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CHAMOSITE IN RECENT SEDIMENTS OF THE NIGER AND ORINOCO DELTAS

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ABSTRACT

The mineralised faecal pellets in Recent shallow-water sediments of the Niger and Orinoco deltas contain mainly authigenic poorly ordered chamosite with a fairly high magnesium content. Photographs, chemical- and X-ray data of these chamositic pellets are given and their origin and occurrence are discussed.

INTRODUCTION

Chamosite is the major clay mineral in many ancient oolitic sedimentary ironstones, but to the author's knowledge no Recent sediments containing authigenic chamosite have yet been recorded. In the present contribution such an occurrence of chamosite, in Recent sediments of the submarine Niger and Orinoco deltas, is described.

The samples from the Niger delta were collected during the Recent Sediment Survey jointly organised by Shell Internationale Research Maatschappij and the British Petroleum Company Limited. The samples from the Orinoco delta were collected during an expedition organised by the N.V. Bataafsche Petroleum Maatschappij.

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RESULTS AND DISCUSSION

The presence of chamosite as the major clay mineral in many well-known oolitic ironstones has been referred to by several authors including Taylor (1949), Bhattacharya (1959) and Millot (1964). In these rocks the chamosite usually occurs as ooids, which, in thin section, show a number of concentric rings around a grain of quartz or other mineral. Chamosite also occurs without these rings or mineral inclusions as pelletoids, and sometimes as a matrix constituent. It is commonly accompanied or replaced by minerals such as goethite and siderite.

The formula of chamosite approximates to:

$(Fe^{2+}, Mg)_{2.3}(Fe^{3+}, Al)_{0.7}(Si_{1.4}Al_{0.6})\ O_5\ (OH)_4$ (Brindley, 1961, p. 105). The structure and X-ray diagrams resemble those of kaolinite or of chlorites. Bubenicek (1960) suggested that the kaolinite-type chamosite can convert into the chlorite type. This hypothesis was based on the observation that the chlorite-type chamosite prevails in those sedimentary rocks that are considered to be in an advanced diagenetic stage. Details of the structure, X-ray identification and chemical composition of chamosite are given by Brindley (1951; 1961) and Caillère and Hénin (1963).

Chamosites have been synthesised in the laboratory at low temperatures (Caillère, Hénin and Esquevin, 1953, 1955; Caillère and Hénin, 1960), but no Recent sediments containing chamosite have yet been recorded (Hollingworth, 1960, p. 534; Braun, 1962, p. 613).

From studies of chamosites in ancient rocks several suggestions concerning their origin have been offered, most authors arriving at the conclusion that the chamosite forms synsedimentarily or in an early diagenetic stage in the sediment. The most likely environment is thought to be shallow marine, near a land mass that could have supplied the necessary iron (lateritic soils).

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During an investigation of the mineralogical composition of mineralised faecal pellets in Recent sediments of the Niger and Orinoco deltas, we observed that chamosite was the main component of almost all pellets that were found at depths less than about 30 fathoms. The colour of these pellets is dark-green, but it may turn to brown if the surface is oxidised to goethite. Examination of thin sections of the pellets showed no signs of concentric layering, except for the outer shell of goethite (fig. 1).

Most pellets contain quartz or other mineral inclusions. These were obviously also consumed by the animals that are responsible for the pellets, and may probably not be considered as nuclei for chamosite formation, but only as impurities. It is noteworthy that, especially in the Niger delta, chamosite like glauconite starts to form mainly in faecal pellets. Glauconite pellets, however, occur in the Niger delta in deeper water than the chamosite pellets do, between the 70 and 120 fathom isobaths. In the Orinoco delta insufficient deep-water samples were analysed for any actual depth-boundaries to be recognised.

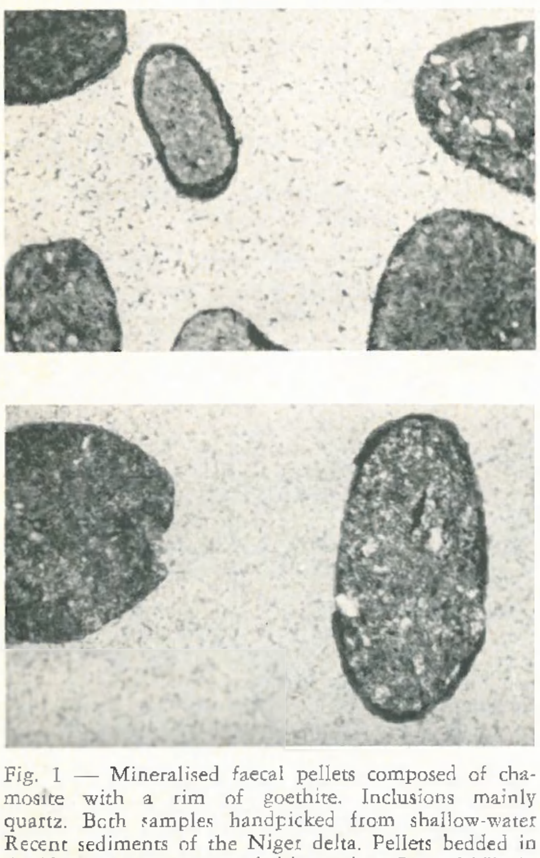

Fig. 1 — Mineralised faecal pellets composed of chamosite with a rim of goethite. Inclusions mainly quartz. Both samples handpicked from shallow-water Recent sediments of the Niger delta. Pellets bedded in Araldite for preparation of thin section. Crossed Nicols. (Magn. 90).

Chamosite contains ferrous iron; in a marine environment with a pH of 8 or slightly less, the oxygen content has to be low for the formation of chamosite. Most of the iron enters the sea as ferric iron, as a detrital-clay-mineral constituent (the average iron content of the $<$2-micron fraction is 6.5%, in the Niger delta), and as coatings on quartz grains, etc. Some of this ferric iron may become mobile and available as ferrous iron for the formation of chamosite, if it is reduced by organic material present in the surface layer of the sediments. The food consumed by animals living in or close to the sea-bottom may be contaminated by inorganic compounds such as clay minerals and debris of other minerals; such animals will therefore produce faecal pellets composed of an intimate mixture of organic and inorganic material. Grey pellets, which in the Niger delta occur at all depths but especially around the 250 fathom isobath and which have not undergone "glauconitisation" or "chamositisation", were found to contain the same amount of iron as, or even less than, the detrital clay matrix in which they occur (see table). The table also shows that the iron content of the chamosite pellets is appreciably higher than that of the matrix. After the pellets have been produced, the iron content is thought to increase during the diagenetic process. It may be noticed that the Recent chamosite pellets have a fairly high magnesium content (as have the Recent glauconite pellets) compared with the older ones (see table).

Down to 7500 ft in the subsurface, in shallow-marine deposits of Miocene age, in the Niger delta, chamosite pellets have been found that did not differ from the Recent ones with respect to the X-ray diagram and the texture as revealed in thin sections; this suggests that no further ordering had occurred. The relatively recent chamosites are poorly ordered, whereas those from the Mesozoic (B r i n d l e y, 1951) and older ironstones are much more ordered (fig. 2).

It is therefore concluded that if this poorly ordered chamosite is considered as the precursor of the better ordered, older types, the transformation will take place at even higher temperatures and pressures than those prevailing at the depth at which this Miocene chamosite is found, or after longer times.

Since the Recent sediments of the Niger and Orinoco deltas generally contain only a few per cent or less of chamosite pellets, it is clear that they cannot be considered as a future clay ironstone after burial and consolidation. Nevertheless, these occurrences of chamosite constitute an interesting example of chamosite formation in Recent deltaic coastal sediments for the many

TABLE

Approximate chemical composition of green chamosite pellets, grey pellets and the clay matrix

	Recent chamosite[1])	*Miocene cham.*[1])	*Jurassic cham.*	*Devonian cham.*[2])	*Grey pellets*[1])	*Clay matrix*[3])
	with goethite and quartz impurities	with goethite and quartz imp.	recast to 100% by Brindley	with siderite impurities, corrected for dolomite	with calcite and quartz impurities	< 2-microns, with quartz impurities
	Nigeria	Nigeria	England	Algeria	Nigeria	Nigeria
SiO_2	52 %	46 %	23.81%	32 %	48 %	50.5%
Al_2O_3	8	13	23.12	15.5	20	17
Fe_2O_3	20 [4])	23 [4])	0.23	34 [4])	7.9[4])	10.6[4])
FeO	n.d.	n.d.	39.45	n.d.	n.d.	n.d.
MgO	8.3	4.7	2.72	4.0	1.7	2.0
CaO	0.5	0.5	—	n.d.	2.2	0.8
Na_2O	0.3	0.4	—	0.2	0.4	0.3
K_2O	<0.5[5])	<0.5[5])	—	<0.5[5])	n.d.	1.5[5])
TiO_2	0.4	0.4	—	0.3	0.9	0.7
H_2O+	11	11	10.67	13.5	15.0	15.0
H_2O-	0.4	0.4			1.8	1.6
	101.4	99.9	100.0	100.0	97.9	100.0

1) Average figures obtained by spectrochemical analysis of 2 samples.

2) One sample analysed Recast to 100 %.

3) Average figures obtained by spectrochemical analysis of 4 samples. They gave a sum of about 110% and were recast to 100%.

4) Owing to smallness of sample, the FeO content could not be determined. All iron reported as Fe_2O_3.

5) Determined by X-ray fluorescence analysis.

All samples were heated to about 700° C, before weighing and spectrochemical analysis. The spectrochemical analyses were performed with a 3.4 m Jarrell-Ash emission spectrograph. The method used was that described by J. Kroonen and D. Vader: "Line interference in emission-spectrographic analysis. A general emission-spectrographic method including sensitivities of analytical lines and interfering lines". Elsevier Publishing Company, Amsterdam, 1963.

investigators of sedimentary ironstones who maintain that, or wonder why, glauconite is the only iron silicate formed in modern oceans (Taylor, 1949, p. 84; Borchert, 1960, p. 267; Braun, 1962, p. 613).

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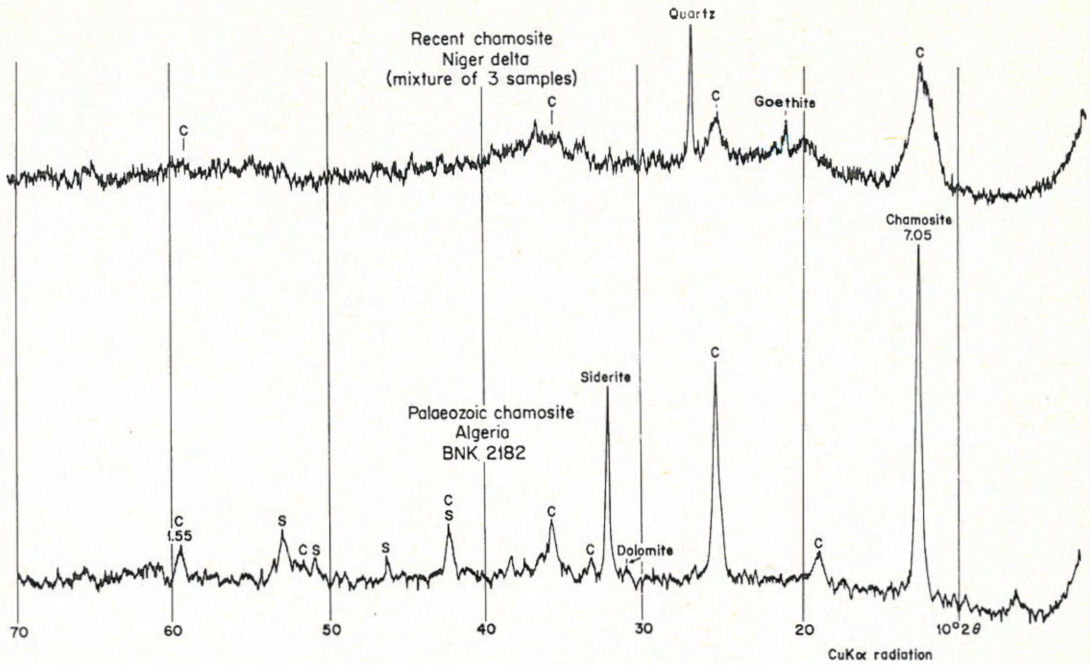

Fig. 2 — X-ray diagrams of Recent and Palaeozoic chamosite.

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