Snake River Geothermal Project - Innovative Approaches to Geothermal Exploration

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Utah State University

Validation of Innovative Exploration Technologies

Mandatory Overview Slide

- Project Baseline information:
  - Timeline
    - Project start date: 24 March 2010
    - Project end date: 23 March 2012
    - percent complete: 2%
  - Budget
    - Total project funding: $6,694,784
    - DOE share: $4,640,674
    - Awardee share: $2,054,674
    - funding received in FY09 None
    - funding for FY10 Final Award Pending
  - Barriers
    - Time line for approval of ICDP cost-share commitment
  - Partners
    - International Continental Drilling Program, Southern Methodist University, Boise State University, University of Alberta, US Geological Survey

Relevance/Impact of Research

Objective: To Implement and Test Geological and Geophysical Techniques for Geothermal Exploration

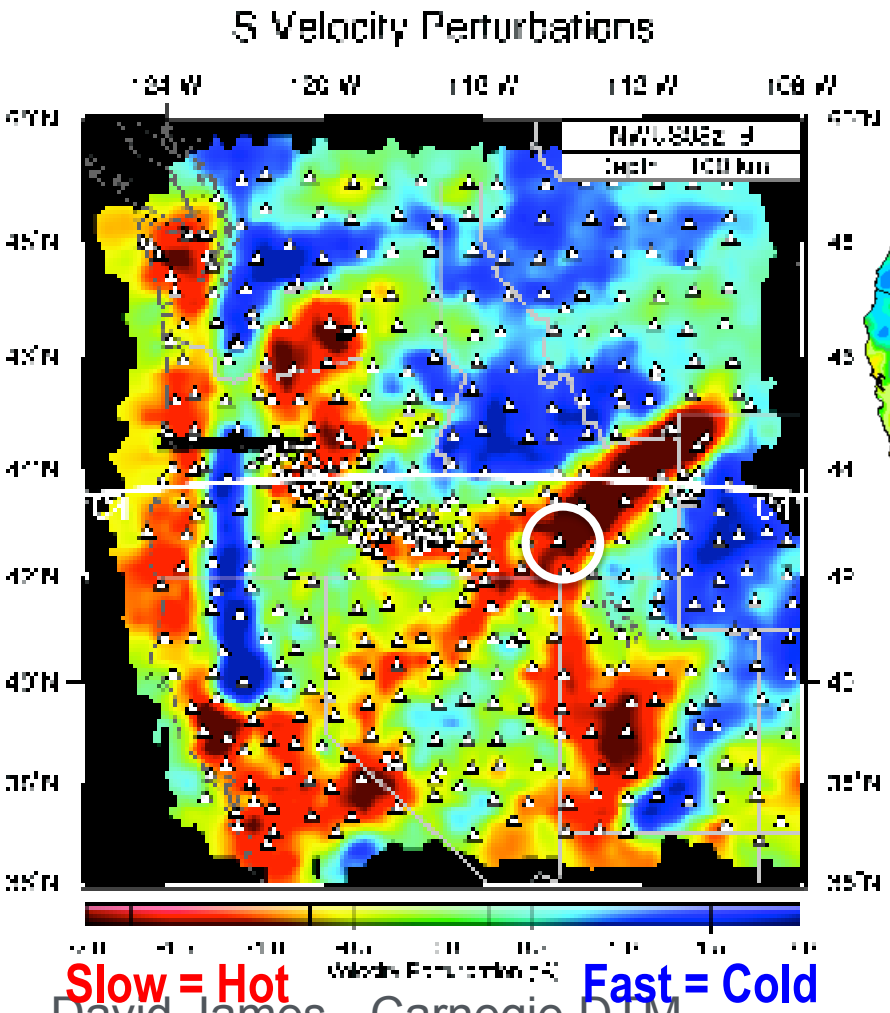
- Our project seeks to lower the cost of geothermal energy development by identifying which surface and borehole techniques are most efficient at identifying hidden resources.
- The project has just begun formally; we have built on a series of workshops and preliminary studies carried out over the last five years to implement project goals quickly.
- Innovative aspects of our project include:
  - Deep (1.2-1.8 km) slim boreholes to document thermal gradients, stratigraphy, and lithologies at depth and correlate with inferences from surface studies,
  - Use of core and bore hole viewers to document fracture porosity,
  - Use of a wide range of surface and borehole geophysical techniques on a preselected set of geothermal test wells.
  - The comparison of data from three distinct settings within the SRP region.

Relevance/Impact of Research

Objective: Address Barriers to Geothermal Exploration and Development

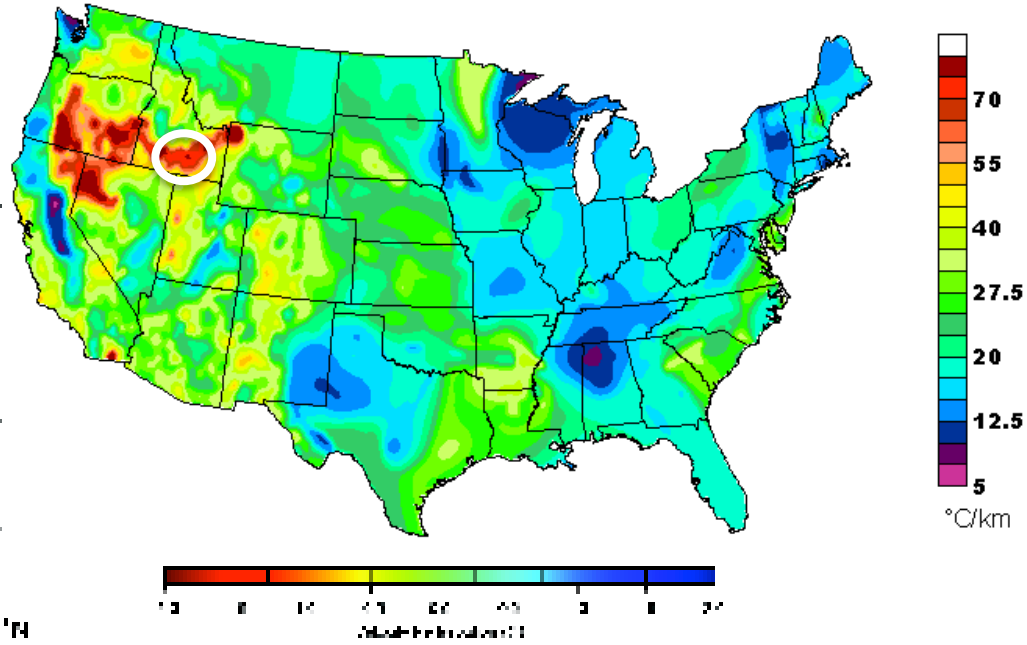
- Improve the availability of accurate and reliable resource data in southern Idaho, which has a high potential for GT development.
- Reduce Exploration Risks and Up-front Costs by validating integrated geological and geophysical techniques that increase success rates in exploration and development.
- Education Workforce Development – Educating graduate students in GT exploration, and creating new programs in GT education at the undergraduate level.
- Workforce Development: Project will involve Faculty and Students from 15 Universities and Colleges in US in all aspects of research.

Science Overview



David James - Carnegie DTM, Earthscope National Meeting, Boise, 2009

RED = HOT

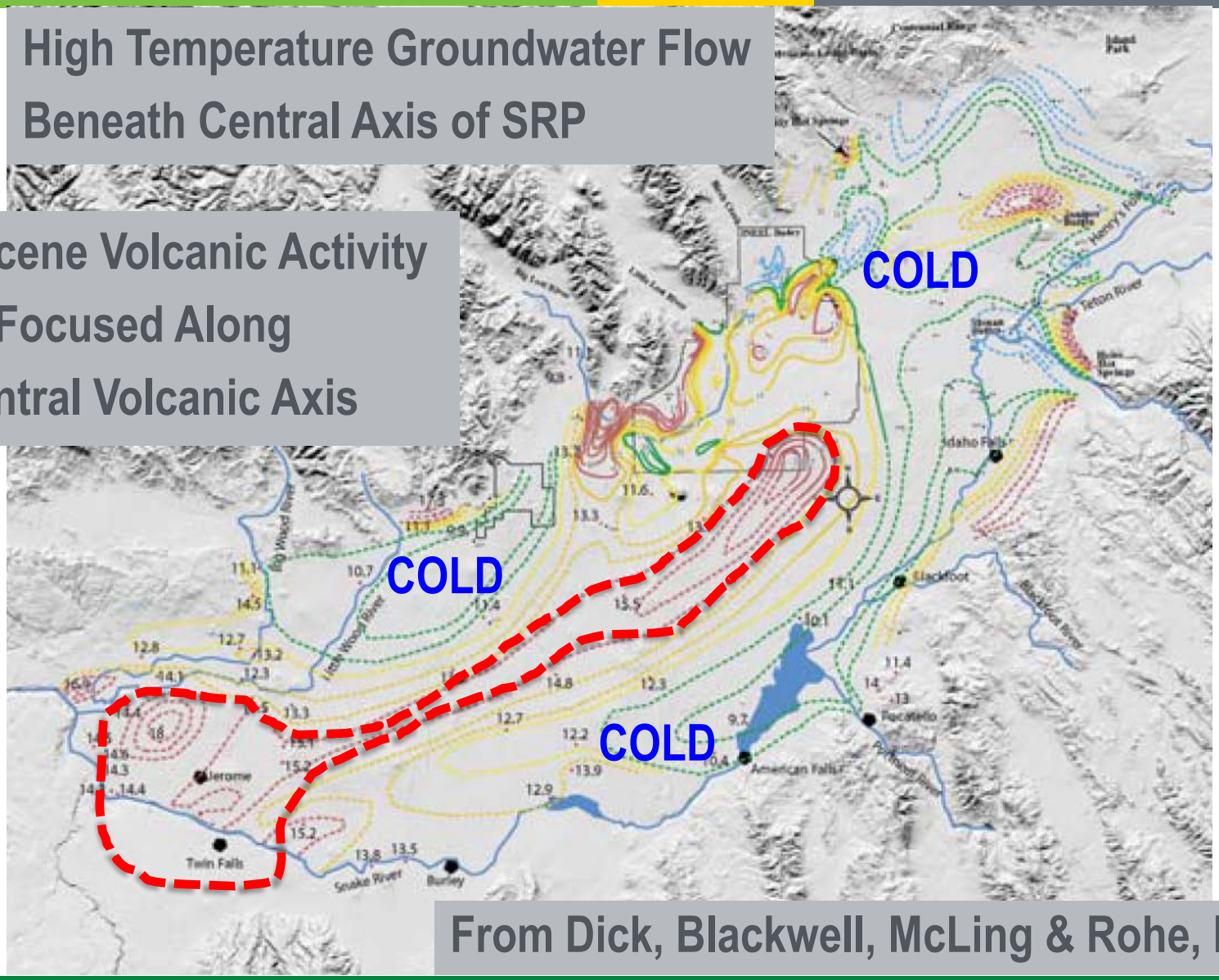


Geothermal Gradient Map of USA:
David Blackwell,
SMU Geothermal Lab

Science Overview

High Temperature Groundwater Flow Beneath Central Axis of SRP

Pleistocene Volcanic Activity Focused Along Central Volcanic Axis



From Dick, Blackwell, McLing & Rohe, In Press

Scientific/Technical Approach

- Planned research will compare gravity, magnetics, surface seismic, resistivity, borehole vertical seismic profiles, and borehole logging techniques, as well as surface mapping, data compilations, and remote sensing.
- Results will include three slim hole test wells (1.2-1.8 km) with temperature gradient and hydrologic conductivity measurements, vertical seismic profiles, and borehole geophysical logs to document the geothermal potential of each setting.
- Hydraulic testing and fracture analysis used to document porosity-permeability and geothermal potential of sites.
- Core from each borehole will document detailed stratigraphy of each site.

Scientific/Technical Approach

- Detailed Gravity & Magnetics: US Geological Survey
- Geothermal Gradient/Heatflow: SMU GT Lab (Blackwell)
- 2D seismic surveys: Boise State Shallow Geophysics Institute and Univ Alberta Centre for Earth Physics.
- Long sweep times using both p-wave and s-wave methods (sources and receivers), and also mode-conversions and anisotropy.
- We will rely on borehole geophysics to ground-truth our surface results and forward model using observed velocity and density measurements.
- We will estimate flow parameters (fracture porosity, transmissivity) using fracture modeling software (FRED™, FRACMAN™, & MAFIC™). [Utah State Univ]

Technical accomplishments – Progress & Plans

- Data compilations and mapping in progress, lease agreements being negotiated, permits applied for.
- Planned activities to begin as soon as funds released
  - Gravity, magnetic surveys (USGS)
  - Seismic reflection surveys (Boise State, Univ Alberta)
  - Drilling at first site begins in July
  - Wireline logs, Temperature logs, and VSP as wells completed (BHT monitored while drilling).
- Team qualifications, special facilities or equipment.
  - DOSECC >30 years experience geothermal/scientific drilling
  - Atlas-Copco 4002 drill rig purchased with this project in mind

Scientific/Technical Approach

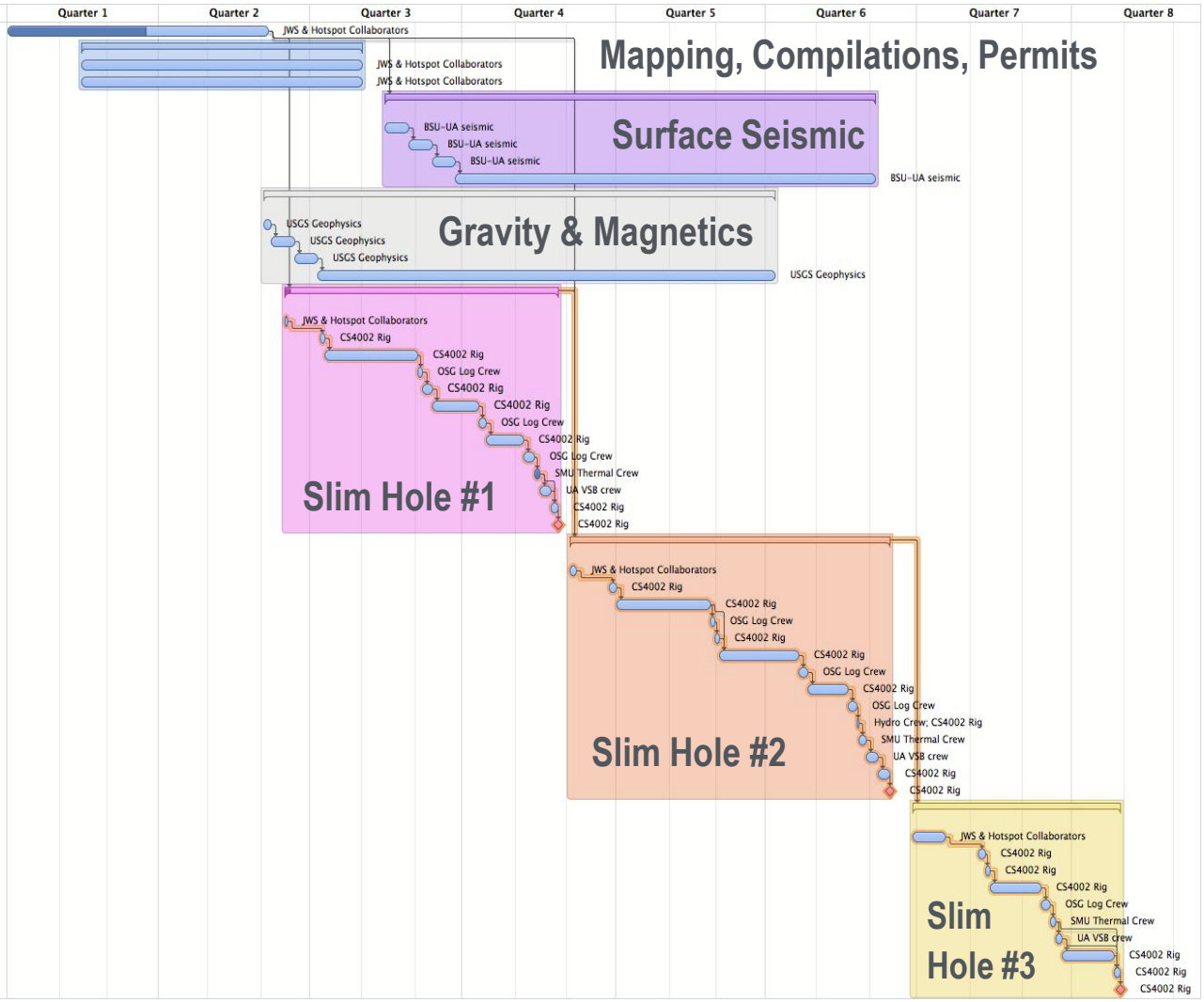
Project Management/Coordination

- Project Management Plans:
  - Project Managed by Project Director (Shervais) with executive committee of co-investigators. PI has worked on DOE-funded studies of core at SRS and has 10 years management experience.
  - USU Contract Office provides budget and accounting help.
  - Project management software used to manage time lines and task coordination.
- Data Management
  - Complete data management system implemented, with primary data entered through ICDP Drilling Information System.
  - Corewall and Psicat used to annotate core and correlate with digitized wireline log data.
  - All systems will be interfaced with the National Geothermal Data System, in cooperation with Walt Snyder at Boise State.
  - All data uploaded to project website using data base functions.

Project Management/Coordination

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

Task	Effort
1) Permitting and MOU's	112d
2) Phase 1 Data Compilation and Mapping	240d
2.1) Task 2.1 Data compilation – wells and geology	120d
2.2) Task 2.2 Surface geology mapping	120d
3) Shallow Seismic surveys – BSU	210d
Lee Liberty Boise State and Doug Schmitt U Alberta. Thumper truck, drop weight, 120...	
3.1) Kimama traverse	10d
3.2) Kimberly traverse	10d
3.3) Mtn Home traverse	10d
3.4) Shallow Seismic data analysis	180d
4) Gravity-Magnetic surveys – USGS	219d
Mobilize crew from USGS to Idaho, 3 weeks data collection	
4.1) Mobilize crew from USGS to Idaho	3d
4.2) Kimama survey – data collection	10d
4.3) Kimberly survey – data collection	10d
4.4) USGS Data analysis	196d
5) Kimama well #1	103d
Well Location Kimama Junction, 1 mile west of BLM Guard station	
5.1) Kimama Permitting	1d
5.2) Kimama Mobilization	2d
5.3) Kimama Drilling Phase 1 PQ 800 m depth	40d
5.4) Kimama Logging Phase 1 0-800 m	2d
5.5) Set casing & BOP	4d
5.6) Kimama Drilling Phase 2 HQ 800-1200 m depth	20d
5.7) Kimama Logging Phase 2 800-1200 m	3d
5.8) Kimama Drilling Phase 3 NQ 1200-1500 m depth	16d
5.9) Kimama Logging Phase 3 Plus hydro testing	5d
5.10) Kimama Thermal logging SMU	2d
5.11) Kimama Vertical Seismic Profile – UAlberta	5d
5.12) Kimama Completion & De-mob	3d
5.13) Kimama well completed	
6) Kimberly well	124d
Univ Idaho Extension Farm, under Dean Agriculture UI. Dennis Geist oru contact.	
6.1) Kimberly Permitting	3d
6.2) Kimberly Mobilization	3d
6.3) Kimberly Drilling – Phase 1 PQ 800 m depth	40d
6.4) Kimberly Logging Phase 1 to 800 m	2d
6.5) Set casing and BOP	2d
6.6) Kimberly Drilling – Phase 2 HQ 1200 m depth	34d
6.7) Kimberly Logging OSG Phase 2 – 800 to 1200 m	4d
6.8) Kimberly Drilling – Phase 3 NQ 1600 m depth	17d
6.9) Kimberly Logging OSG Phase 3 – 1200 to 1600 m	4d
6.10) Kimberly Pressure test, aquifer sampling	2d
6.11) Kimberly Thermal Logging – SMU	3d
6.12) Kimama Vertical Seismic Profile – U Alberta	5d
6.13) Kimberly Completion & demobilization	5d
6.14) Kimberly well completed	
7) Mtn Home well	75d
Well located on MH AFB. Coordinated with USAF geothermal well. Richard Roller and...	
7.1) MH Permitting	14d
7.2) MH Mobilization	3d
7.3) MH Drilling Phase 1 Surface casing 15 m	2d
7.4) MH Drilling Phase 2 – PQ 700 m	22d
7.5) MH Logging Phase 2 surface to 700 m	4d
7.6) MH Thermal Logging SMU	2d
7.7) Vertical Seismic Profile – U Alberta	3d
7.8) Continued Drilling – USAF to 1200 m rotary	22d
7.9) MH Completion & Demobilization	3d
7.10) Mtn Home well completed	



Future Directions

- Deployment strategy FY 2010
  - Geologic Mapping and Data Compilation: Spring-Summer 2010 *(in progress)*.
  - Geophysical surveys roll out summer-fall 2010
  - Drilling slim hole test wells begins July 2010 and continues until all three holes completed (into FY 2011).
  - Milestones:
  - ✓ Completion of Geophysical and Geologic Field Campaigns
  - ✓ Completion and Testing of Kimama GT well
  - ✓ Completion and Testing of Kimberly GT well
  - ✓ Completion and Testing of Mountain Home GT well

Mandatory Summary Slide

- The Snake River Plain represents an *Active Volcanic System* associated with the *Yellowstone Hotspot*, buts its *Geothermal Potential* is Unexplored.
- We will combine geological and geophysical studies on surface with deep slim hole test wells and a full array of downhole geophysical studies to test which approaches represent the most robust exploration techniques.
- We will model fracture porosity using computer software tools normally applied within the petroleum industry.
- This project will interface with Project Hotspot – an initiative that will complement the GT goals (NSF support pending).
- This project will have a significant impact on workforce development at graduate and undergraduate levels.

Supplemental Slides

Supplemental Slide

- Shervais, J.W., Branney, M.J., Geist, D.J., Hanan, B.B., Hughes, S.S., Prokopenko, A.A., Williams, D.F., 2006, HOTSPOT: The Snake River Scientific Drilling Project – Tracking the Yellowstone Hotspot Through Space and Time. *Scientific Drilling*, DOI:10.2204/iodp.sd.3.14.2006.

- Walton, A.W., Miller, K.G., Koeberl, C., Shervais, J., Colman, S., Hickman, S., and Clyde, W., 2009, The Future of Continental Scientific Drilling: US Perspective: DOSECC Workshop Report 1, http://www.dosecc.org/Future_of_CSD_Final_Report.pdf

PI Shervais was co-convener of workshop *"The Future of Continental Scientific Drilling: US Perspective"* held in Denver, Co, in June 2009.

PI Shervais is co-convener of upcoming workshop *"Developing the US Initiative in Continental Scientific Drilling"* to be held in Arlington, Va, in June 2010.