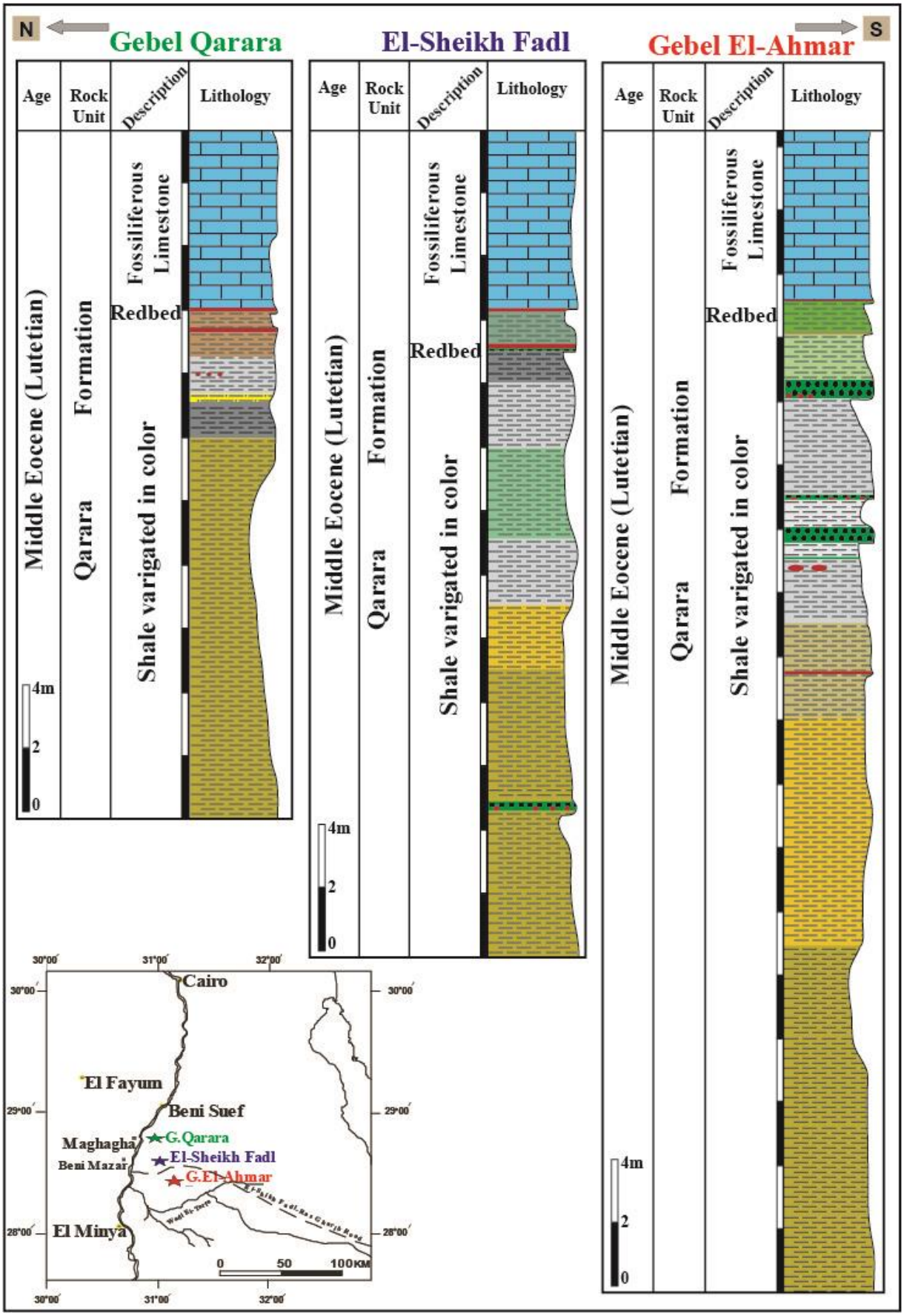


Figure 1: The three sedimentary sections including clay beds at Gebel Qarara (GQ), El-Sheikh Fadl (SF) and Gebel El-Ahmar (GA), located East River Nile at El-Minya Governorate, Upper Egypt.

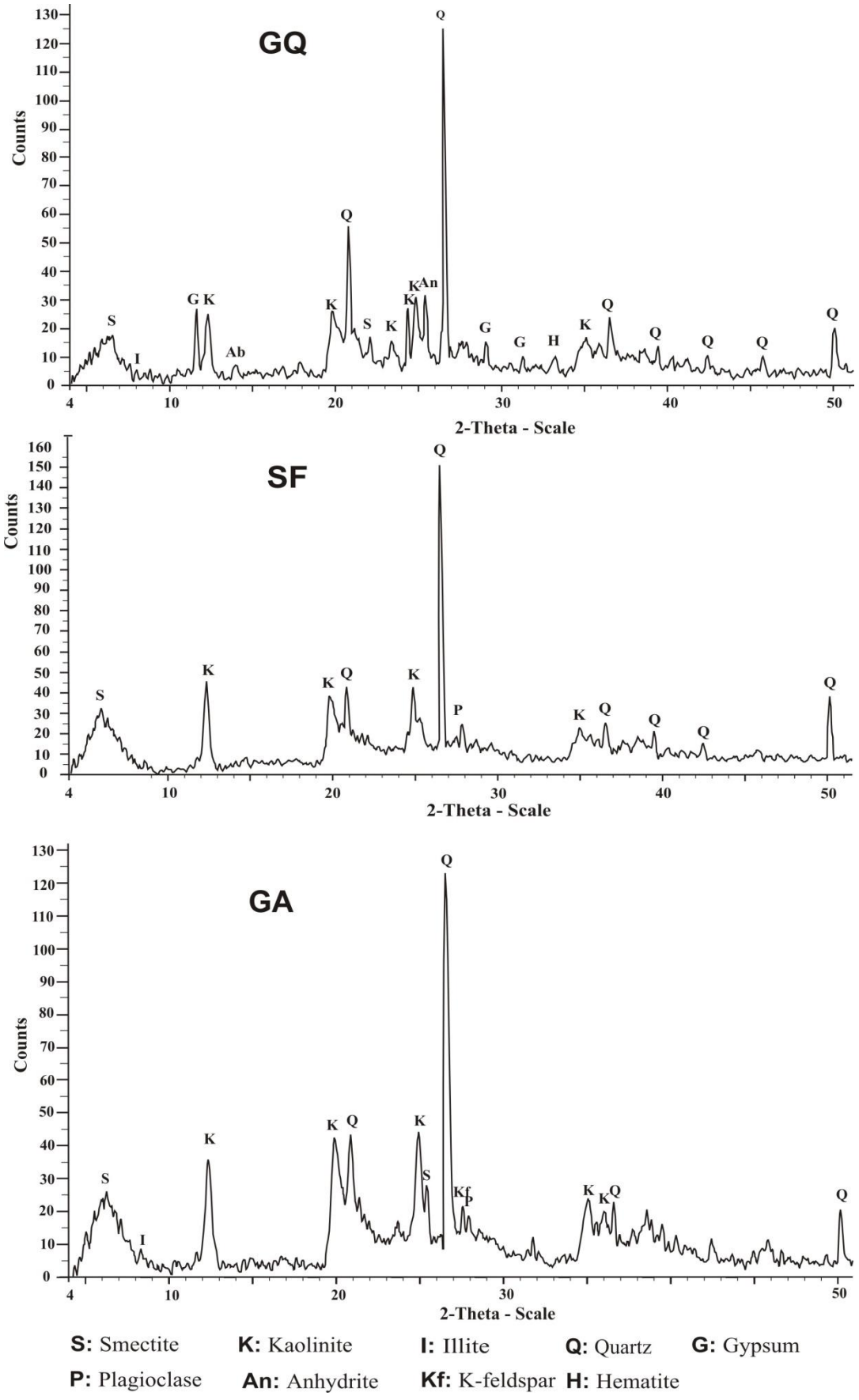


Figure 2: XRD patterns of El-Minya GQ, SF and GA clay powder samples (Cu Kα- Radiation).

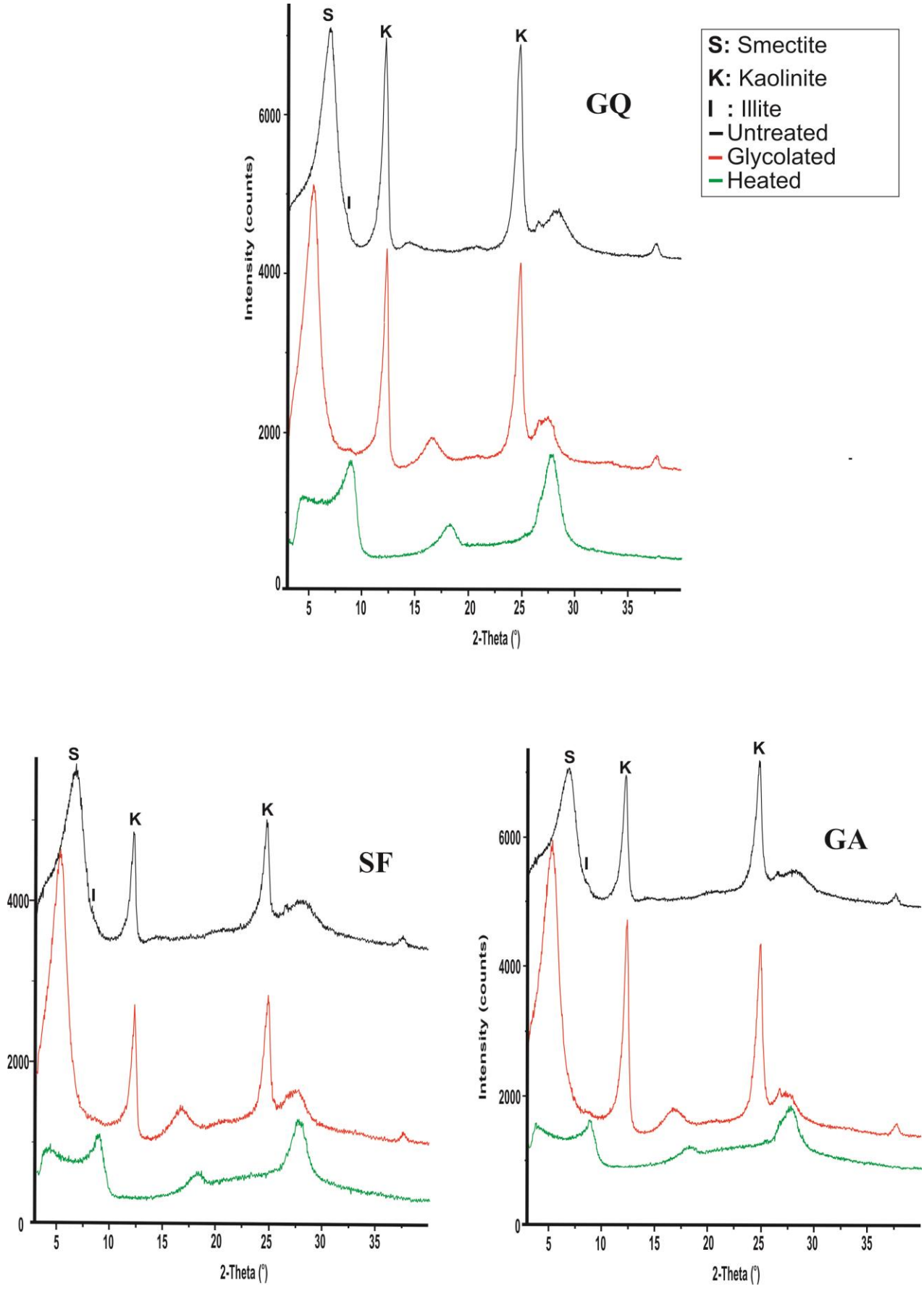


Figure 3: XRD tracing of El-Minya GQ, SF and GA clay fractions.

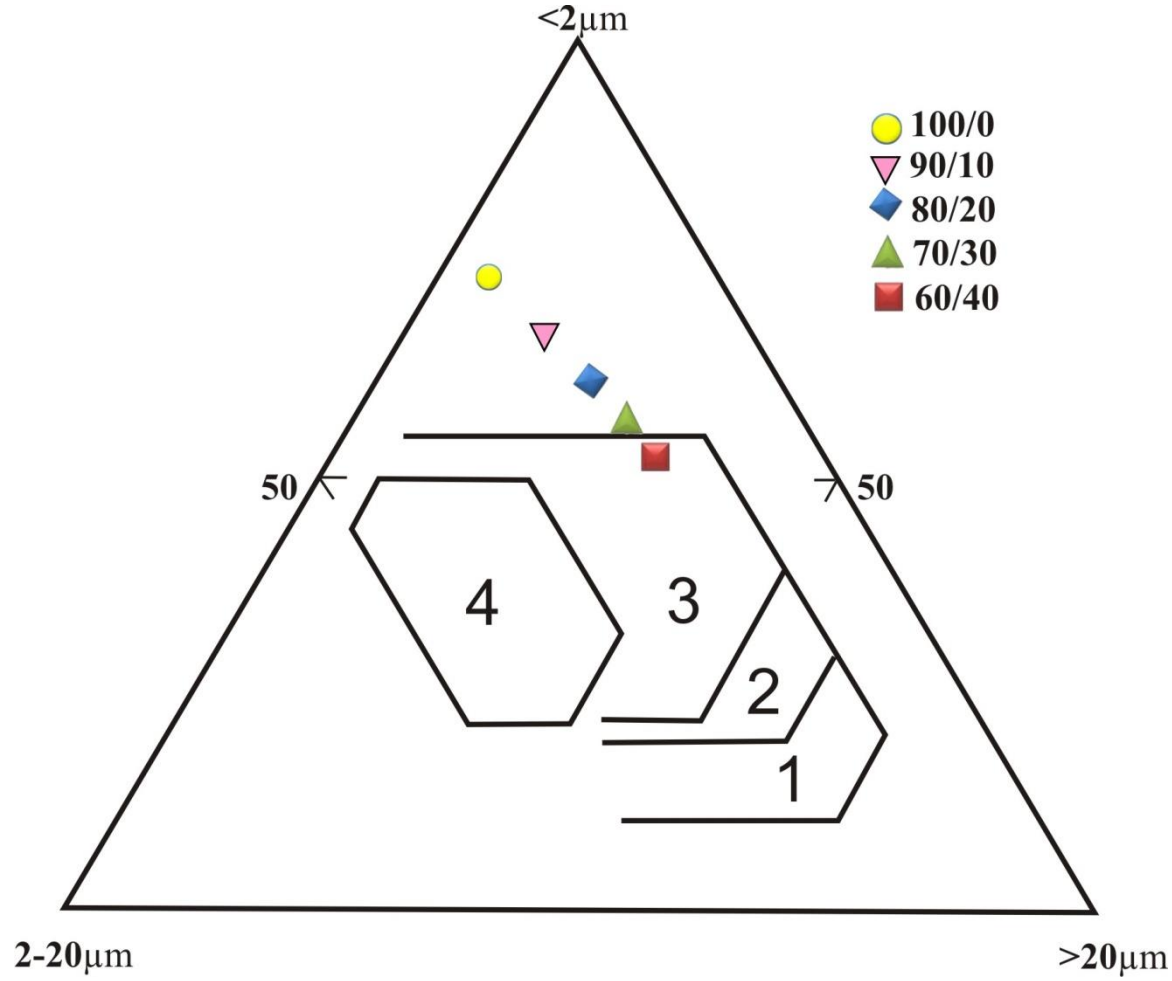


Figure 4: Particle-size composition of El-Minya clay sample without and with sand additions (0-40%) on the ternary clay - fine silt - sand and coarse & medium silt system, given by Winkler (1954), and modified by Nyakairu *et al*. (2002) showing four areas for common (1) & perforated (2) building bricks and roofing tiles (3) & hollow products (4).

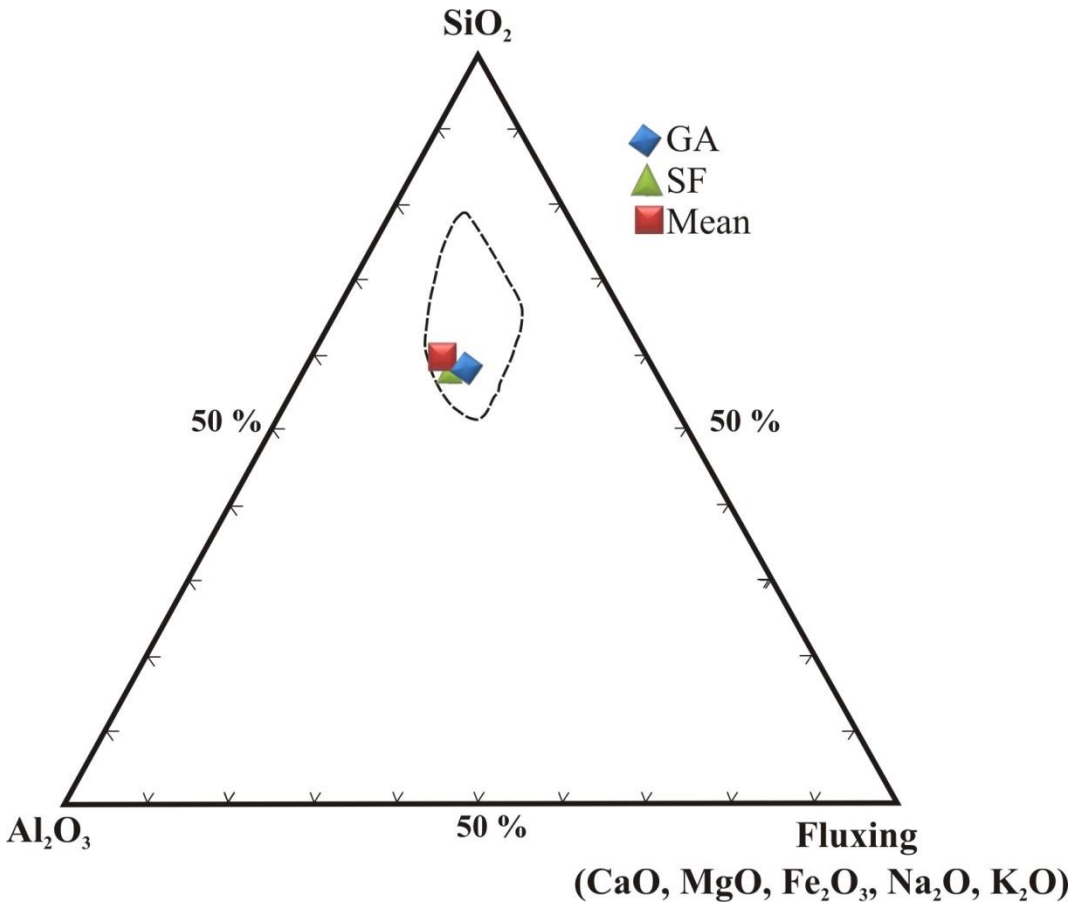


Figure 5: Chemical composition of El-Minya (GA & SF) clays and its representative sample as plotted on Riley's diagram (1951) by means of silica (SiO_2), alumina (Al_2O_3) and total fluxing oxides (TFO) on calcined basis, existing within the area of bloated clays.

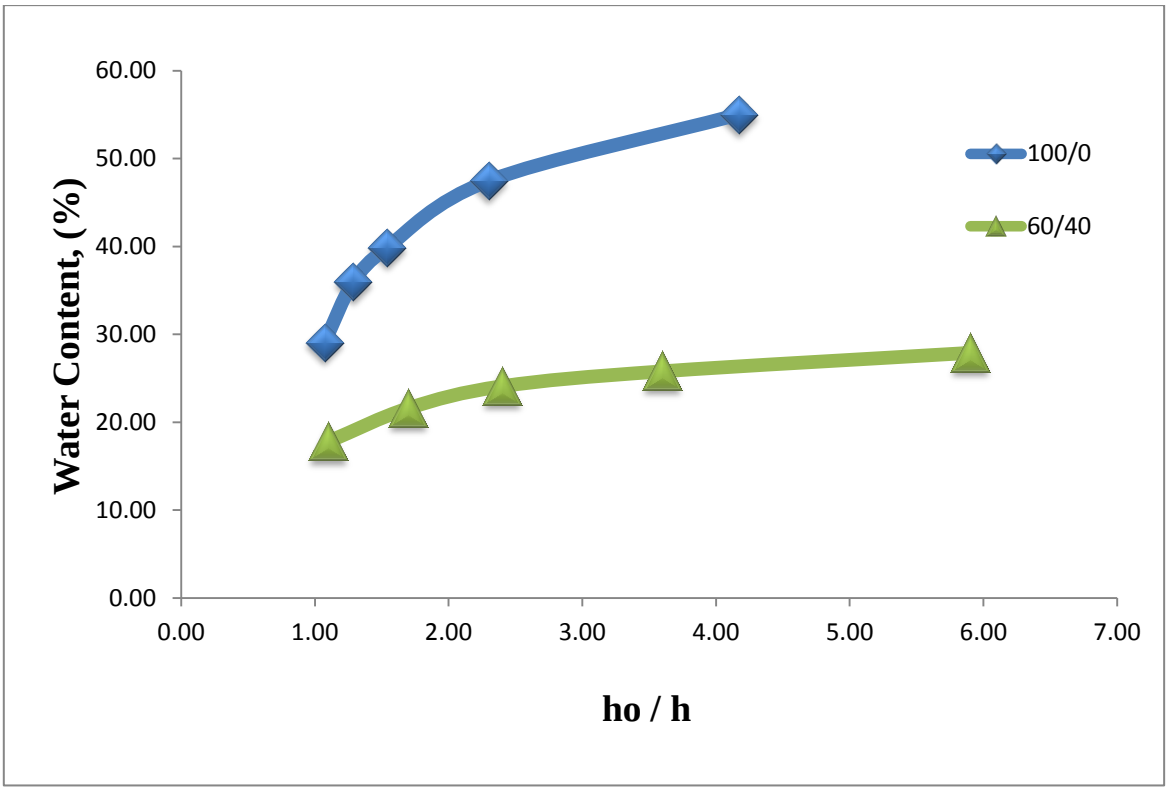


Figure 6: Plasticity curves of El-Minya representative clay sample and its batch with 40% sand grains, according to Pfefferkorn.

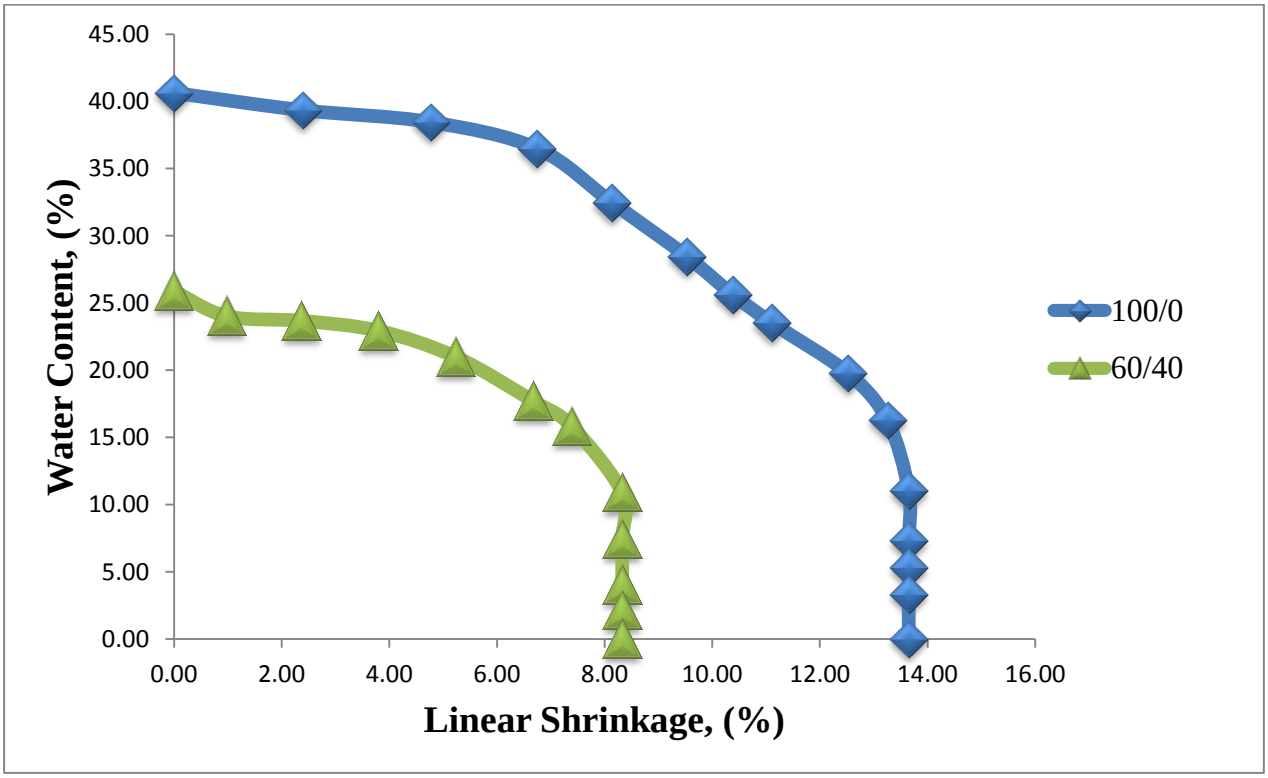
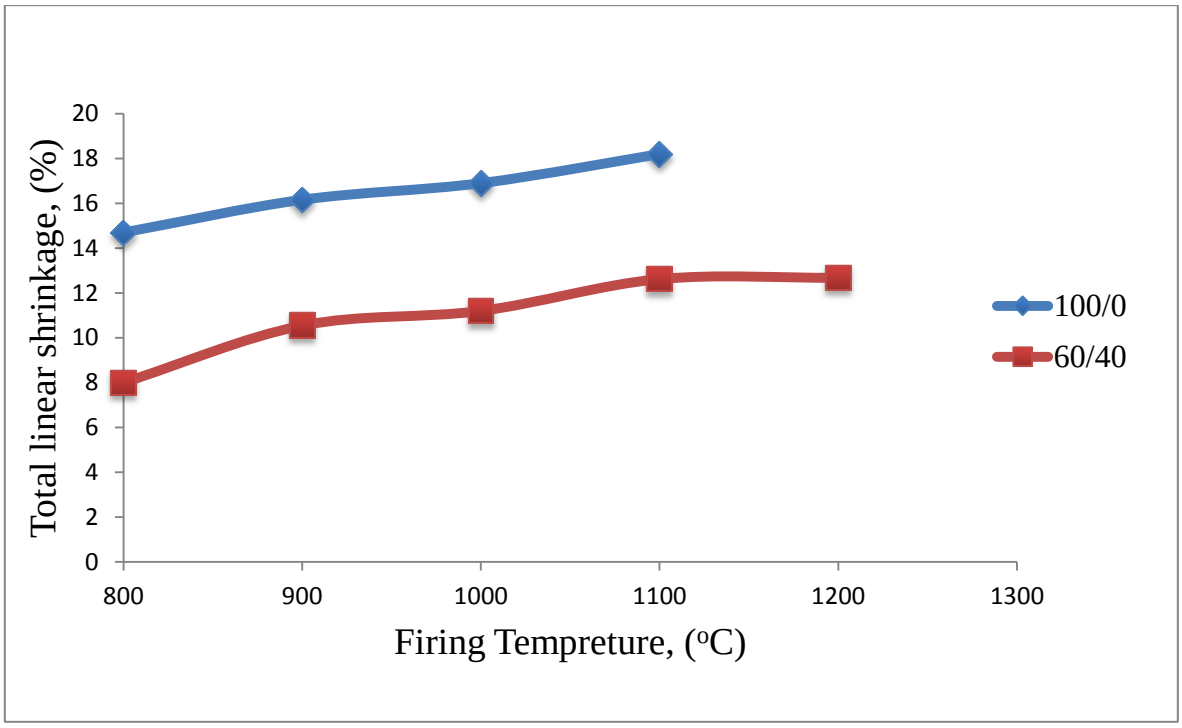
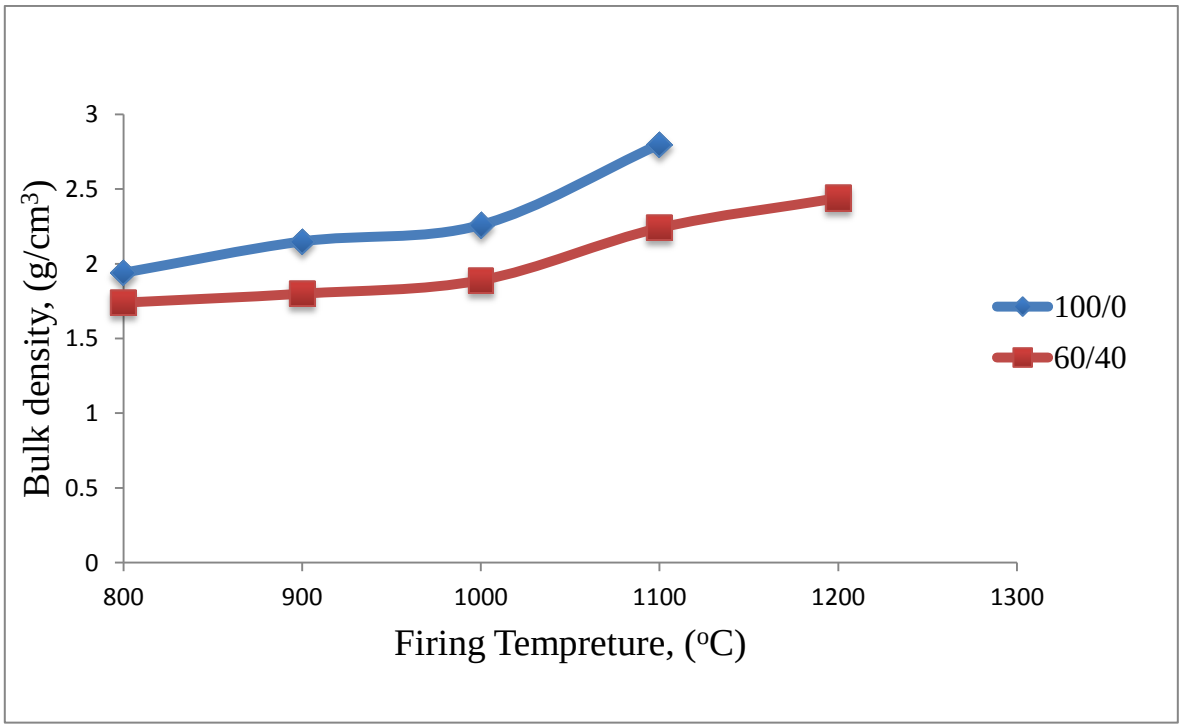


Figure 7: Bigot curves of El-Minya representative clay sample and its batch with 40% sand grains.

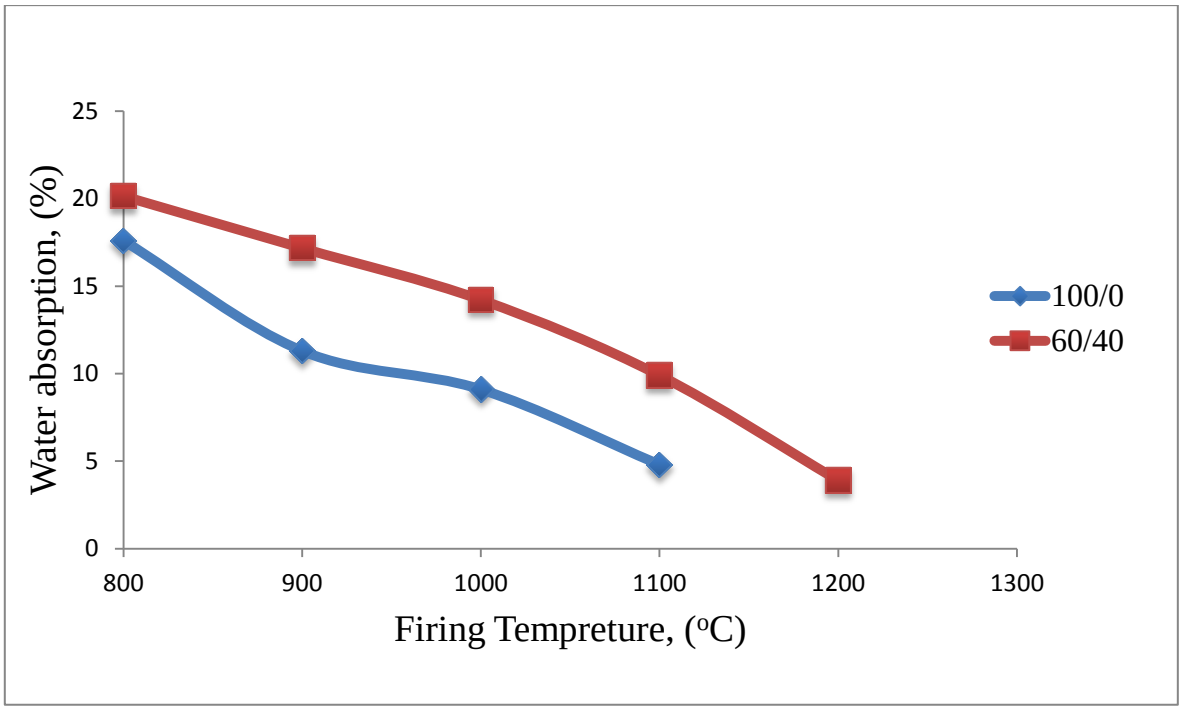


(a)

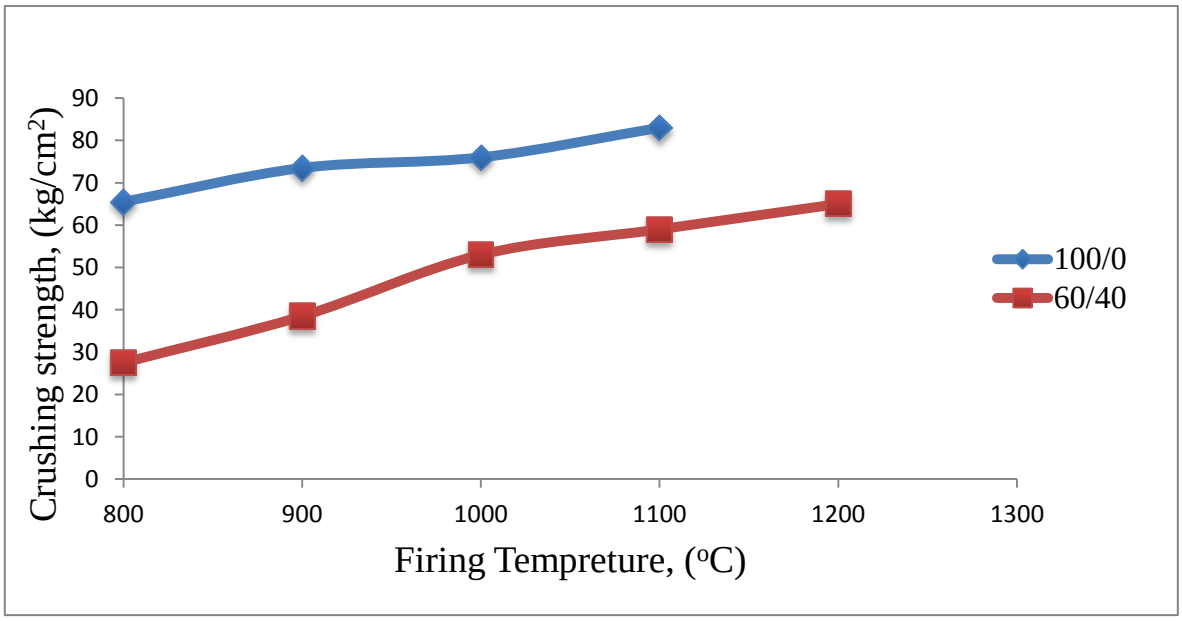


(b)

Figure 8: Total Linear shrinkage (a) and bulk density (b) of the fired briquettes of El-Minya clay and its batch with 40% sand grains as a function of firing temperature between 800 and 1100-1200°C

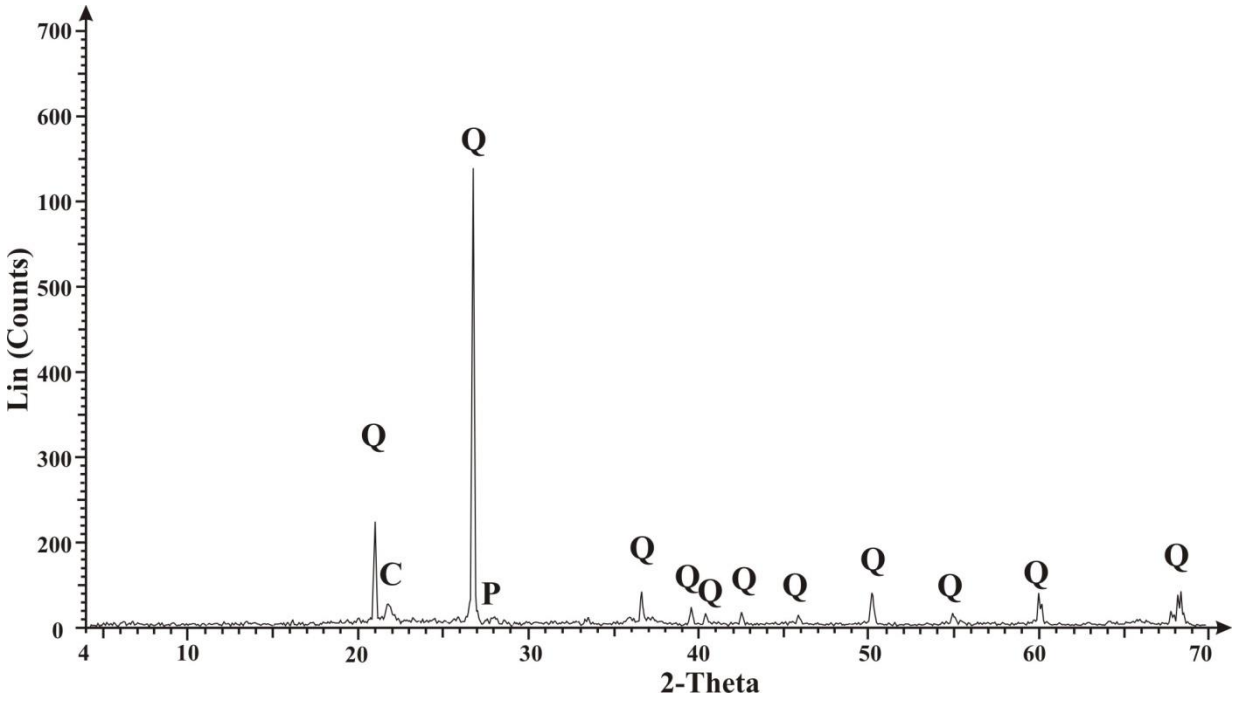


(a)

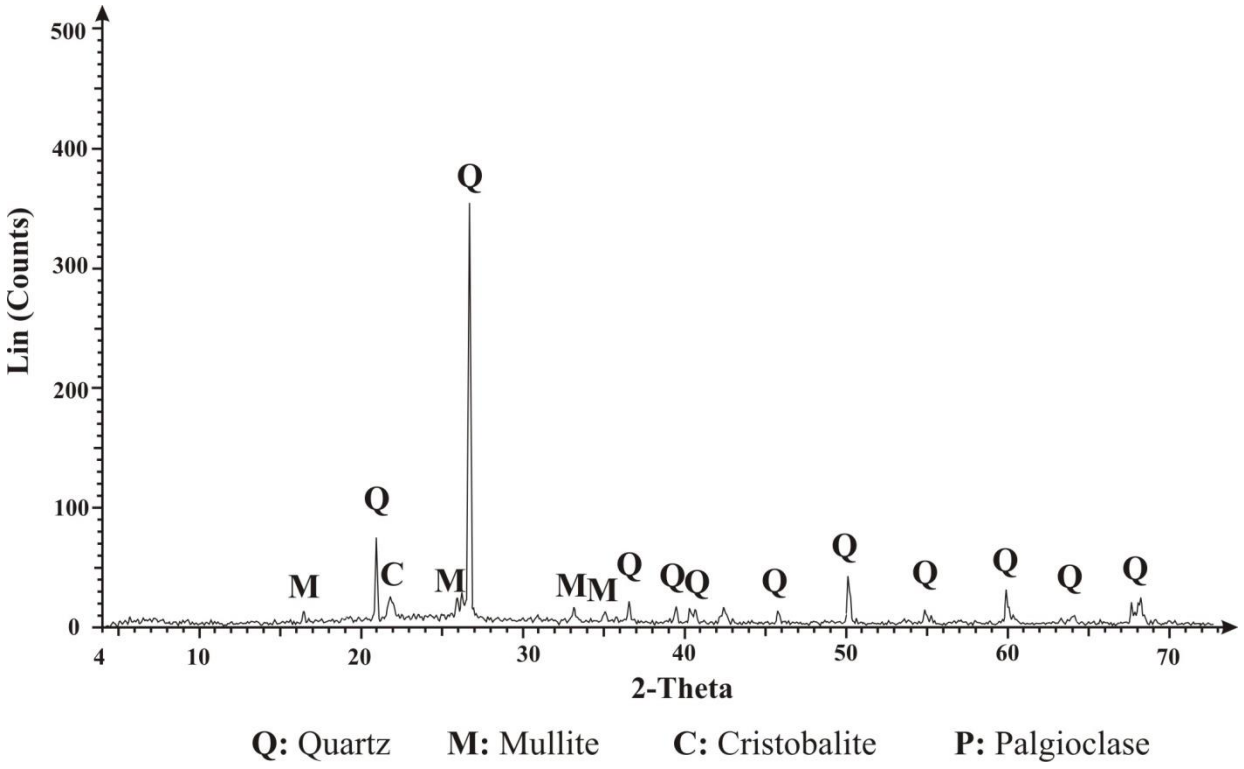


(b)

Figure 9: Water absorption (a) and crushing strength (b) of the fired briquettes of El-Minya clay and its batch with 40% sand grains as a function of firing temperature between 800 and 1100-1200°C



(a)



(b)

Figure 10: XRD patterns of the partially vitrified building-brick (a) and the fully-vitrified ceramic tile (b) samples, after firing up to 1000 and 1200°C, respectively.

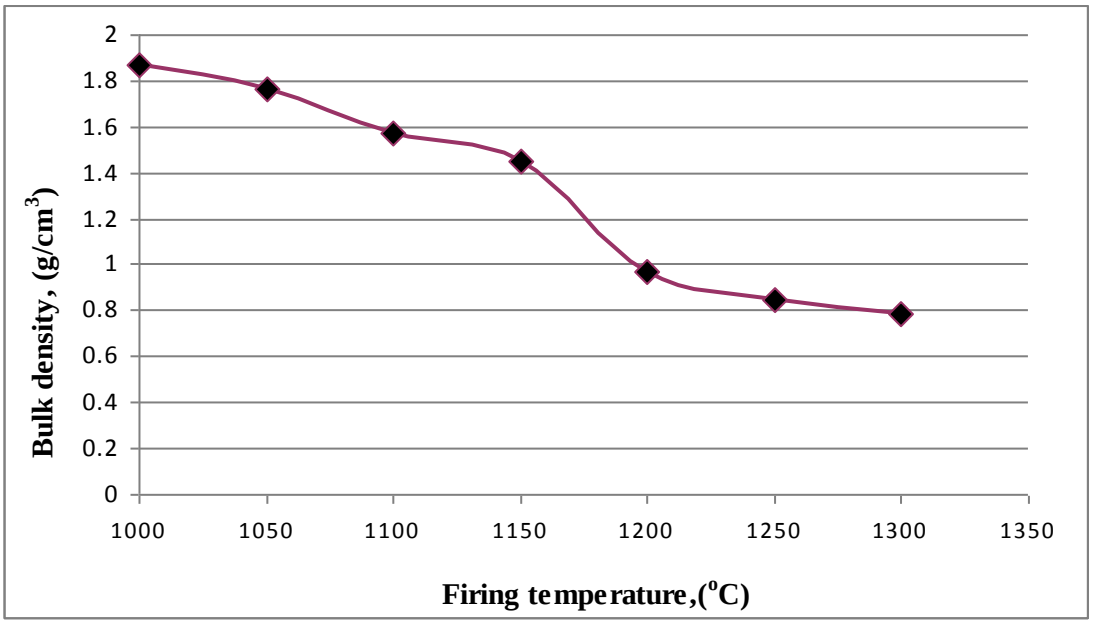


Figure 11: Rate of bloating or decreasing bulk density of El-Minya clay pellets after gradual firing between 1000 and 1300°C.

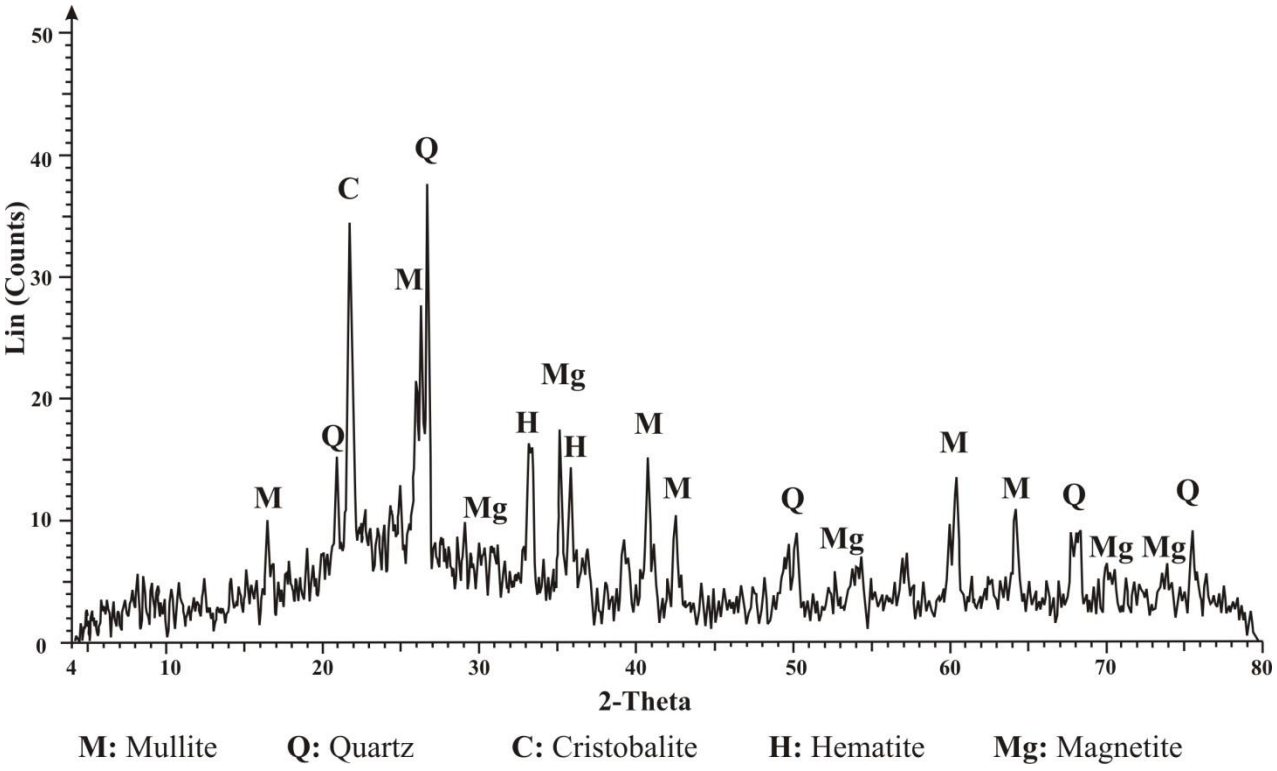


Figure 12: XRD pattern of the bloated clay pellets fired up to 1300°C.

Table 1: Particle-size composition of El-Minya technological clay samples of Gebel Qarara (GQ), El-Sheikh Fadl (SF) and Gebel El-Ahmar (GA).

Size fraction in mm, (%)	GQ	SF	GA	Average
Total sand, (2.0-0.063)	1	1	3	2
Total silt, (0.063-0.002)	34	22	28	28
Coarse and medium silt, (0.063-0.020)	4	1	6	4
Total sand and coarse & medium silt, (2.0-0.020)	5	2	9	6
Fine silt, (0.020-0.002)	30	21	22	24
Clay, (< 0.002 mm)	65	77	69	70

Table 2: Distribution of clay-mineral composition of GQ, SF and GA El-Minya clay samples.

Clay mineral	GQ	SF	GA	Average
Smectite	55	60	54	56
Illite	3	1	2	2
Kaolinite	42	39	44	42

Table 3: Chemical composition of GQ, SF and GA El-Minya clay samples.

%	GQ	SF	GA
SiO_2	41.45	47.48	49.17
Al_2O_3	17.28	20.37	21.82
Fe_2O_3	14.11	8.26	6.69
TiO_2	1.13	1.27	1.34
MgO	1.96	2.90	2.47
CaO	2.52	0.94	0.62
Na_2O	0.72	1.09	0.98
K_2O	1.29	1.02	1.02
P_2O_5	0.82	0.16	0.12
SO_3	4.20	0.99	0.77
LOI	14 .49	15.51	14.98
Total	100.00	100.00	100.00
TFO	25.65	15.37	12.68
Cl	0.67	1.82	1.71

Where, TFO: Total Fluxing Oxides, LOI: Loss On Ignition

Table 4: Physical Properties of the fired briquettes of El-Minya clay and its batch with 40% sand grains as a function of firing temperature between 800 and 1100°C

Physical properties	El-Minya clay sample, at (°C)					Clay/sand batch, (60/40), at (°C)				
	800	900	1000	1100	1200	800	900	1000	1100	1200
Total linear shrinkage, (%)	14.7	16.2	16.9	18.2	--	8.1	10.6	11.2	12.6	12.7
Bulk density, (g/cm^3)	1.94	2.15	2.26	2.80	--	1.74	1.80	1.89	2.24	2.44
Water absorption, (%)	17.6	11.3	9.1	4.8	--	20.1	17.2	14.2	9.9	3.9
Crushing strength, (kg/cm^2)	66	74	76	83	--	28	39	53	59	65