Pilgrim Hot Springs, Alaska

May 19, 2010

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Validation of Innovative Geothermal Technologies

Project Overview

- Timeline
  - Project Length (4/1/10-12/1/12)
    - Preliminary planning complete
- Project Funding
  - Total Project Funding-$6,365,222*
  - DOE Share-$4,616,879*
  - Alaska Energy Authority-$1,745,343*
- GTP Goal
  - Validation of Innovative Exploration Technologies
    - Confirm 400 MW of geothermal energy capacity
    - Validate two new exploration techniques

*Pending

Relevance/Impact of Research

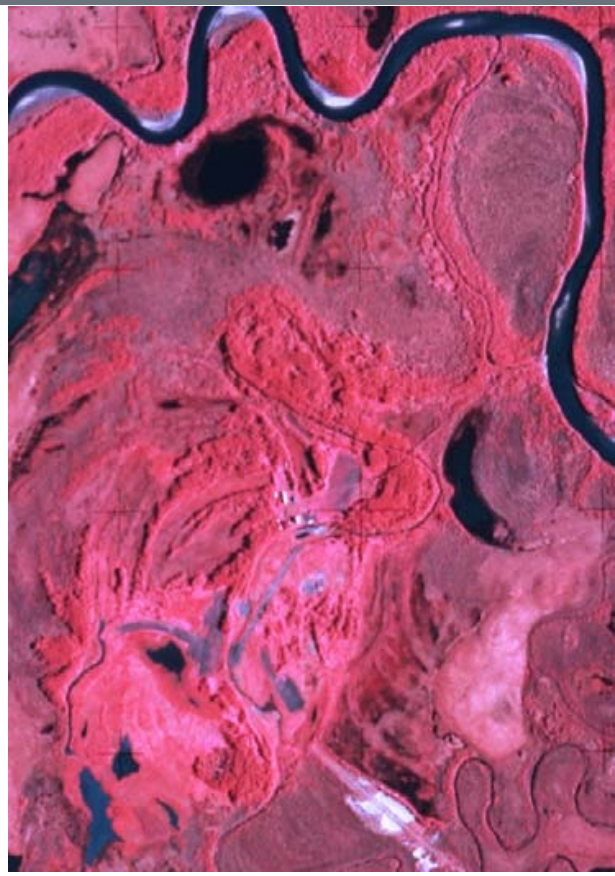
Project Objectives

- Apply existing and innovative remote sensing and geophysical techniques to a known low temperature shallow geothermal resource
- Integrate new and old data sets to develop conceptual model
- Confirm this model through drilling two confirmation slim holes
- Create numerical model to aid investigation of potential resource development
  - Low temperature resource
  - Remote location
  - Current high fuel costs

Scientific/Technical Approach

Phase 1- Geophysics and Ground Based Surveys

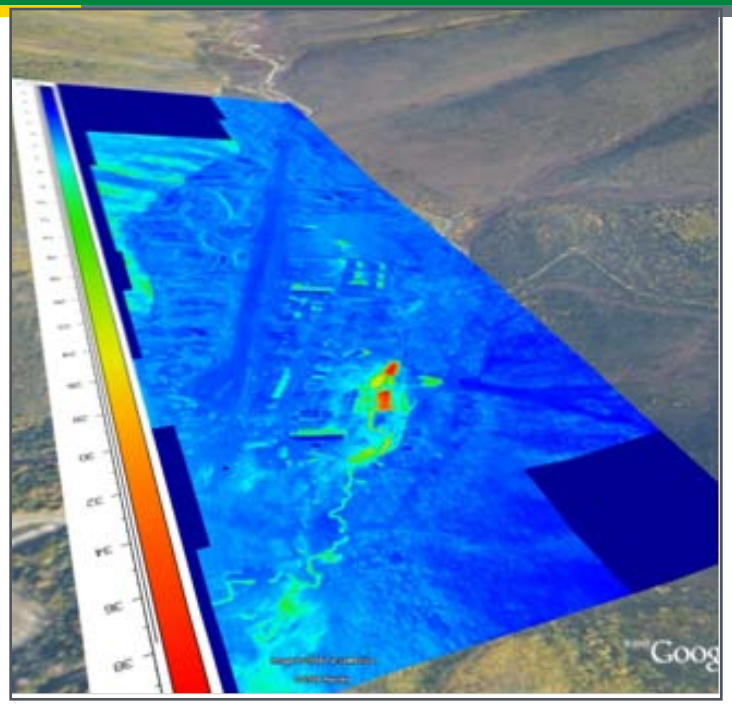
- Land surface temperature and emissivity map using thermal infrared images
  - *Landsat , ASTER.*
- Landcover classification map using optical data
  - *Landsat, ASTER and ALOS (potentially), Color Infra Red (CIR) air photos*
- Acquire airborne thermal infrared images
- Process satellite and airborne images using new algorithms



CIR image from late 70s showing part of the proposed study area

Scientific/Technical Approach

- Airborne thermal infrared images
  - Timing
    - Spring and Fall Acquisition
  - Resolution
    - Reconnaissance Survey
      - 4m spatial resolution
    - Detailed Survey
      - 1m spatial resolution
- Image Processing
  - Create and compare thermal and optical mosaics
    - Account for seasonal and vegetative effects
  - Calculate relative heat flux for thermal anomalies



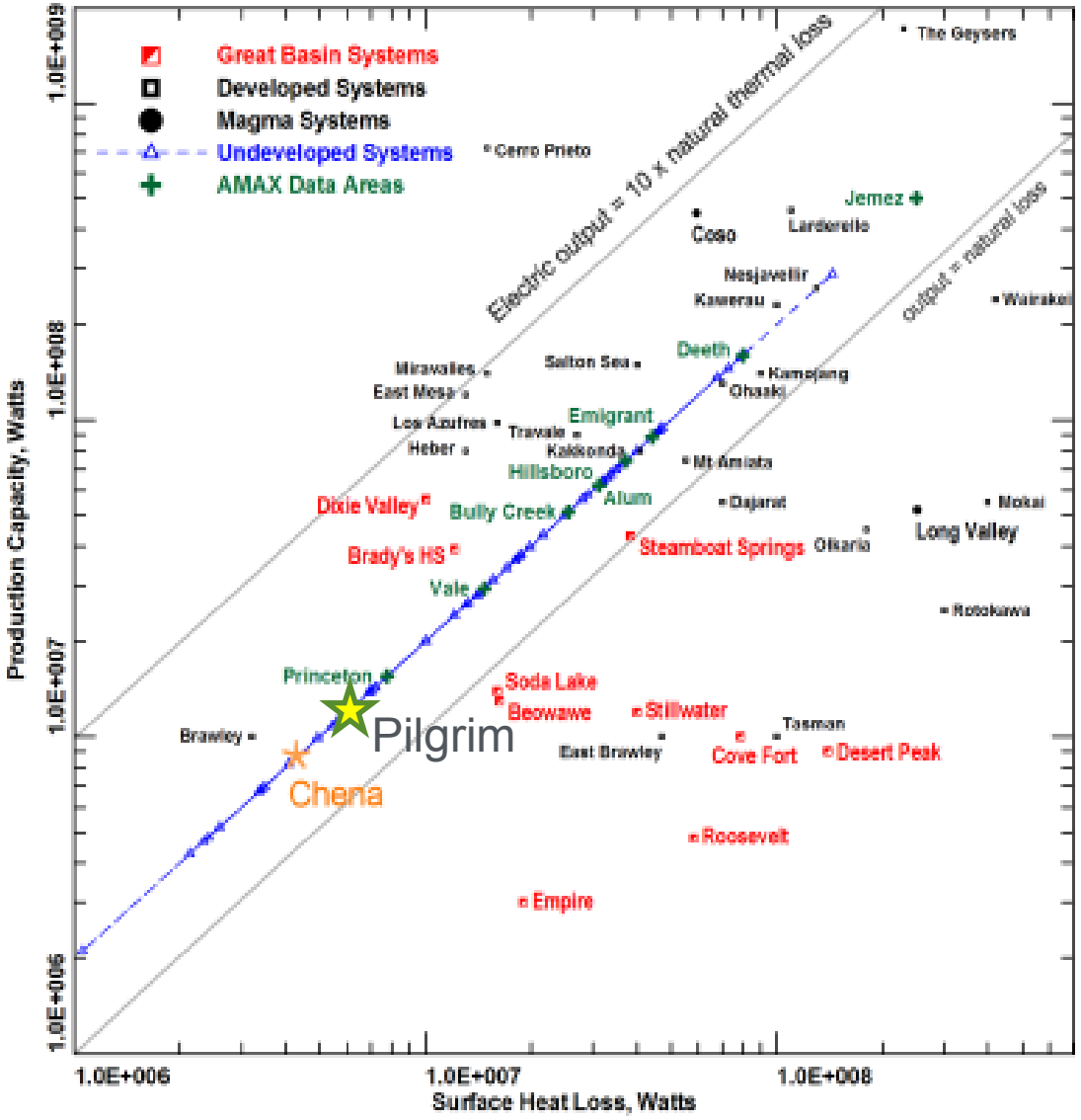
Thermal infrared image of Chena Hot Springs. Differing vegetation shows different temperatures due to the difference in emissivity of various plants and the bare ground.

Source: Dehn, Prakash, Dean, 2006: Input to CHSR GRED III project

Scientific/Technical Approach

- Phase 1- Geophysics and Ground Based Surveys
  - Collect data from existing wells (pressure, temperature etc.)
  - Conduct shallow temperature survey
  - Conduct resistivity survey
  - Synthesize new and old datasets
  - Develop conceptual model

→Site Phase 2 Gradient and Confirmation Holes.

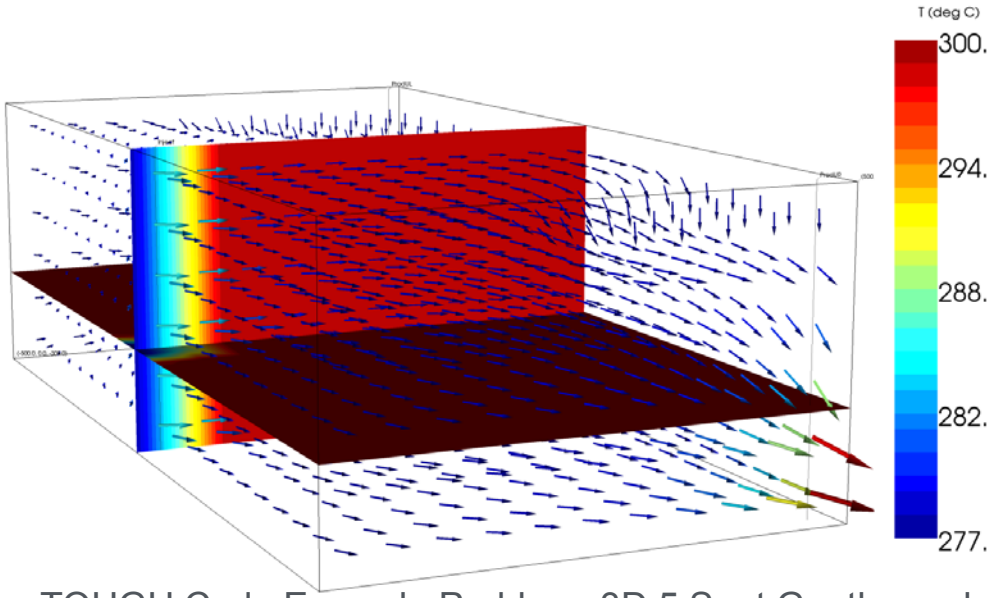


Scientific/Technical Approach

Christensen CS1000 P6 core rig: Fort Yukon

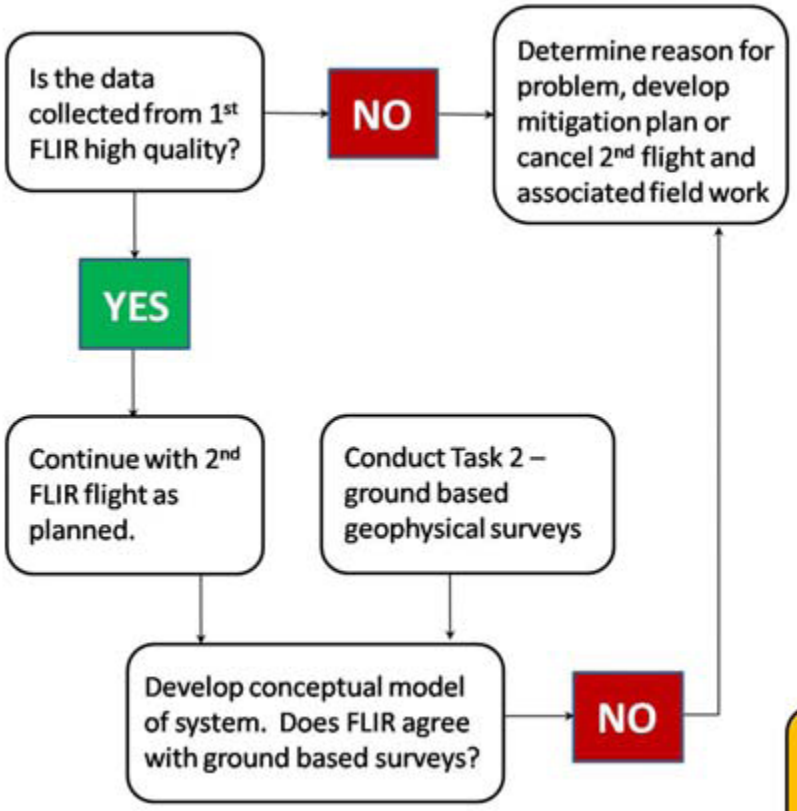
- Phase 2- Confirmation Drilling Program
  - Identify upflow zone
  - Well testing program
  - Assess reservoir productivity

- Phase 3- Reservoir Modeling
  - Quantify resource uncertainties
  - Explore potential development scenarios



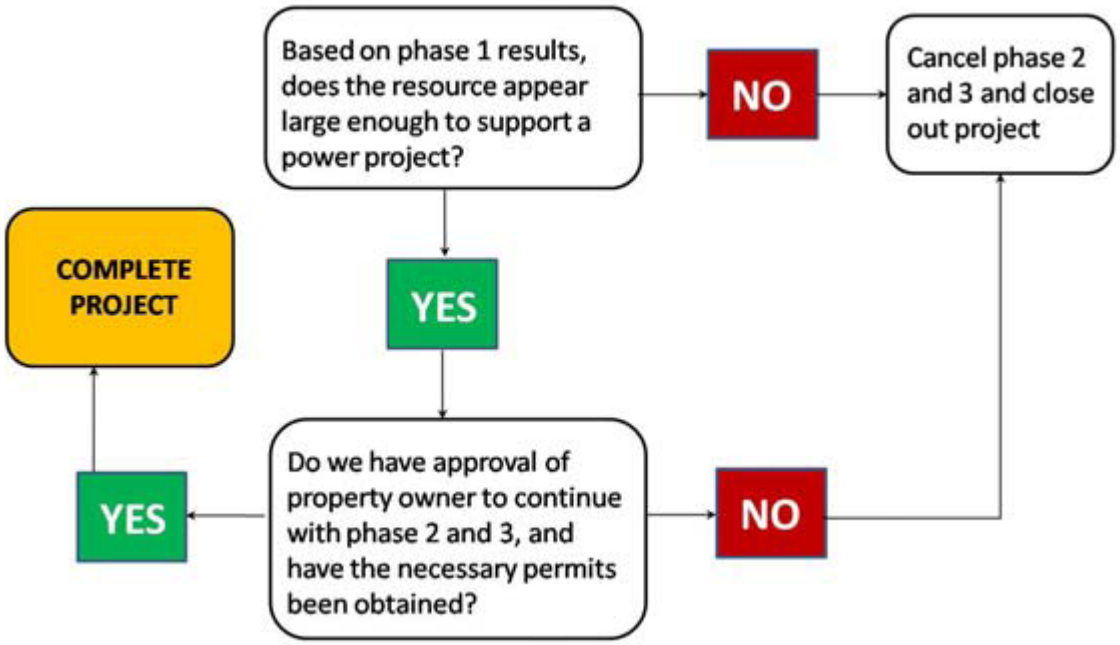
TOUGH Code Example Problem- 3D 5 Spot Geothermal

Scientific/Technical Approach



Phase 1

Phase 2 and 3



Progress to date

- Finalizing Budget and Cost share from Alaska Energy Authority (AEA)
- Summer Fieldwork Planning
  - Staff (3 students, 1 project manager, geothermal consultant)
  - Equipment
  - Contracting FLIR flight

Accomplishments, Expected Outcomes and Progress

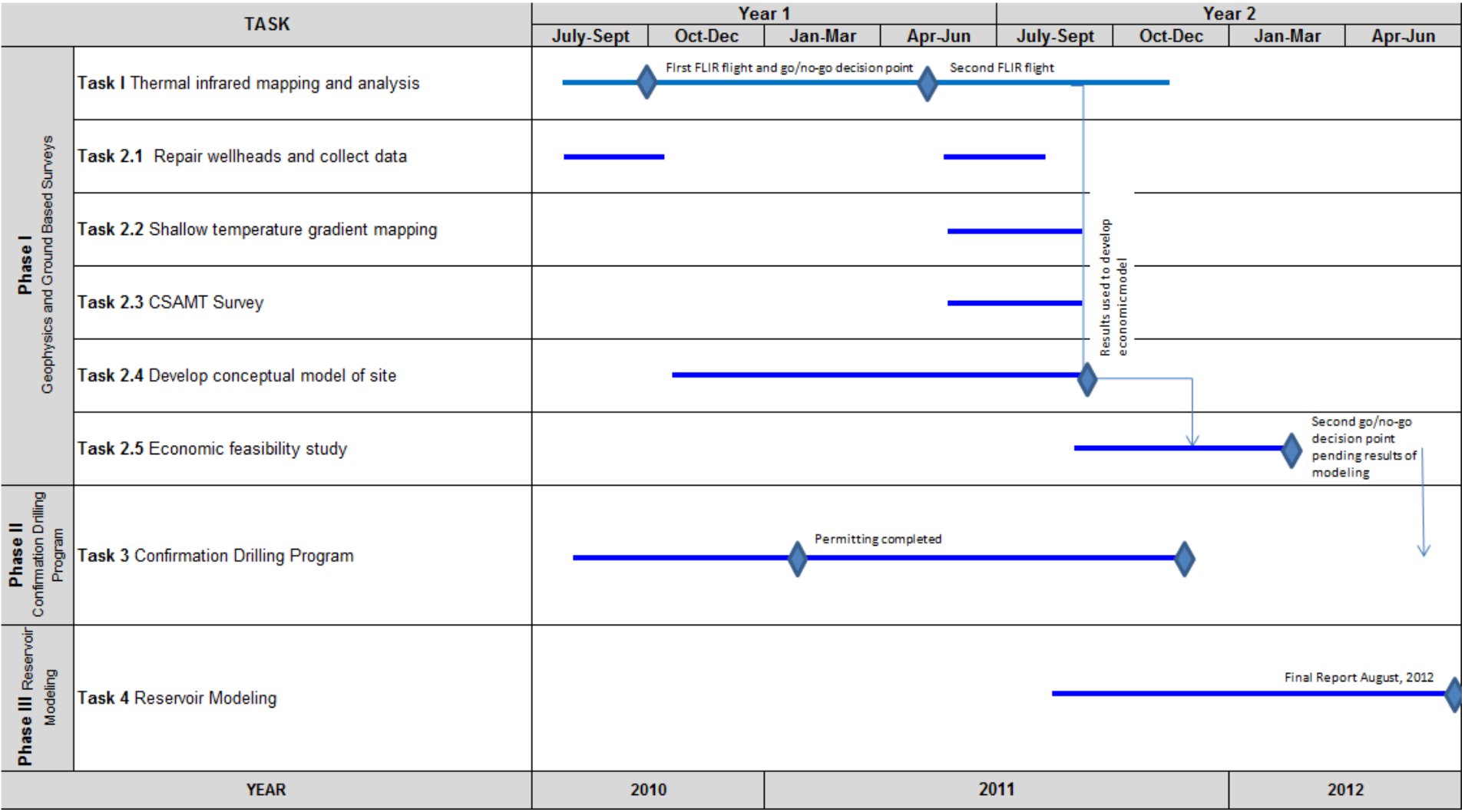
- Gwen Holdmann
  - –PI for GRED III geothermal exploration and development project at Chena Hot Springs
- Co-PI Anupma Prakash
  - remote sensing and GIS
  - thermal infrared data expertise
- Co-PI Jo Mongrain
  - Geophysics/petroleum engineering background
  - Numerical model development

Additional Expertise

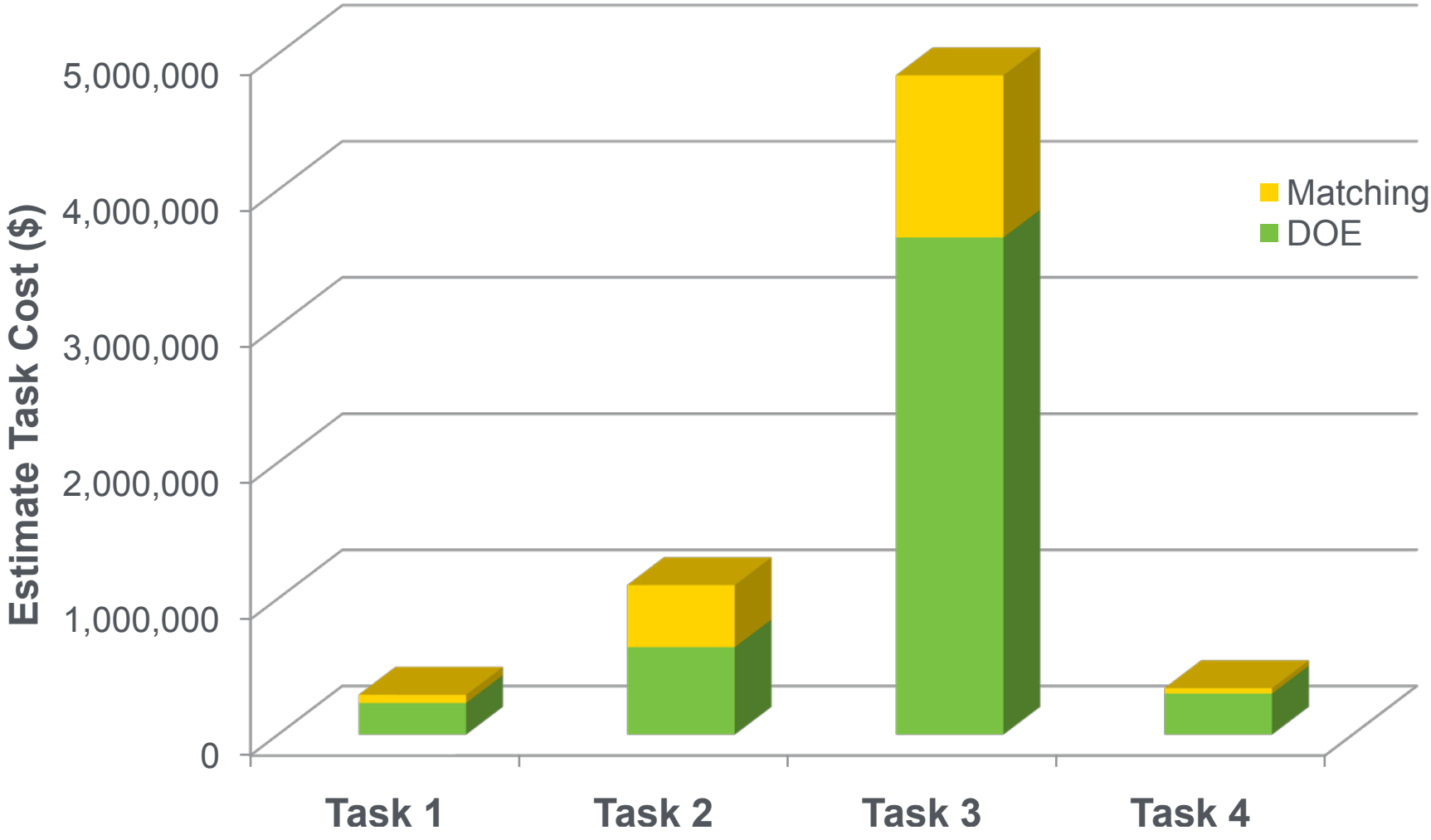
- Dick Benoit
  - Geothermal consultant with ~35 years of experience in field exploration and development

Project Management/Coordination

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Project Management/Coordination



*Budget and spend plan under negotiation. Cost Share pending

Future Directions

- FY10
  - Geophysical and ground based surveys
  - Well Repair and data collection
- FY11
  - Conceptual model build
  - Well planning and permitting

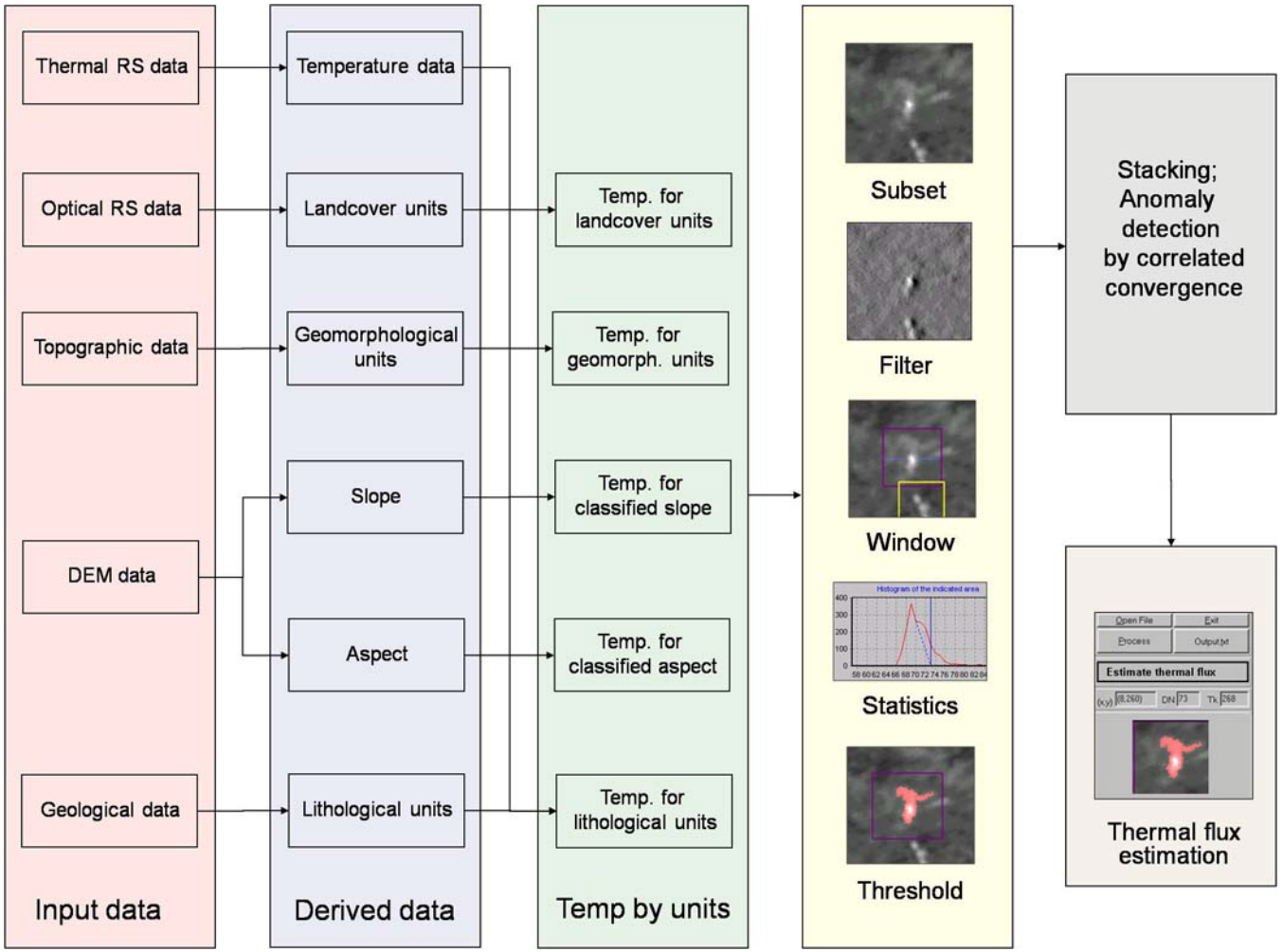
- Innovative data processing and use of FLIR
  - fast, cost effective method to measure natural heat loss
- Pilgrim Hot Springs Resource Development
  - baseload power for the Nome area.

Mandatory Summary Slide

- Innovative geophysical exploration techniques
  - Airborne Thermal Infrared (FLIR)
  - Data Processing Algorithms
    - Cost effective tools suitable for wider deployment
- Integration of multiple data types and techniques
  - Thermal Anomaly mapping (FLIR, Landsat, ASTER)
  - Resistivity Surveys
  - Thermal gradient holes/mapping
  - Confirmation wells
  - Well Testing
  - Numerical modeling
- Aid potential development of geothermal resource
  - Remote community
  - High fuel costs

Supplemental Slides

Supplementary Material



Thermal infrared iterative processing scheme flow chart (Prakash, 2009).