Fossils and the Birth of Paleontology: Nicholas Steno

If one day in history had to be picked as the birth of paleontology, it might be the day in 1666 when two fishermen caught a giant shark off the coast of Livorno in Italy. The local duke ordered that this curiosity be sent to Niels Stensen (better known as Steno), a Danish anatomist working at the time in Florence. As Steno dissected the shark, he was struck by how much the shark teeth resembled "tongue stones," triangular pieces of rock that had been known since ancient times.

Today, most people would instantly wonder whether the tongue stones were giant petrified shark teeth, but in 1666 such a presumption was a tremendous leap. Few could imagine how living matter could be turned to stone, and beyond that, encased in solid rock—especially if the rock were well above sea level and contained remnants of a marine organism. Fossils were instead thought to have fallen from the sky, or to be "sports of nature"—peculiar geometrical shapes impressed on the rocks themselves.

Steno's drawing of a shark head helped him see that "tongue stones" were actually fossil shark teeth (right).

From Living Tissue to Stone

Steno made the leap and declared that the tongue stones indeed came from the mouths of once-living sharks. He showed how precisely similar the stones and the teeth were. But he still had to account for how they could have turned to stone and become lodged in rock. Naturalists of Steno's day were becoming convinced that matter was composed of different combinations of tiny "corpuscles"—what today we would call molecules. Steno argued that the corpuscles in the teeth were replaced bit by bit, by corpuscles of minerals. In this gradual process, the teeth didn't lose their overall shape as they turned from tissue to stone.

Steno's Law of Superposition

These exposed rock layers nicely illustrate Steno's Law, with the youngest layers at the top and the oldest at the bottom.

But how could fossils end up deep inside rocks? Steno studied the cliffs and hills of Italy to find the answer. He proposed that all rocks and minerals were originally fluid. Floating on the surface of the planet long ago, they gradually settled out of the ocean and created horizontal layers, with new layers forming on top of older ones. Molten rock sometimes intruded into the layers, reaching the top and spreading out into a new layer of its own. As the rocks formed, they could trap animal remains, converting them into fossils and preserving them deep within their layers. Those horizontal layers represent a time sequence with the oldest layers on the bottom and the youngest on top, unless later processes disturbed this arrangement. This ordering is now referred to as Steno's **"Law of Superposition"**, his most famous contribution to geology.

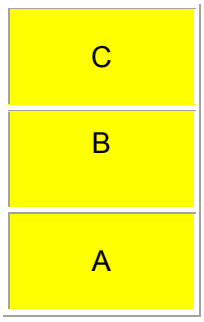
Steno was not the only naturalist of his day to propose that fossils belonged to living creatures. Leonardo da Vinci and Robert Hooke, for example, also took up the same view. But Steno pushed the idea much further. He argued for the first time that fossils were snapshots of life at different moments in Earth's history and that rock layers formed slowly over time. It was these two facts that served as the pillars of paleontology and geology in future centuries. And fossils ultimately became some of the key evidence for how life evolved on Earth over the past four billion years.

Modified from: http://evolution.berkeley.edu/evolibrary/article/_0_0/history_04

STENO'S LAWS

It was recognized in the 1600's that in a sedimentary sequence, the older beds are on the bottom, and the younger beds are on the top. This has come to be called the ***Principle of Superposition***. You can visualize how this occurs if you imagine a stack of newspapers in the corner of a room. Every day you put another newspaper on the pile. After several weeks have passed, you have a considerable stack of newspapers, and the oldest ones will be on the bottom of the pile and the most recent ones will be on the top.

This fairly obvious, but very important fact about layering was first noted by Nicholaus Steno, and is the first of three principles which have come to be known as Steno's Laws.



Layer A is the oldest, layer C is the youngest.

Vertical geologic section

Steno's second law is the ***Principle of Original Horizontality***, which states that sediments are deposited in flat, horizontal layers. We can recognize this easily if we consider a sedimentary environment such as the sea floor or the bottom of a lake. Any storm or flood bringing sediment to these environments will deposit it in a flat layer on the bottom because of the sedimentary particles settling under the influence of gravity. As a result, a flat, horizontal layer of sediment will be deposited.

Steno's third law is the ***Principle of Original Lateral Continuity***. If we consider again the sediment being deposited on the seafloor, the sediment will not only be deposited in a flat layer, it will be a layer that extends for a considerable distance in all directions. In other words, the layer is laterally continuous.

In summary, the three principles which we call Steno's Laws are:

- The Principle of Superposition
- The Principle of Original Horizontality
- The Principle of Original Lateral Continuity

Of the three, the Principle of Superposition is most directly applicable to relative dating. We can examine any sequence of sedimentary strata and determine in a relative sense which beds are older and which beds are younger. All that we need to know is whether the beds are right-side-up or not. This complication comes because tectonic forces can cause sedimentary sequences to be tilted, folded, faulted, and overturned.

Although sediments are originally deposited in horizontal layers, they do not always remain horizontal. A trip to the mountains or a quick look through your textbook is probably all that is needed to convince you that any sedimentary sequences consist of beds which dip at some angle to the horizontal. And in some cases, the beds are vertical or overturned.

Modified from: http://gpc.edu/~pgore/geology/historical_lab/relativedating.htm
Pamela J. W. Gore
Department of Geology, Georgia Perimeter College

Name:_____ Date: _____ Period: _____

General Geologic Concepts/Steno's Laws

After reading the handout on the birth of paleontology and the information on Nicholas Steno, answer the following questions.

1. Nicholas Steno was one of the first scientists to understand that "fossils" came from once-living things by showing how similar they were. How did he propose that the fossils had "turned to stone"?

   _____

   _____

2. How did Steno believe that fossils ended up deep inside the rocks?

   _____

   _____

3. What is the definition of the "***Law of Superposition***"? Why is this concept important in the study of Earth's rock layers and thus its history?

   _____

   _____

   _____

4. What is the definition of the "***Law of Original Horizontality***"? What type of rocks does it apply to?

   _____

   _____

   _____

5. What is the definition of the "**Law of lateral Continuity**"? Explain why you would suspect that a certain type of rock you observed in one location should be present elsewhere.

   _____

   _____

   _____

6. If you observe a sedimentary rock sequence which is **NOT** horizontal, were the rocks originally deposited that way or has some force acted upon them since they were deposited? Explain your answer.

   _____

   _____

   _____

   _____

I-70 Road Cut near Morrison Exit