

Nascita ed evoluzione della Terra

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INAF – Osservatorio Astronomico di Brera

12 novembre 2025

Le nubi interstellari



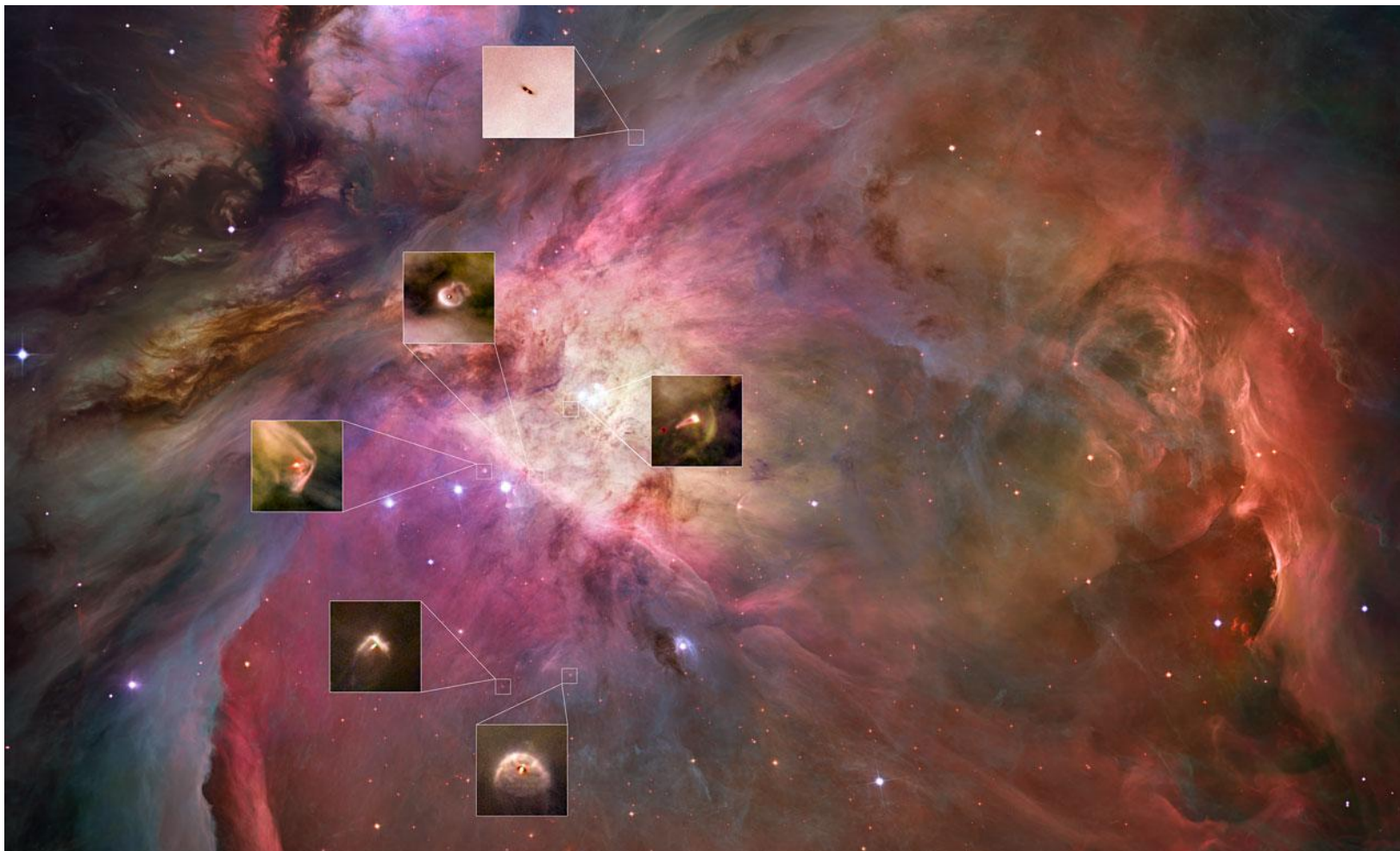
Credit: ESO, Y.Beletsky

Zone di formazione stellare



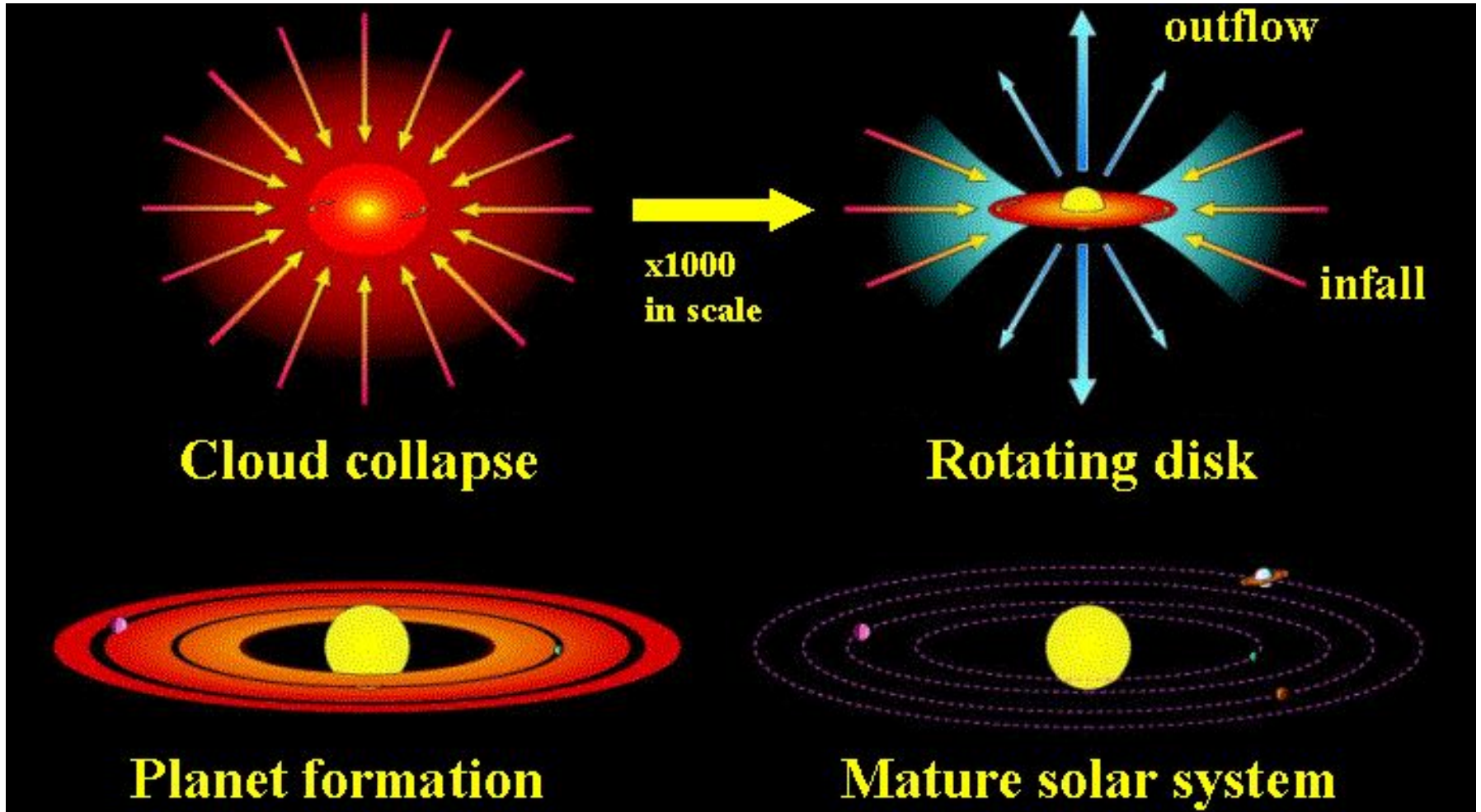
Credit: NASA, ESA, CSA and STScI

La nascita delle stelle...



Credit: NASA, ESA, M. Robberto (STScI/ESA), the Hubble Space Telescope Orion Treasury Project Team and L. Ricci (ESO)

...e dei pianeti



Collasso iniziale



Credit: C.R. O'Dell/Rice University NASA/ESA

Protostella



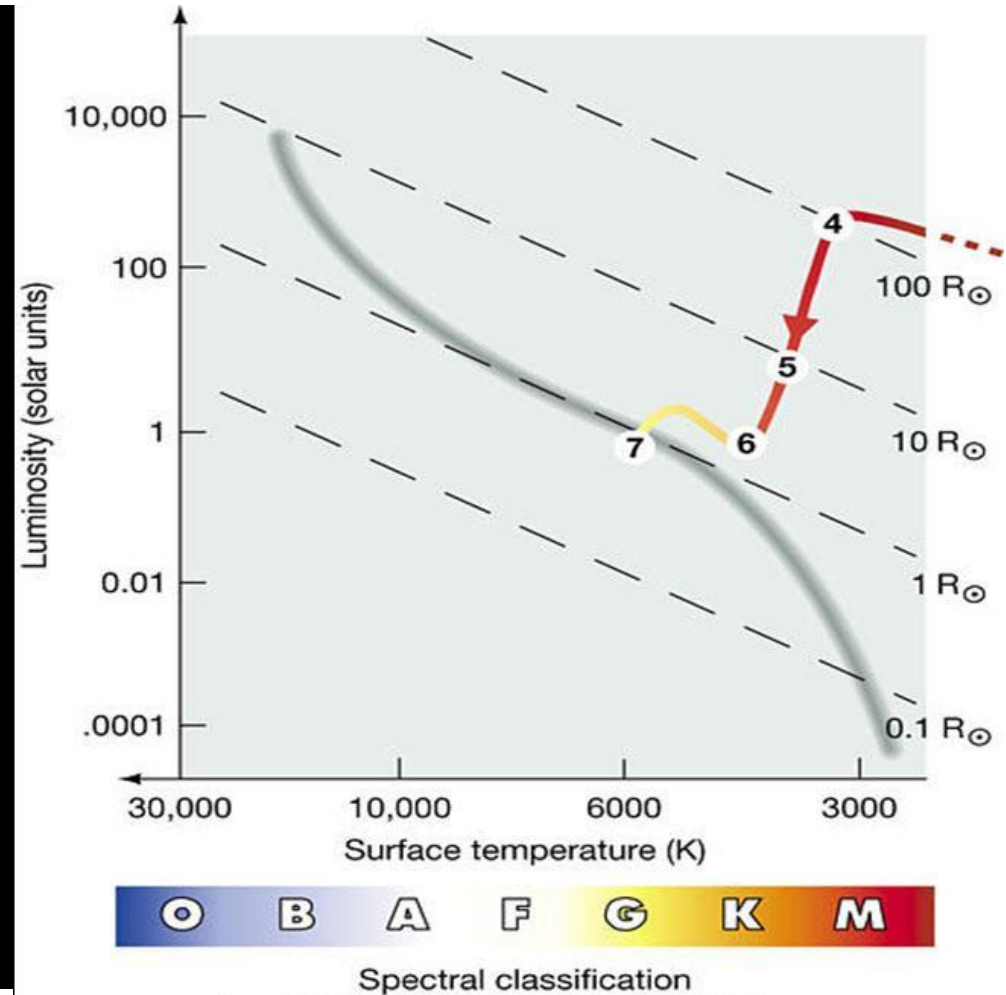
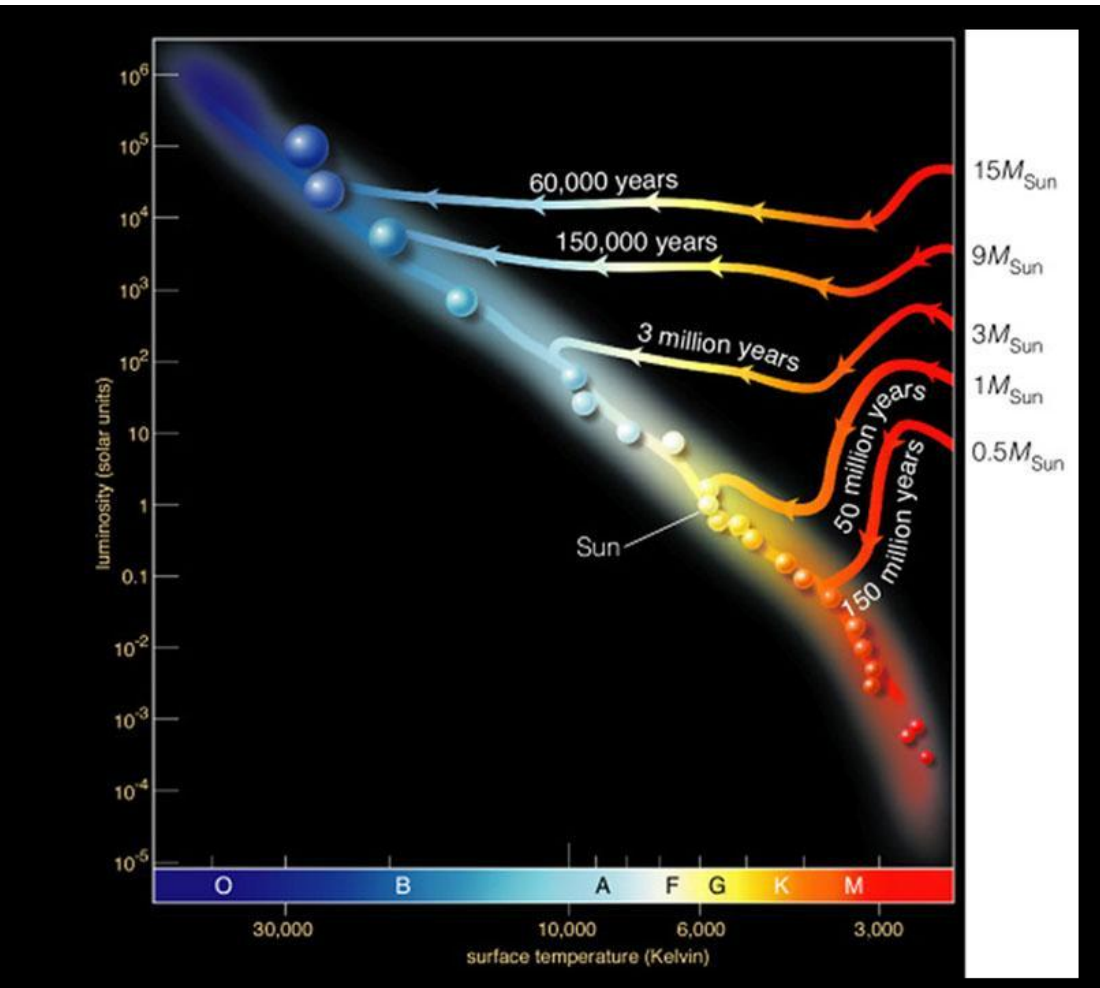
Credit: NASA / ESA / CSA / Joseph DePasquale, STScI.

Stelle T Tauri

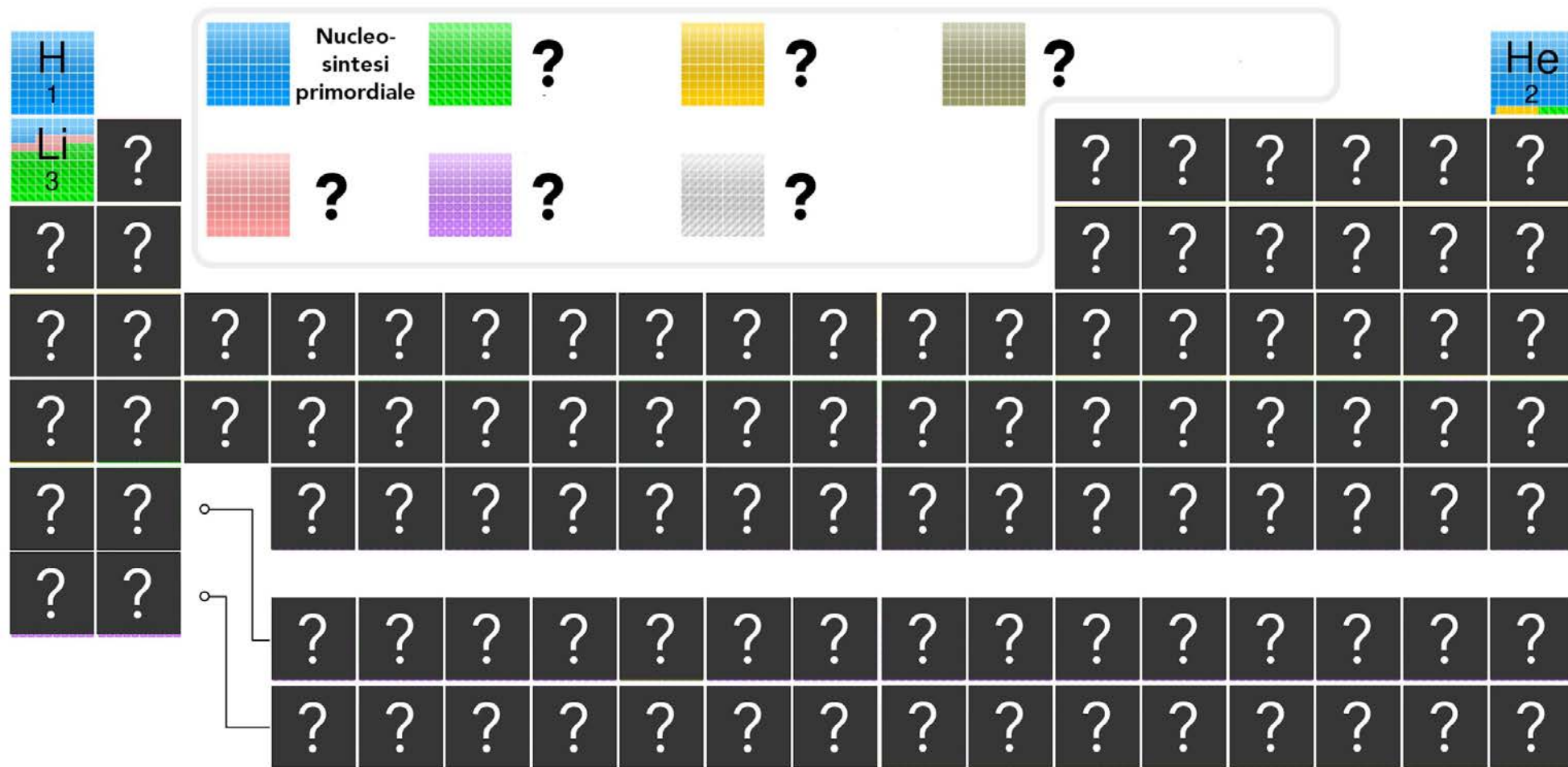


Credit: Adam Block/Mount Lemmon SkyCenter/University of Arizona

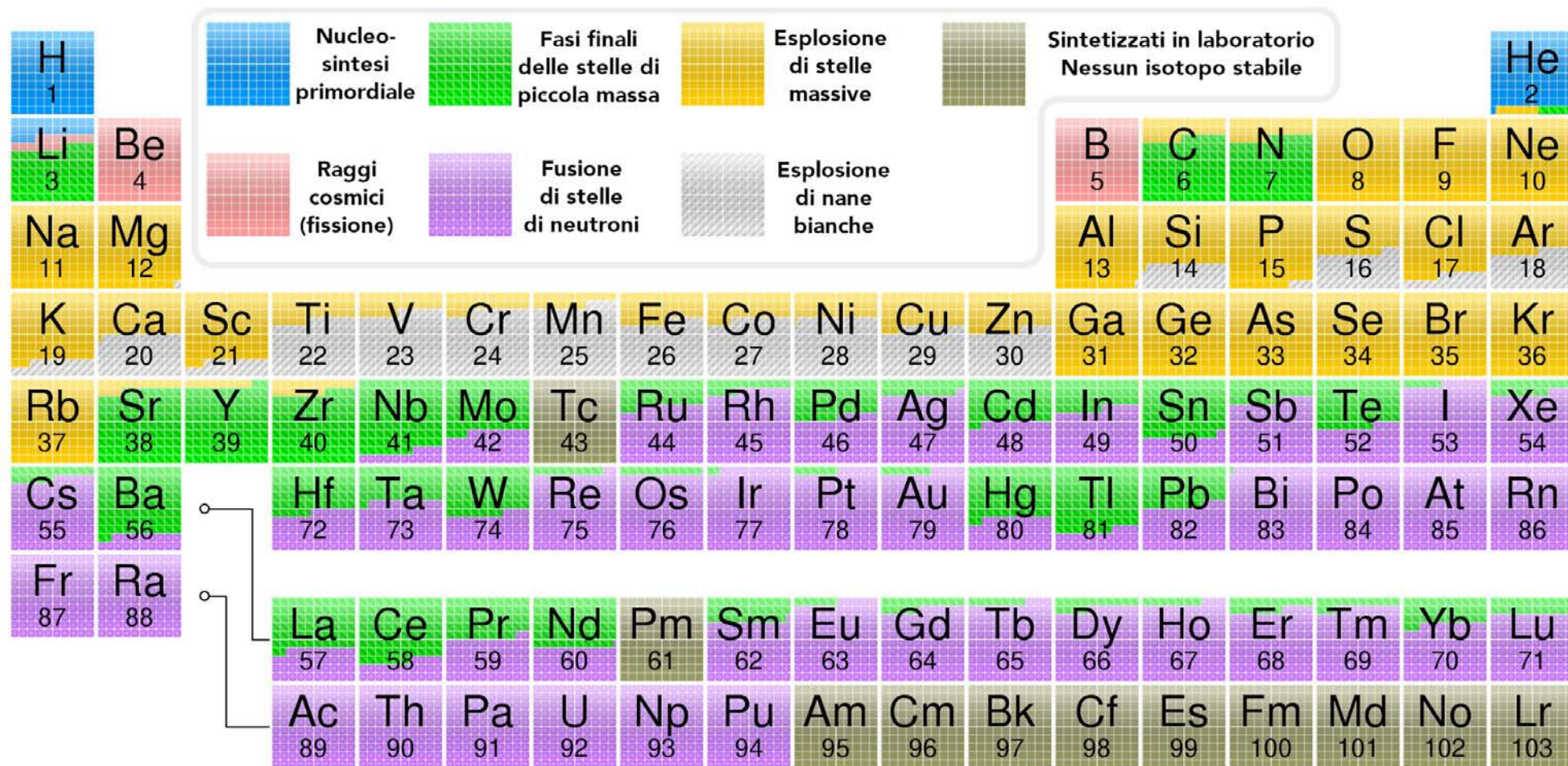
Formazione delle stelle



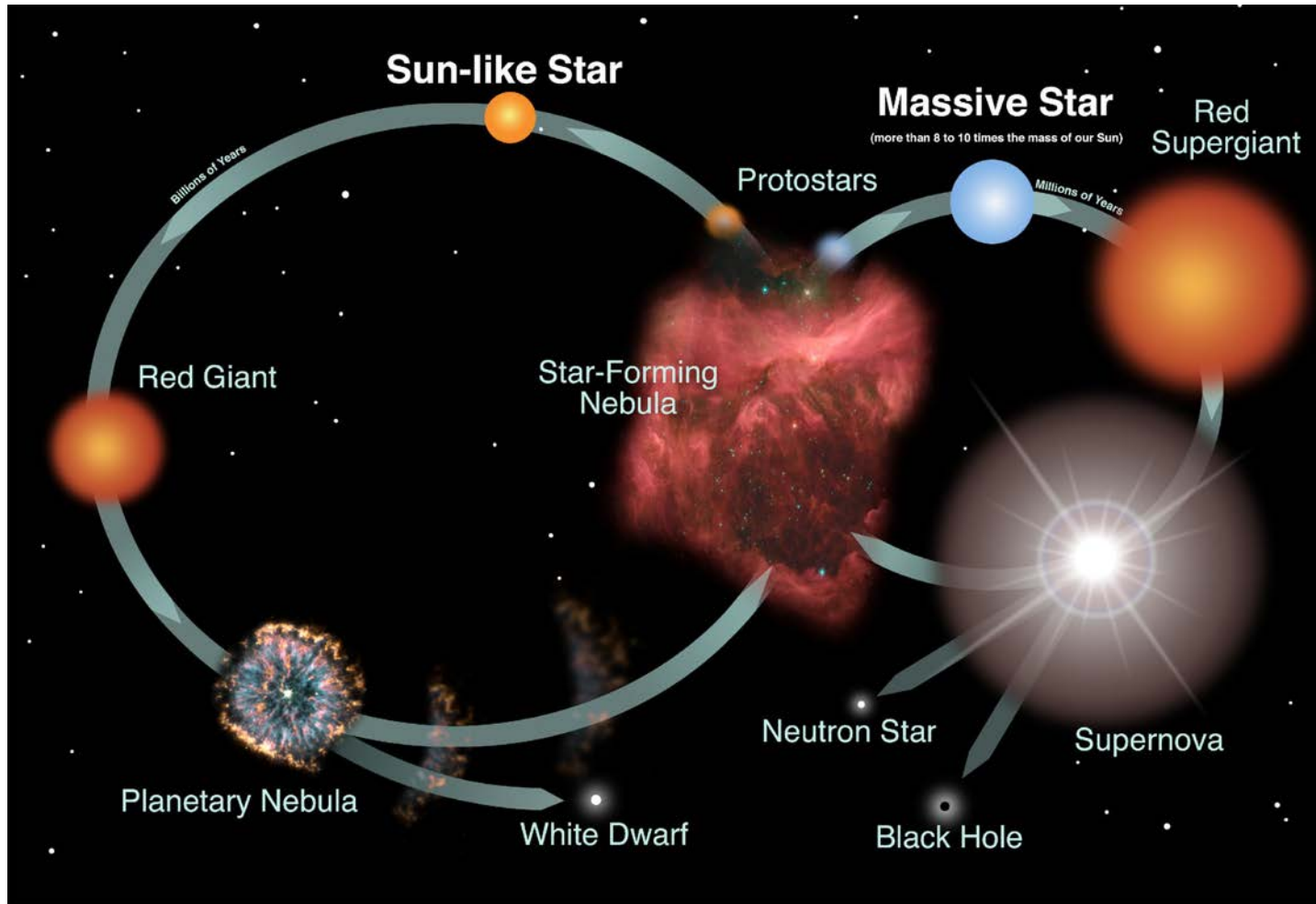
Quali elementi?



Gli elementi della Terra



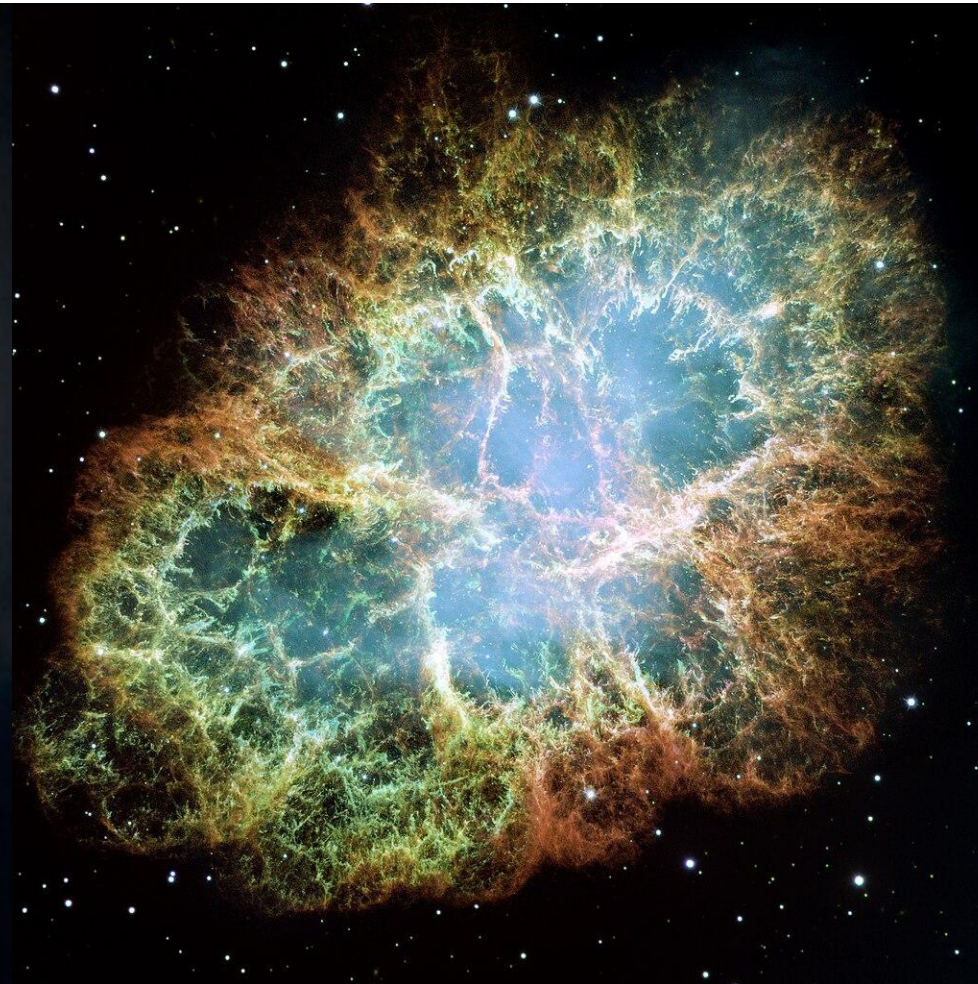
La vita delle stelle



Nebulose planetarie e resti di supernovae

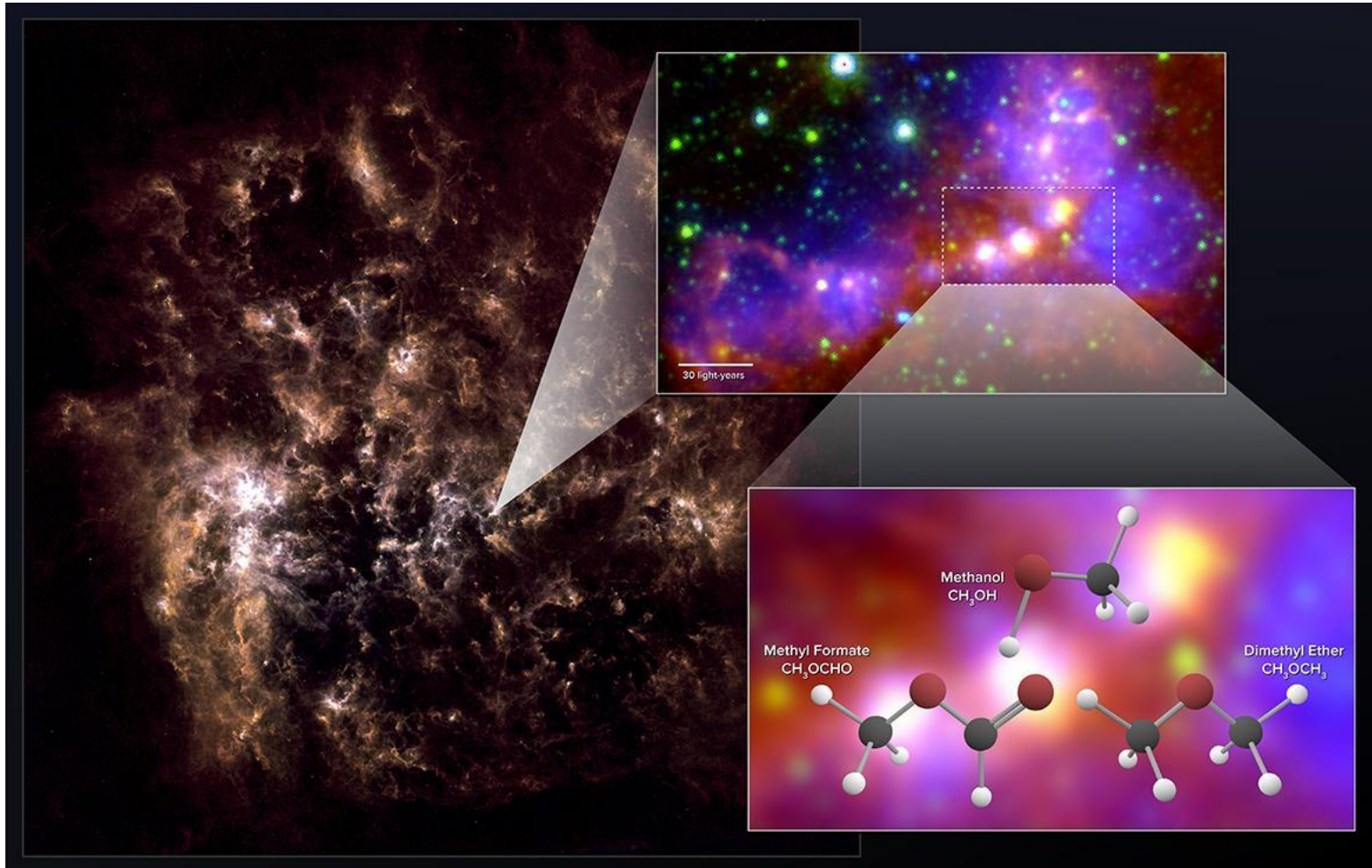


Credit: NASA, ESA, HEIC, and The Hubble Heritage Team (STScI/AURA)

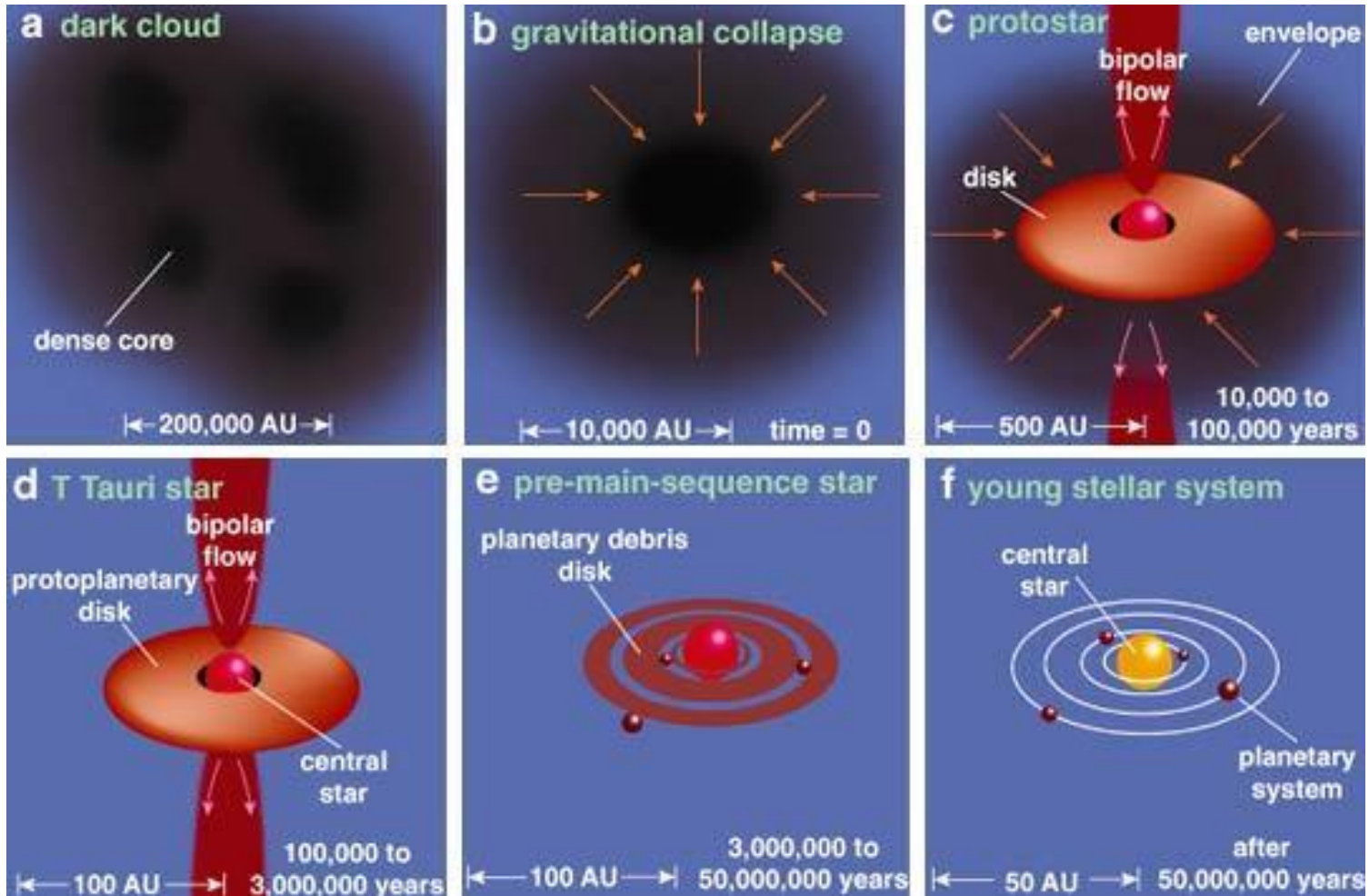


Credit: NASA, ESA, J. Hester and A. Loll (Arizona State University)

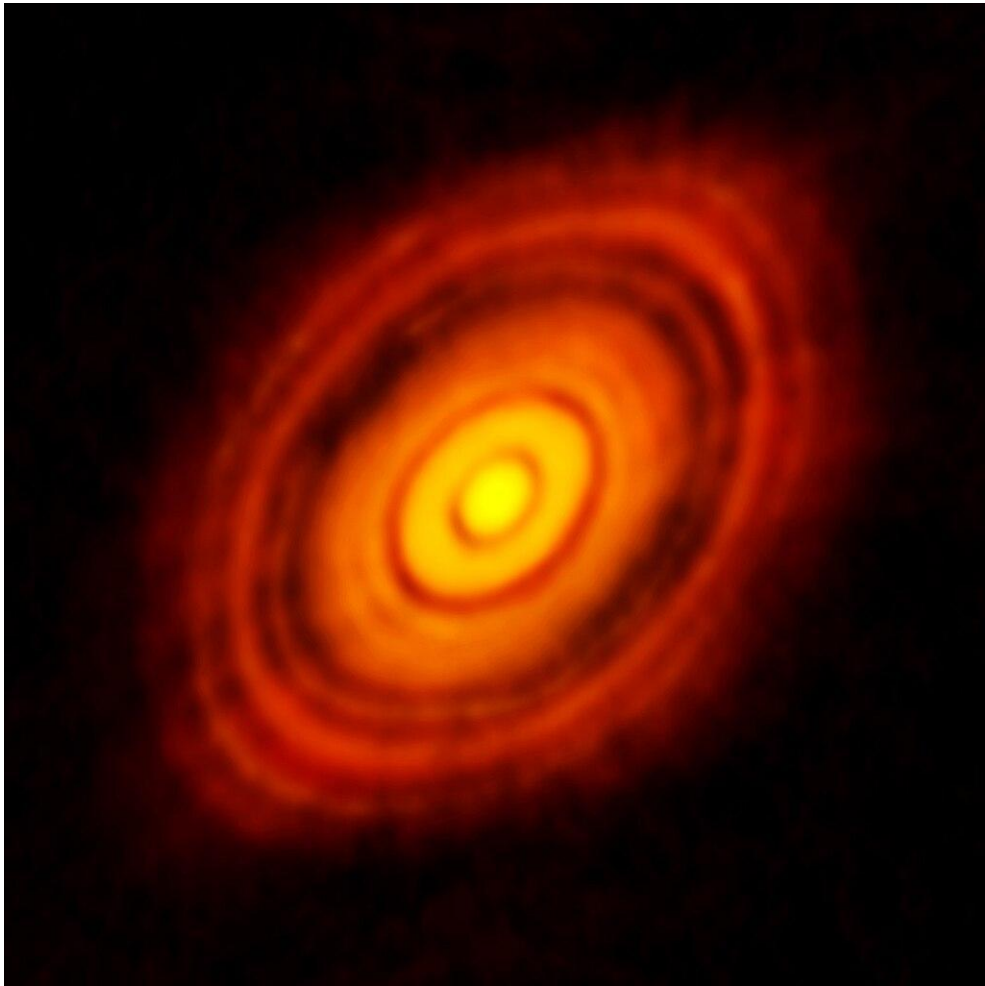
Molecole complesse



Nascita di stelle e pianeti

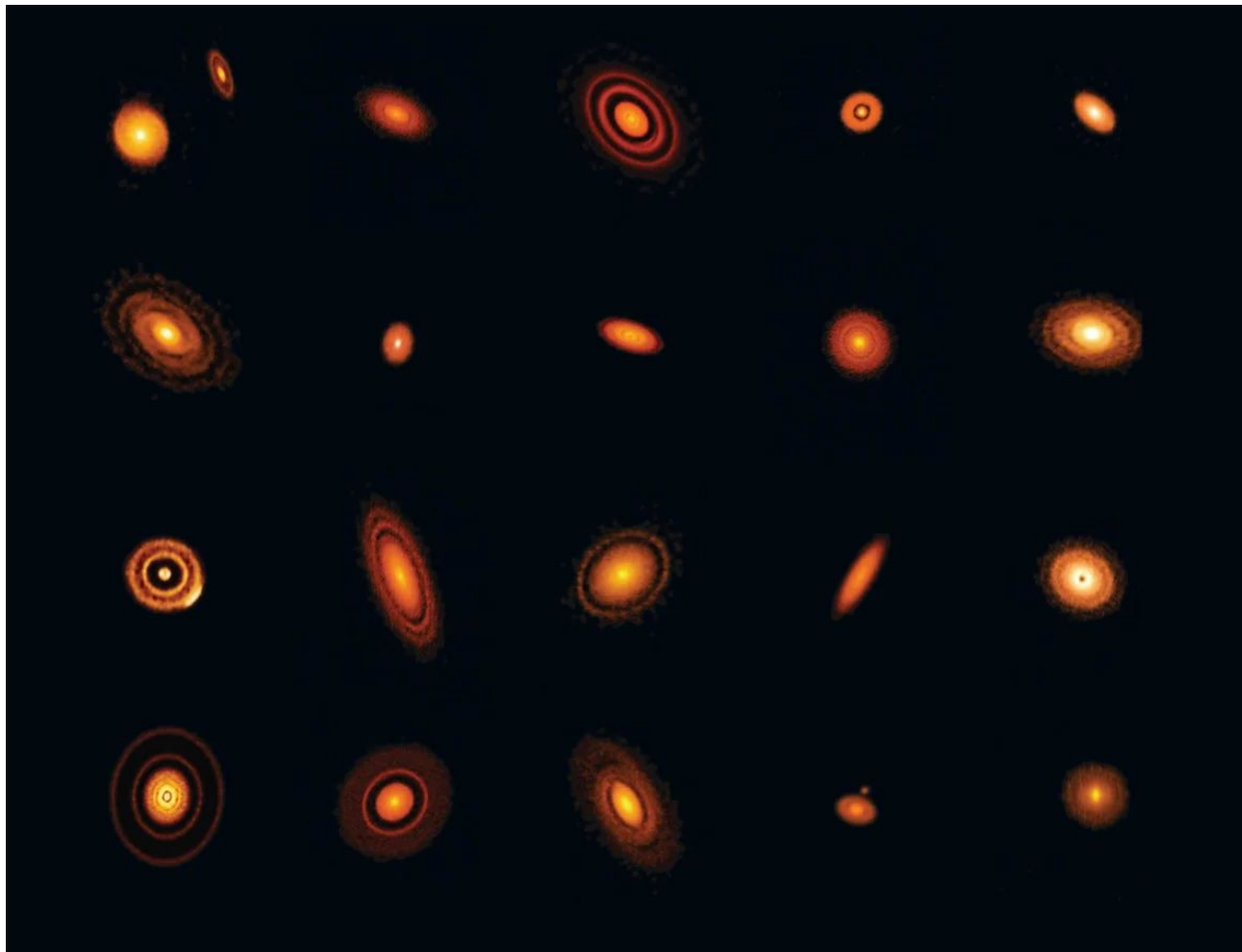


Dischi protoplanetari



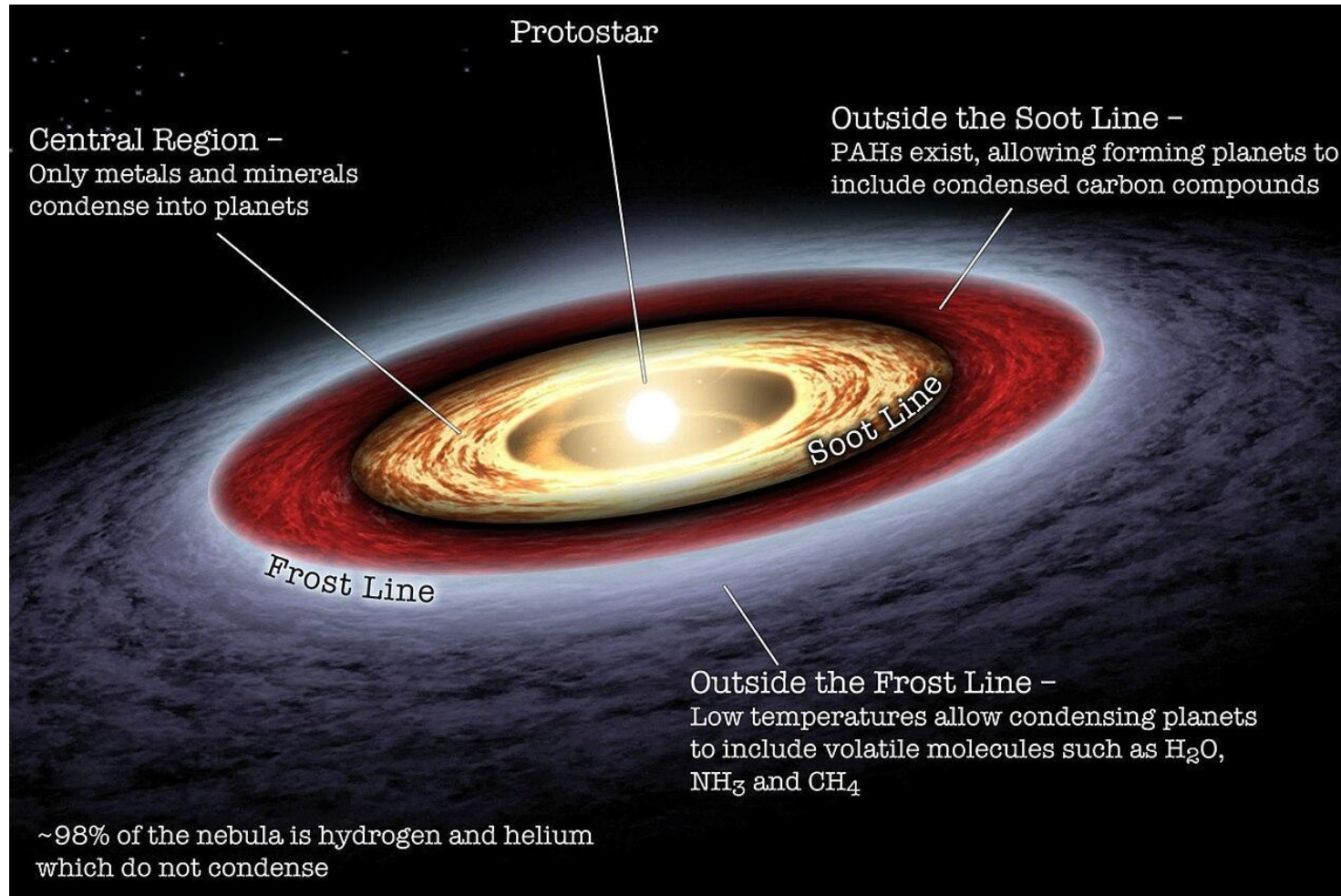
Credit: ALMA (ESO/NAOJ/NRAO)

Dischi protoplanetari



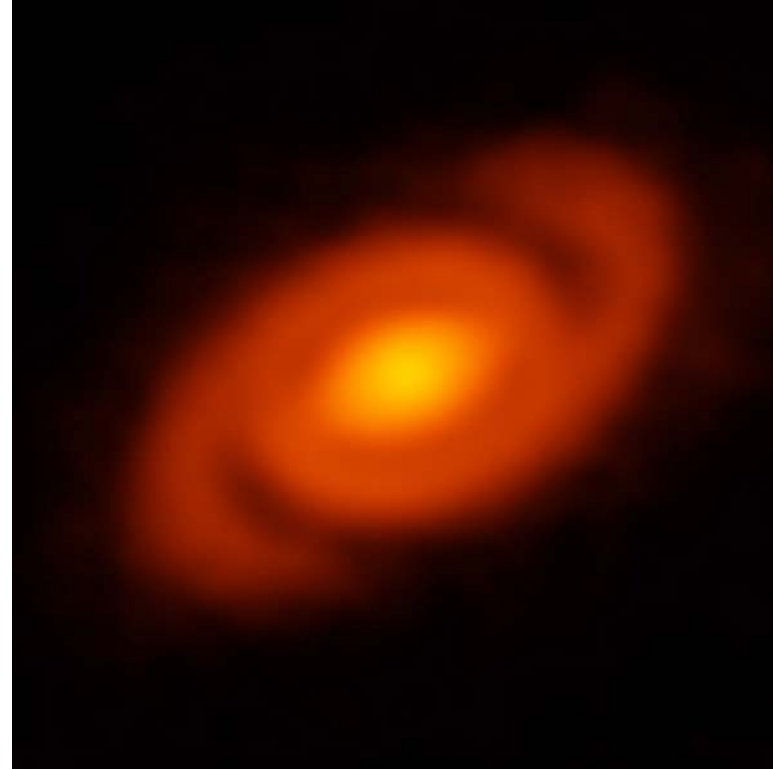
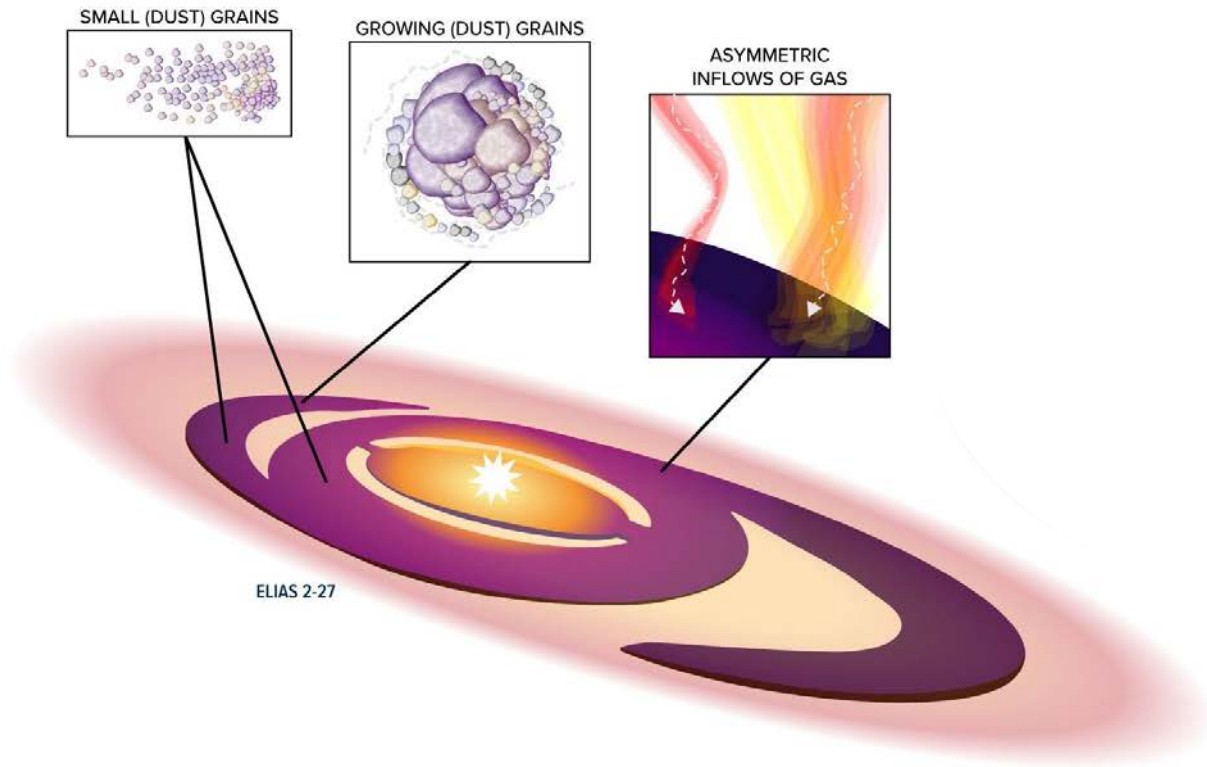
Credit: ALMA (ESO, NAOJ and NRAO), S. Andrews et al. and N. Lira

Dischi protoplanetari

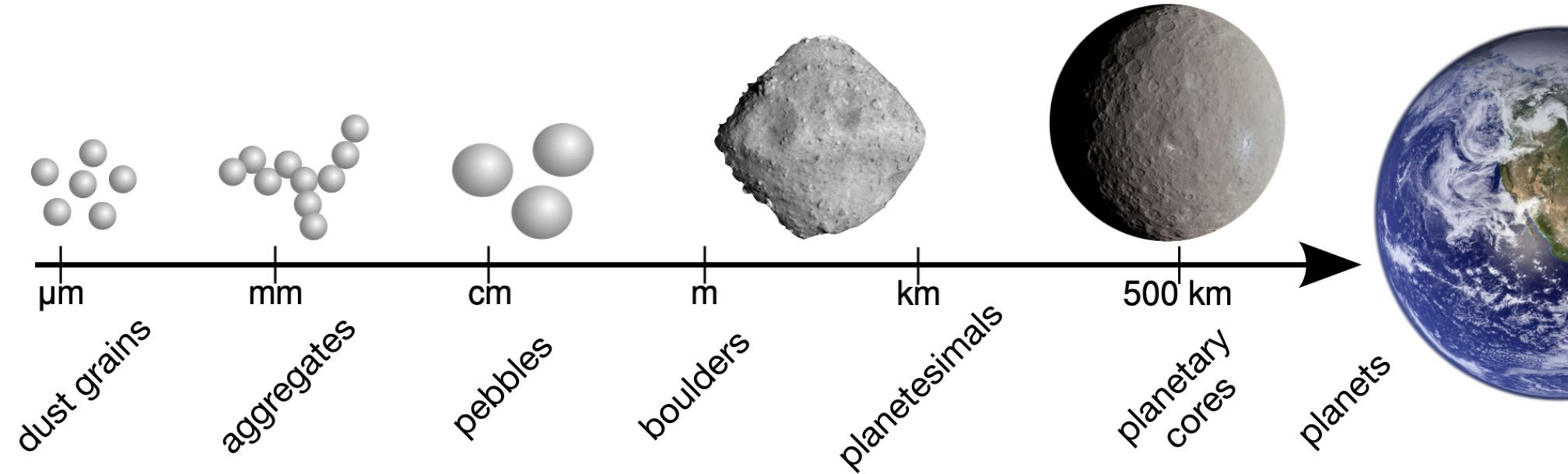


Formazione dei protopianeti

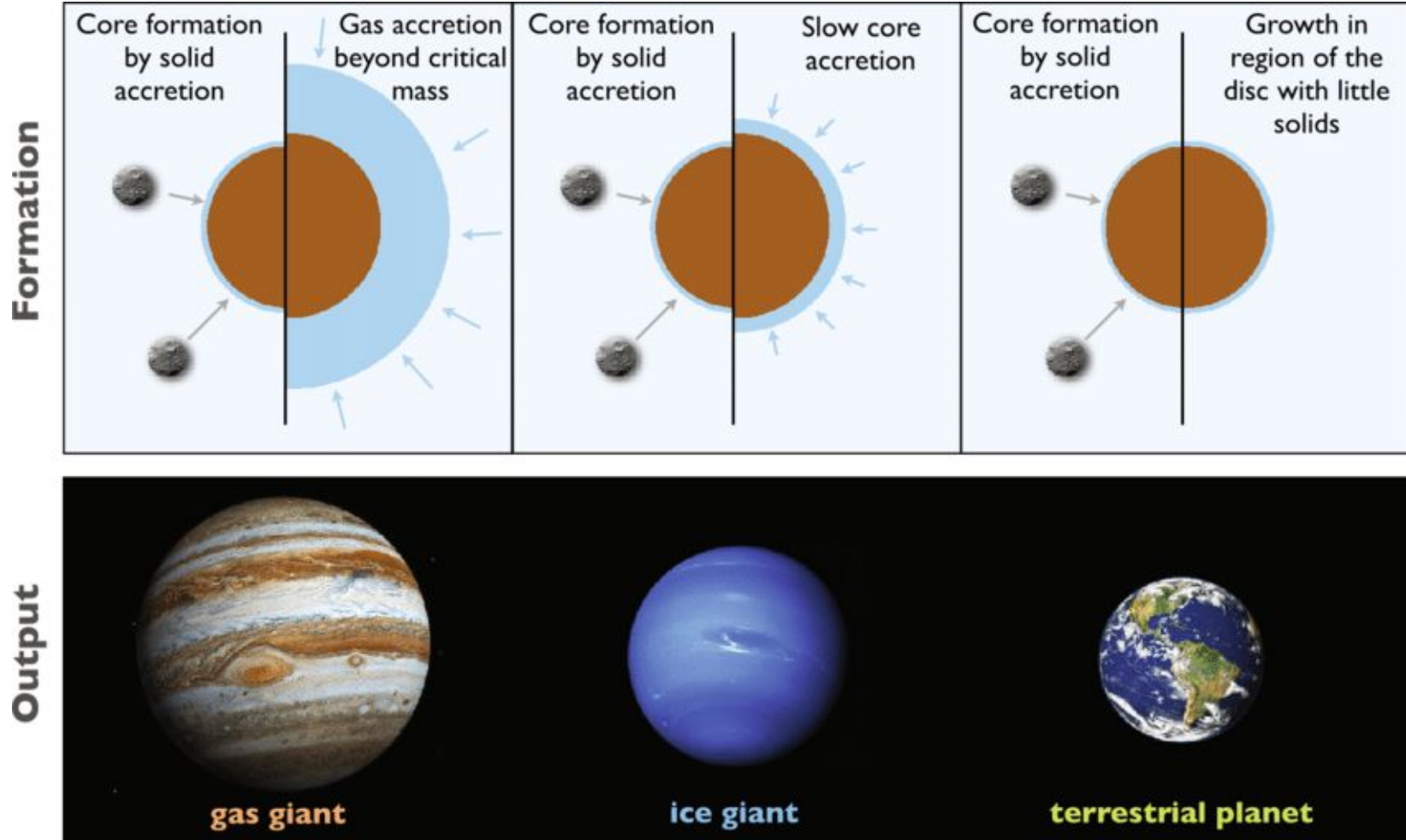
Why Are Gravitational Instabilities Important?



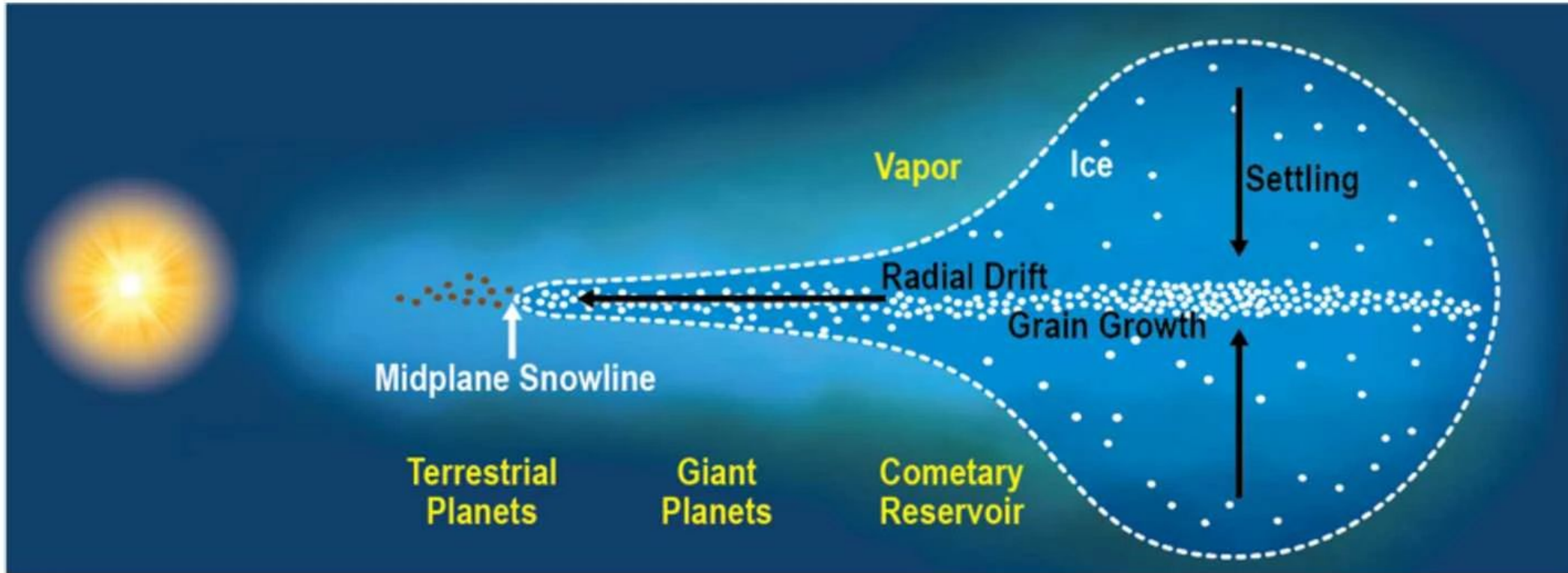
Formazione dei protopianeti



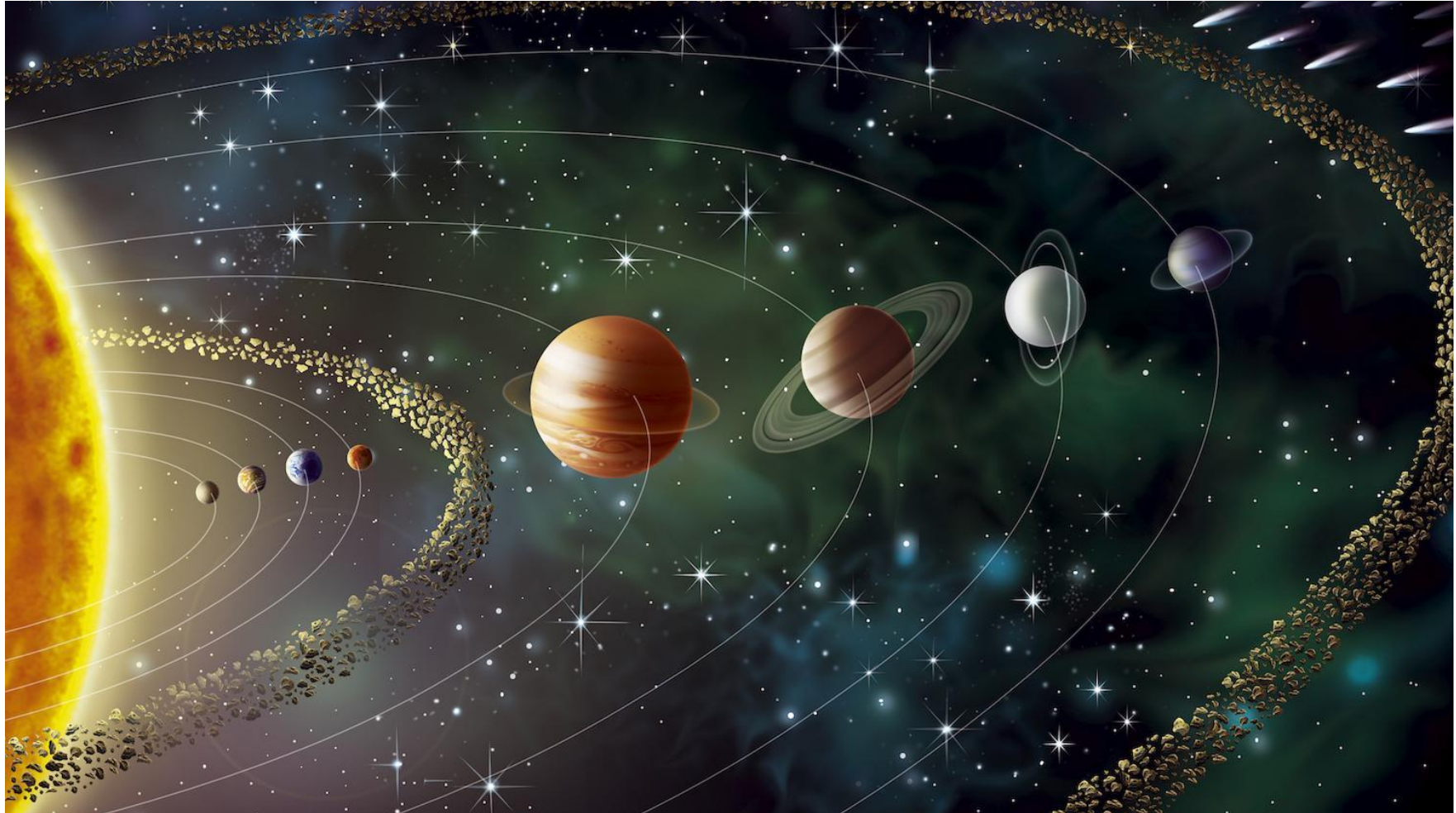
Formazione dei pianeti



Formazione dei pianeti nel disco

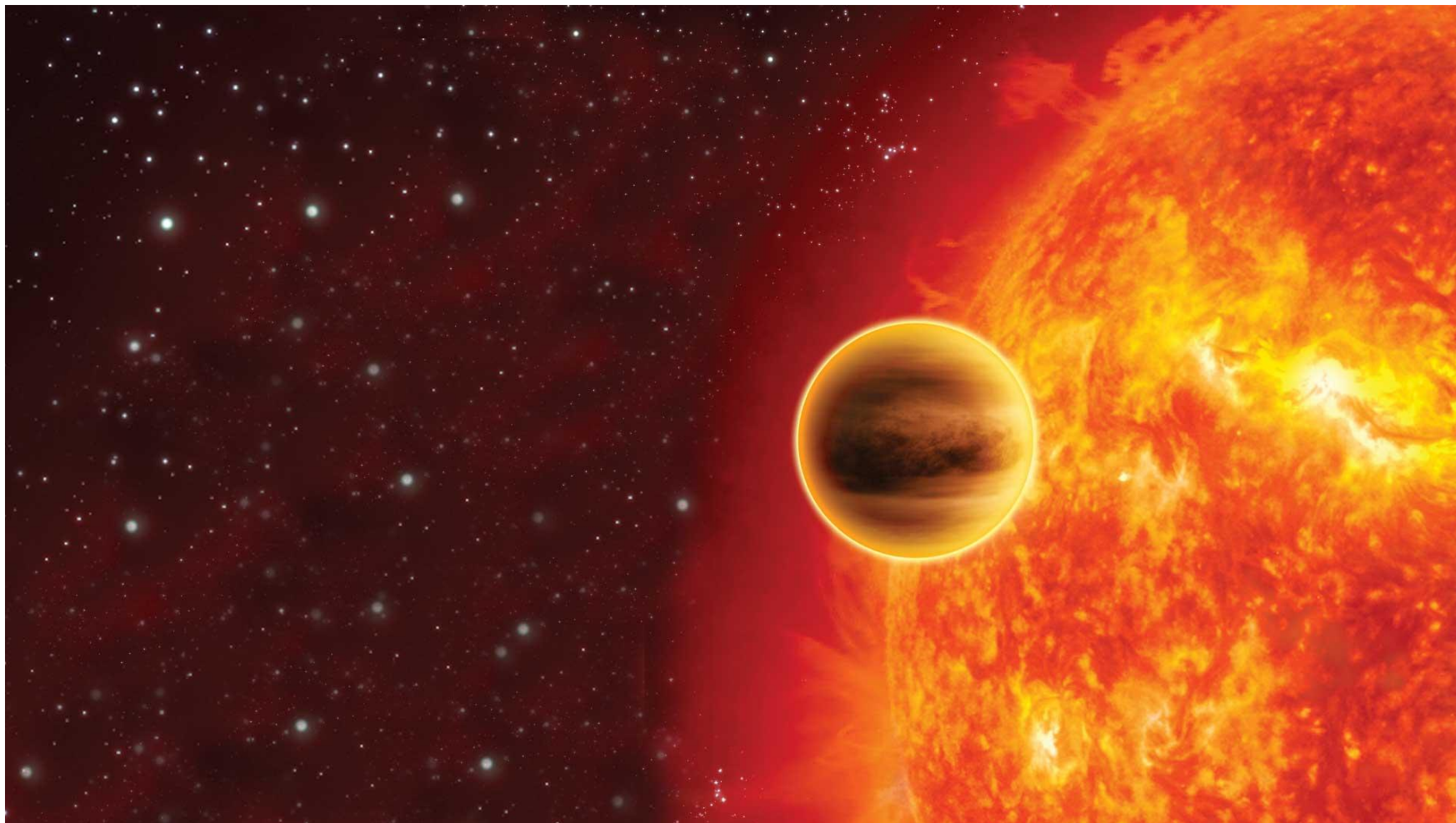


Il Sistema Solare



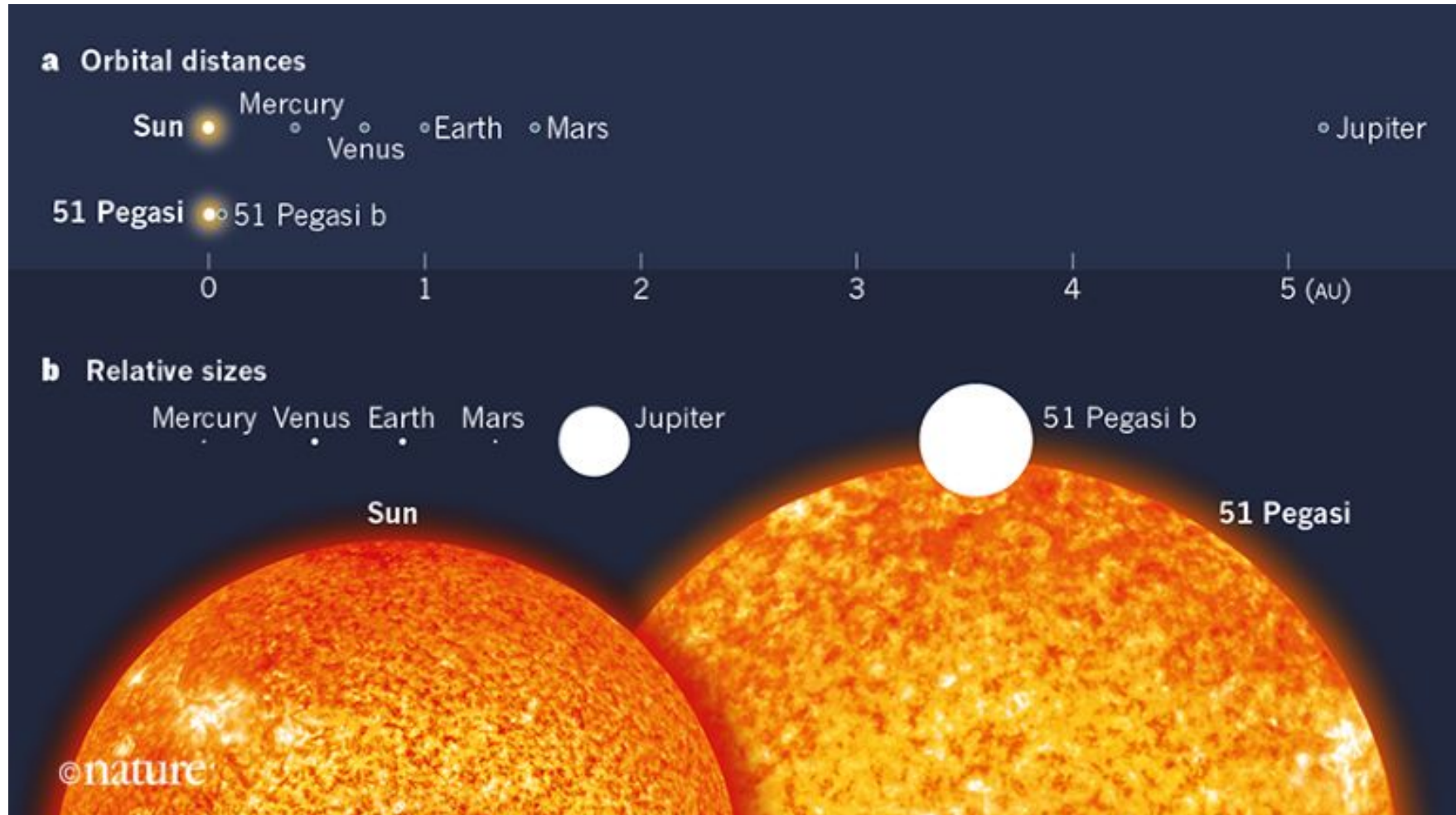
Credit: JACOPIN/BSIP SA/Alamy Stock Photo

La scoperta degli esopianeti

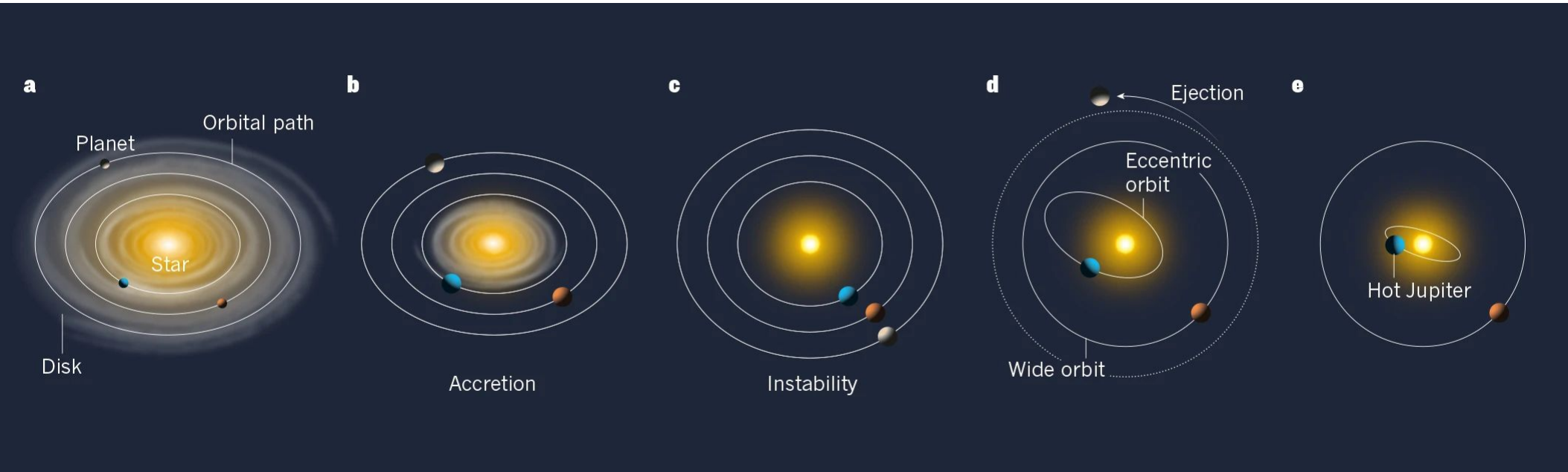


Credit: C. Carreau/ESA

Gioviani caldi



Migrazione dei pianeti

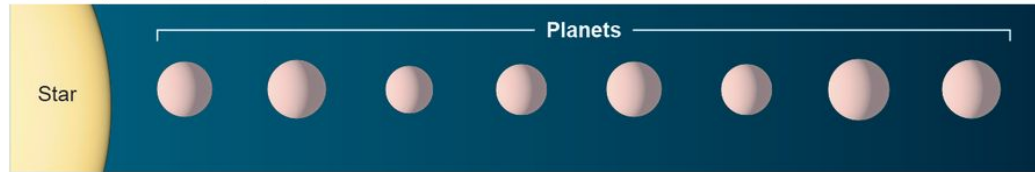


Credit: Triaud, A., 2016, Nature 537, 496

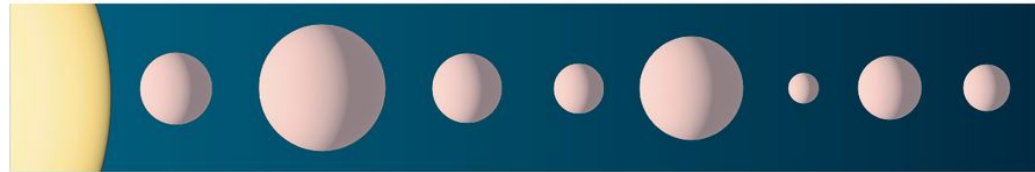
Architettura dei sistemi planetari

The Four Classes of Planetary Systems

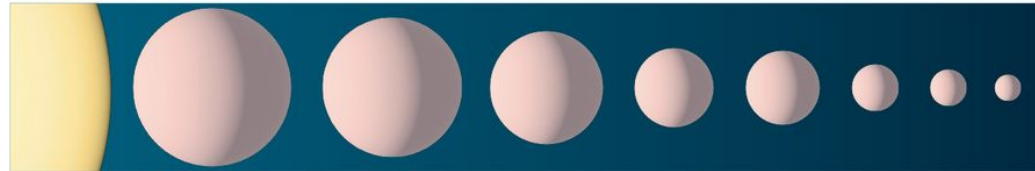
Similar (most common)



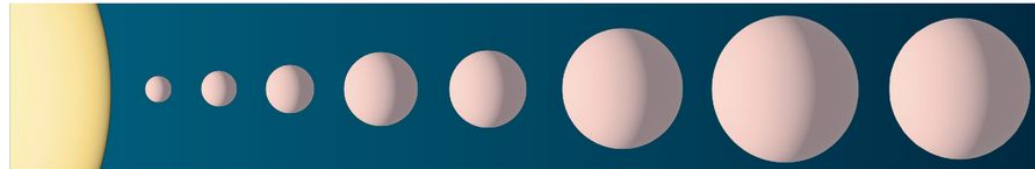
Mixed



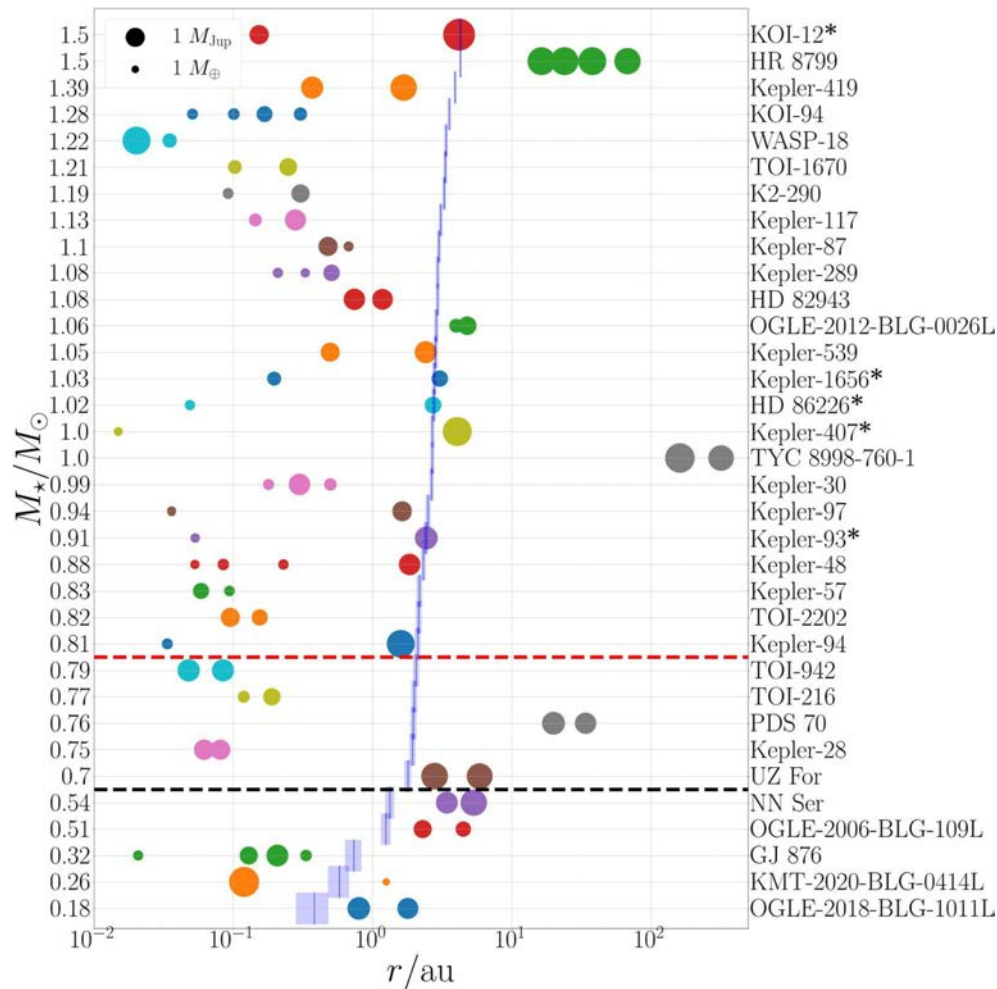
Antiorordered



Ordered (least common)

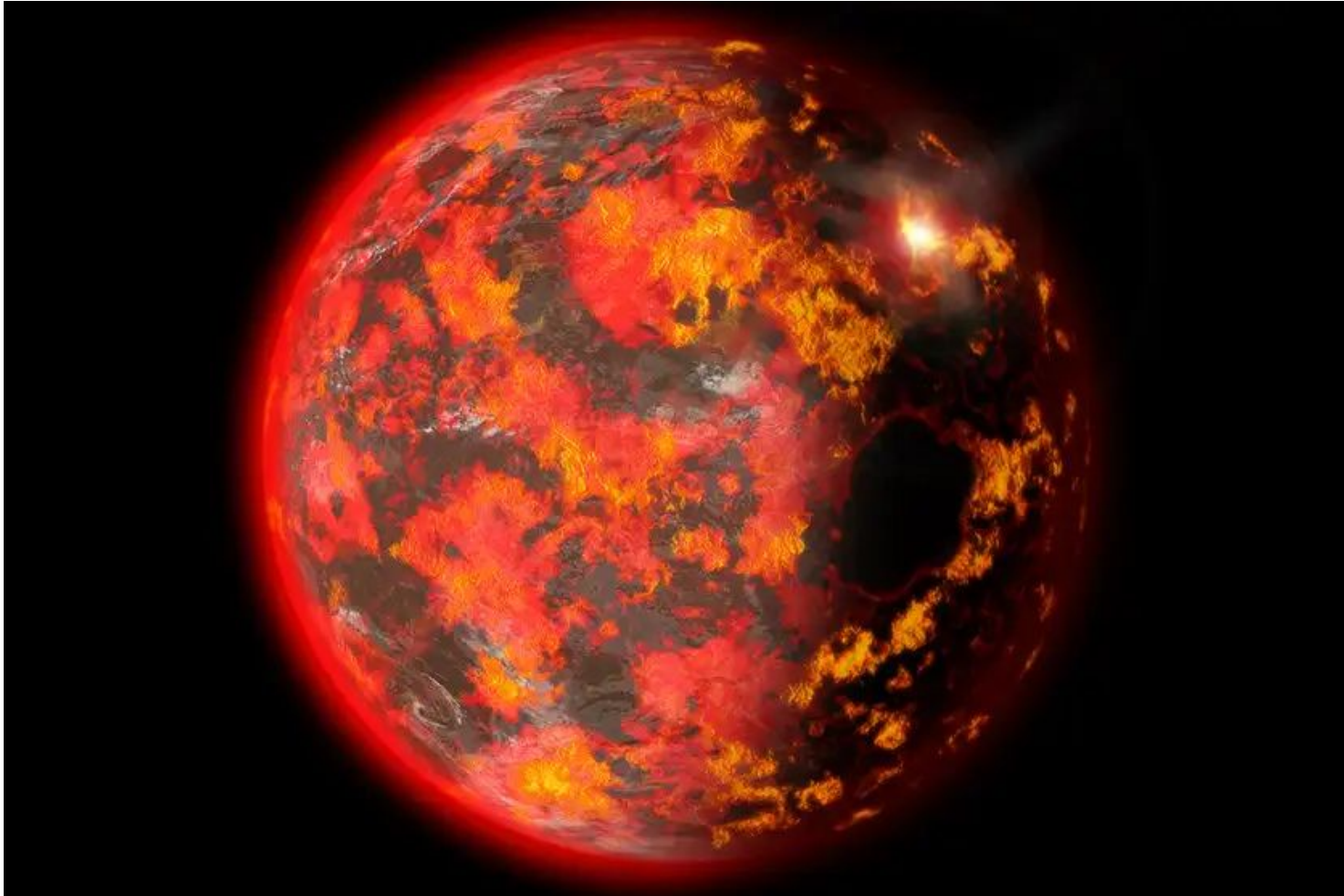


Architettura dei sistemi planetari



Credit: Anna C. Childs et al 2022 ApJL 937 L41

Formazione della Terra

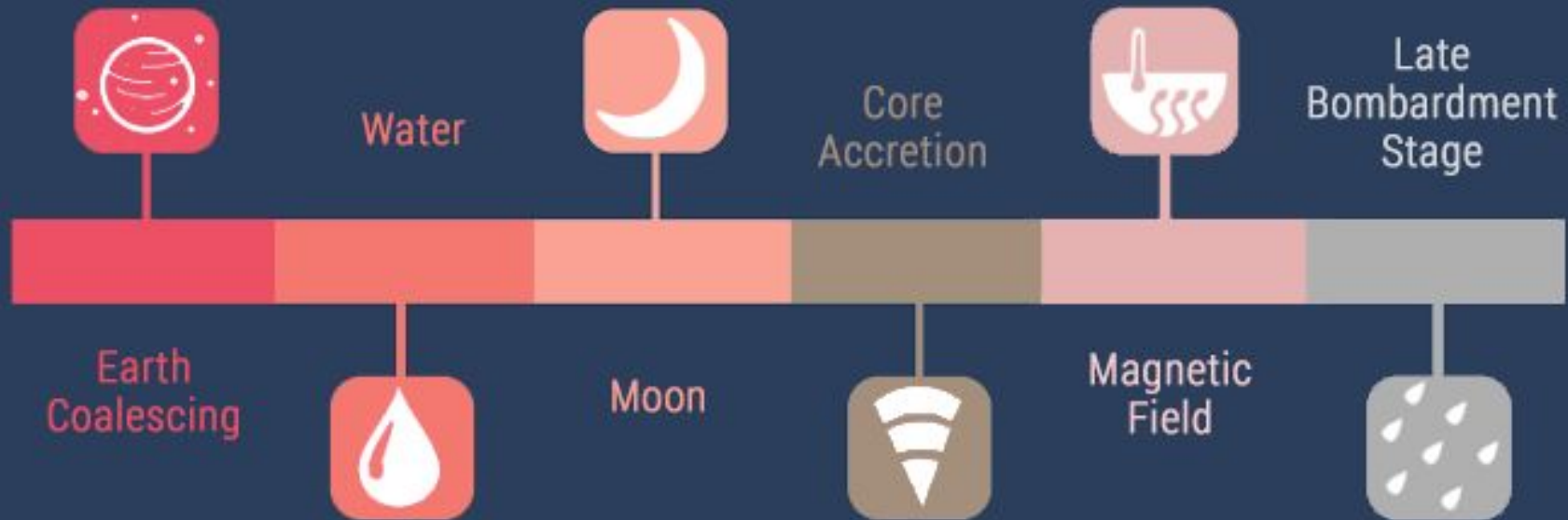


Credit: Shutterstock / Diego Barucco

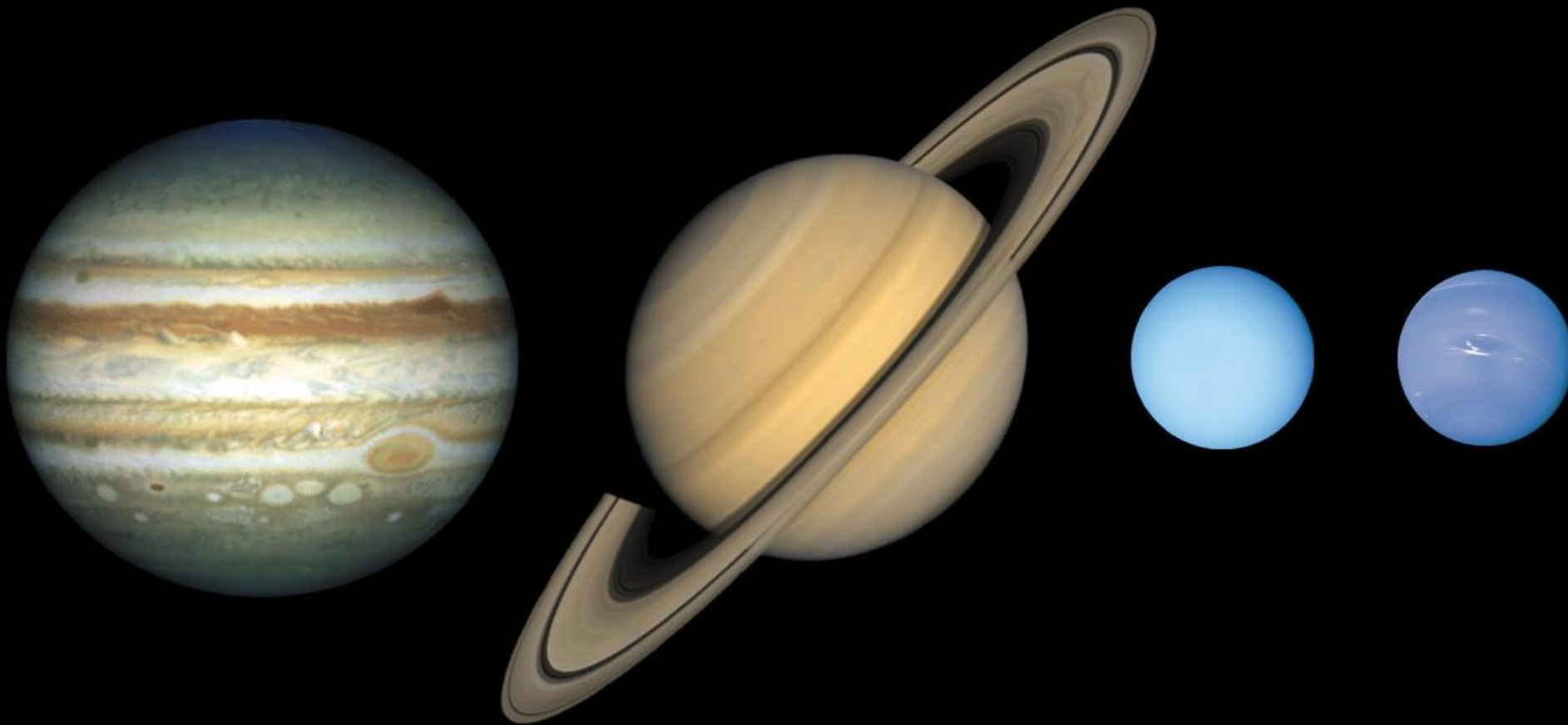
Adeano

HADEAN EON

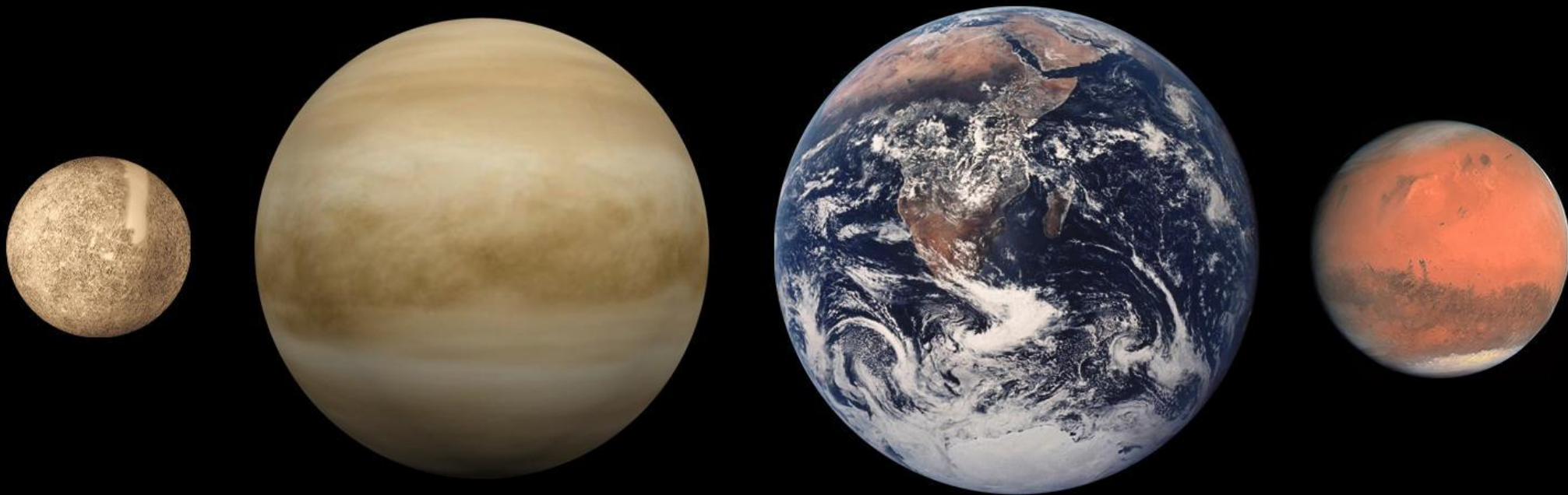
4.6 to 4.0 billion years ago



Atmosfera primaria



Atmosfera secondaria

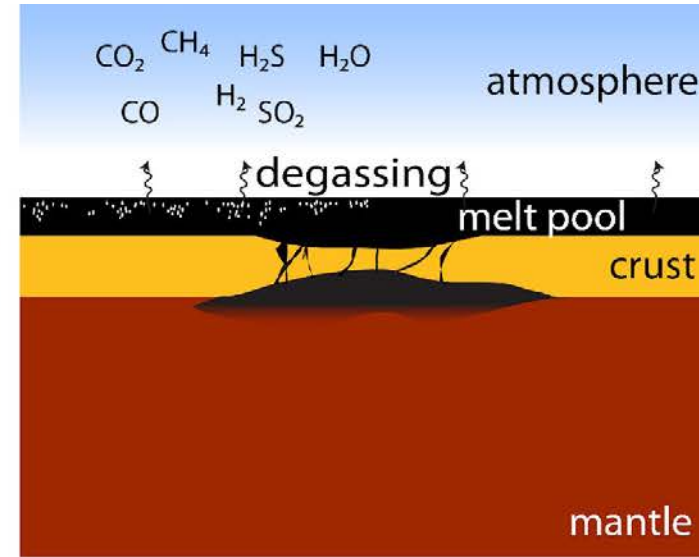
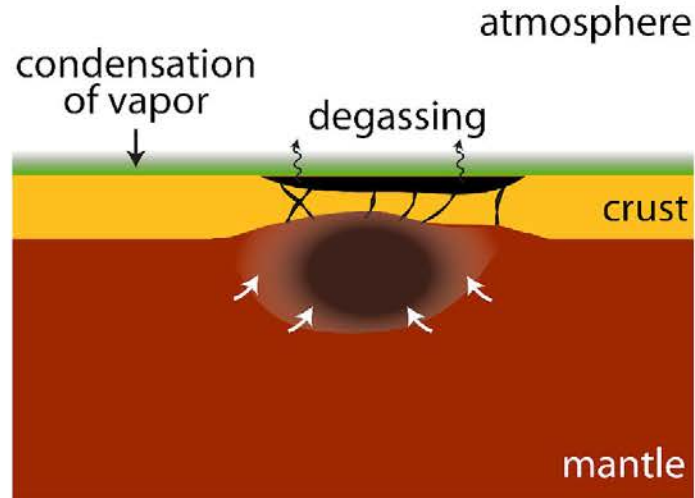
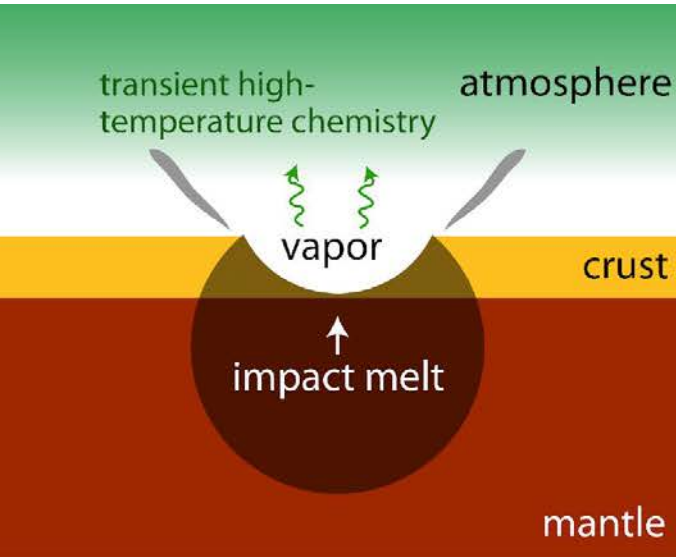


Perdita dell'atmosfera primaria

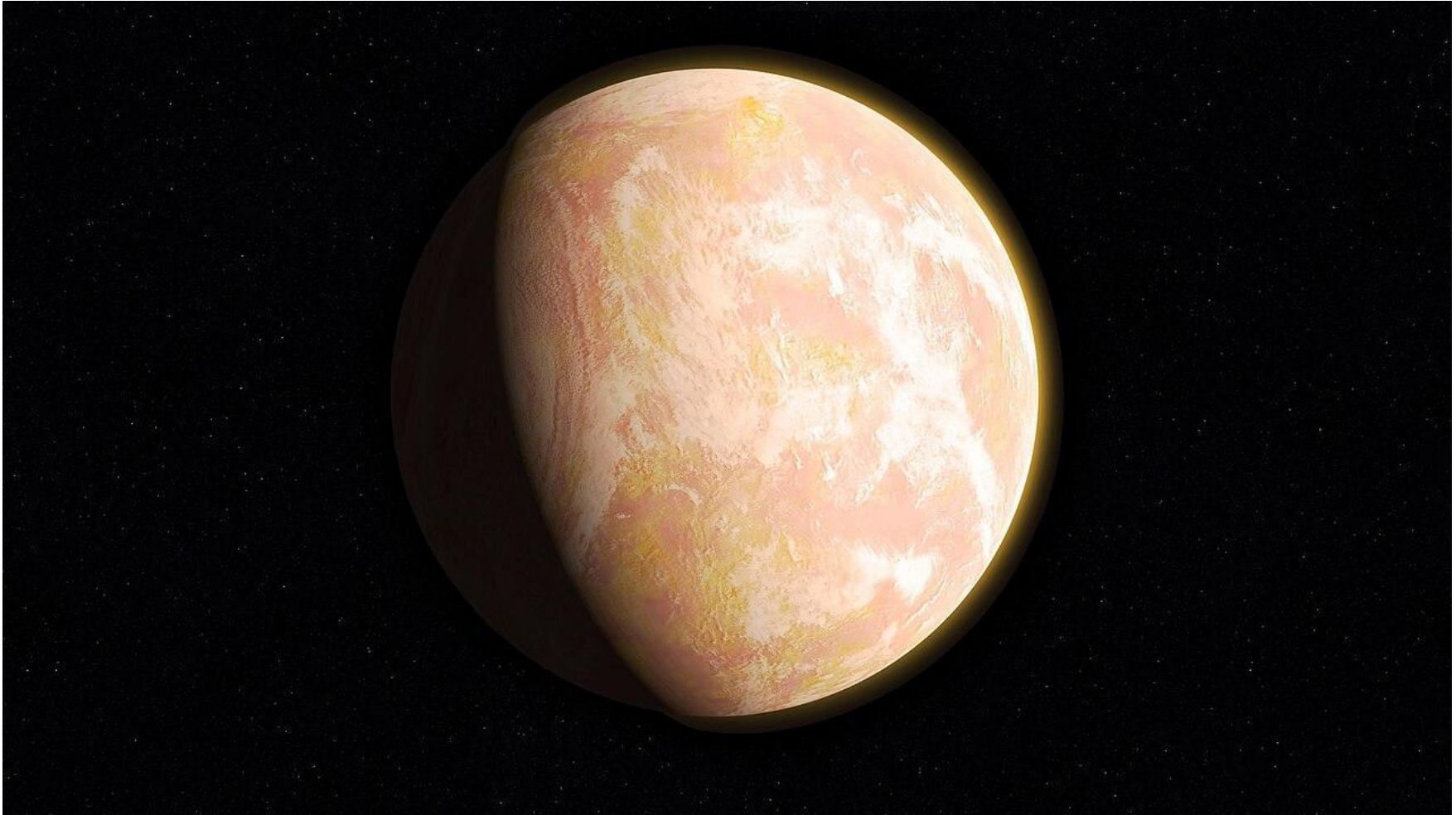


Credit: Jeancarlosptino

Creazione dell'atmosfera secondaria

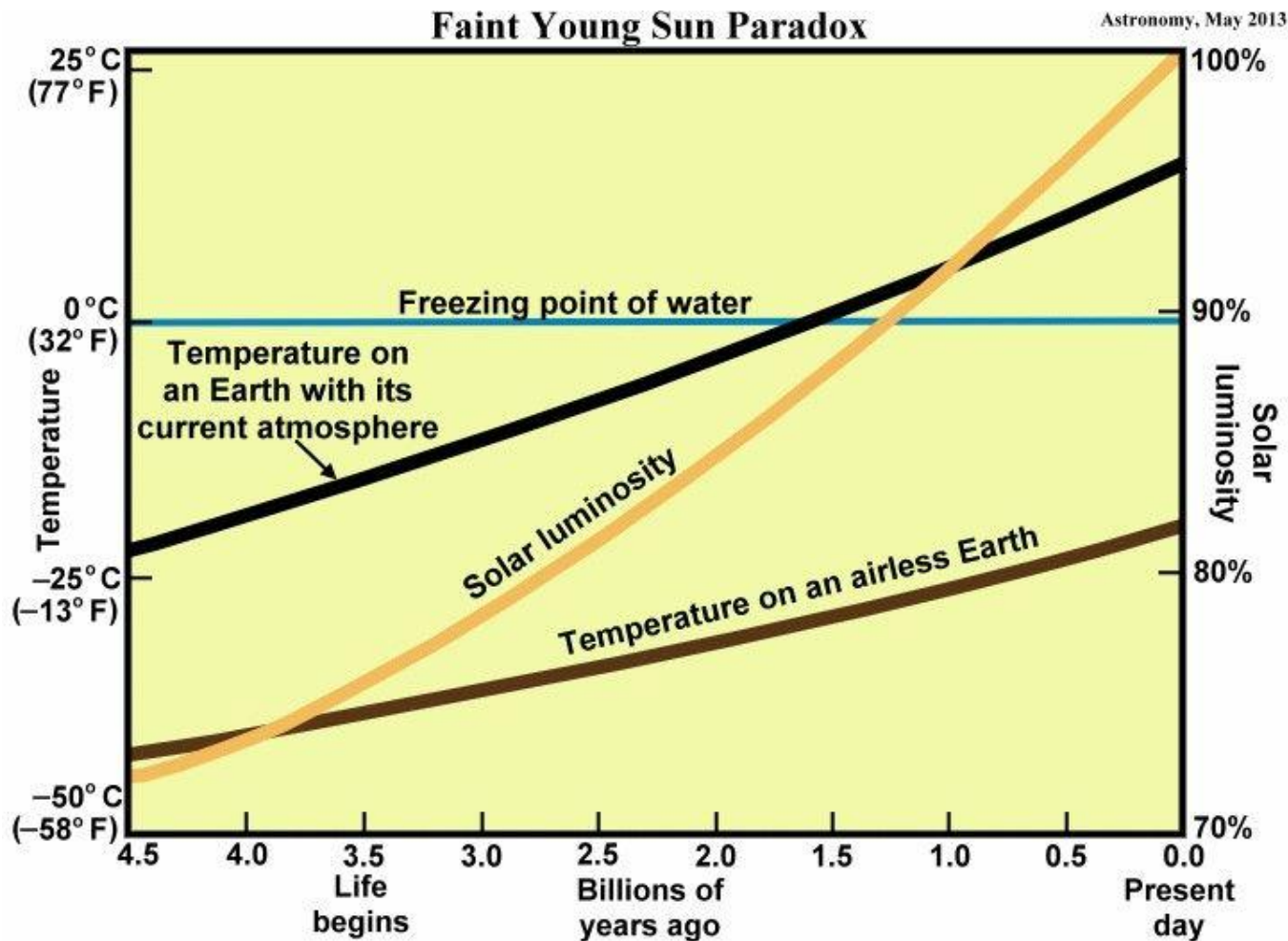


Atmosfera secondaria



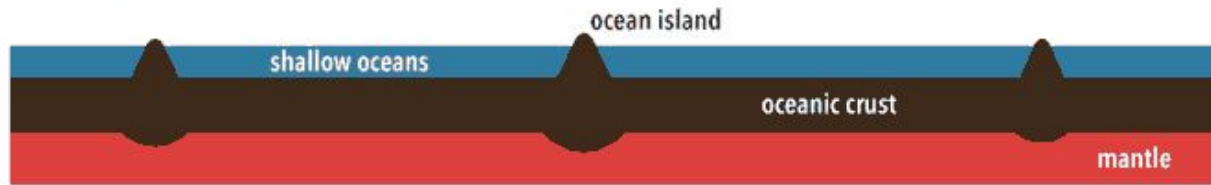
Credit: NASA/Goddard Space Flight Center/Francis Reddy

Il paradosso del Sole giovane



Mondo oceano

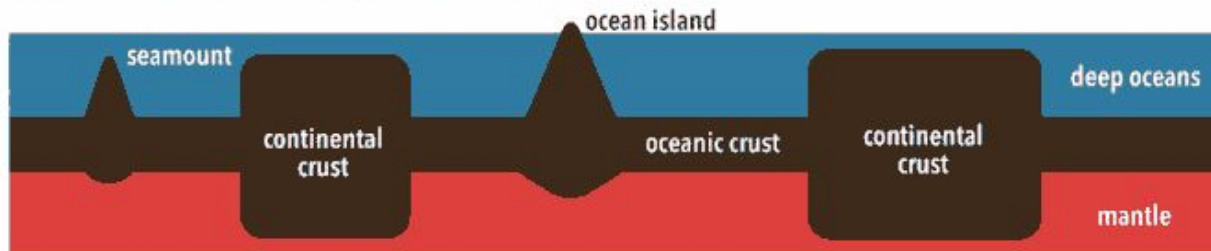
(a) early Hadean (~4.4 Ga)



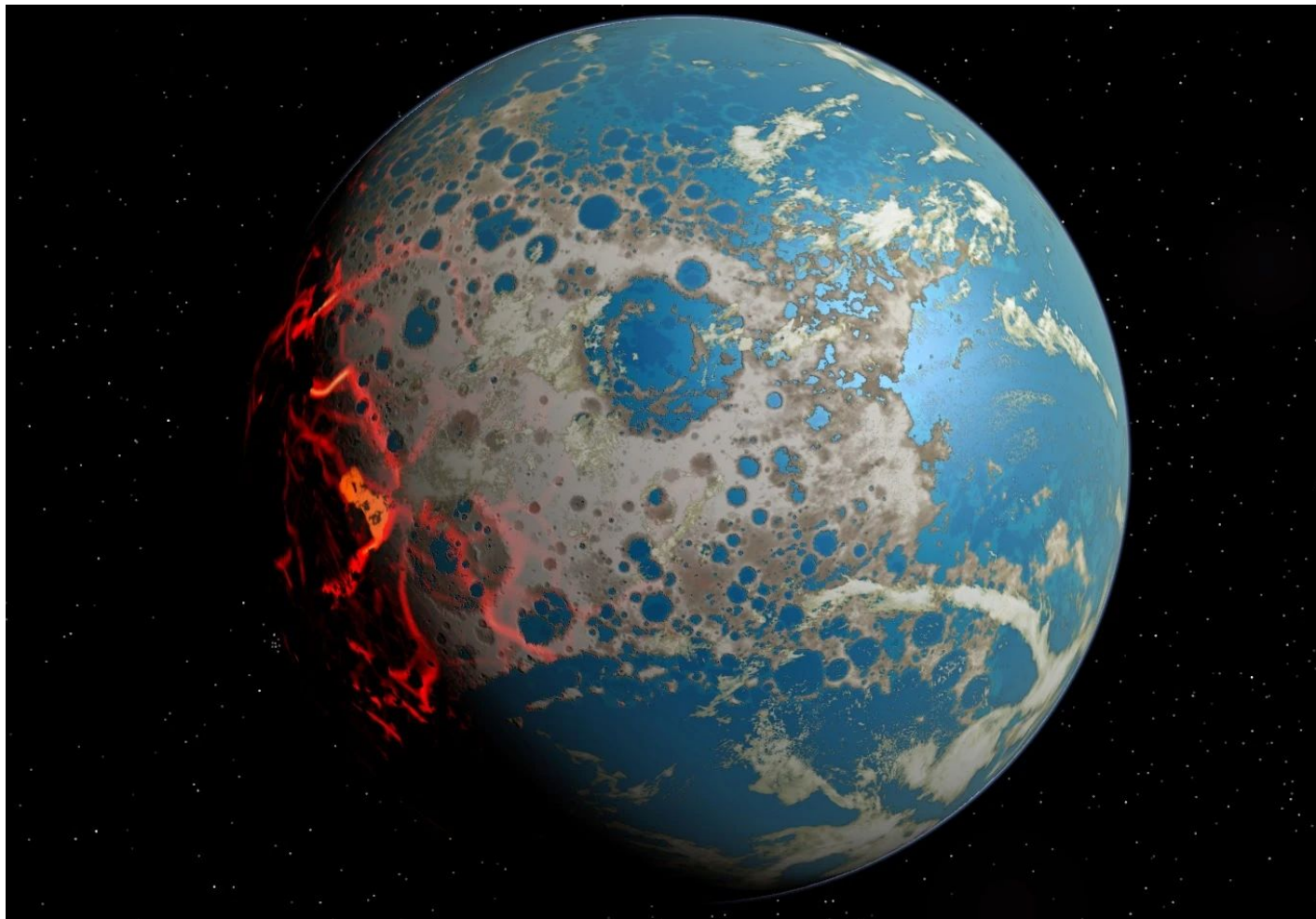
(b) mid-Hadean (~4.2 Ga)



(c) late Hadean to early Archean (~4 to 3.5 Ga)

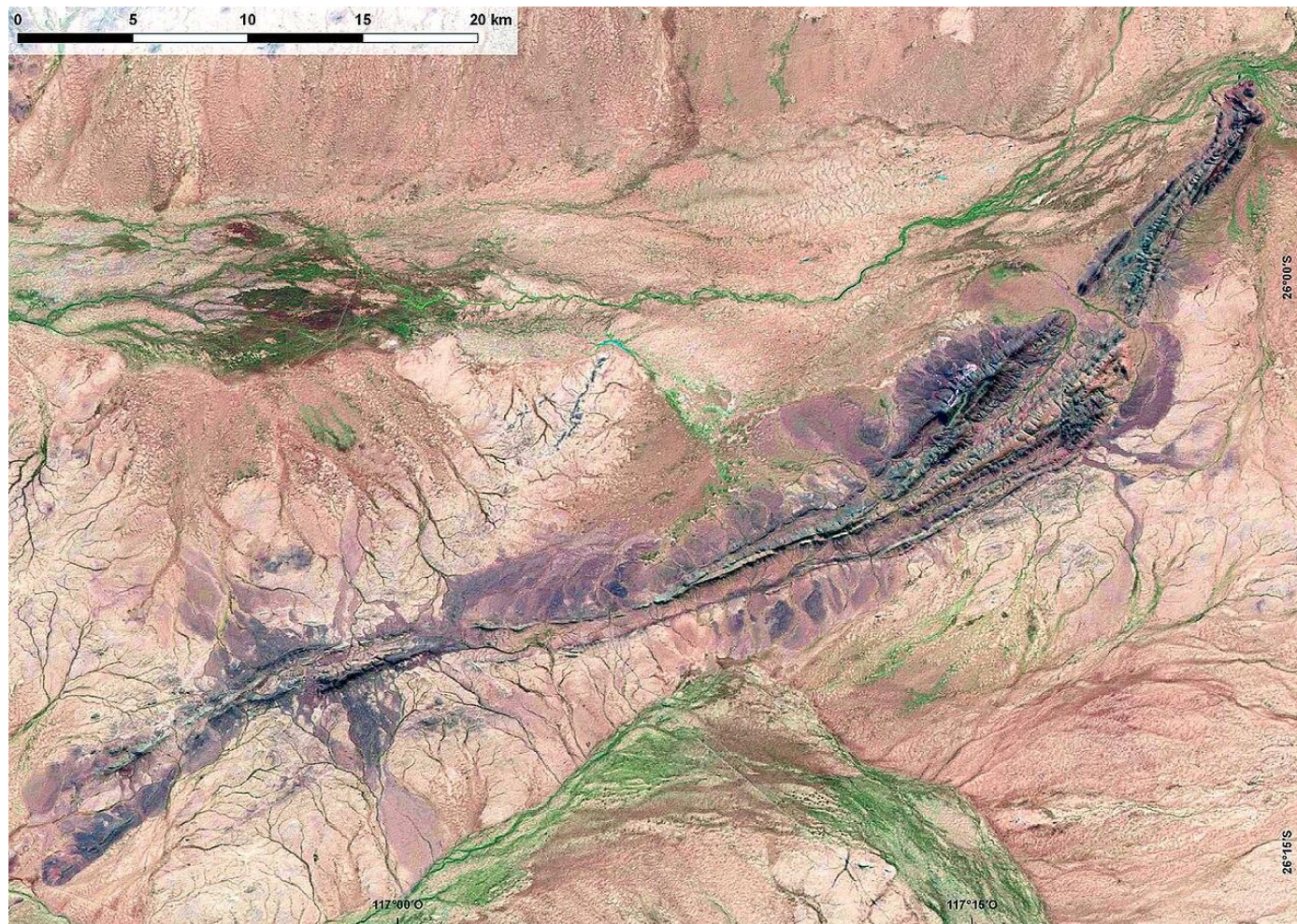


Mondo oceano



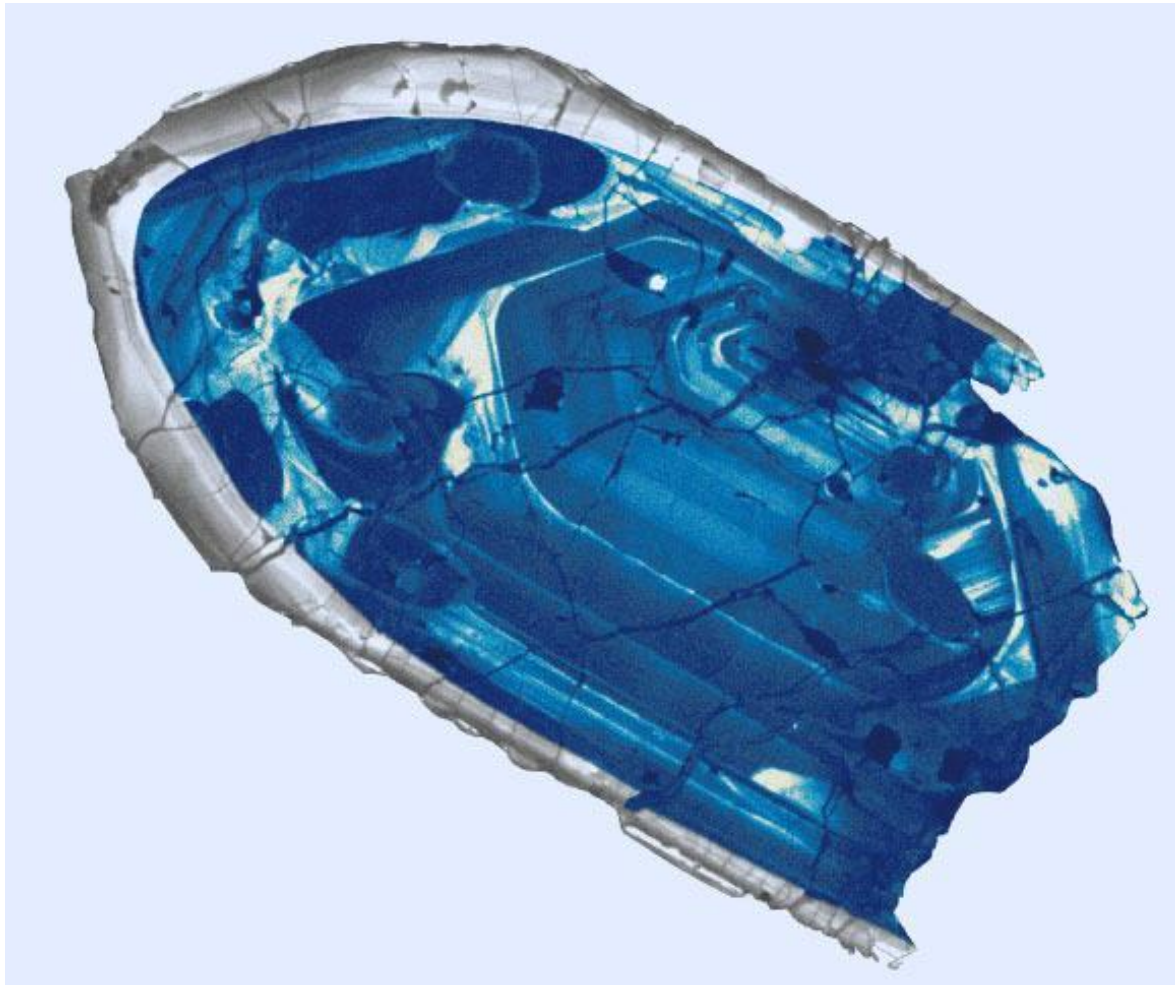
Credit: Simone Marchi

Primi continenti



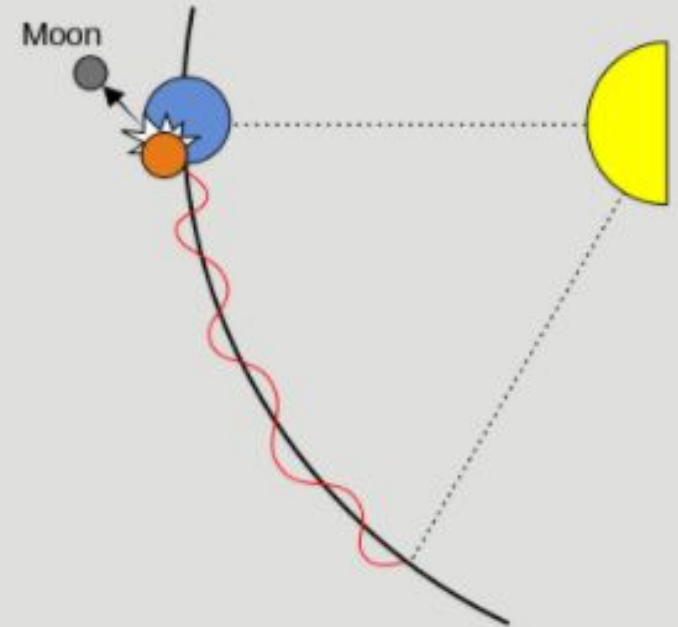
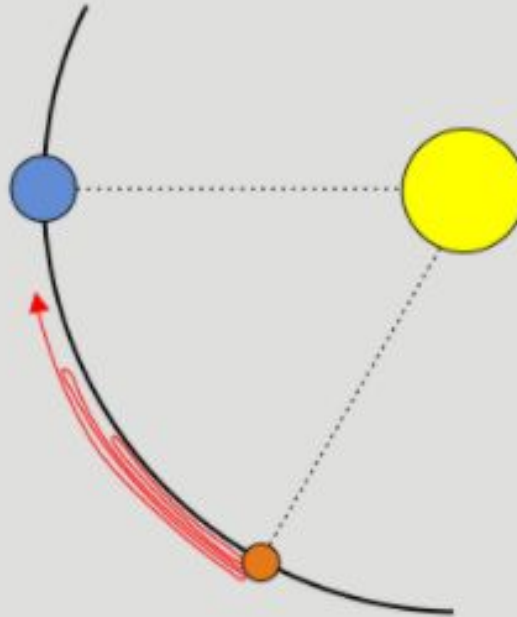
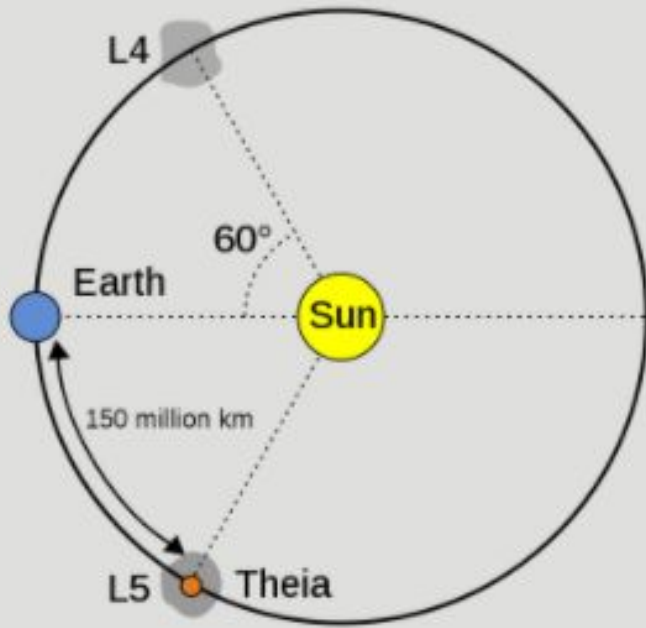
Credit: Gretarsson

Primi continenti



Credit: John Valley

Formazione della Luna

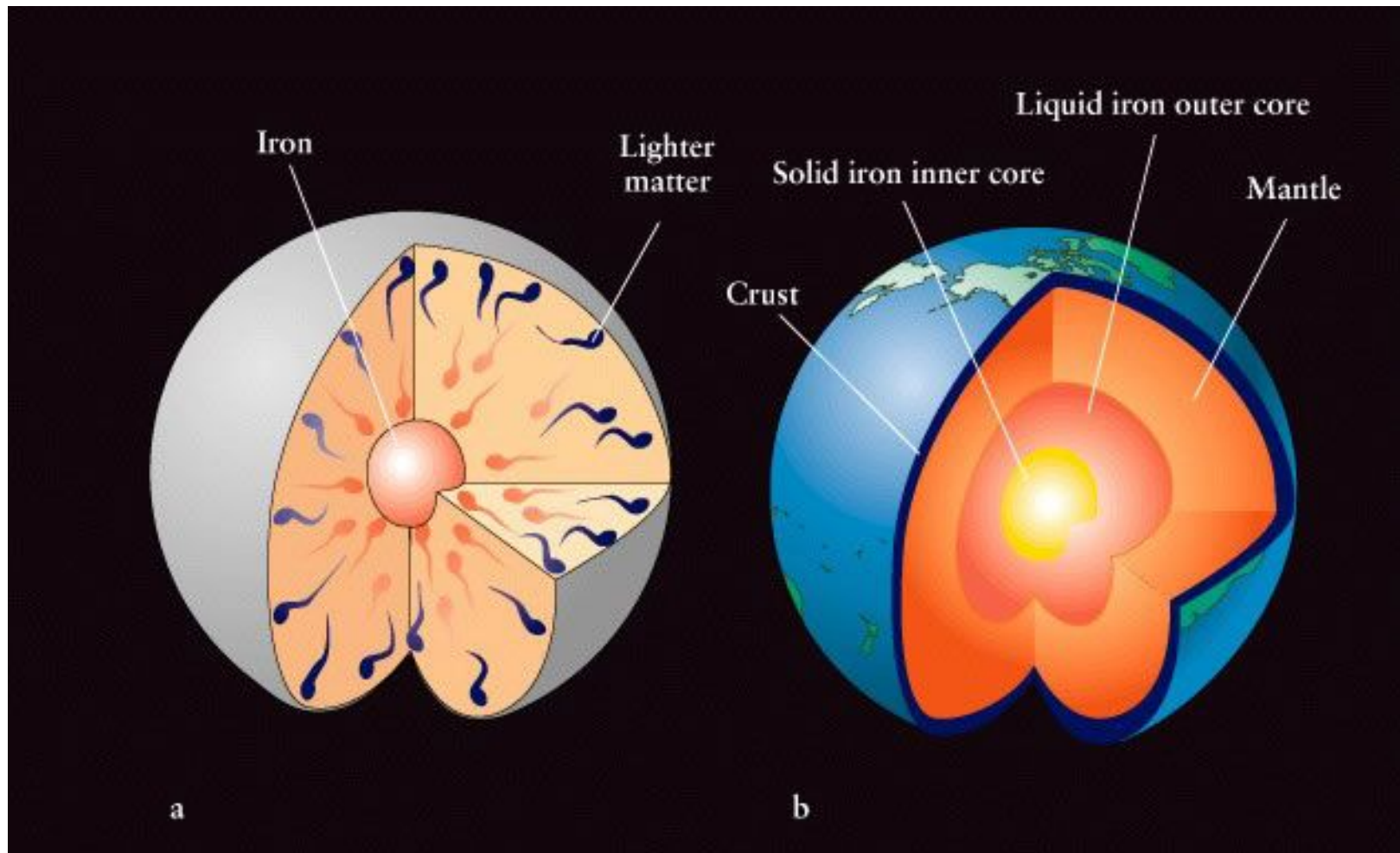


Formazione della Luna

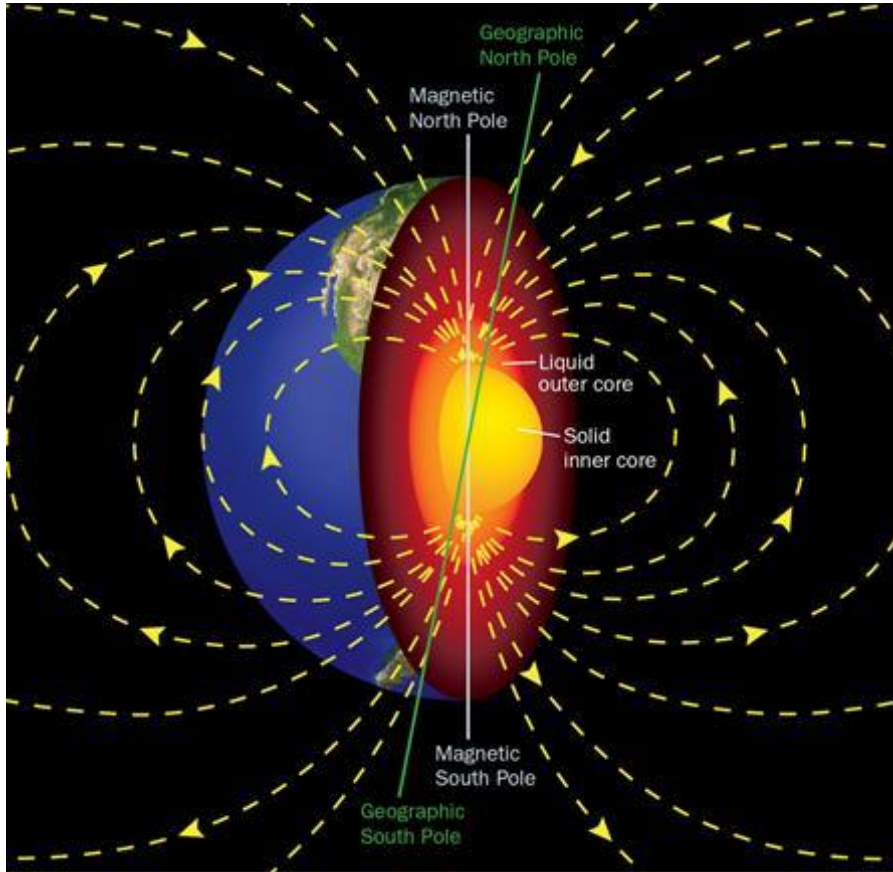


Credit: NASA's Ames Research Center

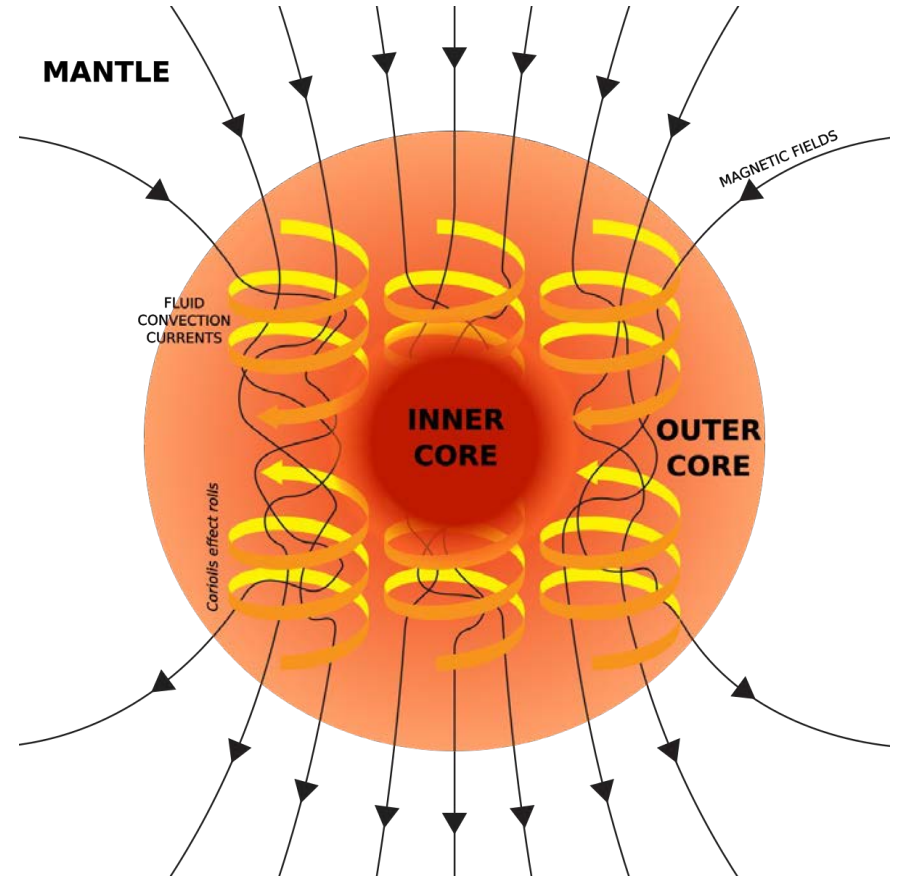
Catastrofe del Ferro



Campo magnetico terrestre



Credit: unknown



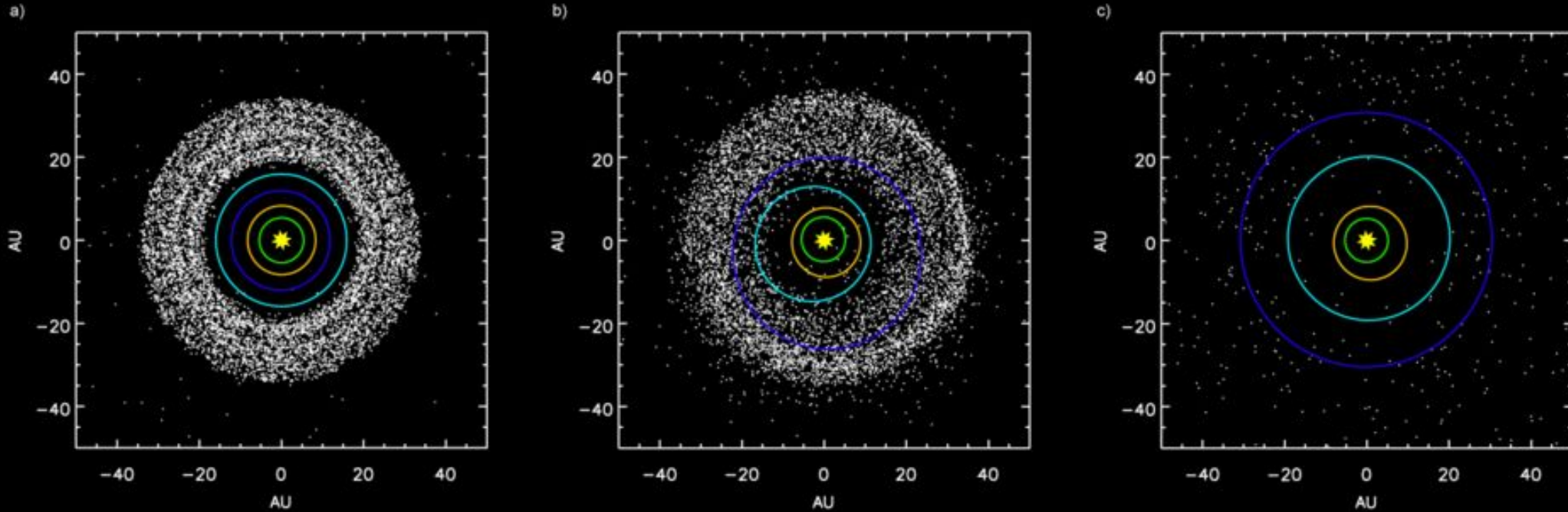
Credit: Andrew Z. Colvin

Late Heavy Bombardment

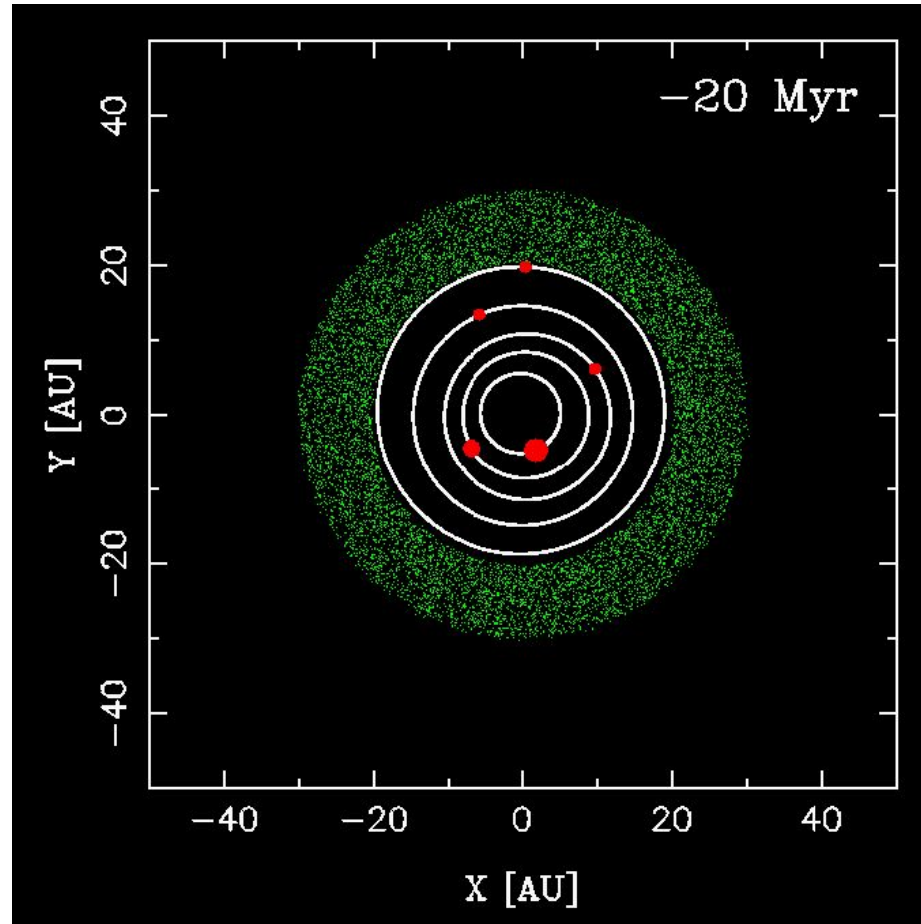


Credit: unknown

Modello di Nizza a 4 pianeti



Modello di Nizza a 5 pianeti



Credit: David Nesvorný/SWRI

Fine dell'Adeano

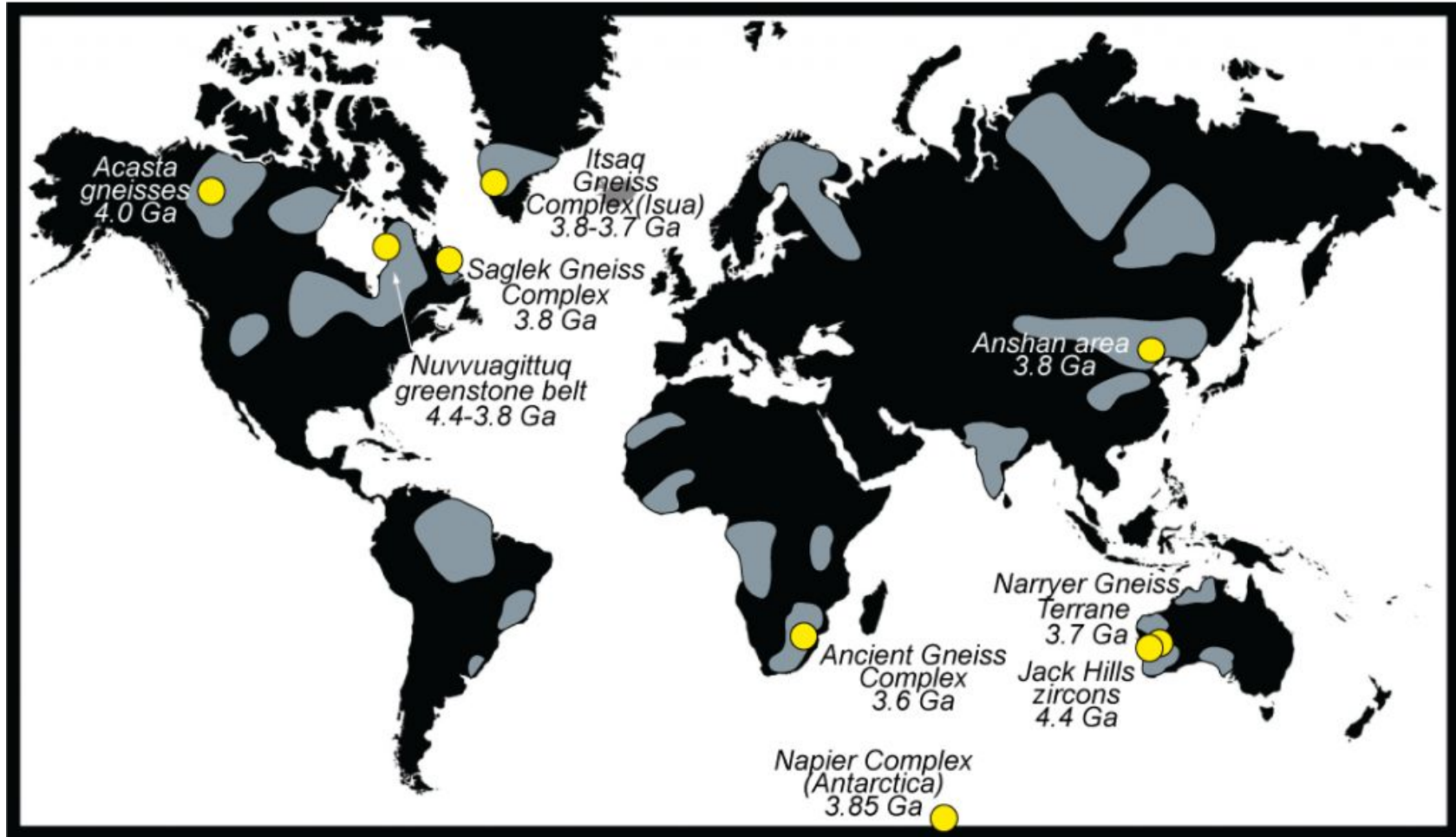
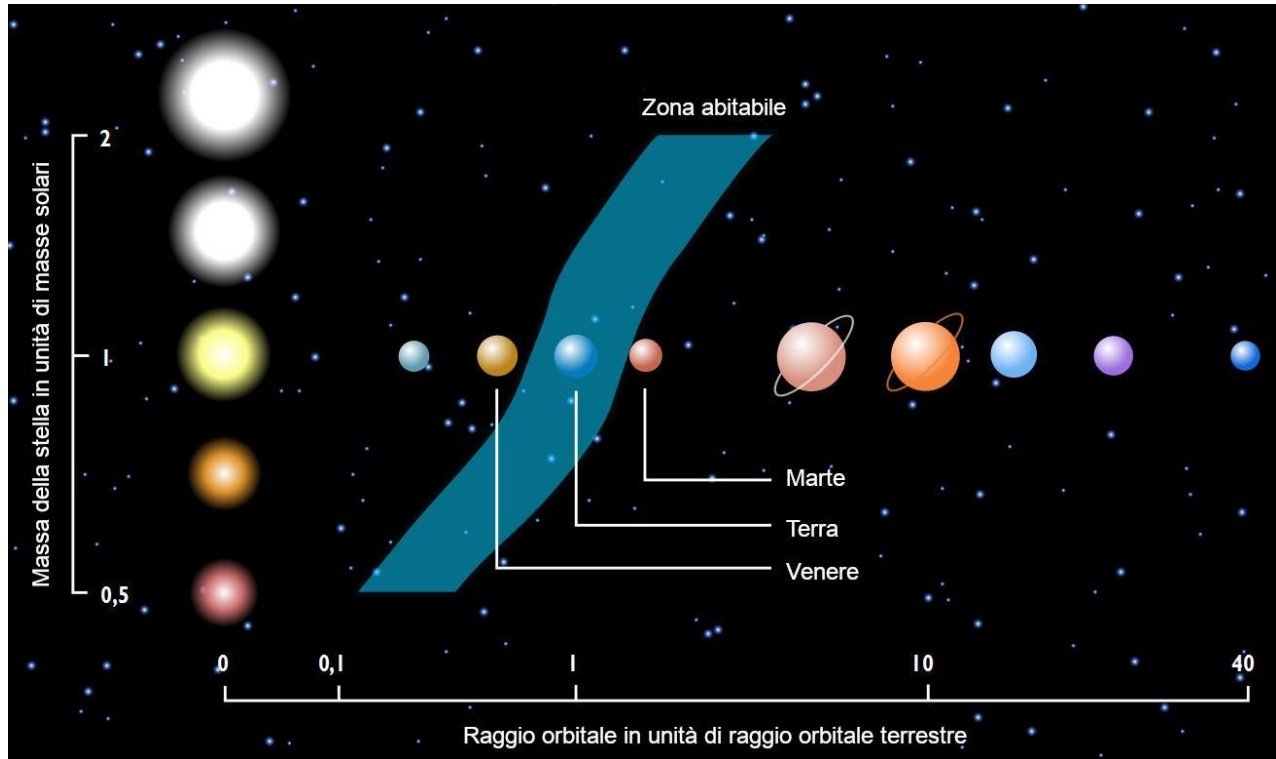


Image from <https://opengeology.org/historicalgeology/case-studies/earths-oldest-rocks/>

La Terra alla fine dell'Adeano

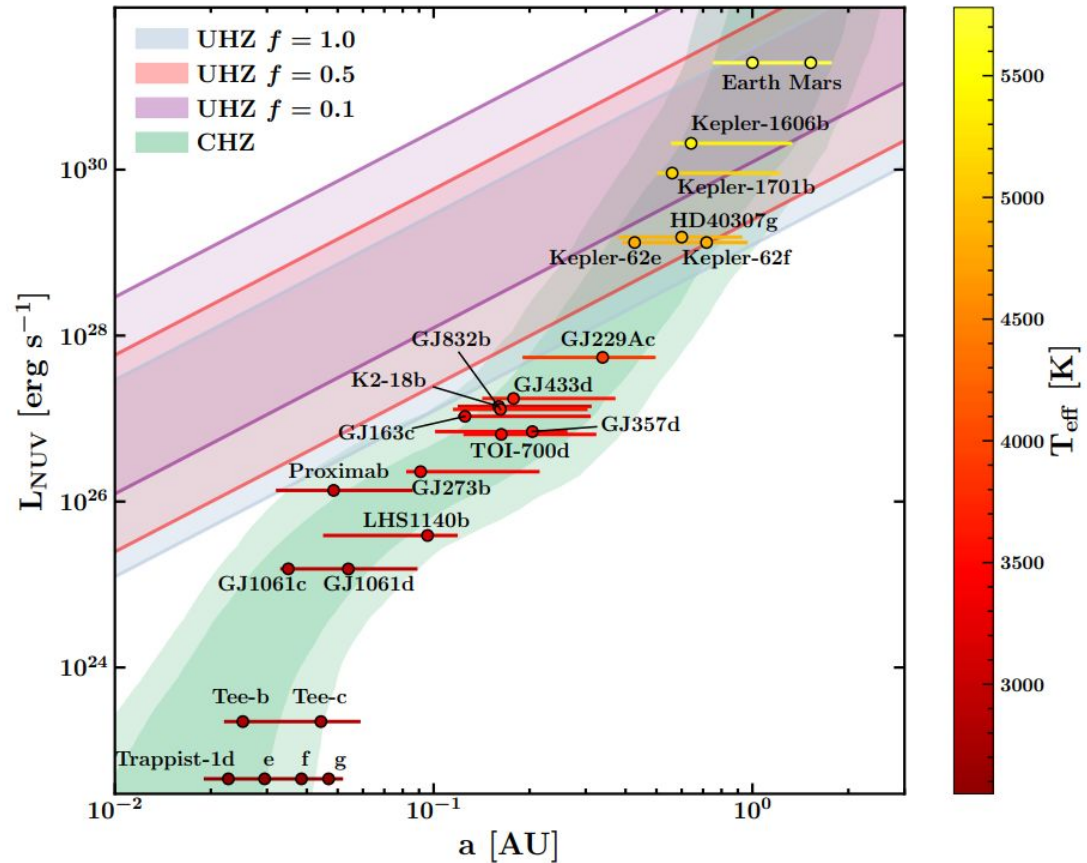
- Acqua allo stato liquido



Credit: Wikipedia

La Terra alla fine dell'Adeano

- Acqua allo stato liquido
- **Basso livello di radiazioni UV**

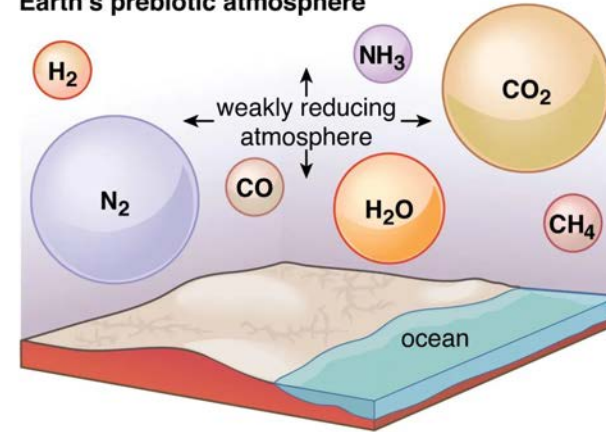


Credit: Spinelli et al., 2023, MNRAS 522, 1411

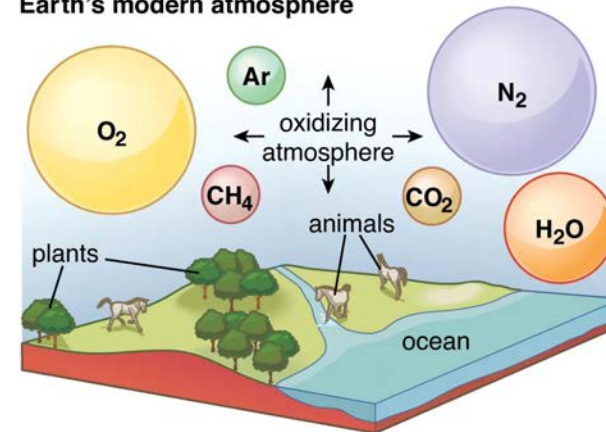
La Terra alla fine dell'Adeano

- Acqua allo stato liquido
- Basso livello di radiazioni UV
- **Presenza di un'atmosfera**

Earth's prebiotic atmosphere



Earth's modern atmosphere

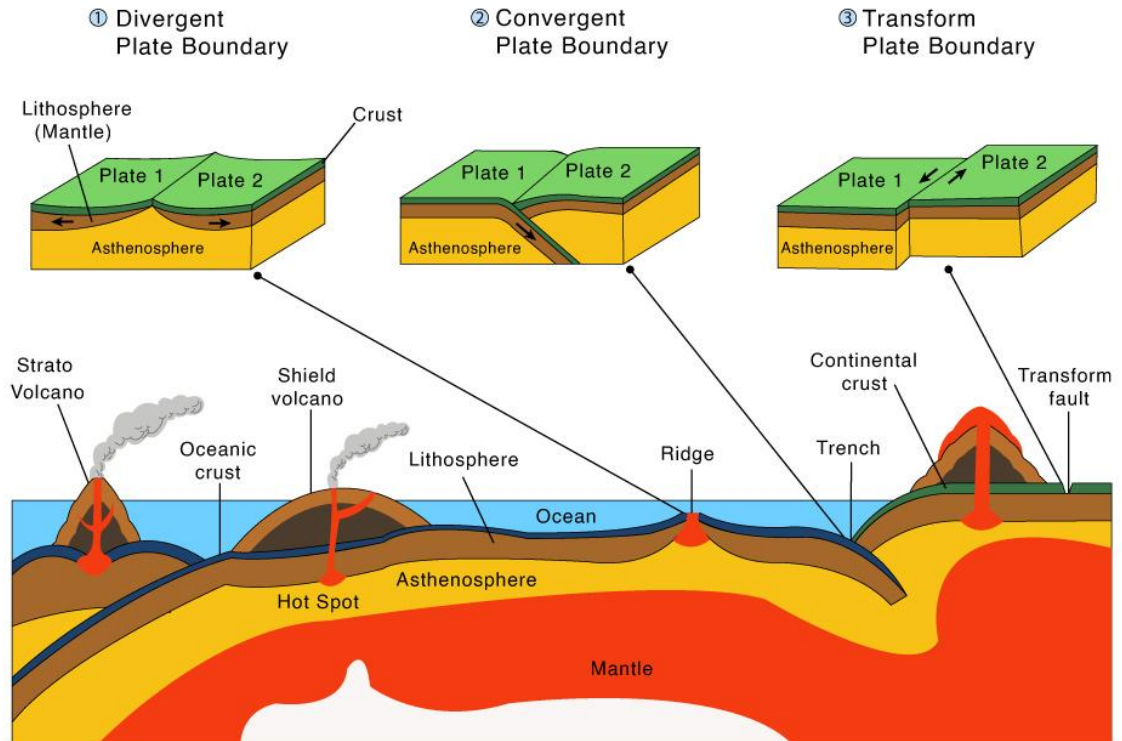


La Terra alla fine dell'Adeano

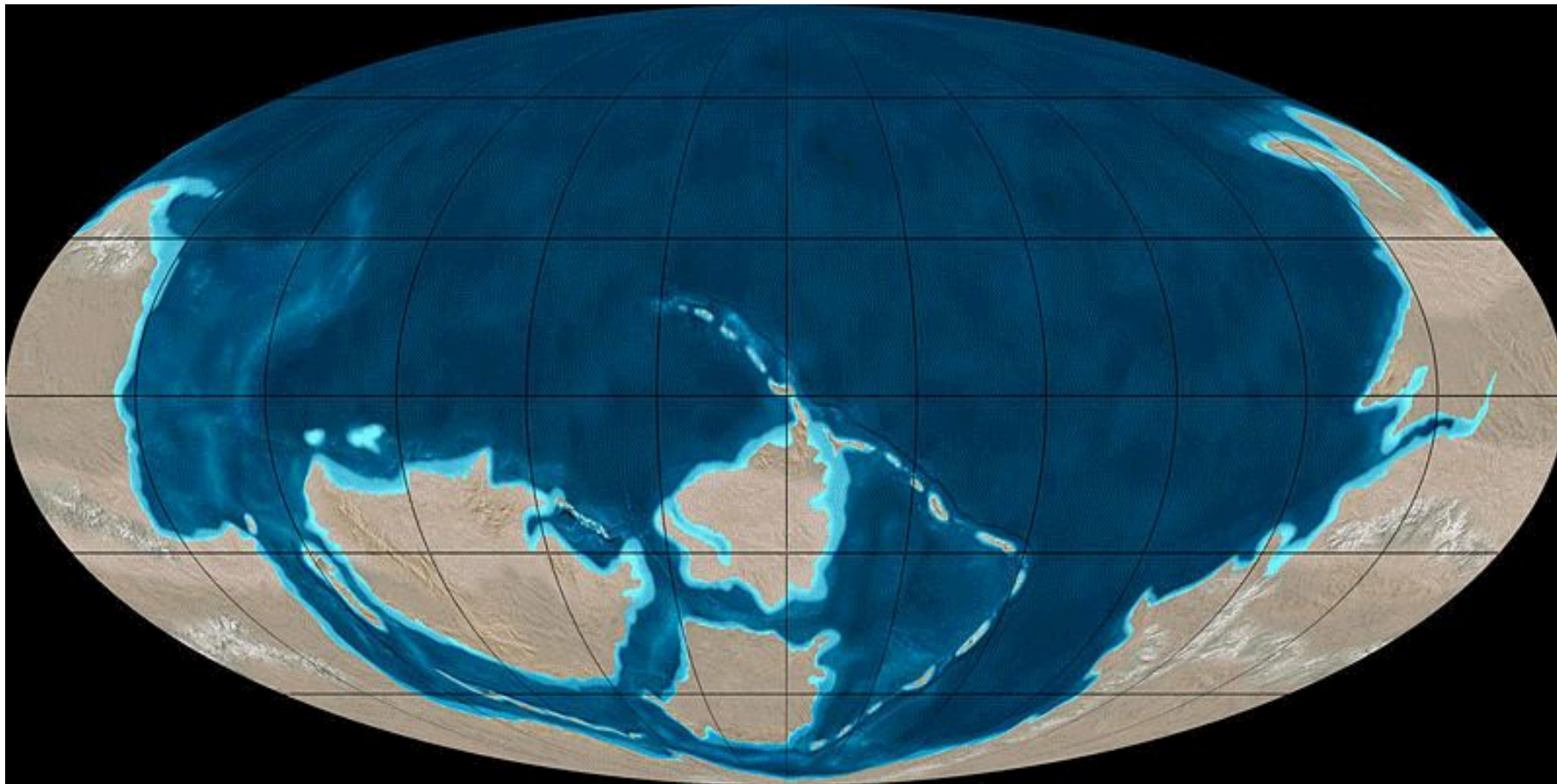
- Acqua allo stato liquido
- Basso livello di radiazioni UV
- Presenza di un'atmosfera
- **Tettonica delle placche**

Plate Tectonic Theory

ScienceFacts.net

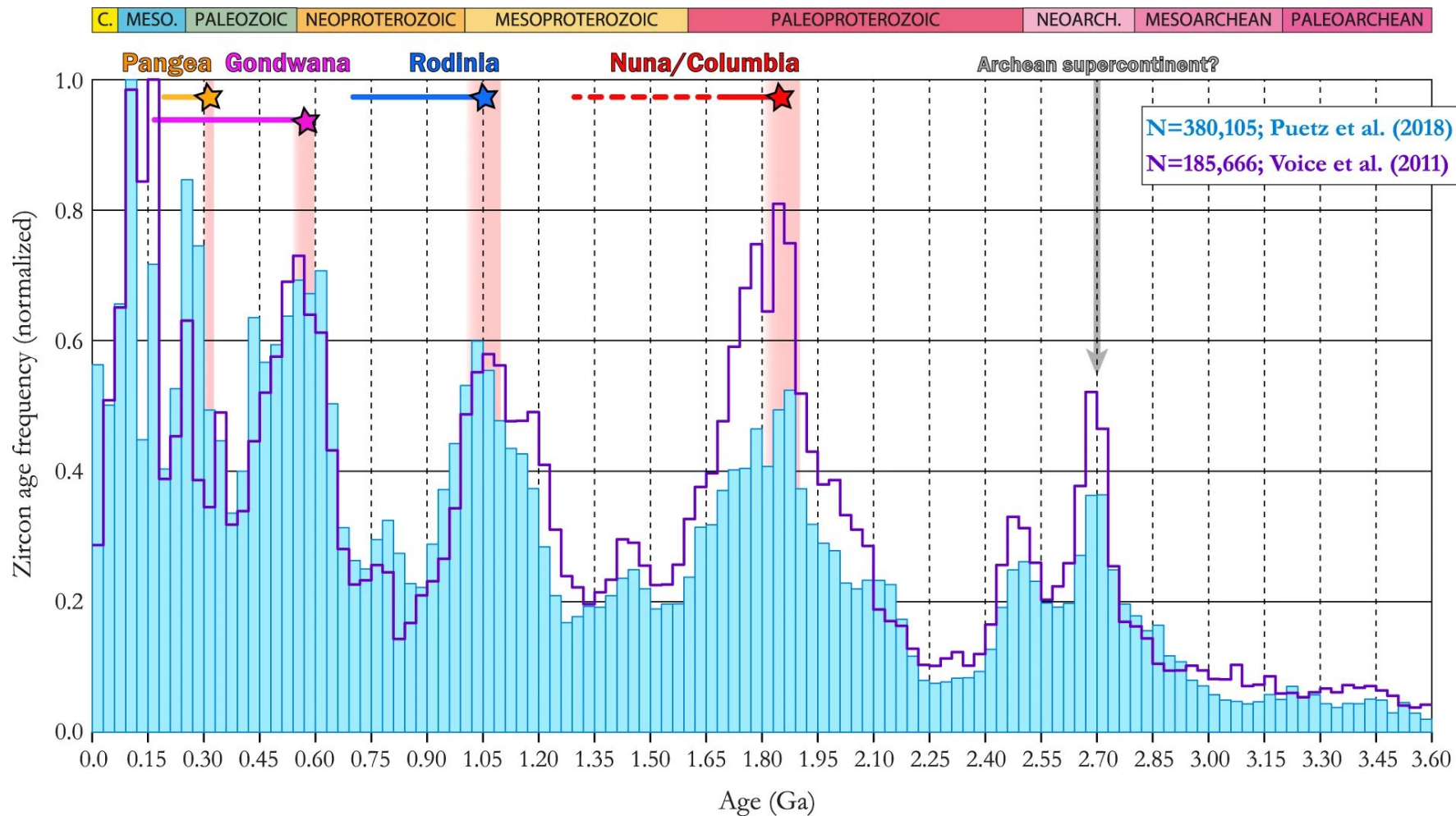


Deriva dei continenti



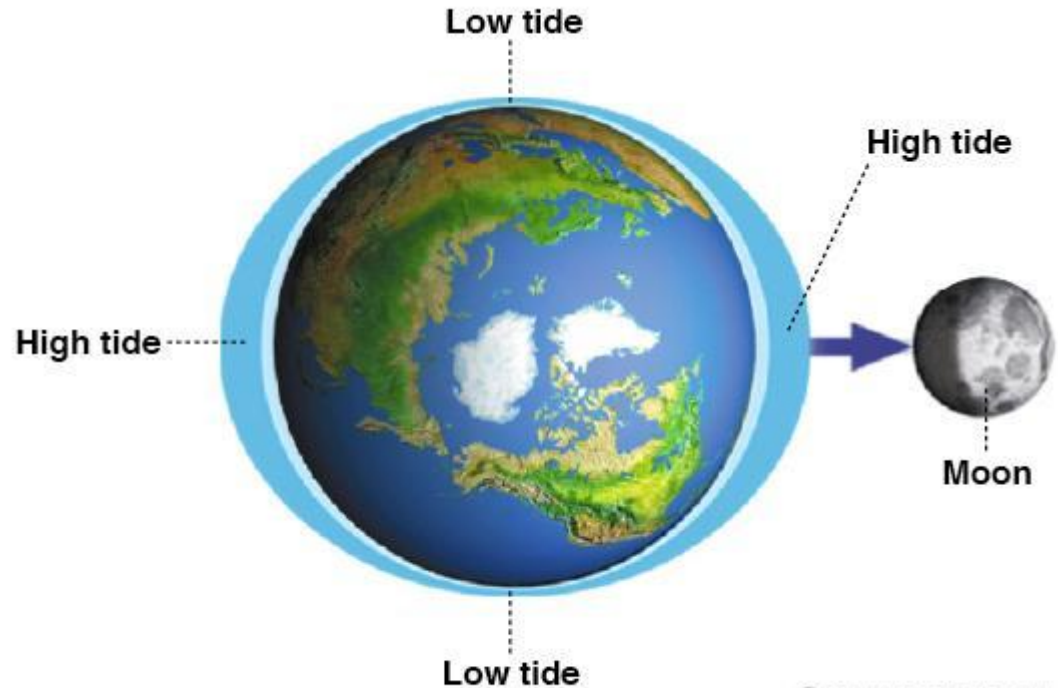
Credit: unknown

Ciclo dei supercontinenti



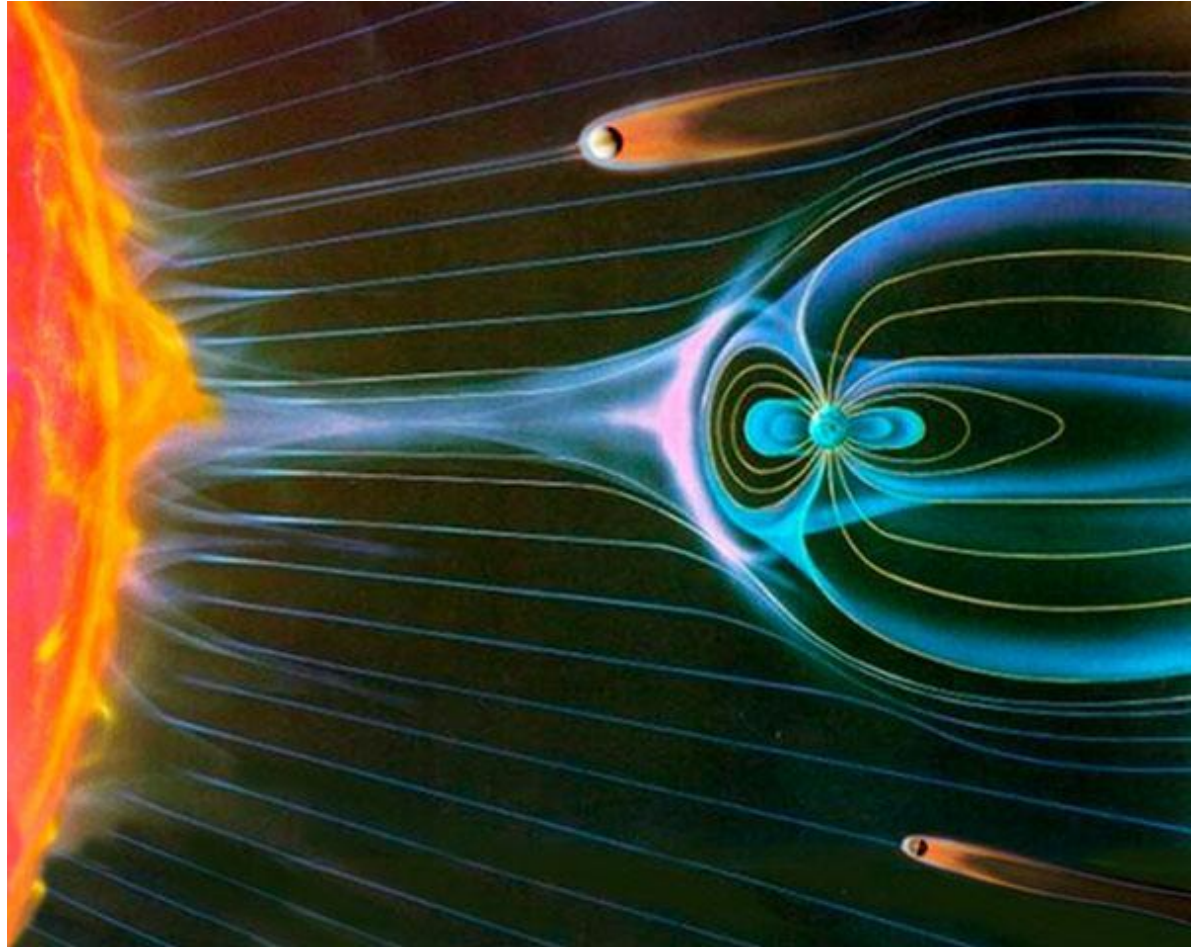
La Terra alla fine dell'Adeano

- Acqua allo stato liquido
- Basso livello di radiazioni UV
- Presenza di un'atmosfera
- Tettonica delle placche
- **Presenza della Luna**

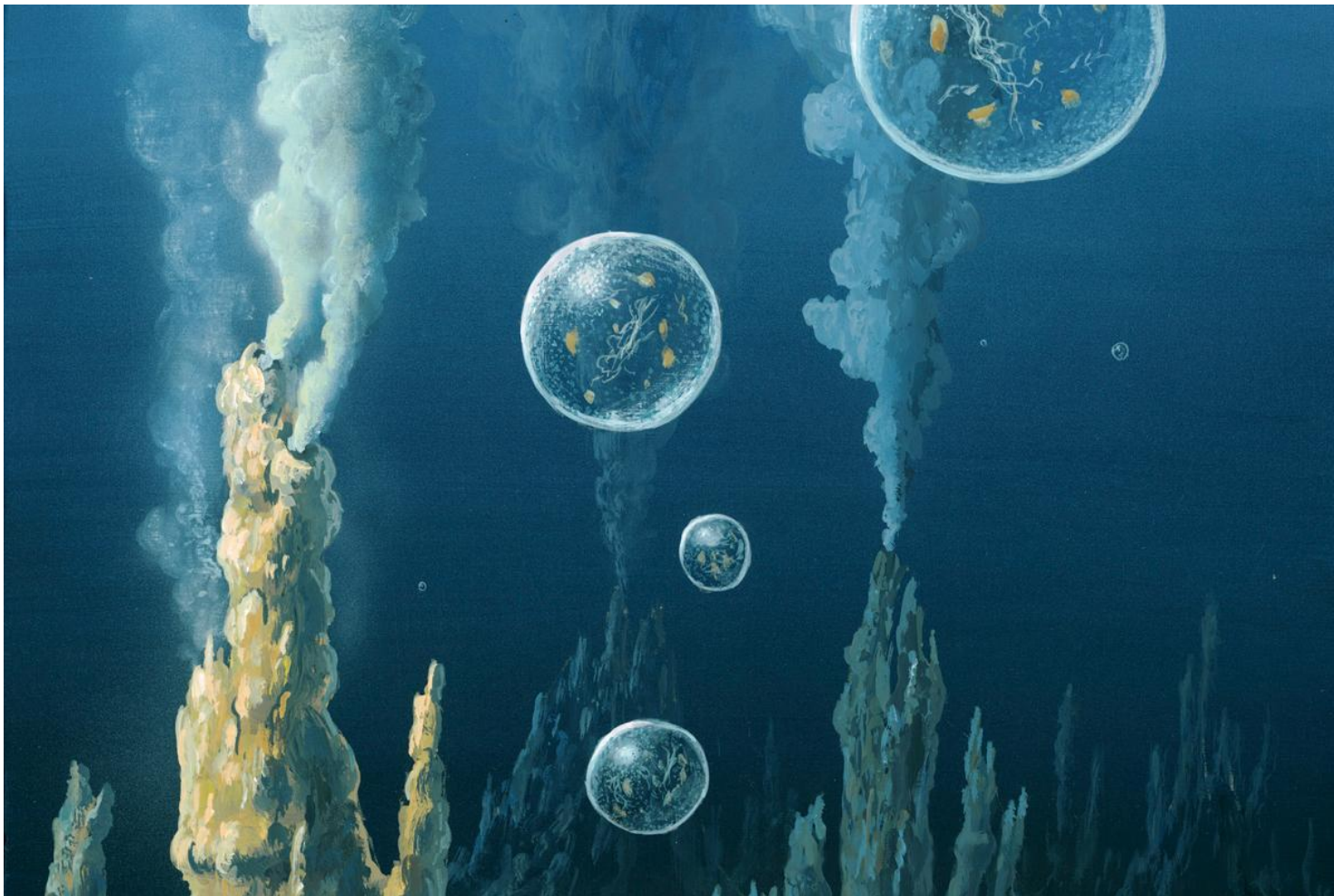


La Terra alla fine dell'Adeano

- Acqua allo stato liquido
- Basso livello di radiazioni UV
- Presenza di un'atmosfera
- Tettonica delle placche
- Presenza della Luna
- **Presenza di un campo magnetico**

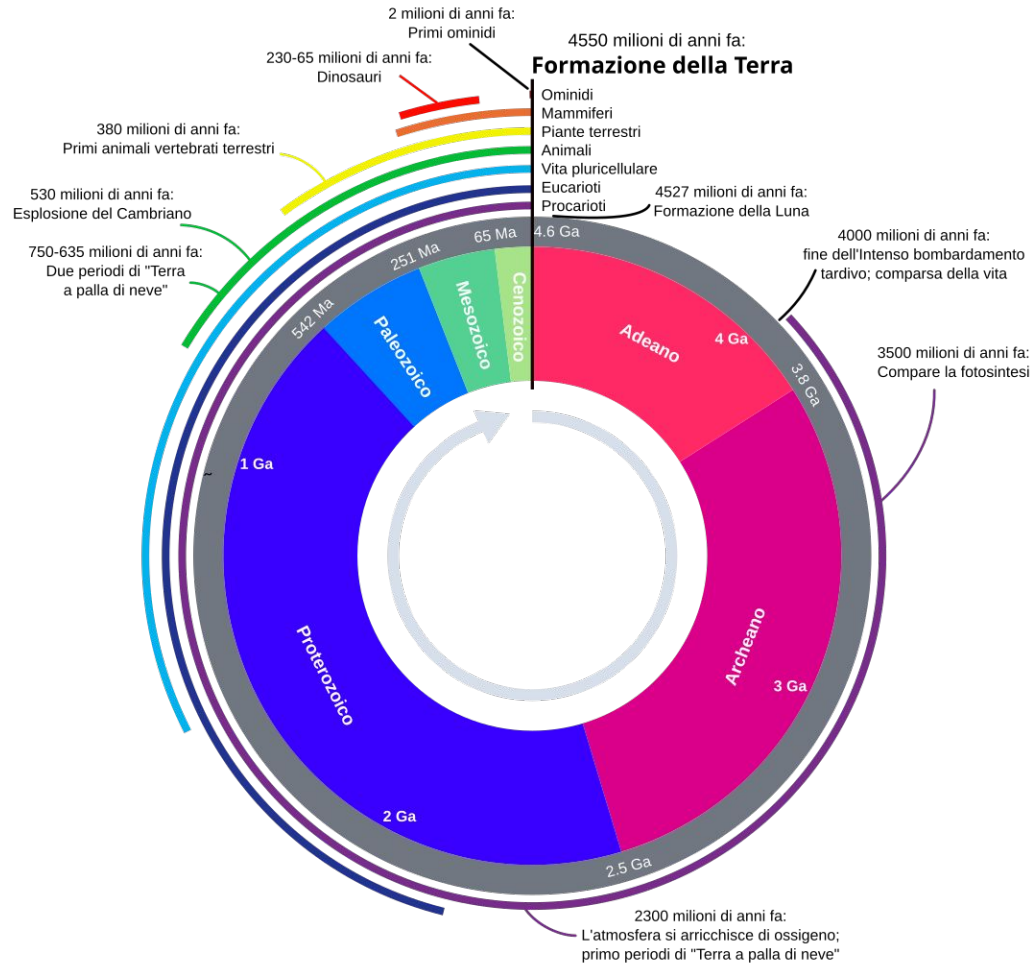


Comparsa della vita



Credit: Richard Bizley/Science Photo Library

Orologio geologico



Credit: Woudloper





Credit: NASA/Apollo 17 crew