Rapid Distributed Sensing of Subsurface In-Situ Stress

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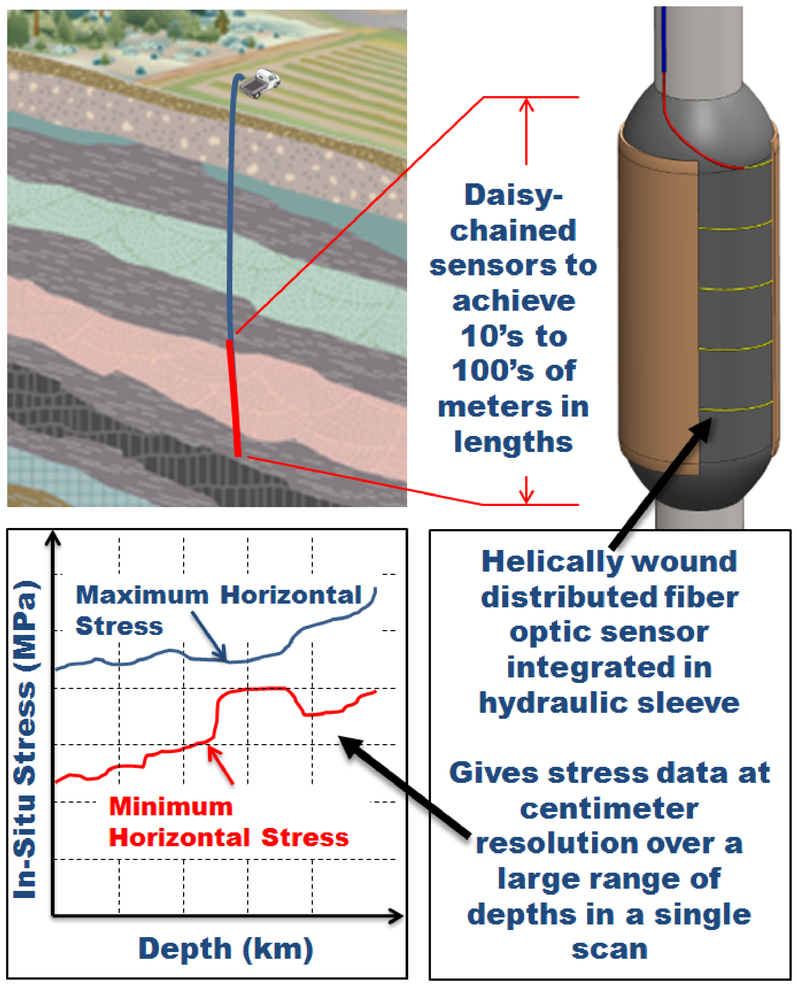
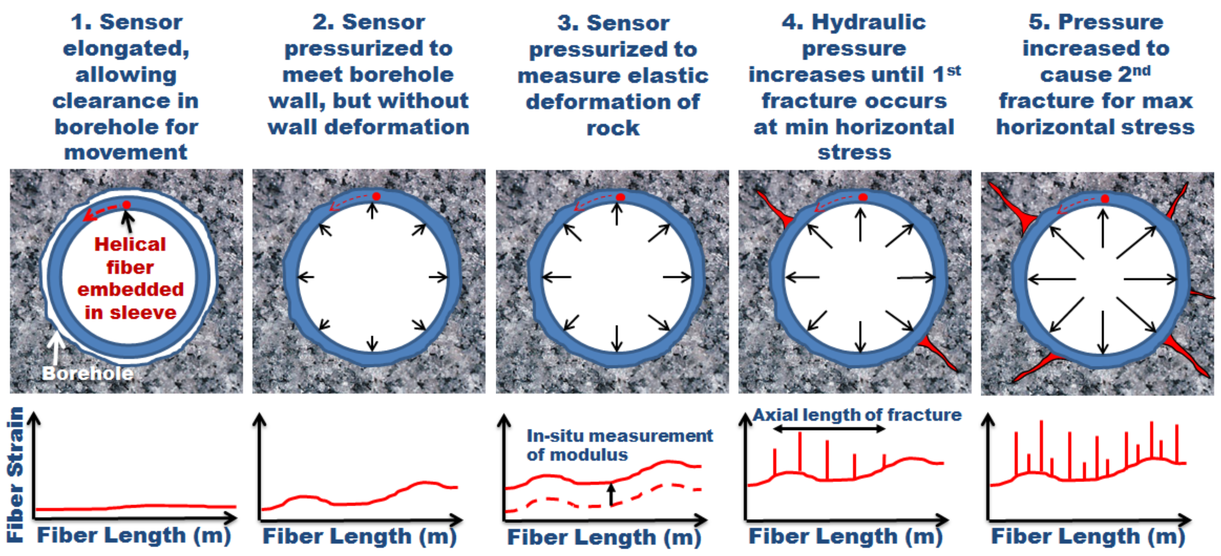
I: Introduction

LUNA has developed a new method using high-definition fiber optic sensing (HD-FOS) technology for directly and precisely measuring strain during hydraulic sleeve fracturing



II: Methods

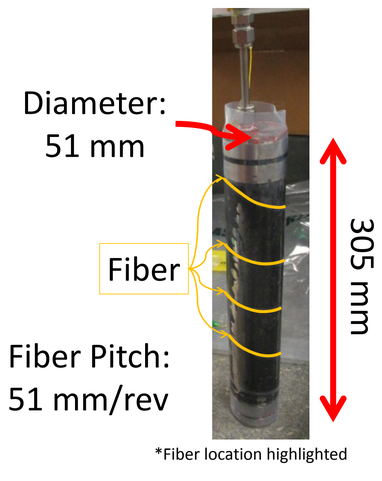
Embedding the sensing fiber within a hydraulic sleeve allows for precise measurement of radial and axial strain



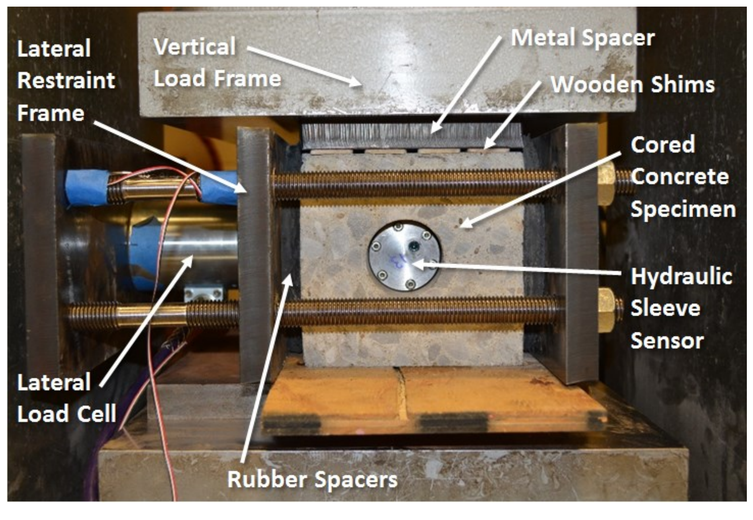
Phase I Feasibility Testing

Fiber optic sensor for measuring distributed strain was helically wound around the outside of the sleeve

Hydraulic Sleeve with Embedded Fiber



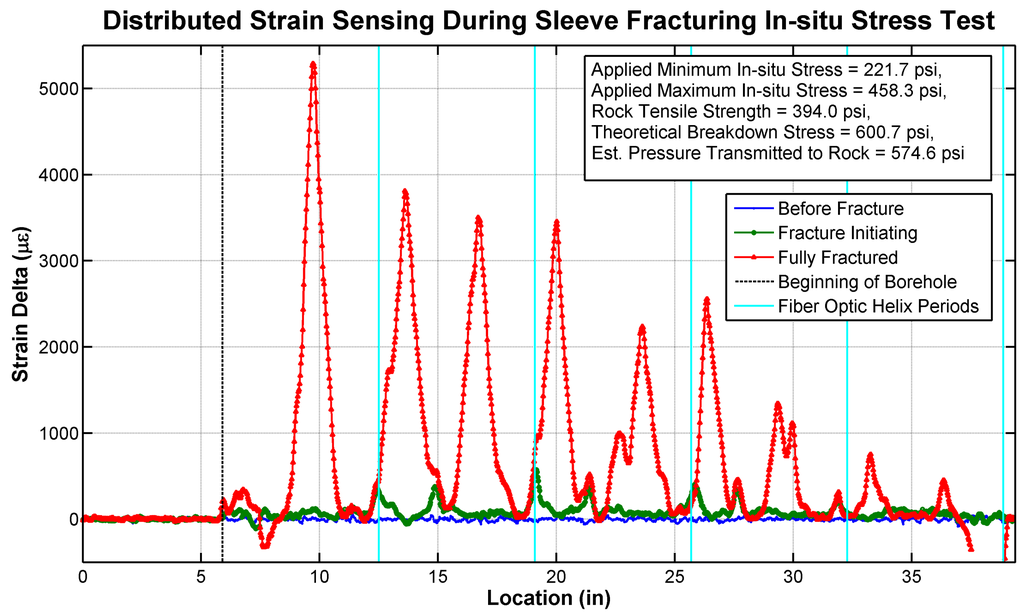
Hydraulic Sleeve Positioned in Load Frame



Loading for testing varied between 200 psi (1380 kPa) to 600 psi (4140 kPa) for principal horizontal stresses

III: Results

Periodic peaks in distributed strain measurement correspond to fracture location



- Pressure to fracture the specimen was within 5% of the theoretical breakdown stress
- Able to distinguish visible continuous strain profiles in more detail than ever before for downhole environments
- The same fiber optic sleeve assembly is capable of being reused for multiple measurements

IV: Conclusions

LUNA has proven the feasibility of a direct high-resolution strain measurement of hydraulic fracture formation and propagation in rock

V: Future Work/Product Development

A procedure for converting the fiber optic data into in-situ stress measurement is being developed

A ruggedized sensor for a variety of borehole lengths could yield immediate in-situ stress measurements in less time than traditional hydro-fracturing techniques

Phase II will perform field experiments at the Sanford Underground Research Facility

Tennessee TECH

Sanford Underground Research Facility

Distributed sensing will reveal new details in in-situ stress, fracture initiation, and rock modulus gradients that have not been visible before