Geoscience Investment Area Portfolio

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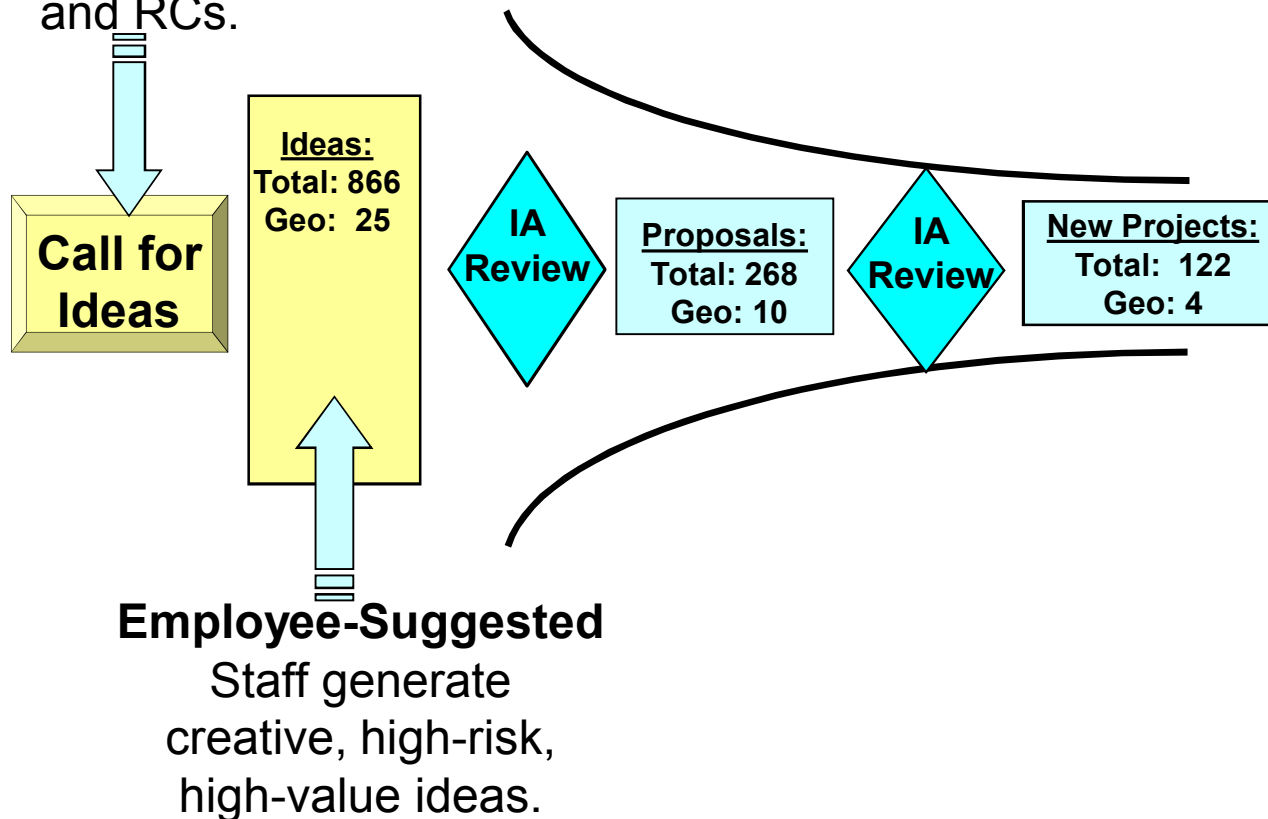### October 3, 2016

LDRD – National Mandate

- Authorized in 1992

- Maintain the scientific and technical vitality of the laboratories;

- Enhance the laboratories' ability to address future DOE/NNSA missions (national security);

- Foster creativity and stimulate exploration of forefront science and technology;

- Serve as a proving ground for new concepts in research and development; and

- Support high-risk, potentially high-value research and development = **<u>BOLD OUTCOMES</u>**

- Is Sandia's sole source of discretionary R&D funding

Corporate (General) Process

Investment Area Calls incorporate strategic guidance, e.g., MAs and RCs.

FY16 data

Call for Ideas

Ideas:
Total: 866
Geo: 25

IA Review

Proposals:
Total: 268
Geo: 10

IA Review

New Projects:
Total: 122
Geo: 4

Employee-Suggested Staff generate creative, high-risk, high-value ideas.

The IA teams review and select ideas and proposals that will best achieve strategic intent.

Major Geoscience Technical Themes

Integrate geosciences and engineering to provide Earth System-related national security solutions

Characterize geomaterials at in-situ conditions

Develop sensors and systems to interrogate the subsurface and atmosphere

Predict Earth system behavior over orders of magnitudes in space and time

geosphere

biogeosphere

atmosphere

cryosphere

hydrosphere
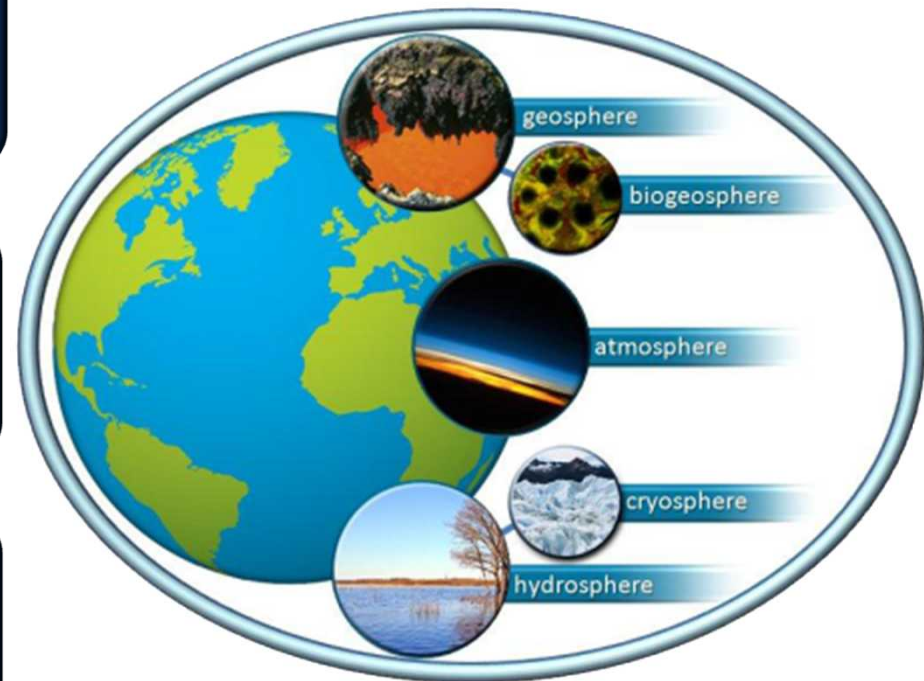
History of Geoscience LDRD Project Portfolio

	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Anthropogenic Greenhouse Gas Emissions at Global Scale	■	■	■						
Predicting the Future Trajectory of Arctic Sea Ice	■	■							
Aerosol Aging Processes and Relevance to Human & Environmental Hazards		■	■	■					
Methane Hydrate Formation on Clay Mineral Surfaces			■	■	■				
Determination of Aerosol Scattering Characteristics				■	■				
Appraisal of Hydraulic Fractures Using Natural Tracers				■	■				
Polyfunctional Desorption of Oil from Shales				■	■				
Detecting Seasonal Changes in Permafrost				■	■				
Predicting the Occurrence of Mixed Mode Failure				■	■				
Technology for Subsurface Imaging with Backscattered Muons				■	■	■			
Disposition and Release of Methane in a Shale Gas Reservoir				■	■	■			
Predicting Growth of Methane Emissions in the Arctic				■	■				
Self-Tuning Seismic Sensor Data Processing					■	■	■		
Detection of Soluble Ligand-Tuned Molecular Tags						■	■		
Real Time Degassing of Rock during Deformation						■	■		
Development of a Downhole Technique for Measuring Enthalpy						■	■		
Digital Rock Physics for Multi-Scale Experiments & Modeling						■	■		
Chemical-Mechanical Modeling of Subcritical-to-Critical Fracture						■	■	■	
High Fidelity Hybrid Method for In Situ Borehole Stress Determination						■	■		
Developing Fugitive Emissions Sensor Networks						■	■		
Prediction and Inference of Multi-scale Electrical Properties of Geomaterials							■	■	■
Monitoring and Repair of Damaged Cement-Geomaterial Interfaces							■	■	■
Integrated Geomechanics and Geophysics in Induced Seismicity							■	■	
Attribution of Methane Emissions in the Arctic and Continental US							■	■	■

Ended 9/30/2016 (Disposition and Release of Methane in a Shale Gas Reservoir)

FY17 New Starts

FY17 Geoscience LDRD Portfolio: Geo Specialty

Title	Mechanics	Chemistry	Physics	Atmospheric	Instruments
Self-Tuning Seismic Sensor Data Processing			✠		✠
Detection of Soluble Ligand-Tuned Molecular Tags for Subterranean Fluid Flow Monitoring Using Resonance Raman Spectroscopy		✠			
Development of a Downhole Technique for Measuring Enthalpy in Geothermal Reservoirs					✠
Digital Rock Physics for Multi-Scale Experiments and Modeling of Fractured Porous Media	✠				
Real Time Degassing of Rock during Deformation	✠				
Chemical-Mechanical Modeling of Subcritical-to-Critical Fracture in Geomaterials		✠			
High Fidelity Hybrid Method for In Situ Borehole Stress Determination	✠				
Developing Fugitive Emissions Sensor Networks: New Optimization Algorithms for Monitoring, Measurement and Verification		✠		✠	✠
Prediction and Inference of Multi-scale Electrical Properties of Geomaterials			✠		
Monitoring and Repair of Damaged Cement-Geomaterial Interfaces in High Pressure High Temperature Repository and Borehole Scenarios	✠				
Integrated Geomechanics and Geophysics in Induced Seismicity: Mechanisms and Monitoring	✠		✠		
Attribution of Methane Emissions in the Arctic and Continental US		✠		✠	

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FY17 Geoscience LDRD Portfolio: Program

Sandia National Laboratories

Title	IHNS[1]	DSA[2]	Energy & Climate				
			Fossil Energy	Repository	DOE/ Office of Science	Geothermal Technology Office	Arctic & Climate[3]
Self-Tuning Seismic Sensor Data Processing	✠		✠				✠
Detection of Soluble Ligand-Tuned Molecular Tags for Subterranean Fluid Flow Monitoring Using Resonance Raman Spectroscopy			✠			✠	
Development of a Downhole Technique for Measuring Enthalpy in Geothermal Reservoirs		✠		✠		✠	
Digital Rock Physics for Multi-Scale Experiments and Modeling of Fractured Porous Media			✠		✠		
Real Time Degassing of Rock during Deformation	✠					✠	
Chemical-Mechanical Modeling of Subcritical-to-Critical Fracture in Geomaterials			✠		✠		
High Fidelity Hybrid Method for In Situ Borehole Stress Determination	✠		✠		✠	✠	
Developing Fugitive Emissions Sensor Networks: New Optimization Algorithms for Monitoring, Measurement and Verification	✠		✠				✠
Prediction and Inference of Multi-scale Electrical Properties of Geomaterials	NEW ✠		✠			✠	
Monitoring and Repair of Damaged Cement-Geomaterial Interfaces in High Pressure High Temperature Repository and Borehole Scenarios	NEW		✠	✠		✠	
Integrated Geomechanics and Geophysics in Induced Seismicity: Mechanisms and Monitoring	NEW		✠		✠		
Attribution of Methane Emissions in the Arctic and Continental US	NEW	✠	✠				✠

1. International, Homeland and Nuclear Security
2. Defense Systems & Assessments
3. Energy & Climate Program Management Unit has four Arctic and Climate LDRDs

FY17 LDRD Selection Criteria

- Science strength **'<u>BOLD</u>'**

- Clearly identify the connection to and potential impact on SNL Mission Areas   **'<u>OUTCOMES</u>'**

- Connect to Sandia's Research Challenges and associated capabilities

- Engage cross-organizational teams

- Partner with the Geoscience Research Foundation's five strategic university partners
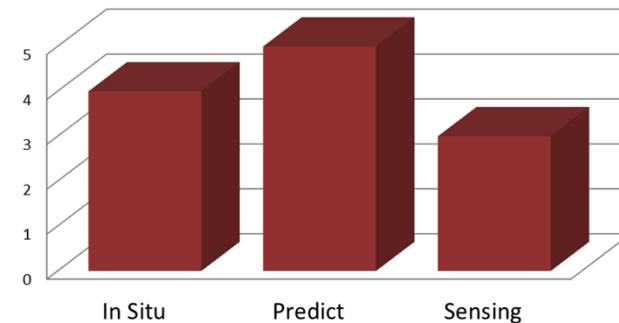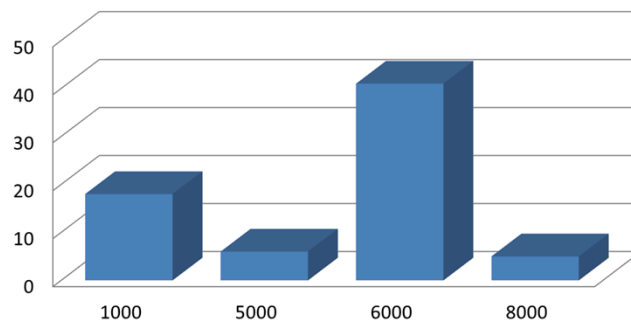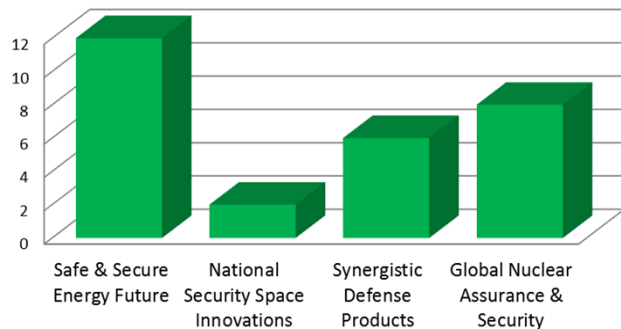
Connections

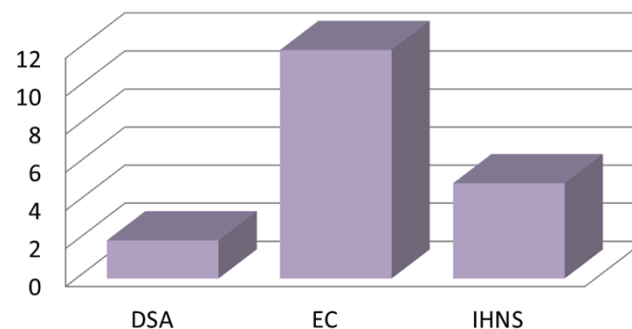FY17 - FY19 Mortgages ($K)
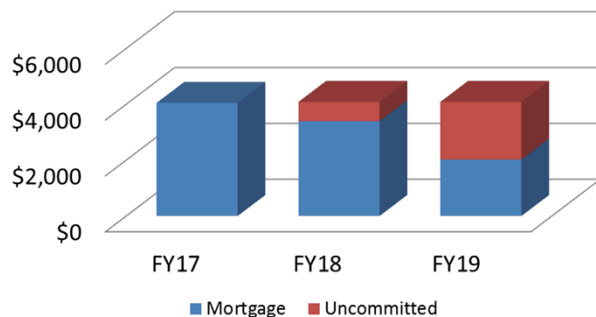
FY17 Geoscience Technical Major Themes

FY17 Anticipated Full Time Staff Charging by Division

FY17 Mission Areas (MAs)

FY17 Program Management Units (PMUs)

Quantitative Leading Indicators

- Early Career
  - FY16: 20 Early Careers; 3 junior staff (Members) and 7 Post-Docs
- Partnerships/Academic Alliances
  - FY16: Texas A&M*, Penn State*, Stanford, University of Montana, University of New Mexico, University of Wisconsin
  - FY17 (Planned): New Mexico Tech*, Purdue, Texas A&M*, Penn State*, Stanford (2 partnerships), University of Montana, University of New Mexico (2), University of Texas – Austin*, University of Wisconsin

*Geoscience Research Foundation strategic university partner

Quantitative Trailing Indicators

- Follow-on Funds

- Peer Reviewed Publications
  - FY16: 4 papers accepted; 2 submitted; 16 in prep; 1 book chapter being published

- Awards

- Intellectual Property
  - FY16: 7 TAs submitted and 1 Patent issued

- Corporate Impacts
  - Research Foundation Annual Reports

Metrics

- Improve Effectiveness of Project Manager (PM) Role
  - Clear expectations
  - Meet quarterly accountability
  - Business Plan

- Alignment with MAs, and PMUs
  - Established Internal Board
  - Engage MA and PMU leadership
    - IHNS
    - DSA
    - Nuclear Weapons

- Build Capabilities
  - Business Plan

Lessons Learned

- Successes
    - The concept of an Internal Board simplifies the management of the Research Foundation, requires significant time of the participants, and has not yet been implemented effectively
    - The FY16 new starts are significantly more diverse in terms of Divisions, Mission Areas, Program Management Units, but we still need better connection to Research Challenges

- Challenges
    - Success of the individual projects hinges strongly on the Project Manager. Improving this is a current Research Foundation priority.
    - Currently, it is difficult to get completely independent review of projects drawing only on internal SNL staff

Back Up Slide

FY16 EC Arctic & Climate LDRDs

- Next Generation Global Atmospheric Model

- A Fundamental Study on the Physicochemical Process of Soot Particle Inception

- High-Resolution Modeling and Measurements in the Arctic

- Integration of Climate and Wave Models to Evaluate Arctic Erosion Caused by Melting Sea Ice