Kumla altar XRF examination						
Site no.	**Region**	**Instrument spectrum**				**Conclusions**
		Strong signal		**Weak signal**		
1	Gilding, backwall	Au	gold	Fe	iron	Water gilding (gold leaf: Au) over iron-oxide (Fe_2O_3) bolus. Gilding is v. well preserved.
		Ca	calcium	Sr [Ag?]	silver?	
2	Reddish-purple brown, backwall	Fe	iron	Pb	lead	The pigment is probably caput mortem (mineral form of iron (III) oxide (Fe_2O_3), the purple variety of haematite iron oxide. The colour is sometimes called cardinal purple.
		Ca	calcium	Zn?	zinc?	
				Sn?	tin?	
				Rh?		
3	Ground w/ pink drip	Ca	calcium	Fe	iron	Chalk ground, mixed with iron-oxide (Fe_2O_3, caput mortem?)
				Rh?	rhodium	
				Ag?	silver	
4	Gilding, backwall	Au	gold	Fe	iron	Water gilding (gold leaf) over iron-oxide bolus. Gilding v. well preserved.
		Ca	calcium	Ni	nickel	
				Sr	strontium	
5 (4b)	Ground with pink, behind Brigitte	Ca	calcium	Fe	iron	Chalk ground, mixed with iron-oxide. Possibly caput mortem (Fe_2O_3)?
				Sr	strontium	
				Zn	zinc	
				Ni	nickel	
				Ag?	silver?	
6	Red drip on frame	Pb	lead	Ca,	calcium	Red lake [perhaps madder or kermes based] over red lead (Pb_3O_4) (but no vermilion at all). This combination could explain the fading as both red lead and lakes are susceptible to fading.
				Fe	iron	
				Zn,	zinc	
				Sr	strontium	
				Ag?	Silver?	
7	golden stencil, frame	Pb	lead	Fe,	iron	Silver stencil on frame, over red lead (Pb_3O_4). Traces of gold is likely to be from the nearby gilding.
		Ca	calcium	Zn	zinc	
		Ag	silver	Sr	Strontium	
				Au	gold	
8	gilding, frame	Au	gold	Fe	iron	Water gilding (gold leaf) over iron-oxide bolus.
		Ca	calcium	Zn	zinc	
				Sr	strontium	
				Ag?	Silver?	
8a	reddish-purple brown, backwall	Fe	iron	Sr	strontium	Probably a purplish iron oxide pigment like caput mortem (Fe_2O_3).
		Ca	calcium	Pb	lead	
8b	red, tracery frame, platform	Pb	lead	Hg	mercury	Mixture of red lead (Pb_3O_4), vermilion and red iron-oxide? (Fe_2O_3), This might have been one way for the workshop to use up extra supplies of red paints used elsewhere in the altarpiece. The paint is applied directly onto wood, with no ground layer.
				Fe	iron	
				S	sulphur	

8c	blue, box frame	Cu	copper	Ca	calcium	Azurite ($2\ CuCO_3 \cdot Cu(OH)_2$), measured in a location over the iron nails securing the hinge.
				Fe	iron	
				Zn	zinc	
				As	mercury	
8d	Red, sidewall	Pb, [Cu?]	lead copper?	Ca	calcium	The presence of lead in this areas suggest that the red colour is red lead (Pb_3O_4). Source for Cu?
				Sr	strontium	
8e	stencil, sidewall	Pb, [As]	lead arsen?	Ca	calcium	Silver foil with yellow glaze over layers of red lead (Pb_3O_4).
				Fe	iron	
				Se	selen	
				Ag	silver	
				Zn	zinc	
9	faded red, frame	Pb	lead	Fe	iron	Same/similar signals for deep-red drip (nr. 6). Faded red lake over red lead (Pb_3O_4)? Colour here is poorly preserved.
				Zn	sink	
				Sr	strontium	
10	degraded glaze on silver	Cu	copper	Fe	iron	Copper green glaze over silver gilding. Bolus colour? Perhaps the bole is a mixture an iron-oxide with red lead (Pb_3O_4), lead white ($2\ PbCO_3 \cdot Pb(OH)_2$)? Gothic ceiling on opposite face is the same. Compare spectra.
		Pb	lead	Ca	calcium	
				Ag	silver	
11	golden applique, frame	Pb,	Lead	Ni	nickel	Gold lead on red lead (Pb_3O_4). The source of silver are probably traces from the surrounding silver applique.
				Au	gold	
		Sr	stron-tium	Ag	silver	
12	silver helmet	Ca	calcium	Fe	iron	Silver foil without bole underneath? The foil is very worn and oxidized. See measurement 32 and sample P7.
		Ag	silver	Zn	zinc	
				Sr	strontium	
12a	red lozenge, ceiling design	Pb,	lead	Fe	iron	Red lead (Pb_3O_4) under or mixed with caput mortem? Haematite? No vermilion (HgS). Colour v. well preserved.
				Zn	zinc	
		Sr	stron-ium			
13	blue tunic	Cu	copper	Ca	calcium	Azurite ($2\ CuCO_3 \cdot Cu(OH)_2$), either mixed with a little lead white ($2\ PbCO_3 \cdot Pb(OH)_2$). or the lead white is in the under layer. Colour v. well preserved.
		Pb	lead	Fe	iron	
				Sr	strontium	
14	purple tunic	Pb	lead	Ca	calcium	Probable mixture of lead white ($2\ PbCO_3 \cdot Pb(OH)_2$) with a little azurite and caput mortem or haematite (both Fe_2O_3). There could possibly also be some red lake in the mixture. Colour v. well preserved.
		Cu	copper	Fe	iron	
				Zn	sink	
				Sr	strontium	
15	orange brocade	Pb	lead	Ca,	calcium	Very weak silver and gold signals. Red lead (Pb_3O_4) perhaps with lead white ($2\ PbCO_3 \cdot Pb(OH)_2$) and vermilion (HgS), with metal brocade pattern. Colour v. well preserved. Source for copper? Sample would be necessary to clarify.
				Cu,	copper	
				Hg?	mercury?	
				Sr	strontium	
				Ag?	silver	
				Zn	zinc	
16	rosey-red stocking	Pb	lead	Fe	iron	Lead white ($2\ PbCO_3 \cdot Pb\ (OH)_2$) mixed with iron-oxide red and vermilion. Colour v. well preserved.
				Hg	mercury	
		Sr	strontiu m			

17	halo	Pb	lead	Fe	iron	Gold foil over lead white? Bolus colour? Fe signal probably from adjacent red passage. This passage is intact.
		Sr	stron-tium	Zn	zinc	
		Au	gold			
		Ca	calcium			
18	green cape	Pb	lead	Fe	iron	Copper green mixed with lead-tin yellw (probably Type I (Pb_2SnO_4), possibly some lead white ($2\ PbCO_3 \cdot Pb(OH)_2$) too. Colour v. well preserved.
				Sn	tin	
		Sr	stron-tium	I	iodine	
		Cu	copper			
19	reddish-purple brown headdress	Pb,	lead	Sr	strontium	Probably an iron-oxide pigment like Caput mortem (Fe_2O_3) mixed with lead white ($2\ PbCO_3 \cdot Pb(OH)_2$).
		Fe	iron			
20	red tunic, above belt	Pb [Se]	lead selen	Ni	nickel	Red lead (Pb_3O_4) with vermilion (HgS). Colour is very well preserved.
		Hg	mercury			
		As	arsen			
21	brownish green glaze on silver	Ca	calcium	Fe	iron	Copper green glaze on silver foil. Colour is better preserved than on the other wing
		Cu	copper	Sr	strontium	
		Ag	silver	Zn	zinc	
				Rh	rhodium	
22	blood	Pb,	lead	Fe	iron	Blood red probably containing red lead (Pb_3O_4) and iron oxide (caput mortem?) over the floor design containing lead-tin yellow (Pb_2SnO_4). Colour is very well preserved.
		Sr	stron-tium	Zn	zinc	
				Sn	tin	
				I	iodine	
23	metal flower, decorative border	Pb	lead	Fe	iron	Tin flower, formed in a mould, then gilt (either with leaf or more likely with shell gold). See sample P6 for the painted area underneath.
				Au	gold	
		Sr	stron-tium	Zr	zirconium	
24	deep green, tree	Pb	lead	Fe	iron	Copper green, probably mixed with a carbon black/black or dark ochre. PbSn is likely from the lead-tin yellow (Pb_2SnO_4) painted leaves very close to the measurement site. There was clearly a reserve left for the trees. No gold is detected underneath but the iron indicates bolus that might have continued under the trees. Colour well preserved.
		Se	selen	Zn	zinc	
		Cu	copper	Sr	strontium	
				Sn	antimony	
25	purple lining (deep tone) of green garment	Pb,	lead	Fe	iron	The purple appears to be a mixture of azurite ($2\ CuCO_3 \cdot Cu(OH)_2$) and caput mortem, perhaps mixed with a little red lead (Pb_3O_4) too (or lead white $2\ PbCO_3 \cdot Pb(OH)_2$). Colour v. well preserved.
		Sr,	stron-tium			
		Cu	copper			
26 (P1)	silver armour with	Ag	silver	Fe	iron	The surface is poorly preserved and thus two measurements were taken (the second on the adjacent silver helmet) to clarify. Results for both are recorded here.
		Ca	calcium	Zr	zirconium	
		Zn	zinc	Sb		
		Sr	stron-tium			

	coloured glaze, sample P1	Rh?	rhodium ?			The foil is silver (apparent in the second measurement but absent in the first), with a protective organic glaze that has discoloured. Analysis of sample P1 suggests traces of pigments in the glaze. Still, the glaze allow the silver to appear as silver, rather than gold.
26a	decorative pattern separating scenes	Pb,	lead	Ag	silver	Twig or coral pattern formed on a dark (black) background, outlined with thin and consistent lines of lead white (2 $PbCO_3$· $Pb(OH)_2$). The pattern has a green cast, but appears to contain no copper green. The strongest signal, apart from lead, came from silver. Colour and form v. well preserved.
				Fe	iron	
		Sr	stron-tium	Zn	zinc	
				Nb	niobium	
27 (P2)	yellow-green garment, mid-tone, sample P2	Pb	lead	Fe	iron	Copper green mixed with lead-tin yellow (Pb_2SnO_4) over an under-layer of lead white. The source of iron might be from the use of green earth ($K[(Al,Fe^{III}),(Fe^{II},Mg](AlSi_3,Si_4)O_{10}(OH)_2$), or red iron oxide mixed with lead white (see sample P2) Both the colour and form is very well preserved in this area and in other similar passages throughout the altar panels. Looking at the layer structure from sample P2, the relatively thick, double layers of yellow-green paint might explain the good state of preservation.
		Cu	copper	Sn	antimony	
28 (P3)	Pink-red garment, mid-tone, sample P3	Pb	lead	Ni	nickel	Vermilion (HgS) mixed with red lead (Pb_3O_4) and lead white (2 $PbCO_3$· $Pb(OH)_2$). Beautiful shade of red, that is both pinkish and fiery at the same time. The built up of layers in sample P3 shows a under layer of white and a thick glaze on top of the very well preserved red colour. This passage and the green recorded in no. 27 were applied over textile along the seam between two panels.
		Hg	mercury			
		As	arsen			
		Sr	stron-tium			
29	yellow hat	Pb	lead	Fe	iron	Lead-tin yellow (Pb_2SnO_4), over a red passage that probably contains red lead (Pb_3O_4) and an ochre (FeO(OH)), possibly caput mortem as the colour has lost its orange tinge.
				Sn	antimony	
		Sr	stron-tium	Sr	strontium	
				I	iodine	
30 (P5)	greyish-violet tone, sample P5	Cu	copper	Ca	calcium	Azurite (2 $CuCO_3$ · $Cu(OH)_2$) mixed with lead white (2 $PbCO_3$· $Pb(OH)_2$) (and probably under-layer of lead white). The presence of iron could indicate the use of caput mortem, but SEM-EDX proved the purplish colour to be an organic lake.
		Pb	lead	Fe	iron	
				Sr	strontium	
31 (P4)	Virgin's blue garment, sample P4	Cu	copper	Re	rhenium	Layer of Azurite (2 $CuCO_3$ · $Cu(OH)_2$). The deep colour of the blue indicate that it is not blended with lead white (2 $PbCO_3$· $Pb(OH)_2$). The layer structure in sample P4 reveal under-layers of lead white mixed with a purple colour. The absence of iron suggest an organic lake, which was reinforced by the SEM-EDX.
		Pb	lead	Sr	strontium	
		Se?	Selen?			

32 (P7)	silver armour, helmet, sample P7	Ca Ag	calcium silver	Cu Pb Sr	copper lead strontium	Silver foil on calsiumbased ground layer (without bole), probably with a glaze that has worn away in places and caused oxidation of the silver. XRF-measurements are supported by the interpretations of sample P7.
33	degraded green grass	Pb, Se	lead selen	Ca Cu Sr	calcium copper strontium	Copper green. The presence of lead could indicate lead-tin yellow (Pb_2SnO_4).
33a	golden stencil (large flower)	Pb	lead	Au Fe Zn	gold iron zinc	Gold foil (probably not zwischgold) on red lead (Pb_3O_4). The pattern is different from that on the corpus and inner wings.
33b	silver stencil (small flower)	Pb Se	lead selen	Ag Fe Zn Sr	silver iron zinc strontium	Silver foil on red lead (Pb_3O_4). The measurements are supported by the built up of layers in the similar passage in sample P8.
34	yellow - faded red?, border (Gabriel)	Pb Cu	lead copper	Fe Ca Sr	iron calcium strontium	Red lead (Pb_3O_4) with a very degraded glaze? The source of the copper content is not apparent.
35	better preserved red over textile, border	Pb, Sr	lead stron-tium	Ca Ag Hg	calcium silver mercury	Red lead (Pb_3O_4) with a less degraded glaze. Possibly also traces of vermilion (HgS). The stencil in this location probably explains the presence of silver.
36 (P10)	dark grey-green, Gabriel's wing, sample P10	Pb Cu Se	lead copper selen	Fe Zn Sr Cd	iron zinc strontium cadmium	Fragmentary copper blue-grey. Possibly azurite ($2\ CuCO_3 \cdot Cu(OH)_2$) blended with lead white ($2\ PbCO_3 \cdot Pb(OH)_2$) and iron oxide (Fe_2O_3)? See layer P10 for layer structure.
37	green passage, Gabriel's drapery	Cu Pb, Sr	copper lead Stront-ium	Fe Rh	iron rhodium	Copper green has retained its colour well (and is adjacent to the area adhered by the textile).
38	golden star, right side of Gabriel	Pb Ca	lead calcium	Fe Ag Zn	iron silver zink	The visual examination and the XRF suggests that this probably is silver foil with yellow glace, and a lead containing layer underneath.