Research Development Fund – Fall 2022 Application

Application Title: Enhancing deformation testing capabilities on geomaterials at a range of unprecedented pressure and temperature conditions

Lead contact for RDF Application:

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Key Participating Units: Center for Tectonophysics; College of Arts and Sciences (Department of Geology & Geophysics, GEPL); College of Engineering (Department of Civil & Environmental Engineering, CVEN)

RDF Amount Requested ($): **$1,289,387.71**

Executive Summary

A better understanding of the deformation of geomaterials (e.g., rocks, soils, etc.) is crucial for addressing societal issues, including natural geological hazards (e.g., earthquakes, tsunamis, volcanic eruptions, and landslides), energy production, water resource management, waste isolation, global warming (e.g., permafrost degradation and gas hydrates dissociation), and space exploration. A recent improvement in geophysical monitoring networks by seismometers and global navigation satellite systems at the Earth's surface has discovered much smaller deformation events, which are non-destructive and undetectable by humans. Yet, the mechanics of these new types of subsurface deformation phenomena and their relationship with regular sometimes devastating earthquakes are not fully understood. The energy demand growth to satisfy the increasing societal and industrial needs has led one to extract fossil fuels from deeper depths and to investigate alternative sources of renewable energy, such as enhanced geothermal systems (EGS). These technologies involve rocks and soils at very high temperature and pressure conditions. Also, engineering solutions for the safe geological storage of the energy sector byproducts (e.g., CO_2 and high-level nuclear waste) require a good understanding of soils and rock at high-pressure, high-temperature conditions.

To address such critical scientific and engineering problems, it is crucial to investigate the deformation of geomaterials at unprecedented pressure and temperature conditions. Laboratory deformation experiments are potent tools that can reproduce subsurface conditions such as pressure and temperature at which geomaterials deform. This RDF application seeks funds to enhance geomaterials deformation capabilities at a broad, and unprecedented range of pressure and temperature conditions at the John W. Handin Laboratory for rock deformation at the Center for Tectonophysics hosted at the Department of Geology & Geophysics (GEPL) and the geotechnical engineering research laboratory hosted at the Department of Civil & Environmental Engineering (CVEN). The plan includes (1) acquiring a new high-pressure, high-temperature triaxial deformation system (up to 200 MPa and 200°C) with in-situ physical properties measurements, (2) acquiring a new medium-pressure, low-temperature triaxial deformation system (up to 70 MPa and –15 to 150 °C), (3) upgrading the low-pressure, low-temperature triaxial deformation and oedometer systems, (4) installing the walk-in temperature-control chamber (–20 to 60°C) that can host a system to deform a larger sample size (i.e., tens of centimeters) than typically used in other deformation testing systems, and (5) upgrading the *high-temperature three-dimensional polyaxial loading system*. The collaborative efforts on enhancing the testing capabilities existing in two different units can strengthen the overall research enterprises on geomaterial deformation in Brazos County and help the university be globally positioned to lead cutting-edge multidisciplinary research. This RDF will also help us prepare for large-scale funding opportunities at NSF, DOE, NASA, and DOD by accelerating collaboration across and outside the campus.