

Object Number	K546	Description	Helmet-crest channel, cast in silver and gilded, with animal ornament and animal-head terminal. Catalogue no. 589. decoration of each side
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	Sample Description and location.
	Sample K546-5 collected from within channel for object K546.



Figure 1. Sample K546-5 collected from white material inside ridge of object K546.

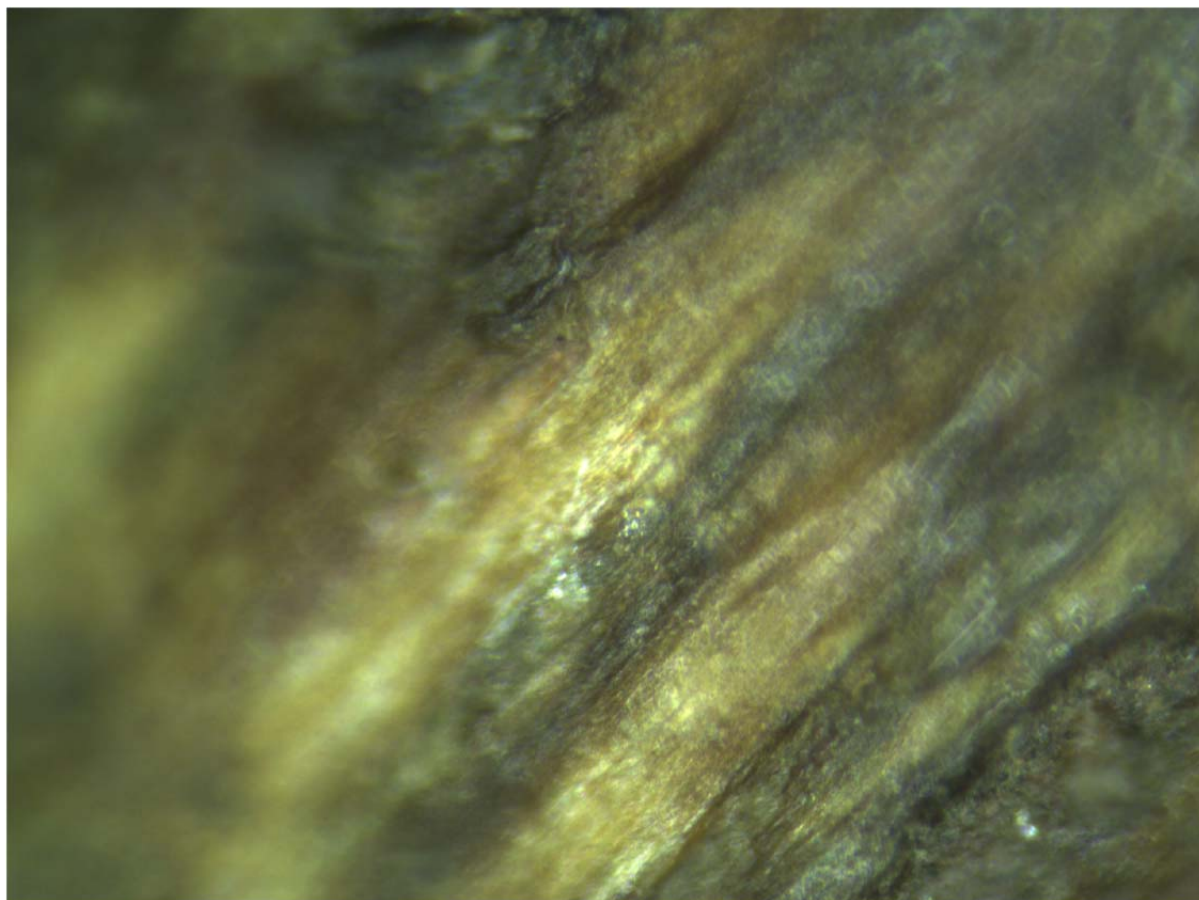


Figure 2. FTIR analysis point for sub-sample K546-5-1

FTIR Analysis

Comments: Spectrum K546-5-1 (top red) is a close spectral match for cellulosic material. The reference spectrum for paper (blue) is shown below for purposed of comparison to cellulosic material. FTIR spectra of different cellulosic plant materials are superficially similar and cannot be readily distinguished by eye (Garside & Wyeth 2003). In addition, degradation of one or more components of the plant material e.g. through oxidation of the cellulose molecule, will influence the position and intensity of spectral peaks relative to non-deteriorated reference spectra (Stuart 2007, Ciolacu *et al.* 2011).

There are, however, a number of fairly consistent spectral peaks indicative of cellulosic carbohydrate within a sample. The majority of cellulosic carbohydrates will exhibit a broad band from 3600–3100 cm^{-1} arising from O-H stretching in bound or absorbed water (Tipson 1968, Stuart 2007, Naumann *et al.* 2007, Bodirlau & Teaca 2009). A broad band relating to C-H stretching from aromatic hydrocarbons at 3100-3300 cm^{-1} can be obscured or partially obscured by the broad O-H stretching band described previously (Tipson 1967). Additional peaks relating to the cellulose component of plant material include peaks for C-H stretching of methylene groups between 3000 and 2800 cm^{-1} , C-H deformation in cellulose and hemicellulose at 1371 cm^{-1} , C-H vibrations at 1319 cm^{-1} , an intense peak at about 1030 cm^{-1} relating to C-O bonding (this is typically a combined peak for cellulose and hemi-cellulose), and a shoulder at 897 cm^{-1} relating to C-H bending. Additional shoulders at 1155 cm^{-1} and 1105 cm^{-1} on the C-O band at about 1030 cm^{-1} relate to stretching and contraction (so called 'breathing') vibrations within the benzene rings, and glycosidic linkages between carbohydrate molecules respectively (Tipson 1968, Naumann *et al.* 2007, Bodirlau & Teaca 2009).

The weak doublet at approximately 2350 cm^{-1} in sample K546-5-1 but not present in the paper spectrum, relates to atmospheric CO₂ detected in error during FTIR acquisition and should be discounted from the spectrum. Sample is likely woody cellulosic material.

SEM Analysis

FTIR analysis of K546-5 was carried out to examine the micro structure of suspected cellulosic material within these samples. A software malfunction removed metadata from figures 20 and 21. The images were captured in SE mode. Figures 22 and 23 also of K546-5 indicate a microstructure consistent with woody cellulosic material. There are some similarities between the microstructure of this material and that of horn, but no protein component was detected in FTIR analysis for this sample.

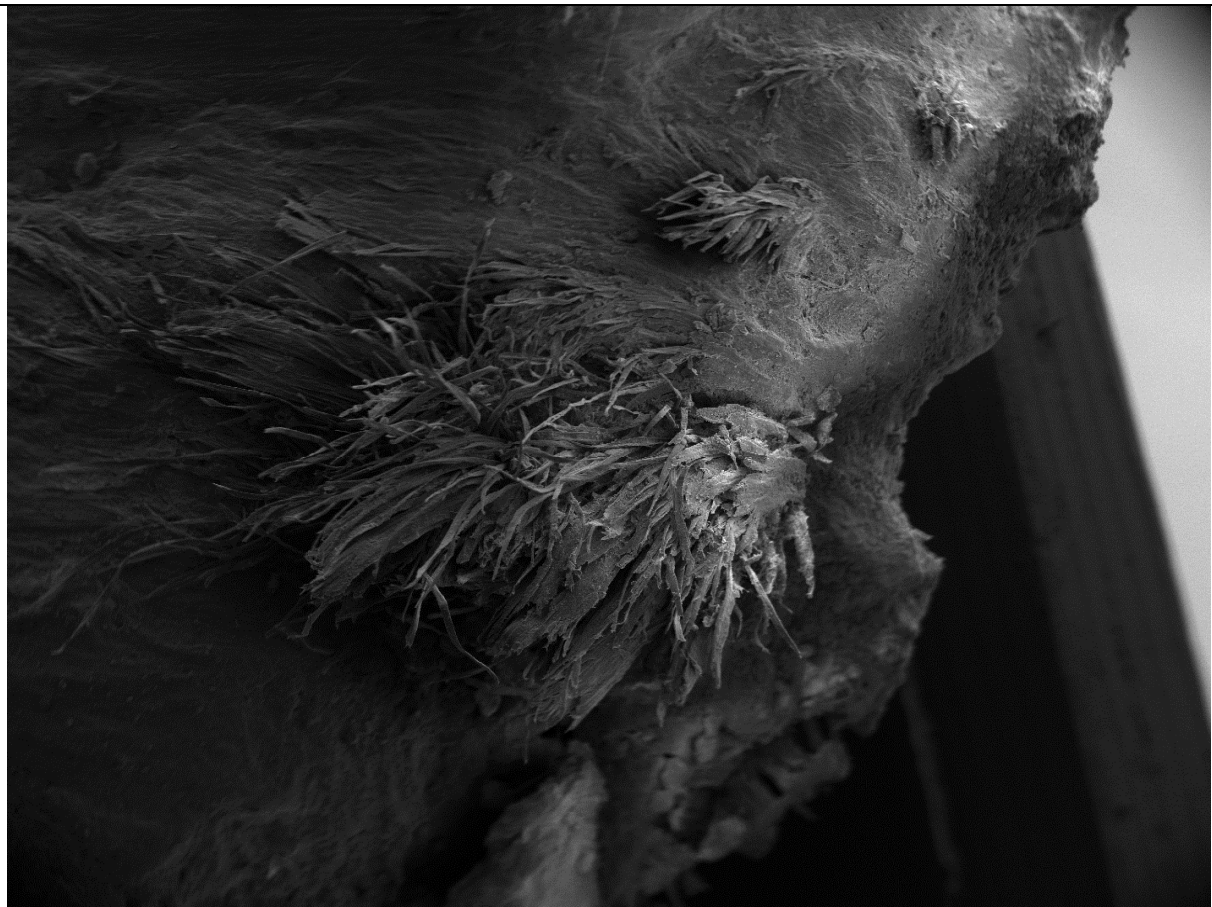


Figure 4. Fibrous material embedded in substrate of sample K546-5 appears to be cellulosic in nature.



Figure 5. Detail of K546-5 showing fibrous material embedded in substrate.

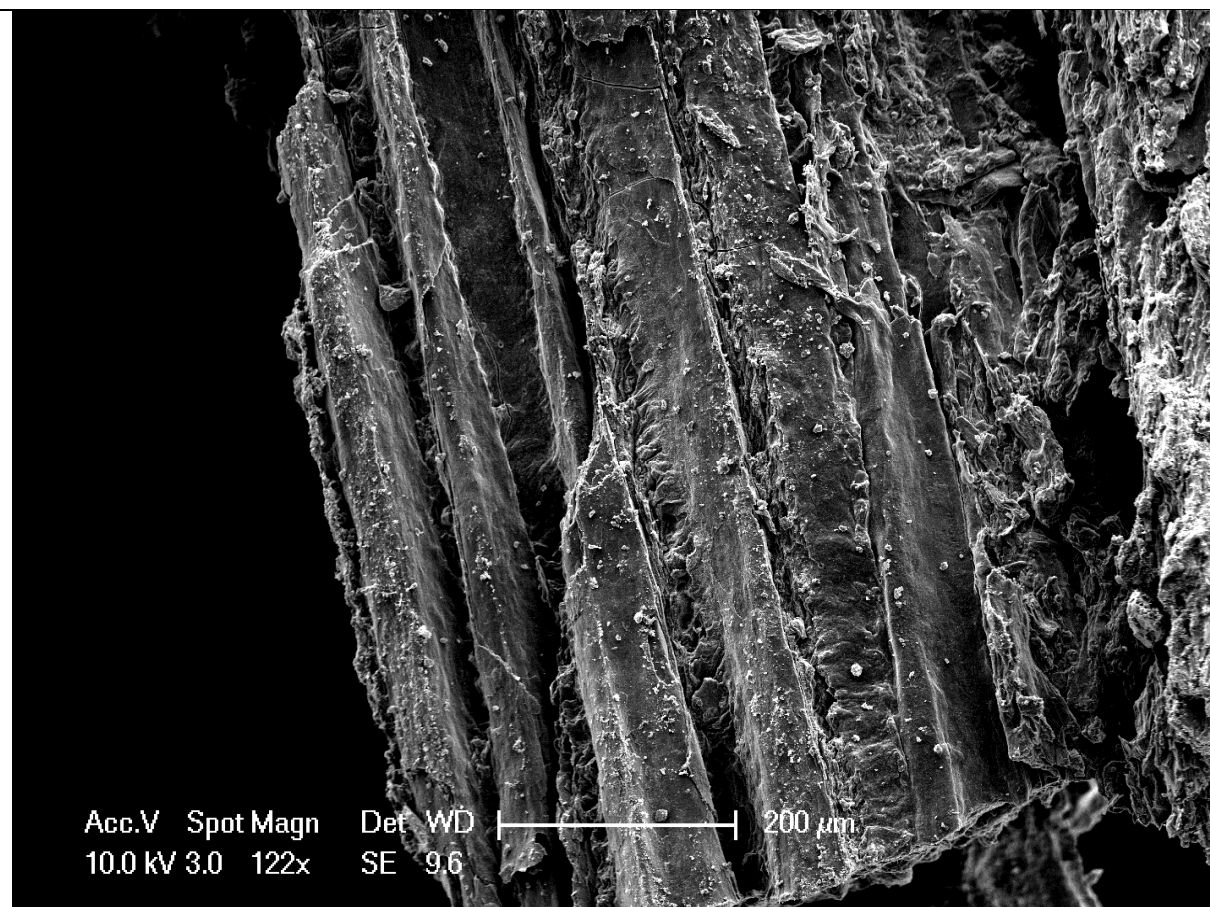


Figure 6. Secondary electron image of sample K546-5 indicates microstructure consistent with cellulosic woody material. Could this also be the lamination visible in horn?

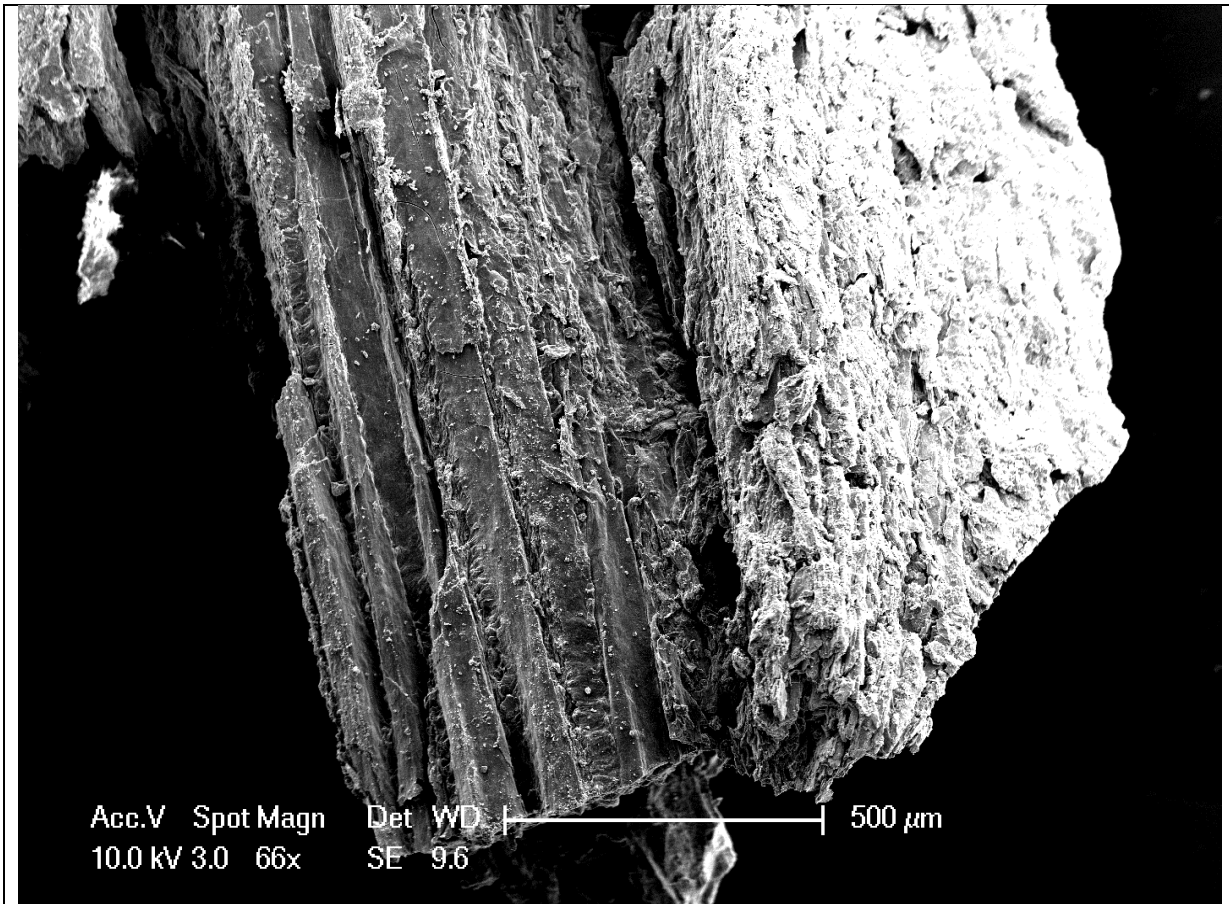


Figure 7. Secondary electron image of sample K546-5 indicates microstructure (left) consistent with cellulosic woody material. The woody material is partially embedded in a mixture of calcium carbonate and earth minerals as characterized by FTIR analysis.