London Atlas: Materials and methods II: data visualisation

From Earthwise

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Ferreira, A, Johnson, C C, Appleton, J D, Flight, D M A, Lister, T R, Knights, K V, Ander, L, Scheib, C, Scheib, A, Cave, M, Wragg, J, Fordyce, F and Lawley, R. 2017. London Region Atlas of Topsoil Geochemistry. *British Geological Survey*.

The dataset described here, the London Region Topsoil Dataset (**LRD**), was initially created to investigate how the geochemical baseline of the London region is influenced by the underlying parent material. The data are a combination of the G-BASE[1] urban data released as part of the London Earth[2] project in 2011 (Johnson, 2011[3]) plus other available rural or urban G-BASE[1] topsoil results falling within the rectangular area shown in **Figure 2**. This includes samples collected over several summer field campaigns from 2005 to 2009, which in practice can be grouped into two main subsets, **SEEN** and **LOND**, as previously described. The area selected was designed to give insight in to how geochemical signatures may change over the same parent materials passing from central London to more rural areas on the periphery. As such, the rectangular areas of the LRA include, whenever possible, a representative number of rural **SEEN** samples over the same parent material (PM, simplified geology) classes that underlie the urban **LOND**. The number of topsoil samples in **LOND** and in **SEEN** subsets collected on each PM are shown in **Table 7**. The simplified geological classes are ordered from the most to the least represented in **LOND**, and the font is coloured grey for the simplified geological class not represented (or poorly represented) in one of the subsets (**LOND** and **SEEN**) at least. The background colour of the first column is according to the geological time period.

Thirteen (out of the 21) PMs observed in the LRA are able to be compared as they are fairly well represented in both subset areas (**LOND** and **SEEN**). Only one of the PM classes represented in the urban **LOND**, Thames Group (sand-gravel), is poorly represented (one sample only) in the surrounding rural **SEEN**. Seven PM classes are represented in **SEEN** subset only, including two on which topsoil was casually not collected, due to small spatial extension relative to the sampling density (**Table 7**). The parent material (PM) mapping method described by Appleton and Adlam (2012)[4] was used to create geochemical images in ESRI® ArcGIS and their geogenic signatures are described in Appleton et al. (2013)[5]. Using PM polygons as soil chemistry mapping units, it is possible to estimate element concentrations based on local averages, without significant errors at PM boundaries (Appleton et al., 2008[6]; Appleton and Adlam, 2012[4]). In case of a large positive skewness distribution, the geometric mean (GM) should be used for mapping the spatial variation in element concentrations, in order to minimise the bias associated with that type of distribution. The PM methodology is generally appropriate in situations and for elements where PM explains a relatively high proportion of the variance, but less so for elements where the proportion of variance explained by PM is low, for example where point or non-point source anthropogenic contamination is a major factor, such as Pb. Previously published London Earth[2] geochemical images were based on standard inverse distance weighted squared (IDW^2) maps created in ArcGIS with an 80 m cell size and an isotropic search radius of 750 m. By contrast, the parent material mapping method uses parent material (simplified geology) polygons subdivided into separate 200 m square cells (subdivisions of the BNG). These store non-topological geometry and attribute information for the spatial features that form the basis for the production of the geochemical maps.

Parent material (PM) codes for each 200 m grid square were attached to the locations of all soil samples. Parent material geochemical mapping was executed using an ArcGIS tool written in Vb.Net (Appleton and Adlam, 2012[4]) to calculate the geometric mean (GM) element concentration for each 200 m-PM polygon. The optimum number of samples for calculating the GMs was between four and seven for topsoil data (Appleton et al. 2008[7]). For the maps generated here, GMs were calculated using data for the nearest four samples on the same PM apart from (a) four very minor PM units (calcrete, peat, the Upper Greensand and the Wealden Group), which comprise about 0.2% of the study area and which have no soil samples located on them and (b) polygons for which the average distance to the four samples required to calculate the GM was greater than 7000 m, which comprise about 4% of the study area. This largely affects sinuous polygon features, such as narrow alluvium areas along the upper reaches of tributaries to the River Thames. This approach was adopted to prevent excessive extrapolation of high element concentrations related to anthropogenic contamination, such as Pb. For both these sets of polygons (a and b), the GM was calculated from soil chemistry data for the nearest four samples, irrespective of PM.

The colour coding of the geochemical maps of the London Region follow the standard G-BASE[1] geochemical map classification applied in past geochemical atlases (e.g., BGS, 2000[8]). The percentiles 5, 10, 15, 25, 50, 75, 90, 95 and 99 of the data distribution are used as class boundaries for a ramp of colours (**Table 8**).

Table 7 The number of topsoil samples (out of 8400) observed in LOND and in SEEN subsets over each simplified geology class.

Geological time period	Simplified geology class	LOND	SEEN	LRD
Palaeogene	Thames Gp. (clay)	2328	274	2602
Quaternary	River terrace deposits	1677	147	1824
Quaternary	Alluvium	618	72	690
Cretaceous	White Chalk SubGp.	449	258	707
Quaternary	Brickearth	370	20	390
Quaternary	Head (clay-silt)	326	100	426
Palaeogene	Thames Gp. (sand-gravel)	306	1	307
Palaeogene	Lambeth Group	178	35	213
Quaternary	Clay-with-flints	159	153	312
Quaternary	Plateau gravels	152	109	261
Palaeogene	Thanet Sand Fm.	136	26	159
Quaternary	Glacial till	68	224	292
Palaeogene	Bagshot Fm.	25	63	88
Quaternary	Head (gravel-sand)	9	14	23
Cretaceous	Lower Greensand Gp.	0	46	46
Palaeogene	Bracklesham Gp. (sand-silt)	0	20	20
Cretaceous	Grey Chalk SubGp.	0	15	15
Cretaceous	Gault Fm.	0	13	13
Palaeogene	Bracklesham Gp. (sand)	0	12	12
Cretaceous	Upper Greensand	0	0	0
Cretaceous	Wealden Gp. (mudstone)	0	0	0

Table 8 Percentiles of topsoil element concentrations (N = 8400) plus LOI (N = 7928) and pH (N = 7929). Concentrations are in wt% for the 10 most abundant elements (shown as oxides) and for LOI; the remaining 34 elements are in mg/kg and pH is in log[H+] mol/L.

Colour	Percentile	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	Ag	As	Ba	Bi	Br	Cd	Ce	Co	Cr	Cs	Cu	Ga	Ge
	Min	0.8	<0.05	0.13	0.12	<0.3	<0.005	<0.3	<0.05	4.6	0.17	<0.5	<2.4	139	<0.3	1.1	<0.5	16	<1.5	9	1	3	1.0	<0.5
	5	**3.9**	**0.37**	**2.09**	**0.74**	**0.4**	**0.022**	**<0.3**	**0.15**	**48.0**	**0.37**	**<0.5**	**8.6**	**257**	**<0.3**	**6.4**	**<0.5**	**33**	**5.3**	**46**	**2**	**13**	**7.2**	**0.5**
	10	**4.7**	**0.50**	**2.48**	**0.88**	**0.4**	**0.030**	**0.3**	**0.18**	**54.2**	**0.41**	**<0.5**	**10.0**	**283**	**<0.3**	**7.4**	**<0.5**	**37**	**6.7**	**52**	**2**	**17**	**7.9**	**0.7**
	15	**5.2**	**0.59**	**2.71**	**0.97**	**0.5**	**0.035**	**0.3**	**0.19**	**56.8**	**0.44**	**0.5**	**10.9**	**300**	**<0.3**	**8.1**	**<0.5**	**39**	**7.7**	**56**	**2**	**20**	**8.4**	**0.8**
	20	5.6	0.67	2.93	1.03	0.5	0.039	0.3	0.218	58.7	0.46	0.5	11.6	313	<0.3	8.7	<0.5	41	8.4	59	2	22	8.7	0.9
	25	**5.9**	**0.74**	**3.10**	**1.08**	**0.6**	**0.043**	**0.3**	**0.22**	**60.2**	**0.47**	**0.5**	**12.2**	**324**	**<0.3**	**9.2**	**<0.5**	**43**	**9.0**	**61**	**2**	**24**	**9.1**	**1.0**
	30	6.2	0.81	3.24	1.13	0.6	0.046	0.3	0.24	61.6	0.49	0.5	12.8	334	<0.3	9.7	0.5	44	9.6	63	2	26	9.4	1.1
	35	6.5	0.89	3.38	1.18	0.7	0.048	0.4	0.25	62.9	0.51	0.5	13.3	344	<0.3	10.1	0.5	45	10.0	65	2	29	9.7	1.2
	40	6.9	0.96	3.52	1.23	0.7	0.051	0.4	0.27	64.1	0.53	0.5	13.8	353	<0.3	10.5	0.5	47	10.5	67	3	32	9.9	1.2
	45	7.2	1.06	3.67	1.27	0.7	0.054	0.4	0.28	65.4	0.55	0.5	14.3	362	<0.3	11.0	0.5	49	11.0	70	3	35	10.3	1.3
	50	**7.6**	**1.18**	**3.80**	**1.32**	**0.8**	**0.056**	**0.4**	**0.31**	**66.6**	**0.57**	**0.5**	**14.8**	**371**	**<0.3**	**11.4**	**0.6**	**50**	**11.4**	**73**	**3**	**38**	**10.6**	**1.4**
	55	8.0	1.32	3.96	1.38	0.8	0.060	0.4	0.31	68.0	0.59	0.5	15.4	379	0.3	11.9	0.6	52	11.9	75	3	43	11.0	1.5
	60	8.4	1.48	4.13	1.45	0.9	0.062	0.4	0.33	69.3	0.61	0.5	16.0	387	0.3	12.4	0.7	54	12.5	78	3	47	11.3	1.6
	65	8.8	1.68	4.31	1.52	0.9	0.066	0.5	0.35	70.5	0.64	0.5	16.6	396	0.4	13.0	0.7	56	13.0	81	3	52	11.8	1.7
	70	9.4	1.92	4.49	1.61	1.0	0.070	0.5	0.37	72.0	0.67	0.5	17.3	405	0.5	13.7	0.7	57	13.7	84	4	59	12.3	1.9
	75	**10.0**	**2.23**	**4.70**	**1.71**	**1.2**	**0.075**	**0.5**	**0.40**	**73.3**	**0.70**	**0.5**	**18.2**	**417**	**0.6**	**14.5**	**0.8**	**59**	**14.4**	**88**	**4**	**67**	**12.9**	**2.1**
	80	10.6	2.65	4.92	1.82	1.1	0.081	0.5	0.43	75.0	0.74	0.5	19.2	432	0.7	15.4	0.9	61	15.2	93	4	77	13.6	2.3
	85	11.3	3.28	5.20	1.94	1.2	0.092	0.6	0.47	76.9	0.78	0.6	20.5	455	0.9	16.6	1.0	64	16.4	98	5	91	14.3	2.6
	90	**12.0**	**4.31**	**5.52**	**2.07**	**1.4**	**0.108**	**0.6**	**0.54**	**79.2**	**0.82**	**1.0**	**22.9**	**490**	**1.2**	**18.5**	**1.3**	**68**	**18.0**	**104**	**5**	**114**	**15.1**	**3.1**
	95	**13.2**	**6.95**	**6.09**	**2.28**	**1.6**	**0.147**	**0.7**	**0.66**	**82.7**	**0.88**	**2.2**	**27.5**	**577**	**2.2**	**22.1**	**1.9**	**74**	**20.8**	**116**	**6**	**167**	**16.3**	**4.1**
	99	**15.3**	**23.26**	**7.14**	**2.58**	**2.2**	**0.264**	**0.9**	**1.09**	**89.1**	**0.97**	**11.5**	**46.5**	**885**	**7.5**	**33.6**	**6.8**	**101**	**31.6**	**172**	**7**	**433**	**18.9**	**7.6**
	Max	25.5	48.97	15.59	3.47	4.6	0.697	10.0	4.49	100.0	1.10	268.8	160.9	3475	70.5	241.1	165.2	238	85.2	2094	11	5326	44.1	38.7

Colour	Percentile	Hf	I	La	Mo	Nb	Nd	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr	Th	U	V	W	Y	Zn	Zr	LOI	pH
	Min	1.1	<0.5	3	<0.2	4.7	<4	<1.3	10	6.5	<0.5	<3	<0.2	0.9	11	<0.7	<0.5	9	<0.6	3	<1.3	35	0.7	2.8
	5	**4.5**	**1.5**	**14**	**0.6**	**9.3**	**10.4**	**11.3**	**38**	**33.1**	**0.7**	**3.0**	**0.2**	**3.1**	**38**	**3.8**	**1.4**	**44**	**0.8**	**12**	**44**	**182**	**3.9**	**4.0**
	10	**5.2**	**1.8**	**16**	**0.7**	**9.9**	**12.9**	**13.9**	**46**	**38.4**	**0.9**	**4.0**	**0.3**	**3.7**	**45**	**4.4**	**1.6**	**50**	**1.1**	**14**	**58**	**204**	**4.5**	**4.6**
	15	**5.5**	**2.1**	**18**	**0.8**	**10.3**	**14.6**	**15.9**	**54**	**41.3**	**1.0**	**4.8**	**0.3**	**4.3**	**50**	**4.8**	**1.7**	**54**	**1.3**	**15**	**66**	**218**	**5.0**	**5.0**
	20	5.9	2.2	19	0.9	10.7	15.9	17.3	62	43.7	1.2	5.4	0.4	4.9	54	5.1	1.8	58	1.4	16	74	230	5.3	5.2
	25	**6.2**	**2.4**	**20**	**1.0**	**11.0**	**17.0**	**18.7**	**70**	**45.9**	**1.3**	**5.8**	**0.4**	**5.6**	**57**	**5.4**	**1.9**	**61**	**1.6**	**17**	**81**	**240**	**5.7**	**5.5**
	30	6.4	2.5	21	1.1	11.3	18.0	19.8	80	48.0	1.5	6.2	0.4	6.5	61	5.7	1.9	63	1.7	18	88	250	6.0	5.8
	35	6.6	2.7	22	1.1	11.6	19.0	21.0	92	50.1	1.7	6.6	0.5	7.4	64	6.0	2.0	66	1.8	19	97	259	6.3	6.0
	40	6.9	2.8	23	1.2	11.9	19.9	22.2	105	52.2	1.9	7.0	0.5	8.4	67	6.2	2.1	69	1.9	19	107	269	6.6	6.2
	45	7.2	3.0	24	1.3	12.3	20.8	23.4	121	54.3	2.1	7.4	0.5	9.6	70	6.5	2.2	72	2.0	20	118	278	6.9	6.4
	50	**7.4**	**3.1**	**25**	**1.4**	**12.6**	**21.8**	**24.6**	**138**	**56.5**	**2.4**	**7.8**	**0.5**	**10.9**	**73**	**6.8**	**2.2**	**75**	**2.1**	**21**	**130**	**288**	**7.1**	**6.5**
	55	7.7	3.3	26	1.5	13.0	22.7	25.9	159	59.1	2.7	8.2	0.6	12.6	77	7.1	2.3	79	2.2	21	144	299	7.4	6.7
	60	8.0	3.5	27	1.6	13.4	23.6	27.2	182	62.0	3.0	8.6	0.6	14.5	80	7.4	2.4	83	2.3	22	159	309	7.8	6.8
	65	8.4	3.7	28	1.7	13.9	24.5	28.6	209	65.1	3.4	9.1	0.6	16.7	83	7.7	2.4	87	2.4	23	178	322	8.1	6.9
	70	8.7	3.9	29	1.8	14.5	25.6	30.2	243	68.6	3.9	9.6	0.7	19.4	87	8.1	2.5	92	2.5	24	199	334	8.5	6.9
	75	**9.1**	**4.2**	**30**	**2.0**	**15.1**	**26.9**	**32.2**	**284**	**72.5**	**4.5**	**10.2**	**0.7**	**22.6**	**93**	**8.4**	**2.6**	**98**	**2.6**	**25**	**225**	**350**	**8.9**	**7.0**
	80	9.6	4.6	32	2.1	15.7	28.3	34.5	340	77.1	5.3	10.9	0.8	26.4	100	8.7	2.7	105	2.8	26	256	368	9.4	7.1
	85	10.3	5.4	33	2.4	16.2	30.1	37.3	415	82.9	6.4	11.7	0.9	32.8	111	9.1	2.8	113	3.0	27	301	391	10.0	7.2
	90	**11.3**	**6.6**	**36**	**2.8**	**16.9**	**32.5**	**41.3**	**531**	**89.5**	**8.2**	**12.6**	**1.0**	**44.2**	**125**	**9.5**	**2.9**	**122**	**3.3**	**29**	**371**	**424**	**10.9**	**7.3**
	95	**12.8**	**8.8**	**40**	**3.6**	**17.8**	**36.7**	**49.6**	**775**	**98.0**	**12.7**	**14.0**	**1.2**	**67.2**	**153**	**10.1**	**3.1**	**135**	**3.9**	**32**	**521**	**478**	**12.5**	**7.4**
	99	**15.8**	**16.7**	**59**	**7.5**	**19.0**	**54.8**	**78.3**	**1668**	**113.5**	**33.1**	**16.9**	**2.3**	**169.1**	**272**	**11.0**	**3.6**	**163**	**8.4**	**50**	**1120**	**580**	**18.3**	**7.6**
	Max	40.7	79.9	134	561.2	146.7	172.7	505.6	25206	157.2	612.3	35.6	19.6	1041.5	601	456.5	11.5	531	316.8	158	10095	1488	72.1	8.4

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- London Region Atlas of Topsoil Geochemistry

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