

# Paintings Analysis

*Our curator is interested in the presence of gold in the metallic pigments used on some of the birds (these spectra all have gold in the title) and whether these gold areas would have been painted with the same pigment. She is also interested in the arsenic levels and any variations in these across the different pages and volumes.*

*Kate Hughes  
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State Library New South Wales  
Macquarie St  
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## STEPS REQUIRED TO DO SPECTRA ANALYSIS USING ARTAX SOFTWARE provided with the Tracer

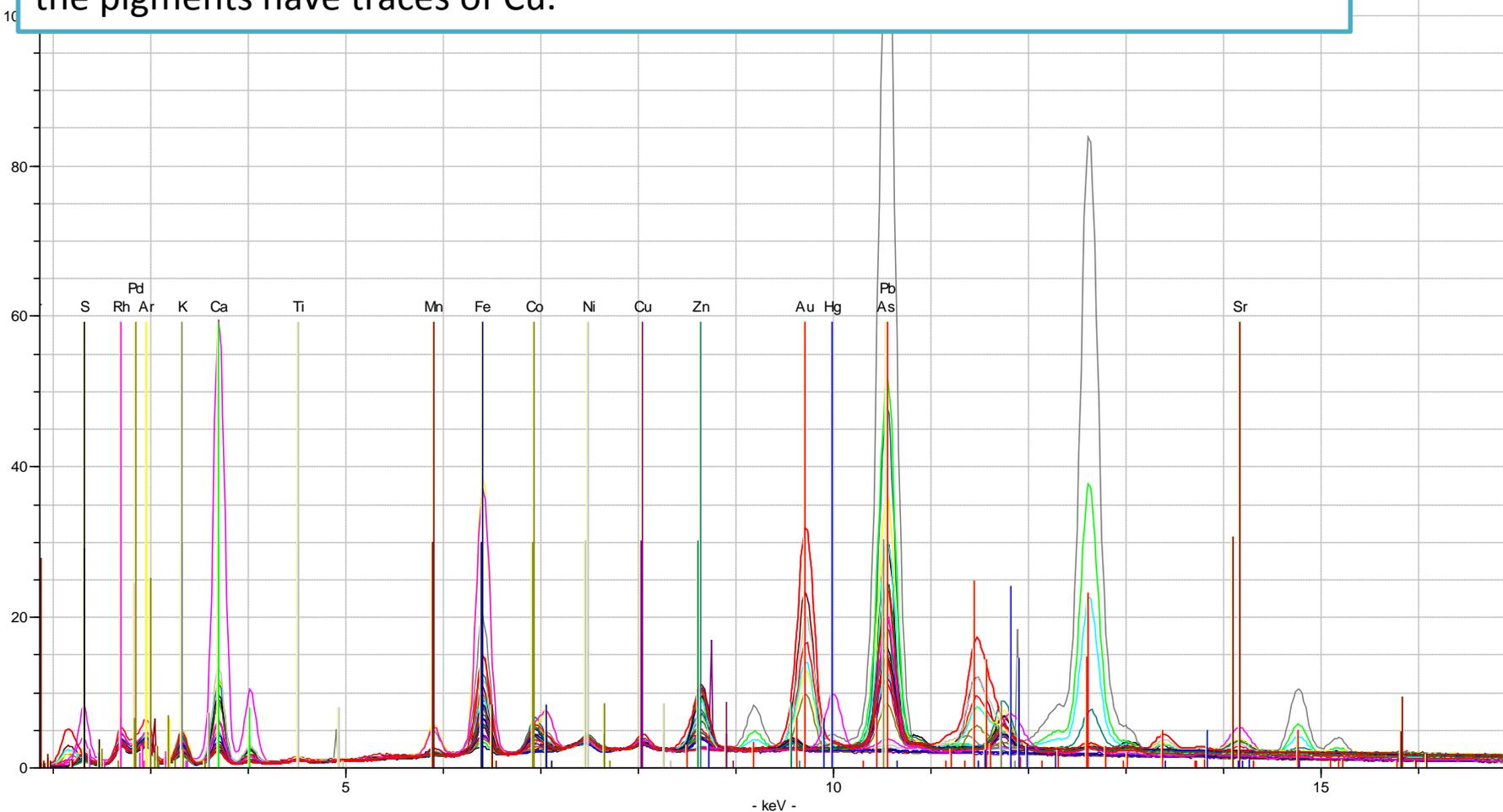
### Net area analysis in Artax 7

1. In ARTAX, click on 'File', click on "open spectrum", file the folder that has all your txt spectrum files, highlight them all and click open
2. Click on "project", click on "new project", right click on "object", click on "add node", enter "Points" in name box. Highlight this folder.
3. Go back to "Project" tab. click on "Add spectrum".
4. Click on "File", click on "save project", give a name (.rtx), click on "save"
5. Click on "spectrum" tab
6. Go to method list and pick your method! See below
7. Highlight the Points folder
8. Click on "Analyze" and then on "Evaluate Results", a progress bar should appear as all the spectra are being evaluated with "your named method"
9. Then click on "Export" and then on "Results to Excel" Then a box will appear so you name the excel file and put it in a folder that you want the results to be in!
10. Now immediately resave your project file because it now contains your spectra and your results. Use the same name you did before and save on top of the old version of the rtx file.
11. Now go to the folder you saved your results in and open the file and got to the Points tab to see all your net area data. You then edit out the area that gives you no information.

### Method Creation

- To create a method open a spectrum that is typical of the spectra you want to analysis, get the periodic table and LABEL ALL THE ELEMENTS THAT ARE IN THE SPECTRUM, YOU CAN NOT SKIP ONE JUST BECAUSE YOU ARE NOT INTERESTED IN IT, YOU MUST LABEL ALL THE ELEMENTS THAT THE SYSTEM HAS DETECTED IN YOUR SAMPLE.
  - Then click on the Method editor that is to the left of the method name.
  - Click on Identification and make sure the dot is in the Preset list option to the left of the periodic table
  - Then click Get elements
  - Then go to the Name box and type in whatever name you would like for your method
  - Click on Corrections then set cycles at 9 and then pick your energy range for fitting, typically the range of analysis.
  - Then click on add
- Then click on ok at the bottom of the popup method editor window. Your method should now be in the method window at the top of the Artax screen

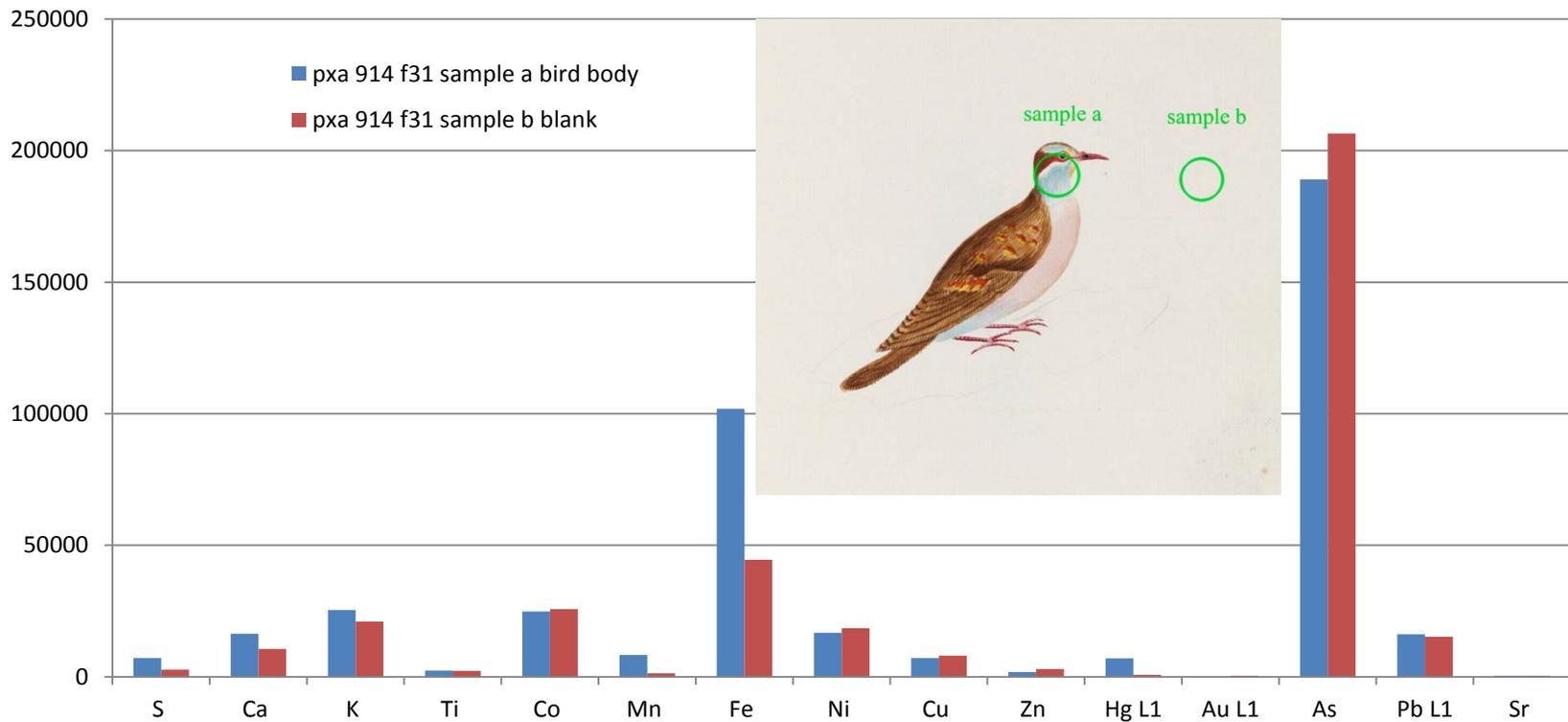
This is an overlay of all the raw photon spectrum of all the analysis. It is apparent from this that most of the Ni and Cu photons seen in the spectra come from the Tracer system itself, because all spectrum show very close to the same intensity, while all the other elements show large variations, indicating they are in the paper or pigments. As you will see below a few of the pigments have traces of Cu.



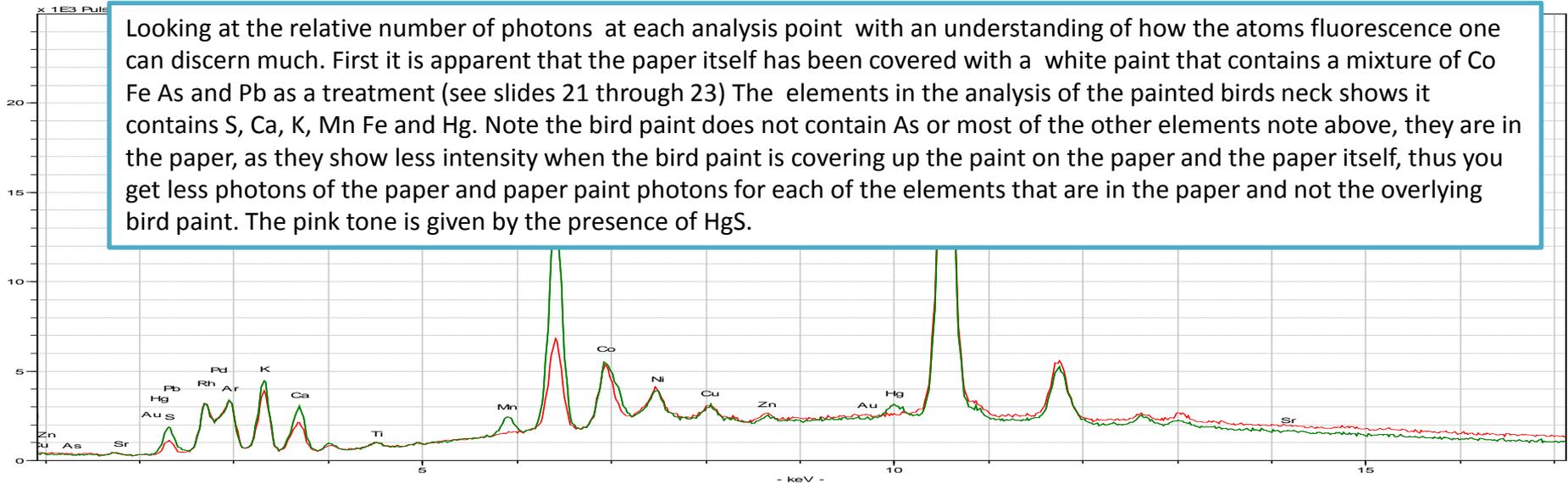
**Note all numbers are the  
relative net number of  
photons from each element  
noted in the 60 seconds of  
analysis at each location  
noted in the photographs**

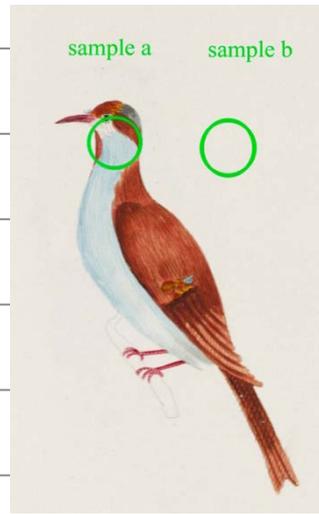
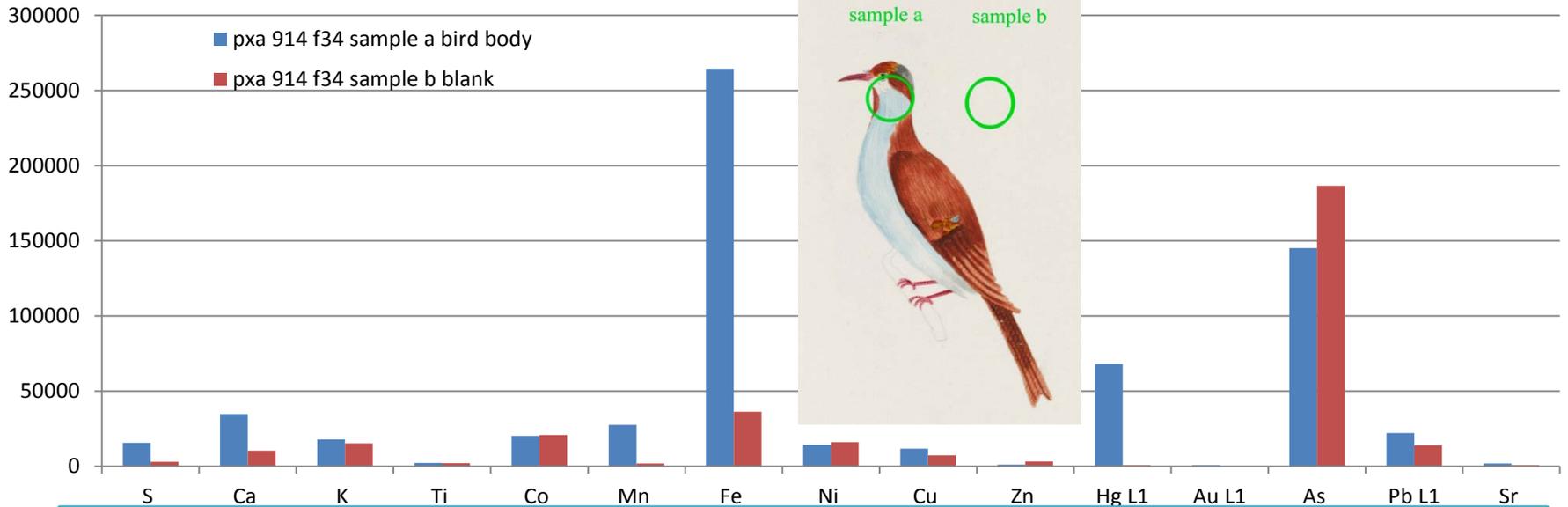
## Number of photons from each element noted in the 60 seconds

	S	Ca	K	Ti	Co	Mn	Fe	Ni	Cu	Zn	Hg L1	Au L1	As	Pb L1	Sr
pxa 914 f31 sample a bird body	7144	16420	25379	2379	24806	8341	101854	16720	7142	1879	7008	105	189065	16136	400
pxa 914 f31 sample b blank	2725	10627	21074	2317	25782	1383	44482	18435	8022	2960	800	459	206453	15228	457
pxa 914 f34 sample a bird body	15612	34659	17796	2155	20255	27426	264535	14227	11706	1050	68075	609	145124	21981	1780
pxa 914 f34 sample b blank	2966	10411	15240	2031	20808	1845	36114	15955	7109	3141	685	157	186622	13935	726
pxd 226 f26 sample a bird body	2631	16966	12681	1951	14478	7502	46864	15631	7632	54187	466	1175	107238	11724	713
pxd 226 f26 sample b blank	3990	18093	20967	2152	18556	5393	35941	20665	9902	87568	383	2000	130367	12573	779
pxd 226 f26 sample c album page	2589	15617	7228	2163	6171	5736	18968	16242	8662	66776	264	1034	53127	7327	1175
pxd 226 f44 sample a blank area	2961	12005	10490	2027	8511	4363	22069	16028	8820	70552	263	1309	85525	9169	1416
pxd 226 f46 sample a bird 1 gold wing	998	10400	11555	2122	12041	7205	50912	14122	9554	48202	3109	94229	80994	6033	145
pxd 226 f46 sample b bird 2 gold wing	2065	11083	12596	2347	12775	9433	51081	18849	17130	68621	5721	290788	101813	15652	383
pxd 226 f46 sample c blank	1531	14234	15100	2348	19067	5028	35397	19393	8533	76001	769	4176	95108	43338	879
pxd 226 f82 sample a gold wing	10301	78879	24853	2020	12822	4028	74850	13960	9876	34576	9444	154652	89632	8869	11357
pxd 226 f82 sample b blank	3659	63546	19792	2225	13523	3193	28518	14785	7943	36674	143	1444	92670	10297	12143
pxd 226 f83 sample a gold wing	2380	63447	23181	3854	12849	29017	254189	12665	8667	31678	1496	84841	95090	9811	13373
pxd 226 f83 sample b blank	4143	57229	21395	2229	15692	3372	31507	16159	7865	38460	538	1329	107035	10770	14165
pxd 226 f84 sample a gold neck	975	20622	8044	2334	7377	1882	61032	8457	6982	13373	1777	78749	44880	5370	6157
pxd 226 f84 sample b blank	3223	68801	13185	1873	16909	2316	31009	16290	8359	30804	1135	1653	104506	12768	14341
pxd 226 f84 sample c album page	32274	294588	9644	1706	4228	1639	16763	11238	7691	1219	259	535	4661	5645	27117
pxd 680 item1 sample a wing	8554	28635	10054	4120	1472	5582	34436	14519	10255	14260	1087	1023	375	3081	831
pxd 680 item1 sample b blank	5736	16600	9429	4305	1633	3098	13844	17615	11541	17238	1277	845	1	1592	351
pxd 680 item2 sample a drakes gold wing	2195	32730	7894	2397	962	6221	60914	12550	12843	13757	3266	173225	2531	705	456
pxd 680 item2 sample b ducks gold wing	1849	45724	7265	1382	1237	4902	53703	11562	8569	12698	983	61219	3129	1127	297
pxd 680 item2 sample c blank	2186	43578	6011	1644	1613	2669	15987	11806	11657	35059	2767	2567	1	1842	858
pxd 1098 vol1 f61 sample a wing	6931	17967	8637	2137	1988	5952	52613	13060	11681	70654	2867	1168	1	295490	1067
pxd 1098 vol1 f61 sample b blank	3067	15441	5761	2064	1517	4011	15214	13086	13643	58720	4718	1230	1	494528	1587
pxd 1098 vol3 f30 sample a bird body	5050	22829	6611	4992	2538	21717	115998	11546	9131	46263	12097	1585	1	935562	2360
pxd 1098 vol3 f30 sample b blank	2868	19772	4957	1798	1032	3525	12399	11420	8212	62248	202	1099	642	4109	775
pxd 1098 vol5 f5 sample a leaf	4577	13273	22599	2588	32013	4547	83928	18741	7643	45033	1871	1552	329314	106521	880
pxd 1098 vol5 f5 sample b blank	1910	12248	19328	1773	33589	4504	55290	19981	7572	47670	766	1877	321738	19296	568
pxd 1098 vol5 f205 sample a stalk	2635	15009	10188	2012	24910	3831	42569	19611	7982	74345	2564	2957	265682	29098	487
pxd 1098 vol5 f205 sample b blank	3238	15864	9216	2049	24234	4049	40555	19046	7449	73785	2410	1830	259683	17228	428
pxd 1098 vol5 f256a white sample a leaf	1564	12048	15766	1770	22971	2616	50266	16252	6994	18106	490	761	132296	13519	2312
pxd 1098 vol5 f256a white sample b blank	1562	14486	21624	1937	27944	2962	58411	18523	8034	19919	788	768	155643	15663	2396

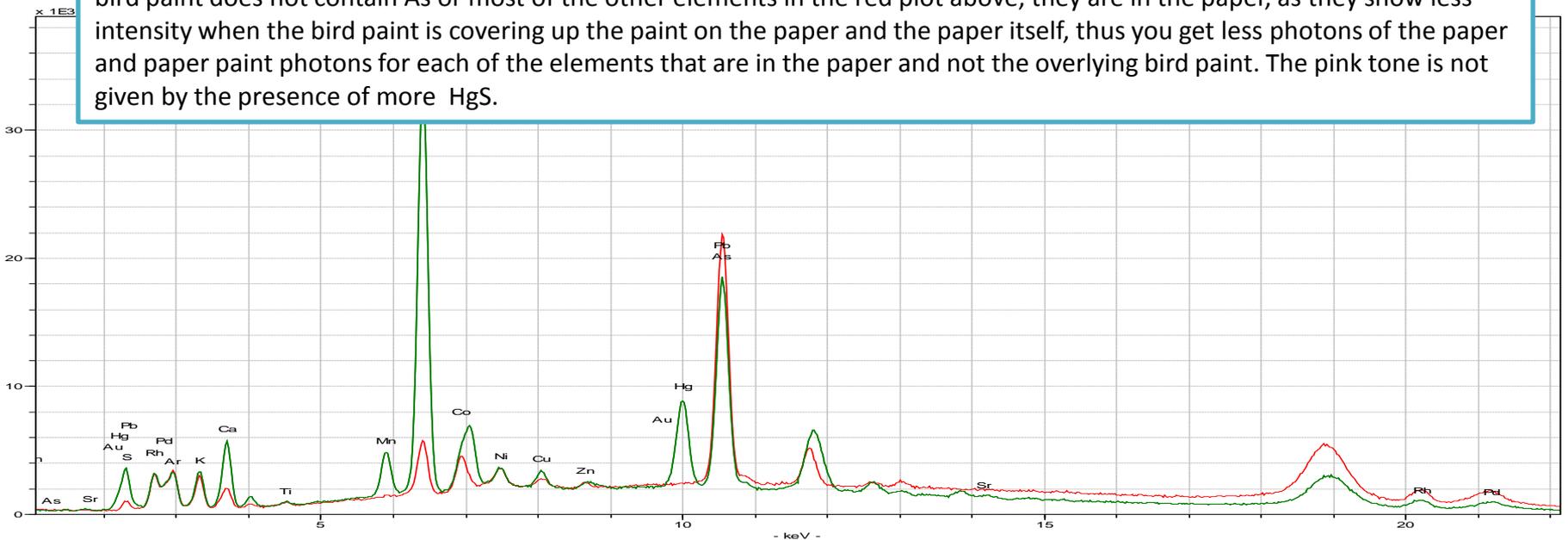


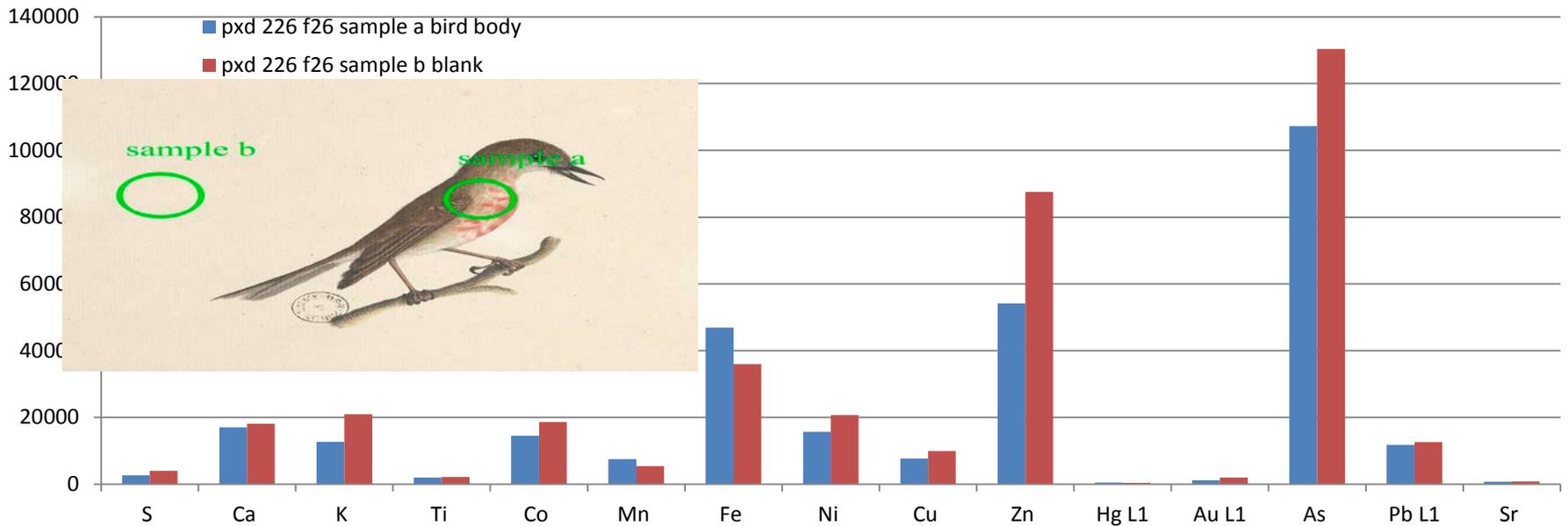
Looking at the relative number of photons at each analysis point with an understanding of how the atoms fluoresce one can discern much. First it is apparent that the paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds neck shows it contains S, Ca, K, Mn Fe and Hg. Note the bird paint does not contain As or most of the other elements note above, they are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint. The pink tone is given by the presence of HgS.



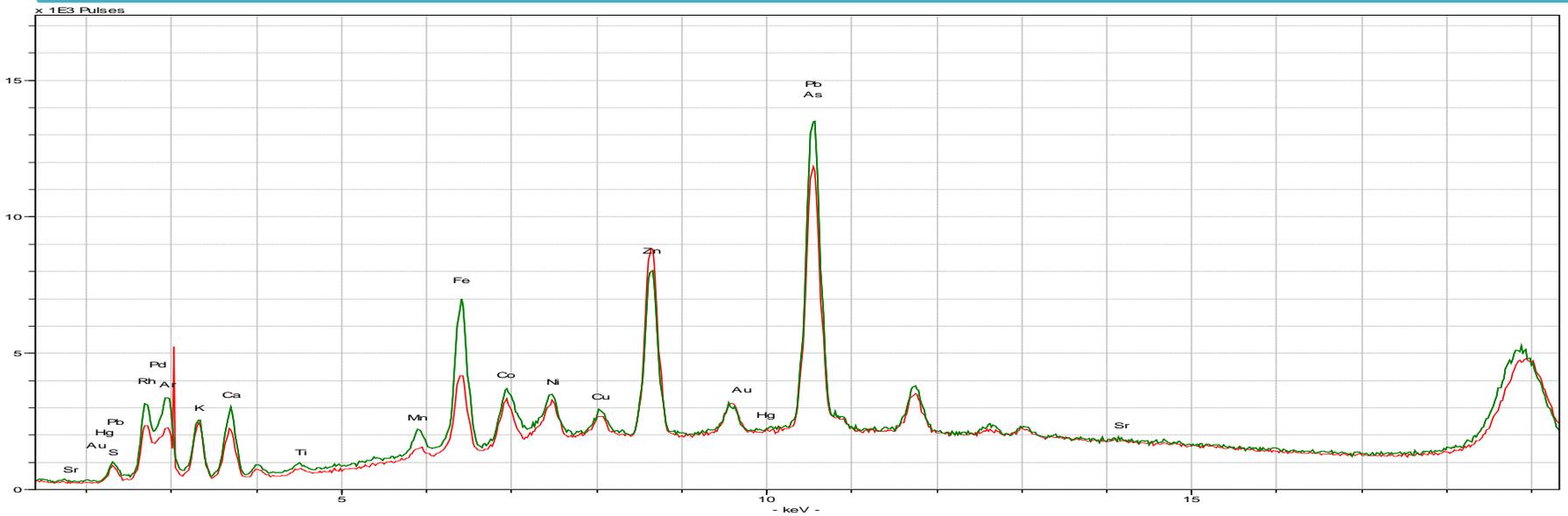


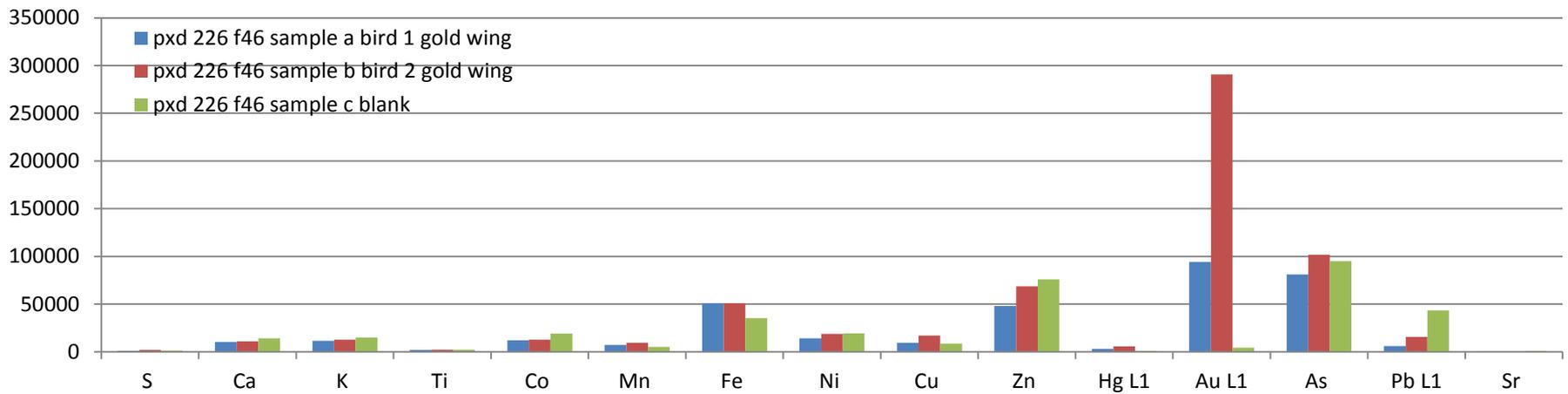
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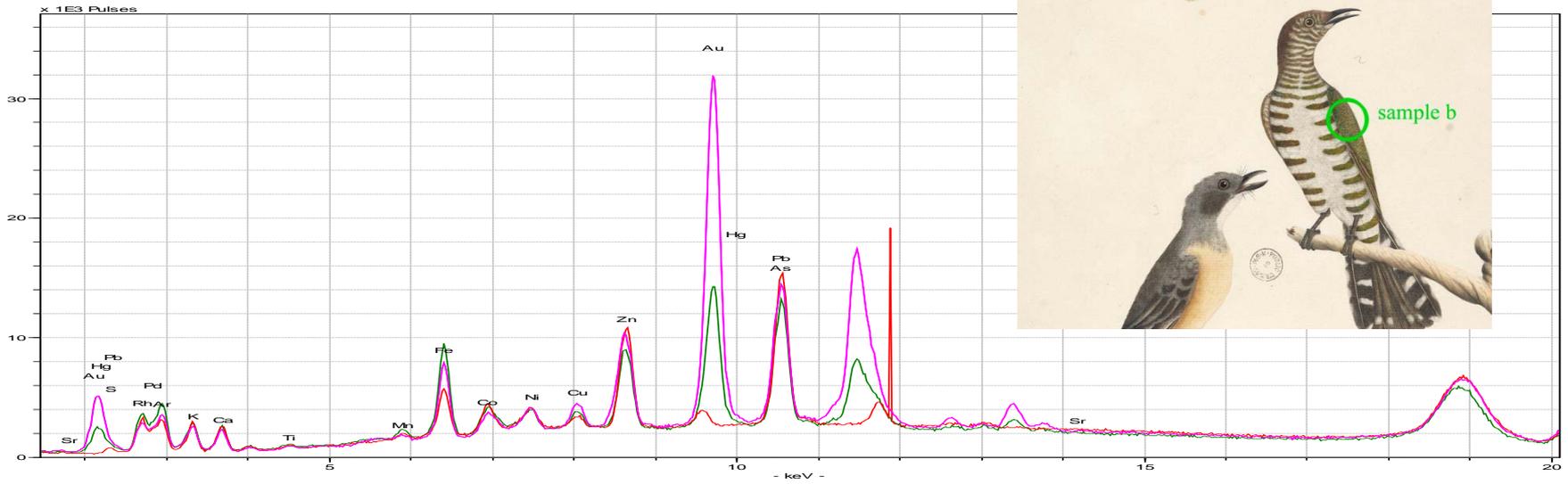
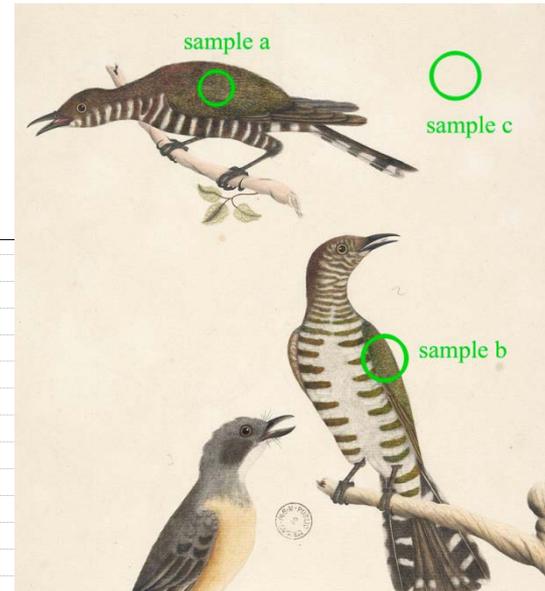


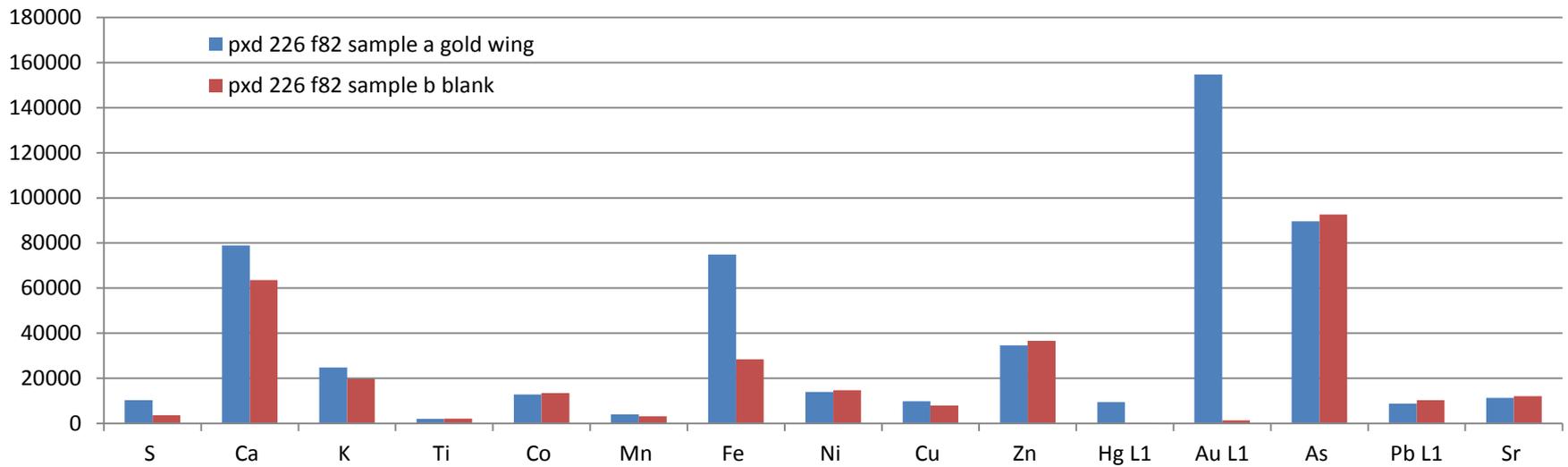
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds neck shows it contains Fe. The other elements in the red plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.



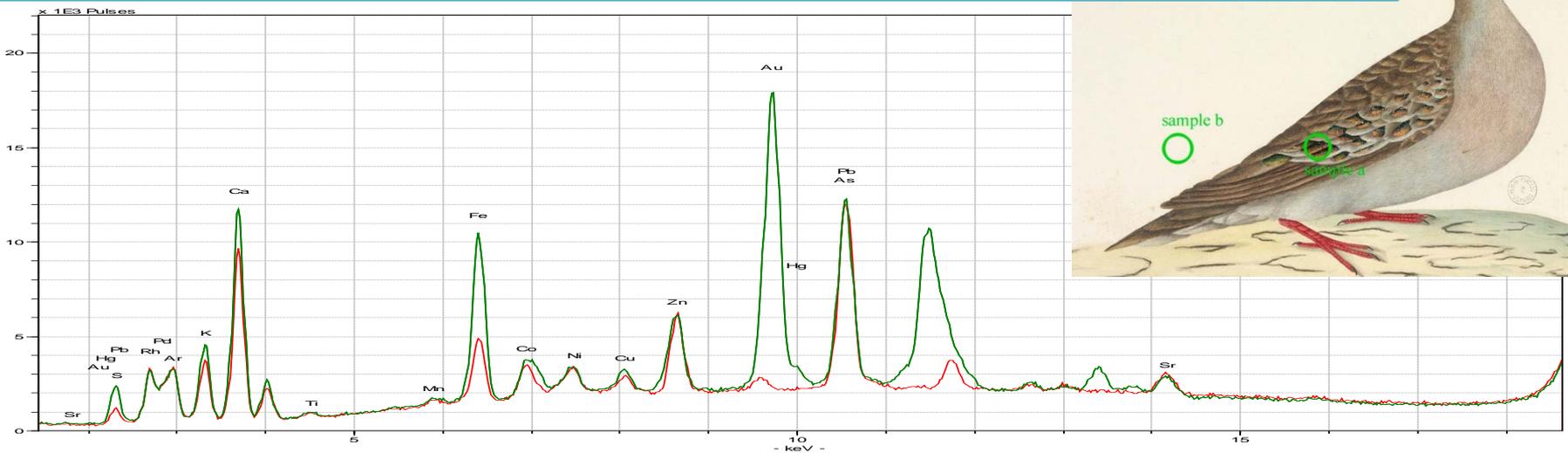


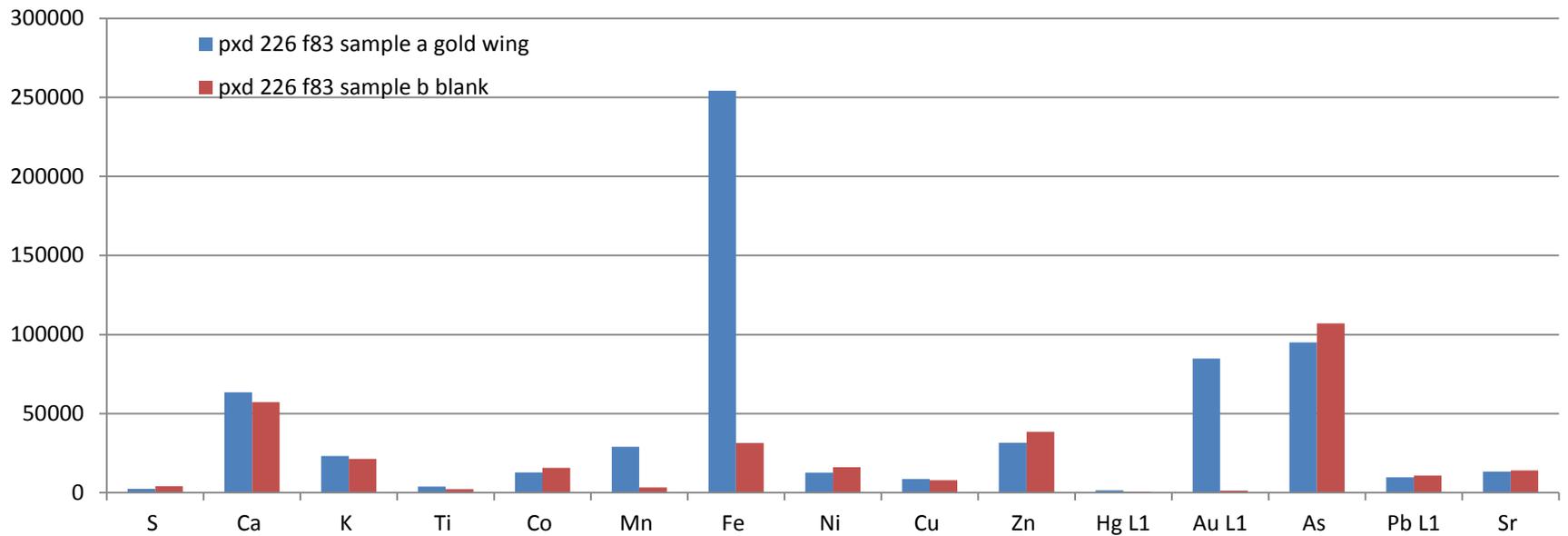
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds wing shows it contains Fe, Mn, Cu and Au. The other elements in the Green plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.



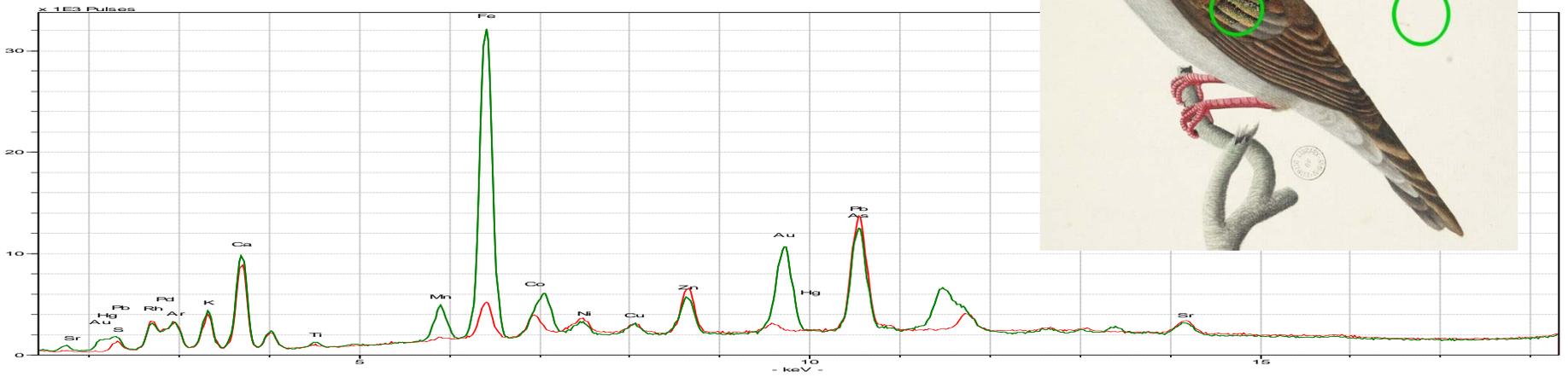
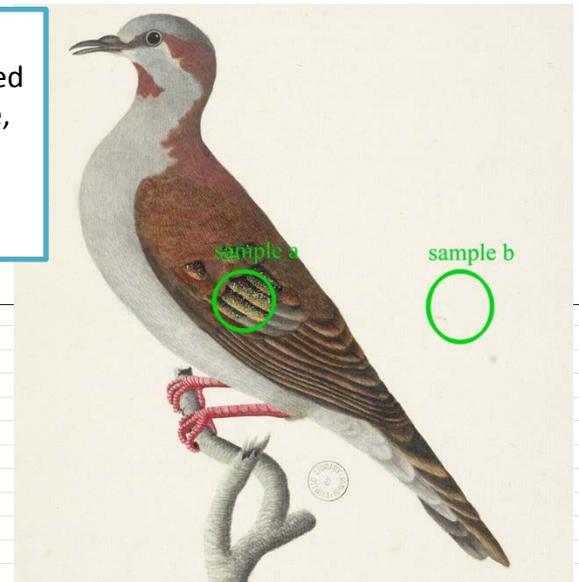


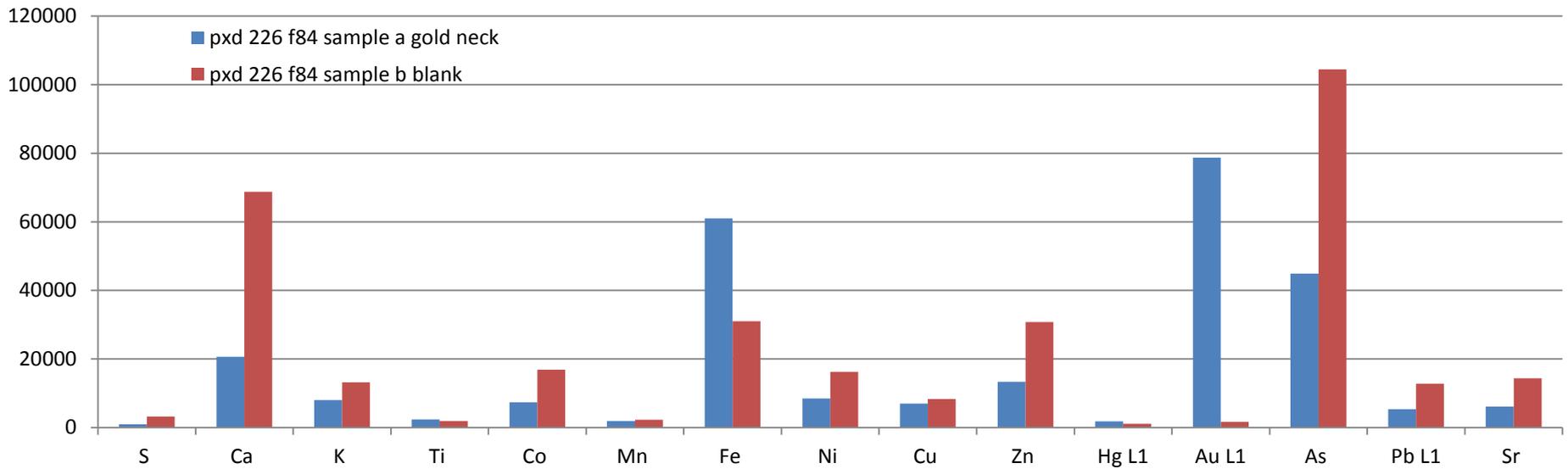
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds wing shows it contains Ca, K, Fe, Mn, Cu, Hg and Au. The other elements in the red plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.



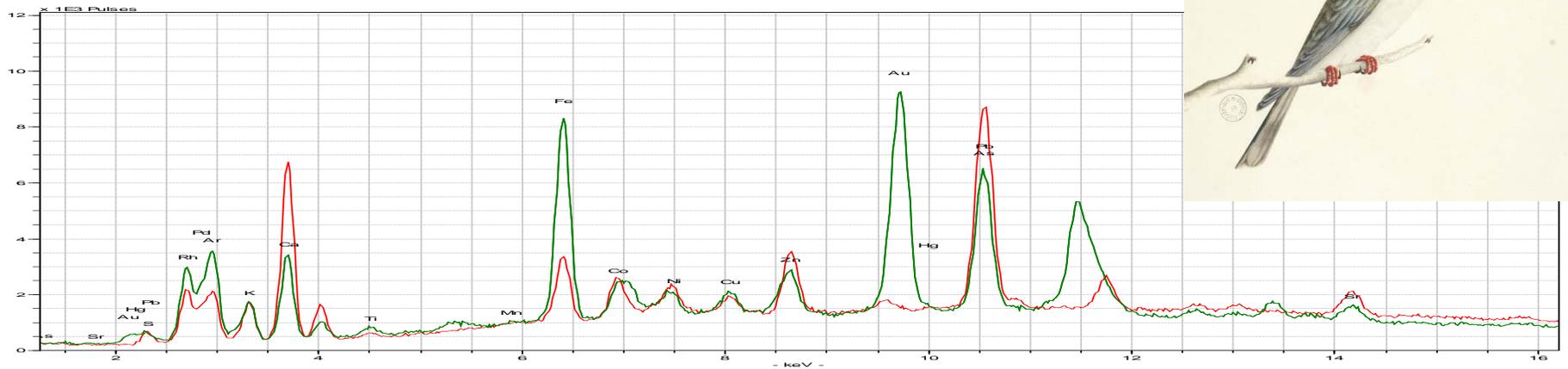
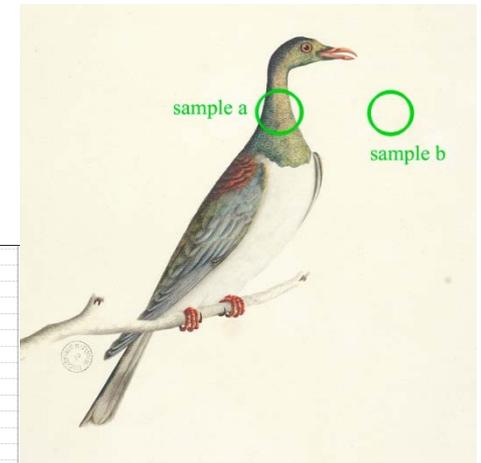


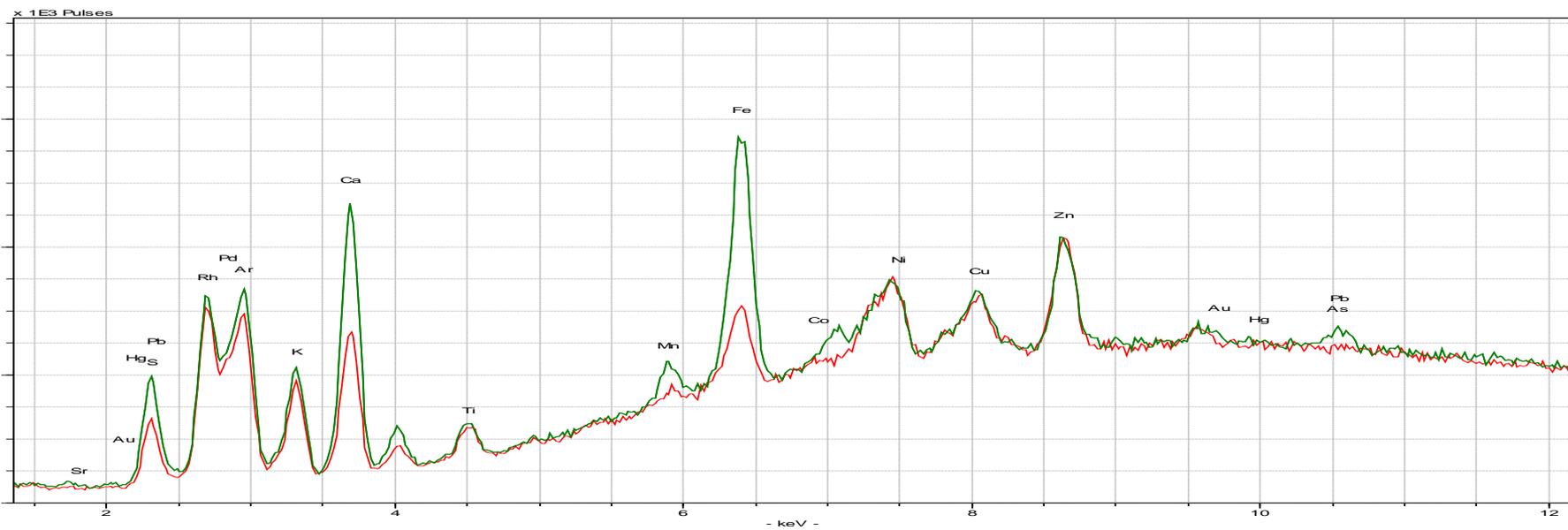
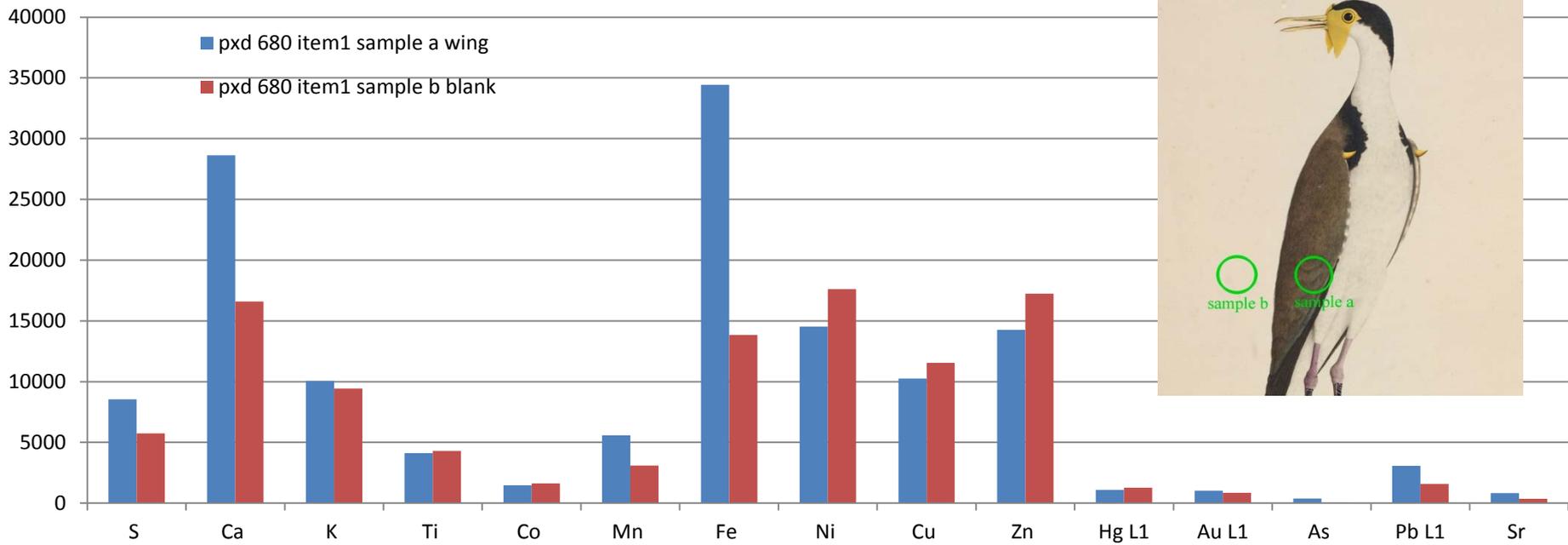
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds wing shows it contains Fe, Mn, Cu, and Au. The other elements in the red plot above, are in the paper, as they show less intensity when the bird paint is covering up the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.

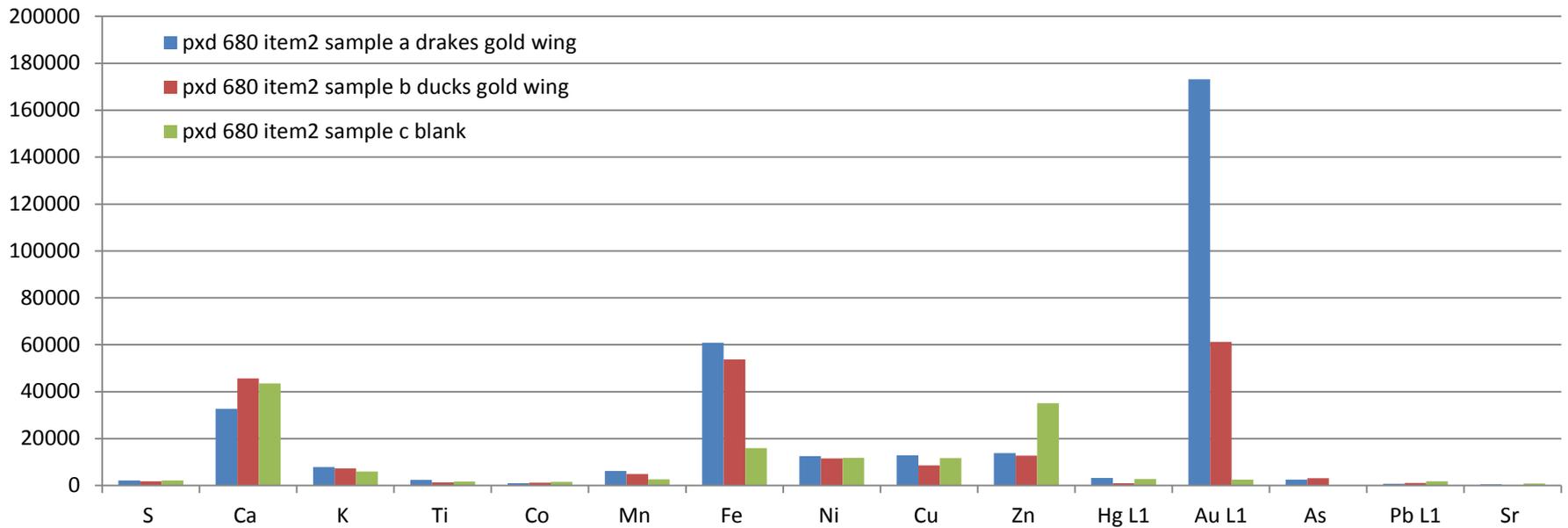




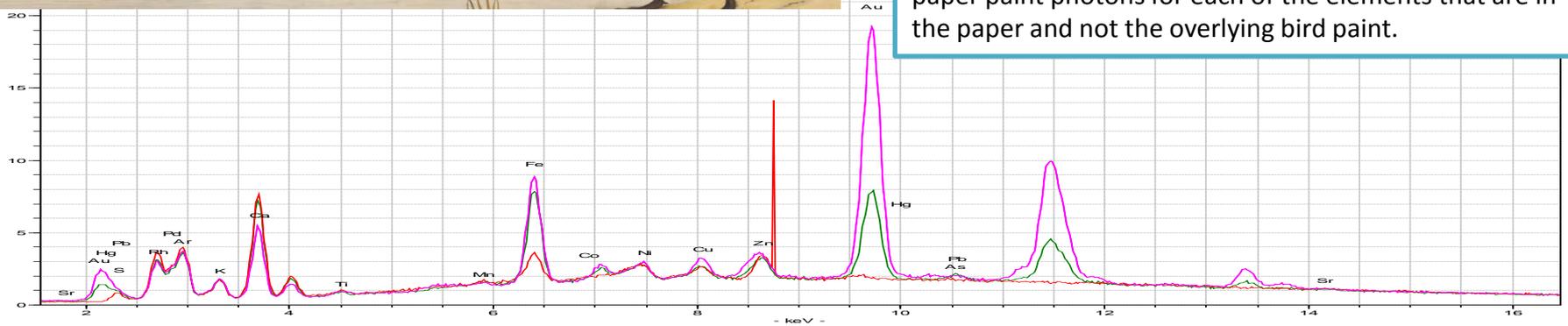
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds wing shows it contains, Fe and Au. The other elements in the red plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.

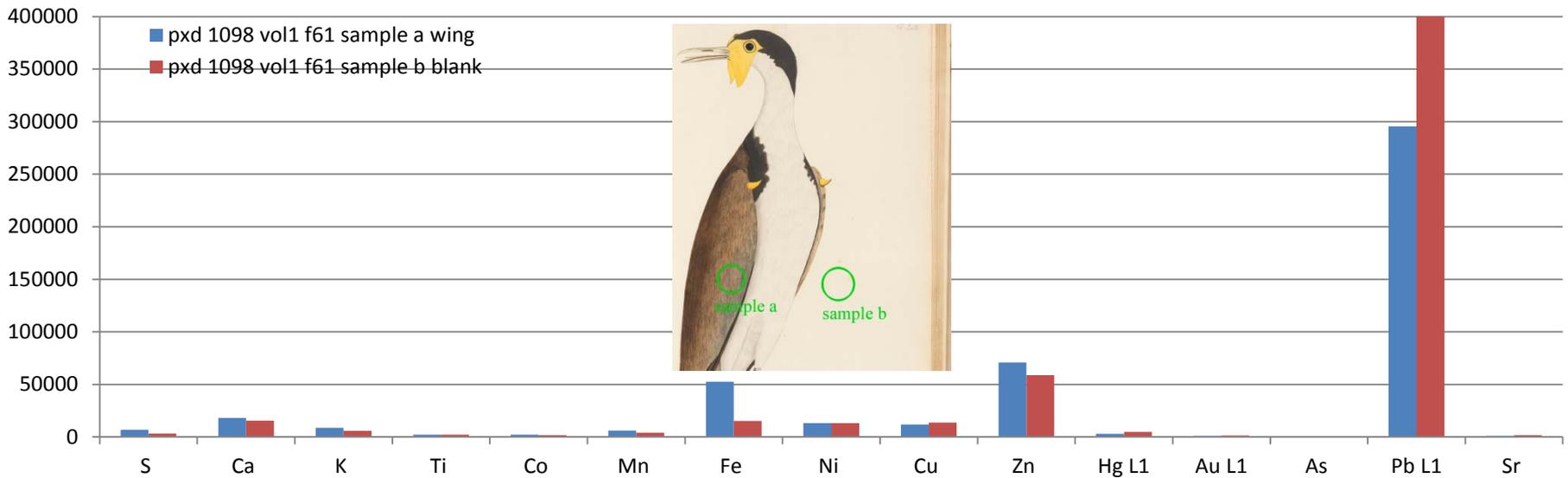




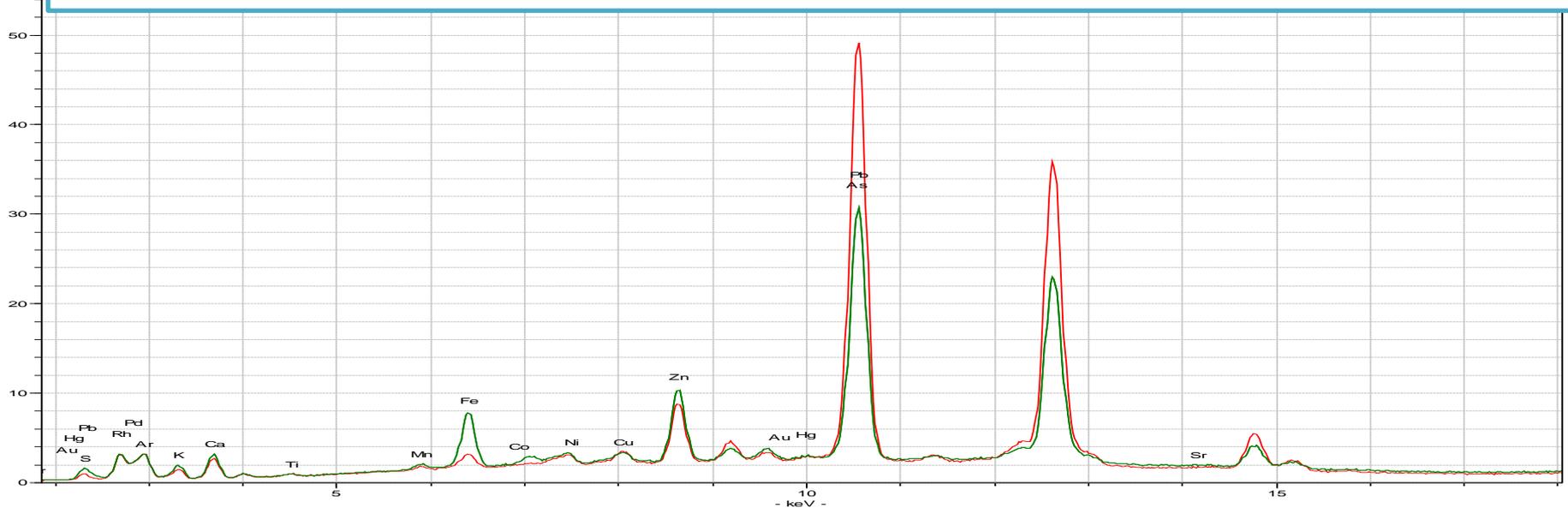


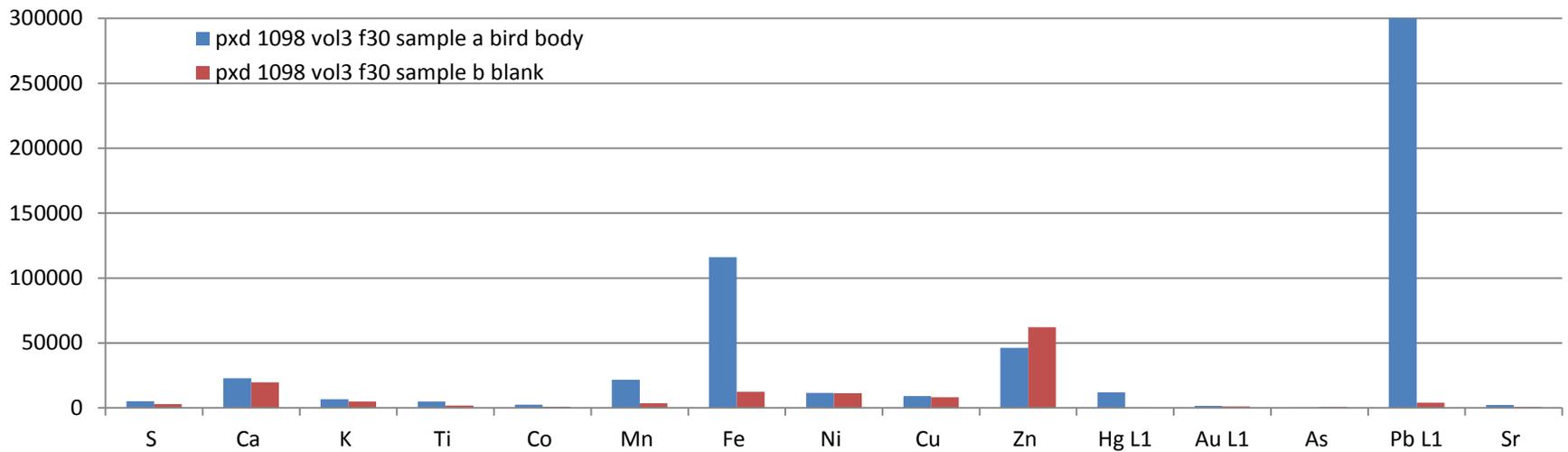
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds wing shows it contains, Fe and Au. The other elements in the green plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.



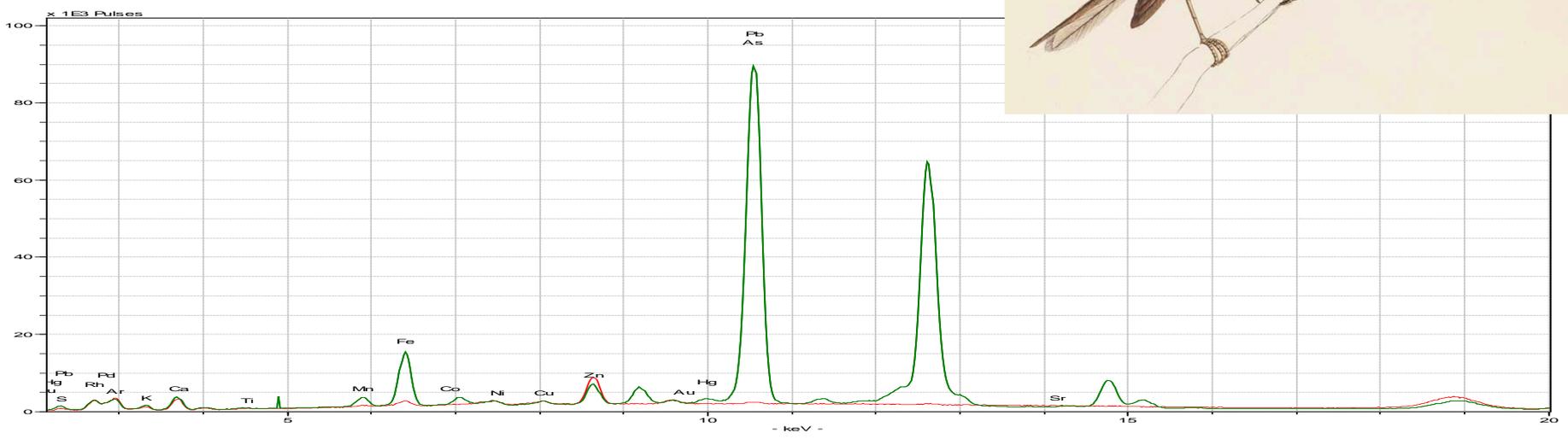
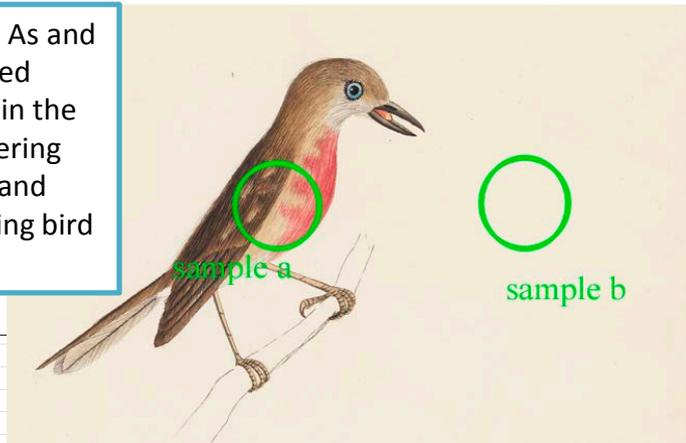


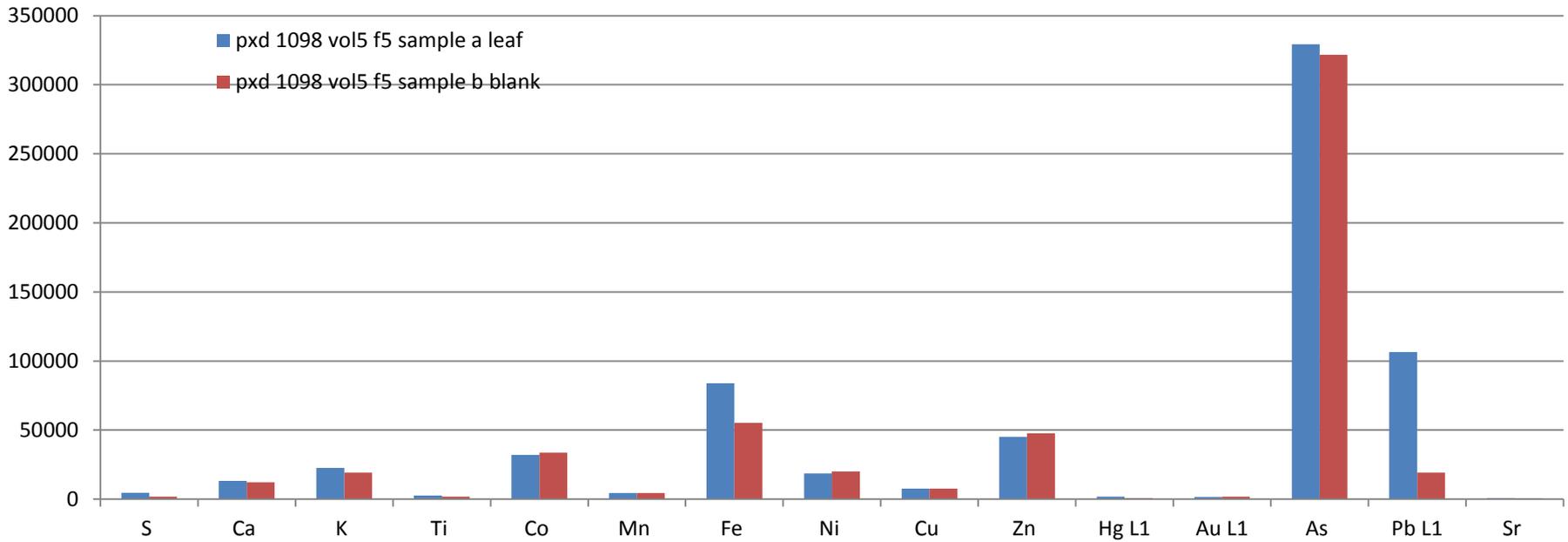
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds wing shows it contains, S, K, Ca, Mn, Fe and Zn. The other elements in the green plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint.



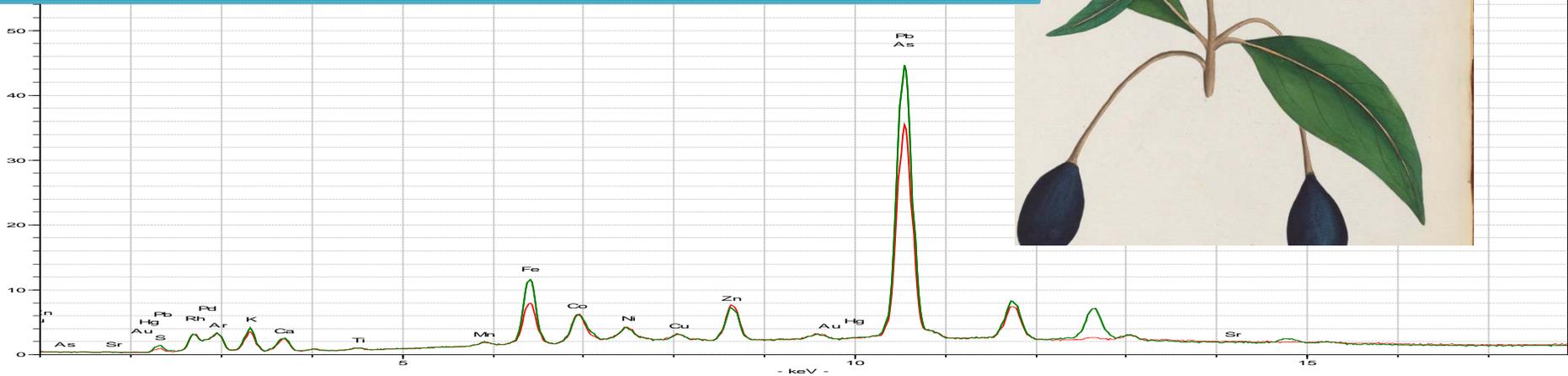
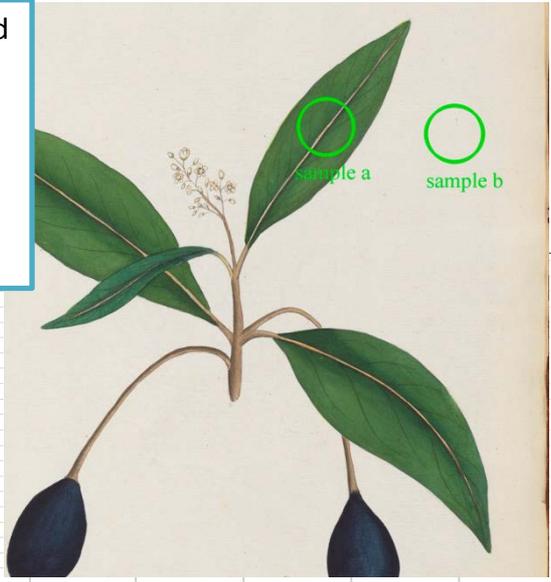


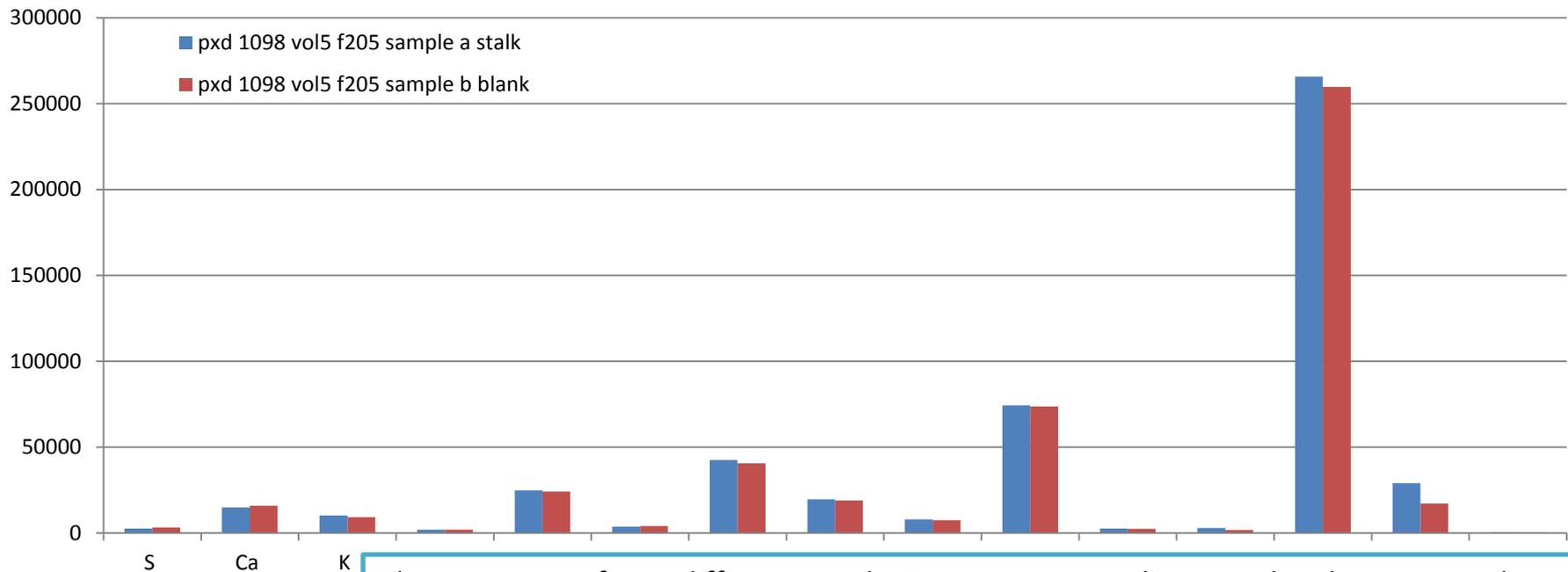
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted birds belly shows it contains, S, K, Ca, Mn, Fe Hg and a lot of Pb. The other elements in the red plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint. It appears the red color come form HgS.



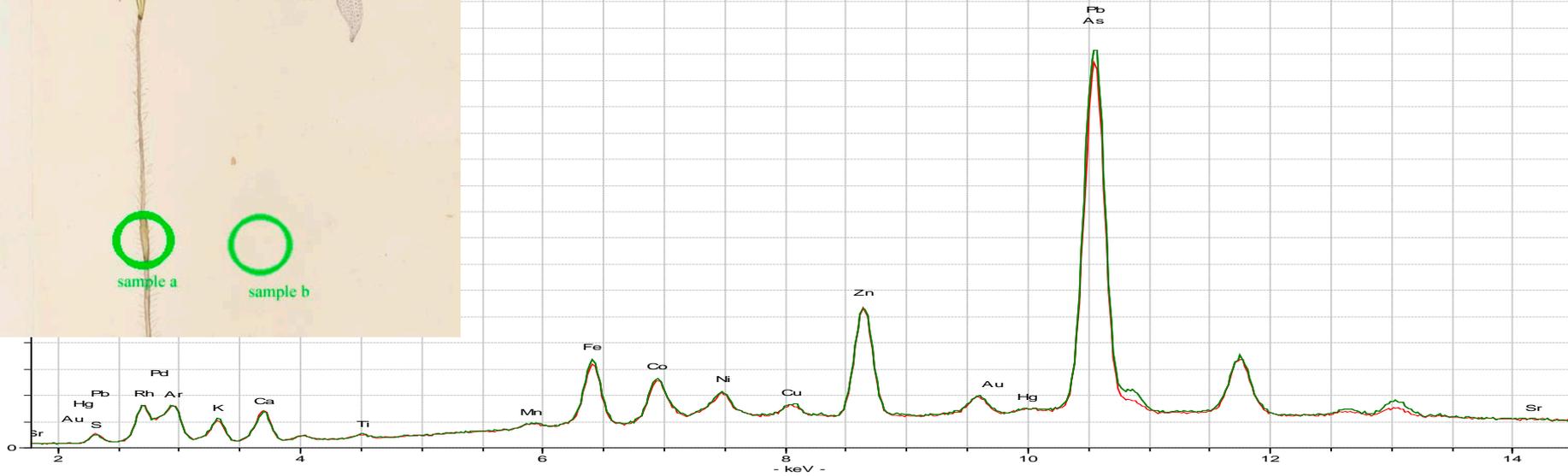
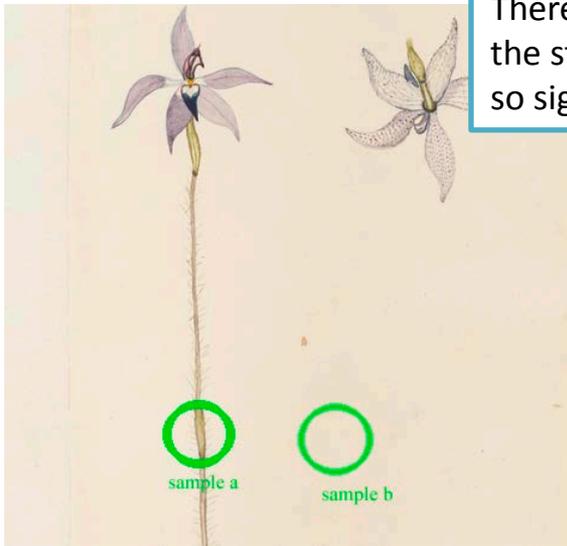


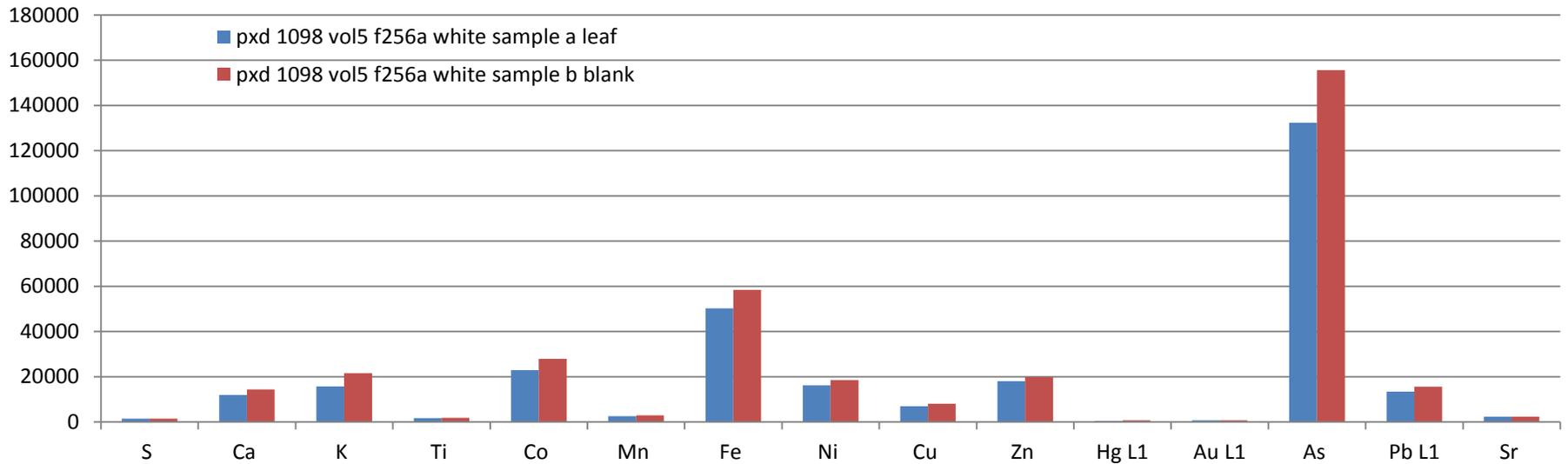
The paper itself has been covered with a white paint that contains a mixture of Co Fe As and Pb as a treatment (see slides 21 through 23) The elements in the analysis of the painted leaf shows it contains Fe and Pb. The other elements in the red plot above, are in the paper, as they show less intensity when the bird paint is covering up the paint on the paper and the paper itself, thus you get less photons of the paper and paper paint photons for each of the elements that are in the paper and not the overlying bird paint. It appears the red color come from HgS.



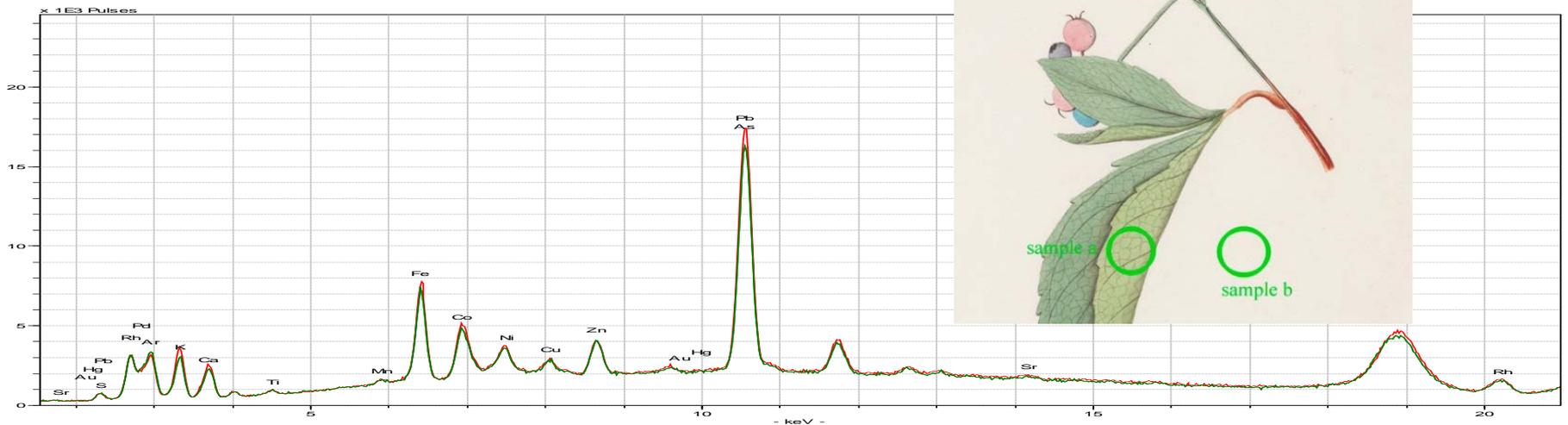
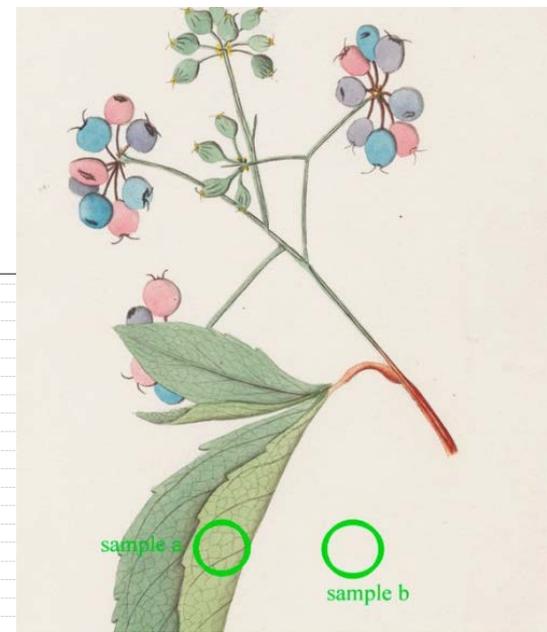


There is no significant difference in the 2 spectra, in part because the elements used in the stem are very similar to the background and also the stem did not cover the beam so significant signal comes from the paper when analyzing the stem.





There is no significant difference in the 2 spectra, in part because the elements used in the background are very similar to the leaf. Or the pigments are organic and do not contain any element heavier than Al.

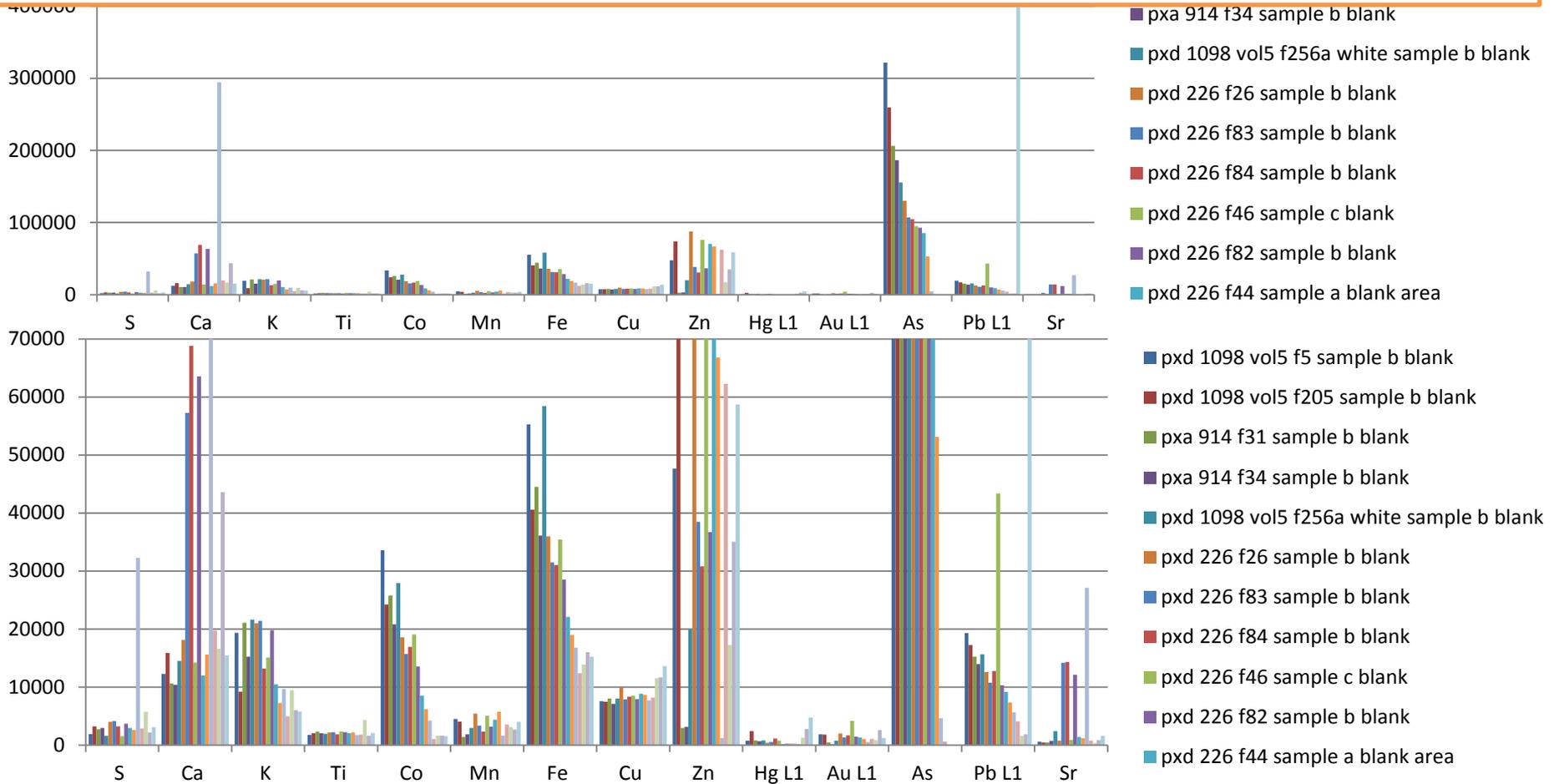


## Looking for correlation in the elements that occur in the paper

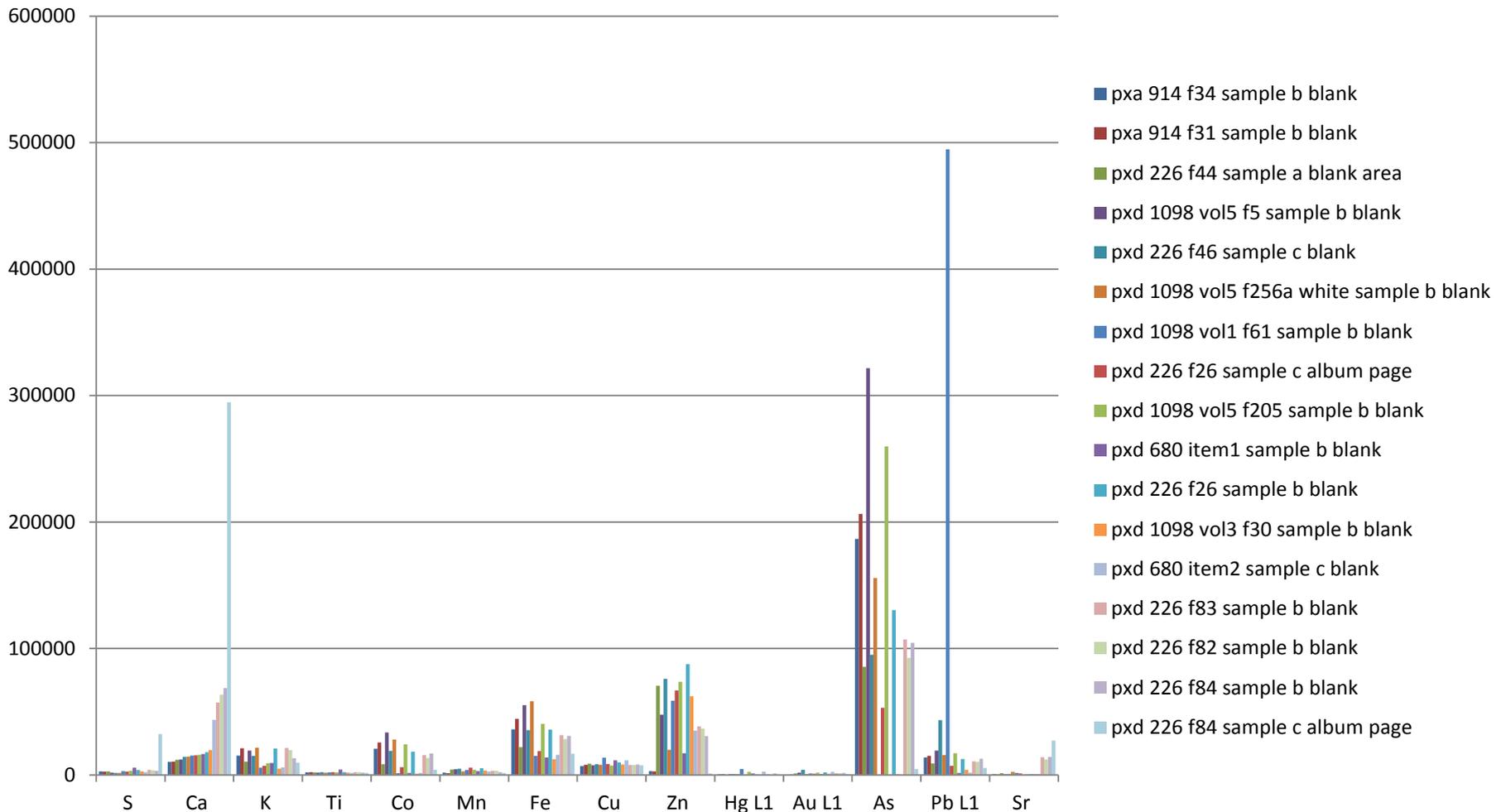
Paper	S	Ca	K	Ti	Co	Mn	Fe	Cu	Zn	Hg L1	Au L1	As	Pb L1	Sr
pxd 1098 vol5 f5 sample b blank	1910	12248	19328	1773	33589	4504	55290	7572	47670	766	1877	321738	19296	568
pxd 1098 vol5 f205 sample b blank	3238	15864	9216	2049	24234	4049	40555	7449	73785	2410	1830	259683	17228	428
pxa 914 f31 sample b blank	2725	10627	21074	2317	25782	1383	44482	8022	2960	800	459	206453	15228	457
pxa 914 f34 sample b blank	2966	10411	15240	2031	20808	1845	36114	7109	3141	685	157	186622	13935	726
pxd 1098 vol5 f256a white sample b blank	1562	14486	21624	1937	27944	2962	58411	8034	19919	788	768	155643	15663	2396
pxd 226 f26 sample b blank	3990	18093	20967	2152	18556	5393	35941	9902	87568	383	2000	130367	12573	779
pxd 226 f83 sample b blank	4143	57229	21395	2229	15692	3372	31507	7865	38460	538	1329	107035	10770	14165
pxd 226 f84 sample b blank	3223	68801	13185	1873	16909	2316	31009	8359	30804	1135	1653	104506	12768	14341
pxd 226 f46 sample c blank	1531	14234	15100	2348	19067	5028	35397	8533	76001	769	4176	95108	43338	879
pxd 226 f82 sample b blank	3659	63546	19792	2225	13523	3193	28518	7943	36674	143	1444	92670	10297	12143
pxd 226 f44 sample a blank area	2961	12005	10490	2027	8511	4363	22069	8820	70552	263	1309	85525	9169	1416
pxd 226 f26 sample c album page	2589	15617	7228	2163	6171	5736	18968	8662	66776	264	1034	53127	7327	1175
pxd 226 f84 sample c album page	32274	294588	9644	1706	4228	1639	16763	7691	1219	259	535	4661	5645	27117
pxd 1098 vol3 f30 sample b blank	2868	19772	4957	1798	1032	3525	12399	8212	62248	202	1099	642	4109	775
pxd 680 item1 sample b blank	5736	16600	9429	4305	1633	3098	13844	11541	17238	1277	845	1	1592	351
pxd 680 item2 sample c blank	2186	43578	6011	1644	1613	2669	15987	11657	35059	2767	2567	1	1842	858
pxd 1098 vol1 f61 sample b blank	3067	15441	5761	2064	1517	4011	15214	13643	58720	4718	1230	1	494528	1587

# Looking for correlation in the elements that occur in the paper

Note the strong correlation between the Co Fe As and Pb, were as the S Ca K Mn Cu and Sr vary randomly relative to them. Thus it is apparent that the pages were coated to various thickness with at mixture of Co Fe As and Pb as a treatment. It is also apparent that there were several different papers used or the pages were also subject to the treatment and not constant page to page.

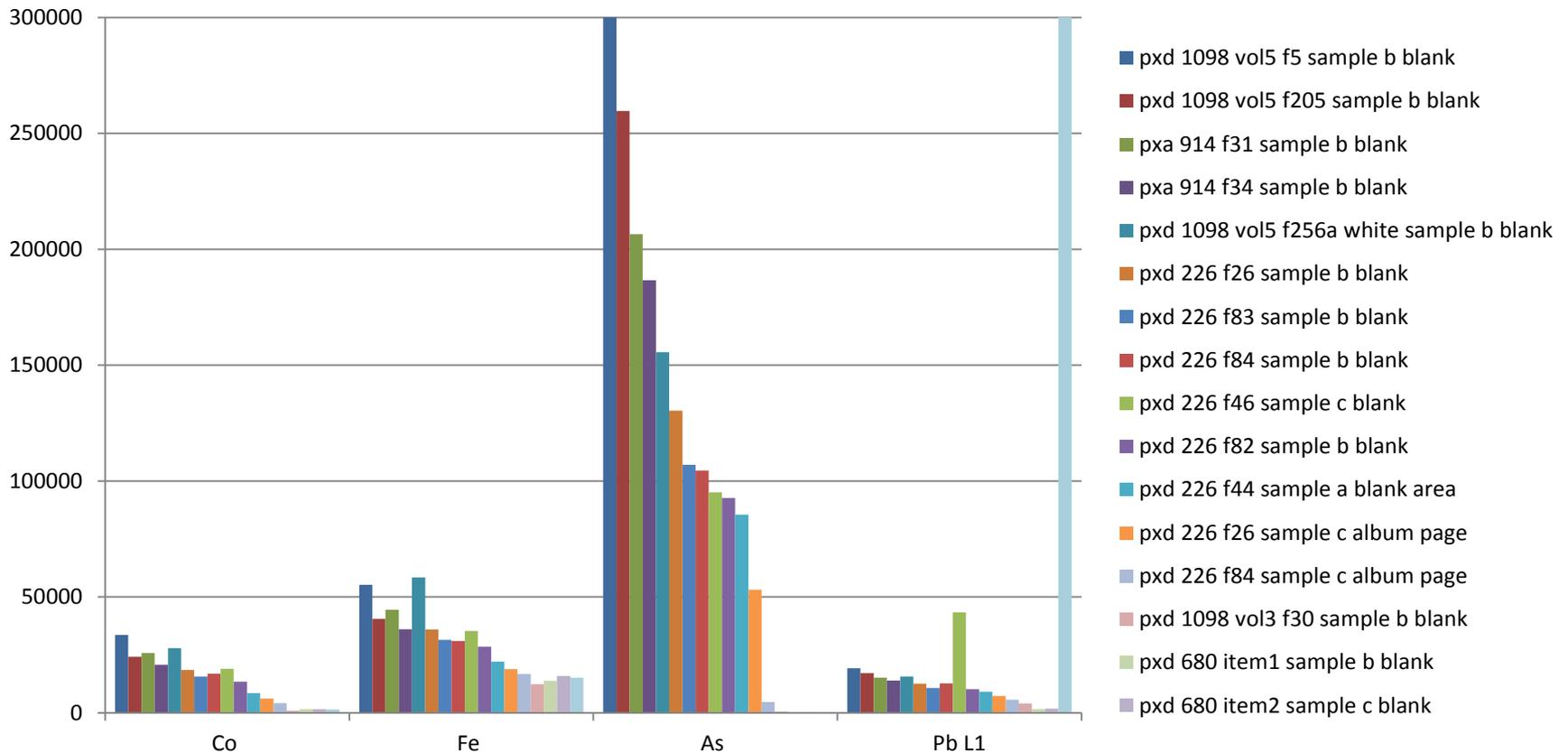


**Note the plot of paper analysis sorted on Ca shows there is no correlation between any other element indicating no other consistent paper treatment page to page**



*She is also interested in the arsenic levels and any variations in these across the different pages and volumes.*

Note the strong correlation between the Co Fe As and Pb, Thus it is apparent that the pages were coated to various thickness with at mixture of Co Fe As and Pb as a treatment. Note the As levels ar significant and these pages should be handled with CARE.

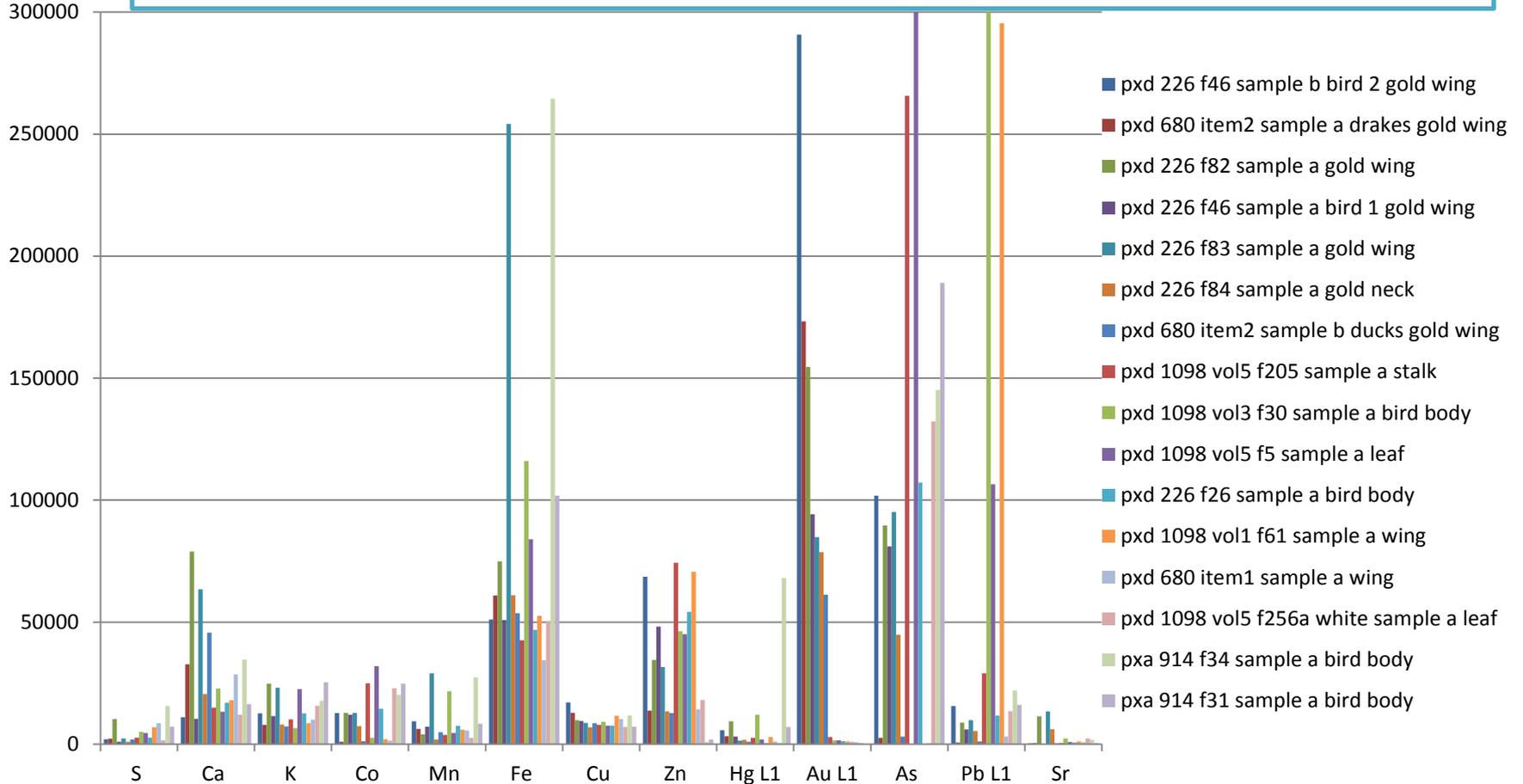


**Where is the  
Au in the paintings?**

## Not surprising but Au occurs in all the spectra that have gold in the file name

Pigments	S	Ca	K	Co	Mn	Fe	Cu	Zn	Hg L1	Au L1	As	Pb L1	Sr
pxd 226 f46 sample b bird 2 gold wing	2065	11083	12596	12775	9433	51081	17130	68621	5721	290788	101813	15652	383
pxd 680 item2 sample a drakes gold wing	2195	32730	7894	962	6221	60914	12843	13757	3266	173225	2531	705	456
pxd 226 f82 sample a gold wing	10301	78879	24853	12822	4028	74850	9876	34576	9444	154652	89632	8869	11357
pxd 226 f46 sample a bird 1 gold wing	998	10400	11555	12041	7205	50912	9554	48202	3109	94229	80994	6033	145
pxd 226 f83 sample a gold wing	2380	63447	23181	12849	29017	254189	8667	31678	1496	84841	95090	9811	13373
pxd 226 f84 sample a gold neck	975	20622	8044	7377	1882	61032	6982	13373	1777	78749	44880	5370	6157
pxd 680 item2 sample b ducks gold wing	1849	45724	7265	1237	4902	53703	8569	12698	983	61219	3129	1127	297
pxd 1098 vol5 f205 sample a stalk	2635	15009	10188	24910	3831	42569	7982	74345	2564	2957	265682	29098	487
pxd 1098 vol3 f30 sample a bird body	5050	22829	6611	2538	21717	115998	9131	46263	12097	1585	1	935562	2360
pxd 1098 vol5 f5 sample a leaf	4577	13273	22599	32013	4547	83928	7643	45033	1871	1552	329314	106521	880
pxd 226 f26 sample a bird body	2631	16966	12681	14478	7502	46864	7632	54187	466	1175	107238	11724	713
pxd 1098 vol1 f61 sample a wing	6931	17967	8637	1988	5952	52613	11681	70654	2867	1168	1	295490	1067
pxd 680 item1 sample a wing	8554	28635	10054	1472	5582	34436	10255	14260	1087	1023	375	3081	831
pxd 1098 vol5 f256a white sample a leaf	1564	12048	15766	22971	2616	50266	6994	18106	490	761	132296	13519	2312
pxa 914 f34 sample a bird body	15612	34659	17796	20255	27426	264535	11706	1050	68075	609	145124	21981	1780
pxa 914 f31 sample a bird body	7144	16420	25379	24806	8341	101854	7142	1879	7008	105	189065	16136	400

**Not surprising but Au occurs in all the spectra that have gold in the file name**



**Note the plot shows there is no correlation between the use of Au and any other pigment**