Lecture 1: Course introduction

1. Introductions
   - A. Who am I?
   - B. Who are you?
2. Course structure
3. Geochemistry
   - A. What does it mean?
   - B. What can it tell us?
   - C. What are the tools of the trade?
4. Making the Earth
   - A. Chemical composition of the solar system

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

Who am I?

- Blake Dyer (he/him/his)
    - I prefer Blake over Dr. Dyer or Professor Dyer
- Undergraduate at Rice University 2006-2010
- PhD at Princeton University 2010-2015
- Postdoc at LDEO (Columbia University) 2016-2019
- Started in SEOS at UVic in Nov 2019
- Sixth time teaching EOS 240
    - Also teach Advanced Sed/Strat, Marine Geology, and The Dynamic Earth

Research interests: the geologic history of climate and life

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Who are you?

Some optional prompts:

- Name
- Why are you here?
    - What program are you in and/or why?
    - What do you hope to learn in EOS 240?
    - What challenges do you anticipate?

Course Outline, Brightspace, and Course Webpage

Brightspace: All important announcements, assignments, and grades will be managed through Brightspace.

Course Webpage: Lecture slides and other course materials can be found on the course webpage, updated shortly after each class. There is a link to this page under Course Materials on Brightspace.

Geochemistry: what does it mean?

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Earth doesn't limit us to *just* Earth, as understanding the *origins* and *history* of Earth means we also study meteorites, stars, other planets, etc.

Geochemistry: what can it tell us?

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- quantify the geologic timescale
- depth and temperature of magma chambers
- that sediments are subducted into the mantle
- the temperature and pressure that metamorphic rocks form at, and as one example this knowledge can help determine the displacement along faults
- how fast mountain belts have risen
- how fast mountain belts are eroding
- how and when the crust formed
- how the mantle convects
- how cold the ice ages were and what caused them
- when life began on Earth
- the impact and causes of acid rain, the ozone hole, greenhouse effect, and global warming
- sources and solutions to environmental contamination

Geochemistry: what are the *tools* of the trade?

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- physical tools such as intruments that make chemical measurements
- chemical experiments
- interpretive tools (models) that explain observations
    - primarily based in thermodynamics, but can include kinetics, aquatic chemistry, trace element geochemistry, isotope geochemistry

Thermodynamics: why is thermodynamics useful to a geochemist?

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- thermodynamics allows us to predict the outcome of chemical reactions under a given set of conditions
    - predict the sequence of minerals that will crystallize from a magma
    - may seem purely academic except that we can use this predictive power to work backwards: can determine the temperature, pressure, and composition of the magma or water from which minerals crystallized
        - allows us to understand how Earth has come to its present condition

Schematic of Earth.

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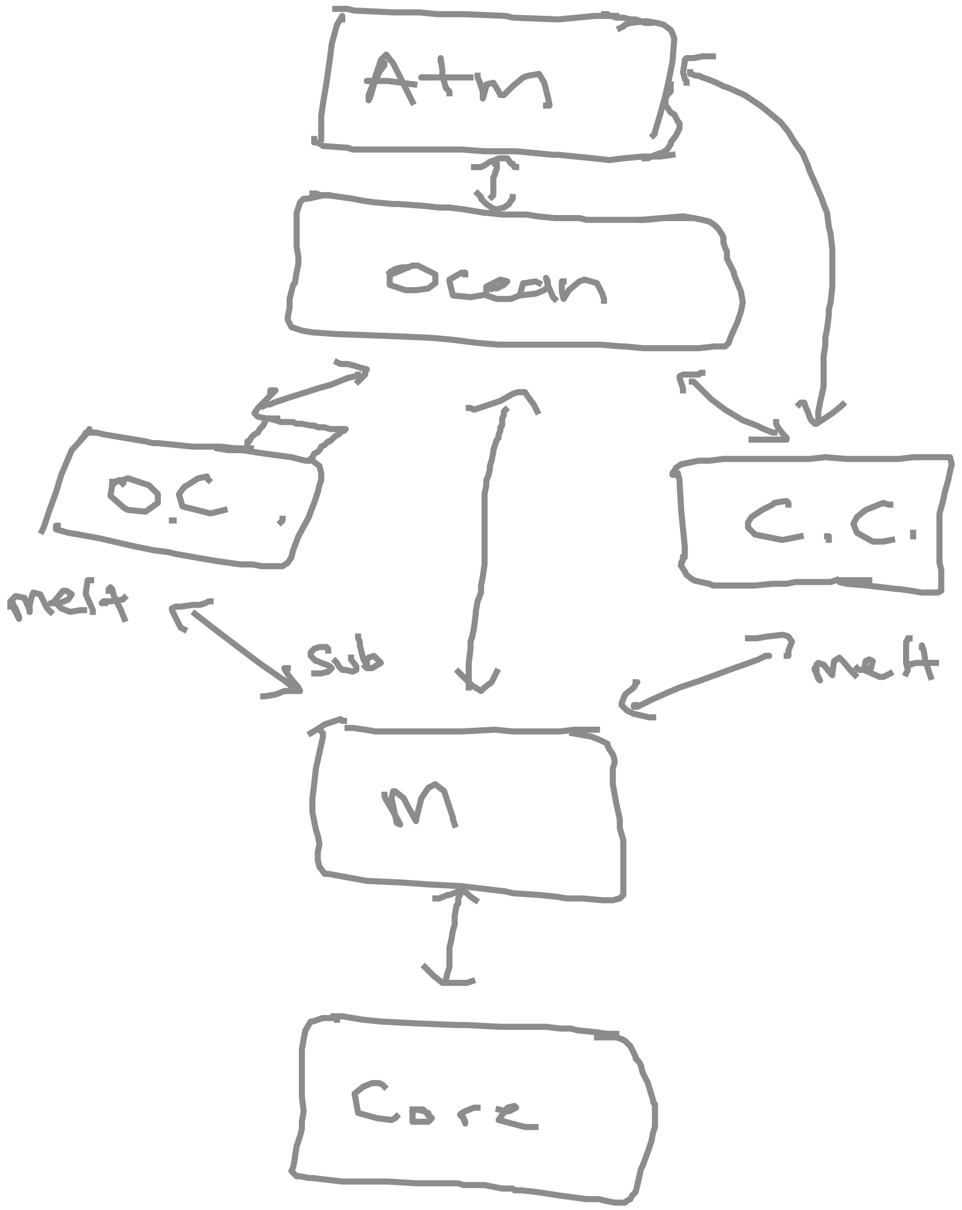
Core < inner / outer
Mantle
Crust < oceanic / continental
Oceans
Atmosphere



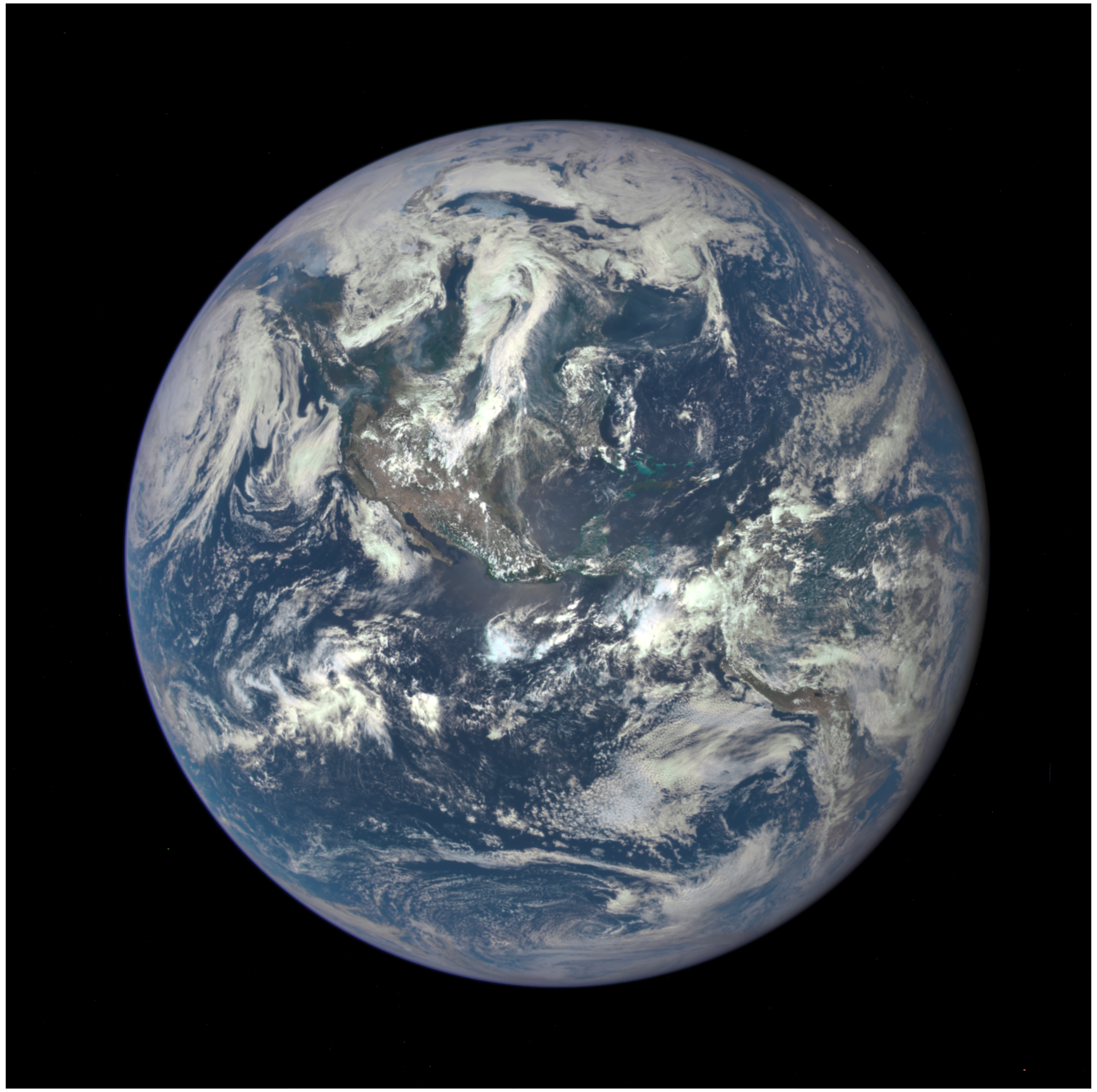
Bulk Earth

?

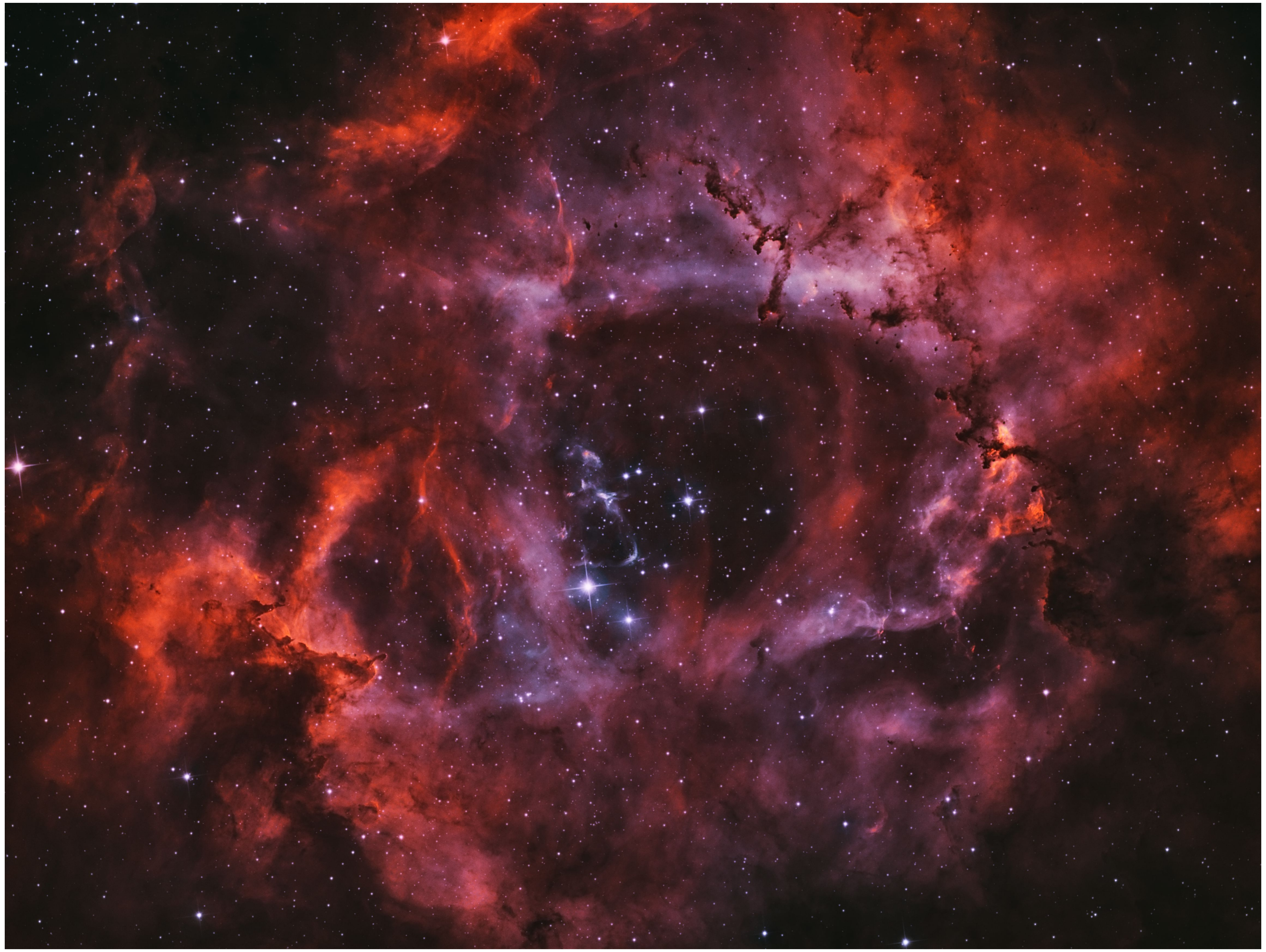
What is the chemistry of

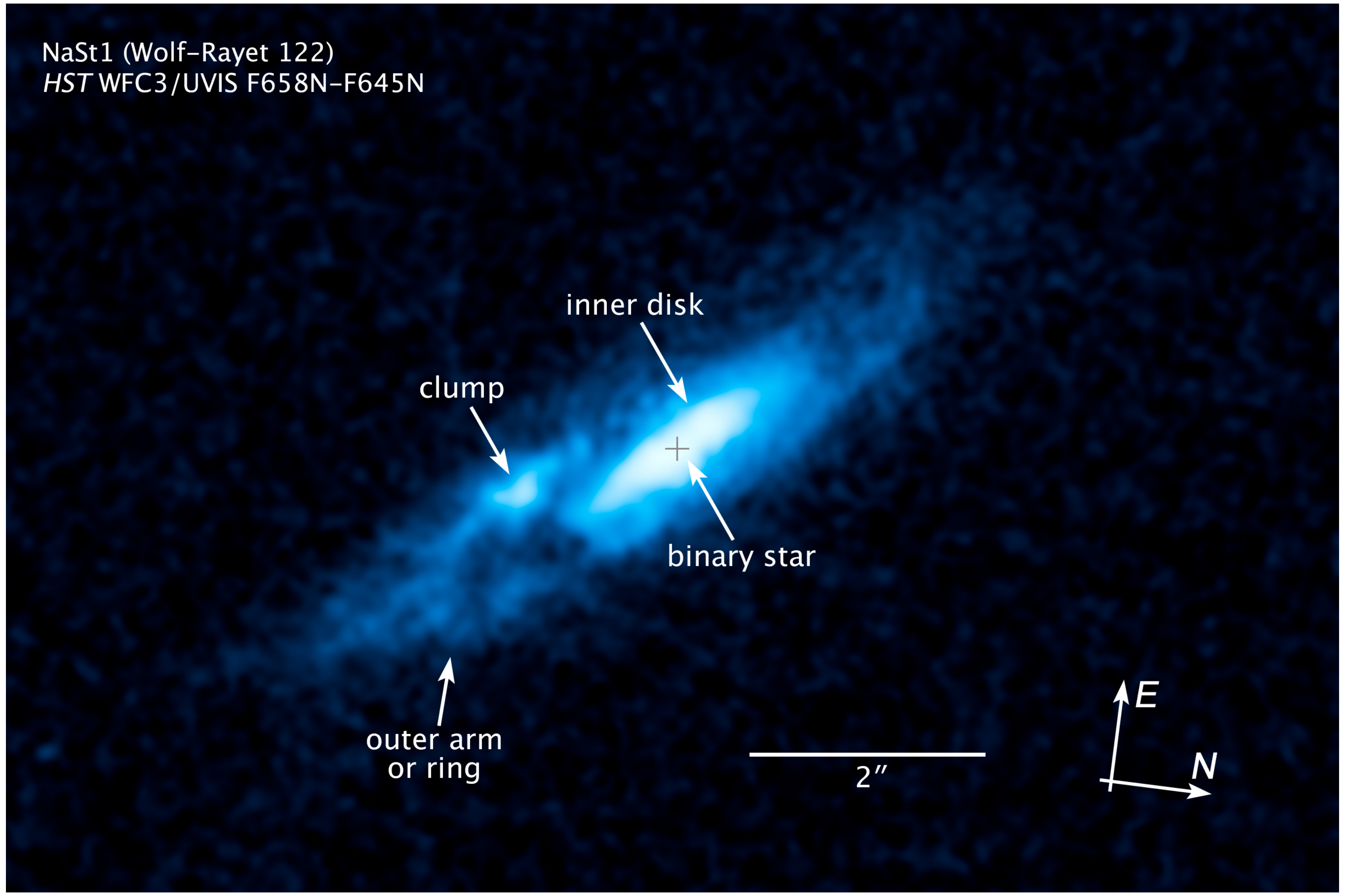
Bulk Earth

What is the chemical composition of Earth?

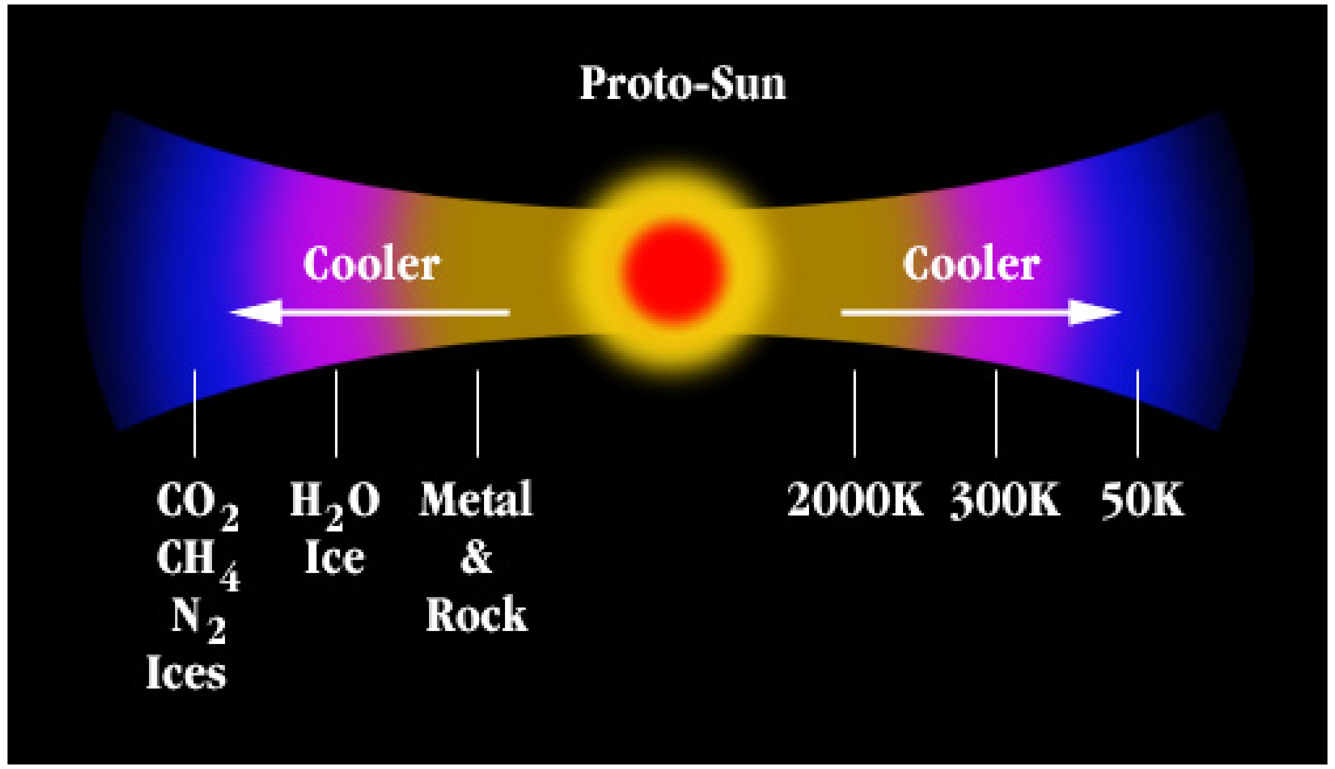


What is the black rock? What are the green bits?

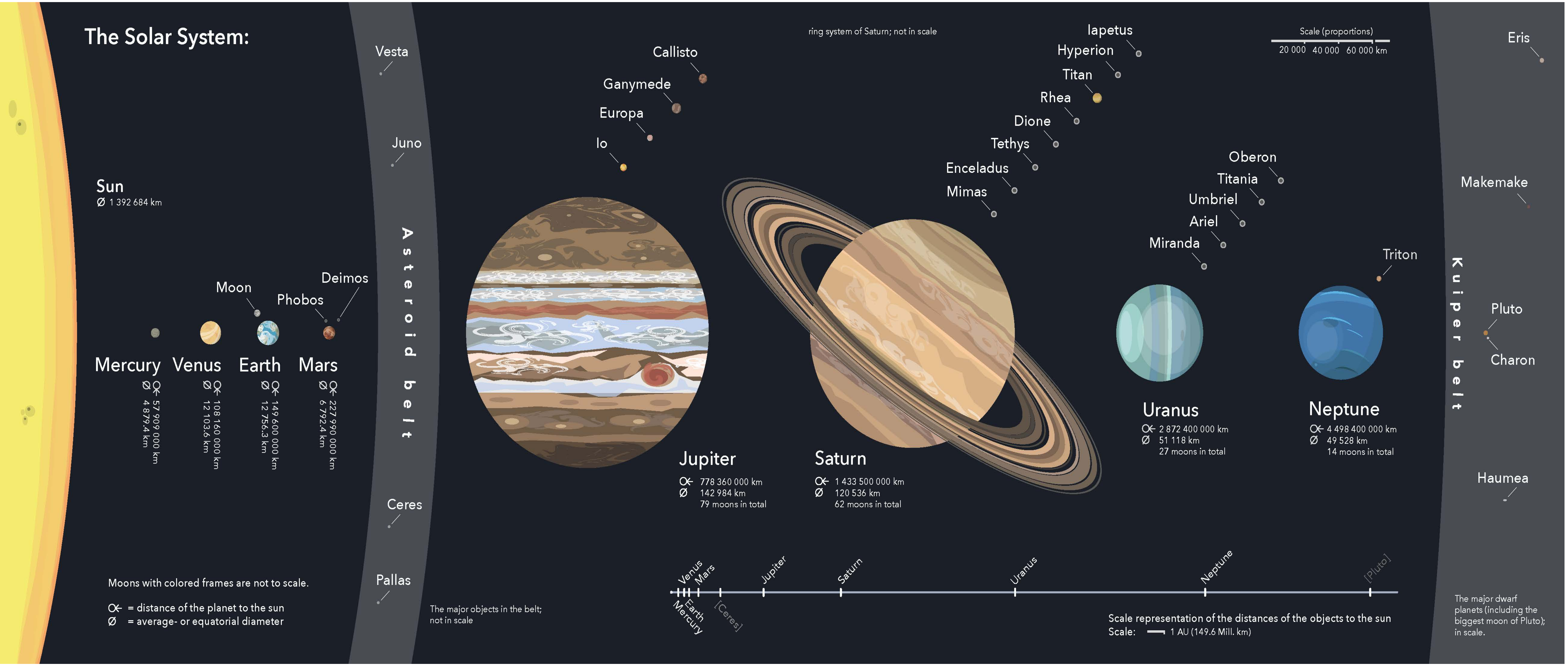




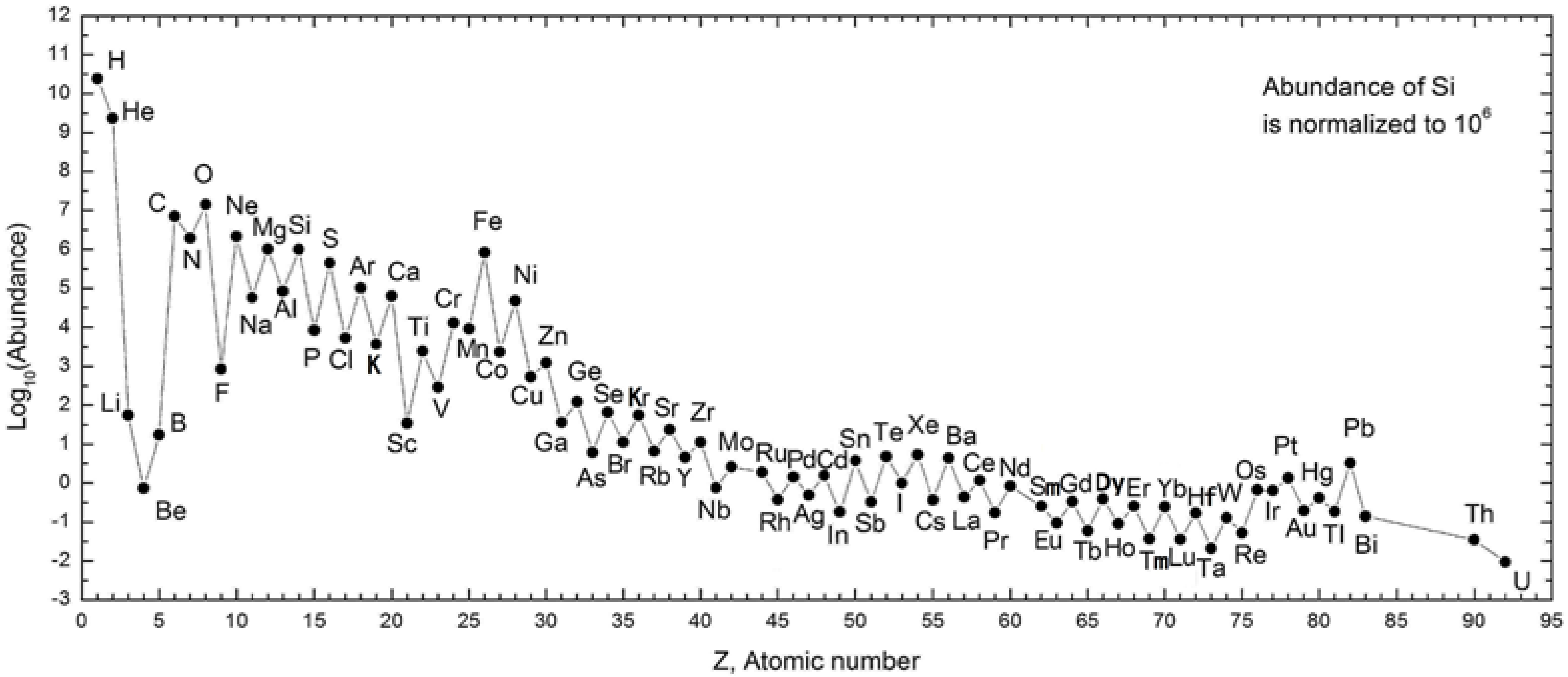
NaSt1 (Wolf-Rayet 122)
HST WFC3/UVIS F658N–F645N
inner disk
clump
binary star
outer arm
or ring
2″
E
N



The hot disk begins to emit radiation to space, rapidly cools, and a temperature gradient develops.



The Solar System:
Sun
Ø 1 392 684 km
Mercury
57 909 000 km
4 879,4 km
Venus
108 160 000 km
12 103,6 km
Earth
149 600 000 km
12 756,3 km
Mars
227 990 000 km
6 792,4 km
Moon
Phobos
Deimos
Vesta
Juno
Ceres
Pallas
Asteroid belt
Callisto
Ganymede
Europa
Io
Jupiter
778 360 000 km
142 984 km
79 moons in total
ring system of Saturn; not in scale
Iapetus
Hyperion
Titan
Rhea
Dione
Tethys
Enceladus
Mimas
Saturn
1 433 500 000 km
120 536 km
62 moons in total
Oberon
Titania
Umbriel
Ariel
Miranda
Uranus
2 872 400 000 km
51 118 km
27 moons in total
Triton
Neptune
4 498 400 000 km
49 528 km
14 moons in total
Scale (proportions)
20 000 40 000 60 000 km
Eris
Makemake
Kuiper belt
Pluto
Charon
Haumea
Moons with colored frames are not to scale.
= distance of the planet to the sun
Ø = average- or equatorial diameter
The major objects in the belt; not in scale
Venus Mars Jupiter Saturn Uranus Neptune [Pluto]
Mercury Earth [Ceres]
Scale representation of the distances of the objects to the sun
Scale: 1 AU (149.6 Mill. km)
The major dwarf planets (including the biggest moon of Pluto); in scale.



Abundance of Si
is normalized to 10^6
Log10(Abundance)
Z, Atomic number
H He Li Be B C N O F Ne Na Mg Al Si P S Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr Rb Sr Y Zr Nb Mo Ru Rh Pd Ag Cd In Sn Sb Te I Xe Cs Ba La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Th U