Hydrogen on Venus, μdiamonds on Earth and Valhalla on Callisto: **signposts of *******s in the Solar System**

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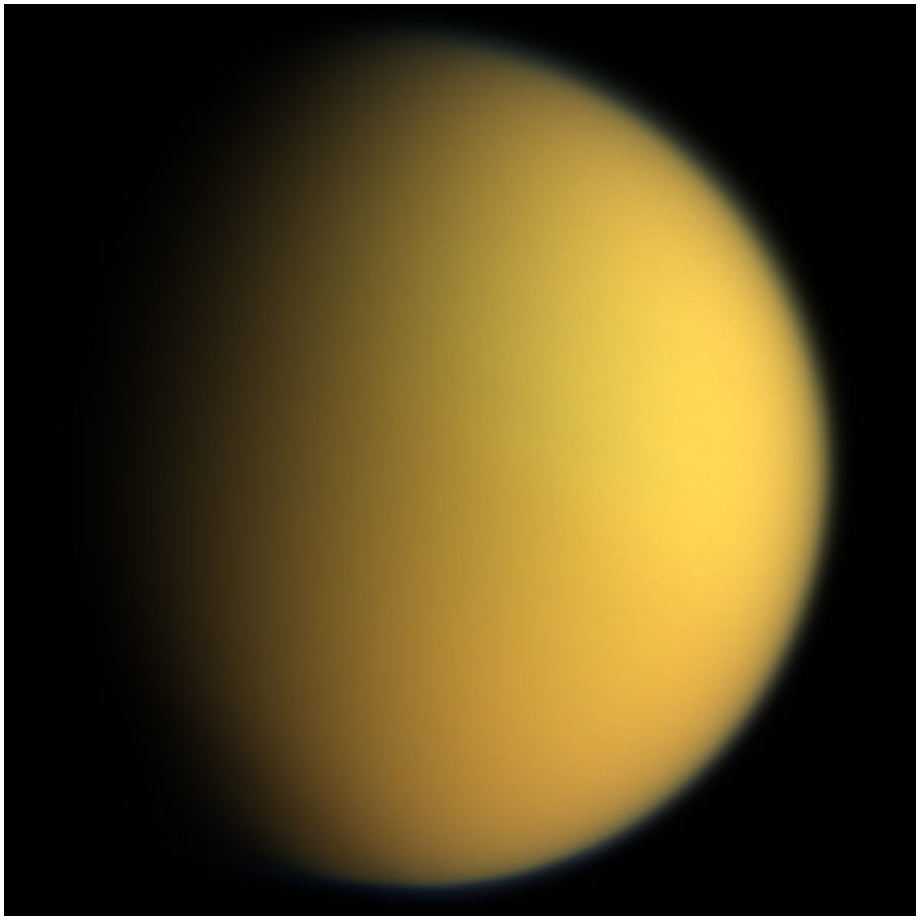
CAB-ESAC μseminars

Atmospheric mass ratio per element:

1. Atmosphere mass of a (spherical) planet

- $P_{atm} = F / S$
- $F = M_{atm}\, g$
- $S = 4\, \pi\, R^2$
- $g = G\, M_{planet} / R^2$
- **$M_{atm} = 4\, \pi\, R^2\, P / G\, M_{planet}$**



M_{atm}/M_{planet}

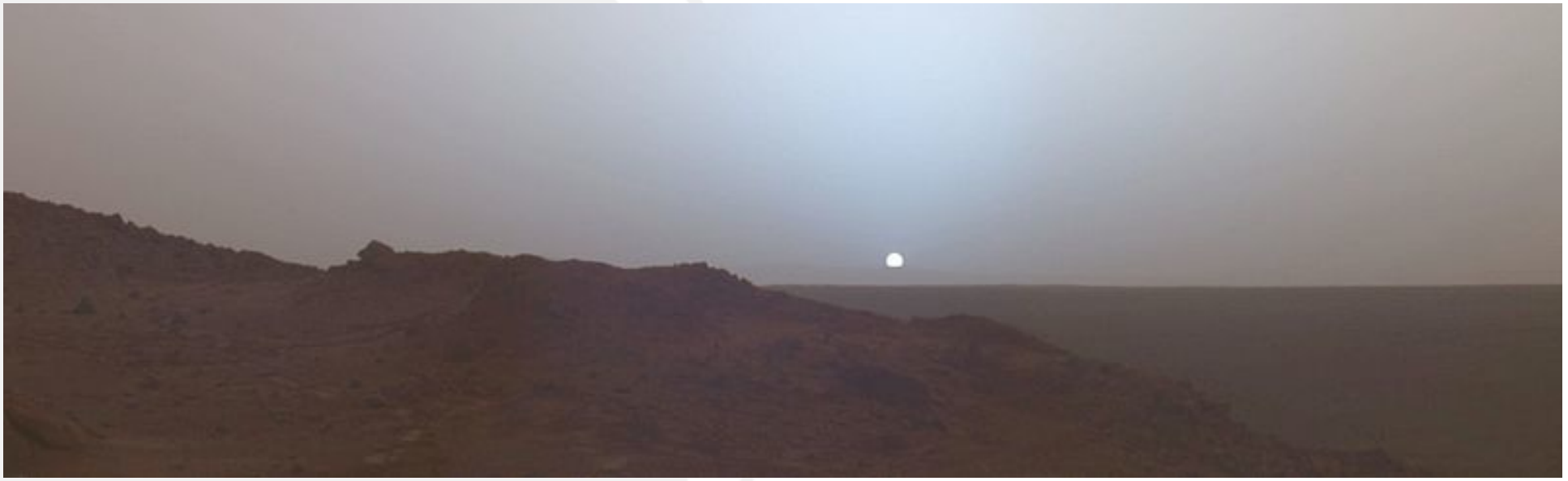
Atmospheric mass ratio per element:

2. Atmosphere composition (mass)

E.g., on Earth:

- $X_N = 0.7808$ [N_2]
- $X_O = 0.2095 + 0.004(16/18) + 0.00039(32/44)$ [$O_2 + H_2O + CO_2$]

$\Sigma X_i = 1$,
i = H, C, N, O, Ar



Atmospheric mass ratio per element:
3. Atmosphere composition (cont.)

- **Venus:** 96.5% CO_2, 3.5% N2, H_2O, SO_2, CO, Ar
- **Earth:** 78.08% N_2, 20.95% O_2, 0.93% Ar, H_2O, CO_2
- **Mars:** 95.3% CO_2, 2.7% N2, H_2O, H2, O_2, CO, Ar
- **Titan:** 95.0% N_2, 4.9% CH_4, traces of Ar

Martian sunset at Gusev crater

Atmospheric mass ratio per element

M_{atm}/M_{planet} M_{Earth}	$^{2}_{1}H$ [10^{-10}]	$^{24}_{12}C$ [10^{-10}]	$^{28}_{14}N$ [10^{-10}]	$^{32}_{16}O$ [10^{-10}]	$^{36}_{18}Ar$ [10^{-10}]
Venus 0.815	2.20	26100	34700	69600	69.4
Earth 1.00	0.196	0.937	6880	1880	82.3
Mars 0.107	0.0146	99.5	10.3	266	6.12
Titan 0.0225	8230	24700	639000	46700	6.72

Atmospheric mass ratio per element:

4. Earth hydrosphere

- M_{hydro} = 1.4 10^{21} kg (M_{Earth} = 5.98 10^{24} kg)
- O: 85.84%, H: 10.82%, C: 0.0028%

$\Sigma X_i = 1$,
i = H, C, O,
Cl, Na, Mg,
Ca, K, Br…

Atmospheric mass ratio per element

M_{atm}/M_{planet} M_{Earth}	$^{2}_{1}H$ $[10^{-10}]$	$^{24}_{12}C$ $[10^{-10}]$	$^{28}_{14}N$ $[10^{-10}]$	$^{32}_{16}O$ $[10^{-10}]$	$^{36}_{18}Ar$ $[10^{-10}]$
Venus 0.815	2.20	26100	34700	69600	69.4
Earth+Hydro 1.00	25400	>> 66.6 (+crust)	6880	$2.01\ 10^{6}$	82.3
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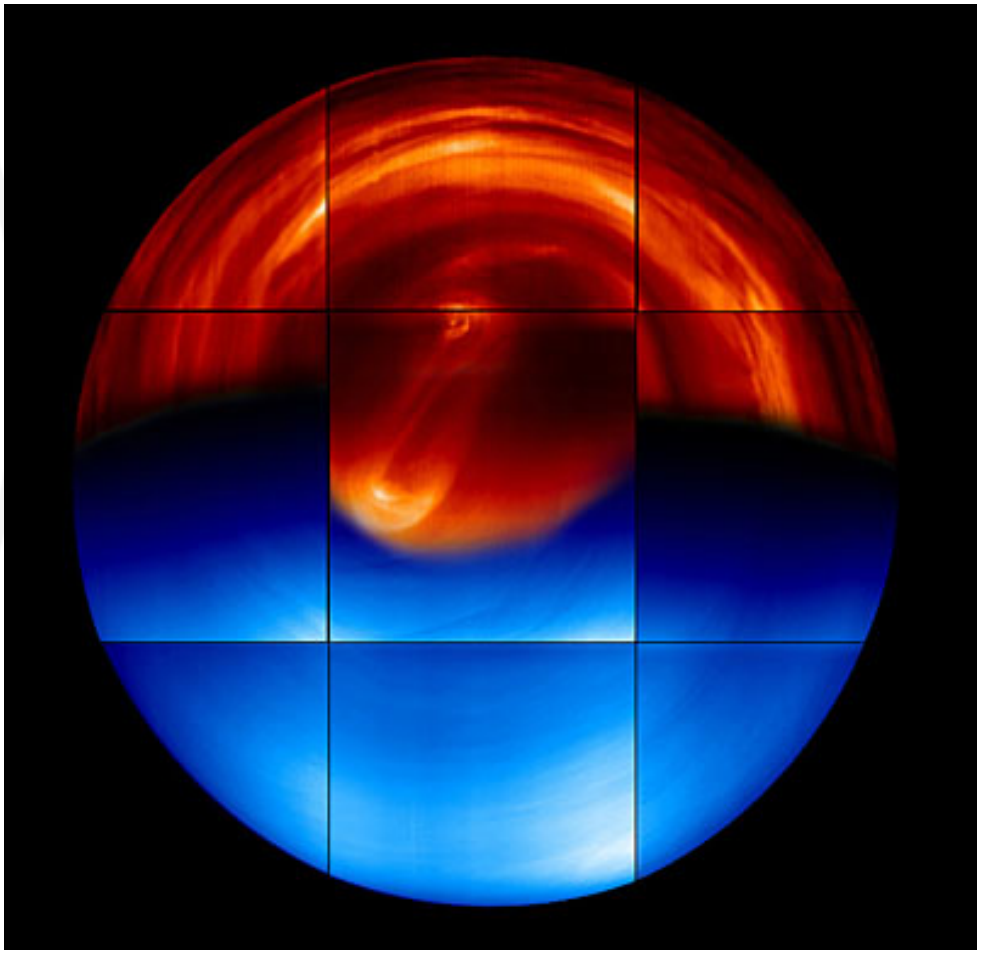
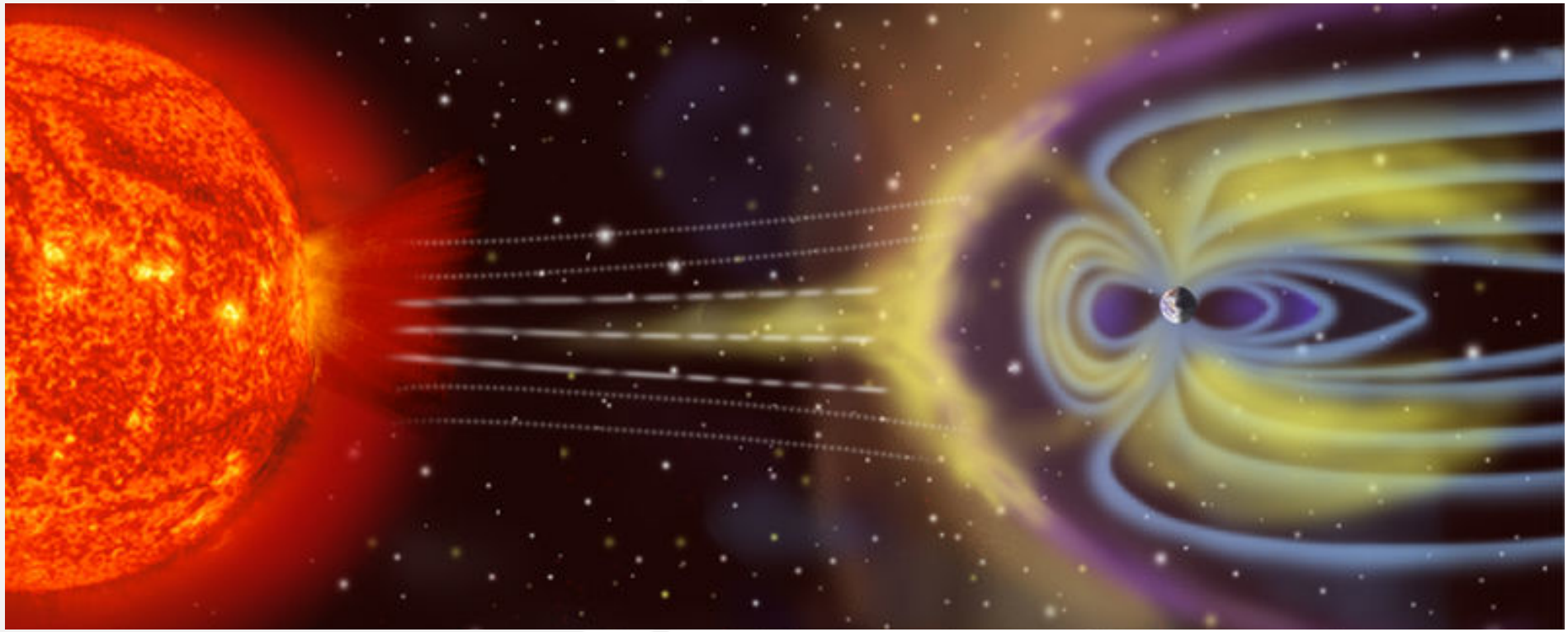
Venus' hydrogen

- A small fraction bound up in H_2SO_4 and H_2S mostly
- The definitive test: **D/H ratio** 0.025 (on Earth 0.00016)
- Deuterium $^{2}_{1}H$ is twice more massive than hydrogen $^{1}_{1}H$
- D/H ratio in Venus' upper atmosphere >> 0.025



LOST IN SPACE



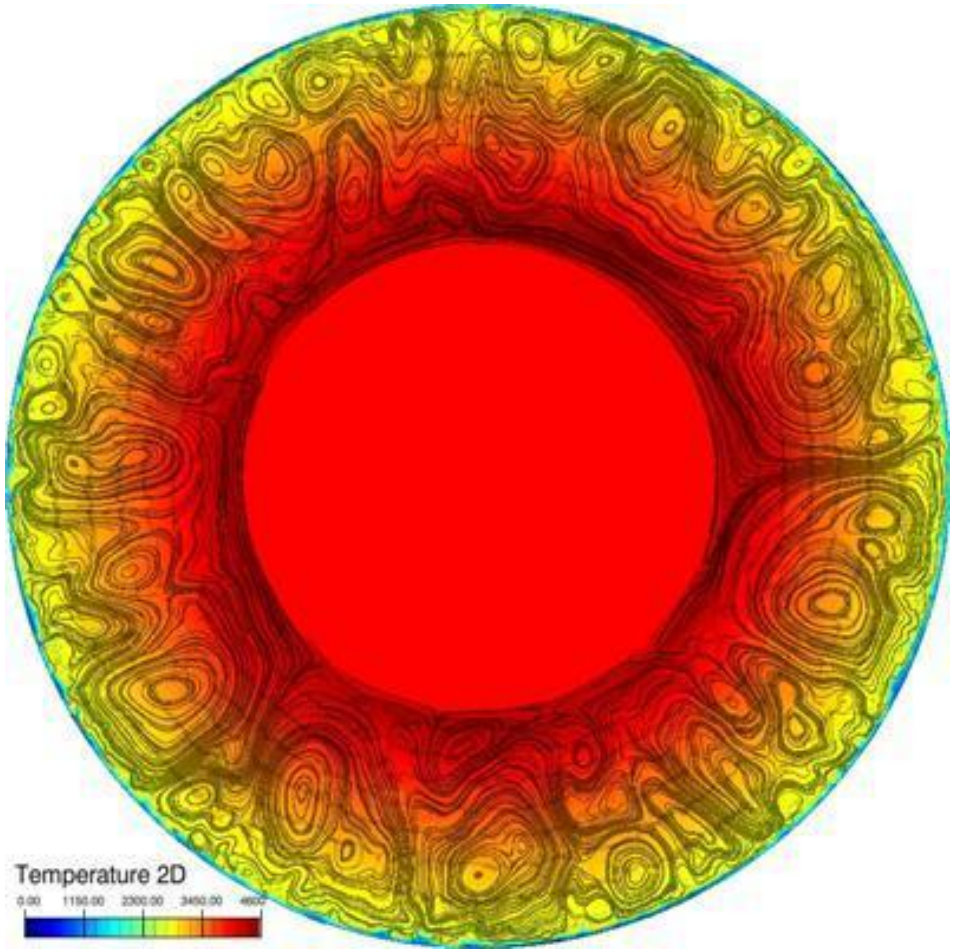
Venus' upper atmosphere

- Solar UV radiation dissociates water molecules into oxygen and hydrogen ions
- Solar wind gives kinetics energy to ions that escape the gravity field
- Atmospheric erosion (H, He, O…) due to a **weak magnetosphere**

F_{UV}, K(m), $B(P_{rot})$

Venus' magnetic field

- Lack of an appreciable magnetic field (internal dynamo vs. ionosphere +solar wind)
- A dynamos requires: a conducting liquid, **rotation** and convection
- Reduced heat loss ← No plate tectonics ← Strong, low-viscosity crust ← Water deficit (heat released during resurfacing events)
- (Sulfur-dependent) status of core is uknown

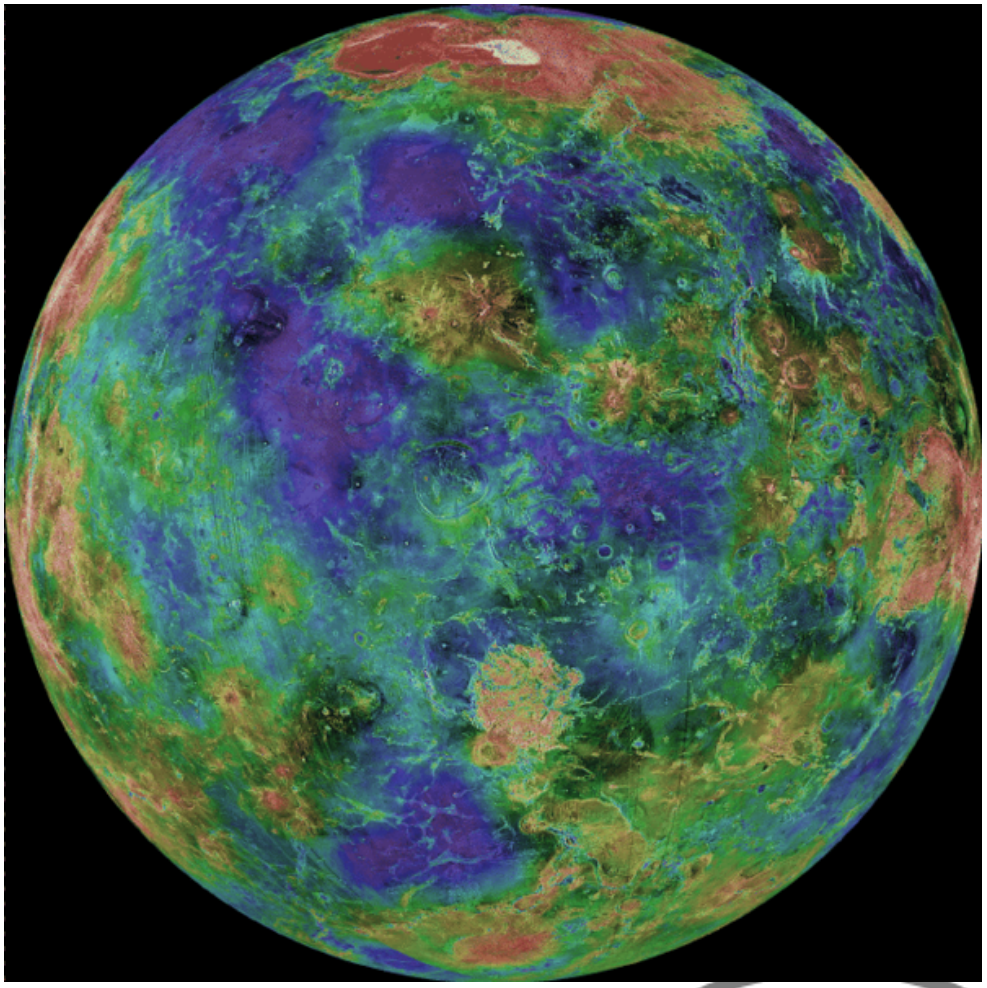


"Problema del huevo y la gallina"

Venus' rotation

- P_{orb} = 224.70 d
- P_{rot} = -243.02 d

SLOW retrograde rotation.
Why? Tidal resonances (Venus atmosphere+ Sun) vs. *****S

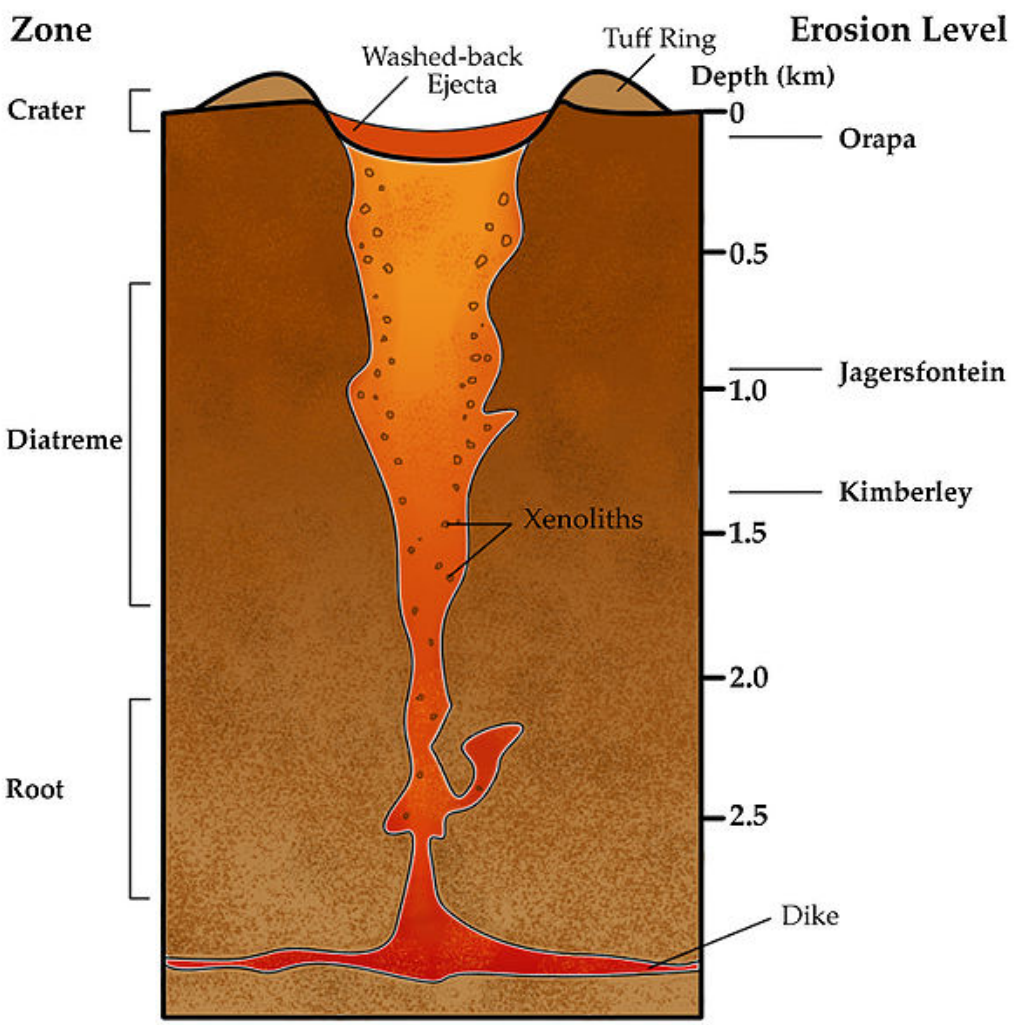


A Jacques Laskar's theory…

Diamonds: an allotrope of carbon

Graphite (graphene), amorphous ("coal"), buckminsterfullerenes (C_{60}, nanotubes), glassy, nanofoam, lynear acetylenic carbon, lonsdaleite

Αδαμασ



(Natural) diamonds: origin

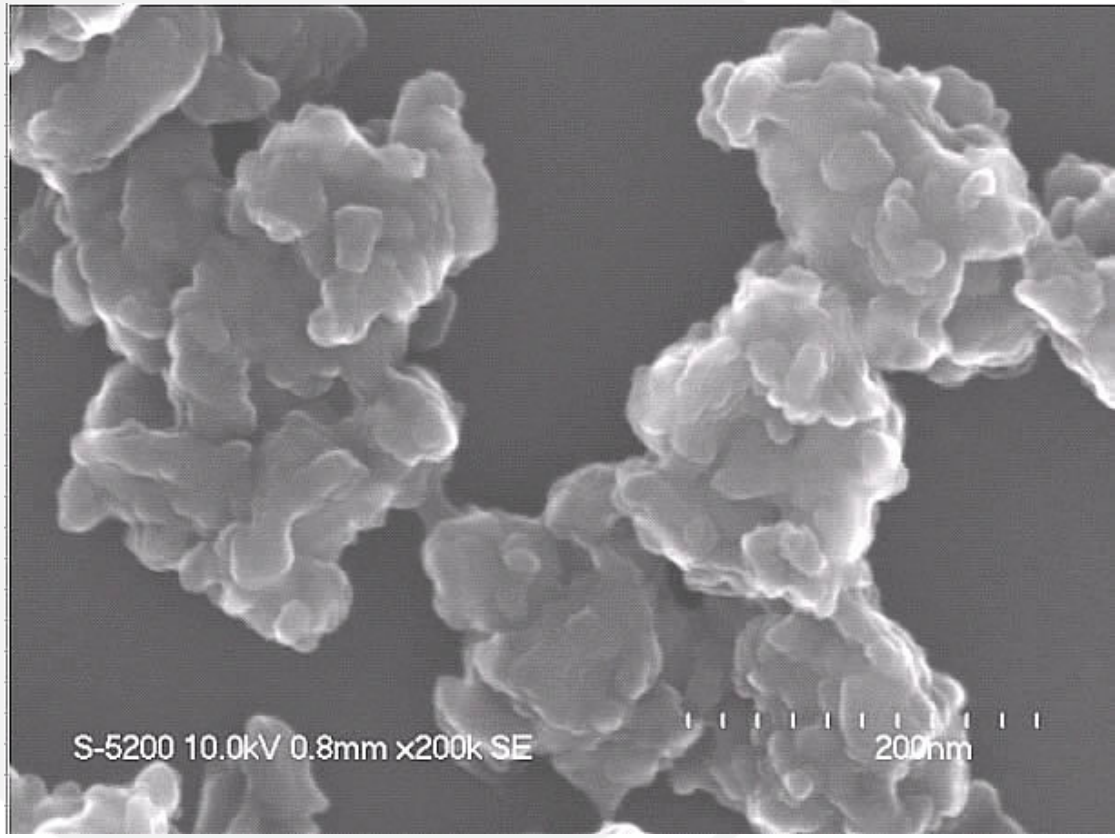
- Very high pressure and temperature
- 140-190 km in depth in mantle from carbon-containing minerals
- Growth for 1.0-3.3 Ga
- Brought to surface by magma during volcanic eruptions

Kimberlites, lamproites

Carbonado diamonds: ?

- "Black diamonds"
- Brought by and asteroid?
- Formed in a supernova explosion???
- Shock metamosphism

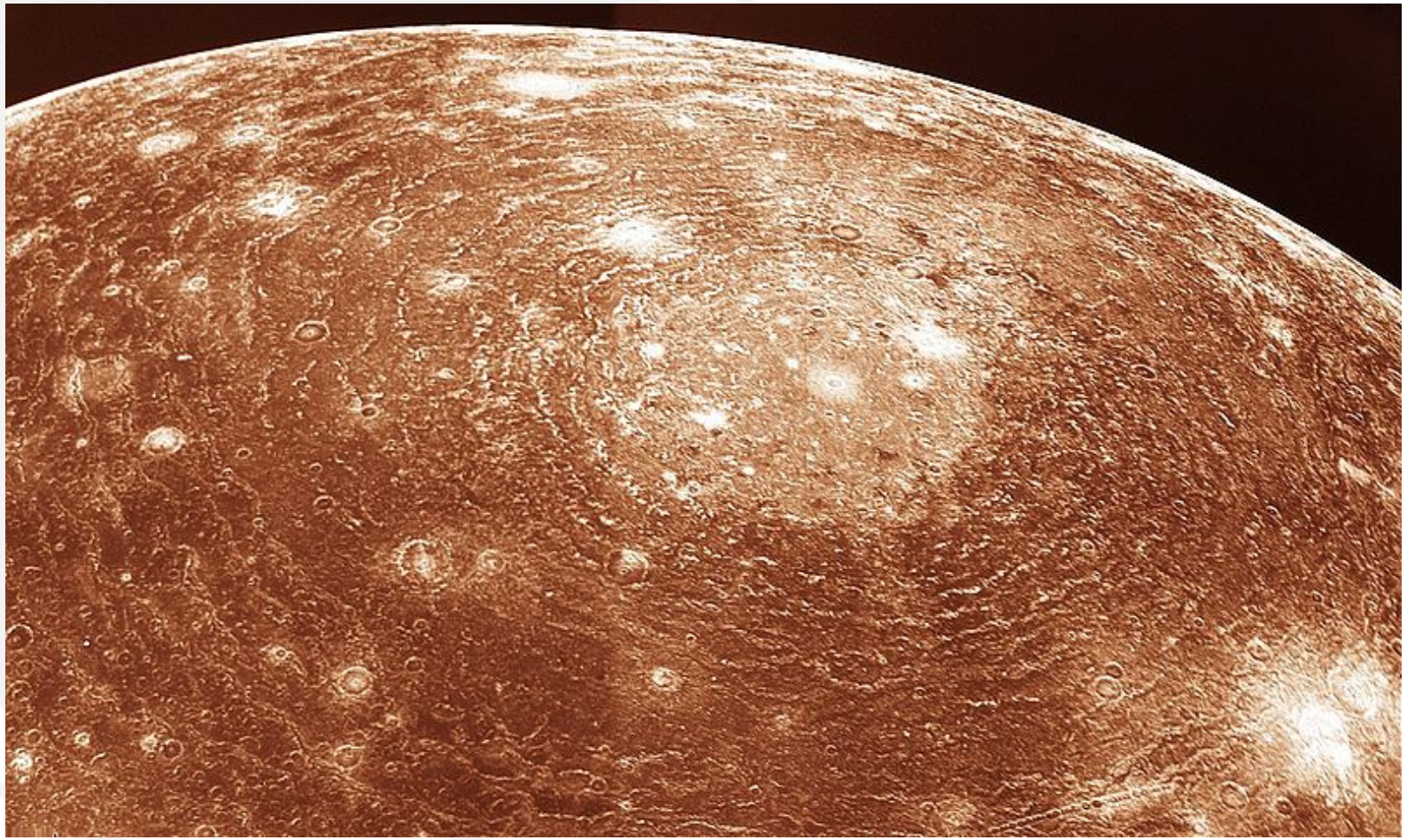
Brasil, Central African Republic



Nanodiamonds: nm to µm

- Ultradispersed detonation nanodiamonds
- Oxygen-deficient mixture of TNT/RDX in a close chamber

And in shock zones…



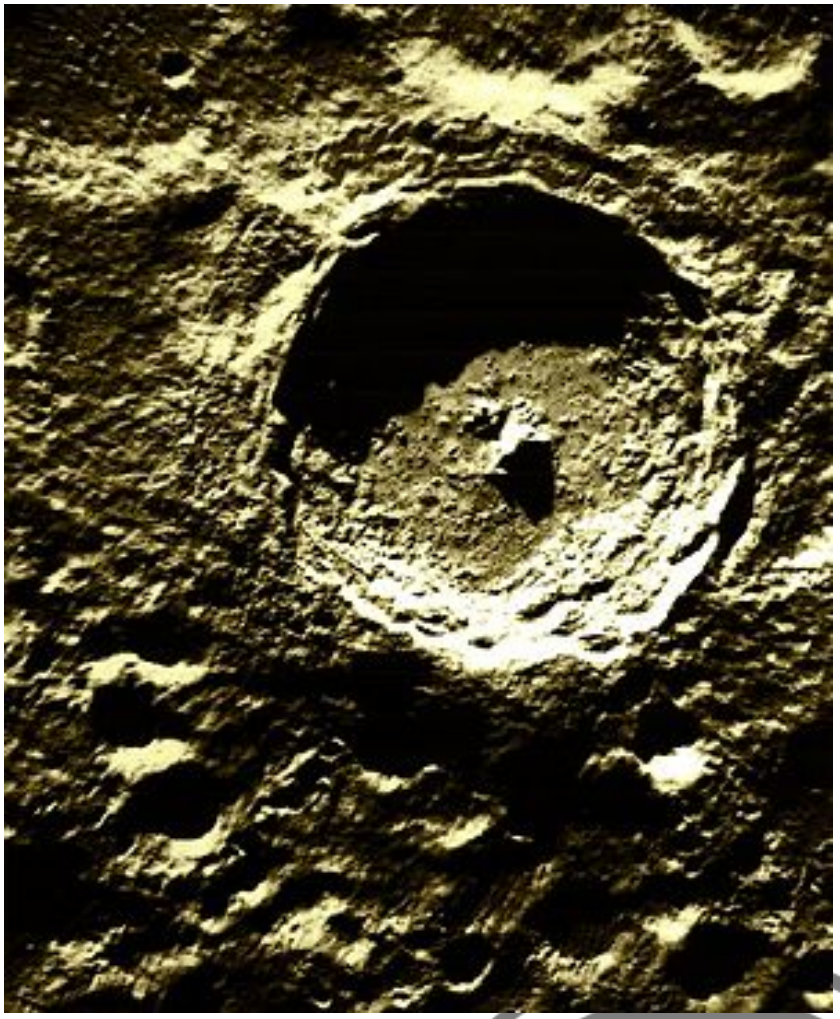
Impact (******) craters

• **Valhalla**: the largest multi-ring basin in the Solar System (3800 km diameter)

Odin's hall in Norse mythology

Impact craters

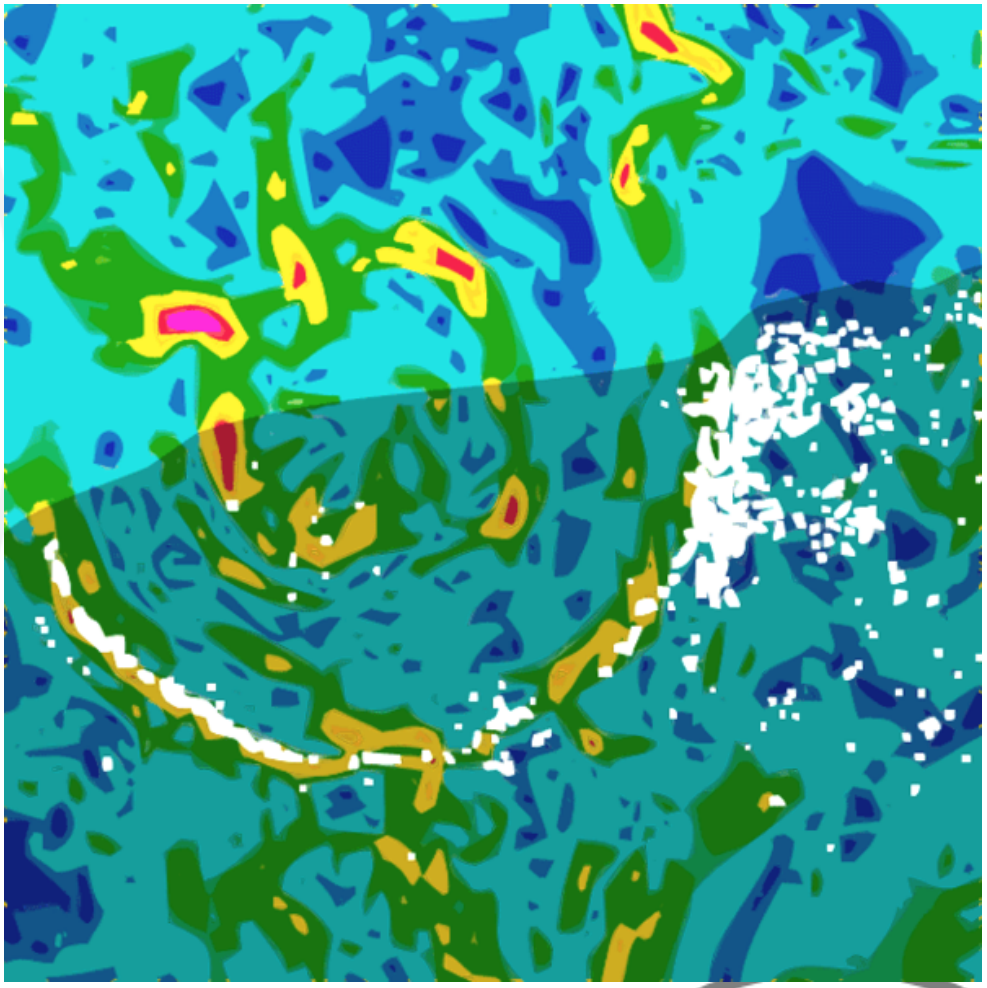
- **Tycho**: 86.21 km in diameter, 4.8 km in depth, 108 Ma old
- Distinctive ray system and system of satellite craters
- Possibly associated to asteroid 289 Baptistina



"TMA-1"

Impact craters

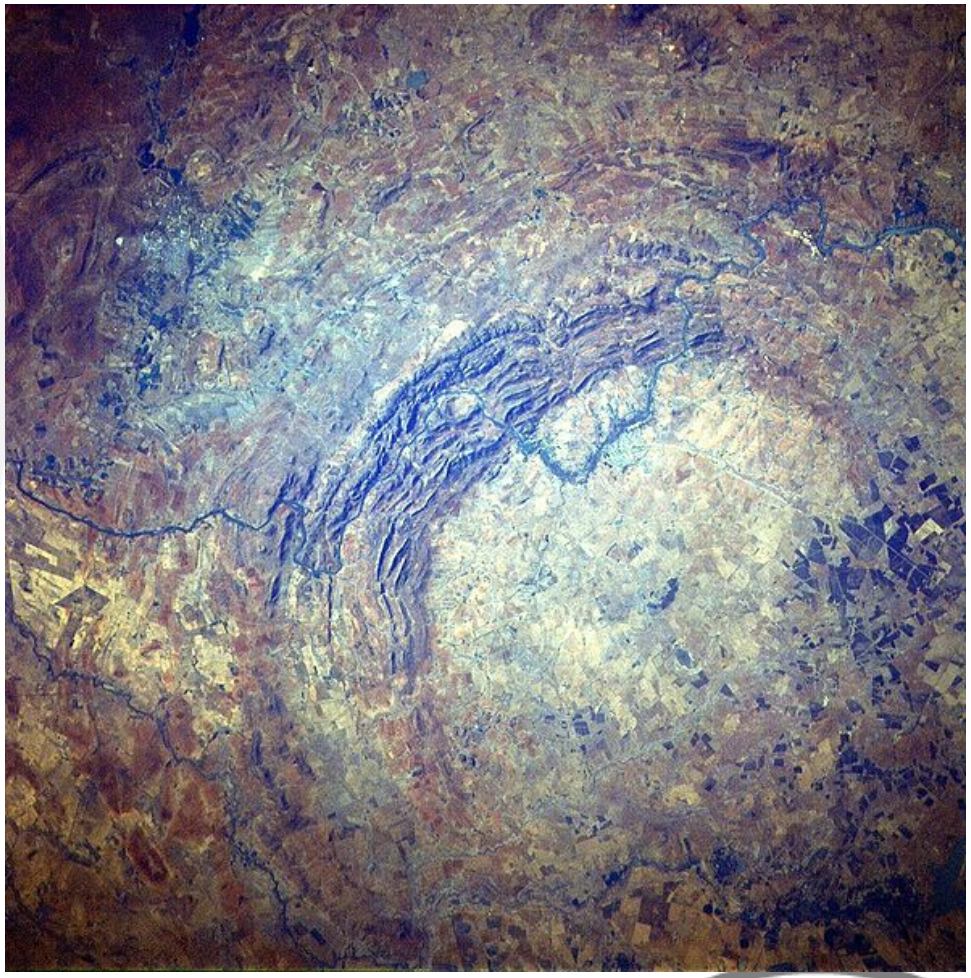
- **Chicxulub**: 180 km diameteter crater in Yucatán Peninsula
- At the Cretaceous-Paleogene boundary (-65.5 ± 0.3 Ma)
- Impacting bolide: 10 km
- Multiple impact crater: simultaneous SL9-like events: Boltysh (24 km), Silverpit/North Sea (20 km)



And Shiva crater (450-600 km)?

Impact craters

- **Vredeford**: 250-300 km diameter in South Africa
- Slightly larger than the Sudbury Basin/Ontario (which is elongated and includes the Temagami Magnetic Anomaly)



Also: Wilkes Land/ Antarctica

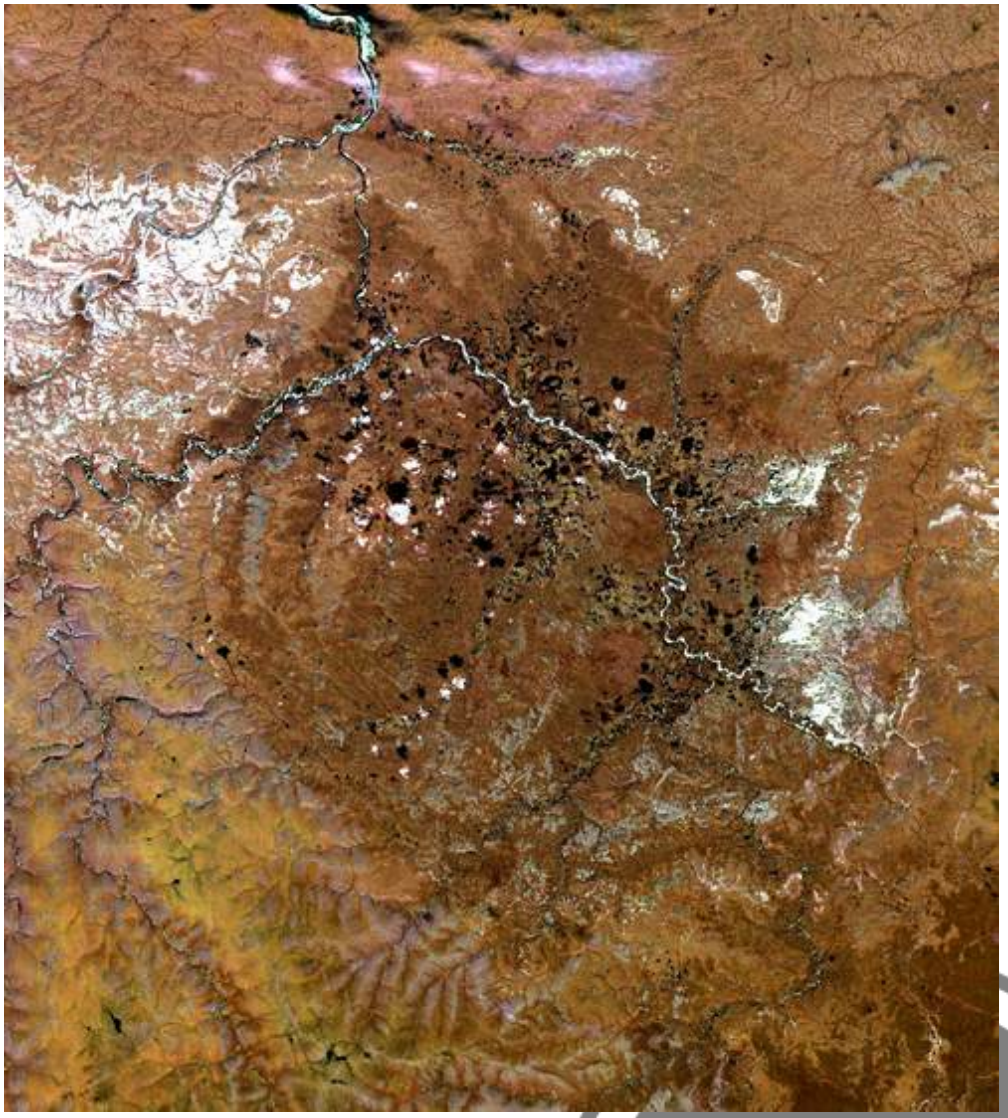
Impact craters

- **Nördlinger Ries**/Bavaria + **Steinheim**/B-W: 24+3.8 km only 14.3-14.5 Ma ago
- Impact of binary asteroid of 1500+150 m, angle of 30-50 deg, velocity of about 20 km/s
- Released energy: 2.4 10^{21} J (1.8 million Hiroshima bombs)

72000 Tm of **µdiamonds** (0.2 mm)

Impact craters

- **Popigai**/Siberia: 100 km, 35.7 ± 0.2 Ma ago
- Impactor: chondrite (8 km) or stony (5 km) impactors
- Not investigated until 1997: mines constructed by gulag prisoners under Stalin
- Shock pressure: graphite into diamonds within 13.6 km radius
- Diamonds 0.5-2 mm



Specimens of up to 10 mm with striations

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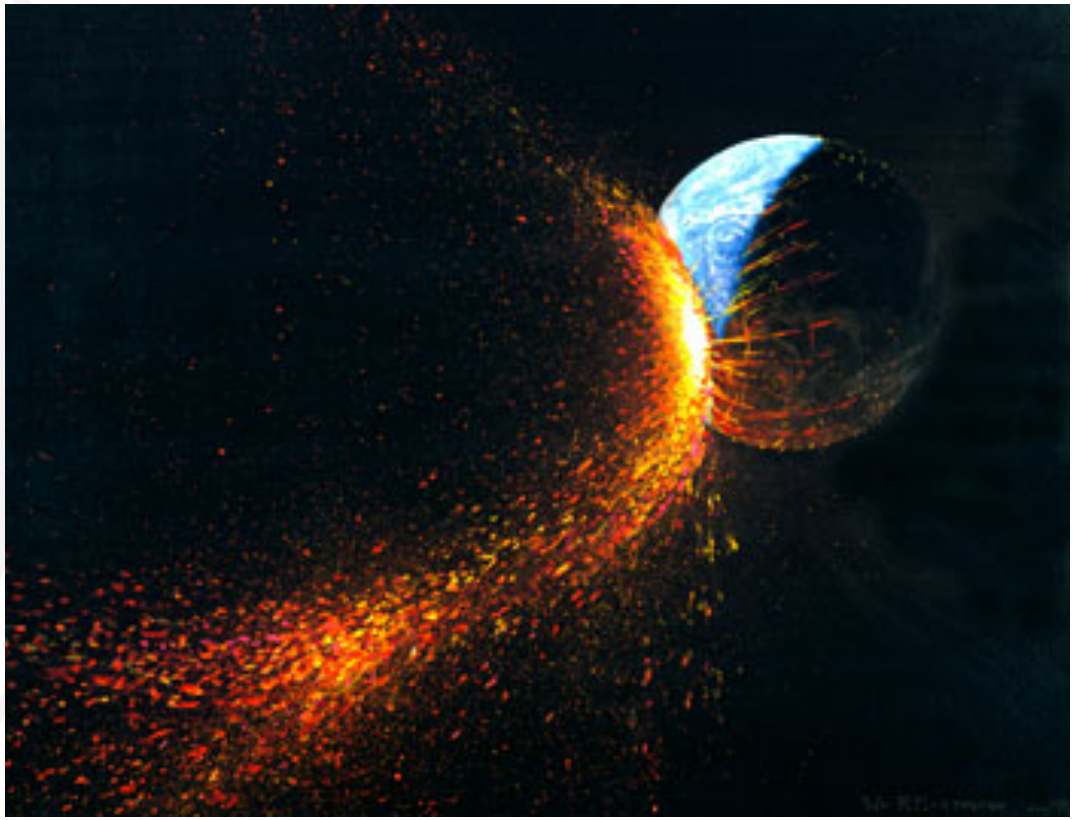
Double impact in Venus may explain both the slow retrograde orbit and the absence of a moon… **Need of *in situ* isotope analysis**



Remember the giant collision hypothesis

http://
exoterrae.eu/