

## NOTES

### A REGULAR MIXED LAYER MICA-BEIDELLITE

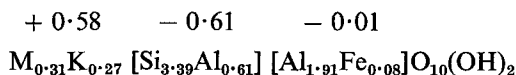
This clay mineral occurs in Pechos de los Cristos, near Serrata de Níjar (Almeria Province). In the vicinity there are several deposits of plastic clay which have been formed by hydrothermal action on the parent rock, hornblende dacites (Linares González, 1963). The sample, which was white and earthy, had impurities of jarosite, quartz, and gypsum of large crystal size. It was purified by dispersion and sedimentation so that the fraction of less than  $2 \mu$  equivalent spherical diameter was collected.

TABLE 1. Chemical analysis of  $<2 \mu$  e.s.d. fraction

SiO <sub>2</sub>	48.62%	Na	10 m-eq/100 g
Al <sub>2</sub> O <sub>3</sub>	30.72%	K	13 m-eq/100 g
Fe <sub>2</sub> O <sub>3</sub>	1.77%	Ca	6 m-eq/100 g
TiO <sub>2</sub>	1.12%	Mg	39 m-eq/100 g
MgO	0.77%		
CaO	0.16%		Σ cat. = 68 m-eq/100 g
K <sub>2</sub> O	3.77%		
Na <sub>2</sub> O	0.30%		
H <sub>2</sub> O-	6.40%		
H <sub>2</sub> O+	6.31%		

Cation exchange capacity 74 m-eq/100 g oven-dried sample.

The chemical composition, exchange capacity (barium acetate method), and the sum of the displaced cations were determined and the results are shown in Table 1. From these results, the half unit cell composition was calculated to be



In accordance with the acid pH of the natural sample, the difference between the exchange capacity and the sum of the exchangeable cations, 6 m-eq/100 g, is likely to be due to exchangeable hydrogen.

The X-ray examination was mainly done with a Philips diffractometer and Cu K $\alpha$  radiation; in addition, the photographic method was used when convenient. Table 2 gives the basal spacings and integrated intensities obtained from oriented aggregates which had been subjected to different treatments. Fig. 1 shows the

TABLE 2. Basal spacings and observed intensities from flakes of  $< 2 \mu$  e.s.d. fraction

Untreated		E.G. treated		110° C*		500° C*		Acid attack†	
$d(\text{Å})$	$I$	$d(\text{Å})$	$I$	$d(\text{Å})$	$I_x$	$d(\text{Å})$	$I_x$	$d(\text{Å})$	$I$
22.8	66	26.6	100	9.81	vs	9.90	s	26.6	100
11.04	100	13.4	92	4.89	ms	4.87	ms	13.3	80
5.22	40	9.1	16	3.49	vw	3.51	vw	9.1	46
3.21	48	5.20	10	3.27	s	3.30	vs	5.18	12
2.50	6	4.48	8	2.86	vw	2.50	w	4.47	18
2.01	17	3.30	31	2.58	w	2.39	vw	3.30	40
		3.00	4	2.02	m	1.99	mw	3.00	3
		2.65	2	1.97	m			2.65	4
		2.03	16					2.03	15
		1.91	17					1.91	18

$I$  = integrated intensities.

$I_x$  = visual estimation on photograph.

\* Flakes in sealed tubes.

† Oriented aggregate treated with  $\text{H}_2\text{SO}_4$ , see Martín Vivaldi & Rodriguez Gallego (1961), and then ethylene glycol treated.

corresponding diffractometer traces. The natural material gave  $d(001)$  of 22.8 Å and this changed to 26.6 Å with ethylene glycol and 28.3 Å with acetonitrile, all three results giving nearly rational orders. Flakes heated to 110° C and sealed, or heated 500° C, gave  $d(001)$  of 10 Å with rational orders. The absence of the odd orders is probably due to the similar thicknesses and structure factors of both layers in the collapsed form of the mineral. However, the natural sample did not re-expand with ethylene glycol, only flakes, which had been Li-saturated and heated to 200° C without subsequent sealing, gave a  $d(001)$  of 11 Å and with ethylene glycol swelled again to 26.8 Å (without higher orders) in accordance with the behaviour of beidellite (Greene-Kelly, 1953). Table 3 gives the non-basal reflections found with the ethylene glycol-treated aggregates. The reflection, 060, at 1.497 Å shows that the mineral is dioctahedral.

TABLE 3. Non-basal reflections and their observed intensities from flakes of  $< 2 \mu$  e.s.d. fraction

$d(\text{Å})$	$I_{(x)}$
4.49	s
2.57	ms
2.42	mw br
2.00	m
1.96	w
1.71	vw
1.497	m

(x) = Visual estimation.

FIG. 1. Diffractometer traces from oriented aggregates of the  $< 2 \mu$  e.s.d. fraction: A, untreated; B, ethylene glycol-treated; C, heated to  $500^\circ \text{C}$ .

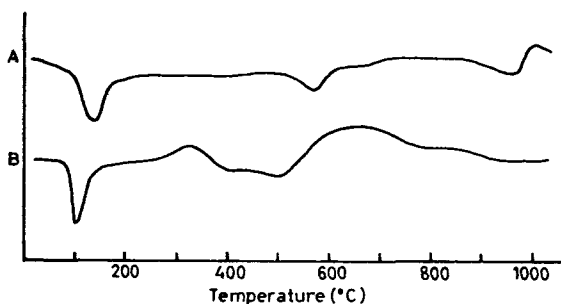
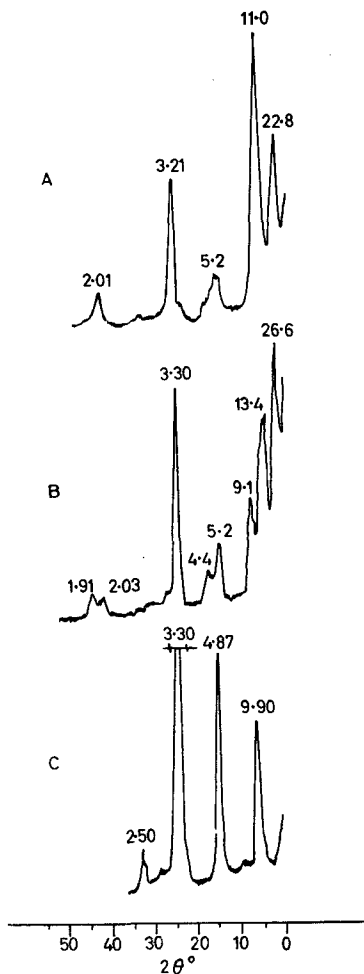


FIG. 2. Differential thermal analysis curves of the  $< 2 \mu$  e.s.d. fraction: A, untreated; B, saturated with piperidinium ions.

Fig. 2 shows the differential thermal analysis curves of the natural and piperidinium-treated mineral. The untreated sample gave endothermic effects at  $132$ ,  $563$  and  $950^\circ \text{C}$ ; the curve is, therefore, similar to rectorite (Bradley, 1950). The piperidinium saturated sample gave an exotherm at  $640^\circ \text{C}$  characteristic of beidellite (Allaway, 1949).

Electron micrographs showed that the sample consisted of very thin tape-like particles but these were not as clearly developed as those of allevardite or rectorite (Brown & Weir, 1963).

### Conclusions

The analyses show that the mineral is an aluminosilicate with predominant tetrahedral substitution. The X-ray results show that it is built up of pairs of dioctahedral layers, the inter-layers being alternatively mica-like and beidellite-like. The structure is obviously similar to allevardite or rectorite (Brown & Weir, 1963). Points of difference are the absence of a 20 Å reflection with the heated mineral, the less regular interstratification (shown by the width of basal reflections and their slight divergence from rationality), and the presence of two separate peaks at 13 and 16 Å with the ethylene glycol-treated sample. The fourier transform method (MacEwan, 1956) showed that the mineral approximated to a 1 : 1 regular interstratification.

Heystek (1954) described a closely similar mineral from Burghersdorp (South Africa) which developed by hydrothermal alteration of dolerite intrusion in shale. The Burghersdorp mineral, however, has a lower exchange capacity than this mineral, 48 m-eq/100 g as opposed to 74 m-eq/100 g. In this connection, it should be noted that the barium acetate method used here gives larger values than the conventional ammonium acetate method, because potassium is not easily replaced by ammonium ions.

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M. RODRIGUEZ GALLEGO  
L. J. ALÍAS PÉREZ

Estación Experimental del Zaidin del  
C.S.I.C., Granada.  
Facultad de Farmacia de la Universidad de Santiago  
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