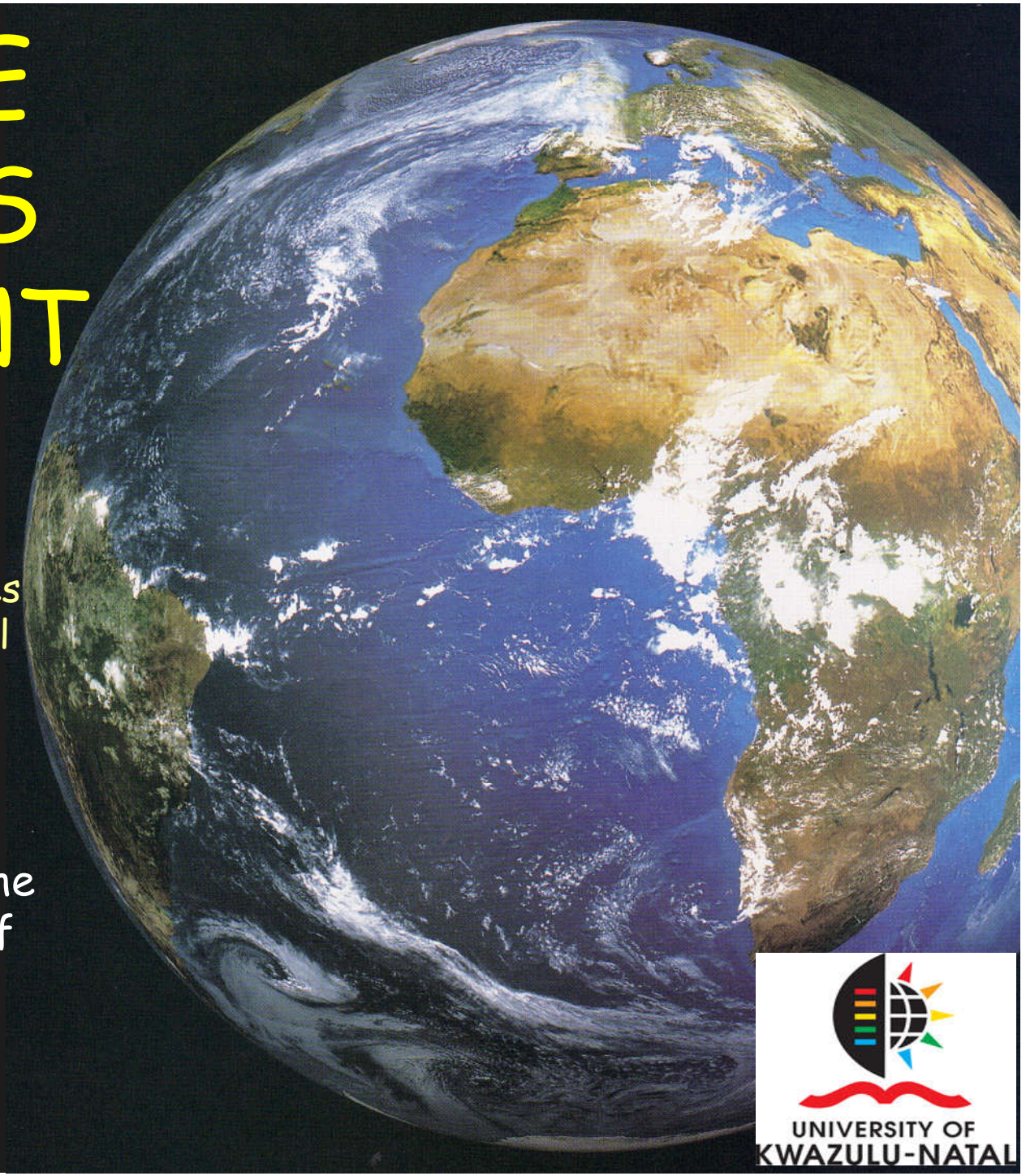
WHY THE EARTH IS DIFFERENT



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Biennial Symposium of the Astronomical Society of South Africa

Durban Country Club

7th-9th August 2008

UNIVERSITY OF KWAZULU-NATAL

SCIENCE VERSUS ??????

ASTRONOMY & ASTROLOGY

GEOLOGY & GEOGRAPHY

Typical member of ASSA?

GEOLOGY

INVOLVES UNDERSTANDING:

THE EVOLUTION OF ENVIRONMENTS

ON, IN AND AROUND THE EARTH

SINCE THE FORMATION OF THE EARTH 4500 MILLION YEARS AGO TO THE PRESENT DAY

AS WELL AS ENVIRONMENTS ON, IN AND AROUND OTHER PLANETS

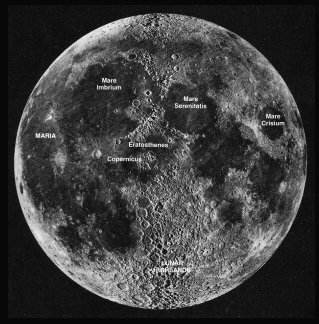
INVOLVES STUDYING ROCKS AND FOSSILS BECAUSE:

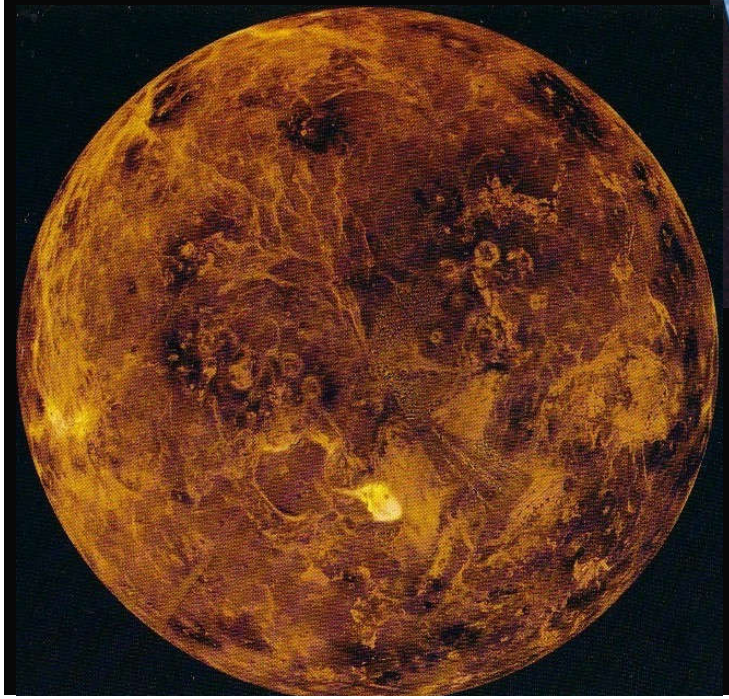
ROCKS PRESERVE THE RECORD OF THE PHYSICAL AND CHEMICAL EVOLUTION OF ENVIRONMENTS THROUGH TIME

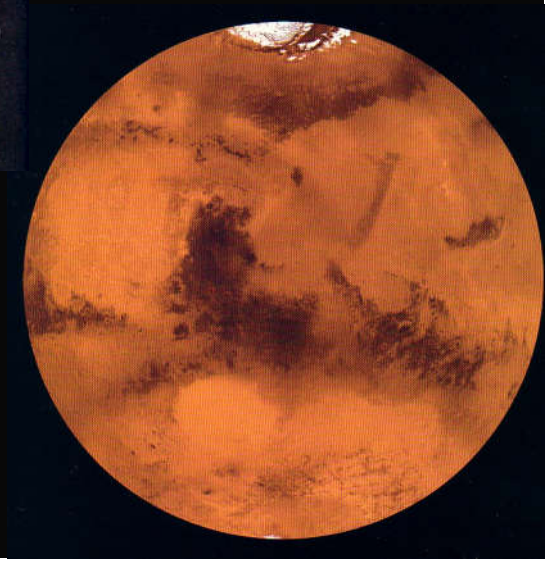
WHILE FOSSILS RECORD THE BIOLOGICAL EVOLUTION THROUGH TIME

GEOLOGY IS THE "SCIENCE OF THE EARTH"

HOLIDAY PHOTOS TAKEN BY AN ALIEN THROUGH HIS/HERS/ITS UFO WINDOW







DIFFERENCES BETWEEN THE EARTH AND THE OTHER ROCKY PLANETS

SURFACE NOT CRATERED

HAS A LARGE MOON

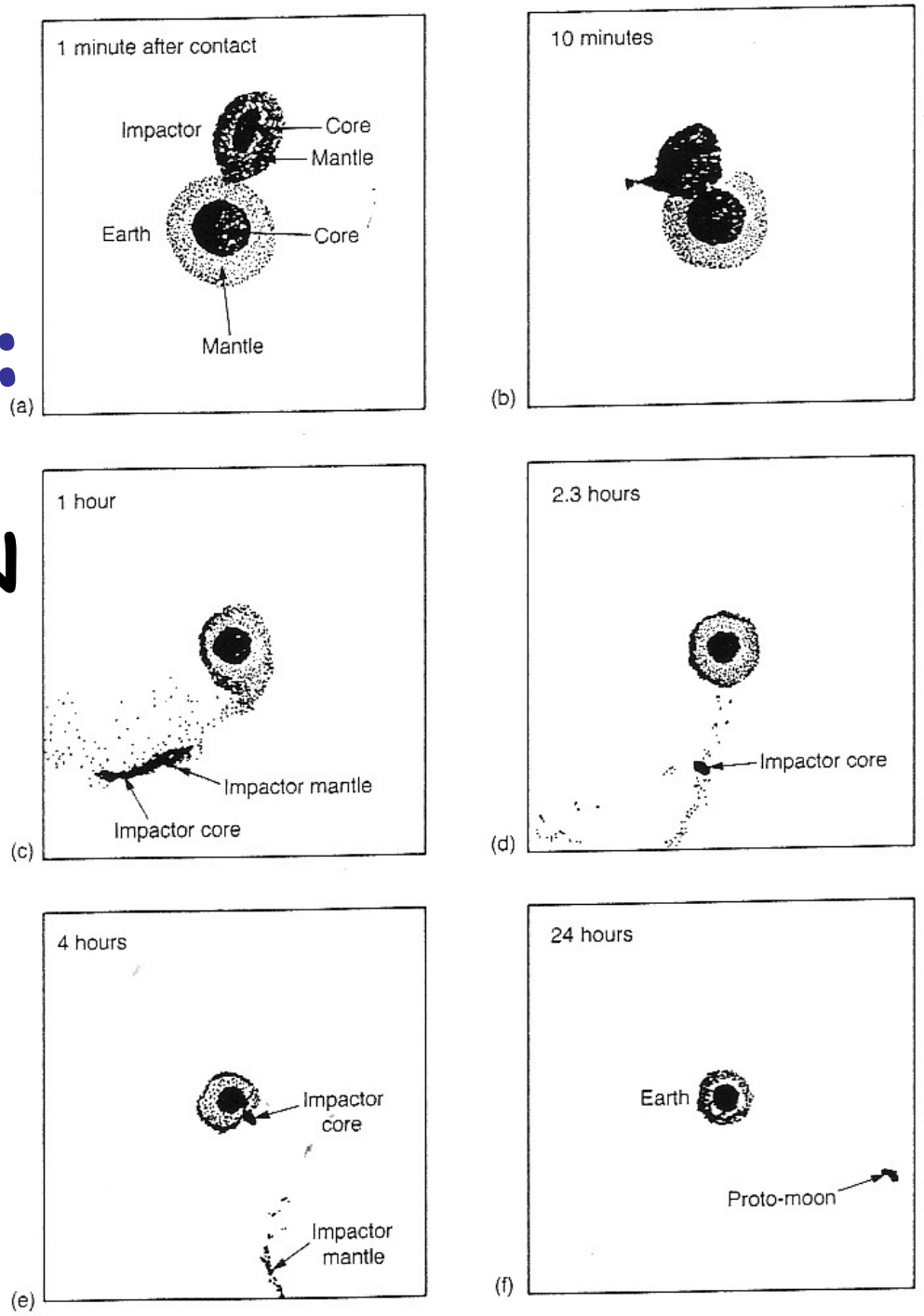
HAS LIFE IN AIR, ON LAND IN THE OCEANS AND IN THE ROCKS

SURFACE LARGELY COVERED BY OCEANS

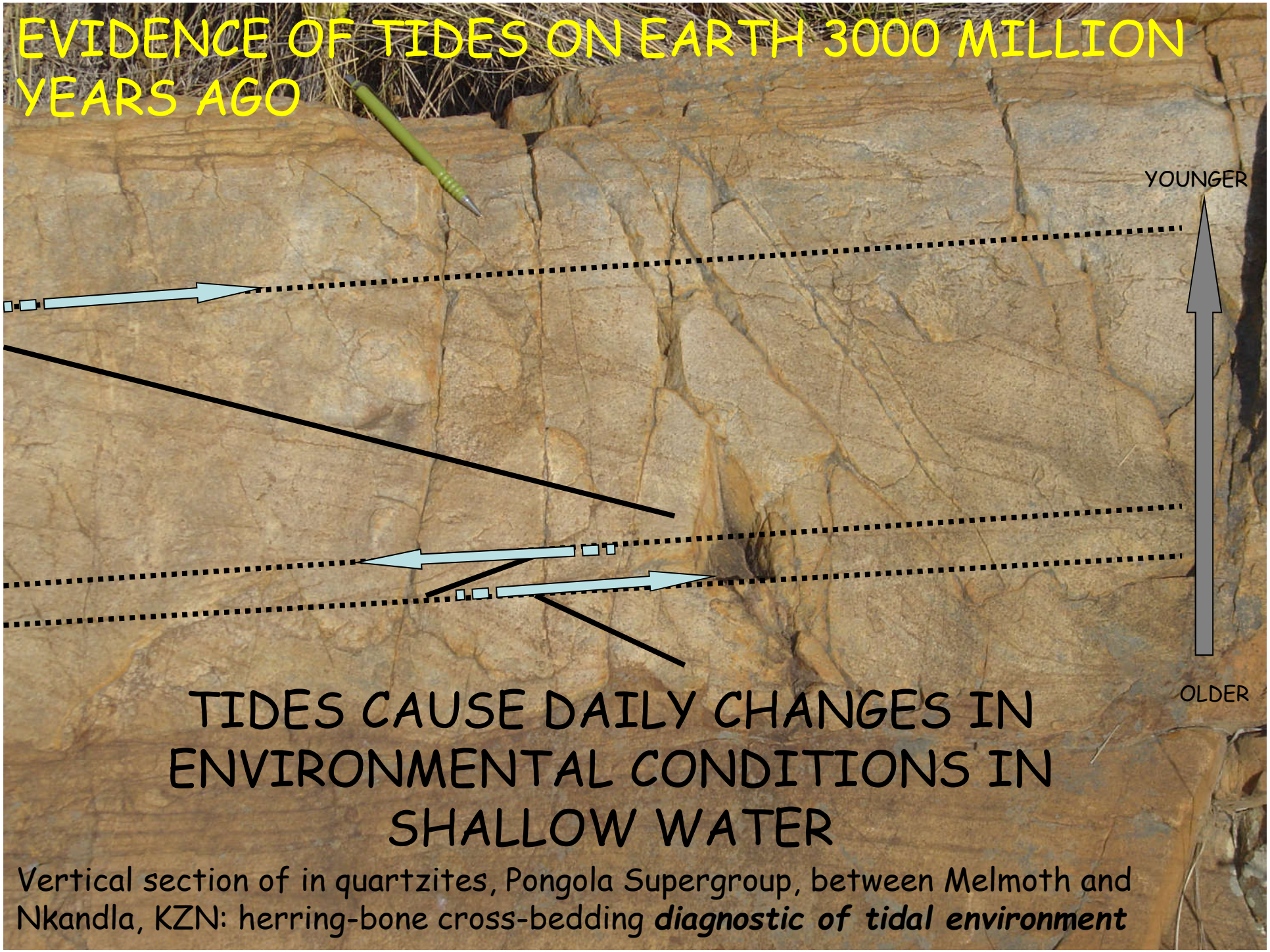
ORIGIN OF EARTH'S LARGE MOON:

FORMATION OF THE EARTH-MOON SYSTEM

"BIG BUMP"
JUST BEFORE
4 500 MILLION
YEARS AGO



EVIDENCE OF TIDES ON EARTH 3000 MILLION YEARS AGO



TIDES CAUSE DAILY CHANGES IN ENVIRONMENTAL CONDITIONS IN SHALLOW WATER

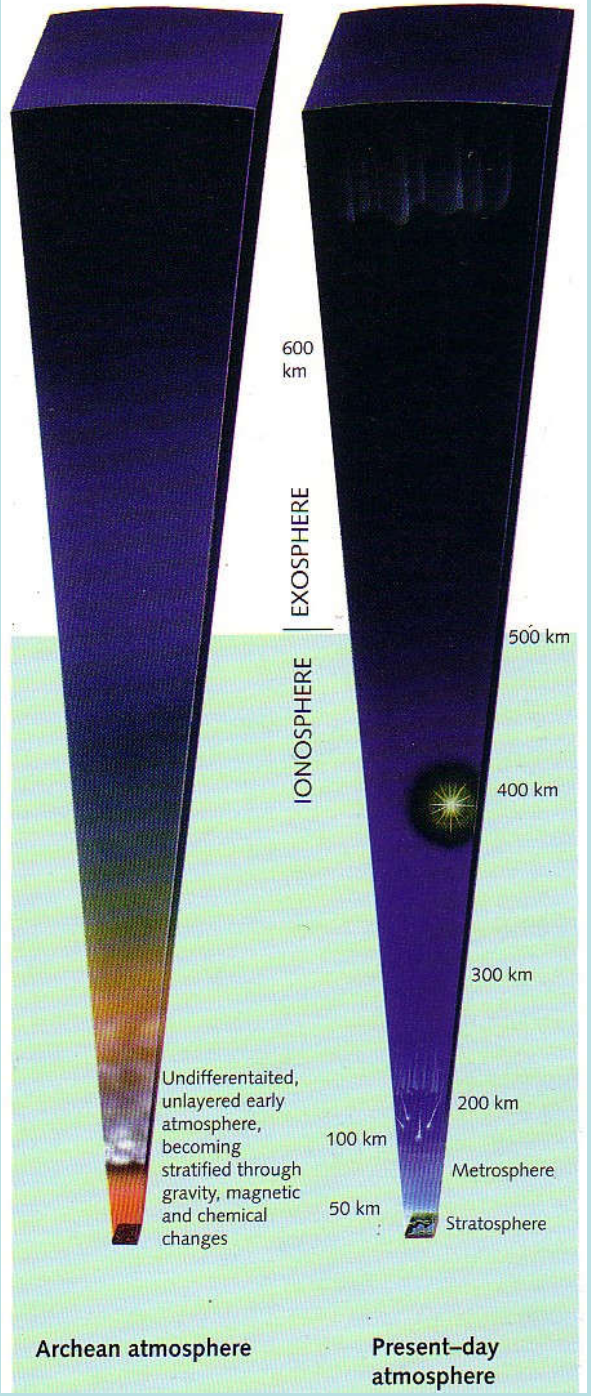
Vertical section of in quartzites, Pongola Supergroup, between Melmoth and Nkandla, KZN: herring-bone cross-bedding ***diagnostic of tidal environment***

ORIGIN OF THE EARTH'S OCEANS

- DEGASSING OF ATMOPHILE ELEMENTS FROM MAGMA OCEAN DURING EARLY EARTH FORMATION

- ATMOSPHERE CHANGED FROM ARCHAEAN TO THE PRESENT:
  - FROM UNSTRATIFIED TO STRATIFIED
  - IN COMPOSITION
- PRESENT ATMOSPHERE,

N_2	78%
O_2	21%
Ar	0.93%
CO_2	0.03%
H_2O	variable



AMOUNTS OF H_2O AND CO_2 COMING OUT OF THE EARLY EARTH MAGMA OCEAN WAS CONSIDERABLY MORE THAN IN THE ATMOSPHERE TODAY:

SO WHERE HAVE THEY GONE?

- H_2O HAS FORMED THE OCEANS
- WHAT ABOUT THE CO_2 ?
  - Not in the atmosphere
  - Surely not in the oceans as water is H_2O and not CO_2 ?

MOST CO_2 IS IN THE OCEANS:

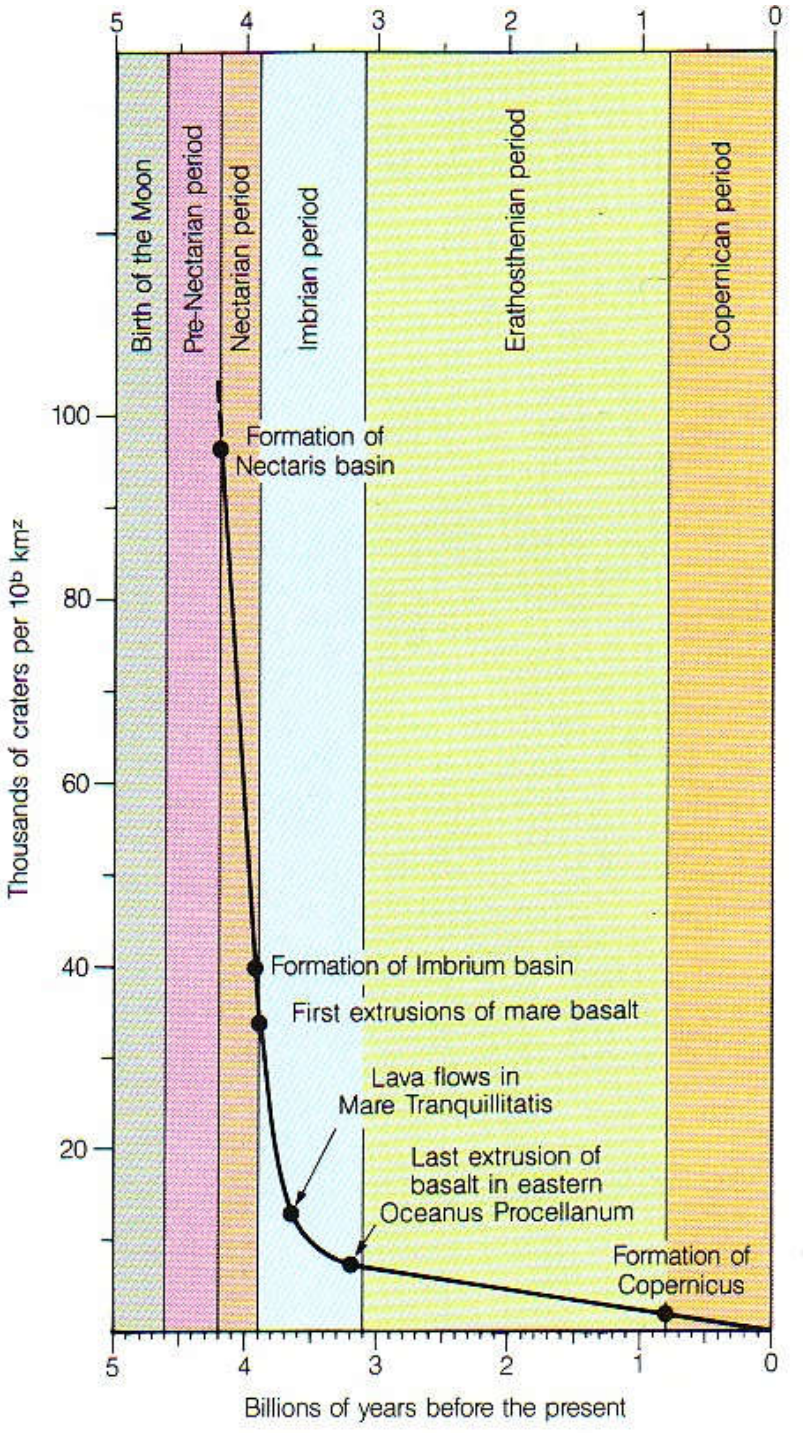
- DEPOSITED AS CALCIUM CARBONATE $CaCO_3$: LIMESTONE
- BUT SOLUBILITY OF $CaCO_3$ INCREASES WITH DEPTH
  - BELOW THE *CARBONATE COMPENSATION DEPTH*, OCEAN WATER IS UNDERSATURATED WITH RESPECT TO CALCIUM CARBONATE
    - Beneath these depths, shells settling on bottom are dissolved
      - 3 km in Pacific
      - 4.5 km in Atlantic
- THE EARTH AND VENUS HAVE THE SAME AMOUNT OF CO_2
  - THE LACK OF OCEANS ON VENUS HAS RESULTED IN THE CO_2 BEING IN THE ATMOSPHERE
    - CAUSE OF THE RUNAWAY GREENHOUSE EFFECT

WHY THE SURFACE OF EARTH IS NOT CRATERED

- EARLIEST CRUST ON EARTH MUST HAVE BEEN BOMBARDED BY METEORITES

Deduced from rate of cratering on the Moon

Oldest rocks on Earth are almost 4 billion years old



- METEORITE BOMBARDMENT PUMMELLED EARTH'S EARLY SURFACE
  - FORCED OCEAN WATER BACK INTO THE MANTLE
- LOWERED THE MELTING POINT OF MANTLE
  - ALLOWED THERMAL CONVECTION OF MANTLE TO TAKE PLACE
    - ROCKS FLOW BY A PROCESS OF CREEP WHEN AT 2/3 MELTING TEMPERATURE
- RESULTED IN PLATE TECTONICS
  - CONTINUOUS TURNING OVER OF THE EARTH'S SURFACE
- THEREFORE THE CRATERED SURFACE WAS REWORKED AND DESTROYED

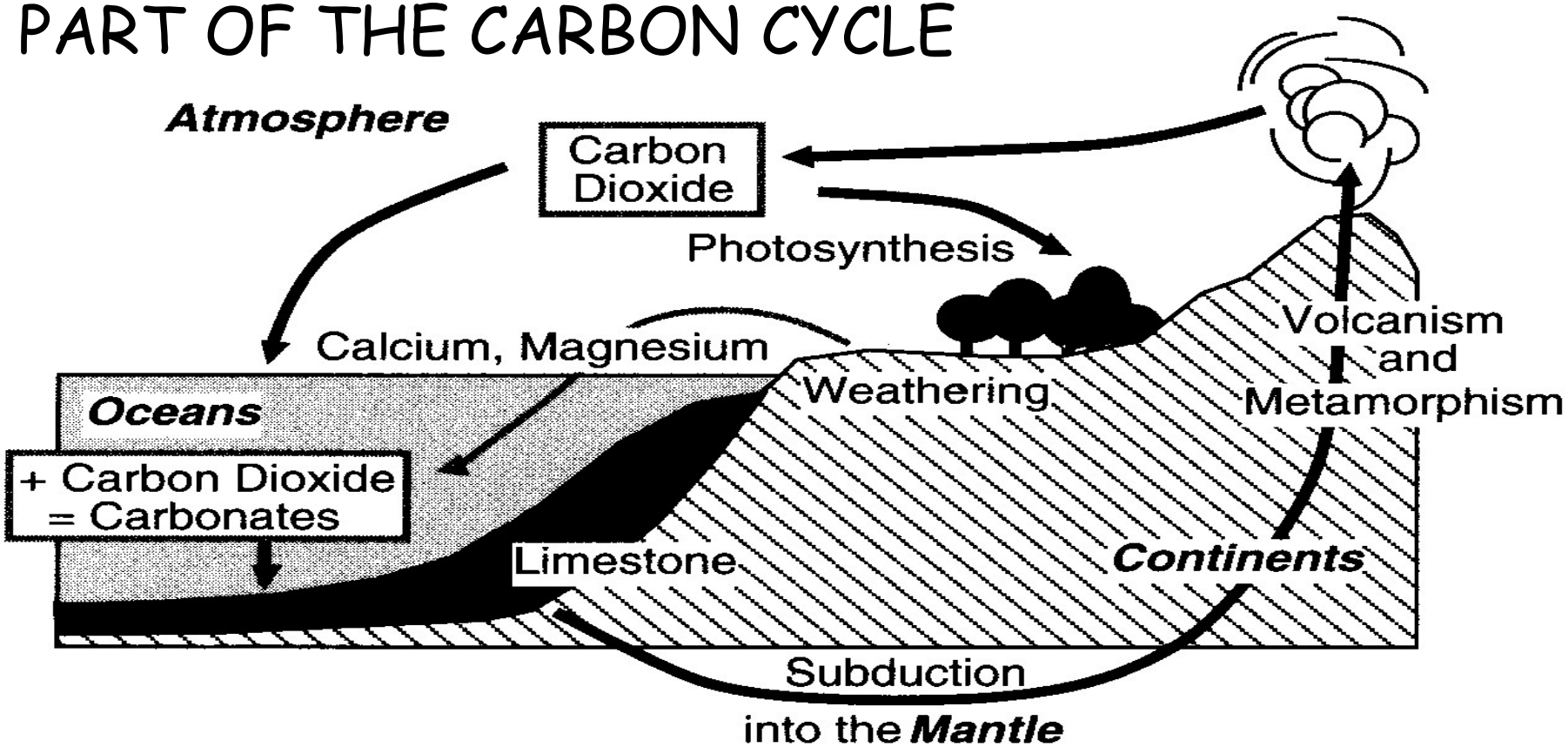
THE SOUTHERN HEMISPHERE DURING THE PAST 200 MILLION YEARS

WINDOW TAB

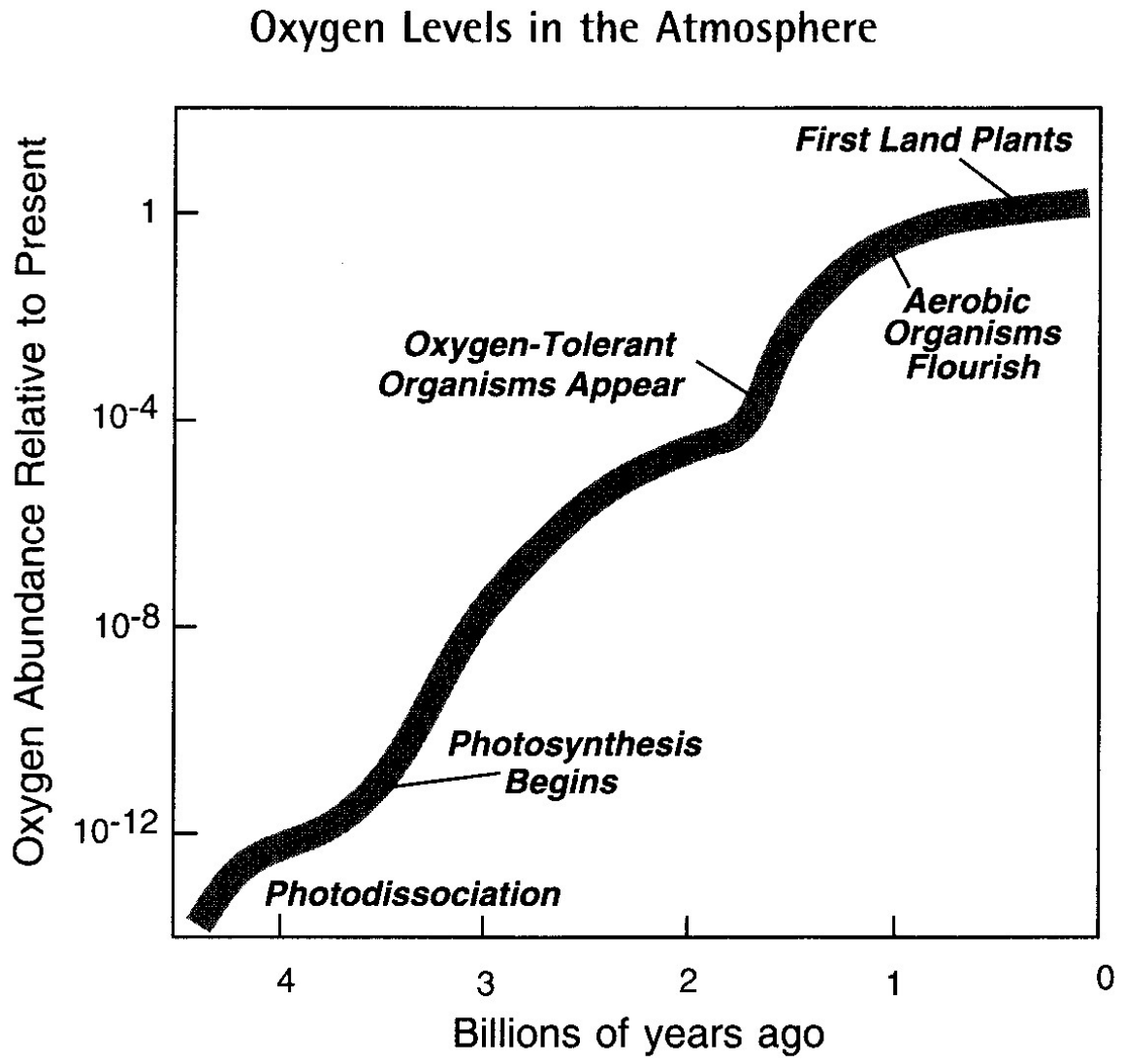
EFFECTS OF LIFE ON EARTH

CO_2 USED IN PHOTOSYNTHESIS

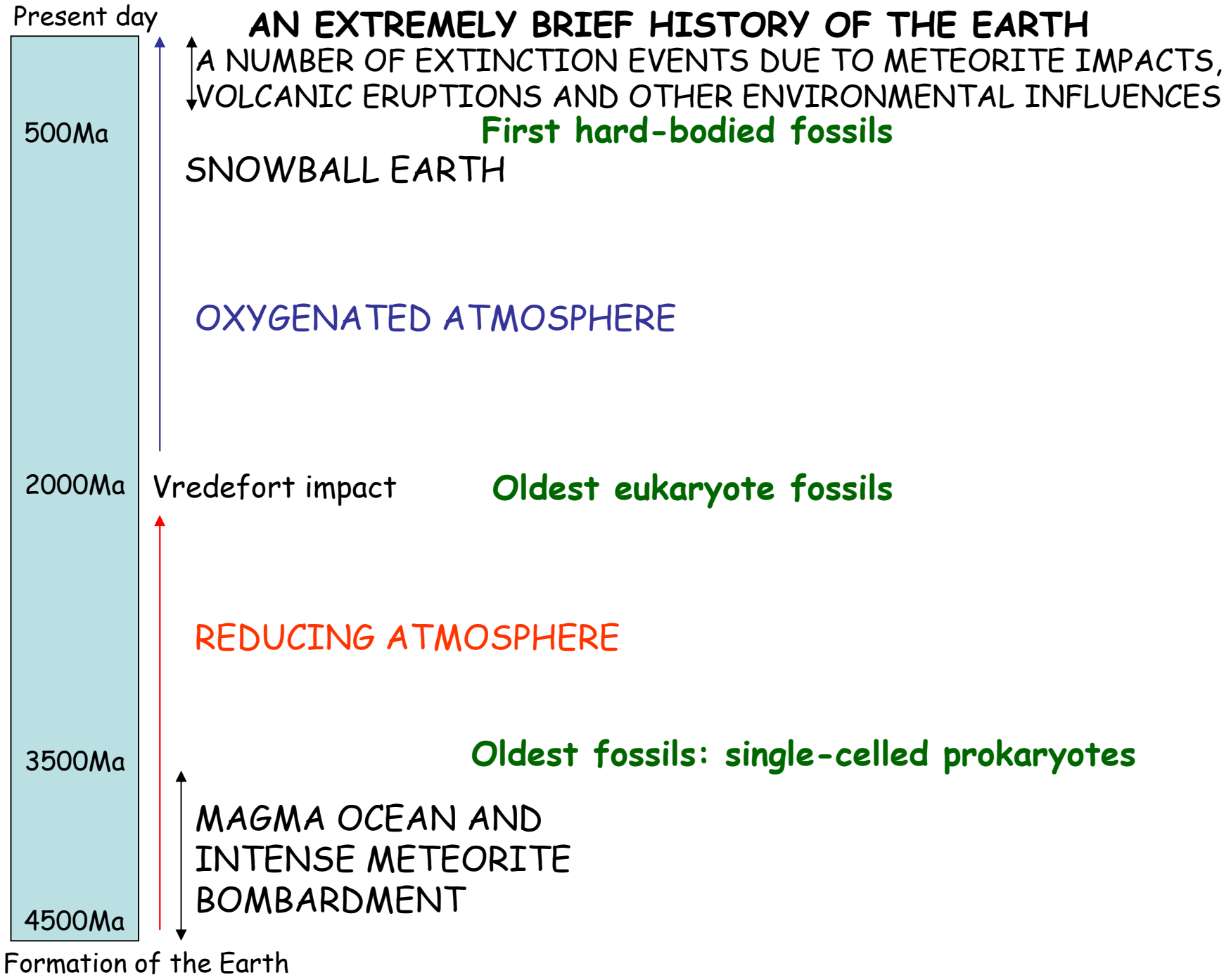
- PROCESS CONVERTS CO_2 AND H_2O INTO CARBOHYDRATES
- RELEASES O_2
- PART OF THE CARBON CYCLE



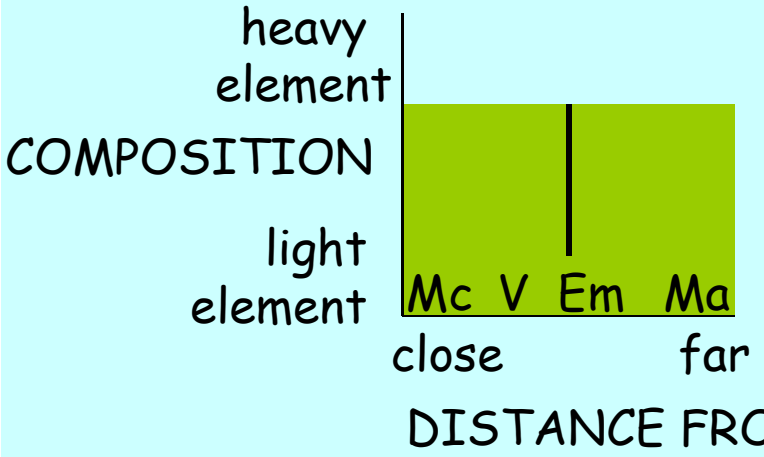
- CHANGE IN COMPOSITION OF THE EARTH'S ATMOSPHERE WITH TIME CAUSED BY BIOLOGICAL PROCESSES



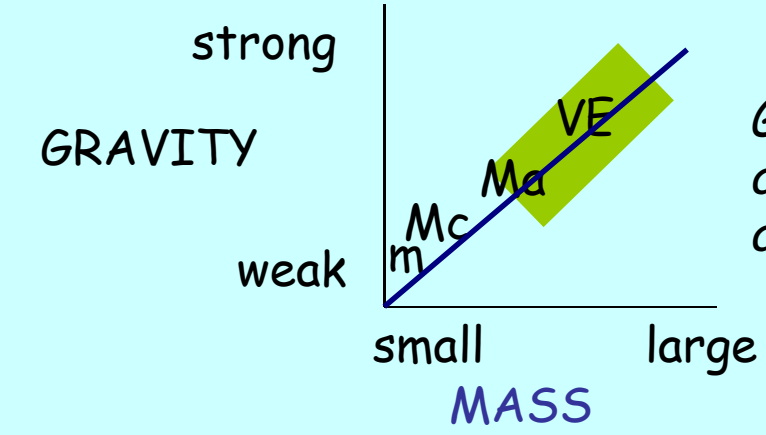
AN EXTREMELY BRIEF HISTORY OF THE EARTH



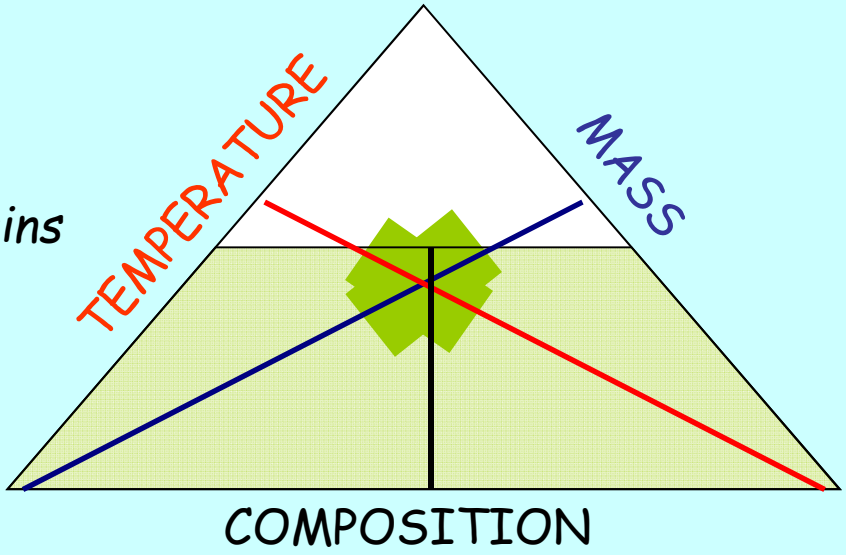
PHYSIO-CHEMICAL CONTROLS THAT MAKE THE EARTH DIFFERENT

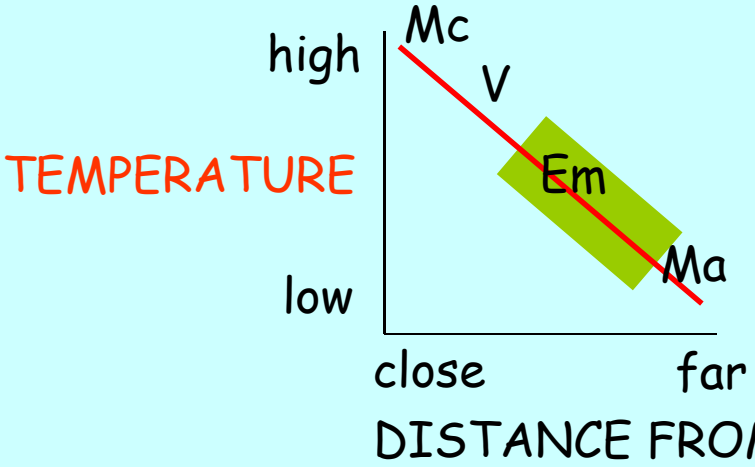


Elements with light to medium mass required for life



Gravity retains atmosphere and oceans





Temperature controls whether water in is solid, liquid or gaseous state

A CONCEPTUAL MODEL

WHY THE EARTH IS DIFFERENT

POSITION AND SIZE

THE EARTH WAS ORIGINALLY MADE OF *THE RIGHT STUFF*

IT THEN UNDERWENT *A SERIES OF UNFORTUNATE EVENTS*