SUPPLEMENTAL

---

# *Teacher's Materials*

# *for*

# THE EARTH *HAS* A HISTORY

*The Geological Society of America*
*3300 Penrose Place • P.O. Box 9140*
*Boulder, Colorado 80301 • (303)447-2020*
*1-800-GSA-1988 • FAX (303)447-1133*

TEACHER MATERIALS FOR

# THE EARTH *HAS* A HISTORY

## 1. VIDEOTAPE (OR 16MM FILM), 19:50 MIN

### Introduction to Deep Time

The objective of this film is to demonstrate to a student, or to a lay group of any age, how simple evidence, which can be seen and understood by anyone, can be used to show without any doubt that the Earth has a history far vaster than human history. Only two principles are involved:

*Original Horizontality*—Almost all sedimentary layers accumulate horizontally. Thus any sedimentary rocks that are significantly tilted from the horizontal are evidence of deformation of the Earth's crust. (Sheet 1)

*Superposition*—In any sequence of layered rocks, the layer on the bottom had to be deposited first, and thus is the oldest layer. (Sheet 1)

The film uses localities all within sight of each other in and around Boulder, Colorado, to demonstrate how the use of these two principles can permit a student to unravel the major features of the geologic history of a region. Art work in the film keeps the students geographically oriented and reinforces the main ideas. The concept of an *unconformity*—an ancient land surface on which younger sediments are deposited—is introduced and plays a key role in working out the geologic story. (Sheet 2)

## 2. CLASS EXERCISES

A. Reinforcement of principles and concepts:

(1) Build a 3-D model. Four cross-section strips (A-D) are provided. Color the units as suggested on sheet 5, cut out the strips, fold on the vertical lines, and join the matching letters (A-A; A'-A') so that the strips form a rectangle about 3 x 5 inches. The 3-D models show the progressive changes in the geologic story presented in the film, and help the students to visualize the key rock relations. (Sheets 3 and 4)

(2) Make geologic maps. The two maps show the distribution of the rocks at the land surface for times A and C. The maps are at the same scale as the 3-D models and can be seen as the "covers" for the models. These may help students visualize the continuity of rock units across a landscape and demonstrate the major idea of dramatic *changes* during geologic (deep) time. (Sheet 5)

B. Put the events in the film into a deep-time context.

(1) Make a time line, with students as markers. Using a school hallway, or an outdoor setting, and either metric or English distances, position students along the 100 ft (or 100 m) line at the distances indicated on each of the posters recommended on sheet 6. Consider zero-distance to be the present. Each poster labels an important event in Earth history, particularly with relation to the record of life. Recommended posters for the principal historical events shown in the film are also given. The film events might be done on a different color of poster board.

The exercise shows how tiny and recent a part of Earth's history has been the province of Man. This can lead to some future discussions about how we handle this inheritance.

(continued)

## 3. HANDOUT

### Introduction to the Concept of Geologic *Rate*

Many important geologic processes, such as those that deform the crust to make mountains, flood the continents with vast seas, cause the continents to "drift," and generate major climate changes, take place at rates that are so slow we hardly notice them. However, some of them have significant human consequences, given the vast amounts of time available for such processes to operate. Sheet 7 is a chart showing some examples of different geologic rates compared to fingernail growth rates actually measured by students in a class activity. You may wish to consult the reference cited and have your class do the fingernail growth rate exercise before using this handout.

## 4. SUMMARY

### The Nature of Science

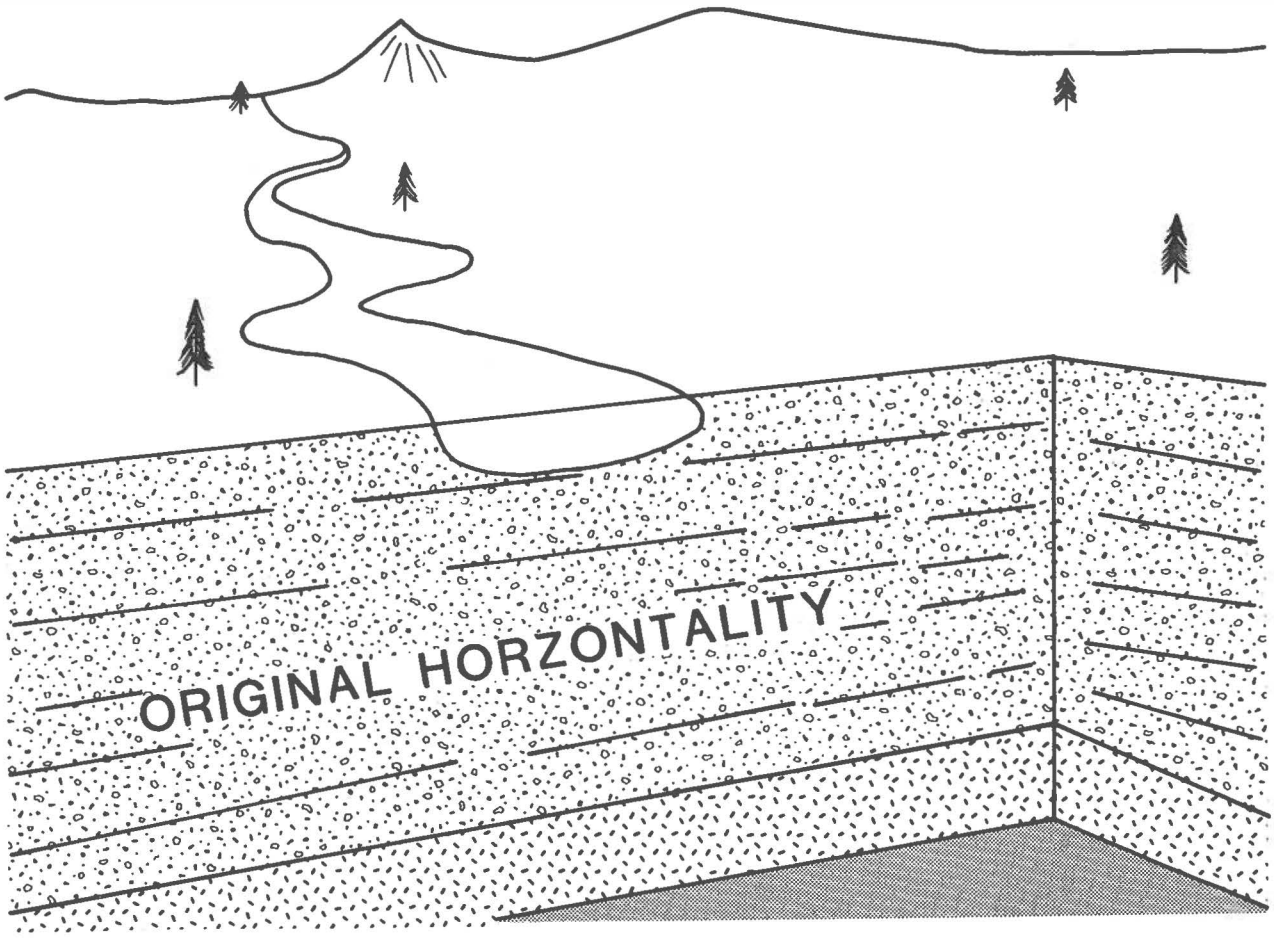
The scientific process is a process of exploration—of formulating questions and searching for answers, and testing our answers against observations. Here, we test the question, "How do we know the Earth is really old?" We also begin the process of thinking about the consequences of our knowledge of the vast age of the Earth.

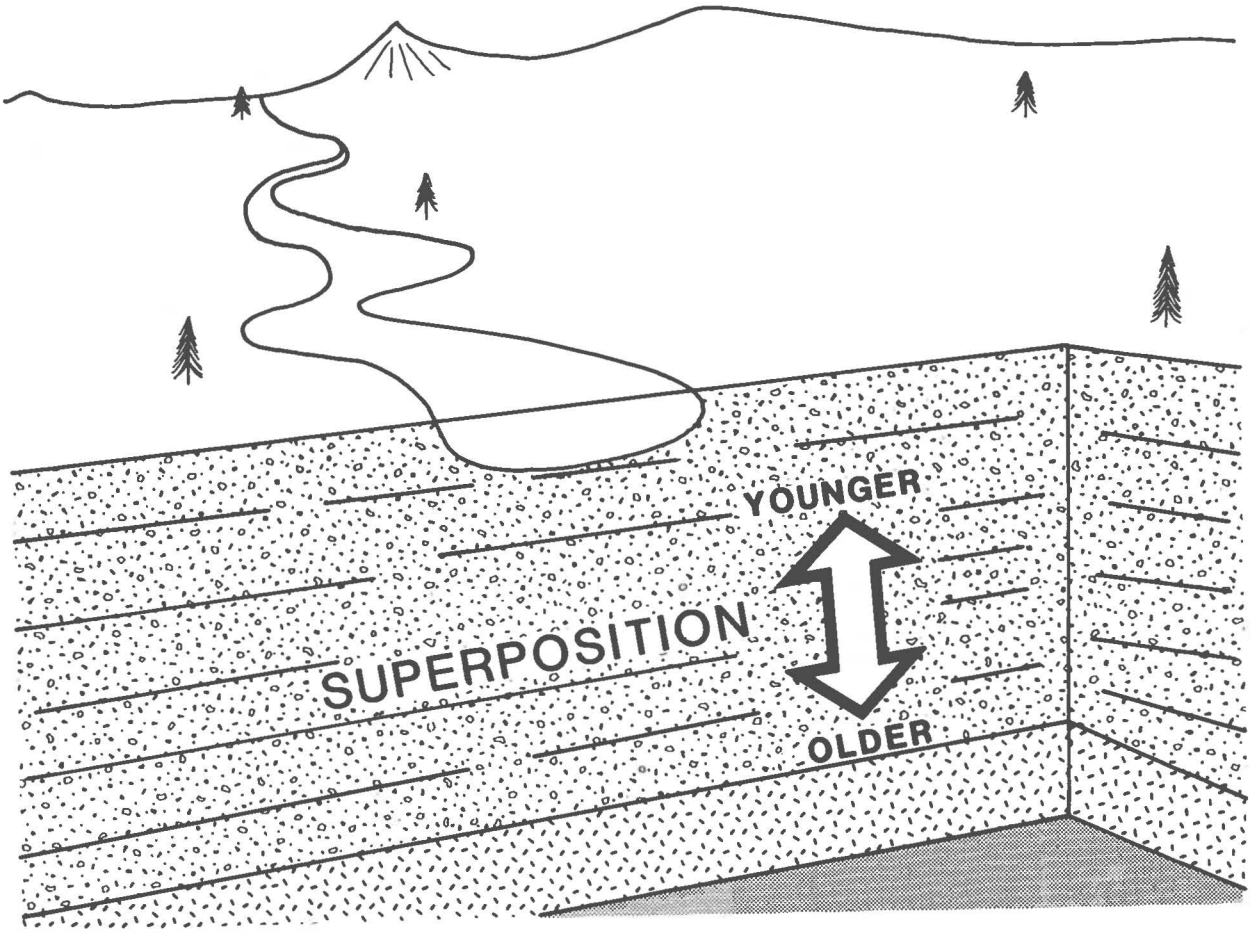
### Principal Conclusions

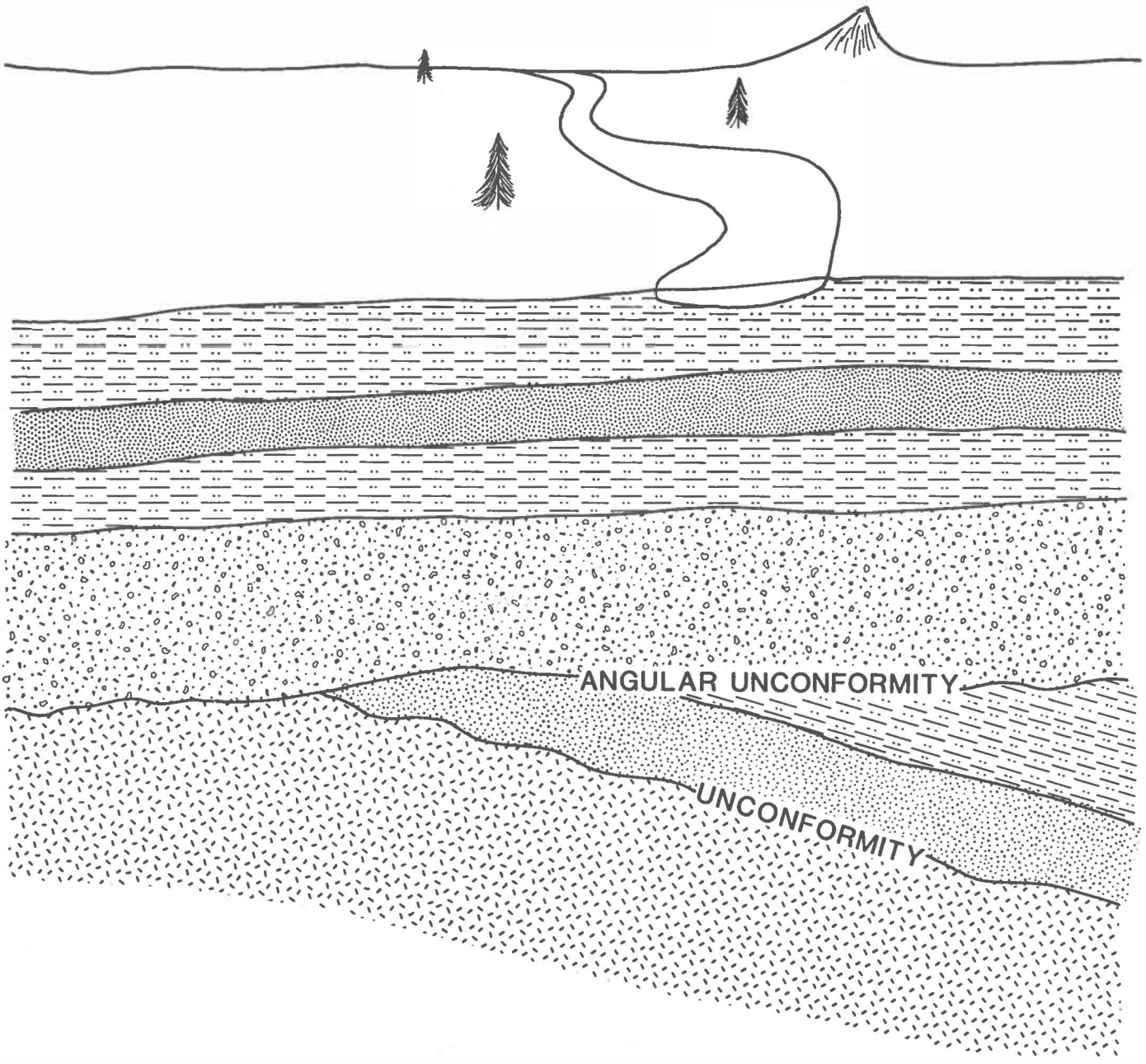
A. We live in a universe with a nearly infinite time dimension.

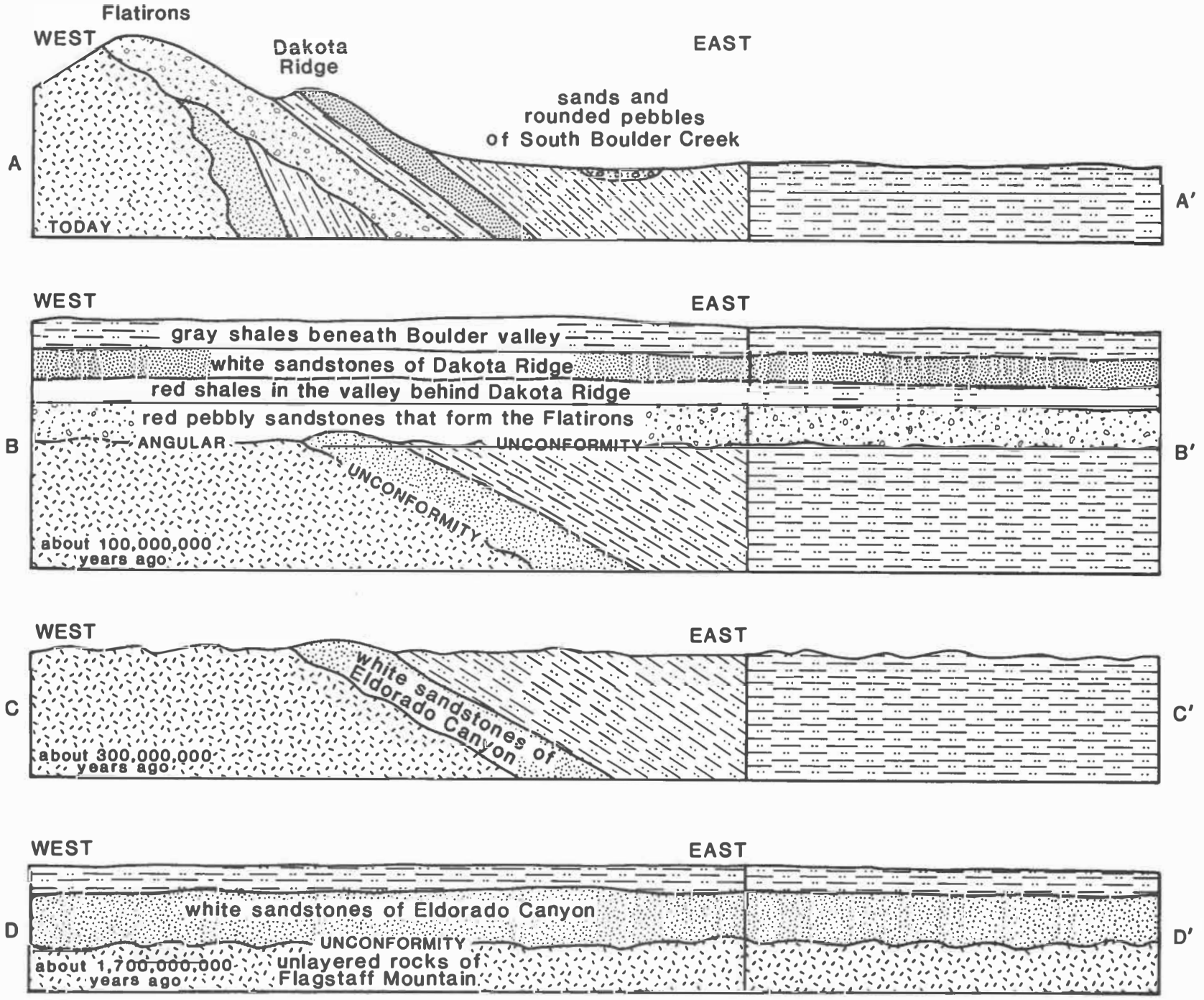
B. Our earth is constantly changing.

C. Some important changes happen at rates so slow we don't observe much change within a lifetime.

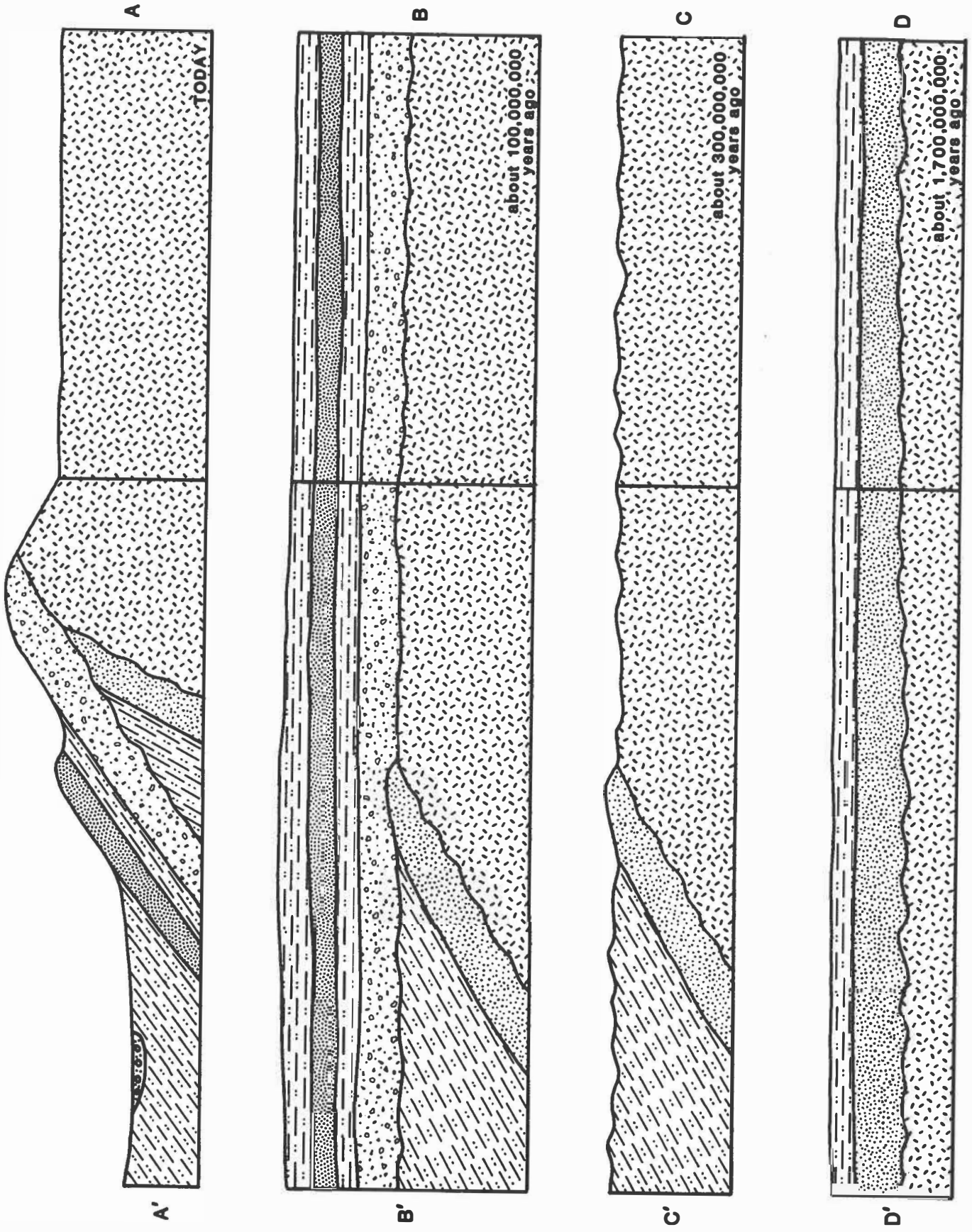

ORIGINAL HORZONTALITY

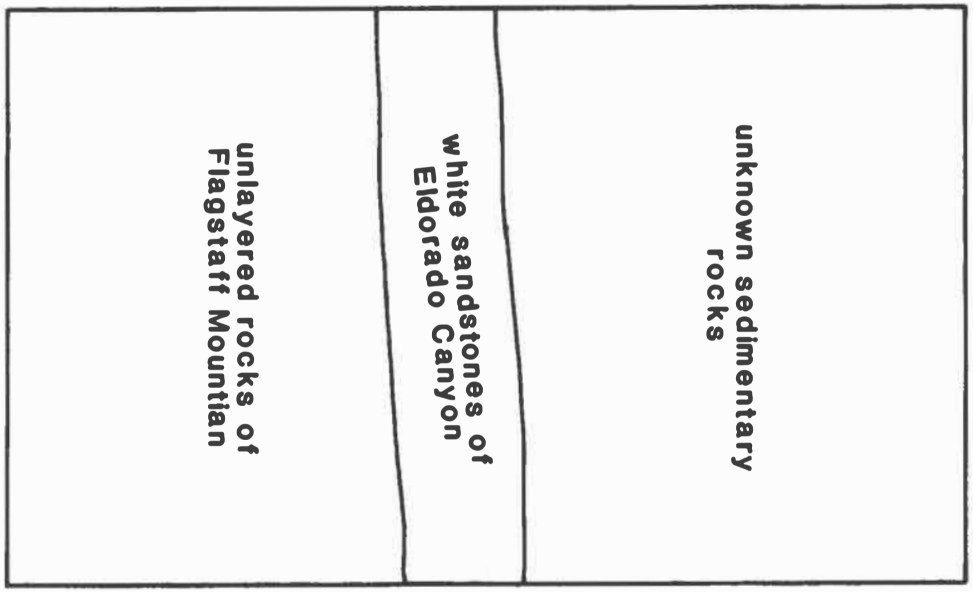

YOUNGER
SUPERPOSITION
OLDER


ANGULAR UNCONFORMITY
UNCONFORMITY

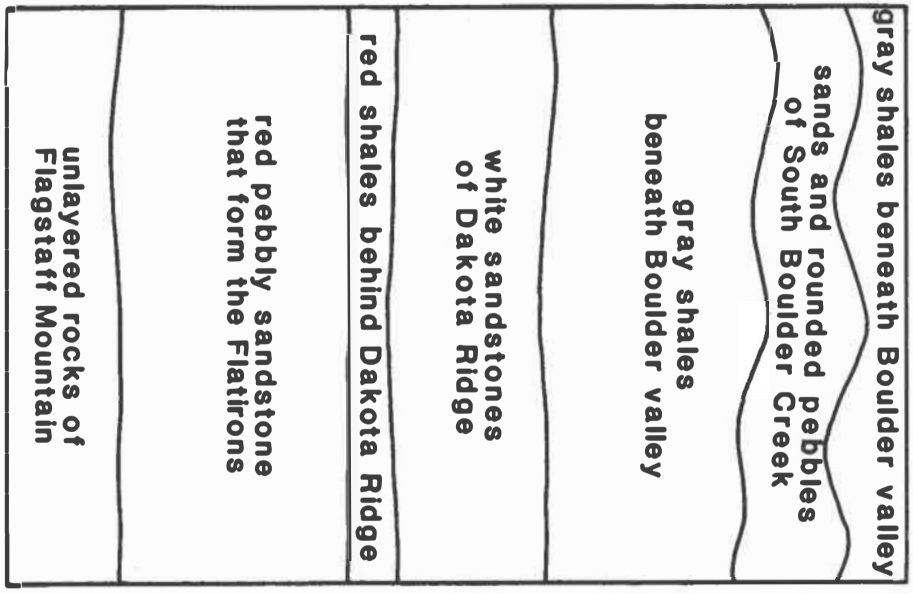



Sheet 3
3-D Model


A
TODAY
A'
B
about 100,000,000 years ago
B'
C
about 300,000,000 years ago
C'
D
about 1,700,000,000 years ago
D'




surface map
about 300,000,000
years ago




surface map
TODAY

| | SUGGESTED COLORS |
|---|---|
| YOUNGEST | |
| sands and rounded pebbles of South Boulder Creek | green |
| gray shales beneath Boulder valley | gray |
| white sandstones of Dakota Ridge | uncolored |
| red shales in the valley behind Dakota Ridge | light red |
| red pebbly sandstones that form the Flatirons | dark red |
| unknown sedimentary rocks | brown |
| white sandstones of Eldorado Canyon | yellow |
| unlayered rocks of Flagstaff Mountain | purple |
| OLDEST | |

Sheet 5
Geologic Maps

**Class exercise to show the relation between the age of the Earth and other events in Earth history and events in human history.**

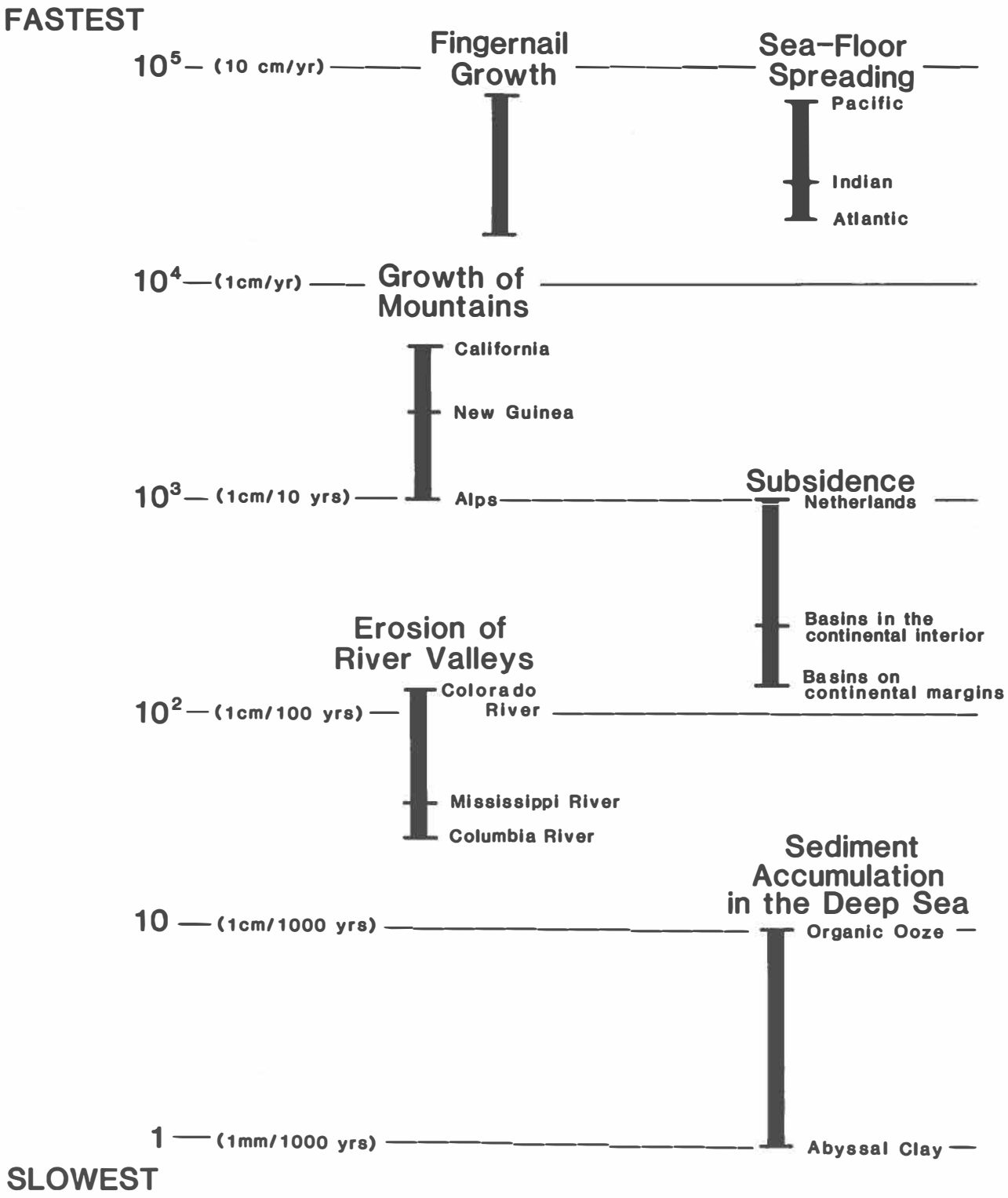
**The age of the Earth is 4,500,000,000 years**

**If scale is 100 meters, 1mm = 45,000 yrs**

**If scale is 100 feet, 1/16in = 234,000 yrs**

| | | |
|---|---|---|
| AGE OF THE EARTH<br>4,500,000,000 yrs<br>100ft 100m | OLDEST FOSSILS (ALGAE)<br>3,500,000,000 yrs<br>78ft 78m | WHITE SANDSTONES OF ELDORADO CANYON<br>1,700,000,000 yrs<br>38ft 38m |
| FIRST FOSSILS WITH SHELLS<br>560,000,000 yrs<br>12ft 12m | FIRST ANIMALS WITH BACKBONES (FISH)<br>500,000,000 yrs<br>11ft 11m | SANDSTONES THAT FORM THE FLATIRONS<br>300,000,000 yrs<br>6.5ft 6.5m |
| FIRST MAMMALS (WARM BLOODED)<br>245,000,000 yrs<br>5.4ft 5.4m | WHITE SANDSTONES OF DAKOTA RIDGE<br>130,000,000 yrs<br>2.9ft 2.9m | DINOSAUR EXTINCTION<br>65,000,000 yrs<br>1.5ft 1.5m |
| EARLIEST HUMAN CULTURE<br>*<br>"MODERN" LANDSCAPE<br>2,000,000 yrs<br>0.55in 4.5cm | PYRAMIDS<br>4,500 yrs<br>0.001in 0.1mm | CHRISTIANITY<br>2,000 yrs<br>0.0005in 0.04mm |

# TIME-DISTANCE RATES OF GEOLOGICAL PROCESSES




Adapted from Rowland, S.M., 1983, Fingernail Growth and Time-Distance Rates in Geology: Journal of Geological Education, v. 31, p. 176-177.