

#### **CENTER FOR NEW TECHNOLOGIES**

CNT INSTRUMENTS, LLC, ST.PETERSBURG

# ELECTRIC-PULSE DISAGGREGATION (EPD) FOR RECOVERY OF COLOURED GEMSTONES

- Knowledge and "know-how"
- Past experience
- Recovery of gemstones

## **EPD** knowledge and know-how

- Russian technology from the 1950's: Laboratory of Electro-hydraulic effect, Agrophysical Institute, Russian Academy of Sciences, St.Petersburg, Russia
- Dr. V.N. Rudashevsky, Consulting Mineralogist, PhD /Mineralogy/Min.processing
- Head of Laboratory of Electro-hydraulic effect (2001-2009)
- Director of CNT Mineral Consulting Inc., Canada (2005-2014) / www.cnt-mc.ca
- CEO CNT Instruments, LLC / www.cnt-mp.com
- Dr. L.J. Cabri, Consulting Mineralogist, PhD, P.Geo./Mineralogy/ 50 y.

experience

- President of CNT Mineral Consulting Inc. (2005-2014)
- CEO Cabri Consulting Inc.
- Over 100 published papers on the use of new mineral processing technologies (incl. EPD), 100s of reports, and 10s of EPD devices sold and set up Worldwide
- CNT Instruments, LLC represents <u>all</u> Commercial EPD devices available on the market, including Swiss Selfrag AG (www.cnt-mp.com)

## **Simplified EPD process**



- Compressive force of crushing replaced by tension due to rending effect of an explosion
- High-voltage power source to capacitors voltage buildup is much higher than input voltage
- Electric discharge triggered by "spark-gaps"
- At >50kV rock breaks down electrically by rapid discharge creating a high density plasma
- Occurs preferentially along zones of weakness –>through the sieve -->out of explosion area

## **Understanding EPD effect**



- EPD efficient liberation of minerals from matrix rocks and/or separation of gemstones from intact minerals, as well as pre-weakening
- Electric Pulse Disaggregation/Electric Hydraulic not to confuse!
- EPD liberates minerals/crystals vs EH results in fracturing
- EPD vs EH same principal but different HV parameters

## **EPD** background

- First commercial CNT EPD Spark-1 is in operation in the West since 1991 (University of Minnesota)
- Exceptional properties of CNT EPD Spark-2 have been used at Gemstone mines since 2002 (Two Demantoid mines, Urals, and one diamond mine, Russia).
- Liberated grains preserve their original shapes
- EPD liberates all mineral grains from any rock type, or grain-size distribution
- Ore surface texture and mineral properties are affecting the efficiency of EPD
- Extensive R&D for gemstones (*emerald, ruby, sapphire, garnet, tourmaline*) as well as diamonds.
- Maximum possible throughput at 50-90% liberation 300 kg/hour per unit
- Possible pre-weakening\* throughput up to 10t/hour per unit

<sup>\*</sup> Note: Pre-weakening EPD process of low energy consumption (1-3kWh/t), aiming at damaging the rock to produce cracks and microcracks along the grain boundaries and reduce rock strength. This approach does not attempt to fracture the feed rocks into free particles to liberate the valuables, but pre-weakens the rock, so that downstream comminution process requires reduced energy.

### Main advantages of EPD devices of Sparkseries for gemstones

- Efficient liberation of minerals from matrix rocks
- Separation of gemstone crystals from intact minerals
- Pre-weakening at larger throughput
- Large chamber convertible from batch and semi-batch to continuous flow
- Environmentally friendly technology: eliminates dust and toxic substances; reduces power consumption
- Modest capital and operating costs
- No security issues two operators control one EPD plant/all process products
- Simple construction and ease of learning
- Same device can be used for:
- R&D/different ores/gemstones (12 laboratories for separation of indicator minerals) + contamination free !!!
- mineral processing and production (2 gemstone mines + one diamond mine)
- resources' valuation (*R&D results for gemstones and diamonds*)
- quality control of recovery by other methods (2 new flowcharts for processing plants)

### EPD – basic components (on example of CNT EPD Spark-series, Canada)



 Spark-2 chamber can be upgraded to semi-batch Spark-3 (see Slide11).

- HV grid (Faradey cage)
  - Health&safety issues
- HV Generator:
  - Power supply (upper right)
  - Marx generator (lower left)
- Stainless-steel chamber:
  - HV electrode (consumable)
  - Stainless-steel sieves (consumables)
- Safety interlock and discharge rod
- Electrical certification
- ESA/CSA certified (Canada & USA).
- "Open" generator is used for robustness and easy maintenance/servicing. However, all HV parts can be metal shielded – enclosed inside oil-filled grounded metal box which will make, f.ex. capacitor changing as "mission impossible".

## **R&D in EPD for gemstones**

- Ore surface texture and mineral properties are affecting the efficiency of EPD
- Pre-weakening tests with kWh/ton evaluation
- Liberation of crystals from matrix rocks
- Separation of gemstone crystals from intact minerals
- Methodology for different gemstones by origin:
- resources valuation
- mineral processing and concentrate production
- quality control of recovery by other methods

### **CNT EPD Spark-3 semi-batch mode chamber**



#### **KEY SPECIFICATIONS**

- Automated chamber loading
- Adjustable processing parameters
- Possibility of recirculating water use
- High standards of operator safety
- Robust construction, easy maintenance, long wear and tear
- Optimal foot print and weight
- All critical parts made of high quality stainless steel and best quality insulation materials

## **Processing plant with CNT EPD Spark-3 chamber**



	1
1 EPD generator	ļ
2 Power supply with controls	1
3 Complete Spark-3 chamber with all accessories	i
4 Vibrating feeder with frame	
5 HV Safety interlock	
6 Water meter	
7 Water pumps 2	2
8 Water recirculating system (if required)	



## Working plant with CNT EPD Spark-3 chamber



- Max throughput for liberation: 0.1-0.3 t/h (depending on conductivity - crystal vs matrix)
- Energy consumption: from 4kWh/t to 10kWh/t (depending on the throughput)
- Restricted HV area with Faraday cage
- Switch on/Switch off capability to swiftly increase/reduce energy consumption
- Feed size: <50 mm
- Product size: variable depending on natural crystal/aggregate size
- Foot print: 3.5x3.5x3.2 m
- Weight: < 2 t
- Water consumption (non recirculating option): from 0.5 to 2 m<sup>3</sup>/t

The maximum possible throughput, energy and water consumption can be verified as a result of test work.

## Methodology for different gemstones

- Ore surface texture and mineral properties are affecting the efficiency of EPD
- Depending on the test results, the best mineral processing flowcharts can be developed for:
  - pre-weakening;
  - liberation of crystals from matrix;
  - re-processing of tailings.
- 100% liberation of preserved crystals allows ideal weight balances and application of the concentrates for resources valuation
- Pristine crystals are amenable for quality control (size, clarity, color)





## **R&D in EPD for gemstones**

- Pre-weakening tests with kWh/ton evaluation SAG/Bond index
- Liberation of crystals from matrix rocks visual examination
- Separation of gemstone crystals from intact minerals microscopic studies



10 pulses result in fracturing and recovery of crystals on the surface







Further EPD result in fractal disaggregation and clean tailings

How many kWh/t? Is it feasible?



## **Conclusions and recommendations**

- EPD is exceptionally efficient for recovery of gemstones but surface texture and mineral properties affect the efficiency of EPD – tests needed!
- CNT EPD Spark-2 is an ideal and fairly priced commercially available device for tests, convertible to Spark-3 (needs only minor modifications, i.e. lower chamber, feeding and screening equipment).
- 100% liberation of preserved crystals allows ideal weight balance and application of the concentrates for resources valuation
- Pristine crystals amenable for quality control (size, clarity, color)
- Potential to become standard technology for Gemstones
- Choice of most appropriate method of mineral processing after EPD
- EPD can be applied for primary ore or tailings processing, as well as preweakening.
- High degree of security (enclosed area and only two operators)
- R&D results for different ores can vary i.e. EPD results of all types of ores/process products have to be evaluated
- Reduces need for further mineral processing options
- New deposits/process samples
- Relatively inexpensive
- Scale up potential for Gemstones

## **Proposal gemstones / stepwise**

- 1. EPD tests in Ottawa most characteristic samples of all types/grades of gemstones containing rocks
- 2. <u>Deliverables</u>: Reports (incl. tables, figures, EPD regimes, analytical data), pristine crystals/monolithic blocks of gemstones amenable for quality control (weight balance, size, clarity, color etc).
- 3. Acquisition of CNT EPD Spark-2 for installation at client's premises for further application (mineral processing, resources valuation and on-line quality control of mineral processing grade, weight, size, clarity, color)
- 4. Upgrade of EPD Spark-2 to Spark-3 and its integration in existing mineral processing plant of gemstones recovery
- 5. Scale up of EPD process to continuous flow recovery number of EPD Spark-3 modules, or different EPD approach (CNT EPD Spark-10 10t/hour throughput)
- 6. Constant R&D process for application of the EPD technology on potential Gemstone mines

### www.cnt-mp.com



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## **THANK YOU FOR YOUR ATTENTION!**

"The ideal project does not exist, each time there is the opportunity to realize an approximation."

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