I. RETURN-TO-WORK PLANS

Return to Work projects are a valuable mechanism for workshop participants' personal and professional development. As part of your sponsorship, you are required to develop a return-to-work plan on a project you will undertake on your return, applying the knowledge and skills gained from the workshop to influence change.

Periodic follow-up on the progress of implementation of the plan will be undertaken using M4DLink.

II. REPORTING STRUCTURE FOR RETURN-TO-WORK PLANS

To facilitate ease of reporting and follow-up on your return to work project, the structure below outlines the key project elements that need to be covered in the reporting. **Please submit a draft Return to Work Project (RWP)** using the structure provided below.

REPORTING STRUCTURE

GENERAL INFORMATION	
Name(s):	Saviour Alomatu
Details: Position: Email: Phone no (office + mob):	 Senior Seismologist alorms_21@yhoo.com; alorms21@gmail.com Tel: +233 302 679236 M: +233 244845150
Brief Description of the project:	Geological information is the springboard to achieving the Country Mining Vision (CMV) and promoting the Neglected Development Minerals (NDMs) for economic and infrastructure development. The project is to update the existing geological database to provide information on the NDM types, where the deposits are located and their economic purposes.
Expected Outcomes:	• Provide updated information on the Neglected Mineral types that are available and where the deposits are located; • Useful for Women in Mining project on women working in quarries; • Contribute towards fulfilling the mandate of the Geological Survey in the generation of geological data and provision of geoscientific information to the end-users (such as investors, stakeholders, individuals and the general public).
Expected Outputs:	

	1. Neglected Minerals Deposits Map . 2. A report on NDMs in Ghana.
Please describe how you plan to implement the return to work project:(outline key partnerships and collaborations across sectors in your country as well as any joint collaboration with other countries)	First sensitize my organization as a whole on the leadership knowledge acquired and on Neglected development minerals by organizing a presentation. Then hold a meeting with the Economic Geology Division to know their program of activities for the year and how and where to fit in to acquire the necessary data. Secondly, collaborate with Minerals Commission to access data and share information on NDMs. Finally, use the data from the various sources to produce a map showing the spatial distribution of neglected mineral deposit types using ArcGISv10.1 software package. Share the output with Minerals Commission and Women in Mining.
What indicators of success will you employ? (include indicators of success that go beyond activity-level implementation)	**Input activities**- Organize presentation; Engage the Information Management, Economic Geology and Clay Mineralogy Divisions. Input indicators- Memo on submission of report on training program and permission to carryout presentation; minutes of meeting held with the Economic Geology Division. **Activities**- • Collect base data from the above Divisions within the Geological Survey and Minerals commission. Activity indicator- base data and information on Neglected minerals. • Carryout a few market surveys. Activity Indicator- Information on pricing, uses and location of Identified NDMs. **Output-** Spatial distribution of the identified neglected mineral deposit types, their uses and locations. Output indicator- Neglected minerals deposits map.

What other strategic opportunities have you identified that will contribute to the success and sustainability of your project? (include opportunities linked to national level policy, strategies and programmes as well as linkage to sub-regional and regional agenda)	The output to be used as a case study to carryout extensive field mapping of neglected minerals in the country. NMTDPF Policy Objectives PROGRAMME 4: Mineral Resource Development and Management 2. Budget Programme Objective To promote sustainable exploration, extraction and use of mineral resources for development and poverty reduction. The main operation of this programme handled by Geological Survey Department includes Exploration and analysis of samples. AMV- Geological information systems
What leadership skills will you apply in conducting this project? (include critical conversations, potential barriers and how you will overcome them)	Collaborations Dialogue Influencing without authority. Potential barrier would be delay in carrying out presentation as most staff will be on field trip and management would want majority audience. Alternatively, I would start communication with the Economic Geology Division to commence data collection.
What are your future plans? (include any additional capacity building needs for your professional development that you have identified during the course of the workshop).	Use the output of this project to make informed decisions on Women in Mining projects such as reaching out to women in quarry. Undertake short course on project management

Contents

1 INTRODUCTION

1.1 THE HISTORY OF MINING IN THE WORLD ECONOMY

Mining has been so important because of the materials that it produces, the technologies and tools that it enables the definition of the timelines of human history according to what is brought up from the ground. In the ancient past of our species, before agriculture began, we have the so-called, Paleolithic or Old Stone Age era. So stone was the main mining object and pouring object. After the end of the last Ice Age and at the beginning of agriculture, about 10,000 years ago, was the Neolithic era, the new Stone Age era. Then, over time, human beings in specific locations close to mineral ores began to master the process of smelting metals. About 3000 B.C. we entered the famed Bronze Age, which was yet another massive advance in human civilization with the smelting of copper and tin and the alloys that were produced creating new technologies, new advances, new ways to make armaments and many other human tools. About 1000 B.C., yet another crucial mineral, iron ore, was smelted to produce iron and small amounts of steel at least, we entered the Iron Age. And again, massive changes of civilization and technology which came with this new mining industry, with this new mineral deposit.

The natural resources are the biggest opportunity for rapid development that many poor countries have. And the supercycle of the last ten years has been the biggest opportunity that they had in history. And for most of them, it's been a missed opportunity. And so it's really important, society to discover what went wrong and what is needed to be understood in order for next time to go better. The challenge of discovering natural resources, getting them out of the ground, and getting them into revenue and them into something that is sustainable since the revenues themselves is only temporary.

So the first step in that is discovering your natural resources. In most poor countries, this has gone badly wrong. That is not because there is less down there under the ground. These are random geological processes of millions of years ago hence, they will be the same. It is because the discovery process, which depended upon investment and prospecting in discovery, has gone wrong in poor countries.

One key solution to the problem is that we need public geological information. There is a strong case for international public money, aid money, to be used to prospect the geology of poor countries so that they know what they have. And the World Bank now has launched a one billion dollar campaign to try and raise money for a comprehensive geological prospecting of Africa.

1.2 OVERVIEW OF GHANA'S MINERALS AND MINING SECTOR

Ghana is well endowed with substantial mineral resources, major ones being gold, diamonds, manganese and bauxite. The country is also endowed with untapped deposits of iron ore, limestone, clays kaolin, mica, columbite-tantalite, feldspar, silica sand, quartz, salt etc. There are minor deposits of ilmenite, magnetite and rutile. Some of these industrial minerals such as brown clays, kaolin and silica sand are being exploited on small scale to supply local industries in manufacturing ceramics, paint and glass respectively. There is a huge potential in solar salt production which is yet to be fully realized.

Currently, the mining sector contributes 27% of government revenue in terms of domestic tax and employs over 29,000 people in the large scale mining industry. An estimated 1,000,000 people are engaged in the small scale gold, diamond, sand winning and quarry industries.

1.2.1 ASM AND TRADITIONAL MINERALS

Countries that have enhance the contribution of natural resource extraction to their national development are those that are themselves active participants in the exploitation of their resources.. Artisanal and Small-scale Mining (ASM) usually reserved for locals, is one way in which a resource owner may participate in the mining enterprise. ASM is an age-old business in Ghana which is reserved for the local people. It produced about 36 per cent of total world gold output between 1493 and 1600, making Ghana the largest gold producer at the time.

Until the late 1980s, small-scale mining activities in Ghana remained largely unregulated and received little, if any, support from government. This, however, changed with the implementation of the national Economic Recovery Programme (ERP). The government at the time recognised the potential contribution ASM could make to the country's revenue mobilisation efforts, and so pursued a policy to regularize the small-scale mining sector through a series of policies and regulations.

The findings of a scoping study on ASM, undertaken by the Ghana EITI suggests that in 2013 about GH₵ 0.5 million was collected as Mineral Rights fees from ASM and Industrial Minerals operators, GH₵ 2.2 Million for royalties excluding payments to MMDAs.

1.2.2 ASM AND NEGLECTED DEVELOPMENT MINERALS

ASM activities also extend to lesser exploited industrial minerals such as salt, stones, clay, and sand which are referred as Neglected Development Minerals (NDMs). To a large extent, salt mining in Ghana is organised as an ASM activity. Ghana's salt, hovering around 250,000 tonnes per annum, is produced mostly from concentrated sea water. Rock salt is also produced in Daboya in the Northern region, also on artisanal scale. The Ministry of Finance estimates that Ghana has more than 2 million metric tons salt production capacity (MOFEP, 2011).

As at June 2015, 12 companies have been duly licensed to produce salt in the country. These have organised themselves into cooperatives that are found in Elmina, Anomabu, Nyanyano and Apam in the Central region and in Ada Songor in the Greater Accra region. It is estimated that about 20% of salt produced in Ghana is consumed locally. Small producers sell either to intermediaries or large buyers such as Unilever. The remaining 80% of production is exported to Burkina Faso, Mali, Niger, Togo and Benin.

A number of quarries operate with licenses obtained from the Minerals Commission. These registered quarries operate with technical expertise as they employ the use of heavy equipment including crushers. At the fringes of some of these operations are some artisanal operators using mostly hammers and pans. They obtain their raw materials from the overburdens of the operating quarries (GHEITI, Scoping study on

the incorporation of artisanal and small-scale mining in Ghana's Extractive Industries Transparency Initiative, 2015).

1.2.3 GENDER ASPECT OF ASM

According to the GHEITI scoping study on extending EITI to ASM, women constitute some 15 per cent of the legalised segment of Ghanaian small-scale mining labour force. Women account for 6 per cent of licensed buyers, 10 per cent of concession holders and 15–20 per cent of the sponsors of work groups, members of cooperatives or mining groups.

Participation is more widespread, however, in small scale clay mining and stone quarrying, where there is a need to perform more basic washing, transport and sieving activities. It is estimated that 80% of artisanal quarry workers are women.

Ghana is signatory to various international and regional commitments to the protection of women's rights and gender equality. In spite of this, women are generally less educated, have less access to information, and limited control over productive resources though the legal regulations do not restrict women. With fewer qualifications, income-generating skills and restricted ability to leverage important economic assets such as land; majority of the women in Ghana's mining communities are significantly disadvantaged when it comes to accessing the industry's potential economic opportunities. Usually the roles of men and women differ in this sector – in both large scale and ASM activities. In ASM men are largely engaged in the mining itself, whereas women serve as labourers. They usually provide goods and services, and are also responsible for household chores. Also, women in ASM operations are mostly part-time workers and are relegated to secondary, labour-intensive activities including carrying the ore and processing activities.

Institutions such as the Minerals Commission still have a lot to do by continuously monitoring and evaluating the impact of regulations designed to ensure removal of discriminatory employment practices, increasing access to capacity building and financing initiatives, engaging women in community consultations and decision-making positions. Through these, women will be better equipped to actively participate in and exploit the economic potential within the various minerals and mining value chains

1.3 Policy framework and objectives, National, Sub-regional & Regional level

Ghana has an established mining sector which has grown considerably in recent years as an important pillar the Ghanaian economy. Government wishes to secure the continued development of a thriving sector that will contribute to sustainable economic development based a number of objectives inter alia

Policy Objectives:

i) Diversify the country's mineral production base to promote a more sustainable support base for the economy;

ii) Promote linkages (backward, forward side stream) to minerals produced locally to the maximum extent possible;

iii) Generate adequate geo-scientific data to promote investment;

iv) Generate detailed geological information in designated areas for demarcation to artisanal and small scale miners; and

vi) Enhance capacity of state institutions and strengthen inter agency collaboration in the management and development of mineral resources.

Policy 9.0 promotion of efficient artisanal and small scale mining operations

10.1 Generating geo-scientific information – for both large scale and small scale mining.

10.3 Diversification of mineral production base

Sub-Regional Level Policy-

- At the sub-regional level, the ECOWAS Mineral Development Policy and ECOWAS Directive on the harmonization of guiding principles and policies in the mining sector have been developed. One of the key objectives is to provide a mining environment that is responsive to sustainable development.
- The policy harmonization efforts of WAEMU form part of the strategy in the sub-region for creating uniform operating conditions and promoting policy convergence within the customs union. The harmonization effort is underpinned by the WAEMU Common Mining Policy (CMP) adopted in 2000. Specific objectives of the CMP include:
  (ii) The diversification of mining production; (iii) the processing of mineral products locally;
  (iv) The co-existence of industrial mines and cottage type mines;
- The CMP encompasses the following programmes:
  (iii) the establishment of a sub-regional system on geo-mining information;
  (iv) the building of capacities of institutions and scientific research bodies.

Regional Level-

- Africa Mining Vision seeks to use Africa's mineral resources to reduce the continent's poverty and accelerate its social and economic development;
- A mining sector that harness the potential of artisanal and small-scale mining to stimulate local/national entrepreneurship, improve livelihoods and advance integrated rural social and economic development;
- Geological and Mining Information Systems.

1.4 MINERALS LICENSING PROCEDURE

A principal tool for the management of national mineral resources is a system of allocating rights to mining companies and persons to carry out mineral exploration and mining operations in return for the performance of explicit and enforceable obligations. The objectives of a licensing systems to allocate minerals rights, in areas not proscribed, to those best able to generate improved knowledge about the minerals endowment in general, to delineate mineralization of commercial value and to carry out commercial production and supply of minerals in an efficient and responsible manner.

This objective can be best achieved through the establishment of a standardized licensing system, with the principal legal and administrative arrangements enshrined in law. This approach is reflected in the mining law, which contains the following arrangements for licensing :

1. The minerals licensing system has provisions for all classes of minerals (including radioactive minerals and industrial minerals such as sand, gravel and salt).

2. There is a range of fixed term (and renewable) mineral rights suited to the various phases of mineral operations from reconnaissance of potential mineral-bearing areas through to mineral extraction and treatment. Limitations may be imposed on the surface area granted under mineral rights, in accordance with the type of mineral operation and ability of the holder to work the area effectively. Specific license are required also to enable a person to buy and deal in minerals.

Table 1: Summary of the Procedure for Acquiring Small Scale Mining License.

	ACTIVITY	RESPONSIBILITY	REMARKS
1	Identify area	Applicant	
2	Conduct official search at Minerals Commission (MC)	Applicant	
3	Prepare site plan (20 copies)	Applicant	
4	Complete application form	Applicant	
5	Submit complete application form with all required attachments to the Commission	Applicant	
6	Acknowledgement of Receipt of Application	MC	Immediate
7	Inspect site for feasibility of operations and accuracy of survey	MC	
8	Send application for publication at the relevant District Assembly	MC	Within 10 days
9	Publication of Application	Assembly	21 days

10	Assembly returns recommended application to Mincom after elapse of the 21 day's publication	Assembly	Within 10 days
11	Write to applicant to apply for Environmental Permit		
12	Submit EPA Permit to the Minerals Commission	Applicant	
13	Issue Offer Letter to applicant**	MC	
14	Pay Ground Rent to Administrator of Stool Lands	Applicant	
15	Pay Consideration Fee and sign Agreement at Minerals Commission	Applicant	Within 60 days
16	Forward Agreement to Minister responsible for Mines for signature	MC	Within 60 days
17	Submit Stamp signed Agreement to Land Valuation Board	Applicant	Within 5 days
18	Stamp signed Agreement	Land Valuation Board & High Court	
19	Send photocopies of Agreement to Mincom	Applicant	
20	Acquire Operating Permit from the Inspectorate Division of MC	Applicant	
	EPA PERMIT ACQUISITION	Responsibility	Remarks
1	Complete relevant application form SSMI1	Applicant	
2	Submit completed application form with all required attachments to the EPA	Applicant	Within 25 days
3	Assessment of proposed site and review of application	EPA	
4	Communicate outcome of review to Applicant	EPA	
5	Issue Invoice to Applicant for payment, if approved	EPA	
6	Applicant Pays permit fees within 3 months	Applicant	
7	Environmental Permit Issued to Applicant	EPA	Within 20 days
	* Application expires when not paid in 3 months		
	** offer letter expires after 60 days from the day of issue		

2 IDENTIFIED NDMs, OCCURENCES AND USES

The Neglected Development Minerals refers to earth materials that can be used for economic and/or industrial purposes. These materials include precious and base materials, non-metallic materials and construction-grade stones.

In Ghana, the most important NDMs commonly called economic or industrial minerals include limestone and dolomite, kaolin, clam shells (lime), silica sand, brown clay, feldspar, barite, quartz and quartzite, aggregate, dimension stone, common salt. Other commodities that occur that may be of commercial importance include mica, talc, kyanite, staurolite, gypsum, ilmenite and rutile.

Most developing countries, including Ghana, face acute housing problems, especially in the larger cities. This is mainly attributed to high population growth rate, deteriorating old swish/mud houses, poor planning and the unstoppable rural-urban migration. Strategies to be adopted to overcome the housing challenges facing Ghana include the promulgation of a comprehensive, workable and enforceable National Housing Policy which will ensure sustainable housing development, and maximum utilization of local building materials for construction, among others.

2.1 GEOMORPHOLOGY

The geomorphology of Ghana (figure 2.1) consists of the following:

1. Low-lying coastal plain; an interior basin (the Voltaian Basin), mainly around Lake Volta;
2. a large, northwest trending sandstone ridge (the Mampong- Mpraeso-Koforidua ridge) extending for 260km from the Eastern Region to the Brong Ahafo Region;
3. the Akwapim-Togo Range east of Lake Volta in the Volta Region;
4. an extensive plateau 150-300m high, with a steep escarpment on the north in the Northern and Upper Regions; and
5. a southwestern plateau that is 150-300 m high and broken by isolated hills in the Brong Ahafo, Ashanti, and Eastern Regions.

In general, the southern part of Ghana is tropical and the northern part is savannah.

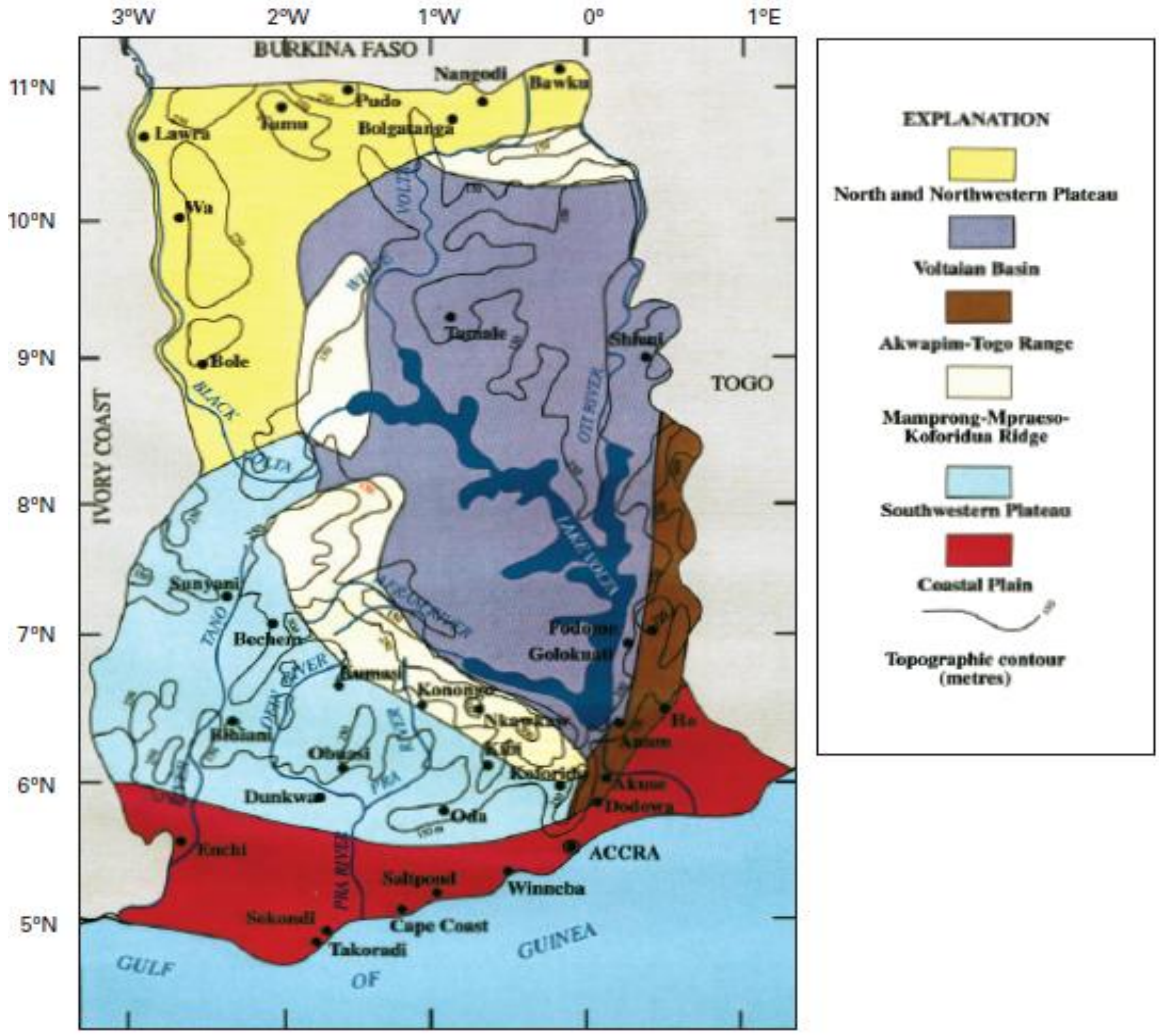


Figure 2.1: Geomorphological map of Ghana

Industrial minerals may be categorized by geologic setting as *in situ* primary commodities, transported and re-deposited or secondary commodities. In Ghana, the primary commodity types are dimension stone, limestone and feldspar. Secondary commodity types comprise the various clay deposits, clam shell deposits, and salt deposits.

Many Ghanaian industrial minerals are associated with basement (mostly Precambrian) terrains, which are typically metamorphic rocks. The basement rocks form areas of subdued relief. Such locations provide large quantities of deeply weathered, highly resistant clay deposits, such as the kaolinite, bauxite, and brown ceramic clay deposits that are found over large tracts in Ghana. Metamorphosed ultrabasic, sedimentary, and meta-volcanic rocks may produce talc, marble, and serpentinite (jade). In some locations, kyanite, andalusite, sillimanite, and pegmatite minerals, including mica and feldspar deposits, are generally associated with higher grade gneissic rocks.

2.2 LIMESTONE AND DOLOMITE

Limestone and dolomite are composed of aggregates of calcium carbonate and calcium magnesium carbonate. Carbonate content determines whether the rock is termed dolomite or limestone Carbonate rocks have industrial, agricultural, and construction applications, and may be the most utilized industrial commodities. Physical, mechanical, and chemical properties of the rocks determine their value and usage, as well as the purity of the deposits.

Limestone and dolomite are used in aggregate, building stone, cement and lime manufacture, railroad ballast, fluxes, refractories, fillers, reactive agents in sulfur dioxide removal, glass making processes, abrasives, soil conditioners, and the manufacture of paper fillers, plastics, and paints. Limestone is used in a variety of industries in Ghana and the bulk of the limestone is imported. The largest amount is used as cement raw material and as lime in gold processing.

- The solid base for many roads as well as in asphalt concrete.
- It is added to toothpaste, paper, plastics, paint, tiles, and other materials as both white pigment and a cheap filler.
- Purified, it is added to bread and cereals as a source of calcium.
- Calcium levels in livestock feed are supplemented with it, such as for poultry (when ground up).
- It can be used for re-mineralizing and increasing the alkalinity of purified water to prevent pipe corrosion and to restore essential nutrient levels.
- It is often found in medicines and cosmetics.
- It is used in sculptures because of its suitability for carving

The principal limestone deposits in Ghana are in the Nauli, Buipe, Oterkpolu, and Bongo Da areas (figure 2.2). All except the Nauli deposit include dolomite. Limestone occurrences for local use are present at Anyaboni, Sadan, Afram plains, Abetifi areas (Eastern Region), Boluan village, Nuba Village, Anwiafutu (Western Region), Kpandu area, Fo river (Volta Region), Longoro- Kintampo area, Prang (Brong Ahafo Region), Salaga-Yeji area (Northern Region), Afrante (Ashanti Region), and Du-Walewale (Upper East Region).

In summary, Limestone is of utmost importance to the economic development of Ghana, as it is the primary commodity in cement manufacture. The limestone and dolomite deposits are typically interbedded with clastic rocks and chert, and are generally flat-lying. Limestone beds are as thick as 9 m (Fo River) and dolomite beds are as thick as 10 m (Buipe). Some deposits are moderately dipping and faulted, fractured, and folded, with localized minor sulfide mineralization. The resources include deposits as much as 40 m deep and deposits with overburden of as much as 15 m.

The following carbonate resources have been estimated:

1. Bongo Da - 15.0 million tonnes, probable and inferred resource
2. Buipe - 20.5 million tonnes of proven limestone resources (an estimated 10 percent of the total deposit)

3. Nauli - 377 million tonnes to a depth of 120 meters, including 23 million tonnes of limestone and dolomite that is cooperative to open-pit mining

Figure **Error! Use the Home tab to apply 0 to the text that you want to appear here.**

2.3 SANDSTONE

An estimated volume of 180,000,000 cubic metres of fresh sandstone resource is being explored. Drilling and further exploration will give the actual reserve of the Asesewa sandstone project.

Figure 2.3: Sandstone deposits near Asesewa (Source: Economic Geology Division of Geological Survey, field work 2015)

Sandstone can be used as dimension stone in the construction industry. An important source of some heavy minerals such as zircon, rutile and tourmaline.

2.4 SILICA SAND

Silica sand is a term used for unconsolidated to semi consolidated grains of quartz with minor impurities such as iron oxide and alkali. Quartz occurs in crystalline, cryptocrystalline, and amorphous forms.
In Ghana, quartz occurs in pegmatite and as quartz veins in many rock types. The sand is reported to be suitable for the manufacture of glass, abrasives, millstones, sandpaper, high-grade refractory bricks, and as an additive in the manufacture of Portland cement

Silica sand occurs in the Atuabo-Eikwe and Aboso areas, in milltailings at Tarkwa, at Bodweseanwo in the Ashanti region, and in the southern Volta Region between Akatsi and Klikor-Agbozume (Accra-Aflao Road). Details of the various silica sand deposits are discussed below.

Nzema Area Silica Sand Deposits:

The Nzema area deposits (figure 20), including the Nglaekyi, Atuabo, and Baku deposits, are bounded on the north by the Amansuri River, on the west by Elonyi village, on the east by Krisin village, and extend 18 km along the coast through Atuabo and Eikwe. The deposits may be reached by secondary road and footpath. The silica sand is variable in color, fine grained, and well sorted. In the southern part of the area, ferruginous material fills the interstices of the grains and the shallow deposits are cemented by iron oxide. In the north, pebbly lateritic sand nodules are present.

Ngalekyi Silica Sand Deposit:

The shallow Ngalekyi deposit consists of an impure humus-rich silica-sand layer 0.2 m thick that is underlain by 0.85-0.90 m of light-greyish white silica sand. Below this sequence is dark brown, ferruginous, laterized silica sand that is cemented by iron oxide. The most recent resource estimates by Geoman Consult of Accra indicate that the Ngalekyi deposit contains an estimated 43.6 million tonnes of silica sand. The deposit is used by Western Casting, Ltd. in Takoradi, and the area has been extensively mined.

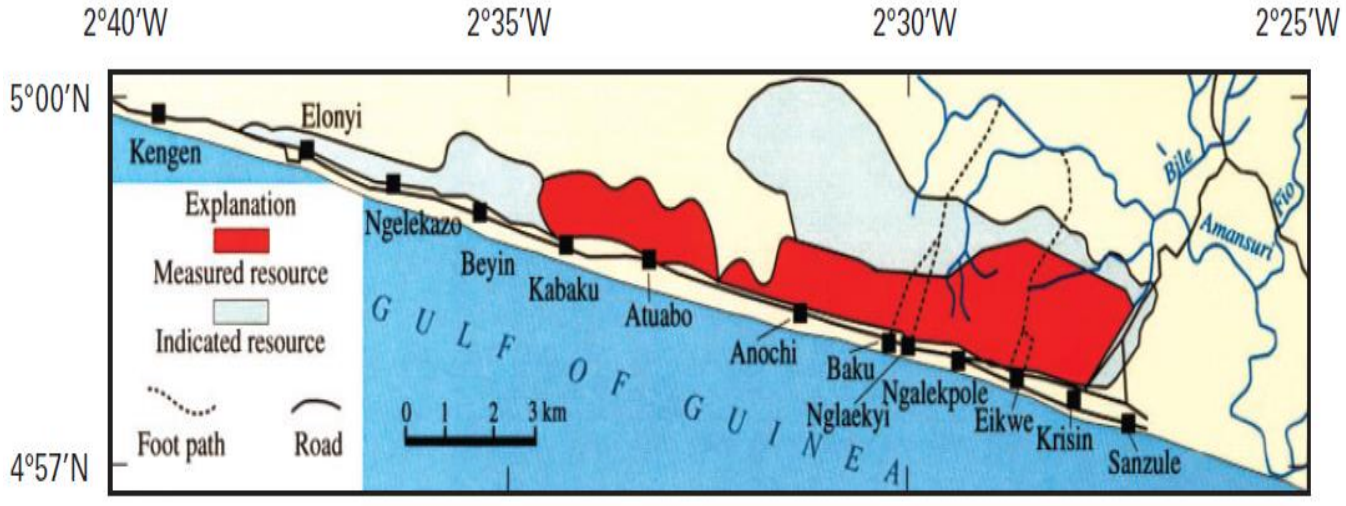


Figure 2.4: Locations of silica sand deposits in the Nzema East area (source: Minerals Commission).

2.5 CLAM SHELLS AND LIME

In Ghana, lime is extracted from extensive alluvial deposits of oyster and clam shells along the lower Volta River below Akosombo Dam (Akuse to Afalipo near Sogakope) in the Volta and Greater Accra Regions (Figure 2.5). The clam shells at Battor and surroundings in Volta Region are good for the production of quicklime.

These high-purity deposits have been exploited for many years. Shells are collected, burnt, and slaked; resulting lime is dried, sieved, and bagged. Clam shells are also crushed to produce quicklime, chalk, terrazzo chippings, and abrasives, and are used as an additive in paint, poultry feed, and aggregate, and in glass manufacture.

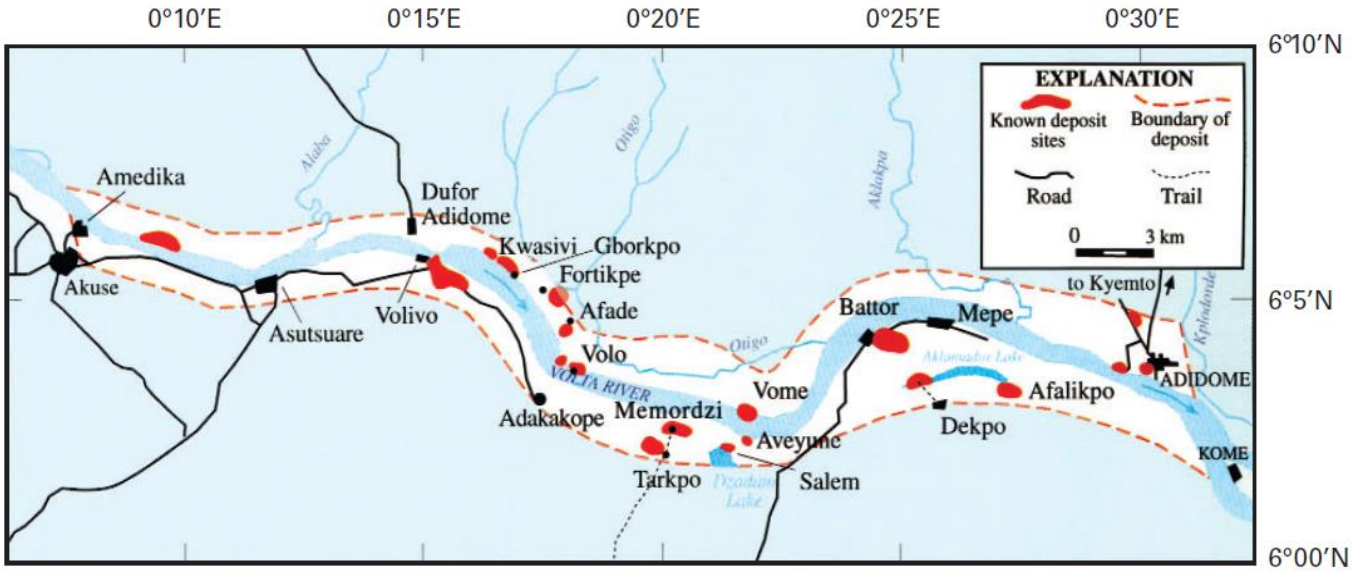


Figure 2.5: Location of Clam shells on the Lower Volta river (source: Minerals Commission).

2.6 DIMENSION AND ORNAMENTAL STONE

Dimension stone is found in Tongo and Bongo red granite (Upper East Region) and in Dahomeyan garnet hornblende gneiss at Shai Hills (Greater Accra Region). Rocks suitable for ornamental stone occur near Kpong in grey nepheline syenite (Eastern Region) and near Ho in Dahomeyan garnet hornblende gneiss (Volta Region).

Floor or paving stone resources are mined and chipped from limestone at Oterkpolu and from most granitic rocks throughout the country. Crushed and screened aggregate (quarry dust from granite and gneiss quarries) are used in terrazzo tile production. Rock used in ornamental stone is mined in slabs and used untreated or is cut and polished.

Jaspers are semi-precious stones which can be use ornamental purposes. In Ghana there is large deposit of this in the Volta region. They range in colour from reddish to greenish and large deposits were found during the recent mapping in the Volta region under the mining sector support programme. Geological evaluation of these jaspers is ongoing by the Economic Geology Division of the Geological Survey of Ghana.

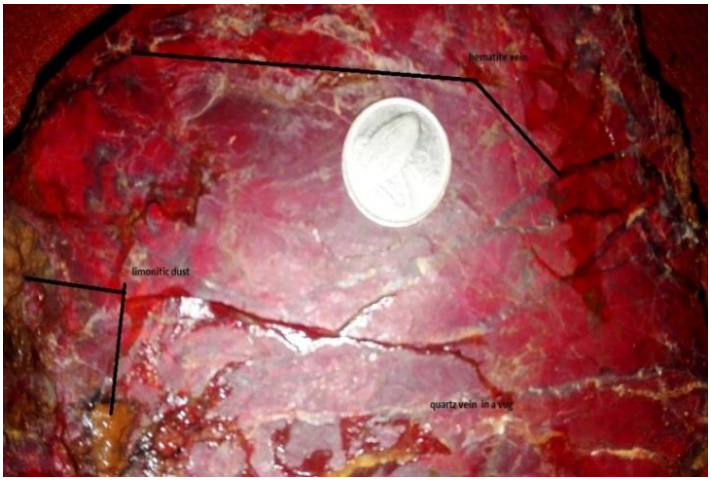


Figure 2.6: Jasper deposits at kwamekrom, Volta Region (Source: Economic Geology Division of Geological Survey, field work 2015)

QUARRY PRODUCTION:

There are large deposit of granites and granitoids in Ghana which can be quarried for constructional works in the Shai hilsl and Nsawan areas of the Greater Accra region. There are a few companies undertaking this quarrying but large deposit are yet to be exploit and also locals in the areas of granitic deposits engage in the crushing of this rocks on small scale for constructional works. Crushed and screened aggregate (quarry dust from granite and gneiss quarries) are used in terrazzo tile production. Flaggy quartzites abound on hills from Weija in the Greater Accra region to Klefe in the Volta region .This quartzites can be used for decoration on the walls of building and also as Floor or wall paving stone. This deposit is mined in the Eastern and Volta regions of Ghana.

Figure 2.7: Some limestone sources along Aburi Mountains, Eastern Region used for wall facing and floor paving. Each of the rock groupings cost GH¢250 or US$65.80 (Source: field survey, 2016).

Figure 2.8: Granite and quartzites from Shai Hills being crushed at a site, Accra. Each grouping of granites cost GH¢250 or US$65.80 (Source: field survey, 2016).

Figure 2.9: Granitic rocks being crushed for construction materials by quarry women at Esuakyir, Central Region.

Cost is GH¢1000 or US$263.16 per truck (Source: Women in Mining fieldwork, 2015).

Quarry Production Trend from 2005 – 2015

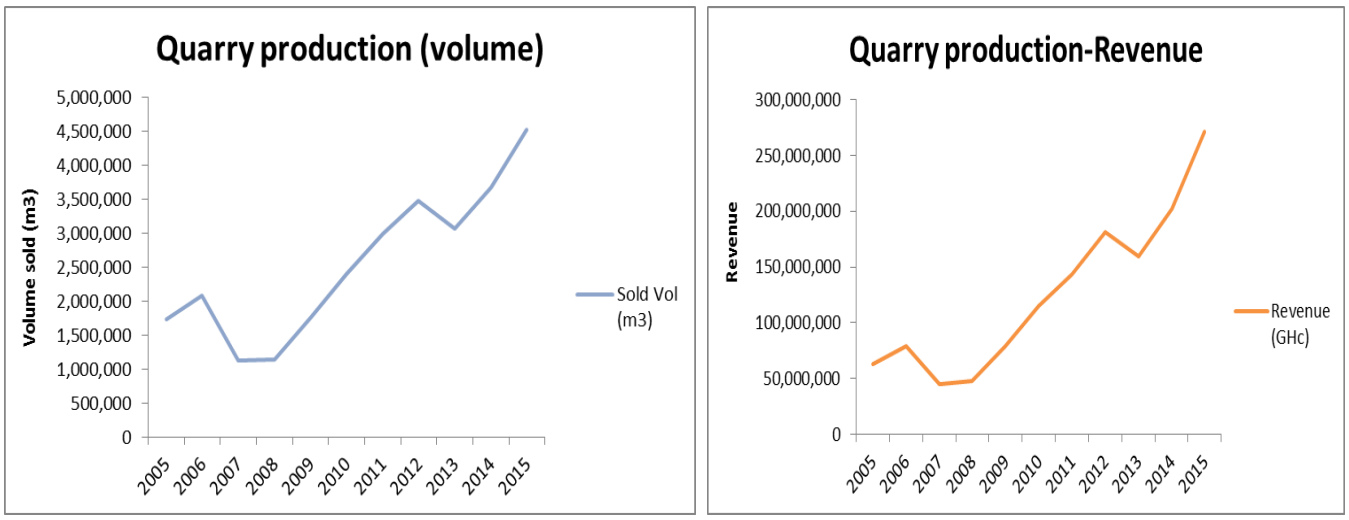


Figure 2.10: Quarry volume sold and domestic revenue generated for 2005-2015 (Data Source: Minerals Commission).

2.7 SALT AND BRINE

Salt deposits are found in both liquid and solid states, and salt categories include rock salt, solar salt, salt brine, or vacuum pan salt. Salt in solid state is often impure and intermixed with other sedimentary minerals. Salt is produced along the coastal region of Ghana west of Accra between Keta and Komenda mostly by evaporation of sea water in lagoons, using the heat of the sun to cause salt crystallization. Near Daboya and Tibogona, Northern Region, brine from the subsurface is used locally for small-scale production of halite. The pools contain locally high concentrations of calcium, sulfate, and possibly magnesium, sodium, and chlorine.

The Volta Region includes salt-producing sites at Afiadenyigba on Keta Lagoon, Dzita and Anyanui on Angaw Lagoon. The greater Accra Region includes sites near Ada on Songaw Lagoon, New Ningo on Dzange Lagoon, Prampram on Laiwi Lagoon, and Mendskrom near Weija at Accra. In the Central Region, salt is produced along the coast at Gomoa-Nyanyano, Gomoa-Fetteh, Mankwadzi on Manko Affah Baka Lagoon, Apam on the Nana Apaa Baka Lagoon, at Sarafa, Kuntu, Anomabu, Elmina, Shama, Komenda Edina Eguafo Abirem, Nkwanda, and Breni Akyim. In the Northern Region, brine-bearing pools occur 1.3 km west of Daboya village and at Tamale.

Common salt, however, is mostly used as an additive in chemical feedstock, in fertilizers and insecticides in the manufacture of chlorine and caustic soda, and in the production of synthetic soda ash used in plastic, glass, solvent, paper, detergent, and ceramics manufacture. Panbros is the major salt producer in Ghana. They produce the highest quality, refined industrial and edible salts.

Other manufacturers of common salt in Ghana do not refine the salt. Edible, non-iodate salt is used for human consumption in the local and export market. Ghanaian salt is also used in the manufacture of caustic soda (NaOH) for use in the soap industry, for the manufacture of hair-care products, and by the food industry for use as a preservative.

Table 2: Highest salt concession owners, 2013 (Source: Council for Scientific & Industrial Research-IIR).

Name	Location/District
Ada Songor Salt Ltd	Ada
Vacuum Salt Products Ltd	Ada Songor
Anlo Solar Salt Works Ltd	Dzita
Sterling Industries Ltd	Prampram-Ningo
Kesington Industries Ltd	Adina-Agavedzi & Blekusu
West African Goldfields Ltd	Blekusu
Volta Investments Co,	Afienya
Solar Chemicals & Allied Ent.	Pute-Ada
Newbridge Investment Ltd	Kponko
White D'or Minerals Ltd	Adafienu

2.8 SUMMARY OF FELDSPAR RESOURCES

Feldspar locations include Egya, Kwanyako, Akuradzi and Moree, all in Central Region. Four potentially economic pegmatite deposits have been described in Ghana. The largest deposit occurs in the Cape Coast and Saltpond area, Central Region, near the Cape Coast granitic batholith. In this area, pegmatite resources are estimated to be 2 million tonnes and feldspar resources are estimated to be 800,000 tonnes. Feldspar crystals vary in length to 60 cm in the Moree area.

2.9 CLAY

Clay minerals are hydrous aluminous silicates with a sheet-like structure in which magnesium or iron may substitute wholly or partly for aluminium and with alkaline earth as essential constituents, giving the rock a variable chemical composition.

The Kaolinite Group - The group has three members, kaolinite, Dicite and Nacrite. It is used in as fillers for paints, rubber and plastics. The largest use is in the paper industry that uses it to produce glossy paper such as is used in most magazines.

Montmorillonite Group - this is composed of several minerals such as pyrophylite, talc, vermiculite and montmorillonite. The minerals differ mostly in chemical content.

Its uses include facial powder, filler for paints and rubbers, electrical heat and acid resistant porcelain, in drilling mud and as plasticizers in molding sands.

Illite Group - the main minerals are muscovite and illite, both components of shale and argillaceous rocks. it is used as filler and in drilling muds.

2.9.1 Classification of clay rocks

Kaolin

- China clay- principally kaolinite with minor amounts of illite, quartz, feldspar and muscovite. iit is white soft clay of variable but low plasticity and dry strength which retains its white colour when fired.
- Ball clay-it is a variety of kaolin which possesses high plasticity and strength.
- Flint clay- it is a compact microcrystalline and breaks with concoidal fracture and has no plasticity.
- Refractory clay- or fire clay is also a variety of kaolin that has a high temperature fusion point above 1425 ^{o} C. the higher the alumina content the more refractory is the clay.

Bentonite

It consists mainly of montmorillonite. there are two types of naturally occurring bentonite- a swelling bentonite which is associated with marine sediments, and non-swelling bentonite that is typically associated with fresh water sediments.

Fullers Earth

This is a group of clay that has a substantial ability to absorb impurities from fats, grease and oils.

Brown clay deposits are useful in ceramics, manufacturing and construction industries are found in all the regions of country. It has been exploited by the people for making earthen ware, cooking pots and water coolers for centuries.

Kaolin Occurrences

Geological investigations have identified occurrences of kaolin in numerous locations in the country. The major deposits occur at the following place:

- Teleku Bokazo - Aluku, Awaso and Wassa Akropong ,Western region;
- Kibi, Eastern region;
- Saltpong - Ekon, Central region
- Anfoega, Volta region.

The Economic Geology and Ceramics and Clay Mineralogy Divisions of the Geological Survey have undertaken research into clays and economic minerals in most parts of the country. The results of tests conducted on the different types of clays in the country show that they have valuable economic/industrial uses.

The Clay Mineralogy Division has developed products from the above raw materials. These include building bricks, pavement bricks, wall and facing tiles and earthenware bowls that were produced from the various clays which are good for the housing industry and pottery industry for women respectively. Insulation bricks have been developed from some identified refractory clays for use in kilns and furnaces, and Crucibles for use in melting of precious and other metals in the Jewelry industry.

2.9.2 Market Survey for Clays

Under the Mining Sector Support Programme, AES Minerals Company Limited was contracted in 2009 to assess the market potential of locally mined kaolin for use by the local industry. The study established extensive use of kaolin in the manufacturing sector of the economy and also confirmed considerable demand for kaolin in the country and neighbouring Togo and Burkina Faso. They also indicated the country has substantial reserves of kaolin to meet national demand and for export.

Industries that use kaolin in their manufacturing process:-

Customers obtain their kaolin supply from two sources:

- Locally produced- either direct from small scale miners or from their own concession. Super Paper Products Limited and Basic Chemicals Limited use the kaolin from Teleku Bokazo-Aluku area.
- Imported from suppliers.

Kaolin is locally mined and transported to factories in Accra, Tema, Kumasi and other consumer centers in the country from the major deposit locations. Estimated kaolin reserves are about 29 million metric tonnes but accurate resource may be over 50 million metric tonnes when detailed evaluations of all deposits are made (2009). Small scale miners employ insufficient mining and processing methods. Consequently they are unable to deliver the required tonnage and grade to customers who, prefer to import kaolin of high grade and quality.

According to the 2009 market survey, the annual national kaolin requirement is about 3000 metric tonnes meanwhile local production averages 1,200 metric tonnes. The shortfall is made up by imports. Major consumers are Unilever Ghana Ltd., BBC Paints, Azar Paints, Ghana Rubber Products Ltd., and some pharmaceutical companies. Oil palm extraction companies such as Benso Oil Palm Plantations and Juaben Oil Mills Limited use kaolin in their production processes.

Small scale users are those involved in soap making in places such as Tarkwa, Sunyani, Tamale, Techiman, Kumasi and spread throughout the regions.

Figure 2.11: Alumni visits Maxima Ceramics, Accra which finishes the pottery from clays for flower pots and artifacts (Source: field survey, 2016)

Interactions with the lady CEO of Maxima Ceramics (in figure 2.11 above), reveals some challenges such as high utility tariffs. Also there is demand for exports but the export taxes are making it unfavourable and wish these challenges could be looked at in order to improve economic growth in the local pottery industry.

2.9.3 Investment Opportunities in Brown Cay and Kaolin

According to statistics from the Ministry of Water Resources, Works and Housing, the housing deficit in the country is about 1.7 million units as at December, 2012. To address the deficit and accommodate new household, there is need for annual delivery of about 170,000 housing units for the next 10 years.

Past governments have tried to find suitable ways of solving the housing problems of the country through various means. One of such means is trying to encourage the use of indigenous local materials such as burnt bricks and tiles. Research findings by CSIR-BRRI and the Geological Survey Department of Ghana indicate that there are enough clay and other soils in all the ten regions of the country which are suitable for making clay bricks for housing and road construction. Extensive use of clay bricks would help reduce the high cost of housing delivery in the country. Hence, investment in the burnt clay bricks industry would boost the country's effort to provide affordable housing to the people.

In order to make this possible, Government's commitment is required to:

- Revamp existing factories and construct new ones to produce the materials building industry;
- Provide efficient mining and processing equipment to deliver high grade and quality kaolin to the industries that use kaolin;
- Resource state institutions which provide technical advice in the use of clay products and
- Increase the number of skilled brick layers through training support.

Local building materials, such as burnt clay bricks, pozzolana cement and compressed earth could reduce housing cost by 20%. Policy and legislation must therefore be put in place to enjoin the State Institutions, Metropolitan, Municipal and District Assemblies to use local building materials for public projects.

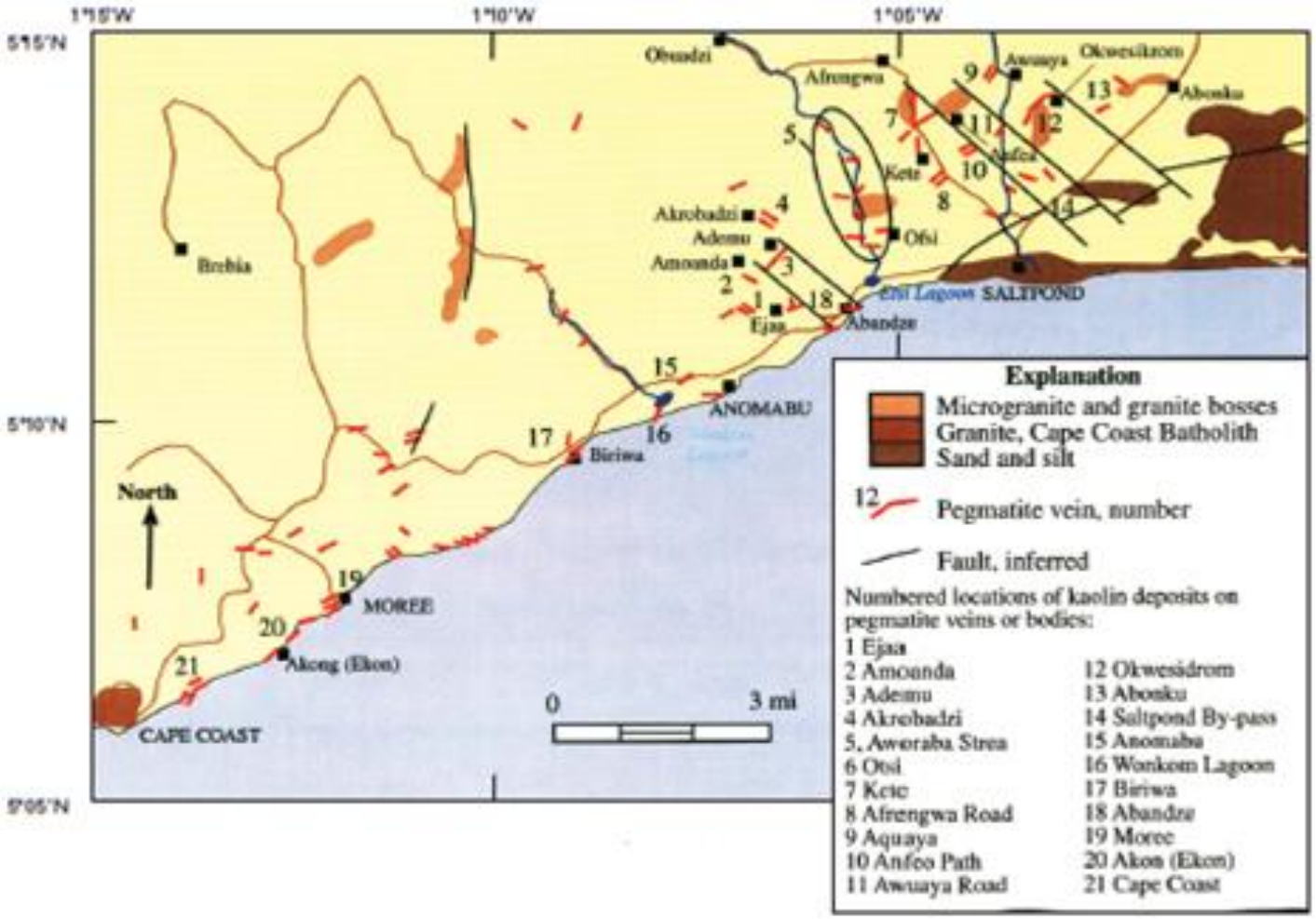
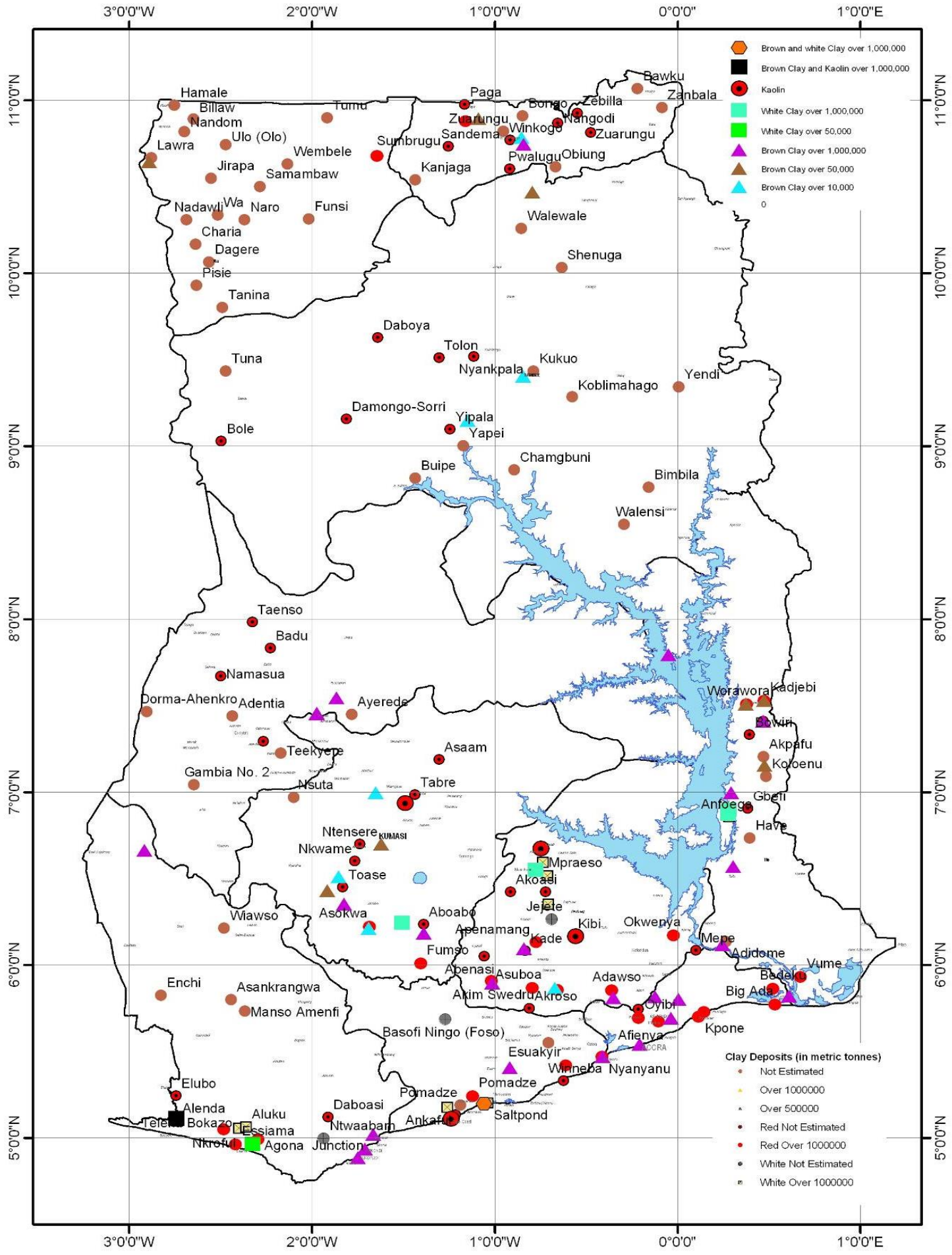


Figure 2.12: Locations of Kaolin deposits on developed on pegmatite veins in Cape Coast area, Central Region.

Figure 2.13: Clay Mineral Deposits in Ghana at scale 1:3000 000 (Geological Survey)



3 Conclusions

Neglected Development Minerals are essential for economic development. Infrastructure improvement and growth of the manufacturing sector requires a reliable supply of good quality construction minerals and a wide range of other industrial mineral raw materials.

In Ghana, granite, limestone, sandstone, phyllites and jasper provide bulk of dimension stones whiles granites are the main quarry materials. The country has substantial reserves of kaolin to meet national demand and for export.

Local construction materials can reduce housing cost by 20%, create employment and improve economic status of the people especially women. In jewelry sector, beads made from clay minerals are receiving more patronage and has potential to improve livelihood of women who are majority in making beads and ornamentals for all occasions in the country.

A commitment and assistance from government would greatly improve NDMs as alternative source of domestic direct investment for economic and infrastructure growth of Ghana.

4 Table of Figures

5 References

Atiemo, E. (2009, October 8). TheHousing Siyuation in Ghana and Strategies to Overcome Challenges. Presentation at National Housing Conference. Accra. Retrieved June 22, 2016, from BRRI Web site: www.brri.org/index.php/2013.../119-proceedings-of-national-housing-conference

Barning, Kwasi. (2005). *Industrial Mineral Resources of Ghana.* (K. Barning, Ed.) Accra: Minerals Commission.

Boadi, J. K., Obeng, K., Danquah, J. A., & Manu, F. (2009, October 8). Need to Re-Launch the Brick and Tile Revolution as answer to National Shelter Problems, Presntation at National Housing Forum. Accra. Retrieved June 22, 2016, from BRRI Web site: www.brri.org/index.php/2013.../119-proceedings-of-national-housing-conference

Geological Survey Department. (2011). Investment in Minerals in Ghana. *Annual Brochure*. Accra, Ghana: Geological Survey Department.

Geological Survey Department. (2015, January). Contributing to the Socio-Economic Development of Ghana. *Annual Brochure*. Accra, Ghana: Geological Survey Department.

Geological Survey of Ghana. (1962). *Bulletin No.28 Occurrences of Economic Minerals in Ghana.* Accra: Ministry of Information.

GHEITI. (2015). *Scoping study on the incorporation of artisanal and small-scale mining in Ghana's Extractive Industries Transparency Initiative, 2015).*

Hutchful, J. (1996). *Report on Bomingo Clay Deposit.* Accra: Geologica Survey Department.

Kesse, G. O. (1980). *Annual Report of the Geological Survey.* Accra: Republic of Ghana.

Kuzrat, M., & Neuzil, J. (1961). *Preliminary Report on the Prospecting for Ceramic Raw Materials in Ghana.* Accra: Geological Survey Department.

Miah, L. (1977). *Final Report on Clay Prospecting in Wuriwuri and Teleku Bokazo Area.* Accra: Report prepared for Geological Survey Department.

Minerals Commission. (2014). *Manual on Clay and its Associated Minerals.* (K. Barning, Ed.) Accra, Ghana: Minerals Commission.

Minerals Commission and Environmental Protection Agency. (2013). *Ghana's Mining and Environmental Guidelines: Revised Draft.* Revised Draft, Accra.

Nsiah Gyabaah, K. (2009, October 8). The Urban Housing Challenge and Prospects for Meeting the Housing Needs of the Urban Poor in Ghana. Accra. Retrieved June 22, 2016, from BRI Web site: www.brri.org/index.php/2013.../119-proceedings-of-national-housing-conference

O., K. G. (1985). *Mineral and Rock Resources of Ghana.* Rotterdam: A A Balkema.

Osei-Tutu, E., & Adjei-Kumi, T. (2009, October 8). An Evaluation of Housing Cost Trends in Ghana For The Period 1991 – 2008. Accra. Retrieved June 22, 2016, from BRRI Web site: www.brri.org/index.php/2013.../119-proceedings-of-national-housing-conference

Republic of Ghana. (2014). *Minerals and Mining Policy of Ghana: Ensuring Mining Contributes to Sustainable Development.* Accra: Republic of Ghana.

WIM Ghana. (2015). *Reaching out series: Esuakyir Quarry Women Fieldtrip Report.* Accra: Unpublished.