Base Technology and Tools for Supercritical Reservoirs

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High Temp Tools, Sensors, Systems, Drilling Systems

Overview Slide

- Project Overview
  - Timeline
    - Project start date; April 2010, Project end date; April 2012
  - Budget
    - ARRA project Total budget $1956k (with $100k cost share)
      - $1269k (funding received to date)

Current Task Financial Summary

FY11 request	Carryover	Transferred funds	FY 11 Costs	Commitments	Available
$	$1269k	0	$245k	$243k	$781k

Relevance/Impact of Research

- Objective
  - Develop building blocks necessary for robust tools that can operate in supercritical environments
    - Building blocks consist of MultiChip Modules (MCMs); each with specific functionality
      - Sandia-designed analog MCM and digital MCM
  - Design and field test tools based on developed building blocks
    - Tools include:
      - 240ºC Dewarless Pressure/Temperature/Collar locator (PTC) Tool
      - 450ºC Dewared PTC tool
      - 450ºC Fluid sampler (not currently funded)
  - Collaborate with universities and industry to help solve the technical challenges detailed in this proposal
    - Packaging reliability
    - Innerconnect issues
    - Improved Dewars
    - High temperature (HT) cables and batteries

Relevance/Impact of Research

- In line with DOE objective of advancing base technology required for developing downhole tools for supercritical reservoirs
- Designing any tool to operate in a supercritical reservoir is ambitious
  - Requires an innovative design approach
  - Advances in electronics packaging and materials are needed
    - Developed concepts will provide a foundation for applications outside this work effort
- Demonstration tools were selected based on EGS requirements

Scientific/Technical Approach

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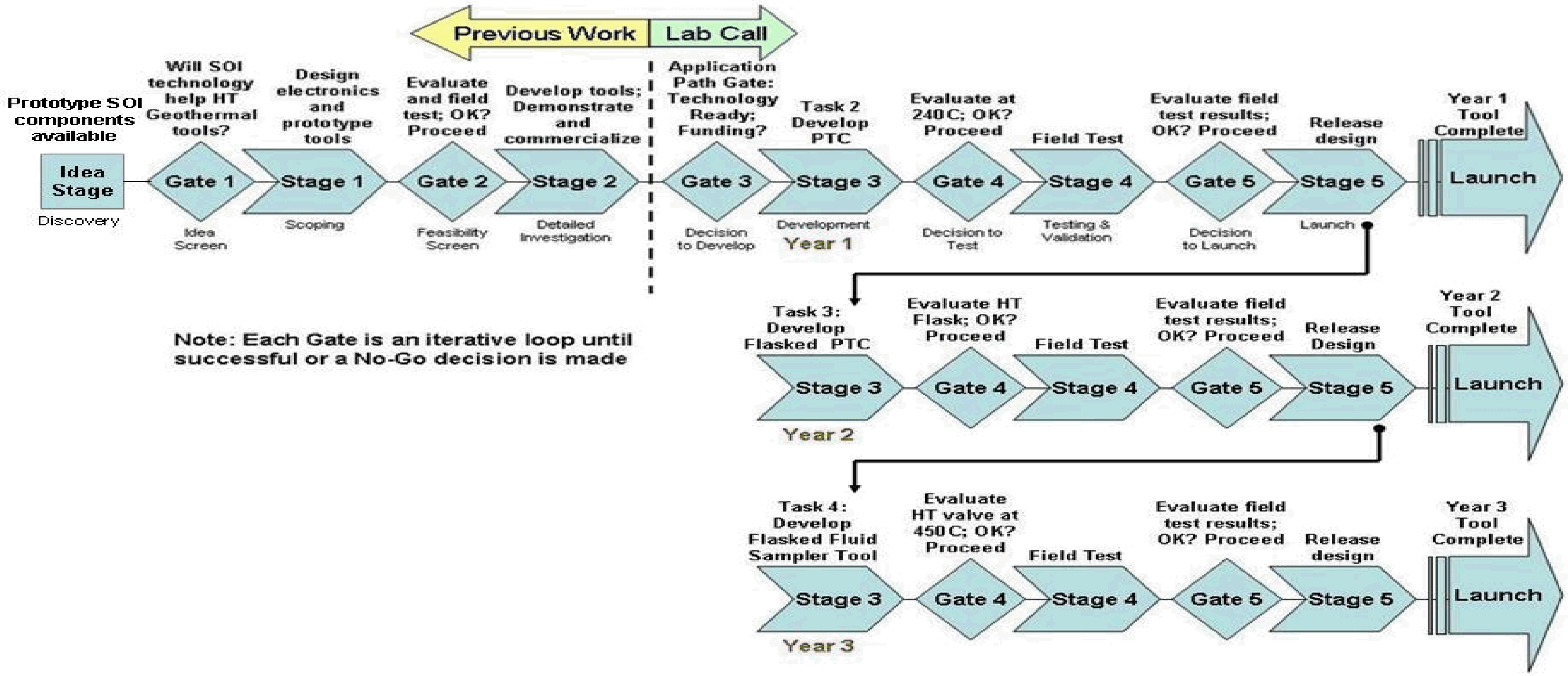
- While keeping in mind DOE's objective, advance base technology that can be utilized in a wide variety of applications
  - Dewar development potentially will enable additional tools to be developed
  - HT valve development could be utilized in tracer work, etc.
  - MCMs are building blocks for future tools
    - Advancements in packaging and innerconnects will increase reliability in MCMs
- Demonstrate advances by fielding tools
  - Choose tools critical to developing and maintaining a supercritical reservoir

Scientific/Technical Approach

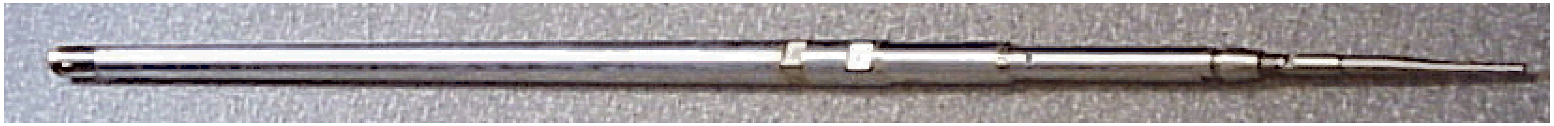


- Major milestones:
  - Year 1: Dewarless 240ºC PTC Tool – April 2011
  - Year 2: Flasked 450ºC PTC Tool – April 2012
  - Year 3: Flasked 450ºC Fluid Sampler Tool

Year 1 Work Plan as stated last year

- Year 1 PTC Tool Development
  - Design, fabricate and assemble PC boards for analog MCM
  - Determine if HT battery will be available; if not, use wireline to deploy
  - Assemble, test, calibrate and verify performance at 240ºC
  - Determine well of opportunity and field tool
- Required subtasks performed in parallel to meet year 2 and year 3 objectives
  - Evaluate conventional Dewars
  - Initiate pyrotechnic actuated valve design
  - Investigate HT cablehead and e-line design for 450ºC
- University Collaboration
  - Initiate collaboration with the Auburn University
    - Model behavior of MCM operating at 250ºC and predict lifetime based on conventional die attach and wire-bonding techniques.

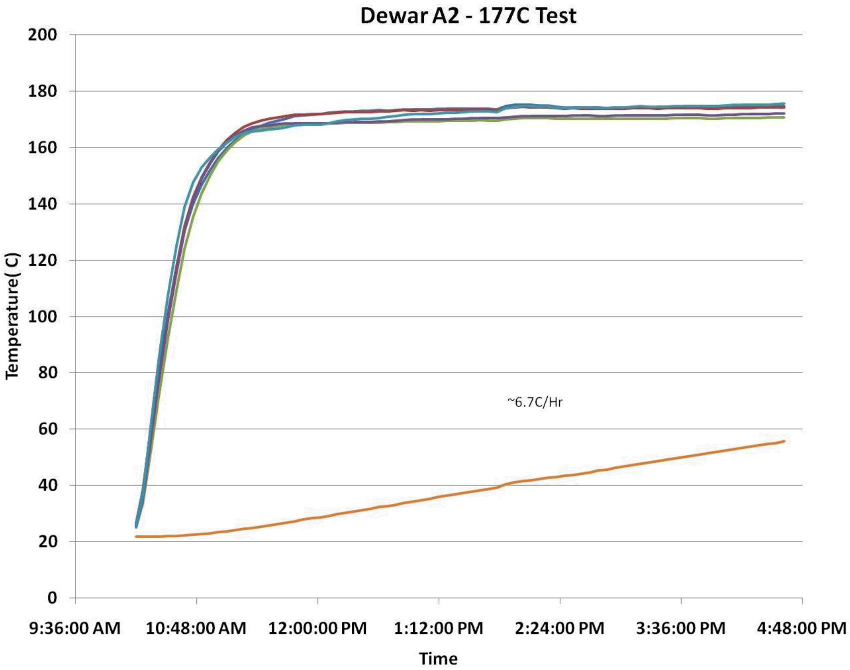
Accomplishments, Results and Progress



- Year 1 PTC Tool Development
  - Electronics complete (assembled, calibrated and tested)
  - Two planned field tests
    - Initial deployment will utilize existing hardware
    - First deployment will enable casing collar locator circuit to be optimized
    - Second field test will use newly designed hardware
      - Design complete; based on commercial hardware and adaptable for Dewar in year 2; hardware design adds a spinner to sensor suite at no design cost, now PTCS Tool
      - Delivery of hardware delayed due to contractual issues; delivery expected 6/2011
  - Analog MCM design complete; success of fielding will enable placement of contract with Quartzdyne
  - As stated in proposal, digital MCM utilized Honeywell's RPDA (Re-configurable Processor for Data Acquisition - Deep Trek activity)
    - After many delays, Honeywell can not support this MCM
    - Re-scoped MCM uses Honeywell's microcontroller, EERPOM and latch
      - Received EEPROM and latch April 2011

Accomplishments, Results and Progress

- Dewar Testing
  - Test plan includes four Dewars; two each of two types
  - Testing in progress and should be complete by late June



Accomplishments, Results and Progress

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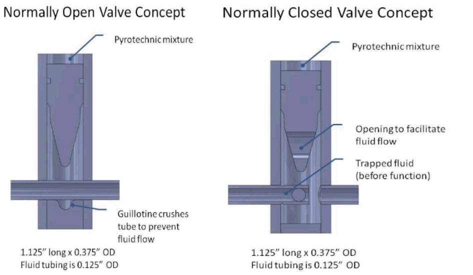
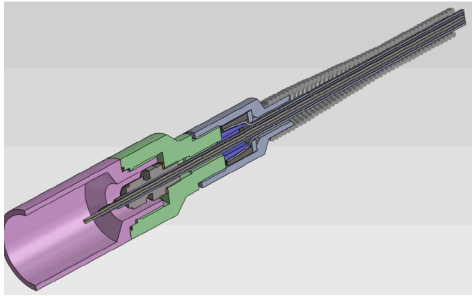
- Pyrotechnic actuated valve design concept complete
  - Pyrotechnic material selection under test to validate stability of material at temperatures up to 400ºC
- MCM reliability study underway
  - Contract placed with Auburn University
- HT cable design complete
  - Draka will build prototype under their ARRA project
    - Expected delivery 7/2011; 1km length
- HT cablehead design concept complete
  - Prototype design based on Draka’s cable
- HT battery options are being pursued
  - Electrochemical Systems – Rechargeable
  - Enser Corporation – primary battery





Project Management/Coordination

- Schedule
  - Year 1 activities nearly complete
  - Year 2 activities underway
- Application of resources
  - Sandia geothermal department – hardware and electronics design
  - Sandia – HT valve mechanical design
  - Sandia explosives department – pyrotechnic development
  - Auburn University– MCM reliability study
- Project Integrated
  - HT tools and samplers are required during the development of reservoirs. As such, this tool is aligned with DOE geothermal program objectives
- Coordination with industry
  - Working with Themochem, Draka

Data Sharing

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- Project data will consists of the following:
  - Summary report
  - GRC presentation in 2012
  - Upon project completion, the data will be provided to the DOE Geothermal Data Repository in the form of a report

Collaborations

- Collaborations with industry include:
  - Auburn University
    - MCM reliability study
  - Thermochem
    - Sample chamber design
  - Draka
    - HT Cable
  - Hydrotech, Pacific Process Systems, or Welaco
    - Subcontractors for deploying tool

Future Directions

- Upcoming Tasks
  - Complete Year 1 milestone; Field Year 1 PTC Tool
    - Field tool with newly designed hardware
      - Delivery of hardware delayed due to contractual issues; delivery expected 6/2011
      - PTC Tool will be fielded shortly after delivery of hardware – electronics assembled and tested
      - Preliminary deployment using existing hardware scheduled for 5/2011; fielding of tool with new hardware by July 2011
  - Report on Dewar tests
  - Report on pyrotechnic material selection and test results
  - Placement of MCM contract
  - Placement of HT battery contract with Electrochemical Systems
  - Completion of HT (450ºC) cable (Draka – design and prototype cable cost is leveraged from Draka's ARRA project)
  - Completion of HT (450ºC) cablehead design
- In parallel, start on year 2 PTCS Tool

Summary

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- Year 1 activities are nearly complete
  - Electronics to be utilized in analog MCM are complete
  - Progress in many areas including: Dewar tests, HT valve, MCM reliability study, HT cable
- In line with Geothermal Technologies Program goals
  - The tools were chosen as they provide information critical to developing and maintaining supercritical reservoirs

	FY2010	FY2011
Target/Milestone	Development of analog MCM design	Fabricate MCM design using discrete components and field test developed tool
Results	Design simulations completed 11/2010	Design complete and lab evaluated; fielding of complete tool PTCS by 7/2011

Supplemental Slides

Task Details

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Updated to reflect actual start date based on received funding and contractual delays

WBS	Task	Subtask	Description
Project Management	1	1.1	Form team for HT sample chamber, HT valve, HT Dewar
		1.2	Year 1 report (summary and recommendations)
		1.3	Revise year 2 work plan based on year 1 results
		1.4	Year 2 report (summary and recommendations)
		1.5	Revise year 3 work plan based on year 2 results
		1.6	Design review
		1.7	Final report
Dewarless 240C PTC Tool	2	2.1.1	Design, layout, manufacture and assembly of PC boards
		2.1.3	Assemble, cal and verify performance of electronics
		2.1.4	Field year 1 tool
		2.2.1	Evaluate existing Dewar technology
		2.2.2	Initiate pyrotechnic actuated valve design
		2.2.3	Investigate HT cablehead and wireline designs (450C)
		2.3.1	Collaborate with AU on modeling of MCM (250C)
Dewar Flasked 450C PTC Tool	3	3.1.1	Convert analog circuit to MCM
		3.1.2	Test MCM for functionality and performance (RT - 250C)
		3.1.4	Assemble, cal and verify performance of electronics
		3.1.5	Field year 2 tool
		3.2	HT Dewar development (design, fabricate, and evaluate)
		3.3	HT valve development (design, fabricate, and evaluate)
		3.4.1	Continue collaboration with UM on testing of MCM (250C)
Dewar Flasked 450C Fluid Sampler Tool	4	4.1.1	Final design review
		4.1.2	Assemble, cal and verify performance of electronics
		4.1.3	Determine well of opportunity and field year 3 tool
		4.2.1	Collaborate with UM on modeling of MCM (300C)

Preliminary look at pyrotechnic material looks promising

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Differential Scanning Calorimetry of THPP