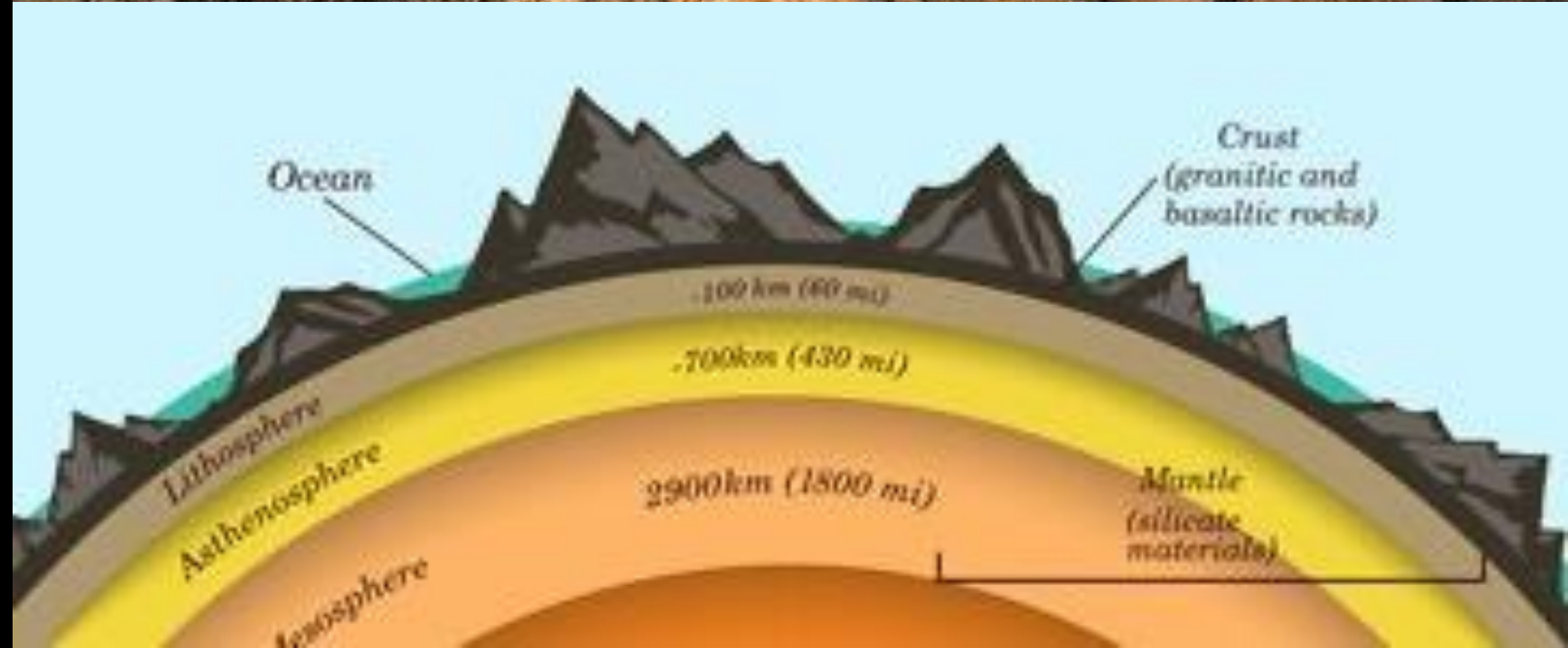


# Role of Fractures in Utilizing Earth Resources



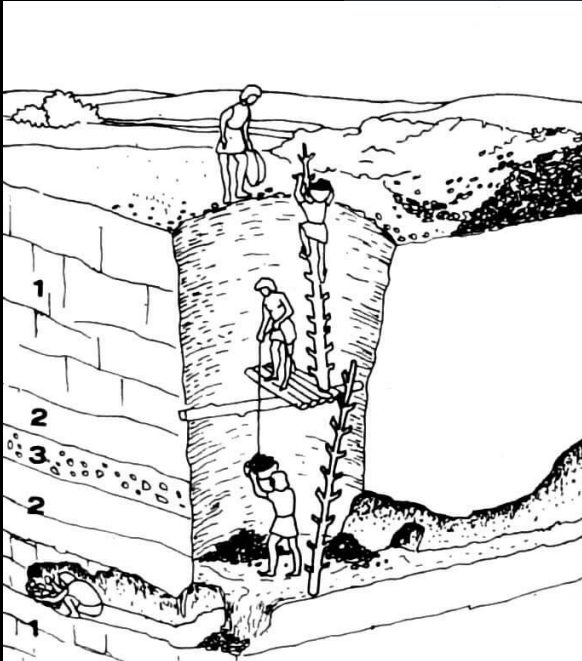
Laura J. Pyrak-Nolte  
Department of Physics &  
Astronomy



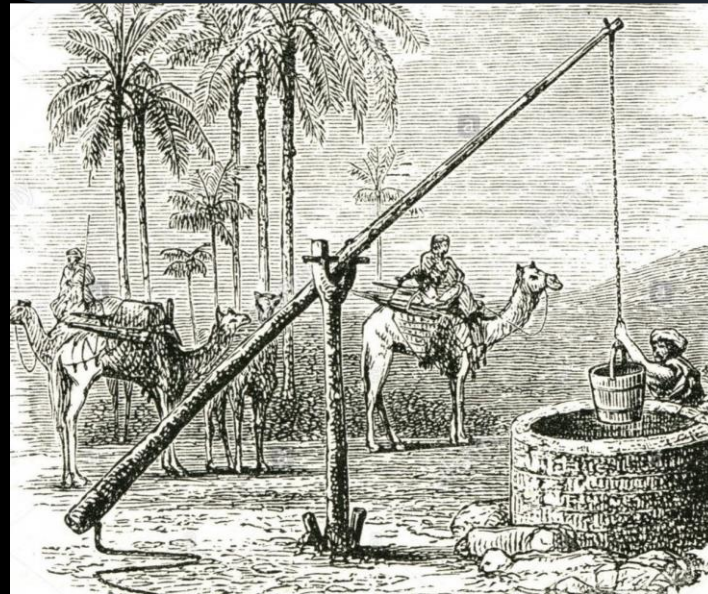


# Earth Resources over Time

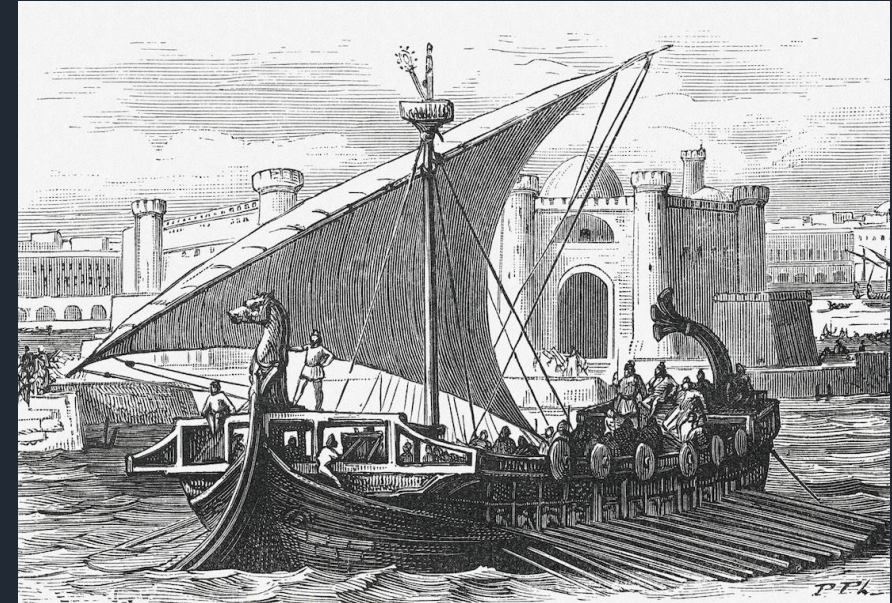
Mineral Extraction  
since 43000 BC



Water wells since 8400 BC



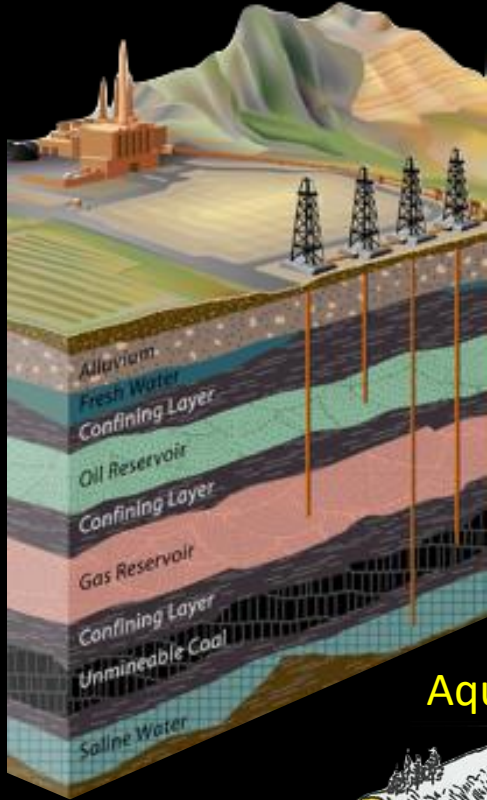
Hydrocarbons since  
4000 BC



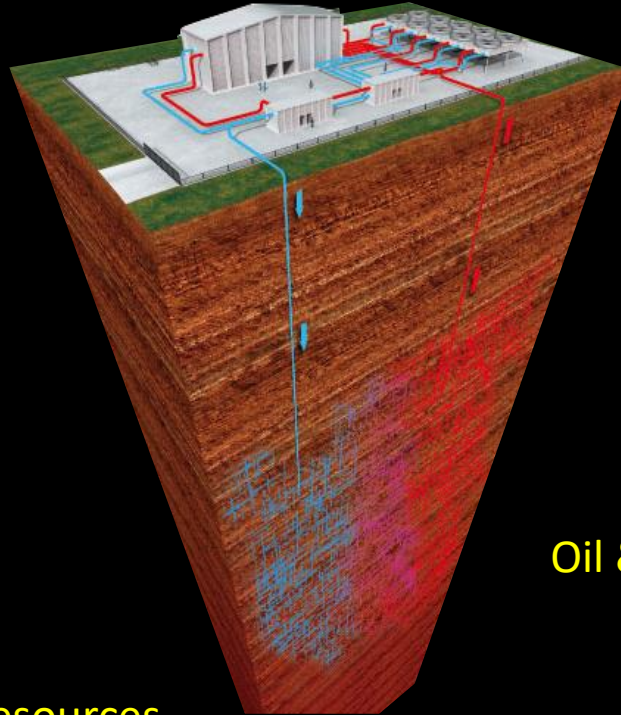


# Desire: Adaptive Control of Subsurface Fractures & Fluid Flow

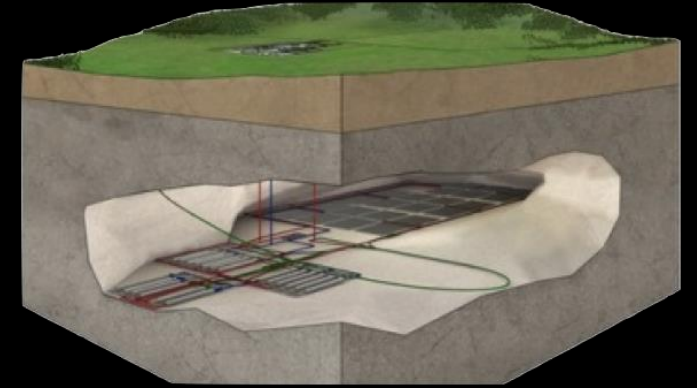
CO<sub>2</sub> Sequestration and Hydrogen Storage



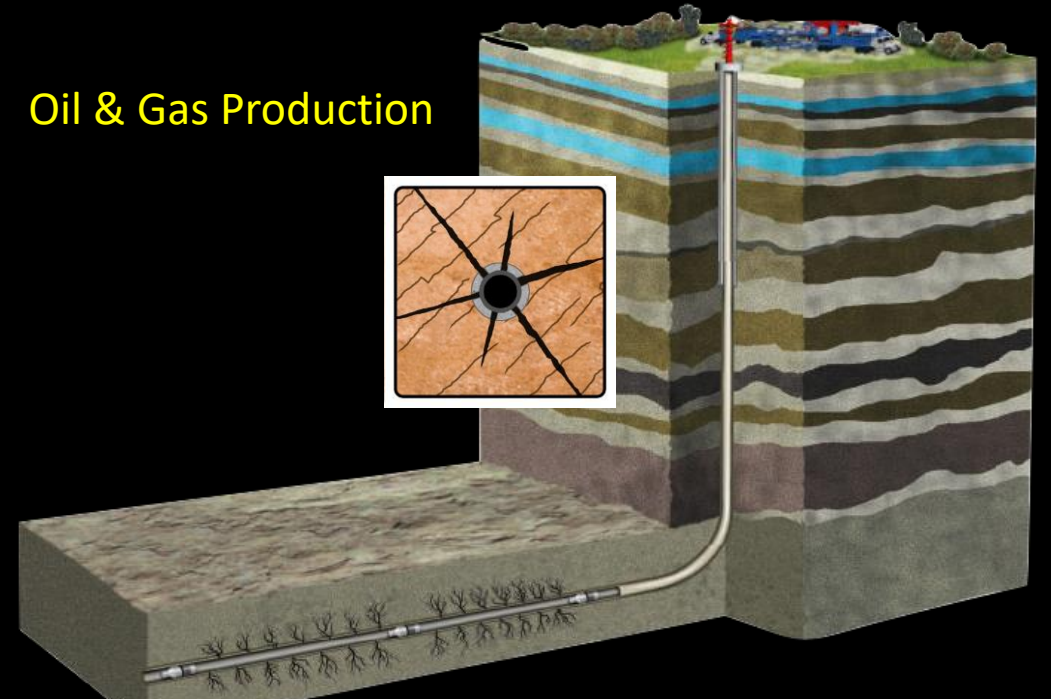
Geothermal Energy



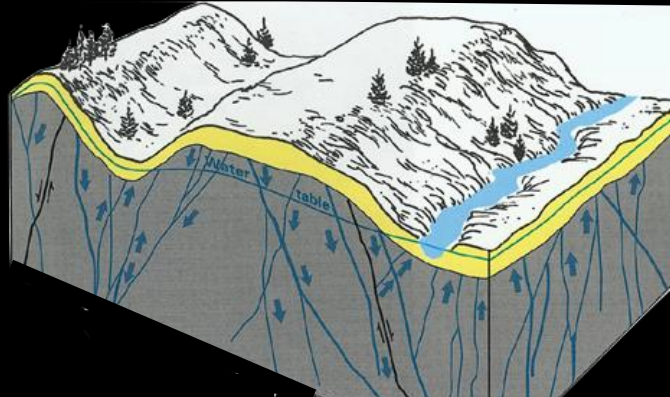
Waste Isolation



Oil & Gas Production

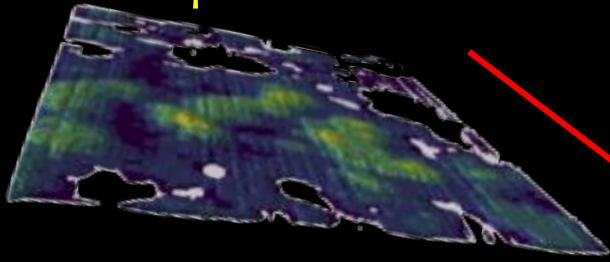


Aquifers & Water Resources

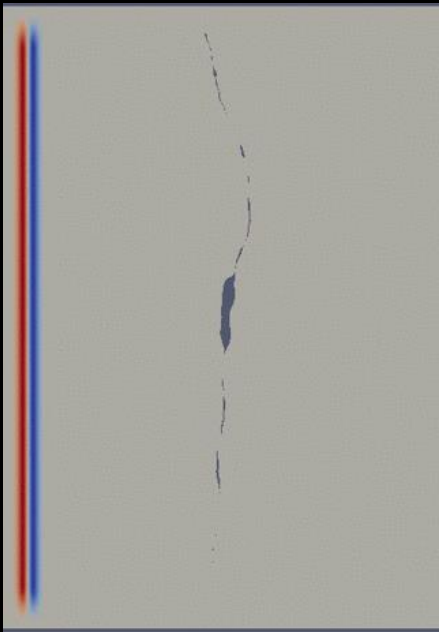


# Fundamental Research into Fractures

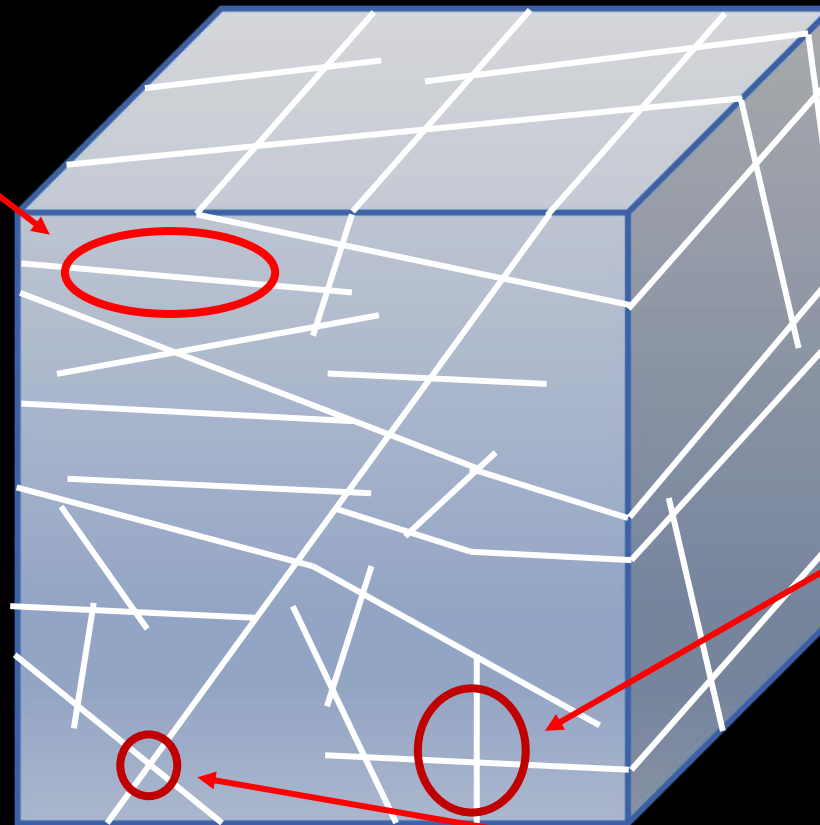
Single Fracture Representation



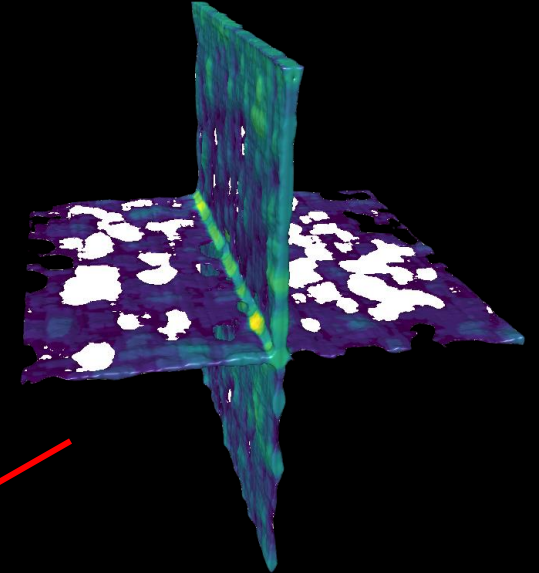
Wave Interaction with Fractures



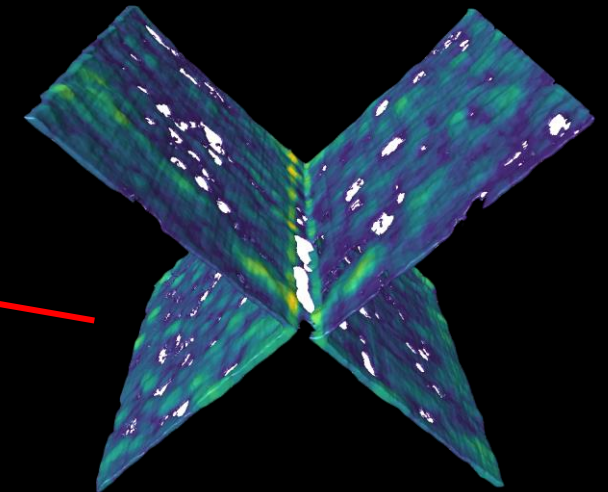
Fracture Network



Fracture Intersections



Impact of Orientation



White: Contact Area  
Blue-Green-Yellow-Red: Increasing Aperture



# Utah FORGE

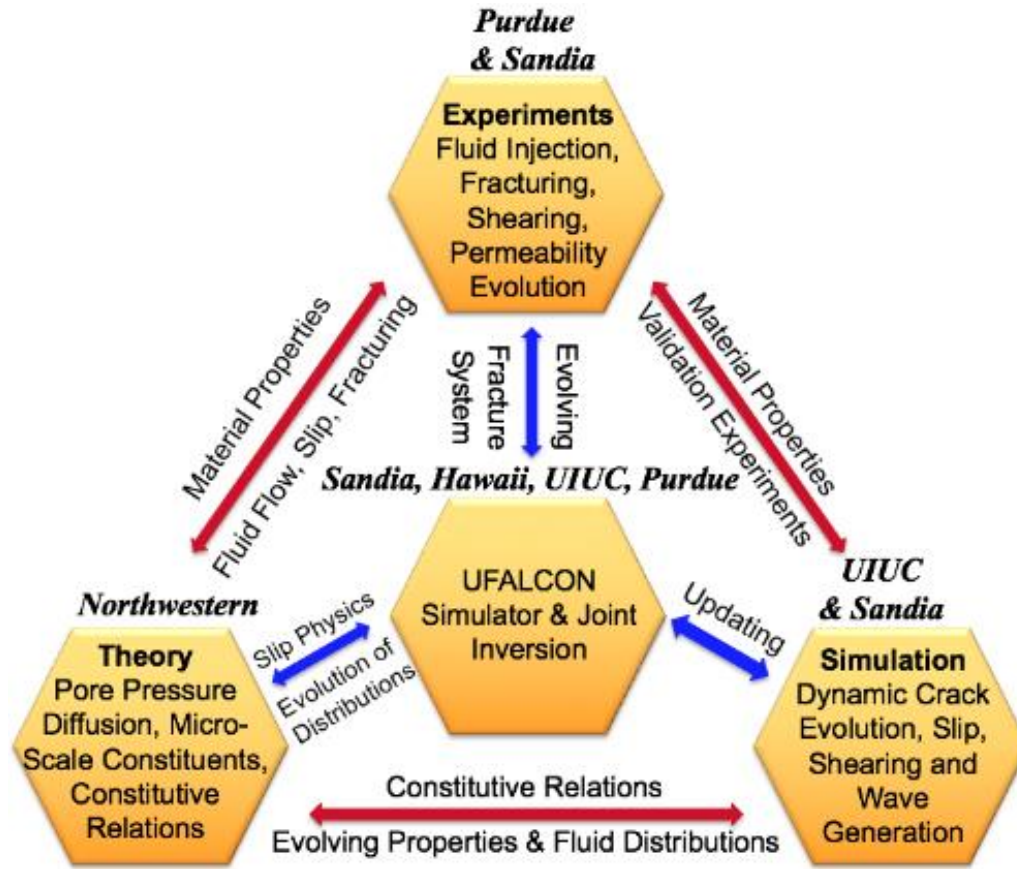
Frontier Observatory for Research in Geothermal Energy



U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

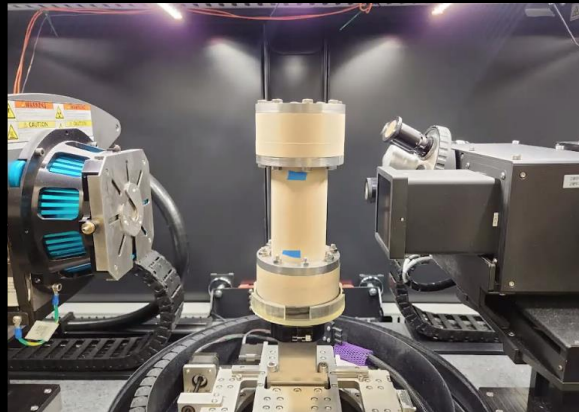
GEOTHERMAL TECHNOLOGIES OFFICE



Northwestern University



UNIVERSITY of HAWAII  
MĀNOA



Sierra White Granite





### Sanford Underground Research Facility (SURF)

