The Age of the Earth

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When naturalists started examining the Earth in the 18th century for evidence of its age, they were to a large extent seeking to confirm the suggestion of the Bible that the Earth was several thousand years old; but the closer they looked, the less certain they were that this was the correct answer.

Geologists examined the rocks across Britain, and noted that the same sequence of rocks occurred in different places, suggesting that the rocks had a common source. They also noticed that different levels of rocks contained different groups of fossils, including fossils of animals different from those of today, and not mentioned in the Bible. Yet the fossils were in similar orders in different locations. Rocks were also classified according to how they were made, and by the order in which they'd been created. In the first case, rocks were classified as sedimentary, igneous or metamorphic. Sedimentary rocks are rocks created by grains of mud or sand laid down over the years on lake or sea floors, and compressed into rock by the weight of material lying above them. Igneous rocks are rocks of volcanic origin. Some are from lava which has cooled solid on the surface of the Earth (such as basalt), while others have cooled while still inside the Earth (such as granite), and emerged after they'd solidified. Metamorphic rocks are rocks (usually sedimentary) which have been altered by heat or pressure (such as limestone being converted to marble).

The relative age of rocks was determined by applying a couple of simple rules. The first was that where different rock types sit in layers, the younger rock usually overlays the older. The second was that where one rock type cuts through another, the younger rock is cutting through the older. The problem is that in nature, erosion, faulting and folding of rock layers can all complicate the picture.

Using these rules, geologists divided the past into a series of ages, with the dividing lines determined by noticeable changes in the rocks and fossil groups. These ages were, in order from oldest to youngest: Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Tertiary and Quaternary. However, at this stage, geologists had no idea of the length of these ages.

By the late 19th century, it was becoming clearer that the Earth had to be a lot older than the Bible suggested. Estimates ranged from the hundreds of thousands to the hundreds of millions of years, but these figures were determined by indirect means. These included the time for the oceans to reach their current level of salinity, the time for the Earth to cool from a globe of lava to its current temperature, and the amount of time it was believed the sun could've been burning.

The last equation yielded the shortest possible period of time - a little under a million years. This appeared to be an insurmountable problem, because of the assumption that the sun was a giant ball of burning coal.

But late in the 19th century, a new field of science was opened up with the discovery of radioactivity. Not only did radioactivity provide an alternate source of fuel for the sun, and of heat in the Earth, but it also provided a means of directly measuring the age of rocks.

When igneous rocks are created, many contain small amounts of radioactive elements, such as uranium. Over time, these radioactive elements decay into other elements which are stable (non-radioactive). Scientists worked out the rates at which various radioactive elements decay, and by measuring the proportion of the radioactive element to its non-radioactive successor they could determine how long ago the rock was created. A number of these sequences are known, and as the rates of decay differ depending on the starting radioactive element, different elements in the one rock can be used to cross-check each other. (Incidentally, the best known form of dating – carbon dating – is effective to ages of about 50,000 years.)

At the start of the 20th century, the Earth's age was estimated at around 1 to 2 billion years, but as the years passed, older and older rocks were discovered, extending the notional age of the Earth. The oldest rocks currently known are about 3.8 billion years old. The oldest objects are crystals embedded in younger rocks. These crystals have been measured at about 4.4 billion years old. The Earth itself is believed to be about 4.55 billion years old. This is supported by the age of the oldest known rocks on the moon.

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