A CLAY MINERALOGICAL STUDY OF THE 
IRONSTONE AT EASTON NESTON, 
NORTHAMPTONSHIRE

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ABSTRACT

An X-ray study of the chamosite occurring in the ironstone beds near Easton Neston, Northamptonshire, has shown that probably the whole of the worked ironstone at this point is part of the Main Oolitic Ironstone Group of the Northampton Sand Ironstone formation. The boundary between the Main Ironstone in this area and the Chamosite-Kaolinite beds which overlie it has hitherto not been clearly identifiable, but it is now certain that the boundary is not more than 2 ft. 6 ins. below the top of the worked ironstone.

INTRODUCTION

The rocks of the Northampton Sand Ironstone formation, which is one of the principal sources of iron ore worked in Britain today, can be grouped into five lithological sub-divisions. Taylor (1949) has described the characteristics by which the five sub-divisions can be distinguished, and their occurrence over the area covered by the formation. The Main Oolitic Ironstone Group is the chief source of workable ore and this bed is present throughout the area of the formation. In general this bed comprises an oolitic ore with siderite and chamosite as its principal constituents. Two other sub-divisions, the Upper and Lower Chamosite-Kaolinite groups, occur only in limited areas of the field, above the Main Oolitic Ironstone. These "top beds" contain much less iron than the Main Ironstone, and are not by themselves economically workable as an ore although in certain cases they may be worked to a small extent with the Main Ironstone. The iron in the Chamosite-Kaolinite beds is present as chamosite, oxidised chamosite, or goethite (limonite); siderite is virtually unknown as a primary mineral of this part of the formation.

In certain parts of the field the Chamosite-Kaolinite beds have undergone enrichment by the secondary development of siderite, often as sphaerosiderite, which increases the iron content to such an extent that they may become workable. The enrichment of the Chamosite-Kaolinite beds by siderite can sometimes proceed to such a stage
that the product is very similar to the rocks of the Main Oolitic Ironstone group and the boundary between these two beds may be uncertain.

Taylor (1949, p. 35) has pointed out the possibility that some of the rocks with chamosite ooliths in a chamosite-siderite groundmass, which are widespread in the Blisworth-Easton Neston area are in fact partially sideritized oolitic chamosite mudstones.

The top few feet of the worked ironstone in the Easton Neston area may therefore belong to either of these two groups. In view of the new facts which have been discovered about chamosite since the appearance of the Northampton Sand Ironstone Petrology monograph in 1949, it seemed possible that the problem might be solved by examining the chamosite content of the ironstones in question.

Brindley (1949, 1951) showed that the chamosite occurring in ironstones and lateritic deposits was a kaolin mineral which was present in two forms, ortho-hexagonal and monoclinic, the former being the more commonly occurring variety. Brindley and Youell (1953) isolated an almost pure specimen of chamosite from the Northampton Sand Ironstone at Corby and analysed it chemically, thermally and by X-rays. The present author (1953, 1955) has shown that there is a wide variation of structure in the ortho-hexagonal chamosite commonly occurring in ironstones. There is a continuous variation between ordered and disordered structures which may be correlated with the iron content of the mineral and the type of environment present in the ironstone in which it occurs. The Main Oolitic Ironstone of the Northampton Sand Ironstone contains a chamosite relatively rich in iron and with very little disorder. Chamosite specimens from this bed can be recognized by the clarity and sharpness of the 20l reflections, which are very greatly affected in intensity and sharpness by any disorder in the a-direction of the structure. The chamosite from both the Upper and Lower Chamosite-Kaolinite beds is considerably different crystallographically from that occurring in the Main Oolitic Ironstone. The work of Cohen (1949; private communication 1953) indicated that the iron content of the chamosite from the Chamosite-Kaolinite beds was variable, and work by the present author has shown that it has an appreciably lower iron content than the Main Ironstone chamosite. Crystallographically, this chamosite shows a high degree of disorder such that the 20l series of reflections are represented only by a weak 200 line and occasionally by weak broad bands for l=1, 2, 3 and 4. The 204 reflection is particularly sensitive to disorder in the structure. The contrast between the
chamosites occurring in the two beds of ironstone is so marked that
the type of structure can be identified not only in the separated
chamosite but also in many X-ray powder diffraction photographs of
the ironstones, obtained without isolating the chamosite content. It
appeared, therefore, that even where normal petrological methods
had proved fruitless, the chamosite content of an ore might be used to
"label" the beds in cases where the boundary between the lithological
sub-divisions was not clear.

It was necessary to ascertain whether or not the secondary enrich-
ment of the Chamosite-Kaolinite beds had caused the X-ray diagram
of the chamosite content to alter. Examination of a specimen known
to be of Chamosite-Kaolinite origin and also known to have under-
gone such enrichment showed that the chamosite was very similar to
the normal type from these beds, and was still easily distinguished
from the Main Ironstone type.

RESULTS

The particular area selected for study by this method was at the
extreme South-West of the Northampton Ironstone near Easton
Neston. The following specimens were examined:—

1. From Easton Neston Pit
   E 20353 2 ft. 6 ins. below top of workable ironstone
   E 20354 5 ft. ......
   E 20209 5 ft. ......
   E 20355 7 ft. ......
   E 12751 7 ft. ......
   —— 8 ft. ......

2. From Catchgate Plantation Pit
   E 20366 3 ft. below top of workable ironstone
   Sample E 12751 (Geological Survey reference) was collected by Dr A. F.
   Hallimond, and the remainder by Professor J. H. Taylor. The field sections in
   question have been described by Hollingworth and Taylor (1951).

X-ray examination was carried out on a Brindley 20 cm diameter
semi-focusing camera, using Cobalt Kα radiation with an iron
β-Filter. Specimens were first examined after crushing to a powder
suitable for the specimen holder. When the crude ore did not give
very clear photographs, attempts were made to separate the constitu-
ents by sedimentation in distilled water. This process (Brindley and
Youell, 1953) in some cases succeeded in removing quartz, siderite
and other coarse minerals, and enriching the suspension in the finely
divided chamosite. The specimens examined contained a wide range
of minerals, and it was not always possible to effect a great concentration of chamosite by this method. Appreciable goethite was present in specimens E 20354/55/66 and sufficient of this very finely divided mineral separated with the chamosite to cause considerable difficulty in identifying the chamosite type accurately.

The Easton Neston specimen 8 ft. below the top of the workable ironstone was examined in some detail. The residual siderite and goethite were not enough to obscure the chamosite pattern which was the ordered Main Ironstone type with 20l reflections sharp. Acid extraction of the original mineral left a residue almost amorphous to X-rays; certainly no aluminous kaolin lines were detected. This indicates that the mineral was a Main Ironstone type, as aluminous kaolin residues are far more likely to occur in the Chamosite-Kaolinite beds. The evidence shows clearly that this specimen came from the Main Ironstone group.

Of the other specimens, E 12751, E 20209 and E 20353 contained chamosite certainly of the ordered Main Ironstone group type. E 20355 was heavily contaminated, but those of the 20l series of reflections which could be observed were not appreciably broadened, so that there appeared a probability that this was also Main Ironstone type. The remaining two specimens, E 20354 and E 20366, contained so much goethite, siderite and oxidised chamosite that it was very difficult to identify the chamosite type. On the whole the evidence is more in favour of the Main Ironstone type, but it is not strong enough to justify more than the term "possible."

The doubtful beds have therefore given four certain Main Ironstone chamosites, one probable and two possible Main Ironstone chamosite. The "possible" verdicts are not confined to the highest beds, in fact the highest sample is certainly a Main Ironstone type. In no case was a Chamosite-Kaolinite type definitely identified. Since the Chamosite-Kaolinite beds invariably occur above the Main Ironstone, the fact that the highest sample is of Main Ironstone type makes it fairly certain that all the doubtful beds belong to the Main Ironstone group. If the boundary between the top and Main Ironstone beds occurs in the worked face, it must be higher than the highest sample examined; that is, within the top 2 ft. 6 in. of the worked exposure. There is, therefore, little chance that any large amounts of enriched top beds are present in the ironstone worked in the Easton Neston area, which must be regarded as a variety of the Main Ironstone type, and not as a heavily sideritised Chamosite-Kaolinite bed.
Figure 1 shows the X-ray powder photographs of untreated ore from the two beds, and also of the purified chamosite extracted from these two beds. The difference between the two chamosite photographs is clear, but careful examination is needed to detect the difference in the untreated ores. Quartz and siderite in particular, are minerals which give much stronger X-ray reflections than chamosite, so that the chamosite type cannot be identified unless a fairly high proportion is present in the specimen.

![X-ray powder photographs taken on a 20 cm diameter Brindley camera.](image)

**Fig. 1**—X-ray powder photographs taken on a 20 cm diameter Brindley camera.


Principal chamosite reflections are indexed, and the strongest siderite lines denoted by S.

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