

**ENVIROMENTAL STUDY OF COAL DEPOSITS OF
SINDH, WITH SPECIAL REFERENCE TO HEAVY AND
TRACE METAL STUDY IN THAR, SONDA AND
METING-JHIMPIR COAL FIELD**



By

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**DOCTOR OF PHILOSOPHY
IN
GEOLOGY**

**NATIONAL CENTER OF EXCELLENCE IN GEOLOGY
UNIVERSITY OF PESHAWAR**

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**NATIONAL CENTER OF EXCELLENCE IN GEOLOGY
UNIVERSITY OF PESHAWAR**

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Dedicated to my Brother

HABIBULLAH SIDDIQUI

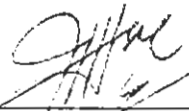
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ABSTRACT

Sindh is the second largest province of Pakistan in terms of population and physiographically known as the Lower Indus Basin. It is bounded by India in the east, Runn of Cutch and Arabian Sea in the south and the province of Punjab and Baluchistan in the north and west, respectively. This province is mainly composed of Western Highlands, Lower Indus Vally and Thar Desert. The Western Highland region includes the N-S crescent like hilly ranges of Kirthar, Pub, Laki and Kohistan area; the Lower Indus valley consists of monoclinal folds with adulatory plains in between and the Thar Desert is generally covering eastern part of the Sindh province. Stratigraphic succession of the Lower Indus Basin in Sindh region include the late Proterozoic magmatic rocks and Jurassics, Cretaceous / Paleocene and Neogene sedimentary sequences. These are covered with Quaternary marine coastal, offshore and aeolian deposits.

Recently, huge coal deposits are explored in the Sindh province and still the exploration of other coal resources are underway. The coal deposits explored so far include the Thar, Sonda, Meting-Jhimpir and Lakhra coalfields. These coal deposits occur in Bara Formation and in the Sonhari member of the Early Eocene Laki Formation. The Thar coalfield is the largest coalfield of Pakistan and is situated in the District Thar Parkar of south-east Sindh. It has the estimated resources of 175 billion tones. Coal in the Thar coalfield is present in the Bara Formation of Paleocene-Eocene age. The Sonda coalfield is located in the deltaic area of lower Indus and is lying in the east and northeast of Keenjhar lake

in District Thatta. Coal seams in the Sonda coalfield occur in the Bara Formation of Paleocene age and the Laki Formation of Eocene age. The total resources of 280 million tones of coal have been explored in the Sonda coalfield. The Meting-Jhimpir coalfield in the District Thatta is the second oldest coalfield after Lakhra explored in Sindh province. It is present in the Sonhari Member of the Laki Formation of Early Eocene age. About 161 million tones of coal resources are present in the Meting-Jhimpir coalfield.

There is greater potential for exploration of coal deposits in the Lower Indus Basin of Sindh. Among the recently explored coal deposits of Sindh, the Thar Sonda and Meting-Jhimpir coalfields are of greater importance because these coal deposits will be exploited and utilized in the power generation plants and in the other industries of Pakistan in near future. The present study has been carried out to investigate the geological and geochemical characterization and environmental assessment of the Sindh coalfields before their use in various types of industries. In this regard, the representative coal samples from the Sindh coalfields, especially Thar, Sonda and Meting-Jhimpir have been investigated for the heavy, trace and light elements, the proximate and ultimate parameters, the combustion properties, the leaching behavior and the mineralogy by using various techniques.

Among the heavy and trace elements, the average Pb contents are 34 ppm, 17 ppm and 23 ppm; average Zn contents are 48 ppm, 44 ppm and 40 ppm;

average Cu contents are 18 ppm, 14 ppm and 22 ppm; average Ni contents are 41 ppm, 34 ppm and 23 ppm; average Cr contents are 20 ppm, 11 ppm and 12 ppm; average Cd contents are 0.31 ppm, 0.27 ppm and 0.24 ppm; average Co contents are 12 ppm, 83 ppm and 0.25 ppm; average Fe contents are 5008 ppm, 5867 ppm and 4500 ppm and average Mn contents are 0.67 ppm, 0.27 ppm and 0.09 ppm in the Thar, Sonda and Meting-Jhimpir coalfields, respectively. Among the light elements, the average amounts of Ca are 250 ppm, 203 ppm and 241 ppm; Mg are 76 ppm, 43 ppm and 60 ppm; Na are 573 ppm, 414 ppm, and 515 ppm and K are 210 ppm, 289 ppm and 252 ppm in the Thar, Sonda and Meting-Jhimpir coalfields, respectively. Among the proximate parameters, the average contents of Fixed carbon are 40.44%, 41.20% and 40.11% and Ash contents are 5.165%, 5.77% and 10.77% in the Thar, Sonda and Meting-Jhimpir coalfields, respectively. Among the ultimate parameters, the average contents of Hydrogen are 6.89%, 6.90% and 6.82%; average Carbon contents are 62.10%, 61.43% and 60.20%; average Nitrogen contents are 0.35%, 0.31% and 0.32% and the average Sulfur contents are 1.17%, 4.33 % and 3.65 % in Thar, Sonda and Meting-Jhimpir coalfields, respectively. The average Calorific values for Thar, Sonda and Meting-Jhimpir coalfields are calculated as 10111 btu/lb, 10301 btu/lb and 10143 btu/lb, respectively. By comparing the heavy and trace elements of Sindh coals with the other coals of Pakistan and elsewhere in the world, it is noticed that Sindh coals are relatively enriched in the Pb, Zn, Ni, Co and Fe. The amounts of fixed carbon, ash hydrogen, carbon and nitrogen in Sindh coals are

within the permissible limit, however, the sulfur contents, especially in the Sonda and Meting-Jhimpir coals are above the permissible limit.

Mineralogically the Sindh coals contain quartz and kaolinite as the dominant mineral phases with subordinate amount of calcite, dolomite, muscovite, illite and pyrite. The quartz and muscovite are generally detrital and the remaining phases are authigenic. The sequential leaching analyses suggest that most of the heavy and trace elements are associated with HCl – soluble compounds and also with the insoluble or organic shielded matters. However, the Fe is generally associated with the HNO₃ – soluble disulfides. The leaching behavior of the Sindh coal suggests that there are chances of contamination of the underground water system due to acid mine drain water during the large scale coal mining in the region. The combustion of the Sindh coals may also pose threat to the environment of the region as far as the S, Pb, Zn and Ni contents of Sonda and Meting-Jhimpir coals are concerned. These coals, therefore need to be cleaned and also the particulate emission level of the power generation plants should be substantially reduced before the use of these coals in power generation plants and other industries of Pakistan.