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Geostatistical Modelling for Coal and Coal Bed Methane Resource Estimation: a case study from a Gondwana Coalfield, India

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Coal deposit modeling using geostatistics based approach provides a factual representation of heterogeneity of deposit parameters and thus, is considered to be of improved relevancy and more useful than conventional modelling. Such a modeling approach aims at adequate characterization of coal deposit for follow-up decisions. An attempt has been made for developing an integrated geo-mathematical model for a Gondwana coalfield in India employing suitable geostatistical techniques for appropriate quantification of heterogeneity in coal and Coal Bed Methane (CBM) resource estimation. Coal exploration data pertaining to select coal seams have been collected from various exploration agencies. The exploration data were initially screened through Exploratory Data Analysis to remove possible outliers. Univariate statistical modeling revealed a wide variation of parameters indicating inherent heterogeneous nature of Ash and Volatile matter content. Studies on inter-relationships of the sample values through bi-variate statistics reveal poor association amongst them, indicating varying inherent nature of individual parameters. While thickness of coal seams represents depositional characteristics, quality parameters reveal the provenance characteristics, impurity and gassiness. Geostatistical semi-variogram analysis revealed a larger range of sample value influence due to a moderate to high degree of spatial correlation among the sample values, which is characteristic of a coal deposit. Use of geostatistical kriging procedure for estimation of block-wise quality parameters provided an improved means of quantifying error of estimation. However, geostatistical simulation, namely, simulated annealing revealed an improvement in the representation of local heterogeneity, being fairly close to the actual variations. Block-wise estimates of coal parameters have been used to arrive at block estimation of CBM resources. The construction of a spatial distribution map of CBM resources provided an improved representation of heterogeneity in terms of thickness and quality variation. Since no systematic study of geo-mathematical derivation of drill hole optimization has been carried out in the coalfield, a geostatistical approach to drill hole optimization strategy has been developed. The study suggested that a drill configuration of 300 m x 300 m grid pattern, with a density of 16 drill holes per square kilometer of area is adequate for exploration in the coalfield. The workflow adopted is provided in Figure 1.

Suitable integration of various geostatistical model parameters provided an improved understanding of the coal sedimentation process in the basin. The holistic geo-mathematical model thus conceptualized for the coalfield resulted in spatial heterogeneity modeling for the coalfield providing adequate

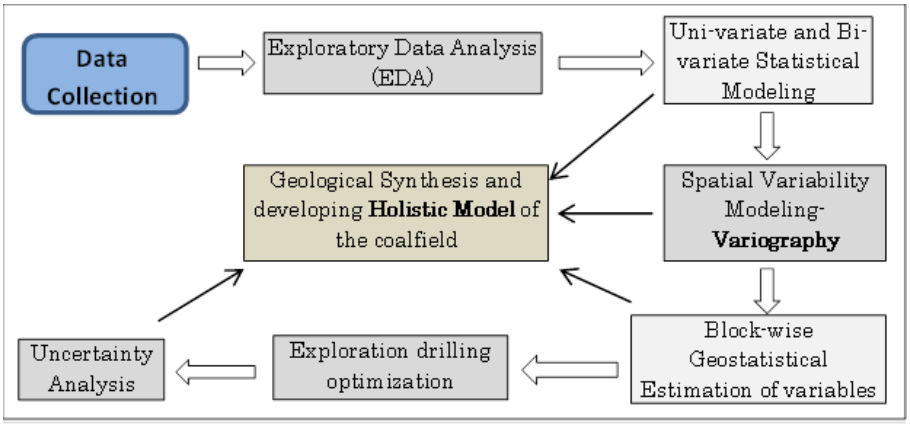

Figure 1: Workflow adopted in the present study for developing Holistic Model

estimation of coal and CBM resources. The study provides an objective approach to geo-characterization of an Indian Gondwana coalfield. The derived relationships are useful in formulation of exploration strategy, estimation of coal and CBM resources and follow-up decision making.