Geological time

Geological maps

Chris Wilson:
The discovery that different successions of assemblages of fossils could be recognised in different parts of England was made by William Smith almost 200 years ago. He was a surveyor and engineer involved in the construction of canals all over the country, so he had plenty of opportunity to see fresh exposures of rocks and collect fossils from them. And this enabled him to come up with the idea that different strata as he called them, contain different assemblages of fossils. This is the oldest of the 3 examples of the illustrations of Smith's fossil assemblages. Each one has a different background colour to match the geological rock formations that Smith recognised and not surprisingly this one has a white background to match the matrix of this chalk bivalve fossil.

The title of these sets of plates is "Strata Identified by Organised Fossils". And this encapsulates Smith's recognition that a clear succession of rocks can be identified in different parts of England, and top of that that each of the unit's within that succession, his 'strata', is characterised by a distinct assemblage of fossils. And later he came to realise that each of these strata was associated with a discrete period of geological time. Well, to illustrate this idea let's have a look at this demonstration.

Let's suppose that these two lines of trays represent collections that Smith made at two locations in England. Using the Law of Superposition we can assume that these trays at the base are the oldest and so the collections get younger as we go in that direction. Let's see how these assemblages match up. In this tray there are remains of trilobites and there's trilobites over here. So we can correlate these two. In the next one there are shales with the remains of planktonic graptolites and the same in the other tray. So they match up. And in the other tray we have limestones with brachiopods, corals and crinoids but something completely different in the other tray, a red sandstone: no fossils at all. So we can't correlate the two. But the tray above the red sandstone also contains brachiopods, corals and crinoids so there's our correlation. So, the sandstone is missing in this succession. And then the other two trays match up nicely, ammonites and belemnites in both. So there's' our correlation line. Then finally at the top remains of fossil mammals, very similar to those living today. So these strata were probably only deposited a few hundred thousand years ago and there, we can correlate them.

So using this idea of correlating strata using fossils and his knowledge of the distribution of rocks throughout England, Smith published a wonderful geological map of the country in 1815. This map represents a milestone in the history of the geological sciences. It's one of the foundations of modern 'stratigraphy '-the study of stratified rocks, how we can correlate them, and how we can use them to work out past events in the history of the earth. Smith showed the distribution of his strata on the map by using water colour washes, for instance the Chalk is shown in green and a much heavier wash is used to show the base of unit. And the same style is used for all the strata. Well, as well as recording his observations on the distribution of strata in 2 dimensions on this map, Smith also thought in the third dimension. He drew a cross-section from London to Oxford to Worcester. The section extends north westwards beyond Worcester to Snowdonia. To the north west of Worcester, the simple south eastward inclination or dip of the strata that Smith shows, is a gross over simplification of what we know about the geology today. But to the south east of the town, the section is remarkablyaccurate. It shows the English scarplands, Smith described these as being like slices of bread and butter arranged on a plate. The key to the map is a rudimentary stratagraphic column with the strata arranged in order with the oldest at the base and the youngest at the top. Several of these names still appear on modern geological maps, which even use some of the same

colours. We've seen how William Smith used the Principles of Superposition and Faunal Succession to work our a stratagraphic column for England. By about the middle of the 19th century others had built on William Smith's ideas and defined the major geological periods; Carboniferous, Permian, Trias Jurassic and so on. And this work has continued, so today we can actually define quite small divisions. So using the range through the geological record of ammonites such as this. In other words: where they appear and where they disappear it's possible to produce a very refined stratagraphic division of a particular rock sequence. There are 75 ammonite zones defined on ammonite species, such as this, in the British Jurassic. So that means that each ammonite zone lasted probably for about a million years on average. Now once we've got this refined kind of record we've realised that in places there are significant gaps in the stratagraphic record.