GHANA'S ONSHORE EXPLORATION EXPERIENCES, CHALLENGES, PROSPECTS AND THE WAY FORWARD
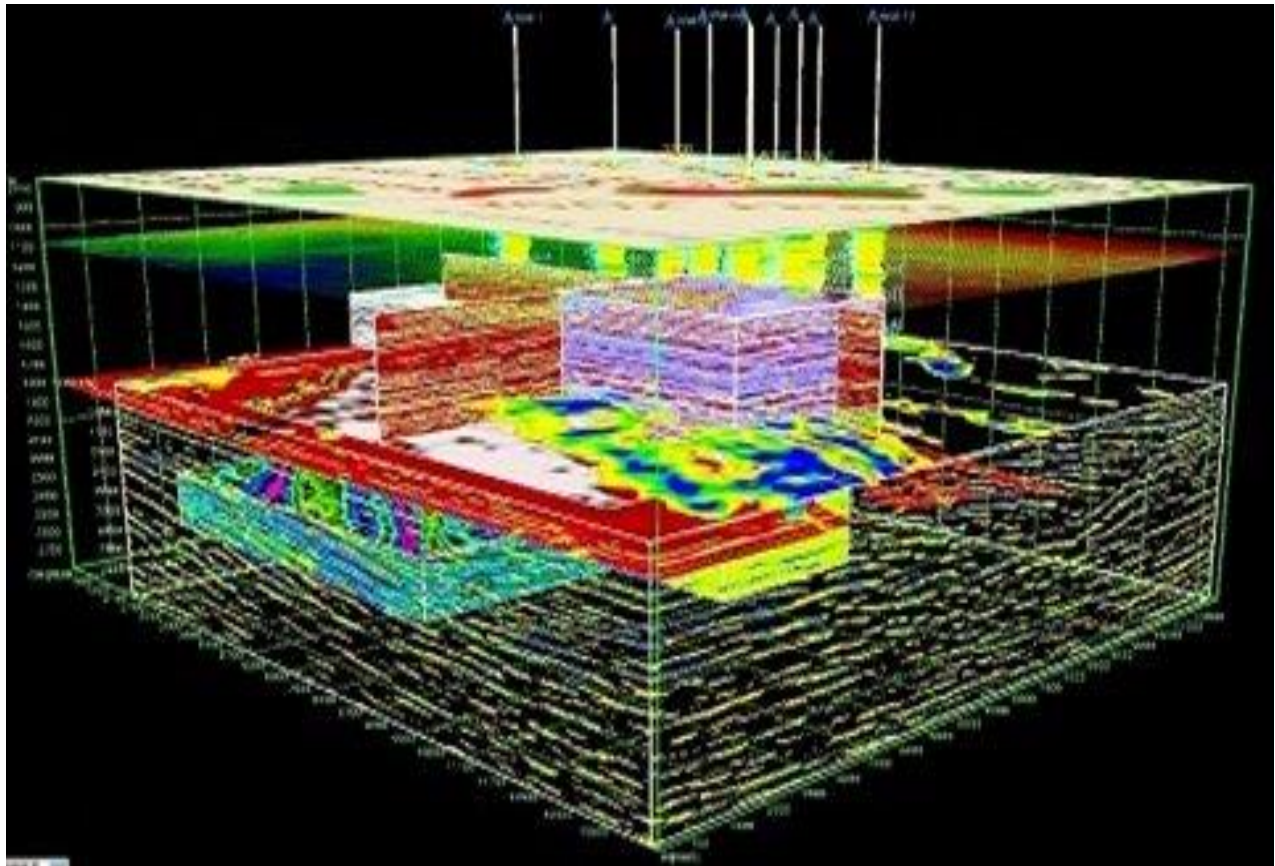
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1.0 Introduction

It is estimated that Ghana's oil reserve is between 1 and 2 billion barrels of crude oil reserves estimated at about 158,987 litres, with a total of 30-50% recoverable from the (Odum, Mahogany-2, Heydua-2 and Mahogany-3) Jubilee fields . In their 2008 status report, the state owned Ghana National Petroleum Company (GNPC), Ghana's total oil deposit is about 800 million barrels with an upside potential of 3 billion barrels of oil [GNPC, 2008].

The discovery and the production of oil and gas in Ghana is seen by Ghanaians as an unparalleled opportunity for boosting the nations spending on job creation, education, agriculture, and infrastructure development for accelerated economic development. Since 2010, the petroleum sector has contributed more than 3 billion dollars to the Ghanaian economy. However, the discovery of his resource came after almost a century of relentless search for the black gold. But how much does Ghanaian know about the history oil search before the discovery in commercial quantity in 2007? This article walks the reader through the journey of onshore and offshore oil exploration from 1896 and highlights the challenges associated them oil exploration as well as recommendations for safeguarding the environment. The article concludes that, while players in the oil and gas industry have a huge responsibility towards the environment and the people, the regulatory institutions must ensure an effective regulatory environment.

2.0 Ghana's Experience of Onshore Exploration

The onshore extraction of crude oil and geothermal energy requires drilling into the underground deposits. The targeted search for crude oil, natural gas and geothermal deposits is called prospecting. Compared to offshore extraction, the onshore extraction of oil and gas is less laborious and more cost-effective. Special methods such as seismic reflection are used for the

exploration of crude oil, natural gas and geothermal deposits. Onshore fields with many oil deposits are under extraction in Germany, frequently distinguishing themselves with a broad maximum extraction volume and a long extraction phase.

According to the "Ghana Geological Survey Bulletin No. 40 "exploration for oil and gas in Ghana started in 1896 in onshore Tano basin (Western Region). This was due to the presence of onshore oil and gas seepages found by early explorers in that area. During that period early wells were drilled without geological understanding and the benefit of seismic data. In 1925, after almost 30 years of inactivity in exploration, Gulf Oil Company acquired the onshore Tano license and drilled four (4) wells at Bonyere, Epunsa, and Kobnaswaso from 1956 to 1957. Apart from well logs, there is very little information on these wells as the wells were drilled without the help of seismic data. From 1896 to 1957, after a period of 61 years, 17 onshore wells had been drilled in the Onshore Tano basin.

Ghana in its first republic witnessed onshore exploration activities. Acting under Ghana-Soviet Union friendship pact, Soviet and Romanian Geoscientists explored for oil and gas in the Keta and Voltaian basins. During this period, the Soviet team drilling for water in the onshore voltaian basin, encountered traces of oil and gas in some of the boreholes in some areas in the Northern and Upper East Regions. Also, calcic waters associated with hydrocarbons were encountered in some of these boreholes. Furthermore, the book, "Rocks and Mineral Resources of Ghana", authored by G. O. Kesse, reports that, there used to be salt mining at Daboya along the White Volta, northwest of Tamale in the Northern Region. The association of salt deposits with hydrocarbons in sedimentary basins worldwide is well documented and these are all pointers to the possibility of commercial accumulation of hydrocarbons in the Voltaian Basin.

In the latter part of 1966, the Industrial Export Company of Romania drilled a stratigraphic well near Atiavi in the Keta Basin. The well penetrated Quaternary, Tertiary, Cretaceous and Devonian age sediments until the crystalline basement was reached at 1,539 m with no indication of hydrocarbons. After the departure of the Soviet and Romanian teams in 1966, following the overthrow of President Kwame Nkrumah's government, was a shift from onshore to offshore exploration in 1967.

Most private oil companies invited to undertake oil exploration in Ghana showed interest in the continental shelf marking the beginning of offshore exploration. The entire shelf was divided into 22 blocks and completely licensed by 1968. The license empowered the companies to undertake oil exploration over a period of three (3) years beginning 1st January, 1969. They were required to drill one or more wells to a total depth of 3,657.5 m (12,000 ft.) within 18 months after the signing of Petroleum Agreement. In 1970, a milestone discovery was made by Signal/Amoco Group with Seago 10 well. This well lead to the discovery of the Saltpond Oil Field (Devonian Section). The Takoradi 11-1 well had encouraging gas shows but subsequent re-mapping suggested the well was drilled off structure and could possibly have a gas discovery if it had been located on the structure.

Between 1972 and 1979, onshore and offshore exploration for commercial oil continued and intensified. Seventeen (17) wells were drilled, two onshore, one in the Accra/Keta basin and the other in the Voltaian basin. The Premuase-1 well in the Voltaian basin, incidentally, is the only exploratory well in this vast frontier region to date. The Saltpond Field came on stream and started producing oil in 1978 with Agri-Petco as the operator. Later in the same year, the first deep water well, the South Dixcove was drilled by Phillips Petroleum in the offshore Cape Three Points in 2,927 Ft.

In 1979, Phillips Petroleum appraised the South Tano discovery and made gas and condensate find on the satellite structure down dip of the main field. They went ahead to further appraise the South Tano find by drilling in 1981 and later declared the South Tano discovery sub-commercial and relinquished the block. Geophysical Services Incorporated (GSI) in 1982, entered into a Petroleum Agreement with the then Ministry of Fuel and Power to acquire a Non-Exclusive 2D seismic survey to accelerate the exploration and production of hydrocarbons offshore Ghana. The data was acquired in late 1982 to 1983 and covered the area from the Eastern border of Ghana to Cape Three Points.

With the establishment of the Ghana National Petroleum Corporation (GNPC) in 1983, the passage of Petroleum Exploration and Production Law (1984) and the promulgation of Petroleum Income Tax Law (1987), several Petroleum Agreements with international oil companies such as Atlantic Richfield Corporation (ARCO), Amoco, and Diamond Shamrock (Onshore Keta) were executed. The Canadian Government, acting through Petro Canada International Assistance Corporation (P.C.I.A.C), expended considerable funds to support GNPC in acquiring extensive 2D seismic data in the offshore Tano/Cape Three points basin in 1984 (PCIAC – 84 -97, 98 & 99 vintages). These datasets are still some of the best in the basin. In addition, P.C.I.A.C funded the drilling of two appraisal wells over the Tano field the drilling of shallow wells in the onshore Tano Basin.

Between 2001 to 2007, attention of exploration for commercial hydrocarbons intensified with some independent Oil Companies such as Kosmos Energy, Hess Corporation and Tullow Oil, acquiring exploration and production rights over areas in deep water (off-shore). There was a shift of focus from shallow water to deep water areas which was occasioned by other deep-water discoveries in the region and by the results of four such wells drilled in Ghana between 1999 and 2003. These wells proved the existence of an active petroleum system, a fact which hitherto was

unknown. However, the discovery of 14ft of light oil column by Hunt Oil's WCTP-2X effectively reduced the risk of petroleum generation in the deep-water areas of Ghana to the neglect of the onshore exploration.

Kosmos Energy (block operator), Anadarko (technical operator), Tullow Oil and E. O. Group struck a significant (about 312ft net) column of high grade oil in the Mahogany prospect with the Mahogany-1 well in the West Cape Three Points License. This is the most significant discovery, crowning years of concerted effort by all. From August 2007 to 2013, 23 discoveries (Odum, Ebony, Tweneboa, Sankofa, Dzata, Owo, Teak-1, Paradise-1, Banda-1, Gye Nyame, etc.) have been made. Except Ebony, all recent discoveries were made in deep-water (water depths ranging from 800 to 1600m).

3.0 Major challenges of onshore oil and gas discovery

It is an undeniable fact that exploration and exploitation of oil and gas resources does not only have economic implications for a country, but also comes with major challenges. This section presents some of these challenges with oil and gas discovery. The exploration and production industry in any country is accompanied by many environmental challenges such as, seismic acquisition, drilling and occupational hazards, development, production, transportation pose and atmospheric emission are great challenges to the environment.

Seismic Acquisition

According to Marful-Sau (2009), seismic acquisition leads to acoustic emission and accidental spills of chemicals that pollute the land including the sea. Research conducted in the Norwegian seas has also proven that seismic shooting could cause fish to travel tens of kilometres, and some may not return unless after a few weeks. In onshore data acquisition, vast areas of vegetation need

to be cleared to improve accessibility to Vibroesis and other seismic acquisition equipment. The destruction to vegetation is made more pronounced in mangroves and forests. This activity affects the aquatic life.

Drilling and occupational hazards

During drilling, a large volume of fluids are circulated through the well and into open, partially enclosed or completely enclosed systems at elevated temperatures, according to Broni-Bediako and Amorin (2010). When these fluids are agitated during circulating process, there is significant potential of the drilling fluid discharge into the environment. Drilling discharge affect environment, thereby affecting the lives and property of individuals who engages in activities which is the major occupation among the environmental composition.

Development and Production

Particulates which are generated from other burning sources such as well testing contribute enormously to atmospheric pollution. Apart from the emission of carbon dioxide and carbon monoxide, nitrogen oxides and hydrogen sulphide gases are introduced into the atmosphere in varying quantities depending on the nitrogen and Sulphur content in the oil. In production, the major waste produced is water containing inorganic salts, heavy metals, solids, production chemicals, hydrocarbons and occasionally, Naturally Occurring Radioactive Material (NORM). These have minimal effect on the environment. Nonetheless the release of the waste water into freshwater bodies and the land requires special care (Sam-Okyere, 2010).

Transportation and Storage

Oil transportation has been a major source of pollution through oil spills and leakages. Oil spills occur as a result of mechanical failure processes that are involved in oil transportation and storage.

As may be the case elsewhere, oil and gas exploration and production in the field involve the various stages that could be accompanied by intrinsic environmental challenges. The environmental impacts arising from oil and gas production activities can be broadly grouped into two, namely (i) ecosystems, and (ii) human, socio-economic and cultural (Exploration and Production Forum/UNEP, 1997).

Environmental pollution

During oil and gas exploration and production, potential impacts on soils arise from physical disturbances due to construction, deforestation and contamination, resulting from spillage and leakage or solid waste disposal. These activities result in land degradation, transformation and fragmentation of natural habitats, and can disable the vital ecosystem processes that support growth (Barnard & Newby, 2009). In the Niger Delta region of Nigeria, three main sources of oil pollution have been identified, namely oil spills, gas flares and waste discharges (Pyagbara, 2007).

Rivers, streams and ponds have been the receiving bodies for oil spills and waste discharges, with their accompanying negative environmental impacts. Available data show that between 9 and 13 million barrels of oil have been spilt in the Niger Delta region in the past 50 years (NCF/WWF/IUCN, 2006). These spills, which occurred on land and destroyed crops, damaged the quality and productivity of soil that the communities use for farming (UNEP, 2011). The spills have also caused the death of birds and mammals, damaged fisheries and contaminated water bodies which are sources of drinking water and other domestic purposes (Amnesty International, 2009). Oil spills and other oil-related pollution have also seriously damaged the Niger Delta's mangroves, which are an important fish breeding area. The damage has resulted in a severely impaired coastal ecosystem, and compromised the livelihoods and health of the region's

impoverished residents (NCF/WWF/IUCN, 2006; Amnesty International 2009), thus, negatively affecting economic activities.

The reasons assigned to the frequent oil spills in the Niger Delta include corrosion of oil pipes, poor maintenance of infrastructure, spills or leaks during processing at refineries (World Bank, 1995), human error and the consequence of deliberate vandalism or theft of oil (Steiner, 2008). The damage to the ecosystem has caused the Ogoni people, who think their lives are intrinsically bound up with the survival of the environment, to stand up against the denigration of their environment (UNEP, 2011).

Atmospheric emissions

Atmospheric emissions are increasingly becoming the subject of concern to both industry and national governments due to its negative effect on climate. Emissions associated with oil development activities, can be grouped as; (i) Flaring, venting and purging of gases; (ii) Combustion processes from diesel engines and gas turbines; (iii) Fugitive gases from loading operations and losses from process equipment; (iv) Airborne particulates from burning sources, such as well testing and soil disturbance during construction and vehicular traffic (E&P Forum/UNEP, 1997).

Of these gas emissions, flaring is the most alarming, and has been a source of major conflict in Nigeria and elsewhere (Sala-i-Martin &Subramanian, 2003; ERA/CJP, 2005). The principal emissions accompanying flared gas contain toxic by-products such as methane, benzene, carbon dioxide, carbon monoxide, volatile organic carbons, Sulphur dioxide, nitrogen sulphide and nitrogen oxide. Some of these gases (e.g. carbon dioxide), contribute to global warming, whereas the Sulphur gases and carbon dioxide contribute to the formation of acid rain, which is detrimental

to soil, moreover, gas flaring has the potential to damage the forest reserve, vegetation and farmlands located offshore the oil field.

4.0 Onshore oil and gas prospect in Ghana.

The Ministry of Energy and Petroleum has been carrying out reconnaissance studies to establish the prospect of oil and gas in the entire Volta Basin in Ghana. Reconnaissance surveys are field surveys often used to gather initial information regarding the presence or absence of historic properties within a project area. They generally include limited shovel testing in areas that are likely to contain archaeological resources.

The acquisition of seismic and Full Sensor Gravity survey over the entire basin is still in review stage under competitive tendering by the ministry of Petroleum and yet to commence.

The prospecting of oil is still on-going in the Mankranho area in the Constituency in the Brong Ahafo Region and the ministry was not going to ignore that project. The outcome of the survey activities would lead to either further enhanced studies to be carried out, or the immediate award of blocks for exploratory activities to begin. The Mankranho onshore project have been placed in the outcome study profile from the above activities to be determined what kind of further work that would be carried out in the Mankranho area, according to the Minister of Petroleum.

5.0 Recommended measures to address onshore concerns in the oil and gas industry

There are various international treaties and conventions, such as the Convention on the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, Nairobi, 1985, Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention), Vienna, 1986, Convention on Biological Diversity (CBD), Nairobi, 1992, Convention on Certain Conventional Weapons, Convention on

Civil Liability for Damage Caused during Carriage of Dangerous Goods by Road, Rail, and Inland Navigation Vessels (CRTD), Geneva, 1989, Convention on Cluster Munitions, Convention on Early Notification of a Nuclear Accident (Notification Convention), Vienna, 1986. These are meant to provide appropriate remedies problems arising from the oil and gas industry and Ghana's environmental protection agency , 1994 (Act 490) is one domestic law that seeks to the protection of the environment in Ghana.

However, there is the urgent need for the Government of Ghana to formulate an all-inclusive oil and gas development policy with environmental issues at the center stage. The policy framework should integrate environmental legislations and management systems, and also mandate stakeholders to develop an environmental value culture at every stage of their business processes to supplement government's efforts in a cost effective manner. Consequently, the policy should be tailored along two main approaches to regulating the environmental performance of an industry, namely the 'prescriptive' and 'performance based' approaches (Technical Meeting Document, 1998).

The Prescriptive Approach

The prescriptive or "command and control" approach is based on legislations indicating specific requirements made by government, to be met by operators. The regulations clearly spell out structural, technical, and procedural requirements to address environmental, health and safety hazards. This makes it relatively easy for government to determine, via an inspection procedure, whether an operator is meeting the requirements. Thus, it is convenient for the Government of Ghana to adopt this approach by setting mandatory environmental codes and standards to regulate and monitor the activities of companies in the oil and gas industry. These standards must include general guidelines for the preparation of an environmental impact assessment and detailed

guidelines for the preparation of an environmental action/management plan to be submitted by firms before the commencement of operations.

It is very important that environmental impact assessment be undertaken prior to the commencement of oil exploration and development. The companies involved would be required to indicate what mitigating measures would be employed to contain the situation. The standards must also include acceptable limits of concentrations of compounds and chemicals in effluent discharges generated through the operations of the various companies. Equally important should be the application of the "polluter pays" principle to ensure that producers of wastes that cause environmental damage are made to pay compensation and the cost of remediation.

Performance-based approach

In the performance-based or "self-regulation" approach, which is based on agreements made between government and operators, greater emphasis, is placed on setting environmental goals or standards to be met by operators in the industry. This requires the operators to define strategies and plans in order to achieve the overall objectives and criteria set by the regulator. Accordingly, the operators are responsible for providing evidence, assuring that they are complying with the agreements. An example is a legally binding Environment Action Plan (EAP) that is formulated by the requirements (Technical Meeting Document, 1998).

The self-regulation approach focuses on self-inspection (internal audits) by company experts, in consultations with skilled external auditors, in order to check compliance and report to the regulator. It, thus, removes some of the burden of auditing and inspection from government, while allowing the operator flexibility in choosing practical measures to meet the environmental objectives (Technical Meeting Document, 1998). This approach could, therefore, be adopted by

opportunity to find other ways of meeting the goals or targets set by government. Thus, the oil companies could be mandated by government to develop Environmental Management Plan (EMP) or Environmental Management System (EMS) to ensure that they operate within the environmental standards for the industry. EMS is a tool which involves continual cycle of planning, implementing, reviewing and improving the processes and actions that will effectively and efficiently enable an organization meet its business and environmental goals (Five Wind International, 2004). This means that there is a review of the system after each cycle to identify areas for further improvement to meet the national environmental standards for the industry.

The EMS, if well implemented, offers a lot of benefits including improved environmental performance, enhanced compliance, and pollution prevention, reduction in emissions, resource conservation and reduction in environmental pollution. As part of operational measures, oil companies should develop innovative environmental technologies to be employed in their operations, and develop a proper disposal of generated solid waste.

The two types of approach could be achieved through the collaborative efforts of the Ministry of Environment, Water and Natural Resource, the oil and gas companies, and other stakeholders in the industry. The EMS, if well implemented, offers a lot of benefits including improved environmental performance, enhanced compliance, and pollution prevention, reduction in emissions, resource conservation and reduction in environmental pollution. As part of operational technologies to be employed in their operations, oil companies should develop innovative environmental technologies to be employed in their operations, and develop a proper disposal of generated solid waste.

Recommended administrative and institutional support

A perfect blend of both prescriptive and performance-based approaches could serve a good purpose in pursuing environmental management in the oil and gas industry. In many countries, performance-based approaches are increasingly being adopted to complement existing prescriptive regulations. Classical examples exist in Norway, the Netherlands and Australia, where the offshore oil and on-shore industry has been moving to a regime based on goal-setting approach, supplemented by the prescriptive system of regulation (Technical Meeting Document, 1998).

However, the mere prescription of environmental codes and setting of standards, as well as the development of EMS, cannot be a panacea for pollution emanating from the oil and gas industry. Guided by the drawbacks encountered in mining industry, it is important that an improved and sustainable strategy be put in place to ensure that oil companies strictly adhere to regulations guiding their activities in the industry, and are not spared any documented punishment if they violate any of the legislations.

6.0 Conclusion and Recommendations

There is no doubt that the positive impact of the oil and gas industry on Ghana's economy is huge. However, an enduring impact of this industry on Ghana calls for skills upgrading, the development of the right attitude and incentives for protecting the environment Furthermore, the establishment of conservation pressure groups, with the requisite expertise should be encouraged to play the appropriate watchdog role, public education and to ensure that the environmental values and habits of preservation and environmental conservation is inculcated. In addition, the following recommendations would also be useful for safeguarding the ecosystem:

a) Government should ensure strict control and enforcement of environmental policies;

b) Strengthening existing regulatory framework for environmental protection;

c) Regular and effective monitoring of oil development activities;

d) Periodic update of environmental guidelines;

e). Periodic upward review of fines/penalties to deter potential polluters;

f). Periodic review of the effectiveness of local environmental agencies;

g) Availability of resources

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