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RESEARCH CENTRE

SUNBURY-ON-THAMES

MIDDLESEX

EXPLORATION AND PRODUCTION DIVISION

PAB/52/82

SEPTEMBER 1982

THE CLAY MINERAL ANALYSIS OF TWENTY-SEVEN SAMPLES FROM NORWEGIAN WELL 6507/10-1 BY X-RAY DIFFRACTION

+ Note: Petrology at Swz 38 at 2950m
L. Wells 25/1/83 2M

by

M.S. Hopkins

BP Petroleum Development Ltd., Norway
(Utenlandsk aksjeselskap)

SØRFLÅTVEIEN 11, P.O. BOX No. 3077 MARIERO, 4001 STAVANGER

STATOIL
Postboks 1212
5001 BERGEN
Attention: S.M. Aasheim

Our reference	Your reference	Telephone (045) 89580 Telex 33339 BPEXPN	Date
AMS/lu/700/075			5.11.82

Dear Sirs,

LICENCE 075, REPORT "CLAY MINERAL ANALYSIS OF 27 SAMPLES FROM 6507/10-1 BY XRD" BP RESEARCH CENTRE

I attach copies of this factual report which indicates the presence of the swelling clay mineral smectite in all samples from 1960 m (Palaeocene) to 2650 m (U. Cretaceous). The measurements were made to assist with explaining the drilling problems. Further work is planned, to quantify the amounts of smectite and to assess whether earlier Haltenbanken wells lacked the mineral.

Yours sincerely,
for BP PETROLEUM DEVELOPMENT LTD., NORWAY U/A

A.M. Spencer
Chief Geologist

cc. L.P. Newman, BP (DOS) London
I. Aarseth, NPD

Tony

The report is clear and fine, I had hoped to quantify the reduction in smectite with depth a bit better though.

Lovell's three-stage approach seems to have two good and one bad point. 1) and 2) is to ~~identify the cause of~~ establish ~~the cause of smectite presence~~ on why we had problems and not Saga. Point 3) however is useless. We ~~need~~ will chose our drilling location from where we believe the hydrocarbons are, not from where the smectite is missing. Point 3) should therefore be something like "determining how we next time can drill through these beds without problems."

Bjarne

BP Petroleum Development Limited

Britannic House, Moor Lane, London EC2Y 9BU

BP Petroleum Development Ltd.,
Norway U.a.,
P.O. Box 3077,
Mariero,
4001 Stavanger,
Norway.

Attention: Dr. A.M. Spencer

Our reference	Your reference	Telephone	Date
DOS/JPBL/SED/EWR/NOR		01-920 8613	14th October, 1982.

Dear Sirs,

CLAYS IN 6507/10-1

We enclose two copies of the report and covering letter from Dr. I.R. Hoskin concerning these clays, which have caused drilling problems. As we have previously discussed, the difficulties have arisen because of the abundance of smectite (swelling clay) throughout a thick sequence.

At our meeting in London on 1st October we discussed possible future work by Sedimentology Branch to help avoid this type of problem during the drilling of the next well in 6507/10 (in 1984?). We suggest a three-stage approach:

1. Analysis of Palaeocene tuffs and Cretaceous mudstones in nearby trouble-free (Saga) wells to establish that the problem arises from geological differences and not from differences in drilling practice.

2. If the problem is geological, attempt to establish controls of smectite distribution.

3. If such controls can be identified, either predict location of trouble-free drilling sites or identify sites where necessary well treatment can be carried out at minimum cost.

Yours faithfully,
for BP PETROLEUM DEVELOPMENT LTD.,

JPB Lovell

J.P.B. LOVELL (DR.)

Encs.

c.t. Dr. D.A.L. Jenkins
Mr. P.G. Tubman
Dr. I.R. Hoskin

CONTENTS

ABSTRACT

X-ray diffraction analysis of 27 samples from well 6507/10-1 showed the presence of a significant quantity of smectite swelling clay together with illite, kaolinite; only minor amounts of chlorite were identified.

There was evidence that the quantity of smectite clay was reducing down hole, certainly the last two samples examined had the least amount of smectite. From this evidence it is possible that the sediments below 2650 metres might be free of swelling clay.

1. INTRODUCTION

Twenty-seven cuttings samples from Norwegian Sector well 6507/10-1 were received from BP Petroleum Development Ltd., Stavanger, Norway, with a request to perform X-ray diffraction analysis on the samples to determine the clay mineral content.

In addition to identification of any clay species present, the request also called for some quantitative data to be produced.

Less than 2 micron particle size preparations were made to exclude non-clay minerals and any coarser clay grade material.

Particular emphasis was placed on the presence of any swelling clays which might contribute to the drilling problems being experienced at the time.

2. SAMPLE LIST

Sample Depth (metres)	Sample Depth (metres)
1960A	2290
1960B	2320
1975	2350
2030	2380
2050	2410
2060	2440
2080	2470
2110A	2500
2110B	2530
2140F	2560
2170	2590
2200	2620
2230	2650
2260	

2.1 SAMPLE PREPARATION

Ten grams of sample was removed and gently ground in a pestle and mortar. This procedure was carried out on both the 'raw' cuttings samples and on sieved samples which had been relieved of any coarse cavings or fine drilling mud.

The crushed samples were placed in 100 ml beakers to which 50 ml of water containing a weak solution of calgon (to inhibit flocculation) was added. The mixtures were stirred and the beakers placed in an ultrasonic vibrator both for 15 minutes to disaggregate the clay particles.

After ultrasonic treatment, the suspensions were left to stand in order to extract a less than 2 micron size fraction. The fine fraction supernatant was then pipetted onto three glass slides which were air dried. This sample preparation produces enhanced basal reflections of clay minerals due to their platy morphology, which cause the clay particles to orientate themselves in one plane as they settle on the slides surface.

2.2 SAMPLE TREATMENT

When dry, three slides were prepared from each sample and given the following treatments:-

i) one slide was heated at 550°C for one hour

ii) one slide was exposed to ethylene glycol vapour in a warm vacuum dessicator for two hours

iii) one slide remained untreated.

The sample treatments may induce certain diagnostic changes in clay minerals which greatly facilitate their identification; this is usually due to water being removed by heating or replaced by glycol, resulting in lattice spacing changes which cause shifts in peak position on the x-ray diffractograms.

3. RESULTS

Due to the contamination of cuttings samples with drilling mud both bulk samples and sieved samples were prepared.

However, no notable change in clay mineralogy between the bulk and sieved samples was detected.

The clay minerals identified were uniform in type throughout but variations in relative abundance were recognised and are summarised below.

All the samples had a broad, diffuse peak near 14Å which shifted to 17Å after ethylene glycol exposure and contracted to 10Å after heat treatment.

This is typical of a smectite swelling clay with little or no interlayering. This smectite clay occurs in all the samples in significant quantities but is quite variable in abundance. It is most abundant in sample 2030 and least in 2650. Overall there is a trend to decreasing abundance of smectite clay down hole.

Most samples contain 7Å and 10Å peaks which do not expand with ethylene glycol treatment, these are attributed to kaolinite and illite respectively. At the top of the sample range they are present in only minor amounts, but in the bottom range they are major clay components.

Between samples 2410 and 2650m, a 14Å peak 'present', after ethylene glycol treatment, suggests the presence of chlorite. However, these samples have less swelling clay, which tends to mask chlorite peaks. Therefore chlorite may also be present in minor amounts in other samples.

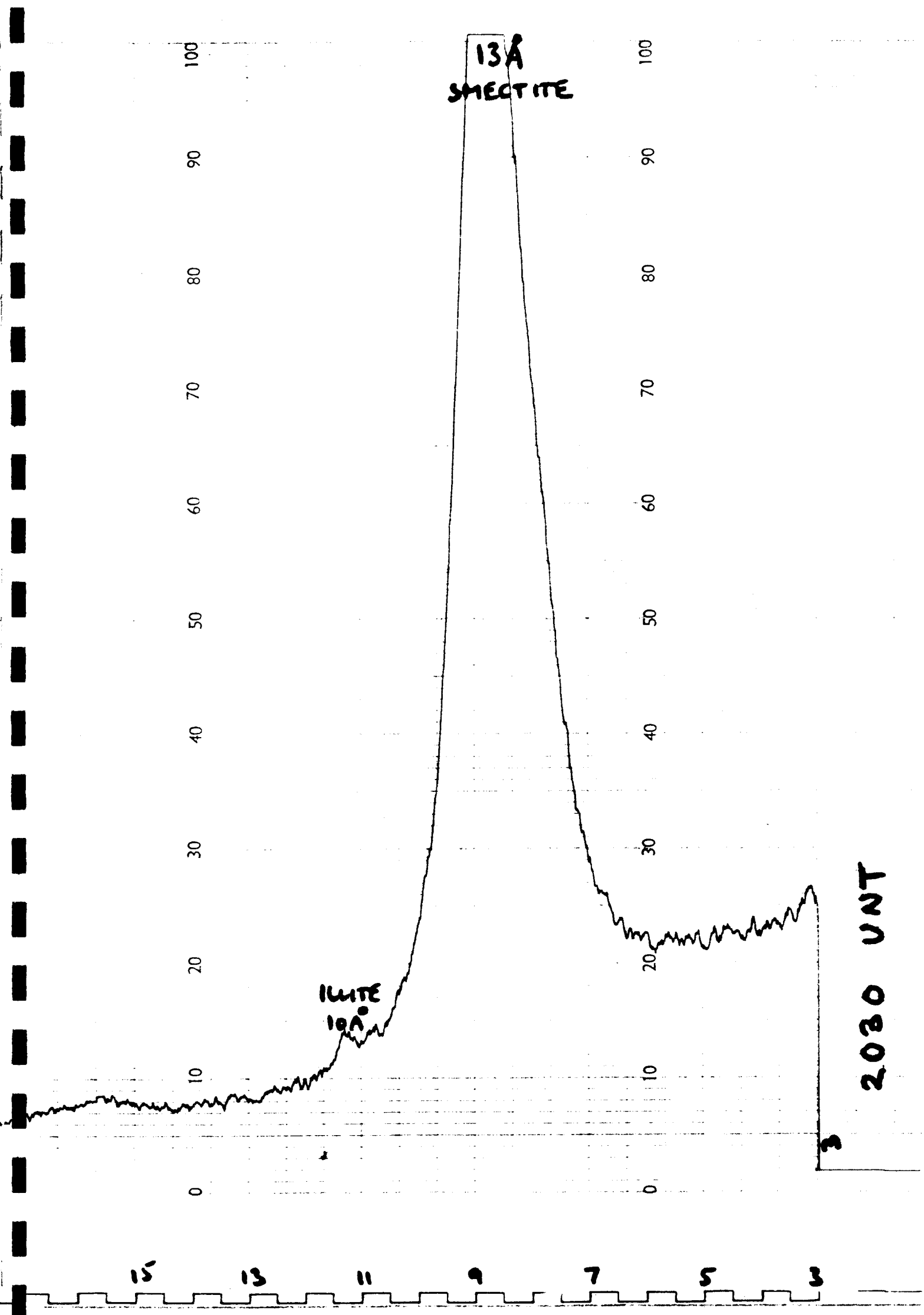
Examples of x-ray diffractograms of samples at depths 2030 metres, 2410 metres and 2650 metres are given at the back of this report.

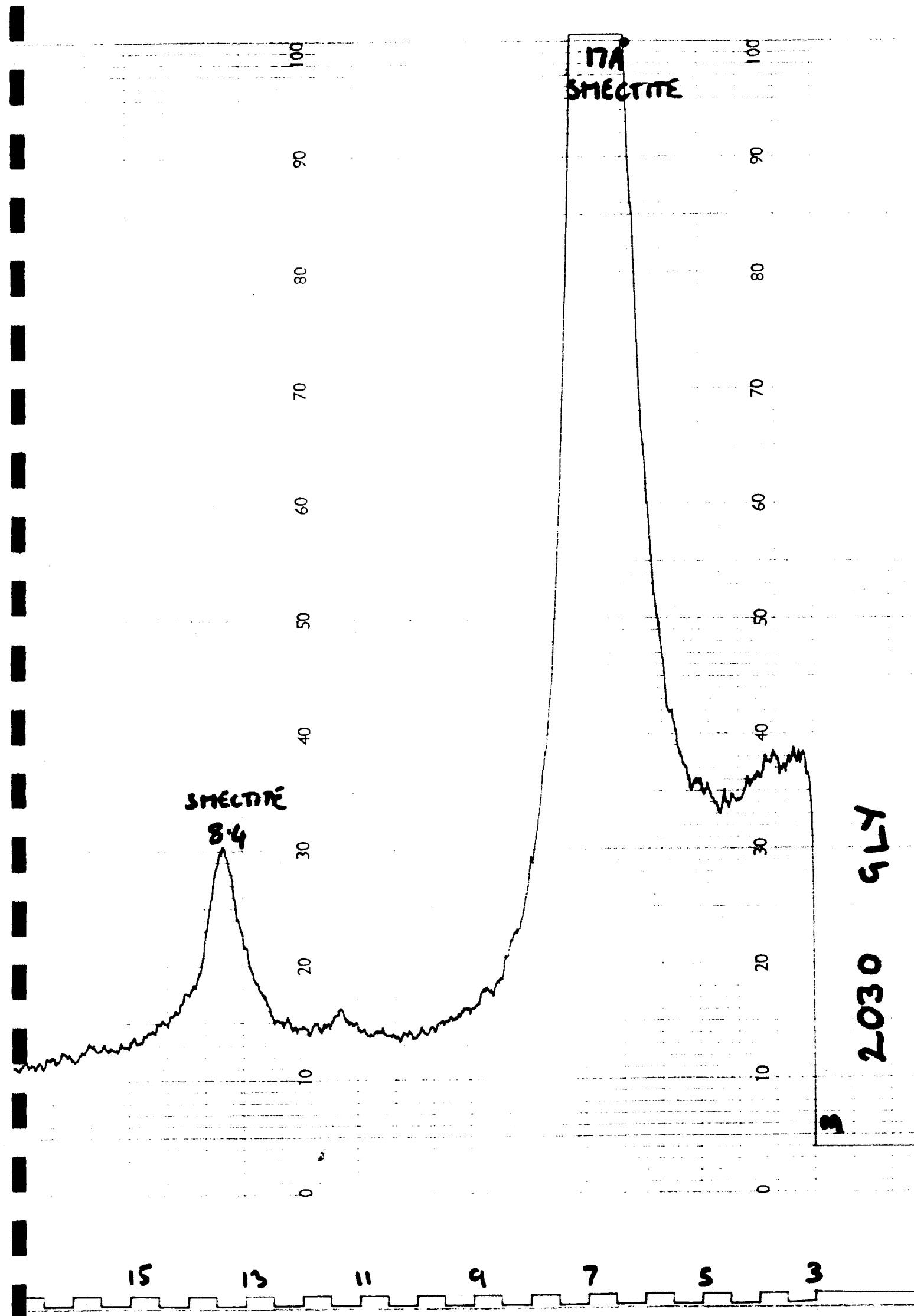
4. CONCLUSIONS

The clay minerals identified in the twenty-seven cuttings samples from well 6507/10-1 are summarised as follows:-

Smectite swelling clay occurs in all samples in significant quantities; there is a trend, however, of decreasing smectite abundance down hole; thus depth 2030 metres has most, 2650 m the least.

Kaolinite and illite clay are present in most samples. There is a trend toward increasing abundance down hole. Minor amounts of chlorite were only detected between 2400 and 2650 metres.


13Å
SMECTITE
ILLITE
10Å
2030 UNT
100
90
80
70
60
50
40
30
20
10
0
15
13
11
9
7
5
3


17Å
SMECTITE
SMECTITE
8.4
2030 GLY
100
90
80
70
60
50
40
30
20
10
0
15
13
11
9
7
5
3

SMECTITE
9.7A°
100
90
80
70
60
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40
30
20
10
0
15
13
11
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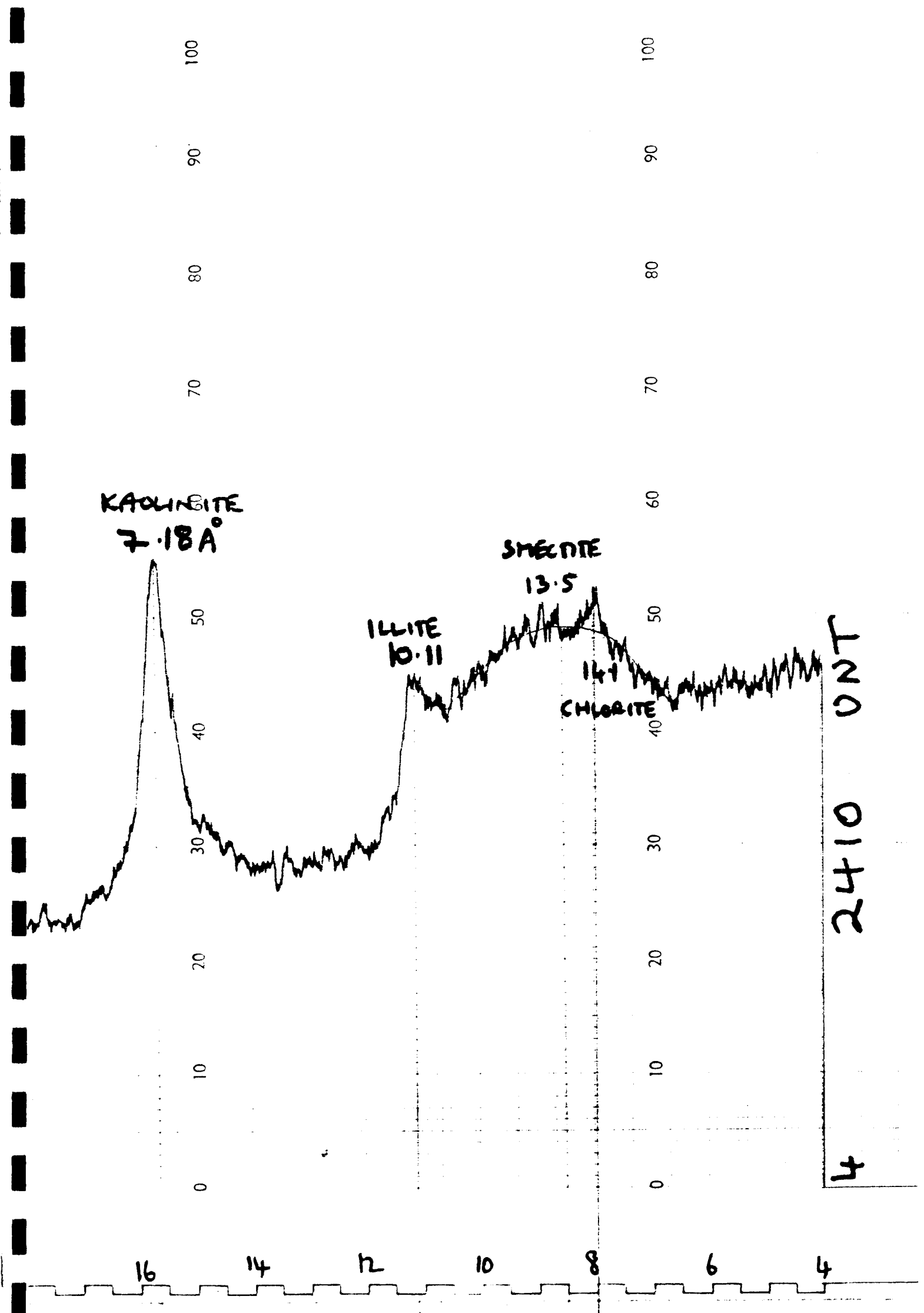
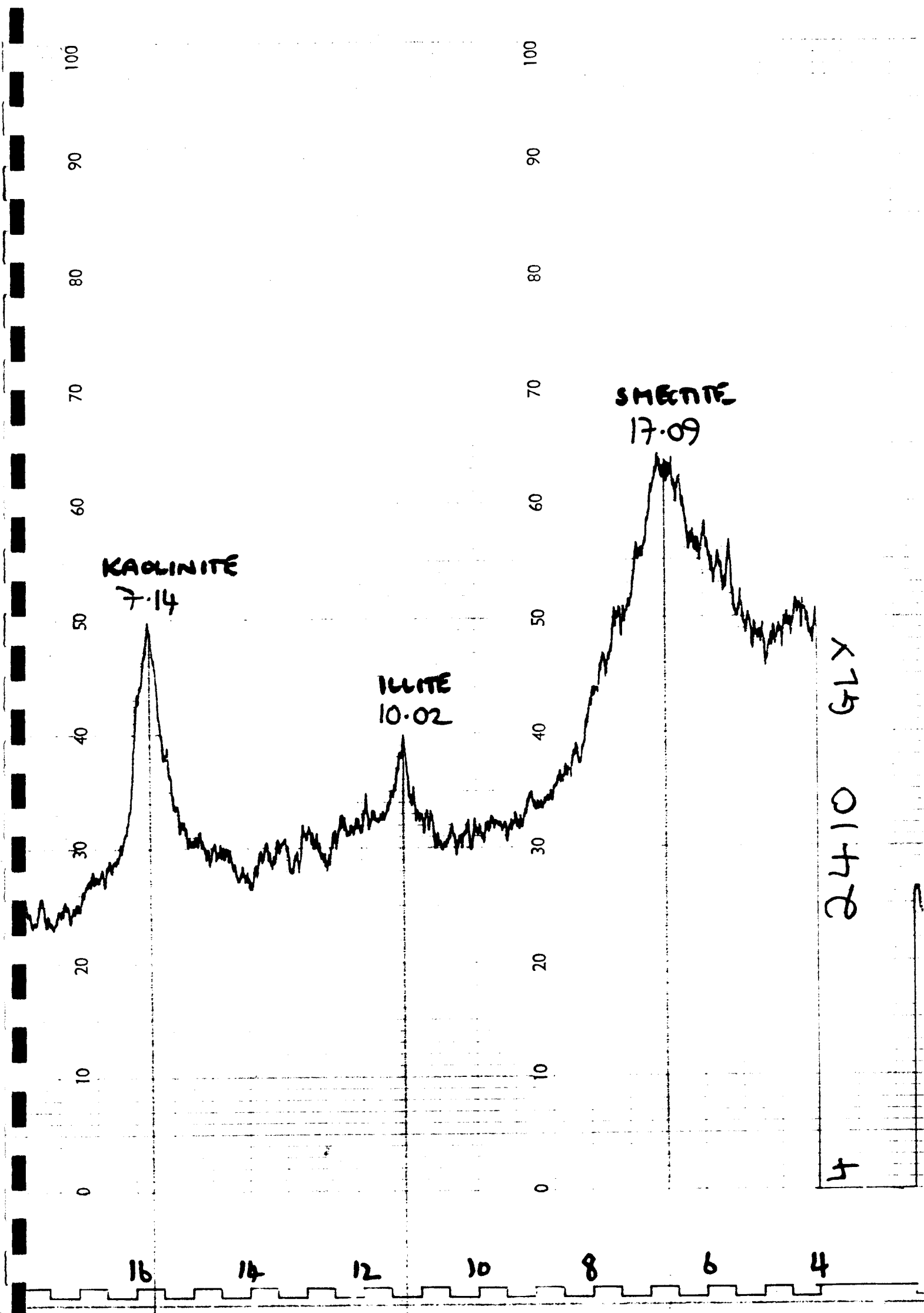
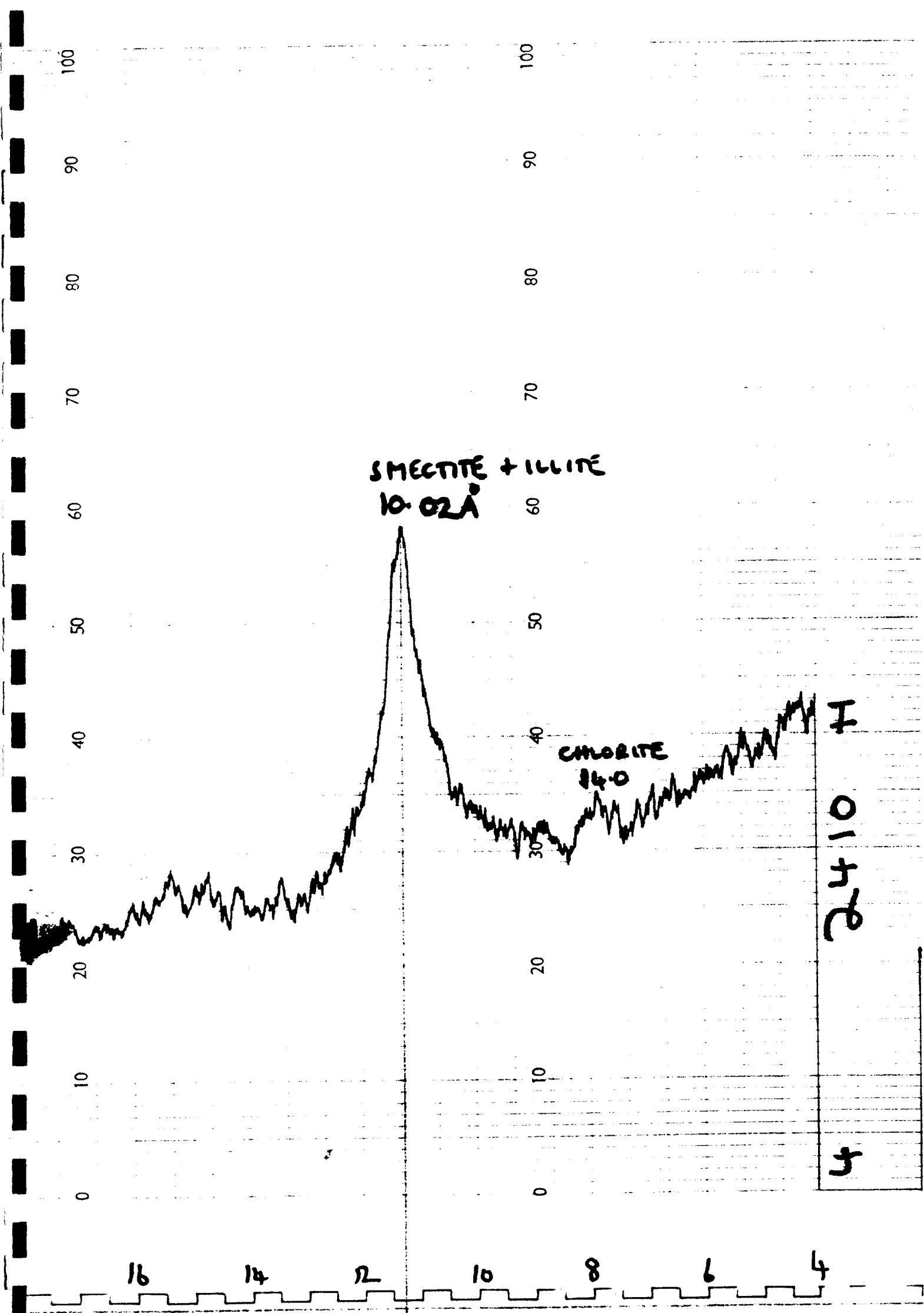
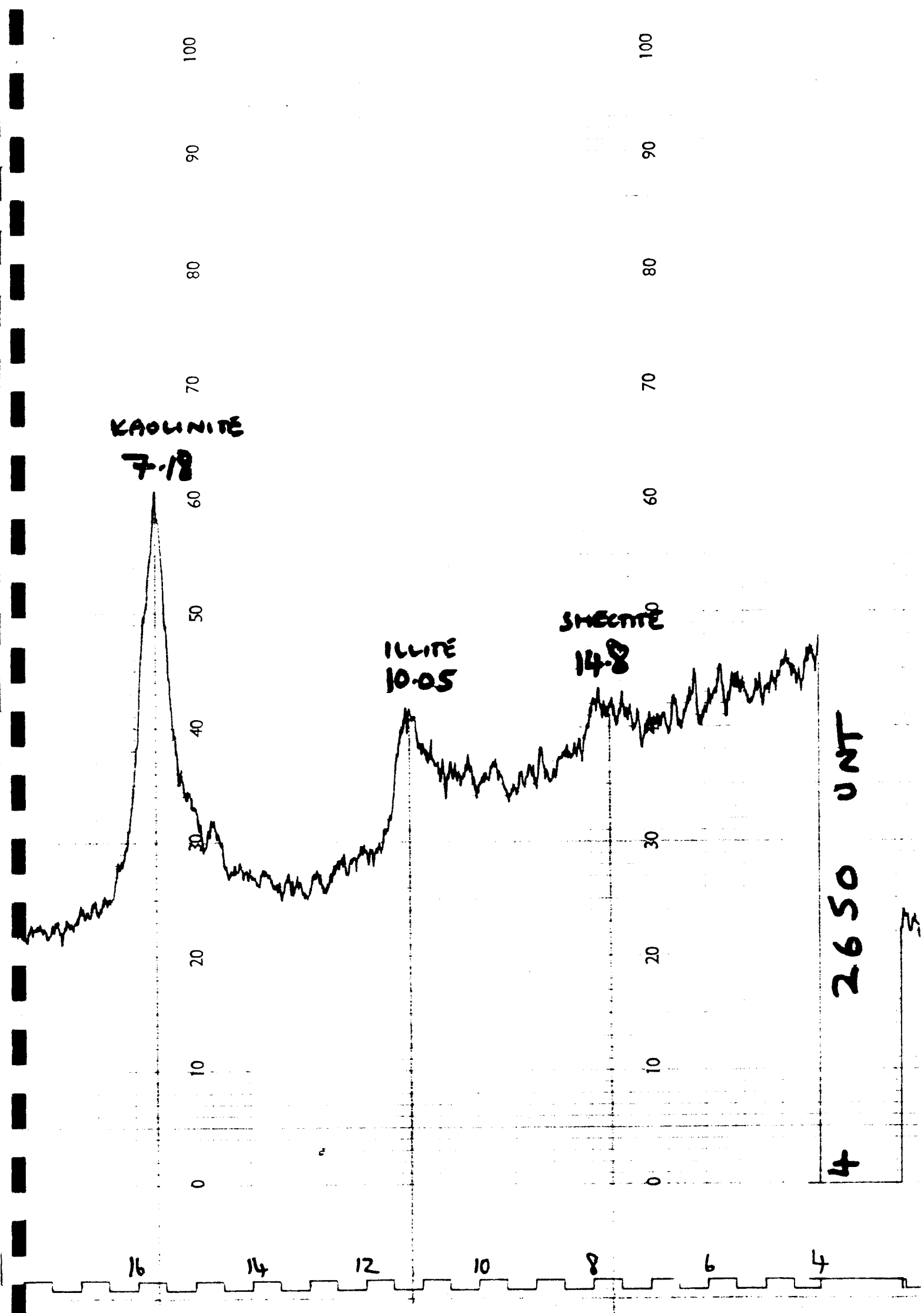
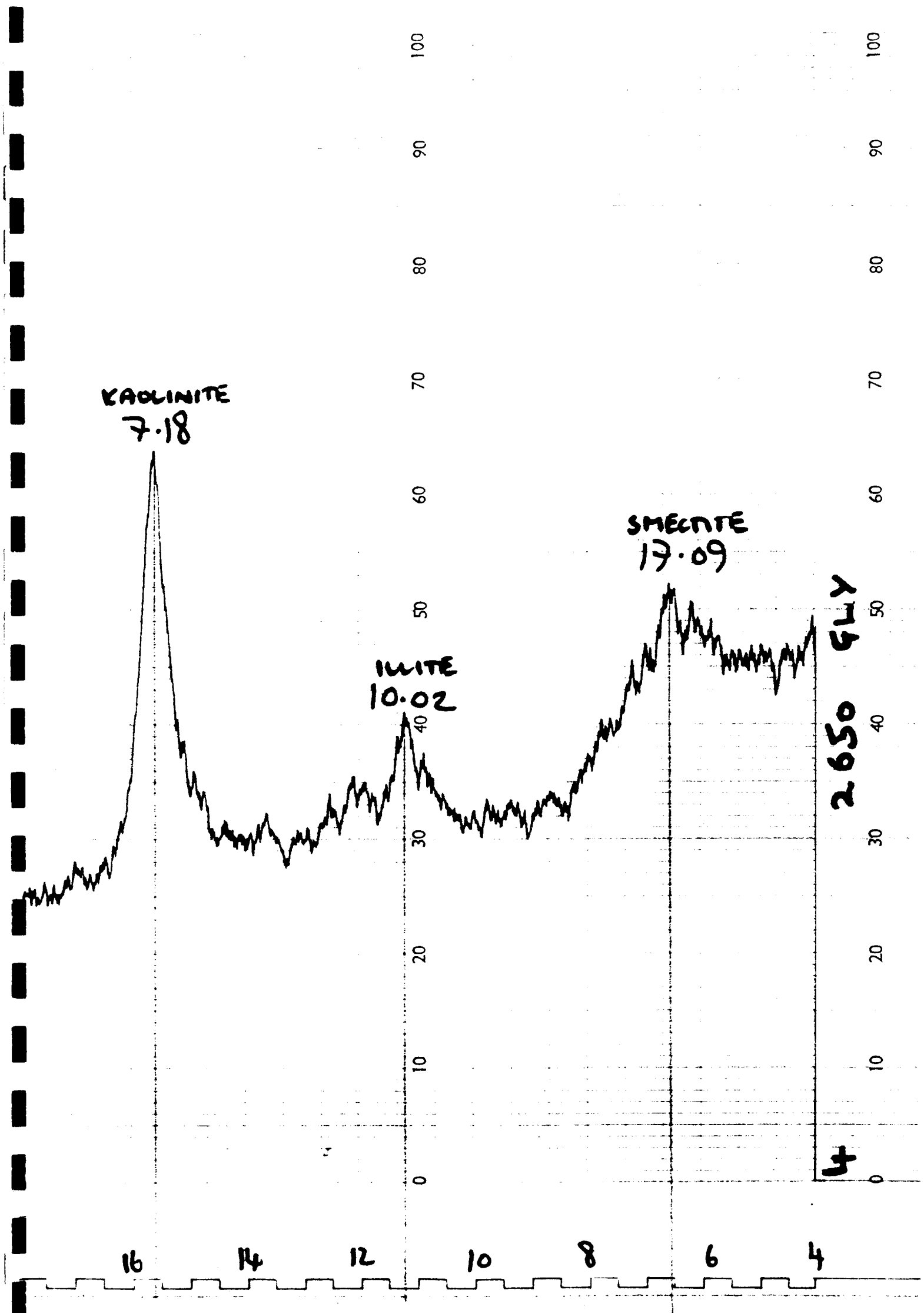
7
5
3
2030 H


KAOLINITE
7·18Å°
ILLITE
10·11
SMECTITE
13·5
14·1
CHLORITE
2410 ORT
4
100
90
80
70
60
50
40
30
20
10
0
16
14
12
10
8
6
4


KAOLINITE
7·14
ILLITE
10·02
SMECTITE
17·09
GLY
2410
100
90
80
70
60
50
40
30
20
10
0
16
14
12
10
8
6
4


SMECTITE + ILLITE
10.02Å
CHLORITE
14.0
I
0 1 2 3
16
14
12
10
8
6
4


KAOLINITE
7.18
ILLITE
10.05
SMECTITE
14.8
2650 UNT
4
100
90
80
70
60
50
40
30
20
10
0
16
14
12
10
8
6
4


KAOLINITE
7.18
ILLITE
10.02
SMECTITE
17.09
2650 GLY
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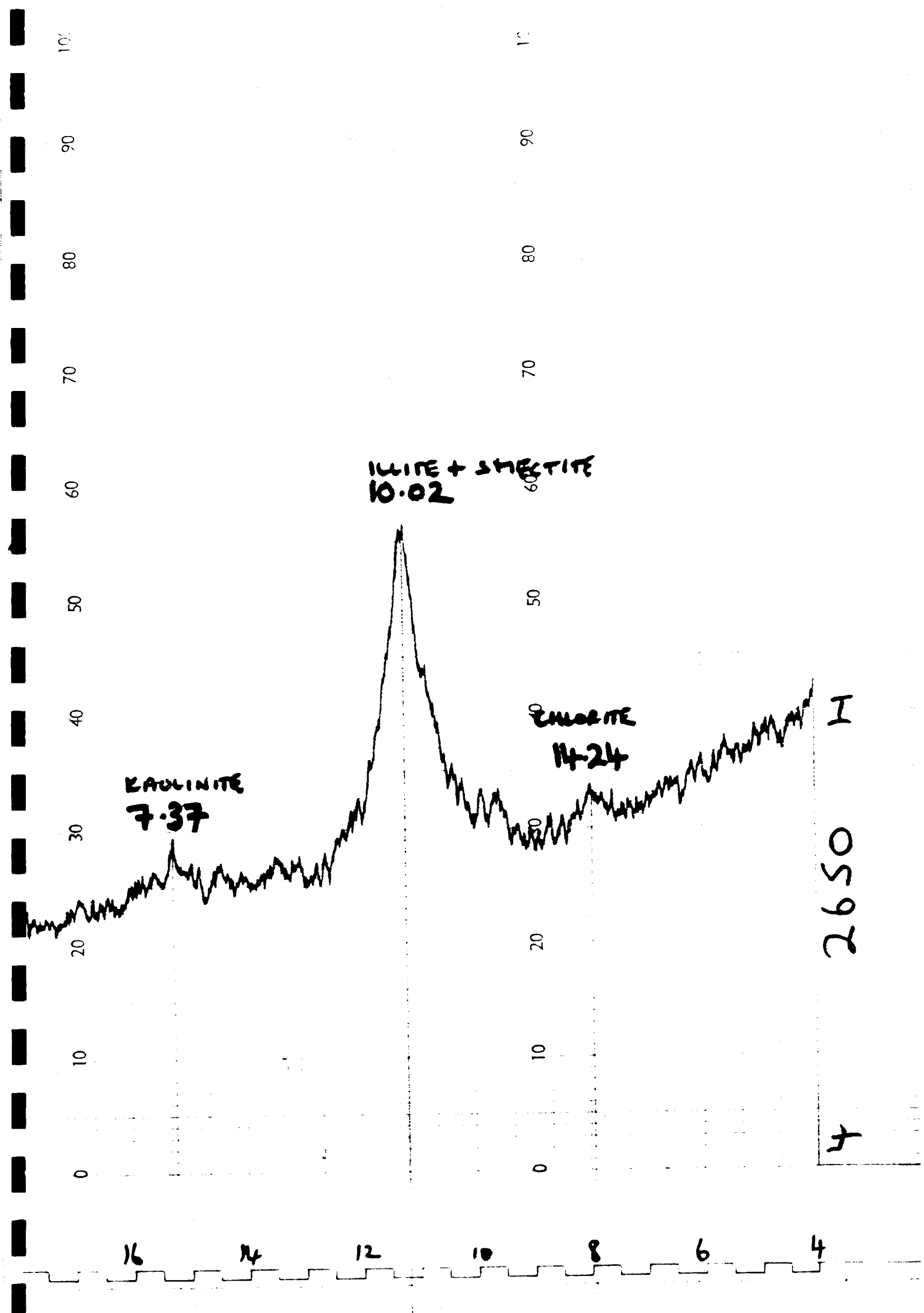
ILLITE + SMECTITE
10.02
KAOLINITE
7.37
CHLORITE
14.24
I
2650
16
14
12
10
8
6
4

BP Petroleum Development Limited

Petrology
Sec 38

Britannic House, Moor Lane, London EC2Y 9BU

BP Petroleum Development Ltd., Norway U.a.,
P.O. Box 3077,
Mariero,
4001 Stavanger,
Norway.

Attention: Dr. A.M. Spencer

Our reference	Your reference	Telephone	Date
DOS/MJM/SED/EUR/NOR		01-920 7668	27th January, 1983.

Dear Sirs,

WELL 6507/10-1

Please find enclosed a file note by Dr. R. Walls concerning a brief study of a sidewall core from 6507/10-1. We look forward to hearing what material is available from the Haltenbanken wells for the diagenetic study which has been proposed.

Yours faithfully,
for BP PETROLEUM DEVELOPMENT LIMITED

M.J. MAYALL (DR.)

Enc.

c.t. Dr. R. Walls

FILE NOTE

NORWEGIAN WELL 6507/10-1: SAMPLE NO. 38 AT 2950.0 m

The sample referred to in letter AMS/bs/700/075 of 8th December, 1982 from BP Petroleum Development Norway has been investigated in the hope of finding an explanation of the high GR response in part of the Brent Unit. However, no radioactive minerals were detected in it.

The SWC recovered a very friable, fine to very fine grained, buff-coloured sandstone and a few pieces of dark-brown to black mudstone. The bulk of the sandstone was in powder when seen, but sufficient had remained coherent to permit a thin section to be made. This shows clear quartz with subordinate feldspar (chiefly microcline) and much detrital mica (both muscovite and bleached biotite). The quartz and feldspar had been severely shattered by the sample-taking device with the production of minute angular chips which tend to obscure the intergranular space. Some poorly-crystalline pore-filling kaolinite can, however, be seen. Many quartz and feldspar grains have a faint pigmented coating. Syntaxial quartz cement has not been observed but there are minor amounts of carbonate cement (possibly siderite from its dark yellowish-brown colour and very high relief).

Heavy minerals (zircon and tourmaline) are not uncommon in the section. A separation was made from the loose sand which was probably contaminated by drilling-mud. It gave abundant zircon, generally as yellowish subhedra, and much brown tourmaline as small prisms or rounded grains. Only one grain of blue tourmaline was seen. Apatite occurs quite plentifully as clear, well-rounded grains. A few flakes of white mica and very rare chlorite were noted. A little ilmenite and leucoxene occur. Barite, in angular and subrounded fragments, is probably a contaminent. The black grains mentioned by Norway seem to be chiefly tourmaline, perhaps with a little ilmenite.

To test for radioactive elements, a sub-sample of the heavy residue was investigated by EDAX (Mr. M. Hopkins). No peaks corresponding to uranium or thorium were found.

A further test was made by exposing (a) the uncovered thin section, and (b) a smear of the dark mudstone to cellulose nitrate film sensitive to alpha-particles (Kodak CA80-15) for 12 days. No alpha-particle tracks were found when the film was etched for five hours in 2.5N KOH solution.

Hence, the SWC did not sample material responsible for the high GR response.

R. WALLS

25th January, 1983