CHAPTER 14

Structural Geology

Materials Needed

- Pencil and eraser
- Protractor
- Metric ruler
- Silly Putty® (provided by instructor)
- Scissors
- Removable tape (optional)

Introduction

Stresses within the Earth bend and break rocks, producing folds, faults, and other geologic structures. These structures are three-dimensional, and they are commonly too large or too poorly exposed to be easily recognized from a single vantage point on the ground. For these reasons, basic geologic data must be collected in the field and plotted on a map to understand the structure fully. This chapter will help you visualize geologic structures in three dimensions so that you can understand them when seen in two dimensions on a geologic map, aerial photograph, or on the Earth's surface. You will learn how the orientations of planar features, such as sedimentary bedding, are described and used to portray the geologic structure on a geologic map. Vertical cross sections of geologic maps illustrate what you expect to see below the surface, and block diagrams combine maps and cross sections to provide a three-dimensional view. A clear understanding of subsurface structures is vital for an understanding of groundwater resources, pollution migration, oil reserves, ore deposits, and the stability of road cuts, tunnels, bridge footings, and building foundations.

Structural geology is the study of the form, arrangement, and internal structure of rocks. It is especially concerned with understanding how rocks are deformed. Evidence for deformation ranges from rocks shattered during earthquakes, to rocks long ago tilted, folded, and shoved over one another, to the foliation seen in slates, schists, and gneisses. The structural geologist puts together all such evidence to unravel the remarkable complex interactions of the Earth's tectonic plates.

Deformation is caused by **stress,** a force acting on an area of a body that tends to change its size or shape. Stress is a force per unit area, so the magnitude of stress depends not only on the magnitude of the force, but also on the area over which the force is applied. Stress will be greater if a given force is applied to a small, rather than large, area; a person wearing high-heeled shoes is more likely to punch a hole in a rotten floorboard than a person wearing tennis shoes. *Compressive stress,* or **compression,** causes shortening (Fig. 14.1A), and is an important type of stress at convergent tectonic plate boundaries. *Tensional stress,* or **tension,** the principal stress at divergent boundaries, causes stretching (Fig. 14.1B). **Shear stress** causes one side of a body to slide past the other (Fig. 14.1C), and is the principal type of stress along transform-fault plate boundaries.

Strain, the physical deformation that occurs in response to stress, is a change in size or shape. Strain may be temporary or permanent. **Elastic strain** is temporary; if the stress is removed, the object snaps back to its original shape. A stretched rubber band and a bouncing ball both undergo elastic strain. **Plastic strain** is permanent; if the stress is removed, the original size or shape is not restored. If you bend a piece of soft wire, the wire undergoes plastic strain; the bend is permanent. If it is bent back and forth at the same place, it eventually breaks or **ruptures.**

A rock undergoing elastic strain can suddenly break: this is **brittle deformation.** A dry stick of wood also behaves this way: it bends only so far before it suddenly breaks (ruptures), and each piece elastically recovers its original straight shape. A rock that undergoes much plastic strain without rupturing is **ductile.** The aforementioned bent wire is ductile.

Pressure, temperature, and rate of deformation determine brittle versus ductile