SUSTAINABLE DEVELOPMENT AND THE PRIMARY COPPER INDUSTRY– PAST, PRESENT AND FUTURE

Dr. Krishna Parameswaran

tfgMM Strategic Consulting

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PRESENTATION BASED ON

- Paper in the Proceedings of International Copper Conference 2019 hosted by the 58th Conference of Metallurgists (COM) 2019 .
- Papers in the Proceedings of Symposia at the First Global Conference of Extractive Metallurgy- Extraction 2018 at COM 2018 and Water, Air and Land: Sustainability Issues in Mineral and Metal Extraction (WALSIM) Symposium at COM 2015.

OVERVIEW OF PRESENTATION

- My career at ASARCO LLC (Asarco) is bookended between stints of consulting at Arthur D. Little Inc and tfgMM Strategic Consulting.
- How I was introduced to sustainable development at Asarco.
- Based on the classic Brundtland Commission definition of "sustainable development," discuss why, contrary to public perception, mining can be sustainable.
- Using select examples from ASARCO LLC (Asarco) past and current operations illustrate how primary copper production can be sustainable.
- Discuss how such sustainability considerations can be applied in the future.

PROFESSIONAL CAREER : OF SILK PURSES AND LEAD BALOONS

- My professional career started at Arthur D. Little Inc, a prominent engineering and Management consulting firm in Cambridge, Massachusetts in 1981.
- The company's founder Dr. Arthur Dehon Little, an MIT chemist believed that science and technology can solve society's problems.

“YOU CAN'T MAKE A SILK PURSE FROM A SOW'S EAR”

- In 1921, Dr. Little set about debunking the myth that you cannot make a silk purse from a sow's ear and entrusted the company's chemists to this project.
- They obtained pig's ears from a slaughterhouse in Chicago, chemically treated it and spun it into a silk-like yarn from which two silk purses were made.
- One is at the Smithsonian Museum in Washington DC and another displayed at the company's boardroom in Cambridge, Massachusetts.

THE GREAT LEAD BALLOON CONTEST.

- In 1978, During my tenure at Arthur D. Little we tried to disprove the adage that "you cannot fly a lead balloon," with the great balloon contest.
- There were three entries- the conventional design in the middle, the contrarian cube design on the right and the hybrid on the left.
- It was decided that since the contest would be covered by the networks (no cable TV at that time) it would be prudent to have a trial run before the main event.
- Employees watched the trial run on the company's parking lot on a Monday afternoon. The balloons were filled with helium. There was a sudden strong gust of wind and all three balloons came out from their tethers.
- The cube sprung a leak and came down right away. The hybrid took off and landed in nearby Cambridge. The conventional balloon took off in the direction of Logan airport in Boston.
- A call was placed to the airport authorities reporting an **identified** flying object. We are told that the strategic air command scrambled and chased the balloon till it landed in the Atlantic. **Punch Line:** There were no balloons to show to the TV networks.

HISTORY OF ASARCO LLC

- Organized in 1899 as the American Smelting and Refining Company.
- Started as a consolidation of lead-silver smelting companies.
- Evolved over the years to an integrated primary non-ferrous metals producer.
- Grupo México acquired Asarco in 1999.
- Is a wholly owned subsidiary of Americas Mining Corporation, a wholly owned subsidiary of Grupo México, S.A.B. de C.V, among the top five primary copper producers in the world.

ASARCO LLC TODAY

Is a major domestic integrated primary copper producer

- Open Pit Mines: Ray, Mission and Silver Bell in Arizona.
- Concentrators: Ray, Hayden and Mission in Arizona.
- Leach, SX-EW Plants: Ray and Silver Bell in Arizona.
- Smelter: Hayden Smelter in Arizona.
- Refinery: Amarillo Copper Refinery in Texas.

Products

- Copper Rod, Cathode and Cake and associated co-products (gold, silver, selenium and tellurium).
- Sulfuric Acid.

MY INTRODUCTION TO SUSTAINABLE DEVELOPMENT

"The 21st Century: Challenges and Opportunities for the Mining Industry," in Proceedings of International Symposium on Environmental Management of Mining and Mineral Industries (EMOMAMI-' 98), Natural Resources Development Foundation and Institute of Advance Technology & Environmental Studies, Bhubaneshwar, India, pp. 87-91.

DEFINITION OF SUSTAINABLE DEVELOPMENT

" Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Source: World Commission on Environment and Development "Our Common Future" 1987 (also known as the Brundtland Commission Report)

IS MINING SUSTAINABLE?

- Mining in this presentation includes mining, beneficiation, smelting and refining.
- At first blush it appears mining may be incompatible with sustainable development.
- Commentator in a financial journal in the early 1990s noted that industrial development was fully compatible with sustainability, "except for mining".
- Others have considered the concept of sustainable development as applied to mining an oxymoron.

REASON FOR SUCH VIEWS

- No single mine can operate forever. Mineral resources are finite and non-renewable.
- Historic mining practices, that are no longer acceptable, have had negative impacts on the environment.

WHY THIS VIEW IS INCORRECT

- Mining is important for the industrial and economic development of many countries.
- Every item of commerce must be produced from something that is mined or grown.
- Sustainable development or for that matter any development not based to some degree on mining is impossible.
- Sustainability incorporates more than continuing availability of the resource. Because mining will end some day, it makes integration of sustainability considerations even more important.

SOME EXAMPLES OF MINES WITH LONG LIVES

- Kennecott Utah Copper Division: Bingham Canyon Mine, operating since 1906.
- During this period the mine has produced well over:
  - Copper 19.5 million tons;
  - Gold 27 million troy ounces;
  - Silver 240 million troy ounces;
  - Molybdenum 1.1 billion pounds.
- Asarco's Ray Mine and Hayden Concentrator celebrated their centennial in 2011 and Hayden Smelter in 2012.
- Freeport-McMoRan's Chino mine started open-pit operations in 1910 and concentrator in 1911.

RECYCLING OF METALS

- Many metals once produced are capable of being recycled, smelted time and again to their original elemental form and refined to demanding specifications:
  - Over 95% of gold ever produced is still in existence
  - Over 60% of the silver mined is still in use
  - Two-thirds of the copper mined since 1900 is still in use
  - Nearly 75% of aluminum produced is still in use
  - Europe and America have a lead acid battery rate exceeding 99%
- Recycling can conserve energy since recycling processes are much less energy intensive than the primary metals production processes.

Recycling is an important attribute of sustainability.

HOW MINING CAN BE SUSTAINABLE

- As demand for metals rise, so do proven and probable resources:
  - Exploration: adds to the resource base.
  - Advances in technology – Froth Flotation, Leach SX-EW of copper ore and Flash and Bath Smelting
- Metals through recycling are infinitely renewable.

MINING IS SUSTAINABLE

- When it is conducted in a manner that balances economic, environmental and social considerations -- often referred to as the " triple bottom line," or the 3 Ps-Profit, Planet and People.
- Sustainable mining practices are those that promote this balance.
- These practices begin with exploration through mine and facility development, operations to eventual closure and reclamation.

PAST PRACTICES

Although the term sustainable development had yet to be coined, primary copper producers like Asarco applied economic, environmental and social considerations in their business decisions for well over a century.

- Company implemented an employee pension plan, conducted research on effect of pollutants on crops and established a health and safety committee early in the 20th century.
- Pioneer in developing and implementing air pollution control technologies in the first half and innovative water pollution in the latter half of the 20th century.
- Developed in the 1980s the Asarco shaft furnace, an efficient copper melting furnace and reatrol technology to improve current efficiency and cathode quality.
- Exploration and development of the Troy mine and Rock Creek project in Northeastern Montana and the Camp Caiman gold exploration project in French Guiana.
- Innovative reclamation techniques such as the use of cattle and biosolids.
- Implementation of INCO Oxygen Flash Smelting at the Hayden Smelter in 1983.

CURRENT PRACTICES

- In the next three slides, I will list examples of current sustainable practices at Asarco's operations, covering mining and beneficiation, including reclamation, smelting and refining.

MINING AND BENEFICIATION INITIATIVES

Reducing groundwater use at the Mission Complex

- Since 2009, Asarco has been using CAP water for its mining and mineral processing operations at the Mission Complex .
- CAP water consumption has represented 48-62% of the water consumption.

Renovation of pumping station at the Hayden well fields and booster pump installation at Ray

- Savings in water and electricity usage and rebate for energy conservation from the utility.
- Improved control of water system leading to greater use of reclaim water.

Tailings Dams and Waste Rock Facility Reclamation Project at the Mission Complex

- Reclamation project completed in 2012 as a collaboration between Asarco and the San Xavier District of the Tohono O'odham Nation.

Avalon Solar Project

- The Pima County Solar Generation Facility also known as the Avalon Solar Project is a utility-scale 57-megawatt (MW) single-axis tracking photo-voltaic (PV) facility. Hosted by Asarco it is located on 500 acres of disturbed lands in Pima County near the Mission Complex.

SMELTING INITATIVES

Anode Furnace Ventilation Project

- In response to the reduction in ambient lead standards in 2008, project completed in 2012/2013 .
- Project resulted in 88-92% reduction in particulate matter, 85-97.5 % reduction in hazardous air pollutants and 13% reduction in natural gas savings and associated greenhouse gas reduction.

Converter Retrofit Project

- In response to lowering of the sulfur dioxide ambient air quality standard in 2010, project completed in 2018.
- Project increases sulfur capture at the smelter to over 99%.

Mining and Smelter Waste Utilization

- Alkaline treatment of tailings and flash furnace smelter slag to produce a geopolymer as substitute for ordinary Portland cement.
- Study conducted with the University of Arizona Civil Engineering Department indicates the resulting geopolymer could be a sustainable construction material.

REFINERY INITATIVES

Application of green chemistry in copper electrorefining at the Amarillo Copper Refinery (ACR)

- Molecular Recognition Technology for bismuth control in copper electrolyte.
- Acid Purification Unit to recover sulfuric acid and arsenic from bleed electrolyte .
- With anode slimes processing moved to Mexico along with selenium and tellurium, recovery some of the remaining tellurium as copper telluride.

Product Stewardship at ACR

- Replace wooden pallets with recyclable high-pressure plastic pallets.
- 75% of the wooden pallets had to be replaced after one use. Plastic pallets could be used 3-7 times before they had to be returned to the manufacturer for recycling resulting in zero waste.

LOOKING AT THE FUTURE

- One issue that has risen to the forefront is the safety and management of tailings dams driven by catastrophic failures of tailings dams, the most recent in Brazil in January 2009.
- Stakeholders including investors are asking for global standards.
- This will need serious attention from the industry in coming years.

EMERGING TRENDS

The metals mining industry has been and will continue to be an essential contributor to the economic and social development of nations endowed with mineral resources.

- Population expected to grow from 7.6 to 9.6 billion by 2050 with increasing per capita consumption. Applying sustainability considerations becomes even more important.
- While demand for minerals will grow, several factors will determine which companies will succeed. Among these are:
  - Transition to a low-carbon economy.
  - Social contract for mining.
  - Modern mining workforce.

EVOLUTION OF SUSTAINABILITY REPORTING

Mining companies have been publicly reporting sustainability performance for well over decade and a half.

- The reports and the underlying sustainability metrics have been useful as tools for self-assessment, assessment by rankers and in communicating the company's performance on environmental, social, economic and governance factors to its stakeholders. To a limited extent it has been useful in identifying sustainability targets for the future.
- There has been pressure from stakeholders on increased disclosures on the following:

  -Stakeholder inclusiveness.

  - Sustainability context

  - Materiality

  - Completeness

- Establishment of U.N. Sustainable Development Goals (SDGs):

  - 17 SDGs and 169 targets.

THE ROAD AHEAD

- In attempting to taking their sustainable development programs to the next level, mining companies need to determine if it is based on a coherent sustainable development strategy and , if not, develop one.
- Stakeholders i.e., communities, investors will continue to demand increased transparency and consultation regarding mining company actions as well as their governance mechanisms.
- Attempt to align strategy with U.N. sustainable development and targets that are consistent with the goals of the business.
- Seek strategic collaboration with other companies:

  - R&D partnership between RIo Tinto and Alcoa to develop ELYSIS™ technology, that will substitute conventional graphite Soderberg anodes with proprietary metal anodes which eliminates the direct greenhouse gases from carbon oxidation and instead produces oxygen as an anode reaction product.

THANK YOU

- Any Questions?
- Contact
  - Email: kparameswaran0346@gmail.com