The Identification of Dust in Historic Houses

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This booklet provides guidance in sampling, examination and interpretation of dust in historical houses and museums.

The booklet includes:

1) **Instructions for collection of samples and the preparation and exposure of sticky sampling surfaces**
2) **Guide to examination with a hand lens and estimating coverage**
3) **Guidance in quantifying dust**
4) **An atlas of typical dust components and identification (can be printed as reference cards)**
5) **Some dust analysis and SEM / EDX examination**
6) **Information about suppliers, contacts, websites and references**

Index

1) Preparation, exposure and collection of dust

1) **Prepare a dust sampler by sticking a label (that are available from stationery stores) onto the slide frame such that the sticky surface is exposed in the window.**
2) **Place the prepared sampler in the desired location, sticky side up and expose for 4-8 weeks. Typical places would be close to visitor routes or where there is a dust problem.**
3) **Avoid direct exposure to sunlight as the colour of sticky surface will change over time and the glue may degrade.**
4) **The slide mount is simply for convenience in handling and storage, so could be neglected in some cases.**
5) **For a quick "grab sample" adhesive labels can be used directly, by gently touching the label to the surface and picking up dust or fibres.**
6) **The samples can be stored in a photographic slide tray.**
7) **Remember: Coarse dust from shoes, clothing and degraded walls and ceilings is likely to fall rapidly to the floor, so might be collected there. Near visitor routes dust and fibres can collect on horizontal surfaces. Such surfaces are also a good place for the 6-8 week exposures**

Sticky sampler

2) Examination

1) Examine the surface of the sampler with a hand lens (~ 10x Magnification) in bright lighting conditions You can also use an illuminated magnifier or a digital magnifier

2) Bring the lens close to your eye (approximately 2cm between eye and the lens) and then focus for a clear image by bringing the sample towards the lens

3) Look for various particle types and use the "atlas" that is provided in the following pages to establish the possible origin of the particles. This is not always easy, but the possible source of some particles is self evident, e,g. fibres and insects. Even where the type of particle is not entirely clear you can eliminate or confirm some possibilities (i.e. it is not a fibre!).

4) It is often useful to create your own reference collection of particles. If you suspect the deposit is breadcrumbs, look carefully at a sample from a kitchen table.

5) Large particles are easier to classify, while small particles may have to be simply lumped together under a heading such as: "many fine particles"

Observation chart (Fiche)

You can annotate and file the characteristics of your samples in a chart as the one shown to the right

DUST EXAMINATION

Start date	
Finish date	
Building	
Location	
Sampling method	
Number visitors	

General description	*type, dominant component, shape, colour, relative size, coverage percentage…*

Other comments	*Record events or characteristics which can influence dust deposition (drafts, cleaning frequency, any unusual deposit, problems with sampling, building work….)*

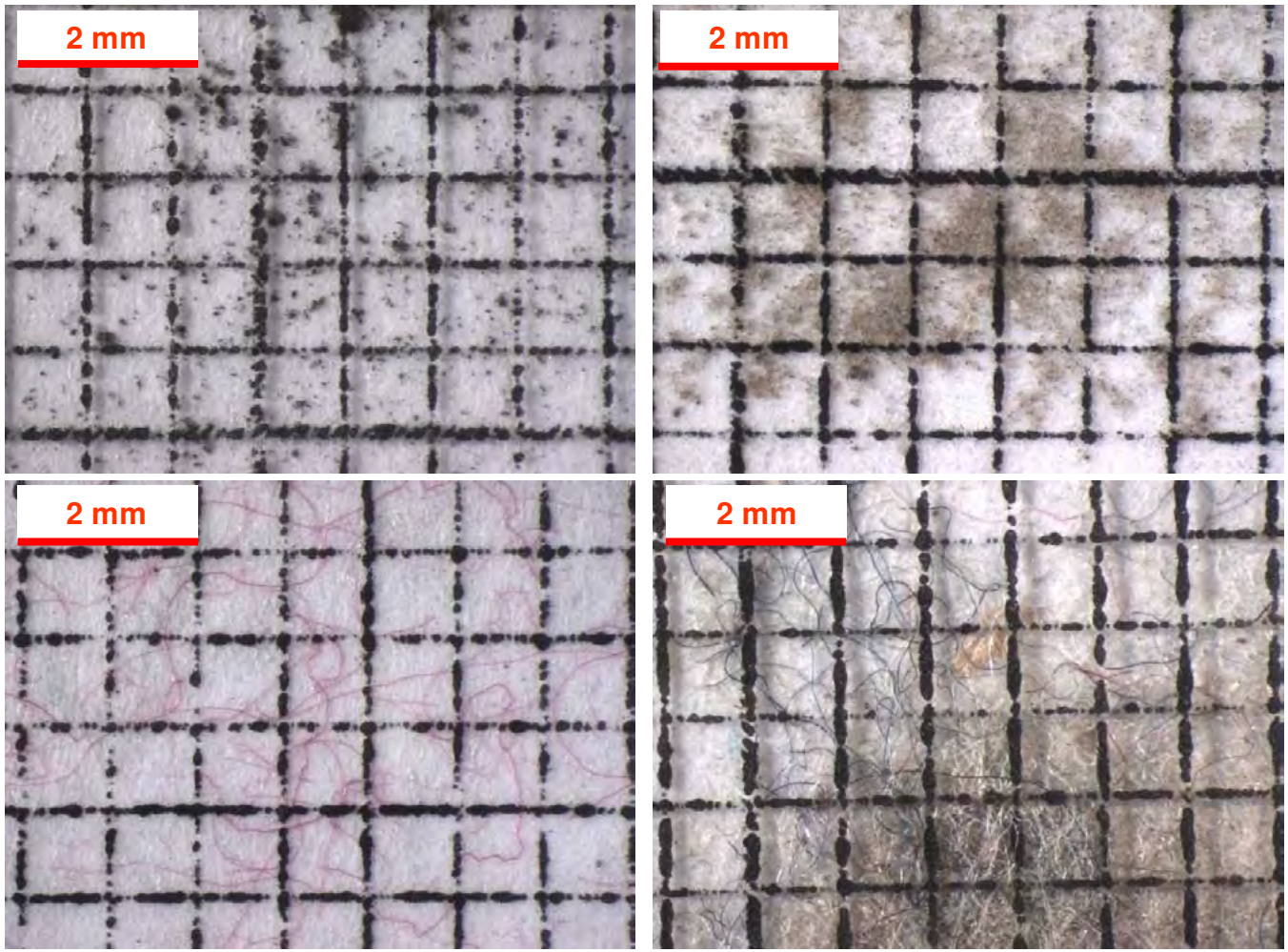
3) Quantification

- **In addition to a qualitative description you may consider the quantifying the coverage by particles**

- **There are simple approaches to measuring size and coverage by particles. If there are not too many particles they can be counted using a grid as a background.**

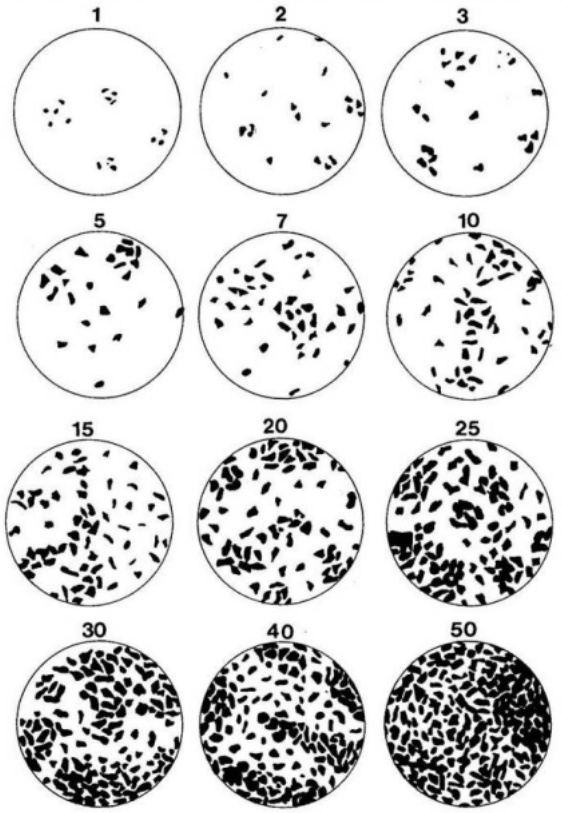
- **The measurements will probably be sufficiently accurate to enable comparison of one room with another.**

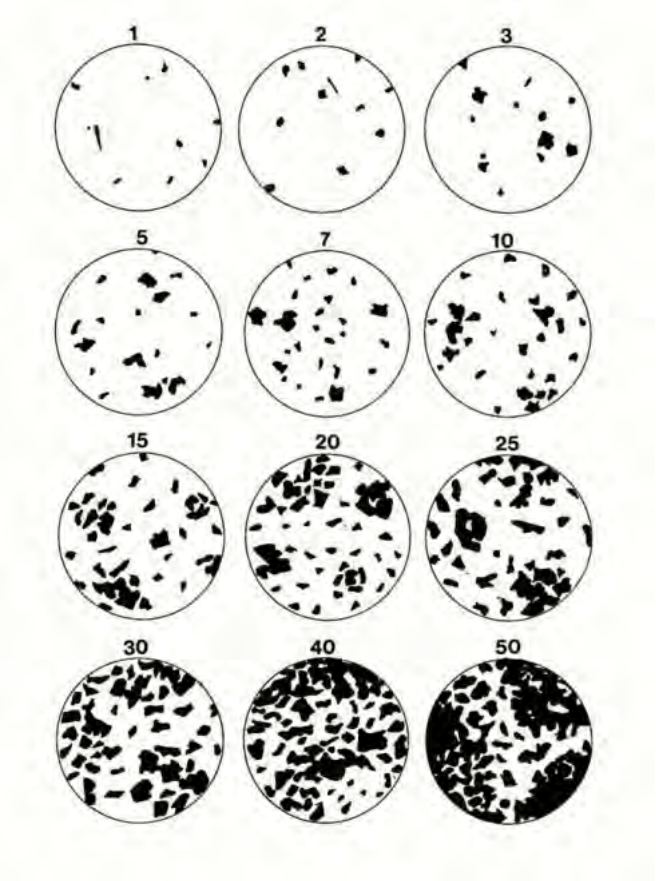
Size: graticule



To estimate the size, a primitive graticule can be made from fine (1mm square) graph paper that can be photocopied and used as a background to observations.

Covering: percentage



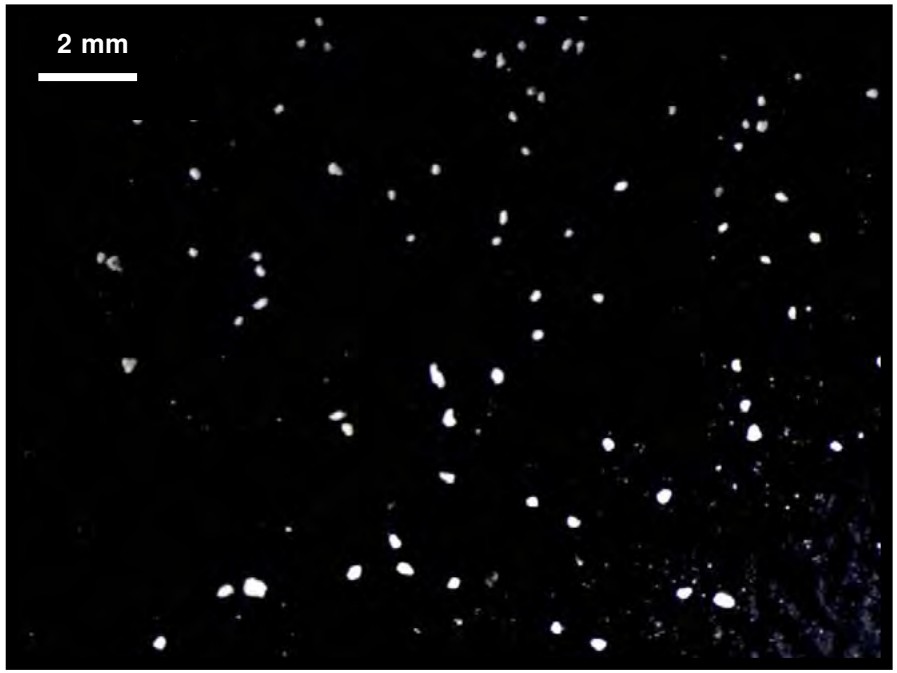


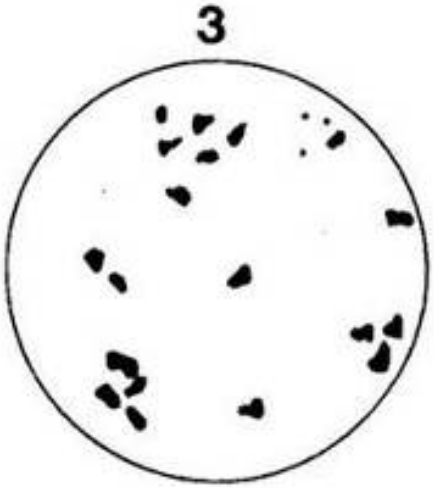
FINE GRAINS **GRANULES**

You could use a chart like those used in microscopic examination to estimate the percentage coverage of grains or minerals.

Reference: Castro Dorado, 1989. Petrografía basica. Texturas, clasificación y nomenclatura de rocas. Paraninfo, Madrid

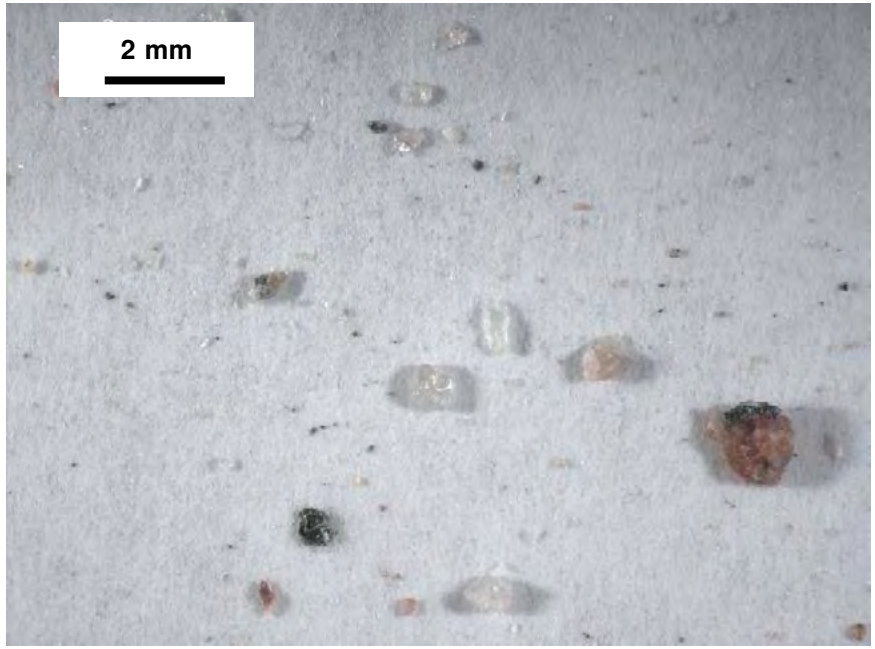
Examples of percentage covering:

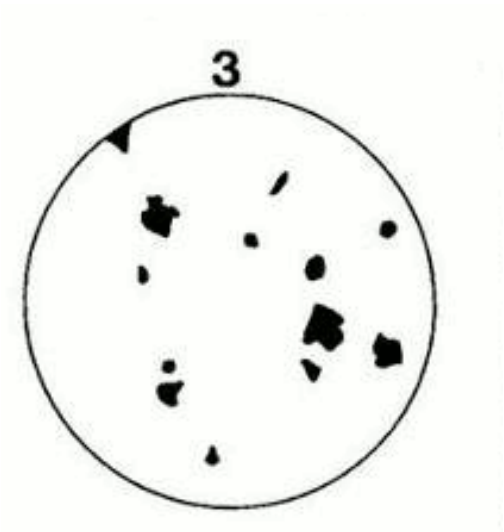




This sample limestone powder from Rouen Cathedral. You can compare it with the chart of percentage covering and find the most similar class. This can slightly vary depending on the observant. In this case the coverage may be between 2-5%.

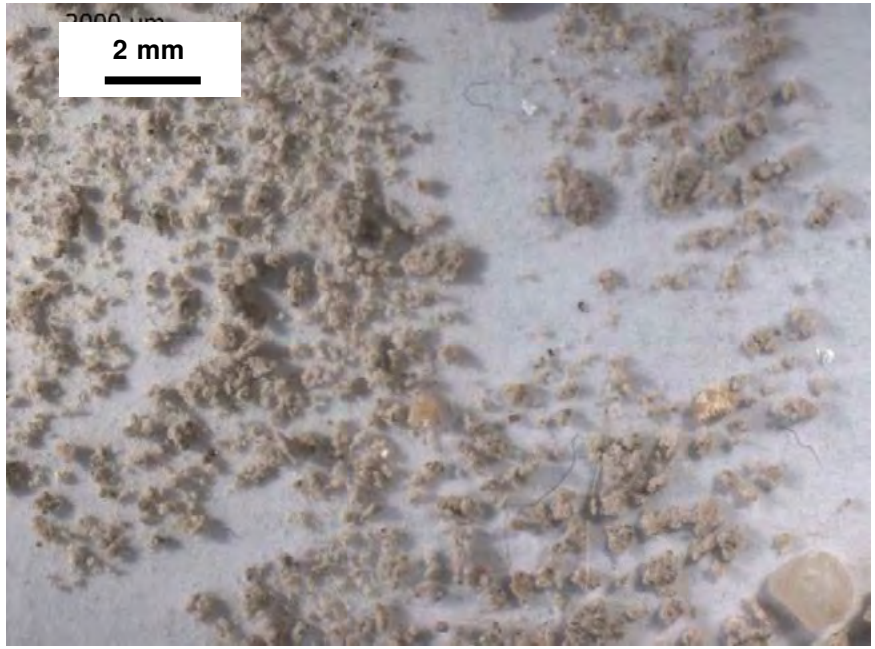
Examples of percentage covering:

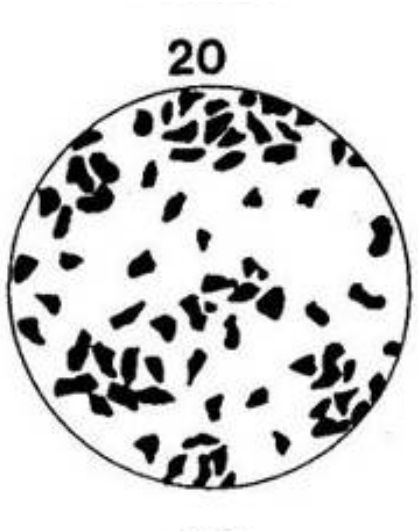




Carpet dust from granite gravel. You can compare it with the chart of percentage covering and find the most similar class. This can slightly vary depending on the observant. In this case the coverage may be around 2-5%.

Examples of percentage covering:





Limestone dust from the Tower of London. You can compare it with the chart of percentage covering and find the most similar class. This can slightly vary depending on the observant. In this case the coverage may be greater than 20%.

4) Dust Atlas

This section includes a series of removable pages (which could be printed as cards) showing micro-photographs of different types of particles typically found in rooms.

Cards include photographs showing particles of soil dust, combustion materials, clothes, insects, plants, paint fragments, skin, hair, wood and food, as well as dust collected from historic houses showing a mixture of particles.

Most pages consist of two binocular microscope photographs: one shows the characteristics that can be seen a 10x magnification hand lens and the other a detailed image of the dust. Typically these pictures printed on A4 size represent magnifications of 8x and the varies between 12-40x magnification.

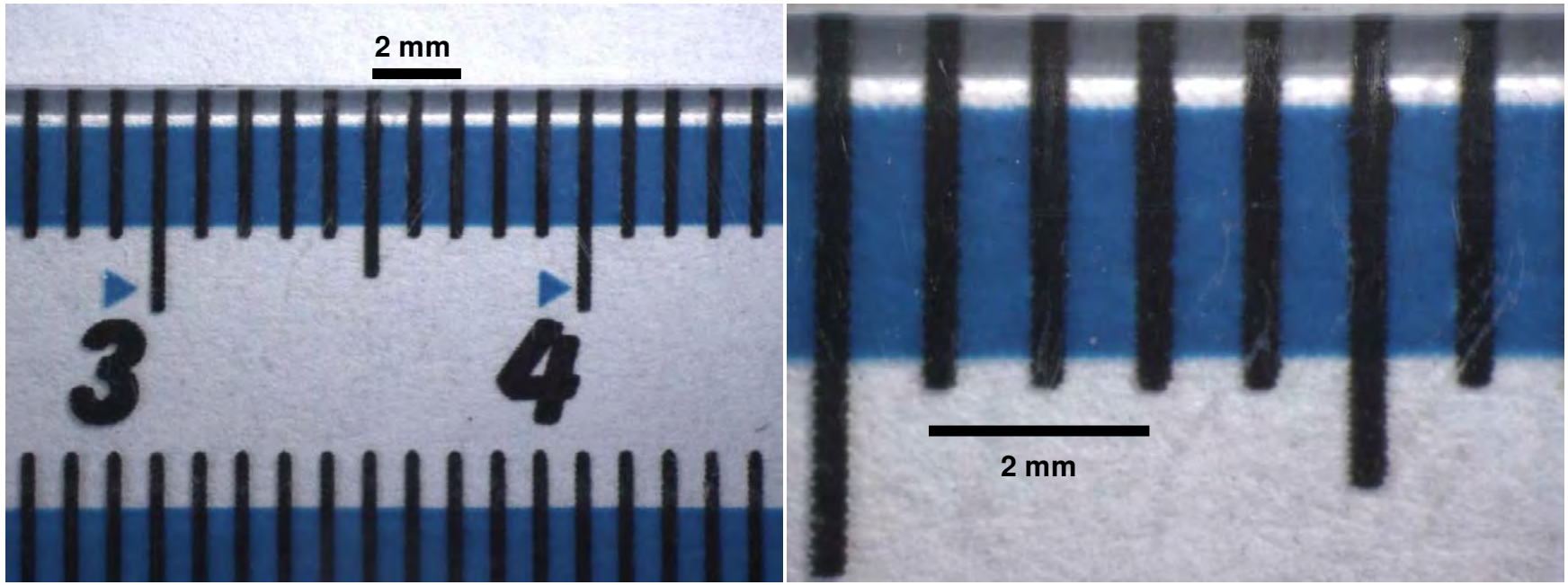
When examining particles it is important to consider their relative size , weight and location. Heavy particles are typically found on the floor, deposited by people's shoes, although some may drop from the ceiling, walls or clothing. Biological particles (insects) and clothing particles may have a seasonal pattern, with noticeable differences between summer and winter.

Pages are laid out so that they can be separated, perhaps put in a ring binder or folder…

Dust Atlas: Binocular microscope

This is the binocular microscope used to take the photographs of dust

Ruler scales



X 8 magnification

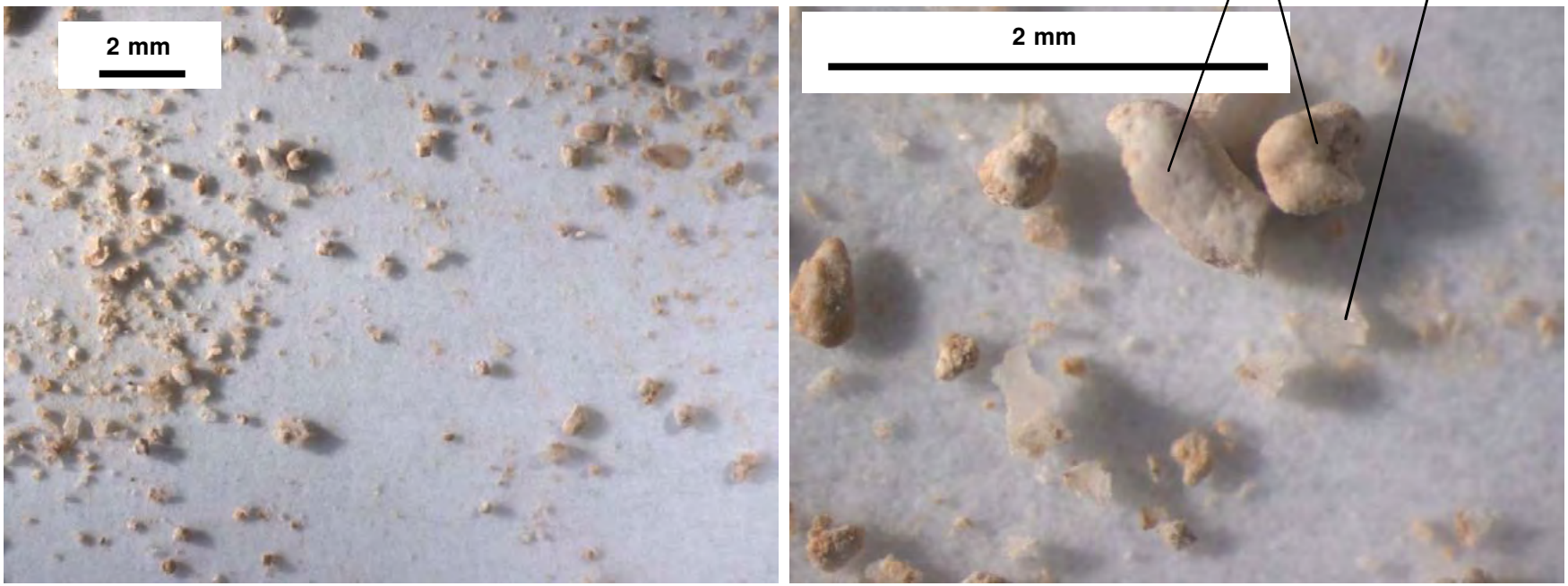
X 20 magnification

Ruler scale photographed under the binocular microscope. You can compare the left scale with the left photo of the atlas pages.

Relative ease in identification of dust components

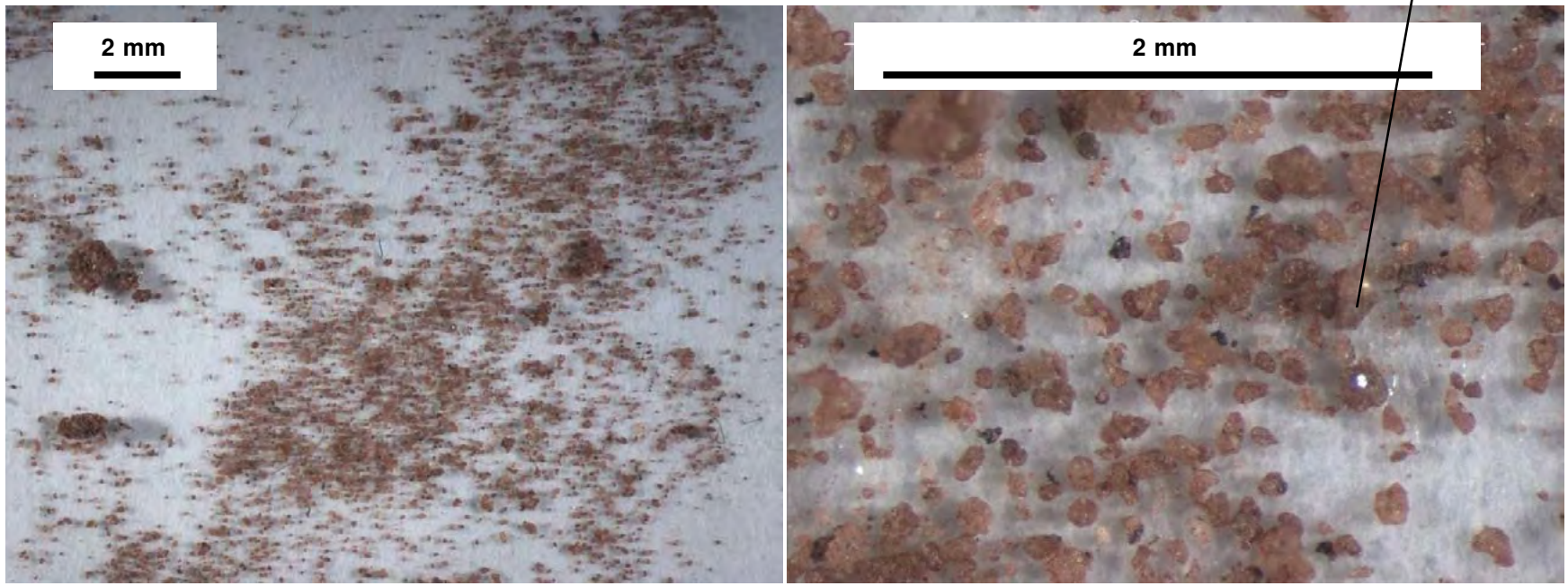
Component	*Identification*	*Comments*
Fibres	Easy to distinguish from other components	Colour easy, but hard to distinguish between different thread types. Easy to identify hair.
Soil dust: mineral grains	Easy to distinguish from fibres, insects or leaves	Can be difficult to distinguish between different mineral types.
Soot	Relatively easy because appears as fine grains and dark	
Insects	Easy if complete. Fragments can be more complicated	There are guides to identify different museums insects. e.g. *D. Pinninger Insect pests in Musums. 1989. Institute of Archaeology publications. London*
Skin	Relatively easy if large fragments	
Food	If small can be difficult to distinguish from mineral grains	
Plants	Small fragments can be difficult	

Soil-mineral dust: limestone



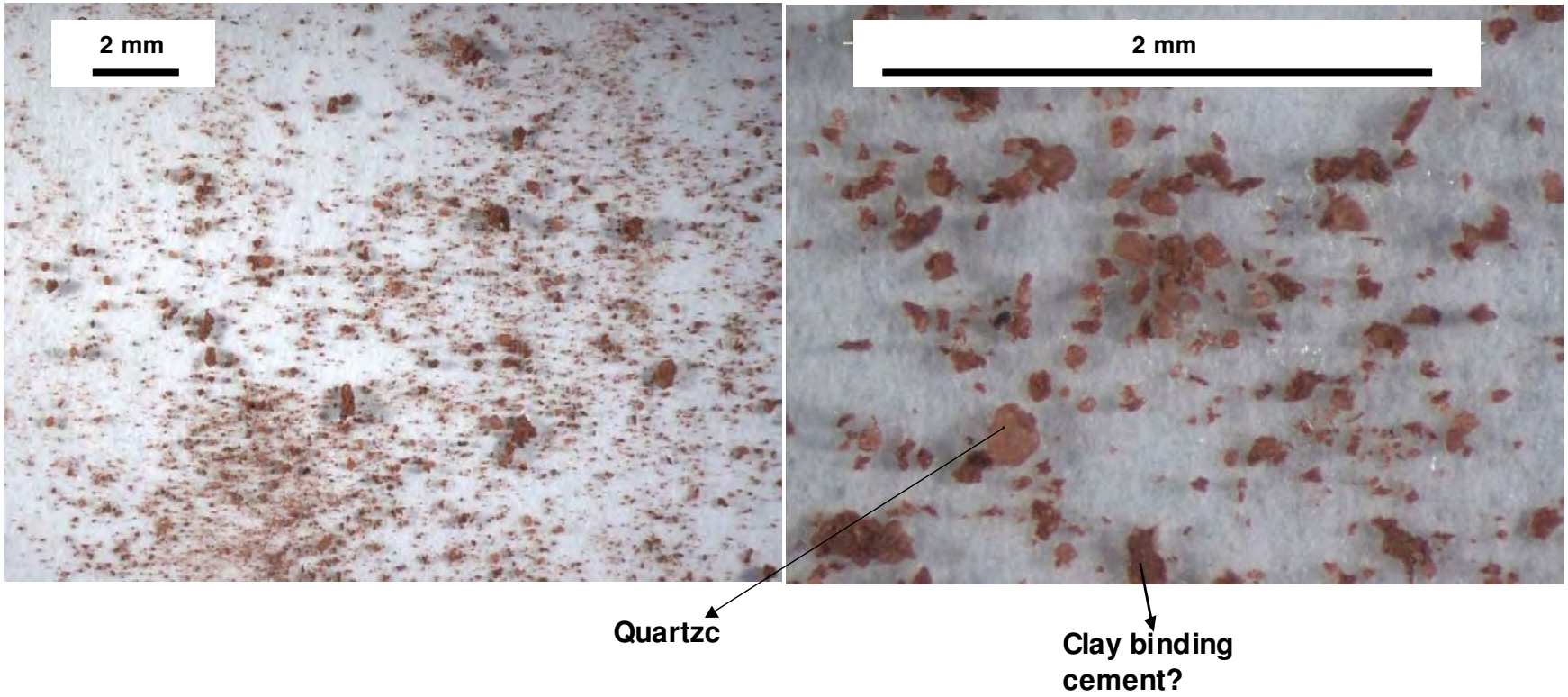
Soil is an important component of indoor dust. The coarser particles (>30 microns) are likely to be brought in on shoes and are typically found on the floor or just 10 or 20 cm above it. Soil dust can be recognised as unevenly shaped mineral grains some brown or off-white in colour and some clear. Smaller particles can be present but they are difficult to recognise. This sample is limestone with oolites (rounded gains) from a historical church in Norwich.

Red sandstone



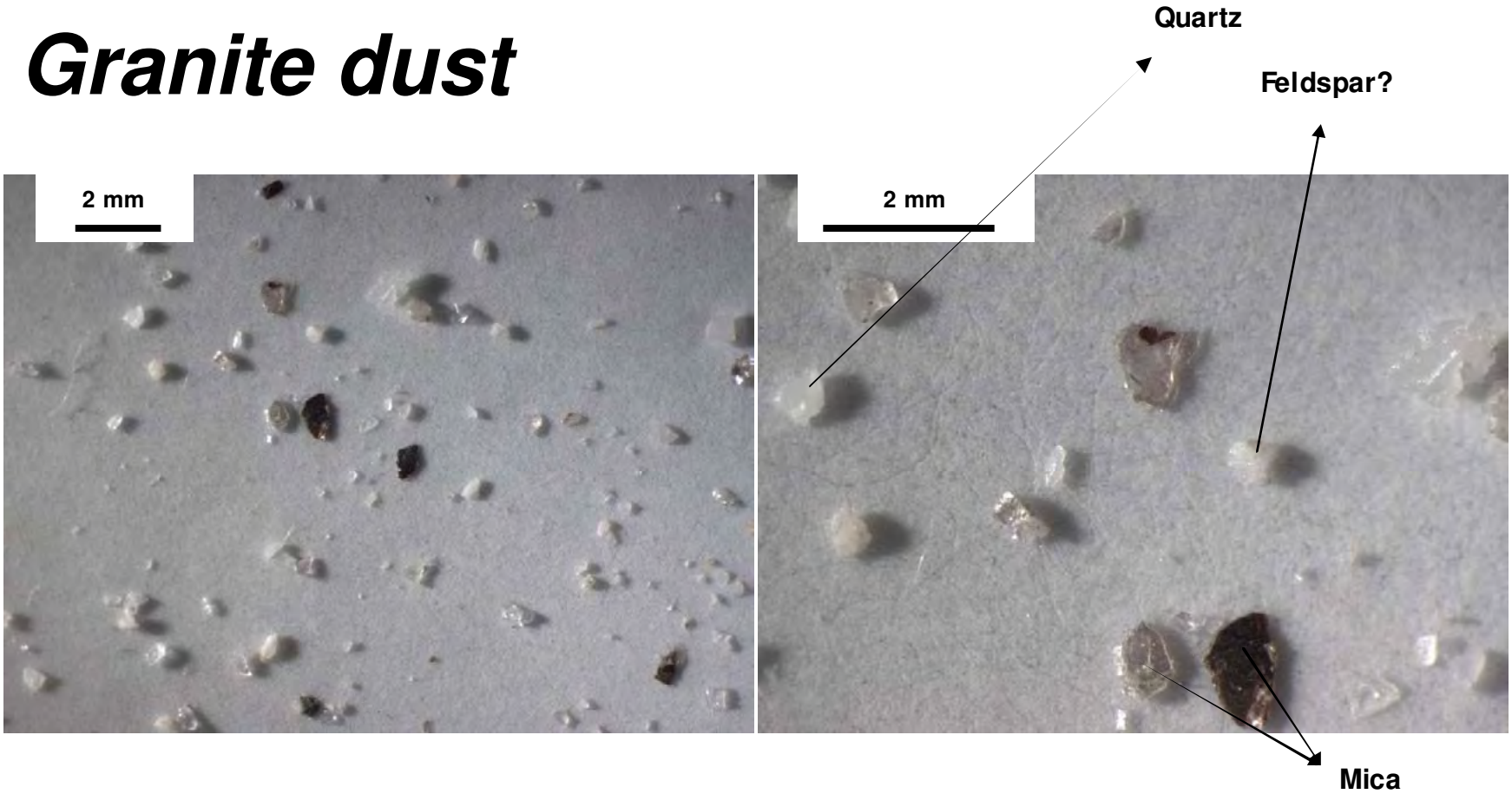
Soil dust includes quartz and other mineral grains such as calcite, clays and salts, for example gypsum and halite. The size is typically between 1-300 microns. Colour varies from colourless, brownish to grey and black. Grains can vary from transparent to opaque, from irregular shaped to rounded conglomerates. These are degraded material from red sandstone from a historical building. Grains are mainly quartz. Iron gives the red colour to the stone. Note small opaque unidentified grains.

Brick dust



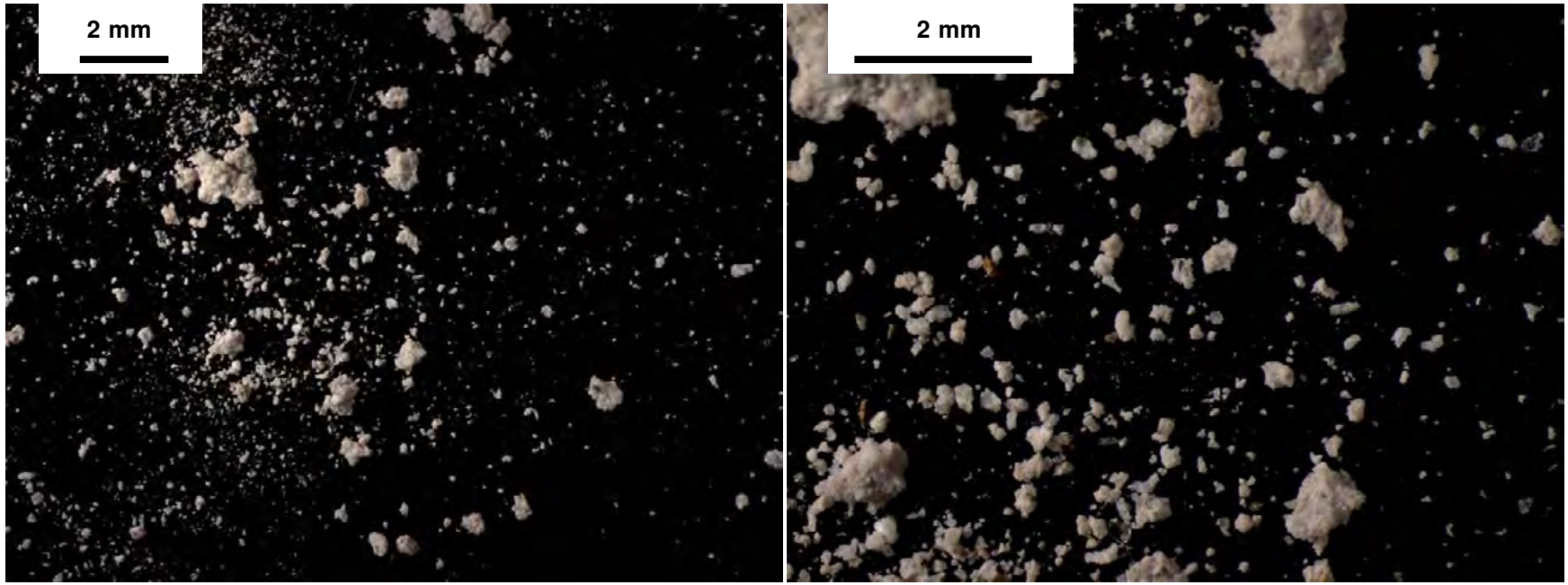
This shows typical minerals from brick powder (historic building).

Granite dust



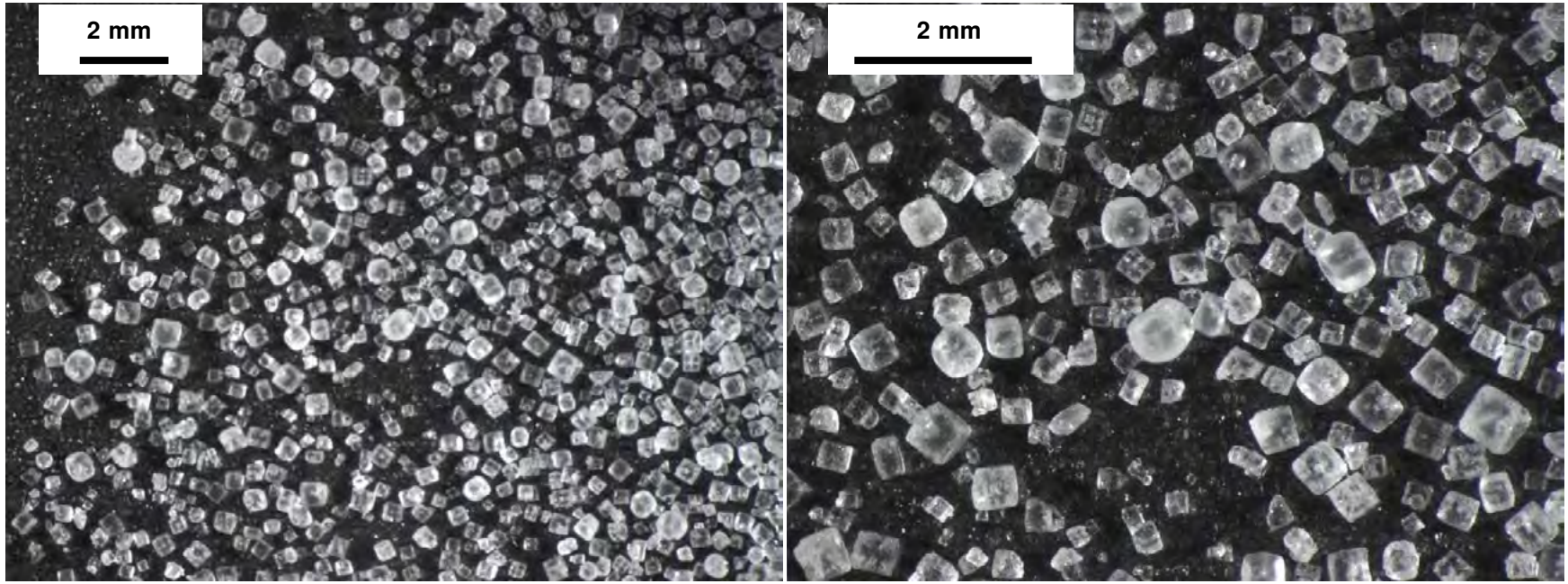
This shows typical minerals from granite grinding, carving or excessive wear. These are mainly quartz (transparent) with other silicates such as feldspars (whitish) and mica (shiny sheets, but sometimes dark). These are most likely to be collected on the floor as they are typical coarse, heavy particles.

Powder from salt damaged limestone



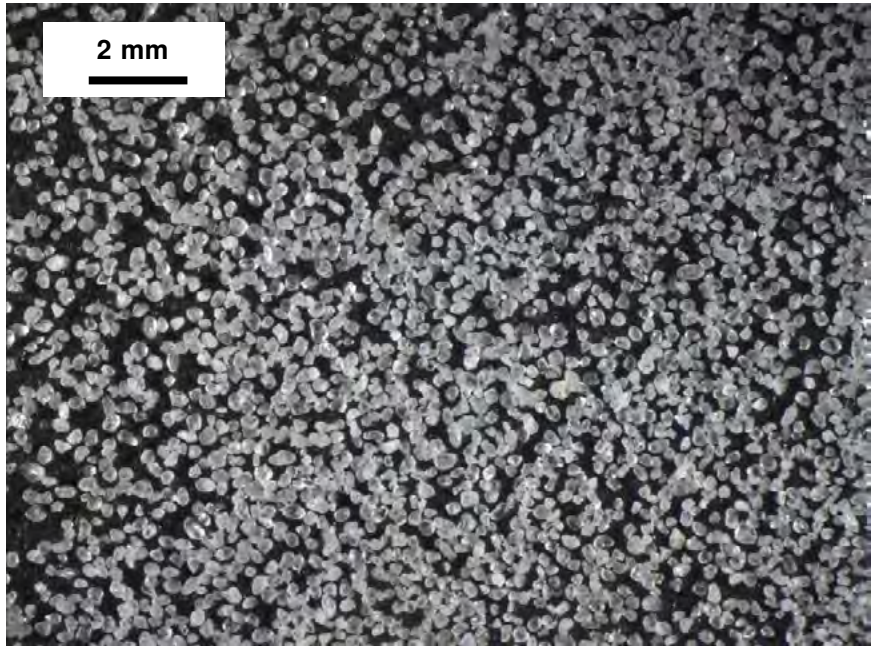
Degraded stone material from the Tower of London. This is typical found where limestone decays via salt weathering. Here the sample was taken from the floor below the damaged wall. The salts and powdered stone are often white. In some cases the crystalline form may be visible in the deposits. Sodium chloride (household salt) is characterised by cube-like structure (see next page).

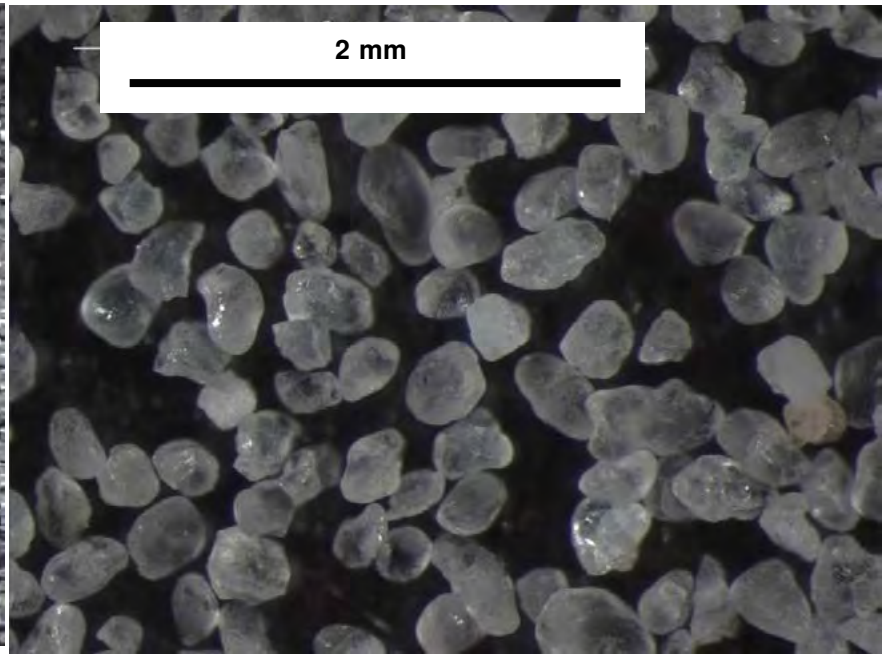
Sodium Chloride (halite)



This show typical household salt (sea-salt/sodium chloride) grains. It is characterised by whitish transparent cubes. This salt dissolves at relative humidity higher than 75.3 %, therefore it can only be observed when the humidity of the room is low. Salt can be a component of dust because of rising damp or from food.

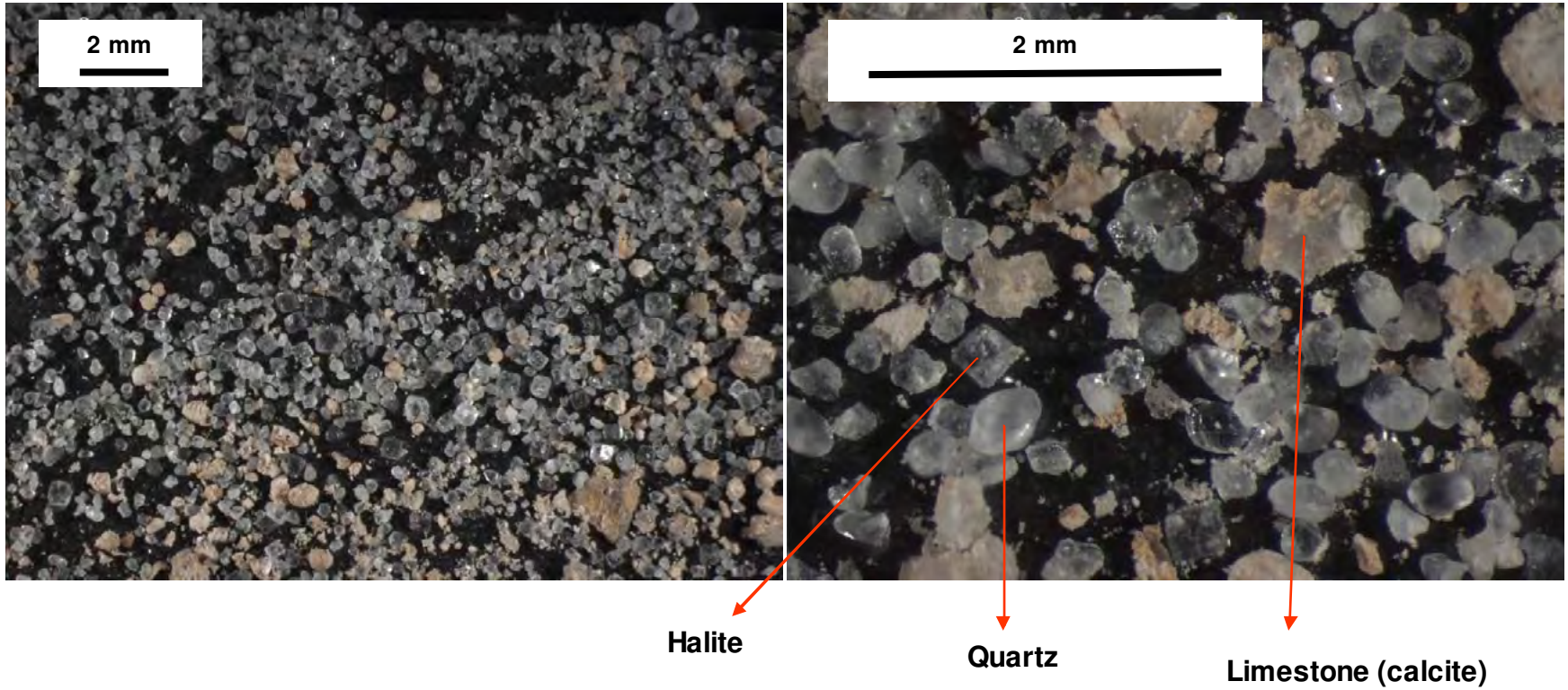
Sand





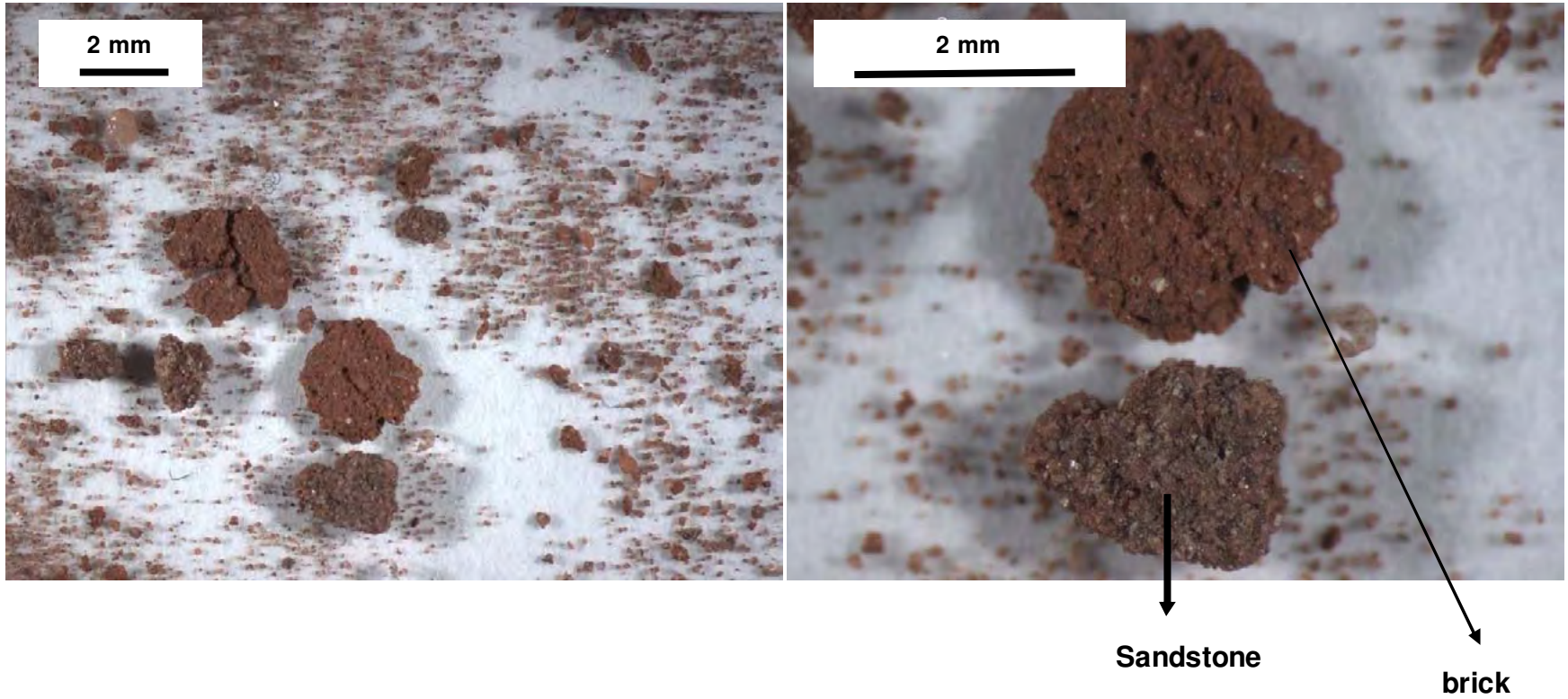
Sand often contains clear slightly rounded particles (quartz) and common because sand is used in building and landscape construction. These are most often found deposited on the floor as the particles are quite large.

Mixture of sand-halite-limestone



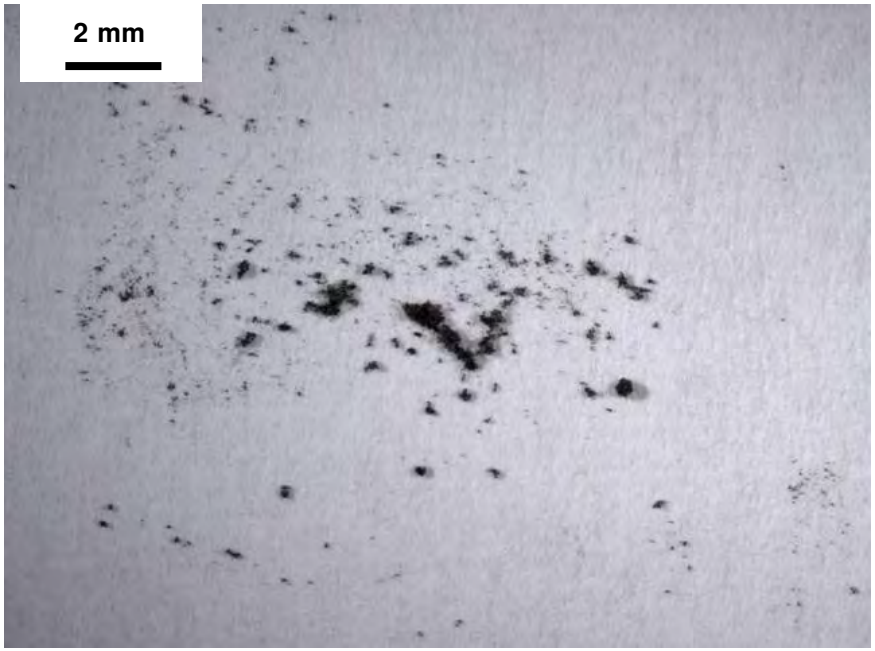
This show a mixture of grains. Halite (sodium chloride) is characterised by whitish transparent cubes. Sand (quartz) are rounded transparent grains. Yellowish grains are limestone dust, somewhat translucent.

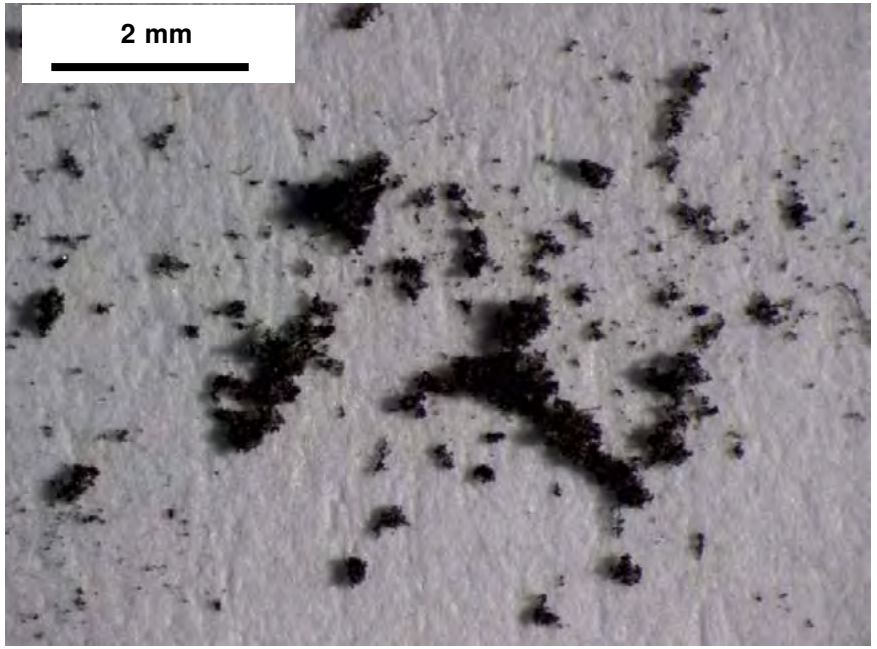
Mixture of red sandstone - brick



This show a mixture of grains and material fragment.

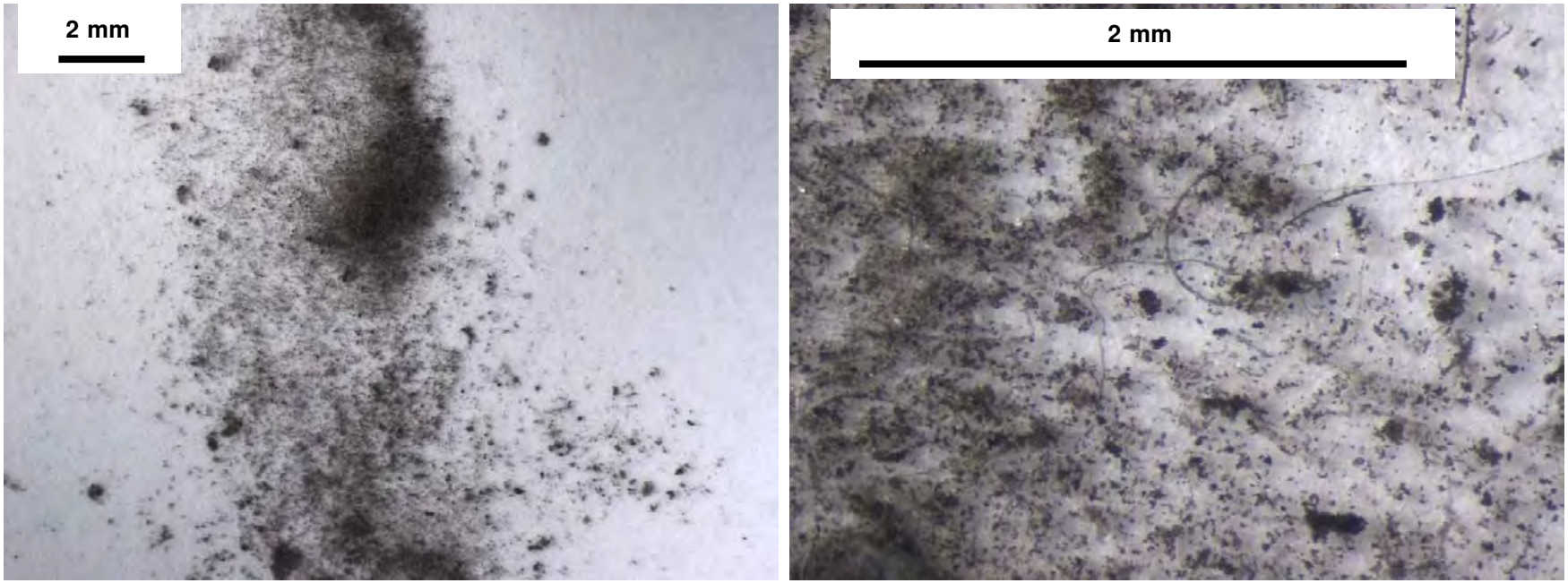
Soot





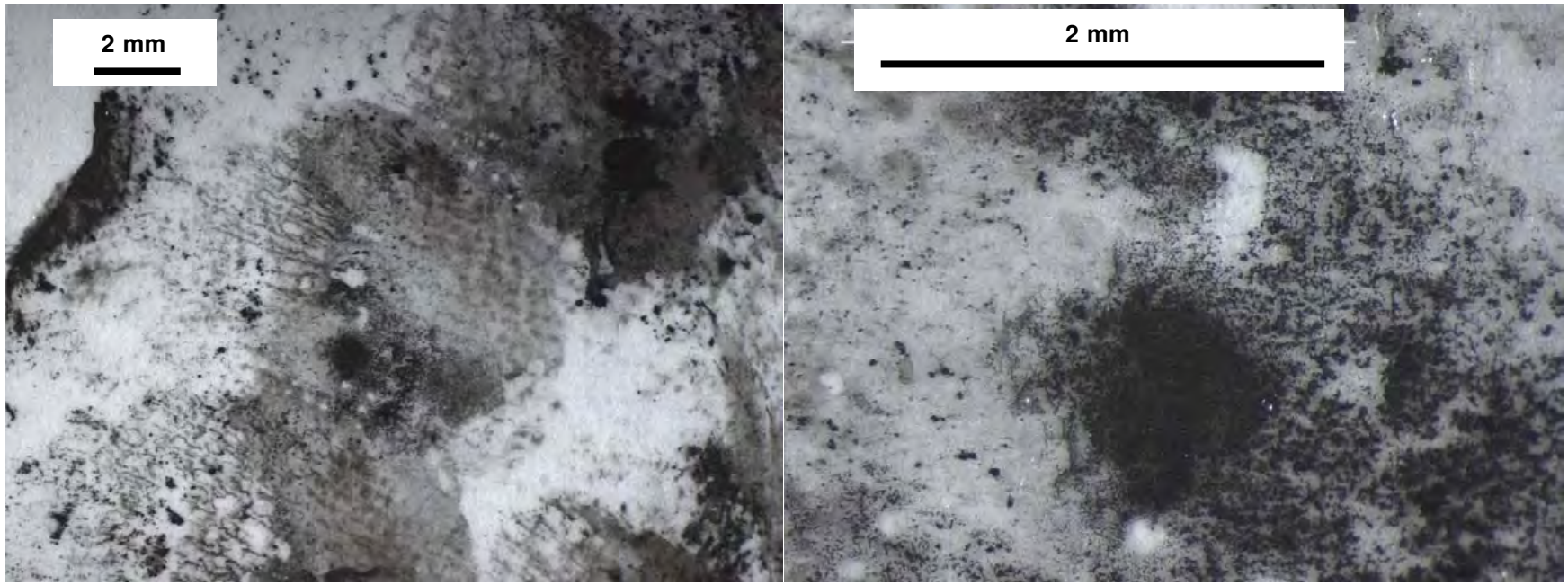
Extensive dust accumulations from Hampton Court Palace show a high soot content. Typical sources of modern soot are traffic emissions, but older deposits accumulated over century-long timescales can indicate historical coal burning (see page 37). Today oil soot can be found from heating boilers. The colour is dark (black, brownish) and particle size is usually small (1-20 µm) with round to irregular shape. These particles tend to join together and form loose clusters of rounded to angular or elongated agglomerates. At very high magnification coal fly ash can exhibit transparent glass spheres and where there are high amounts of iron, can be red in colour.

Soot



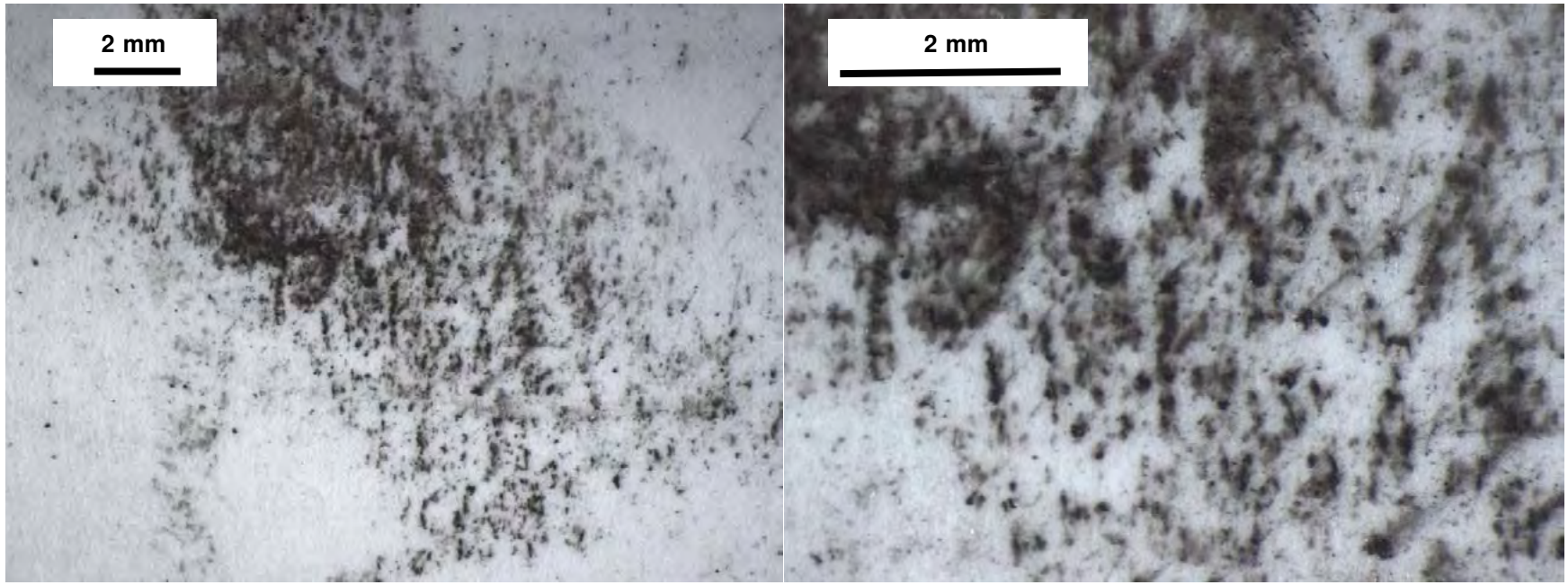
Another view of the dust accumulations from Hampton Court Palace with a possible high soot content. The dark colour and fine grain size is very characteristic of soot deposits. Some fibres can be also observed in the detailed photograph (right)

Diesel Soot



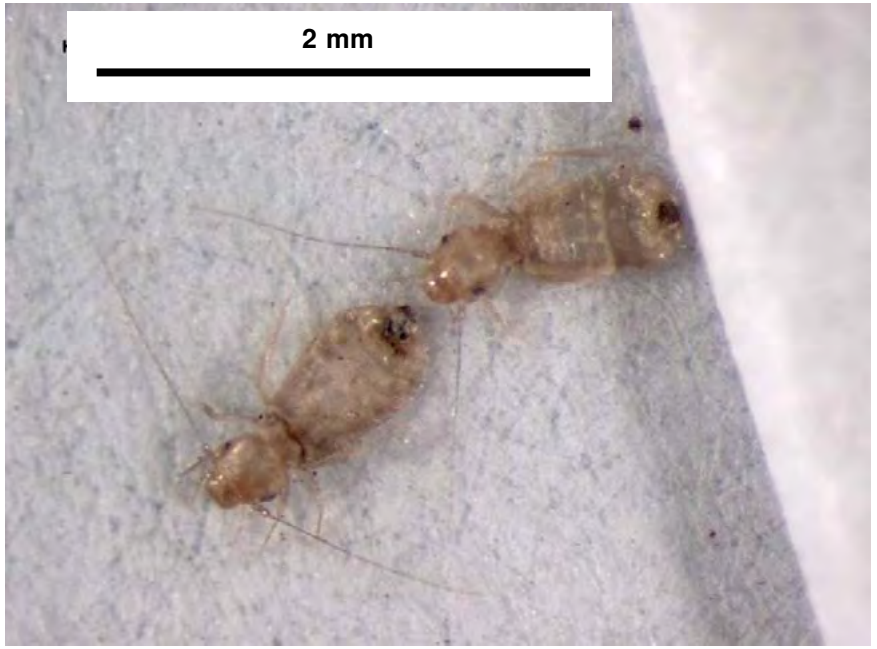
Soot collected from diesel exhaust. Black with very fine grain size is very characteristic of soot deposits, but the fine particles readily aggregate.

Soot from car exhaust



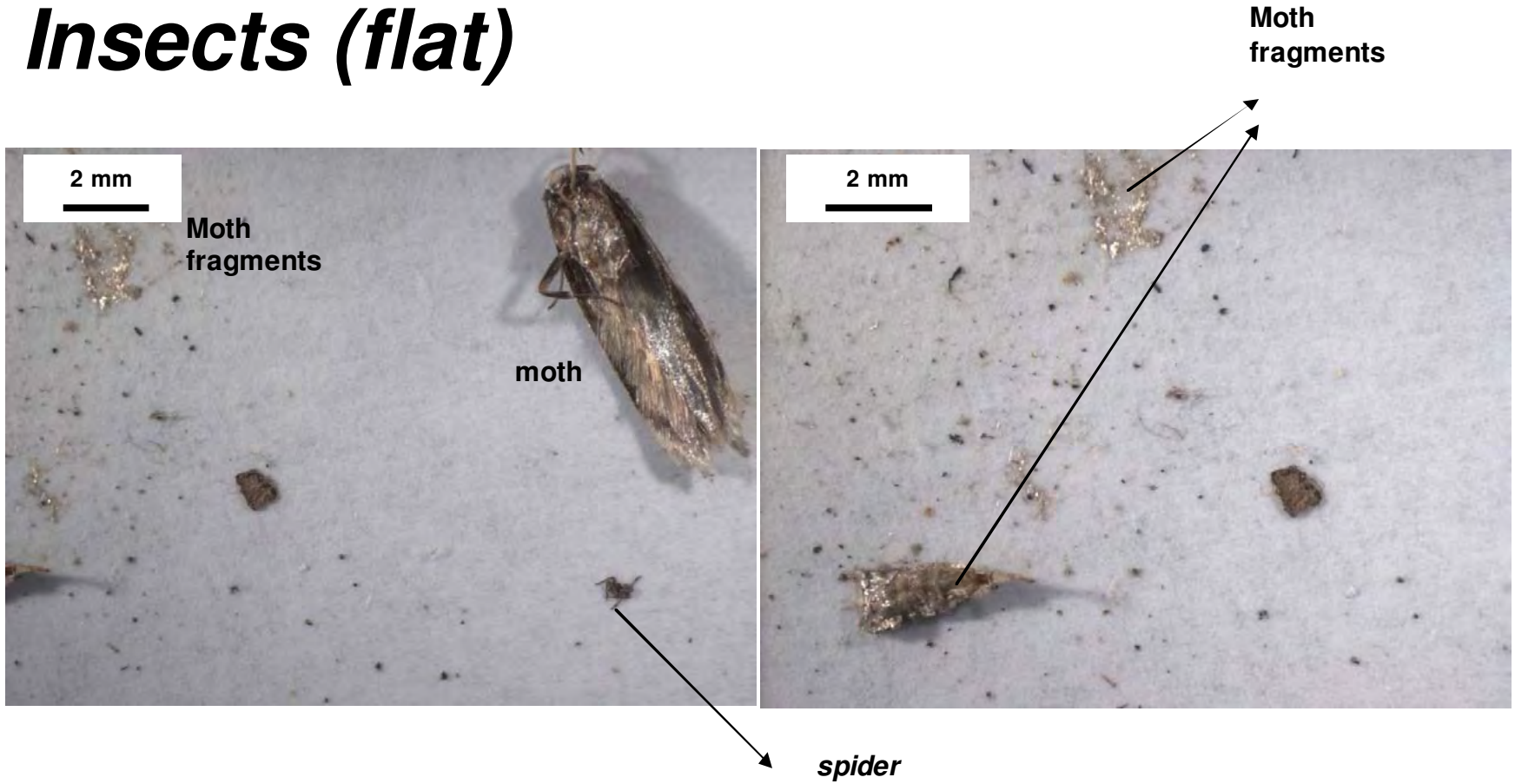
Soot collected from a car. Black fine grain size is very characteristic of soot deposits.

Insects



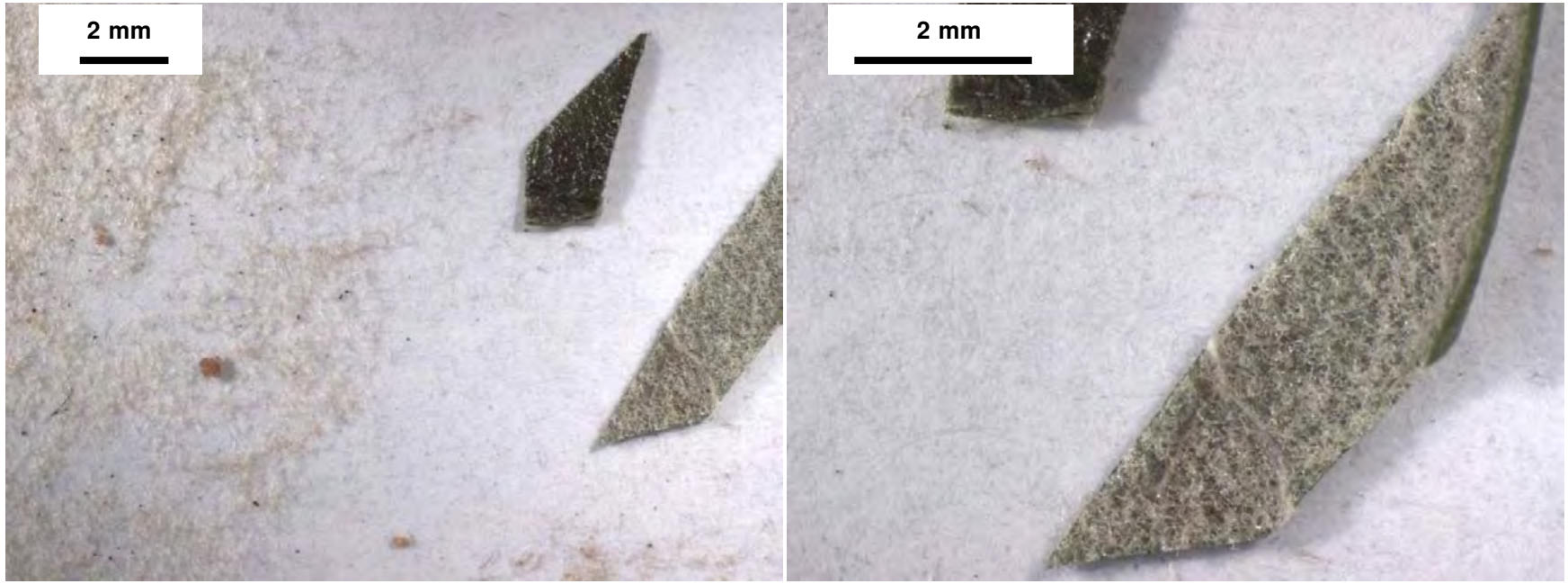
Dust from Canons Ashby House (Northamptonshire) showing insects (book lice in this case) at two magnifications. Through a hand lens you will see them about the size of the left hand image, but with a level of detail that should approach the right hand image. Seasonality may be an important feature of their presence. Insects are typically found when temperature and humidity is high (especially rapid growth over 25º). The photograph is an example of variety of particles that can be found in dust. The picture shows the insects as well as blue thread particles most probably from jeans.

Insects (flat)



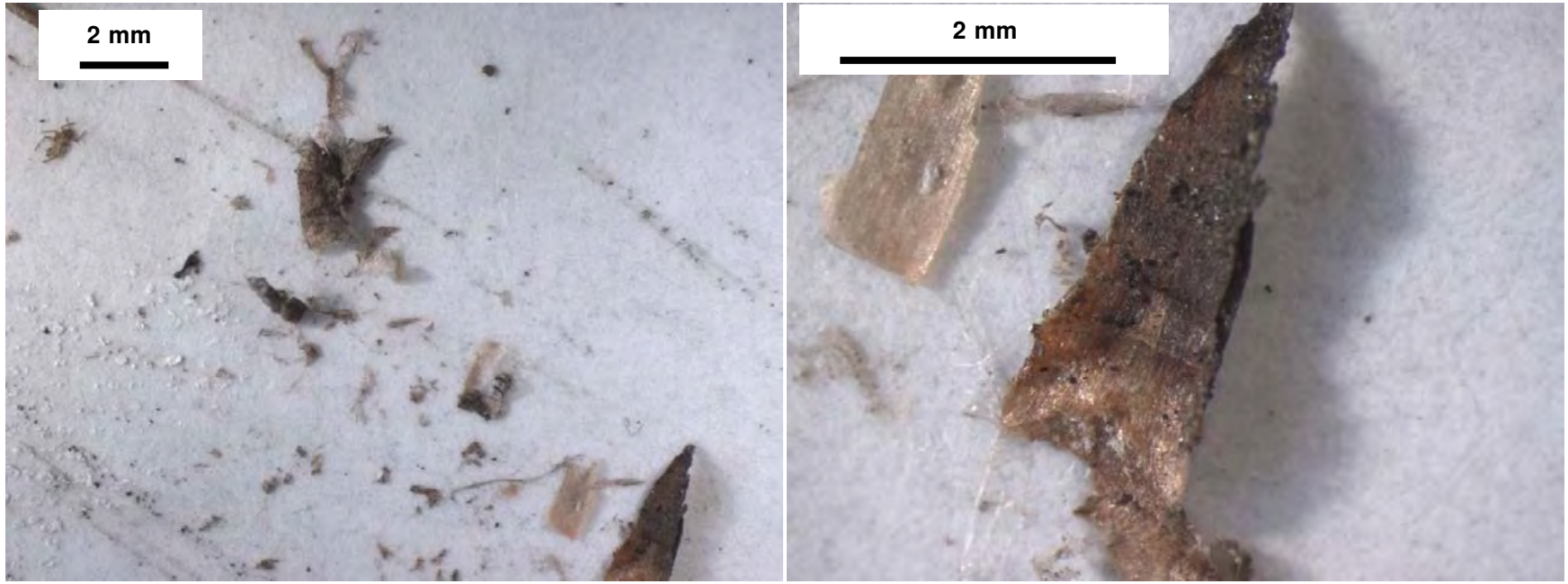
More examples of insects in real dust from a room. We can see a *spider*, a moth and fragments of insects, most probably moths.

Plant fragments: leaves



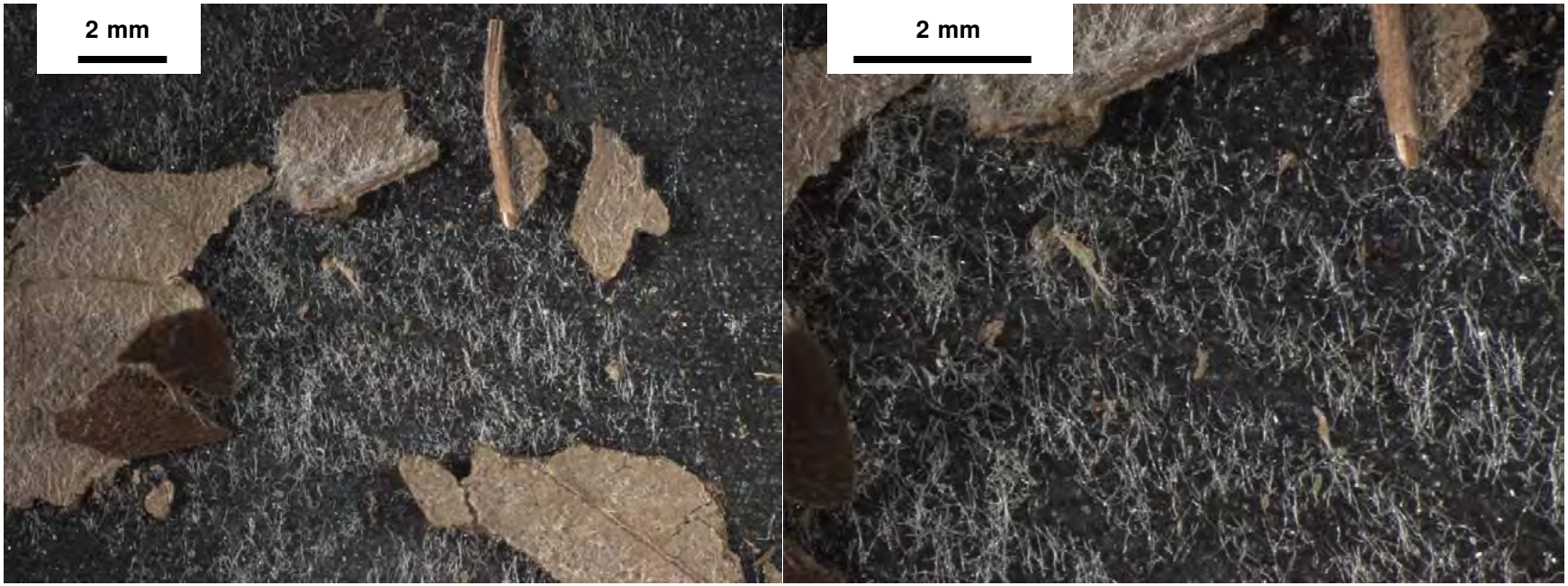
Plant fragments are often relatively large and can be coloured or show evidence of fibres or cells. These photographs show both leaf fragments and leaf fibres.

Plant fragments: pine stem



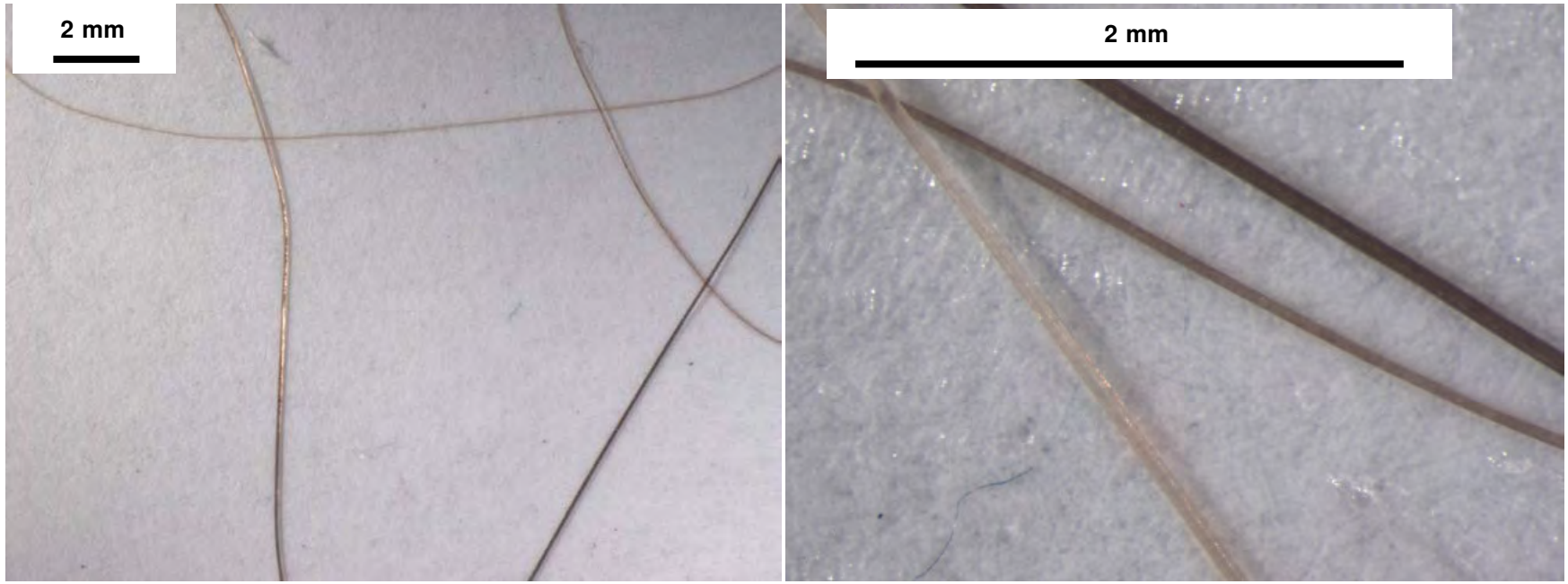
Plant fragments are often relatively large and can be coloured or show evidence of fibres or cells. These photographs show both pine stem fragments and stem fibres.

Plant fragments: dry leaves



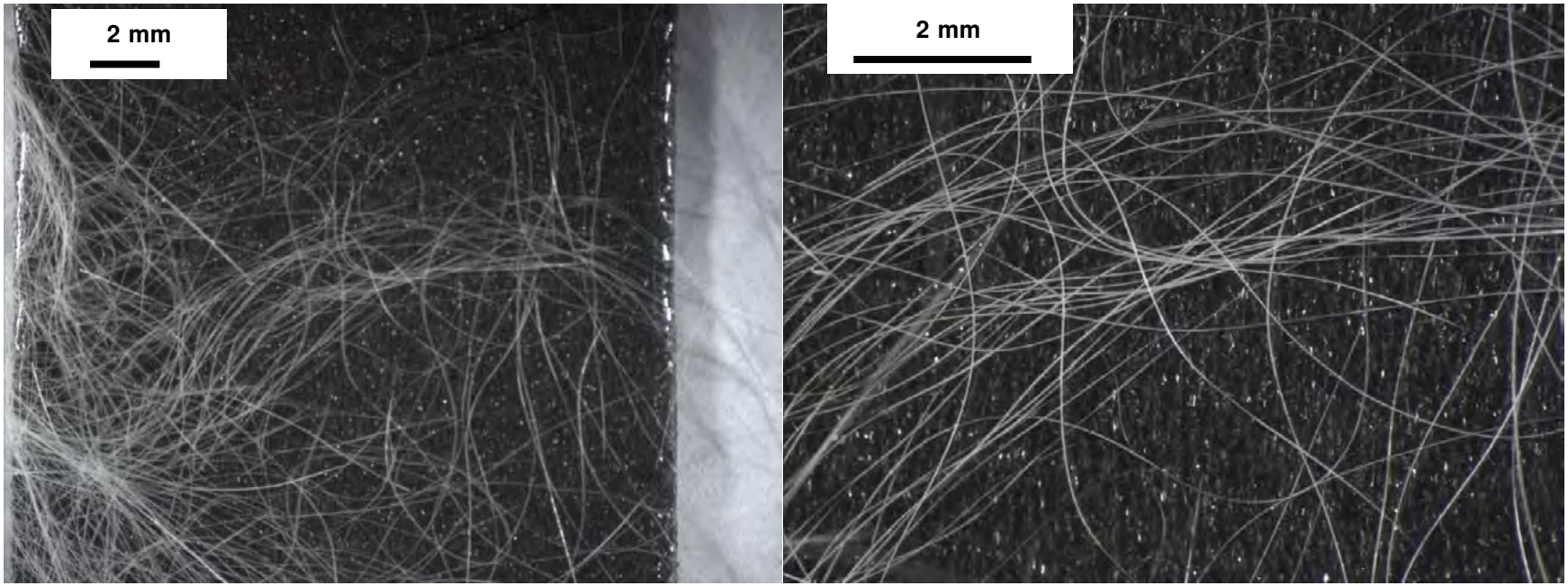
Plant fragments are often relatively large and can be coloured or show evidence of fibres or cells. These photographs show both dry leaves fragments and dry leaf fibres.

Human hair



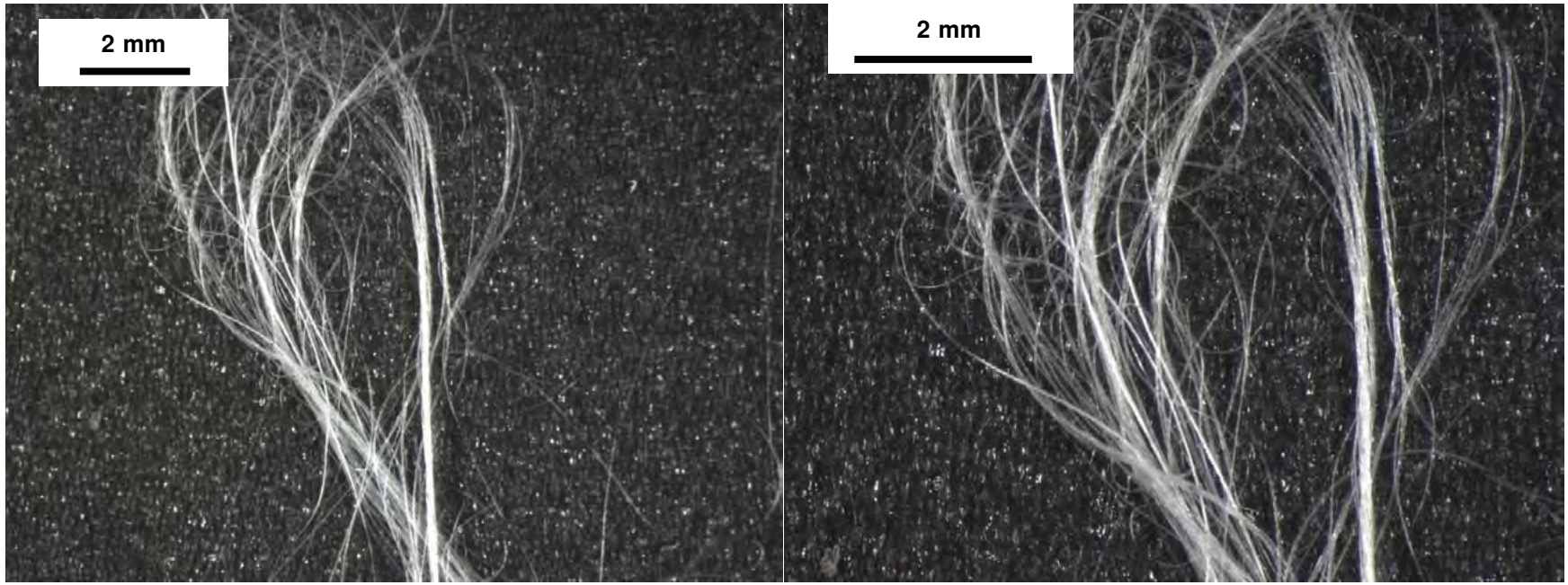
Samples of human hair (dark blonde). Hair samples are usually long and doesn't normally find stubble. Note the smooth well-defined edges and thicker than clothing fibres. Animal hairs can be less than half the diameter of human hair, their colour can be brownish, black and white, from transparent to almost opaque.

Cat hair



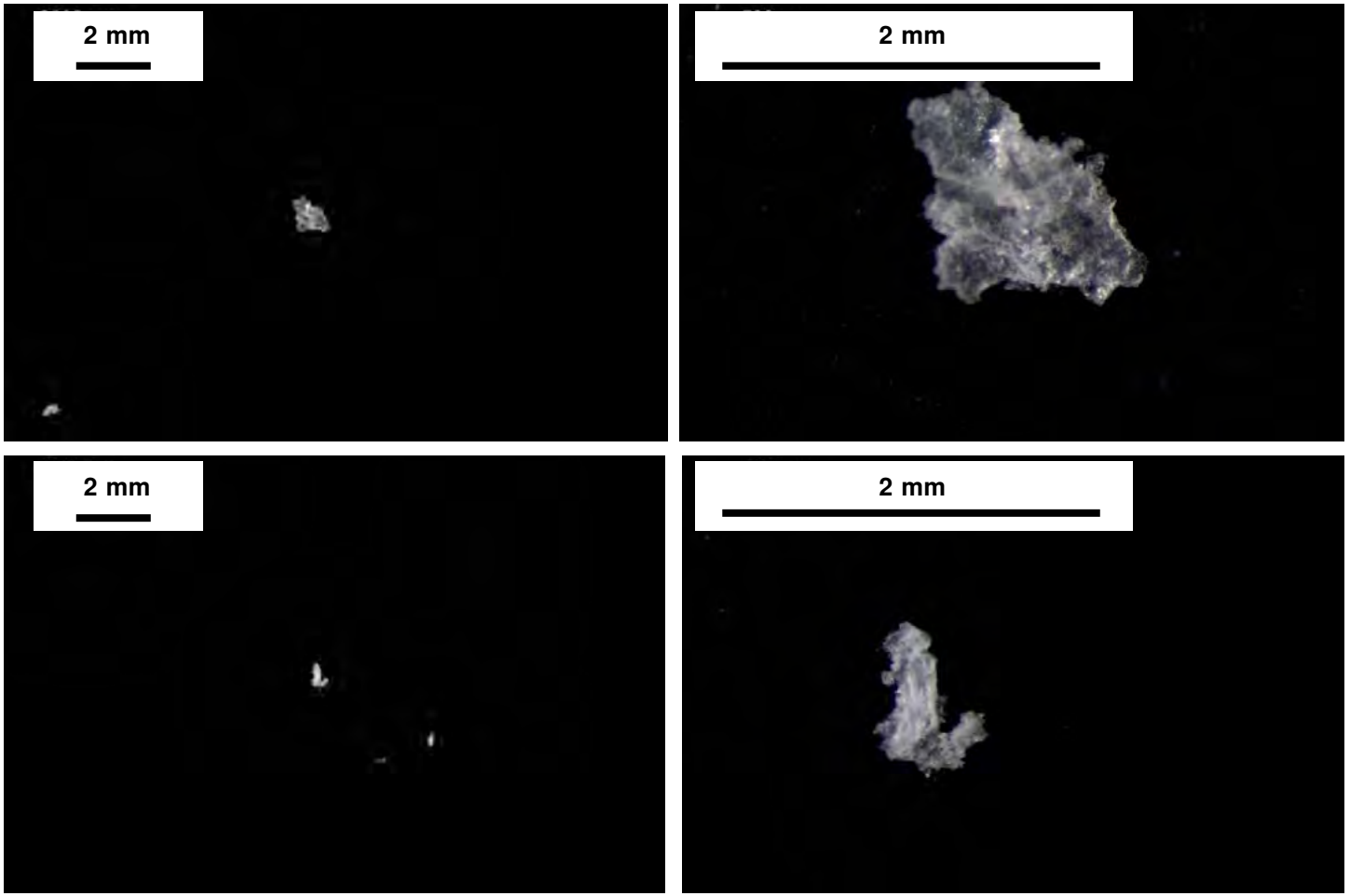
Samples of cat hair (whitish). Animal hairs can be less than half the diameter of human hair, their colour can be brownish, black and white, from transparent to almost opaque.

Dog hair



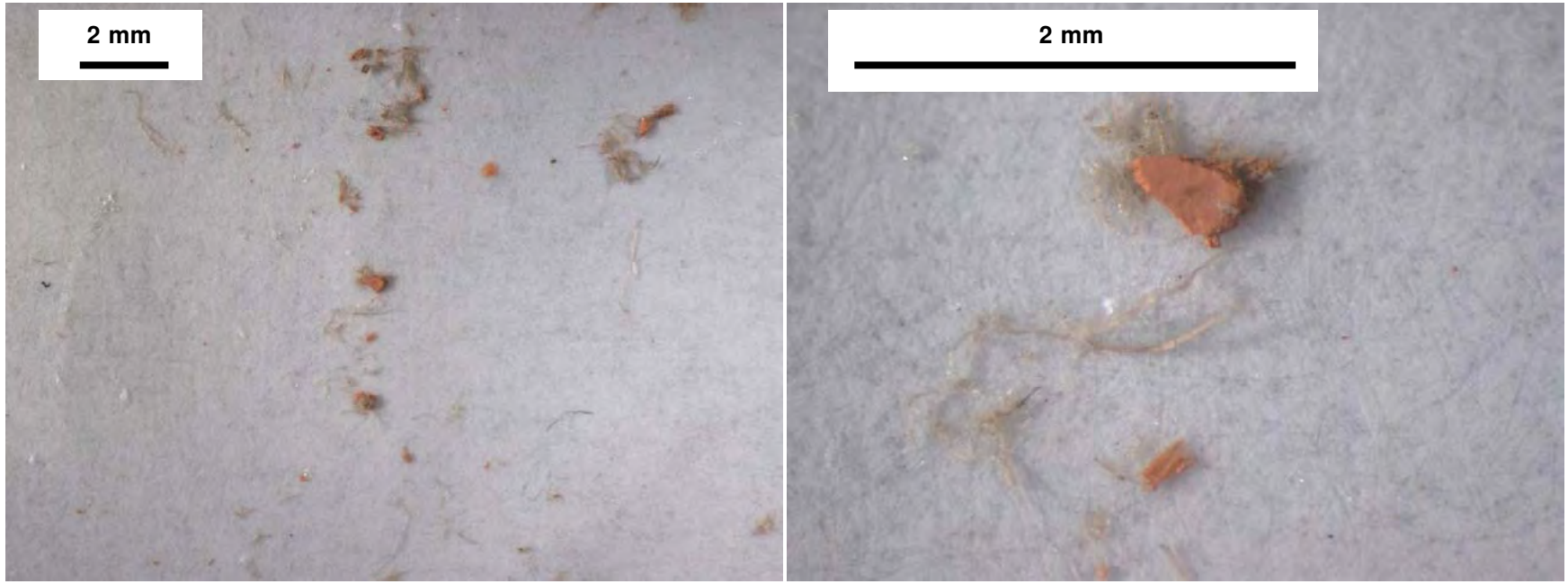
Samples of dog hair (whitish). Animal hairs can be less than half the diameter of human hair, their colour can be brownish, black and white, from transparent to almost opaque.

Human skin/dandruff/dander



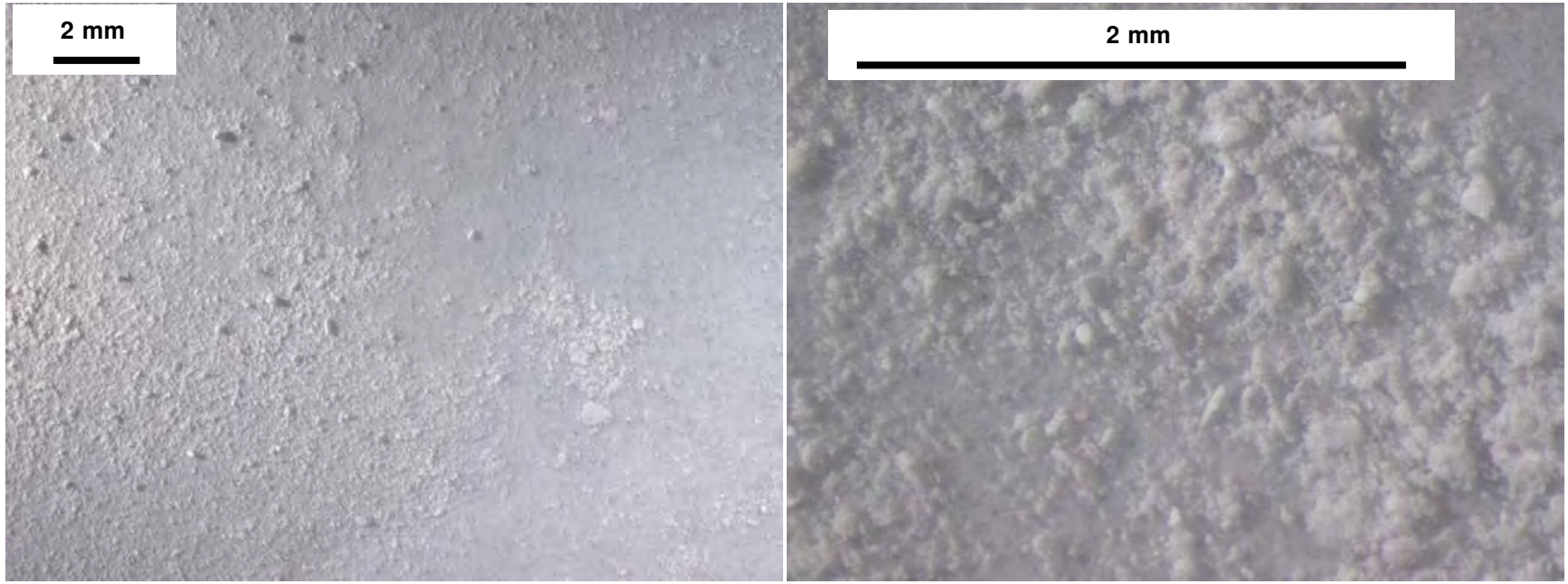
Not necessarily very common, except in places where people spend a lot of time and skin is exposed (bedrooms) or animals shed dander. Particles can be shed from clothes and are quite big. Skin flakes are recognisable because they are translucent. Size is typically 10-300 µm. The colour is whitish or light gray. They are usually irregular shaped, thin, flat flakes of over lapping skin cells.

Paint fragments



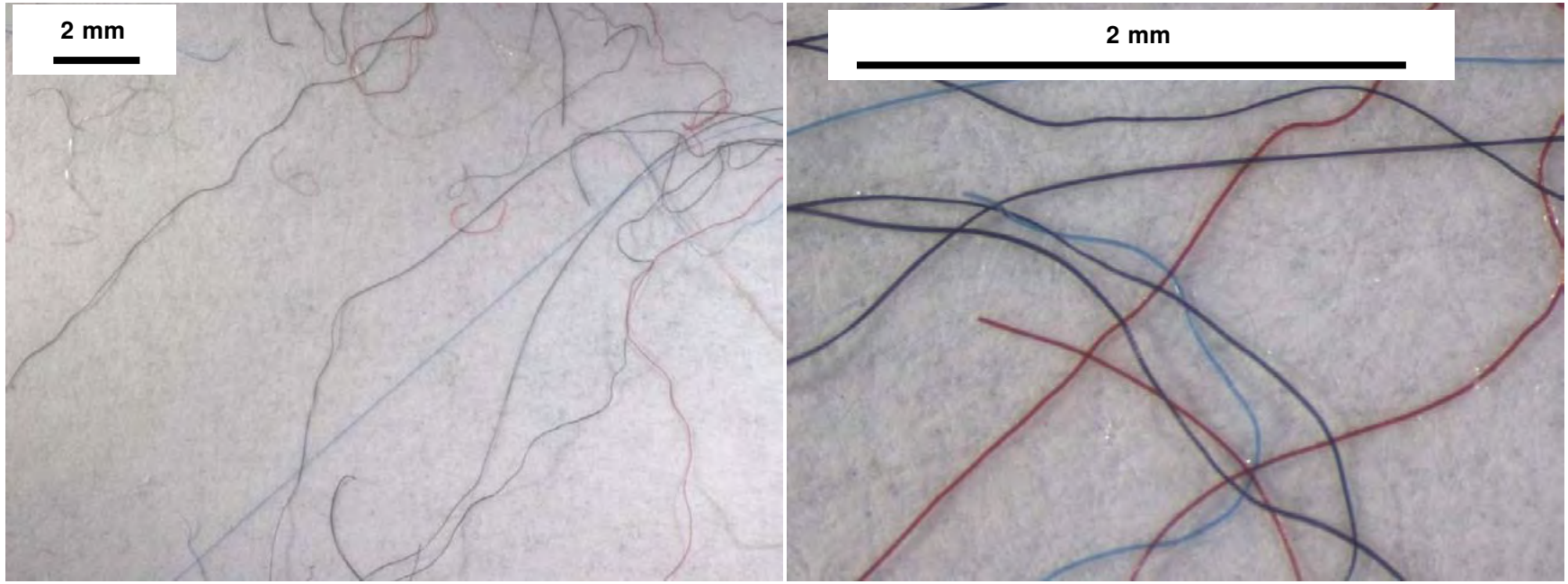
Paint fragments can have a variety of colours (blue, green, red, etc), they are opaque and present irregular shapes.

Plaster



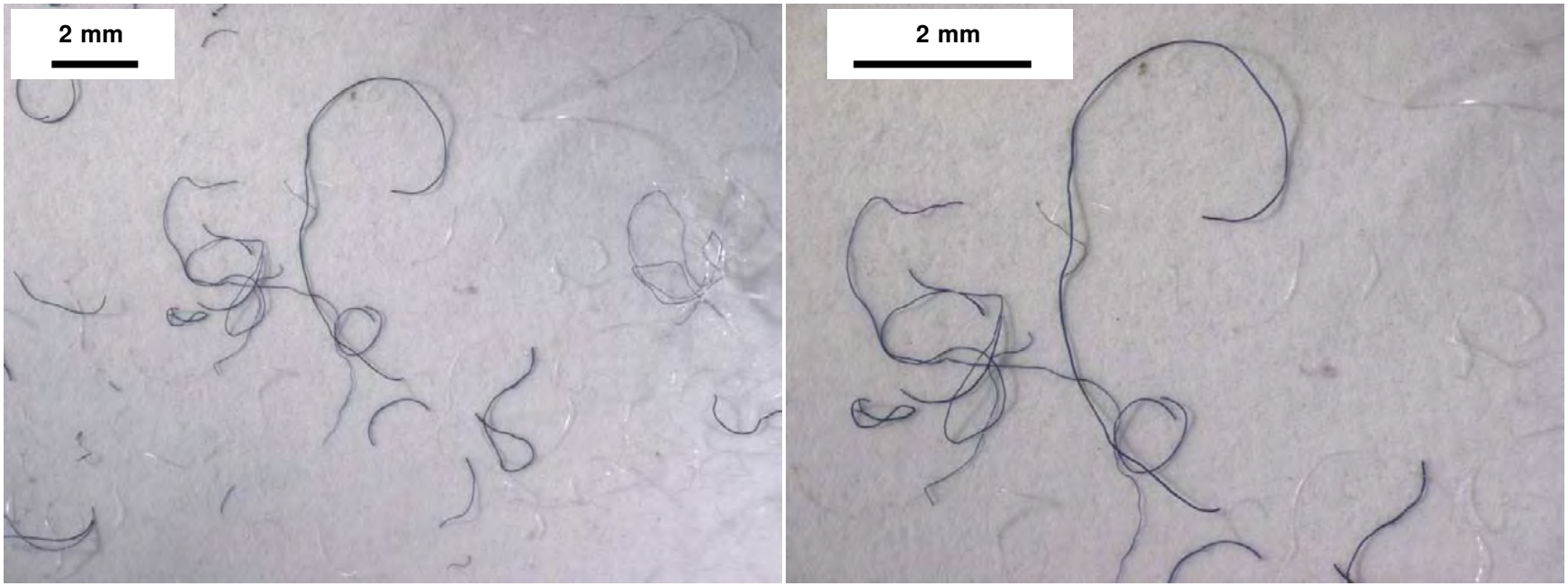
Plaster has white colour and very fine grain size.

Clothing fibres: acrylic



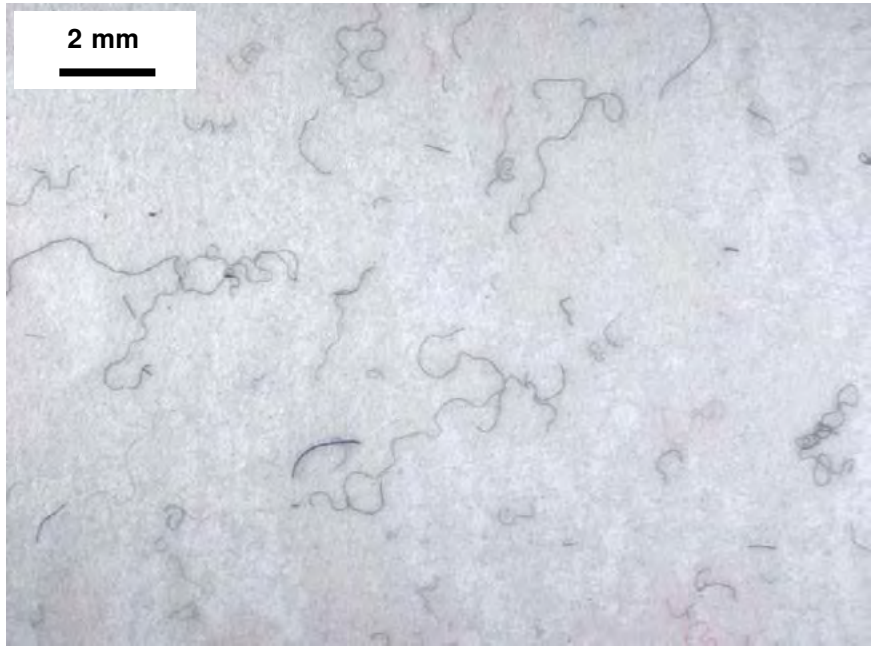
Fibres from a scarf. In deposits within historic properties fibres can occur alone or in clusters and may be much shorter in length.

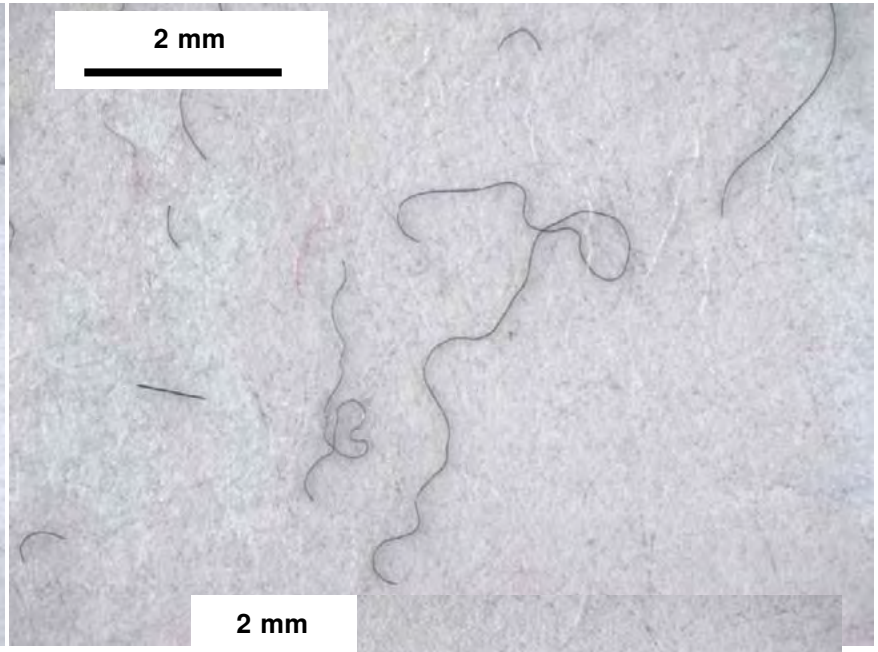
Clothes fibres: wool



Blue wool fibres from a glove. There were also white fibres, but these are only clear on a dark background. Note relatively smooth fibre, fairly thick, but blue and white

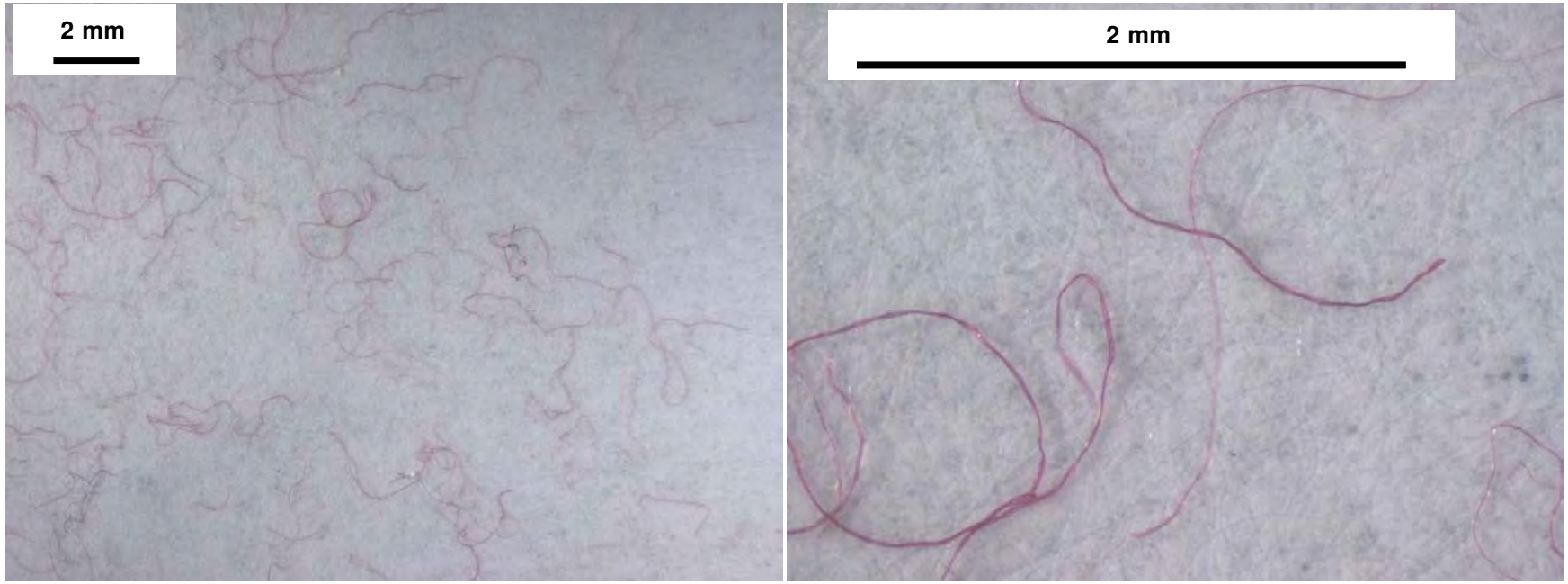
Clothing fibres: cotton





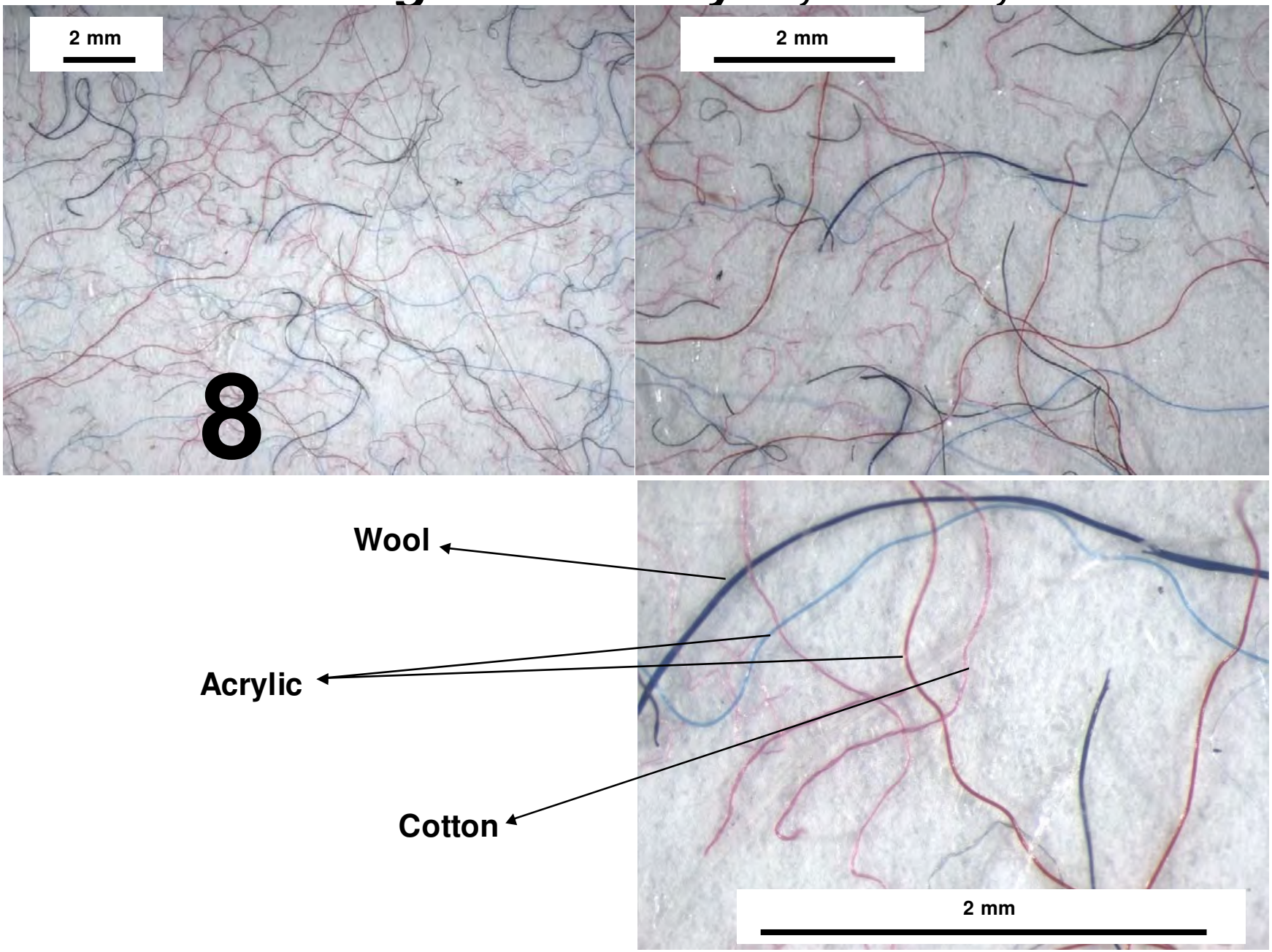
Blue cotton fibres from a light jacket (top photographs). Notably thinner than wool as shown in bottom right – compare with upper left.

Clothing fibres: cotton

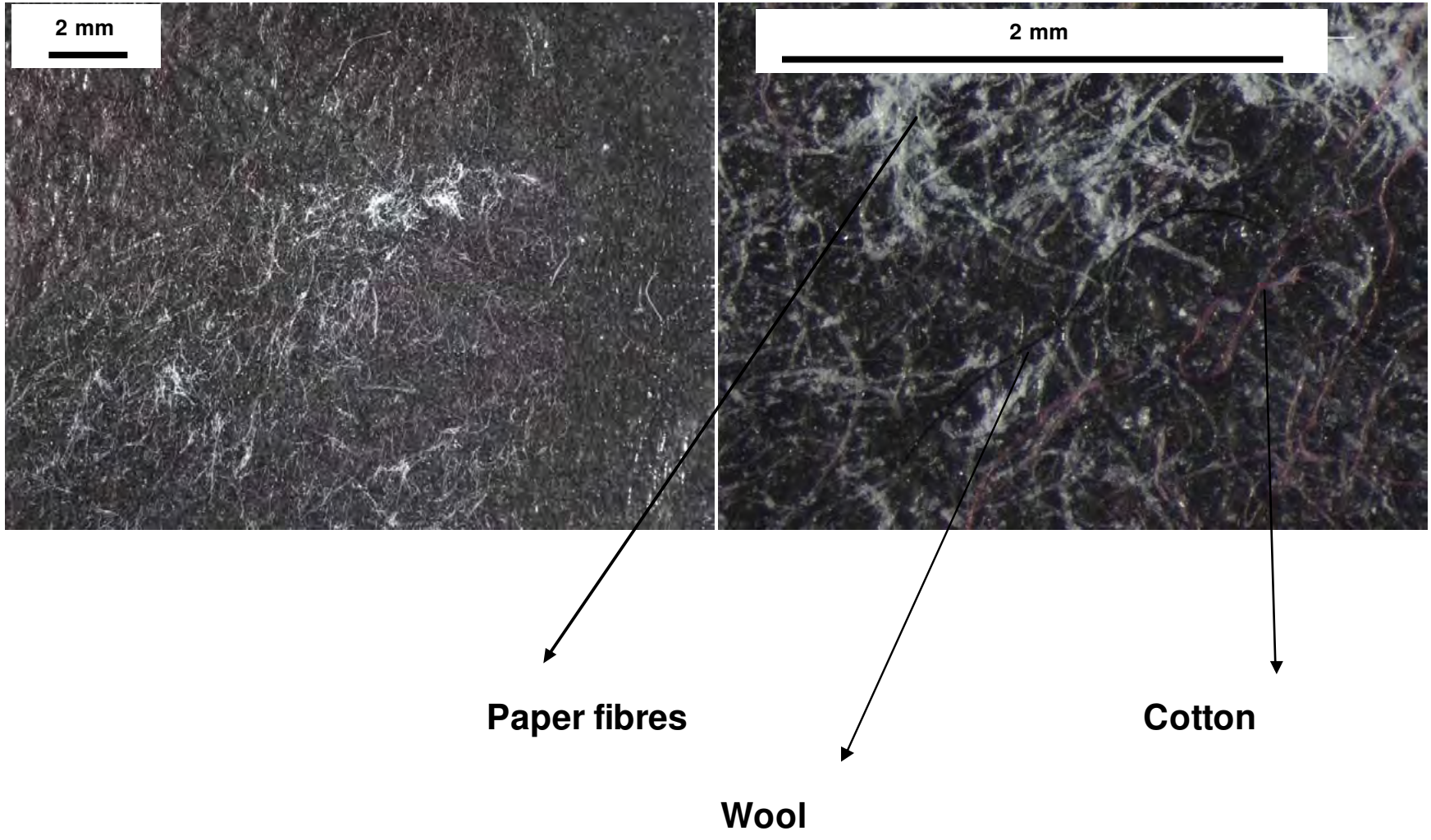


Blue cotton fibres from a purple cardigan. They are notably thinner than wool and acrylic fibres.

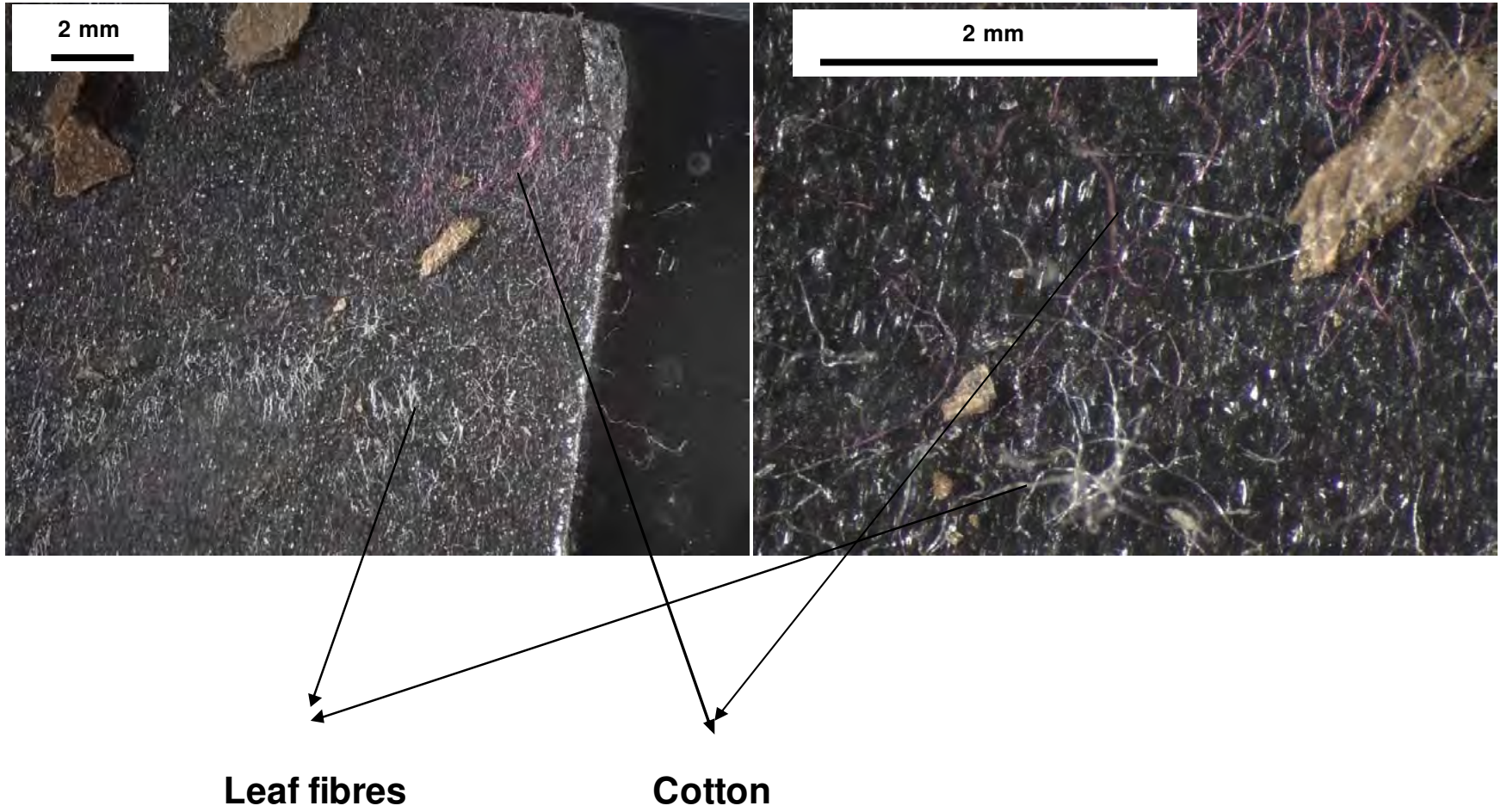
Mixed clothing fibres: acrylic, cotton, wool



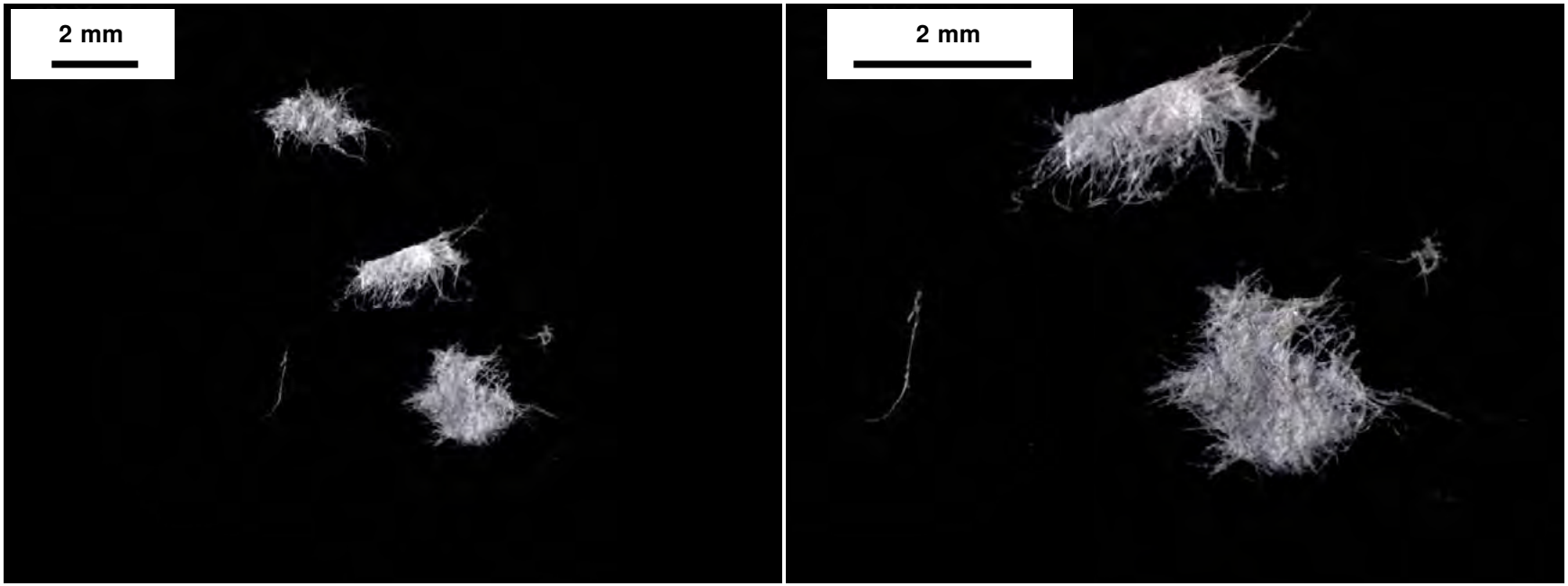
Mixed fibres: wool, cotton, paper



Mixed fibres: cotton, dry leaf fibres

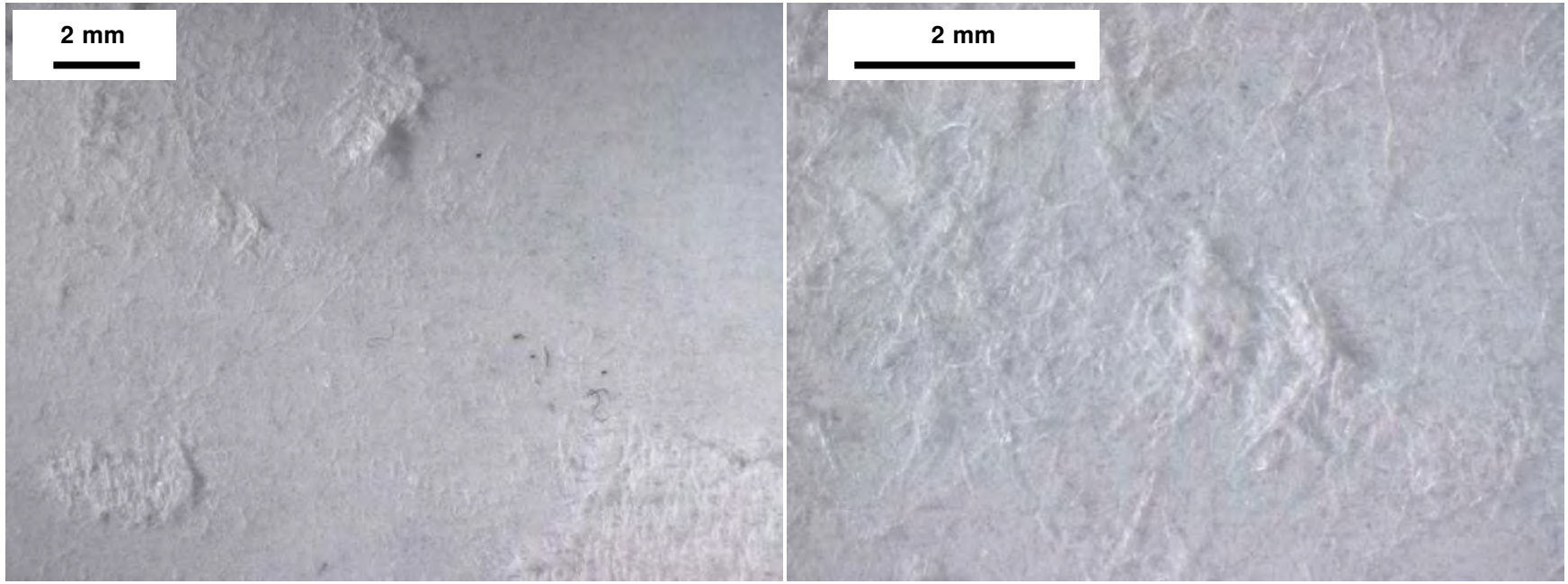


Paper



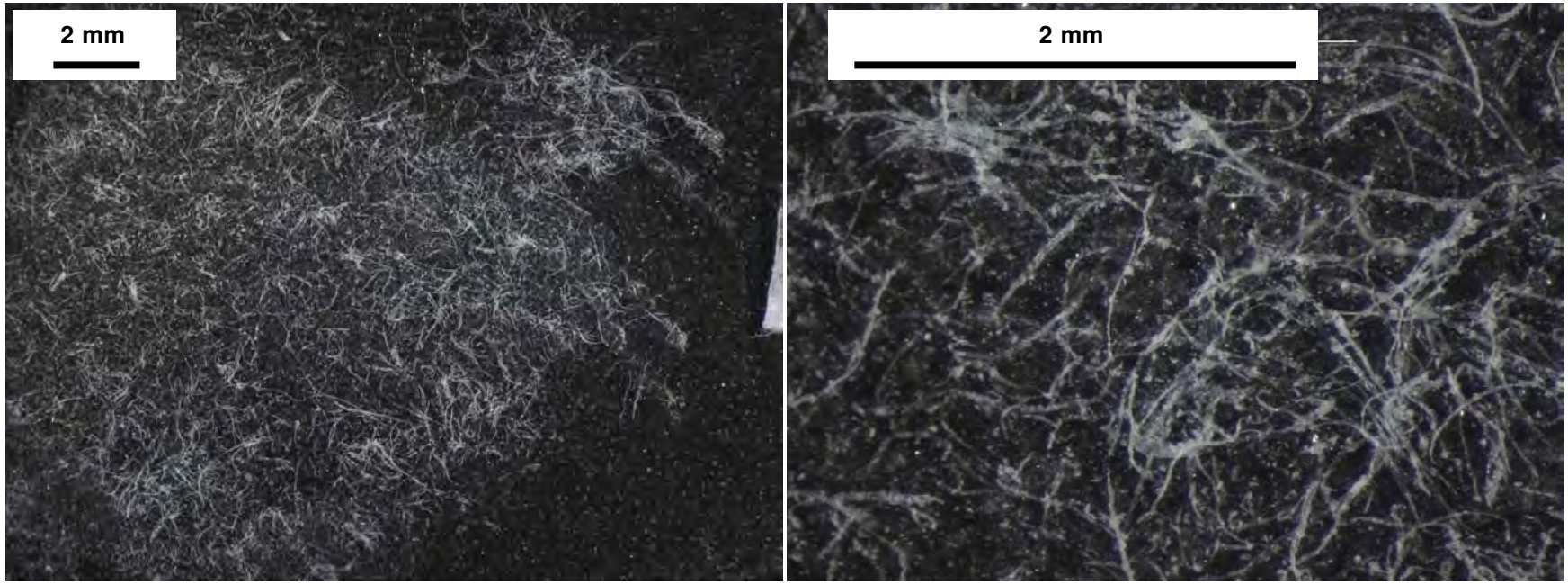
Fibre mats from Kleenex tissue. In historic properties, it is more likely to find a single fibre as to the left of the mats. In the historic context paper fibres may derive from abraded wall paper.

Paper



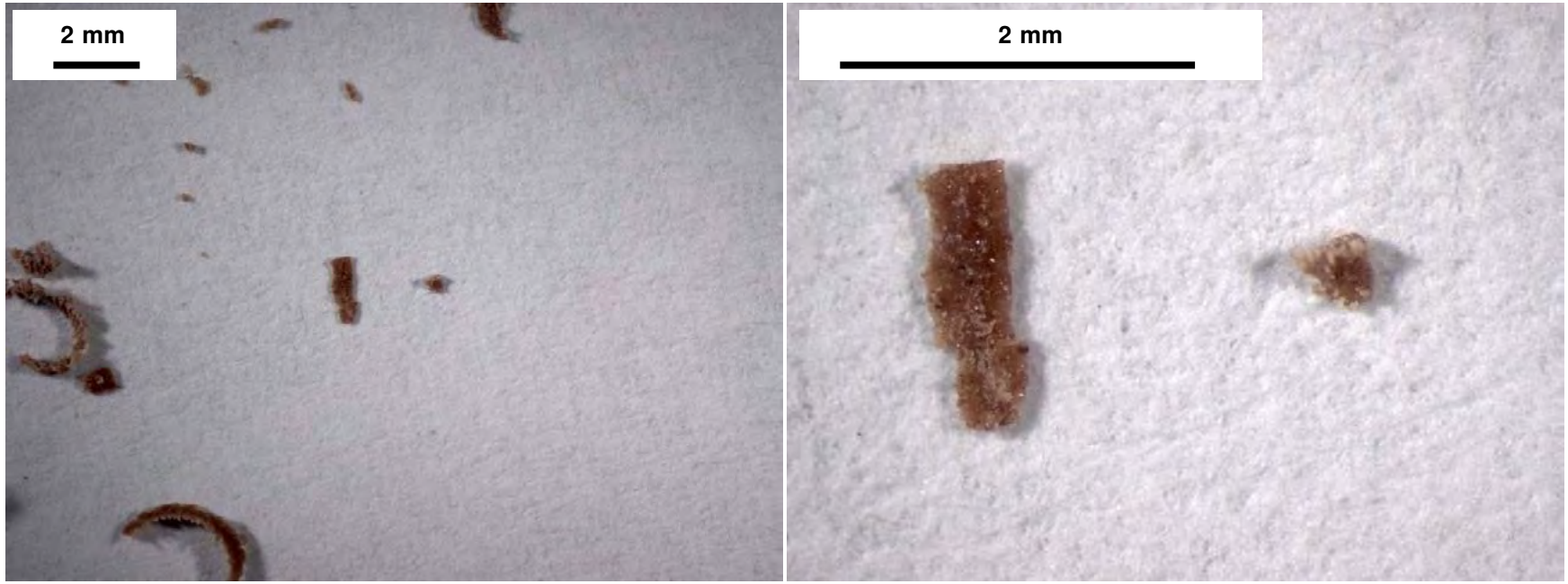
Again rests from Kleenex tissue. In historic properties, it is more likely to find a single fibres as in the image to the right. In the historic context paper fibres may derive from abraded wall paper.

Paper



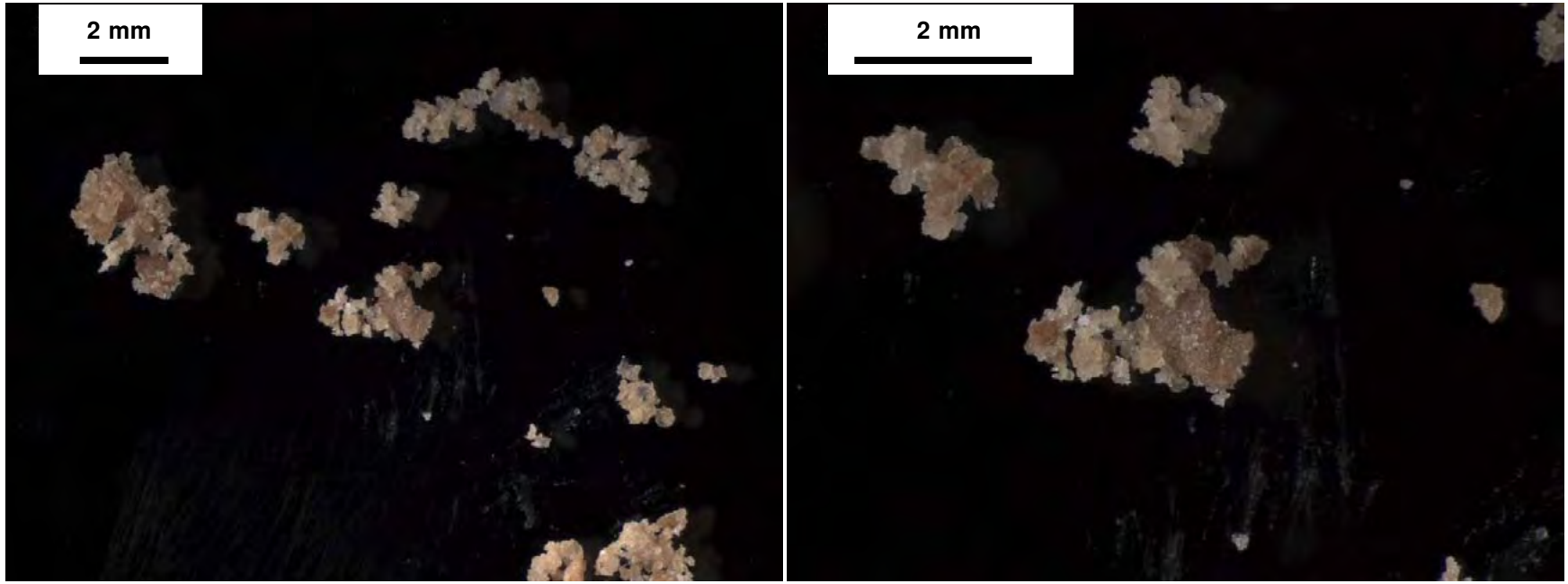
Paper fibres. In historic properties, it is more likely to find a single fibres. that may derive from abraded wall paper. They can by difficult to differentiate from vegetal fibres or even clothe fibres. If the colour of the background contrasts with the fibre colour it makes them more visible.

Chocolate



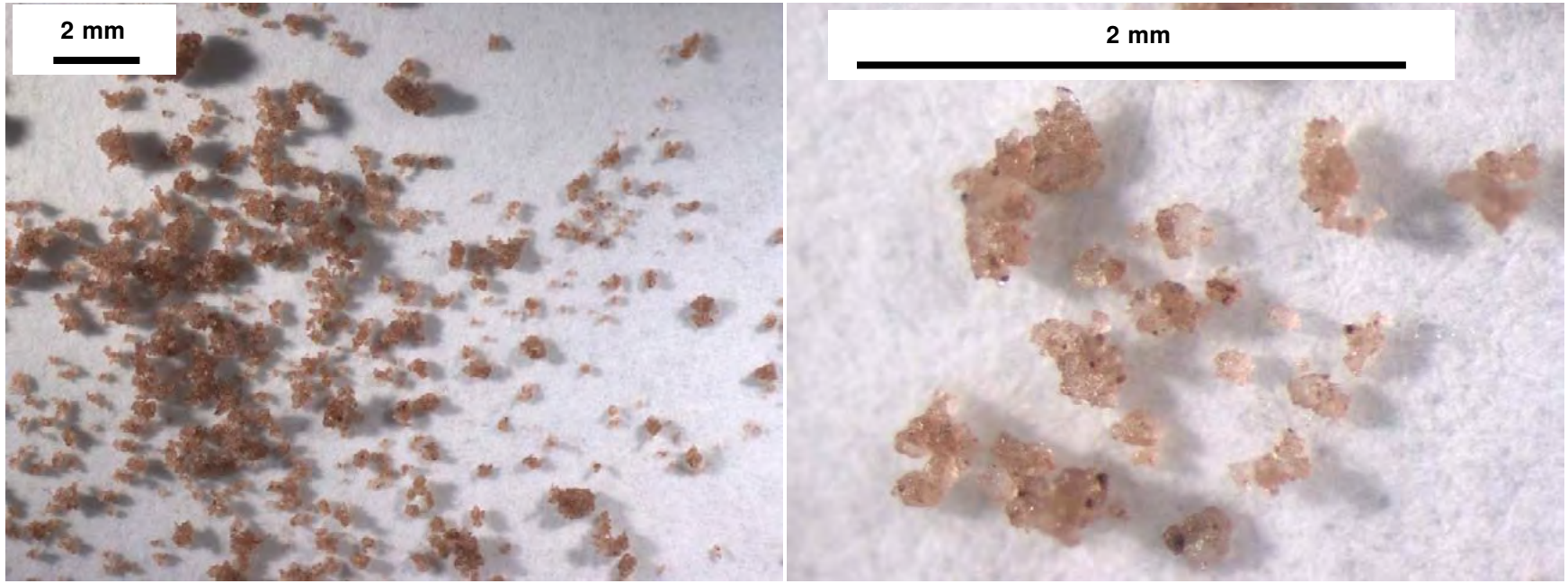
Food is sometimes found as relatively large particles, such as chocolate or bread crumbs.

Cookies



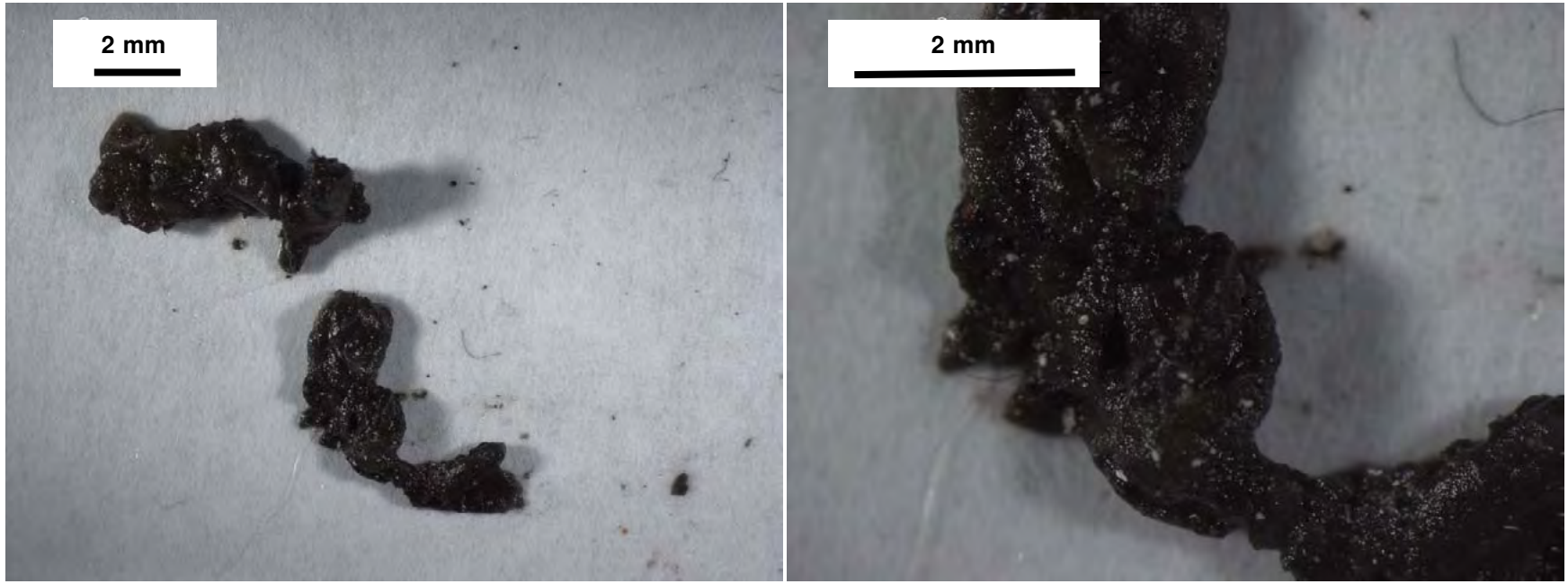
Food is sometimes found as relatively large particles, such as chocolate, cookies or bread crumbs, which have rather angular grains.

Cookies



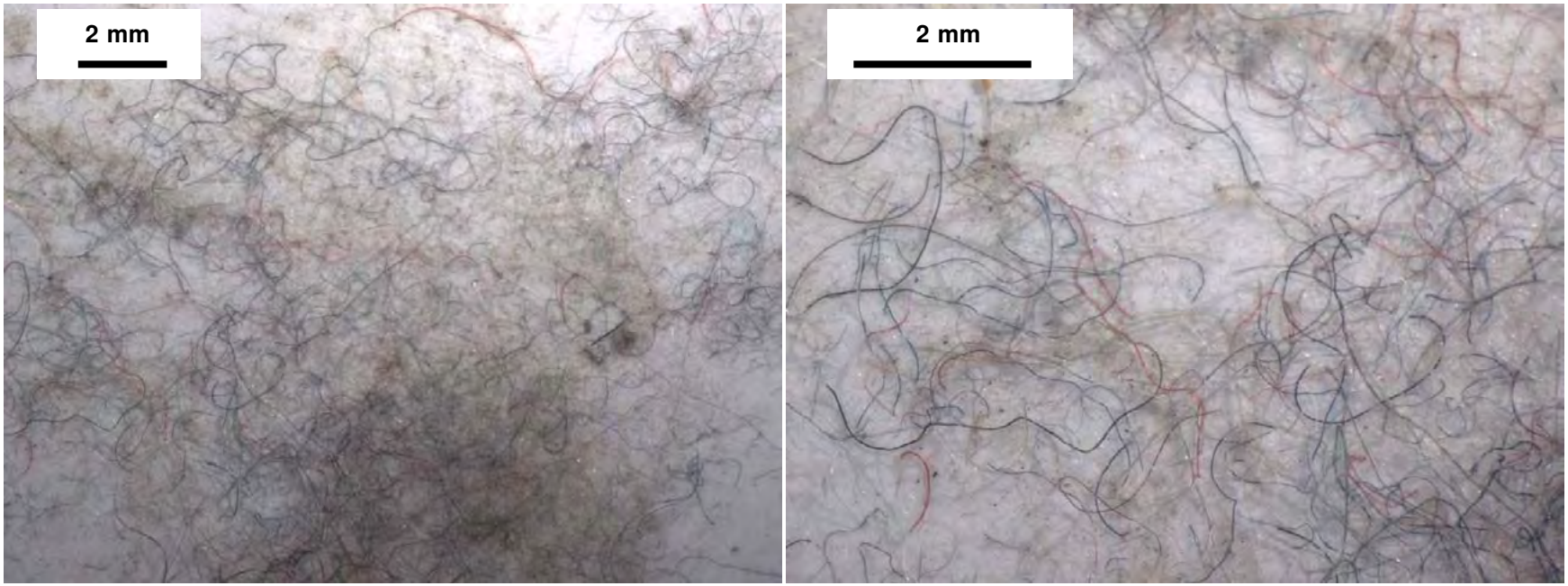
Food is sometimes found as relatively large particles, such as chocolate, cookies or bread crumbs, which have rather angular grains.

Mould collected from a window



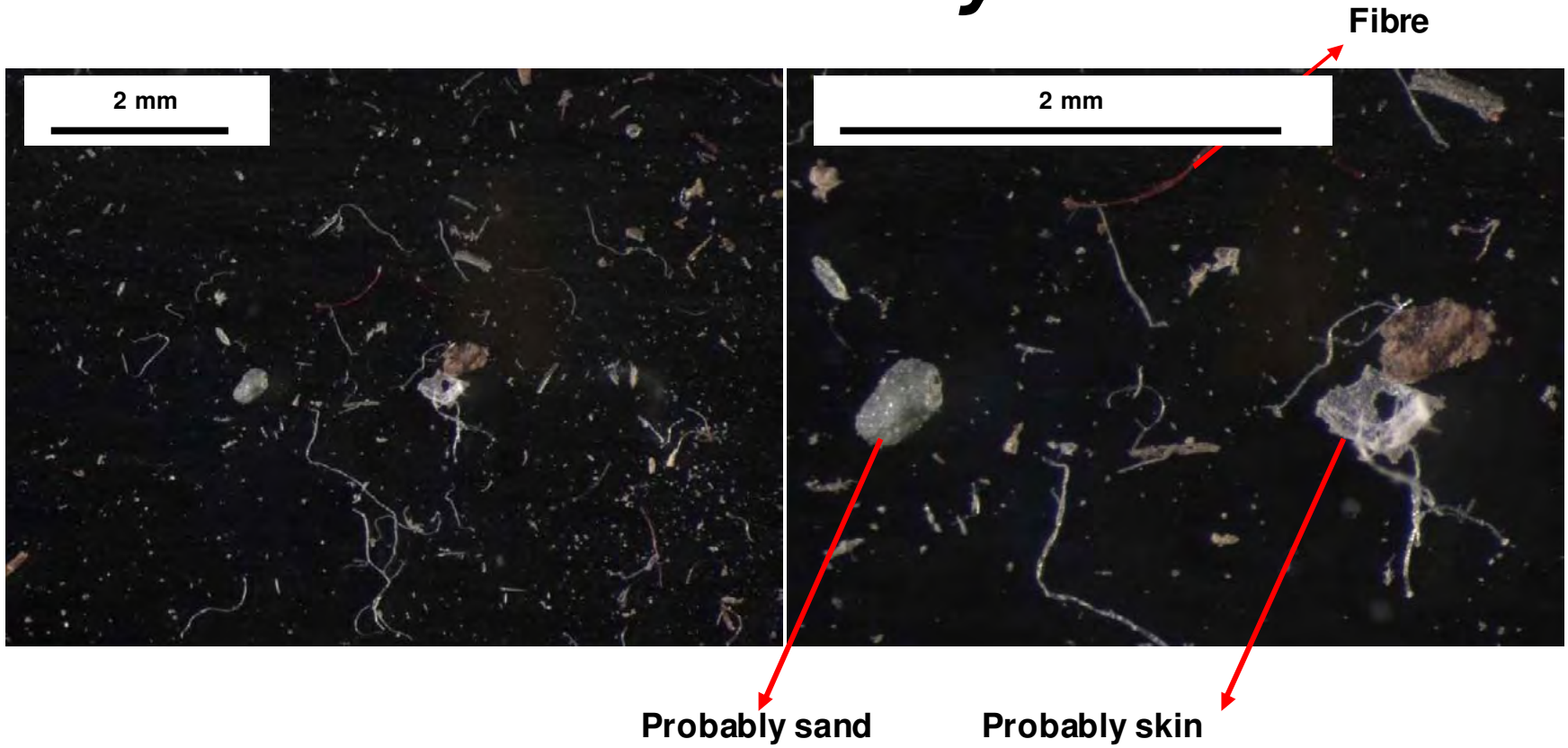
Mould (desiccated)

Real Dust: Brown Gallery, Knole



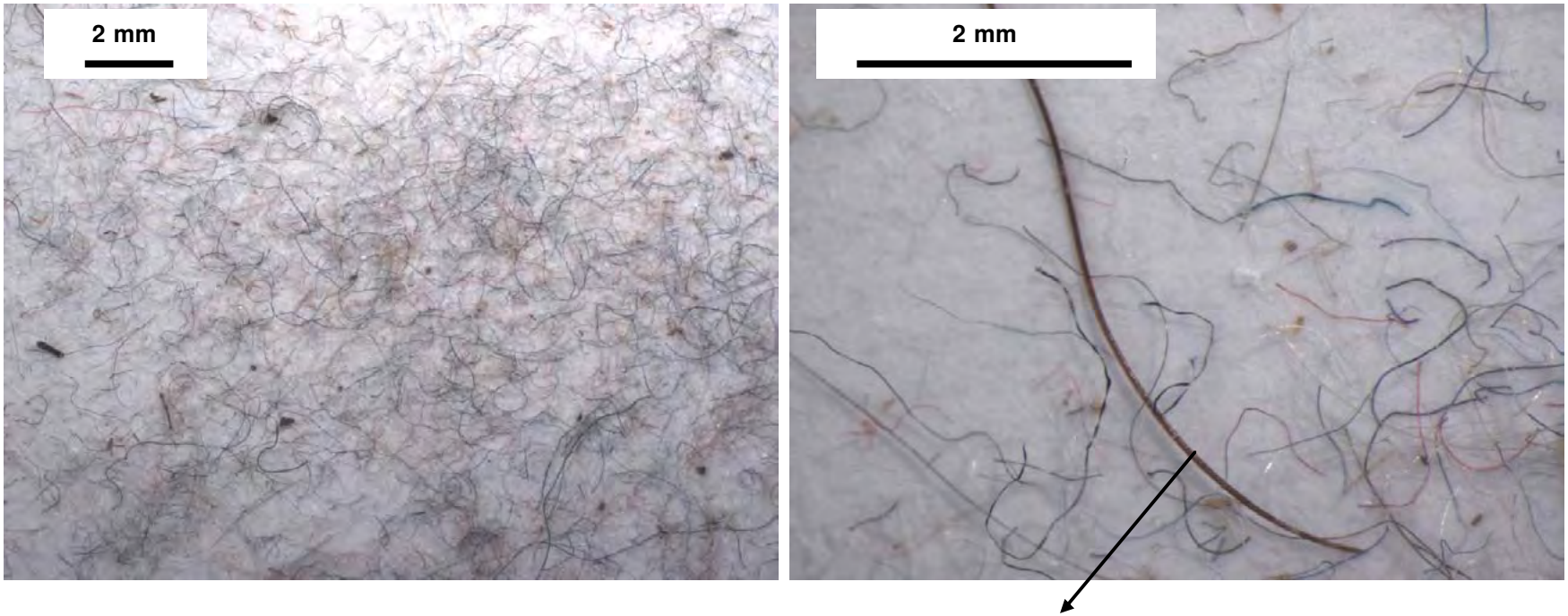
This is dust collected by vacuum cleaner from a pair of open armchairs, with light green silk damask upholstery at the Brown Gallery, Knole. These samples contain different particles among the mat of fibres. The dust is mainly a mixture coloured fibres and some fine dust particles. Scanning electron microscopy examination (SEM) and energy dispersive X-ray spectroscopy (EDX) analysis (see page 62) confirmed the presence of fibres, quartz, gypsum and probably chlorides.

Real Dust. Brown Gallery. Knole



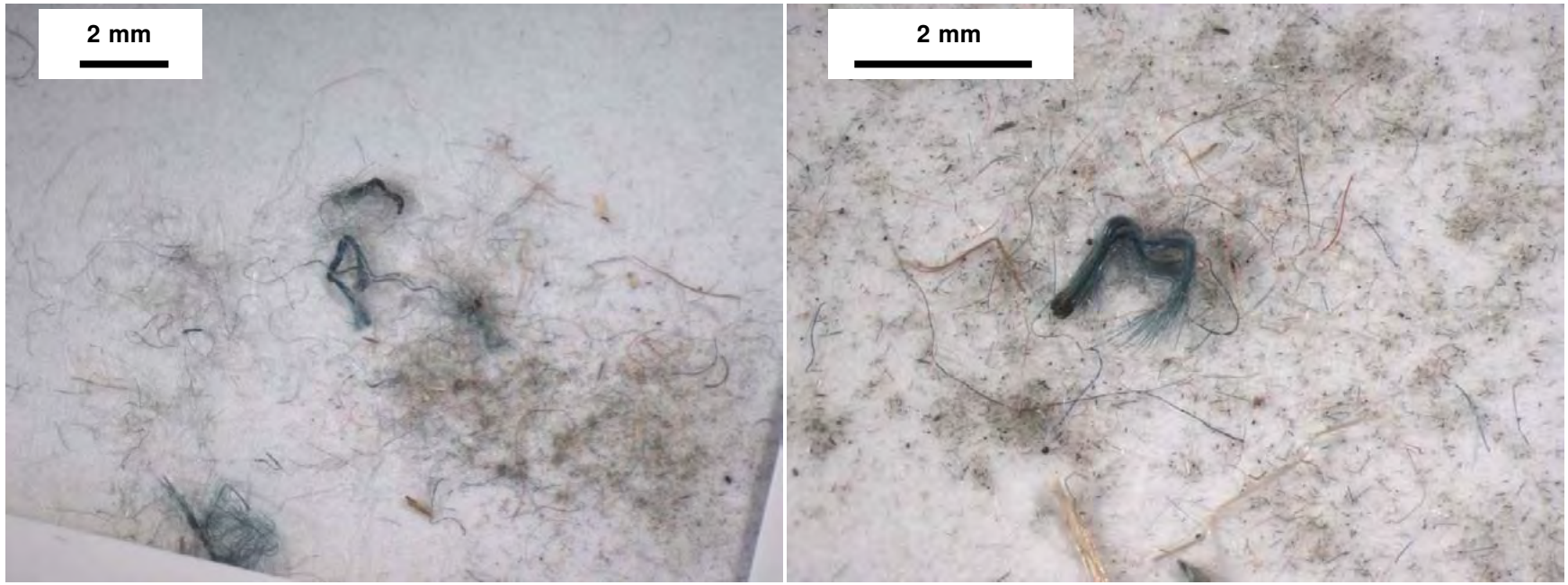
Carpet dust vacuumed from the Brown Gallery. The sample contains many particles. The dust is mainly a mixture of most common particles in rooms (i.e different colour fibres, sand (quartz and other mineral grains) and skin(?). SEM-EDX examination reveals a mainly silicate composition, with sulfur is also detected.

Real Dust. Brown Gallery. Knole



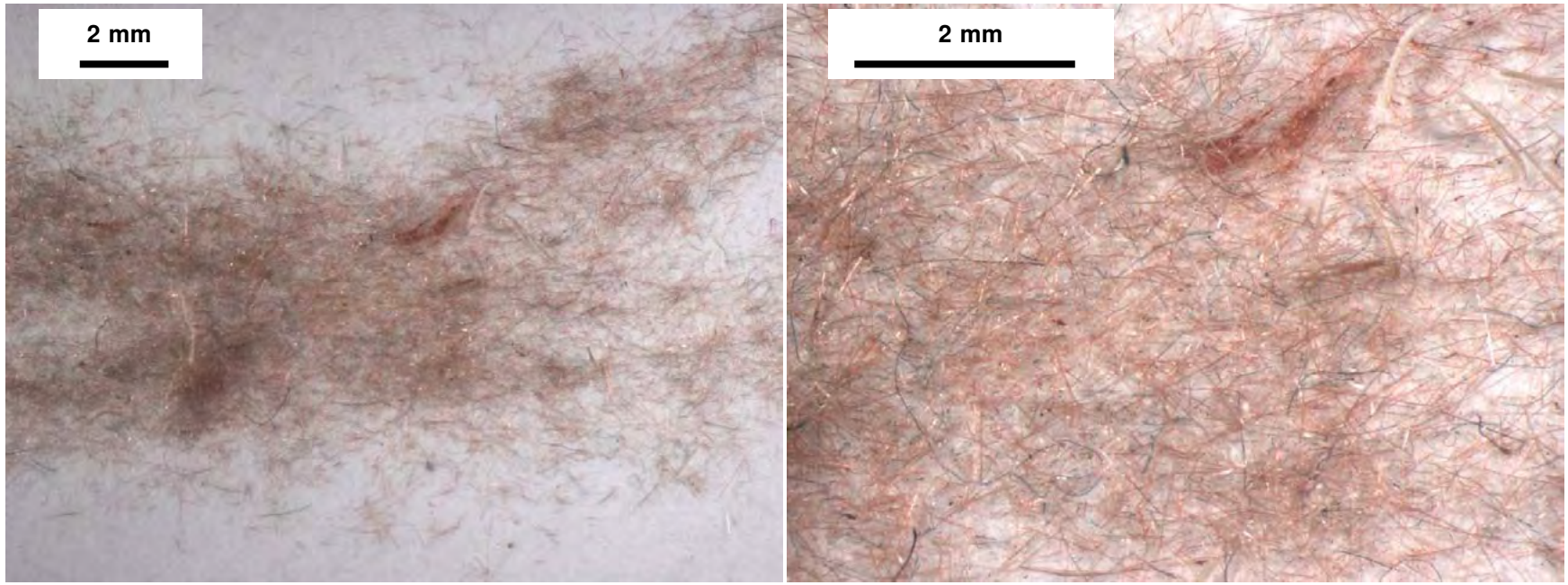
Another sample of carpet dust from the Brown Gallery. The sample contains many particles. The dust is mainly a mixture of most common particles in rooms, mainly different coloured fibres (red, blue and white), a hair and small grains.

Real Dust: Bedroom stool (1). Knole



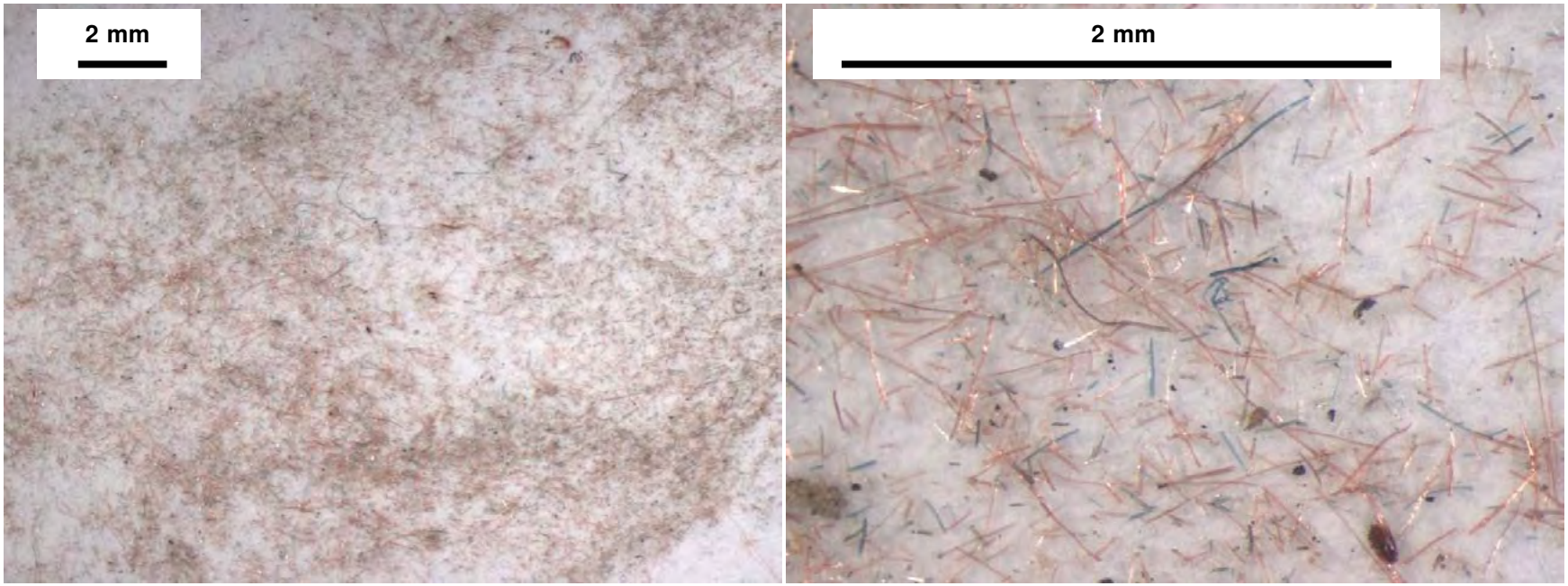
Dust vacuumed from the V-bedroom stool at Knole. The dust consists mainly of blue and also red and golden fibres from the stool and fine small mineral grains, with some mineral grains. SEM/EDX analyses confirm the presence of plaster (a calcium sulfate) and sand (silicon) . Fibres are easily seen and particles are smaller irregular and variable in size, but hard to assign an exact composition.

Real Dust: Bedroom stool (2)



Another sample of dust vacuumed from the V-bedroom stool at Knole. The dust shows mainly red and also some blue fibres from the stool along with some fine mineral grains. The colours suggest the that fibres come from different fabrics on the stool (the fringe was red).

Real Dust: Bedroom stool (2)



Another part of the dust sample from the V-bedroom stool at Knole shown on the previous page. This sample shows mainly red and some blue fibres along with some fine mineral grains. Here the fibres are shorter than on the previous page. The colours suggest the that fibres come from different fabrics on the stool (the fringe was red). This shorter fibres are likely to be more typical of fine dust deposits.

Other potential dust components

It is worth collecting other samples to create a "library" of reference materials that are likely to be encountered. These might include:

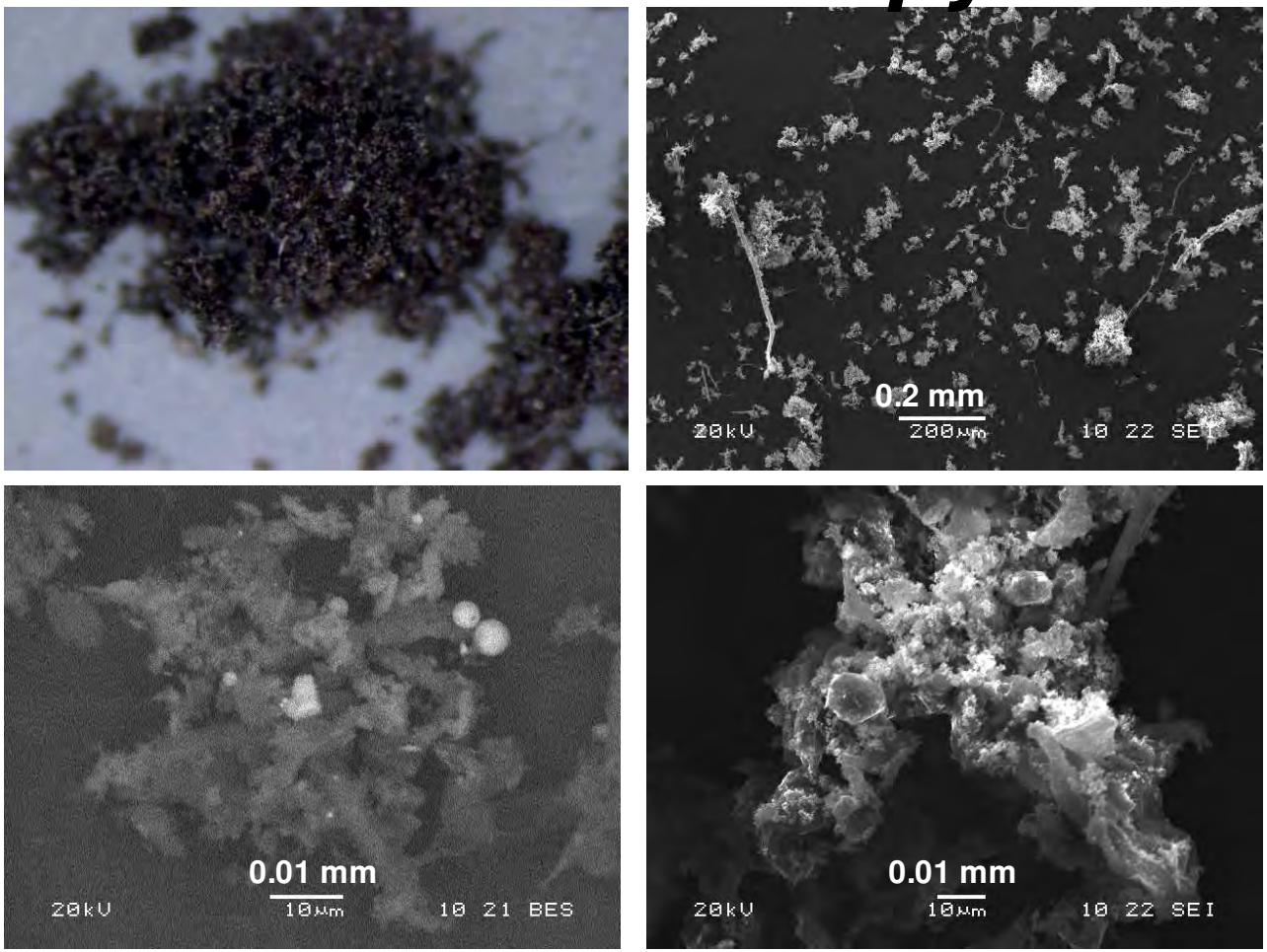
- **Pollen**
- **Wood**
- **Straw**
- **Grass**
- **Coip-coconut fibres from doormats**
- **Reed fibres from rush-matting**
- **Jute hair from floor underlay**

5) Higher magnification and other analysis

- **Scanning electron microscope (SEM) allows the observation of dust at much higher magnifications than a standard magnification lens.**

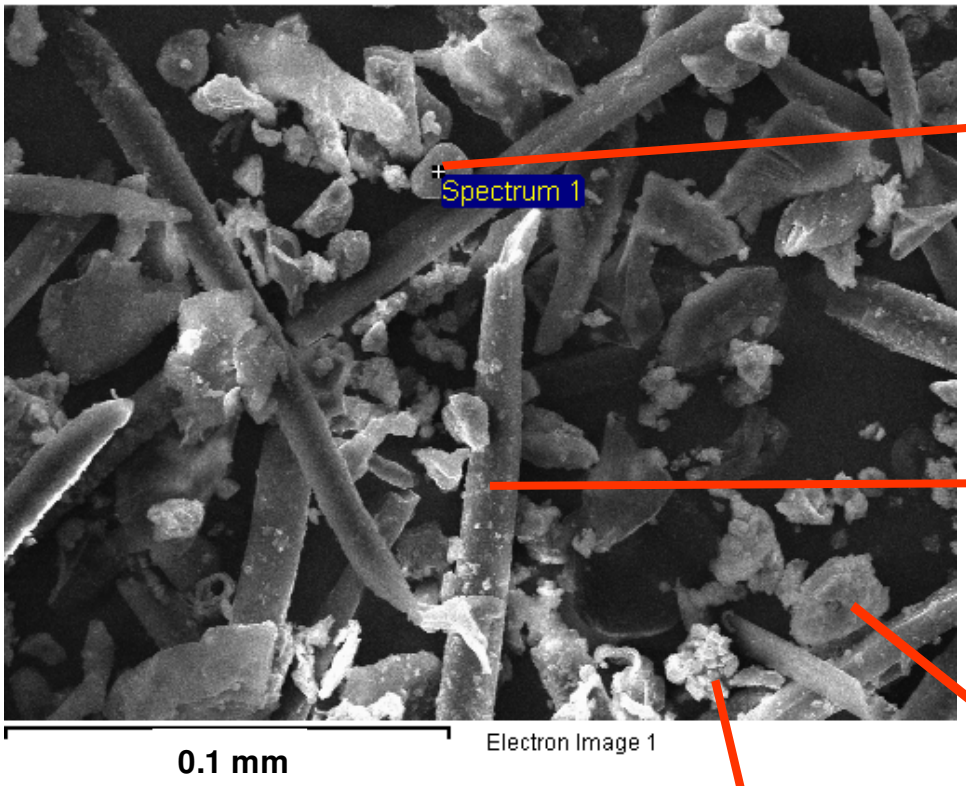
- **Energy dispersive X-ray spectroscopy (EDX) provides chemical analysis of dust.**

Binocular microscopy / SEM



Single particles round or irregular shapes. Some particles are opaque spheres having very rough, dull surfaces, Hampton court, dust containing soot. The spherical particles containing iron (bright in the image lower left) are typical of coal combustion

Real Dust: Brown Gallery



Rich in calcium and chlrorine

Mostly carbon (organic)

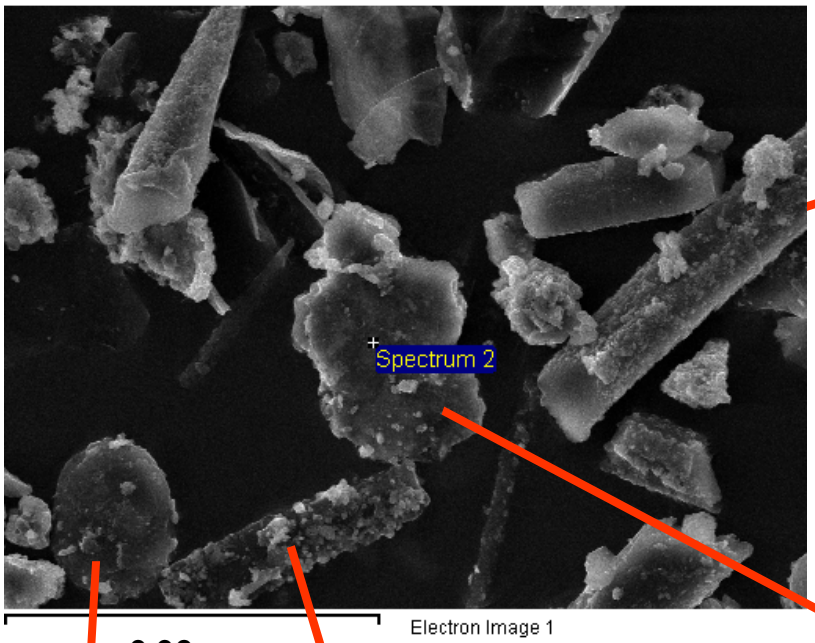
Probably an upholstery fibre

Silicate (sand)

Rich in sulfur. Most probably gypsum

Energy dispersive X-ray spectroscopy (EDX) provides chemical analysis of dust

Real Dust: Bedroom stool



Rich in sulphur. Most probably plaster

Energy dispersive X-ray spectroscopy (EDX) provides chemical analysis of dust

Rich in silicon. Sand (i.e. quartz)?

Rich in sulfur. Most probably plaster

Rich in chlorine

Building a Dust Monitoring Kit

A basic kit would contain items such as:

- ***Hand magnifying lens (x10)***
- ***Slide case for storage***
- ***Slide frames (for making sticky samplers),***
- ***Adhesive labels***
- ***Microscope slides (useful for shaking larger deposits on or creating a darker background)***
- ***Instruction book pages***

A more sophisticated kit might include the items below listed along with potential providers

X10 hand magnifying lens – (or Peak light lupe x10 from CLE)	**Slide storage case or box (hard)**	**Slide mount – paper.**	**Adhesive labels – paper, sheet or roll**	**Microscope slides**	**Graph paper with 1mm squares**
Gowlland Optical Limited*. TEL: 020 8657 0506 FAX: 020 8657 6421; e-mail: gowlland@aol.com; http://www.gowllandoptical.co.uk/magnifs.htm* ***Peak Optics****: http://peakoptics.com/?gclid=CIm3zZ3GiJYCFQ1gQgodtWYREg*	***Gepe slide storage case****: Great Britain distributor: Johnsons Photocopia Ltd. ST5 0SW Staffordshire.Tel: +44 (1) 782 753300; Fax: +44 (1) 782 753399, info@johnsons-photopia.co.uk; http://www.johnsons-photopia.co.uk/; http://www.gepe.com*	***Gepe slide mounts:*** *Great Britain distributor: Johnsons Photocopia Ltd. ST5 0SW Staffordshire.Tel: +44 (1) 782 753300 Fax: +44 (1) 782 753399, info@johnsons-photopia.co.uk; http://www.johnsons-photopia.co.uk/; http://www.gepe.com*	***Systemprintmedia (Spm).*** *Tel: 0161 872 5355; Fax: 0161 872 5377; Email: info@systemsprintmedia.co.uk Website: www.systemsprintmedia.co.uk*	***Chance Propper.*** *Smethwick Warley, England. Tel 0121-553-5551.* ***Scientific Laboratory Supplies Ltd.*** *Nottingham South and Wilford Industrial State. Ruddington Lane, Wilford, Nottingham, NG11 7EP www.scientificlabs.eu , tel: 01159 821111* ***Biotec Microslides*** *http://www.biotecmicroslides.co.uk.*	***ESPO Catalogue. Eastern Shires Purchasing Organisation.*** *Grove Park. Enderby. Leicester LI9 1ES, www.espo.org, tel: 0116 265 7925*