1.0: Introduction to Rheology

The movement of tectonic plates is often thought of on a very large scale, but what actually happen to rocks at plate boundaries? In simple terms, **rheology** tells us how a rock will behave when a force is applied to it. Forces on rocks can come from a variety of places, such as the weight of overlying rock or the pulling apart of crust at divergent boundaries.

An understanding of rheology is crucial for understanding important concepts in geophysics, such as what happens during an earthquake, how mountains and faults are formed, and how rocks deform in the mantle. Rheology is an important concept in structural geology and can help geophysicists to make observations about what forces lead to the creation of a geologic structure, and how those forces may act over a regional scale.

Figure \(\PageIndex{1}\): Rainbow Basin Syncline in Barstow, CA (Public Domain; Wilson44691, via Wikimedia)
In physics, we learn to consider how forces are applied to particles or blocks and we are interested in the resulting displacement or velocity of the particle or block. In geophysics, we turn our attention to how a block (or a rock) deforms internally when forces are applied at its boundary. In this context, in the place of force we consider the **stress** (the force acting over an area), in the place of displacement we consider **strain** (internal deformation) and **strain-rate** (the rate at which deformation occurs).

By the end of this chapter, you should be comfortable with the various ways in which we described the stresses that act on a rock, some ways a rock can respond to those stresses, and how these stresses are related to geologic structures such as faults or shear zones. First, we will examine stress and strain in a 1-D context. Second, we will look at various types of **steady-state deformation** (elastic, viscous, and plastic), the timescales over which deformation occurs, and the effect this has on some geologic structures. Finally, we will cover how **rocks fail** (brittle or plastic) and what happens when they do.