STUDY MATERIAL

ON

GEOLOGICAL TIME SCALE AND BRIEF HISTORY OF EARTH

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The estimate of age of the earth has been a topic of much debate for last several centuries. Until well into nineteenth century based on the biblical stories the age of the Earth was thought to be on 6000 years. Darwin in his famous book 'The Origin of Species' in 1859, estimated the rate of denudation of the Weald anticline in the south-eastern England to conclude that more than 300 million years has elapsed since cretaceous[1]. The estimates from the rates of sedimentation and the total thickness of the Earth's crust, or from the salinity of the ocean etc. obtained much different figures of the same subject. The discovery of radioactivity finally produced acceptable methodologies which could actually assess the age of the Earth based on evidences available[1].

On the basis of the most modern technologies and mathematical modelling now, it is believed that the Universe formed around 13 to 14 Billion years ago. The Earth on the other hand formed dates back to around 4.6 billion years ago. The events taken place therefore, during the evolution of the Earth occupy such a huge frame that, sometimes make it impossible to visualise the pace of events. For instance, if we concise the whole span of Earths age within a year of time, the life span of a normal human being ends almost within half a second, and a blink of eyes cover around a century(precisely 100 years = 0.67 sec). In another metaphoric conversation, if one consider walking down the streets of evolution and sense the scale of Earth's History, then imagining a hundred year per step, a mile takes you 1,75,000 years into the past[2]. Twenty miles a day therefore covers up around 3 million years and to see the birth of Earth you need to walk more than 4 years with the same tenacity. Hence to make sense of the immensity of the Earth's history, the whole range of time has been divided in a hierarchical scheme by geologist.

The largest divisions of the hierarchy are called eons, covering millions of years of development through the origin of the Earth. Hadean, Archean and Proterozoic eon covering the most of the spans of Earth's history do not have any prominent subdivisions. The most recent eon Phenerozoic, since 543 million years ago, is having 3 subdivisions as eras, based on the history of life[3].

Each of the era are further subdivided into Period, Epoch. However, the Carboniferous period of Palaeozoic era and Tertiary period of Cenozoic era are having sub-periods.

In the following pages a table is given with summary of events happened during the evolution of earth and life on the Earth throughout the geological time scale.

Table 1: Geological time scale and important events taken place in Earth's History

EON	ERA	PERIOD		EPOCH	TIME (million years ago)	EVENTS
PHANEROZOIC	Cenozoic	**Quaternary**		Holocene	0.01 – present	Emergence of Modern human Beginning of iron age Release of Iceberge at northern Atlantic / Last glacial
				Pleistocene	1.8 – 0.01	Spread of *Homo spp.* / Origin of *Homo sapience.*
		Tertiary	**Neogene**	Pliocene	5.0 – 1.8	Stone tools in china Arrival of *Homo habilis* followed by *H. erectus* First Hippopotamuses and Mammoths Arrival of *Australopithecus*
				Miocene	24.0 – 5.0	Molecular divergence of Chimp and Human Arrival of *Ramapithecus* Modern lives including cattles and primates disperse through Upliftment of Tibetian platue
			Palaeogene	Oligocene	33.5 – 24.0	Alps and Himalaya formed / First Grazing animals
				Eocene	54.8 – 33.5	Himalaya starts formation / First Whale relatives & Earliest Arthropods
				Palaeocene	65.0 – 54.8	First mammalian primate/ spread of mammals / First Horse KT Extinction event
	Mesozoic	**Cretaceous**			142 – 65	Upper cretaceous (99 – 65 mya): First snake / Extinction of large marine reptiles. India starts moving radially. Lower cretaceous (142 – 99 mya): Maximum sea floor spreading & first flowering plants / Feathered dinosaurs & placental mammals appear.
		Jurassic			199.5 – 142.0	Primitive mammal jaws and first bird (*Archaeopteryx*) appears Madagascar rift from Africa/ India Rift from Australia & Antarctica
		Triassic			252 – 199.5	Largest extinction followed by first primitive mammals & modern shark
	Palaeozoic	**Permian**			290 – 252	Ural mountain formation / Extensive desert form in Lauretia Glaciation in Southern Hemisphere
		Carbonife rous	**Pennsylvanian**		323 – 290	Gondwana converges with laurasia (laurentia & Baltica portion) Development of Corals and Winged Insect First Landsnail and mammal like reptiles

EON	ERA	PERIOD	EPOCH	TIME (million years ago)	EVENTS
		Mississippian		354.0 – 323.0	Low sea level & glaciations / First extensive coal measure forest
		Devonian		418.0 – 354.0	Mass extinction event Oldest terrestrial terapod appears Amalgamation of Laurentia, Avalonia & Baltica to for Laurussia Appearance of Terrestrial animal & wingless insect/ Jawless fish comes to fresh water.
		Silurian		443.0 – 418.0	Mass extinction / lowerd sea level/ first terrestrial vascular plant
		Ordovacian		490.0 – 443.0	Temperature very low/ First Vertibrate Jawless fish First Terrestrial Bryophyte
		Cambrian		543.0 – 490.0	Cambrian explosion of lifeforms Gondwanan continental assmepbly
PROTEROZOIC	**Late**			1000 – 543.0	Glaciations, formation of 2nd and 3rd Snowball Earth
	Middle			1800 – 1000	Multi-cellular eukaryotes appear Amalgamation of Super continent Rodinia and its break
	Early			2500 – 1800	First Snowball earth Oxygen in atmosphere and Oxygen catastrophe First prokaryotes and Eukaryotes appears
ARCHEAN	**Late**			2800 – 2500	High surface temperature falling gradually Oldest Stromatolites
	Middle			3400 – 2800	End of LUCA Microbial photosynthesis starts
	Early			3800 – 3400	Continental crust formation and traces of earliest life
HADEAN				4600 – 3800	Oldest rock evidence Bombardments by planetesimals & meteorites Vapourisation of Oceans Formation of cratons

Further Reading:

1. Emiliani, Cesare. 1992. Planet Earth: Cosmology, Geology and the Evolution of life and Environment. Cambridge University Press. P.719
2. Hazen, Robert M. 2012. The Story of Earth. Viking. P.306.
3. Luhr, James F. 2004. Earth: The Definitive Visula Guide. D.K Publications. P.516
4. USGS Website: https://geomaps.wr.usgs.gov .