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MÖSSBAUER STUDY OF CHANGES IN CLAYS DURING FIRING

N. A. EISSA and H. A. SALLAM

Mössbauer Laboratory, Physics Department
Faculty of Sciences, Al Azhar University, Cairo, Egypt

and

L. KESZTHELYI

Central Research Institute of Physics, Budapest, Hungary

Résumé. — Des expériences de cuisson réalisées sur des argiles du Nil révèlent des variations dans les intensités du Fe^{2+} et du Fe^{3+} ainsi que des composantes magnétiques qui dépendent de la température de cuisson.

Abstract. — Firing experiments performed on Nile clay show variations in intensities of Fe^{2+}, Fe^{3+} and magnetic components depending on firing temperature.

Ancient pottery findings are studied as follows : the pottery sherds are ground, their spectra measured ; clay is collected from the neighbourhood and fired at various temperatures and differing times ; the spectra are compared. In this way objective data can be obtained as to how the pottery was made, in some cases migrations could be traced.

In previous papers [1, 2] we reported the investigations on ancient Egyptian Potteries, here the results of the clay firing experiments are collected which served as a basis for comparison.

Clay from the river Nile, was collected and fired at temperatures from 200 to 1 000 °C. Mössbauer spectra were taken after 1-24 hours firing. The spectra measured at room temperature generally contained quadrupole split peaks characteristic of Fe^{2+}, Fe^{3+} ions and six line patterns of magnetic origin. The parameters of the latter coincided with those of α-Fe_3O_3.

The spectra were first evaluated for intensities of Fe^{2+}, Fe^{3+} and magnetic ions. Collected data are given in figure 1. It can be seen that after 10 hours of firing the ratios are approximately constant. Figure 2 shows the intensity ratios of Fe^{2+} $((Fe^{2+} + Fe^{3+})$ and magnetic ions) total after 10 hours of firing.

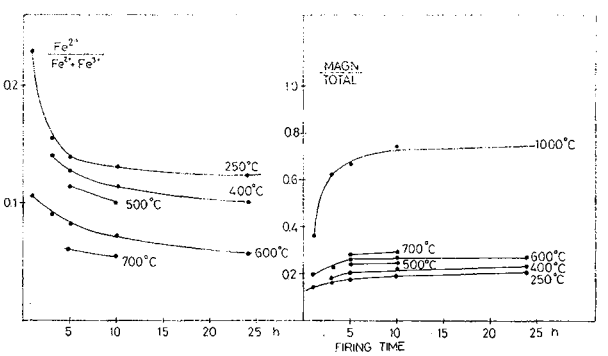

FIG. 1. — Intensity ratios in Mössbauer pattern of clays for different firing temperatures depending on firing time.

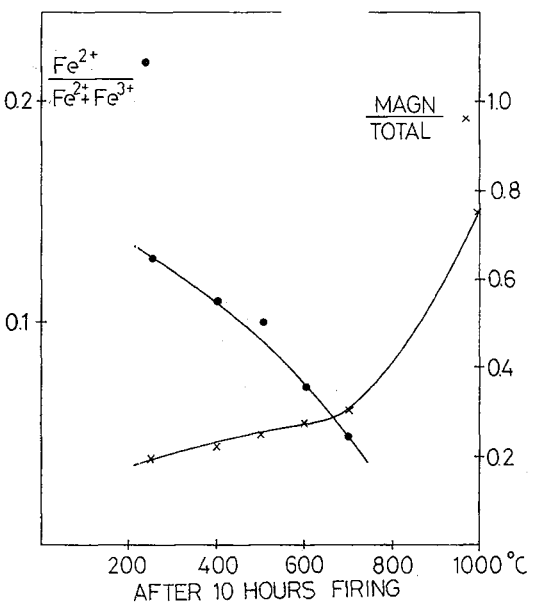

FIG. 2. — Intensity ratios after 10 hours of firing depending on firing temperatures.

The other parameters (quadrupole splitting and isomeric shift values) changed only during the first 5 hours of heat treatment. The temperature dependence of these data taken again for samples fired for 10 hours are shown in figure 3.

In table I we show the analysis of some data of

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pottery sherds from Egypt. The details of manufacturing were characterized using the data of clay firing studies. Table I is taken from reference [2].

This study shows that one can use simple Mössbauer measurements too (at room temperature) to find some archeologically interesting data about potteries. We think it has practical value if we want to propagate the Mössbauer method to archeologist.

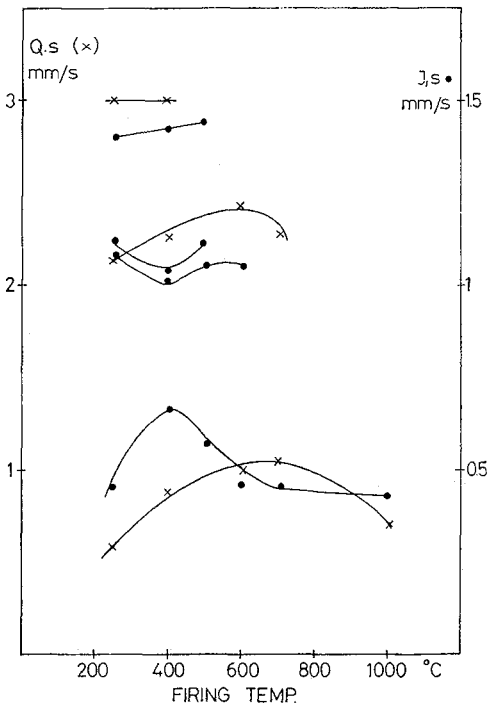

FIG. 3. — Quadrupole splitting (x) and isomeric shift (•) values of clays at different temperatures (after 10 hours of firing). One Fe^{3+} and two Fe^{2+} groups are seen.

TABLE I

Analysis of the data

Sample No	Period	$\frac{Fe^{2+}}{Fe^{3+}}$	$\frac{\text{mag.}}{\text{total iron}}$	Detail of manufacturing
—	—	—	—	—
1	Old State 3200-2777 B. C.	0.051	0.304	Nile clay baked at 700 °C, 10 hours
2	Old State (Saccara) 2778-2723 B. C.	0.165	0.614	Reducing effect of some organic tempering material
3	Old State 2723-2242 B. C.	0.000	0.120	Desert clay
4	Old State (Saccara) 662-525 B. C.	0.000	0.322	Nile clay, baked above 700 °C
5	Greek-Roman 323 B. C. 286 A. C.	0.173	0.231	Nile clay, baked at 600° C
6	Koptic 286-640 A. C.	0.056	0.160	Nile clay, baked at 600° C

References

[1] EISSA, N. A., SALLAM, H. A. and KESZTHELYI, L., *Acta Phys. Hung.* **34** (1973) 337.

[2] EISSA, N. A., SALLAM, H. A. and KESZTHELYI, L., Proc. of Conf. on the Application of Mössbauer Effect, Bratislava, 1973 (to be published).