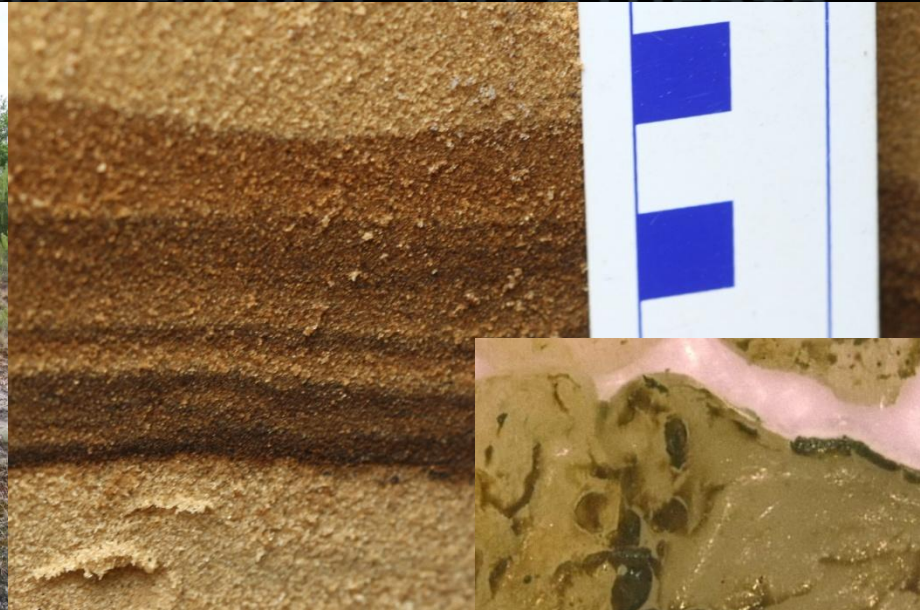


QUARTZ MELT STRUCTURES IN EUROPEAN COVERSANDS MAY SUPPORT YOUNGER DRYAS EXTRATERRESTRIAL IMPACT HYPOTHESIS



Lommel
Laminae

Lommel (Andronikov's work)



Alex Andronikov at Lommel



Intrusion in dark layer at Lommel (Andronikov).



Younger Dryas onset in age, ~12,800 Cal yr BP

Afbeelding



Some variability: in nature: thickness of dark layer, rarely laminated, usually charcoal rich

Van Geel et al 1989, Stapert and Veenstra 1990

WHAT IS THE USSELO HORIZON?

Kaiser et al 2009

Usselo and Finow "Soils"

Dry terrestrial "soil"

Charcoal rich – widespread and repeated fires of unknown origin (natural or human?)

Range of ages from Allerod to Younger Dryas with some outliers in the Preboreal

They reject that it is an event horizon on the basis of age variation

Geochemical markers: They allow that the pre-existing Usselo horizon received extraterrestrial material



Kaiser et al 2009 Palaeopedological marker Horizons in Northern Central Europe
Characteristics of Late Glacial Usselo and Finow Soils

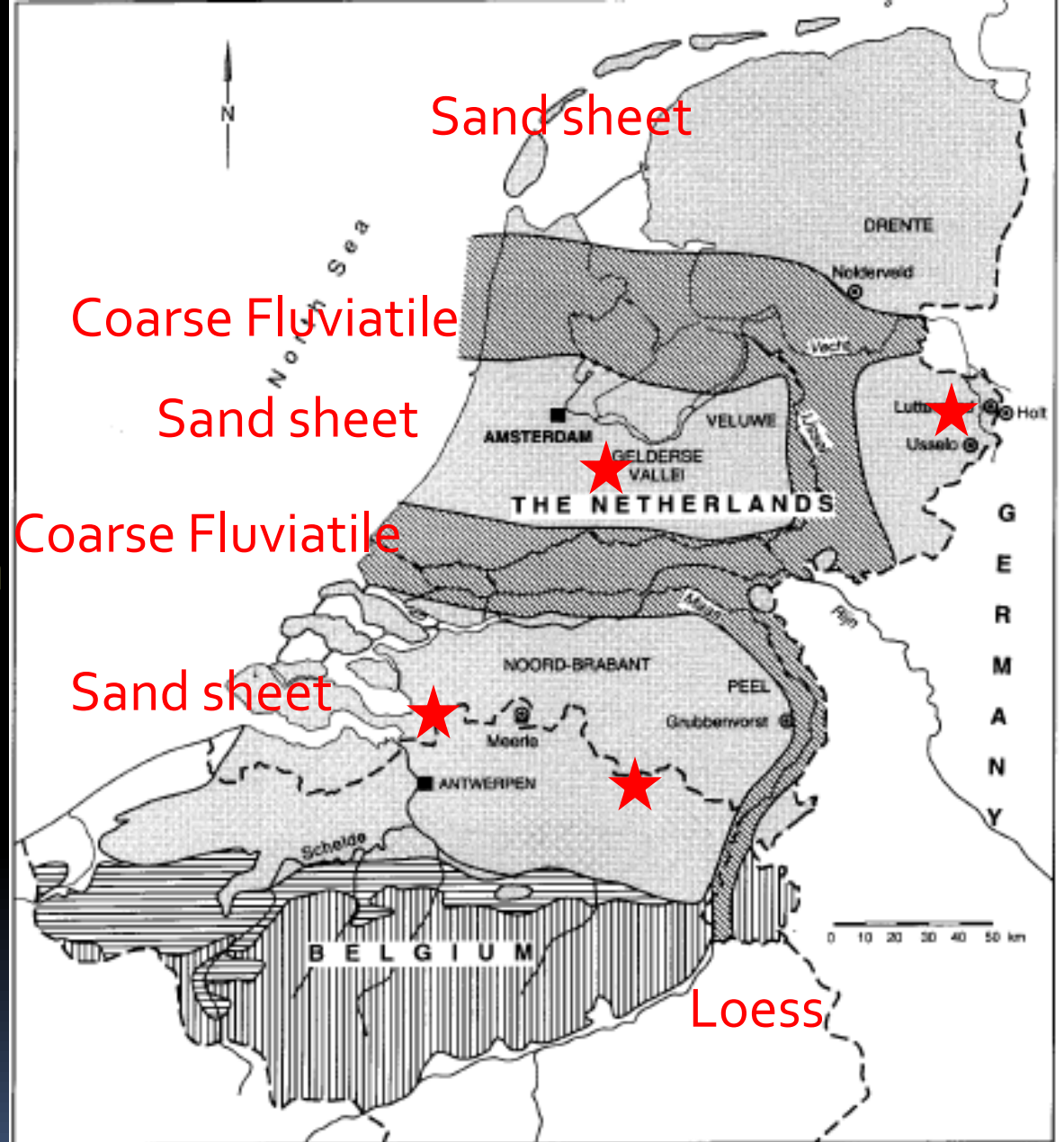
COVERSANDS

Ossendrecht

Laarder Wasmeren

Lutterzand

Lommel

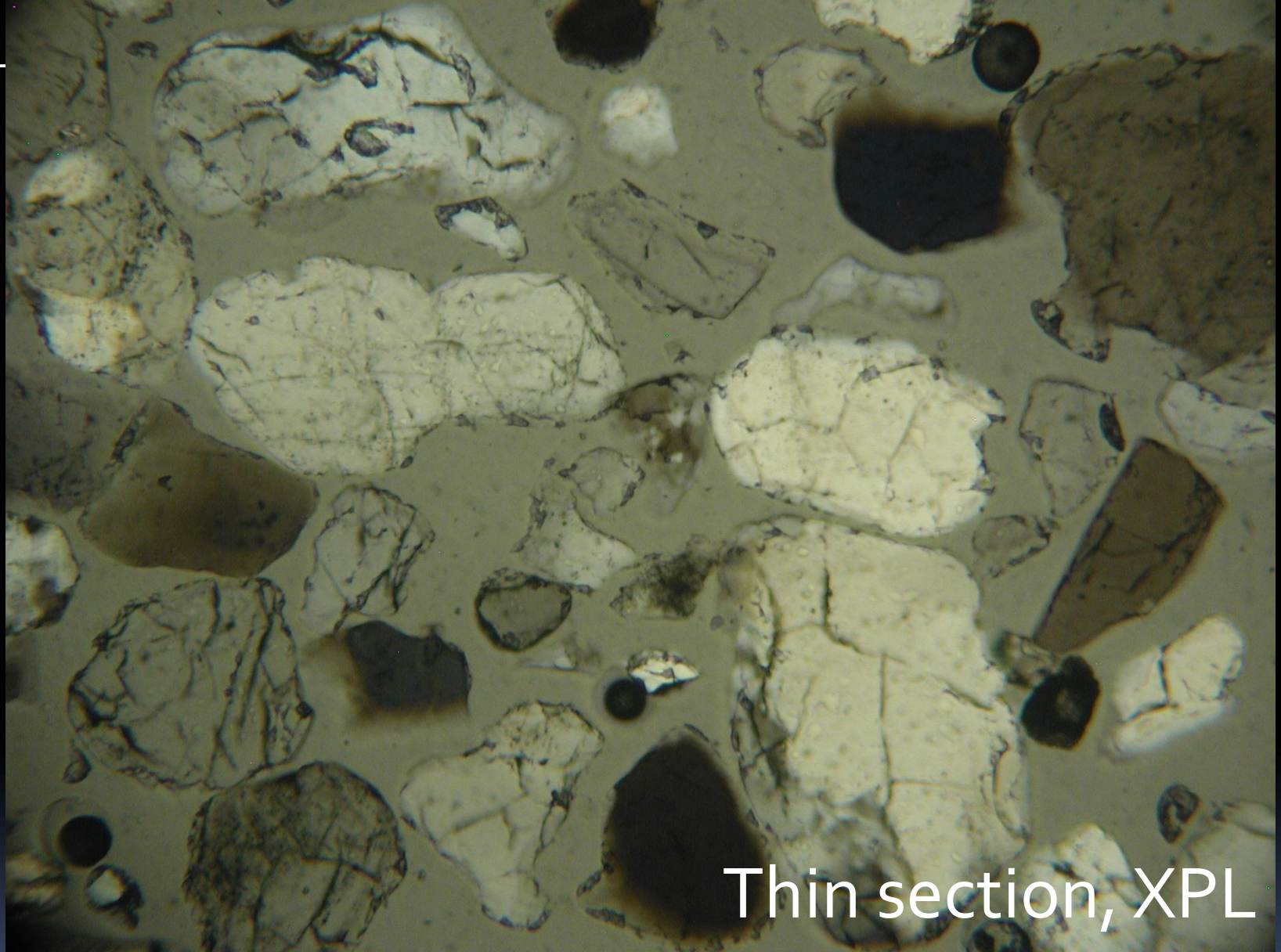


Coarse-grained fluviate deposits of Rhine and Meuse

Sand sheet deposits partly covered by Holocene beds

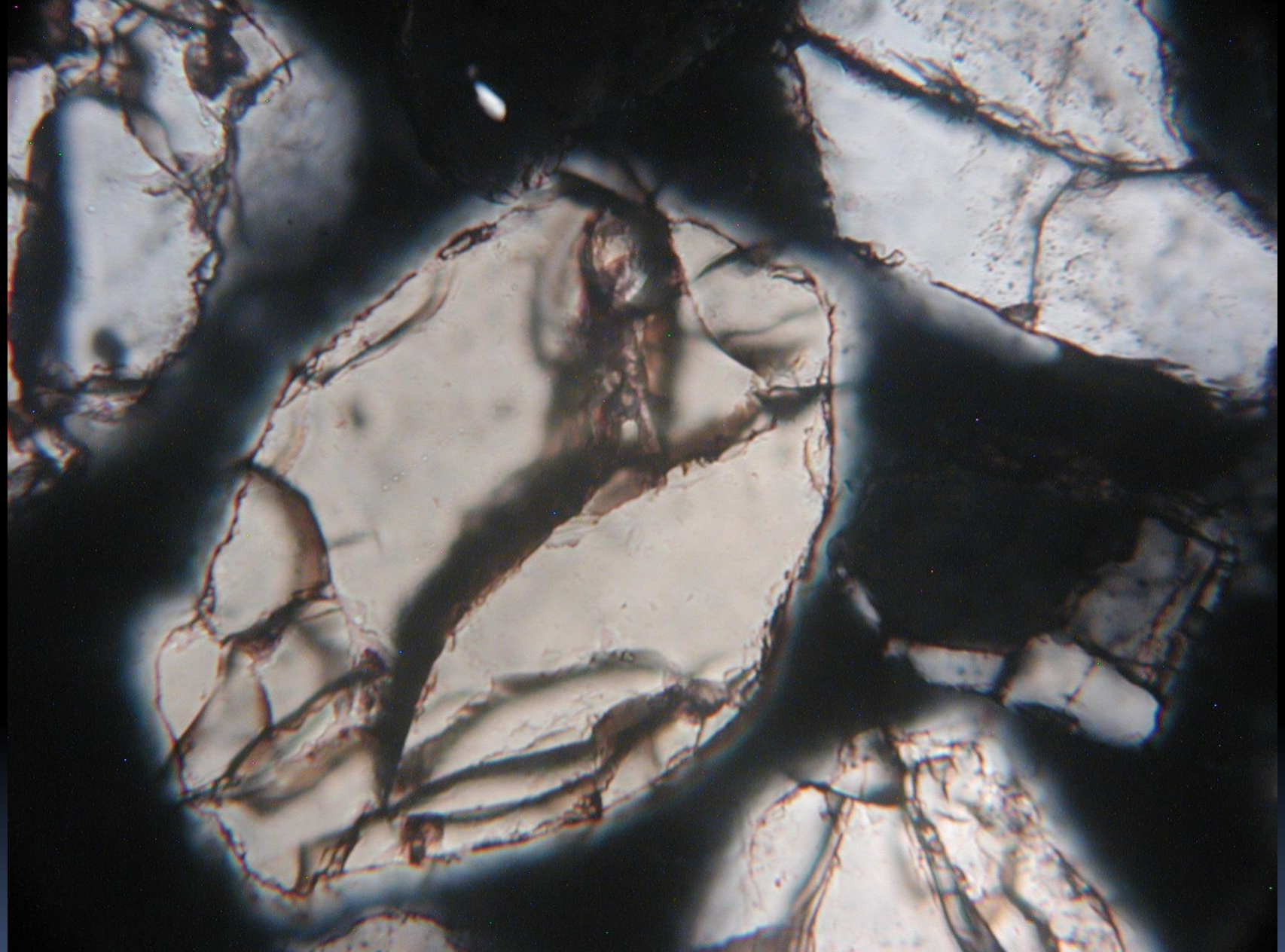
Transition zone („Sandloam“)

Loess area



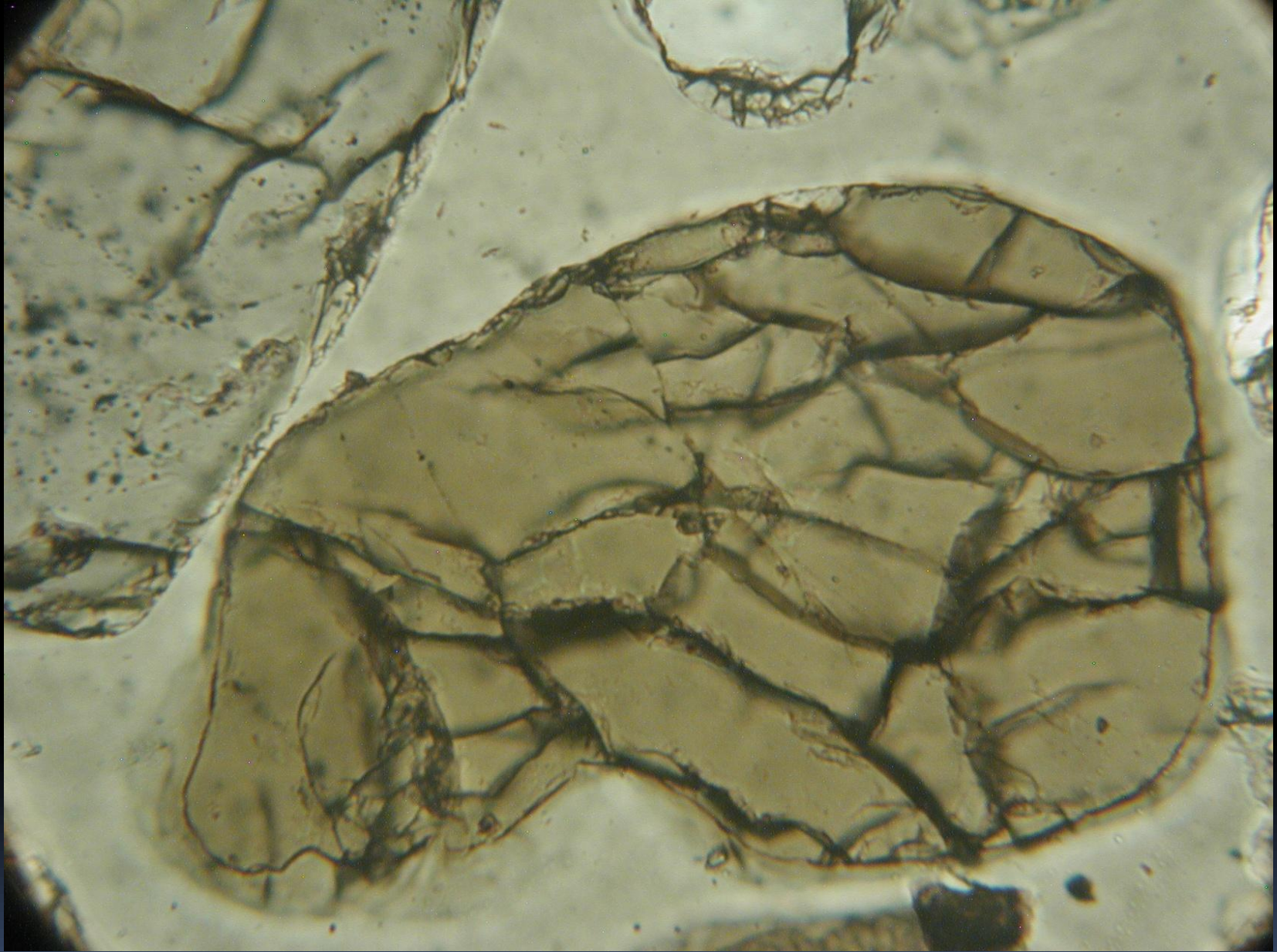
Thin section, XPL

OSSENDRECHT



OSSENDRECHT

Internal fracturing

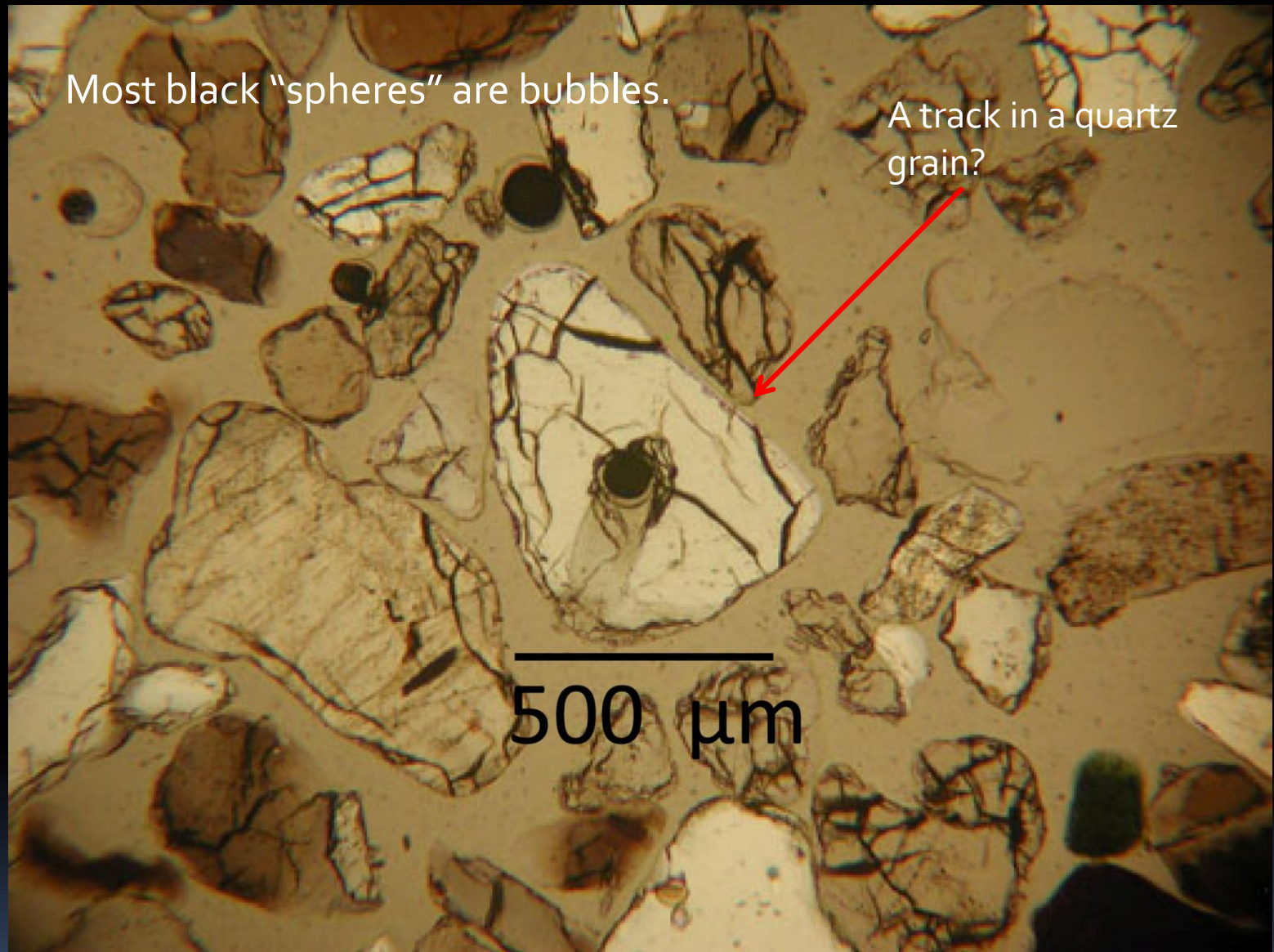


OSSENDRECHT

Internal fracturing

Most black "spheres" are bubbles.

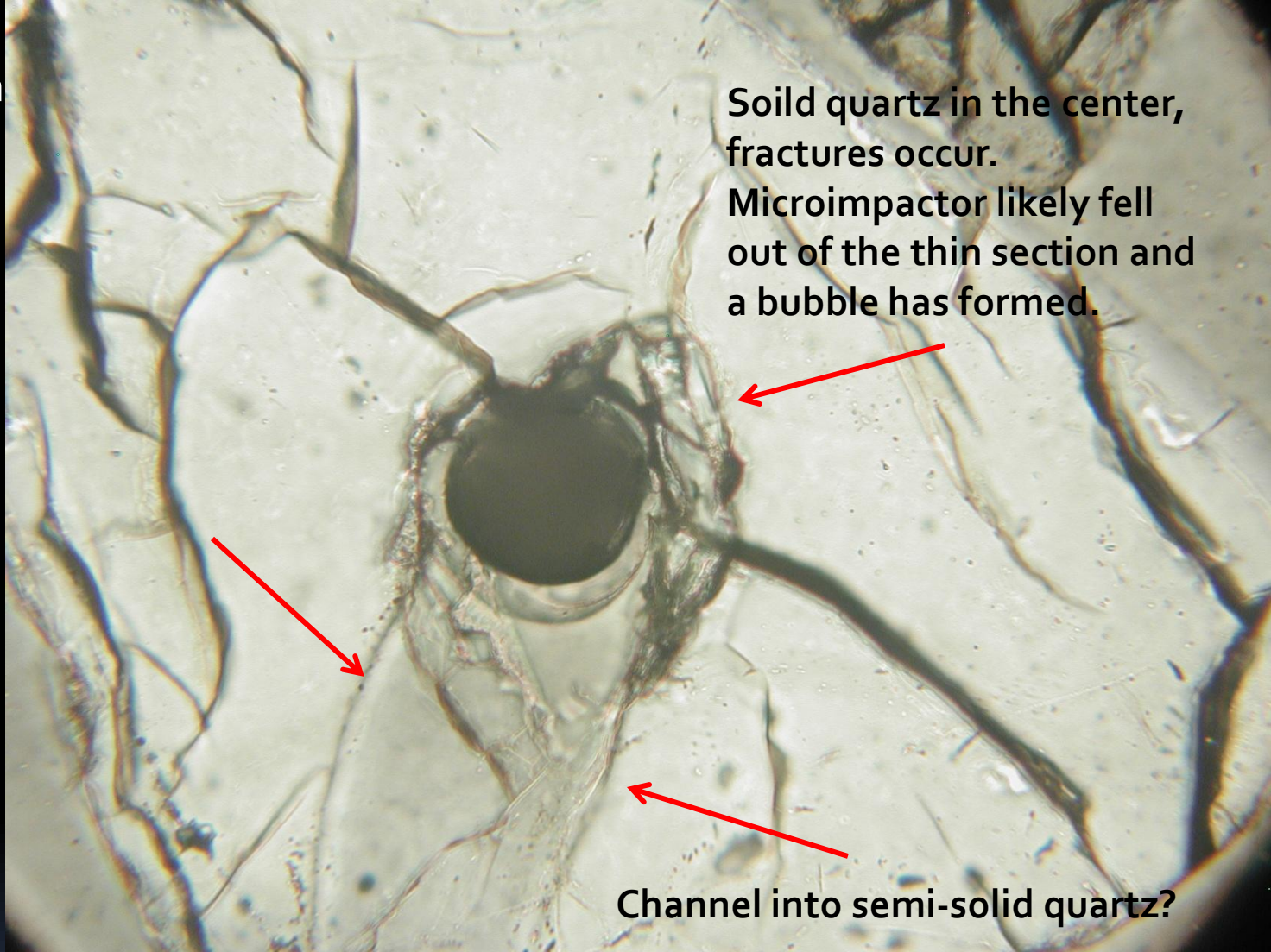
A track in a quartz grain?



500 μm

OSSENDRECHT

Th



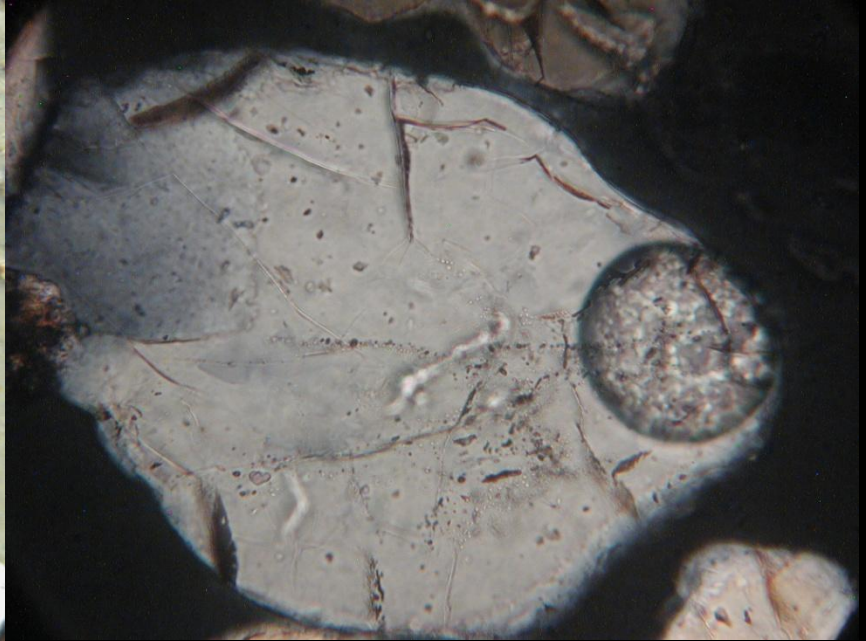
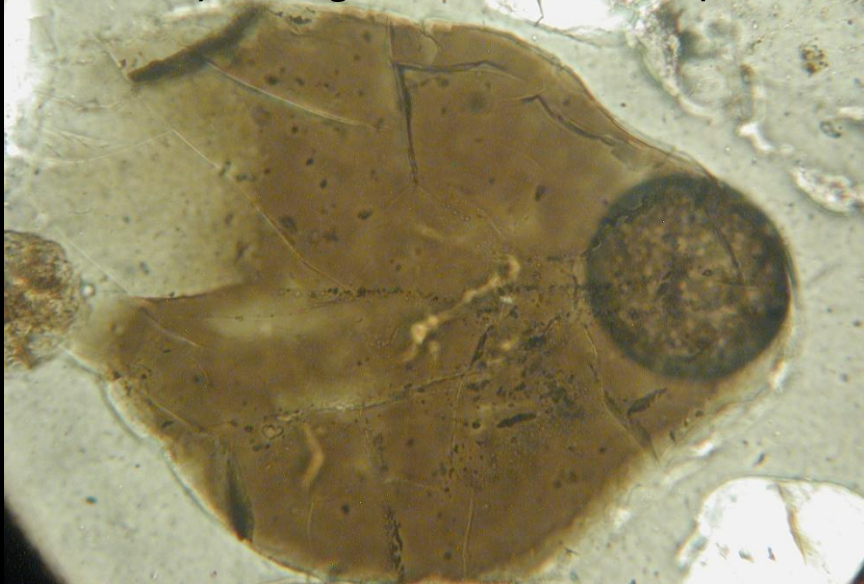
Soild quartz in the center,
fractures occur.
Microimpactor likely fell
out of the thin section and
a bubble has formed.

Channel into semi-solid quartz?

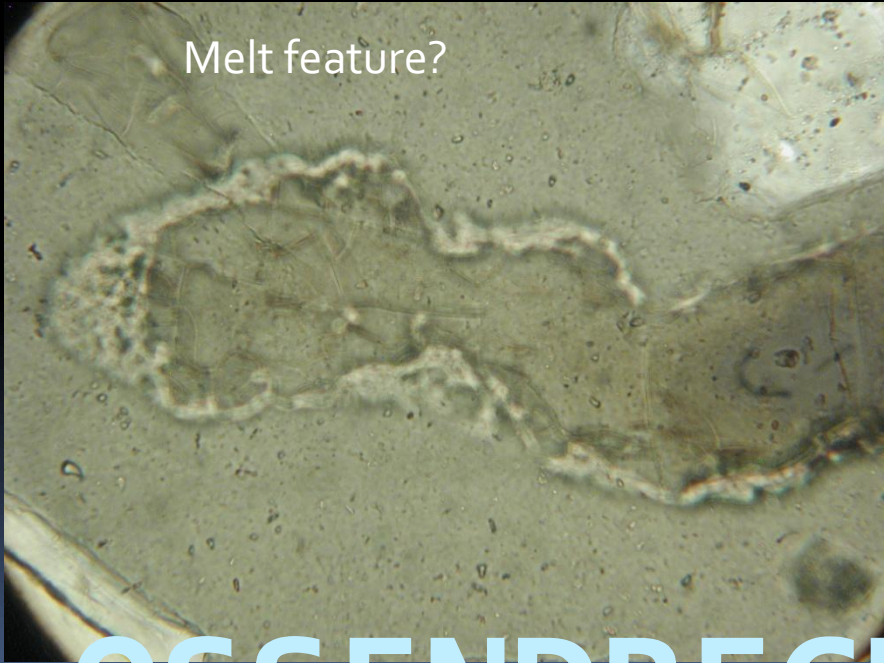
Different phases for microimpactor travel into quartz grain?

OSSENDRECHT

Probably melt glass, and microimpactor?



Melt feature?



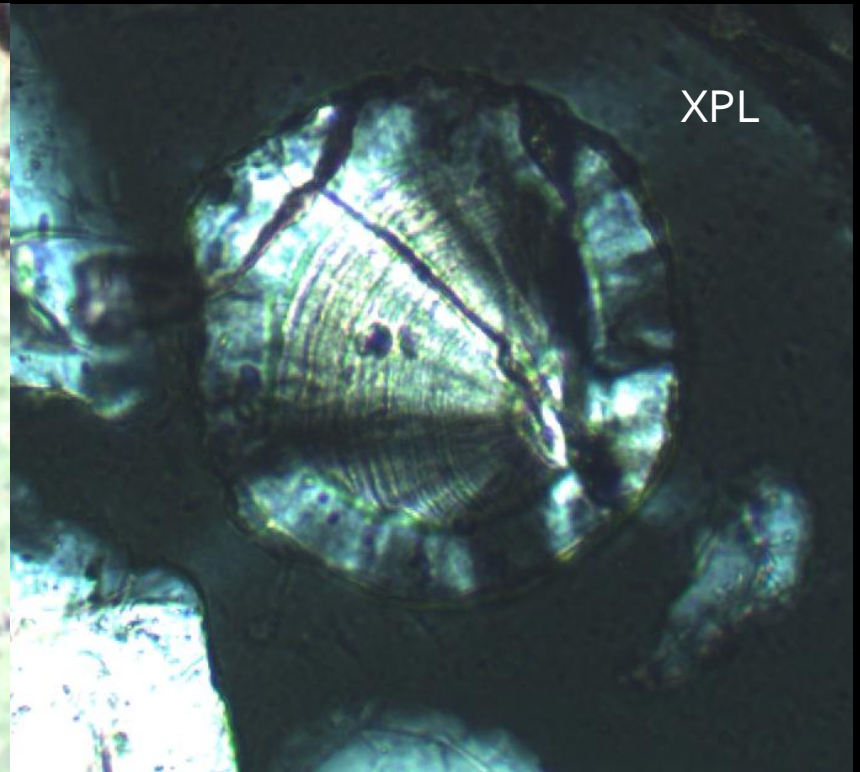
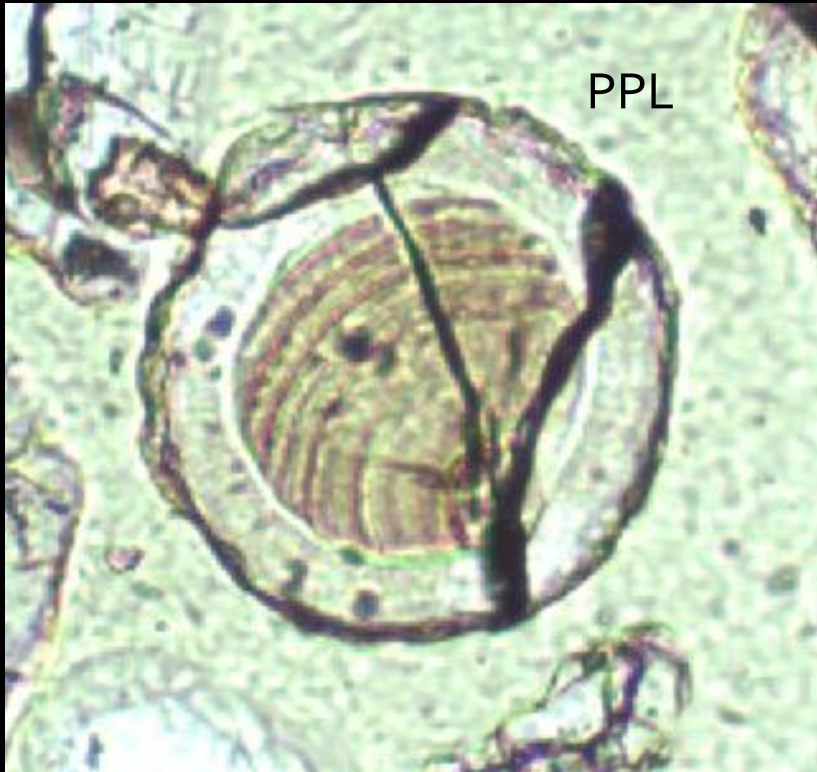
OSSENDRECHT



THE OSSENDRECHT MEDALLION

Note fracture lines, melt rim, and arcuate shock lines?





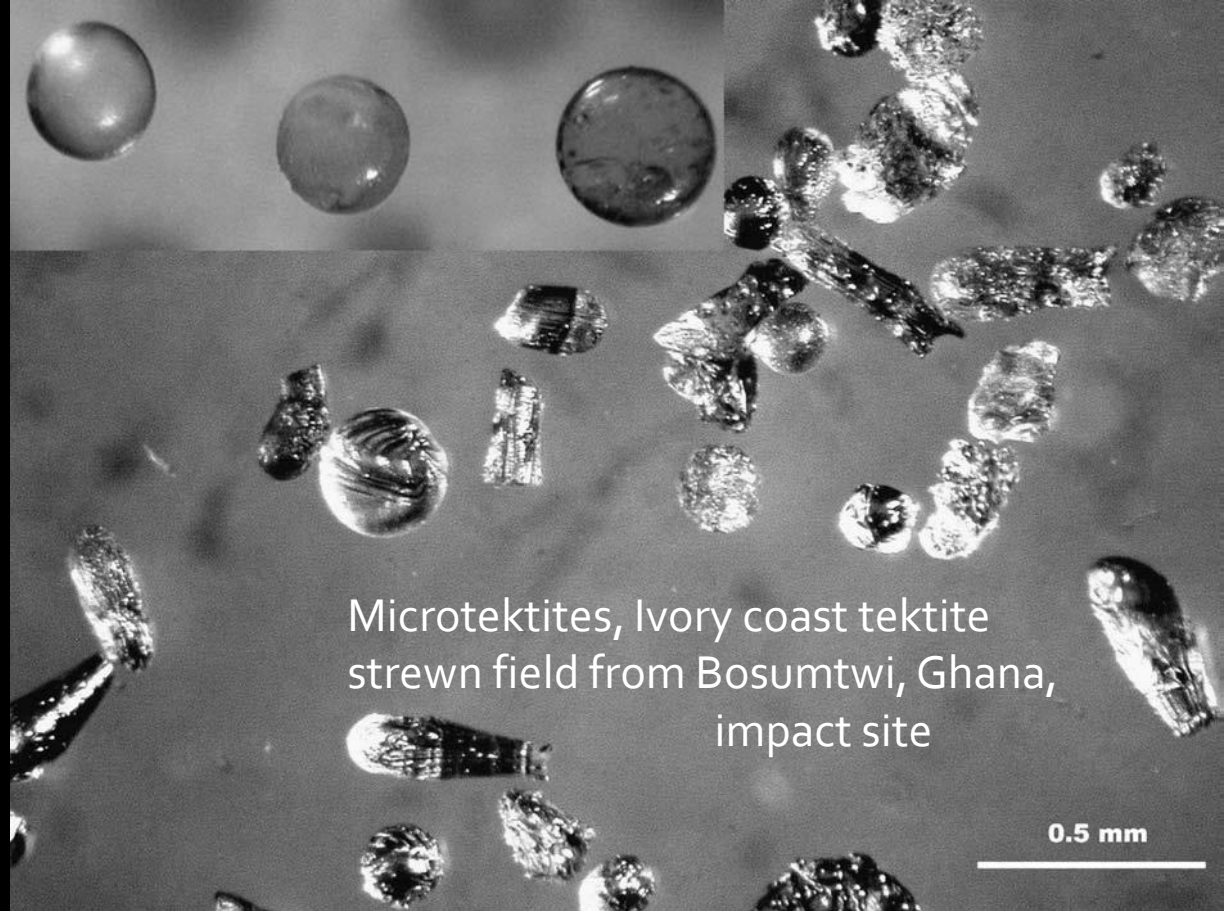
THE OSSENDRECHT MEDALLION

Impactors:

- Meteorites
- Asteroids
- Comets
- Airburst

French and Koeberl 2010 Acceptable Impact SIGNATURES

1. Crater
2. Breccia
3. Shatter cones
4. Shocked quartz
5. Tektites
6. Spherules and microspherule ejecta
7. Coesite, stishovite
8. Ir, Pt [Ni is mined at Sudbury Impact site; may not always be ET)
9. Melt glass – lechatelierite



Microtektites, Ivory coast tektite strewn field from Bosumtwi, Ghana, impact site

0.5 mm

EXTRATERRESTRIAL IMPACT SIGNATURES

Shatter cones

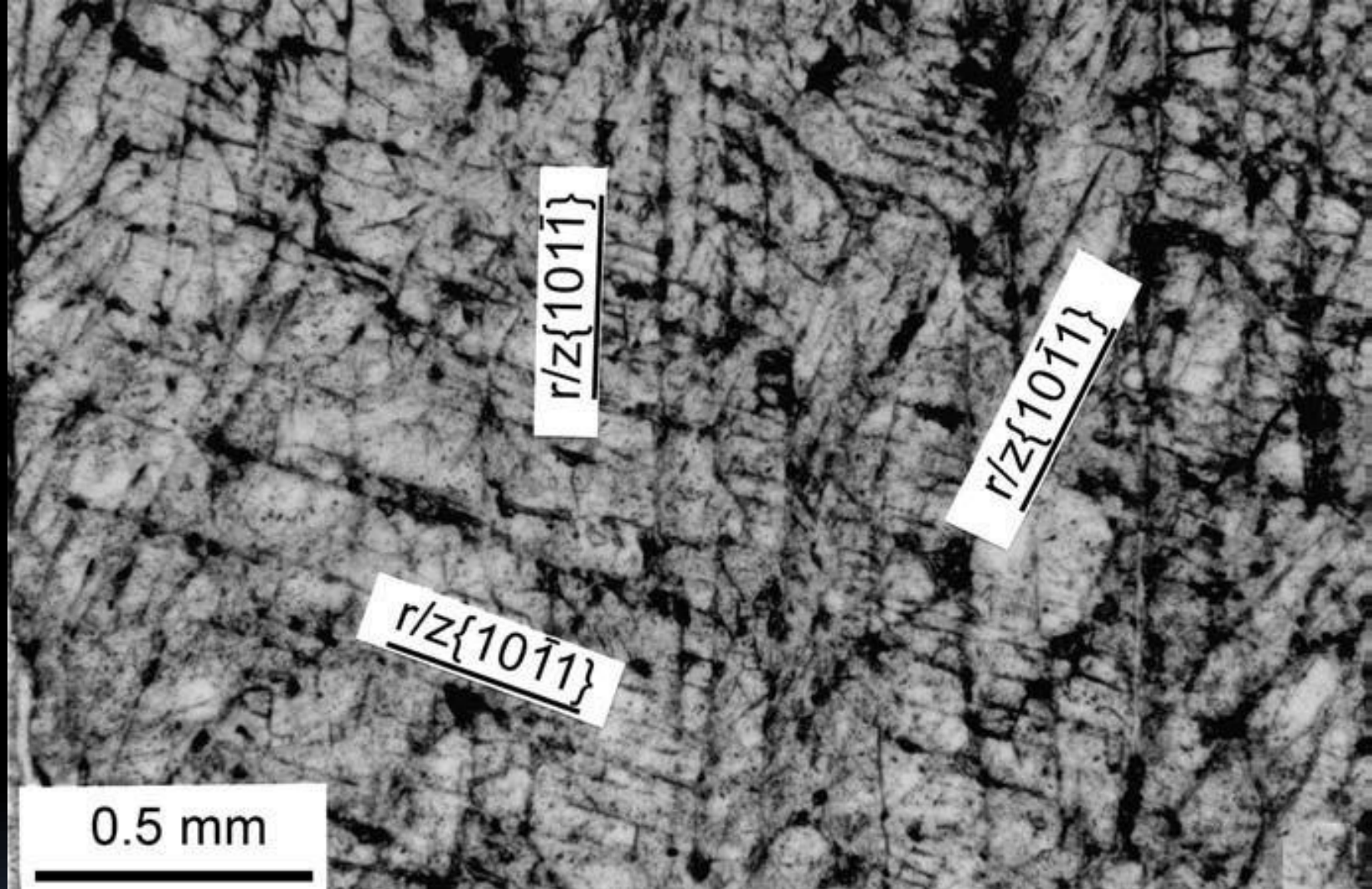


4cm

French and Koeberl 2010

“mare’s tail” features

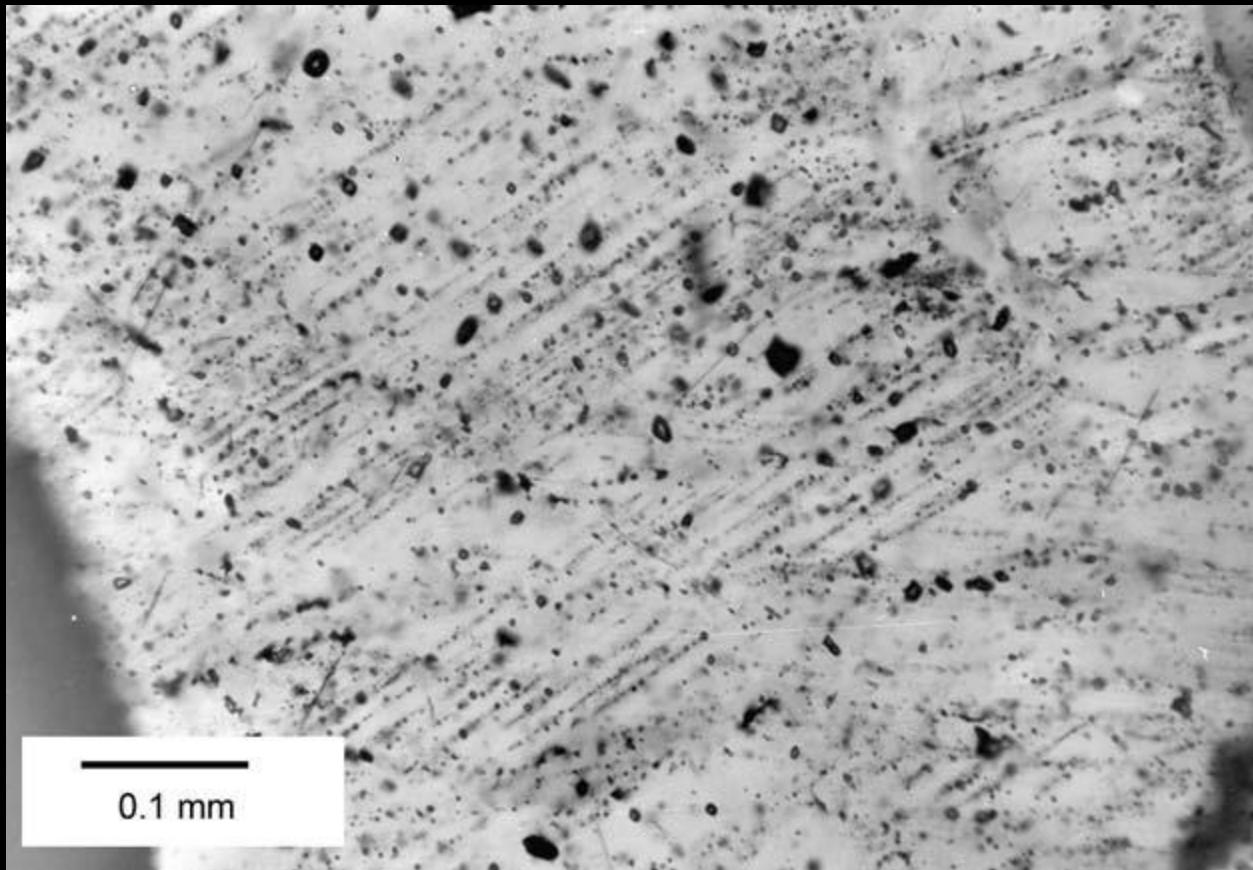
EVIDENCE OF IMPACT



Rock Elm Impact Site Wisconsin

French and Koeberl 2010

CLASSIC SHOCKED QUARTZ - PDFS

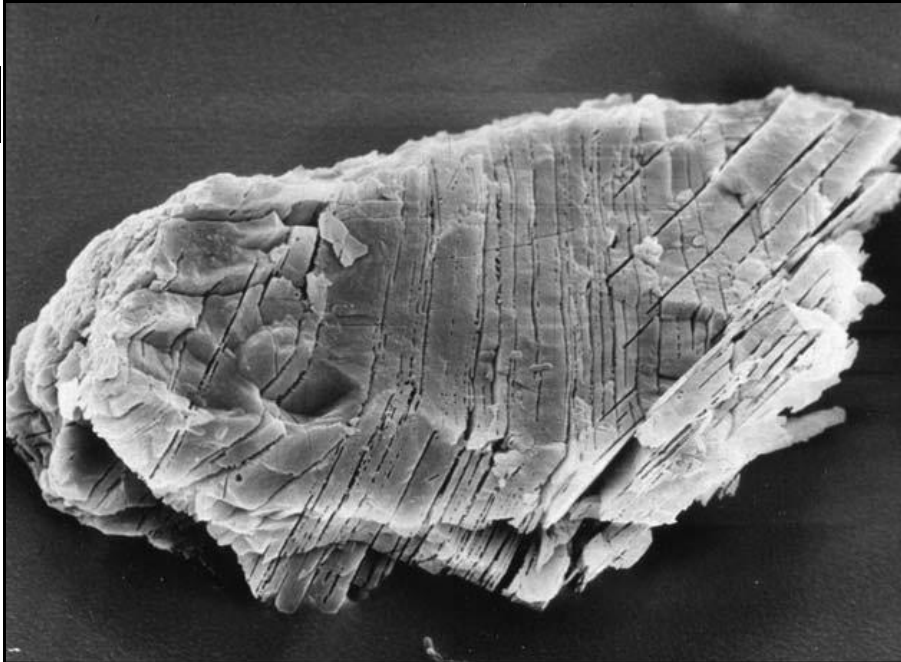


quartz grain from a granite inclusion in a metamorphosed suevite deposit

French and Koeberl 2010

PDF = Planar Deformation Feature

DECORATED PDFS - BUBBLES



10µm 20KV 03 111 S

Acid etched shocked quartz KT Impact
South Pacific DSDP drilling site 596
French and Koeberl 2010



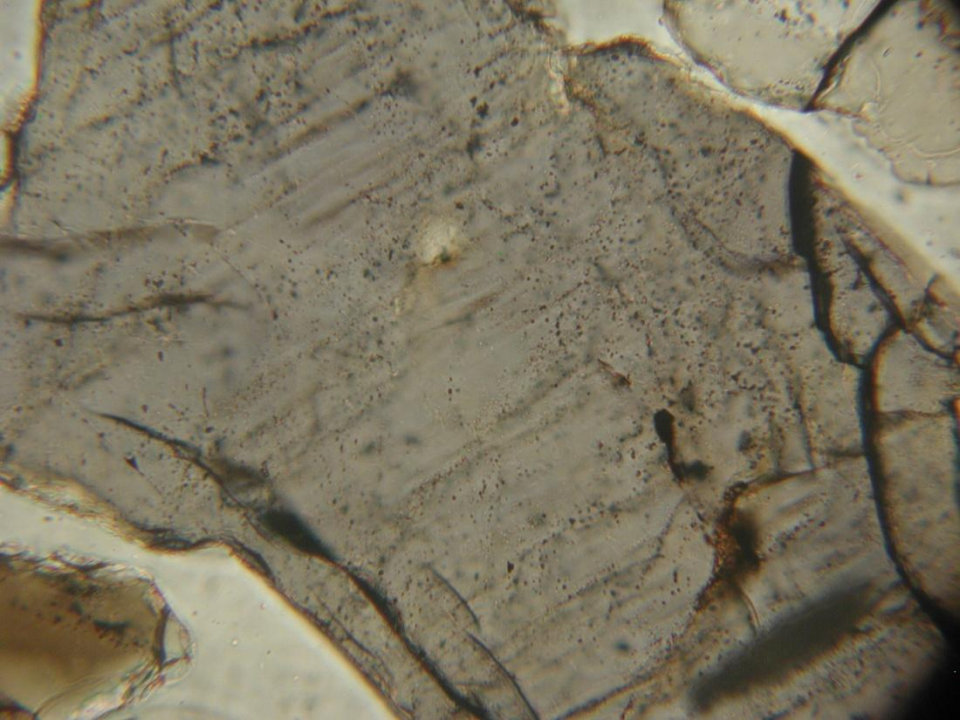
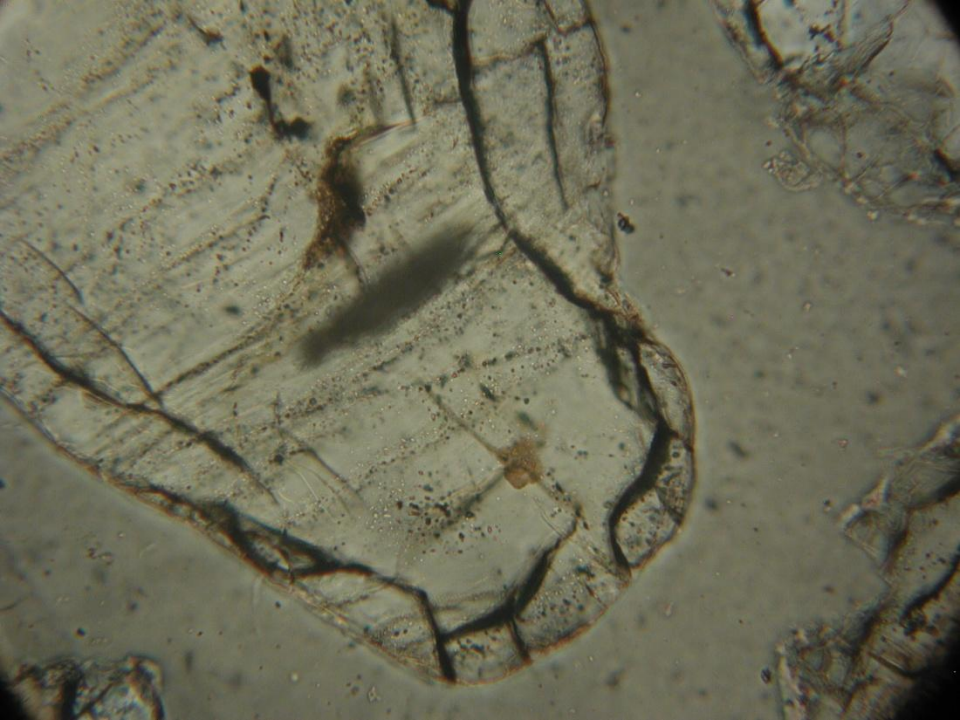
HV | Mag | WD | Det | Spot
15 kV | 800 x | 10.3 mm | not connected | 4
20 µm

Detail, Ossendrecht quartz
grain, SEM, not acid etched



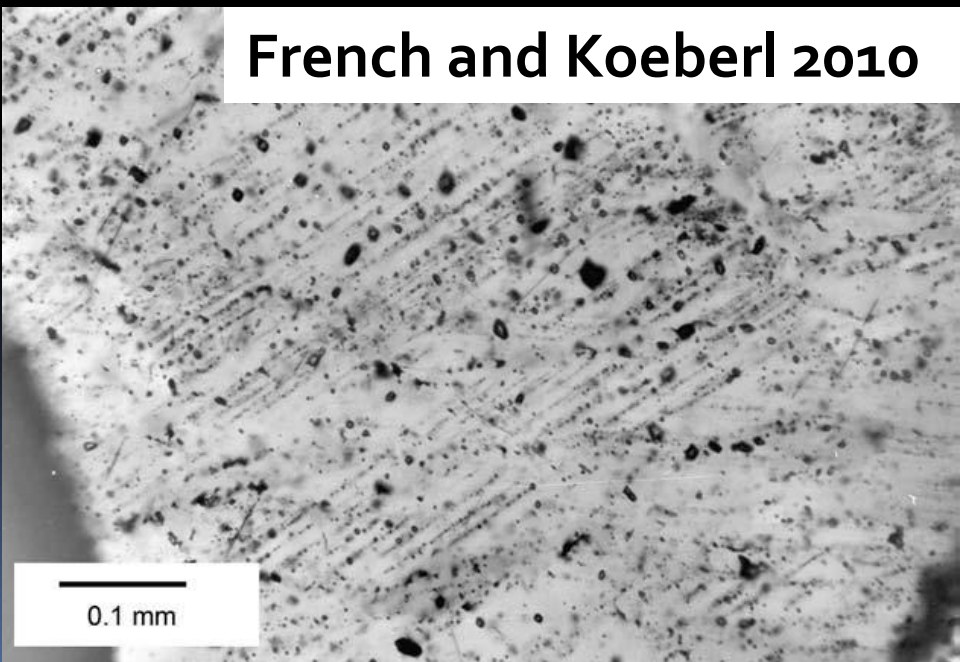
HV | Mag | WD | Det | Spot
15 kV | 200 x | 10.2 mm | not connected | 3
100 µm

SHOCKED QUARTZ AT OSSENDRECHT?



**OSSENDRECHT –
POSSIBLE PDFS**

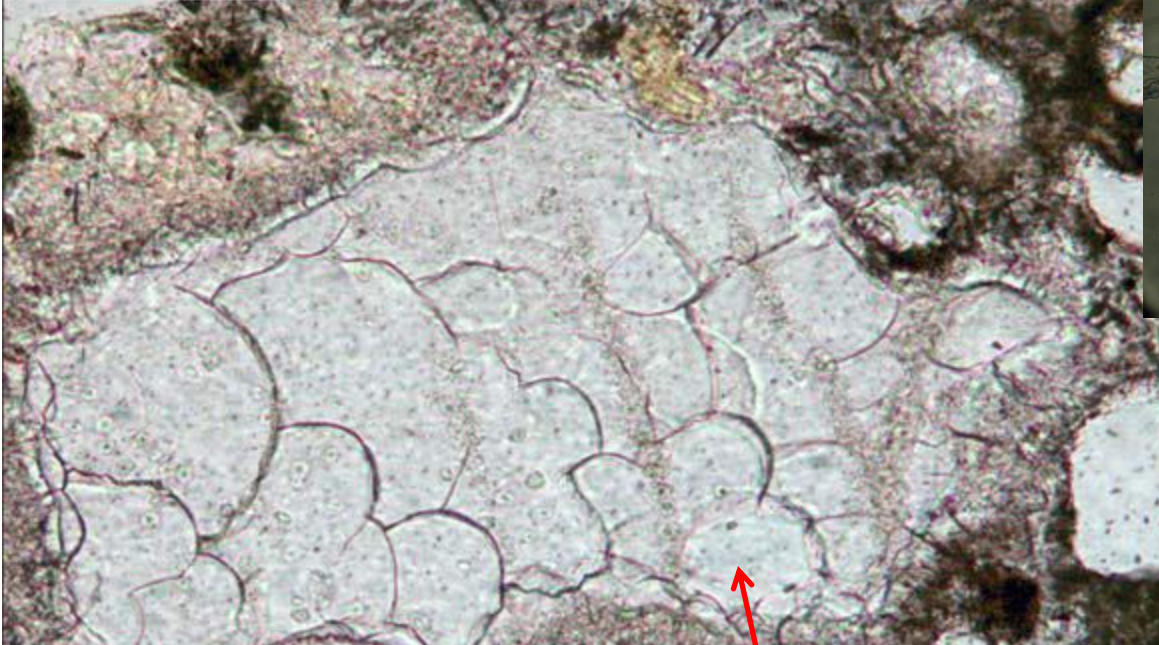
French and Koeberl 2010



0.1 mm

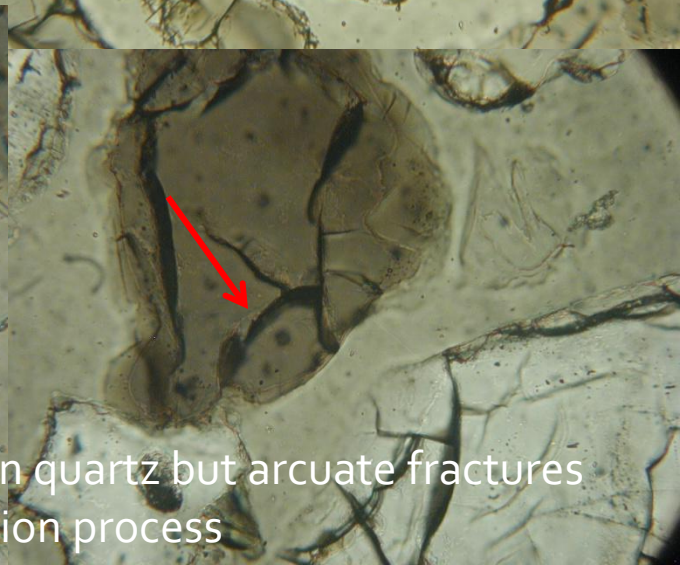
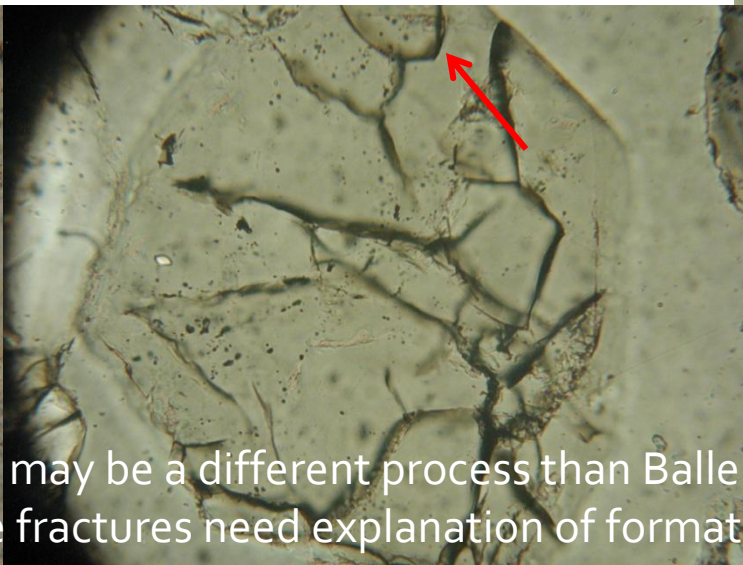
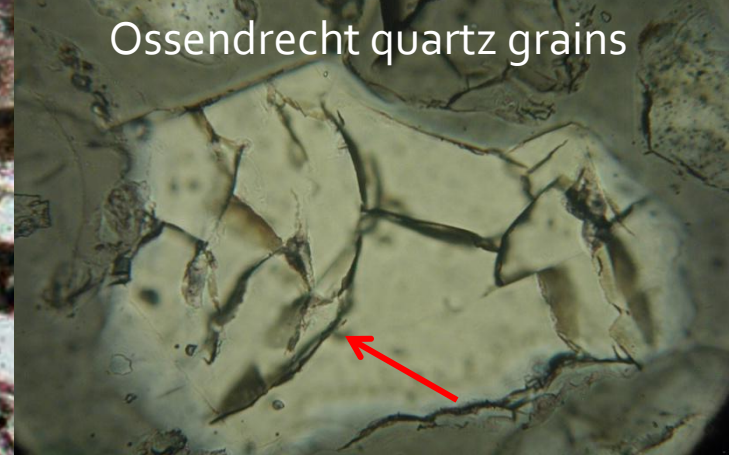
100 μm

BALLEN QUARTZ

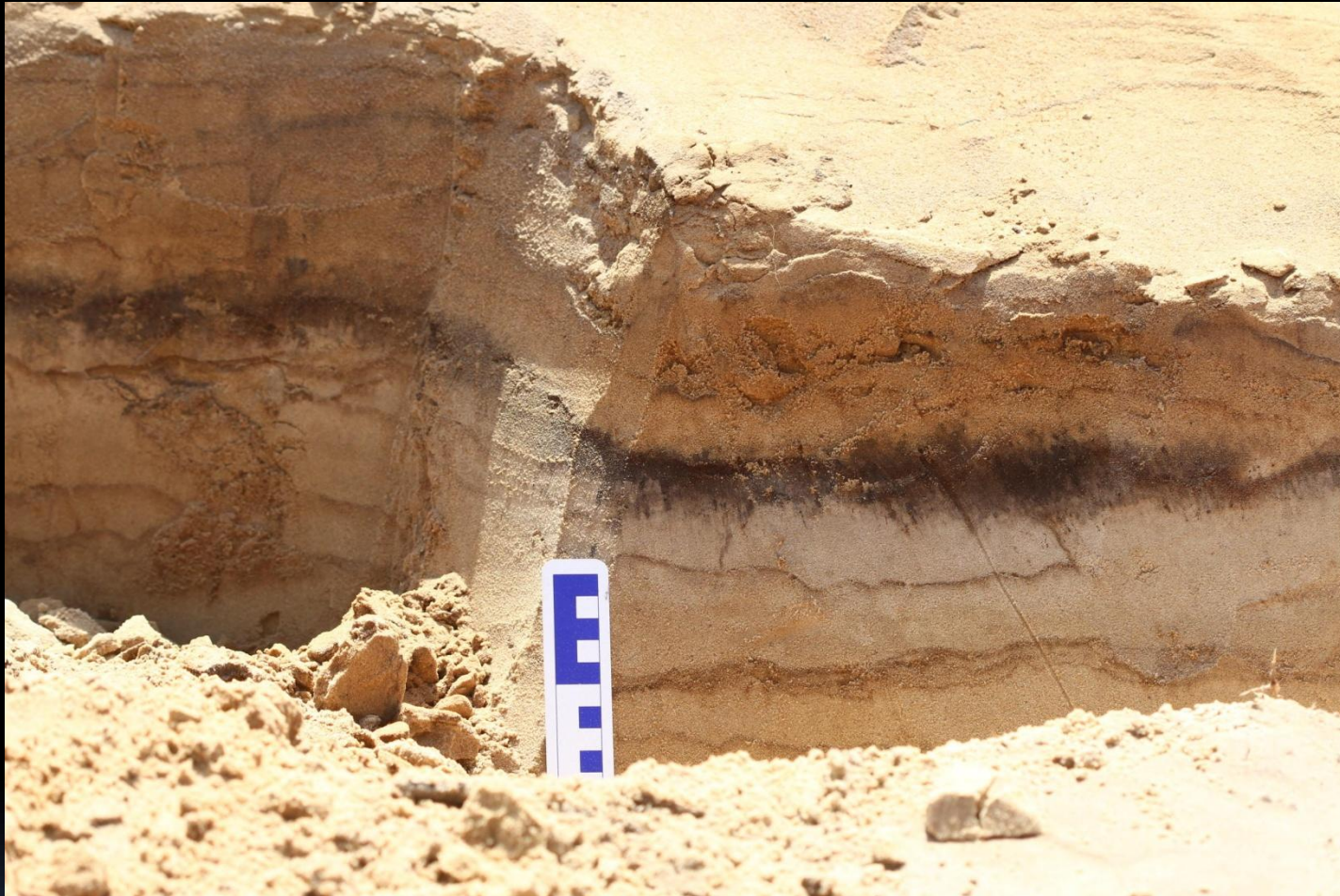


French and Koeberl 2010

Ossendrecht quartz grains



Ossendrecht grains may be a different process than Ballen quartz but arcuate fractures and parallel arcuate fractures need explanation of formation process



**2011 LAARDER WASMEREN
NEAR AMSTERDAM**



**2011 LAARDER WASMEREN
NEAR AMSTERDAM**



Collecting samples with Bas van Geel and Jan Sevink at Laarder Wasmeren

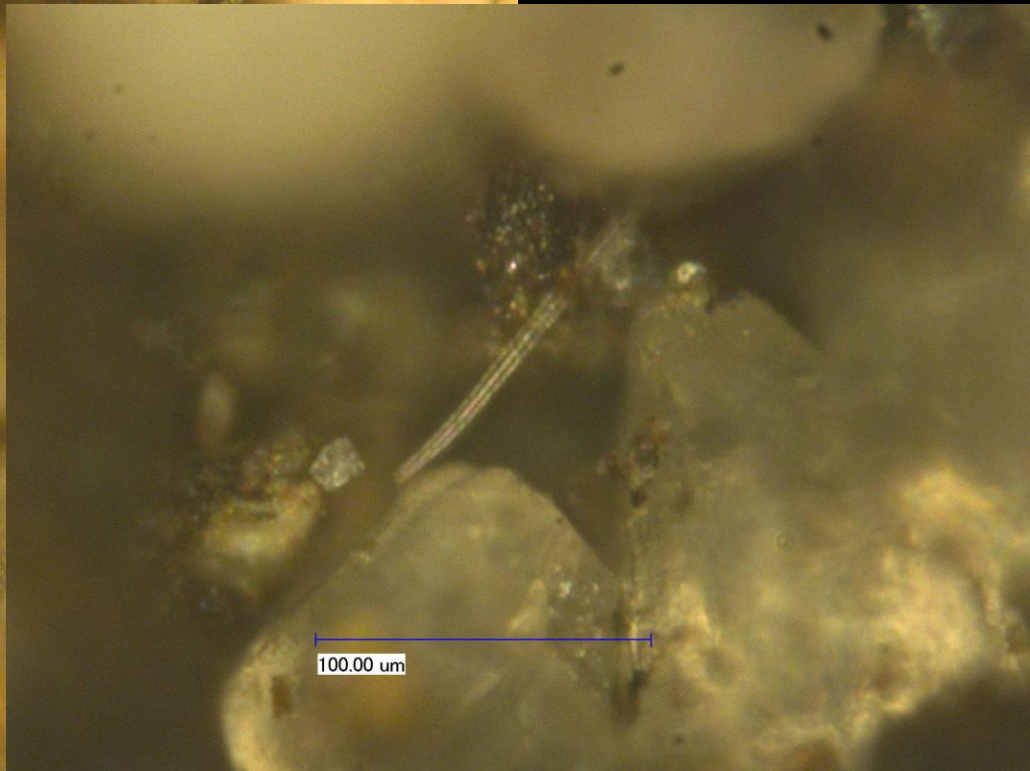


2011 LUTTERZAND, NEAR THE DINKEL RIVER,
EASTERN NETHERLANDS



2011 LUTTERZAND





Quartz needles –some may be sponge spicules
(tapered ends)

2011 LUTTERZAND



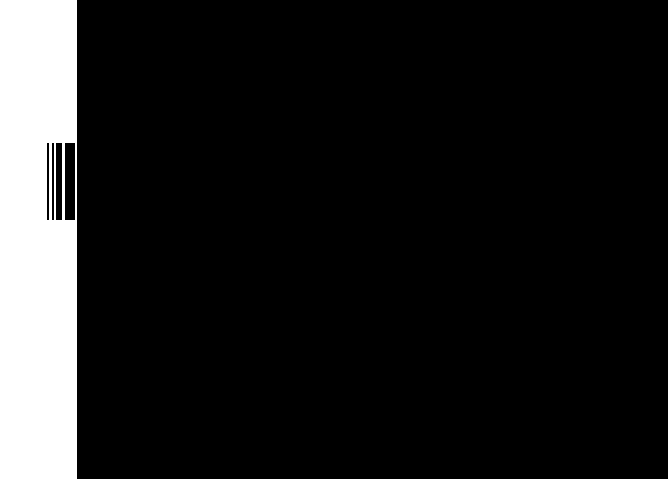
Fused quartz shard

2011 LUTTERZAND



Fresh looking wood fragment – not weathered
Likely quartz melt coating has preserved it

2011 LUTTERZAND



2011 LOMMEL, BELGIUM



More quartz needles at Lommel, may link Usselo in space and time – if sponge spicules, why do they appear at all three sites in the Usselo layer?

2011 LOMMEL, BELGIUM

'Bleaching' due to Nitric acid rain, organic acids?

Initial Xray Fluorescence analysis on dark laminations,



Si 49.9 %
Al 1.5 %

LE 48.2 %
(H,He,Li,
Be, B, F, Ne
C, N, O, Na)
LE= light
elements,
anything below
Mg in Periodic
Table

Fe 0.4
Ni 0.012
Zr 0.011
Zn 0.005
Sr 0.004

2011 LOMMEL, BELGIUM XRF

Melt glass with black grain fused to it



From the
bleached
horizon

2011 LOMMEL, BELGIUM



Charcoal in the laminations

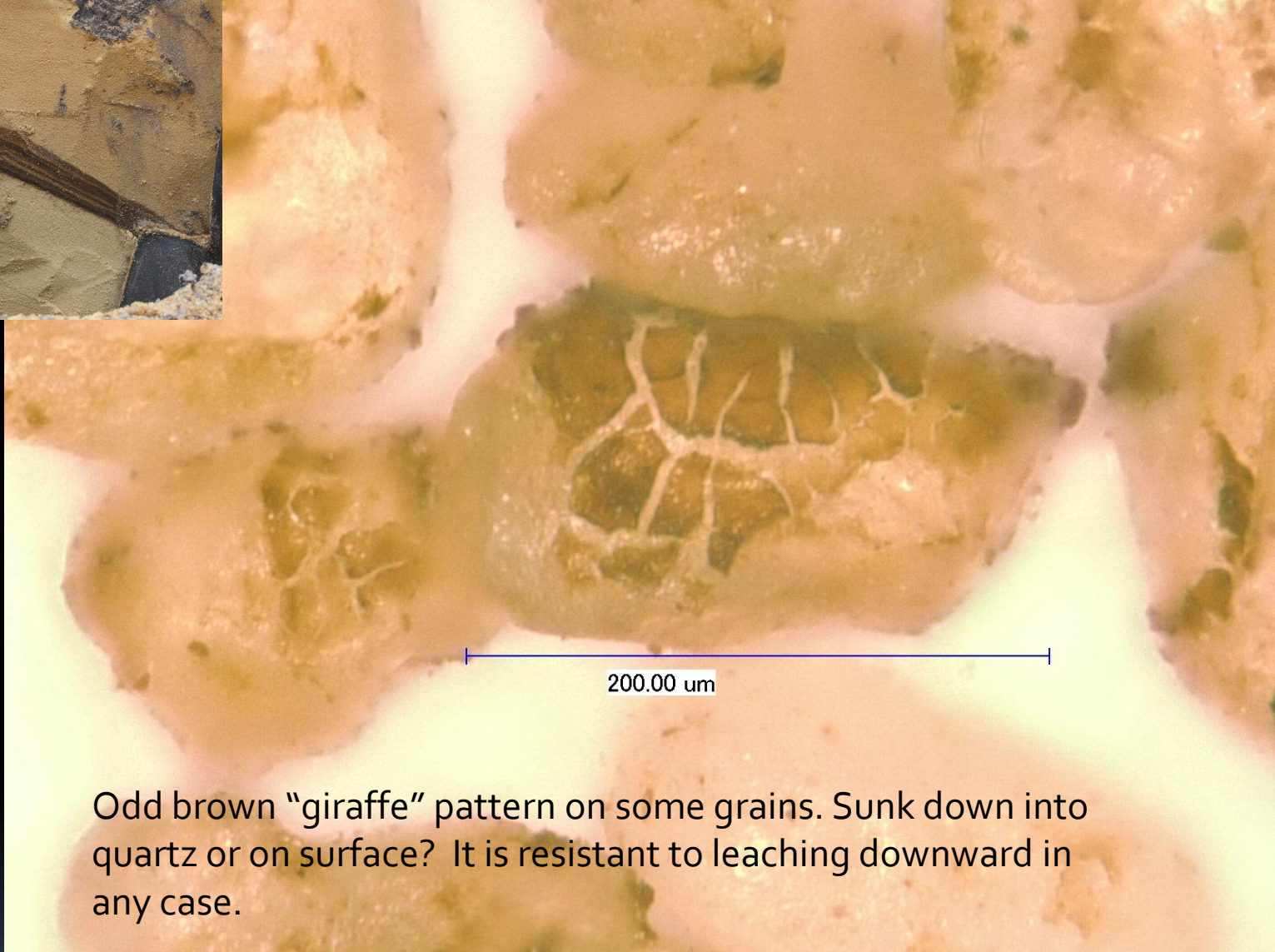


2011 LOMMEL, BELGIUM



Quartz needles (sponge spicules?) at all three locations

2011 LOMMEL, BELGIUM



Odd brown "giraffe" pattern on some grains. Sunk down into quartz or on surface? It is resistant to leaching downward in any case.

2011 LOMMEL, BELGIUM

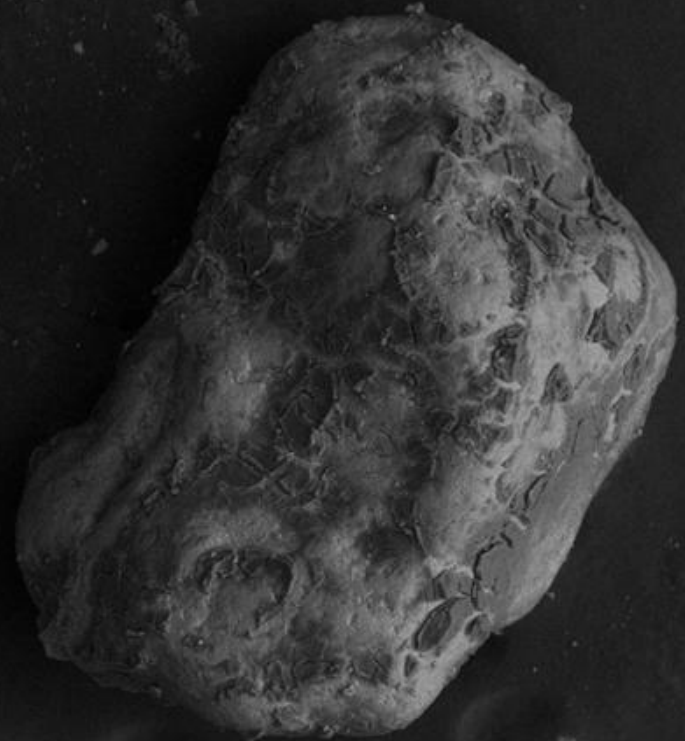
Brown material is surficial but fused, perhaps by organic acids of microorganisms?



13U

X120 100µm

13U



X140 100µm

Possible algae residue on sand that had nutrient input of nitric acid rain for the period of time that the laminations formed. Wetting/drying cycles and additional sand deposited over algal layer resulted in desiccation of algae.

2011 LOMMEL, BELGIUM



Lommel, BE



Laarder Wasmeren



Lutterzand



- * Possible microimpactors into quartz grains
- * Fused grains
- * Quartz "needles" at 3 locations
- * Melt glass – in the bleached layer
- * Possible shocked quartz
- * Likley algal layer at Lommel, due to sudden nutrient input

Hypotheses

- * This is an extraterrestrial event horizon
- * Bleached horizon is due to nitric acid rain
- * Laminated section is nutrient-triggered algae layers with repeated nitric acid rain showers and desiccation
In between



Dark layer is not a result of eluviation
Contains abundant charcoal
Light layer is below not above dark horizon
There is no Eluviated zone below the
bleached-looking horizon in most
Ussele layers

Illuvation moves cations downward to
Eluviated E horizon in B horizon.
B horizon is typically white or gray, and
depleted in nutrients.
Podzols (spodosols) occur in coniferous
forest regions

USSELO HORIZON VS. PODZOLS



Usselo horizon,
Lommel, Belgium



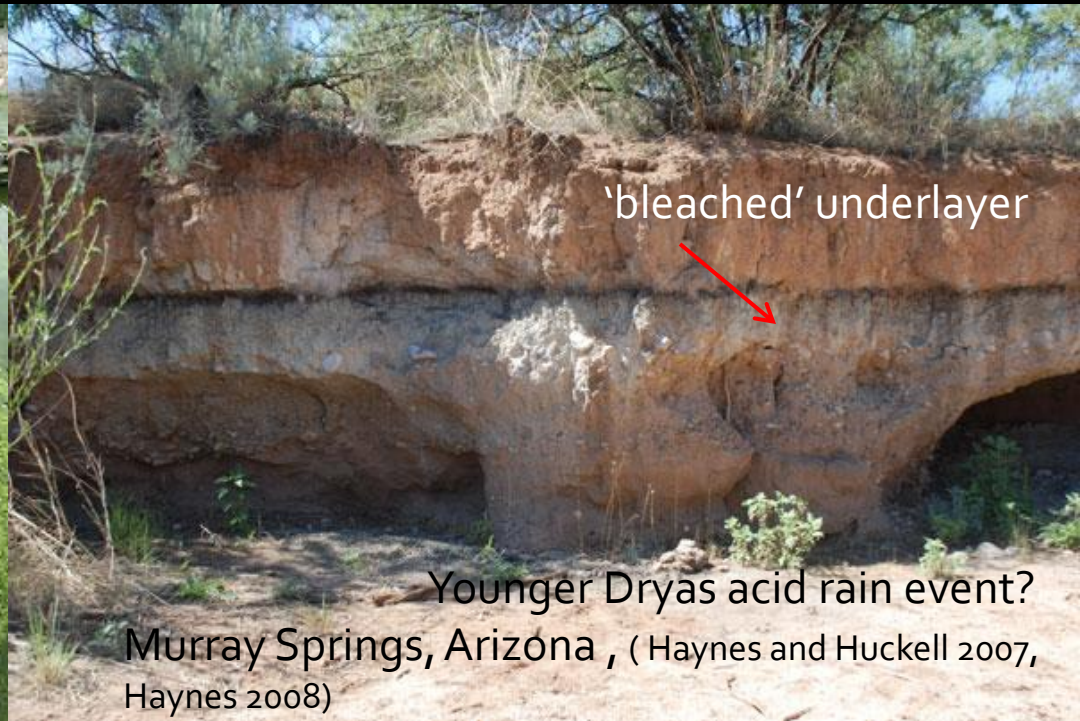
Hungary Placic Albic Podzol

COMPARE TO PODZOLS

Global Distribution of Spodosols




PODZOL DISTRIBUTION MAP



**SUDDEN EXPANSION OF DIATOMS AND ALGAE TAXA
WITH NITRIC ACID RAIN INPUT
BLEACHED SECTION UNDER BLACK MATS MAY BE DUE TO NITRIC
ACID RAIN**

Younger Dryas 12,900 Cal yrs BP



Need C & N isotope data on laminated layer ($\delta^{13}\text{C}$ vs C/N to support algae signal)

Further XRF for platinum evidence

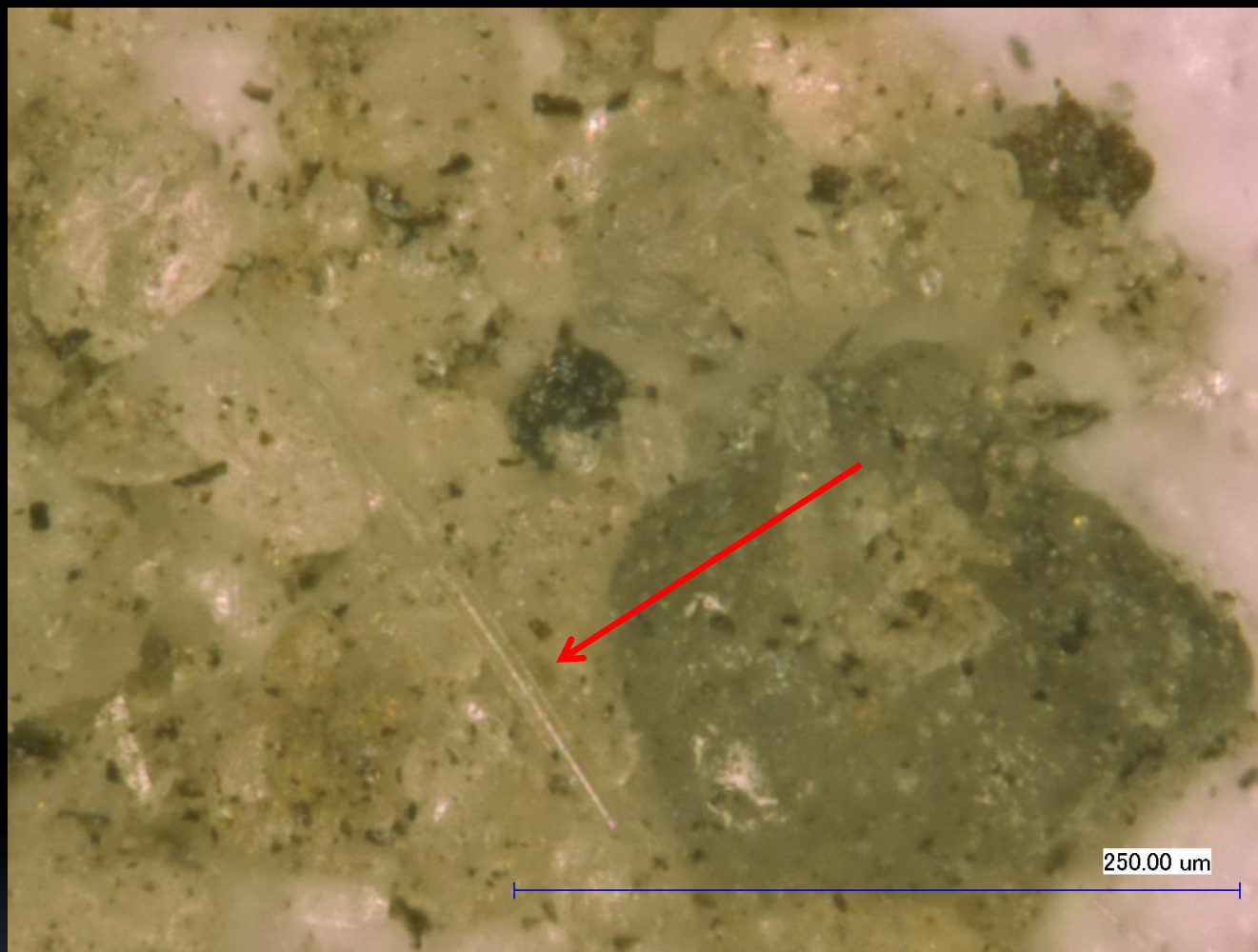
Test for nitric acid rain- enriched in ^{17}O (nitrates from shock wave break down ozone which is enriched in ^{17}O)

More thin sections to compare grains at different depths to establish that the Usselo horizon is unique in its internal fractures, fused grains, etc.

Analyze abundant dark, rounded micrograins for mineralogy, geochemistry



**FUTURE WORK,
RESEARCH QUESTIONS**



Quartz needles at all three locations

2011 LOMMEL, BELGIUM



Quartz needle

2011 - LOMMEL, BE



Quartz needle

2011 - LOMMEL, BE



Quartz needles at all three locations

2011 LOMMEL, BELGIUM



Quartz needles at all three locations

2011 LOMMEL, BELGIUM





2011 LUTTERZAND



Collecting samples from documented severe forest fire in the Netherlands for comparison to Usselo quartz grains. Samples not yet processed



2011 – MODERN FOREST FIRE

Laarder Wasmeren

Ossendrecht

Lutterzand

Lommel



SITES - NETHERLANDS, BELGIUM