

HPC IN THE FIELD: RESEARCH AND RECORDING OF PREHISTORIC ROCK ART USING 3D IMAGE-BASED MODELLING

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DeiC Conference, 4 November 2021



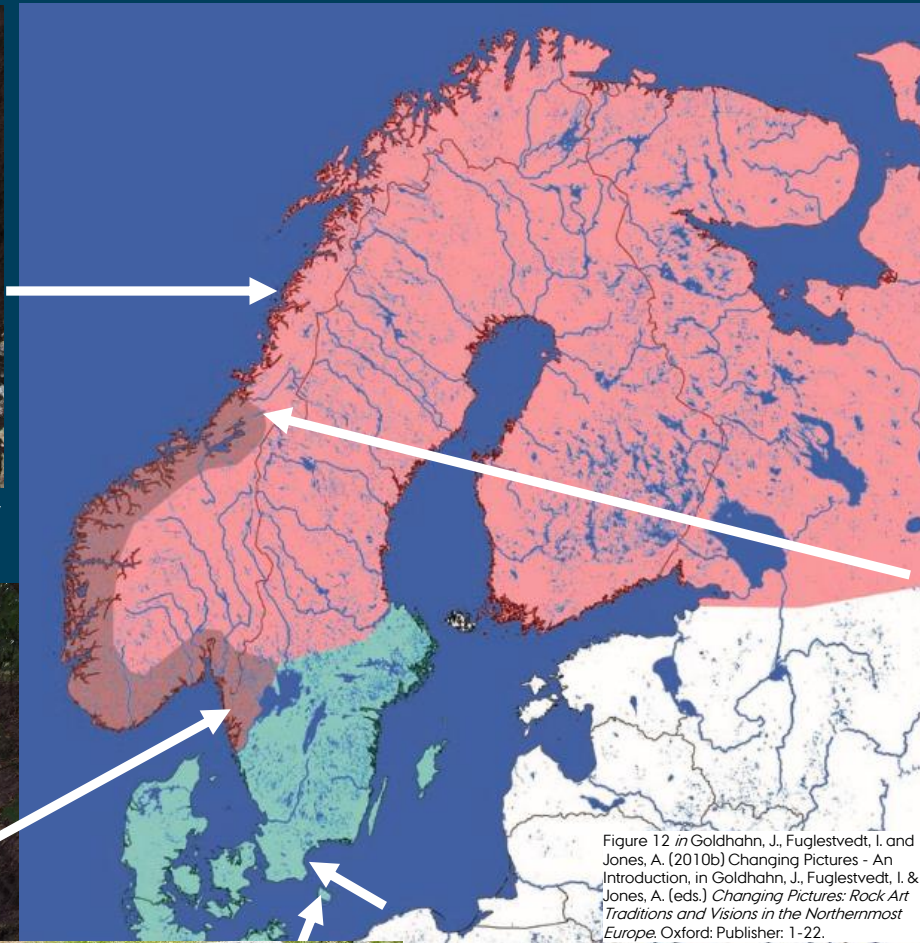
Storløkkebakken 5, 060105-309, Bornholm

Rock Art Research Centre Undersls, and Aarhus University in co-operation with Bornholms Museum.
Processed on AWS.

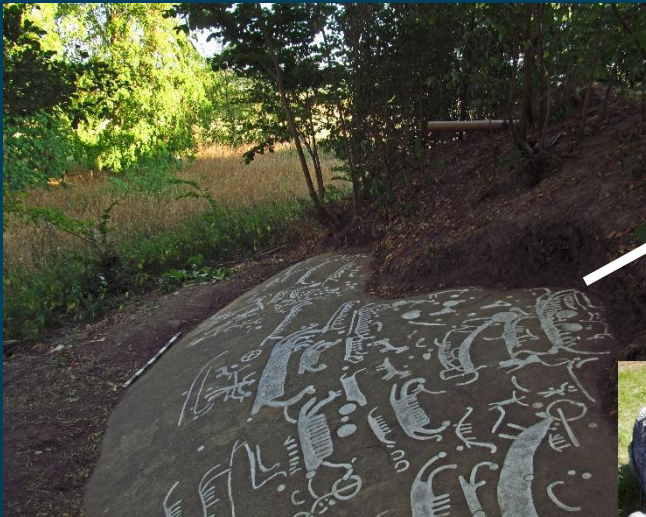
SCANDINAVIAN ROCK ART A (VERY) SHORT INTRODUCTION:



Troihåle, Hamnøya, Nordland, Norway
JDO, 2013, private.



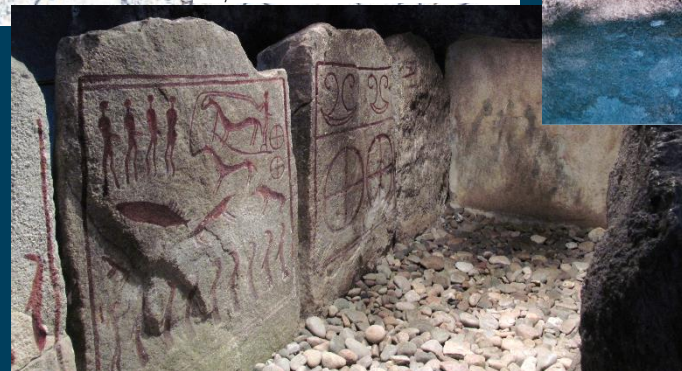
Two groups:
Northern Tradition (red) ca. 6000 BC-900BC
Southern Tradition (blue) ca. 3700 BC-0AD



Slänge, Tanum, Sweden:
 JDO, Rock Art Research Centre Underslös
 (Tanums Hällristningsmuseum Underslös (THU))
 ,Working seminar 2018



Arnager, Bornholm, Denmark
 Kaul/Milstreu 2007
 Rock Art Research Centre Underslös (THU), Sweden.
 Available at www.SHFA.se



Kivik, Sweden
 JDO 2013, private.



Bøla, Trøndelag, Norway
 JDO 2010, private.

Figure 12 in Goldhahn, J., Fuglestad, I. and Jones, A. (2010b) Changing Pictures - An Introduction, in Goldhahn, J., Fuglestad, I. & Jones, A. (eds.) *Changing Pictures: Rock Art Traditions and Visions in the Northernmost Europe*, Oxford: Publisher: 1-22.

THE PROJECT

a (very) short introduction:

Dissertation:

Signs, structure and cryptanalysis

- Analysing rock art as a graphic code using linguistic methodologies

Supervised by

*Associate Professor Jens Bjørn-Riis Andresen,
(Aarhus)*

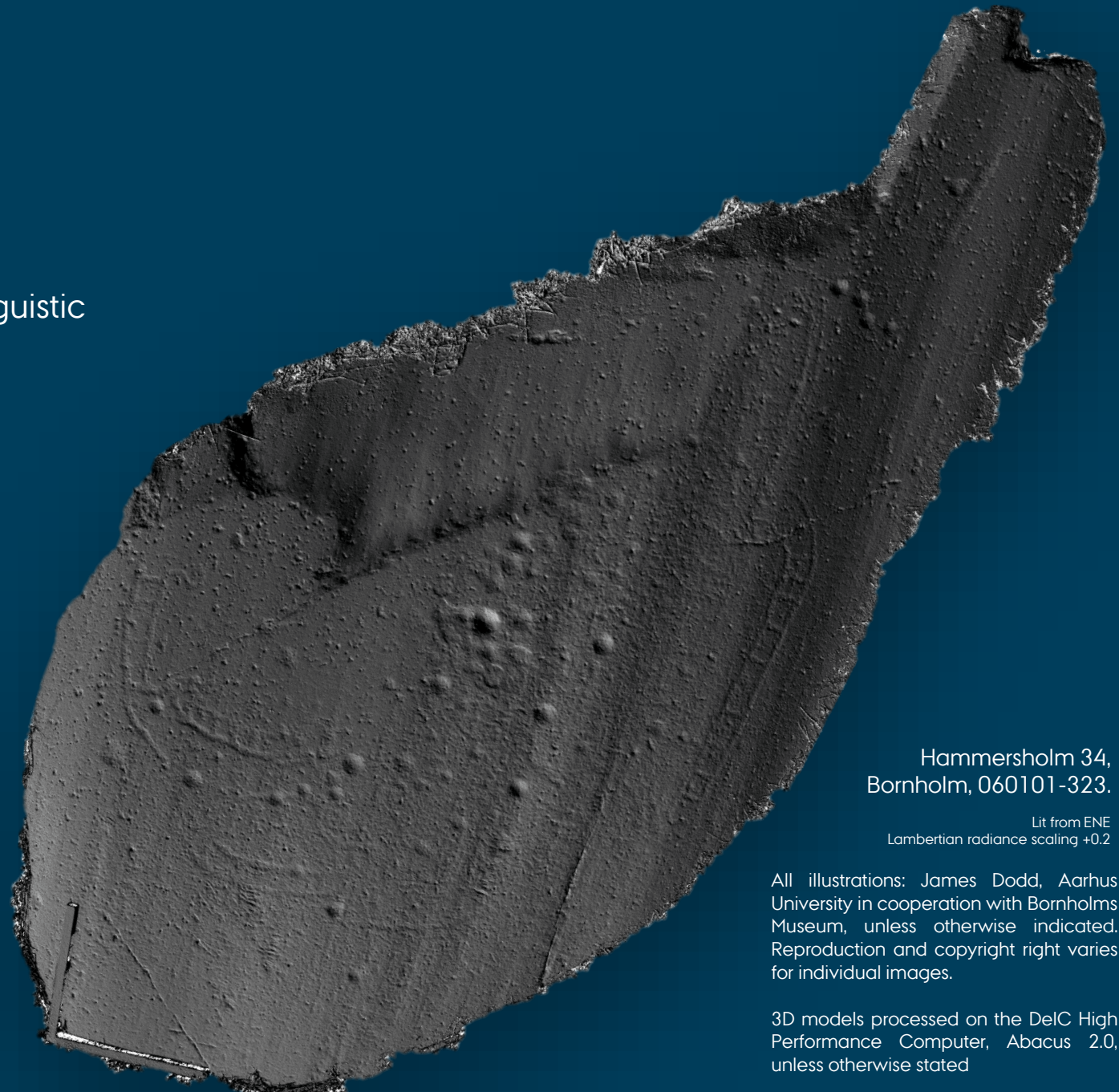
*Professor Johan Ling
(Gothenburg)*

Thanks are extended to:

The Dean of Aarhus University for providing the software licences to enable processing of the image based models



AARHUS UNIVERSITY



Hammersholm 34,
Bornholm, 060101-323.

Lit from ENE
Lambertian radiance scaling +0.2

All illustrations: James Dodd, Aarhus University in cooperation with Bornholms Museum, unless otherwise indicated. Reproduction and copyright right varies for individual images.

3D models processed on the DeiC High Performance Computer, Abacus 2.0, unless otherwise stated

DOCUMENTATION IN THE RESEARCH PROCESS

- Documentation is the basic foundation of research
- Recordings form the transparent basis for observations
- Rock art is a three dimensional medium



Storløkkebakken 5, 060105-309, Bornholm

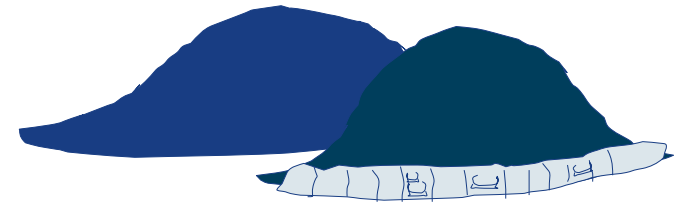
Rock Art Research Centre Undersl s, and Aarhus University in co-operation with Bornholms Museum.

Processed on AWS.



Detail of Madsebakke West, 060101-129, Bornholm

DOCUMENTING ROCK ART IN 3D



Recording:

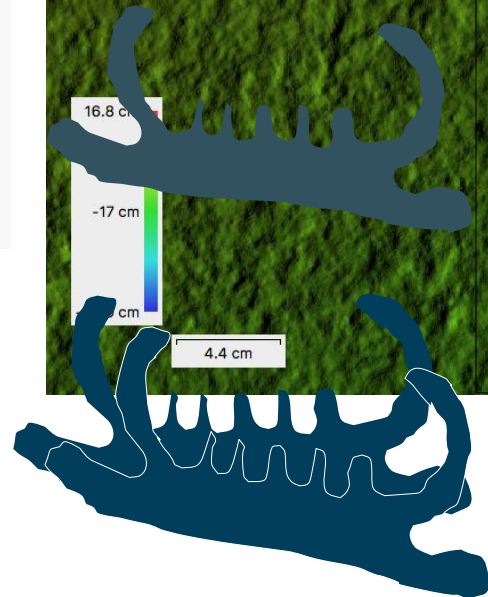
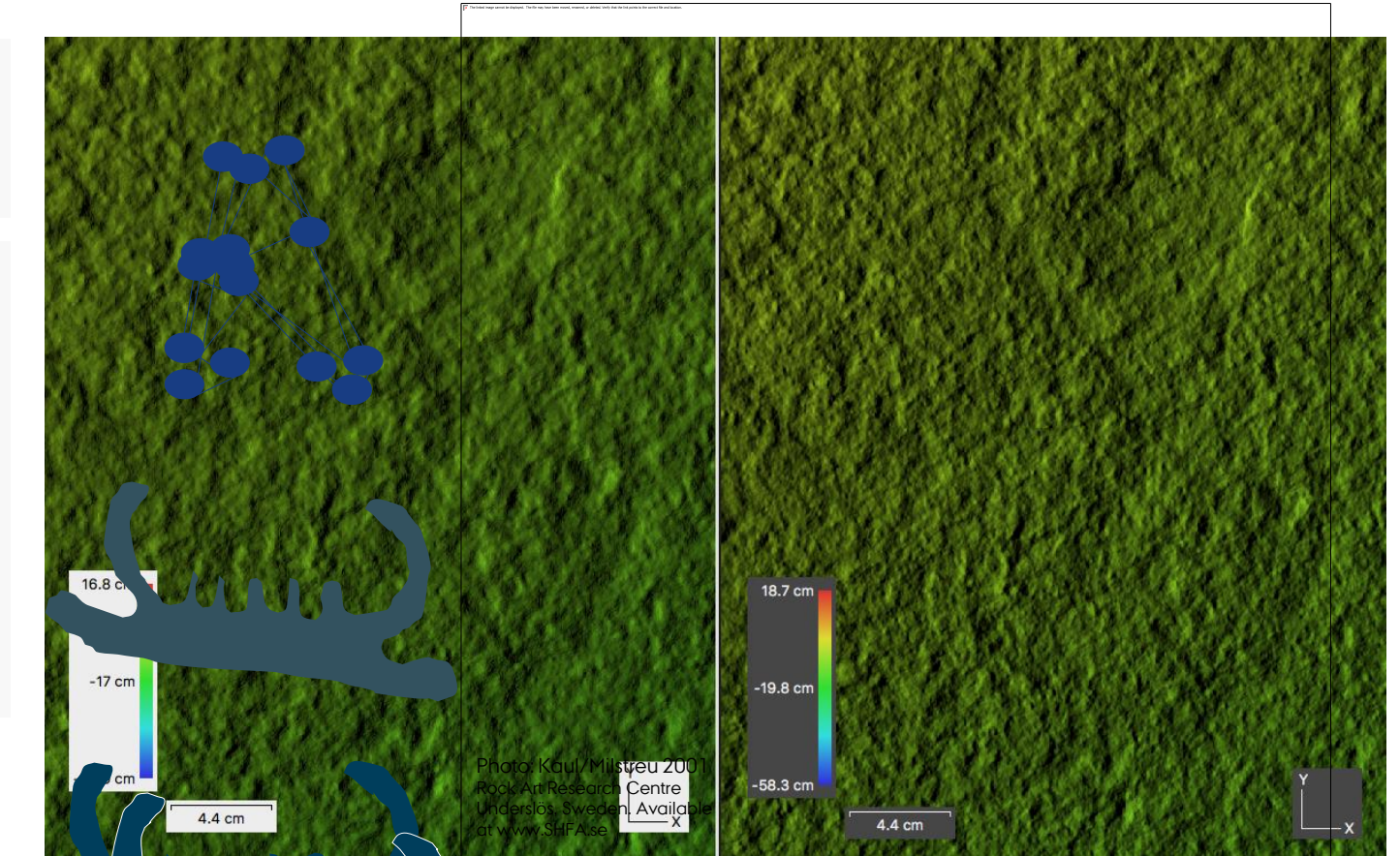
- Entire surfaces, incl. natural environment
- Detail at various scales

Identification:

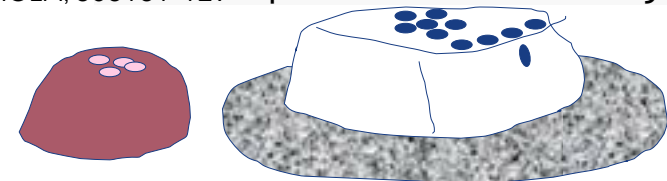
- Requires appropriate visualisations
- We need techniques to assist recognition the patterns (the figures) in 3D
- Need to take account of relations
- Methodology must be transparent and reproducible

Challenges:

- Difficult to process at required quality
- Visualisation methods are few, have known disadvantages and settings cannot be saved with the model

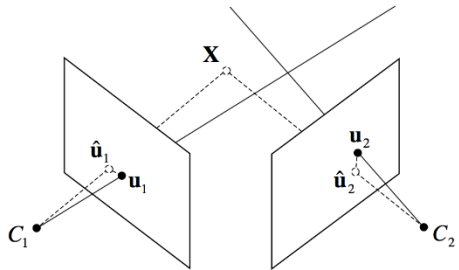


MADSEBAKKE (WEST), BORNHOLM, 060101-27 Resampled (left) versus original (right)



MULTIPLE VIEW STRUCTURE FROM MOTION

3D from images



OUTPUTS

- Meshes, DEM's, orthophotos, point clouds



BMR 2957-1 Blåholtskov 1,
North Bornholm.

Tanum 285:1

Painted illustration, 2018.

©Tanums Hällristningsmuseum, Underslös

Group V: Silvia de Giorgi, Benedikte Tarp,
Josephine Pedersen, Marie Petterson & James Dodd;
*with assistance on the final day
from Ditte Kofod & Ellen Meijer*



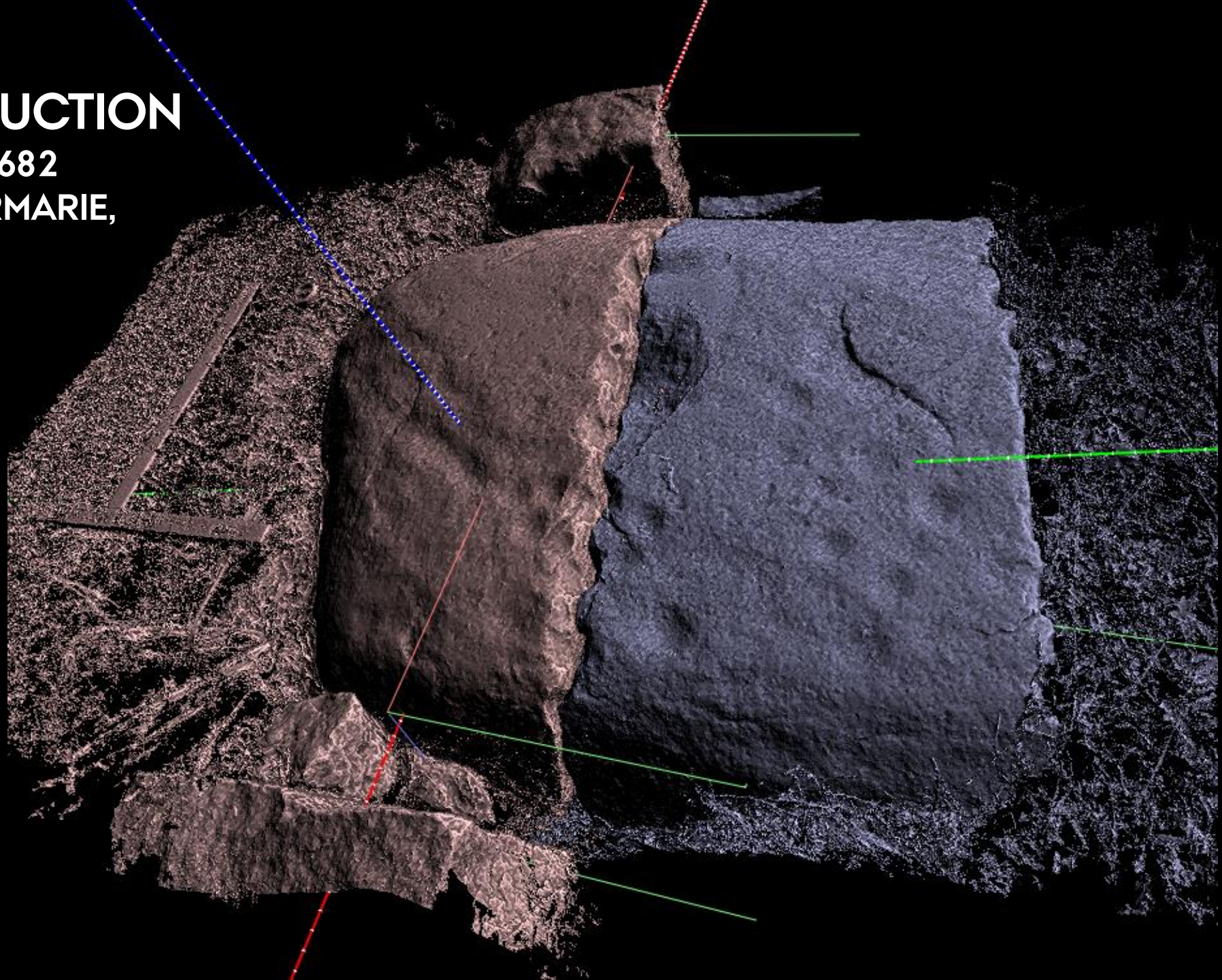
Orthophoto from SfM processed
courtesy of Aarhus University
on the Danish e-Infrastructure Collaboration's
High Performance Computer: Abacus 2.0

DIGITAL RECONSTRUCTION

BMR 2924-30 / SB 060305-682

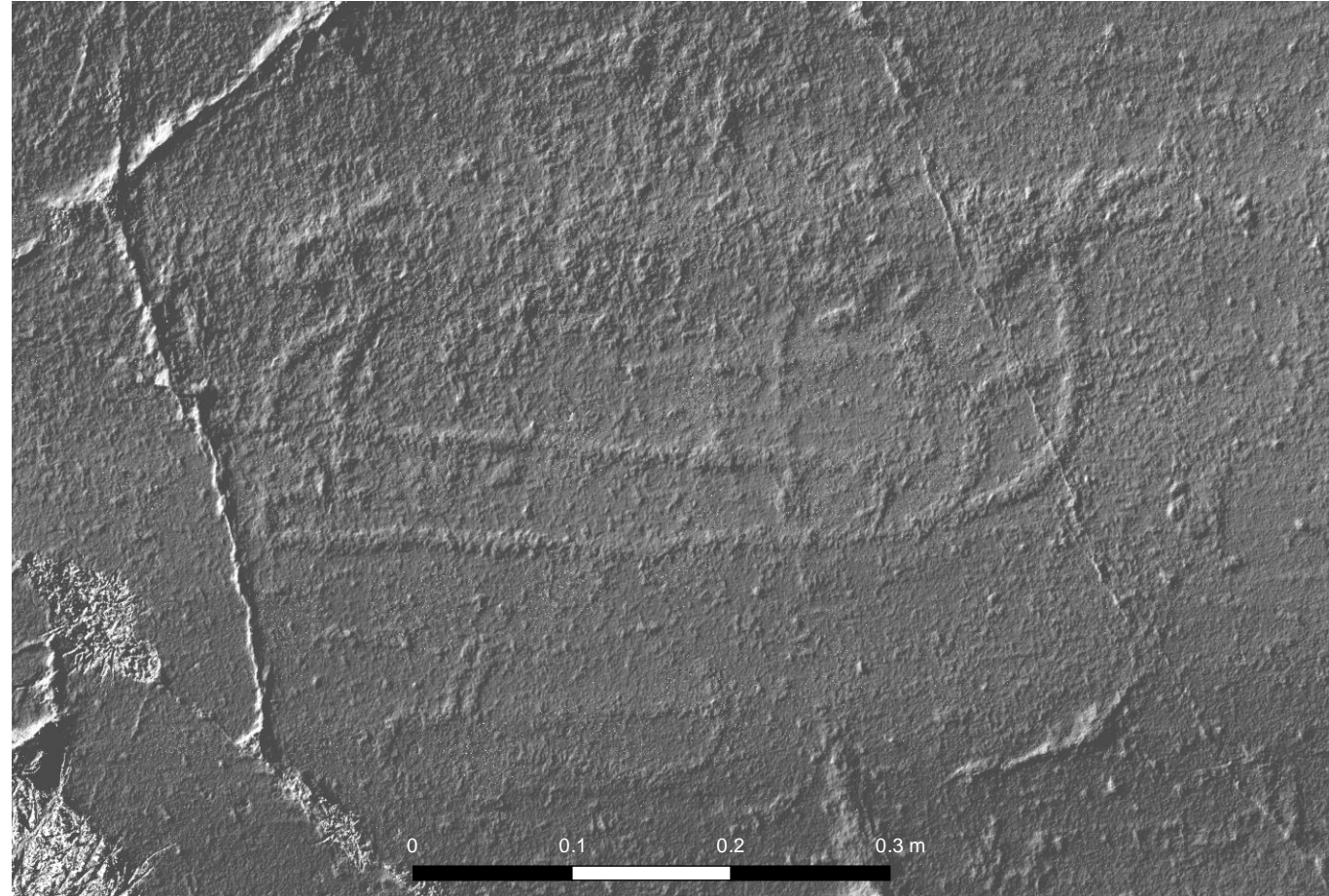
ST. DALBYGÅRD 30, VESTERMARIE,
BORNHOLM, DENMARK

Meshes aligned
in Meshlab



OPPORTUNITIES AND PROBLEMS: IMAGE BASED MODELLING

- Surface based documentation is an essential foundation of research.
- Computing power is necessary to capture detail.
- Results redundant by the time they are ready.
- Model usually processed as part of post-excavation work, or overnight.

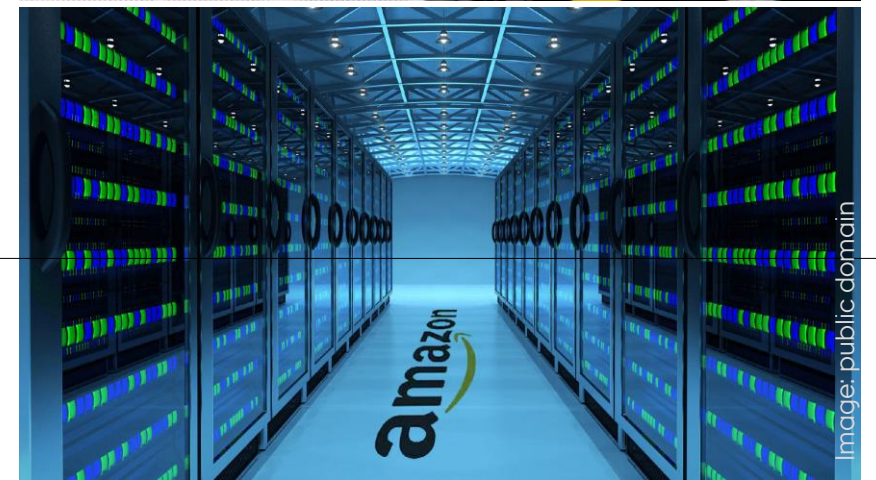
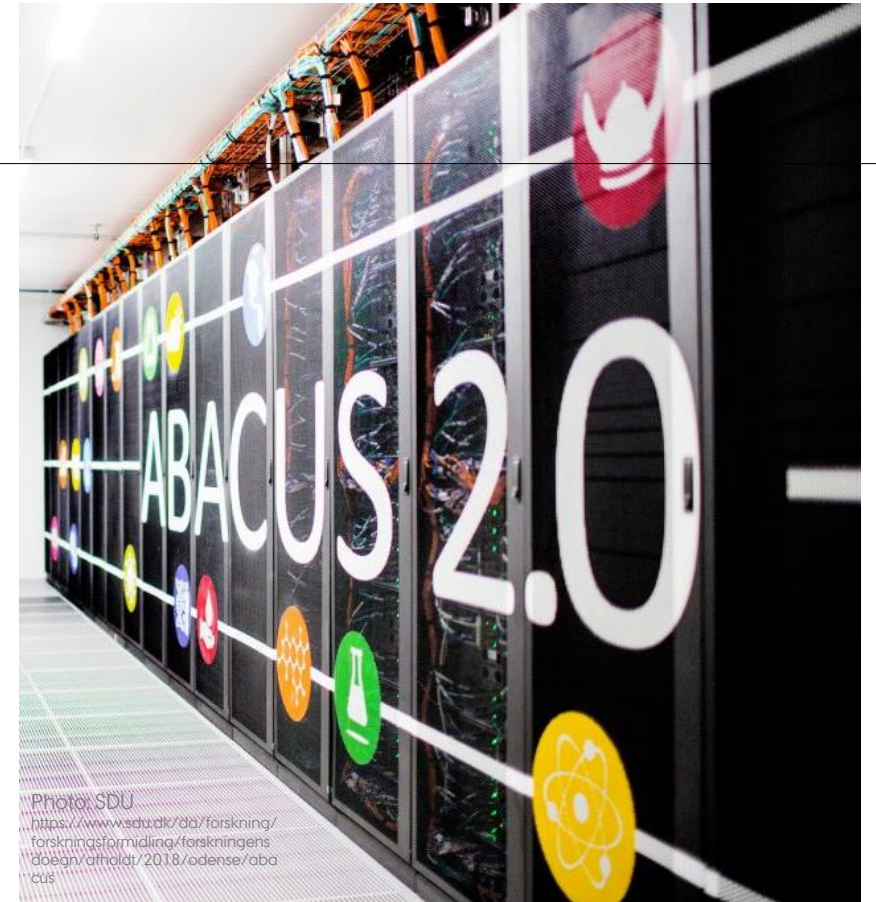


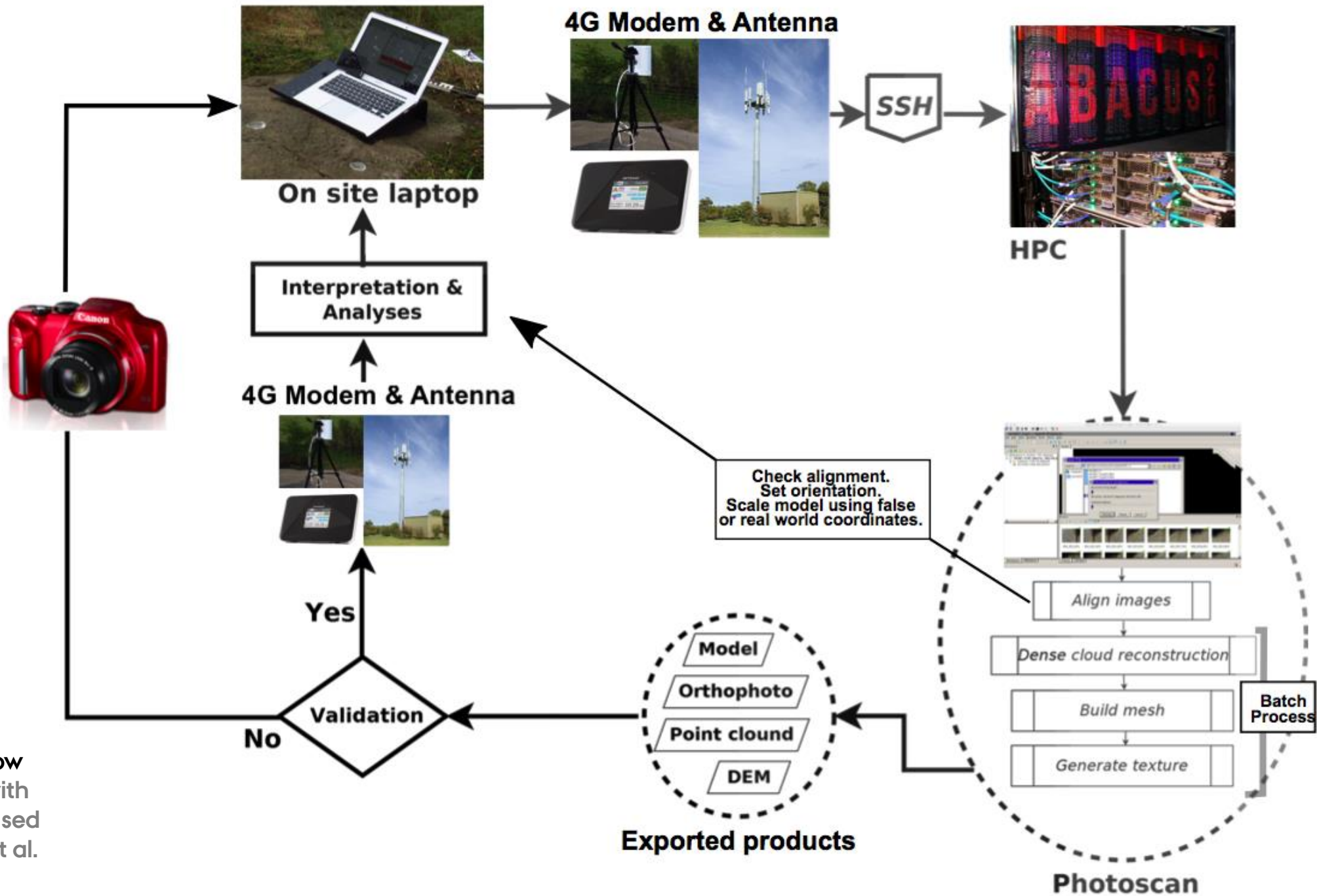
Hillshade DEM visualised in QGIS. Knægten 2. (BMR 1347-2 / 060105-189).

RESAMPLED VERSUS ORIGINAL

OPPORTUNITIES OFFERED BY HPC

- HPC systems are very suitable for fast processing of detailed models.
- Use of an antenna to connect to an HPC turns image based modelling into an on site investigative tool.
- Process more detailed models, faster.





Field workflow
 (reworked with
 additions based
 upon Stott et al.
 2018)

EXPERIENCES WITH HPC: SUMMARY

ADVANTAGES

- Fast – and getting faster
- Results available in the field to assist investigations
- Economies of scale
- Project on the Abacus 2.0 has encouraged the software (Agisoft LLC) providers to make limited HPC accessible to all (50 machine hours /month)

CHALLENGES

- Structure of internet imposes limits
- Reliant on traffic management policies
- Needs are immediate, but must be balanced with other users
- Speed and memory of hardware
- Working over VPN

CONCLUSIONS & FUTURE DIRECTIONS

- Proof of concept - suitable for large scale projects
- Accessible to all with Agisoft Cloud

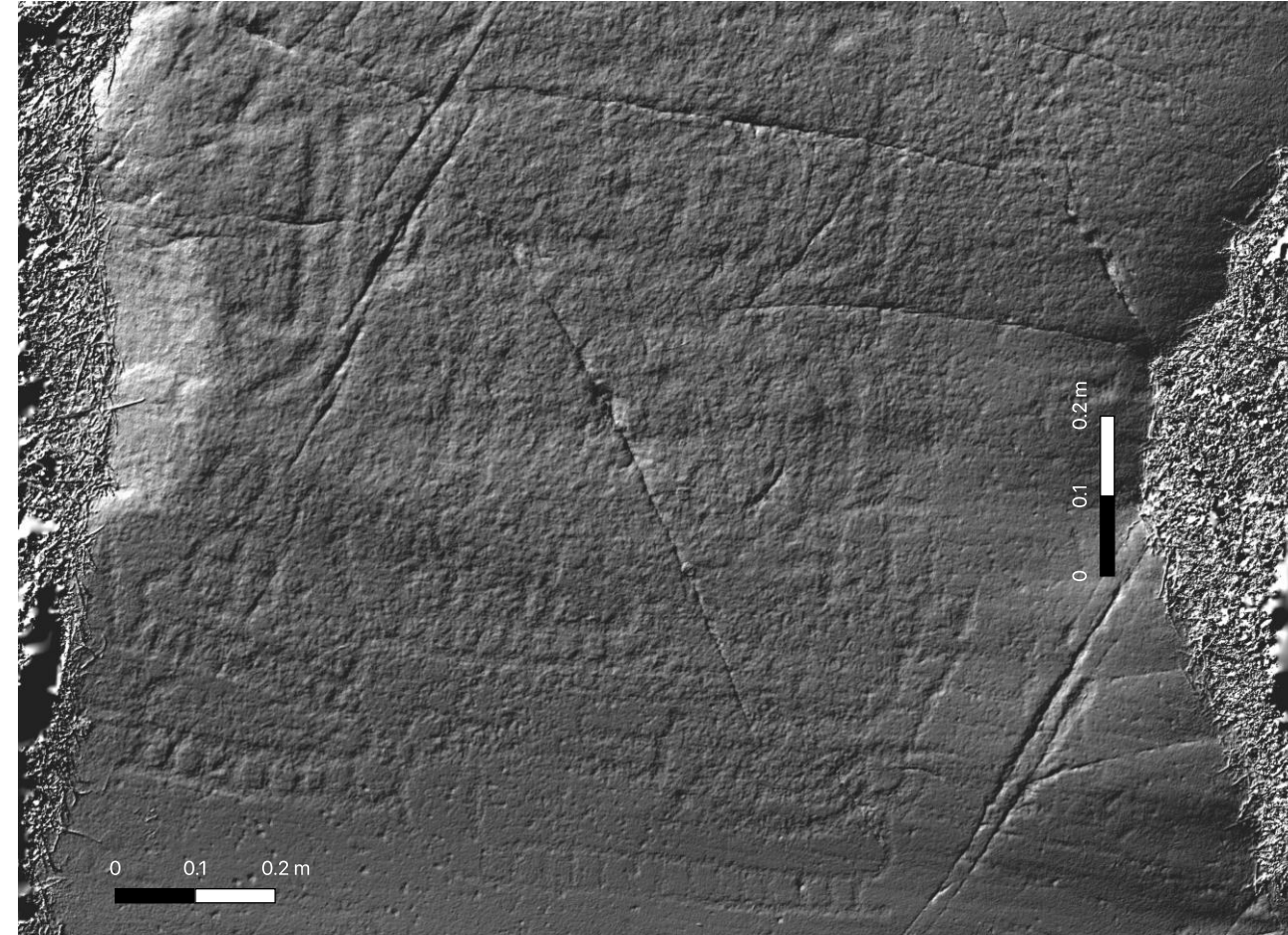
Future/current work:

- ✓ Continual optimization and improvement of software and workflow. E.g. Incremental & realtime.
- ✓ Ray tracing
- ✓ Development of visualisation techniques
- ✓ Integrated with solutions for analysis and archives
- Communicate the benefits of processing on HPC to the state recognized museums

Further reading:

Dodd, J. (2018) The application of high performance computing in rock art documentation and research, *Adoranten*. 92-104.

Stott, D., Pilati, M., Risager, C. M. and Andresen, J.-B. R. (2018) Supercomputing at the trench edge: Expediting image based 3D recording, *CAA 2016: Oceans of Data. Proceedings of the 44th Conference on Computer Applications and Quantitative Methods in Archaeology*. Oslo, Norway: Archaeopress 207-218.



Blåholtshus 1, North Bornholm. Hillshade of DEM visualized in QGIS.



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