ANDYSEZ No 30

THE AGE OF THE EARTH

- Andy Spate

This ANDYSEZ is going to be a little bit of a pot-boiler. Please let me know what topics you would like discussed.

Lots of reports, EISs and reviews cross my desk – and I often see that various NPWS officers have encountered a term such as "Jurassic" and consequently insert a marginal note asking for the age in years to be inserted. I seriously doubt that amending the documents to say "Jurassic Period" helps their comprehension of what is meant by "Jurassic". Millions of years are a fairly nebulous concept to those who life for +/-70 years (or whatever the current figure is). Perhaps we can conceive that our parents lived for, say 20 years before they produced us and that we understand something about their life before us – and that we can see some sort of program for our kids extending across a similar period. Let's be bold and say that we have some sort of time perspective across 150 years – we will call them lifetimes.

This period (150 years) is just 0.015% of one million years. The Jurassic started 195 million years ago, lasted 70 million and finished 65 million years ago. Using our 150 years, the Jurassic started 1.3 million lifetimes ago, lasted about 470,000 lifetimes and finished about 433,333 lifetimes before present. Do these sorts of juggling with numbers make them any more understandable – I don't think so. But there are sure lots of them - we will come back to this point later. Let's try an analogy (apologies to all non-eastern State readers and to those from our geological possession across the Tasman Sea).

THE VASTNESS OF GEOLOGIC TIME

To comprehend the vastness of geologic time think of the following analogy. If the distance from Perth to Sydney (3,291 km) is taken to be equivalent to the age of the Earth, then, traveling from west to east, you would reach the beginning of the Cambrian only 421 km from Sydney, near Wagga Wagga; the earliest evidence of man occurs right in the heart of the city, at Central Railway Station, 3.65 km from the journey's end at the southern end of the Sydney Harbour Bridge; the arrival of the Aboriginal people around 35 metres from the Bridge and the time of European settlement in Australia is less than a hand span (< 150 mm).

A GEOLOGICAL TIME SCALE

EON	ERA	PERIOD	EPOCH	Start - millions of years ago	Duration - millions of years
PHANER0-ZOIC(plant life)	CAINO-ZOIC (new life)	Quaternary	Holocene	0.015	0.015
			Pleistocene	1.8	1.785
		Tertiary	Pliocene	5.0	3.2
			Miocene	24.0	19.0
			Oligocene	37.0	13.0
			Eocene	53.5	16.5
			Palaeocene	65.0	11.5
	MESOZOIC (middle life)	Cretaceous		135	70
		Jurassic		195	40
		Triassic		235	40
	PALAEO-ZOIC (ancient life)	Permian		290	55
		Carboniferous		345	55
		Devonian		410	65
		Silurian		435	25
		Ordovician		490	55
		Cambrian		570	80
PRECAMBRIAN	PROTERO-ZOIC	Late		1400	83
		Middle		1800	400
		Early		2300	500
	ARCHAEAN			>3800	>1500

To a geologist the term "Jurassic" means a time period between two other periods (the younger, the Cretaceous Period, and the older, the Triassic Period). All these "Periods" together form the "Mesozoic Era". Geologists have divided the lifetime of our Planet, Earth, into four groups of time slabs termed Eon, Era, Period and Epoch respectively. How all of these fit together is shown in the following table. Note that you will find many versions of geologic time scales with differing intervals and ages - these things are subject to change and re-interpretation. The Australian Geological Survey Organisation and the Geological Society of Australia produce some nice time scales on card - contact AGSO sales on 02 6249 9642 or sales@agso.gov.au. Visit the site on http://www.agso.gov.au.

Now lets see what these huge numbers mean to us short-lived humans. Using our 150 year "lifetimes":

	million years	million "lifetimes"
Age of the Earth	~4800	32
Oldest reworked rock	~4276	28.5
Oldest non-reworked rock	~ 3962	26.4
Oldest life forms	~ 3556	23.7
Recognisable humanoids	~? 4	?0.027

I have repeatedly pointed out in previous ANDYSEZs that one shouldn't extrapolate backwards using current rates of stalactite development or erosion of surfaces. This is because rates have changed dramatically in response to climate change, atmospheric composition and lots of other things and over the long run today's rates may be completely nonsensical. But I am now going to do some extrapolating to show how slow rates can produce big effects through time.

Consider a stalagmite accumulating at between 0.01 and 0.5 mm per year (these seem to be fairly reasonable figures based on work around the world although Trevor Shaw tabulated a number of rates that had a average value of 3.7 mm per year but a range from 0.007 to 40.09 mm per year - clearly one has to be very cautious - there is so much inter-site variability!). But using the more conservative rates if we allow say, 10,000 and 100,000 years (again not unreasonable ages for an individual cave chamber) to elapse we get the following accumulations:

Growth rate/time elapsed	10,000 years	100,000 years
0.01 mm per year	100 mm accumulation	1000 mm accumulation
0.5 mm per year	5,000 mm accumulation	50,000 mm accumulation

What about erosion, I hear you cry? Let's take some surface lowering examples and run them across time too. But we will again take some measured values and extend them across similar periods - and longer.

Surface lowering/time elapsed	10,000 years	100,000 years	1 million years
bare limestone @ Cooleman Plains - 0.007 mm/year	70 mm lowering	700 mm lowering	7 metres lowering
limestone under soil @ Cooleman - 0.029 mm/year	290 mm lowering	2.9 metres lowering	29 metres lowering

What about continental drift? We will tackle this in a slightly different way. Antarctica and Australia separated about 120 million years ago - they are now about 3,800 kilometres apart. What might be the relative rate of movement between the two continents?

(3,800*1000*100)/120,000,000 = ~3.2 centimetres a year!

Australia is said to be colliding with New Guinea at a rate of around 6 centimetres per year - "around the rate that your finger nails grow". This latter statement shows that slow rates that we can "see" daily, when taken with even moderate amounts of time, can lead to big things if let alone.

But, I must caution again about extrapolating across time - too many of the parameters change through time. Play with numbers, by all means, but don't let the "Old Black Magic" (I am listening to "The Very Best of Glenn Miller" as I type!) of numbers hypnotise you - they are not necessarily facts.

We might come back to continental drift and plate tectonics in later ANDYSEZs. But I had better explain my crack about our geologic possession across the Tasman.

Originally all the southern continents and India formed a supercontinent named Gondwana which in turn was a large fragment of a former supercontinent called Pangea. Around 120 Ma, in Early Cretaceous times, Australia and Antarctica began to split apart with Australia moving north. Australia has wandered around the surface of the globe and has occupied both polar and equatorial positions as it drifted around which helps account for the differing climates in the past. Changes in sea level (regressions = falling; transgressions = rising) and climate change account for many of the changes in the geologic record that we see preserved today. Of course climatic and sea level change effects are also modified by tectonic processes - these are the movements of continents, sea-floor rifting, mountain building, faulting and folding and so on.

Australia has had an extremely long and diverse history. The continent is made up of a series of "blocks" - very old crystalline rocks which form the basement of the continent. As these blocks eroded Australia grew towards the east as sediments eroded from the blocks and were deposited in troughs formed by the rifting apart of

the continental plate. Volcanoes developed in the rifting margin and contributed to the continent building. The rifting and building continues today in that part, geologically, of Australia called New Zealand - so there!

Please, please can I have some questions from you, dear reader!