OUR PLANET’S SUBSURFACE IS A COMPLEX, INTERACTING SYSTEM OF solids, liquids, and gases, as well as the interfaces between each of these phases. Stanford Earth faculty and students apply engineering physics, with its strong grounding in classical physics, chemistry, and mathematics, to study this system from the twin perspectives of theory and practice.

How do fluids and gases behave as they move through what appears to be solid rock—through pores barely wider than the size of the gas molecule? How do the rocks respond? In the laboratory, we conduct experiments to unravel complex physical processes that span multiple scales of time, distance, and phase. We then use this data to design and scale simulations that accurately predict outcomes in real-world applications across the energy enterprise.

Professor Tony Kovscek, for example, uses x-ray microscopy to obtain real-time images of fluids such as oil, water, and gas as they flow through nanoscale pore structures in laboratory core samples. These experimental observations are combined with field measurements and theory to synthesize models to inform efficient resource recovery as well the geological sequestration of greenhouse gases.

Professor Kate Maher uses a geochemical approach to study how carbon dioxide reacts when it comes in contact with mineral surfaces underground, including processes that result in conversion of the greenhouse gas into relatively inert forms, such as carbonate minerals.

Professor Mark Zoback is a geophysicist and an expert on the mechanical behavior of rocks from the pore scale to that of tectonic plates. His research group uses laboratory experiments and field data to optimize recovery from shale gas and tight oil reservoirs and geothermal systems and to reduce the hazards associated with earthquakes induced by energy-related activities.