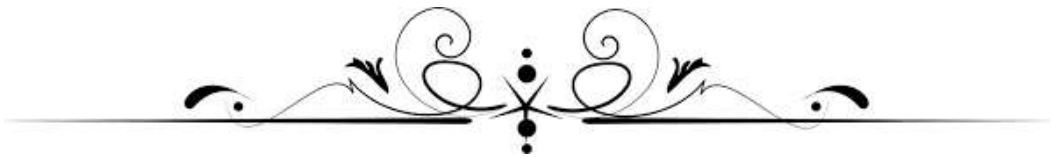
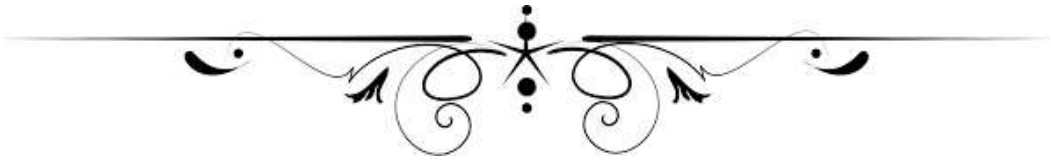


Chapter-5
Megascopic analysis of coal



Chapter-5

Megascopic characterization of Coal

5.1 Introduction

Coal is composed of lithified plant materials due to which it is an organo-clastic sedimentary rock. The formation of coal begins with the development of peat in the swamp which subsequently undergoes a number of physical, chemical and biological changes with time and pressure (Bardet and Pournou 2017). The complexity and heterogeneity in coal is due to the diversity of vegetal matter and the range of environmental conditions (Dai et al. 2020). Coal can be investigated by both, macroscopically and microscopically. Coal may be distinguished as banded or humic coal and non-banded and sapropelic coal as well as genetically also, which is based on macroscopically (Chandra et al. 2000).

Numerous terms describing coal lithotypes have been proposed in the past several decades, but the one used in this study is based on the classification of Stopes (1935), which has been modified by Cameron (1978), Davis (1978), Austin (1979), and Hower et al. (1990). Each lithotype is defined as being at least 3 mm thick, except for fusain, which is recorded at any measurable thickness (Fig. 5.1).

A distinction is made between sapropelic and humic coal, depending upon the genesis and chemical properties (Chandra et al. 2000). The term ‘lithotype’ designates the different macroscopically recognizable bands of coal seams.

5.2 Sapropelic coal

The sapropelic coals are made up of specific kinds of fine grained matter, notably masses of spores or algal material and are homogenous, tough materials often displaying a

marked conchoidal fracture. The lithotypes of sapropelic coals are channel and boghead coals. The channel coals are rich in spores and pollens whereas the boghead coals are rich in algal material. The two can be differentiated physically on the basis of color and streak-channel coal is black in color with a black streak while boghead coal somewhat brownish with a brown streak (Stach 1982).

5.3 Banded or Humic coal

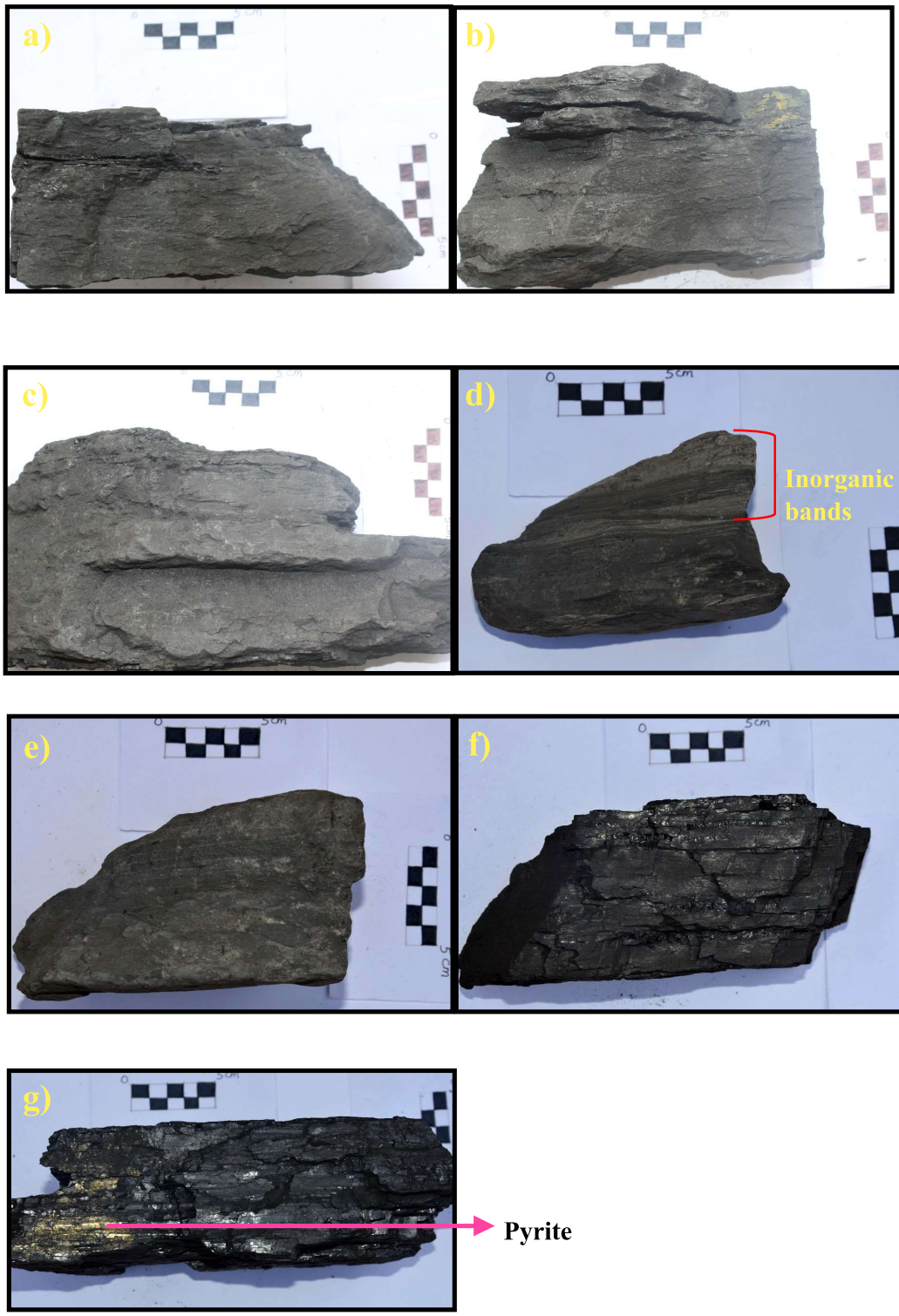
The humic coals are visibly stratified, consisting of layers or bands of organic material of varying appearance with individual layers usually not more than a few mm in thickness. Stopes (1919) determined four basic ingredients of banded bituminous coal. These are vitrain, clarian, durian, and fusion which differ petrologically as well as chemically. At the megascopic level, lithotypes can be regarded as the principal components of coal, and it is believed that different lithotypes reflect some environmental differences in the peat-forming paleomire (Teichmiiiler 1982; Austin 1979; Diessel 1986; Esterle and Ferm 1986).

5.3.1 Vitrain

Vitrain is a black, glassy, vitreous material of bituminous coal that is the brightest one. It is very brittle and breaks with a conchoidal fracture and shows vitreous luster. In hand specimen, the bright bands of 3-10 mm thickness are considered to be vitrain. In coal samples of the study area, this band varies from 0.4 cm to 8 cm. Vitrain was formed under drier surface conditions. On burial stagnant groundwater prevented the decomposition of the woody plant tissue

5.3.2 Clarain

Very finely laminated bands which are bright to semi-bright in nature are referred to as clarian. The composite thickness carries from 3-10 mm and consists of fine vitrain bands


a)
b)
c)
d)
Inorganic bands
e)
f)
g)
Pyrite

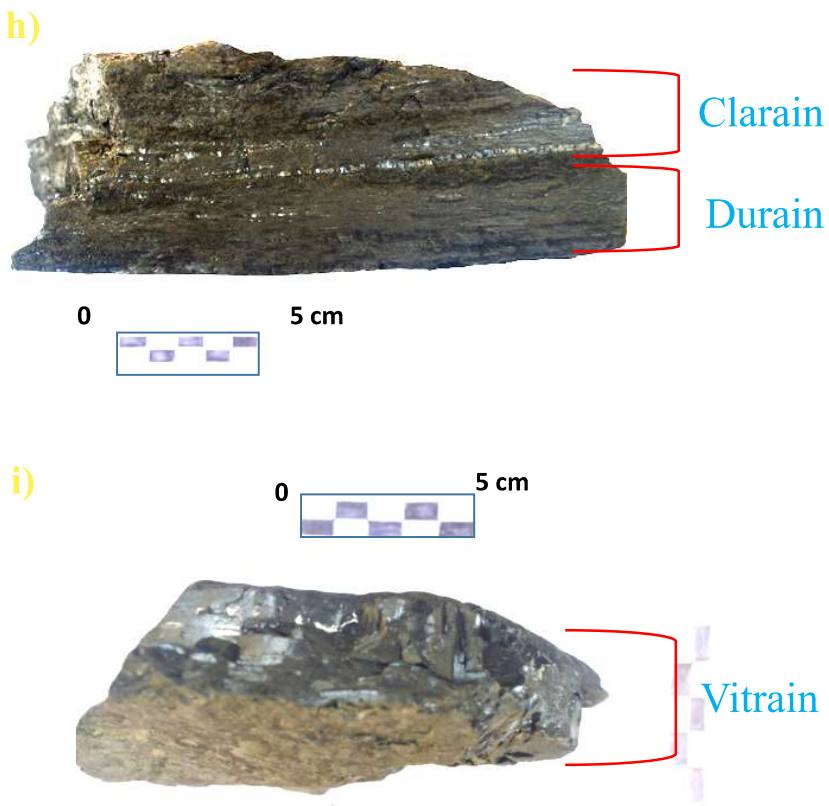


Fig. 5.1: Coal samples of Dhanpuri OCP for megascopic study

in alteration with dull bands. The well-developed clarian bands show silky luster. In coal samples of the study area, this band varies from 1.3 cm to 5.1 cm. It seems to have originated under conditions that alternated between those in which durain and vitrain were formed.

5.3.3 Durain

Durain occurs as grey to black bands with a dull to slightly greasy luster. It is comparatively hard and tends to break into big lumps. Apparently, it resembles carbonaceous shale but has a lower density. Durain is very hard and consequently break into big lumps. Therefore its fracture surfaces are very rough (Figs. 5.1 (a) and (b)). Durain bands are less frequent than bands of vitrain and clairan but sometimes are very thick and persistent. In coal samples of the study area, this band varies from 0.8 cm to 10

cm. Durain is thought to have formed in peat deposits below water level, and inorganic minerals accumulated from sedimentation.

5.3.4 Fusain

Fusain is a friable material that loosely resembles the charcoal from which it derives its name. This unmineralized fusian easily disintegrates into a black fibrous powder. Fusain when impregnated with mineral matter becomes hard. Fusain is found in coal samples of the study area. It closely resembles charcoal in terms of both chemical and physical properties and is believed to have been formed in peat deposits swept by forest fires or by some bacterial action that generated intense heat.

5.4 Origin of bands in coal

These bands are suggestive of seasonal fluctuation in anaerobic and aerobic conditions during peat formation, due to which different bands (lithotypes) were formed in paleo-depositional conditions (Dai et al. 2020). It is widely accepted that cellulose, lignin and hydrogen rich waxy resinous ingredients organic compounds contribute to coal seam formation (Stach et al. 1982).

In addition, the toxicity of the basin floor where peat is formed as well as the subsurface water table also controls the decomposition of vegetal matter into the biochemical stage. The high toxic environment favors the least decomposition of vegetal matter and leads to the form of Vitrain, whereas in less toxic conditions cellulose is destroyed and the hemi-cellulose and lignin together form Clarain (Teichmuller and Teichmuller 1982). Similarly, a high ground water level together with a specific toxic environment favors Vitrain, whereas during low water level, oxidization prevails and Durain is formed. The close interbedding of Vitrain and Clarain definitely indicates rapid seasonal fluctuations with wet-reducing (anaerobic) to dry-oxidative (aerobic) conditions

through time during peat formation. The preferred upward transition of Clarain to Durain and Durain to Fusain further indicates a reduction in toxic medium and lowering of the water table in coal samples of the study area (Tewari and Khan 2014).

5.5 Diessel's classification of coal

On the basis of type and amount of lithotypes present, coal may be grouped into the following classes (Diessel, 1965) as shown following:

1. Bright coal : Dull component <10%
2. Banded bright coal : Dull component =10%-40%
3. Banded coal : Dull component= 50% and Bright component = 50%
4. Banded Dull coal : Bright component =10%-40%
5. Dull coal : Bright component <10%
6. Fibrous coal : Satin lustre, very friable.

Based on Diessel's classification, the coal samples were classified in table 5.1 and 5.2 accordingly. Many type bands were found and classified in coal samples (Fig. 5.1). Different bands present in coal samples, along with pyrite inclusion.

5.6 Macroscopically seam profile

The coal samples were measured quantitatively of all the lithotypes. Macroscopic variations have been recorded in the coal samples for the interpretations. Many types of bands were identified in coal samples of the study area as given in table 5.1 and 5.2. Banded coal was the highest in most of the coal samples, after this Banded bright coal, Bright coal, Banded dull coal and Dull coal have the least of samples.

S.N.	SAMPLE NAME	TYPE OF BAND
1.	A1	BANDED BRIGHT
2.	A2	BRIGHT COAL
3.	B3	DULL COAL
4.	C1	BANDED DULL COAL
5.	C2	BANDED DULL COAL
6.	C3	BANDED COAL
7.	D1	BANDED BRIGHT COAL
8.	E1	BANDED BRIGHT COAL
9.	E2	BRIGHT COAL
10.	F1	BRIGHT COAL
11.	F2	BANDED COAL
12.	G1	DULL COAL
13.	G2	BANDED DULL COAL
14.	J1	DULL COAL
15.	J2	BANDED BRIGHT COAL
16.	K1	BANDED COAL
17.	K2	BRIGHT COAL
18.	L1	BANDED DULL COAL
19.	L2	BANDED BRIGHT COAL
20.	L3	BANDED COAL
21.	M1	BANDED COAL
22.	M2	BRIGHT COAL
23.	N1	BANDED COAL
24.	N2	BANDED BRIGHT COAL
25.	O1	BANDED DULL COAL
26.	O2	BANDED COAL
27.	O3	BANDED BRIGHT COAL
28.	P1	BRIGHT COAL
29.	P2	BANDED COAL
30.	P3	DULL COAL

Table 5.1: Types of band present in coal samples of Dhanpuri OCM

S.N.	SAMPLE NAME	TYPE OF BAND
31.	Q1	BANDED COAL
32.	Q2	DULL COAL
33.	Q3	BANDED DULL COAL
34.	R1	BANDED COAL
35.	R2	BANDED BRIGHT COAL
36.	R3	BRIGHT COAL
37.	S1	BANDED COAL
38.	S2	BANDED COAL
39.	S3	BANDED DULL COAL
40.	T1	DULL COAL
41.	T2	BANDED DULL COAL
42.	T3	BANDED COAL
43.	U1	BANDED BRIGHT COAL
44.	U2	BRIGHT COAL
45.	U3	BANDED BRIGHT COAL
46.	U4	BRIGHT COAL
47.	GV1	BANDED COAL
48.	GV2	BANDED BRIGHT COAL
49.	GV3	DULL COAL
50.	GV4	BANDED DULL COAL
51.	GV5	BANDED COAL
52.	V1	BRIGHT COAL
53.	V2	BANDED BRIGHT COAL
54.	V3	BANDED COAL
55.	W1	DULL COAL
56.	W2	BANDED DULL COAL

Table 5.2: Types of band present in coal samples of Dhanpuri OCM