

“Riding Time’s Cycle along Route 66 in Arizona” - Dr Paul Lyle 12th December 2017.

Route 66 is an iconic road running from east to west through Arizona and toward California. Dr Lyle began with dramatic pictures of the erosion of soil from the ‘dustbowl’ in the great plains, in the 1930s, chronicled by John Steinbeck, which resulted from deep ploughing of the grasslands.

He then introduced the concepts of the one-way nature of geological time, *Time’s Arrow*, and also the cyclical nature of events within this, *Time’s Cycle*. In Monument Valley, just off Route 66, the mesas show evidence of deposition, erosion and re-deposition of material. John McPhee, in his book “Basin and Range”, introduces the term “Deep Time” to describe the immensity of time involved – and the conceit that if the outstretched arm of God in the Sistine Chapel represents the age of Earth, one swipe of a nail-file on the outstretched finger would remove the whole era of human existence.

Herodotus, some 450 years BCE, observed the cycle of annual silt deposition building the Nile delta, and calculated an age of eleven thousand years. James Hutton in the 18th century observed the geological evidence of erosion and deposition, and formulated the concept of uniformitarianism, that the same geological processes that occur now had always done so “with no beginning and no end”.

In the 1960s, the concept of plate tectonics became accepted, with major contributions from the Canadian John Tuzo Wilson. This again shows a cycle of events. Before the closure of the Iapetus ocean around 420 Ma, Scotland and the northern part of Ireland were part of Laurentia, while England was on the other side of the ocean, in what has been named Avalonia. They came together with closure of this ocean. In Greek mythology, Iapetus was father of Atlas, and when a separation developed again between what are now North America and Eurasia, the new ocean was the Atlantic.

The movements of the continents is another cycle – six phases can be discerned which at present are:

- (1) Beginning – the Rift Valley;
- (2) separation of continents – The Red Sea;
- (3) Mature – the Atlantic;
- (4) Declining – the Pacific is closing;
- (5) Terminal – Africa is moving north and colliding with Europe;
- (6) Final, Suturing – India in contact with Eurasia and still pushing the Himalaya upward.

A forward projection in time might show a new supercontinent 250ma in the future.

The Grand Canyon, near Route 66 and west of the town of Flagstaff, shows both Time’s Cycle and Time’s Arrow. It is dramatic in scale – 25 to 30 miles from rim to rim; and with a time difference of 1,250 Ma between bottom and top – a large proportion of the 4.5 billion years age of the earth – the only place on the planet where such a huge chunk of geological time can be seen. It was first explored by John Wesley Powell, a civil war veteran, who went down the Colorado river in 1863 – a very challenging expedition.

Time’s cycle in the Canyon is demonstrated by unconformities or breaks in the succession. At the bottom are the Vishnu schists, and above them sedimentary layers with a disconformity of about 900ma between. All the way up to the top are layers of sedimentary rocks, representing times of deposition, separated by disconformities showing periods when erosion was taking place. All representing changes in sea level at different times all the way up the succession.

Time’s Arrow in the Canyon is seen in the fossil record, from trilobites at the bottom, through fish half-way up to reptiles toward the top.

Around the time that Powell was exploring the Canyon, in Europe there was argument between the concepts of uniformitarianism, supported by Charles Lyell, and the views of Cuvier, who believed that catastrophic events played a part. Evidence for catastrophic events related to impacts can be seen on the surface of the

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moon, in the recent Chelyabinsk and 1908 Tunguska events – and there are asteroids in near-earth orbits. Right beside Route 66 is Meteor Crater (also known as Barringer Crater after the landowner who identified it). It is about a mile wide, A section through the rocks around the crater shows how material has been thrown out by the force of the impact, with the order of stratigraphic layers repeated, but upside-down. Charles Barringer bought the crater in the hope of mining a large mass of nickel or iron from its base, but only fragments are to be found. The meteor is usually thought to have been 25 meters in diameter, and the event to have happened some 50,000 years ago.

This was the first recognised evidence of an impact striking the earth. A more dramatic example is the Chicxulub crater in Yucatan, 100 miles across. This took place in the Cretaceous, and is marked around the world by an iridium-rich layer which marks the junction between the top of the Cretaceous and the Palaeogene (Triassic) above. (Iridium is rare in earth rocks, but common in asteroids). This impact is often described as being responsible for the extinction of the dinosaurs, but it is more likely that this was caused by the eruption of basalts in the Siberian and Deccan traps, over a million years – though the impact may have given them a final push.

The next stop on Route 66 is the Painted Desert, with fantastically coloured ‘Badlands’ landscapes. Just across the road is the Petrified Forest, containing the fossilised remains of fully grown – 75 meter – conifers, with the silicates from volcanic ashes, preserved in great detail. Another example of a catastrophic event which has left its record in the geological column.

You don’t have to go to Arizona to see Time’s Cycle. Suilven in the Scottish highlands is an ‘inselberg’ – an isolated mountain. It is made of torridonian sandstone, but is surrounded by a flat peneplain of Lewisian gneisses. The gneisses were covered by perhaps five km of torridonian sandstones, which have been eroded off, bringing the lewisian gneisses back to the surface after perhaps a billion years.

Time’s Arrow. Not thirty miles from Suilven is the Stac Fada formation – a jumble of fragments which represent ejecta from a meteorite impact. Dr Mike Simms has played a major role in describing this – a vast gravity well indicates the impact point, and rocks on the margin indicate the direction of the ejection of the material.