DATA MANAGEMENT
3D MODELLING
MINE DESIGN

ANALYSE COAL DATA WITH SPEED AND ACCURACY • CREATE 3D SEAM MODELS • MEASURE RESOURCES • DESIGN THE OPTIMAL MINE

Intuitive Mining Solutions

Micromine
Coal Measure
Coal Measure is a dynamic and integrated software solution for coal data management and coal data processing with 3D seam modelling, resource categorisation, resource reporting, pit optimisation, pit design and scheduling.

INTRODUCTION - AN EASY TWO-STEP APPROACH
Coal Measure’s unique two-step approach provides powerful tools to collect, assemble, prepare and correlate all the data associated with a project before modelling the deposit and designing the mine.

Coal Measure’s data management solution provides a flexible and efficient environment for capturing, validating, storing and managing data from diverse sources.

The solution’s powerful modelling environment quickly creates 3D seam block models for either simple or complex deposits.

This intuitive approach saves vast amounts of time. A continuous automated checking process ensures that data such as core logs, assay data, survey information or downhole geophysics, is correct before it is written to the production database. Any mismatches or errors are highlighted and reported to the geologist. This unique feature speeds up the data correlation process and ensures errors are identified before modelling commences, saving time and money.

Once the geologist is confident the data is accurate, Coal Measure generates a logical workflow to map the stratigraphy, identify the pinchouts, model faults and generate a 3D model that can be viewed and checked for accuracy. Depending on the style of the deposit, a block model can then be generated.

In coking coal deposits, Coal Measure’s standardisation tools interpolate missing data, compile a standard wash matrix, and provide features to display and export coal washability tables, as required.

Manage your Coal Measure Investment
Coal Measure is an adaptable, modular solution. As your operation grows and your requirements change, Coal Measure grows with you enabling you to manage your investment.

THE COAL MEASURE PROCESS
Exploration
Coal Measure is used in typical coal exploration processes such as regional mapping, satellite imagery display, interpretation of base maps, defining structures and basin features, geophysics modelling and display, and drill hole planning.

Data Management
Coal data is captured, validated and stored in a centralised database using Coal Measure’s data management tool. Depth adjustment and seam correlation routines are used to generate points of observation, ready for modelling.

3D Modelling
Coal Measure’s intuitive methodology combines traditional gridding and 3D block modelling. The resulting Seam Block Model uses a variable block thickness to efficiently describe the seam structure of the entire area.

Coal quality can be written to the Seam Block Model using various interpolation algorithms. Other attributes, such as resource classification and strip ratios, can also be added.

This means that the modelled information is contained in a single file that becomes the basis for all reporting.

Resource Reporting
Resource classification is easily applied to the model by assigning zones of influence based on established points of observation and drilling spacing. Simple tools facilitate seam coding and generate resource reports.

Easy to use macros can automate the modelling process so that a project can be rerun from beginning to resource report stage at the push of a button.

This provides an audit trail and makes it simple to incorporate changes such as additional information or corrections.

Pit Optimisation
The resulting categorised block model is then used in the pit optimisation process where various economical parameters are applied to generate the optimal pit shell.

Mine Design
Coal Measure’s open cut and underground mine design tools reference the generated grids, wireframes, block models or optimised pit shells to create the optimum mine design.

Scheduling
Coal Measure’s fully integrated scheduling module plans and schedules optimal material extraction. The scheduling workflow comprises five simple steps, is easy to use and eliminates the requirement to import and export files with third party applications.
PRODUCTIVITY BENEFITS
Coal Measure delivers productivity and efficiency benefits including:

Accuracy
To perform effective interpretation of the deposit, you will have all the tools you need to honour both the seam hierarchy definition and recognised fault zones.

Speed
Save time spent modelling coal projects. The robust and sophisticated nature of Coal Measure gives you results quickly and accurately.

User-Friendly Features
Straightforward, clearly defined functions make Coal Measure easy to understand and use.

Excellent Integration of Significant Functions
Coal Measure combines a variety of important functions into one solution. From modelling and design to interfacing seamlessly with corporate borehole data storage systems and ODBC databases, you can depend on a single package which is dynamic and reliable.

COAL MEASURE CONSULTING SERVICES
Geological Data Management Consulting
Coal Measure's geological data management consulting specialists provide consulting services that span the complete data management spectrum, from the development of a data management strategy through to implementation, change management and maintenance. Data management consulting consists of the following services:

• Implementation Services - Coal Measure's professionally qualified team will ensure the implementation of your data meets your geological requirements, complies with your data management strategy and best practice IT governance.

Our team provides custom database designs, database administration services, data management services, data migration, system integration and project management.

• Post Implementation Maintenance Services - A variety of post-implementation maintenance and management services are available. These provide assurance that key data assets are safe, secure and available as required. Maintenance packages are customised based upon client limitations, complexities and needs.

MICROMINE CONSULTING SERVICES
Micromine Consulting Services (MCS) provides a range of geological and mining consulting services to coal and mineral resource companies worldwide.

Services include:
• Exploration and mining studies
• Technical Reports
• Resource and Reserve Estimation
• Competent person reports compliant with all International and Local Standards
• Valuations
• Prospectus
• Project Audits
• Technical reviews and development of modelling technologies
• Reconciliation of reports against previous studies
• Due diligence
• Reports for Initial Public Offerings (IPO's) and private capital raising
WHY MICROMINE?

With over 12,000 clients in more than 90 countries, MICROMINE is a leading provider of intuitive software solutions to the mining and exploration industry. From capturing, managing, visualising and understanding data to controlling and reporting on mine production, MICROMINE has a solution for every stage of the mining process.

MICROMINE understands the software and consultancy needs of exploration and mining operations around the world. Located in 20 of the world’s major mineral producing countries, our team is close to your operation. This means MICROMINE can provide you with local support and services in your language and time zone.

MICROMINE’s intuitive solutions are delivered by a team of specialists who understand the software and how it can be integrated into your operation for maximum results.
## FEATURES AND BENEFITS

<table>
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<tr>
<th>FEATURE</th>
<th>BENEFIT</th>
<th>OUTCOME</th>
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<tbody>
<tr>
<td><strong>GEOLOGICAL DATA MANAGEMENT</strong></td>
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<tr>
<td>Comprehensive Data Management utilising a Relational Data Model</td>
<td>SQL server database with proven data model that manages all data associated with multiple projects. A relational data model allows cross referencing of all project information, facilitating automated checking of core data, assay information, surveyed collar positions, downhole survey data, and tenement boundaries.</td>
<td>Improved confidence in the data. Robust and secure storage with facility to handle all types of coal quality information. Provides concise, correct reports based on clean, valid data.</td>
</tr>
<tr>
<td>Coal Quality Management</td>
<td>Compositing, standardisation and calculation of wash tables.</td>
<td>Easily create wash curves for coking coal data. Complex data results are securely stored.</td>
</tr>
<tr>
<td>Fence Diagrams (seam correlation)</td>
<td>Create 2D fence diagrams by selecting holes from a plan view.</td>
<td>Ideal for visualising, validating and correcting seam correlations. Quickly generates accurate displays.</td>
</tr>
<tr>
<td>Graphical Reports</td>
<td>Detailed visual representation of geotechnical, hydrological, geological and geophysical data.</td>
<td>View data as graphic logs complete with core photos. Historical data is preserved.</td>
</tr>
<tr>
<td><strong>GEOLOGICAL EXPLORATION</strong></td>
<td></td>
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<tr>
<td>Plotting</td>
<td>Plot anything you can see on the screen with two simple keystrokes.</td>
<td>Exceptional speed, saves time.</td>
</tr>
<tr>
<td>Import and Display Geophysical Data</td>
<td>Import LAS files and compare graphically against borehole logs.</td>
<td>Saves time and improves interpretation.</td>
</tr>
<tr>
<td>Depth Adjustment Tool</td>
<td>Corrects stratigraphic interpretations or seam correlations.</td>
<td>Adjusts seam logs onto geophysical logs quickly and accurately. Saves time and improves data quality.</td>
</tr>
<tr>
<td>Coordinate Transformations</td>
<td>Multiple coordinate systems can be used simultaneously and transformed to a single grid.</td>
<td>Multiple datasets can be viewed simultaneously saving time.</td>
</tr>
<tr>
<td>Multiple Data Layers</td>
<td>View third party GIS, image, grid, Google Earth, and CAD files together with drill holes, surfaces, solids, block models and point data.</td>
<td>Graphical, easy-to-use, 3D interface allows virtually any information to be imported so informed decisions can be made by seeing all relevant information in the same window. Feature can be turned on/off easily. Increases understanding of information and saves time.</td>
</tr>
<tr>
<td>Interactively view Standard or Oblique Sections</td>
<td>Open multiple windows or toggle different viewpoints within the same window.</td>
<td>Quickly and easily switch between clipped sections and unconstrained 3D views to view all data in a section at any angle using simple ‘click’ and ‘drag’.</td>
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<tr>
<td><strong>MODELLING</strong></td>
<td></td>
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<tr>
<td>Define and Display Stratigraphy</td>
<td>Identify all seams and splits and visually confirm the seam hierarchy.</td>
<td>Diagrammatic validation of the seam stratigraphy can be generated quickly and easily.</td>
</tr>
<tr>
<td>Automatic Insertion of Interburden and Zero Thickness Layers</td>
<td>Thickness calculations based on neighbouring holes.</td>
<td>Control over how to establish the thickness of undefined layers.</td>
</tr>
<tr>
<td>Extrapolate Above Collar and Below End of Hole</td>
<td>When reference seam is not intersected, use surrounding holes to estimate its position.</td>
<td>Model eroded seams and holes of insufficient depth.</td>
</tr>
<tr>
<td>3D Seam Correlation</td>
<td>3D validation of stratigraphy. Identifies all seams and generates all parent/child seam relationships.</td>
<td></td>
</tr>
<tr>
<td>Fault Zones Modelled Independently</td>
<td>Digitise fault boundaries.</td>
<td>Polygonal definitions allow multiple zones to be modelled simultaneously.</td>
</tr>
<tr>
<td>Seam Block Models</td>
<td>A block model with consistent X and Y dimensions but variable Z (thickness).</td>
<td>No sub-blocks required. A single block defines the vertical extent of each layer.</td>
</tr>
<tr>
<td>Intersect Seam Block Model with Surface</td>
<td>Use a DTM to update Seam Block Model.</td>
<td>Trim to topography or split at base of weathering.</td>
</tr>
<tr>
<td>Strip Ratios</td>
<td>Calculate (cumulative) volume or tonnage strip ratio for every coal block.</td>
<td>Strip ratio can be reported or contoured.</td>
</tr>
<tr>
<td>Convert Seam Block Model to Wireframe</td>
<td>Output surfaces (roof and/or floor) and solids (seams).</td>
<td>Conveniently display a smoothed representation of the Seam Block Model.</td>
</tr>
<tr>
<td>Model Coal Quality Attributes</td>
<td>Coal quality attributes become additional fields in the Seam Block Model.</td>
<td>Leverage the standard block model display (colour coding) and reporting facilities.</td>
</tr>
<tr>
<td>Simple Resource Classification</td>
<td>Define polygonal zone boundaries and then assign these to the Seam Block Model.</td>
<td>Group by resource classification in report.</td>
</tr>
<tr>
<td>Reporting</td>
<td>Basic tonnes and volume, seam by seam, or include classification, coal quality and strip ratios.</td>
<td>Easy to generate with grouping facility.</td>
</tr>
<tr>
<td>Consolidation - everything in one place</td>
<td>Seam Block Model file contains all data relevant to all seams and partings associated with volume, tonnage, density, quality, thicknesses and all relevant information which can be viewed as a table or a 3D object.</td>
<td>Convenience and transparency. No black box.</td>
</tr>
<tr>
<td>Contour any Feature</td>
<td>Thickness, elevation, strip ratio or coal quality.</td>
<td>Generate isopach and other standard maps.</td>
</tr>
<tr>
<td>Pit Optimisation</td>
<td>Determines the most profitable open pit taking into account discounting and production constraints.</td>
<td>Maintains the job in one application, eliminates the import/export step. No need for waste model.</td>
</tr>
<tr>
<td><strong>MINING</strong></td>
<td></td>
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<tr>
<td>Mine Design</td>
<td>Powerful and intuitive tools for open pit mine design enabling development and production.</td>
<td>3D visualisation environment that simultaneously displays, queries, and interactively edits multiple layers.</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Fully integrated with Coal Measure. Provides sequencing of the mining blocks, allocation of resources and time components and generates Gantt chart and real-time reports. Provides integrated visual and animated 3D views of the schedule using Vizex, the Coal Measure 3D environment.</td>
<td>Schedules the extraction of material to meet production and economic targets. Calculates volumes over user-defined time periods. Provides an ordered sequence of events. Provides both time and visual reporting.</td>
</tr>
</tbody>
</table>
SUPPORT IN YOUR LANGUAGE, YOUR TIME ZONE

OTHER MICROMINE SOLUTIONS

MICROMINE CONSULTING SERVICES (MCS)
Micromine Consulting Services provides geological and mining consulting services compliant with international reporting standards such as JORC; NI43-101; SAMREC; SEHK (Chapter 18, Hong Kong); and PERC (Pan-European Reserves and Resources Reporting Committee) Codes. Local standards compliance includes the China MLR and Russian, Ukraine and Central Asian GKZ (State Commission on Mineral Reserves) Standards. All MCS consultants are experienced geologists, mining engineers, metallurgists, surveyors, database managers and GIS specialists with extensive backgrounds in metals, energy and construction.

FIELD MARSHAL
MICROMINE’S Field Marshal solution captures and manipulates exploration and mining geological field data. Compatible with most portable or hand-held devices, Field Marshal ensures field data is valid and reliable, enabling informed decisions. Enter data directly into Field Marshal, saving time, reducing errors and increasing productivity. Inexpensive and easy to use, Field Marshal is a recognised industry standard field data collection solution.

GEOBANK
Geobank is a flexible, reliable and secure data management solution that captures, validates, stores and manages data from diverse sources. Geobank seamlessly integrates with Micromine to enable mining and exploration companies to maintain the quality, integrity and usability of their essential data.

MICROMINE
Micromine is a world leading geological exploration and mine design solution. Developed for all stages of the mineral extraction process, Micromine takes you from target generation through to exploration, geological modelling, resource modelling, pit optimisation, mine design, reserve estimation, production scheduling and grade control.

PITRAM MINE PRODUCTION AND CONTROL MANAGEMENT
Pitram complements Micromine’s exploration and mining solutions, a real-time mine production control system that records and manages mine site operations. Pitram’s powerful planning functionality provides users with a snapshot of their mine. With access to maintenance plans, crew schedules and mining plans, users have the tools needed within a single environment to make informed decisions. From risk management and asset tracking to grade optimisation and stockpile management, Pitram’s real-time viewing environment helps you visualise your operations so that you have a complete production overview. Pitram’s reporting, analysis and integration platform is also vital to ensuring that the data obtained from disparate sources is presented in an organised and integrated fashion. Flowing from intuitive and flexible planning functionality, through to short interval control and open pit and underground optimisation, Pitram drives a continual improvement process.

DOME
Dome is a web-based operational intelligence solution designed for the mining industry. The software application is capable of collecting data from existing systems and presenting decision makers with specific, timely and relevant information. By sourcing data related to a mine’s activities, Dome provides information that supports general data analysis and process improvement methodologies. Mine staff can make informed decisions related to the operation; reducing costs, improving resource utilisation and increasing production.

MICROMINE TRAINING
MICROMINE offers a full suite of training modules ensuring you derive the maximum value from your software. Structured to grow with your MICROMINE investment, MICROMINE training builds on your product knowledge and expertise.
COAL MEASURE: SEAM STRATIGRAPHY WORKFLOW

- Extract seam stratigraphy
- Define seam stratigraphy
- Extract seam information to a new file
- Generate seam file
- Seam splitting?
- YES: Breakdown seam codes into plies
- NO: Extrapolate and extract reference seam and calculate 3D coordinates
- Reference seam above collar or below EOH?
- YES: Extrapolate and extract reference seam and calculate 3D coordinates
- NO: Extract reference seam and calculate 3D coordinates
- Tenement constraints?
- YES: Digitise mining lease boundaries
- NO: Faulting?
- YES: Digitise fault zone boundaries
- NO: Insert interburden
- Generate stratigraphy
- Insert zero thickness and interburden intervals
- Define seam stratigraphy
- Interpolate seams
- Extract unique
- Stratigraphic hierarchy

Interactive tools

Digitise mining lease boundaries

Digitise fault zone boundaries

Extract reference seam

Generate seam file

Breakdown seam codes into plies

Interpolate seams

Extract reference seam

Extract reference seam and calculate 3D coordinates

Extract reference seam

Extrapolate and extract reference seam and calculate 3D coordinates

Extrapolate reference seam
COAL MEASURE: MODELLING WORKFLOW

1. Import, validation data preparation
2. Define and apply seam stratigraphy
3. Identify domain boundaries
4. Choose gridding method
5. Kriging? (YES) Generate elevation (and thickness) variograms
6. Generate reference seam elevation grid
7. Clip to tenement boundary
8. Generate ply and parting thickness grids
9. Convert grids to seam block model (SBM)
10. Trim blocks to topography or base of weathering
11. Insert overburden into SBM
12. Model attributes like coal quality, yield or confidence into SBM
13. Calculate resource classification and apply to SBM
14. Calculate strip ratio
15. Query SBM (reporting)
16. Convert seams into surfaces and/or solids
17. Contour any attributes
### COAL MEASURE: CREATING A SEAM BLOCK MODEL (SBM)

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare</td>
<td><strong>Generate Seam File</strong> - Extract Seam information to a new file. <strong>Stratigraphic Hierarchy</strong> - Define the Parent to Child relationship for all seam splits. <strong>Generate Stratigraphy</strong> - Generate a binary version of the stratigraphic hierarchy, and validate by displaying stratigraphy in a diagrammatic format.</td>
</tr>
<tr>
<td>Process</td>
<td><strong>Interpolate Seams</strong> - Use stratigraphic information to split parent seams into their child components. The pro-rata thickness of the splits can be based on a pre-defined ratio, or on information from neighbouring holes. <strong>Insert Interburden</strong> - Missing intervals between seams are defined as interburden and named according to user defined rules. <strong>Identify Reference Seam</strong> - The elevation for this seam will be modelled, so this is normally the seam intersected by the most holes. The Extract Unique function is used to identify this seam. <strong>Extract Reference Seam (RS)</strong> - Coordinates are calculated for all intersections in the seam file. At the same time the intersections for the reference seam are written to a separate file as a convenience for the elevation modelling. The reference seam can (if required) be modelled for holes where there is no intersection due to insufficient depth or weathering.</td>
</tr>
<tr>
<td>Model Reference Seam (RS) Elevation</td>
<td><strong>Calculate Semi Variogram</strong> - Kriging is the recommended way to model elevation. So the first requirement is to generate a semi variogram. Because there is confidence in the ‘Z’ values of the intersections, the nugget value will be close to zero. <strong>Grid Elevation</strong> - Define an appropriate East and North cell size for the gridding process. This will later define the East and North block size of the Seam Block Model. Create a gridded surface representing elevation (roof, floor or mid) of the reference seam. Clip this surface to the mining lease boundary (or any other restriction).</td>
</tr>
<tr>
<td>Model Thickness</td>
<td><strong>Grid Thickness for all Layers</strong> - All seam and interburden thicknesses are modelled, using the same cell size as the reference seam elevation. If kriging is used as the interpolation method, then firstly generate a semi variogram for thickness.</td>
</tr>
<tr>
<td>Generate SBM</td>
<td><strong>Convert Grids to a Seam Block Model (SBM)</strong> - By combining the elevation and thickness grids for the reference seam, each cell becomes a 3D block. Although all blocks have the same ‘X’ and ‘Y’ dimension, the ‘Z’ dimension will vary to match the modelled thickness. So the top and bottom of each block equates to the roof and floor of the seam. Starting with the interburden immediately above (and below) the reference seam, the thickness grids are used to generate new blocks. Each cell in the original grid has become a vertical column of contiguous blocks, honouring the stratigraphic sequence. The resulting file is called a Seam Block Model.</td>
</tr>
<tr>
<td>Enhance SBM</td>
<td><strong>Modify Existing Content of Seam Block Model (SBM)</strong> - Recode blocks where interburden or coal is less than a defined thickness - Trim blocks to any surface (topography) - Split blocks at any surface (base of weathering) - Insert overburden blocks <strong>Add Fields to Seam Block Model (SBM)</strong> - Model any attribute (density, coal quality) - Calculate strip ratios - Apply classification to coal blocks (Measured, Indicated and Inferred)</td>
</tr>
</tbody>
</table>
COAL MEASURE: CREATING A SEAM BLOCK MODEL (SBM)

1. Prepare

Stratigraphic hierarchy diagram displays parent to child relationships.

2. Process - Interpolate Seams and Insert Interburden

Trace shows raw logged data on the right; the hierarchy diagram and the same data shown on the left after running Interpolate Seams.

3. Model Reference Seam (RS) Elevation

Semi variogram and grid elevation.

4. Generate Seam Block Model

Display shows vertical columns of contiguous blocks, honouring the stratigraphic sequence to generate a SBM.

5. Enhance Seam Block Model

Displays show modified SBM content and addition of fields to the SBM.

6. Report on Seam Block Model

Example of a seam block model report.