

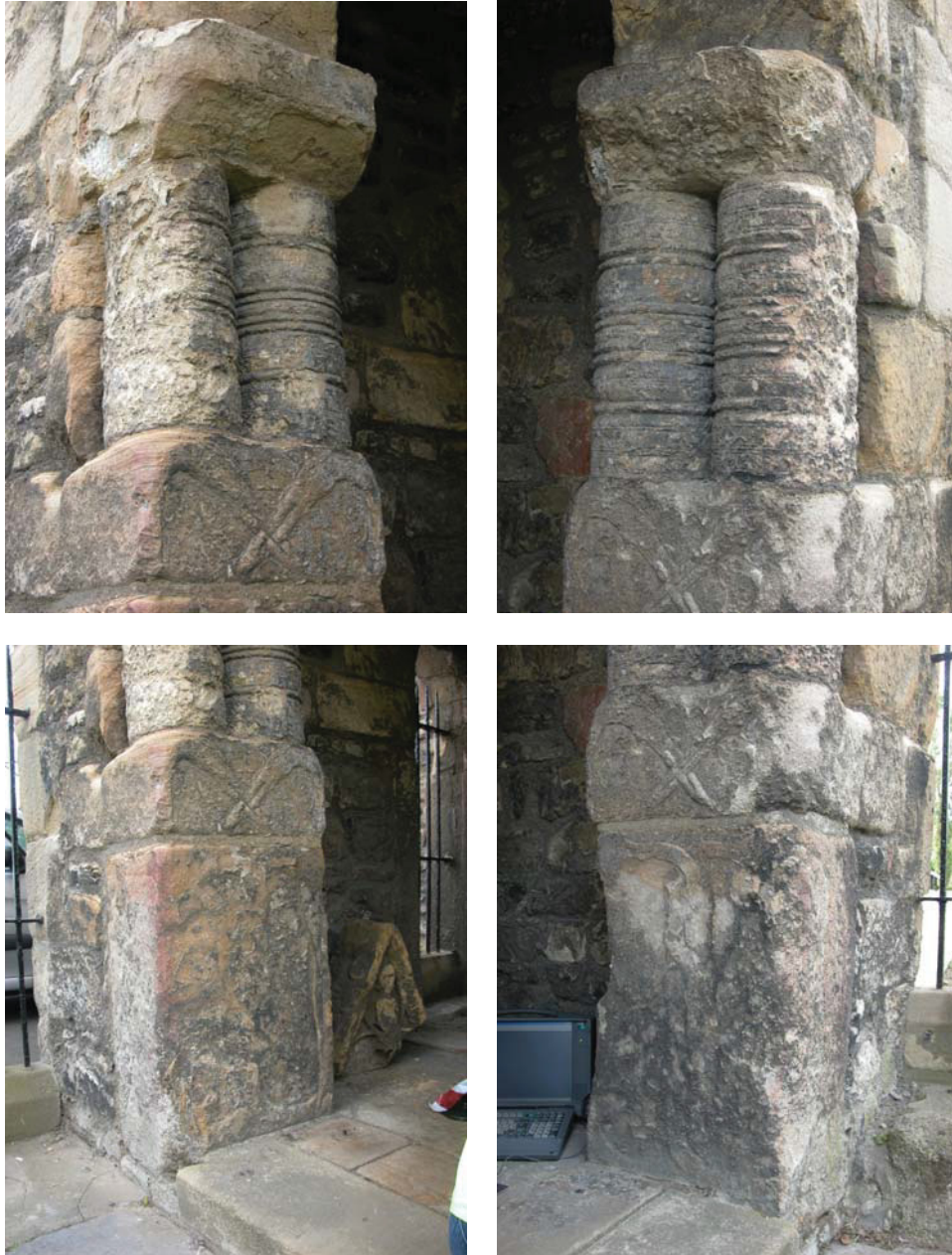


Conservation Technologies: 3D Scanning Metadata


Job	
<i>Job title:</i>	St Peter's Church (Wearmouth)
<i>Client:</i>	Durham University/Newcastle University
<i>Reason for scanning:</i>	Documentation of carvings before conservation work carried out. Possible repeat scanning in future and evaluation of surface loss. Carvings at risk.
<i>Deliverables:</i>	Raw scan data; polygon mesh model(s) (suitable for monitoring); digital photographs; metadata.
Object	
 	



Carved 7th-century stone reliefs in west porch of St. Peter's church, Wearmouth.

<i>Brief description:</i>	Badly eroded sandstone surfaces. Cobwebs removed as far as possible before scanning – some remained where stone very delicate. Evidence of previous consolidation work. Some areas of stone extremely friable.
<i>Approximate size (mm)</i>	Height of relief and baluster approx. 195cm Width of relief approx. 53cm Depth of relief approx. 32cm Left and right (as viewed from outside)
<i>Nature of surface:</i>	See above
<i>Level of detail:</i>	Sub- millimetre

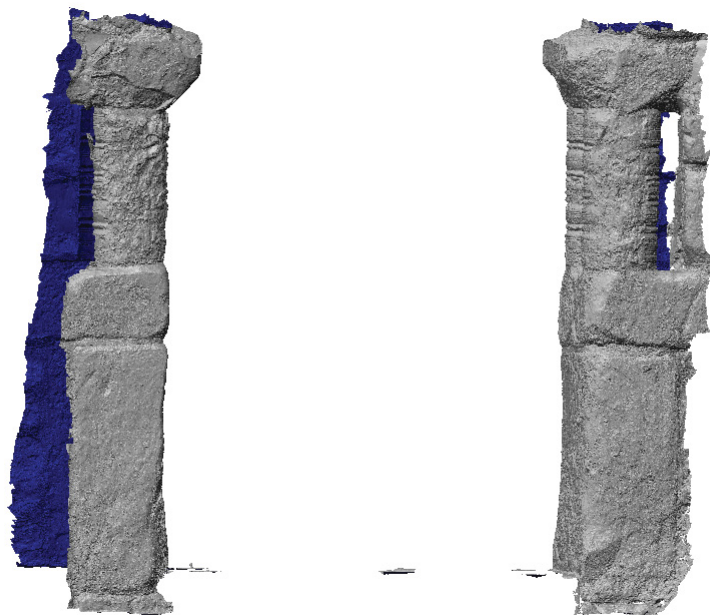
Scanning Process and Scanner Calibration Information			
<i>Location:</i>	St. Peter's church, St. Peter's Way, Sunderland, Tyne and Wear, SR6 0DY		
<i>Scanning set-up:</i>	Modelmaker on portable tripod		
<i>Lighting:</i>	Natural daylight; blankets/umbrellas used later in day to reduce ambient light. Porch facing west so ambient light more of a problem after late morning. Weather was sunny on day 1 and day 2 (am); cloudy day 2(pm) and day 3.		
<i>Carried out by:</i>	AL/MC		
<i>Date:</i>	27-29/07/2011		
<i>Scanner:</i>	ModelmakerX ¹		
<i>Sensor:</i>	X70		
Scanner Calibration			
<i>Arm calibration:</i>	2σ	0.0427mm	
	1) RMS (mm):	0.036	
	2) RMS (mm):	0.032	
	3) RMS (mm):	0.039	
<i>Sensor calibration:</i>	<i>Plane:</i>	<i>RMS (mm) (Probe):</i>	<i>RMS (mm) (Stripe):</i>
	1	0.0113	0.020
	2	0.008	0.023
	3	0.011	0.024
	4	0.010	0.017
	5	0.009	0.019
	<i>Distance:</i>		
	<i>Planes 1-3</i>	99.882	100.145
	<i>Planes 2-4</i>	94.888	95.061
	<i>Error:</i>		
	<i>Planes 1-3</i>	-0.204	0.059
	<i>Planes 2-4</i>	-0.184	-0.011
Sensor to arm calibration checks (Liverpool):			
<i>Corner (mm):</i>	RMS 1) 0.0227, RMS 2) 0.0305		
<i>Plane ov. plane (mm):</i>	RMS 1) 0.0326, RMS 2) 0.0305		
<i>Cross (mm):</i>	RMS 1) 0.0468, RMS 2) 0.0266		
<i>Parallel planes 1-3 (mm):</i>	RMS 1) NSP = 0.0468, SP = 0.0271, Dev. = -0.037		
<i>Parallel planes 2-4 (mm):</i>	RMS 2) NSP = 0.0373, SP = 0.035, Dev. = 0.017		
Sensor to arm calibration checks (On-Site):			
Not carried out – not possible in the scanning environment. Processing showed that the data collected was within tolerance of the above calibration.			

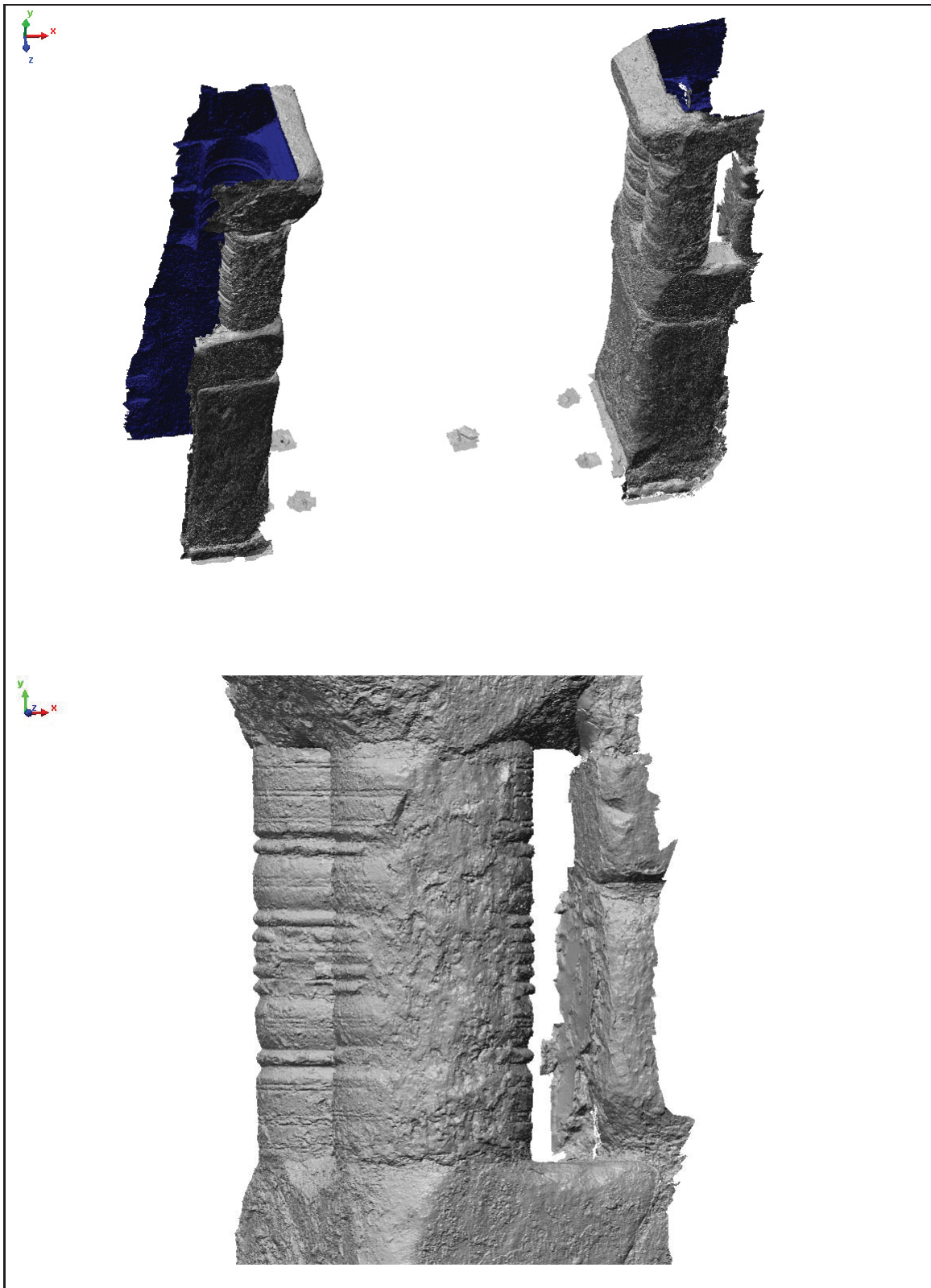
Scanning Parameters	
<i>Tripod:</i>	Faro portable (not glued); on solid stone floor
<i>Power source:</i>	Mains 240V
<i>Ambient threshold:</i>	Variable (~ 2.8 - 3.4)
<i>Laser power:</i>	Variable (~ 110-130)
<i>Stripe width:</i>	Wide
<i>Number of stations:</i>	<p>Three (ST1; ST2; ST3). See below for approx. positions. (Also witness sketch in paper file).</p> <div style="text-align: center;">  </div>
<i>File names:</i>	<p>wm st1a/1b/1c/1d/1e/1f/1g wm st2a/2b/2c/2d/2e/2f/2g/2h/2i/2k/2l/2m/2n/2o/2p wm st3a/3b/3c</p> <p>Approximately, 178 million points were collected during data capture.</p>
<i>File format:</i>	SAB2

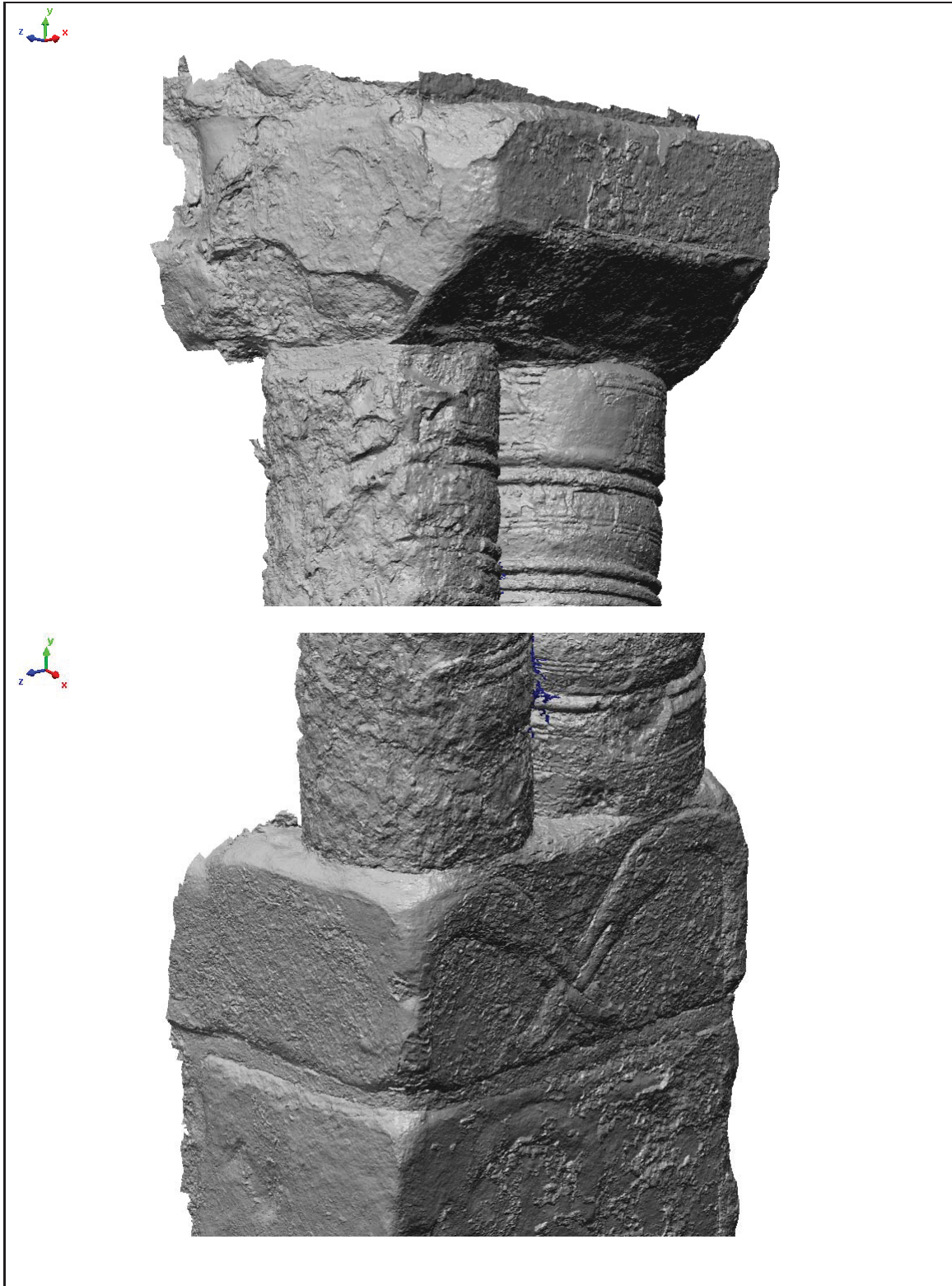
Post-Processing	
<i>Carried out by:</i>	AL
<i>Software used:</i>	Polyworks v11, RF2006
IMAlign Parameters:	
<i>Max. distance (mm):</i>	1.8
<i>Int. step (mm):</i>	0.3 (applied in Modelmaker software)
<i>Max. angle (°)</i>	89
<i>Comp. distance (mm)</i>	2.5, 1, 0.15, and 0.09
<i>Overlap red. (mm)</i>	Applied during meshing – see below
IMMerge Parameters	
N.B. The two pillars were meshed, compressed and hole filled separately, but using the same parameters. Once mesh editing was complete they were merged and the final compression was applied.	
<i>Max. distance (mm):</i>	1.8
<i>Int. step (mm):</i>	0.3
<i>Standard dev. (mm):</i>	0.042
<i>Smoothing level:</i>	Low
<i>Smoothing rad. (mm):</i>	0.6
<i>Smoothing tol. (mm):</i>	0.13
<i>Reduction tol. (mm):</i>	0.0099
<i>Mesh polygon count:</i>	South side = 50 million North side = 47.5 million
<i>IMCompress tol (mm):</i>	0.05 (South side = 12 million, North side = 13 million) 0.06 (South side = 7.9 million, North side = 8.3 million)
<i>Deletion of poor data:</i>	-
<i>Merging:</i>	In IMEdit of South and North side.
<i>Hole filling:</i>	All holes with less than 30 edges were filled automatically. (Wearmouth - autoHF only-13-6 mill.STL) Further hole filling was carried out using IMEdit. There is one hole for which there is some hold filling documentation in the images folder. It concerns an area of fill on the right (north side).
<i>Ab. faces cleaned:</i>	Yes.
<i>Compression tol (mm):</i>	0.084 on merged mesh (9.7 million in complete model) 0.1 to create a lower resolution viewing file (7.4 million polygons) 0.12 to create a low resolution viewing file (5.8 million polygons)
<i>Processing procedure:</i>	Registration, alignment, meshing, compression, hole filling and compression. ²

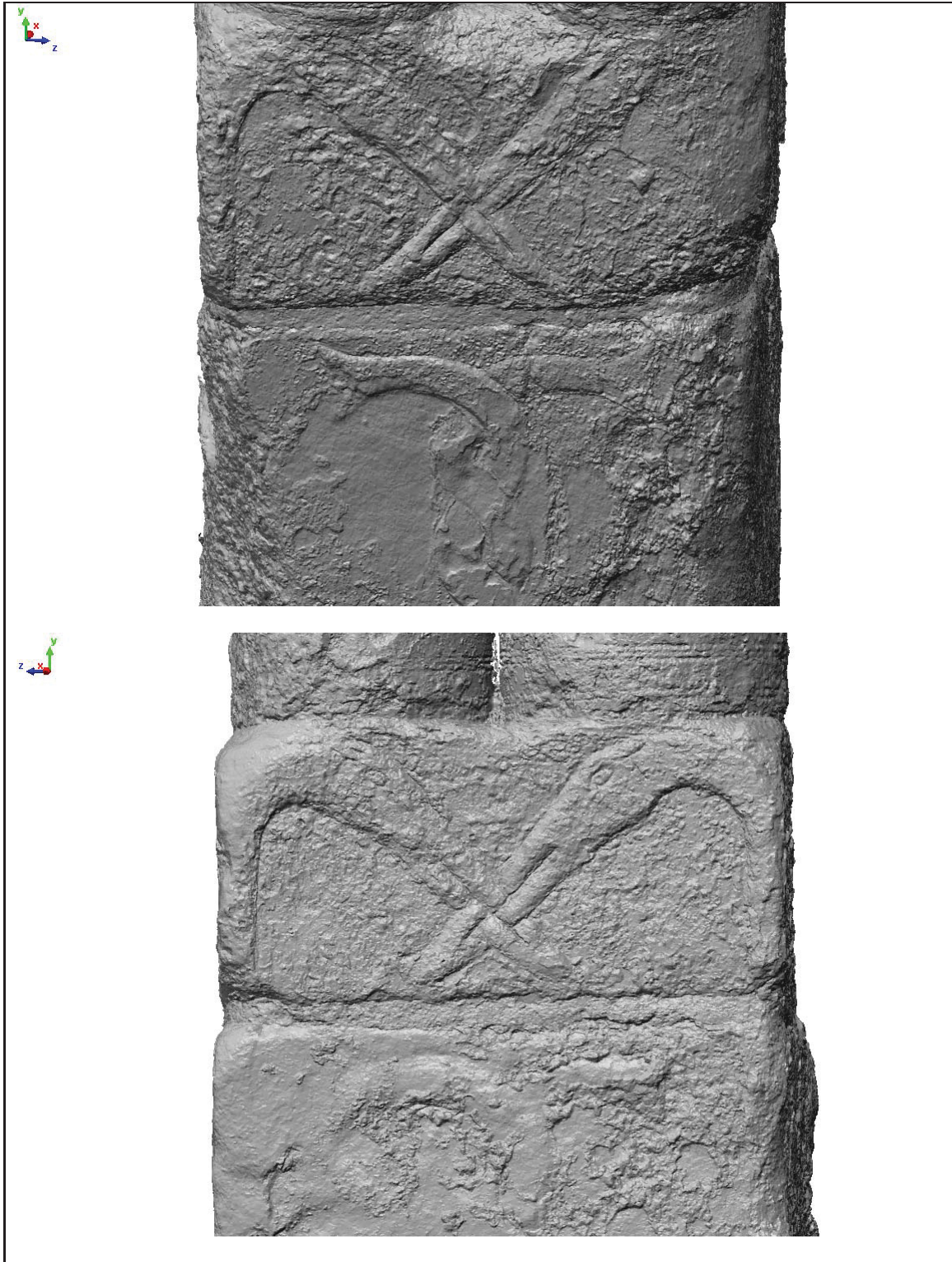
	<p>Complete filenames with description:</p> <p>Wearmouth - autoHF only-13-6 mill.STL All holes with less than 30 edges filled automatically.</p> <p>Wearmouth - Complete-HF-5-8 mill.STL All fill that can be filled are filled – low resolution mesh.</p> <p>Wearmouth - Complete-HF-7-4 mill.STL All fill that can be filled are filled – medium resolution mesh.</p> <p>Wearmouth - Complete-HF-9-7 mill.STL All fill that can be filled are filled – medium resolution mesh.</p> <p>Wearmouth - Complete-HF-14 mill.STL All fill that can be filled are filled – high resolution mesh.</p>
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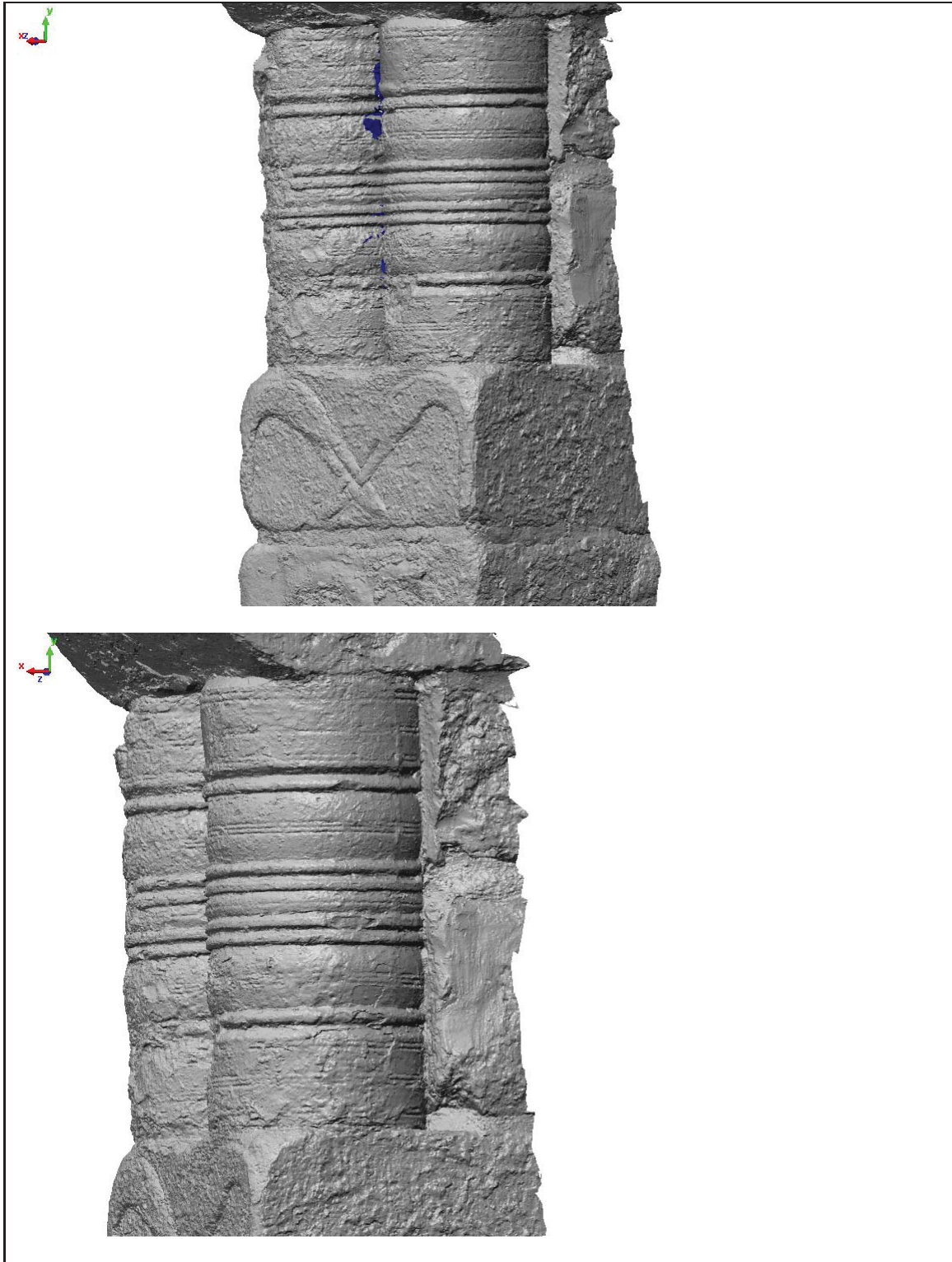
Images:

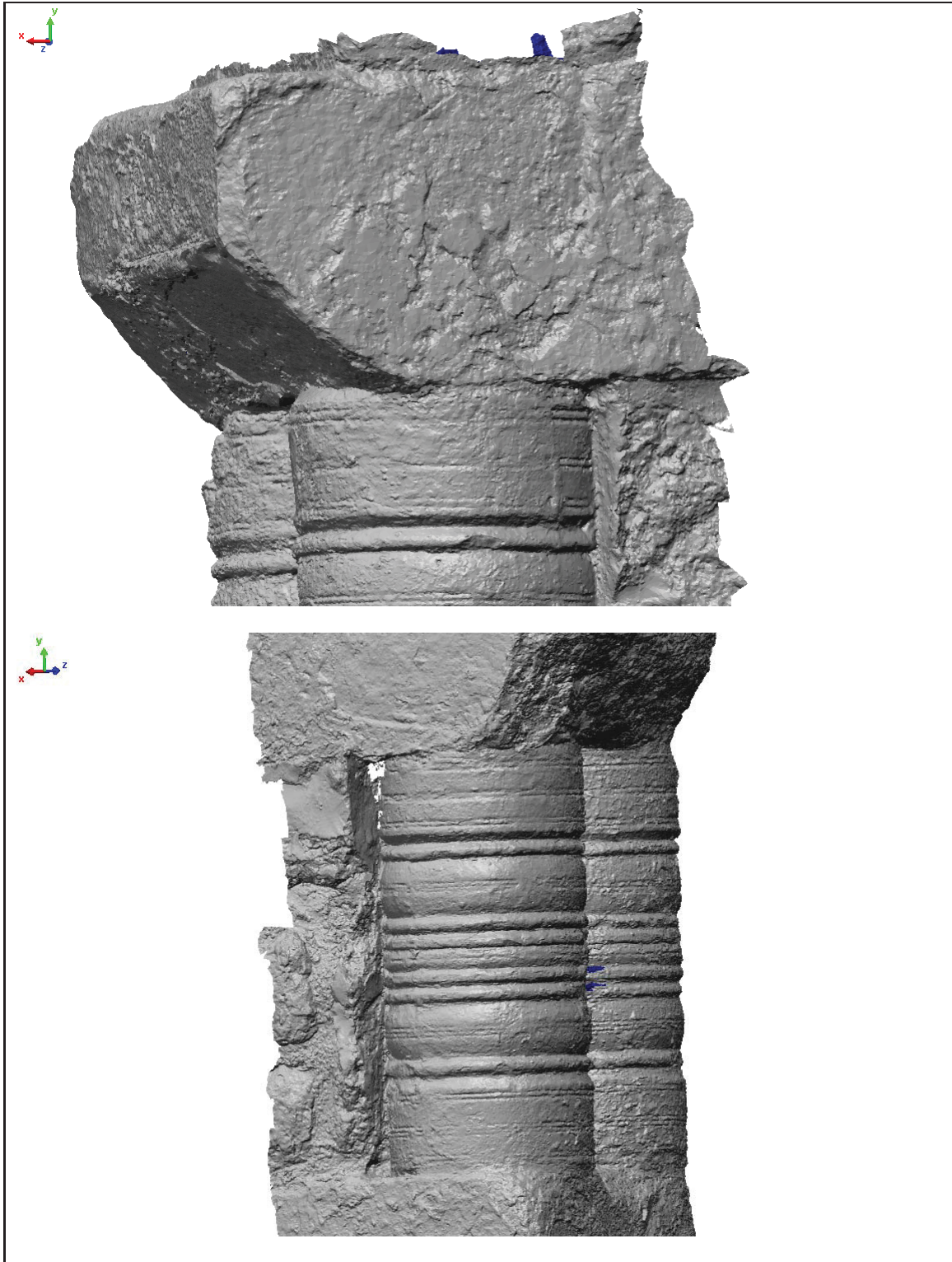


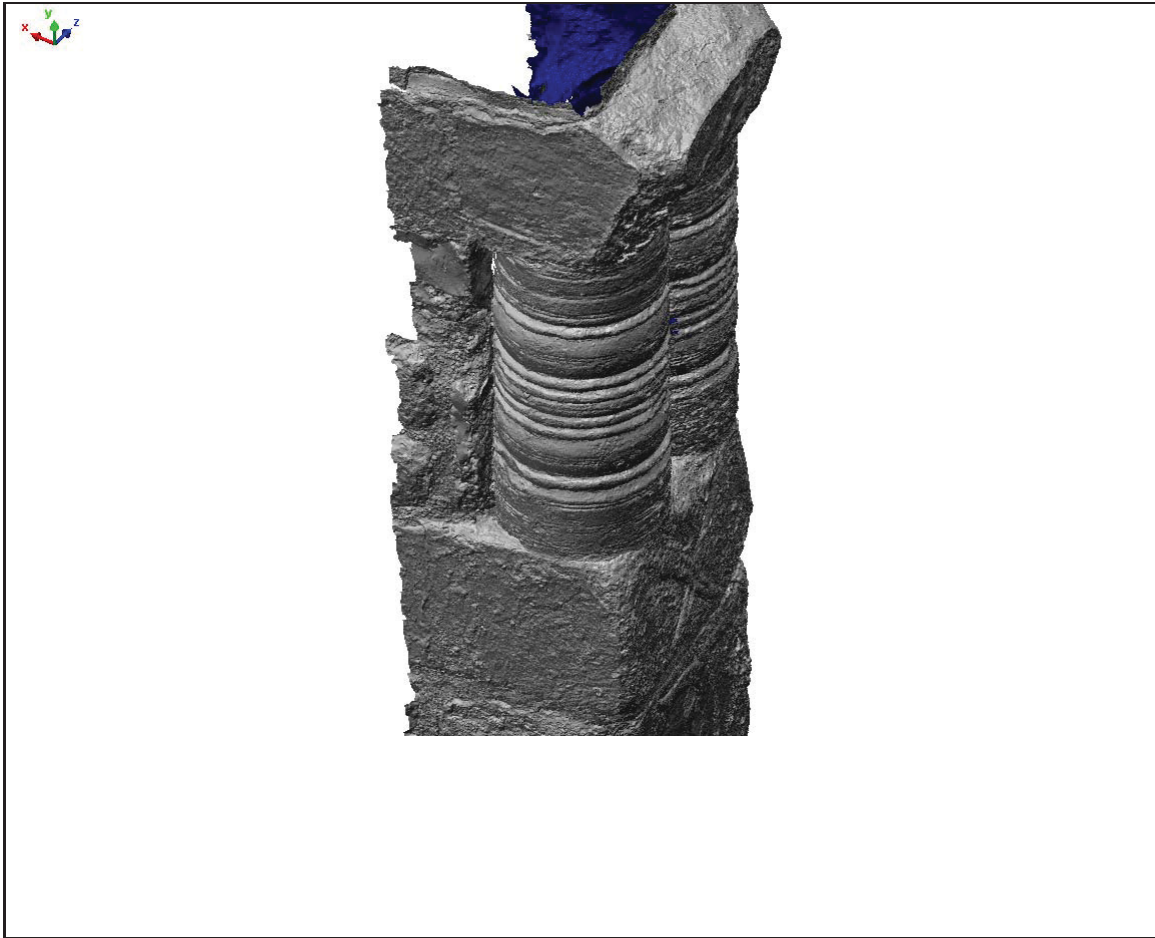












Data Storage			
Raw data CDs:	Number: 1327, 1328, 1329, 1330, 1331, 1332, 1333, 1334	Off Site	Z Drive
Images CDs:	Number: 1334 and 1337	Off Site	Z Drive
Metadata DVD:	Number: 1337	Off Site	Z Drive
Model file names:	<p>Wearmouth - autoHF only-13-6 mill.STL All holes with less than 30 edges filled automatically.</p> <p>Wearmouth - Complete-HF-5-8 mill.STL All fill that can be filled are filled – low resolution mesh.</p> <p>Wearmouth - Complete-HF-7-4 mill.STL All fill that can be filled are filled – medium resolution mesh.</p> <p>Wearmouth - Complete-HF-9-7 mill.STL All fill that can be filled are filled – medium resolution mesh.</p> <p>Wearmouth - Complete-HF-14 mill.STL All fill that can be filled are filled – high resolution mesh.</p>		
Format:	STL		
Complete data DVD:	Number: 1337	Off Site	Z Drive
Client copy sent to:	Sarah Semple Department of Archaeology Durham University South Road, Durham, DH1 3LE.		
Date:	22/09/2011		
Signed off by:	AL		

¹ *The Modelmaker X laser scanning system comprises a 3DScannersUK Ltd.¹ (now Metris) 3D laser scanning sensor mounted on a seven axis Faro Technologies Ltd. 'Gold' measuring arm. The scanner uses the principle of triangulation to record the surface as a thin stripe of laser light is scanned over the object. The length (maximum) of the stripe emitted from the sensor during scanning was 100mm. The distance between measured points along the stripe is 0.10mm. The distance between stripes is dependent on the speed at which the operator moves the sensor over the surface, and on how many times the sensor is passed over a given area. The scanning system captures 27 000 points per second. The accuracy of the system is approximately $\pm 0.1\text{mm}$. Actual accuracy will depend on the nature of the surface of the object and scanning conditions. Calibration checks were carried out to check the scanner was performing within specification (see above)*

² *The raw point data was sampled with a point spacing of 0.3mm prior to registration and alignment. The 2σ value (average error) of the alignment was 0.042mm. The two pillars were meshed, compressed and hole filled separately, but using the same*

parameters. Once mesh editing was complete they were merged and the final compression was applied. The aligned point cloud was meshed using the parameters detailed above, and the resulting polygon models comprised 47.5 + 50 million polygons. Compression gave model comprising 7.9 + 8.3 million polygons. Automatic hole filling was undertaken in PWv11 on all holes less than 30 edges in size. All other holes that were filled were filled manually. The completed models were merged and further compression gave models of 9.4million, 7.4 and 5.8 million polygons. The models provided are listed above.