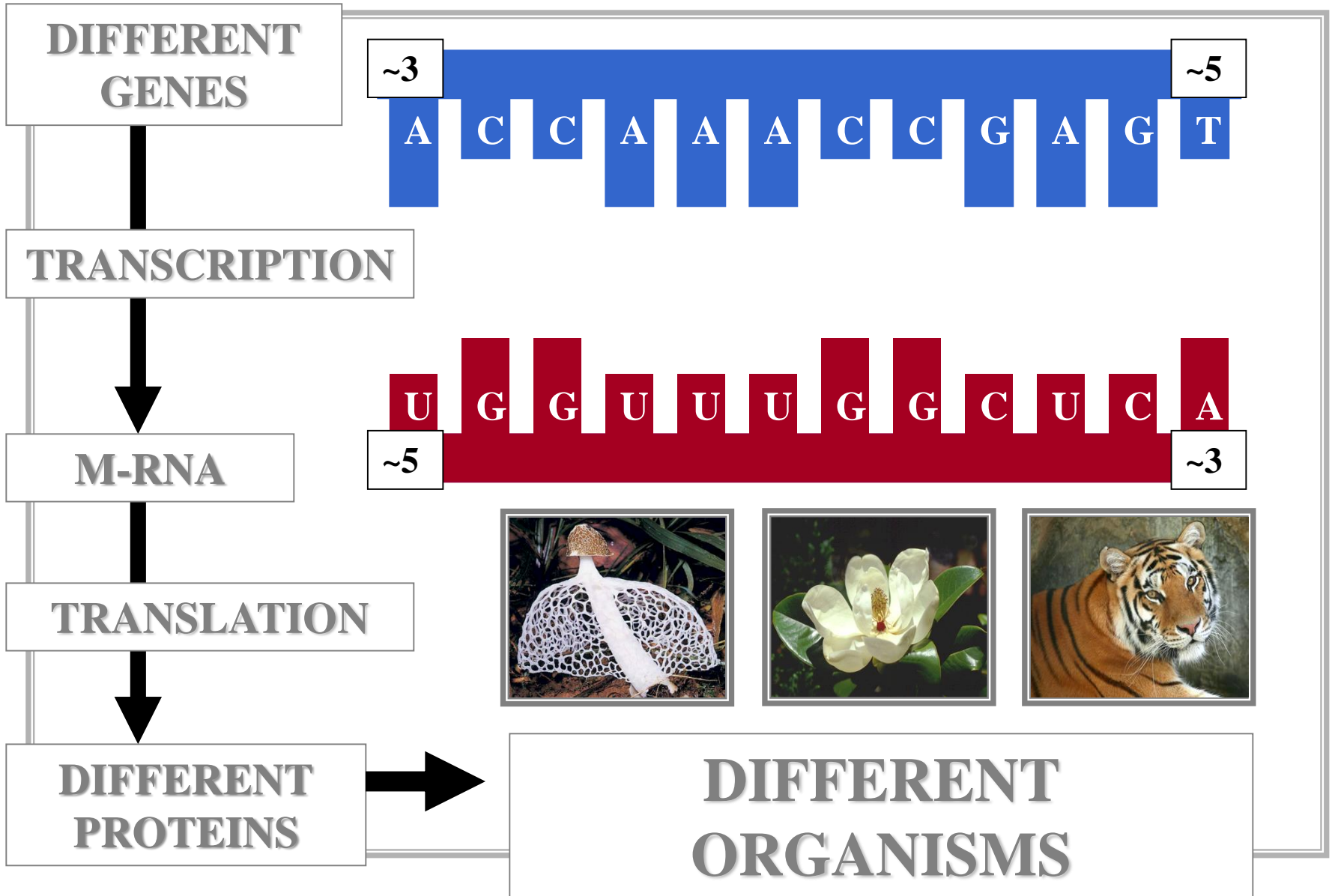


PROTEIN SYNTHESIS





FUNGUS DIVERSITY





PLANT DIVERSITY





ANIMAL DIVERSITY



HUMAN DIVERSITY

D



HUMAN DIVERSITY



CHARACTER DIFFERENCES

HUMAN DIVERSITY



DIFFERENT DNA



CHARACTER DIFFERENCES

HUMAN DIVERSITY

D



DIFFERENT DNA NUCLEOTIDE SEQUENCES



CHARACTER DIFFERENCES

HUMAN DIVERSITY

D



DIFFERENT GENES



CHARACTER DIFFERENCES

HUMAN DIVERSITY

D



DIFFERENT PROTEINS



CHARACTER DIFFERENCES

HUMAN DIVERSITY



DIFFERENT CHARACTER TRAITS



CHARACTER DIFFERENCES

HUMAN DIVERSITY



DIFFERENT ORGANISM



CHARACTER DIFFERENCES

HUMAN DIVERSITY

A

P

>



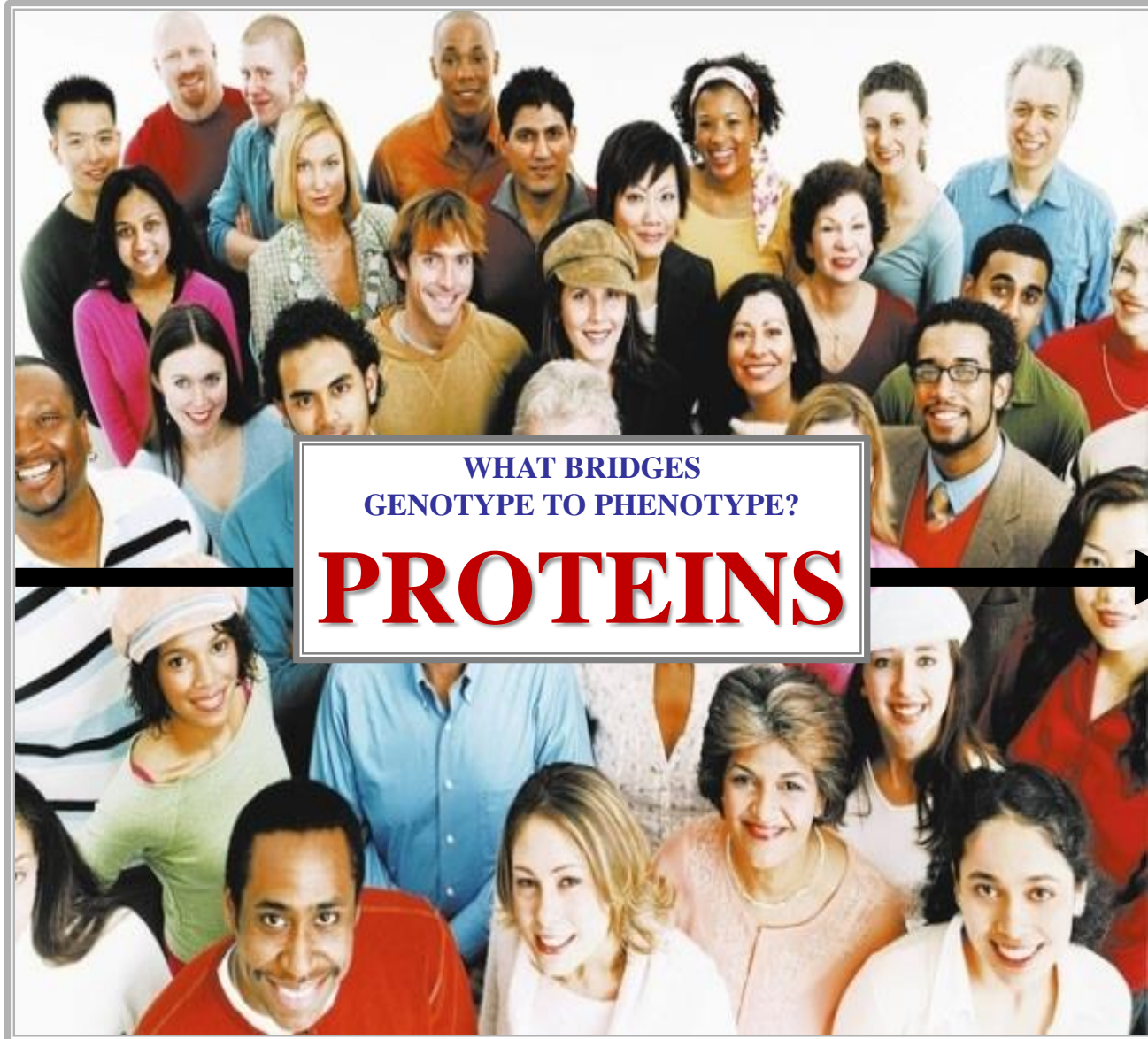
**DIFFERENT
GENOTYPE
GENES**

**WHAT BRIDGES
GENOTYPE TO PHENOTYPE?**

**DIFFERENT
PHENOTYPE
EXPRESSION**

CHARACTER DIFFERENCES

HUMAN DIVERSITY



**DIFFERENT
GENOTYPE
GENES**

**WHAT BRIDGES
GENOTYPE TO PHENOTYPE?**

PROTEINS

**DIFFERENT
PHENOTYPE
EXPRESSION**

CHARACTER DIFFERENCES

CHAPTER 25

ORIGIN OF LIFE



BIOGENESIS CHRONOLOGY

BIOGENESIS
CHRONOLOGY
ACRONYMS

**BIOGENESIS
CHRONOLOGY ACRONYMS**

BYA = BILLION YEARS AGO

**BIOGENESIS
CHRONOLOGY ACRONYMS**

BIOGENESIS CHRONOLOGY ACRONYMS

BYA = BILLION YEARS AGO

**DMBO = DOUBLE MEMBRANE
BOUND ORGANELLES**

**BIOGENESIS
CHRONOLOGY ACRONYMS**



BIOGENESIS CHRONOLOGY ACRONYMS

BYA = BILLION YEARS AGO

**DMBO = DOUBLE MEMBRANE
BOUND ORGANELLES**

→ = OUTCOME

BIOGENESIS CHRONOLOGY ACRONYMS

QUESTION

**HOW OLD
IS THE UNIVERSE?**

QUESTION



~14

BILLION YEARS

UNIVERSE ORIGIN



~14 BILLION YEARS AGO

UNIVERSE ORIGIN

UNIVERSE ORIGIN



PRIMORDIAL NUCLEUS

UNIVERSE ORIGIN

UNIVERSE ORIGIN



PRIMORDIAL NUCLEUS

UNSTABLE

A large, bright, spherical explosion of orange and yellow fire and debris is centered in the frame. The explosion is set against a dark, star-filled space background. A thin, curved, orange-brown band, possibly representing a planet's horizon or a ring, passes behind the explosion. The word "EXPLODED" is superimposed on the explosion in a white box with a black border.

EXPLODED

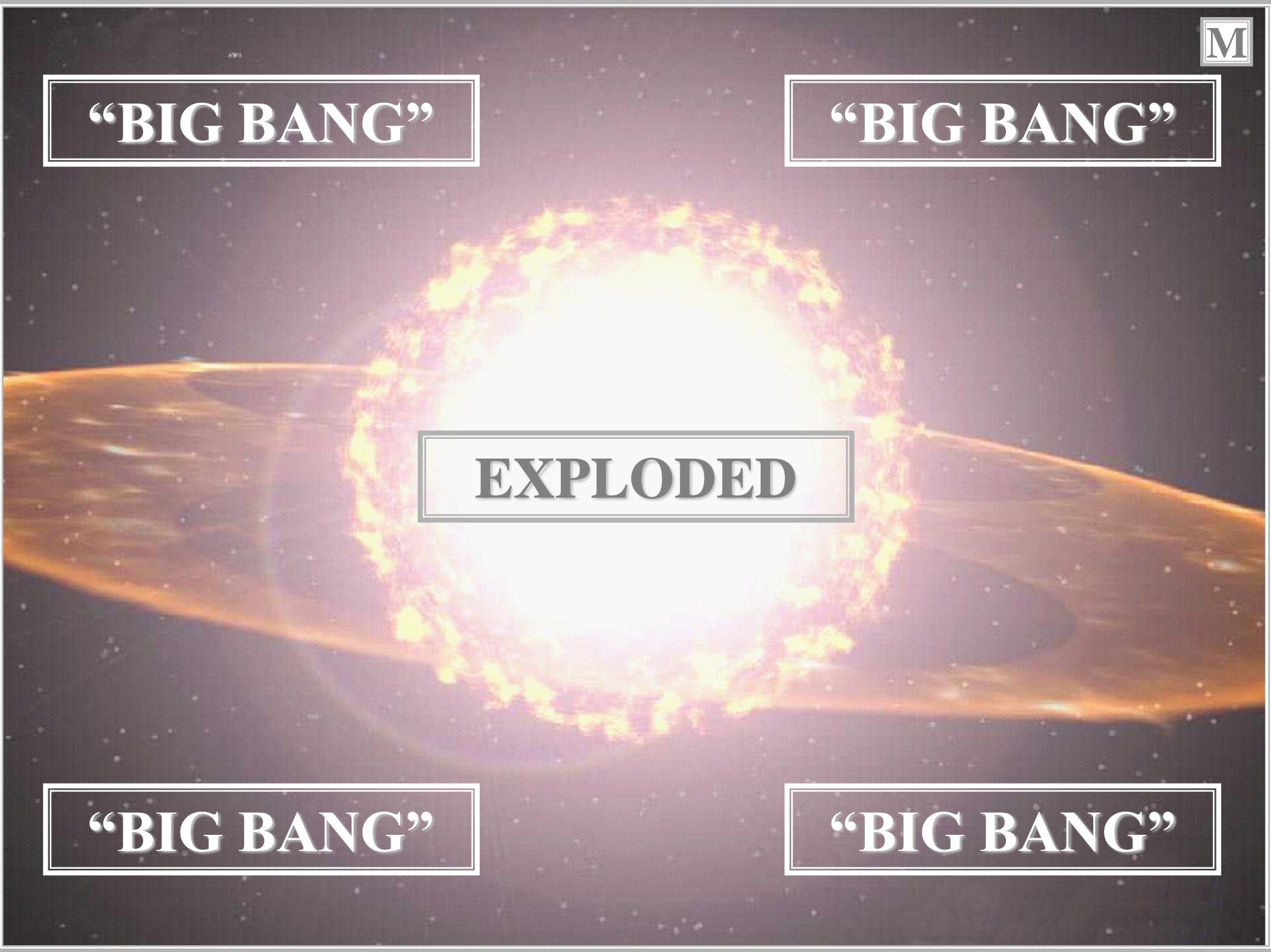
“BIG BANG”

“BIG BANG”

EXPLODED

“BIG BANG”

“BIG BANG”



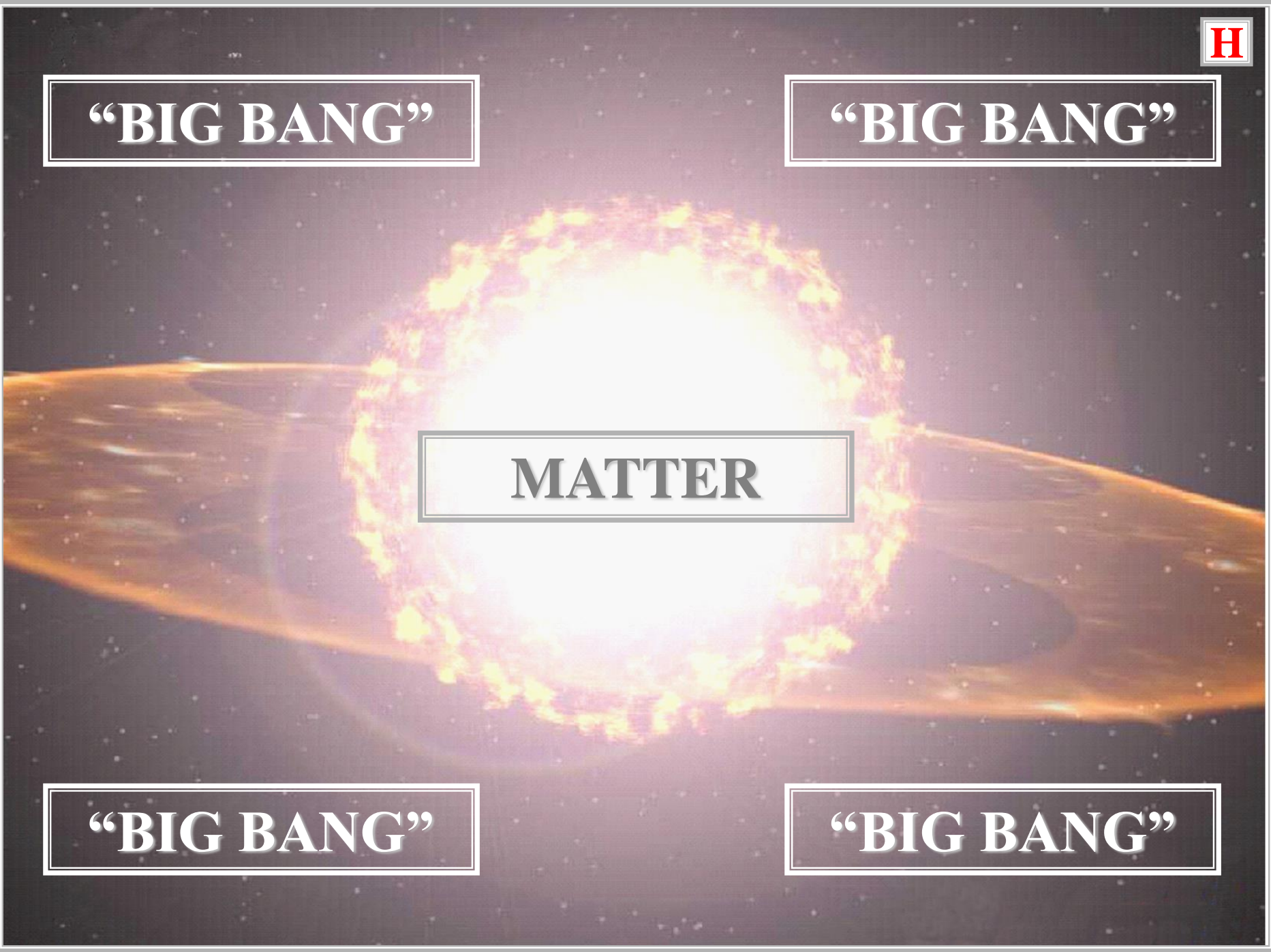
“BIG BANG”

“BIG BANG”

MATTER

“BIG BANG”

“BIG BANG”





“BIG BANG”

“BIG BANG”

HYDROGEN

“BIG BANG”

“BIG BANG”



HYDROGEN CLOUDS

**AGGREGATION
HYDROGEN GAS**

HYDROGEN CLOUDS

STARS

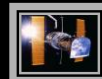




STARS

**AGGREGATION DEEP SPACE
STARS**

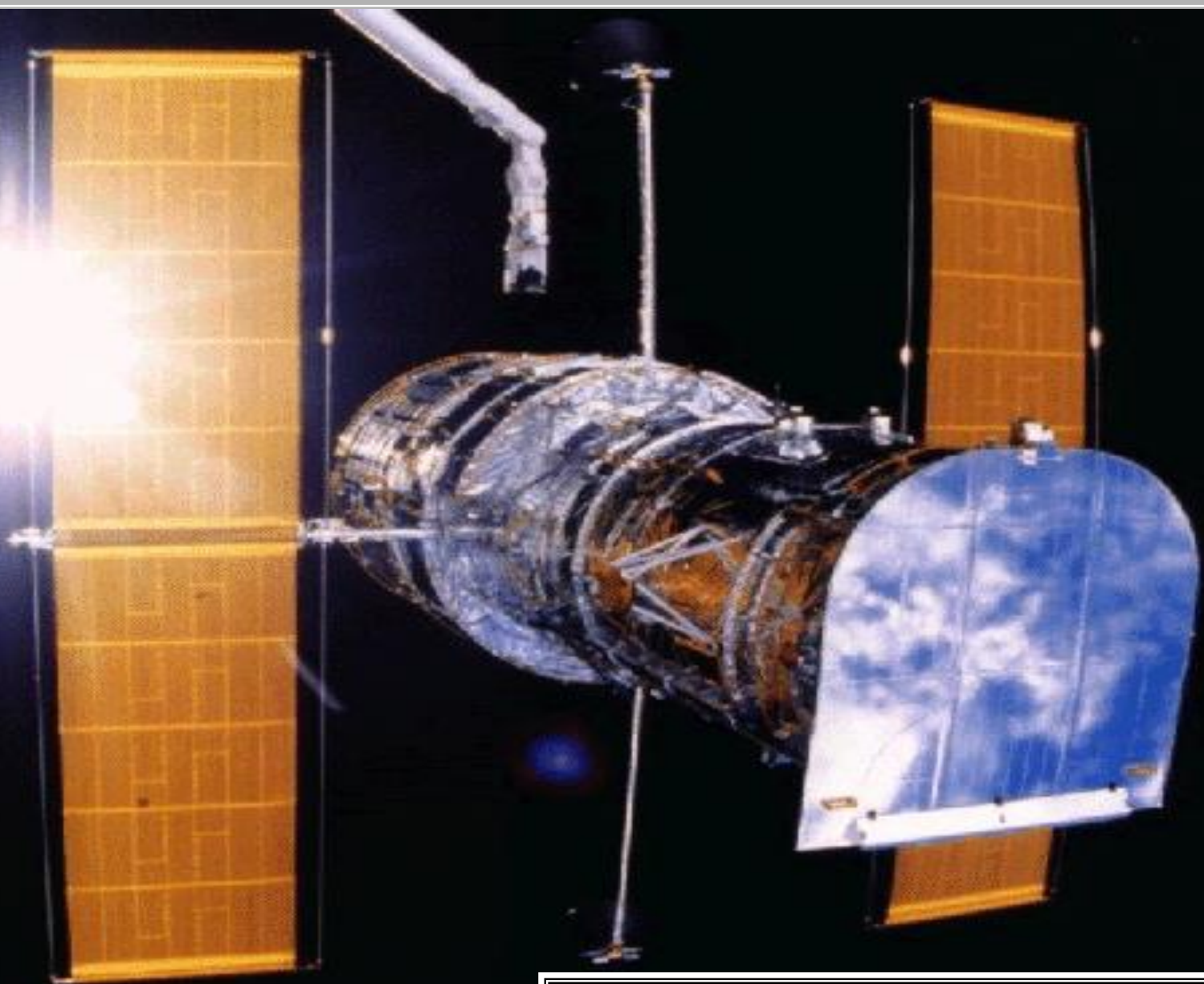
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GALAXY



HUBBLE TELESCOPE



HUBBLE TELESCOPE



#

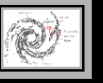
PHOTO DEEP SPACE



~100 BILLION GALAXIES



?



MILKYWAY GALAXY



SAGITTARIUS ARM



ORION ARM



ETA CARINAE



SUN



MONOCEROS R2



ORION NEBULA



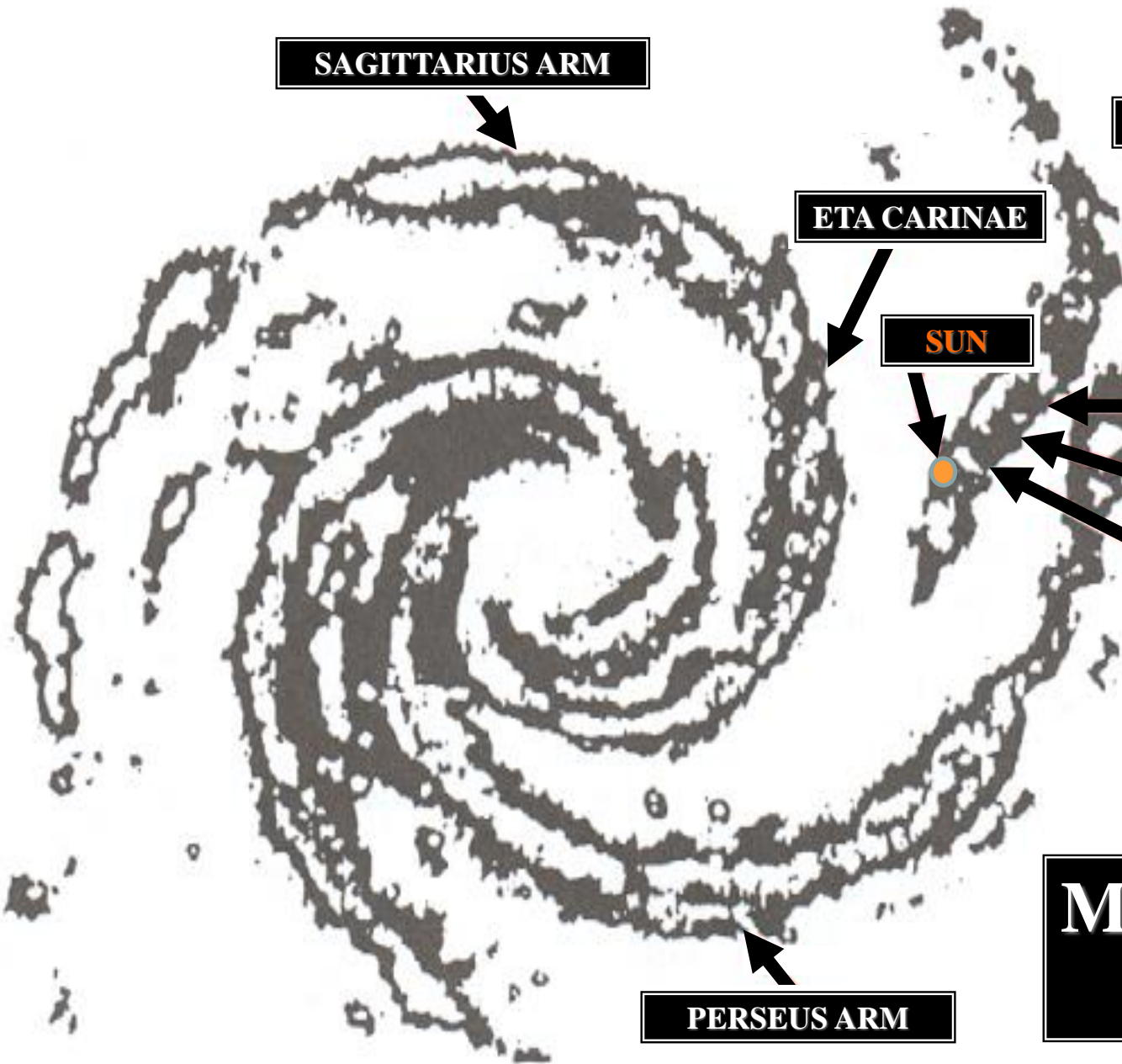
HYADES



PERSEUS ARM



MILKYWAY GALAXY



QUESTION

HOW OLD IS OUR STAR?

QUESTION



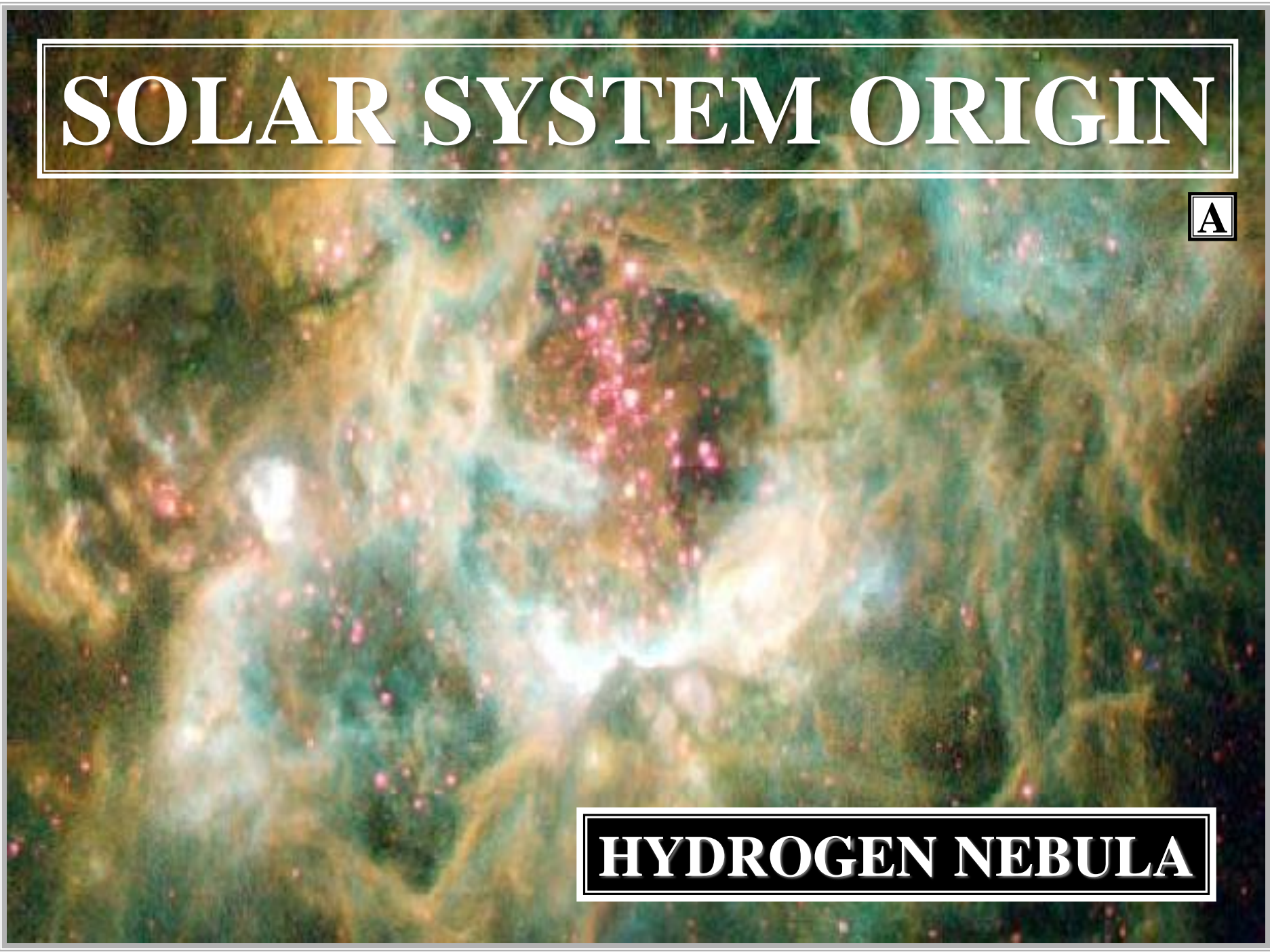
~5

BILLION YEARS

SOLAR SYSTEM ORIGIN

A

HYDROGEN NEBULA



SOLAR SYSTEM ORIGIN



**AGGREGATION
INTERSTELLAR HYDROGEN**

HYDROGEN NEBULA



SUN / STAR ORIGIN

H

P

HYDROGEN

STAR / SUN

HEAT

HYDROGEN

PRESSURE

STAR / SUN



**HYDROGEN
FUSION RXTS**

STAR / SUN



**HYDROGEN
FUSION REACTIONS**



HELIUM

STAR / SUN



**HYDROGEN
FUSION REACTIONS**



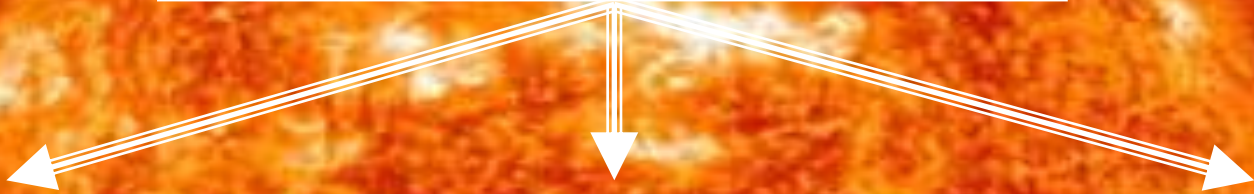
HELIUM

HEAT

STAR / SUN



HYDROGEN FUSION REACTIONS



HELIUM

HEAT

EM-EGY

STAR / SUN

HYDROGEN FUSION REACTIONS

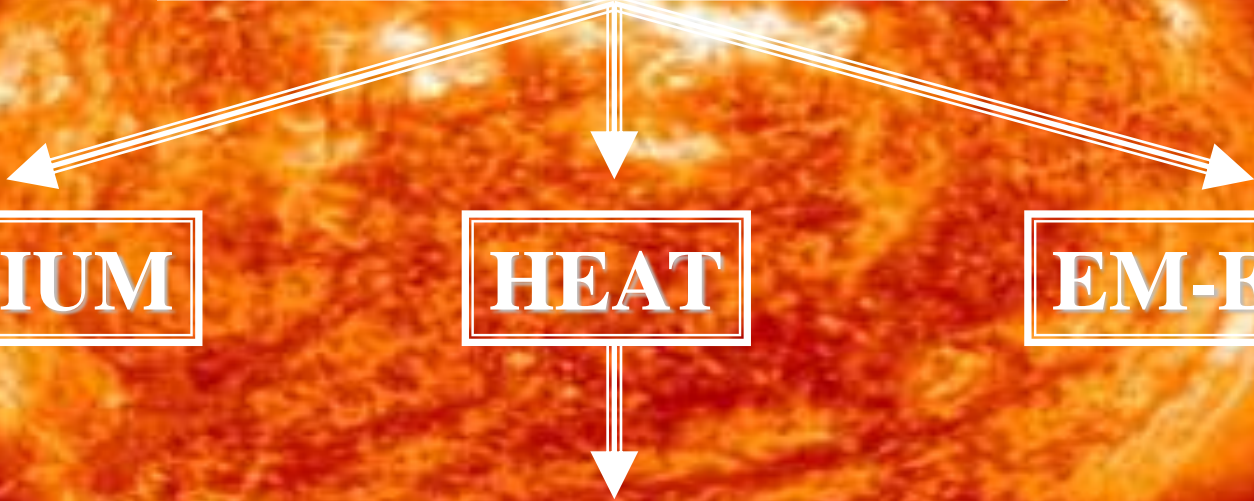
HELIUM

HEAT

EM-EGY



STAR / SUN





HYDROGEN FUSION REACTIONS

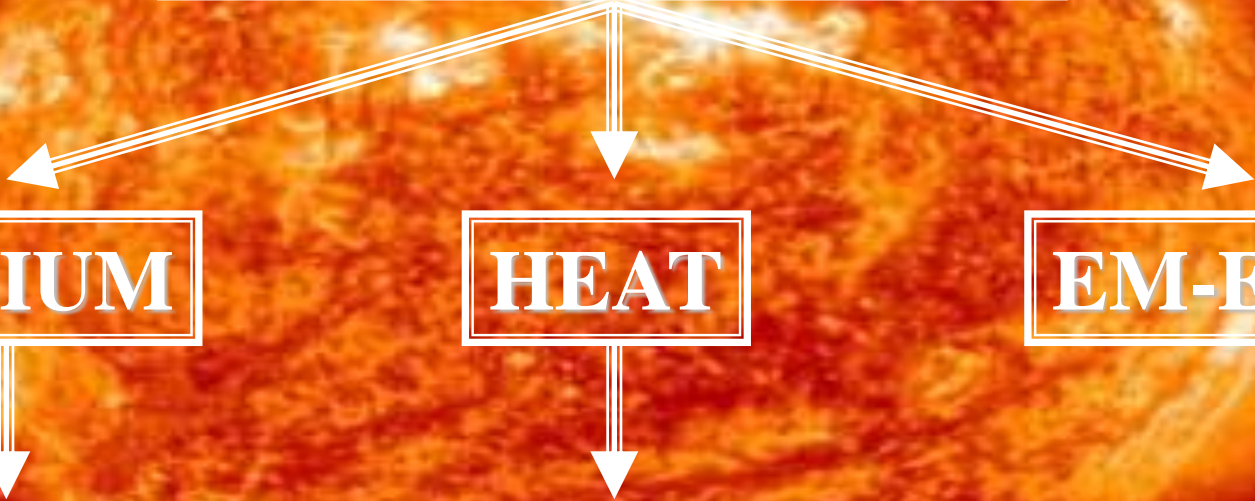
HELIUM

HEAT

EM-EGY

DISSIPATES INTO SPACE

STAR / SUN



HYDROGEN FUSION REACTIONS

HELIUM

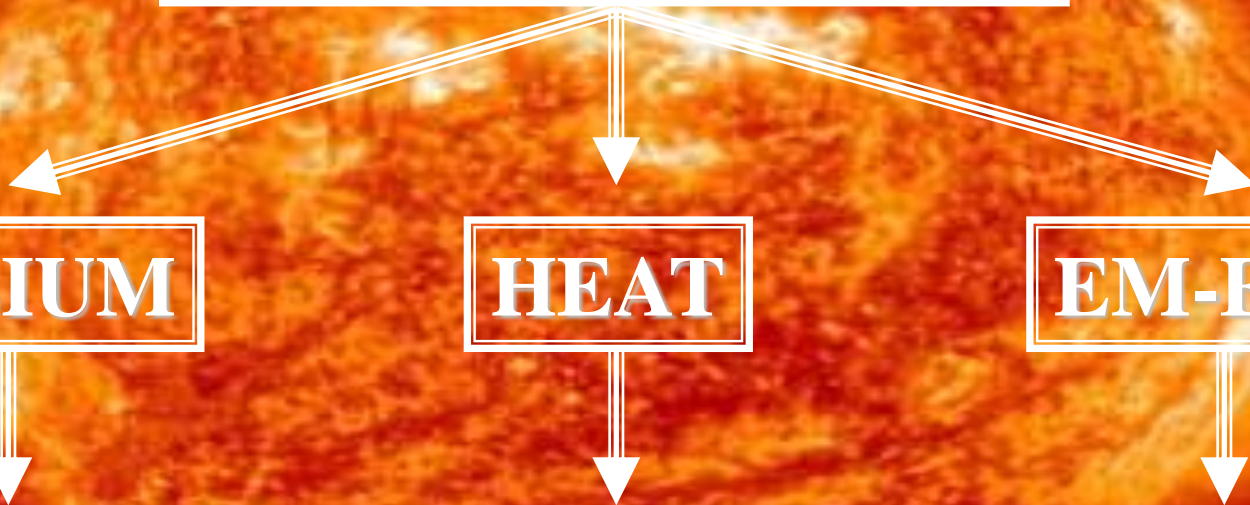
HEAT

EM-EGY

DISSIPATES INTO SPACE



STAR / SUN





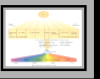
ELECTROMAGNETIC ENERGY

EARTH



HEAT ENERGY

EARTH



HYDROGEN FUSION REACTIONS

HELIUM

HEAT

EM-EGY

DISSIPATES INTO SPACE



STAR / SUN

SUMMARY

A stylized sun with a bright yellow and orange glow and radiating rays.

SUN

HF

A satellite photograph of the Earth showing the continents of Africa and Europe, surrounded by blue oceans and white clouds.

EARTH

ELECTROMAGNETIC ENERGY

**HYDROGEN
FUSION REACTIONS**



SUN

**HYDROGEN
FUSION REACTIONS**

E



ELECTROMAGNETIC ENERGY

**HYDROGEN
FUSION REACTIONS**

SUN

**HYDROGEN
FUSION REACTIONS**

ELECTROMAGNETIC SPECTRUM

*

**HIGH
ENERGY**

**LOW
ENERGY**

Gamma
rays

X rays

Ultraviolet

Visible

Near
infrared

Infrared

Radio
waves

SHORT WAVELENGTH

LONG WAVELENGTH



ELECTROMAGNETIC ENERGY

**HYDROGEN
FUSION REACTIONS**

SUN

**HYDROGEN
FUSION REACTIONS**

P

ELECTROMAGNETIC SPECTRUM

**HIGH
ENERGY**

**LOW
ENERGY**

Gamma
rays

X rays

Ultraviolet

Visible

Near
infrared

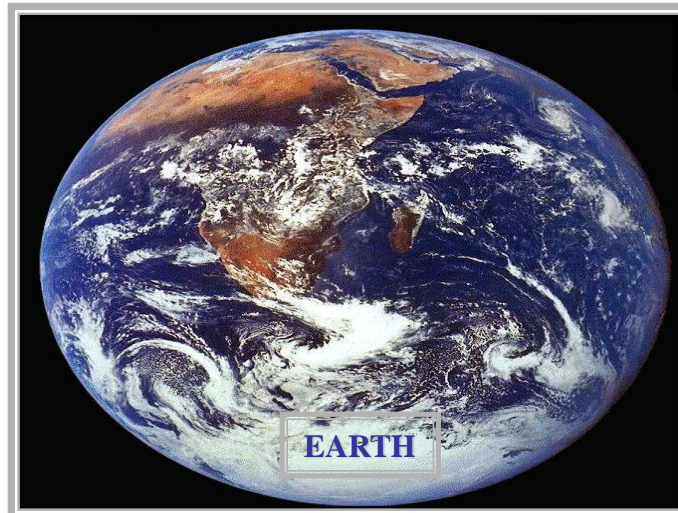
Infrared

Radio
waves

SHORT WAVELENGTH



LONG WAVELENGTH



EARTH

ELECTROMAGNETIC ENERGY

**HYDROGEN
FUSION REACTIONS**

SUN

**HYDROGEN
FUSION REACTIONS**

ELECTROMAGNETIC SPECTRUM

**HIGH
ENERGY**

**LOW
ENERGY**

Gamma
rays

X rays

Ultraviolet

Visible

Near
infrared

Infrared

Radio
waves

SHORT WAVELENGTH

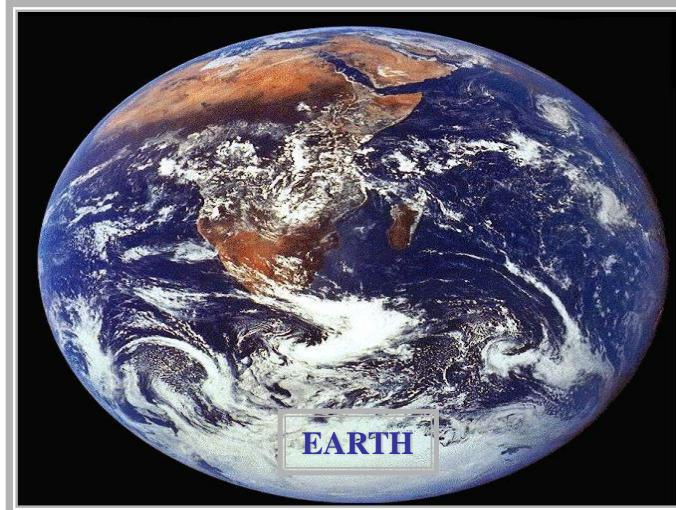
LONG WAVELENGTH

PHOTOSYNTHESIS

PHOTOSYNTHESIS



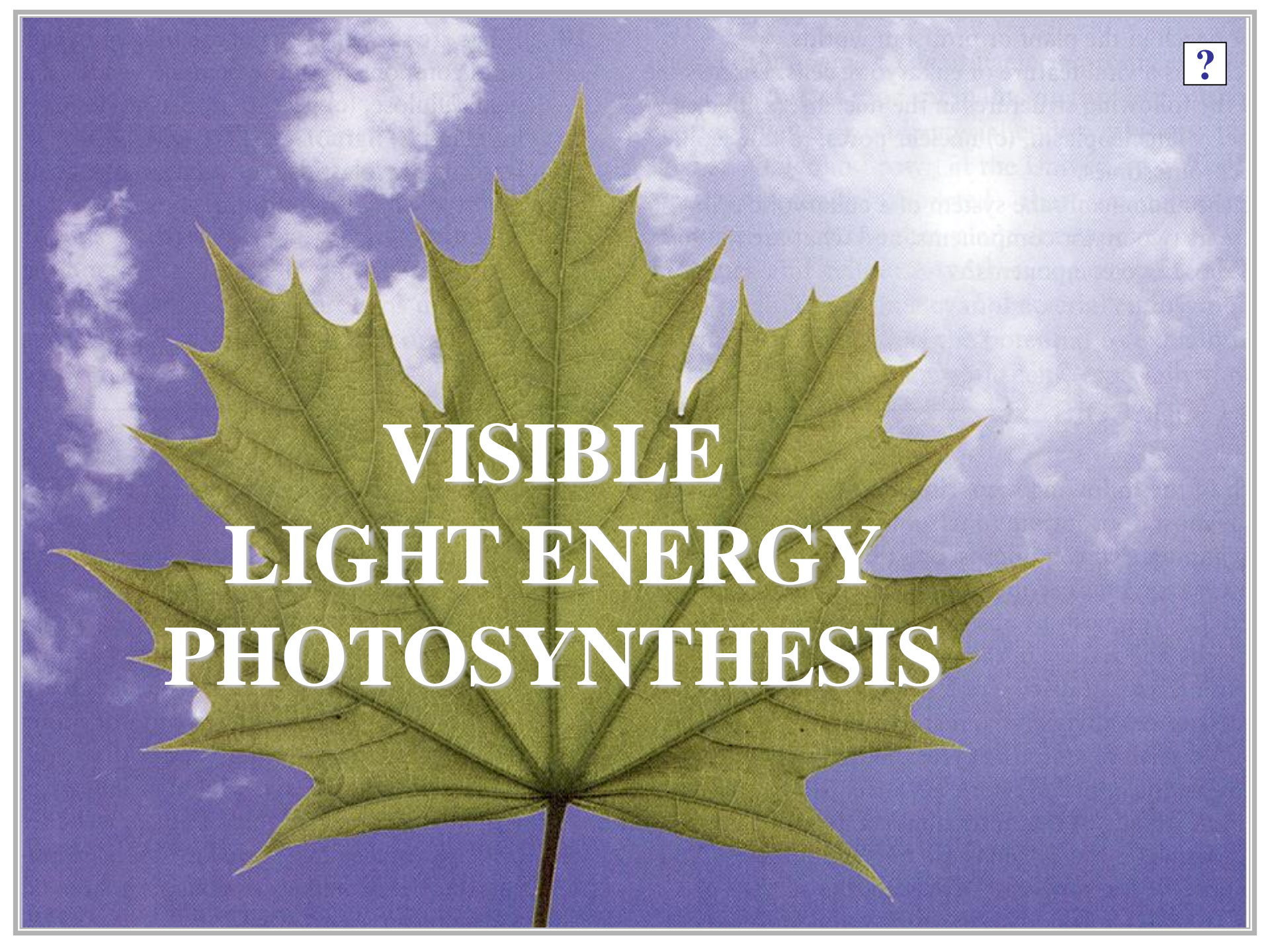
PHOTOSYNTHESIS



EARTH



PHOTOSYNTHESIS

A large, vibrant green maple leaf with prominent veins is centered against a bright blue sky with scattered white clouds. The leaf's stem points downwards.

VISIBLE LIGHT ENERGY PHOTOSYNTHESIS

QUESTION

HOW OLD IS THE EARTH?

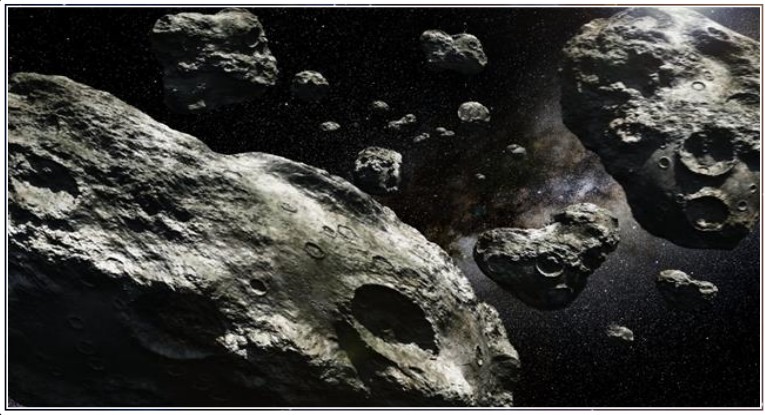
QUESTION



~4.5

BILLION YEARS

EARTH ORIGIN



ICE & DUST

EARTH ORIGIN

AGGREGATION
ICE & DUST



ICE & DUST

EARTH ORIGIN

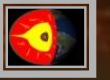


AB

ATMOSPHERE

PRIMORDIAL EARTH

EARTH ORIGIN



ATMOSPHERE: **ABSENT**

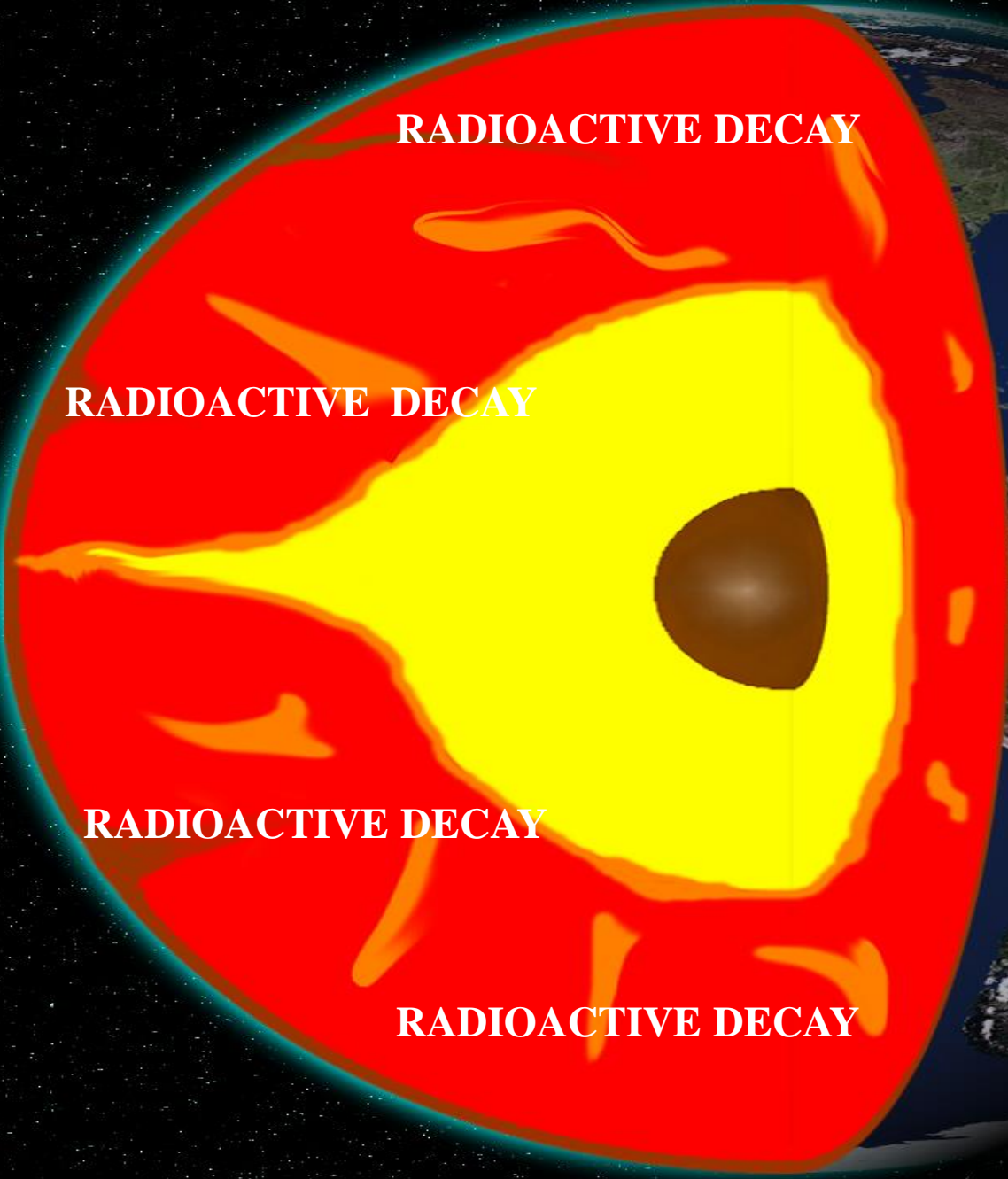
PRIMORDIAL EARTH

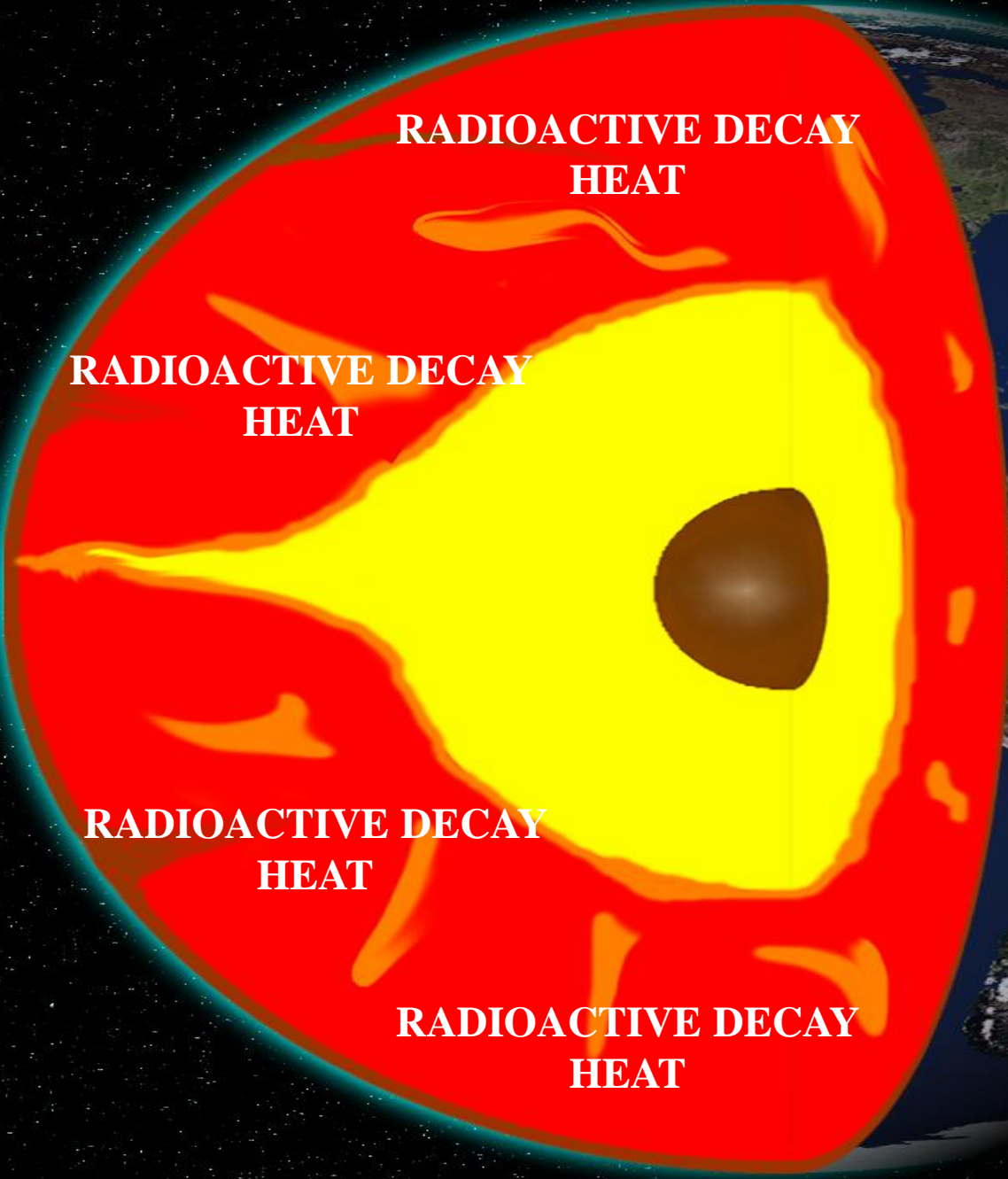
RADIOACTIVE DECAY

RADIOACTIVE DECAY

RADIOACTIVE DECAY

RADIOACTIVE DECAY



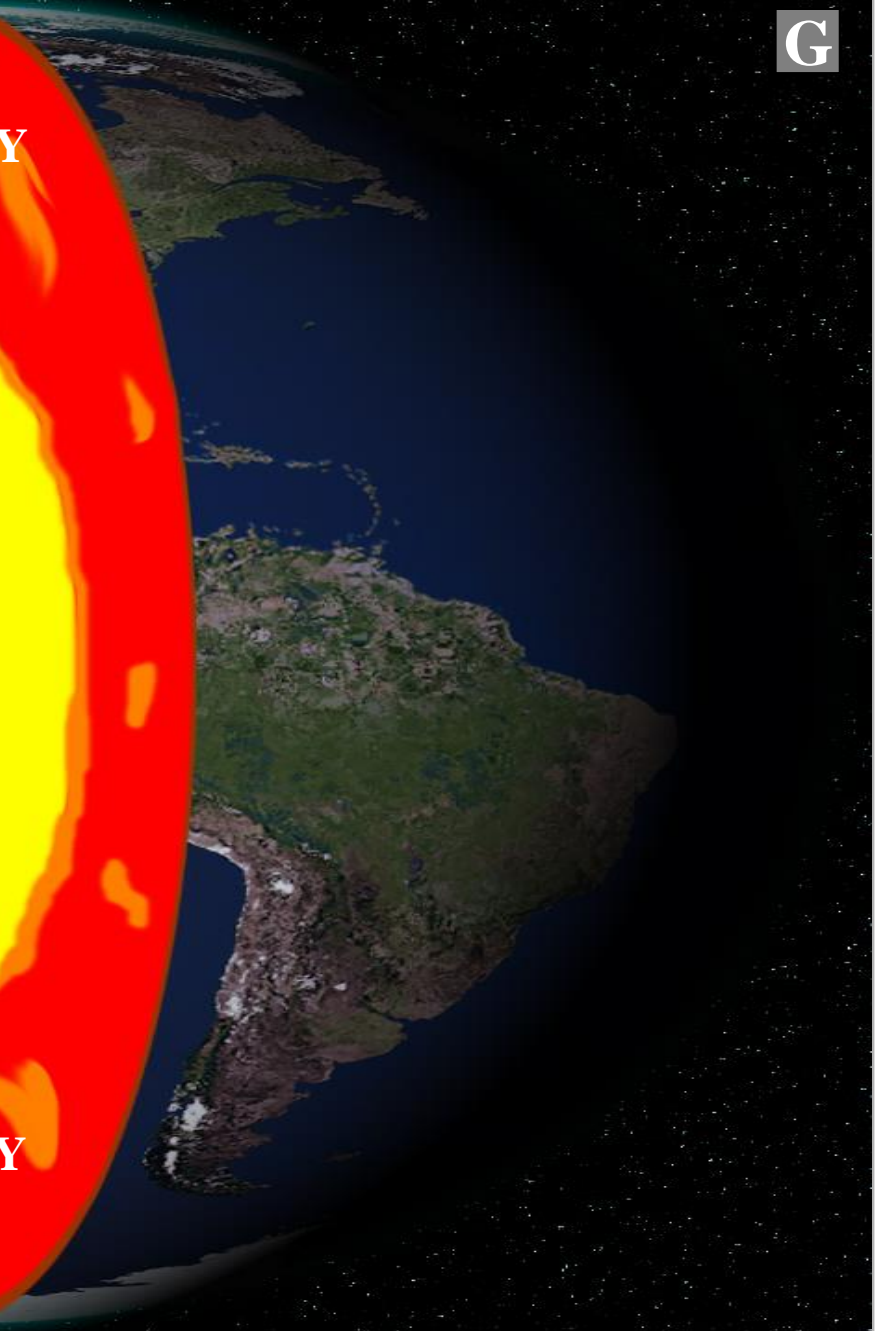


**RADIOACTIVE DECAY
HEAT**

**RADIOACTIVE DECAY
HEAT**

**RADIOACTIVE DECAY
HEAT**

**RADIOACTIVE DECAY
HEAT**

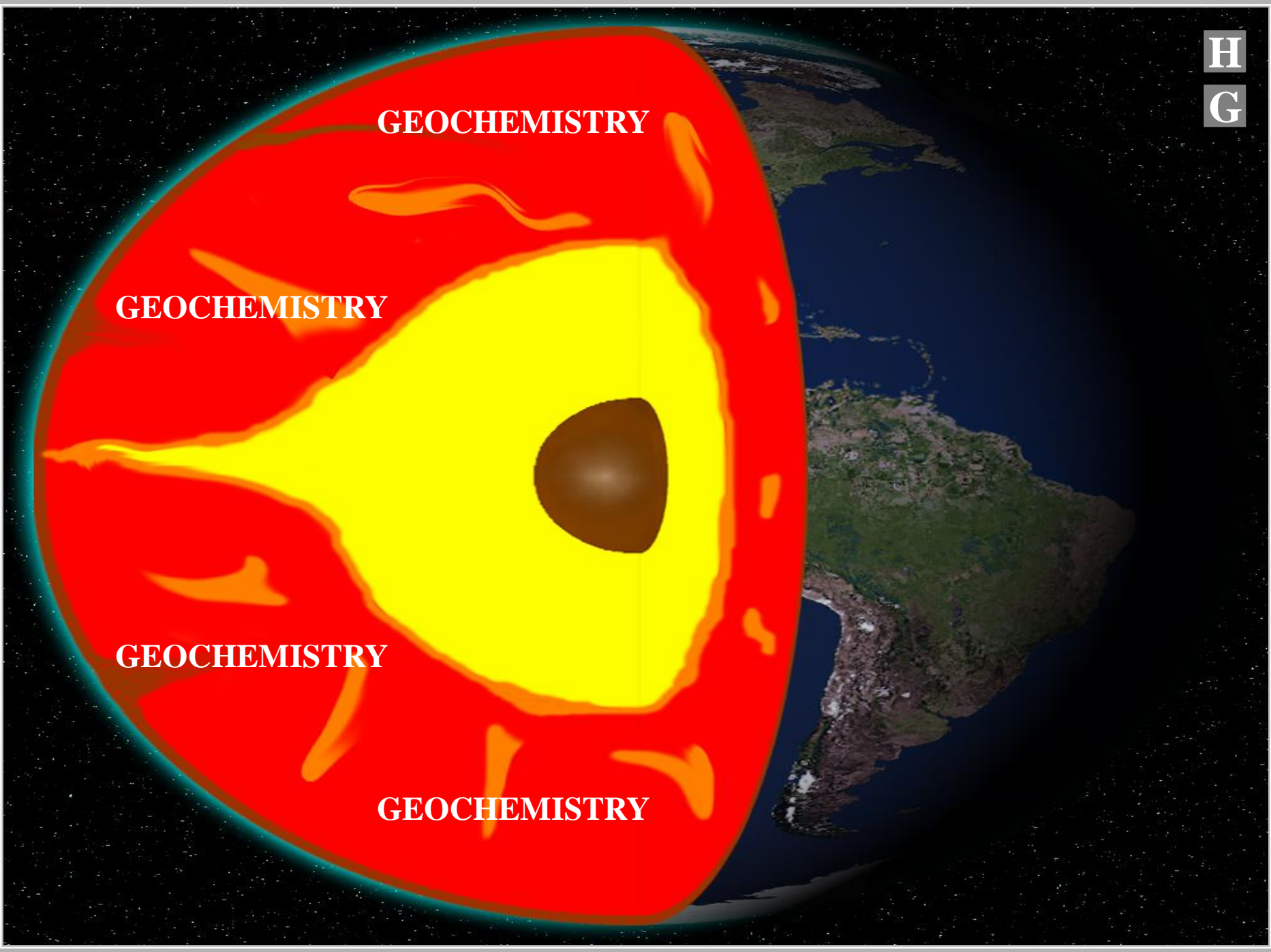


GEOCHEMISTRY

GEOCHEMISTRY

GEOCHEMISTRY

GEOCHEMISTRY





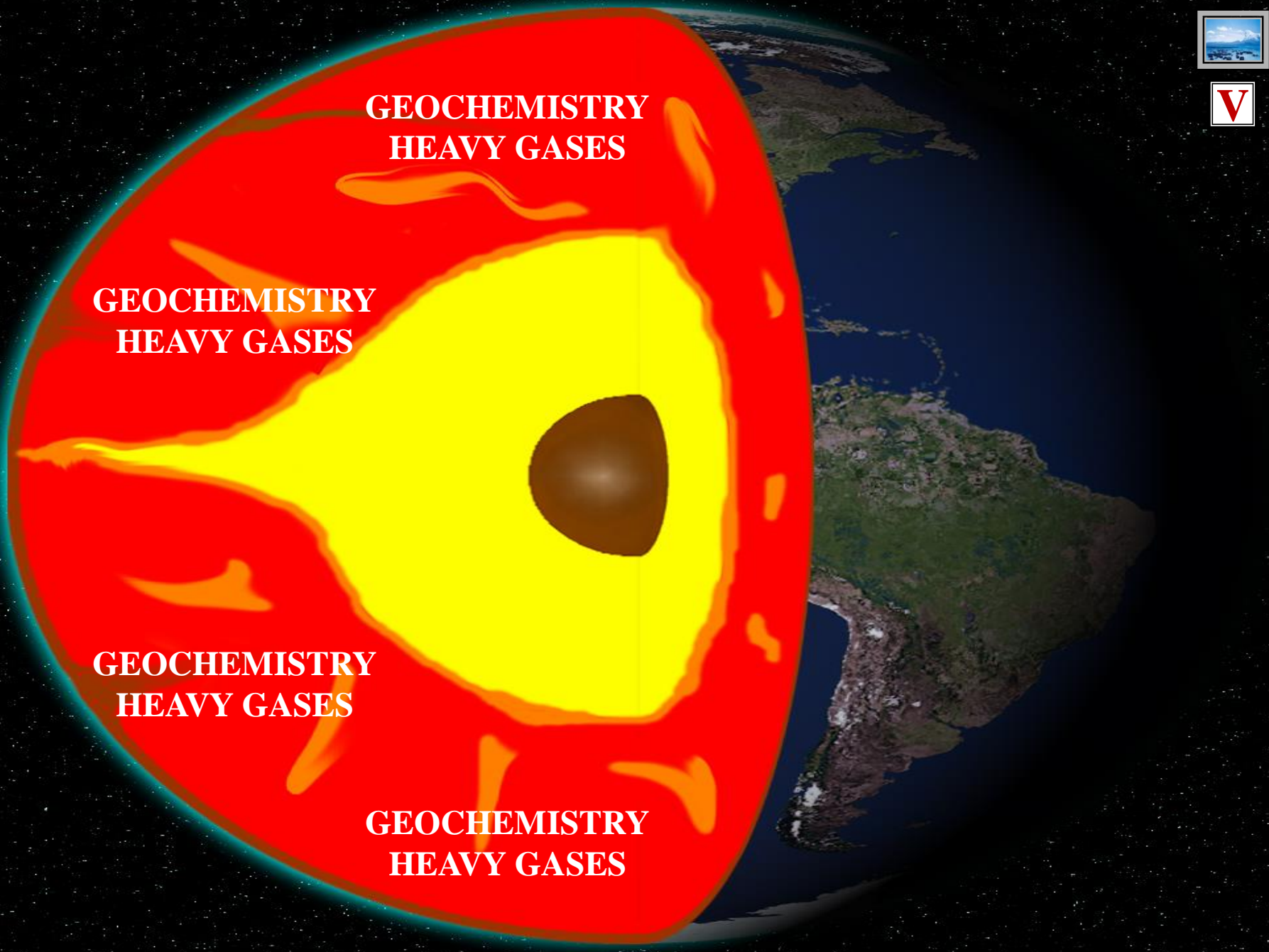
V

**GEOCHEMISTRY
HEAVY GASES**

**GEOCHEMISTRY
HEAVY GASES**

**GEOCHEMISTRY
HEAVY GASES**

**GEOCHEMISTRY
HEAVY GASES**

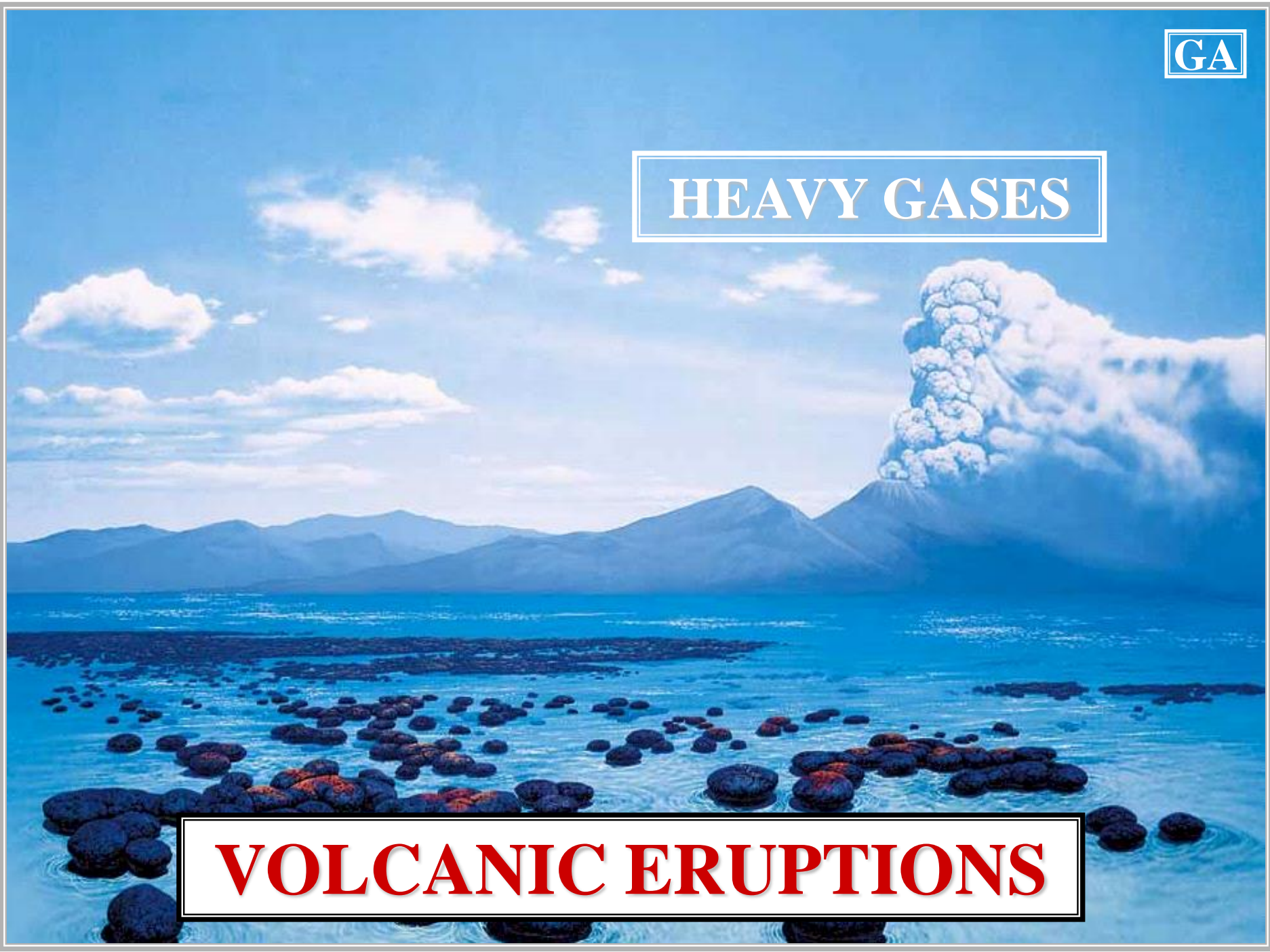




VOLCANIC ERUPTIONS

HEAVY GASES

VOLCANIC ERUPTIONS

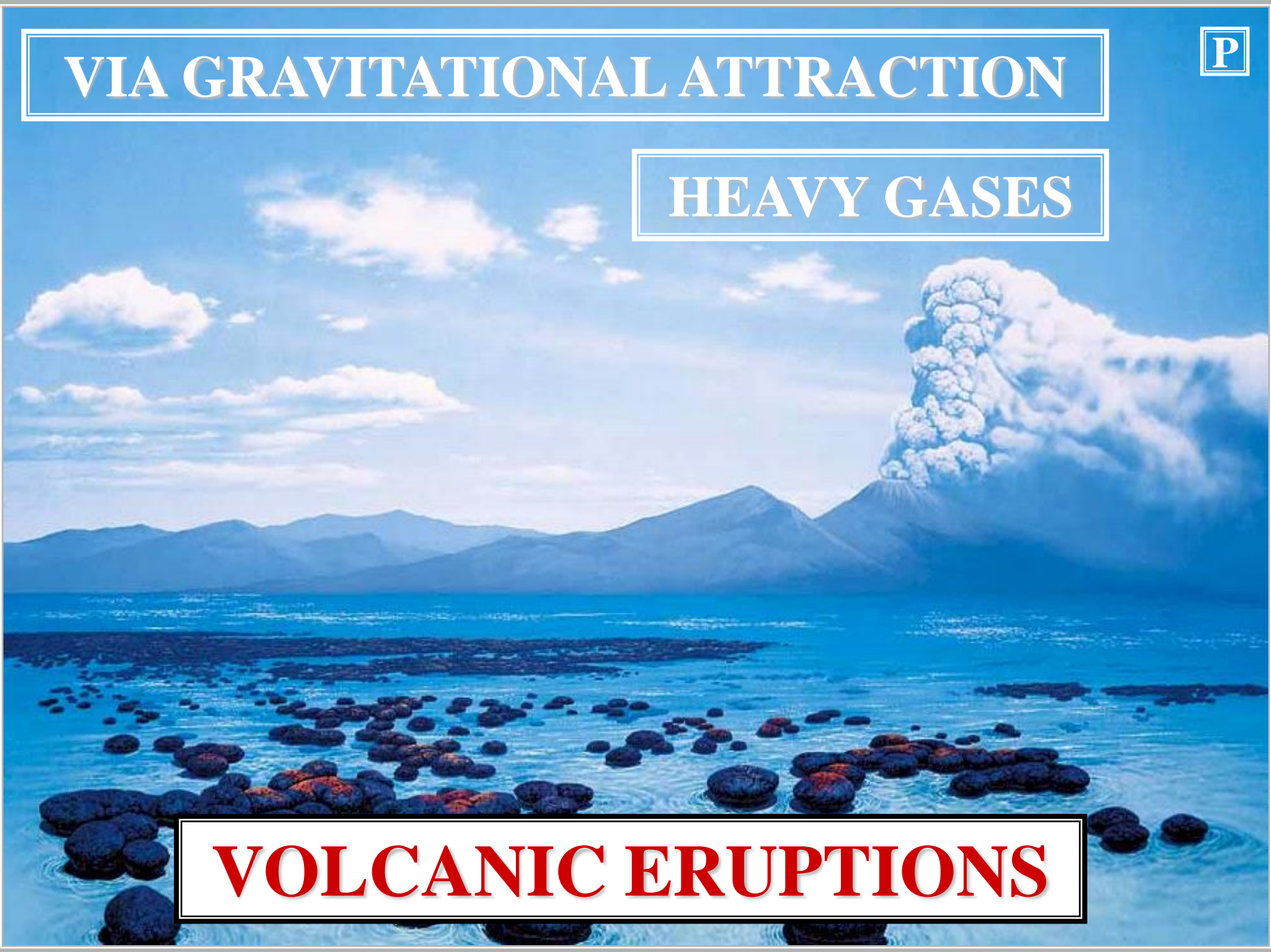


VIA GRAVITATIONAL ATTRACTION

P

HEAVY GASES

VOLCANIC ERUPTIONS



PRIMORDIAL EARTH ATMOSPHERE



HEAVY GASES

A composite image showing a volcanic eruption. In the background, a large volcano is erupting, sending a massive, billowing plume of white ash and steam high into a blue sky with scattered white clouds. The foreground features a rocky beach with numerous dark, rounded volcanic rocks partially submerged in clear, turquoise water. The overall scene is bright and clear, suggesting a clean environment despite the volcanic activity.

VOLCANIC ERUPTIONS



L

+

EARTH PRIMORDIAL ATMOSPHERE

PRIMORDIAL EARTH ATMOSPHERE

N

?

A vibrant, stylized illustration of a volcanic landscape. In the foreground, dark, rounded volcanic rocks are scattered across a shallow, turquoise body of water. The middle ground features a range of blue-toned mountains, with a prominent volcano on the right side emitting a massive, billowing plume of white ash and steam that rises into a clear blue sky. The overall scene is bright and clear, with a few scattered white clouds in the sky.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE

C

NITROGEN

A vibrant, stylized illustration of a volcanic landscape. In the foreground, a dark, rocky beach is scattered with numerous dark, rounded volcanic rocks. The water is a bright, clear blue. In the middle ground, a range of blue mountains stretches across the horizon. On the right side, a large volcano is actively erupting, sending a massive, billowing plume of white ash and steam high into the sky. The sky is a deep blue with scattered white clouds. The overall scene is bright and clear, suggesting a clean, primordial atmosphere.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE



NITROGEN
CARBON DIOXIDE



VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE

H

NITROGEN
CARBON DIOXIDE
WATER

A vibrant blue-tinted landscape depicting a volcanic scene. In the foreground, numerous dark, rounded volcanic rocks are scattered across a shallow, rippling blue body of water. The middle ground shows a range of blue mountains, with a prominent volcano on the right side emitting a massive, billowing plume of white ash and steam that rises into the sky. The sky is filled with soft, white clouds. The overall scene is bright and clear, with a strong blue color palette.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE



NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE



VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE

A

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE

A vibrant blue-toned illustration of a volcanic landscape. In the foreground, dark, rounded volcanic rocks are scattered across a shallow, rippling body of water. The middle ground shows a range of blue mountains, with a prominent volcano on the right side emitting a massive, billowing plume of white and grey smoke or ash that rises into the sky. The sky is a clear, bright blue with some light, wispy clouds. The overall scene depicts a powerful volcanic eruption in a primordial setting.

VOLCANIC ERUPTIONS

PRIMORDIAL EARTH ATMOSPHERE



NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE
AMMONIA



VOLCANIC ERUPTIONS

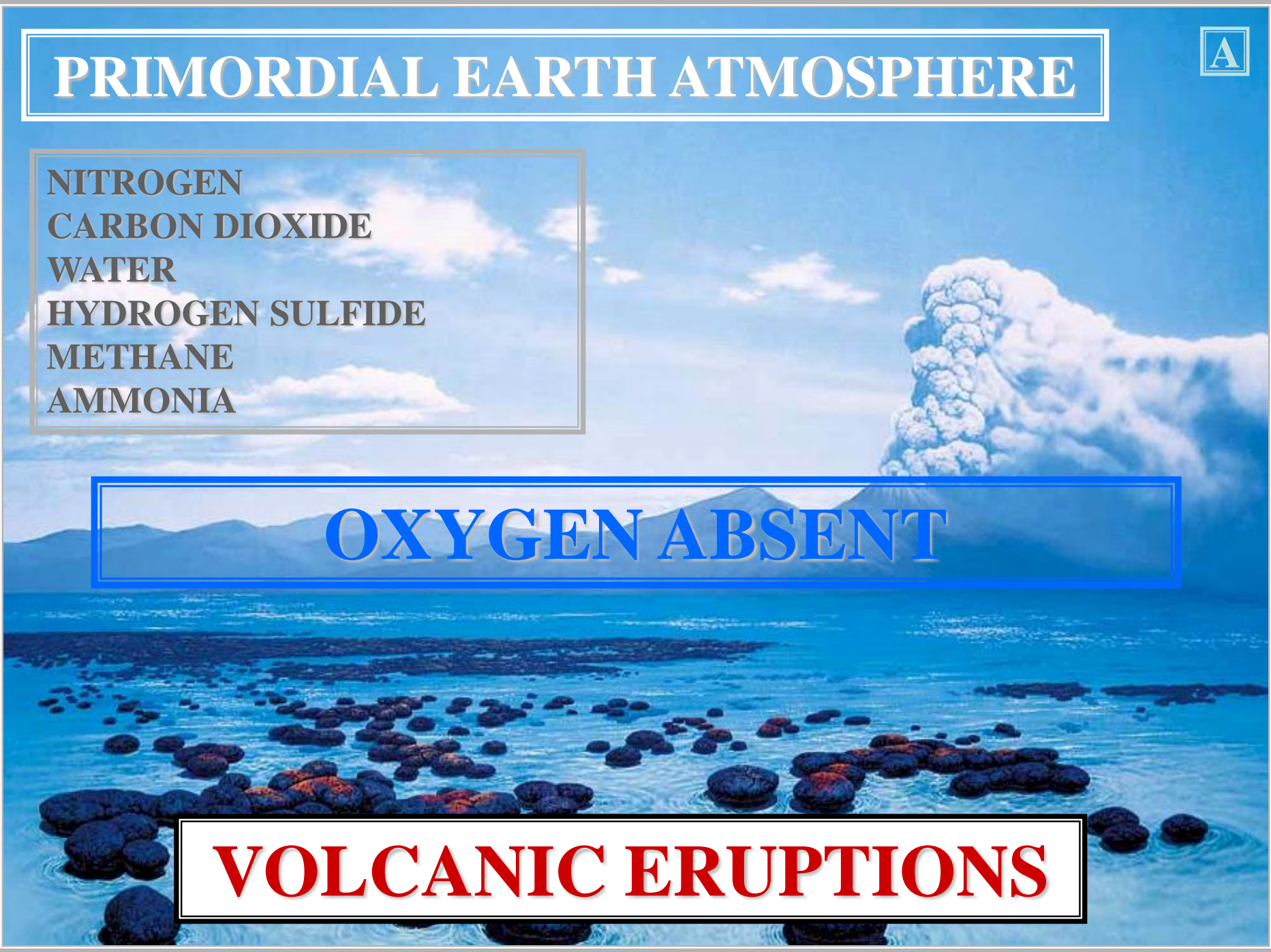
PRIMORDIAL EARTH ATMOSPHERE

A

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE
AMMONIA

OXYGEN ABSENT

VOLCANIC ERUPTIONS

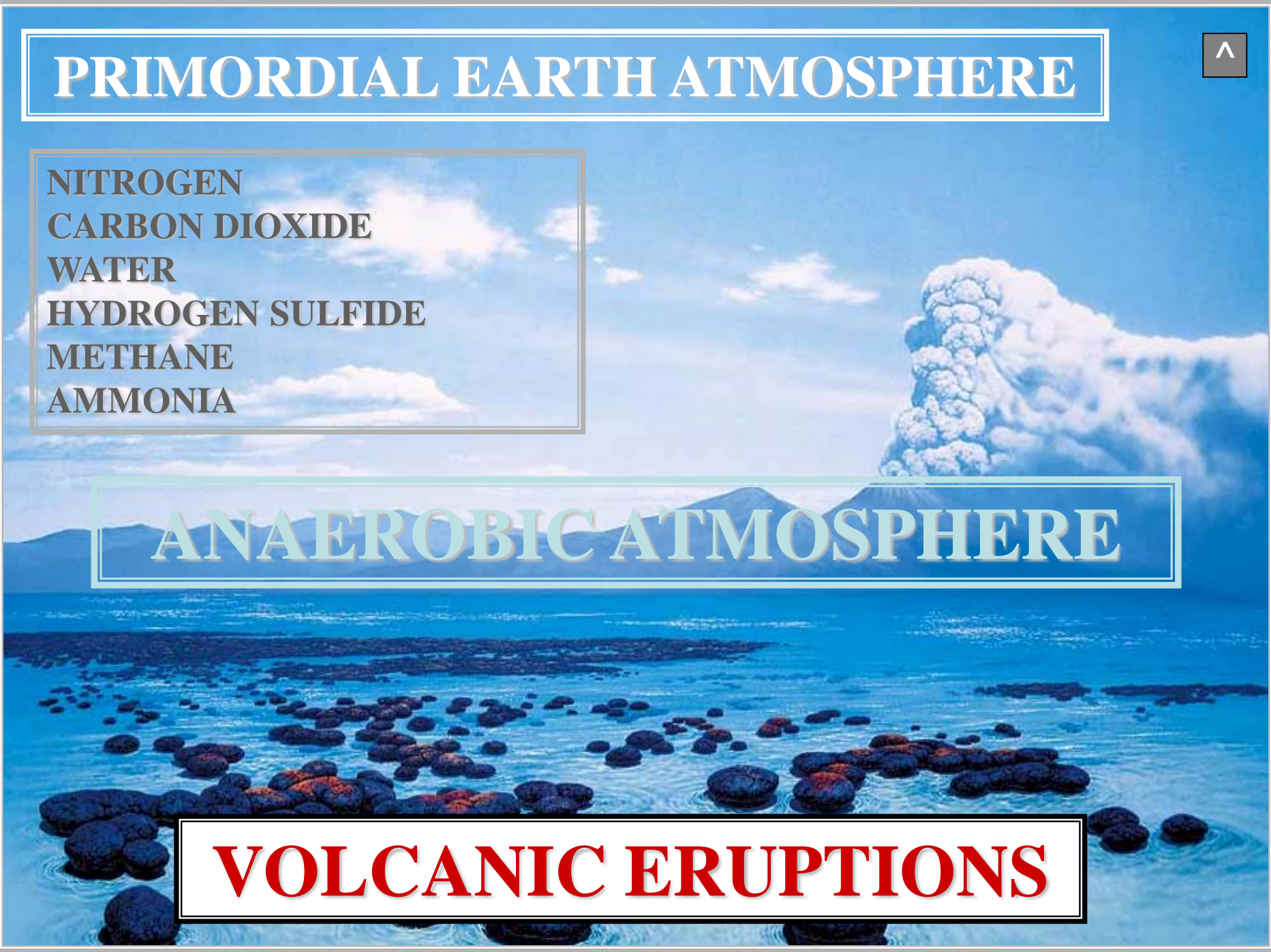


PRIMORDIAL EARTH ATMOSPHERE

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN SULFIDE
METHANE
AMMONIA

ANAEROBIC ATMOSPHERE

VOLCANIC ERUPTIONS



CHEMICAL EVOLUTION

CHEMICAL EVOLUTION



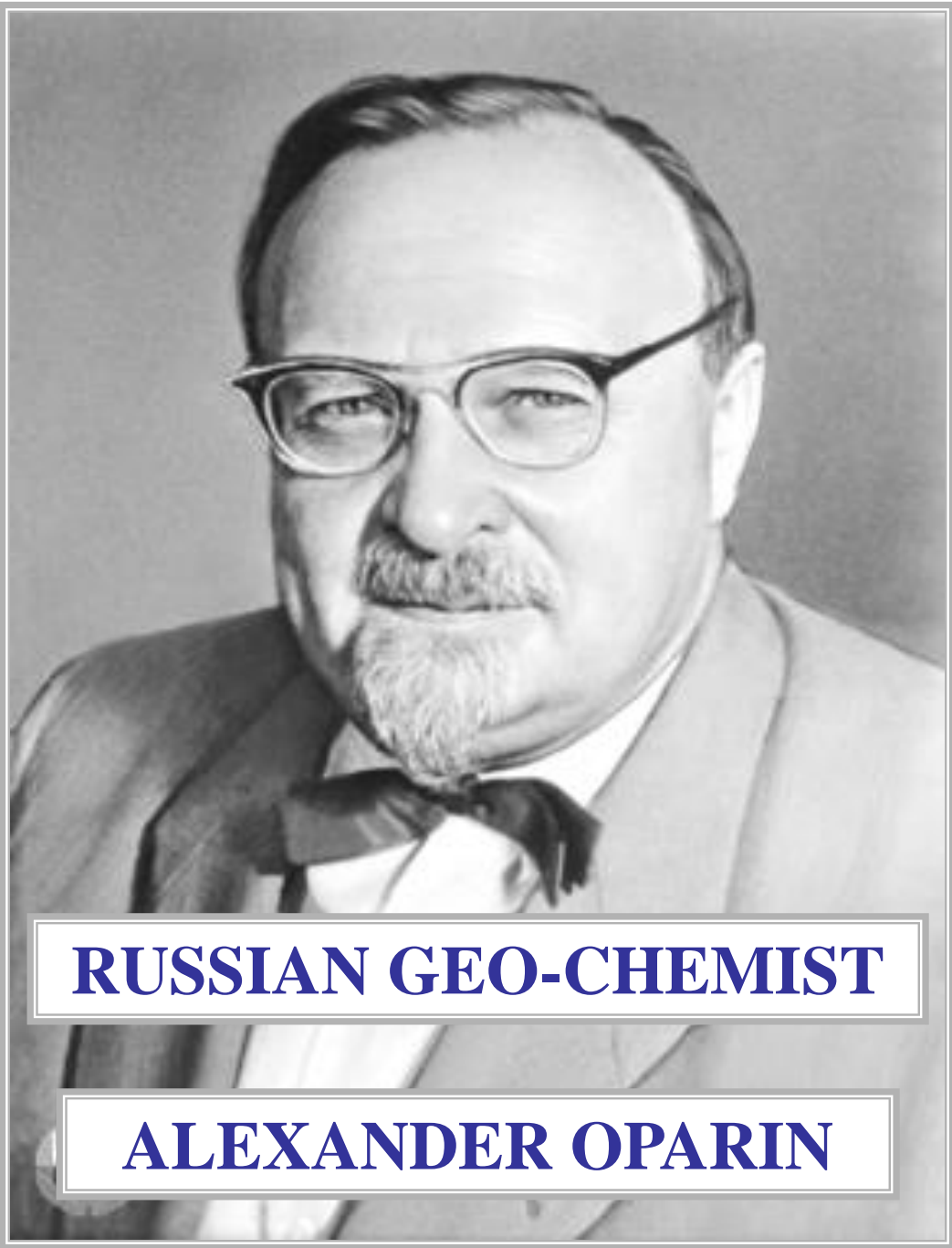
CHEMICAL EVOLUTION

CONVERSION
ATMOSPHERIC GASES
TO COMPLEX ORGANIC
COMPOUNDS

CHEMICAL EVOLUTION



OPARIN THEORY

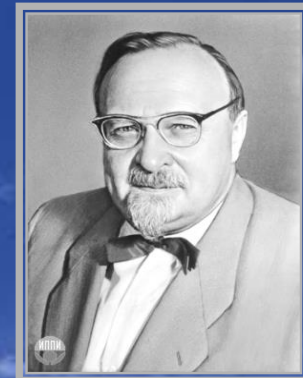


RUSSIAN GEO-CHEMIST

ALEXANDER OPARIN



N_2 CO_2 H_2O
 H_2S CH_4 NH_3

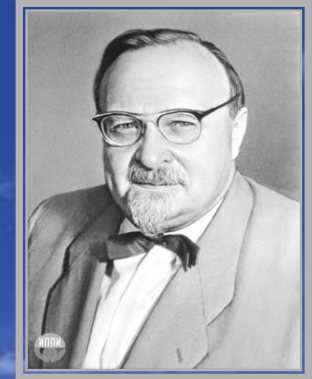


**OPARIN THEORY
EXPLAINS
CONVERSION ATMOSPHERIC
GASES TO COMPLEX
ORGANIC COMPOUNDS**

PRIMORDIAL ATMOSPHERE



N_2 CO_2 H_2O
 H_2S CH_4 NH_3



CONVERSION ENERGY SOURCES

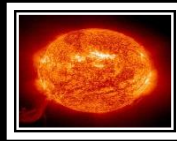
PRIMORDIAL ATMOSPHERE



ATMOSPHERIC LIGHTNING

CONVERSION ENERGY SOURCES

PRIMORDIAL ATMOSPHERE



SOLAR RADIATION



CONVERSION ENERGY SOURCES

U

PRIMORDIAL ATMOSPHERE



**ULTRA-VIOLET
RADIATION**



CONVERSION ENERGY SOURCES

O

AB

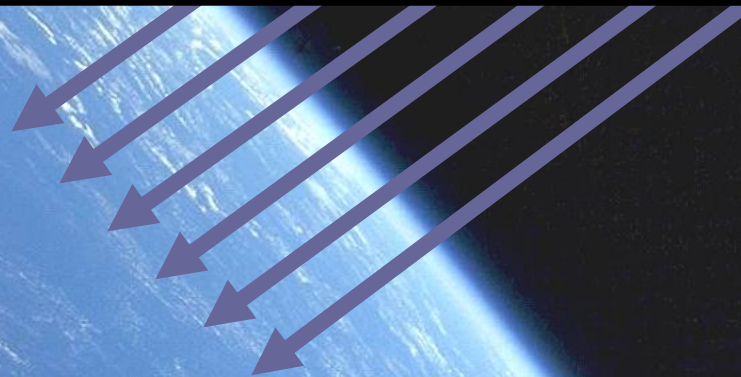
PRIMORDIAL ATMOSPHERE



**ULTRA-VIOLET
RADIATION**



CONVERSION ENERGY SOURCES



N

OZONE LAYER: ABSENT

PRIMORDIAL ATMOSPHERE

NITROGEN
CARBON DIOXIDE
WATER
HYDROGEN
SULFIDE
METHANE
AMMONIA

PRIMORDIAL ATMOSPHERE