

**PERFORMANCE AUDIT ON THE MANAGEMENT OF  
GEOPHYSICAL AND GEOLOGICAL DATA FOR OIL  
AND GAS IN TANZANIA**





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NATIONAL AUDIT OFFICE



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## PREFACE

The Public Audit Act No. 11 of 2008, Section 28 authorizes the Controller and Auditor General to carry out Performance Audit (Value-for-Money Audit) for the purposes of establishing the economy, efficiency and effectiveness of any expenditure or use of resources in the MDAs, LGAs and Public Authorities and other Bodies which involves enquiring, examining, investigating and reporting, as deemed necessary under the circumstances.

I have the honour to submit to His Excellency the President of the United Republic of Tanzania, Dr. John Pombe Magufuli and through him to the Parliament a Performance Audit Report on the Management of Geophysical Data Management for Oil and Natural Gas in Tanzania.

The report contains conclusions and recommendations that directly concern the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC). MEM and TPDC have been given the opportunity to scrutinize the factual contents and comment on the draft report. I wish to acknowledge that the discussions with MEM and TPDC have been very useful and constructive.

My office intends to carry out a follow-up at an appropriate time regarding actions taken by the audited entities in relation to the recommendations in this report.

In completion of the assignment, the office subjected the report to the critical reviews of the following experts namely, Dr. Isack M. Marobhe and Dr. Esther Ndenje - Sichalwe of the University of Dar es salaam, who came up with useful inputs on improving the output of this report.

This report has been prepared by Mr. Kishiwa Magembe - Team Leader, Ms. Ndimwaga Shitindi and Mr. Jeje William - Team Members under the supervision and guidance of Mr. George C. Haule - Assistant Auditor General and Ms. Wendy W. Massoy - Deputy Auditor General.

I would like to thank my staff for their devotion and commitment in the preparation of this report. My thanks should also be extended to the audited entities for their fruitful interaction with my office.



Prof. Mussa J. Assad  
Controller and Auditor General  
United Republic of Tanzania  
March, 2016

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## ABBREVIATIONS AND ACRONYMS

ACM	:	Annual Committee Meeting
BWM	:	Benjamin William Mkapa
ICT	:	Information Communication Technology
IOCs	:	International Oil Companies
INTOSAI	:	International Organization of Supreme Audit Institution
ISSAI	:	International Standards for Supreme Audit Institutions
IT	:	Information Technology
MEM	:	Ministry of Energy and Minerals
MPSA	:	Model Production Sharing Agreement
MTEF	:	Medium Term Expenditure Framework
PSA	:	Production Sharing Agreement
PURA	:	Petroleum Upstream Regulatory Authority
SMT	:	Surface - Mount Technology
TPDC	:	Tanzania Petroleum Development Corporation
TZS	:	Tanzanian Shillings

## MESSAGE FROM THE CONTROLLER AND AUDITOR GENERAL

Tanzania started to engage itself in the exploration and production of petroleum products more than 50 years ago. The aim has always been to produce oil or natural gas profitably and environmentally safe so as to raise the standards of living of Tanzanians. The exploration of petroleum resources has been aided by the improved technology through the use of geoscience data which informs the geoscientists where they can find oil or natural gas deposits.

Geoscience data are very important and valuable assets. They are used to assess and determine the amount of oil or natural gas deposits that can be expected. They are the key inputs in the promotion processes of our frontier areas and the licensing rounds depend on their reliability. Geoscience data is costly to acquire and sensitive to handling so it needs special care over a long period of time. However, for these data to provide accurate, true and reliable information about oil or natural gas deposits, they must be professionally, ethically and effectively handled and managed.

I believe that management of Geoscience data in the country needs to be given its due attention. Tanzania must have appropriate human resource with the professionalism, training and ethics to serve in the area of Geoscience Data Management. The infrastructure to store data must be given due attention as it facilitates the conditions of accuracy, truth and reliability of geoscience data.

MEM and TPDC are trusted to undertake the managerial and operational perspective of managing our geoscience data. They must take a good care of these assets. Our future income in petroleum resources depends on the quality of our geoscience data and whether they are reliable and can be trusted by our stakeholders.

Let me take this opportunity to outline some key issues in the Geoscience Data Management in the country.

First, the Government, through the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC), should establish a comprehensive Geoscience Data Management Policy that would lay down the principles and guidelines of good geoscience data management. Good data management practices emphasize the

mechanisms of integration of data management central components which are data policies, processes, people, technology and the data. It will facilitate the state's ownership agenda of geoscience data, minimize loss of data, improve data quality and reliability, ensure security of data - both online and physical and eventually maintain the indispensable value of our geoscience data.

Second, professionalizing personnel integrated in the Geoscience Data Management processes should not lag behind. The government must be confident in the personnel trusted to handle these invaluable assets. Professionalism is a key component of reliable results. The Government needs to ascertain and build the capacity of the staff charged with the responsibility for managing geosciences data, periodically assess their ability and credibility in terms of professional qualifications, competency and integrity.

Third, the Government, through the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC), should establish and maintain adequate physical facilities and infrastructure needed to safely store geoscience data. The current situation requires urgent attention. Current facilities and management practices do not meet the basic standards of best practices in the oil and gas industry. For example, the temperatures, humidity and the general storage environments are not adequately managed and controlled. This results in a quick decline in quality of samples, hence risking uselessness of these expensive assets.

Fourth, government officials must build a thorough understanding of the country's resource base—both the quantum of resource and its geographic distribution. The quantum of the resource base informs key decisions on the rate of exploitation and potential future revenues. Information on the geographic location guides the establishment of property rights and exploration licenses within the country and future social and environmental impacts.

Pre-licensing investment in geological and geophysical surveys, funded by the government or external donors, can provide a high return on investment for the government if the resulting information increases the attractiveness of the geology to investors, thereby attracting higher bids. However, more knowledge can also make the geology

appear less attractive if it demonstrates the geology is less favorable for discoveries.

In conclusion, I believe the government has a duty to collect, store and analyze technical information arising from all exploration operations carried out under its jurisdiction. This information is key to building the government's geological understanding, which will serve to strengthen its negotiating position with investors and better enable it to optimize the licensing regime. This information may also be of good use for other IOCs in the future. If the exploration license holder decides not to use the location, other IOCs might ask that information later on to assess whether they want to use the location instead. This helps Tanzania to extract as much resources as possible. To this end, the government must act quickly.

## EXECUTIVE SUMMARY

Accurate, quality and reliable geophysical and geological data are crucial assets in the country and globally. Drilling targets of natural resources are located by the use of geophysical and geological data. These data are also used to determine the availability and amount of oil and natural gas available in the areas under exploration.

The Tanzania Petroleum Development Corporation (TPDC), under the Petroleum (Exploration and Production), Act 1980 is mandated to acquire, process, interpret, store and distribute information to stakeholders. Furthermore, the Ministry of Energy and Minerals (MEM) is an overseer of these activities. It ensures that, planning, implementation, monitoring and evaluation of the management of Geophysical and Geological data at TPDC are in place and working.

Risks on the reliability, quality and accuracy of Geophysical and Geological data were key variables which motivated the undertaking of the audit. These variables may lead into miss - targeting the potential of oil and gas and consequently, the loss of financial capital and time. Also, inadequately managed Geophysical and Geological data might discourage investors to bid for exploration licenses.

The main objective of the audit was to determine whether the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC) have effective mechanism for managing Geophysical and Geological data for oil and natural gas in Tanzania.

The audit focused mainly on the operations and practice of the management of Seismic data and geological samples. These operations include: acquisition, processing, interpretation and storage of Geophysical and Geological Data. The audit covered issues on controls put by the MEM and TPDC on Planning of activities, protection of data, quality controls of data and information, assignments of roles and accountability of Geophysical and Geological data management activities and feedback on ensuring an effective and efficient system on management of Geophysical and Geological data. The audit covered a period of five years: 2010/2011 - 2014/2015.

Primary data was collected using interviews and observation. Secondary data was obtained at the Tanzania Petroleum Development Corporation and Ministry of Energy and Minerals.

### **Main Findings**

Following the documents review, interviews and observations, the audit came up with the following key findings. The detailed findings are described in Chapter Three.

### **Key Findings at Tanzania Petroleum Development Corporation (TPDC)**

#### ***Absence of Geophysical and Geological Data Management Policy and Framework to govern the management of Geophysical and Geological data***

TPDC has not yet formulated a framework that governs management of Geophysical and Geological data. The audit noted that failure to have data management policy is one of the factors that contributed to the absence of framework. It was found that presence of data management policy is an important tool towards effective Geophysical and Geological data management activities.

#### ***Inadequate assignments of Roles and Responsibilities***

TPDC has failed to demarcate roles and responsibilities for management of Geophysical and Geological data. The audit found that there is inappropriate allocation of roles and responsibilities that are performed by data managers and IT personnel. This was contributed by unclear identification of roles from TPDC scheme of service.

#### ***Lack of necessary skills to Operate software***

The audit found-out that, Data management personnel lacks necessary skills on operating the available software. Misallocation of personnel to deal with data management issues has contributed into misallocation of personnel for training. It was found that in some cases personnel dealing with data management issues tend to attend IT courses due to unclear division of responsibilities of IT and Data management staffs.

### ***Weak Mechanisms for restricting access to Geophysical and Geological database***

It was found that, TPDC Mechanism for restricting access to geophysical and geological database by unauthorized personnel are weak. It was revealed that TPDC has not yet put in place system software that is capable in restricting access to unauthorized personnel.

### ***Unfavorable Geological Data storage facilities***

The audit found that, data storage facilities are not favorable to meet the requirements. The data storage facilities at TPDC Headquarters were observed to have leakages from the roof to the geological samples. This might damage samples and in the long-run change the geo scientific properties of those samples, and thus leading to inaccurate results when processed.

## **Key Findings at the Ministry of Energy and Minerals (MEM)**

### ***Absence of internal policies to ensure integrity of geophysical and geological data***

It was noted that, MEM have not put in place internal policies to ensure integrity of geophysical and geological data. The Act requires MEM to make regulations prescribing all matters including exploration activities. MEM has not developed internal policies necessary for ensuring integrity geophysical and geological data.

### ***Inadequate personnel for monitoring of geophysical and geological data management***

MEM has inadequate personnel to perform different activities pertaining to geophysical data management. The MEM marshal plan shows that there is a great deviation for the number of personnel required and available staffs. Furthermore the audit noted that MEM has no clear defined procedures on dealing with received reports from TPDC regarding daily performance of data management activities.

### ***Absence of independent Review for the upstream activities***

It was found that, MEM does not conduct independent review that covers upstream activities that would identify the weaknesses and alert for improvement. It was further noted that independent reviews conducted mostly cover in-depth the downstream and midstream.



## OVERALL CONCLUSIONS

The overall conclusion of this audit work is that geophysical and geological data for oil and natural gas in Tanzania are ineffectively managed since there is ineffective control and weak mechanism for assessing the acquisition, processing storage, accessibility and ownership. Specific plans that govern geophysical and geological data management are not in place. Geophysical and Geological data are important because they are used to determine the availability and amount of oil and natural gas available in the areas under exploration. Their key application is the prospecting of natural resources including oil and Natural Gas under the ground.

## SPECIFIC CONCLUSIONS

The audit came up with the following specific conclusion

- TPDC's mechanisms over acquisition, processing, storage, accessibility and ownership of geophysical and geological data are ineffective. This is due to the lack of plans governing management of geophysical and geological data, inadequate mechanism for assurance that the procedure for managing geophysical and geological database has been followed and working. Moreover, TPDC has not put in place data policy that could act as a catalyst for effective management of geophysical and geological data.
- TPDC failed to design and maintain a framework that reflects its geophysical and geological data requirements. Lack of defined framework for management of geophysical and geological data management activities is due to lack of working data management unit, unfavorable storage facilities and absence of disaster plan and backup system for geophysical and geological data.
- TPDC's mechanisms for assessing the completeness and accuracy of geophysical and geological data is insufficient. TPDC has failed to put in place mechanism for ensuring completeness and accuracy of geophysical and geological data due to limited skills of responsible data personnel.
- MEM failed to adequately oversee TPDC's management of geophysical and geological data. Also MEM is not adequately using performance indicators to monitor TPDC performance on management of geophysical and geological data.

## Recommendations

### *Recommendations to the Tanzania Petroleum Development Corporations*

Tanzania Petroleum Development Corporations should:

- a) Formulate internal data policy that will form a basis from which framework, guidelines and plans will rely upon in ensuring effectiveness of geophysical and geological data management;
- b) Develop detailed storage requirements and a mechanism for managing geological samples as per standards to avoid deterioration agents such as excessive humidity, temperature and direct sunlight;
- c) Establish off-site storage facilities which will serve as backup in events of disasters and emergencies; and
- d) Ensure that its personnel dealing with geophysical and geological data management are adequately trained.

### *Recommendations to the Ministry of Energy and Minerals*

The Ministry of Energy and Minerals should:

- a) Develop a monitoring and evaluation system that will allow tracking of progress of TPDC in management of geophysical and geological data for oil and natural gas;
- b) Put in place policies that would ensure integrity of geophysical and geological data for oil and natural gas and ensure that those policies are properly controlled, maintained and safeguarded;
- c) Prioritize data management activities in oil and natural gas subsector.

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background

Geophysical and geological data on oil and natural gas industry are crucial assets for the exploration of oil and natural gas reserves in the country and globally. Drilling targets of natural resources are located by the use of geophysical and geological data<sup>1</sup>. These data are used to determine the availability and amount of oil and natural gas available in the areas under exploration. Their key application is the prospecting of natural resources including oil and Natural Gas Reserves under the ground<sup>2</sup>.

The acquisition of Geophysical and geological data involves taking measurements at or near the Earth's surface that are influenced by the internal distribution of physical properties. Analysis of these measurements can reveal how the physical properties of the Earth's interior vary vertically and laterally.

According to the *Petroleum (Exploration and Production) Act, 1980* and the *Petroleum Act, 2015* geophysical and geological data are the property of the Government, must be accurate, must not be exported without proper written authorization, must be included in a National Oil and Gas Resource Data Bank for storage, and must be confidential.

The natural resources can only be discovered effectively when the data are accurate. IOCs use these data to assess the natural resources and the profitability of exploiting the concerned area. If data are inaccurate, IOC's/investors cannot make a reliable decision to consider a bid. This might hamper the drilling of natural resources which result in less revenues for the country.

Quality of data is also a crucial aspect of Geophysical and geological Data Management. Quality and accurate data minimizes the risk of missing the targets of the resources<sup>3</sup>. This also encourages exploration and development companies to buy the geophysical and geological data and bid for the Exploration and Development licenses.

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<sup>1</sup>Florida Department of Environment Protection, 2015

<sup>2</sup> Kearey, Brooks, & Hill, 2012

<sup>3</sup> Experts from the University of Dar es salaam

Adequately managed geophysical and geological data ensures quality, reliability and accuracy of its contents, confidentiality, ownership and timeliness and responsible access to all stakeholders. The recoverable costs after the discovery of resources can only be realistic if acquisition, processing and interpretation of geophysical and geological data is properly managed. Government ownership and confidentiality of data are also prerequisites for an effective management of the entire process of data acquisition and processing.

Issues of geophysical and geological Data Management in Tanzania are solely vested to the Tanzania Petroleum Development Corporation (TPDC) and overseen by the Ministry of Energy and Minerals (MEM).

## 1.2 Motivation of the Audit

The audit was motivated by the fact that risks on the reliability, quality and accuracy of both promotional<sup>4</sup> and IOC acquired geophysical and geological data may lead into miss - targeting the potential of oil and gas and loss of capital and time. This might discourage investors to bid for exploration licenses. According to MEM, some companies have missed the targets and lost a significant amount of money<sup>5</sup>. Unreliable and inaccurate geophysical and geological data may be among the main reasons for missing target. This may result in loss of revenue for the country because potential IOC might limit their investments on the exploration activities and processes.

The Government of Tanzania has recently increased its engagement in the Exploration and Production of Oil and Natural Gas. Also for this reason, it is of great importance that geophysical and geological data are reliable, accurate and of high quality.

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<sup>4</sup>Preliminary geophysical data acquired by TPDC for the purpose of persuading potential IOCs to engage for further exploration activities.

<sup>5</sup>Extract from the Ministry of Energy and Mineral's Press Release in 2014

Therefore, the Controller and Auditor General decided to conduct a performance audit for the area of geophysical and geological Data Management. This report gives details on objective, scope, assessment criteria, methodology, findings, conclusions and recommendations based on Performance Audit conducted on the Management of Geophysical and Geological Data for Oil and Natural Gas in Tanzania by the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC) in the area of geophysical and geological data management.

### **1.3 Design of the Audit**

#### **1.3.1 Objective of the Audit**

The overall objective of the audit was to determine whether the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC) have effective mechanism for managing<sup>6</sup> geophysical and geological data for oil and natural gas in Tanzania.

#### **1.3.2 Specific Audit objectives**

In order to address the mentioned audit objective, the following specific objectives were used. These objectives were to:

- a) determine the effectiveness<sup>7</sup> of TPDC's mechanisms over acquisition, processing, interpretation, storage, accessibility and ownership of geophysical and geological data for oil and natural gas in Tanzania;
- b) assess the adequacy of TPDC's mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical and geological data for oil and natural gas; and
- c) assess whether MEM is adequately overseeing TPDC to ensure effective management and ownership of geophysical and geological data for oil and natural gas.

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<sup>6</sup> Data Management is a group of activities relating to the planning, development, implementation and administration of systems for the acquisition, storage, security, retrieval, dissemination and archiving of data

<sup>7</sup> The extent to which target problems are solved

### 1.3.3 Scope of the Audit

The audit assessed the system for managing geophysical and geological data applied by Tanzania Petroleum Development Corporation (TPDC) as a mandatory custodian of geophysical and geological data and its related records. The audit also assessed the operations by the Ministry of Energy and Minerals with regard to the management of geophysical and geological data as an overseer of TPDC's operations.

The main focus of the audit was on the operations and practice of the management of seismic data and geological samples for both off-shore and on-shore.

The audit covered issues on controls put in place by MEM and TPDC on planning of activities, protection of data, quality controls of data and information, assignments of roles and accountability of geophysical and geological data management activities and feedback on ensuring an effective and efficient system on management of geophysical and geological data.

The audit focused mainly on the operation and practice of management of seismic surveys data and geological samples because they provide clues about the fluid content, porosity, permeability, age, and formation sequence (layering) of subsurface rocks. Furthermore, seismic surveys data are widely used because they yield the most useful information about rock structures. In particular, they can be used to identify traps capable of containing oil and gas<sup>8</sup>.

Other geophysical data like magnetic surveys were not the focus of this audit because they are preliminary surveys and have relatively low costs compared to seismic surveys, a logging samples and cuttings.

The main audited entities were the Tanzania Petroleum Development Corporation (TPDC) and the Ministry of Energy and Minerals (MEM).

This audit covered a period of five financial years i.e. from 2010/2011 up to 2014/2015 where Tanzania Petroleum Development Corporation (TPDC) together with the Ministry of Energy and Minerals (MEM) had

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<sup>8</sup> Raymond & Leffler, 2006

engaged seriously on exploration activities in the country and also to establish the trend of performance over the period.

#### 1.3.4 Assessment Criteria

In order to assess the performance of Tanzania Petroleum Development Corporation and Ministry of Energy and Minerals on the Management of Geophysical and geological data, assessment criteria drawn from various sources were used.

*Effectiveness of TPDC's mechanisms over acquisition, processing, interpretation, storage, accessibility and ownership of geophysical and geological data*

*The Petroleum (Exploration and Production) Act of 1980* requires TPDC to control and safeguard geophysical data as assets of the corporation and the nation to ensure their integrity, reliability and availability to stakeholders. This involves instituting controls over acquiring, accessing, processing, storing, purging and manipulating data in accordance with the internal control framework and the data management structure.

According to *Earth Science Academic Archive - The principles of good data management*<sup>9</sup>, the fundamental step for any organization wishing to implement good data management procedures is to define a data policy and to develop guiding framework for data management operations.

Also, the *TPDC Scheme of Service, 2013* requires the chief exploration geologist to prepare all geological programs and in collaboration with the chief geophysicist in the preparation of geophysics programs, as well as planning and maintenance of petroleum exploration data bank. Moreover, the Public Service Act of 2002 requires all government institutions to formulate scheme of services so as to reflect its operations and activities.

Furthermore, a review of *TPDC's strategic plan 2005 - 2015* reveals that, the Upstream Directorate is required to monitor the actual

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<sup>9</sup><https://www.bgs.ac.uk/downloads/start.cfm?id=890>

expenditure on various activities against budget, and timelines of implementation of activities and delivery of outputs scheduled in work-plans. The Monitoring activity is the basis for generating periodic reports for review within the year at TPDC meetings.

On the other hand *MEM's Strategic Plan for the period 2011/12 - 2015/16* obliges the ministry to conduct periodic monitoring on TPDC's performance relative to strategic objectives and key performance indicators. Also, *Petroleum Exploration and Production Act of 1980* requires TPDC to provide to the Ministry of Energy and Minerals a list of maps, reports and other geological and geophysical data prepared in respect of period concerned. Furthermore, *TPDC's Strategic Plan for the period 2007 - 2017* requires TPDC to undertake assessment of existing capacity, determine skills gaps and locate training to address them.

#### *TPDC's mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical and geological data*

TPDC is required to establish mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical and geological data for oil and natural gas. This is according to *TPDC's Guidelines for working in Data Bank, 2005*.

The *National Petroleum Policy of 2015* requires that all petroleum and other related data and information are appropriately and systematically collected, assembled, sorted, processed, harmonized, stored and made available to the government and stakeholders. Also, the *Petroleum (Exploration and Production) Act of 1980* requires TPDC as a license-holder to keep accurate geophysical and geological records and interpretation relating to the area that has been licensed.

Furthermore, according to *Guidelines for working in Data Bank of August, 2005*, TPDC has to ensure that data management systems are designed to collect and protect data, and ensure their integrity and that those data systems meet user's needs.



### *Effectiveness of MEM in overseeing TPDC activities in ensuring effective management and ownership of geophysical and geological data*

*The Petroleum (Exploration and Production) Act of 1980*, requires MEM to establish the level of confidence that the integrity, reliability and timeliness of the TPDC's data management provides to support MEM's decisions making, controlling operations, and fulfilling their stewardship obligations. Also, MEM should periodically monitor and evaluate the performance of TPDC's activities and when appropriate, take necessary action to rectify identified challenges and shortcomings.

The *MEM's Strategic Plan for the period 2011/12-2015/16* outlines the need to put in place a comprehensive policy, legal and regulatory frameworks for guiding the emerging development of the oil and natural gas industry to ensure optimal benefits to the Nation and all Tanzanians at large.

Also, according to *Section 91.1 of the Petroleum (Exploration and Production) Act, 1980* requires the Minister to make regulations prescribing all matters that are required or permitted to be prescribed including in particular provisions for or with respect to (91.1 a) the exploration for petroleum and the carrying on of operations, and the execution of works.

Similarly, *MEM's Strategic Plan for the period 2011/12-2015/16* spells-out one of MEM's strategic focus areas as to "improve human resources and financial management" and MEM intends to put resources for capacity building, particularly in the oil and natural gas sub-sector.

#### **1.3.5 Audit methodology**

The audit was mainly conducted in Dar es Salaam where the main audited entities (MEM and TPDC) are located and where most of the information was obtained. Similarly, the audit team visited Mtwara, Lindi and Morogoro regions (where data operators are located) to collect data regarding geophysical and geological data acquisition. Mtwara and Lindi regions were chosen to represent the off-shore exploration activities while Morogoro region was representing the on-

shore exploration activities. Purposive sampling method<sup>10</sup> was applied to select a region from each category.

Interviews, document reviews and observations were used as main techniques of data collection from the Ministry of Energy and Minerals, Tanzania Petroleum Development Corporations, three selected regions and relevant stakeholders such as Tanzania Extractive Industry Transparency, University of Dar es Salaam, Economic and Social Research Foundation and activists.

### *Interviews*

A total of thirty seven (37) interviews were held with officials, junior staff, senior staff and the management, who are responsible for geophysical and geological data management from MEM and TPDC. This categorization was aimed at obtaining facts about the practice of managing geophysical and geological data at MEM and TPDC. Information from these three categories of interviewees were linked, correlated and compared to find out the actual picture on the issues regarding geophysical and geological data management in the country.

Fifteen (15) TPDC and six (6) MEM officials including key informants were interviewed. Data operators were also interviewed as they are the key actors in the geophysical and geological data management.

Interviews were conducted mainly to confirm and obtain further clarifications of the documents reviewed as well as to obtain clues of the relevant information where information that was supposed to be provided in the formal documents was lacking or missing. Interviews were also used to provide context and additional perspectives on the information obtained from the documents reviewed.

### *Documentary reviews*

The review of documents was done in order to get a comprehensive, relevant and reliable picture of the performance of MEM and TPDC in relation to the Management of Geophysical and geological Data.

The documents were reviewed to obtain the information on the effectiveness of TPDC's controls over acquisition, processing,

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<sup>10</sup> A non-probability sampling method, where units investigated are based on the judgment of the auditor

interpretation, storage, accessibility and ownership of geophysical and geological data, adequacy of TPDC's mechanisms for assessing completeness and accuracy of reported raw and processed geophysical and geological data and adequacy of MEM's capacity in overseeing TPDC's activities regarding its management and ownership of geophysical and geological data.

Furthermore, documents were also reviewed to confirm some responses from interviews.

Documents reviewed with their specific purposes in line with the audit process are shown in Appendix four.

### *Observations*

The Audit team also made some site visits. Two data storage facilities of TPDC namely, the one located at TPDC Headquarters and at its other premises located at Upanga Plots No. 37 and 38 were visited. The reason for visiting these two data storage facilities was to observe the actual storage environments. Observations were done to corroborate information from the documents reviewed and the interviews conducted with TPDC and MEM's officials.

Furthermore, Data operation centers at Mtwara, Lindi and Morogoro were visited by the audit team with the intention of observing and getting more insights on the practices of off-shore and on-shore geophysical and geological data acquisition.

More details on the methods for data collection are provided for in Appendix Four.

#### **1.3.6 Data Validation Process**

The Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC) were given an opportunity to go through the draft report and comment on the information being presented. They confirmed on the details of the information being presented in the audit report presented.

Furthermore, the information was cross-checked and discussed with experts in the field of Geophysical Data Management to ensure validation of the information obtained and presented.

### 1.3.7 Standards Used for the Audit

The audit was done in accordance with the International Standards for Supreme Audit Institutions (ISSAIs) issued by the International Organization of Supreme Audit Institutions (INTOSAI).

These standards require that the audit is planned and performed in order to obtain sufficient and appropriate evidence to provide a reasonable basis for the findings and conclusions based on the audit objectives.

### 1.3.8 Structure of the Report

The report covers the following:

*Chapter One* provides the background of the audit, audit objective, audit questions, scope, assessment criteria and methodology of the audit.

*Chapter Two* provides details of the system for Managing of Geophysical and Geological Data for Oil and Natural Gas in Tanzania.

*Chapter Three* presents the audit findings on the effectiveness of TPDC's mechanisms over acquisition, processing, interpretation, storage, accessibility and ownership of geophysical and geological data for oil and natural gas in Tanzania; adequacy of TPDC's mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical and geological data for oil and natural gas; and effectiveness of MEM in overseeing TPDC activities in the management and ownership of geophysical and geological data for oil and natural gas.

*Chapter Four* provides audit conclusions and *Chapter Five* outlines audit recommendations for implementation in order to improve the current situation.

## CHAPTER TWO

### GEOPHYSICAL AND GEOLOGICAL DATA MANAGEMENT SYSTEM IN TANZANIA

#### 2.1 Introduction

This chapter provides an explanation of the system for Geophysical and Geological Data Management system in Tanzania. The specific issues covered include: governing policies and legislations, roles and responsibilities of main actors, steps and procedures, staffing level and source of funds for Geophysical and Geological Data Management.

#### 2.2 Governing Policies and Legislations in Geophysical and Geological Data Management

The system for Geophysical and Geological Data Management in the country is defined in various policies and legislations. These are detailed below:

##### 2.2.1 Policies

*The National Natural Gas Policy (2013)* stipulates that Natural gas is a national resource and must be managed in a way that benefits the entire Tanzanian Society for present and future generation.

*The National Petroleum Policy of Tanzania (2015)* sets the operational and managerial principles on the upstream<sup>11</sup>. It also identifies ownership, storage and dissemination of petroleum data and other related data and information as issues in the information and data management in the Petroleum sub-sector.

The objective of the policy is “to ensure that all petroleum and other related data and information are appropriately and systematically collected, assembled, sorted, processed, harmonized, stored and made available to the government as well as industry stakeholders”.

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<sup>11</sup>Activities related to exploration, appraisal, development and production stages of oil and gas

## 2.2.2 Legislations

The Management of Oil and Natural Gas in the country is legislated in four main laws and their regulations, namely: Petroleum (Exploration and Production) Act No. 27 of 1980, Petroleum Act, 2015, Oil and Gas Revenues Management Act, 2015 and Tanzania Extractive Industries (Transparency and Accountability) Act, 2015.

The Petroleum (Exploration and Production) Act No. 27 of 1980, provides the mandate to Tanzania Petroleum Development Corporation (TPDC), as the Petroleum Regulatory Authority<sup>12</sup>, to own, store and manage all Geophysical and Geological Data for the Government of Tanzania. The same is emphasized in the Petroleum Act, 2015.

## 2.3 Roles and Responsibilities of Main Actors on Geophysical and Geological Data Management

The Management of Geophysical and Geological Data operations and processes involve a number of key actors. Three main actors who are directly involved in ensuring that there is quality control and adequate monitoring of geophysical and geological data in the country includes: the Ministry of Energy and Minerals (MEM), Tanzania Petroleum Development Corporation (TPDC), and International Oil Companies (IOCs).

### 2.3.1 Ministry of Energy and Minerals

The Ministry of Energy and Minerals is responsible for policy making for all matters related to energy, minerals and petroleum. The Ministry is also responsible for overseeing the operations of TPDC.

According to the Petroleum (Exploration and Production) Act of 1980, the Ministry has the following specific roles in respect of the Management of Geophysical and Geological Data:

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<sup>12</sup>The new Petroleum Act, 2015, has mandated the Petroleum Upstream Regulatory Authority (PURA) to own, store and manage all data for the Government. Hence, once PURA is operational then this task will be performed by PURA and TPDC will remain as the National Oil Company. The main task of TPDC will be to conduct exploration and development of oil and gas projects.

- a) sets laws, policies and principles on the management of geophysical and geological data;
- b) sets the principles, practice and quality control and assurance on the acquisition, processing, interpretation, evaluation and storage of geophysical and geological data;
- c) oversees the management of geophysical and geological data; and
- d) monitors the operations of data acquisition, storage and ownership.

### 2.3.2 Tanzania Petroleum Development Corporation

The Tanzania Petroleum Development Corporation is a Government owned corporation through which the MEM implements its petroleum exploration and development policies. It was established under the Public Corporations Act No.17 through the Government Notice No.140 of 30<sup>th</sup> May, 1969 and it became operational in 1973.

According to the Petroleum (Exploration and Production) Act of 1980, TPDC, is the custodian of all data and information in respect of oil and gas in the country. TPDC has the following specific roles in respect to the Management of Geophysical and Geological Data:

- a) acquire, process, interpret, evaluate and store geophysical and geological data;
- b) promote geophysical and geological data; and
- c) sell geophysical and geological data.

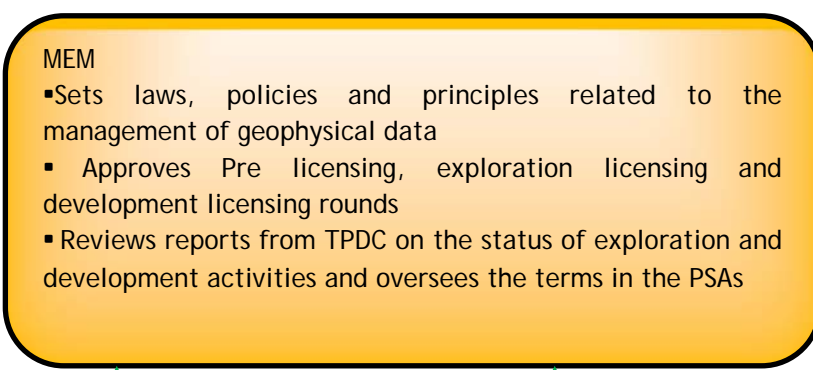
### 2.3.3 International Oil Companies (IOCs)

International Oil Companies (IOCs) are the ones who are contracted by Tanzania Petroleum Development Corporation giving them the authority to: acquire, process, interpret, evaluate and store geophysical and geological data.

The IOCs are in practice holders of exploration and development licenses using the Petroleum Act, 1980 and PSA. The Act permits the Government to enter into a petroleum agreement under which an oil company may be granted exclusive rights to explore for and produce geophysical and geological data.

Figure 2.1 summarizes the system of the Management of geophysical and geological data. It indicates the roles, relationships and coordination of the management of geophysical and geological data in the country.



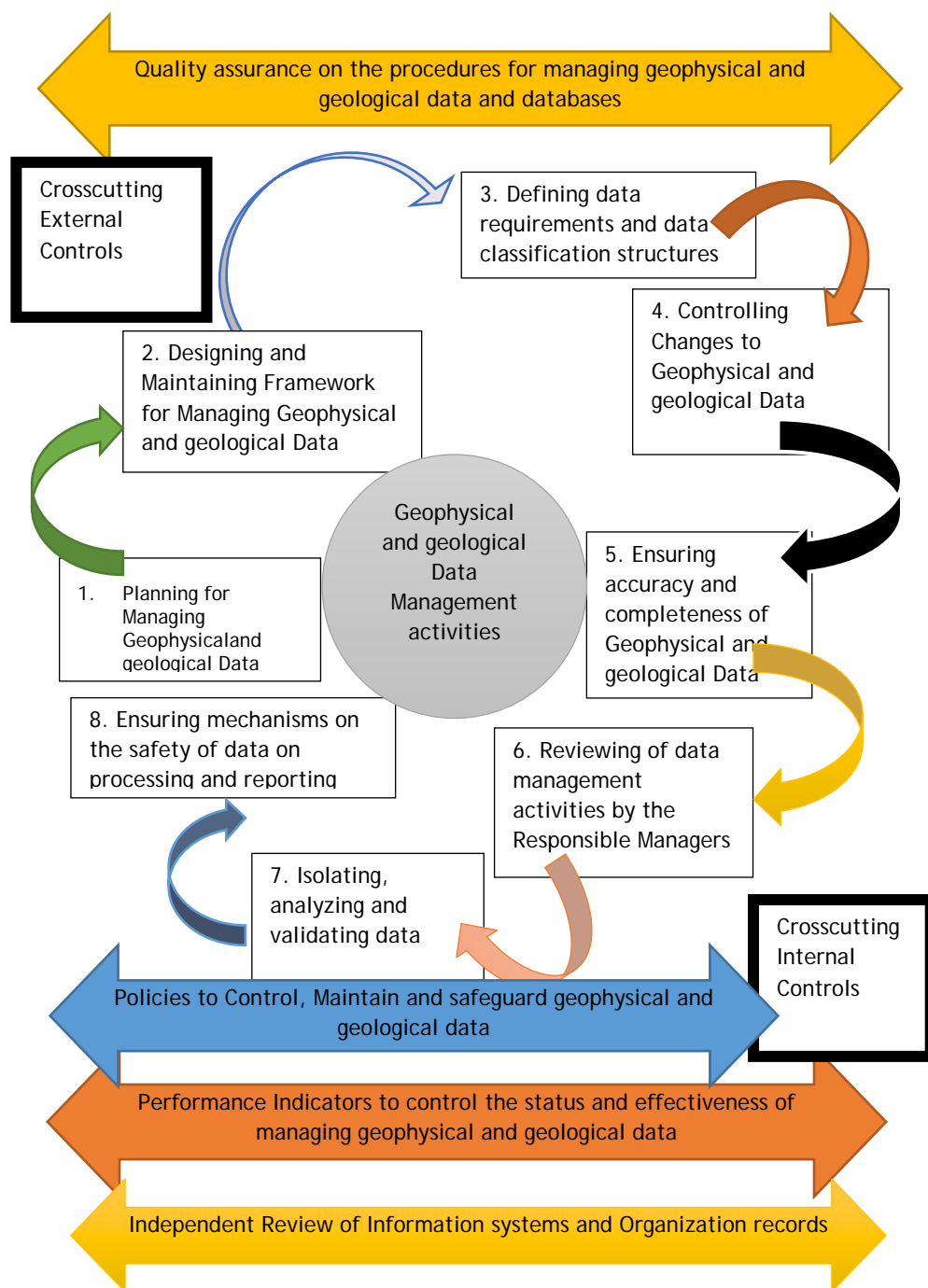


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## 2.4 Steps and Procedures in Geophysical and Geological Data Management

The Geophysical and Geological Data Management involves a number of activities which are categorized into planning, implementation, reporting, quality control, assurance and evaluation activities. Figure 2.2 summarizes the activities involved in the process of managing Geophysical and Geological Data in Tanzania.

**Figure 2.2: Activities involved in Geophysical and Geological Data Management in Tanzania**



The details of each of the activities are provided below:

### *Planning for Managing Geophysical and Geological Data*

This activity is performed by both the Tanzania Petroleum Development Corporation and the IOCs. It is based on the Model Production Sharing Agreement (MPSA). An MPSA is approved by the Annual Committee Meeting (ACM). The Ministry of Energy and Minerals is invited as an observer. The meeting approves a work-plan which involves: activities to be performed, schedule and the budget for exploration activities. Furthermore, TPDC has an internal plan which was prepared in accordance to the Tanzania Development Corporation Strategic Plan 2007 - 2017. The TPDC's internal plans are delivered from TPDC's Strategic Plan and are produced annually.

### *Designing and Maintaining Framework for Managing Geophysical and Geological Data*

TPDC is required to design and maintain framework for managing Geophysical and Geological Data. This is as stipulated in the Petroleum (Exploration and Production) Act, 1980 and the PSA which requires that the way geophysical and geological data are going to be acquired, processed, interpreted, evaluated and stored to be designed. Similarly, maintenance of data through reviews, Isolating, analyzing and mechanisms on the safety of data on processing and reporting is defined.

### *Defining data requirements and data classification structures*

TPDC is required to define data requirements and classification structures. This includes the procedures on how to work with Geophysical and Geological data. TPDC uses a Sampling Guideline, 2013 which actually addresses the procedures for handling customers who apply for geological samples. Seismic data requirements and structures are stipulated in the Guideline on Working in Data Bank, 2005.

### *Controlling Changes in ensuring accuracy and completeness of geophysical and geological data*

TPDC is required to have a control over changes to geophysical and geological data. This includes control from the acquisition to storage. The TPDC's Guideline on Working in Data Bank, 2005 give guidance on all the procedures. It includes: guidelines for receiving seismic tapes from field; guidelines for copying and transmitting seismic data tapes to IOCs; checking for tape integrity; guidelines on how to make tape labels; and maintaining tapes database. The Petroleum (Exploration and Production) Act, 1980, requires TPDC as a custodian of data and information to ensure its accuracy and completeness.

### *Reviewing of data management activities by the Responsible Managers*

According to TPDC Strategic Plan (2007 - 2017), at Directorate level, it is required to monitor actual expenditure on various initiatives (including data management) against budget, and timeliness of implementation of planned activities and delivery of outputs scheduled in work plans. This monitoring activity will provide a basis for generating periodic reports for review every year at TPDC meetings, and consumption by the TPDC Board.

### *Isolating, Analyzing and validating data*

TPDC is required to properly isolate, analyze and validate data inputs. This is according to the Petroleum (Exploration and Production) Act, 1980.

### *Ensuring mechanisms on the safety of data on processing and reporting*

TPDC is required to ensure mechanisms on the safety of data through instituting controls over data input and manipulation. The mechanisms are set through the TPDC's Guideline on Working in Data Bank, 2005

### *Policies to Control, Maintain and safeguard geophysical and geological data*

The National Petroleum Policy, 2015, is set to control, maintain and safeguard geophysical and geological data. Policies are set by the Ministry of Energy and Minerals.

*Performance Indicators to control the status and effectiveness of managing geophysical and geological data*

TPDC is required to furnish on weekly basis reports to MEM as performance indicators on the status and effectiveness of managing geophysical and geological data. The report must include information on the kind of operation done by IOC, its cost and the future plans. These reports are furnished in accordance with the PSA and the TPDC's strategic Plan for the period 2007 - 2017 gives guidelines.

*Independent Review of Information systems and Organization records*

According to TPDC's Strategic Plan for the period 2007 - 2017, MEM is required to monitor TPDC's performance relative to the strategic objectives and key performance indicators. According to TPDC strategic plan, TPDC requires a robust performance management system on management of geophysical and geological data to:

- Operationalize its strategy;
- Communicate to all within the organization that performance matters;
- Measure its performance against targets;
- Devise initiatives for addressing performance shortfalls; and
- Devise appropriate reward and recognition systems in order to motivate people to meet targets.

*Quality assurance on the procedures for managing geophysical and geological data and databases*

The Petroleum (Exploration and Production) Act, 1980, requires TPDC to acquire, process and store geophysical and geological data. This includes putting in place a Quality Assurance process and procedures for managing geophysical and geological data and the databases.

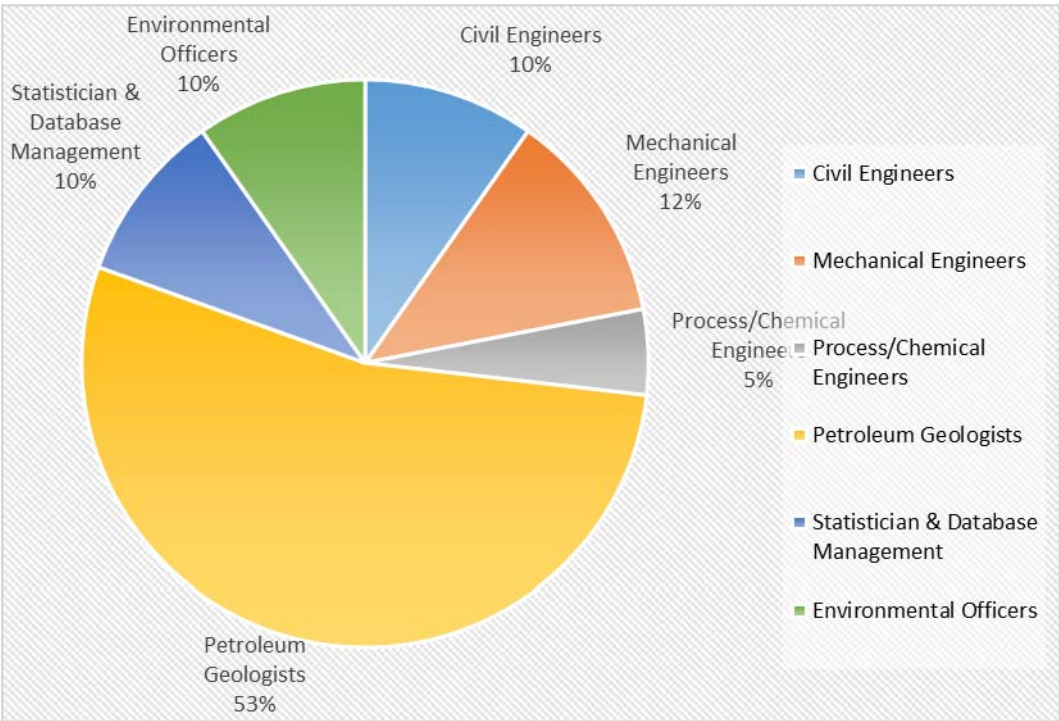
2.5 Staffing Level and Source of funds for Geophysicaland Geological Data Management

This section covers staffing level and source of funds for geophysical data management in the Ministry of Energy and Minerals

Ministry of Energy and Minerals

The Ministry of Energy and Minerals has a number of personnel to carry out its roles of Monitoring the Management of Geophysicaland Geological Data. Figure 2.3 shows the technical staffing level at MEM engaged in overseeing the management of geophysicaland geological data.

Figure 2.3: Staffing Level at the Ministry of Energy and Minerals



Source: Human Capital Development Program in the Oil and Natural Gas Sub - Sector (MEM) 2012

### *Tanzania Petroleum Development Corporation*

The management of geophysical and geological data includes the acquisition, processing, interpretation, evaluation and storage. Table 2.1 presents the technical staffing level at TPDC engaged in the managerial and operations of the management of geophysical and geological data.

**Table 2.1: Staffing Level at TPDC responsible for data management**

Financial Year	Professional	No. of Available Staff
2009/10	Geophysicists	2
2010/11	Geophysicists	2
2011/12	Geophysicists	2
2012/13	Geophysicists	2
2013/14	Geophysicists	4
2014/15	Geophysicists	10

*Source: TPDC's Staff Database (2009/10 - 2014/15)*

Table 2.1 shows that the number of geophysicists has been low for the past five years but has increased significantly in the year 2014/15. This was due to the increase in activities in the Petroleum Explorations industry which necessitated changes in the TPDC's data management personnel.

#### **2.5.1 Source of Funds for Geophysical and Geological Data Management**

##### *Ministry of Energy and Minerals*

The Ministry of Energy and Minerals receives its funds from the Government budget as appropriated by the Parliament annually. Table 2.2 shows the amount of funds received by the Ministry for activities related to Management of Geophysical and Geological Data for the last four years.

**Table 2.2: MEM Budget allocated for Management of Geophysical and Geological Data**

Financial Year	Budget (Mill. TZS)
2011/12	527
2012/13	580
2013/14	354
2014/15	658

*Source: Data extracted from MEM's MTEF (2011/12 - 2014/15)*



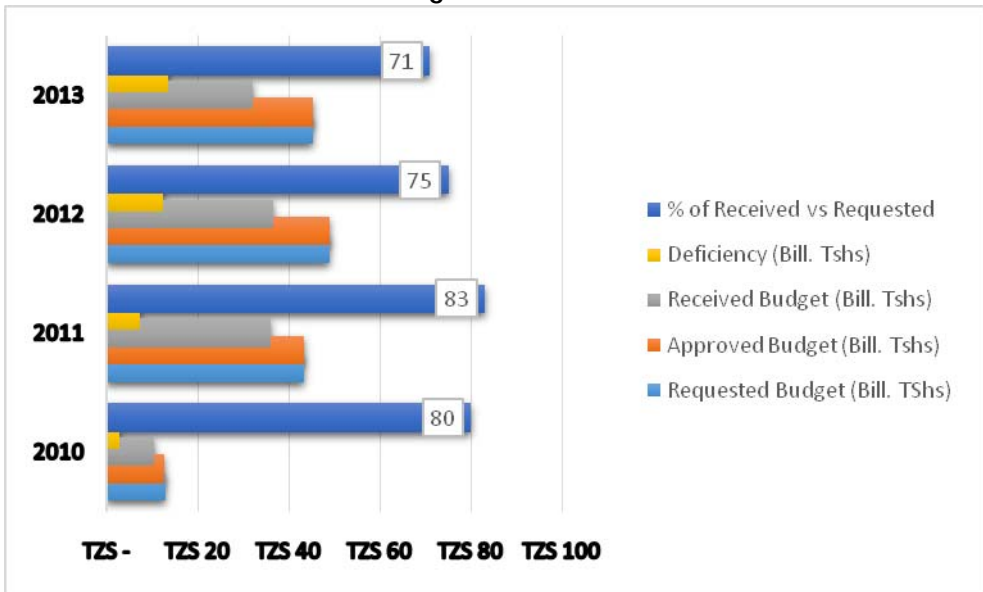
According to Table 2.2, the financial resources allocation is fluctuating and this is due to varying of activities related to geophysicaland geological Data Management.

### Tanzania Petroleum Development Corporation

The main sources of funds for the Tanzania Petroleum Development Corporation are Government Budget and the sale of Geophysicaland Geological Data.

TPDC annually allocate budget for the activities regarding Management of Geophysicaland Geological Data. Figure 2.3 provides the details of the budget requested, approved and received at TPDC for the management of geophysicaland geological data.

Figure 2.4: TPDC Budget allocated for Geophysical and Geological Data Management’s activities



Source: Extract from TPDC’s Financial Records (2011/12 -2014/15)

Considering the information presented in Figure 2.3, TPDC received more than 70 per cent of the requested budget from the Government.

## CHAPTER THREE

### AUDIT FINDINGS

#### 3.1 Introduction

This chapter presents findings of the audit that provide answers to three audit questions described in chapter one of this report. The questions cover the following main areas:

- effectiveness of TPDC's controls over acquisition, processing, interpretation, storage, accessibility and ownership of geophysical and geological data for oil and natural gas in the country;
- adequacy of TPDC's mechanisms for assessing completeness and accuracy of reported raw and processed geophysical and geological data for oil and natural gas; and
- adequacy of MEM's in overseeing TPDC activities regarding its management and ownership of geophysical and geological data for oil and natural gas.

#### 3.2 Present Controls over Geophysical and Geological Data Management

This section discloses findings related to the first audit-question "*Are TPDC's controls over acquisition, interpretation, processing, storage, accessibility and ownership of geophysical and geological data for oil and natural gas in Tanzania effective?*"

The issues addressed include: planning for Managing Geophysical and Geological Data for Oil and Natural Gas; Data requirement and its structure for classification; framework for designing and maintaining Geophysical and Geological Data; assigned responsibilities, accountability and authority for performing geophysical and geological data management activities; established and working controls over changes to geophysical and geological data; reviewing controls over the processing and maintenance of geophysical and geological data; quality assurance mechanisms on procedures for managing geophysical and

geological data; training to data management personnel; and mechanisms for assessing completeness and accuracy of geophysical and geological data

The following are the main findings regarding the assessment made on the above mentioned audit question:

### **3.2.1 Planning for Managing Geophysical and Geological Data for Oil and Natural Gas**

Findings indicated that TPDC has not prepared plans specifically for the management of geophysical and geological data for oil and natural gas. The only plans available are 10 years Strategic Plan and the Annual Operational Plan for the Upstream Directorate. However, it was found that the annual plan does not say much about Geophysical and Geological Data Management.

However the reviewed TPDC's annual plans for 2012/13 and 2013/14 was found to have limitations as they did not provide information on managerial aspects details regarding seismic data with respect to its processing, storage and interpretation. Moreover the team found out that the same plans have no information regarding geological samples.

On the other hand, there were no defined procedures for developing plans for the implementation of various activities regarding geophysical and geological data management. The defined procedures were expected to provide detailed guidance on how, what and when various planning activities in this arena can be done.

The interviews held with Geophysicists at TPDC working in Data Management Unit indicated that there are two main reasons for non-preparations of plans for the management of geophysical and geological data within TPDC.

*First*, there is no formal guideline for developing that sort of plans despite of the fact that Geophysicists acknowledged the importance of having those plans. *Second*, geophysical and geological data personnel are not much aware of the need to prepare plans specifically geared to implement all activities related to the management of geophysical and geological data. This is due to the fact that this

requirement has not been communicated among staff working with data management activities in TPDC.

From the reviewed TPDC's Data Unit Plan issued on December 2014 and SAFARI report of 5th Regional Petroleum Data Management Seminar conducted at Arusha, in September 2011; as part of DMU's medium term goals there was a plan to establish data guidelines which would govern flow of data from acquisition, transfer, storage, retrieve and use and data quality such as completeness, uniqueness, consistency and validity.

Furthermore, lack of plans necessary for implementing geophysicaland geological data management activities was more likely influenced by the absence of a well-defined framework<sup>13</sup> for Managing Geophysicaland Geological Data that would be adopted from the strategic plan.

Interviews held with Geophysicaland Geological Data experts pointed out lack of existence of a well-defined framework for operationalizing various activities within TPDC. The situation has rendered geophysicaland geological data management activities to be given little attention and resulted into lack of a well-defined protocol for activities to be carried out by the personnel attached to data acquisition during operation when on-site.

The lack of plans for implementing geophysicaland geological data management activities has three adverse effects. These were noted through the interviews held with TPDC's officials.

*First*, TPDC was not in a good position to document and address various challenges, activities, processes and needs connected to geophysicaland geological data management. Auditors noted that it is hard for TPDC to incorporate challenges encountered in the previous year to the current year since no plans are developed and hence they disregard those challenges. Moreover, lack of plans might deny them an opportunity to learn more and improve their practices.

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<sup>13</sup>Framework in this audit entails the entire integral component of data management process activities. This include issues of planning of activities, development, Implementation, monitoring and following up. Planning which entails the pre definition of the activities, challenges and risks of implementation and the means of mitigation of the risks is a key component of a framework.

*Second*, since planning is not given due attention as it was supposed to be, this might affect the prioritization of some activities. It was noted during the inspection made to the TPDC's storage rooms that physical storage of geological samples was not adhered to. Finding from the interview indicated that TPDC staff responsible for geological samples, are not aware of the storage requirements in terms of humidity, temperate and the general environment for storing those data.

It was observed further that geological samples might lose their geo-scientific properties necessary for laboratory checking if not properly handled by a scheduled and qualified personnel. These samples require periodical checks in terms of their physical conditions while stored in.

*Third*, the audit team noted that there is a possibility for having unrealistic results due to geological data which changed their geo-scientific properties as a result of unfavorable storage conditions.

### **3.2.2 Data requirement and its structure for Classification**

The audit team visited two sites that TPDC use for storage of geological sample and noted poor arrangement of the geological sample that were mixed in one storage facility. There were also difficulties in accessing the geological samples once needed due to inappropriate coding used to label different samples.



Photo 3.1: Cuttings are stored in used boxes, "Sandarusi" and plastic buckets seated on the ground as observed from Benjamin William Mkapa Basement floor - Photo taken on 2/11/2015



Photo 3.2: Geological sample arrangement at Geological Survey of the Netherlands

It was noted that for all types of geological sample there is inadequate documentation mechanism. Through observation and further analysis the audit team found that despite having the electronic version for the geological samples, the excel database that is being used is not comprehensive enough as there is no control used for data entry verification such as checking for errors and data completeness. The effects that would be considered related to this is that of not having updated information regarding number and types of geological sample present in storage facilities.



Photo 3.3: Geological samples with faint labels as observed from Benjamin William Mkapa Basement floor - 2/11/2015



Photo 3.4: Protected Coding and labelling standards for geological samples at Geological Survey of the Netherlands

The audit further noted that the possible effects that would emerge from mixing and poor labeling of geological sample as it might take long to identify a particular geological sample with pre identified specifications and possibly that of giving incorrect geological samples for clients.

### 3.2.3 Framework for designing and maintaining Geophysical and Geological Data

*Findings show that TPDC does not have a framework that reflects geophysical and geological data management requirements.*

There is no established data management policy within TPDC which is necessary for managing Geophysical and Geological Data. This is the requirement of the Petroleum (Exploration and Production) Act, 1980 which calls for having data management framework.

Furthermore, during the visit to the storage facilities, the auditors noted the existence of unfavorable storage facilities for geological sample. The analysis of the reasons for those unfavorable storage facilities was due to absence of Data Management Policy at department level that would provide guidance on the maintenance of geophysical and geological data. Furthermore, the audit team noted that TPDC management is aware of the prevailing storage conditions for geological samples and its requirements though these seem to be given low attention.

Reviewed TPDC data unit plan December 2014; revealed that TPDC is aware of the present storage condition as noted from the plan that "cores are stored in different areas including Mlalakuwa warehouse, Mikocheni warehouse, Upanga Ex-head office and BWM pension Tower basement. These areas are not well protected, furnished and the temperature is not well maintained and some areas are dirty e.g. BWM basement. If these data are left for a long time we will lose them".





Photo 3.5: Fire Extinguisher not working as observed at Upanga Data storage facilities -  
Photo taken on 9/11/2015

The review of TPDC organization structure and job-description showed that TPDC does not have a working data management unit. All data management activities including geophysical and geological data management are performed by personnel from different units within TPDC. Interviewed officials from both TPDC and MEM indicated that this is a bottleneck since it hampers continuity of their work and also it affects the quality of what they are doing.

Overall the ultimate effect that would be derived from not having the working framework on management of geophysical and geological data conceived to be that of varying multi-practices which in turn might result into having unrealistic or miss-leading results on geophysical and geological data management activities.

#### **3.2.4 Assigned responsibilities, accountability and authority for performing geophysical and geological data management activities**

##### ***Assigned Responsibility***



This section presents findings on assigned responsibilities, accountability and authority for performing geophysical and geological data management activities.

Findings indicate that TPDC has shown to have no proper assignment of responsibility as there is no clear demarcation for the roles and responsibilities between data managers and IT personnel. During the interviews held with IT personnel, it was noted that some of the activities such as advising on giving specifications for procurement of data management software contrary to the requirement of TPDC's ICT Policy (TPDC Information and Communication Technology, Undated) which requires that all software installed on PCs must be purchased centrally with involvement of ICT Unit whilst complying fully with the Public Procurement Act. It was further noted that management of software licenses, software maintenance, and administration of access to server system that were initially designed to be performed by IT experts were done by geoscientists.

The audit noted that this was mainly contributed by the fact that data management roles for personnel dealing with data management issues were not specifically identified as learnt from the reviewed TPDC's Scheme of Service of 2013.

Furthermore, this was also noted to be the result of the absence of policy at departmental level that would provide guidance for the establishment of data management unit and the specific roles there in to be performed by each of the staff.

### ***Authority for performing geophysical and geological data management activities***

Referring to the absence of specific staff who would have been available to work with data issues, the audit noticed that for the available procedures undertaken by staff dealing with data management issues though not relevant personnel, TPDC are at the higher risk for the entire undertakings of geophysical data management activities as the authority for performing the tasks that are not clearly understood among staffs especially those residing from the Upstream Department.

Despite having a new revised Scheme of Service<sup>14</sup> that has been taken into account the necessity of having specific personnel dealing with data management issues, the audit team reviewed that the current practice is associated with lack of control and failure to hold into account for personnel dealing with activities related to management of data.

### ***Accountability for performing geophysical and geological data management***

Through review of the TPDC's Scheme of Service of 2013, the audit found-out that the roles and responsibilities identified therein relied heavily on higher level cadre of staff for each Directorate and none were specified or identified for cadres under the Directorate when referring to upstream department. The audit came to note that the personnel whom are to be accounted for the outlined responsibilities are the ones at the higher ranks who have supervisory role for their sub-ordinates.

It has been explained as the common norms for higher ranking officials to delegate some of their authorities to other subordinates. Delegating authority helps to monitor and hold accountable any personnel engaged in the course of conduct as planned.

Further, despite the fact that TPDC has data that is not managed by the appropriate personnel, the audit through the interviews held with data management personnel noted that even for those personnel assigned the tasks undertaken are not clear such as to whom they should be accountable for his/her conducts.

#### **3.2.5 Established and working controls over changes to geophysical and geological data**

The audit found-out the inadequate working control over changes of geophysical and geological data. This was noted during the interview held with senior staff from TPDC working with data management as the currently mentioned roles do not align with what

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<sup>14</sup> TPDC Scheme of service 2014/15

is stipulated in presentscheme of service.The scheme requires the data personnel to work on Data Management activitieswhichare to:

- receive, validate and catalogues petroleum and production data;
- define, documents, loads, manages and archives data inventory;
- record the exploration and production data;
- scan, copy and store original data in electronic format; and
- verify exploration and production data.

This is perceived to have resulted from TPDC not having established adequate control which might also have been contributed by having improper data personnel in place.

The risk associated with the current undertaking on data management regarding its control is the possible occurrence of alterations/changes of data that might have resulted from performing the mentioned activities differently compared to what it should be.

### **3.2.6 Reviewing controls over the processing and maintenance of geophysicaland geologicaldata**

It was noted that during interviews held with TPDC's officials, activities conducted by TPDC to ensure that control over the processing and maintenance of geophysicaland geological data were not adequately reviewed. Despite having requested a separate five year annual review plans, the audit team was provided with one year annual plans for the financial year 2012/13 review which covers details on seismic acquisition with no information regarding geological samples.

The main reason given for inadequate reviews of various activities is the lack of departmental guidelines that would have been used to guide reviewers within TPDC on issues to be reviewed, methods to be followed and how they can report the results of those reviews.

The audit team further noted that the review task is one of the main activities supposed to be performed by senior officials within TPDC and has been indicated in their job descriptions.

The analysis made by auditors on the data management activities performed within TPDC noted that the failure to conduct periodical and independent reviews might have two main effects:

*First*, it denied TPDC opportunity to identify and document available strengths and weaknesses appearing therein in the Geophysical and Geological Data Management process. Hence, the audit team noted that there is no any action taken to address observed weaknesses as well as safeguarding the achievements made.

*Second*, the TPDC management is not in full control in terms of quality, accuracy and quantity of geophysical and geological data managed by TPDC. This was noted during the interviews held with TPDC's officials that it poses the risk for the TPDC to deliver geophysical and geological data that do not reflect the real scientific value for the procedures undergone.

### **3.2.7 Quality Assurance mechanisms on procedures for managing geophysical and geological data**

TPDC is charged with the functions of acquisition, processing, interpretation, storage and distribution of geophysical and geological data to stakeholders (MEM, The Petroleum (Exploration and Production) Act, 1980). Hence, TPDC is required to establish mechanisms of assurance and quality controls to ensure that quality and economic geophysical and geological data are maintained in the country.

The finding shows that TPDC has inadequate mechanism for providing MEM with assurance that the procedures for managing Geophysical and Geological Data and database have been followed and working.

Through the interviews held with officials from TPDC and reviews of weekly progress reports that TPDC send to MEM, it was noted that TPDC's mechanisms for providing assurance to MEM covers acquisition

and drilling but it does not cover other aspects of data management activities such as storage of data. Moreover, the audit team found-out that these assurance mechanisms were weak due to the absence of policy at departmental level (Upstream Directorate) that provides guidance on how activities are performed in the directorate.

Furthermore, it was also noted that TPDC use contractual documented guidelines like PSA as regards to reporting of acquisition, processing and interpretation to MEM. However interview with senior staff pointed out that TPDC do not report to MEM on the storage of geophysicaland geological data because they have not yet formulated a policy that would establish guidelines to rely on.

Inadequate mechanisms of reporting to MEM may result into receiving reports only on one part of the entire Geophysicaland Geological Data Management activities and might led MEM to providing the public and Government with misleading information.

### **3.2.8 Training to data management personnel**

Despite having formal schedule on training matters, the audit team noted that junior staff working inData Management Unit lackappropriate skillson running the available software namely, Petrel and SMT which is mandatory in the daily executions of their activities.

The interviews held with senior geophysicists from TPDC pointed-out that there is lack of in-service trainings or courses offered to personnel dealing with data management which could expose them to the new developments in their respective fields.

The lack of necessary software application skills may result into failure to efficiently and effectively operate the software which might lead to inadequate data management.

Further discussions with TPDC's officials pointed-out that there is misallocation of personnel on training. There were scenarios that were cited whereby the content of the identified in-service training or course meant for IT personnel but geophysicists tend to attend because of failure of ICT personnel(s) to align with data management activities and more likely that IT staff are not fully involved in Geophysicaland Geological Data management.

Apart from the fact that IT personnel have the role to play in the management of geophysical and geological database such as maintenance of server, granting access permission to users etc. they are also partially involved in the trainings directly linked to the management of geophysical and geological data.

### 3.2.9 Restricting access to unauthorized personnel

*Finding indicate inadequate system for restricting access to the geophysical and geological data to unauthorized personnel*

The system for restricting access to geophysical and geological data is not capable of restricting access to the geophysical and geological data to unauthorized personnel. TPDC has established a data security which is a server-based system and can only control the log-in during access.

It was further noted that the system is not efficient in alerting system administrators who has accessed the system and what has been altered. The reason given by the interviewed TPDC's officials who are responsible for geophysical and geological data management for having this simple and ineffective security system is that there was no large data volume enough to have the complex security system, but upon the review of the Data Unit Plan, December 2014, it was revealed that TPDC started to have a huge volume of Exploration and Production data since 2010. The team noted that this was due to low attention given on data issues.

There was also few data at TPDC which did not need a complex security system. Further analysis indicated that the loss of data, theft and unreliable data may be a result of not having a capable system to restrict access to unauthorized personnel. This was also noted through the interviews held with TPDC's personnel working in the Upstream Directorate.

### 3.3 Mechanisms for assessing completeness and accuracy of geophysical and geological data

In this section, we present findings related to audit - question two *“Are TPDC’s mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical and geological data for oil and natural gas in the country effective?”*

The issues addressed include: system for assessing the accuracy and completeness of data input; capability of isolating, analyzing and validating data; detecting and reporting data lost; and restricting access to unauthorized personnel.

The following are the main findings regarding the assessment made on the above mentioned audit question.

### **3.3.1 Systems for assessing seismic data input**

*TPDC’s personnel have limited skills on operating software for data input*

The interview with the Director of Upstream indicated that personnel at the directorate have limited skills to apply the Petrel and SMT software to solve different geophysical data management tasks. This brings out a question as to how TPDC ensures that the systems can accurately and completely handle the geophysical data.

The underlying cause of this situation is that, most of TPDC staff have low exposure to the software. The consequence is that, a chance of making errors is higher when the systems are operated with unskilled personnel.

### **3.3.2 System’s capability for isolating, analyzing and validating data**

TPDC has no effective mechanism in ensuring that data processing steps related to isolation, analyzing and validation of geophysical data are taken care of. This was noted during the interviews held with TPDC’s staff that TPDC use several data management software such as Petrel and SMT as per data manipulation’s requirements. The main reasons given for the lack of effective mechanism were: first, limited skills among TPDC’s staff responsible for geophysical data management. Hence, these staff are failing to effectively operate and

manage the mentioned software. Second, the software for data management were procured without needs and capability analysis which bring questions on the effectiveness on using the software.

Furthermore, the audit team decided to analyze the capability of the software acquired by TPDC for isolating, analyzing and validating geophysical data. During the analysis the audit team requested the needs analysis report which was prepared by TPDC before acquiring the software. The intention of developing needs analysis was for them to acquire the software that will be able to suffice their needs.

That report was not submitted to the auditors together with the requested specifications of the acquired software. Hence, the auditors were not able to comment on whether the said software is suitable or not.

It was also noted that one of the main reason for lacking effective mechanisms for data management is due to lack of data managers who among other activities have the role of performing various tasks such as receiving, validating and cataloguing data. They also define, document, load, manage and archive data inventory and scan, copy and store original data in electronic format relevant for guaranteeing effectiveness of data management mechanism in TPDC.

Failure to have appropriate data personnel in place and that of complying on specific data needs as regard to its manipulation would result into TPDC having data that would be miss interpreted and give miss leading results.

### **Detecting and reporting data lost**

Finding indicates that TPDC have inadequate system for detecting lost data. Through the interviews held with officials from TPDC it was noted that TPDC use server-based devices for data storage, though it was mentioned that personnel working with data management are aware of the need to have data management system with auto backup capability in case of any disasters that would be appropriate as compared to the current practice.



Despite having restricted mechanism for data access from the server, there are associated risks which could emerge as a result of lowering the level of data safety. These are activities such as copying and deleting original data when individual personnel access the data through server system.

### 3.4 Overseeing TPDC's activities by MEM

In this section, we present findings related to the audit-question three *"is MEM adequately overseeing TPDC to ensure effective management and ownership of geophysical and geological data for oil and natural gas in the country?"*

The issues addressed include: set policies for ensuring integrity of data; safeguarding sufficient resources for geophysical and geological data management; effectiveness of performance indicators in place; and reviewing of the activities, outputs and set controls of geophysical and geological data management.

The following are the main findings regarding the assessment made on the above mentioned audit question:

#### 3.4.1 Set policies for ensuring integrity of data

According to Section 91.1 of the Petroleum (Exploration and Production) Act, 1980 requires the Minister to make regulations prescribing all matters that are required or permitted to be prescribed including in particular provisions for or with respect to the exploration of petroleum and the carrying on of operations, and the execution of works.

The audit team found-out that, there is no internal policy which prescribes the management of geophysical and geological data including its integrity. This was noted during the interviews held with the senior staff from the Ministry of Energy and Minerals. The audit found lack of attention from officials on issues related to geophysical and geological data. Finding indicated that this factor lead to MEM's failure to have control over issues related to geophysical and geological data.

### 3.4.2 Resources for geophysical and geological data management

*Finding indicates that MEM does not adequately ensure that resources are provided for Geophysical and Geological Data management*

#### ***Inadequate Personnel***

The reviewed Marshal plan showed that MEM is operating with inadequate number of required personnel. This was caused by the rapidly growing Oil and Gas industry in Tanzania. Inadequate personnel at the Ministry level caused the Monitoring and Evaluation (M&E) function to be ineffective.

Furthermore, inadequate staff may have resulted in TPDC's ineffectively conducting its activities related to Geophysical and Geological Data management, which also might result into deviation from the intended objective(s).

*Finding shows further that absence of server system (to have a centralized server system for data backup in case of emergency)*

Interviews held with MEM's staff indicated that there is no centralized server system to back up the available information in case of emergency. The reason for not having a server at MEM is the matter of low level of awareness and not inadequate resources.

It was further found out that absence of server may lead to the loss of important data and information that would be necessary for reference purposes.

### 3.4.3 Effectiveness of Performance indicators in place

*Finding shows that MEM does not effectively use performance indicators to monitor status and effectiveness of Geophysical and Geological Data management activities*

The audit team found-out that the Ministry of Energy and Minerals does not provide feedback for received reports from TPDC. Furthermore, the audit team found-out that there are no reports that

have been received from TPDC. This indicates that performance reports are not reviewed and worked upon.

The reason for this practice is the absence of pre-defined procedures at the Ministry which could guide for what should be done with received reports from TPDC.

Monitoring of on-going explorations is weakened and this endangers the compliance of the PSA. The validity of the received reports is not confirmed as well.

It was also learnt that failure to monitor reported activities (especially acquisition daily costs) that may lead to unrealistic recoverable costs by the Government in case of any discovery and hence cause the country to lose revenue through overpayment.

#### 3.4.4 Reviewing of the activities, outputs and set controls of geophysical and geological data management

*Finding indicates inadequate Independent reviews for activities related to Geophysical and Geological Data Management*

The Ministry of Energy and Minerals, with other stakeholders and consultants, undertakes annual reviews on its activities. The reviews are called 'Joint Energy Sectors Reviews'. The audit team reviewed the available Joint Energy Sectors reports for the period from 2010 up to 2014.

The audit team found-out that critical reviews were on the Mid-stream and Down-stream of the oil and gas value chain. The upstream and specifically the Geophysical and Geological Data issues were not given due attention.

The given reason for not critically reviewing the activities related to geophysical and geological data management is low priority on the upstream activities compared to midstream and downstream activities. Furthermore, it was also established through the interviews held with TPDC and MEM's officials that failure to identify own strengths and weaknesses on the Management of Geophysical and Geological Data may lead to the failure to identify and focus on areas that need further improvements.

## CHAPTER FOUR

### CONCLUSION

#### 4.1 Introduction

The audit findings presented in chapter three give reasons to draw the following conclusions:

#### 4.2 Overall Conclusion

The overall conclusion of this audit work is that geophysical and geological data for oil and natural gas in Tanzania are ineffectively managed since there are ineffective controls and weak mechanisms for assessing the acquisition, processing, storage, accessibility and ownership of geophysical and geological data. Specific plans that govern geophysical and geological data management are not in place. Geophysical and Geological data are important because they are used to determine the availability and amount of oil and natural gas that can be accessed in the areas under exploration. Their key application is the prospecting of natural resources including Oil and Natural Gas under the ground.

Furthermore, Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporation (TPDC) have failed to prioritize data management activities due to the fact that responsibilities and authority for performing different activities pertaining to geophysical and geological data management are not specifically assigned.

### 4.3 Specific Conclusions

The following are specific conclusions based on audit objectives:

#### 4.3.1 TPDC's mechanisms over acquisition, processing, interpretation, storage, accessibility and establishing ownership of geophysical and geological data are ineffective

The audit concludes further that TPDC's mechanisms over acquisition, processing, interpretation, storage, accessibility and ownership of geophysical and geological data for oil and natural gas in Tanzania are ineffective. This is due to the fact that acquisition, processing, storage, accessibility and ownership of geophysical and geological data is insufficient because there are no plans for geophysical and geological data management, no documented guidelines as regard to reporting of processing, storage and interpretation of geophysical and geological data, poor arrangement of geological sample particularly in the TPDC's storage rooms and inadequate documentation of the data in their respective files.

Similarly, TPDC's mechanisms over management of geophysical and geological data failed to take advantage of independent quality control and assurance in identifying areas for further improvements in its data management. There is no any independent review for information systems and organization records conducted for the last five years. This may have resulted from the lack of awareness on the issues related to reviewing data management as described in job descriptions. This means that any risk factor or weaknesses that could have been detected and addressed by independent reviewers remained undetected and the only way of detecting them is through operational staff of TPDC. Furthermore, this has led into TPDC to inadequately provide MEM with assurance that the procedures for managing geophysical and geological data and databases have been followed and working

*TPDC failed to design and maintain a framework that reflects its geophysical and geological data requirements*

The audit concludes that TPDC has failed to design and maintain a framework that reflects its geophysical and geological data requirements and management. This is because there is no framework reflecting geophysical and geological data requirements, no established data policy governing flow of data, absence of working and effective data management unit, improper and inappropriate storage facilities for geological samples and lack of documented disaster management plans and backup system for geophysical and geological data management.

**4.3.2 TPDC's mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical and geological data is inadequate**

The mechanisms for assessing the completeness and accuracy of reported raw and processed geophysical data for oil and natural gas industry in Tanzania is inadequate. This is because the assessment of data completeness and accuracy is inadequate.

Inadequate assessment of data completeness and accuracy has been contributed by: *first*, the system for ensuring that data input is accurate, complete and that data are entered only once is not adequately defined. The system is not checking that and also, there is no independent individual personnel, who can do the verification. So, whenever data is entered there is no way of verifying it against the main parameters of accuracy, completeness and also an assurance that it was entered only once and there are no double entries.

Therefore, the system for ensuring accuracy and complete data input is not adequately defined. There is also lack of trained personnel to verify data entered into the system. This has resulted into difficulties in isolating, analyzing and validating data or incorrectly entered geophysical and geological data.

Lastly, another reason for the failure to guarantee completeness and accuracy of geophysical and geological data under the custodianship of

TPDC is that the system is not capable of restricting access to the geophysical and geological data to unauthorized personnel. Security features which are in place are not strong enough to deter unauthorized personnel to do any data manipulation. There is no check and balance mechanism that prevents personnel from manipulating data.

#### **4.3.3 MEM fails to adequately oversee TPDC's management and ownership of geophysical and geological data**

MEM fails to oversee TPDC's performance over management and ownership of geophysical and geological data for oil and natural gas. This is because MEM has failed to put in place policies that would ensure integrity of geophysical and geological data for proper management of oil and natural gas. Furthermore, those policies would ensure that geophysical and geological data are properly controlled, maintained and safeguarded.

Another reason for MEM's failure to oversee TPDC's management and ownership of geophysical and geological data is that MEM did not ensure that there are adequate resources for geophysical and geological data management related activities, such as the provision of technical personnel, physical storage facilities and computers, tools and required software for data management within TPDC.

In addition, MEM has failed to effectively use the required performance indicators such as the accuracy of records, number of errors detected during data processing, the quality of data captured (e.g., their accuracy, completeness, relevance and timeliness) when monitoring the performance of TPDC and assessing the effectiveness of geophysical and geological data management activities within TPDC. MEM rarely used those indicators and the only information managed was the availability of geophysical and geological data.

## CHAPTER FIVE

### RECOMMENDATIONS

#### 5.1 Introduction

The audit findings and conclusion pointed out weaknesses in the management of geophysical and geological data for oil and natural gas in Tanzania.

This chapter provides recommendations to the Ministry of Energy and Minerals (MEM) and Tanzania Petroleum Development Corporations (TPDC). The National Audit Office believes that these recommendations need to be fully addressed in order to improve the effectiveness of mechanism in the management of geophysical and geological data for oil and natural gas in Tanzania as well as for optimizing the use of geophysical and geological data when extracting oil and natural gas in the country.

Therefore, the following are the recommendations for TPDC and MEM:

#### 5.2 Recommendations to the Tanzania Petroleum Development Corporations

Tanzania Petroleum Development Corporations should:

- a) formulate data management policy that will act as a road-map towards effective and efficient geophysical and geological data management;
- b) develop guidelines for geophysical and geological data management, its database structures and supporting systems;
- c) prepare specific and comprehensive plans that govern activities of geophysical and geological data and ensure that they are followed and the results of its implementation are regularly reported to the Ministry of Energy and Minerals;
- d) improve the storage of geological samples in the TPDC's storage rooms to allow easy tracing of samples as well as safety and



develop coding system that will easily assist in the identification of geological samples.

- e) develop detailed storage requirements and a mechanism for managing geological samples as per standards to avoid deterioration agents such as excessive humidity, temperature and direct sunlight;
- f) conduct effective periodical independent reviews on the information systems and organization records for geophysical and geological data management and the results of the reviews are used to improve TPDC's performance;
- g) design and maintain a framework that reflects its geophysical and geological data requirements, management, documentation, disaster management plans and back-up system for geophysical and geological data;
- h) develop a monitoring system for assessing completeness and accuracy of geophysical and geological data once received from IOCs as well as ensuring that geophysical and geological data are adequately protected against manipulation, theft and loss;
- i) establish off-site storage facilities which will serve as back-up in the event of a disaster;
- j) ensure that its core personnel dealing with geophysical and geological data management are well trained; and
- k) promote a thorough awareness on the importance of geophysical and geological data management.

### 5.3 Recommendations to the Ministry of Energy and Minerals

The Ministry of Energy and Minerals should:

- a) develop a monitoring and evaluation system that will allow tracking of progress of TPDC's management of geophysical and geological data for oil and natural gas;
- b) develop key performance indicators to be used to monitor the status and effectiveness of geophysical and geological data management activities;
- c) put in place policies that would ensure integrity of geophysical and geological data for oil and natural gas and ensure that those policies are properly controlled, maintained and safeguarded;
- d) develop a system/mechanism that will ensure that TPDC is providing MEM with adequate assurance that the procedures for managing geophysical and geological data and databases have been followed and are working well; and
- e) Prioritize data management activities in oil and natural gas sub-sector.

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# APPENDICES

## Appendix 1: Responses from the Ministry of Energy and Minerals (MEM)

### A: Overall Responses

The scope of the performance audit is relevant to the country as it aims at ensuring that the government gets their fair share of revenue likely to accrue from the petroleum industry. However, some of the findings are passed by events and some are started to be worked on or implemented. So the Ministry hopes that, the information will be updated accordingly.

### B: Specific Responses

No.	Recommendation	MEM's Comment(s)	Action(s) to be taken	Timeline
1.	develop a monitoring and evaluation system that will allow tracking of progress of TPDC in management of Exploration and Production data for Oil and Natural gas	To be developed	To develop monitoring and evaluation plan	By July, 2017
2.	develop performance indicators to monitor the status and effectiveness of Exploration and Production data management activities	MEM will address TPDC board to provide performance indicators to TPDC Management.		
3.	put in place policies that would ensure integrity of Exploration and Production data for Oil and Natural gas and ensure that those	TPDC Board to be advised to prepare internal policies is improving,	To make rules and guidelines as Petroleum Act, 2015	By July, 2017

	policies are properly controlled, maintained and safeguarded	control, maintain and safeguard the data.	require	
4.	develop a system/mechanism that will ensure that TPDC is providing MEM with adequate assurance that the procedures for managing Exploration and Production data and databases have been followed and working well	MEM will advise TPDC Board put in place necessary procedures for managing geophysical data	To facilitate formation of the system.	By July, 2017

## Appendix 2: Audit Questions and Sub-Questions used during the audit

The audit objective was addressed through the following three audit questions:

<b>Audit Question 1</b>	:	Are TPDC's controls over acquisition, interpretation, processing, storage, accessibility and ownership of geophysical and geological data for oil and natural gas in Tanzania effective?
<i>Sub-question 1.1</i>	:	<i>Are the plans for managing geophysical and geological data for oil and natural gas established, communicated and maintained?</i>
<i>Sub-question 1.2</i>	:	<i>Data requirements and data-classification structures are defined and documented in accordance with users' needs?</i>
<i>Sub-question 1.3</i>	:	<i>Is TPDC designing and maintaining a framework that reflects its geophysical and geological data requirements?</i>
<i>Sub-question 1.4</i>	:	<i>Is the TPDC ensuring that responsibility, accountability and authority for performing different geophysical and geological data management activities are adequately assigned?</i>
<i>Sub-question 1.5</i>	:	<i>Are controls over changes to geophysical and geological data, database structures or supporting systems established and working?</i>
<i>Sub-question 1.6</i>	:	<i>Are information systems and organization records independently reviewed to ensure that controls over the processing and maintenance of geophysical and geological data are working as intended?</i>
<i>Sub-question 1.7</i>	:	<i>Are the responsible managers review data-management activities on a periodic and actions taken to address observed weaknesses?</i>
<i>Sub-question 1.8</i>	:	<i>Does TPDC has mechanisms for providing MEM with assurance that the procedures for managing geophysical and geological data and databases have been followed and working?</i>
<i>Sub-question 1.9</i>	:	<i>Are the individuals performing data-management activities receive appropriate training?</i>
<b>Audit Question 2</b>	:	Are TPDC's mechanisms in assessing the completeness and accuracy of reported raw and



		<i>processed geophysical and geological data for oil and natural gas in Tanzania adequate and effective?</i>
<i>Sub-question 2.1</i>	<i>:</i>	<i>Is the system ensuring that data input is accurate, complete and that data are entered only once?</i>
<i>Sub-question 2.2</i>	<i>:</i>	<i>Is the system capable of properly isolating, analyzing and correcting out-dated data?</i>
<i>Sub-question 2.3</i>	<i>:</i>	<i>Is the system ensuring that no geophysical and geological data are lost and that they are completely processed and reported?</i>
<i>Sub-question 2.4</i>	<i>:</i>	<i>Is the system capable of restricting access to the geophysical and geological data to unauthorized personnel(s)?</i>
<b>Audit Question 3</b>	<b>:</b>	<b><i>Is MEM adequately overseeing TPDC in ensuring effective management and ownership of geophysical and geological data for oil and natural gas in the Tanzania?</i></b>
<i>Sub-question 3.1</i>	<i>:</i>	<i>Has MEM put in place policies that ensure integrity of geophysical and geological data for oil and natural gas is properly controlled, maintained and safeguarded?</i>
<i>Sub-question 3.2</i>	<i>:</i>	<i>Is MEM ensuring that adequate resources (e.g., human, physical, technical and financial) are provided for geophysical and geological data-management activities?</i>
<i>Sub-question 3.3</i>	<i>:</i>	<i>How effectively is MEM using performance indicators such as: the accuracy of records, number of errors detected during data processing, the quality of data captured (e.g., their accuracy, completeness, relevance and timeliness) to monitor the status and effectiveness of geophysical and geological data-management activities?</i>
<i>Sub-question 3.4</i>	<i>:</i>	<i>Are the activities, outputs and controls of geophysical and geological data management independently reviewed to ensure that they meet the MEM's and TPDC's needs and are working as intended?</i>

## Appendix 3: Detailed Methodology approach of the Audit

### A. Interviews

People Interview	Reason for Interviewing them	Entity
Junior Staff <ul style="list-style-type: none"> <li>• Geophysicists</li> <li>• Geologists</li> </ul>	They are responsible on the operational level of activities of Managing Geophysical and geological Data. They are involved in the day to data activities and hence they have the practical insights of the operations	TPDC
Mid - Level Staff <ul style="list-style-type: none"> <li>• Geologists</li> <li>• Geophysicists</li> <li>• Paleontologists</li> <li>• Geochemists</li> </ul>	They are both at operation level and supervisory functions level of managing activities related to Geophysical and geological Data	
Senior and Principal Staff <ul style="list-style-type: none"> <li>• Paleontologist</li> <li>• System Analyst</li> </ul>	They are responsible both in the operational, supervisory and Planning levels of managing geophysical and geological data.	
Managerial Staff <ul style="list-style-type: none"> <li>• Exploration Manager</li> <li>• Director of upstream</li> </ul>	They are responsible for planning, decision making and monitoring of activities related to geophysical and geological data management.	
Principal Geologist	He is responsible on reviews of progress reports from TPDC on activities related to Managing Geophysical and geological Data	MEM
Energy Engineer	Responsible on Policy making and budget preparations and other program	
Senior Geologist	He is responsible on reviews of progress reports from TPDC on activities related to Managing Geophysical and geological Data	

People Interview	Reason for Interviewing them	Entity
Petroleum Experts	They have wide experience and knowledge of Petroleum industry in the Country.	<ul style="list-style-type: none"> <li>• EPZA</li> <li>• UDSM</li> </ul>
Exploration Operators	To have exploration Operators' experience, Challenges and opinions on the management of Geophysical Data in Tanzania as key stakeholders of Geophysical and geological Data.	<ul style="list-style-type: none"> <li>• BG</li> <li>• Heritage</li> <li>• StatOil</li> <li>• Petrabras</li> <li>• Swala Energy</li> </ul>

## B. Documentary Reviews

Document	Reasons for Reviewing
The National Natural Gas Policy of Tanzania, (2013)	To understand the underlying principles laid by the Government on Managing Geophysical and geological Data. The documents were also reviewed as criteria for assessment of the performance of Managing Geophysical and geological Data by TPDC and MEM
National Petroleum Policy of Tanzania, (2015)	
Petroleum (Exploration and Production) Act, 1980	These documents govern the entire process of managing Geophysical and geological Data. They were reviewed and set as criteria for the audit.
Production Sharing Agreement - PSA	
Petroleum Act (2015)	The document was reviewed to know how the upstream activities have been addressed.
TPDC Strategic Plan 2007- 2017	These are TPDC's internal documents. They were reviewed to highlight the internal controls at TPDC on managing geophysical and geological data.
Guidelines on Working in Data Bank , TPDC - (2005)	
TPDC - Upstream Annual Activity Plan (2015)	
TPDC - Sampling Guidelines (2013)	
Progress Reports from Operators to TPDC	
Progress Report from TPDC to MEM	
Transmittal Reports and Logbook	

Document	Reasons for Reviewing
TPDC Scheme of Service (2005) (2013) and (2014)	These are TPDC's internal documents. They were reviewed to highlight the internal controls at TPDC on managing geophysical and geological data and responsibility of duties
TPDC Approved Functions and Organization Structure (2014)	
Software Technical Specifications	
MEMS Marsha Plan	To review Personnel capacity and skills available at MEM
Joint Energy Review 2010 -2014.	To review the effectiveness of Independent Reviews on the issues related to Geophysical and Geological Data Management
Scientific Researches/Publications	To have an understanding on the Petroleum industry and specifically on issues related to Geophysical and Geological Data

### C. Observation

TPDC Data Storage Facilities	Data storage facilities at TPDC Headquarters and Upanga Plot No 37 and 38 were visited to observe the actual situation of storing and Handling the geological samples
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## Appendix 4: Detailed description of Geophysical and Geological data

Geophysical Data Type	Definition/Meaning
2D seismic surveys data	The 2D seismic surveys data provide valuable information to geologists on the location and orientation of geological structures <sup>15</sup> . However in some sub-surface areas where geological conditions are more complex, more detailed seismic information is required. The 2D seismic data are acquired by the contracted Oil and Gas companies and in most cases, they are also contracted for processing, interpretation, evaluation and storage.
Aeromagnetic Surveys	Aeromagnetic surveys are data used to produce geological maps during reconnaissance of the frontier areas. They also allow the production of the magnetic map which allows a visualization of the geological structure of the upper crust in the subsurface, particularly the spatial geometry of bodies of rock and the presence of faults and folds
Electrical resistivity geological survey	Electrical resistivity geological survey uses electrical principles to determine the geological characteristics of the <i>frontiers areas which are virgin exploration areas with limited geological and geophysical and geological data</i> <sup>16</sup> .
Electro magnetic geological survey	- Electro - Magnetic geological survey is an advanced technique of determining the geological characteristics of land for exploration.
Gravity geological surveys	This kind of survey, geologists use remote sensing mechanism for understanding of sub surface geology.
3D seismic surveys data	3D seismic surveys provide a more detailed picture of subsurface geological conditions for interpretation by geophysicists/geologists than 2D surveys.
Core sampling	A core sample is a roughly cylindrical piece of subsurface material removed by a special drill and brought to the surface for examination. Such a sample is needed to

<sup>15</sup> [http://www.google.co.tz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&ved=0CFQQFjAJ&url=http%3A%2F%2Fwww.bhpbilliton.com%2Fhome%2Fsociety%2Fregulatory%2FDocuments%2F\\_coal%2Fnsweec%2Fcaroona%2F100601\\_coal\\_nswec\\_caroona\\_caroonaCoalFactSheet2dAnd3dSeismicStudies.pdf&ei=7YFUVf3DJIGxUveygPAE&usg=AFQjCNGM9ymCj8DX4J9FQBC16qfSMd-zZQ&bvm=bv.93112503,d.d24](http://www.google.co.tz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&ved=0CFQQFjAJ&url=http%3A%2F%2Fwww.bhpbilliton.com%2Fhome%2Fsociety%2Fregulatory%2FDocuments%2F_coal%2Fnsweec%2Fcaroona%2F100601_coal_nswec_caroona_caroonaCoalFactSheet2dAnd3dSeismicStudies.pdf&ei=7YFUVf3DJIGxUveygPAE&usg=AFQjCNGM9ymCj8DX4J9FQBC16qfSMd-zZQ&bvm=bv.93112503,d.d24) accessed on 14th May, 2015

<sup>16</sup> National Petroleum Policy of Tanzania, 2014

Geophysical Data Type	Definition/Meaning
	ascertain bulk properties of underground rock, to investigate the peculiar features of a given zone of strata (e.g., to compare strata at a given level with those known to bear oil or gas) <sup>17</sup> .

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<sup>17</sup> <http://www.britannica.com/EBchecked/topic/137466/core-sampling> accessed on 14th May, 2015