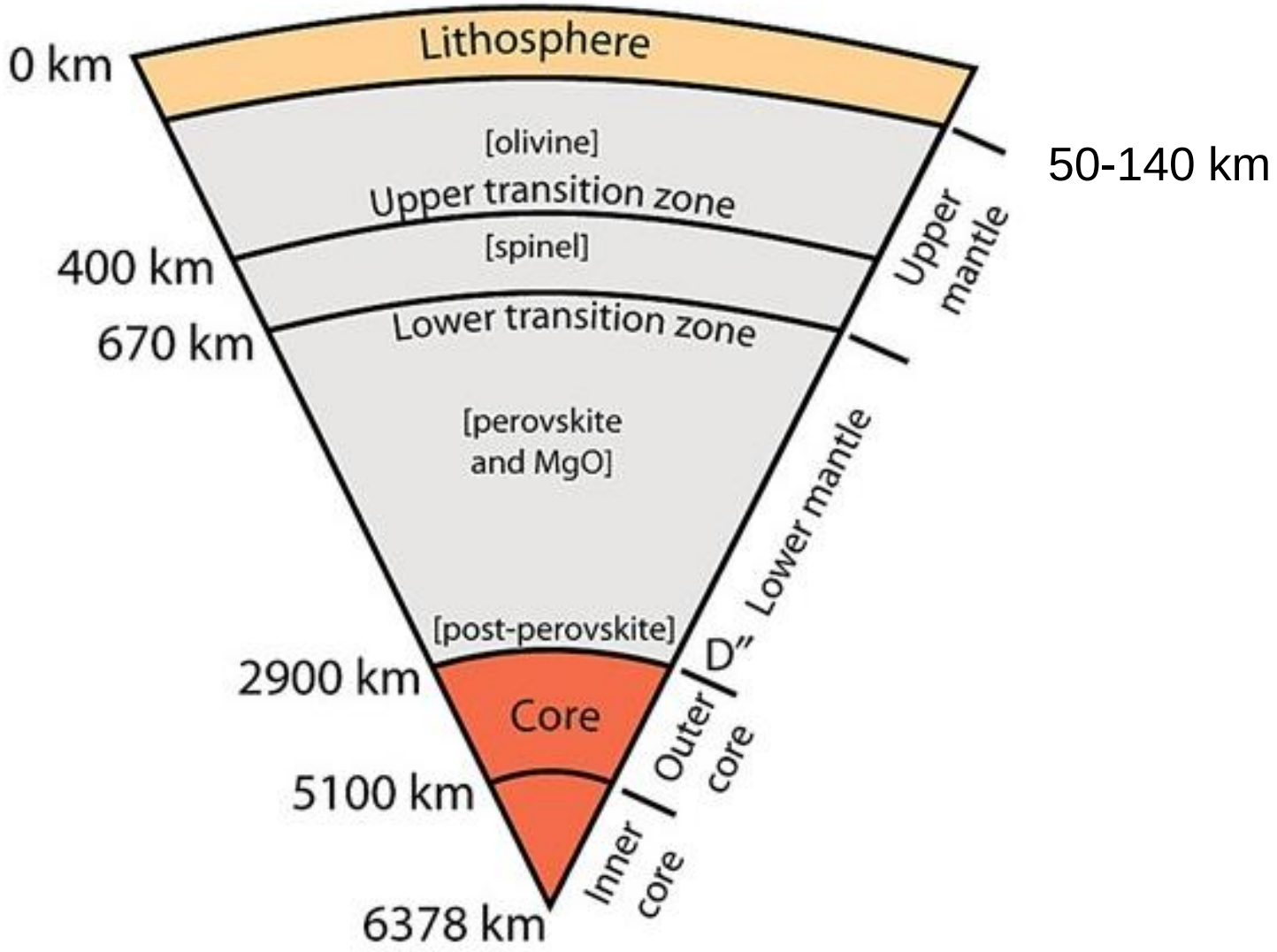
Rocks vs. Minerals

Rocks vs. Minerals

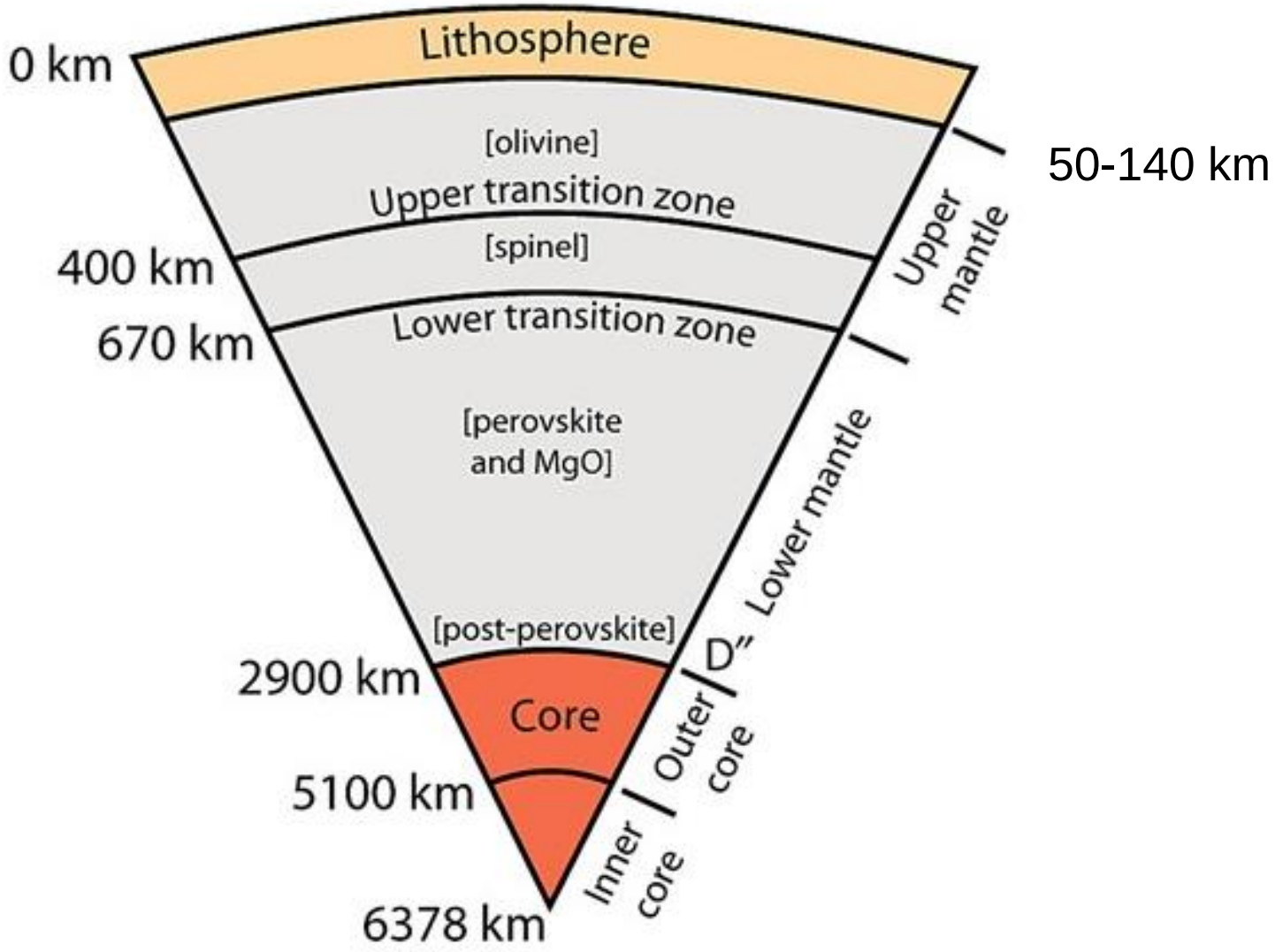
- What's the difference between a rock and mineral?
- How about the difference between a "mineral deposit" and an "ore deposit"?
- What's a gangue mineral?
- How are minerals concentrated in the Earth?
- How do we know where they are? How do we find them?

Element	Value in 1 km^3 of crust ($million)	Value in 1 tonne of crust ($)	Average crustal abundance (ppm)
Aluminum	172,000	140.00	81,500
Iron	37,000	30.00	39,200
Manganese	2,100	1.70	774
Nickel	1,100	0.91	47
Copper	233	0.19	28
Zinc	170	0.14	67
Gold	83	0.068	0.0015
Tin	59	0.05	2.1
Lead	43	0.035	17
Molybdenum	42	0.034	1.1
Platinum	3.1	0.003	0.0005

What is the structure of the Earth?

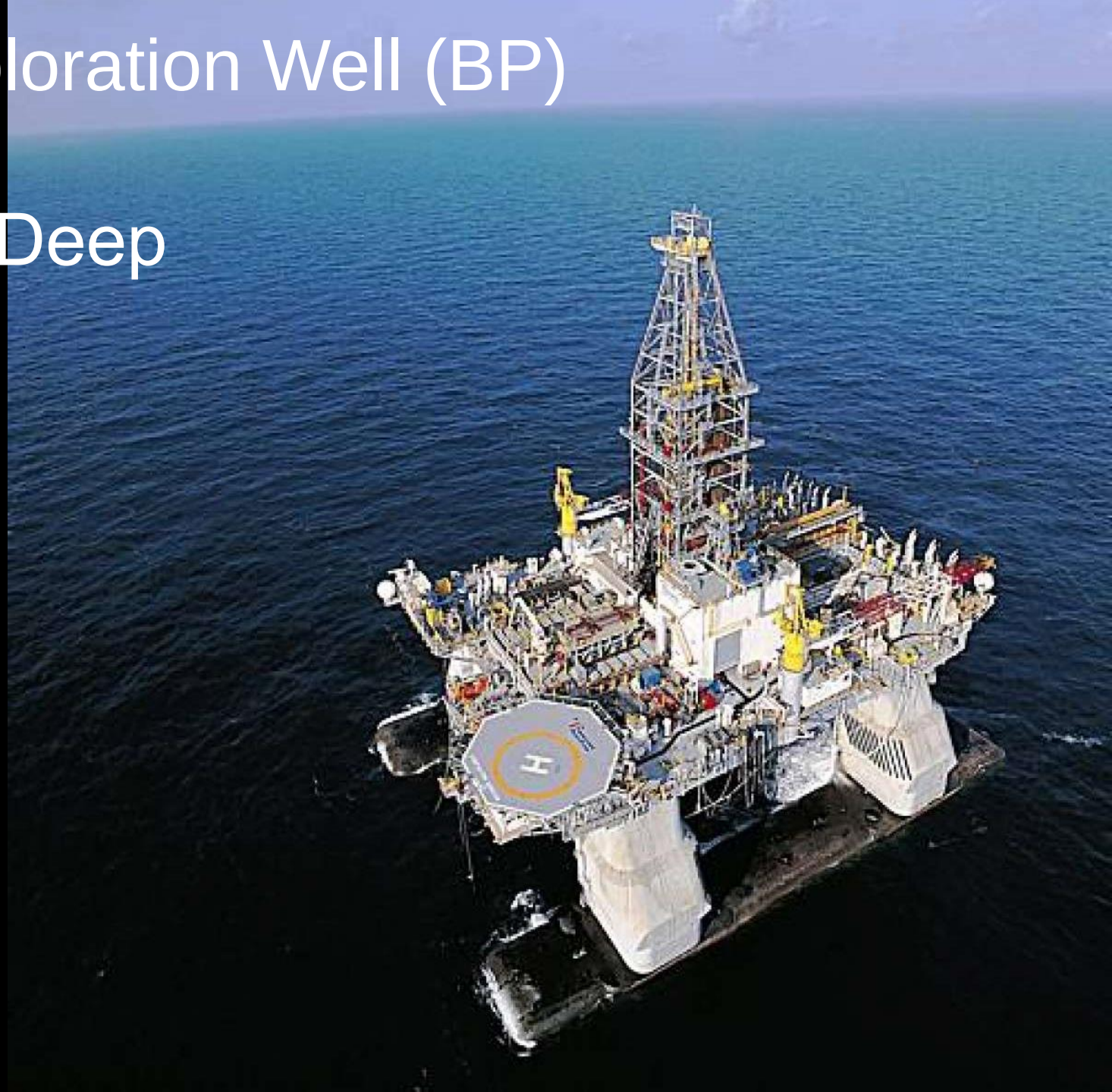


How do we know?

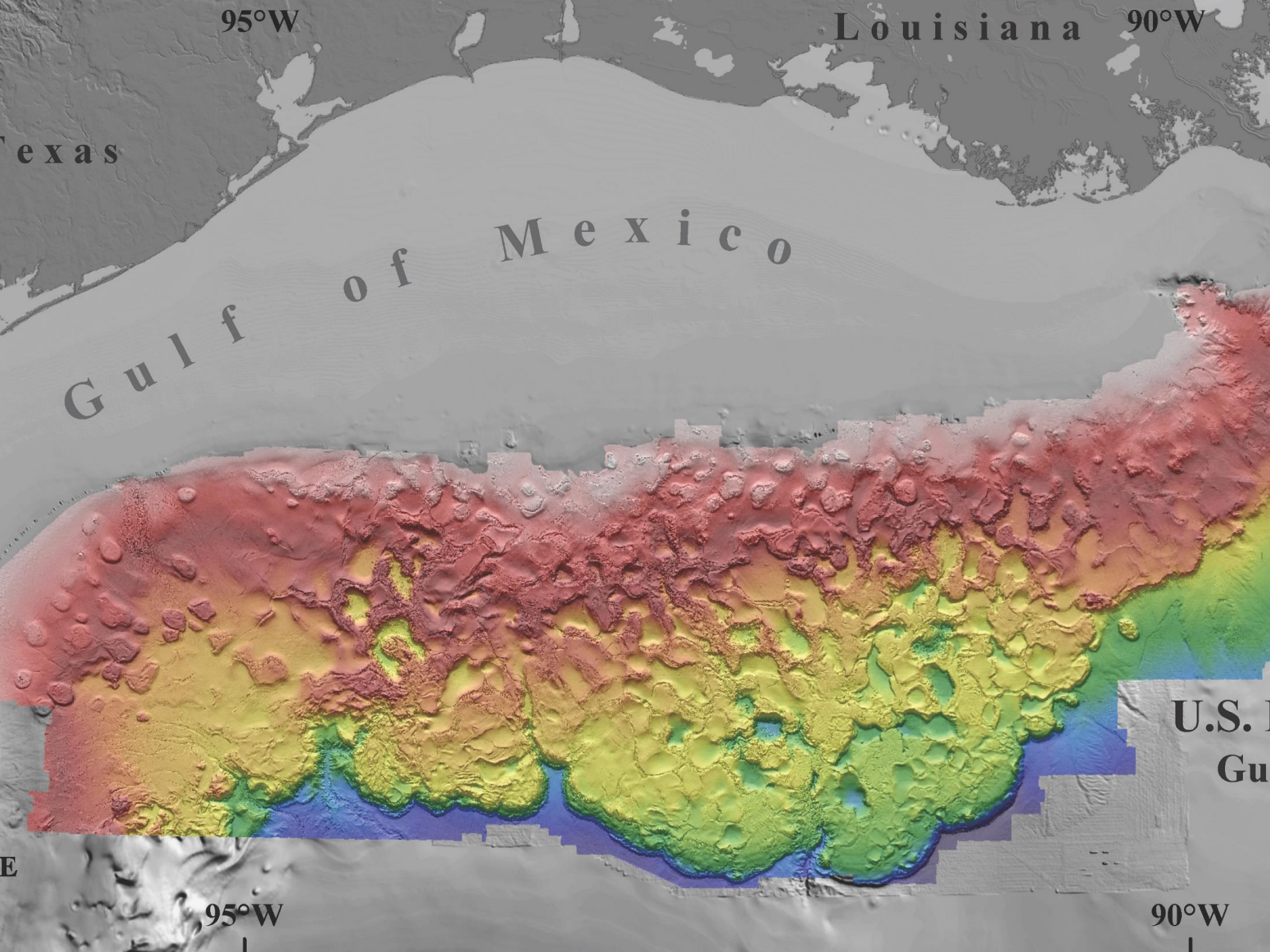


Tiber Exploration Well (BP)

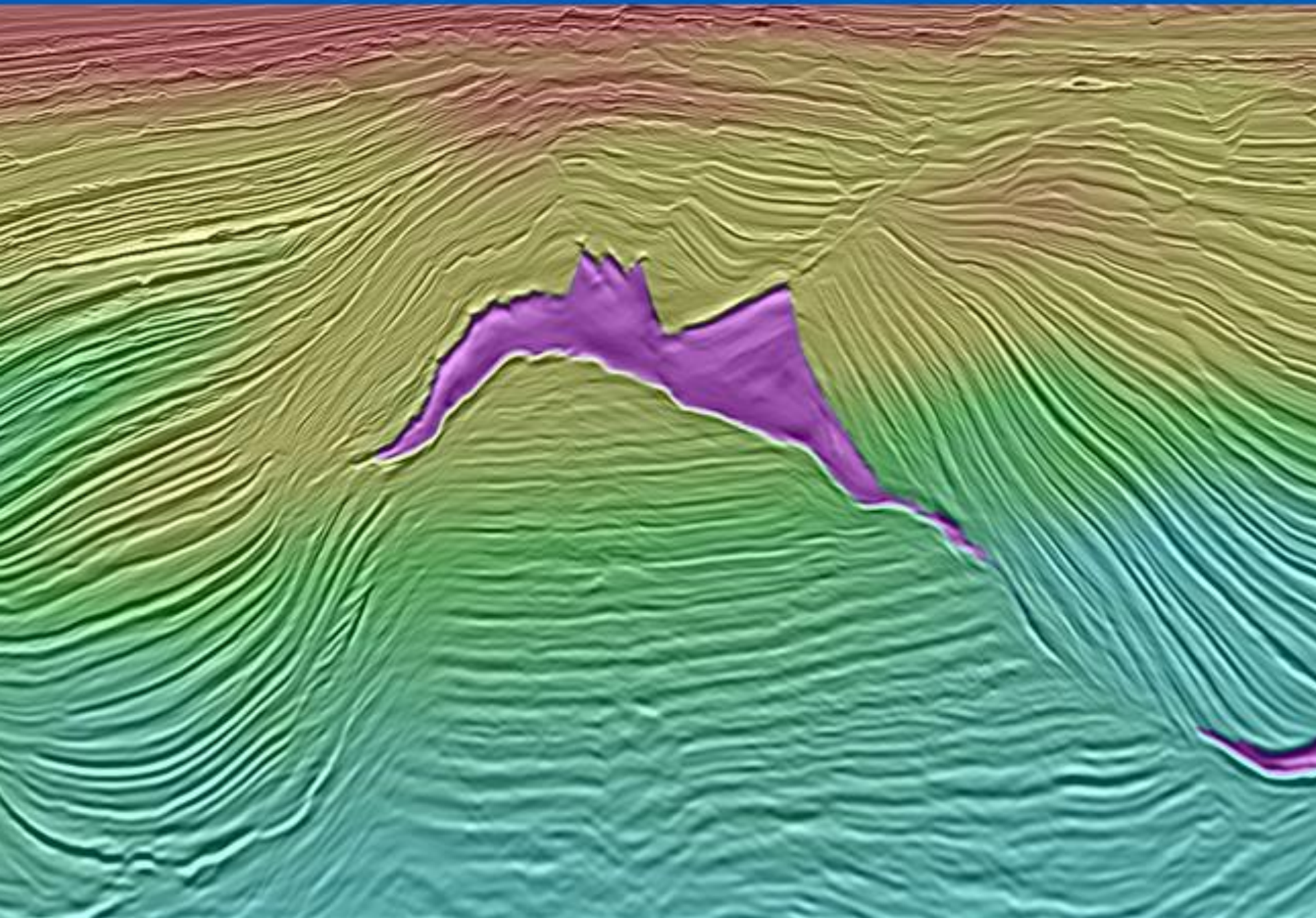
~35,000’ Deep

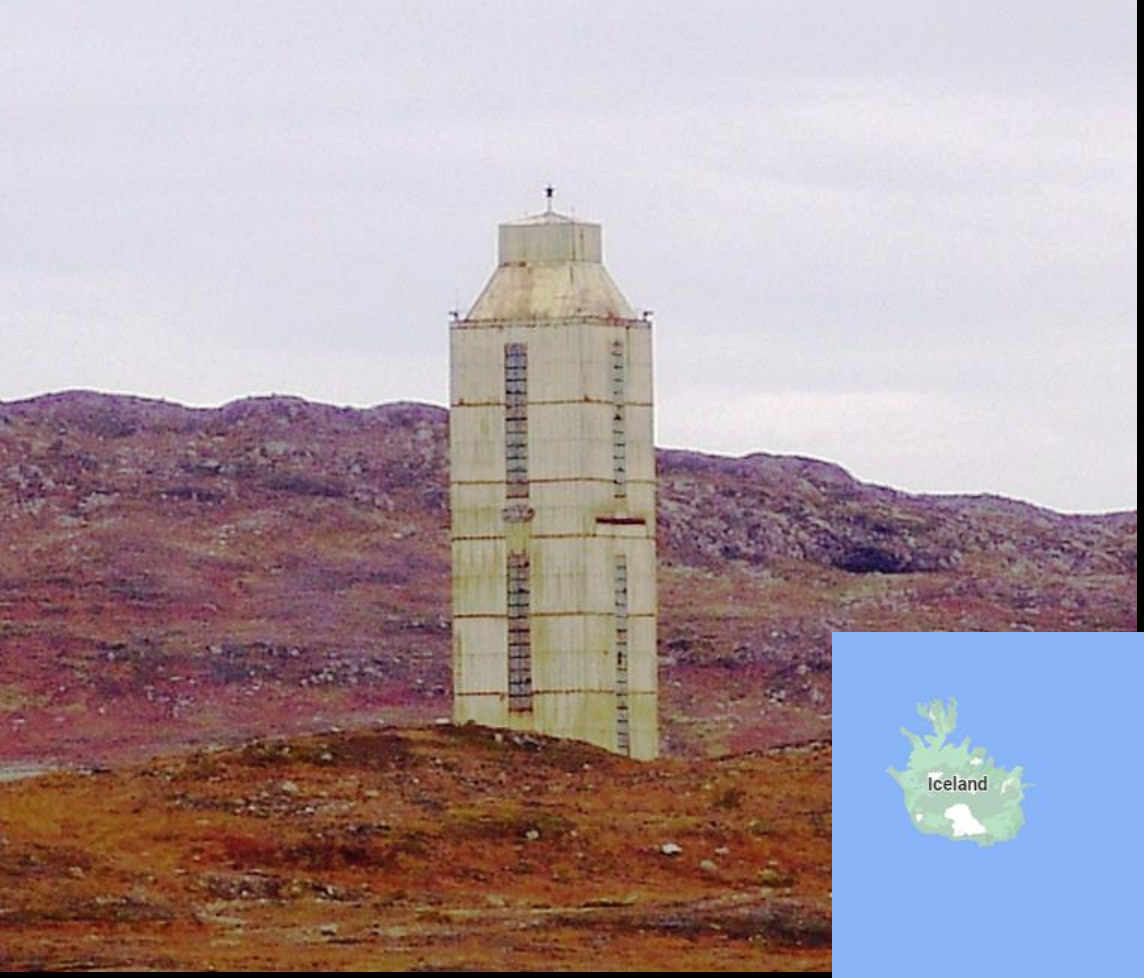


Macondo Oil Spill, 2010 (BP)


95°W
Louisiana
90°W
exas
Gulf of Mexico
U.S.
Gu
E
95°W
90°W

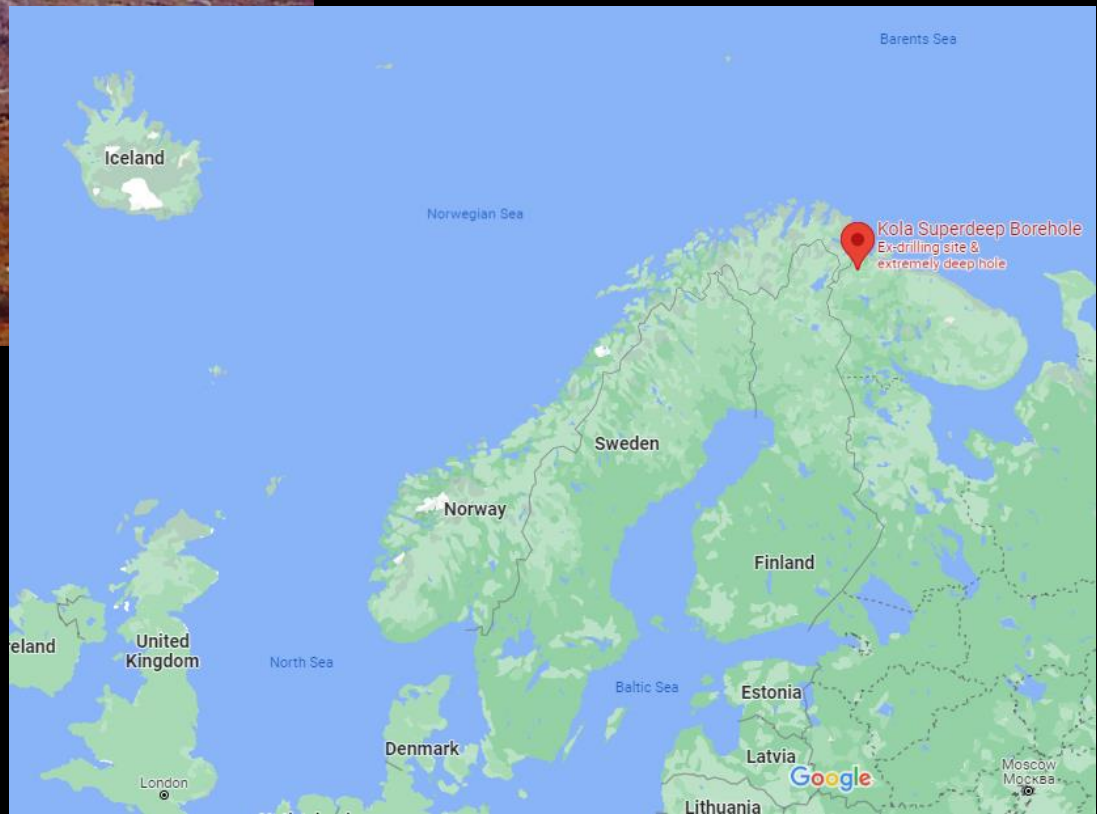
Flex Vision | RTM imaging reveals subsalt reservoirs

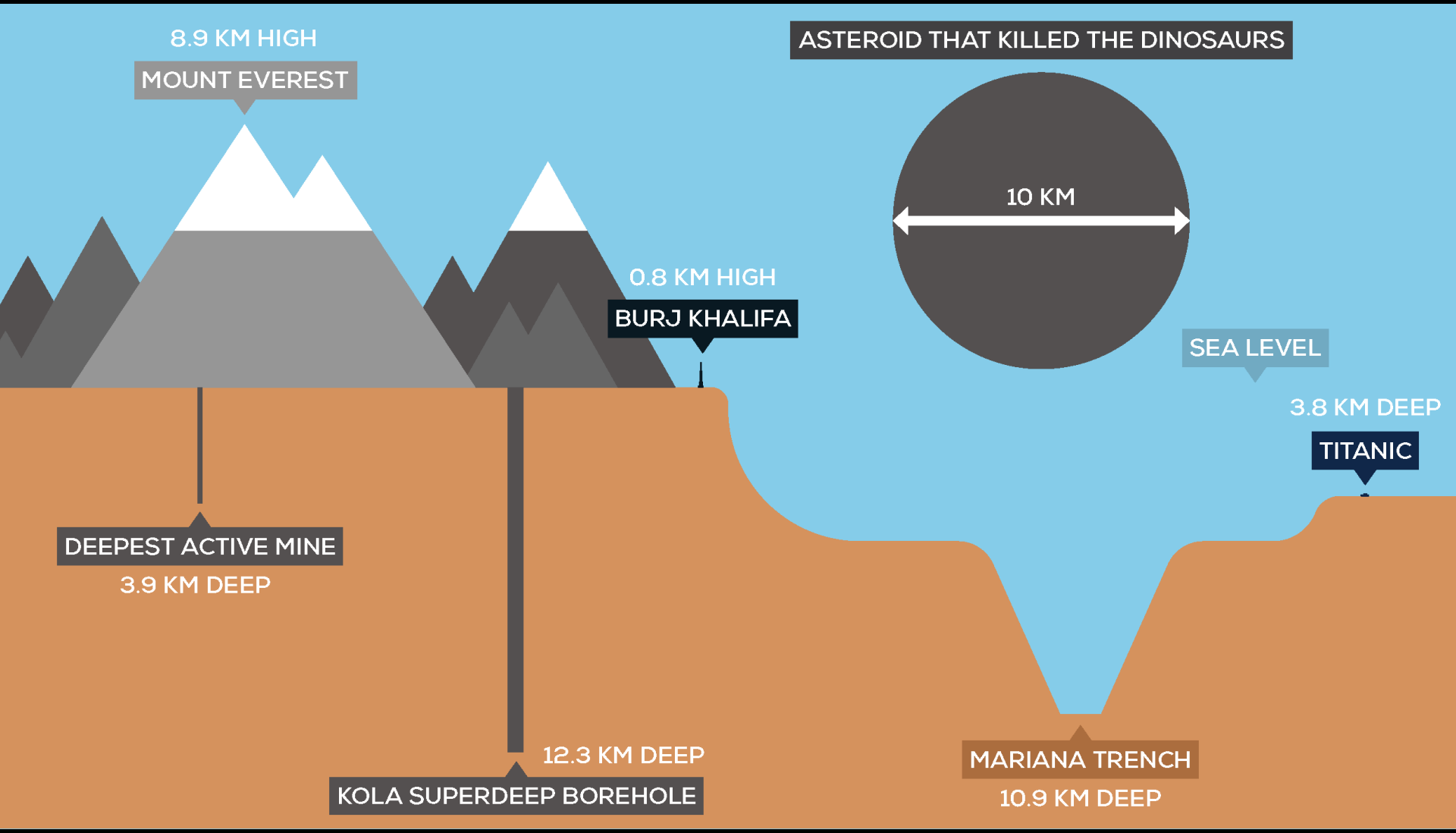


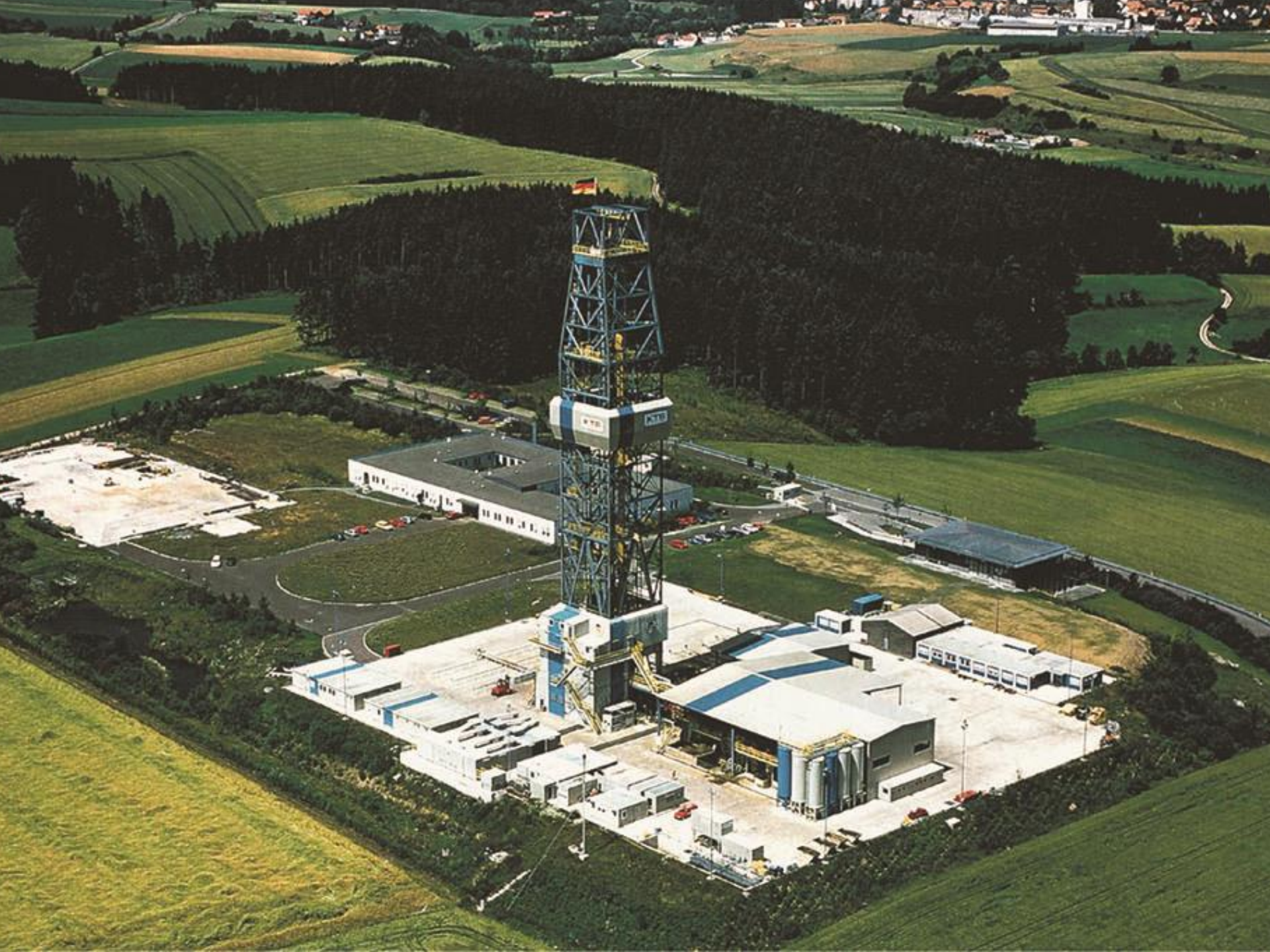


Kola Superdeep Borehole

40,230 feet (12,262 m)
356 F (453 K)

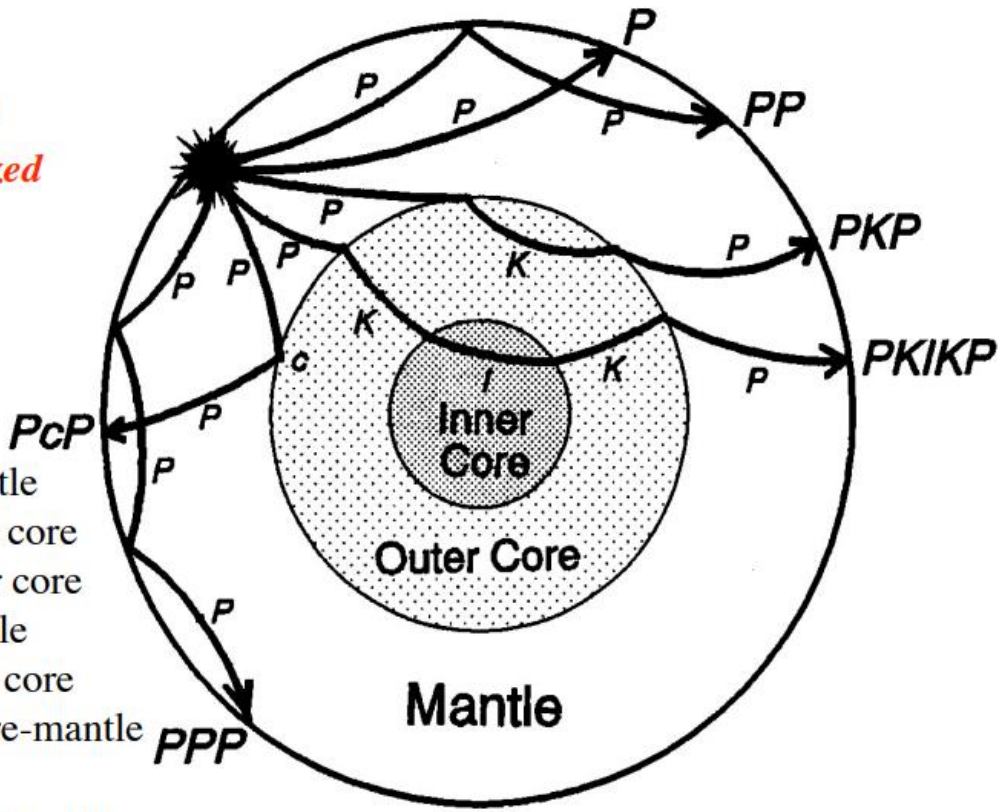



8.9 KM HIGH
MOUNT EVEREST
ASTEROID THAT KILLED THE DINOSAURS
10 KM
0.8 KM HIGH
BURJ KHALIFA
SEA LEVEL
3.8 KM DEEP
TITANIC
DEEPEST ACTIVE MINE
3.9 KM DEEP
12.3 KM DEEP
KOLA SUPERDEEP BOREHOLE
MARIANA TRENCH
10.9 KM DEEP



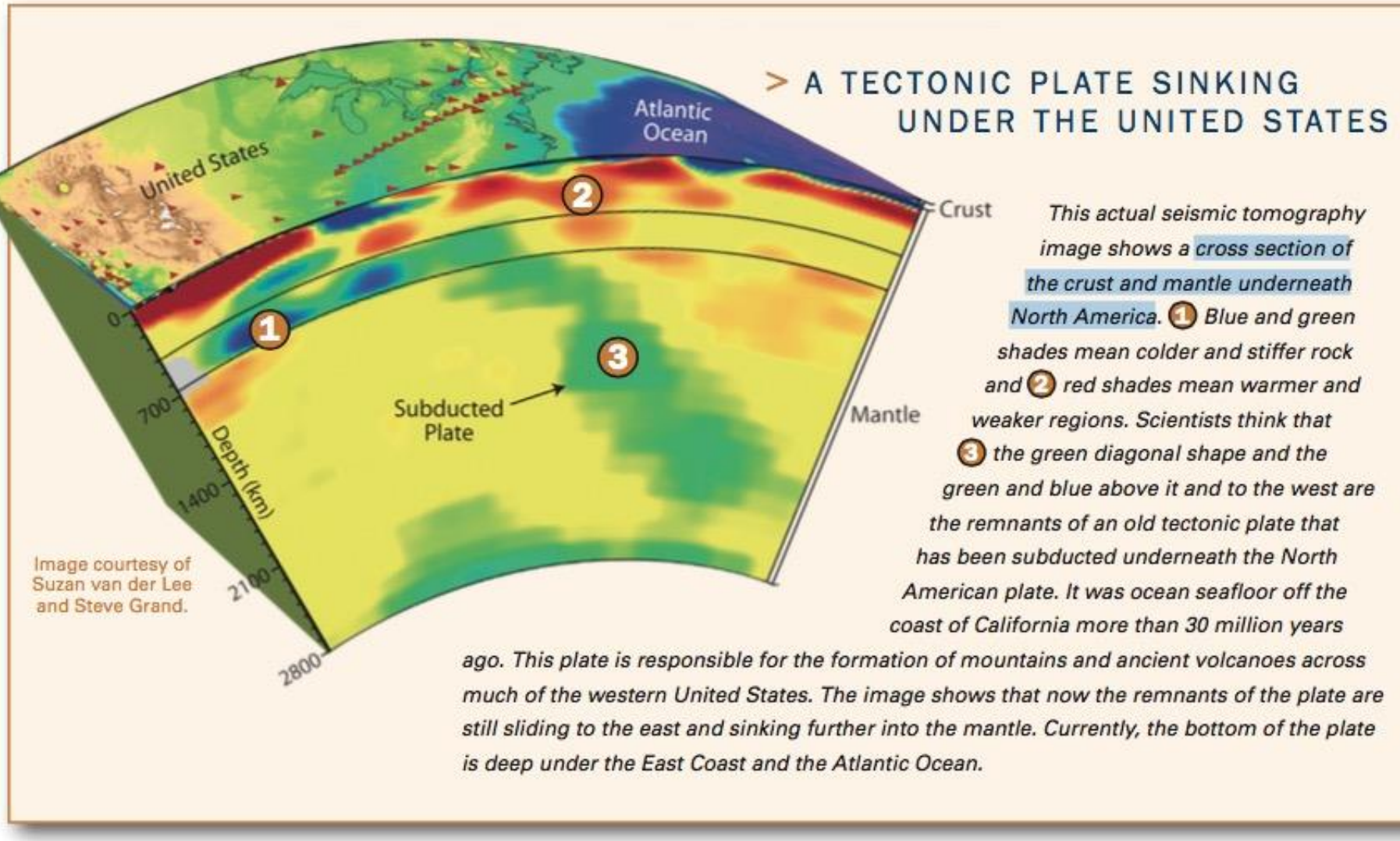
Seismic Waves Provide Images of the Earth's Interior

Naming conventions
(*Note: small and capitalized letters do matter!*)



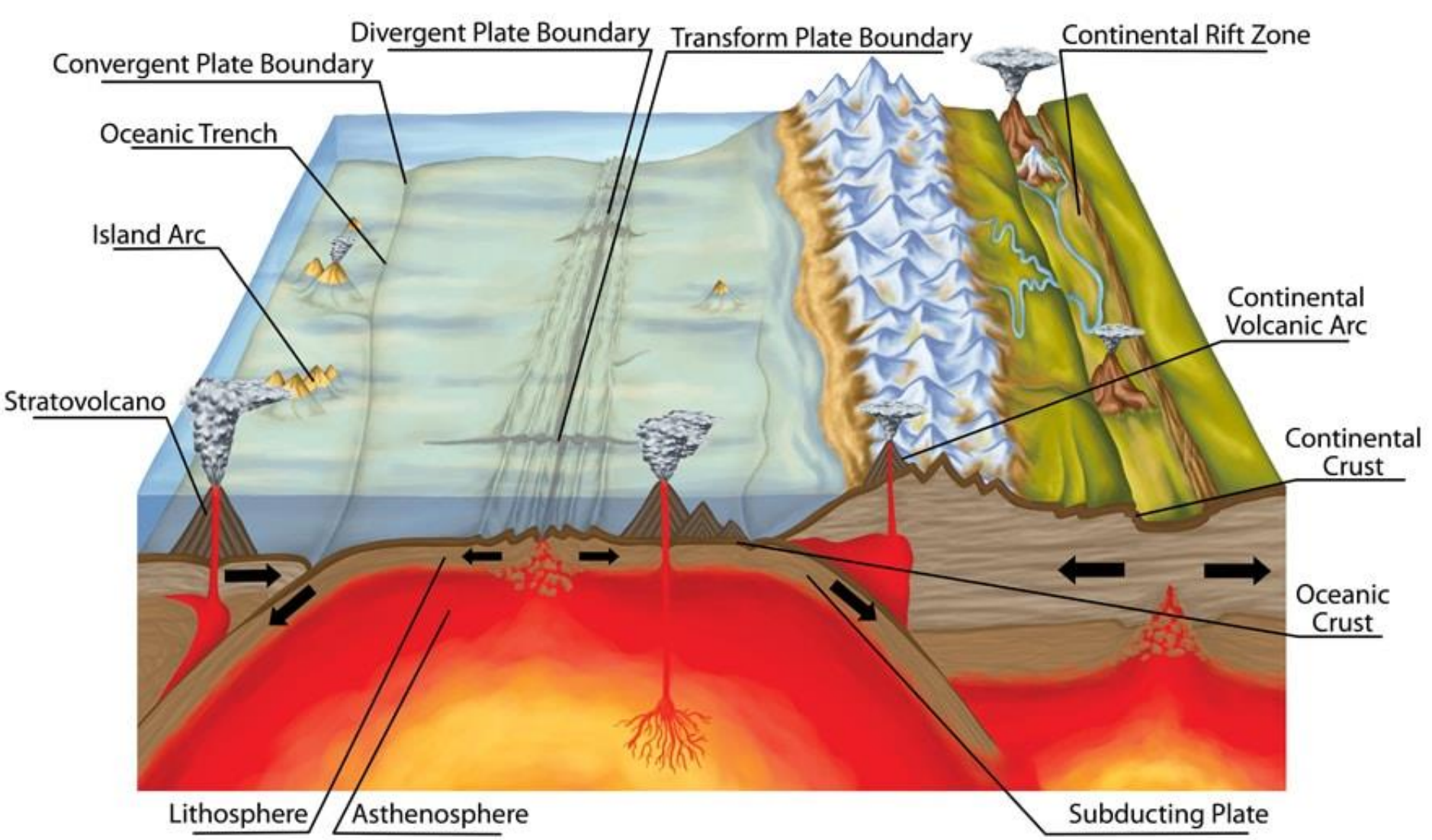
P: P- wave in the mantle
K: P-wave in the outer core
I: P-wave in the inner core
S: S-wave in the mantle
J: S-wave in the inner core
c: reflection off the core-mantle boundary (CMB)
i: reflection off the inner-core boundary (ICB)
PmP: Reflection off of Moho
Pn: refracted wave on Moho

Different waves have different paths, hence are sensitive to different parts of the Earth

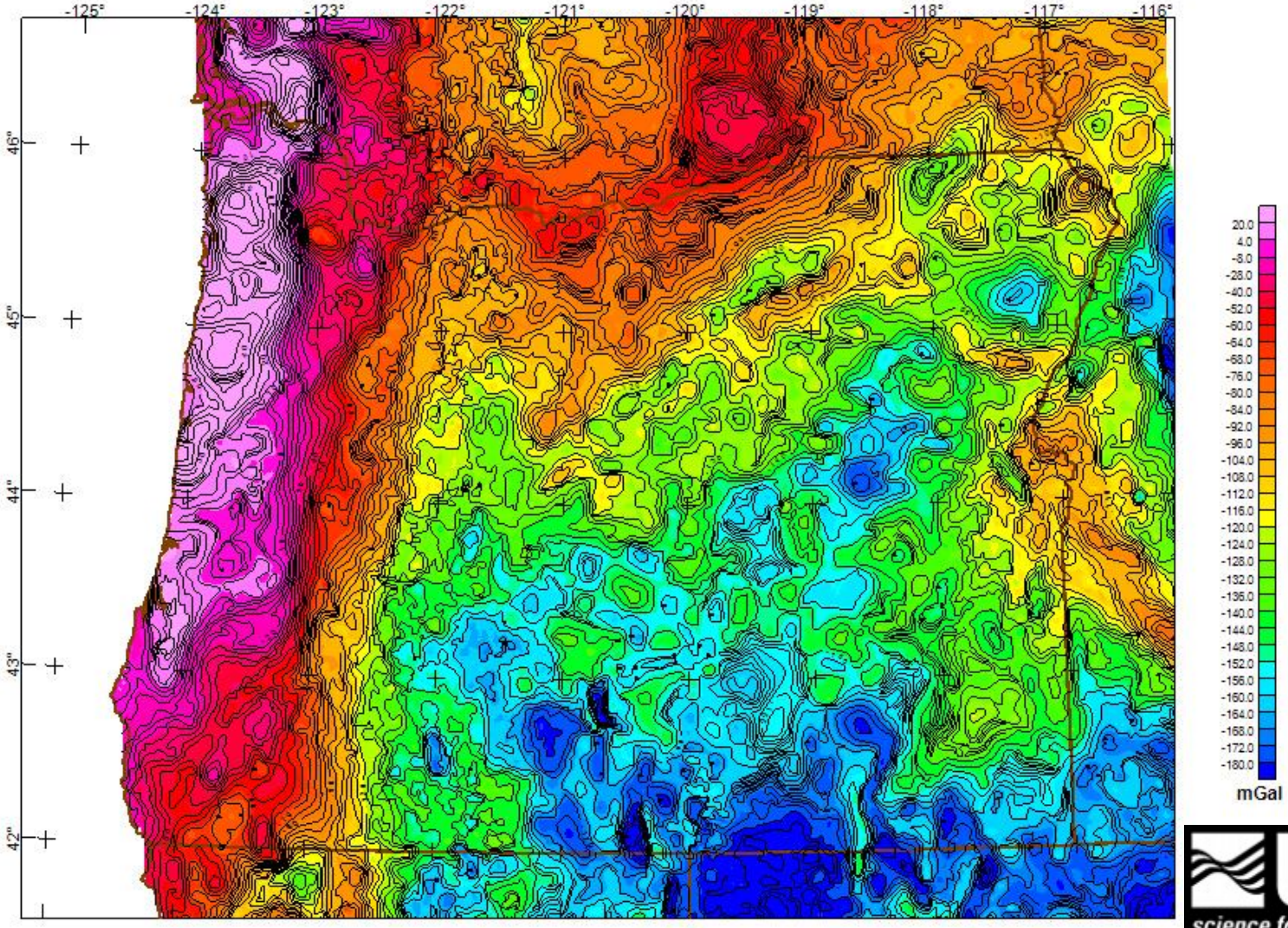


Seismic Tomographic Model of Earth

Plate Tectonics Influences the Distribution of Minerals throughout Earth



Gravity Data Tells us about the Earth's Interior



USGS
science for a changing world

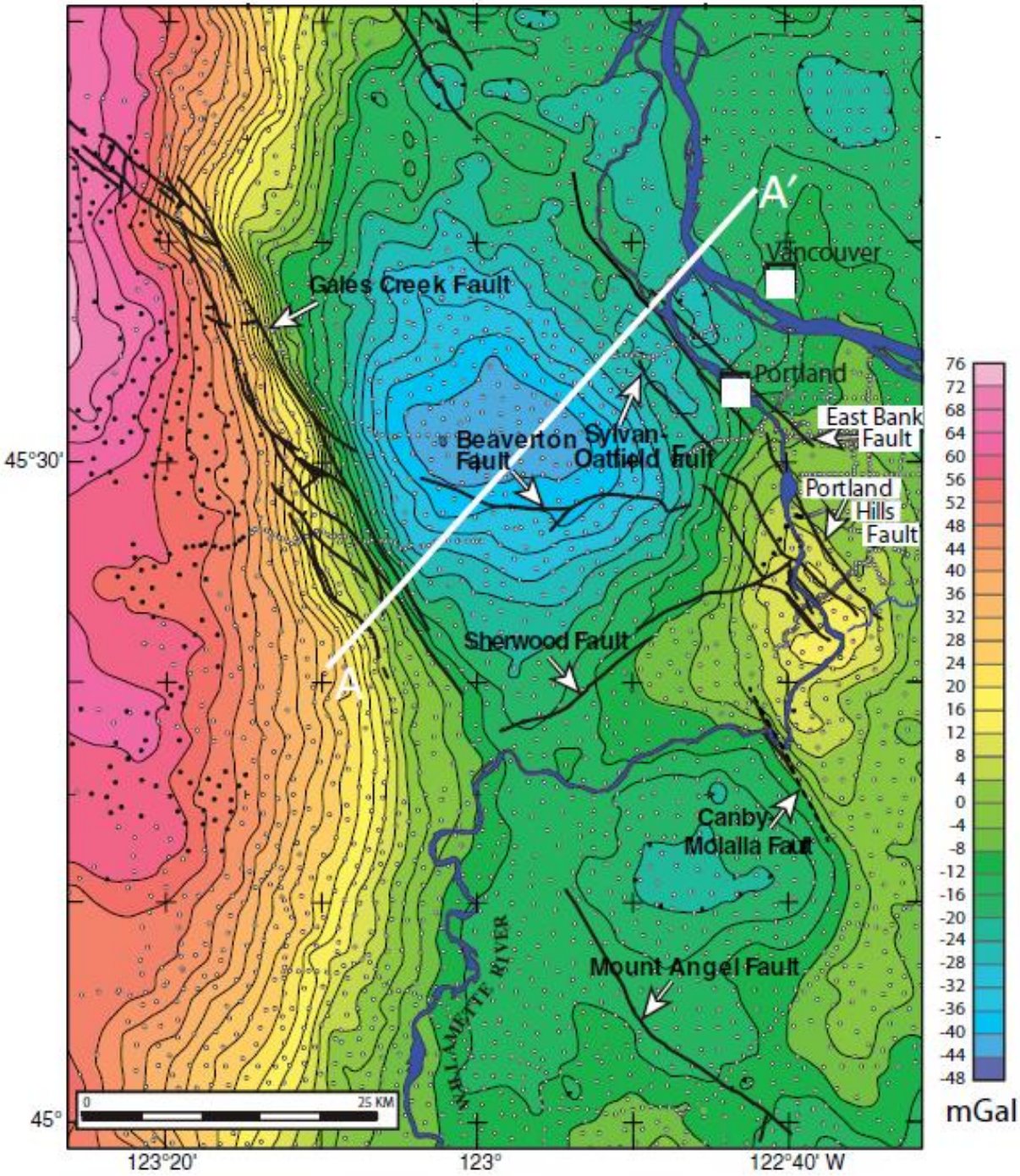


Figure 2. Isostatic gravity map of the Tualatin basin and surrounding area with major faults (from Fig. 1). Contour interval is 4 mGal. White dots—gravity measurements; black dots—gravity measurements on basement; white squares—cities.

McPhee et al., 2014

How do we know the composition and structure of the Earth?

- Drill Wells / Dig
- Remote Sensing!
  - Seismic Tomography
  - Potential Fields (gravity and magnetics)

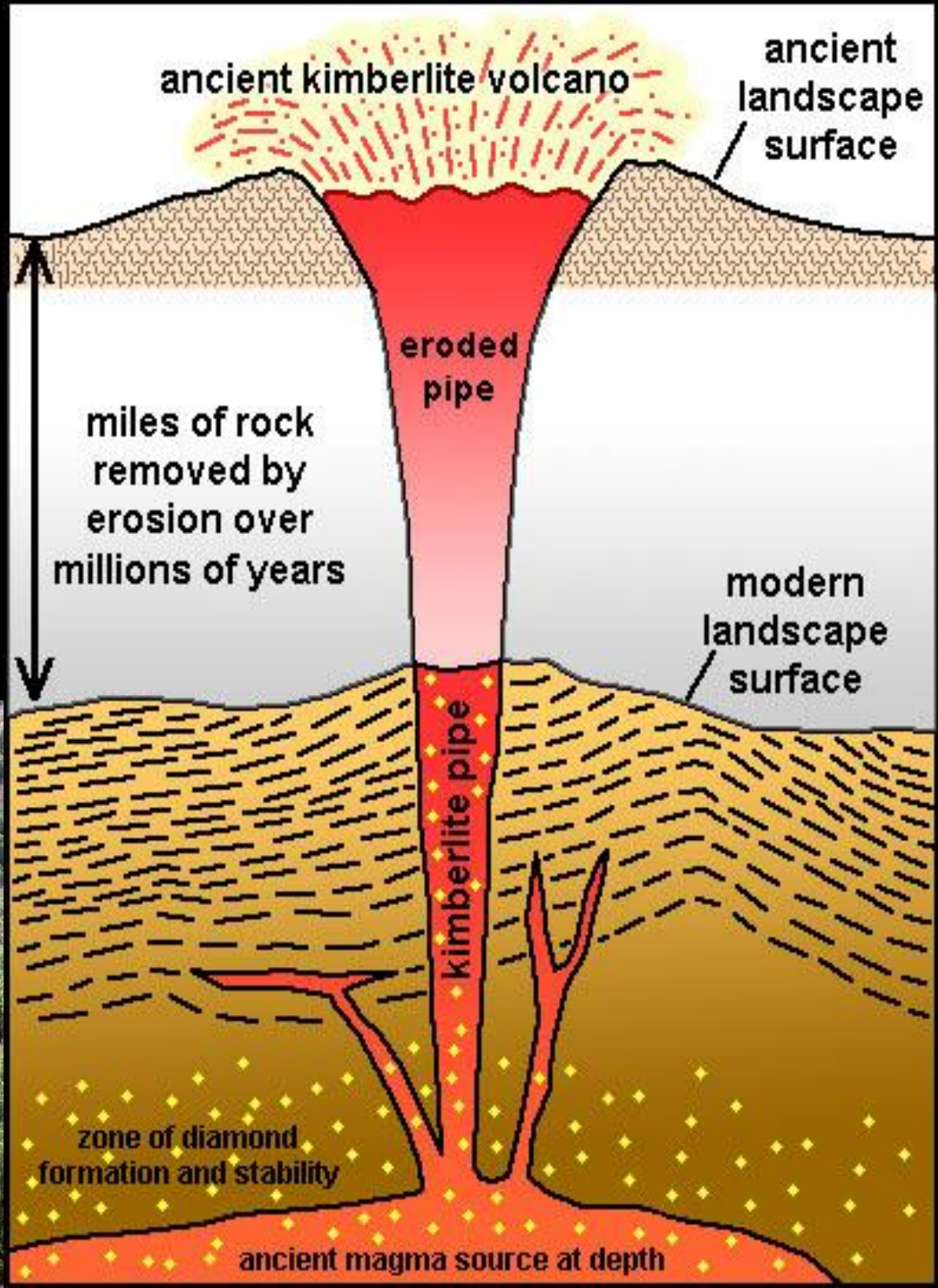
Anything else??

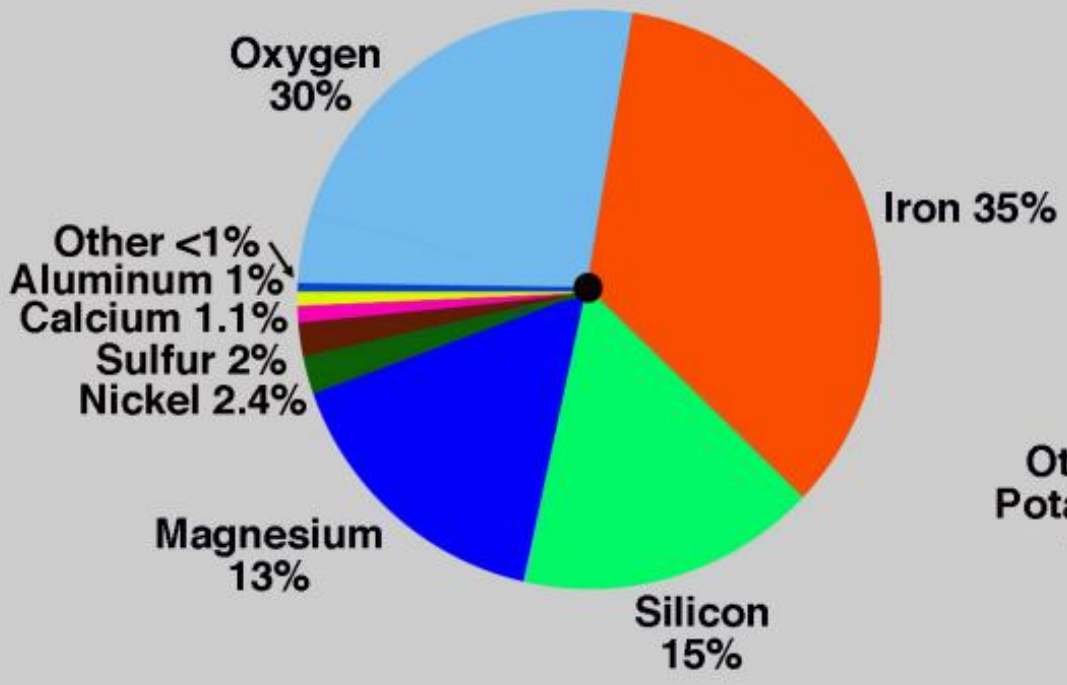
How do we know the composition and structure of the Earth?

- Drill Wells / Dig
- Remote Sensing!
  - Seismic Tomography
  - Potential Fields (gravity and magnetics)

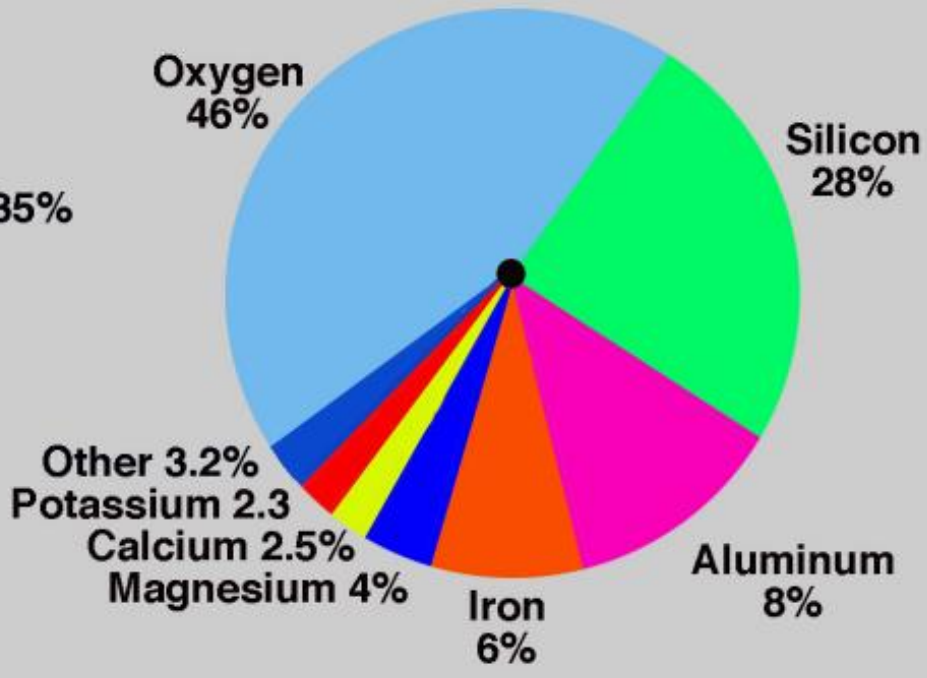
Igneous Rocks (geochemistry)

Kimberlite Pipes are the necks of ancient, deep sourced volcanoes that have been eroded away





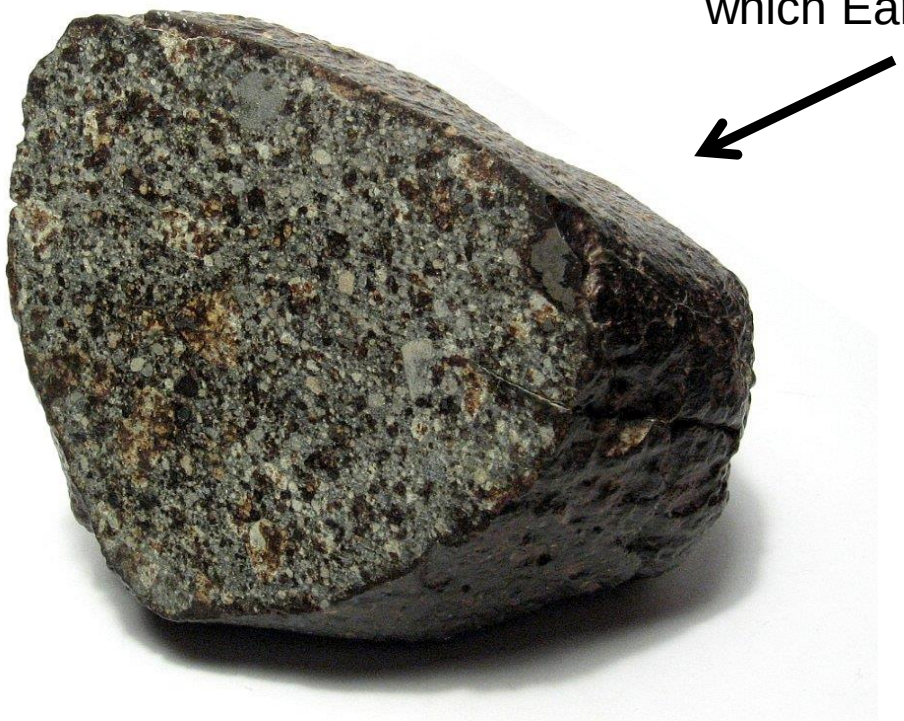
Whole Earth



Crust

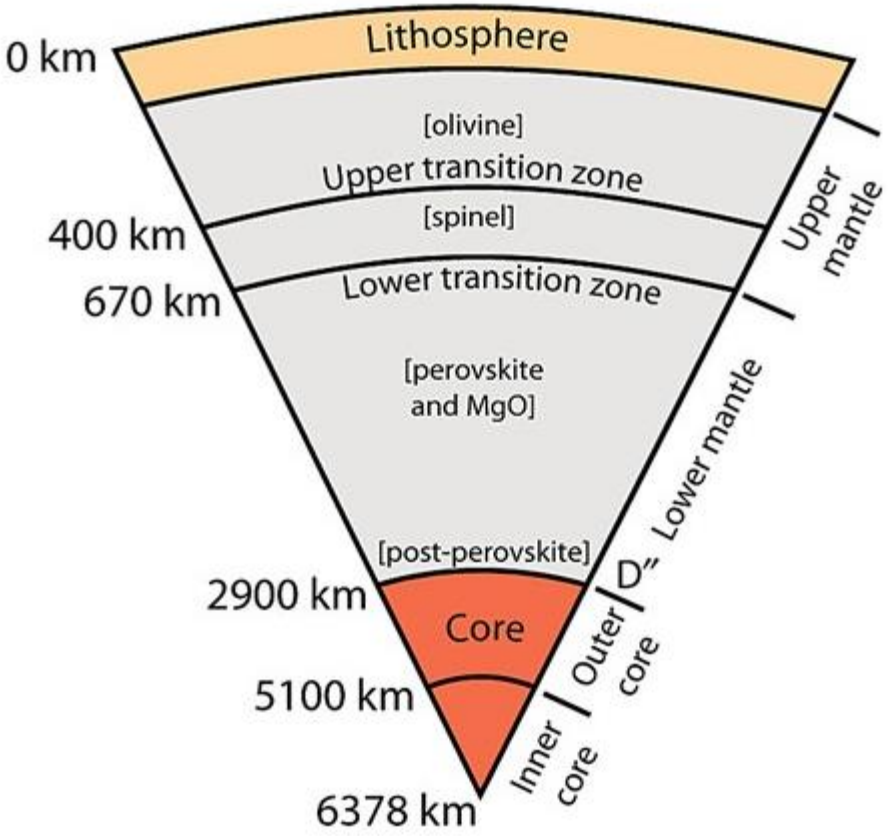
However the “whole Earth” has a different composition from the crust. Why?

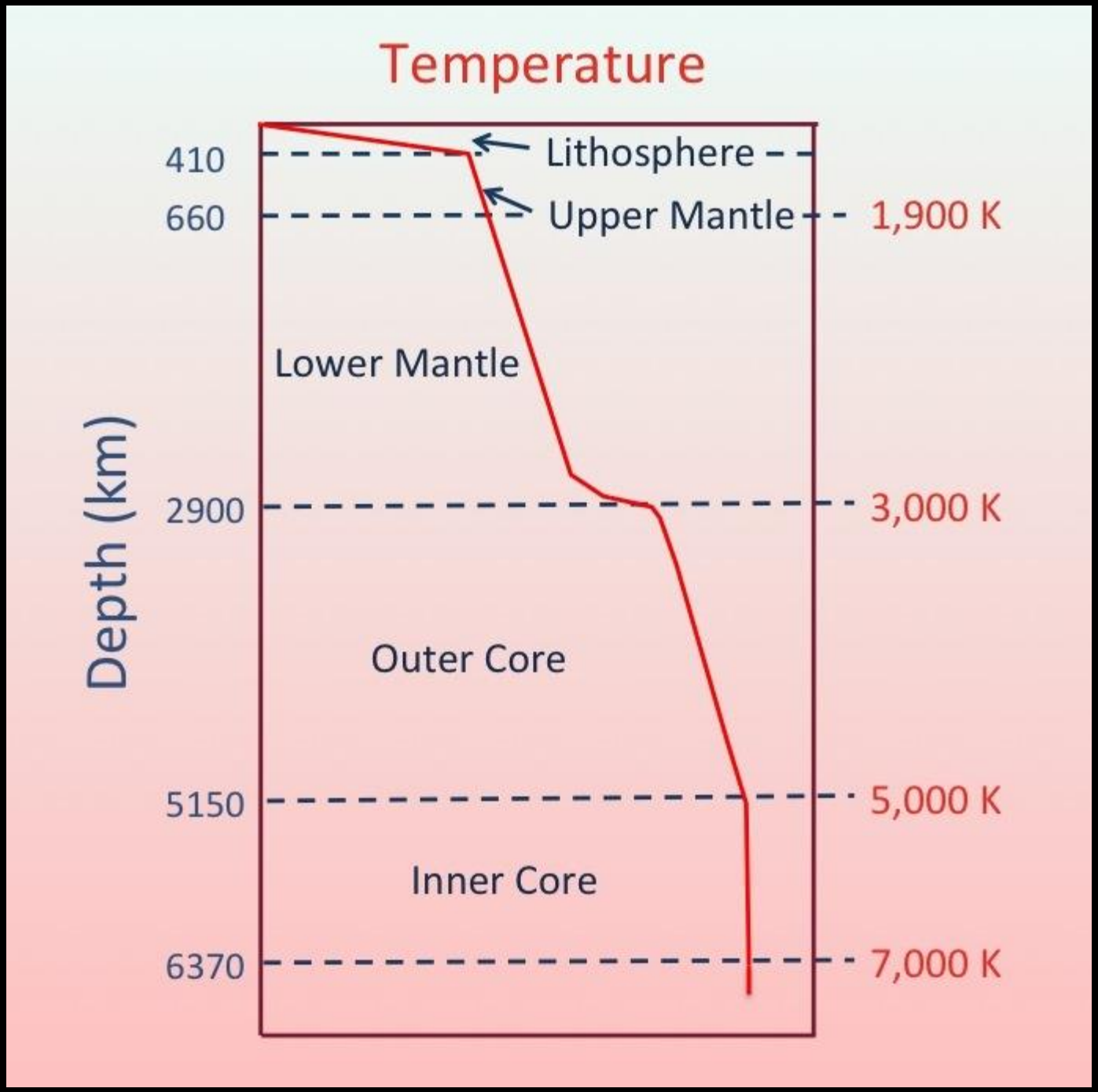
A chondrite… meteorite whose composition is thought to mirror the space dust from which Earth formed



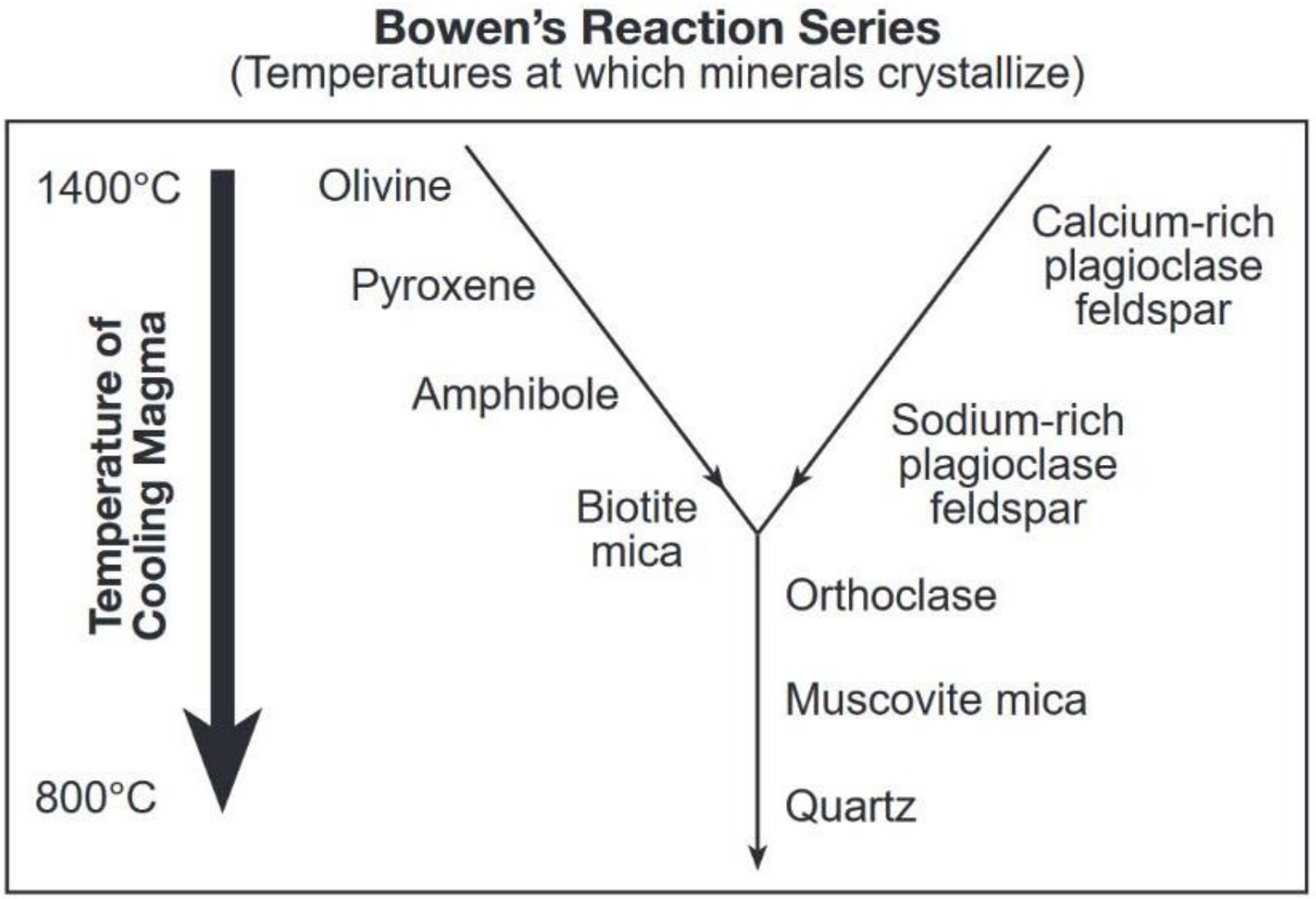
Chondrites represent whole Earth composition

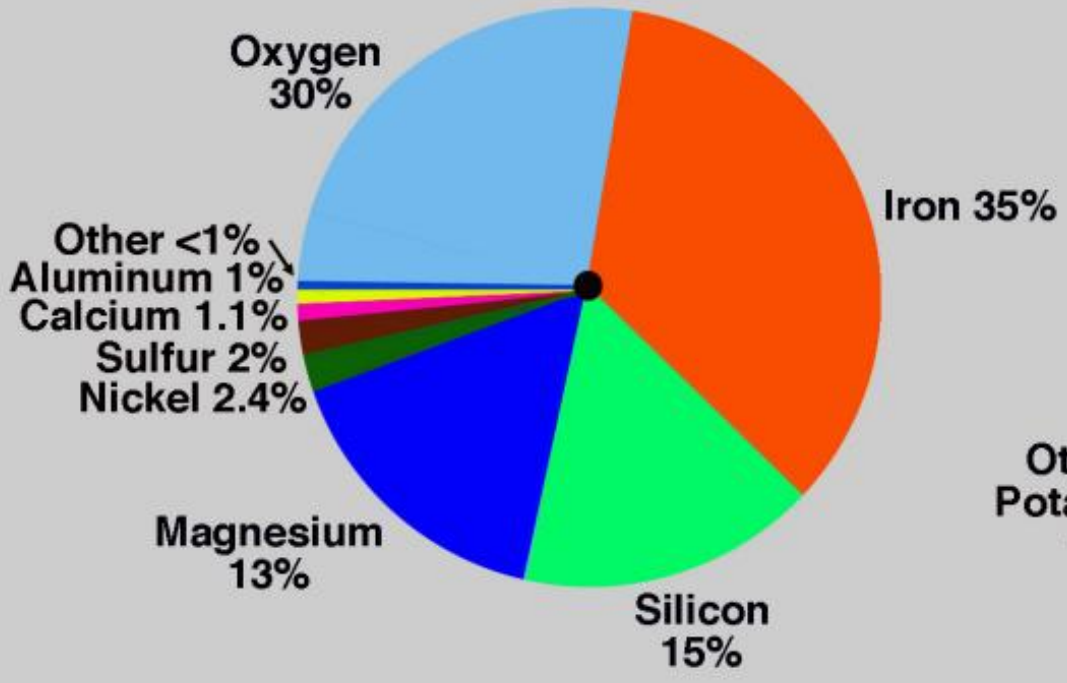
How are minerals concentrated in the Earth to become ***"ore"*** (economic)?



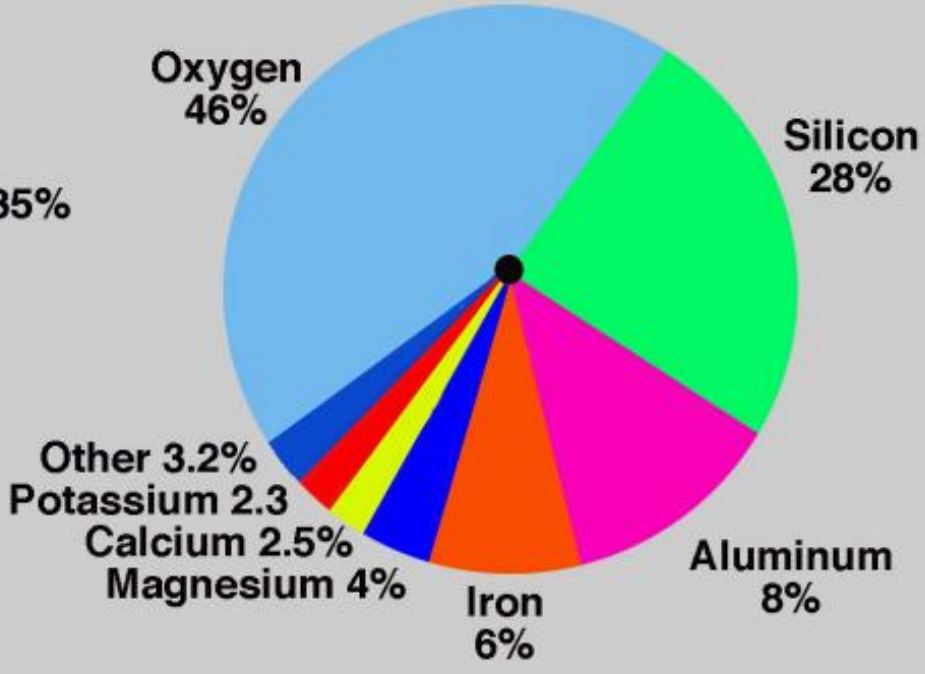

Temperature
Depth (km)
410
660
2900
5150
6370
Lithosphere
Upper Mantle
Lower Mantle
Outer Core
Inner Core
1,900 K
3,000 K
5,000 K
7,000 K

One way different minerals become “concentrated” in the crust relative to the mantle





Whole Earth

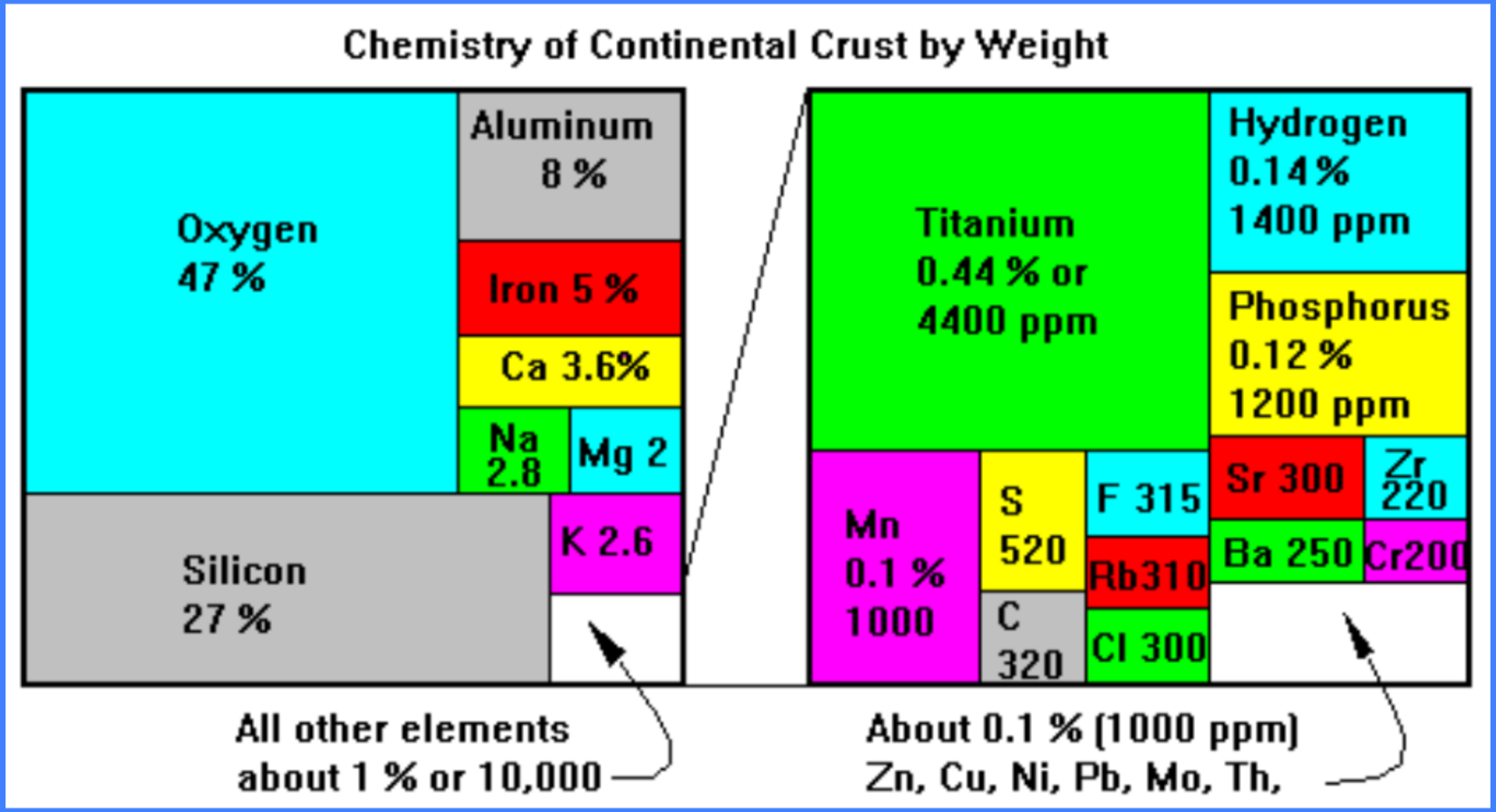


Crust

Question:

Gold is found in sea water and copper is found in average rock. Why do we not use these materials as sources of these metals?

What geologic processes further increase their concentration?



http://www.uwgb.edu/dutchs/Graphics-Geol/rockmin/ccrustwt.gif

Where do Minerals concentrate *within* the crust? (Ch.2)

1. Soil (through weathering)
2. Groundwater
3. Magmatic / Metamorphic processes

Question:

Although mineral deposits are forming today by natural geologic processes, we refer to them as "non-renewable resources." Why?