FOSSIL PLANT REMAINS PRESERVED AS CHARCOAL WITHIN PROXIMAL EJECTA BLANKETS OF IMPACT CRATERS

wildFIRE lab

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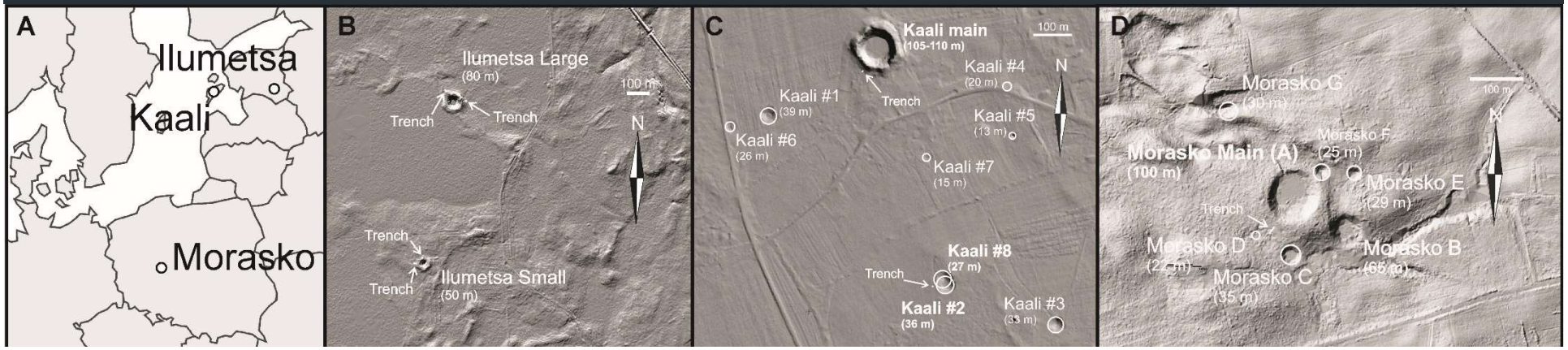

Plenty of impact craters in Solar System

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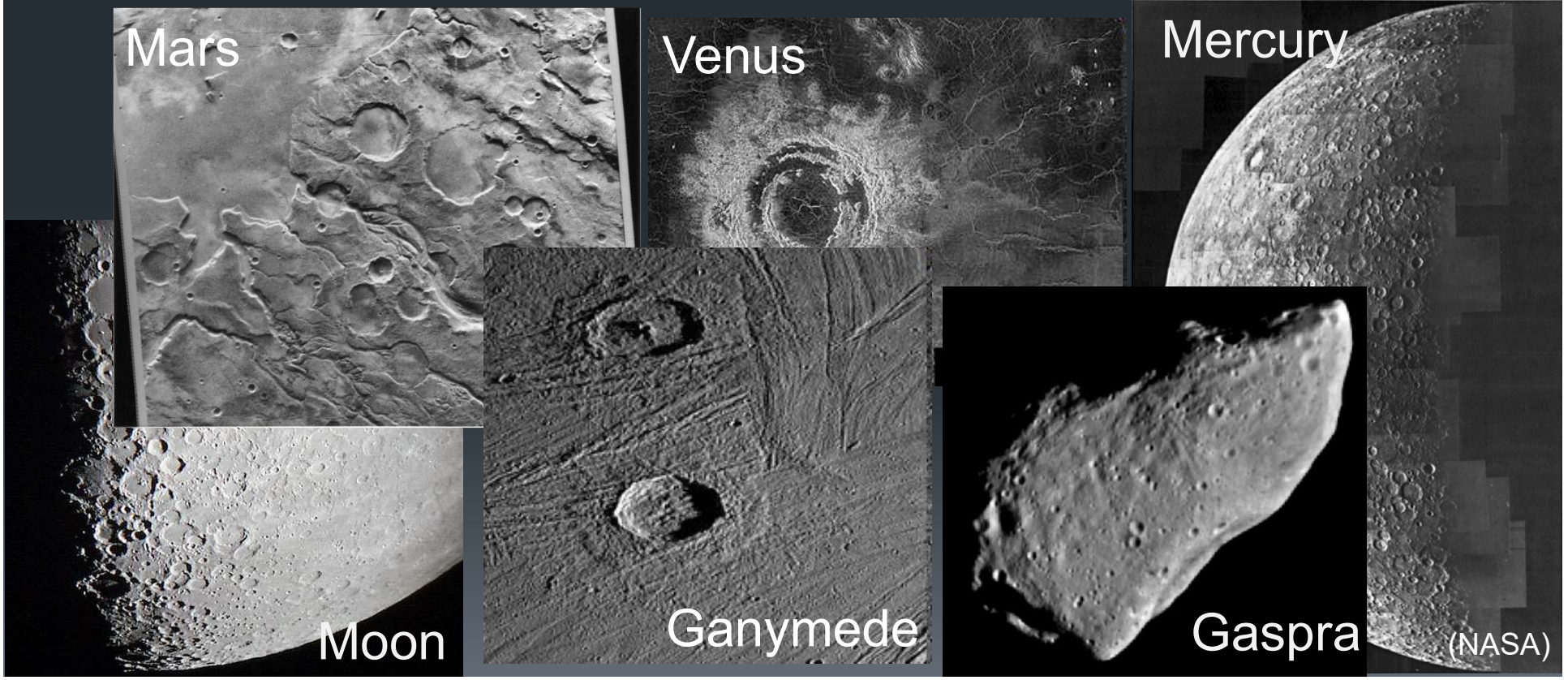

~200 Impact craters on Earth

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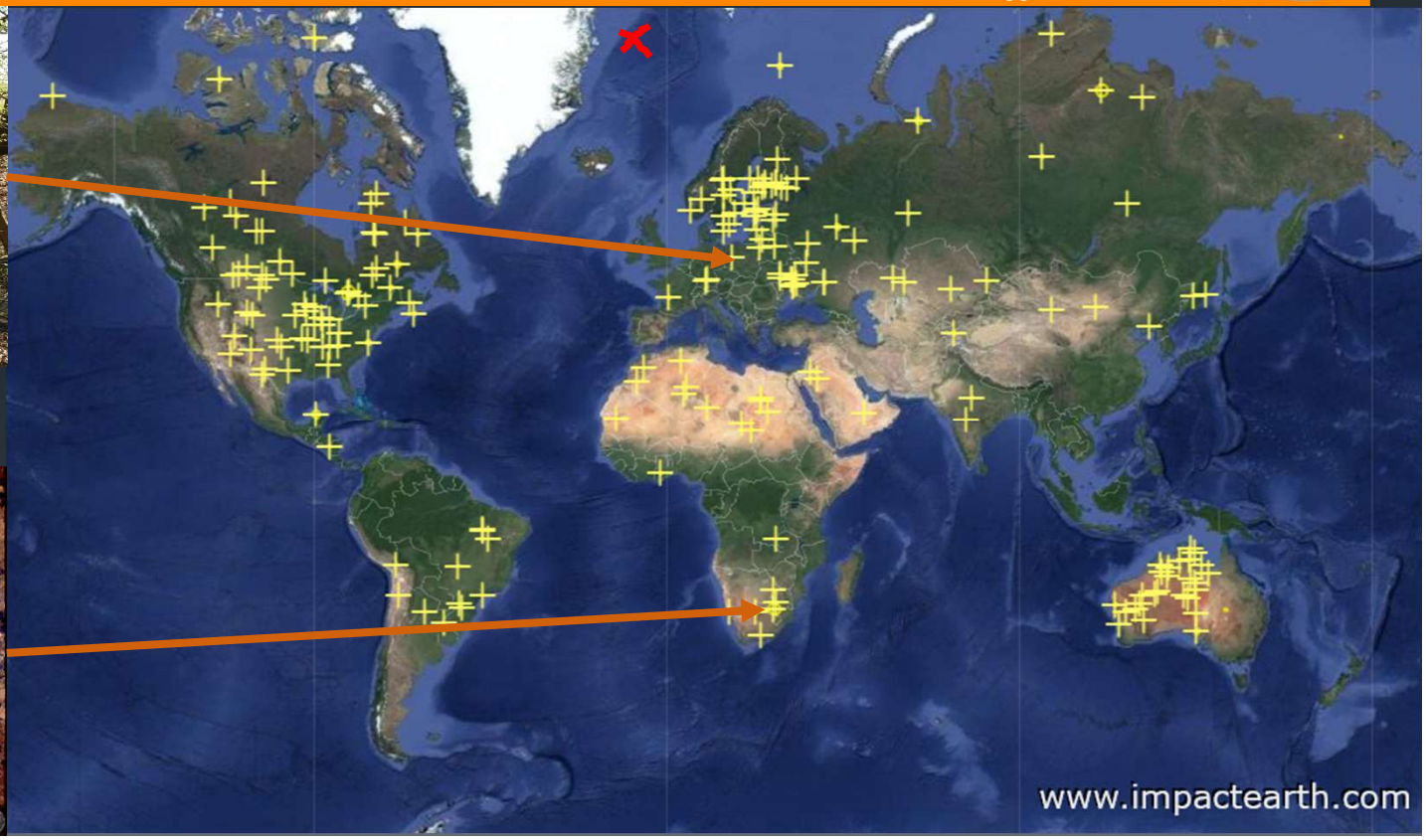

Impact cratering proces

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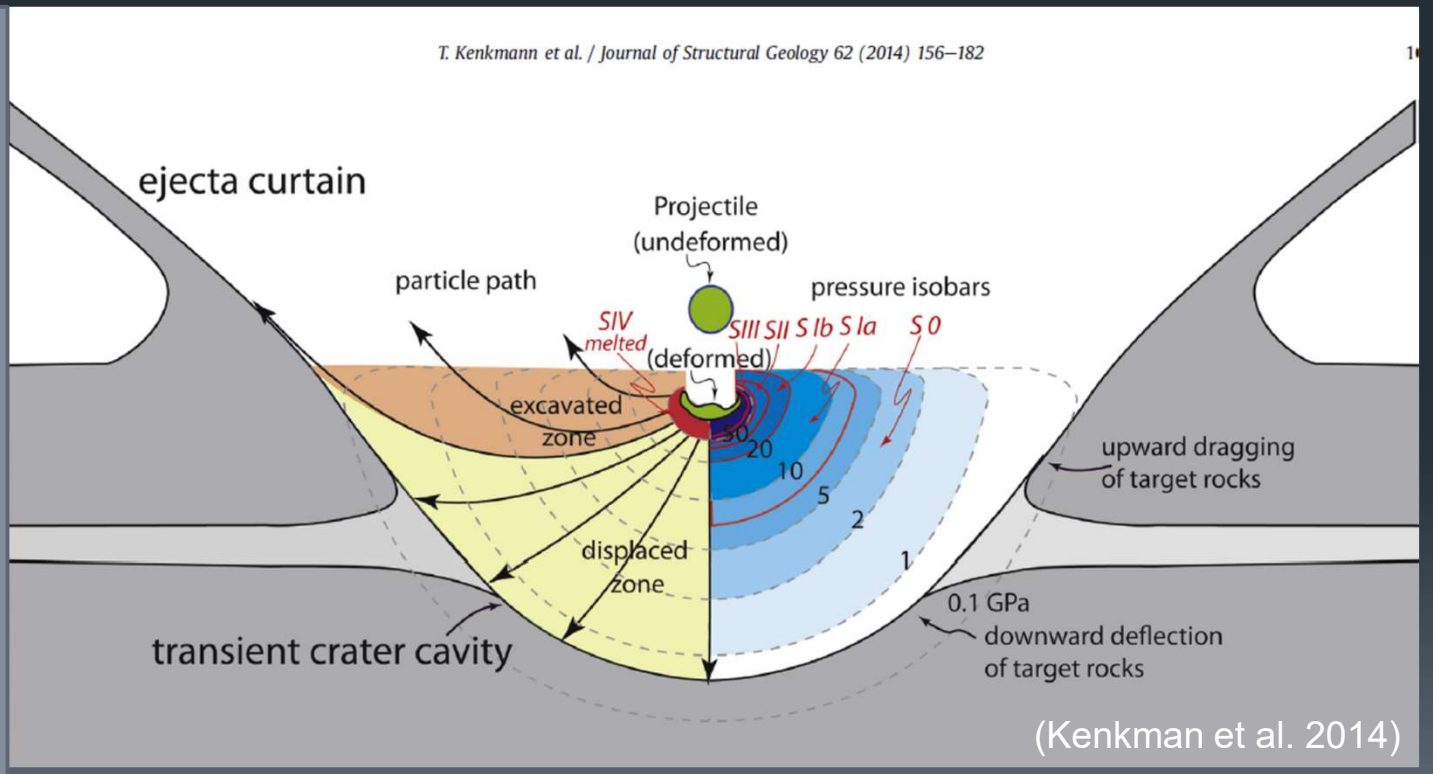
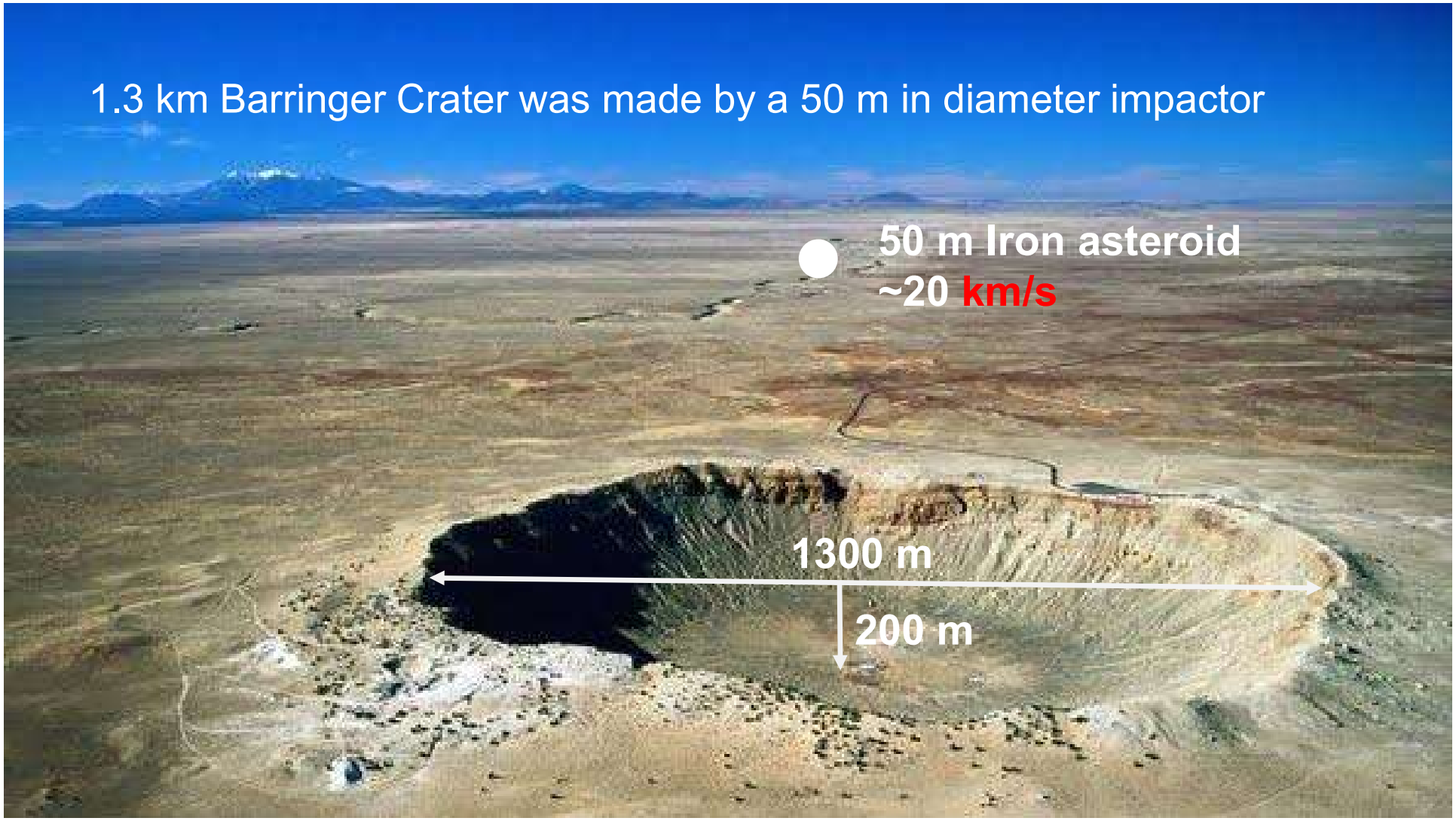
Asteroids form craters that are >10 times the diameter of the impactor because they more with velocities of ~20 **km/s.**
Target rocks are vaporised/melted/displaced under extreme pressure and temperature conditions.

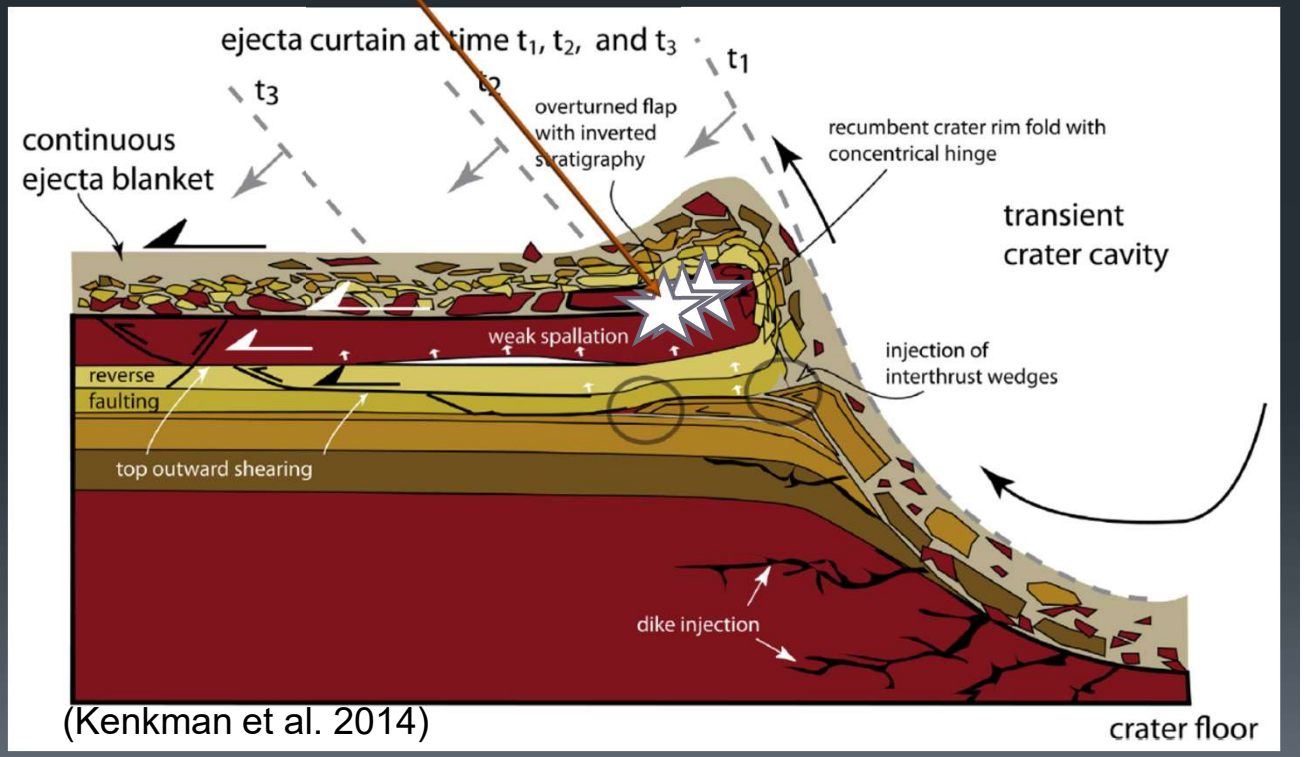


(Kenkman et al. 2014)


1.3 km Barringer Crater was made by a 50 m in diameter impactor
50 m Iron asteroid
~20 km/s
1300 m
200 m

Fossil plant remains preserved as charcoal within proximal ejecta blankets of impact craters

- reveal the influence of asteroid collisions with the Earth's surface
- provide a snap-shot of environmental conditions during the impact.



(Kenkman et al. 2014)

Kaali Craters

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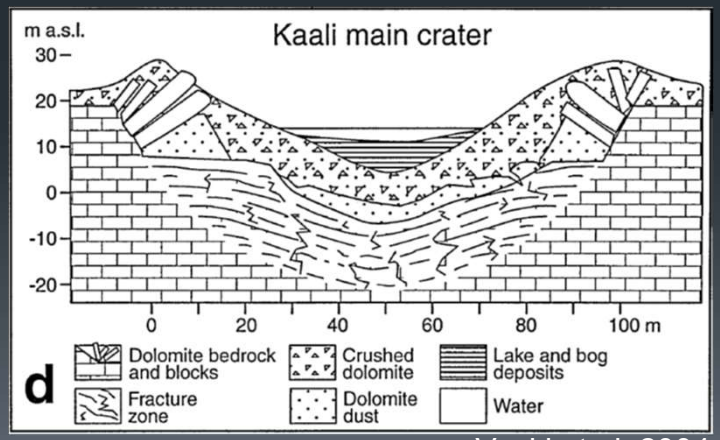
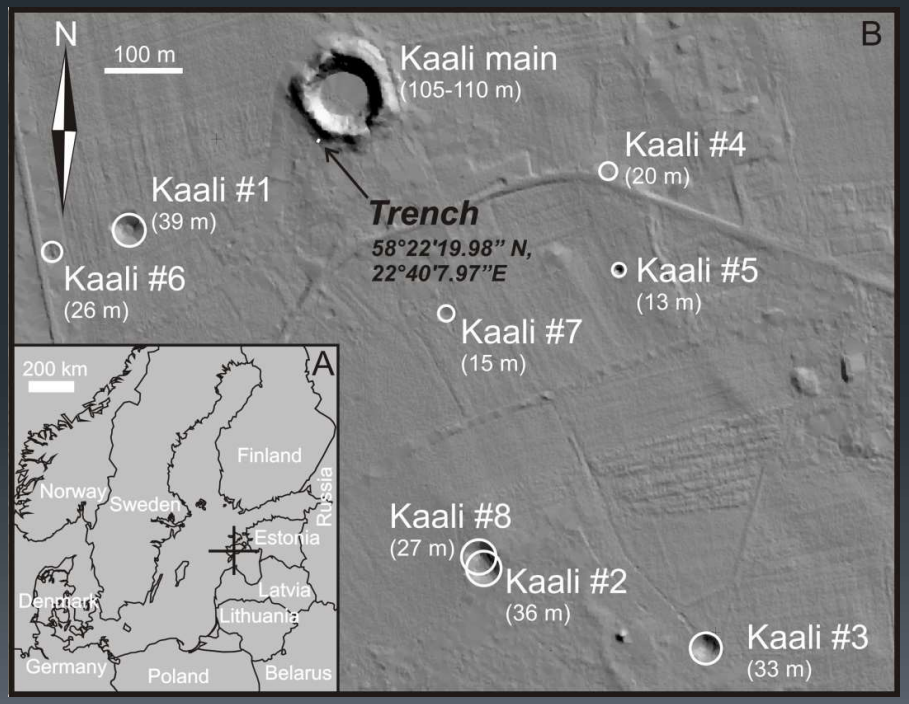
- 8 craters formed in the same time
- The largest is 110 m in diameter
- ~3500 BP old (Losiak et al. 2016)



Veski et al. 2004



Kaali Craters

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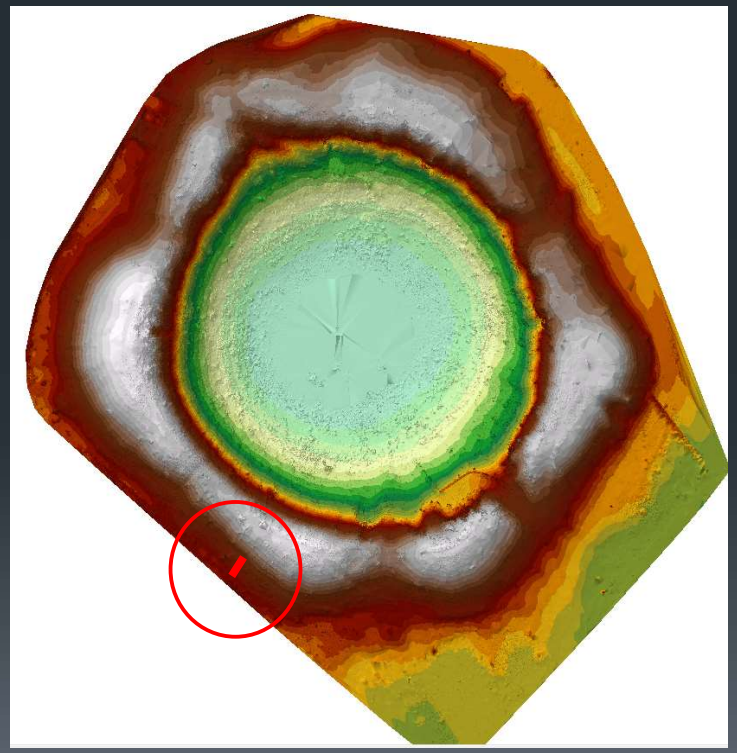
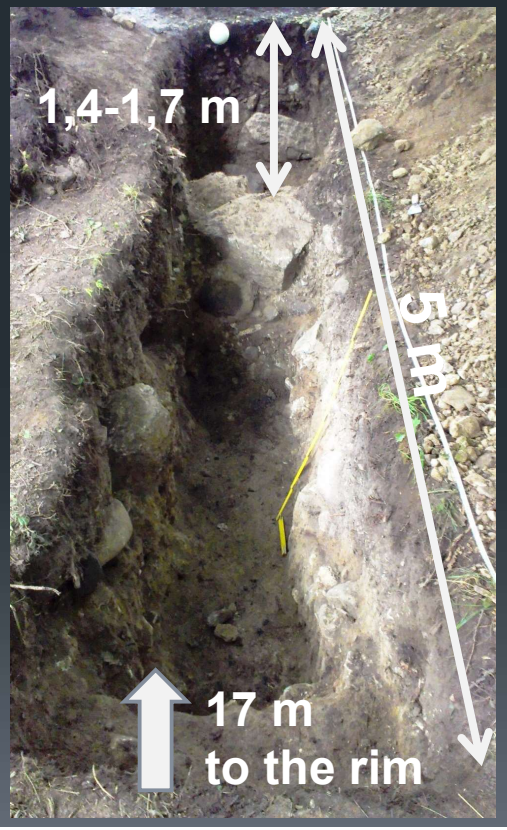
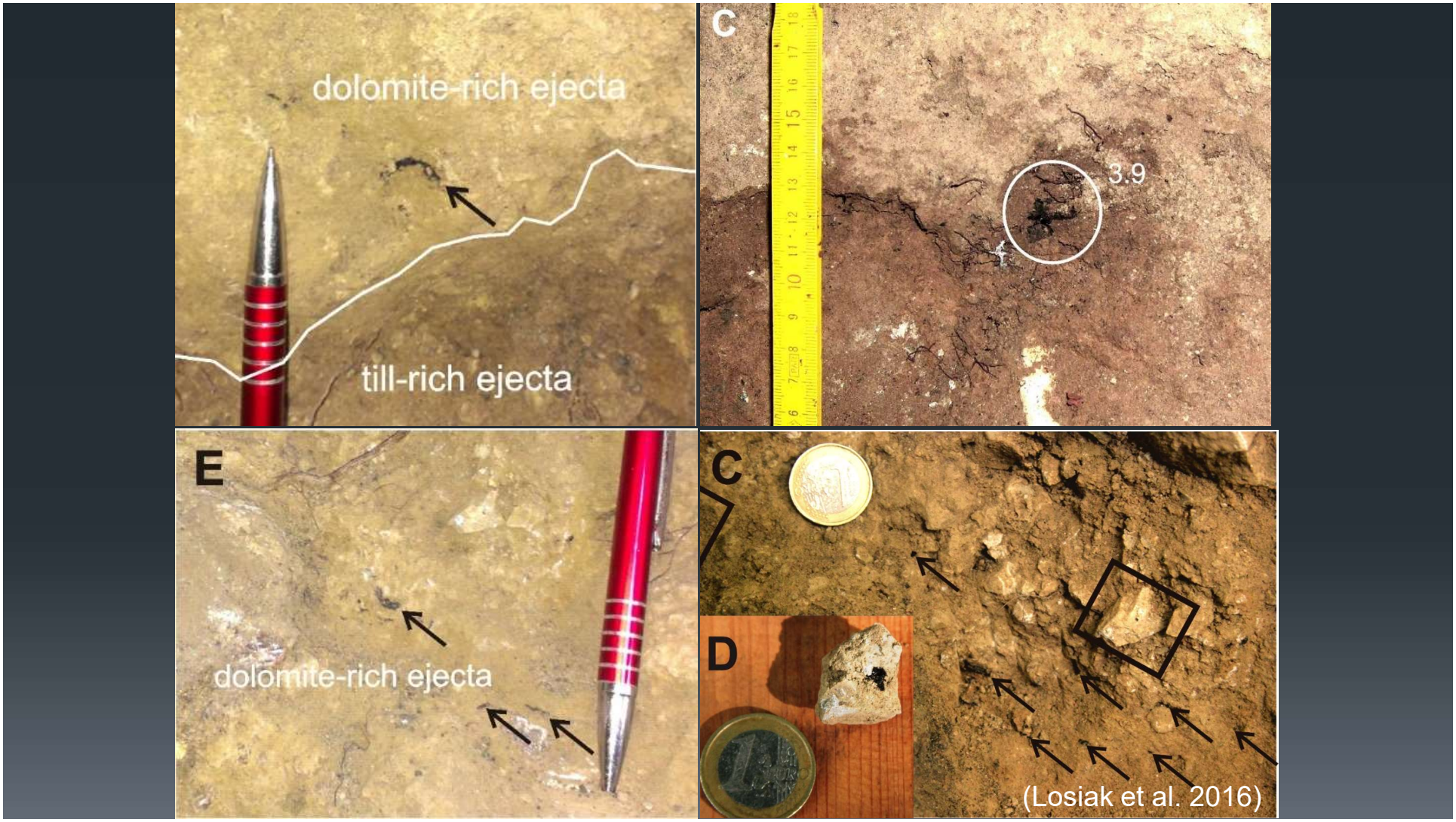
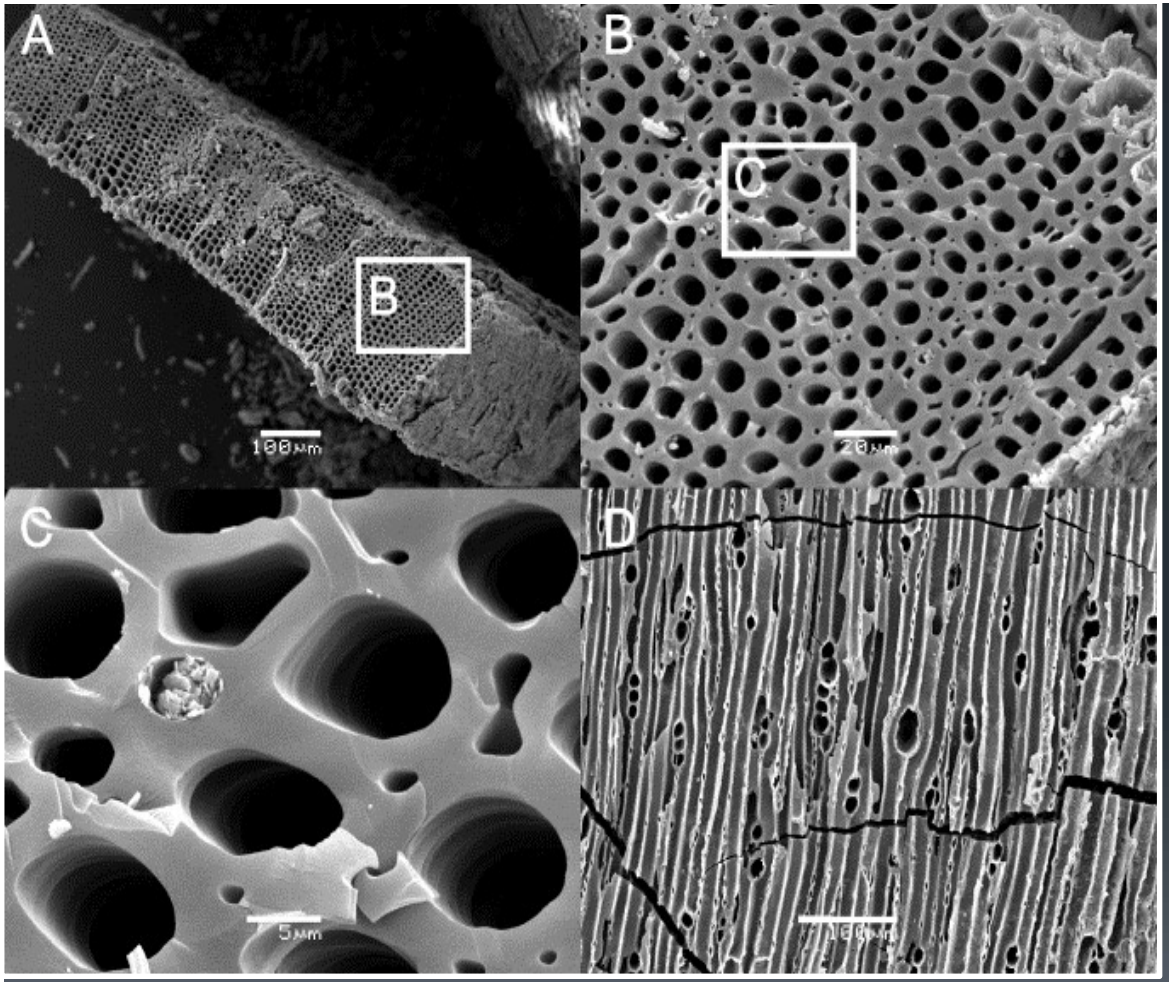


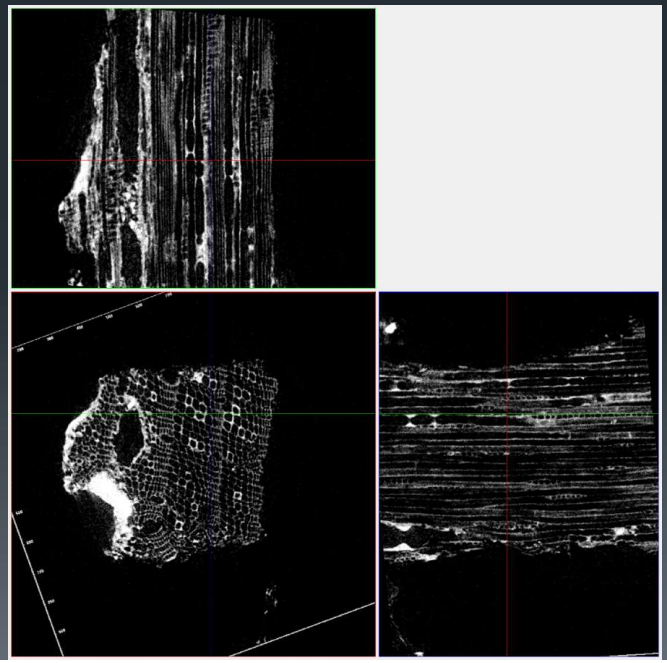
Zanetti et al. 2015




dolomite-rich ejecta
till-rich ejecta
C
3.9
E
dolomite-rich ejecta
C
D
(Losiak et al. 2016)



Spruce branches



Similar particles in other proximal ejecta blankets

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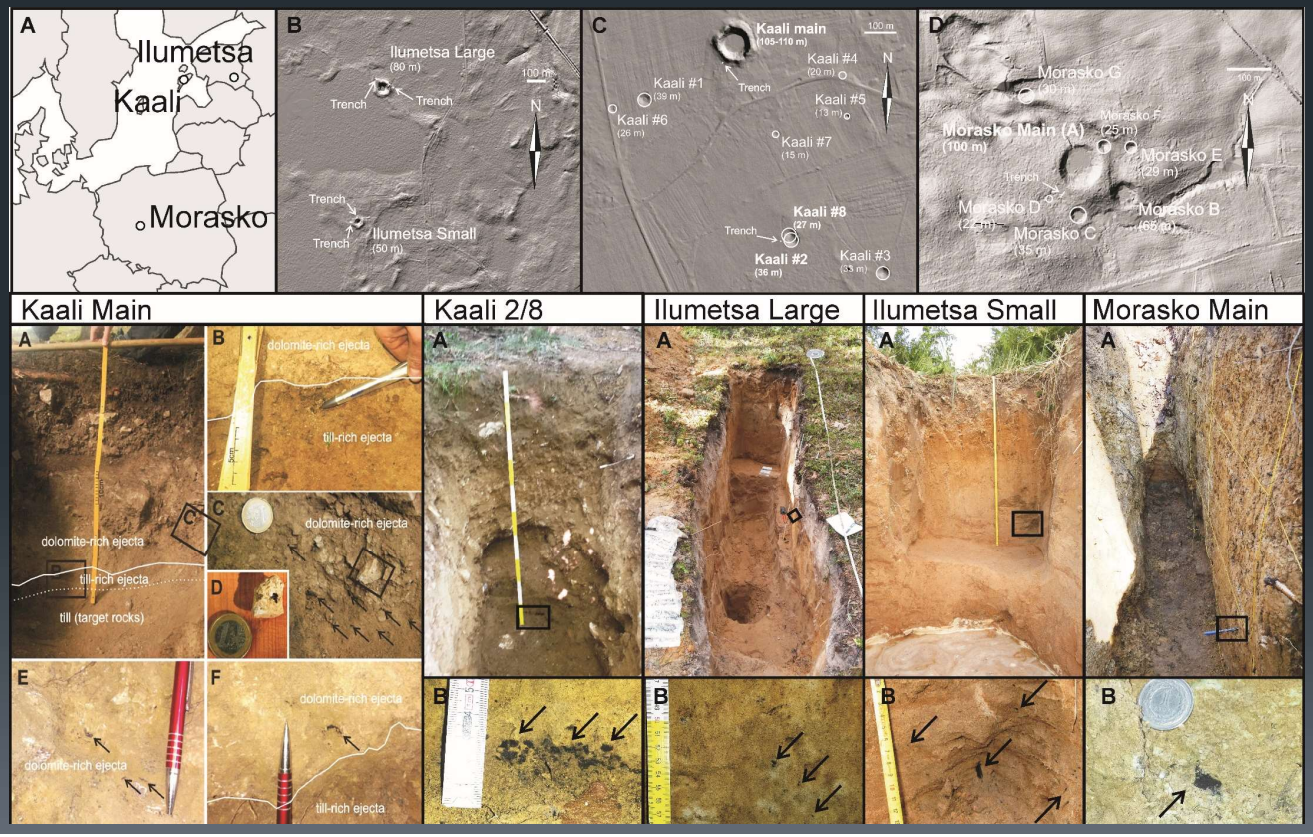

Ries, Germany 24 km

Methods: Charcoal reflectance

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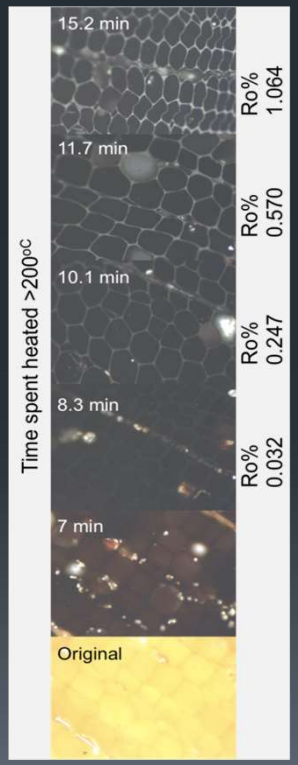
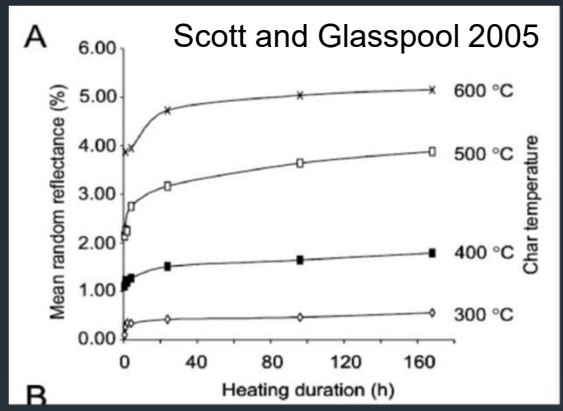
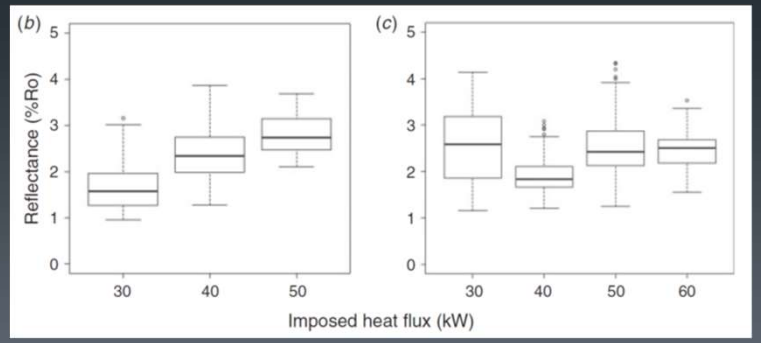
- Charcoal Reflectance
  - Temperature of formation
  - Time of heating
  - Ignition
  - Fuel moisture
    - Fuel type

- Embedded in polyester resin, analysed under oil with a microspectrometer



Belcher et al. 2018

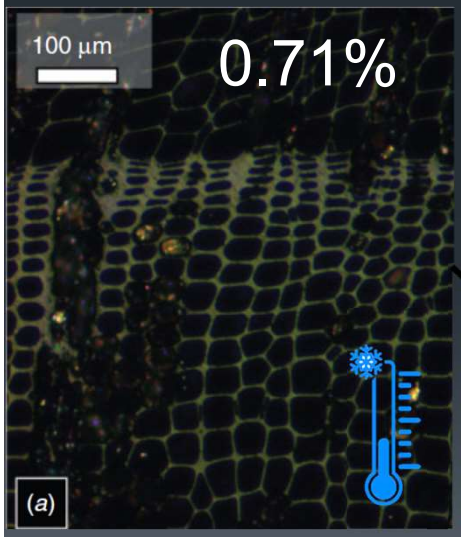


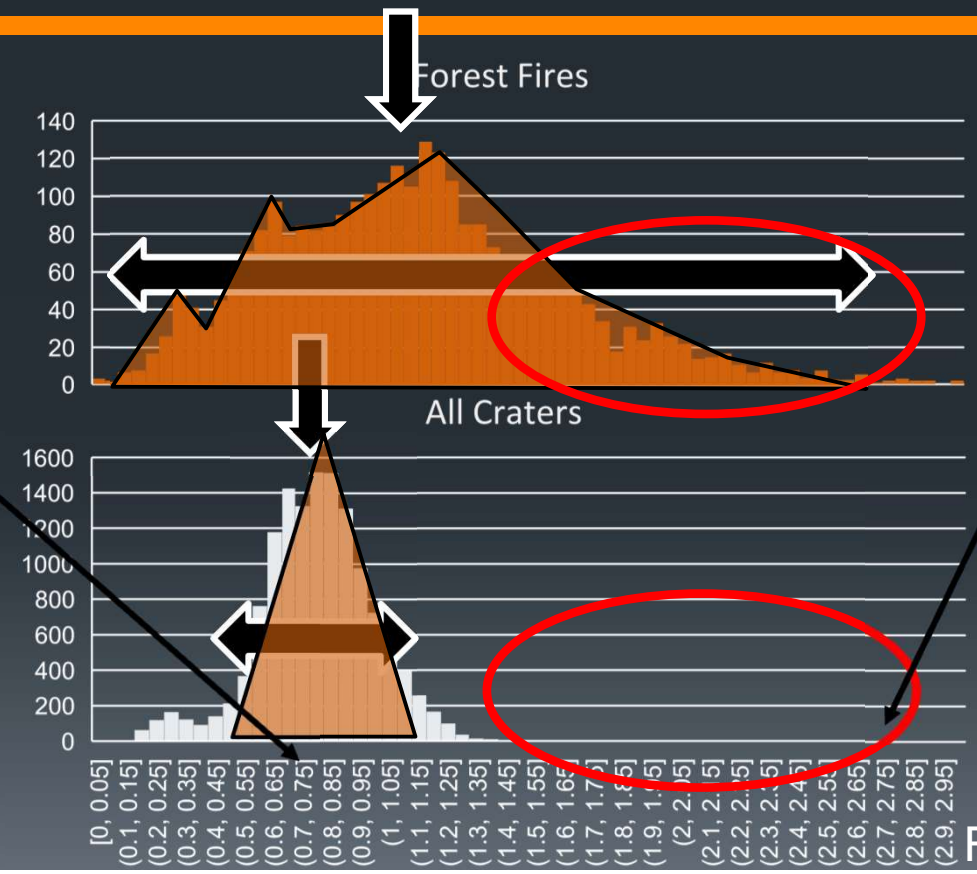


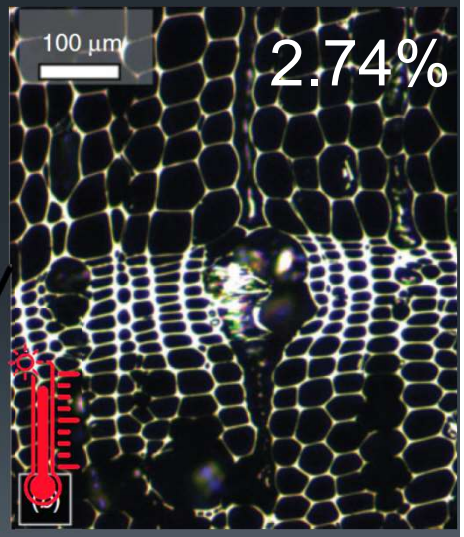
Belcher and Hudspithch 2018

WildFire vs Impact charcoal

wildFIRE lab







Belcher and Hudspith 2016

- Specific location within ejecta blanket
  - On clasts
- Fragmental
- Up to 7x25 mm
- All pieces same ~^{14}C age
- Uniform reflectance

Methods of formation

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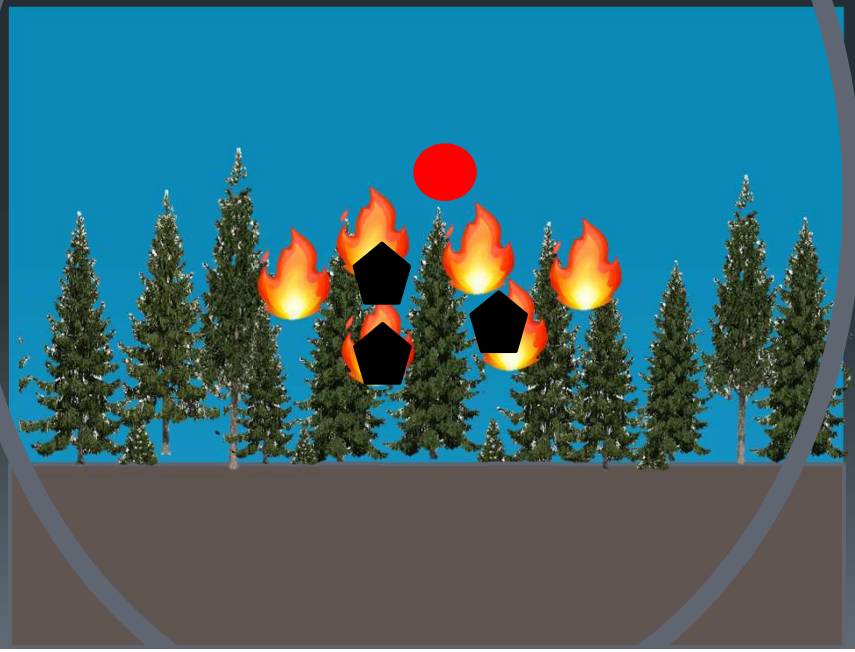
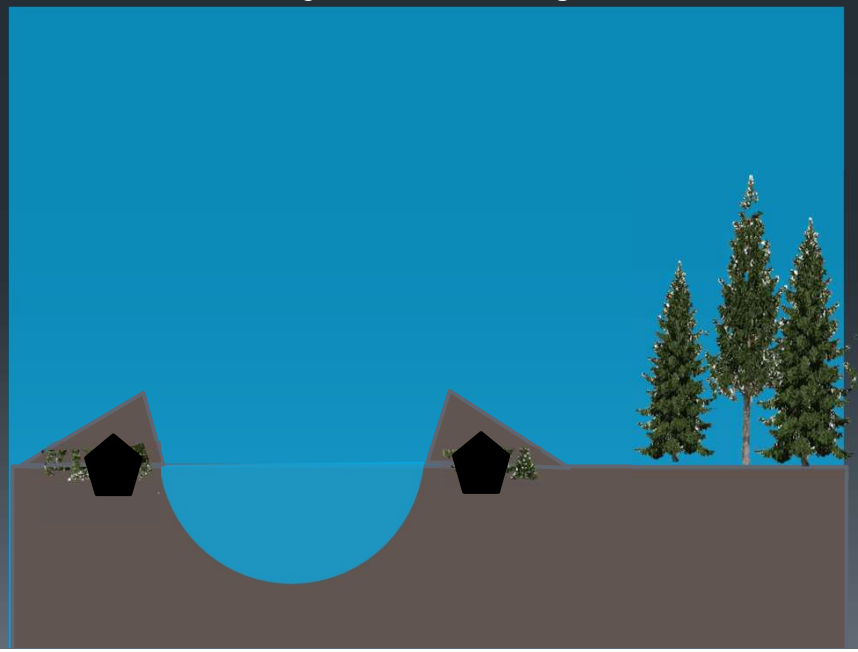
Charring by radiation from incoming impactor



Charring by burying in locally warm ejecta



Methods: Experiment 1

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iCone Calorimeter

At wildFIRE lab

@ Uni of Exeter

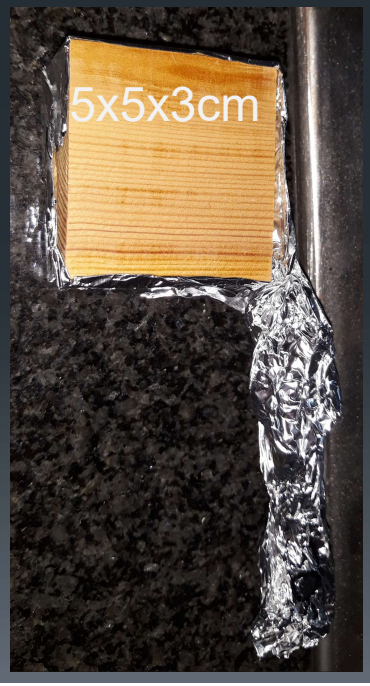
(Fire Testing Technology, UK)

Methods: Experiment 1

wildFIRE lab

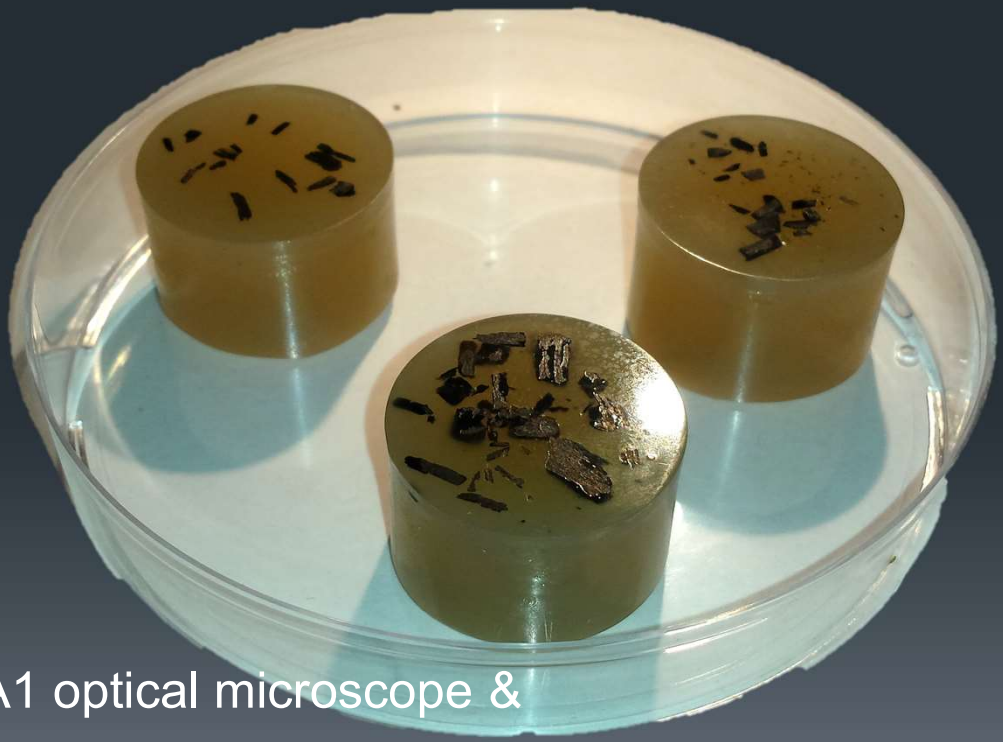
Dry (13%) Pine 15-100 kW/m2 5 - 400 s

Avoid flaming



Methods: Reflectance measurement

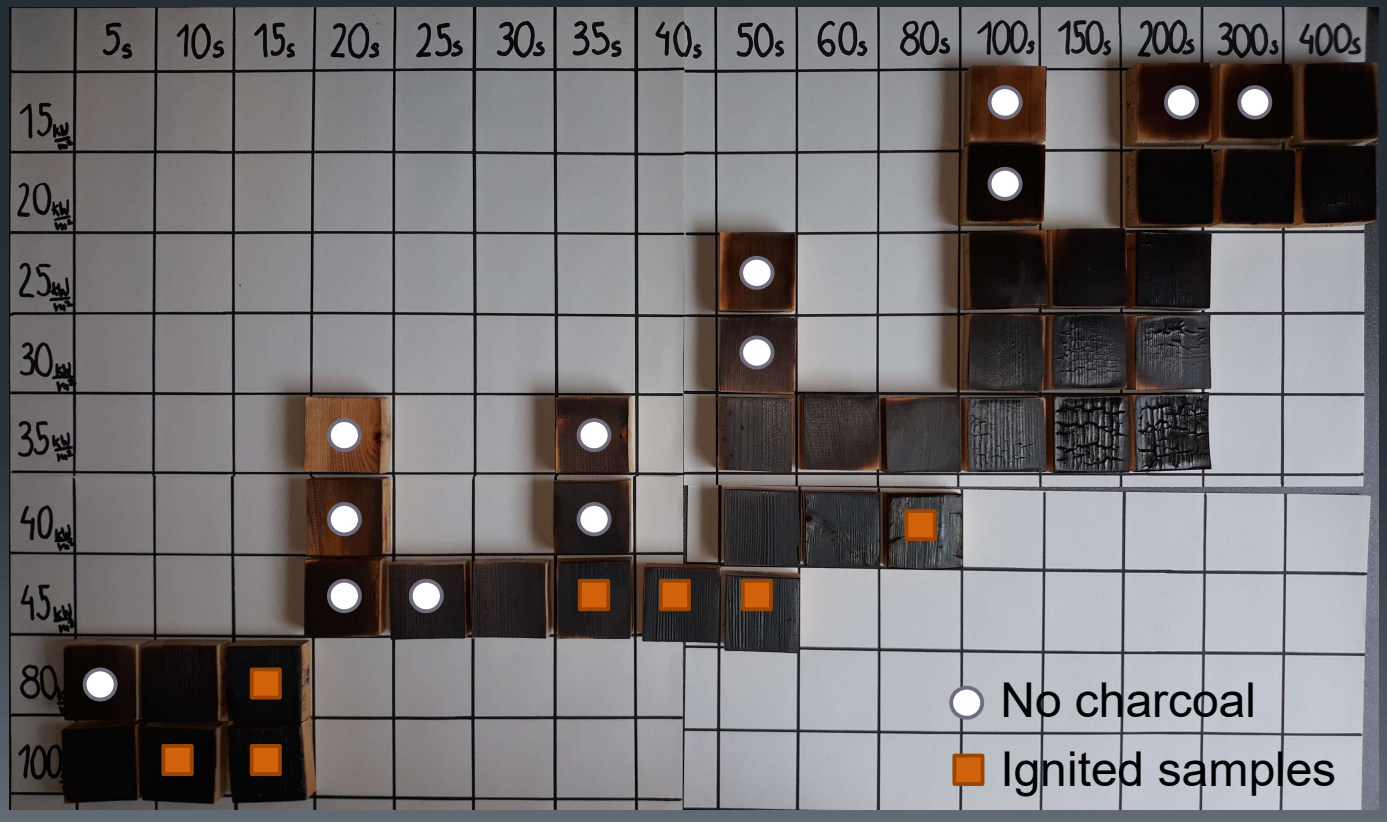
wildfIRE lab



Zeiss Axio-Scope A1 optical microscope &
TIDAS-MSP 200 microspectrometer (SMCS Ltd, Baldock, UK).

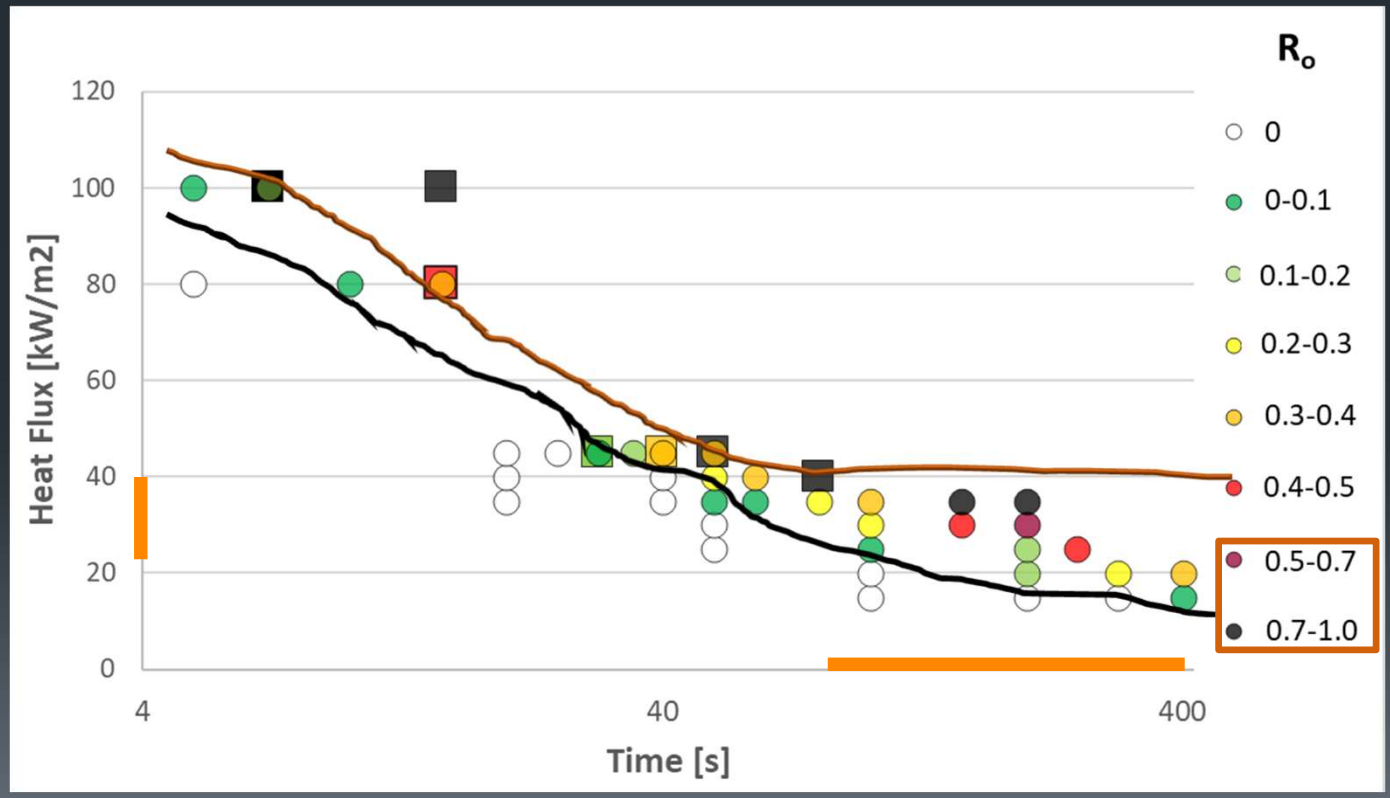
Experimentally produced charcoal

wildfIRE lab



Experimentally produced charcoal

wildFIRE lab



Experimentally produced charcoal

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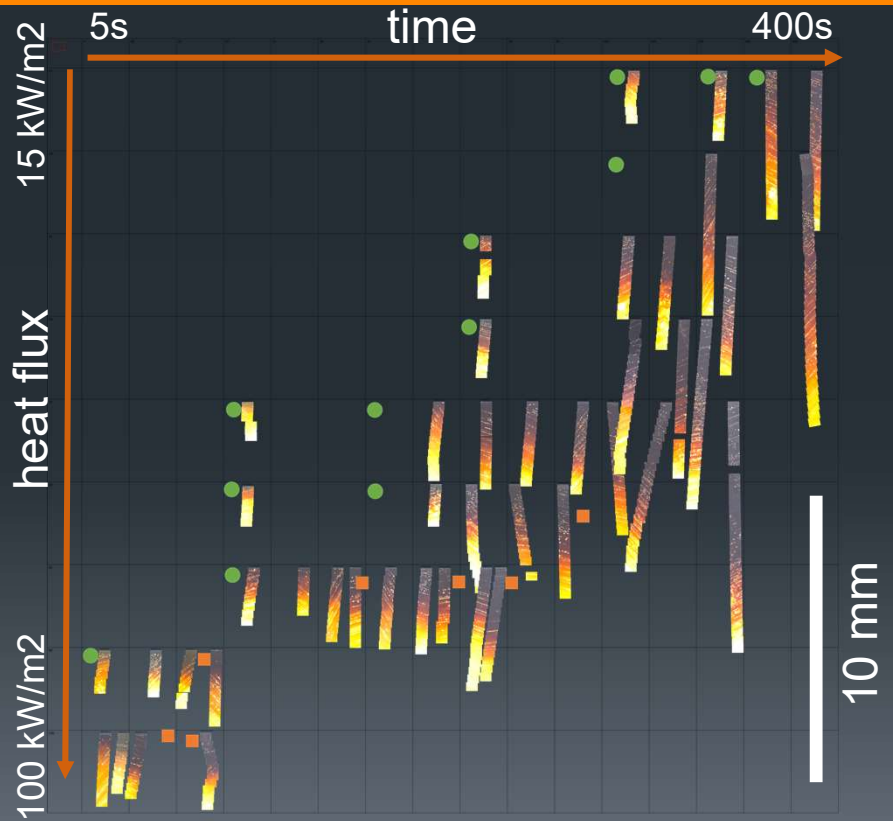
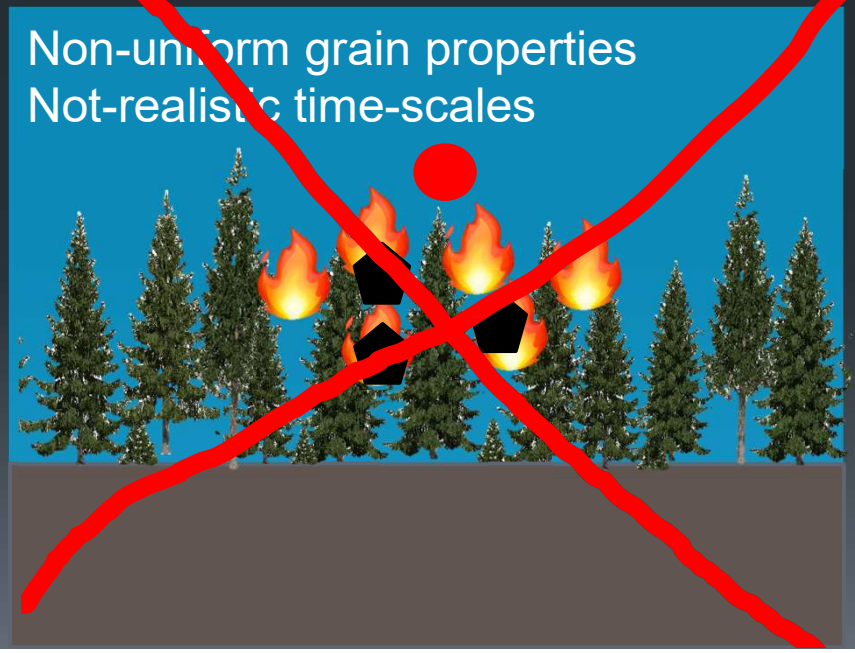


Methods of formation

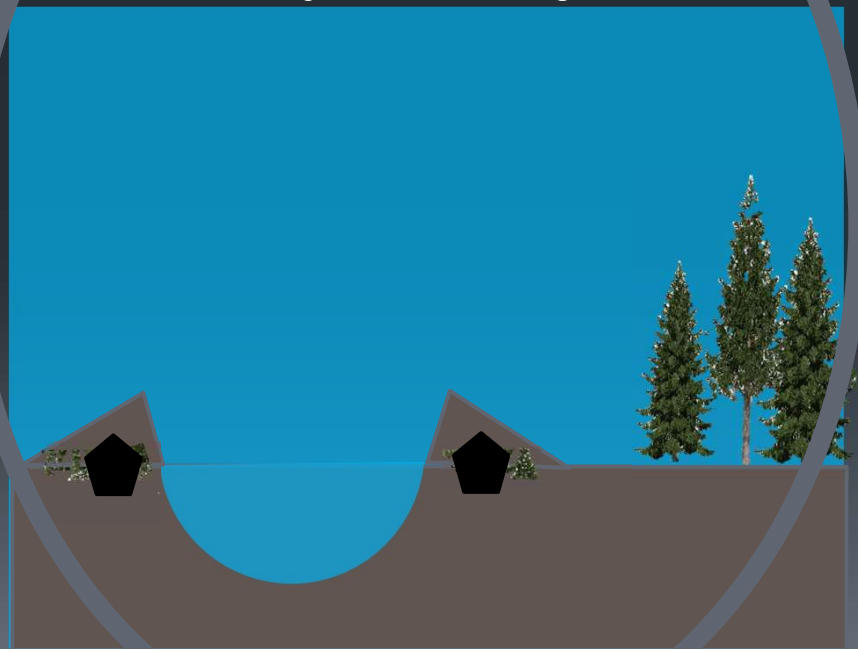
wildfIRE Lab

Charring by radiation from incoming impactor

Non-uniform grain properties
Not-realistic time-scales



Charring by burying in locally warm ejecta



Methods: Experiment 2

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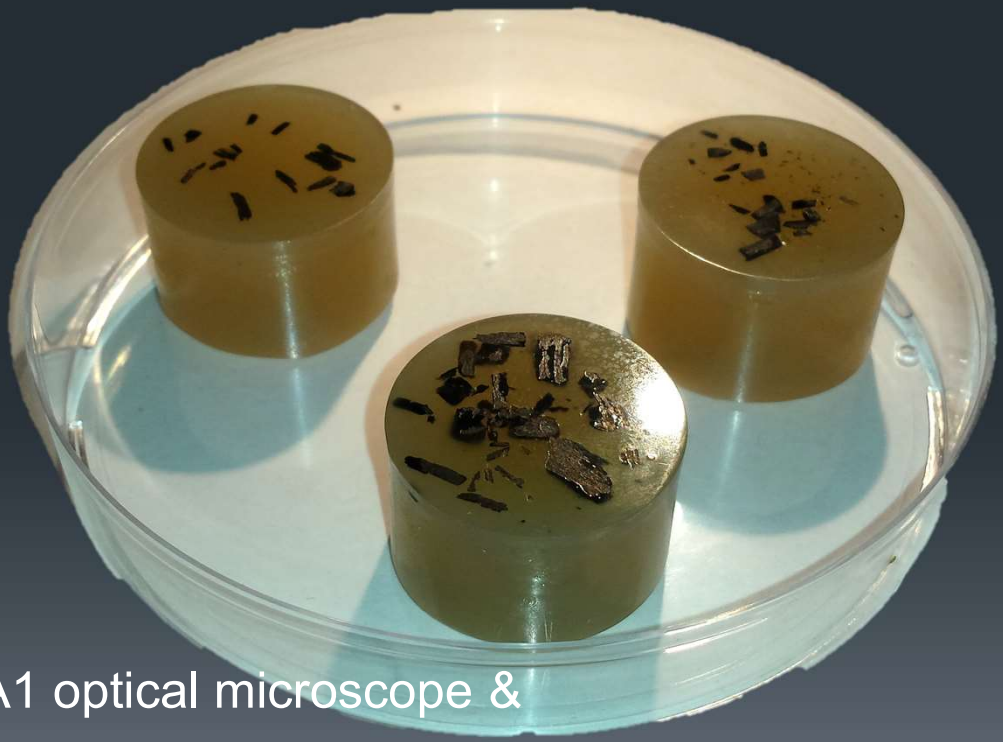
Dry (13%) Pine 1,5x1,5x1cm
Spruce: fresh 55%, dry 15%

Sand heated for
2 h to 300-650ºC

Methods: Reflectance measurement

wildfIRE lab



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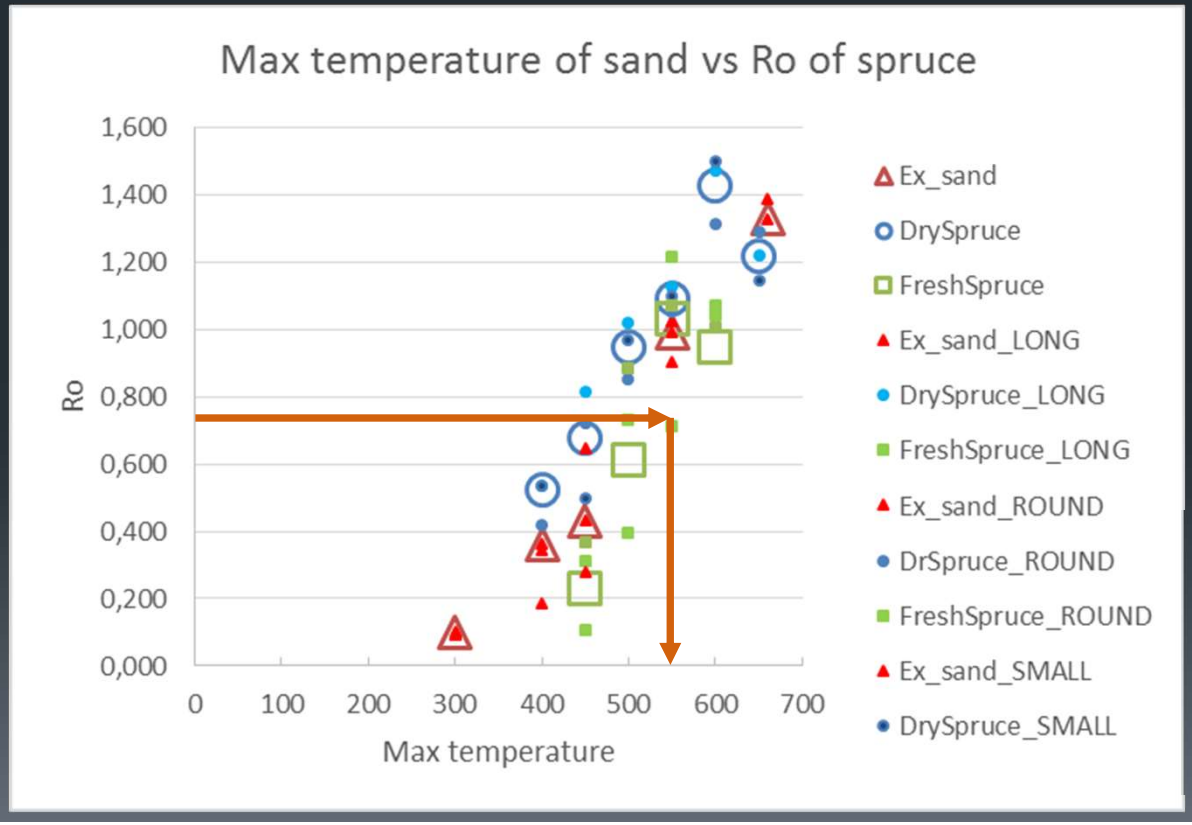
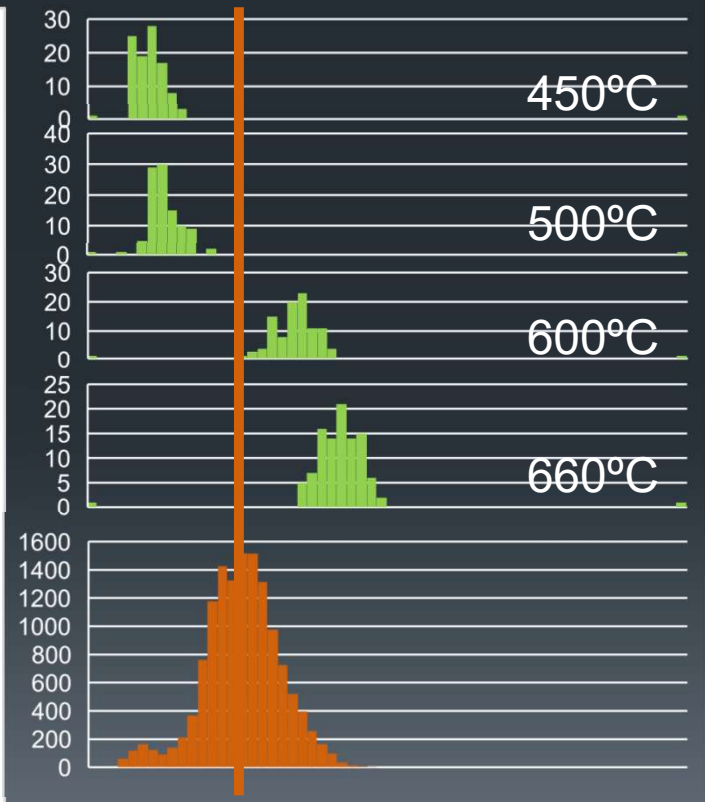
Heated sand experiments

wildFIRE lab





Conclusions

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1. Asteroids forming small impact craters kill
2. Charcoal is formed
   - Consistent properties among studied craters <= 100 m
3. Formation mechanism requires prolonged heating for >400 s to ensure charcoal homogenisation.
   - a noncharred plant material is incorporated into the ejecta which then heats the plant remains forming char.
   - Slow roasting in locally ~550ºC ejecta
4. Impact charcoal can be used to identify small impact craters on Earth
   - As long as it killed some plants