Object Number	K645	Description	Strip-mount in gold with garnet cloisonné decoration (part). Catalogue no. 551.

Sample Description and location.

K645-1 collected from dark material near left hand side of objet edge in figure 1. Sample was removed with a fine needle and transferred to a glass storage vial. FTIR spectroscopy was performed on a Bruker Lumos FTIR microscope with liquid nitrogen cooled MCT detector. The infrared spectra were recorded using attenuated total reflectance (ATR) mode in the range of 4000-600cm-1. The scans averaged 64 scans at a resolution of 4cm-1. A 64 scan background scan was completed at a resolution of 4cm-1 between each sample. Samples were placed directly on the microscope stage, and the motorized germanium ATR crystal with internal pressure control brought into contact with the sample. The microscope stage and ATR crystal were cleaned with acetone on a cotton swab, and allowed sufficient time to dry between each scan.

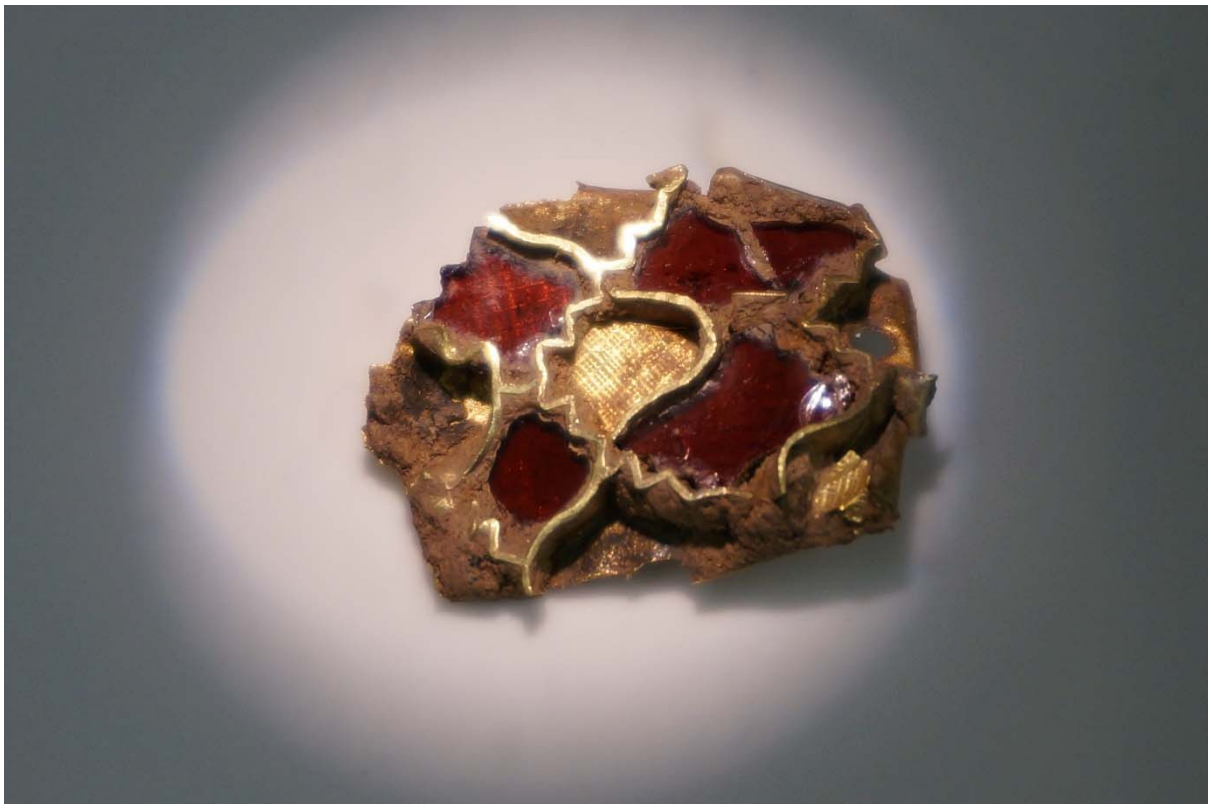

Figure 1. Sample K645-1 collected from dark material in empty cell on left side of object. Dark brown in colour, hardened paste. FTIR analysis was carried out using a Bruker

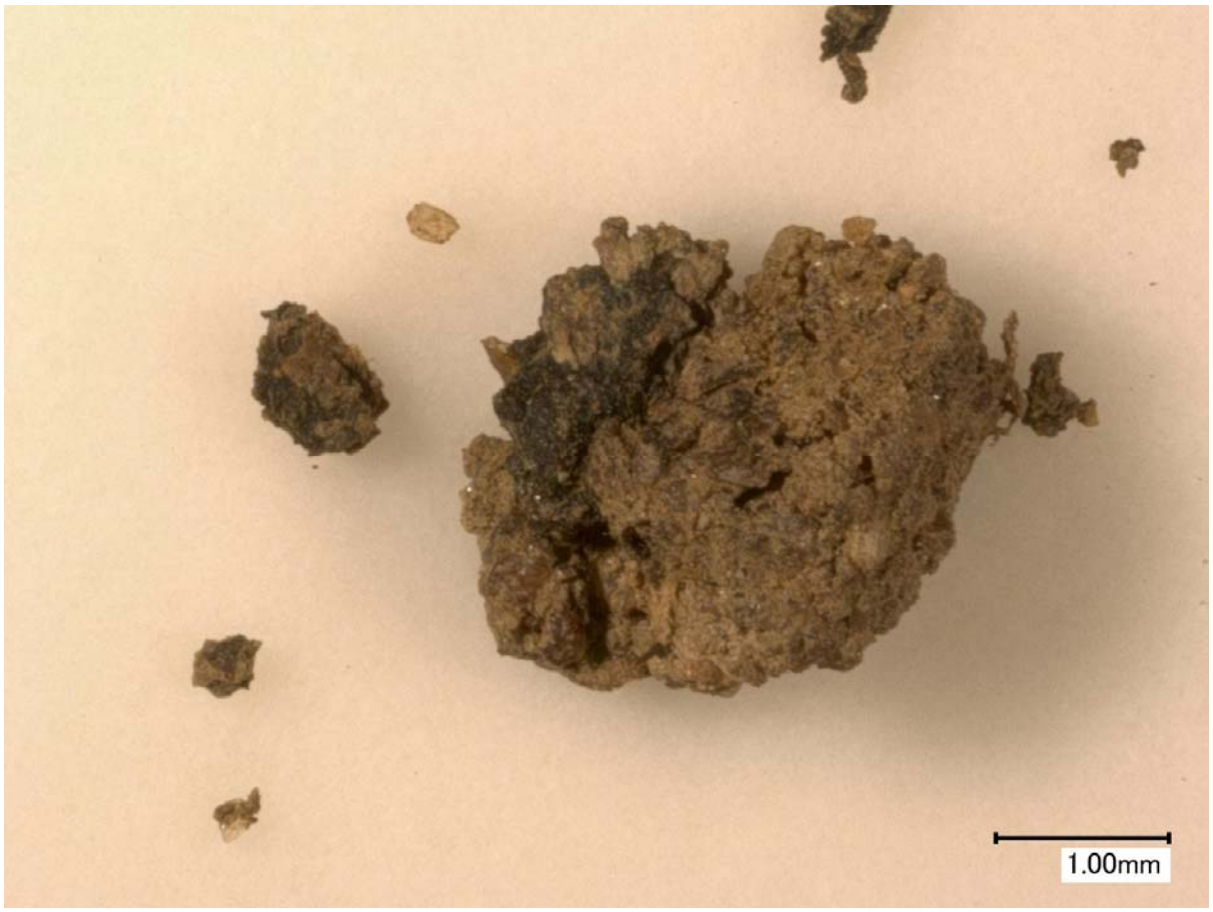

Figure 2. Detail of sample K645-1.

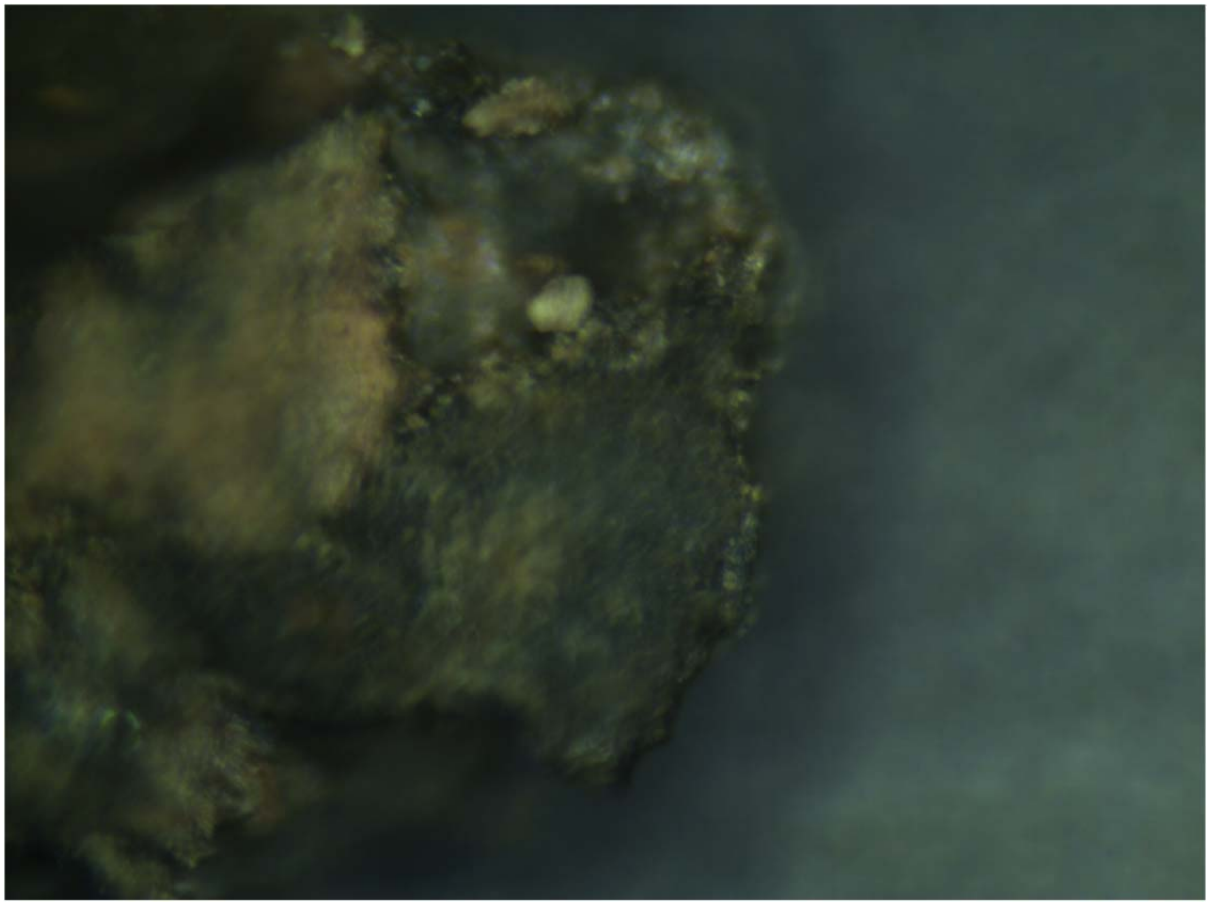

Figure 3. Detail showing FTIR analysis point for sub-sample K645-1-2

FTIR Analysis

Comments: Spectrum K645-1-2 appears to be a mixture of a keratin based animal glue such as hoof glue and beeswax. The FTIR spectra for keratinous materials exhibit characteristic bands for amide I (C=O stretching) between 1700 and 1600 cm^{-1}, and amide II (CN stretching and NH bending) between 1560 and 1500 cm−1, and a broad band centred at around 3300cm^{-1} related to N-H stretching. A doublet between 3000 and 2800cm^{-1} relating to C-H stretching of methylene groups are characteristic of keratinous proteinaceous materials. (Welsch et al. 2012, Kennedy et al. 2013, Mansilla et al. 2011, Derrick et al. 1999). In oxidised keratinous materials such as the oxidised horse hair spectrum shown in Fig. 4, an intense peak at about 1030cm^{-1} is attributable to S=O bonding in cysteic acid. (Welsch et al. 2012, Kennedy et al 2013, Mansilla et al. 2011). This peak should be interpreted with some caution in this sample however as silicate based material such as is found in earth minerals also exhibit a sharp band at approximately 1000cm^{-1} which relates to Si-O bonding. The peak at 1030cm^{-1} may derive from cysteic acid in oxidised keratinous tissue, silicate based earth minerals deliberately added to the paste or from the burial environment, or a combination of both.

The FTIR spectrum for beeswax is characterized by dominant absorption bands around 2950cm^{-1} and 2850cm^{-1} that relate to C-H stretching of the methylene (CH_2) groups, a band at 1740cm^{-1} that relates to C=O bonding characteristic of the ester groups, a band around 1460cm^{-1} relates to C-H bending, and a doublet between 720 and 730cm^{-1} relating to non planar skeletal deformation vibrations of long chain hydrocarbons (Derrick *et al* 1999, Birshtein and Tul'chinskii 1977). The bands in the region 1350 - 1180 cm^{-1} may be assigned to a phenomenon known as a 'band progression' present in fatty acids and fatty acid esters which result in a series of evenly spaced bands in this region. These are due to wagging and twisting vibrations of successive carboxyl coupled methylene groups (Baeten et al. 2010) shown in more detail in Fig.5.

Representative Spectrum

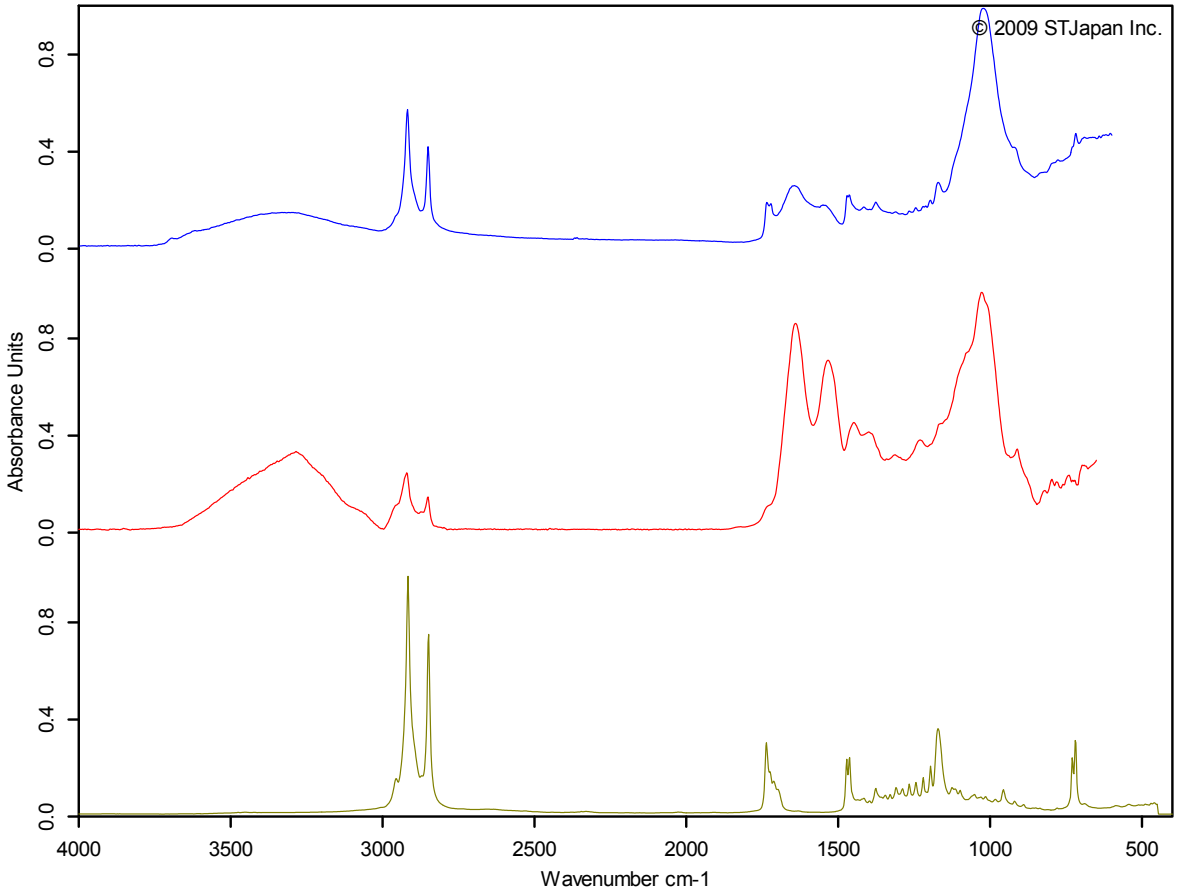

Figure 4. Top (blue) spectrum for K645-1-2. Middle (red) Oxidised horse hair reference spectrum, ST Japan 2009. Bottom (green) Beeswax (green) reference sample, ST Japan 2009.

Representative Spectrum

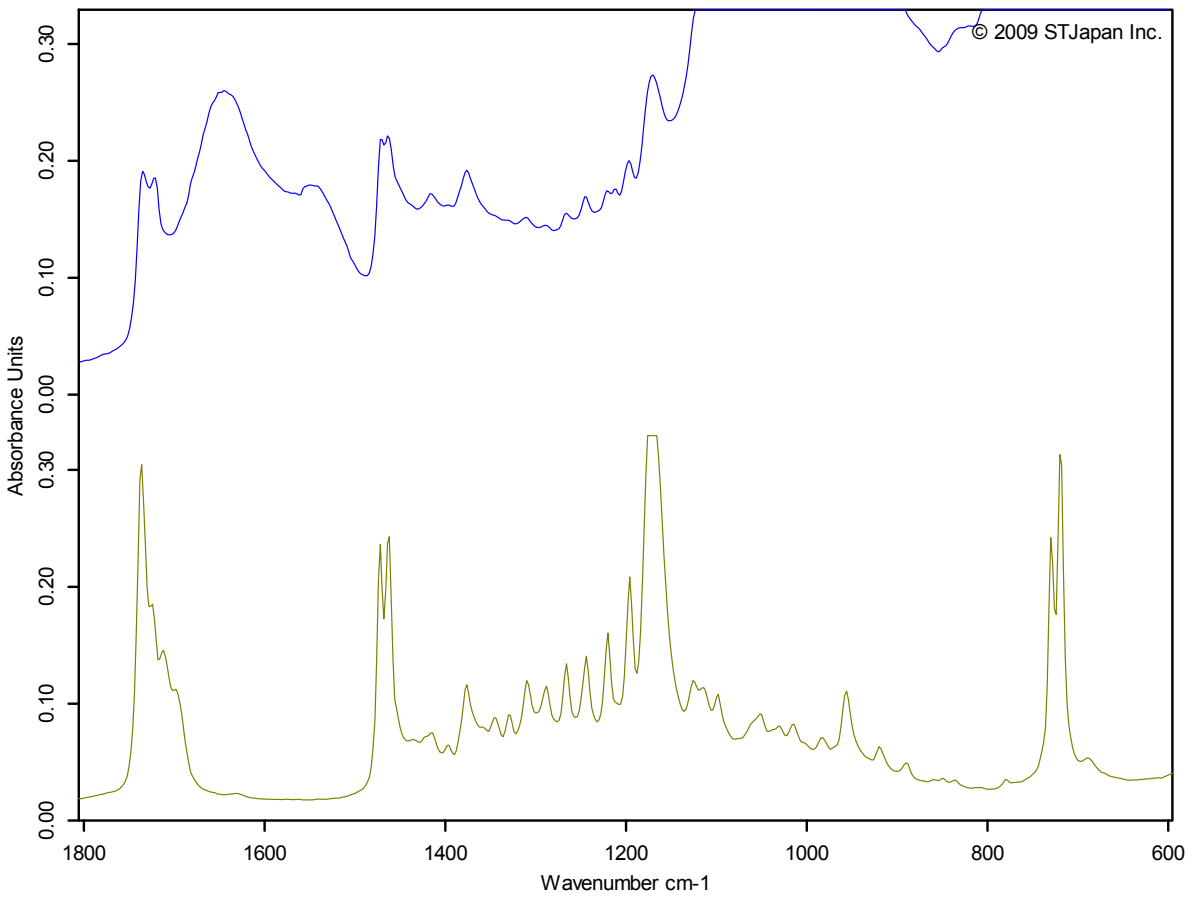

Figure 5. Detail of 600 – 1800 cm-1 region showing subtle confirmative peaks for beeswax between Top (blue) spectrum for K645-1-2. Bottom (green) Beeswax reference sample, ST Japan 2009. The bands in the region 1350 - 1180 cm^{-1} for beeswax may be assigned to a phenomenon known as a 'band progression' present in fatty acids and fatty acid esters which result in a series of evenly spaced bands in this region. They are thought to be due to rocking and twisting motions of methylene groups in the trans-configuration in aliphatic chains (Shearer, 1989), or to wagging and twisting vibrations of successive carboxyl coupled methylene groups (Baeten et al. 2010)