CHAPTER – 1
INTRODUCTION

1.1 AREA OF STUDY: Gujarat state lying in the North Latitudes 20°02’ & 24°42’ and East Longitude 68°04’ & 74°30’ has an areal extent of 1,96,024 sq. km. and is bordered by the coastal tract along the Arabian Sea in the west. The state of Gujarat has a long coastline (approx. 1550 km) from Sir Creek in the north-west to Umerego in the south-west which form nearly one third of Indian coastline. The coastal tract borders the Kutch Peninsula, the Saurashtra Peninsula & central plains of Gujarat. The south-eastern part is occupied by the Deccan Plateau whereas the south-western part forms the Saurashtra (Kathiwar) Peninsula. In the north-east of state, conspicuous chain of hills represent the southward continuation of Aravalli Ranges. The Kutch Peninsula and Rann of Kutch occupy the northwestern part of the state. The Kutch Peninsula is a central high plateau dissected on all sides except east. In the northern part of Kutch Peninsuala, hill ranges of Jurassic rocks with steep northern slopes are present, in the south Deccan Trap’s hills and in the west gently sloping peripheral coastal tract of Palaeogene/Neogene rocks are present.

The investigations under the present thesis work deal with the palyno-stratigraphic and petrologic studies of panandhro lignites. Panandhro lignite field is located in Lakhpat Taluka of Kutch District, Gujarat, India (Fig. 1.1). The Panandhro lignite field represents a valley base surrounded by hills of Deccan traps, housing the lignite deposits in an area of about 8.34 sq. km with the estimated reserve of 95-100 million tones. The lignite deposits in the area belong to the sediments of Panandhro Formation exposed in the NW part of Kutch Basin. The Panandhro lignite fields (23°41’ N; 68°45’ E) falls in the Survey of India topographic sheet no. 41A/10. The field was discovered by the Commissionerate of Geology & Mining, Gujarat in 1965-66, while undertaking drilling in western part of Kutch Basin. The total lease area for Panandhro lignite field is 17.19 sq. km., out of which 8.50 sq. km. area is lignite bearing. Depending upon the characteristics of lignite, Panandhro lignite field has been divided into four minable blocks (Fig. 1.2). Lignite occurring here is dark brown in colour, hard, compact uniform in texture, impregnated with resin and pyrite. Moisture content, ash content,
volatile matter and fixed carbon content of lignite is 33.83 %, 17.71 % 27.46 % and 21.00 % respectively. Calorific value of the lignite is 2995.28 (Kcal/kg). Average lignite to overburden ratio is 1:3.64, the overburden material of this field consists of soil 15%, limestone 7%, clay & shale 45% and carbonaceous clay 33%. Other economic minerals observed in the area are gypsum, bauxite, dolomite, fluorite, limestone & Quartz. Lignite deposits of Panandhro mine occur with the alternation of shales and clays at shallow depth without any hard strata as overburden and interburden (within the adjacent lignite seams). The lignite is being extracted by opencast mining, using hydraulic excavators and dumper combination along with ancillary equipment such as Dozer, Water Sprinkler, Motor Grader, blasting etc. since commencement of mining in 1974 (Fig. 1.3 a, b, c, d, e & f). The excavation of lignite in Panandhro is being undertaken by many agencies viz. Geological Survey of India, Commissionarate of Geology & Mining, Gujarat and Gujarat Mineral Development Corporation Limited (GMDC). Major consumers of Panandhro lignite in this region are: Akrimota Thermal Power Station, Kutch Lignite Thermal Power Station, Gujarat Electricity Board, Gujarat Heavy Chemicals Limited and Tata Chemicals Limited.

1.2 PALYNOLOGY: Palynology a branch of Earth Science and Biological Science, particularly Plant Science. It deals with the study of living and fossil Palynomorphs, including pollen, spores, acritarchs, chitinozoans, dinoflagellate cysts, and scolecodonts together with dispersed organic matter in sedimentary rocks. Palynology is mainly used to infer and reconstruct palaeoenvironmental and palaeoclimatic conditions prevailing during the geological history through terrestrial vegetation, marine and freshwater phytoplankton communities. Palynological studies are efficient in dealing with several problems related to age determination of strata, correlation of marine and fresh-water deposits, determination of palaeoecology and palaeoenvironment of rock sequences, fine biostratigraphic zonation and demarcation of stratigraphic successions and delineation of areas favourable for hydrocarbons generation.

1.3 STRATIGRAPHY: Stratigraphy is one of the most important branches of study in the geological sciences. Stratigraphy reveals original succession, age relations, lithologic composition, fossil content and their distribution, mineral resources, correlation, geological and geochemical properties of rock strata, and also setup the base for
interpretation in terms of environment or mode of origin. Rock strata may be classified into many different categories based on the lithology, age relation, fossil content etc., and each of which has its own distinctive units. The three main divisions of stratigraphy are:

**1.3.1 Lithostratigraphy:** that element of stratigraphy which is concerned with the organization of strata in to units based on their lithologic characters, mapability and field relations.

**1.3.2 Biostratigraphy:** that element of stratigraphy which is concerned with the organization of strata in to units based on their fossil content.

**1.3.3 Chronostratigraphy:** that element of stratigraphy which is concerned with the organization of strata in to units based on their age relations.

**1.4 COAL PETROLOGY:** Coal petrology is the branch of science that deals with the origin, formation, composition and classification of coal/organic deposit. During the last few decades coal petrology has developed as specific field of research, of equal importance from both the scientific and industrial view points. In the early 20\textsuperscript{th} century many leading geoscientists like C.E. Bertrand, B. Renault, H. Potonie and D. White laid a foundation for the systematic coal petrography. In 1927 a special laboratory for coal petrography was established in Berlin under the guidance of E. Stach who introduced the concept of examining polished section under an oil-immersion lens. E. Stach and his co-worker F. L. Kuhlwein, also developed the method of grain analysis by means of which coal components can be quantified.

Coal petrography in India was initiated in the Geological Survey of India. Subsequent works at different academic and research institutions like BSIP, Lucknow and some universities helped to elevate the level of knowledge in this field at par with international standards.

**1.5 PHYSIOGRAPHY, CLIMATE & VEGETATION:** Kutch has experienced several episodes of earth movement and this has given rise to youthful topography. The Kutch region is an excellent manifestation of tectonically controlled landscape. The structure and evolution of the basin has been worked out by Biswas (1965, 2005, 2012). According to him the Kutch basin is a pericratonic rift basin bounded by Nagar Parkar uplift in the north and Saurashtra or the Kathiawar fault in the south, Radhanpur arch in the west. The main structural features that have played a vital role in the geological evolution of Kutch...
include a group of E-W trending uplifts surrounded by a residual depression (The Great Rann of Kutch and The Little Rann of Kutch). The major uplifts are Pachcham, Khadir and Bela islands, Chorar hill, Wagad highland, Kutch mainland, and Saurashtra. The major uplifts are bounded at least on one side by a fault/flexure and on the other side by a gently dipping peripheral plain. The marginal fault separating the uplift has been referred to as “Master Faults” which are the Great Rann Fault, Patcham Khadir Bela Fault and Kutch Mainland Fault.

The state of Gujarat is divided into following 6 physiographic units.

i) Southern Arravallis and adjoining hill tract.
ii) Deccan Plateaus and adjoining hill tract of south-east Gujarat.
iii) Central plains of Gujarat.
iv) Saurashtra Peninsula
v) Kutch Peninsula
vi) Rann of Kutch

The area under present investigation is characterized by gentle to undulating and rugged topography with a few small isolated mounds and hillocks. The landscape of Kutch comprises of highlands standing out like islands amidst vast plains of Great and Little Rann of Kutch. Kutch is a thinly populated area due to its adverse climatic conditions.

There are numerous small rivers in the Kutch region. The Korawadi and Kali rivers flowing through the Panandhro Lignite field run dry in the major portion of the year except during monsoon. Some of other main rivers in Kutch are Khari, Kaila, Niruna, Nara, Matiweriwal, Rukmavati, Kankavati, Bhukhi, etc. There are dams across Khari, Kaila, Niruna and the other rivers are also prepared to be harnessed by having storage schemes to tide over water scarcity conditions affecting this region quite frequently.

Kutch has a dry and hot climate. This area experiences arid to semi arid type of climate and has extreme temperature during the summer and winter. The monsoon is very irregular and scanty and is generally active from June to September. The annual average rainfall varies from a few mm to 900 mm. with the average being 335 mm. However, it was 1150 mm in the year 1967, which was an exception. The distribution of rainfall is
very erratic and the groundwater in the region is highly saline. Kutch area is practically devoid of any vegetation except some thorny bushes, cactuses and babuls, whereas it is rich in its mineral wealth like bauxite, gypsum, agate, limestones etc.

1.6 ACCESSIBILITY: The Panandhro lignite field is located in Panandhro village of Kutch District, Gujarat, India. The panandhro lignite fields can be easily approached from Kurukshetra to Bhuj via Delhi by Indian Railway network trains and by the state government or private buses from Bhuj to Panandhro.

1.7 AIMS AND OBJECTIVES: The research investigations in the proposed area were planned to be carried out with the following objectives:

1) Systematic study of rock/lignite samples of Panandhro Formation for recovery of microfloral assemblages to constitute a formal biostratigraphic sequence in the area.

2) Organic petrolographic studies for characterization of Panandhro lignites.

3) Precise age determination of Panandhro Formation on the basis of microfossils contained in them.

4) Deduction of depositional environment based on Palynobiota and maceral analysis of Panandhro lignites.
Figure 1.1: Location map of Panandhro Lignite Fields, Kutch District, Gujarat, India.

Figure 1.2: Mining blocks of Panandhro Lignite Fields.
Figure 1.3 (a) Panandhro lignite mine showing excavation of overburdens in block-1, (b) Site ready for blasting in block-2, (c) Lignite benches alongside local River Kaveri, (d) Lignite with alternation of shale and clay in block-3, (e) Conveyor belt installed in block-4, (f) Exposed lignite seam in block-4.