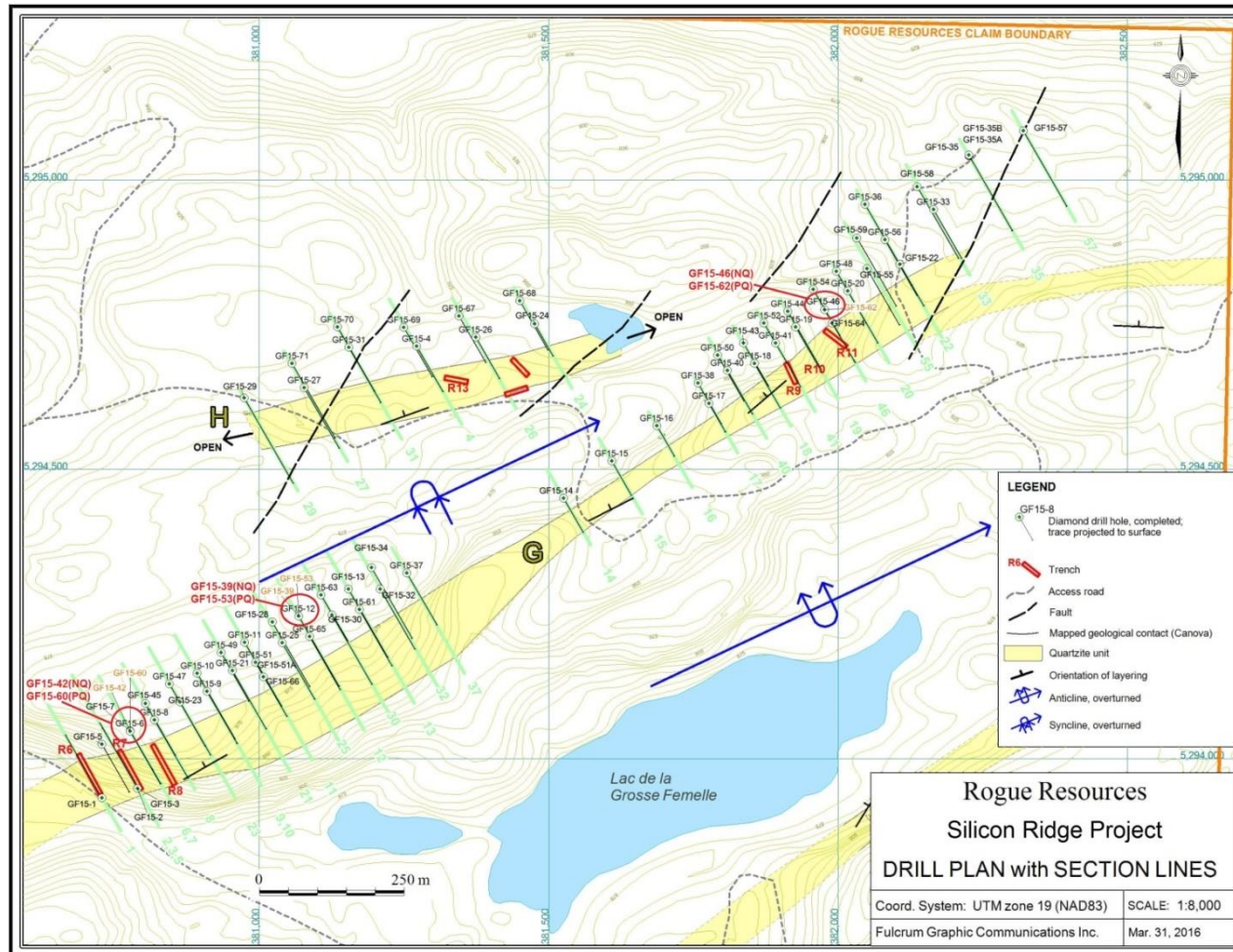


**Figure 5:** *Picture of the sample from NQ drill core GF15-42; drilling depth 56.4 – 58 m*



# Drill core detail (cont'd)

**Figure 6: Drill core location map**





# Mineralogical Analyses- steps

- Mineral and Fluid Inclusions
- X-ray diffraction analysis
- Chemical analyses by X-ray fluorescence spectroscopy
- Grain size distribution
- Main element analysis
- Trace element analysis (P and B)

Source: The ANZAPLAN study, April 2016



# Mineral Processing- analysis steps

- Crushing and grinding
- Classification
- Optical sorting
- Dry Magnetic separation via HGMS
- Scrubbing (Attrition)
- Flotation
- Acid washing
- Wet Magnetic Separation
- High tension (electrostatic) separation

Source: The ANZAPLAN study, April 2016



# Tests- for *Silicon Applications*

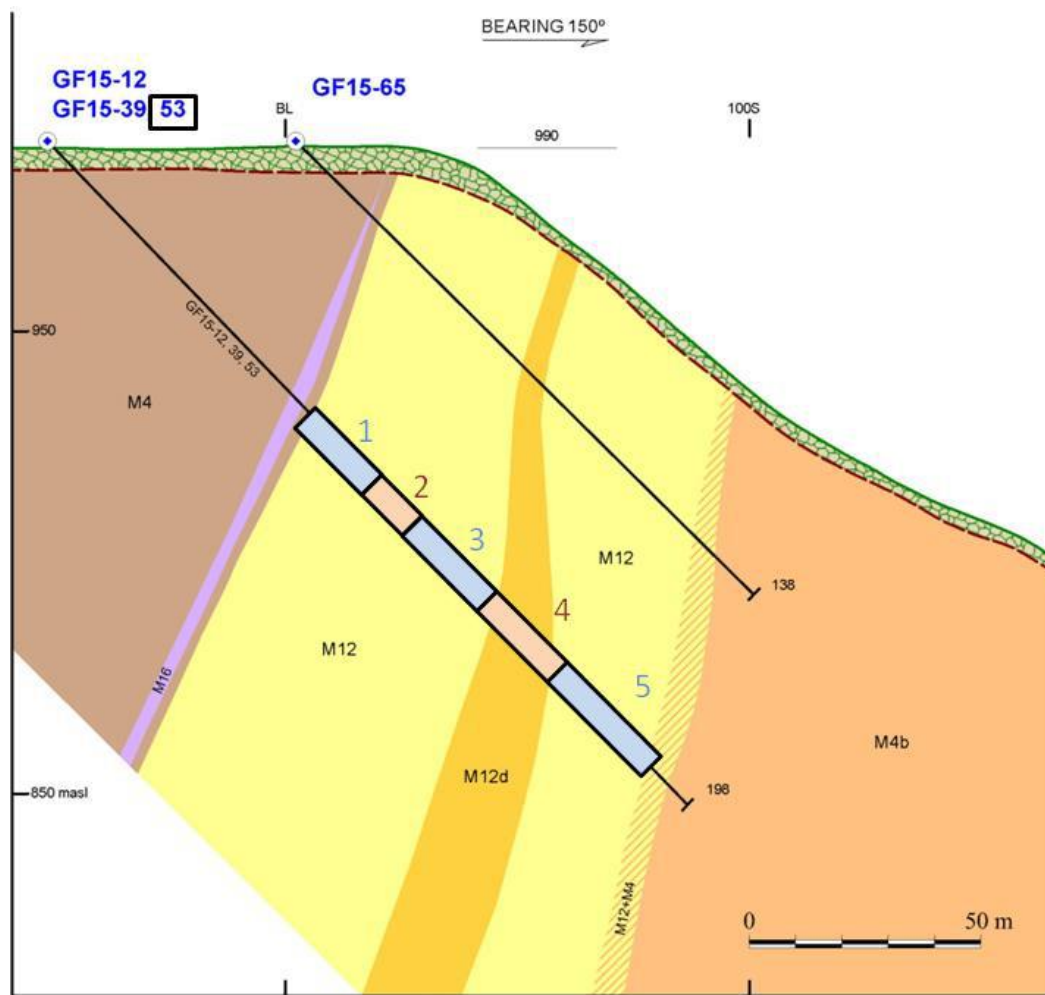
- Sample definition
  - Five samples from each PQ drill core were defined for processing tests based on the chemical analysis of paralleled NQ drill cores, the drill core logging (provided by Rogue) and visual inspection of the PQ drill core samples. Target of the test work was to produce quartzite products suitable for silicon and ferrosilicon production. The samples defined are visualized in Figure 9 to Figure 11.
- Crushing and screening
- Optical sorting (sensor based sorting)

Source: The ANZAPLAN study, April 2016



## Tests- for *Silicon Applications* (cont'd)

**Figure 9:** Samples 1-5 of PQ drill core 15-53 for processing tests for silicon application



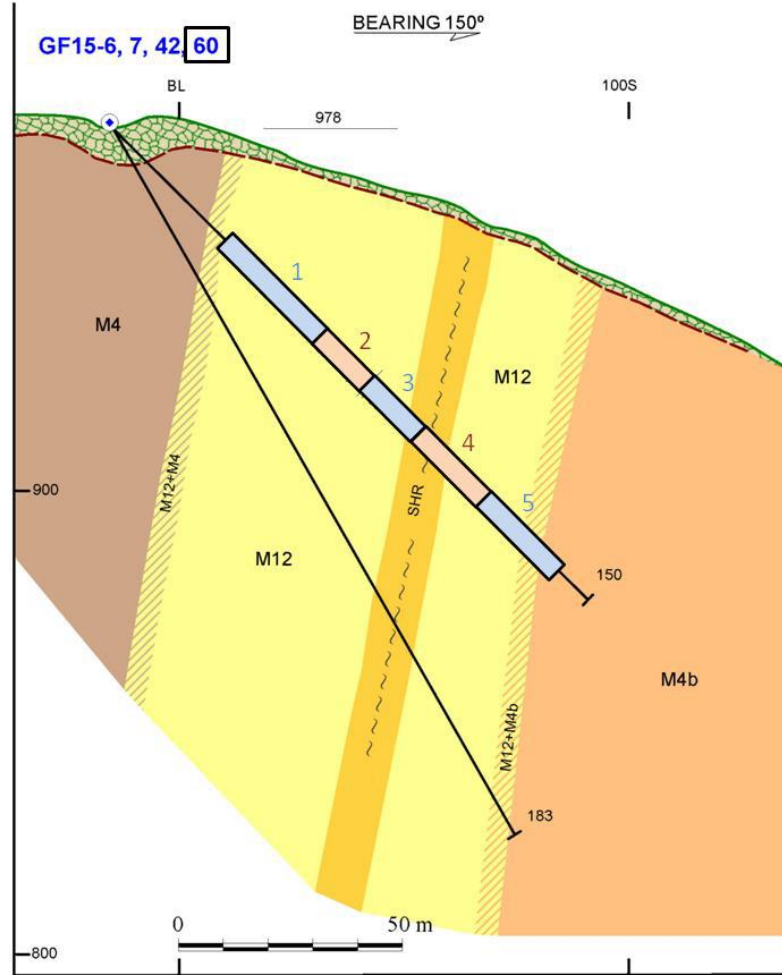
Source: The ANZAPLAN study, April 2016





# Tests- for *Silicon Applications (cont'd)*

**Figure 10:** Samples 1-5 of PQ drill core 15-60 for processing tests for silicon application

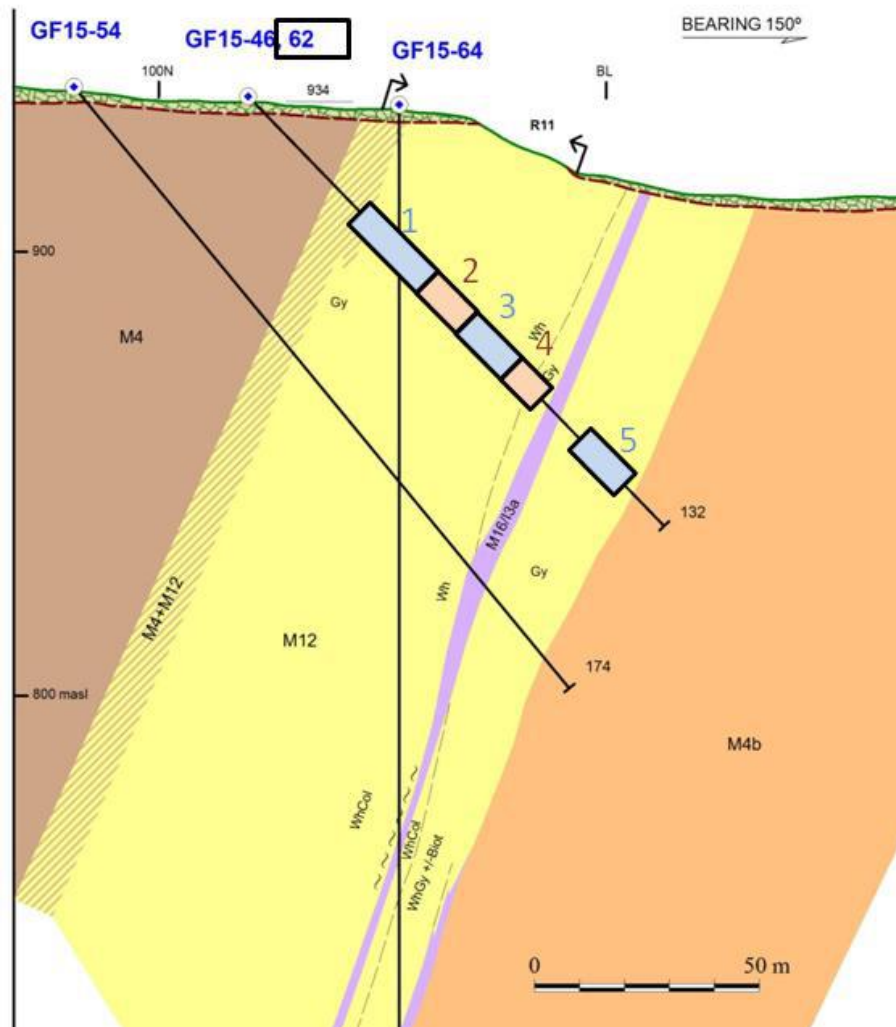


Source: The ANZAPLAN study, April 2016



# Tests- for *Silicon Applications (cont'd)*

**Figure 11:** Samples 1-5 of PQ drill core 15-62 for processing tests for silicon application



Source: The ANZAPLAN study, April 2016



# Tests- for *High Value Applications*

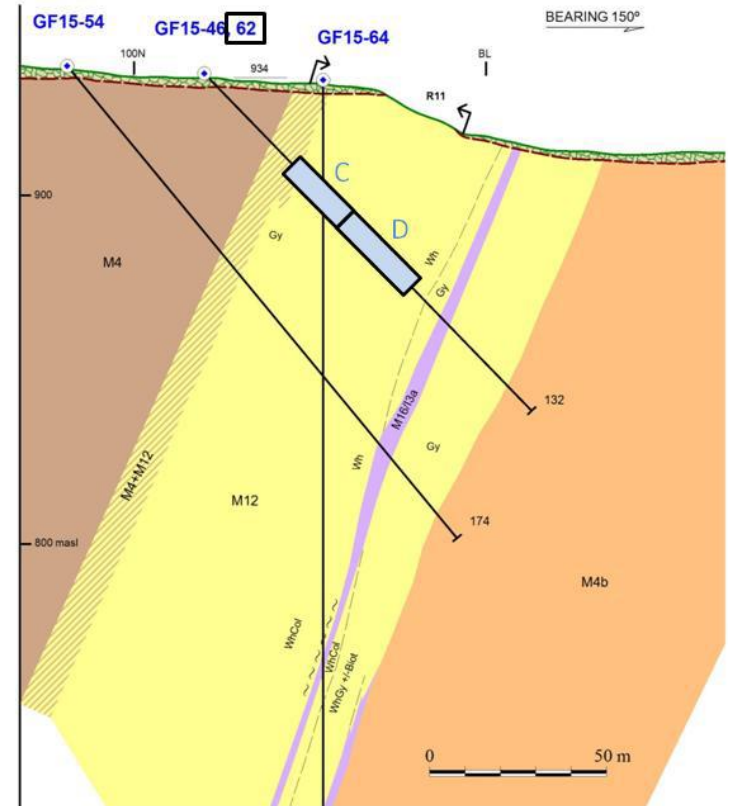
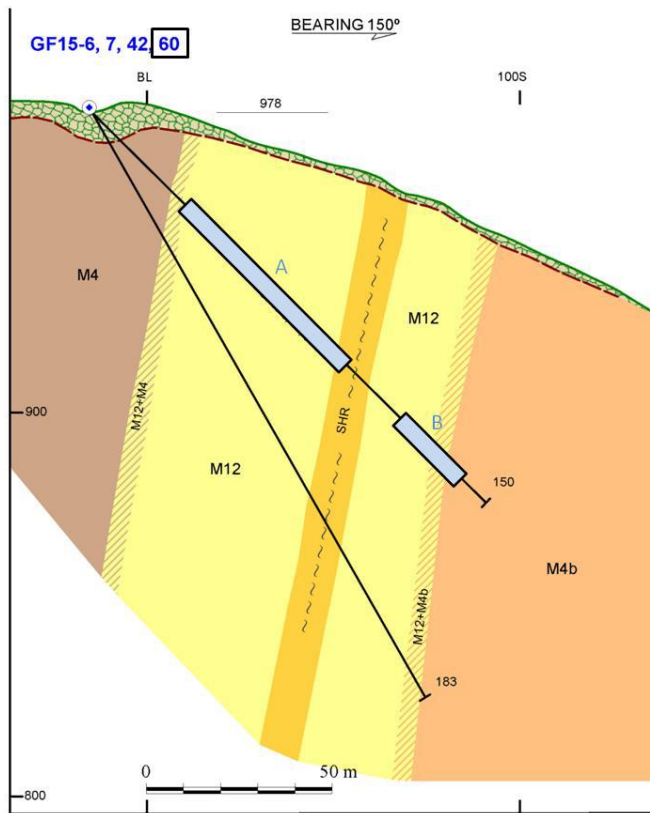
- Sample definition
  - For high value applications new samples were defined. For GF 15-60 samples < 20 mm from above the shear zone (samples 1-3) were combined to sample A, and fraction < 20 mm of sample 5, which is below the shear zone, formed the new sample B.
  - Since GF 15-62, located in the eastern part of quartzite formation “G”, does not contain a shear zone, two samples from the zone “above the metagabbro” were defined for further processing. Fraction < 20 mm from original sample 1 represents the new sample C and fractions < 20 mm from original samples 2 and 3 are combined to form the new sample D.
- Optical sorting of fraction < 20 mm
- Crushing and grinding
- High force magnetic separation
- Scrubbing
- Flotation
- High tension (electrostatic) separation
- Acid washing
- Chemical analyses of high value applications

Source: The ANZAPLAN study, April 2016



# Tests- for *High Value Applications (cont'd)*

**Figure 18:** Samples A and B of PQ drill core GF 15-60 for processing tests for high value application from fractions < 20 mm



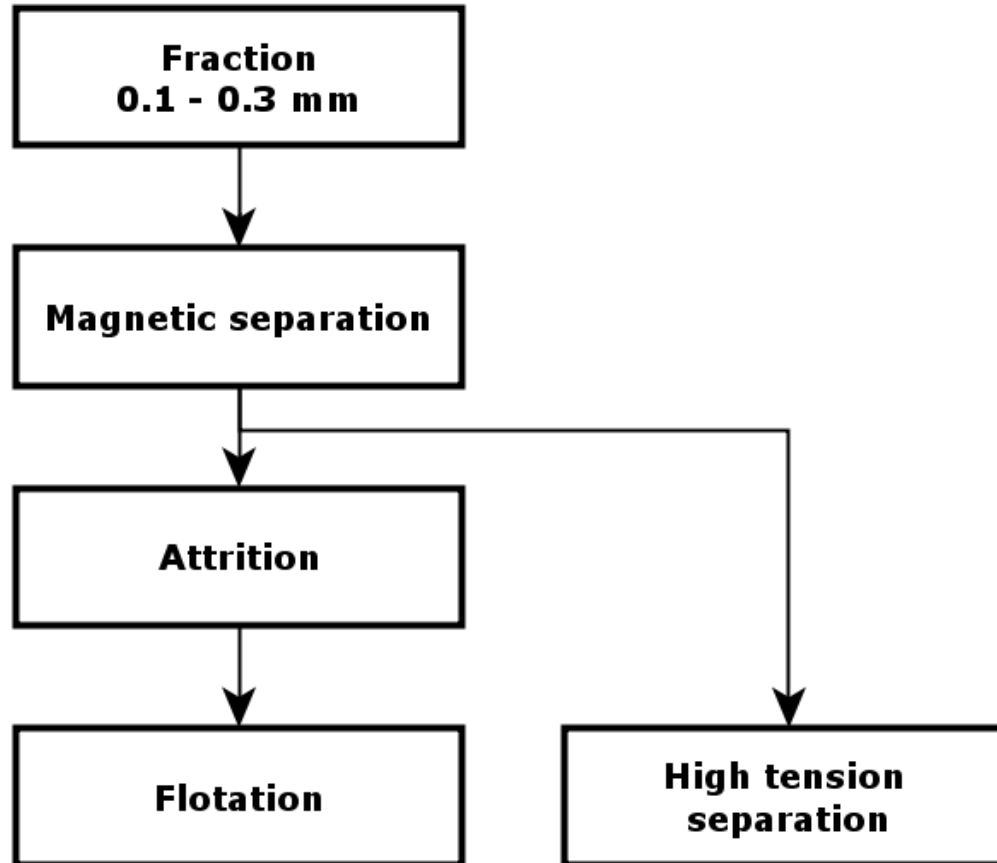
**Figure 19:** Samples C and D of PQ drill core GF 15-62 for processing tests for high value application from fractions < 20 mm

Source: The ANZAPLAN study, April 2016



# Tests- for *High Value Applications*

**Figure 19:** Flow sheet of processing tests for high value applications



Source: The ANZAPLAN study, April 2016



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