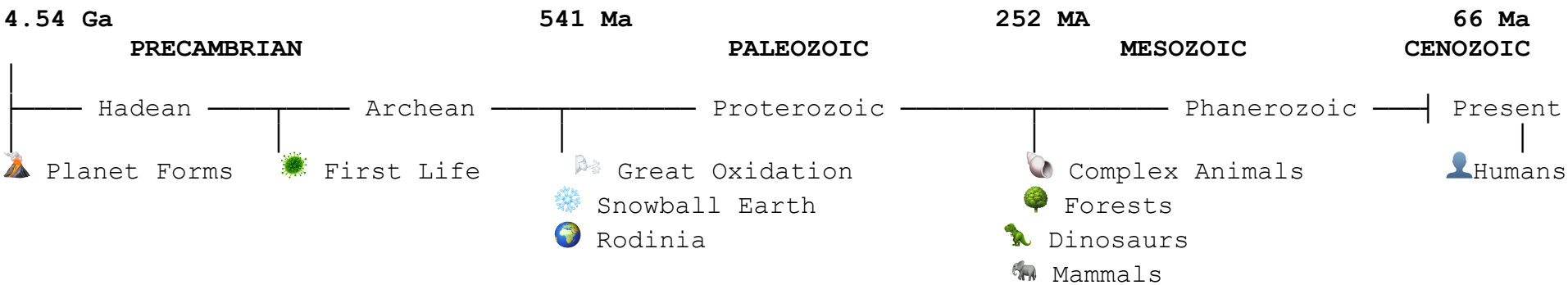


Geological Time & Earth's Chemical Evolution

EARTH HISTORY (4.54 Ga–Today)

	 Time	 Eon / Era / Period	 Key Geological Developments	 Key Chemical & Atmospheric Changes
PRECAMBRIAN	4.5–4.0 Ga	HADEAN	Earth forms; crust cools; oceans begin forming; heavy bombardment	Atmosphere rich in CO ₂ , H ₂ O vapor, N ₂ ; virtually no free oxygen
	4.0–2.5 Ga	ARCHEAN	First continents (cratons); earliest life; proto-supercontinents	Methane-rich atmosphere; biological carbon cycling begins
	2.5–1.6 Ga	PALEOPROTEROZIC	Continental growth; major mountain-building events	 Great Oxidation Event (~2.4 Ga); iron formations deposited
	1.6–1.0 Ga	MESOPROTEROZOIC	Assembly of Rodinia	Oxygen slowly increases; complex cells diversify
	1.0–0.541 Ga	NEOPROTEROZOIC	Rodinia breaks apart; Snowball Earth episodes	Oxygen rises toward modern levels
PALEOZOIC	541–485 Ma	CAMBRIAN	Shallow seas widespread	Cambrian Explosion of animal life
	485–444 Ma	ORDOVICIAN	Marine biodiversity expands	CO ₂ declines; cooling trend begins
	444–419 Ma	SILURIAN	First substantial land plants	Plants begin transforming soils and atmosphere
	419–359 Ma	DEVONIAN	First forests; reef expansion	Increased weathering removes atmospheric CO ₂
	359–299 Ma	CARBONIFEROUS	Vast coal-forming swamps	 Oxygen reaches perhaps 30–35%; massive carbon burial
	299–252 Ma	PERMIAN	Formation of Pangaea	Increasing aridity; volcanic CO ₂ contributes to end-Permian crisis
MESOZOIC	252–201 Ma	TRIASSIC	Pangaea begins rifting	High greenhouse gas levels
	201–145 Ma	JURASSIC	Atlantic Ocean opens	Warm climate; active carbon cycling
	145–66 Ma	CRETACEOUS	Continents approach modern positions	High sea levels; elevated CO ₂
CENOZOIC	66–23 Ma	PALEOGENE	Mammals diversify; major mountain building	Long-term CO ₂ decline begins cooling Earth
	23–2.58 Ma	NEOGENE	Uplift of Himalayas and other ranges	Expansion of grasslands; continued CO ₂ decline
	2.58 Ma–11.7 ka	PLEISTOCENE	Repeated Ice Ages	CO ₂ fluctuates with glacial cycles
	11.7 ka–Today	HOLOCENE	Human civilization develops	Rapid rise in CO ₂ , CH ₄ , and reactive nitrogen

EARTH LIFE SYSTEMS EVOLUTION



NOTE: Ga = Billion years ago MA = Million years ago ka = Thousand years ago