minerals

MDPI

Supplementary Materials

Invasive and Non-invasive Analyses of Ochre and Iron-based Pigment Raw Materials: A Methodological Perspective

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Table S1. EDXS data compared with ICP-OES (major) data for 5 geologic samples (powder pellets). Contents in major elements were normalised to 100% by using a conventional list of elements (ICP-OES data). The relative difference (ICP-OES data used as references) is higher than 10% for the three major elements Si, Fe, Al when their concentration is higher than 6%, and higher than 25% when lower.

	14043a				**14050b**				**14696c**				**14697a**				**14699a**			
Oxide	**EDXS**		**ICP-OES**		**EDXS**		**ICP-OES**		**EDXS**		**ICP-OES**		**EDXS**		**ICP-OES**		**EDXS**		**ICP-OES**	
	AVG	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**	**AVG**	**SD**
SiO_2	**55.9**	0.6	**55.6**	0.6	**46.5**	0.1	**46.6**	0.5	**55.8**	0.3	**58.0**	0.5	**2.5**	0.1	**2.0**	2.6	**17.7**	0.2	**17.5**	0.2
Al_2O_3	**25.0**	0.2	**25.5**	0.3	**26.2**	0.1	**26.3**	0.3	**27.0**	0.3	**26.5**	0.2	**4.0**	0.4	**3.4**	0.1	**17.7**	0.2	**17.2**	0.9
Fe_2O_3	**11.0**	0.3	**10.9**	0.2	**16.7**	0.1	**17.0**	0.3	**6.0**	0.2	**5.1**	0.1	**89.7**	0.4	**91.5**	1.8	**60.4**	0.4	**61.8**	1.2
MnO	**nd**	-	**0.062**	0.003	**0.1**	0.1	**0.113**	0.006	**nd**	-	**0.003**	0.001	**nd**	-	**0.020**	0.001	**nd**	-	**0.008**	0.001
MgO	**0.9**	0.1	**0.8**	0.1	**1.2**	0.1	**1.0**	0.1	**2.1**	0.2	**1.8**	0.1	**0.5**	0.1	**0.3**	0.1	**0.2**	0.1	**0.2**	0.1
CaO	**0.1**	0.1	**<L.D.**	-	**0.3**	0.1	**<L.D.**	-	**0.1**	0.1	**0.0**	-	**0.2**	0.1	**0.2**	-	**nd**	-	**<L.D.**	-
Na_2O	**0.5**	0.1	**0.4**	0.1	**0.8**	0.1	**0.4**	0.1	**2.4**	0.3	**2.0**	-	**0.4**	0.1	**0.2**	-	**0.2**	0.1	**<L.D.**	-
K2O	**5.0**	0.1	**5.1**	0.1	**6.3**	0.1	**6.4**	0.1	**5.7**	0.1	**5.4**	0.1	**0.1**	0.1	**0.1**	-	**0.4**	0.1	**0.4**	0.1
TiO_2	**1.1**	0.1	**1.4**	0.1	**1.3**	0.1	**1.7**	0.1	**1.0**	0.1	**1.1**	0.1	**0.0**	nd		-	**0.1**	0.1	**0.1**	0.1
P_2O_5	**0.4**	0.1	**0.3**	0.1	**0.5**	0.1	**0.3**	0.1	**0.0**	0.1	**0.1**	-	**2.5**	0.1	**2.1**	-	**3.3**	0.1	**2.8**	0.3
Total	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-

AVG : average ; SD : standard deviation ; nd :not detected ; L.D.: detection limit.

Table S2. Comparison of PIXE data with ICP-OES (major) and ICP-MS (traces) results for 5 geologic samples (powder pellets). Contents in major elements were normalised to 100% by using a conventional list of elements (ICP-OES data). The relative difference was calculated by using ICP values as references. In red: relative diff. >10% for major elements; >25% for trace elements.

Oxide/element		14043a			14050b			14696c			14697a			14699a		
		ICP	PIXE	Relative Diff.	ICP	PIXE	Relative Diff.	ICP	PIXE	Relative Diff.	ICP	PIXE	Relative Diff.	ICP	PIXE	Relative Diff.
SiO_2	%	55.6	54.6	**1.7**	46.6	46.8	**−0.5**	58.0	56.5	**2.7**	2.0	2.2	**−8.8**	17.5	18.4	**−5.5**
Al_2O_3	%	25.5	26.9	**−5.6**	26.3	26.5	**−0.7**	26.5	28.5	**−7.4**	3.4	3.7	**−9.7**	17.2	18.3	**−6.3**
Fe_2O_3	%	10.9	10.6	**3.1**	17.0	16.8	**1.5**	5.1	5.0	**2.6**	91.5	91.3	**0.2**	61.8	60.1	**2.7**
MnO*	%	0.1	0.1	**6.8**	0.1	0.1	**16.4**	0.01	nd	**-**	0.01	n.d.	**-**	0.01	nd	**-**
MgO	%	0.8	0.7	**8.9**	1.0	0.9	**10.9**	1.8	1.5	**16.3**	0.3	0.3	**1.6**	0.2	0.2	**18.6**
CaO	%	<L.D.	0.1	**-**	0.2	0.3	**−49.0**	0.0	0.1	**−78.7**	0.2	0.2	**24.6**	<L.D.	0.0	**-**
Na_2O	%	0.4	0.4	**−0.7**	0.4	0.5	**−12.6**	2.0	1.9	**3.3**	0.2	0.3	**−59.0**	<L.D.	0.1	**-**
K_2O	%	5.1	5.0	**2.2**	6.4	6.1	**3.3**	5.4	5.5	**−2.0**	0.1	0.1	**−0.1**	0.4	0.4	**6.2**
TiO_2	%	1.4	1.4	**−1.0**	1.7	1.7	**−2.2**	1.1	1.1	**−0.3**	0.0	0.0	**6.0**	0.1	0.1	**25.3**
P_2O_5	%	0.3	0.3	**10.4**	0.3	0.3	**9.6**	0.1	nd	**-**	2.1	1.8	**14.3**	2.8	2.4	**12.8**
Total	%	100.0	100.0	**-**	100.0	100.0	**-**	100.0	100.0	**-**	100.0	100.0	**-**	100.0	100.0	**-**
As	ppm	40.8	39.3	**3.6**	85.3	80.7	**5.4**	1.6	nd	**-**	36.2	35.0	**3.4**	41.8	39.3	**5.9**
Ba	ppm	618.2	660.3	**−6.8**	738.8	608.3	**17.7**	648.3	598.7	**7.7**	437.2	441.0	**−0.9**	52.5	nd	**-**
Cr	ppm	105.2	71.0	**32.5**	171.7	130.3	**24.1**	96.53	109.0	**−12.9**	21.67	nd	**-**	102.7	98.0	**4.6**
Cu	ppm	32.5	19.0	**41.6**	24.3	17.0	**30.0**	8.3	11.3	**−36.1**	15.2	19.3	**−27.1**	56.7	45.0	**20.7**
Ga	ppm	39.7	31.7	**20.3**	45.4	37.0	**18.6**	34.0	26.7	**21.6**	1.7	5.0	**−190.9**	3.8	4.5	**−16.9**
Nb	ppm	25.1	25.3	**−1.0**	29.9	34.3	**−14.7**	18.2	17.0	**6.5**	0.5	nd	**-**	1.1	nd	**-**
Ni	ppm	25.7	36.0	**−39.9**	22.5	32.3	**−43.8**	9.8	27.7	**−181.0**	32.5	60.3	**−85.9**	27.7	25.7	**7.4**
Pb	ppm	52.3	49.7	**5.0**	70.9	67.3	**5.1**	7.9	8.5	**−7.7**	5.8	nd	**-**	30.3	25.0	**17.6**
Rb	ppm	184.7	183.0	**0.9**	221.8	232.0	**−4.6**	279.8	291.0	**−4.0**	5.0	5.0	**−1.0**	14.9	12.7	**15.2**
Sr	ppm	151.6	147.0	**3.0**	194.7	201.3	**−3.4**	67.7	69.7	**−3.0**	47.3	55.0	**−16.2**	6.6	8.0	**−21.4**
Th	ppm	25.1	21.7	**13.6**	27.9	26.7	**4.4**	28.0	24.7	**11.7**	7.5	nd	**-**	3.0	nd	**-**
V	ppm	102.6	169.5	**−65.2**	138.4	215.0	**−55.3**	101.0	nd	**-**	6.9	nd	**-**	15.9	35.5	**−122.7**
Y	ppm	57.4	50.0	**12.9**	71.2	73.7	**−3.5**	38.9	36.7	**5.8**	6.6	5.0	**23.7**	7.2	6.0	**16.9**
Zr	ppm	476.7	438.7	**8.0**	338.6	333.7	**1.5**	207.5	204.0	**1.7**	16.7	18.0	**−7.7**	16.4	16.3	**0.2**
Zn	pp	70.5	48.	**30.9**	83.	64.	**23.4**	56.	38.	**32.3**	24.	25.	**−2.3**	55.1	39.	**28.6**

m	7		5	0		1	0		4	0		3

Diff.: difference; nd: not detected.

Table S3. Detailed results of SEM-EDXS analyses of archaeological samples (surface and section).

Sample	Mode	Analysis	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	K_2O	CaO	TiO_2	V_2O_5	MnO	Fe_2O_3	ZrO	*Total*
13681 (shale)	**Surface**	AVERAGE	1.2	2.1	**20.6**	**52.4**	4.5	1.9	nd	5.5	1.9	1.0	nd	0.1	**9.4**	0.1	*99.6*
		SD	0.4	0.3	**1.8**	**5.8**	2.5	1.6	-	0.7	0.4	0.2	-	0.1	**5.1**	0.3	-
	Section	1 (edge)	0.3	0.7	**18.5**	**69.6**	1.1	nd	nd	3.7	0.5	0.9	nd	nd	**4.5**	nd	99.8
		2	0.3	0.8	**19.9**	**66.6**	1.2	nd	nd	4	0.4	1.2	nd	nd	**5.2**	nd	99.8
		3	0.3	0.8	**20**	**67.2**	1.1	nd	nd	4.3	0.4	0.9	nd	nd	**4.7**	nd	99.8
		4	0.3	0.8	**19.6**	**68.2**	1	nd	nd	4	0.4	0.8	nd	nd	**4.7**	nd	99.8
		5	0.4	0.9	**19**	**67**	1.2	nd	nd	4.4	0.4	1.4	nd	nd	**5.3**	nd	99.8
		6	0.5	1.1	**21.8**	**61.9**	1.3	nd	nd	5.1	0.4	1.3	nd	nd	**5.9**	0.6	99.7
		7	0.3	0.7	**20.1**	**68.4**	0.8	nd	nd	4.1	0.2	0.6	nd	nd	**4.7**	nd	99.8
		8	0.3	0.7	**21.6**	**66.5**	1.1	nd	nd	4.1	0.3	0.9	nd	nd	**4.3**	nd	99.7
		9	0.2	0.4	**15.8**	**76.4**	0.5	nd	nd	2.2	0.2	1	nd	nd	**3.2**	nd	99.8
		10	0.4	0.9	**20.4**	**65**	1.4	nd	nd	4.7	0.4	1	nd	nd	**5.1**	0.4	99.7
		11	0.3	0.8	**18.1**	**70.7**	1.3	nd	nd	3.4	0.4	0.8	nd	nd	**3.8**	nd	99.6
		12 (edge)	0.3	0.7	**19.2**	**69**	1.5	nd	nd	3.1	0.4	1.6	nd	nd	**3.6**	nd	99.6
		AVERAGE	*0.3*	*0.8*	***19.5***	***68.0***	*1.1*	-	-	*3.9*	*0.4*	*1.0*	-	-	***4.6***	*0.1*	*99.7*
		SD	*0.1*	*0.2*	***1.6***	***3.5***	*0.3*	-	-	*0.8*	*0.1*	*0.3*	-	-	***0.8***	*0.2*	-
		MAX	*0.5*	*1.1*	***21.8***	***76.4***	*1.4*	-	-	*5.1*	*0.5*	*1.4*	-	-	***5.9***	*0.6*	-
		MIN	*0.2*	*0.4*	***15.8***	***61.9***	*0.5*	-	-	*2.2*	*0.2*	*0.6*	-	-	***3.2***	*nd*	-
13690 (ferr)	**surface**	AVERAGE	3.4	3.1	**4.2**	**16.3**	0.5	0.2	nd	3.2	0.6	0.6	nd	nd	**66.9**	nd	98.9
		SD	1.2	1.2	**1.1**	**3.6**	0.2	0.1	-	1.0	0.2	0.2	-	-	**7.1**	-	-
	section	1 (edge)	0.5	1.4	**5.1**	**26.2**	0.2	nd	nd	1.8	0.1	1.0	0.1	nd	**63.1**	nd	99.5
		2	0.5	1.2	**4.9**	**24.0**	0.2	nd	nd	1.7	0.1	0.8	nd	nd	**66.2**	nd	99.5
		3	0.4	1.0	**4.7**	**26.7**	0.2	nd	nd	1.5	0.1	0.6	0.2	nd	**64.1**	nd	99.5
		4	0.4	1.0	**4.9**	**24.4**	0.2	nd	nd	1.5	0.1	0.7	0.1	nd	**66.1**	nd	99.5
		5	0.5	1.0	**5.1**	**24.9**	0.2	nd	nd	1.5	0.1	0.7	nd	nd	**65.4**	nd	99.5
		6	0.5	1.3	**5.8**	**22.5**	nd	nd	nd	1.4	0.1	0.6	0.1	nd	**66.9**	nd	99.4
		7	0.5	1.1	**4.9**	**22.5**	0.2	nd	nd	1.3	nd	0.6	0.1	nd	**68.2**	nd	99.4
		8	0.4	1.1	**4.8**	**22.7**	0.2	nd	nd	1.4	0.1	0.6	nd	nd	**68.1**	nd	99.4
		9	0.5	1.4	**5.9**	**27.3**	0.3	nd	nd	1.7	0.1	0.7	nd	nd	**61.6**	nd	99.5
		10	0.4	1.0	**4.8**	**30.2**	nd	nd	nd	1.4	0.1	0.7	nd	nd	**60.8**	nd	99.5
		11	0.2	1.0	**4.9**	**32.0**	0.2	nd	nd	1.5	0.1	0.8	0.2	nd	**58.8**	nd	99.7
		12	0.3	1.4	**5.7**	**30.9**	0.3	nd	nd	1.6	0.1	0.8	0.1	nd	**58.5**	nd	99.6
		13 (edge)	0.3	1.2	**5.0**	**28.8**	0.3	nd	nd	1.6	0.1	0.8	nd	nd	**61.6**	nd	99.7
		14 (edge)	0.4	1.1	**4.7**	**27.5**	nd	nd	nd	1.4	0.1	0.7	0.2	nd	**63.5**	nd	99.7
		AVERAGE	*0.4*	*1.2*	***5.1***	***26.5***	*0.2*	-	-	*1.5*	*0.1*	*0.7*	*0.1*	-	***63.8***	-	*99.5*
		SD	*0.1*	*0.2*	***0.4***	***3.2***	*0.1*	-	-	*0.1*	*0.0*	*0.1*	*0.1*	-	***3.2***	-	**-**
		MAX	*0.5*	*1.4*	***5.9***	***32.0***	*0.3*	-	-	*1.8*	*0.1*	*1.0*	*0.2*	-	***68.2***	-	**-**
		MIN	*0.2*	*1.0*	***4.7***	***22.5***	*nd*	-	-	*1.3*	*nd*	*0.6*	*nd*	-	***58.5***	-	**-**

Sample	Mode	Analysis	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	K_2O	CaO	TiO_2	V_2O_5	MnO	Fe_2O_3	ZrO	Total
	Surface	AVERAGE	1.1	1.8	**7.0**	**9.3**	0.8	0.1	nd	1.3	0.7	0.5	nd	nd	**76.6**	nd	99.4
		SD	1.0	0.7	**1.4**	**1.9**	0.3	0.1	-	0.4	0.3	0.2	-	-	**5.6**	-	-
	Section	1 (edge)	nd	0.5	**7.3**	**9.7**	0.6	nd	nd	1.3	0.4	0.3	0.8	nd	**78.9**	nd	99.9
		2	0.2	0.5	**8.0**	**10.5**	0.4	nd	nd	1.4	0.3	0.2	0.7	nd	**77.6**	nd	99.8
		3	0.3	0.5	**7.4**	**9.8**	0.3	nd	nd	1.4	0.2	0.3	0.8	nd	**79.0**	nd	99.9
		4	nd	0.4	**7.3**	**10.1**	0.3	nd	nd	1.5	0.2	0.3	0.7	nd	**79.0**	nd	99.8
		5	0.2	0.6	**6.5**	**8.7**	0.7	nd	nd	1.4	0.9	0.3	0.5	nd	**79.7**	0.3	99.7
		6	0.2	0.7	**6.1**	**8.3**	0.9	nd	nd	1.3	0.9	0.3	0.5	nd	**80.6**	nd	99.7
13712		7	0.1	0.6	**5.6**	**7.7**	0.6	nd	nd	1.2	0.8	0.3	0.6	nd	**82.3**	nd	99.8
(shale)		8	0.2	0.5	**5.8**	**7.6**	0.7	nd	nd	1.2	0.8	0.2	0.6	nd	**82.2**	nd	99.9
		9	nd	0.5	**4.8**	**6.0**	0.7	nd	nd	0.9	0.7	0.4	0.7	nd	**85.1**	nd	99.9
		10	0.1	0.5	**5.5**	**7.0**	0.6	nd	nd	1.1	0.6	0.4	0.6	nd	**83.3**	nd	99.9
		11	0.2	0.5	**6.0**	**8.1**	0.4	nd	nd	1.2	0.3	0.3	0.7	nd	**82.3**	nd	99.9
		12 (edge)	0.1	0.5	**7.0**	**9.2**	0.4	nd	nd	1.3	0.3	0.3	0.5	nd	**80.2**	nd	99.9
		AVERAGE	*0.1*	*0.5*	***6.4***	***8.6***	*0.6*	-	-	*1.3*	*0.5*	*0.3*	*0.6*	-	***80.9***	*nd*	*99.8*
		SD	*0.1*	*0.1*	***1.0***	***1.4***	*0.2*	-	-	*0.2*	*0.3*	*0.1*	*0.1*	-	***2.2***	*0.1*	-
		MAX	*0.3*	*0.7*	***8.0***	***10.5***	*0.9*	-	-	*1.5*	*0.9*	*0.4*	*0.8*	-	***85.1***	*0.3*	-
		MIN	*nd*	*0.4*	***4.8***	***6.0***	*0.3*	-	-	*0.9*	*0.2*	*0.2*	*0.5*	-	***77.6***	*nd*	-
	Surface	AVERAGE	2.1	1.8	**1.4**	**2.8**	3.5	0.2	0.7	1.1	0.9	nd	nd	0.3	**85.4**	nd	100.0
		SD	0.3	0.4	**0.5**	**1.2**	0.5	0.1	0.1	0.1	0.3	-	-	0.1	**2.8**	-	-
	Section	1 (edge)	0.4	1.2	**1.3**	**6.0**	2.5	nd	nd	0.4	0.3	nd	nd	0.1	**87.5**	nd	99.8
		2	0.4	0.4	**0.8**	**2.4**	2.8	nd	nd	0.3	0.4	nd	nd	0.1	**91.8**	0.3	99.8
		3	0.4	0.4	**0.8**	**2.3**	2.9	nd	nd	0.5	0.4	nd	nd	0.1	**91.9**	nd	99.7
		4	0.4	0.4	**0.8**	**3.2**	2.6	nd	nd	0.4	0.4	nd	nd	0.1	**91.3**	nd	99.8
		5	0.4	0.5	**0.8**	**3.3**	2.8	nd	nd	0.4	0.3	nd	nd	0.1	**91.2**	nd	99.8
13741		6	0.5	0.4	**0.8**	**3.4**	2.7	nd	nd	0.4	0.4	nd	nd	0.1	**91.0**	nd	99.8
(ferr)		7	0.6	0.5	**0.7**	**1.3**	2.9	nd	nd	0.6	0.4	nd	nd	0.1	**92.7**	nd	99.7
		8	0.6	0.5	**0.8**	**1.2**	2.8	nd	nd	0.5	0.3	nd	nd	0.2	**92.9**	nd	99.7
		9	0.7	0.5	**0.7**	**1.7**	2.8	nd	nd	0.7	0.4	nd	nd	0.2	**91.9**	nd	99.7
		10 (edge)	0.5	0.6	**0.8**	**4.0**	2.7	nd	nd	0.6	0.4	nd	nd	0.1	**90.1**	nd	99.7
		AVERAGE	*0.5*	*0.5*	***0.8***	***2.9***	*2.8*	-	-	*0.5*	*0.4*	-	-	*0.1*	***91.2***	*0.0*	*99.8*
		SD	*0.1*	*0.2*	***0.2***	***1.4***	*0.1*	-	-	*0.1*	*0.0*	-	-	*0.0*	***1.5***	*0.1*	-
		MAX	*0.7*	*1.2*	***1.3***	***6.0***	*2.9*	-	-	*0.7*	*0.4*	-	-	*0.2*	***92.9***	*0.3*	-
		MIN	*0.4*	*0.4*	***0.7***	***1.2***	*2.5*	-	-	*0.3*	*0.3*	-	-	*0.1*	***87.5***	*nd*	-

Sample	Mode	Analysis	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	K_2O	CaO	TiO_2	V_2O_5	MnO	Fe_2O_3	ZrO	Total
	Surface	AVERAGE	0.9	3.3	**17.5**	**40.9**	0.6	0.1	0.0	4.2	1.0	0.7	nd	0.0	**29.2**	nd	98.5
		SD	0.5	0.9	**2.0**	**2.5**	0.2	0.1	0.0	0.5	0.2	0.1	-	0.0	**5.2**	-	-
	Section	1 (edge)	0.1	0.8	**13.3**	**46.4**	0.4	nd	nd	3.8	0.1	0.7	nd	nd	**34.2**	nd	99.8
		2	0.1	0.9	**12.9**	**48.6**	0.4	nd	nd	4.0	0.2	0.9	nd	nd	**31.8**	nd	99.8
		3	0.2	1.0	**13.4**	**49.4**	0.3	nd	nd	4.3	0.2	0.7	nd	nd	**30.4**	nd	99.8
		4	0.1	1.0	**13.2**	**48.2**	0.4	nd	nd	4.2	0.2	0.8	nd	nd	**31.7**	nd	99.8
		5	0.1	1.0	**13.9**	**53.2**	0.2	nd	nd	4.4	0.1	0.7	nd	nd	**26.1**	nd	99.8
13773		6	0.2	1.0	**14.0**	**50.2**	0.3	nd	nd	4.6	0.2	0.8	nd	nd	**28.5**	nd	99.8
(shale)		7	0.2	1.0	**13.9**	**51.0**	0.3	nd	nd	4.5	0.2	0.8	nd	nd	**27.9**	nd	99.8
		8	0.2	1.1	**14.0**	**52.7**	0.3	nd	nd	4.7	0.1	0.9	nd	nd	**25.7**	nd	99.8
		9	0.1	1.0	**13.6**	**45.7**	0.3	nd	nd	4.1	0.2	0.8	nd	0.1	**34.0**	nd	99.8
		10 (edge)	0.1	0.9	**12.6**	**48.0**	0.3	nd	nd	3.7	0.1	0.7	nd	nd	**33.4**	nd	99.9
		AVERAGE	*0.1*	*1.0*	***13.5***	***49.3***	*0.3*	-	-	*4.2*	*0.2*	*0.8*	-	*0.0*	***30.4***		*99.8*
		SD	*0.1*	*0.1*	***0.5***	**2.5**	*0.1*	-	-	*0.3*	*0.1*	*0.1*	-	*0.0*	**3.2**		-
		MAX	*0.2*	*1.1*	***14.0***	***53.2***	*0.4*	-	-	*4.7*	*0.2*	*0.9*	-	*0.1*	***34.2***		-
		MIN	*0.1*	*0.8*	***12.6***	***45.7***	*0.2*	-	-	*3.7*	*0.1*	*0.7*	-	*nd*	***25.7***		-

Nd: not detected.

Table S4. Detailed results of PIXE analyses of archaeological samples (surface and section).

Sample	Analysis		SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)	Total (%)	As ppm	Ba ppm	Cr ppm	Cu ppm	Ga ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sr ppm	V ppm	Y ppm	Zn ppm	Zr ppm
13681 (shale)	Surf	1	54.4	24.8	7.4	0.05	1.9	1.0	0.9	5.7	1.8	2.2	100	48	760	201	37	31	33	27	60	217	285	nd	49	49	508
		2	59.4	23.2	5.1	0.05	1.9	1.0	0.8	4.7	1.8	2.1	100	34	*306*	*72*	38	26	26	26	43	171	205	*112*	40	42	629
		3	54.2	24.5	7.8	0.05	1.9	1.0	0.8	5.8	1.8	2.2	100	53	706	*113*	37	35	34	28	67	228	298	*251*	57	53	593
		AV	56.0	24.2	6.7	0.05	1.9	1.0	0.8	5.4	1.8	2.2	100.0	45	591	129	37	31	31	27	57	205	263	182	49	48	577
		SD	3.0	0.8	1.5	0.00	0.0	0.0	0.0	0.6	0.0	0.1	0.0	10	248	66	1	5	4	1	12	30	50	98	9	6	62
	Sect	1	63.5	22.5	5.6	0.02	1.0	0.3	0.4	4.3	1.4	1.0	100	34	361	141	34	24	24	25	*38*	178	175	*141*	65	48	954
		2	69.6	19.9	4.2	0.02	0.7	0.2	0.3	3.2	1.0	0.8	100	26	424	*84*	31	18	18	26	*26*	130	112	nd	27	38	740
		3	64.5	22.6	4.9	0.03	0.9	0.3	0.4	4.1	1.2	1.1	100	32	300	126	29	24	20	*18*	*33*	170	158	*74*	52	45	208
		4	69.5	20.4	3.6	0.02	0.7	0.3	0.3	3.2	1.1	1.0	100	30	321	*90*	33	18	18	21	*22*	136	231	nd	38	36	557
		AV	66.7	21.4	4.6	0.02	0.9	0.3	0.3	3.7	1.2	1.0	100.0	31	352	110	32	21	20	23	30	154	169	108	46	42	615
		SD	3.2	1.4	0.9	0.00	0.1	0.1	0.1	0.6	0.2	0.1	0.0	3	55	28	2	3	3	4	7	24	49	47	17	6	316
13715 (shale)	Surf	1	52.6	25.9	10.8	0.09	1.3	0.5	0.8	5.8	1.8	0.5	100	53	*479*	nd	30	34	34	*38*	74	208	184	*182*	89	61	931
		2	55.4	26.6	8.3	0.06	1.4	0.4	0.8	5.4	1.3	0.3	100	35	655	*94*	27	26	23	22	59	157	136	*88*	34	48	291
		3	52.9	26.6	9.7	0.08	1.4	0.6	0.9	5.8	1.6	0.4	100	51	768	*82*	32	31	32	*24*	68	190	184	*111*	87	57	317
		4	53.3	26.2	9.0	0.09	1.5	0.8	1.1	5.8	1.4	0.8	100	48	798	*104*	33	30	27	30	56	182	162	nd	47	62	415
		AV	*53.5*	*26.3*	*9.5*	*0.08*	*1.4*	*0.6*	*0.9*	*5.7*	*1.5*	*0.5*	*100.0*	*47*	*675*	*93*	*31*	*30*	*29*	*29*	*64*	*184*	*167*	*127*	*64*	*57*	*489*
		SD	*1.2*	*0.3*	*1.1*	*0.01*	*0.1*	*0.2*	*0.1*	*0.2*	*0.2*	*0.2*	-	*8*	*144*	*11*	*3*	*3*	*5*	*7*	*8*	*21*	*23*	*49*	*28*	*6*	*300*
	Sect	1	59.4	22.3	11.0	0.07	0.8	0.3	0.4	4.3	1.2	0.3	100	47	669	*116*	25	27	23	27	56	167	153	nd	42	53	609
		2	57.8	23.9	10.7	0.08	0.9	0.1	0.4	4.4	1.6	0.2	100	46	692	*99*	23	27	28	*22*	49	169	165	*133*	77	51	352
		3	56.1	26.2	9.1	0.07	0.8	0.2	0.3	5.0	1.9	0.3	100	51	702	*74*	21	30	31	34	65	191	198	*159*	53	58	885
		4	59.3	22.9	10.7	0.09	1.0	0.1	0.3	4.3	1.2	0.2	100	51	594	*76*	26	28	23	34	57	163	142	*218*	37	51	379
		AV	58.1	23.8	10.3	0.08	0.9	0.2	0.3	4.5	1.4	0.3	100.0	49	664	91	24	28	26	29	57	173	165	170	52	53	556
		SD	1.5	1.7	0.9	0.01	0.1	0.1	0.1	0.3	0.3	0.1	-	3	49	20	2	1	4	6	7	13	24	44	18	3	248
13716 (shale/ sandstone)	Surf	1	40.0	8.2	43.6	0.01	1.1	0.8	1.7	2.5	0.2	2.0	100	*13*	*51*	*38*	24	*4*	*6*	50	58	78	56	nd	63	176	1014
		2	46.5	7.8	35.2	0.01	1.1	2.2	2.3	2.6	0.3	2.1	100	*10*	*92*	nd	22	*5*	*4*	44	55	70	56	*38*	12	202	33
		3	44.1	9.0	37.8	0.00	1.0	0.8	2.0	3.0	0.4	2.0	100	*8*	*106*	*34*	22	*6*	*7*	*23*	44	77	60	nd	12	141	176
		AV	43.5	8.3	38.8	0.00	1.0	1.2	2.0	2.7	0.3	2.1	100.0	10	83	36	23	5	6	39	52	75	57	38	29	173	408
		SD	3.3	0.6	4.3	0.00	0.1	0.8	0.3	0.3	0.1	0.1	-	3	29	3	1	1	2	14	7	4	2	nd	29	31	530
	Sect	1	59.4	7.7	28.9	0.00	0.5	0.1	0.2	2.3	0.4	0.6	100	*10*	*140*	*30*	14	7	*4*	*28*	26	80	55	*113*	25	100	256
		2	52.9	5.6	38.4	0.00	0.3	0.1	0.2	1.5	0.2	0.8	100	*9*	*32*	nd	*9*	*5*	*4*	*26*	*18*	54	35	*61*	*8*	110	26

3	63.0	7.0	26.4	0.00	0.4	0.1	0.1	2.1	0.4	0.5	100	*7*	nd	*16*	*7*	6	7	*20*	*17*	80	55	*100*	16	92	460
4	57.4	5.4	34.2	0.00	0.3	0.1	0.1	1.6	0.3	0.6	100	*7*	*94*	*47*	*9*	*5*	*5*	*30*	22	65	33	*36*	11	111	47
AV	58.2	6.4	31.9	0.00	0.4	0.1	0.2	1.9	0.3	0.6	100.0	8	89	31	10	6	5	26	21	70	45	78	15	103	197
SD	4.2	1.1	5.4	0.00	0.1	0.0	0.0	0.4	0.1	0.1	-	2	54	16	3	1	1	4	4	13	12	35	*7*	9	204

Sample	Analysis		SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)	Total (%)	As ppm	Ba ppm	Cr ppm	Cu ppm	Ga ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sr ppm	V ppm	Y ppm	Zn ppm	Zr ppm
13773 (shale)	Surf	1	47.2	16.5	27.7	0.06	2.5	0.5	0.6	3.4	0.8	0.7	100	*23*	*279*	174	*14*	17	15	*17*	*54*	135	82	*149*	*10*	24	163
		2	46.4	19.3	25.9	0.05	2.5	0.4	0.5	3.5	0.8	0.6	100	*19*	*666*	163	*8*	19	17	*23*	85	125	130	*184*	*23*	29	153
		3	44.2	17.1	29.2	0.08	2.5	0.7	0.8	3.7	0.9	1.0	100	*25*	1043	176	*12*	22	19	nd	95	144	137	*210*	*14*	32	196
		AVSD	45.9	17.7	27.6	0.06	2.5	0.5	0.7	3.5	0.8	0.7	100.0	22	663	171	11	19	17	20	78	135	116	181	16	28	171
			1.6	1.5	1.6	0.01	0.1	0.1	0.1	0.1	0.0	0.2	-	3	382	*7*	3	3	2	4	21	10	30	31	*7*	4	23
	Sect	1	52.1	15.4	26.4	0.06	0.7	0.1	0.1	3.9	0.9	0.3	100	*11*	518	184	*8*	17	16	*24*	88	168	107	*130*	48	106	260
		2	53.9	15.9	23.7	0.05	0.9	0.2	0.1	4.1	0.9	0.3	100	*7*	348	*107*	*3*	18	19	*24*	96	178	109	*191*	34	107	216
		3	54.2	15.6	23.9	0.05	0.8	0.1	0.2	4.1	0.8	0.2	100	*8*	501	132	*3*	16	17	*20*	89	164	112	*195*	30	108	214
		4	51.3	14.4	28.6	0.07	0.8	0.2	0.2	3.5	0.8	0.2	100	*12*	463	177	*4*	17	14	*18*	64	154	59	*191*	*16*	88	183
		AVSD	*52.9*	*15.3*	*25.7*	*0.06*	*0.8*	*0.1*	*0.2*	*3.9*	*0.8*	*0.2*	*100.0*	*10*	*458*	*150*	*5*	*17*	*17*	*22*	*84*	*166*	*97*	*177*	*32*	*102*	*218*
			1.4	*0.6*	*2.3*	*0.01*	*0.1*	*0.0*	*0.0*	*0.3*	*0.1*	*0.0*	-	*2*	*77*	*37*	*2*	*1*	*2*	*3*	*14*	*10*	*25*	*31*	*13*	*10*	*32*
13741 (ferr)	Surf	1	4.0	1.6	87.4	0.17	1.7	0.4	1.3	1.0	0.0	2.3	100	*22*	nd	nd	*22*	*3*	*2*	146	120	*3*	18	141	19	1342	22
		2	6.5	1.6	84.9	0.21	1.6	0.4	1.4	1.0	0.0	2.3	100	*28*	*150*	nd	*18*	nd	nd	161	106	*4*	23	93	17	1328	21
		3	3.0	1.3	88.3	0.20	1.7	0.5	1.6	1.0	0.0	2.5	100	*11*	nd	nd	*28*	*5*	nd	186	142	*2*	21	*56*	20	1426	25
		AVSD	4.5	1.5	86.9	0.20	1.7	0.4	1.4	1.0	0.0	2.4	100.0	20	150	nd	23	4	2	164	123	3	21	97	19	1365	23
			1.8	0.2	1.8	0.02	0.1	0.0	0.1	0.0	0.0	0.1	-	9	nd	nd	5	1	nd	20	18	1	3	43	2	53	2
	Sect	1	2.8	1.0	91.5	0.10	0.6	0.4	0.7	0.4	0.0	2.4	100	*16*	nd	nd	*13*	nd	nd	171	135	*2*	16	*93*	19	1988	19
		2	2.5	0.9	91.9	0.10	0.6	0.4	0.8	0.4	0.0	2.5	100	*17*	nd	nd	*9*	*2*	nd	156	117	*2*	16	*71*	19	1991	17
		3	3.1	0.9	91.4	0.11	0.7	0.4	0.6	0.5	0.0	2.3	100	*10*	*58*	nd	*17*	nd	*2*	176	129	*5*	12	*74*	19	1992	16
		4	19.4	1.7	74.7	0.11	0.9	0.3	0.5	0.4	0.0	2.0	100	*20*	*78*	*28*	*14*	*2*	nd	127	75	*4*	10	114	18	1390	13
		AVSD	6.9	1.1	87.4	0.11	0.7	0.4	0.6	0.4	0.0	2.3	100.0	16	68	28	13	2	2	158	114	3	14	88	19	1840	16
			8.3	0.4	8.4	0.00	0.1	0.1	0.1	0.0	0.0	0.2	-	4	14	nd	3	0	nd	22	27	2	3	20	1	300	3

In italic: values close to the detection limit; nd: not detected.