



# AMG LITHIUM

AMG Advanced Metallurgical Group N.V.  
Lithium Project Update July 20, 2016



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## AMG LITHIUM – PROJECT HISTORY

- **2002 – 2013:** AMG began development of a pilot plant process route for the flotation of Mica and Feldspar from tailings
- **2007 – 2008:** Flotation equipment installed
- **2009 – 2010:** Dry magnetic separator installed
- **2011:** First set of samples produced and tested by industrial customer
- **2012:** Electric rotate dryer was installed to enable batch trials for technical grade Spodumene
- **2013:** AMG provided 43,603kg of spodumene to industrial customer to develop a tank test, following which pilot plant operations were halted
- **2015:** The pilot plant received basic maintenance and wet magnetic separators were rented, placing the pilot plant back into operational condition

# AMG LITHIUM – PROJECT OVERVIEW

## PHASE I – Lithium Concentrate

### OBJECTIVE

Monetization of substantial lithium mineral deposits currently residing in AMG Mineração's tailings ponds and tailing stockpiles

AMG will construct a lithium concentrate (spodumene) production facility, co-located with AMG Mineração's tantalum mine and upgrading plant in Brazil

### PLANNED PRODUCTION

90,000 metric tons per year of lithium concentrate, with an option to expand to 140,000 metric tons

### STATUS

Phase I capital investment of approximately \$50m was approved by the AMG Supervisory Board on July 19<sup>th</sup>, 2016

Lithium concentrate operations to commence in the first quarter of 2018

## PHASE II – Lithium Chemical

### OBJECTIVE

Downstream conversion of lithium concentrate into lithium hydroxide monohydrate and/or lithium carbonate

### PLANNED PRODUCTION

14,000 metric tons lithium carbonate equivalent (LCE) per year (hydroxide and/or carbonate), expandable to 20,000 metric tons

### STATUS

Affirmative scoping and site location studies completed

Pre-feasibility study for the construction of a lithium chemical plant will be completed in the fourth quarter 2016

AMG's objective is to be the low-cost producer of spodumene globally

## AMG LITHIUM – PROJECT STRENGTHS

- Existing management and mining infrastructure – not a new mine project
- Strong understanding of the mine geology
- AMG Mineração's last mineral resource estimate, published in 2013 and prepared in accordance with National Instrument 43-101 Guidelines, and endorsed and signed-off by Coffey, identified 19.3 million tons of measured, indicated and inferred resources, which includes tantalum, niobium, tin and lithium
- Mining infrastructure already in place and operational
- Ore extraction and crushing costs absorbed by profitable tantalum operation
- Lithium concentrate (spodumene) plant will be fed via lithium deposits in existing tailings, as well as incremental lithium-bearing tailings generated via tantalum production
  - 2.8 million metric tons of spodumene plant feed stock already extracted in the form of on-site tailings
- AMG has operated a spodumene pilot plant since 2010 (see slide 7)
- Phase 2 lithium chemical plant pre-feasibility work being performed by Hatch, the world's leading builder of lithium plants

AMG has operated the Mibra mine for 38 years

# AMG LITHIUM – PROJECT TIMELINE

2010-12

2013-14

2015

2016

2017

2018-20

## PHASE I

- Spodumene concentration processing route development
  - Mineralogical characterization on tailings from Ta2O5 plant
  - Laboratorial scale flotation tests
  - Pilot plant operation
  - Industrial production scoping study

- Sample production of lithium concentrate for glass / ceramic industry
- Updated 43-101 compliant resource statement – life of mine extended

- Lithium concentrate (spodumene) plant studies completed Q4 2015 by Outotec
  - Conceptual study
  - Pre-feasibility study

- Spodumene plant basic engineering completed July 2016 by Outotec
- **AMG Supervisory Board approval July 19<sup>th</sup>, 2016**
- Spodumene plant construction to commence Q3 2016
- Resource expansion drilling campaign to start Q3 2016

- Updated 43-101 compliant resource statement to be completed
- Spodumene plant construction to be completed Q4 2017

- Spodumene plant to be at full capacity Q3 2018

## PHASE II

- Hatch lithium chemical plant scoping and location studies completed Q2 2016
- Hatch lithium chemical plant pre-feasibility study to be completed Q4 2016

- **Lithium chemical plant investment decision Q2 2017**



## AMG VALUE PROPOSITION

LEADER IN ADVANCED TECHNOLOGIES  
TO ADDRESS CO<sub>2</sub> REDUCTION

# CO<sub>2</sub> REDUCTION

A GLOBAL IMPERATIVE FOR THE 21ST CENTURY

### AMG: MITIGATING TECHNOLOGIES

Products and Processes saving  
raw materials, energy and CO<sub>2</sub>  
emissions during manufacturing  
(i.e., recycling of Ferrovandium)

### AMG: ENABLING TECHNOLOGIES

Products and Processes saving  
CO<sub>2</sub> emissions during use  
(i.e., light-weighting and fuel efficiency in  
the aerospace and automotive industries)

AMG HAS DEVELOPED INTO A LEADER  
IN ENABLING TECHNOLOGIES

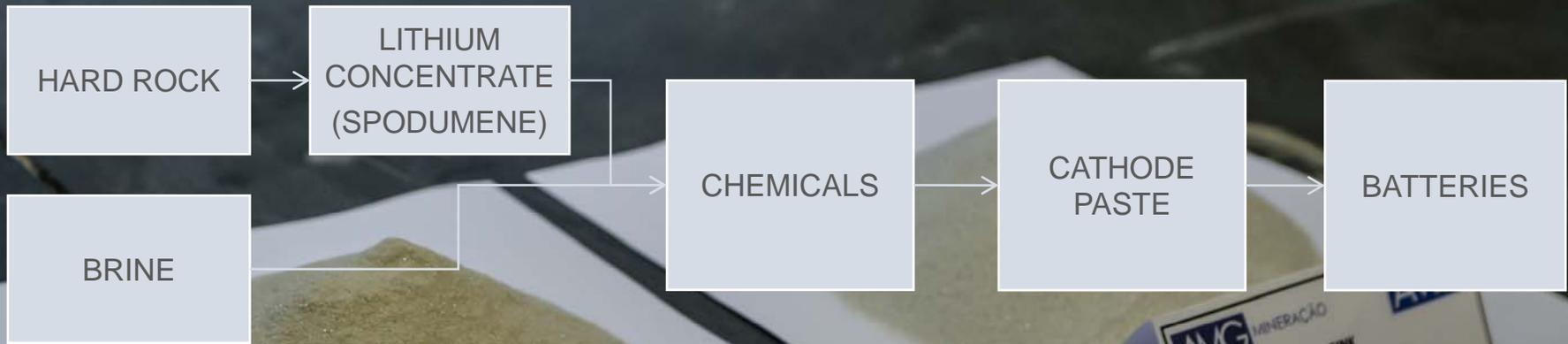
– LITHIUM FITS WELL WITHIN THIS STRATEGY

# MARKET FUNDAMENTALS

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# LITHIUM INDUSTRY BASICS & BATTERY VALUE CHAIN







































# GLOBAL LITHIUM DEMAND AND PRICING OUTLOOK

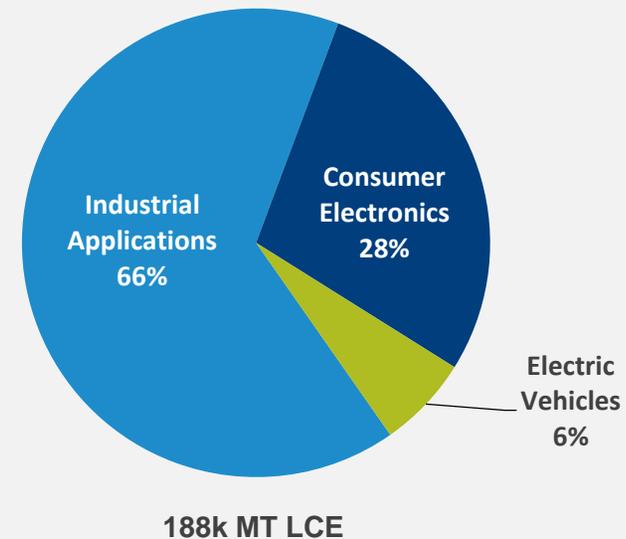
## FUNDAMENTALS

Lithium-ion battery costs are falling rapidly as global battery producers expand manufacturing facilities

Global lithium demand was 182k MT lithium carbonate equivalent (LCE) in 2015, with EV demand doubling YoY and accounting for 14% of global demand

Global lithium supply has increased at a 7% compound average growth rate (CAGR) from 1995 to 2015 to meet increased demand from mobile phones and other electronics

LITHIUM DEMAND BY APPLICATIONS  
(2015 ACTUAL)



Source: Citibank Deep Dive | Commodities report, Oct 16, 2015, Figure 2. Lithium Supply Demand Balance, pg. 5

## PRICING OUTLOOK

**Rapidly growing market** driven by growth in electric vehicles and falling cost of production of lithium-ion batteries

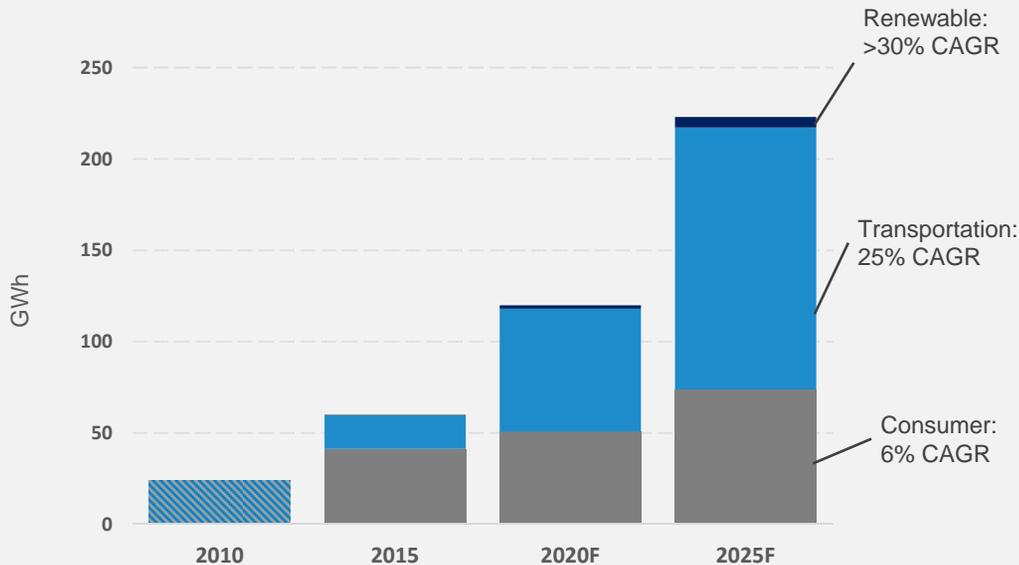
**New production**  
Hard rock mining projects at higher cost

**Disjointed pricing**  
Chinese lithium hydroxide spot prices are currently estimated at US\$19,315/MT with medium term forecasts around \$10,000/MT (Roskill)

# BATTERY SEGMENT GROWTH

**Transportation & Renewable Energy:**  
two key end markets driving long term growth,  
with further upside potential

WORLD MARKET FOR RECHARGEABLE LITHIUM BATTERIES BY END-USE



Source: Roskill 2016 Lithium Market Report

## Renewable Energy (Grid Storage)

Driven by growth in renewable energy and need for resources to provide system flexibility and balance supply/demand

Global installed base of ~1.1 GW, projected annual installations reaching up to >12 GW by 2025 (Navigant Research)

## Transportation

Fast-growing market for hybrids and electric vehicles driven by regulations on CO2 emissions, falling battery costs, expanding charging infrastructure and desire for an enhanced driving experience

## Consumer Electronics & Devices

Slowing demand for laptops and conventional mobile phones are offset by robust demand growth for smart phones, tablets and wearables, driven by trend towards higher-capacity batteries

# LITHIUM ELECTRIC VEHICLE (“EV”) MARKET FORECAST

## OVERVIEW

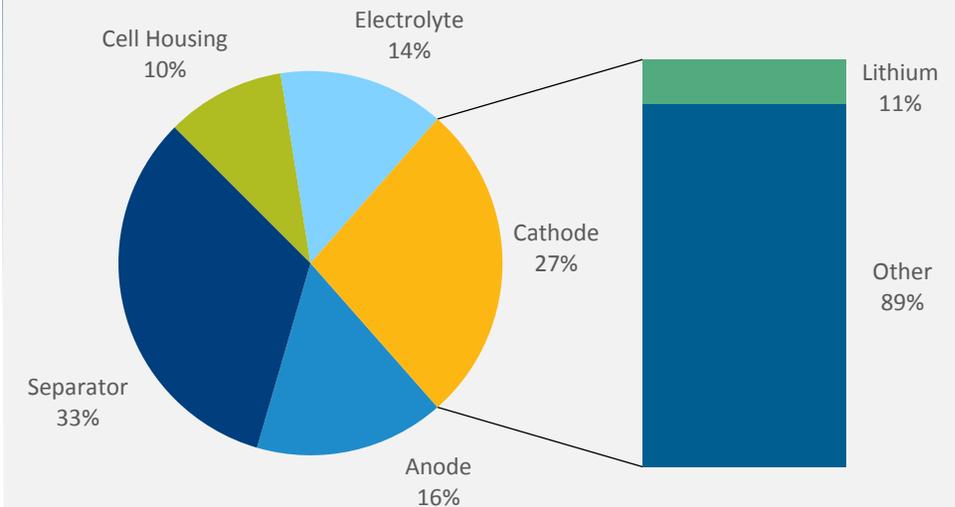
Global lithium carbonate market has been short of supply since 2013

It is estimated that there is ~6k MT of pure EV driven lithium demand today

Leading automakers are committing to developing a wider range of EV models which are more lithium-intensive than hybrid EVs or plug-in EVs

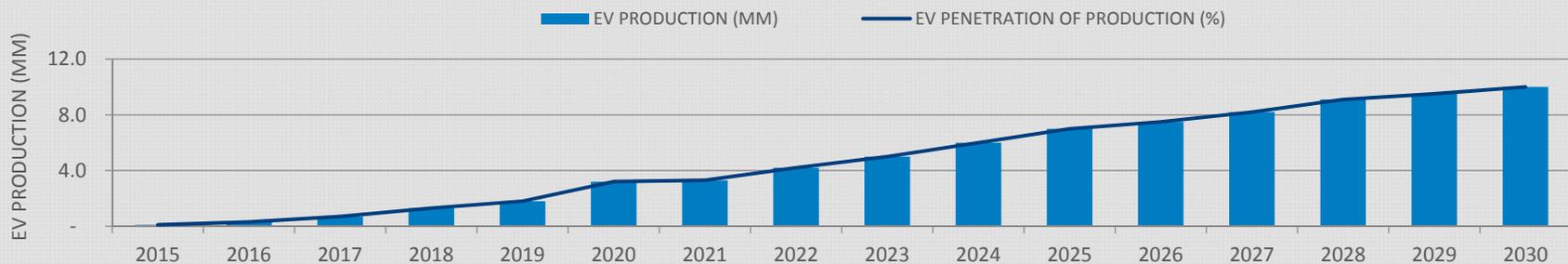
Lithium only accounts for 3% of battery costs

## LIMITED EFFECT OF LITHIUM COSTS ON BATTERY PRICING



Source: Journal of Power Sources, Volume 320

## EV PENETRATION OF PRODUCTION



Source: Morgan Stanley

# GLOBAL LITHIUM SUPPLY

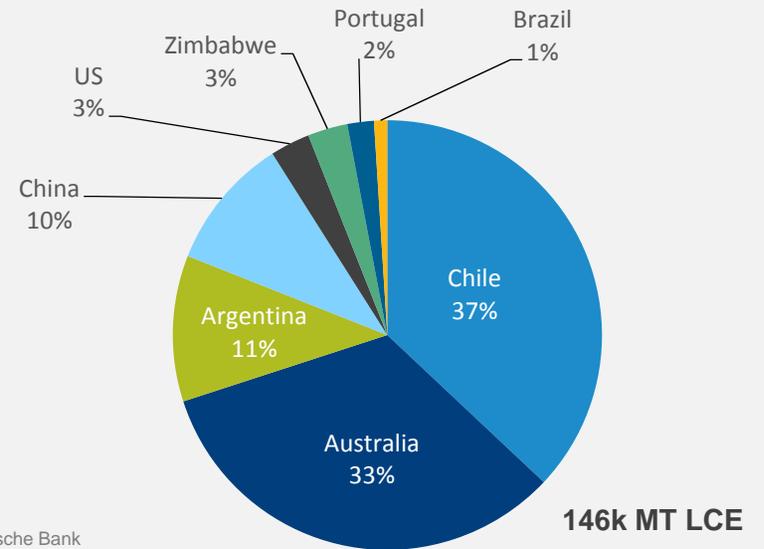
## FUNDAMENTALS

Global supply of lithium minerals has been historically dominated by large-scale lithium brine operations in South America

Global lithium supply has increased at a 7% compound average growth rate (CAGR) from 1995 to 2015 to meet increased demand from mobile phones and other electronics

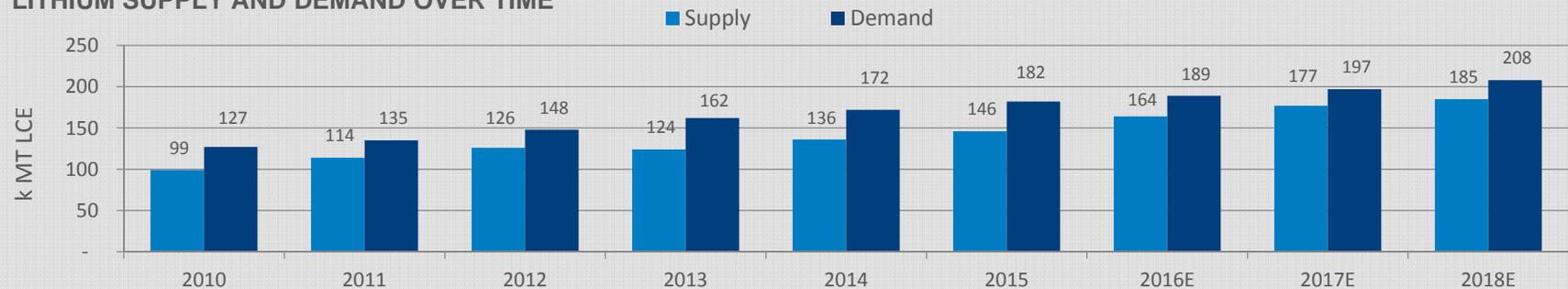
2016 global lithium supply is around 164k MT LCE, split roughly 50:50 between hard-rock and brines

LITHIUM SUPPLY BY COUNTRY (2015 ACTUAL)



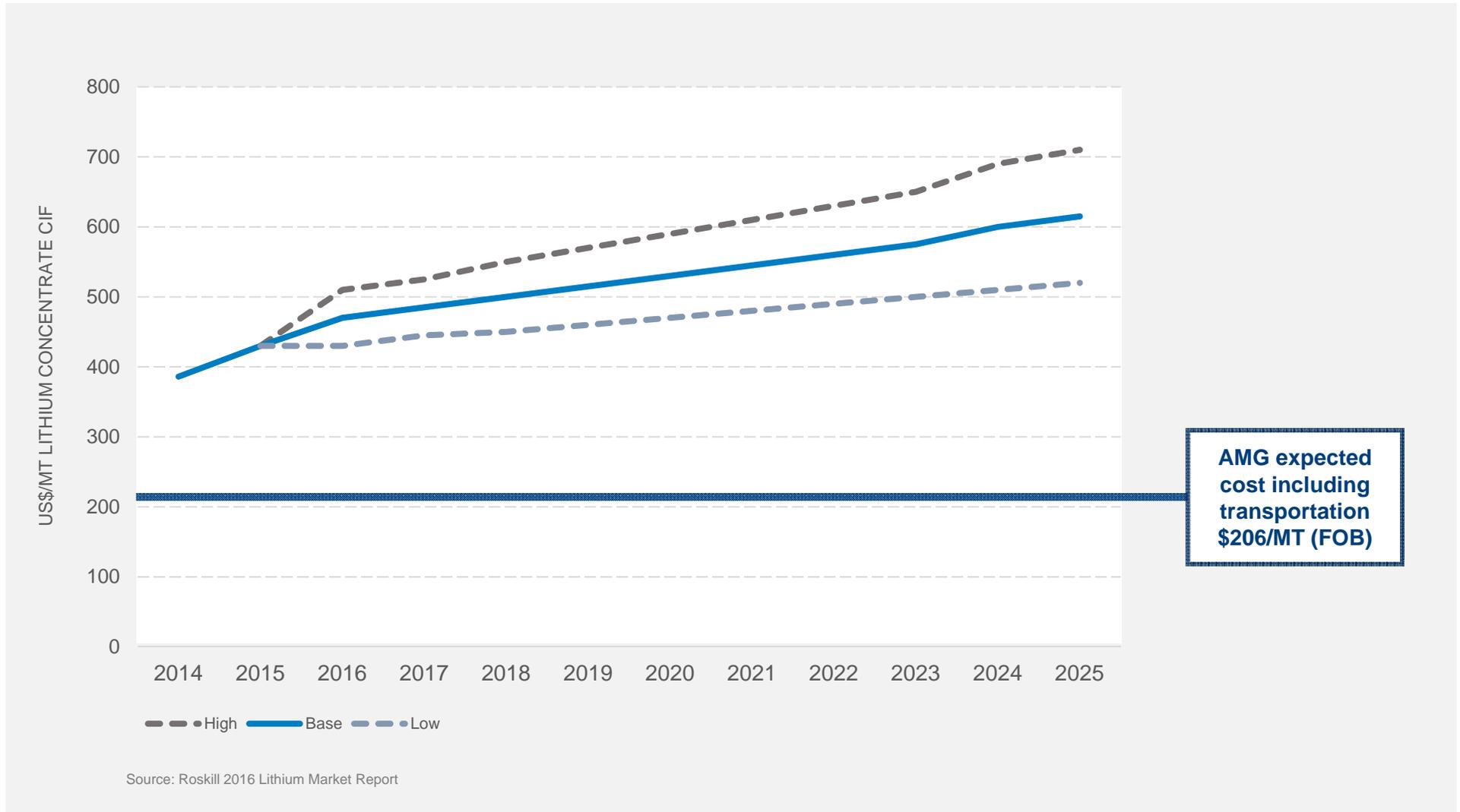
Source: Deutsche Bank

LITHIUM SUPPLY AND DEMAND OVER TIME

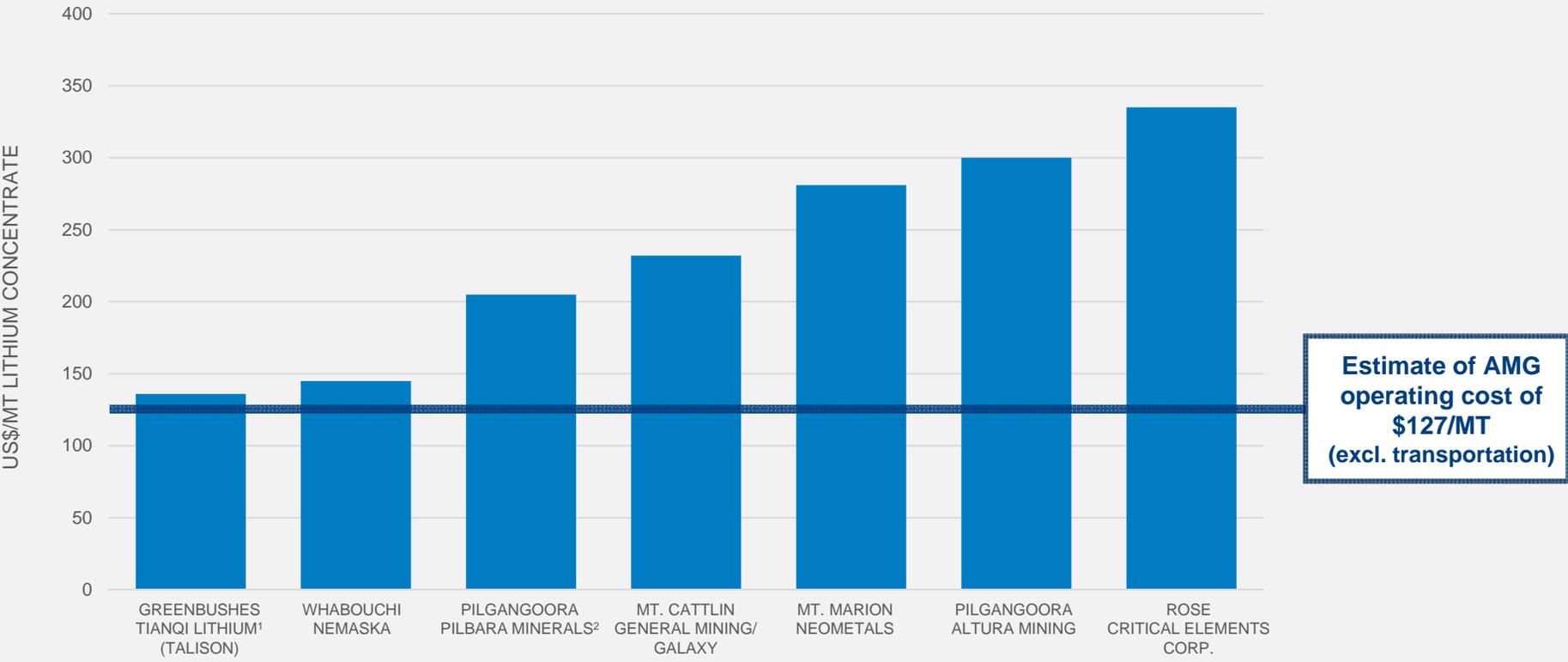


Source: Morgan Stanley

# MARKET PRICE FORECASTS – LITHIUM CONCENTRATE (SPODUMENE)



# LITHIUM PRODUCER / PROJECT COST POSITION – LITHIUM CONCENTRATE (SPODUMENE)



Source: Roskill 2016, Ehren Gonzalez Ltda, Hatch; Note – Operating costs only, not including transportation  
 Note: AMG cost estimates per Outotec of \$127/MT; includes production costs and SG&A costs; does not include cost of transportation to port

<sup>1</sup> Greenbushes cost includes G&A but excludes selling expenses  
<sup>2</sup> Pilbara Minerals figure includes credits from tantalite production; includes transport and loading costs of \$37/t concentrate



# LITHIUM MARKET BALANCE, THROUGH 2025

Outlook for lithium consumption remains optimistic. Additional supply needed to feed strong demand in multiple markets.

## Demand

Overall cumulative average growth rate (CAGR) from FY12 to FY25 of 6.4% (Base Case)

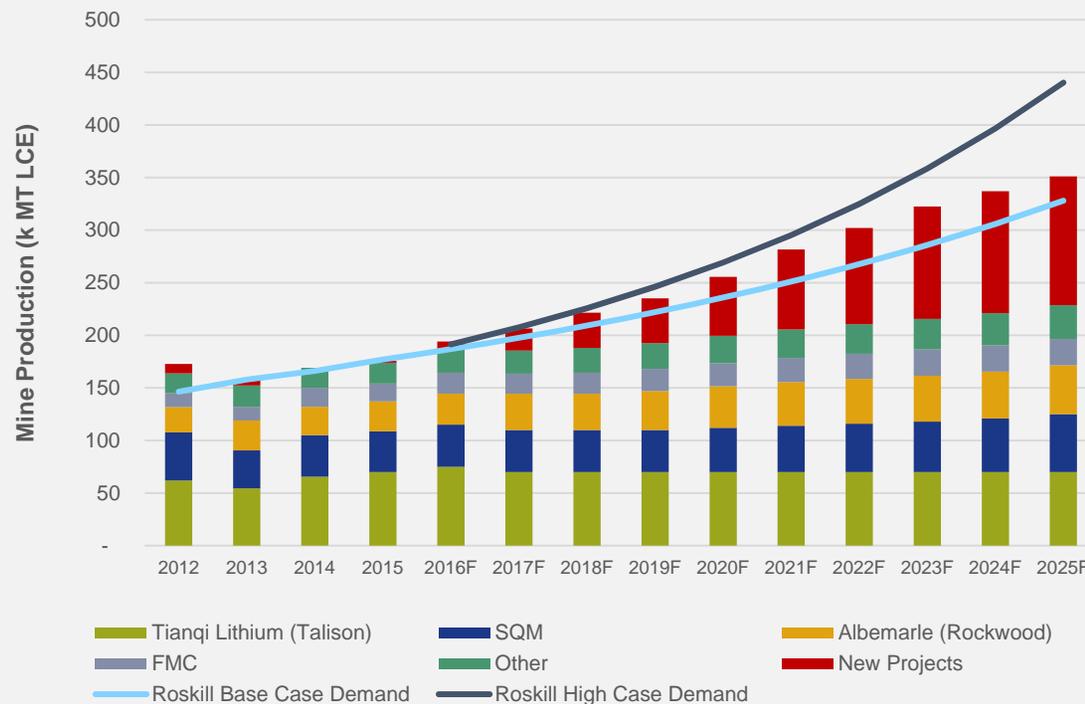
Battery demand CAGR of 12.6%

High Case – stronger global economy, surging demand for battery and energy applications – 9.5% per annum growth

1% increase in electric vehicle penetration would increase demand by 70k MT lithium carbonate equivalent (LCE) per year

## Supply

Forecasted production is based upon current capacity, as well as publicly announced expansions



Source: Roskill 2016 Lithium Market Report  
 Note: new mine projects include Orocobre, Galaxy Resources, RB Energy, Lithium Americas/SQM, Eramet, Neometals, Nemaska Lithium, and Western Lithium.

# AMG MINERAÇÃO MIBRA MINE

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# AMG MINERAÇÃO – MIBRA MINE

## History and Overview

**The mine was founded** in 1945 and acquired by Metallurg / AMG in 1978

**Activities include** open pit mining, crushing/grinding, gravimetric and electromagnetic concentration

**Extract tantalum** and niobium bearing ores and sells as tantalum concentrate

**Current production** of 300k pounds of tantalum concentrate annually

## Present Product Lines

**Tantalum** concentrate sold exclusively to United States under long term contract

**Feldspar** sold in local market to ceramics and glass producers

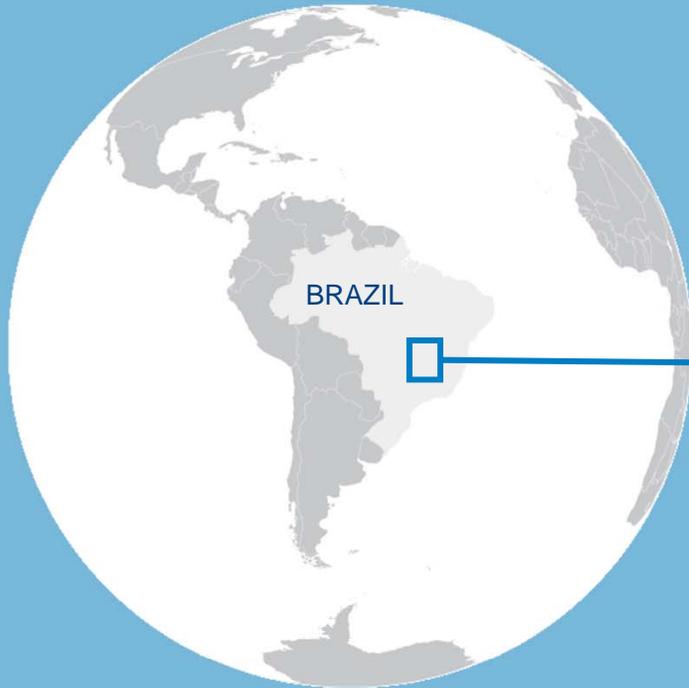
**Tin** sold primarily in local market

- **Smelting of byproduct** into tin metal occurs at third party operations

# MIBRA MINE AERIAL VIEW



# MIBRA MINE – LOCATION

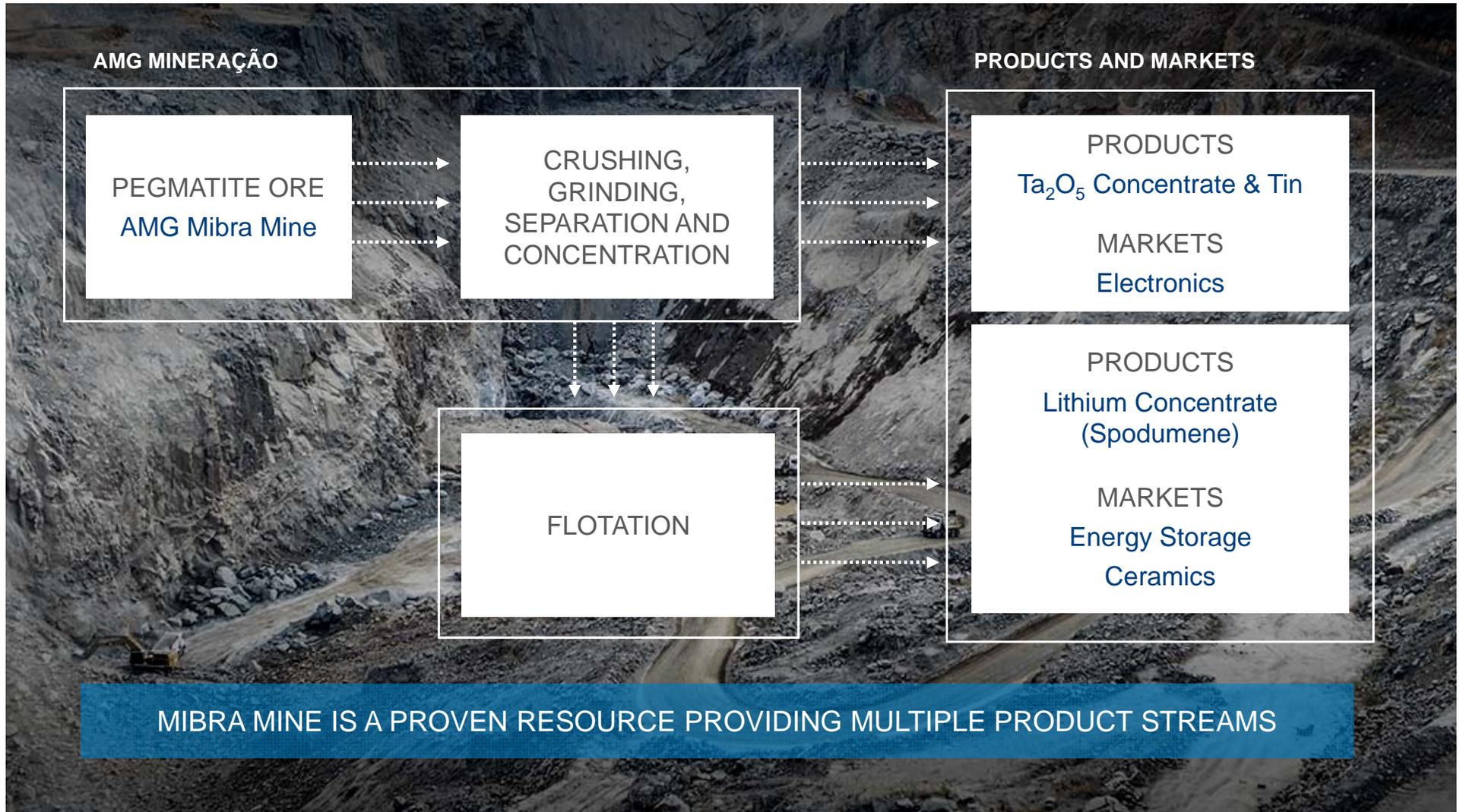


AMG’s mining operation in Brazil is located in Minas Gerais State, near the city of Nazareno

Approximately 225 km Northwest of Rio de Janeiro and 130 km Southwest of Belo Horizonte

Approximately 300 km from Port of Santos, most important port in Brazil together with Rio de Janeiro

# MIBRA MINE – PRODUCTION PROCESS OVERVIEW



# MIBRA MINE – MINERAL RESOURCES

Source	MT Material (ore/Tailings)	% Li <sub>2</sub> O Contained	MT Li <sub>2</sub> O Contained in Ore	MT LCE Contained	MT Li <sub>2</sub> O Contained in Spodumene Concentrate	MT Spodumene Concentrate
Ore source – 2013	19,360,000 <sup>1</sup>		146,363	361,019	90,745	1,463,630
Less consumption	3,214,584 <sup>3</sup>		15,517	38,274	9,620	155,167
Net Ore Balance	<b>16,145,416 <sup>2</sup></b>	<b>0.81%</b>	<b>130,846</b>	<b>322,745</b>	<b>81,125</b>	<b>1,308,463</b>
Tailings-Ponds 1&2 <sup>4</sup>	2,070,110	1.00%	20,701	51,061	13,870	223,705
Net Ore & Tailings Ponds	<b>18,215,526</b>		<b>151,547</b>	<b>373,807</b>	<b>94,994</b>	<b>1,532,168</b>
Tailings-Stockpiles <sup>4</sup>	750,000	1.15%	8,625	5,779	5,779	93,206
Total Resources	<b>18,965,526</b>		<b>160,172</b>	<b>379,586</b>	<b>100,773</b>	<b>1,625,374</b>

## RESOURCE EXPANSION – OBJECTIVES

- Update new resource in the west area of the mine, not included in 2013 resource statement
- Upgrade existing mineral resources from Inferred to Indicated and / or Indicated to Measured
- Exercise to be completed 1H 2017



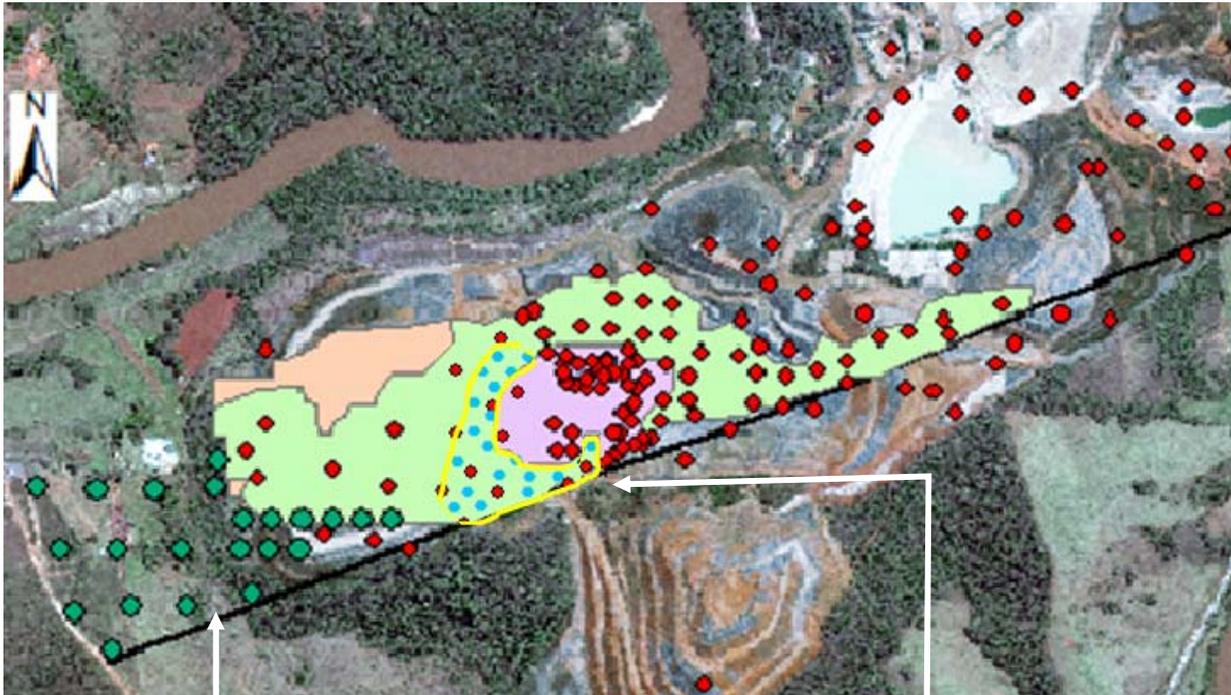
<sup>1</sup> Ore balance per 2013 NI 43-101 Statement

<sup>2</sup> Prior to resource expansion

<sup>3</sup> AMG estimate of ore consumed in Ta and Feldspar production; residual quantities to tailings ponds

<sup>4</sup> Preliminary AMG estimates

# MIBRA MINE – MINE LIFE EXTENSION – DRILLING CAMPAIGN & RESOURCE EXPANSION



## Purpose & Benefits

Expand existing tantalum and lithium resources in Mibra

Upgrade existing mineral resources from 'Inferred' to 'Indicated' and / or 'Indicated' to 'Measured'

Extend useful life of mine

Comply with legal requirements of Mineral Right 831.043/2013 which requires exploration be conducted to maintain the license.

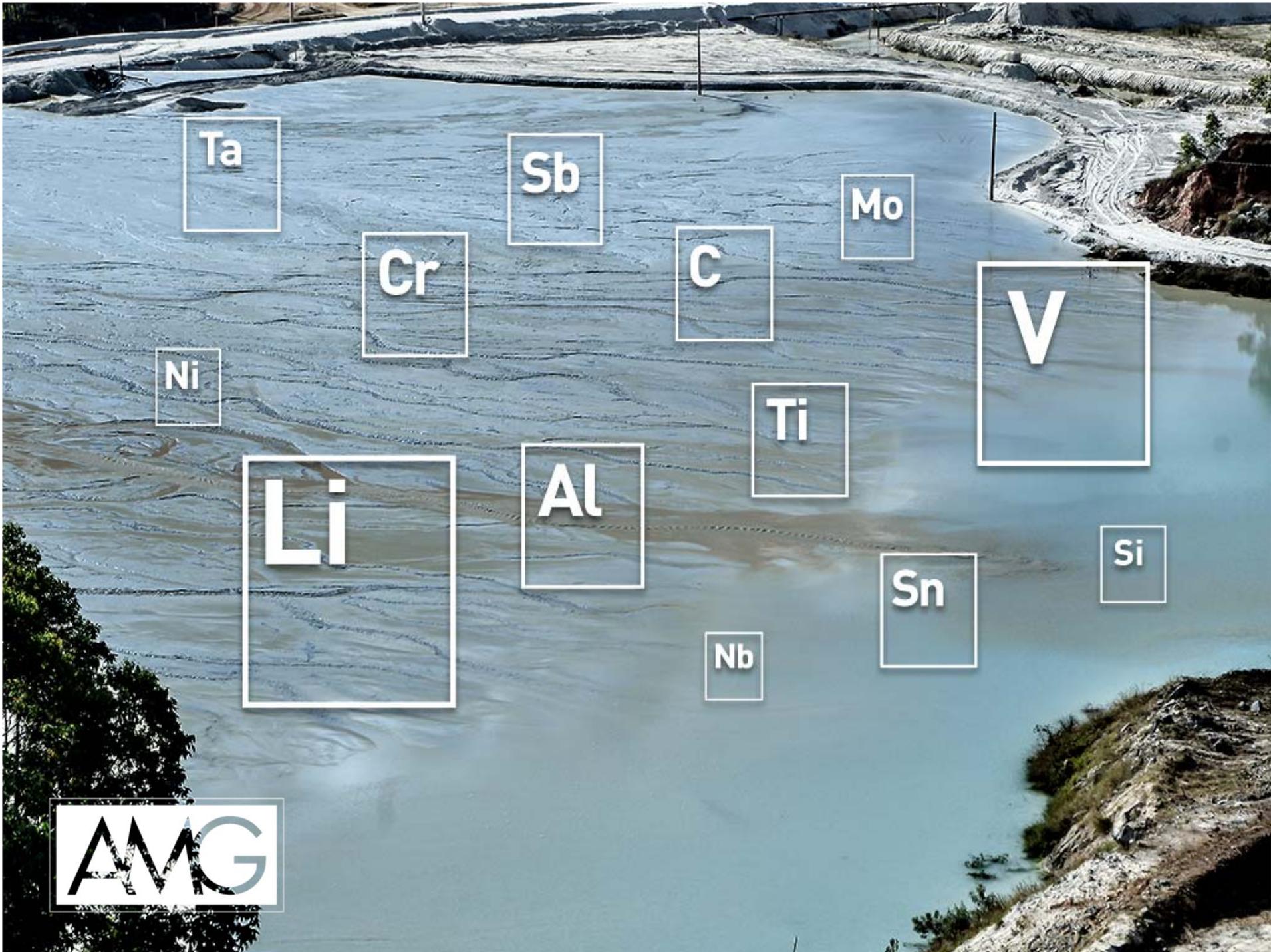
### Objective

Update new resource in the west area of the mine; not included in 2013 resource statement

### Objective

Upgrade existing mineral resources from 'Inferred' to 'Indicated' and / or 'Indicated' to 'Measured'

- Drill Plan- New Resource
  - Drill Holes Executed
- ORE A RESOURCE
- Measured
  - Indicated
  - Inferred



**AMG**