

LUNA



# Installation Case Study

## Mount Rushmore Rock Block Monitoring System (RBMS)

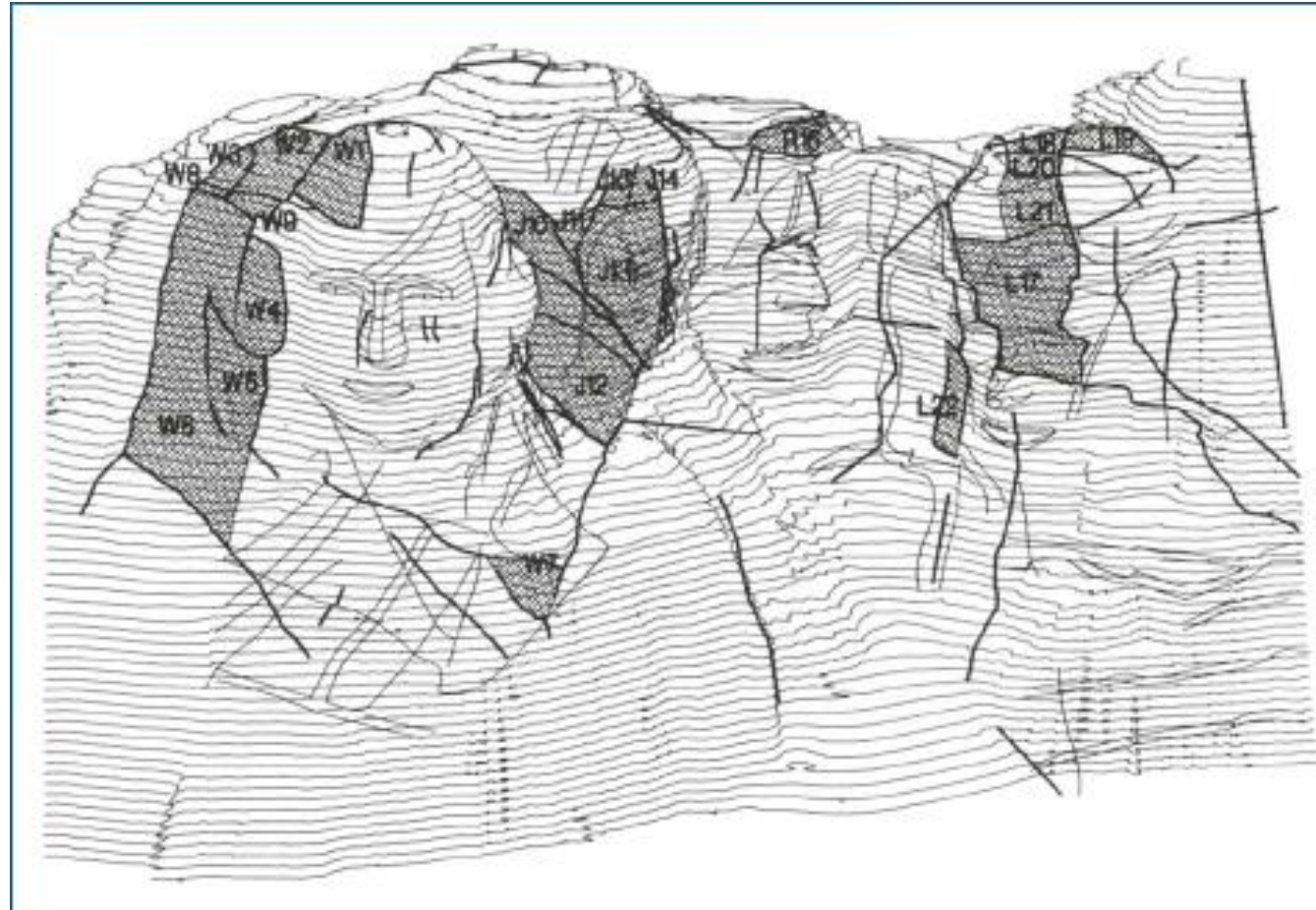
Keystone, South Dakota, USA

# Mount Rushmore, Fiber Optic Strain Gage Install

Aim	Improve data quality and reliability and reduce maintenance cost by replace aging Rock Block Monitoring System (RBMS)
Location	Mount Rushmore National Memorial, South Dakota. Four locations on the monument, two on Washington, one on Roosevelt, and one on Lincoln.
System Integrator	Respec Consulting and Services
End Customer	US National Park Service
Date	September 8-10, 2010
Instrumentation	1 sm125, Luna Optical Sensing Interrogator
Sensors	<ul style="list-style-type: none"><li>• 24 os3110 Optical Strain Gage, Spot Weld</li><li>• 12 os4310 Non-metallic Temperature Sensor</li></ul>
Software	ENLIGHT Sensing Analysis Software
FBG Technology Benefit	Eliminated hundreds of pounds of copper wiring from the monument. Replaced lightning damage prone electrical based sensor system.

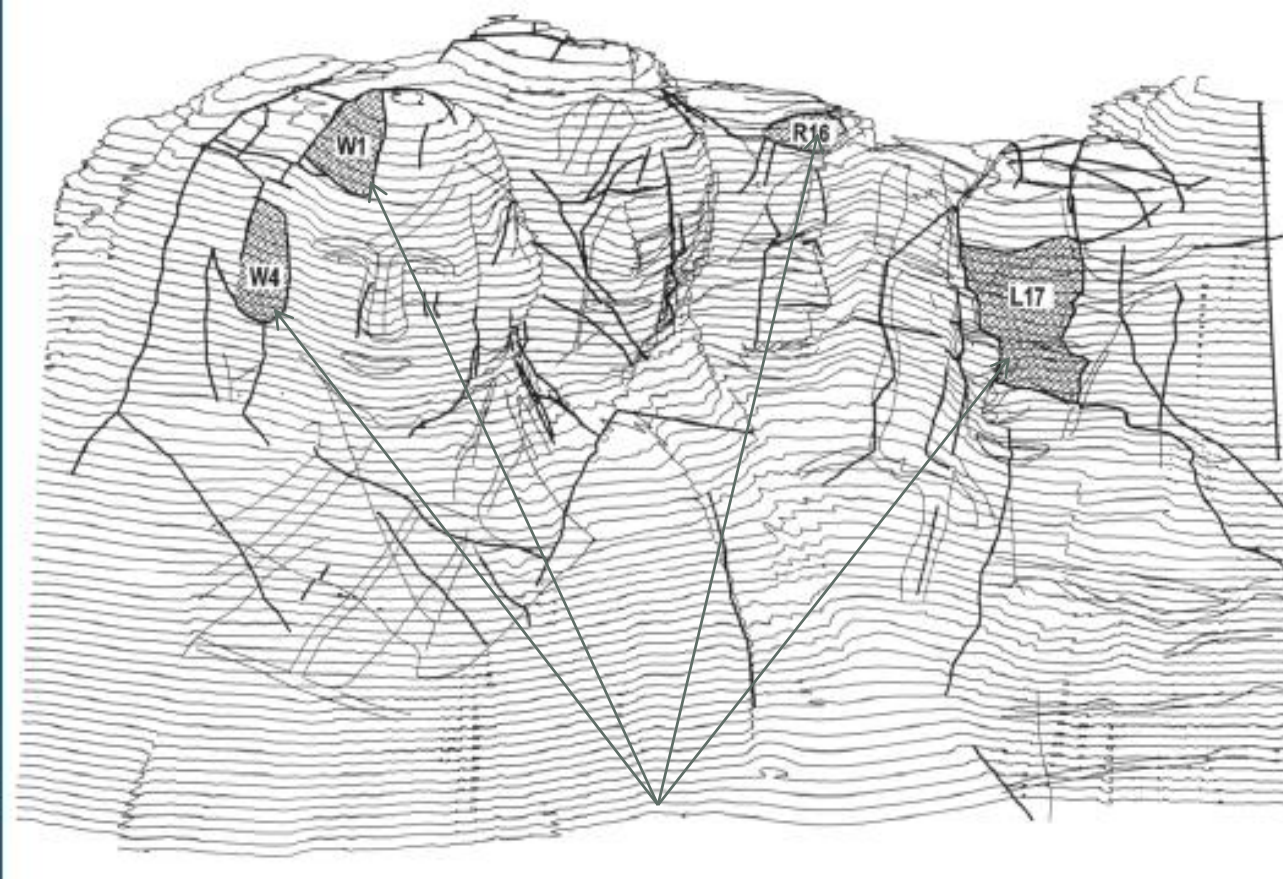
# Mount Rushmore, Rock Block Definition

- A rock block is defined by one or more fractures combining to form a continuous trace
- 22 Rock blocks identified



# Mount Rushmore, Four Monitored Rock Blocks

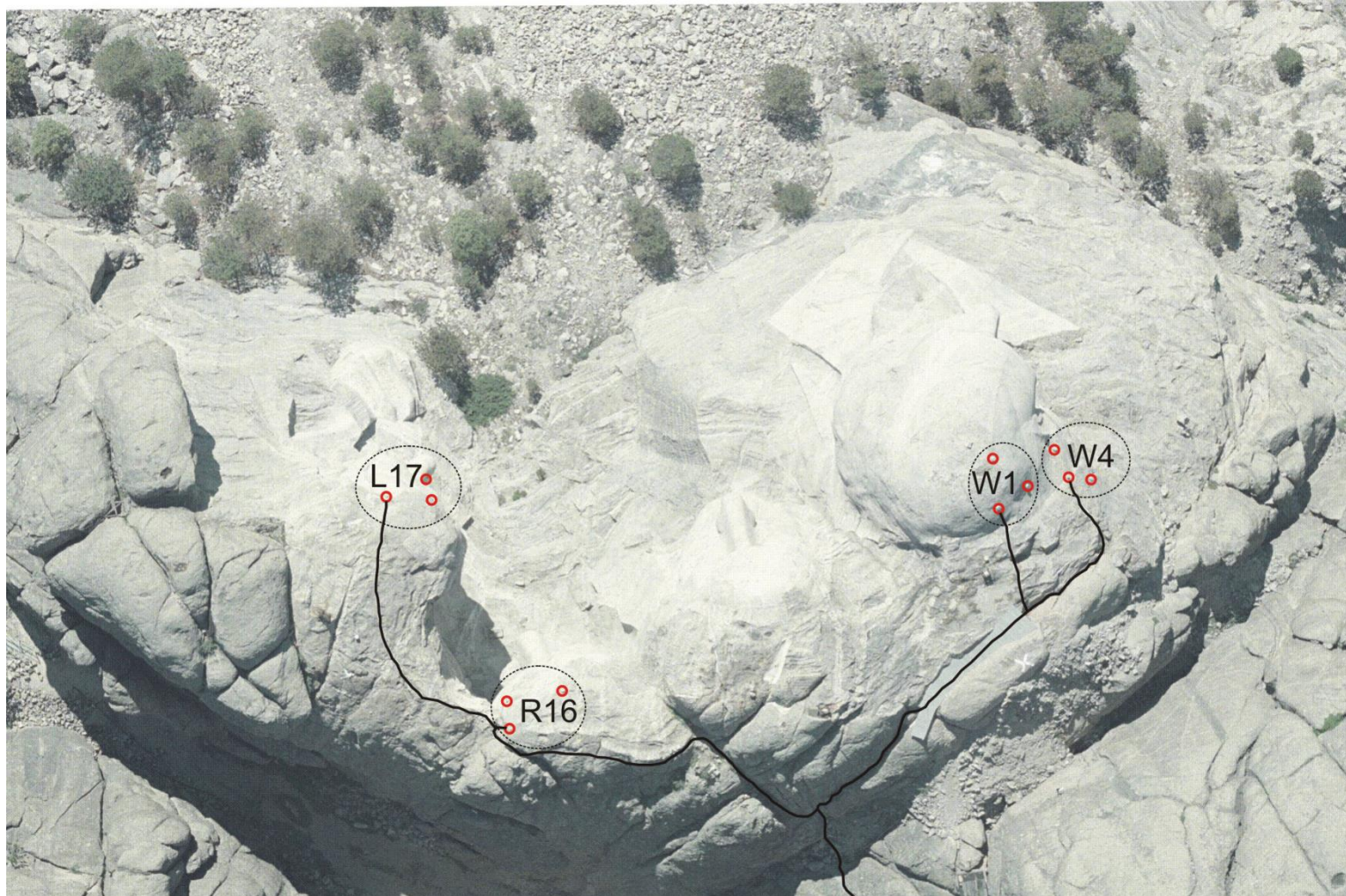
- Block R16  
Forehead of Roosevelt
- Block L17  
Face of Lincoln
- Block W4  
South of Washington
- Block W1  
Top of Washington



**Four Monitored Locations**



# Mount Rushmore, Monitored Rock Blocks (cont.)



Top view of monitoring locations

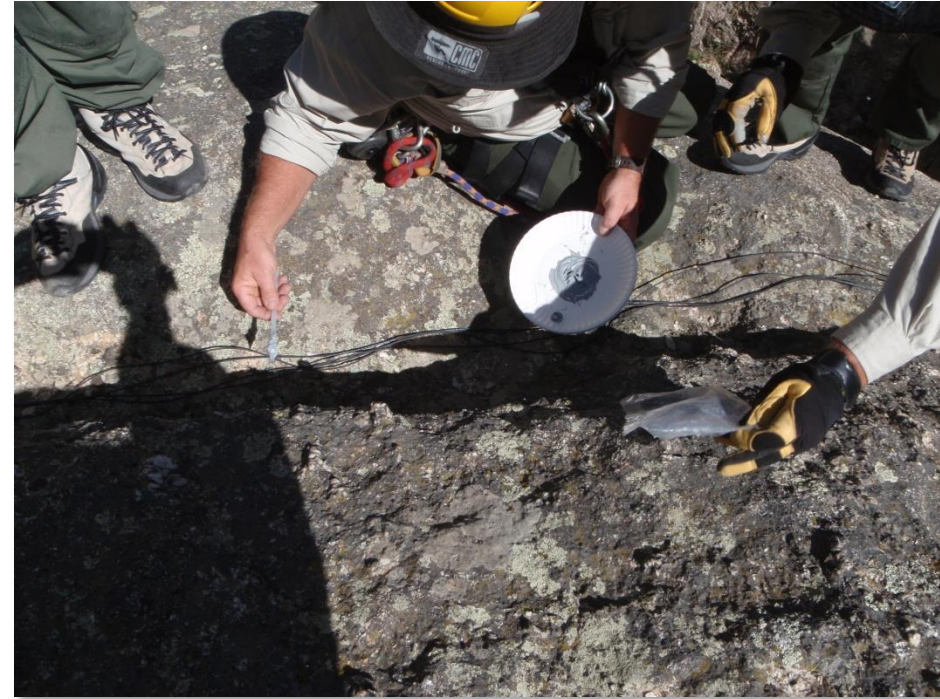


# Mount Rushmore, Fiber Optic Strain Gage Install

---



Installation of cables to each of the four monitoring locations.



Securing the tie down clips to the rock with epoxy for securing the cables.



# Mount Rushmore, Fiber Optic Strain Gage Install



Previous monitoring system using LVDT's

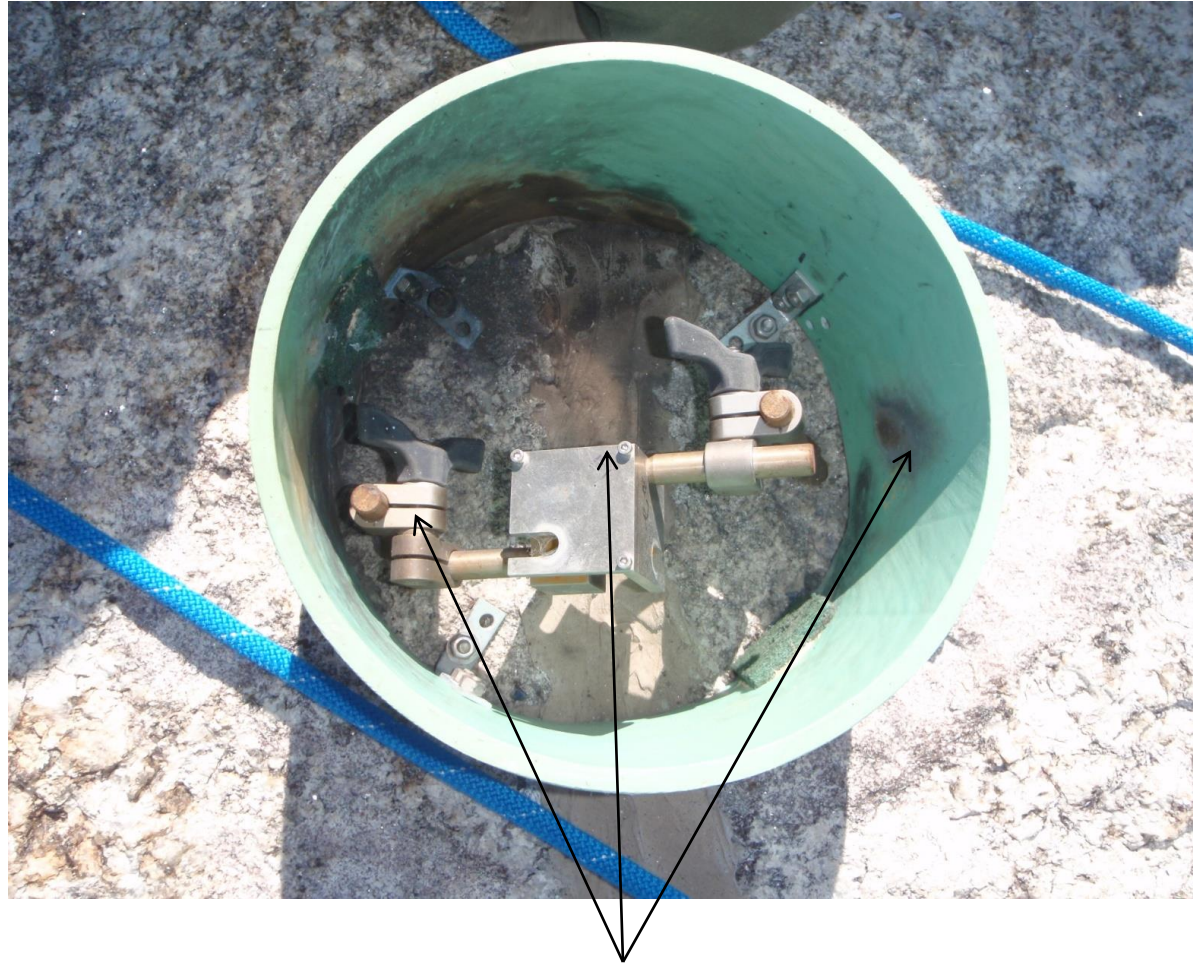
New monitoring system using os3110 fiber optic strain gages mounted on either side of the small cantilever beam. Temperature compensation is realized thru an active dummy gage configuration.



os3110 Weldable Strain Gage

# Mount Rushmore, Fiber Optic Strain Gage Install

---



Location previously abandoned due to lightning strikes. Notice areas of charring or discoloration.



# Mount Rushmore, Fiber Optic Strain Gage Install

---



National Park Service Rope Access Team roped off and performing installations.



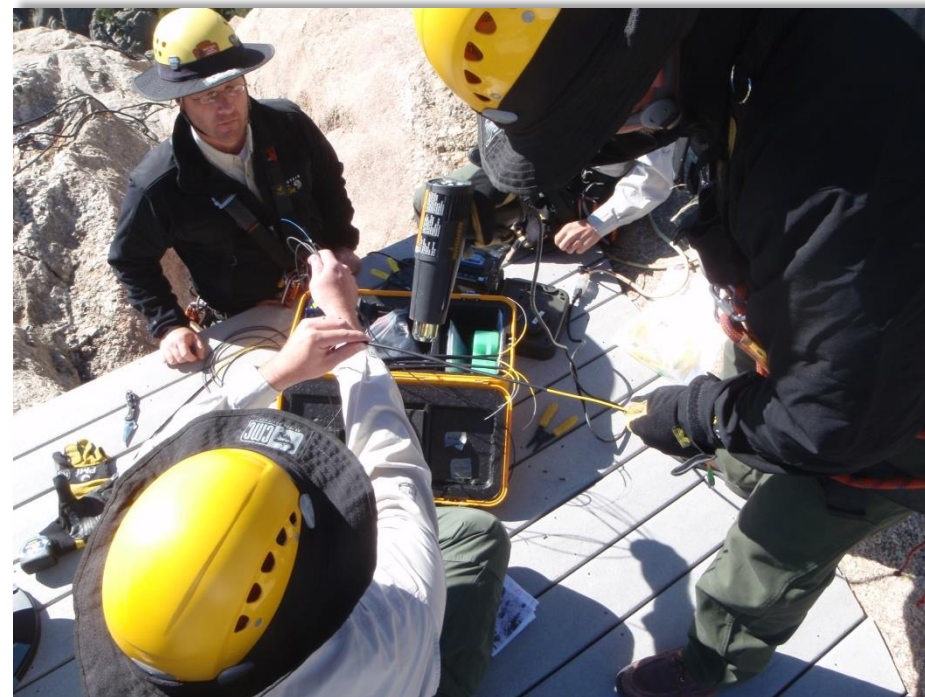


# Mount Rushmore, Fiber Optic Strain Gage Install

---



Rope Access Team performing splicing operations on top of Mount Rushmore





# Results and Acknowledgements

---

## ■ Results

- The installation process was a success. Gage attachment, cable layout, and fiber optic splicing all went smoothly. Simplifying these installation process is especially valuable performed while roped off and hanging in place in front of the monitoring stations.
- It is anticipated that frequent sensor replacement and repair trips will no longer be necessary, and . The system was designed such that additional gages and cable can be added with minimal intervention.
- Absolute temperature measurements will be made at each of the locations with an os4310. temperature gage, for strain, is realized thru the active dummy gage configuration on a cantilever beam.
- A previously monitored station, abandoned due to lightning, has been reactivated with the fiber optic sensing system. Hundreds of pounds of copper cable was replaced with five pounds of rugged fiber optic cables. This eliminated the need for cumbersome and unattractive cable harnesses that previously were in the public view of the monument.

## ■ Acknowledgements

- National Park Service (end customer)
  - Duane Bubac, email: [duane\\_bubac@nps.gov](mailto:duane_bubac@nps.gov), Don Hart, email: [Don\\_Hart@nps.gov](mailto:Don_Hart@nps.gov), Allan Sage, email: [allan\\_sage@nps.gov](mailto:allan_sage@nps.gov), Aileen Crawford, email: [aileen\\_crawford@nps.gov](mailto:aileen_crawford@nps.gov)
- Respec
  - Tel: (605)394-6400, Rich Barry email: [rich.barry@crazyhorse.org](mailto:rich.barry@crazyhorse.org), Cody Vining email: [cody.vining@respec.com](mailto:cody.vining@respec.com), Vicki Franzen email: [vicki.franzen@respec.com](mailto:vicki.franzen@respec.com)
- Luna Innovations, Inc
  - Tel: 404-325-0005, [lunainc.com](http://lunainc.com)