EXGID – A prototype exploration geological information system for Jharia Coalfield, India

Kalyan Saikia and B C Sarkar*

Department of Applied Geology, Indian School of Mines, Dhanbad 826 004

Received 16 March 2006; revised 15 February 2007; accepted 19 February 2007

A prototype exploration geological information system (EXGID) has been developed to provide a quick and user-friendly means for rapid access, search and retrieval of information in respect of various mine blocks and coal seams of Jharia coalfield. EXGID consists of three sub-systems (Geological, Mine Exploration Block and Coal Seam), each of which is further segmented into several information categories to provide detail information in respect of the coalfield. Core program of EXGID system has been developed in Visual Basic environment (Version 6.0) and database management part of the system has been developed using Microsoft Access. EXGID system comprises a visual basic executable file (EXGID.exe), two microsoft access datafiles (geostruc.mdb, seamstat.mdb) and a number of BMP files for visualization of location map of various mine exploration blocks of Jharia coalfield. The system provides a facility for rapid search and retrieval of user’s required geological and exploration information ensuring minimum redundancy.

Keywords: EXGID, Exploration, Information system, Jharia coalfield

Introduction

Exploration of Indian coalfields has generated vast geological and exploration data, which had been stored conventionally in the form of exploration reports and at the most in form of discrete datafiles. In this context, a prototype exploration geological information system (EXGID) has been developed to provide a quick and user-friendly means for rapid access, search and retrieval of information in respect of various mine blocks and coal seams of Jharia coalfield, India.

Geological Description of Jharia Coalfield

Jharia coalfield1-2 located in Dhanbad district of Jharkhand state is the largest coking coalfield in India. It is the only source of prime coking coal in the country with more than 100 years of mining history. The coalfield is bounded between latitude N23°37’32” and N23°52’22” and longitudes E86°06’2’’ and E23°30’2’’. It covers an aerial extent of 456 sq km extending along east west direction. The coalfield represents a coal basin in the Koel-Damodar valley that is situated in the eastern part of the valley along the north of river Damodar.

The coalfield displays a thick sedimentary sequence of about 2900 m of shallow water, fluviatile, lacustrine and glacial environment ranging in age from Carboniferous to Permian3. Stratigraphically, the coalfield comprises rocks of Talchir and Damuda Group of lower Gondwana system resting unconformably over the metamorphosed gneissic rocks of Archean age with intrusive igneous rocks of younger age. The Damuda Group consists of Barakar, Barren Measures and Raniganj formations. A total of 46 coal seams in Barakar formation and 24 coal seams in Raniganj formation have been identified4. Coal seams of Barakar formation are superior and higher in rank than coal seams of Raniganj formation5,6.

Being the only source of prime coking coal in India, the Jharia coalfield has been extensively explored by Geological Survey of India (GSI), Central Mine Planning and Design Institute (CMPDI), Bharat Coking Coal Limited (BCCL), a subsidiary of Coal India Limited (CIL) and National Coal Development Corporation (NCDC) through surface diamond drilling of several thousand metres. The vast amount of information on geology and exploration generated from these exploration campaigns and as available in published texts.
and exploration reports have been compiled and incorporated into the EXGID prototype system.

This paper highlights the architecture and structure of EXGID in respect of various geological and exploration data acquired over the decades by various agencies in Jharia coalfield, India.

Proposed EXGID Information System

Hardware Requirements

The core program of EXGID prototype system has been developed in Visual Basic environment (Version 6.0) and database management part of the system has been developed using Microsoft Access. The system operates under Windows 98 or higher platform on any IBM PC compatible computer, preferably Pentium – III or higher microprocessor with at least 256 MB RAM. The hard disk space requirement is 10.7 MB for the entire system. However, the size of the EXGID system further increases with incorporation of new data into the system.

Information Categories of the EXGID Prototype System

EXGID prototype information system is a menu-driven system consisting of three sub-systems (Geological, Mine Exploration Block and Coal Seam), each of which is further segmented into several categories to provide information in respect of coalfield.

Geological Information Sub-system

Geological information sub-system provides basin geology, exploration details, coal seams, physico-chemical properties and petrographic properties of coal, coal reserves and coal bed methane (CBM) potentiality. Each of these information categories is linked to text files containing information on the related categories. A detailed geological map of the coalfield is made available along with the basin geology to explain spatial disposition of various geological units of the coalfield. Under exploration details, history of exploration activities carried out by various agencies in Jharia coalfield, have been provided. Nature and characteristics of various coal seams of Jharia coalfield are documented under the information category on coal seams. Physico-chemical and petrographic properties of various coal seams of Jharia coalfield can be obtained from the information categories on physico-chemical and petrographic properties respectively. Under coal reserves information category, type-wise (prime coking, medium coking and non coking) coal reserve of Jharia coalfield have been provided. Information regarding CBM potentiality of the coalfield as revealed from various exploration activities is incorporated under the information category CBM potentiality.

Mine Exploration Block Sub-system

Mine exploration block sub-system of the EXGID system has been developed to impart various information on geographic location of blocks, subsurface geological structure, exploration status, coal reserves, coal quality and type and number of coal seams. Each of these information categories are further partitioned into several information fields (Table 1) resulting in a total of 34 information fields under this sub-system. Individual maps displaying geographic location of various mine exploration blocks of the coalfield are included under this sub-system.

Coal Seam Information Sub-system

Jharia coalfield is comprised of a total of 46 coal seams in Barakar formation and that of 24 in Raniganj formation including both regional and local coal seams. To provide comprehensive information on various quality parameters of these coal seams, the coal seam information sub-system has been developed. This sub-system includes statistics of various constituents of proximate analysis of coal (ash, volatile matter, moisture and fixed carbon, seam thickness). In addition, depth range of occurrence of these coal seams and their spatial disposition within the coalfield are also incorporated into this sub-system.

System Architecture

Architecturally, EXGID information system comprises a visual basic executable file, EXGID.exe, two microsoft access datafiles (geostruc.mdb, seamstat.mdb) and a number of BMP files for visualization of location map of various mine exploration blocks of Jharia coalfield (Fig. 1). The core program file (EXGID.exe) contains information on linking of various menus and their connection with two datafiles. On execution of the program, the information stored in each information fields is displayed in respective display information fields of various menus.

The geostruc.mdb contains information on various mine exploration blocks of Jharia coalfield, and seamstat.mdb contains statistics of quality parameters of various coal seams. Both datafiles store data in tabular form and connected to Open Data Base Connectivity (ODBC) of the computer system to provide internal communication between visual basic executable file and the two microsoft access datafiles. Because of this
SAIKIA & SARKAR: EXGID – A PROTOTYPE EXPLORATION GEOLOGICAL INFORMATION SYSTEM

Table 1—Various information categories and related information fields of mine exploration sub-system of EXGID

<table>
<thead>
<tr>
<th>Information category</th>
<th>Information field</th>
<th>Field type (Fields width)</th>
<th>Information category</th>
<th>Information field</th>
<th>Field type (Fields width)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic location of block</td>
<td>Latitude</td>
<td>S (10)</td>
<td>Coal reserves</td>
<td>Prime coking</td>
<td>N (3)</td>
</tr>
<tr>
<td></td>
<td>Longitude</td>
<td>S (10)</td>
<td>Medium coking</td>
<td>N (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>S (15)</td>
<td>Non coking</td>
<td>N (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>N (5)</td>
<td>Net coal reserve</td>
<td>N (4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Towards North</td>
<td>S (20)</td>
<td>Type and number of seams</td>
<td>Seam group</td>
<td>S (10)</td>
</tr>
<tr>
<td></td>
<td>Towards South</td>
<td>S (20)</td>
<td>Stratigraphic unit</td>
<td>S (10)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Towards East</td>
<td>S (20)</td>
<td>No. of major seam</td>
<td>N (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Towards West</td>
<td>S (20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsurface geological structure</td>
<td>Strike Direction</td>
<td>S (10)</td>
<td>No. of local seam</td>
<td>N (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dip amount</td>
<td>N (2)</td>
<td>No. of fire affected seam</td>
<td>N (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dip direction</td>
<td>S (7)</td>
<td>Thickest seam</td>
<td>S (10)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. of subsurface fault</td>
<td>N (3)</td>
<td>Thinnest seam</td>
<td>S (10)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range of fault throw</td>
<td>N (5)</td>
<td>Maximum parting</td>
<td>N (5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remarks</td>
<td>S (50)</td>
<td>Minimum parting</td>
<td>N (5)</td>
<td></td>
</tr>
<tr>
<td>Exploration status</td>
<td>Total no. of drillholes</td>
<td>N (3)</td>
<td>Seam quality</td>
<td>Prime coking</td>
<td>S (15)</td>
</tr>
<tr>
<td></td>
<td>Total meterage</td>
<td>N (6)</td>
<td>Partly prime coking</td>
<td>S (15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drillhole location plan</td>
<td>Map</td>
<td>Medium coking</td>
<td>S (15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Non coking</td>
<td>S (15)</td>
<td></td>
</tr>
</tbody>
</table>

internal communication with ODBC on execution of the program, various information fields are connected automatically with the display fields.

User Interface of EXGID

EXGID information system, a menu-driven, multi-level window based system, is designed to provide a high level user-friendly environment while browsing, searching and acquiring information stored in the system. The system can be operated using both mouse and keyboard. The main menu of the system provides three links to its three sub-systems. On accessing the geological information sub-system, a list of various

![Architecture of the EXGID information system](image-url)
information categories of this sub-system would be viewed from which specific geological information of the coalfield can be selectively retrieved. The window for mine exploration block information sub-system (Fig. 2) is provided with a list of names of both open-cast and underground mine blocks along with links for various information categories of this sub-system. On selecting a particular block from the list, a map of Jharia coalfield showing all the mine blocks and highlighting the selected block would be displayed (Fig. 2) in the lower part of the same window. This provides the user an easy means to locate the selected block in the map of Jharia coalfield and its position with respect to other blocks. To view the information of the selected block, a user has to specify the information category from the list by clicking through mouse on it. This opens another window displaying the specified information of the selected block.

The window for coal seam information sub-system (Fig. 3) is provided with a list of seam numbers for which information is available and a space to enter the seam number for which the user wants to retrieve information. On providing a coal seam number in the specified field, the system would automatically draw the statistics of the entered copal seam from seamstat.mdb datafile and accordingly display opening a new window. Each of the windows displaying various information under each sub-system are linked to the EXGID main menu through a option button.

Conclusions
EXGID prototype information system provides a quick and pragmatic means for storage, rapid search and retrieval of required exploration and geological information of Jharia coalfield ensuring minimum redundancy. EXGID system offers a sound scientific base for use and aid in coal resource assessment, decision based planning and policy formulation of Jharia coalfield. System aims to provide a role model for development of a national coal information system for India in line of coal resource databases of United States Coal Resource Database (USCOAL), the Coal Database (COAL) developed by Council for Geoscience for South Africa etc. System has been made flexible to accommodate new data as and when available. Future strategies to modify EXGID system also include making it an online information system so that users from any part of the country can access the information stored in this system.

Acknowledgements
Authors thank Department of Applied Geology, ISM, Dhanbad for providing necessary infrastructure while developing the prototype information system. Author (KS) acknowledges CSIR, New Delhi for financial support through grant no. 9/85 (97)/2K2/EMR-I.

References
1 Fox C S, The Jharia Coalfield, GSI Memoir No. 56 (Geological Survey of India, Kolkata) 1930, 1-255.
2 Mehta D R S & Murthy B R N, A revision of the geology and coal resources of the Jharia coalfield, GSI Memoir No. 84 (2) (Geological Survey of India, Kolkata) 1957, 1-142.
5 Chandra D, Jharia Coalfields (Geological Survey of India, Bangalore) 1992, 1-149.
6 Chatterjee C N, Ghose S & Chandra D, Micropetrographic characteristics of certain lower Permian coal seams of India wit special reference to their mode of formation, Coal Geol, 14 (1990) 295-308.