

Linking climate to observed damage – assessment of storage conditions for polychrome sculpture & frontals at Museum of Cultural History (KHM).

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INTRODUCTION

KHM holds one of the most important collections of Northern European early medieval polychrome sculpture and frontals. Whilst a large proportion of the collections are on display in an exhibition designed by architect Sverre Fehn, a substantial number remains in storage (See fig. 1). Although the conditions in the storage are within 55 ± 5 % RH for 95% of the time throughout the year, and do not stray far from these limits for the remaining 5%, a small amount of damage has still been observed. This has occurred on the most sensitive painted objects as blind cleavage between the ground and the wooden substrate and pin-head loss of paint. Although the pin-head loss is minute it is noticeable because of the bright white ground that is revealed. The occurrence of damage to this collection suggests that the environmental conditions, although considered to be good by international standards for a 19th century museum building, still pose a risk.

A partnership between Conservation Studies (IAKH) and the paintings & polychrome sculpture conservation section of the Museum of Cultural History (KHM) has been formed to determine if the climate within the store is responsible for this damage. Initiated in autumn 2009, this poster presents preliminary findings. Whilst the immediate goal is to determine the cause of this damage, there is also a broader goal to re-evaluate what have been commonly accepted as appropriate limits of environmental control in light of the new standard prEN 15757: Specifications for temperature and relative humidity to limit climate-induced mechanical damage in organic hygroscopic materials. It is hoped that this work will allow the setting of future environmental limits based on consideration of the current conditions with a view to identifying environmental factors that remain a potential risk. This will include parameters that are beyond what is currently considered when managing the museum climate. These include the wider remit of sustainable management and energy conservation, including:

- 1) Low energy use and clearly identified passive measures of control.
- 2) Environmental set points, daily variation limits, permissible rates of change in environmental conditions, annual drift in conditions based on external climate and the capacity of the building to act as an environmental buffer.
- 3) Evaluation of the conditions that the collections have been exposed to in the past.
- 4) New knowledge for the behaviour of these objects generated by this research.

The research is based on a thorough examination of existing records and the collection of new environmental and conservation data. Changes that have occurred will be mapped, in order to identify events that may have caused an alteration in the conservation status of the collection and assess their impact in terms of risk. This will allow decisions on the environment to be made in an informed manner and the feasibility of the new standard prEN 15757, which is due to be adopted within Norway in 2010, to be tested.

THE STORAGE ROOM AND THE COLLECTION

The store room for polychrome sculpture and panel paintings is located in the basement of the Historisk Museum, which is part of KHM situated in the centre of Oslo. The front of the museum is adjacent to a busy four lane road and there are minor roads on either side, one of which has tram tracks. To the rear of the museum is a large open space which is currently being used by the National Museums of Oslo as an outdoor display space. The basement store is located along the North-East facing outer wall, has a volume of about 229m³ (63,6m²) and has been used for this purpose since the 1960's. The room has two large windows and two doors (the windows and one door is blocked). It has been protected from possible water leaks from the different water pipes and other installations above the ceiling of the room by a large aluminium tray with its own drainage point. Self supporting sculptures, frontals and altar shrines are stored vertically on a shelf that runs along the outer wall and flat on a central shelving unit in the middle of the room, and crucifixes are hung on a metal grid along the inner walls.

Climate control measures have been in place since the 1960's using local humidification based on the evaporation principle. In 1978 the storage room was connected to a newly-installed central control plant located in the adjacent room (Bakken 1983). After a difficult start-up period the decision was taken to retain an independent humidifier in the room, which would operate in addition to the central climate plant. This arrangement has been in use ever since. Whilst the central system is managed by the technical department, the local humidifier and environmental monitoring has remained under the control of the conservation department.

The principle problem that has been observed in the past is related to excessive humidity during the summer months. Some years ago a dehumidifier was installed to resolve this problem. Since March 2008 the space has been telemetrically monitored using a system that allows remote inspection of the conditions via the Internet. Before this date, conditions within the room were constantly monitored with a drum thermohygraph.

The central control plant is old of age and has been undergoing a series of modifications in order to improve conditions elsewhere within the museum. There are plans to shut it down. To avoid any potentially disastrous environmental occurrences within the store the vents to and from the central equipment have been blocked since March 2009. In effect this has allowed the space to be better controlled and more stable conditions to be maintained.

PAST TREATMENTS

Due to the value of the collection even the smallest deterioration is of concern and is therefore worthy of investigation. The collection underwent a general emergency treatment in the late 60's and early 70's. Since that time only minor damage has been observed, leading to the opinion that the environmental conditions have been stable and suitable. In such a valuable collection it is the cumulative effect of minor damage and the triggers for such damage that is interesting to this project (See figure 2).

If the causes of these small changes in the objects conservation condition could be identified then it may be possible to suggest environmental parameters that represent even more closely the optimal preservation environment.

PRELIMINARY EVALUATION OF POLLUTION MONITORING

The monitoring strips are suspended horizontally in order to study the difference between the upper surface, exposed to dust and pollution, and the under-surface which is just exposed to pollution. In the short time (3 weeks) that the strips have been place the lead strip has significantly tarnished suggesting that a significant source of pollution is present. The project plans to evaluate the strips periodically using electrochemical techniques which should be able to quantify the rate of corrosion and the species of corrosion product formed.

CONCLUDING REMARKS

The environmental assessment demonstrates that relative humidity and temperature is maintained within what are considered to be acceptable limits within the store. This does not mean that the mean levels, the constant small fluctuations and the occasional higher fluctuation are not the cause of the observed damage. The influence of these conditions will be assessed as part of the ongoing project.

The large amount of small size minerals in the dust is likely to have come from the repaving of the front of the museum with white granite in 2006, when the stone was cut to size on site. Whilst this type of dust is not considered to be a major agent of deterioration for polychrome wood, it may contain mobile salts and may cause abrasion which indirectly jeopardizes the condition of the collection. The large amount of mineral dust detected demonstrates the risks from dust associated with building work in the vicinity of a museum and the importance of dust monitoring as part of a wider environmental monitoring programme. The detection of fibre glass suggests that insulation work has occurred which is probably associated with the air conditioning ducts. Whilst not representing a significant risk to the collections it may pose a health risk that needs to be mitigated. The ongoing dust monitoring will be able to identify whether the composition of dust has changed and its rate of deposition.

The pollution monitoring although empirical at this stage in the project has detected a disturbing level of reactivity. The project will focus on establishing the source and level of pollution and then isolating or removing it. We will also be investigating whether this could be the cause of the pin-head loss that has been observed. In the past similar pinhead damage has been linked to stress caused mineral change and blind cleavage which has been linked to the level and rate of change in RH and temperature. The project will also be focusing on these areas of research in near future.



Fig. 1 A view of the crucifix wall in the store.



Fig 2 Damage that has occurred in the paint layer since the restoration of the frontal from Øye, Oppland C17806, in 1975. The objects has kept in this store since that date.

SETTING UP OF MONITORING AND THE INITIAL RESULTS

The research initially focused on assessment of past and present relative humidity, temperature, dust and pollution. Past environmental records were evaluated, dust was collected and an "Oddly test" style pollution monitoring device was used to assess the reactivity of the atmosphere (See figure 3). The remaining sections of the poster will report on these three subjects:

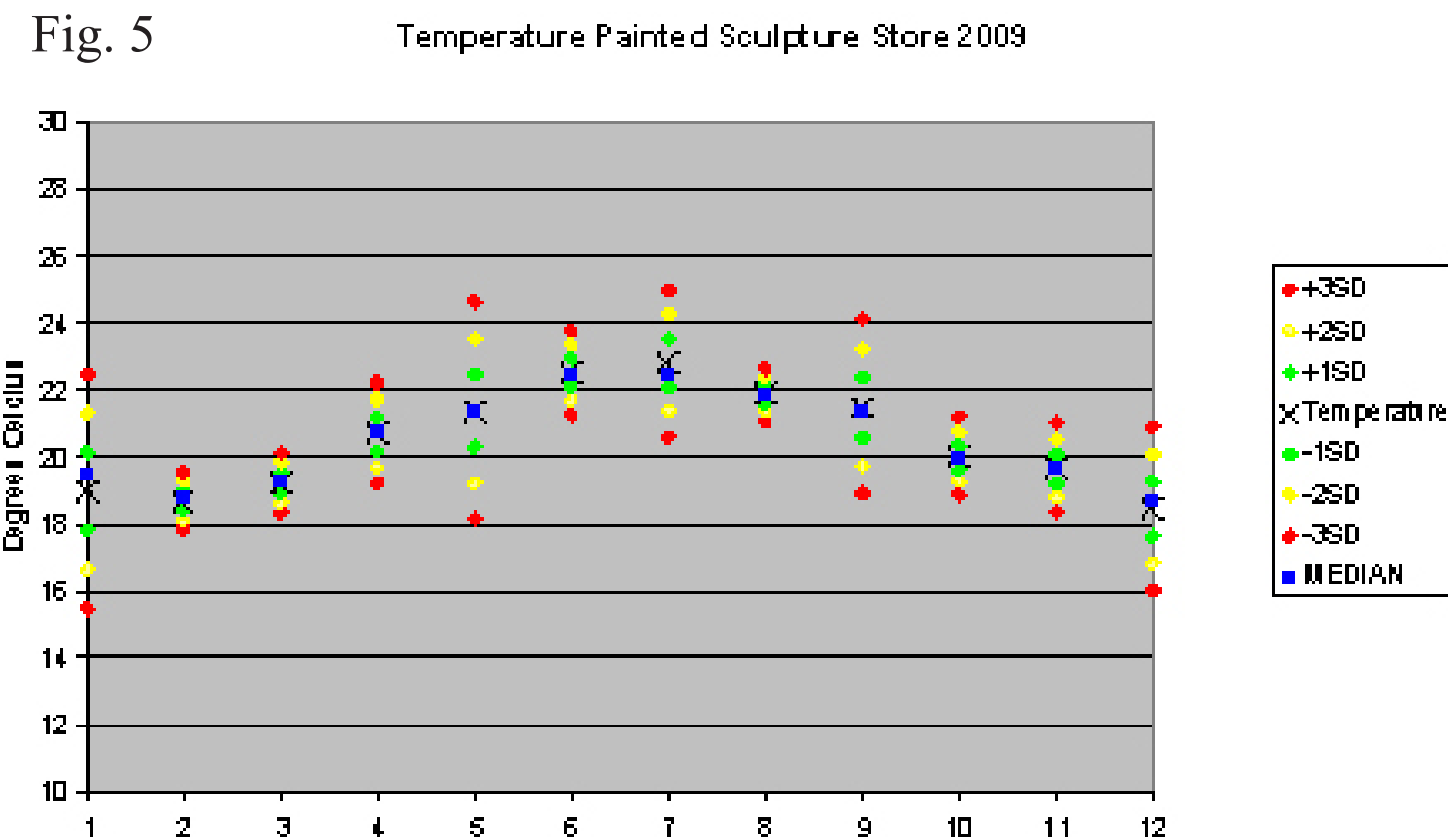
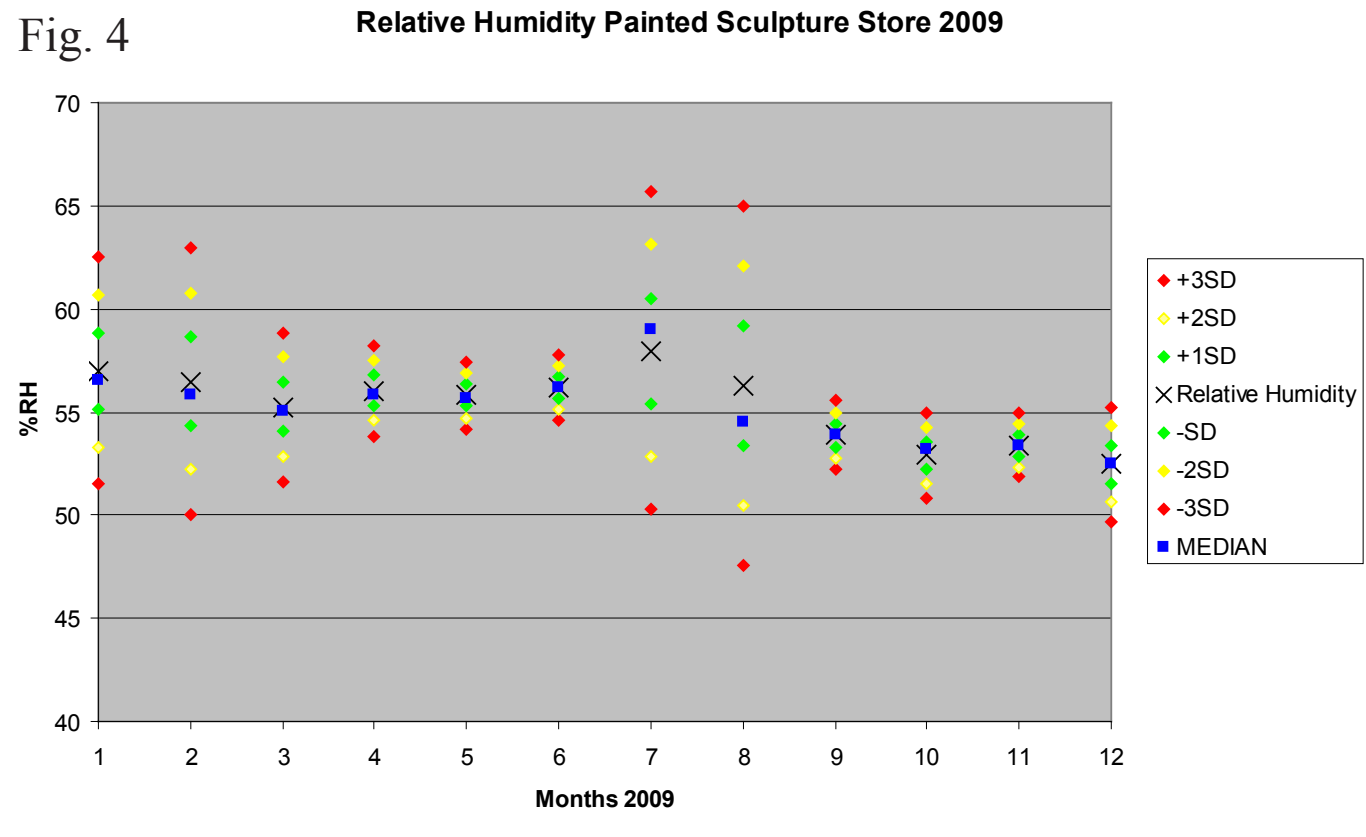
ENVIRONMENTAL RECORDS

2009 was selected as representative of a typical year because the number of climate events in the stores was not unusual and because it was easier to trace the cause of the recent events. 2009 also represented the first full year of a new datalogger system.

Analysis of the data shows that conditions within the store during 2009 fall well within the limits of acceptability for a museum building from around 1910. The

crosses in figure 4 indicate the monthly mean relative humidity. The blue dots represent the median value. The range between the two green points represents conditions 68% of the time, the values between the yellow points 95% of the time and the values between the red points 100%. The data shows that during March to June and September to December 2009 the conditions were very stable. The widest variance is under $\pm 4\%$ with conditions during the majority of time remaining within $\pm 2\%$. Even in January, February, July and August 2009 the conditions remain within $\pm 5\%$ for 95% of the time.

The distance between the average value and the median illustrates the level of asymmetry in the data. For example in July the median is just over 1% above the mean and in August the median is approximately 1.7% below the mean.



In months with the least deviation the mean and median are approximately the same. The skewness of the dataset provides an understanding of the distribution of data. In this case it shows that the tail of the distribution is longer towards the upper values in July and towards the lower values in August suggesting that the mean RH is biased in those directions for those months.

This is supported by the weekly charts which show two events: a gradual drift from 55% to 60% over a two week period after which the conditions remain at the upper level for a further two weeks and then is suddenly readjusted back to 55%. A similar event occurs at the beginning of August when the relative humidity rises over 5 days to 63% after which it drops over the same period of time back to just under 55%. Both incidents prompted the replacement of the dehumidifier on the 10th of August. No further events took place in that year.

EVALUATION OF DUST

This part of the investigation is intended to establish the content, level and the sources of dust. The current deposits of dust present in the stores were sampled from 8 locations using 2 x 11 cm gelatin lifters and carbon tape on Scanning Electron Microscope studs. Where the surface was not an object and was uniformly flat, pressure was applied using the roller supplied. Where sampling was carried out on the surface of objects great care was exercised and the back of the gelatin strip was gently rubbed with a finger. Clean microscope slides have been placed on in the sampling locations to evaluate the rate of deposition. See figure 6.

The gel foil samples were visually analysed using optical microscopy with transmitted, reflected and dark field polarized light. The SEM analysis is yet to be carried out. The particles were visually classified into organic (skin), fibre, mineral and black soot-like from images taken in the ANALYSIS programme connected to the microscope. Because the plastic film on the back of the gelatin strips interfered with the polarization of light, selected foil samples were transferred to glass slides in order to carry out mineral specification.

The dust appears to be quite evenly distributed throughout the room when taking into account that some of the areas have been covered or cleaned more frequently. The samples show a relatively low proportion (~1.5%) of skin flakes, textile fibres and human hair. This was not unexpected as the storage area does not experience a lot of human traffic. A reasonable proportion (~14%) of the dust is black amorphous particles that look like soot. Many are a uniformly small size which may have come from outside. This is expected in a building situated in the center of Oslo. A small amount of larger particles is thought to come from the air conditioning before it was blocked.

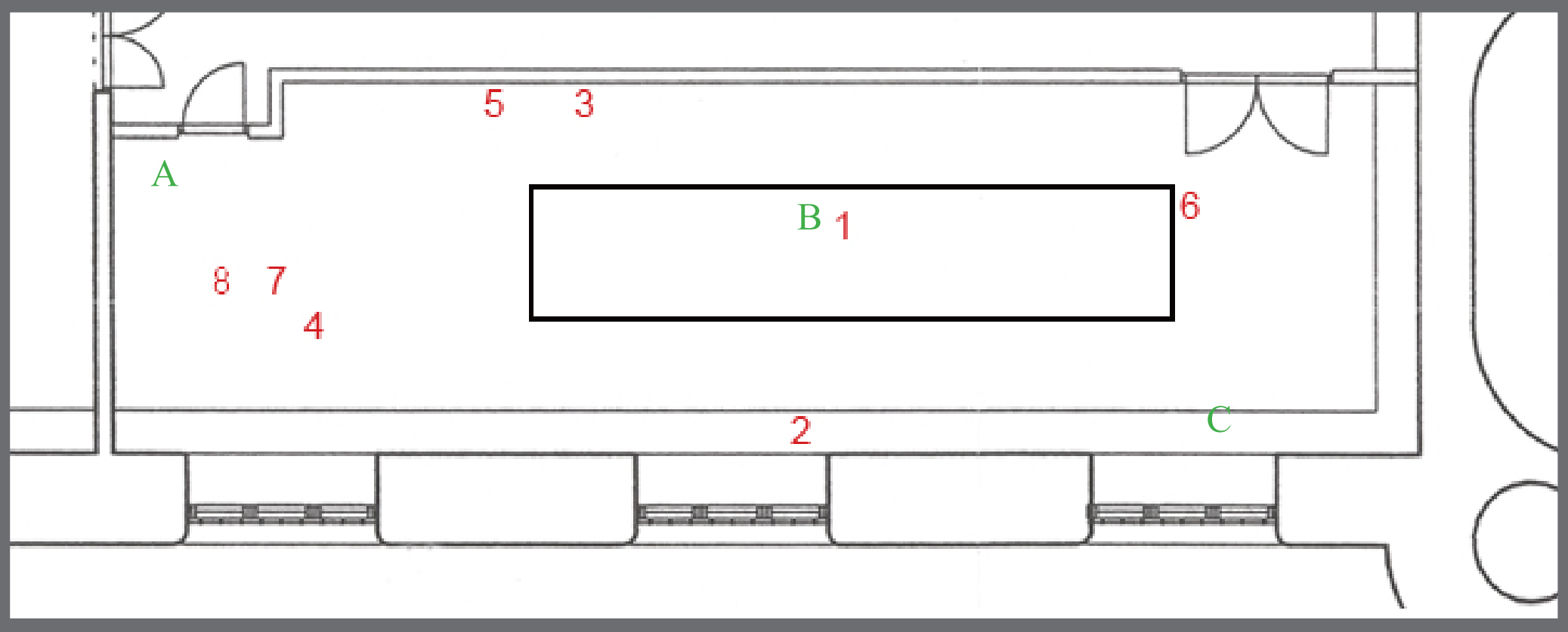


Fig. 6 Sample 1-8: Dust samples collected at different height and locations of the store room. Sample A-C: "Oddly tests".

What was surprising was the large proportion of fairly similarly sized sharp mineral grains, representing by far the largest proportion of dust (~83%). A significant number of glass fibres were also recorded. The large amount of wood fibres sampled from the upper-shelf is associated with the storage of a degraded piece of wood that has been removed.

The mineral grains were examined in dark field polarized light. The largest proportion was small sharp water-white grains that are suggested to be quartz. These do not have a grain structure and do not interfere with the light in crossed-polarization suggesting that they have a uniform crystal structure. There are a small proportion of larger colourless grains exhibiting interference colours which suggests muscovite. Occasional large, cubic grains can be seen which have tartan or grid twinning. This suggests feldspar and other smaller grains are light brown and semi transparent with lesser interference colours suggesting biotite. No extinction angles were calculated so identification can only be tentative. A more definitive identification will be undertaken in the near future. The combination of quartz, biotite, muscovite and feldspar suggests a granite source.

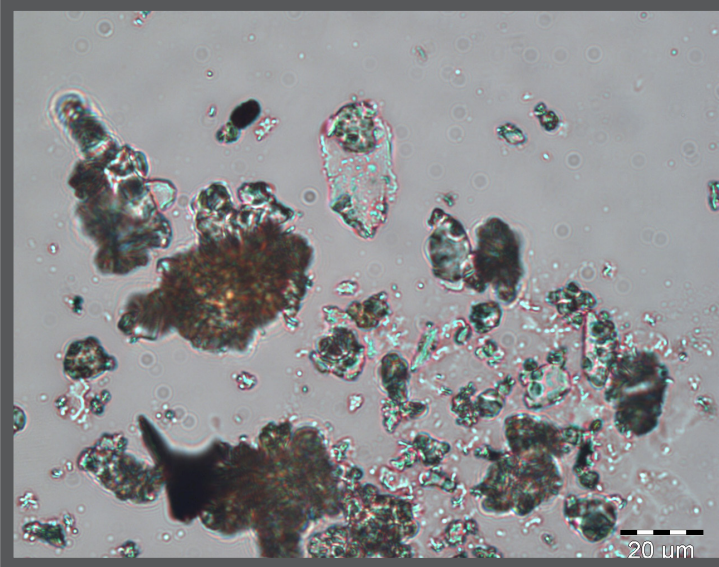


Fig 8 Dust in reflective light 200x.

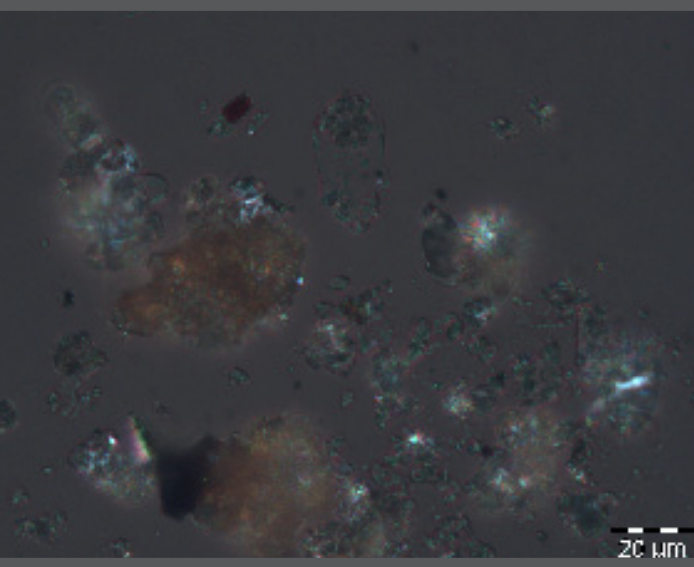


Fig 9 is fig. 8 in polarized light showing some birefringence.

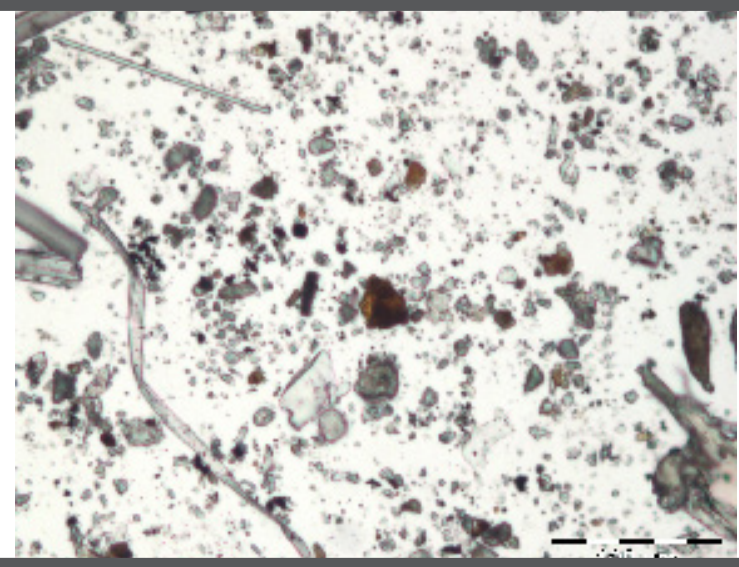


Fig 10 A typical dust sample showing the amount of sharp edged minerals 200x. Note the glass fibre rod in the upper left corner 200x.

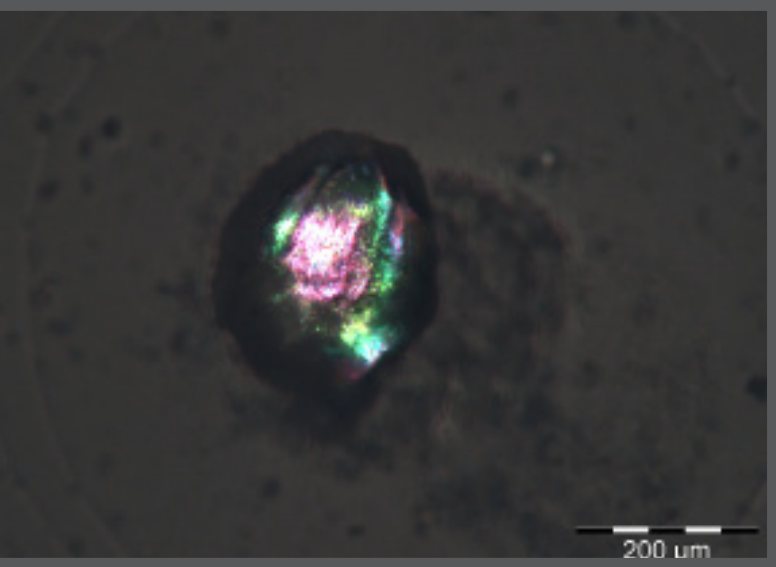


Fig 11 Large birefringent particle 500x.

Footnote

¹ BVDA Environmental Gel Lifters, Art.no. B-17000, from: P-B Miljø, Enebaervej 7, DK-8850 Bjerringbro.

LITERATURE

Bakken, Arne (1983): Sentral kontroll, *Museumsnytt* 4, pp. 11-13.

Gundhus, Grete (1983): Lokal klimatisering i Oldsaksamlingen, *Museumsnytt* 4, pp. 13-20.

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