Numerical Modeling Simulation of Old Works Stability

New Technologies - Practical Considerations

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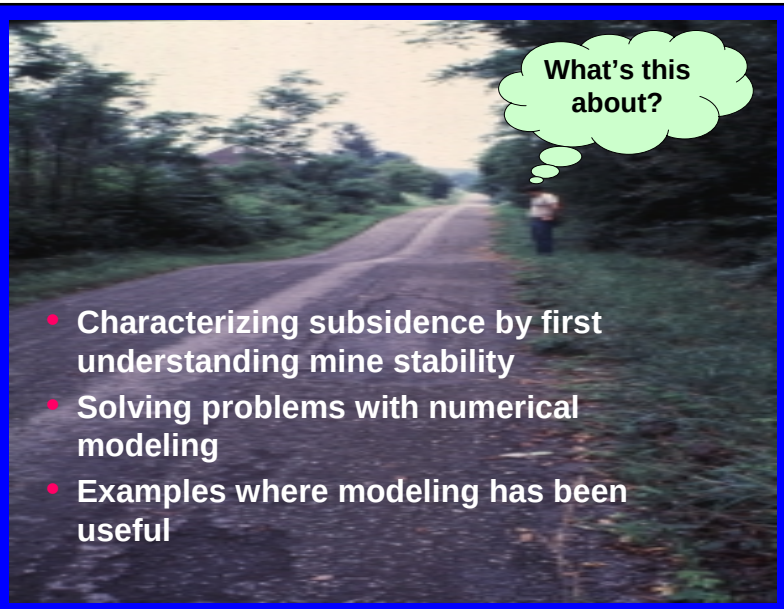
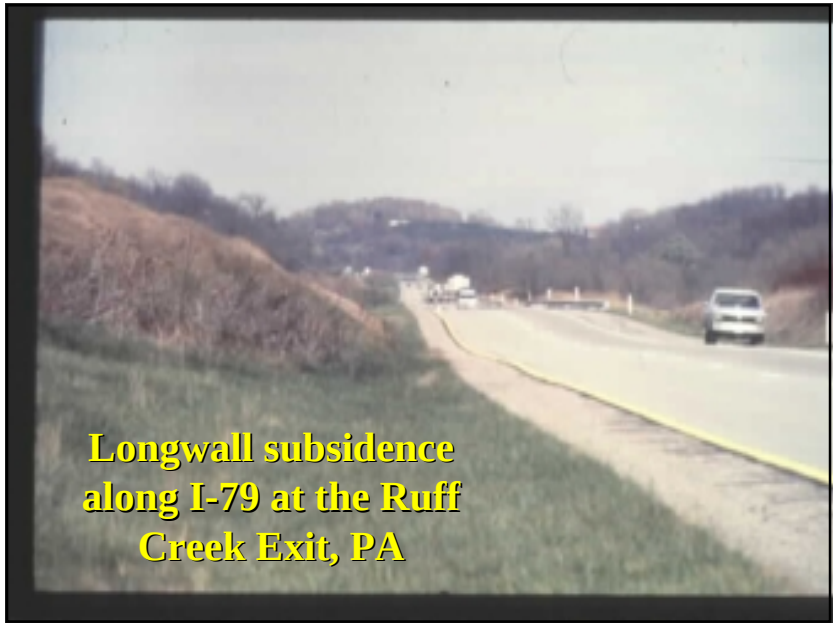
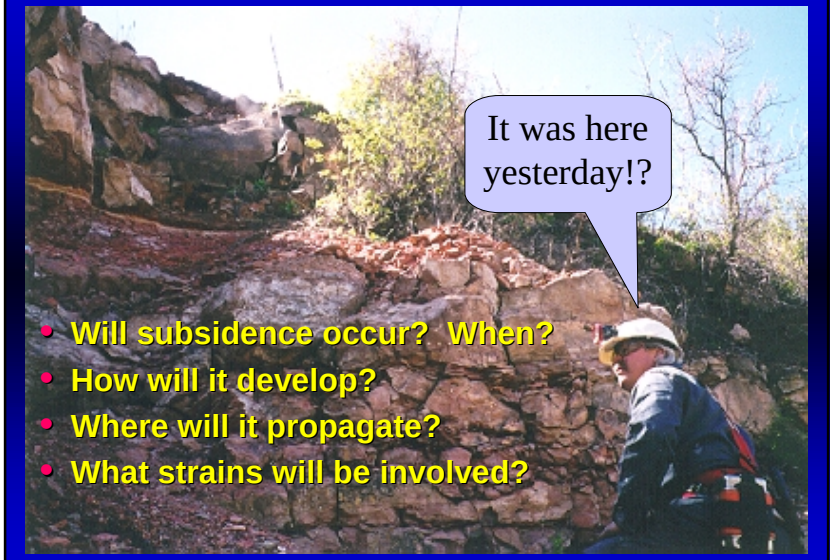


- Characterizing subsidence by first understanding mine stability
- Solving problems with numerical modeling
- Examples where modeling has been useful

Sinkhole development through
strong overburden.

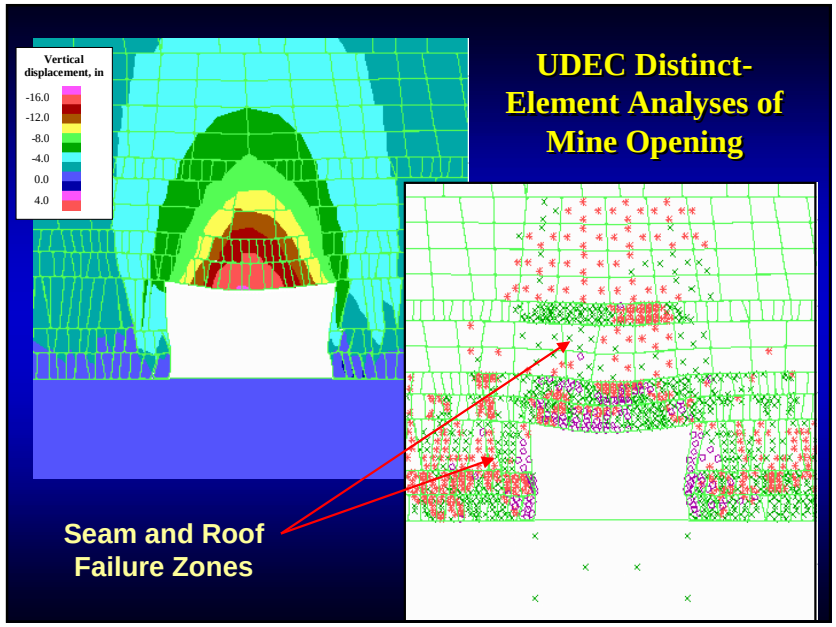
Vertical and horizontal strains
due to deep mining.

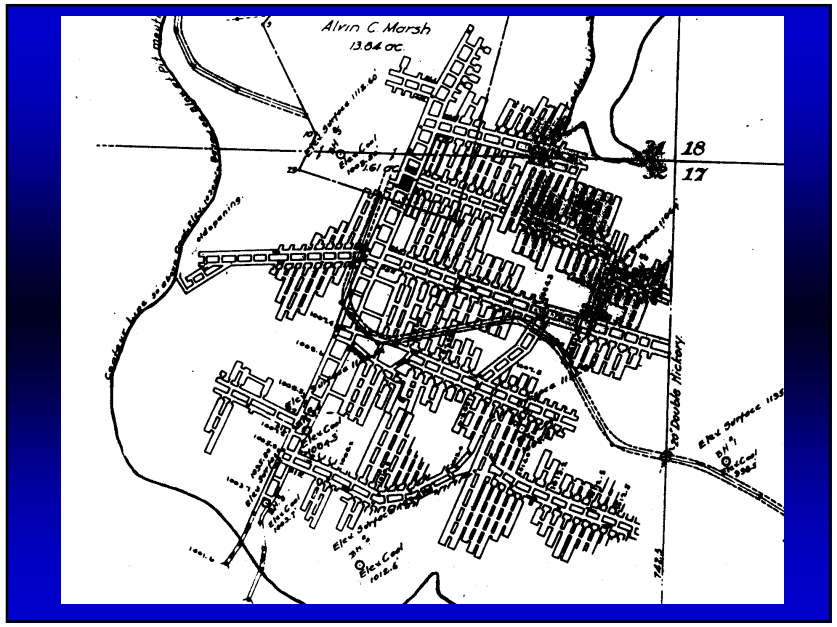

Longwall subsidence
along I-79 at the Ruff
Creek Exit, PA



- Will subsidence occur? When?
- How will it develop?
- Where will it propagate?
- What strains will be involved?

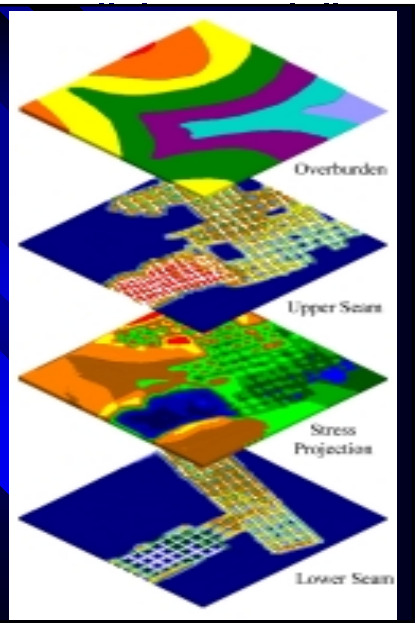
- Empirical method?
- Analytical method?
- Numerical modeling?

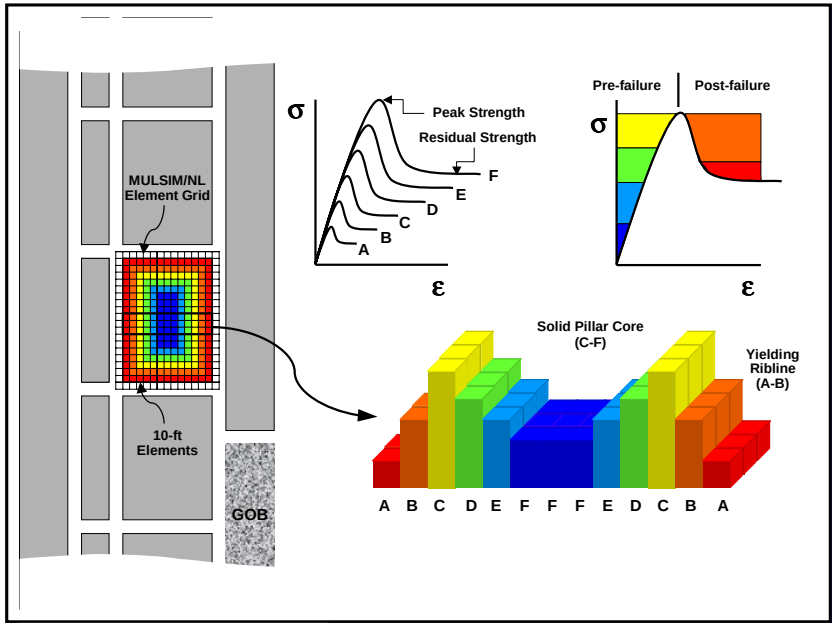

Vertical displacement, in
-16.0
-12.0
-8.0
-4.0
0.0
4.0
UDEC Distinct-Element Analyses of Mine Opening
Seam and Roof Failure Zones

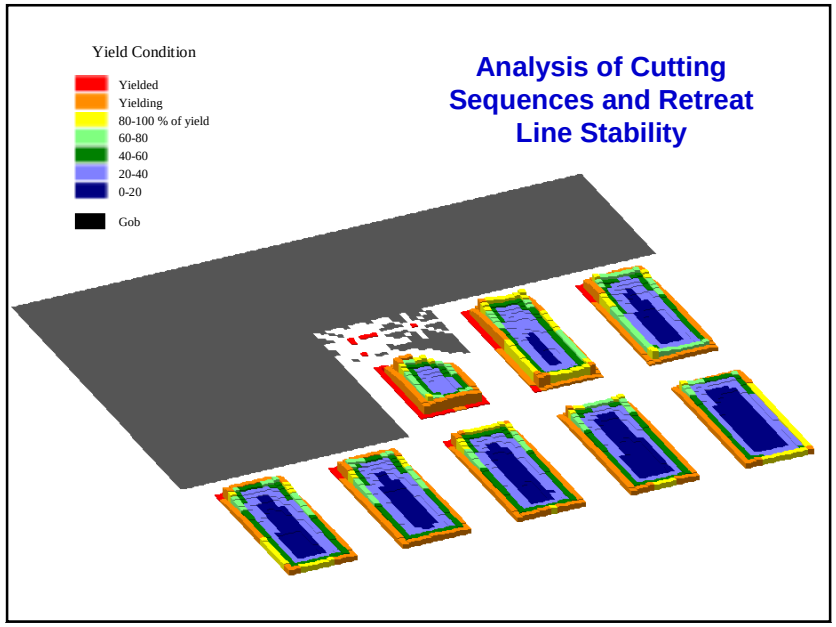

Alvin C Marsh
18
17

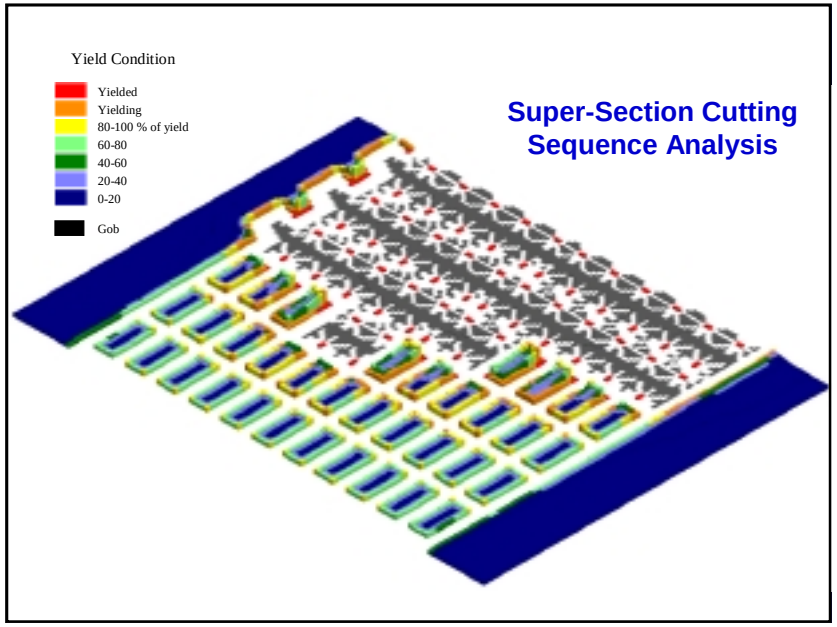
MULSIM/NL & LAMODEL
Boundary Element Codes

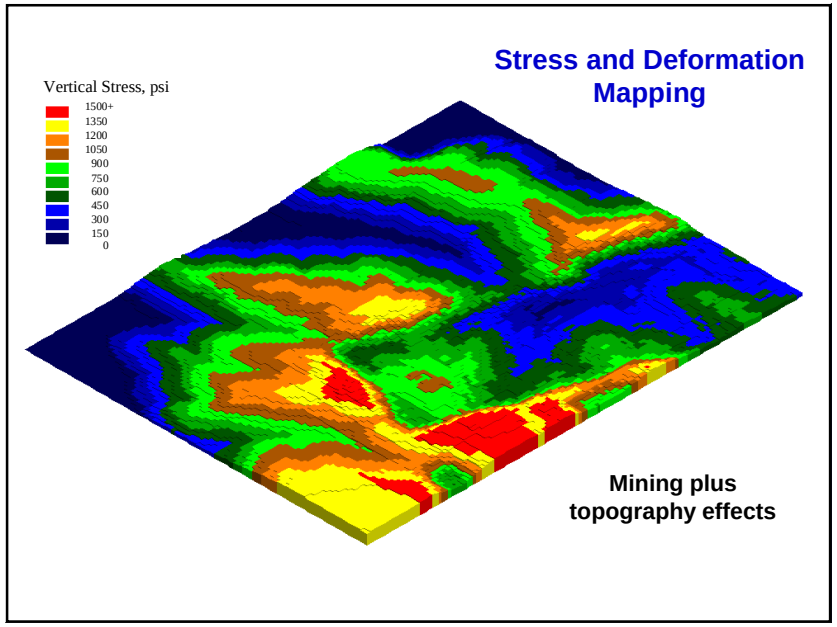
- Highly complex settings
- Multiple seam conditions
- Actual topography
- Confined-core mechanics
- Off-seam deformations
- Vertical subsidence strains
- Rapid, user-friendly analyses
- Yield condition and stress projection mapping
- Calibration-oriented results

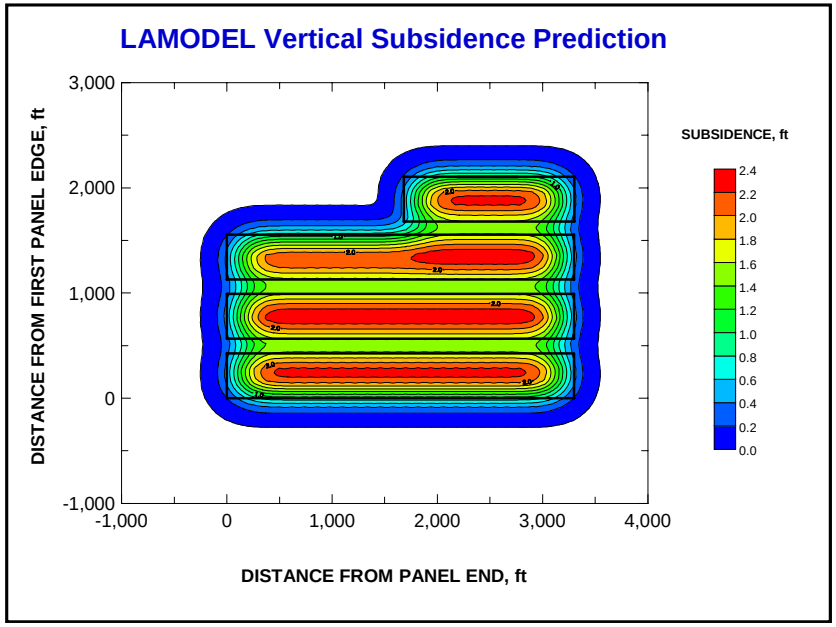


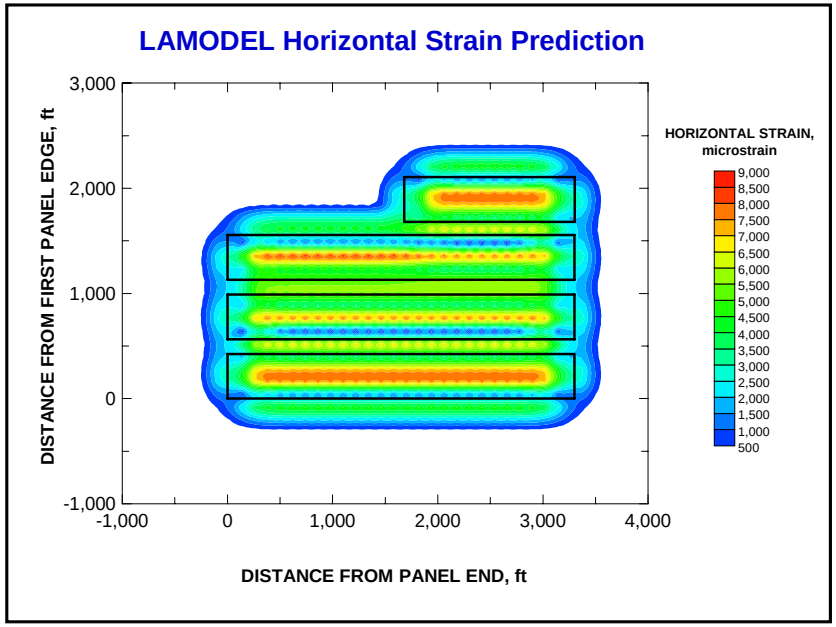



Yield Condition
Yielded
Yielding
80-100 % of yield
60-80
40-60
20-40
0-20
Gob
Analysis of Cutting Sequences and Retreat Line Stability


Yield Condition
Yielded
Yielding
80-100 % of yield
60-80
40-60
20-40
0-20
Gob
Super-Section Cutting Sequence Analysis


Stress and Deformation Mapping
Vertical Stress, psi
1500+
1350
1200
1050
900
750
600
450
300
150
0
Mining plus topography effects


LAMODEL Vertical Subsidence Prediction
DISTANCE FROM FIRST PANEL EDGE, ft
3,000
2,000
1,000
0
-1,000
-1,000
0
1,000
2,000
3,000
4,000
DISTANCE FROM PANEL END, ft
SUBSIDENCE, ft
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0

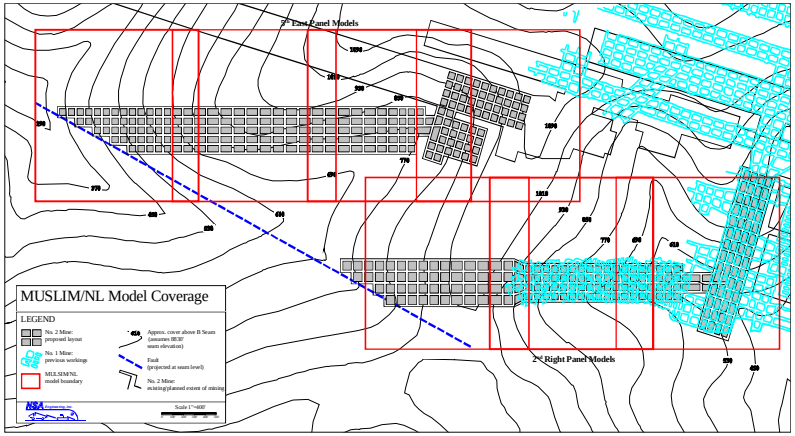


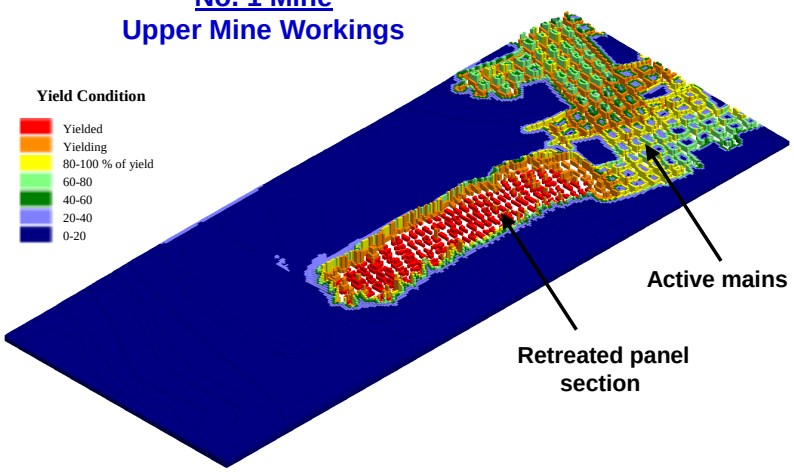
Case No.1

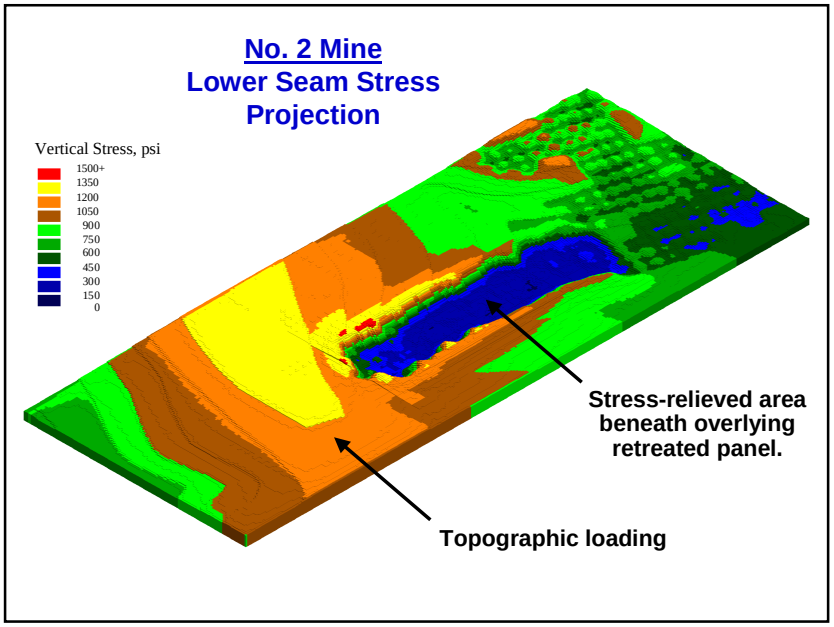
MULSIM/NL

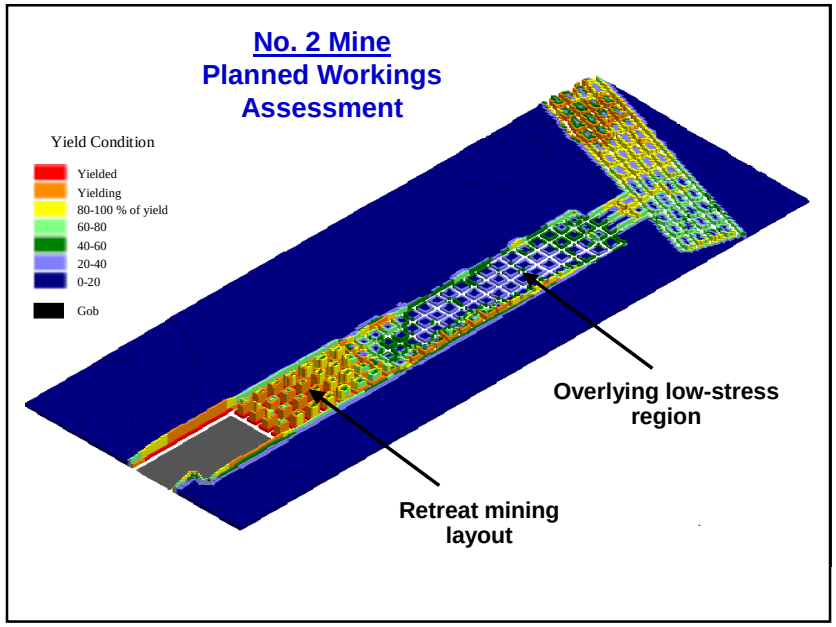
Multi-Seam Mine Design in Mountainous Topography

Initial Model Layout





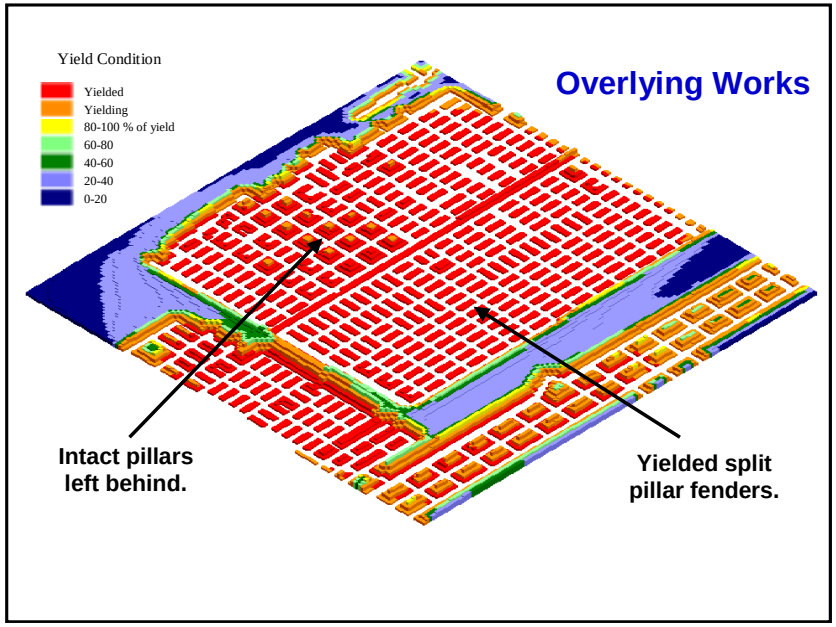

No. 2 Mine
Lower Seam Stress
Projection
Vertical Stress, psi
1500+
1350
1200
1050
900
750
600
450
300
150
0
Stress-relieved area beneath overlying retreated panel.
Topographic loading

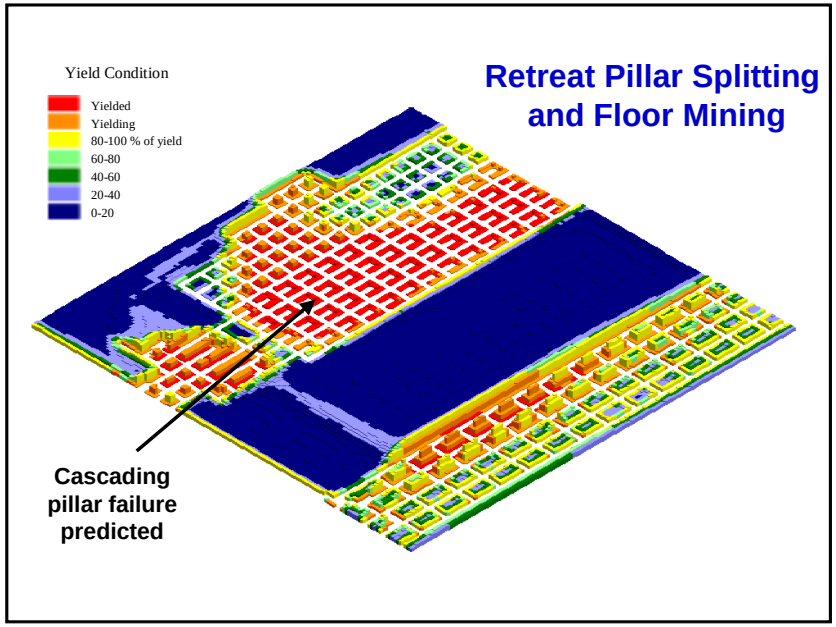

No. 2 Mine
Planned Workings
Assessment
Yield Condition
Yielded
Yielding
80-100 % of yield
60-80
40-60
20-40
0-20
Gob
Overlying low-stress region
Retreat mining layout

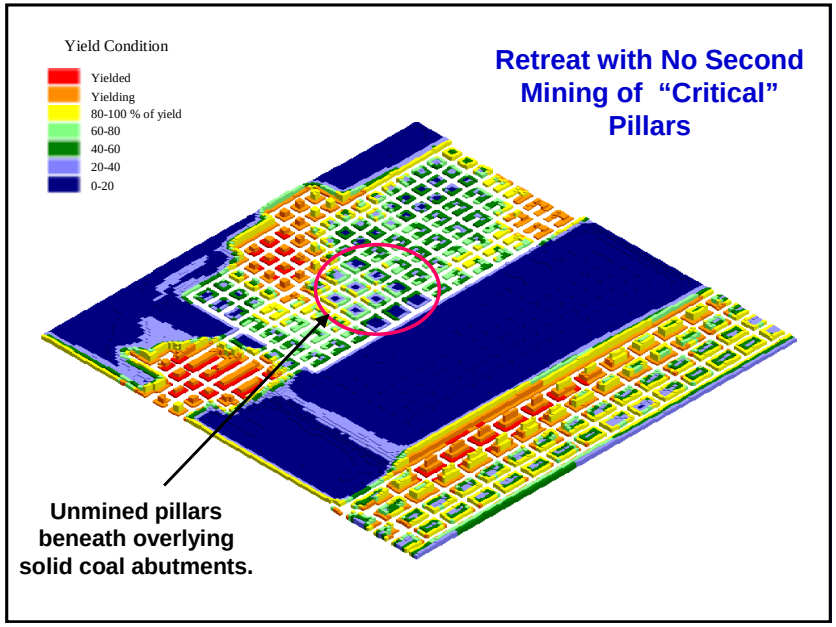
Case No.2

MULSIM/NL

Multi-Seam Mine Design and Cascading Pillar Failure



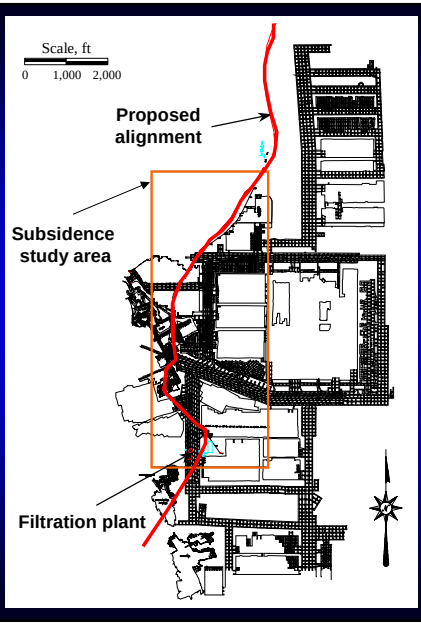

Yield Condition
Yielded
Yielding
80-100 % of yield
60-80
40-60
20-40
0-20
Retreat Pillar Splitting and Floor Mining
Cascading pillar failure predicted

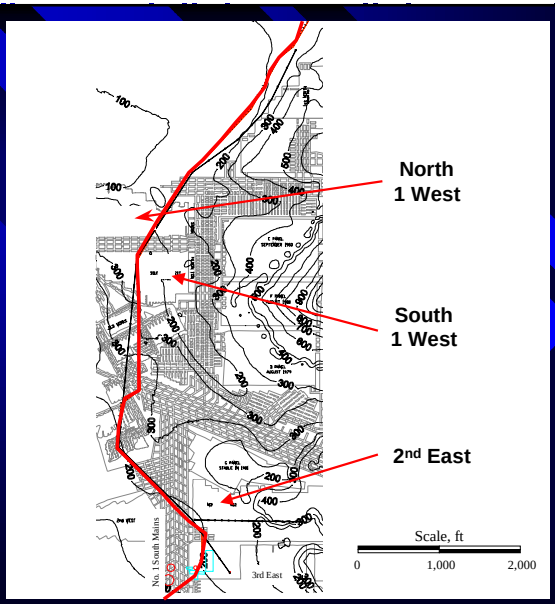

Yield Condition
Yielded
Yielding
80-100 % of yield
60-80
40-60
20-40
0-20
Retreat with No Second Mining of "Critical" Pillars
Unmined pillars beneath overlying solid coal abutments.

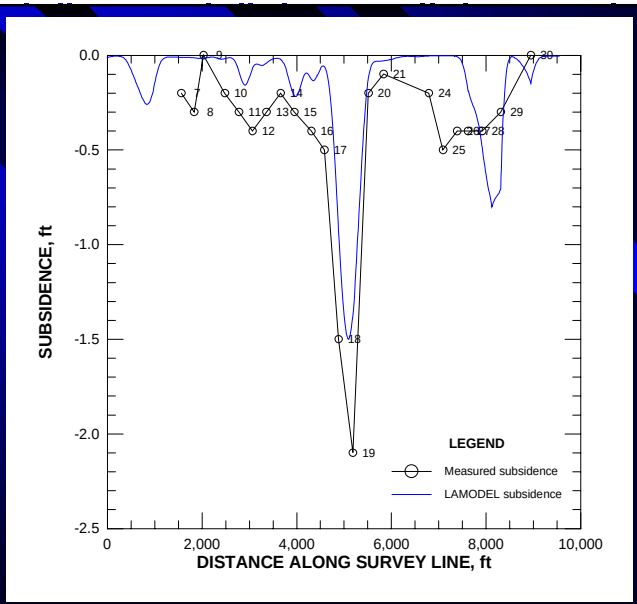
Case No.3

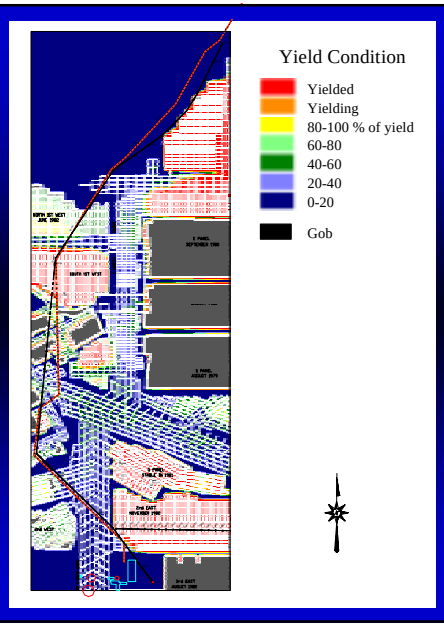
LAMODEL

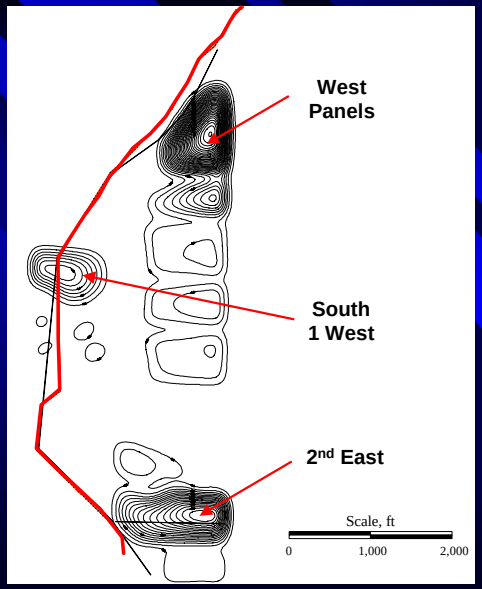
Long-term Pipeline Subsidence Prediction Evaluation




North
1 West
South
1 West
2nd East
Scale, ft
0
1,000
2,000
No. 1 South Mains
3rd East


SUBSIDENCE, ft
DISTANCE ALONG SURVEY LINE, ft
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
0
2,000
4,000
6,000
8,000
10,000
LEGEND
Measured subsidence
LAMODEL subsidence


Yield Condition
Yielded
Yielding
80-100 % of yield
60-80
40-60
20-40
0-20
Gob


West Panels
South 1 West
2nd East
Scale, ft
0
1,000
2,000

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