Year 2 of 3
SAND2020-0729D

Direct Sub-Surface Measurements Through Precise Micro Drilling

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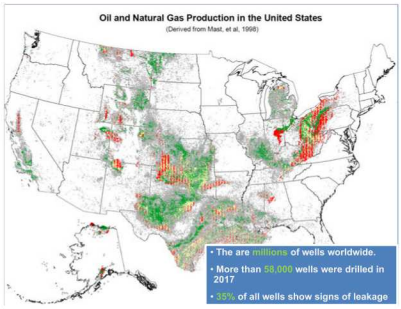
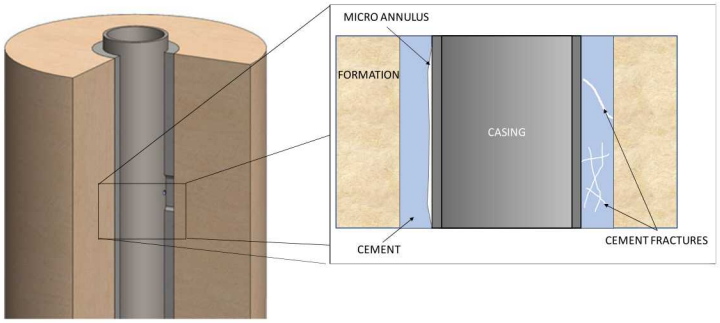
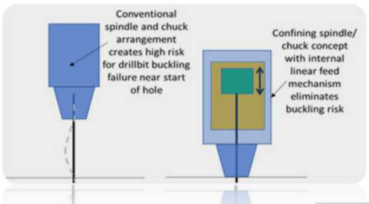
Background

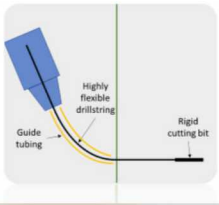




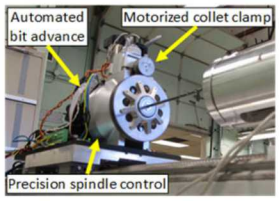
Remote Precision Drilling

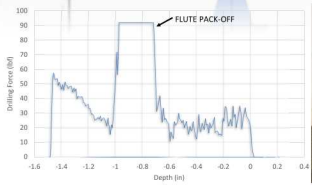
Goal: produce methods to remotely drill and clean precise small diameter, high aspect-ratio holes through casing and cement in downhole environments

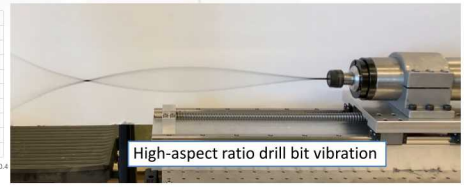




- Compact, auto-indexing module for remote, high aspect ratio, small diameter holes
  - Eliminates buckling challenges to theoretically drill to arbitrary depths limited only by drill-bit length
- Flexible Nitinol drill bit extenders to enable >90^0 bends
  - Drill deep holes orthogonal to borehole



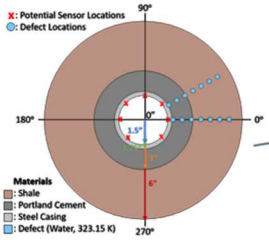


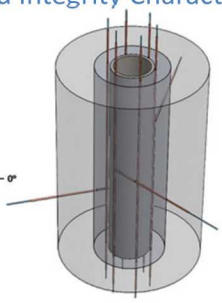


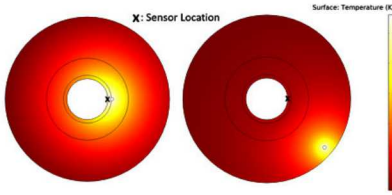
- Stiffness / buckling challenges
- Chip clearing: rapid drilling deterioration when flutes packed

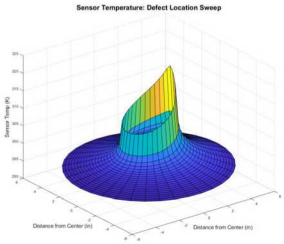
Defect Detection and Integrity Characterization

Goal: Characterize system response to changes due to leaks









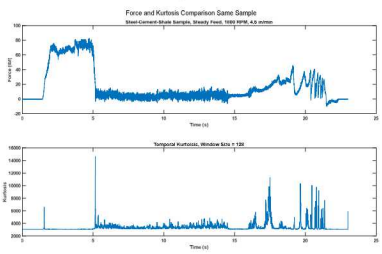
Change defect locations to create thermal map for each sensor location

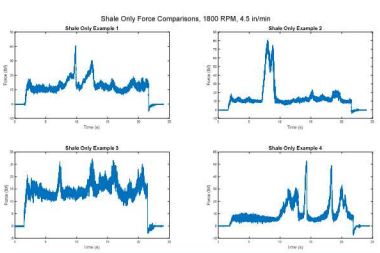
Proposed Test Bed With Designed Defects

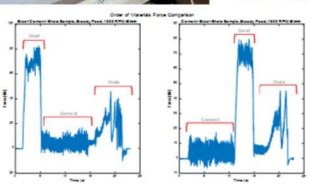
COMSOL: 2D Steady State Thermal Analysis of 323.15 K Leaks (ambient 293.15 K, 1 atm)

Future work: Plot thermal results for several different sensor and defect combinations, correlate defect/sensor distance and sensor reading

Signal Processing and Sensor Emplacement for Long-term Monitoring







$$TK = \frac{\frac{1}{N}\sum_{i=1}^{N}(\mu_i - \mu)^4}{\left(\frac{1}{N}\sum_{i=1}^{N}(\mu_i - \mu)^2\right)^2}$$

Temporal kurtosis showing rapid changes in force data which is hypothesized to correspond to the drill transition between materials in real time

Nonhomogeneous composition in Mancos shale sample causing unexpected force variability from sample to sample

Unique force signature observed for each given material

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