# **FOCUS** GRAPHITE

Processing and Performance of Lac Knife Natural Crystalline Flake Graphite from Quebec, Canada

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# Lac Knife Graphite Project

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Qualified Person: The included scientific and technical information regarding exploration activities as defined in NI 43-101 s. 1.1, was either prepared, reviewed and/or approved by Marc-André Bernier géo. (QC), P.Geo., (ON), M.Sc., Technical adviser for Focus Graphite Inc. and a Qualified Person under National Instrument (NI) 43-101 guidelines.

All measurements provided in this presentation are in metric units. All monetary amounts are expressed in Canadian dollars (\$) unless otherwise indicated.



# **Outline of Presentation**

- History of the Lac Knife Graphite Deposit
- Lac Knife Exploration and Drilling Program
- Pilot Plant Testing Program Conducted on Lac Knife Graphite
- Purification of Lac Knife Graphite
- Production and performance of Specialty products







## **Project Location** Lac Knife, Québec, Canada

- Located in northern Québec, 27 km southwest of Fermont
- Large, established iron-ore mining camp and home to billion-dollar mining projects – ArcelorMittal, RioTinto's IOC, Champion Iron's Bloom Lake and Wabush Mines
- Consists of 57 claims covering 3,000 ha/7,500 acres
- ~60 km to the Wabush Airport (YWK)
- Near 2 railway lines connected to Port-Cartier and the Port of Sept-Iles



# Lac Knife has a Proven History

- Graphite showing discovered by Québec Ministry mapping survey in 1959
- Prospected and explored for graphite by Mazarin Inc. and Le Fond d'Exploration Minière du Nouveau Québec 1982-1988
- Drilling program in 1989 by Mazarin indicated the potential for an 8.1 Mt deposit grading 16.7% Cg (NI 43-101 non- compliant)
- Pre-Feasibility and Feasibility studies were conducted for mine development















# Lac Knife has a Proven History

- Joint Venture agreement between Mazarin and Cambior in August 1990
- In 2002 Graftech International and Ballard Power Systems (looking for graphite for fuel-cell batteries) and Mazarin plan a joint venture to start production in 2004
- In 2010, Focus Graphite acquires Lac Knife from IAMGOLD and begins assessing the resource



The geological contact between ore and waste at the Lac Knife flake graphite deposit, Quebec, Canada. Following up an early report of a graphite exposure of one square metre, Mazarin Inc. has proved up a substantial flake graphite reserve which it is currently developing — production is scheduled for 1991.



## **Drilling Rig and Cores**





## Lac Knife Deposit Drill Holes





# **Objectives of Pilot Flotation Test Program**

- Evaluate the performance of proposed flowsheet under continuous operating conditions
- Produce concentrate for downstream testing
- Generate data to support engineering design
- Generate representative tailings samples to use in environmental studies
- Prepare samples for customers and performance testing of products







## Flowsheet for Lac Knife Pilot Plant

- 2 Rod Mills
- 4 Polishing Mills
- 7 Sets of Flotation Cells
- 5 Cleaning Columns
- 5 Screens
- 40+ Tons of Ore Processed





## **Cleaning Circuit & Rougher Flotation Cell**





# High Purity Lac Knife Flake Graphite Concentrate

#### **SGS Lakefield Pilot Plant Tests**

- 11.1% large flake +48 @ 98.8% Cg
- High-purity affords low-cost Value-Added Products as a result of very cost-effective purification processes
- Overall Carbon Recovery of 91%
- Adding of fines polishing circuit could increase Cg content of -200 mesh fines to 97% Cg

Size	Distribution	Total Carbon Grade
Coarse (+80 mesh)	33.5%	98.3%
Medium and fine (-80 to +150 mesh)	29.8%	98.2%
-150 to +200 mesh	16.6%	98.0%
Average of all sizes (+200 mesh)		98.1%
-200 mesh	20.0%	91.1%



## Comparison of SEMs and Carbon Contents of Lac Knife Flake Concentrate with Purified Flake

### Flotation Concentrate



# Concentrate after Polishing



# Lac Knife Graphite after Purification



96% Cg

98.3% Cg

99.98%+ Cg





# Electrothermal Purification of Lac Knife Graphite

Converts electricity directly into heat (+2500°C)











# **Electrothermal Furnace Design**

Patent Number : US 2005/0062205 A1 Inventors : Mark S. Zak, William Mark Harrison, Joseph E. Doninger Company : Superior Graphite

**Design Elements:** 

Flake concentrate feed material (38) Purified flake product (40) Exhaust gases (42) Fluidized bed zone (28) Fluidizing gas inlet (26) Fluidizing gas inlet nozzles (22) Free board zone (30) Conical gas distributor (20) Furnace body (12) Furnace shell (11)



## **SEM of Expanded Lac Knife Graphite**



#### **Purified Graphite**

#### **Expanded Graphite**



## **Production of Expanded Lac Knife Graphite for Conductivity Applications**





**Intercalated Natural Flake Graphite** 



## **Resistivities in Li-Ion Cathode Matrix - LiNiMnCoO**<sub>2</sub>





## Formation of Spherical Graphite for Lithium-ion Batteries





#### Formation of a Graphite Sphere

#### **Spherical Graphite**



## Particle Size Distribution of 3 Grades of Lac Knife Spherical Graphite (SPG)





## Comparison of the Performance of Lac Knife Flake Graphite with Synthetic Graphite in Lithium-ion Coin Cells

Focus Graphite Coin Cell Test Samples	l <sup>st</sup> Cycle Capacity, (Ah/Kg)	Irreversible 1 <sup>st</sup> Cycle Loss (%)	Reversible Capacity (Ah/Kg)
Focus Li ion Fine Grade of Coated SPG D <sub>50</sub> = 21.44 µ. Tap Density = 0.93 g/cc Surface Area = 0.44 m²/g	366.0	0.65% (99.35% Efficient)	363.6
Commercial Li ion Synthetic Grade # 1 D <sub>50</sub> = 15.8 µ. Tap Density = 0.88 g/cc Surface Area = 0.97 m²/g	347.2	6.45% (93.55% Efficient)	324.8 (10.7% lower)
Commercial Li ion Synthetic Grade # 2 D <sub>50</sub> = 20.6 µ. Tap Density = 0.87 g/cc Surface Area = 1.15 m²/g	345.4	3.46% (96.54% Efficient)	333.4 (8.3% lower)



### Comparison of the Extended Long Term Cycling Performance of Lac Knife Carbon Coated SPG with Two Commercial Grades of Carbon Coated SPG





## Lac Knife Flake Graphite Products

#### **Flotation Concentrates from Pilot Plant Tests**

- Coarse (+80 mesh) 98.3%C
- Medium (-80x150 mesh) 98.2%C
- Fine (-150x200 mesh) 98.0%C

#### Purified Flake - 99.98+%C

#### **Carbon Coated Spherical Graphite (SPG)**

- Standard D<sub>50</sub> = 23.9 μm
  Fine D<sub>50</sub> = 17.4 μm
- Superfine  $D_{50} = 11.9 \,\mu\text{m}$

#### **Sized Purified Graphites**

- Flake GraphiteExpanded Graphite
- D<sub>50</sub> = 21, 16, 10 and 7µm D<sub>50</sub> = 21, 15.8 and 3.5 µm

#### **Grades Under Development**

- Silicon Enhanced Carbon Coated Spherical Graphite
- High-Rate Capability Graphite
- Oxidation Resistant Graphite



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