Part 01

ENVIRONMENTALLY SAFE AND EFFECTIVE OFFSHORE MINING FOR MAGNETITE IRON SAND, GOLD, PALLADIUM, PLATINUM, SILVER AND OTHER MINERALS AT THE OFFSHORE AREAS OF THE PHILIPPINES

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CHAPTER I

Executive Summary

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- The Environmental Protection minded civil and religious societies plus the influential non-government organizations in every part of the globe are strongly pushing most governments to minimize, limit, if not put a complete stop to the heavy extractive industry, like extraction of boulder types of Iron Ores, Nickel, Copper, Gold ,and the like, from the mountains where these minerals are hugely extracted using heavy earth moving equipments. Hence, mining of Magnetite Iron Sand and other minerals offshore, that are not originally part of the ocean, but are just deposited by gushing down of rivers, coming from the mineralized mountains would be the better alternative for sustainable mining operations and continuing supply to the steel industry.

- Iron Ore sourcing cost will later on become prohibitive, while Magnetite Iron Sand are abundant in supply in the offshores of ARC countries. Except in Japan where they have almost been exhausted.

- The same situation may also happen to minerals like Nickel, Gold, Palladium, Platinum, Silver, and the like.

- The offshore commercial extraction of Magnetite Iron Sand and other minerals of the earth will have NIL environmental effect, as its operation will be by simple siphon mechanism with magnetic separator that can generate only minor turbidity under the sea level. Once the siphon pipe is lifted from the area, the nearby deposits will cave into the area siphoned, as if nothing happened.

Further, only an average of 10% of the siphoned and magnetically separated Magnetite Sand is stored to the hull of the siphon vessel for industrial use/sale, or for export shipments. The rest of the 90% is returned back under the sea that may form as sand mounts, that can later develop into fresh fish habitation.

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This phenomenon according to Dr. Minoru Yoneno, a High Technology Consultant of Nippon Steel, was the “Japan Experience”, where after 8 decades of exhausting their Magnetite Iron Sand and other minerals from their offshores, substantially contributed to Japan’s industrialization. And 90% of the sand returned back to the sea crust, and were already cleared of toxic elements of the minerals after magnetic separation or segregation became sand mounts that further developed as natural fish weirs. Thus, the 90% under sea water without the steel component that used to warm that portion underneath the sea is now said to be equivalent to Cold Deep Ocean Water that became the habitats of fresh fishes and the 7 Succulent Sea Beasts in some areas of Japan. If everyone is aware about mining experiences in those other countries, it would seem that the next wave of the future to sustain mineral supplies to the world is Offshore Mining.

Just like in the Philippines where mineral deposits for Magnetite Iron Sand, Gold, Nickel, Palladium, Platinum, Silver, and the like, have been deposited in our offshores for about fifty million years. Where billions and billions of tons are buried under the sea that have been carried and deposited offshores by rivers, creeks and natural water ways gushing down from tall and highly mineralized mountains.

Per the experiences of Filipino scientist and mining expert Dr. Felipe Calderon and Japanese Siphon and Grab Vessel designer Takazo Toyoshima, rapid technological developments are happening for the last fifteen (15) years in the design, construction and putting up of Offshore Dredging, Mining Equipments, Anchor Handling Tugs, Drilling Facilities, and the like in Japan, USA, Germany, Norway, Australia and other advanced nations.

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This phenomena from the advanced countries could probably be their conclusion, that the way to go to the future about the much environmentally hated Extractive Industry for minerals from underneath and the surfaces of the earth may no longer be sustainable in huge volumes needed. Hence, they started to embrace the option of Offshore Commercial Mining as another alternative, or, support to feed the Steel and Industrial Sectors of the globe with the sustained supply of minerals from another technological sourcing similar to the way adopted by Fuel and Energy Sectors for renewable energy. Henceforth, the Offshore Commercial Mining operation as a look to the future. The key is Technological Development of Environmentally Safe and Effective Offshore Mining Systems with the use of technology designed Offshore Facilities for Mining Operation.

Exponentially, those Offshore Vessels, or, Barges Facilities for the last several decades were already being used Offshore for Mining, Dredging and Explorations in Indonesia, New Zealand, Japan, Russia, West Africa, and Canada.

CHAPTER II

Introduction

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For the long-term, based on the present activities of anti-mining advocates, pressure groups from the religious sectors and non government organizations that are against all forms of destructive surface and soil underground mining, using heavy extraction equipments, and the leaning tendencies of governments in deference to those protests both in the Philippines and in other parts of the globe, the future of the Extractive Industry onshore and on land could start to be on a limited scale. The mining industry may have to look seriously into Offshore Mining for Minerals as an alternative, or, support to sustain Industrial production stability worldwide for steel supply.

Very good examples are the experiences of specialists and experts, from the Philippines, Dr. Felipe Calderon and Japanese Engr. Takazo Toyoshima, both claimed that in the past several decades of offshore mining of Magnetite Iron Sand deposits in countries like Japan, New Zealand and Indonesia, there have been no evidence nor information published of any negative effects to human habitation, aquamarine life, nor to the ecological balance from offshore mining in those ARC countries. Therefore, this is a big boost to the business potential of the offshore Magnetite operation and other minerals for any offshore mining outfit in the Philippines. The Philippines, specifically in the provinces of Pangasinan, Ilocos Sur, La Union, Ilocos Norte and Cagayan, belong to those ARC countries with rich Magnetite Sand deposits.

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Magnetite Iron Sand mining has, in fact, been beneficial to Japan, New Zealand, and Indonesia. From the time they started Magnetite mining, it has been economically beneficial to the industrialization of the rural areas of those countries up to the present.

New Zealand has been supplying the world with specialty steels for the automotive industries, airplanes, sea crafts and the like. While Indonesia has started supplying the world with Pig, Cast, and Pelletized Irons that have heavy applications for the manufacture of heavy equipment and locomotive parts, as well as steel rollers and rails, that come from their Magnetite Sand deposits.

Indonesia moreover has notified the exporters of raw Magnetite Sand, that they will soon ban Magnetite Sand exportation to allow their own production plant to have greater access to raw Iron Sand inventories for pelletized and pig iron, as well as, intermediate Steel production rather than raw Magnetite exportation. This move of Indonesia is a big boost to Magnetite Iron Sand commercial operation for the Philippines.

There are only four (4) countries in the world that are called ARC countries with huge Magnetite Sand deposits. These are Japan, New Zealand, Indonesia and the Philippines. All three (3) have exploited their Magnetite Sand resources to the economic advantage of their people, their government, and their advanced stage of Industrialization.

Here in the Philippines we are still struggling, debating, and arguing as to how we can legally, effectively and safely exploit our huge resources for Magnetite Iron Sand.

The only reason why there are negative information on Black Sand Mining in the Northwestern Philippines, Ilocos, Pangasinan, and Northeastern Cagayan is because there has never been (from the1970's up to this time) a legal and large mining permit to be able to do so.

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Hence, due to huge demand for Magnetite Iron Sand and its other valuable mineral contents from steel smelter plants in the world, most specifically the nearby markets to the Philippines like China, Taiwan, India and Korea. Other groups are resorting to illegal mining and illegal exporting (smuggling out) of Magnetite Iron Sand. This is highly disadvantageous to the people, the communities, the LGU's and the Philippines as a whole.

Thus, if LGU's and the communities allow the Magnetite Iron Sand to go through, and the DENR can efficiently process the immediate governmental actions needed thereto, the Philippines could be one in the league of those ARC countries with large scale Magnetite mining operations that may lead to Rural Industrialization in those provinces of the country.

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The two (2) experts also state that Gold Mineral particles in great volumes can also be found at the offshore areas specifically in nearby discharges of rivers, streams, and creeks coming down from those tall and highly mineralized mountains all over the Philippine Islands.

The two (2) experts also find enthusiasm and positive affirmation in the recent findings of United States Geological Services USGS and NASA about their discovery of the biggest deposit/reserve of Palladium Mineral Resources and its allied Platinum Group of Metal in the offshore Coasts of Mindoro, Masbate, Romblon, Panay/Negros Areas in Southern Luzon, Philippines.

CHAPTER III

Description of Magnetite Sand & its Effective Uses

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Magnetite Iron Sand is a black colored oxide mineral and an important ore mineral of iron and special steels with the following chemical composition (Fe304).

Specific Gravity : 5.2

Hardness : 5.5 to 6.5

Color : Mostly black, but may come into grey, brown to black.

Luster : Metallic to Sub Metallic Magnetism Strong

Appearance : Mostly streak black

Where to Find Magnetite Sand

The magnetic sand placer iron ore deposit can be found in large quantities on the beach, sand areas, and coasts of New Zealand, California, Italy, Indonesia, parts of Australia, Brazil, Peru, and in other foreign countries. Such minerals as iron sand or black sand as commonly called, can be found in these foreign countries along beaches and alluminal sediments on and mostly offshore.

In the Philippines they are found in numerous places like the beaches in Bicol Peninsula, Masbate, Zambales, and Eastern Leyte. The most extensive ones quality and quantity wise are on the on and offshore areas of Northwestern Luzon specifically Pangasinan, La Union, Ilocos Sur and Ilocos Norte, and Northeastern Luzon like Cagayan and Isabela.

The abundance of this type of sand part of the Philippine Archipelago can be traced through Fifty (50) Million years of mountain river discharges to the sea coming from the mountains of Benguet, Cordillera, Caraballo, Sierra Madre and other highlands. Periodic earthquakes and rains have contributed much to the surges in volume of this Magnetite Sand in the sea near the shore, offshores and shorelines of such areas.

Effective uses of Magnetite Iron Sand

The mineral is often mined as an ore of Iron, and lately, through the use of magnetic separator / processing plant and chemical intervention, Magnetite Iron Sand became a primary source of raw material like Iron Ore for Steel and Cast Iron manufacturers when they are developed in the form of Iron Lumps, Balls, Fines, and Pellets. When formed as such, they are technically called Direct Reduced Iron (DRI) which are used to feed electric blast furnaces in the iron and steel making process.

Currently, the demand for this DRI feed stock is very high and fetching as high as US $ 82.50 per dry metric ton, to a low of US $42 in China, depending on the demand and inventory situation.

Hence, these recent validated phenomena in the Steel Industry have led to the upsurge in demand, in the global steel-manufacturing sector for Magnetite Iron Sand. When properly processed, high value Vanadium and Titanium can also be effectively obtained from Magnetite Iron Sand.

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CHAPTER IV

Description of Palladium, Platinum, and Silver, and their Effective Uses

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The history of Palladium naturally starts with the history of Platinum and the Platinum group metals of which it is a member. Whether Platinum was recognized as a separate body by early civilizations is doubtful. Traces of it have been found among artifacts from ancient Egypt. The best known example being a small strip of native Platinum set on the surface of a box among many Hieroglyphic Inscriptions, dated to the 7th century BC and from Thebes. It had been hammered out in the same fashion that Theban craftsmen treated Silver, and most likely had been mistaken by them for Silver.

The most successful early exploitation of platinum occurred rather in Americas – the New World – by the Esmeraldas people in the coastal region of Northern Ecuador many centuries before the arrival of the Spanish. Small pieces of jewelry, rings, pendants, etc., have been found made of Platinum or of Platinum and Gold combined, which displayed significant and sophisticated metallurgical skill.

William Farabee, a distinguished anthropologist of the University of Pennsylvania (1865-1925) wrote about one find:

"The native Indian workers of Esmeraldas were metallurgists of marked ability; they were the only people who manufactured platinum jewelry. In our collection will be seen objects of pure platinum, objects with a platinum background set with tiny balls of gold used to form a border, and objects with one side platinum and the other side gold."

The Indian’s metallurgic method aroused considerable curiosity, and further study by others pointed to the conclusion that they had used a quite sophisticated technique of powder metallurgy – sintering in the presence of a liquid phase. Radio carbon dating has placed the date of these artifacts to between the first and fourth centuries AD. Photomicrographs of some samples, both of objects identified as starting materials and of finished pieces, clearly showed the presence of sintering and the dispersion of platinum particles in a gold matrix. Few of platinum finds from Ecuador or Columbia have an archeological context, unfortunately, because they were found by treasure hunters. Jewelry appears to have continued to be made up until the time of the conquest. Many centuries passed before the Spanish rediscovered the source of the platinum and longer yet before the scientists of Europe could make it malleable and useful.

CHAPTER V

Data on Prospective Magnetite Sand Deposit in Northwestern and Northeastern Luzon, Specifically the Provinces of Pangasinan, La Union, Ilocos Sur, Ilocos Norte, and Cagayan

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The Philippines is a country that is rich in mineral resources where it is touted to be the 5th largest source of mineral reserves, following countries like United States, Brazil, West Africa, Australia and Peru. However, these vast mineral reserves have not been effectively tapped due to socio-economic reasons, legal entanglement, environmental concerns, and lack of capital, and lack of governmental push to make it happen.

Per existing record of Mines and Geo-Sciences Bureau, or MGB of the Department of Environmental and Natural Resources (DENR), the mineral reserve of the country stood at 6.67 Billion Metric Tons of Metallic Minerals and 78.74 Billion Metric Tons of Non-Metallic Minerals, excepting Magnetite Iron Sand that has heavy deposit concentration along the coasts in the provinces of Pangasinan, La Union, Ilocos Sur, Ilocos Norte, and Cagayan.

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Per data presented through the United Nations Development Program (UNDP) through its Technical bulletin and several MGB reports, the following are published items for Magnetite Iron Sand:

In Lingayen Gulf of Pangasinan, the Magnetite reserves are 572 Million cubic meters or 2.9 Billion tons.

The Province of Ilocos Sur and Ilocos Norte would not be far behind as its coastal length of approximately 150 kilometers is the nearest area of river discharges coming from the upland mountains of Northern Luzon with La Union, and Northeastern Luzon, Cagayan Province and Isabela, where the length of shorelines with substantial Magnetite Iron resources both on and offshore extends beyond 200 kilometers in length.

The Magnetite Iron deposit offshore in these provinces has already reached more than 22 kilometers long from the shorelines.

The wave action of the sea for 24 hours daily plus the periodic typhoons that visit the Northwestern Luzon and Northeastern Luzon frequently have allowed these Magnetite Iron Sand deposit to further be concentrated within 500 meters to 22 kilometers range from the shore, and due to wave actions of the sea even deposited huge volumes to the shorelines of some of the towns of these provinces. Hence, per the opinion of the Japanese Technician Engr. Takazo Toyoshima who is familiar with Magnetite Iron Sand extraction, the best area to efficiently extract, operate and mine the Magnetite Sand is within 500 to 20,000 meters of the coastal area from the shore, as technically designed series of siphon mechanism, magnetic separators and processing apparatuses can be installed effectively into a so called Siphon Vessel with Magnetic Separators and Power Plant.

The continuing wave action of the sea combined with replacement volumes from the mountains gushing down through the creeks and rivers especially during rainy, typhoon and monsoon months will provide unlimited volume potentials to replace Magnetite Iron Sand delivered without intervention to the shore and offshore for processing and export in huge endless volumes.

The above findings were based on the actual experiences of Magnetite Iron Sand mining in the ARC countries like Japan, New Zealand and Indonesia, while in the Philippines was based on the sampled exploration activities in one (1) sampled area where Mines and Geo-Sciences Bureau (MGB) and Nations Development Program UNDP jointly conducted in April 1987 as follows:

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a). Research for Preliminary information and data

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b). Reconnaissance survey

c). Sea bottom sampling along Damortis Bay in Southern LA Union within the Eastern side of Lingayen Gulf, which confirmed the presence of high grade Magnetite deposit covering 7 to 8 kilometers long from the shore, specifically from 300 meters to 5 kilometers long and showed an average depth of Magnetite Iron Sand deposit from a low of 2.6 meters up to 40 meters depth on the average, and the magnetic anomaly show much more depth on longer distances from shore.

d). Marine Geo-Physical Survey through the running of high resolution seismic, side scan, sonar, and magnetic and echo sounder survey in predetermined track of lines, thereby, obtaining detailed information on the stratigraphy of the unconsolidated sediments in order to delineate areas with economic concentration of detrital heavy minerals like Magnetic Iron Sand.

Recorded data of JICA Metal Mining Agency in Japan also confirm above findings.

CHAPTER VI

Data on Prospective Deposits of Platinum Group Metals, Palladium, Silver and the Like, Specifically in the Provinces of Mindoro, Masbate, Romblon, Panay/Negros Island

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Another positive information about the future of Offshore Mining for the Philippines is the latest from United States Geological Survey (USGS) report, as confirmed by NASA where the Philippines could be one of the richest countries in Asia following the discovery of the world's biggest Palladium reserve off the coasts of Negros, Panay, Mindoro, Romblon and Masbate Islands, south of Luzon.

NASA, together with USGS, (United States Geological Survey), released a 3-year study report detailing the 8,450 square kilometer palladium deposits lying below the seas of Visayas, Sibuyan, and Tablas Strait.

The current biggest producer of Palladium is Russia with 44%, followed by Africa with 40%, and the rest are from Canada and the US.

The report also stated that, if the Philippine government allows foreign investors to dig and mine the palladium deposits, the country can expect around $9.8 Billion a year in net profit.

USGS estimated that the whole deposit is 2% bigger than that of Russia with a total volume of around 3.8 million metric tons.

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CHAPTER VII

Identified Enabling Laws that Can Be Used to Assure Stability of Investment in the Mining of Magnetite Iron Sand

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EXECUTIVE ORDER OF PRESIDENT BENIGNO AQUINO III recently developed by the Minerals Development Council (MDC) in Malacañang.

EXECUTIVE ORDER NO. 79 recently issued by President Benigno Simeon Aquino II

EXECUTIVE ORDER NO. 270 issued by President Gloria Macapagal-Arroyo on January 16, 2004, provides for set principles that will govern the revitalization of the mining industry with the objective of Economic Development, Environmental Protection and Social Equity.

MINERAL ACTION PLAN of the Department of Environment and Natural Resources (DENR) that started in some areas that made Executive Order 270 operational, thereby addressing the specific obstacles related in the revitalization of the mining sector.

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PHILIPPINE MINING ACT of 1995, and affirmed by the Philippine Supreme Court which, among others, lifted the ban on offshore and on shore mining of Magnetite Iron Sand and allowed foreigners under certain conditions to explore, mine and export minerals both processed and unprocessed from the Philippines.

LOCAL GOVERNMENT CODE of 1991, whereby it provides to allow the Provincial Governments to issue, Small Scale Mining Permits (SSMP) and Ore Transport Permits (OTP), or, mining operations through the Minahang Bayan, DENR Regional Offices and LGU initiated commercial mining.

CHAPTER VIII

Professional, Geological, and Engineering Works Needed for Long Term Sustainability and to Determine Data Accuracy

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- Continuing exploration, research, and references to experts;
- Perform magnetizing and/or sounding depth survey and partial strategic drilling activities to establish basis for larger and actual drilling later for commercial extraction potentials in terms of volume and quality.
- Follow-up study to independently verify available data;
- Ground magnetic and seismic surveys from on to offshores to identify prospective belt of reserves and replacement volumes in the future;
- Scoping Study and Metallurgical Works;
- Further the trail of magnetic anomaly through oceanography or other technical means;
- Secure Strategic foreign partner for funds needed for Large Scale Operation for Exploration, Extraction, Processing, and eventually Production Plant for special Steels and Pig Iron Plants and Rare/Special Minerals like the Platinum Group of Metals, and the like. And also Gold now being identified as Primary Monetary reserves of countries;

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CHAPTER IX

Social Acceptability and Community Development Plans and Programs

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The negative environmental impact of the Magnetite Beach Sand and offshore beach area sand recovery process is NIL. The extraction of the Iron Sand, whether taken from the offshore, or within the 20 kilometer radius would be very simple.

For offshore, it is via siphon vessel with magnetic separator, and processing apparatuses on board. This system has no hazard at all and no social complication as the siphon vessel is stationed at the ocean far from the shore.

The siphoning action of the Siphon Vessel for Magnetite Sand Offshore based on findings of the experts and specialists does not produce significant sea bottom topography disturbances due to the following reasons:

a) There is no explosive use. Hence, there is no blasting activities;

b) There is no permanent structure buried to the sea bottom;

c) The area underneath the sea agitated by the siphon pipe/s, while it can cause localize turbidity, would immediately cave in upon pull out of the siphon pipe/s due to continuing action of the sea under current;

d) The magnetic separator on the siphon vessel would only qualify about 10% average for quality grading required. Hence, will return back to the same area the 90% of the lesser grade Magnetite Iron Sand;

e) The sand mounts with lesser magnetite that can be created by the return after magnetic separation under the sea, may even become series of new fishing areas during calm season nearer the shorelines.

f) The continuing replacement every time it rains allows the 10% extracted for higher grade to be separated for export shipment;

For several hundreds of years those Iron Smelting plants in Japan are importing Iron Sand for their own Magnetite Iron shortfalls, from Philippines, Brazil, Peru, Indonesia and New Zealand. There has been neither incident nor actual record of any environmental degradation in those areas where Iron Sand Offshore and Onshore extraction has been reported or had happened.

Onshore Magnetite Iron mining may be done either from offshore delivery to the shore or, from the deposits on the shore itself.

To deliver the offshore Magnetite Iron Sand within the said radius requires only technically designed and simple air pumps and compressors with hose attachments. The small machine is floated 500 (or more) meters offshore and the conveyance pipe to carry the sand and a small water portion to the shore for separation is buried under the sand up to shoreline stockpile area. Hence, no disturbances to anybody at all. The said equipment can be duplicated to match the volume needed to equalize the number of units of the magnetic separator.

Likewise the processing of Magnetite Iron Sand on the shore is very simple, using a small processing plant similar to a 2 Bagger Portable Concrete Mixer. It is accomplished by mixing up the high and middle grade Magnetite Sand in a slurry tank that feeds wet magnetic separation drums. Maximum capacity for such size would average up to a maximum of 100 tons per hour. Under this process, the non-magnetic materials are redistributed back on to the beach as grey, or white sand and returned to its natural state which is suitable for walking bare feet in the sand.

Large Offshore operations through Siphon Vessel/s with magnetic separator / processing plant may also be resorted to for very large mining operation.

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The large operation program for offshore magnetite mining may have to be adapted for <u>immediate,</u> <u>medium,</u> and <u>long-term.</u> So that the people in the community can dramatically start to feel the benefits of the operation without the fear of negative impact to their coastlines as offshore operations are distant from people's view. Said plans will also be beneficial to the present and future owners and stakeholders in the Community where the mining operations will be made.

<u>The principal negative thoughts fed by groups with vested interest to people in the target area of magnetite mining are the following unfounded ideas and without scientific basis:</u>

That magnetite mining can increase vulnerability to floods as Magnetite Sand holds the sand together. The absence of Magnetite in the sand can deplete and erode the coastal and near shore areas as the experience of Bauang, La Union has shown.

THIS IS EXTREMELY **<u>NOT TRUE:</u>**

1) The Magnetite Sand does not magnet each other, it's the ACTUAL MAGNET that can keep them together. Magnetite does NOT mean the sand possesses Magnetic character.

2) There has never been a Magnetite Sand Mining Operation that has caused flooding and coastal erosion as the wave action of the sea toward the shore is actually replenishing whatever volume is to be taken from any specific area.

3) Latest scientific findings show that **global warming** has tremendously increased the water level of the ocean, thereby submerging and flooding most of the low lying areas like Bauang, La Union and the areas of Malabon, Navotas, and parts of Bulacan and Pampanga where Magnetite Sand extraction never took place.

ON THE OTHER HAND THE LATEST SCIENTIFIC FINDINGS ABOUT THE EFFECTS OF THE MAGNETITE IRON SAND PRESENCE ARE AS FOLLOWS:

a).**ON THE ENVIRONMENT** – The high temperature being produced by Magnetite Iron Sand on its area of concentration of deposits contribute to having the formation of so much rains in the area hence, the flooding and erosion.

It destroys the ozone layer on the area, or, community of its high concentration like Pangasinan, La Union, Ilocos, Cagayan, Isabela, hence, during heavy rain, the down pour of rainwater on these areas are very high in millimeter (measuring volume of PAG-ASA). These events periodically destroy infrastructures, agriculture, community facilities, people's lives, dwellings, and other assets of these areas in higher proportion when compared to other regions.

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For the last several hundred years, mining for the Magnetite Iron Sand is being done in ARC countries like Japan, New Zealand and Indonesia, as well as Brazil, Peru and the like. There has been NO SCIENTIFIC REPORT or any OFFICIAL PUBLICATION that Magnetite Iron Sand mining has resulted in the degradation of the environment in those countries.

In fact, as experts have discovered, there is <u>no life form</u> <u>nor aquatic marine life</u> therewith in specific areas in those countries where there are presence of Magnetite Iron Sand deposits. Just like the Dead Sea due to its salinity and high mineral contents. Likewise, the Northwestern Luzon and Northeastern Luzon shorelines and its offshore areas with presence of Magnetite Iron Sand deposits allow <u>no living thing</u> to flourish. Therefore, there have been no environmental disturbances in those places to living things during its extraction for mining.

Submitted professional studies show that mining for Magnetite Iron Sand has never resulted in environmental change of any magnitude that have posed danger to lives, health, and habitats in those areas where there have been mining operations for Magnetite Iron Sand due to the following expert observations and findings:

1. That, Magnetite Iron Sand is NOT AN ORGINAL PART OF THE OCEAN AREAS WHERE THEY ARE NOW BURIED, HENCE, NOT AN ORIGINAL PART OF THE SHORELINES WHERE THEY ARE NOW DEPOSITED. EXTRACTING THEM ARE SIMPLE AND NOT HARMFUL;

2. That, Magnetite Iron Sand is originally part of the mountains near the sea where they are deposited. From the mountains, they are continuously being delivered gushing down through the rivers and creeks to the shorelines, which is most heavily during advents of rains and typhoons.

Hence, enormous volumes of those Magnetite Iron Sand in millions and millions of tons (and in other areas even billions of tonnages) are continuously abounding on those sea shores and oceans;

3. That, Magnetite Iron Sand is deposited in concentration to Offshore and Onshore areas nearer the coast lines and on the shorelines due to the 24 hours continuing wave action of the sea.

4. That, data and information also show that the international required grade of Magnetite Iron Sand for Steel and Cast Iron production of 59% up to 63% desirable percentage grade is only between 8% up to 12% of the Magnetite Sand Deposit, or an average of only 10%. Hence, after magnetic separation and processing, the average 90% component is returned back from its source either Onshore or Offshore;

5. That, Magnetite Iron Sand in the Northeastern Luzon and the Northwestern Luzon is "God's Blessing" because the presence of our highly mineralized and tall mountains become its endless source of continuing replacements as they are mined in the future.

b).<u>**ON FISHING**</u> – High grade Magnetite Black Sand is <u>toxic to aquatic life</u>. Hence, history will tell us that for the last several hundred years, there has been a continuing decline of aquamarine products like fish within the area where the Magnetite Black Sand is highly concentrated. Fisher folks have to resort to using their motorized *bancas* up to about 20 kilometers or more from the shore before they can catch fish, or, other fishing livelihood products.

c).**<u>ON TOURISM</u>** – The beaches and ocean fronts of the areas with heavy concentration of high grade Black Iron Sand, or, Magnetite Iron Sand WOULD NEVER be able to put forward a sustainable tourism program that can cater to foreigners specially from the western culture due to the following:

1. Ocean front beaches must be walk-able by bare feet. The high temperature produced by Magnetite Iron Sand is like **walking on a series of very hot flat iron.**

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2. Beach areas are desired by Western or Asian tourists, so they can lie flat, or, relax while sun tanning (exposure to the sun to get skin vitamins). No one can lie flat, or, relax on high temperature <u>Iron Sand that can burn one's skin.</u>

3. Medical records also show that Black Sand is harmful to human skin same as it is harmful to plants and marine life.

4. No animal, human, marine, or aquatic life can sustainably stay very long on Magnetite Iron Sand due to <u>its harmful temperature</u>.

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SOCIAL DEVELOPMENT AND MANAGEMENT PROGRAM

The proponent is mandated to do Social Development and Management Program to be presented to the LGU's, NGO's and the entire community of the Project Area.

The proponent must set aside, between 1% to 2 % of its GROSS Revenue Proceeds for the Human Community upliftment and development of the community in the Project Area.

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CHAPTER X

Electronic Data Recording for Magnetizing and Grab Sampling, as well as Preliminary Exploration, Depth and Sounding Survey, Geology, Geo-Chemical, Partial Strategic Drillings and Laboratory Test Results

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A good example that can serve as a model for “Best Practices” was done by JDVC Resources Inc., by recording historically and electronically its several years of Exploration and Resource. Estimating in the Province of Cagayan for its Magnetite Iron Sand Projects.

As a matter of fact the success of JDVC Resources Inc. was positively reconfirmed by PMRC Competent Person on Exploration Result and Mineral Resource Reporting by Rafael R. Liwanag in his “ Comprehensive Report on the Results of Exploration and Mineral Resource Estimates for those Proposed Offshore Magnetite Mining Project of JDVC Resources Corporation Denominated as MPSA-338-2010-II-OMR Located Offshore Areas of the Municipalities of Sanchez Mira, Pamplona, Abulug, Ballesteros, Aparri, Buguey and Gonzaga, Province of Cagayan”.

This paper cited some results, engineering works and geological best practices employed by JDVC's hired professionals and are herewith attached for the better understanding of the readers.

This paper likewise cited some of the Comprehensive Report on the Results of Exploration and Mineral Resource Estimates for those Proposed Offshore Magnetite Mining Project of JDVC Resources Corporation Denominated as MPSA-338-2010-II-OMR Located Offshore Areas of the Municipalities of Sanchez Mira, Pamplona, Abulug, Ballesteros, Aparri, Buguey and Gonzaga, Province of Cagayan by PMRC Capital Competent Person Report dated August 15, 2015,

CHAPTER XI

Technical Application Requirement in Accordance to Environmental Laws and Compliances, Field Situation, DENR, and MGB-EMB Compliances Requirements and Guidelines

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To be able to develop a Comprehensive and Strategic Plan for Environmentally Safe and Effective Offshore Mining for Minerals in the Philippines. Professional Scientists and Experts must have thorough and adequate general, information of the Geology and Mineral Resources of the Philippines.

Their information may allow the Team of Experts to design, develop and build applicable Exploration Drilling and Siphon Vessels with Appropriate Loading of Minerals to Magnetic Separators, and Cargo and Siphon Vessels with Grab Facility and Segregators for processing of Platinum Group of Metals, and Minerals Anchor Handling Tug for those kinds of offshore Vessels and the like.

JRCC Consultants, Inc. through its Principal Dr. Felipe Calderon has been tapped to provide the herewith-executive summary on Geology and Mineral Resources of the Philippines, and the more comprehensive write-up on General Information of the Geology and Mineral Resources of the Philippines.

Licensed Geologist Louis T. Santos, a younger Geologist with a substantial professional experiences and engagements was likewise tapped for the actual and physical exposure to the targeted Offshore Mining Sites to assist the designers.

JRCC Consultants, Inc.

Chemical Engineering * Metallurgy and Metallurgical Engineering * Process Engineering
Manufacturing Engineering * Mining and Geological Engineering * Management Engineering

EXECUTIVE SUMMARY ON GEOLOGY AND MINERAL RESOURCES OF THE PHILIPPINES

Advanced Technology Resources Mining & Business Process Technology Provider Corp.

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The **Science of Geology** is divided into two broad areas, physical and historical. **Physical geology** examines Earth's rocks and minerals and seeks to understand the hundreds of processes that operate beneath or upon its surface. The aim of **historical geology** in contrast is to understand Earth's origin and how it changed through time. **Historical geology** strives to establish the chronology of physical geology and biological changes in the past. Today**, uniformitarianism** is a fundamental principle of modern geology. It states that the physical, chemical and biological laws that operate today also operated in the geologic past. The concept of geologic time is new to many non-geologists. People are accustomed to dealing with increments of time measures in hours, days, weeks and years. History books often examine events over spans of centuries, but even a **"century"** is difficult to appreciate fully. A 1000 years old artifact is understood as **"ancient".**

By contrast, those who study geology must routinely deal with vast time periods – millions or even billions (thousands of millions) of years. When viewed in this context of Earth's 4.5 billion year history, a geologic event that occurred 100 million years ago for instance maybe characterized as **"recent"** by geologist and a rock sample that has been dated at 10 million years maybe called **"young".** An appreciation for the magnitude of geologic time is important in the study of geology because many processes are also gradual that vast of times are needed as in the case of **magnetite sand** before significant changes occur.

In this report therefore, it has been found extremely necessary to begin with the Philippine geologic history in general and to the Northwest Luzon environment in particular, in order to understand the processes that have occurred in the **"recent past"** to serve as scientific evidence of the presence of ironsand deposits, their origin, behavior, and chemical character, both at the onshore and offshore environments.

Effort has been made to present information why the presence of iron sand deposits in Japan, Philippines, Indonesia and New Zealand, the so called **Volcanic Island Arc Countries,** are the only geologic environments in the world where substantial volume of iron sand deposits are found. It is in this context that one may infer why the Philippines comparatively indicate more substantial volume than the other three environments. Similarly, information has been provided with regard to the commercial exploitation in the past of the onshore iron sand deposits at the Northwest Luzon area exemplified by the **Filmag (Philippines) Inc.** operations. The **"Filmag"** magnetite iron sand concentrates was proven to have exceptionally good and satisfactorily physic-chemical properties that as a result, several large iron and steel makers of Japan, then the world's largest manufacturer, continued to import from **"Filmag"** until the Philippine government during the Marcos Government banned the mining of iron sand. It goes without saying therefore that consequently, **substantial amount of deposits onshore** have been left behind and remained untouched until today.

Further information has been provided about the early activities of forward looking Filipino geologist in the investigation of offshore ironsand deposits. The geologic past and the subsequent modern understanding of geology described above guided the geologist to delineate the offshore deposit. Satisfactory, geotechnical and engineering analyses of the offshore deposit prompted FILMAG to undertake the feasibility of establishing a special iron and steel making complex with the assistance of Japanese Experts. The project was found commercially viable and was readily approved by the government for implementation. The project, however was unfortunately discontinued because of the following Philippine Revolution that ensured shortly thereafter.

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Detailed information has also been provided about the very successful **UNDP – Philippine Bureau of Mines Offshore Iron sand Exploration Project** that confirmed the presence of commercial qualities of offshore iron sand deposits. **Finally**, detailed information has been provided with regard to the current activities of several offshore mining outfits covering the offshore environments of the **Northeastern Luzon Iron Sand Resources.** This undertaking has been made possible necessarily because there are sufficient information and evidence experienced in the past to guide them in their exploration and exploitation activities.

Guided by the principle **of physical and historical geology** and **advances** made in modern geotechnical studies, the report concludes that the measurement works done in **Ilocos Norte, Ilocos Sur, Bauang and Carlatan in La Union, San Fabian and Lingayen in Pangasinan is considered an ECONOMIC ZONE** for the all important sought after detrital deposit waiting to be systematically explored and exploited for the benefit of the country and people specially in this part of the world.

Likewise, the USGS/NASA report about the largest deposit of Palladium and the related Platinum Group of metals off the Coasts of Mindoro, Masbate, Romblon Panay/Negros area in South Luzon is another phenomenon in the Philippine Mining Sector that could be worthy of Exploration.

The report has been sourced basically from well known International and Domestic Published Literatures and related publications, pronouncements of scientific discoveries, often utilized by Academicians and Professional Practitioners. Additionally, from standard science, engineering, technical practices and experiences in the field. The report has been professionally assimilated and edited where necessary, that served to provide a collective and useful foundation guide to attain the primary objectives of the report.

DR. FELIPE P. CALDERON
Dr. Science and Engineering
Reg. EM. Reg. E., MScE, Pr. Geol., Pr. Phy. Sc

I. Introduction

General Information of the Geology and Mineral Resources of the Philippines

1. Geology of the Philippines – Emphasis on Region I

The Philippine Archipelago lies in the West Pacific Ocean, just north of the junction of three great tectonic plates of the lithosphere, the Eurasian Plate, Pacific Plate and Indo-Australian Plate. It forms a roughly triangular area bounded by the Bashi Channel on the north, the North Luzon-Manila-Palawan Trench and ridge system on the west, the Sulu-Sabah Ridge Complex and Cotabato Trench on the south and the Philippine-East Luzon Trench on the east.

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Morphologically, the Philippines may be described as a composite of linear, subparallel ridges alternating with basins and troughs following the trend of bordering trenches. The ridges are upthrusted and /or uplifted belts of ophiolite and volcano-plutonic complexes. The intervening lows are sedimentary basins and troughs exposed partly on land areas following uplift or folding. The archipelago is defined by a main arc of islands facing the Pacific and two narrower arcs projecting from its southwest flank linking it to Borneo. The main arc may be viewsws as made of convex arc, the northern arc convex westward and the southern arc, convex eatward.

The archipelago is classified into two major structural units, a mobile belt and a stable region. The mobile belt, a broad zone of active deformation characterized by pronounced seismicity and volcanism runs longitudinally throughout the entire length of the archipelago. Tectonic activity is defined by active crustal underthrusting or subduction along its bordering trenches. On the east, the Philippine Sea floor is underthrusted along a west-dipping subduction one marked by the Philippine Trench. On the west, the South China Sea bottom is underthrusted along the east-dipping Manila Trench. Active subduction is likewise occurring along the east-dipping Negros and Cotabato trenches.

In contrast to the mobile belt, the southwestern part of the archipelago which embraces mainly Palawan and Sulu Sea is generally considered a stable or aseismic zone. The Sulu and Palawan trench-arc complexes appear as generally inactive subduction system which in north Palawan show a remnant of continental platform developed most probably in the Early Jurassic.

The archipelago is here divided into four physiographic units, namely, 1) Palawan, 2) Western, 3) Central, and 4) Eastern physiographic provinces.

1.1 Physiographic

The Philippines is an archipelago of 7,107 islands and islets in the southern part of the western Pacific island arc system bordering continental Asia. It lies between South China Sea and Philippine Sea, and straddles Sulu Sea and Celebes Sea on the southwest. It is separated by seaways from Taiwan, Borneo, Sulawesi, and Halmahera islands. D'yami is the northernmost island and Sibutu, the southernmost. The territory is bounded roughly by 4^{o} and 22^{o} N latitudes and 116^{o} and 127^{o} E longitudes. The total land area is 300,000 square kilometers. The major islands are Luzon (106,000 sq km), Mindanao (96,000 sq km), Samar (13,000 sq km), Palawan (12,000 sq km), Panay (12,000 sq km), and Mindoro (10,000 sq km).

Eastern, Central and Western physiographic provinces altogether constitute a region bounded on both sides by deep trenches and are composed of a series of ridges and troughs generally parallel to the trenches. The Palawan Physiographic Province is separated from the rest by a channel connecting Sulu and Manila trenches. The NE-SW trend of ridges and troughs in this provinces is almost at right angles to the NS to NW-SE trends in the other provinces.

The marginal sea basins, trenches, and troughs are of the same order of prominence as the physiographic provinces.

The Western Physiographic Province is composed of ridges and troughs which collectively comprise the western segment of the Philippine "mobile belt". The northern part is parallel to the Manila Trench; the southern to the Sulu Trench. The province is divided into three sub-provinces.

Zambales Subprovinces

Zambales Subprovinces is composed of West Luzon Trough, Lubang Ridge, Ilocos Lowlands, Zambales Range, Western Mindoro and Buruanga Peninsula.

West Luzon Trough (Ludwig, et al, 1967) extends from west of Zambales to south of Taiwan. The portion within the Philippine territory is about 720 km long with widths varying from 15 to 35 kilometers. The average depth is 400 meters. Geophysical data indicate that the rough is half filled with slightly folded to undisturbed sediments.

Lubang Ridge is a submarine ridge that starts from Taiwan and surfaces at Lubang Island, northwest of Mindoro. It is 900 km long and 40 km wide. The crest is 2600 below sea level.

The Ilocos Lowlands is along Northwestern Luzon.

It measures about 95 km long and 35 km at its widest, extending from south of Vigan to Pasaleng. It is bounded on the east by the western limits of Luzon Central Cordillera. This lowland consists of low rolling hills and a narrow plain following the western coastline.

A striking drainage feature is the braided stream pattern developed in upper Laoag River where alluvial fans are formed. A fault cuts the downstream course of the river. At the downthrown block, the anastomosing river channels converge into a single stream before emptying into the South China Sea.

Zambales Range is about 220 km long and 40 km wide. It extends from Lingaqyen Gulf on the north to Bataan Peninsula on the south. The range consists of high peaks and rugged ridges. Prominent among the peaks are High Peak (2037 m), Iba (1601 m), Pinatubo (1780 m) and Natib (1287 m).

The northern part of the range is bordered by low rolling hills which merge with small coastal plains. Short, rapid streams drain the western slopes. Interrupting the rocky western shoreline are small plains.

Western Mindoro covers an area of about 6000 sq km and is bounded on the west and south by Mindoro Strait, on the north, by Verde Island Passage, and on the east by Eastern Mindoro lowlands. The terrain is characterized by rugged mountains, intervening valleys and elongated plateaus with rolling lands along the coastal region. Among the mountain peaks are Halcon (2587 m), Baco (2487 m), Calavite (1312 m), Exline (1170 m), and Pamucuban (790 m). streams develop braided drainage systems near their mouths.

Buruanga Peninsula protrudes westward from northwestern Panay. It has an area of about 400 square kilometers. It exhibits three types of physiographic development influenced principality by the nature of the underlying rocks. Contrasting patterns are shown by marbleized limestone, undifferentiated metamorphic, and quartz diorite in conformity with their varying resistance to weathering.

On the central part, marble forms broad highlands. Drainage is largely subterranean. On the east, the folded metamorphic rock sequences is truncated and leveled by erosion to a lower relief. Drainage is controlled by schistosity planes. On the southeast, the quartz diorite forms low hill with intervening shallow valleys. The western fringe of the peninsula exhibits karst topography. A saddle between the towns of Pandan and Nabas forms the isthmus of the peninsula.

Antique Subprovince

Antique Subprovince corresponds to the north-south trending Antique Range along the western coast of Panay. The range is approximately 200 km long. It consists of sharp ridges and deeply dissected valleys. Westward, it slopes rather steeply to the Antique Trough. Eastward, the range slopes gradually and forms a wide belt of foothills that merge with the western side of Panay Central Plain.

Elevation on both extremities of the range reach more than 900 meters. The highest peak is Mt. Nangtud (2049 m) at the center.

Zamboanga –Sulu Subprovince

This subprovince consists of Zamboanga Peninsula and Sulu Archipelago including Basilan Island. Zamboanga Peninsula is the westernmost part of Mindanao. It is linked to the mainland by an isthmus between Panguil and Illana Bays. It is bounded by the Sulu Sea on the north and west, the Moro Gulf on the immediate south and Basilan Strait on the southern tip. The coast is generally rocky with limited stretches of beaches.

The northeastern part of the peninsula is rugged and mountainous. Prominent peaks are Dansalan (718 m), Sharp (753 m), Tupilac (683 m), and Silingan (899 m). The Area is dissected by large streams. The southern part is composed of rugged mountains of moderate elevations. At the southern extremity of the peninsula, near Zamboanga City, is a small coastal plain of uplifted coral reefs.

The Malangas-Sibuguey highlands are within Zamboanga del Sur. The northern part consists of patches of folded and faulted volcanic rocks. On the south, promontories consist of elevated reef limestone. Several peaks are within the area: Mts. Sibuguey (320 m), Tres Reys (366 m) and Kabasalan (391 m).

Basilan island lies south of Zamboanga Peninsula across Basilan strait. It is composed of numerous young volcanic cones, the highest being Basilan Peak (1106 m) at the center. Several islets surround Basilan Island. Among these are Lampiningan, Malamis, Coco, Lanhi, Sibago and Kauluan.

The Sulu Island Group is at the southernmost part of the Philippines and is composed of islands and islets scattered over a distance of 322 kilometers. The islands form two parallel trending northeast.

The northern belt called Pangutaran Group is covered entirely by reef limestone. The southern belt has more and larger islands; most of the islands are young volcanic cones. Others are covered with reef limestone. Tawi-tawi Group is composed of peridotite, metavolcanics anf Tertiaty sedimentary rocks. The relief in the southern belt is lower that in the northern.

1.2 Stratigraphy

Philippine Stratigraphy has been characterized by a proliferation of formational names. To minimize the ill effects and to obtain maximum information in the utilization of these formational nomenclatures in regional geologic studies, a composite stratigraphy for particular areas /regions is here presented. These area based on available data from various geological activities.

Stratigraphic work in the Philippines has been for a long time, a piece-meal affair, as part of geological reports and confined to certain areas and regions, in connection with oil exploration activities, off-and-on regional mapping, and canvassing and verification of economic minerals. The most comprehensive report published is that of Corby et al (1951) on the Geology and Oil Possibilities of the Philippines.

The geologic knowledge during the Spanish period consisted only of meager records mostly of Spanish friars dealing with mineral production for local consumption. With the American regime, considerable interest in prospecting and mining was initiated by foreigners, reaching its peak in the mid 1930's. Consequently, geologic exploration was stimulated, but while the other branches of geology received much impetus, little interest was given to the study of Paleontology and Stratigraphy.

The internationally recognized subdivisions generally used at the time were adopted by the earliest workers most of whom were foreigners. They employed mainly molluscan fossils and, to some extent, larger Foraminifera as the bases for their age determinations and in the chronostratigraphic classification of rock units. Other workers dated rocks using lithologic features and structural relationships, the results of which were not always reliable. The early stratigraphic studies which were carried out with other phases of geologic wrk here and in the nearby regions pertained to the local faunal sequences.

Among the important early workers were Antonio Francisco Llanos who wrote Terrenos Nummuliticos de Filipinas in 1861 and Ferdinand von Richtofen who reported on the Nummulites of the Binangonan Peninsula in Luzon in 1862.

Felix Karrer contributed the Tertiary Smaller Foraminifera from Western Luzon in 1878; Karl Martin described the molluscan fauna from Miocene beds in Cagayan Valley and La Union Province in Luzon and from Plicene beds in the Agusan valley in 1896. Warren D. Smith reported the occurances of Philippines orbitoidal species in 1906. In 1911, Henri Douville described and correlated orbitoids from Cebu and Bataan Island. 1913, W.E. Pratt and W.D. Smith recognized and named a succession of rocks in Bondoc Peninsula. The area has consequently become classic for Philippine Tertiary Stratigraphy. 1919, Hisakatsu Yabe, in collaboration with Shoshiro Hanzawa, reported the first Camerina and Discocyclina species and illustrated their usefulness in recognizing older Tertiary rocks.

From 1920 to 1031, the more outstanding contributions to Philippine Paleontology and Stratigraphy were those of Roy Dickerson (1921, 1928) on the fauna of the Vigo Group in Bondoc Peninsula and on the distribution of marine fossils; Warren D. Smith (1924) comprehensively reviewed all available information on Philippin stratigraphy and correlation and, thereafter, formally proposed the use of formational names; Leopoldo A. Faustino (1926) has the distinction of being the first Filipino to initially correlate Philippine Tertiary sedimentary sequences with those of other areas in the Indo-Pacific Region. He advocated the use of formational names instead of the standard European subdivisions to indicate horizons. A majority of the formational names, however, were local and were tentatively used only in particular areas to indicate horizons.

Correlations of biostratigraphic units prior to the Petroleum Survey of 1939 were carried out principally on the basis of Smith's published works, revised several times by noted Philippine geologist such as Leopoldo Faustino. Victoriano Elicaño and Antonio Alvir.

The first intensive and systematic study of upper Mesozoic and Tertiary Paleontology was made in 1939 -1941 by the National Development Company under the guidance of Grant W. Corby. The results of this survey were published in 1951 as Technical Bulletin No. 21 with Corby as senior author.

Robert M. Kleinpell introduced a scheme using letter symbols for Philippin Tertiary subdivisions. The scheme was patterned after the Indonesian letter-alphabet system proposed by Van der Vlerk in 1931. Control sections was establishes and the Philippine Tertiary was divided into six stages, represented by the letters U to Z based on the stratigraphic ranges of different fossil groups which were compared with published types from the East Insies fauna.

The above subdivisions were used until the adaptation of the Indonesian letter classification in 1954 on the suggestion of Teves, for uniformity in usage and to facilitate stratigraphic correlations with other areas in the Indo-Pacific region. Teves transformed Kleinpell's provisional Tertiary U-Z letter-stage system into the Tertiary a-h classification of Van der Vlerk.

Due to the extreme lateral variation of rock types and partly to the difficulty ot tracing lithologic boundaries on account of the Philippn archipelagic nature, hundreds of formational names have been proposed. In the early 1960's, the lack of a standard for formational names but even after the Code of Stratigraphic Nomenclature of the Philippines was set up in 1968, formations have still been named in discriminately because of the absence of control on the proper nomenclature usage.

Under the above circumstances, the utilization of all existing nomenclature becomes impractical when involved in a regional geologic study because the broader geological outlines are lost in this maze of formational names. W.D. Smith (1913), Wataru Hashimoto (1938) and L.M. Santos-Yñigo (1956) were among those who proposed that broader stratigraphic units be used for regional correlation. Working along the same concept, J.R. Huth (1962) and E.R. Kintanar (1966) introduced lithologic groups for all sedimentary rocks. Huth defined five groups composed of eleven formations on the basis of lithology and stratigraphic positions. Many workers, however, do not confirm with his formational system as later studies of the major basins revealed other equally important time-equivalent lithologic units that should be incorporated.

The research for petroleum extended knowledge fossil faunas. To cope with the needs of modern oil exploration, Filipino paleontologists and foreign specialists working in the country introduced refinements in their attempt to put Philippine Stratigraphy on a firmer and sounder footing. They turned to the more specialized phases of stratigraphic studies, including boifacies and paleonenvironment analyses, correlations and such investigations related to the differentiation of morphogenetic stages of foraminifera evolutionary series. Intro-and extra-basinal correlations of economically important horizons were successfully carried out, greatly facilitating the rapid evaluation of the overall economic outlook of each prospective region.

In 1961, B.A. Gonzales revised the equivalent of some of the units in the Indonesian letter classification as used in the Philippines. This revised system was used by the Bureau of Mines until about 1974 when the biostratigraphic zonation based on plank tonic assemblages developed by W.H. Blow (1961) was found to be applicable to the Philippine Tertiary. Before this, however, Orville Bandy (1962) and F.L. Amato (1965) proposed a plank tonic zonation for the Cenozoic marine strataalso based on plank tonic Foraminifera markedly similar to those in Trinidad, Venezuela and Italy.

Both Bandy's plank tonic zonation and Amato's basic zonation did not gain wide acceptance among the geologists and paleontologists working in the country. While they agreed on the sequence of plank tonic zones presented, there was criticism against the zonations mainly because they were based entirely on plank tonic Foraminifera. The abundance of shallow water limestone deposits devoid of plank tonic species throughout the Cenozoic section posed the problem of determining biofacies relationships between time equivalent lithologic variants, and therefore, the necessity of establishing an equivalent zonation for the shallow-water sedimentaries was apparent.

Although most of the stratigraphic and paleontologic information contributed by the oil exploration companies utilized the letter alphabet, a few workers used the classical European standards. While it was recognized that this would be the most ideal system to use, there was no consensus as to the exact correlations of its stage boundaries with those in the letter-stage classification, particularly for the Miocene and younger intervals. Moreover, direct comparisons between the fauna of the stages defines in Europe and those characteristic of the Philippin sedimentary sequence had been carried out on a very limited scale; hence its usage in local biostratigraphy was then considered questionable. There is also the accepted opinion that the Indo-Pacific fauna of which the Philippine group forms a part, evolved independently and somewhat differently sometime during the Tertiary.

Today, Paleontology and Stratigraphy assume as undisputedly important role in geologic investigations, especially in the canvassing of strategic minerals and in the exploration of possible energy sources, notably petroleum. Researches on the systematic, evolutionary lineages, stratigraphic distribution, paleo-environmental analyses and correlations of the different groups of fauna are being conducted in paleontological laboratories that were set up as a result of the growing awareness of the importance of biostratigraphy in geological exploration.

Thus, from the meager records of geologic knowledge of the Spanish friars, the present literature touching on the various disciplines of geology have become sophisticated and reached a mature stage. All the available work in various areas and/or regions of the Philippines is compiled. Charts were prepared for each area and/or region showing the stratigraphy as presented by each worker. All the manuscripts were reviewed and re-evaluated as to boundaries and ages of the different formations. Old sample on file at the Bureau of Mines and Geo-Sciences Paleontology Section were re-examined; new paleontologic data was utilized in updating the original age assignments of the different formations. To minimize confusion resulting from the proliferation of names and eliminate the indiscriminate naming of lithologic units, a composite stratigraphy for each and/or region, although not exhaustive, was set up. Priority in the choice of formational names was considered. The nomenclature of the original authors was retained as much as possible. However, the boundaries of the formations were changed as succeeding formations in areas of similar lithologies and ages were incorporated into the old units.

The Stratigraphy of the Philippines is here divided into four physiographic provinces in accordance with the chapter on Physiography. However, the Palawan Physiographic Province, having the oldest formations, takes priority in the grouping.

The formational names, the original author and year the manuscript was written or published are given. The treatise included subsequent changes in the original nomenclatures, their boundaries, geologic age assignments and the relationships of different formations. They are correlated with other units within the same and other regions. Detailed descriptions of individual lithologic unita are presented in the succeeding chapters on Sedimentaries, Intrusives, Metamorphics and Volcanics.

While the classical European standards are used for the ages of the various formations their usage is based on the biostratigraphic zonation proposed by Blow (1967) Table II-2 which has been found to be applicable to the Philippine Tertiary. Whenever possible, the previous datings using the provisional letter classification of Kleinpell and the Indonesian letter classification of Teves (1954) and Gonzales (1961) were re-evaluated by checking the faunal contents of samples so that their present ages confirm with the new classification. However, in cases where there are no available data, the original equivalents of the letter classifications used prior to 1974 with the classical European are retained.

Ilocos Region

The oldest rocks known are crystalline schists and quartzites herein called Suyo Metamorphics, probably of pre-Tertiary age. They are in fault contact with Cretaceous-Paleogene serpentinized peridotite. Smith (1929) reported micaceous schists near Pasuquin, actinolite schists in patches bordering a serpentine area, magnetite schists near Baruyen River and epidote-magnetite schists in an unnamed locality. Large outcrops of serpentinized peridotite cut through Upper Miocene limestone along a fault zone (Fernandez and Pulanco, 1967). Crenulated chlorite-actinolite-tremolite schists enclose serpentinized peridotite. Supposedly pre-Tertiary granitic dikes referred to as granulite by Smith and trondhjemite by Irving and Quema (1948), occur as intrusions in serpentinite.

The **Baruyen Formation** (Smith, 1929), a chaotic assemblage of chert interbedded with basic volcanic and sediments, were subsequently metamorphosed into schists and serpentine. Smith considered the chert as Jurassic on the basis of the supposed Rediolaria they contain. However, Irving and Quema believe that the Radiolaria found by Smith represents crystallization of silica hence they did not give a definite age for the chert but presumed it to be pre-Miocene. They were not able to identify the pre-existing floor rocks upon which the cherts were deposited unless they are included among some of the crystalline schists.

A sedimentary sequence herein tentatively called Bangui Formation is composed of conglomerate, sandstone, and shale. The sandstone member is apparently the Bangui Sandstone of Smith (1907). The formation is exposed along the road between Baruyen and Pasaleng. Bangui, in apparent fault contact with the Baruyen Formation. A similar sequence with intercalated marble containing Late Eocene fossils is found in the Lammin area within the Central Physiographic Province, hence a late Eocene age is considered for the formation.

In the **Burgos-Pasuquin** area is the Lower-Middle Miocene Bojeador Formation resting unconformably on the Baruyen Formation, peridotites and schists. The formation includes the Bojeador Agglomerate and Tuff (Irving and Quema), Negra Tuff and Ash Beds (Smith, 1907), and the Lower to Middle Miocene sedimentary rocks, volcanic flows and pyroclastics of Fernandez and Pulanco. The rocks were folded, faulted and peneplaned before the deposition of the Upper Miocene Pasuquin limestone (Smith).

Quartz diorite occurs in **Pasaleng** intruding the supposedly Cretaceous-Paleongene rocks. Fernandez and Pulanco gave a Middle Miocene age to these intrusive which is here called Pasaleng Diorite. The age is based on its correlation with the Agno Batholith in the Baguio District which probably intruded Middle Miocene rocks. It does not however, intrude the Pasuquin Limestone.

The **Pasquin Limestome** lies unconformably over the Bojeador Formation. It is equivalent to the Punta Negra and Punta Blanca Orbitoidal Limestone of Smith.

In the plains anf foothills of LAoag, the Pliocene Laoag Formation (LAoag Calcareous Sandtone of Irving and Quema) occurs as flat lying sandtones and shales.

Two levels of coral reefs were recognized by Smith. One is elevated three to four meters above high tide level, the other is elevated about 30 meters. Coral reefs at Cape Bojeador lie over the Bojeador Formation and the Pasuquin Limestone.

Coral Fragments and other calcareous debris of Quaternary age partly cover the coastal plain from Dirique Inlet to Cape Bojeador. The debris mantle extends up to the low foothills formed by the Pasuquin limestone.

1.3 Sedimentary

Philippine Stratigraphy is grouped into four divisions based on major unconformities, degree of metamorphism and lithology. These are Carboniferous to Triassic, Jurassic to Tertiary (Oligocene), Tertiary (Miocene) and Tertiary (Pliocene) to Quarterly. The Philippines is also divided into Eastern, Central, Western and Palawan Physysiographic provinces on the basis of inland and submarine morphorlogy. Following chapters on Physiography ans Stratigraphy, the sedimentary rocks are therefore grouped into divisions within physiographic provinces and specific areas of occurrence in each province. The formation, type locality, geographic distribution, lithology, age, paleoecology and thickness.

The lithologic classification of the rocks follows the scheme of Pettijohn (1975) that sediments are exogenetic or clastic and endogenetic or nonclastic. In his classification, exogenetic sediments are divided into epicplastic, pyroclastic, cataclastic and residues; the endogenetic, precipitated and organic residues. Exogenetic sediments are conglomerates, sandstones, shales and tuffs; endogenetic sediments are limestone, dolomite, cherts and coal. Sediments having characteristics of noth the exogenetic and endogenetic are called hybrid sediments. These are the calcareous shales. Calcareous sandstones, carbonaceous shales, tuffaceous shales, tuffaceous sandstones, argillaceous shales and others.

Sedimentary rocks are distributed and widespread in all physiographic provinces, the most widespread occurrence being in the Central Physiographic Province. The oldest sedimentary rocks occur mostly in the Palawan Physiographic Province and to a limited extent, other physiographic provinces. Younger rock types are distributed in the four physiographic provinces. Miocene sediments are the most extensive.

Ilocos Region

Baruyen Formation

This rock unit was first named Dungan-Dungan Formation by Smith (1907). In 1924, he called it the Baruyen Formation, however, it is commonly known as the Baruyen Chert. The type locality is in the Dungan-Dungan estate along the BAruyen River in Ilocos Norte. It also crops out along the Caroan River in Pasuquin. The chert is dirty red, fine grained, hard and easily breaks into slabs. Irvinf and Quema (1948) described the chert as intensely folded, strongly fractured and brecciated. Hashimoto et al (1975) mentioned that at Smith's type locality, the rock is not a true chert but a mélange-like deposit. Smith dated the chert as Jurassic on the basis of the radiolarians Cenosphaera and Dictyomitra. Irving and Quema, however, did not believe that these are fossils but are centers of chert crystallization.

Bangui Formation

The name Bangui was first used by Smith for the sandstone which is the upper member of his Baruyen Series. It is called Bangue Formation to include not only the sandston but also the associated conglomerate ans shale of Fernandez and Pulanco (1967) southwest of Pasaleng in northeastern Ilocos Norte. These rocks are also seen along the road br=etween Baruyen and Pasaleng. The formation was dated Late Eocene based on similar rocks with an Upper Eocene limestone interbed further south.

Bojeador Formation

This formation was originally named Bojeador Agglomerate and Tuff by Irving and Quema (1948) for the rocks at Cape Bojeador, northwestern Ilocos Norte. It includes the conglomerate, gray wacked, shale, limestone and associated basic flows and pyroclastics of Fernandez and Pulanco (1967) exposed east of Vintar, Ilocos Norte and northeast of Vigan, Ilocos Sur. The conglomerate is thick with poorly sorted pebbles and cobbles of angular to subrounded andesite, basalt and limestone set in a sandy and slightly calcareous matrix. The sandstone and shale are well bedded, cream to buff and locally slightly recrystallized. The formation is dated Early to Middle Miocene.

Pasuquin Limestone

The Pasuquin Limestone was called Pasuquin Arenaceous Limestone by Smith (1907). This is exposed along Pasuquin River, northeast of Pasuquin, Ilocos Norte. It is well bedded, light cream to light buff, porous and sandy in some places. Late Miocene Foraminifera area abundant.

Smith (1907) first named the sediments exposed along the highway between Bacarra and Laoag, Ilocos Norte, Laoag Marl Beds. Irving and Quema (1948) renamed the rocks, Laoag Calcareous Sandstone. It is here called Laoag Formation. The formation is made up of sandstone and interbedded siltstone and clay stone with occasional limestone. These sediments are well bedded, sandy, cream to buff and calcareous. The beds are fossiliferous from which a probable Pliocene age was given.

Uplifted Coral Reefs

Smith recognized two levels of raised coral reefs along the shores of Ilocos Norte: one elevated 30 m high; the other, about three to four meters above the high tide level. These reefs are consolidated coral fragments and other calcareous debris. Irving and Quema gave a Late Quaternary age to these reefs.

Quaternary Alluvium

Quaternary alluvial deposits composed of silt, sand and pebbles, cobbles and boulders of older rocks are confined along coastal plains and at the lower reaches or large river systems.

1.4 Volcanic

This section presents available data on Philippine volcanic rocks. It includes rocks altered or metamorphosed but with original volcanic characteristic still discernible.

The volcanic rock formations are grouped according to ages as follows: Carboniferous to Triassic, Jurassic to Tertiary (Oligocene), Tertiary (Miocene), and Tertiary (Pliocene) to Quaternary. For each age group, the formations are further subdivided according to physiographic provinces and specific areas of occurrence. In cases where there are overlaps in the age and/or spatial distribution of a formation, that particular formation is mentioned in the two age groups to which it belongs, and/or in the two physiographic provinces/areas where it occurs, however, the formation is described in detail in the section under the age group and/or physiographic province/area where it is first mentioned. Furthermore, whenever a formation consists of a volcanic and non-volcanic member(s), only the former is described in detail.

Depending on the availability of data, the detailed description of each volcanic formation may include the following: formational name, type locality, extent and distribution, petrologic assemblage and facies variation, physical characteristics, mineral and chemical composition of the constituent rocks, related mineralization, genesis and age.

Based on geologic reports which are the main sources of data, the classification scheme of volcanic rocks generally accepted by geological workers in the Philippines is more or less. Among the rock types, only rhyolite and the alkali extrusives have no known occurrences in the Philippines, although their intrusive equivalents have been reported in the archipelago, such as the granite in Palawan and the tinguaite in the syenite complex in Cordon, Isabela.

The oldest reposted volcanis rocks belonging to the Carboniferous to Triassic age group are associated with metamorphosed complexes and occur in Palawan, Western and Eastern Physiographic provinces, specifically in offshore West Palawan, Mindoro and Buruanga Peninsula.

The Jurassic to Tertiary (Oligocene) volcanic occur in the four physiographic provinces. The volcanic of this age group generally consists of flows which are intimately associated with pyroclastic and/or clastic rocks, commonly exhibiting various degrees of hydrothermal alteration. The volcanic flows and pyroclastics are commonly basaltic or andesitic, locally dacitic. Whenever the flows are basaltic, they are almost always spilitic; exhibits pillow and vesicular/amygdaloidal structures; and occurs with chert. Limestone lenses are locally intercalated with the volcanic.

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Tertiary (Miocene) volcanic rocks are represented in the four physiographic provinces. The characteristics of these volcanic are not much different from those of Jurassic to Tertiary (Oligocene). The former also consist of volcanic flows, and well associated pyroclastic and clastic rocks and are commonly hydrothermally altered. The composition of the volcanic ranges from basaltic to andesitic and dacitic. The only difference is the more widespread occurrences of pyroclastics in Tertiary Miocene.

Tertiary (Pliocene) to Quaternary volcanic occurs in the four physiographic provinces. They occur as lava flows and pyroclastics some of which are associated with tuffaceous clastic rocks. Their composition generally ranges from basaltic to andesitic and dacitic. A few of these volcanic make up plateau basalts such as those in lanao, Zamboanga and Cuyo Island. Many of the volcanic comprise cones, plugs and stratovolcanoes which appear to mark centers of volcanic activity. Several of these volcanic centers are still ejecting volcanic materials.

An attempt to interpret Quaternary volcanism in relation to the tectonic processes affecting the whole archipelago was made by Datuin and Uy (1979). They recognized three major Philippin volcanic belts defined by Quaternary volcanoes, which are parallel and adjacent to trenches. These are the western, eastern and southwestern volcanic belts believed to be related to the Manila Trench, Philippine Trench and Sulu Sea Trench, respectively.

The **western volcanic belt** which has an arcuate convexity towards the Asian continent is associated with volcanoes composed dominantly of dacite and andesite cones. These include the submarine volcanoes in the extreme north, the volcanoes of southwest Luzon Upland, Zambales Range amd eastern Mindoro.

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The eastern volcanic belt extends from Camarines Norte down to Cotabato and has an arcuate convexity towards the Pacific Ocean. It is defined by Quaternary volcanoes which include Labo, Isarog, Iriga, Malinao and Bulusan in Luzon; Biliran and Cabalian in Leyte; and Matumtum, Apo, and other smaller cones in Mindanao.

The southwest volcanic belt is parallel to the trend of Sulu Archipelago and is convex to the southeast. It is associated with active volcanoes of Bud Dajo and other volcanic cones in Sulu Archipelago.

Based on available chemical data which are computed and plotted on a total alkali-silica relation diagram, Datuin and Uy were able to delineate volcanic suites in the western and eastern volcanic belts.

The **western volcanic belt** is divided into three volcanic suites. These are the tholeiitic suite facing the South China Sea, the alkali suite which passes along Central Luzon, and the calc-alkali suite which lie between and overlaps the other rock suites. The radiometric dates of the Quaternary volcanic in this belt increase from the west to the east. This is an indication that the volcanic activity along Manila Trench has migrated eastward through time, producing rock suites changing from tholeiitic to calc-alkali to alkali.

Volcanic rocks of tholeiitic affinity in the western volcanic belt are mostly basalt, andesie and pyroclastic ejecta. Odom (1977) placed the age of these rocks from 0.6-7.0 million years. Representative volcanoes of this suite are western Mariveles and its adventives cones, western Natib volcanic complex, Carilao and Namiranlic.

Active and inactive strato-volcanoes of basalt-andesite and dacite rocks predominantly characterized the calc-alkali suite in the western volcanic belt. The age of the calc-alkali volcanoes range from 4 million to less than 10,000 years. The typical volcanoes of the suite are the eastern part of Natib complex, eastern Mariveles including Samat, Orion, limay, Pinatubo, Mapingon, Atimba, Cuyapo, Balungao, San Audre, Makiling and Dumali. Taal rocks are calc-alkali but closely related to the tholeiites.

The extrusive rocks associated with the volcanoes of the inner alkali suite in the western volcanic belt are basalt, trachyte and latite, representative volcanoes are Sembrano, Banahaw, San Cristobal and Arayat.

In the eastern volcanic belt, the three volcanic rock suites are also represented. The thoeiitic rock suite faces the Pacific Ocean while the alkali rock suite passes through Canlaon and the western volcanic complex of Camiguin. The calc-alkali rock suite comprises most of the volcanoes in the eastern volcanic belt which are basalt-andesite-dacite association. Representative volcanoes of the calc-alkali rock suited in this volcanic belt are Mayon and Malinao in Luzon, eastern volcanic complex of Camiguin, and the volcanoes of Leyte and northern Davao. A shift in the site of eruptive activity through time has been observed in the Bicol Peninsula where volcanic activity migrated from north to south, and in the Camiguin Province where the migration is from southeast to northwest.

Ilocos Region

Bojeador Formation

The Bojeador Formation (Bojeador Agglomeratesand Tuff) of Irving and Quema, (1948) takes its name from Cape Bojeador in the northwest corner of Burgos-Pasuquin area in Ilocos Norte. The aggregate thickness may be as much as 650 meters.

The western and southern parts of the formation are mainly massive agglomerate consisting of angular blocks of dark gray to dark brown vesicular andesite. The blocks vary from a few centimeters to 30 cm in diameter and are weakly cemented in a matrix of sandy ash to lapili tuff. Some buff to brown, fine-grained, thin-bedded tuffs are interbedded with the massive agglomerates. These agglomerates are well exposed north and northwest of Burgos as prominent northeasterly trending ridges. Near Punta Negra, the formation becomes increasingly tuffaceous. Smith (1907) called it the Negra Tuff and Ash Beds.

The northeastern section, the sea-cliff east of Punta Negra, is composed of cream to buff, well-bedded tuff, with excellent grading from base to top of each horizon. Individual layers vary from about three centimeters to ten meters. Agglomerates constitute only a small part of the section. The tuff and agglomerate are probably correlative in age, the agglomerate representing material that was deposited near the vent from which it was erupted, and the tuffs, the finger-grained material wafted to greater distances. The original vents may have existed in the Bojeador Lighthouse-Dirique-Siek area (Irving and Quema).

The Bojeador wedges sharply southward and eastward against the basement, or may be un fault contact with the basement. It is much younger than the basement rock upon which it rests, but is older that the Upper Miocene Limestone overlying it. It is here considered Early to Middle Miocene.

1.5 Intrusive Rocks

Intrusive rocks are grouped into acidic-intermediate and mafic-ultramafic rocks. The first group includes the deep-seated varieties of granitic-dioritic rocks, their hypabassal equivalents and volcanic rocks within the same compositional range exhibiting intrusive relationships. The most dominant rocks of this group are diorites. Peridotites, dunites, pyroxenites, anorthosites, gabbros and serpentinites comprise the mafic-ultramafic rocks.

The intrusive rocks are subdivided according to age, physiographic province and specific areas of occurrence within each province. The acidic-intermediate rocks are discussed under the following age divisions: Permian to Triassic. Jurassic to Tertiary (Oligacene) and Tertiary (Miocene). The mafic-ultramafic rocks are grouped according to physiographic provinces, as most of their ages of emplacements fall within the Mesozoic to Tertiary (Eocene). Only a few are considered pre-Tertiary Description of the rock units in each particular are includes formational name, author of formation, type locality, distribution, relationship with other formations, physical characteristic, mineral and chemical composition of the rocks, related mineralization, genesis and age.

Potassium-Argon dating and field relationships with adjacent rock units which were dated based on fossils were used in establishing periods of intrusion.

The granitic-dioritic intrusive rocks occur sporadically buy they have been studied extensively because of their genetic relationship to metallic mineralization. They occur as batholiths, stocks, dikes, sills and as apophyses and/or erosional windows. From the northern tip of Luzon to the southernmost part of Mindanao are trains of small to batholithic bodies disposed in distinct belts. These belts were delineated based on the age of emplacement, conformity in trend and composition and distribution. They are grouped into pre-Paleogene and Neogene.

Pre-Paleongene intrusive are distributed in northern Palawan, Mindoro, Lubang Island, Romblon Island Group and Buruanga Peninsula. The Paleogene masses are divided into eight belts: the Western Luzon, Eastern Luzon, Western Bicol, Caramoan, Guimaras, Samar, Eastern Mindanao and Zamboanga belts. The Neogene belts are the Luzon Central Cordillera, Marinduque, Tablas, Eastern Mindanao, Mindanao Central Cordillera, Cotabato, Zamboanga and Eastern Bohol.

Ilocos Region

Trondhjemite

Northeast-trending dikes referred to as granulite by Smith (1907) and trondhjemite by Irving and Quema (1948) crop out in the Burgos-Pasuquin area. They occur as narrow dikes and as irregular lenticular bodies about a meter wide to as much as eight meters long intruding a highly sheared zone of metamorphic rocks. The rock is while to slightly greenish, medium to coarse grained, and composed of feldspars, quartz, muscovite, biotite and chlorite.

This pre-Tertiary intrusive probably post-date regional metamorphism of the schists and serpentinities (Irving and Quema).

Pasaleng Diorite

In northeastern Ilocos Norte, Fernandez and Pulanco (1967) reported quartz diorite bodies intruding the Cretaceous-Paleogene rock suite and the Lower Miocene rocks. This rocks, here called Pasaleng Diorite, occurs in Pasaleng, Pagudpod and is given a Middle Miocene age. The rock is leucocratic, coarse grained, and is composed of quartz, feldspar and some dirty green minerals.

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1.6 Metamorphic Rocks

Metamorphic rocks in the Philippines are dominantly schists, phyllites, slates, marbles, quartzite sang gneiises. Limited occurrences of eclogites, skarns, cataclasites and mylonites were also reported.

The dominant rocks types are widely distributed in the four physiographic provinces. Their outcrops are generally discontinuous and adjacent to major structures like the faults and trenches. The most extensive occurrences are in Palawan, Mindoro, Romblon, Camarnes Sur and Quezon. Generally, the metamorphic rocks in the Western Palawan physiographic provinces are older than those in the Central and Eastern physiographic provinces.

These rocks are grouped under two geologic periods separated by a major tectonic event: Carboniferous to Triassic and Jurassic to Tertiary. Rocks of the first group were derived from a Carboniferous to Upper geosynclinals sequences. Their ages were establiched by fossil evidences in northern Palawan, southern Tablas, Carabao Island, northwestern Panany and Mindoro, those of the second group are post-Middle Jurassic. Rocks of the first group are generally metamorphosed up to the green schist facies, those of the second, up to the amphibolites facies.

Ilocos Region

Suyo Metamorphics

The metamorphic in Suyo, Burgos, Ilocos Norte made up of amphibolites, quartz-biotite, actinolite-tremolite-talc schists and quartzite here called Suyo Metamorphics are in fault contact with the serpentized peridotite. They are pre-Tertiary.

The amphibolites schist is light to dark green, fine to medium grained and is characterized by the planar orientation of green amphibole, chlorite, feldspar and quartz. The rock exhibits usually nematoblastic texture with large bluish green amphibole and prismatic, light colored epidote. Widely distributed fine granules of sphene occur as inclusions or as accessory mineral.

The quartz-biotite schist consisting dominantly of quartz with lesser amounts of biotite, epidote, garnet, hematite and piedmontite occurs intimately with the amphibolites schist.

The actinolite-tremolite-talc achiest, a product of dynamo thermal metamorphism is structurally confined along the contact of the intensely sheared serpentinized perdotite.

1.7 Tectonics

Tectonics, the discipline of geology that deals with the development of the earth's structure, when applied to the Philippines, logically starts from an examination of first order physiographic features of the archipelago and surrounding seas. The ridges and basins, the trenches and ocean rises, their distribution, geometry, geologic structure and composition – these provide the initial framework upon which the logic of Philippine tectonics is built because they are the most prominent signature of the architectural plan that governs the structural development of this part of the earth.

Earthquakes and volcanic activity, both very prevalent in the Philippines, are the most perceptible evidences of on-going processes of structural development. They are of important concern in the Philippine tectonics.

In recent years, developments in geophysics and geochemistry have made possible the measurement of the physical and chemical properties of the crust underlying the Philippines and surrounding areas. Gravity, seismicity and seismic properties; magnetic and paleomagnetic properties; temperature, thermal gradients and heat flow; chemical composition of rocks, including isotopic ratios – all these have become available in varying degrees of coverage and reliability. They are useful in the understanding of the dynamics, structure and history of this part of the earth.

The type and pattern of fold and fault structures; the occurrence, dimension and distribution of certain lithologic units; the order of superposition of strata; the changes in lithologic facies; unconformities; and other observable geologic feature on land and offshore – all these have to be considered in any attempt to understand Philippine tectonics.

It is therefore the task of this section to present the available data covering the above cited features so as to allow the reader to construct a logical picture of the structural framework and development of the Philippines.

Tectonics is basically an interpretative discipline. Its objective is to fit the various geological data and observations into a logical and universally applicable concept or model of crustal development. In this regard, the authors have found the Plate Tectonic model to be the most coherent evolutionary framework with which to unify the various information on the geology, structure and geophysics of the Philippine Archipelago.

Tectonic Implications of Physiography

The section on Physiography recognized the importance of the depths and morphology of icean basins around the archipelago, the trenches and the parallel arrangements of ridges and basins with respect to them, and the wide shallow shelf areas in northern Palawan and Cuyo Island Group. Recognition of the ordering of physiographic elements is expressed in the physiographic divisions.

By simple isostatic principles, elevations would imply that ocean basins are composed of materials much denser than those underlying the islands and ridges in the archipelago. However, considering that many of the islands are in fact composed of dense ultramatic materials, a process more dynamic than isostasy must be in operation. This process coild be plate tectonics.

The tendency of the ocean basins to deepen toward the trenches is explained by plate tectonics in terms of the subduction process which allows dense oceanic crust to be underthrusted beneath less dense continental crust or equally dense oceanic crust. If indeed the trenches are zones of subduction, plate tectonics imply that they are convergent plate boundaries and the dynamic condition has to be compressional. Compressional dynamics in zones of subduction is consistent with the arrangement of narrow, elongated ridges and basins parallel to the trenches in the direction of subduction. The regular occurrence of belts of volcanic edifies in the concave front of the trenches is consistent with the accepted relation of subduction and magmatism.

The presence of a substantially wide shallow in northern Palawan and Cuyo Island Group, when correlated with the underlying continental-type crust, can be explained by plate tectonics. It can be interpreted as a fragment of continental crust incorporated in a trench-arc system developed in the margin of the continent.

The prominent difference in trend of Palawan and Sulu Archipelago, on the one hand, and the rest of the Philippine Archipelago, on the other, is explainable.

Plate tectonics could allow the Palawan and Sulu Island chains to be pat of trench-arc system or plates essentially independent of the rest of the archipelago; or it could be the abrupt changes in trends by structural displacement or dismembering of portions of otherwise coherent trench-arc system or plates as lateral plate movements proceed.

A prominent aspect of Philippine physiography is the presence of opposite facing trenches on the eastern and western borders of the main Philippine Physiographic region. This includes Manila Trench as against East Luzon Trench, Negros-Sulu Trench as against Philippine Trench and Cotabato Trench as against Philippine Trench. Since these trenches are interpreted as subduction zones, the main Philippine physiographic region could be considered as a wedge caught between two oppositely dipping subduction zones. The complexity of the physiography at the center of this wedge can thus be related to the complex interaction of the converging subduction system. The possibility of suturing of trench-arc systems in this region is very strong.

One important aspect of Philippine physiography is the presence of linear escarpments traceable over long distance. The offset of stream valleys and ridges perpendicular to them reveal the relative movement of faults following those lines. The Philippine Fault Zone which runs from Lingayen Gulf through Dingalan Bay, thence to Pujada Peninsula in Davao Oriental, is interpreted as a left-lateral transcurrent fault based on those offsets. The Cotabato, Mindoro and Marikingan faults are considered to be gravity faults because of the lack of lateral stream offsets and differences in elevation of their sides. The Tablas Lineament is also recognized as a major fault as it defines the boundary of Tablas Ridge and the deep Sibuyan Basin, the boundary between continental Buruanga Peninsula and ophiolitic Antique Range and the edge between Antique Trough and Antique Range. The sense of displacement is not apparent.

II.Mineral Resources of the Philippines

II.1 Introduction

Mineral are among the enviable resources endowments of the Philippines. Metal, non-metal and energy resources abound in the mountains, the plains, the coasts and even in the offshore area. Gold, copper, chromite, iron, nickel, cobalt, limestone, bentonite, kaolin, bauxite, coal, petroleum, geothermal energy and many other mineral resources palladium, platinum, silver and the like, belonging to Platinum Group Metals, that are a great deal of advantage for the nation. On gold alone, an economic geology expert of the United States reported that the Philippines possesses more gold per unit area than any other country except South Africa (Mitchell, 1984).

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Under these circumstances, Philippine government pay a great deal of attention to mineral resources development. The Spanish regime (1521-1898), from its initial years in the 1570's pais serious attention to gold. In the mid-1800's, the Spanish government through its Inspeccion de Minas prospected for copper. Thus, the first copper mine was opened by San remigio Copper Mines in Carawisan, Antique in 1842. This was followed by Mankayan Mines which was operated by Cantabro-Filipino Compania from 1864. Interest on oil and coal also surfaced during this time as encouraging reports of geological investigation pcame from Cebu, Negros and Bondoc Peninsula.

The American regime (1898-1946) gave strong emphasis on mineral resources development. Eveland (1907) commented that "almost since the day when Spain released the islands to the United States, prospecting and development of mineral resources of the country has gone on." Infrastructure development at the start of the regime was focused towards the development of gold deposits in Benguet, and later in other areas. As a result, gold mines proliferated in all corners of the country until the Japanese occupation in 1941. Hand in hand with the focus on gold, the American regime also paid particular attention to strategic minerals such as iron and oil. Hence, the declaration of the Surigao Iron Reservation in 1914 and its further expansion in 1937. For oil, government-owned National Development Company undertook extensive geological assessment of oil possibilities from 1939 until 1941.

During the Japanese regime (1941-1945), many known deposits of minerals used in steel and arms manufacture were worked out. Some of those explored or operated were the copper deposits of Mankayan (Benguet). Rapu-Rapu (Albay), Carawisan (Antique), Lutopan (Cebu) and Sipalay (Negros); the chromite deposits of Acoje and Coto (Zambales), Dinagat (Surigao) and Opol (Misamis Oriental) the manganese deposits of Busuanga (Palawan), Guindulman (Bohol) and Siquijor (Negros); and the iron deposits of Larap (Camarines Norte), Mati, (Davao) and Sibuguey (Zamboanga del Sur). The laterite iron deposits in Surigao were also studied and tested for metallurgical processing.

From 1946, mineral resources surveys and development efforts rested in the hands of the Philippine Republic. Rehabilitation of gold mines in Benguet, Surigao and Camarines Norte was the pre-occupation in the late 1940's. the Philippine Bureau of Mines, which was created by the Commonwealth Government in 1937, carried out extensive exploration work for copper in the early 1950's with strong technical assistance from the International Cooperation Agency (ICA) of the United States of America. This resulted in the development and eventual operation of many copper mines in the late 50's. aided by new technologies in the exploration and exploitation of large low-grade porphyry copper deposits, the copper industry rose to be the dominant sector in the mineral industry during the 60's, the 70's and even the present decade.

Towards the end of the 80's, however, it is expected that gold will once again take over the dominant role from copper. The high expectations for gold arise from the following factors: 1) economic constraints on existing copper mines to limit production from ore deposits with appreciable amounts of recoverable gold or other by products; 2) government thrust on gold exploration and development since 1983; 3) principally gold-oriented exploration activities of the private sector since 1980; 4) emergence of small-scale mining as a principal contributor of Philippine gold production and government rationalization of this sector through the Small-Scale Mining Decree of 1983; and 5) the discovery of new gold deposits through mass-based prospecting and application of recently developed concepts of gold metallogenesis related to volcanic activities.

The disparity in importance of mineral commodities from one period to another is balance by continued surveys and assessment conducted by the government. Specialized surveys for a raw materials used in steel manufacturer, cement raw materials, ceramic raw materials, energy resources and other mineral useful for industrial and economic advancement are being conducted on a continuing basis. The Bureau of Mines (Bureau of Mines and Geo-Sciences since 1981) shoulders the bulk of this burden since the Commonwealth days. In 1976, the oil crisis prompted the creation of the Bureau of energy Development, under the Ministry of Energy, which took over from the Bureau of Mines the responsibility of developing energy resources. These two bureaus, together with a host of other government agencies, and the private sector, strive to mobilize the country's mineral resources for the benefit of the Filipino people through environmentally safe and socially acceptable technologies.

11.2 General Geologic Setting

Geological processes lead to the formation of unusual concentrations of minerals that we call mineral deposits. Once these deposits are removed from the earth's surface they can never be replaced again, thus we regard them as non-renewable resources.

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Philippine mineral deposits have formed in three distinct environments: oceanic, island arc and continental. Oceanic environments are characterized by thin but dense crust expanding by lateral spreading from a rift system usually at the middle of the ocean basin and bounded by continents or island arcs. Large spreading ocean basins, like the Pacific and Atlantic, are called normal ocean basins while small ones usually at the margins of continents like South China Sea, West Philippine Sea and Japan Sea are marginal sea basins. Marginal sea basins formed by spreading at the back of island arc system are called spreading back arc basins. Those formed by segmentation of large ocean basins and trapping in between island arc systems are called trapped ocean basins.

Island arc environments are between the continents and normal ocean basins. One complete island arc system comprises, from the outer oceanward side, a trench, a fore arc, a fore arc basin, a magmatic arc, and a black arc basin. The trench is where oceanic lithosphere sinks in a process called subduction. The subduction process brings about the arc-basin configuration of the island arc system and causes partial melting of minerals along the interface between the sinking and overriding slabs at a point beneath the magmatic arc. The melted materials are the magmas that rise upward to form plutonic bodies when solidified at depth and volcanic rocks when they reach the surface. Rifting of volcanic arc or back arc basin may happen due to prolonged subduction and result in the formation of a spreading back arc basin.

Continental environments are characterized by thick but light crust, stable over long period of geologic time, and composed of thick non-volcanic sedimentary sequences, acidic igneous rocks, and large amounts of metamorphic rocks. Continents may be bounded by island arc systems like the Pacific side of mainland Asia, by subducting oceanic lithosphere like the Pacific side of South Africa, or normal non-subducting ocean basins like the Atlantic side of the American continents.

Many of the tectonic regions in the Philippines are a mixture of several environments due to the amalgamation or suturing of different tectonic terranes and overprinting of younger geologic environments over older ones.

II.3 Mineral Economics

Philippine mineral resources include a wide variety of metallic and non-metallic minerals. As of 1982, the total metallic reserve is 10.3 billion tons while non-metallic ore reserves is 24.4 billion tons. The principal metallic ore reserves are copper (4.3 billion tons), gold (2.1 billion tons) and nickel (1.2 billion tons) and lately the USGS/NASA report of the largest deposits of Palladium, Platinum, Silver and etc that are Part of Platinum Group of Metals off the Coasts of Mindoro, Masbate Romblon Panay/Negros areas. For non-metallic minerals, the principal reserves are limestone (9.7 billion tons), cement raw materials (6.2 billion tons), marble (3.9 billion tons) and clay (1.1 billion tons).

II.4 Economics of Iron Ore

Iron mining dates back to pre-Spanish times when the natives practiced the art of smelting introduced by the Chinese. The early uses of iron were limited mostly to the manufacturer of utensils and implements. Among the first deposits exploited were those in Bulacan, Rizal, and Camarines Norte.

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The largest known deposit in Bo. Larap, Jose Panganiban, Camarines Norte was explored by the Bureau of Science from 1940 to 1915 although its existence was known much earlier. Mining operations commenced three years later but were suspended after the end of the First World War. During its short-lived production, 48,000 MT of iron were shipped to Japan. Mining was resumed in 1934 by the Philippine Iron Mines (PIM). In 1938, Samar Mining Co. and Gold Star Mining Co. began production in Samar and Marinduque, respectively. Paracale Iron Mines in Camarines Norte followed suit.

The Seconf\d World War saw the closing of the iron mines. Rehabilitation work led to the resumption of operations by the Philippine Iron Mines in 1948. Samar Mines Inc. and Marinduque Iron Mines Inc., which took over the property of Gold Star, resumed production in 1950.

In 1955, Atlas Consolidated Mining worked the Mati deposits in Davao. Felipe Iron Mines operated in Bulacan for two years from 1956. At this time, Samar Mining shifted its operations from the Camcuevas Mine in Samar to Sibuguey in Zamboanga del Sur.

The next decade welcomed United Mining and Development Corporation in Camarines Norte, Metropolitan Mining and Development Co. in Cebu, and Hercules Iron Mines in Bulacan. Philex Mining Co. in Benguet and Atlas Consolidated Mining Co. in Cebu began to recover magnetite as by-product of its porphyry copper mining. Beach sand magnetite mining became active from the mid-60's to the mid-70's. **Filmag Inc. in La Union and Ilocos.** Anglo-Philippine Oil and mineral Corp. in La Union, and Inco Mining Co. Inc. were the top producers.

Production steadily increased from 1948 with the million marks reached in 1962. Production exceeded two million MT during the three-year period from 1971 bur drastically declined in the succeeding years. Adverse market condition together with the imposition of a ban on beach mining reduced the industry to insignificant level from 1977 when only a few thousand metric tons were produced annually.

Practically, all the Philippine iron ore production went to the export market. From 1949 to 1976, approximately 43.18 MT were exported mainly to Japan with only small amounts to the United States, Australia and Taiwan.

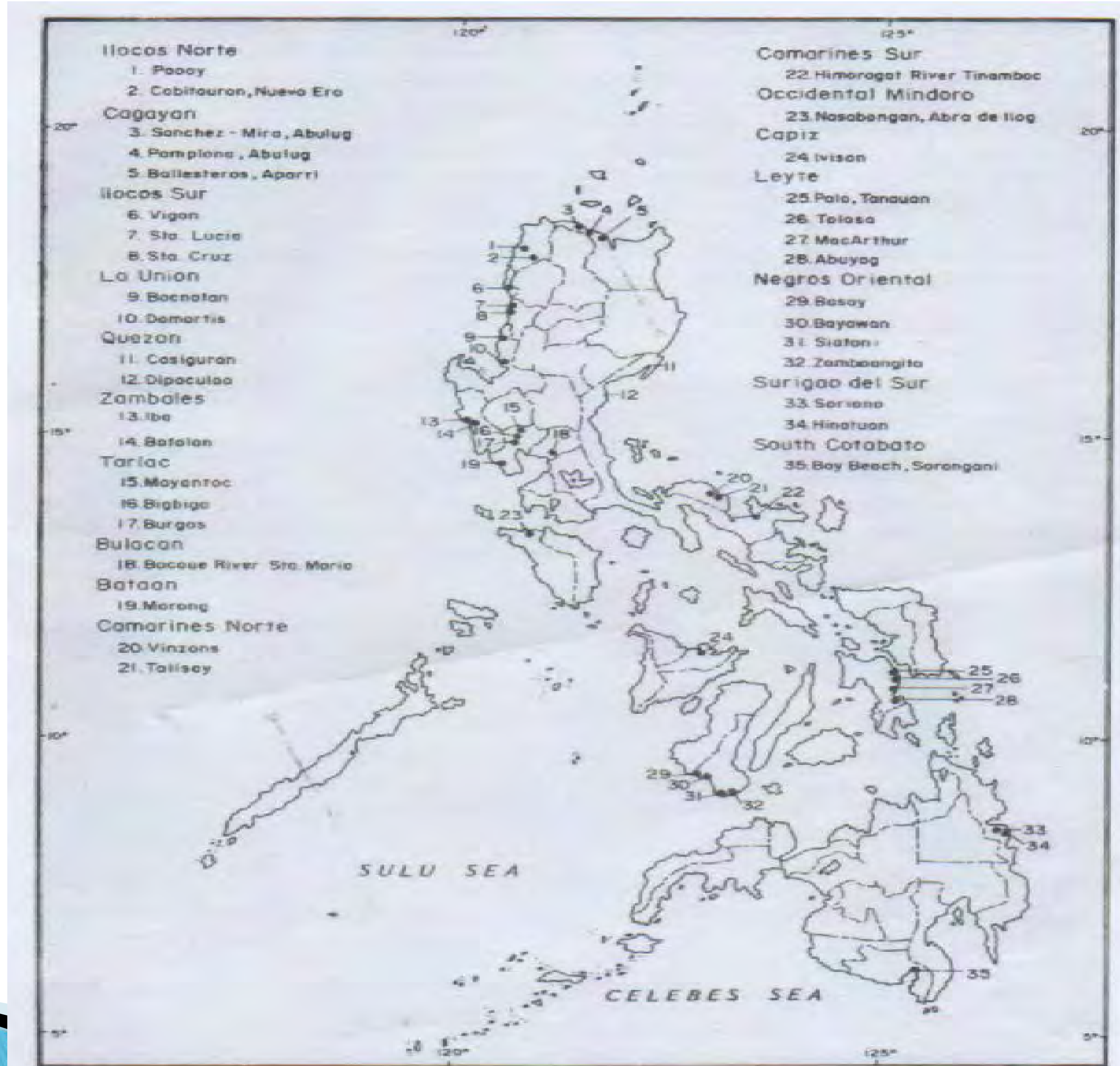
II.4.1 Magnetite Sand Deposits

This type of iron deposits consists of magnetite (Fe_3O_4) concentrations in beach and alluvial sand. Economic deposits generally contain 15 to 30 percent magnetite which when concentrated yield about 55 to 60 percent iron (Fe). The magnetite concentrate usually contain impurities of titanium and vanadium which interfere with the smelting process thus lowering the quality of the iron ore. The value of the magnetite concentrate is however enhanced when the titanium and/or vanadium content are high enough to produce special steel.

The distribution of magnetite sand deposits is shown in Fig. II.1. the most extensive ones are those along the beaches of Northern Luzon, Northwestern Luzon and Eastern Leyte. The deposits in Ilocos Norte are in sand dune of raised beaches around Paoay Lake, hence are situated inland. Those in Damortis, La Union extend offshore in Lingayen Bay as submerged sand dunes rich in magnetite. In Pampanga and Bulacan the magnetite sand deposits are alluvial flood plains quite far from shore.

The total magnetite sand reserve is 101.6 million MT in magnetite fraction of 40 percent Fe.

Figure II.1 – Magnetite Sand Resources of the Philippines



III. Background Information on the Iron sand Mining Resources of the Philippines and Similar Resources outside of the Philippine

1. Magmatic Origin

1.1 Magmas

Magmas are masses of molten matter within the earth's crust from which igneous rocks crystallize. Their composition, however, is not the same as that of the rocks to which they give rise, because magmas contain water and other small but important qualities of volatile substances that escape before complete consolidation occurs. Strictly speaking, they are high-temperature mutual solutions of silicates, silica, metallic oxides, and always some dissolved volatile substances. They obey the laws of ordinary chemical solutions. Their temperature, according to Larsen, ranges from 600^{O}C for rhyolite magmas up to 1,250 ^{O}C for basaltic magmas.

Their composition is as variable as the vast array of rocks that they yiled it ranges from extreme silicic to extreme basic. The volatiles consist chiefly of predominating water, carbon dioxide, sulphur, chlorine, fluorine, and boron. Although minor in amount, the volatiles play an important role in decreasing viscosity, in lowering the melting point, in collecting and transporting metals, and in the formation of mineral deposits. These constituents are largely expelled when the magma consolidates.

Magmas are temporary features within the earth's crust. They form in magma pockets or reservoirs, are forced upward, and then consolidate. The melting is local; no continuous molten layer underlies the solid crust. The prevalent view is that at depth the rock temperature, due to internal heat of the earth, is above its melting point but the enormous pressure induced by the superincumbent rock load prevents melting.

However, should the pressure be relieved by upward buckling, faulting, or removal of the overlying load by erosion, then melting would follow and magma would result. It should be mentioned, however, that other views have been advanced to account for the melting, such as accumulated heat of radioactivity, or heat generated by crustal movements. Nevertheless, the general occurrence of igneous intrusions and lava outpouring along great zones of weakness in the earth's crust where crustal disturbances have occurred indicates that such places where relief of pressure occurs favor magma formation and its movement.

Liquid magma, like any liquid under pressure, tends to move to the place of least pressure. The direction of movement is thus dominantly upward. Movement may be induced by the relief of pressure caused by forces already mentioned, by earth movements that tend to squeeze the magma out; or the magma may melt and assimilate the overlying cover rock and “eat’ its way upward, aided by gas pressure within itself. In its upward movement, the magma may pry off blocks of roof rock that sink into the liquid, giving rise to magmatic stopping it may wedge apart weak rocks, or it may be squirted into fractures or along bedding planes, forming laccoliths, dikes, or sills. It may be expelled to the surface, giving rise to volcanic extrusives or it might solidify at depth, forming such large intrusive as stocks or batholiths.

1.2 Cryztallization

In as much as magmas are solutions and obey the laws of aqueous solutions, crystallization of the constituent minerals, which are dependent upon their solubility in the rest of the magma, will commerce when the magma temperature falls below their individual saturation points. Crystallization of the minerals is not determined by their temperatures of fusion, although obviously no mineral can crystallize above its fusion point. Also, the solution of one constituent in another may give a lower melting point that that of either constituent. Consequently, magma may remain fluid at a temperature below the melting point of all its constituents. Crystallization commences below this point and as the temperature drops complete crystallization eventually ensure, giving rise to individual minerals or isomorphous mixtures.

1.3 Order of Cryatallization

The most insoluble substances crystallize first, and these in general are the accessory minerals, such as **apatite, zircon, titanite, rutile, ilemite, magnetite, and chromite. In general, the order of crystallization is one of decreasing basicity.** Olivine and orthorhombic pyroxene are among the earliest essential minerals to crystallize, followed by clino-pyroxenes, basic plagioclase, hornblende, medium plagioclase, acid plagioclase, orthoclase, mica, and quarts. This is the normal succession, but there may be exceptions. Naturally, not all of these minerals occur in the rock, but represent sequences from ultra basic to silicic rocks.

With the subtraction of the more basic minerals from the magma, the residual magma in general becomes progressively more salicic. Granitic residual magmas are solutions rich in silica, alkalies, and water, some of this may be squeezed out into fissures to form pegmatites. With basic magmas, however, the residual magma may be rich in iron. Volatile substances or mineralizers, such as fluorine, boron, chlorine, along with tin, concentrate in the mother liquors of silicic rest-magmas and may become tapped off to form pegmatite dikes rich in rare minerals.

With progressing crystallization the final aqueous extracts gather the metals that originally were sparsely contained in the magma, along with the rare elements, the rare earth, and chlorine, boron, fluorine, hydrogen, sulphur, arsenic, and other substances.

These mother liquors become expelled upon final crystallization and constitute the magmatic solutions that give rise to most economic mineral deposits. Consequently, they are a part of the magma of particular interest to economic geologist.

2. Tectonic Origin

When two oceanic slabs converge, one descends beneath the other, initiating volcanic activity in manner similar to that occurs at an oceanic-continental convergent boundary. **In this case, however, the volcanoes form on the ocean floor rather than on a continent. If this activity is sustained, it will eventually build volcanic structures that emerge as islands**. The volcanic islands are spaced about 80 kilometers apart and are built upon submerged ridges a few hundred kilometers wide. This newly formed land consisting of an arc-shaped chain of small volcanic islands is called a volcanic island arc. The Aleutian, Mariana, and Tonga islands are examples of volcanic island arcs. Island arcs such as these are generally located 200 to 300 kilometers from a trench axis. Located adjacent to the island arc just mentioned are the Aleutian trench, Mariana, and the Tonga trench.

Only two volcanic island arcs are located in the Atlantic, the Lesser Antilles arc adjacent to the Caribbean Sea, and the Sandwich Islands in the South Atlantic. The Lesser Antilles are a product of the subduction of the Atlantic plate beneath the Caribbean plate. Located within this arc is the island of Martinique where Mount Pelee erupted in 1902 destroying the town of St. Pierre and killing an estimated 28,000 people, and the island of Montserrat, where volcanic activity has occurred very recently.

In a few places, volcanic arcs are built upon both oceanic and continental crust. For example, the western section of the Aleutian are consist of numerous islands built on oceanic crust, whereas the volcanoes at the eastern end of the chain are located on the Alaska Peninsula. Further, some volcanic island arcs are built of fragments of continental crust that have been rifted from the mainland. This type of volcanic island arc is exemplified by the Philippines and Japan.

Figure III.1 – Volcanic Island Arc Formation

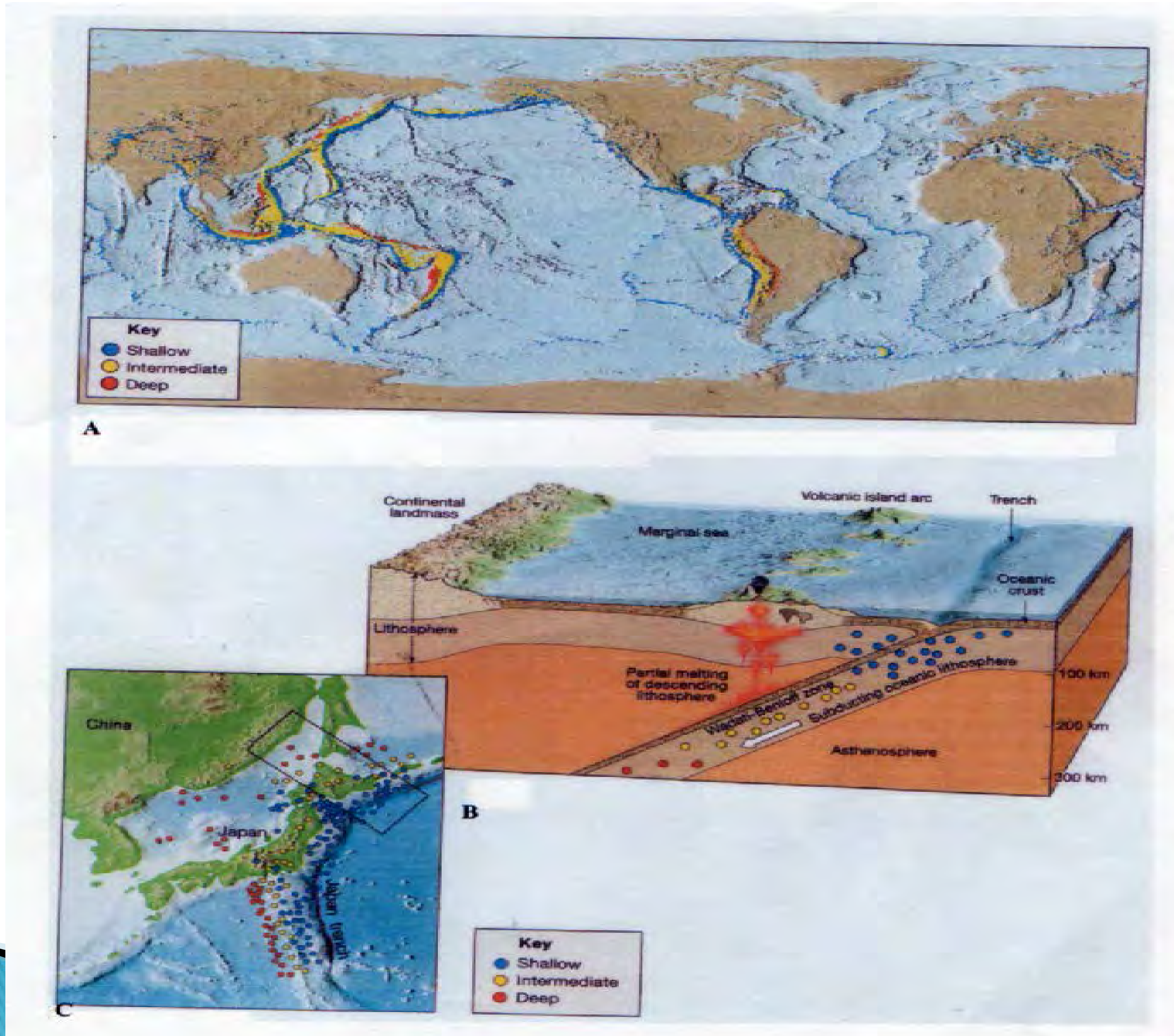


Figure III.2 – The Philippines

Figure III.2 - The Philippines

The islands emerged from the grind of tectonic plates in the Pacific some 50 million years ago. Their shorelines fell and rose with the ice ages, and they were sometimes linked to one another by land bridges. But the Asian mainland remained hundreds of miles away, except for a few stepping-stone islands. Migration back and forth was impossible for most creatures, so each Philippine island evolved in virtual isolation, with its own unique species.

Figure III.3 – New Zealand

Experience of Magnetite Sand Exploitation in the Philippines and Similar Areas outside of the Philippines.

IV.1 Introduction

This introductory section is necessary in order to avoid unpleasant confusion and/or misconception on the terminology IRON ORE RESERVE as commonly used in commercial convention, specifically for conventional Iron and Steel Making Industry, reported as Crude Ore and Iron Content.

The world's leading sources of Crude Iron Ore Reserve are the United States, Australia, Brazil, Canada, China, India and Russia which range in the 5-25 billion tons each **located within a continental environment.**

On the other hand magnetite ironsand reserve is limited to the so called **Island Arc Countries like Japan, the Philippines, Indonesia and New Zealand. The reserve is quite small compared to the large conventional iron ore in continental environment.** Small they maybe but they are extremely useful and important as we shall see below. The paragenesis of the magnetite ironsand reserve appears unique and therefore, I consider it unconventional and must be looked at carefully in these terms compared to the continental conventional iron ore reserve. It is this uniqueness that makes it very important and useful.

IV.2 Iron sand Magnetite Concentrate Considerably Improves the ECONOMICS of the Conventional Iron and Steel Manufacture. Additionally it is the Unique Source of special pig iron for special iron castings and the added advantage of recovering the valuable Titanium and Vanadium Content is special processes designed for it.

Today, the world produces more than 1.4 billion tons of steel annually. China is the biggest producer at about 500 million tons per year. **Japan**, one of the Island Arc countries where magnetite ironsand is found **discovered its magnificent use and application in their blast furnace iron making process, additionally**, they were able to **develop a new process in the manufacture of special pig iron for the manufacture of special cast iron products. Vanadium was also recovered in the process to produce the expensive special alloy of Ferro-Vanadium in demand in the Ferro-alloy industry worldwide**.

While Japan was enjoying the benefits of their unique iron sand resources, the rest of the Island Arc countries an\d probably the world were unaware of this development. China is the world's expert in small blast furnaces. Japan is the world's expert in large blast furnaces. Japan built for China, their early large blast furnaces. **Today, China stands as the expert in both categories**. It is therefore safe to assume that with the advances of blast furnace technology especially in the field of the use of **AI-System**, the control and use of titanium oxide in magnetic sand concentrate in the blast furnace operation must have been largely known by the Chinese Metallurgical Scientists. Theoretically therefore, in order to use this unique technology, they need to add to their **Blast Furnace Burden** about 44 million tons per year of magnetite ironsand concentrate. This will be covered further below.

From the point of view of the large conventional, continental iron ore suppliers, magnetite ironsand concentrate, comparability small therefore must **be useful in some special easy. Firstly,** the answer may be found in a Japanese report which for convenience will be summarized as follows.

1) It has an excellent natural state of fineness.
2) It is inherently free form harmful tramp elements.
3) Contains precious metals of titanium and vanadium.
4) Controlled TiO_2 in blast furnace slags prolongs the operating life of the bosh refractory system, an extremely useful development for the economics of blast furnace iron making.
5) The sad conclusion – "We should have known better and not wasted this precious iron ore resource the way we had. Everything is too late. The reserve is all gone."

Secondly, the New Zealand experience:

1) Items 1-3 above, has always be been known by New Zealand.

2) Items 4-5 served as a lesson for them and therefore planned foremost to conserve this unique iron ore resource by developing their own unique technology for it.

3) Today, they operate the only integrated iron and steel plant based on this iron ore resource.

4) Part of their ironsand magnetite concentrate however is still exported to Japan and China.

Thirdly, the Philippines Ironsand Concentrate Experience:

1) For a period of more than 10 years until about the later 1975's ironsand magnetite concentrate production were all exported to Japan. New Zealand also exported to Japan. The proximity of the Philippines to Japan was a definite marked advantage in transport economics over New Zealand.

2) Attempt was made to do the Japanese route to self reliance and produce products with highly added value products. The attempt failed because the government banned ironsand mining until 1995 when it was lifted. Today for the last 20 years, **this valuable iron ore resource remains untouched.**

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Lastly, the Indonesian Ironsand Concentrate Experience:

1) The availability of natural gas in the country and other type of iron ore lead them to undertake a different route to establish an integrated iron and steel industry as opposed to New Zealand's.

2) Today, however like everyone else, **the doctrine of self sufficiency and raw materials conservation** lead them to do a New Zealand route. Feasibility studies have been completed for implementation.

IV.3 One can now attempt to provide meaningful answer come basic. It is unfortunately unavoidable to integrate certain items in order to signify collective importance rather than treating them individually, necessarily because the material under consideration emanates from a common paragenetic origin and more so, the close proximity to each other relative to global consideration mentioned above.

1. Reserve and quality investigation – Compared to the conventional and large continental iron ore reserve, magnetite ironsand concentrate considerations came late in the game. **Firstly,** because it was an unconventional material, limited in volume and originating from comparatively small scattered area and **secondly** its techno – economic significance has not been a priority consideration at that time.

2. It has not been until the Japanese has found its tremendous usefulness that the world attention was caught specially the United Nation's UNDP, ECAFE and CCOP using the latest understanding of Tectonics initiated the latest advances in Marine Geophysical Prospecting Methods in this part of the world where the Philippines was one of the earliest recipients of the technology thus, enhancing the recognition of the importance of this Philippine Ironsand resources.

3. **Ironsand Magnetite Reserve** – for millions of years, the evolved Island Arc countries like Japan, Philippines, Indonesia and New Zealand, the primary sources, bearing Iron, Titanium and Vanadium, weathering played a major role. Next, gravity and erotional agents like waves, running water and wind, removed these products of weathering and carried them to new locations where they are deposited. In our case, they were largely deposited in onshore and offshore environments. From purely economic considerations attention was focused largely on the readily observable onshore deposits specially when Japan's own iron sand magnetite resources were completely depleted and looked at the Philippines and New Zealand as potential suppliers. It is important to emphasize that the Philippines due to its proximity to Japan has the distinct advantage over New Zealand especially in the context of the all sensitive delivery and transport cost.

3.1 **The Philippine Source** – It was mentioned above that iron sand mining activities ceased in 1975. Twenty years later in 1995, the Supreme Court lifted the ban and once again fueled the interest of investors. More than 20 years ago, the BMG, without the benefit of systematic exploration estimated the total reserve at a cut-off grade of 40% Fe localities distributed all over the Archipelago to be over 100 million tons onshore. This is certainly an overly conservative estimate since percent magnetic in the sand averages 15-25%. Actual exploration and mining in the past for export to Japan indicated a much larger deposit. The CCOP_BMG Geophysical Survey on a 2, 744 line kilometer traverse suggests an onshore and offshore deposit better than 2 billion tons where onshore resources may amount to better than 500 million tons.

3.2 **The New Zealand Source** – New Zealand in just one onshore area reports a 675 million tons reserve. Other areas have not been officially reported.

3.3 **The Indonesia Source** – Indonesia reports in one small area alone an equivalent deposit onshore of better than 5 million tons (This number is frequently found in the Philippines in several locations similar to that of Indonesia). On this basis Indonesia can easily have a total volume similar to those of the Philippines and New Zealand at better than 500 million tons. Similarly other areas have not been officially reported.

4. Market for Ironsand Magnetite Concentrate

4.1 The market for ironsand concentrate would be mainly Japan and China. While other countries may want to take advantage and use the Japanese Blast Furnace Technology largely for economic reasons, delivery and transport cost of the ironsand concentrate alone becomes highly prohibitive. After the present economic crisis shall have been surmounted by Japan, it is estimated that Japan will produce about 120 million tons of steel per year that may require 8-10 million tons of ironsand concentrate per year. China, the largest steel manufacturer at 500 million tons per year may require 35-45 million tons of ironsand concentrate per year.

4.2 While the availability of ironsand resources from the three sources appear substantial, the ability to recover the volumes required can become a serious problem so that the exporters are in fact carefully looking at better opportunities for higher value added products and give preference to satisfying their local Engineering Industries and contribute effectively in development and industrialization of their respective countries.

4.2.1 New Zealand for instance with a population of about 3-4 million has a present capacity to produce steel better than 750,000 tons per year from ironsand resources. Their kilogram steel per capita consumption appears comparatively high.

4.2.2 Indonesia has already an existing integrated steel facility but intends to start a unit of 300-400 tons per year steel from ironsand resources. This appears necessary because of their huge population and the advantages of exploiting their precious ironsand resources and converting them to products that will fuel and accelerate their development and industrialization.

4.2.3 The Philippines has an extremely low per capita steel consumption considered an underdeveloped country. There are no meaningful Engineering Industries in the country. The relatively large ironsand resources is therefore a ripe opportunity to be exploited and ultimately satisfy the urgent needs of the local iron and steel industries and hopefully will catch up with New Zealand and Indonesia.

I. Summary and Conclusions

1. There appears to be a substantial source of ironsand concentrate in the three Island arc countries of New Zealand, Philippines and Indonesia.

2. The Japanese has proven it in the past and following closely behind is China in the economic advantage of using controlled titaniferous magnetite in the Blast Furnace Burden. The total requirement would be substantial and therefore highly dependent on the ability of the suppliers to cope.

3. It is just a matter of time when conservation of resources and producing high value added products that will subsequently result to a more healthy international financial dollar reserve will **ultimately push the suppliers to decide to have a second look at the ironsand resources for themselves in the manner the Japanese did in the past.**

4. The foreign buyers will gain a lot in terms on continuity of supply to consider simultaneously two things:

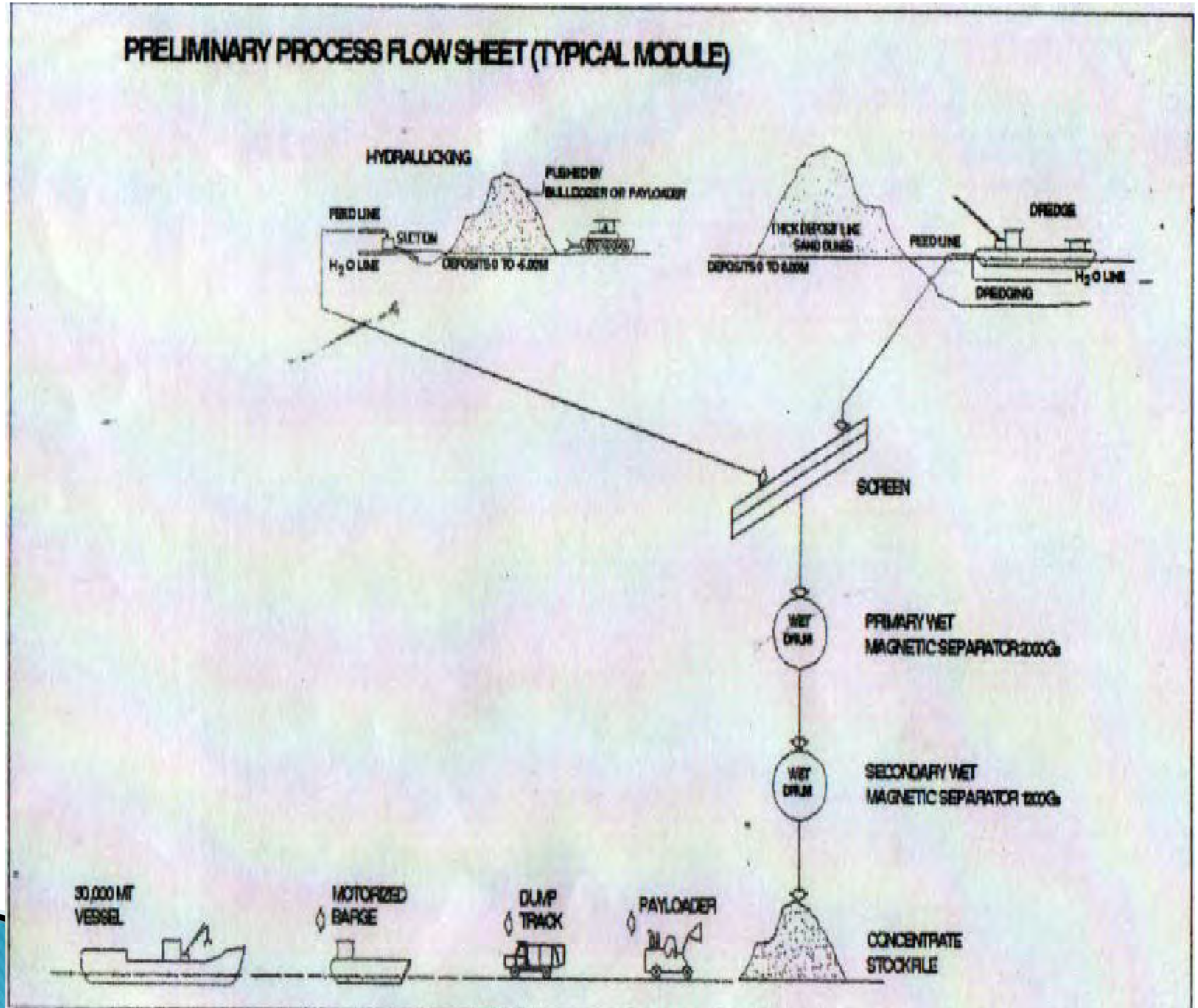
4.1 Invest in the exploration and exploitation phase of the ironsand resources.

4.2 Invest in processing units similar to those of New Zealand and Indonesia to produce specialized high value added products to be utilized both in their own Home Engineering Industries and the Engineering Industries of the host country, an ideal symbolic relationship indeed.

5. The Philippines has a distinct advantage in terms of proximity to Japan and China and has a highly educated work force both in the professional level and highly skilled level to satisfy the needs of item 4 for the benefit of both the host country and the buyer country.

In closing and personally judging at the rate of depleting the world's iron ore resources including ironsand resources a seller's market is silently rising in the horizon.

Figure V.8 D – Magnetite Irosand Beneficiation Process



VII. Offshore exploration Considerations of the North Luzon Ironsand Resources

Along the coastal areas of San Fabian going northward, a high grade magnetite beach has already been reported by the Mines and Geosciences Bureau. Likewise, before the banning of magnetite beach mining in the country, certain mining company (Anglo Philippine Oil and Mining Company) is known to be mining the magnetite sand deposit from 1972 to 1974 along the beach of Sto. Tomas, La Union. In connection with this, the promising horizon delineated along line 23 is probably the offshore extension of the reported magnetite beach deposits in the area. The offshore extension is further inferred to extend from Aringay Offshore in the north down to san Fabian Offshore in the south.

Beach sand was also exploited by Filmag (Philippines), Inc. on the west coast of Luzon, Marabeni Consolidated Mines Inc. on the east coast of Luzon and Anglo Philippines Oil Co. in Cagayan Province at the Northern end of Luzon Island.

Magnetite concentrates, containing about 60% of Fe and 7% of TiO_2 were shipped to Japan. Those concentrates are mainly used by Nippon Kokan Co. Ltd., Kobe Steel Works Ltd., Yawata Iron and Steel Co. Ltd., Nisshin Steel Co. Ltd., Sumitomo Metal Industries and Kawasaki Steel Corporatio.

Typical analysis (in percent) of the concentrates shipped by Filmag, as reported by Nisshin Steel co ltd., of Japan is as follows: Total fe, 61.61 (FeO, 25.21 Fe_2O_3, 59.44); TiO_2, 6.17; Mn, 0.58; Pb, trace; SiO_2, 2.34; Zn, 0.081 Al_2O_3, 3.03 Bi, 0.004 S, 0.098 Ni, 0.006; MgO, 2.40; Cr, 0.021; CaO, 0.66, and Cu, 0.011. A screen analysis showed the following size distribution (percent) 1mm to 0.5mm, 0.1 0.5mm to 0.125mm, 74.9;; and finer than 0.125mm, 25.0.

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VII.1 Background Information

1) Tectonics in the early 1960s was hardly in existence, however a series of remarkable discoveries in marine geology, the phenomenon has become evident and international experts became aware of this most exciting frontier of geosciences. The origin of detrital deposits on interest is now as evidenced by the Island Arc of New Zealand, Philippines, Indonesia and Japan. These four countries for years have exploited the onshore ironsand deposits.

2) The ECAFE recognizing the extraordinary implication of this phenomenon organized the COMMITTEE for COORDINATION of PROSPECTING for MINERAL RESOURCES in ASIA OFFSHORE AREAS to become known as the CCOP or simply THE COMMITTEE. The important factor to emphasize is that the COMMITTEE created the TECHNICAL ADVISORY GROUP (TAG) and TECHNICAL SECRETARIAT consisting of highly impressive line of experts that steered the COMMITTEE successfully through most of its early years of activities. The Philippines is a FOUNDING MEMBER of the COMMITTEE.

3) All publications including those of the Philippines embracing the offshore research and studies have passed through the scrutiny and review of the TAG based in Bangkok. It is important to emphasize that all information on the off-shore survey originating from the CCOP via our own BMG is factual and legitimate that maybe used as reference and guide in the pursue of EXPLORATION activities.

4) In the development of this report, I have encountered some misconceptions and interpretations especially by non-technical people. I find it therefore necessary to clarify the following

a) All proven theories in science are based on recognized fundamental laws that help explain the phenomenon (a) under consideration. Geo-Science in our present case is a good example.

b) In the field of TECTONICS which is now a recognized phenomenon leads to certain criteria that guide the PROSPECTING of off-shore potential economic detrital deposits (magnetite in our case). Prospecting therefore is not guesswork. Possible chances especially of success when properly understood and implemented are based on accepted scientific principles. EXPLORATION on the other hand means to investigate systematically and get into at depth by use of known method(s) and guided by the findings during the prospecting activities, such as boundaries, areas and elevations. Finally, the body maybe proved to be an ORE, one that can be exploited at a profit.

5) While exploration is still to be done, reason of which the BMG carefully assess and guides potential areas, provides EXPLORATION permits which under the Law provides rules and regulations to protect potential investors. The professional responsibility and exposure of the National Government via the DENR, therefore, cannot be over emphasized more especially for the benefit of foreign investors.

6) There is nothing wrong in working out preliminary or indicative quantitative determinations of deposits for as long as they are within the premise defined by the results of prospecting and does not contravene any controlling physical law of science embracing the subject under consideration. Some people call it, preliminary, indicative or inferred. Therefore some numbers may float around and to give an example:

6.1 The Lingayen Gulf Area alone gives about 2.9 billion tons. However, it is necessary to investigate what assumptions were made. In my own personal experience after considering some controlling factors, the number results to 1.7 billion tons.

6.2 In the Ilocos Sur and Ilocos Norte area the number gives 1.5 billion tons. In like manner as item 6.1, my own gives 800 million tons. It is interesting to note that a similar area in New Zealand provides a number of 600 million tons.

Finally, the important thing to consider is the actual measurement work done in Ilocos Sur, ilocos Norte, Bauang and Carlatan in La Union and san Fabian and Lingayen Gulf in Pangasinan according to the Marine Geo-Survey by CCOP and BMG. The Northwestern Luzon Area is considered an ECONOMIC ZONE for the sought after detrital deposits waiting to be EXPLORED. The Northeastern Luzon, the Cagayan Province Area has the same good potential and volumes.

VII.2 Offshore and Coastal Geophysical Surveys in Northwest Luzon

The Philippine Mines and Geo-Sciences Bureau (MGB) successfully conducted a shallow marine geophysical survey along the northwest coast of Luzon in early 1987 with the support and cooperation of the UNDP/ESCAP Technical Support project to CCOP. In undertaking the survey, the Project provided some equipment on loan and the advisory services of Dr. John Ringis and an electronics engineer. The joint project was implemented with the primary objectives of obtaining detailed knowledge on the stratigraphy and mineral potential of the surveyed area as well as to provide an opportunity for the Mines and Geo-sciences personnel to gain additional experience in conducting a high resolution marine geophysical survey for detrital heavy minerals. The project completed 2,744 line kilometers ot traverse (Fig. 1). Preliminary processing and interpretation of the data was undertaken by three MGB participants of the survey at the CCOP Headquarters in Bangkok under the guidance of Project experts. The in-house training/secondment of these technical personnel, funded by UNDP/CCOP, was extended from the original 2 months to 2 ½ months duration. Further interpretation of data is being undertaken at the Mines and Geo-Sciences Bureau.

VII.3 Early Offshore Investigations

Sand deposits rich in magnetite are known to occur on many beaches around the Philippines. The potential of the Lingayen Gulf area as source of magnetite sand was realized and the exploitation of the beach deposits in La Union province was begun by Filmag. To verify the presence of a sizeable offshore deposit off Damortis Bay, an initial survey was conducted in July and August of 1969. Subsequently, testing by boring was conducted from January to March 1970 to determine the thickness, quality and reserves of magnetite in the ore zones delineated in Damortis Bay.

Figure VII.1 – Northwest Luzon Magnetite Sand Resources Shallow Marine Geophysical Survey

Location and accessibility

The magnetite sand deposit is located off Damortis, La Union, at latitude 16° 15' N and longitude 120° 25' E. Damortis is 250 km north-northwest of Manila and 40 km south of San Fernando, the capital of La Union province. Damortis is readily accessible from Manila by road and rail and there are regular flights of commercial aircraft between Manila and San Fernando

Geologic Setting

The magnetite sand deposit explored constitutes part of a submerged sandbar 4 km west of Damortis Bay which is undertaken by recent gravel and coarse sand mixed with a few shells. These sediments, including the magnetite sand, were brought into Lingayen Gulf by the Bued and Agno Rivers, with headwaters near Benguet and which cut through the volcanic, sedimentary and intrusive rock complexes of the Baguio Mineral District and the sedimentary rocks of the Rosario Formation in La Union.

Topographically, the area consists of a shallow undersea hill or sand bar. As also shown well in the topographic map, the eastern landward side of the sand bar is steep. It is believed that the sand bar was developed by long shore currents which are still native in the area. The top of the sand bar is remarkably flat and the water depth over it ranges 4 to 7 m. in this investigation, it was observed that ripple marks being formed on the sand bar face towards the NNW direction. This strongly indicates that current and swells are oriented towards this direction.

Long shore currents and storm waves are principally responsible for the redistribution of these sediments and the accumulation and concentration of the heavy mineral which are made up mostly of iron oxides. The sand is composed mainly of quartz grains; pyroxene and hornblende are common while andesite and chert fragments are sometimes included. In addition to the magnetite, other heavy minerals included in the sand are ilmenite, chromite and rarely gold.

Offshore test Boring Methods

Much research is being done on methods of taking adequate submarine cores. In the case of testing magnetite sand deposits which requires determination of thickness and magnetic fraction to a shallow penetration depth of only about 5 m, “rope boring” is the most applicable because of its simplicity and low cost. This method was used early in the investigations but, because of the gravel mixed with the sand in this locality, the method was changed to pump boring during the course of the investigation.

Survey boat and equipment

A two-boat system was initially planned for the survey but, because of difficulty in finding two suitable boats in the area, only one 10-tom fishing boat was used. The boat was kept stable with four anchors, each weighing about 40 kg. in order to keep the centre of the boreholes stable, the boat's position was kept facing the direction of wind and swell as much as possible. The fact that the boat was easily affected by wind and swell made operations difficult.

Rope boring

This method, sometimes known as the “jet blow” method, is commonly used to obtain sludge samples from gravelly sands as it can penetrate to greater depths through gravels the sample recovery is almost perfect and changes in the sand formation can be readily observed. Sampling was made was more than 20 mm because the clearance inside the pipe is only 20 mm. a maximum depth of 6 m depth was reached and the average boring depth was 3m. the bedrock of the sands and gravels, consisting of mud and coral reef, could not be reached because of difficulties in drilling through the gravelly layer, limitations imposed by weather conditions and the fact that boring was usually stopped at 4-5 m, below with the grade of the deposit continue to be low.

Ore Reserves

The area tested was subdivided into small blocks individually defined by three boring points. Selection of the points was arbitrary but the triangles were made as close as possible to the figu8re of a right triangle. For each individual block, the average thickness of the deposit and average magnetic fraction at the three boring points of each triangle were used to calculate the quantity of magnetite ore in each block.

Based on the 48 holes drilled, the average thickness of the deposit is 2.6 m and the average magnetic fraction is 9.4 percent. The highest grade found in a one-meter section had an average of 39.8 percent of magnetic fraction. The calculations indicate that the total ore reserve is 7,400,000 tons of which 1,000,000 tons consist of more than 15 percent of magnetite fraction and 3,000,000 tons contain a little less than 10 percent of magnetic fraction.

Chemical Composition and Grain Size

The average Fe content of the concentrates is 59.5 percent and the TiO_2 content ranges from 7.00 to 7.5 percent. The grain size does not exceed 500 microns and 64.4 percent consists of grains within the range of 125-250 microns.

Mineralogical Relationships

Observation under the reflection microscope showed that the grains are mainly magnetite but associated minerals were noted as follows; (1) Magnetite with exsolution of hematite; (2) magnetite with exsolution with incuded hematite and ilmenite.

It should be noted that magnetite and ilmenite, because of their similar colors and hardness, are difficult in distinguish from each other, however, magnetite is etched by Hcl whereas ilmenite and hematite are not. Under the microscope, the hematite is yellowish-grey, anisotropic and higher in reflecting properties.

VII.4 Later Offshore Investigation

VII.4 A Preparations for the Offshore Survey

The study of tectonic framework within the Northwest Luzon offshore and onshore region provides geologic informations and facts that could give clues to the provenance of pelagic/hemipologic sediments. Analyses of these geologic data serve as the basis for the establishement of the tectonic setting and areas of economic importance in the region.

Subsequent processes involving the subduction of the Manila Trench resulted in the formation of bathymetric features such as the North Luzon trough. West Luzon through and Stewart Sack. Relative strike – slip faulting, upliftment and distruption of the fore are basin dominated the structural development. Several large submarine canyons including the Vigan and Paoay high at the north and those observed at the Lingayen Gulf area had cut through the Luzon Continental margin and had given access for clastic sediment deposition. Further geological/geophysical study at the Northwest Luzon Region carried out by both local and foreign corporations had provided additional informations and interpretations. **Deposition of magnetite and other associated heavy minerals were discovered within the coastline that extends from Bacarra in the north Dagupan in the south.**

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This report was made in relation to the marine geological survey operation which will be conducted by the Bureau of Mines and Geo-Sciences in cooperation with the Committee for Coordination of Joint Prospecting for Mineral resources in Asian Offshore areas (CCOP), an intergovernmental agency supported by UNDP, with the following objectives: a) providing a detailed knowledge of the stratigraphy of the unconsolidated sediment sequences along the **Northwestern coast of Luzon;** b) locating areas with the best potential for the occurrences of economic concentrations of detrital heavy mineral deposits; c) **mapping the bedrock geology and providing the opportunity for Bureau of Mines and Geo-Sciences personnel in obtaining additional experience in conducting high resolution marine geophysical surveys for detrital heavy minerals.**

VII.4 B Marine Geological Survey

A marine geophysical survey off Lingayen Gulf was conducted jointly by the Mines and Geosciences Bureau and CCOP/UNDP under project RAS/86/138 between April 22 and April 30, 1987

Processing and interpretation of results were done at the CCOP Technical Secretariat in Bangkok, Thailand under the guidance of the Project Team Leader. All navigation echo sounder and magnetic data were processed and plotted on maps and preliminary contours of bathymetry and magnetic were drawn. A preliminary interpretation of the seismic reflection profiler data was mostly completed and preliminary profiles were drawn but of the seismic and magnetic data from the surveyed area.

Analyses of the reflection seismic data includes identification of different seismic sequences on the profiles based on their individual reflection characteristics and on the strength and continuity of the reflection horizons separating them as well as the internal reflection pattern characterizing each sequence. Type sections were constructed on selected areas to illustrate the deduced seismic sequences. Areas of inferred prospective sediments and features of geologic interest were also delineated. Finally, a review of the magnetic and bathymetric data was made to recognized indication of possible extent of basic or ultra basic rocks in the area and to map the extent of any other magnetic features which may help in delineating areas with the best potential for the concurrence of economic concentrations of detrital heavy mineral deposits.

VII.4 B-1 Introduction

A marine geophysical survey consisting of shallow marine seismic reflection, magnetic, bathymetric and side scan sonar measurements was conducted along the near shore and offshore areas of Lingayen Gulf from April 22 to April 30, 1987. The survey was actually a part of RPS EXPLORER Cruise 87-1 along the NW Coast of Luzon which was conducted from March 17, 1987 to May 10, 1987 aand consisted of 8 legs extending from Cape Bojeador in the north to Mariveles Harbor. The survey cruise was jointly undertaken by the Mines and Geosciences Bureau (MGB) and CCOP/UNDP under Project RAS/86/138 "Technical Support for Regional Offshore Prospecting in East Asia" with the following objectives:

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1. To obtain a detailed knowledge of the stratigraphy of the unconsolidated sediments in order to delineate areas with the best potential for the occurrences of economic concentrations of detrital heavy mineral gold and ilmenite;

2. To map the bedrock geology of the surveyed areas;

3.To provide information on potential geologic hazards for offshore engineering cable laying and other activities in the area; and

4. To provide the opportunity for MGB personnel to obtain additional experience in concluding high resolution marine geophysical surveys for detrital heavy minerals.

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Participants involved in the survey were twelve (12) MGB technical personnel for shipboard operation and ten (10) more additional personnel for establishing and operating the onshore navigation control stations. The ship's crew numbered twenty three (23). The Project Team Leader, a senior marine geologist / geophysicist, and an expert electronics engineer from the UNDP Project RAS/86/138 participated in the survey cruise. The survey vessel used was the RPS EXPLORER of the MGB.

Although the survey consisted of various geophysical methods such as shallow marine high resolution seismic reflection, magnetic, bathymetric and side scan sonar measurements, this paper describes only the results of interpretation of seismic, bathymetric and navigation data due to time constraint.

The study area is located between the latitude 16^{O} 5' and 16^{O} 40' and longitudes 120^{O} o' and 120^{O} 24' (Figure 12). It is a broad and gentle trough suggestive of a basin structure that had experienced faulting along the western and north-central portion. It plunges slightly west from northwest and is inferred to be overlain by thick sequence of unconsolidated to semi consolidated tertiary and quaternary marine sediments.

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VII.4 B-2 Survey Methods and Instrumentation

The following geophysical and navigation equipment were used in the survey:

(i) Continuous seismic reflection profiling system using a multi-electrode high resolution spark-array at different power outputs.

(ii) Side scan sonar for mapping geological and other features beneath the gulf.

(iii) Echo sounding.

(iv) Precise navigation control using a Motorola Miniranger III electronic positioning system with positions plotted automatically at 2 minute intervals.

(v) Marine M-123 Barringer Proton Magnetometer

(vi) Base Station Magnetometer

The survey was carried out by running continuous measurements of seismic reflection, magnetic and bathymetric lines and a few selected lines for side scan sonar recordings. Seismic measurements were done by a seismic recorder (model EPC 4800) which generates trigger pulses at regular intervals causing the trigger unit to discharge energy (400-800 joules) through the seismic sound source (50 electrodes spark array) towed portside behind the ship. The seismic pulse thus generated travels through the water and is partially reflected from the sea floor and from the various layers beneath the gulf. The returning pulses are detecxted by the hydrophone array consisting of 20 individual hydrophones which is also towed 20 meters behind the vessel on the starboard side.

A bamboo pole was attached to the back of the ship wherein the hydrophone array was fastened at one end of the pole using a piece of shock cord in order to put more distance between the sparker and the hydrophone array and at the same time to isolate the ship's noise from the hydrophone. The distance between the hydrophone array and the spark array was approximately 9 meters. The signals detected by the hydrophone array are passed through the signal processing unit which is a band pass filter (KROHN-HITE Model 3700) set at 100 and 1200 Hz for low and high cut frequencies, respectively, and then to the recorder where they are amplified and recorded as a continuous profile.

Continuous measurements of the earth's magnetic field were also taken coincidental with the seismic reflection using a marine precision proton magnetometer and a land based station magnetometer to monitor diurnal variation. In addition continuous bathymetric measurement using the NEC 12 KHZ echo sounder were taken all throughout the survey and a number of side scan sonar records were collected along some selected lines.

Total survey coverage was about 917 line-kilometers covering an approximately area of 1600 km^2. The results were generally of good quality and will enable the objectives of the survey to be met.

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VII.4 B-3 Regional Geology

La Union province embraces the sourthern portion of the western flank of the Cordillera Central, Northern Luzon, extending through the shores of South China Sea and Lingayen Gulf. Basically, the province is made up og Tertiary lithologic units locally called the Klondyke conglomerates, Roario, Damortiz and the Paraoir Formations. The Rosario and Damortiz formations are intensely folded. Strike slip and gravity faulting are common; some constitute splays of the Philippine fault. The possible economic deposits of the province are limited in association to young Tertiary and Quaternary deposits.

The otherwise straight shoreline of La Union is modified by the Sto. Tomas sand spit, the deltaic on the main river systems, and the land jutting off San Fernando, the Poro Point. The Sto. Tomas sand spit is probably formed by the south flowing long shore current originating from the northeastern part of the Gulf. The Aringay-Pugo River is the most probable source of materials that made up the sand spit. The sand spit is 2 kilometers in its widest portion and tapers gradually to a distance of 8 kilometers to the south.

The Pleistocene and Recent rocks are composed of elevated coral reefs, terrace gravel deposits and alluvium. The coral reefs are essentially calcareous materials occurring along the sea shore. The alluvial deposits are extensive along the flood plain of the rivers and coast of the sea.

Two sets of faulting are the most prominent structural features in the area. The generally north-northeast trending regional faults, Calaclan, Inab-aban and San Agustin are believed to be major splays of the Philippine Fault. They are steeply dipping and parallel to each other.

The east-west faults appear to be genetically related to the regional faults. Most of them are normal with almost vertical dips.

In NW Luzon region is dissected by major and minor drainage systems. The NW portion is deeply encroached inland by numerous rivers that traverse various rock units. Bauang River as well as Aringay River whose headwaters reaches into the hinterlands, passes over diorite bodies, undifferentiated volcanic and sedimentary rocks of the region. Along these rivers, the loose components of the rocks are carried downward and deposited on the sea floor as on the beaches.

VII.4 B-4 Discussion of Results

1)Navigation

A final results of the processed navigational track chart of Lingayen Gulf was constructed to illustrate the actual positions of the traversed geophysical lines to give a more accurate and reliable discussion of results on the interpretations of the gathered geophysical data. The ship's positions provided by the Mini-Ranger Positioning System (MRS III) were plotted on the map every 5 fixes which is equivalent to 10 minutes interval in time. In some areas where the MRS II weakened or lost its signal, thus giving inaccurate ranges or sometimes no ranges at all, the ship's radar navigation data is substituted instead. In such cases, the data provided by the ship's radar navigation system were plotted every 15 minutes.

2)Bathymetry and Geologic Structure

Lingayen Gulf is a broad and gentle trough that is suggestive of basin structures that plunges slightly west from northwest. As shown by the bathymetric contours, a major northwest trending lineament extending several kilometers offshore was recognized along the western part of the area. This major fault structure is inferred as the probable offshore extension of the NW trending gravity fault that runs longitudinally on the western boundary of the Central Luzon valley basin. Shoreline characteristic in this part is irregular suggesting reefal structures which are best exemplified by the presence of the so-called hundred islands protruding above the sea floor.

The north-central portion of the gulf is characterized by flat bottom topography at an average depth of 90 meters. However, several major and minor faults have been delineated along this area exhibiting a curvilinear feature. Those structural features are interpreted to be related to the major splays of the Philippine Fault. Further north, the sea bottom slopes down gradually up to several kilometers offshore.

All the above mentioned fault structures have pronounced vertical displacements with the downthrown blocks located on the inner sides of the gulf. In some areas disruption extends to the sea floor indicating recent movements. Likewise, on the eastern portion of the gulf several small northeast-southeast trending sets of faults are observed. Most of these faults have also vertical displacements and some exhibit step faulting.

Possible causes of the observed faulting include vertical tectonic movement associated with the Manila trench to the west, movements along the major splays of the Philippine fault on the adjacent land areas and probably by the differential compaction of the sediments in the gulf depositional basin.

On the eastern side of the gulf, an offshore extension of the large sand spit situated west of Damortiz Bay was also inferred.

As seen from the bathymetric contour map and the 3 dimensional bathymetric profiles, the sea bottom area along the eastern side is characterized by a moderately steep slope resembling a ridge like pattern running longitudinally on a north-south trend.

3)Interpretation of seismic Profile

Seismic profile interpretation was carried out with the objective of (a) determining the thickness of unconsolidated/semi-consolidated sediments underlying the gulf, (b) delineating areas with possible accumulation of detrital heavy minerals and (c) to map structures, probably faulting, which might have directly or indirectly controlled the accumulation of unconsolidated/semi-consolidated sedimentary units.

Since no sampling had been done yet in the survey area, interpretation of the seismic data in terms of sediment types was based largely in the textural pattern of seismic records. The deduced seismic sequences along selected areas were illustrated in type sections. Such sections were constructed along lines 23 and 41. Line 23 has been deduced to be the best site for probable accumulation of detrital heavy mineral whereas in line 41, prospective sediment sequences and features of geological interest such as faults, etc. were delineated.

Based on the selected seismic sections, three (3) main unconsolidated/semi-consolidated sedimentary units or layers were recognized.

Along the most of the seismic profiles the “economic basement” reflector could be clearly identified. The term “economic basement” used in this paper refers to the base limit of the deduced probable concentration of detrital heavy minerals within the unconsolidated sedimentary sequence.

For identification, the following “units” are used in this report in the valuation of the surveyed area. It does not necessarily follow however, that these units occur consistently and in the same order of succession throughout the surveyed lines.

Overlying, the economic basement is the semi-consolidated layers designated as unit 3. Unit 3 is characterized by a chaotic reflection pattern and is inferred to consists of terrestrial eluvial/colluvial sediments of variable grain size but containing a high percentage of coarse material deposited in a higher energy environment. The coarse materials possibly resulted from a greater influx of coarser sediments from a nearby terrestrial source during a fall in sea level. The reflection horizon between the economic basement and unit 3 is characteristically irregular. This is interpreted to be am erosional surface representing successive falls and subsequent rise in sea level, giving rise to the eventual deposition of unit 3. Unit 2 and unit 1 are distinguished by an essentially reflection free to simple parallel reflection patterns. These are inferred to consist of fine sediments. To somewhat medium grain sediments.

On the basis of the textural reflection pattern within the delineated sedimentary unit, a promising horizon designated as seismic facie unit A has been delineated. This is characterized by a lateral facies change within unit 1 on line 23. The prospective area is situated approximately 2 kilometers from the shoreline of Agoo, La Union. From the isopach map, the thickness of unconsolidated/semi-consolidated sediments in this area is about 45 meters comprising of recent gravel and coarse sand and forms a part of the large submerged sand bar approximately 2 kilometers west of Damortiz Bay. Elsewhere the sediment is considerably less particularly on the western portion of the Gulf. Likewise several rock outcrops, probably limestone, were observed in this area.

The long shore current and storm waves of Bued and Agno rivers which cut through the volcanic, sedimentary and intrusive rock complex of the Baguio Mineral District and of the Rosario Formation are responsible for sediment distribution and probably the concentration of detrital heavy minerals.

Other most promising areas for heavy minerals deposition are the coastlines of Bauang and Carlatan, La Union and San Fabian in Pangasinan. The accumulation of unconsolidated/semi-consolidated sediments in these areas were also mapped and sediment thickness taken.

Along the coastal stretch of San Fabian going northward, a high grade magnetite beach deposit has already been reported by geologist of the MGB. Likewise, before the banning of magnetite beach mining, certain mining company (Anglo Philippine Oil and Mining Company) is known to be mining the magnetite sand deposit from 1972 to 1974 along the beach of Sto. Tomas, La Union. In connection with this, the promising horizon delineated in line 23 is probably the offshore extension of the reported magnetite beach deposits in this area. The offshore extension is further inferred to extend from the Aringay Offshore in the north down to San Fabian Offshore in the south.

4)Conclusion

The following conclusion has been deduced based on the results of interpretation of geophysical data gathered in Lingayen Gulf.

(i) Three (3) main seismic units had been mapped based on the internal reflection pattern of each sedimentary sequence. The thickness of these unconsolidated / semi-consolidated sediments sequence range from 15 to 45 meters, the thickest part being on the eastern side of the survey area.

(ii) on the eastern portion of Lingayen Gulf covering line 23, a promising accumulation site for detrital heavy minerals has been delineated. The area is situated at approximately 7 kilometers offshore from the shoreline of Damortiz, La Union and adjacent to the submerged portion of the Sto. Tomas sand spit. In addition, not far from this area, previous magnetite beach mining activity was reported along the near shore areas of Sto. Tomas, La Union. In relation to this, the promising horizon delineated in line 23 could probably be the offshore extension of the magnetite beach deposit along the near shore areas of Sto. Tomas.

(iii) that observed NW trending fault on the survey area is interpreted to be the offshore continuation of the gravity fault that runs longitudinally on the eastern fringe of Zambales Range.

(iv) The north-central fault which exhibits a curvilinear feature in inferred to be related to the splays of the Philippine Fault and seemingly the offshore extension of one of the splays.

5) Recommendations

1.) The eastern portion of Lingayen Gulf is underlain by thick sequence of unconsolidated/semi-consolidated sediments which might contain economic concentrations of detrital heavy minerals. In this regard, an evaluation of the area to determine the sediments type and the actual thickness of each sedimentary unit should be given priority in the next cruise of the research vessel “RPS EXPLORER”. This type of evaluation could be attained by detailed geological sampling using at least 6 meter length piston corer for deeper penetration since the overburden capping the prospective horizon is 3 to 5 thick.

2.) Computer aided processing of bathymetric data have greatly helped in the interpretation. An example of this is the bathymetric contour map transformed into a three dimensional view. In this kind of projection, the interpreter can clearly and understandably identify various topographic features and probably some of the structure, possibly faulting. The computer aided processing is applicable also in the processing of magnetic data, gravity data and other geology related problems. Considering the voluminous pile of geophysical data being gathered annually by this division, the MMRD, acquiring a PC computer would not only enhance the quality of the output but would make processing and interpretation a lot easier and faster. Likewise, storage and retrieval of various geographical data (c.g. bathymetric, magnetic, seismic) could be organized systematically. Training on processing and Interpretations of Shallow Marine Geophysical data gathered on the NW Coast of Luzon was held at the CCOP Technical secretariat in Bangkok, Thailand.

VIII. Summary*

The **Science of Geology** is divided into two broad areas, physical and historical. **Physical geology** examines earth's rocks and minerals and seeks to understand the hundreds of processes that operate beneath or upon its surface. The aim of **historical geology** in contrast is to understand earth's origin and how it changes through time. **Historical geology** strives to establish the chronology of physical geology and biological changes in the past. Today, **uniformitarianism** is a fundamental principle of modern geology. It states that the physical, chemical and biological laws that operate today also operated in the geologic past. The concept of geologic time is new to many non-geologists. People are accustomed to dealing with increments of time measured in hours, days, weeks and years. History books often examine events over spans of centuries, but even a "**century**" is difficult to appreciate fully. A 100 years old artifact is understood as "**ancient**".

By contrast, those who study geology must routinely deal with vast time periods –millions or even billions (thousand of millions) of years. When viewed in this context of Earth's 4.5 billion year history, a geologic event that occurred 100 million years ago for instance maybe characterized as **"recent"** by geologist and a rock sample that has been dated at 10 million years maybe called **"young".** An appreciation for the magnitude of geologic time is important in the study of geology because many processes are so gradual that vast of times are needed as in the case of **magnetite sand** before significant changes occur.

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In this report therefore, it has been found extremely necessary to begin with the Philippine geologic history in general and to the Northwest Luzon environment in particular, in order to understand the process that have occurred in the **"recent past"** to serve as scientific evidence of the presence of ironsand deposits, their origin, behavior, and chemical character, both at the onshore and offshore environments.

Effort has been made to present information why the presence of ironsand deposits in Japan, Philippines, Indonesia and New Zealand. The so called **Volcanic island Arc Countries**, are the only geologic environment, in the world where substantial volume of ironsand deposits are found. It is in this context that one may infer why the Philippines comparatively indicate more substantial volume that the other tree environments.

Similarly, information has been provided with regard to the commercial exploitation in the past of the onshire ironsand deposits at the Northwest Luzon area exemplified by the **Filmag (Philippines) Inc.** operations. The **"Filmag"** magnetite ironsand concentrates was proven to have exceptional good and satisfactory physic-chemical properties that as a result, several large iron and steel makers of Japan, then the world's largest manufacturer, continued to import from **"Filmag"** until the Philippine government during the Marcos Government banned the mining of ironsand. It goes without saying therefore that consequently, substantial amount of deposits onshore have been left behind and remained untouched until today.

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Further information has been provided about the early activities of forward looking Filipino geologists in the investigation of offshore ironsand deposits. The geologic past and the subsequent modern understanding of geology described above guided the geologists to delineate the offshore deposit. Satisfactorily, geotechnical and engineering analyses of the offshore deposit prompted FILMAG to undertake the feasibility of establishing a special iron and steel making complex with the assistance of Japanese Experts. The project was found commercially viable and was readily approved by the government for implementation. The project, however, was unfortunately discontinued because of the following Philippine Revolution that ensured shortly thereafter.

Detailed information has also been provided about the very successful **UNDP – Philippine Bureau of Mines Offshore Ironsand Exploration Project** that confirmed the presence of **commercial qualities** of offshore ironsand deposits. **Finally,** detailed information has been provided with regard to the current activities of several mining companies intending to do offshore Mining covering both onshore and offshore environment of the **Northwest Luzon Ironsand Resources.** This undertaking has been made possible necessarily because there are sufficient information and evidence experienced in the past to guide them in their exploration and exploitation activities.

Outside of Magnetite Iron Sand Prospecting, the next Philippine largest deposits of Palladium and related Platinum Group of Metals have been reported by USGS/NASA off the Coasts of Mindoro, Masbate Romblon, Panay/Negros; a new Phenomenon worth Exploring for Financial Gains both for the Mining Industry, the Country, and its people.

NOTE*

This report has been sourced basically from well known International and Domestic Published Literatures and related publications, scientific announcements by known Institutions of Research like USGS/NASA, often utilized by Academicians and Professional Practitioners. Additionally, from standard science, engineering, technical practices and experiences in the field. The report has been professionally assimilated and edited where necessary, that served to provide a collective and useful foundation guide to attain the primary objectives of the report.

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SUPREME COURT DISMISSAL OF THE WRIT KALIKASAN CASE FILED VERSUS ALTAMINA EXPLORATION AND RESOURCES CORPORATION

Sometime in April 2012, a Writ of Kalikasan case was filed before the Supreme Court docketed as GR NO 204858 by several politicians, NGO’s and the religious sectors in Ilocos Sur and Pangasinan Versus the Large Scale FTAA Offshore and Onshore Mining for Magnetite Iron Sand by Altamina Exploration and Resources Inc., such case was remanded to the Court of Appeals for hearing proper.

Altamina engaged the services of Environment and Mining Lawyers, Cortina & Buted Law offices, and specialists and experts, Dr. Felipe P. Calderon, Japanese Engr. Takazo Toyoshima, and Mr. Alejandro G. Cruz-Herrera to defend the Corporation.

The Writ of Kalikasan Case was centered on the following issues:

a) Constitutionality and Validity of the FTAA of Altamina.

b) The p ossible negatives effects of on and offshore Magnetite Iron Sand Mining to human habitation, to aqua-marine life, and to the ecological balance of the environment like flora, fauna, and benthic environment etc.

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The legal arguments on Constitutionality and Validity of the FTAA were settled immediately during the court proceedings as Cortina & Buted Law offices were ably assisted by the Office of the Solicitor General and a witness from DENR Region I.

The scientific and expert discussions and presentations for/and against the Environmental and Ecological balance that will be caused by Magnetite Iron Sand Mining both for onshore and offshore needed the court presentations of expert witnesses on both sides of the opposing camps.

The Petitioners presented to the Court two (2) of their expert witnesses who are professors from the University of the Philippines (UP) one male and one female.

Respondent Altamina presented one specialist with experiences in Magnetite Mining for offshore and onshore, Dr. Felipe Calderon and another expert Engineer Takazo Toyoshima with the same kind of experiences in Japan and Indonesia for the same minerals.

Since the Court requested the Bio-data of specialists and experts presented by both opposing camps prior to the start of the hearings, the male professor from UP withdrew from the court proceedings, probably upon seeing the heavy weight bio-data status of Altamina experts.

All the other Political personalities that filed the case also withdrew from the case proceedings.

Without being able to present any document, the expert lady witness of the petitioners stated her oral argument on:

a) Perceived Coastal Erosion that will be caused by Magnetite Mining operation off and onshore

b) Perceived Negative Effects to aqua marine life due to offshore mining of Magnetite Iron Sand

c) Perceived damage to ecology, environment and human habitation

d) Misplaced perception that Magnetite Iron Sand magnet each other and serves to protect the coastal community from storm surges, tsunamis and the like.

e) Air pollution, water turbidity and noise pollution that can be caused by offshore and onshore Iron Sand extraction and will disturb the community, flora and fauna as well as the natural habitat in the area.

When it was the turn of Dr. Felipe Calderon to present his defense and counter comment for all the misplaced perceptions on Magnetite Iron Sand Mining, he stated the following:

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1)That he is a Doctor of Science and Engineering, a professional scientist, registered mining engineer, registered metallurgical engineer with masteral and doctorate degree in metallurgy, have written more than 50 books and writings published and unpublished on mining and environment, and most of all, studied the Magnetite Iron Sand mining operations in Japan, New Zealand, Indonesia, and that in the Philippines. He became President of Filmag, the very first Philippine Company that exported Magnetite Iron Sand in Japan.

2)That, science and engineering specialists of governments involved in mining mandated that mining of minerals for offshore and onshore <u>must</u> always have provisions for 500 meters buffer zone offshore and 200 meters onshore, scientifically, more than enough provisions for community safety.

Furthermore if Magnetite Iron Sand Mining can be suspect for any Coastal Erosions, why are there Coastal Erosions in areas like Malabon, Navotas, several Coastal Towns of Bulacan and Pampanga where there is no presence of off or onshore mining?

Dr. Calderon proceeded to discuss about the latest scientific findings that climate change and global warming have tremendously increased the water level of the ocean thereby occasionally submerging and flooding most of the low lying coastal areas like Bauang, La Union, and the areas of Malabon, Navotas and parts of the Coastal Towns of Bulacan and Pampanga, hence, the occasional Coastal erosions in the areas.

3) That, areas in offshore with heavy deposits of Magnetite Iron Sand and other minerals have toxic elements and possess Iron properties that cause the warning of the undersea water that in effect is harmful to the aqua-marine life.

Further, that per book of Rogers 1990, sedimentations coming from tall and highly mineralized mountains and that are delivered to the ocean by gushing waters from mountain rivers and creeks have been documented to contribute to the loss of coral reefs by decreasing light penetrability, thereby affecting photosynthesis and the constant particle loading in the substrate that inhibits growth or colonization by corals or sea grass, sea weeds or reef ecosystem (Babcock and Davies 1991).

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Furthermore, those mineral reserves under the sea of magnetite iron and other iron minerals are inert or lifeless, hence, no living things or life form like fish, marine organisms, food for fish and the like can ever exist underneath that portion of the sea.

In view hereof we see or fisher folks needing to travel as far as of more than 22 kilometer offshore through their fishing boats in order to catch fish outside of the area where the heavy deposits under the sea of magnetite iron sand and other minerals are present.

4) That the perception that magnetite iron sand magnet each other on the ocean fronts that serves to protect the coastal community from storm surges, tsunamis and the like is extremely not true as Magnetite Iron Sands have no magnetic properties.

5) That, the water turbidity of river waters creeks and water stream gushing down to offshore coming from the highly mineralized and tall mountains are of even higher degree of turbidity that constantly affects the ocean water vis a vis water turbidity of the siphon or grab vessels and/or the commercial drilling equipments.

6) Further that Air Pollution, Water Pollution, Noise Pollution and Water Turbidity that can be caused by Offshore Mining Extraction will disturb the community, natural habitat flora and fauna can all be addressed and mitigated by Technological designs of Siphon or Grab Vessel and the related and support marine equipments like Anchoring Tug, Commercial drilling barge and etc.

On the other hand adequate scientific planning and monitoring of the Commercial Extraction Methodology during project operation can effectively mitigate the possible impact on every project area of say 200 to 400 hectares where siphon or grab extraction will only be operated for a specific period of time of say one (1) year or less, then said operation will be programmed to move to another area, hence, the alternating system or programmed area of operation would allow establishment of refuge area for the benthic faunal organisms and allow faster re-colonization of the directly impacted area.

The return back to the sea crust of the sand cleared of magnetic properties and sieved mud would reduce the effect of further sedimentation in the water column.

7) The designs of Siphon Vessels and its support marine equipment were demonstrated to the Court of Appeals Justices, by expert Mr. Alejandro Cruz-Herrera and the Mineral Technician Joseph Barce as trained by Mr. Takazo Toyoshima.

CHAPTER XII

The Japanese Experience

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Our Japanese designer and specialist, Engineer Takazo Toyoshima speaks of the “Japan Experience” on the Onshore and Offshore Commercial Extraction of Magnetite Iron Sand for the last eight (8) decades that have been fed to their Steel Smelter Plants.

The Onshore extraction generated an average of eight (8%) percent of the volume while the Offshore Magnetite Mining generated ninety two (92%) percent. At present there is only very small portion left off and onshore in some prefectures and are being commercially made available to production of samurai’s, kitchen wares, traditional tea pots, and some heritage uses, and the like.

In the Mid-1930's up to 1940's in preparation for World War II, Japan made use of its Magnetite Iron Sand mostly in the manufacture of war planes, battle ships, land based heavy weapons, and other artilleries.

After the war, their Magnetite Iron Sand were abundantly used for the production of industrial materials for steel, cars, trucks, rail ways, train bodies, factories, light and heavy equipments, and more.

During those period of heavy commercial extractions that led to the exhaustion of most of the Magnetite reserves of Japan, two (2) universities namely, Kyoto University and Okinawa University were asked to help monitor, be in consultation, and provide academic and professional assistance to keep the ecology and human habitation balanced as well as the fauna, flora, benthic environment, and coastal community inhabitants, and the like.

Scientists' help were also sought to instill geo-scientific, research, and field regulatory works in order to protect the marine environment that included protected areas, fishery reserves and the people.

Air, land, and water pollution were also monitored, hence, commercial extraction operations were always watched for their compliances.

The design of equipment, installations, infrastructures, and the development of Siphon and/or Grab Vessel together with related marine support equipment protective devices and machineries are made sure to be done by licensed professionals.

Apparatus, Siphon or Grab Vessels operators, mechanics, protective device specialists, and machinery maintenance staff, were strictly seen to be adequately trained to mitigate any danger to the environment.

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Several days of test runs were made to make sure the mining methodology, operational scheme and the related operations personnel and staff of the Siphon and Grab Vessels can comply to containment of particulates during extraction and transferring of the minerals.

During such extraction and transferring of the minerals to the cargo vessels, it was made sure that all activities were pollution compliant, least disturbance to marine environment, ecology and benthic environment plus imposition of strict, mine safety and health standards.

The Commercial drilling equipments were always equipped with sonar system, or scanning devices under the sea to identify any sunken treasures, cables and any living things, prior to drilling and extraction under the seabed, likewise the commercial drilling team head is mandated to be trained skillfully to recommend to the Geologist the closure plan per offshore area for its rehabilitation, as he has the facilities to see underneath the sea.

Mr. Takazo Toyoshima likewise maintained that due to the strict Japanese university discipline to follow all the above guidelines, almost all Japanese in Kyoto University and Okinawa University including some Filipino students like Dr. Felipe Calderon became knowledge specialist in Magnetite Iron Sand Mining.

In the 8 decades of Magnetite Mining Operation in Japan, there has been no negative reports ever published that violated any Environmental situation, Ecological, Bio-Diversity and the like in Japan. The same thing has been happening in New Zealand and Indonesia as they adapted our Japanese designs and standards of operation and monitoring.

On the other hand, another Japanese High Tech Consultant Dr. Minoru Yoneno a Specialty Consultant by Nippon Steel for Vanadium and Titanium Mineral Development says, “that after 8 decades of exhausting their Magnetite Iron Sand and other minerals from their offshore that substantially contributed to Japan’s Industrialization, the 90% sand returned back to the sea crust that were already cleared of toxic elements of the minerals after magnetic separation or segregation became sand mounts, that, further develop as natural fish weirs.

Thus, the 90% under sea water without the steel component that used to warm that portion underneath the sea is said to now be equivalent to Cold Deep Ocean Water that became the habitat of fresh fishes and the 7 Succulent Sea Beasts in some areas of Japan".

Dr. Yoneno showed lists, where majority of delicious fish varieties and succulent sea beasts of Japan, that are always being made available by the Cold Sea Water of Japan as a result of exhaustion of the toxic minerals to aqua marine life, and warm sea water generated by Magnetite Iron Sand minerals deposits in most of Japan's ocean before.

CHAPTER XIII

Downside and Upside of Mining in the Philippines – Current Situation

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In a news article published in the early part of 2008 in Beijing China by Xinxhua news agency, the paper said that in an interview with Dr. Young Quing of Beijing Mines Engineering Co Ltd. (Group), who did a wide range of research for the purpose of establishing a possible stable and long term sourcing of minerals from the Philippines needed by China steel smelters, for minerals like Magnetic Iron Sand, Iron Ore, Chromite, Nickel, Copper, Manganese Platinum Group Metals and the like. Dr. Quing came up with the following conclusions and findings:

A. UPSIDE OF MINING IN THE PHILIPPINES

1. The Philippines is the 5th country in the world that has substantial mineral resources for the steel industry of China, Japan, Korea and India.

2. The Philippines has strategic advantage of its nearness to China that makes it economical in terms of freight cost, turn around shipment time, and efficient shipment arrival that makes a factory attain competitive advantages;

3. The Philippines has enough laws and established government procedures that can make mining business doable, viable and legally feasible provided the right approach, connection and resources are employed;

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4. The Philippines has enough inventories of good technical people with proper education in mining, both in government and private sectors;

5. Being an islands nation, almost all possible mine sites are surrounded by seas, or if not, just near it, hence, once vessel docking facilities are put in place as port of origin, shipment intervals can be programmed just in time;

A. DOWNSIDES OF MINING IN THE PHILIPPINES

1. There exists strong conflicting turf wars between and among officials of national agencies, regional offices, and local governments, and even the lowest barangays in the issuances of clearances, permits for mining, licenses for commercial extraction, Ore transport permits, Mineral Ore Export Permits (MEOP) and the like, where despite the presence of enabling laws and implementing guidelines, ill intentioned government officials with strong personalities can make the documentation system crumble and make the exporting of minerals difficult and costly;

2. The negative perceptions of the very influential Catholic Bishops on mining activities where their powerful voices can put a stop to any ongoing commercial operation. Hence, putting the huge mining investment at constant risks;

3. The proliferation of well funded non-government organizations and some civil society groups whose funding sources are suspicious. When one does a source trail, one would discover that they are from countries whose economies are heavily dependent on mining exports like Australia, Canada and the like.

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The suspicion is that the Mining Chambers, as well as the mining government agencies of these countries that are very far from the markets like China, Japan and India are worried about the strong competition from the Philippines. Hence, the theory is that these covert operations established these NGO's and civil society groups through manipulation, destructive and negative mining information, reverse propaganda etc., and turn their mindset into a total anti-mining advocacy and masqueraded themselves as "Natures Protectors" without them noticing the manipulations due to abundance of flow of funds for their continuing existence.

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In the book of Michael Porter’s Competitive Advantage of Nations, this type of reverse economic invasion is a theory that can be adopted by countries whose main source of gross national revenue is threatened by the potential growth of a strong market competition.

This Competitive strategy of market preservation would not be far fetch for countries like Australia, Brazil, Canada, and the like, which can really delay or put a halt in the mineral resource development and success of Philippine mining export.

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The report further states that the strategic framework developed in spreading the negativism of mining in the Philippines is for these well funded NGO's and Civil Society Groups to have a deep penetration amongst the religious sector, local NGO's in the community where mining is to be developed, indigenous people, the left and cause oriented groups, and the like. Who are outright vulnerable due to lack of thorough information on mining and who can be influenced to be "Nature Protector" and push the community to do away with it.

4. The presence of Australians and Canadians mining companies in the Philippines, who have secured during the early times large mining areas with very good potentials that up to this time are not put into operational production, practically sits on them and at present non productive for the industry.

Could this be another strategy to put a halt at development of mineral source in the Philippines as a framework under the Competitive Advantage of Nation book by Michael Porter?

5. The legal entanglements in the Philippines of so many claim areas with very good mining resources and development potentials which problem were also suspiciously initiated by people from foreign countries;

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Per the opinion of Mr. Quing of Beijing, if the Philippines and its mining stakeholders can play their cards well, put their acts together, take a cue from Mr. Michael Porter's book of Competitive Advantage of Nation……..with just Magnetite Iron Sand resources alone in the Northwestern and Northeastern Philippines, the taxes that can be derived from existing volumes of potential inventories are enough to pay half of the entire Philippine Foreign Debt of US $56 Billion.

United States Geological Services (USGS) reports together with a confirmation from NASA, that the Philippines could be the richest country in Asia with the discovery of the largest Palladium deposits off the Coast of Mindoro, Romblon, Masbate, Panay Negros.

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If the Philippine government allows foreign investors to dig and mine the Palladium deposits, the country can expect around $9.8 billion a year in net profit, report said.

USGS estimated that the whole deposit is 2% bigger than that of Russia with a total volume of around 3.8 million metric tons.

Current price of processed 99.9 carats of Palladium is $24,570 per kilogram. The total estimated price for the whole deposit is <u>$93 billion, or 410 trillion PHP.</u>

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Aside from the discovery of Palladium, other mineral related to it such as Nickel, Platinum, Aluminum, Silver, and Gold are also expected, to be extracted from the main mineral.

The deposit can sustain the country’s budget in the next 100 years (or more) according to the source. The price of Palladium is increasing every year and it can double in the next ten years according to the press release.

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