Introduction to the Natural Environment Research Council

Dr Sarah Webb
Associate Director International
Introduction to NERC and UKRI
Who is NERC?

NERC’s Remit

Relevant Investments
Highlight of a selection of past and present strategic investments, relevant to this workshop

Conclusions
We work with the government to invest over £7 billion a year in research and innovation by partnering with academia and industry to make the impossible, possible. Through the UK’s nine leading academic and industrial funding councils, we create knowledge with impact.
Who is NERC?

UK’s largest funder of environmental science.

• The Natural Environment Research Council’s vision is to place environmental science at the heart of responsible management of the planet, to foster a productive, healthy and resilient environment.
• Taking a whole systems, solutions focused approach to tackling global challenges.
• We invest c.£330M each year in cutting-edge research, postgraduate training and innovation in UK universities and research centres
Who is NERC?

We Support…

• 3,000 scientists and 1,000 PhD students
• 1,000 research projects and 60 UK or international programmes
• 55 universities and 20 research institutes
• UK national capability: 4 ships, 7 aircraft, 6 polar stations, 6 data centres, 32 community facilities
NERC Remit

• NERC scientists study the whole planet, across the breadth of environmental science including terrestrial, marine, freshwater, earth science, atmospheric and polar sciences.
• Our research is increasingly multi- and interdisciplinary.
• We fund strategic research that addresses key societal challenges, helping business, government and society benefit from natural resources, build resilience to environmental hazards and manage environmental change.
Relevant NERC Investments
There are several current past and present NERC investments that are relevant to this area.
Minerals/Mining

Security of Supply of Mineral Resources

- 2011-2019, £12m total funding (NERC, EPSRC, FAPESP)
- Funded a number of catalyst proposals, and four large consortium grants:
  - SoS RARE
  - Cog 3
  - Marine E+tech
  - Tease
- The programme involved collaboration between academics and over 50 industrial partners
- Funded more than 20 universities and research organisations, 24 postdoctoral research associates and 17 PhD researchers
Minerals/Mining

Security of Supply of Mineral Resources (continued).

• The programme aim was to enhance global security of supply of e-tech elements in two ways;

  1) Improved understanding of e-tech element cycling and concentration in natural systems

  2) To use this information to develop improved recovery processes from primary sources in order to mitigate the environmental effects and impacts of extraction and recovery of e-tech elements.
Air Quality

Clean Air Programme

• **Wave 1** - Develop actions to reduce the health impacts of air pollution on the most vulnerable parts of society, (£20.5m)

• **Wave 2** - to proactively tackle new and emerging air quality challenges related to changes in the types of air pollutants emitted with regards to exposure patterns and impacts on vulnerable groups. (£22m)
Ecosystem Services

ESPA – Ecosystem Services for Poverty Alleviation

- Improved understanding of how ecosystems function, the services they provide, the full value of these services, and their potential role in achieving sustainable poverty reduction
- 2009-2018, £42.5m (NERC, ESRC, DfID)
  - Projects included research in the following relevant areas:
    - Trace metal pollution and human health effects of contaminants
    - Artisan mining
    - Ecosystem trade-offs and tipping points
    - Water quality
India-UK Water Quality Programme

- NERC, EPSRC, DST (India)
- 2017-2021
- £4.2m
- Research focused on improving water quality by providing a better understanding of the sources and fate of different pollutants, and supporting the development of management strategies and technologies to reduce pollution levels.
Conclusions

• The NERC (UK) community brings with it a wealth of interest and experience in many areas relevant to this workshop – we are excited to discuss!

• Thank you (in advance) for your engagement!
Philippine Council for Industry, Energy, and Emerging Technology Research and Development (PCIEERD)

UK-Philippines Minerals and Mining Scoping Meeting
Hotel Astoria, Puerto Princesa, Palawan
3-5 March 2020

Dr. Enrico C. Paringit
Executive Director
DEPARTMENT OF SCIENCE AND TECHNOLOGY

DOST OFFICE OF THE SECRETARY

SECTORAL PLANNING COUNCILS (3)
- PCAARRD: Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development
- PCIEERD: Philippine Council for Industry, Energy and Emerging Technology Research and Development
- PCHRD: Philippine Council for Health Research and Development

R&D INSTITUTES (7)
- ASTI: Advanced Science and Technology Institute
- FNRI: Food and Nutrition Research Institute
- FPRDI: Forest Products Research and Development Institute
- ITDI: Industrial Technology Development Institute
- MIRDC: Metals Industry Research and Development Center
- PNRI: Philippine Nuclear Research Institute
- PTRI: Philippine Textile Research Institute

S&T SERVICES (6)
- PAGASA: Philippine Atmospheric, Geophysical and Astronomical Services Administration
- PHIVOLCS: Philippine Institute of Volcanology and Seismology
- PSHSS: Philippine Science High School System
- SEI: Science Education Institute
- STII: Science and Technology Information Institute
- TAPI: Technology Application and Promotion Institute

COLLEGIAL AND SCIENTIFIC BODIES (2)
- NRCP: National Research Council of the Philippines
- NAST: National Academy of Science and Technology

REGIONAL OFFICES (16)

PROVINCIAL S&T CENTERS (80)
The Philippine Council for Industry, Energy, and Emerging Technology Research and Development (PCIEERD) is one of the three sectoral planning councils of the Department of Science and Technology (DOST).
Our Mandate

- Support for Research and Development
- Human Resource and Institution Development
- S&T Information Dissemination and Promotion
- Support for Technology Transfer and Commercialization
- Policy Development and Advocacy
Our Sectoral Coverage

INDUSTRY
- Electronic & Semiconductor Industries
- Mining & Minerals
- Metals & Engineering
- Food Processing
- Process

ENERGY
- Energy efficiency
- Transportation

EMERGING TECHNOLOGY
- Materials Science/Nanotechnology
- Genomics/Biotechnology
- Information & Communications Technology
- Space Technology Applications
- Photonics
- Artificial Intelligence
- Data Science
- Creative Industries

SPECIAL CONCERNS
- Climate Change Adaptation
- Disaster Risk Reduction & Management
- Environment
- Human Security
Funding Mechanism for R&D

PCIEERD - GIA
- below 50M
- Research is aligned to the roadmap/priority researches of the sectors

DOST-GIA
- 50M and above
- Research is aligned to the roadmap/priority researches of the sectors

Science for Change Program (S4CP)
- Research should be on R&D capacity building and improvement of industry competitiveness in the regions

Technology Innovation for Commercialization (TECHNICOM)
- R&D projects towards market-readiness and commercialization of locally-developed technologies

Small Enterprise Technology Upgrading Program (SETUP)
- enables firms to address their technical problems through technology transfer and technology interventions
MINING AND MINERALS SECTOR

MINERALS

METALLIC

NON-METALLIC

Program for Value-adding of Metallic Minerals
- Gold
- Copper
- Nickel
- Iron
- Chromite

Program for Rare Earth Elements (REE)
- Scandium
- Yttrium
- Lanthanide Series

Program for the Rehabilitation of Mined Area
- Acid Mine Drainage
- Tailings
- Wastewater
- Biodiversity
- Waste utilization

Program for Value-adding of Non-Metallic Minerals
- Construction Minerals
- Industrial Minerals
- Precious Gems

EXPLORATION
MINING
BENEFICIATION
PRODUCT DEVELOPMENT
REHABILITATION
NICKEL PROJECTS

Exploration of Rare Earth Elements (REEs) from Laterite Ores (completed)

- Full mineralogical, sedimentological and geochemical characterization of nickeliferous laterite deposits

Pilot Scale Production of Nickel Pig Iron from Low Grade Laterite Ores (on-going)

- Pig iron as raw material for steel

Recovery of Nickel, Cobalt, Iron and Rare Earth Elements (REEs) (new)

- Application for current and future green energy technologies

3R Approach to Sustainable Management of Nickel Laterite Ore Tailings (on-going)

- Bricks for industrial application
- WWT for AMD treatment

DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE COUNCIL FOR INDUSTRY, ENERGY, AND EMERGING TECHNOLOGY RESEARCH AND DEVELOPMENT (DOST-PICEERD)

INNOVATION COUNCIL
FOR INDUSTRY, ENERGY AND EMERGING TECHNOLOGIES (DOST-PCIEERD)
IRON PROJECTS

Baseline data for possible local extraction and a contribution to downstream processing of Philippine ores.

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Blacksand (iron magnetite sand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasible Process</td>
<td>Rotary Kiln Electric Arc Furnace (RKEF)</td>
</tr>
<tr>
<td>Existing Plant</td>
<td>New Zealand Steel</td>
</tr>
</tbody>
</table>
**GOLD PROJECTS**

**Putting-up of Non-mercury, Non-cyanide Gold Extraction Facility for Small-scale Miners (on-going)**

- Benguet
- Camarines Norte
- Agusan del Norte
- Iligan
- Compostela Valley

**Resource Assessment of REEs in the Porphyry and Epithermal Cu-Au-Mo Deposits in Nueva Vizcaya (new)**

- Three-dimensional presentation of the REE ore body in Didipio and Run runo deposits

**Geopolymerization and its Potential Application in Artisanal Gold Mine Tailings Stabilization (completed)**

- Utilization of mercury contaminated tailings to produce bricks using geopolymerization technique
OTHER PROJECTS OF PCIEERD
One-stop Laboratory Services for Global Competitiveness (OneLab)

- a network of laboratories anchored on an IT Platform to provide a referral system for testing and calibration services at a single touch point.

OneLab Services for the Mining Sector

- Advanced Device and Materials Testing
- Metrology and Calibration Services
- Mechanical Metallurgy Services
- Biochemical Testing
- Corrosion Testing
- Formula of Conversion
- Organic Chemistry Testing

- Inorganic Chemistry Testing
- Instrumentation Testing
- Non-Destructive Testing
- Nuclear Analytical Techniques Application Services
- Gamma or Electron Beam Irradiation Services
- Physical and Performance Testing
- Radiation Protection Services
Advanced Manufacturing Center (AMCen)

A user access facility featuring two state-of-the-art research facilities set to spur interest in Additive Manufacturing Research, namely:

- Multiple Materials Platform for Additive Manufacturing (MATDEV)
Advanced Device and Materials Testing Laboratory (ADMATEL)

- A DOST national testing laboratory established to reinforce and upgrade the failure analysis and materials testing facilities of our local industry, provide a shorter turnaround time for analysis at competitive cost of services, and to entice potential investors seeking for a more conducive business environment.
Projects on Plasma & Coatings

- Development of a Low-Energy Ion Source System for the Synthesis of Diamond-like Carbon Films of University of the Philippines Diliman

- Hard Coating Thin Film Synthesis Using DC and RF Magnetron Sputtering via Gaseous Discharges

- Fabrication of Metal Oxide Thin Films for Optical Coatings with Plasma Assisted Deposition Using a Plasma Enhanced Chemical Vapor Deposition (PECVD) System of Ateneo de Manila University
Functional & Innovative Materials

*Electrochemical and Quantum Mechanical Investigation of Various Small Molecule Organic Compounds as Corrosion Inhibitors in Mild Steel*

Employs a computational and experimental approach in finding potential small molecule organic compounds that have high corrosion inhibition properties. Computational studies via quantum mechanical calculations will be carried out to design new small molecule organic compounds (SMOC) which can be used as corrosion inhibitors.

The compounds resulting from the computations will then be prepared or synthesized and its corrosion inhibition efficiency will then be measured via electrochemical measurements. Quantum mechanical calculations will then be employed to study the interactions of steel surface and organic compounds which have high corrosion inhibition efficiency.
PCIEERD-supported Projects on Space Technology Applications
Strategies for Space Industry Development

- Creation of Space Industry Development Agenda
- Joint projects of the academe-government-industry
- Incentive programs for the academe and industry
- Offering of high-value products and services locally and abroad
PHL-Microsat

Developed in-house capabilities in UP EEEI for local design, assembly and testing of key components from Diwata-2. Engaged PNRI, EPDC, ADMATEL, PTRI and NSB Engineering.

STAMINA4Space

Formal partnerships with local industries to work together and exchange best practices in furthering mastery, innovation and advancement in space technology.
Space Technology and Applications Mastery, Innovation and Advancement (STAMINA4Space) Program

Program Leader: Dr. Joel Joseph Marciano, Jr.
DOST-ASTI - Acting Director

SATELLITE TECHNOLOGY RESEARCH & DEVELOPMENT

Project 1
Optical Payload Technology, in-depth Knowledge Acquisition and Localization (OPTIKAL)
Dr. Maricor Soriano
Project Leader
Affiliation: UP NIP

Project 2
Building PHL-50: Localizing the Diwata-1 and Diwata-2 Bus System as the Country’s Space Heritage 50kg Microsatellite (PHL-50)
Dr. Marc Caesar Talampas
Project Leader
Affiliation: UP EEEI

UP NIP, UP TCAGP
Implementing Institution

UP EEEI
Implementing Institution

TECHNOLOGY & KNOW-HOW PROLIFERATION

Project 3
Space Science and Technology Proliferation through University Partnerships (STeP-UP)
Engr. Paul Jason Co
Project Leader
Affiliation: UP EEEI

UP EEEI
Implementing Institution

OPERATION AND DATA PRODUCTS

Project 4
Ground Receiving, Archiving, Science Product Development and Distribution (GRASPED)
Dr. Joel Joseph Marciano, Jr.
Project Leader
Affiliation: DOST-ASTI

DOST-ASTI, UP TCAGP, UP IESM
Implementing Institutions
Future collaboration with the Philippine Aerospace Industries

Semiconductor / Electronics
- Electronics manufacturing and laboratory services
- Failure analysis and materials characterization
- Electro-hydraulics and electro-mechanical actuation systems
- Electronics – PCB Assembly
- OSAT, RF, Microwave, Millimeter wave assembly and test
- Software

Materials / Machining / Tooling
- Machining
- Sheet metal fabrication
- Furnishing / Fixtures for commercial aircrafts
- Toolings
- Aluminum extrusions
- Surface finishing
- Aerospace materials (aluminum and metal sheets)
- Surface treatment, chemicals and metal working fluids
Data Science and Remote Sensing: DATOS Helpdesk

Capitalizes on current computing technology advancements to provide maps and other information for Disaster Risk Reduction applications. These advancements include:

- Geographic Information Systems (GIS)
- Remote Sensing (RS)
- Artificial Intelligence (AI)
- Data Science
Computing and Archiving Research Environment (CoARE)

Targets to enable multiple data integration from various data sources coming from the Advanced Science and Technology Institute’s (ASTI) deployed weather-related sensors, the Philippine Atmospheric, Geophysical and Astronomical Services Administration's (PAGASA) doppler radar, and other data sources from complementing projects.

Data Integration
Philippine Earth Data Resource and Observation Center (PEDRO)

Targets to enable multiple data integration from various data sources coming from the Advanced Science and Technology Institute’s (ASTI) deployed weather-related sensors, the Philippine Atmospheric, Geophysical and Astronomical Services Administration’s (PAGASA) doppler radar, and other data sources from complementing projects.
Integrated and Intelligent Sensors and Actuators (IISA) Program

Integration of Intelligent Sensor Networks, coupled with AI, to improve existing systems and/or develop new services and breakthroughs in science such as, but not limited to:

- Internet of Things Platform for Traffic Management, Human Security, Disaster Management
- Smart Cities
- Smart Buildings
- Smart Homes
- Intelligent Factories

AI Robot developed by DOST - ASTI and Dr. Jose Ildefonso Rubrico, a BSP Awardee
Artificial Intelligence and Data Science Program

- Provides a more general framework of processing remote sensing data using state-of-the-art Artificial Intelligence (AI) techniques
- Maximizes usage of fast growing government data by leveraging AI/deep learning methodologies
- Provides a scalable middle ground for various applications
- Develops an Artificial Intelligence (AI) robot that will help in intelligent factories
Capability Building in Artificial Intelligence through Training and Acquisition of High-Performance Computing Device

The project aims to acquire high performance deskside technology and systems and train at least 20 professionals from the AI Pinas participants for the enhancement and evolution of the AI supercomputing capability for research and development. It also aimed to produce several AI funded projects from the trained participants.

Enhancing Man-Machine Interaction through Intelligent Conversational Agents

Involves the design of a dialogue model that will enable a conversational agent or chatbot to enrich its conversation with children through the use of stories.
Retailgate

Retailgate is a Filipino tech startup that harnesses the power of Artificial Intelligence to help brick-and-mortar retailers remain competitive through retail analytics, actionable insights, and data-driven strategies. Through its services, RetailGate is able to gather in-store consumer behavior data and identify actionable insights, allowing us to help retailers make better decision on managing operations, driving more purchases, and increasing profitability.
CATCH ALL
Contactless Apprehension of Traffic Violators on 24-hours Basis, All Vehicle Detection System

Retailgate is a Filipino tech startup that harnesses the power of Artificial Intelligence to help brick-and-mortar retailers remain competitive through retail analytics, actionable insights, and data-driven strategies. Through its services, RetailGate is able to gather in-store consumer behavior data and identify actionable insights, allowing us to help retailers make better decision on managing operations, driving more purchases, and increasing profitability.
Follow us on social media!

/dostpcieerd

@dostpcieerd

@dostpcieerd

/pinoyscience
Thank you!
Aims and Objectives of the Workshop

Dr Sarah Webb
Associate Director International
Aims of the Workshop - 1

To clearly articulate the challenges affecting the Philippines in the mining sector, and identify the gaps and opportunities for a research programme to help to address these challenges.

- The first half of day 1 is dedicated to starting to understand the challenge, and the opportunity for new investment in this space, but this theme will continue throughout the programme.

- *Listen, absorb, and start to think!*
Aims of the Workshop - 2

To define the scope of a potential new UK-Philippines programme:

• The impacts of past/current mining practices
• The abiotic and biotic factors that inform mining practice
• New, innovative, less invasive techniques and practices for mineral discovery, processing and extraction
• The evidence and data needed to inform policy and regulatory decisions on the sustainability of mining in the Philippines.
Aims of the Workshop - 3

To facilitate links between the UK and Philippines research communities in the area of natural environment research and new technology development.

• There will be a lot of conversation

• There will be time to network and form new links as part of the workshop

• We will ask for your inputs in how we might shape a new collaboration, and how we might best facilitate these links
Rules of Engagement

• There are a number of representatives from the NERC and PCIERRD who are running the workshop. We will be facilitating the day and are here to help – please ask!

• The agenda is full – we will need to stick to time

• Please attend all sessions if possible

• Enjoy yourselves
Questions?
THE PHILIPPINE MINING INDUSTRY: Nowhere to Go But Up

Atty. Ron S. Recidoro
Executive Director,
Chamber of Mines of the Philippines
## The Philippines’ Estimate Mineral Inventory

<table>
<thead>
<tr>
<th>Mineral Commodity</th>
<th>Volume of Mineral Resource (in MT)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ORE</td>
<td>MINERAL CONTENT</td>
</tr>
<tr>
<td>Copper</td>
<td>8.0 billion</td>
<td>74.7 million</td>
</tr>
<tr>
<td>Gold</td>
<td>4.9 billion</td>
<td>6,700</td>
</tr>
<tr>
<td>Nickel</td>
<td>811.6 million</td>
<td>10.2 million</td>
</tr>
<tr>
<td>Iron</td>
<td>480.3 million</td>
<td>177.8 million</td>
</tr>
<tr>
<td>Aluminum</td>
<td>433.9 million</td>
<td>119.7 million</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>306 million</td>
<td>245,000</td>
</tr>
<tr>
<td>Chromite</td>
<td>39.7 million</td>
<td>8.8 million</td>
</tr>
<tr>
<td>Mercury</td>
<td>18.3 million</td>
<td>1.1 million</td>
</tr>
<tr>
<td>Zinc</td>
<td>13.3 million</td>
<td>328,000</td>
</tr>
<tr>
<td>Manganese</td>
<td>2.7 million</td>
<td>1.2 million</td>
</tr>
</tbody>
</table>
METALLIC MINING INDUSTRY: FACTS AND FIGURES

LARGE-SCALE METALLIC MINING INDUSTRY¹

Mines:
- Nickel: 17
- Gold: 6
- Copper: 3
- Chromite: 1

Plants:
- Nickel HPAL: 2
- Gold: 2
- Copper Smelter: 1

¹ From MGB (2017). Processing plant statistics are captured under Manufacturing.

EXPOERTS *

$4.04B – 5.9% OF TOTAL EXPORTS
(includes exports from plants)

GDP*

P146.2B – 0.84% OF TOTAL GDP
(excludes contribution of plants)

TAXES*

P25.9B - 1.01% OF TOTAL TAXES
(excludes taxes from from plants)

EMPLOYMENT*

180,000 – 0.43% OF TOTAL WORKFORCE
(excludes workforce in plants)

2 It is estimated that about 8 mines are currently not operating.
3 It is estimated that about 2 mines are currently not operating.

* Source: PSA, 2018 figures
While the national impact of mining is small, in certain regions that host large-scale mining, the impact is large (% contribution of mining to Regional GDP)*:

<table>
<thead>
<tr>
<th>Region</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV B MIMAROPA</td>
<td>29.0</td>
</tr>
<tr>
<td>XIII CARAGA</td>
<td>22.1</td>
</tr>
<tr>
<td>VI Western Visayas</td>
<td>13.7</td>
</tr>
<tr>
<td>I Ilocos</td>
<td>5.6</td>
</tr>
<tr>
<td>II Cagayan Valley</td>
<td>4.8</td>
</tr>
</tbody>
</table>

The impact is particularly evident in the wealth created in municipalities that host large-scale mining:

<table>
<thead>
<tr>
<th>Type of Metal</th>
<th>Municipality/Province</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICKEL:</td>
<td>Bataraza, Palawan</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Sta. Cruz, Zambales</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Quezon, Palawan</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Narra, Palawan</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Claver, Surigao del Norte</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Cantilan, Surigao del Sur</td>
<td>1st</td>
</tr>
<tr>
<td>GOLD:</td>
<td>Aroroy, Masbate</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Mankayan, Benguet</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Siocon, Zamboanga del Norte</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Maco, Compostela Valley</td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>Bunawan, Agusan del Sur</td>
<td>1st</td>
</tr>
<tr>
<td>COPPER:</td>
<td>Tuba, Benguet</td>
<td>1st</td>
</tr>
</tbody>
</table>

* Contribution of Mining (includes Quarrying) to Regional GDP in Percent – Top Five Regions. Source: Phil Statistics Authority
THE METALLIC MINING INDUSTRY: FACTS AND FIGURES

- The contribution of large-scale metallic mining to the development of host communities in remote areas becomes even evident when the following are considered:

**LGU TAXES**
- Php5.4B* in taxes & fees to LGUs

**SOCIAL DEVELOPMENT**
- Php1.7B on mandated expenditures to host communities

**IP ROYALTIES**
- Php300M+ on royalty payments to IPs in ancestral domains

**MULTIPLIER EFFECT**
- Direct employment: 18,000
- Indirect employment: 720,000 (4X)

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Source: EITI 2016 Country Report

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Source: MGB, 2018

*P2.9B in direct taxes and fees
P1.9B in share of Excise Tax
P0.6B in share of Royalties in Mineral Reservations

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MGB Estimate
Mining’s Footprint

- The 43 operating large-scale metallic mines occupy less than 10,000 hectares of the country’s 30 million hectare land area (0.03%);

- Future mining projects in the pipeline will only take up an additional 10,000 hectares;

- With mining contributing Php146.2 billion to GDP, mineral lands have a production value of nearly Php490 million per hectare, compared to agricultural lands at Php115,000/ha.
Production Values

- In 2017, the mining industry produced P176.3 billion worth of minerals, and contributed P135 billion (0.85%) to Philippines GDP;

- Mining activities are currently concentrated in only 13 provinces: Benguet, Zambales, N. Vizcaya, Palawan, Masbate, E. Samar, Leyte, Cebu, Agusan del Norte, Surigao del Norte, Surigao del Sur, Dinagat Islands, and Compostela Valley.

- In MIMAROPA - Region 4B and CARAGA - Region 13, the mining industry contributes approximately 25% of their regional GDP.
So what’s the problem?

- **Policy uncertainties abound.** Since 2011, government has not actively pursued investments in minerals development, focusing instead on reviewing the fiscal regime for mining;

- **EO79 (2012)** Moratorium on new mining permits until a new mining tax regime is legislated. In the TRAIN 1 package of tax reforms, the excise tax on mining has doubled from 2% to 4% of gross output. The MICC has stated that such increase is not enough to recommend the lifting of the moratorium.

- **DENR AO 2017-10:** Ban on open pit mining, instituted during the time of the former DENR Secretary, but currently remains in place.

- **MINE CLOSURES ORDERED BY SEC. GINA LOPEZ.** Over 20 mines were served with closure orders following an audit. With closure orders on appeal, these mines continue to operate, albeit under a cloud.

- **LEGACY MINES:** Quite a number of old, closed-down mines have not undergone rehabilitation. Although belonging to a different era, they remain as points of attack for the anti-mining groups.
So what’s the problem?

• The three years of the Duterte administration have been a mixed bag for the mining industry. The DENR and MGB have yet to come out with a clear policy to promote and reinvigorate investments in the mining and minerals processing sector.

• SINGLE VIEW OF THE INDUSTRY: No distinction among the general public of the difference between the formal large-scale sector and the largely illegal small-scale, another contributor to the poor image of the industry.

• PERCEPTION THAT THE INDUSTRY IS NOT PAYING ENOUGH TAXES. As a result, the DOF and Congress have pushed for an overhaul of the fiscal regime for mining, proposing a new royalty and windfall profits tax.

• As a result, the Philippine mining industry is now in deep freeze. No new mining agreements have been approved and even projects with approved ECCs and DMPFs have not moved forward.

• Investors have largely taken a wait-and-see posture, unwilling to risk their capital under such uncertain conditions.
A “Silver Lining”?

- Government’s thrust towards industrialization and its Build! Build! Build! Program will necessitate a strong mining industry;

- Roadmaps and development plans have been, and are still being crafted, for copper, iron and steel, and cement;

- Global commodities prices are slowly recovering and are on their way up from the lows of 2014-15; Philippine mines are relatively well-positioned to take advantage of increased demand;
• **Improve the standards for operating mines** through the adoption of international standards in mining operations, environmental protection, and social development;

• **Improve our data gathering and reporting capabilities** by pushing for sustainability and transparency reporting by all COMP members; *EITI Compliance and TSM implementation*;

• **Create and operationalize an Oversight Committee** within the Chamber of Mines with powers to investigate and recommend action on complaints against mining operations.

• **Enhance our SDMP and CSR activities** to encompass not just environmental protection and social development, but more relevantly, also address climate change resiliency and adaptation.

• **Improve our information education and communications campaigns** by better defining our publics and developing tailored messages for each.
INDUSTRY ACHIEVEMENTS AND INITIATIVES

• **WINNERS IN FIRST ASEAN MINERAL AWARDS** – Two Philippine mining operations, Nickel Asia’s Rio Tuba nickel mine and Oceana Gold’s Didipio copper concentrator plant, win in the first ever ASEAN Mineral Awards for best practices in sustainable mineral development and best plant, respectively, as voted by the ASEAN mining ministers (Nov. 2017). The best metallic mine and plant in ASEAN is in the Philippines!

• **FIRST COUNTRY TO ACHIEVE 2016 EITI STANDARDS** - The Philippines becomes the first country to achieve the 2016 Extractive Industries Transparency Initiative (EITI) Standard, as noted by the EITI International Board (Oct 2017). EITI is a global standard for good governance of extractive industries. It is a multi-stakeholder initiative composed of government, industry and CSOs and is being implemented in 51 countries.

• **FIRST COUNTRY IN ASIA TO ADOPT THE TOWARDS SUSTAINABILITY MINING (TSM) PROGRAM** - Members of the Chamber of Mines have agreed to implement the TSM program developed by the Mining Association of Canada, increasingly becoming a global standard for assessing performance and improving in sustainability mining practices.
Figure 1: Simplified sketch of the Santa Lourdes-Sitio Honda Bay area.
I. Objectives:
1. To determine the health impact of mercury and other heavy metals exposure to adults and children in these communities
2. To introduce preventive and treatment strategies to affected individuals
3. To empower local health personnel on the recognition of heavy metal poisoning secondary to exposure to mine tailings in these areas
### TABLE 1. Number of Patients seen.

<table>
<thead>
<tr>
<th>DATE EXAMINED</th>
<th>Number of patients</th>
<th>Brgy Sta. Lourdes</th>
<th>Brgy Tagburos</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>August 2018</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADULT</td>
<td>24 (Total of 58 to include those with missing data)</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>PEDIA</td>
<td>29</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>53</strong></td>
<td><strong>67</strong></td>
<td></td>
</tr>
<tr>
<td><strong>November 2018</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADULT</td>
<td>24</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>PEDIA</td>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>29</strong></td>
<td><strong>7</strong></td>
<td></td>
</tr>
</tbody>
</table>
After the March 2017 health assessment with physical, neurologic and laboratory findings of mercury intoxication among members of these Barangays, and also based on numerous public health studies of communities with exposure to mercury, these follow-up assessments were tailor-fitted or streamlined to determine and examine the most vulnerable organ systems that could be affected with exposure to mercury. And these are the nervous system and the kidneys. One of the other heavy metal of concern is cadmium.
Table 2. Parameters of the medical sum score for chronic inorganic mercury intoxication

<table>
<thead>
<tr>
<th>TEST</th>
<th>MEDICAL SCORE SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANAMNESTIC DATA</strong>*</td>
<td></td>
</tr>
<tr>
<td>Excessive salivation</td>
<td>0/1</td>
</tr>
<tr>
<td>Tremor at work</td>
<td>0/1</td>
</tr>
<tr>
<td>Sleeping problems at night</td>
<td>0/1</td>
</tr>
<tr>
<td><strong>CLINICAL DATA</strong></td>
<td></td>
</tr>
<tr>
<td>Gray to bluish discoloration of the oral cavity</td>
<td>0/1</td>
</tr>
<tr>
<td>Ataxia of gait</td>
<td>0/1</td>
</tr>
<tr>
<td>Dysdiadochokinesia</td>
<td>0/1</td>
</tr>
<tr>
<td>Heel to shin ataxia</td>
<td>0/1</td>
</tr>
<tr>
<td>Urine proteinuria</td>
<td>0/1</td>
</tr>
<tr>
<td><strong>NEUROPSYCHOLOGICAL TESTS</strong>**</td>
<td></td>
</tr>
<tr>
<td>Matchbox</td>
<td>0/1</td>
</tr>
<tr>
<td>Pencil tapping test</td>
<td>0/1</td>
</tr>
<tr>
<td><strong>MAXIMUM SUM SCORE</strong></td>
<td><strong>10/10</strong></td>
</tr>
</tbody>
</table>

Coding of the parameters of the medical score sum

* Anamnestic and clinical data: 0 = no symptom, 1 = pathological symptom

** Neuropsychological tests: 0 = first quartile, 1 = worse performance than first quartile.

²Medical sum score as proposed by Doering, et al (1)
A. Pertinent Signs and Symptoms:

Subjective signs and symptoms (anamnestic data) and objective findings in neurologic examination are correlated with laboratory or bioexposure levels of mercury as determined (blood, urine, hair mercury) to get a risk assessment of mercury intoxication. Thus a medical score (Table 2) indicating the anamnestic and neurologic findings including determination of urine proteinuria is correlated with mercury levels (Table 3). These data are then correlated with the bioexposure indices in blood, urine and hair as indicated in Tables 3 and 4. And a risk assessment of the presence of absence of chronic mercury intoxication is derived.
Table 3. Exposure limit values of mercury in urine, blood and hair.

<table>
<thead>
<tr>
<th></th>
<th>Hg-urine (ug/L)</th>
<th>Hg-blood (ug/L)</th>
<th>Hg-hair ug/g</th>
<th>Exposure$^1$ values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Below 1\textsuperscript{st} exposure limit value</strong></td>
<td>Less than or equal to 7</td>
<td>Less than or equal to 5</td>
<td>Less than or equal to 1</td>
<td>LOW LEVEL</td>
</tr>
<tr>
<td><strong>Between 1\textsuperscript{st} to 2\textsuperscript{nd} exposure limit value</strong></td>
<td>&gt;7 to less than or equal to 25</td>
<td>&gt;5 to less than or equal to 15</td>
<td>&gt;1 to less than or equal to 5</td>
<td>ALERT LEVEL</td>
</tr>
<tr>
<td><strong>Over 2\textsuperscript{nd} exposure limit value</strong></td>
<td>More than 25</td>
<td>More than 15</td>
<td>More than 5</td>
<td>ACTION LEVEL</td>
</tr>
<tr>
<td></td>
<td>MEDICAL SCORE SUM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0-2</td>
<td>3-4</td>
<td>5-10</td>
<td></td>
</tr>
<tr>
<td>Hg in all specimens</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>&lt;1&lt;sup&gt;st&lt;/sup&gt; exposure limit value</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hg at least in 1 specimen</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>&gt;1&lt;sup&gt;st&lt;/sup&gt; exposure limit value</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>&gt;2&lt;sup&gt;nd&lt;/sup&gt; exposure limit value</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>
A. Bioexposure indices and Correlation with Medical scores

Tables 5-7 show the level of bioexposure indices and the percentages of mercury intoxicated patients. The following findings are noted:

1. More patients from Brgy Sta Lourdes participated in the health assessment activities. The first health assessment in 2017 showed most number of patients examined medically and subjected to laboratory and heavy metal testing. It is noted that patients from Brgy Tagburos were only about 17 participants. The total number of participants in the health assessments (2) in 2018 dwindled and was marked in Brgy Tagburos.

2. Levels of mercury in blood, urine, and hair were noted to be higher from patients coming from Brgy Tagburos with higher medical scores hence higher percentages of patients with chronic mercury intoxication.
3. Table 7 shows that as bioexposure indices decrease, so do medical scores and percentages of positive chronic mercury intoxication. Since August 2018, multivitamins with selenium supplements were distributed to patients from both barangays.

4. Laboratory examination results (Table 8) show the persistence of elevated serum creatinine levels and urine proteinuria in patients from both barangays. SGOT and serum calcium were noted to be elevated.
### TABLE 5 HEALTH ASSESSMENT of ADULT PATIENTS from BRGY STA. LOURDES

<table>
<thead>
<tr>
<th></th>
<th>Number of Adult Patients</th>
<th>Mean Blood Mercury level</th>
<th>Mean Urine Mercury level</th>
<th>Mean Hair Mercury level</th>
<th>Mean Med Score</th>
<th>Mercury Intoxication</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 2017</td>
<td>69</td>
<td>13.9ug/L</td>
<td>13.0ug/L</td>
<td>3.3ug/G</td>
<td>1.9</td>
<td>36.2%</td>
</tr>
<tr>
<td>August 2018</td>
<td>24</td>
<td>11.3 ug/L</td>
<td>1.68ug/L</td>
<td></td>
<td>1.1</td>
<td>NO MERCURY INTOXICATION</td>
</tr>
<tr>
<td>November 2018</td>
<td>24</td>
<td>1.6 ug/L</td>
<td>2.25 ug/G</td>
<td></td>
<td>0.7</td>
<td>NO MERCURY INTOXICATION</td>
</tr>
</tbody>
</table>

1. Acceptable levels of bioexposure - Blood Hg: less than 5; Urine Hg: less than 7ug/L; Hair Hg: less than 1ug/G or 1 ppm
### TABLE 6. HEALTH ASSESSMENT of ADULT PATIENTS from BRGY TAGBUROS

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Adult Patients</th>
<th>Mean Blood Mercury level</th>
<th>Mean Urine Mercury level</th>
<th>Mean Hair Mercury level</th>
<th>Mean Med Score</th>
<th>Positive Mercury Intoxication</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 2017</td>
<td>17</td>
<td>21.4ug/L</td>
<td>25.8ug/L</td>
<td>6.0ug/G</td>
<td>2.1</td>
<td>35.3% PXS</td>
</tr>
<tr>
<td>August 2018</td>
<td>56</td>
<td>19.2ug/L</td>
<td>2.3ug/L</td>
<td></td>
<td>1.9</td>
<td>28.6% PXS</td>
</tr>
<tr>
<td>November 2018</td>
<td>7</td>
<td>3.1 ug/L</td>
<td>3.6 ug/G</td>
<td></td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

1. Acceptable levels of bioexposure - Blood Hg: less than 5; Urine Hg: less than 7ug/L; Hair Hg: less than 1ug/G or 1 ppm
### TABLE 7. COMPARATIVE HEALTH ASSESSMENT RESULTS of ADULT PATIENTS from BRGY STA. LOURDES AND BRGY TAGBUROS PALAWAN

<table>
<thead>
<tr>
<th>BRGY</th>
<th>Number of Adult Patients</th>
<th>Mean Blood Mercury level</th>
<th>Mean Urine Mercury level</th>
<th>Mean Hair Mercury level</th>
<th>Mean Med Score</th>
<th>POSITIVE Mercury Intoxication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>November 2017</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA LOURDES</td>
<td>69</td>
<td>13.9ug/L</td>
<td>13.0ug/L</td>
<td>3.3ug/G</td>
<td>1.9</td>
<td>36.2% PXS</td>
</tr>
<tr>
<td>TAGBUROS</td>
<td>17</td>
<td>21.4ug/L</td>
<td>25.8ug/L</td>
<td>6.0ug/G</td>
<td>2.1</td>
<td>35.3% PXS</td>
</tr>
<tr>
<td><strong>August 2018</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA LOURDES</td>
<td>24</td>
<td>11.3ug/L</td>
<td>1.68ug/L</td>
<td></td>
<td>1.1</td>
<td>NO MERCURY INTOXICATION</td>
</tr>
<tr>
<td>TAGBUROS</td>
<td>56</td>
<td>19.2ug/L</td>
<td>2.3ug/L</td>
<td></td>
<td>1.9</td>
<td>28.6% PXS</td>
</tr>
<tr>
<td><strong>November 2018</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STA LOURDES</td>
<td>24</td>
<td>1.6ug/L</td>
<td>2.25 ug/G</td>
<td></td>
<td>0.7</td>
<td>NO MERCURY INTOXICATION</td>
</tr>
<tr>
<td>TAGBUROS</td>
<td>7</td>
<td>3.1 ug/L</td>
<td>3.6 ug/G</td>
<td></td>
<td>1</td>
<td>NO MERCURY INTOXICATION</td>
</tr>
</tbody>
</table>

1. Acceptable levels of bioexposure - Blood Hg: less than 5; Urine Hg: less than 7ug/L; Hair Hg: less than 1ug/G or 1 ppm
## TABLE 8. COMPARATIVE LABORATORY RESULTS of ADULT PATIENTS from BRGY STA. LOURDES AND BRGY TAGBUROS PALAWAN

<table>
<thead>
<tr>
<th>Month</th>
<th>BRGY</th>
<th>Number of Adult Patients</th>
<th>Elevated Serum Creatinine</th>
<th>Elevated Urine Protein</th>
<th>Elevated SGOT</th>
<th>Elevated serum calcium</th>
<th>Low hemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 2017</td>
<td>STA LOURDES</td>
<td>69</td>
<td>16.9%</td>
<td>NA</td>
<td>36.6%</td>
<td>45.6%</td>
<td>50.7%</td>
</tr>
<tr>
<td></td>
<td>TAGBUROS</td>
<td>17</td>
<td>33.3%</td>
<td>NA</td>
<td>46.7%</td>
<td>17.6%</td>
<td>26.7%</td>
</tr>
<tr>
<td>August 2018</td>
<td>STA LOURDES</td>
<td>24</td>
<td>25.8%</td>
<td>25%</td>
<td>NA</td>
<td>NA</td>
<td>37.5%</td>
</tr>
<tr>
<td></td>
<td>TAGBUROS</td>
<td>56</td>
<td>47.2%</td>
<td>35.8%</td>
<td>NA</td>
<td>NA</td>
<td>28.3%</td>
</tr>
<tr>
<td>November 2018</td>
<td>STA LOURDES</td>
<td>24</td>
<td>26.8%</td>
<td>48.8%</td>
<td>NA</td>
<td>NA</td>
<td>34.1%</td>
</tr>
<tr>
<td></td>
<td>TAGBUROS</td>
<td>7</td>
<td>NA</td>
<td>57.1%</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>BRGY</td>
<td>Number of Pedia Patients</td>
<td>Mean Blood 1\textsuperscript{1} Mercury level</td>
<td>Mean Urine 1\textsuperscript{1} Mercury level</td>
<td>Mean Hair 1\textsuperscript{1} Mercury level</td>
<td>Exposure Assessment\textsuperscript{2}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------</td>
<td>---------------------------------------------</td>
<td>---------------------------------------------</td>
<td>---------------------------------------------</td>
<td>----------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November 2017</td>
<td>STA LOURDES</td>
<td>20</td>
<td>12.7</td>
<td>7.73</td>
<td>ALERT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TAGBUROS</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August 2018</td>
<td>STA LOURDES</td>
<td>29</td>
<td>8.7</td>
<td>1</td>
<td>ALERT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TAGBUROS</td>
<td>11</td>
<td>14.8</td>
<td>1.1</td>
<td>ALERT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November 2018</td>
<td>STA LOURDES</td>
<td>5</td>
<td>NA</td>
<td>0.41</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TAGBUROS</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{1}Acceptable levels of bioexposure - Blood Hg: less than 5; Urine Hg: less than 7ug/L; Hair Hg: less than 1ug/G or 1 ppm
RECOMMENDATIONS:
Only comparative evaluation in terms of percentages between the barangays is feasible as the population are not near equal in numbers. Still the conclusions and recommendations are as follows:
1. People living in Brgy Sta Lourdes and Tagburos are exposed to inorganic, organic and methylmercury from ingestion and inhalation (food, water or dust), from eating mercury contaminated freshwater and saltwater fish and other aquatic food. This condition is brought about by exposure to mercury mine tailings left after the closure of PQMI.
RECOMMENDATIONS:

2. The level of exposure of people from these barangays are documented by exposure indices blood mercury (indicative of acute methylmercury exposure), urine mercury (indicative of inorganic and elemental mercury exposure) and hair mercury (indicative of methylmercury exposure. These toxicologic tests were correlated with signs and symptoms, neuropsychological tests comprising a medical score which was also correlated with the exposure assessment (low, alert, action levels) giving us an assessment of negative or positive chronic mercury intoxication. Results revealed that during the March 2017 health assessment higher levels of mercury, higher number of persons were exhibiting mercury poisoning in terms of medical score and exposure assessment indicating an ALERT and ACTION status in terms of public health. It is important to emphasize that higher levels of mercury in blood, hair and urine with higher medical scores were seen from persons from Brgy Tagbueros which may necessitate relocation and evacuation.
RECOMMENDATIONS:

3. There are indications that administration of selenium supplements may be beneficial to counteract the ill health effects of mercury. Thus there may be basis of providing these supplementation under medical supervision to these communities.

4. Overall public health education, efforts by other sectors of government might have contributed to better health status but we must encourage the communities of these affected barangays to participate more actively in health activities like health monitoring assessments that should be conducted yearly at least, health education and planning with regards nutrition, preventive medicine, and adherence to healthy lifestyle. Environmental education and protection should be forefront concerns by DENR, BFAR, DAR, and other government agencies because these communities derive their food, sustenance from the environment.
RECOMMENDATIONS:

5. The health efforts to determine the impact of mercury in children have been limited and wanting. Neurodevelopmental assessments should be conducted and effects on mental health, immune status and nutrition of children should be prioritized.

6. Exhaustive environmental health and risk assessment must be done to remediate these contaminated sites.
PLANS:

1. Conduct regular monthly monitoring of mercury levels (ideally speciated) in all aquatic food source and a regular WARNING ADVISE on allowable consumption especially for pregnant and child bearing women in the community.

2. Conduct a yearly health assessment to determine the level of exposure and intoxication in these affected barangays.
Green Alliance for Mining and the Environment

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Professor of Chemical Engineering
Head, Waste and Resource Management
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www.dlsu.edu.ph/research/gamers
Caraga anti-mining advocates to join Earth Day commemoration

By ROEL CATOTO - APRIL 21, 2014 7:24 PM

SURIGAO CITY (MindaNews / 21 April) – Hundreds are expected to join the commemoration of Earth Day here tomorrow as residents in the Caraga Region, in a forum today, expressed their opposition against environmental destruction caused mainly by mining.

DOST, Chamber of Mines to seek tech-driven solutions for mining

By Edd K. Usman

The Department of Science and Technology (DOST) and the Chamber of Mines of the Philippines (COMP) signed a Memorandum of Agreement (MOA) last April 4 to develop technology-driven solutions for “responsible mining”.

‘Legacy’ of the mines: Ghosts of mining’s past continue to haunt industry

By Jonathan L. Mayuga - October 28, 2017
Our Multi-R Approach to Green Mining

A portfolio of SOLUTIONS

REDUCE

RESPONSIBLE Mining

RECOVER RESOURCES

REUSE

RECYCLE

REPROCESS

REHABILITATE, REIMAGINE

REMEDIATE
“Turning Wasteland to Wonders”

Source:https://sea.mashable.com/culture/4155/the-efforts-that-made-sunway-city-kuala-lumpur-the-self-sustaining-city-it-is-today
3R Approach to sustainable management of nickel laterite ore mining waste: *Reuse, Recycle* and *Reprocessing* for environmental remediation and *material valorization*. 
*Dr. Carlito Tabelin / University of New South Wales, Australia

*Dr. Richard Alorro / Curtin University, Australia

*Balik Scientist / International Consultants
3R APPROACH TO SUSTAINABLE MANAGEMENT OF NICKEL LATERITE ORE MINING WASTE: REUSE, RECYCLE AND REPROCESSING FOR ENVIRONMENTAL REMEDIATION AND MATERIAL VALORIZATION

Michael Angelo B. Promentilla, (Program Leader, DLSU)
Dr. Aileen Huelgas-Orbecido (Project Leader, DLSU)
Dr. Ivyleen C. Bernardo-Arugay (Project Leader, MSU-IIT)
Dr. Vannie Joy T. Resabal (Project Leader, MSU-IIT)
Einstine M. Opiso (Project Leader, CMU)
Research Program: 3R4 Green Mining

Ni Laterite Mining → Silt

Component 2 (CMU)
Recycling and Reprocessing for wastewater treatment applications

Component 3 (MSU-IIT)
Reprocessing to recover nanominerals

Component 1 (DLSU)
Reuse for acid mine drainage treatment and carbon sequestration

Component 4 (DLSU)
Recycling of silt and spent residue from reprocessing as raw materials for geopolymer composite
18M DOST-funded Research Program (2018-2020)
3 Research-oriented Universities
4 Projects
20 Researchers
Project 1

Utilization of Low-Grade Nickel Ore in AMD Treatment and Carbon Sequestration
TEAM MEMBERS

Dr. Aileen Orbecido
PROJECT LEADER

Dr. Arnel Beltran
CO-PROJECT LEADER

Casey Oliver Turingan
Kimmie Mae Dela Cerna
Jainalyn Delantar
RESEARCH ASSOCIATES
3R. REUSE

Utilization of low-grade nickel ore in ACID MINE DRAINAGE treatment

**AMD and Media (Raw Material)**

- **Synthetic AMD**
  - pH = 2.2
  - Fe = 2500 ppm
  - Ni = 300 ppm
  - Al = 260 ppm
  - SO$_4^{2-}$ = 61000 ppm

- **LGO (goethite)**
- **Limestone (calcite)**

**Configurations**

- **Single Medium (Jar Test Experiment)**
- **Dual Media (Batch Test Experiment)**

**Results**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>LGO</th>
<th>Limestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.36</td>
<td>7.76</td>
</tr>
<tr>
<td>Fe Removal</td>
<td>&gt;99%</td>
<td>&gt;99%</td>
</tr>
<tr>
<td>Ni Removal</td>
<td>&gt;93%</td>
<td>&gt;99%</td>
</tr>
<tr>
<td>Al Removal</td>
<td>&gt;99%</td>
<td>&gt;99%</td>
</tr>
<tr>
<td>SO$_4^{2-}$ Removal</td>
<td>93%</td>
<td>68%</td>
</tr>
</tbody>
</table>

**Change in pH of treated AMD**

- **Parameters**
  - **Oxic**
  - **Anoxic**
  - pH: 5.79 vs. 5.75
  - Fe Removal: >99% vs. >99%
  - Ni Removal: 97% vs. 94%
  - Al Removal: >99% vs. >99%
  - SO$_4^{2-}$ Removal: 81% vs. 79%
3R. REUSE

Utilization of low-grade nickel ore in CARBON SEQUESTRATION

End Product: FeCO₃ (siderite)

- **Fe**: 95.3%
- **Al**: 80.3%
- **Mg**: 68.9%
- **Si**: 7.0%

*experiments are ongoing

Image Source: https://www.minerals.net/mineral/siderite.aspx

PROJECT 1

Utilization of low-grade nickel ore in AMD treatment and carbon sequestration
Project 2

Recycling and Reprocessing for wastewater treatment applications
TEAM MEMBERS

Dr. Einstine Opiso
PROJECT LEADER

Leonar Jun Gabiana
PROJECT STAFF

Leonard Marc Ramos
RESEARCH ASSOCIATE

Jet Ryan Delfinado
RESEARCH ASSISTANT
3R. RECOVER

RATIONALE

Lateritic silt contains significant amount of iron which can cause environmental problems when unattended but can be reprocessed into useful nanoparticles.
3R. RECOVER

DESCRIPTION

Coprecipitation is the most facile and cost-effective methodology for the production of magnetic iron-based nanoparticles.
Magnetic powder synthesized from the silt (left) and when subjected under a magnetic field (right). SEM micrograph of the powder showing needle-like structures. XRD pattern corresponds to magnetite.

Extract from the silt and its precipitated form.

PROJECT 2
Recycling and Reprocessing for wastewater treatment applications.
Project 3

Recovery of Nanominerals and Minerals from Silt for Various Ceramic Applications
TEAM MEMBERS

Dr. Ivyleen C. Bernardo-Arugay
PROJECT LEADER

Dr. Vannie Joy T. Resabal
CO-PROJECT LEADER

Fel Jane Echavez
Rae Homer Aquiatan
Joel Esencia
RESEARCH ASSOCIATES
3R. REPROCESS

Magnetic & Sub-sieve powders extracted from Silt

PROJECT 3
Recovery of nanominerals and minerals from silt for various ceramic applications
3R. REPROCESS

Few Ceramics for industrial application developed from Silt

Ceramic thermal sink

Ceramic floor and wall tiles

Ceramic pipes & tubes

Recovery of nanominerals and minerals from silt for various ceramic applications
3R. REPROCESS

Ceramics for household and artwares application developed from Silt

Ceramic plate

Ceramic ovenware

Ceramic cup

Ceramic teacup set

Recovery of nanominerals and minerals from silt for various ceramic applications
Project 4

Recycling of silt and spent residues from reprocessing as raw material for geopolymer
TEAM MEMBERS

Dr. Michael Angelo Promentilla
PROJECT LEADER

Roy Alvin Malenab
RESEARCH ASSOCIATE

April Anne Tigue
RESEARCH ASSOCIATE

Alberto Longos
RESEARCH ASSOCIATE
3R. RECYCLE

408,000 m³ nickel mine waste generation

1.14 MMT coal fly ash generation

Waste valorization

eco-friendly material

Precursor + alkali activator

Geopolymer

Recycling of silt and spent residues from reprocessing as raw material for geopolymer
1. RAW MATERIAL PREPARATION
- Oven Drying
- Grinding and Sieving (50-mesh)
- Calcination (700 °C, 2 hrs, 10 °C/min)

2. RAW MATERIAL CHARACTERIZATION
- Chemical analysis (XRF)
- Morphological analysis (SEM)

3. GEOPOLYMER SYNTHESIS
- Mixing of nickel-laterite, fly ash and alkali activator

4. OPTIMIZATION
- I-optimal Mix Design
- Response Surface Methodology

5. PRODUCT CHARACTERIZATION
- Mechanical strength test (UCS)
- Morphological analysis (SEM/EDX)

PROJECT 4
Recycling of silt and spent residues from reprocessing as raw material for geopolymer
Recycling of silt and spent residues from reprocessing as raw material for geopolymer

*DPWH and ASTM standards for corresponding applications
“Innovation work doesn’t happen in isolation, it requires a network of ideas, individuals, and institutions to come together to be more than a sum of their parts”

- Dr. Mahmoud Mohieldin
World Bank’s Senior Vice President for the 2030 Development Agenda, United Nations Relations, and Partnerships.
The Green Mining Alliance is looking for...

Committed partners from the mining industry, academe and government agency
Thank you...

Let’s build together a GREENER Future!
Reducing the footprint of exploration and mining: a key role for mineral sciences

Richard Herrington
Head of Earth Sciences, Natural History Museum, London
Imperial College (Royal School of Mines), London
Camborne School of Mines, University of Exeter
New tools for improved exploration

- New technologies are improving exploration efforts
  - Remote sensing – cameras, scanners, airborne and ground geophysics
  - Hand held and portable instruments for direct analysis
  - Better drilling systems – continuous drilling, downhole sensors, less water
New tools - Better (and more) mineral data leads to better (and more cost effective) decision making

• New technologies with new scientific advances leads to robust exploration tools

  • Automated SEM analysis – yields data on composition, mineral identity, abundance, relationships, morphologies

  • Laser-ablation ICPMS analysis – detailed follow up geochemical data

  • Producing large integrated geochemical datasets that can be used for fertility, vectoring and geometallurgical studies
Automated SEM analysis

- Instrument is ‘trained’ to identify and then find minerals of interest – collects a range of data
- Data for exploration fertility & vectoring and more efficient processing strategies
Integrating SEM mineral analysis with LA-ICPMS geochemistry – multi element analyses

Automated SEM
Rapid scan of a full section of the rock/ore of interest

Identifies the grains and provides internal standard

Analysis using LA-ICPMS

Precise 20 micron spot leading to multi-element analysis of mineral grain
Mineral chemistry data used to test magmatic system fertility – e.g. apatite

- **Top**: MIs from MSH show correlation between Cu & Cl, consistent with sequestration of metals by Cl-rich fluids exsolved at 1–2 kbar.

- **Bottom**: Cl and SO$_3$ content in the mineral apatite from N Luzon. Samples from Santo Tomas II (diamonds) are more enriched than Pinatubo samples (crosses) implying Pinatubo is depleted, perhaps via volatile loss.
Porphyry system fertility, navigation and targeting tools using multivariate statistics

Chlorite multivariate compositional data – AMIRA P1060 database + NHM in-house database

Supervised discriminant projection analysis
Data can be used to possibly discriminate the likelihood of large deposits in a belt.
Modelled data successfully predicted the buried porphyry 1 km below surface.

Courtesy Paul Agnew, Rio Tinto
Scientifically robust and commercially adopted
FAMOS project

- From arc magmas to ores: A mineral systems approach
- £4.3M including industry in kind support
- Porphyry system focus
- ~45 UK-based researchers plus industry and international partners
Water quality impacts of mining

Adam Jarvis
Newcastle University, UK
Mine water pollution generation

Causes:

1. Exposure of metal minerals, during mining, to oxygen / water
2. Mobilisation of weathering products in water e.g. mine flooding, rainfall
3. Discharge of contaminants to surface waters and groundwaters

Weathering of pyrite (disulphide)

\[
\begin{align*}
2\text{FeS}_2(s) + 7\text{O}_2(aq) + 2\text{H}_2\text{O} &\rightarrow 2\text{Fe}^{2+} + 4\text{SO}_4^{2-} + 4\text{H}^+ \\
2\text{Fe}^{2+} + \frac{1}{2}\text{O}_2 + 2\text{H}^+ &\rightarrow 2\text{Fe}^{3+} + \text{H}_2\text{O} \\
2\text{Fe}^{3+} + 6\text{H}_2\text{O} &\rightarrow 2\text{Fe(OH)}_3(s) + 6\text{H}^+ \\
14\text{Fe}^{3+} + \text{FeS}_2(s) + 8\text{H}_2\text{O} &\rightarrow 2\text{SO}_4^{2-} + 15\text{Fe}^{2+} + 16\text{H}^+
\end{align*}
\]

Weathering of monosulphides

Sphalerite: \(\text{ZnS}_\text{(s)} + 2\text{O}_2(aq) \rightarrow \text{Zn}^{2+} + \text{SO}_4^{2-}\)

Galena: \(\text{PbS}_\text{(s)} + 2\text{O}_2(aq) \rightarrow \text{Pb}^{2+} + \text{SO}_4^{2-}\)

Millerite: \(\text{NiS}_\text{(s)} + 2\text{O}_2(aq) \rightarrow \text{Ni}^{2+} + \text{SO}_4^{2-}\)

Greenockite: \(\text{CdS}_\text{(s)} + 2\text{O}_2(aq) \rightarrow \text{Cd}^{2+} + \text{SO}_4^{2-}\)

Covelite: \(\text{CuS}_\text{(s)} + 2\text{O}_2(aq) \rightarrow \text{Cu}^{2+} + \text{SO}_4^{2-}\)

Consequences for water quality:

Pyrite weathering:
- Increased concentrations of iron and sulphate
- Increased concentrations of other metals due to low pH (increased metal solubility)
- Acidity / low pH

Monosulphide weathering:
- Increased concentrations of metals and sulphate (no decrease in pH)
Water quality impacts of mining

- Mine water pollution a pervasive issue: mines abandoned decades ago; pollution ongoing

- Persistence downstream, and impacts, may differ depending on the metal

- Solubility, especially with respect to pH, is critical

Point source discharge of pH $\approx 3$ water containing Fe and Zn (Pb mine)

Point source discharge of pH $\approx 7$ water containing Zn (Pb/Zn mine)
Water quality impacts of mining

- Collectively > 250 t / yr Zn to freshwaters of England and Wales (> 50% of total flux)
- Freshwater quality standard (UK) for Zn is ≤ 0.05 mg/L (max.)
- Mines abandoned decades / centuries ago, but problems remain widespread
- Use of GIS & water quality data to assess scale of / prioritise impacts

From Mayes et al., Sci Total Environ, 2009, 407, 5435-5447
Trivalent metals (e.g. Fe$^{3+}$) tend to form hydroxide solids in receiving waters:

⇒ smothering of stream bed
⇒ impacts on benthic invertebrates

- Localised impacts (… but re-suspension at high river flows)

- Divalent metals (e.g. Zn$^{2+}$, Ni$^{2+}$) stay ‘dissolved’ at pH of most surface streams

- Persist downstream, and metals are ecotoxic

```
\begin{table}
\begin{tabular}{|c|c|c|}
\hline
\textbf{[Zn](ug/L)} & \textbf{No of Taxa} & \textbf{EQS Fails} & \textbf{EQS Passes} \\
\hline
0 & 5 & 0 & 0 \\
10 & 10 & 0 & 0 \\
20 & 15 & 0 & 0 \\
30 & 20 & 0 & 0 \\
40 & 25 & 0 & 0 \\
50 & 30 & 0 & 0 \\
60 & 35 & 0 & 0 \\
70 & 40 & 0 & 0 \\
80 & 45 & 0 & 0 \\
90 & 50 & 0 & 0 \\
100 & 55 & 0 & 0 \\
110 & 60 & 0 & 0 \\
120 & 65 & 0 & 0 \\
130 & 70 & 0 & 0 \\
140 & 75 & 0 & 0 \\
150 & 80 & 0 & 0 \\
160 & 85 & 0 & 0 \\
170 & 90 & 0 & 0 \\
180 & 95 & 0 & 0 \\
190 & 100 & 0 & 0 \\
200 & 105 & 0 & 0 \\
210 & 110 & 0 & 0 \\
220 & 115 & 0 & 0 \\
230 & 120 & 0 & 0 \\
240 & 125 & 0 & 0 \\
250 & 130 & 0 & 0 \\
260 & 135 & 0 & 0 \\
270 & 140 & 0 & 0 \\
280 & 145 & 0 & 0 \\
290 & 150 & 0 & 0 \\
300 & 155 & 0 & 0 \\
310 & 160 & 0 & 0 \\
320 & 165 & 0 & 0 \\
330 & 170 & 0 & 0 \\
340 & 175 & 0 & 0 \\
350 & 180 & 0 & 0 \\
\hline
\end{tabular}
\end{table}
```

Relationship between [Zn] and number of invertebrate taxa for rivers in Wales

Water quality impacts of mining
Water quality impacts of mining

Chemical impacts: Especially elevation of metal concentrations (failure to meet standards), but elevated $\text{SO}_4^{2-}$ in arid climates (drinking water)

Ecological impacts: Impacts at multiple trophic levels e.g. diatoms, invertebrates, fish

Physical impacts: Increased sediment runoff (operational mines and abandoned mine wastes) $\Rightarrow$ smothering / geomorphological impacts

Examples from Honduras and the UK of diffuse sources of mining pollution
Water quality impacts of mining

- Diffuse sources of metals pollution from mining are very significant
- Mine wastes are a source of diffuse pollution; sediments from them both a sink for, and source of, metals within rivers
- Reliable hydrometric and water quality data required to evaluate metal flux
Water quality impacts of mining

- Condoraque mine site, Peru: Abandoned tungsten mine 4600 m a.s.l., and above downstream communities
- Water quality impacts with (potential) human / livestock health implications
- Actual risks to health uncertain
Water quality impacts of mining

Operational Cu mine, Peru

- Uncertain risks / links to livestock health
- Effective participatory monitoring
Technology Challenges in Philippine Mineral Discovery & Processing

Dr. Carlo A. Arcilla
Professor, National Institute of Geological Sciences, Univ. Philippines
Director, Philippine Nuclear Research Institute
• Gold and copper recoveries in PHL are world-class
• Main challenge in mineral recovery – very high energy costs, especially in case of Nickel mining where PHL is one of the biggest sources – option is export wholesale unprocessed nickel ores to China
• Disjointed policies which have discouraged investments in mining
• Perception of bad practices of “small-scale” mining and processing shades good practitioners in mining industry
• Biggest future challenge – safe tailings management
World market metal motivations

Material Criticality: Comparing China, Europe, Japan and the USA

R. Eggert, S. Fulton, J. Hofer, B. Jordan, H. Kim, S.K. Lee and B. Smith
Colorado School of Mines, and Critical Materials Institute
Goldschmidt, Paris, August 2017
Material criticality by country

Cu: important
For China, Europe,
USA, Japan

Nickel is
Important but
Even more
Is Cobalt,
Which is rich
In Nickel ore!

Rare earth elements
Will be in short supply
Because of green
Technology demand
For magnets and
Solar power
Battery components
Summary

- Considering all needs, the most exigent scenario (Garcia-Olivares et al., 2012) requires by 2050:
  
  300 Mt Cu: 18 years of present production, 50% of known reserves
  8 Mt Li: 100 years of production, 50% of known reserves
  66 Mt Ni: 40 years, 95% of known reserves
  31 Mt Pt: 19 years, 44% of known reserves

  ...and a considerable amount of energy to produce these raw materials

- Dynamic modelling is necessary to avoid blind driving and help defining the less exigent energy scenario in terms of mineral resources needs and environmental impacts
Philippines Supply role in World Material Criticality in view of green technology to combat climate change (source of critical metals for batteries for energy storage)

- Rich source of copper
- Nickel
- If we process nickel ores locally, Cobalt and Scandium
Rare Earth Element Geochemistry of Philippine Nickel Laterite Ores: Analytical Validation and Economic Implications

Carmela Alen Tupaz*, Carlo Arcilla
University of the Philippines
Diliman, Philippines
Petrography and Mineralogy: Intex Resources

Limonite:
- **Major mineral:** Goethite (G)
- **Minor minerals:** Chromite (C), Hematite (H), Magnetite (M)

Saprolite:
- **Major mineral:** Serpentine (S)
- **Minor mineral:** Goethite

Bedrock:
- **Major minerals:** Serpentine, Olivine (O), Enstatite (E)
- **Minor mineral:** Magnetite
ZDMC, Zambales

Limonite
Saprolite
Serpentinized Harzburgite

Depth, m

wt. %
0 50 100
wt. %
0 2
ppm
0 200 400

SiO₂
MgO
Fe₂O₃
Al₂O₃
CoO
NiO
MnO
Sc
Y
ΣREE

The diagram shows the depth profile and the distribution of various elements and compounds at ZDMC, Zambales. The layers are labeled as Limonite, Saprolite, and Serpentinized Harzburgite. The graph on the right side illustrates the concentration of different elements such as SiO₂, MgO, Fe₂O₃, Al₂O₃, CoO, NiO, MnO, Sc, Y, and ΣREE as a function of depth. The map in the background indicates the location in the Philippines.
Cobalt

• Lithium-ion batteries contain cobalt allowing batteries to be denser therefore smaller.
• Cobalt allows batteries to increase energy density, and to hold their charge longer.
• Cobalt prices have increased by more than 47% year-over-year, resulting in one of the largest gains in the metals spectrum, even surpassing gold.
• Currently, the largest deposits of cobalt are found in the Democratic Republic of Congo (DRC).
• Worryingly, children are used for the mining of cobalt in the DRC.
Philippine Black Sand Characterization

NATIONAL INSTITUTE OF GEOLOGICAL SCIENCES,
UNIVERSITY OF THE PHILIPPINES DILIMAN
ILLEGAL BLACK SAND MINING
INTRODUCTION

Magnetite

- Good Fe source (72.4% Fe)
- Associated elements/metals?
METHODOLOGY
RESULTS – La Union
RESULTS – Leyte

High amounts of iron oxide (all municipalities sampled)

- Palo
- Dagami
- Tabontabon
- Tanauan
- Tolosa
- Dulag
- Mayorga
- Macarthur
Is the Philippines receiving its fair share of value from its mineral exports? Ans: NO

- Only with Cu concentrate is the Phil. receiving “value” from exports

Source: G. Bjutor
Resource potential of scandium in nickel laterite

Kenzo Sanematsu$^{1,2}$ and Carlo Arcilla$^2$

$^1$ Geological Survey of Japan, AIST, Japan,
$^2$ University of the Philippines Diliman, Philippines,

k-sanematsu@aist.go.jp
China import stats show higher ore prices vs. declared ore prices in the Philippines...

2013 China = $55/dmt
2013 Philip = $35/dmt

2013 China = 17.5% LME
2013 Philip = 12.8% LME
Transfer Pricing in Nickel?

2013 MOEP Data, ≤1.3 %Ni
Why can’t we manufacture steel when we have all ingredients (Fe, Ni, Cr)

Electric power is needed in smelting and our power rates are among the highest in the world!
The median Filipino family pays more than 10% of their take home pay for electricity!
Nuclear Power to lessen our energy costs?
Krsko Nuclear Power plant, Slovenia, twin of BNPP

40 years of Safe, profitable Operation..
• Encourage local processing of ores, but this should be economically feasible, learning from lessons of Indonesia
  – For this to happen have COMPREHENSIVE studies on ALL elemental contents of exported Philippine ores
    (processing will entail energy demands, high capital costs, and greater environmental challenges)
Cleaning mercury polluted mine tailings in the Philippines

Extracting mercury and gold from mine tailings created by small-scale gold miners in the Philippines

1 Peter W. U. Appel, 2 Leoncio Na-Oy, 3 Yuichi Hatsukawa, 3 Takahito Osawa, 1 Jørgen Kystol & 1 Lars L. Sørensen

1 Geological Survey of Denmark and Greenland
2 Benguet Federation of Small-scale Miners
3 Japan Atomic Energy Agency
<table>
<thead>
<tr>
<th>GEUS sample no.</th>
<th>Type of tailings sample</th>
<th>Gold gram/ton</th>
<th>Mercury gram/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>494855</td>
<td>Before cyanide treatment</td>
<td>16.5</td>
<td>250</td>
</tr>
<tr>
<td>494856</td>
<td>After cyanide treatment</td>
<td>13.6</td>
<td>200</td>
</tr>
<tr>
<td>494857</td>
<td>Before cyanide treatment</td>
<td>14.0</td>
<td>120</td>
</tr>
<tr>
<td>494858</td>
<td>After cyanide treatment</td>
<td>13.1</td>
<td>73</td>
</tr>
</tbody>
</table>
Figure 2. Twelve year old girl multi handicapped from mercury poisoning in pre-natal state, Mindanao.
Siltation from Nickel Mining
REGION IV-B

Berong Nickel Corp.
Quezon, Palawan

Environmental violation:
Siltation of coastal waters

94 farmers affected

Siltation ponds of Berong Nickel
## Sediment Flux

<table>
<thead>
<tr>
<th>River System</th>
<th>Sediments during dry season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mining areas</td>
</tr>
<tr>
<td>Nayom</td>
<td>0.28%</td>
</tr>
<tr>
<td>Sta. Cruz</td>
<td>2.1%</td>
</tr>
<tr>
<td>Pamalabawan</td>
<td>3.5%</td>
</tr>
<tr>
<td>Cabaluan</td>
<td>7.2%</td>
</tr>
</tbody>
</table>
Mining and rehabilitation in Rio Tuba nickel mine, southern Palawan
Empower Environmental Management Bureau (EMB) by making it independent (take it away from DENR), like the US Environmental Protection Agency, but staff it with competent and responsible scientists free of ideology and update Fines for environmental violations

-- this way, ANY project that is from the outset, not environmentally compliant, should NOT even start, and if violations of ECC are noted, severe penalties imposed
“Hazardscape” of the Philippines

The geographic and geologic setting of the Philippines make it prone to various hazards, including:

- typhoon/rain-related
- volcano-related
- earthquake-related
- tsunami
Status of Mining and Minerals Industry in the Philippines

ENGR. RODOLFO L. VELASCO, JR.
Mine Safety, Environment and Social Development Division
Mines and Geosciences Bureau

UK-Philippines Minerals and Mining Scoping Workshop

March 3, 2020
Hotel Astoria, Puerto Princesa City, Palawan
I. Status of Minerals Industry in the Philippines
II. SHES Provision at Each Stage of Mining Operation
III. Financial Mechanisms for the Implementation of Environmental Programs
Chapter I

Status of Minerals Industry in the Philippines
PHILIPPINE MINERALS

PHILIPPINES LAND MASS: 30 MILLION HECTARES

14.546 MILLION HECTARES ARE WITH MINING POTENTIAL

SOURCE: MGB
PHILIPPINE MINERALS

PHILIPPINES LAND MASS:

30 MILLION HECTARES

14.546 MILLION HECTARES
ARE WITH MINING POTENTIAL

ONLY
170 THOUSAND HECTARES
OR 0.567%
ARE CURRENTLY BEING UTILIZED

SOURCE: MGB
PHILIPPINES LAND MASS: 30 MILLION HECTARES

14.546 MILLION HECTARES ARE WITH MINING POTENTIAL.

ONLY 170 THOUSAND HECTARES OR 0.567% ARE CURRENTLY BEING UTILIZED.

PHILIPPINE MINERALS

NICKEL

ZAMBALES

PALAWAN

SURIGAO DEL NORTE

AGUSAN DEL NORTE

SURIGAO DEL SUR

SOURCE: MGB
PHILIPPINES LAND MASS: 30 MILLION HECTARES

14.546 MILLION HECTARES ARE WITH MINING POTENTIAL

ONLY 170 THOUSAND HECTARES OR 0.567% ARE CURRENTLY BEING UTILIZED

GOLD

BENGUET
CAMARINES NORTE
MASBATE
AGUSAN DEL SUR
DAVAO DEL NORTE

SOURCE: MGB
PHILIPPINES LAND MASS: 30 MILLION HECTARES

14.546 MILLION HECTARES ARE WITH MINING POTENTIAL

ONLY

170 THOUSAND HECTARES OR 0.567% ARE CURRENTLY BEING UTILIZED

POLYMETALLIC

BENGUET

CEBU

ZAMBOANGA DEL NORTE

SOURCE: MGB
PHILIPPINE MINERALS

METALLIC
- Gold
- Copper
- Nickel
- Iron
- Chromite

NON-METALLIC
- Sand & Gravel
- Limestone
- Marble
- Clay
- Aggregates
# STATUS OF MINING RIGHTS

As of January 2020

<table>
<thead>
<tr>
<th>Mining Tenements</th>
<th>No.</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration Permits</td>
<td>16</td>
<td>43,397.1445</td>
</tr>
<tr>
<td>Mineral Production Sharing Agreements</td>
<td>300</td>
<td>580,604.1125</td>
</tr>
<tr>
<td>Financial or Technical Assistance Agreements</td>
<td>5</td>
<td>95,500.0244</td>
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<tr>
<td>Industrial Sand and Gravel Permits</td>
<td>137</td>
<td>1,694.1222</td>
</tr>
<tr>
<td>Mining Patents</td>
<td>223</td>
<td>1,946.9057</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>745</strong></td>
<td><strong>723,142.3093</strong></td>
</tr>
</tbody>
</table>
METALLIC OPERATIONS

51 Metallic Mines

- 11 Gold Mines
- 3 Copper Mines
- 4 Chromite Mine
- 30 Nickel Mines
- 3 Iron Mine
NON-METALLIC OPERATIONS

54 Non-metallic Mines

- 27 Limestone and Shale
  - 1 Greywacke/pozzolan mine
  - 4 Marbleized Limestone Mines
  - 2 Silica Mines
- 14 Aggregates Mines
  - 1 Dolomite Mine
  - 3 Clay Mines
  - 1 Sand and Gravel
  - 1 Volcanic Tuff
PROCESSING PLANT OPERATIONS

5 Processing Plants
1. Copper Smelter
2. Gold Processing Plant
2. Nickel Processing Plant
## ECONOMIC CONTRIBUTIONS

<table>
<thead>
<tr>
<th>Indicator</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross Production Value</strong></td>
<td>PhP 157.1 B</td>
<td>PhP 199.5 B</td>
<td>PhP 169.5 B</td>
<td>PhP 154.2 B</td>
<td>PhP 170.2 B</td>
<td>PhP 179.6 B</td>
</tr>
<tr>
<td><strong>GDP Contribution (At current prices)</strong></td>
<td>PhP 115.42 B</td>
<td>PhP 130.19 B</td>
<td>PhP 108.11 B</td>
<td>PhP 114.68 B</td>
<td>PhP 133.96 B</td>
<td>PhP 146.18 B</td>
</tr>
<tr>
<td></td>
<td>1.00 %</td>
<td>1.03 %</td>
<td>0.81 %</td>
<td>0.79 %</td>
<td>0.85%</td>
<td>0.84 %</td>
</tr>
<tr>
<td></td>
<td>6.3 %</td>
<td>6.5 %</td>
<td>4.8 %</td>
<td>4.09 %</td>
<td>6.24 %</td>
<td>5.99 %</td>
</tr>
<tr>
<td><strong>Employment</strong></td>
<td>250,000</td>
<td>235,000</td>
<td>236,000</td>
<td>219,000</td>
<td>204,000</td>
<td>207,000</td>
</tr>
<tr>
<td></td>
<td>0.7 %</td>
<td>0.6 %</td>
<td>0.6 %</td>
<td>0.53 %</td>
<td>0.50 %</td>
<td>0.50 %</td>
</tr>
<tr>
<td><strong>Taxes, Fees &amp; Royalties from Mining</strong></td>
<td>PhP 24.45 B</td>
<td>PhP 32.75 B</td>
<td>PhP 30.12 B</td>
<td>PhP 35.44 B</td>
<td>PhP 25.70 B</td>
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MANDATE

The MGB is the primary government agency under the DENR responsible for the conservation, management, development and proper use of the country’s mineral resources.

Republic Act No. 7942 – Philippine Mining Act of 1995
DAO No. 2010-21 – Revised Implementing Rules and Regulations
MAJOR PROGRAMS OF MGB

Geohazard Assessment Program
- Vulnerability and Risk Assessment
- Sub-surface Assessment
- IEC Campaign to barangays

Geological Assessment Program
- Groundwater resource and vulnerability assessment (provincial and municipal level)
- Geologic mapping

Mining Industry Development Program
- Compliance monitoring of mining permits/contracts
- Anti-illegal mining operations

Mineral Investment Promotion Program
- Approval of mining permits/contracts
- Declaration of Minahang Bayan areas

Communication Plan for Mineral Resources and Geosciences Development
- Advocacy programs on responsible mining and geosciences thru fora, consultations, trainings, tri-media campaigns, etc.

Mine Rehabilitation Program
- Rehabilitation of abandoned/inactive mines
Current Regime in Mining

DAO No. 2017-10
Banning the Open Pit Method of Mining for Copper, Gold, Silver, and Complex Ores in the Country

EO No. 79
Moratorium on the grant of Mineral Agreement (MPSA, JVA and Co-Production)

DENR Memorandum Order No. 2016-01
Audit of All Operating Mines and Moratorium on New Mining Projects
Current Regime in Mining

Train 1
Excise tax increased from 2% to 4%

EO No. 79
Moratorium in the acceptance and processing of mining applications in Palawan

EO No. 79
Expanded areas closed to mining, i.e. SAFDZs
Recent Policy Issuances

**MGB Memorandum Order No. 2020-001**
Guidelines for Care and Maintenance for Program for Mining Projects

**DAO No. 2019-24**
Amendment of Item III, Section 4(B) of the DENR Administrative Order No. 2019-13, "Rationalizing Dredging Activities in the Heavily-silted River Channels of Bucao in Botolan, Maloma in San Felipe and Sto. Tomas Traversing the San Marcelino, San Narciso, and San Felipe Municipalities in the Province of Zambales"

**DAO No. 2019-13**
Rationalizing Dredging Activities in the Heavily-silted River Channels of Bucao in Botolan, Maloma in San Felipe and Sto. Tomas Traversing the San Marcelino, San Narciso, and San Felipe Municipalities in the Province of Zambales
Recent Policy Issuances

MGB Memorandum Circular No. 2019-004
Clarification on Quarry Resources Pursuant to DAO No. 2010-21, the Consolidated Implementing Rules and Regulations of RA No. 7942, The Philippine Mining Act of 1995

MGB Memorandum Circular No. 2019-002
Supplemental Guidelines to MGB MC No. 2018-01
Otherwise known as Guidelines in the conduct of apprehension, seizure, confiscation and disposition of illegally sourced minerals/mineral products and by-products, tools, conveyances and equipment used

MGB Memorandum Circular No. 2019-001
Clarificatory Guidelines on the Industrial Sand and Gravel Permit
Recent Policy Issuances

**DAO No. 2018-13**
Lifting of the Moratorium on the Acceptance, Processing and/or Approval of Applications for Exploration Permit under Department Memorandum Order No. 2016-01

**MGB Memorandum Circular No. 2018-02**
Guidance for Compliance Monitoring and Rating/Scorecard of Mining Permits/Contracts

Provides for a STANDARD MONITORING SYSTEM that ascertains compliance with the terms and conditions of mining permits/contracts and laws, rules and regulations

**DAO No. 2018-19**
Guidelines for Additional Environmental Measures for Operating Surface Metallic Mines

Provides new environmental policies that will ensure sustainable environmental conditions at every stage of mining operation, and minimize the disturbed area of a mining project at any given time
Chapter II

SHES Provision at Each Stage of Mining Operation
STAGES OF MINING OPERATION

EXPLORATION

DEVELOPMENT

PRODUCTION

FINAL MINE REHABILITATION & DECOMMISSIONING

PROGRESSIVE REHABILITATION
ENVIRONMENTAL RESPONSIBILITIES AT EACH STAGE OF MINING OPERATION

**EXPLORATION**
- Environmental Work Program (EWP)
- 10% of Exploration Expenditures
- Rehabilitation of explored areas
- Pollution control
- Campsite rehabilitation
- Drillsite rehabilitation
- SHP
- CDP

**DEVELOPMENT**
- ECC
- EPEP
- Erosion control
- Tailings dam/pond construction
- Storage of hazardous chemical management
- MRF & MTF
- SDMP
- SHP

**PRODUCTION**
- EPEP
- Tailings pond/ dam management
- Siltation ponds
- Reforestation
- Hazardous wastes management
- Slope stabilization
- SHP

**FINAL MINE REHABILITATION & DECOMMISSIONING**
- FMRD/P
- Removal of infrastructures
- Rehabilitation of all mine sites
- Remediation/ removal of all potential source of contaminants
- Maintenance of tailings dams
- FMRDF
- SHP
EXPLORATION

- means searching or prospecting for mineral resources by geological, geochemical and/or geophysical surveys, remote sensing, test pitting, trenching, drilling, shaft sinking, tunneling or any other means for the purpose of determining their existence, extent, quality and quantity and the feasibility of mining them for profit (DAO 2010-21 Sec. 5.aj)
Development means the work undertaken to explore and prepare an ore body or a mineral deposit for mining, including the construction of necessary infrastructure and related facilities. (DAO 2010-21 Sec. 5.s)
PRODUCTION

- extraction or disposition of minerals
- mineral processing
- marketing of minerals/mineral products
- implementation of Environmental Protection and Enhancement Programs and Social Development and Management Programs
FINAL MINE REHABILITATION AND DECOMMISSIONING

- involves establishment of a functional land use capability proximate to the land use prior to the disturbance of mine area

- involves implementation of the Final Mine Rehabilitation and/or Decommissioning Plan
Certificate of Environmental Management and Community Relations Record (CEMCRR)

- A proof of the applicant’s satisfactory environmental management and community relations in its past and/or present mineral resource use or mining-related ventures.
- Mining permit/agreement applicants with neither past nor present mineral resource use or mining-related ventures are exempted and instead issued a Certificate of Exemption.
- Requirements in the approval of Mineral Agreements, FTAA, Quarry or Commercial/Industrial Sand and Gravel Permit and MPP
Environmental Work Program (EWP) for Exploration

- Description of the expected and considered acceptable impacts and shall set out the environmental protection and enhancement strategies based on the best practice in environmental management in mineral exploration.

- This should include costs to enable sufficient financial resources to be allocated to meet the environmental and rehabilitation commitments (at least 10% of the exploration cost).
A systematic identification and evaluation of potential impacts of proposed projects, plans, programs or legislative actions relative to the physical-chemical, biological, cultural and socio-economic components of the total environment.
ENVIRONMENTAL REQUIREMENTS

Environmental Compliance Certificate (ECC)

- Document issued by DENR to certify that the project under consideration will have minimal environmental effects for as long as the conditions stipulated in the ECC are strictly followed, and that the proponent has complied with the requirements of the EIS System.
Environmental Protection and Enhancement Program (EPEP)

- It provides the description of the expected impacts of the mine and sets out the life-of-mine environmental protection and enhancement strategies based on best practice in environmental management in mining operation.
ENVIRONMENTAL REQUIREMENTS

Annual Environmental Protection and Enhancement Program (AEPEP)

Document prepared to effectively implement the approved EPEP, shall be based on the approved EPEP and shall be implemented during the year for which it is submitted.
ENVIRONMENTAL IMPACTS and CONTROL STRATEGIES

Land Resources

South Wall Side of the Pit - Oceana Gold Philippines, Inc.

Installation of cocomat

Hydroseeding

Lnl Archipelago Mineral, Inc.
ENVIROMENTAL IMPACTS and CONTROL STRATEGIES

Land Resources

Revegetation and slope protection

Forage planting

Taganito Mining Corporation

Tailings Storage Facility No. 2- Coral Bay Nickel Corporation
ENVIRONMENTAL IMPACTS and CONTROL STRATEGIES

Land Resources

Construction of a series of siltation pond

Desilting of siltation pond

Hinatuan Mining Corporation

Rio Tuba Nickel Mining Corporation
Installation of piezometers and data loggers
ENVIRONMENTAL IMPACTS and CONTROL STRATEGIES

Water Resources

Maintaining marine protected areas

Installation of artificial coral reefs

Filminera Resources Corporation

Hinatuan Mining Corporation
ENVIRONMENTAL IMPACTS and CONTROL STRATEGIES

Water Resources

Water recycling facility

Sewerage Treatment Facility- Oceana Gold Philippines, Inc.

Water treatment facility

Water Treatment Plant Area- Oceana Gold Philippines, Inc.
ENVIRONMENTAL IMPACTS and CONTROL STRATEGIES

Noise and Vibration

Processing Plant - Oceana Gold Philippines, Inc.
Air Quality

Water sprinkling along haulage roads

Rio Tuba Nickel Mining Corp.
Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP)

- A plan for returning the mine sites and affected areas to viable and, whenever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.
MIMAROPA Region

Rio Tuba Nickel Mining Corporation

Rio Tuba, Bataraza, Palawan

2008
MIMAROPA Region

Rio Tuba Nickel Mining Corporation

Rio Tuba, Bataraza, Palawan
MIMAROPA Region
Coral Bay Nickel Corporation
Rio Tuba, Bataraza, Palawan
Region IX

PHILEX GOLD PHILIPPINES, INC.

Sibutad, Zamboanga del Norte

1999

2018
SOCIAL REQUIREMENT

SOCIAL DEVELOPMENT AND MANAGEMENT PROGRAM (SDMP)

❑ This is a tool for the development and implementation of community programs, projects and activities for the host and neighboring communities of a mining project/area.

❑ This is a 5-year plan geared towards the development of a responsible, self-reliant and resource-based communities capable of developing, implementing and managing development programs, projects and activities.
SOCIAL RESPONSIBILITIES AT EACH STAGE OF MINING OPERATION

- **Exploration**
  - CDP is supported by a fund equivalent to a minimum of ten percent (10.0%) of the budget of the approved two (2)-year Exploration Work Program
  - Developed in consultation and in partnership with the host communities within the area subject of active exploration activities

- **Development**
  - Social Development Management Program
    - 1.5% of the operating cost
    - 75% for the development of host and neighboring community
    - 10% for the development of mining technology and geosciences
    - 15% for the institutionalization of public awareness and education on mining and geosciences

- **Production**
  - Social Plan
    - Consider the impact of mine closure, both for the workforce and impacted communities
  - Retrenchment Package
  - Labor Support Policies and Programs
  - Transfer of social assets and services

- **Final Mine Rehabilitation & Decommissioning**
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

1. Human Resource Development and Institutional Building
2. Enterprise Development and Networking
3. Assistance to Infrastructure Development and Support Services
4. Access to Education and Educational Support Programs
5. Access to Health Services, Health Facilities and Health Professionals
6. Protection and Respect of Socio-Cultural Values
7. Use of facilities/services within the mine camp or plant site
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Human Resource Development and Institutional Building

Sustainable agriculture-based Cooperatives
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Enterprise Development and Networking

Puto-making Training

Hollow-block

Atsara-making
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Enterprise Development and Networking

Training on local product weaving

Distribution of farm tractors
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Enterprise Development and Networking

Distribution of fishing boat

Livestock production
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Assistance to Infrastructure Development and Support Services

Road construction

Foot Bridge
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Assistance to Infrastructure Development and Support Services

- Construction of water reservoir
- Installation of solar-powered street light
CREDITED EXPENDITURES OR
ACTIVITIES OF SDMP

Assistance to Infrastructure Development and Support Services

Construction of multi-purpose building

Footwalk concreting
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Assistance to Infrastructure Development and Support Services

- Construction of recreational facility
- Construction of evacuation center
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Access to Education and Educational Support Programs

Provision of school supplies

Scholarship Program for indigenous people
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Access to Education and Educational Support Programs

Provision of Scholarship Programs
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Access to Education and Educational Support Programs

Provision of classroom

Provision of computers
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Access to Education and Educational Support Programs

Feeding Program of Day Care pupils

Provision of School Boat
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Access to Health Services, Health Facilities and Health Professionals

Emergency and medical assistance

Dental assistance
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Access to Health Services, Health Facilities and Health Professionals

Provision of medical supplies and medicines

Provision of medical doctors
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Protection and Respect of Socio-cultural Values

Support to local festivities

Provision of musical instruments
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Protection and Respect of Socio-cultural Values

Renovation/construction of Church
CREDITED EXPENDITURES OR ACTIVITIES OF SDMP

Use of facilities/services within the mine camp or plant site

Shuttle service of students
CORPORATE SOCIAL RESPONSIBILITY

Construction of classroom

Housing project
CORPORATE SOCIAL RESPONSIBILITY

Employment of local residents
Mine safety and health is a shared responsibility

The employer (mining company) must provide ways and means (training and personal protective equipment) for a safe work place; workers should learn how to perform their work safely; and government should be responsible for the development of regulations on safe working conditions.
Safety and Health Program

- Promote Safety & Health culture
- Strict enforcement of S & H regulations
- Establish effective systems of monitoring, inspection and investigation
- Promote training and human resource development

Holistic approach to ensure that mine workers are provided with a just, safe and humane working environment
Elements of Annual SHP

1. Leadership and Administration
2. Organizational Rules
3. Management and Employee Training
4. Good Housekeeping
5. Health Control and Services
6. Provision for Personal Protective Equipment
7. Monitoring and Reporting
8. Environmental Risk Management including an Emergency Response Program
...IS A SAFE MINE.

Safety Induction in Republic Cement Corp. - Bulacan Plant

Validation of safety records and performance of SR Metals, Inc.

Health control and service at TVI Resource Dev't Phils., Inc.

Emergency Response & Preparedness Drill in Apex Mining Co., Inc.

Mining Company and Service Contractors Consultation in Republic Cement Corp. - Bulacan Plant

MGB RO Seminar/Worshop in MGB-CAR
Good Housekeeping Promotion

Proper use of Personal Protective Equipment in the underground mine of Apex Mining Co., Inc.

Review of Safety and Health policies and regulations

Safety & Health Investigation at Tribal Mining Corp.

First Aid Training in the community of Tampakan, South Cotabato

Coordination with other agencies
Chapter III

FINANCIAL MECHANISMS FOR THE IMPLEMENTATION OF ENVIRONMENTAL PROGRAMS
CONTINGENT LIABILITY AND REHABILITATION FUND

CLRF

ENVIRONMENTAL TRUST FUND (ETF)
No fixed amount; minimum of PhP 50,000

MINE REHABILITATION FUND (MRF)

MINE WASTE AND TAILINGS FEE RESERVE FUND (MWTRF)
PHP 0.05/MT of mine waste
PHP 0.10/MT of tailings

FINAL MINE REHABILITATION and DECOMMISSIONING FUND (FMRDF)

REHABILITATION CASH FUND (RCF)
10% of the total amount needed to implement the EPEP or PHP 5M whichever is lower

MONITORING TRUST FUND (MTF)
maintained at PhP 150,000/ quarter
CONTINGENT LIABILITY AND REHABILITATION FUND (CLRF)

- CLRF is an environmental guarantee fund mechanism institutionalized to ensure just and timely compensation for damages and progressive and sustainable rehabilitation for any adverse effect a mining operation or activity may cause.

- There are two (2) forms of CLRF namely: the Mine Rehabilitation Fund (MRF) and the Mine Waste and Tailings Fees (MWTF).

- The MRF is composed of the Rehabilitation Cash Fund (RCF) and the Monitoring Trust Fund (MTF).
These are fees collected semi-annually from each operating mining company based on the amount of mine waste and tailings it generated for the said period to be used for payment of compensation for damages caused by any mining operations.

This shall be deposited in a Government depository bank and shall accrue to a Mine Waste and Tailings Reserve Fund.

PhP0.05/MT of mine waste produced

PhP0.10/MT of mill tailings generated
This fund is in cash deposited in a mutually acceptable government depository bank and covers the maintenance and other operating budget for the transportation and travel expenses, cost of laboratory analysis, supplies and materials, communication services, consultancy work and other reasonable expenses incurred by the multi-partite monitoring team in the amount of **PhP150,000.00 replenishable every quarter**.
This is established to ensure compliance with the approved rehabilitation activities and schedules for specific mining phase including research as defined in the EPEP/AEPEP in the amount equivalent to ten percent (10%) of the total amount needed to implement the EPEP or PhP5 Million, whichever is lower.
The FMRDF shall be established by each operating Contractor/Permit Holder to ensure that the full cost of the approved FMR/DP is accrued before the end of the operating life of the mine. It shall be deposited in a Government depository bank and shall be used solely for the implementation of the approved FMR/DP.

Annual cash provisions shall be based on the formula:

Annual Provision = Cost of Implementing the Approved FMR/DP x Percentage Required Per Table 1
# Schedule of Annual Cash Provisions to the FMRDF

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<th>Years to Lodge FMRDF</th>
<th>Mine Life</th>
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MANAGEMENT OF FUNDS

Contingent Liability and Rehabilitation Fund Committee (National)

- Chair - MGB Director
- Vice-Chair – EMB Director
- Members - Director LMB, FMB, BSWM, BPI, BFAR, NIA

Mine Rehabilitation Fund Committee (Regional)

- Chair – MGB Regional Director
- Co-Chair – DENR Regional Executive Director & EMB Regional Director
- Members – representatives from LGU, local NGOs/POs, Contractor/Permit Holder, and Autonomous Regional Government, when applicable
Multipartite Monitoring Team

Chair - MGB RO

Representatives
- DENR RO
- EMB RO
- Contractor/Permit Holder
- Affected community(ies)
- Affected ICCs, Environmental NGO
“Proposed mining projects should be technically feasible, environmentally compliant, socially acceptable and financially viable. Any of these imperatives absent, it is not time to mine.”
MARAMING SALAMAT!
INTERNATIONAL DEVELOPMENTS
CHALLENGES AND OPPORTUNITIES

JONATHAN HOBBS
The Enabling Environment

VALUE CHAIN
(Governance and Financial Flows)

- Contracts/licenses
- Regulation and Monitoring
- Collecting Taxes and Royalties
- Revenue Management and Distribution
- Investing in SD

SUPPLY CHAIN
(Commodity)

- Miner
- Buyer Trader
- Smelter Refiner Polisher
- Manufacturer Marketeer
- Consumer Recycler

PROJECT LIFE CYCLE
(Mining and Minerals)

- Exploration
- Planning
- Construction
- Operation
- Closure and Legacy

POLICY
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<td>2: Emerging Mining and Sustainability Theory?</td>
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<td>3: Search for Solutions</td>
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<td>4: Towards a Strategic Framework/ Opportunities for Collaboration</td>
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<tr>
<td>5. Research Possibilities.</td>
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</table>
PART ONE
PROBLEM ?
PARADOX OF PLENTY:
A COUNTRY’S NATURAL RESOURCES SHOULD BE BASIS FOR....

POVERTY REDUCTION
AND
SUSTAINABLE
DEVELOPMENT

HOWEVER

RESOURCE RICH COUNTRIES
CHARACTERIZED
CONFLICT, POVERTY, CORRUPTION, CIVIL STRIFE,
DISTORTED ECONOMIC GROWTH
ENVIRONMENTAL DEGRADATION
SITUATION IN 2000S: ECONOMIC SUPER CYCLE/BOOM TIMES

GOOD NEWS FOR SOME:

IMPLICATIONS?

- Remote areas explored
- Capital intensive technologies developed
- Infrastructure continued to expand
- Prices encouraged new actors entered the sector (China, juniors, ASM).
- Not engaged in standards formulation
- Not subject to investor conditionality
**Government**

- Legalisation and Formalisation
- Access to Finance and Encouraging Investment
- Strengthening policies and systems for Managing ASM and ASM revenues.

*No ‘One Size Fits All Solutions’.*

Need to understand their Motivations

*Not Always Policing*

**The Sector:**

- *Supply chain due diligence*
- Encouraging LSM ASM collaboration/Mentoring.
Bad News for Others.

Mines operated as Enclaves, Divorced from Landscapes and Communities in which they operated.

RESULTS
• Increased Community/CSO Mistrust and Conflicts.
• High Value Conservation Areas/ Ecological integrity/Biodiversity Threatened.
• Opaque Decision Making
• Unfair Distribution of Benefits.

- Reduced Access to Finance, Land, Talent etc
- Increased Risks, Costly Delays, Mine Closures, Fines/Prison
- Increased Scrutiny /(Social Media- Could no longer Hide)
KEEP THINGS IN PERSPECTIVE

MINING’SECOLOGICAL FOOTPRINT?
Relatively small compared to commercial agriculture, forestry, urbanisation……

CANNOT BLAME MINING ALONE

MAGNITUDE OF MINING IMPACTS

SIGNIFICANCE OF MINING IMPACTS
SPATIAL SCOPE FOR IMPACTS MAY BE EXTENSIVE

- Collateral Damage of Mining- Infrastructure
- Impacts through Natural Systems
- Through Value and Supply Chains
**Intended:**

Legal Resource extraction
Planned settlements

**Unintended:**

Opens pristine areas to ILLEGAL Resource Exploitation (poaching, timber extraction).
INFORMAL Settlements
Spread of Communicable Diseases
Land Speculation/Grabing
INDIRECT RISKS
OF THE ‘BELT and ROAD’

ASEAN’S
ECOLOGICAL INTEGRITY AND BIODIVERSITY?

What does the Belt and Road
Mean for
Asia’s Ecological integrity and
Biodiversity?

EXAMPLE INDIRECT IMPACT: BRI and BORNEO
Overlap between Mining Concessions and Orangutan
Habitat
CUMULATIVE EFFECTS
INCREMENTAL, INTERACTIVE, SYNERGISTIC.
SOCIETIES EXPECTATIONS CHANGING
Is the Resource Curse Inevitable?

Can mining ever be ‘sustainable’?

Unleashed a lot of initiatives / soul searching.
PART TWO
MINING and SUSTAINABILITY THEORY?
Mining deals in *Non – Renewable, Finite Resources* – not Sustainable Yields. (NB> Ignore Geologists/ Recyclers for now!)

Mining is a *Process that Converts* Non - renewable Natural Capital into other forms of Capital (social, financial, renewable, produced, human.) i.e. more sustainable opportunities.
# Good Governance of Mineral Value Chain

<table>
<thead>
<tr>
<th>Decision Chain</th>
<th>Guiding Principles</th>
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<tbody>
<tr>
<td><strong>Overarching Issues</strong>  &lt;br&gt;(Securing the greatest benefit for citizens.)</td>
<td>National Strategy, Legal Frameworks Competent Institutions Accountable Decision Makers</td>
</tr>
<tr>
<td><strong>Discovering the Wealth</strong></td>
<td>Transparent contracts and licensing Efficient/Effective Rights allocation.</td>
</tr>
<tr>
<td><strong>Getting a Good Deal</strong></td>
<td>Transparent Contracts / Tax regimes (reflecting full/true value of resource). Environmental and Social Costs accounted for. Pursuit of local benefits</td>
</tr>
<tr>
<td><strong>Managing the Revenues/Investing for Development</strong></td>
<td>Resource revenues invested transparently. Beneficiation and Diversification Take account of Revenue Volatility</td>
</tr>
<tr>
<td><strong>Project Management</strong></td>
<td>Ensure international Environmental and Social standards applied.</td>
</tr>
<tr>
<td><strong>Investing for (S)Development</strong></td>
<td>Beneficiation Diversification</td>
</tr>
</tbody>
</table>
All Mines (where they are appropriate) should aim to maintain and improve……

Social Welfare, Economic Rigor and Environmental Sustainability
A USEFUL DISTINCTION//CONTINUUM?:
‘RESPONSIBLE’ OR ‘SUSTAINABLE’ MINING?
PROFILING RESPONSIBLE MINING Progressing to Sustainability.

Business Ethics and Integrity: Abides by International laws, Transparency, Respects Human Rights, Engages (meaningfully) with all stakeholders, complaints and grievance mechanisms, Payment and Revenue Transparency.

Planning and Managing for Positive Legacies. ESIA, EMPs, (FPIC/SLO), CDAs, Avoiding Involuntary Resettlement, Emergency Prep and Response, Planning and Financing Reclamation and Closure.

Social Responsibility. Fair Labour practices, Occ Health and Safety, Community Health and Welfare, Preventing contributing to Conflict in High Risk Areas, respecting cultural heritage, forging positive relations with ASM.

IS RESPONSIBLE MINING ADEQUATE?

NO NET LOSS

Mining success should be judged beyond *Mitigating* Negative impacts.

NET POSITIVE

Sustainable Mining calls for both *Human and Ecological* well-being to be Improved.
SUSTAINABLE MINING

Go Beyond Compliance/Collaborate with various standards and certification schemes,

Move from Resource Use to a Resource *Stewardship* (Recognizing Shared Assets and Risks)

Engage in Inclusive and Transparent Dialogue and Partnerships.

Ask fundamental Questions about Mining Company’s role in Society

Mining cannot achieve SD on its own. Must be Partners in Sustainable Development.

Align Company’s Mission to the SD Agendas
IN REALITY.... NOT ‘EITHER / OR’
BUT
RESPONSIBLE AND SUSTAINABLE MINING

Responsibility and Sustainability – are Mutually Interdependent

The Chances are that…

An Irresponsible Company will have very little chance of being Sustainable

And

A Sustainable Company Inherently be a Responsible One..
PART THREE

THE SEARCH FOR SOLUTIONS
ASSESSING MINING AND ENVIRONMENT CANNOT BE LEFT TO THE PROJECT LEVEL/STAGE.

Probably All ASEAN countries have Mandatory EIA regulations – before Mining Project Approval.

Some have Mining Specific Guidelines.
  e.g. AsDB: Myanmar.
COMMON PROBLEMS WITH EIA:

• Too late in the decision-making process to have meaningful influence on decisions. (Strategic decisions already made/irreversible)
• Range of alternatives limited and focus Mitigation of Fait Accompli.
• Tick Box exercise. Viewed only as means to get a Permit/
• ‘Implementation Deficit’ – Capacity Issues
• Monitoring and Compliance Enforcement/ weak
• Asymmetry of Information
RESULTS?

- Communities/CSOs have no influence on decisions:
  - Adversarial/Antagonistic Relations/
  - Conflicts.
  - Anti-Mining Campaigns.

Result.

- Costly Delays/Increased Costs/Mine Closure.
New Gold Mine.
Situated on ‘Silk Road’
Sensitive Caucasus Mountain
Trying to Develop and Mine Responsibly.

Rigorous Investor Scrutiny/EBRD ES Performance Standards
10 versions of EIA/Comprehensive Compliance Register
Additional Research (e.g. Dust blow/ Groundwater concerns
Regular Audits
Action Plans: Community Engagement, Biodiversity (New National Park)
BUT....

Impasse for One Year.
Mine access roads blocked.
Litigation

Armenia has undergone (Velvet) Revolution.
Democratization novelty
(Previous approvals were by former government)
Anti Mining campaign driven by Bigger Issues.

• Perceptions have been shaped by Soviet legacy.
• No understanding of ‘Responsible Mining’ concept.
  • Supreme court ruling not implemented.
• Doubts about how representative protestors are.
• Some NGOs coming up with Obstructive new issues

RESULT

Lack of Trust
TALKING PAST EACH OTHER
Some opposition exists as a matter of **PRINCIPLE**.

‘Responsible Mining’, is going to be irrelevant to people who are vehemently against Mining *per se*.

**Stakeholders are Not Homogeneous.**
PART FOUR

TOWARDS A STRATEGIC FRAMEWORK FOR SUSTAINABLE MINING

Strategic Environmental Assessment
Ensure **Environmental** Factors are included in Developing/ Reviewing Strategies alongside Economic and Social Priorities.

**Policies, Plans and Programmes.**
(I.E. At the Earliest Stages of Decision Making.)

Basis for Guiding Sustainable Development and Setting Context for Mining Investments
UPSTREAM ENVIRONMENT IN THE DECISION-MAKING HIERARCHY

POLICY

PLAN

PROGRAMME

PROJECTS

STRATEGIC ENVIRONMENTAL ASSESSMENT

ACCUMULATIVE IMPACT ASSESSMENT

ENVIRONMENTAL (AND SOCIAL) IMPACT ASSESSMENT (EIA)
A GOOD SEA PROCESS …

- Elevates Environmental Considerations to Strategic Level.
- *Syndrome.*
- *Helps Identify…*
  - *Full Range of Options.*
  - *Shared Risks and Responsibilities*
  - The Role of Mining in Sustainable Futures/Scenarios.
- Aligns Mining plans with other priorities.
- Creates Platform to Engage Diverse Stakeholders
- Helps Reduce Conflicts/ Builds Trust
- Improves cross sector Coordination/Collaboration.
- Exposes Policy Inconsistencies.
- Contributes to Quality/ Well-Informed Decisions
- Addresses Cumulative, Trans-boundary issues
- Streamlines the Project EIA Process.
APPLY THE “MITIGATION” HIERARCHY ONCE STRATEGY AGREED

AVOID
• By exploring Alternatives - (No Go)

MINIMIZE
• By Managing/ Reducing Risks (and maximizing opportunities)

RESTORE
• By Repairing Unavoidable impacts.

OFF SET
• By Investing in Equivalent Opportunities (Compensation)

Phnom Prich Wildlife Sanctuary, Cambodia
TO MINE OR NOT?

In some circumstances perhaps the best use of resource endowments may be to Leave in the Ground?

Is Receiving Environment considered Too Sensitive.
Is Commodity Acceptable and Need compatible with SD?
Can Risks of Negative impacts be reasonably predicted (and therefore adequately managed).
Is Mining Appropriate at this place and time?

If so, can we successfully maximize positive and minimize negative impacts?

Overlay Sensitivity and Suitability Criteria.
CONCLUSION: The Way Ahead?
SET FRAMEWORKS FOR MINING FUTURES

Need To:

• Strengthen Systems for Ensuring Good Quality Mining Projects in Appropriate Place.

• Establish Profile of a Responsible/ Sustainable Mining Company and Project Acceptable to the Philippines.

• Inform Prospective Investors of Philippines Priorities (e.g. Land Use Plans)

Develop a Templates/ Indices to

• Screen Potential Investors/Companies/Projects and assess their Track Record (e.g. On Community Relations Environmental Standards)

Devise Requirements for:

SLO process/Contractual CDA with shared responsibilities, Strengthen EIA systems and Compliance Monitoring

WILL INVESTORS BE GOOD PARTNERS IN SDG.........
Potential Areas for more Rigorous Measurement/Modelling of Environmental and Social Impacts to inform Decisions?

**Decision to open an area for extraction.** To understand how positive impacts (inc revenues) will compare with the cost of negative impacts.

**Calculating Compensation Schemes for Affected Communities.**

**Modelling/Measuring “Off- Set” Options;** to establish Equivalence in Biodiversity and Ecosystem Services.

**Design of Community Development Programmes.** to ensure minimizing costs and maximizing benefits to communities from extraction.

**To Explain Policy Trade Offs.** To explain how Benefits for the mining sector will impact other sectors in the economy.

(EG How pollution from mining may impact agriculture or fisheries.)
**Improving the Rigor of Existing Tools**

**Cost-benefit analysis.** To compare the strengths and weaknesses of alternative options or scenarios—as a basis of comparing investment decisions.

**Ecosystem Services Calculations.** Valuing various ecosystem services (provisioning, regulating, habitat, cultural) and determining how these values will change as a result of planned activities.

**Ecological Foot-printing.** To quantify the impacts of human activities measured in terms of the area of biologically productive land and water required to produce the goods and assimilate wastes generated.

**Environmental Assessment.** Assessing the likely environmental/social impacts (positive and negative) of a project.

**Input-output.** Economic method to assess the inputs and outputs through an organization, industry or economy.

**Life Cycle Assessment.** (LCA) To evaluate the environmental aspects of a product or service through all stages of its life cycle.
MARAMING SALAMAT
THANK YOU