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NOTE ON CHAMOSITE IN SEDIMENTS OF THE SURINAM SHELF

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INTRODUCTION

Chamosite can be found as authigenic clay mineral in mineralized faecal pellets (coprolites) and fillings of the tests of micro-organisms. Porrenga (1965, 1966, 1967) has found this mineral in recent sediments of tropical areas, such as the Orinoco and Niger deltas and the Sarawak shelf. This recent chamosite can be distinguished according to Porrenga by the colour (green to brown) into three varieties, which are supposed to represent different stages in the diagenetic development.

But not all coprolites and fillings of tests of micro-organisms contain chamosite. Burst (1958) has found that the coprolites of the Tertiary inner-neritic to swampy sediments of Texas are characterised by a 7 Å mineral component, so that besides chamosite also kaolinite and chlorite can be mentioned as possible constituents. In sediments off Florida Ehlmann et al (1963) found kaolinite as one of the constituents of the light-green to white fillings of the tests of foraminifera and also in some of the dark-green to black particles.

Moreover chamosite occurs as transition form of chlorite. Porrenga (1967) in some samples, found at a depth of 50 m of the Sarawak shelf, has observed a great number of such transition forms and even transitions from biotite to chamosite were found, though to a minor extent.

The Surinam shelf area with the sandy soil samples can be regarded as a relict of the late-Pleistocene and Holocene, transgression (Nota, 1969). Investigation of sediments of the Surinam shelf shows the presence of chamosite, which can be determined by X-ray analyses.

MATERIAL AND PROCEDURES

The sediment samples of the Surinam shelf are collected by Dr. D.J.G. Nota with the surveying ship H.NL.M.S. Snellius of the Netherlands Marine in April-May 1966. For this investigation on the occurrence of chamosite some samples of the line of sample collection F (Nota, 1969), which runs across the shelf, are chosen.

By mechanical analyses of the samples investigated, sand fractions were obtained. From these similar granules according to colour and external morphology are picked out by means of a binocular microscope.

Some material, consisting of hand-picked similar granules, is pretreated for X-ray investigation. Thermal treatment at 400°C and 550°C each during one hour is carried out. Hydrazin-hydrate and aethylene-glycol treatments are also applied at a temperature of about 60°C during 24 hours.

The similar granules are crushed in an agate mortar, mounted in the goniometer in a 0.2 mm glass capillary and irradiated by a CoK_α radiation, generated at 30 kV and 10 mÅ during 4 hours. Powder X-ray diffraction patterns (photographs) are obtained by means of a 57.3 mm Debey-Scherrer camera of an Evershed-Enraf X-ray apparatus. One DTA analysis is carried out with a Du Pont-900 apparatus.

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TABLE I: d-values and intensities

1		2		3		4		5		6	
F41-depth 63m		F41-depth 63m		F41-depth 63m		F37-depth 121m		F46-depth 28m		F47-depth 27m	
d (Å)	I	d (Å)	I	d (Å)	I	d (Å)	I	d (Å)	I	d (Å)	I
7.23	s	7.21	s	7.23	s	7.22	s	7.23	m	7.21	s
4.56	s	4.54	s	4.57	s	4.53	m	4.52	s	4.52	s
4.23	w	4.24	w	4.26	w	4.22	w	4.23	w	4.22	w
3.55	m	3.54	s	3.54	m	3.55	w	3.55	w	3.54	w
3.33	s	3.33	m	3.32	s	3.34	s	3.34	m	3.33	s
						3.00	vs				
2.65	w	2.63	w	2.65	w	2.70	w	2.62	w	2.60	m
2.40	w	2.44	w	2.42	w	2.47	m	2.45	w	2.45	m
						2.25	w				
						2.09	w				
						1.97	w				
						1.88	w				
						1.82	w				
						1.73	w				
1.54	m	1.54	m	1.54	m	1.54	m	1.55	w	1.54	m

1. Green to dark-green fillings of the tests of a foraminifera species
2. Black fillings of the tests of a foraminifera species as 1, with glossy surface and a light-coloured interior part
3. Item as 2, but of some species of micro-organisms
4. Black fillings of the tests of some species of micro-organisms, whereby some still have a little chalk-test
5, Greenish black granules, white spotted, oblonged and with rounded sides some rather sheet-like
6. Greenish black granules, white spotted, oblonged and with rounded sides rounded sides

I = intensity of the line, visually ascertained
vs = very strong
s = strong
m = moderate
w = weak

7		8		9		10		11		12	
F45-depth 32/33m		F43-depth 36m		F41-depth 63m		F41-depth 63m		F41-depth 63m		F41-depth 63m	
d (Å)	I	d (Å)	I	d (Å)	I	d (Å)	I	d (Å)	I	d (Å)	I
				14.00	s	14.10	s			14.10	m
7.20	m	7.22	m	7.19	s	7.18	s	7.20	w	7.20	m
4.52	s	4.52	s	4.56	m	4.55	m	4.56	w	4.52	s
								4.46	m		
4.24	w	4.22	w					4.17	s		
3.54	w	3.55	w	3.55	w	3.55	w			3.54	w
3.34	m	3.33	m							3.32	w
2.60	m	2.60	w	2.63	w	2.64	w	2.69	w	2.64	m
								2.57	w		
2.46	m	2.45	w	2.44	w	2.43	w	2.45	s	2.42	w
								2.25	w		
								2.18	w		
								1.72	w		
								1.56	w		
1.54	w	1.53	w	1.54	w	1.54	w	1.53	w	1.53	m
								1.51	w		

7. Greenish black granules, white spotted, oblonged with rounded sides and some rather platy
8. Black granules, with a rather dull surface, rounded sides and some rather platy
9. Dark-green to black, sheet-like granules
10. Dark-green to black, accordion-shaped granules, with light-green material between the cleavage-planes
11. Light to dark-brown, sheet-like granules
12. Dark-green to black granules, oblonged and rounded (coprolite), some with "cracks"

RESULTS AND DISCUSSION

The presence of chamosite (7.2Å, 4.54Å, 3.55Å) is concluded from the X-ray diffraction patterns of the hand-picked granules of the sediment samples. The calculated d-values generally agree with the d-values of iron-chamosite, which are given by A.S.T.M. The first three d-values according to A.S.T.M. are 7.06Å, 4.54Å and 3.53Å.

The patterns show bands at 4.5Å, between 2.6 and 2.4Å and at 1.5Å and in addition a few lines of interference, which show that the formation of well-ordered chamosite does not make great progress. The calculated d-values of the base-lines are higher than usually observed with chamosite. The somewhat higher value of the (001) reflection approximates that of kaolinite, but on the other hand the (060) reflection is at 1.54, which indicates the trioctahedral character of chamosite.

On heating at 400°C of a mixture of the materials nrs 9 and 10, and material nr. 3 the 7Å line disappears, which indicates a decomposition of chamosite; according to Burst (1958) that line must still be present by kaolinite. On heating at 550°C no more reflections of chamosite remain. The colour of chamosite changes from greenish black to brown on heating the samples in the air. The presence of chamosite finally can be proved by the hydrazin-hydrate treatment, which causes no shifting of the 7Å line. Concerning kaolinite, according to Thielepape (Quakernaat, 1968) the 7Å is shifted to the 10Å position. The D.T.A. curve of the mixture of materials nrs 9 and 10 shows an endothermic reaction below 220°C and another one starting at about 360°C. The endotherm peaks are inconspicuous (peak-width – great, peak-height – small), which characterises the ferri-form of chamosite, because the mineral according to Brindley and Youell (1953) is already for the greater part dehydrated.

The colour of the investigated materials is green to greenish black, which is caused by a relatively high Fe and Mg content.

The formula of chamosite according to Porrenga (1967) approximates to:

$$(Fe^{2+}, Mg)_{2.4}(Fe^{3+}, Al)_{0.6}(Si_{1.4}Al_{0.6})\ O_5\ (OH)_4$$

According to Brindley and Youell (1953) the formula of ferrichamosite is:

$$(Fe^{3+}_{1.8}, Mg_{0.2}, Al_{0.8})(Si_{1.3}Al_{0.7})O_5O_{2.3}(OH).$$

Fillings of the tests of micro-organisms (table I nr. 1 up to 4) besides chamosite also contain quartz (3.33 Å); on heating of the material 3 at 550°C only the reflections of quartz remain. They belong to the greenish type of chamosite of Porrenga, which probably represents the youngest stage in the mineralization process. Material nr. 1 consists of greenish to greenish black coloured fillings of a small foraminifera species, while nr. 2 represents the special "subtype" of Porrenga, consisting of fillings of the tests of the same foraminifera species with a blackish coloured glossy surface over a lighter green interior part. Material nr. 3 further shows, that the formation of chamosite can take place in the tests of different species of micro-organisms; Porrenga has also shown that there is no relationship between type of organism and chamosite variety. The presence of calcite (3.00 Å), which envelops the fillings as rest of the test, is clearly seen on the X-ray diffraction pattern of material nr. 4. The greenish black to entirely blackish coloured grains (nr. 5, 6, 7 and 8), of which the morphology of the organisms has disappeared, also contain chamosite and quartz. An interesting case is observed in sample F41, which is taken from a depression of 61 m depth. Nota (1969) has considered this subsidence as a submerged river valley. In this sample a great number of greenish black granules is encountered, which are sheet-, accordion-, lobate- and coprolite-shaped. The sheet-shaped granules show layers and sometimes the hexagonal morphology; yellowish green material is seen between the cleavage planes or spotted at the sides. The accordion-shaped granules are similar to the sheet-shaped granules with thin layers of lightgreenish material, but they are swollen by uptake of water. The lobate-shaped granules have a somewhat botryoidal shape, whereby the rounded parts are separated from one another by a layer of light-greenish material. Superficially these forms sometimes resemble foraminifera. The coprolite-shaped granules are oblonged and rounded, and often show cracks. The four granules mentioned before are met with in the pictures, which Galliher (1935) has given in his description of the formation of coprolites derived from greenish "biotite". The hand-picked sheet-, accordion- and coprolite-shaped granules (resp. nr. 9, 10 and 12) have been investigated separately by X-ray diffraction.

Besides chamosite chlorite is formed and also quartz is present in the coprolites. Glycolisation of the mixture of materials nrs 9 and 10 has shown that the 14 Å line is not affected. On heating at 550°C. chlorite is also decomposed, because this mineral encountered in recent sediments, is still badly crystallized. The chamosite of the Sarawak shelf has been considered by Porrenga (1967) as a transitionform of chlorite and biotite; the 10 Å line of biotite is not present here. The submerged valley of the Surinam shelf apparently can be considered as a favourable reducing environment for chamositisation processes.

From the same sample F41 also are collected light to dark-brown sheet-shaped granules (material nr. 11), some of which have greenish black spots. Sometimes they show the hexagonal morphology and layers, showing light-coloured material between the cleavage planes. Goethite (4.17 Å, 2.44 Å) and little chamosite are the component part of these granules, which can be classified as the brown type of Porrenga and may be considered as an older, partly oxidized form of the greenish type. According to Porrenga (1967) this brown type probably represents the transition of the green chamosite granules to the completely brown goethite granules.

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