

# ROUNDUP 2001

---

## A Dilemma for New Producers of PGE Concentrates – Downstream Processing to Saleable Metals

*John A. Chapman*

*J.A. Chapman Mining Services*



Finished PGE  
Products



Smelting & Refining



Producing PGE  
Rich Sulfide  
Concentrates

# Today's Situation



- Oligopoly of vertically integrated major mining, smelting & refining companies
- Restricted access for new PGE rich sulfide concentrate producer(s) to smelting & refining facilities of majors
- Toll (custom) smelting and refining, if negotiated, is very expensive
- With very few facilities available concentrate transportation costs may be significant



# Integrated PGE Smelters and Refineries

		Principal Purpose of Smelter	BMR	PGE Refinery
Outokumpu	Finland	Nickel	✓	
Norilsk	Russia	Nickel	✓	✓
Anglo Platinum	South Africa	PGE's	✓	✓
Implats	South Africa	PGE's	✓	✓
Lonmin	South Africa	PGE's	✓	✓
Zimplats	Zimbabwe	PGE's	✓	✓
Union Miniere	Belgium	Cu-Pb	✓	✓
Inco	Sudbury	Nickel	✓	✓
Falconbridge	Sudbury	Nickel	✓	✓
Stillwater	Montana, USA	PGE's	✓	

# Smelter Terms

## Charges & Penalties

---

- Typical concentrate contains Ni, Cu, Co, PGE's, Au, Ag
- Moisture content 10% +/- 2%
- Approximate grade set on each payable metal in concentrate
- May be rejected due to deleterious elements or off-specification moisture or metals grades
- Treatment charge on dmt basis of feed

# Smelter Terms

## Credits

---

- Smelter sets “accountable” metal recoveries (%) or a minimum deduction
- Credits based upon refined “accountable” base, precious and PGE metals with a deduction for refining charge
- Smelting and refining charges adjusted annually by various price indices

# Smelter Terms

## Credits (cont.)

---

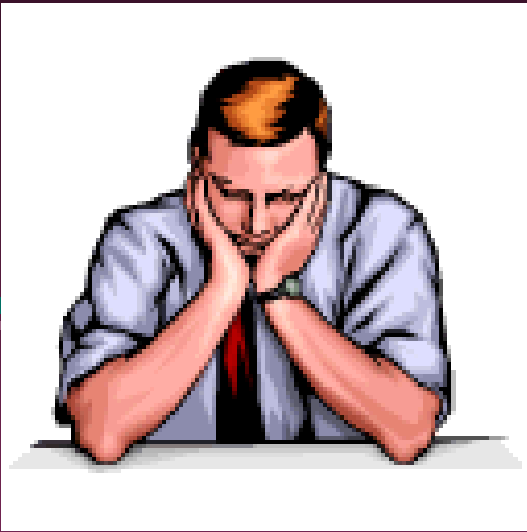
- Smelter price participation against base prices of metals (usually LME)
- Final payments may be spread over considerable time periods for different metals

# Independent Refiners

---

- Johnson Matthey
- Union Miniere Precious Metals
- Heraeus Metal Processing
- Sabin Metal Corp
- Engelhard Corporation
- Degussa Corporation
- Handy & Harman Refining Group, Inc.
- See [www.ipmi.org](http://www.ipmi.org) for complete list of Refiners





# The Dilemma

---

You have a PGE property that appeared to be technically and economically viable until the feasibility study showed the X-Mine costs were so high that the project was rendered uneconomic  
(PROJECT NPV = NIL)

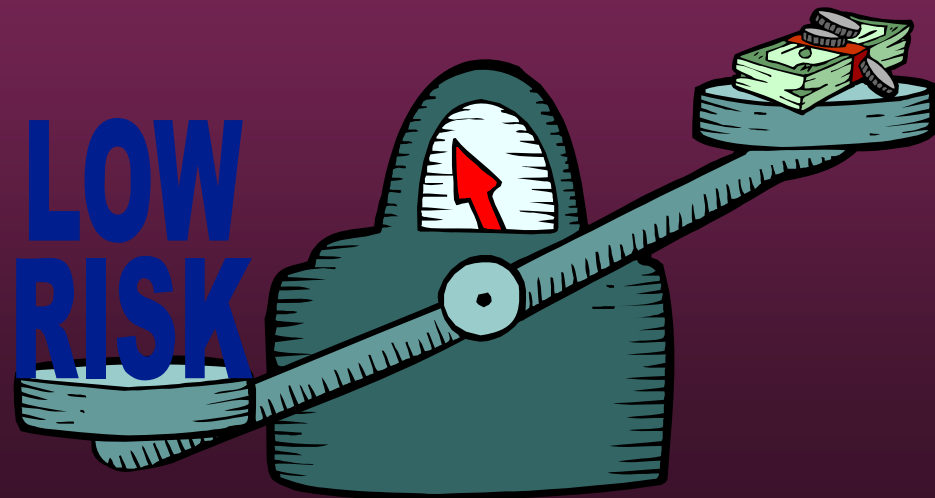
# Possible Solutions To The Dilemma for Large Deposits

---

- The Stillwater Mining Company “model”
  - proven smelting & base metal refining technology that is cost sensitive to concentrate grade and economy-of-scale
- New technology, “PlatSol”
  - high risk but with potential high reward

# The “Stillwater” Model

- Commenced production in 1987 at Nye, Montana and shipped concentrate to UM (~35K oz/yr PGE’s)
- Added a smelter in 1990 and shipped granulated matte to UM (~250K oz/yr PGE’s)



# The Stillwater Model (cont.)

---

- Added a BMR in 1996 and shipped high grade PGE residue to JM and UM and copper and nickel solutions to Sherritt (~300K oz/yr PGE's)
- Expanded smelter and BMR in 2000, ship PGE residues to JM et al, and now produce cathode copper and nickel-cobalt crystallization at site (~400K oz/yr PGE's and increasing)

# Stillwater BMR & Smelter (1998 Photo)

**PGE's in Flotation Concentrate Upgraded From 50 opt to 60%  
Then Shipped to Off-Site PGE Refineries**



**Byproducts Include Cathode Copper  
And Nickel/Cobalt Xtals**

# PGE Smelter

## Process Description

---

- Electric 5 mW Furnace (EF)
  - 100 tons concentrate per day processing design capacity
  - Removes oxide materials ( $\text{SiO}_2$ ,  $\text{FeO}$ ) from concentrate
  - Upgrades PGE's from 50 opt to 200 opt
  - Smelter PGE recovery is plus 99%

# New Stillwater Electric Furnace



# PGE Smelter

## Process Description (cont.)

---

- Top Blown Rotary Converter (TBRC)
  - Processing capacity equivalent to 50-60 tons concentrate/day
  - Removes iron ( $\text{FeO}$ ) and sulfur ( $\text{SO}_2$ ) from EF matte
  - Upgrade PGE's from 200 opt to 600 opt



# New Stillwater TBRC



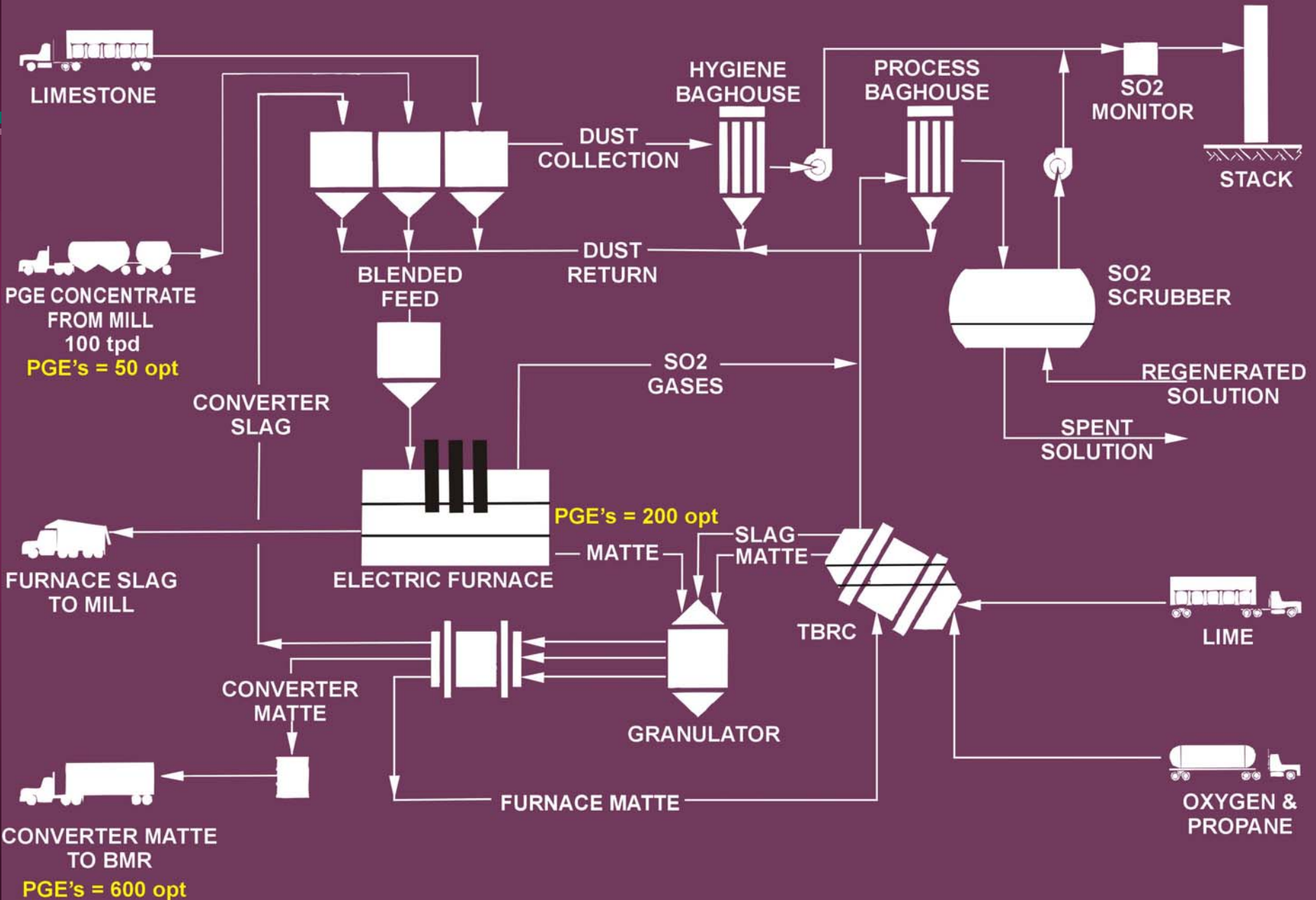
# PGE Smelter

## Process Description (cont.)

---

- Granulation/Regeneration
  - Water jets cool EF and TBRC matte
  - High efficiency scrubbing captures plus 99.5% SO<sub>2</sub>
  - Regeneration product is gypsum, used locally as a soil amendment
  - No discharge of process solutions

# Stillwater PGE Smelter



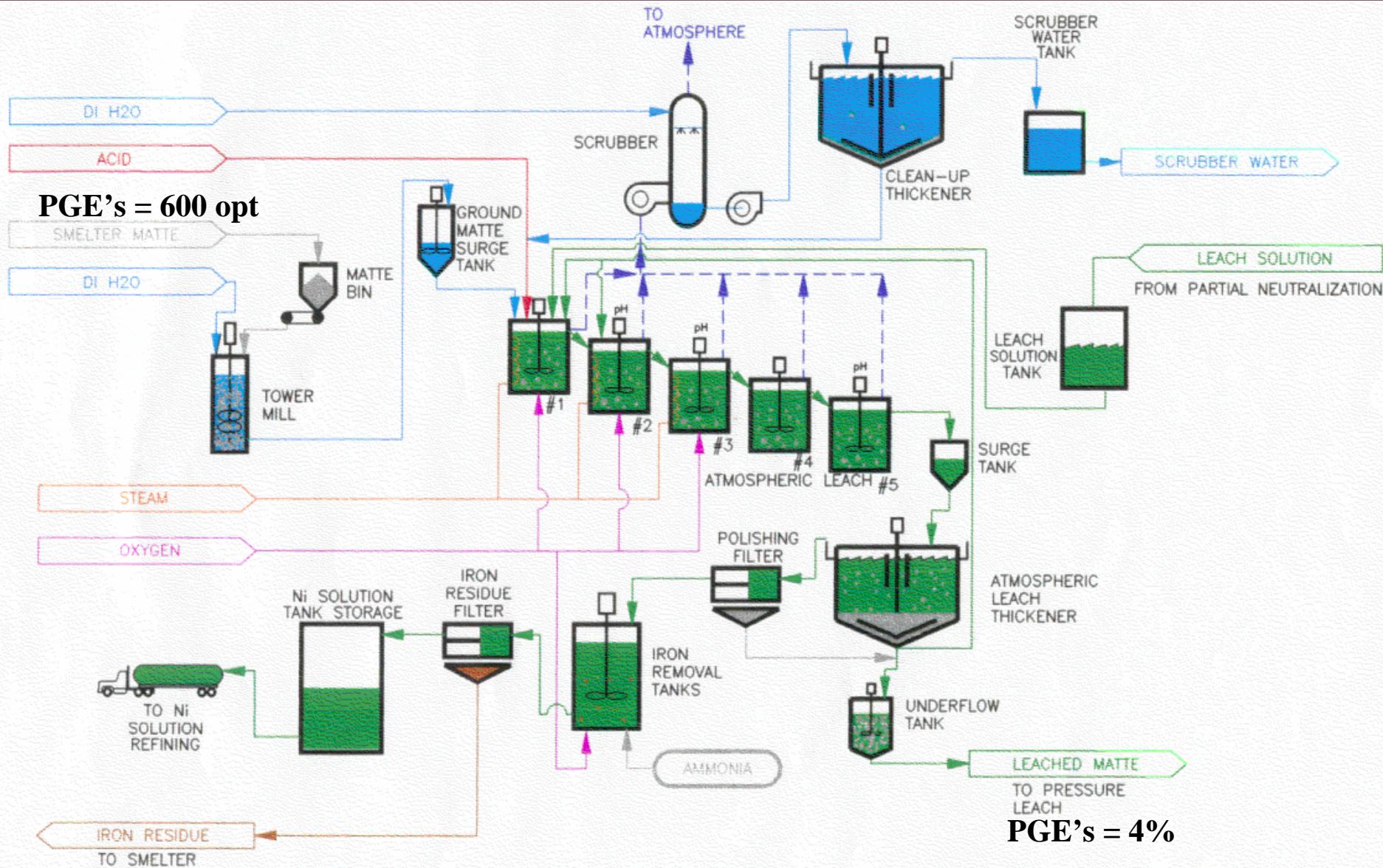
# BMR

## Process Description

---

- Grinding – Batch Process
  - Tower mill grinds smelter matte to 85% passing 200 mesh
- Atmospheric Leach
  - Leaches nickel, iron, cobalt and some copper
  - Precipitates out any PGE's from solution
  - Upgrades PGE's from 2% to 4%

# Stillwater Mining Company Base Metals Refinery Atmospheric Leach



# BMR

## Process Description (cont.)

---

- Pressure Leach
  - Autoclaves operate on a batch basis
  - Leaches nickel, copper and iron from the atmospheric leach residue
  - Upgrades the PGE's from 4% to 60-65%
- Iron Removal
  - Precipitates iron (Goethite) from solution (recycled to smelter)

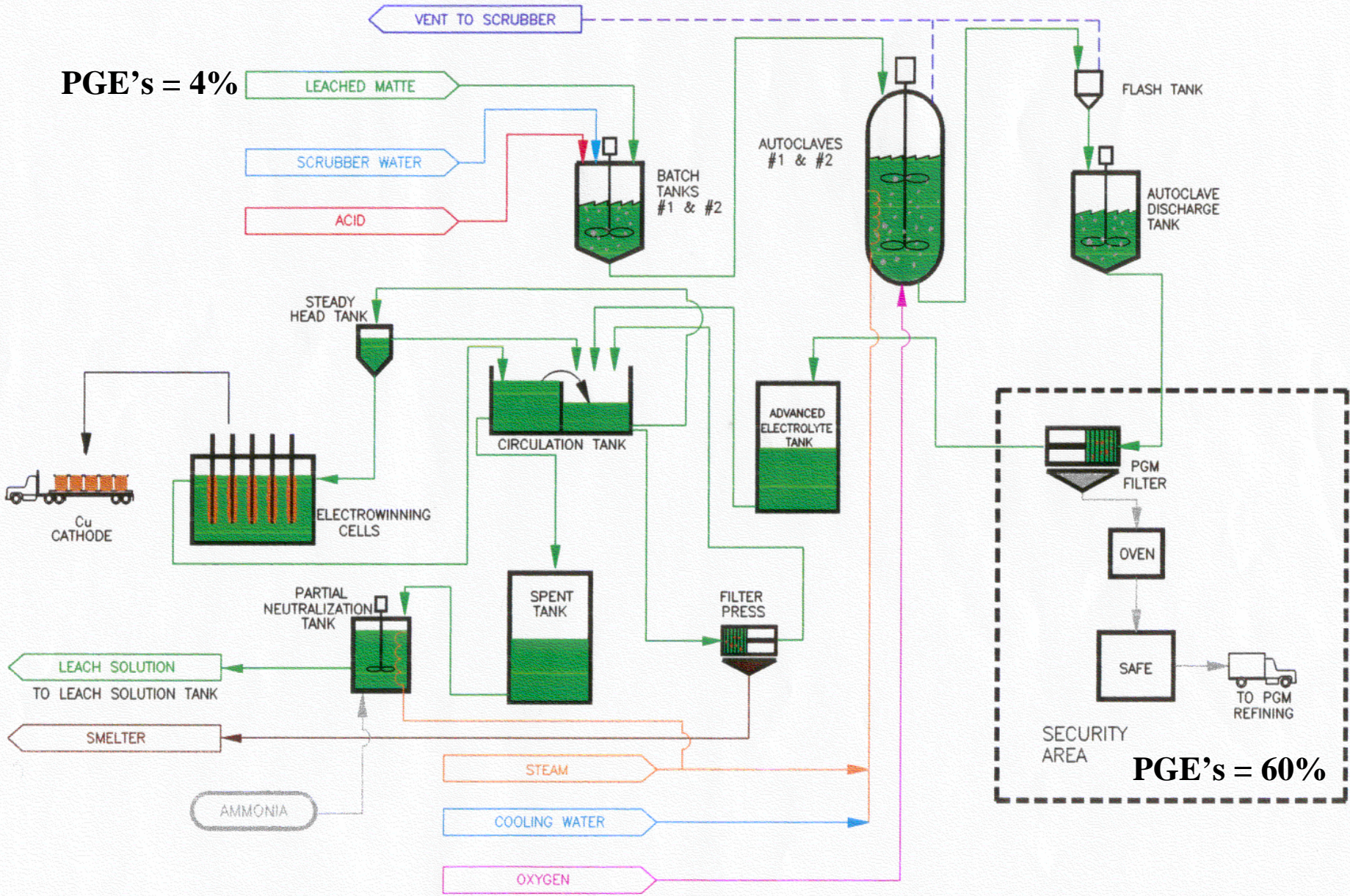
# BMR

## Process Description (cont.)

---

- The nickel/copper/cobalt sulfate solution
  - Nickel/cobalt crystallized and shipped offsite
  - Copper electrowinning on site
- PGE Residue Processing
  - Filtered and shipped offsite for refining

# Stillwater Mining Company Base Metals Refinery Pressure Leach





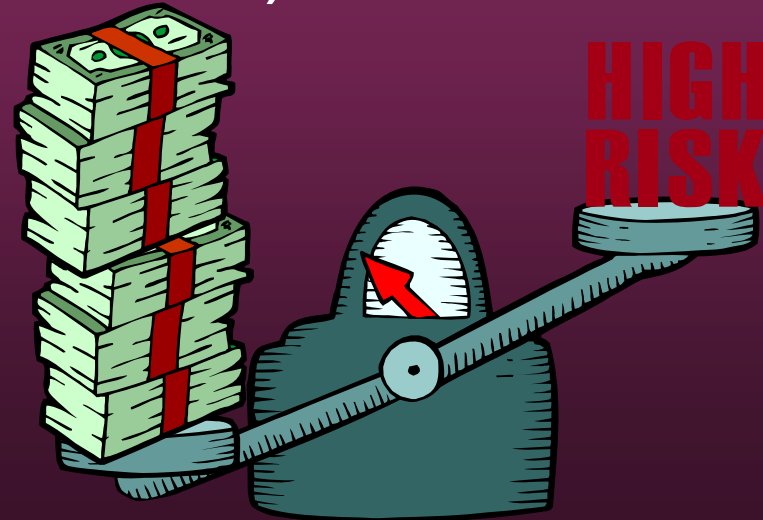
# The PlatSol Process

---

- Patented process by International PGM Technologies Ltd.
- First pilot testing done in 2000 at Lakefield Research in Ontario for PolyMet Mining Corporation on a bulk sample from the NorthMet deposit

# The PlatSol Process (cont.)

- Process uses an innovative combination of concentrate pressure leaching followed by precipitation (gold & PGE's), SX-EW (copper) and crystallization (nickel & cobalt)



# Lakefield Research Facilities Lakefield, Ontario



# Pilot Plant Crushing



# Pilot Plant Concentration



# Pilot Plant Pressure Leaching & Metals Recovery

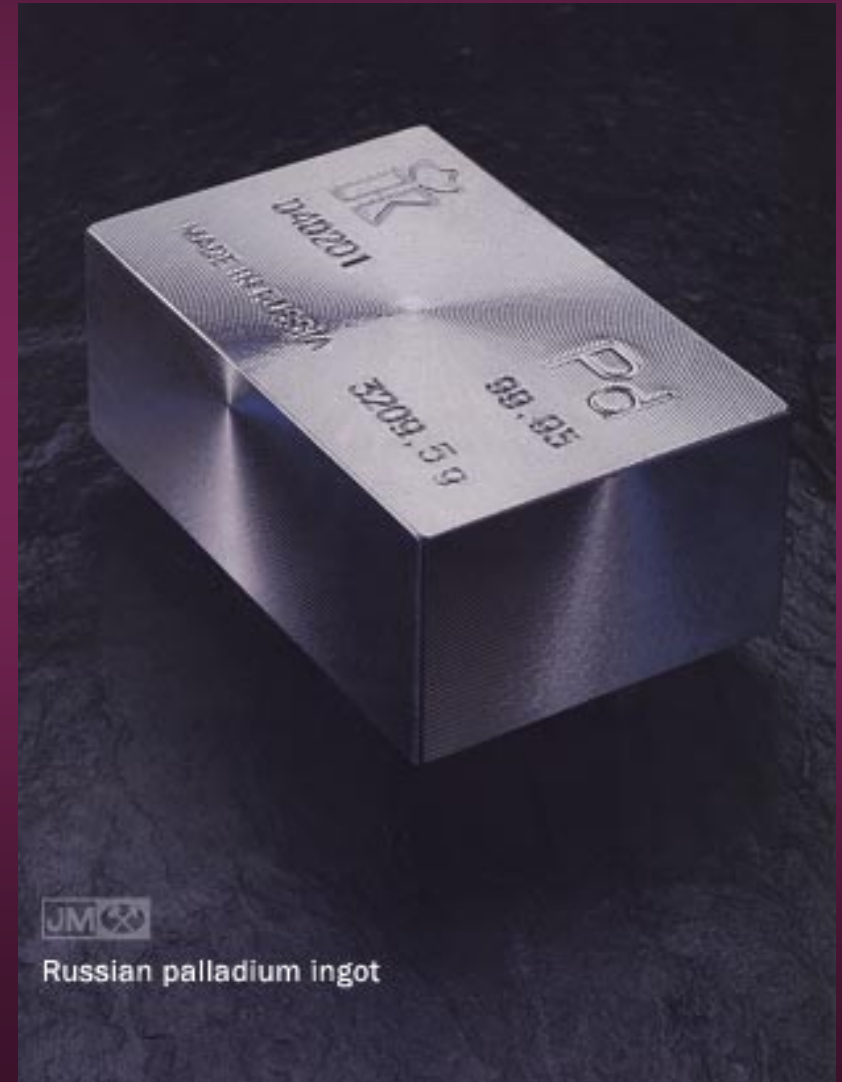
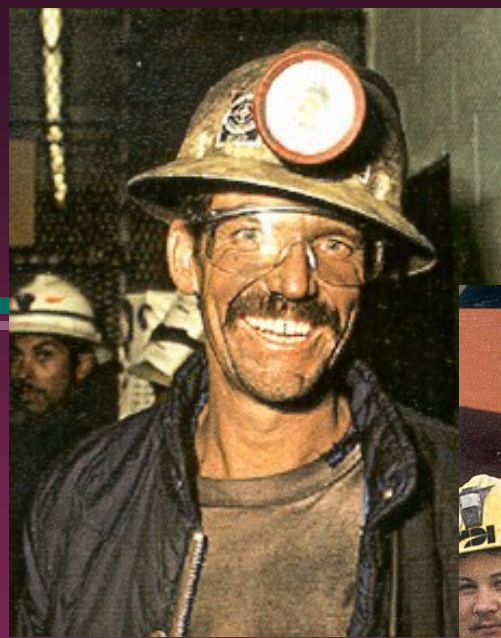


# Conclusions

---

- Very restricted access to PGE smelters
- Deposits of +2.5 million ounces PGE's have a chance of processing to finished metals at or near the mine-site, and could yield a viable NPV for development
- Smaller deposits will have great difficulty in achieving a viable NPV for project development because of the smelter situation

# The Goal!



A  
Technically  
Feasible &  
Economically  
Viable PGE  
Operation

JMCO

Russian palladium ingot