Non-Conventional Movements due to Longwall Mining

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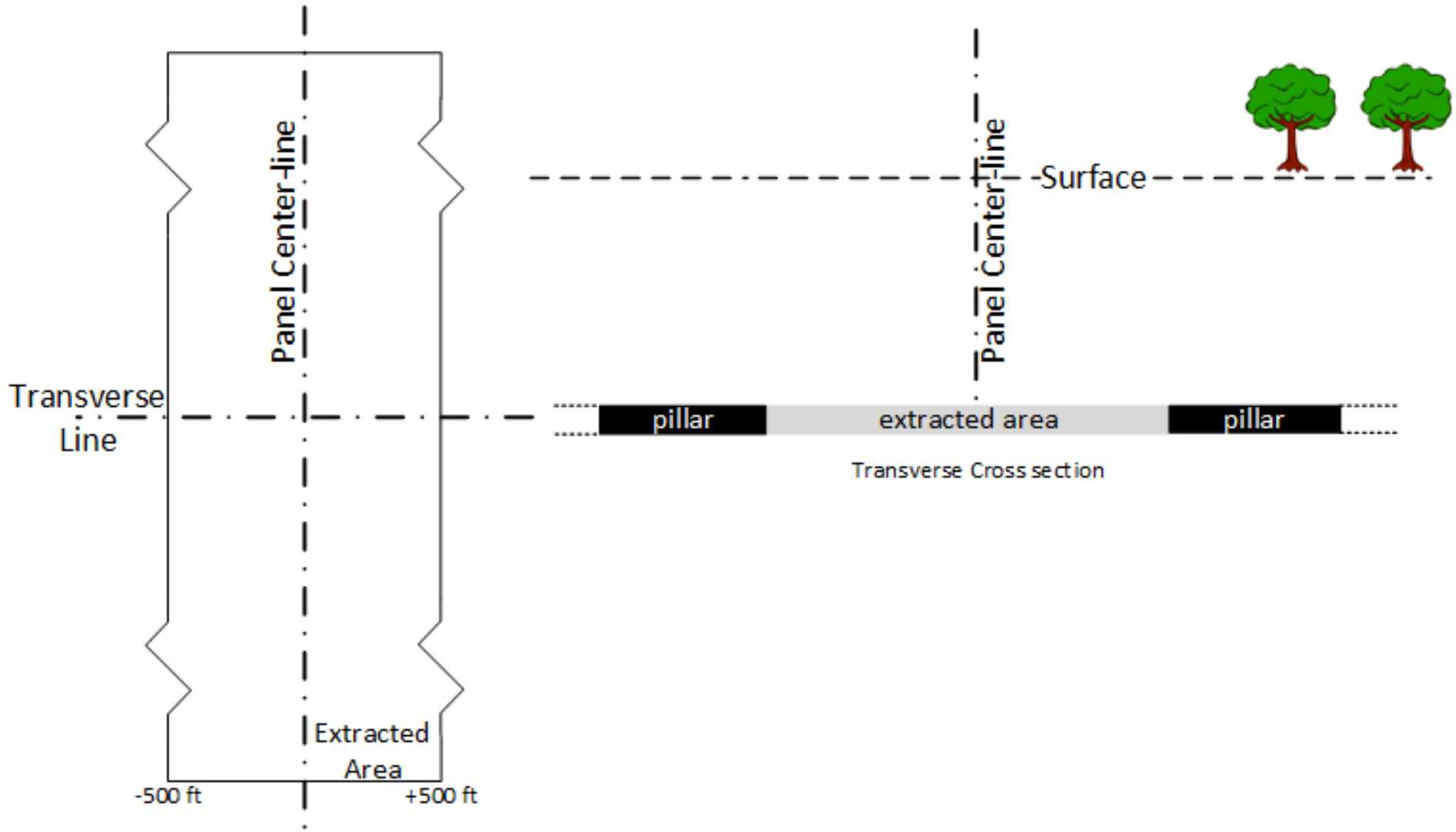
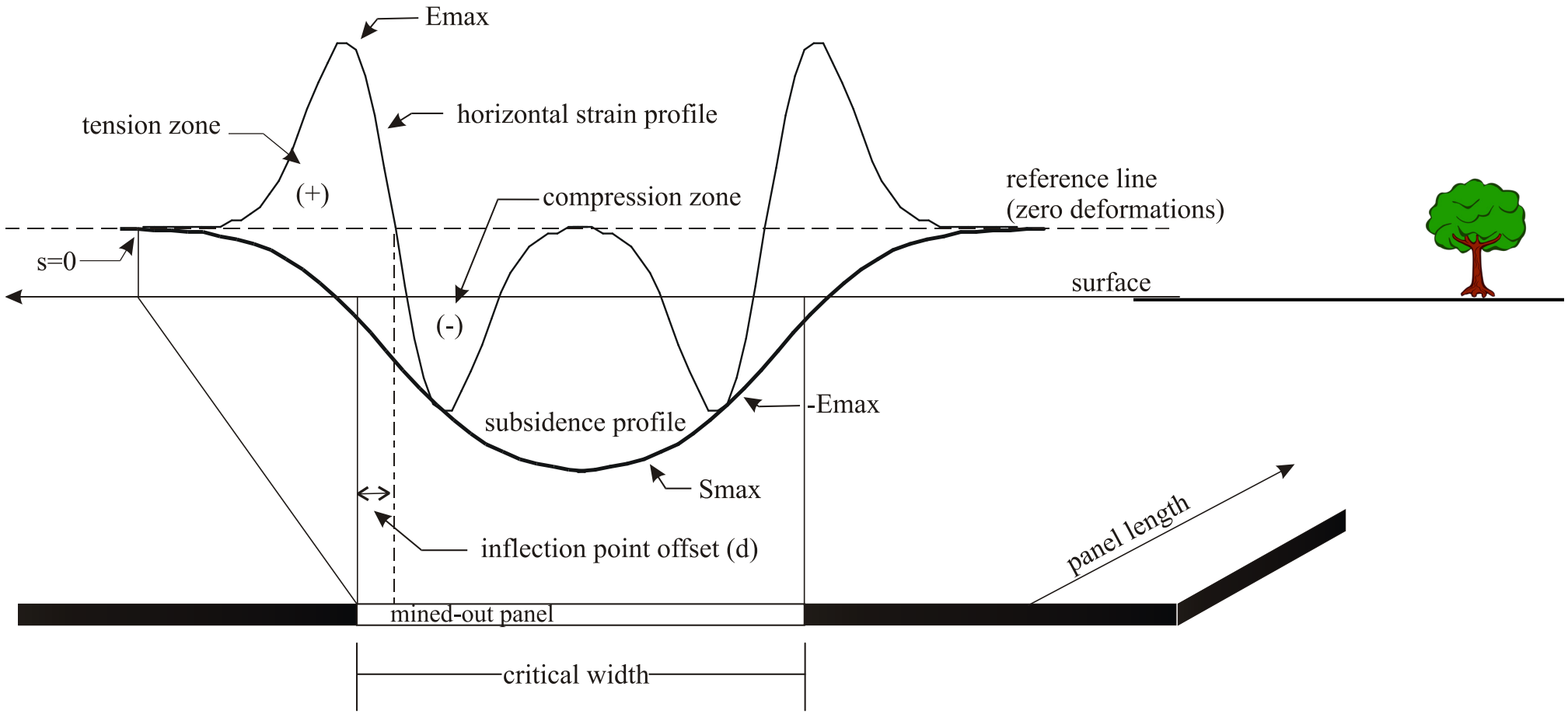
Main Presentation Points

- Conventional and Non-Conventional Movements
- Where and under what conditions have Non-Conventional Movements been observed?
- Why do Non-Conventional Movements Occur?

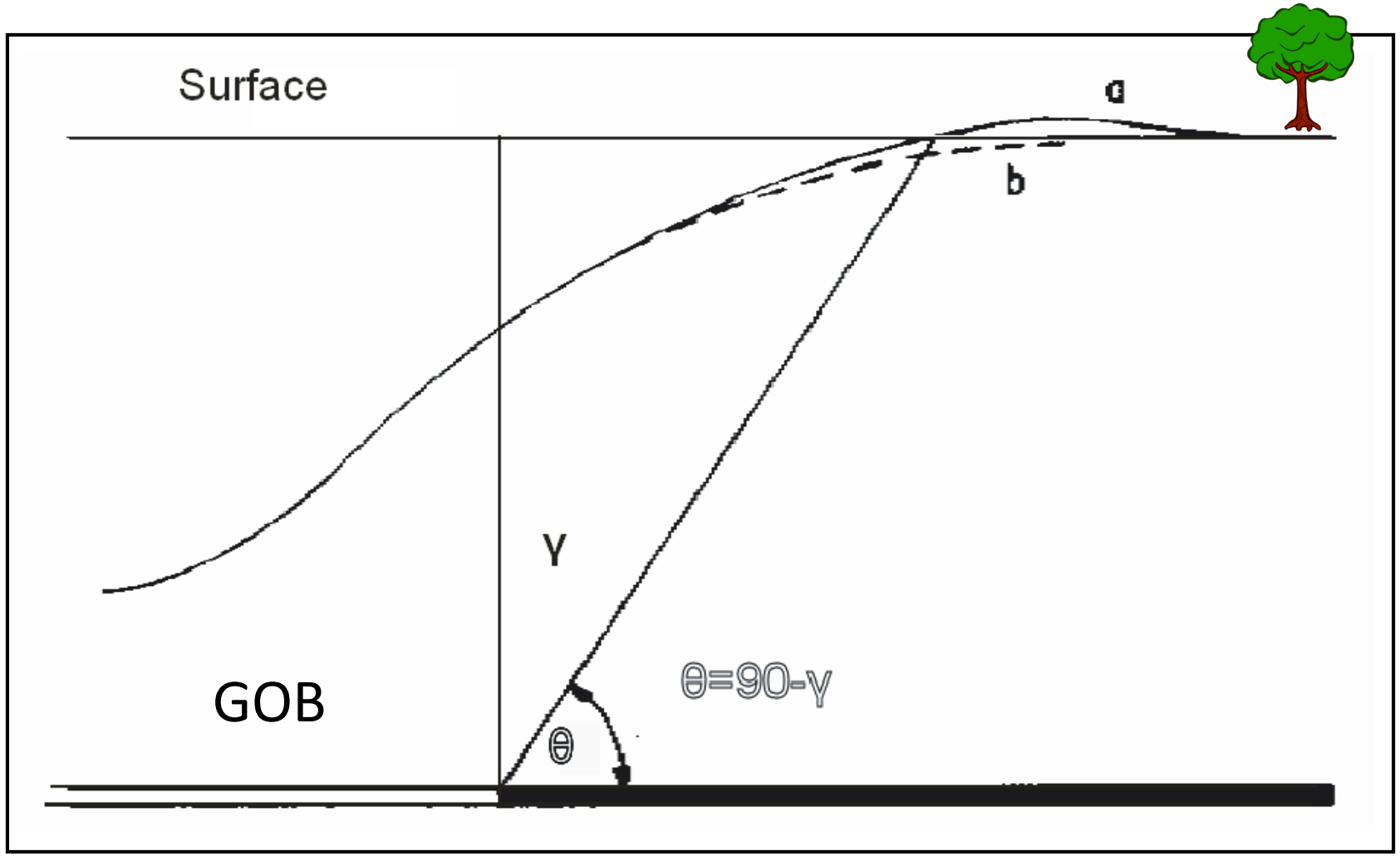
A typical Longwall Panel Cross Section



Typical Subsidence and Horizontal Strain Curves

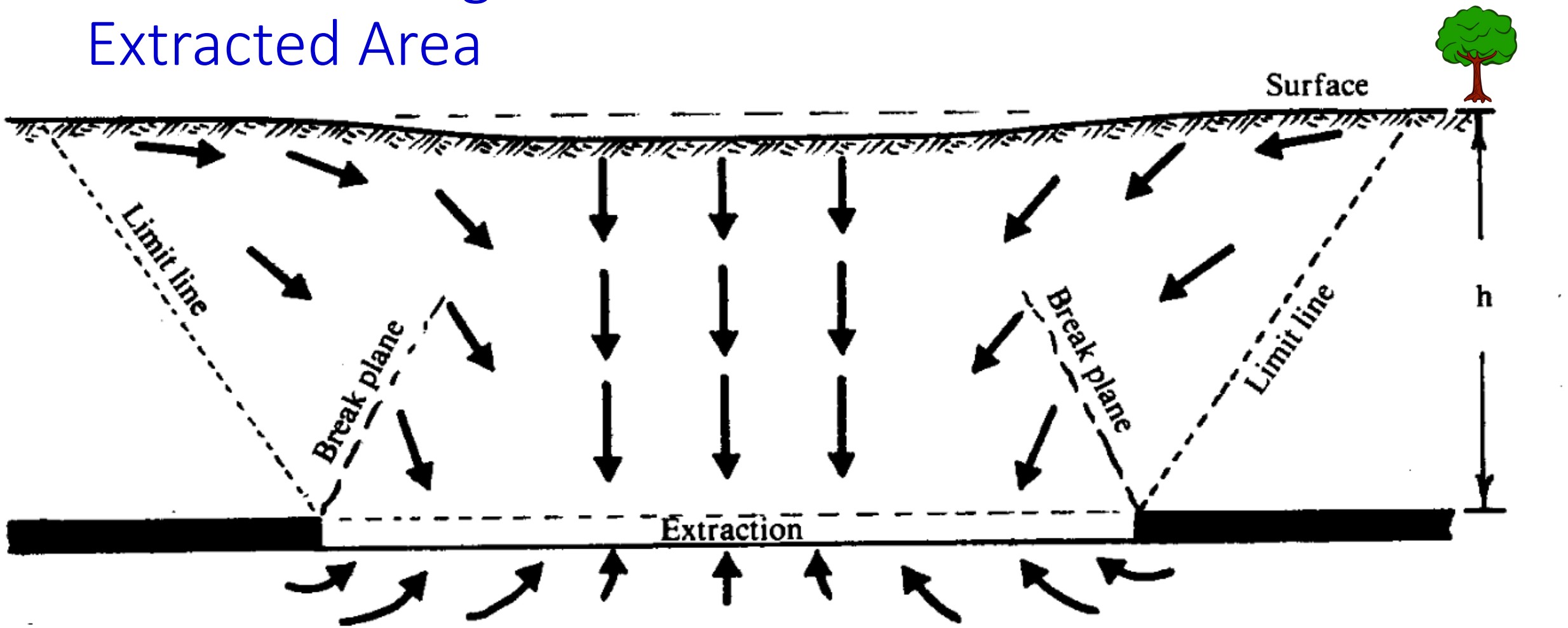


Definition of the Limit Angle (complementary to the Angle of Draw)



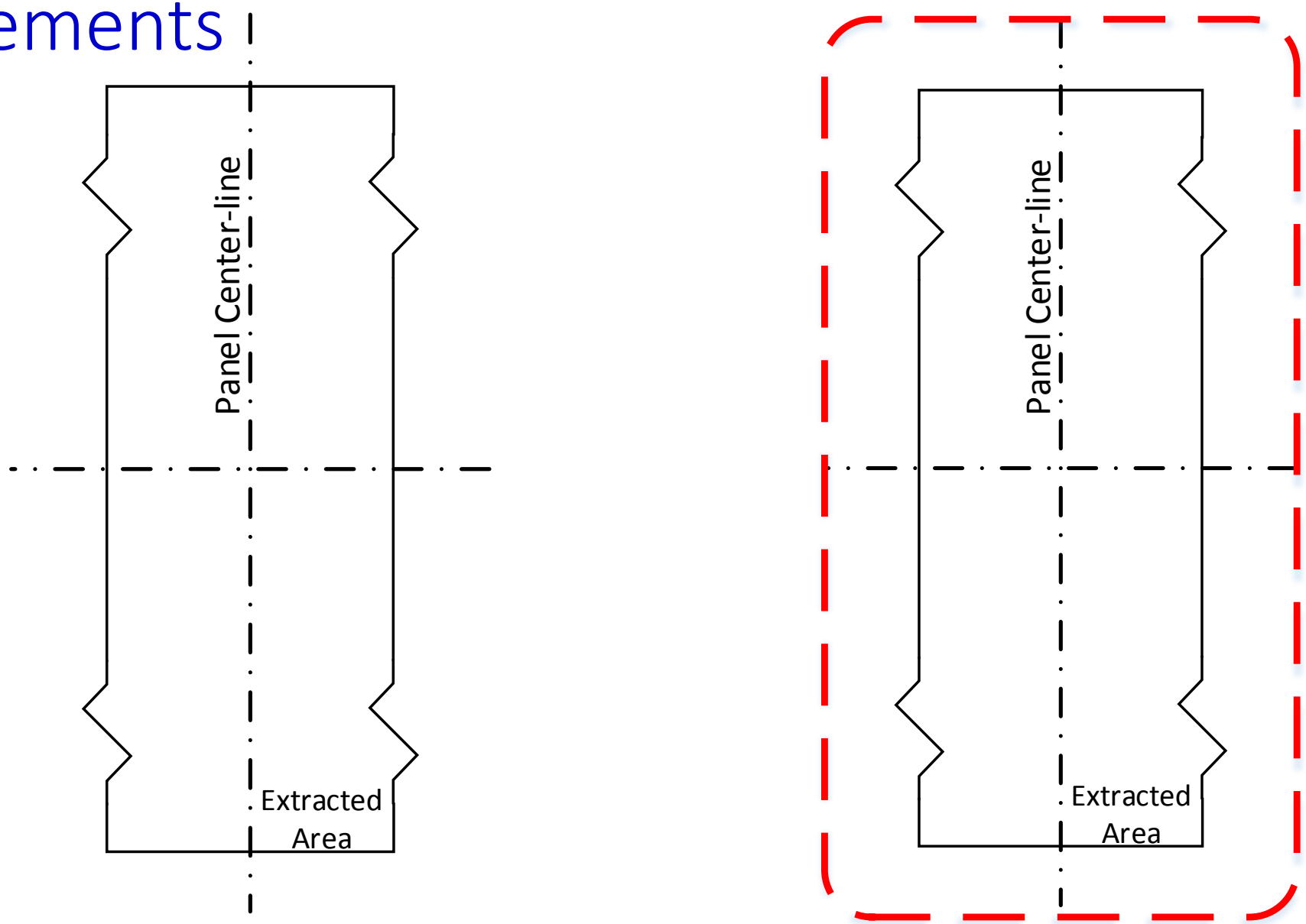
(Brauner, 1973)

Normal Mining Induced Movements above an Extracted Area

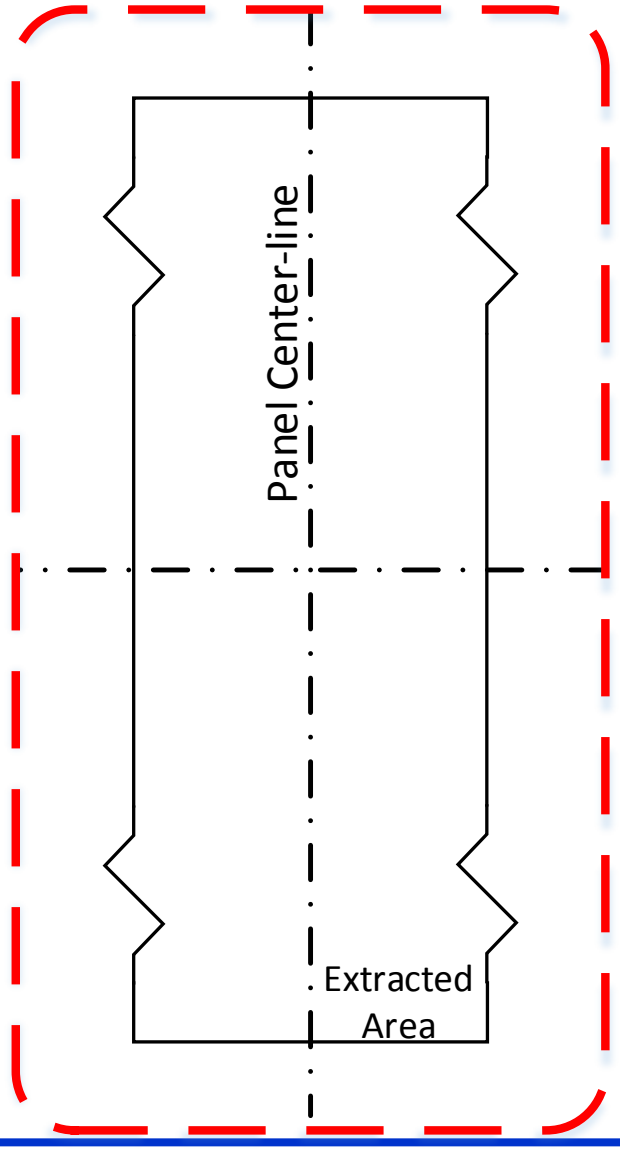


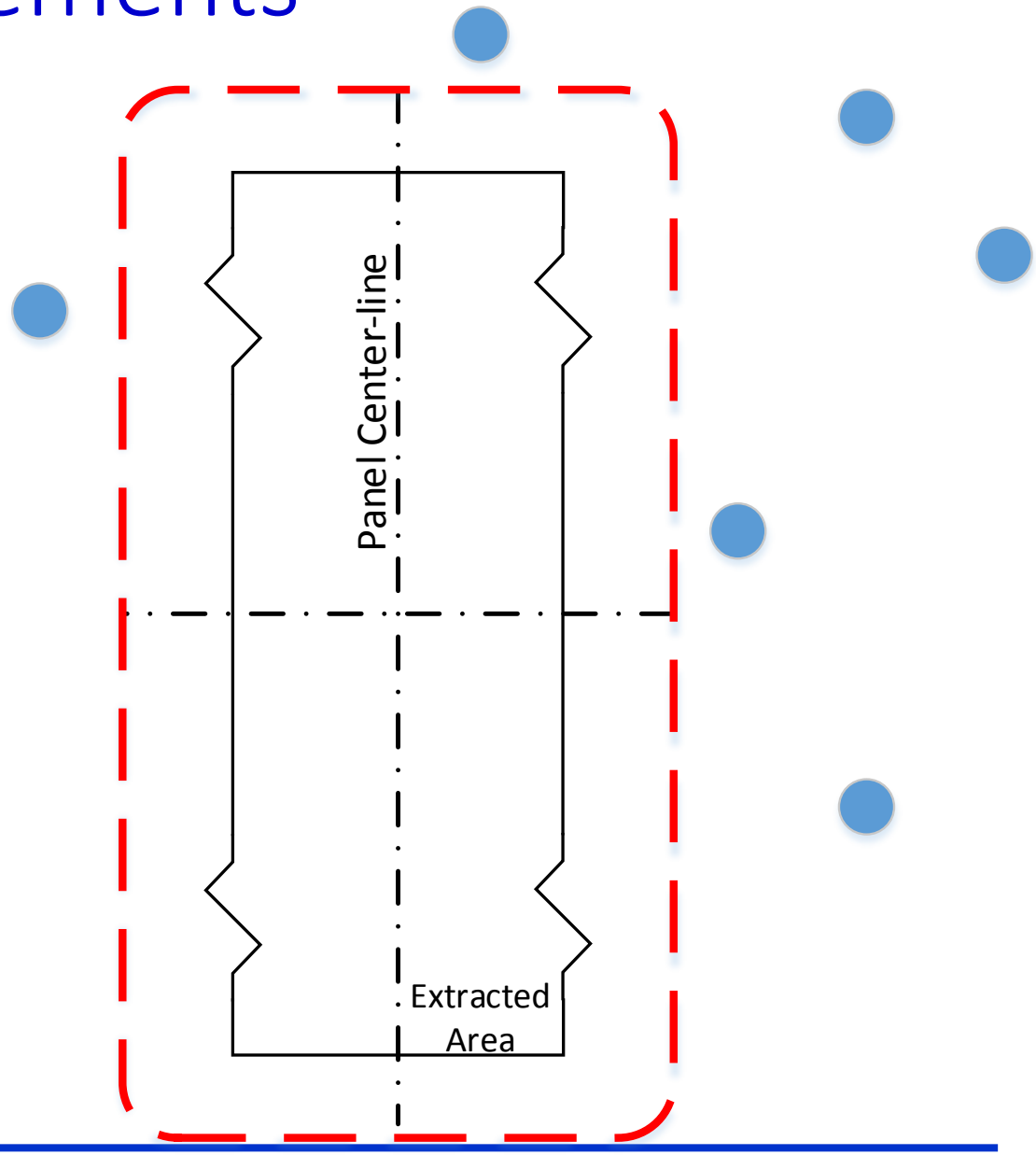
Whittaker et al (1985)

Angle of Draw Limit or Limit for Conventional Movements

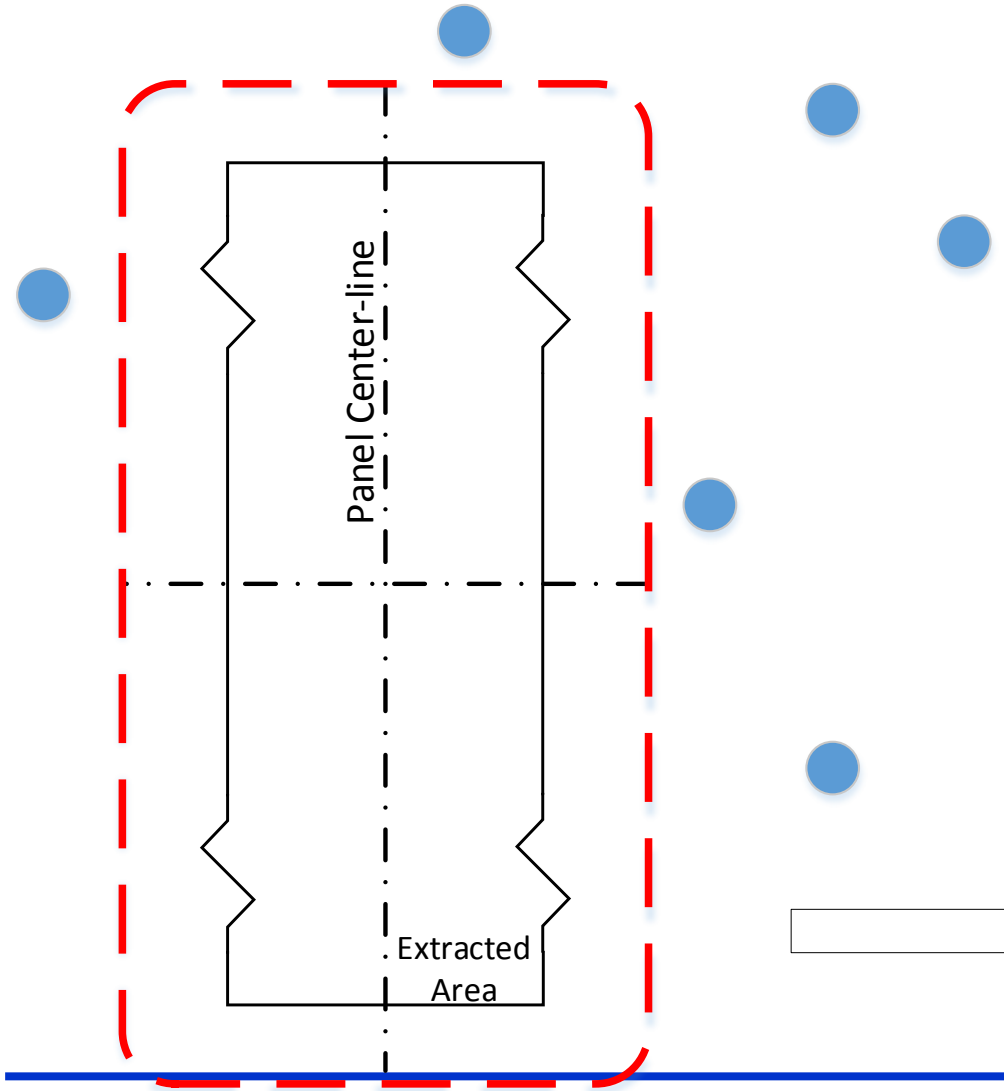


Non-Conventional Movements





Location angles for every point on the surface



Conventional movements

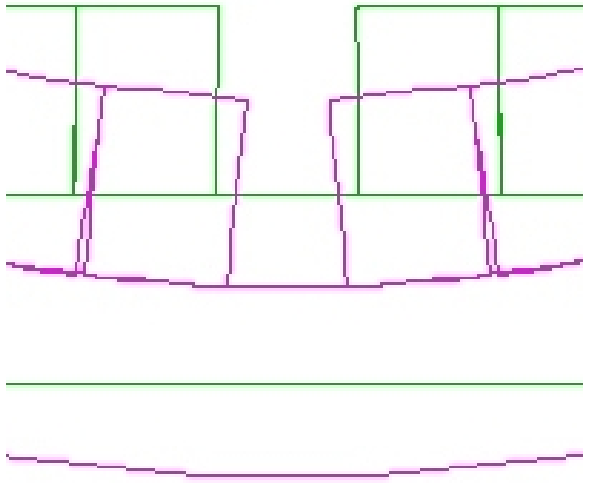
- Typically smooth in shape and can be explained by the expected caving mechanisms associated
- Vertical and Horizontal Movements within the angle of draw
- Australians use 20mm (0.79”) as the limit subsidence value
- Other approaches include 0.6% of Smax or other absolute values

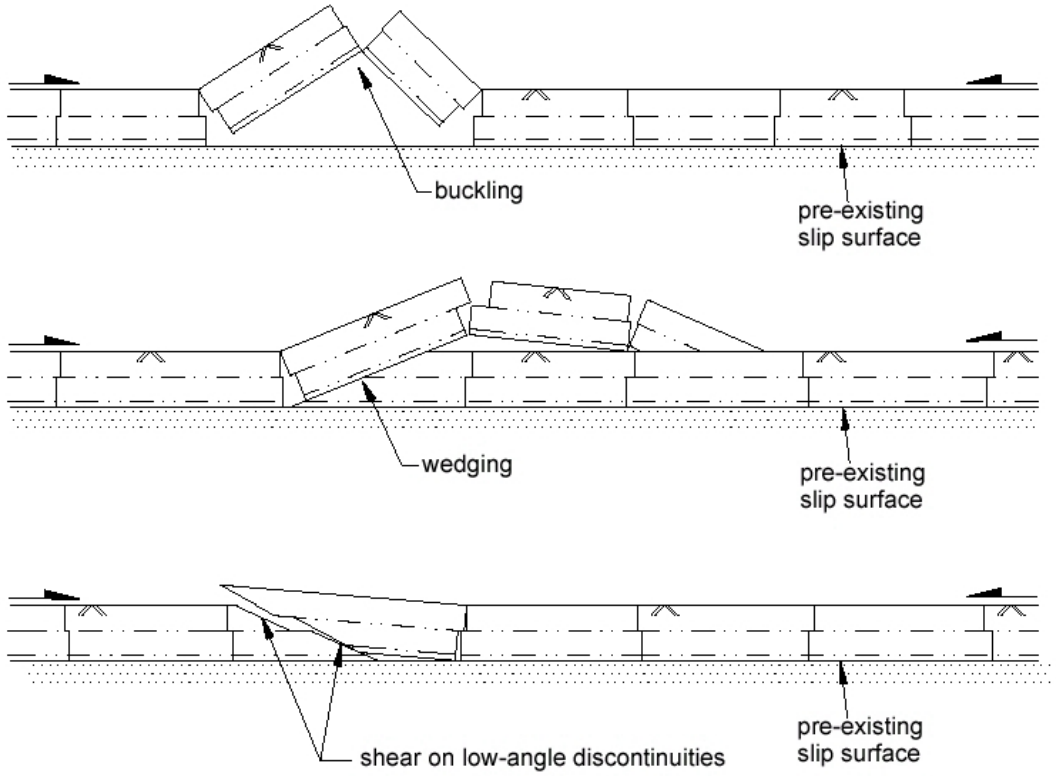
Non-Conventional Movements

- Observed irregular ground movements are not easily explained – some use the term “anomaly” when referring to such movements.
- Movements typically inside the angle of draw
  - Upsidence
  - Valley Closure
  - Downslope Movements
- Movements typically outside the angle of draw
  - Far Field **horizontal** movements
- A lot of relevant data have been collected from the Southern Coal Fields, Australia

Non-Conventional Movements Explained (1/3)

- Upsidence: Upward movement of valley floor
- Valley closure: Inward movement of valley sides and shoulders, and most pronounced when valley is directly above longwall

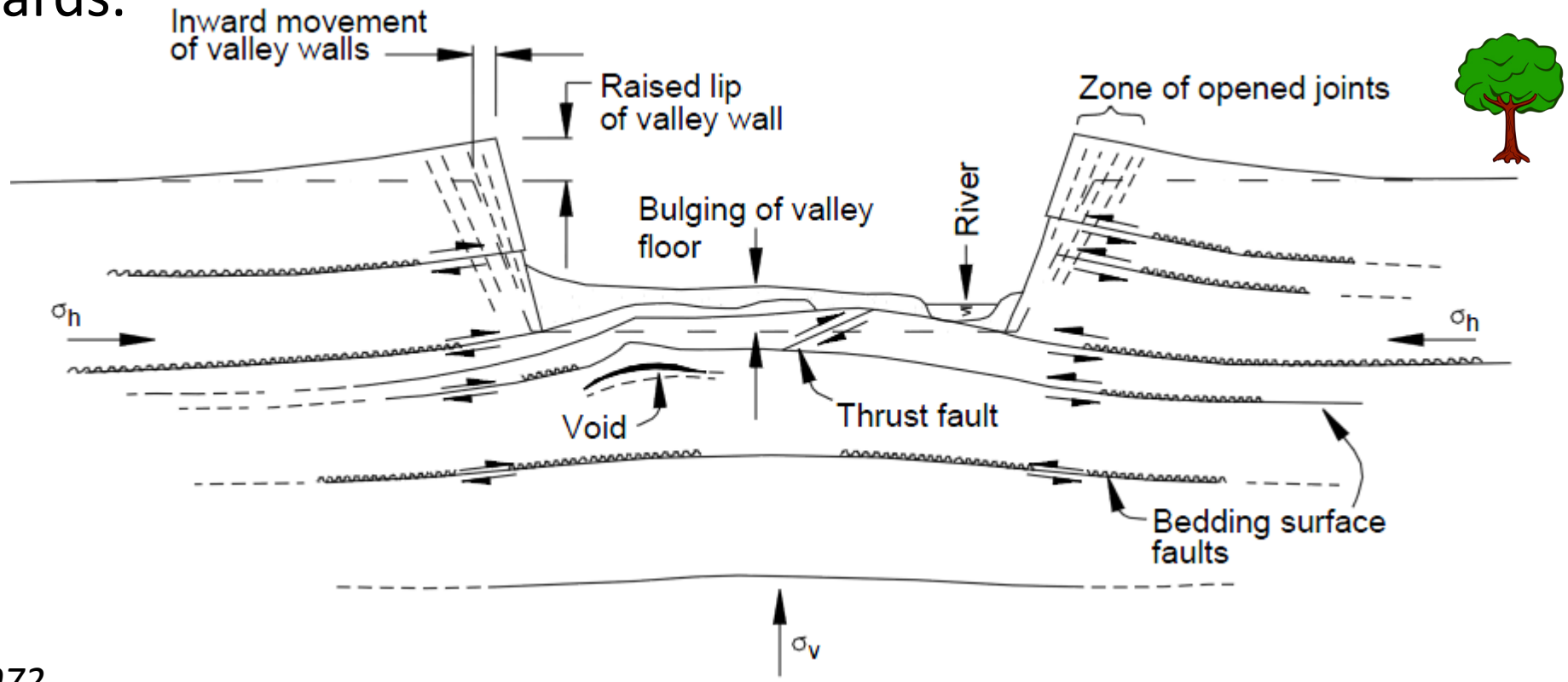




Keilich (2006)

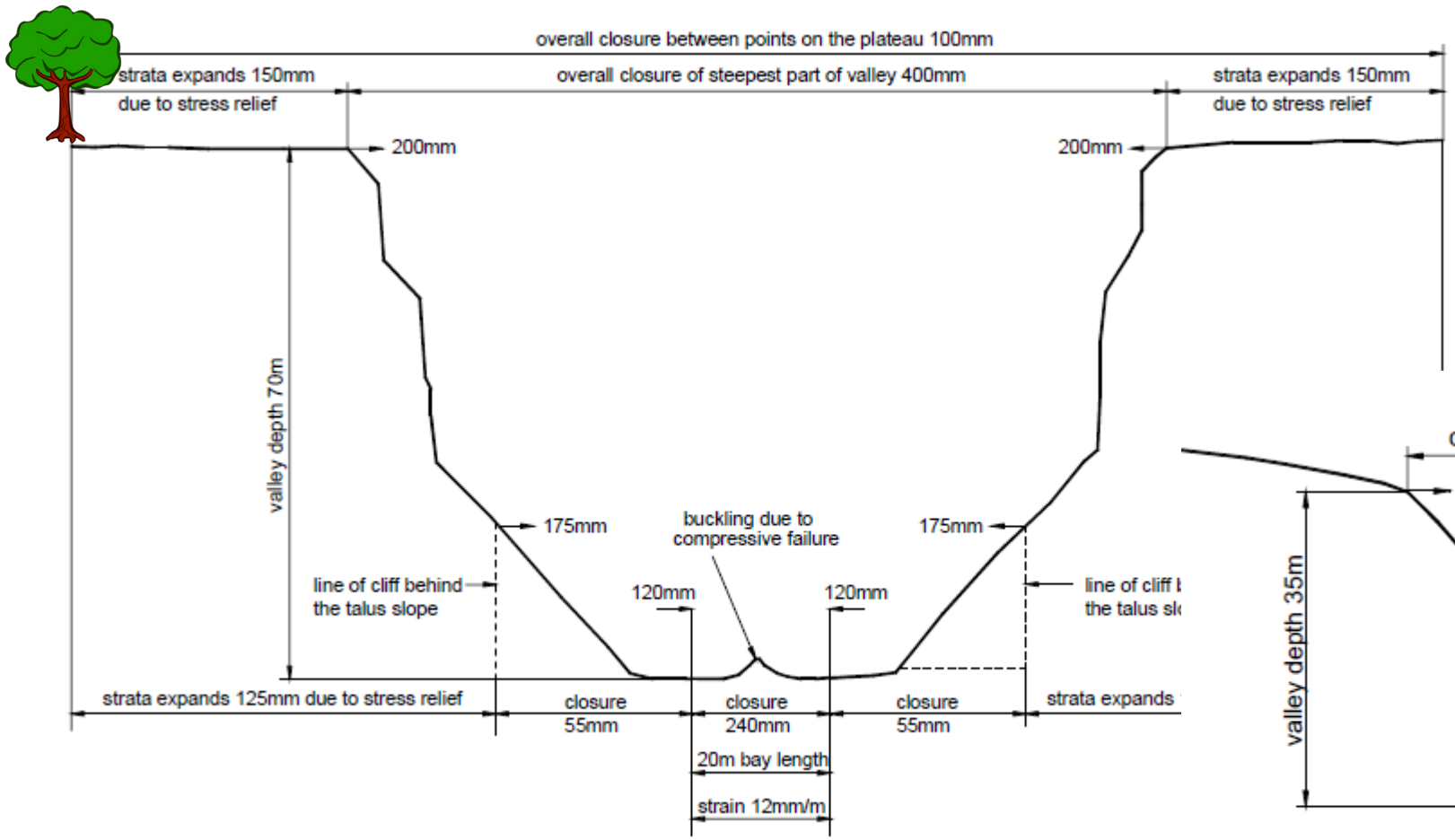
Upsidence in Creek and River Beds

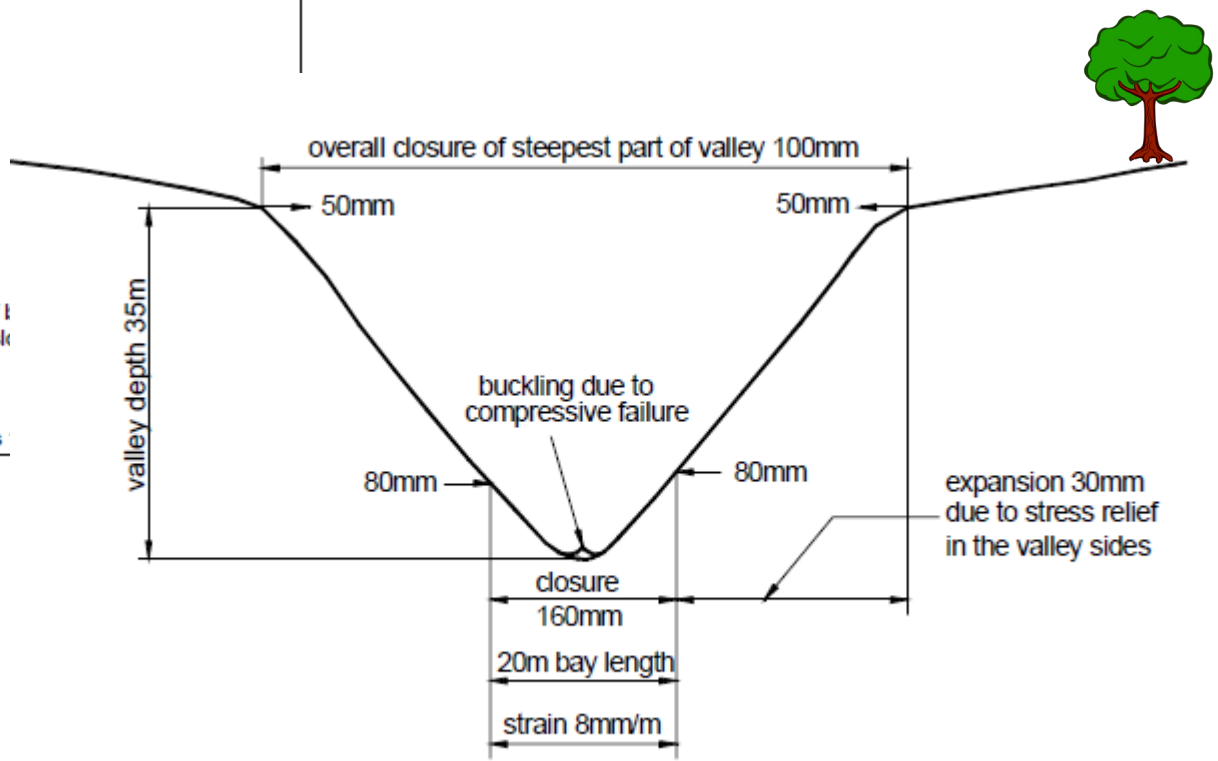
- When mining occurs under creeks and /or river valleys, the observed subsidence in the base of the creek or river is generally less than what would be expected in flat terrain. This is due to the floor of the valley buckling upwards.



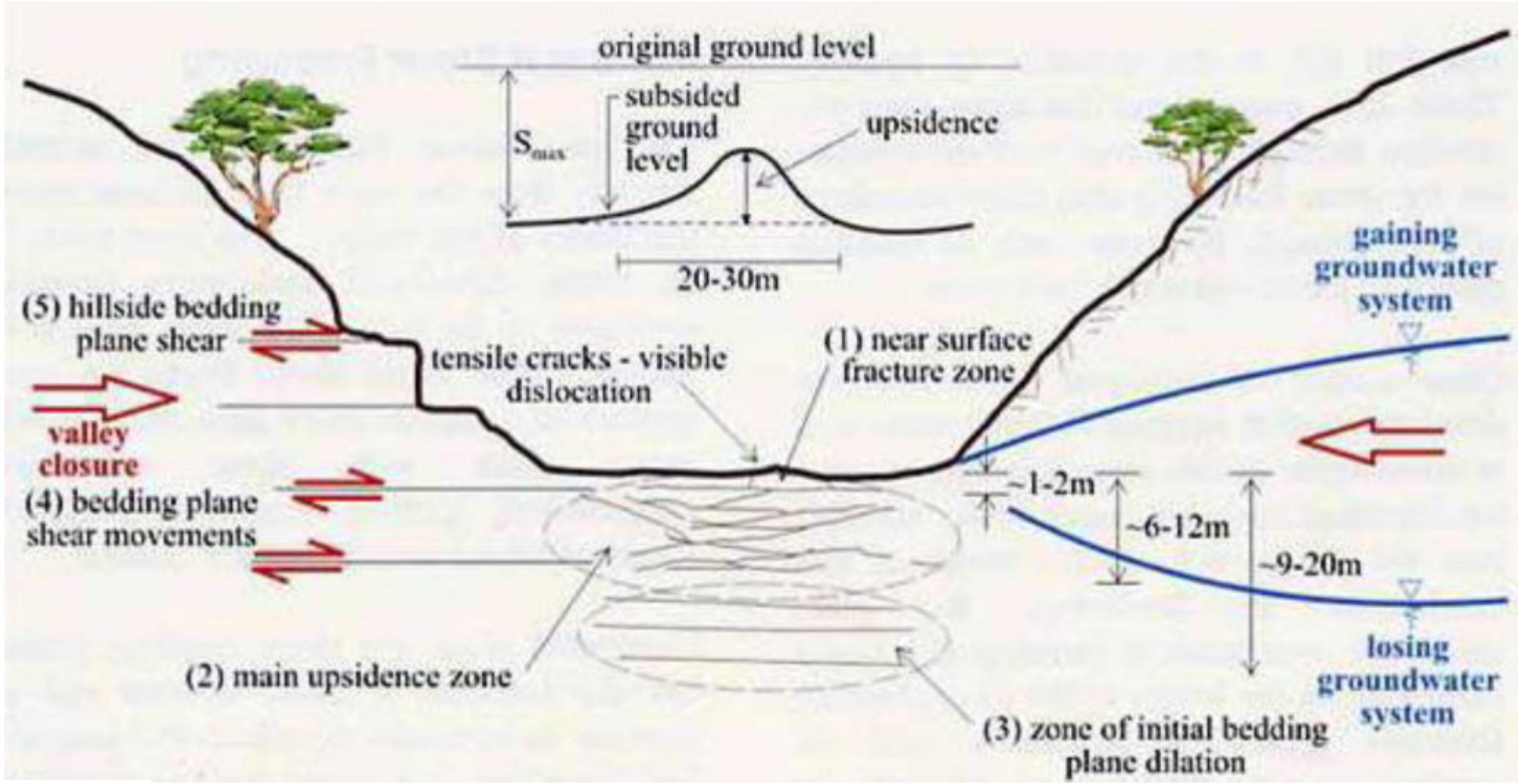
Patton and Hendren 1972

Closure in Steep-Sided Gorge and V-Shaped Valley



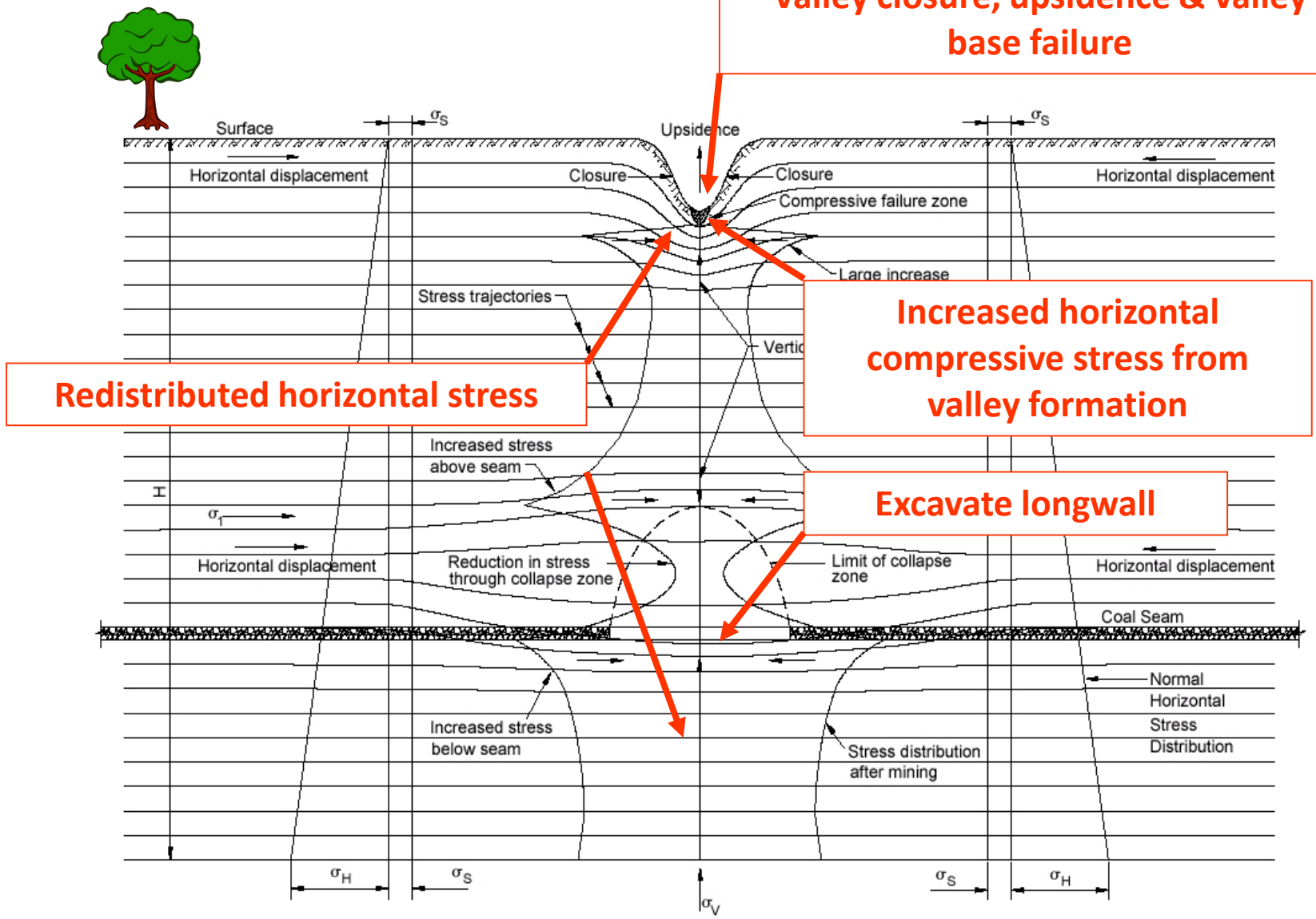


Waddington and Kay, 2003



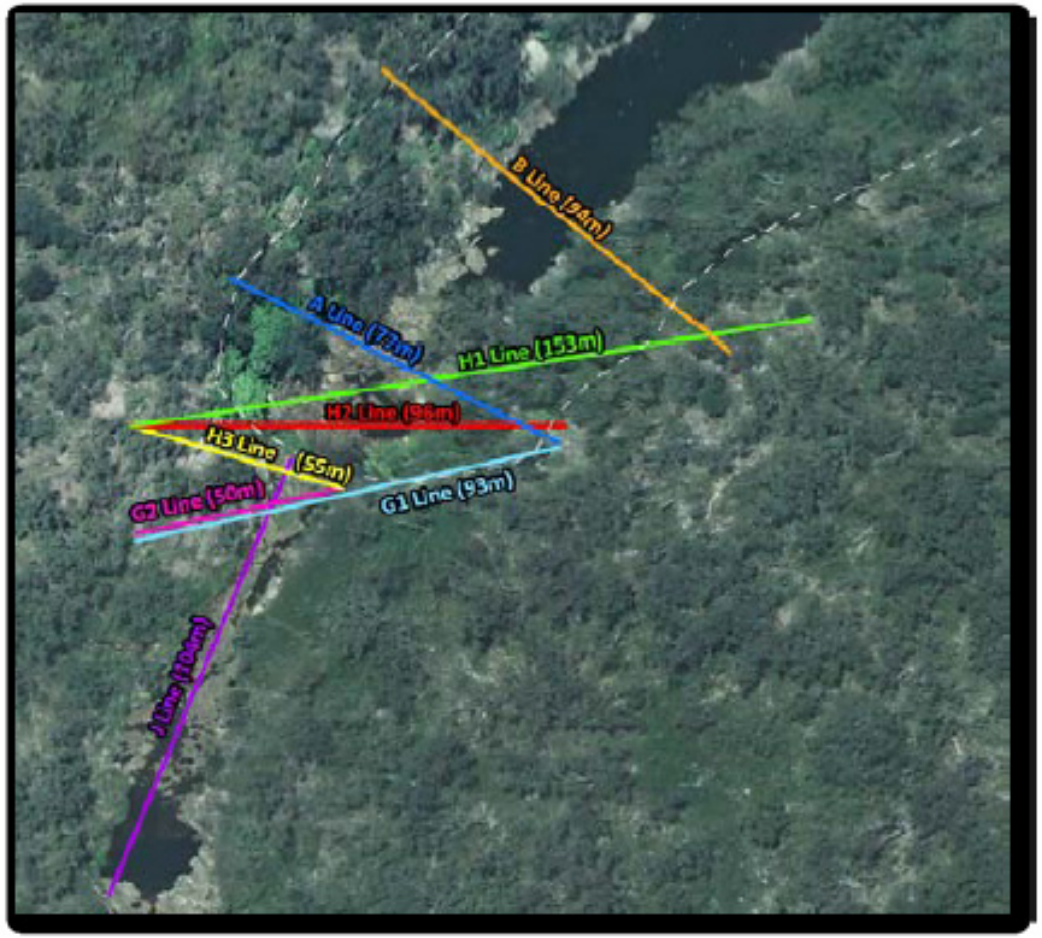
Mechanisms of valley closure and upsidence caused by coal mining-induced subsidence (© Copyright, Mills 2008).

Conceptual Model



Keilich, 2006

High Resolution Survey Lines to Measure Valley Closure

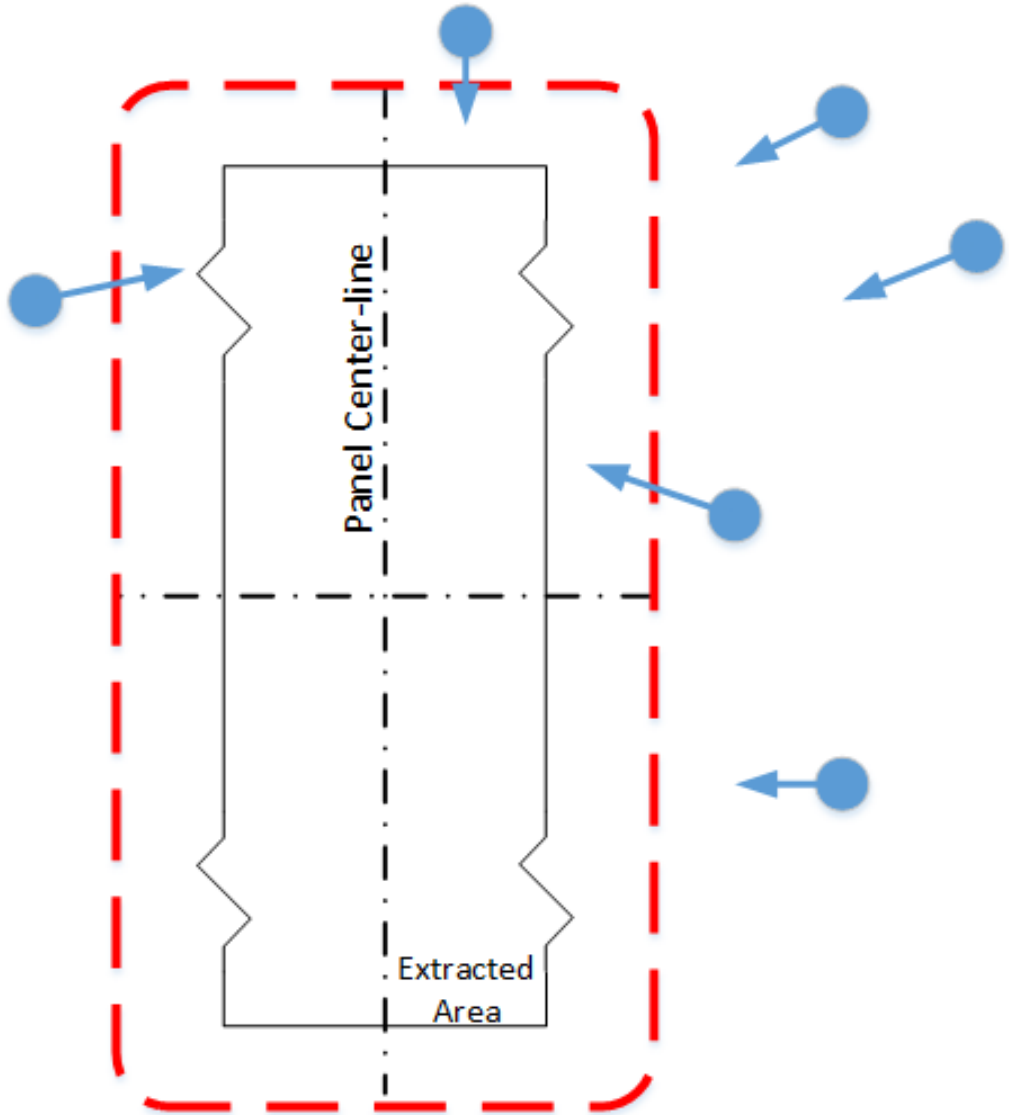


Walsh et al, 2014

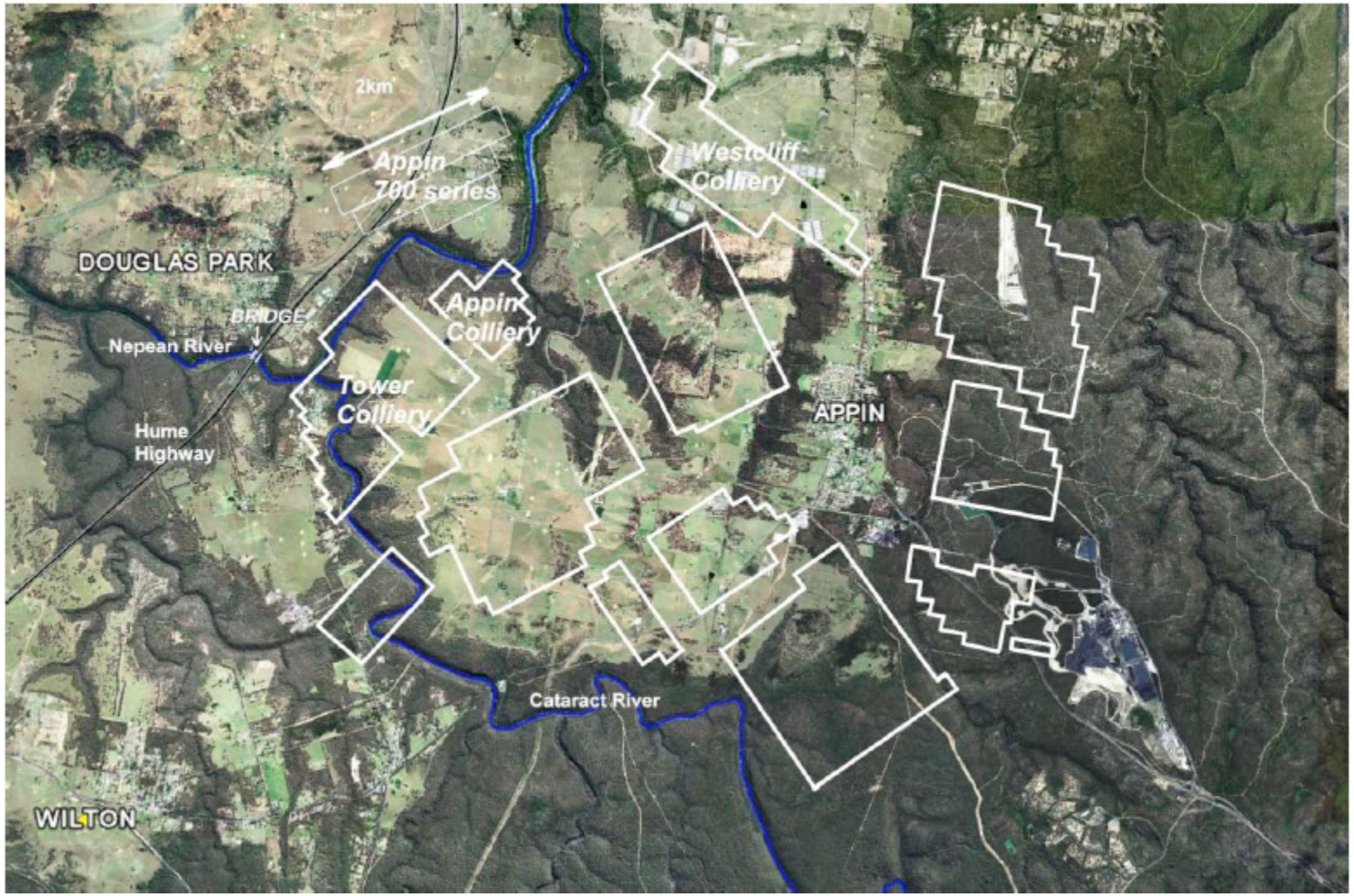
Downslope Subsidence due to Steep Topography

- Non-conventional movements can also result from downslope movements where longwalls are extracted beneath steep slopes. In these cases, elevated tensile strains develop near the tops of the steep slopes and elevated compressive strains develop near the bases of the steep slopes.
- The potential impacts resulting from down slope movements include the development of tension cracks at the tops of the steep slopes and compression ridges at the bottoms of the steep slopes.

Far Field Displacements

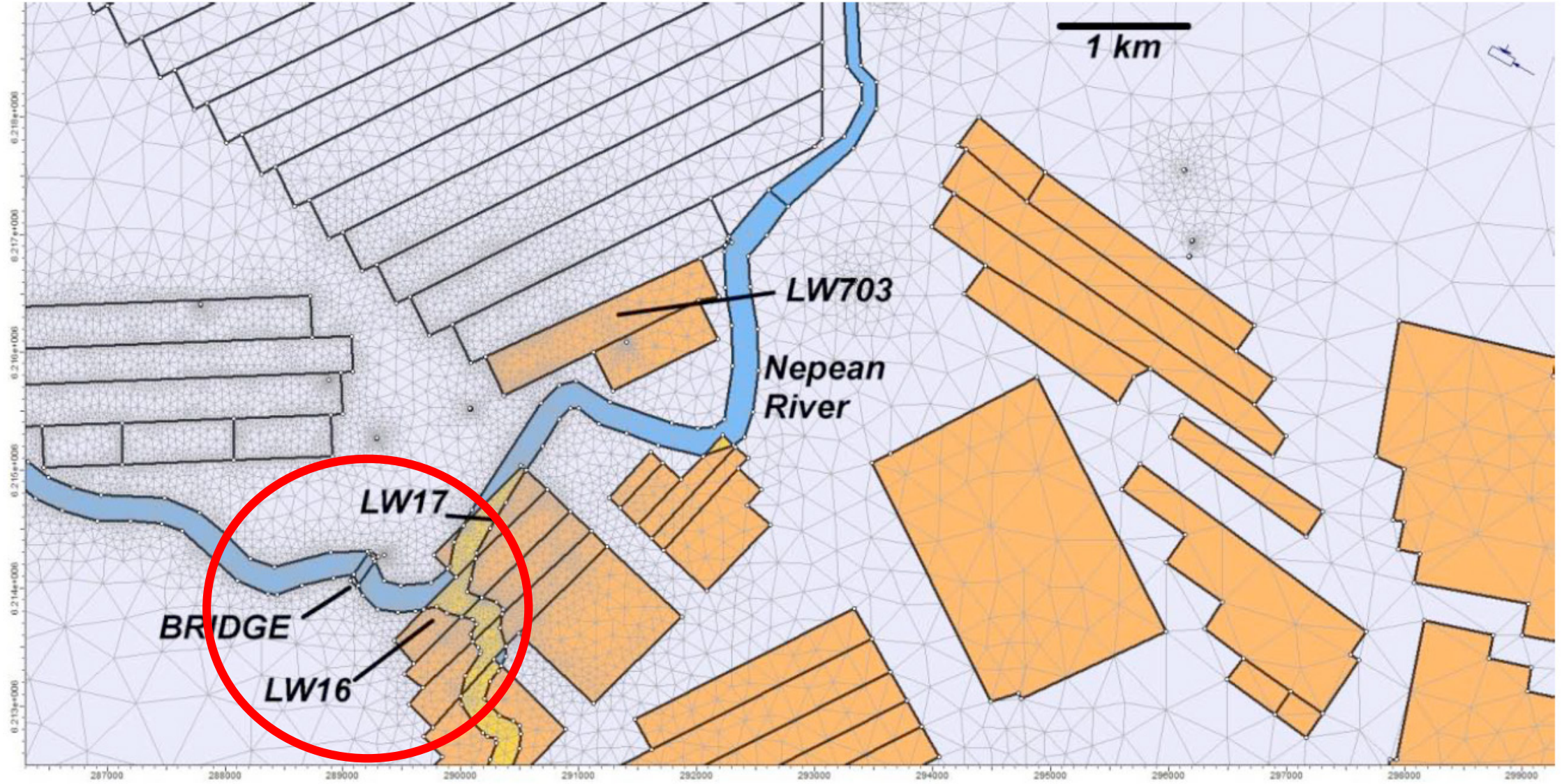


Areas of LW Extraction in the Vicinity of Appin and Wilton, Southern Coalfields, NSW.



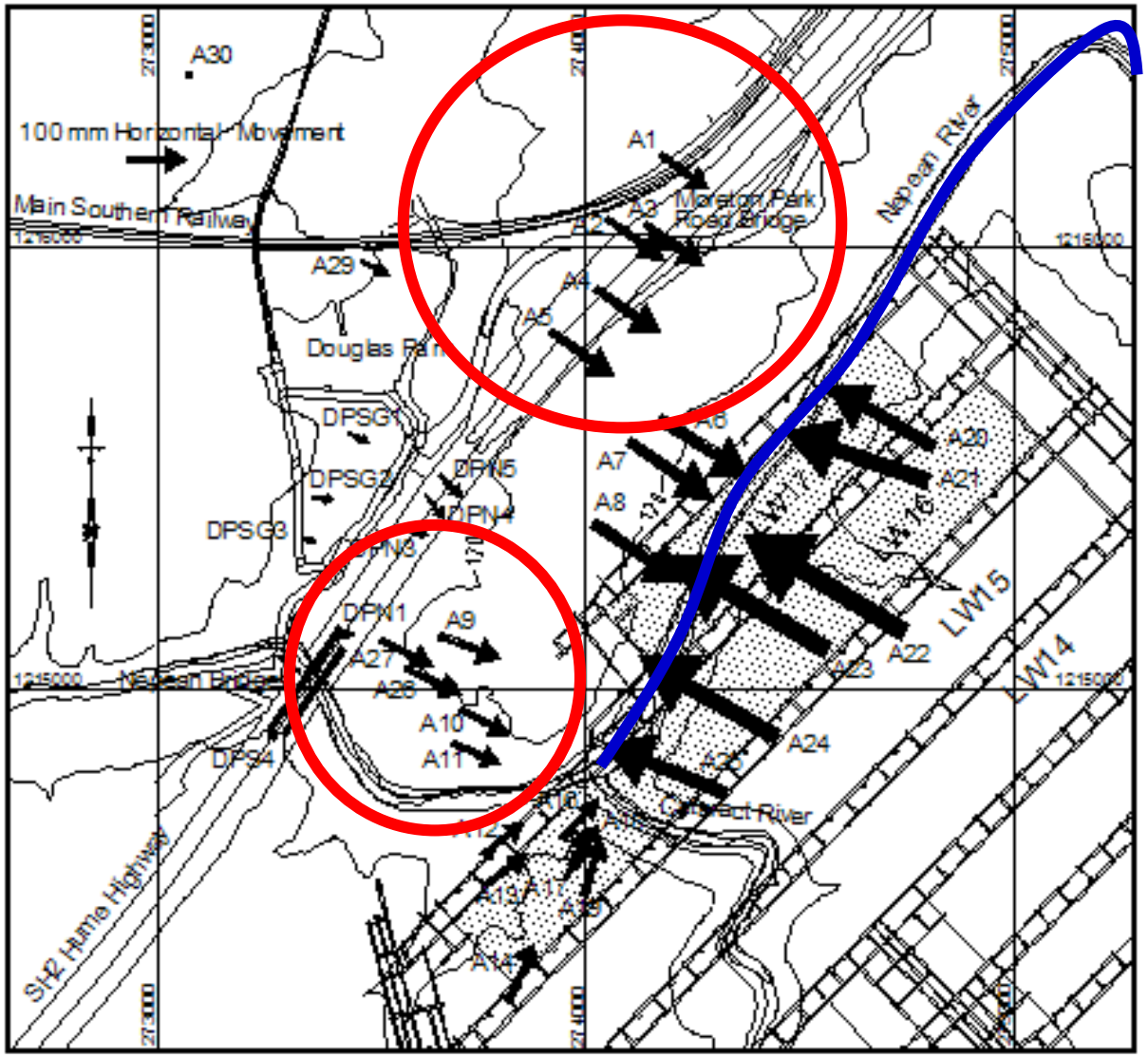
Pells, 2011

FEM used for Predicting Far Field Movements



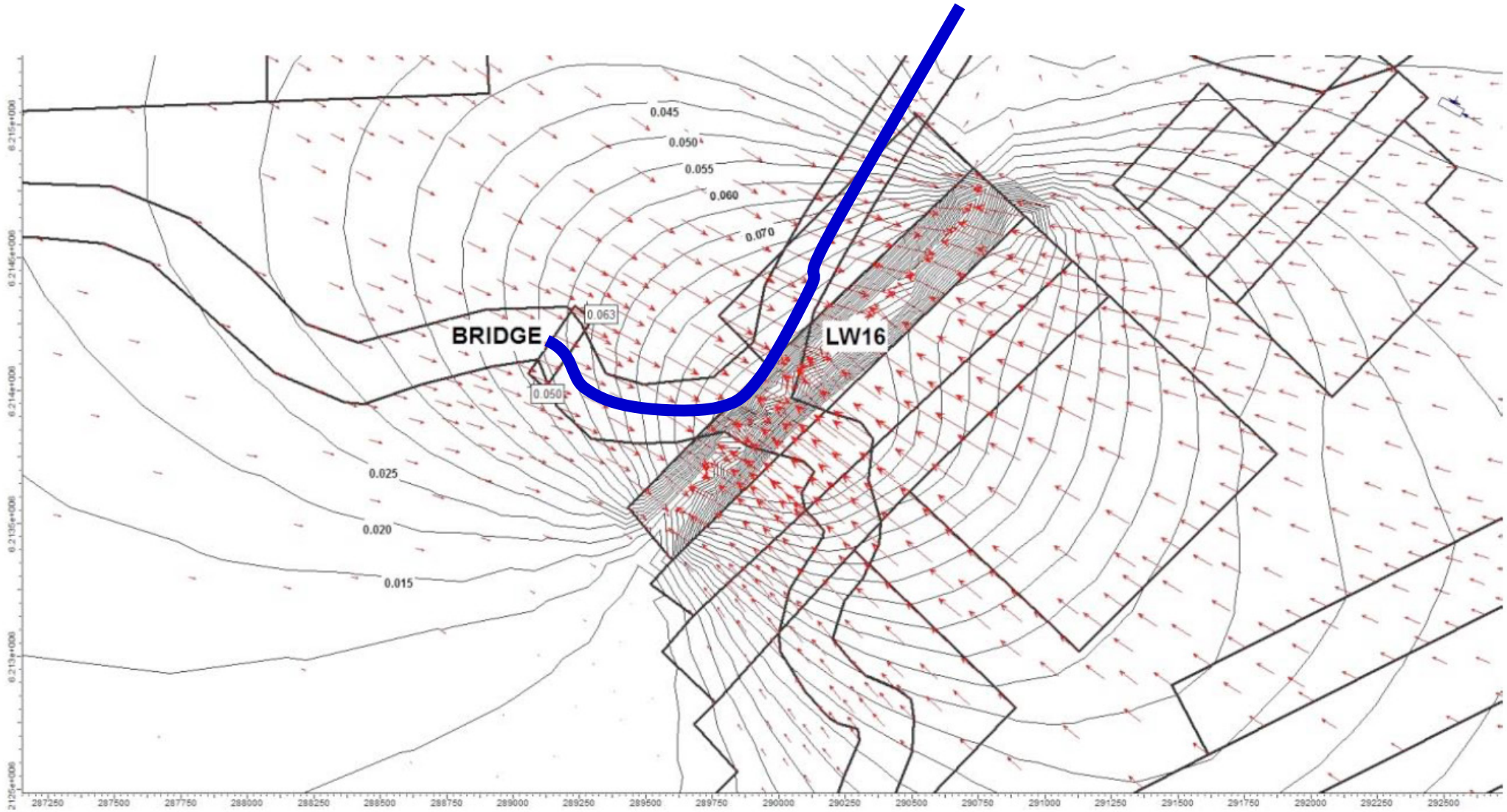
Pells, 2011

Horizontal Displacements Due to the Extraction of LW-16 and LW-17



Hebblewhite et al, 2001

Computed Horizontal Movements

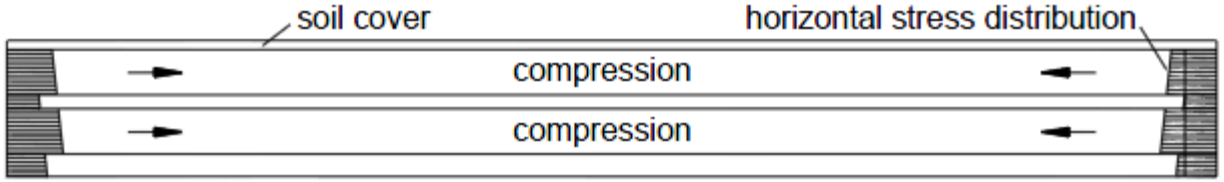


Pells, 2011

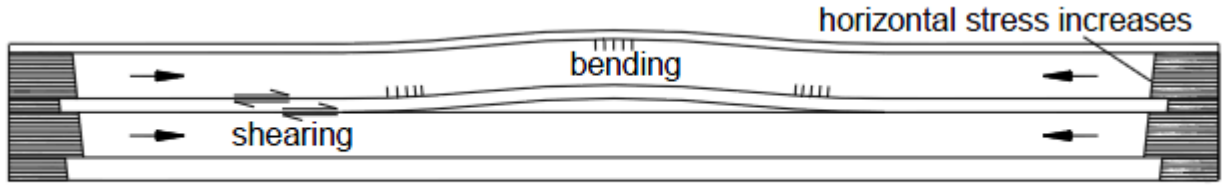
Possible Causes for Far Field Displacements

- Stress relaxation towards mining excavations (Hebblewhite 2009)
- Horizontal movements aligned with the principal in-situ compressive stress direction (Hebblewhite 2009)
- Redistribution of the stresses in the strata between the seam and the surface due to regional mining activity (MSEC 2009)
- Perturbation of the natural horizontal stress field due to macro changes to the stiffness of the strata above areas of total extraction (Pells 2011)

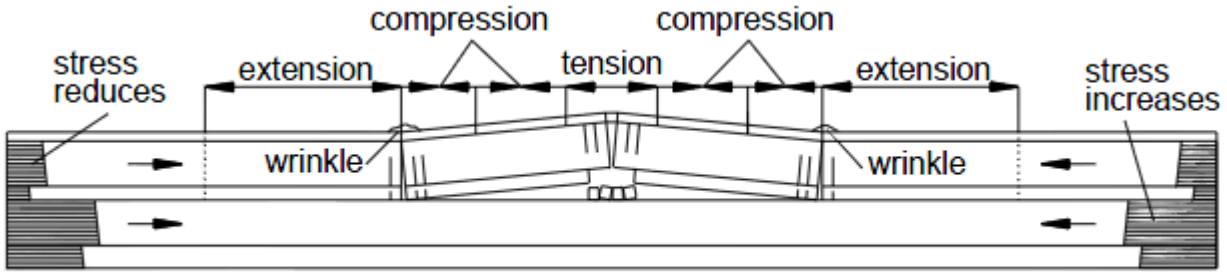
High Horizontal Stresses – Are they responsible?



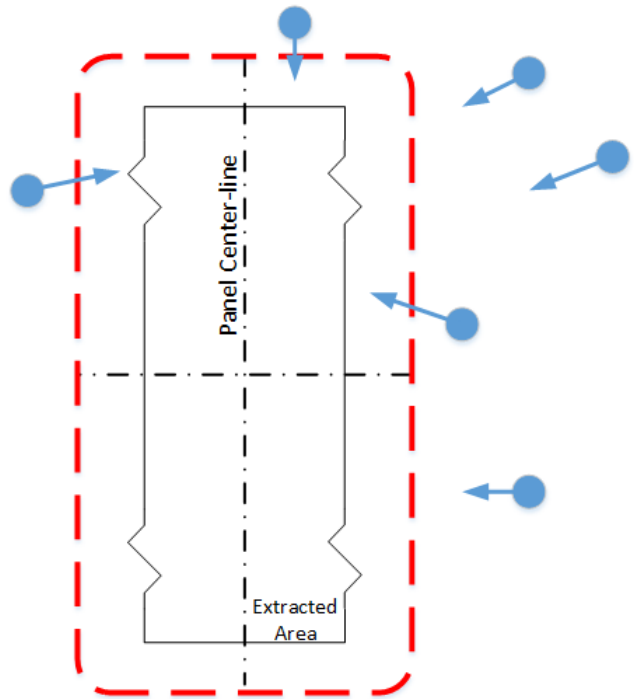
1. Strata are subjected to in situ horizontal stress



2. The in situ horizontal stress increases causing shearing and bending



3. The strata fail in compression and buckle


Panel Center-line
Extracted
Area