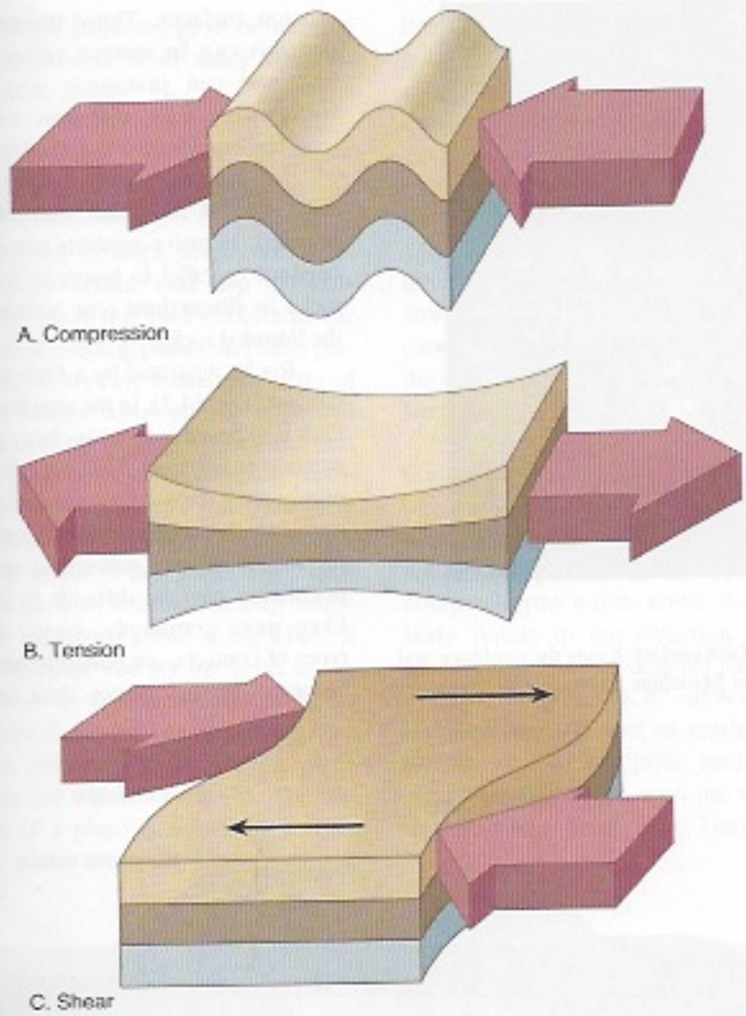

FIGURE 14.1
The three principal types of stress: A. compression; B. tension; C. shear.

Table 14.1
Conditions Required for Brittle versus Ductile Deformation of Rocks

Surrounding Conditions	*Brittle*	*Ductile*
Pressure	Low	High
Temperature	Low	High
Stress rate	Rapid	Slow
Stress magnitude	High	Low to high

behavior (Table 14.1). Cold rocks at the Earth's surface that experience a rapidly applied stress (like a hammer blow) tend to experience brittle fracture. Ductile deformation is more likely under the high temperature and pressures found deep underground, especially when stresses are applied slowly. The folded rocks visible in many mountain ranges were deformed well below the surface by forces acting over long periods of time (millions of years). The combination of depth and time enables deep rocks that would be brittle at the surface to behave plastically and gradually bend into folds. Eventually, erosion of overlying rock material and gradual uplift bring the deformed rocks to the surface where we can view them.

Recognizing and Describing Deformed Rocks

A geologist must be able to visualize rock structures in three dimensions. In some parts of the world, rocks are so well exposed at the surface that it is easy to see and understand their structure. In most areas, however, the rocks are buried beneath soil or young, unconsolidated sediment, and are exposed only in a few **outcrops** located far apart. In such places, it is difficult to understand the three-dimensional aspects without carefully examining the rocks, measuring their orientation, and plotting these data on a map.

What to Look for: Stratification, Contacts, and Fault and Joint Surfaces

How can you tell if sedimentary rocks have been deformed? It generally is easy—just look at the orientation of the strata. The original sediments were deposited as continuous horizontal or nearly horizontal **strata** (layers). If the strata are still horizontal and not broken, then they have not been deformed, although they may have undergone gentle uplift or subsidence. If strata are broken or not horizontal, then they have been deformed. Deformation takes many forms, from slight tilting of strata to complex folding, as described in a later section.

Contacts are surfaces separating adjacent bodies of rock of different types or ages. Understanding the nature of the contact is important, because the contact records a change, an event. There are several kinds of contacts.

Depositional contacts separate older bodies of rock from younger sedimentary rocks deposited upon them. In a sequence of sedimentary rocks deposited continuously, or **conformably,** in a basin of deposition, the contacts between adjacent layers are planar **bedding planes** (Fig. 4.3); they are parallel to—and, in fact, define—the bedding or stratification. Some depositional contacts are ancient