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ASSESSING EFFECTS OF THERMAL LOADING ON THE STABILITY OF EMPLACEMENT DRIFTS

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OUTLINE

- Significance of Stability of Emplacement
- Finite Element Model
- Approach To Assessing Drift Stability
- Results
- Conclusion

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SIGNIFICANCE OF STABILITY OF EMPLACEMENT DRIFTS

- Preclosure Period: Emplacement Drifts Need to Be Stable to Support Operations
  - Waste emplacement
  - Inspection and monitoring
  - Waste relocation if necessary
  - Maintenance
  - Closure operations

- Postclosure Period: Rock Fall, Rubble Accumulations, and Degraded Drift Configurations Need to Be Considered in Performance Assessment

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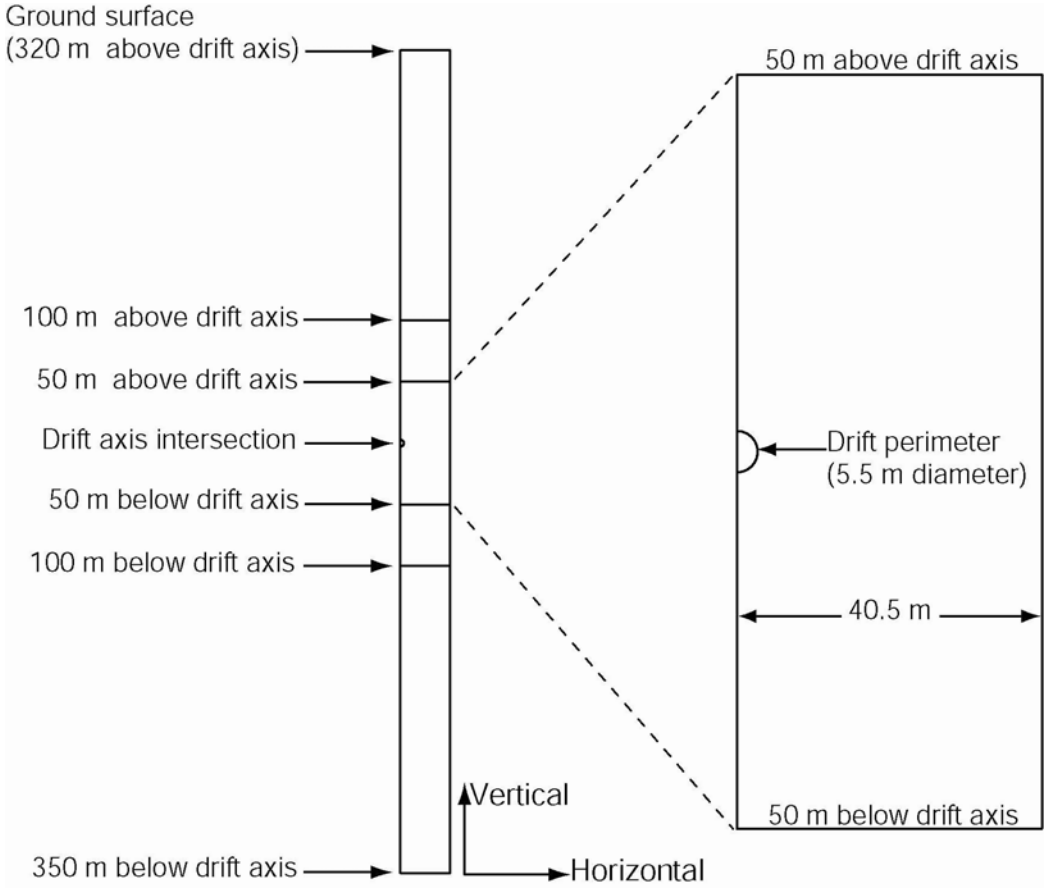
DRIFT-SCALE FINITE ELEMENT MODELING OF THERMAL-MECHANICAL BEHAVIOR



- Vertical Section Through Drift Axis
- Symmetry Between Adjacent Drifts
- Used for Heat Conduction and Thermal-Mechanical Analyses

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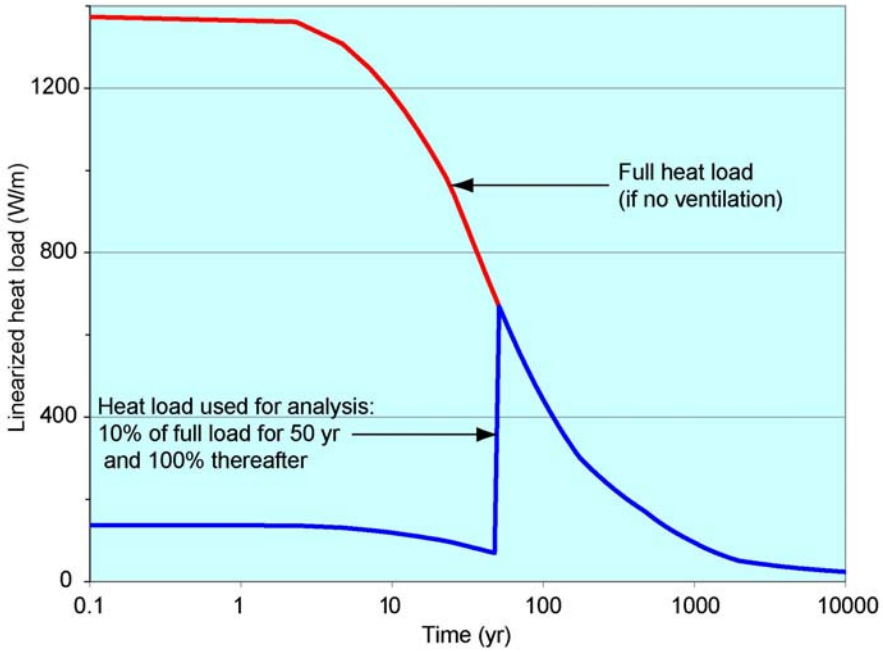
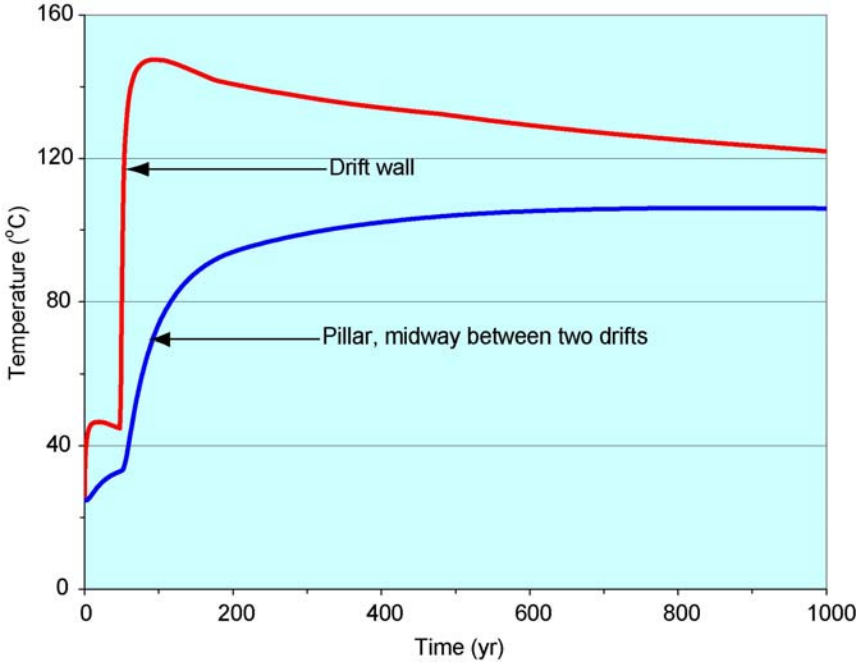
INPUT THERMAL LOAD AND SELECTED OUTPUT TEMPERATURE HISTORIES





- Assumed 90% of Thermal Load During First 50 Yr Would Be Removed Through Ventilation
- Calculated Temperature Histories Used as Input for Mechanical Analysis

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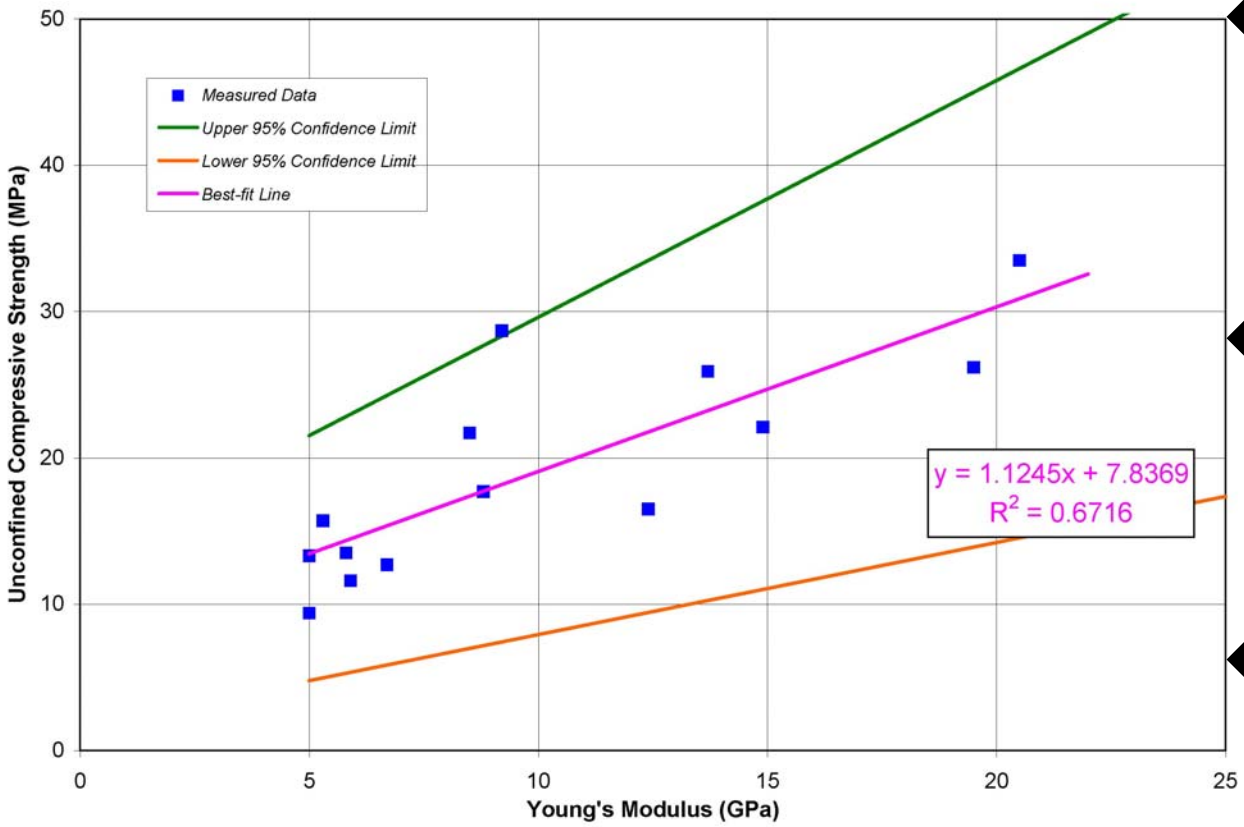
ROCK MASS STRENGTH AND STIFFNESS BASED ON YUCCA MOUNTAIN PROJECT INFORMATION



- Upper and lower-bound strength based on 95% confidence limits from laboratory data
- Relationships between rock strength and stiffness control thermal-mechanical behavior
- Full range of the relationships were considered for stability assessment

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STABILITY ASSESSMENT OF EMPLACEMENT DRIFTS BASED ON OVER STRESS INDICATIONS

- Over stress indicated by maximum principal stress at the drift perimeter greater than the unconfined compressive strength
- A drift with over-stressed perimeter could be stabilized with ground support if the over-stressed rock is held in place by the support system
- An over-stressed drift perimeter, if unsupported, would spall progressively until the exposed surface is not over-stressed or the drift opening is filled with rubble

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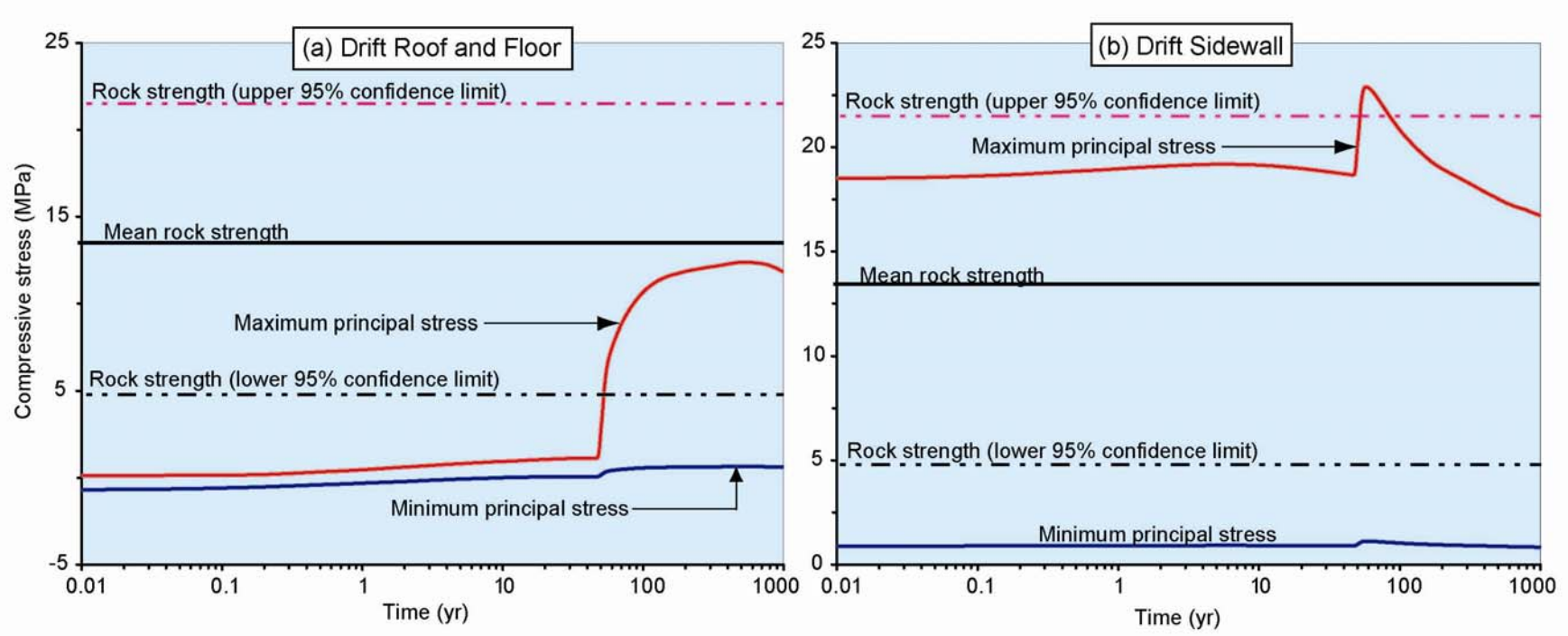
OVER-STRESS ASSESSMENT OF EMPLACEMENT DRIFTS IN LOW-GRADE LITHOPHYSAL ROCK (E = 5 GPa)



- Drift segments in this rock grade would be over-stressed in sidewall areas
- Progressive spalling of unsupported drift segments in this rock grade can be expected, beginning at the sidewall and progressing toward the roof

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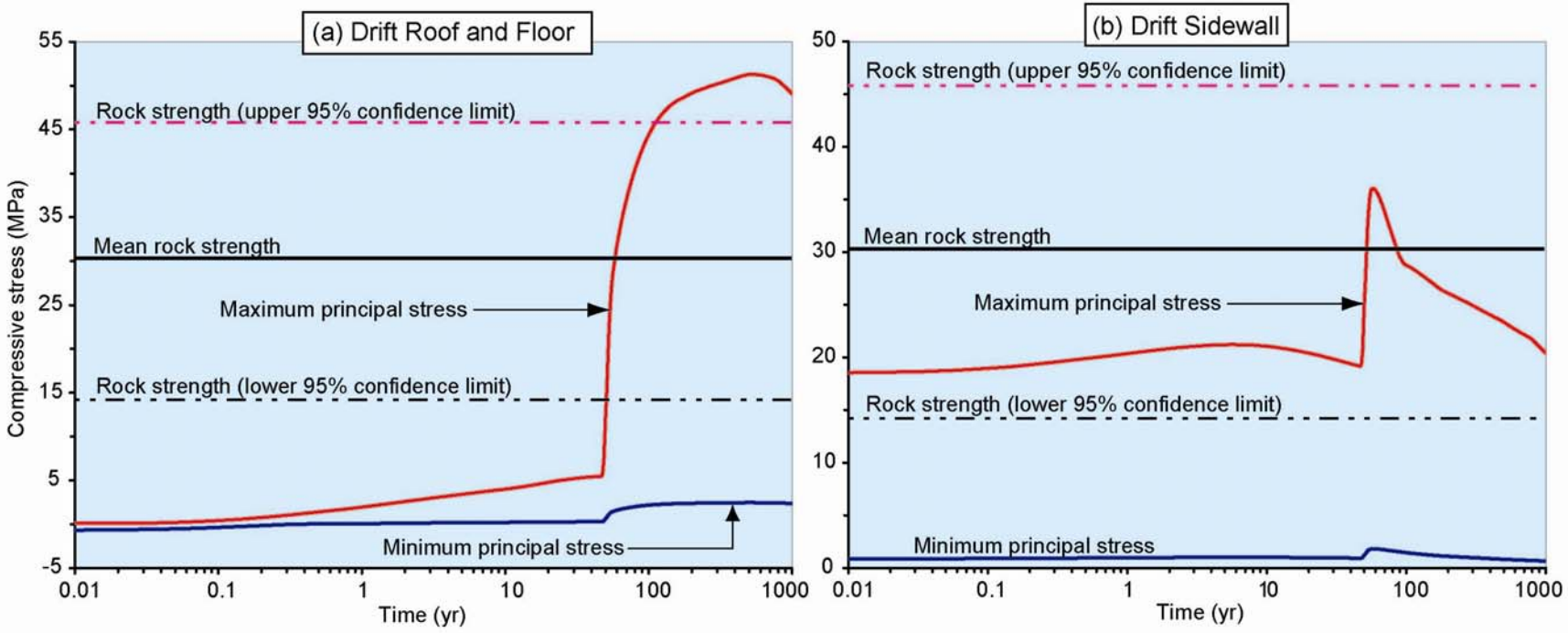
OVER-STRESS ASSESSMENT OF EMPLACEMENT DRIFTS IN HIGH-GRADE LITHOPHYSAL ROCK (E = 20 GPa)



- Roof and floor of drift segments in this rock grade would be over-stressed
- Spalling of unsupported drift segments in this rock grade can be expected, beginning in the roof areas and progressing vertically
- Conditions favorable for spalling would develop after termination of ventilation and persist for several hundred years

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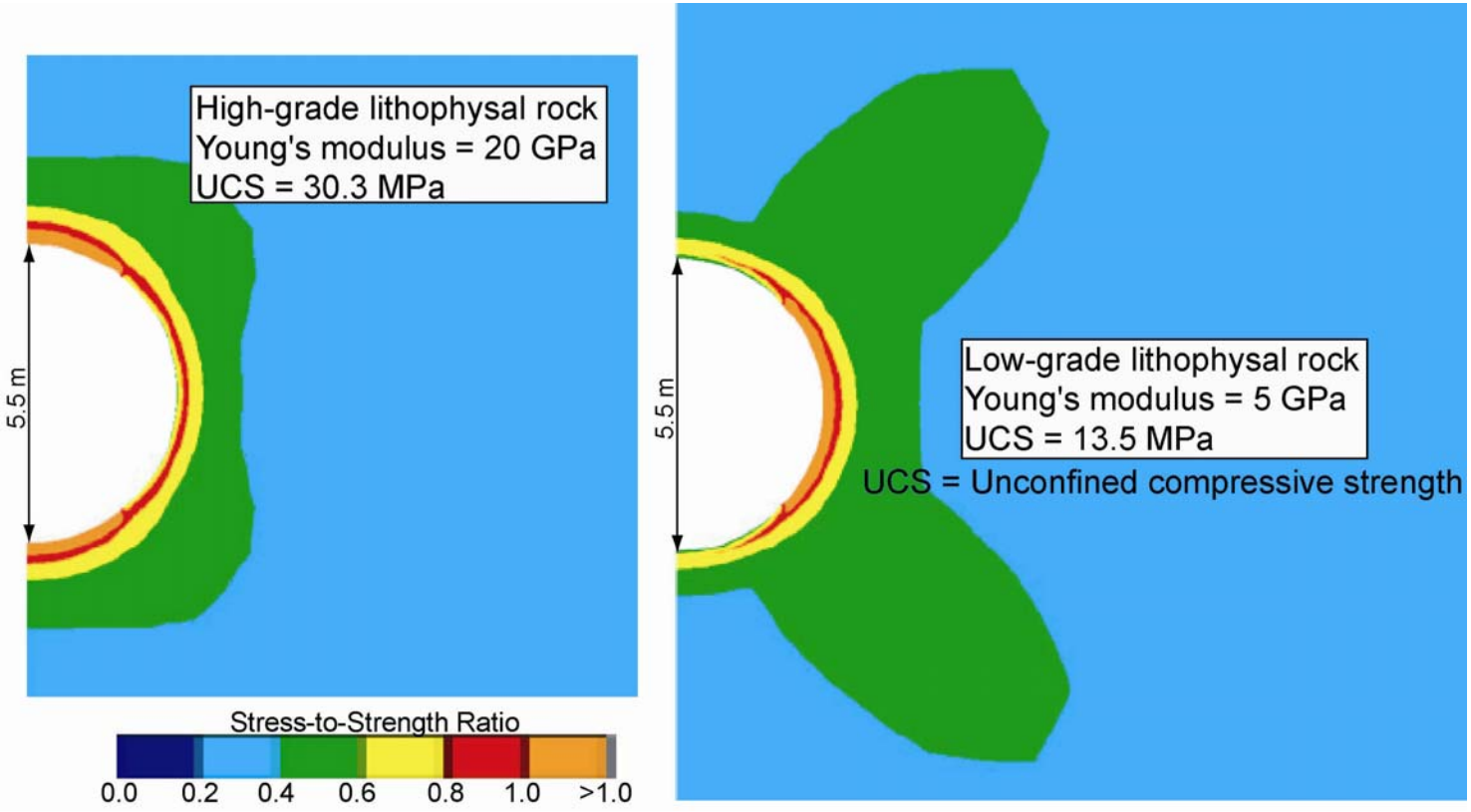
SHAPE AND EXTENT OF THE INITIAL ZONE OF OVER-STRESSED ROCK



- Over-Stressed Rock Would Remain in Place if Stabilized with Ground Support but Would Spall Progressively if Unsupported

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CONCLUDING REMARKS

- Rock near the perimeter of drift openings could be over stressed owing to thermal loading
- Ventilation of emplacement drifts could reduce potential over stress
- Over stress developed after the termination of ventilation would persist through the thermal pulse, potentially several hundred years
- A drift over-stressed near its perimeter could be stabilized with ground support
- An over-stressed drift perimeter, if unsupported, would spall progressively until the exposed surface is not over-stressed or the drift opening is filled with rubble

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