Development of an Improved Cement for Geothermal Wells

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Principal Investigator

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Trabits Group, LLC

Track

Specialized Materials and Fluids and Power Plants

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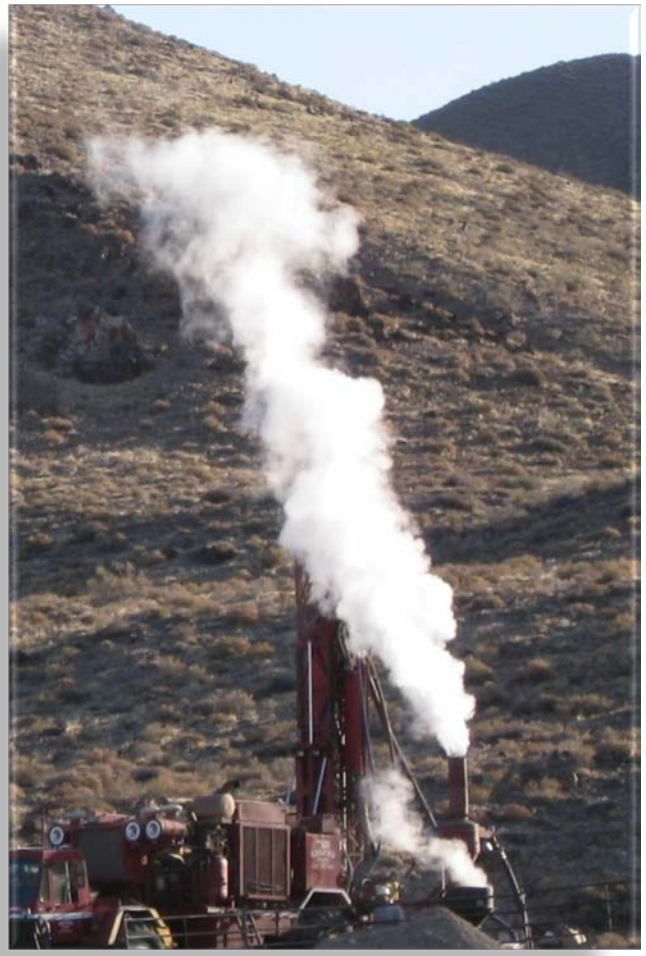

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Project Objective

Develop a novel, zeolite-containing lightweight, high temperature, high pressure geothermal cement, which will provide operators with an easy to use, flexible cementing system that saves time and simplifies logistics.

Period of Performance

January 29, 2010 through December 31, 2012

Project Budget

- DOE Share $2,154,238
- Awardee Share $ 538,557
- Total Project $2,692,795

Improved Geothermal Cement Characteristics

- Thermal stability with little strength retrogression to 300° C.
- Tensile strength to withstand temperature and pressure changes.
- Low-density, low-viscosity slurries with low equivalent circulating densities (ECD) without the need for air or nitrogen foaming.
- A single cement blend allowing density adjustments without adversely affecting slurry properties to eliminate the need for separate blends for lead and tail slurries.
- Resistance to carbonation.
- Accurate downhole densities throughout cement placement without significant changes in viscosity.
- Water absorption capacity without retaining free water.
- Good bonding to casing and formation.
- Adequate compressive strength.

Research Approach

- Build on existing zeolite-containing cement technology for low temperature, weak formation applications.

- Systematic, scientific approach on trial cement blends to consider the variables of:
  - Zeolite type
  - Zeolite particle size
  - Zeolite percentage by weight of cement
  - Additives for thermal stability and resistance to carbonation

Impact of New Cement Development

- Provide an easy to use, flexible cementing system.
- Save time and simplify logistics.
- Eliminate the requirement to “sterilize” pumping equipment before use.
- Eliminate the need to foam the slurry to achieve lightweight qualities.
- Eliminate incompatibility issues in the selection of retarders and accelerators.
- Provide predictability and minimize the effect of down-hole temperature fluctuation.
- Facilitate the development of geothermal resources in remote locations.

Research and Development Conducted in Five Tasks

- Task 1 – Research
  - Literature Search
  - Geothermal Practices and Constraints
  - Mechanisms of Geothermal Well Failure
- Task 2 - Design
  - Compile Research Findings
  - Modification of Project Tasks 3 and 4

Scientific/Technical Approach

- Task 3 – Develop
  - Zeolite Sample Acquisition
  - Zeolite Type Confirmation
  - Zeolite Particle Size Preparation
  - Initial Screening of Cement Formulations

    ✓ Zero percent free water
    ✓ Rheological properties of less than 200 reading at 300 rpm
    ✓ 24 Hour compressive strength greater than 500 psi
    ✓ Thickening time and consistency, end thickening under 70 Bc
    ✓ Slurry density less than 13.5 lbs/gal

Scientific/Technical Approach

➢ Task 4 – Test

Second Stage and Final Cement Development

- Rheological properties of cement slurry (shear stress versus shear rate)
- Slurry density measurement
- Slurry consistency and thickening time
- Compressive strength at 12 hour and 24 hour
- Tensile strength of set cement
- Percent free water measurement
- Response to retarders at high pressure and high temperature
- Quality of cement to casing bond
- Resistance to geothermal brines (long term stability)
- Compressive strength retrogression over a three to six month period
- Determination of the optimum blend ratio of silica flour and other additives to zeolite for thermal stability
- Permeability of set cement
- Poisson's ratio and Young's modulus of set cement
- Thermal conductivity of set cement

Scientific/Technical Approach

- Task 5 – Demonstrate
  - Laboratory Scale Demonstration

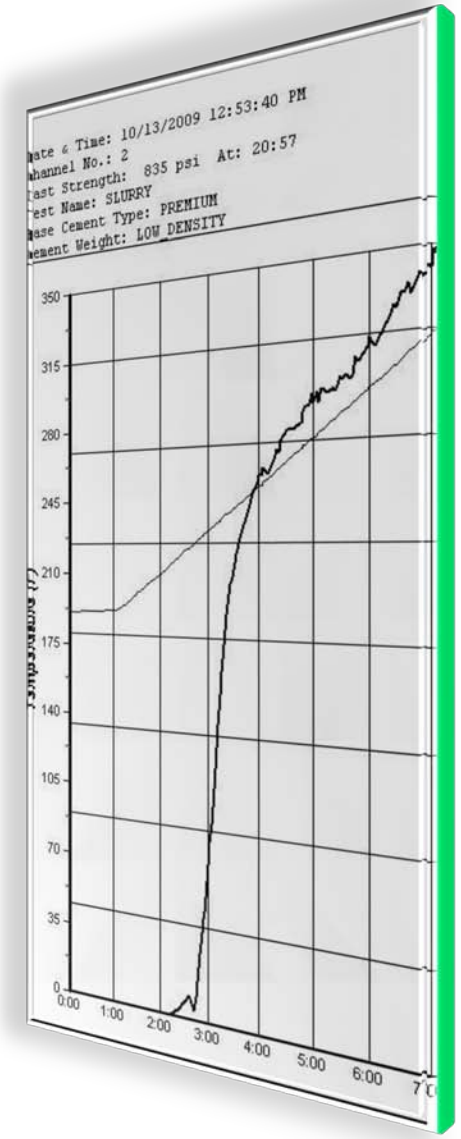
    Cement samples will be subjected to conditions of heat and brine for 3 month and 6 month exposures.

  - Logistics / Ease of Use

    Place the cement using local contractors with customary methods and equipment.

  - High Temperature Well

    Cement will be tested in an available well under development.



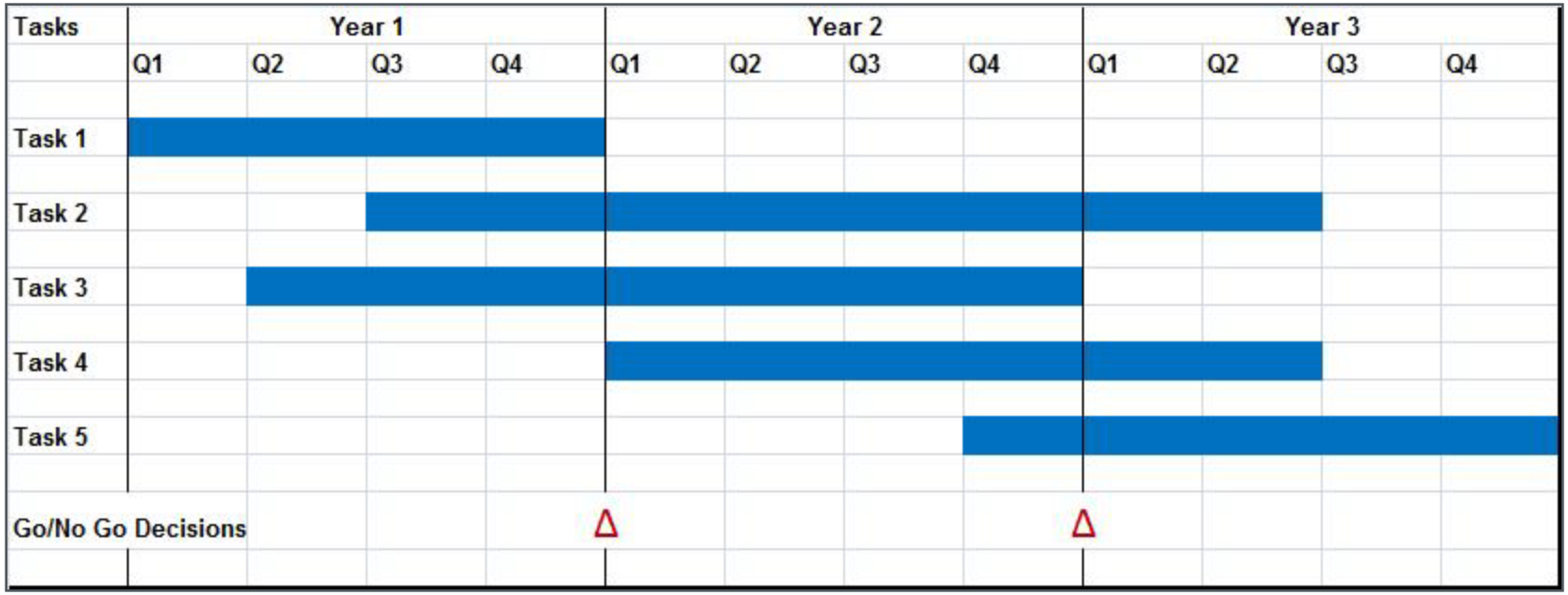
Project Kick Off Meeting
March, 2010

- Reviewed Project Team Task assignments.
- Discussed bulk zeolite sample acquisition.
- Discussed preparation of micronized laboratory samples.
- Discussed establishing an FTP site for data management.
- Discussed potential variability of Class G and Class H cement used in screening formulations.

Project Management/Coordination

- Project Objectives (Targets) have been formulated as specific performance characteristics that are necessary for a high temperature cement.
- Each of the Objectives requires measurable data that can be evaluated to determine the success or failure of a particular cement blend.
- Clear and concise performance characteristics provide a systematic method for initial screening, second stage development and ultimately for the final stage of cement development.
- This logical progression of scientific study results in five Tasks that lead to realistic project milestones and go / no-go decisions points.

Schedule



Spend Plan

Year 1	$ 932,959
Year 2	$1,042,420
Year 3	$ 717,416

Future Directions

- FY 2010 Project Activities
  - Complete Literature Search
  - Complete Review of Current Practices and Constraints
  - Complete Review of Mechanisms of Well Failure
  - Complete Zeolite Sample Acquisition
  - Complete Zeolite Type Confirmation
  - Complete Micronized Zeolite Laboratory Samples
  - Begin Initial Screening of Cement Formulations
- FY 2011 Project Activities
  - Complete Initial Screening of Cement Formulations
  - Modification of Second Stage Development Based on Initial Screening Results
  - Begin Second Stage Cement Development
  - Continue Research on Additives and Methods

Summary

- The project is in keeping with the stated goals of the Geothermal Technologies Program under the Multi-Year Research, Development, and Demonstration plan.
- The improved geothermal cement has characteristics to withstand through-casing stimulation which is necessary for EGS development.
- There will be a high level of UAF student involvement throughout the project. Graduate students will be in residence at ThermaSource's laboratory.
- Successful completion of the project will result in the development of a cementing solution for geothermal wells that is cost effective as well as logistically simple.