



Mine Stability Mapping

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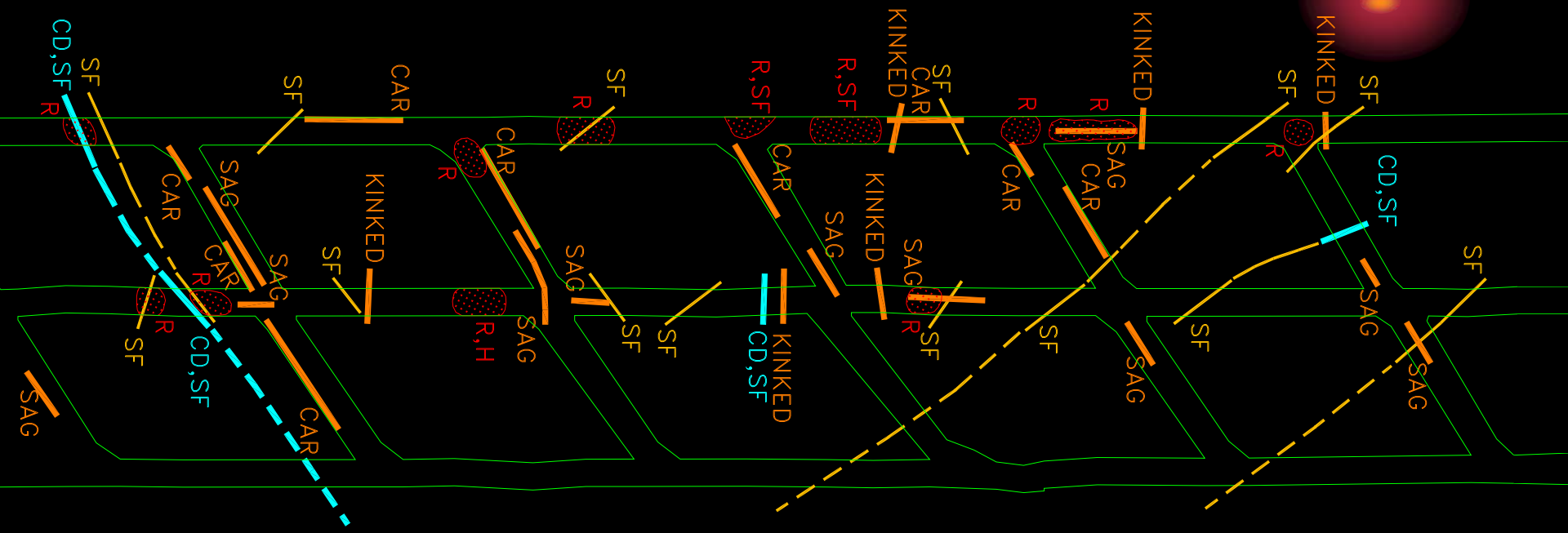
Associate Professor
Department of Mining Engineering
West Virginia University

Stability Mapping (Hazard Mapping)



- **Has been practiced for many years:**
 - **Initial stability maps hand-drawn and highlighted one feature**
 - **With computers, more comprehensive information is available and more complex (accurate?) analysis is easier to perform.**
 - **Geologic Databases, LaModel, CMRR**

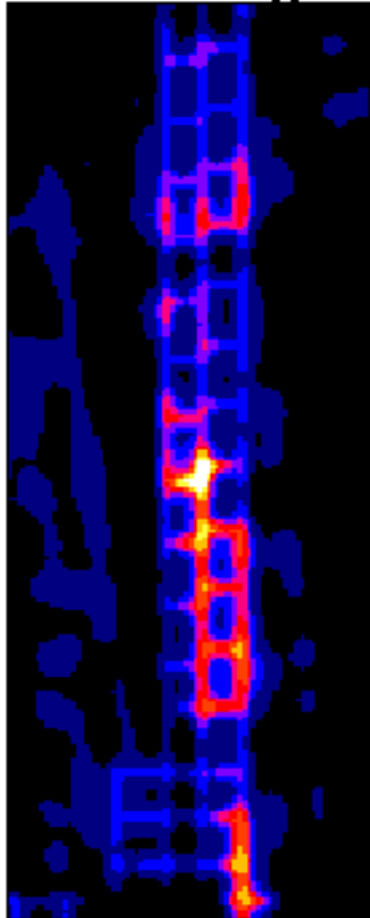
Geologic Hazard Map



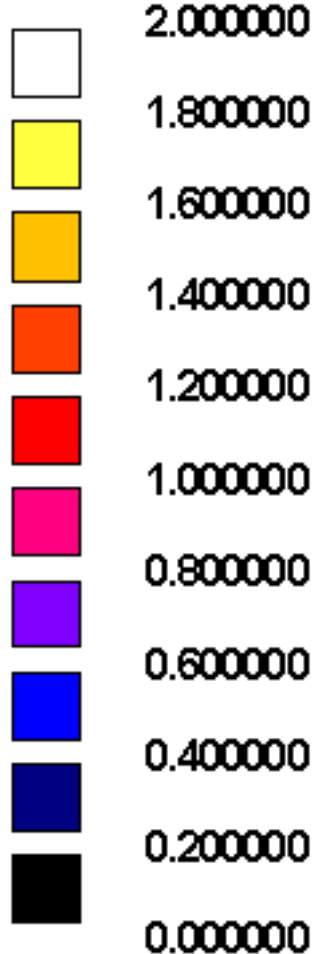
Stress Hazard Map



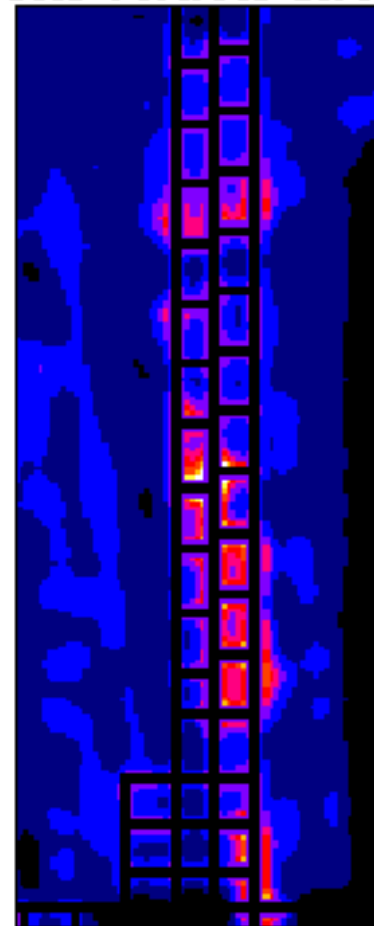
Seam Convergence



Scale



Total Vertical Stress



Scale



Integrated Stability Mapping System



➤ Combines:

➤ **AutoCAD** as the basic drawing and mapping foundation.

➤ **SurvCADD** as the geologic characterization and database model.

➤ **LaModel** for the overburden and multi-seam stresses, subsidence-based strains and pillar safety factors.

➤ **CMRR** for the structural analysis of geology

Stability Mapping Application

The screenshot displays the AutoCAD interface with the SurvCADD 2006 application. The main window shows a mine plan with three longwall panels labeled B1, B2, and B3. The plan includes contour lines (green) and main roads (blue). A context menu is open, listing various stability mapping functions. The command line at the bottom shows the application menu is installed and loaded successfully.

AutoCAD with SurvCADD 2006 - [CRD: NONE] - [C:\Documents and Settings\Heasley\My Documents\KeithWP\Conferences\SME\SME07\Bow...]

File Edit View Insert Format Tools Draw Dimension Modify Window Acrobat Markups Stability Mapping Adobe PDF Help

Reload Stability Modules

- Define Base Grid
- Factor from Contour Lines
- Factor from Point Features
- Factor from Linear Features
- Factor from Area Boundaries
- Topography Stress Calculation
- Horizontal Stress Gridding
- RFRI Utilities and Calculations
- Topography Grid Generation for LaModel
- Seam Grid Generation for LaModel
- LaModel Calculation
- Transfer LaModel/MulSim Results
- Transformation of Individual Factors
- Final Stability Index
- Index Mapping
- Grid Utilities
- Polyline Utilities
- Unload Stability Modules
- About

Contours - 200 ft - Index

ByLayer

B1 Longwall

B2 Longwall

B3 Longwall Panel

East Mains

West Mains

1600

1400

800

600

1200

1000

400

600

200

0 500 1000 1500

Model Layout1

Stability Mapping Application Menu is installed!
OARXWIZDEBUB - OnkLoadDwgMsg() called.stability2006.arx successfully loaded.

Command:

Reload Stability Modules by Mining Engineering, WVU

Stability Mapping Application

Reload Stability Modules
Define Base Grid
Factor from <u>C</u> ontour Lines
Factor from Point Features
Factor from Linear Features
Factor from <u>A</u> rea Boundaries
<u>T</u> opography Stress Calculation
<u>H</u> orizontal Stress Gridding
<u>R</u> FRI Utilities and Calculations ▶
Topography Grid Generation for LaModel
<u>S</u> eam Grid Generation for LaModel
<u>L</u> aModel Calculation
Transfer <u>L</u> aModel/MulSim Results
Transformation of Individual <u>F</u> actors
Final Stability <u>I</u> ndex
<u>I</u> ndex Mapping
Grid <u>U</u> tilities
<u>P</u> olyline Utilities ▶
Unload Stability Modules
About



Stability Mapping at Bowie



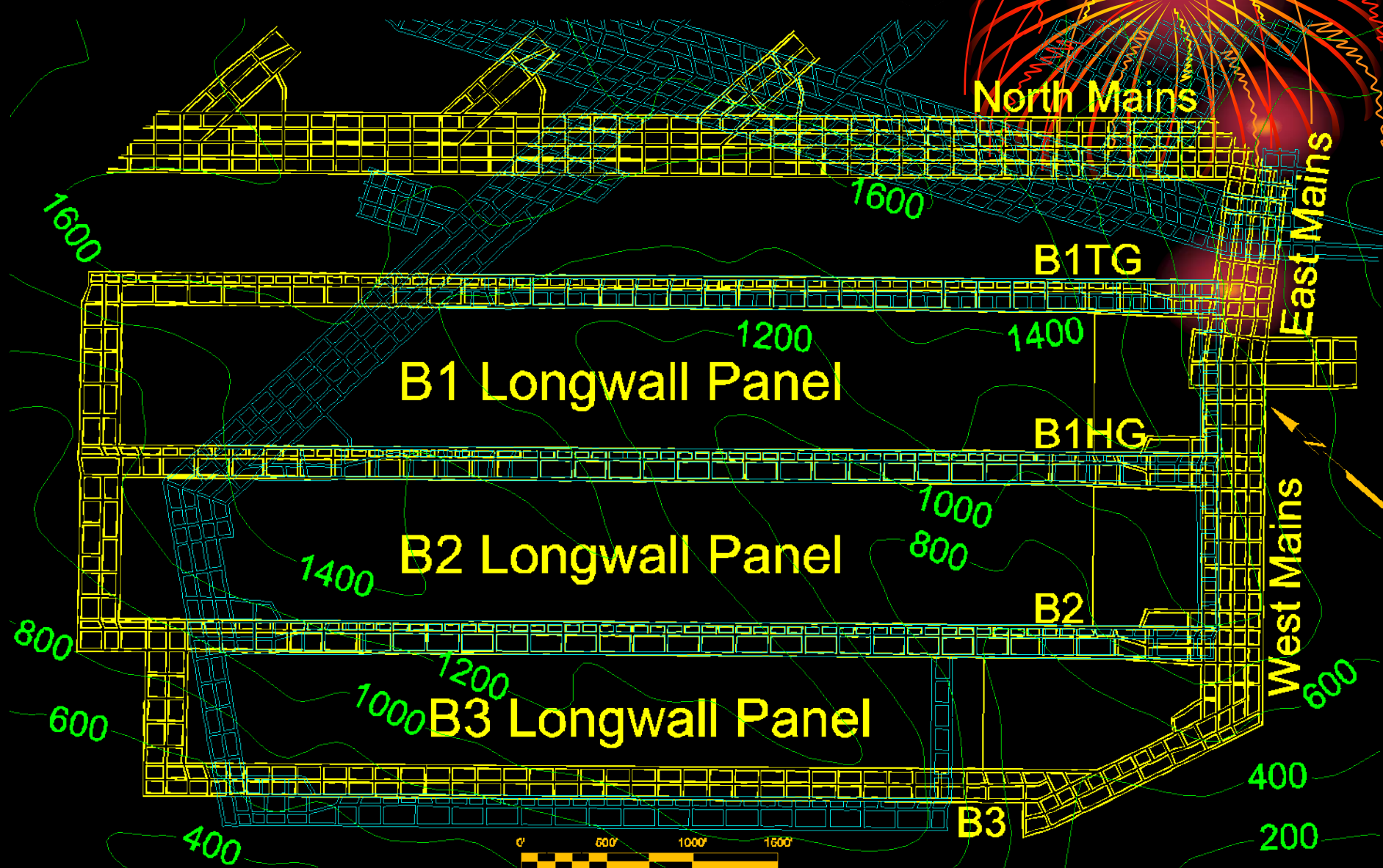
➤ **Bowie Resources, LLC:**

➤ **Paonia, Colorado, Somerset Coal Field,
Piceance Basin, 4 Million tons per year**

➤ **Bowie No. 2 – D Seam, 9.5 ft extraction**

➤ **Bowie No. 3 – B Seam, 250 ft interburden**

Southwest Mining District

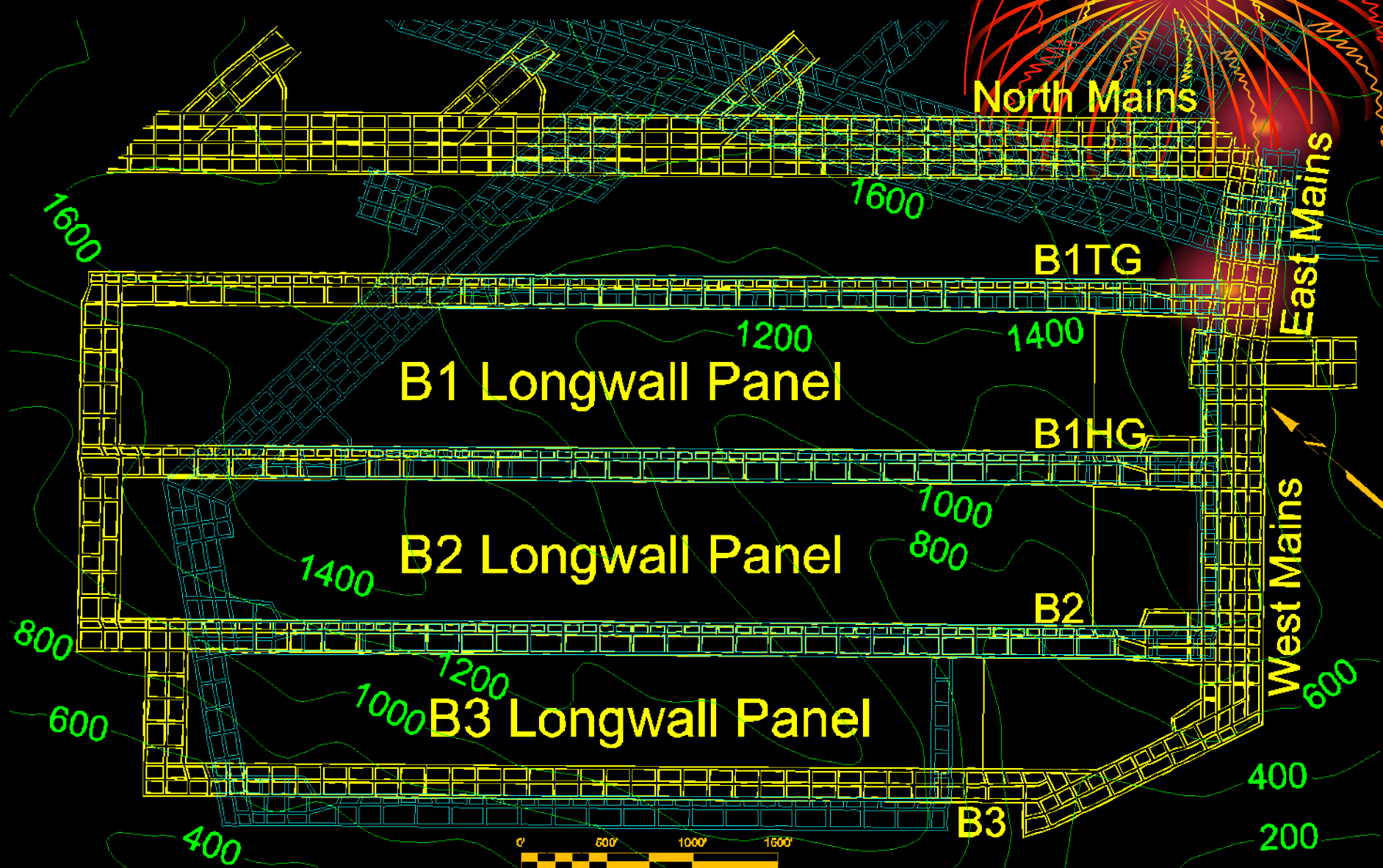


Critical Parameters at Bowie



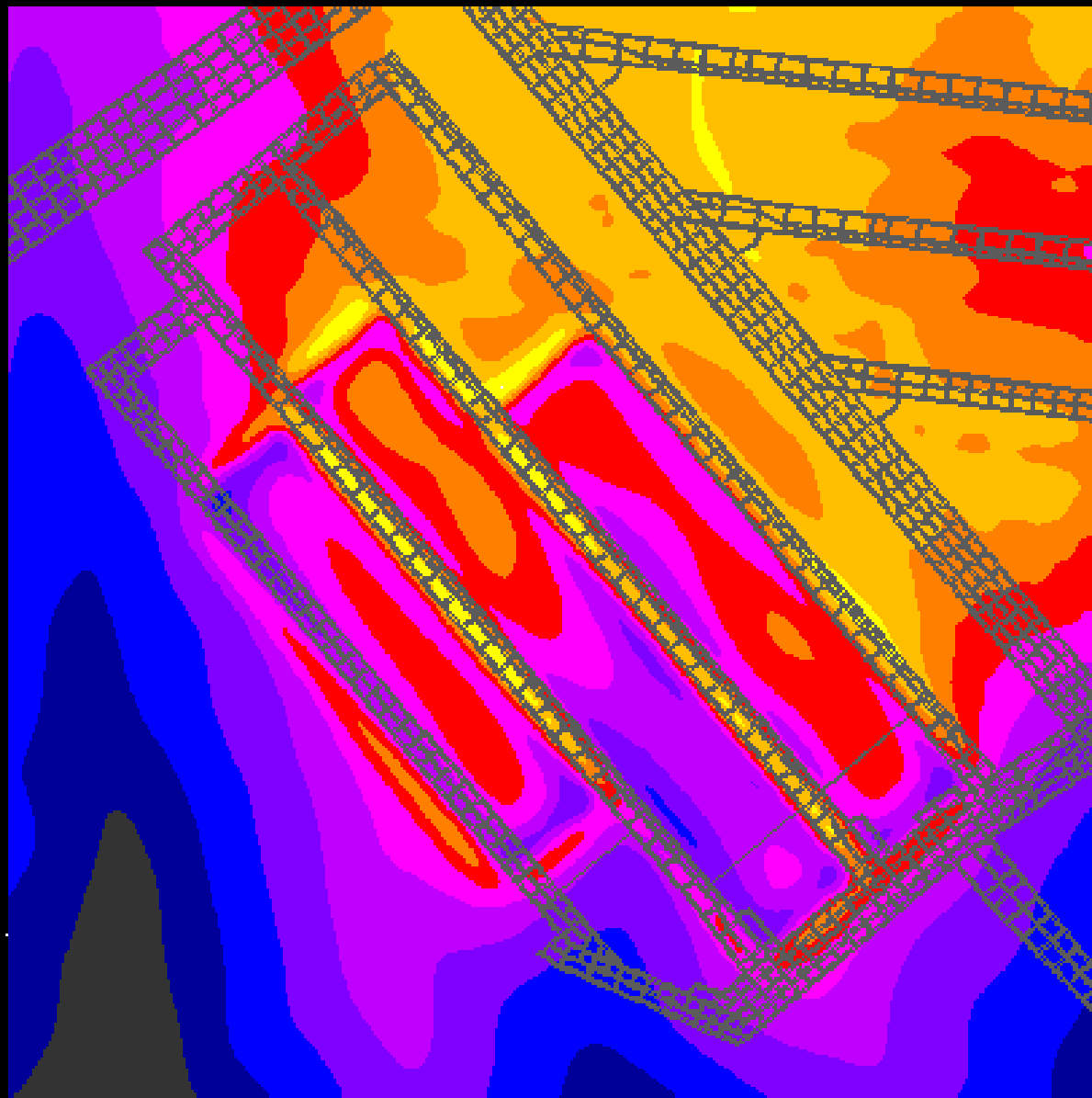
- **Overburden and Multiple-Seam Stress**
- **Interburden to Rider Seam**
- **Sandstone Channels**
- **Faults, Slumps and Warps**
- **Coal Mine Roof rating**

Southwest Mining District



Insitu Stress

Scale (psi)



2120

1915

1710

1501

1295

1090

880

675

470

265

55

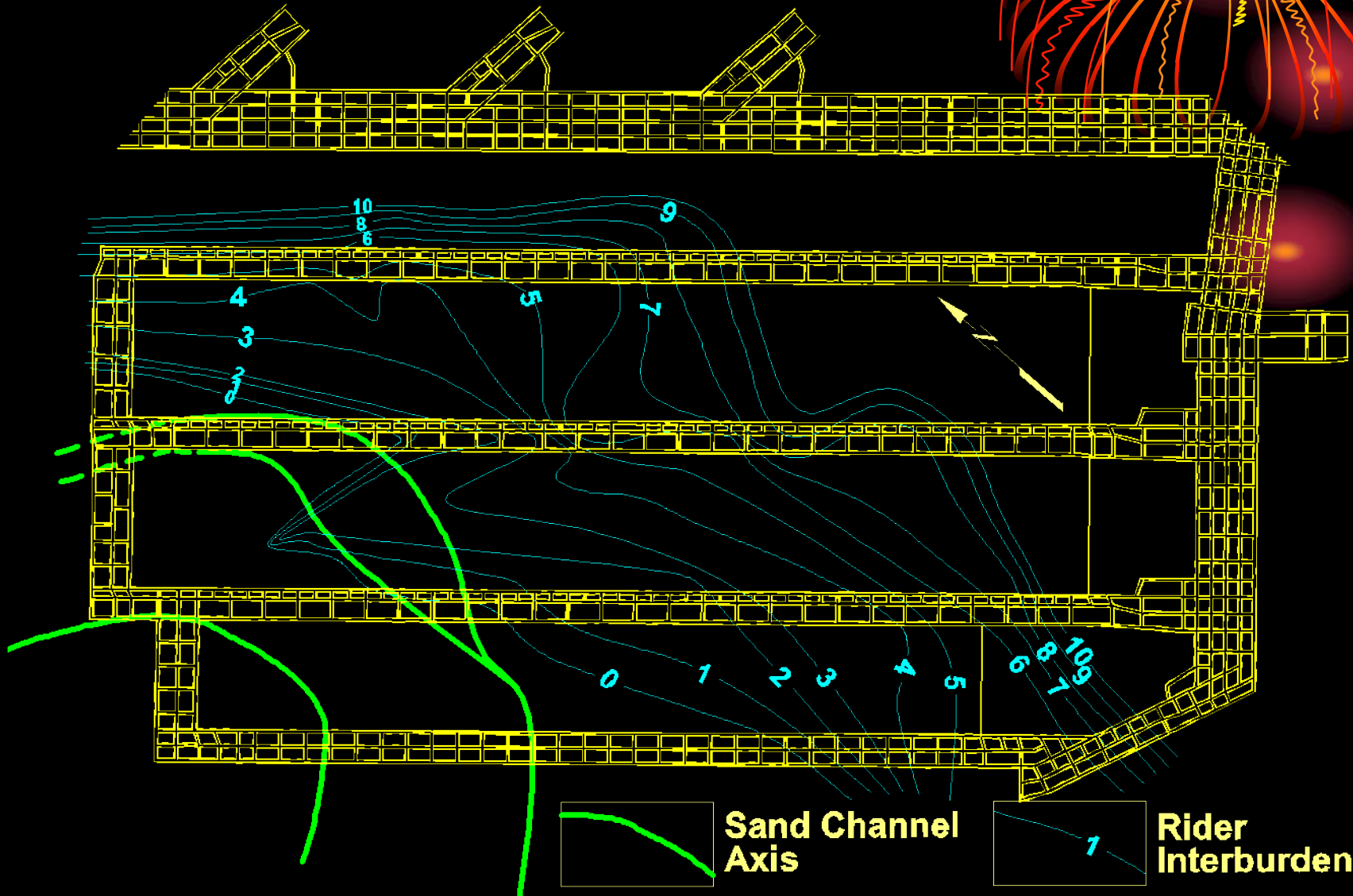
-150

Critical Parameters at Bowie



- **Overburden and Multiple-Seam Stress**
- **Interburden to Rider Seam**
- **Sandstone Channels**
- **Faults, Slumps and Warps**
- **Coal Mine Roof Rating**

Rider Interburden



Critical Parameters at Bowie



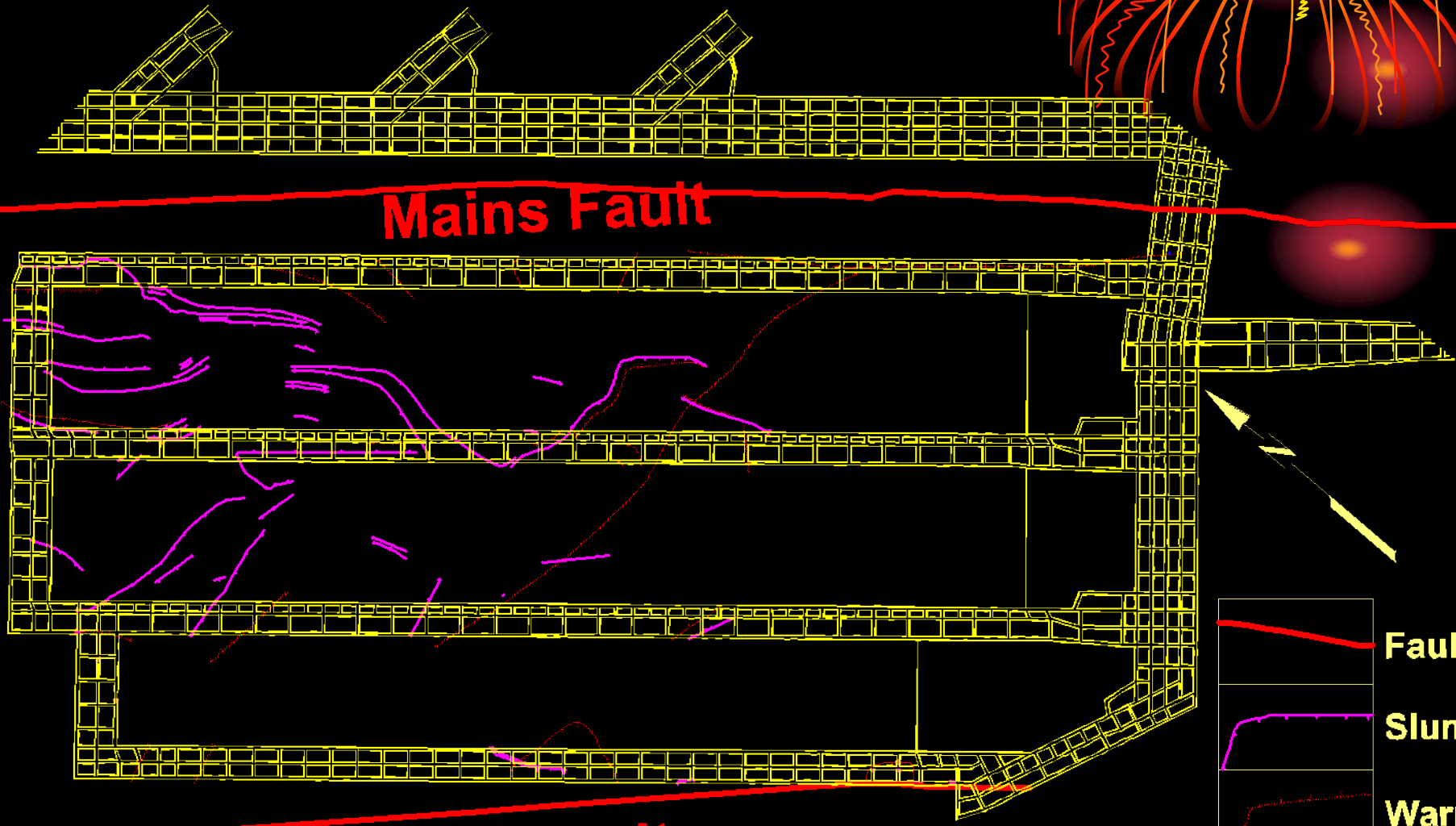
- **Overburden and Multiple-Seam Stress**
- **Interburden to Rider Seam**
- **Sandstone Channels**
- **Faults, Slumps and Warps**
- **Coal Mine Roof Rating**


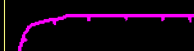

Faults, Slumps & Warps



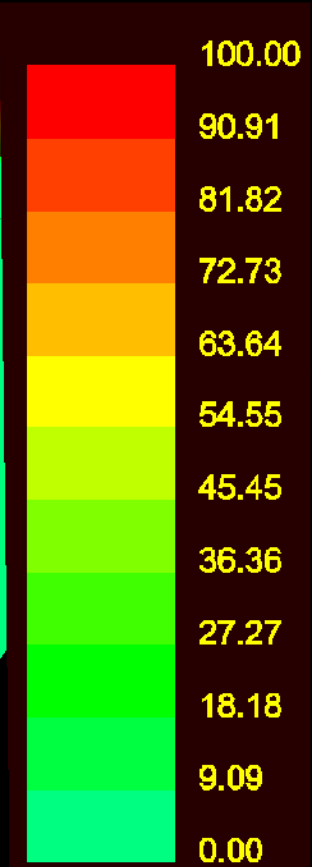
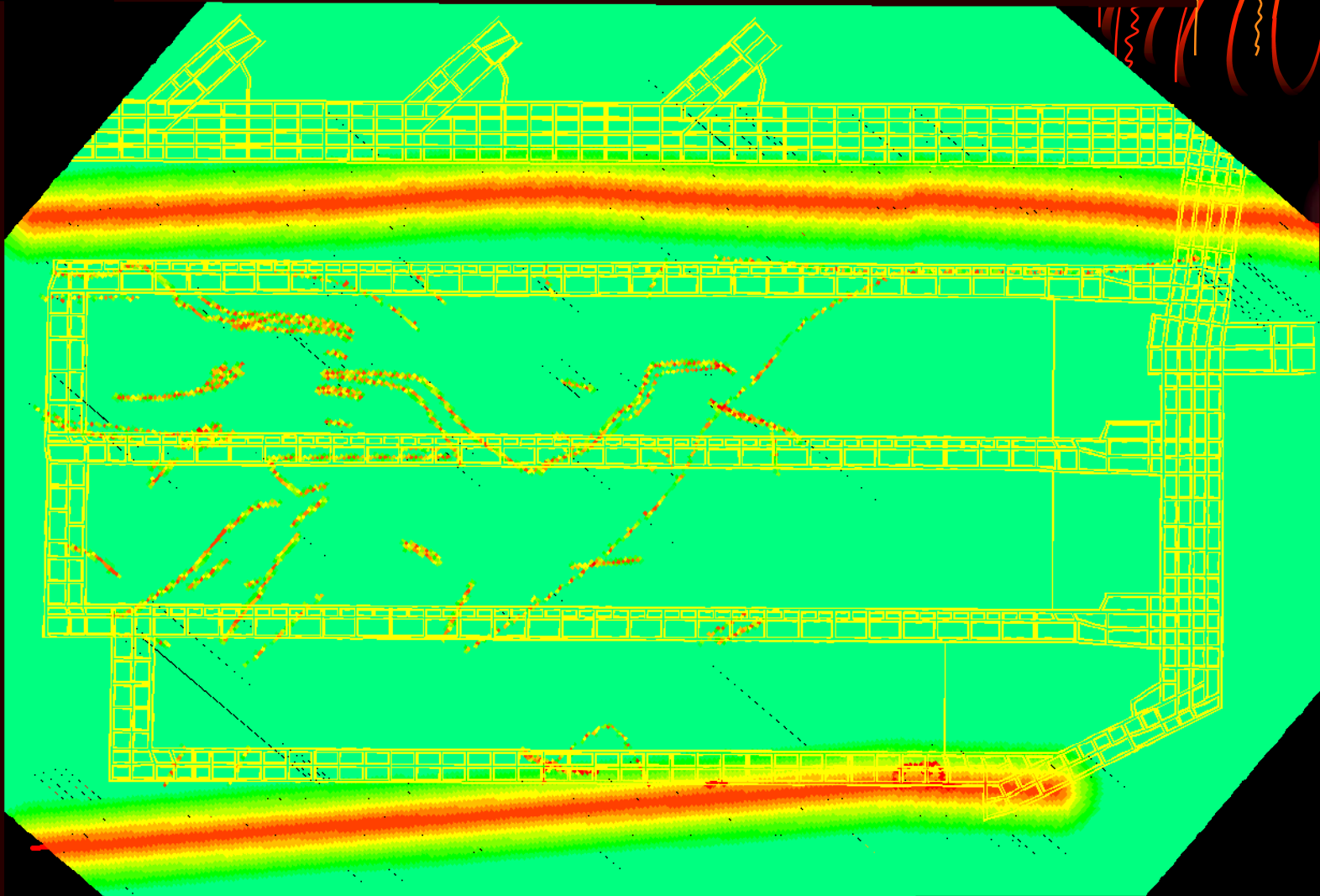
Mains Fault

B3 Fault



	Faults
	Slumps
	Warps

Faults, Slumps, Warps Index



Critical Parameters at Bowie



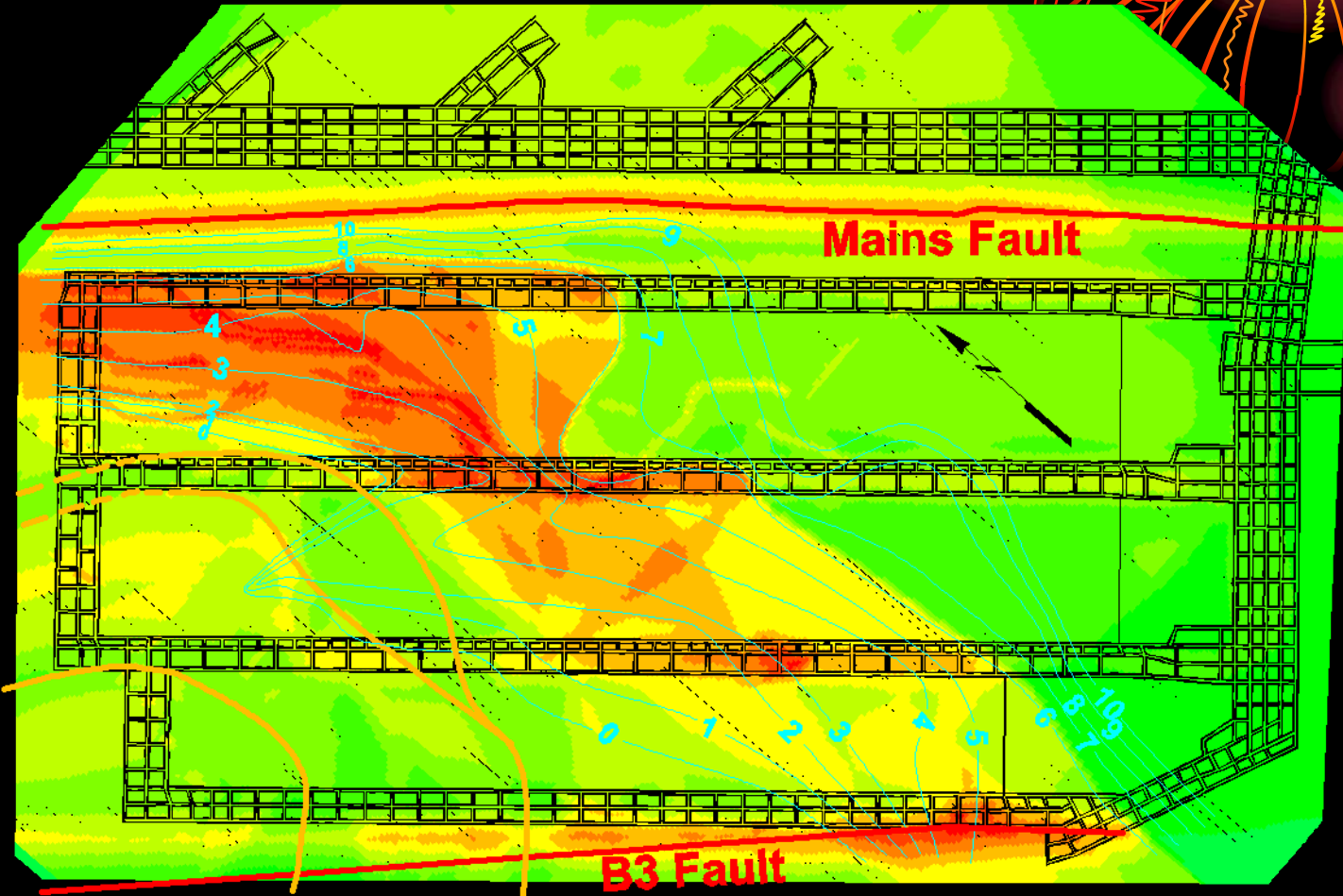
- **Overburden and Multiple-Seam Stress**
- **Interburden to Rider Seam**
- **Sandstone Channels**
- **Faults, Slumps and Warps**
- **Coal Mine Roof Rating**

Parameters Weightings

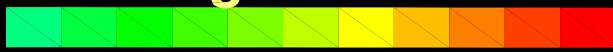


Critical Parameter	Final Weighting
Overburden Stress	20
Multiple-Seam Stress	15
CMRR	20
Sandstone Channels	10
Interburden Thickness	20
Faults	20
Slumps	10
Warps	5

Final Stability Map

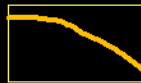


Mining Conditions



Normal

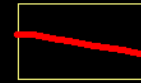
Adverse



Sand Channel
Axis



Rider
Interburden



Faults

Results

- **Weighting Factors were optimized with results from mining in the first panel**
- **In subsequent mining, the stability mapping successfully predicted problematic zones**
- **With foreknowledge of the problem zones, the management was able to be pro-active in their ground support plan**



Roof Support



- **Roof Support was applied based on the stability rating:**
 - **Minimum 7 ft torque-tension bolt**
 - **Supplemented with 12 ft cable bolts, 4 per row, heavy mats, 5 ft max row spacing**
 - **24 in Burrell cans, 2 per row, 8 ft max spacing**

Part of a Bigger System



- **Comprehensive geologic data collection:**
 - **Roof bolters log lithology**
 - **Underground core drilling**
 - **Underground mapping**
 - **Geologic model continuously updated**

- **Weekly “Quality” meetings to communicate ground conditions**

Conclusions

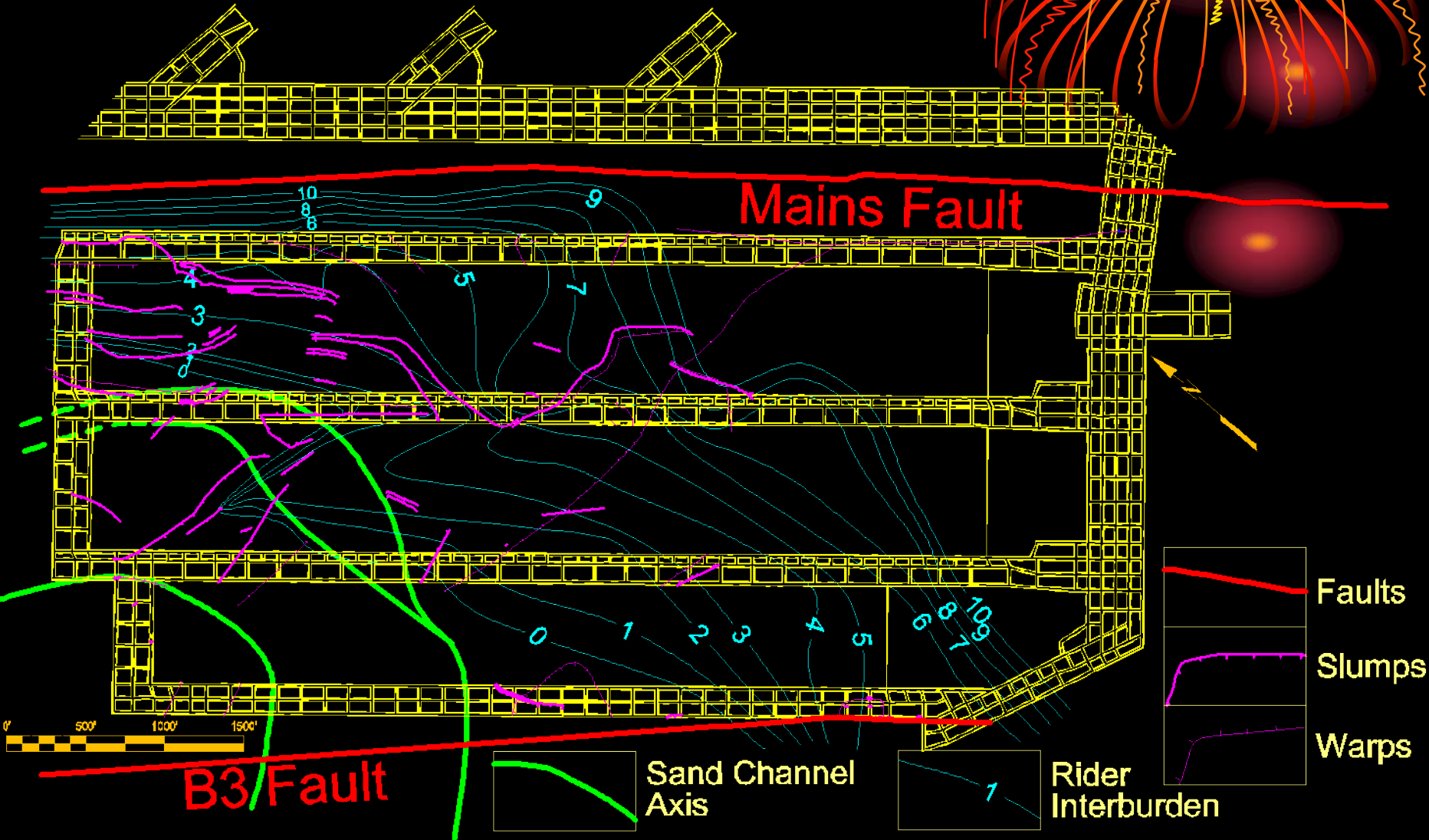


- **The operational plans developed from projecting problem zones through stability mapping have allowed Bowie Resources to successfully mine through difficult conditions, safely and successfully**
- **Bowie Resources continues to use the stability mapping system on their present and future panels**

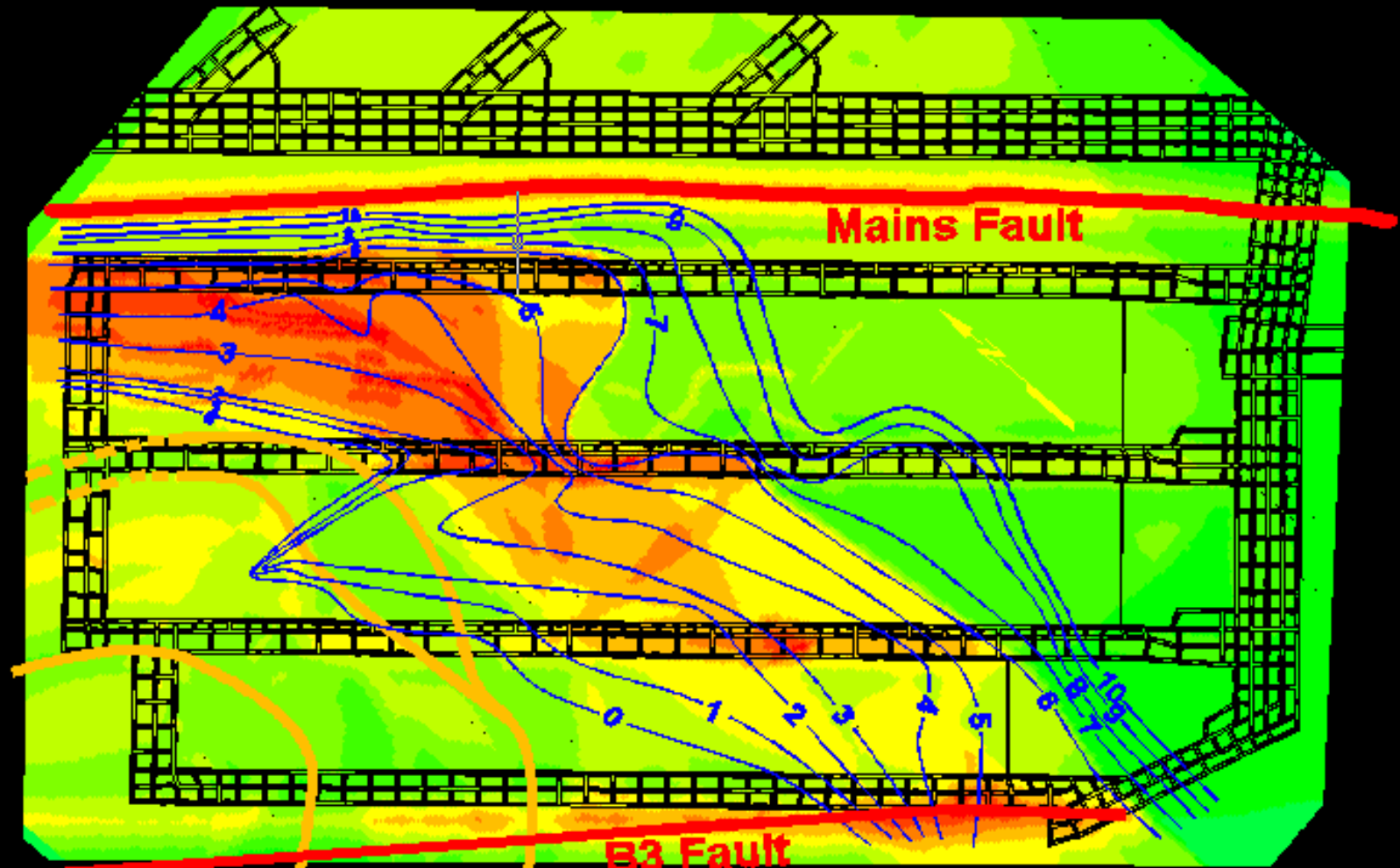
Questions



Structural Parameters



Final Stability Index



Mining Conditions

