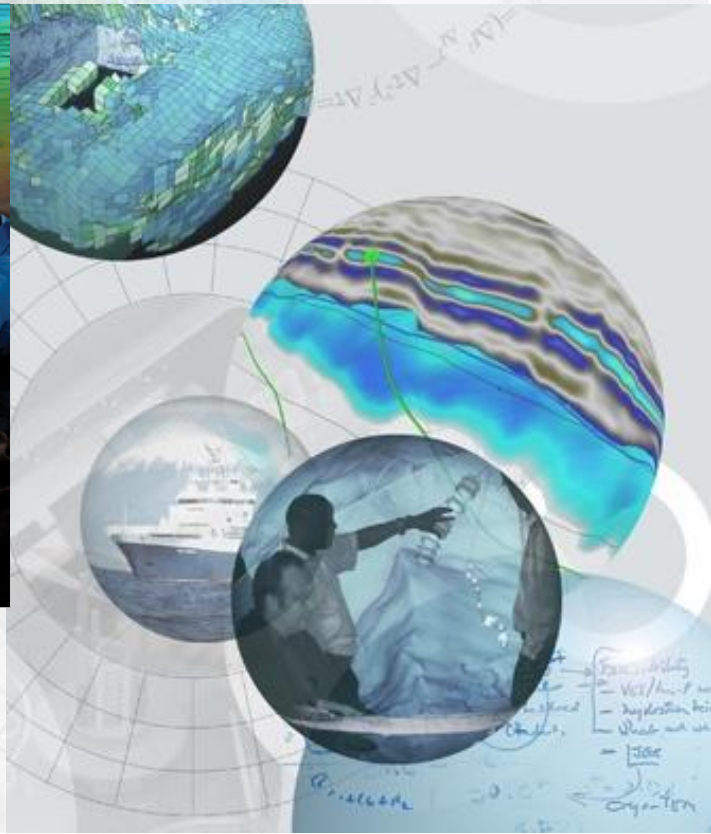
Flexible Cement, What Properties Do We Need?

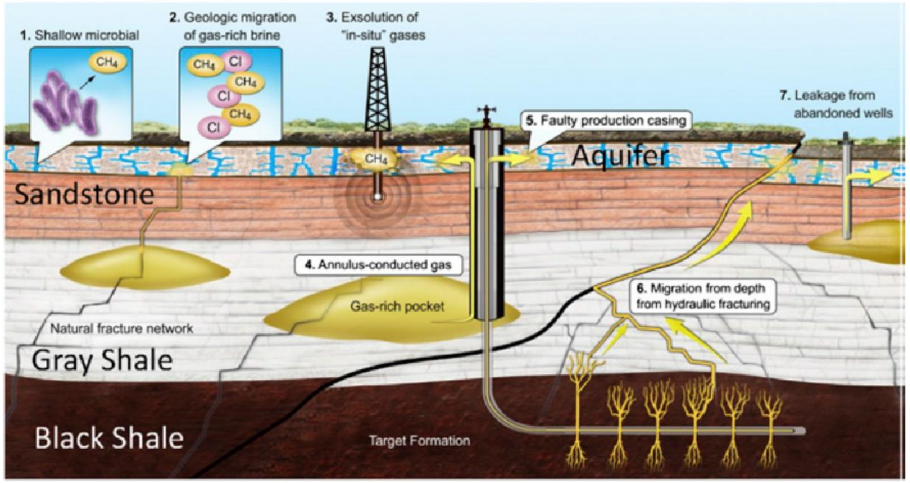
Schlumberger



Gunnar DeBruijn PE, Well Integrity Domain Manager North America

Proceedings National Academy of Science

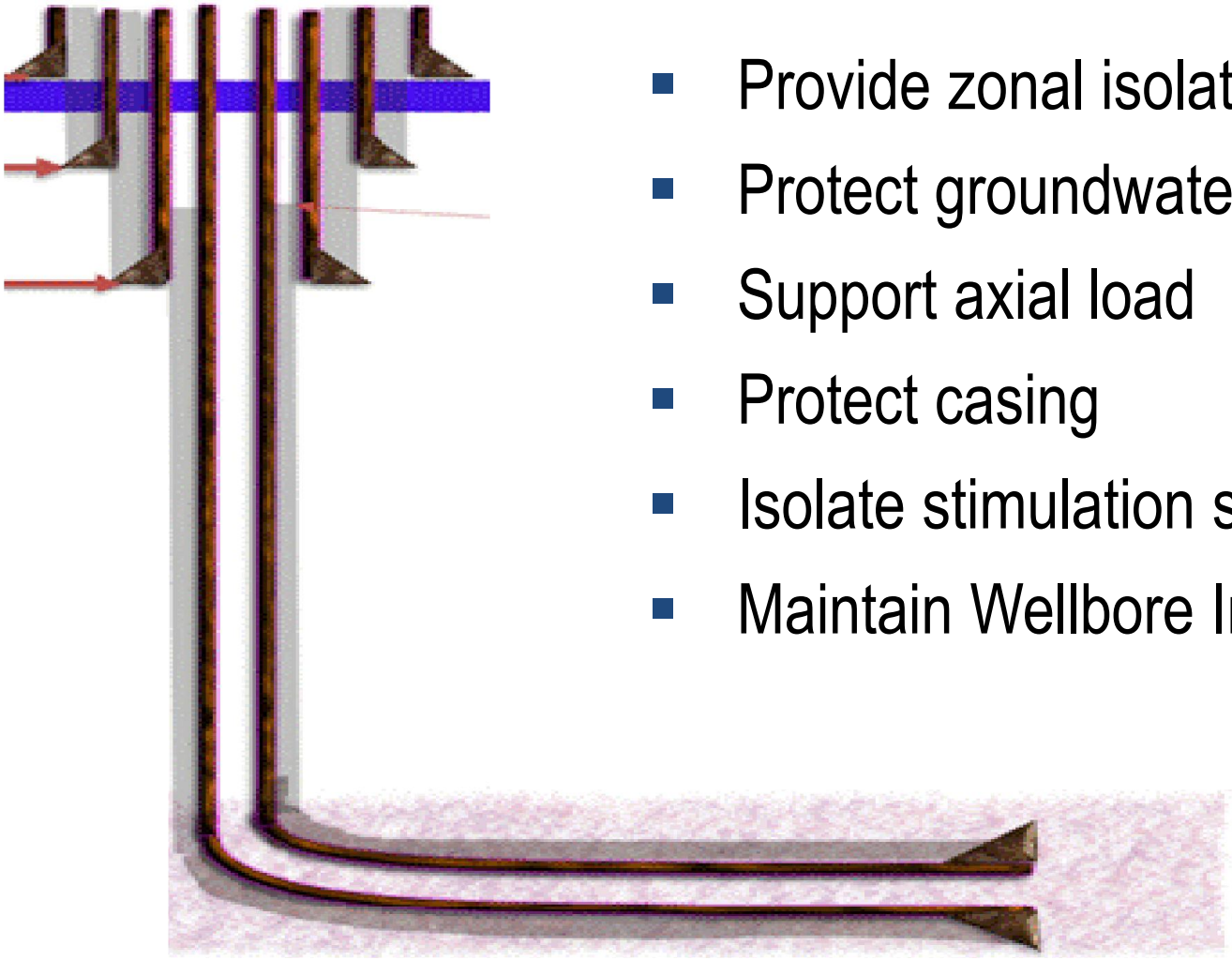
- Noble gases identify the mechanisms of fugitive gas contamination in drinking-water wells overlying the Marcellus and Barnett Shales
- … probably as a result of poor cementation



What Properties Do We Need?

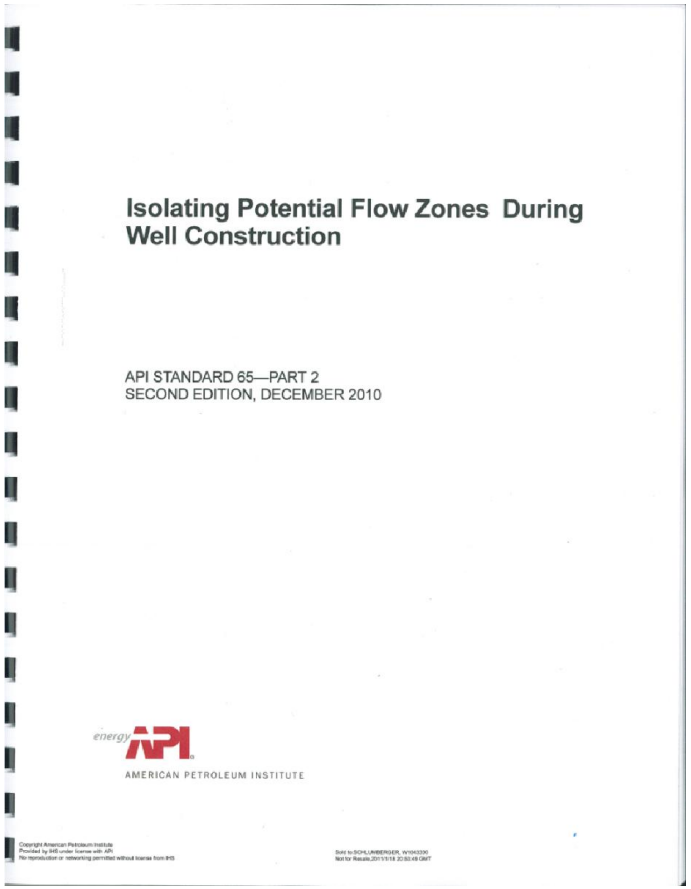
- Cement Objectives
- Industry Standard Practices
- Cement Sheath Stress
- Example Stress Simulations
- Flexible Systems
- Self Healing Systems

Cementing Objectives



- Provide zonal isolation
- Protect groundwater
- Support axial load
- Protect casing
- Isolate stimulation stages
- Maintain Wellbore Integrity

Industry Standard - Isolation



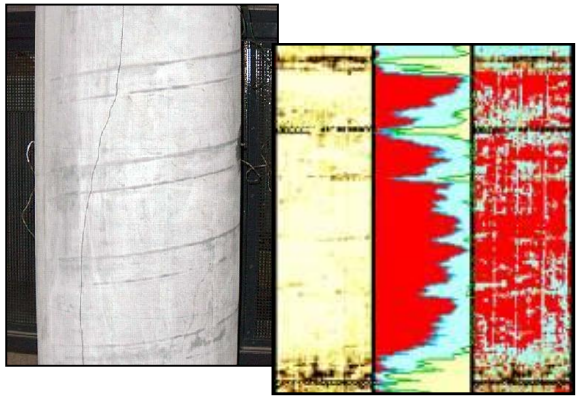
Chapter 5: Cementing Practices and Factors Affecting Cement Success

- Hole Geometry
- Drilling Fluid Type
- Casing Hardware
- Close-tolerance and Other Flow Restriction Considerations
- Engineering Design
- Slurry Design and Testing
- Wellbore preparation and conditioning
- Cement Job Execution
- Post Cementing Operations

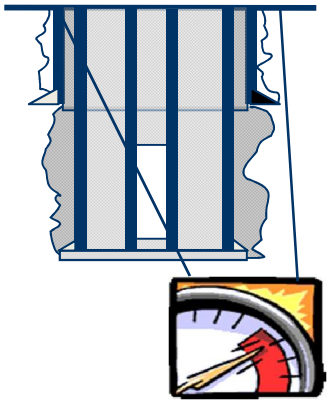
Concerns

Pressure and temperature changes during:

Drilling

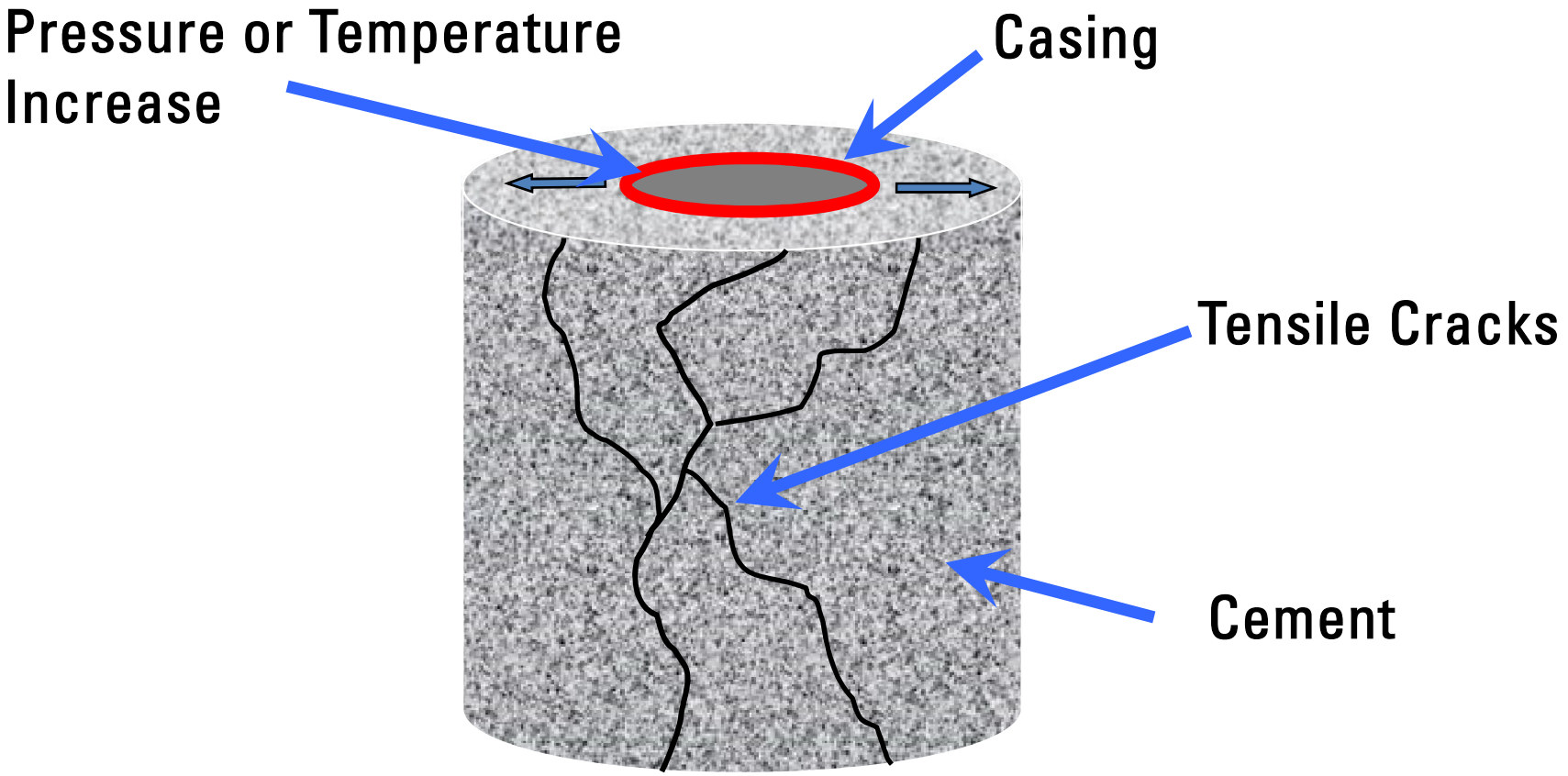


Production

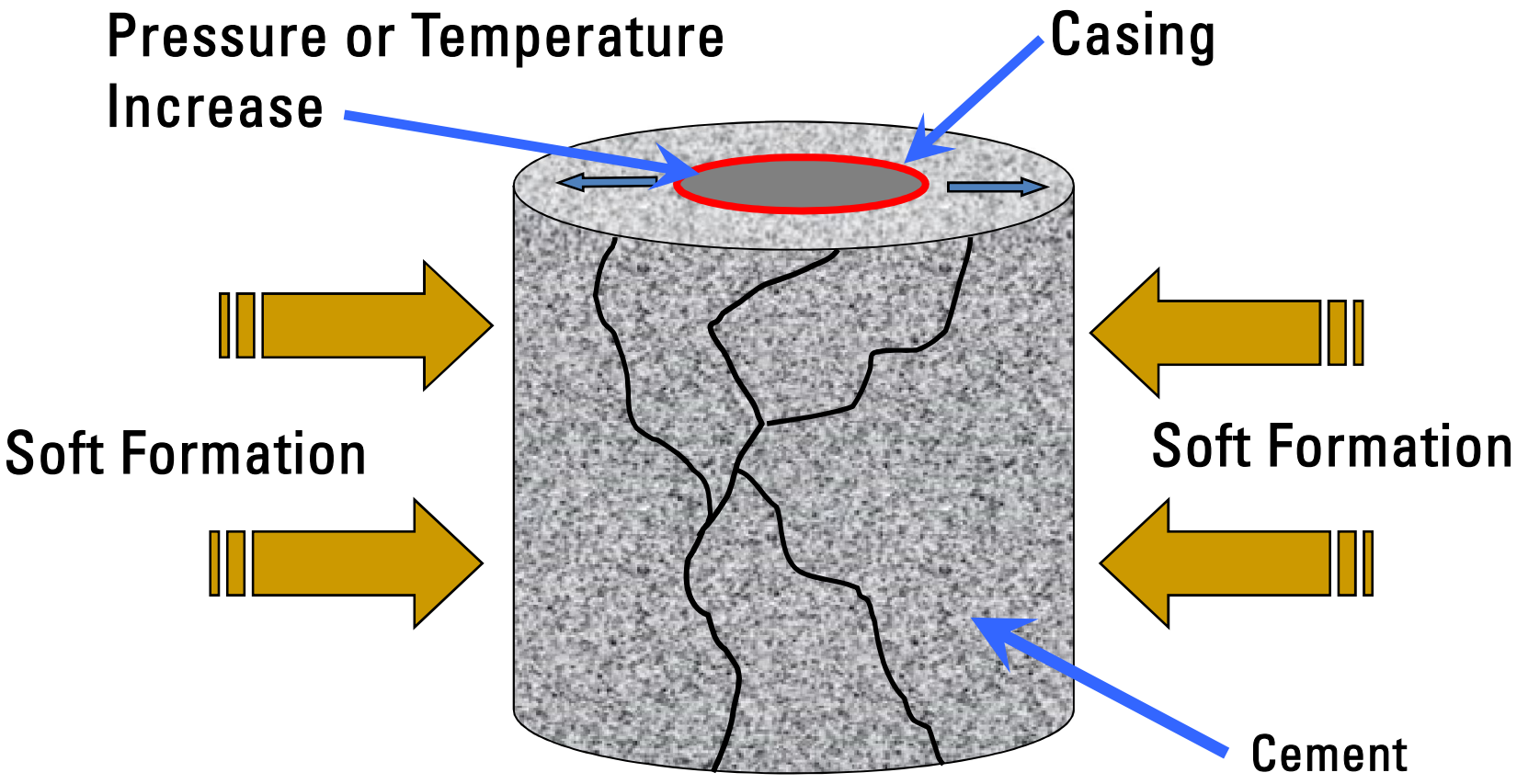


Stimulation

Stress Concepts: Casing - Cement

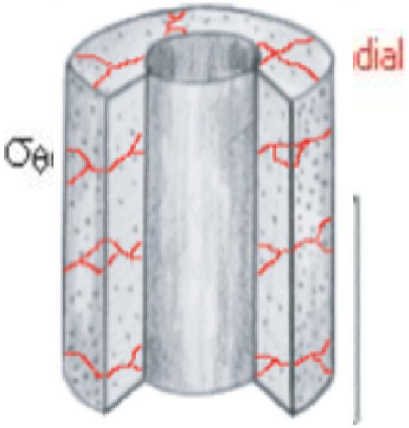


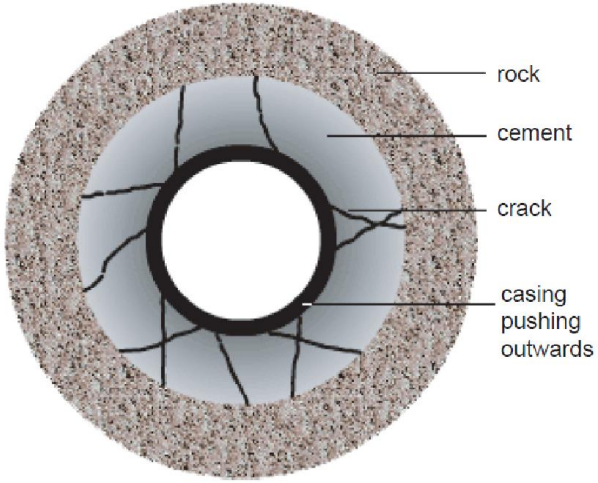
Stress Concepts: Casing-Cement-Formation

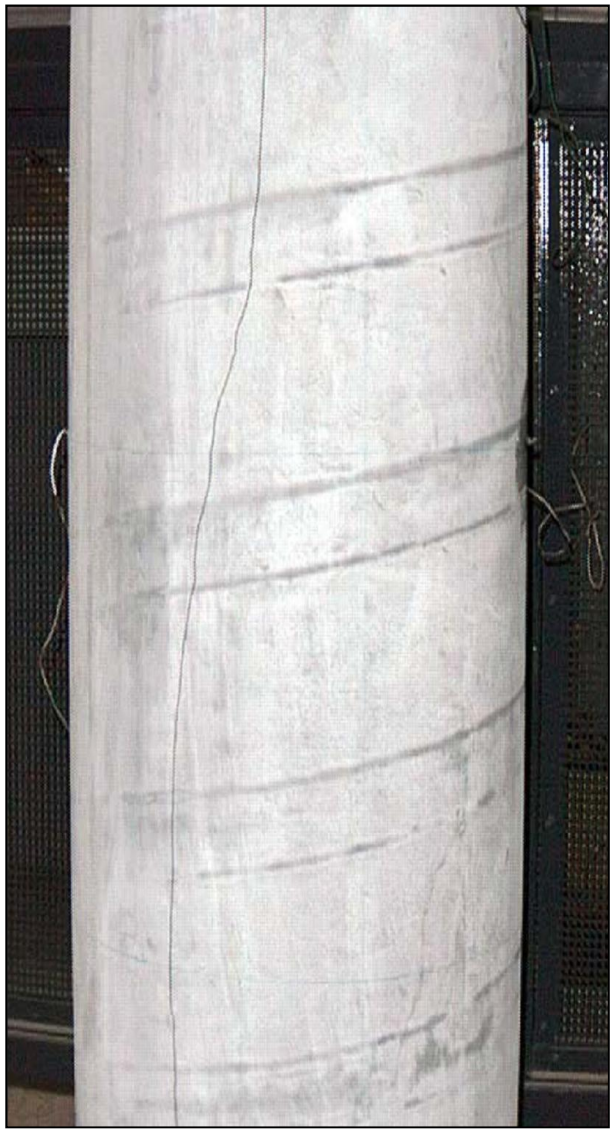


Cement Stress Simulation

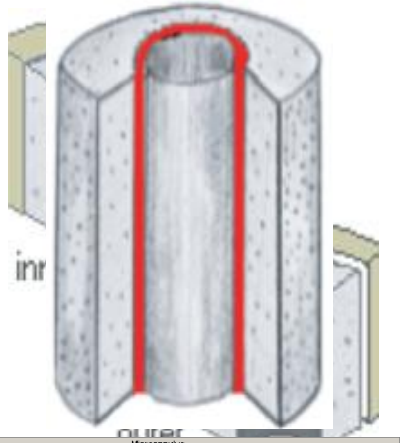
Compression Failure

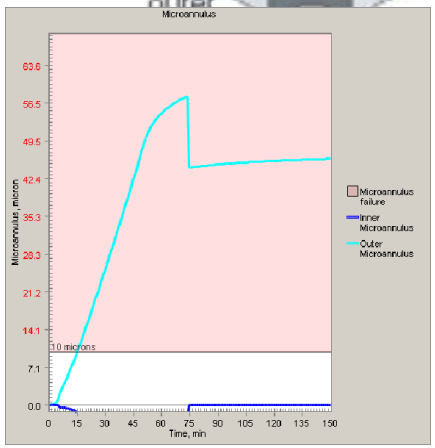






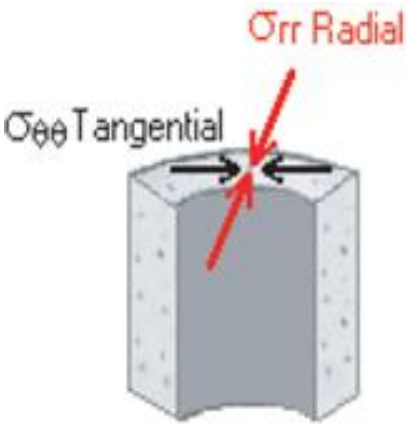
Microannulus Detected



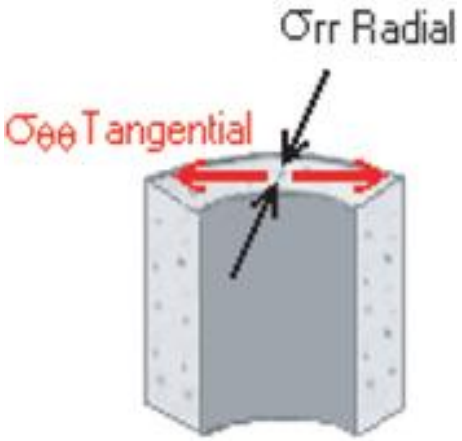


Cement Stress Simulation

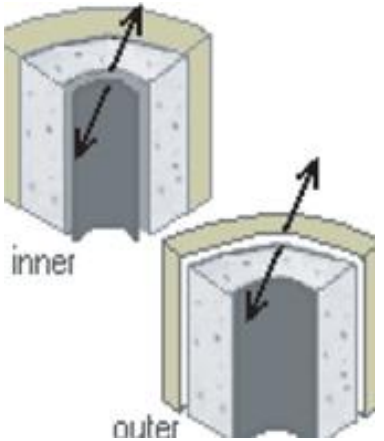
Compression



Traction

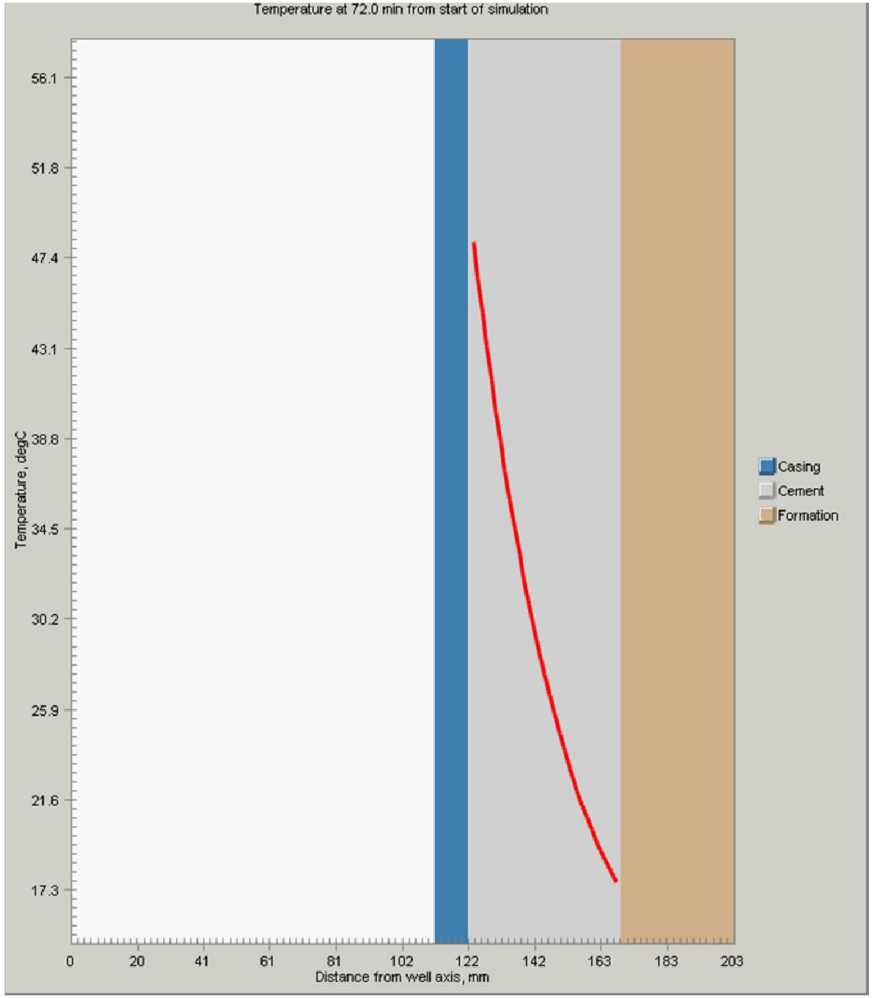


Microannulus



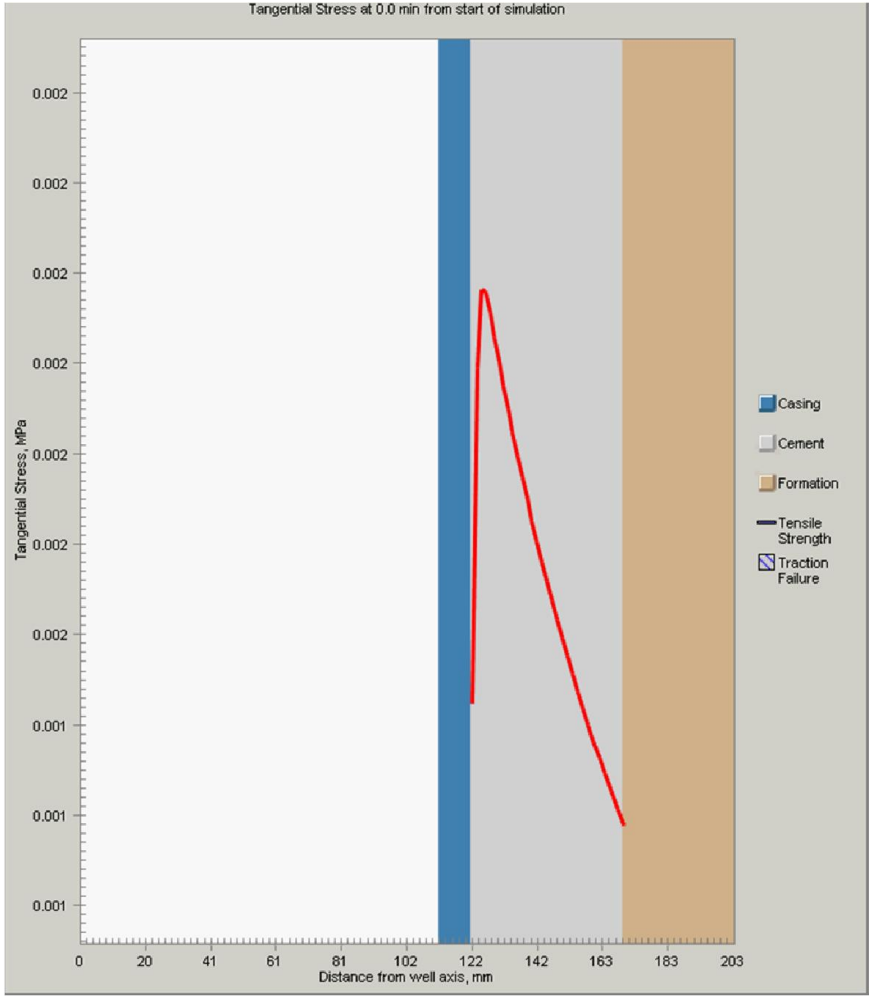
Cement Stress Simulation

- Enter Well Operation Schedule
  - Simulate Temperature



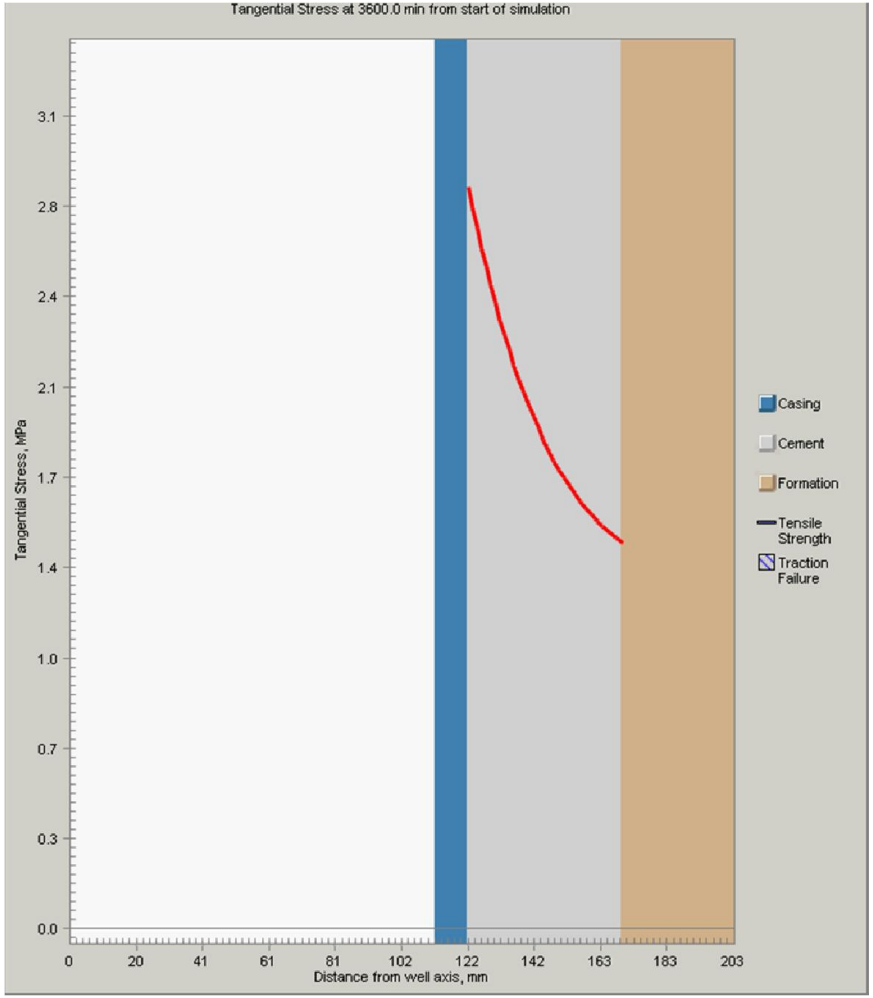
Cement Stress Simulation

- Enter Well Operation Schedule
  - Simulate Temperature
  - Simulate Stress



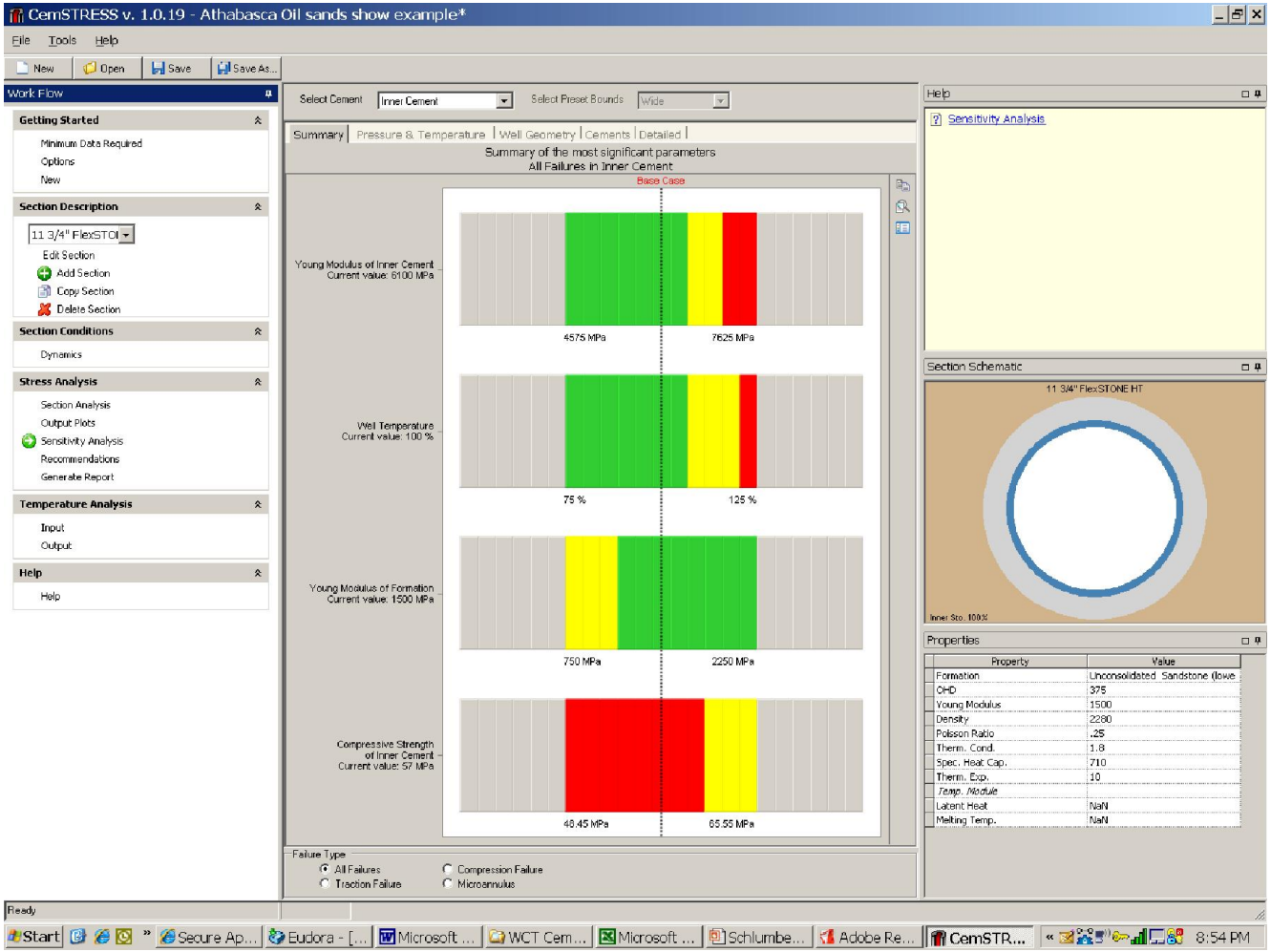
Cement Stress Simulation

- Enter Well Operation Schedule
  - Simulate Temperature
  - Simulate Stress
  - Optimize Operation

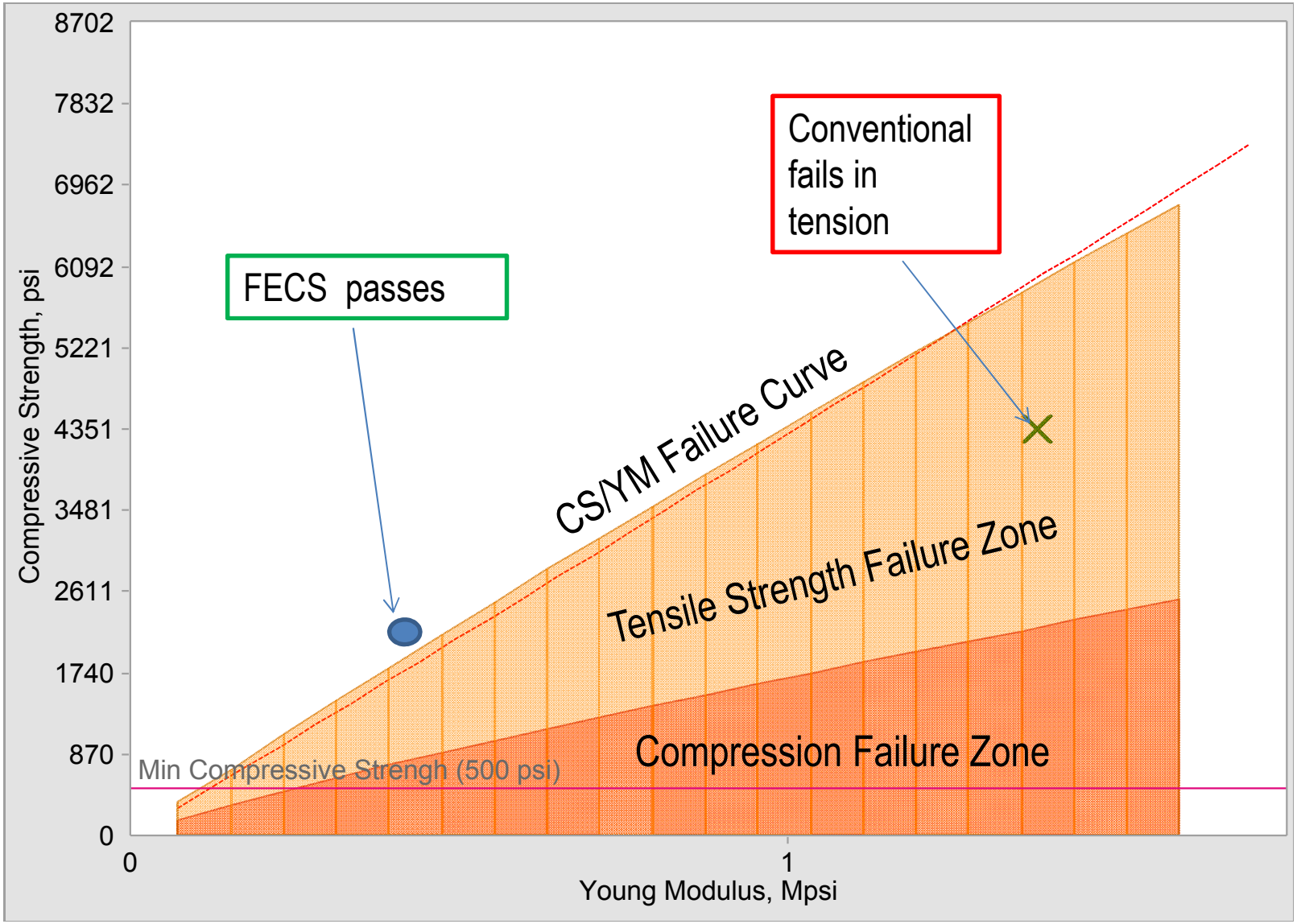


Cement Stress Simulation

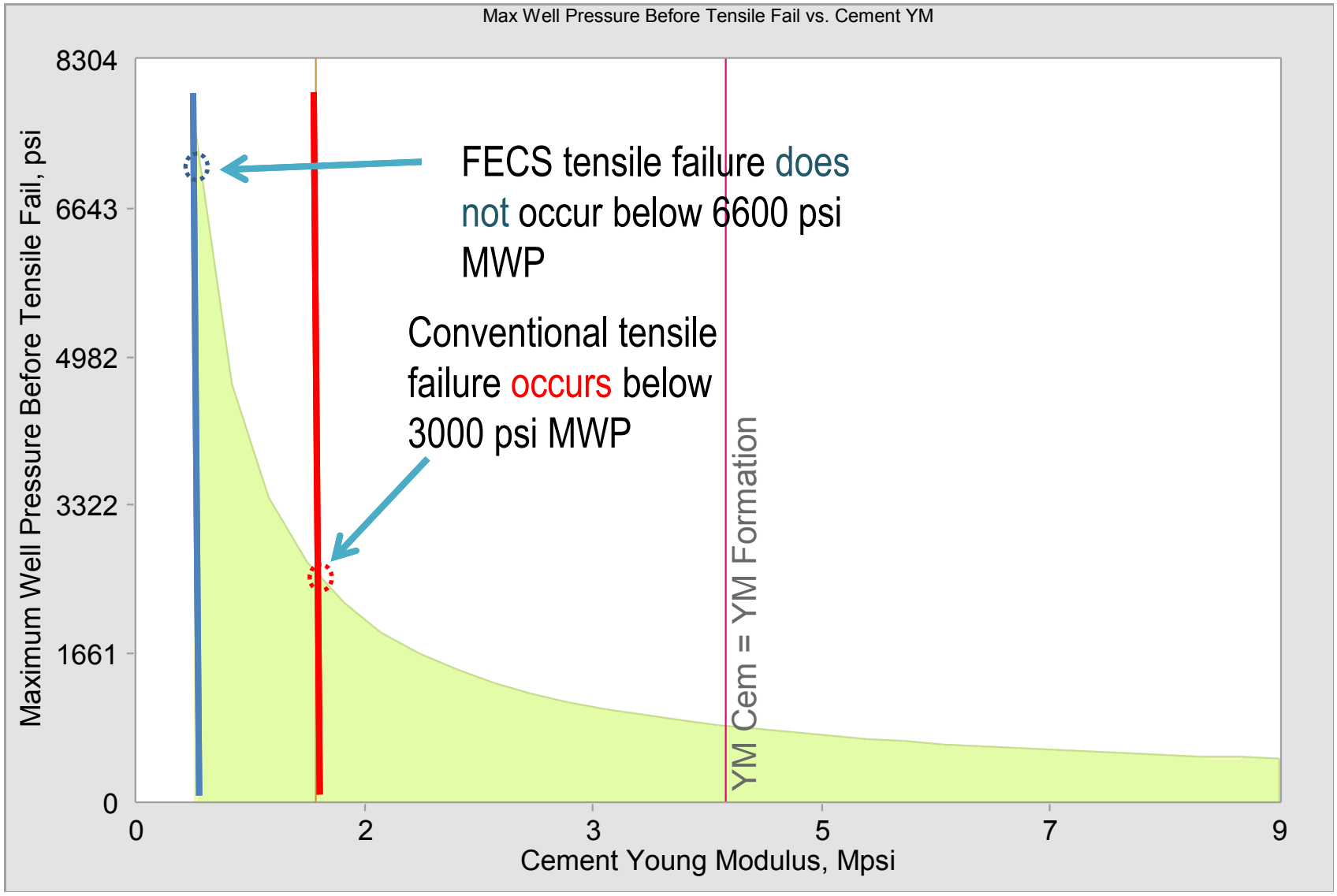
- Sensitize and optimize



Compressive and tensile failure envelopes

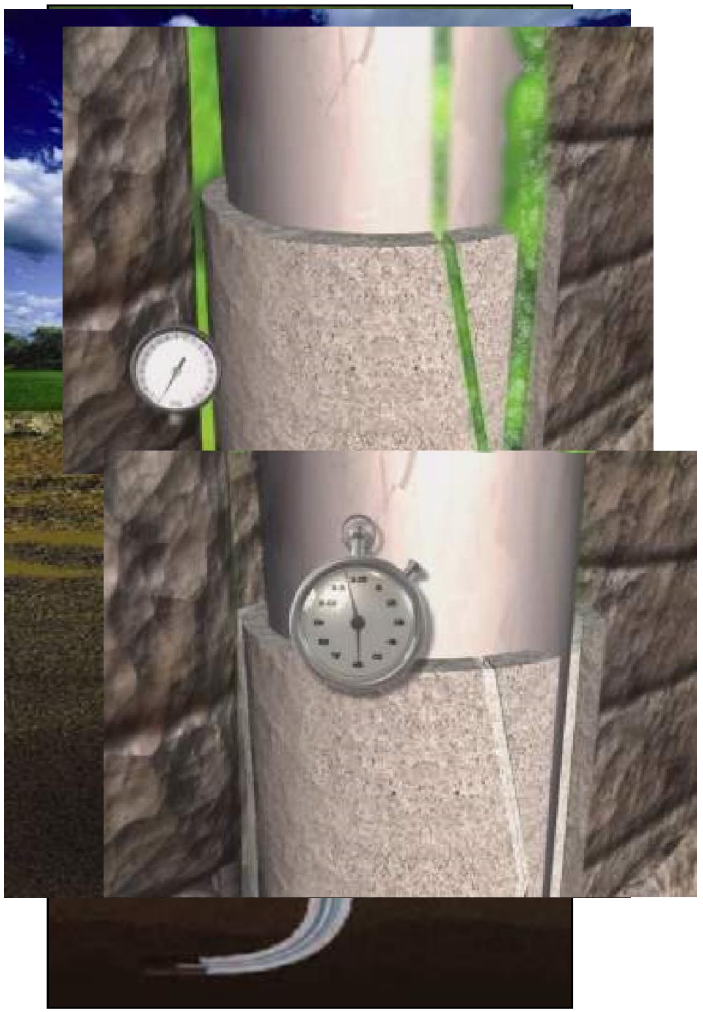


Example - Maximum Pressure Analysis



What if a cementing technology existed that…

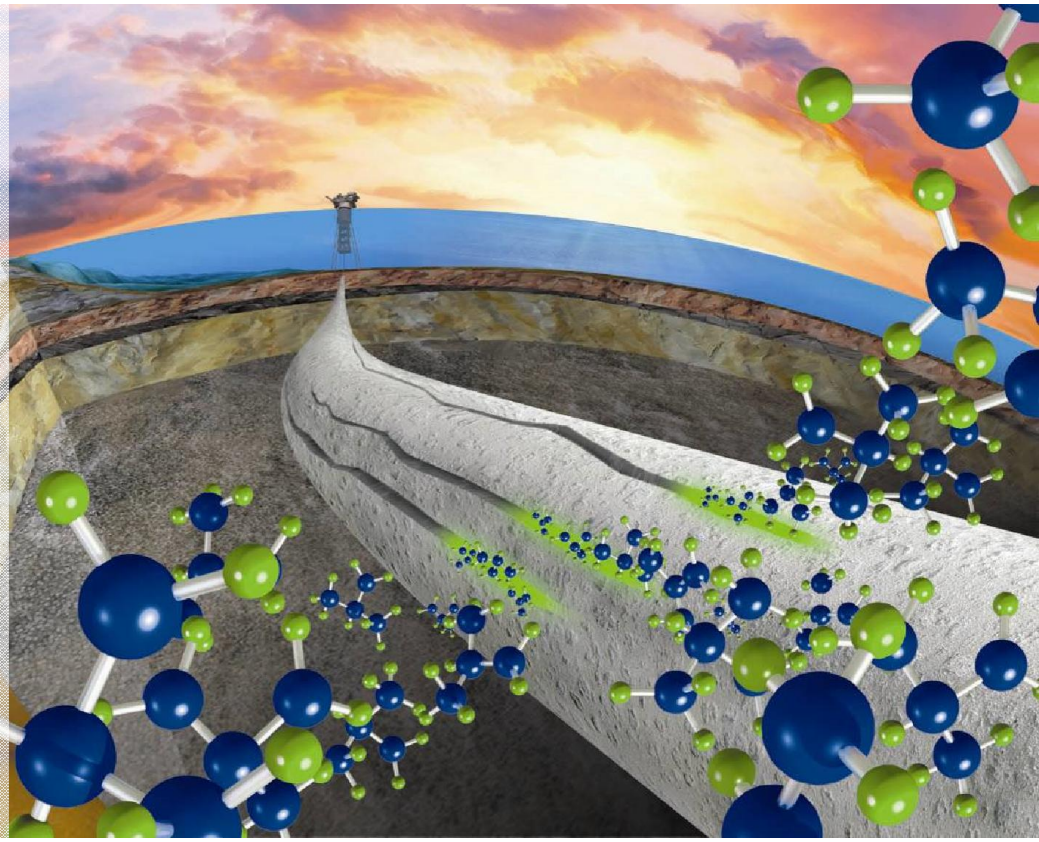
- stops downhole isolation problems before they appear at surface?
- provides long-term well integrity during the productive life of the well…and beyond?
- offers enhanced protection and can be mixed and pumped as part of primary cementing operation?
- responds automatically to problems when and where they arise?



What if cement could actually heal itself?

Enhancement - Active Set-Cement Technology:

- Prevents interruptions to production
- Facilitates compliance with regulatory requirements
- Protects the environment
- Eliminates cost of repairing or losing a producing well
- Easily incorporated into well construction programs



Conclusion

- Industry Standards
- Simulate cement sheath stress
- Flexible and Self Healing Cement Systems

Technical Material Key SPE papers

- SPE 56535: Case Studies of Expanding Cement to prevent microannular formation
- SPE 59132: New Cements for Durable Zonal Isolation
- SPE 78950: Implementation of Advanced Cementing Techniques to Improve long Term Zonal Isolation in Steam Assisted Gravity Drainage Wells
- SPE 87195: Evaluation of Cement Systems for Oil and Gas Well Zonal Isolation in a Full-Scale Annular Geometry
- SPE 89622: Utilizing Innovative Flexible Sealant Technology in Rigless Plug and Abandonment
- SPE 92193: Achieving Long-Term Isolation for Thin Gas Zones in the Adriatic Sea Region
- SPE 98891: Cementing of an Offshore Disposal Well Using a Novel Sealant that Withstands Pressure and Temperature Cycles
- SPE 100390: Application of Engineered Cementing Solution to Solve Long-Term Cement Integrity Issues in Tunisia
- SPE 149440 Flexible Expanding Cement System (FECS) Provides Isolation across Marcellus Shale Gas Trends