The Truth About Plastic Deformation
(Folded Rock Layers)

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www.answersincreation.org/plasticdeformation.htm

Occasionally you may hear or read about the young earth arguments concerning folded rock layers. They claim that if rock layers were folded when they were dry, they would show signs of fractures. The absence of fractures in folded rocks, they claim, is evidence that they were folded while they were still soft and unconsolidated.

Warped Earth (AiG) (answersingenesis.org/creation/v25/i1/warped.asp)

Grand Canyon strata show geologic time is imaginary (AiG) (answersingenesis.org/creation/v25/i1/grandcanyon.asp)

In order to set the record straight, we need to examine the principles behind what is known as plastic deformation. The truth is that rocks can bend and fold without fracturing, yet you won't hear or see this scientific principle addressed by the young earth theorists.

What is it?

A simple definition would say that plastic deformation is the ability of a rock layer to bend without breaking (see below).

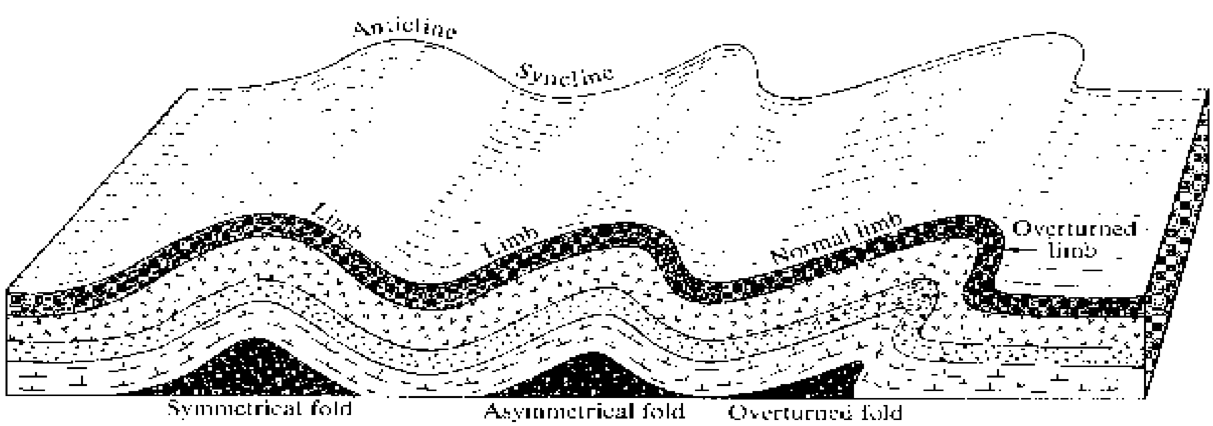


Figure 8.9 *Simplified block diagram of principal types of folded strata.*

Rock layers can bend with several degrees of severity. The most extreme deformation is with the *overturned fold*, seen above, where a rock layer bends back over itself.

First, let's look at the three stages of deformation. The first stage is *elastic*. In this stage, if the stress is removed from the rock, it will return to its original shape and size. As you stress a rock, there is another factor to consider called the *elastic limit*. This is the point that, if exceeded, the rock will not return to its original size, but will remain deformed to some degree. If it is below this elastic limit, the material under stress will obey Hooke's law, which states that strain is proportional to stress.

Once stress exceeds the elastic limit, the deformation is *plastic*. This simply means it will only partially return to its original state. When there is a continued increase in stress, it will eventually fail by *rupture*.

The nature of the substance under stress determines the elastic limit and rupture points. Brittle substances will rupture before any significant plastic deformation takes place, whereas ductile substances can undergo a large amount of deformation before rupturing. The young-earth theorists seem to ignore the fact that substances, even solids, can deform without fracturing.

Plastic Deformation

Most rocks at room temperatures and pressures fail by rupture before attaining a state of plastic deformation. However, at high temperatures and confining pressures, rocks deform plastically. This can happen in a laboratory setting even under short time durations. Given the longer times in the real world, and you can see the possibilities of deforming/folding rock layers without breaking. To understand this more fully, let's consider what features of a rock allow it to deform plastically.

Mechanics of Plastic Deformation

How can solid rocks change their shape without fracturing? There are three processes at work; intergranular movements, intragranular movements, and recrystallization.

Intergranular movement is the displacement between individual grains. If rocks are subjected to stress, the individual crystals and grains can move independently of one another. A greater range of movement can occur in sedimentary rocks, as igneous rocks tend to have grains that are interlocking, thus limiting their movements. Where the rocks fold, and the distance between the grains increases, the rock thins, automatically adjusting for the space in between the grains.

Intragranular movements, for which much experimental work has been done, occurs within the individual crystals by gliding and dislocations. Some minerals have no glide planes, some have a single glide plane, while others have multiple glide planes. The atomic structure controls the position and number of glide planes present within a mineral. Gliding consists of two types, translation-gliding and twin-gliding.

In transitional gliding, deformation occurs along horizontal glide planes, such as is illustrated below.

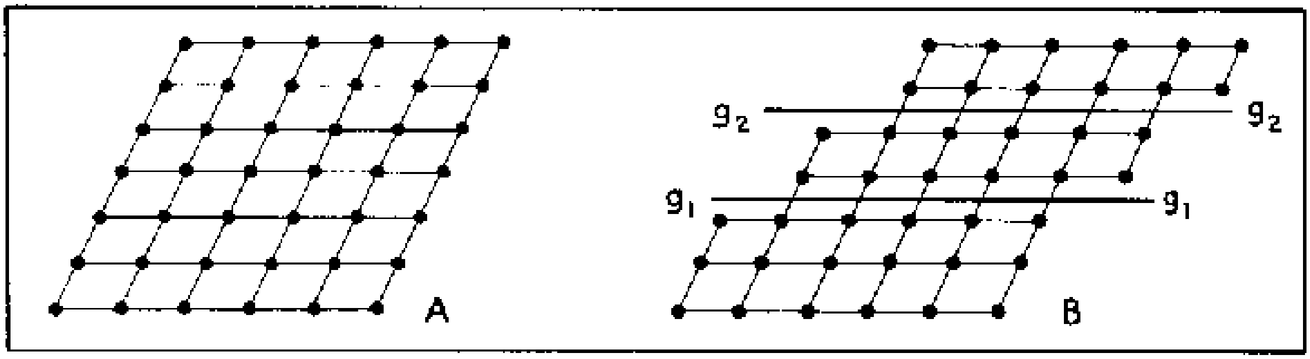
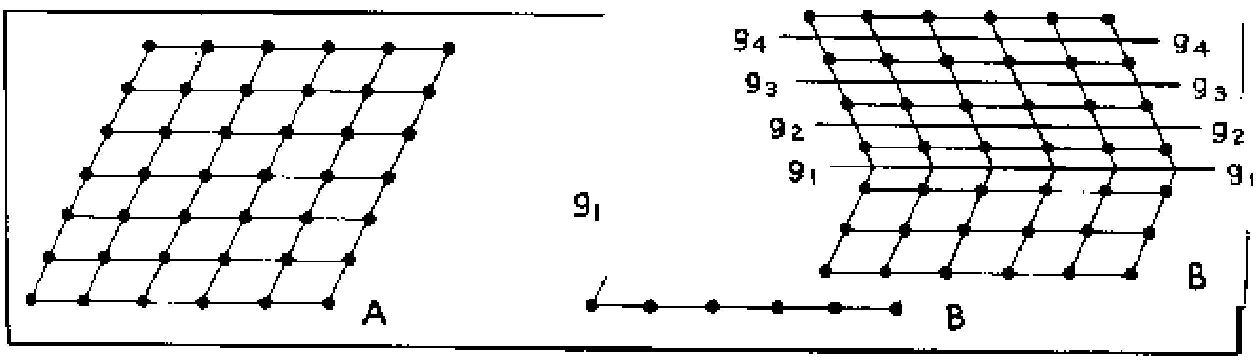


Diagram A shows the pre-deformation rock, and diagram B illustrates the deformation along two glide planes in this cross-section.

In twin-gliding, the layers slide relative to adjacent layers, as illustrated below.

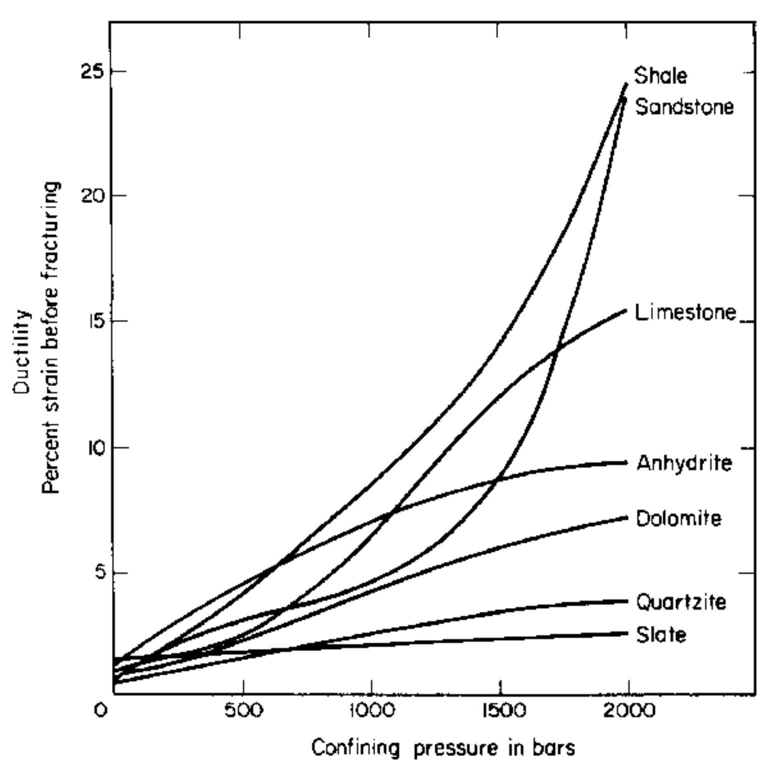


This provides a symmetrically altered shape with respect to the lower, undisplaced part.

In recrystallization, rocks under conditions of differential pressure may recrystallize, shortening them in one direction, while lengthening them in another direction.

Variables in Plastic Deformation of Rocks

Several factors contribute to the deformation we see in folded strata. These factors are confining pressure, temperature, time, and solutions. Pressure and temperature are simple and need no explanation. Laboratory experiments of different rock samples under pressure show that you can bend limestone up to 15 percent, and sandstones and shales, up to 25 percent, before they fracture (see below).



Obviously, rocks are folded much more than 25 percent in the real world. That is where time, temperature, and solution come into play. In the laboratory experiments, only pressure was measured, and that was done over a brief period of time. In the field, obviously we have millions of years to work with, not just hours. With the burial of rock layers within the earth, the temperature is also higher, a result of the layer receiving heat from the earth, which insulates it, and heat built up due to the increased pressure. The slow, continuous deformation with the passage of time is known as *creep*. Creep can be measured on a creep curve (see below).

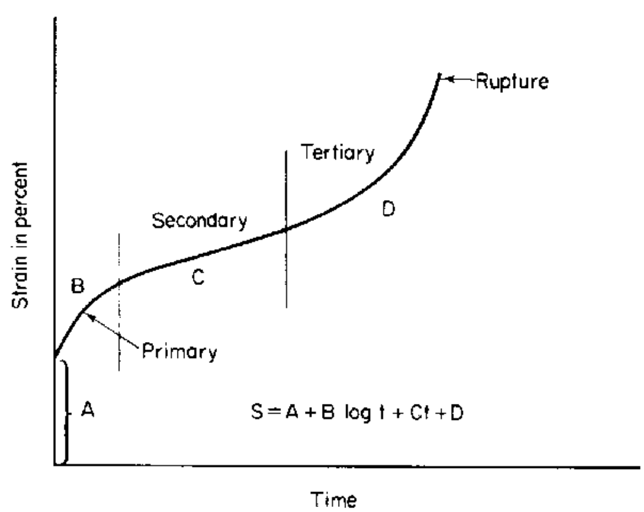


Fig. 2-14. Ideal creep curve. (A) Instantaneous deformation. (B) Primary creep. (C) Secondary creep. (D) Tertiary creep. *S* is the total strain; *t* is time.

You can see that the more time increases, the greater the folding of the rock without rupturing. In addition to time, solution can also play a part in aiding deformation. Rocks by their very nature are porous. There may be chemicals present in the pore spaces that are capable of reacting with the minerals in the rock. This is especially true of metamorphic rocks. Creep experiments have been conducted on rocks to demonstrate the effectiveness of a solution in deforming the rocks.

Young Earth Article

Look at the claims made in the article linked above called Warped Earth. Of rock layers, the author says of the instructors "They could not suggest any gradual process that could deform rocks into tight folds under normal temperature conditions without fracturing them." Taken by itself, this is a true statement. However, you have seen above that temperature is not the only variable. We also have pressure, time, and solution. The author gives no mention of these in this statement.

Please note the author also mentions "normal temperature." What is "normal temperature?" I assume its tied to climate, i.e. what we are used to experiencing on the surface of earth. When rocks are buried, they are subjected to higher temperatures which aids deformation. It's as if the author asked the instructor "Can rocks fold like this at 80 degrees Fahrenheit"? The obvious answer is no...the instructor could not answer otherwise...they have left the instructor no choice but to answer in such a way as to support young earth creationism.

It is obvious that the author is not telling the whole truth about plastic deformation. Apparently the only way to reach a young-earth conclusion is to withhold some of the facts.

Conclusion

Given time, pressure, temperature, and solution, laboratory results have demonstrated the plastic deformation capabilities of rocks, confirming the theories of rock folding which we see exhibited in the rock record. Contrary to young earth theorists claims, it is absolutely possible to fold rocks over long periods of time without the rocks exhibiting any signs of fractures. Once you study the science behind the rocks, you can see right through the empty claims by the young earth authors.

First Illustration (Figure 8.9) from Earth Science, 2nd edition, by Tarbuck and Lutgens
All other illustrations from Structural Geology, 3rd edition, by Billings