Sepiolite at a locality in the Keuper Marl of the Midlands.

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Summary.—Sepiolite has been identified in the Keuper Marl at a Midlands locality by X-ray diffraction data, electron microscopy, differential thermal analysis, and chemical analysis. It has been calculated that a sample representing 30 ft. thickness of clay may contain as much as 39 % sepiolite. Apart from sepiolite, the Keuper Marl in the area examined consists mainly of mica, quartz, calcite, and ferric oxide.

IN the course of examination of Keuper Marl samples from a Midlands locality it became clear that an unusual clay mineral was present. The evidence presented below shows that this mineral is sepiolite. As far as the author is aware, this is the first recorded occurrence in Great Britain.

The stratigraphical range of sepiolite-bearing clay is at least 50 ft. and the area so far proved amounts to about 2 acres, mainly representing material that has already been removed and used for brickmaking, the samples having been taken from the perimeter of a brick-pit. Apart from sepiolite, the clays consist in the main of quartz grains and calcite crystals in the coarse fraction, and mica, ferric oxide, and a trace of kaolinite in the fine fraction. The results recorded below were obtained from a sample representing about 30 ft. stratigraphical thickness which appeared to be somewhat richer in sepiolite than the rest of the clay exposed.

X-ray results. The powder photographs are unfortunately not sufficiently clear for direct reproduction. The diagrams in fig. 1 have therefore been constructed in order to show the resemblance between the Keuper Marl fine fraction and theoretical sepiolite. In the diagram representing the Keuper Marl sample, the continuous lines are those attributed to sepiolite, and the broken lines to other minerals, mainly mica. It will be seen that the lines correspond closely, particularly the 12·1 Å. line, the presence of which in all the samples X-rayed is an important feature in establishing the mineral as sepiolite.

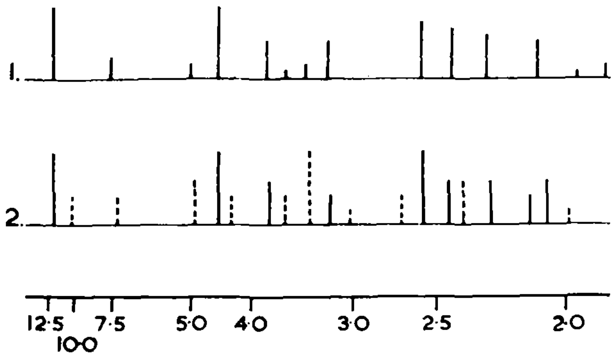
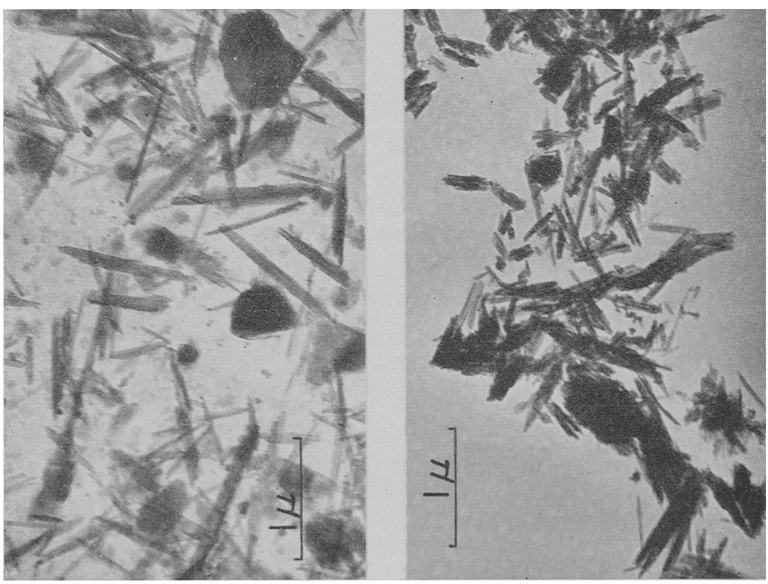


FIG. 1. X-ray powder diagrams of sepiolite (1) and the fine fraction from a Keuper Marl (2). Lattice spacings in Å.; broken lines indicate other minerals, mainly mica.



a *b*

FIG. 2. Electron micrographs of (*a*) the Keuper Marl fine fraction, and (*b*) sepiolite from Salinelles.

Electron micrographs. The electron micrograph of the Keuper Marl fine fraction (fig. 2*a*) shows a fibrous mineral (sepiolite) and equidimensional flakes, with the suggestion of hexagonal shape, probably of mica. The sepiolite fibres appear to be lath-shaped with lengths of 0·2–2 μ. They occur singly and in bunches with the long axes parallel.

The only sepiolite readily available for comparison was Salinelles (fig. 2*b*), which also shows lath-shaped fibres but shorter and more bunched together than the Keuper Marl material.

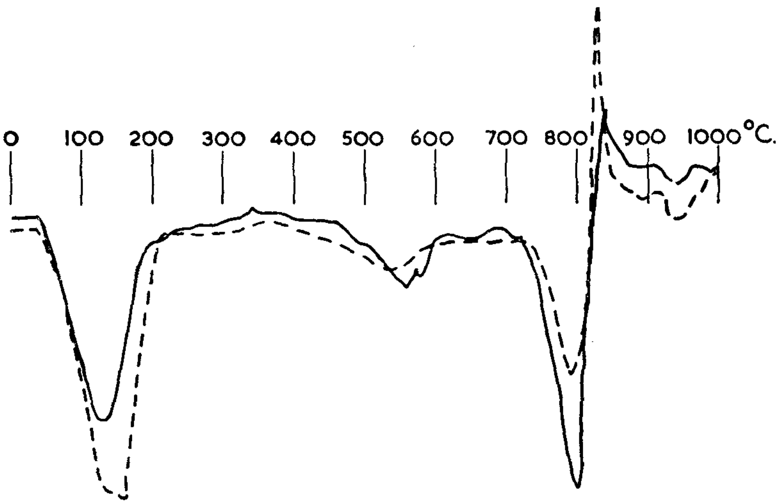


FIG. 3. Differential thermal analysis curves of the Keuper Marl (continuous line) and of a fraction with equivalent spherical diameter $< 2\mu$.

Differential thermal analysis. The results shown in fig. 3 were obtained for the whole clay and for a $< 2\,\mu$ equivalent spherical diameter fraction. The dominant features are a large endothermic peak at about 150° C., a small broad endothermic peak between 500° and 600° C., a sharp endothermic peak at 800° C., and a well-defined exothermic peak at 830° C. The peaks at 150°, 800°, and 830° C. are thought to be due to sepiolite but the endotherm at 800° C. may well include the effects of other minerals such as mica and calcite. The small endotherm between 500° and 600° C. may be due to the presence of a little kaolinite.

These results for the Keuper Marl agree well with published curves for sepiolites from other sources.[1]

Chemical analyses. Chemical analyses for the whole clay and a fraction with equivalent spherical diameter $< 1\,\mu$ prepared from it are given in table I. The fine fraction comprised about one-third of the material.

[1] P. F. Kerr, J. L. Kulp, and P. K. Hamilton, Amer. Petroleum Inst. Res. Proj., 49, 1949, Prelim. Rep. No. 3.

TABLE I. Chemical analyses of (1) the whole clay, and (2) a fraction with equivalent spherical diameter $< 1\mu$, together with (3) the calculated mineral composition of the whole clay.

	1.	2.		3.
SiO_2	55·85	51·10	Sepiolite	39
TiO_2	0·54	0·35	Mica	28
Al_2O_3	10·26	12·26	Quartz	18
Fe_2O_3	3·83	5·25	Calcite	10
CaO	5·66	0·54	Kaolinite	tr.
MgO	11·30	18·81	Ferric oxide	4
Na_2O	0·19	0·49		
K_2O	3·01	2·58		
Li_2O	0·03	0·03		
Loss on ign.	9·62	8·69		
MnO	0·05	0·06		
	100·34	100·16		

X-ray examination of the fine material showed the presence of sepiolite and mica, the former predominating, with traces of kaolinite and quartz. Assuming that the alkalis represent mica and that the balance of alumina represents kaolinite, the total proportion of these two minerals, using ideal formulae, works out at 32 %, leaving the rest as sepiolite and ferric oxide. The SiO_2:MgO molecular ratio for the sepiolite, after deducting the SiO_2 required by the mica and kaolinite, works out at 1·3, which falls within the range 1·21–1·80, obtained for sepiolites by Migeon (quoted by Caillère).[1]

The whole clay, according to mineralogical examination, contains sepiolite, mica, quartz, calcite, ferric oxide, and a trace of kaolinite. Assuming ideal formulae (sepiolite, $2MgO.3SiO_2.H_2O$; mica, $K_2O.3Al_2O_3.6SiO_2.2H_2O$ and soda analogue) the mineral proportions work out as in col. 3, table I. The figure of 39 % for sepiolite should be taken as a maximum, because the results for the fine fraction indicate a lower SiO_2:MgO molecular ratio than the assumed 1·5, and a small proportion of the magnesia may be combined in other minerals.

For the sepiolite content of the clays as a whole in the locality a conservative estimate of 25 % has been made.

Discussion. According to Millot,[2] sepiolite was formed under unusual conditions in highly basic, saline lakes. The clay mineral normally formed in such environments is illite, and the conditions required for sepiolite are at present unknown. It seems clear, however,

[1] G. W. Brindley, X-ray Identification and Structures of Clay Minerals, London, 1951, chap. 8.

[2] G. Millot, Géol. appl. et Production Minière, 1949, Tome 2, Nos. 2, 3, 4.

that MgO combined with SiO_2 to form sepiolite in preference to combining with CaO and CO_2 to form dolomite. High concentration of SiO_2 and low concentration of Al_2O_3 might help to provide the necessary environment. Such conditions might well be found in lakes receiving drainage from a lateritic hinterland as envisaged by Wills[1] for the Keuper period.

The discovery of sepiolite recorded above is not the first time that an unusual clay mineral has been found in the Keuper Marl. Honeyborne[2] has reported the presence of clay minerals that appear to have a mixed chlorite and montmorillonite lattice and these minerals have also been studied by Stephen and MacEwan.[3] More knowledge about the mineralogy of the clays as a whole, including the lateral and stratigraphical extent of the unusual clay minerals, would assist in interpreting palaeogeographical conditions.

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[1] L. J. Wills, Palaeogeographical Atlas of the British Isles and Adjacent Parts of Europe, 1951. London: Blackie and Sons.

[2] D. B. Honeyborne, Clay Min. Bull., 1951, vol. 1, p. 150.

[3] I. Stephen and D. M. C. MacEwan, ibid. p. 157.