



Beamline: ID13	Experiment title: Identification of 2000 year old textile fibres from the cave of Letters by X-ray microdiffraction	Experiment number: ME-655
	Date of experiment: from: 1/3/04 to: 5/03/04	Date of report: 28/02/05
	Shifts: 9	Local contact(s): Manfred Burghammer
Names and affiliations of applicants (* indicates experimentalists): *Prof. Dr. Martin MUELLER, Kiel University, Germany *Dr. Jan GUNNEWEG, The Hebrew University of Jerusalem, Israel Dr. Bridget MURPHY, Kiel University, Germany *Dr Emmanuel PANTOS, Daresbury Laboratory, UK *Dr Manfred BURGHAMMER, ESRF, ID13 Prof. Howell G. M. EDWARDS, Bradford University, UK Dr Irina SNIGIREVA, ESRF		

Report:

The aim of the experiment was to identify textile fibres found in the “Cave of Letters” (CoL) in the Dead Sea region [1]. The Cave of Letters is called so because of the find of the Bar Kochba (last freedom fighter) letters in the second revolt of the Jews against the Romans around 135 AD. The cave is located on the northern cliff-face of Nahal Hever and is some 150 meters long. The last Jews used the cave as habitat. Nahal Hever is 1/5th the distance between En Gedi and Masada, and about three kilometres West of the Dead Sea. The CoL textiles are unique of second century AD only. Wool and linen and all kind of garments were found, sometimes even near-complete tunics. From the archaeological point of view, the study of these textiles will be without any doubt of great importance for what the Romans and the Jews wore in the second century AD and where they got the materials from.

The cliffs where the CoL is located are the continuation of the Qumran cliffs. Textiles from the caves of Qumran have been previously investigated at the Microfocus Beamline ID13 in a short test experiment (see Experimental Report CH-929). The microdiffraction results obtained complemented microscopic investigations and standard X-ray diffraction and led to the unambiguous identification of flax (linen) and – most unexpectedly for archaeologists – cotton textiles [2,3]. An ESRF press release 25/03/2004 [4] also has related material for the benefit of the public, scientific and lay.

Although thorough analysis of the data is still in progress, while waiting for the completion of SEM/EDX analysis of the fibres used in these experiment (I. Snigireva, ESRF) and interpretation, preliminary conclusions were reported at the recently held “SR in Art and Archaeology” (SR2A) conference in Grenoble, 9-11 Feb 05 (presentation can be viewed on the web at [5]).

Briefly, some fibres from CoL are suprisingly well preserved (Fig.1), while others (some from Qumran as well) show distinct signs of degradation, as judged from comparison of the WAXS patterns with modern standards. Most fibres are dyed wool, only a few colourless bast fibres were found.

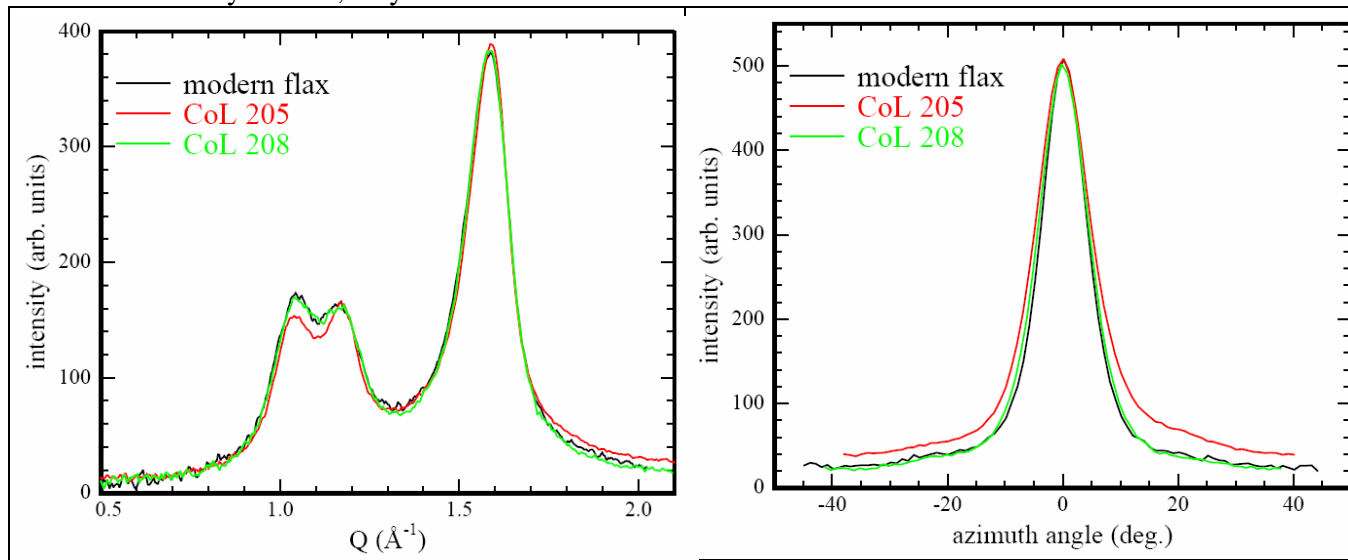


Fig.1. Q and Azimuth integrated patterns for two CoL fibres compared with modern flax.

More significantly perhaps, micro-XRF spectra taken simultaneously with the micro-XRD patterns, show presence of elements (Cu, Zn, Fe, and Mn in some cases), Fig.2 and Tab. 1, that were not expected at such high concentrations on the basis of what might be expected in textile fibres, whether dyed or not.

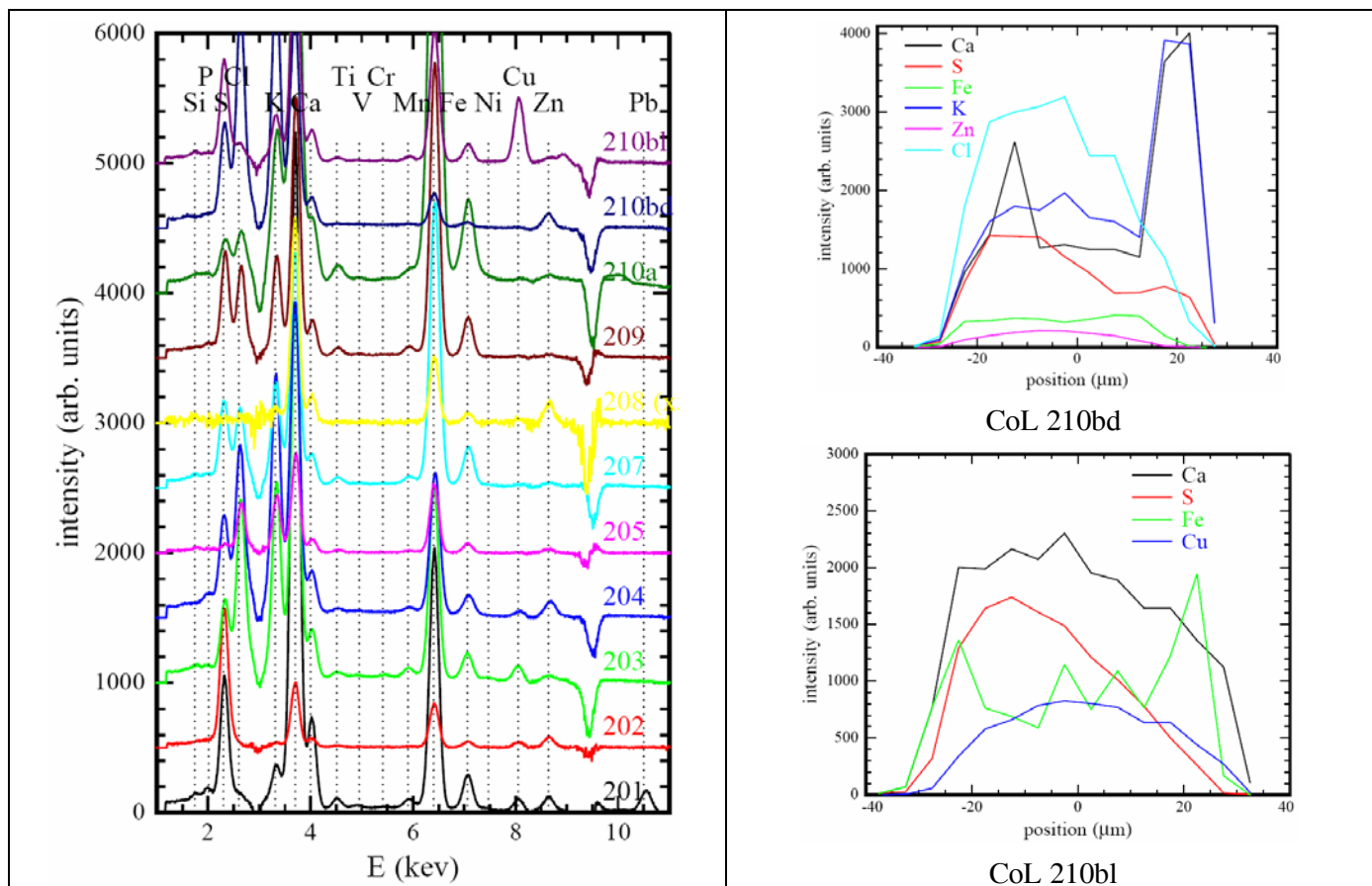


Fig. 2. Left: XRF spectra of CoL textiles. Right: Local elemental distribution profiles for two of the fibres (scans across single fibres).

At this point in time, it would be prudent not to rush into conclusions. It is clear though that further work is needed to a) study further the state of degradation of some of the fibres compared with modern standards using combined WAXS/SAXS and b) to pursue further the molecular nature of the dyes on those of the fibres that are coloured, whether flax or wool, from Qumran or from the CoL using XRF/XANES and possibly also FTIR as most of the dyes are very likely to be non-crystalline materials, non-detectable by XRD and not recognizable by XRF alone.

References

- [1] Y. Yadin. The Finds from the Bar Kochba Period in the Cave of the Letters, The Israel Exploration Society, Jerusalem (1963). See also <http://www.uwec.edu/col/> (site of providers of CoL samples).
- [2] M. Müller, M. Z. Papiz, D. T. Clarke, M. A. Roberts, B. M. Murphy, M. Burghammer, C. Riekel, E. Pantos, and J. Gunneweg. Identification of the textiles from Khirbet Qumran using microscopy and synchrotron radiation x-ray fibre diffraction. In: Jean-Baptiste Humbert and Jan Gunneweg, editors, *Archaeological Excavations at Khirbet Qumran and Ain Feshka - Studies in Archaeometry and Anthropology*, volume II, chapter XII, pages 177-186. Presses Universitaires de Fribourg (Suisse), Fribourg, in press. <http://srs.dl.ac.uk/arch/publications/qumran-textiles-micro-xrd.pdf>.
- [3] M. Müller, M. Z. Papiz, D. T. Clarke, M. A. Roberts, B. M. Murphy, M. Burghammer, C. Riekel, E. Pantos and J. Gunneweg, Identification of ancient textile fibres from Khirbet Qumran caves using synchrotron radiation microbeam diffraction, *Spectrochimica Acta B* (2004), 59(19-11):1669-1674, 2004.
- [4] ESRF Press Release: 25/03/2004 Unravelling the threads of history at the ESRF, <http://srs.dl.ac.uk/arch/what-the-papers-say/Unravelling-the-threads-of-history.htm>
- [5] <http://srs.dl.ac.uk/arch/talks/Mueller-SR2A-Feb05.htm>

name	type	colour	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Pb
201	wool	br. red	o	o	++		+	++	+	o	o	+	++		+	+	+
204	wool	br. red		+	++	++	++	++	o			o	++		+	+	
207	wool	brown	o	o	++	++	++	++	+	o		+	++			o	
209	wool	brown		o	++	++	++	++	+	o		+	++		o	o	
210a	wool	brown	o	o	++	++	++	++	+	o		o	+++		o	o	
202	wool	dk. blue			++		o	++	+				++		+	+	
210bd	wool	dk. blue			++	++	++	++	o			o	+		o	+	
210bl	wool	lt. blue	o	o	++	+	+	++	+	o	o	+	++		++	+	
203	wool	black	o	o	++	++	++	++	+	o	o	+	++	o	+	+	
205	bast	native	o		o	++	++	++	+			o	++			+	
207	bast	native					o	++					++		o	+	
key33	bast	native					o	++				+	++			+	
key3	cotton	native		o	o	++	o	++	o			+	++			+	
na1	bast	native			o	o		++	o			o	++				
na2	bast	native						++					++				
shroud	?		++				++	+	+	+			+++		+	+	
qum535c	cotton	native						++					++	++	o	+	
qum535d	skin?		o	o	+	o	+	++	+	o	o	o	++	++	+	+	
qum535e	cell. IV	native		o	+	o	+	++					++	++	+	o	
flax	bast	bleached						++				o	+				
linen	bast	bleached						+							o	+	
jute	bast	native					+	+	o				+				
ramie	bast	bleached					+	o									
ramie	bast	native						+	o				+				
ramie	bast	ecrue						+	o				+				

Table 1: Elemental analysis of archaeological fibres and modern standards with micro-XRF on single fibres. Relative abundance of elements found varies from very strong XRF signals (+++) over ++ and + to small traces (o).