CHAPTER 1
INTRODUCTION

This Chapter contains a brief introduction to the subject to put the problems and investigations in proper perspective. It also provides a brief introduction to the study, motivation for the research, objectives of the research and an outline of organization of this research work with a Chapter wise summary.

1. 1 INTRODUCTION

Once a nuisance and mine safety hazard, coal-bed natural gas (CBNG)—also referred to as coal bed methane—has now become a valuable part of any Nation's energy portfolio.

In terms of coal bed methane exploration, production and exploitation, USA is considered role model worldwide. Recent Coal bed Methane (CBM) success in North America has been due to a number of coincidental factors such as the existence of extended coal basins, strong gas prices, a dense distribution network, and little competition with declining conventional gas production.

Strong demand for both oil and gas is pushing the rest of the world (Australia, China and India) to speed up CBM development. However, favorable geological factors such as occurrence of thick gas-rich coal seams with good porosity/permeability characteristics do not necessarily coexist with an ideal business environment in many of these countries. Outside the North America, Australia has the most commercially advanced CBM industry. The country contains about thirty(30) coal bearing basins , mostly Permian and Mesozoic in age. Proven reservoir in Australia have been estimated at nearly 9tcf. In China, an estimate size of CBM resource is very impressive 1200 tcf. The initial exploratory efforts in the coal bed methane in any country tend to draw analogies with the US basins. But detailed analysis indicates existence of a divergent geological settings between the CBM plays of USA and India.

India is also making an effort to attract both local and international companies to explore CBM potential in the country. West Europe is favourable for CBM

development : however environmental issues and lack of gas-saturated coal seams extended over large areas may slow down full scale production from coal beds. Some countries are offering incentives to CBM investors ,which make CBM exploration and production a feasible alternative to conventional gas.

1. 2 NEED FOR THE STUDY

Since the beginning of the Coal bed Methane industry, operators have relied greatly on technology from the Mining and Petroleum Industries to evaluate and develop coal bed Methane properties. They are facing some specific barriers in achieving their objectives as:

- Evaluation of coal-bed methane plays, prospects, and properties is challenging work as it is very Complex and computationally intensive.
- It employs a considerable diversity and volume of data, and involves a lot of interpretive analysis and mapping.
- The sources of data can also be a bit typical and there will also be need to combine and display the data in unusual ways.

To tackle these practical problems, present topic of research "**Application of Geophysical methods in CBM Prospect Evaluation**" is conceptualized. Geophysical logs provide rapid measurements that can be used in well-site decision-making. CBM Prospect evaluation needs: knowledge of thermal history, pressure regime, hydro-dynamics, and regional stress. These are inferred parameters. In addition to those , the coal characteristics, coal ranking, gas adsorption capacity, initial gas phase concentration and critical saturation are important laboratory derived parameters needed to predict gas generation and production potential. To work out

these parameters, one relies on following information sources : cores and cuttings, Well logs, Input from mines, outcrop information and other geological data. **The approach to evaluation therefore is an integration and co-viewing of multi-disciplinary data.**

1.3 PRESENT STATE OF KNOWLEDGE IN THIS AREA-BRIEF LITERATURE REVIEW

Coal has been recognized for thousands of years as a natural rock material with qualities beneficial to the economic well-being of man. Recognition of the wide range of chemical and physical properties of coal and the relationship of these properties to a great variety of uses is relatively recent.

The emergence of coal bed methane gas as a major hydrocarbon resource has resulted in establishment of integrated exploration and development concepts. One of these concepts utilizes knowledge of depositional environment of coal beds to predict their continuity, thickness, geometry and distribution. Understanding coal bed depositional environments originates from information of their modern physical, biological and chemical processes. [*Landis et al., 1993*].

Natural gas is generated in coal by two distinct processes: biogenic and thermogenic. Biogenic gas, primarily methane and carbon dioxide is produced by decomposition of organic matter by micro-organisms and is commonly generated in peat swamps.[*Kim and Douglas, 1972*].The breakdown of organic matter leading to methanogenesis is performed in a complex series of processes by a diverse population of microbes, each of which contributes to the partial oxidation of organic matter[*Woese et al., 1990*]. The generation and accumulation of biogenic gas in

ancient sequences is described by Rice and Claypool(1981),Zhang and Chen(1985) and Rice(1992).

The applicability of Seismic method has been discussed and experimented outside India. Vertical seismic profiles of a coal-bed methane test well near Red Deer, Alberta provide useful data regarding the physical properties of the coal and its suitability for development. In seismic exploration, Vibroseis unit is an appropriate source for imaging coal seams at a depth of approximately 300 m, generating much higher resolution data. Ardley coal zone contacts at the Red Deer site may be effectively imaged and surfaces within the coal may be detected using the high-frequency source. [*Richardson, S.E., Lawton D.C., 2002, Deffenbaugh, M., Shatilo, A., Schneider, B., and Zhang, M., 2000.*] For Indian scenario, multiple Gondwana coals seams ranging in thickness from 1- 40m are distributed over a large stratigraphic column of about 700 m. Depth of occurrence of Barakar Coals seams range from 250m to 1200m. (AOI for the research work) Conventional Seismic tools does not have adequate resolution to detect & identify characteristics of individual coal seam. Though, through seismic studies, coal and non-coal packs can be identified. In Durgapur area Seismic (high resolution 2D-seismic) data were acquired, no individual coal seams could be obtained. But data was useful for having a feel of overall geological setup of the area.

Valuable geologic information can be obtained by utilizing wireline conveyed measurements. Most tools are made up of sensing section called sonde and signal amplification and processing unit called cartridge. Among different well logs, clay will cause resistivity logs to read low [*Johnston,1990,Mullen ,1988,and Mavor,1991*].For sonic logs, they generally read high porosity in

coals[*Johnston, 1990, Ellis et al., 1988*].Because of low matrix density of coals, density logs will read low density . [*Johnston et al., 1990*].

1. 4 RESEARCH OBJECTIVES

The overriding objective of this research project is to carry the convergence/unification of business interest and CBM technology further through a study of the Geophysical Application relevant to CBM exploitation processes as mentioned below:

- 1) Establishing the applicability of Well-logging method to the interpretation of coal bed methane data with potential reserves of Methane gas.
- 2) Feasibility study of application of Seismic data in CBM Scenario in correlation with Well logs.
- 3) Create a lay-out for reservoir characterization, resource assessment and finally estimation of the reserves depending on CBM properties.
- 4) Develop a CBM standard workflow model on basis of Well-logs data and data from other resources like cores and cuttings, input from mines, outcrop analogue and other geological data.

1. 5 SIGNIFICANT CONTRIBUTIONS OF THE RESEARCH

The following are some of the significant contributions emanating from the research work:-

1. A detail study of the Indian CBM scenario was conducted with real time data from a premier National Oil Company and it was shown that Wireline Logging method has a very critical role to play in CBM Prospect determination.

2. Feasibility study of Seismic method in correlation with Well-logging method was studied for Indian CBM Industry perspective.
3. A detailed lithology of the area of interest has been delineated which will be a base for further research on the same area.
4. Resource assessment for the Area of Interest(AOI) has been done with the help of present research work which is a very critical aspect in any CBM exploitation program.
5. Creation of a standardized work-flow on CBM prospect evaluation has also been attempted.

1. 6 ORGANIZATION OF THIS THESIS

The work done has been presented in the following chapters:

Chapter 1 is "Introduction." It contains a brief introduction to the subject to put the problems and investigations in proper perspective . It also provides a brief introduction to the study, need for the research, objectives of the research and an outline of organization of this research work with a Chapter wise summary.

Chapter 2 is "Literature review". It reviews the literature relevant to this research. Literature review is focused on the contemporary work being done towards convergence of the disciplines of applied Geophysics and Petroleum Engineering. Valuable geologic information can be obtained by utilizing wireline conveyed measurements. Among different well logs, clay will cause resistivity logs to read low .[*Johnston,1990,Mullen,1988,and Mavor,1991*]. Relevant literature on related domain has also been reviewed, in particular, those areas that are relevant to the research

being envisaged. Literature on the geophysical applications of various methods including Well-logging processes and other geological processes has also be studied to identify gaps in existing knowledge in the field.

Chapter 3 is "World wide CBM Exploitation Scenario." we attempt to depict the present scenario of CBM Exploitation and technical challenges to achieving it as an emerging energy source. In terms of coal bed methane exploration, production and exploitation, USA is considered role model worldwide. The initial exploratory efforts in the coal bed methane in any country tend to draw analogies with the US basins. But detailed analysis indicates existence of a divergent geological settings between the CBM plays of USA and India. An attempt has been made to draw comparison among some of the US basins ,Bowen basin of Australia and Damodar Valley Gondwana basins of India.

Chapter 4 is " Geological Background of Origin of CBM". This chapter has dealt with the parameters of depositional systems and structural features which are the primary geological controls on Coal bed Methane resources and the recoverability. We start with a generalization theory that introduce Depositional systems and structural features which are the primary geological controls on Coal bed Methane resources. We've done detailed study with the Geological background of origin of CBM.

Chapter 5 is " Coal as a reservoir and Feasibility studies of Seismic Method". Through this chapter, we've tried to establish the fact that characteristics of CBM reservoir is utmost important for the proper exploitation program. Rational development of this resources requires accurate data on geologic and hydraulic

properties of the potential reservoirs. Also the feasibility studies of Seismic method in CBM has been discussed in detail.

Chapter 6 is "Application of Geophysical Logs on CBM & Geological study of Area of Interest(AOI)" . We attempt a generalization of application of Geophysical methods particularly Wire-line logging method and its role in CBM Exploitation. Here the Geological and Stratigraphical analysis of the Area of Interest(AOI) has also been discussed.

Chapter 7 is " Research Methodology and Analysis" Here, we apply the well-logging application. We chose our Area of interest (area of study) and complete the entire logging analysis for the above mentioned area. Creation of cross-section is also a part of it. This is done for the correlation purpose.

Chapter 8 is " Summary and Conclusion". Calculation of GIP(Gas-in-Place) has been completed in this chapter. Creation of CBM work flow model is done. This chapter contains major findings and significant contributions of the research duly summarized followed by limitations and future scope of the research further.

1. 7 CONCLUSIONS

The following are some of the important outcomes of this research work:-

- Analysis of the various Well logs are important information source for identifying coal layers and infer their characteristics. It provides several important parameters such as net pay thickness, reservoir pressure and host of inputs for map preparation necessary for reserve estimation and forecasts spatial extent, gas

potential and recovery factor. Well logs have been found useful in all stages of CBM project management –venture exploration, evaluation and exploitation.

- Interpretation of the Well-logs and determination many important reservoir properties like thickness, density and other parameters for CBM reservoir.
- Creation of the detailed lithology of the Area of Interest(AOI) which will be ultimately helpful for the detailed Geological analysis of the mentioned area of interest.
- Cross-sections of the major wells has been created which will ultimately proves the lateral continuity of the coal seams.
- Calculation of Gas-in-Place for prominent seams as the Area of Interest has a multi-seam environment. Finally evaluation of resource potential of the area has been completed.
- The final creation a lay-out of standard workflow for overall CBM play. The integral part of the workflow are geological mapping, log analysis, cross-section building to assess gas-in-place and finally forecasting the resource potential of CBM for that particular area.