

AN UPDATE ON METEORITE IMPACTS IN CHILE and their **astrobiological** implications



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Introduction

Meteorite/Asteroid Impacts as a main geological process in the Solar System

The study of the flux of ET matter to Earth from Atacama desert

Chile and its record of impact events

Monturaqui crater (and others)

New tektite field: Atacamaites

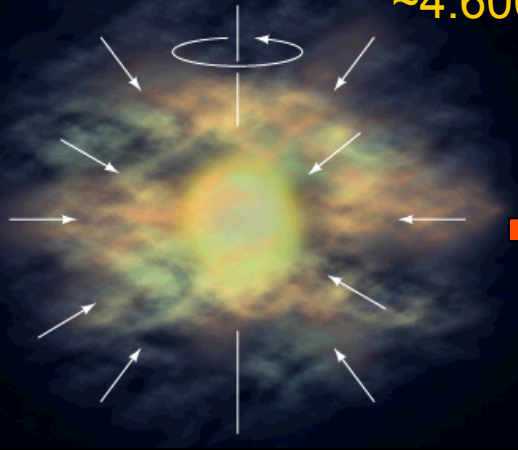
Possible Pleistocene-Holocene
Tunguska-like event

Astrobiological perspective

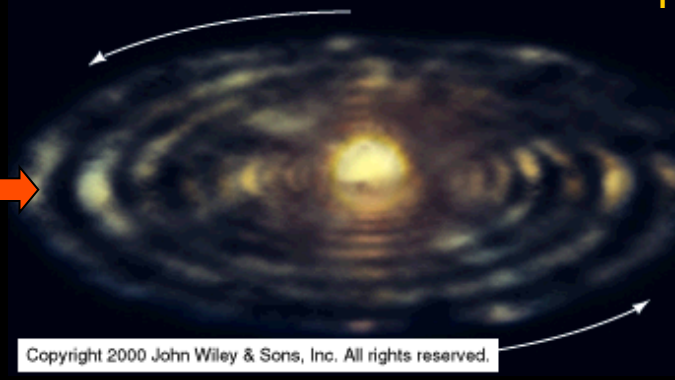
Future work

Introduction impact process SS * Atacama * Chile: Monturaqui Atacamaites Tunguska-like Future

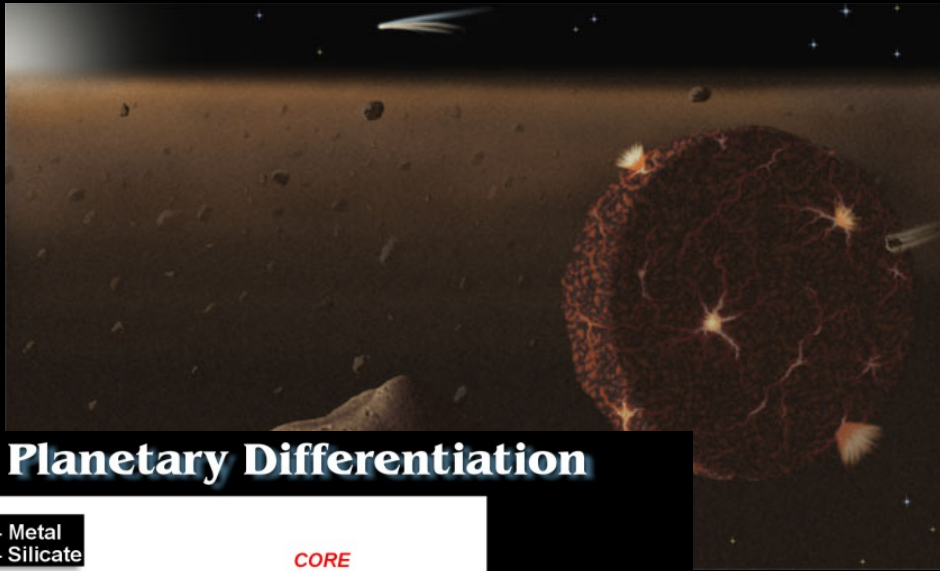
~4.600 Ma



~4.560 Ma



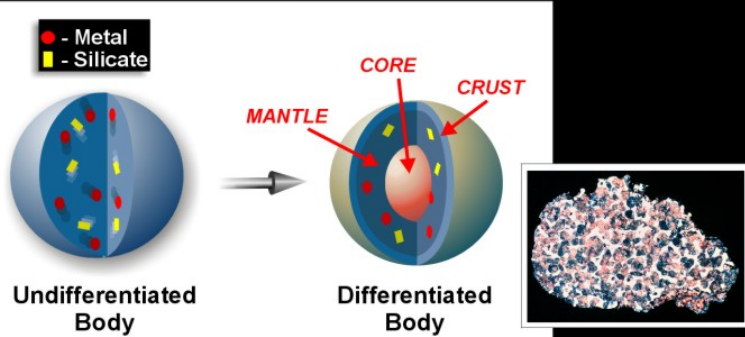
~4.550 Ma



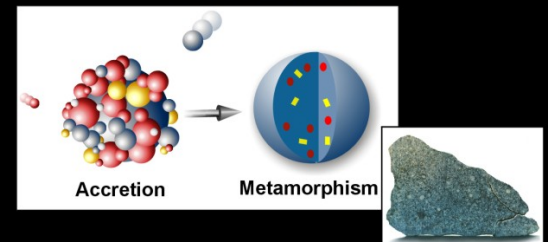
Planetary Differentiation



Accretion

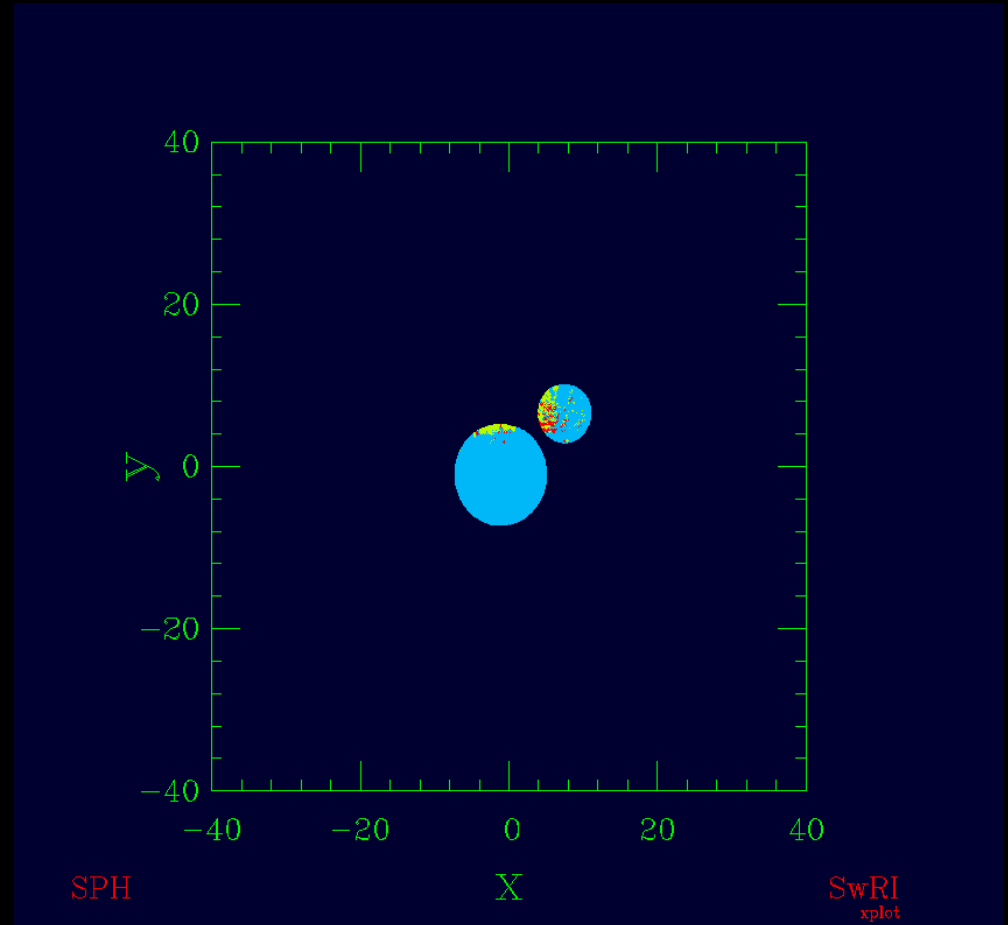
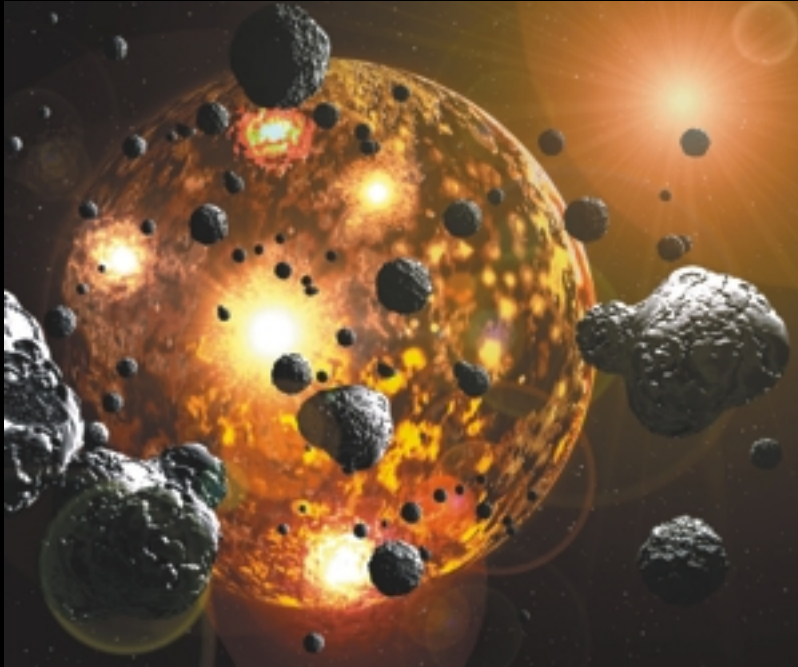


4515-4500 Ma



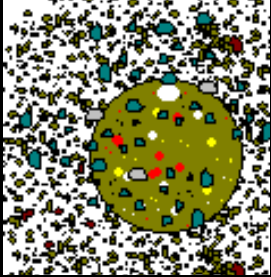
Moon formation for giant impact

~4500 Ma

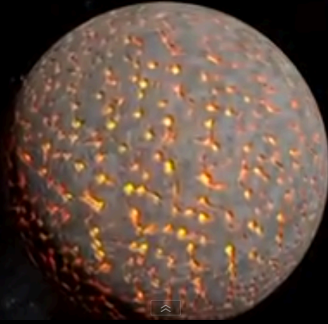


Robin Canup/Southwest Research Institute.

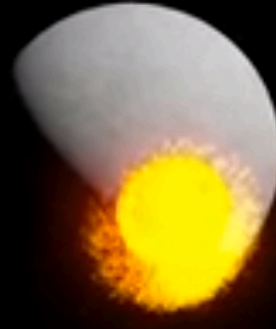
Relative ages of the moon surfaces



ca. 4,5 -4.3 Ga
accretion



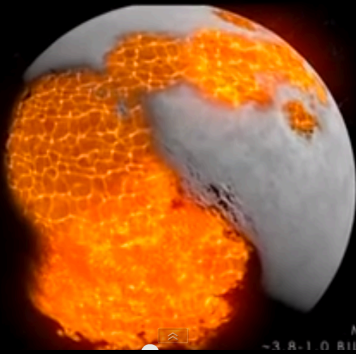
ca. 4.3 Ga



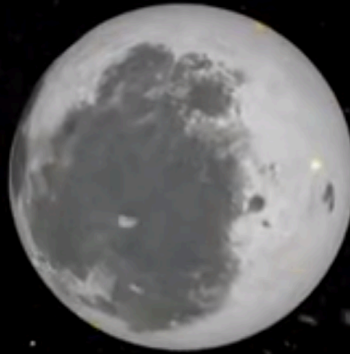
4,3 Ga
South-Pole-Aitken Basin.



ca. 4.1-3,8 Ga
Basin formation



ca. 3,8 – 1 Ga
Mare volcanism



ca. 1 Ga
Intermediate cratering

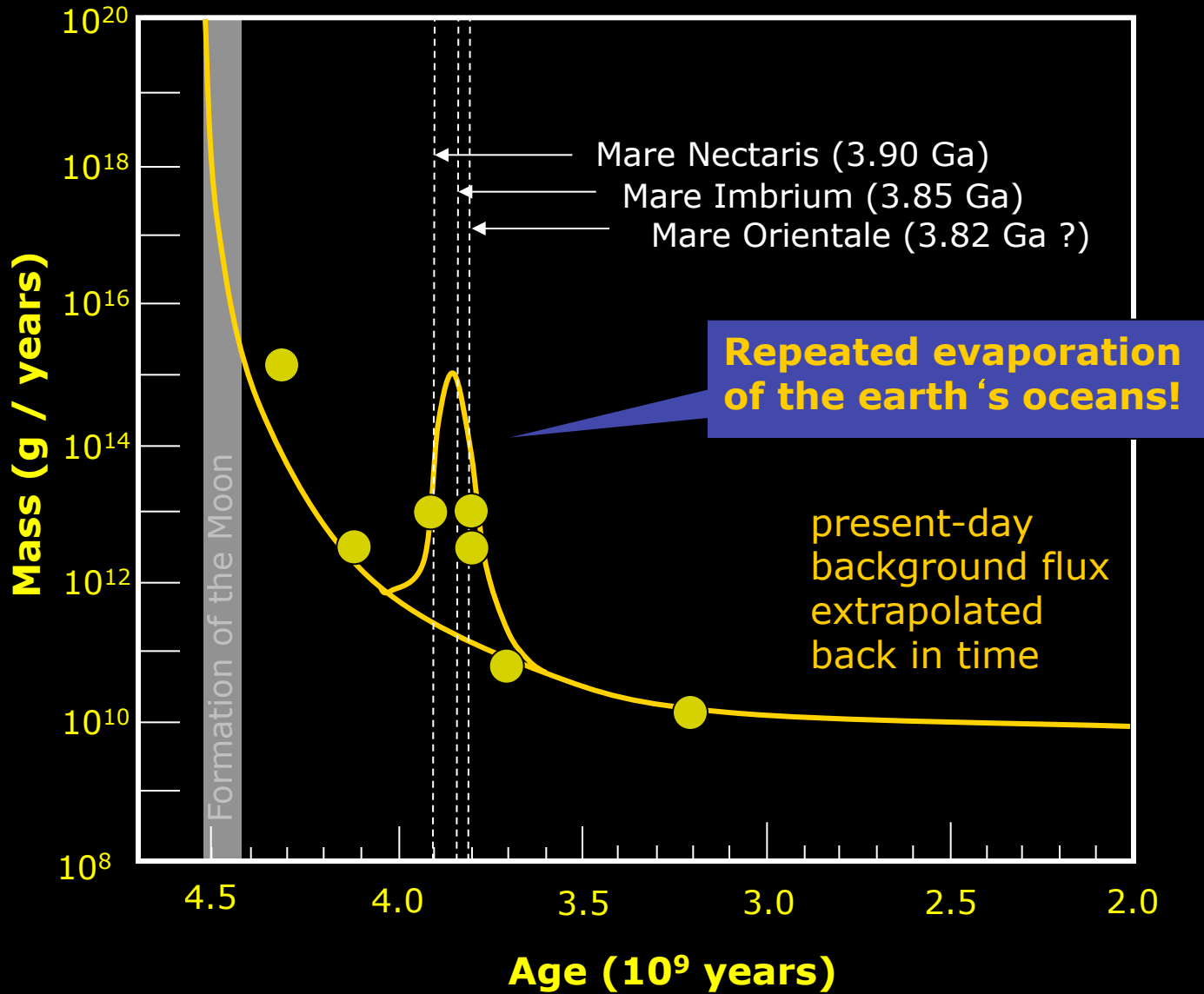


ca. 1 Ga - present
Ray crater

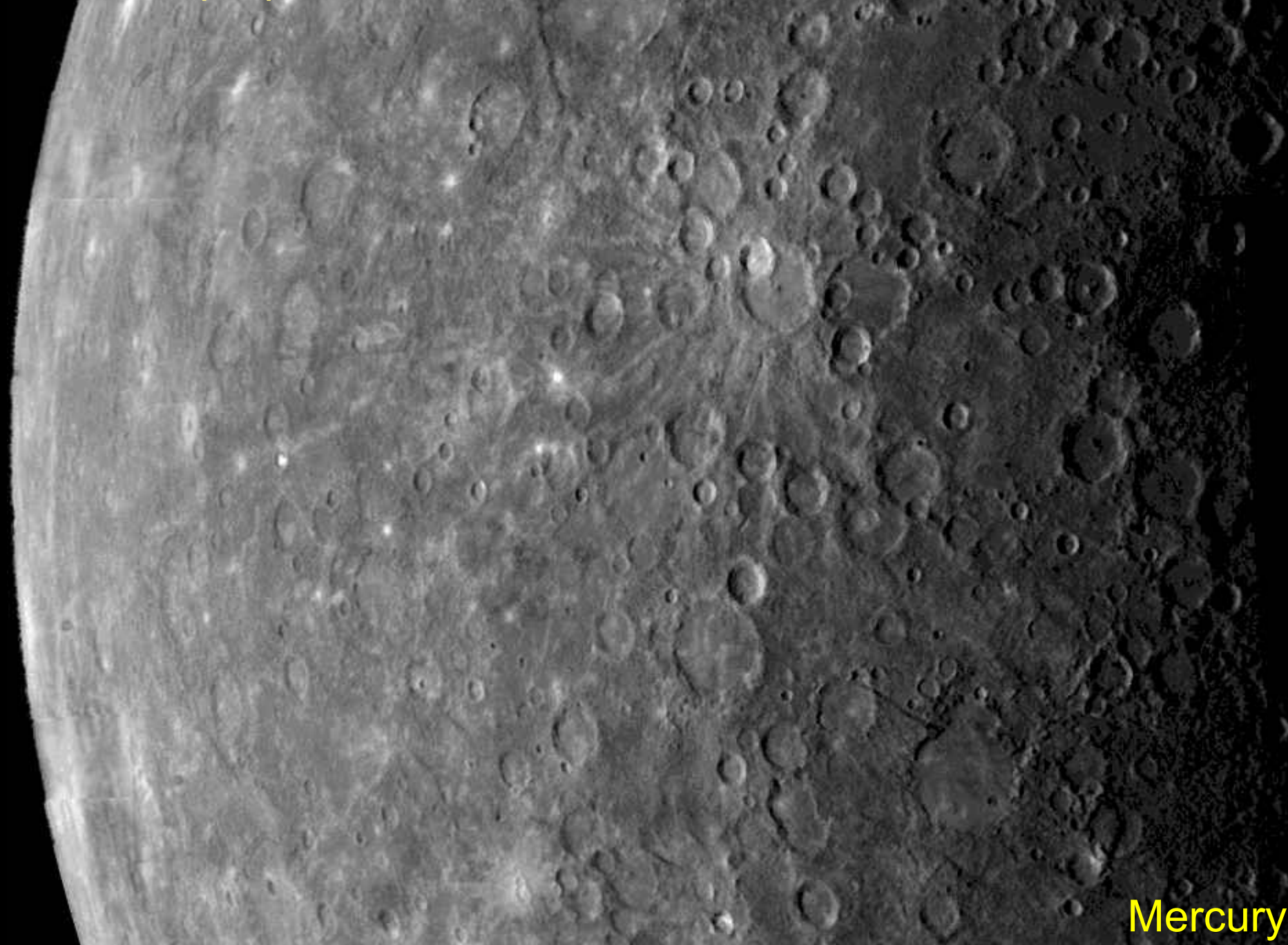
Introduction impact process SS * Atacama * Chile: Monturaqui Atacamaites Tunguska-like Future



The Late Heavy Bombardement

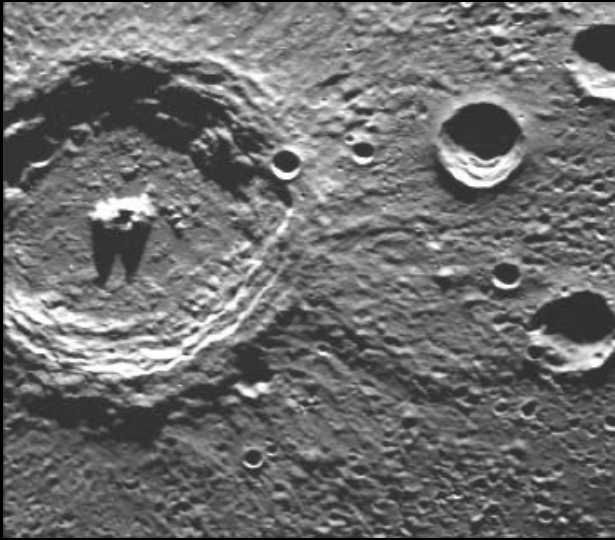


Introduction impact process SS * Atacama Chile Monturaqui Atacamaites Tunguska-like Future

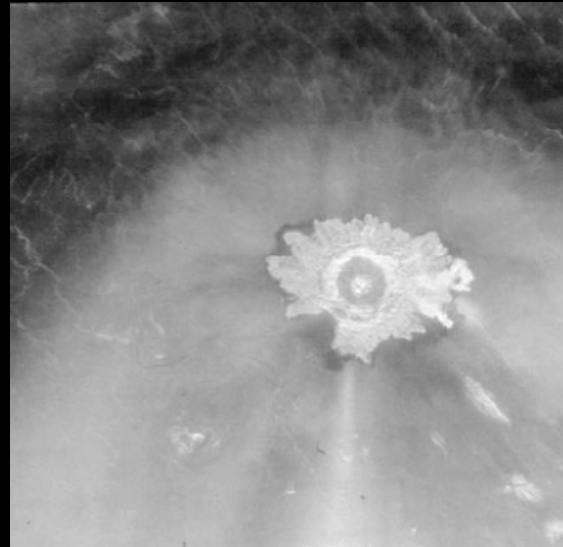


Mercury

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Mercury



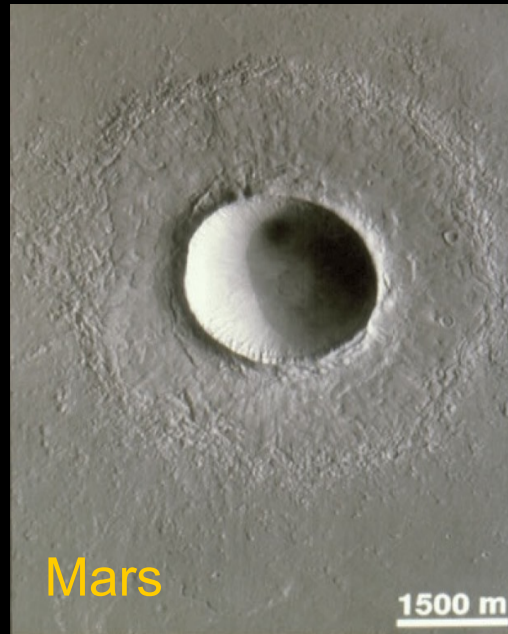
Venus



Moon



Earth



Mars

1500 m



Asteroids

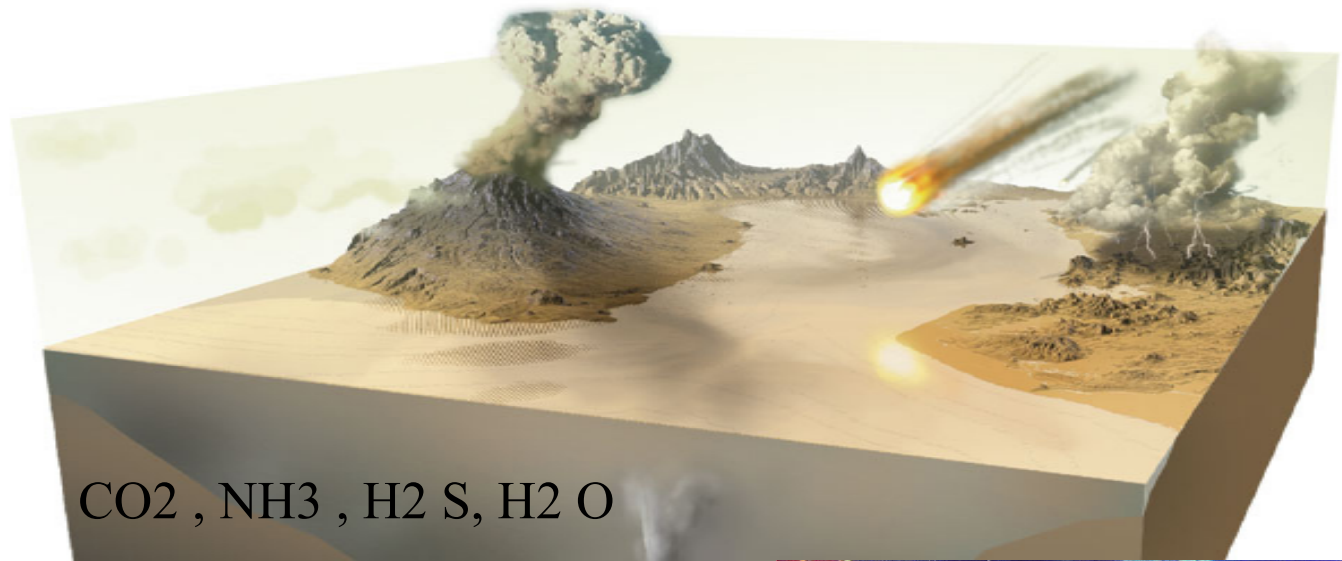
Comets and meteorites brought the building blocks for life



Impacts promote fracturing of rocks, generation of structures that can sustain life

... + planetary conditions

CO_2 , CO , N_2 , H_2S , H_2O , CH_4



CO_2 , NH_3 , H_2S , H_2O

Amino acids, nucleobases,
sugars, lipids, oligomers of
biochemical compounds

Lazcano, Natural History(Feb/2006)

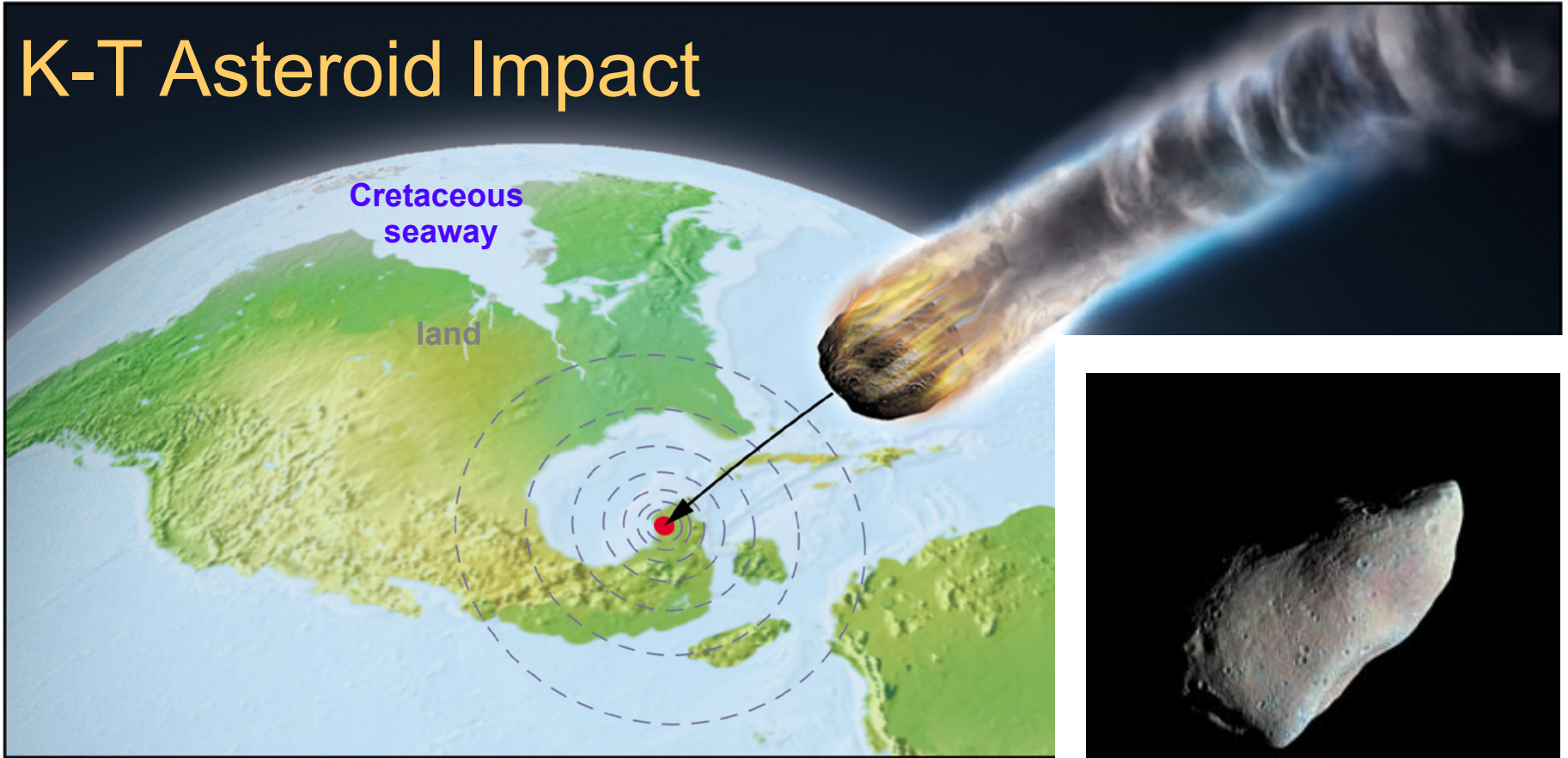


Black smokers



Extinctions

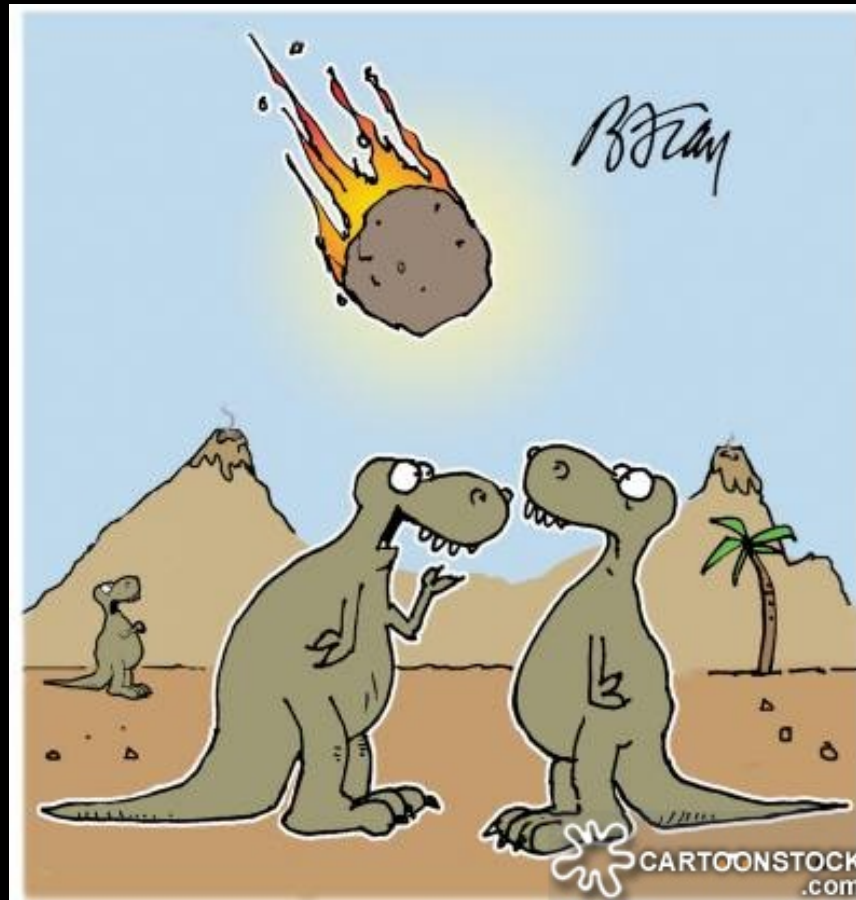
K-T Asteroid Impact



Chicxulub crater, Yucatan Peninsula
Gulf of Mexico

Asteroid Gaspra: 10 miles long
- the size of the Chicxulu impactor

**Massive extinctions!!!
(75% biomass on K-T boundary)**



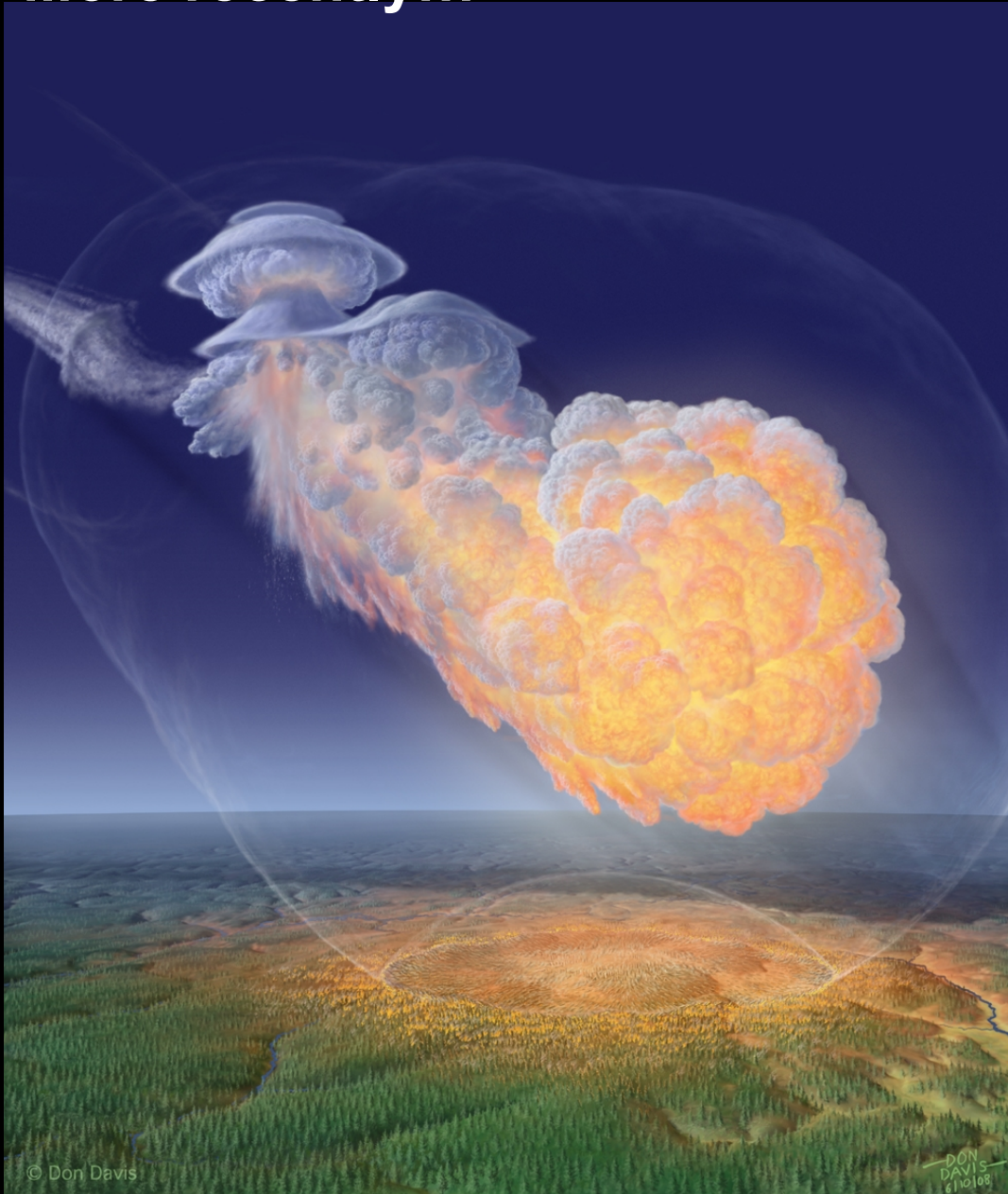
**"SO, NO MATTER HOW BAD THINGS
MAY LOOK, YOU JUST HAVE TO SAY
TO YOURSELF, 'HEY, IT'S NOT THE
END OF THE WORLD!'"**

More recently...

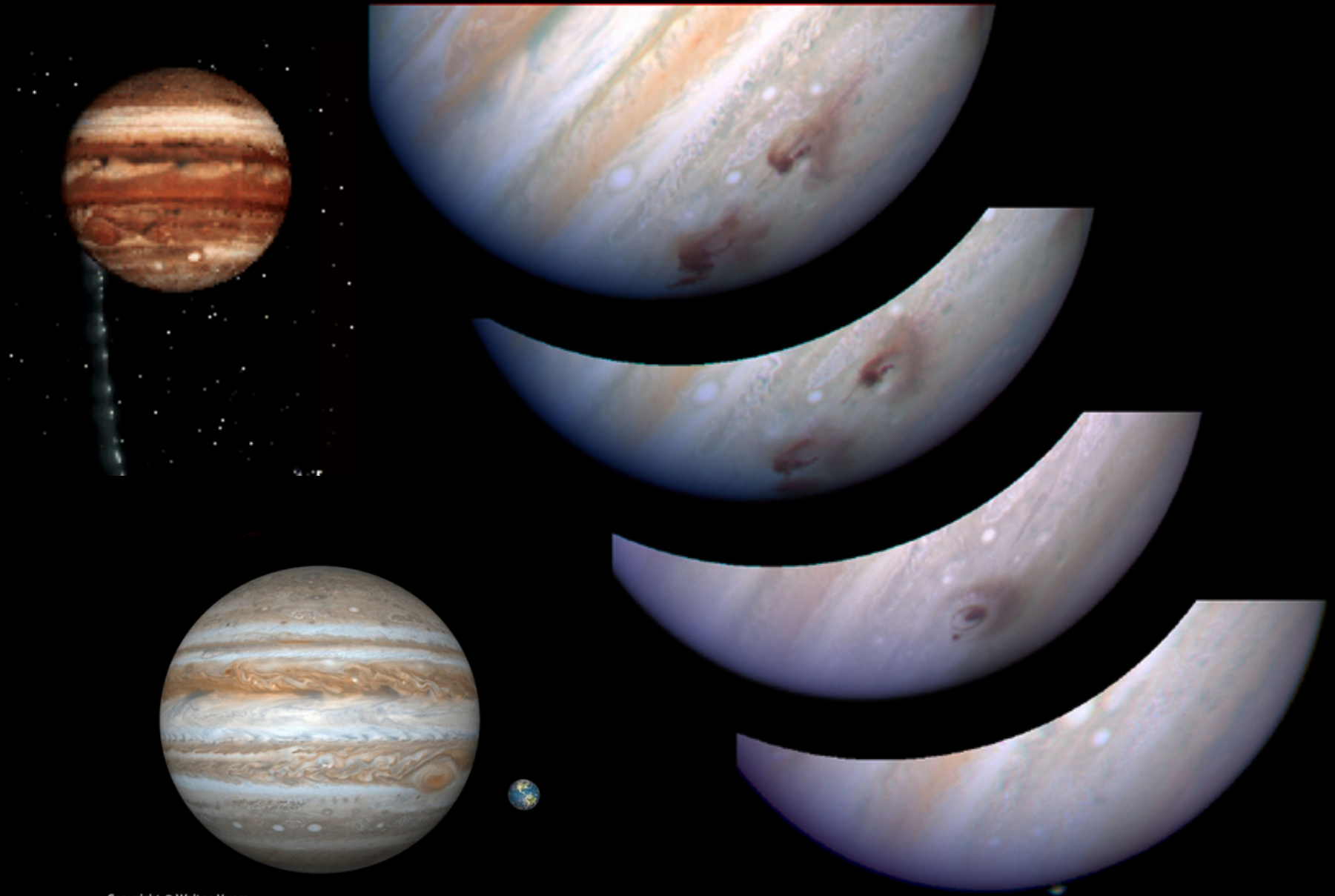
Tunguska, Siberia (30/06/1908)



Object 20-30 m diameter
Exploded in the air
Released energy ~ 10 MT
Observed over all Europe and
recorded by sismometers
Knock down trees over 2000 km²
Fires



Impact of Comet Shoemaker Levy 9 in Jupiter on 1994

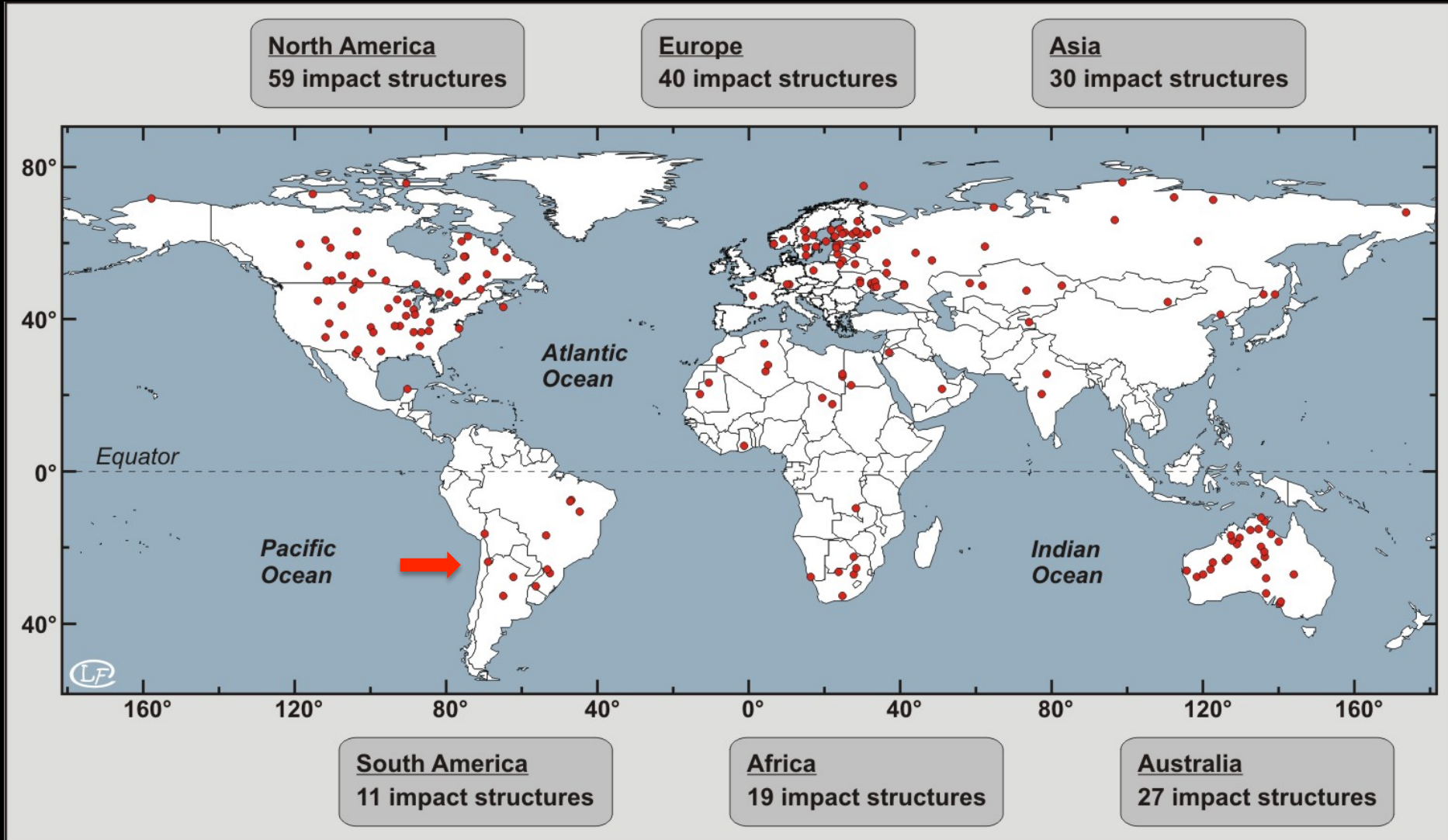


Chelyabinsk airburst and fall, Russia, February 2013



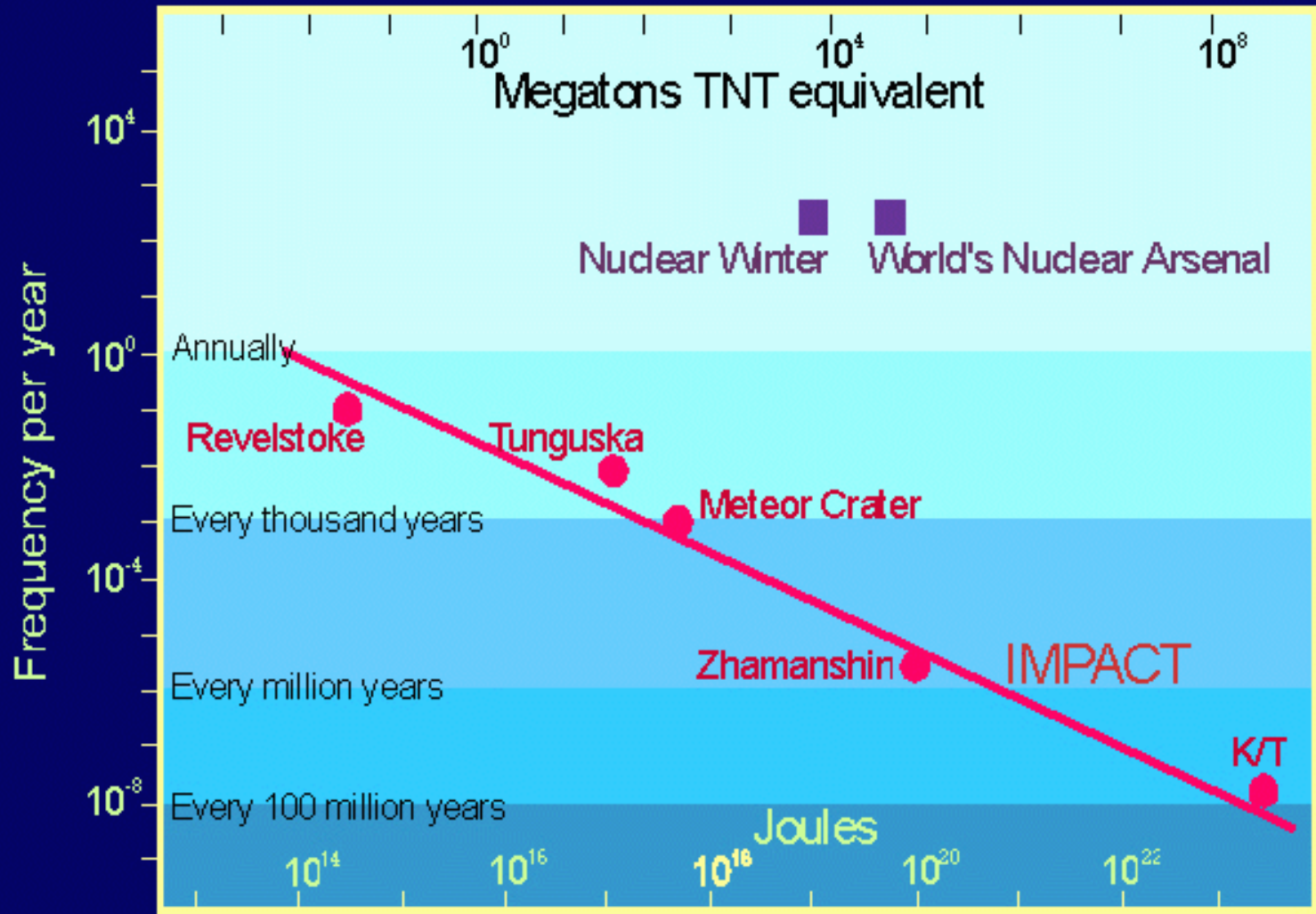
Object 20m diameter exploded in the air
generating a shock wave that made explode
windows (+ de 1000 ople injured)
Released energy ~ 500 kT
Biggest meteorite found: 650 ton
- Ordinary chondrite

Earth



~ 186 proven craters

Earth





Flux of Extraterrestrial
material to Earth
 $10^4 - 10^7$ ton/año

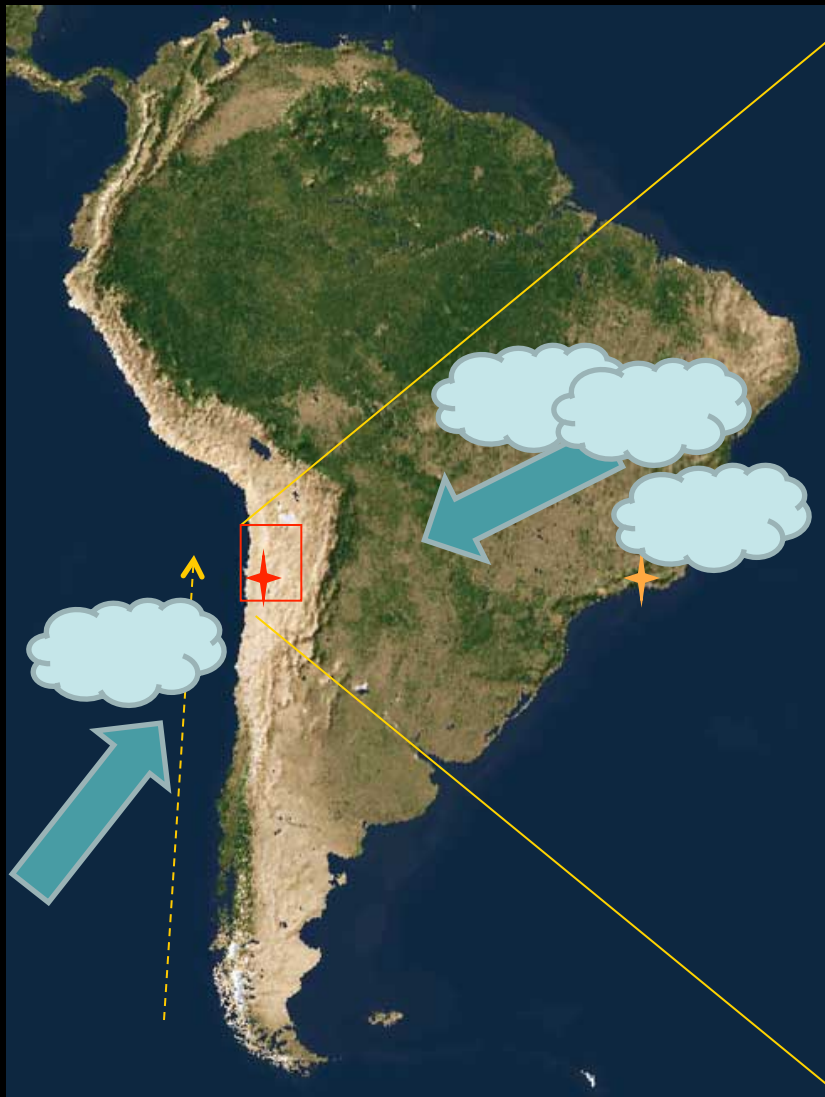
Just 1% of that
material is recoverable

Random fall

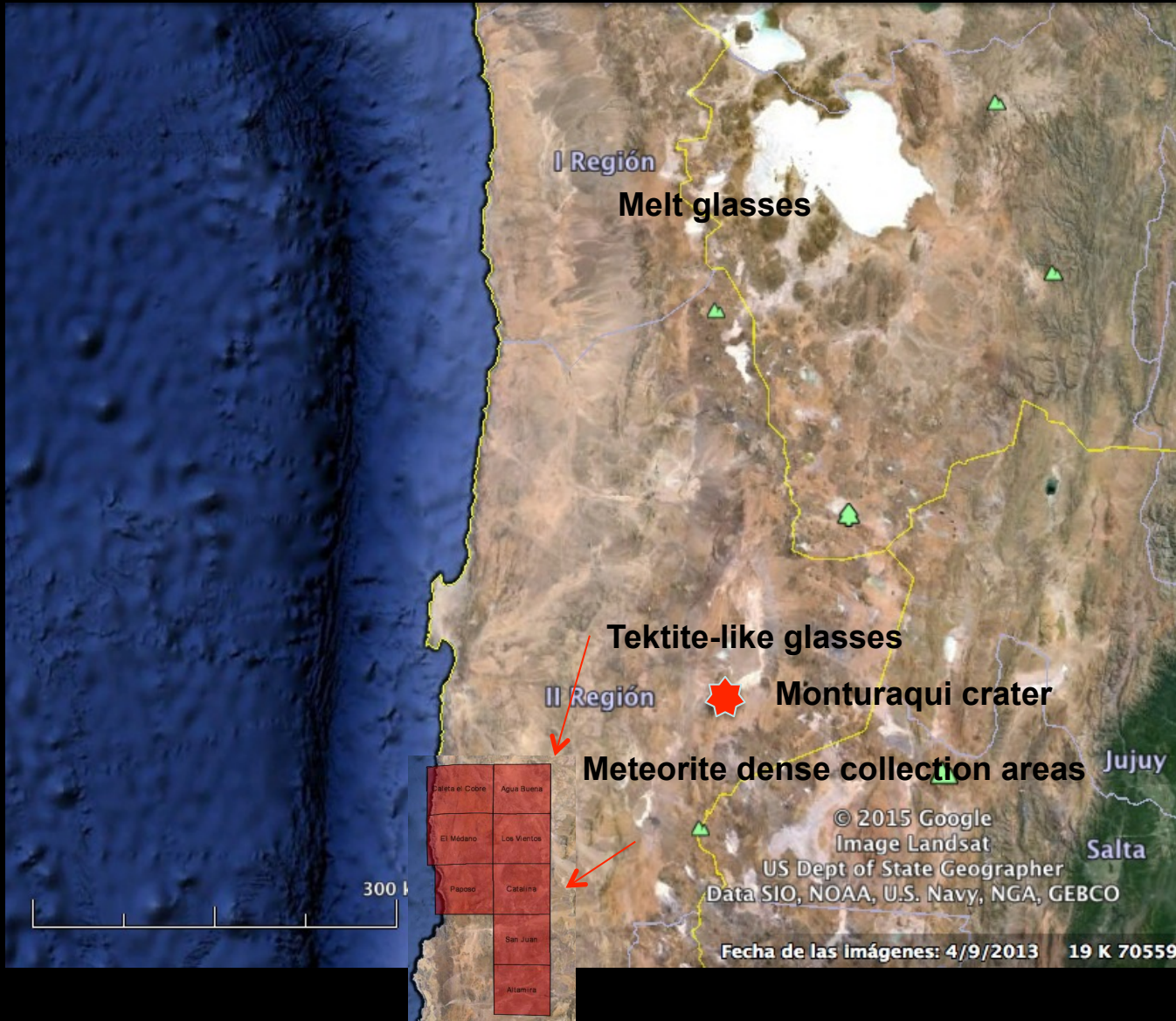
Preferential accumulation

in deserts

The aridest desert in the world: ATACAMA



Location



10 years of findings!
From 60 meteorites
in the chilean collision
to more than 600

Monturaqui Crater



South of Atacama Salar (II región)
Descubierto en 1966 (Sanchez y Cassidy)
Edad: 600.000 años
Diámetro (km): 0.46
Meteorito impactor corresponde a un siderito del tipo Octahedrita IAB

Expedición Diciembre 2003
U de Chile – U. De Toronto



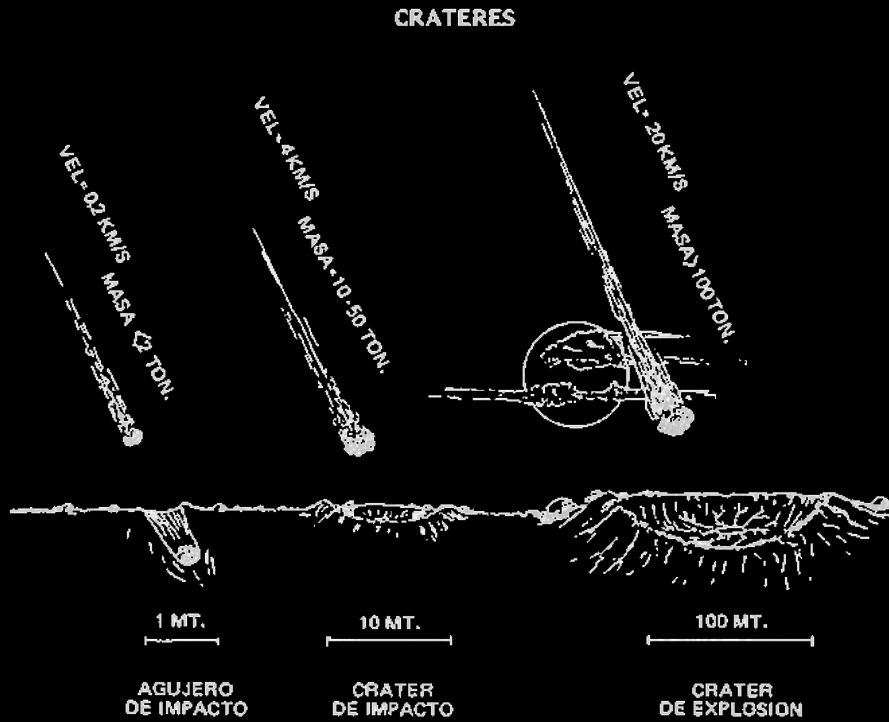
Now trying to presented as a Natural Monument to protect it
Personally I'd like a planetary sciences educational station there!
(Need sponsors!!)

Case: Meteor (or Barringer) Crater, Arizona

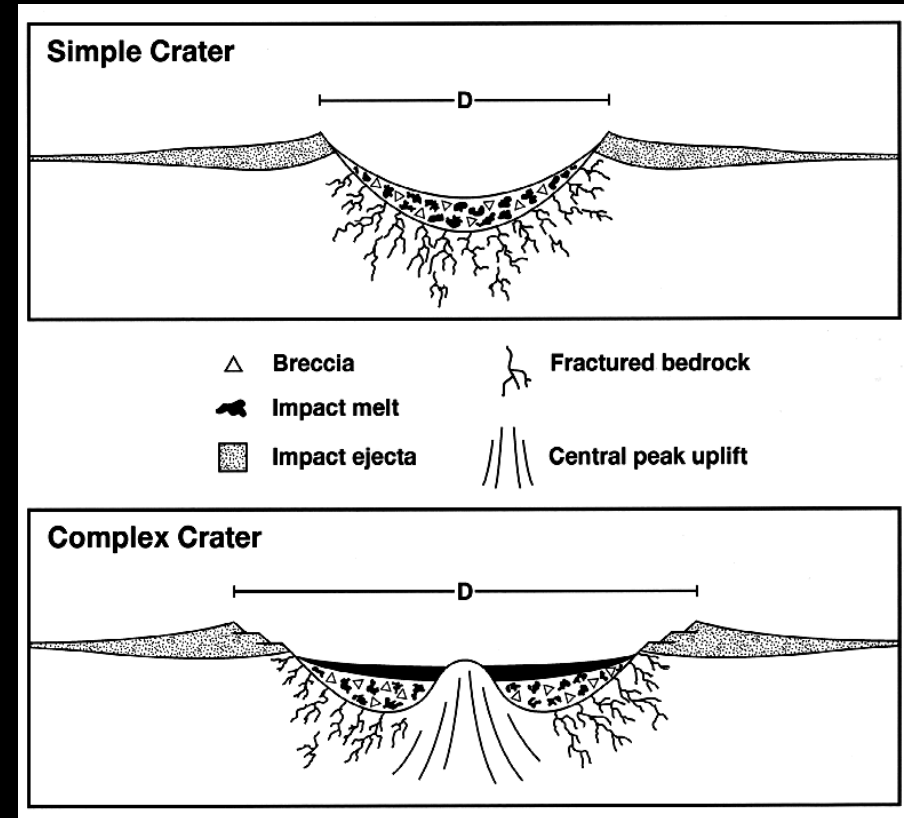


And its interactive Visitor Center





www.museodelmeteorito.cl



French 2008



www.museodelmeteorito.cl

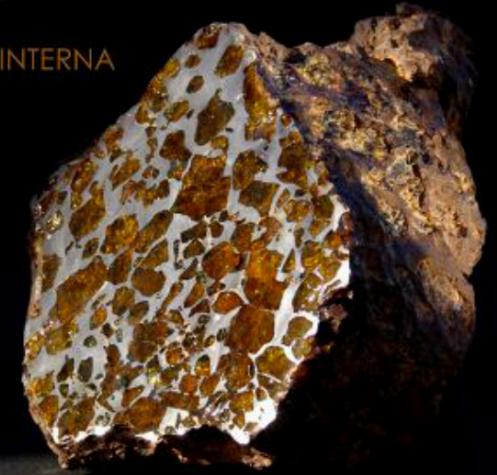
Crater Imilac (II región – 1820 aprox)

Diametro/profundidad: 15m / 4m

Edad: ?

Meteorito impactor corresponde a un mesosiderito del tipo Palasita

IMILAC
PALASITA
MATRIZ INTERNA





www.museodelmeteorito.cl

VACA MUERTA
MESOSIDERITO
CRISTALES DE OLIVINO



Cráteres Vaca Muerta (II región - 1861)

Diámetro/profundidad: 9,3 a 7,2 m / 1 a 2 m

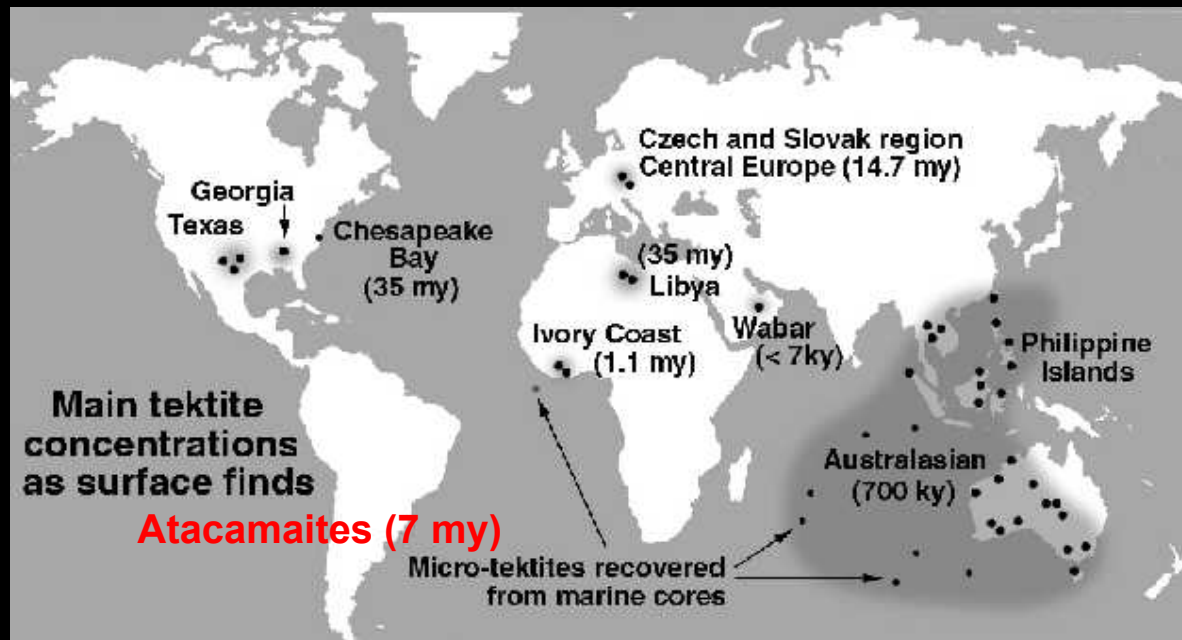
Edad: ?

Meteorito impactor corresponde a un mesosiderito

Discovery of melt glasses with aerodynamical form → possible tektite-like ejecta or impact glasses (~7 My)



New tektite field? Proposed name ATACAMAITES

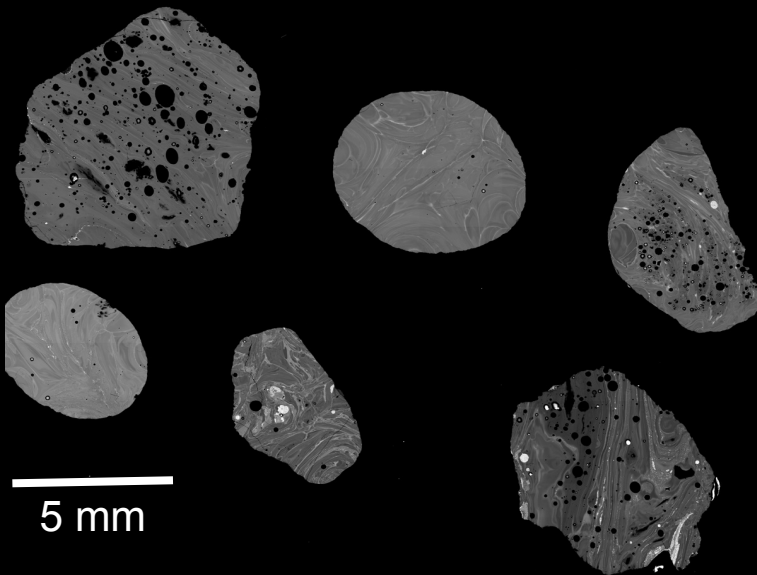


Atacamaites



No crater identified yet

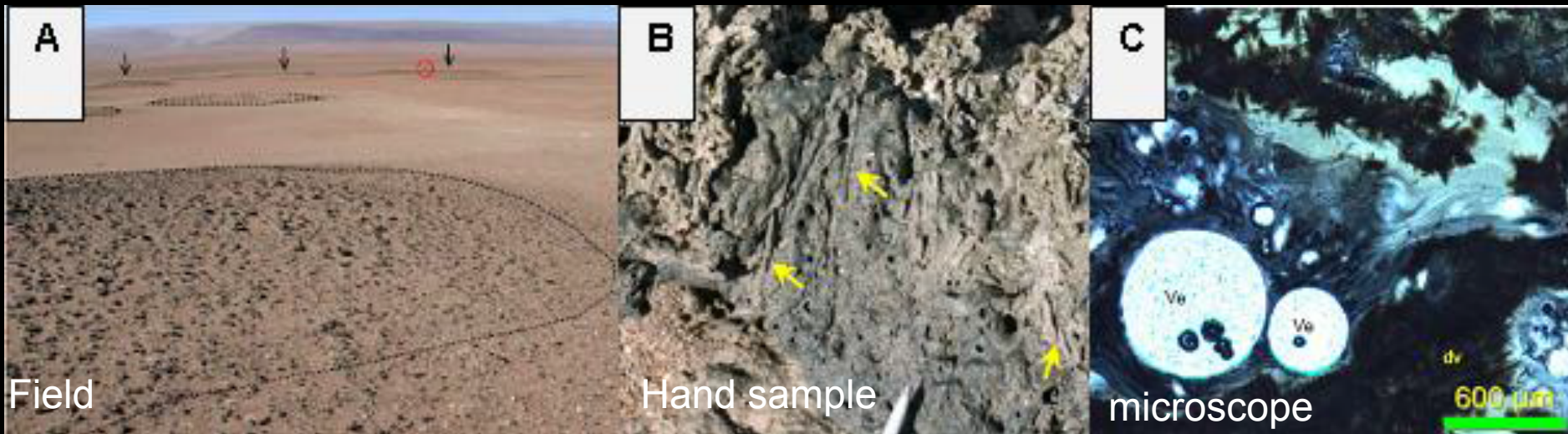
**(can be covered by sediments,
lavas etc)**



Discovery of impact ? glasses

- During mapping of a regional chart, two senior geologists from the Chilean Geological Service discovered in 2011 patchy deposits of glasses, total extension of 60 km, in the vicinity of the Andes precordillera. Baked red soils deposits were also found associated with them, but not displayed in all the localities.





Melt glasses found in northern Chile:
To do glasses → high T° and quick cooling

possible origins:



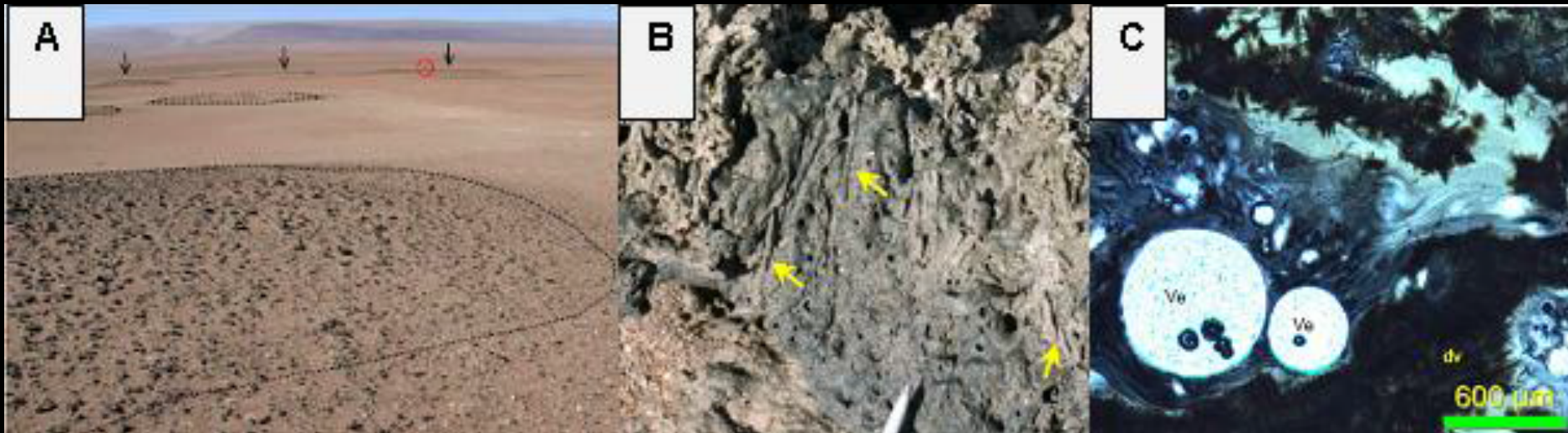
Fulgurites

Volcanic activity

Human slags

Airburst





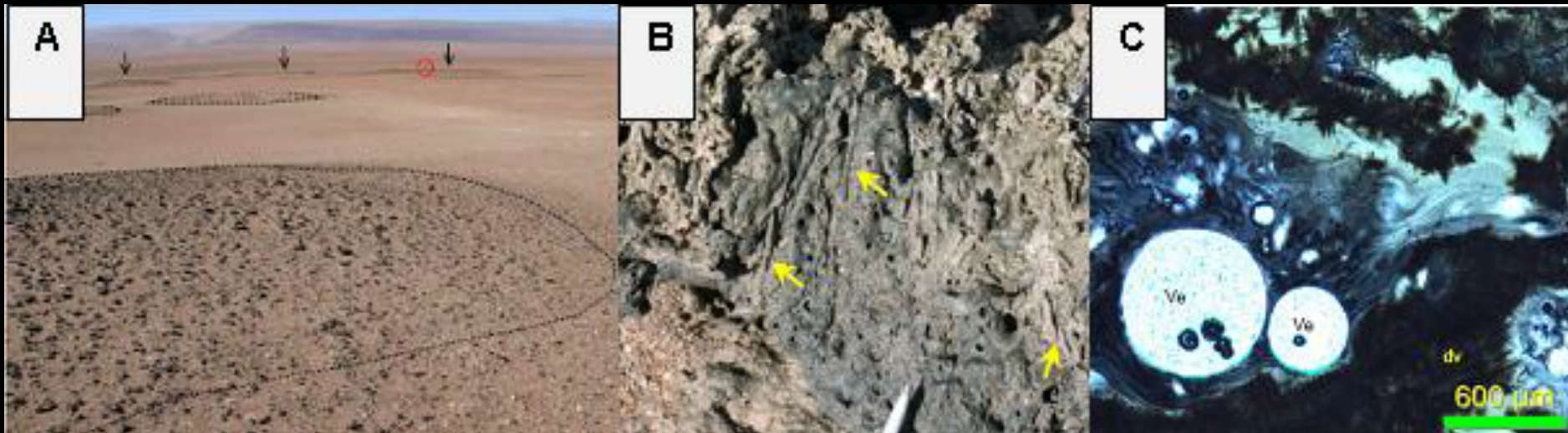
Melt glasses found in northern Chile:
To do glasses → high T° and quick cooling
possible origins:



Fulgurites
Volcanic activity
Human slags
Airburst



Volcanic range
at 70 km to E
Ruled out by
geological
observations



Melt glasses found in northern Chile:
To do glasses → high T° and quick cooling

possible origins:

Fulgurites

Volcanic activity

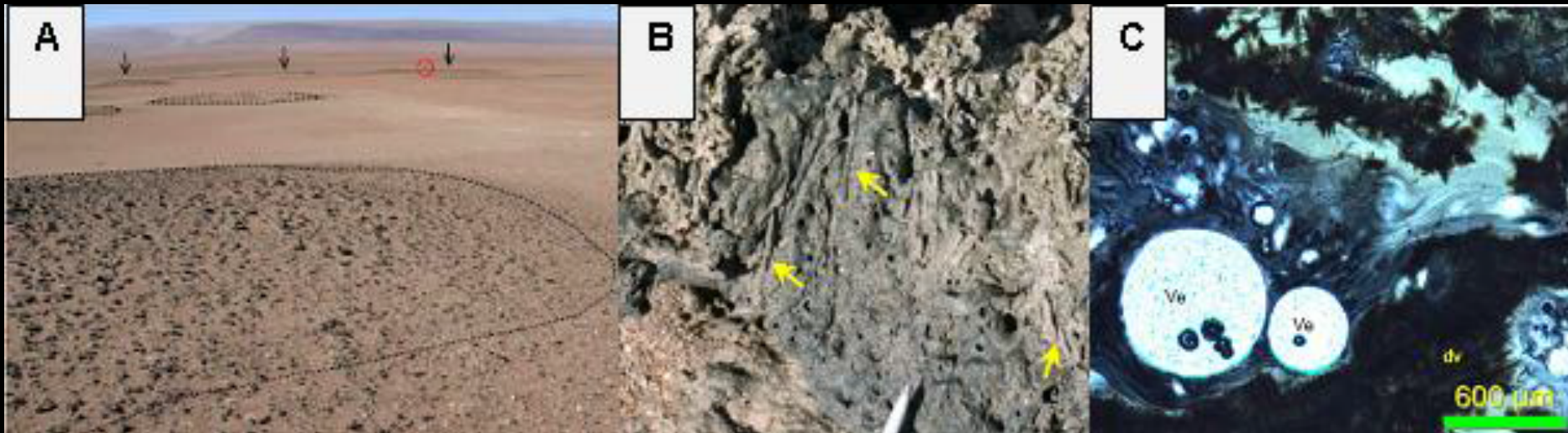


Human slags



Airburst

No vestiges of such
kind of human activity
in this area



Melt glasses found in northern Chile:
To do glasses → high T° and quick cooling

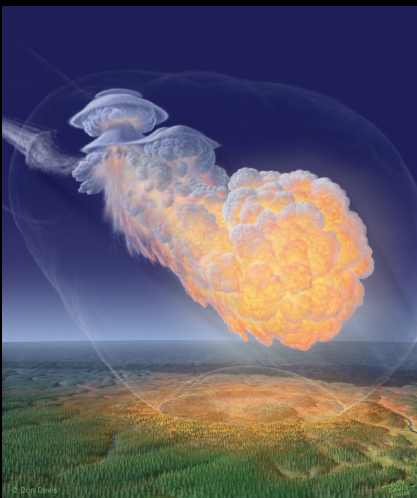
possible origins:

Fulgurites

Volcanic activity

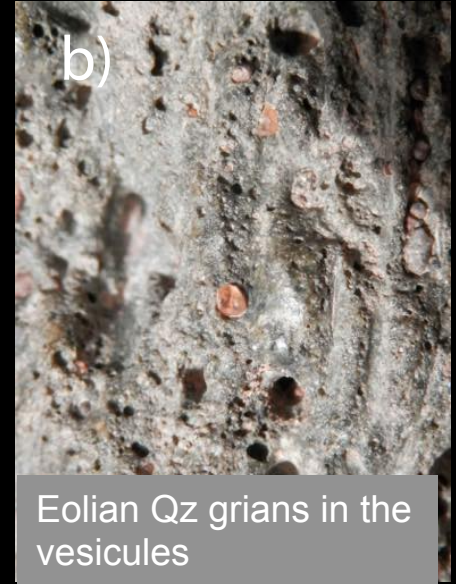
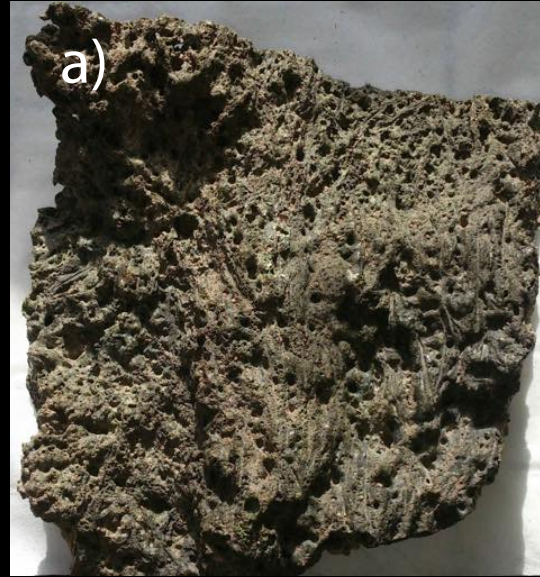
Human slags

Airburst



Preliminary results: hand samples

Transition from sandy bottom to pure green glass to the surface



Eolian Qz grains in the vesicles

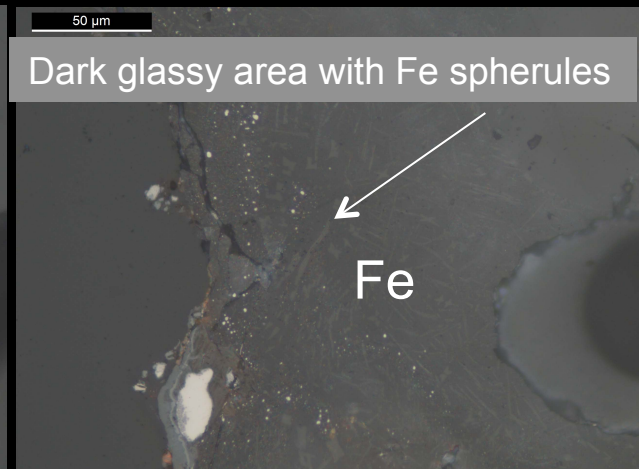
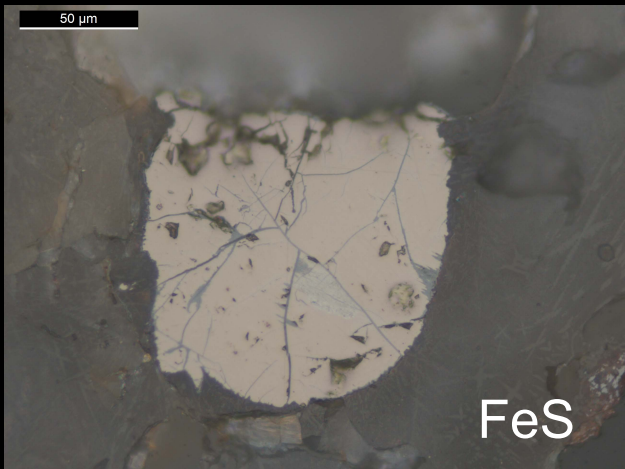
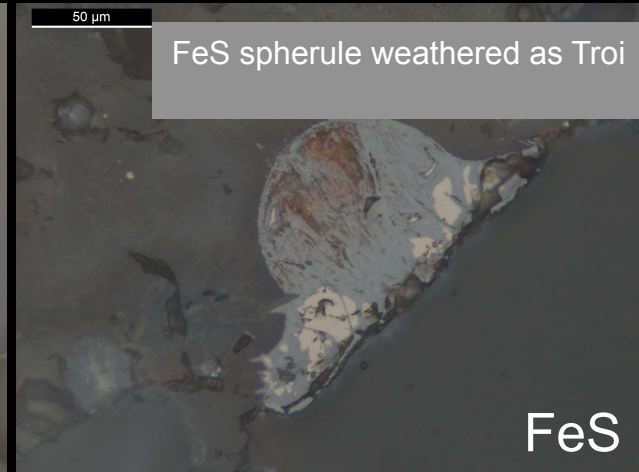
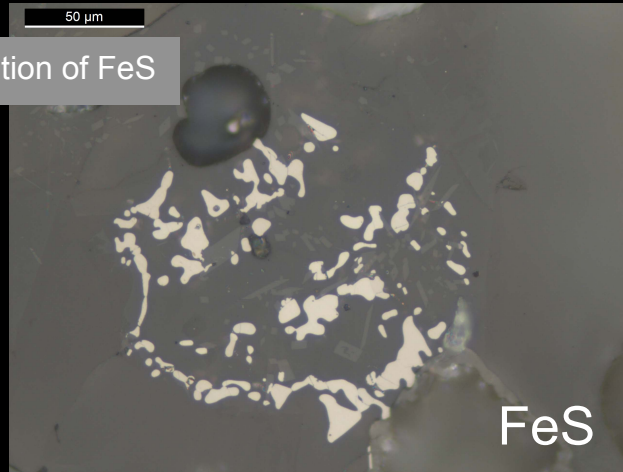
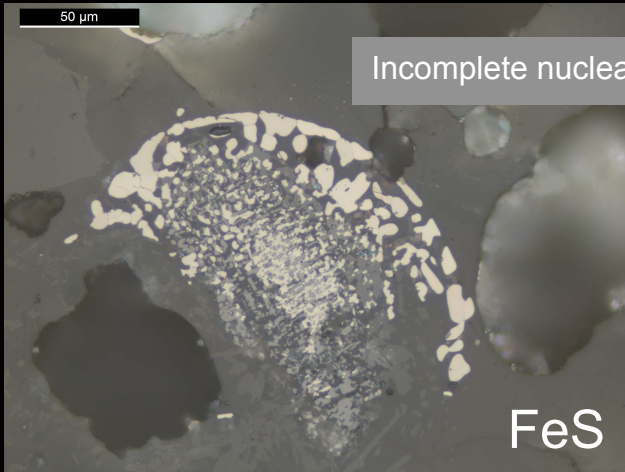


Baked soils



Plants inside the glasses

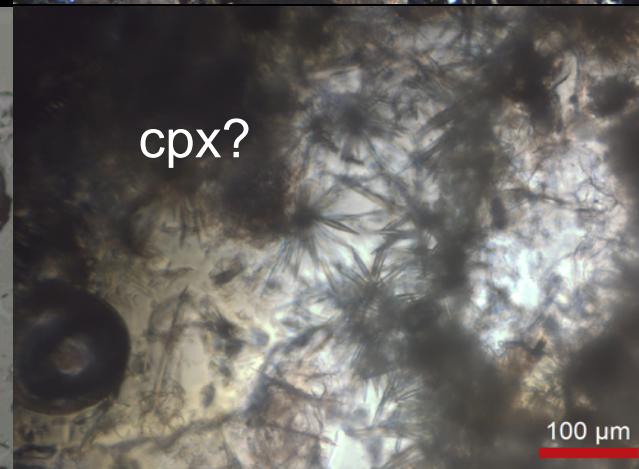
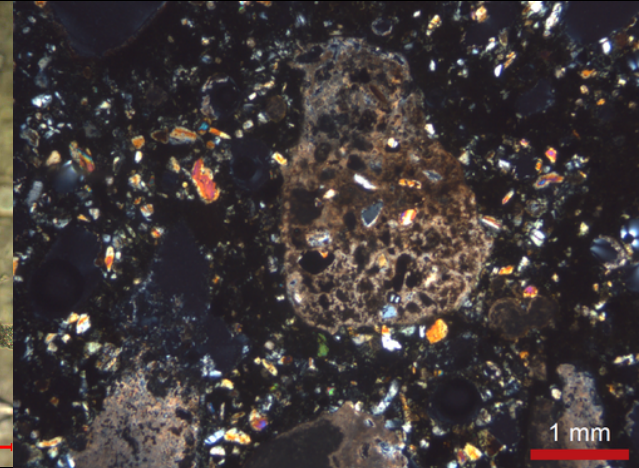
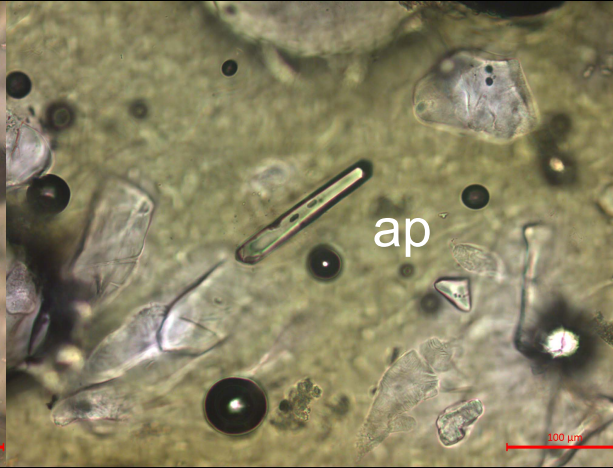
Opaques: iron sulphides, magnetite, phosphides, Fe, chromite



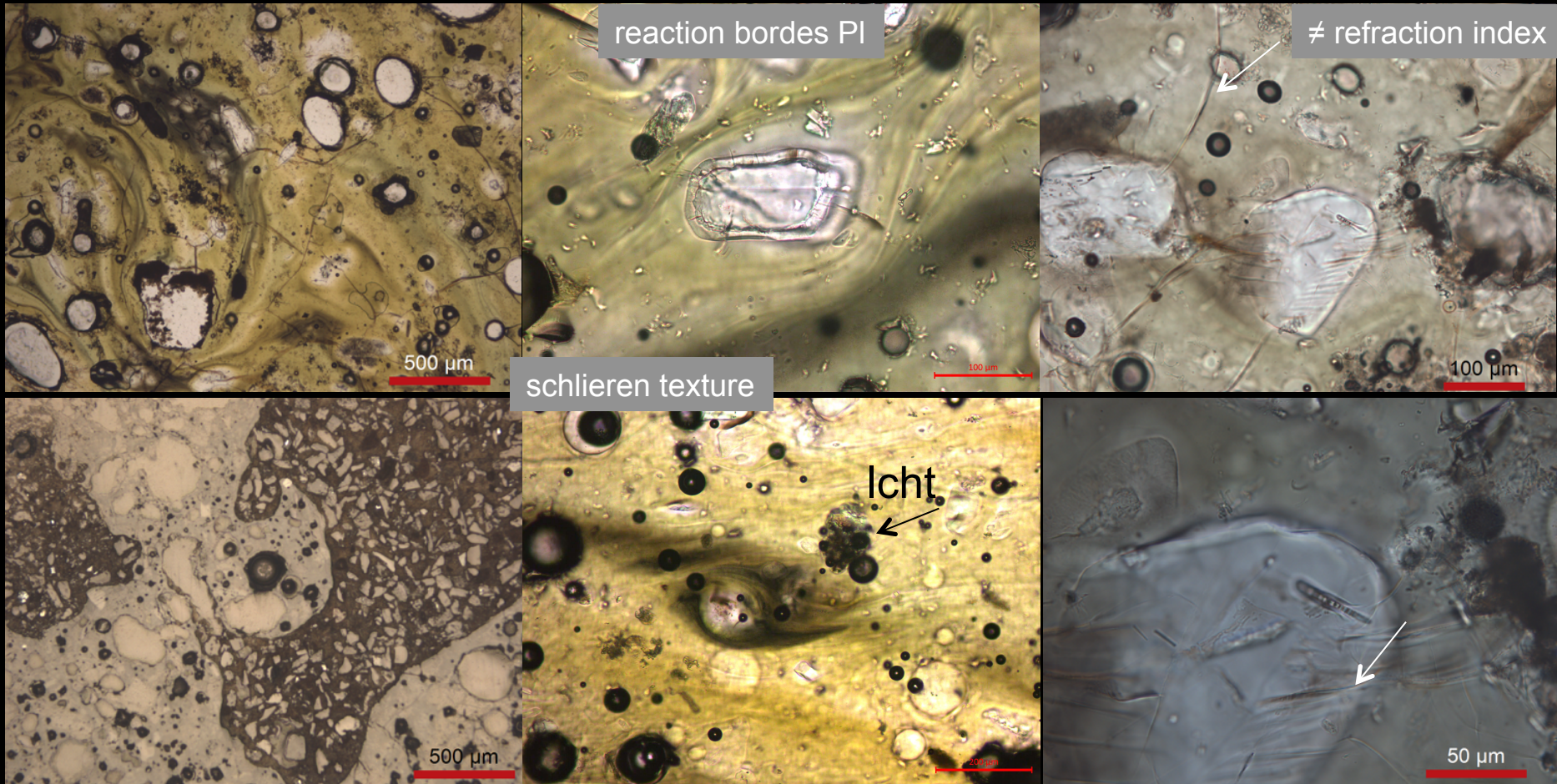
Magnetite often part of the breccia clast, or the cement. FeS and FeP developed in the borders of vesicules

Minerals: Relicts fragm crystals (from target deposit): plag + qzo + px + anf + K-Fd + Ti + ap + zir

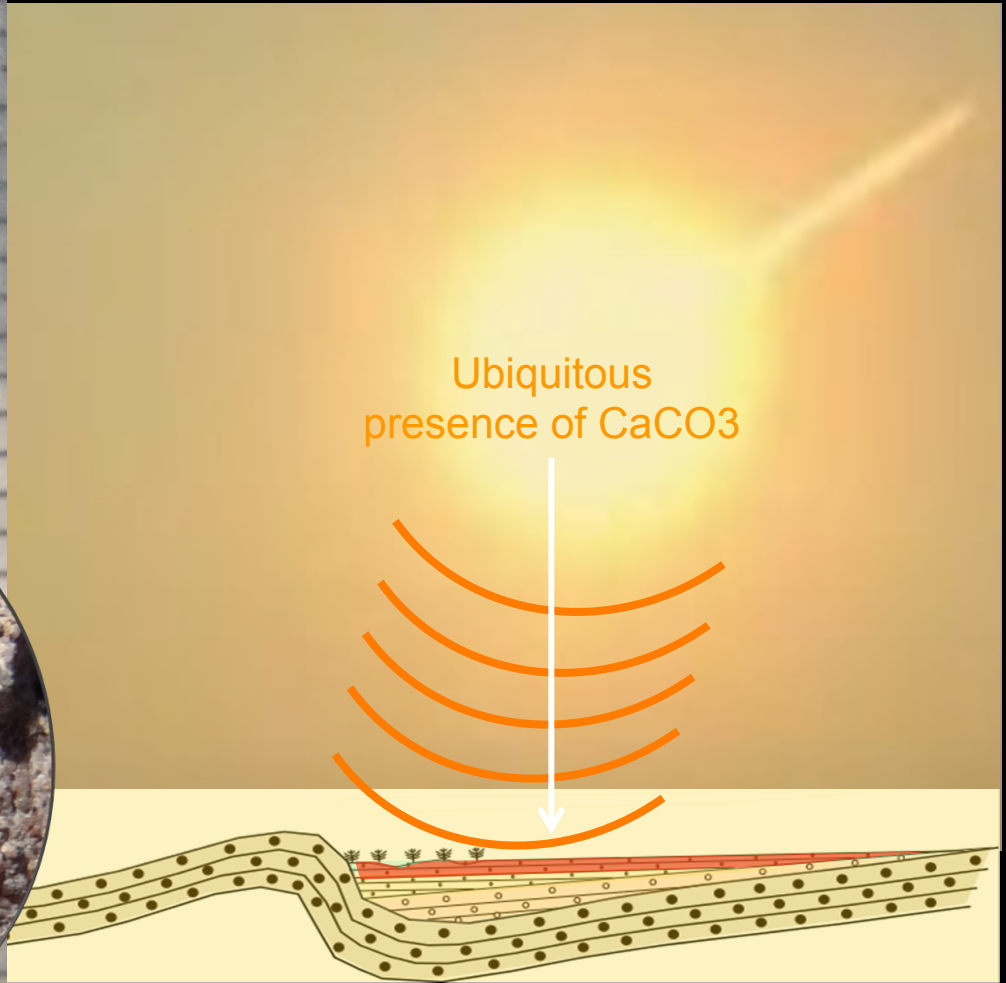
Neoformed: diaplectic glass: lechatelierite + melilite crystalites



Others: Fluid texture in the glass, reaction borders in relict grains, different refraction indexes in the glass, presence of breccia fragments with fractured crystals (suevite?), planar fractures in some crystals.



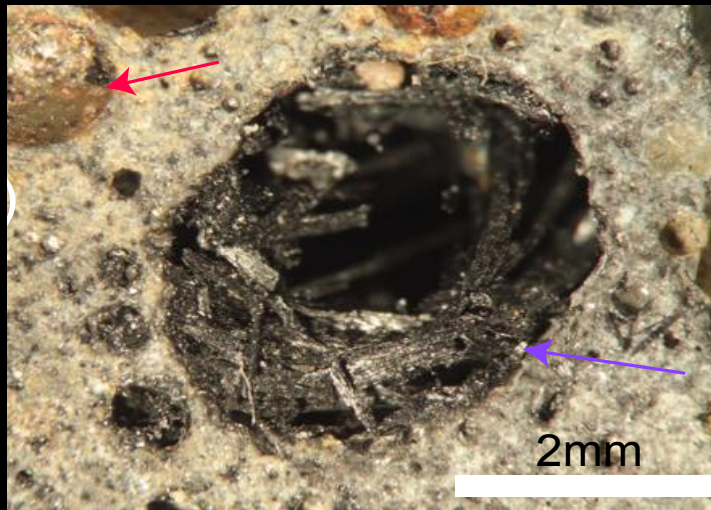
Possible modele to explain distribution glasses



Geology, mineralogy needed to put constraints

The astrobiology perspective of these studies

Plants inside the glasses



Geology, published online on 15 April 2014 as doi:10.1130/G35343.1

Preserved flora and organics in impact melt breccias

P.H. Schultz^{1*}, R. Scott Harris², S.J. Clemett³, K.L. Thomas-Keprta³, and M. Zárate⁴

Similar glasses found in Argentina
at different layers → different ages

Conditions to preserve organic material:
ultra-high T° (>1500°C) + rapid quenching

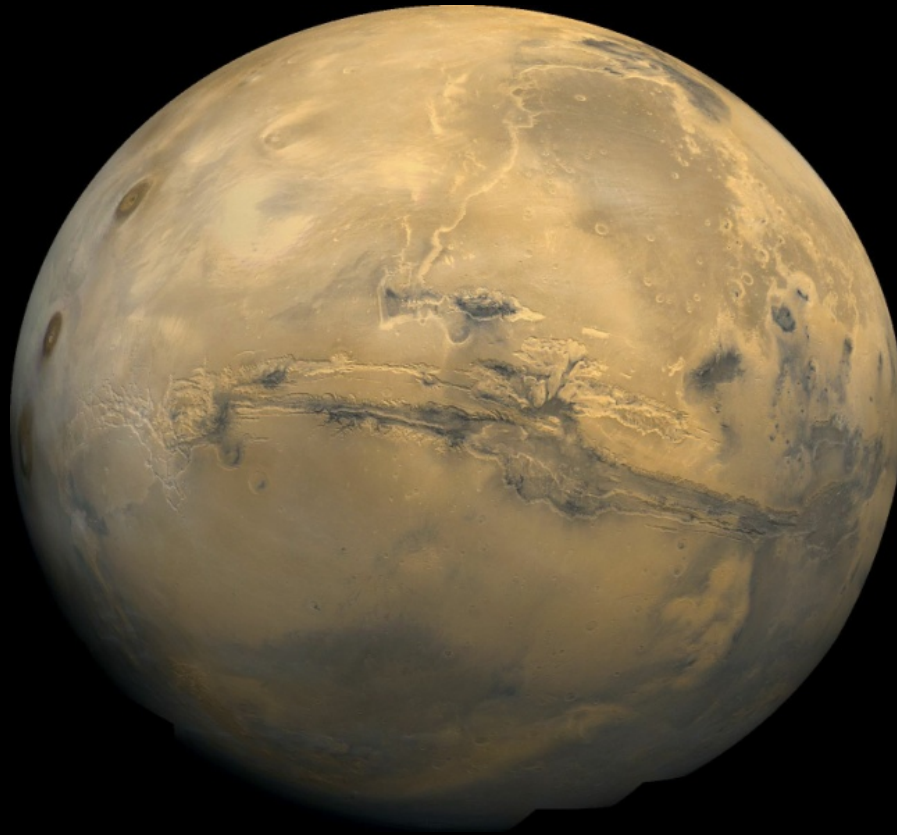
Little animals associated to that layer



Under study now (field trip just 2 weeks ago)

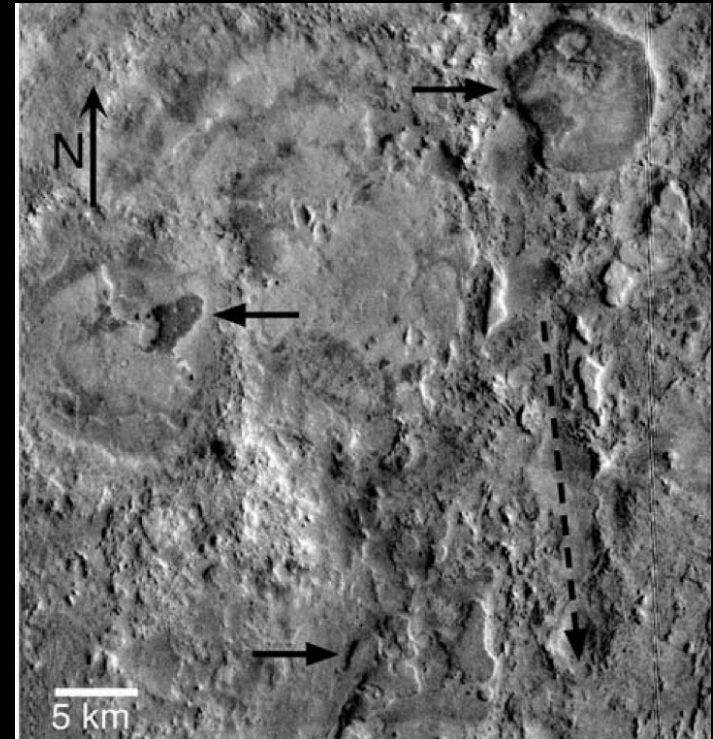
- Ages (14C)
- Petrology
- Paleomagnetic measurements

The astrobiology perspective of these studies



New targets to look for life in Mars!

Because the target rocks are compared to sediments on Earth that generate melt glasses



Impact melts and glasses on Mars

Peter H. Schultz and John F. Mustard

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 109, E01001, doi:10.1029/2002JE002025, 2004

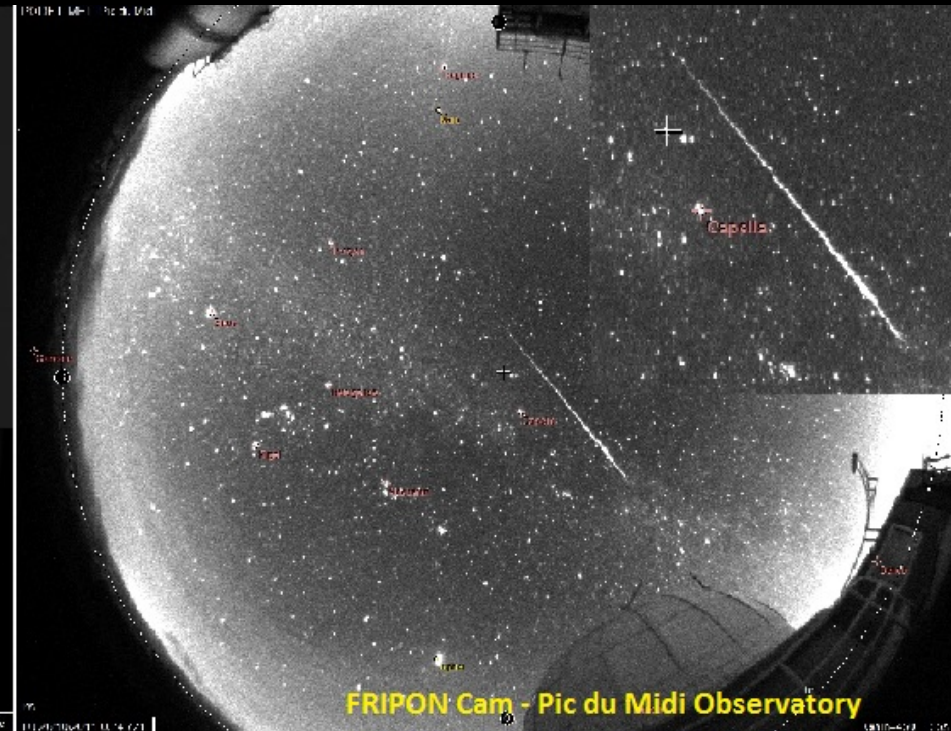
FRIPON CHILE



Fireball Recovery and InterPlanetary Observation Network

Initiative to connect meteorites with their parent bodies, and study impact related hazards

Unidad de Astronomía
Universidad de Antofagasta



collaborations

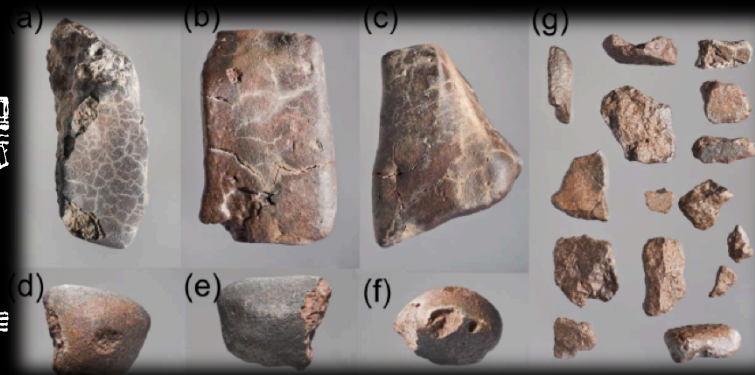
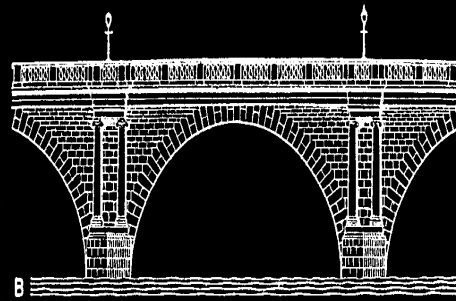


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Future Group of Meteorites and Planetary Sciences of the Sociedad Geológica de Chile

The bridge between asteroid
belt and terrestrial
meteorites



Gracias por su atención