



Acoustic Smart Cement for Well Integrity Diagnostics

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Presentation Outline

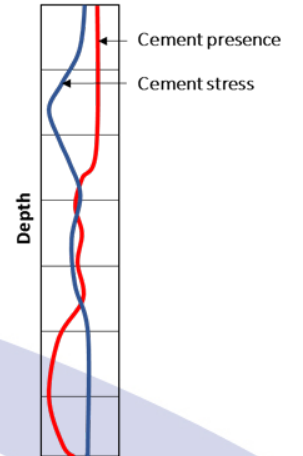
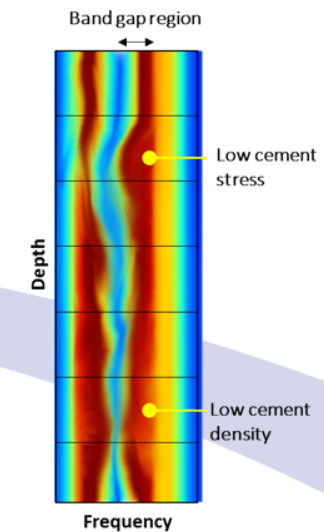
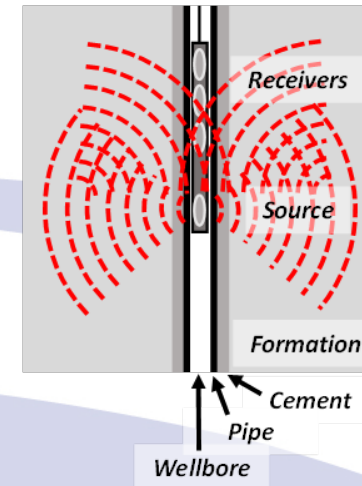
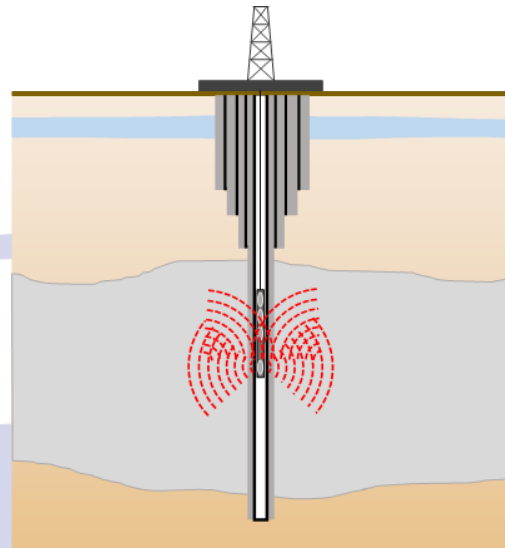
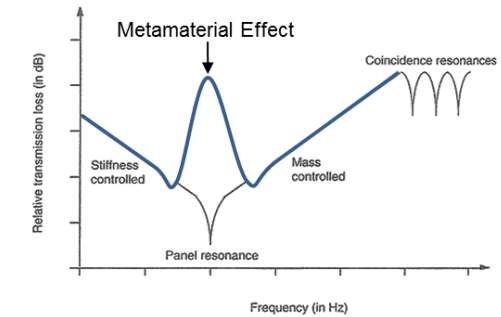
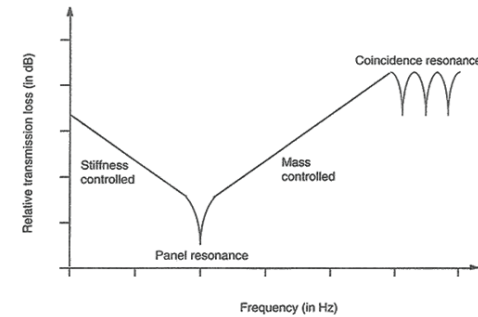
- Project Background
- Acoustic Smart Cement
- Technical Status
 - Cement filler production
 - Laboratory testing
 - Pilot field testing
 - Phase I results
- Accomplishments to Date
- Project Summary

Project Background

- Problem:
 - Well cement integrity shortfalls and catastrophic failure pose risks to human and environmental health.
 - The quality and condition of well cement impact the economic costs of production due to insufficient zonal isolation and production control.
 - Increased knowledge of cement placement, integrity, and mechanical stress will help to better guide well construction and operation.
- *The smart cement will improve measurements of hydraulic containment, casing stress state, and cement condition.*
- *It can also inform well design and operation through increased understanding of geomechanical effects.*
- Overall, the project will promote human health and environmental safety as well as more efficient production.

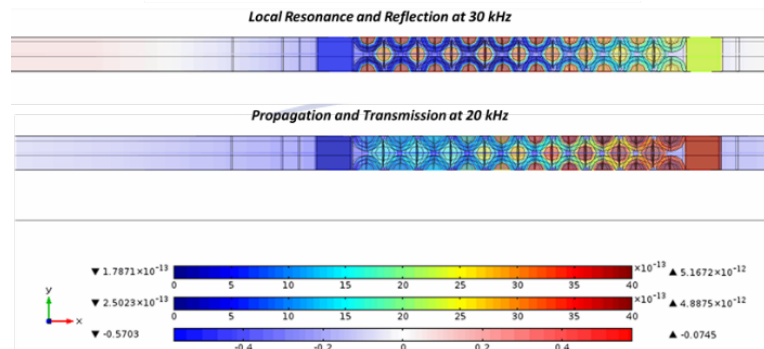
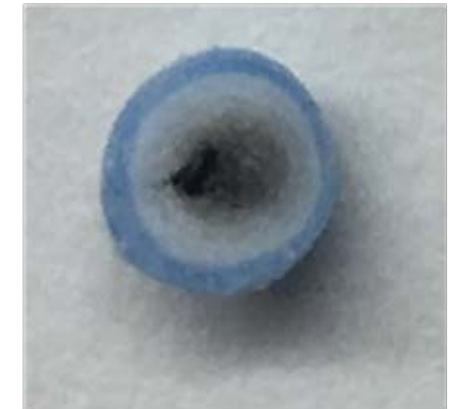
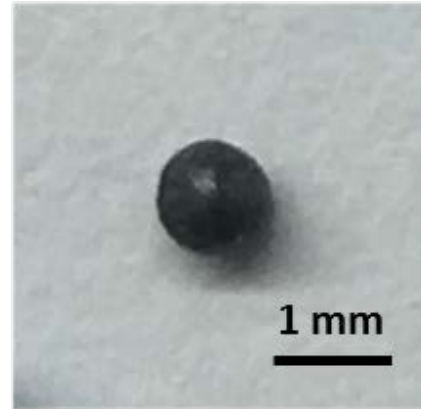
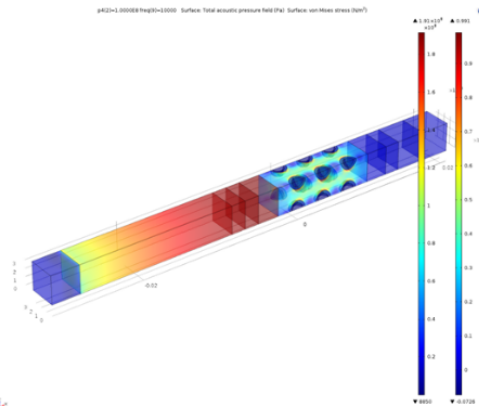
Acoustic Smart Cement

- Well cement integrity



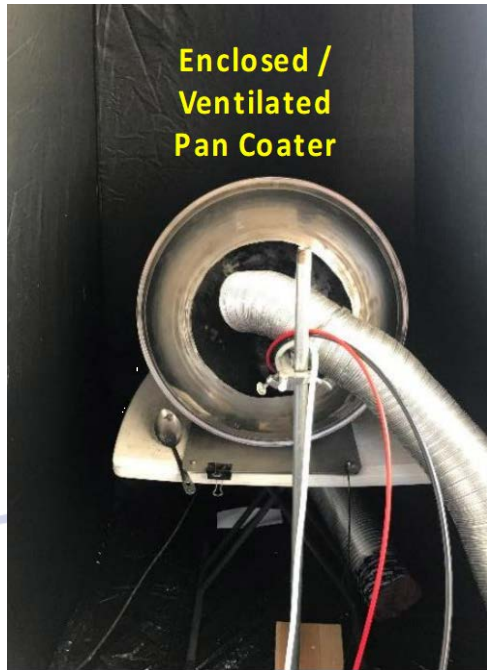
Acoustic Smart Cement

- Cement filler design



Technical Status

- Cement filler production



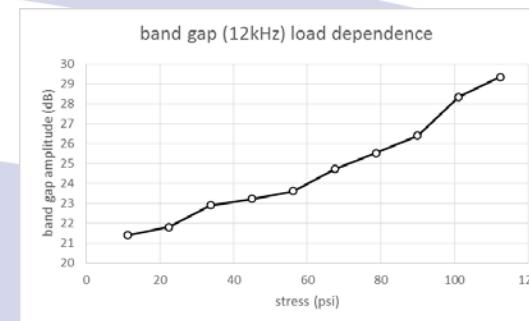
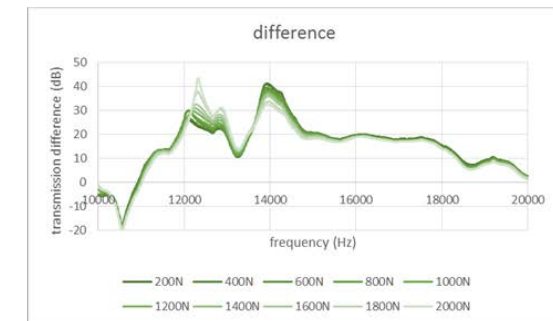
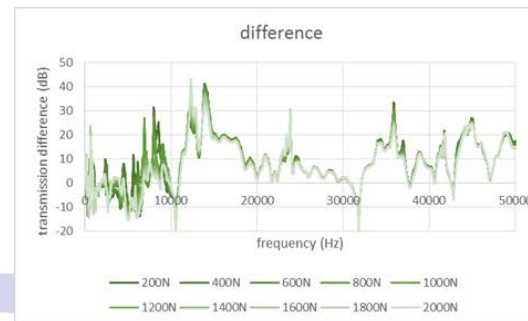
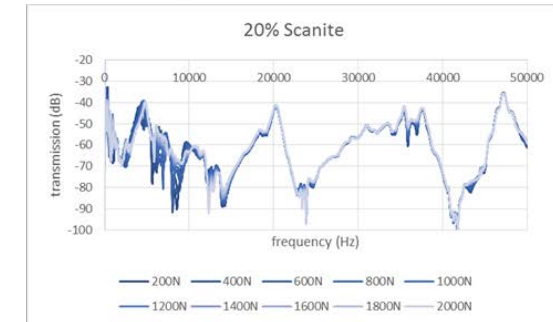
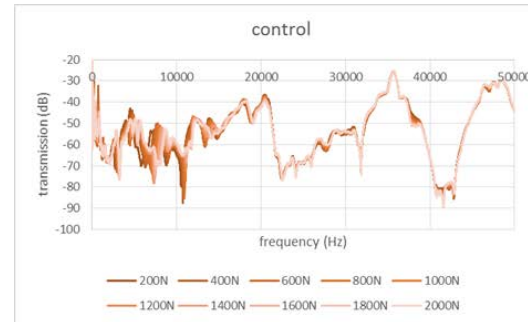
Pan coating



Fluidized bed coating

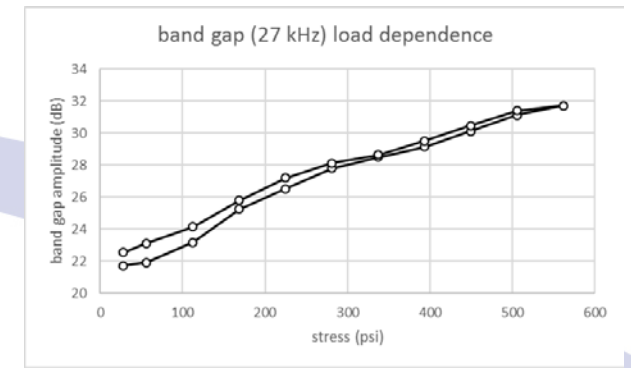
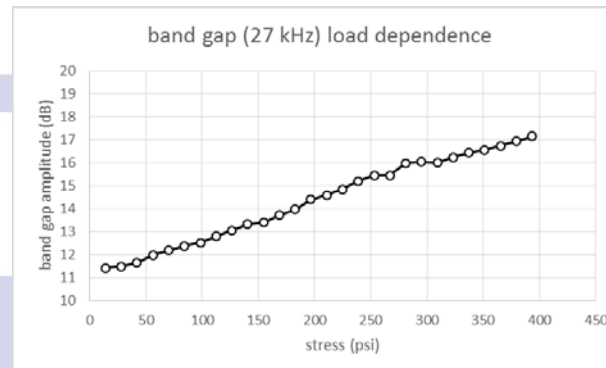
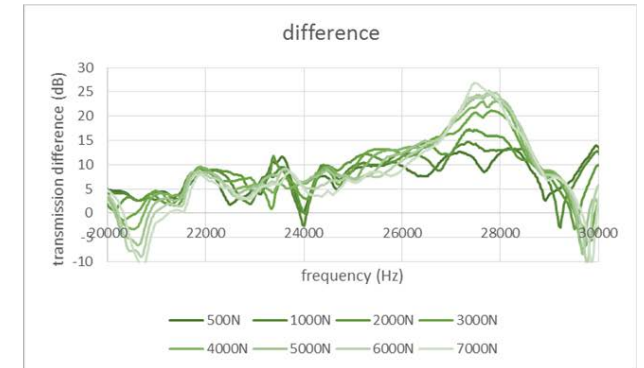
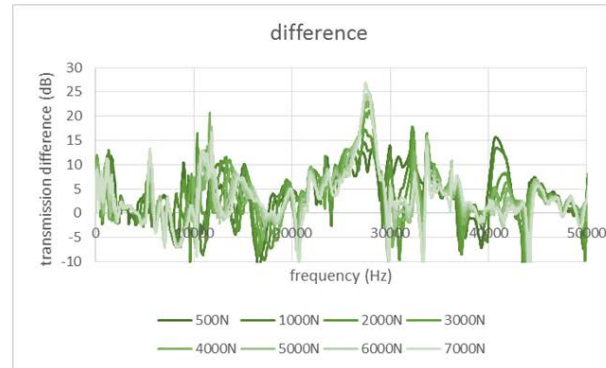
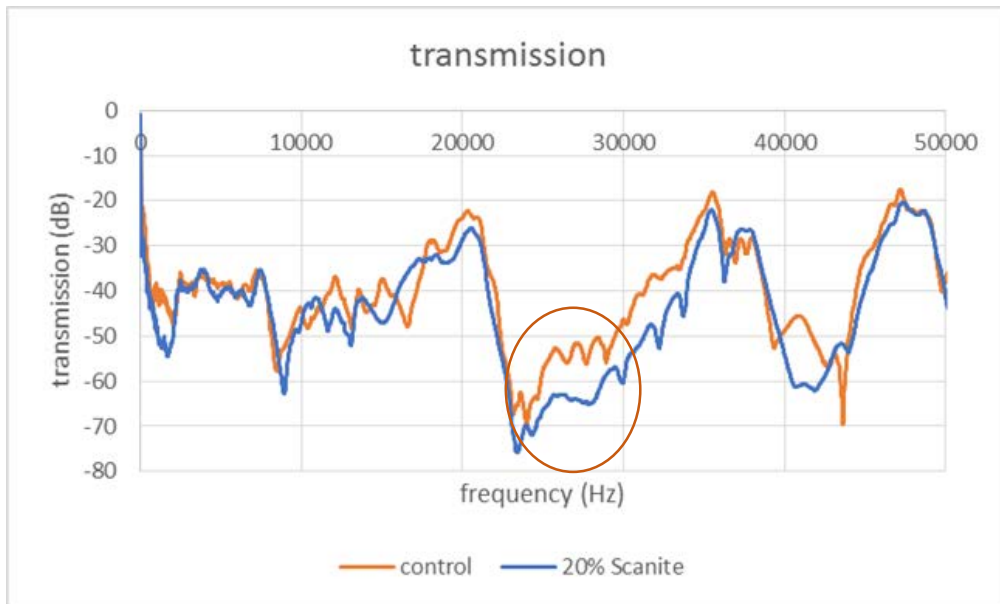
Technical Status

- Laboratory Testing



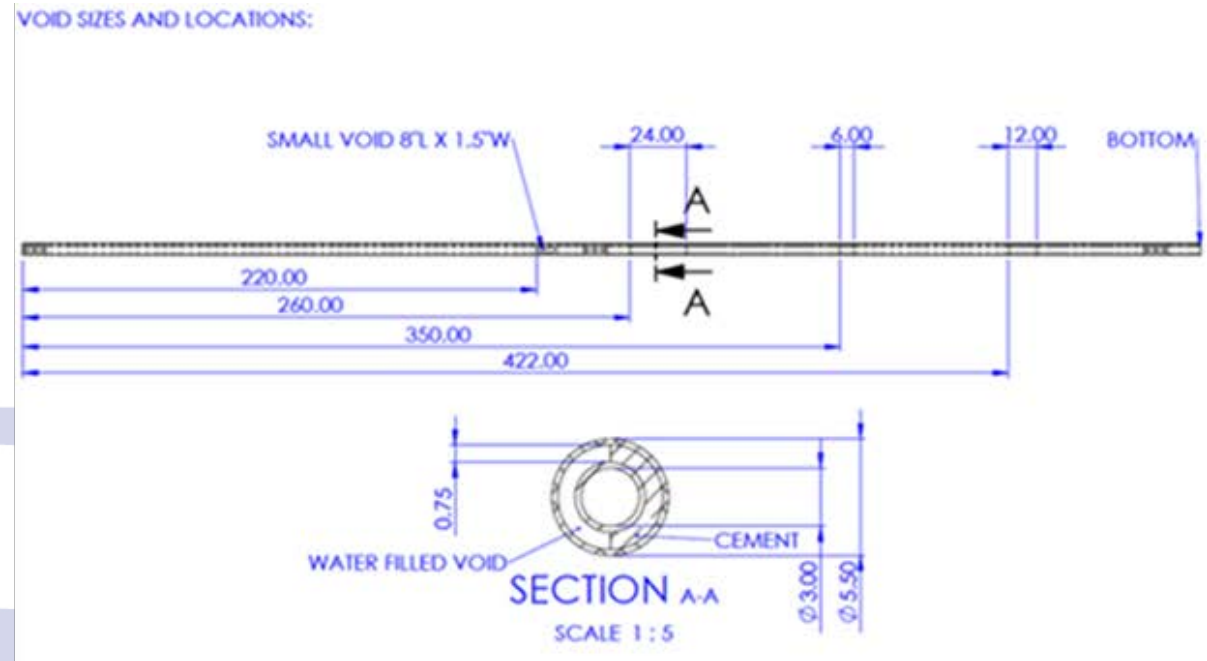
Technical Status

- Laboratory Testing



Technical Status

- Pilot field testing



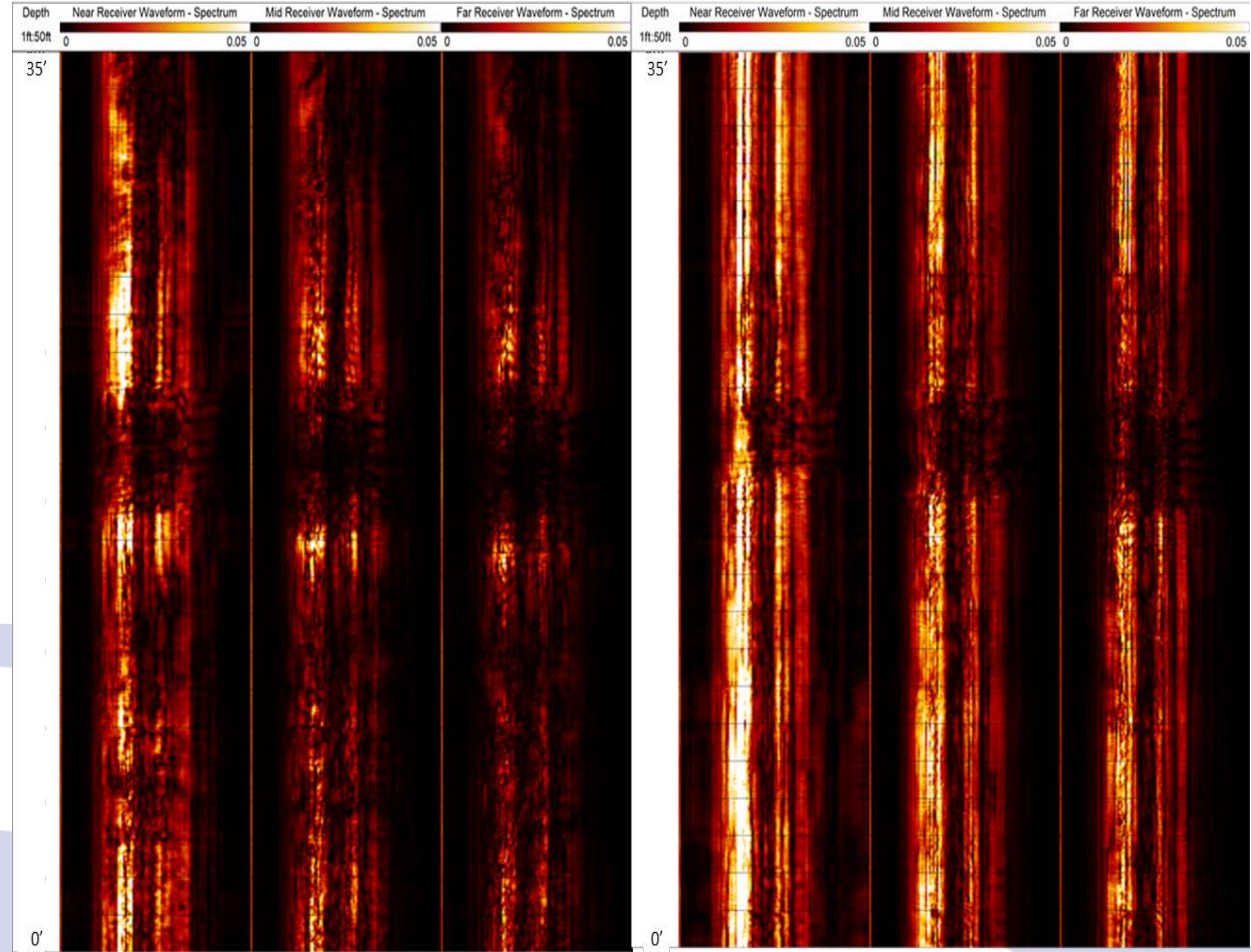
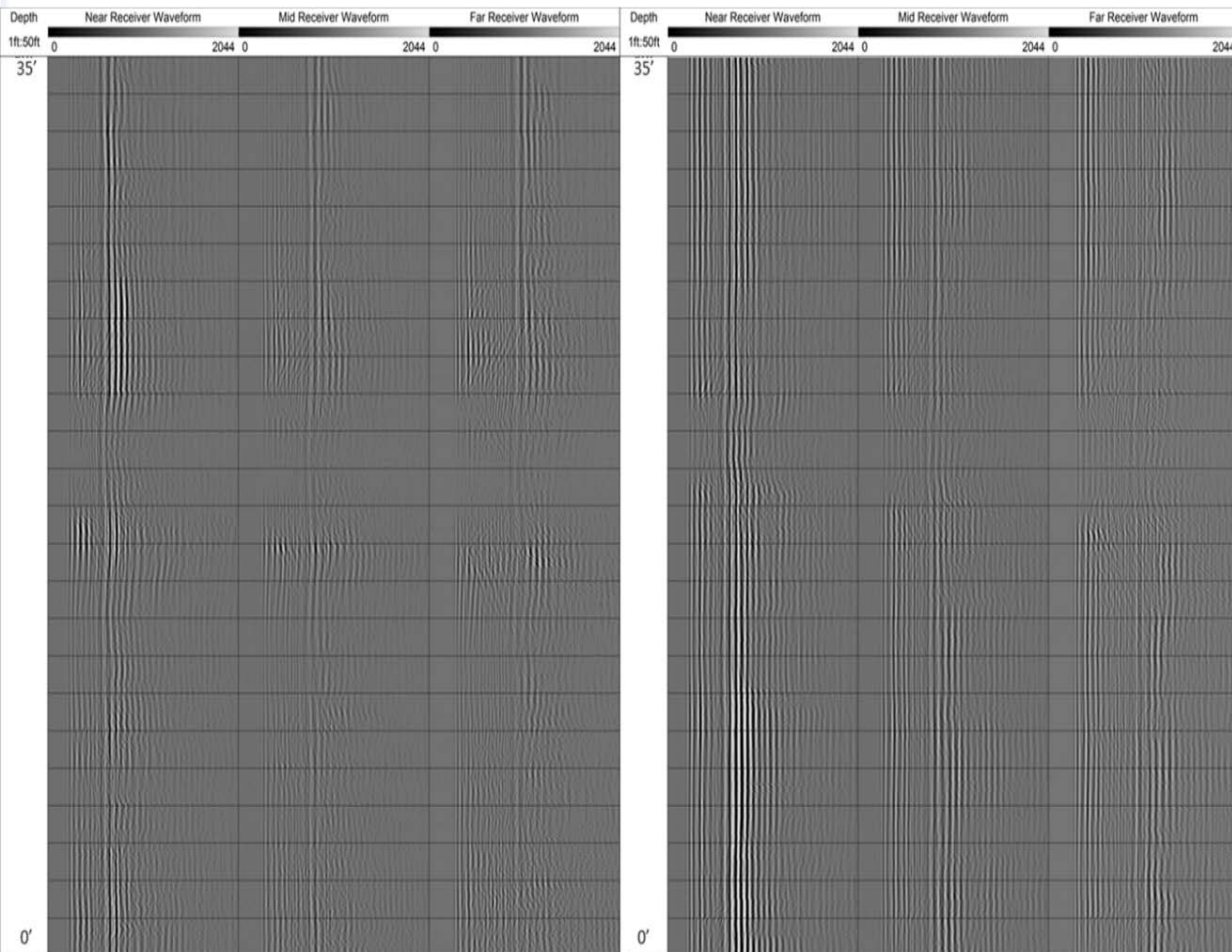
Technical Status

control cement

acoustic smart cement

control cement

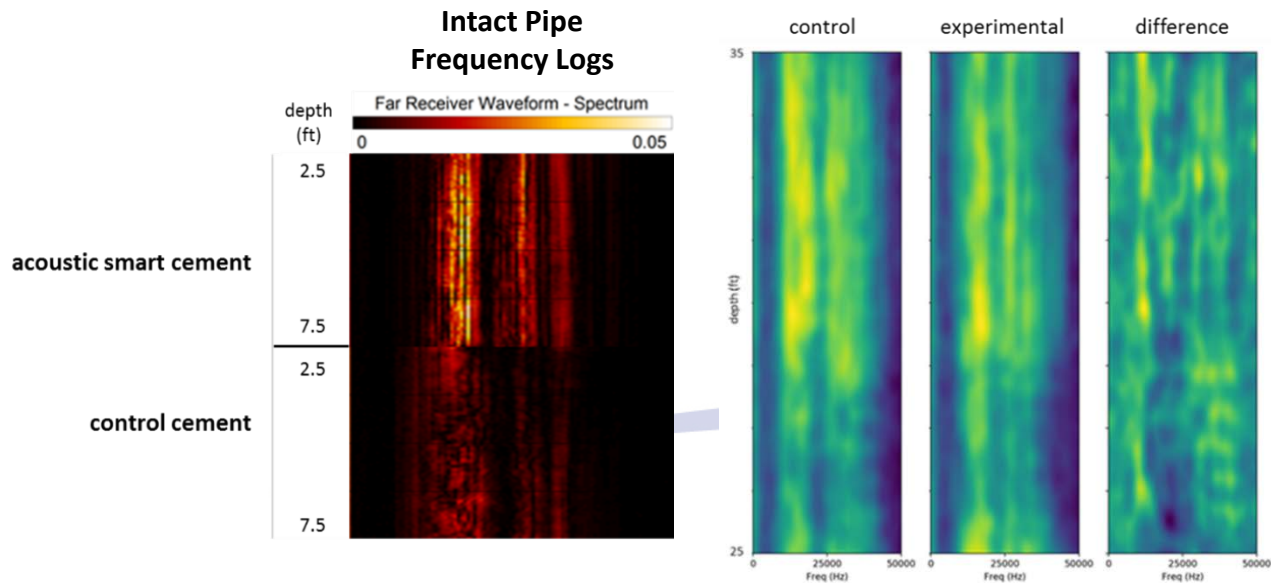
acoustic smart cement



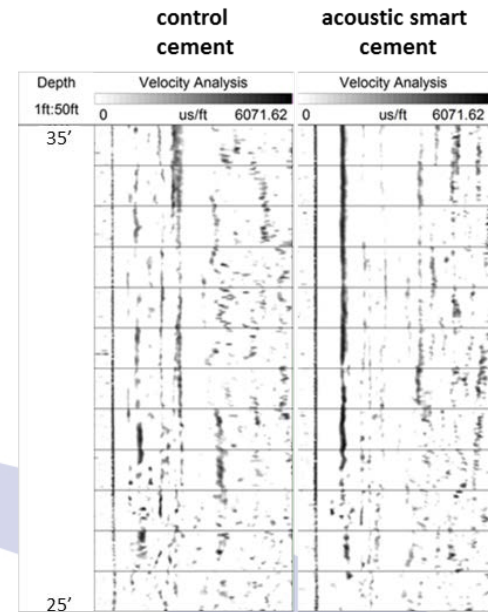
Technical Status

- Phase I results

Intact Pipe Frequency
Logs and Difference



Semblance Logs

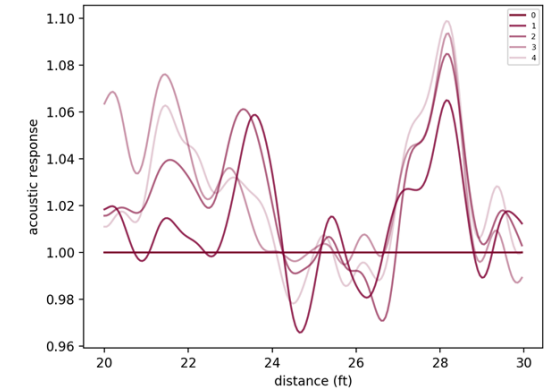
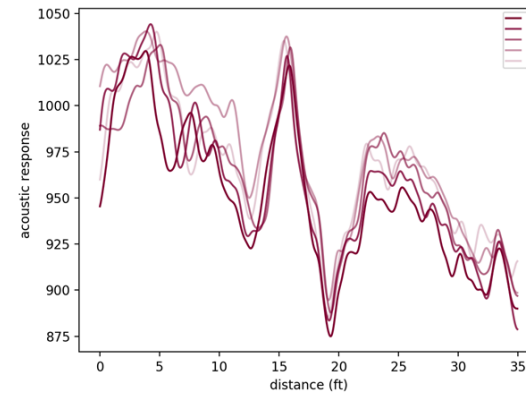


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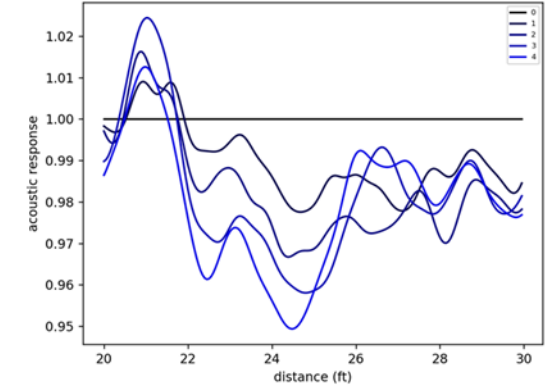
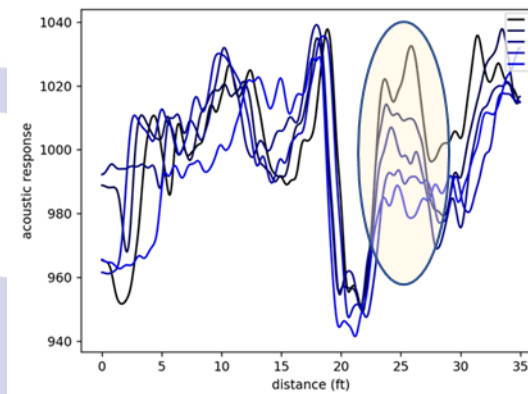
- Phase I results



control cement

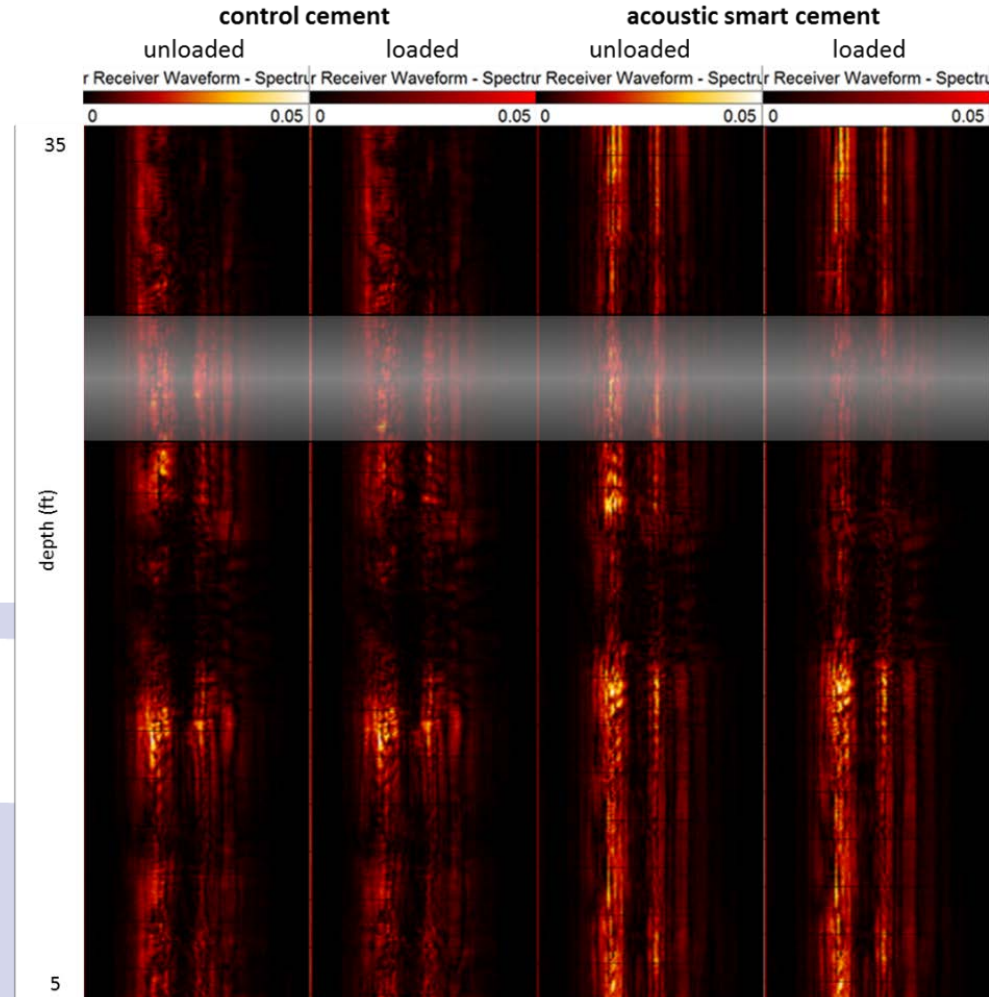
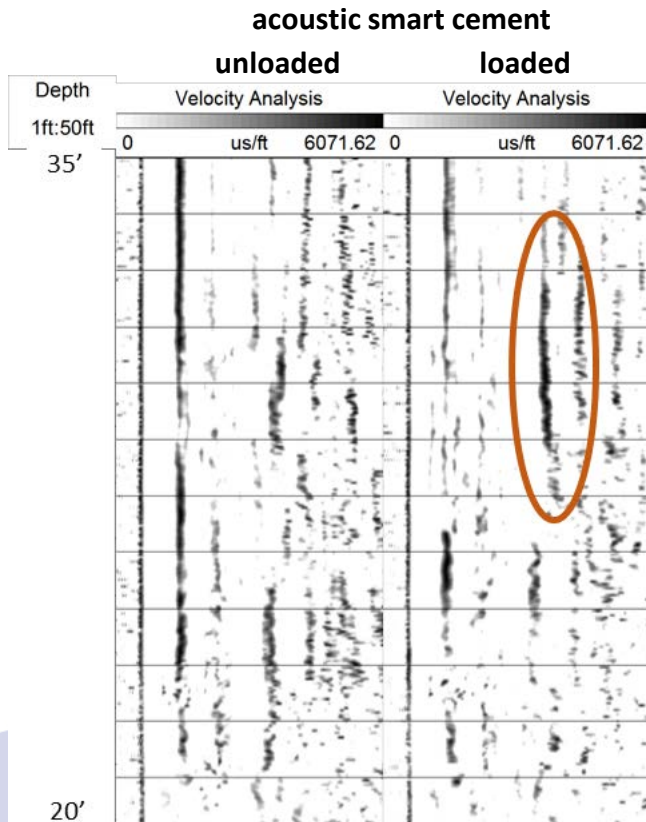


acoustic smart cement



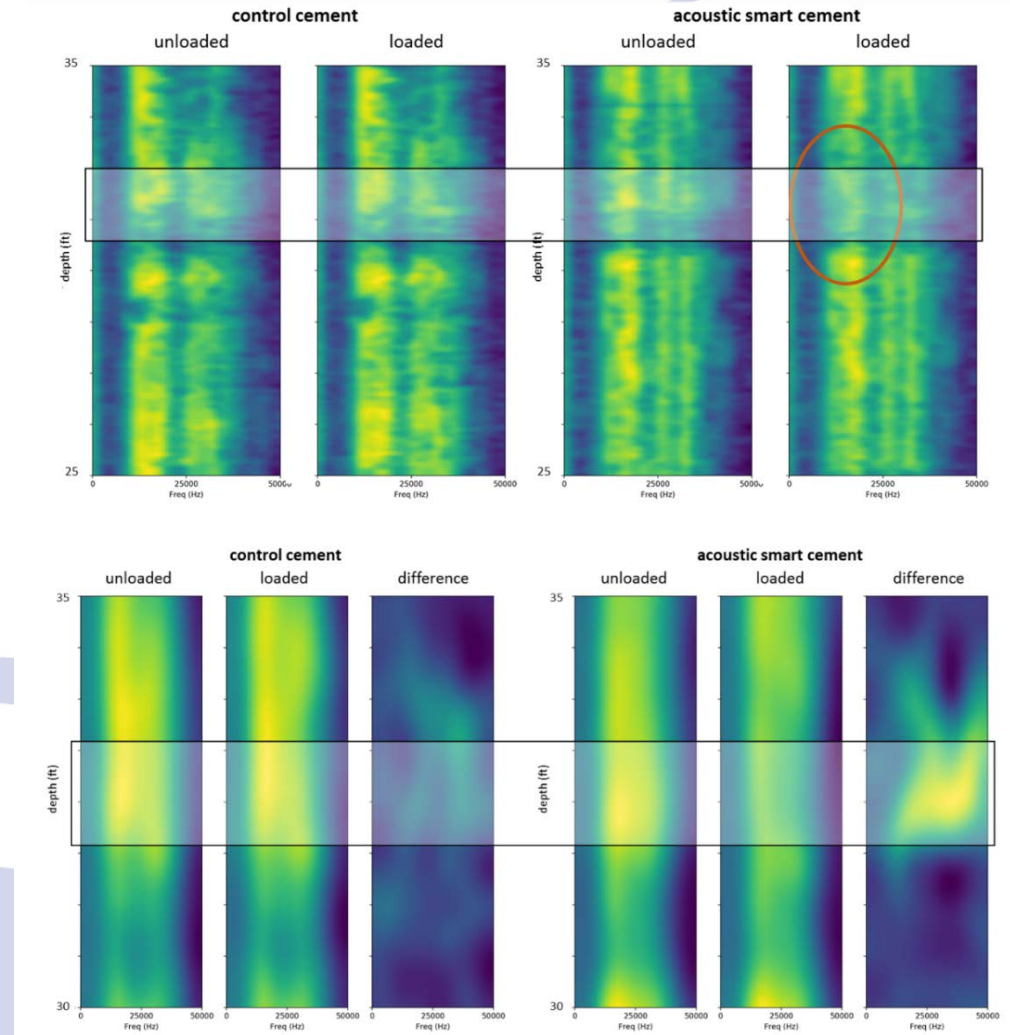
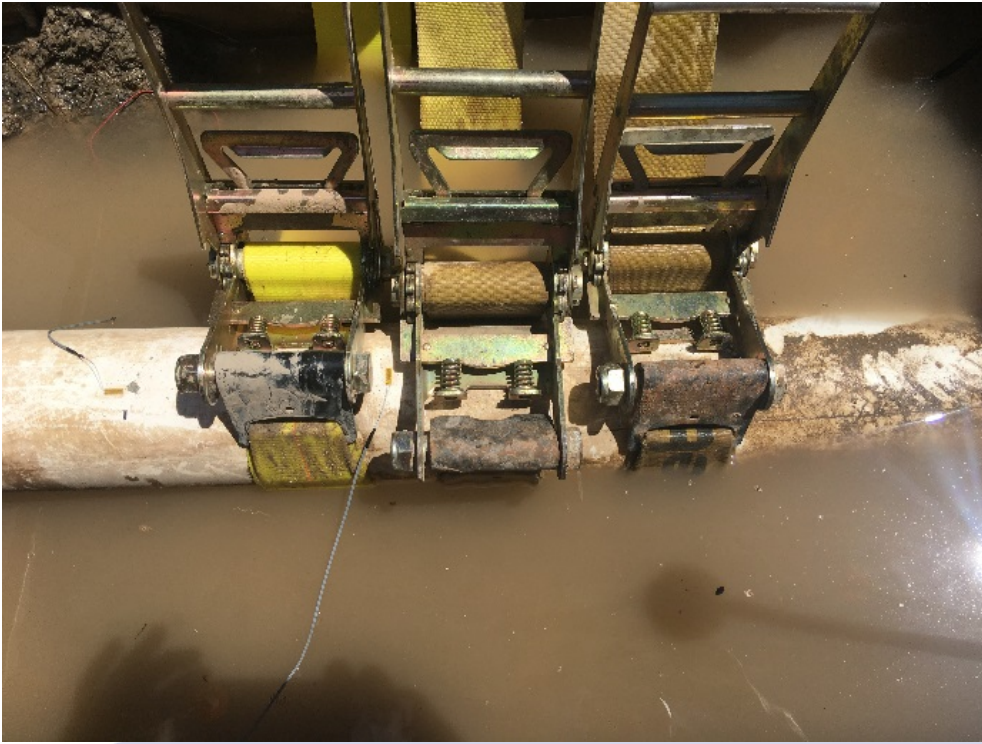
Technical Status

- Phase I results



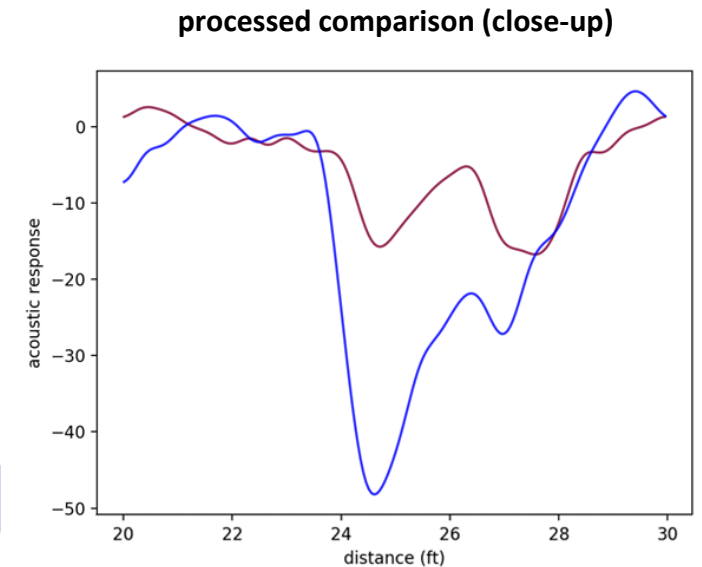
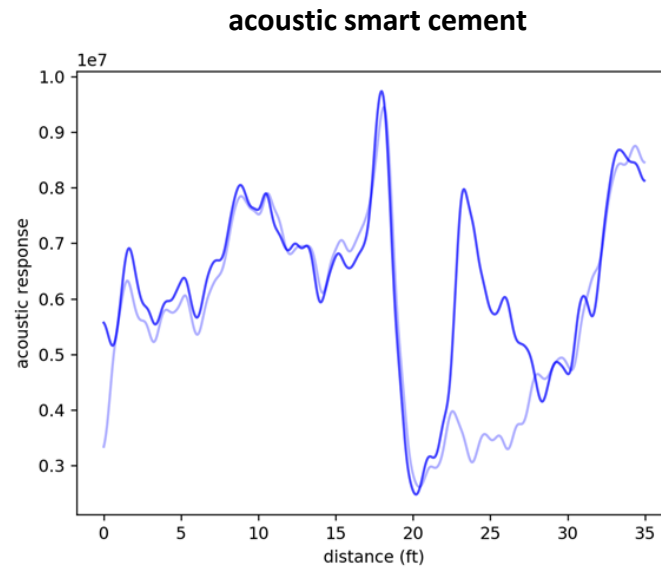
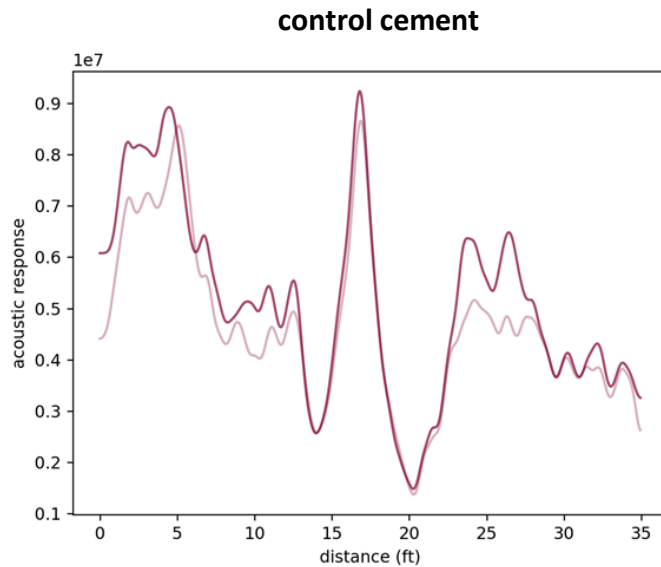
Technical Status

- Phase I results



Technical Status

- Phase I results

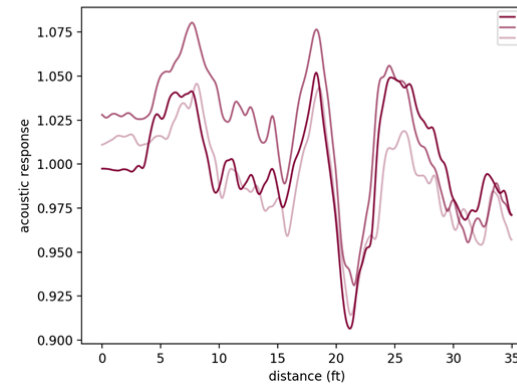


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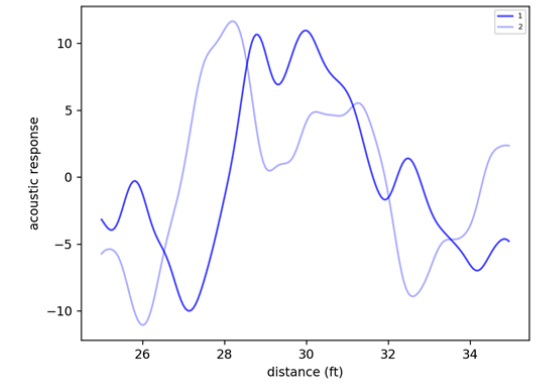
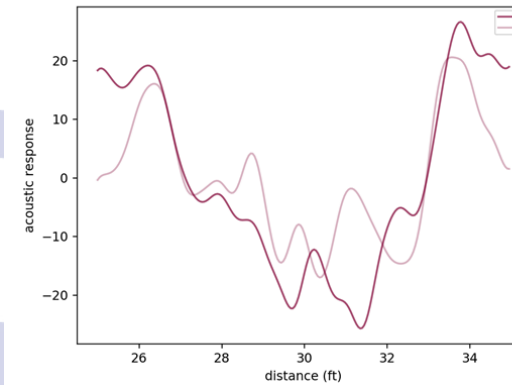
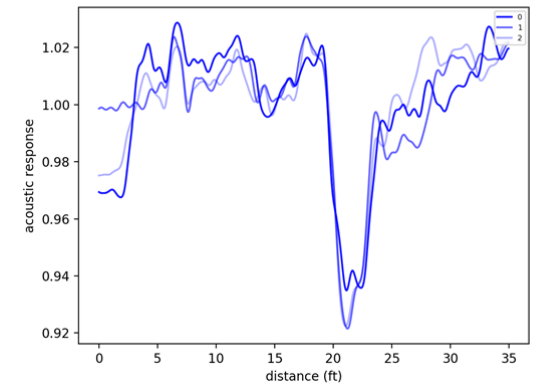
- Phase I results



control cement



acoustic smart cement



Accomplishments to Date

- Simulation and design of acoustic metamaterial filler for cement
- Laboratory scale production of acoustic metamaterial filler.
- Physical and acoustic characterization of acoustic metamaterial filler in cement composites.
- Sub-scale testing of cement-steel composites and annular pipe constructs.
- Pilot scale construction and installation of shallow buried 40' pipe constructs with control and experimental foam cement.
- Acoustic interrogation of annular pipe constructs with monopole full waveform sonic logging tool.
- Acoustic mapping of cement construct with engineered voids and applied mechanical stress.
- Development of data analysis techniques for determining cement location and mechanical loading.
- Scale-up of acoustic metamaterial filler particles for field deployment.

Project Summary

- Key findings
 - Oceanit acoustic smart cement provides improved cement-void contrast and stress detection.
 - Acoustic band gap effect and load dependence were demonstrated in lab, subscale, and pilot field studies.
 - The smart cement has potential to enhance well integrity diagnostics and design and provide insight into subsurface mechanics.
- Lessons learned
 - Balancing of acoustic and mechanical performance of smart cement compositions
 - Formulation changes required for scaled-up and economically viable production
 - Importance of matching material acoustic response to tool capabilities for particular applications
- Next steps
 - Continued production process scale-up
 - Cement API characterization
 - Material and detector optimization
 - Partnerships and field trials