Scientific Analysis of Tea Caddy Linings

In the vast majority of tea containers, the compartments for the tea were lined with a metal foil, variously described as zinc, tin or lead, or sometimes given the pseudo-technical name of 'tea pewter'. In order to identify the metal(s) more specifically, a scientific analysis of small samples of the material lining seven different containers was undertaken in connection with research for this book by Professor Nicholas St. J. Braithwaite of the Open University Oxford Research Unit, and his colleague Dr Xian Wei Liu. In each case, the linings appeared to be original to the container.

<u>Method</u>:

The investigative method used was energy dispersive X-ray microanalysis in a scanning electron microscope (SEM). The underlying principle of this method is that when electrons of appropriate energy impinge on a sample, they cause the emission of X-rays. The process of X-ray emission comes about as follows. First, an energetic electron causes an electron to be ejected from an inner shell of an atom of the sample. The resulting vacancy in that shell is then filled by an electron from a higher-energy shell in the atom. In dropping to a state of lower energy, this vacancy-filling electron must give up some of its energy, which appears in the form of electromagnetic radiation. The energy of the emitted radiation, then, is equal to the energy difference between the two electronic levels involved. Since this energy difference is fairly large for inner shells, the radiation appears as X-rays. The X-ray energies are intimately related to the atomic structure of the substances that emit them, so every element in a sample will emit a unique and characteristic pattern of X-rays, and the relative abundance of the X-rays depends upon the composition of the sample.

In this investigation each specimen was fixed on a specimen holder by a carbon tab, for EDX microanalysis on a JSM-820 scanning electron microscope. The EDX microanalysis was carried out with a NORAN system under the conditions of 25 keV accelerating voltage, 47.5118° take-off angle, and 100 second dwell-time.

<u>Results</u>:

To illustrate the detailed results, the findings for two samples, one of which proved to be predominantly tin, and the other to be predominantly lead, are shown below.

Sample 1: Canister from a tea chest-on-stand veneered with casaurina wood, c. 1820

Figure A2.1: SEM image of Sample 1. The spots where EDX microanalysis took place are numbered. The analytical results are shown in Table A2.1.

Figure A2.2: X-ray spectrum for Sample 1, spot 2.

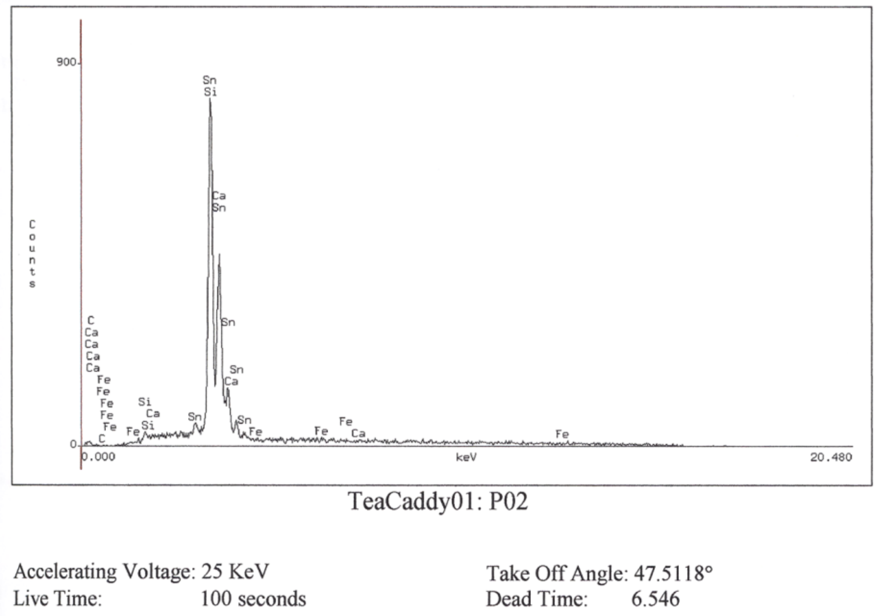


Table A2.1: EDX Microanalysis of Sample 1.

Spot	Sn %	Ca %	Si %	Fe %
1	100			
2	97.67	1.11	0.81	0.41
3	98.10	1.03	0.86	
4	97.92	1.44	0.63	
5	98.62	0.50	0.88	
6	98.52	0.95	0.53	

Sample 7: Single tea compartment in a caddy veneered with quartered fiddle-back sycamore, with central oval inlays of hawthorn wood on all faces, c. 1790.

Figure A2.3: SEM images of Sample 7, and spots where EDX microanalysis took place are numbered. The analytical results are shown in Table A2.2.

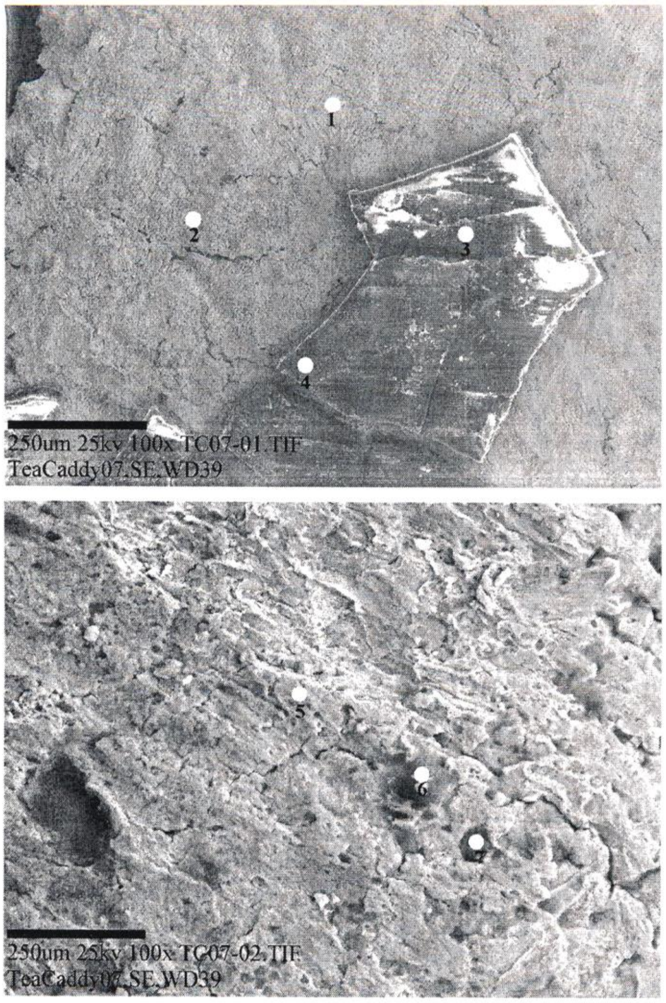
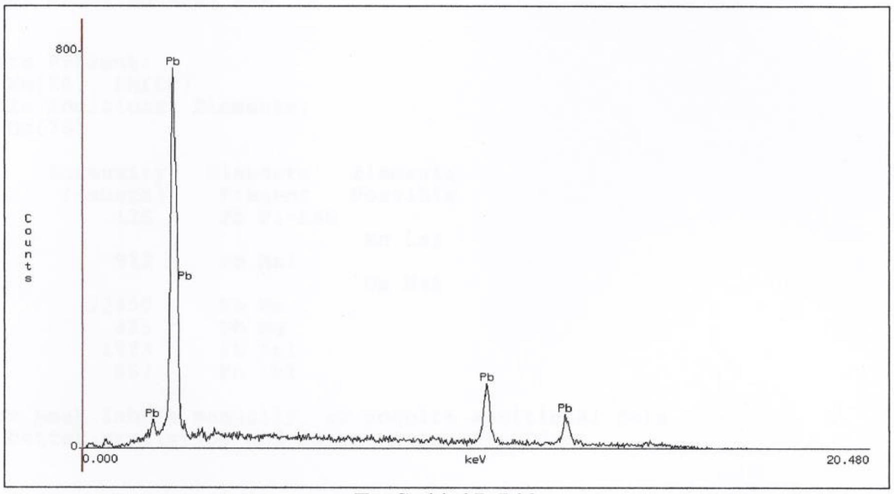


Figure A2.4: X-ray spectrum for Sample 7, spot 2



TeaCaddy07: P02

Accelerating Voltage: 25 KeV
Live Time: 100 seconds

Take Off Angle: 47.5118°
Dead Time: 7.357

Table A2.2: EDX microanalysis of Sample 7.

Spot	Pb %	Sn %	C %	Ca %	S %	Si %	Al %	K %
1	97.14	2.86						
2	100							
3					85.03		14.97	
4			72.06	7.59	15.33			5.01
5	94.55	5.45						
6	93.23	3.59		1.81		1.38		
7	35.11			64.89				

<u>Summary of results</u>:

The above samples were each subjected to EDX analysis and several spots. The average quantitative analysis for each sample is summarized in Table A2.3.

Table A2.3: The average findings for all the samples.

Sample	Sn %	Pb %	Ca %	Si %	C %	Fe %	Al %	W %
1	98.48		0.83	0.62		0.07		

2	98.96		0.35	0.69				
3	96.81		0.67	1.30	0.69		0.53	
4	99.65		0.35					
5	100							
6	2.31	97.69						0.15
7	1.71	98.29						

Samples:
1. Chest-on-stand veneered with casuarina wood, c. 1820
2. Chest veneered with sycamore with penwork decoration, c.1840
3. Teapoy veneered with partridge wood, c. 1820
4. Caddy veneered with green tortoiseshell, c. 1840
5. Caddy decorated with Tunbridge ware mosaic, c. 1870
6. Harewood caddy, c. 1790
7. Caddy veneered with sycamore, c. 1790

Key:

Sn	Tin	C	Carbon	K	Potassium
Pb	Lead	Fe	Iron	S	Sulphur
Ca	Calcium	Al	Aluminium		
Si	Silicon	W	Tungsten		

Conclusion:

All but two of the linings (samples 1-5) were made of pure tin, with a few trace elements present. The two exceptions (samples 6 and 7) consisted of thinly rolled lead – possibly because the maker could not acquire the specialist foil, whereas lead, being used in the building trade, was widely available, or alternatively, because the caddy had, in fact, been re-lined later by a non-specialist artisan. The findings also show that the widely used appellation of ‘tea pewter’ is erroneous, because, although pewter is predominantly composed of tin, at different times it also contained varying amounts of antimony, copper, bismuth or lead (see Chapter 18: Pewter). With the exception of lead, none of these constituents appeared in any of the samples taken.