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Comparative studies and evaluation of Pench valley and Wardha valley coalfields, India

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Abstract
Pench-Kanhan-Tawa Valley Coalfield and *Wardha Valley Coalfields* holds a premier position in India for having the considerable share of reserve of thermal grades non-coking coal for catering the demand of coal in the western part of country. The present study reflects about the properties of a given coal samples that can be related to three independent geological parameters, each of which is determined by some aspect of the coal's origin. As discussed more fully by authors such as Ward (1984), Diessel (1992), Taylor et al. (1998), and Thomas (2002), these parameters are briefly defined. They are rank (reflects the degree of metamorphism), type (the nature of the plant debris from which the original peat was derived) and grade (reflects the extent to which the accumulation of plant debris has been kept free of contamination by inorganic material). Coal is an extremely complex material and exhibits a wide range of physical properties. The rapidly expanding use of coal in the twentieth century made it necessary to devise acceptable methods for coal analysis with the goal of correlating composition and properties with behaviour. It is only by assiduously using careful analyses of coal that the various aspects of coal usage can be achieved in an environmentally acceptable manner. As a part of the multifaceted program of coal evaluation, new methods are continually being developed and the already accepted methods may need regular modification to increase the accuracy of the technique as well as the precision of the results. Furthermore, proper interpretation of the data resulting from the analysis of coal requires an understanding of the significance of the analytical data.
Both coal mining and coal consumption have a significant impact on the natural environment. Thus, although coal is an important contributor to the economic and social development of many countries, there is a strong need to minimize and where possible reduce the negative impacts associated with its mining and use.

Keywords: coal, proximate analysis, ultimate analysis, material and method, califoric value, pench and wardha valley coalfield

Introduction
Coal is the most abundant specimen among the fossil fuels, i.e. the coals, oil shales, oil, and gas deposits of Earth. It is the deposit of organic matter the remains of dead plants and animals – entrapped in sedimentary rocks at the site of organic matter growth many millennia ago. Coals generally contain 10-30% of inorganic material made up of clay minerals, quartz silt, and sand, thus contributing to metal emission load upon their combustion. Coal is a combustible sedimentary rock, composed essentially of lithified plant debris. The plant debris was originally deposited in a swampy depositional environment to form a soft, spongy sediment called peat. However, physical and chemical processes brought about by compaction and elevated temperatures with prolonged burial at depths of up to several kilometres and over periods of up to several hundred million years then changed the peat into coal through a process referred to as coalification or rank advance.
The source of vegetation contains from low plant forms i.e., moss to significant woody plant precursors. Although the heating value is provided by the carbon contents of coal, however the other factors such as moisture contents, ash contents and Sulfur contents play an important role for defining the rank for a particular source of coal. The top ranked coal is anthracite with highest contents of carbon e.g., 86-98% and having a calorific value of ranges from 22-28 million BTU/ton. It contains low percentage of volatile elements and is used for commercial and residual purposes. Bituminous and Sub-bituminous coals have calorific values of ranges from 20-30 million BTU/ton and 17-23.5 million Btu/ton respectively.

Geological Framework of Study Area
Pench-Kanhan-Tawa Valley Coalfield has occupied a land area of near about 2426.00 sq. Km. situated in the Chhindwara and Betul region of Madhya Pradesh province. This coalfield is categorised into three parts: Pench valley coalfield, Kanhan valley coalfield and Tawa Valley coalfield. It has Latitude 220 05' to 220 25'and Longitudes 780 00' to 790 05' and found in the middle part of India i.e. Madhya Pradesh. Pench, Kanhan area presents a rugged topography surrounded with the landscape consist of hilly and valleys- Structural hills surrounded by Gondwana are seen in northward denudational hills in the southward and divided Deccan Elevated plain into eastern and north-eastern parts. The area is drained by two major rivers - Pench and Kanhan River.
In contrast with above, *Wardha Valley Coalfield* covers an area of about 5225.36 sq. Km situated in the Yavatmal and Chandrapur district of Maharashtra. It is surrounded by Latitude 200 29' 06" to 200 48' 22" and Longitudes 790 09' 15" to 790 26' 39" and situated in middle India. The area has nearly flat to gently undulating terrain grew over Precambrian, Gondwanas and Trap rocks covered with black soil and alluvium. The general slope of the area is southward. The area is used up primarily by the Wardha, the

Penganga and the Erai rivers. The reserved forests in the Wardha Valley coalfield are Tadoba, Balharsha and Bhandak in the western side, Rajura in the southern side, Satna, Rajkot, Pardi and Borgaon in the eastern side. These coalfields hold a premier position in India for having a considerable share of the reserve of thermal grades non-coking coal for catering the demand of coal in the western part of the country.

Materials and Method

Material

Coal samples were obtained from two different locations namely: PENCH valley and WARDHA valley Coalfields. The samples were stored in appropriately labelled air-tight containers to retain their as-received conditions. A known weight of each pulverized sample of coal from each of the sites was taken for different analyses.

Method

The large sample achieved by sampling procedure and the sample is mashed with the help of mechanical means, combines thoroughly and quartered. Two quarters are retained and the rest rejected. The material so obtained is crushed to 12.5mm size by a Jaw crusher and then to 3.35 mm by a reduction mill. This material is then reduced by conning and quartering till 2kg of sample is obtained. This coal sample was pulverized in a mini hammer mill. The pulverized sample is sieved to pass through BS-72 mesh (212µ) sieve size. Any retained particles on the sieve were crushed in a mortar and pestle and sieved again. This process was repeated until all the material passed through the sieve and the quantity is finally reduced to 1.5kg. The sample was preserved in glass bottles and labelled accordingly.

Proximate Analysis

The proximate analysis of Pench valley and Wardha valley coal reserves was carried out. For Moisture Content (MC), carefully place the vessels in oven and uncover the lid of the vessel in the drying oven and heat at temperature of 108 ± 2°C until there is no further loss in mass. This normally takes 1 to 1.5 hours. Replace the cover, cool in a desiccator for 20 minutes and weigh. The process of heating, cooling and weighing was repeated until a constant of coal (anhydrous) was achieve. The % MC was determined according to following formula.

$$MOISTURE\% = \frac{Wt.\,of\ coal - Wt.\,after\ heating\ for\ 1hr}{Wt.\,of\ sample\ taken} \times 100$$

Heat empty VM crucible with lid in a muffle furnace maintained at 900± 10°C for 7 minutes. Remove from the furnace, cool the crucible on metal plate for 5-10 minutes. Weigh empty VM crucible with lid and weigh accurately 0.8-1.2g coal in it. The previous moisture free samples were covered and placed in a muffle furnace and heated at 950° C for 7 minutes.

The VM was determined according to following formula.

$$M\% = \frac{\{Wt.\,of\ crucible\ with\ coal - Wt.\,after\ heating\}}{Wt.\,of\ coal\ taken} - Moisture \times 100$$

The 0.8-1.2 g of coal samples were placed in a crucible and Insert the uncovered dish into the muffle furnace at a room temperature; raise the temperature to 500°C in 30 minute and to 815 ± 10°C in a further 30 to 60 minutes. Remove from the muffle furnace and allow cooling at room temperature for 10-20 minutes. The residue obtained were used to obtain the % AC by following formula.

$$ASH\% = \frac{Wt.of\ Ash\ obtained}{Wt.of\ coal} \times 100$$

The fixed carbon was determined as in formula

$$FIXED\ CARBON = 100 - [Moisture\% + Ash\% + VM]\%$$

Ultimate Analysis

The determination of elements BY VARIO MACRO CUBE ELEMENTAL ANALYZER. Carbon, hydrogen, sulphur, nitrogen and oxygen of organic part of coal in their relative proportion is known as the ultimate analysis of coal. The ultimate analysis of coal involves the estimation of the proportion of ash, carbon, hydrogen, nitrogen, oxygen, Sulphur and Phosphorus. The amounts of carbon, hydrogen and nitrogen are determined directly, and that of oxygen is obtained by difference. The presence of a high percentage of oxygen is very undesirable, as it not only reduces the heating value of coal but also affects its coking property. The elemental analysis depends upon the high-temperature combustion and subsequent analysis of the combustion gases. The perfect separation of the analyte gases before the detection is crucial for ultimate analysis.

Result and Discussion

Proximate Analysis

Proximate analysis of all coal samples was analysed. The average of each 5 samples calculated. The maximum carbon contents were found in PENCH valley coalfield samples while the lowest carbon contents were observed in WARDHA valley coalfield samples.

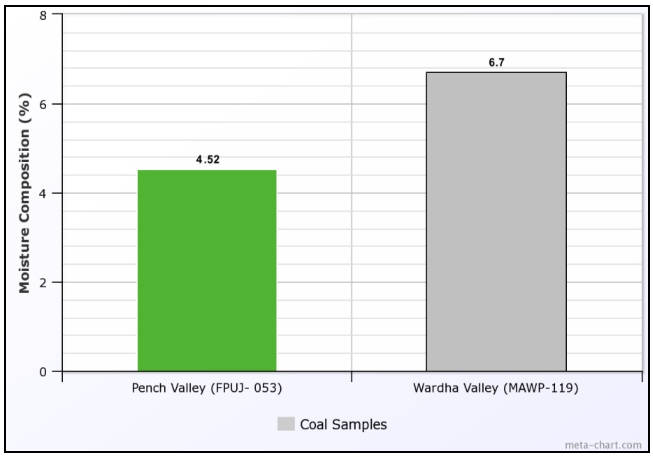

Fig 1: Percent Composition of Moisture present in Pench valley and Wardha valley samples

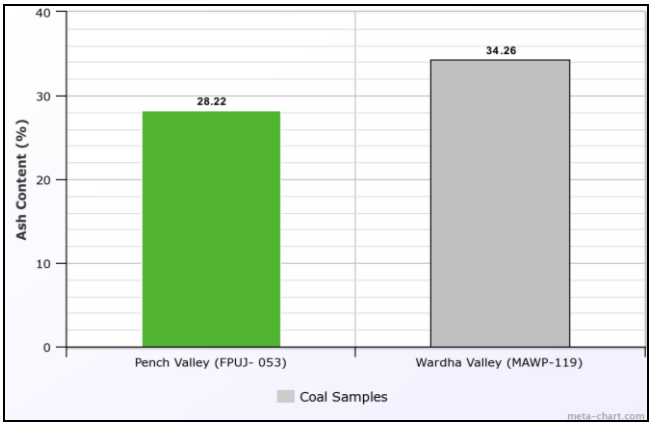

Fig 2: Percent composition of Ash Content present in Pench valley and Wardha valley samples

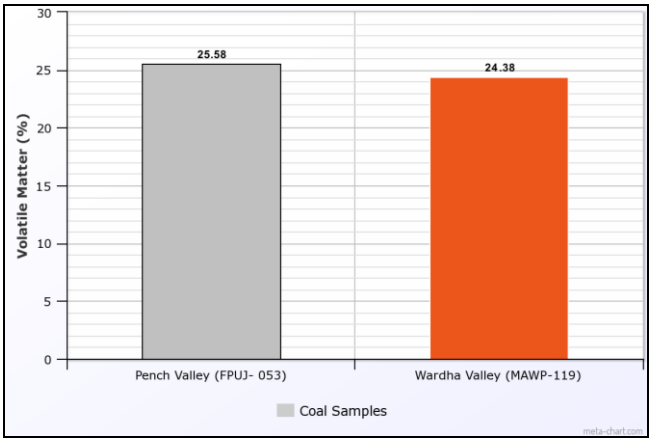

Fig 3: Percent composition of Volatile Matter present in Pench valley and Wardha Valley samples

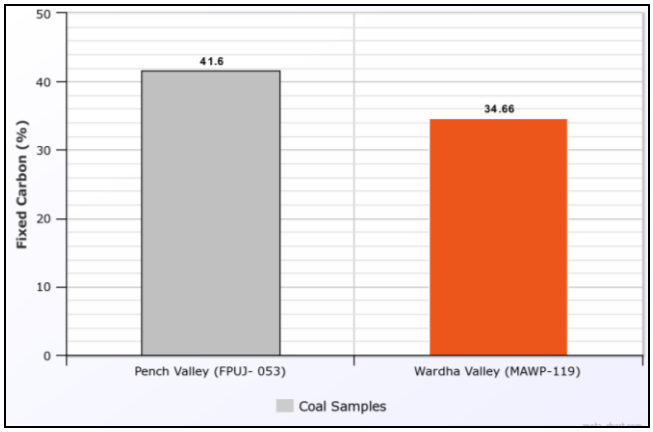

Fig 4: Percent composition of Fixed Carbon present in Pench valley and Wardha valley samples

Califoric Value

The average of each 5 samples was taken as a result of calorific values are shown in Figure 5 respectively. Calorific value indicates the degree of heat content of the coals. Bomb calorimetry was used to determine the Net Calorific Value.

PENCH coal reserve marked highest of 5009.8 KJ/kg and least by WARDHA Coal reserve 4219 KJ/kg coal reserve. All the two coal reserves are good for heating and power generation. However, the higher calorific values of PENCH coal reserves would be the best. The WARDHA valley and PENCH valley coal samples are of G-9 to G-13 and G-4 to G-11 grade of non-caking coal respectively.

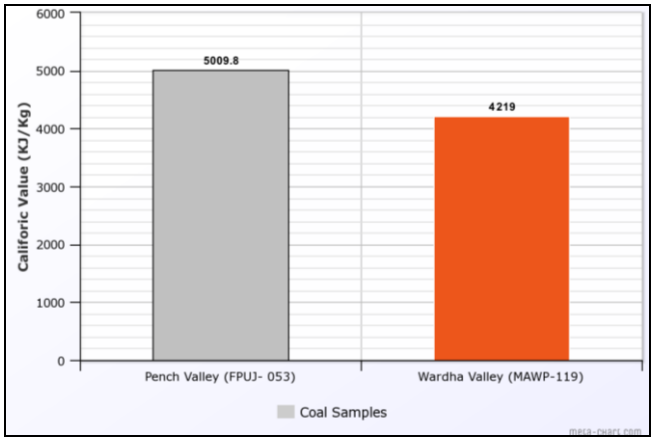

Fig 5: Percent composition of Califoric Value present in Pench valley and Wardha Valley Sample

Ultimate Analysis

The average of each 5 samples were calculated. The results of ultimate analysis have shown that PENCH valley coalfield have highest carbon content 55.16 % while WARDHA Valley Coal field have Lowest carbon content 44.14% respectively. This resulted in Bituminous and Sub-Bituminous ranking of coal samples. The sulphur and nitrogen contents are found very lowest amount for all coal samples studied. As such, limited NO_x and SO_y gases will be released to the environment during combustion. Thus, the coals are friendly to the environment.

Table 1: Percent composition of Ultimate Analysis of Pench valley and Wardha Valley Samples

Sr. No.	Coal Samples	Ultimate Analysis				
		C %	H %	N %	S %	O%
1.	Pench Valley (FPUJ-053)	55.16	3	1	0.5	7.8
2.	Wardha Valley (MAWP-119)	44.14	2.4	0.8	1.2	6.2

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Conclusion

Based on the above study, it can be concluded the parameters present in a proximate analysis like moisture and Ash were found high in Wardha valley coalfield as compare to Pench Valley coalfield. While Ultimate analysis showed that carbon contains found in Pench valley coalfield is significantly in higher extent than Wardha Valley coalfield. Overall, it can be concluded that the bituminous coal was found in Pench valley coalfield and sub-bituminous coal was found in Wardha valley coalfield

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