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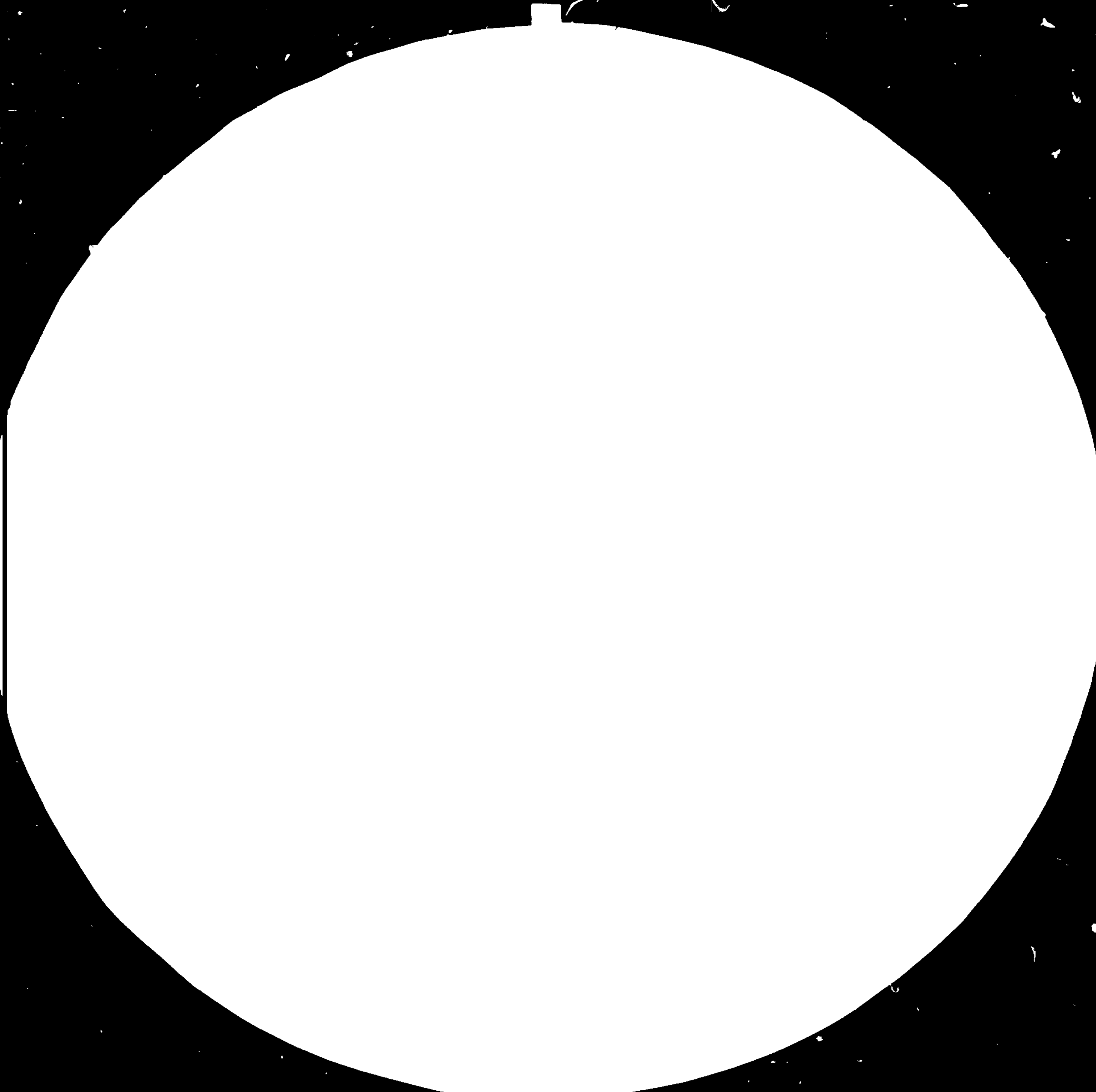

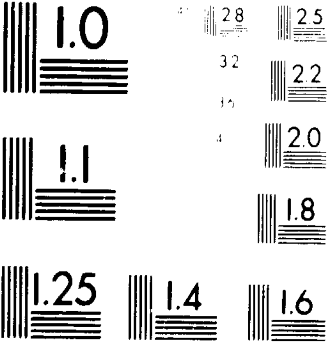

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

KHD HUMBOLDT WEDAG AG

14242-E

(1 of 2)

PRELIMINARY STUDY
OF THE IRON ORE DEPOSITS
AT SAY
REPUBLIC OF NIGER

UNIDO PROJECT DP/RAF/79/067

FINAL REPORT

prepared by

KHD HUMBOLDT WEDAG AG

Cologne, March 1984

3095

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Preliminary Study of the Iron Ore Deposit at Say, Republic of Niger

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Part A

Summary and Introduction

KHD HUMBOLDT WEDAG AG

Preliminary Study of the Iron Ore Deposit at Say, Republic of Niger

A.1. SUMMARY

The iron-ore occurrences south-east of Niamey, located within the plateaus of Doguel Kaina - Say and in the plateau of Kolo are - in general - of vertical, three part division, i.e.

- one upper horizon with iron Oolithes Indurées
- Intercalation with oolith bearing sands and clays
- bottom horizon with iron Oolithes Tendres.

Their thicknesses, reserves and contents have been specified in the table below:

	Oolithes Indurées in the area of		Intercalations in the area of		Oolithes Tendres in the area of	
	Doguel Kaina	Kolo	Doguel Kaina	Kolo	Doguel Kaina	Kolo
Average thickness m	2.53	2.22	1.13	1.06	2.90	2.00
Fe_{total} %	50.45	46.10	32.96	23.93	45.49	43.64
P_2O_5 %	1.73	1.66	1.14	0.91	2.07	2.37
SiO_2 %	8.32	14.98	35.44	46.84	13.54	13.75
Al_2O_3 %	4.34	4.64	5.83	8.21	5.89	7.33
Ore reserves in M t	390.2	94.7	134.8	41.2	483.7	71.2

Consequently, the average overall thickness of the ore horizons amounts to 6.56 m in the Doguel Kaina area and to 5.28 m in the Kolo area.

The total reserves in the Doguel Kaina area equal 1,008.7 Mt at an average iron content of 45.73 % Fe. Assuming a cut-off of 35 % Fe for the Intercalation, the total reserves calculated equal 936.7 Mt at an average Fe content of 47.44 %.

The total reserves in the area of Kolo equal 207.1 M t at an average Fe content of 40.84 %. Considering a cut-off of 35 % Fe for the Intercalation, the overall calculated reserves amount to 173.2 Mt at an average Fe content of 44.67 %.

For the larger portion of the deposit the iron-ore horizons are covered by clays and sandstones of the Continental Terminal formation and by sand dunes. The thickness of the overlying material ranges from 0 to 25 m.

Within an area of 3.4 km^2 size near Doguel Kaina such overburden is either missing completely or has a thickness of less than 10 m. The reserves existing within that area are:

Oolithes Indurées - at an average thickness of 2.22 m; 20.1 M t with 50.35 % Fe and 1.55 % P_2O_5

Intercalation - at an average thickness of 0.82 m; 7.4 M t with 29.17 % Fe and 0.83 % P_2O_5

Oolithes Tendres - at an average thickness of 2.54 m; 22.9 M t with 44.17 % Fe and 1.92 % P_2O_5

Emphasis is put on this area because the relatively thin overburden and the favourable ratio of Fe: P_2O_5 in the Oolithes Indurées might be the starting point for an initial economic mining of the iron-ore.

Mineralogically the iron-ore is composed of iron oolites and pisolites mainly of a size of 0.5-5 mm being surrounded by a matrix of kaolinite, quartz and minor portions of superfine oolitic fragments.

Oolites and pisolites - per se - consist of concentric shells of goethite (- $FeO\,OH$) surrounding mainly goethite fragments. Phosphorus could not be located as mineral of its own. Instead, it probably exists as adsorptive bond to goethite very finely and uniformly distributed in the oolites.

This means that even when grinding down to micron size it will be impossible to liberate the phosphorus components.

With respect to process technique it means that there will be no feasible mechanical way for concentration of Fe and simultaneous reduction of phosphorus. Although the iron content can be concentrated at a rate of 3 - 4 % above the R.O.M. analysis, i.e. to approx. 54 % Fe, this concentrate will however contain about 2 % P_2O_5, and also 4 - 8 % SiO_2 and 3 - 5 % Al_2O_3.

For obtaining such a concentrate a preparation process has been developed on the basis of the tests made which provides for crushing the surface-mined iron-ore to minus 3 mm and subsequent screening of the fraction 0.5 - 3 mm.

The fraction corresponding approximately to the natural size range of the ooliths is subjected to attrition for removing the adhering clay particles.

An ore concentrate won in that manner and used as feed for metallurgical tests yielded the following composition for samples from:

- Oolithes Indurées: 53.7 % Fe; 2.15 % P_2O_5; 4.25 % SiO_2; 3.31 % Al_2O_3
- Oolithes Tendres: 49.34 % Fe; 2.37 % P_2O_5; 8.29 % SiO_2; 4.9 % Al_2O_3.

The mixed concentrate made up of Oolithes Indurées and Oolithes Tendres had been ground to pelletizing size (Blaine number 1 800 cm^2/g). With bentonite and pulverized limestone added, green pellets could be produced which featured satisfactory values as to strength in green and dry state. The pellets sintered of that mixture were characterized by optimum values regarding tumbler index, abrasion and cold compressive strength. However, the Fe-contents of these sintered pellets equalled no more than 57.1 % and the P content about 1.1 %.

In spite of having added limestone, it has been impossible to produce pellets of a basicity of 0.8 which fact has to be attributed to the high quartz portion.

Tests carried out for direct reduction of the sintered pellets with gas as reducing agent yielded acceptable reduction rates and metallization at reduction temperatures of 900 °C; moreover, the reduced pellets featured good cold compressive strength.

Although reduction tests performed with coal of similar composition as that occurring in the Republic of Niger resulted in adequate compressive strength in cold state and disintegration strength, their maximum metallisation did not exceed 73 %.

For any direct reduction test, phosphorus remained in the reduced pellets and in the sponge iron respectively or it has been relatively concentrated during such operation. Consequently, removing the phosphorus will be possible only by suitable slag handling when further processing the material to pig iron or steel.

A.2 INTRODUCTION AND OBJECTIVES

A.2.1 SUBJECT OF THE STUDY

For a long time iron-ore occurrences have been known to exist in various parts on the territory of the Republic of Niger, and have been made use of in a simple, handicraft like manner to produce pig iron.

The iron-ores are iron oolite horizons which have been formed as part of the Continental Terminal formation of Miocene age as deposits in the Iullemeden basin.

These oolitic iron-ores have been located as large-area outcrops at the surface in the 'Massif Termit', in 'Le Dallol Maouri' (Dogondoutchi), in 'l'Adar Doutchi' (Tahoua) and in the valley of the central section of the river Niger (between Niamey and Say and near Kolo) (fig.A 1 and A 2, page A 9 and A 10).

Because of good accessability and advantageous location to the city of Niamey (40 km distance) the iron-ore deposits near the central section of the river Niger have, in particular, been since long of geologic and economic interest and subject to several exploration campaigns.

A.2.2 PREVIOUS INVESTIGATIONS

First geological investigations have been carried out as early as between 1930 and 1945 which were extended and intensified between 1948 and 1957 by additional investigating parties. An evaluation of the quality and reserves of the iron oolite occurrences at the central part of the river Niger south-east of Niamey have been the topic of a systematic study prepared by R. BOURNAT, D. BELPAUME and J. BOULANGER of B.R.G.M. and O.C.R.S., between 1960 and 1962. It is mentioned in reports that in 1961 the IRSID carried out processing and smelting tests for concentrating the Fe content. However, no information is available as to the results of these tests.

In 1977 the experts M.E. COHEN and W.J. RIDDEL were asked by UNIDO to provide for a technical-economic approach and to submit suggestions as to "Utilisation des Gisements de Fer de Say en République du Niger". Their reports state:

- that the deposits of several hundred million tonnes on an average contain very low Fe-contents of 42 - 49 % associated with relatively high P_2O_5 contents above 1.0 %.
- that a concentration to more than 55 % Fe could be achieved with the aid of processing and metallurgical operations
- that subject to coke or fuel oil being available in the vicinity of Niamey open-hearth steelworks could be set up and operated. However, to be run profitably such steelworks would have to have an annual capacity of at least several million tonnes of steel
- that transport routes are missing for exporting the ores from Say to Nigeria or other neighbouring countries and that - apart from that drawback - the distances are in general too long. This means that the transport cost per tonne of ore alone would be higher than the price of iron-ores of superior quality, e.g. from Brazil or Liberia.

These experts requested additional preliminary examinations and tests, in particular, as to geology and benefication of the ores so as to ascertain geological and technical parameters which could be used as a basis for preparing a detailed feasibility study giving information on exploitation of the iron-ore deposits near Say.

In consideration of the above statements and of the recommendations made in the reports of COHEN and RIDDELL, the Council of Ministers of the Niger-Nigeria Joint Commission for Cooperation (NNJC) decided in 1978 to have a detailed preliminary study made.

A.2.3 OBJECTIVES OF THE STUDY AND CONTRACT AWARD

A tender entitled "Preliminary Study of the Iron Ore Deposits at Say in the Republic of Niger" was issued by Unido in February 1981 under the project no. DP/RAF/79/067.
It included the following main objectives of the work:

- to identify the quantity and quality of the iron-ore resources to be economically mined
- to assess techno-economically the beneficiation characteristics of the ore including the associated iron-ore recovery and the quality of concentrates
- to assess techno-economically the pelletization characteristics of the concentrates and direct reduction characteristics of the pellets.

The 'Terms of reference' stipulated that the drilling and trenching work, as well as chemical analytical activities should be carried out by local staff and equipment of the 'Niger Department of Mines'.

The contractor was to establish, perform, supervise and evaluate the geological exploration programme and to supervise the chemical analyzing work in the project area.

The beneficiation and metallurgical tests were to be carried out in the research laboratories in the country of the contractor.

The period fixed for implementing the preliminary study has been three years.

Under date of June 10, 1981 UNIDO awarded the contract by telex to KHD Humboldt Wedag AG for realizing the study in accordance with the detailed investigation programme submitted by KHD.

A.2.4 SCHEDULE OF EXECUTION

Following the briefing by the project leader of KHD Humboldt Wedag AG at the Vienna offices of UNIDO on July 2, 1981, immediate action was taken to prepare the starting of the work in the project area in the Republic of Niger.

During a first trip to Niamey by the project leader, the chemical expert and the project geologist between September 21 and October 8, 1981, preparations were made and discussions held with the Niger counterparts about the necessary activities and equipments.

The geological work in the project area, including the drilling and trenching activities, lasted from November 2, 1981 to August 31, 1983 and required the project geologist to stay in the project area for a total of 14.6 months.

The chemical expert who originally was to supervise the chemical analytical work in the laboratories of the Niger partner at more or less random intervals only, finally had to perform most of the analyzing himself because no qualified personnel was available locally. The complete stay of the chemical expert in Niger, made up of several periods, equalled 16 months.

The project leader visited the project area four times and, on the whole, stayed there for almost 3 months for assisting in the settlement of organisational and contractual problems and to attend meetings of the Technical Committee.

A bulk sample for technical tests could be prepared and dispatched only after completion of the drilling and trenching work. The beneficiation and metallurgical tests could be started not earlier than after arrival of that consignment in the Cologne laboratories at the beginning of June 1983, i.e. 5 months later than specified in the corresponding time schedule.

The processing tests and the production of 1.5 tonnes of concentrate material were completed in October 1983.

Pyrometallurgical tests for pellet production and for direct reduction have been carried out at the pertinent sub-contractor, i.e. the 'STUDIENGESELLSCHAFT FÜR EISENERZAUFBEREITUNG' at Othfresen/FRG, between mid October and mid December 1983.

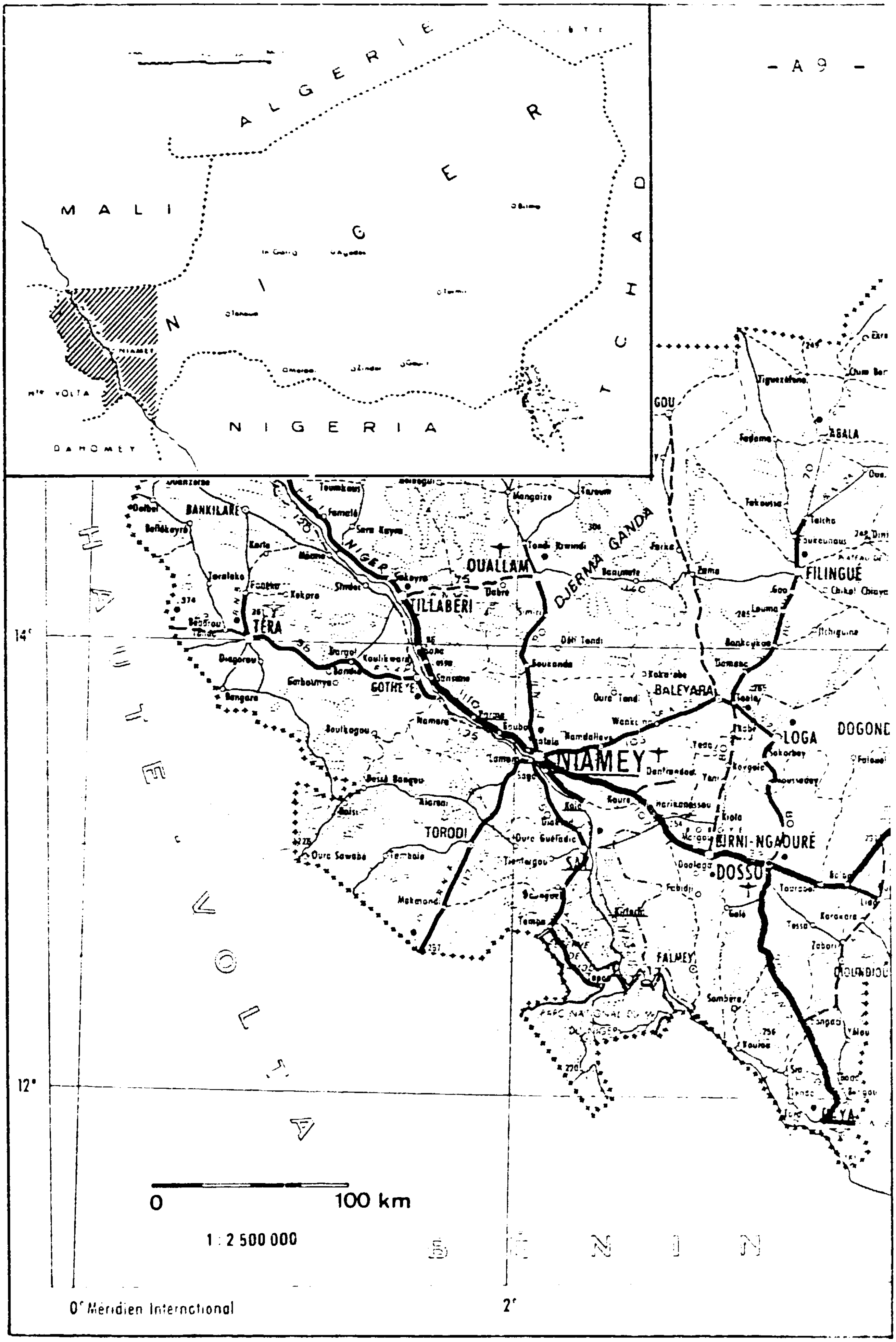

Fig. A 1: Location map of western part of Republic of Niger

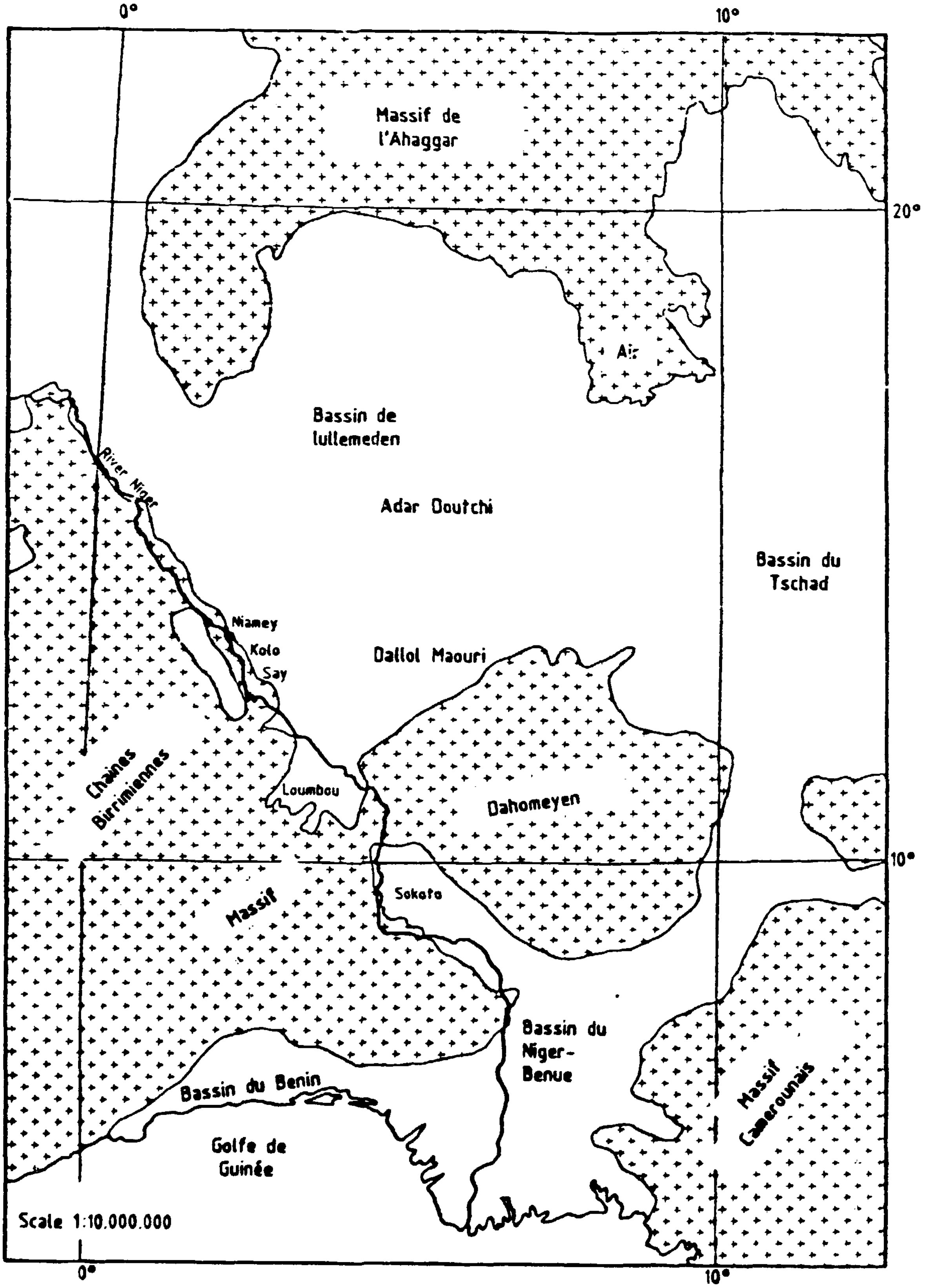

Fig. A-2: Situation des Massifs et des Bassins

A.3 EXTENT AND CHRONOLOGY OF THE INVESTIGATION WORK

A.3.1 GEOLOGY

A.3.1.1 SELECTION OF THE INVESTIGATION AREAS

According to the Terms of Reference the investigation and field work were to focus to areas of lower phosphorus content; these have been selected on the basis of literature studies and evaluation of previous reports and initial field inspections.

The thickness of the ore body, visible at outcrops, the ore quality and the extension of the deposit as known from preliminary investigations suggested to give priority to the plateau of Doguel Kaina - Say (Fig. A3).

The plateau of Kolo has been classified as area of second priority. Here the ore thicknesses in the outcrops are considerably less than those noticed within the area of the Doguel Kaina - Say plateau. Moreover, literature studies and preliminary investigations suggested the Kolo deposit is smaller than that of Doguel Kaina. However, the thickness of the overburden to be expected for the Kolo deposit is less than at Doguel Kaina.

Compared with the plateaus of Doguel Kaina - Say and Kolo that of Dyabou seemed to be of subordinate importance so that expenditure as regards time and work were to be kept low.

In the course of the field work, adjacent areas of the locations mentioned above have been investigated with respect to their iron-ore potential.

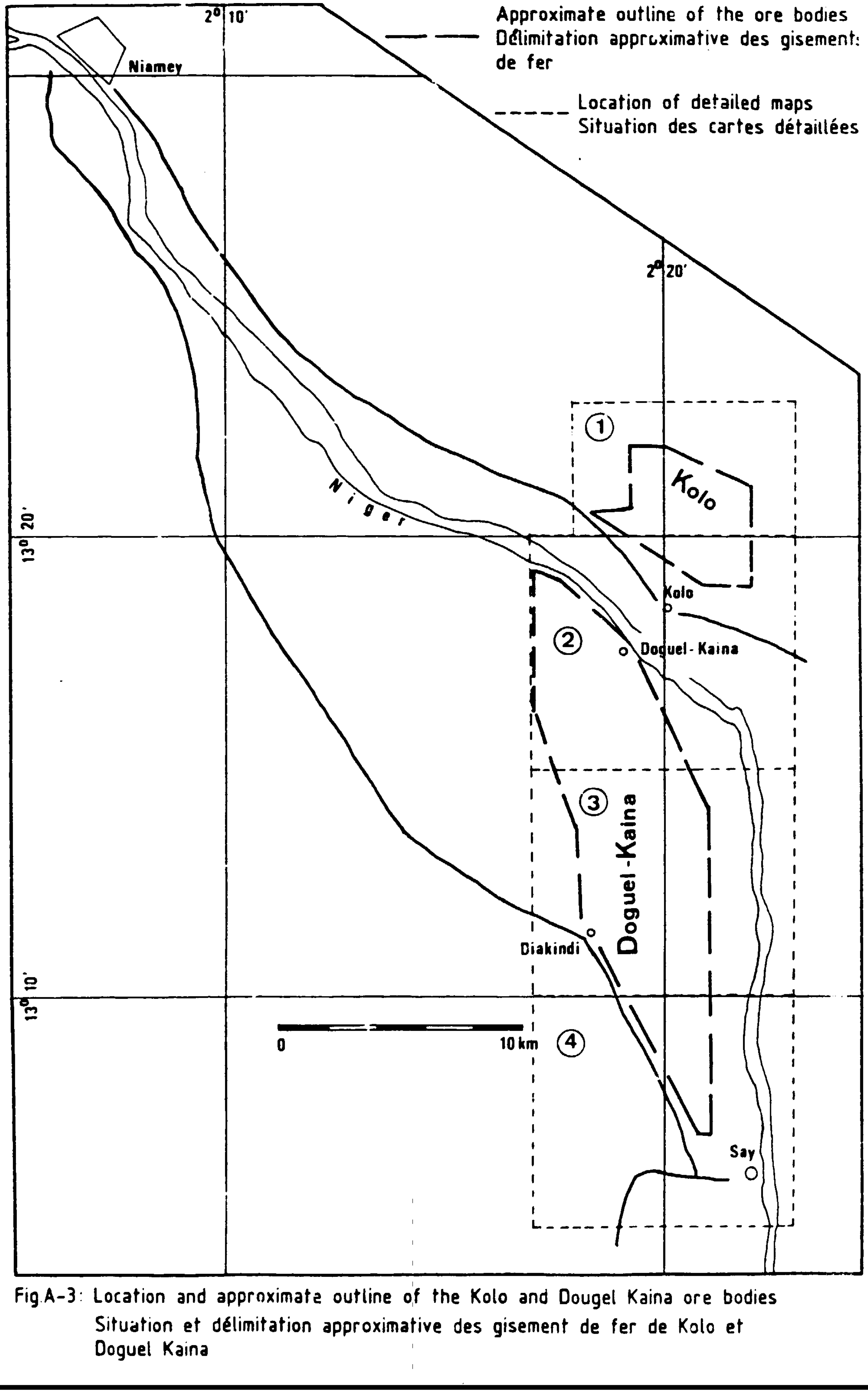

Fig.A-3: Location and approximate outline of the Kolo and Dougel Kaina ore bodies
Situation et délimitation approximative des gisement de fer de Kolo et Doguel Kaina

A.3.1.2 OUTCROP CONDITIONS AND GEOLOGICAL MAPPING

The ore bodies to be examined are the bottom part of the flat-lying sediment series of the 'Continental Terminal'. They are only outcropping at the edges of the Niger river valley where they form escarpments. These escarpments are the only natural outcrops within the area of the plateau. The ore outcrops in the field have been geologically mapped with the aid of aerial photographs. The ore bodies inside the plateaus are located under more or less thick covering sediments and they could only be reached by way of drilling or pitting.

A.3.1.3 PITTING AND TRENCHING

The iron-ore horizons have been exposed along the escarpments by trenches on their complete thickness (fig.A 4)

Fig. A4: Digging of a trench at the escarpment.

The trenches have been dug by 3 - 4 workers by no more than picks, crowbar and shovels. No blasting work was required. These teams required 2 - 3 weeks on an average for completing one trench. 1 to 5 teams have been working at the same time.

Most of the trenches have been put down as channel trenches, but some had to be dug as pits. The depth varied from 3 to 10 m, the average depth has been near 5 m. In general, the stability of the trenches has been good.

Four trenches within the working area of the Doguel Kaina (PDK 17, 29, 30, 31) have come across groundwater.

The pits and trenches in the Doguel Kaina area have been marked PDK (Puits Doguel Kaina), in the Kolo area PK (Puits Kolo) and in the Dyabou area PSD (Puits Say-Dyabou).

The initial spacing from one trench to another has been 1 000 m and has been later condensed to 500 m.

Pitting and trenching in the Doguel Kaina deposit had been started mid-November 1981 and lasted until end of June 1982. A total of 51 trenches (PDK) have been put down with a total depth of 397.50 m. In the area between Say and Dyabou (PSD) 6 trenches with a total depth of 22.70 m were completed from May to June 1982. In the Kolo deposit 5 trenches (PK) with a total depth of 27.00 m were dug in November and December 1982.

A.3.1.4 CORE DRILLING WORKS

Drilling pattern

The drilling points in the area of Doguel Kaina have been marked with the aid of a compass and tape or measured in strides. After completion of the drilling work, the coordinates and the altitudes of the drilling points and the trenches respectively have been surveyed topographically by the 'Service Topographique du Niger'.

For avoiding the time-consuming coordinate fixing in the terrain, an orthognal grid oriented to the geographical north has been laid over the drilling area of Kolo with the aid of a theodolite and a tape measure; this grid had been fixed on a survey point. This grid meant that the drilling points only had to be levelled. These work was carried out by KHD Humboldt Wedag.

The distance of the drilling lines running in north-south and northwest-southeast direction respectively at the Doguel Kaina deposit equals 750 m and the space of the drilling points on the lines is 1.0 to 1.5 km (annex B-4). The drilling points along the drilling lines have been shifted in north-south direction by 500 m and 750 m resp. relative to the parallel line of drillings.

Consequently, a better statistical distribution could be achieved over the exploration surface with the same number of drillings.

The distance between the drilling lines is 750 m for the Kolo deposit, too, and the spacing of the drillings along the lines equals 1 000 m. The drillings have again been shifted by 500 m in north-south direction relative to the adjacent line of drillings.

Drilling capacity

The drilling work was executed by one BBS and one Long Year 38 drilling machine of ONAREM. Work has been done during two shifts of 6 hours/day each during 7 days a week. The drilling work had to be discontinued repeatedly for lack of spares and towards the end of the campaign because of fuel rationing.
During the first part of the drilling compaign from January to May 1982 the average capacity for drillings with sufficient core recovery amounted to 1.22 m/shift and machine (corresponding to 4.88 m/day). That figure could be raised to 1.96 m/shift and machine (corresponding to 7.84 m/day) during the second part of the campaign from November 1982 to March 1983.

A total of 104 drill holes with a total depth of 2495.80 m have been drilled. These were made up of
70 drillings of 2,038.60 m at Doguel Kaina
28 drillings of 330.55 m at Kolo and
6 drillings of 126.65 m at Dyabou.

All core drillings had a diameter HQ or 96 mm. During the first part of the campaign, the average core recovery has been near 74.60 %; it could be improved to 78.53 % during the second half of the campaign.

Drilling methods

The core drilling work was started with conventional wire line core drilling using core barrels of 3 m length. Due to the softness of the ore the core recovery in the upper horizon was 30 % at the maximum and in the lower horizons only 0 to 5 %.

The drilling method therefore was changed. Through the sandy and clayey overburden drilling and coring was executed with the conventional equipment, as described above, to a depth 1 - 2 m above the upper ore horizon. This depth had to be determined for each bore hole by the geologist.

High core recovery, which was most essential for the ore horizons, could be achieved by two ways:

- either by use of the conventional wire line core drilling with diamond bits, whereby the single core runs were reduced to only 0.30 m. These short runs ensured even in case of little core recovery of 0.10 m = 33 % an exact determination of the stratigraphic position of the extracted core and in cases of 50 % core recovery sufficient core material for representative sampling

- or by use of a pipe fitted with a hardened steel bit, which was driven by a hammer weight, especially into soft unconsolidated ore horizons. This method resulted in average core recoveries of 90 %.

A.3.1.5 SAMPLING AND SAMPLE PREPARATION

Channel samples and core samples have been taken from the iron ore won in the trenches and in the drillings. The lengths of sample sections depended from the lithology of the ore.
A total of 347 samples have been taken from pits and trenches, i.e.

311 samples from pits and trenches at Doguel Kaina - Say
17 samples from pits and trenches at Kolo
19 samples from pits and trenches at Say - Dyabou.

A total of 439 samples have been taken from drillings, i.e.

338 samples from drillings at Doguel Kaina - Say
92 samples from drillings at Kolo
9 samples from drillings at Dyabou.

In addition, 15 samples have been taken from various outcrops so that on the whole 801 samples result.

For preparing the samples for analysis these have been pre-crushed with a jaw crusher, if necessary, then quartered and ground to analytical fineness in a vibratory disk mill.

Sampling and sample preparation have been carried out simultaneously with the drilling and trenching work.

A bulk sample of a total weight of 13 t has been taken as combined sample from trenches and drill cores and shipped to Germany. It was to be used for benefication and metallurgical tests. The sample material was kept separately for each of the three ore types (Oolites Indurées, Intercalation, Oolithes Tendres).

A.3.2 CHEMICAL ANALYTICS

Each of the 801 samples taken has been quantitatively analysed for 8 elements. Fe total, SiO_2, P_2O_5 and Al_2O_3 being the main constituents have been determined by the following methods:

Fe total	by the dichromate method
SiO_2	by the perchloric acid method
P_2O_5	photometrically
Al_2O_3	first by atomic absorption spectrometry then gravimetrically due to defect of the spectrometer

TiO_2, CaO, MgO and MnO are secondary constituents and have been determined by the following methods:

TiO_2	photometrically
CaO	first by atomic absorption spectrometry then by titrimetry due to defect of the spectrometer
MgO	first by atomic absorption spectrometry then due to defect of the spectrometer by titrimetry together with determination of CaO
MnO	by atomic absorption spectrometry

Furthermore, the total moisture has been determined at 500°C which after air drying of the samples in the arid climates of Niger essentially corresponded to the hydrate water of the iron hydroxides and, finally, the loss on ignition at 1 000°C has been determined.

For verifying the analytical results, 21 selected samples have been subjected to complete chemical analyzing for control purposes and, in addition, 71 individual analyses carried out for determining specific elements.

This results in a total of 822 complete chemical analyses. Systematic chemical analyzing of the iron-ore samples was started on January 28, 1982 and completed in November 1983.

Details of the analytical results are given in annex B 2.1 to B 2.43.

A.3.3 MINERALOGY AND BENEFICIATION TESTS

A bulk sample of iron-ore weighing 13 t was sent to the KHD research and development centre in Cologne in June 1983. The material had been packed separately for the three types of ore; i.e. Oolithes Indurées, Intercalation and Oolithes Tendres.

Test work was taken up immediately after receipt of the sample material. It could be completed in December 1983.

The main target of the tests has been lowering the phosphorus content and increasing the iron content in the ore.

To that purpose various tests have been carried out for processing the raw material, i.e.

- concentration by classification
- concentration by selective comminution and subsequent classification
- concentration by selective comminution, attrition and classification
- concentration by sink-and-float methods
- concentration by high-intensity wet magnetic separation.

After a suitable beneficiation method had been developped in the course of the test work, two concentrates were prepared during a continuous process for carrying through metallurgical tests (pelletizing).

A.3.4 PELLETIZING- AND METALLURGICAL TESTS

For carrying out metallurgical tests, which have been started in mid-October 1983, a mixed concentrate was prepared from the two ore concentrates, and was chemically analyzed.

The mixed concentrate had been subjected to drying and fine grinding before it was applied for the production of green pellets, for which it was mixed with different additives.

After checking of the physical properties of the green pellets obtained in this way, such as moisture content, drop hardness number, green strength and strength in dry state, the green pellets were sintered in a facility, identified as "pot-grate" at a temperature of approx. 1 300 °C.

The physical properties of the sintered pellets, such as screen analysis, tumbler index, porosity and compressive strength in cold state, were determined subsequently.

The sintered pellets were tested as to their reduction- and smelting properties with the aid of gas and coal as reducing agent. Moreover, tests for determining the softening- and smelting properties of the pellets were carried out and evaluated.
All these tests were completed in mid-December 1983.

Part B

Geology

RESULTS OF THE INVESTIGATIONS AND TESTS

The tests carried out under this study covered three spheres, i.e. geology, beneficiation and metallurgy of the iron-ores and the results obtained are specified in the following sections B., C. and D.

B. GEOLOGY

B.1 GEOGRAPHIC LOCATION, INFRASTRUCTURE, MORPHOLOGY

The geological examinations of the oolitic iron-ores have been carried out in the areas of Doguel Kaina - Say, Kolo and Dyabou (fig. A 3 and Annexes B 5 to B 11)*

B.1.1 DOGUEL KAINA - SAY AREA

The iron-ore deposit of Doguel Kaina - Say is located some 50 km South-East of Niamey on the right side of the Niger river. It is accessible over the not yet tarred road from Niamey to Say (RN 27) in about 40 - 50 minutes driving time. The deposit extends between the Niger river and the RN 27 and is well accessible over three connecting roads to Doguel Kaina, Tokey and Ganki Bassarou (being non-consolidated roads). The extension of the investigated area in north-south direction covers 24 km and its max. width in east-west direction equals 5.6 km. The total surface of the investigated area is about 100 km^2.

The corner points of the investigated area are identified by the coordinates:

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*According to the 'Terms of reference' the drill sites and the results of geologic investigations were to be shown on maps scale 1 : 10,000. Since only topographic maps of a scale of 1 : 50,000 were available of the project area, these had to be enlarged to a scale 1 : 10,000 by the Niger cartographers of ONAREM. KHD Humboldt Wedag AG received prints of these enlargements which, however, allowed copies only of unsatisfactory quality.

13° 19' 18'' N / 2° 16' 57''E	north-west of Kohan Garanké
13° 18' 54'' N / 2° 17' 52''E	east of Kohan Garanké
13° 14' 23'' N / 2° 20' 49''E	north-east of Warkéré
13° 07' 00'' N / 2° 20' 49''E	north-west of Say
13° 11' 32'' N / 2° 18' 15''E	Diakindi
13° 18' 09'' N / 2° 16' 31''E	

Morphologically the terrain is a flat plateau, i.e. the plateau of Doguel Kaina - Say. The average altitude ranges between 175 m in the lowlands of the river and 220 m on the plateau. The morphologically topmost point of the investigated area is about 4 km west of Doguel Kaina, at about 230 m. The plateau is interrupted by a side valley of a Niger tributary oriented west-north-west to east-south-east; that side valley is located at an altitude of 190 - 200 m above sea level.

In the east and north-east respectively the plateau of Doguel Kaina - Say is bordered by the natural erosion edge of the Niger river which forms an up to 10 m high escarpment in this area. The ore body outcrops visibly at this escarpment. The Niger valley which reaches max. widths of 3 km is situated at an altitude of 175 - 180 m above sea level.

Six permanent villages and numerous small hamlets are situated within the area of the deposit. The hamlets are occupied temporarily only or their locations are altered as required.

The original savanna vegetation has been cleared and the plateau is agriculturally utilized by rainy season cultivation (sorghum) and extensive pasture farming. Apart from the interconnecting tracks to the larger villages there are several smaller ways and paths which have the area well opened up.

B.1.2 KOLO AREA

The iron-ore deposit of Kolo is situated some 20-25 km south-east of Niamey on the left, eastern side of the river. Kolo can be reached over a tarred road from Niamey within 20 - 25 minutes driving in a car.

The terrain investigated by drilling and trenching extends in north-west to south-east direction over 7.0 km and has a maximum width in north-east to south-west direction of 3.5 km. It is identified by the coordinates:

13° 20' 16'' N / 2° 18' 32'' E
13° 21' 53'' N / 2° 19' 48'' E
13° 19' 58'' N / 2° 21' 54'' E
13° 18' 52'' N / 2° 21' 54'' E

The surface of the terrain investigated at the Kolo deposit covers approx. 18 km^2.

As to its morphology, the area of Kolo is a flat plateau with average altitudes of 185 m above sea level at the escarpment in the south-west and of 200 m in the north-east and south-east of the inspected terrain. The north-west extension is at an altitude of 190-200 m. Some 3 km east of Kolo rises a small mesa of approx. 0.5 km^2 and a maximum height of 205 m above sea level and beyond the surrounding level of 190 m.

A dry valley passes through the south-east part of the deposit in north-east to south-west direction which drains the area towards the Niger river during the rainy season.

The largest village within the inspected area is the agricultural centre of Kolo. Only small hamlets exist on the plateau of Kolo within the area of the deposit but no permanent, larger villages. As the plateau of Doguel Kaina, the plateau of Kolo is agriculturally utilized by rainy season cultivation, mainly sorghum, and extensive pasture farming. Near Kolo large rice plantations exist along the Niger river. Small ways and paths and the flat morphology make the working terrain easily accessible.

B.1.3 DYABOU AREA

The third working area, i.e. the plateau of Dyabou, is located between the east-west oriented rivers Goroubi and Dyamongou, some 80 km or 2 hours car driving south-south-east of Niamey. The area is accessible over the RN 27 from Niamey over Say and further in the direction of Tapoa and a 8 km long connection road which branches off 3 km south of the Goroubi bridge.

In contrast to the deposit areas of Doguel Kaina - Say and Kolo described above, the plateau of Dyabou is not yet agriculturally utilized to the same extent because the partly dense original vegetation (bushes and small trees) severely impairs its accessability.

The plateau of Dyabou has s size of 180 - 200 km^2, some 70 km^2 of which had been included in the investigations.
It is bordered by the coordinates:
12° 53' 41'' N / 2° 16' 07'' E
12° 53' 55'' N / 2° 22' 00'' E
12° 46' 40'' N / 2° 15' 46'' E
12° 48' 25'' N / 2° 25' 26'' E

From altitudes of about 240 - 250 m in its western part, it descends morphologically to the east down to the escarpment edge at the Niger river at an altitude of 200 m. The Niger flows at an altitude between 173 and 174 m above sea level.

B.2 PREVIOUS INVESTIGATIONS AND THEIR RESULTS

The sedimentary, oolitic iron-ores outcropping along the central Niger valley have been known since the early 30-ties and have been repeatedly subject of geological exploration.

They were first mentioned by N. REFORMATSKY (1930-32). A.CHERMETTE (1938) described the iron-ores as limonitic iron oolites occuring between claystones and the "basic sandstone" of the Continental Terminal. Between 1948 and 1957 J.GREIGERT and H. FAURE dealt among others with the two intracratonic basins, the Iullemeden and the Tschad basin. In the course of their work they realized the enormous areal extension of the iron sediments at the base of the Continental Terminal.

In 1960, B.R.G.M. carried out prospecting work in the central Niger valley between Karma and Kirtachi by order of the Government of Niger (fig. A-1).

As regards ore quality and thickness of the ore horizons, the plateaus of Doguel Kaina - Say, Kolo and Dyabou were selected for additional investigations.

These areas were inspected once again by B.R.G.M. in 1961/62 but on a smaller scale and these investigations included primarily putting down trenches as well as geological logging and sampling of existing water wells. For technical reasons only parts of the deposit could be investigated that were covered by overburden of little thickness. Therefore, activities in the areas of Doguel Kaina - Say and Dyabou were concentrated on the ore outcrop at the escarpment. A smaller area directly north of Doguel Kaina was explored over its entire surface and in detail by 15 pits and trenches because the overburden thickness was very small. Over the rest of the deposit, the pits and trenches put down by B.R.G.M. had a spacing between 1 and 8 km. Estimation of the iron-ore reserves has furthermore been based on geological logging and sampling of 19 water wells situated west of the ore outcrop at the inside of the plateau of Doguel Kaina - Say.

The plateau of Dyabou has been inspected by 17 pits and trenches.

The iron-ore occurrence on the plateau of Kolo is cov red almost completely by an overburden of less than 5 m thickness; that area has been inspected over the entire surface by 9 shaft pits.

The reports of B.R.G.M. available specified the following iron-ore reserves:

plateau of Doguel Kaina - Say:

safe reserves: 16.5 M t at an average Fe content of 48.8 % and 0.7 - 3.5 % of P_2O_5 (for the area directly north of Doguel Kaina which has been investigated in detail)

probable reserves: 152 M t at an average Fe content of 48.8 % and 0.7 - 3.5 % of P_2O_5

geological reserves: 420 M t at an average Fe content of 48.8 % and 0.7 - 3.5 % of P_2O_5

plateau of Dyabou:

geological reserves: 180 M t at an average Fe content of 49.5 % and 0.7 - 3.5 % of P_2O_5

plateau of Kolo:

safe reserves: 80 M t at an average Fe content of 42.3 % and 0.7 - 3.5 % of P_2O_5

B.3 STRATIGRAPHY AND DESCRIPTION OF THE VARIOUS STRATA AND THEIR REGIONAL DISTRIBUTION

The stratigraphically oldest rocks underlying the iron-ore bearing formation in the area of the three iron-ore deposits are according to MACHENS (1964) of the Precambrian age of the Birrimien. (fig. B-1)

These are predominantly medium-grained to coarse-grained granites. In addition, phyllites and mica schists occur some of which are garner bearing. Moreover, graphite schist horizons have been observed in these mica schists. There are very isolated quartzite occurrences and quartzitic conglomerates of which it may be assumed that they correspond stratigraphically to the Volta sandstone (Eocambrian).

The crystalline basement outcrops in river or wadi valleys with seasonal, eroding water discharge.

These basement rocks, particularly those rich in feldspar have been subjected to deep kaolinitic alteration. The thickness of the kaolinitic rocks underneath the iron-ore bearing layers partly reach 10 m, especially in paleomorphologic depressions. Some of this is in situ kaolinite, whereas there are other places where the kaolinite seems to have been subject to redeposition.

Following a stratigraphical gap of several hundred million years reaching from the Cambrian incl. up to Lower Tertiary, the continental sediments of the Continental Terminal have been deposited discordantly on the basement. These are of the Miocene Age (Upper Tertiary). Paleogeographically the sediments of the Continental Terminal, including the iron-ore deposits, are located in the western part of the intracratonic Iullemeden basin which covers large areas of West Niger and North-West Nigeria. In the deepest part of the Iullemeden basin which has an asymmetric cross section, sediment thicknesses of more than 3,000 m are reported.

However, within the inspected area south-east of Niamey the maximum thickness amounts to 50 m only.

The sediments of the Continental Terminal start above the kaolinitized basement with a sandy-clayey transitional layer of 0.0 to 1.0 m thickness. Already that layer displays iron-bearing portions in the form of isolated ooliths and pisoliths changing over without clearly defined boundary into high grade iron-ore.

The entire iron-ore horizon can generally be divided into three sub-layers which differ with respect to chemical and mineralogical composition, granulometry and rock hardness. The oolitic-pisolitic iron-ore horizon (fig. B-2) forming the deposit and made up of the lower Oolithes Tendres, an Intercalation and the upper Oolithes Indurées will be described in detail in chapter B-4.

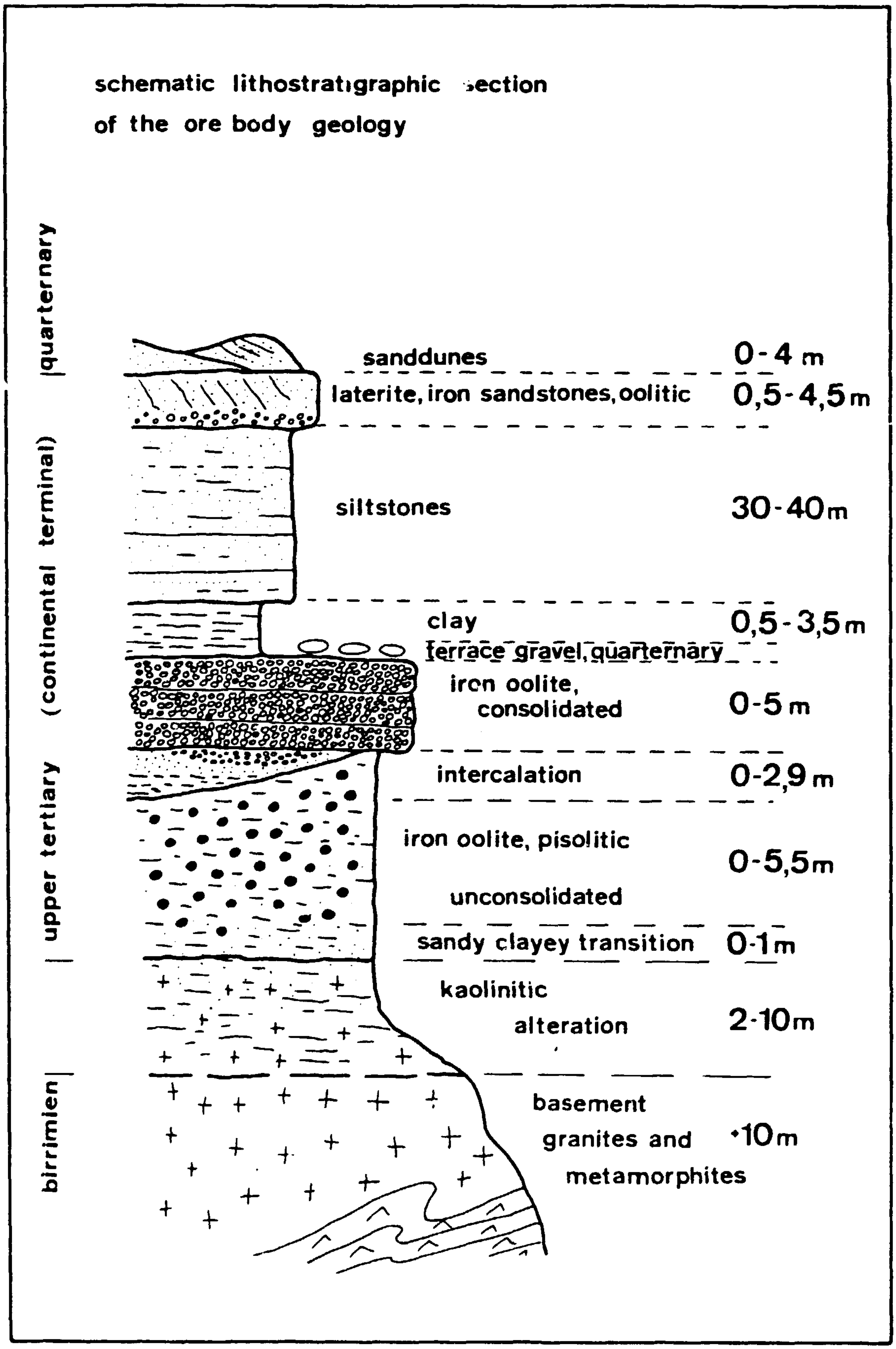


Fig. B 1: Schematic Lithostratigraphic section of the ore body geology

Fig. B-2: Escarpment near Tokey: On top plateau of Doguel Kaina, formed by Oolithes Indurées; persons standing on Intercalation; at the bottom Oolithes Tendres.

The topmost iron oolite is followed by a clay layer of 0.5 to 3.5 m thickness. That clay is mostly hardened due to seasonally varying moisture content and of light-brown colour. In some drillings and outcrops at the escarpment that clay is of light-grey to pink colour and displays plastic properties.

On top of that layer follow alternate layers of silt rock and fine grained sandstones with thicknesses up to 30 to 40 m, depending on the grade of erosion. Their colours range from red-purple over brown-yellow to light grey-white. Further iron oolite horizons with up to 0.30 m thickness occur intercalated in the silt rock.

During a phase of laterization iron sandstones of strongly varying thickness between 0.5 and 4.5 m have been formed within certain parts at the top of the sediments of the Continental Terminal. At the base of these iron sandstones 0.2 to 1.0 m thick horizons of iron oolites and quartz conglomerates have been intercalated. Mobilized iron solutions which were afterwards again precipitated have cemented iron sandstones and iron oolites so that both rocks have been excessively hardened. The Fe and SiO_2 contents in the iron sandstones reach about 27 % Fe and 45 % SiO_2; the average figures for the iron oolites are 39.85 % Fe and 28.26 % SiO_2.

Gravels of old Niger river terraces of Quarternary age superimpose at some areas sediments of the Continental Terminal and have been located at a level of 190 - 195 m above sea level. The pebbles are mainly well rounded milky quartzes of 1.0 to 7.0 cm diameter and poorly rounded iron oolite and iron sandstone pebbles up to 20 cm diameter. Pebbles of quartzite or basement rock are found very rarely. The pebbles are embedded in quartz sand which latter has been weakly consolidated by iron hydroxides.

The sedimentation ends on the plateaus with subrecent to recent eolian fine sands of little thickness which have been blown to small dunes by the wind and may have thickness up to 4 m.

Fine sands and black-brown, humus mud have been deposited in the subrecent to recent flooding areas of the Niger river.

B.4 RESULTS OF THE PITTING/TRENCHING AND THE DRILLING CAMPAIGN

B.4.1 PETROGRAPHY AND MINERALOGY

Stratigraphy, petrography and mineralogy of the three ore horizons are described below. (Fig. B-1) The statements made are essentially applicable to all three deposits, i.e. Doguel Kaina - Say, Kolo and Dyabou.

Above the kaolinitized basement the Continental Terminal commences with a sandy-clayey transitional layer in which first occurrences of iron oolites and pisoliths have been noticed (fig. B-3).

Fig. B-3: Outcrop at the escarpment near Say. On top of the white kaolinitized basement follow the brown Oolithes Tendres.

With ooliths and pisoliths increasing to 80% at a max. of the mineral content, the clay-sandstones change over without a clearly defined geologic boundary into non-consolidated pisolitic iron oolites and oolitic iron pisolites respectively which have been designated as "Oolithes Tendres".

Note: ooliths and pisoliths differ only by their grain size; ooliths have a diameter of less than 2 mm, pisoliths a diameter of more than 2 mm. Both are built of spherical to ellipsoidal, concentric-shelly goethite bodies (α -FeOOH) (fig. B-4 and fig. C-6).

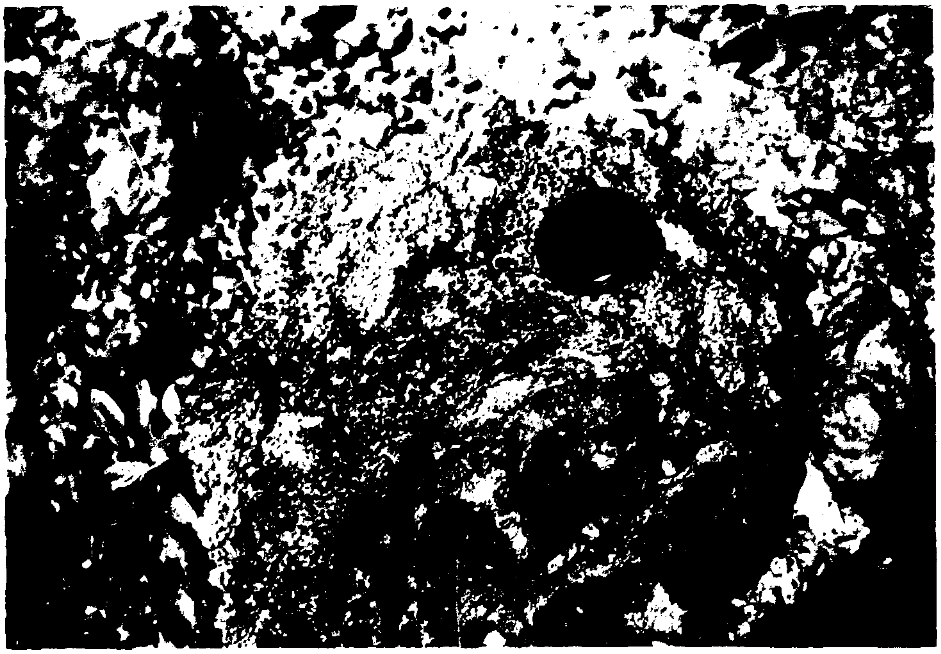


Fig. B-4: Coarse-grained pisoliths and smaller ooliths.

The iron ooliths and -pisoliths are surrounded by a matrix of yellow-brown, silty clay. Quartz sand of fine to coarse grain-size occurs as coarser clastic component. It may amount to up to 30 % in the lower parts of the layer and decrease to about 2 - 5 % more or less continuously towards the roof. However, a horizon-specific distribution of the portion of iron ooliths and -pisoliths, as well as of the clayey binder could not be observed in the Oolithes Tendres horizon. The estimated portion of pisoliths varies over the horizon between 5 and 30 %.

Fig. B-5: Uniform ooliths in the Oolithes Tendres

The sediment structure is unbedded to massive in the trenches and the few natural outcrops. The colour of the rock is medium grey to brown.
The Oolithes Tendres have thicknesses between 0 and 5.5 m.

On top of the Oolithes Tendres follows a layer which is developed in large portions of the investigated areas. It is laterally and partly also vertically differentiated and indicates thus certain differentiations of the sedimentation basin and conditions.

Fig. B-6: Outcrop at the escarpment east of Tokey: Oolithes Tendres at the bottom and Oolithes Indurées on top, with thin Intercalation at the level of the hammer

That layer which hereinafter is named as "Intercalation" consists of the following components:

- iron oolites with ooliths bigger than 0.5 mm in clayey-sandy matrix; in which the mostly light-grey clay forms "schlieren" in the rock.
- strongly coarse-sanded iron oolites
- coarse sands made up of unrounded quartz grains
- light-brown, sandy-silty clays which contain some isolated ooliths

The phenomenon of the varying thickness (0 - 2.90 m) and, corresponding to the facies, the strongly varying iron contents of the 'Intercalation' is dealt with under para B.4.3 below.

The Intercalation is followed to the top by a dark red-brown iron oolite which appears stratified in the outcrop. Compared with the two underlying ore horizons this iron oolite has been significantly more consolidated and is hereinafter referred to as "Oolithes Indurées". Because of its hardness it forms the upper edge of the escarpment towards the Niger valley over parts of the deposits. At its base some isolated reworked iron-oolite pebbles have been noticed.

Fig. B-7: Escarpment near Tokey: Bedded Oolithes Indurées

The rock consists at more than 90 % of spherical to ellipsoidal goethite ooliths. Most of these display radiated fissures which may be healed by iron hydroxide. Apart from that fractures of ooliths occur which are indicative of a deformation or fragmentation of the ooliths in solid state.

Particle size measurements made with 4 polished sections and by screen analyses revealed that up to 38.7 % of the ooliths consist of the fraction minus 0.5 mm and more than 62 % of the fraction 0.5 - 2.0 mm. Only up to 2.5 % are in the fraction plus 2.0 mm and can be defined as pisoliths.

The portion of well-rounded quartz grains has been determined to equal 7 % at a max. in a polished section and consisted mainly of the fraction smaller than 0.63 mm. For the other polished sections examined the quartz portion has been below 1 %.

Evidently the pisoliths, ooliths and quartz grains are more densely packed in the Oolithes Indurées than in the Oolithes Tendres. Apart from that they do not have such strong clayey matrix. Because of the resulting interstices between the ooliths the rock gives a porous impression. The interstices are only partly filled with reddish-brown and yellowish-brown clay. On the basis of microscopical examination and tests with the X-ray diffractometer, the clay was determined to be kaolinite.

The stronger consolidation of the Oolithes Indurées, varying by strata, is attributable to a bonding or cementation due to remobilized iron hydroxide as a consequence of strain solution at the outer rims of the ooliths and pisoliths. In isolated cases the ooliths interstices are filled with goethite precipitations.

The structure of the oolites at the escarpment is bedded with thickness of the beds from 0.10 - 0.60 m.

The Oolithes Indurées reach thickness of 5.0 m, in some parts of the deposits, however, thin-out to 0.0 m towards the rims of the old sedimentation basin.

In the soft parts of the Oolithes Indurées, the Intercalation and the Oolithes Tendres at the escarpment face very often small channels or tubes can be observed which most probably result from digging activities of worms or insects or from roots (fig. B-8).

Fig. B-8: Escarpment near Warkéré: Digging or root channels in the Oolithes Tendres

Summarizing, the mineralogy and paragenesis of the ore can be described as follows:

The Oolithes Tendres and the Oolithes Indurées are a sedimentary, oolitic iron-ore, being little or not at all solidified.

The main mineral and Fe-carrier of the ore is goethite (α - FeOOH), building up the ore by loosely to densely packed, spherical to ellipsoidal ooliths and pisoliths. In very rare cases, also finely-grained hematite was identified as iron mineral.

Goethite occurs mainly in the oolith- and pisolith components, but also in the matrix i.e. either finely-distributed in the clay fraction, or in many places as cement, which in the form of remobilized and re-precipitated FeOOH may bond the ooliths.

Hydroxide iron phosphates (such as vivianite) were presumed to be the carriers of the phosphorus.

A phosphor mineral of its own could, however, not be identified, i.e. neither by microscopic investigation nor by X-ray analizing. Micro-probe investigations revealed that the major portion of the P in the sediment is bound to goethite and that the P- and Fe-contents are directly proportional to each other. P is present in the ooliths extremely finely-distributed and is not concentrated in different oolith shells. The extremely fine distribution of the P in the ooliths and the X-ray amorphism suggest that P is adsorptively bond to goethite as PO_4^{3-}-ion or that by an anion exchange of PO_4^{3-} against the OH-shell the PO_4^{3-}-ion has been coupled to the goethite.

In the ore detrital quartz is present as gangue component as well-rounded sand grains in the medium- and coarse fraction, and - moreover - very finely grained as silt in the matrix.

Clay in the form of kaolinitic clay minerals is the main matrix component. Further details have been included in the chapter "Mineralogical investigation of the oolitic iron-ore", chapter C.4.1.

B.4.2 GEOCHEMISTRY AND ORE GRADES

The lithological differences within the ore horizons which had been discovered in the outcrops and also in the drill cores could be confirmed by the chemical analyses and quantitatively determined by the ore grades.

B.4.2.1 VERTICAL GEOCHEMICAL DISTRIBUTION

Considering the vertical geochemical development in the three ore horizons from the bottom to the top the following can generally be stated for the deposits at Doguel Kaina as well as at Kolo (see drill and trenching logs, annexes B.3.1 - B.3.123, and analyses tables, annexes B.2.1 - B.2.45).

The sandy clayey transitional layer between kaolinitized basement and the bottom layer of the Oolithes Tendres is characterized by high SiO_2-contents of more than 45 % at correspondingly low Fe-contents of less than 25 % and P_2O_5-contents of approx. 1 %.

In the Oolithes Tendres, there are more or less continuous increases in the Fe-content from the bottom to the top from less than 25 % to 47 % and in some cases even to 51 %, max. and in the P_2O_5-content from 1 % to 2 % and 2.8 %, max., at a simultaneous reduction of SiO_2 from more than 45 % to 12 % or 15 %. There are no systematic changes as regards the Al_2O_3 in the Oolithes Tendres.

The table below compares the weighted average contents of all samples from the Oolithes Tendres from the deposits Doguel Kaina and Kolo with an average thickness of 2.90 m in Doguel Kaina and of 2.00 m in Kolo.

	Doguel Kaina	Kolo
$Fe_{tot.}$	45.49 %	43.64 %
P_2O_5	2.07 %	2.37 %
SiO_2	13.54 %	13.75 %
Al_2O_3	5.89 %	7.33 %

In this connection, it has to be pointed out that a cut-off of 35 % of $Fe_{tot.}$ has been taken as a basis for determining the average contents, i.e. only those samples of the Oolithes Tendres were considered for calculating that had an Fe-content of more than 35 %.

Under the conditions mentioned above, the Oolithes Tendres of both deposits are characterized only by slight differences with regard to the contents of the main elements. It is however striking that the average P_2O_5-content of the Kolo deposit is higher and the Fe-contents is lower than that of Doguel Kaina deposit.

According to the heterogenous regional facies of the Intercalation, which may consist of iron oolite, sand, clay or an alternation of these, also the geochemical pattern is very variable. Thus, the SiO_2-content of the Intercalation in sand facies, e.g. reaches more than 60 % at an Fe-content of partly lower than 15 %. If, however, the Intercalation is present in iron oolite facies, the Fe-content may reach more than 45 % and SiO_2 may be less than 20 %.

The weighted average contents of all Intercalation samples from the deposits Doguel Kaina and Kolo are as follows:

	Doguel Kaina	Kolo
$Fe_{tot.}$	32.96 %	23.93 %
P_2O_5	1.14 %	0.91 %
SiO_2	35.44 %	46.84 %
Al_2O_3	5.83 %	8.21 %

The average thicknesses of the Intercalation equal 1.13 m in Doguel Kaina and 1.06 m in Kolo.

A comparison of the geochemistry of the Intercalations from both deposits reveals an Fe-content being on the average almost 9 % higher in the Doguel Kaina deposit than in the Kolo deposit.

The average P_2O_5-content in the Doguel Kaina deposit is by 0.23 % slightly increased compared to the Kolo deposit. Contrary to this, the average SiO_2-content is higher by 11 % in Kolo than in Doguel Kaina. The Al_2O_3-contents are likewise by 2.38 % higher in Kolo than in Doguel Kaina.

In comparison with the Intercalation the superimposed Oolithes Indurées have a very uniform geochemical composition .

The contents of the different components in the two deposits range from - to:

	Doguel Kaina	Kolo
Fe_{tot} %	45.0 - 55.0	37.16 - 53.17
P_2O_5 %	1.13 - 2.41	1.21 - 2.19
SiO_2 %	2.88 - 13.87	4.05 - 25.50
Al_2O_3 %	2.49 - 7.54	1.92 - 7.54

Comparing the weighted average contents of the Oolithes Indurées for the two deposits, the differences are as follows:

	Doguel Kaina	Kolo
$Fe_{tot.}$	50.45 %	46.10 %
P_2O_5	1.73 %	1.66 %
SiO_2	8.32 %	14.98 %
Al_2O_3	4.34 %	4.64 %

The average thickness of the Oolithes Indurées are in the Doguel Kaina deposit of 2.53 m and in the Kolo deposit of 2.22 m.

Comparing the average composition of the Oolithes Indurées in the two deposits show that the average Fe-content is 4.35 % higher in the Doguel Kaina deposit than in Kolo, whereas the SiO_2-content in the Kolo deposit exceeds that of the Doguel Kaina deposit by 6.6 %. The P_2O_5-contents and the Al_2O_3-contents are of the same magnitude for both deposits.

The extremely low CaO-contents are characteristic for all three ore horizons of the two deposits and also for those of the Dyabou Plateau.

The average content of CaO + MgO on the whole of the ore horizon is 0.15 %, with maximum values of 0.5 % which presumably originate from anorthite-rich feldspars in the sandy intercalation.

On the basis of the stoicheiometrical ratio it can be excluded that the phosphorus phase is bonded to Ca and is present as apatite.

The TiO_2-contents are always below 1 % and mostly even below 0.5 %. No specific geochemical distribution patterns of TiO_2 have been discovered. The same applies to MnO, the contents of which being of the same magnitude as for TiO_2.

B.4.2.2 REGIONAL GEOCHEMICAL DISTRIBUTION

On the basis of the vertical geochemical distribution in the trenches and drilling cores, the regional distribution of Fe and P_2O_5 has been investigated in the different horizons in detail for the Doguel Kaina deposit.

For the smaller deposit at Kolo with the little number of drillings such a distribution pattern could not be elaborated.

Maps have been prepared by way of electronic data processing, which calculated and showed the weighted average Fe- and P_2O_5-contents in the different horizons - Oolithes Tendres, Intercalations, Oolithes Indurées - as well as the total ore horizon (Annexes B-22 to B-29).

In the major part of the Doguel Kaina deposit, the Fe-content of the Oolithes Tendres exceeds 45 % and reaches a maximum of 51 % (annex B 22). In the northernmost part of the area of investigation, along the escarpment and in two east-west running strips in the southern part the Fe-content is below 45 %.

According to the bonding of the phosphorus to the iron carriers in the ore, described above, P_2O_5-contents of more than 2 % can be encountered in the areas, in which the Fe_{tot}-contents exceed 45 %. Areas implying P_2O_5-contents below 2 % substantially coincide with those, in which the Fe-content is below 45 %. (Annex B-23)

In accordance with the differentiated lithological structure of the Intercalation, a heterogenous regional distribution pattern of Fe and P_2O_5 results (Annex B-25 and B-26). However, the correlation of Fe- and P_2O_5-contents can clearly be ascertained also in the Intercalation. The absolute values of Fe and P_2O_5 are, however, substantially lower than in the Oolithes Tendres underneath. Merely three larger coherent areas in the northern, central western part in the south-east of the deposit could be identified, in which the Fe-contents exceed the cut-off of 35 %.

Just like the Fe-contents, the P_2O_5-contents are with 0.2 % - 1.6 % distinctly lower than in the Oolithes Tendres.

Except for three partial areas near the escarpment at the eastern side of the Doguel Kaina deposit and a smaller area in the central western part, the weighted average Fe-contents in the Oolithes Indurées exceed 50 % (annex B-28). In the portions having an Fe-content of more than 50 %, the regional Fe-distribution is very uniform and is within a range between 50 and 54 % Fe.

Except for two smaller areas in the valley in the south-east of the deposit, the P_2O_5-contents are below 2 %. The two areas mentioned have P_2O_5-contents of 2.2 or 2.4 %. The correlation between Fe-contents and P_2O_5-contents being distinct in the Oolithes Tendres and in the Intercalation is not so obvious for the Oolithes Indurées.

To summarize the results on the vertical and regional geochemical distribution of the components in the ores of the Doguel Kaina and the Kolo deposits it can be stated:

1. The main elements in the ore horizons are Fe, Si, Al and P, accompanying elements are Ti, Mn, Ca, Mg.
2. The highest average Fe-contents of 50.45 % are present in the Oolithes Indurées of the Doguel Kaina deposit.
3. The Intercalation of both deposits is lithologically and thus geochemically built- up very heterogeneously. Some parts of the deposits featuring an Fe-content of more than 35 % are minable (see also para B.4.3 'thicknesses' and para B.7 'reserve calculation'). In large parts of both deposits, the Fe-content is less than 35 % and considered as not being worth mining. The weighted average iron contents of the Intercalation are 32.96 % for the Doguel Kaina deposit and 23.93 % for the Kolo deposit (table A-1).
4. In the Oolithes Tendres of both deposits, the Fe-content increases more or less continuously from the bottom to the top. The weighted average of all drill and trench samples equals 45.59 % in Doguel Kaina and 43.64 % in Kolo.
5. The phosphorus is bonded to the iron carrier. The highest P_2O_5 contents with an average of 2.07 % are found in the Oolithes Tendres of the deposit Doguel Kaina and of 2.37 % in the deposit Kolo.
6. Ca occurs in extremely low quantities only, so that for stoichiometrical reasons it can be excluded that the phosphorus phase is bonded to Ca and is present as apatite or phosphorite.
7. In control analyses, sulfur was found in traces only.

8. The weighted average ore contents for the single ore horizons of the Doguel Kaina and the Kolo deposits are listed in the table below.

	Oolithes Indurées in the area of		Intercalations in the area of		Oolithes Tendres in the area of	
	Doguel Kaina	Kolo	Doguel Kaina	Kolo	Doguel Kaina	Kolo
Average thickness m	2.53	2.22	1.13	1.06	2.90	2.00
Fe_{total} %	50.45	46.10	32.96	23.93	45.49	43.64
P_2O_5 %	1.73	1.66	1.14	0.91	2.07	2.37
SiO_2 %	8.32	14.98	35.44	46.84	13.54	13.75
Al_2O_3 %	4.34	4.64	5.83	8.21	5.89	7.33

The average contents of the total ore horizon amounts to 45.84 % of Fe and 1.80 % of P_2O_5 at a total thickness of 6.02 m at Doguel Kaina, and to 41.27 % of Fe and 1.76 % of P_2O_5 at a total thickness of 4.24 m at Kolo.

The calculation of the average ore content was based on a cut-off of 35 % Fe in the Oolithes Tendres and the Intercalation. Thus, certain marginal drillings and the corresponding deposit areas featuring non-mineable thicknesses or low ore grades have not been considered. This explains the lower average thicknesses in both deposits Doguel Kaina and Kolo, compared with the cumulative average thicknesses of the individual horizons.

B.4.3 THICKNESSES OF THE ORE HORIZONS AND OF THE OVERBURDEN

B.4.3.1 DEPOSIT DOGUEL KAINA

Oolithes Tendres

The average thickness of the Oolithes Tendres is 2.90 m; this serves as a reference value for the following evaluation on the thickness distribution (annex B-24).

Thicknesses of this ore horizon of more than 3 m are found between the Y-coodinates 1463000 and 1455000 and reach a maximum thickness of 5.5 m between the Y-coordinates 1459000 and 1460000 in the western area of the deposit. North of the Y-coordinates 14630000 to 1468000 the thickness of the Oolithes Tendres is between 2.0 and 3.0 m. Further north, the thickness decreases continuously, and finally, the Oolithes Tendres thin out completely. The deposit thickness in the southern area decreases as well - down to less than 0.5 m. This also applies to the escarpment where the thicknesses between the Y-coordinates 1463000 and 1465500 decrease to less than 1.5 m.

Intercalation

A map of the isolines of thickness of the Intercalation is given in annex B-27.

The average thickness of the Intercalation in the Doguel Kaina deposit is 1.13 m. However, there is an extended area with an Intercalation thickness of more than 1.0 m, reaching even 2.7 m. It is limited by the X- and Y-coodinates 425000/1461000, 429000/1464500, 423000/1470000 and 427000/1468000 (of the national grid). The Intercalation thins out to the north-west and the thickness decreases to less than 1.0 m to the north-east. To the south, the thickness also reduces to less than 1.0 m and the Intercalation thins out completely in certain areas.

In areas with thicknesses exceeding 1.0 m, the Intercalation consists mainly of sandy-clayey facies, while in the adjacent southern area of small thicknesses, it is of iron-oolitical character.

Oolithes Indurées

The average thickness of the Oolithes Indurées measures 2.53 m.

There are three larger areas with thicknesses of more than 2.5 m and reaching in one area even a maximum of 5.0 m. These areas are situated:

1) between the X-coordinate 426000 and the escarpment and the Y-coordinates 1455500 and 1462500,

2) in a strip of approx. 0.5 to 2.0 km width running north-north-west to south-south-east along the escarpment between the Y-coordinates 1463000 and 1465500, and
3) between the X-coodinates 423000 and 426500 and the Y-coordinates 1466500 and 1470500 in the north-east of the deposit.

In the northern-most and southern-most part of the investigated area the Oolithes Indurées thin out completely or to thicknesses of less than 1 m.

Total ore horizon

The calculated average thickness of the total ore horizon, i.e. the sum of the individual thicknesses of the Oolithes Tendres, of the Intercalation, and of the Oolithes Indurées, amounts in the Doguel Kaina deposit to 6.56 m.

In large parts of the deposit (annex B-6 to B-8) between the Y-coordinates 1456500 and 1469500, the thickness exceeds 6.00 m. Between the Y-coordinate 1458000, north of the valley section, and the Y-coordinate 1461500, the thickness of the total horizon exceeds 7.0 m. This also applies to the region west of the X-coordinate 426000 and to the area of the western-most drilling line (DK 33 to 37, 18 and 59) between the Y-coordniates 1461500 and 1469000. In the drilling DK 2, the maximum total ore thickness, found in the area, is 9.60 m. In a 6 km long and an approx. 500 to 700 m wide strip along the escarpment between the Y-coordinates 1464000 and 1470000 the average thickness of the total ore horizon is less than 6.00 m.

In the same way as the individual ore horizons the total ore horizon pinches out completely to the north of the Doguel Kaina area. In the south of the deposit the thickness thins out.

Overburden

The thickness of the overburden is, in addition to the ore grades and the ore thicknesses, an important characteristic for evaluating a deposit with respect to open pit mining.

The ore : overburden ratios of the individual areas will be dealt with in detail under para B 7.1. Here merely a general account on the overburden thicknesses of the Doguel Kaina deposit is given (annex B-10 to B-12).

The thickness of the overburden in the Doguel Kaina deposit generally increases from east to west with increasing distance from the escarpment; this means, at the escarpment where the ore horizons crop out the overburden thickness equals 0 m. In a 100 to 2,000 m wide strip west of the escarpment with three larger partial areas, the overburden thickness is 0 to 15 m (see also para B 7.1). The majority of the ore deposit is covered by 15 to 20 m of overburden.

In the north-western part of the deposit, the overburden thickness increases to more than 25 m.

B.4.3.2 KOLO DEPOSIT

Ore horizon

Apart from the eastern area, the ore body Kolo is overlaid by terrace gravels of the Niger river. In other words, the original geological profile, as described under item B.3 and B.4.1 does for large parts of the Kolo deposit not exist completely, but has been partly eroded prior to sedimentation of the terrace gravels. The Oolithes Indurées particularly have been affected by this erosion so that - at least in the western part of the deposit - important sections of the ore body have been eroded.

The distribution of the total ore body thickness and the thickness of the overburden in the Kolo deposit are shown in the annexes B-5 and B-9.

The average thicknesses of the individual ore horizons have been determined on the basis of drilling and trenching results:

Oolithes Indurées:	2.22 m
Intercalation:	1.06 m
Oolithes Tendres:	2.00 m

The average thickness of the total horizon amounts to 5.28 m.

The ore thicknesses vary between 0.0 and 7.0 m at a maximum. Annex B-5 shows that the southern and eastern region feature thicknesses of more than 4.0 m while the thicknesses of the northern and western area are less than 4.0 m.

Overburden

The overburden thickness of the Kolo deposit range between 0.0 and 15.35 m (in drilling K 20) and are thus considerably less than at the Doguel Kaina deposit (annex B-9 and B-10). Generally, the overburden thicknesses of the Kolo deposit increase towards the east and the north.

The overburden thicknesses will be dealt with in detail in para B.7.1.

B.5 EXTENSION, STRUCTURE AND TECTONIC OF THE IRON-ORE DEPOSITS AT KOLO AND DOGUEL KAINA

The stratified oolitic iron-ores of the deposits Doguel Kaina and Kolo are lying tectonically completely undisturbed like a plate on the Precambrian basement of the Birrimien.

The ore is bedded horizontally or dips with less than 1 ° to the east.

The ore body of the Doguel Kaina deposit pinches out in northern and north-western direction and reduces its thickness to the south. Towards the east and north, it is cut off by the natural escarpment of the river Niger but continues east of the river valley, i.e. within the Kolo deposit as well as south of it. However, extent and thickness of the oolitic iron-ore deposit outside Kolo are unknown.

The iron-ore horizons also continue to the west, however, are covered by very thick overburden.

B.6 CONCLUSIONS AND INTERPRETATION ON THE GENESIS OF THE OOLITIC IRON-ORES

The recent formation of iron oolites can be observed in the Lake Tschad, where LEMOALLE & DUPONT assume the following conditions to have prevailed:

Reactive iron oxides and iron hydroxides bonded adsorptively to clay are transported together with the quartz sands of the rivers, in this particular case of the river Chari, the southern inflow, into the Lake Tschad. Compared with the fresh river water, the pH-value and the electrolyte concentration in the Lake Tschad are higher because of the prevailing evaporation. The clay particles become instable when entering the differing environment and release the absorptively bonded reactive iron. The formation of iron oolite in the form of goethite ooliths then occurs by assembling iron hydroxide material around clay nuclei, more rarely around quartz nuclei or around oolith fragments, at the bottom of the in average 3.5 m deep lake the water of which is well aerated and stirred by the wind and has a temperature of 18 to 30 °C.

Comparing the Tschad basin, which nowadays, too, is an active inland basin without outflow, with the Iullemeden basin which at the time of the sedimentation during the Tertiary Continental Terminal was also an inland basin without outflow and which is now subject to erosion due to uplift of the West-African craton, several similar geological and climatic aspects become noticeable, such as

- large-scale tectonic and paleogeographic position as intracratonic basin
- morphology - reflected by a shallow basin with inflowing rivers of little gradient
- country rocks subjected to humid weathering
- climate
- presumably similar seasonally intermittent main discharge pattern of the inflows transporting the sediments

Due to the aforementioned similarities of the Tschad- and the Iullemeden basin it can be assumed that the oolitic iron-ore deposits at the western border of the Iullemeden basin have been formed similar to the iron oolite sediments of recent genesis in the Lake Tschad.

One could imagine that the iron-ore deposits subject of this study have been formed as detailed below:

A river system - the size and drainage area of which can no longer be traced - discharges into the intracratonic Iullemeden basin which at the time the Conti- nental Terminal was deposited had no outflow system. Possibly, at that period, the Iullemeden basin was subdivided into a number of smaller basins (i.e. one in the central part of the Niger river near Dyabou, Say, Kolo and Niamey, and another one in the region of Loumbou-Loumbou further south-east). Similar to the present situation, the rivers may have featured seasonally varying discharge and they transported - apart from clayey and sandy material - reactive iron bonded to clay. The prevailing pH-values and redox-potential exclude the transportation of sub- stantial amounts of iron in dissolved form. The iron transported by the river water could originate, for instance, from paleo-laterites or from basement rocks rich in Fe. Based on the above assumptions one might imagine that the iron-transporting river system discharged into the basin from the west.

Similar to the current situation in the Tschad basin, the temperatures prevailing in the Iullemeden basin presumably were higher than those of fresh river water and the concentration of electrolyte was higher because of evaporation. This might have caused the detachment of the reactive iron from the clay minerals.

The iron could assemble on amply existing clay nuclei, less frequently around quartz nuclei, and then form iron ooliths in the agitated shallow water.

In the course of time the original clay nuclei of the ooliths might have been replaced by goethite as a result of material exchange.

In view of the mineralogic-microscopic findings it may be assumed for the Phosphorus that it has been transported in the form of PO_4^{3-} ions and then assembled adsorptively to goethite in the iron ooliths and -pisoliths. Free phosphates in the form of phosphorites have not been located in the sediments of the Continental Terminal.

The sedimentological pattern allows the conclusion that the period during which the 'Oolithes Tendres', were deposited was characterized by uniform, steady sedimentation where the newly formed iron ooliths accumulated jointly with large amounts of clayey and sandy material at the bottom of the basin.

During the formation of the 'Intercalation' the supply of iron has obviously been less or sedimentation within the area of deposition has been more differentiated which entailed a clearly defined deposition in the form of sand, clay and iron oolite.

The high Fe content in the 'Oolithes Indurées' might be due to extreme iron contents of the arriving sediment material. Just as well, it could be possible that the higher iron content - compared with the 'Oolithes Tendres' and the 'Intercalation' - can be attributed to a redeposition and the resulting sorting effect and iron concentration in the 'Oolithes Indurées'.

The geological maps of the Iullemeden basin show iron oolitic formations within the Continental Terminal only in the western part of the basin up to about 20 km east of the Niger river. However, oolites have also been located near Tahoua and Malbaza in Niger and near Sokoto/Nigeria which proves that iron oolites have been widely spread within the Continental Terminal.

B.7 ORE RESERVES OF THE DEPOSITS DOGUEL KAINA AND KOLO

B.7.1 BOUNDARIES AND PARTITION OF THE ORE BEARING AREAS AT DOGUEL KAINA AND KOLO

Doguel Kaina

Towards the east and the north-east, the deposit is limited by the natural erosion border at the river valley (annex B-10 to B-12).

For determining the north and north-west boundary of the mineable area, the ratio between total iron-ore thickness and overburden thickness (including sandy clayey Intercalation) has been chosen to be 1 : 5.

The same procedure has been applied for the determining the southern boundary which is additionally given by the site of the new Islamic University of Say.

In the south-west, the potential mineable area is limited by the road from Niamey to Say.
The western border of the working area is defined by the position of the western drilling line. It should be noted that west of this line further iron-ore can be expected, however under very thick overburden.

The investigated area of Doguel Kaina with ore reserves covers a total of 59.92 km^2.

Depending on the thickness of the overburden covering the ore, the area was sub-divided into four categories:

7.86	km ^{2} covered by overburden with thicknesses	of 0 to 10 m
5.87	km^2 covered by overburden with thicknesses	of 10 to 15 m
26.26	km^2 covered by overburden with thicknesses	of 15 to 20 m
19.93	km^2 covered by overburden with thicknesses	of 20 to 25 m

The areas covered by varying overburden layers have been hatched accordingly in annex B-10 to B-12.

Of the 7.86 km^2 covered with a thin overburden layer of less than 10 m, one large, coherent area of 3.41 km^2 is situated north-west, west and south-east of the village Doguel Kaina. This area is distinctively hatched in annex B-10.

Other areas with maximum 10 m thick overburden are located in a north-south strip east of Tokey and in a strip north and south of the Niger side valley.

Kolo deposit

The limits of the Kolo deposit are shown in annex B-9 and B-10. The total ore-bearing area of the Kolo deposit covers 17.86 km^2.

The sub-division of the Kolo mineable area was based on the same criteria, i.e. on the overburden thickness:

13.00 km^2 are covered by overburden with thicknesses of 0.0 to 5.0 m
3.80 km^2 are covered by overburden with thicknesses of 5.0 to 10.0 m
1.06 km^2 are covered by overburden with thicknesses of 10.0 to 15.0 m

In general, it can be said that the overburden layer of the Kolo deposit is considerably thinner than that of the Doguel Kaina deposit.

B.7.2 ORE RESERVES

The reserves of the Oolithes Tendres, of the Intercalation and of the Oolithes Indurées at the Doguel Kaina and Kolo deposits have been determined for each horizon individually.

For the Intercalation, in addition to the total reserves, the ore reserves with a cut-off 35 % Fe, i.e. of an average Fe-content of more than 35 %, were calculated. Also for the Oolithes Tendres a cut-off of 35 % Fe was chosen because of their Fe-content, which decreases more or less continuously towards the base.

The specific density of the run-of-mine ore was determined to be 2.65 g/cm^3.

The iron ore reserves of the Doguel Kaina deposit are summarized in the table:

Ore Horizon	Ore Reserves M t	Average Fe-content %	Average P_2O_5-content %
Oolithes Indurées	390.2	50.45	1.73
Intercalation total	134.8	32.96	1.14
Intercalation (at 35 % Fe cut-off)	62.8	41.80	1.56
Oolithes Tendres (at 35 % Fe cut-off)	483.7	45.49	2.07
Total of all ore horizons	1,008.7	45.73	1.81
Total of all ore horizons (at 35 % Fe cut-off)	936.7	47.44	1.88

Thus, the total ore reserves in the Doguel Kaina deposit amount to 1008.7 M t at an average Fe-content of 45.74 % and an average P_2O_5 content of 1.81 %.
If a cut-off 35 % Fe is chosen for the Intercalation and the Oolithes Tendres the total ore reserves amount to 936.7 M t at an average Fe-content of 47.44 % and an average P_2O_5 content of 1.88 %.

The iron-ore reserves of the Kolo deposit are shown in the table below:

Ore Horizons	Ore Reserves M t	Average Fe-content %	Average P_2O_5-content %
Oolithes Indurées	94.7	46.1	1.66
Intercalation(total)	41.2	23.93	0.91
Intercalation (at 35 % Fe cut-off)	7.3	36.47	1.21
Oolithes Tendres (at 35 % Fe cut-off)	71.2	43.64	2.37
Total of all ore horizons	207.1	40.84	1.75
Total of all ore horizons (at 35 % Fe cut-off)	173.2	44.67	1.92

Thus, the total ore reserves in the Kolo deposit amount to 207.1 M t at an average Fe-content of 40.8 and an average P_2O_5 content of 1.75 %. If a cut-off of 35 % Fe is chosen for the Intercalation and the Oolithes Tendres the total ore reserves amount to 173.2 M t at an average Fe-content of 44.67 % and an average P_2O_5 content of 1.92 %.

Due to the homogeneity of the composition and thickness of the ore horizons the reserves can be classified as 'safe to probable' inspite of the big spacing of the drilling grid.

B.8 THE ORE DEPOSIT IN THE DYABOU PLATEAU SOUTH OF SAY

A first reconnaissance at the beginning of the field work revealed that the Dyabou Plateau with respect to the ore body thickness and to the ore grades is less important than the deposits at Kolo and Doguel Kaina. Therefore only few trenches and drillings were executed in the Dyabou area (annex B. 4.2 map 1:50.000). Their results confirmed the small thickness and the low grade of the ore horizon in this area.

The subdivision of the ore body in Oolithes Indurées, Intercalation and Oolithes Tendres does not exist in the Dyabou Plateau and in the area between Say and the Goroubi river.

Lithologically the iron-ore of the Dyabou plateau equals the Oolithes Indurées in the Doguel Kaina deposit, however, the content of quartz sands is higher in the Dyabou area. The ore was found cemented by mobilized and reprecipitated goethite in the cores of four drillings executed in this area.

In the area between Say and the Gouroubi river 4 trenches (PSD 1-4) were dug on the escarpment of the River Niger and the Goroubi river. They had a total depth of 14.85 m. The iron ore body was found in all four trenches (annex B 3.118 to B 3.119) but its thickness was much smaller than in the Doguel Kaina area. The total ore horizon has an average thickness of 2.15 m with average contents of 43.88 % Fe and 1.75 % P_2O_5.

The Dyabou Plateau was investigated by two trenches with a total length of 8.10 m and by 6 core drillings with a total length of 129.15 m (annex B 3.118 to B 3.125).

The thickness of the iron-ore horizon in the two trenches PSD 5 and PSD 6 averaged to 2.75 m with contents of 48.61 % Fe and 1.67 % P_2O_5.

In only four core drillings (D 1 to D 3 and D 6) iron-ore was intersected with an average thickness of the ore body of 2.50 m and average contents of 46.53 % Fe and 1.12 % P_2O_5. The SiO_2-content is quite high and reaches 20 %.

The thickness of the overburden ranged from 8 to 15 m.
The drill holes D 4 and D 5 did not reveal any iron-ore.

Part C

Beneficiation

C. BENEFICATION TESTS

C.1 OBJECTIVE OF THE TESTS

In accordance with the terms of reference the processing tests to be carried out with the iron-ores from Say had the following objectives:

- reduction of the phosphorus content while simultaneously concentrating the iron minerals, duly considering various processing methods, and

- working out an industrial beneficiation process adapted to the specific conditions prevailing in the Republic of Niger.

C.2 SAMPLE MATERIAL

The sample material taken during and after completion of the exploration work for carrying out processing tests (see under chapter A.3.1.5) originated from:

- the upper layer of the Oolithes Indurées (sample no. 1), and
- the bottom layer of the Oolithes Tendres (sample no. 2)

These samples had been packed separately in 38 barrels with a total weight of 13 t. The consignment arrived at the KHD Research and Development Centre at Cologne-Porz on June 15, 1983.

C.3 EXECUTION OF TESTS

C.3.1 HOMOGENIZING OF THE SAMPLES

Preceding the test work the samples were mixed separately to enable an extraction of a representative sample of the upper and lower layer, each, and to enable homogenizing of the sample material for the tests.

C.3.2 EXECUTION OF ORIENTING TESTS

On the basis of the two representative samples obtained, screen analyses, chemical analyses, tapped and bulk density assessments were carried out to gain information for the subsequent concentration tests.

The classifying tests were carried out according to DIN-standard with the aid of hand sieves.

C.3.3 EXECUTION OF CONCENTRATION TESTS

To follow the objectives, and this is to elaborate a process for the beneficiation of the iron-ores technically and economically feasible under local consideration, numerous test series have been conducted.

These series commenced with the application of the simpliest technology - namely the classification - and the complexity of beneficiation methods was appropriatly increased.

The following processing methods were applied:
- comminution
- attrition
- sink and float sorting
- jigging and
- high intensity magnetic separation

C.3.3.1 CRUSHING TESTS

The crushing tests were carried out in a hammer crusher, type PHM 400-250, with grate insert with oblong holes of 30 x 6 mm and at a rotor speed of 1,210 /min.

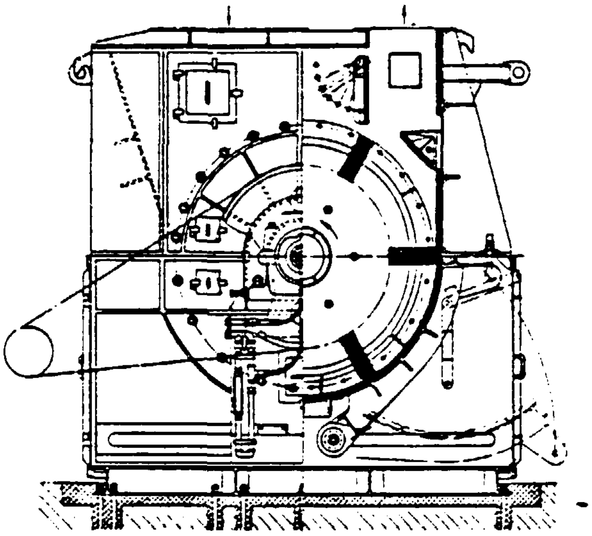


Fig. C-1: Hammer crusher, type PHM

To produce a larger volume of concentrates to be used in subsequent metallurgical tests hammer mill, type HEM-630 was applied, since this mill enables a higher troughput rate. The rotor speed equalled 900 /min = 29.7 m/s circumferencial speed.

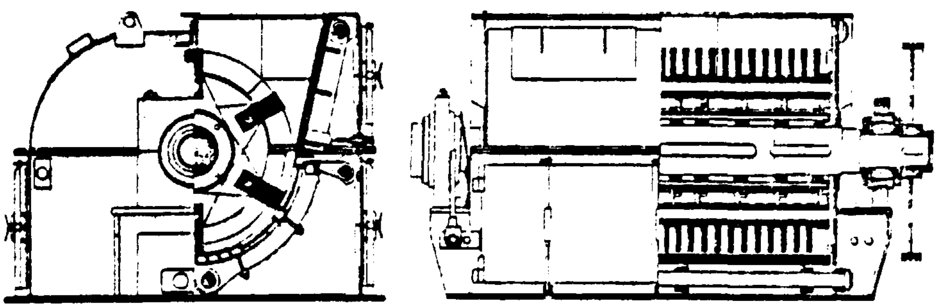


Fig. C-2: Hammer mill, type HEM

C.3.3.2 ATTRITION TESTS

Attrition was applied to remove bonding agent residues adhering to the oolith surface, thereby raising the Fe-content of the ore. The tests have been carried out in a 30 l - attrition apparatus with double-blade agitator.
The double blades of the agitator are adjusted such that one blade lifts the pulp and the other forces it downward. The tests were carried out at a solids content of the pulp of approx. 1,100 g/l for sample 1 and with approx. 1,300 and 1,000 g/l for sample 2. The agitator speed was kept constant.

C.3.3.3 SINK AND FLOAT TESTS

With the sink and float tests the upper separation cut was chosen at a density of 3.45 g/cm^3 in order to obtain a clear concentration of the iron-ore in the sink product.

C.3.3.4 JIGGING TESTS

The jigging tests have been carried out in a U-tube machine. In this machine raw material with minerals of different specific gravity is separated in water, following the principle of difference in velocity of fall.

The results from these tests should have served as confirmation of the results obtained in the sink and float tests. Though a small amount of low graded ore was separated there was no remarkable concentration in the heavy product range and no clear sectional cut visible. Therefore the results have not been further evaluated and the tests discontinued.

C.3.3.5 CONCENTRATION TESTS BY MEANS OF WET HIGH-INTENSITY MAGNETIC SEPARATION

The tests for magnetic concentration have been carried out with the aid of a wet high-intensity magnetic separator, type "Jones P 40". During the different tests, varying magnetic field strengths were adjusted for optimizing the sorting results.
Each test yielded three products:
- magnetic material (mags.)
- middlings (middl.)
- non-magnetic material (non mags.)

The products were chemically analysed and the mass distribution was determined. The results have been specified in annexes C 29 - C 46.

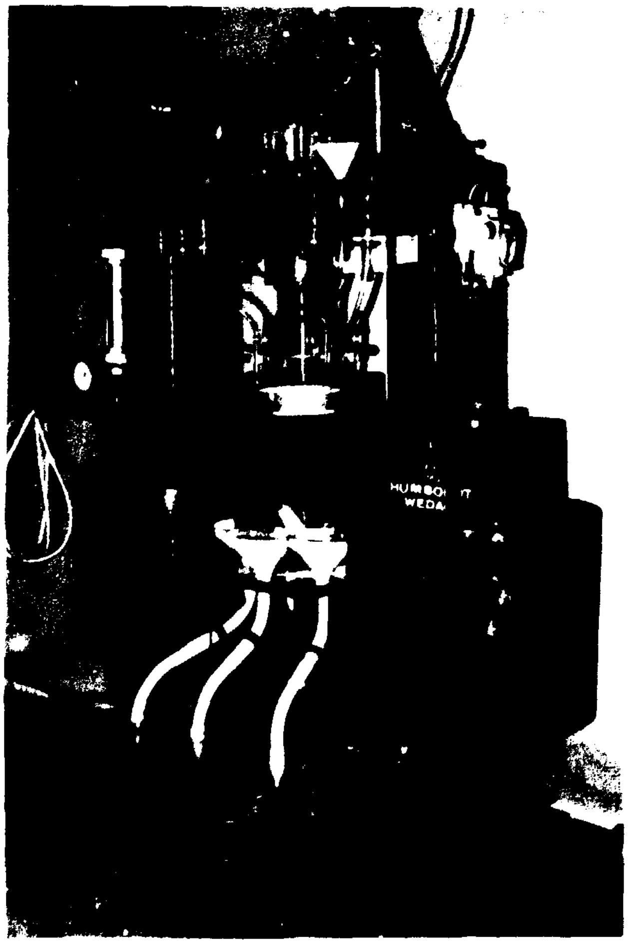


Fig. C-3: JONES-P 40, wet high-intensity magnetic separator

The material to be tested (in the form of a pulp) was introduced into the magnetic separator via a tank- mounted vertical pump and a feed nozzle. The rotor speed of the separator equalled approx. 3 rpm. The different products were collected in separate tanks and subsequently prepared for chemical analysis and mass determination.

C.4 TESTWORK RESULTS

C.4.1 ORIENTING INVESTIGATIONS

The orienting investigations include mineralogical, chemical and physical data.

C.4.1.1 MINERALOGICAL INVESTIGATIONS OF THE RAW MATERIAL

Two representative samples of the oolitic iron ore were investigated.
Sample 1 = upper horizon (Oolithes Indurées)
Sample 2 = lower horizon (Oolithes Tendres)

The following testing methods were applied:

Microscopical examinations in reflected- and in transmitted light, X-ray diffraction method and micro-probe analyses.

C.4.1.1.1 MICROSCOPIC INVESTIGATION

Ooliths/Pisoliths

Goethite ooliths are the iron carriers of the iron-ore. The structure of the ooliths is concentrically-shelly. The different shells consist of needle- shaped goethite crystallites. On account of varying crystallographic orientation and grain size of the crystallites, the shell structure will become visible upon polishing (fig. C-4). The diameters of the ooliths vary between 0.2 and 2.0 mm (average size: 0.6 mm).

Frequently, the ooliths incorporate a nucleus. The size of the oolith nuclei is within a range of 60 to 900 um. The nucleus material almost exclusively is goethite. Rarely, the nuclei consist of quartz. On account of their structure, the goethite nuclei can be classified as

- homogenous, solid goethite nuclei lacking clearly defined structure
- oolith fractures (fig. C-5).

The portion of oolith fractures is predominant. The nuclei are characterized by a degree of roundness, reaching from rounded-off to well-rounded.

The outer oolith form is spherical to spheroidal. Larger nuclei may influence the shape of the ooliths; the added shells are then not sufficiently thick to ensure the round shape of the nucleus.

It is of secondary importance to observe porous ooliths. A number of ooliths show fissures, being occasionally healed with goethite, quartz and kaolinite.

Inclusions in the ooliths are

- quartz grains (more frequently)
- heavy minerals (zirconium, rutile) (less frequently).

At the rim of the ooliths, especially in case of heavily weathered samples, gel-type, reniform-botry-oidal goethite has formed (fig. C-4,C-5,C-6) which - in turn - may be encrusted by a mixture of quartz and kaolinite (fig. C-12, C-13). The rim width of this goethite-quartz-kaolinite crust varies between 20 um and 120 um. Crusty, radiating lepidocrocite (γ - FeOOH) as secondary formation, occurs rarely in the rim zone of the ooliths.

Quartz

Quartz occurs as grains in the matrix and as inclusions in the ooliths.
The quartz grains in the matrix are rounded-off to rounded; they are clear and rarely have inclusions.

Kaolinite

The clay mineral existing in the ore could not be determined unambiguously by microscopic investigation. The X-ray diffraction analysis yielded kaolinite as clay mineral.
The more weathered the sample material, the higher the portion of kaolinite.

Heavy minerals

The ore is characterized by a very small portion of heavy minerals. Opaque heavy minerals were not observed. Zirconium and rutile could be identified by microscopic investigation.
the heavy minerals occur

- in the matrix (grain sizes between 10 um and 120 um)
- as inclusions in the ooids and rarely in the quartz granules.

Matrix

As bonding agent between the ooliths occur -

- small to smallest particles of oolith fragments
- quartz, being partly stained yellowish to yellowish-brown by superfinely distributed goethite
- kaolinite, being partly intimately intergrown with other matrix materials, forming partly independant "kaolinite clusters".

C.4.1.1.2 MICRO-PROBE INVESTIGATIONS

Chemical- and X-ray emission analyses of the oolitic iron-ore yielded a P_2O_5-content up to 2.0 % by weight. A micro-probe investigation was carried out to answer the question as to the phosphorus occurence in the ore.

Ooliths

Scanner shots of the element distribution of Fe, Al, Si, P, in the ooliths show (fig. C 6 - C 10, C 11-C 14)

- high Fe-contents, being bonded to goethite
- traces of uniformly distributed Al
- uniformly distributed P
- that silicon is present in the ooliths only in traces.

The uniform distribution of the elements Al and P in the ooliths suggests that no independant Al- and P-minerals are existing. It is likely that aluminium is incorporated in the goethite crystal lattice as Al^{3+}-ion diadochite and that phosphorus is adsorptively bonded to goethite as phosphate.
Hence, the phosphorus carrier is goethite.

Matrix

The shots showing the distribution of elements (fig. C-8, C-9), reveal high contents of Al and Si in the matrix.
Where the Al- and Si-element distributions coincide, Al and Si are bonded to kaolinite. Phosphorus cannot be ascertained in the matrix, or only to the extent in which oolith fragments occur as smallest particles in the matrix.

Adsorptive bonding of phosphate-ions to goethite can take place during oolith formation. Upon precipitation of iron, which had been dissolved in surface waters in different forms, iron hydroxide-gels are formed, which contain either positive or negative electric loads as a function of the pH-value, ionic strength of the solution and the type and volume of other present ions. Therefore, anions as well as cations are adsorbed. Thus, frequently SiO_2, Mn-, phosphate-, Ca-, arsenate- and vanadate-ions are adsorptively bonded to goethite.

Fig. C-4: Backscattered electron image
Oolitic iron-ore, SAY, Niger 1000 µm
The ooliths are showing concentrical structure and are encrusted by gel-type goethite.

Fig. C-5: Backscattered electron image
Oolitic iron-ore, SAY, Niger 100 µm
One oolith has incorporated a nucleus of a oolith fragment

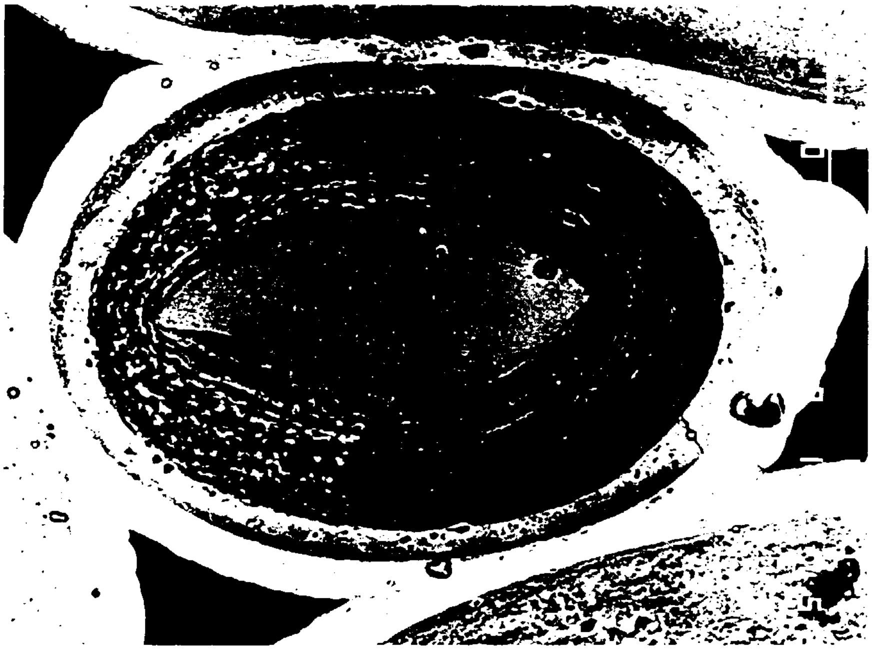


Fig. C-6: Backscattered electron image
Oolitic iron-ore, SAY, Niger

100 µm

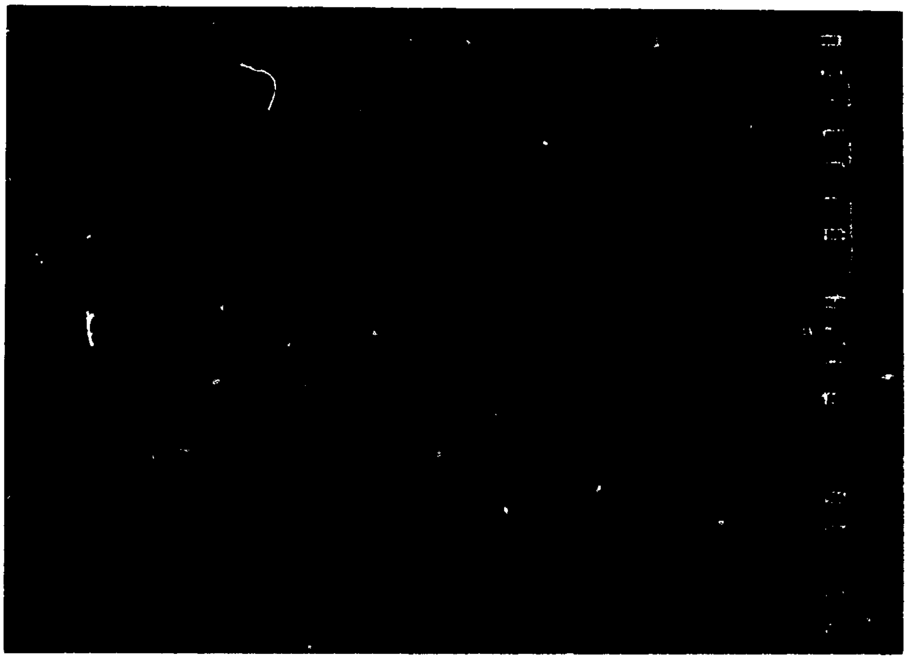


Fig. C-7: Fe-K$_\alpha$ X-ray image of fig. C-6.

100 µm

Fig. C-8: Si-K_α X-ray image of fig. C-6

100 µm

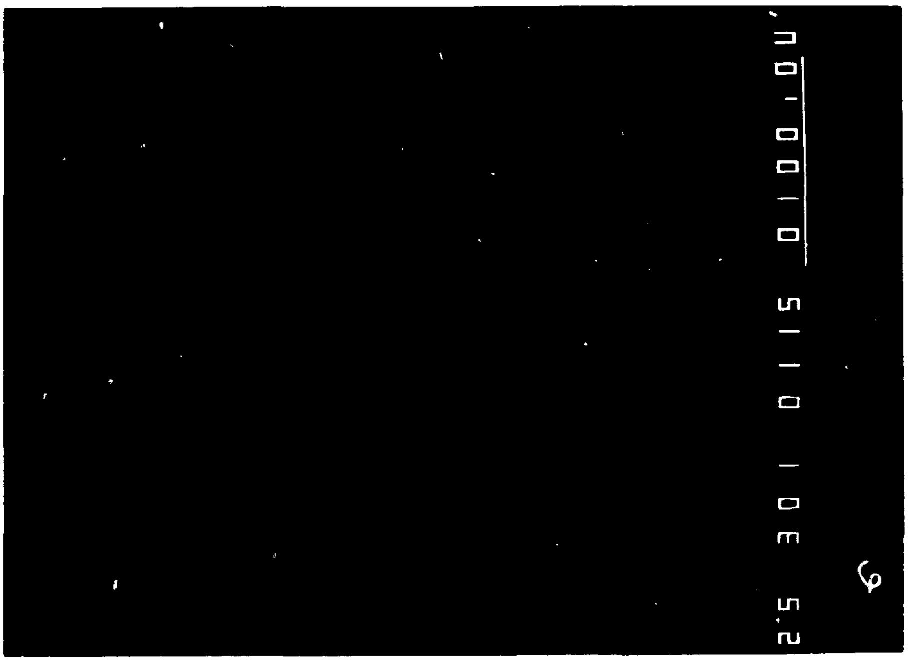
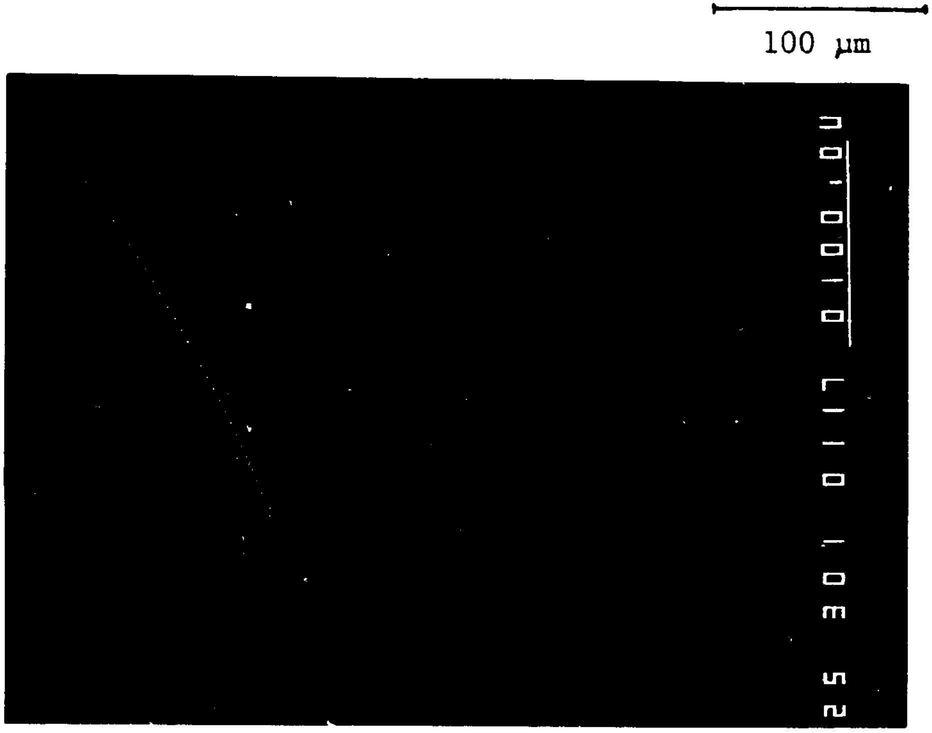


Fig. C-9: Al-K_α X-ray image of fig. C-6.

100 µm

Fig. C-10: P-K_α X-ray image of fig. C-6



OOLITIC IRON ORE, [illegible]

Fig. C-11 FE-DISTRIBUTION
ENLARG. 320X

[illegible] LTEC IRON ORE, NIGER

Fig. C-12: AL-DISTRIBUTION
ENLARG. 32 X

Fig. C-13: SI-DISTRIBUTION
ENLARG. 320X

Fig. C-14: F-DISTRIBUTION
ENLARG. 320X

C.4.1.2 CHEMICAL AND PHYSICAL INVESTIGATION

On the basis of the two samples, the specific densities of the raw material were determined and the screen analyses were carried out.

	Sample 1 Oolithes Indurées	Sample 2 Oolithes Tendres
weight per unit volume:	2.65 kg/l	2.65 kg/l
bulk density:	1.93 kg/l	1.92 kg/l
tapped density	2.10 kg/l	2.09 kg/l
	SCREEN ANALYSIS	
fraction	% by weight	% by weight
+ 80 mm	2.09	-
80 - 60 mm	10.47	1.03
60 - 40 mm	20.83	3.14
40 - 20 mm	23.11	6.90
20 - 10 mm	9.20	7.25
10 - 8 mm	0.70	1.28
8 - 5 mm	2.09	3.79
5 - 3 mm	1.48	3.55
3 - 2 mm	2.12	10.12
2 - 1 mm	13.21	31.23
1 - 0.5 mm	7.72	17.55
- 0.5	6.98	14.16
total:	100.00	100.00

Annexes C-2 and C-5 include a graph of the screen analyses.

No content of free water could be evidenced for the two samples.

A representative sample taken from the two samples, was subjected to wet-chemical analyses.

	Sample 1 Oolithes Indurées	Sample 2 Oolithes Tendres
$Fe_{tot.}$	48.84 %	40.45 %
Fe^{++}	0.13 %	0.11 %
Fe^{+++}	48.71 %	40.34 %
SiO_2	8.13 %	17.70 %
P_2O_5	1.68 %	1.04 %
CO_2	0.71 %	0.64 %
F	traces	0.05 %
Na_2O	0.19 %	1.51 %
K_2O	0.08 %	0.28 %
V	0.05 %	0.04 %
MgO	0.09 %	0.12 %
CaO	0.08 %	0.12 %
TiO_2	0.09 %	0.26 %
MnO	0.38 %	0.43 %
Al_2O_3	6.85 %	8.96 %
L.O.I. (2 hours at 1,000 °C)	14.18 %	13.52 %

The different screening fractions of the crude ore screen analyses of the two samples were investigated for their contents of $Fe_{tot.}$, P_2O_5 and SiO_2. The contents and distributions in the different portions are listed in annexes C-1, C-3, C-4 and C-6.

C.4.2 CONCENTRATION TESTS

The results of mineralogic investigation indicate that the phosphorus exists finely distributed over the entire spectrum of the ooliths. This has significantly limited the opportunities of lowering the phosphorus content by processing methods.

Initial exploratory tests confirmed the findings of the mineralogic tests (i.e. both as to microscopic size and kind of phosphorus bonding). Consequently, it will be impossible to reduce the P content of the iron-ore tested by way of processing methods because of the superfine distribution of the phosphorus. Therefore, emphasis has been put on maximum possible concentration of the iron minerals during several processing test series. (see fig. C 15 on the following page).

To determine the possible extent of concentration of the Fe mineral, some 50 pure ooliths from each sample have been manually separated (after attrition) under a stereomicroscope. The chemical analysis of the individual ooliths of sample 1 (Oolithes Indurées) yielded an Fe content of 54.21 %. The individual ooliths of sample 2 (Oolithes Tendres) contained 53.40 % of Fe.

This shows that mechanical processing methods enable a concentration to 53 - 54 % of Fe provided a liberation grade is chosen that is within the range of the oolith size (approx. 0.5 mm).

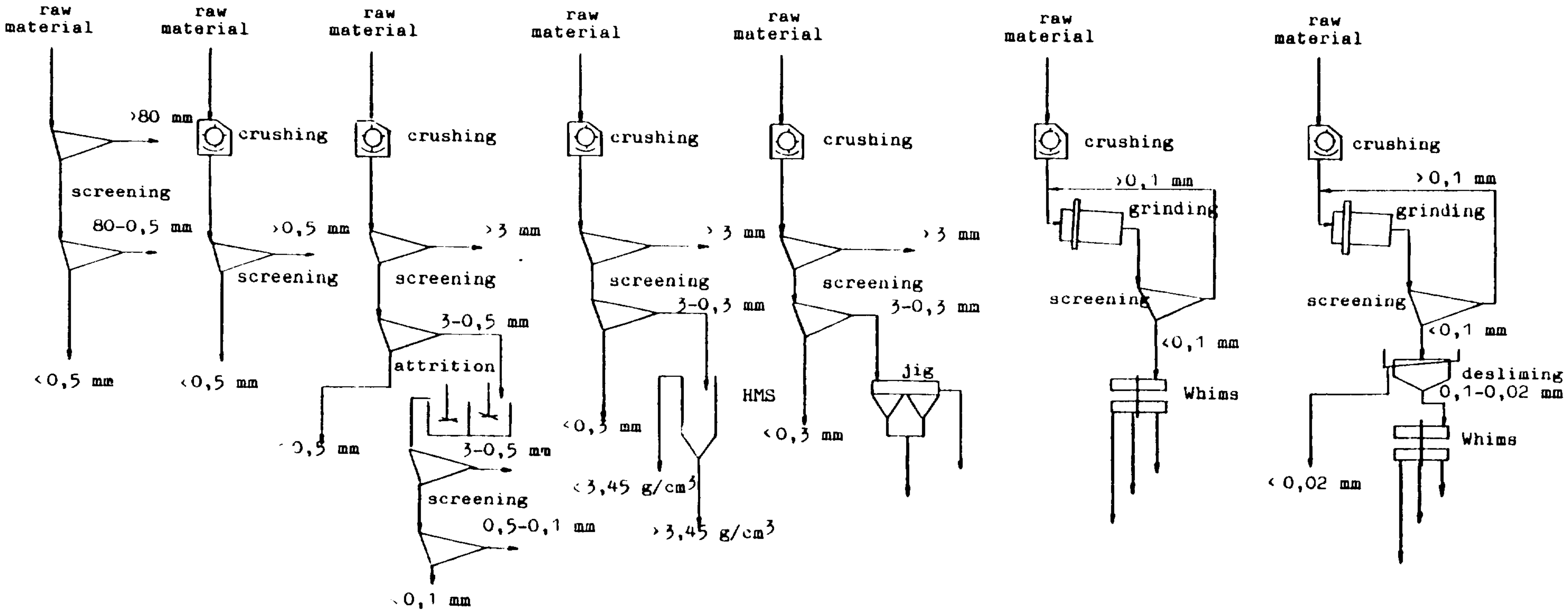
C.4.2.1 CONCENTRATION BY CLASSIFICATION OF THE RAW MATERIAL

C.4.2.1.1 SAMPLE 1 (OOLITHES INDUREES)

On the basis of the screen-metal-analysis (annex C 1) of the raw material, a reduction of the Fe-contents as from fraction 1 - 0.5 mm - or, more pronounced as from minus 0.5 mm - could be determined. Annex C 3 is a summary of 3 fractions.

fraction in mm	% by weight	% Fe
+ 80	2.09	52.66
80 - 0.5	90.93	51.05
- 0.5	6.98	30.28
total:	100.00	49.64

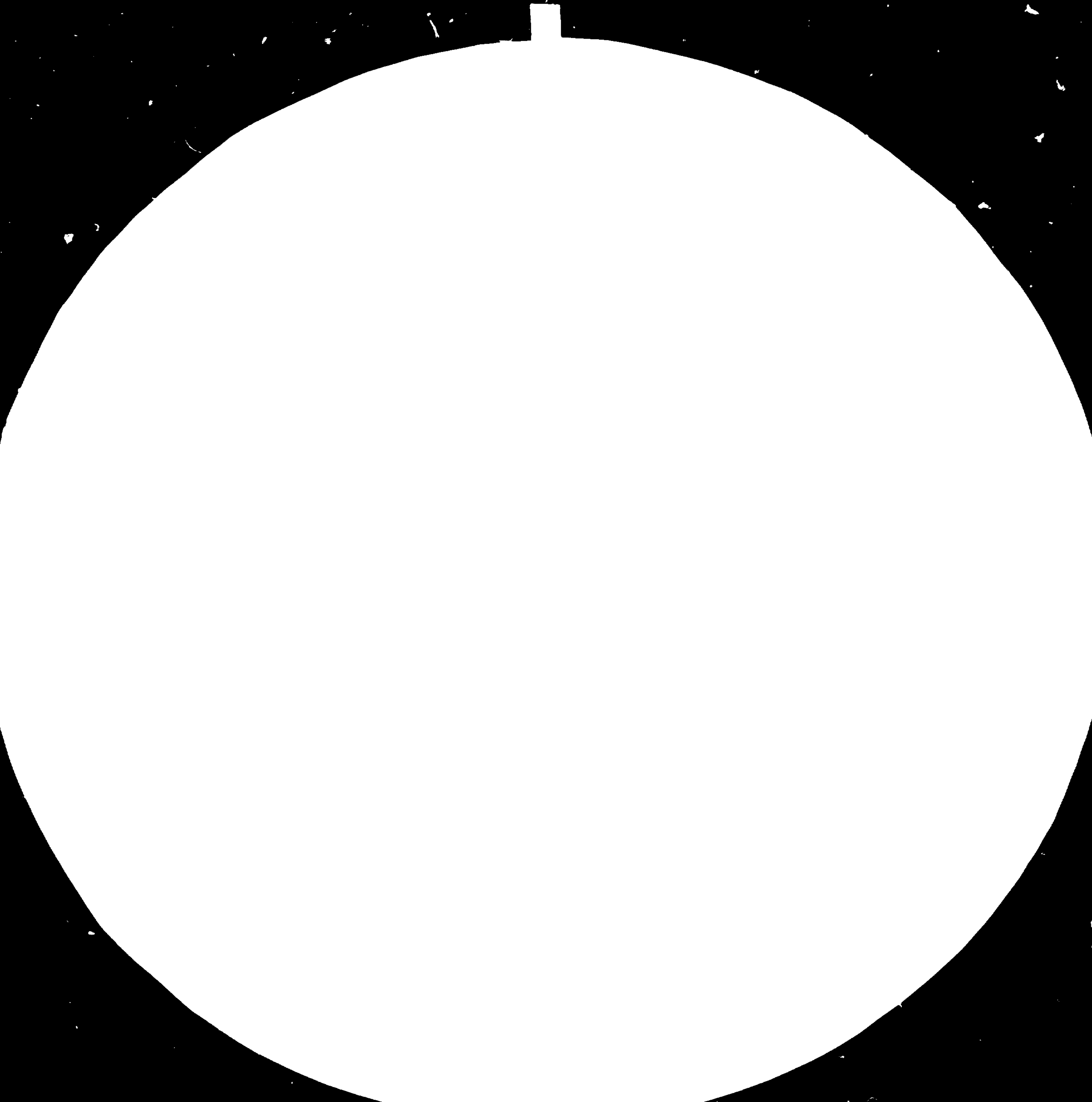
By separating 6.98 % by weight, the Fe-content of the residual material can be raised by approx. 1.5 %.

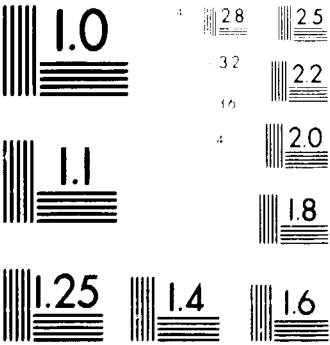


Whims = Wet high intensity
magnetic separator

HMS = Heavy media separation

Fig. C.15: Scheme of test procedure
Iron ore, SAY, Niger




1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

C.4.2.1.2 SAMPLE 2 (OOLITHES TENDRES)

The 3 screened products have been summarized in annex C-6.

fraction in mm	% by weight	% Fe
60 - 5	23.39	41.87
5 - 0.5	62.45	47.84
- 0.5	14.16	21.63
total:	100.00	42.73

By separating fraction minus 0.5 mm, the Fe-content of the residual material is increased by approx. 3.5 %.

Since oolith bonding was macroscopically clearly visible in case of the coarser fractions, this bond should be disintegrated by crushing and part of the matrix be exposed to enable a separation by way of screening.

C.4.2.2 CONCENTRATION BY SELECTIVE CRUSHING AND SUBSEQUENT CLASSIFICATION

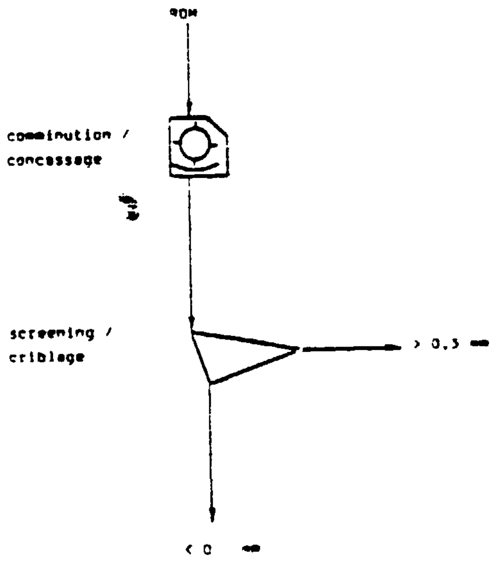


Fig. C-16: Schematic description of selective crushing with subsequent classification

The raw material was crushed in a hammer crusher described in chapter C.3.3.1, with inserted grate with opening dimensions of 30 x 6 mm, thus providing for crushing to minus 5 mm. The screen-metal-analyses of the crushed products are summarized in annexes C 7 - C 14.
Annexes C-9, C-10, C-13 and C-14 include summaries of the screened fractions.

Annexes C-8, and C-12 include the results of the screen analyses of the crushed products in a grading graph, which clearly shows that despite varying solidification of the two samples, they are characterized by similar crushing properties.

C.4.2.2.1 SAMPLE 2 (OOLITHES INDUREES)

Subject to a cut point of 0.5 mm, an Fe-content of 52.27 % will result for the fraction minus 0.5 mm, at a mass recovery of 71.32 % and an Fe-recovery of 74.88 %. (annex C 9)
The material of fraction minus 0.5 mm has an Fe-content of 43.60 % at a mass recovery of 28.68 % and an Fe-recovery of 25.12 %.

C.4.2.2.2 SAMPLE 2 (OOLITHES TENDRES)

As regards the separated fraction plus 0.5 mm, an Fe-content of 46.81 % results at a mass recovery of 73.08 % and an Fe-recovery of 82.87 %. For the fines portion minus 0.5 mm the Fe-contents equals 26.28 %.

C.4.2.3 CONCENTRATION BY CRUSHING, ATTRITION AND CLASSIFICATION

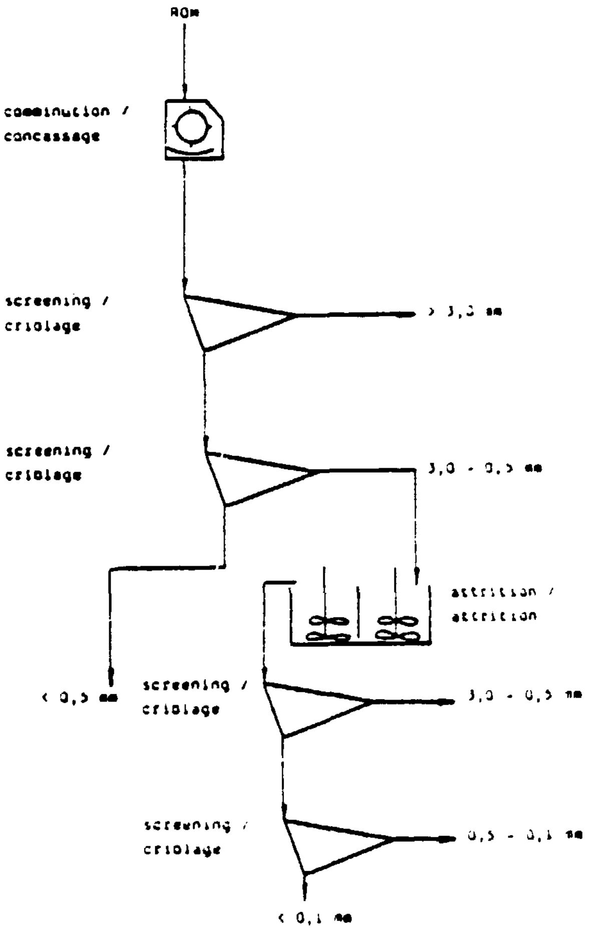


Fig. C-17: Schematic description of the attrition

Since during crushing only the bond will not come off the ooliths and further sticks to the oolith surfaces, an additional process step was applied to produce an Fe-concentrate of a higher grade by separation of further bond portions. This process step is the attrition method.

C.4.2.3.1 SAMPLE 1 (OOLITHES INDUREES)

Out of the material crushed in a hammer crusher, fraction 3 - 0.5 mm had been separated by way of wet screening. This material was subjected to attrition for 5, 7 and 10 minutes. After 5 minutes of attrition, the Fe-content for fraction 3-0.5 mm could be increased from 52.3 % to 53.73 %. (See annex C 9, to be compared with annex C 16)

The blending of the attritioned product with the earlier screened material of the fractions plus 3.0 mm yields to a mixing product in the fractions plus 0.5 mm with an Fe-content of 53.52 %, a mass recovery of 58.44 % and an Fe-recovery of 62.51 %. An extended attrition period will not bring about substantially better results (see annex C 15-C 20).

C.4.2.3.2 SAMPLE 2 (OOLITHES TENDRES)

The material prepared as for sample 1 was likewise subjected to attrition for 7, 10 and 13 minutes. Longer attrition periods had been selected, since the material of the lower horizon is characterized by higher matrix-portions and since the Fe-content of the raw material is lower than that of sample 1. The results have been included in annexes C 21 - C 26. After 7 minutes of attrition, a product of an Fe-content of 51.05 % can be produced at a mass recovery of 60.52 %. Combined with the earlier separated material volume plus 3.0 mm, the Fe-content is increased from 46.81 % to 50.30 %. The mass recovery 65.58 % and the Fe-recovery 76.80 %. (Annex C-1).

No major shifts nor improvements result from attrition for sample 1 and 2 as regards the P_2O_5-contents. The phosphate portions cannot be separated of the iron portions. It is noticed that the SiO_2-portions are raised in the separated fines portion minus 0.5 mm, indicating that an abrasion has taken place during attrition. This is substantiated by the increase of the total fines portion minus 0.5 mm.

C.4.2.4 CONCENTRATION BY SINK-/FLOAT PROCESS

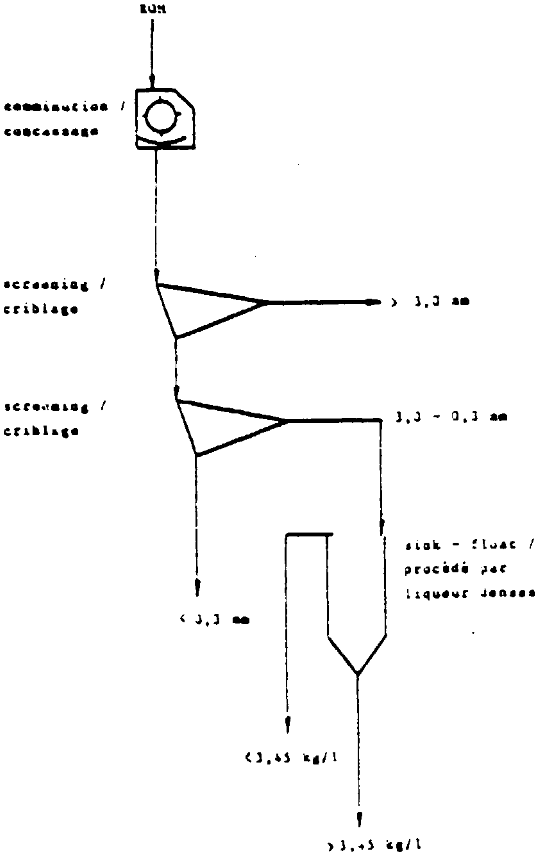


Fig. C-18: Schematic description of the sink-/float process

For application of this mode of Fe-concentration, crushed test material (fraction 3 - 0.3 mm) was separated in organic heavy media of varying specific densities. It is shown that an Fe-concentration can be achieved by means of this method. However, this method likewise cannot provide for lowering of the phosphorus portion.

C.4.2.4.1 SAMPLE 1 (OOLITHES INDUREES)

The initial material of this sample had an Fe-content of 49.96 %. In the density range of plus 3.45 g/cm^3, 73.85 % by weight and 77.53 % of the Fe were recovered at an Fe-content of 52.46 %. (Annex C-27, refer).

C.4.2.4.2 SAMPLE 2 (OOLITHES TENDRES)

The sample had an Fe-content of 45.39 %. In the density range of plus 3.45 g/cm^3, 80.28 % by weight and 80.03 % of the Fe were recovered, at an Fe-content of 52.69 %.
(Annex C-28, refer).

C.4.2.5 CONCENTRATION ON THE JIGGING MACHINE

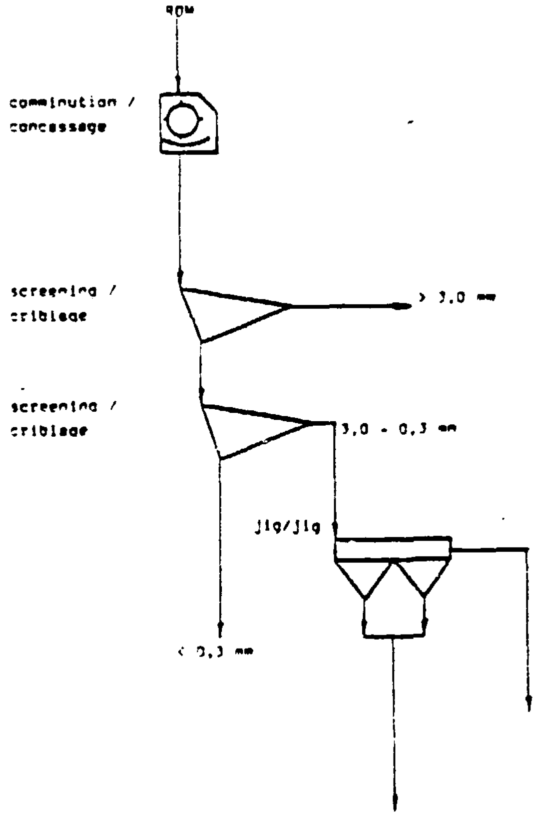


Fig. C-19: Schematic description of the concentration by means of jigging

Tests have also been carried out on the jigging machine for concentrating the iron portions of fractions between 3 mm and 0.5 mm.

Preliminary tests have shown that an iron concentration is feasible. The result of separation is, however, substantially inferior to that obtained by means of the sink and float process (heavy medium). As expected the phosphorus portions have not been reduced.

On account of this result, the tests on the jigging machine were discontinued.

C.4.2.6 CONCENTRATION BY WET HIGH-INTENSITY MAGNETIC SEPARATION

Magnetic separation was tested as a further method for concentrating the iron minerals and for producing a concentrate product.

C.4.2.6.1 FRACTION MINUS 0.5 mm

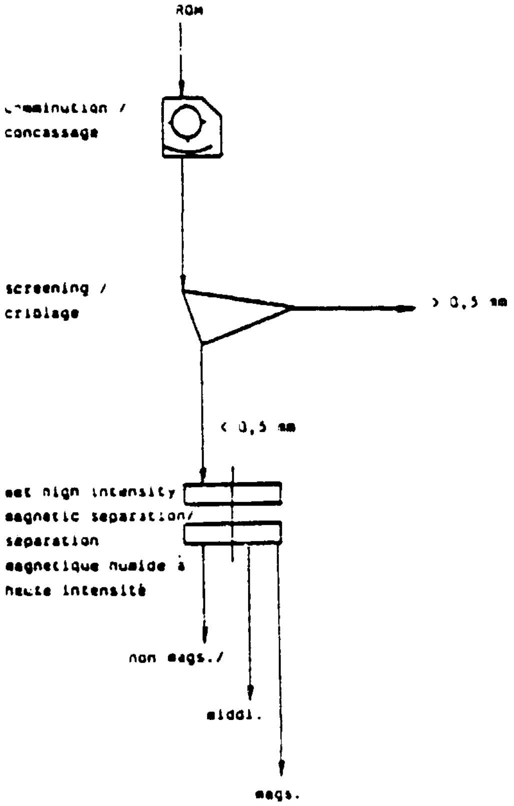


Fig. C-20: Schematic description of the treatment of the fractions minus 0.5 mm.

Fraction minus 0.5 mm of the material discharged from the hammer crusher was selected as test material.
During the different tests, the magnetic field strength was varied, whereas the feed volume and pulp density remained unchanged. Field strengths applied were 1.5 / 1.2 / 0.8 Tesla. It was

ascertained that upon decreasing field strength, the mass and Fe-recovery are likewise reduced; as regards the contents of valuable substances of the magnetic material, there are hardly any changes.

Sample 1 (Oolithes Indurées) (annexes C 29 - C 31)

The feed material of this sample had an Fe-content of 41.59 %.
At a field strength of 1.2 Tesla, an optimal magnetic product of 53.37 % of Fe was generated, in 41,70 % of mass and at 56.06 % of Fe-recovery.

Sample 2 (Oolithes Tendres) (annexes C 32 - C 34)

The feed material contained only 22.81 % of Fe.
At an adjusted field strength of 1.2 Tesla, a magnetic product of 42.19 % of Fe was generated. The mass recovery equalled 23.97 % and the Fe-recovery 47.95 %.

C.4.2.6.2 GROUND RAW MATERIAL MINUS 0.1 mm

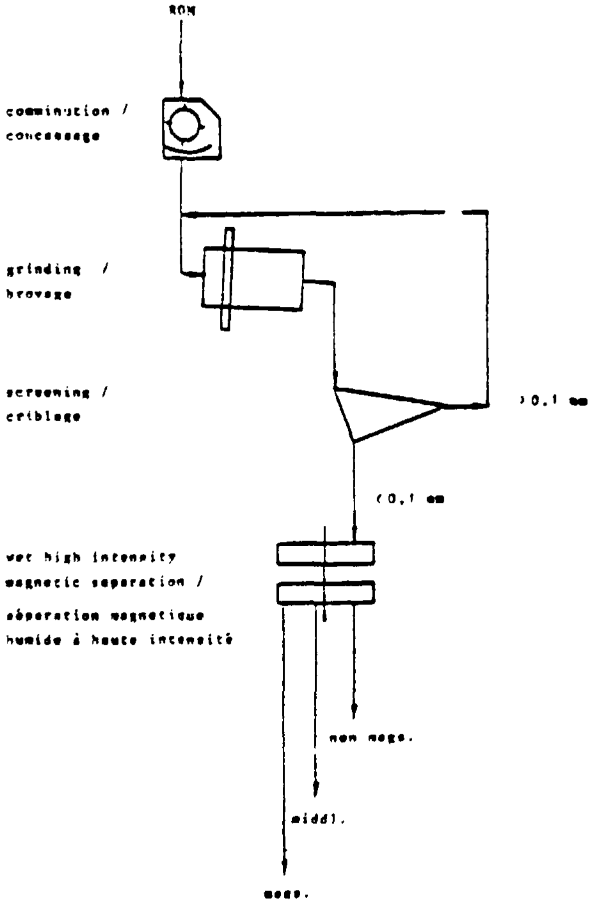


Fig. C-21: Schematic description of the treatment of the ground raw material minus 0.1 mm

A partial sample of the raw material of both samples was crushed to minus 0.1 mm for further checking the suitability of magnetic separation for concentration of the iron portion. Annexes C-35 (sample 1) and C-36 (sample 2) include the screen analyses of the crushed products with the Fe-contents of the different fractions.
Crushing was done with the aid of a hammer mill with subsequent grinding in a ball mill with provision for screening of the discharged ground product and recycling of the residues retained on the screen. Crushing was done with dry test material, whereas grinding and screening were done with wet material.

Sample 1 (Oolithes Indurées)

The material ground to minus 0.1 mm was tested at field strengths 1.5/ 1.2/ and 1.0 Tesla of the magnetic separator.
The maximum Fe-value in the concentrate (magnetic material) of 54.20 % was achieved at a field strength of 1.2 Tesla. The mass recovery equalled 61.47 %, the Fe-recovery 67.20 %.
In all three tests, the Fe-contents of the middlings with 44.88 %, 46.19 % and 47.41 % was yet relatively high.
The results have been summarized in annexes C 37 - C 39.

Sample 2 (Oolithes Tendres)

Sample 2 was not separately investigated in this connection, since comparetively similar results were expected.

C.4.2.6.3 GROUND BLENDED ORE OF SAMPLES 1 AND 2 (MINUS 0.1 mm)

Ground material (minus 0.1 mm) of samples 1 and 2 was mixed at a ratio of 1 : 2 in a further step for assessing the suitability of magnetic separation. At three varying magnetic field strengths (1.5/ 1.2/ 1.0 Tesla), this mixed product was separated in the wet magnetic separator.
At 1.5 Tesla, a magnetic material of 52.37 % Fe could be produced. The feed material contained 45.37 % of Fe. The mass recovery equalled 59.39 % and the Fe-recovery 68.55 %.
Annexes C 40 - C 42 include the results of these tests.

C.4.2.6.4 GROUND AND DESLIMED RAW MATERIAL (0.1 - 0.02 mm)

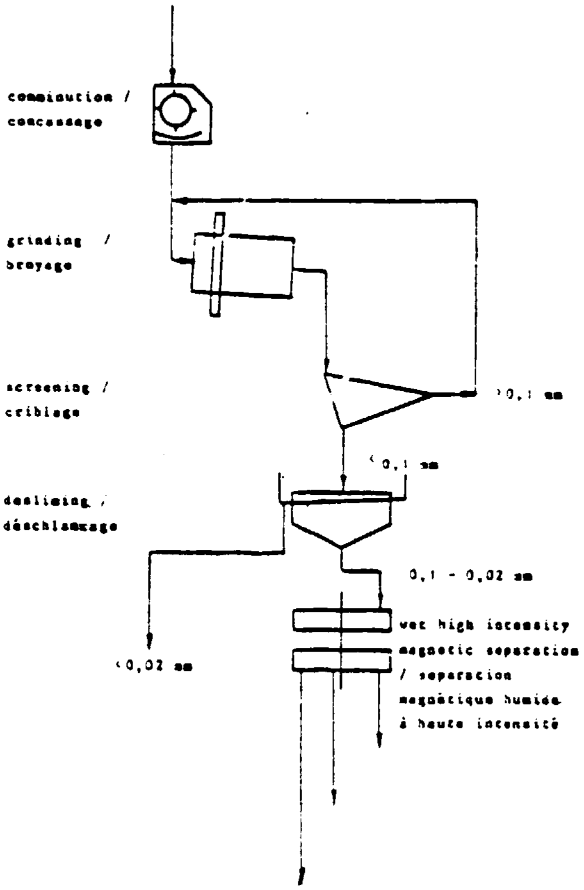


Fig. C-22: Schematic description of the treatment of ground and deslimed raw material

Additional tests of magnetic separation have been conducted in accordance with the tests carried out with material of the fraction minus 0.1 mm, for which the test material had been deslimed at a cut point of 20 um.

Sample 1 (Oolithes Indurées)

On account of desliming, the feed material already contained 52.68 % of Fe during the tests made at 1.5 and 1.2 Tesla. At field strength of 1.2 Tesla, a magnetic material of 54.50 % Fe could be generated. The middlings had an Fe-content of 52.27 %.(Annex C-43 and C-44, refer).

C.4.2.6.5 GROUND AND DESLIMED RAW MATERIAL BLENDED OF SAMPLES 1 and 2 (0.1 - 0.02 mm)

At field strengths of 1.5 and 1.2 Tesla, the tests with mixed product of samples 1 and 2 were also carried out with deslimed mixed material, to enable comparisons with the tests carried out with non-deslimed material; (for which the mixing ratio remained 1 : 2).
A maximum Fe-content of 53.18 % could be achieved in the magnetic material. The deslimed feed material contained 48.52 % of Fe.
The mass revovery equalled 58.85 % and the Fe-recovery 63.74 %. Annexes C-45 and C-46 include a summary of the tests results.

C.5 EVALUATION OF THE TEST RESULTS

The test results attained have to be evaluated critically under two aspects:
the decrease of phosphorus content in the ore and the increase of the iron content at optimal yield.

C.5.1 THE DECREASE OF PHOSPHORUS CONTENT

The information on the structure of the ore obtained during the mineralogical investigation unambiguously exclude that the phosphorus can be removed by processing methods:

In the ore the phosphorus exists uniformly and superfinely distributed in the ooliths. The phosphorus carrier is the mineral goethite, being at the same time the major iron carrier.

A concentration of the goethite thus inevitably entails a concentration of the phosphorus portions instead of a reduction of the latter.

This fact applies to the Oolithes Indurées (sample 1) as well as to the Oolithes Tendres (sample 2).

C.5.2 THE INCREASE OF IRON CONTENT

As regards the iron and steel industry, an increase of iron content in the ore, i.e. a concentration is desired to lower the slag portion and therewith energy expenditure. The increase of the phosphorus portions of the magnitude involved here, i.e. 1.8 % to 2 % of P_2O_5, is of minor importance here.

C.5.2.1 CONCENTRATION

With regard to the concentration of iron minerals the tests have been successful. Contents of 52 % - 54 % of $Fe_{tot.}$ upon loss on ignitions between 13.5 and 14.2 %, originating from the water of hydration of the goethite and kaolinite, are to be considered satisfying values, considering the fact that - apart from goethite - the ooliths contain in their fis- sures kaolinite up to an amount of 5 %. A further limited increase of the iron content would only theoretically be possible by means of a superfine grinding of the ooliths to micron size, thus partly exposing these impurities.

These tests were not carried out, since a further grinding of the ore down into micron range in industrial scale would be burdened by excessive losses of energy for grinding and subsequent dewatering.
Aggravating must be added that the iron recovery is overproportionally dropping at such required small fractions, whilst the iron content can only be increased insignificantly.

Under these aspects it should be the aim to concentrate the ore as cost saving as possible, i.e. to gain optimal results at minimum investment and lowest possible running cost. Thus the following process steps have been considered:

Crushing the r.o.m. ore to minus 3 mm is meant to release the ooliths from their matrix. On account of the difference in hardness of ooliths and matrix, the latter will be comminuted to a substantially finer size upon applying the same energy for crushing. Matrix concentration will take place in the fraction minus 0.5 mm.

Thus a separation of the fines minus 0.5 mm of crushed material by classification will already ensure a first iron concentration.

Attrition of the coarse fraction (plus 0.5 mm) following the classification will back up the concentration process.

Matrix residues still adhering to the ooliths after crushing, are abraded from the oolith surface during the attrition process and washed out in an overflow tank.

The tests of concentrating the iron content in a heavy medium process can likewise be considered successfully carried out. Similar Fe-contents as in the attrition tests could be achieved in the heavy medium.

Since the heavy medium process requires a higher capital expenditure in comparison with attrition, and for operation continuously ferrosilicon, it should not be taken into consideration for dressing the ore in Niger. Ferrosilicon would have to be imported at high cost.

Altough preliminary tests carried out on the jigging machine for the coarse fraction (3 mm - 0.5 mm) have revealed that a concentration of the iron portion is possible, the sorting effect, however, was found to be inferior when compared with the results of the sink-/float sorting process. The Fe-contents, achieved and the Fe-recovery were inferior by some percentage points.

This result should not be surprising, since it is known from a great number of comparing tests with other ores that more precise cut-off points than on a jigging machine can be achieved by means of the heavy medium process.

Since the Niger river is permanently water-bearing, it is taken for granted that sufficient water can always be available for possible wet processing of the ore. Based on this assumption, magnetizing roasting tests, which were included in the working schedule for water shortage occurrences, have not been conducted.

Moreover, the good results obtained by high-intensity magnetic separation tests revealed that the ore is characterized by a sufficiently high susceptibility in the magnetic field, which renders a high-energy thermal treatment superfluous.

It should also be mentioned that by means of magnetizing roasting, followed by fine grinding and dry magnetic separation the phosphorus content in this ore cannot be reduced.

C.5.2.2 RECOVERY

The application of the wet high intensity magnetic separator leads to a considerable increase in Fe-recovery, treating the fraction minus 0.5 mm.

A fine product relatively equivalent in quality to the coarse grain, can be generated at an optimized machine setting and suitable secondary treatment of the middlings obtained in the magnetic separator.

The quantity of concentrates can thus be increased by 14 - 15 %.

In these considerations it must be taken into account that an additional major capital expenditure will be necessary for providing for the high-intensity magnetic separator stage with compulsorily required dewatering system and eventually grinding system.

C.5.3 PORCESS TECHNICAL CONCLUSIONS OF THE CONCENTRATION TESTS

An evaluation of the described results of the investigation and tests revealed that the processing methods for further concentrating iron portions are limited by the fact that following attrition, being required at any rate, the ooliths as the actual iron carriers already exist in pure form.

Processes other than those applied during the tests have therefore not been taken into consideration.

C.6 CONCEPTION FOR THE EXPLOITATION OF THE IRON ORE DEPOSIT

C.6.1 TREATABILITY OF THE DIFFERENT ORE HORIZONS

As regards the deposit, it has to be pointed out that the ore from the Oolithes Indurées can be concentrated more easily than the ore from the Oolithes Tendres. The reason for this may be that the iron content of the raw material already differs by 5 - 8 %. The Oolithes Tendres have also as higher matrix portion, being shown by a substantially higher fines portion and, thus, ballast in sample 2.

The raw material of sample 2 (Oolithes Tendres) includes twice the quantity of fraction minus 0.5 mm than that of sample 1 (Oolithes Indurées).

To obtain an identical quality the ore of the lower layer would have to be dressed more intensively than that of the upper layer. Identical dressing would only yield an inferior quality, thus deteriorating the overall product, the micture of concentrate out of Oolithes Indurées and Oolithes Trendes.

A deteriorated product should, however, be avoided for the reasons of the increased slag occurrence and energy expenditure for smelting.

These considerations and the considerable deposit contents - on the basis of the results of tests and investigations - are in favour of the process being described in the follwoing chapter.

According to this process, an iron concentrate of the following grade shall be produced:

	(in ignited state)
53.8 % Fe, total	61.1 % Fe, total
approx. 2 % P_2O_5	approx. 2.3 % P_2O_5
" 4 % SiO_2	" 4.5 % SiO_2

The concentrate is obtained in a grain size minus 3 mm.

An ore of this quality is difficult to be sold on the world market. Export qualities as they are required today worldwide by steel producers contain about 64 % - 68 % Fe with P_2O_5 contents below 0.2 %.

For this reason further technical and economical considerations should lead to local consumption of the iron-ore.

C.6.2 DEVELOPMENT OF A PROCESS FLOWSHEET FOR THE CONCENTRATION OF THE IRON ORE FROM SAY

During the first years after commissioning of a smelter (still to be planned) only the upper layer of the deposit should be quarried for concentration purpose. To obtain a smeltable concentrate, the ore of the upper layer can be treated in the following process, proven by tests:

- Extraction of the raw material with bulldozer and transportation to the plant.
- Primary crushing stage to minus 80 mm with jaw crusher
- Secondary crushing stage to minus 3 mm with impact crusher
- Screening of the product discharged from crusher
    - = at 5 mm. Fraction plus 5 mm are returned to the impact crusher at closed circuit
    - = at 0.5 mm. Fraction minus 0.5 mm are rejected and dumped as tailings near or within the quarry.
    - = The medium fraction 5 mm - 0.5 mm are directed to attrition (scrubber drum or super-scrubber)
- The overflow from attrition (slimes) is discarded in the tailings pond.
- The underflow from attrition (5 mm - 0.5 mm) is either
    - = directed to a decanter basin for dewatering and afterwards transported to a grinding and pelletizing plant or

= is ground immediately after attrition down to pelletizing size, thickened, dewatered on a filter and thermically dried to pelletizing moisture of 8 - 9 %.

Quarrying the lower horizon and recovering the iron portions of the fines minus 0.5 mm of the upper horizon could be started several years after commissioning.

To that end it will be required to provide for a wet high-intensity magnetic separation stage.

The proposed process flowsheet is shown on the next page for both stages in fig. C 23

C.7 PREPARATION OF CONCENTRATES FOR METALLURGICAL TESTS

According to the terms of reference in the frame of this study also the metallurgical properties of the iron-ores of SAY have to be tested.

For this purpose a larger quantity of concentrates of the Oolithes Indurées and Oolithes Tendres had to be produced.

C.7.1 TEST PROCEDURE

Based on the perceptions of the investigations and test work described in chapter C.4 and their critical evaluation (chapter C.5) the required concentrates have been produced according to the following flowsheet (see annex C 47):

- crushing of the raw material,
- screening at 3 mm,
- attrition of the fraction minus 3 mm,
- desliming of the attritor discharge by means of screening at 0.5 mm
  = the fraction 3 mm - 0.5 mm represents concentrate I
  = the fraction minus 0.5 mm has been treated on a wet high intensity magnetic separator. The magnetic product represents concentrate II.

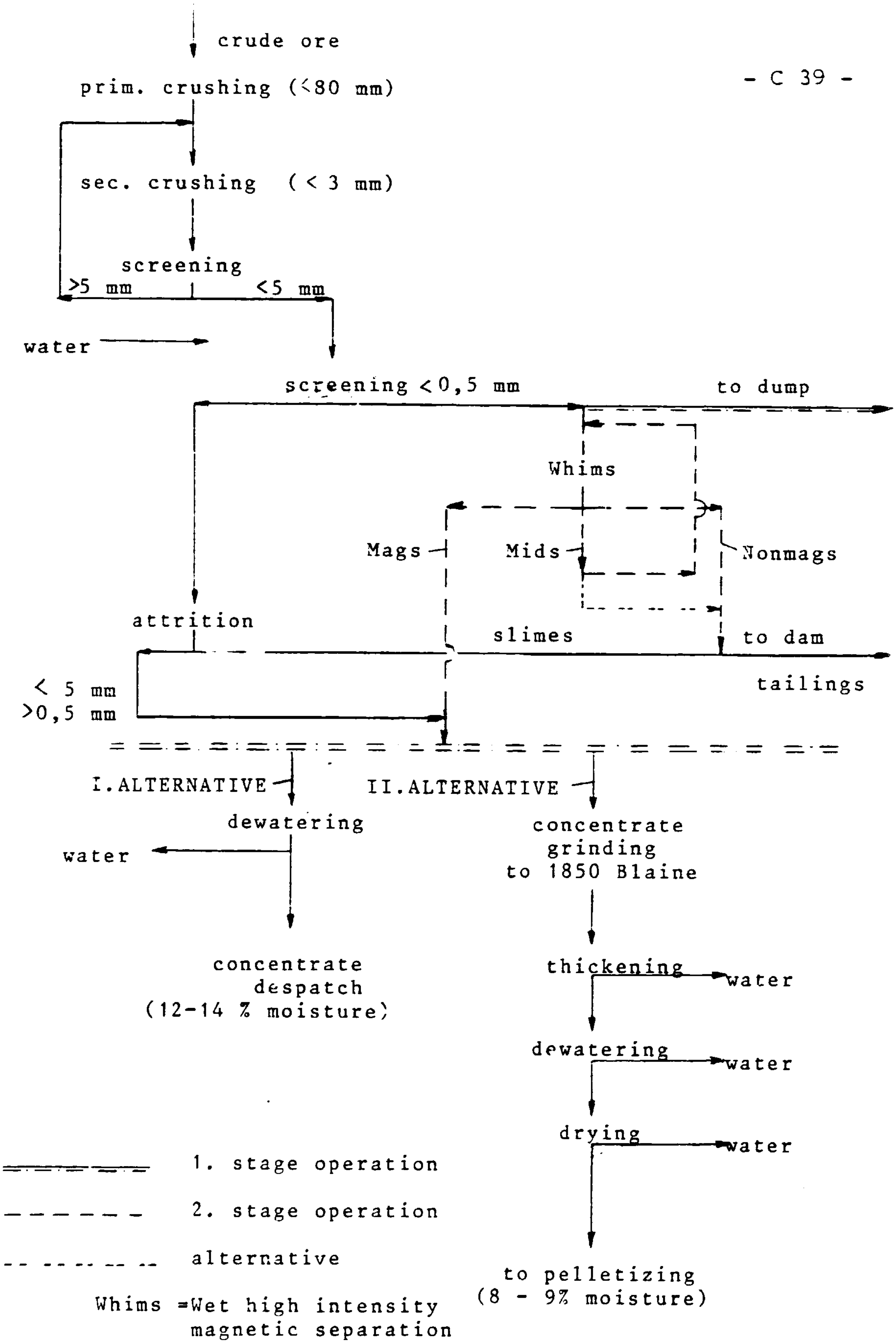


Fig. C.23 :PROPOSED PROCESS FLOWSHEET
OOLITIC IRON ORE,SAY / NIGER

C.7.2 RESULTS

C.7.2.1 SAMPLE 1 (OOLITHES INDUREES)

At a mass recovery of 68.92 % and an Fe-recovery of 74.12 %, a concentrate I with an Fe-content of 53.72 % was generated on the basis of the material of sample 1, (Oolithes Indurées).

Concentrate 1/II contained 52.97 % of Fe at a mass recovery of 16.95 % and an Fe-recovery of 17.97 % (the values relate to a raw material feed = 100 %).

C.7.2.2 SAMPLE 2 (OOLITHES TENDRES)

On the basis of this sample, a concentrate 2/I was produced that contained 49.34 % of Fe at a mass recovery of 72.43 % and an Fe-recovery of 85.72 %.

Concentrate 2/II contained 46.47 % of Fe at a mass recovery of 3.81 % and an Fe-recovery of 4.25 % of Fe (all recovery values refer to the raw material feed).

The results of the chemical analyses of the iron-ore concentrates are specified in the table hereafter:

Chemical compound or element	contents of concentrate in % (by weight)			
	1/I fraction 0.5-3 mm	1/II magnetic material	2/I fraction 0.5-3 mm	2/II magnetic material
$Fe_{tot.}$	53.72	52.97	49.34	46.47
Fe	traces	traces	tracess	traces
SiO_2	4.25	3.69	8.29	9.37
CaO	traces	traces	traces	traces
MgO	0.02	0.04	0.05	0.11
Al_2O_3	3.3	4.3	4.9	7.59
TiO_2	0.12	0.17	0.20	0.48
MnO	0.16	0.22	0.17	0.24
S	0.09	0.08	0.07	0.24
P_2O_5	2.15	1.97	2.37	2.10
K_2O)) Na_2O)	0.30	0.35	0.31	0.33
F	traces	traces	traces	traces
L.O.I.	12.08	12.94	12.27	12.42

Table: Chemical analyses of the iron-ore concentrates

Part D

Metallurgy

D. METALLURGY

D.1 OBJECTIVE

According to the terms of reference, besides conducting the geological examinations, it is necessary to carry out ore benefication tests with a representative iron-ore Sample to obtain an iron-ore concentrate with which metallurgical tests regarding pellitization and direct reduction are to be performed.

These pelettizing and direct reduction tests *) were to find out whether pellets of acceptable quality for the metallurgical industry (regarding physical pellet properties) can be obtained from iron ore concentrates of inferior quality featuring a low Fe-content (about 50 - 53 % Fe) and a high proportion of gangue and a relatively high P_2O_5-content equalling 2.1 %. The produced pellets shall be examined as to their metallurgical properties to create the basis for using the pellets for the direct reduction and smelting reduction process respectively associated with the production of sponge iron and pig iron respectively. Moreover this study is to indicate possibilities of metallurgical smelting for transferring the disturbing impurity element of the pellets, i.e. the high P-content, into the slag in order to produce pig iron and steel respectively of low phosphorus content and a slag of high phosphorus content (e.g. phosphate slag). The capital expenditure for a mini smelter (annual capacity approx. 100,000 t of steel) are estimated on the basis of a selected process.

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*) The pelletizing and metallurgical tests have been carried out at the "STUDIENGESELLSCHAFT FÜR EISENERZ-AUFBEREITUNG", Othfresen, F.R.G. under the supervision of KHD.

D.2 PELLETIZING TESTS

D.2.1 RAW MATERIALS FOR PELLET PRODUCTION AND PREPARATION OF THESE RAW MATERIALS

As described in chapter C.7 four different concentrate samples of varying grain size (two samples 0.5 - 3 mm and two samples - 0.5 mm two samples from Oolithes Indurées and two samples from Oolithes Tendres, have been produced. The chemical analyses of these samples have been specified in the beneficiation part C. of this report, chapter C.7.2. Having been dried, the four samples have been mixed at the ratio of their two portions in the total iron ore deposit. This mixture has been used for producing a concentrate suitable for the production of pellets.

The chemical analysis of the mixed sample prepared as specified above is as follows:

Fe_{tot}	51.2 %
SiO_2	7.35 %
Al_2O_3	4.30 %
CaO	0.09 %
MgO	0.09 %
MnO	0.45 %
TiO_2	0.15 %
Na_2O	0.01 %
K_2O	0.02 %
S	0.03 %
P_2O_5	2.1 %
L.O.I.	12.3 %

The grain size of the mixed sample was still too coarse for pelletizing. For preparing the sample for fine grinding to pelletizing size (Blaine-number about 1,800 cm^2/g) it has first been subjected to primary comminution in a smooth roll press to 100 % minus 0.5 mm.

The Blaine-number ascertained for the pre-crushed product equalled 300 cm^2/g.

Further fine grinding has been done discontinuously in a laboratory ball mill of Messrs. Voest-Alpine having the following specifications:

Dimensions:	800 mm diameter; 160 mm long
Ball Filling:	80 kgs
Ball Diameter:	16 - 40 mm
Speed:	30 rpm
Charge Weight:	25 kg

The grinding period of each charge has been about 20 minutes after which the required pelletizing size (Blaine-number about 1850 cm^2/g) had been attained. Table D-1 shows the grain size distribution of the material after fine grinding. Fig. D-1 is a graph showing the grain size distribution the pellet concentrate.

Grain size um	Portion by Weight %	Cumulative Portions by %
Plus 100	36.0	36.0
100 - 63	13.4	49.4
63 - 40	10.1	59.5
40 - 25	7.4	66.9
Minus 25	33.1	100.0

Table D-1: Grain size distribution of the fine-ground pellet concentrate; Blaine-number measured: 1850 cm^2/g.

Stoff:
Material:
Produit: ______________________

Firma:
Customer:
Client: ______________________

Maschine:
Machine:
Appareil: ______________________

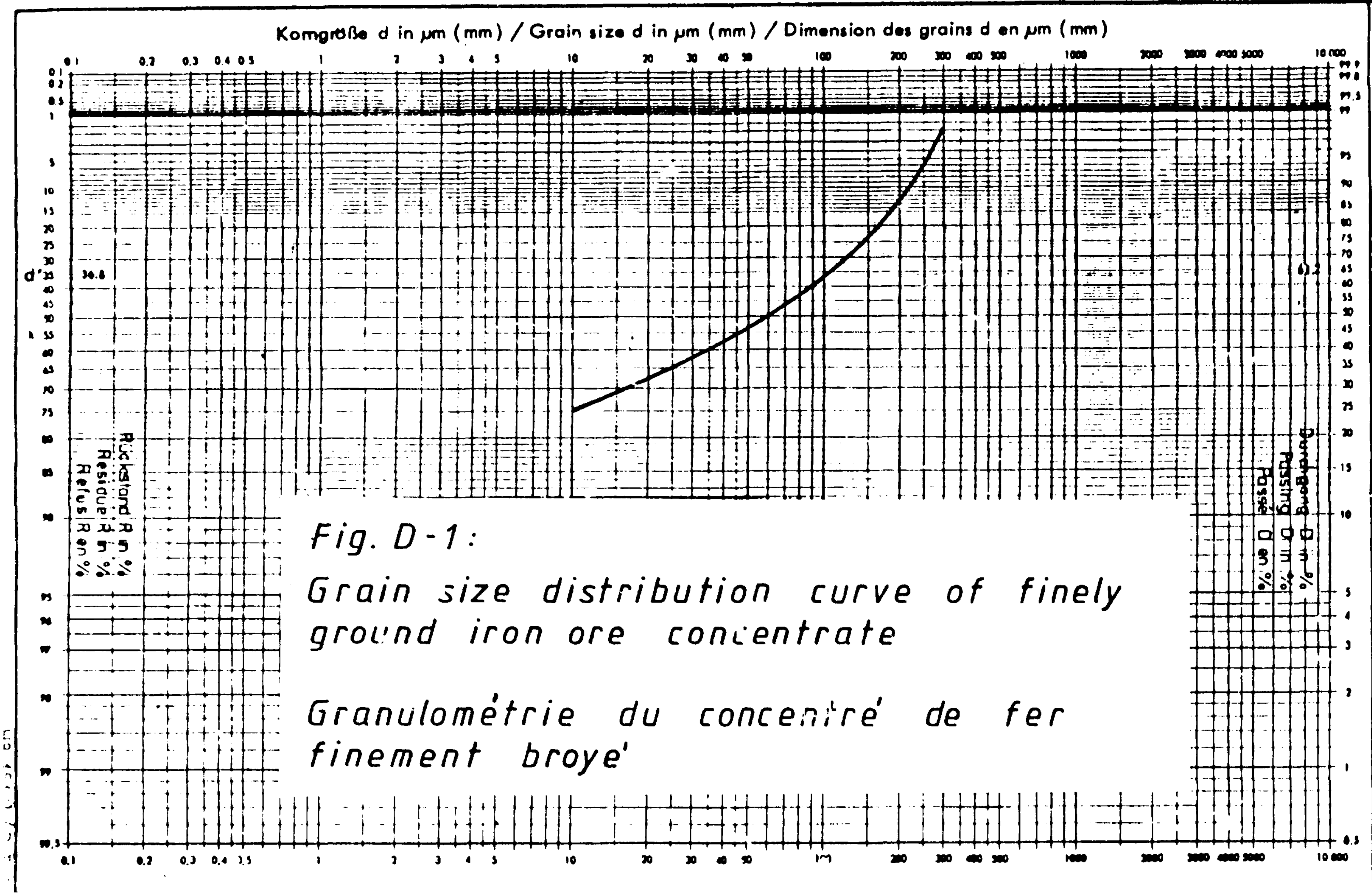

Fig. D-1:

Grain size distribution curve of finely ground iron ore concentrate

Granulométrie du concentré de fer finement broyé

Körnungsnetz / Grading graph
Diagramme granulométrique

D-4

Based on the grinding time of 20 minutes required for fine grinding it can be assumed that the ore is soft and can be ground fairly easily. The energy requirement for fine grinding is approxi- mately 4 to 5 kWh/t of feed.

D.2.2 PRODUCTION OF GREEN PELLETS

The fine ground iron ore concentrate has first been intensively mixed in a forced circulation mixer with the binders required for pelletizing and with the additives necessary for adjusting the pellet basicity (ratio $CaO:SiO_2$) and with water serving as pelletizing liquid. The production of green pellets has been done on a pelletizing disc of 1 m diameter. Six different samples of green pellets (approx. 50 kgs of each sample) have been produced, indurated and evaluated.

The green pellets have been tested for moisture content, drop hardness number, strength of green pellets and strength of dried pellets. Table D.2 shows the physical characteristics of the green pellets produced.

First of all a sample has been prepared without adding any binder or additives (Sample NEP 1). The properties of these green pellets have just been acceptable. For all other samples binders and/or additives have been added for improving the pellet quality.

D.2.3 PRODUCTION OF HEAT-HARDENED PELLETS

Heat-hardening of the green pellets has been done in an induration device specially suitable for this purpose, the so-called "POT-GRATE".

This pot-grate allows simulating the induration of pellets under conditions being most closely to the practice. This means that the quality of the heat-hardened pellets corresponds to that of pellets produced on industrial scale.

The test equipment has a diameter of 300 mm and the total height of the pellets layer equals 400 mm. The layer of green pellets has been 270 mm and the grate cover, made up finished pellets, amounted to 130 mm.

Sample No.	Dimension	NEP1	NEP2	BEP3	NEP4	NEP5	NEP6
Blaine-Number	cm^2/g	1850	1850	1850	1850	1850	1850
% by Weight - 40 um		40.5	40.5	40.5	40.5	40.5	40.5
Additives							
Bentonite (Grain Size 100 um)	%, dry	-	-	0.7	0.7	-	0.7
Limestone (" " ")	%, dry	-	2.0	2.0	-	-	2.0
Hydrated Lime (" " ")	%, dry	-	-	-	1.2	1.2	-
Charcoal (" " 160 um)	%, dry	-	-	-	-	-	1.0
Properties of Green Pellets							
Water Content	%	12.2	10.8	13.4	14.0	11.9	13.6
Drop Hardness Number (45 cm Height)		4.8	5.2	20.5	13.3	4.7	23.1
Strength of Green Pellets	daN/P	0.8	0.9	1.1	0.9	0.9	1.2
Strength after 3 Drops from a Height of ... cm	daN/P	0.6 50	0.7 45	0.9 60	0.8 50	0.6 45	0.9 65
Strength of Dried Pellets	daN/P	2.4	2.4	4.5	2.8	1.5	5.8
Bulk Weight	t/m^3	1.74	1.74	1.72	1.73	1.65	1.77

Table D-2: Physical properties of the green pellets produced

Since the mode of operation of the test equipment for pellet firing is well known to experts all over the world we shall not give a detailed description in this study.

Fig. D-2 is a photograph of the pot grate.

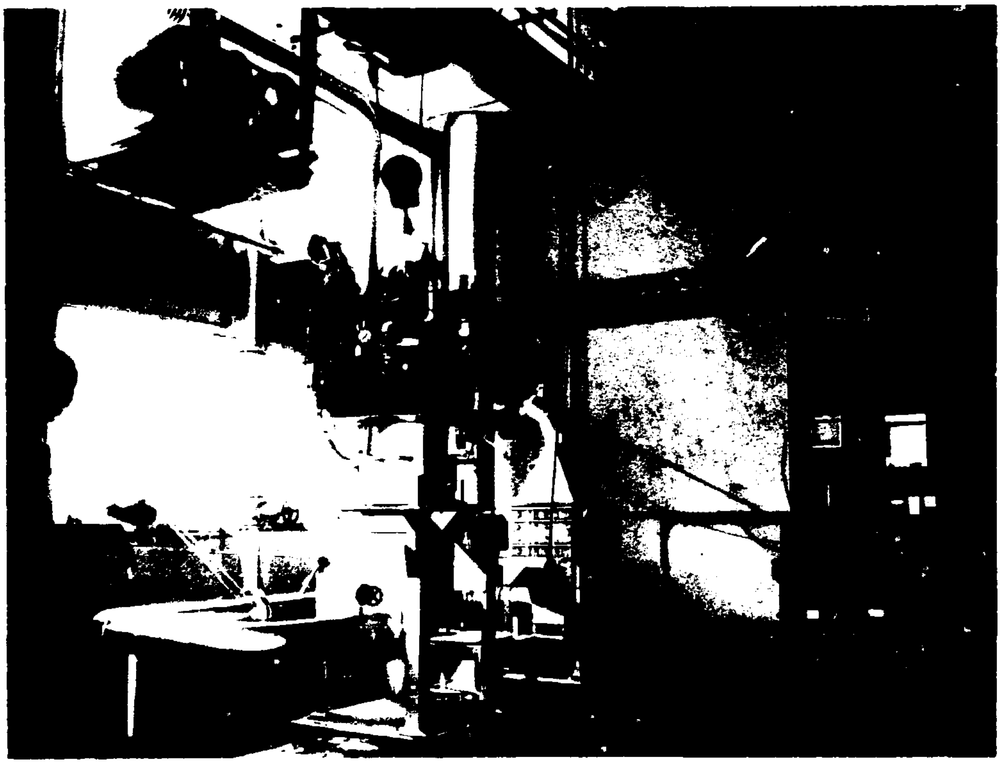

Fig.D-2: Pellet firing device (Pot-Grate) with control panel

The green pellets have a higher water content than usual for other iron-ore concentrates because of the goethite-limonite character of the iron-ore from Niger and the resulting portion of water of hydration and because of the pelletizing liquid added. Therefore drying and heating of the green pellets has to be done very carefully. The drying and heating operations have been done similar to the manner practiced in an operational plant processing similar ore. The reference parameter for the duration of firing has been the temperature of the bottom-most pellet layer.

The complete firing cycle adapted to the conditions of the travelling grate has been specified in Table D-3 below.

Firing Stage	Temperature °C	Time min	Pressure Pa
Up-draught drying	300	4	4415
Down-draught drying	280	3	3434
Heating-up Phase I	280 to 650 °C	6	4415
Heating-up Phase II	650 to 1340 °C	1	4415
Firing	up to t = 1300 °C in the bottom layer	variable	4415
After-firing	ambient temperature	until the temperature in the bottom layer starts dropping	4415
Cooling	room temperature 20 °C	until the pellet temperature (central layer) reaches 100 °C	4905

Table D-3: Firing cycle for the induration of iron-ore pellets

Table D-4 shows the temperatures adjusted and the O_2-content in the exhaust gas during induration.

Sample No. Sintering Conditions		NEP1	NEP2	NEP3	NEP4	NEP5	NEP6
Hot gas temperature	°C	1280	1250	1250	1260	1260	1260
Temperature in the pellet layer							
- top layer	°C	1355	1350	1345	1340	1345	1350
- bottom layer	°C	1325	1340	1340	1335	1340	1335
Temperature in the grate layer	°C	1255	1310	1315	1320	1315	1260
Stopping temperature	°C	1320	1340	1340	1335	1340	1335
Minimum O_2-content in the exhaust gas	%	16.0	17.3	16.0	15.5	17.9	15.6

Table D-4: Temperature- and waste gas setting when firing iron-ore pellets from Niger.

D.2.4 TESTING THE QUALITY OF THE HEAT-HARDENED PELLETS

The heat-hardened pellets are checked as to their bulk density, size distribution, ISO-tumbler index, cold compressive strength, porosity, and chemical composition. Cold compressive strength has been determined for three separate pellet layers, i.e. for the upper, medium, and lower layer. All other tests have been carried out for the complete charges.

Table D-5 shows the results of induration as well as of the quality tests carried out for fired pellets. Table D-5 indicates that sample NEP1 to which no binder and additives had been added, yielded unsatisfactory results after firing. This is true both for ISO-tumbler index and for cold compressive strength.

In another test (NEP2) 2 % limestone has been used as additive so as to increase basicity of the pellets. The results of testing the green pellets have been similar to those of test NEP1. The quality of the fired pellets, however, has been significantly improved by the addition of limestone. A tumbler-index of 93.9 % and an average cold compressive strength of 348 daN/P have been determined.

A further test (NEP3) has been carried out with 0.7 % bentonite and 2 % limestone. The properties of the green pellets reached acceptable values due to the addition of bentonite. The hardened pellets yielded an optimum tumbler index (96.2 %), abrasion (2.9 %), and cold compressive strength (average value 361 daN/P).

In another two tests, NEP4 and NEP5, the additive limestone has been substituted by hydrated lime. NEP4 was carried out by adding bentonite (0.7 %) whereas test NEP5 has been performed without adding bentonite. Because of having added bentonite the results of NEP4 revealed very good properties of green and hardened pellets compared with the results of NEP5 for which no bentonite had been used.

Because of the goethite-limonite character of the initial ore, the specific firing capacity has been very low for all tests (approx. 10 - 12 t per m^2 of firing surface and 24 h). The induration process is characterized by a high energy requirement which is very typical of ores of this type.

The addition of charcoal to the pellets has proved to be a suitable means for increasing the firing capacity. This has been investigated by a last test (NEP6) to which 1 % of charcoal from a Brazilian source was added. Apart from charcoal, 0.7 % bentonite and 2 % limestone were added to the pellets. The physical properties of the green and fired pellets have been satisfactory. It turned out, however, that the specific firing, capacity could not significantly be increased by the addition of charcoal. Even upon further optimizing the firing cycle the specific firing capacity will at any rate be lower than for normal magnetite and hematite iron ore concentrates.

Because of the relatively large amounts of slag in the pellets which have to be attributed to the high gangue contents, the porosity values have been fairly low (21 - 22 % on an average). The porosity values of other iron ore pellets are about 25 % on an average.

The chemical analysis of the fired pellets has been determined for one type of pellets (NEP3) after adding 0.7 % of bentonite and 2 % of limestone (see table D-6). Because of the high portion of gangue in the ore feed, the fired pellets had a Fe-content of no more than 57.1 %. In contrast to this, the SiO_2-content equalling 8.85 % and the Al_2O_3-content equalling 5.10 % have been very high. Due to the addition of 2.0 % of limestone the CaO-content has been increased in the pellets to 1.24 % from 0.1 % in the contentrate feed. The P-content is high (1.1 %) whereas the contents of S and $Na_2O + K_2O$ are fairly low (S = 0.01 % and $Na_2O + K_2O = 0.08$ %). The fired pellets had a basicity of $CaO:SiO_2 = 0.14$. Producing basic pellets of a basicity of 0.8 % which had originally been planned was not realized because the very high SiO_2-contents would have required the addition of large amounts of limestone (approx. 7 %). This means even lower Fe-contents in the pellets which, in turn, would adversely affect the production output of pig iron and the production costs respectively.

Pellet sample No. Results	Dimension	NEP1	NEP2	NEP3	NEP4	NEP5	NEP6
Pellet Composition	% dry						
Bentonite 100 um	"	-	-	0.7	0.7	-	0.7
Limestone 100 um	"	-	2.0	2.0	-	-	2.0
Hydrated Lime 100 um	"	-	-	-	1.2	1.2	-
Charcoal 160 um	"	-	-	-	-	-	1.0
Specific firing capacity	$t/m^2.24$ h	12.0	10.9	10.0	9.1	9.6	11.4
Bulk density	t/m^3	1.73	1.67	1.71	1.69	1.64	1.71
Size Distribution of fired Pellets							
16 mm	% by weight	1.8	11.8	18.4	12.9	20.7	11.2
16 - 12.5 mm	% " "	13.3	16.2	29.2	33.7	10.6	17.9
12.5 - 10 mm	% " "	65.9	42.7	36.2	37.2	40.3	50.1
10 - 6.3 mm	% " "	18.3	28.9	15.8	16.1	27.0	20.7
6.3 mm	% " "	0.7	0.4	0.4	0.1	1.4	0.1
ISO-Tumbler index 6.3 mm	% by weight	66.4	93.9	96.2	95.6	92.9	93.6
Abrasion 0.5 mm	% " "	27.5	4.4	2.9	3.5	4.6	5.4
Cold Compressive Strength							
Average of complete charge	daN/P	160	348	361	386	287	225
Average of upper layer	"	303	388	420	390	363	321
Average of medium layer	"	135	372	309	422	293	213
Average of bottom layer		44	285	354	348	206	143
Open Porosity	% by Volume	21.2	22.8	20.4	21.2	20.4	22.1

Table D-5: Results of heat-hardening and physical properties of the fired iron-ore pellets from Niger

	% by weight
Fe_{tot}	57.1
FeO	0.6
SiO_2	8.85
Al_2O_3	5.10
CaO	1.24
MgO	0.13
P	1.1
S	0.01
Na_2O	0.04
K_2O	0.04
MnO	0.53
TiO_2	0.21
Ratio CaO : SiO_2	0.14
" CaO+MgO:SiO_2+Al_2O_3	0.10

Table D-6: Chemical analysis of the fired pellet sample NEP3 to which 0.7 % bentonite and 2 % limestone have been added

Table D-7 shows examples of chemical composition of pellets having specifications which according to the latest state of the art are required for direct reduction. Comparing the pellet qualities with that of the iron-ore pellets from Niger reveals the inferior quality of the latter because of their lower Fe-content and high P-content associated with the high portion of gangue.

Consequently, the iron ore pellets from Niger do not have export quality and can most probably be processed only in Niger while accepting high smelting costs in the form of high energy expenses and additional costs for the phosphorus removal.

Fig. D-3 is a photograph of fired pellets sample NEP3; grain size of the pellets 10 - 16 mm. Fig. D-4 is a cross section of a fired pellet shown at a magnification of 6.5.

Fig. D-3:Photograph of fired pellets, Sample NEP 3
Magnification: 1:1

Pellet Type	LKAB (MPRD)	CVRD	SAMARCO	HIERRO	FIRE LAKE	SAY
Source	Sweden	Brazil	Brazil	Peru	Canada	Niger
Chemical Analysis	%	%	%	%	%	%
Fe_{tot}	67.1	68.0	67.6	67.5	67.5	57.1
SiO_2	1.2	1.46	1.4	1.5	1.9	8.85
Al_2O_3	0.4	0.79	0.9	0.6	0.4	5.10
CaO	1.1	0.5	2.0	0.4	0.5	1.24
MgO	0.8	0.1	0.3	0.6	0.4	0.13
P	0.015	0.026	0.027	0.01	0.008	1.10
S	0.01	0.01	0.015	0.018	0.01	0.01
TiO_2	0.25	0.08	0.05	-	0.01	0.21
Physical Properties						
ISO-Tumbler Index % by weight	95	95	95	95	94.5	96.2
Abrasion % by weight	4.5	4.0	4.0	4.0	4.5	2.9
Cold Compressive Strength daN/P	260	440	400	250	200	361

Table D-7: Typical chemical and physical specifications of pellets suitable for direct reduction shown by the example of MIDREX-Process (MIDREX, Vol.8,No.4,1983)

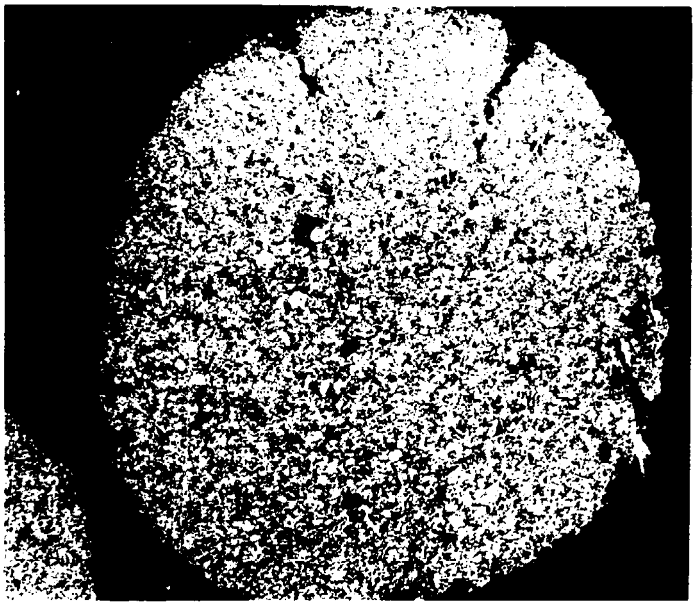

Fig.D-4: Cross sectional view of a fired pellet, Sample NEP3, Magnification 6.5x

D.3 METALLURGICAL TESTS

D.3.1 METALLURGICAL BEHAVIOUR OF IRON-ORE PELLETS FROM NIGER USING GAS AS REDUCING AGENT

Well-known reduction processes which have been introduced on the market on large scale for some years, as e.g. the MIDREX- and the HYL-process*) use gas a reducing agent. This gas which consists mainly of CO and H_2 is produced by thermal decomposition of CH_4 from natural gas (crude oil) with O_2, CO_2 or H_2O at a temperature suitable for the process run.

Determining the reduction characteristics of pellets as to their suitability for direct reduction processes can be done by simulating gas and temperature parameters in laboratory reduction reactors. By now corresponding ISO (International Standard Organization) proposals have been made which have been accepted as standard test methods by experts.

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*) HYL-Process = HOJALATA-Y-LAMINA-Process

For instance, the ISO-Proposal No. ISO/TC 102/SC 3 (DE-26) 429 E of November 1978 is used for determining reducibility, metallization and clustering tendency. This proposal is known among experts as RMC-(Reducibility-Metallization-Clustering)-test.

Similarly ISO-Proposal No. ISO / TC 102 / SC 3 (DE-25) 428 E of November 1978 is used for testing the disintegration behaviour of pellets during direct reduction. This proposal is known among experts as DRDS-(Direct-Reduction-Disintegration-Strength)-Test.

The description of the ISO-Test methods to perform the RMC- and the DRDS-tests as well as their evaluation can be obtained from the 'STUDIENGESELLSCHAFT FÜR EISENERZAUFBEREITUNG', Othfresen, Germany.

D.3.1.1 RESULTS OF THE RMC-TEST AND THEIR EVALUATION

Reducibility, clustering tendency and metallization have been determined on pellet type NEP3 which had yielded optimum results during pellet firing. The results have been quoted in Table D-8. The test has been repeated at 3 different reduction temperatures, i.e. 850, 900 and 950 °C. As expected the reduction rate increased as a function of the raising reduction temperature. Clustering of the pellets occurred only at 950 °C which entailed a more pronounced trend of change in the height of pellet layer which, in turn, resulted in deteriorated gas permeability. The examined pellet sample showed below 950 °C no or only very little clustering tendency when compared with similar samples tested earlier.

The metallization figures of more than 98 % obtained at the end of the test for reduction temperatures of 900 and 950 °C have to be considered very satisfactory which is also true of the cold compressive pellet strength after reduction.
Fig. D-5 is a photo-micrograph of a polished pellet section reduced at 900 °C.

	Pellet Sample No.	Dimension	NEP3		
	Firing Temperature	°C	1340		
	Porosity	% by Volume	20.4		
1.	Test Conditions				
	Pellet Size				
	16 - 12.5 mm	%	50		
	12.5 - 10 mm	%	50		
	Reactor Feed	g	2000		
	Reducing Gas H_2	% by Volume	55		
	CO	% by Volume	35		
	CO_2	% by Volume	6		
	CH_4	% by Volume	4		
	Gas Quantity	Nm^3/h	2.4		
	Ram Pressure	MPa	0.14		
	Reduction Time	min	180		
	Reduction Temperature	°C	850	900	950
2.	Test Results				
2.1	Reducibility				
	a) $(\frac{dR}{dt})_{40}$	% min	1.37	1.60	1.93
	b) Reduction Time for 90 % Reduction	min	88	70	56
	c) Reduction Time for 95 % Reduction	min	102	86	64
	d) Reduction at Test End (after 180 /min)	%	99	99	99
2.2	Change in bed height (CBH)				
	a) CBH at 90 % Reduction	%	0.6	2.7	5.2
	b) CBH at Test End	%	2.0	5.7	17.1
	c) Differential Pressure at 90 % Reduction	Pa	0	0	11.8
	Differential Pressure at Test End	Pa	0	0	35.3
2.3	Clustering Characteristics				
	20 mm after reduction				
	a) determined after 2 minutes sieving	% by weight	0	0	80
	b) additional 2 minutes sieving	% by weight	0	0	58
2.4	Cold Compressive Strength of Pellets after Reduction				
	Sample Average	daN/P	102	116	119
2.5	Chemical Analysis of the Pellets after Reduction				
	Fe_{tot}	%	75.5	79.2	76.4
	Fe_{met}	%	72.6	78.1	75.7
	C	%	0.09	0.22	0.10
	Metallization	%	96.2	98.7	99.1

Table D-8: Results of the RMC-Test

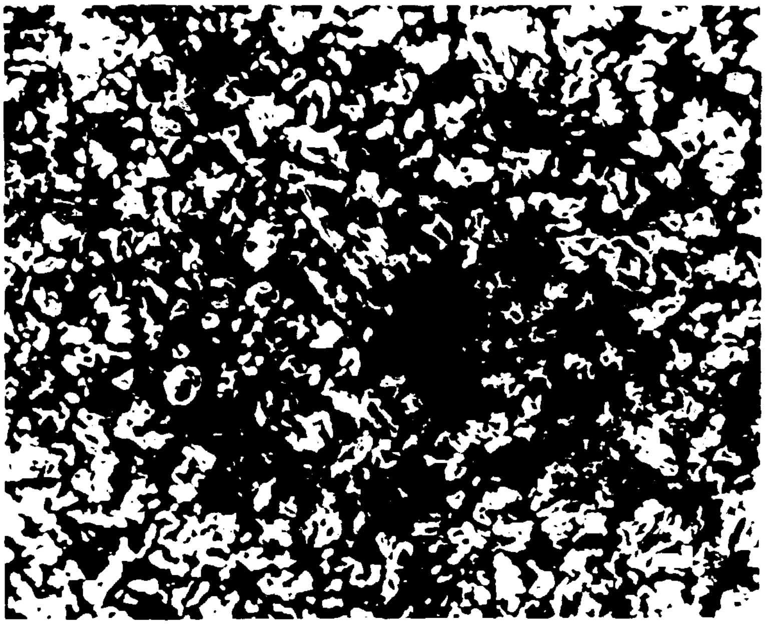

Fig.D-5: Micro-photograph of a polished pellet section reduced at 900 °C (pellet sample NEP3). Magnification: 220x

D.3.1.2 RESULTS OF THE DRDS-TEST AND THEIR EVALUATION

As specified under para D.3.1.1 the disintegration strength during reduction has been examined for pellet sample NEP3. The test has been carried out in a rotary cylinder of 150 mm diameter and 540 mm length; this cylinder had been additionally equipped with four lifters. The speed of rotation of the cylinder has been 10 /min. As for the RMC-test, the size of the tested pellets, the pellet quantity as well as composition and quantity of the reduction gas have been kept constant; details are listed in Table D-8. The maximum reduction temperature selected for the test has been 750 °C. The results of the DRDS-test carried out with sample NEP3 have been compiled in Table D-9.

That table indicates that the disintegration strength, expressed as size fraction in % by weight + 6.3 mm, related to the actual furnace-charge is near 93 % and, consequently, satisfactory. At an average value of 104 daN/pellet the cold compressive strength of the reduced pellets is adequately high.

Pellet Sample No.	Dimension	NEP3
1. Test Parameters		
Reduction Time	min	180
Reduction Temperature	°C	750
2. Test Results		
2.1 Clustering and Disintegration Strength		
Rated Furnace Discharge	g	1544
Actual Furnace Discharge	g	1484
Differential Weight = Clustering + Dust Loss	g	60
Of that Quantity Clustering (Weight of Cylinder)	g	0
2.2 Disintegration Strength and abrasion		
Related to Rated Furnace Discharge		
> 6.3 mm	% by weight	89.2
> 3.15 mm	"	91.7
Abrasion < 0.5 mm	"	7.0
Related to Actual Furnace Discharge		
> 6.3 mm	"	93.0
> 3.15 mm	"	95.7
Abrasion < 0.5 mm	"	3.2
2.3 Cold Compressive Strength of reduced Pellets		
Average Value	daN/P	104
2.4 ISO-Tumbler index		
> 6.3 mm	% by weight	52.9
Abrasion < 0.5 mm	"	17.1
2.5 Chemical Analysis of the Pellets after Reduction		
Fe_{tot}	%	74.0
Fe_{met}	%	64.8
Metallization	%	87.6
2.6 Porosity	% by volume	52.0
2.7 Bulk density		
loose	g/cm^3	1.48
after shaking	g/cm^3	1.58

Table D-9: Results of DRDS-test

In contrast to that, the ISO-tumbler index measured to equal 52.9 % by weight of the fraction 6.3 mm has to be considered low. It means that increased abrasion due to transportation has to be expected when handling reduced pellets inside the steel plant or when exporting the pellets. Because of the low reduction temperature equalling 750 °C, the metallization has been approximately 88 % at the end of the test.

D.3.2 METALLURGICAL CHARACTERISTICS OF IRON ORE PELLETS FROM NIGER WHEN USING SOLIDS (COAL) AS REDUCING AGENT

Apart from the gas reduction process described under item D.3.1 above, including e.g. the MIDREX- and the HYL-process, there are so-called solids direct reduction processes known as SL-RN-*), KRUPP-CODIR-**) or ACCAR-***) process. These processes can be applied on large scale just as the gas reduction processes. They use solid fuel, as for instance coal or coke as reducing agent. The reduction equipment is a rotary kiln. Suitability of a specific type of pellets for reduction in a rotary kiln can be determined by simulating tests in a laboratory furnace. The description of the corresponding standardized test set-up, the test procedure and its evaluation can be obtained from the Studiengesellschaft für Eisenerzaufbereitung, Othfresen, Germany.

The test material was iron ore pellets, sample NEP3 (sample weight: 750 g; sample size 10 to 16 mm). The coal required for solid reduction should approximately feature the composition of the coal occurring in the Republic of Niger. However, it has been impossible to procure such coal sample because of insufficient time available for carrying out the test. Therefore, a Philippine coal called "Semirara coal" has been used instead. Like coal originating from Niger, it is a highly reactive, volatile coal of inferior quality and high ash content.

Table D-10 shows the chemical composition of coal occurring in the Republic of Niger (reference coal, as specified by SONICHAR, Niger) and of the coal used for the solids reduction test (test coal). The coal quantity used for each test equalled 650 g, its grain size has been minus 10 mm.

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*) SL-RN = STELCO/LURGI-REPUBLIC STEEL/NATIONAL LEAD
**) KRUPP-CODIR = KRUPP-COAL-ORE-DIRECT-IRON-REDUCTION
***) ACCAR = ALLIS-CHALMERS-CONTROLLED-ATMOSPHERE-REDUCTION
(See also literature list)

Source, Deposit		Reference Coal Niger, Anou-Araren	Test Coal Philippines, Semirara
C_{fix}	% (waterfree)	40	31.2
Volatiles	% "	20	33.7
Ash	% "	40	35.1
S_{tot}	% "	1	3.7

Table D-10: Chemical composition of the reference- and of the test-coal

Dolomite of a grain size of 0.2 to 1.6 mm and a quantity of 30 g/test has been used for desulfurizing the reduced iron.

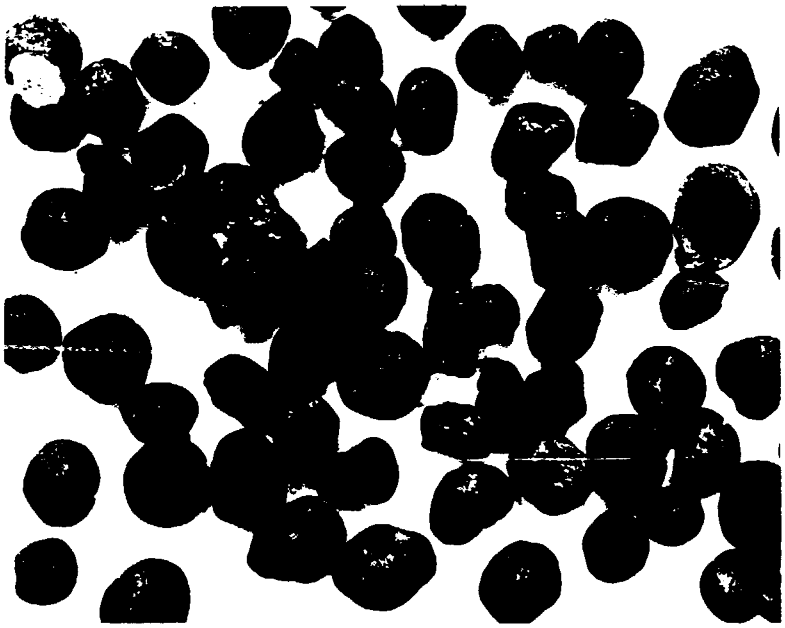
Two reduction tests have been carried out, both at a reduction temperature of 1000 °C. The reduction time has been varied. It equalled 90 minutes for the first test and 105 minutes for the second test.

D.3.2.1 RESULTS OF SOLIDS REDUCTION TESTS AND THEIR EVALUATION

The test results compiled in Table D-11 and their evaluation should be seen against the background of varying analyses of the reference- and the test-coal.

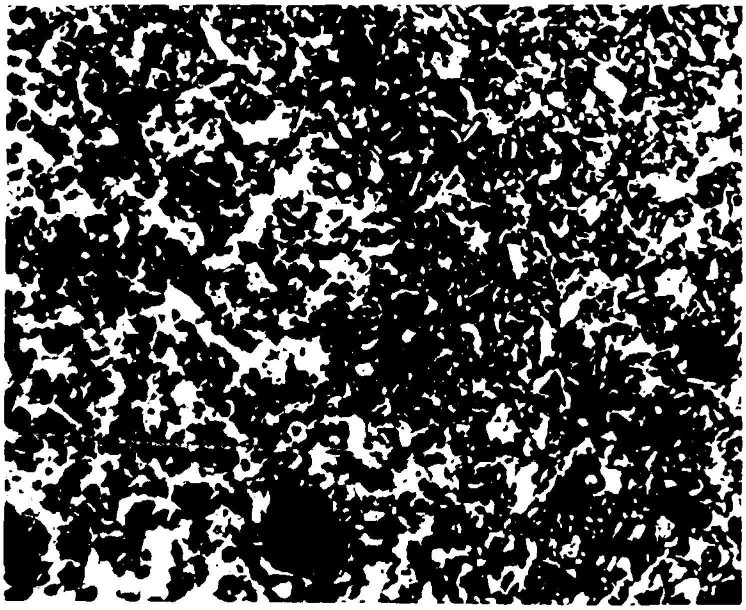
Fig. D-6 is a micro-photograph of the samples reduced with Semirara coal at 1000 °C during 90 minutes (Pellet Sample No. NEP3).

Fig. D-7 is a cross sectional view of a reduced pellet at 110 times magnification.



Magnification: 1:1

Fig. D-6: Photograph of the pellets reduced with solid fuel (Semirara coal, reduction temperature: 1000 °C; reduction time: 90 minutes)



Magnification: 110

Fig. D-7: Microcross section of a pellet reduced with Semirara coal (reduction temperature: 1000 °C; reduction time: 90 minutes). Note phase change from pellet perifery (Metallic phase) to the core (oxide phase)

Pellet sample No.		NEP 3							
	Dimension								
Reduction temperature	°C	1000				1000			
Reduction time	min	90				105			
1. Furnace discharge									
Discharge weight	g	921				909			
Of that non-react.coal	g	21				26			
Portion of magnetic product	g	612				–			
Bulk density loose	kg/l	1,16				1,16			
Bulk density after shaking	kg/l	1,25				1,29			
2. Screen analysis	mm	6,3	6,3-3,15	3,15-1,6	1,6	6,3	6,3-3,15	3,15-1,6	1,6
Total portion	% weight	65,7	10,4	8,7	15,2	66,8	13,2	7,6	12,4
of that Portion of magnetic product	"	63,4	1,8	0,1	1,1	64,0	3,0	0,1	0,5
Portion of non-magnet. product	"	2,3	8,6	8,6	14,1	2,8	10,2	7,5	11,9
3. Metallurgical Results									
3.1 Chemical Analysis									
Fe_{total}	%	71,4	77,0		48,3	71,3	74,6		59,0
Fe_{met}	%	52,3	67,3		43,8	49,4	62,0		54,2
Metallization	%	73,3	87,4		90,7	69,3	83,1		91,9
C	%	0,03	0,12		n.d.	0,12	0,21		n.d.
S	%	0,34	0,41		n.d.	0,6	0,32		n.d.
3.2 Cold Compressive Strength (Fraction 10-12,5 mm)									
Average value	daN/P	96	n.d.		n.d.	69	n.d.		n.d.
3.3 Porosity	% vol.	36,1	n.d.		n.d.	n.d.	n.d.		n.d.
3.4 Bulk Density	kg/l	1,83	n.d.		n.d.	1,85	n.d.		n.d.
3.5 Disintegration Characteristics									
Disintegration strength > 6,3 mm	% weight	95,4	n.d.		n.d.	94,7	n.d.		n.d.
> 3,15 mm	"	98,2	n.d.		n.d.	99,1	n.d.		n.d.
Abrasion < 1,6 mm	"	1,6	n.d.		n.d.	0,9	n.d.		n.d.

Table D-11: Results of solids reduction test in a rotary furnace

The metallization of the reduced pellets (fraction + 6.3 mm) has been measured to be only 70 to 73 % which has to be considered insufficient for industrial practice. Large scale application requires metallization degree of at least 90 % for being able to smelt the reduced pellets to sponge iron at acceptable energy consumption in an arc furnace. In spite of the addition of dolomite ranging from 0.3 to 0.8 %, the S-content of the reduced pellets must be considered to be high; this sulfur originates from the fuel. Other quality parameters such as cold compressive strength and disintegration characteristics of the reduced pellets have been within acceptable limits.

Because of the inadequate metallization of the reduced pellets obtained during the two tests performed, the results require additional optimizing so as to find out whether reduction in rotary kilns using solid fuel will be suitable for iron ore pellets from Niger or not.

D.3.3 SMELTING REDUCTION PROPERTIES OF IRON ORE PELLETS FROM NIGER

Apart from using gas- and solids reduction processes for iron ore pellets resulting in the production of reduced pellets (sponge iron), other so-called smelting reduction processes have been developed on large scale for the last 10 years approximately. These processes, which can be of single or multi-stage type, use pellets, pellet and lump ore mixtures as well as fine-grained ore as charging material. The final product discharge from the last stage is liquid metal. The attainable product quality ranges between liquid iron and semisteel depending on the process run. An additional refining stage will be necessary for producing quality steel. Examples of these processes are:

the INRED 1)	- Process	
the ELRED 2)	- Process	Swedish Developments
the PLASMARED 3)	- Process	
the KR-Process 4)		German Developments
the Krupp-Coin-Process 5)		

Out of the processes listed above only the KR-Process has been developed to industrial scale till now.

D.3.3.1 TESTS WITH RESPECT TO REDUCTION, SOFTENING AND SMELTING CHARACTERISTICS

Suitability of the iron ore pellets from Niger for the KR-process could be examined the laboratory with the aid of the so-called REAS-test 6). A description of the test set-up, of the heating up and the gas programme, the test procedure and its evaluation can be obtained from the 'STUDIENGESELLSCHAFT FÜR EISENERZAUFBEREITUNG', Othfresen, Germany.

Similar to the KR-process where the liquid metal is produced in two stages, the REAS-test also comprises two stages. To begin with, the iron ore pellets originating from test NEP3 have been subjected to primary reduction in a cylindrical reactor of 75 mm diameter by admitting a reducing gas of 70 % CO, 25 % H_2 and 5 % N_2; the reduction degree obtained has been 91.1 %.The temperature in the pellets at the end of this primary reduction stage equalled 900 °C and the reduction time has been 100 minutes.

Further evaluation of the results of primary reduction yielded a reduction rate of 1.6 % O_2-removal/min. At the end of the primary reduction stage the pellets have been cooled under an N_2-atmosphere and then used as feed material for the REAS-test which simulates the smelting characteristics. The results of the primary reduction test as well as those of the REAS-test are specified in table D-12.

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1) INRED = INTENSIVE REDUCTION
2) ELRED = ELECTRICAL REDUCTION
3) PLASMARED = PLASMA REDUCTION
4) KR = Kohle-Reduction
5) KRUPP-COIN = KRUPP-COAL-OXYGEN-INJECTION
6) REAS = Reduktion-Erweichung-Abschmelz-Simulierung

D.3.3.2 RESULTS AND EVALUATION OF THE REAS-TEST

Table D-12 indicates that the softening temperature, defined as temperature upon reaching 50 % shrinkage of the pellets used, is at 1140 °C and the smelting temperature at 1240 °C. Initial dripping of liquid iron started at 1310 °C. The temperature measured at 5 % of the metal having dripped-off has been used as the criterion to judge the smelting characteristics of the pellets. This occured for sample NEP3 at 1410 °C. Further dripping-off of liquid iron proceeded rela- tively quickly with the temperature increasing to 1550 °C (test end temperature). The total quantity of metal that has dripped-off has been determined to equal 61.7 % of the theoretically possible quantity. These results are in full accordance with other tested pellet types of low Fe- and high gangue content. Fig. D-8 is a photograph of the iron that has dripped-off and cooled on a metal plate. Fig. D-9 is a microphotograph of a polished section of the dripped-off iron at 110 times magnification.

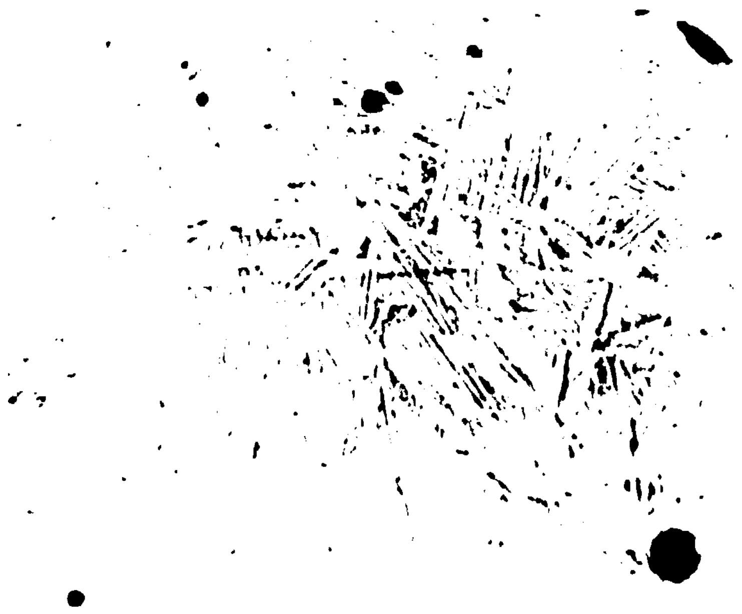
The chemical analysis of the dripped-off iron yielded the following values (table D-13).

Component	% by weight
Fe_{tot}	95.40
C	2.08
Si	0.42
Mn	0.08
P	1.94
S	0.03

Table D-13: Chemical analysis of the dripped-off iron from the REAS-test

Magnification: 1:1

Fig. D-8: Photograph of the dripped-off iron of the REAS-test (iron-ore pellet sample: NEP3)



Magnification: 110

Fig. D-9: Microphotograph of the polished section of the dripped-off iron of the REAS-test (iron-ore pellet sample: NEP3).

	Pellet Sample No.		N E P 3
I.	Test Parameters	Heating-Up	Gas
	Load: 0.1 MPa	20 to 450 °C at 5 °/min	1800 Nl/h N_2
		450 to 900 °C at 10 °/min	1260 Nl/h CO = 70 % 450 Nl/h H_2 =25 % 90 Nl/h N_2 = 5 %
		further heating up to 1550 °C at 5 °/min	"
		after reaching 90 % Reduction	1800 nl/h N_2 (up to P = 2 KPa) then reducing N_2 to P = 0.2 kPa as flushing gas
II.	Test Results	Dimension	
II.a	Primary Reduction Stage		
	Total reduction time	min	100
	Reduction temperature at end of the test	°C	900
	Reduction up to isothermal heating phase	%	75.1
	Final reduction degree	%	91.1
	Time up to 65 % reduction	min	48.5
	$\left(\frac{dR}{dt}\right)_{40}$	%/min	1.6
II.b	REAS-Test		
	Softening temperature TE	°C	1140
	Smelting temperature TS	°C	1240
	Inited drip-off temperature TAL	°C	1310
	Temperature after 5 % of the metal has dripped-off TA2	°C	1410
	Temperature at P_{max}	°C	1230
	Time from beginning of reduction up to Pmax = 2 KPa	/min	238
	Total dripped-off metal	g	223.5
	Metal recocery	% by weight	61.7

Table D-12: Results of the primary reduction and the REAS-test

D.4 OVERALL ASSESSMENT OF THE PELLETIZING AND METALLURGICAL TESTS

D.4.1 PELLETIZING TESTS

The iron-ore concentrate from Niger iron-ore prepared after completion of the beneficiation tests can be considered of inferior quality. Because of the goethite-limonite character of the ore only up to a maximum of 53 % Fe can be obtained in the concentrate after beneficiation. After expelling the water bonded to limonite and further heat-hardening of the green pellets, Fe-contents of 59 % result in the pellets. In contrast to this, the iron content of pellets for blast furnaces or for direct reduction processes offered on the pellet market range at least from 64 - 67 %.

Similarly, the high P-content in the heat-hardened pellets equalling approx. 1.1 % adversely affects the metallurgical application of the pellets. Although the phosphorus can principally be removed during smelting to pig iron and steel - a subject which will be discussed in the chapter D.5 - it requires additional expenses for raw materials and energy. This means higher production costs of the final product.

The grinding expenditure of the concentrate for producing green pellets was relatively low because of the soft character of the ore (4 - 5 kWh/t of ground product). For producing green pellets of adequate strength the material has to be ground down to a Blaine number of 1850 cm^2/g. The dry strength of the pellets during firing could be significantly improved by adding about 0.7 % bentonite.

The pellets featured adequate cold compressive strength after firing; the porosity of the pellets is low equalling approx. 21 - 22 %, being a result of the high slag contents. In view of the goethite-limonite character of the ore the average induration capacity of 11 $t/m^2 \cdot 24$ h is very low. This results in a high energy consumption for heat-hardening the iron-ore pellets from Niger.

Apart from low Fe-contents and high P-values, the chemical analysis of the fired pellets revealed high SiO_2 (8.85 %) and low CaO-contents (0.1 %). The iron ore pellets from direct reduction should normally have low SiO_2-contents (1 - 2 %) at a basicity of $\frac{CaO}{SiO_2} = 0.3$. Recently, basic pellets with limestone and/or dolomite addition($\frac{CaO+MgO}{SiO_2} = 1.6$) are also used for direct reduction.

Because of the high SiO_2-contents the production of basic pellets with the iron ore concentrate from Niger is impossible because this would require the addition of inacceptably large quantities of very pure limestone and dolomite respectively. Apart from that, the pellet hardening process will be adversely affected by additives and would result in even lower production values on the firing machine.

D.4.2 REDUCTION TESTS

D.4.2.1 GAS REDUCTION

In spite of large slag quantities, the gas reduction tests have revealed that clustering of the pellets does not occur at temperatures of 900 °C. This is noticed only at temperatures above 950 °C. Acceptable reduction rates and degrees of metallization as well as cold compression strength of the pellets after reduction could be achieved at a temperature of 900 °C. The shrinkage of pellet layer increases with raising reduction temperature (above 900 °C); this phenomenon entails deteriorated penetration of the gas through the pellet layer.

Examining the disintegration strength at 750 °C in a laboratory scale rotary furnace has indicated that the disintegration strength (expressed in the fraction plus 6.3 mm) is adequately high at 93 %. However the transport strength, expressed as ISO-tumbler index and the degree of metallization achieved are not quite satisfactory. The reduced pellets are not suitable for export or for transportation over long distances.

D.4.4.2 SOLIDS REDUCTION

The solids reduction tests have been simulated in a laboratory scale rotary furnace at 1000 °C by using a highly volatile coal similar to the coal originating from Niger. The test coal used was from Philippines (Semirara Coal).

At a reduction time of 90 minutes, a metallization of only 73.3 % (for the size fraction of plus 6.3 mm) has been reached. Extending the reduction time to 105 minutes did not improve that result. Further increasing the temperature to beyond 1000 °C is not permissible because of the danger of clustering. Industrial scale processes of this type as for instance the SL-RN-process reach metallization degrees of more than 90 %.

Additional tests have to be carried out with solids reduction to be able to find and the most optimum parameters to achieve good results.

D.4.2.3 SMELTING REDUCTION

The examination of the smelting reduction characteristics for which purpose a newly developed test equipment (REAS-Test) has been used revealed that the pellets produced can certainly be treated in a smelting reduction process, as for instance the KR-process. The softening, smelting and dripping-off temperatures respectively measured during the REAS-test as well as the quantity of iron that dripped-off are typical of ores with large gangue proportions and acidic slags.

The P-content of the pellets migrates into the sponge iron after reduction. The removal of phosphorus is possible during further processing to pig iron and crude steel by suitable slag handling which subject will be dealt with in the following chapter D.5.

D.5 CONSIDERATION OF POSSIBLE IRON PROCESSING METHODS

D.5.1 GENERAL REMARKS

There are several ways in the iron metallurgy to produce steel from iron-ore; one possibility is the conventional way, i.e. using the blast furnace and the steel melting converter. Another way is by using the recently developed so-called direct reduction processes. A third way could be applying the modern smelting reduction processes.

According to the conventional method iron-ore in the form of sinter, pellets and lump ore will be charged into the blast furnace. Together with coke manufactured from a good coking coal and used as a heat supplier and reducing agent, a pig iron is produced from the blast furnace. The impurities present in the ore like sulphur and phosphorus will migrate during the smelting process into the pig iron either wholly or partly according to the blast furnace operating conditions. The conversion of impure liquid pig iron from the blast furnace to a quality steel is performed in a steel blowing converter while at the same time removing the undesired elements like S and P. Modern steel making furnaces use oxygen as a refining agent. The oxygen is blown on the surface of the pig iron melt with the help of one or more lances as in the case of LD-process *) for example. The oxygen could also be introduced under the melt through the so-called "bottom-tuyeres" as in the case of 'Q-BOP'-Process **) developed by the Maxhütte, Sulzbach-Rosenberg, W-Germany. In the steel converter the carbon dissolved in the iron is burnt to CO/CO_2 and the S and P contents in the iron could be converted into the slag through maintaining proper slag composition.

The conventional iron and steel plants on the basis of blast furnace-steel converter route possess raw steel capacities between 1 and 5 Mill. t/a.

For an integrated plant on the green site, the total specific investments are of the order of 1200-1600 US $ per t raw steel per year depending upon the yearly production rate of the plant (SZEKELY, 1980).

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*) LD-process = Linz-Donawitz-process

**) Q-BOP-process = Quiet-Bottom-Oxygen-Process

For developing countries without an own energy base (for example availability of good coking coal), basic infrastructure and basic know-how, the construction of integrated steel plants with a high capital investment requirement cannot be recommended.

Since about the beginning of the seventies, the conception of the so-called "MINI-MILL", based on the direct reduction - electric arc furnace route, has been introduced. The principle of the mini-mill consists in the production of an intermediary solid product, the so-called "sponge-iron" from iron-ore pellets and lump ore. The sponge iron is produced in a counter current shaft furnace or a rotary kiln. The reduction takes place by means of a gaseous reducing agent consisting of CO and H_2 produced with natural gas or with fixed carbon in the form of coal or coke breeze. The degree of metallization of the sponge iron produced will be beyond 90 % and its chemical quality is better in comparison to the steel scrap. Examples of direct reduction processes to be installed as mini-mills are for example:

- the MIDREX-process (shaft furnace) [KORF ENGIN., pamphlet 1983]
- the SL-RN-process (rotary kiln) [RANGEL, SCHNABEL, a.o. 1983]

Depending upon the production costs, the sponge iron produced could be sold on the free market as a scrap substitute or could be converted to liquid steel in a further process step inside the mini-mill itself. To perform the smelting operation, which requires external energy, either electrical energy (e.g. electric arc furnace) or coal (e.g. in a melting converter) could be used. The quality steel produced after refining will be cast in continuous casting units to the desired steel profiles.

The annual production capacity of a mini-steel-mill could vary between 100.000 and 1 Mill. t of liquid steel depending upon the local or export demand. The specific investment cost of such a mini-mill will be lower than that of a conventional mill on the basis of blast furnace-steel converter route [ULRICH, JANSSEN, 1983].

Mini-mills could be erected everywhere, where cheap energy and raw materials e.g. iron ore are abundantly available.

D.5.2 IRON PROCESSING METHODS FOR THEIR APPLICATION IN THE REPUBLIC OF NIGER

The yearly demand for raw steel in the Republic of Niger is estimated to be about 100.000 t. For this capacity it is advantageous to consider the erection of a mini-mill on the basis of either direct- or smelting reduction process. Since it is known that the Republic of Niger does not possess any proved resources of natural gas, one can rule out the possibility of applying any one of the classical direct reduction processes as for example the MIDREX- or the HYL-process [PRICE, DOMINGUEZ, 1983]. For these processes the required reducing gas CO and H_2 is produced by the cracking of natural gas (CH_4).

Besides these, there are other direct reduction processes applying coal or coke as reducing agent as for example, the SL-RN-process of the KRUPP-Codir-Process. According to these processes, iron ore pellets are reduced with coal or coke in a rotary type kiln at temperatures between 900 and 1000 °C. The iron ore pellets are reduced to sponge iron in a counter current gas flow to a metallization degree of beyond 90 %. The sponge iron will be converted in a second step in an electric arc furnace to quality steel.

The rotary kiln processes are suitable for their application to use cheap and low quality coals as reducing agent. One plant of this type with a nominal capacity of 30.000 t per year of sponge iron is operating since 1981 near KOTHAGUDEM, INDIA [RANGEL, SCHNABEL, a.o. 1983]. This plant, which was financially supported by UNIDO, VIENNA, Austria, was supplied, erected and commissioned by the LURGI CHEMIE und HÜTTENTECHNIK GmbH, Frankfurt/Main, Germany. The design and operation of the plant are simple. Similar mini-plants could be erected in all developing countries, which do not possess a steel industry till now and which wish to industrialise on the basis of indigenous raw materials.

The principle of a SL-RN-rotary kiln plant is shown in fig. D-10.

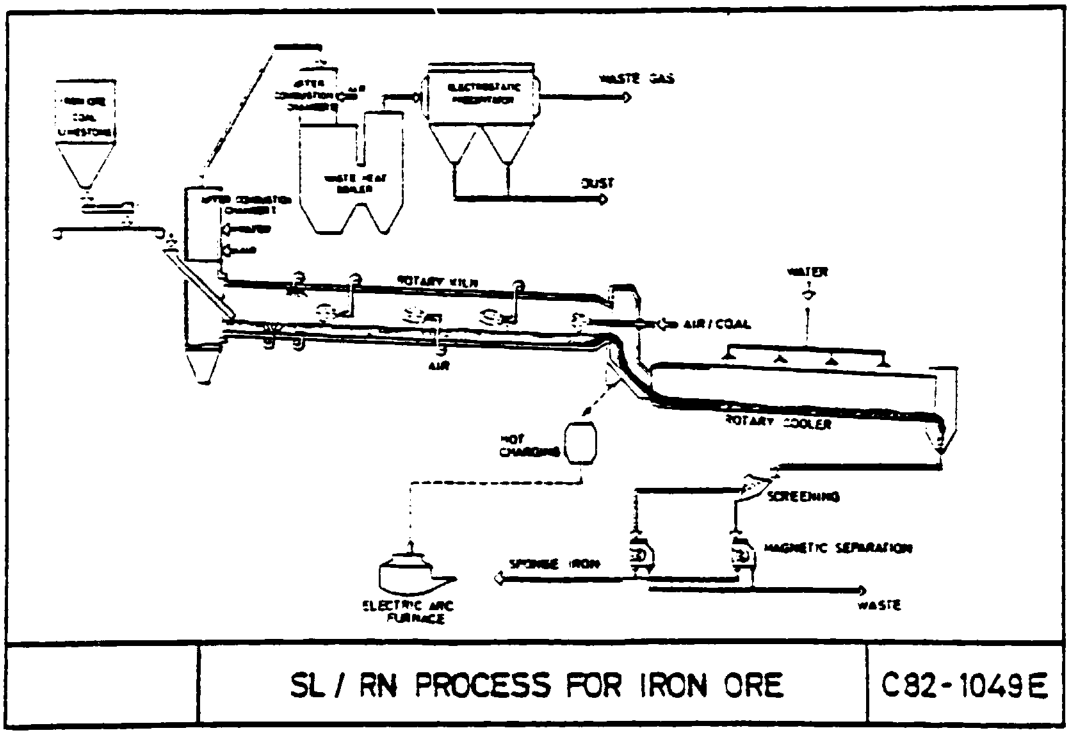


Fig. D-10: Process lay-out of a SL-RN-direct reduction plant.

Another possible application for a mini-mill in the Republic of Niger could be the recently developed smelting reduction processes. Among many developments in this field, which are already mentioned in chapter D.3.3, the KR-process is the only one which can be applied on an industrial scale. Similar to the SL-RN-process, the KR-process is also suitable for using low-grade, non-coking coals as a heat supplier and as a gas producing agent.

A semi-industrial KR-unit is operating discontinously since 1981 in Kehl, Germany, with a maximal capacity of 60.000 t per year of pig iron. The rights for commercialisation of industrial scale KR-units are in the possession of Messrs. KORF-ENGINEERING GmbH, Düsseldorf, Germany and Messrs. VOEST-ALPINE AG, Linz, Austria [KORF ENGIN.pamphlet, 1984].

The KR-process principle is simple. The main units resemble a devided blast furnace (see process flowsheet, fig. D-11) and comprise a smelting gasifier unit (1) and reduction shaft furnace unit (2).

Hot sponge iron from (2) will be continuously smelted to pig iron in the smelting gasifier unit (1) by means of excess heat generated through partial oxidation of coal. The coal with a size grading of 0 to 30 mm is introduced into the smelting gasifier via a coal bin (3) and gasified with oxygen in a fluidised bed. The fluidised bed of coal is formed in the upper empty part of the smelting gasifier. The reducing gas produced from the gasification of coal contains 95 % CO and H_2. The smelting gasifier plays the role of a blast furnace hearth, where coke will be gasified with hot blast and the prereduced iron-ore from the shaft will be smelted to liquid pig iron.

The reduction shaft furnace unit (2) is located just above the smelting gasifier and is equipped with screw conveyor for hot discharge of sponge iron. The hot reducing gas from the smelting gasifier unit is directed into the reduction shaft furnace via a hot gas cyclone (4) for dedusting and a gas cooler (5). By means of this reducing gas, the iron ore pellets charged at the top of the shaft furnace will be reduced to sponge iron in a counter current gas flow.

The exhaust gas from the reduction shaft furnace passes through a gas cooler (6) and is subsequently cleaned. This gas with a net calorific value of 8400 kJ per Nm^3 can be considered as an export gas and can be used for power generation, O_2-production etc. outside the battery limits of the KR-plant.

The pig iron produced at the bottom part of the smelting gasifier can be refined in following process steps (in ladles, in O_2-converters etc.) to quality steel practically free of sulphur and phosphorus. The liquid steel can be subsequantly cast to billets in a continuous casting plant.

According to the present status of development of the KR-process, single KR-moduls with capacities up to 300.000 t/a of pig iron can be installed.

KR PLANT

BASIC FLOW SHEET

LEGEND / LEGENDE :

1 MELTER GASIFIER
EINSCHMELZVERGASER
INSTALLATION DE GAZEIFICATION PAR FUSION

2 REDUCTION SHAFT FURNACE
REDUKTIONSOFEN
FOUR A REDUCTION

3 COAL FEED BIN
KOHLE - AUFGABEBUNKER
TREMIE D'ALIMENTATION DE CHARBON

4 HOT DUST CYCLONE
HEISSZYKLON
DEPOUSSIEREUR

5 GAS COOLER
GASKÜHLER
REFROIDISSEUR DE GAZ

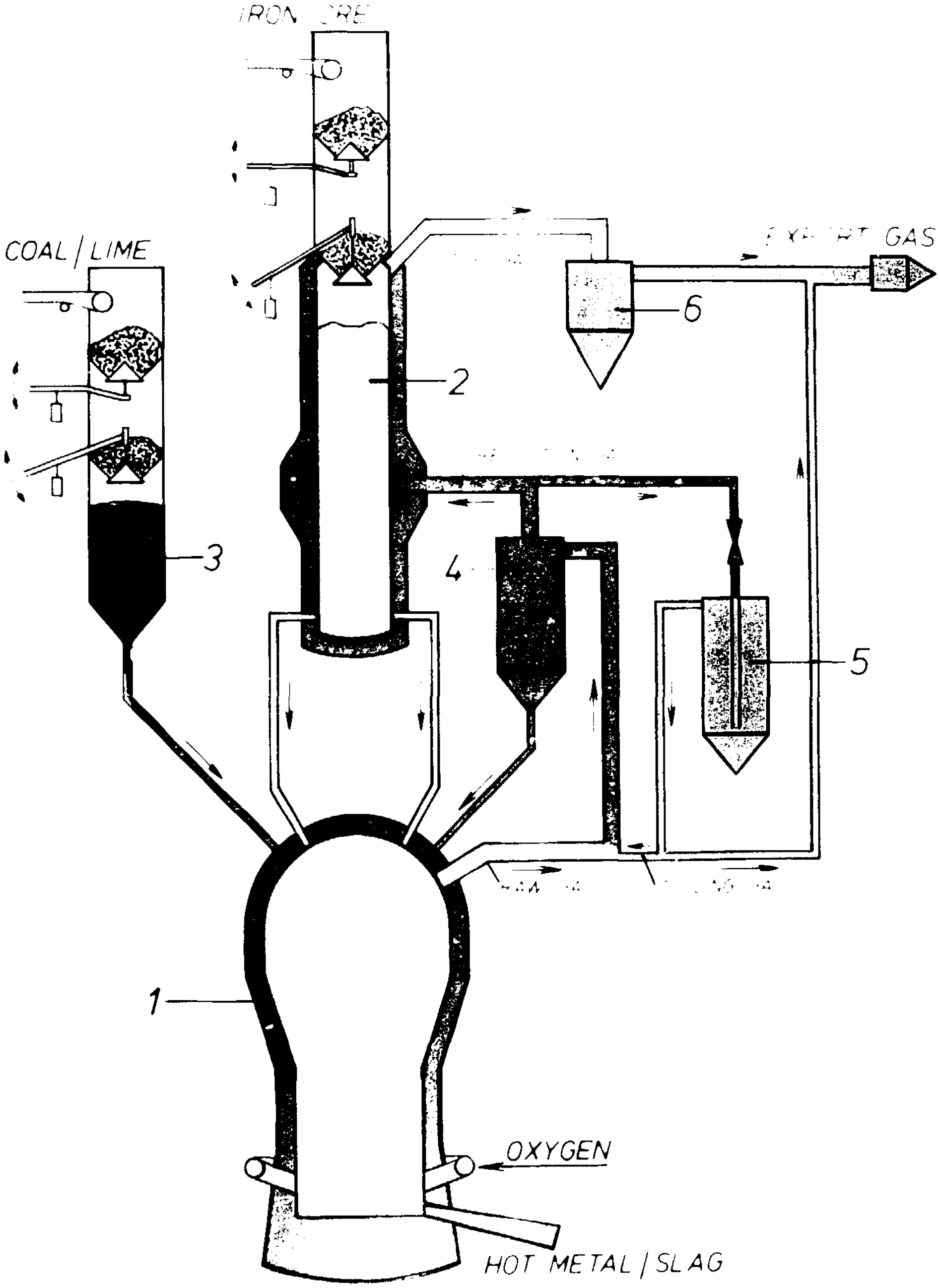
6 TOP GAS COOLER
GICHTGASKÜHLER
REFROIDISSEUR DU GAZ DE GUEULARD

SECTION 1

R FUSION

ON

ARD



KR PLANT

BASIC FLOW SHEET

SECTION 2

D.5.3 THE BEHAVIOUR OF PHOSPHORUS IN IRON ORE PELLETS DURING THE SMELTING PROCESS

Under strongly reducing conditions which prevail in a smelting unit such as blast furnace, direct reduction or smelting reduction units, the phosphorus contained in the ore or pellets is largely absorbed by the liquid iron or sponge iron respectively.

During the smelting process, phosphorus in the form of P_2O_5 in the ore or pellets is completely reduced with carbon, CO or even through liquid iron according to following reactions:

$$P_2O_5 + 5\ C \qquad 2\ [P] + 5\ CO$$

$$P_2O_5 + 5\ CO \qquad 2\ [P] + 5\ CO_2$$

$$P_2O_5 + 5\ Fe \qquad 2\ [P] + 5\ (FeO)$$

The reduced phosphorus will be mostly dissolved in the iron as iron phosphide $[Fe_3P]$ according to:

$$3\ [Fe] + [P] \qquad Fe_3P$$

The dephosphorization of iron is only possible in a subsequent process step, where the essential metallurgical conditions for a successful dephosphorization of the iron are maintained. This aspect is discussed in the succeeding chapter.

D.5.4 POSSIBILITIES FOR PHOSPHORUS REMOVAL FROM PIG IRON OR SPONGE IRON DURING REFINING TO STEEL

It is well known to iron metallurgists that the oxidation of metalloids like Si, Mn, P etc. during steel making depends primarily from the formation of ferrous oxide (FeO) in the slag. Ferrous oxide forms during the refining of the iron melt with air, oxygen-enriched air or pure oxygen. The ferrous oxide formed reacts with P or Fe_3P dissolved in iron melt to form (P_2O_5) according to:

$$5\ [FeO] + 2\ [P] \qquad (P_2O_5) + 5\ [Fe]$$

$$5\ [FeO] + 2\ [Fe_3P] \qquad (P_2O_5) + 11\ [Fe]$$

As a primary reaction product from phosphorus oxidation, the formation of iron phosphate according to the reaction:

$$3\,[FeO] \;+\; 5\,[O] \;+\; 2\,[P] \quad (3\,FeO\,.\,P_2O_5)$$

is also possible. Under the conditions prevailing in a steel converter both P_2O_5 as also iron phosphate are unstable. Therefore it is necessary that these reaction products are stabilised in a basic slag having a high CaO activity. This can be achieved by blowing lime and/or dolomite powder into the melt during the refining period.

P_2O_5 is bound by the CaO slag according to:

$$2\,[P] \;+\; 5[O] + 3\,[CaO]\;(3\,CaO.P_2O_5)$$

$$2\,[P] \;+\; 5[O] + 4\,[CaO]\;(4\,CaO.P_2O_5.$$

The metallurgical conditions necessary for a successful dephosphorization of the steel melt can be summarised as follows:

- Increasing the (FeO)-activity of the slag for the oxidation of dissolved phosphorus in the melt.

- Adjusting the slag composition to be strongly basic (high CaO and low SiO_2 values in the slag) to increase the phosphorus in-take capacity of the slag

- low bath temperatures to improve the phosphorus distribution between the metal and the slag

- low P_2O_5-content of the slag to reduce the P-activity and to improve the P-transfer from the metal into the slag.

For the evaluation of the steel making slags as regards to their dephosphorization capacity, the important criteria are the basicity index expressed as the molar ratio of basic to acidic components of the slag and the oxygen potential expressed by the ferrous oxide activity in the slag.

An increase in the slag quantity per t of steel has a positive effect on the dephosphorization of the metal because in this case the P_2O_5 content of the slag will be decreased. A similar effect has also the two-slag practice (removal of the primary slag after the oxidation period and formation of a secondary slag during the refining period) which is commonly employed in the electric arc furnace refining of steel.

The phosphorus content of the produced steel depends also on the type of steel making process employed. The BESSEMER-process of the past, whereby air or O_2-enriched air is blown into the melt through bottom tuyeres, is best suited for the dephosphorization of phosphorus-rich pig iron.

The basic Bessemer slags contain 15 - 20 % P_2O_5 with a CaO-content of 45 - 50 % and can be used as fertilizers.

The Bessemer process is practically substituted by more modern steel making practices like for example, the Q-BOP-, the LD- (LDAC-) or the basic electric arc furnace process.

The Q-BOP-process, just like the Bessemer process, is particularly suited to refine phosphorus-rich pig irons. In this process, the dephosphorization conditions in the melt are much improved when compared with the Bessemer process through the injection practice of the lime powder together with oxygen in the form of a oxygen-lime-suspension through the bottom tuyeres. The turbulent melt leads to new reaction surfaces, thereby intensifying the decarburization and dephosphorization rates. Both C - and P - oxidation run parallel to each other. Just as in Bessemer practice, the by-product slag which is rich in P_2O_5 content, can be used as a fertilizer. The lime consumption is definitely lower than in the case of LD- or LDAC-process.

Through [illegible]oining the Q-BOP-process with the two-slag practice mentioned above, it is possible to refine phosphorus-rich pig irons containing up to 1.6 % P to low-phosphorus steels containing about 0.015 % phosphorus [BROTZMANN, LANKFORD, a.o., 1976].

In the last few years further advances were made in the steel making practice to produce ultra-pure steels for special purposes. By using the so-called 'combined-blowing'-practice, it is possible to refine steel to very low phosphorus contents below 0.01 % P. In this practice the refining gas oxygen along with lime powder and purging gases like N_2, Ar, CO, CO_2 etc. are blown into the steel converter through lances from the top and through bottom tuyeres into the melt (JAPANESE PATENT).

From the broad description given in this chapter, it can be seen that there are many metallurgical possibilities to produce quality steels from phosphorus-rich pig iron which is attained through smelting phosphorus-rich iron ores of the Republic of Niger. To examine which type of steel making process is best suited to obtain the desired steel qualities is not a scope of this study and should be investigated in detail as a separate project.

Part E

Conclusions and Perspectives

E. CONCLUSIONS DRAWN AND PERSPECTIVES AS TO UTILIZATION OF THE IRON ORES OF SAY IN THE REPUBLIC OF NIGER

The objective of the present 'Preliminary study of the iron ore deposits at Say' has been to establish those technical economic data and parameters that were to serve as a basis of a prefeasibility or a feasibility study as suggested by RIDDEL and COHEN in 1978.

Although going beyond the limits of a preliminary study we are adding below some considerations and conclusions regarding further evaluation and utilization of the iron ores existing in Niger.

E.1 IRON AND STEEL DEMAND IN NIGERIA, THE REPUBLIC OF NIGER AND IN NEIGHBOURING COUNTRIES

In their report NNJC/02/78 RIDDEL and COHEN requested to ascertain the iron and steel requirements of Nigeria, the Republic of Niger and several neighbouring countries and they recommended to have this task transferred to members of NNJC.
It is not known to us whether these facts and statistic particulars have already been collected. Our considerations are based on statistic data originating from different years as well as on information from the press.
Hence, they are incomplete and can only give an idea of the order of magnitude of demand for and production of iron and steel.

Niger

Since the Republic of Niger does not have its own steel or iron production, the quantities imported of these materials correspond to the local consumption.

The consumption figures for iron and steel in the Republic of Niger have been available for the years 1975, 1976, 1977 (partly) and 1981:

Year	Qty. in t	Value
1975	7,707	FCFA 1,150,000,000
1976	17,273	US $ 6,230,000
1977 (5 months)	7,275	FCFA 1,338,000,000
1981	12,994	US $ 8,634,000

The above quantities cover the various classes of goods, such as flat rolled steel and sheet, hot rolled bars, sectional steels, wires, pipes/tubes, shaped products, etc. The demand for these products is subject to similar pronounced fluctuations during the various years as the overall demand for iron and steel products in Niger.
The figures available show a maximum annual demand of 20,000 t of iron and steel in Niger.

No statistical data are at hand for the neighbouring countries (Upper Volta, Tschad, Mali). Assuming a similar per capita consumption of iron and steel as in Niger, the aggregate demand of these countries should be near 80,000 t/year.

Nigeria

Altough no statistical data in quantities were available regarding the iron and steel imports into Nigeria, corresponding values were given in US-Dollars. These covered the imports of 1978 (US$ 709.480 mill.) and of 1979 (US$ 585.685 mill.).

The 'Steel Statistical Year Book' of the INTERNATIONAL IRON AND STEEL INSTITUTE, Brussels, published the following figures regarding iron and steel imported into and consumed in Nigeria:

Year	Imports Qty. in t	Consumption Qty. in t
1978	1 024 000	1 380 000
1979	698 000	1 025 000
1980	1 500 000	1 900 000
1981	1 400 000	1 750 000

The above figures reveal that during the years specified, some 350,000 t of steel have been produced locally per year in a smaller existing steelworks.

For covering the complete iron- and steel demand by local production, two large integrated steelworks have been under construction and commissioned resp. since 1982:

1) At Warri (Bendel State), Delta Steel Company Ltd. have been operating since 1982 a direct reduction plant of a capacity of 1,200,000 t/year of direct reduced iron. The iron ore demand of this direct reduction plant equals 1,500,000 t of iron pellets (of 66 % Fe; 0.015-0.03 % P and 0.02 % S) and lump ore to be procured from Guinea and Brazil.

2) On behalf of Ajaokuta Steel Company Ltd., a steel works of an annual capacity of 1,300,000 t of steel products is under construction at Ajaokuta (Kwara State); it is to take up operation in 1983/84. The raw material required by this plant is to be supplied from the iron ore occurrence Itakpe, discovered and examined during the last few years within the Kwara State. That deposit is said to include 200 M t of hematite and magnetite iron-ore of approx. 30 - 36 % Fe. By way of the pertinent benefication processes it can be concentrated to about 67 %, less than 0.04 % P and some 4 % SiO_2.

E.2 POTENTIAL USE OF THE IRON ORES FROM SAY IN NIGERIA AND THE REPUBLIC OF NIGER

E.2.1 EXPORT OF THE ORES

The iron ore qualities specified and requested for the steelworks in Nigeria reveal that high-grade iron-ores or pellets of Fe-contents above 65 % and P contents below 0.04 % shall be used.

High-grade ores of that type have been fully developped for mining and are available in vast deposits containing several billion tonnes in Brazil, Venezuela, Guinea, Liberia and in other countries. The 1984 prices 'cif' European port are near US$ 20-25/t for 64-68 % grading lump ore and near US$ 27-32/t for pellets.

This means that the iron-ores originating from Say/Niger will not be suitable for use as iron ores or pellets in Nigeria because of their specific composition and of a concentration of approx. 54 % Fe and some 2 % P_2O_5 attainable with the aid of benefication procedures.

Similarly, the extremely high P_2O_5 content of the ores from Niger will obstruct their being exported and used in steelworks in other countries without iron ore resources of their own.

Apart from that the long distance of the iron-ore deposits from the coast implies the drawback of particularly high transport costs.

Consequently, winning of the ores existing in the Republic of Niger for being exported can be excluded.

E.2.2 UTILIZATION AND UPGRADING OF THE ORES WITHIN THE REPUBLIC OF NIGER

The iron-ores from Say should actually be utilized in a new steelworks to be set up in the Republic of Niger. However, the capacity of that plant could only be very small. The annual steel consumption in Niger has been below 20,000 t during the last few years. Even when adding the estimated consumption of a number of neighbouring countries located far away from the coast and not having steel producing facilities of their own (such as Upper Volta, Tschad, Mali) an overall annual requirement of 80,000 - 100,000 t of steel will result, including all steel classes and products.

The maximum capacity of a steel plant in the Republic of Niger meant to cover local demands and those of the neighbouring countries thus is estimated to amount to 100,000 t/year. It has to be duly considered in this respect that no more than the most important ordinary steels, such as structural steel, sheet steel and sectional steel could be produced in that works. Because of the little demand in Niger proper and in the neighbouring states, it would definitely be uneconomic to have special steels produced as well. The steelworks and the facilities for subsequent processing have been described in detail and shown as flowsheet in para E.5 below.

E.3 REQUIREMENT, RESERVES AND WINNING OF THE IRON-ORES

E.3.1 REQUIREMENT OF IRON-ORE

Approx. 300,000 t of iron ore would have to be extracted per year for producing 100,000 t/a of steel upon upgrading the r.o.m. ore (containing some 50.5 % Fe) to a concentrate of 54 % Fe in a plant as described in para C.6 above and in para E.4 below.

E.3.2 RESERVE AREA

It is recommended to have these relatively small quantities of iron-ore won in a part of the deposit of Doguel Kaina Say, i.e.
- where an as high-grade iron-ore as possible exists
- where no overburden at all or only small quantities of overburden exist
- which is located as close to the Niger river as possible for having water available for processing.

These prerequisites are given in an area of about 3.4 km^2 (see para B 7.1 and annex B 10) south-east of Doguel Kaina where the overburden measures less than 10 m. Within this area, exploitation can initially be limited to the upper iron-ore horizon of the Oolithes Indurées. The average thickness of that horizon within this area equals 2.22 m with average Fe contents of 50.35 % and average P_2O_5 contents of 1.55 %.
The Oolithes Indurées reserves within this area equal 20.1 million t of iron-ore and would, consequently, be enough for a production period of more than 60 years at an annual production rate of 300,000 t.

E.3.3 MINING

The iron-ore will at any rate be exploited by open-pit mining. It is expected that the average ore : overburden ratio within that area equals 1 : 2.5. This means that in addition to an extraction of 300,000 t/year of iron-ore, 750,000 t/year of predominantly loose overburden will have to be removed.

Loosening and winning of the iron-ore horizon can probably be done without blasting work; it could be carried out with a crawler dozer with ripper teeth. However, a field test will have to verify whether this is feasible.

Loading of overburden material and of iron-ore can be tackled by two front-end loaders of a shovel capacity of 4.5 m^3.

As a site for the processing facility has not yet been chosen and, hence, the distance between mine and processing plant is not yet known, we have presumed a distance of 2 000 m each between mine and processing facility and between mine and overburden dumping area. These distances have to be known for calculating the number of haulage vehicles required.

Subject to the above haulage distances and to using 25 t dumpers, 7 dumpers would be needed for transporting 1 000 t of ore/working day and 2 500 t of overburden/working day.

Moreover, a wheel-mounted hydraulic impact hammer will have to be provided in the mine for secondary breaking of large ore boulders. Furthermore, a grader will be needed for road construction and maintenance.

The mine outfit needed for open pit mining of 300,000 t/a of iron-ore and of 750,000 t/a of overburden and comprising the equipments mentioned above (i.e. 'rip-dozer', front-end loader, dumpers, wheel-mounted hydraulic impact hammer and grader, as well as personnel and material vehicles) would require capital investments of US Dollar 2,200,000.-- (prices valid in Germany in 1984).

The above estimated investments do <u>not</u> include the costs of:

- spare parts for the equipment and machinery mentioned above,
- ancillary facilities, such as workshops, stores, offices and staff rooms
- infra-structural measures.

The above figures are a rough estimate which will have to be specified more exactly by detailed planning of working, equipment requirement and utilization. These detailed data will have to be included in a feasibility study.

E.4 PROCESSING PLANT

A production rate of 100,000 t/a of steel requires an iron ore extraction rate of approx. 300,000 t/a.

A plant for dressing this volume, i.e. for producing approx. 200,000 t of concentrate, should particularly include the following machinery:
- jaw crusher for primary crushing,
- vibrating screen for intermediate screening,
- impact crusher for secondary crushing,
- DSM- or micro-sieves for separation of the fines minus 0.5 mm
- super-scrubber (vessel- or drum-type) for removing impurities adhering to the ooliths and
- horizontal filter for dewatering the concentrate.

From the actual point of view, it is estimated that a capital investment of US Dollar 3.0 - 3.5 mill. will be required for setting up this processing plant, completely equipped with the necessary intermediate transportation facilities and electrical equipment, the auxiliary and secondary sections.

The plant can be operated with a labour force of 45 - 50 staff members. The water requirement will equal approx. 60 m^3/h, of which approx. 20 m^3/h can be utilized in a recycling circuit. Thus, 40 m^3/h of fresh water will have to be taken from the Niger river.

The period from erection of the processing plant until going into production will take 24 - 28 months, as from the date of order placing.

At first, however, detailed investigation for exactly dimensioning the machinery, for assessing the conditions relating to the infrastructure and for fixing a location of the plant, will have to be carried out for the purposes of a feasibility study.

E.5 CONCEPT OF A MINI-SMELTER FOR THE PRODUCTION OF STEEL IN THE REPUBLIC OF NIGER

The demand for steel and iron products in the Republic of Niger and neighbouring countries has been estimated in para E.3.1 above to equal approx. 100,000 t/year.

These steel quantities can be produced in a mini smelter comprising the following process operations which latter have to be designed for the appropriate capacities (fig. E-1).

A continuous casting facility and a rolling mill will have to be set up downstream the steel converter. The most important steel products required in the Republic of Niger will have to be produced in that rolling mill; these are structural steel, sectional steels and sheet steels.

The capital expenditure involved in a mini smelter of that type and having an annual production capacity of 100,000 t will be in an order of magnitude of US Dollar 60 to 80 million for a green-field site (not including infra-structural measures).

The above concept and the figures quoted are pure estimates which will have to be carefully verified under a separate feasibility study.

The total investments for equipment and installations for mining, processing plant and smelter plant of the iron-ores of Say for producing 100,000 t/a of steel and iron are estimated to be in the range of US Dollar 66 to 85 million not including infra-structural measures, building of ancillary facilities, etc.

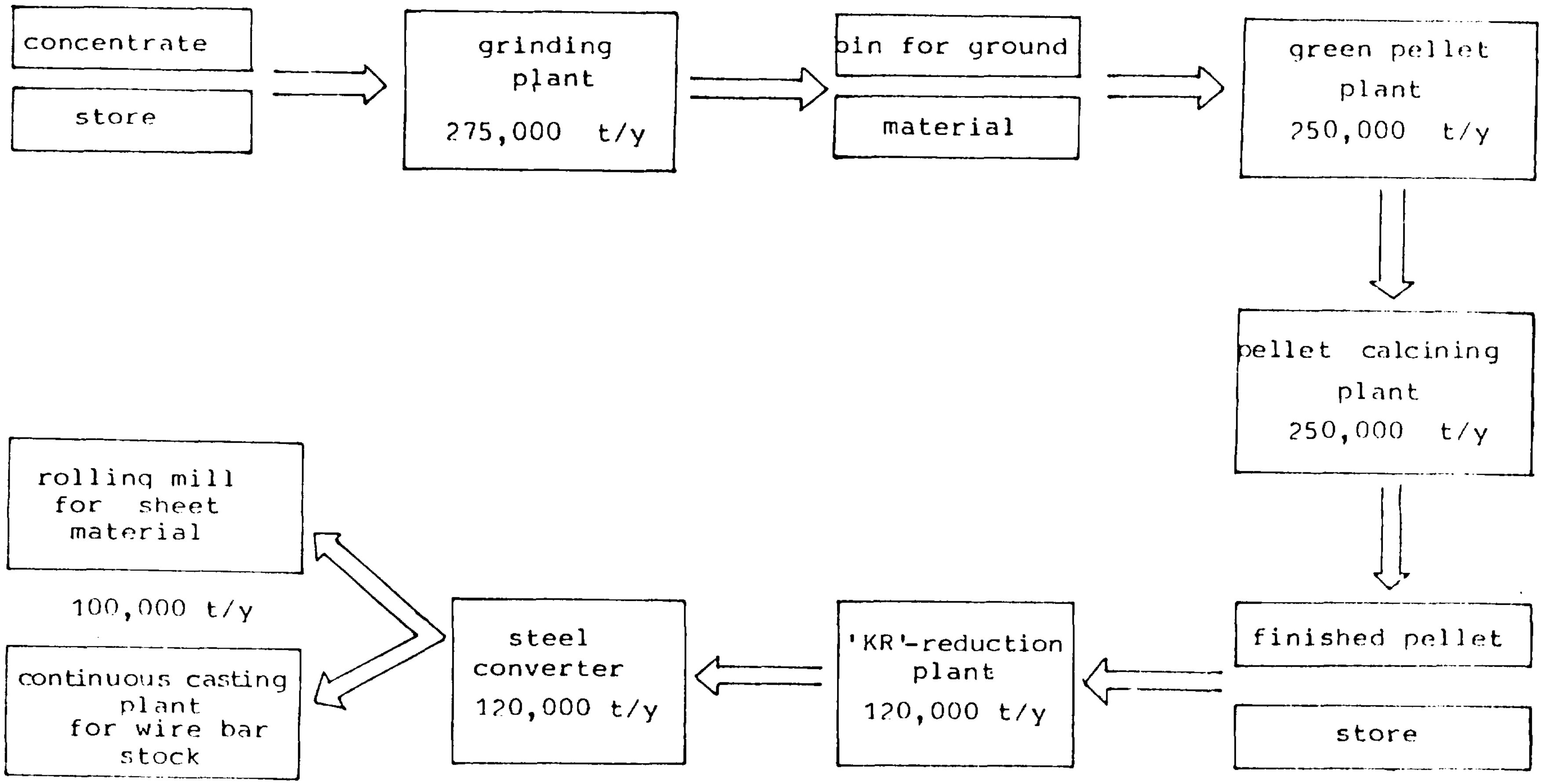


Fig. E 1: Conception for a mini-mill and steelworks in the Republic of Niger

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C.2	Graph of the screen analysis of sample 1, ROM
C.3	Summary of screen analysis, sample 1
C.4	Screen analysis sample 2, ROM, with chem. analyses
C.5	Graph of screen analysis sample 2, ROM
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C.7	Crushing by means of hammer crusher, sample 1
C.8	Graph of screen analysis
C.9	Summary of fractions
C.10	Summary of fractions
C.11	Crushing by means of hammer crusher, sample 2
C.12	Graph of the screen analysis
C.13	Summary of fractions
C.14	Summary of fractions
C.15	Sample 1, attrition for 5 minutes
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C.42	Samples 1 and 2 (1:2) test, material minus 0.1 mm, 1.0 Tesla,
C.43	Sample 1 - Jones test, minus 0.1 mm, incl. 1.5 Tesla
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C.45	Samples 1 and 2 (1:2) minus 0.1 mm, incl. 1.5 Tesla
C.46	Samples 1 and 2 (1:2), minus 0.1 mm, incl. 1.2 Tesla
C.47	Sample 1 and 2, flowsheet for concentrate production for supplementary tests

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C 1

Probe, sample, echantillon 1

iron ore/minerai de fer
Niger

Rohmaterial, raw material, matiere premiere

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	SiO2 content teneur %	SiO2 m%*c% m%*t%	SiO2 recov debit %	P2O5 content teneur %	P2O5 m%*c% m%*t%	P2O5 recov debit %
1.: >80 mm	2.09	52.660	110.06	2.22	5.110	10.68	1.29	2.030	4.24	2.57
2.: 80-60 mm	10.47	52.460	549.26	11.07	5.320	55.70	6.73	1.990	20.84	12.62
3.: 60-40 mm	20.83	53.890	1122.53	22.61	4.560	94.98	11.47	1.670	34.79	21.07
4.: 40-20 mm	23.11	50.760	1173.06	23.63	6.920	159.92	19.31	1.760	40.67	24.64
5.: 20-10 mm	9.20	50.820	467.54	9.42	8.100	74.52	9.00	1.550	14.26	8.64
6.: 10- 8 mm	0.70	48.640	34.05	0.69	10.660	7.46	0.90	1.670	1.17	0.71
7.: 8- 5 mm	2.09	50.000	104.50	2.11	9.750	20.38	2.46	1.660	3.47	2.10
8.: 5- 3 mm	1.48	48.090	71.17	1.43	10.350	15.32	1.85	1.470	2.18	1.32
9.: 3- 2 mm	2.12	49.530	105.00	2.12	7.950	16.85	2.04	1.700	3.60	2.18
10.: 2- 1 mm	13.21	49.940	659.71	13.29	6.350	83.88	10.13	1.550	20.48	12.40
11.: 1- 0,5 mm	7.72	46.040	355.43	7.16	10.820	83.53	10.09	1.610	12.43	7.53
12.: < 0.5 mm	6.98	30.280	211.35	4.26	29.350	204.86	24.74	1.000	6.98	4.23
feed/alimentation	100.00	49.637* 48.840	4963.67	100.00	8.281* 8.130	828.09	100.00	1.651* 1.680	165.10	100.00

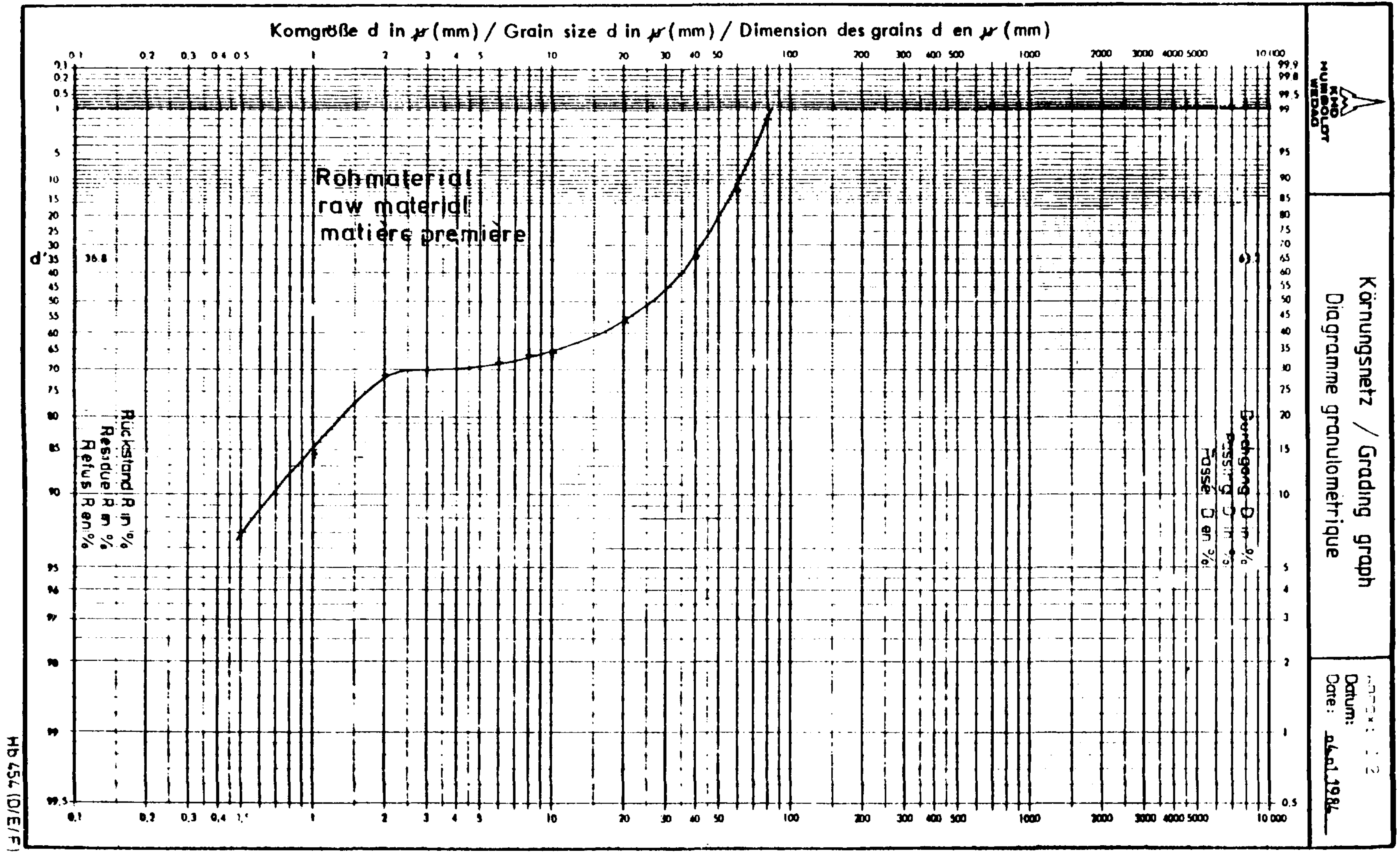
remarks/remarques:
* = calculated values / valeurs calculees

C 1

Stoff: Eisenerz
Material: iron ore Probe 1
Produit: minerai de fer

Firma:
Customer:
Client:

Maschine:
Machine:
Appareil:



KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

Probe, sample, echantillon 1
Rohmaterial, raw material, matiere premiere

annex/annexe: C 3

iron ore/minerai de fer
Niger

product produit	mass masse		Fe			SiO2			P2O5		
	%	V/O%	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
>80 mm		2.09	52.660	110.06	2.22	5.110	10.68	1.29	2.030	4.24	2.57
80-60 mm	11.51	10.47	52.460	549.26	11.07	5.320	55.70	6.73	1.990	20.84	12.62
60-40 mm	22.91	20.83	53.890	1122.53	22.61	4.560	94.98	11.47	1.670	34.79	21.07
40-20 mm	25.42	23.11	50.760	1173.06	23.63	6.920	159.92	19.31	1.760	40.67	24.64
20-10 mm	10.12	9.20	50.820	467.54	9.42	8.100	74.52	9.00	1.550	14.26	8.64
10- 8 mm	0.77	0.70	48.640	34.05	0.69	10.660	7.46	0.90	1.670	1.17	0.71
8- 5 mm	2.30	2.09	50.000	104.50	2.11	9.750	20.38	2.46	1.660	3.47	2.10
5- 3 mm	1.63	1.48	48.090	71.17	1.43	10.350	15.32	1.85	1.470	2.18	1.32
3- 2 mm	2.33	2.12	49.530	105.00	2.12	7.950	16.85	2.04	1.700	3.60	2.18
2- 1 mm	14.53	13.21	49.940	659.71	13.29	6.350	83.88	10.13	1.550	20.48	12.40
1- 0,5 mm	8.49	7.72	46.040	355.43	7.16	10.820	83.53	10.09	1.610	12.43	7.53
80-0,5mm	100.00	90.93	51.053*	4642.25	93.52	6.737*	612.55	73.97	1.692*	153.88	93.20
< 0.5 mm		6.98	30.280	211.35	4.26	29.350	204.86	24.74	1.000	6.98	4.23
feed/alimentation		100.00	49.637*	4963.67	100.00	8.281*	828.09	100.00	1.651*	165.10	100.00
			48.840			8.130			1.680		

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C 4

Probe, sample, echantillon 2

iron ore/minerai de fer
Niger

Rohmaterial, raw material, materie premiere

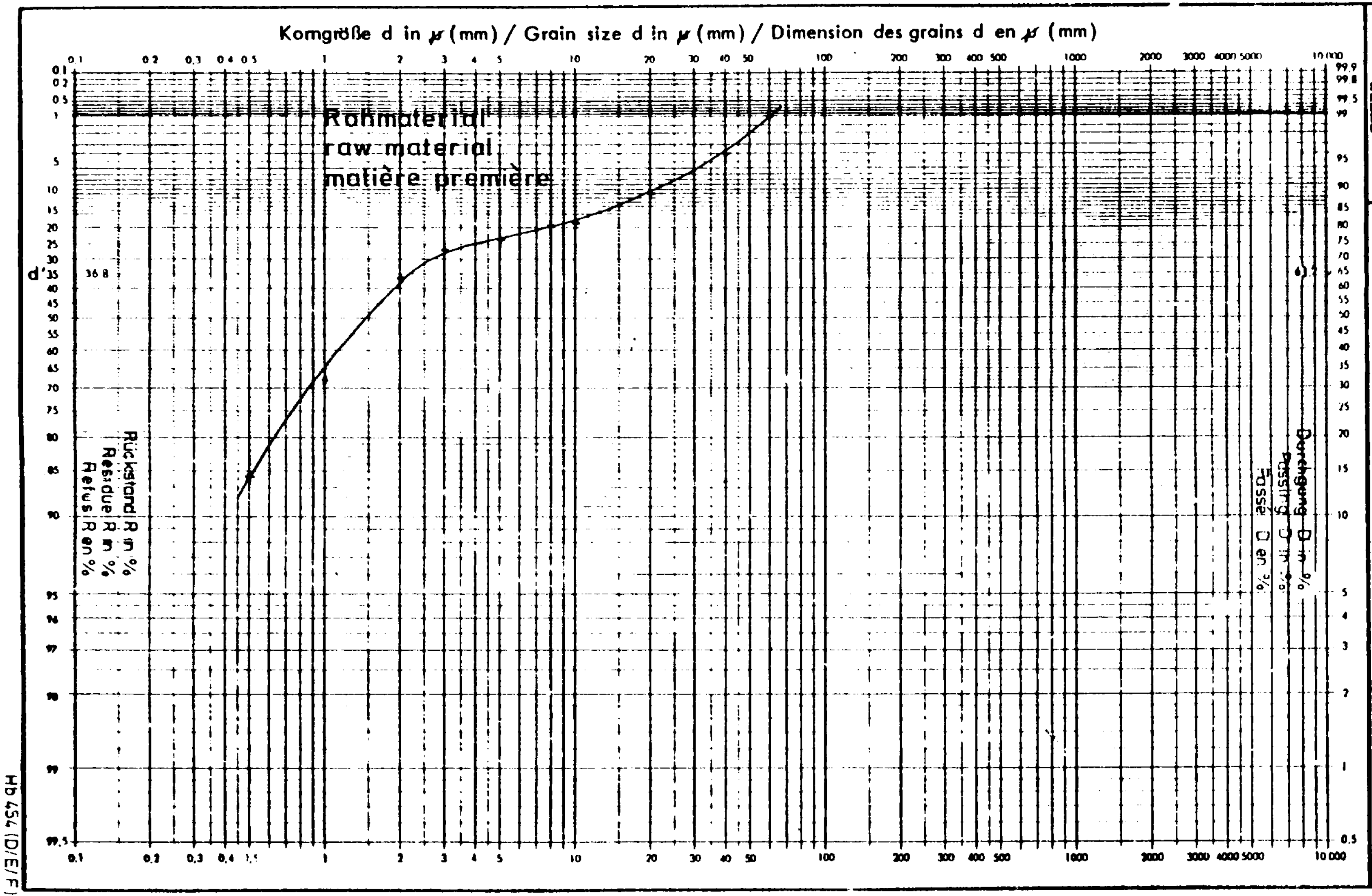
product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	SiO_2 content teneur %	SiO_2 m%*c% m%*t%	SiO_2 recov debit %	P_2O_5 content teneur %	P_2O_5 m%*c% m%*t%	P_2O_5 recov debit %
1.:)60 mm	1.03	42.550	43.83	1.03	17.480	18.00	1.04	1.200	1.24	1.22
2.: 60-40 mm	3.14	44.940	141.11	3.30	14.470	45.44	2.62	0.120	0.38	0.37
3.: 40-20 mm	6.90	41.800	288.42	6.75	17.790	122.75	7.07	1.130	7.80	7.69
4.: 20-10 mm	7.25	41.660	302.03	7.07	18.500	134.13	7.72	1.040	7.54	7.44
5.: 10- 8 mm	1.28	40.160	51.40	1.20	20.890	26.74	1.54	0.150	0.19	0.19
6.: 8- 5 mm	3.79	40.230	152.47	3.57	21.130	80.08	4.61	0.680	2.58	2.54
7.: 5- 3 mm	3.55	42.620	151.30	3.54	17.990	63.86	3.68	1.590	5.64	5.57
8.: 3- 2 mm	10.12	50.120	507.21	11.87	8.650	87.54	5.04	1.500	15.18	14.97
9.: 2- 1 mm	31.23	50.060	1563.37	36.58	7.900	246.72	14.20	1.040	32.48	32.04
10.: 1- 0.5 mm	17.55	43.640	765.88	17.92	17.190	301.68	17.36	1.220	21.41	21.12
11.: (0.5 mm	14.16	21.630	306.28	7.17	43.110	610.44	35.14	0.490	6.94	6.84
feed/alimentation	100.00	42.733*	4273.32	100.00	17.374*	1737.38	100.00	1.014*	101.37	100.00
		40.450			17.700			1.040		

remarks/remarques:
* = calculated values / valeurs calculees

Stoff: Eisenerz
Material: iron ore Probe 2
Produit: minerai de fer

Firma:
Customer:
Client:

Maschine:
Machine:
Appareil:



KHD HUMBOLDT WEDAG

Körnungsnetz / Grading graph
Diagramme granulométrique

Annex:
Datum:
Date: 24.01.1984

Hb 454 (D/E/F)

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique
Niger
Probe, sampel, echantillon 2
Rohmaterial, raw material, materie premiere

annex/annexe: C 6

iron ore/minerai de fer
Niger

product produit	mass masse %	 V/0%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P205 content teneur %	 m%*c% m%*t%	 recov debit %
)60 mm	1.20	1.03	42.550	43.83	1.03	17.480	18.00	1.04	1.200	1.24	1.22
60-40 mm	3.66	3.14	44.940	141.11	3.30	14.470	45.44	2.62	0.120	0.38	0.37
40-20 mm	8.04	6.90	41.800	288.42	6.75	17.790	122.75	7.07	1.130	7.80	7.69
20-10 mm	8.45	7.25	41.660	302.04	7.07	18.500	134.13	7.72	1.040	7.54	7.44
10- 8 mm	1.49	1.28	40.160	51.40	1.20	20.890	26.74	1.54	0.150	0.19	0.19
8- 5 mm	4.42	3.79	40.230	152.47	3.57	21.130	80.08	4.61	0.680	2.58	2.54
)60-5mm	27.25	23.39	41.867*	979.27	22.92	18.262*	427.14	24.59	0.843*	19.72	19.45
5- 3 mm	4.14	3.55	42.620	151.30	3.54	17.990	63.86	3.68	1.590	5.64	5.57
3- 2 mm	11.79	10.12	50.120	507.21	11.87	8.650	87.54	5.04	1.500	15.18	14.97
2- 1 mm	36.38	31.23	50.060	1563.37	36.58	7.900	246.72	14.20	1.040	32.48	32.04
1- 0.5 mm	20.45	17.55	43.640	765.88	17.92	17.190	301.68	17.36	1.220	21.41	21.12
5-0,5mm	72.75	62.45	47.843*	2987.77	69.92	11.206*	699.80	40.28	1.196*	74.71	73.70
)60-0,5 mm	100.00	85.84	46.214*	3967.04	92.83	13.128*	1126.94	64.86	1.100*	94.43	93.16
(0.5 mm		14.16	21.630	306.28	7.17	43.110	610.44	35.14	0.490	6.94	6.84
feed/alimentation		100.00	42.733* 40.450	4273.32	100.00	17.374* 17.700	1737.38	100.00	1.014* 1.040	101.37	100.00

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C 7

Probe, sample, echantillon 1
Zerkleinerung, crushing, consassage
Hammermuehle, hammer mill, broyeur a marteaux

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
1.:) 5 mm	1.32	50.880	67.16	1.35	8.800	11.62	1.44	0.820	1.08	0.66
2.: 5 - 3 mm	3.28	51.220	168.00	3.37	9.420	30.90	3.83	1.510	4.95	3.01
3.: 3 - 1 mm	34.21	52.560	1798.08	36.12	5.490	187.81	23.29	2.000	68.42	41.53
4.: 1 - 0.5 mm	32.51	52.120	1694.42	34.04	5.610	182.38	22.61	1.310	42.59	25.85
5.: 0.5- 0.3 mm	13.09	48.160	630.41	12.66	9.600	125.66	15.58	1.820	23.82	14.46
6.: 0.3- 0.1 mm	10.82	41.980	454.22	9.12	15.720	170.09	21.09	1.560	16.88	10.25
7.: 0.1- 0.063 mm	2.24	36.010	80.66	1.62	20.570	46.08	5.71	1.400	3.14	1.90
8.: (0.063 mm	2.53	33.660	85.16	1.71	20.570	52.04	6.45	1.530	3.87	2.35
feed/alimentation	100.00	49.781* 48.840	4978.12	100.00	8.066* 8.130	806.58	100.00	1.648* 1.680	164.75	100.00

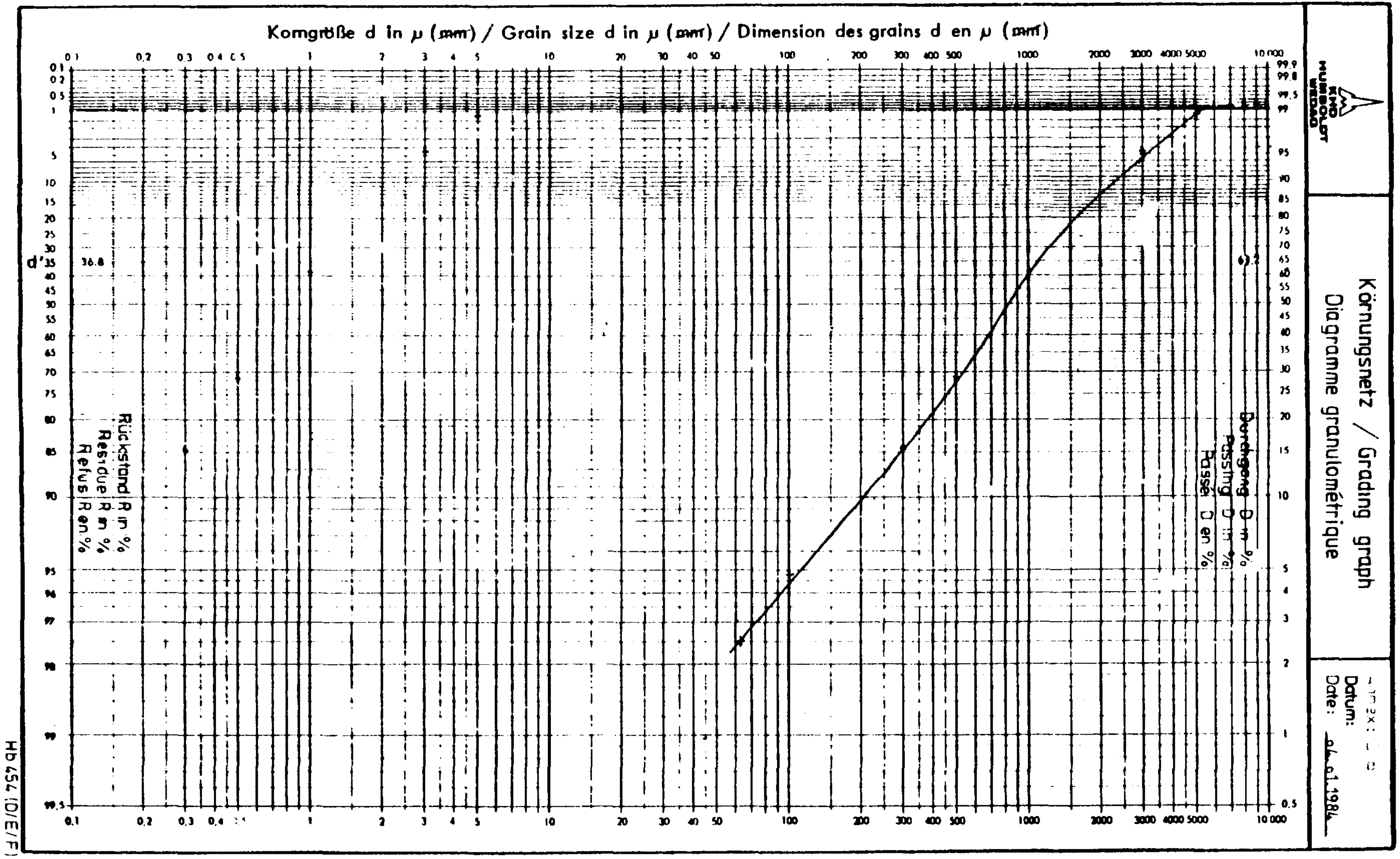
remarks/remarques:
* = calculated values / valeurs calculees

C 7

Stoff: Eisenerz
Material: iron ore Probe 1
Produit: minerai de fer

Firma:
Customer:
Client:

Maschine: Hammermuhle
Machine: hammer mill
Appareil: broyeur a marteaux



Körnungsnetz / Grading graph
Diagramme granulométrique

Datum:
Date: 04.01.1984

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C 9

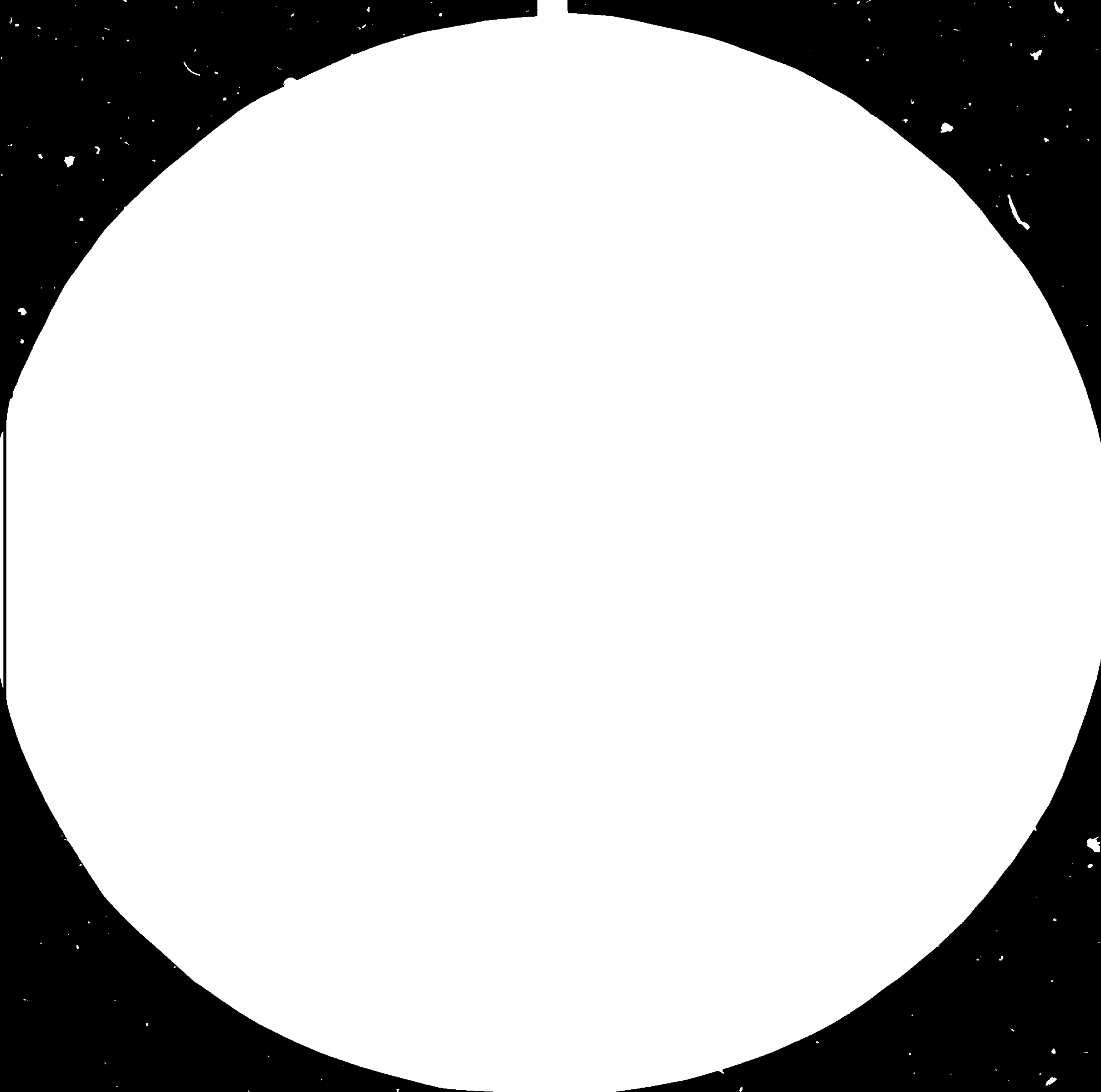
Probe, sample, echantillon 1
Zerkleinerung, crushing, consassage
Hammermuehle, hammer mill, broyeur a marteaux

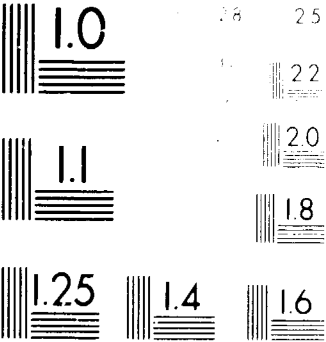
iron ore/minerai de fer
Niger

product produit	mass masse %	 V/O%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
> 5 mm		1.32	50.880	67.16	1.35	8.800	11.62	1.44	0.820	1.08	0.66
5 - 3 mm		3.28	51.220	168.00	3.37	9.420	30.90	3.83	1.510	4.95	3.01
3 - 1 mm		34.21	52.560	1798.08	36.12	5.490	187.81	23.29	2.000	68.42	41.53
1 - 0.5 mm		32.51	52.120	1694.42	34.04	5.610	182.38	22.61	1.310	42.59	25.85
0.5- 0.3 mm	54.75	13.09	48.160	630.41	12.66	9.600	125.66	15.58	1.820	23.82	14.46
0.3- 0.1 mm	45.25	10.82	41.980	454.22	9.12	15.720	170.09	21.09	1.560	16.88	10.25
0.5- 0.1mm	100.00	23.91	45.363*	1084.64	21.79	12.369*	295.75	36.67	1.702*	40.70	24.71
0.1- 0.063 mm	46.96	2.24	36.010	80.66	1.62	20.570	46.08	5.71	1.400	3.14	1.90
< 0.063 mm	53.04	2.53	33.660	85.16	1.71	20.570	52.04	6.45	1.530	3.87	2.35
< 0.1mm	100.00	4.77	34.764*	165.82	3.33	20.570*	98.12	12.16	1.469*	7.01	4.25
feed/alimentation		100.00	49.781* 48.840	4978.12	100.00	8.066* 8.130	806.58	100.00	1.648* 1.680	164.75	100.00

remarks/remarques:
* = calculated values / valeurs calculees

C 9





MICROCOPY RESOLUTION TEST CHART

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KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C III

Probe, sample, echantillon 1
Zerkleinerung, crushing, consassage
Hammermuehle, hammer mill, broyeur a marteaux

iron ore/minerai de fer
Niger

product produit	mass masse %	 V/O%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
> 5 mm	1.85	1.32	50.880	67.16	1.35	8.800	11.62	1.44	0.820	1.08	0.66
5 - 3 mm	4.60	3.28	51.220	168.00	3.37	9.420	30.90	3.83	1.510	4.95	3.01
3 - 1 mm	47.97	34.21	52.560	1798.08	36.12	5.490	187.81	23.29	2.000	68.42	41.53
1 - 0.5 mm	45.58	32.51	52.120	1694.42	34.04	5.610	182.38	22.61	1.310	42.59	25.85
> 0.5mm	100.00	71.32	52.267*	3727.66	74.88	5.787*	412.71	51.17	1.641*	117.04	71.04
0.5- 0.3 mm	45.64	13.09	48.160	630.41	12.66	9.600	125.66	15.58	1.820	23.82	14.46
0.3- 0.1 mm	37.73	10.82	41.980	454.22	9.12	15.720	170.09	21.09	1.560	16.88	10.25
0.1- 0.063 mm	7.81	2.24	36.010	80.66	1.62	20.570	46.08	5.71	1.400	3.14	1.90
< 0.063 mm	8.82	2.53	33.660	85.16	1.71	20.570	52.04	6.45	1.530	3.87	2.35
< 0.5mm	100.00	28.68	43.600*	1250.46	25.12	13.733*	393.87	48.83	1.664*	47.71	28.96
feed/alimentation		100.00	49.781* 48.840	4978.12	100.00	8.066* 8.130	806.58	100.00	1.648* 1.680	164.75	100.00

remarks/remarques:
* = calculated values / valeurs calculees

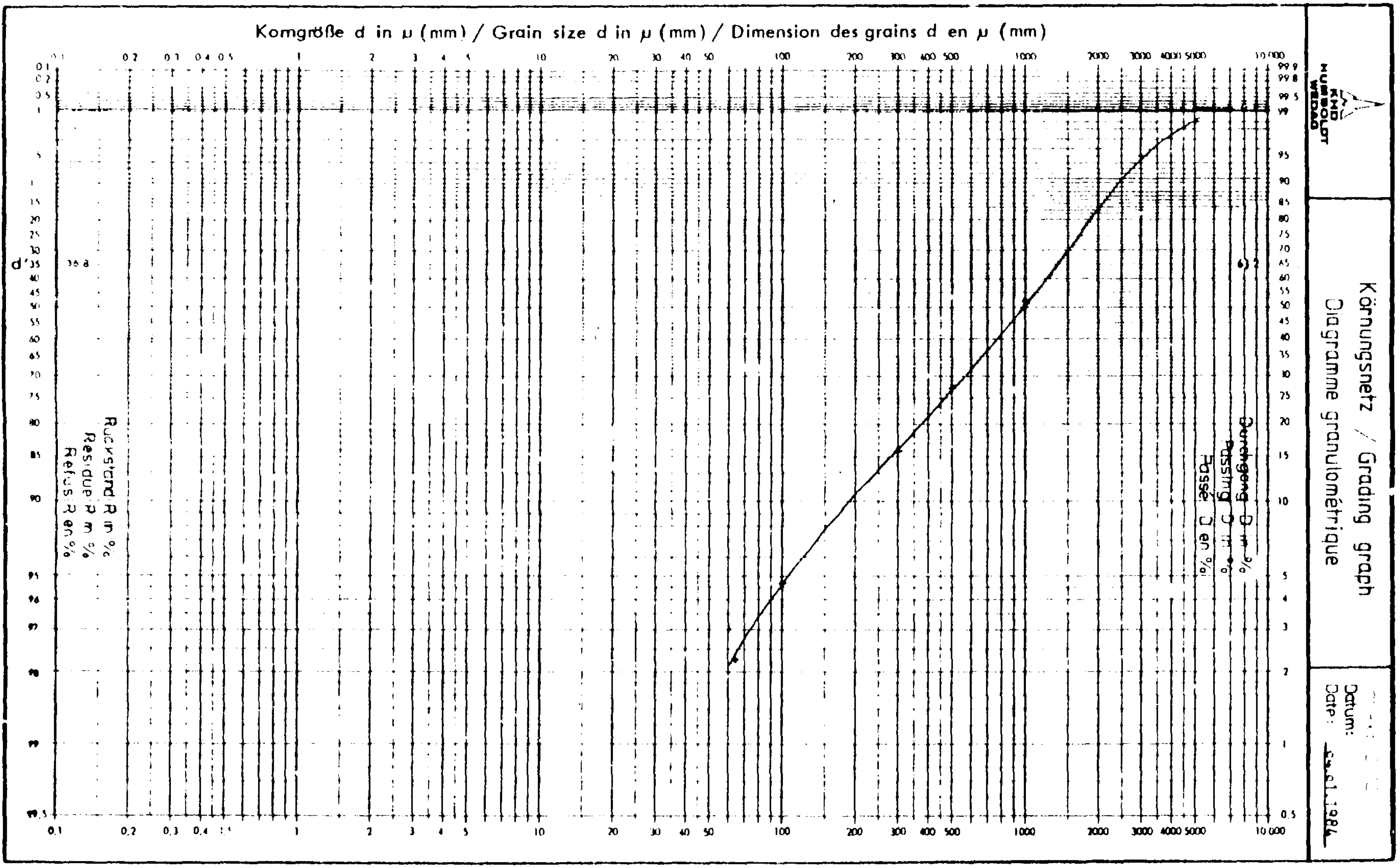
```
  KHD           Siebanalyse, screen analysis, analyse granulometrique            annex/annexe:C 11
HUMBOLDT
 WEDAG          Probe, sample, echantilion  2                                    iron ore/minerai  de fer
                Zerkleinerung, crushing, consassge                                      Niger
                     Hammermuehle, hammer mill, broyeur a marteaux

######################################################################################################
                             |          |                 Fe            |            SiO2          |             P2O5
          product            |   mass   | content  m%*c%     recov | content   m%*c%    recov | content   m%*c%    recov
          produit            |   masse  | teneur   m%*t%     debit | teneur    m%*t%    debit | teneur    m%*t%    debit
                             |    %     |  %                  %    |  %                  %    |  %                  %
######################################################################################################
 1.:     ) 5       mm        |     2.07 | 41.130    85.14    2.06 | 16.930    35.05     1.93 |  1.890      3.91     2.03
 2.: 5   - 3       mm        |     2.99 | 41.470   124.00    3.00 | 16.970    50.74     2.79 |  1.690      5.05     2.62
 3.: 3   - 1       mm        |    42.75 | 48.840 2 87.91    50.57 |  7.380   315.50    17.37 |  2.160     92.34    47.96
 4.: 1   - 0.5     mm        |    25.27 | 44.480 1124.01    27.23 | 18.190   459.66    25.30 |  2.060     52.06    27.04
 5.: 0.5- 0.3      mm        |    11.17 | 34.100   380.90    9.23 | 27.880   311.42    17.14 |  1.510     16.87     8.76
 6.: 0.3- 0.1      mm        |    11.02 | 22.200   244.64    5.93 | 41.130   453.25    24.95 |  1.730     19.06     9.90
 7.: 0.1- 0.063    mm        |     2.41 | 16.530    39.84    0.96 | 45.690   110.11     6.06 |  0.730      1.76     0.91
 8.:     ( 0.063   mm        |     2.32 | 18.100    41.99    1.02 | 34.890    80.94     4.46 |  0.640      1.48     0.77
######################################################################################################
      feed/alimentation      |   100.00 | 41.284* 4128.42 100.00 | 18.167* 1816.67  100.00 |  1.925*   192.54   100.00
                             |          | 40.450                  | 17.700                   |  1.040
######################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

Stoff: Eisenerz
Material: iron ore Probe 2
Produit: mineral de fer

Firma:
Customer:
Client:

Maschine: Hammermühle
Machine: hammer mill
Appareil: broyeur a marteaux



Körnungsnetz / Grading graph
Diagramme granulométrique

Datum:
Date: 25.01.1984

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C 13

Probe, sample, echantillon 2
Zerkleinerung, crushing, consassge
Hammermuehle, hammer mill, broyeur a marteaux

iron ore/minerai de fer
Niger

product produit	mass masse		Fe			SiO2			P2O5		
	%	V/O%	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
> 5 mm	2.83	2.07	41.130	85.14	2.06	16.930	35.05	1.93	1.890	3.91	2.03
5 - 3 mm	4.09	2.99	41.470	124.00	3.00	16.970	50.74	2.79	1.690	5.05	2.62
3 - 1 mm	58.50	42.75	48.840	2087.91	50.57	7.380	315.50	17.37	2.160	92.34	47.96
1 - 0.5 mm	34.58	25.27	44.480	1124.01	27.23	13.190	459.66	25.30	2.060	52.06	27.04
> 0,5mm	100.00	73.08	46.812*	3421.05	82.87	11.781*	860.94	47.39	2.099*	153.36	79.65
0.5- 0.3 mm	41.49	11.17	34.100	380.90	9.23	27.980	311.42	17.14	1.510	16.87	8.76
0.3- 0.1 mm	40.94	11.02	22.200	244.64	5.93	41.130	453.25	24.95	1.730	19.06	9.90
1- 0.063 mm	8.95	2.41	16.530	39.84	0.96	45.690	110.11	6.06	0.730	1.76	0.91
< 0.063 mm	8.62	2.32	18.100	41.99	1.02	34.890	80.94	4.46	0.640	1.48	0.77
< 0,5mm	100.00	26.92	26.277*	707.37	17.13	35.503*	955.73	52.61	1.455*	39.18	20.35
feed/alimentation		100.00	41.284* 40.450	4128.42	100.00	18.167* 17.700	1816.67	100.00	1.925* 1.040	192.54	100.00

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

Probe, sample, echantillon 2
Zerkleinerung, crushing, consassge
Hammermuehle, hammer mill, broyeur a marteaux

annex/annexe: C 14

iron ore/minerai de fer
Niger

product produit	mass masse %	 V/0%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
) 5 mm		2.07	41.130	85.14	2.06	16.930	35.05	1.93	1.890	3.91	2.03
5 - 3 mm		2.99	41.470	124.00	3.00	16.970	50.74	2.79	1.690	5.05	2.62
3 - 1 mm		42.75	48.840	2087.91	50.57	7.380	315.50	17.37	2.160	92.34	47.96
1 - 0.5 mm		25.27	44.480	1124.01	27.23	18.190	459.66	25.30	2.060	52.06	27.04
0.5- 0.3 mm	50.34	11.17	34.100	380.90	9.23	27.880	311.42	17.14	1.510	16.87	8.76
0.3- 0.1 mm	49.66	11.02	22.200	244.64	5.93	41.130	453.25	24.95	1.730	19.06	9.90
0.5- 0.1mm	100.00	22.19	28.190*	625.54	15.15	34.460*	764.67	42.09	1.619*	35.93	18.66
0.1- 0.063 mm	50.95	2.41	16.530	39.84	0.96	45.690	110.11	6.06	0.730	1.76	0.91
(0.063 mm	49.05	2.32	18.100	41.99	1.02	34.890	80.94	4.46	0.640	1.48	0.77
(0.1mm	100.00	4.73	17.300*	81.83	1.98	40.393*	191.06	10.52	0.686*	3.24	1.68
feed/alimentation		100.00	41.284*	4128.42	100.00	18.167*	1816.67	100.00	1.925*	192.54	100.00
			40.450			17.700			1.040		

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analyse, analyse granulometrique

Probe, sample, echantillon 1

Attrition, attrition, attrition 5min

annex/annexe: C 15

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	SiO2 content teneur %	SiO2 m%*c% m%*t%	SiO2 recov debit %	P2O5 content teneur %	P2O5 m%*c% m%*t%	P2O5 recov debit %
1.: > 5 mm	1.32	50.880	67.17	1.34	8.800	11.62	1.54	0.820	1.08	0.58
2.: 5 - 3 mm	3.28	51.220	168.02	3.36	9.420	30.90	4.09	1.510	4.95	2.64
3.: 3 - 1 mm	25.63	53.610	1374.16	27.46	3.860	98.94	13.08	1.950	49.98	26.63
4.: 1 - 0.5 mm	28.21	53.840	1518.98	30.35	3.610	101.85	13.47	2.140	60.38	32.17
5.: 0.5- 0.1 mm	35.03	47.410	1660.94	33.19	10.600	371.36	49.11	1.780	62.36	33.23
6.: < 0.1 mm	6.52	33.010	215.25	4.30	21.710	141.56	18.72	1.370	8.93	4.76
feed/alimentation	100.00	50.045* 0.000	5004.51	100.00	7.562* 0.000	756.23	100.00	1.877* 0.000	187.69	100.00

remarks/remarques:
* = calculated values / valeurs calculees

C 15

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analyse, analyse granulometrique

annex/annexe: C 16

Probe, sample, echantillon 1

iron ore/minerai de fer
Niger

Attrition, attrition, attrition 5min

product produit	mass masse %	 V/0%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
> 5 mm	2.26	1.32	50.880	67.17	1.34	8.800	11.62	1.54	0.820	1.08	0.50
5 - 3 mm	5.61	3.28	51.220	168.02	3.36	9.420	30.90	4.09	1.510	4.95	2.64
> 3mm	7.87	4.60	51.122*	235.19	4.70	9.242*	42.52	5.62	1.312*	6.04	3.22
3 - 1 mm	43.86	25.63	53.610	1374.16	27.46	3.860	98.94	13.08	1.950	49.98	26.63
1 - 0.5 mm	48.27	28.21	53.840	1518.98	30.35	3.610	101.85	13.47	2.140	60.36	32.17
3 - 0.5mm	92.13	53.85	53.730*	2893.14	57.81	3.729*	200.79	26.55	2.050*	110.36	58.80
> 0.5mm	100.00	58.45	53.525*	3128.33	62.51	4.163*	243.31	32.17	1.991*	116.39	62.02
0.5- 0.1 mm	84.31	35.03	47.410	1660.94	33.19	10.600	371.36	49.11	1.780	62.36	33.23
< 0.1 mm	15.69	6.52	33.010	215.25	4.30	21.710	141.56	18.72	1.370	8.93	4.76
< 0.1mm	100.00	41.55	45.150*	1876.19	37.49	12.343*	512.92	67.83	1.716*	71.29	37.98
feed/alimentation		100.00	30.045* 0.000	5004.51	100.00	7.562* 0.000	756.23	100.00	1.877* 0.000	187.69	100.00

remarks/remarques:
* = calculated values / valeurs calculees

```
  KHD           Siebanalyse, screen analysis, analyse granulometrique          annex/annexe: C 17
HUMBOLDT
 WEDAG          Probe, sample, echantillon   1                                 iron ore/minerai  de fer
                                                                                   Niger
                Attrition, attrition, attrition   7min

#################################################################################################
                         !          !               Fe         !              SiO2          !              P205
         product         !   mass   ! content  m%*c%    recov  ! content  m%*c%     recov  ! content  m%*c%    recov
         produit         !  masse   ! teneur   m%*t%    debit  ! teneur   m%*t%     debit  ! teneur   m%*t%    debit
                         !    %     !   %                 %    !   %                  %    !   %                 %
#################################################################################################
 1.:     ) 5   mm        !     1.32 ! 50.880     67.16    1.34 !  8.800     11.62    1.48 !  0.820      1.08    0.58
 2.: 5   - 3   mm        !     3.28 ! 51.220    168.00    3.36 !  9.420     30.90    3.95 !  1.510      4.95    2.65
 3.: 3   - 1   mm        !    25.81 ! 53.670   1385.22   27.69 !  4.260    109.95   14.05 !  1.990     51.36   27.46
 4.: 1   - 0.5 mm        !    27.73 ! 54.090   1499.92   29.98 !  3.750    103.99   13.29 !  2.110     58.51   31.28
 5.: 0.5- 0.1  mm        !    34.86 ! 47.340   1650.27   32.99 ! 10.740    374.40   47.86 !  1.770     61.70   32.99
 6.:     ( 0.1 mm        !     7.00 ! 33.120    231.84    4.63 ! 21.640    151.48   19.36 !  1.350      9.45    5.05
#################################################################################################
   @ feed/alimentation   !   100.00 ! 50.024*  5002.41  100.00 !  7.823*   782.33  100.00 !  1.871*   187.06  100.00
                         !          !  0.000                   !  0.000                    !  0.000
#################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

annex/annexe: C 18

Probe, sample, echantillon 1

iron ore/minerai de fer
Niger

Attrition, attrition, attrition 7min

product produit	mass masse		Fe			SiO_2			P_2O_5		
	%	V/0%	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
> 5 mm	2.27	1.32	50.880	67.16	1.34	8.800	11.62	1.48	0.820	1.08	0.58
5 - 3 mm	5.64	3.28	51.220	168.00	3.36	9.420	30.90	3.95	1.510	4.95	2.65
> 3mm	7.91	4.60	51.122*	235.16	4.70	9.242*	42.51	5.43	1.312*	6.04	3.23
3 - 1 mm	44.39	25.81	53.670	1385.22	27.69	4.260	109.95	14.05	1.990	51.36	27.46
1 - 0.5 mm	47.70	27.73	54.090	1499.92	29.98	3.750	103.99	13.29	2.110	58.51	31.28
3 - 0.5mm	92.09	53.54	53.888*	2885.14	57.67	3.996*	213.94	27.35	2.052*	109.87	58.74
> 0.5mm	100.00	58.14	53.669*	3120.30	62.38	4.411*	256.45	32.78	1.994*	115.91	61.96
0.5- 0.1 mm	83.28	34.86	47.340	1650.27	32.99	10.740	374.40	47.86	1.770	61.70	32.99
< 0.1 mm	16.72	7.00	33.120	231.84	4.63	21.640	151.48	19.36	1.350	9.45	5.05
< 0.5mm	100.00	41.86	44.962*	1882.11	37.62	12.563*	525.88	67.22	1.700*	71.15	38.04
feed/alimentation		100.00	50.024*	5002.41	100.00	7.823*	782.33	100.00	1.871*	187.06	100.00
			0.000			0.000			0.000		

remarks/remarques:
* = calculated values / valeurs calculees

```
  KHD            Siebanalyse, screen analysis, analyse granulometrique           annex/annexe: C 19
HUMBOLDT
 WEDAG           Probe, sample, echantillon   1                                 iron ore/minerai  de fer
                                                                                     Niger
                 Attrition, attrition, attrition   10min

##########################################################################################################
                             |          |                 Fe              |               SiO2             |               P2O5
         product             |   mass   | content   m%*c%       recov  | content   m%*c%      recov  | content   m%*c%      recov
         produit             |   masse  | teneur    m%*t%       debit  | teneur    m%*t%      debit  | teneur    m%*t%      debit
                             |     %    |   %                     %    |   %                    %    |   %                    %
##########################################################################################################
 1.:       ) 5     mm        |     1.32 | 50.880      67.16      1.35  |  8.800      11.62      1.49  |  0.820      1.08      0.58
 2.: 5   - 3       mm        |     3.28 | 51.220     168.00      3.37  |  9.420      30.90      3.97  |  1.510      4.95      2.65
 3.: 3   - 1       mm        |    24.06 | 53.440    1285.77     25.77  |  4.190     100.81     12.94  |  1.990     47.88     25.57
 4.: 1   - 0.5     mm        |    28.12 | 54.160    1522.98     30.52  |  3.630     102.08     13.10  |  2.100     59.05     31.54
 5.: 0.5- 0.1      mm        |    35.71 | 47.430    1693.72     33.94  | 10.490     374.60     48.07  |  1.790     63.92     34.14
 6.:      ( 0.1    mm        |     7.51 | 33.570     252.11      5.05  | 21.200     159.21     20.43  |  1.380     10.36      5.53
##########################################################################################################
     feed/alimentation       |   100.00 | 49.897*   4989.74    100.00  |  7.792*    779.21    100.00  |  1.873*   187.25    100.00
                             |          |  0.000                      |  0.000                       |  0.000
##########################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

KHD
HUMBOLDT
WEDAG

Siebanalyse, screen analysis, analyse granulometrique

Probe, sample, echantillon 1

Attrition, attrition, attrition 10min

annex/annexe: C 20

iron ore/minerai de fer
Niger

product produit	mass masse %	 V/O%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO_2 content teneur %	 m%*c% m%*t%	 recov debit %	P_2O_5 content teneur %	 m%*c% m%*t%	 recov debit %
> 5 mm	2.32	1.32	50.880	67.16	1.35	8.800	11.62	1.49	0.820	1.08	0.58
5 - 3 mm	5.78	3.28	51.220	168.00	3.37	9.420	30.90	3.97	1.510	4.95	2.65
> 3mm	8.10	4.60	51.122*	235.16	4.71	9.242*	42.51	5.46	1.312*	6.04	3.22
3 - 1 mm	42.37	24.06	53.440	1285.77	25.77	4.190	100.81	12.94	1.990	47.88	25.57
1 - 0.5 mm	49.52	28.12	54.160	1522.98	30.52	3.630	102.08	13.10	2.100	59.05	31.54
3 - 0.5mm	91.90	52.18	53.828*	2808.75	56.29	3.888*	202.89	26.04	2.049*	106.93	57.11
> 0.5mm	100.00	56.78	53.609*	3043.91	61.00	4.322*	245.40	31.49	1.990*	112.97	60.33
0.5- 0.1 mm	82.62	35.71	47.430	1693.72	33.94	10.490	374.60	48.07	1.790	63.92	34.14
< 0.1 mm	17.38	7.51	33.570	252.11	5.05	21.200	159.21	20.43	1.380	10.36	5.53
< 0.5mm	100.00	43.22	45.022*	1945.84	39.00	12.351*	533.81	68.51	1.719*	74.28	39.67
feed/alimentation		100.00	49.897* 0.000	4989.74	100.00	7.792* 0.000	779.21	100.00	1.873* 0.000	187.25	100.00

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse , screen analyse , analyse granulometrique

annex/annexe: C 21

Probe, sample, echantillon 2

iron ore/minerai de fer
Niger

Attrition, attrition, attrition 7min

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	SiO_2 content teneur %	SiO_2 m%*c% m%*t%	SiO_2 recov debit %	P_2O_5 content teneur %	P_2O_5 m%*c% m%*t%	P_2O_5 recov debit %
1.: > 5.0 mm	2.07	41.130	85.14	1.98	16.930	35.05	2.32	1.890	3.91	1.87
2.: 5.0- 3.0 mm	2.99	41.470	124.00	2.89	16.970	50.74	3.36	1.690	5.05	2.41
3.: 3.0- 1.0 mm	38.60	51.710	1996.01	46.47	4.520	174.47	11.56	2.380	91.87	43.82
4.: 1.0- 0.5 mm	21.92	49.900	1093.81	25.47	7.800	170.98	11.33	2.310	50.64	24.15
5.: 0.5- 0.1 mm	27.99	31.270	875.25	20.38	31.330	876.93	58.09	1.690	47.30	22.56
6.: < 0.1 mm	6.43	18.840	121.14	2.82	31.330	201.45	13.34	1.690	10.87	5.18
feed/alimentation	100.00	42.953* 0.000	4295.33	100.00	15.096* 0.000	1509.61	100.00	2.096* 0.000	209.64	100.00

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse , screen analyse , analyse granulometrique

Probe, sample, echantillon 2

Attrition, attrition, attrition 7min

annex/annexe: C 22

iron ore/minerai de fer
Niger

product produit	mass masse %	 V/O%	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	SiO_2 content teneur %	SiO_2 m%*c% m%*t%	SiO_2 recov debit %	P_2O_5 content teneur %	P_2O_5 m%*c% m%*t%	P_2O_5 recov debit %
) 5.0 mm	3.16	2.07	41.130	85.14	1.98	16.930	35.05	2.32	1.890	3.91	1.87
5.0- 3.0 mm	4.56	2.99	41.470	124.00	2.89	16.970	50.74	3.36	1.690	5.05	2.41
) 3.0mm	7.72	5.06	41.331*	209.13	4.87	16.954*	85.79	5.68	1.772*	8.97	4.28
3.0- 1.0 mm	58.86	38.60	51.710	1996.01	46.47	4.520	174.47	11.56	2.380	91.87	43.82
1.0- 0.5 mm	33.42	21.92	49.900	1093.81	25.47	7.800	170.98	11.33	2.310	50.64	24.15
3.0-0.5mm	92.28	60.52	51.054*	3089.81	71.93	5.708*	345.45	22.88	2.355*	142.50	67.98
) 0.5 mm	100.00	65.58	50.304*	3298.95	76.80	6.576*	431.23	28.57	2.310*	151.47	72.25
0.5- 0.1 mm	81.32	27.99	31.270	875.25	20.38	31.330	876.93	58.09	1.690	47.30	22.56
(0.1 mm	18.68	6.43	18.840	121.14	2.82	31.330	201.45	13.34	1.690	10.87	5.18
(0.5 mm	100.00	34.42	28.948*	996.39	23.20	31.330*	1078.38	71.43	1.690*	58.17	27.75
feed/alimentation		100.00	42.953* 0.000	4295.33	100.00	15.096* 0.000	1509.61	100.00	2.096* 0.000	209.64	100.00

rem. rks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse , screen analysis , analyse granulometrique

annex/annexe: C 23

Probe, sample, echantillon 2

iron ore/minerai de fer
Niger

Attrition, attrition, attrition 10min

product produit	mass masse %	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
1.: > 5.0 mm	2.07	41.130	85.14	2.02	16.930	35.05	2.10	1.890	3.91	1.89
2.: 5.0- 3.0 mm	2.99	41.470	124.00	2.94	16.970	50.74	3.04	1.890	5.65	2.73
3.: 3.0- 1.0 mm	34.34	51.990	1785.34	42.33	4.620	158.65	9.49	2.500	85.85	41.54
4.: 1.0- 0.5 mm	22.65	49.540	1122.08	26.61	8.550	193.66	11.59	2.360	53.45	25.87
5.: 0.5- 0.1 mm	29.75	31.480	936.53	22.21	31.420	934.74	55.92	1.700	50.57	24.47
6.: < 0.1 mm	8.20	20.030	164.25	3.89	36.420	298.64	17.87	0.880	7.22	3.49
feed/alimentation	100.00	42.173* 0.000	4217.33	100.00	16.715* 0.000	1671.48	100.00	2.067* 0.000	206.66	100.00

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

Siebanalyse , screen analysis , analyse granulometrique

Probe, sample, echantillon 2

Attrition, attrition, attrition 10min

annex/annexe:C 24

iron ore/minerai de fer
Niger

product produit	mass masse %	 V/O%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
> 5.0 mm	3.34	2.07	41.130	85.14	2.02	16.930	35.05	2.10	1.890	3.91	1.89
5.0- 3.0 mm	4.82	2.99	41.470	124.00	2.94	16.970	50.74	3.04	1.890	5.65	2.73
> 3.0mm	8.15	5.06	41.331*	209.13	4.96	16.954*	85.79	5.13	1.890*	9.55	4.63
3.0- 1.0 mm	55.34	34.34	51.990	1785.34	42.33	4.620	158.65	9.49	2.500	85.85	41.54
1.0- 0.5 mm	36.50	22.65	49.540	1122.08	26.61	8.550	193.66	11.59	2.360	53.45	25.87
3.0-0.5mm	91.85	56.99	51.016*	2907.42	68.94	6.182*	352.31	21.08	2.444*	139.30	67.41
> 0.5 mm	100.00	62.05	50.226*	3116.55	73.90	7.060*	438.09	26.21	2.399*	148.87	72.04
0.5- 0.1 mm	78.39	29.75	31.480	936.53	22.21	31.420	934.74	55.92	1.700	50.57	24.47
< 0.1 mm	21.61	8.20	20.030	164.25	3.89	35.420	298.64	17.87	0.880	7.22	3.49
< 0.5 mm	100.00	37.95	29.006*	1100.78	26.10	32.500*	1233.39	73.79	1.523*	57.79	27.96
feed/alimentation		100.00	42.173*	4217.33	100.00	16.715*	1671.48	100.00	2.067*	206.66	100.00
			0.000			0.000			0.000		

remarks/remarques:
* = calculated values / valeurs calculees

```
  KHD          Siebanalyse , screen analysis , analyse granulometrique          annex/annexe: C 25
HUMBOLDT
 WEDAG         Probe, sample, echantillon   2                                   iron ore/minerai  de fer
                                                                                       Niger
               Attrition, attrition, attrition   13min

###########################################################################################################
                        !         !               Fe               !             SiO2          !             P2O5
       product          !  mass   ! content  m%*c%      recov ! content   m%*c%     recov ! content  m%*c%     recov
       produit          !  masse  ! teneur   m%*t%      debit ! teneur    m%*t%     debit ! teneur   m%*t%     debit
                        !    %    !   %                  %    !   %                   %   !   %                  %
###########################################################################################################
 1.:     > 5.0 mm       !    2.07 ! 41.130    85.14     2.03 ! 16.930    35.05      2.05 !  1.890     3.91      1.92
 2.: 5.0- 3.0 mm        !    2.99 ! 41.470   124.00     2.96 ! 16.970    50.74      2.98 !  1.690     5.05      2.48
 3.: 3.0- 1.0 mm        !   35.03 ! 52.110  1825.41    43.53 !  4.410   154.48      9.06 !  2.520    88.28     43.29
 4.: 1.0- 0.5 mm        !   21.76 ! 49.280  1072.33    25.57 !  9.100   198.02     11.61 !  2.310    50.27     24.65
 5.: 0.5- 0.1 mm        !   28.93 ! 30.940   895.09    21.34 ! 32.410   937.62     54.98 !  1.670    48.31     23.69
 6.:     < 0.1 mm       !    9.22 ! 20.820   191.96     4.58 ! 35.740   329.52     19.32 !  0.880     8.11      3.98
###########################################################################################################
    feed/alimentation   !  100.00 ! 41.939* 4193.93   100.00 ! 17.054* 1705.43    100.00 !  2.039*  203.93    100.00
                        !         !  0.000                   !  0.000                    !  0.000
###########################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

KHD
HUMBOLDT
WEDAG

Siebanalyse , screen analysis , analyse granulometrique

annex/annexe: C 26

Probe, sample, echantillon 2

iron ore/minerai de fer
Niger

Attrition, attrition, attrition 13min

product produit	mass masse %	 V/O%	Fe content teneur %	 m%*c% m%*t%	 recov debit %	SiO2 content teneur %	 m%*c% m%*t%	 recov debit %	P2O5 content teneur %	 m%*c% m%*t%	 recov debit %
> 5.0 mm	3.35	2.07	41.130	85.14	2.03	16.930	35.05	2.05	1.890	3.91	1.92
5.0- 3.0 mm	4.83	2.99	41.470	124.00	2.96	16.970	50.74	2.98	1.690	5.05	2.48
> 3.0mm	8.18	5.06	41.331*	209.13	4.99	16.954*	85.79	5.03	1.772*	8.97	4.40
3.0- 1.0 mm	56.64	35.03	52.110	1825.41	43.53	4.410	154.48	9.06	2.520	88.28	43.29
1.0- 0.5 mm	35.18	21.76	49.280	1072.33	25.57	9.100	198.02	11.61	2.310	50.27	24.65
3.0-0.5mm	91.82	56.79	51.026*	2897.75	69.09	6.207*	352.50	20.67	2.440*	138.54	67.93
> 0.5 mm	100.00	61.85	50.232*	3106.88	74.08	7.086*	438.28	25.70	2.385*	147.51	72.33
0.5- 0.1 mm	75.83	28.93	30.940	895.09	21.34	32.410	937.62	54.98	1.670	48.31	23.69
< 0.1 mm	24.17	9.22	20.820	191.96	4.58	35.740	329.52	19.32	0.880	8.11	3.98
< 0.5 mm	100.00	38.15	28.494*	1087.05	25.92	33.215*	1267.14	74.30	1.479*	56.43	27.67
feed/alimentation		100.00	41.939* 0.000	4193.93	100.00	17.054* 0.000	1705.43	100.00	2.039* 0.000	203.93	100.00

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

sink-float-analysis, procede par liqueur denses

annex/annexe: C 27

sample, echantillon 1
hammer mill, broyeur a marteaux
discharge, decharge 3.0 - 0.3 mm

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	SiO2 content teneur %	SiO2 m%*c% m%*t%	SiO2 recov debit %	P2O5 content teneur %	P2O5 m%*c% m%*t%	P2O5 recov debit %
1.:) 3.45 g/cm3	73.85	52.460	3874.17	77.53	2.500	184.63	34.33	1.960	144.75	79.40
2.: 3.45- 3.00 g/cm3	22.52	47.980	1080.51	21.62	5.880	132.42	24.62	1.600	36.03	19.76
3.: 3.00- 2.84 g/cm3	0.70	25.320	17.72	0.35	39.780	27.85	5.18	0.800	0.56	0.31
4.: 2.84- 2.70 g/cm3	1.20	9.270	11.12	0.22	70.630	84.76	15.76	0.320	0.38	0.21
5.: (2.70 g/cm3	1.73	7.600	13.15	0.26	62.500	108.13	20.11	0.340	0.59	0.32
feed/alimentation	100.00	49.967* 0.000	4996.67	100.00	5.378* 0.000	537.77	100.00	1.823* 0.000	182.31	100.00

remarks/remarques:
* = calculated values / valeurs calculees

```
 KHD                sink-float analysis, procede par liqueur denses                       annex/annexe: C 28
HUMBOLDT
 WEDAG              sample, echantillon     2                                             iron ore/minerai , de fer
                    hammer mill, broyeur a marteaux                                            Niger
                    discharge, decharge     3.0 - 0.5 mm

#############################################################################################################
                            |         |           Fe             |          SiO2            |          P2O5
          product           |  mass   | content  m%*c%     recov | content  m%*c%     recov | content  m%*c%    recov
          produit           |  masse  | teneur   m%*t%     debit | teneur   m%*t%     debit | teneur   m%*t%    debit
                            |    %    |   %                  %   |   %                  %   |   %                 %
#############################################################################################################
 1.:        ) 3.45 g/cm3    |  70.28  | 51.690  3632.77   80.03 |  2.870   201.70   17.70 |  2.420   170.00   81.35
 2.: 3.45- 3.00 g/cm3       |  18.56  | 44.270   821.65   18.10 | 10.700   198.59   17.43 |  1.870    34.71   16.60
 3.: 3.00- 2.84 g/cm3       |   1.34  | 21.260    28.49    0.63 | 39.430    52.84    4.64 |  1.550     2.08    0.99
 4.: 2.84- 2.70 g/cm3       |   2.59  |  8.530    22.09    0.49 | 66.310   171.74   15.07 |  0.320     0.83    0.40
 5.:        ( 2.70 g/cm3    |   7.23  |  4.710    34.05    0.75 | 71.190   514.70   45.17 |  0.190     1.37    0.66
#############################################################################################################
     feed/alimentation      | 100.00  | 45.391* 4539.06  100.00 | 11.396* 1139.58  100.00 |  2.091*  209.06  100.00
                            |         |  0.000                   |  0.000                   |  0.000
#############################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

```
  KHD           magnetic separation, separation magnetique                          annex/annexe: C 29
HUMBOLDT
 WEDAG          sample, echantillon  1                                              iron ore/minerai  de fer
                feed, alimentation  <0,5mm / 800g/l                                     Niger
                ~ 1,5 Tesla

################################################################################################
                              !          !              Fe             !                              !
           product            !   mass   ! content  m%*c%      recov   ! content   m%*c%     recov    ! content   m%*c%     recov
           produit            !   masse  ! teneur   m%*t%      debit   ! teneur    m%*t%     debit    ! teneur    m%*t%     debit
                              !    %     !   %                   %     !   %                   %      !   %                   %
################################################################################################
 1.: mags.                    !   37.73  ! 53.370  2013.65   50.11  !                                 !
 2.: middl.                   !   33.56  ! 41.990  1409.18   35.07  !                                 !
 3.: non-mags.                !   28.71  ! 20.740   595.45   14.82  !                                 !
################################################################################################
     feed/alimentation        !  100.00  ! 40.183* 4018.28  100.00  !                                 !
                              !          ! 41.590                   !                                 !
################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

sample, echantillon 1
feed, alimentation <0,5mm / 800g/l
~ 1,2 Tesla

annex/annexe: C 30

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	41.70	53.370	2225.53	56.06						
2.: middl.	28.96	42.290	1224.72	30.85						
3.: non-mags.	29.34	17.720	519.90	13.10						
feed/alimentation	100.00	39.702* 41.590	3970.15	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

C 30

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

annex/annexe: C 31

sample, echantillon 1
feed, alimentation <0,5mm / 800g/l
~ 0,8 Tesla

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	42.05	53.720	2258.93	55.90						
2.: middl.	31.91	40.080	1278.95	31.65						
3.: non-mags.	26.04	19.330	503.35	12.46						
feed/alimentation	100.00	40.412*	4041.23	100.00						
		41.590								

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

sample, echantillon 2
feed, alimentation <0,5mm / 800g/l
~ 1,5 Tesla

annex/annexe: C 32

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	18.08	48.840	883.03	42.80						
2.: middl.	14.37	20.840	299.47	14.51						
3.: non-mags.	67.55	13.040	880.85	42.69						
feed/alimentation	100.00	20.633* 22.810	2063.35	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

annex/annexe: C 33

sample, echantillon 2
feed, alimentation (0,5mm / 800g/l
~ 1,2 Tesla

iron ore/minerais de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags	23.97	42.190	1011.29	47.95						
2.: middl.	16.52	31.620	522.36	24.77						
3.: non-mags.	59.51	9.670	575.46	27.28						
feed/alimentation	100.00	21.091* 22.810	2109.12	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

C 33

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

sample, echantillon 2
feed, alimentation <0,5mm / 800g/l
~ 0,8 Tesla

annex/annexe:C 34

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	 m%*c% m%*t%	 recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	25.62	45.110	1155.72	56.55						
2.: middl.	20.25	17.870	361.87	17.71						
3.: non-mags.	54.13	9.720	526.14	25.74						
feed/alimentation	100.00	20.437* 22.810	2043.73	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

C 34

KHD
HUMBOLDT
WEDAG

screen analysis, analyse granulometrique

sample, echantillon 1

raw material ground, materie premiere broye (0.1mm

annex/annexe: C 35

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.:) 0.090 mm	15.46	52.780	815.98	16.48						
2.: 0.090- 0.071 mm	13.26	52.980	702.51	14.19						
3.: 0.071- 0.063 mm	6.43	52.880	340.02	6.87						
4.: 0.063- 0.045 mm	11.04	52.880	583.80	11.79						
5.: 0.045- 0.032 mm	9.00	52.880	475.92	9.61						
6.: 0.032- 0.020 mm	11.74	52.070	611.30	12.35						
7.: -(0.020 mm	33.07	42.950	1420.36	28.69						
feed/alimentation	100.00	49.499*	4949.88	100.00						
		0.000								

remarks/remarques:
* = calculated values / valeurs calculees

C 35

KHD
HUMBOLDT
WEDAG

screen analysis, analyse granulometrique

sample, echantillon 2

raw material ground, materie premiere broye < 0.1mm

annex/annexe: C 36

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe								
		content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: > 0.090 mm	18.67	48.220	900.27	20.56						
2.: 0.090- 0.071 mm	13.57	47.300	641.86	14.66						
3.: 0.071- 0.063 mm	5.75	46.900	269.67	6.16						
4.: 0.063- 0.045 mm	10.85	47.100	511.03	11.67						
5.: 0.045- 0.032 mm	7.85	47.300	371.30	8.48						
6.: 0.032- 0.020 mm	10.75	47.100	506.32	11.56						
7.: < 0.020 mm	32.56	36.210	1179.00	26.92						
feed/alimentation	100.00	43.795* 0.000	4379.46	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

sample, echantillon 1
feed, alimentation <0,1mm / 600g/1
~ 1,5 Tesla

annex/annexe: C 37

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	64.17	53.690	3445.29	70.01						
2.: middl.	9.80	44.880	439.82	8.94						
3.: non-mags.	26.03	39.810	1036.25	21.06						
feed/alimentation	100.00	49.214* 50.040	4921.36	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

sample, echantillon 1
feed, alimentation <0.1mm / 600g/1
~1.2 Tesla

annex/annexe: C 38

iron ore/minerai de fer
Niger

		Fe								
product produit	mass masse %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur . %	m%*c% m%*t%	recov debit %
1.: mags.	61.47	54.200	3331.67	67.20						
2.: middl.	12.84	46.190	593.08	11.96						
3.: non-mags.	25.69	40.220	1033.25	20.84						
feed/alimentation	100.00	49.580* 50.040	4958.00	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

annex/annexe: C 39

sample, echantillon 1
feed, alimentation <0.1mm / 600g/l
~ 1.0 Tesla

iron ore/minerai de fer
Niger

		Fe								
product produit	mass masse %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	54.03	53.890	2911.68	59.15						
2.: middl.	14.03	47.410	665.16	13.51						
3.: non-mags.	31.94	42.140	1345.95	27.34						
feed/alimentation	100.00	49.228*	4922.79	100.00						
		50.040								

remarks/remarques:
* = calculated values / valeurs calculees

C 39

KHD
HUMBOLDT
WEDAG

magnetic separation, separatin magnetique

annex/annexe: C 40

sample, echantillon 1+2 (1:2)
feed, alimentation (0.1mm / 600g/l
1.5 Tesla

iron ore/minerai , de fer
Niger

product produit	mass masse %	Fe content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	59.39	52.370	3110.25	68.55						
2.: middl.	12.41	40.420	501.61	11.06						
3.: non-mags	28.20	32.820	925.52	20.40						
feed/alimentation	100.00	45.374*	4537.39	100.00						
		0.000								

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

annex/annexe: C 41

sample, echantillon 1+2 (1:2)
feed, alimentation (0.1mm / 600g/1
~ 1.2 Tesla

iron ore/minerai de fer
Niger

		Fe								
product produit	mass masse %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags..	58.15	51.760	3009.84	66.69						
2.: middl.	11.99	41.130	493.15	10.93						
3.: non-mags	29.86	33.830	1010.16	22.38						
feed/alimentation	100.00	45.132* 0.000	4513.16	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

```
  KHD             magnetic separation, separation magnetique                  annex/annexe: C 42
HUMBOLDT
 WEDAG            sample, echantillon  1+2   (1:2)                            iron ore/minerai  de fer
                  feed, alimentation   (0.1mm / 600g/1                             Niger
                  ~ 1.0 Tesla

##########################################################################################
                        |         |          Fe                  |                              |
          product       |  mass   | content  m%*c%   recov | content   m%*c%     recov | content   m%*c%     recov
          produit       |  masse  | teneur   m%*t%   debit | teneur    m%*t%     debit | teneur    m%*t%     debit
                        |    %    |   %                %   |   %                   %   |   %                   %
##########################################################################################
 1.: mags.              |   55.65 | 52.170  2903.26  64.08 |                             |
 2.: middl.             |   12.79 | 41.230   527.33  11.64 |                             |
 3.: non-mags.          |   31.56 | 34.850  1099.87  24.28 |                             |
##########################################################################################
     feed/alimentation  |  100.00 | 45.305* 4530.46 100.00 |                             |
                        |         |  0.000                 |                             |
##########################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

C 42

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

annex/annexe: C 43

sample, echantillon 1 deslimed, deschlamme
feed, alimentation <0.1mm / 600g/l
~ 1.5 Tesla

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1. : mags.	50.58	54.700	2766.73	52.34						
2. : middl.	25.87	52.680	1362.83	25.78						
3. : non-mags.	23.55	49.130	1157.01	21.89						
feed/alimentation	100.00	52.866* 52.680	5286.57	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

C 43

```
  KHD              magnetic separation, separation magnetique                                  annex/annexe: C 44
HUMBOLDT
 WEDAG             sample, echantillon  1  deslimed, deschlamme                                iron ore/minerai  de fer
                   feed alimentation  <0.1mm / 600g/1                                               Niger
                   ~ 1.2 Tesla

##############################################################################################################
                        |           |              Fe              |                              |
          product       |    mass   | content  m%*c%     recov | content    m%*c%      recov | content    m%*c%     recov
          produit       |   masse   | teneur   m%*t%     debit | teneur     m%*t%      debit | teneur     m%*t%     debit
                        |     %     |   %                  %   |   %                     %   |   %                    %
##############################################################################################################
 1.: mags.              |    65.68  | 54.500  3579.56   68.05 |                              |
 2.: middl.             |    19.22  | 52.270  1004.63   19.10 |                              |
 3.: non-mags.          |    15.10  | 44.770   676.03   12.85 |                              |
##############################################################################################################
    feed/alimentation   |   100.00  | 52.602* 5260.22  100.00 |                              |
                        |           | 52.680                   |                              |
##############################################################################################################
remarks/remarques:
* = calculated values / valeurs calculees
```

C 44

KHD
HUMBOLDT
WEDAG

magnetic separation, sparation magnetique

annex/annexe: C 45

sample, echantillon 1+2 (1:2) deslimed, deschlamme
feed, alimentaion < 0.1mm / 600g/l
~ 1.5 Tesla

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	 m%*c% m%*t%	 recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	59.45	52.680	3131.83	63.53						
2.: middl.	25.10	46.800	1174.68	23.83						
3.: non-mags.	15.45	40.320	622.94	12.64						
feed/alimentation	100.00	49.294* 48.520	4929.45	100.00						

remarks/remarques:
* = calculated values / valeurs calculees

KHD
HUMBOLDT
WEDAG

magnetic separation, separation magnetique

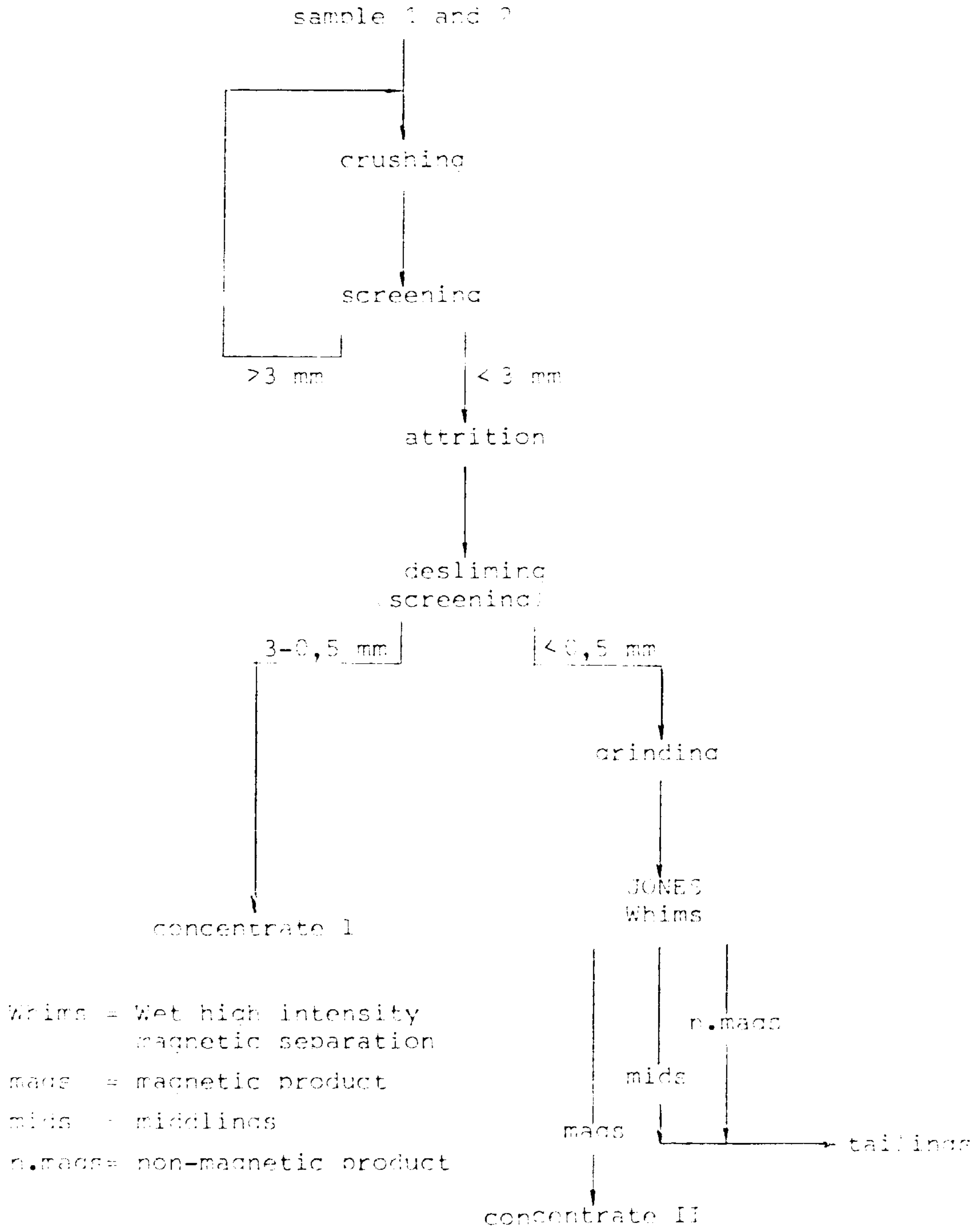
annex/annexe:C 46

sample, echantillon 1+2 (1:2) deslimed, deschlamme
feed, alimentation < 0.1mm / 600g/l
~ 1.2 Tesla

iron ore/minerai de fer
Niger

product produit	mass masse %	Fe content teneur %	Fe m%*c% m%*t%	Fe recov debit %	content teneur %	m%*c% m%*t%	recov debit %	content teneur %	m%*c% m%*t%	recov debit %
1.: mags.	58.85	53.180	3129.64	63.74						
2.: middl.	20.63	47.610	982.19	20.00						
3.: non-mags.	20.52	38.900	798.23	16.26						
feed/alimentation	100.00	49.101* 48.520	4910.06	100.00						

remarks/remarques:
* = calculated values / valeurs calculees



Whims = Wet high intensity
magnetic separation
mags = magnetic product
mids = middlings
n.mags = non-magnetic product

Annex C. 47: Samples 1 and 2; iron ore SAY, Niger; Flow-sheet of the production of concentrates for metallurgical testing.

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Annex B 1.1 to B 1.10

Tables of drillings and trenches with coordinates, altitudes, depths, and number of samples

Number of trench	Coordinates X	Coordinates Y	Altitudes of trenches above mean sea level (m)	Final depth (m)
PDK 1	429460	1458924	190,57	7,50
PDK 2	429352	1459770	191,43	6,80
PDK 3	429409	1460236	191,18	7,60
PDK 4	429613	1461642	201,37	15,90
PDK 5	429410	1462740	199,08	14,40
PDK 6	429264	1463596	189,20	7,50
PDK 7	428841	1464500	188,77	5,00
PDK 8	428400	1465345	186,91	5,50
PDK 9	427950	1466365	186,31	6,30
PDk 10	427510	1467181	187,74	8,00
PDK 11	429525	1457868	193,24	12,50
PDK 12	429316	1456828	192,20	9,00
PDK 13	429365	1455850	192,17	8,00
PDK 14	429553	1454851	201,08	17,50
PDK 15	427668	1466770	186,46	12,25
PDK 16	428209	1465825	187,13	6,50
PDK 17	428579	1464940	186,00	6,25
PDK 18	429091	1464080	187,92	8,20
PDK 19	429308	1463315	192,56	7,30
PDK 20	429522	1462225	194,99	10,85

Overburden to a depth of (m)	Oolithes indurées to a depth of (m)	Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Number of samples in iron ore
0,0	3,0	n.d.	6,85	7,50	7
0,0	2,0	3,0	6,00	6,80	6
0,0	2,40	3,40	6,00	7,60	7
8,45	10,20	n.d.	14,60	15,90	7
8,25	11,65	12,65	14,00	14,40	7
0,50	4,60	6,00	7,15	7,50	9
0,75	4,80	5,00	---	- -	5
0,0	2,50	4,60	5,20	5,50	2
0,0	2,00	3,70	5,50	6,00	6
0,0	2,90	4,70	6,60	8,00	10
1,70	3,60	n.d.	9,55	12,50	8
0,0	3,60	n.d.	7,60	9,00	10
0,0	2,00	n.d.	7,00	8,00	8
8,90	10,80	11,25	16,25	17,50	7
5,90	8,35	10,00	11,70	12,25	7
0,0	2,70	4,70	5,85	6,50	4
0,0	3,70	5,85	6,25	---	8
2,15	6,00	8,20	---	---	5
1,40	4,50	6,00	6,90	7,30	5
3,00	6,00	6,35	10,15	10,85	8

Annex B 1.1

Number of trench	Coordinates X	Y	Altitudes of trenches above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)
PDK 21	429625	1461305	190,46	9,50	0,0
PDK 22	429503	1460580	192,01	8,45	0,0
PDK 23	429407	1459404	192,20	9,30	0,0
PDK 24	429566	1458340	191,32	8,00	0,0
PDK 25	429428	1457445	191,71	8,10	0,0
PDK 26	429348	1456318	193,18	7,25	0,0
PDK 27	429417	1455279	192,10	6,75	0,0
PDK 28	429042	1457450	192,75	9,25	0,0
PDK 29	428320	1457370	193,55	8,25	0,0
PDK 30	427920	1457715	194,67	7,00	0,0
PDK 31	426854	1457756	196,19	7,25	0,0
PDK 32	429676	1453750	191,76	6,00	0,0
PDK 33	429701	1452669	192,86	6,70	0,0
PDK 34	429619	1451595	192,55	6,20	0,0
PDK 35	429604	1450995	193,23	5,50	0,0
PDK 36	429174	1450012	193,74	4,60	0,0
PDK 37	424925	1471160	184,13	11,50	4,30
PDK 38	427368	1467722	187,66	7,20	0,0
PDK 39	427201	1468110	190,47	5,50	0,0
PDK 40	427059	1468660	188,06	5,50	2,00

Annex B 1.2

Oolithes indurées to a depth of (m)	Intercalation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Number of samples in iron ore
2,50	3,00	9,00	9,50	8
3,15	3,60	7,40	8,25	6
2,80	3,25	7,80	9,30	9
2,15	2,60	7,50	8,00	7
1,65	2,40	6,40	8,10	7
2,35	2,55	6,80	7,25	9
1,80	2,20	6,15	6,75	7
2,40	3,20	8,10	9,25	8
2,80	3,50	8,25	---	6
2,40	2,75	7,00	---	9
3,00	3,30	7,25	---	7
1,60	1,90	4,50	6,00	5
1,45	n.d.	4,10	6,70	4
1,70	n.d.	4,10	6,20	3
2,15	n.d.	4,70	5,50	4
1,00	2,20	4,00	4,60	3
8,00	9,80	10,60	11,50	5
1,60	2,80	5,00	7,20	5
1,15	2,00	4,00	5,50	4
er.	er.	3,80	5,50	2

Number of trench	Coordinates X	Y	Altitudes of trenches above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)
PDK 41	429645	1454206	192,48	7,00	0,0
PDK 42	429669	1453220	192,64	5,80	0,0
PDK 43	429634	1452160	192,04	5,20	0,0
PDK 44	424015	1471880	189,02	4,30	0,0
PDK 45	426890	1469085	190,49	7,00	0,0
PDK 46	426670	1469605	188,88	7,50	0,0
PDK 47	426423	1469960	188,96	8,50	0,0
PDK 48	425952	1470265	184,86	7,00	0,0
PDK 49	425450	1470528	185,76	7,90	0,40
PDK 50	423159	1472382	189,67	3,65	1,15
PDK 51	422263	1472691	188,19	3,00	0,0

Oolithes indurées to a depth of (m)	Intercalation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Number of samples in iron ore
2,00	n.d.	5,90	7,00	6
2,00	n.d.	4,90	5,80	5
1,05	n.d.	4,60	5,20	4
2,30	n.d.	3,20	4,30	4
2,40	3,00	6,55	7,00	6
3,05	3,90	6,65	7,50	6
2,95	3,10	8,00	8,50	6
3,05	3,25	6,00	7,00	6
4,55	n.d.	7,50	7,90	8
2,95	3,20	n.d.	3,65	4
0,60	n.d.	n.d.	3,00	1

Annex B 1.3

Annex B 1.4

Number of drillhole	Coordinates		Altitudes of drill-holes above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)	Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Core recovery in the iron ore (%)	Number of samples in iron ore
	X	Y									
DK 1	428135	1458635	212,84	27,70	18,75	24,17	n.d.	25,79	27,70	83,24	7
DK 2	428026	1459813	211,90	28,55	17,17	21,95	23,15	26,75	28,55	97,48	8
DK 3	427943	1460882	211,85	28,00	20,70	24,40	n.d.	27,40	28,00	77,61	5
DK 4	427756	1461899	213,09	28,40	19,50	22,60	n.d.	28,00	28,40	84,65	8
DK 5	427536	1463886	215,23	28,70	22,50	25,90	26,54	28,40	28,70	84,27	5
DK 6	427328	1463910	212,88	25,50	20,95	22,25	23,45	25,00	25,50	92,00	3
DK 7	427271	1464852	212,39	26,10	19,40	21,85	24,15	25,65	26,10	91,72	5
DK 8	426798	1465689	214,26	28,80	21,90	24,30	26,75	28,30	28,80	73,37	6
DK 9	426159	1466505	211,83	26,20	18,85	21,32	23,30	25,45	26,20	71,82	4
DK 10	425553	1467307	214,16	28,60	20,70	23,61	25,46	27,96	28,60	74,24	5
DK 11	424887	1468110	219,44	25,25	17,45	19,25	22,15	24,75	25,25	94,52	6
DK 12	428052	1458047	209,54	25,30	17,40	22,70	n.d.	23,30	25,30	75,95	4
DK 13	427831	1456701	215,20	29,80	20,85	23,80	n.d.	28,85	29,80	95,55	9
DK 14	427685	1455733	214,50	28,50	21,32	25,65	n.d.	28,30	28,50	89,58	5
DK 15	42600	1468708	205,41	18,30	9,80	12,40	13,75	16,05	18,30	83,20	6
DK 16	423371	1468198	230,57	37,55	30,45	33,95	35,75	36,85	37,55	73,94	5
DK 17	424020	1466950	230,05	40,00	30,90	33,50	35,90	39,55	40,00	95,37	5
DK 18	424827	1465560	224,49	33,50	25,30	27,10	30,30	32,90	33,50	96,05	5
DK 19	425582	1464508	214,25	26,20	18,20	19,80	22,52	25,40	26,20	74,72	2
DK 20	425860	1463022	214,44	28,40	19,65	21,80	22,75	27,20	28,40	84,52	7

Number of drillhole	Coordinates X	Y	Altitudes of drill-holes above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)
DK 21	426130	1461542	212,21	25,30	17,51	19,80
DK 22	426365	1460058	212,72	26,65	17,90	21,85
DK 23	426592	1458572	213,17	28,40	19,20	22,85
DK 24	426612	1456957	216,67	30,25	22,10	24,25
DK 25	426619	1455306	212,08	26,45	19,40	21,70
DK 26	422484	1469438	229,70	39,05	33,55	37,20
DK 27	421377	1470521	230,42	42,50	36,10	35,70
DK 28	424032	1469381	219,17	31,00	22,31	27,10
DK 29	423013	1470527	226,79	40,40	34,05	34,55
DK 30	427706	1454682	213,47	28,12	19,80	20,80
DK 31	427714	1453655	213,94	28,18	24,35	n.d.
DK 32	426638	1453841	211,61	24,37	18,40	19,90
DK 33	424992	1458370	209,37	21,95	16,35	16,60
DK 34	424930	1459640	216,75	29,10	21,16	23,60
DK 35	424738	1461129	216,61	30,75	23,10	25,20
DK 36	424728	1462808	218,31	27,95	21,95	24,35
DK 37	424824	1464447	219,58	32,60	24,75	27,95
DK 38	426147	1468041	210,24	22,55	15,10	18,50
DK 39	426661	1467249	213,30	25,30	18,00	19,30
DK 40	427122	1466380	214,91	27,70	20,40	22,20

Annex B 1.5

Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Core recovery in the iron ore (%)	Number of samples in iron ore
21,00	24,40	25,30	78,95	4
n.d.	25,35	26,65	53,14	3
24,20	27,40	28,40	64,88	5
n.d.	29,55	30,25	58,50	7
n.d.	24,65	26,45	59,00	5
n.d.	37,95	39,05	87,50	4
n.d.	n.d.	42,50	83,50	1
29,25	30,20	31,00	62,36	3
35,35	n.d.	40,40	95,00	---
24,30	25,80	28,12	57,50	---
n.d.	27,40	28,18	29,50	---
21,30	23,60	24,37	53,10	5
n.d.	21,55	21,95	85,12	3
n.d.	28,75	29,10	81,66	5
25,80	30,45	30,75	95,51	7
25,55	27,60	27,95	52,00	4
29,15	32,40	32,60	94,25	7
18,90	21,65	22,55	74,50	6
22,05	24,25	25,30	92,80	7
24,80	21,65	27,70	79,01	5

Number of drillhole	Coordinates		Altitudes of drill-holes above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)
	X	Y				
DK 41	427552	1465523	213,80	29,25	22,40	25,25
DK 42	427951	1464650	213,39	29,45	22,30	25,20
DK 43	428329	1463635	211,76	28,95	20,75	23,55
DK 44	428462	1462598	213,01	29,95	20,90	23,05
DK 45	428542	1461277	208,75	25,55	17,40	20,00
DK 46	428531	1460179	211,00	27,20	17,15	20,60
DK 47	428353	1459349	211,84	27,50	17,95	19,60
DK 48	428777	1458188	207,51	23,50	15,25	17,35
DK 49	428651	1456067	210,38	25,90	18,65	20,85
DK 50	428590	1455260	213,15	28,20	20,65	22,90
DK 51	428629	1454169	212,37	25,40	20,50	21,60
DK 52	427356	1454846	214,79	29,08	22,90	24,15
DK 53	427234	1456357	215,74	27,90	20,10	22,85
DK 54	427281	1459294	213,33	28,35	19,20	21,65
DK 55	427213	1460804	212,12	27,70	19,90	22,25
DK 56	426866	1462426	215,73	30,90	23,30	25,70
DK 57	426568	1463701	214,60	27,70	20,30	22,55
DK 58	426261	1464949	213,28	27,70	19,60	22,85
DK 59	425104	1466319	222,57	32,30	23,20	25,60
DK 60	424503	1467500	222,67	36,85	27,50	31,90

Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Core recovery in the iron ore (%)	Number of samples in iron ore
27,05	28,45	29,25	86,45	5
26,90	28,95	29,45	77,14	3
23,95	26,50	28,95	91,65	5
23,35	27,60	29,95	83,43	5
20,40	25,05	25,55	81,70	7
21,40	26,70	27,20	69,74	5
20,20	26,80	27,50	87,91	7
17,95	21,95	23,50	66,12	4
21,20	25,55	25,90	96,38	5
23,20	26,80	28,20	51,30	4
21,95	24,80	25,40	87,67	5
n.d.	26,80	29,08	57,20	2
23,15	26,80	27,90	79,21	5
22,55	27,10	28,35	92,38	5
23,45	27,20	27,70	90,00	6
26,90	28,45	30,90	52,80	4
25,40	27,30	27,70	93,00	7
24,35	26,50	27,70	89,57	8
28,20	31,55	32,30	81,32	7
32,75	35,95	36,85	96,57	7

Number of drillhole	Coordinates X	Coordinates Y	Altitudes of drill-holes above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)	Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Core recovery in the iron ore (%)	Number of samples in iron ore
DK 61	422996	1469137	227,40	41,15	34,25	35,05	38,15	39,60	41,15	n.a.	---
DK 62	422456	1470216	228,76	36,35	36,35	n.d.	n.d.	n.d.	n.a.	---	---
DK 63	425247	1469043	210,57	16,85	8,95	12,15	13,40	15,80	16,85	56,90	5
DK 64	424391	1470234	217,80	19,80	13,15	14,40	15,20	16,45	19,80	52,60	5
DK 65	426231	1456219	213,85	26,80	18,90	22,05	22,20	26,60	26,80	83,37	4
DK 66	426000	1457740	209,28	20,40	13,65	15,55	n.d.	20,35	20,40	84,60	4
DK 67	425782	1459229	212,79	26,80	18,25	20,90	21,45	25,90	26,80	55,9	5
DK 68	425587	1460652	213,23	25,90	17,90	20,30	20,80	25,70	25,90	88,44	5
DK 69	425275	1462028	213,65	26,20	17,75	19,95	20,60	25,30	26,20	85,69	6
DK 70	425073	1463436	214,28	25,60	17,40	18,50	21,50	25,25	25,60	84,59	7

Annex B 1.7

Number of trench	Coordinates X	Coordinates Y	Altitudes of trenches above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)	Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Number of samples in iron ore
PK 1	425201	1474419	188,04	6,10	0,0	5,50	n.d.	n.d.	6,10	3
PK 2	426030	1473737	185,80	4,00	0,0	1,85	2,50	3,60	4,00	4
PK 3	426719	1473210	187,84	6,30	0,0	2,90	3,30	4,80	6,30	3
PK 4	427410	1472893	186,52	4,65	0,0	1,10	n.d.	4,40	4,65	3
PK 5	428521	1472380	186,77	6,50	0,0	2,60	n.d.	6,00	6,50	4

Annex B 1.8

Number of drillhole	Coordinates		Altitudes of drill-holes above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)	Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Core recovery in the iron ore (%)	Number of samples in iron ore
	X	Y									
K 1	427521	1473350	186,00	10,30	3,45	4,50	n.d.	n.d.	10,30	71,42	1
K 2	427521	1447400	189,54	7,80	3,00	4,20	5,40	7,50	7,80	86,22	4
K 3	427521	1475400	196,16	8,50	4,50	6,75	n.d.	7,35	8,50	68,40	5
K 4	427521	1476400	193,55	7,75	3,95	4,95	5,70	n.d.	7,75	80,00	2
K 5	427521	1477390	195,17	9,20	3,05	6,80	n.d.	n.d.	9,20	71,46	2
K 6	428271	1476915	196,14	10,56	3,45	8,55	n.d.	n.d.	10,56	75,10	3
K 7	428271	1475905	194,25	8,20	3,10	4,60	n.d.	n.d.	8,20	72,00	1
K 8	428271	1474910	189,97	10,00	1,80	6,00	6,90	8,80	10,00	81,30	5
K 9	428267	1473879	188,40	8,00	2,20	3,75	4,30	7,60	8,00	82,40	4
K 10	428970	1473350	187,86	10,40	2,40	5,30	6,40	9,20	10,40	76,80	5
K 11	429021	1474400	188,93	10,95	2,70	5,35	6,10	9,15	10,95	82,80	5
K 12	429021	1475400	195,50	11,25	4,58	5,10	7,50	8,90	11,25	100,00	4
K 13	429021	1476400	199,11	15,45	9,70	12,45	13,65	14,25	15,45	68,00	3
K 14	429770	1473879	186,98	10,65	2,70	5,00	6,15	8,50	10,65	76,20	5
K 15	429770	1472879	188,03	11,20	1,90	4,60	6,15	8,50	11,20	76,40	4
K 16	429770	1471879	189,93	11,55	3,65	6,25	6,55	9,40	11,55	81,91	5
K 17	430525	1472371	187,90	11,20	2,60	5,75	6,90	9,13	11,20	66,92	5
K 18	430525	1473350	190,10	27,90	5,50	7,40	8,85	11,30	27,90	84,83	4
K 19	430525	1474400	189,79	12,10	5,55	8,55	8,90	11,75	12,10	93,71	5

Annex B 1.9

Number of drillhole	Coordinates		Altitudes of drill-holes above mean sea level (m)	Final depth (m)	Overburden to a depth of (m)	Oolithes indurées to a depth of (m)	Inter-calation to a depth of (m)	Oolithes tendres to a depth of (m)	Basement to a depth of (m)	Core recovery in the iron ore (%)	Number of samples in iron ore
	X	Y									
K 20	431275	1473879	199,52	22,25	15,35	15,85	18,25	21,30	22,25	87,53	3
K 21	431275	1472879	193,80	16,85	10,35	11,05	13,15	15,65	16,85	76,60	4
K 22	431275	1471879	190,77	11,80	6,10	7,60	8,50	10,00	11,80	85,13	3
K 23	426769	1473879	193,43	12,60	8,55	8,80	9,00	10,80	12,60	71,11	2
K 24	426769	1474910	193,17	9,40	9,00	n.d.	n.d.	n.d.	9,40	---	---
K 25	426769	1475905	197,39	8,50	3,75	7,00	n.d.	n.d.	8,50	53,85	2
K 26	426769	1476915	192,98	6,92	2,35	4,37	n.d.	n.d.	6,92	77,23	1
K 27	429770	1474975	196,88	19,20	13,70	15,00	16,20	18,30	19,20	69,80	4
K 28	430525	1475400	191,70	9,95	4,05	4,65	6,10	8,55	9,95	84,08	1

Annex B 1.10

KHD HUMBOLDT WEDAG AG

Annex B 2.1 to B 2.43

Tables of chemical analyses results

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 1	11	0,0 - 1,0	1,0	51,67	73,89	1,75	5,36	4,76	0,21	0,14	0,60	1,66	10,90
PDK 1	12	1,0 - 2,0	1,0	52,32	74,65	1,97	5,06	4,58	0,20	0,12	0,48	1,55	12,15
PDK 1	13	2,0 - 3,0	1,0	50,02	71,53	2,20	7,08	5,70	0,23	0,10	0,29	1,94	11,27
PDK 1	14	3,0 - 4,0	1,0	46,54	66,50	2,05	10,37	7,18	0,38	0,16	0,51	1,43	11,40
PDK 1	15	4,0 - 5,0	1,0	44,31	63,34	1,76	10,66	9,01	0,38	0,16	0,47	1,48	11,65
PDK 1	16	5,0 - 6,0	1,0	42,97	61,45	1,89	14,96	8,39	0,34	0,20	0,57	1,32	11,13
PDK 1	17	6,0 - 6,95	0,85	34,28	48,99	1,38	30,04	8,55	0,36	0,10	0,29	1,06	9,45
PDK 2	18	0,0 - 1,0	1,0	50,57	72,32	1,85	5,85	4,80	0,20	0,12	0,41	2,35	11,07
PDK 2	19	1,0 - 2,0	1,0	51,67	73,89	1,83	5,66	4,84	0,16	0,08	0,41	2,27	11,04
PDK 2	20	2,0 - 3,0	1,0	40,13	57,38	1,12	23,33	6,73	0,25	0,11	0,74	2,11	8,23
PDK 2	21	3,0 - 4,0	1,0	46,31	66,23	1,82	10,71	3,04	0,31	0,22	0,48	2,70	10,19
PDK 2	22	4,0 - 5,0	1,0	45,49	65,05	1,87	11,04	8,78	0,28	0,20	0,58	2,44	10,70
PDK 2	23	5,0 - 6,0	1,0	39,72	56,79	1,43	21,86	8,91	0,30	0,26	0,48	3,51	8,03
PDK 3	24	0,0 - 1,0	1,0	47,64	68,11	1,61	11,29	4,53	0,33	0,15	0,83	3,10	9,52
PDK 3	25	1,0 - 2,0	1,0	51,96	74,29	2,22	5,65	3,73	0,25	0,18	0,49	2,88	10,76
PDK 3	26	2,0 - 2,40	0,40	52,24	74,67	2,34	5,16	4,15	0,21	0,17	0,31	2,55	11,08
PDK 3	27	2,40 - 3,40	1,0	38,40	54,90	1,36	24,75	7,30	0,56	0,13	0,38	3,37	7,56
PDK 3	28	3,40 - 4,40	1,0	48,32	69,09	2,00	8,70	5,80	0,54	0,15	0,78	3,05	9,71
PDK 3	29	4,40 - 5,40	1,0	44,76	64,00	2,04	11,34	7,63	0,47	0,21	0,76	3,88	9,21
PDK 3	30	5,40 - 6,0	0,6	42,18	60,31	1,85	18,20	6,39	0,42	0,13	0,75	3,29	8,48

Annex B 2.1

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 4	39	8,75 - 9,75	1,0	48,04	68,70	1,51	8,77	6,13	0,28	0,09	0,71	1,24	11,77
PDK 4	40	9,75 - 10,20	0,45	47,48	67,90	1,87	10,57	6,37	0,30	0,10	0,42	1,26	12,08
PDK 4	41	10,20 - 11,20	1,0	29,61	42,34	0,93	37,43	7,59	0,45	0,13	0,24	1,18	8,40
PDK 4	42	11,20 - 12,20	1,0	43,85	62,70	1,71	14,59	7,06	0,46	0,10	0,38	1,31	10,99
PDK 4	43	12,20 - 13,20	1,0	48,46	69,29	2,12	7,83	6,18	0,43	0,10	0,54	1,57	11,29
PDK 4	44	13,20 - 14,20	1,0	43,57	62,31	1,84	12,84	8,52	0,41	0,12	0,39	1,28	11,46
PDK 4	45	14,20 - 14,60	0,4	33,38	47,73	1,11	28,61	9,13	0,85	0,21	0,32	1,27	9,58
PDK 5	46	8,25 - 9,25	1,0	47,58	68,04	1,49	8,82	6,09	0,19	0,10	0,84	4,56	8,85
PDK 5	47	9,25 - 10,25	1,0	51,71	73,94	2,15	4,58	5,38	0,21	0,07	0,43	3,70	10,23
PDK 5	48	10,25 - 11,25	1,0	47,03	67,20	2,00	9,33	6,52	0,22	0,08	0,34	4,76	9,66
PDK 5	49	11,25 - 11,65	0,4	47,31	67,60	1,93	8,79	5,67	0,22	0,09	0,29	4,73	9,11
PDK 5	50	11,65 - 12,65	1,0	37,13	53,10	1,47	23,13	9,45	0,42	0,10	0,25	4,40	6,66
PDK 5	51	12,65 - 13,65	1,0	43,18	61,70	1,92	15,98	7,82	0,28	0,11	0,29	5,58	6,83
PDK 5	52	13,65 - 14,00	0,35	40,16	57,39	1,61	21,97	5,87	0,23	0,10	0,26	4,93	6,19
PDK 6	53	0,50 - 1,50	1,0	48,51	69,37	1,30	7,27	5,47	0,14	0,12	1,08	4,58	9,28
PDK 6	54	1,50 - 2,50	1,0	45,63	65,24	1,59	12,36	7,80	0,22	0,06	0,37	3,80	9,44
PDK 6	55	2,50 - 3,50	1,0	44,53	63,67	1,33	13,77	8,17	0,25	0,08	0,30	3,68	9,35
PDK 6	56	3,50 - 4,60	1,10	41,37	59,15	1,23	19,26	8,63	0,35	0,10	0,40	5,05	6,69
PDK 6	57	4,60 - 5,60	1,0	42,33	60,53	1,37	16,50	8,55	0,58	0,12	0,26	4,87	7,19
PDK 6	58	5,60 - 6,00	0,4	37,24	53,26	1,16	26,48	8,19	0,52	0,10	0,18	2,97	7,70
PDK 6	59	6,00 - 6,40	0,4	41,37	59,15	1,47	18,08	7,85	0,60	0,10	0,28	5,11	6,20
PDK 6	60	6,40 - 6,80	0,4	33,67	48,15	0,96	27,00	11,17	1,06	0,12	0,17	4,20	6,89
PDK 6	61	6,80 - 7,15	0,35	39,85	56,99	1,35	19,78	9,63	0,65	0,10	0,26	3,26	8,55

Annex B 2.2

ANALYSES RESUL

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %
PDK 7	62	---	0,70	40,39	57,76	0,57
PDK 7	63	0,75 - 1,75	1,0	48,92	69,96	1,34
PDK 7	64	1,75 - 2,75	1,0	46,45	66,42	1,44
PDK 7	65	2,75 - 3,75	1,0	39,17	56,01	1,23
PDK 7	66	3,75 - 4,80	1,05	35,32	50,51	1,15
PDK 8	101	0,0 - 1,0	1,0	52,52	75,10	1,23
PDK 8	102	1,0 - 2,50	1,50	49,58	70,90	1,63
PDK 9	83	0 - 1,0	1,0	46,86	67,01	1,19
PDK 9	84	1,0 - 2,0	1,0	48,10	68,78	1,34
PDK 9	85	2,0 - 2,9	0,9	34,36	49,13	1,09
PDK 9	86	2,9 - 3,70	0,8	17,32	24,76	0,51
PDK 9	87	3,70 - 4,70	1,0	41,50	59,35	1,61
PDK 9	88	4,70 - 5,50	0,8	36,56	52,27	1,44
PDK 10	75	0 - 1,0	1,0	51,61	73,80	0,84
PDK 10	76	1,0 - 2,0	1,0	46,09	65,90	0,88
PDK 10	77	2,0 - 2,20	0,2	43,44	62,12	1,26
PDK 10	78	2,20 - 2,40	0,2	48,59	69,49	1,73
PDK 10	79	2,40 - 2,90	0,5	44,34	63,40	1,47
PDK 10	80	2,90 - 3,90	1,0	29,39	42,02	0,59
PDK 10	81	3,90 - 4,20	0,3	14,52	20,76	0,47
PDK 10	82	4,20 - 4,70	0,5	19,27	27,56	0,66
PDK 10	99	4,70 - 5,70	1,0	43,57	62,30	1,98
PDK 10	100	5,70 - 6,60	0,9	36,74	52,53	1,61

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SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%
27,65	3,65	0,11	0,04	0,28	1,66	8,10
7,98	7,20	0,22	0,32	0,60	2,31	11,12
10,16	7,88	0,27	0,12	0,46	2,50	10,92
18,62	11,60	0,35	0,16	0,38	2,12	10,77
26,69	10,61	0,48	0,14	0,37	2,00	9,27
5,32	4,44	0,21	0,12	0,49	2,28	10,93
7,61	5,03	0,28	0,10	0,33	2,32	11,09
13,00	6,12	0,22	0,12	0,24	3,38	9,05
11,89	5,43	0,20	0,10	0,24	3,15	9,46
35,97	5,52	0,30	0,08	0,20	2,43	6,45
54,74	10,92	0,82	0,12	0,12	2,40	5,55
17,76	9,20	0,43	0,16	0,34	3,44	8,91
27,30	8,00	0,32	0,14	0,27	4,28	6,52
7,20	4,43	0,21	0,11	0,51	2,40	10,45
13,12	6,94	0,23	0,19	0,31	2,29	10,10
18,34	5,03	0,20	0,21	0,44	1,98	9,55
10,07	4,88	0,19	0,17	0,34	2,50	10,23
16,62	5,45	0,23	0,17	0,28	2,44	9,39
40,47	6,98	0,37	0,19	0,21	2,02	6,26
57,55	12,21	0,81	0,30	0,17	3,78	4,26
50,24	10,21	1,49	0,32	0,16	3,69	4,27
15,64	6,80	0,36	0,17	0,40	2,22	10,00
29,16	4,78	0,33	0,19	0,33	2,62	7,77

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 11	67	1,70 - 2,70	1,0	50,81	72,66	2,04	6,07	4,46	0,24	0,06	0,50	3,05	10,86
PDK 11	68	2,70 - 3,60	0,9	52,16	74,59	2,44	5,37	3,75	0,20	0,06	0,33	3,53	9,93
PDK 11	69	3,60 - 4,60	1,0	47,79	68,34	2,07	10,70	5,72	0,44	0,08	0,53	3,87	9,00
PDK 11	70	4,60 - 5,60	1,0	46,97	67,16	2,20	11,12	6,60	0,39	0,08	0,53	2,47	10,74
PDK 11	71	5,60 - 6,60	1,0	45,87	65,59	2,10	12,47	6,14	0,29	0,08	0,55	2,80	10,12
PDK 11	72	6,60 - 7,60	1,0	39,55	56,56	1,82	22,66	6,53	0,35	0,08	0,56	3,68	8,12
PDK 11	73	7,60 - 8,60	1,0	30,35	43,40	1,36	39,24	6,77	0,39	0,08	0,24	2,21	7,33
PDK 11	74	8,60 - 9,55	0,95	25,54	36,53	1,01	45,83	6,54	0,50	0,14	0,17	2,27	6,46
PDK 12	89	0,0 - 1,0	1,0	48,24	68,98	1,74	9,70	6,58	0,23	0,08	0,39	2,34	10,32
PDK 12	90	1,0 - 1,30	0,3	52,77	75,46	1,85	5,03	5,59	0,17	0,08	0,29	2,40	10,87
PDK 12	91	1,30 - 1,70	0,4	48,92	69,96	1,40	10,19	6,00	0,20	0,08	0,44	1,93	10,73
PDK 12	92	1,70 - 2,70	1,0	43,98	62,89	1,68	15,35	8,00	0,22	0,08	0,23	2,15	10,36
PDK 12	93	2,70 - 3,60	0,9	39,03	55,81	1,43	21,46	8,92	0,32	0,11	0,27	2,16	9,93
PDK 12	94	3,60 - 4,60	1,0	42,19	60,33	1,81	15,77	9,62	0,32	0,11	0,42	3,75	8,66
PDK 12	95	4,60 - 5,60	1,0	41,09	58,76	1,63	17,01	9,74	0,32	0,13	0,49	2,11	10,38
PDK 12	96	5,60 - 6,30	0,7	39,30	56,20	1,58	20,66	8,96	0,31	0,11	0,54	2,98	8,94
PDK 12	97	6,30 - 7,30	1,0	32,43	46,38	1,47	32,95	9,13	0,30	0,13	0,34	1,74	8,54
PDK 12	98	7,30 - 7,60	0,3	25,56	36,55	1,02	44,18	9,53	0,31	0,14	0,22	1,54	7,32
PDK 13	237	0,0 - 0,3	0,3	52,45	75,01	1,90	4,66	3,85	0,18	0,18	0,31	0,75	12,50
PDK 13	238	0,3 - 1,0	0,7	50,49	72,20	2,22	7,15	4,93	0,19	0,13	0,17	0,68	12,27

Annex B 2.4

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 13	239	1,0 - 2,0	1,0	42,22	60,37	1,85	16,93	6,59	0,31	0,24	0,52	0,68	11,40
PDK 13	240	2,0 - 3,0	1,0	45,58	65,18	1,84	13,84	5,63	0,34	0,15	0,31	0,98	11,15
PDK 13	241	3,0 - 4,0	1,0	43,62	62,37	1,85	13,36	7,83	0,38	0,14	0,38	0,98	11,78
PDK 13	242	4,0 - 5,0	1,0	40,53	57,96	1,71	19,68	7,70	0,33	0,16	0,35	0,77	10,99
PDK 13	243	5,0 - 6,0	1,0	33,66	48,13	1,46	31,82	7,01	0,36	0,15	0,35	0,63	9,55
PDK 13	244	6,0 - 7,0	1,0	26,32	37,51	1,02	43,76	8,06	0,38	0,19	0,17	0,68	8,09
PDK 14	103	0,90 - 1,90	1,0	53,63	76,70	1,89	4,34	4,01	0,25	0,08	0,39	2,64	10,37
PDK 14	104	1,90 - 2,80	0,9	50,06	71,58	1,97	8,08	5,47	0,32	0,08	0,29	1,98	11,08
PDK 14	105	2,80 - 3,25	0,45	41,81	59,78	1,62	18,21	8,58	0,60	0,10	0,25	2,93	9,01
PDK 14	106	3,25 - 4,25	1,0	44,28	63,32	2,01	12,65	8,58	0,44	0,10	0,34	3,91	9,02
PDK 14	107	4,25 - 5,25	1,0	43,70	62,49	2,00	12,84	9,27	0,32	0,16	0,55	3,15	9,83
PDK 14	108	5,25 - 6,25	1,0	35,21	50,34	1,51	25,90	9,83	0,52	0,24	0,33	2,22	9,07
PDK 14	109	6.25 - 7,35	1,10	28,33	40,51	1,16	39,26	8,84	0,48	0,16	0,20	3,36	5,91
PDK 15	110	5,90 - 7,0	1,10	46,84	66,99	1,18	12,92	6,16	0,25	0,13	0,17	0,73	11,57
PDK 15	111	7,0 - 7,25	0,25	46,84	66,99	1,38	14,40	4,95	0,21	0,12	0,17	0,94	11,06
PDK 15	112	7,25 - 8,35	1,10	46,70	66,79	1,65	13,16	5,52	0,18	0,10	0,14	0,82	11,39
PDK 15	113	8,35 - 9,30	0,95	31,42	44,93	0,81	39,50	6,03	0,38	0,13	0,12	0,52	8,09
PDK 15	114	9,30 - 10,0	0,70	19,21	27,48	0,42	56,25	7,68	1,18	0,17	0,05	0,44	6,32
PDK 15	115	10,0 - 11,0	1,00	41,66	59,57	1,79	17,95	7,80	0,36	0,14	0,21	1,00	10,96
PDK 15	116	11,00 - 11,70	0,70	36,33	51,95	1,60	28,59	6,67	0,39	0,11	0,19	0,66	9,67

Annex B 2.5

Annex B 2.6

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to	Thick-ness of Sample	Fe-tot.	Fe_2O_3	P_2O_5	SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
		(m)	(m)	%	%	%	%	%	%	%	%	%	%
PDK 16	117	0,0 - 1,0	1,0	48,65	69,57	1,15	10,90	5,78	0,21	0,1	0,41	3,96	8,28
PDK 16	118	1,0 - 2,0	1,0	51,53	73,69	1,28	7,13	5,46	0,20	0,09	0,31	3,36	9,96
PDK 16	119	2,00 - 2,70	0,7	47,41	67,80	1,44	10,96	7,07	0,21	0,06	0,24	5,04	7,99
PDK 16	120	4,70 - 5,85	1,15	41,91	59,94	1,65	15,68	8,75	0,36	0,08	0,37	3,08	8,78
PDK 17	229	0,0 - 1,0	1,0	49,71	71,09	1,24	10,12	4,68	0,29	0,08	0,40	2,70	9,86
PDK 17	230	1,0 - 2,0	1,0	49,29	70,49	1,59	9,86	4,79	0,29	0,08	0,20	2,56	10,62
PDK 17	231	2,0 - 3,0	1,0	48,14	68,85	1,59	11,51	4,62	0,26	0,10	0,20	2,51	10,44
PDK 17	232	3,0 - 3,70	0,70	44,40	63,50	1,29	18,70	4,65	0,30	0,07	0,33	2,41	9,18
PDK 17	233	3,70 - 3,90	0,20	20,24	28,95	0,60	56,30	6,21	0,95	0,09	0,07	1,34	5,29
PDK 17	234	3,90 - 4,50	0,60	38,54	55,11	1,34	23,62	7,28	0,55	0,08	0,33	2,29	8,72
PDK 17	235	4,50 - 5,85	1,35	21,92	31,35	0,50	42,91	13,02	1,59	0,12	0,09	1,76	7,81
PDK 17	236	5,85 - 6,25	0,40	44,54	63,70	1,80	15,31	6,56	0,48	0,09	0,28	2,57	9,47
PDK 18	201	2,15 - 3,0	0,85	42,01	60,07	1,26	16,98	7,89	0,43	0,16	0,66	3,28	9,97
PDK 18	202	3,0 - 4,0	1,0	49,10	70,22	1,55	7,08	5,60	0,32	0,18	0,36	3,10	11,26
PDK 18	203	4,0 - 5,0	1,0	44,70	63,93	1,38	13,82	7,23	0,47	0,12	0,26	3,73	10,27
PDK 18	204	5,0 - 6,0	1,0	44,56	63,72	1,29	15,37	4,43	0,34	0,16	0,69	2,85	12,74
PDK 18	205	6,0 - 7,0	1,0	36,76	52,56	1,11	23,75	8,46	0,78	0,18	0,27	2.23	9,72
PDK 19	251	1,40 - 2,40	1,0	50,65	72,43	1,54	7,16	4,76	0,25	0,14	0,90	1,59	11,77
PDK 19	252	2,40 - 3,40	1,0	50,24	71,84	2,04	7,08	5,93	0,25	0,08	0,24	1,50	12,45

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 19	253	3,40 - 4,50	1,10	46,59	66,62	1,76	11,53	6,09	0,31	0,10	0,56	1,64	12,09
PDK 19	254	4,50 - 6,0	1,50	43,87	62,72	1,62	17,93	6,21	0,58	0,15	0,34	1,77	10,05
PDK 19	255	6,0 - 6,90	0,90	46,05	65,84	1,83	12,20	5,86	0,28	0,11	0,49	1,60	12,00
PDK 20	301	3,0 - 4,0	1,0	46,77	66,88	1,56	9,91	6,75	0,26	0,06	0,49	2,33	10,84
PDK 20	302	4,0 - 5,0	1,0	48,69	69,63	1,93	7,64	5,31	0,15	0,04	0,42	2,29	11,20
PDK 20	303	5,0 - 6,0	1,0	41,13	58,81	1,51	20,27	5,75	0,23	0,06	0,32	2,18	9,68
PDK 20	304	6,0 - 6,35	0,35	39,34	56,26	1,36	21,90	9,32	0,52	0,06	0,27	2,08	9,74
PDK 20	305	6,35 - 7,0	0,65	45,39	64,91	1,87	11,55	7,05	0,39	0,12	0,38	2,09	10,39
PDK 20	306	7,0 - 8,0	1,0	47,04	67,27	2,06	10,09	6,50	0,44	0,10	0,41	2,03	10,68
PDK 20	307	8,0 - 9,0	1,0	44,02	62,94	1,76	13,04	8,72	0,44	0,12	0,42	2,17	10,50
PDK 20	308	9,0 - 10,15	1,15	42,92	61,37	1,75	15,64	7,63	0,37	0,08	0,34	2,16	10,25
PDK 21	277	0,0 - 1,0	1,0	52,36	74,80	1,86	4,80	3,75	0,10	0,07	0,80	2,34	11,10
PDK 21	278	1,0 - 2,50	1,50	48,31	69,09	2,06	11,52	4,31	0,13	0,08	0,33	2,32	10,51
PDK 21	279	2,0 - 3,00	0,50	41,61	59,50	1,51	18,72	7,75	0,59	0,09	0,41	2,11	9,84
PDK 21	280	3,00 - 4,00	1,0	47,47	67,89	2,01	9,64	6,58	0,37	0,09	0,34	2,23	10,49
PDK 21	281	4,00 - 5,00	1,0	47,23	67,54	2,30	9,31	6,57	0,47	0,10	0,52	1,93	10,93
PDK 21	282	5,00 - 6,00	1,0	46,53	66,54	2,17	10,32	7,25	0,35	0,14	0,49	2,13	10,91
PDK 21	283	6,00 - 7,50	1,50	40,11	57,35	1,81	18,97	7,87	0,54	0,14	0,56	2,31	9,76
PDK 21	284	7,50 - 9,00	1,50	36,05	51,56	1,62	27,30	7,00	0,53	0,16	0,60	2,13	8,72

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 22	343	0,0 - 1,0	1,0	52,36	74,55	1,89	4,40	3,99	0,14	0,08	0,88	2,87	10,41
PDK 22	344	1,0 - 2,0	1,0	49,52	70,81	1,95	7,78	5,62	0,19	0,12	0,49	2,86	10,64
PDK 22	345	2,0 - 3,15	1,15	43,60	62,35	1,76	16,43	6,13	0,25	0,12	0,45	2,63	9,40
PDK 22	346	3,60 - 5,00	1,40	47,32	67,67	2,21	9,48	6,06	0,27	0,10	0,51	2,49	10,17
PDK 22	347	5,0 - 6,0	1,0	42,92	61,37	2,19	14,53	8,06	0,35	0,14	0,61	2,58	10,32
PDK 22	348	6,0 - 7,40	1,40	41,26	59,01	1,91	17,47	7,71	0,19	0,08	0,50	2,65	9,48
PDK 23	309	0,0 - 1,0	1,0	52,07	74,46	1,76	4,54	3,95	0,11	0,12	0,91	3,28	9,66
PDK 23	310	1,0 - 2,0	1,0	51,66	73,87	2,11	5,40	4,26	0,11	0,10	0,26	3,09	10,36
PDK 23	311	2,0 - 2,80	0,80	50,96	72,88	2,06	6,44	3,76	0,11	0,09	0,39	2,75	10,03
PDK 23	312	2,80 - 3,25	0,45	39,12	55,94	1,51	21,10	7,74	0,47	0,14	0,39	2,33	9,02
PDK 23	313	3,25 - 4,0	0,75	43,03	61,54	1,82	14,70	7,36	0,45	0,13	0,50	2,55	9,66
PDK 23	314	4,0 - 5,0	1,0	45,55	65,03	2,07	11,33	7,51	0,39	0,08	0,48	2,57	9,94
PDK 23	315	5,0 - 6,0	1,0	41,82	59,81	1,92	14,85	8,13	0,37	0,14	0,61	2,96	9,68
PDK 23	316	6,0 - 7,20	1,20	39,47	56,44	1,71	21,19	6,98	0,39	0,20	0,58	2,67	8,99
PDK 23	327	7,20 - 7,80	0,60	30,47	43,57	1,21	37,73	6,19	0,41	0,17	0,51	2,14	7,14
PDK 24	206	0,0 - 1,0	1,0	52,23	74,68	1,78	5,13	4,46	0,24	0,14	0,31	1,99	12,29
PDK 24	207	1,0 - 2,15	1,15	49,67	71,03	1,89	10,03	3,94	0,26	0,10	0,40	2,02	10,79
PDK 24	208	2,15 - 2,60	0,45	43,57	62,30	1,43	16,80	5,97	0,50	0,20	0,56	2,55	9,63
PDK 24	209	2,60 - 4,0	1,40	47,26	67,58	1,87	10,52	6,28	0,53	0,18	0,60	2,78	10,36
PDK 24	210	4,0 - 5,35	1,35	45,70	65,35	1,89	11,83	6,97	0,47	0,16	0,63	2,21	11,32

Annex B 2.8

Annex B 2.9

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to	Thick-ness of Sample	Fe-tot.	Fe_2O_3	P_2O_5	SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
		(m)	(m)	%	%	%	%	%	%	%	%	%	%
PDK 24	211	5,35 - 6,30	0,95	37,89	54,19	1,50	23,43	6,77	0,42	0,18	0,46	1,96	37,89
PDK 24	212	6,30 - 7,50	1,20	29,52	42,21	1,06	37,81	7,22	0,42	0,16	0,30	9,51	29,52
PDK 25	121	0,0 - 1,0	1,0	52,53	75,12	2,24	4,69	4,01	0,23	---	0,32	2,07	11,70
PDK 25	122	1,0 - 1,65	0,65	51,16	73,16	2,32	5,59	4,38	0,30	---	0,41	2,01	11,64
PDK 25	123	1,65 - 2,40	0,75	40,98	58,60	1,66	18,78	7,01	0,65	---	0,49	2,51	9,68
PDK 25	124	2,40 - 3,40	1,0	47,03	67,25	1,90	9,49	5,77	0,46	---	0,49	2,78	10,27
PDK 25	125	3,40 - 4,40	1,0	42,91	61,36	2,06	14,55	7,17	0,44	---	0,68	3,41	9,84
PDK 25	126	4,40 - 5,10	0,7	33,01	47,20	1,55	30,19	7,42	0,48	---	0,46	3,42	7,80
PDK 25	127	5,10 - 6,40	1,30	29,98	42,87	1,31	38,95	6,16	0,40	---	0,29	3,15	6,33
PDK 26	220	0,0 - 1,05	1,05	50,52	72,25	1,63	6,79	3,79	0,26	0,12	0,62	1,83	11,38
PDK 26	221	1,05 - 2,0	0,95	47,54	67,99	1,60	11,56	4,49	0,27	0,16	0,24	2,74	10,13
PDK 26	222	2,0 - 2,35	0,35	44,85	64,13	1,32	15,45	5,53	0,50	0,16	0,30	3,20	9,14
PDK 26	223	2,35 - 2,55	0,20	37,75	53,98	1,25	26,10	5,55	0,53	0,16	0,37	1,30	9,67
PDK 26	224	2,55 - 3,50	0,95	45,70	65,35	1,82	12,18	6,40	0,43	0,16	0,50	2,44	10,31
PDK 26	225	3,50 - 4,50	1,0	45,70	65,35	1,95	12,07	6,18	0,39	0,12	0,53	1,66	11,78
PDK 26	226	4,50 - 5,30	0,8	43,29	61,90	1,54	17,83	5,67	0,38	0,14	0,62	1,23	11,28
PDK 26	227	5,30 - 6,0	0,7	41,01	58,65	1,19	23,84	5,45	0,36	0,16	0,55	1,28	10,17
PDK 26	228	6,0 - 6,80	0,8	29,99	42,82	1,63	40,61	5,86	0,34	0,18	0,29	1,29	7,83
PDK 27	213	0,0 - 1,0	1,0	51,67	73,89	2,11	5,00	3,95	0,18	0,10	0,27	1,01	12,40

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
PDK 27	214	1,0 - 1,80	0,80	45,72
PDK 27	215	1,80 - 2,20	0,40	39,97
PDK 27	216	2,20 - 3,20	0,90	44,46
PDK 27	217	3,20 - 4,30	1,10	43,48
PDK 27	218	4,30 - 5,60	1,30	33,24
PDK 27	219	5,60 - 6,15	0,55	28,21
PDK 28	182	0,0 - 1,0	1,0	49,47
PDK 28	183	1,0 - 2,40	1,40	50,16
PDK 28	184	2,40 - 3,20	0,80	41,78
PDK 28	185	3,20 - 4,20	1,0	44,80
PDK 28	186	4,20 - 5,20	1,0	43,98
PDK 28	187	5,20 - 6,30	1,10	40,82
PDK 28	188	6,30 - 7,30	1,00	36,69
PDK 28	189	7,30 - 8,10	0,80	27,90
PDK 29	190	0,0 - 1,45	1,45	50,57
PDK 29	191	1,45 - 2,80	1,35	44,25
PDK 29	192	2,80 - 3,50	0,70	29,68
PDK 29	193	3,50 - 4,50	1,0	39,85
PDK 29	194	4,50 - 5,50	1,0	39,58
PDK 29	195	5,50 - 6,80	1,30	41,78

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
65,38	1,91	13,05	5,50	0,29	0,16	0,18	1,01	11,35
57,16	1,50	21,09	6,53	0,41	0,26	0,30	1,09	10,32
63,58	1,94	12,72	6,93	0,36	0,24	0,42	0,98	11,50
62,17	1,90	14,82	7,05	0,31	0,30	0,43	0,92	11,45
47,53	1,31	31,36	7,68	0,39	0,27	0,32	0,87	9,48
40,34	1,08	41,24	6,98	0,35	0,23	0,19	0,81	8,06
70,75	1,82	7,17	6,25	0,16	0,09	0,33	3,56	9,62
71,73	2,18	6,39	5,84	0,15	0,07	0,39	3,27	10,30
59,74	1,25	17,35	7,89	0,32	0,22	0,91	2,52	8,55
64,07	1,80	13,84	8,36	0,32	0,30	0,56	3,76	9,00
62,89	2,00	11,25	9,23	0,31	0,16	0,66	4,07	8,99
58,37	1,79	18,03	7,98	0,34	0,27	0,66	4,24	7,74
52,47	1,49	24,78	8,24	0,31	0,19	0,44	3,79	7,51
39,89	1,01	38,05	8,17	0,34	0,13	0,23	4,05	5,25
72,32	1,77	6,69	5,81	0,25	0,28	0,36	2,31	10,62
63,28	1,39	14,40	6,70	0,22	0,11	0,26	2,20	9,96
42,45	1,02	36,62	8,17	0,33	0,17	0,27	3,17	5,86
56,99	1,52	20,42	8,32	0,41	0,24	0,35	1,87	9,60
56,60	1,70	18,82	8,84	0,32	0,16	0,37	1,59	10,01
59,74	1,79	15,99	8,88	0,35	0,14	0,37	1,78	10,74

Annex B 2.10

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %
PDK 30	263	0,0 - 0,90	0,90	48,04
PDK 30	264	0,90 - 1,75	0,85	50,27
PDK 30	265	1,75 - 2,40	0,65	50,55
PDK 30	266	2,40 - 2,75	0,35	34,21
PDK 30	267	2,75 - 2,95	0,20	47,59
PDK 30	268	2,95 - 4,0	1,05	48,69
PDK 30	269	4,0 - 5,0	1,0	46,49
PDK 30	270	5,0 - 6,0	1,0	45,12
PDK 30	271	6,0 - 6,60	0,6	38,24
PDK 31	256	0,0 - 1,0	1,0	52,45
PDK 31	257	1,0 - 2,0	1,0	50,36
PDK 31	258	2,0 - 3,0	1,0	49,02
PDK 31	259	3,0 - 3,30	0,3	41,74
PDK 31	260	3,30 - 4,30	1,0	47,34
PDK 31	261	4,30 - 5,30	1,0	48,61
PDK 31	262	5,30 - 6,30	1,0	46,38
PDK 32	291	0,0 - 1,0	1,0	52,48
PDK 32	292	1,0 - 1,60	0,6	50,14
PDK 32	293	1,60 - 1,90	0,3	41,75
PDK 32	294	1,90 - 3,0	1,10	46,00

ANALYSES RESULTS

Fe_2O_3	P_2O_5	SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%	%	%
68,70	1,91	11,27	5,51	0,46	0,10	0,35	1,11	10,93
71,89	1,76	9,34	4,05	0,19	0,08	0,25	1,15	11,54
72,29	1,71	7,89	5,04	0,13	0,10	0,41	0,86	12,26
48,93	1,22	35,07	4,98	0,34	0,16	0,31	0,80	8,34
68,06	1,81	11,60	4,48	0,39	0,20	0,34	3,15	8,73
69,63	2,16	7,94	5,00	0,28	0,12	0,43	3,72	9,01
66,49	2,30	8,37	6,45	0,27	0,16	0,46	3,63	9,56
64,52	2,12	14,44	5,61	0,25	0,12	0,40	2,80	8,46
54,68	1,30	25,04	6,74	0,35	0,12	0,35	3,07	8,02
75,00	1,52	5,75	4,35	0,21	0,15	0,38	1,56	11,85
72,01	1,42	7,76	4,67	0,23	0,12	0,25	1,62	11,92
70,08	2,05	10,10	4,67	0,25	0,11	0,19	1,43	11,84
59,69	1,13	19,84	7,21	0,48	0,13	0,39	2,31	9,63
67,69	1,81	12,15	5,80	0,38	0,12	0,39	1,71	11,05
69,31	2,21	8,32	6,18	0,33	0,12	0,39	1,74	11,57
66,32	2,09	10,94	6,77	0,35	0,12	0,38	1,55	11,57
75,05	1,81	5,45	2,61	0,39	0,13	0,25	1,42	12,59
71,69	2,19	8,63	3,11	0,28	0,17	0,21	1,73	11,75
59,70	1,81	19,16	6,31	0,41	0,17	0,33	1,39	10,63
65,79	1,95	11,93	6,30	0,54	0,21	0,38	1,25	11,97

Annex B 2.11

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
PDK 32	295	3,0 - 4,50	1,50	45,58
PDK 33	356	0,0 - 1,45	1,45	54,78
PDK 33	357	1,45 - 2,50	1,05	45,47
PDK 33	358	2,50 - 3,50	1,00	40,22
PDK 33	359	3,50 - 4,10	0,60	32,12
PDK 34	340	0,0 - 1,70	1,70	49,96
PDK 34	341	1,70 - 3,30	1,60	44,70
PDK 34	342	3,30 - 4,10	0,80	34,63
PDK 35	352	0,0 - 1,00	1,00	50,87
PDK 35	353	1,00 - 2,15	1,15	49,58
PDK 35	354	2,15 - 3,15	1,0	50,49
PDK 35	355	3,15 - 4,70	1,55	41,88
PDK 36	349	0,0 - 1,00	1,00	50,34
PDK 36	350	1,00 - 2,20	1,20	39,06
PDK 36	351	2,20 - 4,00	1,80	39,67
PDK 37	196	5,00 - 6,00	1,00	52,91
PDK 37	197	6,00 - 7,00	1,00	47,27
PDK 37	198	7,00 - 8,00	1,00	47,82

ANALYSES RESULTS

Fe_2O_3	P_2O_5	SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%	%	%
65,18	1,36	14,70	4,58	0,51	0,17	0,38	1,12	11,00
78,34	1,52	4,58	2,78	0,16	0,10	0,28	1,00	11,78
65,02	1,89	11,61	6,89	0,38	0,12	0,39	0,91	11,71
57,51	1,82	21,20	6,54	0,40	0,12	0,40	0,99	10,37
45,93	1,32	37,48	6,17	0,44	0,10	0,28	0,87	8,32
71,44	1,51	8,64	4,97	0,24	0,18	0,19	2,60	10,44
63,93	1,83	13,09	7,22	0,34	0,14	0,48	3,49	9,66
48,52	1,37	34,36	6,29	0,32	0,16	0,25	1,75	8,10
72,74	1,22	7,61	4,45	0,19	0,07	0,26	1,03	11,75
70,89	1,61	8,14	4,58	0,18	0,08	0,21	1,57	11,69
72,21	2,06	8,00	4,85	0,39	0,10	0,38	1,54	11,71
59,89	1,95	17,65	7,09	0,29	0,09	0,36	1,22	10,90
71,99	1,45	9,03	4,65	0,25	0,08	0,40	2,17	9,96
55,86	1,35	24,64	5,89	0,26	0,10	0,29	2,60	8,88
56,73	1,44	22,01	6,46	0,31	0,10	0,44	2,71	8,56
75,66	1,09	5,95	4,12	0,12	0,10	0,36	3,11	9,61
67,60	1,40	15,56	3,40	0,12	0,12	0,53	2,07	9,43
68,39	1,47	14,53	4,79	0,14	0,09	0,38	3,32	8,69

Annex B 2.12

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %
PDK 37	199	8,00 - 8,65	0,65	40,54
PDK 37	200	9,80 - 10,60	0,80	40,13
PDK 38	330	0,00 - 0,80	0,80	48,56
PDK 38	331	0,80 - 1,60	0,80	46,77
PDK 38	332	1,60 - 2,80	1,20	30,95
PDK 38	333	2,80 - 3,80	1,00	46,77
PDK 38	334	3,80 - 5,00	1,20	30,06
PDK 39	326	0,0 - 1,15	1,15	48,75
PDK 39	327	1,15 - 2,00	0,85	26,37
PDK 39	328	2,00 - 3,00	1,00	46,83
PDK 39	329	3,00 - 4,00	1,00	40,51
PDK 40	324	0,0 - 1,00	1,00	46,28
PDK 40	325	1,00 - 1,80	0,80	37,78
PDK 41	318	0,0 - 1,00	1,00	50,90
PDK 41	319	1,00 - 2,00	1,00	51,17
PDK 41	320	2,00 - 3,00	1,00	46,22
PDK 41	321	3,00 - 4,00	1,00	45,12
PDK 41	322	4,00 - 5,00	1,00	40,99
PDK 41	323	5,00 - 5,90	0,90	33,25

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
57,97	1,30	19,19	9,11	0,67	0,10	0,34	3,31	8,66
57,38	1,50	20,81	8,70	0,34	0,44	0,26	4,37	7,36
69,44	2,20	9,66	4,94	0,12	0,08	0,26	2,60	10,08
66,88	1,84	14,30	4,75	0,15	0,08	0,22	2,19	9,52
44,26	1,27	40,98	5,33	0,31	0,06	0,14	1,81	6,66
66,88	2,10	11,83	6,48	0,23	0,08	0,28	2,42	10,14
55,86	2,00	20,40	8,34	0,23	0,14	0,34	2,48	9,45
69,71	1,73	13,11	3,94	0,24	0,04	0,24	2,88	9,52
37,70	0,74	46,30	5,88	0,94	0,08	0,14	1,91	6,31
66,97	2,16	11,23	7,00	0,40	0,07	0,29	2,75	10,40
57,93	1,85	22,50	6,15	0,36	0,07	0,25	3,08	8,53
66,18	1,73	12,23	7,11	0,36	0,11	0,27	3,79	9,11
54,03	1,85	25,69	6,59	0,31	0,11	0,23	3,52	7,53
72,78	1,66	6,13	5,14	0,11	0,06	0,29	2,95	10,46
73,18	1,89	6,38	4,43	0,13	0,05	0,23	3,15	10,43
66,09	1,93	11,07	6,49	0,22	0,09	0,38	3,12	9,39
64,52	2,07	11,23	7,88	0,15	0,08	0,43	3,14	9,73
58,62	1,86	21,21	6,05	0,12	0,06	0,40	2,40	8,62
47,55	1,46	33,39	5,88	0,28	0,08	0,39	2,15	7,43

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 42	335	0,0 - 1,00	1,00	51,72	73,96	1,51	7,04	4,08	0,07	0,09	0,29	2,23	10,63
PDK 42	336	1,00 - 2,00	1,00	44,57	63,73	1,11	15,97	6,20	0,22	0,08	0,23	1,86	10,17
PDK 42	337	2,00 - 3,00	1,00	39,75	56,85	1,62	19,34	8,30	0,36	0,08	0,41	2,10	10,20
PDK 42	338	3,00 - 4,00	1,00	40,90	58,48	1,85	19,20	7,31	0,25	0,07	0,35	2,18	9,69
PDK 42	339	4,00 - 4,90	0,90	35,21	50,35	1,56	30,95	6,30	0,26	0,08	0,38	2,40	7,65
PDK 43	360	0,0 - 1,05	1,05	54,28	77,62	1,57	3,69	2,90	0,14	0,06	0,30	0,99	11,75
PDK 43	361	1,05 - 2,00	0,95	49,09	70,19	1,97	7,69	6,10	0,32	0,13	0,40	0,77	12,57
PDK 43	362	2,00 - 3,25	1,25	41,51	59,37	1,79	19,05	6,73	0,26	0,09	0,28	0,73	11,03
PDK 43	363	3,25 - 4,60	1,35	24,68	35,30	0,94	48,30	6,22	0,25	0,11	0,18	0,51	7,24
PDK 44	432	0,0 - 1,05	1,05	54,32	77,68	1,20	5,55	2,49	0,18	0,08	0,43	2,65	9,69
PDK 44	433	1,05 - 1,70	0,65	48,33	69,12	1,57	11,65	4,08	0,25	0,08	0,26	2,66	10,10
PDK 44	434	1,70 - 2,30	0,60	45,84	65,55	1,50	16,25	3,77	0,15	0,14	0,37	2,34	9,50
PDK 44	435	2,30 - 3,20	0,90	50,13	71,69	1,79	8,92	3,97	0,27	0,08	0,23	2,70	10,22
PDK 45	364	0,0 - 1,00	1,00	51,80	74,07	1,31	7,07	3,59	0,13	0,08	0,33	2,36	10,18
PDK 45	365	1,00 - 2,40	1,40	48,95	70,01	1,93	9,68	4,72	0,18	0,06	0,21	2,47	10,30
PDK 45	366	2,40 - 3,00	0,60	33,59	48,03	0,68	36,17	5,02	0,63	0,08	0,44	1,75	6,74
PDK 45	367	3,00 - 4,00	1,00	45,41	64,93	1,76	12,58	7,12	0,42	0,09	0,35	2,62	9,75
PDK 45	368	4,00 - 5,30	1,30	43,93	62,83	2,05	13,47	7,18	0,38	0,10	0,32	2,58	9,86
PDK 45	369	5,30 - 6,55	1,25	37,34	53,40	1,73	24,44	7,35	0,42	0,10	0,25	2,50	8,63

Annex B 2.14

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 46	495	0,0 - 1,25	1,25	47,74	68,28	1,41	12,95	3,73	0,25	0,05	0,29	1,75	11,24
PDK 46	496	1,25 - 3,05	1,80	37,35	53,41	1,06	28,53	4,75	0,18	0,06	0,34	1,61	9,64
PDK 46	497	3,05 - 3,90	0,85	30,16	43,13	0,65	39,65	5,70	0,29	0,08	0,31	1,56	8,04
PDK 46	498	3,90 - 5,00	1,10	48,48	69,33	1,84	9,24	5,30	0,27	0,10	0,36	2,06	11,17
PDK 46	499	5,00 - 5,70	0,70	42,42	60,67	1,83	16,00	7,16	0,27	0,10	0,32	1,98	11,02
PDK 46	500	5,70 - 6,65	0,95	40,17	57,44	1,71	20,31	6,58	0,32	0,08	0,25	1,73	10,90
PDK 47	489	0,0 - 1,20	1,20	50,55	72,29	1,34	9,02	3,89	0,12	0,13	0,29	2,44	9,91
PDK 47	490	1,20 - 2,95	1,75	51,79	74,07	1,65	9,01	2,36	0,13	0,08	0,38	2,40	9,83
PDK 47	491	3,65 - 5,85	2,20	48,89	69,92	1,92	9,89	4,89	0,44	0,09	0,33	2,33	10,27
PDK 47	492	5,85 - 7,20	1,35	45,69	65,33	2,05	13,01	6,21	0,34	0,08	0,28	2,38	9,83
PDK 47	493	3,10 - 3,65	0,55	48,67	69,60	1,65	9,96	4,67	0,54	0,08	0,40	2,27	10,02
PDK 47	494	7,20 - 8,00	0,80	39,51	56,51	1,82	24,43	5,84	0,38	0,10	0,22	2,28	8,77
PDK 48	510	0,0 - 1,15	1,15	54,12	77,43	1,60	5,51	2,70	0,15	0,10	0,28	0,67	11,50
PDK 48	511	1,15 - 2,15	1,00	53,45	76,44	1,47	7,47	2,44	0,14	0,14	0,39	0,62	11,07
PDK 48	512	2,15 - 3,05	0,90	48,75	69,70	1,47	14,80	2,66	0,10	0,10	0,35	0,52	10,63
PDK 48	513	3,25 - 4,25	1,00	46,56	66,59	1,73	13,00	5,71	0,39	0,19	0,39	0,60	11,30
PDK 48	514	4,25 - 5,25	1,00	44,74	63,98	1,98	13,98	6,86	0,36	0,23	0,33	0,65	11,59
PDK 48	515	5,25 - 6,00	0,75	41,94	59,97	1,88	19,55	6,71	0,34	0,17	0,28	0,59	10,96

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PDK 49	502	0,40 - 1,25	0,85	52,19	74,63	1,66	6,45	3,91	0,15	0,10	0,39	2,32	10,43
PDK 49	503	1,25 - 2,60	1,35	47,85	68,43	1,65	10,59	5,27	0,25	0,11	0,36	2,35	10,90
PDK 49	504	2,60 - 3,15	0,55	36,10	51,62	1,09	30,52	5,47	0,27	0,13	0,26	1,89	8,35
PDK 49	505	3,15 - 3,85	0,70	36,44	52,10	1,20	27,33	6,93	0,33	0,11	0,22	2,17	9,57
PDK 49	506	3,85 - 4,55	0,70	34,90	49,91	1,09	34,08	4,55	0,16	0,09	0,27	1,93	8,16
PDK 49	507	4,55 - 5,75	1,20	36,37	52,02	1,26	24,67	8,58	0,80	0,13	0,36	2,14	9,26
PDK 49	508	5,75 - 6,10	0,35	32,25	46,11	1,05	31,47	8,41	0,44	0,13	0,23	2,10	9,12
PDK 49	509	6,10 - 7,50	1,40	35,60	50,91	1,56	27,40	7,22	0,43	0,15	0,27	2,55	8,74
PDK 50	436	1,15 - 1,60	0,45	52,11	74,52	1,67	7,62	3,09	0,16	0,07	0,45	2,64	9,92
PDK 50	437	1,60 - 2,15	0,55	49,17	70,32	1,83	10,12	3,84	0,26	0,08	0,45	2,80	9,95
PDK 50	438	2,15 - 2,95	0,80	51,13	73,12	2,02	8,38	3,08	0,23	0,07	0,47	2,68	10,04
PDK 50	439	2,95 - 3,20	0,25	34,09	48,74	1,26	25,23	11,13	0,69	0,09	0,19	2,05	10,27
PDK 51	440	0,0 - 0,60	0,60	47,36	67,72	1,38	17,59	1,60	0,16	0,09	0,73	2,28	8,66

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
DK 1	136	18,75 - 19,80	1,05	52,53
DK 1	137	19,80 - 20,57	0,77	51,11
DK 1	138	20,57 - 21,34	0,77	49,13
DK 1	139	22,85 - 24,17	1,32	51,97
DK 1	140	24,12 - 25,34	1,17	41,75
DK 1	142	25,34 - 25,79	0,45	40,61
DK 1	143	25,77 - 27,01	1,24	27,27
DK 2	128	17,17 - 19,90	2,73	56,38
DK 2	129	19,90 - 21,35	1,45	55,01
DK 2	130	21,35 - 21,95	0,60	51,16
DK 2	131	21,95 - 23,15	1,20	38,09
DK 2	132	23,15 - 24,35	1,20	51,57
DK 2	133	24,35 - 25,55	1,20	51,30
DK 2	134	25,55 - 26,75	1,20	48,89
DK 2	135	26,75 - 28,30	1,55	33,56
DK 3	272	20,70 - 22,11	1,41	52,51
DK 3	273	22,11 - 24,40	2,39	50,24
DK 3	274	24,40 - 25,60	1,20	49,96
DK 3	275	25,60 - 26,50	0,90	49,67
DK 3	276	26,50 - 27,40	0,90	47,12

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
75,12	2,15	5,42	3,98	0,14	0,12	0,24	2,98	10,83
73,09	2,42	4,41	4,41	0,14	0,11	0,20	2,92	11,41
70,25	2,40	9,00	4,98	0,26	0,11	0,39	3,23	9,73
74,31	2,63	4,64	4,85	0,24	0,12	0,45	2,52	10,78
59,70	1,31	24,37	3,36	0,14	0,09	0,78	2,43	8,15
58,07	1,98	21,55	5,81	0,28	0,14	0,39	3,82	7,78
39,00	1,27	46,61	5,03	0,28	0,14	0,34	2,94	4,88
80,62	1,56	2,01	2,76	0,11	0,20	1,14	2,89	10,17
78,65	1,88	2,46	2,92	0,11	0,19	0,47	2,94	11,00
73,15	1,49	7,90	3,40	0,15	0,18	0,40	2,91	9,93
54,45	1,34	29,11	3,32	0,24	0,16	0,73	3,01	6,86
73,75	2,06	5,90	4,22	0,34	0,16	0,66	3,23	9,76
73,35	2,31	5,41	4,86	0,32	0,17	0,56	3,90	9,39
69,91	2,14	7,68	4,95	0,29	0,12	0,55	3,62	9,46
47,98	1,47	31,89	6,09	0,41	0,15	0,43	4,46	5,73
75,09	1,80	3,41	4,24	0,15	0,12	0,70	2,37	11,23
71,84	2,02	9,02	3,27	0,19	0,08	0,53	2,96	10,65
71,44	2,25	7,74	5,12	0,50	0,08	0,48	2,66	10,29
71,03	2,28	7,87	5,25	0,36	0,12	0,48	2,79	10,25
67,38	1,97	13,93	4,33	0,27	0,08	0,48	2,78	9,25

Annex B 2.17

ANALYSES RESU

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %
DK 4	161	19,50 - 20,20	0,70	51,43	73,55	1,89
DK 4	162	20,20 - 21,40	1,20	53,03	75,91	2,18
DK 4	163	21,40 - 22,60	1,20	50,75	72,57	1,84
DK 4	164	22,60 - 23,80	1,20	52,81	75,52	2,23
DK 4	165	23,80 - 25,00	1,20	50,88	72,76	2,10
DK 4	166	25,00 - 26,20	1,20	49,06	70,16	2,32
DK 4	167	26,20 - 27,20	1,00	47,45	67,85	2,18
DK 4	168	27,20 - 28,00	0,80	46,21	66,08	1,89
DK 5	169	22,50 - 23,61	1,11	52,37	74,89	1,37
DK 5	170	23,61 - 25,13	1,52	50,74	72,56	1,62
DK 5	171	25,90 - 26,54	0,64	34,91	49,92	1,33
DK 5	172	26,54 - 27,14	0,60	46,04	65,83	1,72
DK 5	173	27,14 - 28,40	1,26	47,55	68,00	1,99
DK 6	174	20,95 - 22,25	1,30	52,11	74,52	1,27
DK 6	175	23,45 - 24,05	0,60	47,09	67,33	1,94
DK 6	176	24,05 - 25,00	0,95	46,96	67,15	1,96
DK 7	177	19,40 - 20,65	1,25	51,81	74,09	1,33
DK 7	178	20,65 - 21,85	1,20	51,95	74,28	1,69
DK 7	179	21,85 - 22,70	0,85	41,09	58,76	1,51

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SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
5,74	5,63	0,21	0,11	0,53	3,62	9,79
3,34	4,37	0,11	0,10	0,90	3,35	10,46
7,38	6,10	0,31	0,10	0,55	2,93	9,67
4,64	4,84	0,20	0,07	0,38	3,14	10,66
8,16	5,38	0,36	0,11	0,50	2,55	9,74
8,31	5,97	0,32	0,10	0,52	2,94	9,65
10,02	7,13	0,39	0,27	0,61	2,88	9,43
13,13	6,41	0,24	0,78	0,33	2,61	9,08
4,66	4,76	0,23	0,18	0,93	2,31	10,50
6,34	5,24	0,16	0,20	0,58	2,85	10,26
35,00	3,70	0,21	0,14	0,30	2,19	6,24
13,58	7,49	0,65	0,14	0,61	2,71	9,00
11,10	6,75	0,60	0,12	0,45	1,96	10,01
8,78	2,84	0,21	0,07	0,37	1,87	10,89
12,42	4,35	0,61	0,09	0,48	2,31	9,56
13,18	4,61	0,74	0,12	0,33	2,56	9,25
6,38	4,07	0,13	0,24	0,39	1,74	10,77
5,11	5,00	0,17	0,06	0,31	2,86	10,92
23,55	5,69	0,42	0,09	0,33	1,93	8,28

Annex B 2.18

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %
DK 7	180	22,70 - 23,30	0,60	46,93
DK 7	181	24,15 - 25,65	1,50	44,53
DK 8	245	21,90 - 23,10	1,20	52,04
DK 8	246	23,10 - 23,70	0,60	50,81
DK 8	247	24,30 - 25,50	1,20	41,88
DK 8	248	26,05 - 26,75	0,70	39,96
DK 8	249	26,75 - 27,80	1,05	49,30
DK 8	250	27,80 - 28,30	0,50	44,49
DK 9	399	18,85 - 21,32	2,47	52,87
DK 9	400	21,32 - 22,08	0,76	26,07
DK 9	401	23,30 - 24,80	1,50	47,38
DK 9	402	24,80 - 25,45	0,65	44,33
DK 10	296	20,70 - 22,22	1,52	53,24
DK 10	297	22,22 - 23,61	1,39	51,11
DK 10	298	23,61 - 24,37	0,76	41,03
DK 10	299	25,46 - 26,66	1,20	48,13
DK 10	300	26,66 - 27,96	1,30	43,45
DK 11	285	17,45 - 19,25	1,80	53,56

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
67,11	1,83	11,78	5,78	0,66	0,10	0,38	1,67	10,29
63,67	2,02	13,03	6,79	0,32	0,00	0,49	1,77	10,31
74,43	1,48	8,73	3,06	0,22	0,13	0,32	1,90	11,02
72,66	1,56	8,55	3,46	0,28	0,17	0,25	2,09	11,28
59,90	1,48	24,39	4,13	0,41	0,17	0,20	2,69	7,74
57,14	1,56	23,92	5,40	0,81	0,20	0,27	3,65	7,40
70,50	2,39	8,32	4,21	0,36	0,15	0,36	3,15	9,84
63,63	2,03	16,51	4,72	0,41	0,17	0,36	3,23	9,03
75,60	1,62	4,74	3,83	0,13	0,09	0,26	1,45	12,15
37,28	0,88	52,89	2,51	0,21	0,10	0,13	1,81	5,55
67,75	2,25	10,51	5,81	0,35	0,06	0,37	1,90	10,82
63,39	2,04	17,95	4,69	0,25	0,07	0,31	1,43	10,22
76,13	1,56	5,49	3,27	0,41	0,12	0,21	2,80	10,07
73,09	1,67	11,05	2,95	0,27	0,10	0,21	2,88	9,33
58,68	1,38	26,49	3,49	0,24	0,12	0,20	2,61	7,81
68,83	2,37	9,71	5,58	0,46	0,17	0,35	4,28	8,60
62,13	2,09	17,62	6,07	0,50	0,15	0,44	4,42	7,63
76,59	1,59	5,29	3,10	0,19	0,12	0,34	2,45	10,69

Annex B 2.19

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
DK 11	286	19,25 - 21,65	2,40	45,18	64,61	1,47	20,01	2,20	0,19	0,13	0,30	2,30	8,91
DK 11	287	21,65 - 22,15	0,50	47,52	67,95	1,57	13,70	3,60	0,63	0,18	0,38	2,15	10,00
DK 11	288	22,15 - 22,85	0,70	50,95	72,86	1,91	9,01	3,67	0,45	0,20	0,34	2,72	9,85
DK 11	289	22,85 - 24,05	1,20	47,24	67,55	2,22	11,04	4,49	0,45	0,18	0,40	2,04	10,84
DK 11	290	24,05 - 24,75	0,70	39,28	56,16	1,89	25,25	4,07	0,43	0,17	0,31	1,94	8,75
DK 12	157	17,40 - 19,80	2,40	55,01	78,26	2,10	3,56	2,82	0,22	0,04	0,33	2,24	10,97
DK 12	158	21,35 - 22,70	1,35	52,81	75,52	2,63	4,88	3,57	0,30	0,14	0,48	2,26	10,66
DK 12	159	22,70 - 23,30	0,60	49,78	71,19	2,43	9,82	4,44	0,27	0,12	0,44	2,86	9,53
DK 12	160	23,30 - 24,70	1,40	20,63	29,50	0,79	56,78	4,54	0,75	0,14	0,14	3,02	3,53
DK 13	143	20,85 - 22,00	1,15	53,65	76,71	1,90	4,08	4,34	0,16	0,08	0,20	3,58	10,43
DK 13	144	22,00 - 23,20	1,20	52,23	74,68	2,32	4,64	4,39	0,18	0,08	0,23	3,51	10,85
DK 13	145	23,20 - 23,80	0,60	49,41	70,65	2,11	8,38	4,70	0,26	0,10	0,25	2,35	11,03
DK 13	146	23,80 - 24,40	0,60	49,13	70,25	2,00	7,87	5,88	0,42	0,08	0,43	2,59	10,56
DK 13	147	24,40 - 25,60	1,20	47,97	68,60	2,35	7,80	6,93	0,41	0,10	0,45	3,73	9,82
DK 13	148	25,60 - 26,20	0,60	47,69	68,19	2,34	9,32	6,66	0,36	0,10	0,40	3,02	10,38
DK 13	149	26,20 - 26,80	0,60	44,99	64,33	2,08	15,16	5,94	0,26	0,10	0,43	2,29	10,25
DK 13	150	26,80 - 28,00	1,20	36,76	52,56	1,75	27,62	7,33	0,41	0,12	0,32	2,56	8,49
DK 13	151	28,00 - 28,85	0,85	35,34	50,53	1,71	30,85	6,64	0,32	0,20	0,26	2,14	8,14
DK 14	152	21,32 - 22,85	1,53	53,03	75,91	1,98	4,16	4,57	0,20	0,08	0,22	2,29	11,41

Annex B 2.20

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
DK 14	153	22,85 - 24,65	1,80	53,36
DK 14	154	24,65 - 25,65	1,00	49,51
DK 14	155	25,65 - 26,82	1,17	50,06
DK 14	156	26,82 - 28,30	1,48	38,51
DK 15	411	9,80 - 11,20	1,40	50,94
DK 15	412	11,20 - 12,40	1,20	48,44
DK 15	413	13,75 - 14,20	0,45	50,55
DK 15	414	14,20 - 14,80	0,60	47,48
DK 15	415	14,80 - 15,50	0,70	47,47
DK 15	416	15,50 - 16,05	0,55	42,12
DK 16	442	30,45 - 32,25	1,80	52,73
DK 16	443	32,25 - 33,95	1,70	51,76
DK 16	444	33,95 - 34,70	0,75	33,93
DK 16	445	34,70 - 35,75	1,05	33,66
DK 16	446	35,75 - 36,85	1,10	49,15
DK 17	380	30,90 - 33,50	2,60	51,77
DK 17	381	33,50 - 34,40	0,90	45,59
DK 17	382	34,40 - 35,90	1,50	35,16
DK 17	383	35,90 - 38,60	2,70	49,99
DK 17	384	38,60 - 39,55	0,95	36,39

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
76,30	2,34	5,01	3,67	0,24	0,06	0,29	2,06	11,12
70,80	2,37	7,92	5,60	0,32	0,07	0,39	2,28	10,93
71,58	2,36	8,11	5,24	0,25	0,05	0,41	2,41	10,53
55,06	1,81	25,08	5,19	0,36	0,06	0,26	2,40	8,15
72,85	1,32	9,49	3,47	0,19	0,10	0,24	1,13	11,04
69,26	1,80	12,76	3,45	0,18	0,12	0,19	1,01	11,09
72,29	2,03	9,90	3,72	0,35	0,10	0,29	0,97	10,81
67,90	2,30	10,40	5,75	0,50	0,12	0,34	1,31	11,08
67,88	2,28	12,23	5,77	0,31	0,12	0,29	1,09	11,11
60,23	2,05	20,60	5,74	0,43	0,12	0,29	0,80	10,27
75,40	1,45	5,39	2,68	0,13	0,10	0,23	0,84	12,35
74,01	1,41	9,02	2,03	0,13	0,07	0,22	0,97	11,10
48,53	0,73	35,34	5,55	0,86	0,12	0,33	0,90	7,78
48,13	0,78	34,08	5,80	0,84	0,14	0,36	0,95	8,79
70,29	2,00	10,91	3,54	0,26	0,10	0,24	0,78	11,26
74,03	1,65	6,73	3,02	0,23	0,06	0,28	2,45	12,27
65,20	2,18	16,03	3,75	0,39	0,06	0,30	3,08	8,93
50,56	1,21	34,34	3,97	0,41	0,10	0,29	2,06	7,51
71,48	2,39	8,81	4,28	0,38	0,08	0,28	2,48	10,67
52,04	1,76	31,68	5,00	0,50	0,09	0,24	2,32	7,89

Annex B 2.21

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %
DK 18	375	25,30 - 27,10	1,80	51,22
DK 18	376	27,10 - 28,90	1,80	38,99
DK 18	377	28,90 - 30,30	1,40	34,19
DK 18	378	30,30 - 32,30	2,00	50,26
DK 18	379	32,30 - 32,90	0,60	47,52
DK 19	373	18,20 - 19,80	1,60	54,66
DK 19	374	22,52 - 25,40	1,88	52,05
DK 20	385	4,00 - 6,00	2,00	26,09
DK 20	386	6,00 - 6,55	0,55	27,85
DK 20	387	6,55 - 8,35	1,80	36,53
DK 20	388	19,65 - 21,80	2,15	50,54
DK 20	389	21,80 - 22,75	0,95	40,90
DK 20	390	22,75 - 26,00	3,25	48,34
DK 20	391	26,00 - 27,20	1,20	47,79
DK 21	392	17,51 - 19,80	2,29	49,50
DK 21	393	19,80 - 21,00	1,20	40,43
DK 21	394	21,00 - 23,15	2,15	49,57
DK 21	395	23,15 - 24,40	1,25	47,33

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
73,25	1,57	10,28	2,69	0,26	0,12	0,26	2,28	10,16
55,76	1,41	31,53	2,06	0,18	0,08	0,18	2,18	7,37
48,90	1,32	38,49	2,2[illegible]	0,35	0,12	0,16	2,66	5,97
71,87	2,47	7,65	3,77	0,39	0,08	0,29	3,16	10,01
67,95	1,61	16,05	2,24	0,12	0,08	0,25	2,16	9,65
78,16	1,43	5,36	2,38	0,20	0,13	0,29	2,92	9,96
74,43	2,51	6,65	3,87	0,34	0,07	0,28	2,88	9,96
37,31	0,20	39,32	10,37	0,50	0,10	0,56	4,42	5,77
39,82	0,35	47,41	5,46	0,26	0,06	0,06	2,04	5,60
52,24	0,64	33,74	3,97	0,19	0,06	0,11	2,07	7,18
72,27	1,62	9,75	4,36	0,20	0,04	0,25	2,40	10,50
58,48	1,62	24,00	5,26	0,38	0,08	0,28	2,62	7,84
69,13	2,20	10,15	5,58	0,48	0,06	0,30	3,46	9,54
68,34	2,15	13,44	4,32	0,25	0,08	0,30	2,92	9,22
70,78	1,68	11,53	3,52	0,18	0,06	0,31	1,67	11,10
57,82	1,54	28,88	2,18	0,23	0,09	0,29	1,68	7,93
70,88	2,30	7,03	4,75	0,34	0,10	0,37	1,20	11,66
67,68	2,29	11,61	4,39	0,24	0,08	0,27	1,43	10,95

Annex B 2.22

ANALYSES RESUL

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %
DK 22	396	3,25 - 6,90	3,65	40,24	57,54	0,78
DK 22	397	17,90 - 21,85	3,95	53,76	76,88	1,81
DK 22	398	21,85 - 25,35	3,50	50,29	71,92	2,42
DK 23	540	19,20 - 22,85	3,65	51,39	73,49	1,74
DK 23	541	23,60 - 24,20	0,60	44,83	64,10	1,95
DK 23	542	24,20 - 25,00	0,80	47,48	67,90	2,30
DK 23	543	25,00 - 26,20	1,20	35,61	50,92	1,68
DK 23	544	26,20 - 27,40	1,20	36,73	52,52	1,77
DK 24	465	12,80 - 13,25	0,55	40,83	58,38	0,89
DK 24	466	22,20 - 23,05	0,85	52,69	75,35	1,70
DK 24	467	23,05 - 24,25	1,20	52,56	75,16	1,83
DK 24	468	24,25 - 25,00	0,75	48,03	68,69	1,95
DK 24	469	25,00 - 25,25	0,25	51,38	73,47	1,98
DK 24	470	25,25 - 28.45	3,20	49,01	70,08	2,05
DK 24	471	28,45 - 29,55	1,10	28,57	40,86	1,33
DK 25	447	6,80 - 7,30	0,50	41,79	59,77	1,02
DK 25	448	19,40 - 20,70	1,30	49,48	70,75	2,10
DK 25	449	20,70 - 21,90	1,20	47,81	68,38	1,75
DK 25	450	21,90 - 23,15	1,25	45,95	65,70	2,10
DK 25	451	23,15 - 24,65	1,50	38,89	55,61	1,79

TS

SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%
28,35	3,67	0,06	0,06	0,14	2,50	7,47
4,10	3,95	0,08	0,06	0,29	2,79	11,04
6,85	4,67	0,25	0,06	0,34	3,00	10,03
8,08	3,37	0,21	0,06	0,32	0,94	11,76
15,97	5,19	0,34	0,10	0,35	0,92	11,13
11,34	5,00	0,29	0,08	0,42	0,99	11,38
31,01	6,00	0,39	0,09	0,33	0,86	9,19
32,07	4,68	0,29	0,09	0,35	0,78	8,65
22,93	5,63	0,24	0,08	0,12	0,86	9,49
5,31	4,08	0,20	0,07	0,26	0,94	11,66
6,90	3,24	0,16	0,11	0,47	0,93	11,49
9,39	6,16	0,61	0,12	0,38	0,97	11,35
9,25	2,93	0,23	0,07	0,31	0,83	11,39
8,66	5,02	0,34	0,10	0,37	0,84	11,63
43,32	5,26	0,51	0,14	0,17	0,70	7,21
25,96	2,59	0,16	0,08	0,10	1,04	9,24
8,20	4,30	0,25	0,12	0,36	1,29	12,29
14,49	1,94	0,14	0,10	0,52	1,04	12,56
14,47	4,98	0,36	0,12	0,40	0,83	11,35
27,97	4,72	0,40	0,12	0,23	1,12	8,80

Annex B 2.23

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
DK 26	452	33,55 - 34,00	0,45	56,14
DK 26	453	34,00 - 35,95	1,95	49,71
DK 26	454	35,95 - 37,20	1,25	53,76
DK 26	455	37,20 - 37,95	0,75	41,48
DK 27	441	36,10 - 36,70	0,60	56,05
DK 28	370	22,31 - 24,37	2,06	54,70
DK 28	371	24,37 - 25,90	1,53	51,15
DK 28	372	25,90 - 27,10	1,20	50,63
DK 32	456	6,10 - 7,60	1,50	41,34
DK 32	457	18,40 - 19,90	1,50	54,88
DK 32	458	20,40 - 20,60	0,20	52,93
DK 32	459	20,60 - 21,30	0,70	29,47
DK 32	460	21,30 - 23,60	2,30	42,17
DK 33	651	16,35 - 18,40	2,05	48,85
DK 33	652	18,40 - 20,50	2,10	43,70
DK 33	653	20,50 - 21,55	1,05	38,43
DK 34	654	21,16 - 21,70	0,54	55,12
DK 34	655	21,70 - 22,30	0,60	24,97

ANALYSES RESULTS

Fe_2O_3	P_2O_5	SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%	%	%
80,28	1,52	3,27	2,92	0,14	0,07	0,33	1,19	11,69
71,09	1,78	11,50	3,30	0,24	0,09	0,42	1,11	10,76
76,88	2,20	3,85	3,12	0,18	0,09	0,43	1,06	11,91
59,31	1,57	25,89	3,62	0,23	0,08	0,46	0,97	8,34
80,15	1,46	2,00	1,90	0,13	0,12	0,40	0,94	11,55
78,22	1,41	2,98	2,90	0,14	0,11	0,31	0,70	12,03
73,14	1,59	11,12	2,18	0,13	0,08	0,24	0,70	11,29
72,40	1,61	11,92	1,92	0,13	0,11	0,25	0,86	11,14
59,11	0,83	24,73	4,91	0,29	0,06	0,32	0,94	11,76
78,48	2,05	3,26	3,13	0,19	0,10	0,35	0,92	11,13
75,69	2,17	5,47	3,72	0,29	0,08	0,42	0,99	11,38
42,14	1,12	40,59	5,46	0,44	0,09	0,33	0,86	9,19
60,31	1,90	18,84	5,93	0,35	0,09	0,35	0,78	8,65
69,86	2,12	8,87	5,84	0,36	0,14	0,41	1,07	11,54
62,48	2,06	16,57	6,38	0,31	0,15	0,36	0,75	11,10
54,95	1,79	26,39	5,74	0,38	0,14	0,26	0,97	9,36
78,82	1,27	3,10	3,66	0,13	0,09	0,28	0,72	12,45
35,70	0,68	30,14	18,23	0,95	0,50	0,11	1,07	11,25

Annex B 2.24

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
DK 34	656	22,30 - 23,60	1,30	53,86
DK 34	657	23,60 - 26,50	2,90	51,33
DK 34	658	26,50 - 28,75	2,25	44,88
DK 35	644	23,10 - 23,70	0,60	55,01
DK 35	645	23,70 - 24,90	1,20	29,96
DK 35	646	24,90 - 25,20	0,30	53,61
DK 35	647	25,20 - 25,80	0,60	29,96
DK 35	648	25,80 - 27,60	1,80	50,81
DK 35	649	27,60 - 29,20	1,60	48,43
DK 35	650	29,20 - 30,45	1,25	46,89
DK 36	526	7,55 - 11,25	3,70	39,80
DK 36	527	21,95 - 24,35	2,40	50,55
DK 36	528	24,35 - 25,55	1,20	30,72
DK 36	529	25,55 - 27,60	2,05	50,55
DK 37	659	24,75 - 25,50	0,75	50,81
DK 37	660	25,50 - 27,35	1,85	52,37
DK 37	661	27,35 - 27,95	0,60	47,91
DK 37	662	27,95 - 29,15	1,20	32,79
DK 37	663	29,15 - 30,15	1,00	48,80

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	$CaO + MgO$ %	MnO %	L.O.I. %	Hydrates (500°) %
77,02	1,75	4,72	3,60	0,15	0,09	0,39	0,88	11,91
73,41	2,29	5,57	5,68	0,38	0,12	0,36	0,56	12,23
64,18	2,12	17,19	4,38	0,25	0,12	0,26	0,55	10,60
78,67	1,81	3,42	2,89	0,21	0,08	0,32	1,62	11,25
42,84	1,01	45,08	2,96	0,17	0,11	0,14	0,89	6,88
76,66	2,13	5,03	2,75	0,17	0,06	0,14	1,35	11,98
42,84	1,12	42,41	4,44	0,62	0,14	0,14	1,55	6,55
72,66	2,36	6,82	4,87	0,42	0,09	0,30	1,43	11,36
69,26	2,51	8,18	6,00	0,42	0,14	0,26	1,20	11,83
67,06	2,45	13,04	4,52	0,39	0,11	0,25	1,19	10,92
56,91	0,73	30,36	3,80	0,16	0,08	0,13	0,75	8,55
72,29	1,61	9,85	3,48	0,14	0,11	0,24	0,89	11,42
43,93	1,13	42,36	3,79	0,25	0,13	0,29	0,70	7,44
72,29	2,32	6,58	4,60	0,34	0,16	0,38	0,84	12,07
72,66	1,36	9,53	3,65	0,21	0,08	0,28	1,73	10,78
74,88	1,55	8,20	2,12	0,22	0,07	0,29	1,34	11,57
68,51	1,49	15,75	2,20	0,14	0,08	0,33	0,79	10,98
46,89	1,06	39,05	3,45	0,49	0,10	0,26	1,55	7,08
69,79	1,99	8,51	5,81	0,57	0,09	0,32	2,18	10,75

Annex B 2.25

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
DK 37	664	30,15 - 31,70	1,55	50,98
DK 37	665	31,70 - 32,40	0,70	44,23
DK 38	747	15,10 - 16,55	1,45	51,12
DK 38	748	16,55 - 17,80	1,25	51,12
DK 38	749	17,80 - 18,50	0,70	43,58
DK 38	750	18,50 - 18,90	0,40	13,83
DK 38	751	18,90 - 21,00	2,10	45,68
DK 38	752	21,00 - 21,65	0,65	36,88
DK 39	708	18,00 - 18,30	0,30	46,79
DK 39	709	18,30 - 19,20	0,90	53,50
DK 39	710	19,20 - 19,80	0,60	43,02
DK 39	711	19,80 - 22,05	2,25	18,58
DK 39	712	22,05 - 22,55	0,50	44,28
DK 39	713	22,55 - 23,45	0,90	51,12
DK 39	714	23,45 - 24,25	0,80	42,88
DK 40	715	20,40 - 22,20	1,80	52,54
DK 40	716	22,20 - 23,45	1,25	41,64
DK 40	717	23,45 - 24,80	1,35	20,68
DK 40	718	24,80 - 25,90	1,10	49,05
DK 40	719	25,90 - 26,50	0,60	45,70

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
72,91	2,52	5,61	5,22	0,32	0,07	0,26	1,98	11,31
63,25	2,07	17,42	4,90	0,38	0,12	0,26	1,68	10,07
73,11	2,06	8,51	2,95	0,23	0,04	0,23	1,06	11,77
73,11	2,30	7,05	4,18	0,24	0,06	0,31	0,78	12,24
62,32	1,98	20,54	3,26	0,26	0,07	0,21	1,15	9,96
19,77	0,46	60,94	9,39	2,30	0,08	0,05	2,17	4,55
65,32	2,34	12,63	5,71	0,42	0,08	0,36	0,99	11,58
52,73	1,88	27,28	6,69	0,47	0,11	0,31	1,24	9,55
66,91	1,42	13,10	5,35	0,42	0,10	0,16	1,47	11,30
76,50	1,75	5,90	2,39	0,17	0,06	0,18	1,59	11,57
61,52	1,71	24,11	2,14	0,23	0,06	0,14	1,08	9,50
26,57	0,48	63,64	3,41	0,39	0,10	0,17	0,58	4,68
63,32	1,97	13,09	7,32	0,66	0,11	0,27	1,72	11,03
73,11	2,45	5,53	5,30	0,35	0,09	0,28	1,05	12,26
61,32	2,19	19,30	5,07	0,44	0,09	0,27	1,20	10,40
75,14	1,66	5,71	3,90	0,21	0,12	0,27	0,98	12,21
59,55	1,53	24,81	3,62	0,29	0,13	0,26	0,64	9,56
29,57	0,73	54,71	6,23	0,95	0,19	0,12	0,53	6,19
70,14	2,39	8,00	5,94	0,35	0,13	0,55	0,68	12,09
65,34	2,28	15,16	5,12	0,31	0,13	0,44	0,61	11,05

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
DK 41	742	22,40 - 22,85	0,45	49,27	70,46	1,38	9,57	5,42	0,33	0,11	0,25	1,36	11,43
DK 41	743	22,85 - 23,75	0,90	47,59	68,06	1,39	11,47	5,26	0,27	0,09	0,18	1,19	11,71
DK 41	744	23,75 - 25,25	1,50	51,65	73,86	1,59	7,56	3,31	0,17	0,08	0,19	1,03	12,18
DK 41	745	25,25 - 27,05	1,80	24,22	34,63	0,75	47,66	6,75	1,14	0,12	0,14	0,83	7,21
DK 41	746	27,05 - 28,45	1,40	45,77	65,45	2,22	13,96	5,14	0,53	0,12	0,36	0,88	11,15
DK 42	765	22,30 - 25,20	2,90	52,50	75,08	1,76	5,02	3,64	0,15	0,10	0,37	2,15	12,11
DK 42	766	25,20 - 26,90	1,70	21,74	31,08	0,51	42,55	12,52	2,09	0,14	0,28	1,58	8,41
DK 42	767	26,90 - 28,95	2,05	46,46	66,44	2,04	12,41	5,21	0,41	0,09	0,45	1,87	10,60
DK 43	768	20,75 - 22,40	1,65	52,63	75,26	2,08	4,79	3,40	0,38	0,11	0,56	1,68	11,94
DK 43	769	22,40 - 23,55	1,15	49,45	70,71	2,03	9,37	3,74	0,27	0,08	0,32	1,80	11,61
DK 43	770	23,55 - 23,95	0,40	23,80	34,03	1,10	52,59	4,63	0,62	0,10	0,19	1,23	5,94
DK 43	771	23,95 - 25,15	1,20	46,77	66,88	1,93	14,37	3,57	0,58	0,11	0,43	1,44	10,46
DK 43	772	25,15 - 26,50	1,35	49,15	70,29	1,98	10,29	4,26	0,74	0,10	0,30	1,26	10,87
DK 44	760	20,90 - 23,05	2,15	46,79	66,91	1,74	13,16	4,63	0,33	0,08	0,36	1,83	10,91
DK 44	761	23,05 - 23,35	0,30	22,91	32,76	0,98	52,77	4,82	0,56	0,12	0,18	1,53	5,79
DK 44	762	23,35 - 23,65	0,30	46,86	67,01	1,95	12,91	4,85	0,68	0,11	0,47	1,54	10,64
DK 44	763	23,65 - 25,15	1,50	48,89	69,91	2,00	9,67	4,74	0,62	0,11	0,37	2,00	10,48
DK 44	764	25,15 - 27,60	2,45	47,21	67,51	2,10	10,95	5,31	0,63	0,12	0,29	1,93	10,43

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
DK 45	753	17,40 - 19,70	2,30	53,99	77,20	2,03	3,34	2,54	0,14	0,09	0,62	1,81	11,78
DK 45	754	19,70 - 20,00	0,30	39,94	57,11	1,27	28,69	1,83	0,14	0,12	0,78	1,78	7,78
DK 45	755	20,00 - 20.40	0,40	27,06	38,70	0,93	45,95	4,58	0,39	0,18	0,73	1,31	6,95
DK 45	756	20,40 - 21,40	1,00	46,42	66,37	1,89	13,15	5,13	0,44	0,14	0,69	1,77	10,49
DK 45	757	21,40 - 22,55	1,15	51,28	73,33	2,37	5,57	4,39	0,41	0,11	0,39	1,92	11,11
DK 45	758	22,55 - 24,05	1,50	50,20	71,79	2,42	6,29	5,51	0,35	0,10	0,43	1,87	11,34
DK 45	759	24,05 - 25,05	1,05	49,36	70,59	2,15	9,72	3,39	0,23	0,11	0,37	2,06	10,49
DK 46	777	17,15 - 20,60	3,45	52,94	75,70	2,15	3,88	3,15	0,24	0,07	0,49	0,84	12,86
DK 46	778	20,60 - 21,40	0,80	31,15	44,54	1,04	40,70	4,15	0,41	0,22	0,50	0,83	8,16
DK 46	779	21,40 - 23,30	1,90	49,17	70,31	2,30	8,02	5,41	0,45	0,11	0,39	1,48	11,40
DK 46	780	23,30 - 25,50	2,20	47,49	67,91	2,23	10,63	5,43	0,30	0,11	0,48	0,89	11,95
DK 46	781	25,50 - 26,70	1,20	31,71	45,34	1,42	33,90	7,69	0,77	0,12	0,31	1,16	9,23
DK 47	782	17,95 - 19,60	1,65	49,69	71,06	2,07	7,27	4,59	0,27	0,07	0,31	1,76	11,94
DK 47	783	19,60 - 20,20	0,60	25,27	36,13	1,06	49,26	5,25	0,39	0,09	0,19	1,42	6,30
DK 47	784	20,20 - 20,80	0,60	42,30	60,49	1,36	21,34	4,86	0,46	0,08	0,36	2,16	8,88
DK 47	785	20,80 - 22,30	1,50	49,28	70,47	2,24	8,17	5,10	0,44	0,07	0,46	2,50	10,28
DK 47	786	22,30 - 24,10	1,80	49,84	71,27	2,43	5,86	5,93	0,30	0,07	0,49	2,76	10,73
DK 47	787	24,10 - 25,60	1,40	45,34	64,84	2,21	11,90	6,77	0,32	0,12	0,58	3,02	9,90
DK 47	788	25,60 - 26,80	1,20	30,46	43,56	1,42	38,07	5,91	0,50	0,16	0,38	2,05	7,08

ANALYSES RESULT

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %
DK 48	773	15,25 - 17,35	2,10	52,54	75,14	2,39
DK 48	774	17,35 - 17,95	0,60	40,66	58,15	1,75
DK 48	775	17,95 - 20,85	2,90	47,93	68,54	2,30
DK 48	776	20,85 - 21,95	1,10	41,36	59,15	2,00
DK 49	794	18,65 - 20,85	2,20	52,10	74,50	2,43
DK 49	795	20,85 - 21,20	0,35	42,35	60,56	1,26
DK 49	796	21,20 - 24,10	2,90	46,84	66,98	2,16
DK 49	797	24,10 - 25,00	0,90	35,76	51,14	1,68
DK 49	798	25,00 - 25,55	0,55	29,03	41,51	1,29
DK 50	472	9,95 - 10,40	0,45	39,66	56,71	1,02
DK 50	473	20,65 - 22,90	2,25	52,37	74,89	1,90
DK 50	474	22,90 - 23,20	0,30	47,48	67,90	1,98
DK 50	475	23,20 - 26,80	3,60	45,11	64,50	2,13
DK 51	789	20,50 - 21,60	1,10	51,86	74,17	1,75
DK 51	790	21,60 - 21,95	0,35	43,97	62,89	1,57
DK 51	791	21,95 - 23,15	1,20	49,42	70,67	2,23
DK 51	792	23,15 - 24,20	1,05	48,80	69,07	2,12
DK 51	793	24,20 - 24,80	0,60	39,23	56,10	1,61
DK 52	476	22,90 - 24,15	1,25	53,49	76,48	2,05
DK 52	477	24,15 - 26,80	2,65	48,18	68,90	2,20

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SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
5,03	3,63	0,19	0,12	0,33	1,26	11,94
21,89	5,86	0,57	0,22	0,42	1,39	9,62
9,82	5,19	0,47	0,16	0,60	1,44	11,03
21,24	5,14	0,43	0,19	0,52	1,36	9,83
5,40	3,48	0,17	0,08	0,20	1,89	11,55
20,20	5,10	0,48	0,11	0,34	1,46	9,90
10,56	5,72	0,38	0,11	0,41	1,53	11,37
29,53	5,86	0,42	0,11	0,38	2,15	8,26
42,61	4,85	0,37	0,12	0,18	1,89	6,65
28,79	3,28	0,14	0,06	0,21	1,04	8,98
5,93	3,91	0,18	0,08	0,37	1,08	12,30
11,71	5,26	0,38	0,08	0,31	1,13	11,16
14,43	5,31	0,31	0,10	0,42	1,08	11,29
5,23	3,99	0,26	0,08	0,24	2,86	11,01
18,49	4,55	0,51	0,09	0,40	2,28	9,35
6,43	4,45	0,40	0,08	0,51	2,71	10,65
9,95	4,52	0,23	0,08	0,34	2,77	10,76
25,32	4,80	0,27	0,07	0,33	2,39	8,86
5,44	3,13	0,25	0,07	0,44	1,00	11,84
9,82	5,55	0,41	0,08	0,41	0,91	11,71

Annex B 2.29

ANALYSES RESULT

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %
DK 53	681	20,10 - 21,95	1,85	50,18	71,75	1,55
DK 53	682	21,95 - 22,85	0,90	51,73	73,97	2,11
DK 53	683	22,85 - 23,15	0,30	39,46	56,43	1,85
DK 53	684	23,15 - 25,60	2,45	48,98	70,04	2,36
DK 53	685	25,60 - 26,80	1,20	37,35	53,41	1,61
DK 54	696	19,20 - 21,65	2,45	51,79	74,07	1,86
DK 54	697	21,65 - 22,55	0,90	33,92	48,51	1,22
DK 54	698	22,55 - 24,65	2,10	50,26	71,87	2,36
DK 54	699	24,65 - 25,85	1,20	49,56	70,87	2,42
DK 54	700	25,85 - 27,10	1,25	36,71	52,50	1,87
DK 55	671	19,90 - 21,10	1,20	50,84	72,71	1,81
DK 55	672	21,10 - 22,25	1,15	50,01	71,51	2,22
DK 55	673	22,25 - 23,15	0,90	44,84	64,12	1,97
DK 55	674	23,15 - 24,90	1,75	49,31	70,51	2,21
DK 55	675	24,90 - 26,50	1,50	52,38	74,90	2,40
DK 55	676	26,50 - 27,20	0,70	45,96	65,72	1,96
DK 56	461	10,00 - 10,45	0,45	37,84	54,12	0,72
DK 56	462	23,30 - 25,70	2,40	53,76	76,88	1,81
DK 56	463	26,90 - 27,75	0,85	47,48	67,90	1,98
DK 56	464	27,75 - 28,45	0,70	44,55	63,70	1,71

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SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%
7,95	5,28	0,22	0,05	0,29	2,63	10,76
5,93	3,41	0,15	0,04	0,25	1,79	12,19
27,74	3,17	0,19	0,06	0,18	1,38	9,26
7,27	5,88	0,30	0,06	0,44	2,02	11,39
26,28	6,47	0,41	0,10	0,36	1,83	9,29
5,29	3,66	0,15	0,05	0,27	2,59	11,26
36,20	3,59	0,29	0,08	0,54	1,83	7,27
6,22	4,64	0,39	0,12	0,40	2,90	10,23
7,69	4,44	0,25	0,08	0,33	2,92	10,55
28,93	4,88	0,33	0,09	0,33	2,27	8,07
6,80	4,58	0,32	0,09	0,37	1,33	11,96
6,19	4,51	0,17	0,07	0,43	1,06	13,92
13,80	4,76	0,30	0,08	0,43	1,02	13,27
9,18	4,13	0,44	0,10	0,54	1,97	10,62
5,05	4,13	0,27	0,10	0,34	1,09	11,80
16,41	3,91	0,26	0,10	0,60	1,28	10,08
32,59	3,28	0,16	0,06	0,21	0,94	8,15
4,72	2,49	0,13	0,08	0,69	1,10	12,25
11,74	5,10	0,56	0,12	0,37	1,09	10,78
19,96	2,95	0,24	0,10	0,34	1,20	9,73

Annex B 2.30

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
DK 57	701	20,30 - 21,95	1,65	52.73	75,41	1,58	4,92	3,46	0,23	0,16	0,32	2,57	11,32
DK 57	702	21,95 - 22,55	0,60	49.64	70,99	1,85	8,88	4,16	0,29	0,10	0,26	2,24	11,17
DK 57	703	22,55 - 23,75	1,20	31,27	44,72	1,20	40,54	4,18	0,58	0,11	0,21	1,68	6,84
DK 57	704	23.75 - 24,35	0,60	45.36	64,87	1,82	15,89	4,29	0,58	0,11	0,31	1,95	9,64
DK 57	705	24,35 - 25,40	1,05	41.51	59,36	1,70	18,25	6,92	0,95	0,11	0,28	2,38	9,48
DK 57	706	25,40 - 26,80	1,40	47.54	67,98	2,20	10,39	5,37	0,43	0,11	0,34	2,42	10,59
DK 57	707	26,80 - 27,30	0,50	35.97	51,44	1,66	30,60	4,74	0,38	0,13	0,61	1,91	8,29
DK 58	727	19,60 - 19,90	0,30	38,82	55,51	0,75	29,13	4,55	0,23	Tr.	0,07	0,79	8,66
DK 58	728	19,90 - 20,50	0,60	49,75	71,14	1,52	9,18	4,34	0,13	0,12	0,14	1,04	11,92
DK 58	729	20.50 - 21,65	1,15	43.10	61,63	0,71	19,39	5,12	0,18	0,02	0,17	1,01	11,02
DK 58	730	21,65 - 22,85	1,20	41,19	58,90	1,14	24,28	3,41	0,10	0,11	0,28	1,59	9,54
DK 58	731	22,85 - 23.45	0,60	29,05	41.54	1,34	43,78	3,58	0,37	Tr.	0,18	1,43	7,21
DK 58	732	23,45 - 24,35	0,90	39,57	56,59	1,88	20,04	8,03	0,33	0,08	0,22	2,83	8,88
DK 58	733	24,35 - 26,20	1,85	47,88	68,47	2,63	8,14	6,47	0,38	0,04	0,21	1,92	11,13
DK 58	734	26,20 - 26,50	0,30	41.94	59,98	2,40	17,56	6,68	0,37	Tr.	0,22	1,85	10,26
DK 59	735	23,20 - 24,10	0,90	54.75	78,29	1,67	4,27	2,39	0,22	0,05	0,40	1,76	10,92
DK 59	736	24.10 - 25,60	1,50	52.92	75,68	1,74	6,21	2,80	0,15	0,10	0,31	2,35	10,55
DK 59	737	25.60 - 26,50	0,90	40.67	58,15	1,52	28,11	1,77	0,17	0,09	0,24	1,24	8,68
DK 59	738	26,50 - 27,20	0,70	49.97	71,46	1,98	11,55	2,01	0,13	0,09	0,27	2,26	9,81
DK 59	739	27,20 - 28,20	1,00	17,60	25,17	0,55	59,78	6,73	0,68	0,13	0,21	1,11	5,32

Annex B 2.31

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
DK 59	740	28,20 - 30,15	1,95	50,26
DK 59	741	30,15 - 31,55	1,40	44,11
DK 60	720	27,50 - 29,80	2,30	51,91
DK 60	721	29,80 - 31,90	2,10	50,20
DK 60	722	31,90 - 32,55	0,65	23,31
DK 60	723	32,55 - 32,75	0,20	26,33
DK 60	724	32,75 - 35,00	2,25	48,18
DK 60	725	35,00 - 35,65	0,65	45,01
DK 60	726	35,65 - 35,95	0,30	34,29
DK 63	535	8,95 - 10,95	2,00	52,09
DK 63	536	10,95 - 12,15	1,20	49,44
DK 63	537	12,15 - 13,40	1,25	40,50
DK 63	538	13,40 - 15,05	1,65	47,90
DK 63	539	15,05 - 15,80	0,75	36,59
DK 64	478	13,15 - 13,70	0,55	53,07
DK 64	479	13,70 - 14,40	0,70	51,67
DK 64	480	14,45 - 15,20	0,75	24,30
DK 64	481	15,20 - 16,30	1,10	36,73
DK 64	482	16,30 - 16,75	0,45	45,94

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
71,87	2,21	7,86	4,74	0,34	0,06	0,39	2,77	10,11
63,09	1,90	17,76	4,28	0,27	0,06	0,32	1,68	9,12
74,23	1,75	6,46	3,57	0,12	0,05	0,19	1,29	11,91
71,78	1,85	9,91	2,74	0,05	0,04	0,21	1,14	11,80
33,34	0,64	60,15	1,00	0,07	Tr.	0,17	0,61	3,71
37,66	1,07	40,47	9,67	0,99	0,05	0,15	1,63	7,87
68,90	2,64	8,19	5,94	0,42	Tr.	0,25	1,51	11,69
64,37	2,62	14,46	5,40	0,30	Tr.	0,19	1,23	11,07
49,03	2,02	31,18	6,65	0,50	Tr.	0,19	1,33	9,00
74,49	1,46	6,99	3,52	0,20	0,08	0,33	0,81	11,53
70,69	1,46	12,45	3,30	0,16	0,10	0,40	0,91	10,41
57,91	1,29	21,13	5,85	0,76	0,12	0,63	1,03	10,19
68,50	2,24	10,17	5,28	0,30	0,09	0,39	0,90	11,51
52,32	1,63	29,65	4,46	0,49	0,11	0,57	0,82	9,06
75,88	1,14	6,08	3,36	0,16	0,10	0,27	0,89	11,78
73,89	1,12	8,27	3,49	0,19	0,11	0,32	0,87	11,61
34,75	0,39	48,10	6.88	0,45	0,19	0,10	0,83	7,06
52,52	1,21	33,24	2,98	0,14	0,11	0,66	0,78	8,18
65,70	1,73	14,96	4,23	0,26	0,12	0,27	0,83	11,43

Annex B 2.3

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
DK 65	677	18,90 - 22,05	3,15	51,66	73,87	2,06	5,08	4,64	0,13	0,05	0,14	1,04	12,53
DK 65	678	22,05 - 24,00	1,95	41,69	59,62	2,06	15,07	9,20	0,47	0,06	0,24	1,65	11,13
DK 65	679	24,00 - 25,10	1,10	40,63	58,10	2,13	19,69	6,97	0,27	0,05	0,20	1,03	10,94
DK 65	680	25,10 - 26,60	1,50	29,40	42,05	1,58	40,00	6,63	0,43	0,03	0,10	1,20	7,67
DK 66	686	13,65 - 15,55	1,90	50,45	74,14	1,67	7,76	4,56	0,15	0,06	0,15	1,31	11,73
DK 66	687	15,55 - 18,30	2,75	46,78	66,89	2,42	8,63	7,60	0,33	0,04	0,25	1,63	11,69
DK 66	688	18,30 - 19,50	1,20	38,51	55,08	1,97	23,57	6,98	0,26	0,04	0,22	0,81	10,65
DK 66	689	19,50 - 20,35	0,85	33,84	48,39	1,72	30,87	7,24	0,60	0,04	0,10	0,85	9,39
DK 67	530	6,10 - 7,65	1,55	40,08	57,31	0,97	27,47	4,70	0,21	0,08	0,17	1,08	9,11
DK 67	531	18,25 - 20,90	2,65	53,07	75,88	1,83	5,36	3,71	0,15	0,07	0,28	1,23	11,85
DK 67	532	20,90 - 21,45	0,55	29,88	42,74	1,05	42,80	4,49	0,46	0,12	0,18	0,94	6,94
DK 67	533	21,45 - 24,50	3,05	44,97	64,30	2,01	14,37	6,28	0,36	0,13	0,35	1,12	10,91
DK 67	534	24,50 - 25,90	1,40	35,19	50,32	1,39	31,70	5,05	0,38	0,11	0,28	0,96	8,55
DK 68	666	17,90 - 20,30	2,40	49,59	70,92	1,70	8,50	5,01	0,18	0,09	0,13	1,48	11,67
DK 68	667	20,30 - 20,80	0,50	17,02	24,34	0,76	61,56	6,19	0,37	0,02	0,06	1,68	4,63
DK 68	668	20,80 - 23,75	2,95	47,23	67,54	2,43	8,94	6,81	0,37	0,04	0,19	1,32	11,97
DK 68	669	23,75 - 25,00	1,25	46,22	66,10	2,44	11,64	6,26	0,28	Tr.	0,16	0,96	11,88
DK 68	670	25,00 - 25,70	0,70	30,31	43,34	1,58	39,24	6,27	0,38	Tr.	0,09	0,76	8,05

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %
DK 69	690	17,75 - 19,30	1,55	50,70	72,50	1,67	9,10
DK 69	691	19,45 - 19,95	0,50	48,44	69,26	1,86	11,65
DK 69	692	19,95 - 20,60	0,65	35,60	50,90	1,43	30,88
DK 69	693	20,60 - 23,05	2,45	49,75	71,14	2,41	6,99
DK 69	694	23,05 - 25,00	1,95	49,65	70,99	2,58	6,31
DK 69	695	25,00 - 25,30	0,30	39,98	57,17	2,10	23,99
DK 70	637	17,40 - 18,50	1,10	49,14	70,27	1,52	10,57
DK 70	638	18,50 - 19,50	1,00	47,18	67,47	1,47	14,31
DK 70	639	19,50 - 20,30	0,80	45,87	65,59	2,47	12,45
DK 70	640	20,30 - 21,50	1,20	39,17	56,02	1,20	27,25
DK 70	641	21,50 - 23,05	1,55	50,25	71,86	2,63	4,73
DK 70	642	23,05 - 24,40	1,35	48,74	69,79	2,36	7,86
DK 70	643	24,40 - 25,25	0,85	40,80	58,46	1,63	23,59

Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%
3,52	0,10	0,10	0,15	0,84	11,48
3,44	0,08	0,05	0,12	0,99	11,88
5,99	0,43	0,14	0,13	1,18	8,72
5,35	0,33	0,03	0,25	1,18	11,89
5,73	0,30	0,02	0,18	1,07	12,26
4,84	0,36	Tr.	0,17	0,78	10,18
4,41	0,15	0,08	0,15	1,07	11,24
4,10	0,11	0,10	0,11	1,01	11,05
5,87	0,29	0,04	0,13	1,15	11,09
4,50	0,15	0,11	0,19	0,89	9,59
5,90	0,28	0,06	0,16	1,17	12,33
6,23	0,47	0,17	0,18	1,09	11,50
4,46	0,38	0,14	0,18	1,15	9,77

Annex B 2.34

ANALYSES RESULT

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %
K 1	403	3,45 - 4,50	1,05	37,16	53,14	1,67
K 2	483	3,00 - 4,20	1,20	46,32	66,24	1,83
K 2	484	4,20 - 5,40	1,20	35,85	51,26	1,30
K 2	485	5,40 - 6,30	0,90	43,75	62,57	2,32
K 2	486	6,30 - 7,50	1,20	31,47	45,00	1,61
K 3	404	4,50 - 5,15	0,65	43,00	61,49	1,28
K 3	405	5,15 - 5,75	0,60	41,49	59,33	1,70
K 3	406	5,75 - 6,35	0,60	41,33	59,11	1,22
K 3	407	6,35 - 6,75	0,40	36,30	51,91	1,06
K 3	408	6,75 - 7,35	0,60	39,02	55,80	1,67
K 4	409	3,95 - 4,95	1,0	40,08	57,31	1,21
K 4	410	4,95 - 5,70	0,75	20,19	28,87	0,29
K 5	487	3,35 - 4,85	1,50	43,50	62,21	1,44
K 5	488	4,85 - 6,80	1,95	47,53	67,97	1,62
K 6	559	3,45 - 5,55	2,10	44,91	64,22	1,52
K 6	560	5,55 - 6,75	1,20	46,07	65,88	1,66
K 6	561	6,75 - 8,55	1,80	38,97	55,73	1,31

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SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%
24,48	7,85	0,23	0,18	0,18	2,42	9,51
15,00	4,16	0,12	Tr.	0,19	1,93	10,12
31,95	5,12	0,20	Tr.	0,22	1,73	8,05
13,09	7,83	0,37	0,04	0,27	1,94	11,01
36,50	6,50	0,35	0,05	0,24	1,43	8,25
19,44	7,85	0,13	0,12	0,23	1,63	10,04
25,76	5,02	0,08	Tr.	0,11	1,26	9,22
21,54	2,40	0,17	0,22	0,18	1,61	9,94
31,25	5,43	0,12	0,10	0,16	1,51	8,35
21,56	4,82	0,32	0,14	0,11	2,87	8,74
25,50	4,70	0,12	0,17	0,14	1,78	9,05
60,38	3,77	0,12	0,22	0,07	1,22	4,12
17,23	5,51	0,50	0,02	0,24	1,75	10,40
12,20	4,59	0,13	0,03	0,27	1,51	11,16
16,33	5,22	0,22	n.d.	0,12	1,55	10,48
15,54	4,34	0.16	n.d.	0,12	1,93	10,02
25,21	4,26	0,15	n.d.	0,13	2,03	10,17

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %
K 7	520	3,10 - 4,60	1,50	45,82	65,52	1,29	16,85
K 8	545	1,80 - 4,00	2,20	49,04	70,12	1,69	10,65
K 8	546	4,00 - 6,00	2,00	42,50	60,35	1,63	22,04
K 8	547	6,00 - 6,90	0,90	30,00	42,91	0,70	41,31
K 8	548	6,90 - 7,60	0,70	43,00	61,49	2,94	14,60
K 8	549	7,60 - 8,80	1,20	27,44	39,24	1,52	42,14
K 9	550	2,20 - 3,70	1,50	46,88	66,57	1,76	14,40
K 9	551	3,70 - 4,30	0,60	16,01	22,89	0,57	50,60
K 9	552	4,30 - 6,30	2,00	41,19	58,90	2,31	14,46
K 9	553	6,30 - 7,60	1,30	28,60	40,90	1,63	36,30
K 10	554	2,40 - 4,00	1,60	43,91	62,78	1,81	14,32
K 10	555	4,00 - 5,30	1,30	46,93	67,11	1,89	11,87
K 10	556	5,30 - 6,40	1,10	21,29	30,46	0,91	47,87
K 10	557	6,40 - 7,90	1,50	43,60	62,35	2,41	12,80
K 10	558	7,90 - 9,20	1,30	32,02	45,79	1,76	30,81
K 11	521	2,70 - 4,00	1,30	46,37	66,31	1,68	16,04
K 11	522	4,00 - 5,50	1,50	42,34	60,55	1,75	22,50
K 11	523	5,50 - 6,10	0,60	11,31	16,17	0,41	60,50

Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
3,77	0,12	0,02	0,27	1,51	10,23
3,67	0,10	0,07	0,21	1,63	11,17
3,96	0,90	0,04	0,26	1,60	9,94
5,47	0,47	0,09	0,27	1,64	6,23
8,00	0,48	0,08	0,28	1,60	11,46
6,83	0,50	0,05	0,23	1,06	8,18
3,93	0,11	0,03	0,13	1,13	10,98
14,58	1,03	0,13	0,06	1,50	7,70
7,72	0,40	0,13	0,19	1,52	10,72
9,47	0,73	0,13	0,15	2,52	7,46
6,63	0,30	n.d.	0,11	1,48	11,10
5,48	0,17	n.d.	0,13	1,48	11,34
10,41	0,63	n.d.	0,10	1,36	7,62
8,39	0,33	n.d.	0,12	1,83	11,54
9,21	0,57	n.d.	0,12	2,02	9,06
3,51	0,10	0,02	0,26	1,64	10,30
3,74	0,12	0,02	0,25	1,63	9,24
12,98	1,00	0,15	0,04	3,20	4,71

Annex B 2.36

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
K 11	524	6,10 - 7,30	1,20	42,39
K 11	525	7,30 - 9,15	1,85	39,07
K 12	562	4,58 - 5,10	0,52	44,51
K 12	563	5,10 - 5,65	0,55	29,40
K 12	564	5,65 - 7,50	1,85	11,58
K 12	565	7,50 - 8,90	1,40	40,79
K 13	584	9,70 - 10,30	0,60	49,04
K 13	585	10,30 - 11,85	1,55	46,37
K 13	586	11,85 - 12,45	0,60	31,67
K 14	587	2,78 - 3,90	1,20	46,07
K 14	588	3,90 - 5,00	1,10	38,71
K 14	589	5,00 - 6,15	1,15	21,55
K 14	590	6,15 - 7,60	1,45	46,83
K 14	591	7,60 - 8,50	0,90	43,35
K 15	580	1,90 - 4,60	2,70	45,92
K 15	581	4,60 - 5,00	0,40	38,77
K 15	582	5,00 - 6,15	1,15	17,97
K 15	583	6,15 - 8,50	2,35	42,85

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
60,62	2,31	13,50	8,90	0,38	0,15	0,08	2,29	11,47
55,87	2,14	22,70	6,81	0,33	0,12	0,18	1,38	10,37
63,65	1,57	18,44	3,06	0,12	n.d.	0,16	1,54	10,44
42,04	1,25	37,84	7,56	0,33	0,02	0,07	1,76	8,12
16,56	0,49	62,68	11,03	1,02	0,05	0,04	1,61	5,59
58,32	2,25	16,88	7,93	0,55	Tr.	0,16	1,93	10,89
70,13	1,80	12,47	2,53	0.07	0,04	0,30	0,95	10,98
66,31	1,89	16,68	2,98	0,07	0,04	0,20	0,92	10,76
45,29	1,22	42,02	2,91	0,13	0,02	0,20	0,86	7,28
65,88	1,52	17,81	3,02	0,08	0,20	0,30	1,10	9,60
55,37	1,59	26,71	4,66	0,17	0,05	0,10	0,87	9,68
30,82	0,79	45,94	10,33	1,13	0,34	0,20	2,30	7,26
66,96	2,65	9,31	6,47	0,33	0,06	0,20	1,50	11,73
61,99	2,47	14,46	7,21	0,40	0,09	0,20	1,55	11,10
65,66	1,79	12,25	6,47	0,21	0,09	0,20	2,22	10,87
55,44	1,55	26,02	5,09	0,17	0,05	0,30	1,54	9,16
25,70	0,78	51,18	12,09	0,79	0,19	0,20	1,56	6,98
61,27	2,34	15,89	7,53	0,33	0,08	0,10	1,31	10,87

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
K 16	601	3,65 - 4,60	0,95	52,11	74,52	1,56	5,52	3,86	0,15	0,09	0,31	1,40	11,93
K 16	602	4,60 - 6,25	1,65	45,26	64.73	1,87	13,71	5,90	0,20	0,05	0,25	1,14	11,68
K 16	603	6,25 - 6,55	0,30	19,03	27,22	0,80	43,44	16,38	1,46	0,02	0,10	2,39	7,88
K 16	604	6,55 - 8,20	1,65	45,97	65,74	2,53	8,96	7,59	0,32	0,03	0,30	1,35	12,32
K 16	605	8,20 - 9,40	1,20	39,88	57,02	2,15	18,77	8,29	0,40	0,07	0,30	1,46	11,00
K 17	606	2,40 - 4,90	2,50	49,85	71,28	2,05	6,36	5,02	0,18	Tr.	0,33	1,53	12,58
K 17	607	4.90 - 5,75	0,85	35,95	51,41	1,35	32,47	3,81	0,12	Tr.	0,23	1,42	8,53
K 17	608	5,75 - 6,90	1,15	12,78	18,29	0,52	56,30	15,18	1,60	Tr.	0,13	3,94	3,90
K 17	609	6,90 - 8,25	1,35	46,83	66,96	2,74	8,56	6,98	0,37	0,09	0,28	2,21	11,47
K 17	610	8,25 - 9,13	0,88	42,70	61,06	2,49	15,59	6,98	0,37	0,10	0,26	1,61	11,12
K 18	633	5,50 - 6,40	0,90	46,37	66,31	1,47	16,39	3,89	0,15	0,20	0,15	1,26	9,95
K 18	634	6,40 - 7,40	1,00	23,46	33,55	0,91	51,59	5,49	0,35	0,04	0,19	1,44	5,96
K 18	635	8,85 - 10,35	1,50	46,37	66,31	2,31	11,15	7,01	0,40	0,08	0,15	1,20	11,30
K 18	636	10,35 - 11,30	0,95	43,60	62,35	2,42	15,33	6,87	0,35	0,13	0,18	1,31	10,93
K 19	592	5,55 - 7,10	1,55	46,37	66,31	1,67	16,50	2,73	0,08	0,05	0,30	0,95	10,86
K 19	593	7,10 - 8,55	1,45	41,64	59,54	1,63	24,88	2,73	0,05	Tr.	0,20	0,83	9,66
K 19	594	8,55 - 8,90	0,35	16,51	23,62	0,74	50,22	15,25	1,60	Tr.	0,08	1,90	6,51
K 19	595	8,90 - 10,35	1,45	47,83	68,40	2,59	9,23	5,91	0,28	0,04	0,23	2,09	10,86
K 19	596	10,35 - 11,75	1,40	45,77	65,45	2.64	10,40	7,05	0,40	0,06	0,28	2,28	10,86

Annex B 2.38

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thickness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
K 20	623	15,35 - 16,15	0,80	37,81	54,07	1,36	32,12	2,08	0,07	0,13	0,36	1,05	8,56
K 20	624	18,25 - 20,70	2,45	46,62	66,67	2,82	9,71	6,13	0,33	0,14	0,28	1,83	11,87
K 20	625	20,70 - 21,30	0,60	32,73	46,80	1,57	33,70	6,40	0,33	0,09	0,20	2,03	8,21
K 21	626	10,35 - 11,05	0,70	52,66	75,31	1,86	5,88	3,11	0,08	0,09	0,23	1,59	11,57
K 21	627	11,05 - 11,85	0,80	22,46	32,11	0,78	57,10	2,98	0,10	Tr.	0,09	1,00	5,48
K 21	628	13,15 - 14,60	1,45	46,02	65,81	2,52	9,79	7,47	0,47	0,12	0,15	2,38	11,08
K 21	629	14,60 - 15,65	1,05	42,70	61,06	2,31	16,51	6,86	0,33	0,11	0,16	1,56	10,82
K 22	597	6,10 - 7,60	1,50	53,17	76,03	2,19	4,05	3,73	0,20	Tr.	0,24	1,70	11,57
K 22	598	7,60 - 8,50	0,90	20,24	28,94	0,79	49,71	10,84	1,21	Tr.	0,17	2,05	6,23
K 22	599	8,50 - 10,00	1,50	45,67	65,30	2,54	12,26	6,19	0,37	Tr.	0,13	1,20	11,84
K 23	621	8,55 - 9,00	0,45	35,95	51,41	0,65	35,75	5,04	0,30	0,15	0,25	1,39	4,97
K 23	622	9,00 - 10,80	1,80	41,44	59,26	1,88	18,93	6,83	0,43	0,22	0,22	1,84	10,23
K 25	630	3,75 - 5,85	2,10	47,83	68,40	1,48	12,77	4,19	0,12	0,11	0,17	1,47	11,04
K 25	631	5,85 - 7,00	1,15	45,82	65,52	1,59	12,69	5,97	0,18	0,11	0,17	1,93	11,39
K 26	632	2,35 - 4,37	2,02	43,45	62,14	1,40	17,53	5,59	0,21	0,17	0,15	1,47	10,81

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
K 27	576	13,70 - 15,00	1,30	43,05	61,56	1,60	23,32	1,92	0,05	0,02	0,20	1,51	8,91
K 27	577	15,00 - 16,20	1,20	10,67	15,26	0,50	53,26	19,28	1,70	0,21	0,02	3,27	6,39
K 27	578	16,20 - 17,10	0,90	44,81	64,08	2,74	12,17	7,52	0,46	0,06	0,18	2,06	10,73
K 27	579	17,10 - 18,30	1,20	46,12	65,95	2,71	10,81	6,66	0,42	0,09	0,17	2,16	10,62
K 28	600	6,10 - 8,55	2,45	39,93	57,10	2,01	18,20	9,22	0,57	0,08	0,13	2,30	10,20
PK 1	614	0,00 - 2,00	2,00	52,31	74,81	1,81	7,53	2,54	0,06	0,03	0,21	1,18	11,52
PK 1	615	2,00 - 4,00	2,00	51,76	74,02	1,85	7,02	3,06	0,06	0,18	0,22	1,47	11,69
PK 1	616	4,00 - 5,50	1,50	44,41	63,50	1,43	17,76	4,65	0,15	0,13	0,29	1,23	10,36
PK 2	617	0,00 - 0,65	0,65	51,05	72,94	1,52	7,41	3,79	0,16	0,15	0,31	1,60	11,79
PK 2	618	0,65 - 1,85	0,90	49,24	70,42	1,91	9,04	4,60	0,13	0,08	0,19	1,75	11,69
PK 2	619	1,85 - 2,70	0,85	36,05	51,55	0,91	28,15	6,80	0,70	0,14	0,26	2,11	8,93
PK 2	620	2,70 - 3,60	0,90	42,09	60,19	1,87	16,73	7,50	0,33	0,19	0,24	1,95	10,60
PK 3	569	0,00 - 2,90	2,90	48,34	69,12	1,70	10,37	4,37	0,12	0,13	0,25	1,30	12,56
PK 3	570	2,90 - 3,30	0,40	36,05	51,55	1,40	26,77	7,47	0,79	0,06	0,31	1,67	9,52
PK 3	571	3,30 - 4,80	1,50	42,95	61,42	2,20	15,14	7,90	0,33	0,09	0,20	1,51	11,10

ANALYSES RESULTS

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %	Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
PK 4	611	0,00 - 1,10	1,10	42,70	61,06	1,42	19,61	4,92	0,16	0,15	0,30	2,01	10,07
PK 4	612	1,10 - 3,00	1,90	47,83	68,40	2,27	8,71	6,79	0,37	0,13	0,27	1,45	11,54
PK 4	613	3,00 - 4,00	1,0	41,69	59,62	2,16	17,59	7,59	0,37	0,13	0,24	1,28	10,95
PK 5	572	0,0 - 1,30	1,30	47,63	68,11	1,62	11,77	4,35	0,14	0,17	0,20	1,96	10,77
PK 5	573	1,30 - 2,60	1,30	32,17	46,01	1,27	38,06	4,19	0,12	0,06	0,20	1,54	7,70
PK 5	574	2,60 - 4,00	1,40	45,72	65,38	2,39	10,37	7,42	0,33	0,14	0,20	1,97	11,11
PK 5	575	4,00 - 6,00	2,00	40,18	57,46	2.27	19,49	8,06	0,39	0,07	0,20	2,69	9,34

Annex B 2.41

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
PSD 1	417	0,0 - 0,80	0,80	48,44
PSD 1	418	0,80 - 1,80	1,00	42,85
PSD 1	419	1,80 - 2,40	0,60	42,70
PSD 2	420	1,15 - 1,50	0,35	49,85
PSD 2	421	1,50 - 2,60	1,10	40,98
PSD 2	422	2,60 - 3,00	0,40	37,46
PSD 2	423	3,00 - 4,00	1,00	25,63
PSD 3	516	1,00 - 1,40	0,40	51,81
PSD 3	517	1,40 - 2,00	0,60	45,16
PSD 3	518	2,00 - 2,80	0,80	42,09
PSD 3	519	2,80 - 3,10	0,30	37,46
PSD 4	424	0,00 - 0,80	0,80	53,16
PSD 4	425	0,80 - 2,35	1,55	40,88
PSD 5	426	0,50 - 1,90	1,40	46,62
PSD 5	427	1,90 - 2,45	0,55	48,54
PSD 5	428	2,45 - 3,30	0,85	48,39
PSD 6	429	0,00 - 1,35	1,35	53,42
PSD 6	430	1,35 - 2,40	1,05	46,17
PSD 6	431	2,40 - 2,80	0,40	46,07

ANALYSES RESULTS

Fe_2O_3 %	P_2O_5 %	SiO_2 %	Al_2O_3 %	TiO_2 %	CaO + MgO %	MnO %	L.O.I. %	Hydrates (500°) %
69,26	1,62	9,22	6,60	0,20	Tr	0,20	1,91	10,91
61,27	1,45	14,37	9,40	0,25	0,28	0,08	2,49	10,32
61,06	1,79	15,59	8,04	0,23	0,18	0,16	2,40	10,17
71,28	1,99	6,17	6,17	0,21	0,10	0,24	1,92	11,15
58,61	1,98	16,06	9,57	0,41	0,10	0,21	2,15	10,56
53,57	1,74	25,54	7,25	0,30	0,06	0,21	2,17	8,93
36,64	1,17	40,22	10,93	0,45	0,24	0,18	2,54	7,46
74,09	1,94	5,97	4,38	0,28	0,21	0,31	1,59	10,91
64,58	2,01	11,34	7,61	0,43	0,28	0,23	1,91	10,95
60,19	1,93	16,02	8,52	0,35	0,20	0,19	2,30	10,14
53,57	1,55	26,54	7,11	0,27	0,07	0,17	1,87	8,69
76,03	1,99	3,49	4,21	0,10	0,06	0,24	1,91	11,48
58,46	1,47	19,39	8,33	0,30	0,08	0,12	1,98	9,70
66,67	1,39	13,25	6,70	0,22	0,04	0,11	1,85	9,75
69,41	1,84	8,19	6,57	0,20	0,05	0,09	2,25	10,54
69,19	1,89	9,30	6,40	0,17	0,09	0,12	2,07	10,33
76,39	1,60	5,19	3,75	0,13	0,03	0,12	1,81	10,59
66,02	1,80	13,70	6,22	0,23	0,02	0,11	2,24	9,56
65,88	1,90	12,05	7,32	0,38	0,03	0,14	2,33	9,91

Drill-hole/ Trench No.	Sample Number	Section of Sample from - to (m)	Thick-ness of Sample (m)	Fe-tot. %
D 1	799	7,65 - 8,60	0,95	46,03
D 1	800	8,60 - 9,60	1,00	42,52
D 2	801	7,60 - 8,40	0,80	50,37
D 2	802	8,40 - 9,50	1,10	44,21
D 3	803	12,60 - 14,00	1,40	49,67
D 3	804	14,00 - 14,90	0,90	47,85
D 3	805	14,90 - 16,20	1,30	45,33

ANALYSES RESULTS

Fe_2O_3	P_2O_5	SiO_2	Al_2O_3	TiO_2	CaO + MgO	MnO	L.O.I.	Hydrates (500°)
%	%	%	%	%	%	%	%	%
65,82	1,14	15,29	4,97	0,27	0,07	0,28	2,38	9,21
60,82	1,15	20,85	5,20	0,27	0,06	0,30	2,00	8,73
72,03	1,10	10,52	3,41	0,23	0,07	0,12	2,66	9,37
63,22	0,94	19,54	4,64	0,26	0,06	0,11	2,10	8,70
71,03	1,21	11,20	3,64	0,23	0,06	0,11	2,27	9,59
68,43	1,29	15,28	3,23	0,22	0,06	0,12	2,11	8,92
64,82	0,96	19,35	4,12	0,23	0,06	0,05	2,13	8,68

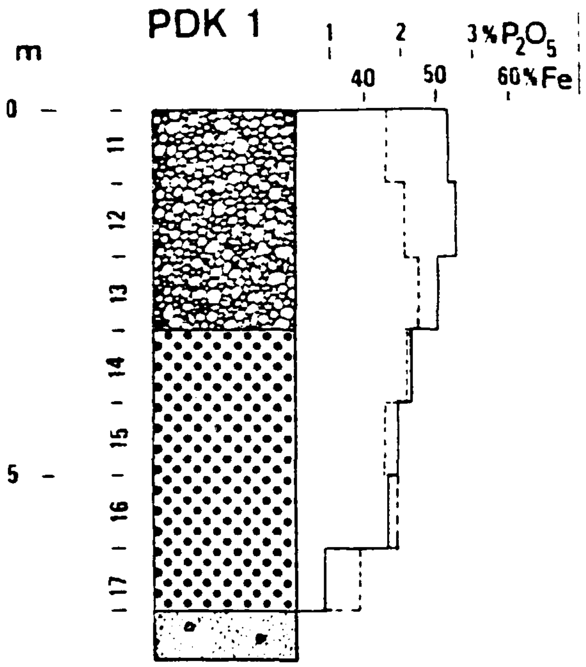
Annex B 2.43

KHD HUMBOLDT WEDAG AG

Annex B 3.1 to B 3.125

Descriptions and logs of drill holes and trenches

Annex B 3.1

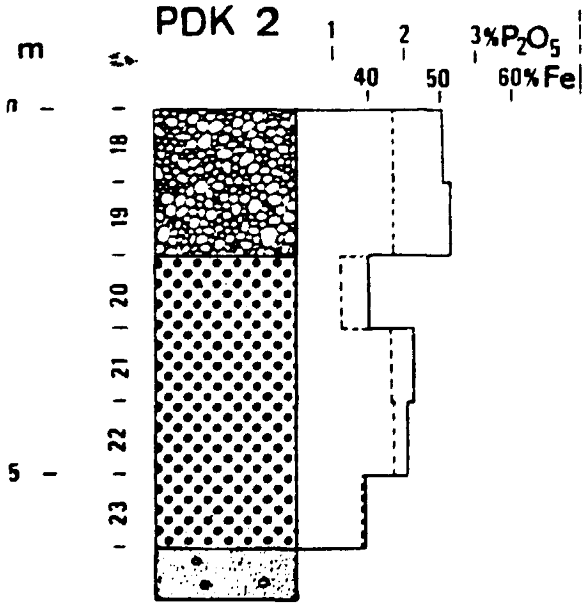


Iron oölite, consolidated, ca. 95 % ooliths, ca. 5 % clay-limonite matrix, dark red-brown, evidence of bioturbation between 1 and 2 m

Iron oölite, pisolitic, uncosolidated, clay matrix, silty, grey-brown

increasing content of quartz sand

Sandstone, fine to medium grained, silty, 5 to 10 % ooliths and pisoliths light brown



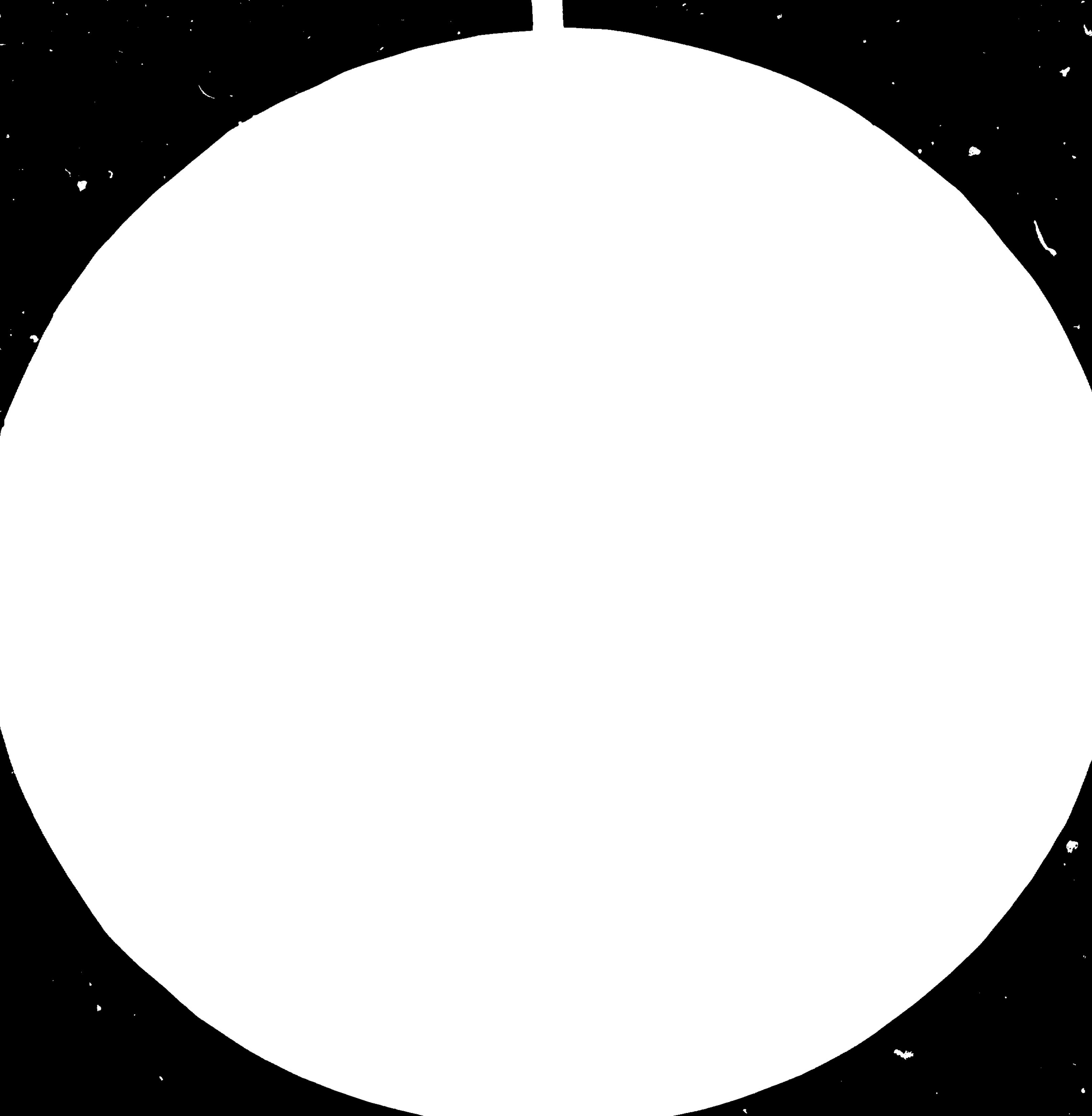
Iron oölite, consolidated, ca. 95 % ooliths ca. 5 % clay-limonite matrix, dark red-brown,

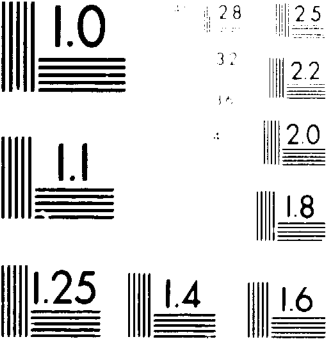
Iron oölite, ca. 60 % oöliths, ca. 35 % quartz sand clay-limonite matrix, red-brown; avidence of bioturbation and ironcrusts

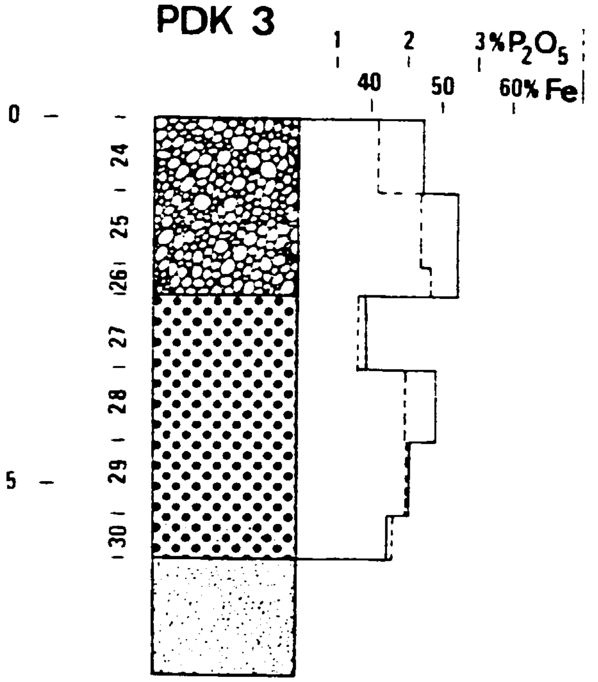
Iron oölite, pisolitic, unconsolidated, clay matrix, silty, grey-brown

increasing content of quartz sand

Sandstone, fine to medium grained, silty, slightly oolitic and pisolitic, light brown to white-red




1.0
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.1
1.8
1.25
1.4
1.6



Iron oölite,consolidated ca. 95 % ooliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite ca. 60 % ooliths, 30 to 35 quartz sand, clay-limonite matrix, red-brown, evidence of bioturbation

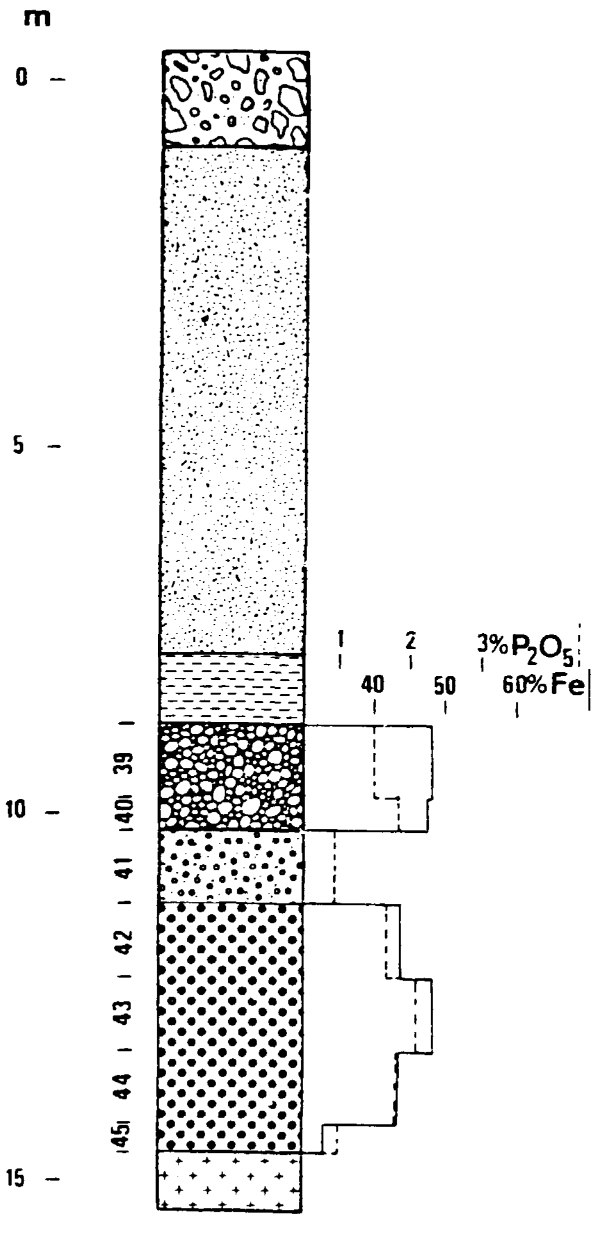
Iron oölite,pisolitic, unconsolidated, clay matrix, silty, grey-brown

slightly increasing sand content

Sandstone, fine to medium grained, silty, light red

Annex B 3.3

PDK 4



Iron sandstone, brecciated, and pisolitic sandy
Iron oölite, dark brown
strongly consolidated

Siltstone, sandy-clayey,
white-grey to light brown and light red

Clay, slightly silty, white-grey to light brown

Iron oölite, moderately consolidated,
ca. 95 % ooliths, ca. 5 % clay-limonite matrix,
dark brown

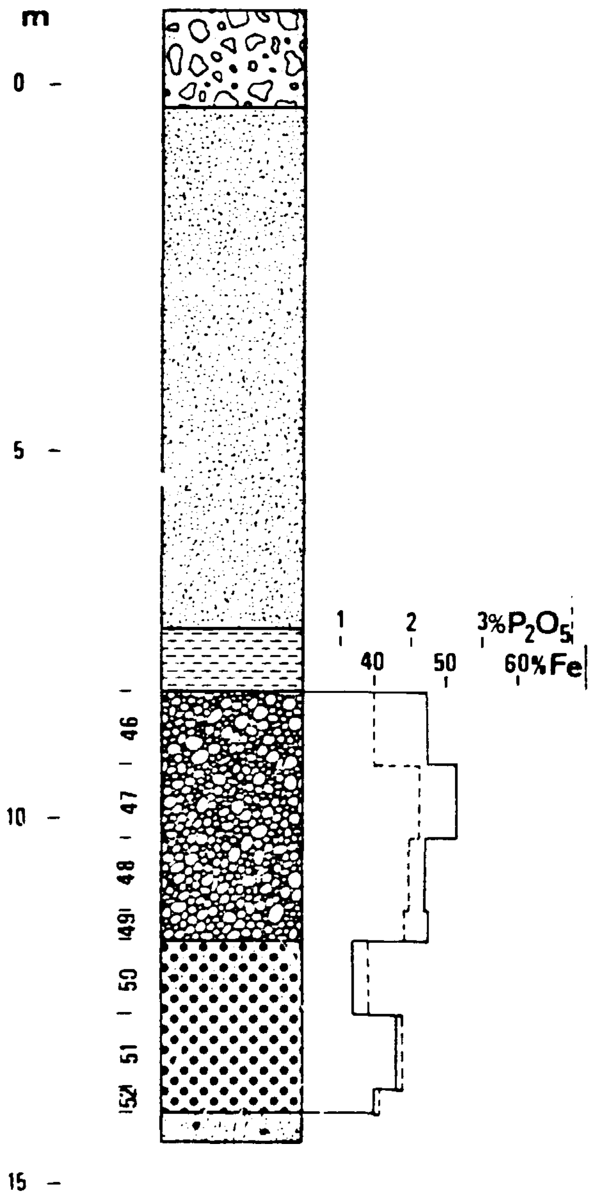
Iron oölite, strongly sandy, unconsolidated
clay matrix, grey-brown

Iron oölite, pisolitic, silty
clay matrix, grey-brown

Strongly sandy

Sandstone, silty-clayey, grey-white
altered basement

PDK 5



Iron sandstone, brecciated and oölitic, sandy
Iron pisolite, dark brown
strongly consolidated

Siltstone, sandy-clayey
Light red to light brown and white

Clay, slightly sandy-silty, white-grey
to light brown

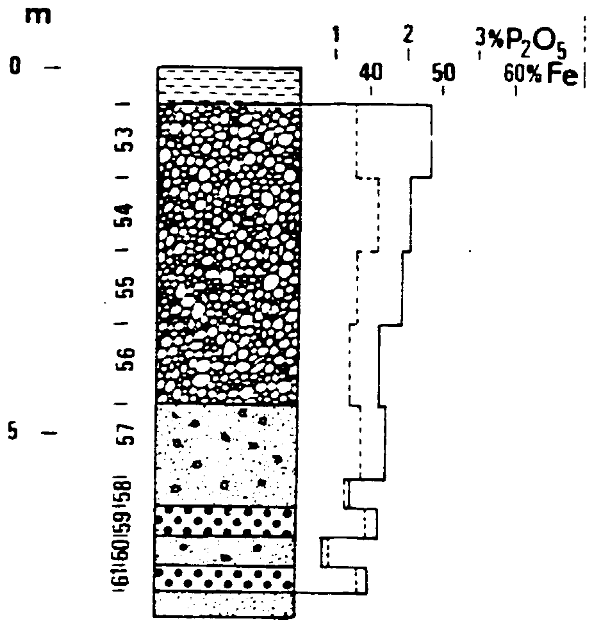
Iron oölite, consolidated, ca. 95 % ooliths,
ca. 5 % clay-limonite matrix
evidence of red clay injoints
dark brown

Iron oölite, moderately sandy, unconsolidated
clay matrix, grey-brown

Iron oölite, pisolitic, sandy-silty, unconsolidated
clay matrix, grey-brown

Sandstone, silty-clayey, light-grey to light brown
medium grained

PDK 6



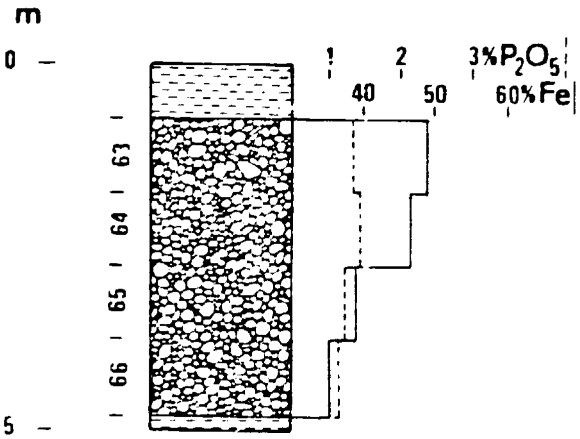
Clay, silty, light brown

Iron oölite, consolidated, 90 to 95 % ooliths,
5 - 10 % clay-limonite matrix
dark brown

Iron oölite, sandy-clayey, unconsolidated
light brown

Iron oölite, pisolitic, clay matrix, grey-brown
Sandstone, slightly consolidated, oolith-bearing, grey-brown
Iron oölite, pisolitic clay matrix, grey-brown
Sandstone, medium grained, light brown

PDK 7



Clay, sandy-silty, light-brown

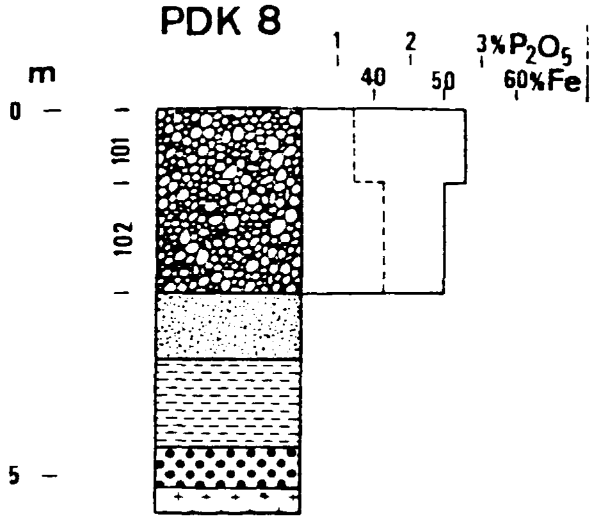
Iron oölite, consolidated, 90-95 % ooliths
5 - 10 % clay-limonite matrix
dark brown

increasing sand content to the foot wall

Clay sandy-silty, light-brown

Annex B 3.6

PDK 8



Iron oölite, consolidated, ca. 95 % ooliths ca. 5 % clay-limonite matrix

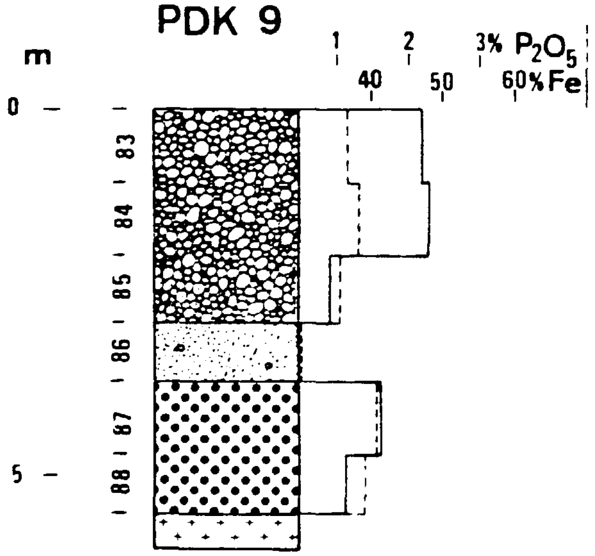
Sandstone, slightly consolidated, isolated oöliths, light grey, medium grained

Clay, sandy-silty, red to light brown

Iron oölite, pisolitic, slightly consolidated, clay matrix, grey-brown

Sandstone, clayey, white-grey altered basement

PDK 9



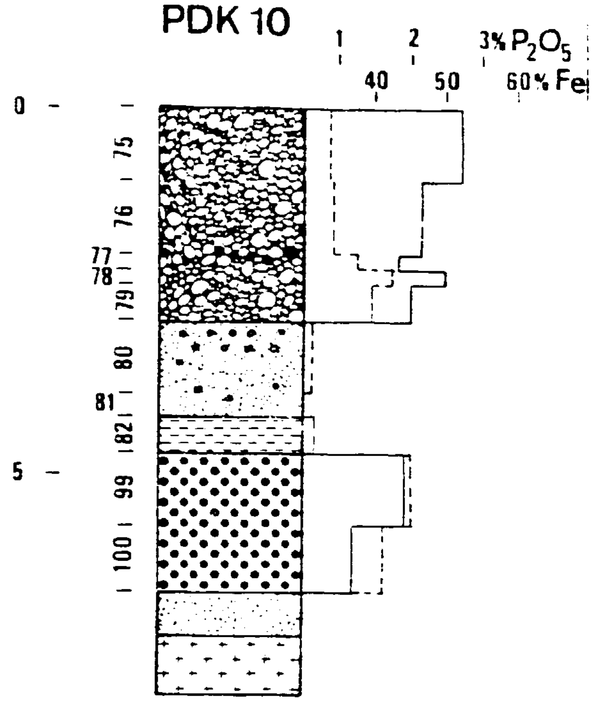
Iron oölite, consolidated, strongly altereted and evidence of bioturbation and iron crusts, red-grey-brown

Sandstone, slightly consolidated, isolated oöliths, light grey-brown

Iron oölite, pisolitic, unconsolidated, 70-80 % oöliths and pisoliths, clay matrix, sandy-silty lightbrown-greenish

Kaolinitic Clay, sandy, white-grey strongly altered basement

PDK 10



Iron oölite, consolidated, ca. 95 % ooliths, ca. 5 % clay-limonite matrix, dark brown, strong evidence of bioturbation and iron crusts

Pisolite-Layer

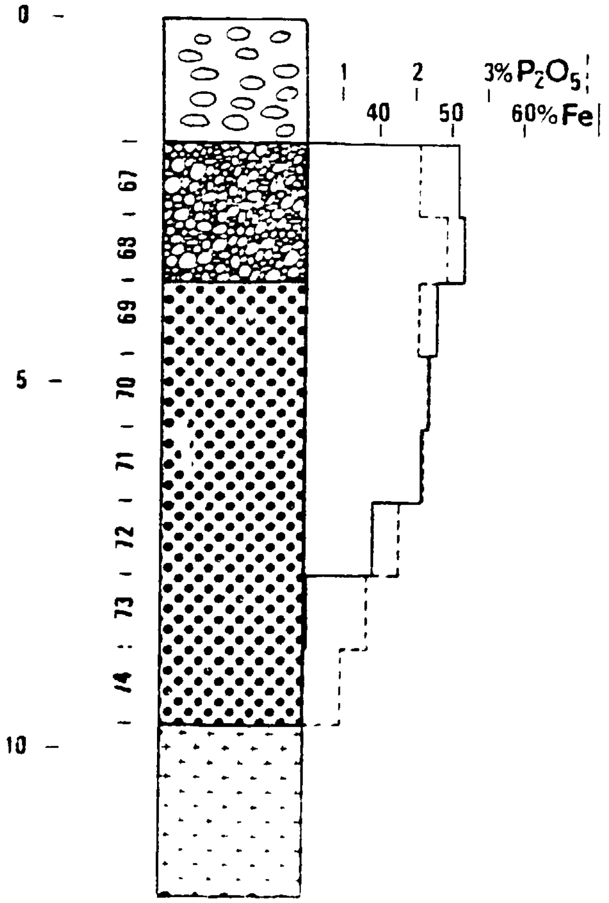
Sandstone, oölitic
decreasing oolith content to the foot wall

Clay, slightly sandy-silty, light brown

Iron oölite, pisolitic, unconsolidated, clay matrix

Sandstone, fine grained, silty, slightly consolidate
isolated oöliths, light red-brown
Kaolinitic clay, sandy, white-grey
altered basement

PDK 11



Gravel of river Niger terrace

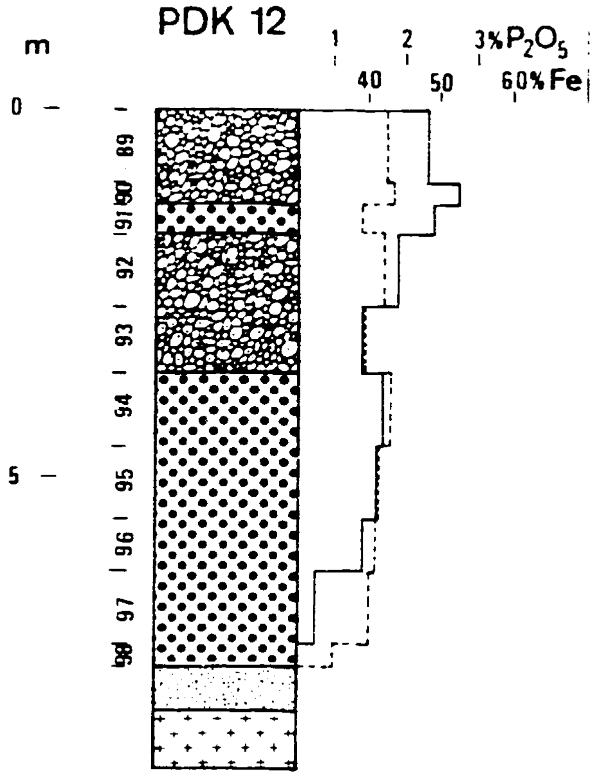
Iron oölite, consolidated, ca. 95 % ooliths
ca. 5 % limonite matrix, dark brown

Iron oölite, pisolitic, unconsolidated
clay matrix

Strongly increasing sand content
to the foot wall

strongly altered basement
kaolinitic, white-grey

PDK 12



Iron oölite,consolidated, ca. 95 % oöliths
ca. 5 % clay-limonite matrix
dark brown

Iron pisolite,moderately consolidated, clay matrix

Iron oölite,consolidated, ca. 95 % oöliths,
ca. 5 % clay-limonite matrix
dark brown

+ ca. 10 - 15 % quartzsand

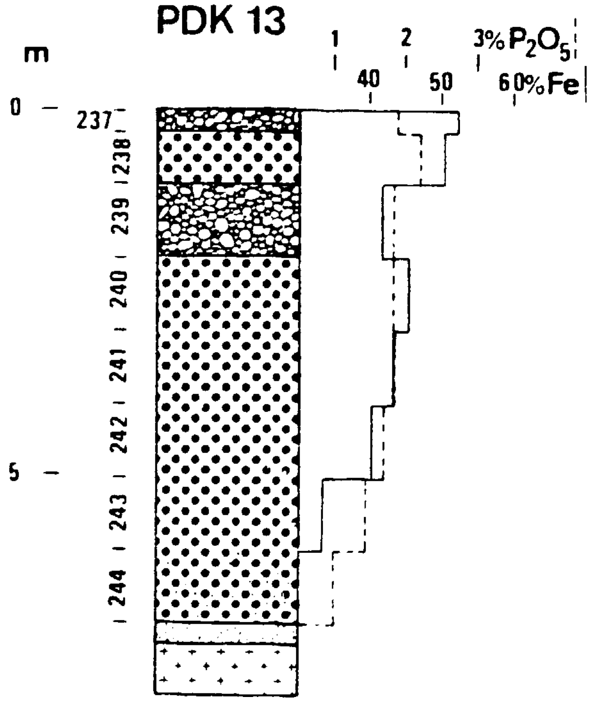
Iron oölite,pisolitic, unconsolidated
clay matrix, grey-brown
evidence of iron crusts

Strongly increasing sand content to the foot wall

Sandstone fine to coarse grained, oolith bearing
red-brown to red-white

altered basement, strongly kaolinized

PDK 13



Iron pisolite,moderately consolidated, dark brown

Iron oölite,consolidated, ca. 95 % oöliths,
ca. 5 % clay-limonite matrix, dark brown
evidence of bioturbation

Iron oölite,pisolitic, moderately
consolidated, ca. 40 - 50 % pisoliths
clay matrix, grey-brown

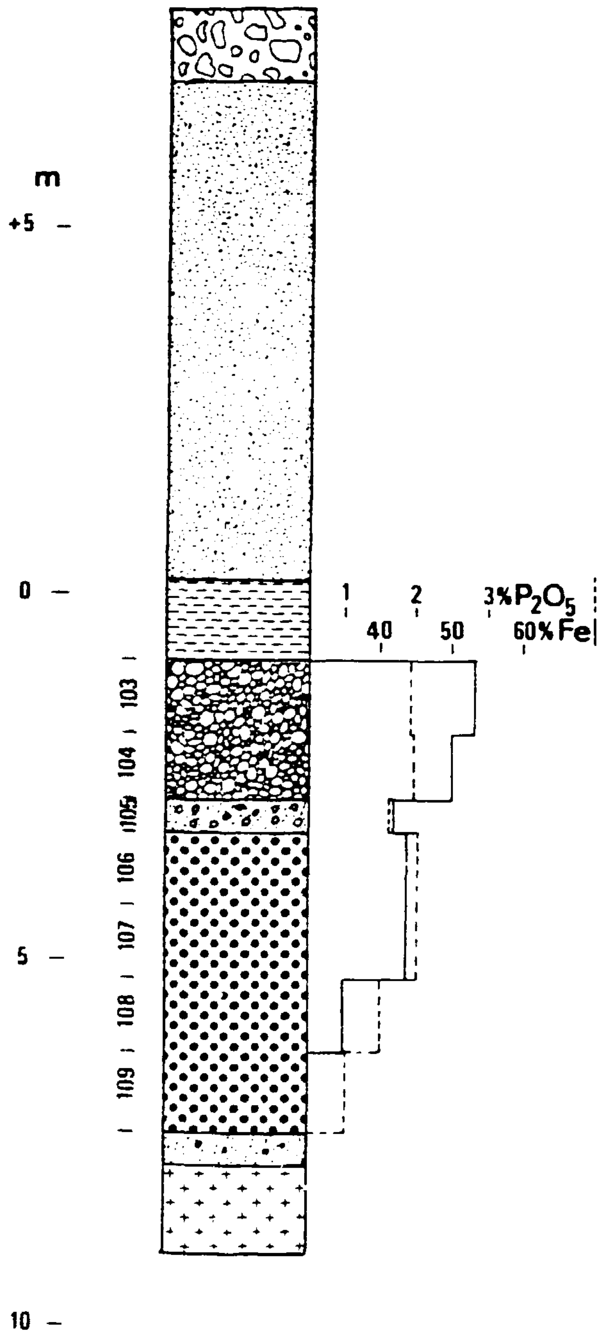
strongly increasing sand content to the
foot wall, up to 20 %

Siltstone, sandy, red

Sandstone, kaolinitic, white-grey

altered basement

PDK 14



Iron oölite, strongly sandy and strongly consolidated, limonite matrix, dark brown

Siltstone, sandy-clayey
red-brown to yellow-white

Clay, silty, red-white

Iron oölite, consolidated, ca. 95 % oöliths,
ca. 5 % clay-limonite matrix
dark brown

Sandstone, clayey and oölitic, brown

Iron oölite, pisolitic, unconsolidated,
clay matrix

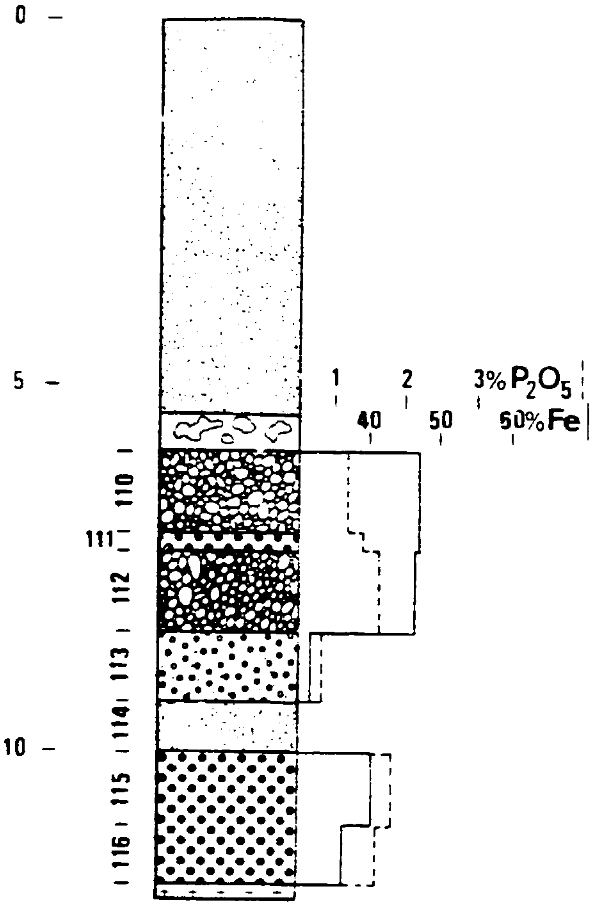
increasing sand content to the foot wall
up to 30 %

Sandstone, silty, red-white

Kaolinitic clay, sandy, white
strongly altered basement

Annex B 3.10

PDK 15



Eolian sand,
fine to medium grained, well sorted,
yellowish-brown

Colluvial bed containing quartz- and iron sand-stone-fragments

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red brown

Iron pisolite layer in iron oölite

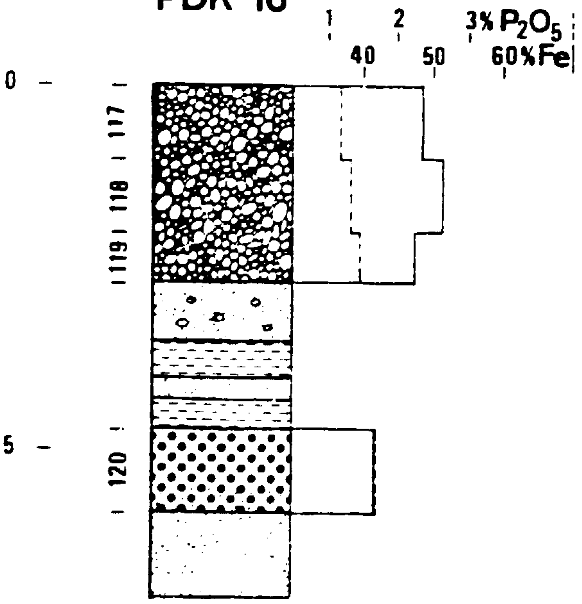
Iron oölite, moderately consolidated, strongly sandy up to 30 - 40 %, yellowish-red

Sandstone, clayey, slightly consolidated yellowish-brown

Iron oölite, pisolitic, slightly consolidated, clay matrix, silty, grey-brown

Clay, sandy, white-grey, altered basement

PDK 16



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark brown

Layer of intraformational pebbles

Sandstone, clayey, oölith-bearing, slightly consolidated, brown

Clay, silty, light brown

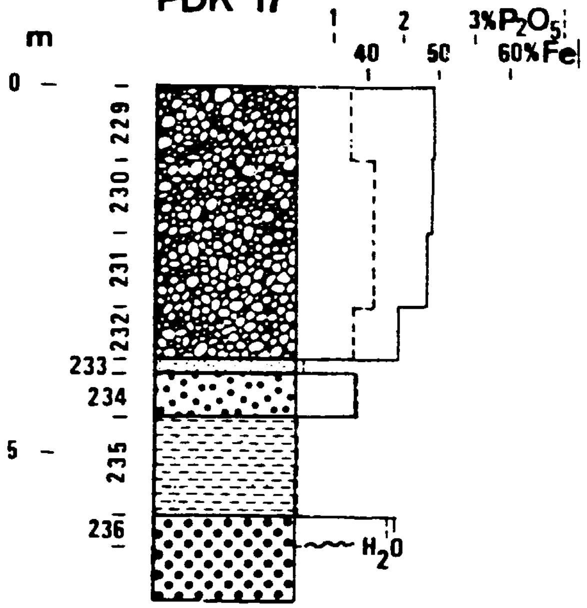
Sandstone, medium to coarse grained, light brown

Clay, sandy-silty, light brown

Iron oölite, pisolitic, unconsolidated, sandy, clay matrix, grey-brown

Sandstone, clayey, red-white

PDK 17



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

from 3,60-3,70 horizon of intraformational pebbles

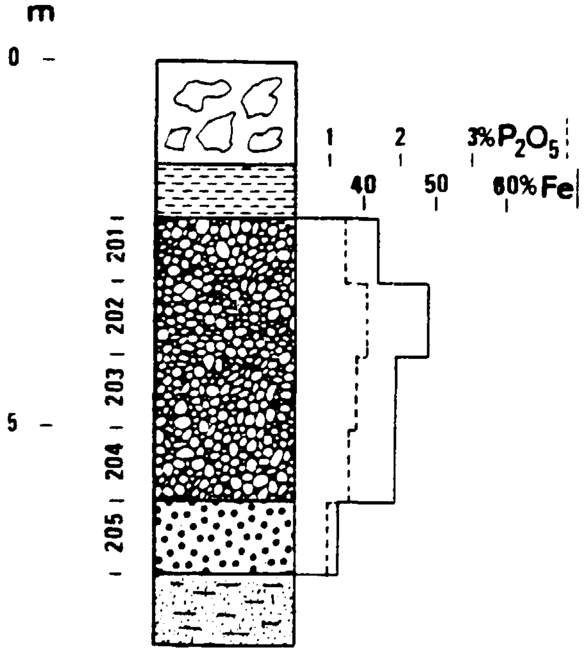
Sandstone, coarse grained, light grey-brown

Iron oölite, sandy-clayey

Clay, sandy-silty, with isolated oöliths, red-yellow-brown

Iron oölite, pisolitic, unconsolidated clay matrix, from 6,25 m ground water

PDK 18



Colluvial bed, containing boulders of silicfied iron oölite and quartz

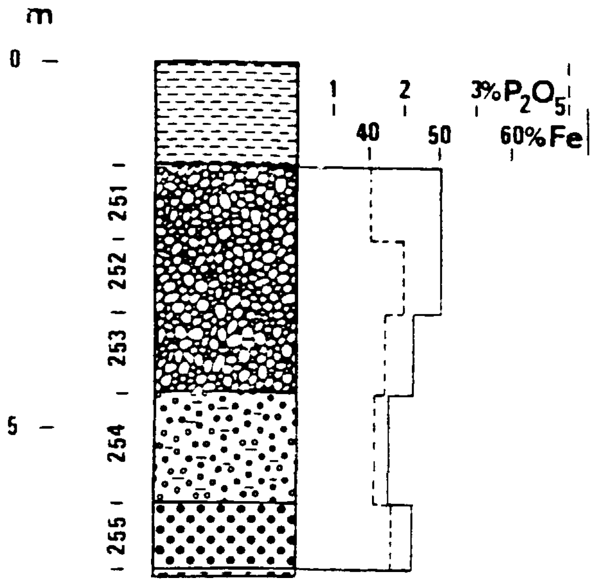
Clay, silty, yellow-white

Iron oölite, consolidated by limonite, ca. 90 - 95 % oöliths, dark red brown

Iron oölite, strongly clayey, grey-brown

Sandstone, strongly clayey, yellow-white

PDK 19



Clay, silty, red-yellow

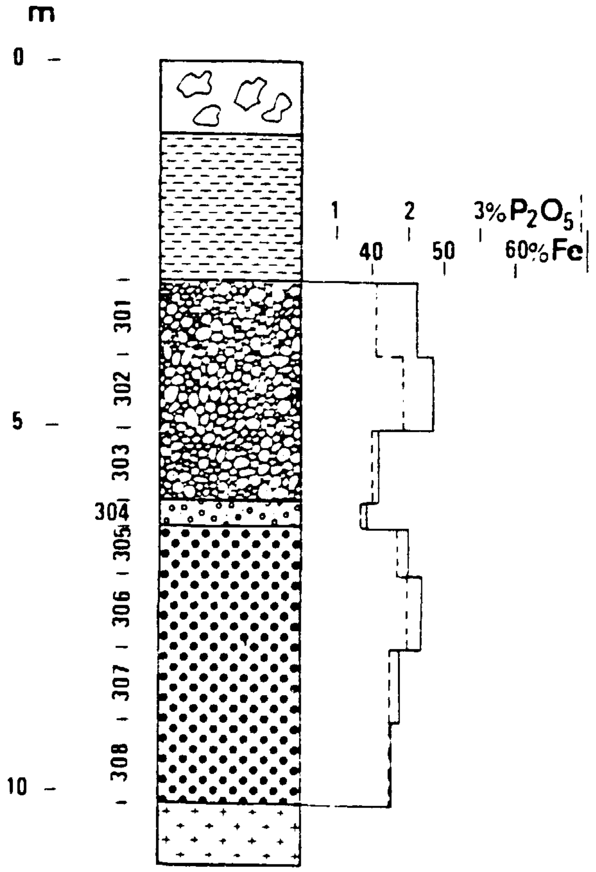
Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix dark red-brown

Iron oölite, slightly consolidated, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Clay, silty, yellow-brown

PDK 20



Colluvial bed, containing boulders of silicified iron oölite and quartz

Clay, slightly silty, white-grey

Iron oölite, consolidated, 90 - 95 % oöliths, clay-limonite matrix, dark red-brown

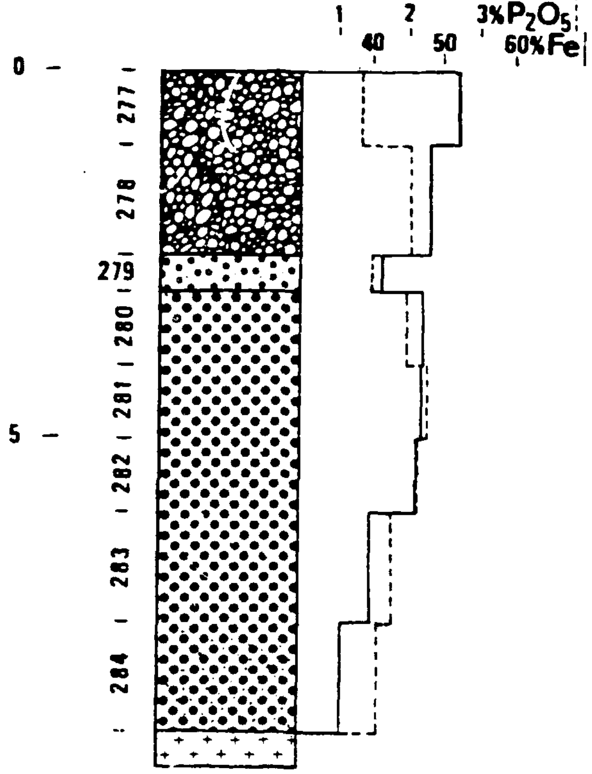
Iron oölite, sandy, evidence of iron crusts

Iron oölite, pisolitic, unconsolidated clay matrix

increasing sand content to the foot wall up to ca. 10 %

Kaolinitic Clay, sandy, white-grey altered basement

PDK 21



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

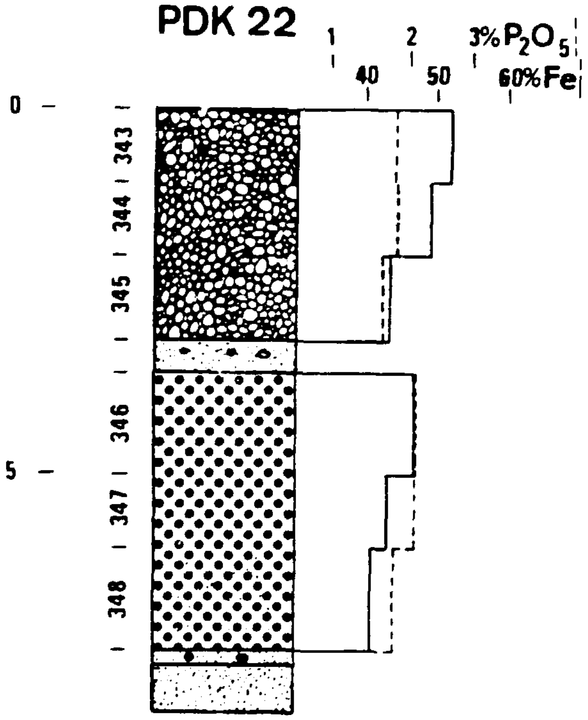
Iron oölite, sandy, clay matrix, grey-brown, evidence of bioturbation

Iron oölite, pisolitic, unconsolidated, clay matrix, silty, grey-brown

increasing sand content to the foot wall up to 20 %

Sandstone, silty-clayey, grey-white altered basement

PDK 22



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark brown

Sandstone, slightly oölitic

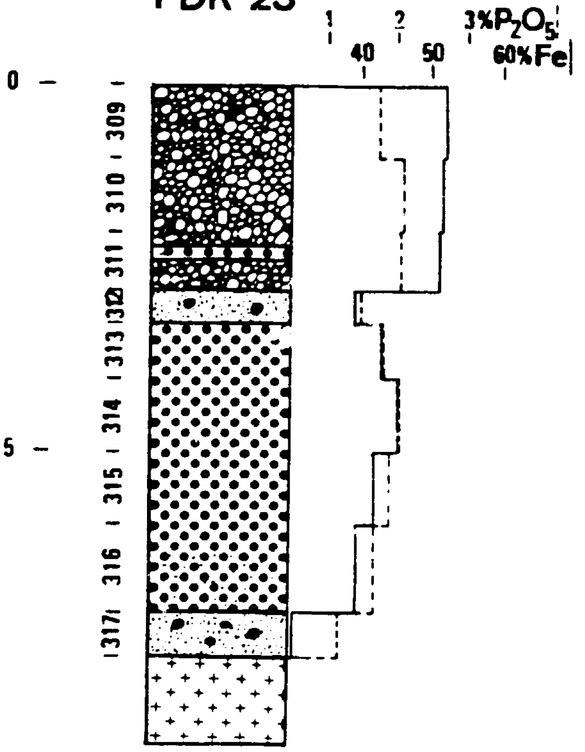
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 5 %

Sandstone, slightly oölitic and pisolitic

Sandstone, medium grained, red to light brown

PDK 23



Iron oölite, consolidated, ca. 95 % oöliths, 5 %clay-limonite matrix, dark red-brown, evidence of bioturbation from 0,5 to 1,0 m

Iron pisolite, consolidated, dark brown

Iron oölite, consolidated, dark red-brown

Sandstone, oölitic, clay matrix

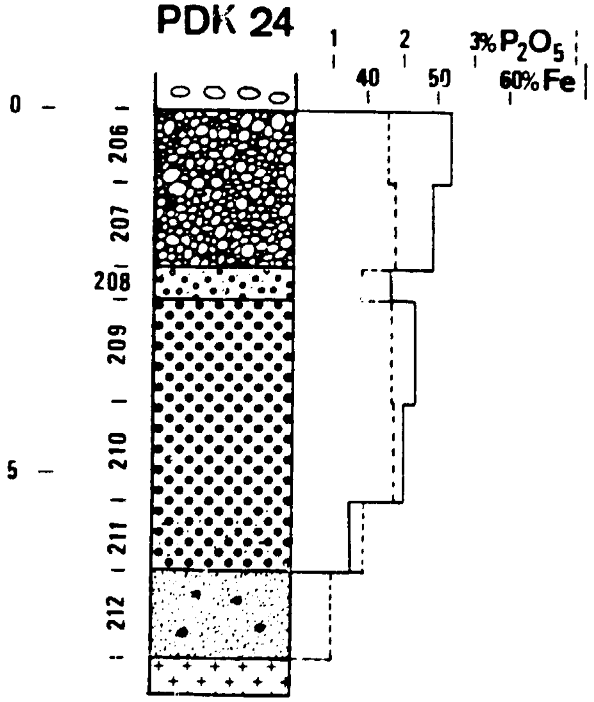
Iron oölite, pisolitic, ca. 30 % pisoliths, clay matrix, grey-brown

increasing sand content to the foot wall up to 5 %

Sandstone, oölitic and pisolitic, light brown

Kaolinitic clay, sandy, white-grey altered basement

PDK 24



Terrace gravel

Iron oölite, consolidated, ca. 90 - 95 % oöliths, clay-limonite matrix dark red-brown

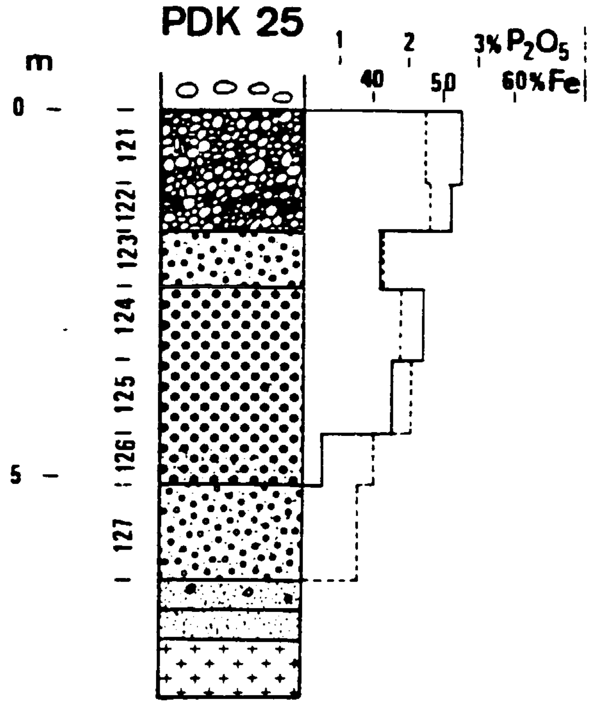
Iron oölite, sandy, clay matrix

Iron oölite, pisolitic, ca. 20 - 30 % pisoliths; clay matrix, grey-brown

increasing sand content to the foot wall up to 30 %

Sandstone, medium grained, oölith bearing, light grey to light brown

Sandstone, strongly clayey, white grey, altered basement



Gravel of river Niger terrace

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red brown

Iron pisolite, moderately consolidated

Iron oölite, sandy-clayey, slightly consolidated, brown

Iron oölite, pisolitic, unconsolidated, clay matrix, sandy-silty

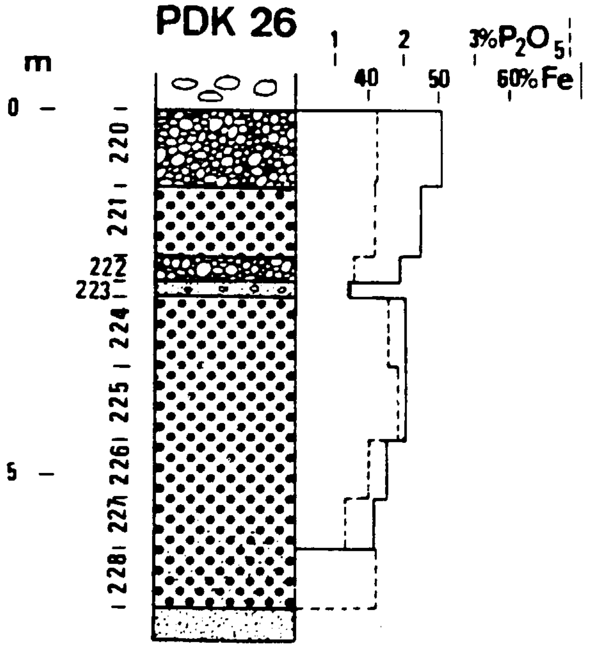
increasing sand content to the foot wall

Iron oölite, strongly sandy, clay matrix isolated pisoliths, grey-brown

Sandstone, oölitic, clayey, grey

Sandstone, clayey, white-grey

Kaolinitic clay, sandy, white, altered basement



Terrace gravel

Iron oölite, consolidated, ca. 95 % oöliths, limonite matrix, dark red-brown, evidence of bioturbation at 0.5 m

Iron pisolite, slightly consolidated, dark brown, evidence of bioturbation from 2.00 to 2.35 m

Iron oölite, consolidated

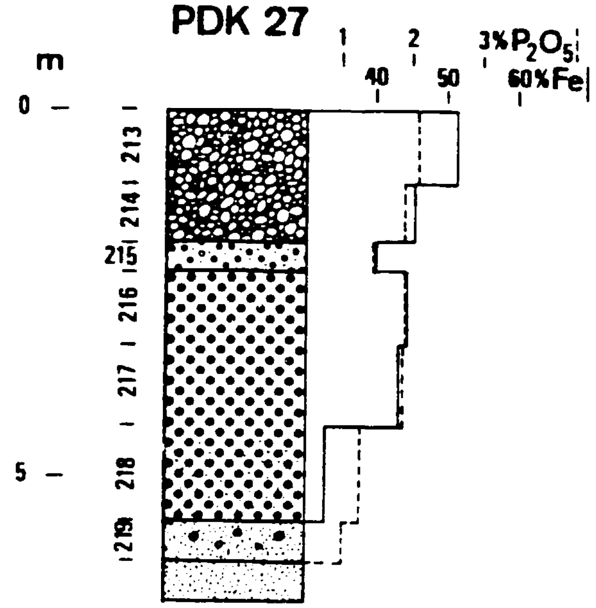
Sandstone, medium to coarse grained, oölitic

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 30 %

Sandstone, fine to medium grained, white to light-brown

PDK 27



Iron oölite, consolidated, ca. 95 % oöliths, clay, matrix, dark red-brown evidence of bioturbation from 1,80 to 2,00 m

Iron oölite, sandy, clay matrix. light grey-brown

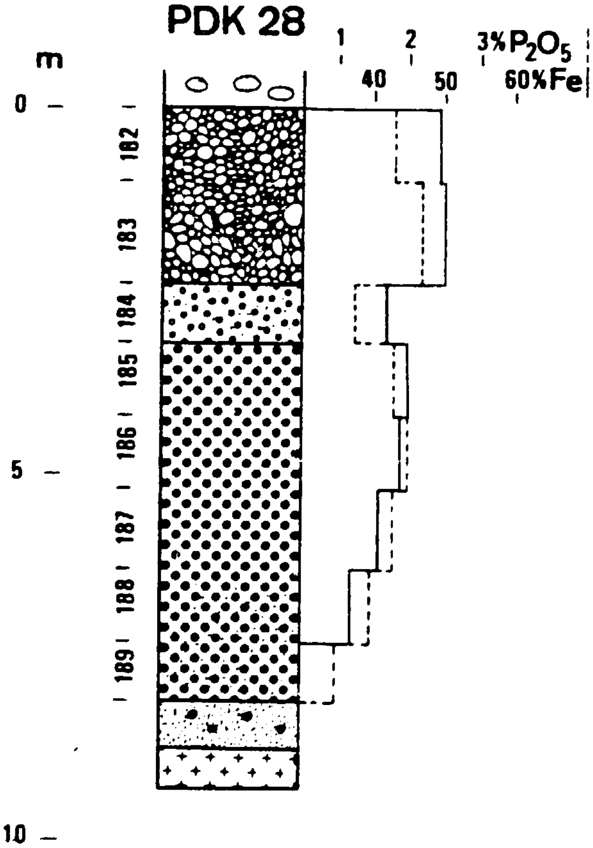
Iron oölite, pisolitic, ca. 20 % pisoliths, clay matrix, grey-brown

increasing sand content to the foot wall up to 10 %

Sandstone, oölitic and pisolitic, clayey

Sandstone, medium grained, red-white

PDK 28



Gravel of river Niger terrace

Iron oölite, consolidated, ca. 97 % oöliths, ca. 3 % clay-limonite matrix dark brown

Iron oölite, sandy, clayey, unconsolidated grey-brown

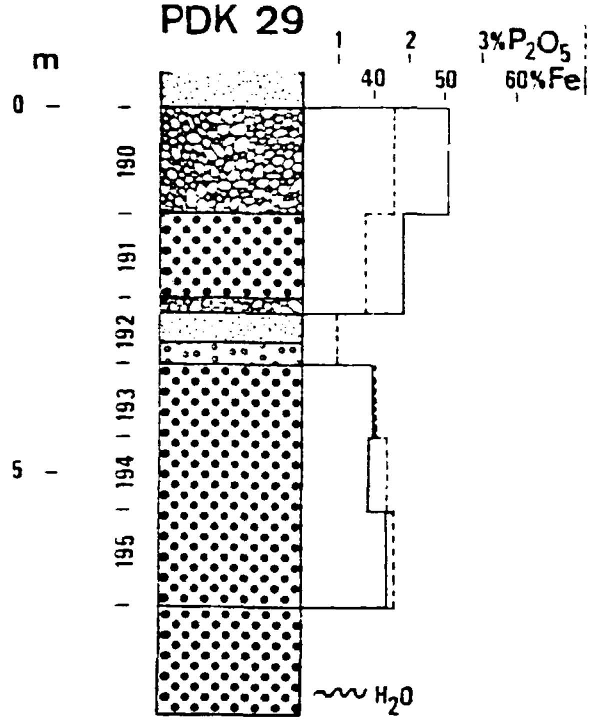
Iron oölite, pisolitic, slightly consolidated clay matrix, grey-brown

strongly increasing sand content up to 30 %, light grey-brown

Sandstone, clayey, isolated oöliths and pisoliths, light brown

Sandstone, clayey, kaolinitic, white-grey, altered basement

PDK 29



Eolian sand, fine to medium grained

Iron oölite, consolidated, ca. 95 % oöliths, 5 % clay-limonite matrix, dark red-brown

Iron pisolite, slightly consolidated; ca. 50 % pisoliths, 30 - 40 % oöliths, clay matrix, brown

Iron oölite, consolidated

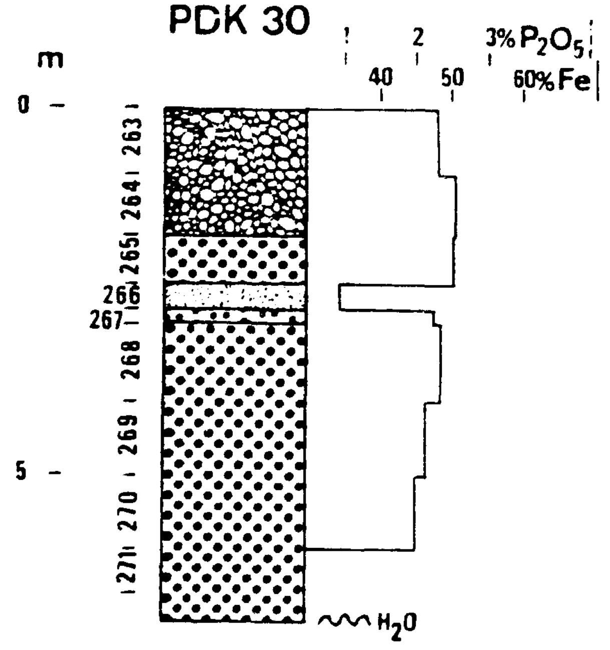
Sandstone, coarse grained, slightly consolidated

Iron oölite, sandy-clayey

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

from 8,00 m ground water

PDK 30



Iron oölite, consolidated, ca. 90 - 95 % oöliths, clay-limonite matrix, dark brown

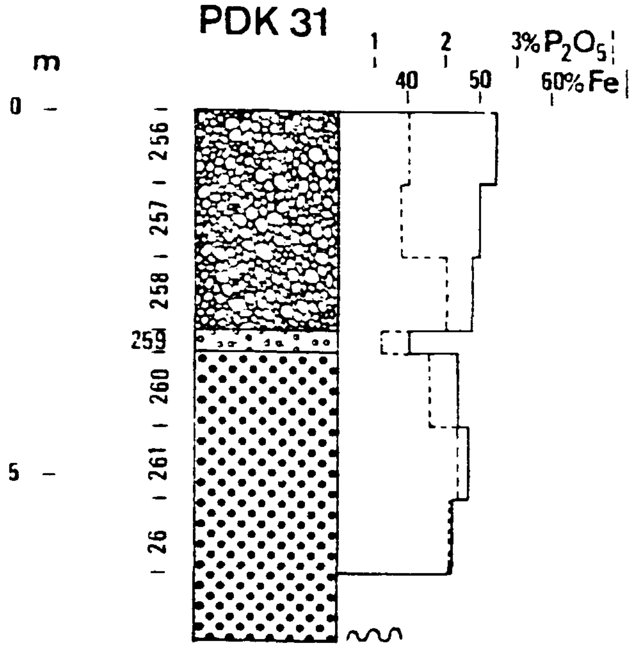
Iron pisolite, slightly consolidated, dark brown

Sandstone, slightly consolidated, coarse grained

Iron oölite, sandy-clayey

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

from 7,00 m ground water



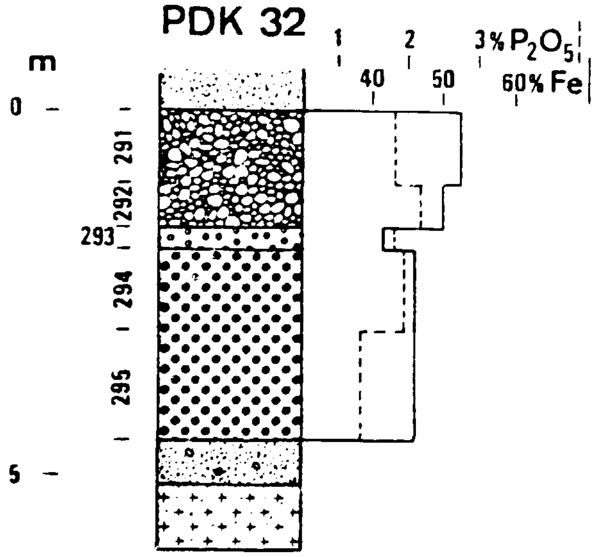
Iron oölite, consolidated ca. 90 - 95 % oöliths, dark red-brown

Iron oölite, sandy-clayey, slightly consolidated

Iron oölite, pisolitic, unconsolidatec ca. 30 % pisoliths and ca. 30 % oöliths, clay matrix

strongly clayey

from 7,10 m ground water



Eolian sand, fine to medium grained

Iron oölite, moderately consolidated, ca. 90 - 95 % oöliths, 5 - 10 % clay-limonite matrix, dark brown

Iron oölite, strong evidence of bioturbation

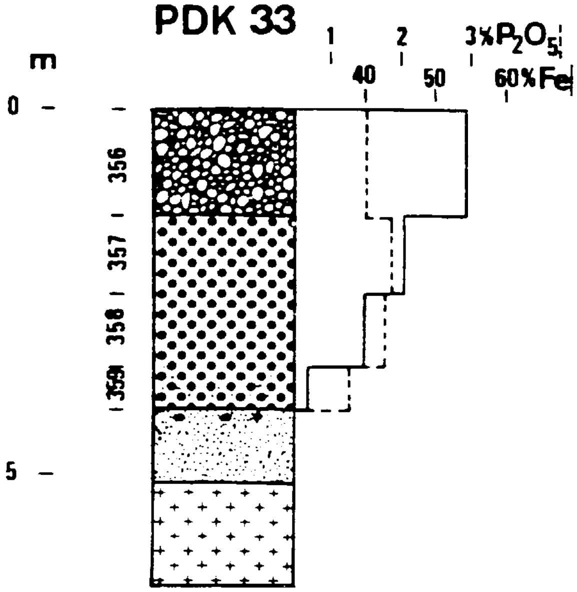
Iron oölite, pisolitic, slightly consolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 5 %

Sandstone, fine to medium grained, oölitic and pisolitic, red to white

Sandstone, kaolinitic clay matrix, white to grey-red, altered basement

PDK 33



Iron oolite, consolidated, ca. 95 % ooliths, ca. 5 % clay matrix, strong evidence of iron crusts, dark red-brown

Iron oolite, pisolitic, unconsolidated ca. 40 % pisoliths, 30 % ooliths, clay matrix, grey-brown

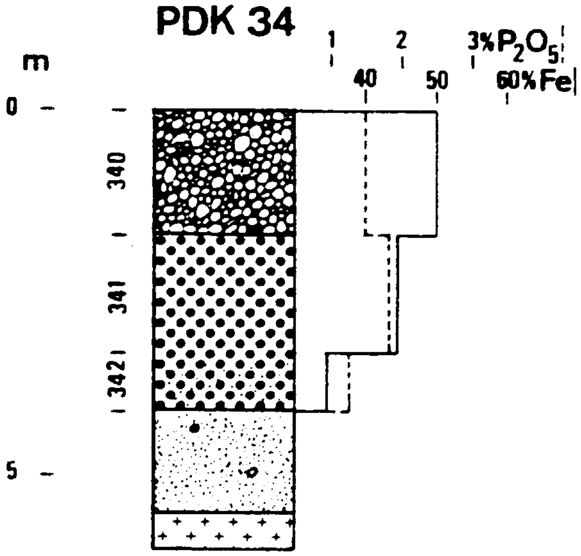
increasing sand content to the foot wall up to 10 %

Sandstone, oolitic and pisolitic

Sandstone, medium to coarse grained, light red to light brown

Kaolinitic clay, sandy, white, altered basement

PDK 34



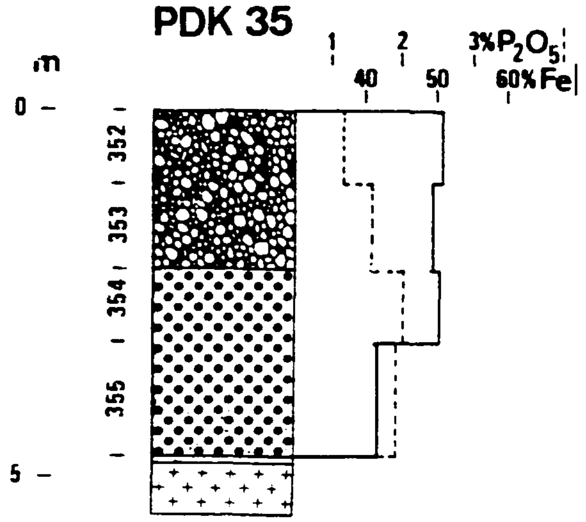
Iron oolite, consolidated, ca. 95 % ooliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oolite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 30 %

Sandstone, slightly oolitic, medium grained, light red

Sandstone, kaolinitic clay matrix, altered basement



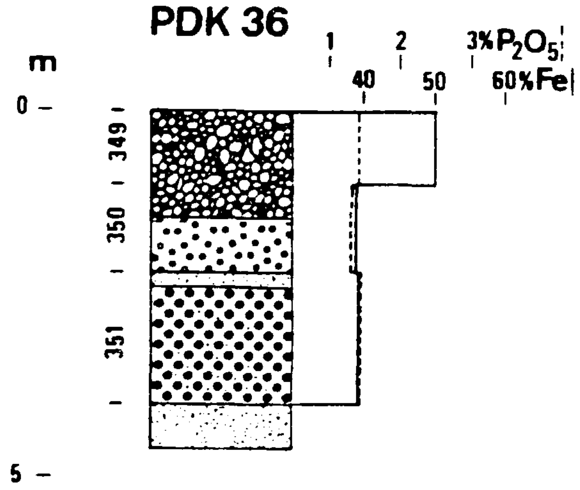
Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay matrix, strong evidence of iron crusts on the first 0,30 m, dark red-brown

Iron oölite, pisolitic, unconsolidated, ca. 40 % pisoliths, 30 % oöliths, clay matrix, grey-brown

increasing sand content to the foot wall up to 5 %

Sandstone, fine to medium grained, red

Sandstone, medium grained, white to grey-red altered basement



Iron oölite, moderately consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, slightly silty, dark red-brown

Iron oölite, sandy, strong evidence of iron crusts

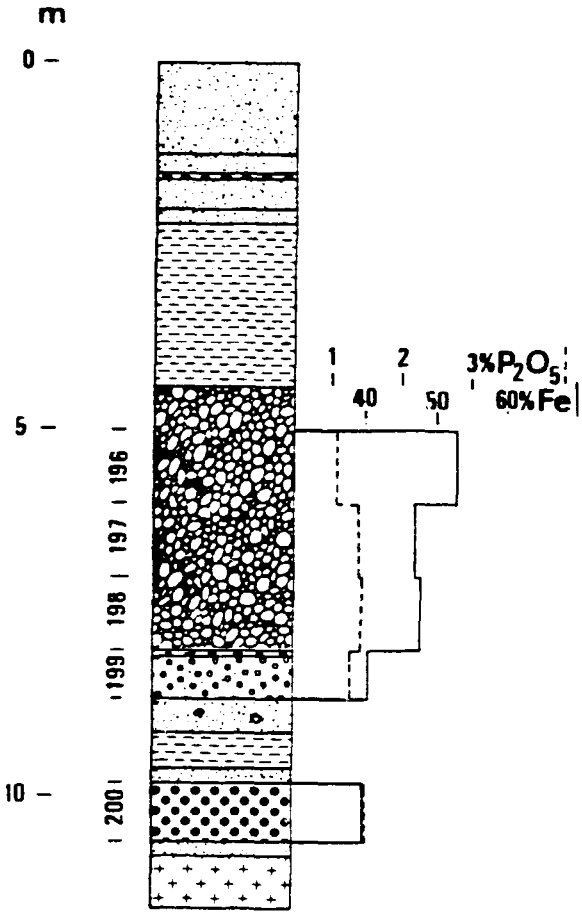
Sandstone, fine grained, dark red

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Increasing sand content to the foot wall up to 20 %

Sandstone, slightly oölitic and pisolitic, light brown

PDK 37



Siltstone, clayey, red to white

Sandstone, fine grained, light brown

Clay

Siltstone, sandy, white to light brown

Sandstone, fine grained, red

Clay, slightly silty,
white to light brown

Iron oölite, consolidated, ca. 95 % oöliths
ca. 5 % clay matrix, dark brown

Limonitic clay

Iron oölite, sandy, clay-limonite matrix, brown

Siltstone, sandy, isolated oöliths, light brown

clay, white

Siltstone, clayey, light-brown

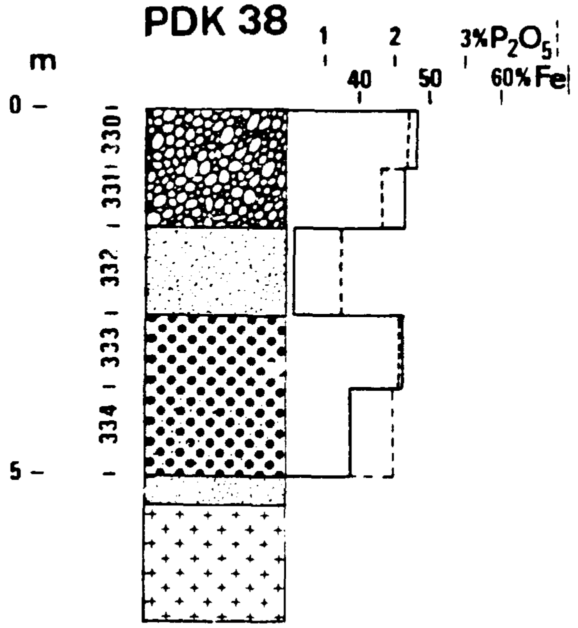
Iron oölite, pisolitic, moderately consolidated

clay matrix, grey-brown

Sandstone, clayey-silty, brown

Sandstone, medium to fine grained, clayey
white-grey, altered basement

PDK 38



Iron oölite, consolidated, 90 - 95 % oöliths,
5 - 10 % clay, limonite matrix, dark
red-brown

Sandstone, medium to coarse grained,
slightly oölitic, evidence of bioturbation

Iron oölite, pisolitic, unconsolidated, slightly
sandy-silty, clay matrix, grey-brown

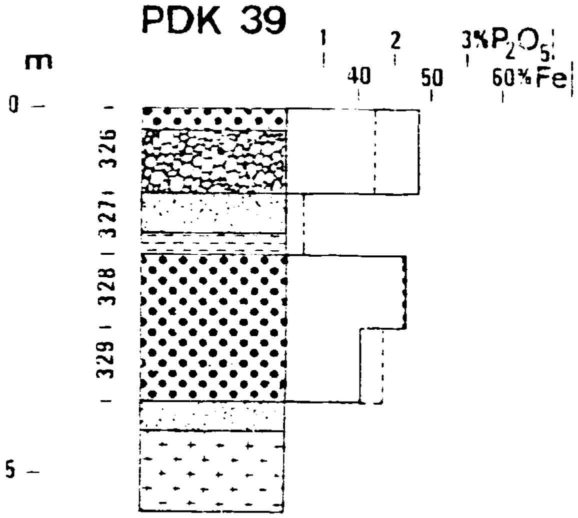
increasing sand content to the foot wall
up to 10 %

Sandstone, fine to medium grained, light brown

Kaolinitic clay, sandy, white to light
grey, altered basement

Annex B 3.22

PDK 39



Iron pisolite, moderately consolidated, dark brown

Iron oolite, consolidated, ca. 95 % ooliths, ca. 5 % clay-limonite matrix, dark brown

Sandstone, medium to coarse grained, light brown

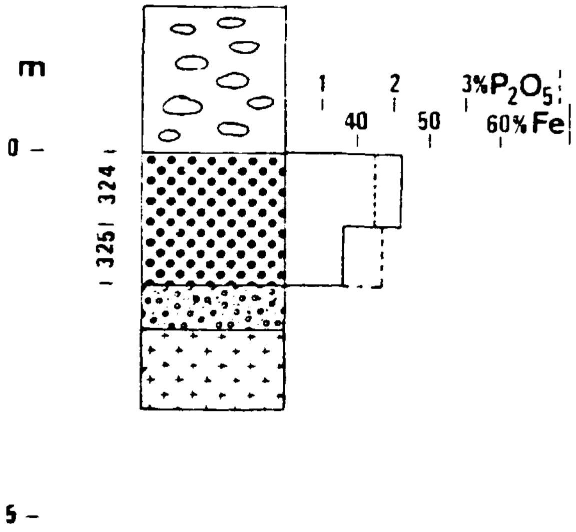
Clay, silty, yellow

Iron oolite, pisolitic, unconsolidated, clay matrix, slightly sandy, grey-brown

Sandstone, fine to medium grained, light brown

Sandstone, kaolinitic clay matrix altered basement

PDK 40



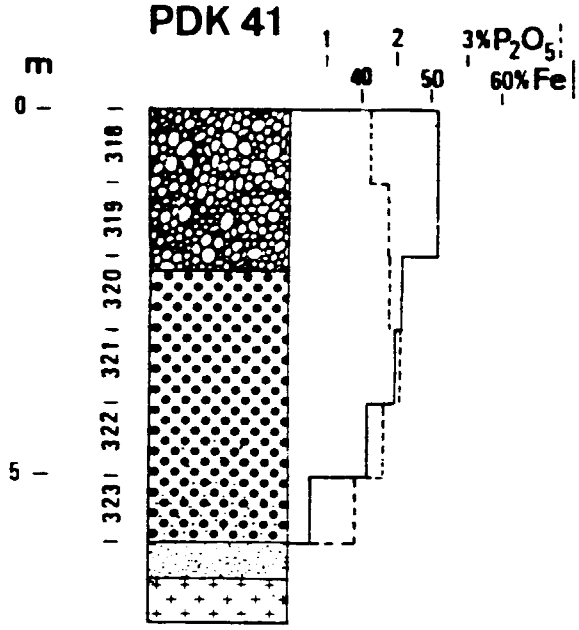
Terrace gravel

Iron oolite, pisolitic, unconsolidated, slightly sandy, clay matrix, grey-brown

Iron oolite, strongly sandy, evidence of iron crusts

Sandstone, kaolinitic clay matrix, light brown to white, altered basement

PDK 41



Iron oölite, consolidated, ca. 95 % oöliths, 5 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall

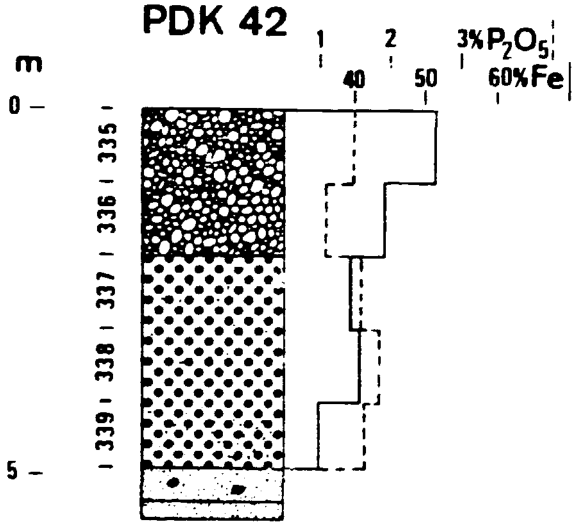
up to 20 %

up to 30 %

Sandstone, fine to medium grained

Sandstone, kaolinitic clay matrix, white to light red, altered basement

PDK 42



Iron oölite, moderately consolidated, 90 - 95 % oöliths, 5 to 10 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, slightly sandy, unconsolidated, clay matrix, grey-brown

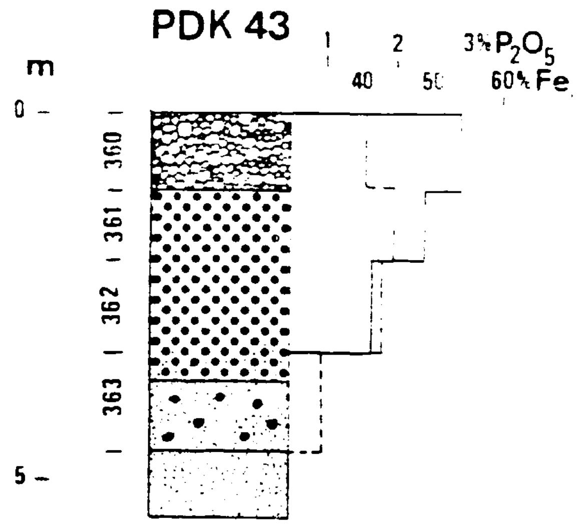
increasing sand content to the foot wall

up to 30 %

Sandstone, oölitic and pisolitic

Sandstone, fine to medium grained, red

PDK 43



Iron oölite, consolidated, ca. 90 % oölites, ca. 10 % clay-limonite matrix, dark red-brown

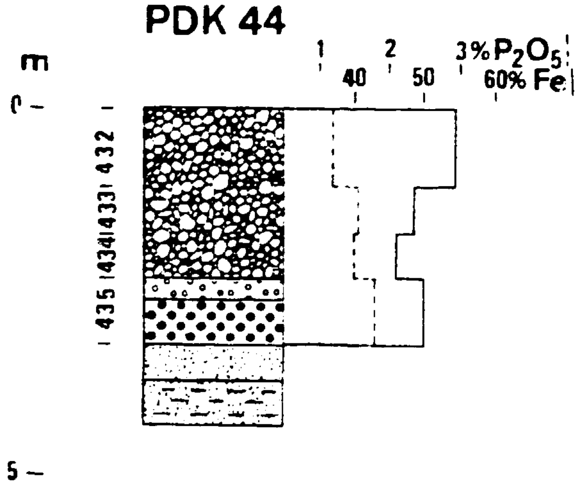
Iron oölite, pisolitic, unconsolidated, silty, clay matrix, grey-brown

increasing sand content to the foot wall up to 20 %

Sandstone, oölitic and pisolitic, clayey, light brown

Sandstone, medium grained, red

PDK 44



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

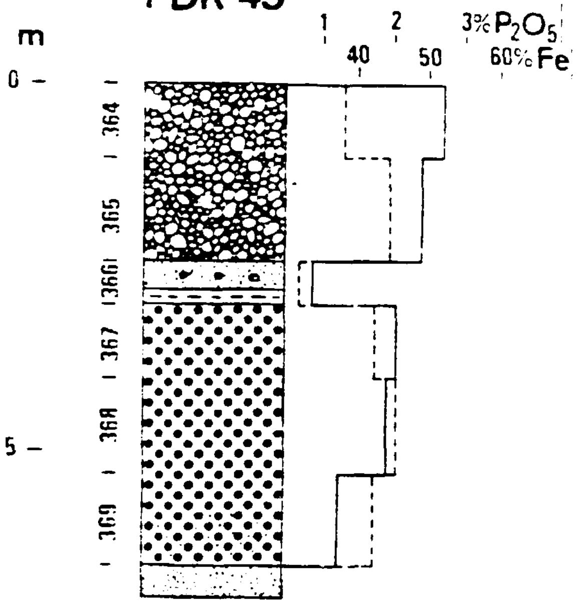
Iron oölite, sandy, clay matrix

Iron oölite, pisolitic, unconsolidated, grey-brown

Sandstone, slightly clayey

Clay, strongly sandy, yellow-brown

PDK 45



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark brown

Sandstone, coarse grained, light brown

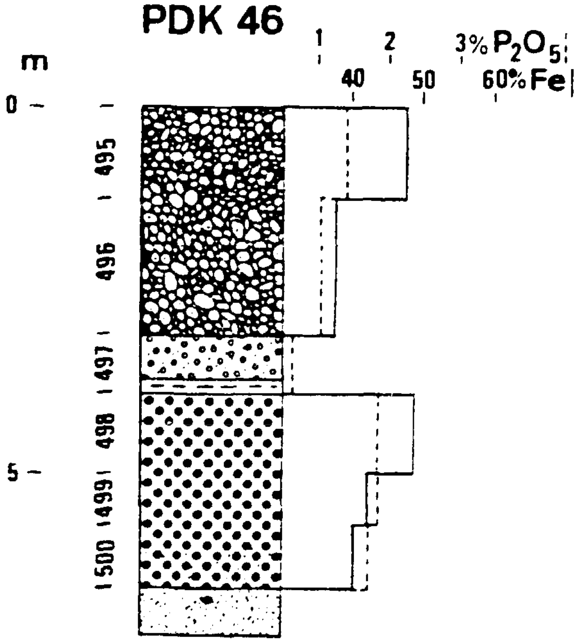
Clay, sandy-silty

Iron oölite, pisolitic, unconsolidated, ca. 85 % oöliths and pisoliths, clay matrix grey-brown

increasing sand content to the foot wall up to ca. 15 %

Sandstone, medium grained, grey-brown

PDK 46



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix; dark brown

strongly sandy

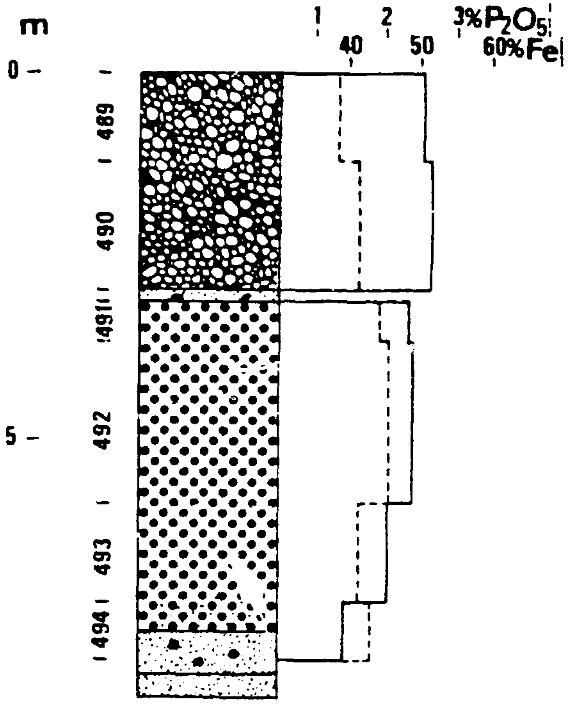
Iron oölite, very strongly sandy,

Clay, sandy

Iron oölite, pisolitic, unconsolidated, ca. 45 % pisoliths, clay matrix, sandy, grey-brown

Sandstone, fine to medium grained, clayey, light brown

PDK 47



Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

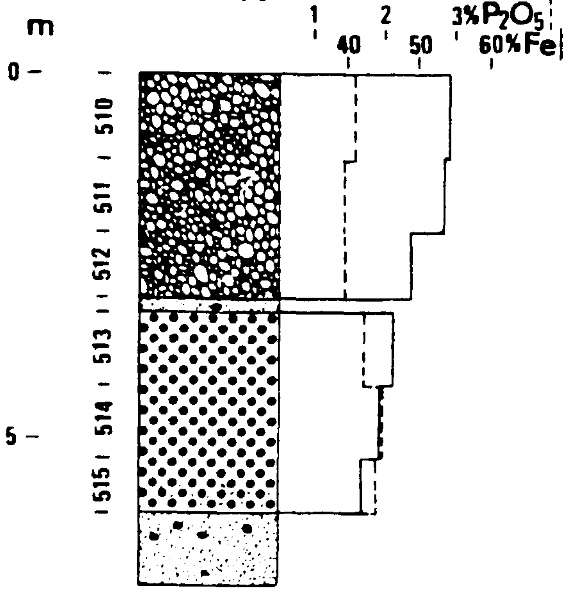
Sandstone, fine to medium grained

Iron oölite, pisolitic, moderately consolidated, clay matrix, grey-brown

Sandstone, oölitic and pisolitic,

Sandstone, fine to medium grained, grey-white

PDK 48



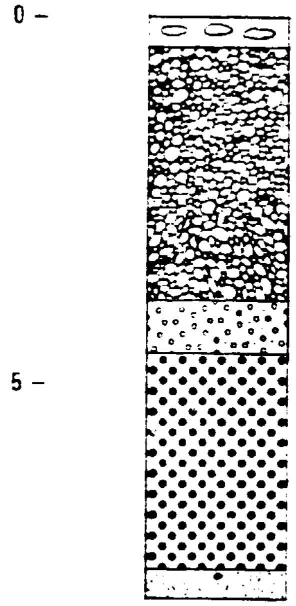
Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Sandstone, fine to medium grained

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, fine to medium grained, clayey, oölith and pisolith bearing

PDK 49



Terrace gravel

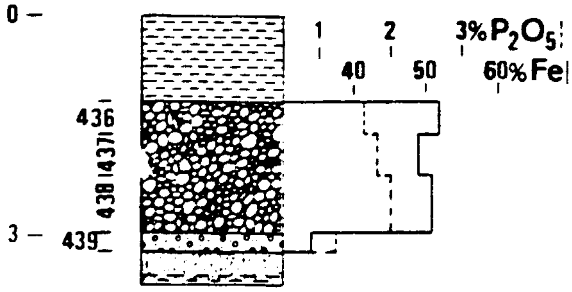
Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite, sandy

Iron oölite, pisolitic, unconsolidated, clay matrix, slightly sandy, grey-brown

Sandstone, fine grained, oölitic and pisolitic

PDK 50



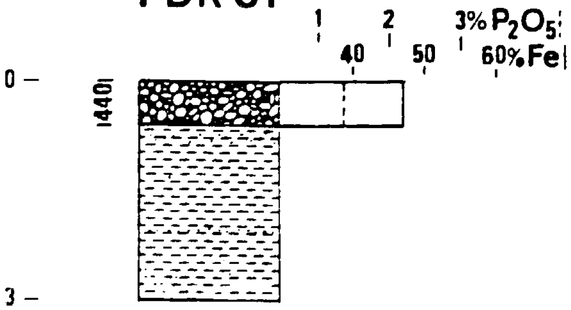
Clay, silty, light brown

Iron oölite, consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, dark brown

Iron oölite, sandy,

Sandstone, medium grained, clayey, red-brown

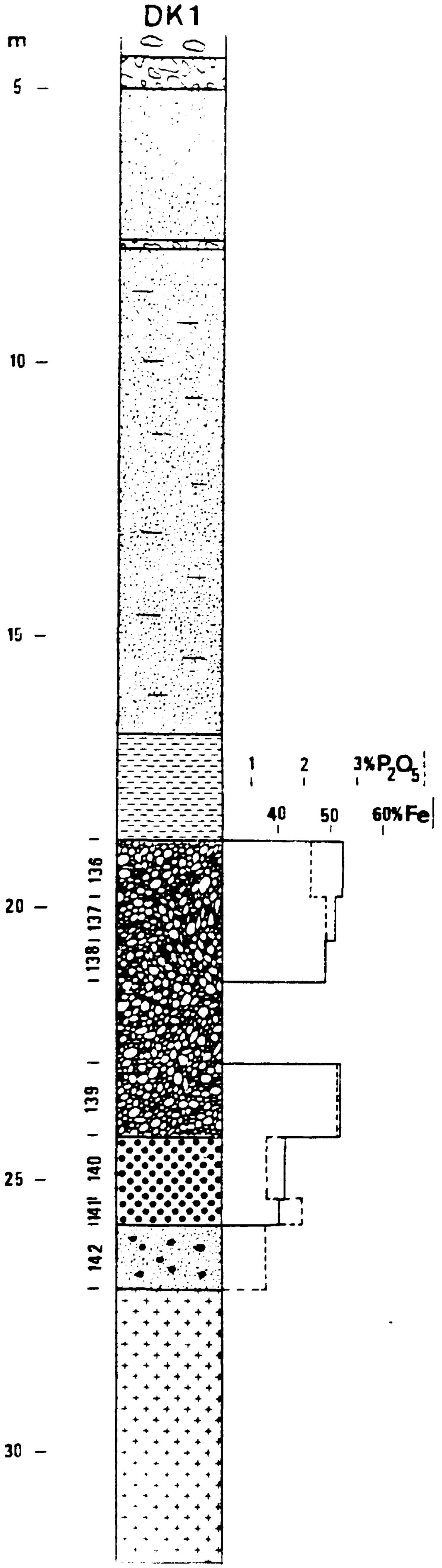
PDK 51



Iron oölite, consolidated, ca. 95 % oöliths

Clay, sandy-silty, light brown

Annex B 3.28



Quartz conglomerate in iron sandstone matrix

Laterite, brecciated, iron sandstone matrix

Siltstone to fine grained sandstone, red-brown

Sandstone, fine grained, oölitic, lateritic

Siltstone, sandy-clayey, grey-white to red-brown

Clay, silty, white to light brown

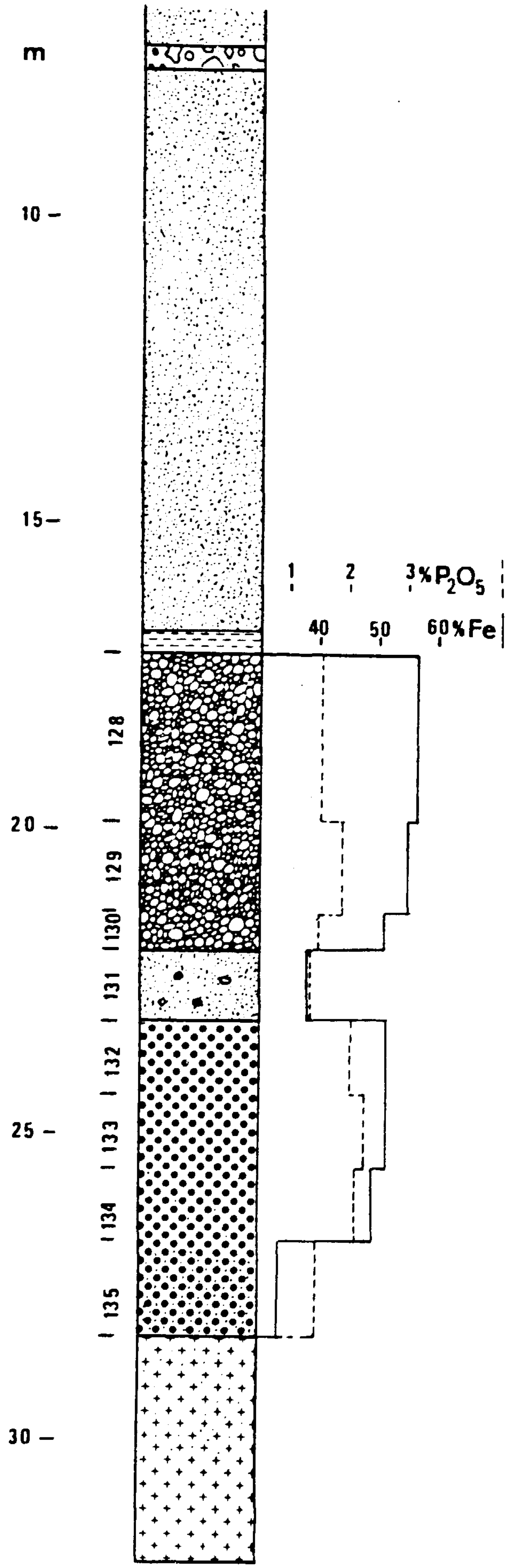
Iron oölite, consolidated, ca. 95 % oöliths, ca. 2 % quartz sand, clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, medium grained, oölitic and pisolitic, light brown

Kaolinitic clay, sandy, white-grey, altered basement

DK2



Siltstone, sandy, red to white

Lateritic breccia, sand, limonite matrix

Siltstone, sandy, layers of fine grained sand, grey-red to light brown

Clay, silty, grey

Iron oölite, consolidated, ca. 95 % oöliths, slightly sandy, clay-limonite matrix, dark red-brown, evidence of isolated pisoliths

Sandstone, medium grained, oölitic, slightly clayey, brown

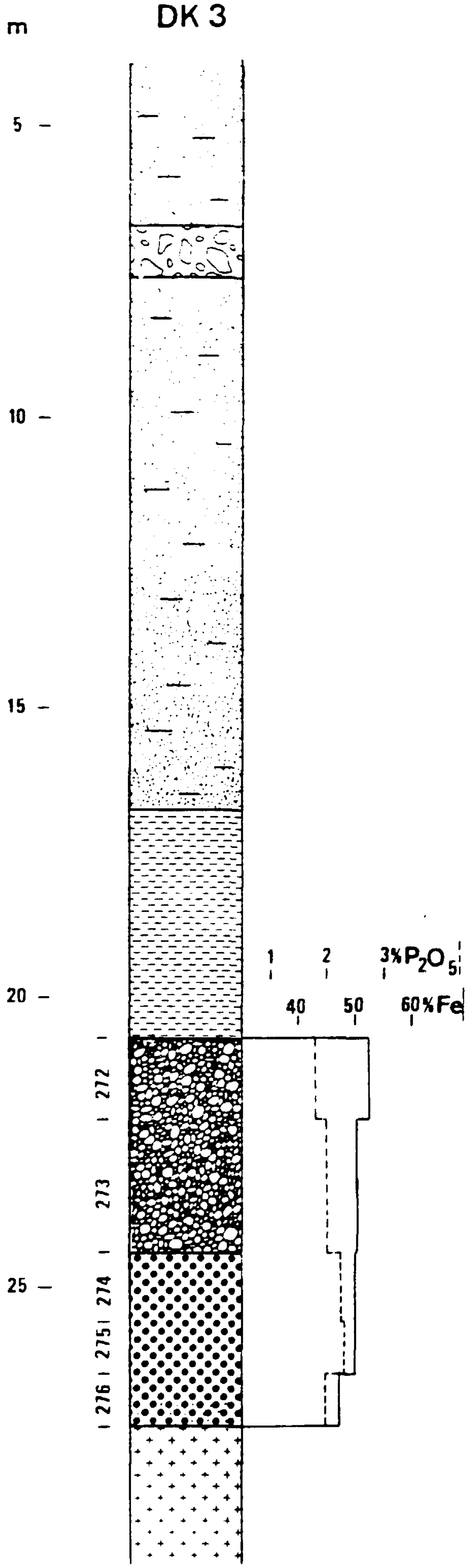
Iron oölite, pisolitic, unconsolidated, ca. 10 - 20 % pisoliths, clay matrix, grey-brown

increasing sand content up to ca. 5 %

increasing sand content up to ca. 35 %

Sandstone and kaolinitic clay, grey-white, altered basement

DK 3



Siltstone, clayey and sandy, white to red-brown

Iron oölite, strongly sandy, limonite matrix

Siltstone, clayey and sandy, White to red-brown

Clay, silty, grey-white

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

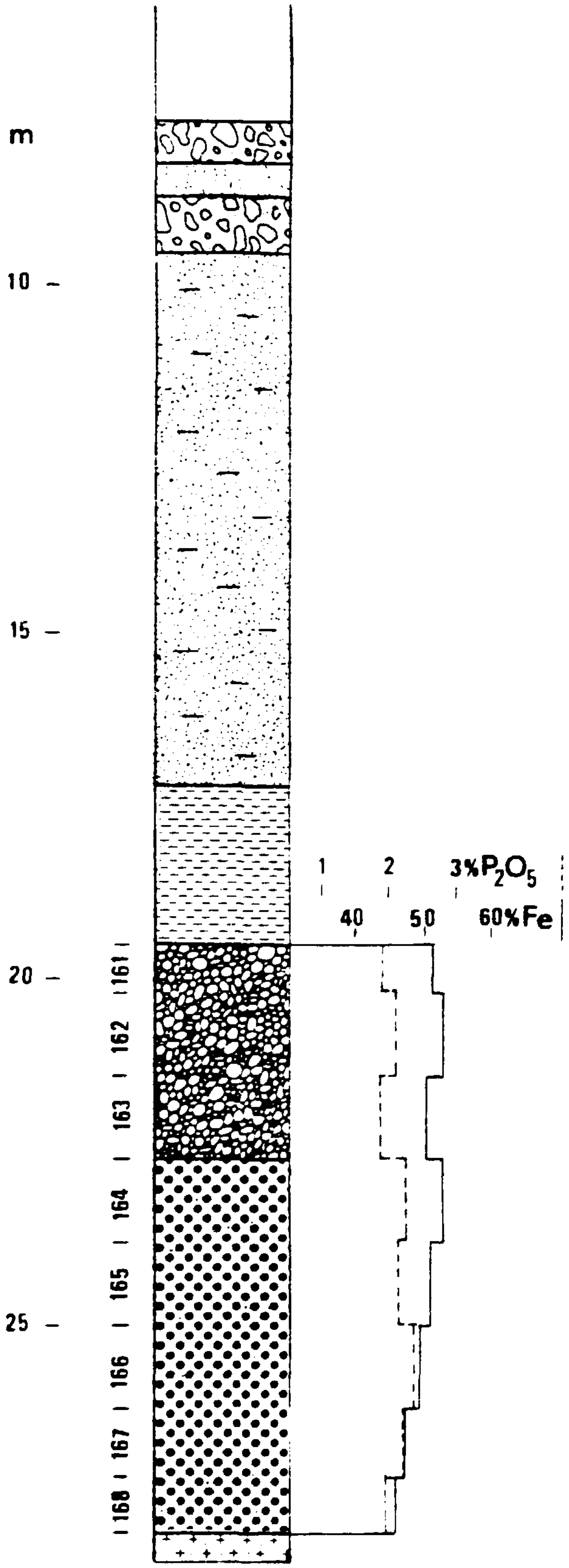
Iron oölite, pisolitic, moderately consolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 10 %

Kaolinitic clay, sandy, white-brown, altered basement

Annex B 3.31

DK 4



not cored

Laterite, brecciated, sandstone in limonite matrix

Siltstone, slightly ferruginous

Laterite, brecciated, with boulders of strongly sandy iron oölite

Siltstone and fine grained sandstone, clayey, grey-red to light brown

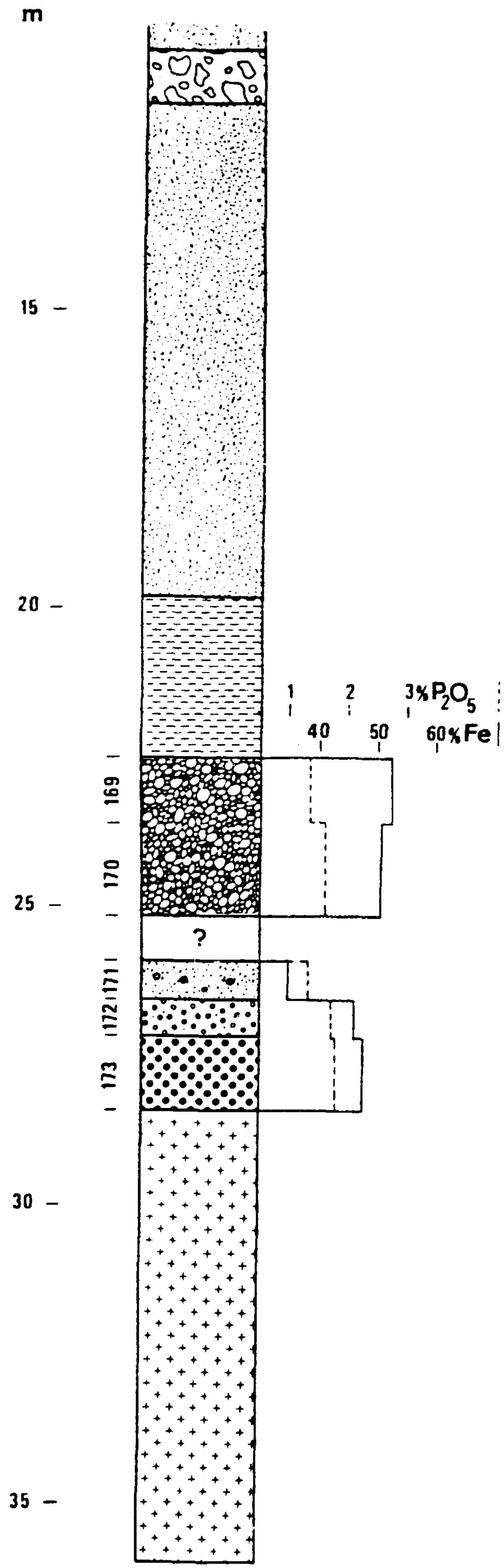
Clay, slightly silty, grey-red to light grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, sligthly sandy, clay matrix, grey-brown

Kaolinitic clay, sandy, white, altered basement

DK 5



Siltstone, sandy, red-brown

Laterite oölitic and pisolitic, sandy, brecciated, limonitic matrix, dark brown

Siltstone and fine grained sandstone, light brown to light red

Clay, light grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Sandstone, coarse grained, oölitic, light brown

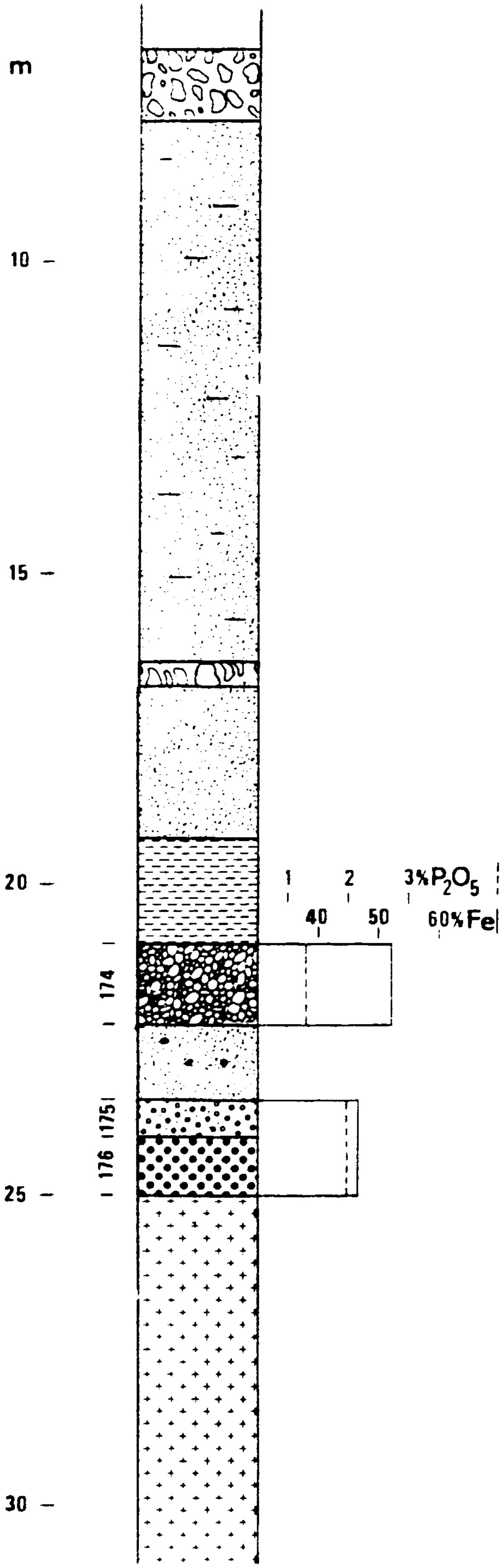
Iron oölite, sandy-clayey, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Kaolinitic clay, sandy, white, altered basement

Annex B 3.33

DK 6



not cored

Laterite, brecciated, strongly sandy, slightly oölitic, limonite matrix

Siltstone, clayey, light brown to light red

Iron sandstone

Sandstone, fine grained, light red to light brown

Clay, white to pink

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

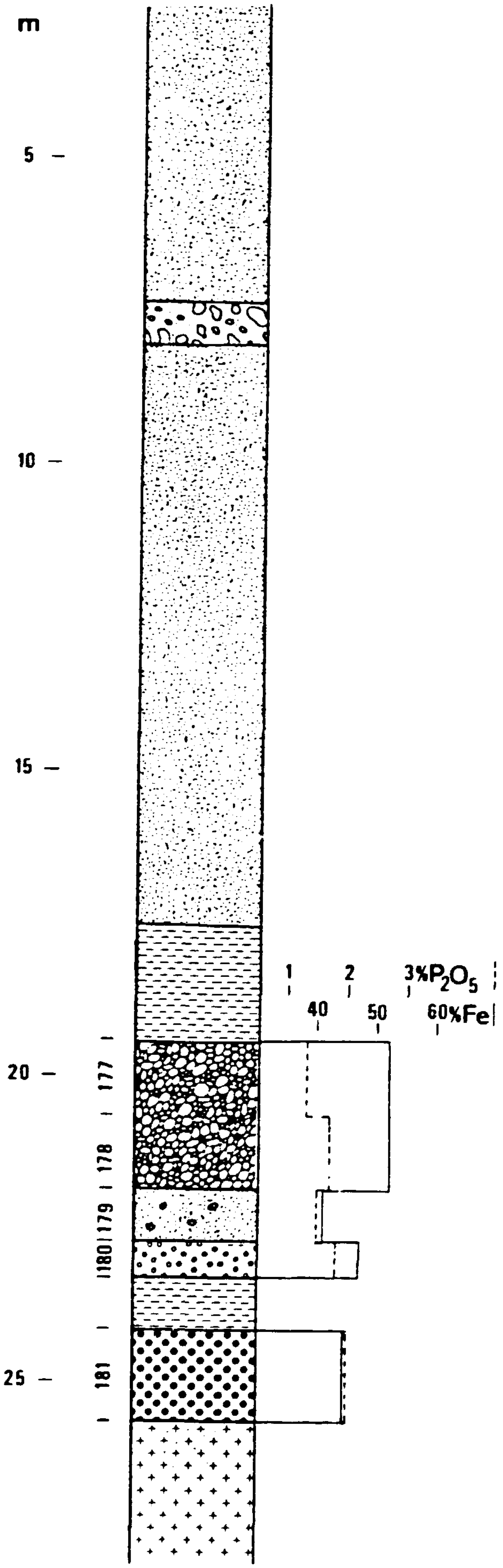
Sandstone, coarse grained, slightly oölitic, light brown

Iron oölite, sandy-clayey

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Kaolinitic clay, sandy, light grey, altered basement

DK 7



Siltstone and fine grained sandstone, light brown

Laterite, sandy-oölitic, limonite matrix, black-brown

Siltstone and fine grained sandstone light red to light brown

Clay, light red to white-grey

Iron oölite, consolidated, 90 - 95 % oöliths, 5 - 10 % clay-limonite matrix; dark red-brown

Sandstone, medium to coarse grained, oölitic, light grey-brown

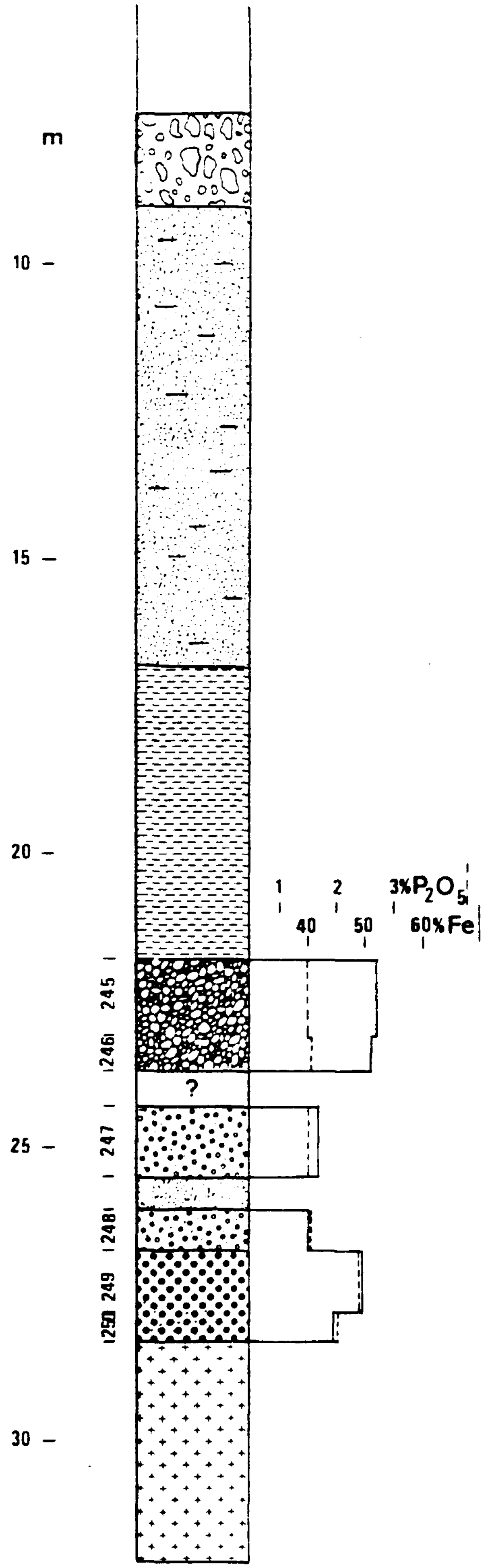
Iron oölite, sandy, grey-brown

Clay, light brown

Iron oölite, pisolitic, moderately consolidated, clay matrix, grey-brown

Sandstone, fine grained, white and kaolinitic, sandy clay altered basement

DK 8



not cored

Laterite, quartz pebbles, sandy, also oölitic, limonite matrix

Siltstone, clayey, light red to light brown

Clay, silty, grey-white with reddish stripes

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

no core

Iron oölite, sandy, clay matrix, moderately consolidated, grey-brown

Sandstone, coarse grained, light brown

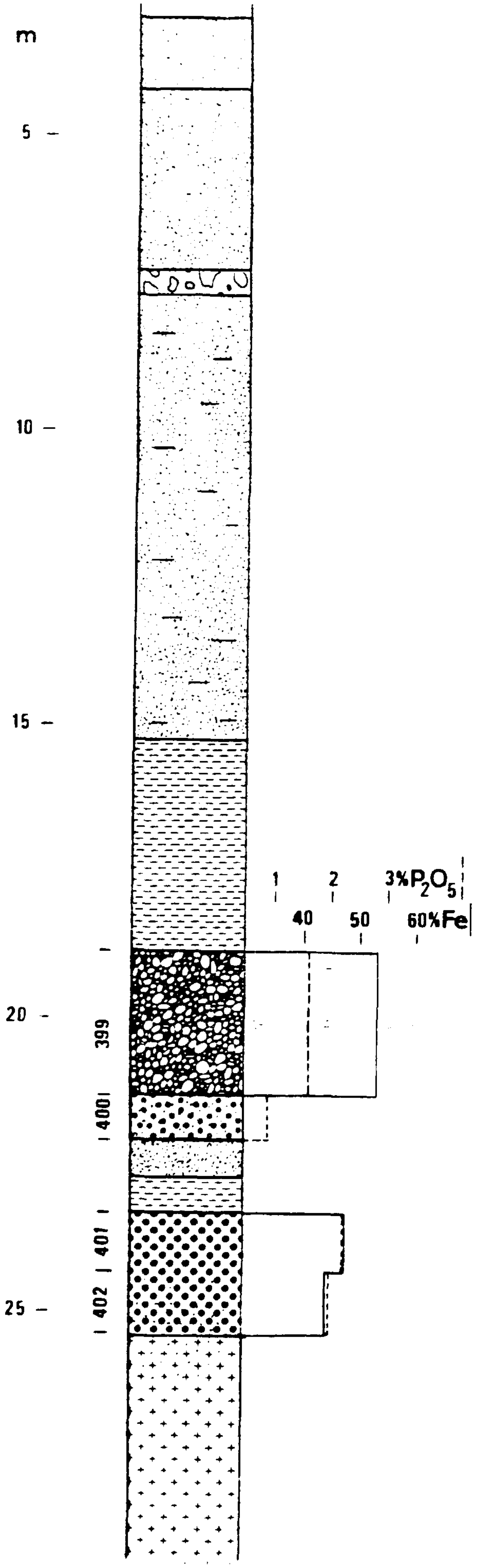
Iron oölite, sandy, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey brown

slightly increasing sand content up to 5 %

Sandstone, medium grained kaolinitic clay matrix, white-grey, altered basement

DK 9



Sand, medium grained, slightly consolidated, light red-brown

Iron sandstone, medium grained, grey-brown

Laterite, brecciated, sandy, oölitic, dark bro

Sandstone, fine to medium grained, light red-brown

and

Siltstone, sandy-clayey, light red to white-brown

Clay, silty, white-grey to light brown

Iron oölite, consolidated, ca. 95 % *oöliths. ca. 5 % limonite matrix,* dark red-brown

Iron oölite, strongly sandy, clay matrix

Sandstone, coarse grained, light brown to red

Clay, silty, light brown with white schlieren

Iron oölite, pisolitic, unconsolidated, ca. 15 % pisoliths, clay matrix, grey-brown

increasing sand content up to 5 %

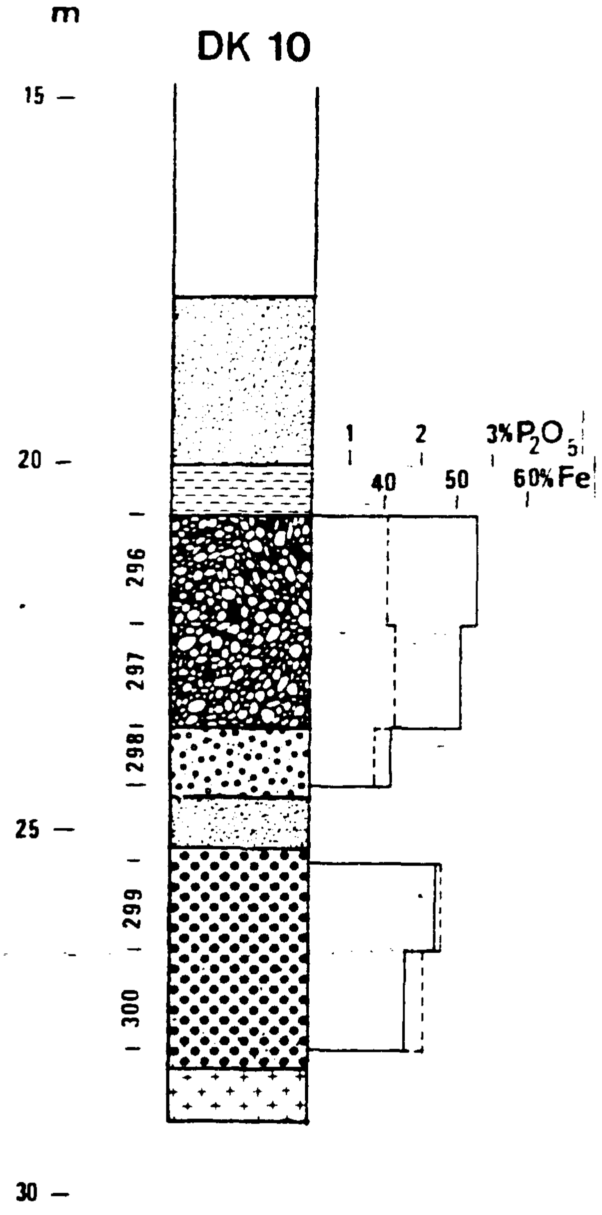
increasing sand content up to 10 %

Sandstone, fine grained, yellow-white

and

Kaolinitic clay, sandy, white

altered basement



not cored

Sandstone, medium grained, light brown

Clay, silty, light brown to grey-white

Iron oölite, consolidated, ca. 90 % oöliths, ca. 5 - 10 % clay-limonite matrix, isolated pisoliths, dark red-brown

Iron oölite, sandy, clay matrix, grey-brown

Sandstone, medium grained, light brown to red

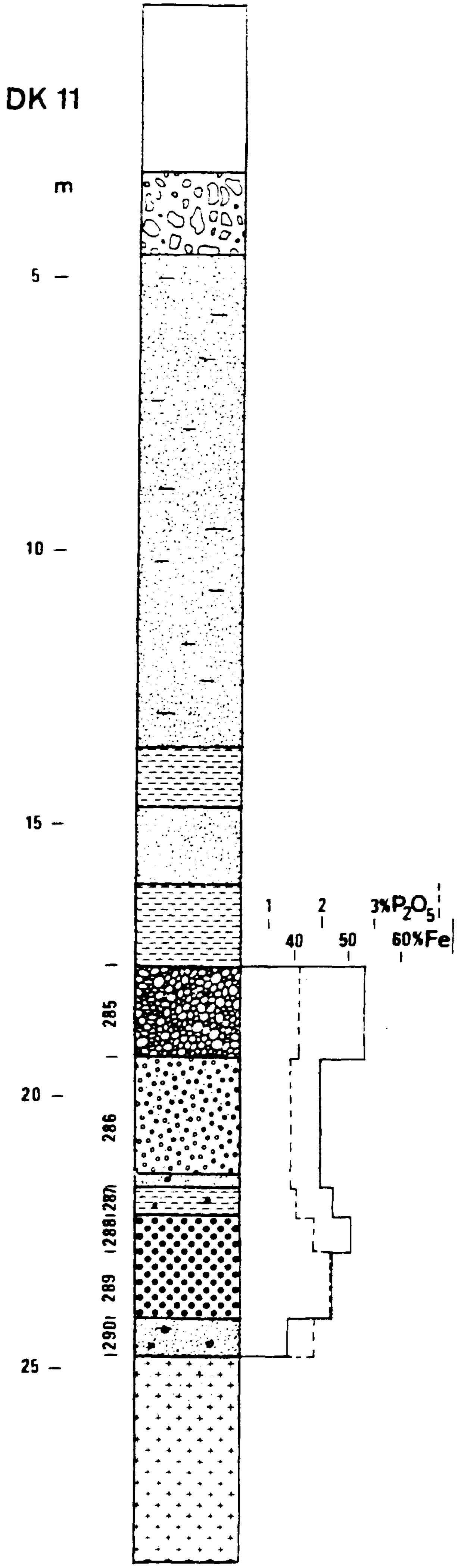
Iron oölite, pisolitic, moderately consolidated, clay matrix, grey-brown

increasing sand content up to 5 %

increasing sand content up to 10 %

Sandstone, kaolinitic clay matrix grey-white, altered basement

Annex B 3.38



not cored

Laterite, brecciated, quartz fragments, sandy, limonite matrix

Siltstone, sandy-clayey, light grey to light brown

and

Sandstone, fine to medium grained, red

Clay, white-grey

Siltstone to fine grained sandstone, clayey, light brown to white

Clay, light brown

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay - limonite matrix, dark red-brown

Iron oölite, moderately consolidated ca. 70 - 80 % oöliths, 5 % quartz sand, clay matrix, grey-brown

Iron siltstone, slightly oölitic, hematitic, r

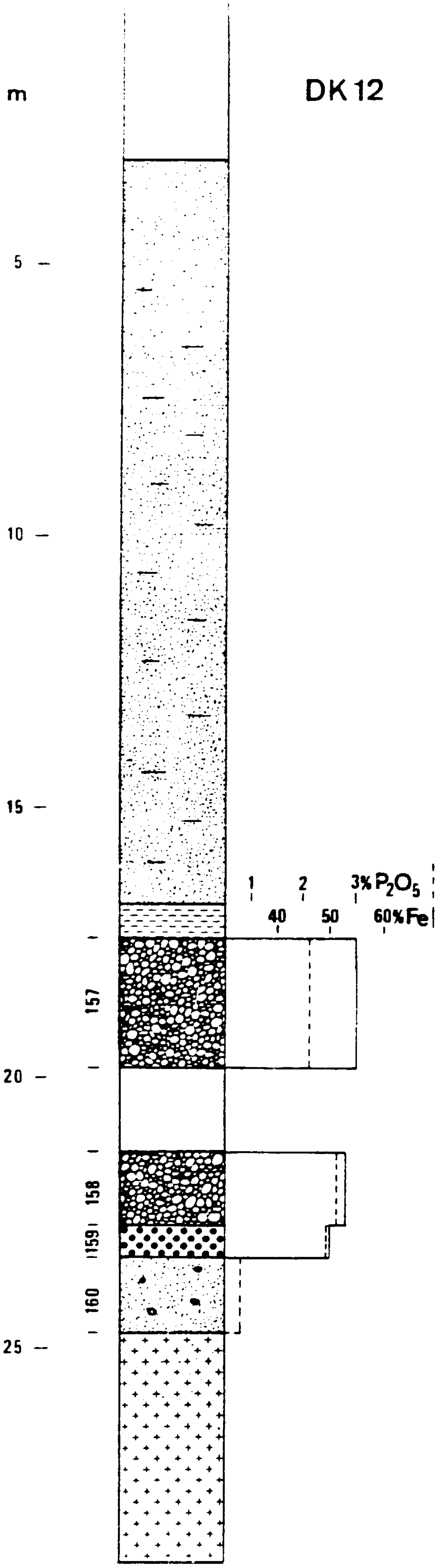
Clay, silty, oölitic, light brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Iron oölite, strongly sandy to oölitic sandstone, clayey, grey-brown

Sandstone, kaolinitic clay matrix, white-grey, iron stained in the upper part, altered basement

DK 12



not cored

Siltstone, clayey, red to light grey

Clay, white to light brown

Iron oölite, consolidated, 90 - 95 % oöliths, 5 - 10 % clay-limonite matrix, isolated pisoliths, dark red-brown

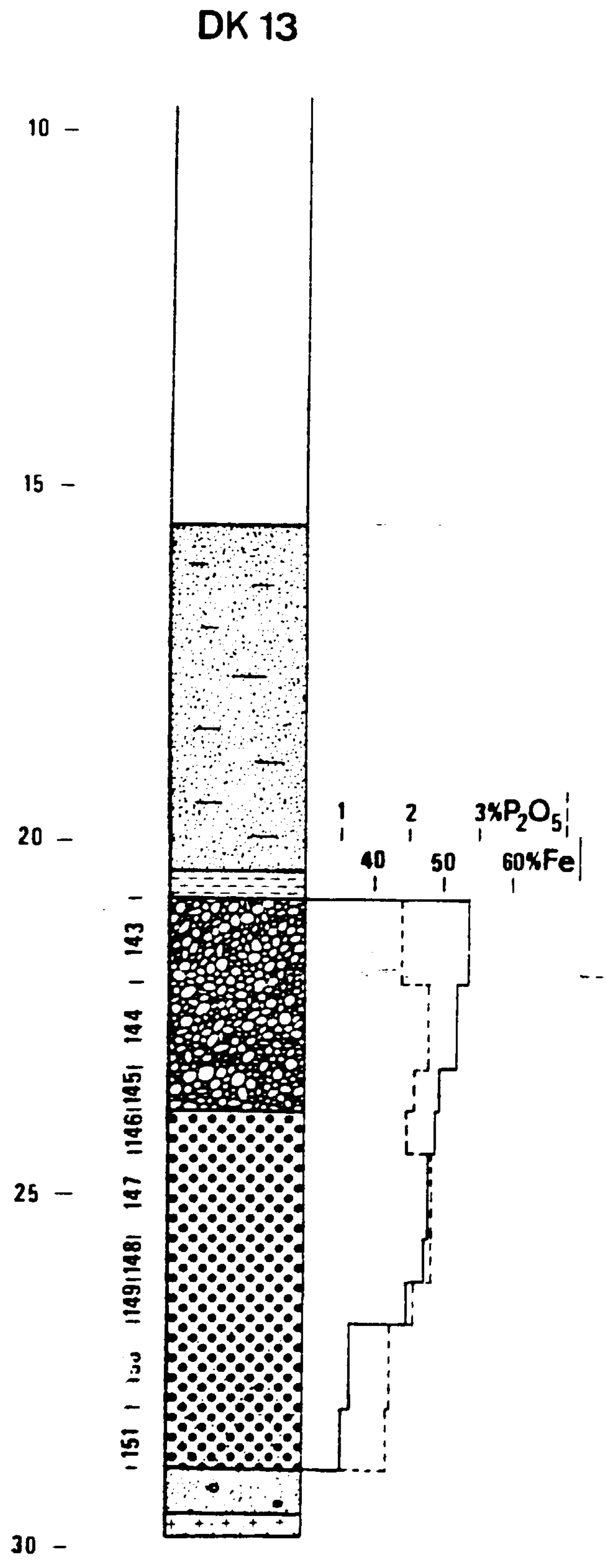
no core

Iron oölite, consolidated, 90 - 95 % oöliths, 5 - 10 % clay, limonite matrix, pisolitic, dark red-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, medium grained, oölitic and pisolitic, brown

Sandstone, kaolinitic clay matrix, white-grey, altered basement



not cored

Siltstone, clayey, light red

Clay, white-grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content up to ca. 5 - 8 %

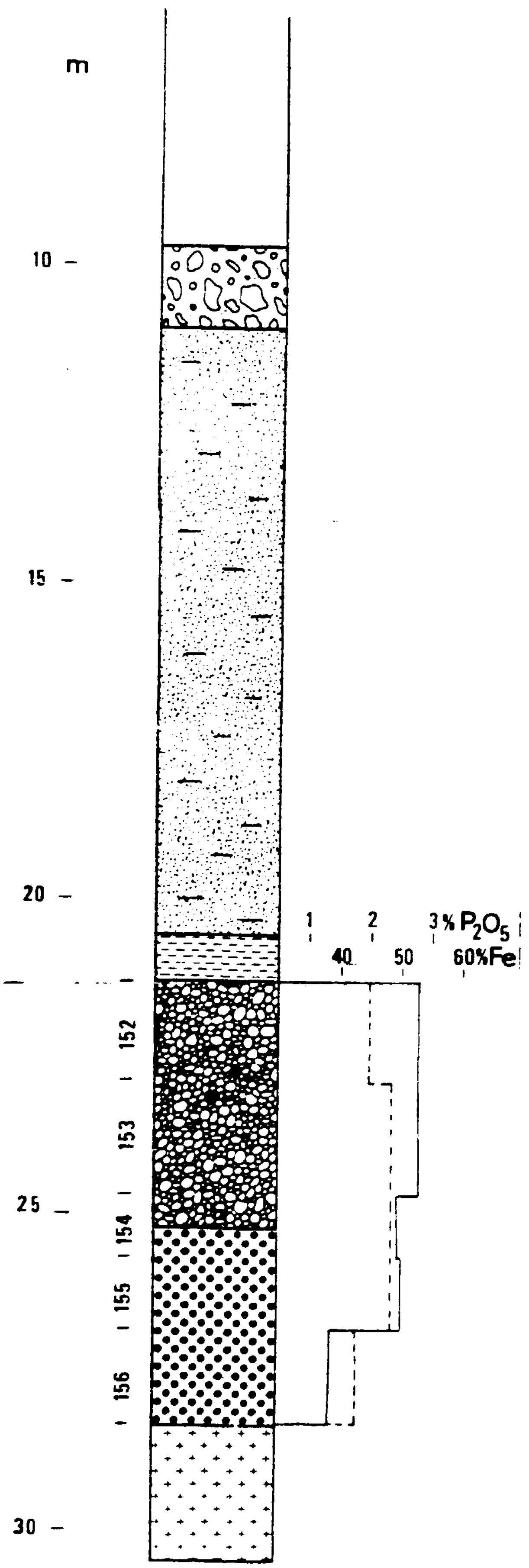
increasing sand content up to 10 %

Sandstone, medium grained, oölitic

Kaolinitic, clay, sandy, grey-white

altered basement

DK 14



not cored

Laterite, sandy-oölitic - pisolitic, strongly consolidated, limonite matrix, black-brown

Siltstone, clayey-sandy, white-grey to light red-brown

Clay, silty, light red to light brown

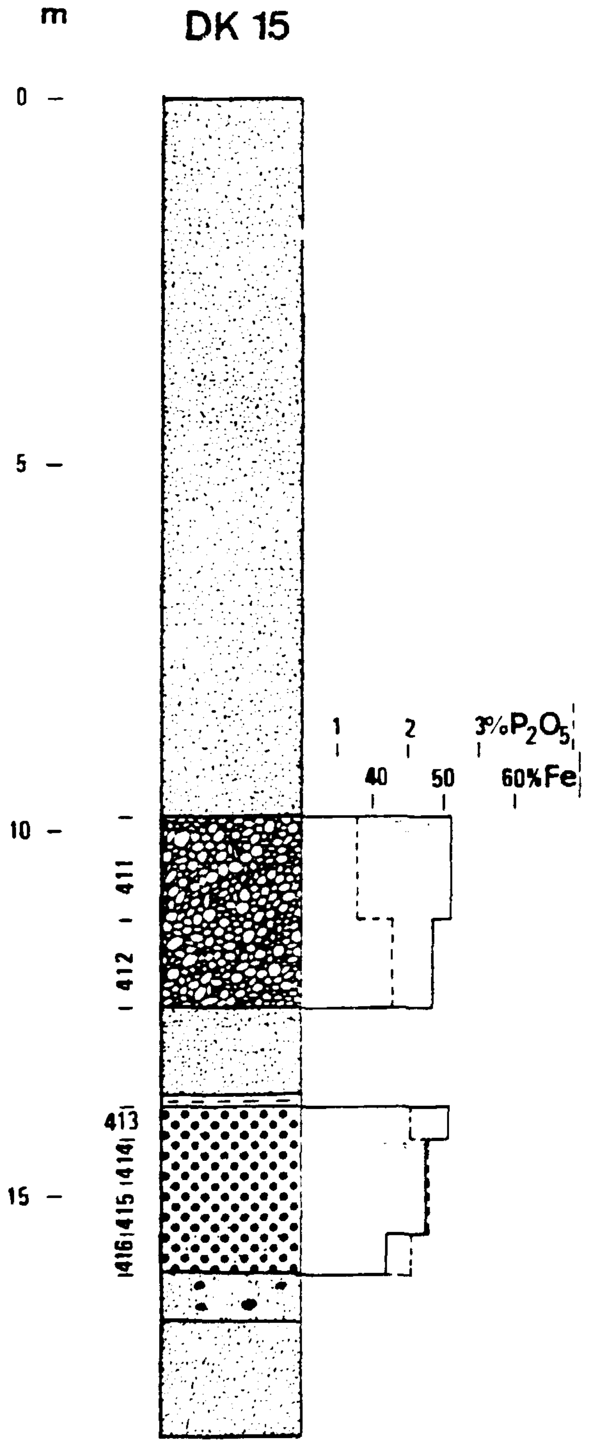
Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, pisolitic, dark red-brown

Iron oölite, pisolitic, slightly consolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 15 %

Kaolinitic clay, sand, grey-white, altered basement

Annex B 3.42



Eolian sand
fine to medium grained, well sorted
yellowish-brown

Iron oölite, consolidated, ca. 95 % oöliths,
ca. 5 % clay-limonite matrix, pisolitic,
dark red-brown

Sandstone, medium grained,
light brown

Clay, silty, light brown

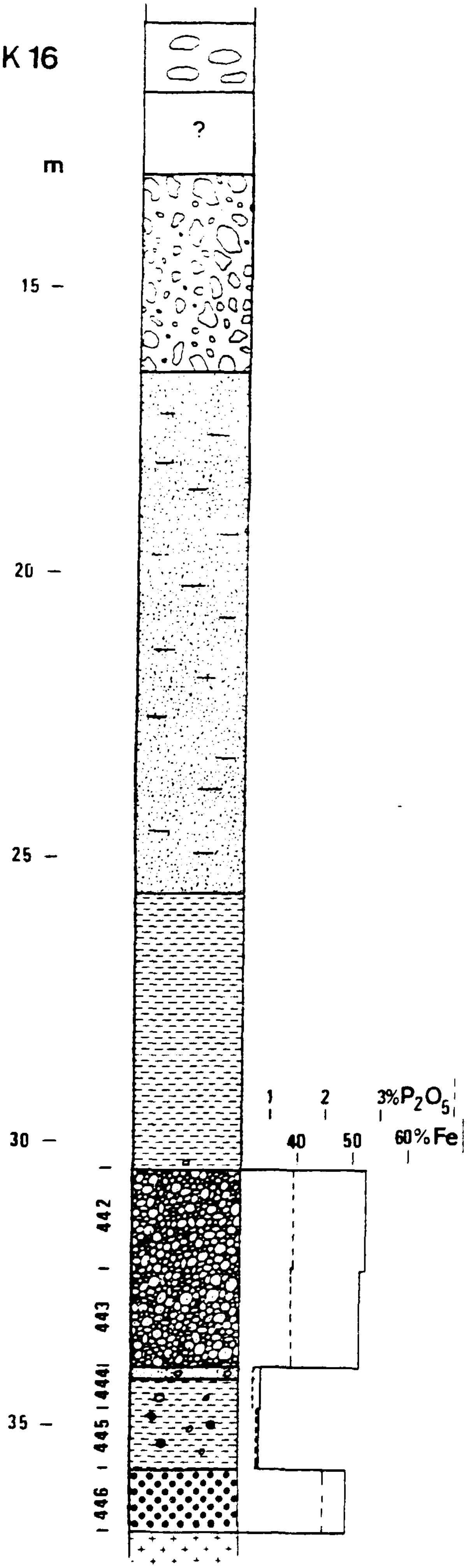
Iron oölite, pisolitic, unconsolidated,
clay matrix, grey-brown

increasing sand content up to 5 %

Sandstone, oölitic and pisolitic, medium
grained

Sandstone, fine to medium grained,
light brown to light grey

DK 16



Conglomerate, sandy, dark red-brown

Core loss

Laterite, iron sandstone and fragments of strongly sandy oölite, limonite matrix, dark brown

Siltstone, sandy-clayey, light brown to grey white, iron stained

Clay, silty, grey-white to light pink

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, sandy, dark red-brown

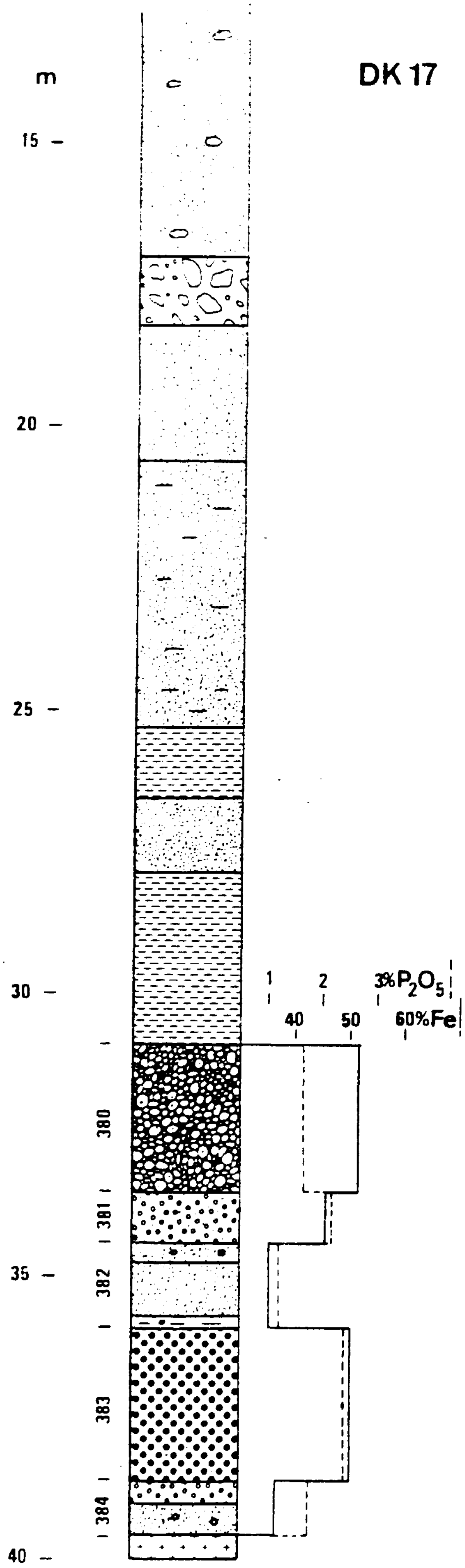
Sandstone, oölitic, clayey

Clay, oölitic and pisolitic, silty, brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Kaolinitic clay, white, altered basement

DK 17



Sandstone, coarse grained, conglomeratic, containing feldspar fragments, slightly clayey, red

Iron sandstone, conglomeratic to brecciated, slightly oölitic, limonite matrix, dark brown

Sandstone, containing ca. 5 - 10 % feldspar, medium grained, light red

Siltstone, clayey-sandy, light brown to grey-white

Clay, silty, white-grey

Sandstone, fine grained, silty-clayey, light brown to light red

Clay, white to light pink

Iron oölite, consolidated, slightly sandy, ca. 90 % oöliths, 5 - 10 % clay-limonite matrix, dark red-brown

Iron oölite, sandy, clay matrix, grey-brown

Sandstone, medium grained, oölititc

Sandstone, medium to coarse grained, red-brown

clay, silty-oölitic, light brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

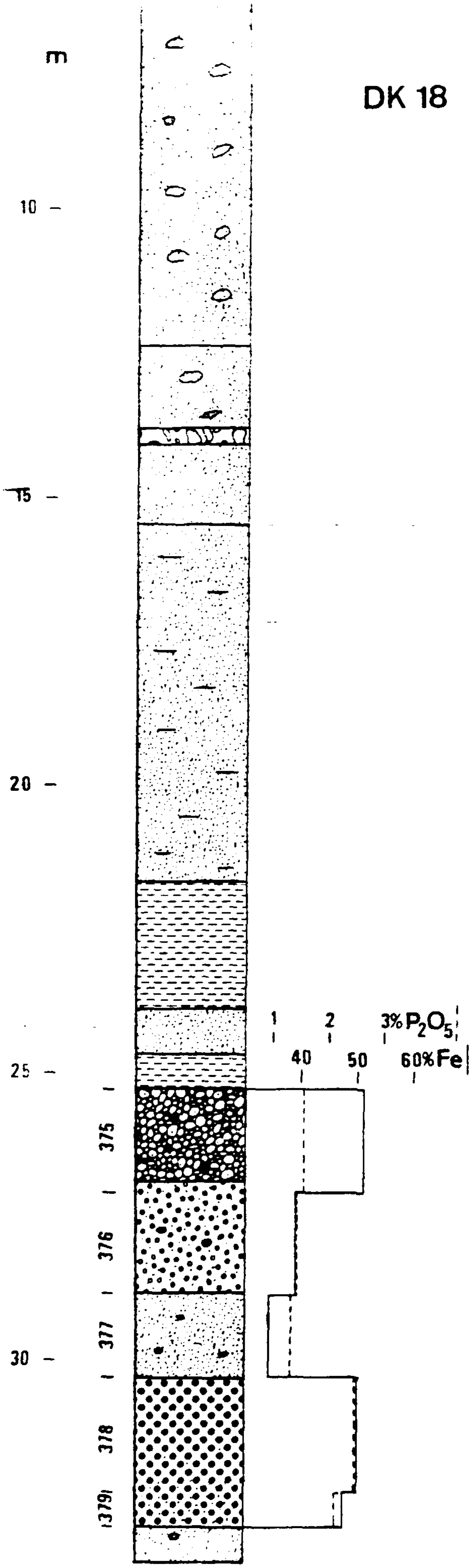
increasing sand content up to 5 %

Iron oölite, sandy, clay matrix

Sandstone, oölitic, medium grained

Kaolinitic clay, sandy, white, altered basement

DK 18



Conglomerate of quartz pebbles, strongly sandy, light red-brown

Sandstone, medium to coarse grained, conglomeratic, light red-brown

Iron oölite, strongly sandy, black-brown

Sandstone, medium grained, light brown

Siltstone, clayey, white to light brown

Clay, white-grey to light brown

Siltstone and fine grained sandstone light brown

Clay, silty, white-brown

Iron oölite, consolidated, 90 - 95 % oöliths, clay-limonite matrix, slightly pisolitic, dark red-brown

Iron oölite, sandy, ca. 3 % pisoliths clay matrix, grey-brown

Sandstone, medium to coarse grained, oölitic, light brown

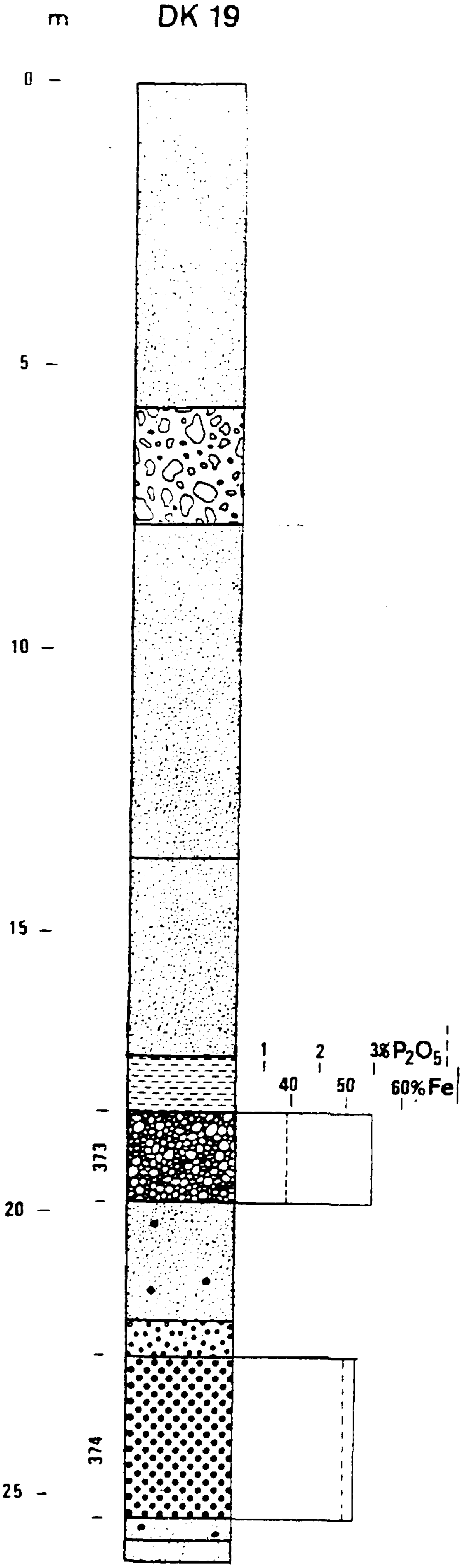
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content up to 5 %

increasing sand content up to 8 - 10 %

Sandstone, medium grained, slightly oölitic

DK 19



Eolian sand, medium grained, light brown

Laterite, brecciated, quartz pebbles, sandy-oölitic, limonite matrix

Siltstone, clayey, grey-white to light brown

Sandstone, fine to medium grained, light brown

Clay, silty, light grey to light brown

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Sandstone, medium to coarse grained, slightly oölitic, brown

Iron oölite, unconsolidated, clay matrix, oöliths ca. 0,3 to 0,5 mm in diameter

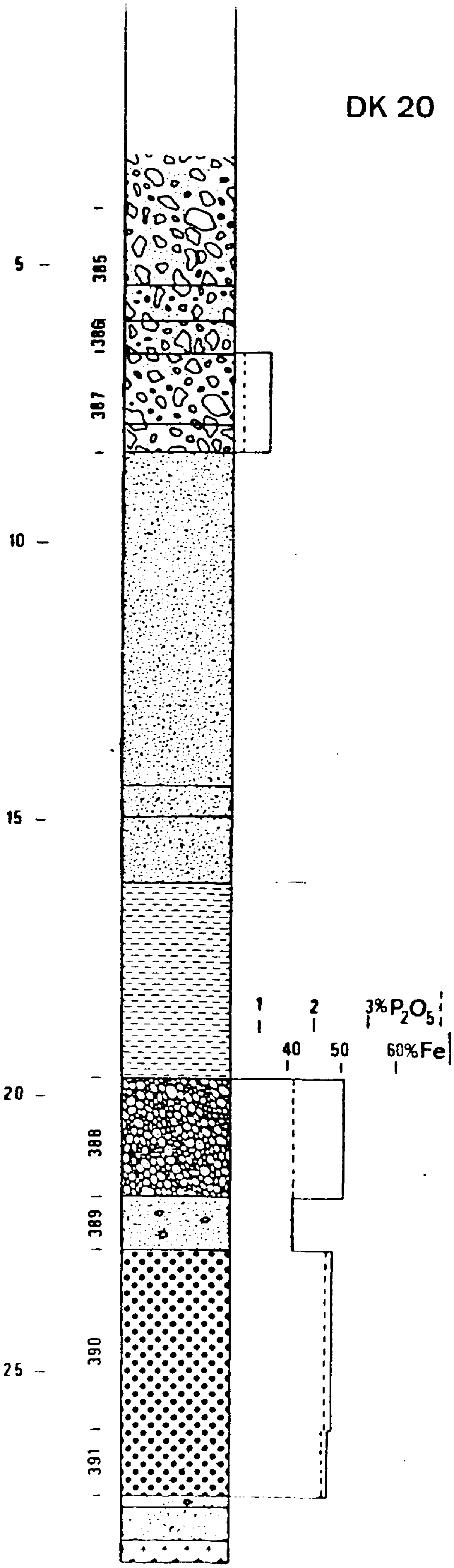
Iron oölite, pisolitic, unconsolidated, **clay matrix, grey-brown**

increasing sand content up to 5 %

Sandstone, fine to medium grained, oölitic

Sandstone, fine to medium grained, light brown to white-grey

DK 20



not cored

Laterite, iron sandstone, conglomeratic to brecciated, limonite matrix, dark brown

Laterite, conglomerate containing quarz pebbles and iron sandstone pebbles, dark brown

Iron pisolite, oölitic, strongly sandy, dark brown

Siltstone, sandy, light brown to red

Sandstone, fine grained, yellow-red

Siltstone, clayey, light grey to yellow-red

Clay, silty, light brown to light grey

Iron oölite, consolidated, 90 - 95 % oöliths, 5 - 10 % clay-limonite matrix, sandy, dark red brown

Sandstone, fine to medium grained, oölitic, brown-grey

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

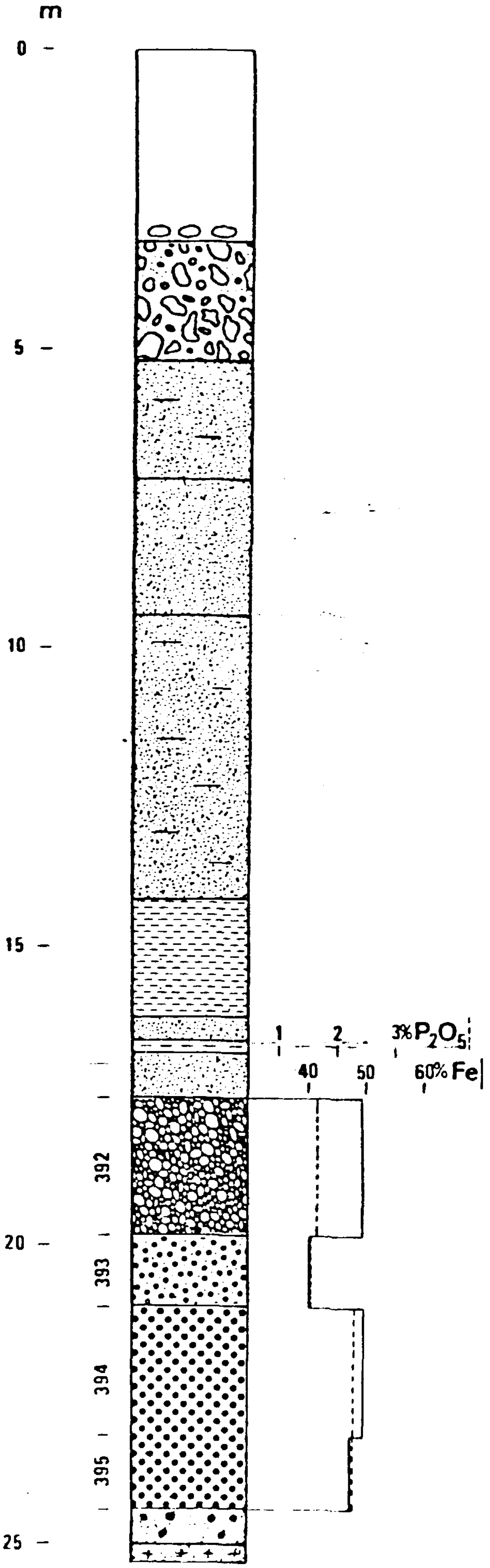
slightly increasing sand content up to 5 %

Sandstone, fine grained, oölitic, white-grey

Sandstone, fine grained, white grey

Kaolinitic clay, sandy, white, altered basement

DK 21



not cored

Conglomerate, quartz pebbles

Laterite, iron sandstone,
limonite matrix, dark brown
evidence of iron oöliths

Sandstone, medium grained, clayey
light brown

Sandstone, fine grained, silty
light brown

Siltstone, clayey, white to light brown,
with isolated nodules of argillaceous
iron ore

Clay, silty, grey-white to light brown

Sandstone, fine grained, silty, red-white

Clay, white to light brown

Sandstone, fine grained, light grey to light brown

Iron oölite, consolidated, ca. 95% oöliths,
ca. 5 % clay-limonite matrix,
dark red-brown

Iron oölite, sandy, slightly consolidated,
ca. 60% oöliths, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated,
clay matrix, grey-brown

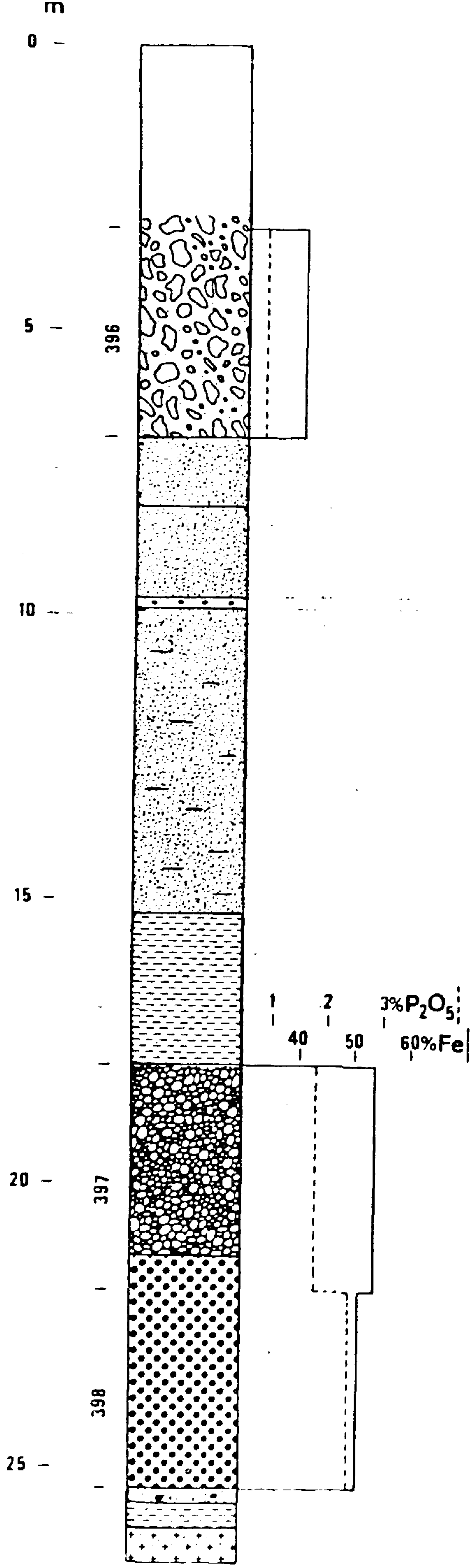
slightly increasing sand content up to 5 %

increasing sand content up to ca. 10 %

Sandstone, oölitic and pisolitic, brown

Sandstone, fine grained, grey-white

DK 22



not cored

Laterite, iron sandstone, brecciated, slightly oölitic and pisolitic, dark brown

Sandstone, fine grained, silty, red

Siltstone, sandy-clayey, grey-white to red

Iron oölite, sandy, consolidated, black-brown

Sandstone, fine grained, silty, to

Siltstone, sandy, grey-white to light brown

Clay, silty, white-grey to light brown

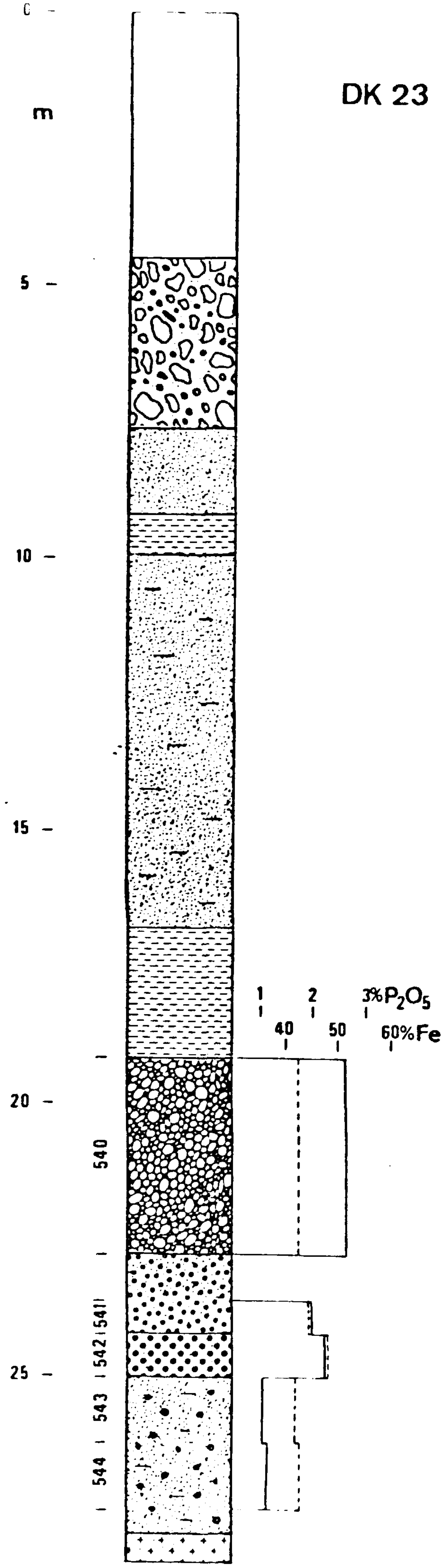
Iron oölite, consolidated, ca. 95 % oöliths, 5 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, slightly consolidated, clay matrix, grey-brown

Sandstone, oölitic and pisolitic,
Clay, kaolinitic, grey-white
Clay, kaolinitic, grey-white, altered basement

Annex B 3.50

DK 23



not cored

Laterite, iron sandstone, slightly oölitic, dark brown

Sandstone, silty, light brown

Clay, silty, white-yellow

Siltstone, sandy-clayey, grey-white to light reddish-brown

and

Sandstone, fine grained, silty-clayey, red to light brown

Clay, silty, white-grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite, strongly sandy, clay matrix, slightly consolidated, grey-brown

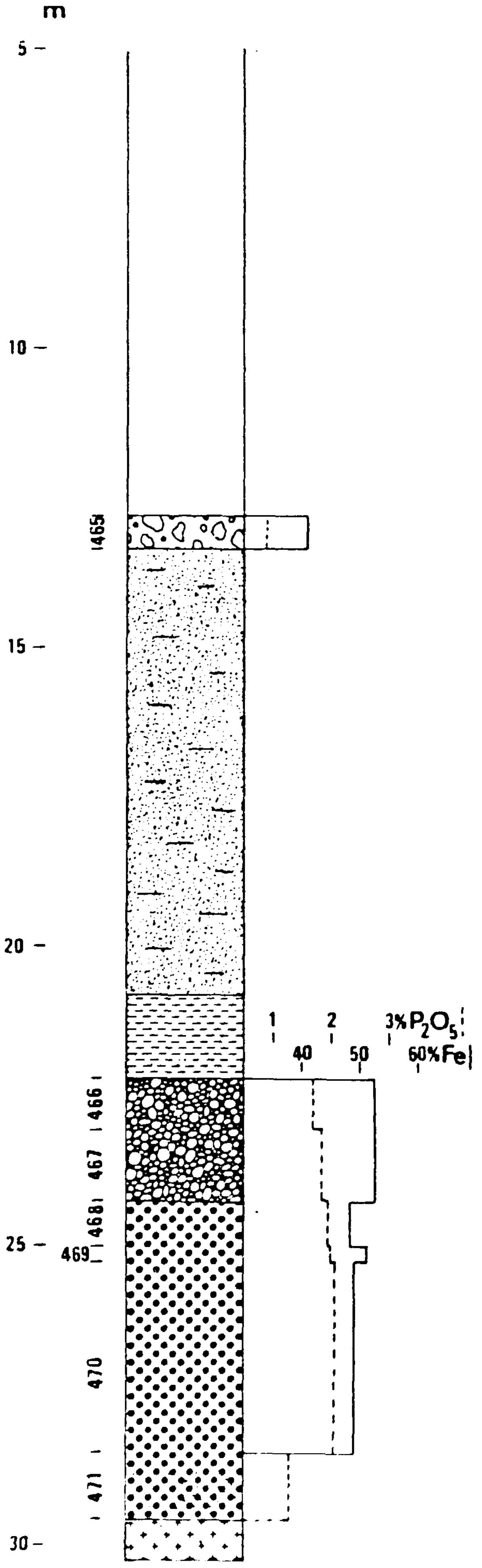
Iron oölite, sandy, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, medium grained, oölitic and pisolitic, clayey, moderately consolidated, light grey-brown

Sandstone, kaolinitic clay matrix, altered

DK 24



not cored

Iron oölite, strongly sand, consolidated, black brown

Siltstone, sandy-clayey, light brown to red

Clay, silty, grey-white to light brown

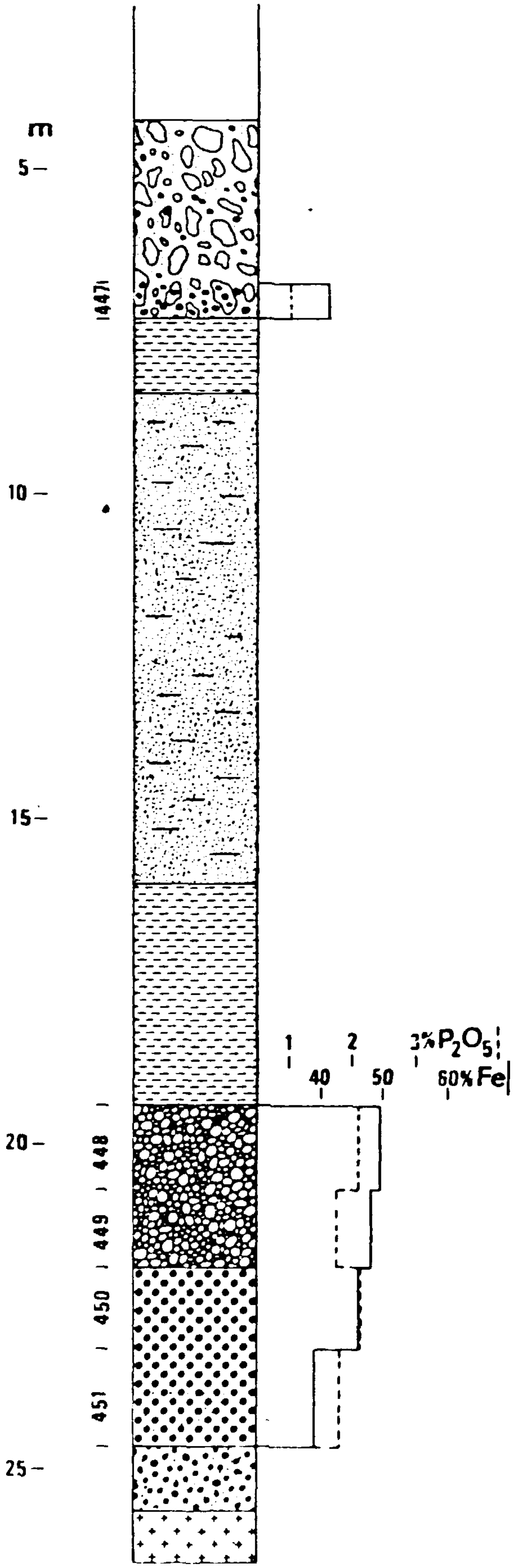
Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, silty, clay matrix, grey-brown

strongly increasing sand content up to ca. 25 %

Kaolinitic clay, sandy, grey-white, altered basement

DK 25



not cored

Iron sandstone, dark brown

Laterite, iron sandstone, brecciated, oölitic, dark brown

Iron pisolite, strongly sandy, dark brown

Clay, silty, light brown

Siltstone, sandy-clayey, white-grey to pink-red

Clay, sligtly silty, light brown

Iron oölite, consolidated, 90-95 % oöliths, 5 - 10 % clay-limonite matrix, dark red-brown

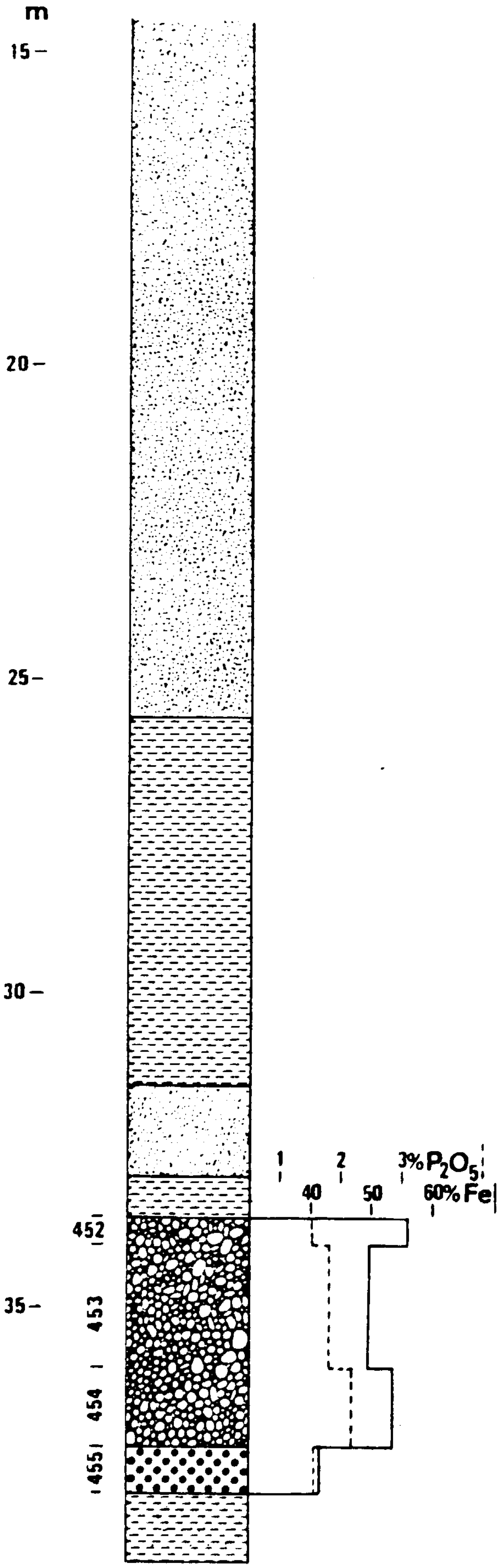
Iron oölite, pisolitic, unconsolidated, ca. 80 % to 85 % oölites and pisolites, clay matrix, grey-brown

increasing sand content up to ca. 5 %

Iron oölite, pisolitic, strongly sandy, clay matrix

Kaolinitic clay, sandy, grey-white, altered basement

DK 26



Sandstone, fine grained, clayey, light brown to red-white

Clay, grey-white to light brown

Sandstone, fine grained, light brown

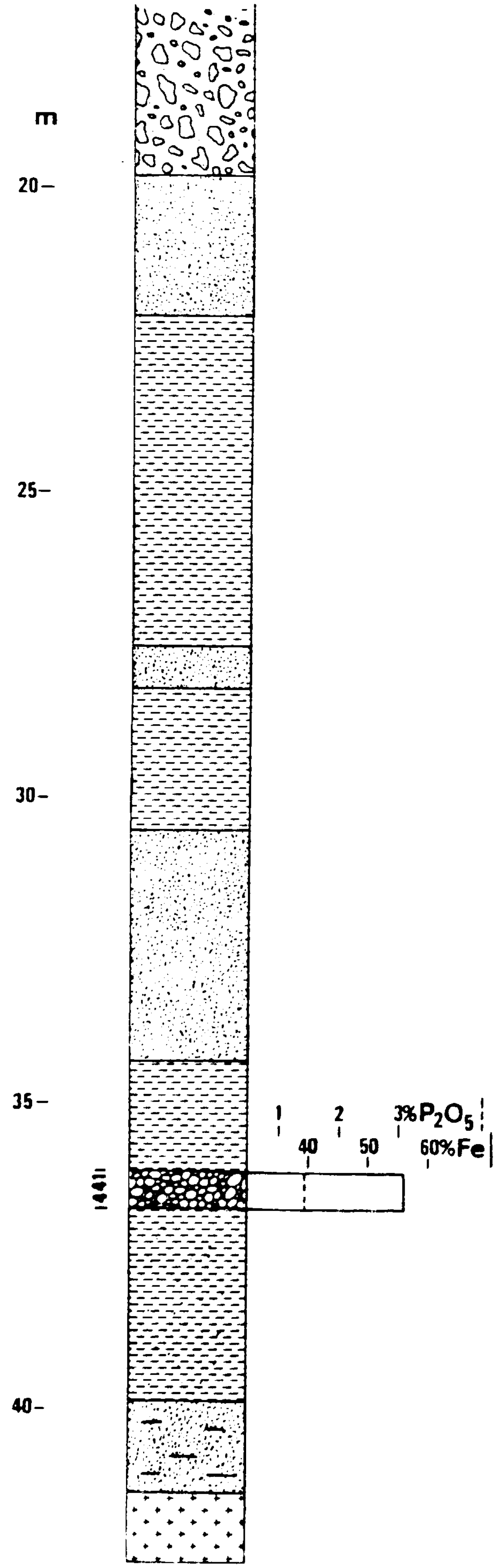
Clay, silty, light brown

Iron oölite, moderately consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Clay, sandy, light brown

DK 27



Iron sandstone, brecciated, clayey, light brown to dark brown

Iron sandstone, fine to medium grained, hematite-limonite matrix, dark red

Clay, sandy-silty, grey-white to light brown

Sandstone, fine grained, light brown

Clay, sandy-silty, light brown

Sandstone, fine grained, silty, white-brown

Clay, light brown to white-grey

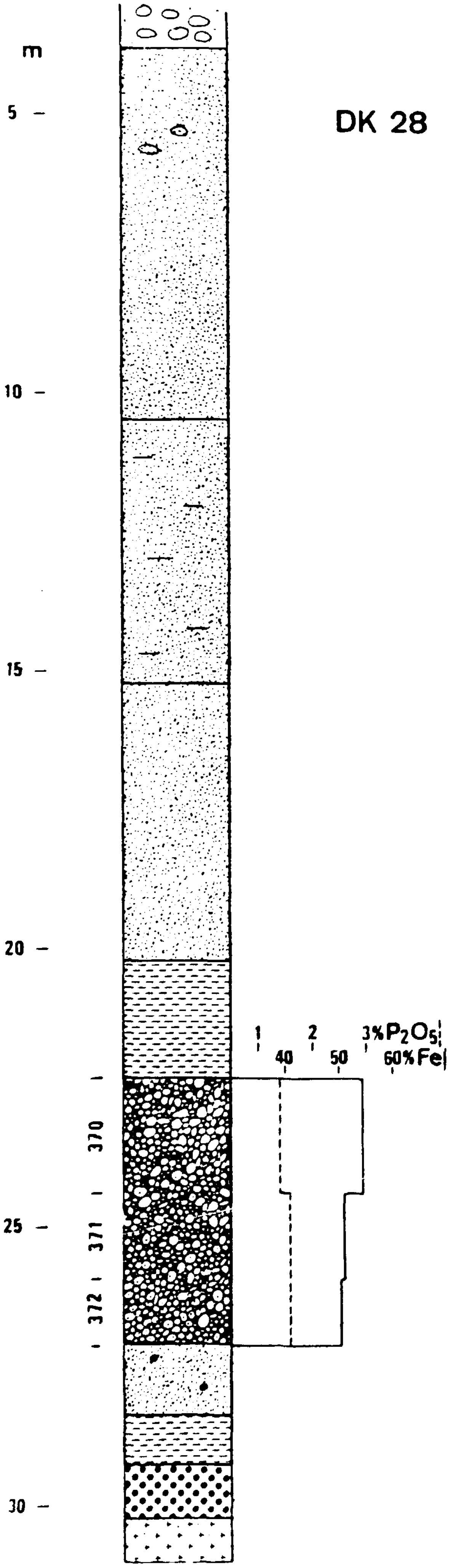
Iron oölite, consolidated, ca. 95 % oöliths, dark red-brown

Clay, white-brown to brown

Sandstone, fine grained, strongly clayey, light brown

Kaolinitic clay, sandy, white-grey, altered basement

Annex B 3.55



Conglomerate, slightly consolidated, sandy, light grey-red

Sandstone, medium to coarse grained, slightly conglomeratic, red to grey-brown

Sandstone, **fine grained**, silty-clayey, evidence of some light mica, light red to light brown to
Siltstone, sandy-clayey, light brown to light red

Sandstone, fine grained, silty-clayey, white to yellow-red

Clay, silty, white to light grey

Iron oölite, consolidated, ca. 95% oöliths, ca. 5 % clay-limonite matrix, dark red-brown

— slightly increasing sand content to the foot wall up to ca. 5 %

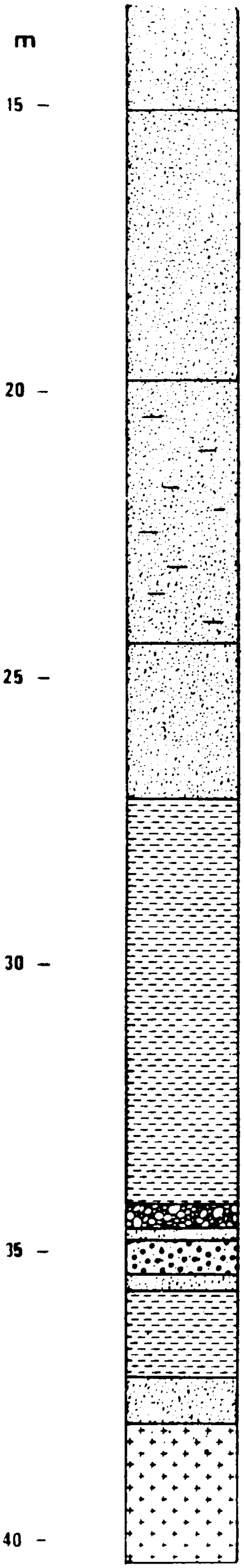
Sandstone, fine grained, ca- 5-10 % oöliths and pisoliths, silty-clayey, brown

Clay, light brown to light grey

Iron oölite, pisolitic, slightly consolidated, clay matrix, grey-brown

Kaolinitic clay, sandy, white, altered basement

DK 29



Sandstone, medium grained, silty, isolated quartz pebbles, light brown

Sandstone, fine grained, silty-clayey, light grey

Siltstone, sandy-clayey, light grey to light brown

Sandstone, fine grained, silty-clayey, white grey to light brown

Clay, slightly silty, white-red to light brown

Iron oölite, consolidated, ca. 95 % oöliths, brown

Siltstone, clayey, white-grey

Iron oölite, strongly sandy, red

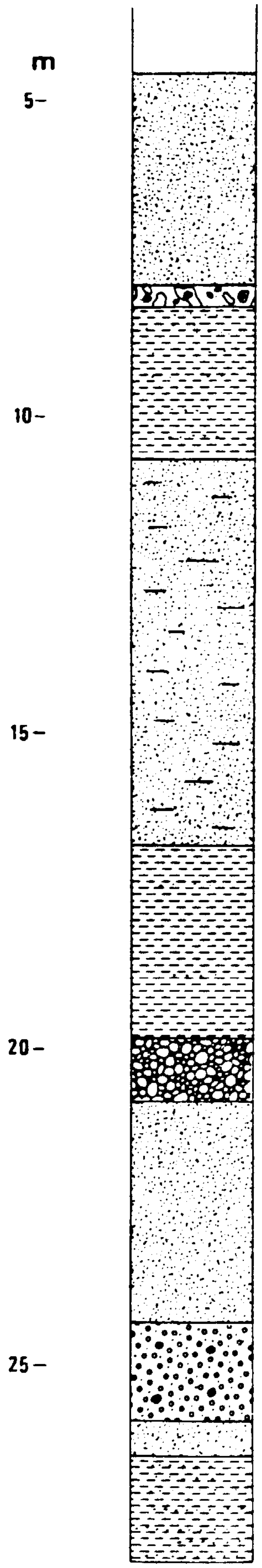
Sandstone, coarse grained, silty, brown

Clay, silty, white-brown

Sandstone, medium grained, silty-clayey, brown

Kaolinitic clay, sandy, white, altered basement

DK 30



not cored

Iron sandstone, slightly clayey, limonite matrix, dark red-brown

Iron oölite, pisolitic, strongly consolidated, brown

Clay, silty, light brown

Siltstone, silty-clayey to

Sandstone, fine-grained, silty-clayey, light brown to light red

Clay, slightly silty, light brown

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, brown

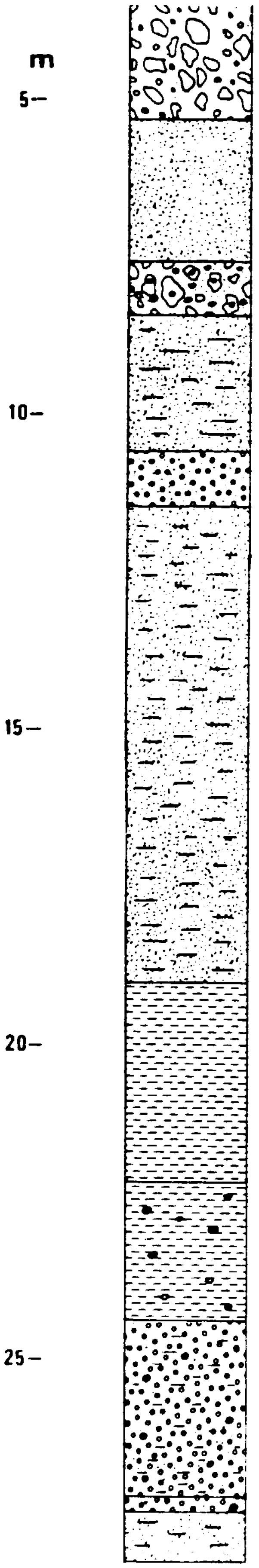
Sandstone, coarse grained, light brown

Iron oölite, pisolitic, strongly sandy, clay-matrix, grey brown

Sandstone, fine to medium grained, red

Clay, sandy, red to white-grey

DK 31



Laterite, pebbles of iron sandstone limonite matrix, red brown

Iron sandstone, moderately consolidated, limonite-hematite matrix, dark red

Laterite, sandy, consolidated, isolated oöliths, red-brown

Sandstone, fine to medium grained, strongly clayey, light brown to red

Iron oölite, strongly sandy, consolidated, dark brown

Siltstone, sandy-clayey, light brown to red and grey

Clay, light brown to white-grey

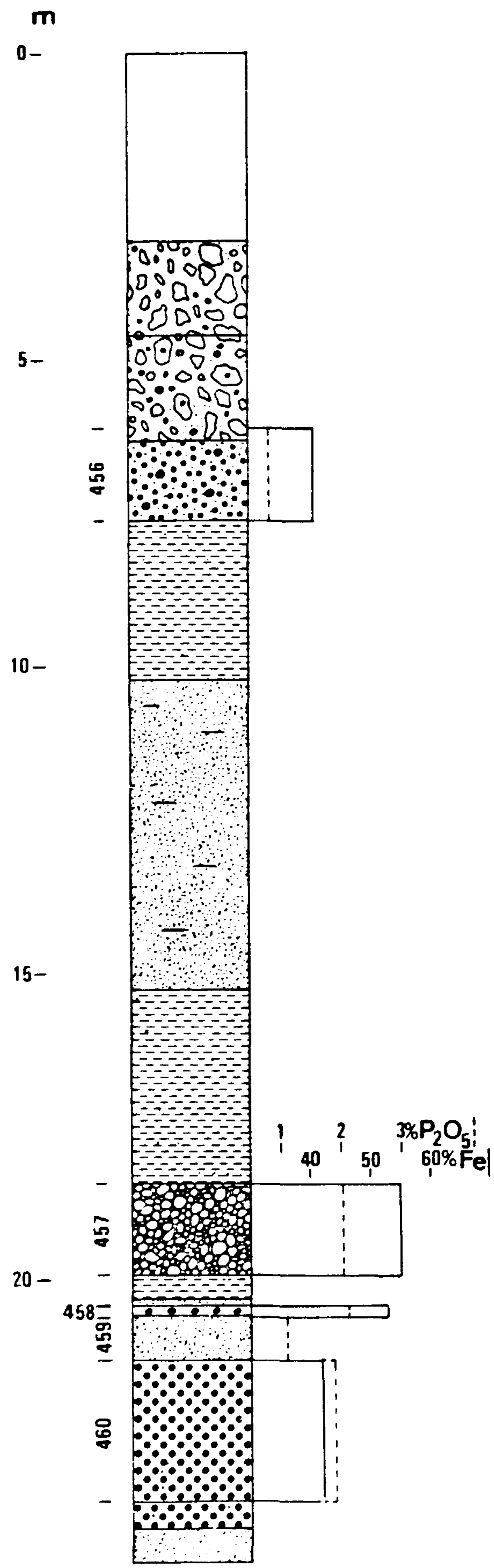
Clay, oölitic and pisolitic, light to medium brown

Iron oölite, slightly pisolitic, unconsolidated, ca. 70 % oöliths, sandy, clay-matrix, grey-brown

decreasing oölith content

Sandstone, fine to medium grained, clayey, light grey to light brown

DK 32



not cored

Laterite, fragments of iron sandstone and quartz, limonite matrix, red brown

Laterite, sandy, less fragments of iron sandstones, isolated oöliths and pisoliths, limonite matrix, red brown

Iron oölite, pisolitic, strongly sandy, consolidated, dark brown

Clay, silty, light grey to grey-white

Siltstone , clayey-sandy to

Sandstone, fine grained, light brown

Clay, slightly silty, light brown to white-grey

Iron oölite, consolidated, ca. 90 % oöliths, isolated pisoliths, clay-limonite matrix, dark red brown

Clay, light brown

Sandstone, limonite matrix

Iron pisolite

Sandstone, medium to coarse grained, light brown

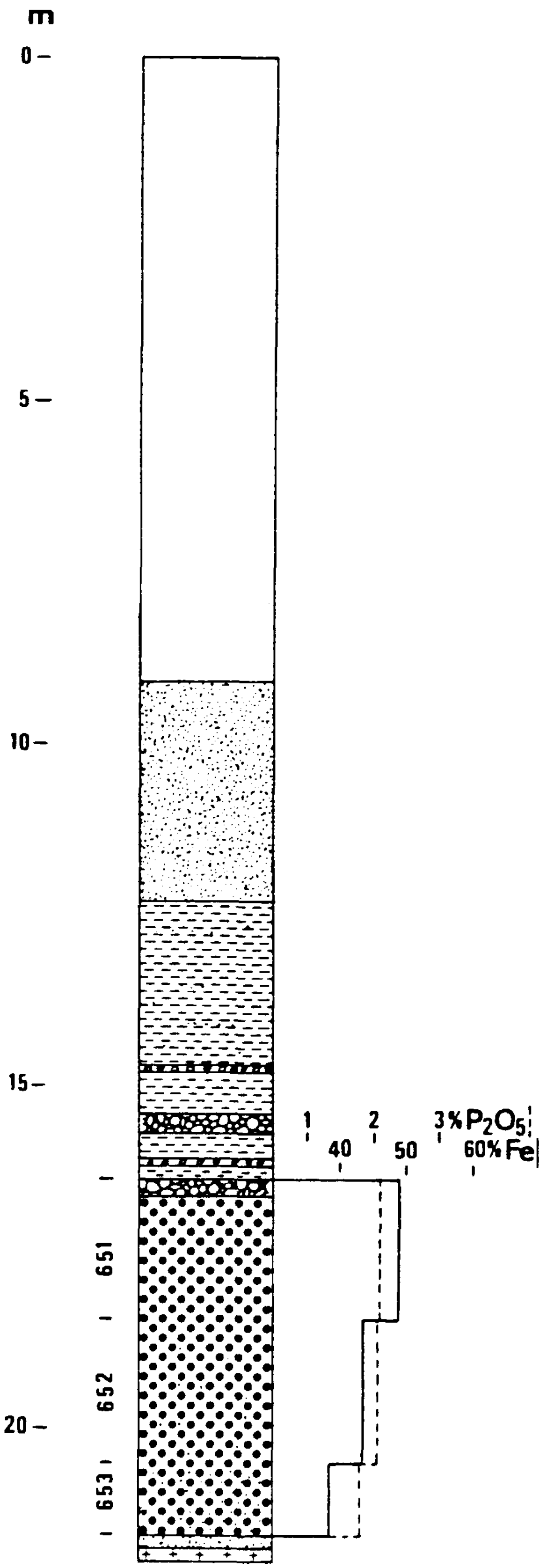
Iron oölite, pisolitic, unconsolidated, ca. 80 % oöliths and pisoliths, clay matrix, grey-brown

strongly increasing sand content to the foot wall

Sandstone, fine to medium grained, dark red

Annex B 3.60

DK 33



not cored

Sandstone, fine grained, silty-clayey
to Siltstone, sandy, light brown

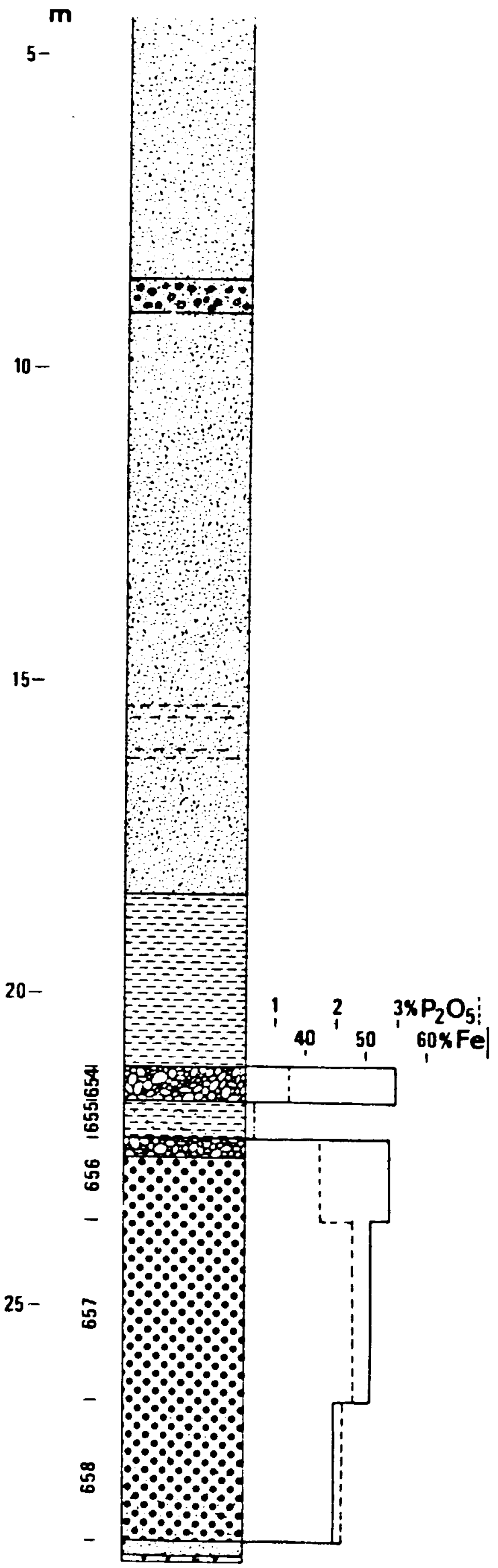
Clay, sandy-silty, light brown to white

Iron oölite, consolidated, 70-80% oöliths
Clay, sandy-silty, light brown to white
Iron oölite, consolidated,ca.95% oöliths,limonite ma
Clay, silty, light brown tr
Clay Ironoölite
Iron oölite, consolidated,ca.95% oöliths, 5 %
clay-limonite matrix
Iron oölite, pisolitic, unconsolidated,
clay matrix, brown

Increasing sand content to the foot wall
up to 15 - 20 %

Sandstone, fine to medium grained, red
Kaolinitic clay, slightly sandy, white,
slightly contaminated by limonite,
altered basement

DK 34



Sand, medium grained, light brown

Sandstone, oölitic, consolidated, dark brown

Sandstone, silty-clayey,
to Siltstone, sandy-clayey,
light brown to reddish-white

Layers of silty clay

Clay, light brown to white

Iron oölite, consolidated, ca.95% oöliths,ca. 5 %
clay-limonite matrix, dark red brown

Clay, silty, light brown

Iron oölite,consolidated,ca.95% oöliths,ca.5% matrix

Iron oölite, pisolitic, unconsolidated,

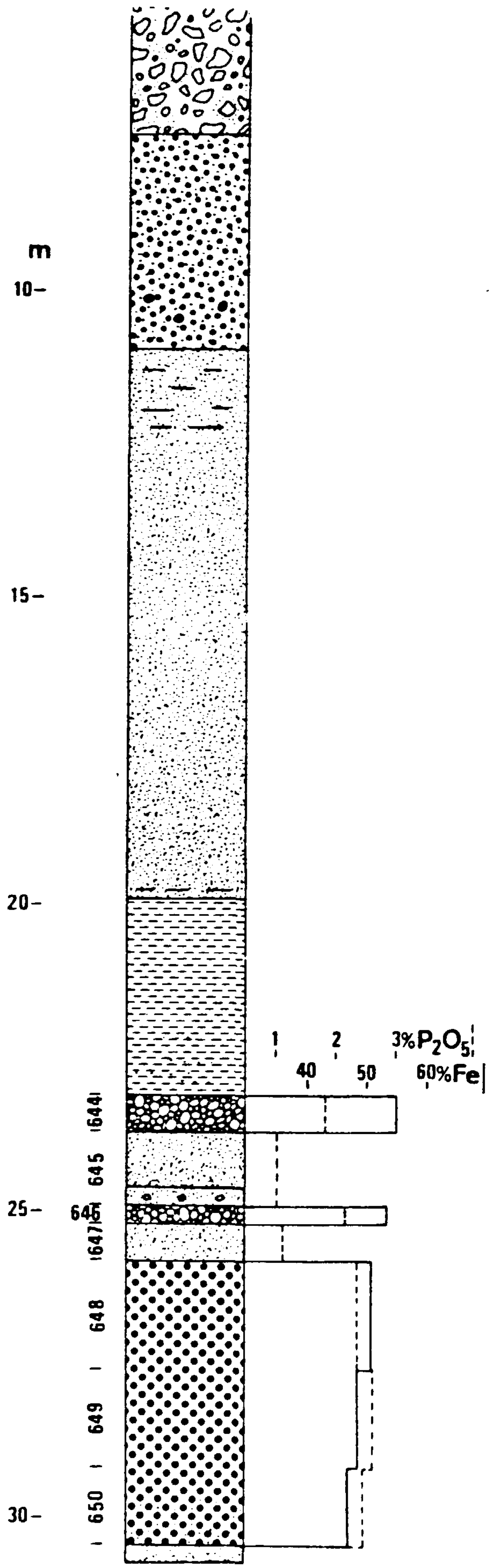
clay matrix, grey-brown

Increasing sand content to the
foot wall up to 10 - 15 %

Sandstone, medium to coarse grained, white

Kaolinitic clay, slightly sandy, white

DK 35



Laterite, brecciated, sandy, dark brown

Iron oölite, strongly sandy to

Sandstone, oölitic, dark brown

pisolitic to the foot wall

Siltstone, sandy-clayey, light brown

to

Sandstone, fine grained, silty-clayey, light brown

Clay, white to light red

Iron oölite, consolidated, ca. 95% oöliths, ca. 5% limenite matrix, dark red brown

Sandstone, coarse grained, medium brown

ca. 10 - 20 % oöliths

Iron oölite, consolidated, ca. 95% oöliths

Sandstone, coarse grained, light brown

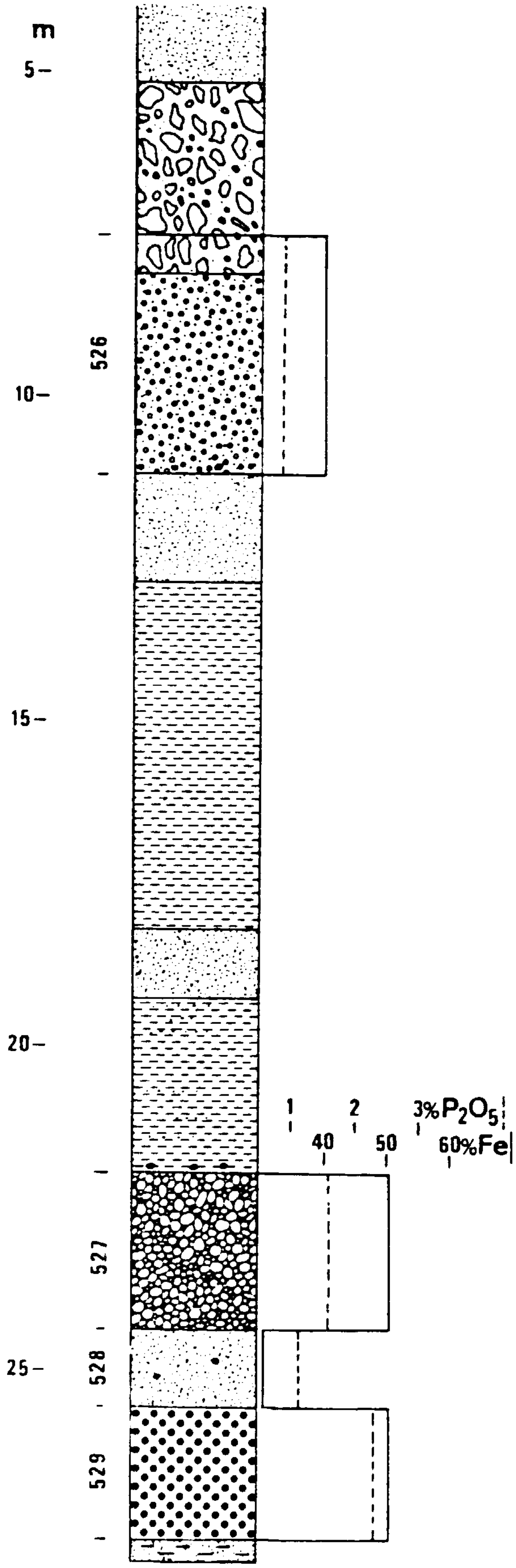
Iron oölite, pisolitic, unconsolidated,

clay-silt matrix, grey-brown

slightly increasing sand content to the foot wall up to 5 %

Sandstone, medium grained, light reo-brown to white

DK 36



Eolian sand, fine to medium grained, light brown

Iron sandstone, medium to coarse grained, limonite matrix, red-brown

Iron sandstone, coarse grained, brecciated, limonite matrix, red brown

Iron oölite, strongly sandy, strongly consolidated, dard red-brown

pisolitic

Sandstone, fine grained, slightly clayey, light red

Clay, sandy,silty, light brown

Sandstone, fine grained, clayey, slightly consolidated, light red to light brown

Clay, silty, light brown to grey-white

isolated oöliths

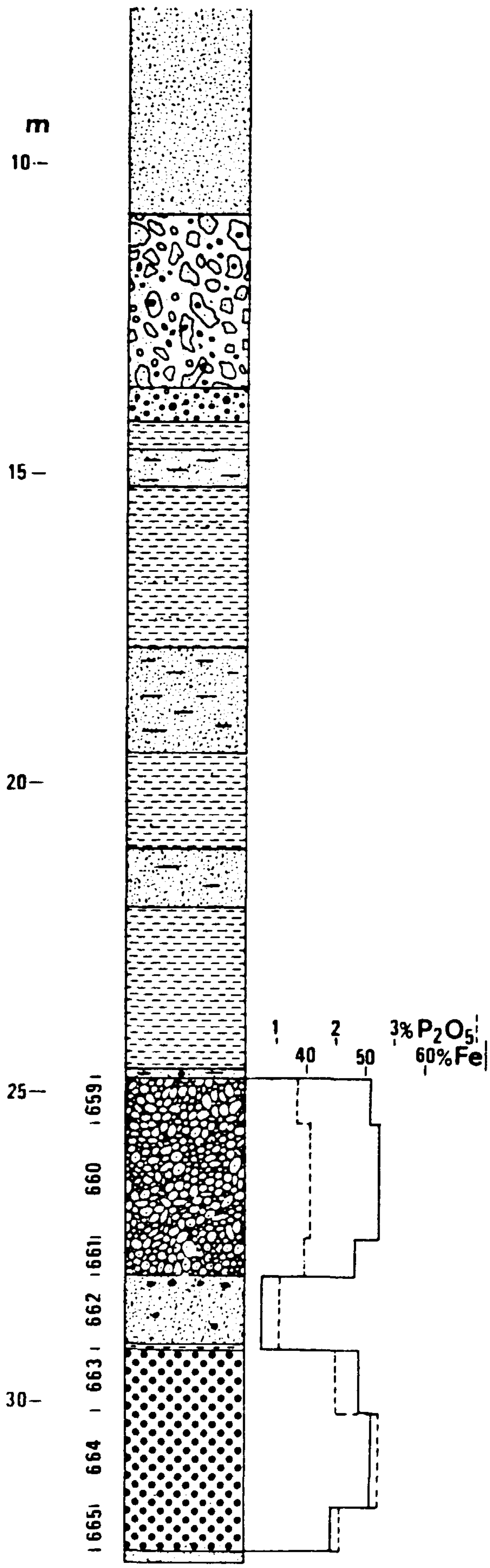
Iron oölite, consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, dark red-brown

Sandstone, medium to coarse grained, isolated oöliths, iron stained, light brown

Iron oölite, pisolitic, unconsolidated, ca. 75 to 80 % oöliths and pisoliths, clay matrix, grey-brown

Sandstone, fine grained, kaolinitic clay matrix, white-grey

DK 37



Sand, slightly consolidated, medium grained, light brown

Laterite, brecciated, sandy, quartz pebbles, dark brown

Iron oölite, pisolitic, strongly sandy, consolidated

Clay, silty, light brown

Siltstone, clayey, light brown

Clay, sandy-silty, light brown to white red

Siltstone, clayey, light brown

Clay, silty, light brown to light red

Sandstone, fine grained, clayey, light red

Clay, yellow-white

Sandstone, clayey, oölitic, light brown

Iron oölite, consolidated, limonite matrix

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Increasing sand content to the foot wall up to 5 - 10 %

Sandstone, medium to coarse grained, isolated oöliths and pisoliths, light-grey to brown

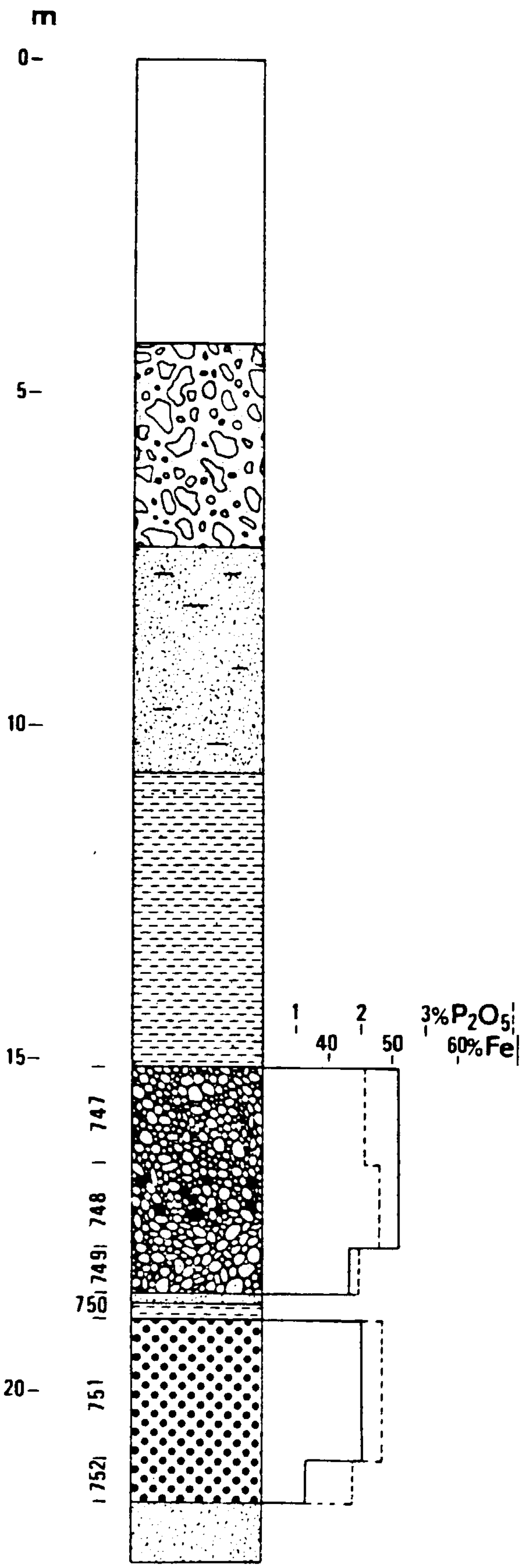
Clay, sand, light-grey

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content up to 5 to 10 %

Sandstone, medium grained, light grey to brown

DK 38



not cored

Laterite, sandy, brecciated, limonite matrix, red brown

Siltstone, sandy-clayey, light brown to grey-red

Clay, silty, light brown to grey-white

Iron oölite, consolidated, ca. 95 % oöliths, clay-limonite matrix, dark red-brown

strongly pisolitic

increasing sand content to the foot wall up to 5 %

Sandstone, medium to coarse grained

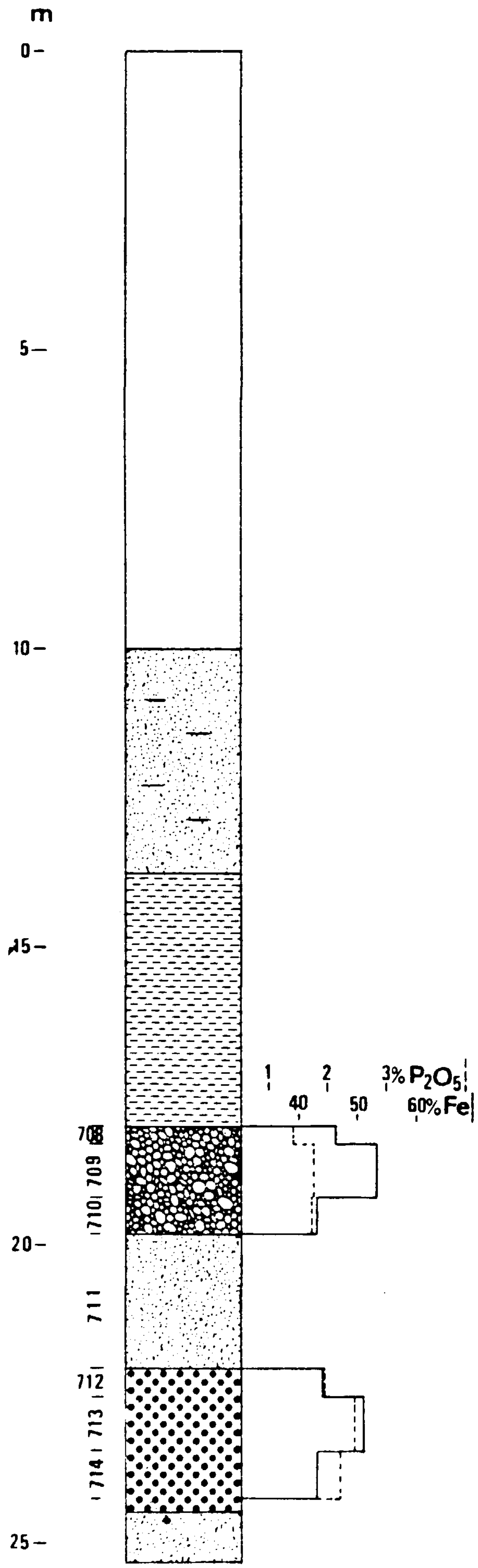
Clay, light brown to white

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 10 %

Sandstone, fine to medium grained, light brown to grey-white

DK 39



not cored

Siltstone, sandy, light brown to grey-white to light red

Clay, light brown to white

Iron oölite, consolidated, ca. 90 % oöliths, ca. 5-10 % clay-limonite matrix, dark red-brown

increasing sand content to the foot wall

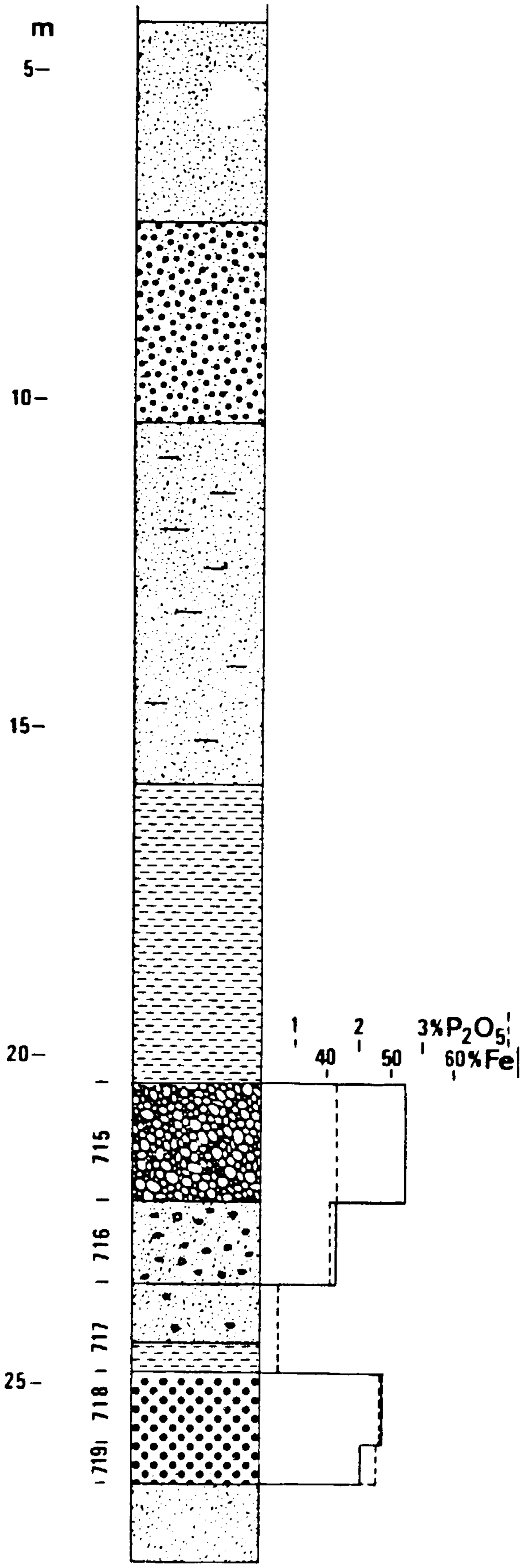
Sandstone, medium to coarse grained, slightly clayey, light brown to brown and light to dark red

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 20 %

Sandstone, fine to medium grained, light brown to yellow brown

DK 40



not cored

Sandstone, fine to medium grained, iron stained, red brown

Iron oölite, strongly sandy, limonite matrix, dark red brown

Siltstone, sandy-clayey, light brown to grey-red

Clay, slightly silty, light brown to grey-white

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Sandstone, medium grained, strongly oölitic, clay matrix, light brown

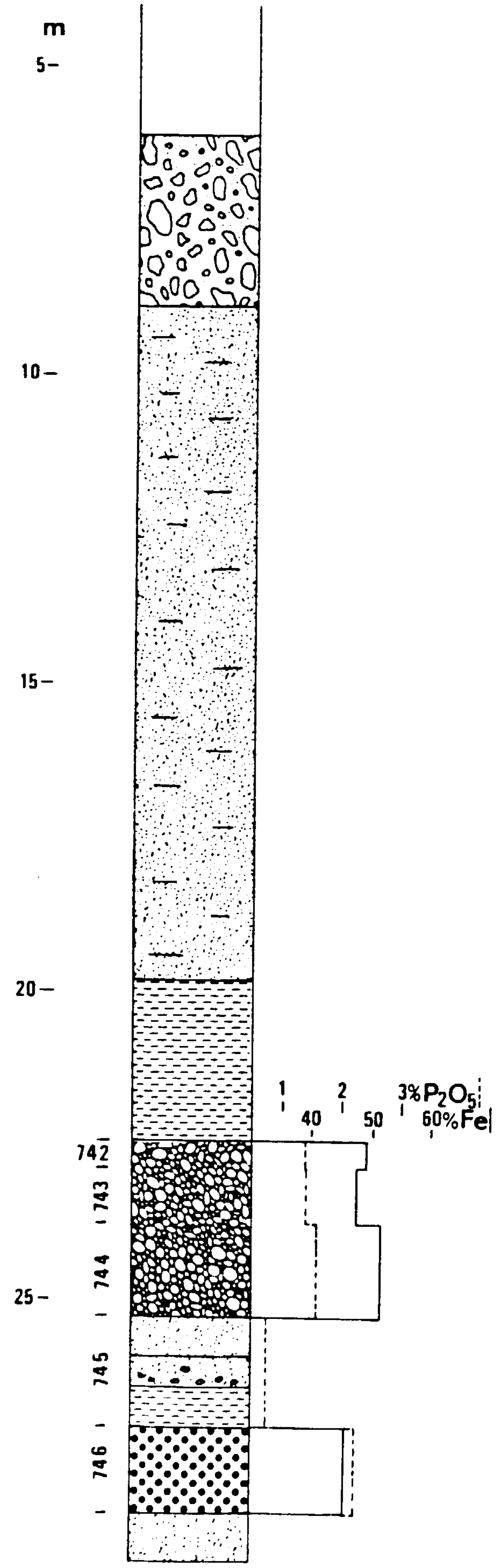
Sandstone, medium to coarse grained, slightly oölitic, light brown

Clay, brown to white

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, fine grained, light brown

DK 41



not cored

Laterite, brecciated, sandy, quartz and iron stone pebbles, limonite matrix, red brown

Siltstone, sandy-clayey, light brown to grey-red

Clay, slightly sandy, light brown to grey-white

Iron oolite, consolidated, ca. 95 % oöliths, clay-limonite matrix, dark red-brown

Sandstone, coarse grained, slightly consolidated, light brown

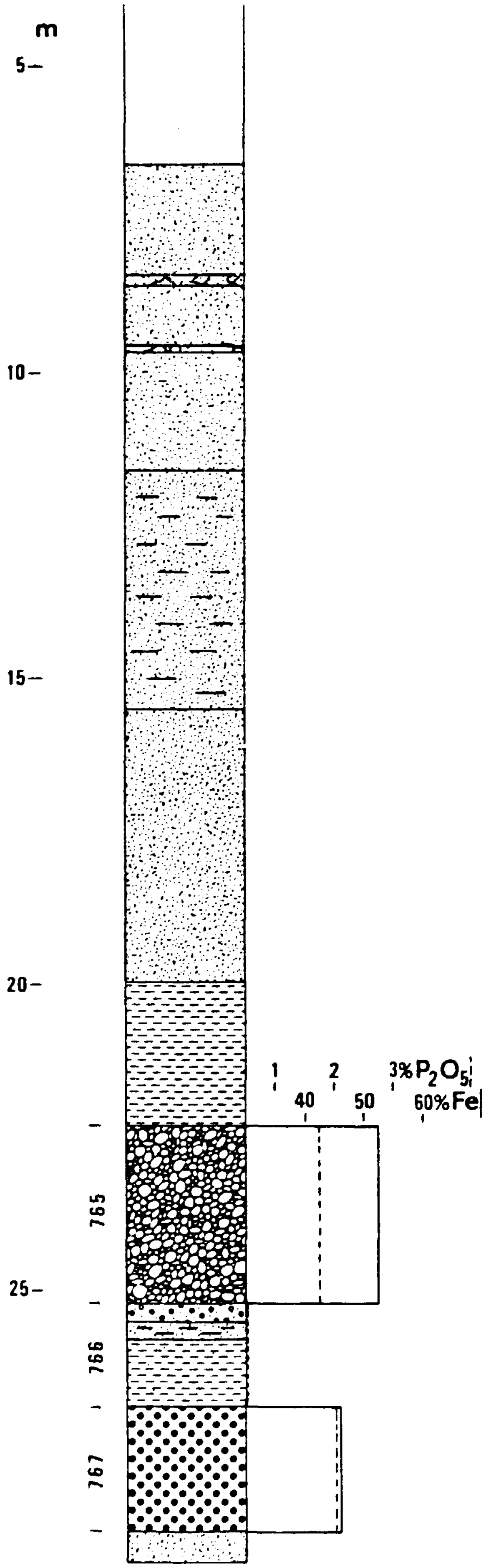
Sandstone, coarse grained, oölitic, light brown

Clay, slightly sandy, light brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, fine to medium grained, light brown

DK 42



not cored

Sandstone, medium grained, iron stained, brown

Lateritic layer

Lateritic layer

Sandstone, fine grained, light brown

Siltstone, sandy-clayey, light brown to reddish-white

Sandstone, fine grained, light reddish-brown

Clay, light grey to light brown silty

Iron oölite, consolidated, ca. 95% oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Iron oölite, sandy

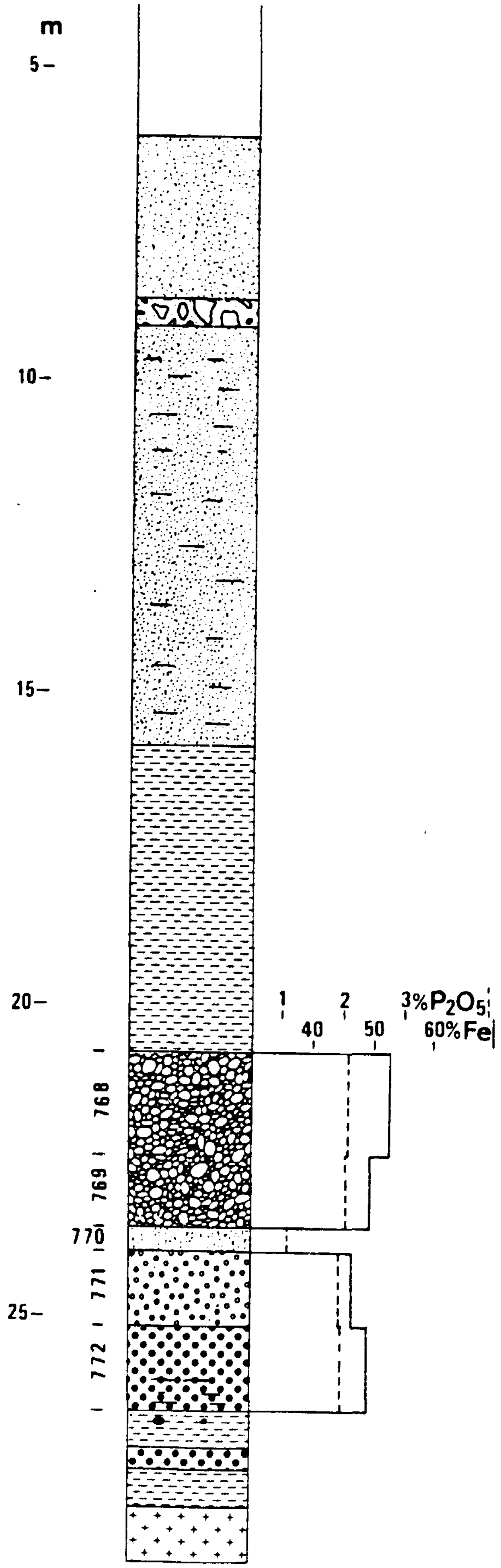
Sandstone, medium grained, clayey, light reddish-brown

Clay, silty, light-brown to reddish-white

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, medium grained, kaolinitic clay matrix, white

DK 43



not cored

Sandstone, fine grained, silty, light brown

Iron sandstone, medium grained, dark brown

Siltstone, sandy-clayey, light brown to light red

Clay, silty, light grey-brown

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red brown

Sandstone, coarse grained, light brown

Iron oölite, unconsolidated, ca. 90 % oöliths, ca. 3 % quartz sand, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

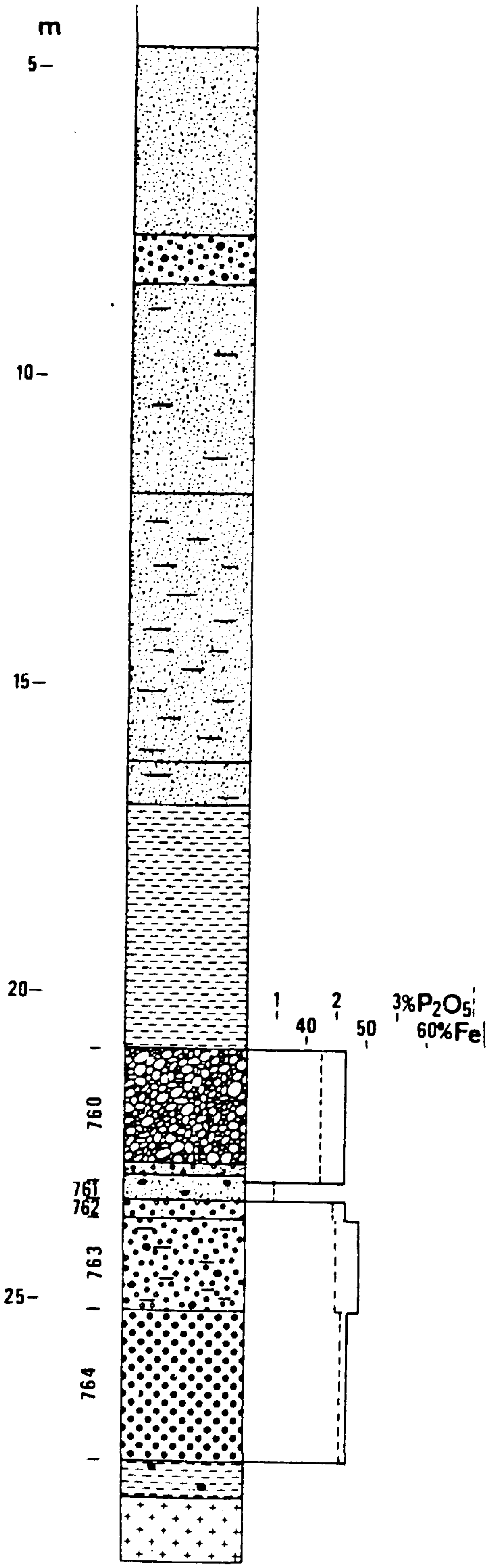
Clay, oölitic and pisolitic, silty, light brown

Iron oölite, pisolitic, unconsolidated, clay matrix

Clay, silty, grey-red

Kaolinitic clay, slightly sandy, white altered basement

DK 44



not cored

Sandstone, fine to medium grained, partly iron stained, brown

Iron oölite, pisolitic, strongly sandy, consolidated, limonite matrix, dark brown

Siltstone, clayey light brown

Siltstone, strongly clayey, light brown to reddish-white

Siltstone, light brown

Clay, slightly silty, light brown to white

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % limonite matrix, dark red-brown

Iron oölite, sandy

Sandstone, medium to coarse grained, oölitic

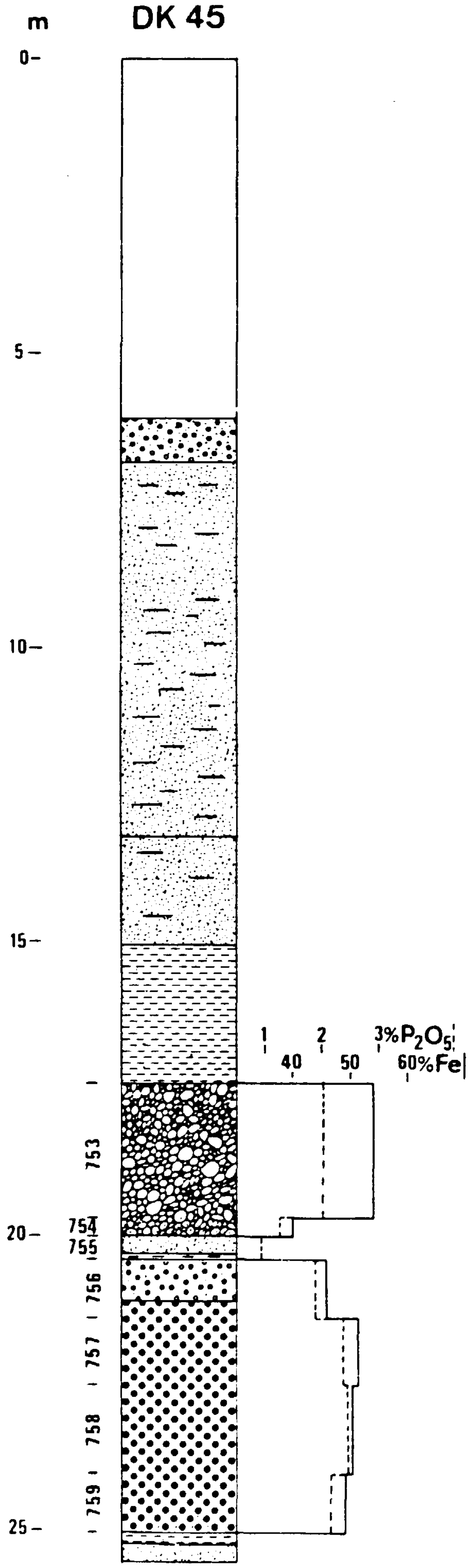
Iron oölite, clay matrix

Iron oölite, slightly pisolitic, unconsolidated, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Clay, light brown, slightly pisolitic

Kaolinitic clay, slightly sandy, altered basement



not cored

Iron oölite, consolidated, strongly, sandy, dark brown

Siltstone, clayey, light brown to white-red

Siltstone, clayey, light brown

Clay, light brown to white

Iron oölite, consolidated, 90-95% ooliths, 5-10 % limonite matrix, clay on joints, dark red-brown

strongly increasing sand content up to 15 %

Sandstone, coarse grained, light brown

Clay

Iron oölite, unconsolidated, sandy, grey-brown

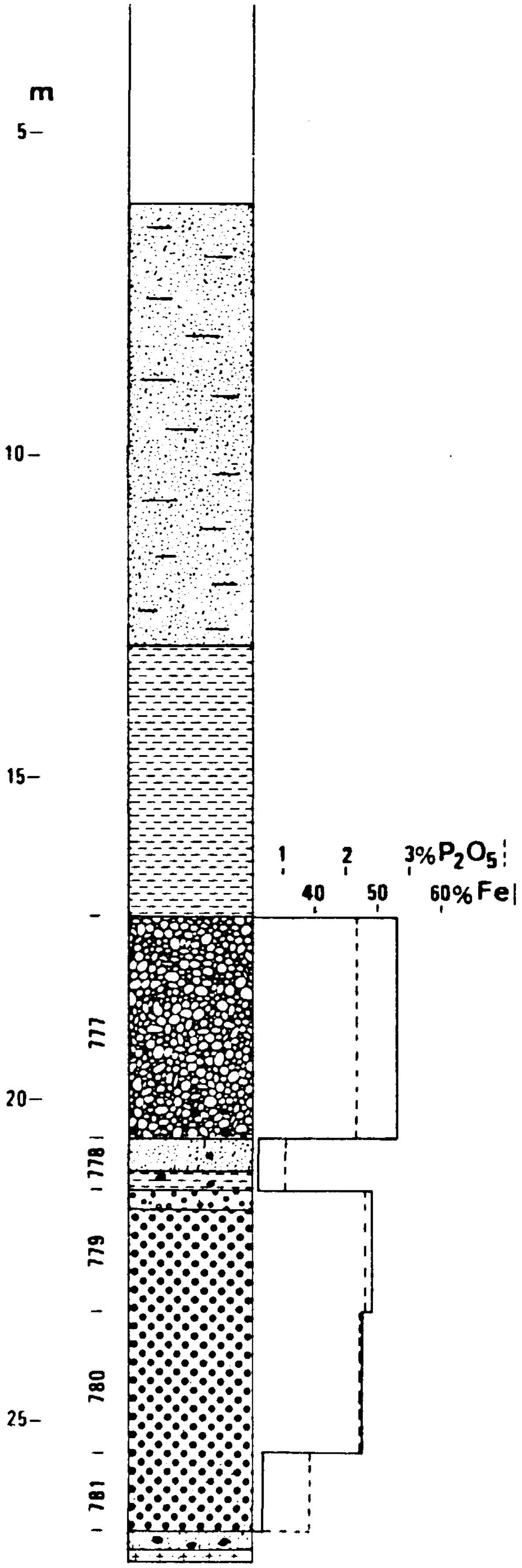
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

slightly increasing sand content up to ca. 5 %

Clay, silty, grey-white

Sandstone, fine grained, light grey to red

DK 46



not cored

Siltstone, sandy, light brown to white-red

Clay, silty, light brown to light pink

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

isolated pisoliths

Sandstone, medium to coarse grained, light brown

Clay, sandy, oölitic and pisolitic, light brown

Iron oölite, sandy, clay matric, brown

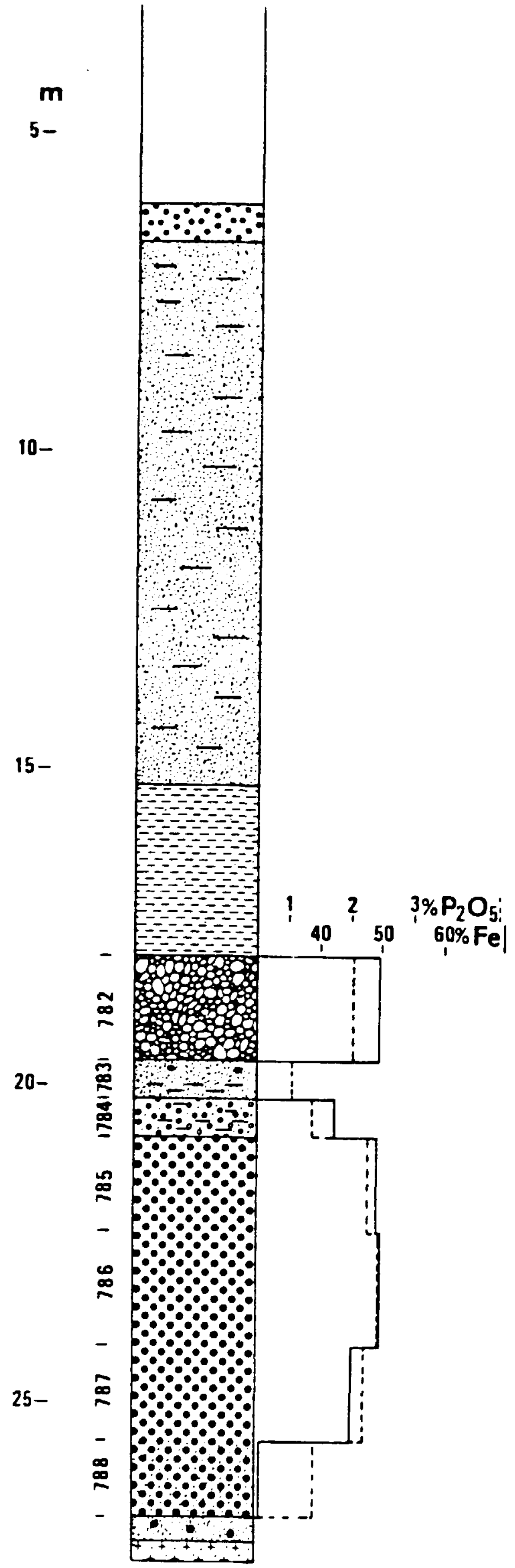
Iron oölite, pisolitic, unconsolidated, 75 - 80 % oöliths and pisoliths, clay matrix, grey-brown

increasing sand content to the foot wall

Sandstone, medium grained, oölitic and pisolitic

Sandstone, fine grained, kaolinitic clay matrix, white, altered basement

DK 47



not cored

Iron oölite, consolidated, sandy, dark brown

Siltstone, sandy-clayey,
light brown to white-red

Clay, white to brown-red, silty

Iron oölite, consolidated, ca. 95 % oöliths,
ca. 5 % clay-limonite matrix, dark red-brown
isolated pisoliths

Sandstone, medium to coarse grained, oölitic and pisolitic, clayey, brown

Iron oölite, sandy, strongly clayey, brown

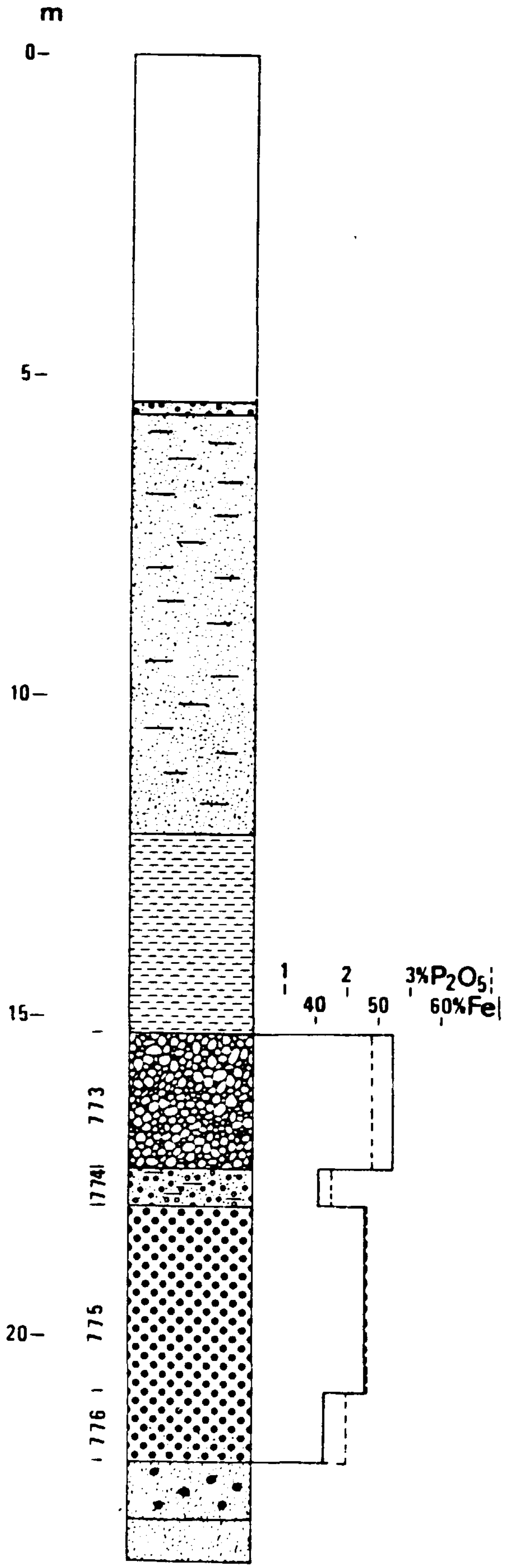
Iron oölite, pisolitic, unconsolidated,
70 - 80 % oöliths and pisoliths, clay,
matrix, grey-brown

increasing sand content to the foot wall
up to 30 %

Sandstone, medium grained, oölitic and pisolitic

Kaolinitic clay, sandy white, altered basement

DK 48



not cored

Iron oölite, lateritic, consolidated, sandy brown

Siltstone, sandy-clayey, grey-white to light brown and red

Clay, sandy-silty, light brown reddish

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, some red clay on joints, dark red-brown

Iron oölite, strongly sandy, clay matrix, grey brown

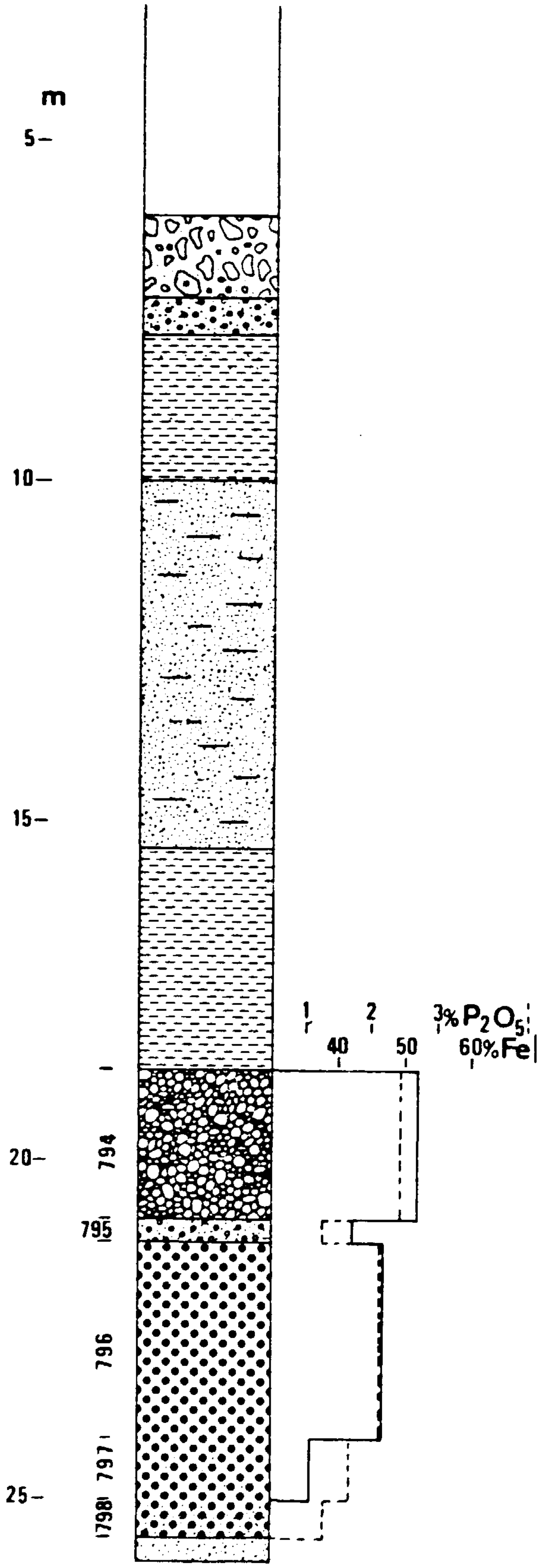
Iron oölite, pisolitic, unconsolidated, ca. 80 % oöliths and pisoliths, clay matrix

increasing sand content to the foot wall up to 5 %

Sandstone, medium grained, oölitic and pisolitic, light brown to light grey

Sandstone, fine to medium grained, slightly kaolinitic, white to light grey

DK 49



not cored

Laterite, brecciated, sandy, dark brown

Iron oölite, strongly consolidated, sandy, slightly pisolitic, black-brown

Clay, sandy-silty, light brown

Siltstone, sandy-clayey, light brown to reddish-white

Clay, slightly silty, light brown to white

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

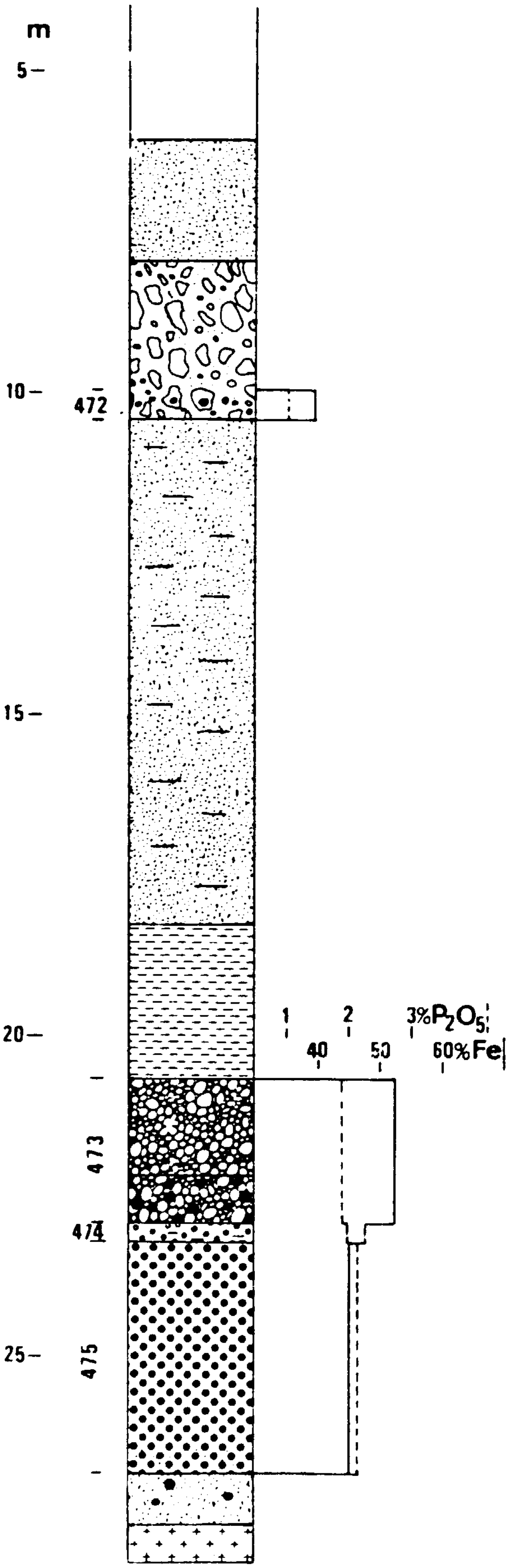
Iron oölite, coarse, sandy, clay matrix, grey-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 20 %

Sandstone, medium grained, slightly clayey light brown

DK 50



not cored

Sandstone, medium to coarse grained, limonite matrix, red-brown

Laterite, sandy, brecciated, limonite matrix

Iron oölite, pisolitic, strongly sandy, consolidated, limonite matrix, dark red-brown

Sandstone, fine-grained, silty-clayey, light brown and dark red to pink in same parts

Clay, light brown to light red with white stripes

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, red-brown

Iron oölite, pisolitic, consolidated, red-brown

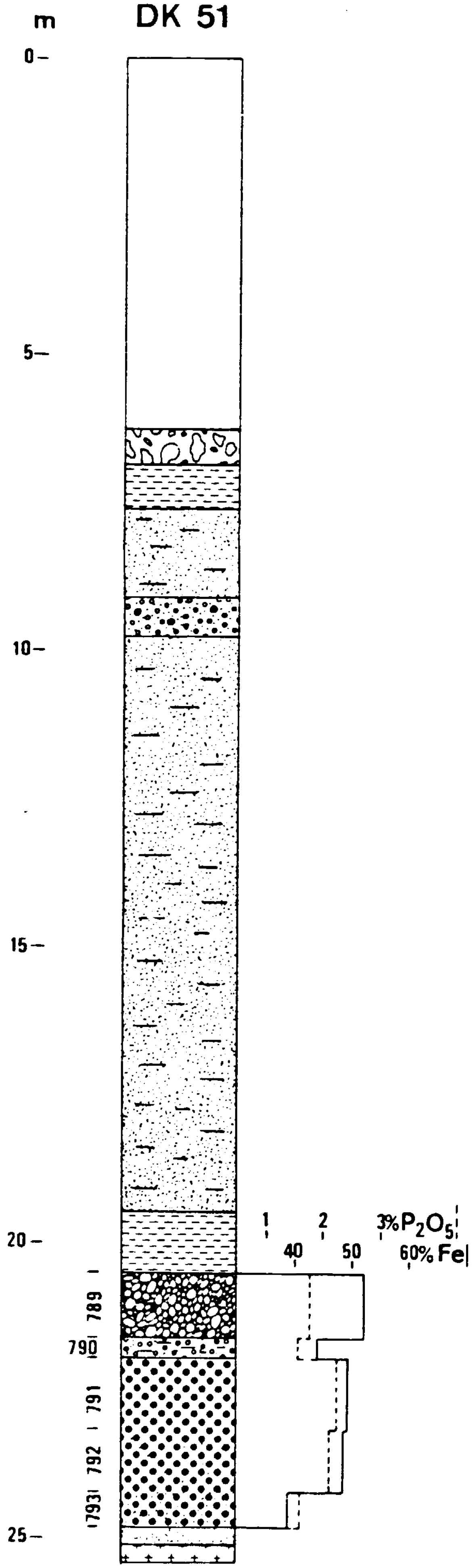
Iron oölite, clay matrix, grey to light brown

Iron oölite, pisolitic, unconsolidated, ca. 70 % ooliths and pisoliths, clay matrix, grey-brown

Sandstone, fine to medium grained, clayey, isolated oöliths and pisoliths, red to light brown

Kaolinitic clay, sandy, white-grey, altered basement

DK 51



not cored

Laterite, brecciated, sandy, dark brown

Clay, silty, brown

Sandstone, clayey, iron stained, brown

Iron oölite, pisolitic, consolidated, strongly sandy, black brown

Siltstone, sandy-clayey, light brown to grey-red

Clay, silty, light brown

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % limonite matrix, dark red-brown

Iron oölite, sandy,clay matrix,evidence of iron crust

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

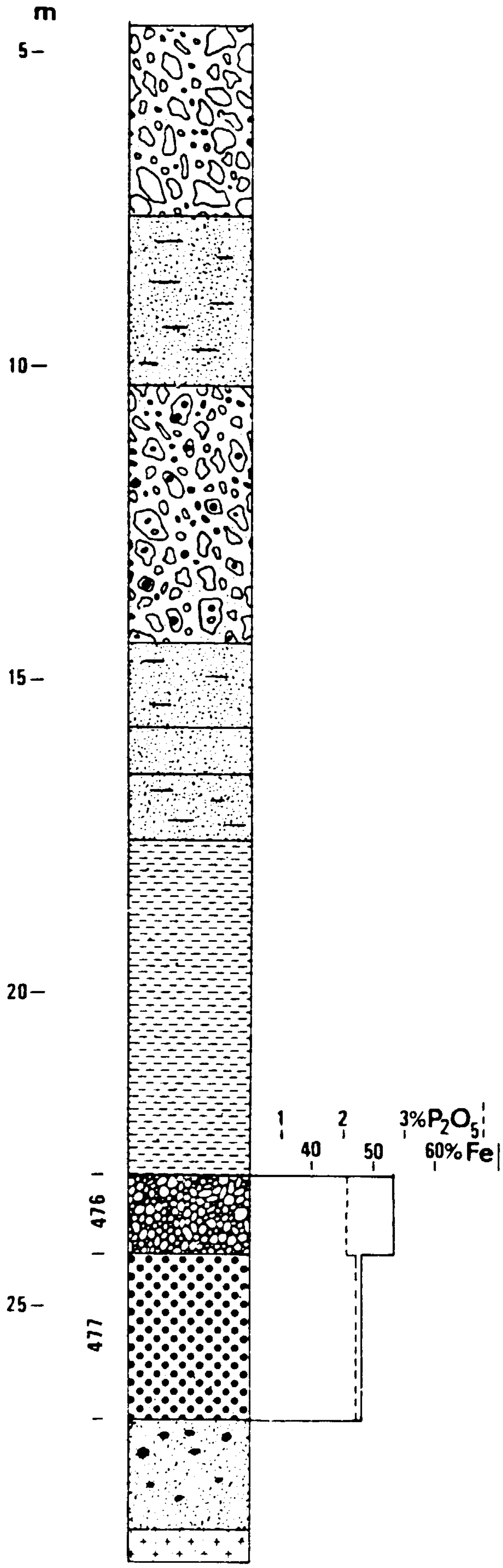
increasing sand content up to 3 - 5 %

Increasing sand content up to 10 %

Sandstone, fine grained, light brown to white

Kaolinitic clay, sandy, white, altered basement

DK 52



Laterite, coarse sandy, brecciated, limonite matrix, black-brown

Sandstone, clayey, slightly consolidated, light brown to red

Laterite, oölitic and pisolitic, strongly sandy, limonite matrix, consolidated, red-brown

Sandstone, fine grained, clayey, red to light brown

Sandstone, fine grained, iron stained, red

Sandstone, fine grained, light brown

Clay, sandy, light brown to grey-white

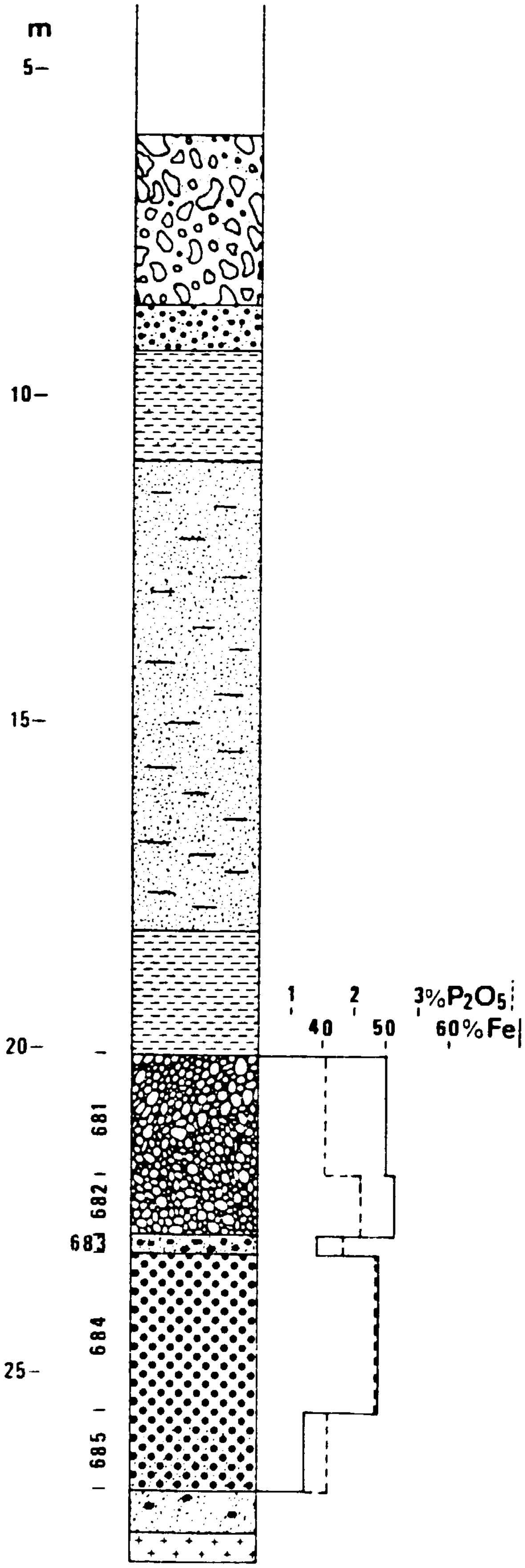
Iron oölite, consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, ca. 80 % oöliths and pisoliths, clay matrix, grey-brown

Sandstone, fine to medium grained, ca. 20 % oöliths and pisoliths, light brown

Kaolinitic clay, sandy, white altered basement

DK 53



not cored

Laterite, brecciated, quartz pebbles, sandy, slightly oolitic, dark brown

Iron oölite, sandy consolidated, dark brown

Clay, silty, light brown

Siltstone, sandy-clayey, light brown to reddish-white

Clay, light brown to white-red

Iron oölite, moderately, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Sandstone, medium to coarse grained, oölitic

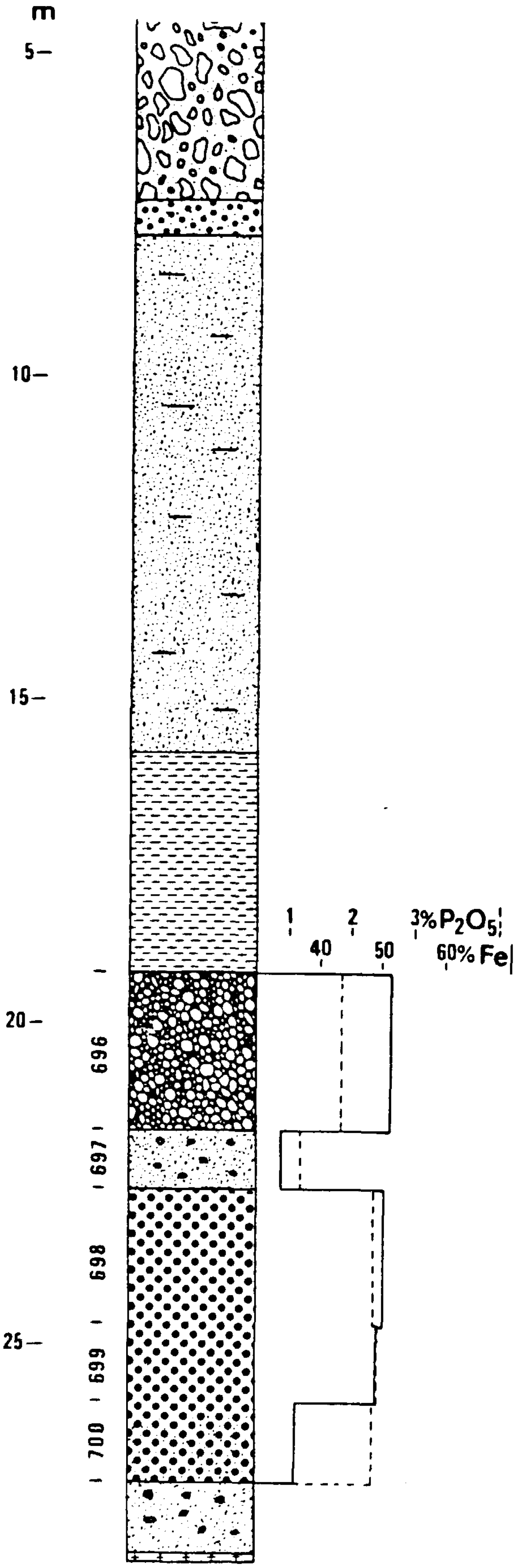
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 20 %

Sandstone, medium grained, slightly oölitic, light red-brown

Kaolinitic clay, sandy, white, altered basement

DK 54



Laterite, sandy, quartz pebbles, limonite matrix, red brown

Iron oölite, strongly sandy, dark brown

Siltstone, sandy-clayey, light brown

Clay, slightly sandy-silty, light brown to white

Iron oölite, consolidated, 90-95 % ooliths, 5-10 % clay-limonite matrix, dark red-brown

Sandstone, medium to coarse grained, oölitic, slightly clayey, red-brown

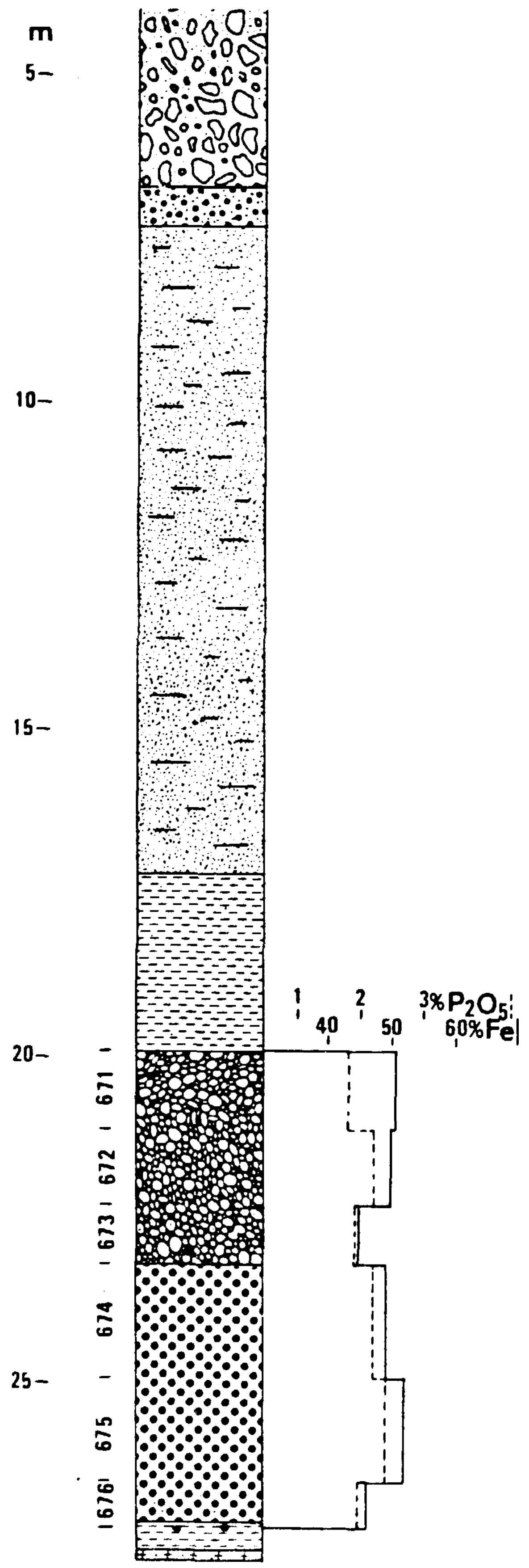
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 30 %

Sandstone, medium to coarse grained, oölitic and pisolitic, brown

Sandstone, medium to coarse grained, kaolinitic clay matrix, white, altered basement

DK 55



Laterite, quartz and iron sandstone pebbles, sandy, limonite matrix, red brown

Iron oölite, strongly sandy, consolidated, dark red brown

Siltstone, sandy-clayey, light brown to white-red

Clay, slightly sandy silty, light brown to white-grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red brown

increasing sand content to the foot wall up to 5 %

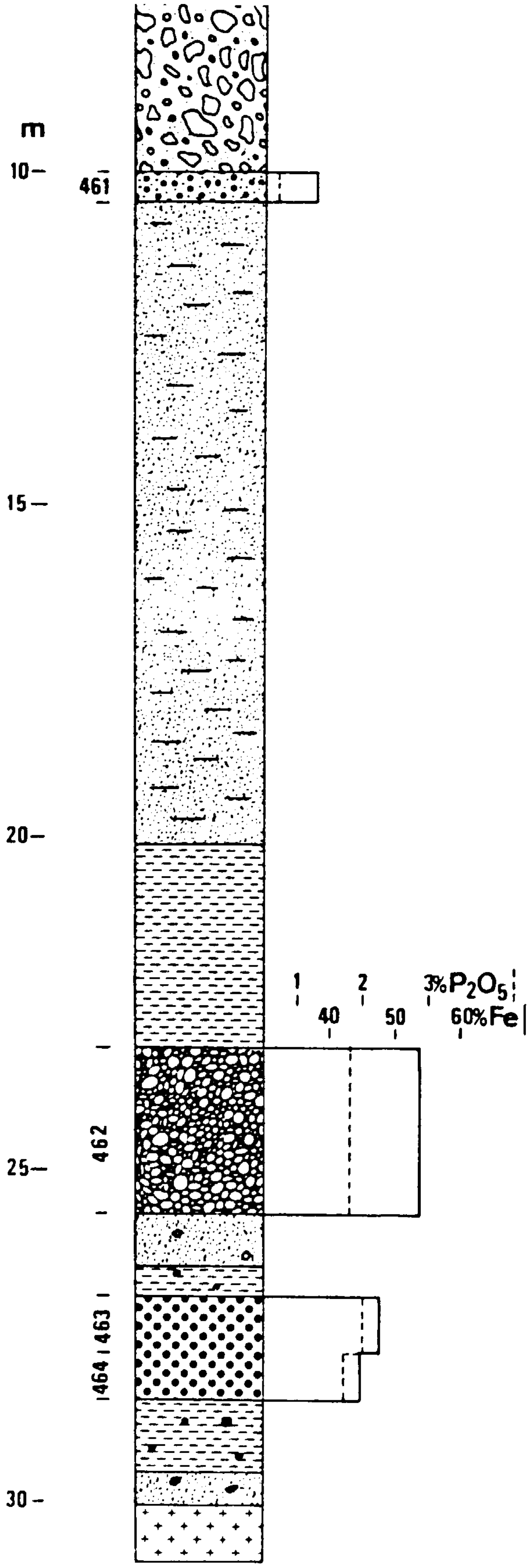
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Clay, slightly pisolitic, light grey to brown

Kaolinitic clay, sandy, white, slightly consolidated by limonite, altered basement

Annex B 3.83

DK 56



Iron sandstone, partly brecciated, isolated oöliths, limonite matrix, red brown

Iron oölite, strongly sandy, consolidated, black-brown

Siltstone, sandy-clayey, to

Sandstone, fine grained, silty-clayey, light brown to light grey, partly red

Clay, silty, light brown to light grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red brown

Sandstone, medium grained, isolated oöliths, brown

Clay, isolated oöliths, light brown

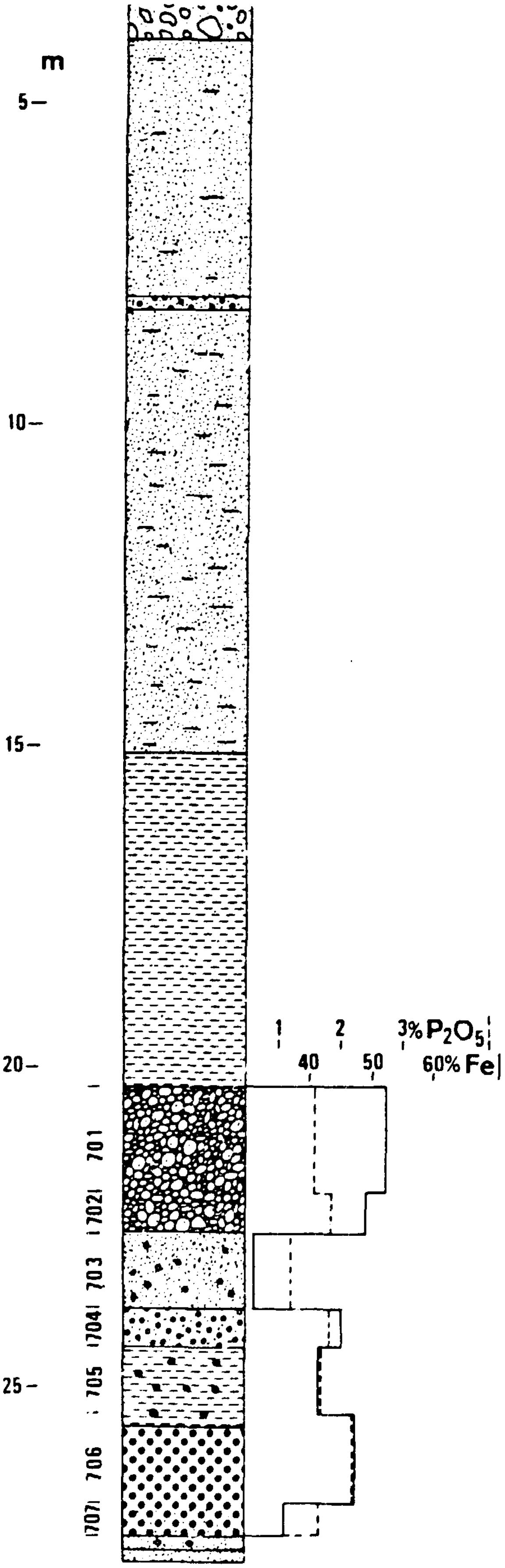
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Clay, silty, slightly oölitic and pisolitic, light brown

Sandstone, fine to medium grained, isolated oöliths and pisoliths, light brown

Kaolinitic clay, sandy, white, altered basement

DK 57



Laterite, sandy, limonite matrix, red brown

Sandstone, fine to medium grained, clayey, iron stained, red brown

Iron oölite, strongly sandy, consolidated, dark brown

Siltstone, sandy-clayey, light brown to white red

Clay, slightly silty, white grey to light brown

Iron oölite, consolidated, 90 - 95 % oöliths, 5 - 10 limonite-clay matrix, dark red-brown

slightly increasing sand content to the foot wall

Sandstone, medium to coarse grained, oölitic, light brown

Iron oölite, sandy-clayey, unconsolidated, light brown

Clay, strongly pisolitic and oölitic, brown

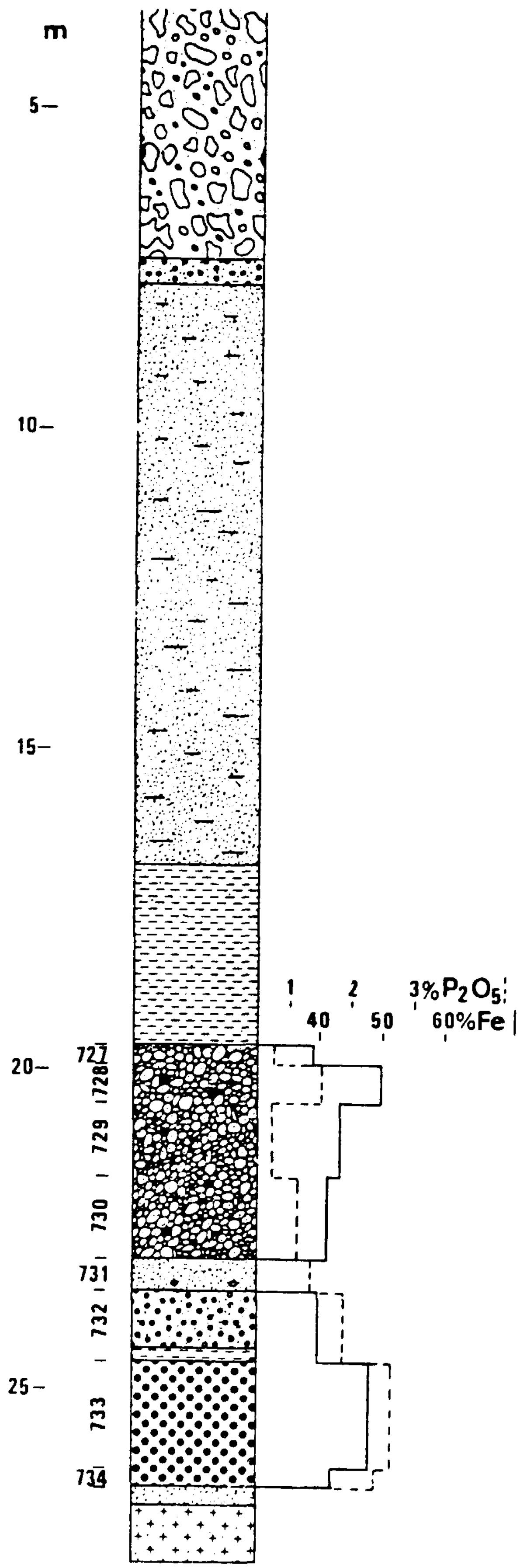
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 15 %

Sandstone, fine grained, oölitic and pisolitic, light brown

Sandstone, fine grained, slightly kaolinitic

DK 58



Laterite, quartz and limonitic iron stone pebbles, sandy, limonite matrix

Iron oölite, strongly sandy, dark brown

Silstone, sandy-clayey, light brown to grey-red

Clay, slightly sandy-silty, light brown to grey-white

Iron oölite, consolidated, isolated pisoliths, ca. 80 % oöliths, ca. 10 % medium to coarse grained sand, clay-limonite matrix, dark red brown

Sandstone, medium to coarse grained, oölitic

Iron oölite, sandy, clay matrix, unconsolidated, grey-brown

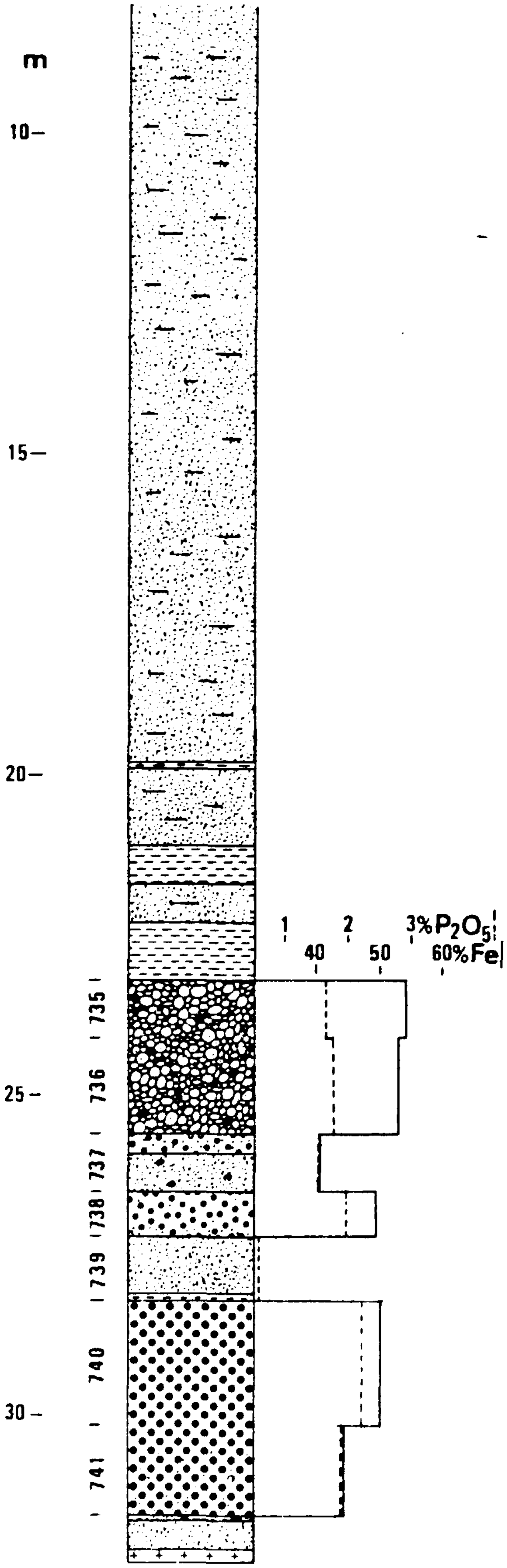
Clay, light grey to yellow

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, fine to medium grained, grey

Sandstone, kaolinitic clay matrix, white, altered basement

DK 59



Sandstone, fine grained, to
Siltstone, sandy-clayey,
red-white, light brown

Clay, white to yellow-brown

Sandstone, silty-clayey, light brown

Clay, sandy-silty, white-grey to light brown

Siltstone, sandy-clayey, light brown

Clay, slightly sandy-silty, grey-yellow

Iron oölite, consolidated, ca. 90 %
oöliths, isolated pisoliths, ca. 10 % clay-
limonite matrix, dark red brown

Iron oölite, strongly sandy, clay matrix

Sandstone, medium to coarse grained, oölitic,
moderately consolidated, light grey-brown

Iron oölite, sandy, clay matrix, slighly
consolidated

Sandstone, medium to coarse grained, slightly
clayey, light brown

Clay, sandy-silty, light brown

Iron oölite, pisolitic, unconsolidatd,
clay matrix, grey-brown

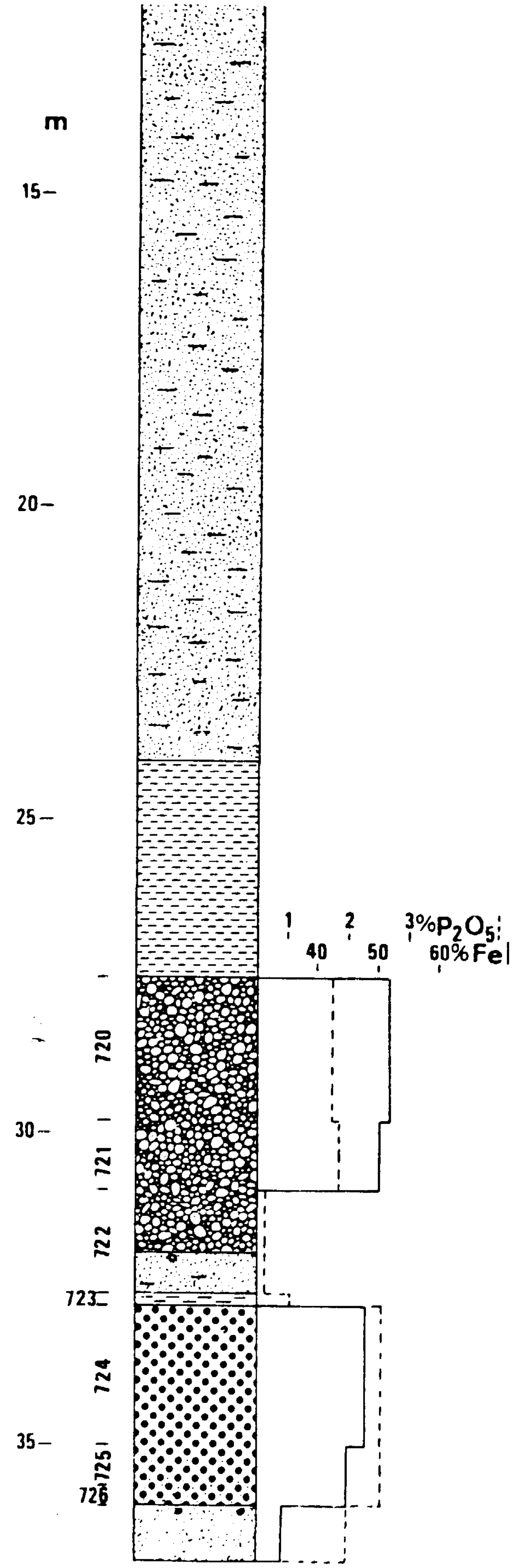
increasing sand content to the foot wall

Sandstone, oölitic, brown

Sandstone medium grained, white-grey

Kaolinitic clay, white, altered
basement

DK 60



Siltstone, sandy-clayey, light brown to grey-red

Clay, slightly silty, light brown to white

Iron oölite, consolidated, ca. 95 % oöliths, isolated pisoliths, ca. 5 % clay-limonite matrix, dark red-brown

Sandstone, medium grained, isolated oöliths clay-hematite matrix, dark red to pink

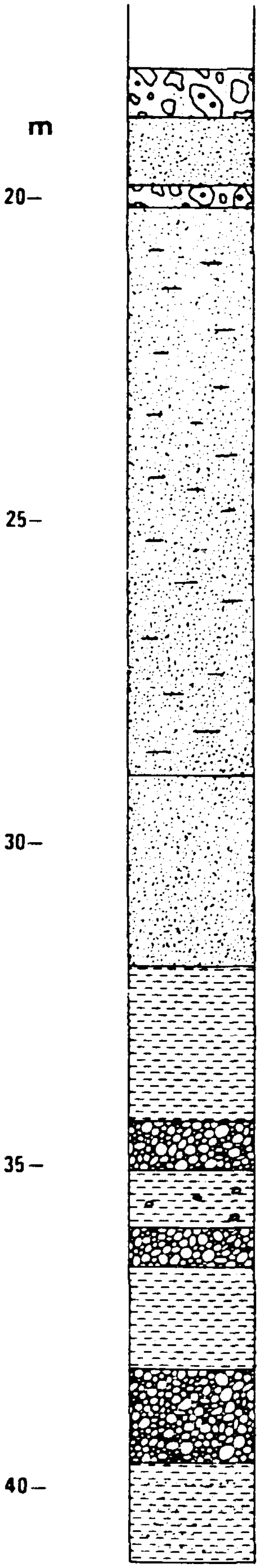
Clay, light brown to white

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

slightly increasing sand content to the foot wall

Sandstone, fine grained, isolated oöliths at the top, kaolinitic clay matrix, white

DK 61



not cored

Laterite, brecciated, strongly sandy, limonite matrix, red brown

Sandstone, fine to medium grained, isolated quartz pebbles, light brown

Iron sandstone, coarse grained, red brown

Siltstone, sandy-clayey, light brown

Sandstone, fine to medium grained, slightly clayey, light red

Clay, light brown to grey-white

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red-brown

Clay, slightly oölitic, light brown

Iron oölite, consolidated, ca. 85 % oöliths, sandy, clay-limonite matrix, red-brown

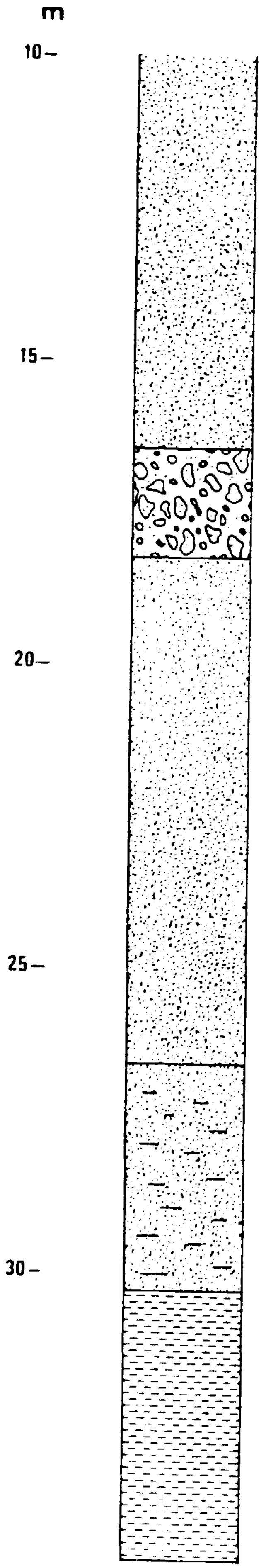
Clay, light brown

Iron oölite, consolidated, ca. 80 % oöliths, sandy, clay-limonite matrix, red brown

Clay, slightly sandy, light brown

Annex B 3.89

DK 62



Sandstone, fine to medium grained, light red

Iron sandstone, consolidated, limonite matrix, dark brown

Sandstone, fine to medium grained, moderately consolidated, light brown to grey-white

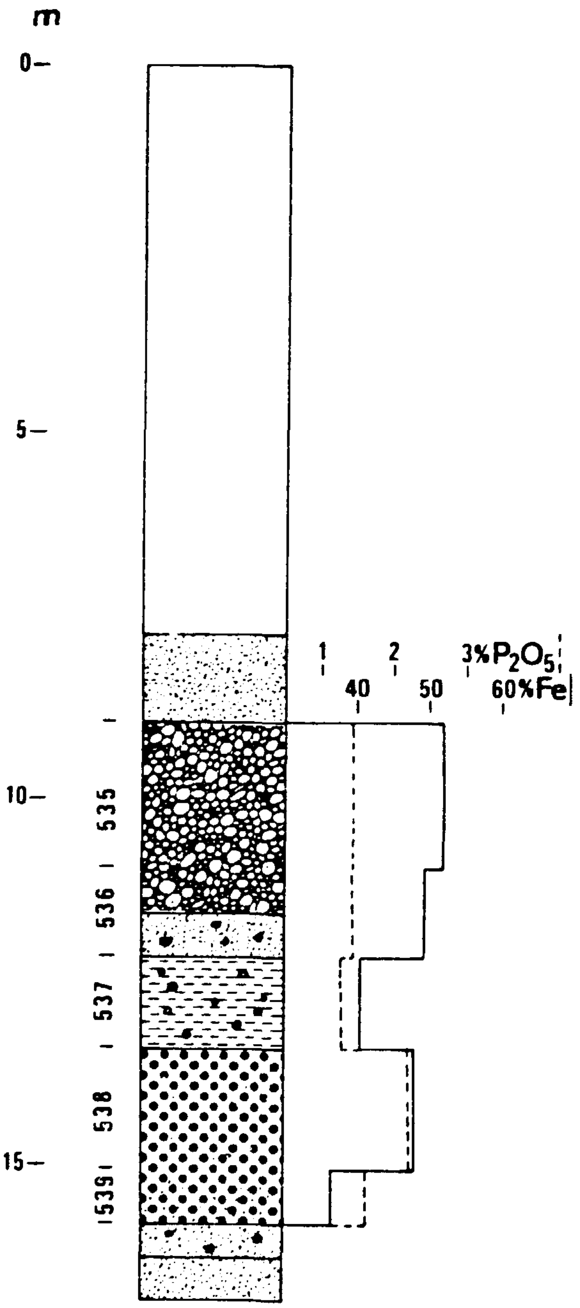
Siltstone, silty-clayey, to

Sandstone, fine grained, light brown to grey-white

Clay, slightly sandy, grey-white with light brown stripes

Annex B 3.90

DK 63



not cored

Sand, slightly, consolidated, fine to medium grained, light red-brown

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix, dark red brown

Sandstone, coarse grained, oölitic-pisolitic, limonite-hematite matrix, red-pink

Clay, strongly oölitic and pisolitic, brown

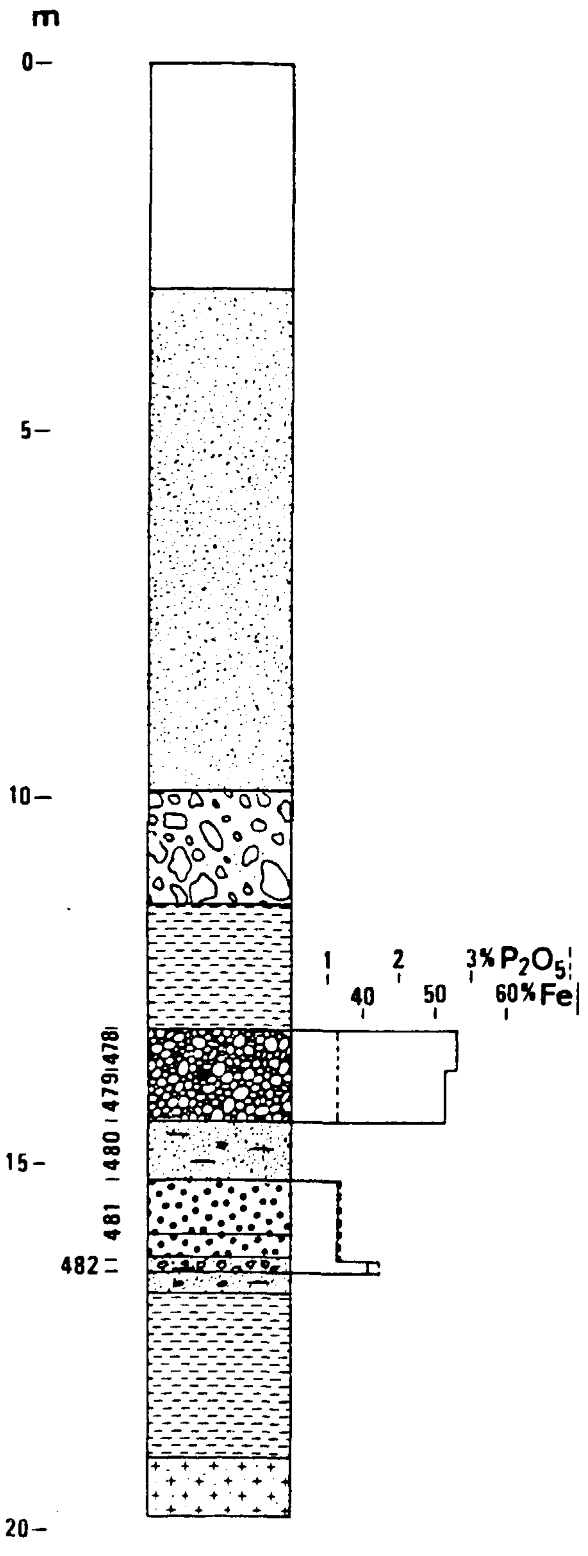
Iron oölite, pisolitic, unconsolidated, slightly silty, clay matrix, grey-brown

increasing sand content to the foot wall up to 20 %

Sandstone, oölitic and pisolitic, light brown

Sandstone, fine to mediuum grained, clayey, light brown

DK 64



not cored

Sand, fine to medium grained, slightly consolidated, light brown

Sandstone, *fragments of iron sandstone* and lateritic material, light brown to light red

Clay, light brown

Iron oölite, consolidated, 90-95 % oöliths, isolated pisoliths, clay-limonite matrix dark red-brown

Sandstone, fine to medium grained, clayey, isolated oöliths, medium brown

Iron oölite, strongly sandy, ca. 70 % oöliths, clay matrix brown

ca. 60 % oöliths

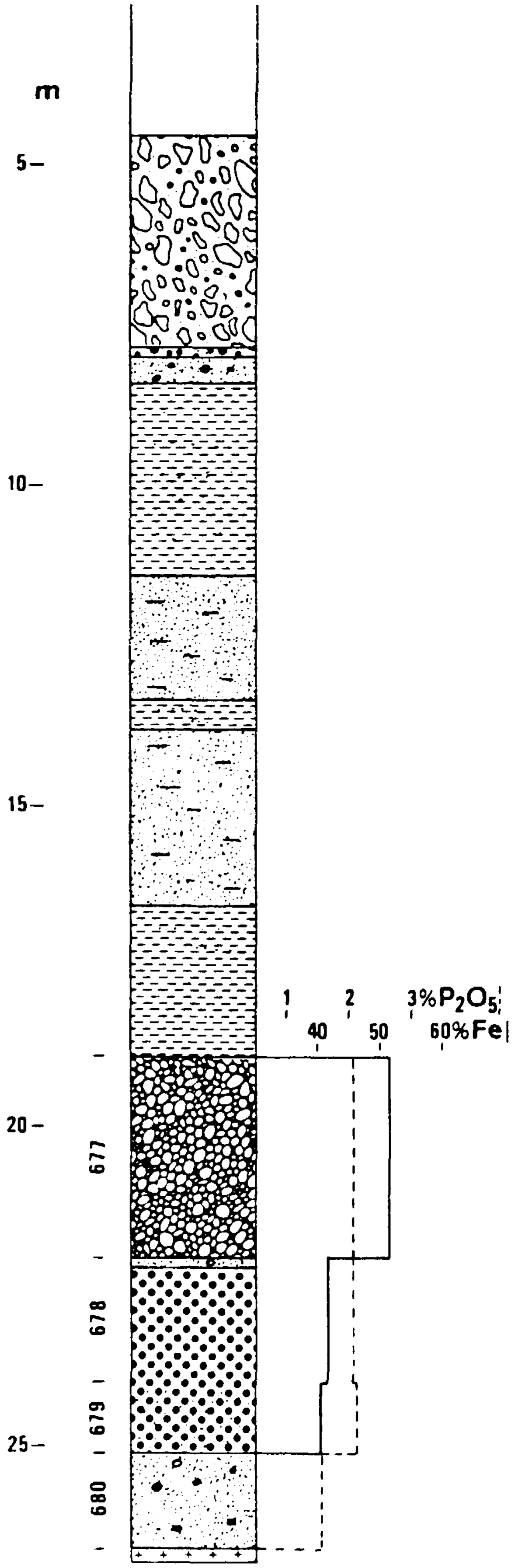
Sandstone, strongly oölitic, clayey, brown

Clay, light brown

Kaolinitic clay, sandy, white

altered basement

DK 65



not cored

Laterite, brecciated, sandy, quartz pebbles, isolated oöliths, dark brown

Iron oölite, pisolitic, sandy, consolidated, black brown

Sandstone, oölitic and pisolitic, brown

Clay, sandy-silty, light brown

Siltstone, sandy-clayey, light brown to white-red

Clay, silty, light brown

Siltstone, sandy-clayey, light brown to white-red

Clay, sandy-silty, light brown to grey

Iron oölite, consolidated, ca. 95 % oöliths, ca. 5 % clay-limonite matrix dark red-brown

Sandstone, clayey, isolated ooliths

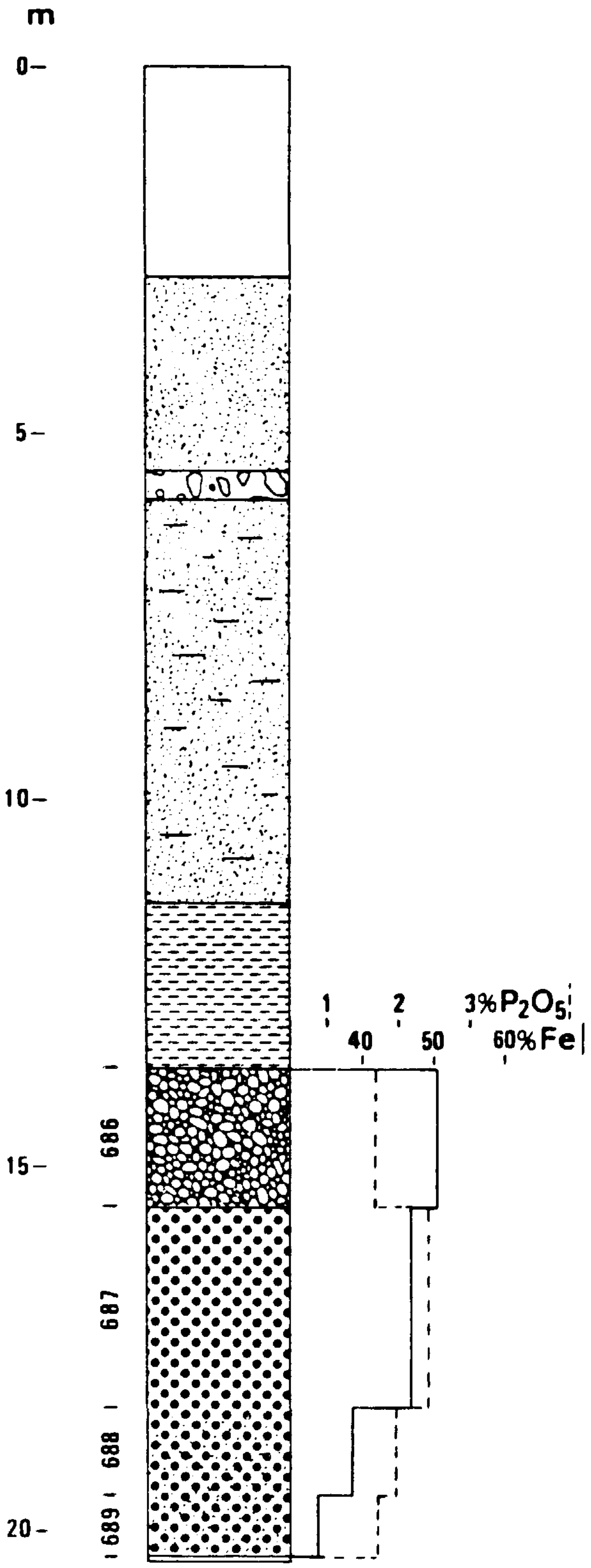
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 10 %

Sandstone, medium grained, oolitic and pisolitic, brown

Kaolinitic clay, slightly/ sandy white altered basement

DK 66



not cored

Sandstone, medium grained, light brown

Laterite, sandy, quartz pebbles, dark brown

Siltstone, sandy-clayey, light brown

Clay, silty, light brown to white red

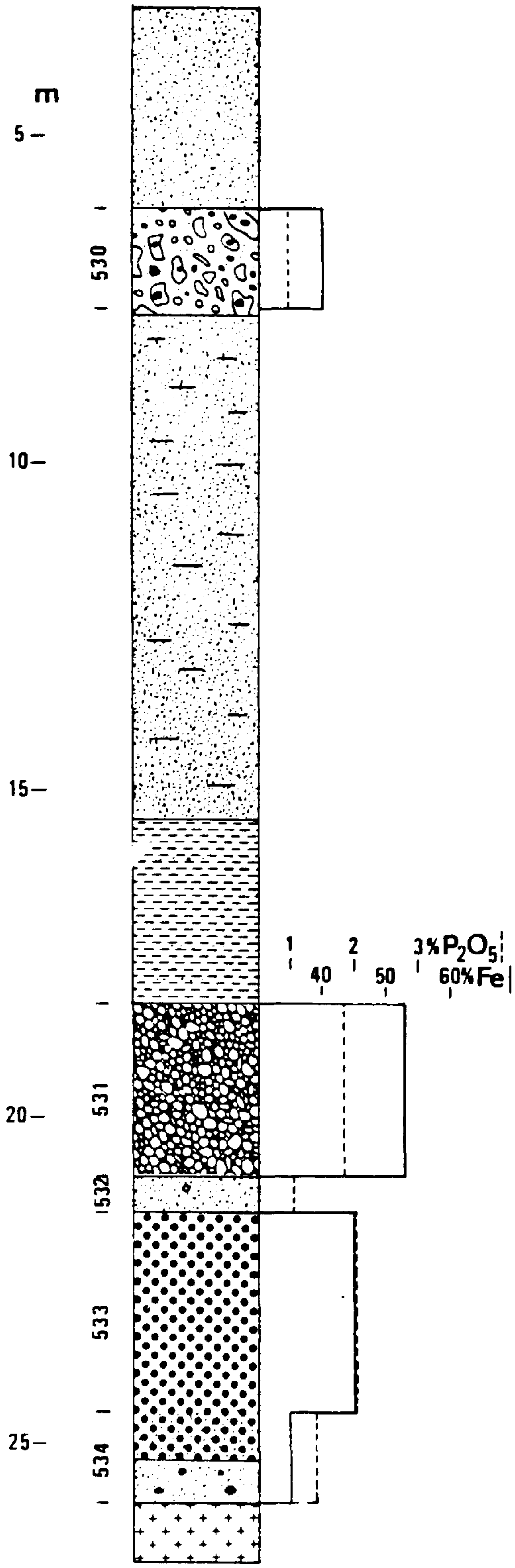
Iron oölite, consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, dark red-brown

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall up to 25 %

Kaolinitic clay, sandy, white altered basement

DK 67



Iron sandstone, medium grained, slightly clayey, limonite matrix, brown-red

Iron oölite, strongly sandy, brecciated, consolidated, limonite matrix, black brown

Siltstone, sandy-clayey, to

Sandstone, fine grained, silty-clayey, light red-brown to grey-white

Clay, grey-white to light brown

Iron oölite, consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, dark red-brown

Sandstone, coarse grained, isolated oölitns, brown

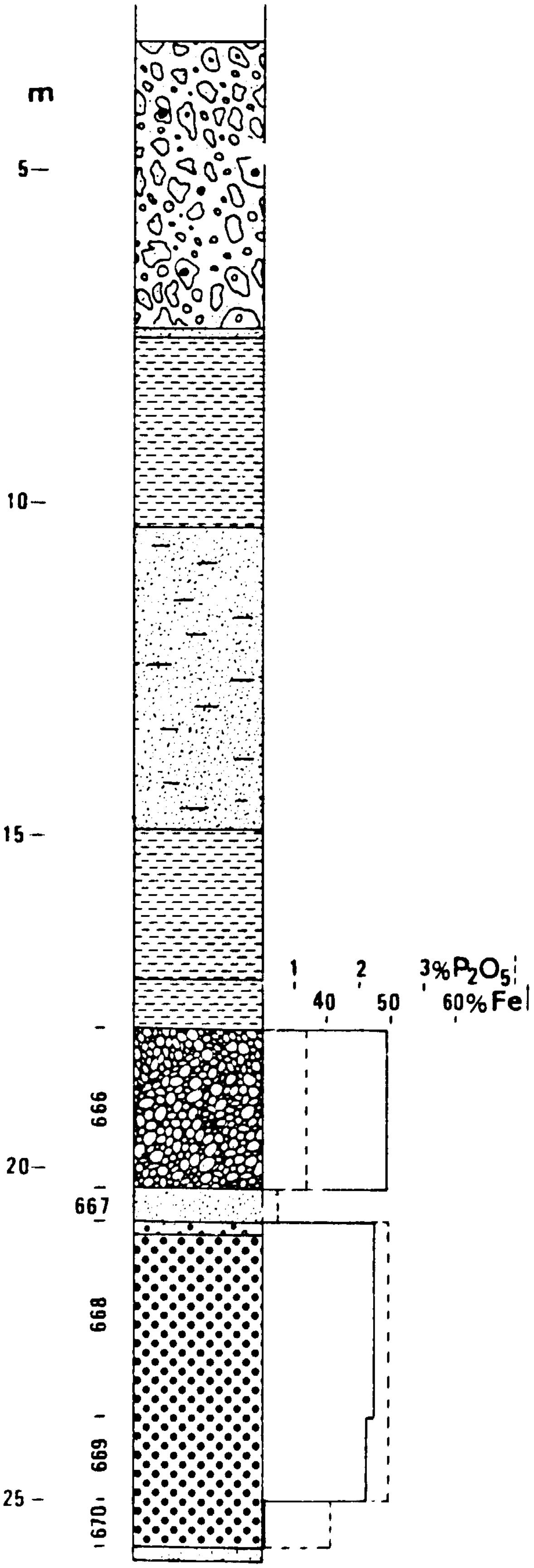
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall

Sandstone, fine to medium grained, oölitic and pisolitic, light grey-brown

Kaolinitic clay, slightly sandy, white, altered basement

DK 68



not cored

Laterite, brecciated, sandy
slightly oölitic and pisolitic,
quartz pebbles, dark brown

Sandstone, medium grained, light brown

Clay, silty, light brown

Siltstone, sandy-clayey,
light brown to red-white

Clay, silty, light brown to white

Clay, red-white

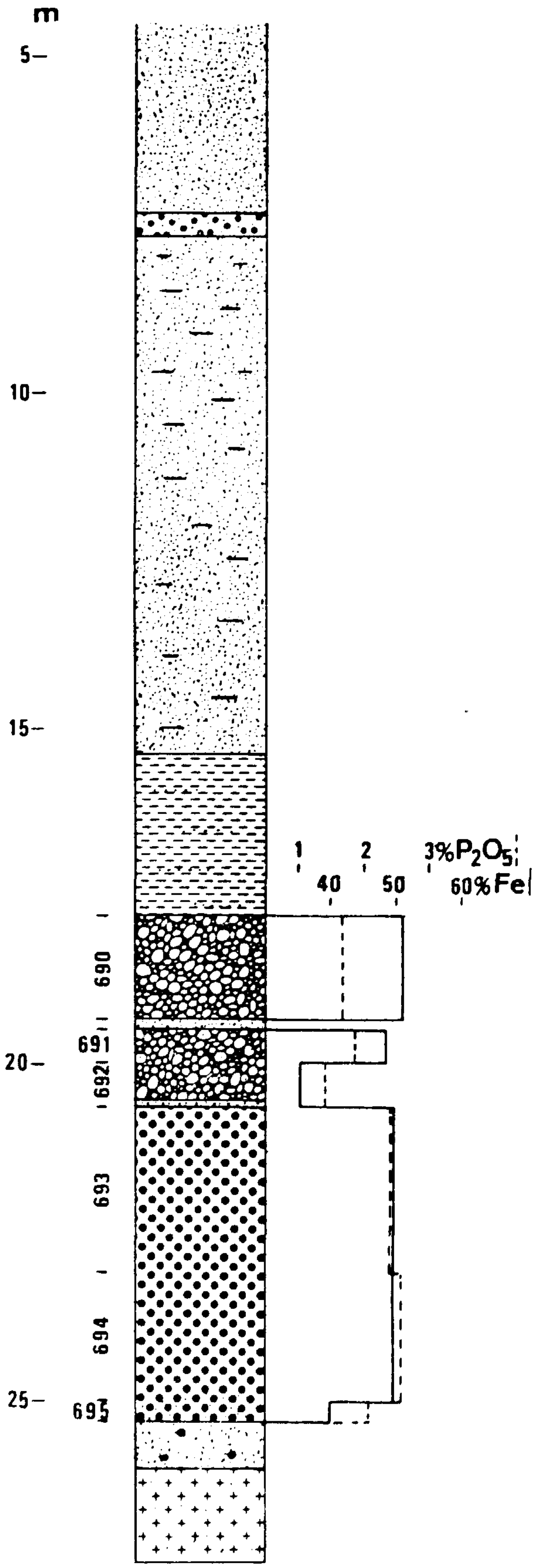
Iron oölite, consolidated, ca. 85 to 95 %
oöliths, 5-10 % clay-limonite matrix
dark red-brown

Sandstone, medium to coarse grained, light brown,
increasing oölith content to the foot wall

Iron oölite, pisolitic, unconsolidated,
clay matrix

Sandstone, medium grained, white-red

DK 69



Sandstone, fine to medium grained, light brown, iron stained

Iron oolite, strongly sandy, dark brown

Siltstone, sandy- clayey, light brown to white-red

Clay, slightly silty, light brown

Iron oölite, consolidated, 90-95 % oöliths, 5-10 % limonite matrix, dark red-brown

Sandstone, coarse grained, light brown

Iron oölite, consolidated, ca. 90 % oöliths, ca. 10 % clay-limonite matrix, sandy, dark red-brown

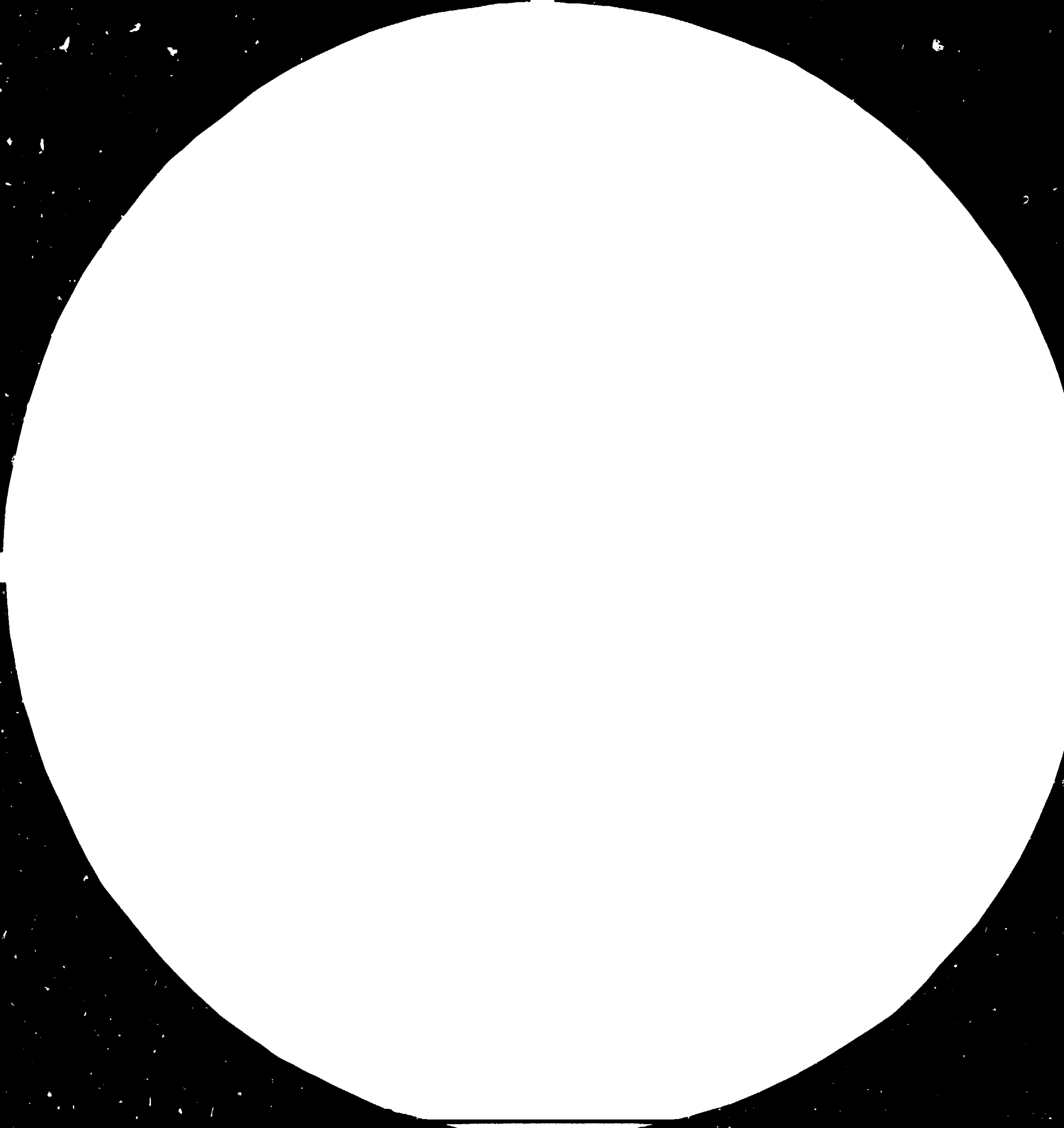
Sandstone, medium grained, oolitic

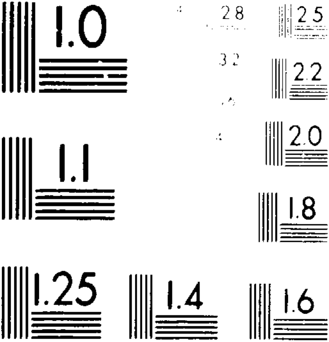
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

slightly increasing sand content to the foot wall

Sandstone, fine grained, oolitic and pisolitic, light brown

Kaolinitic clay, sandy, white, altered basement





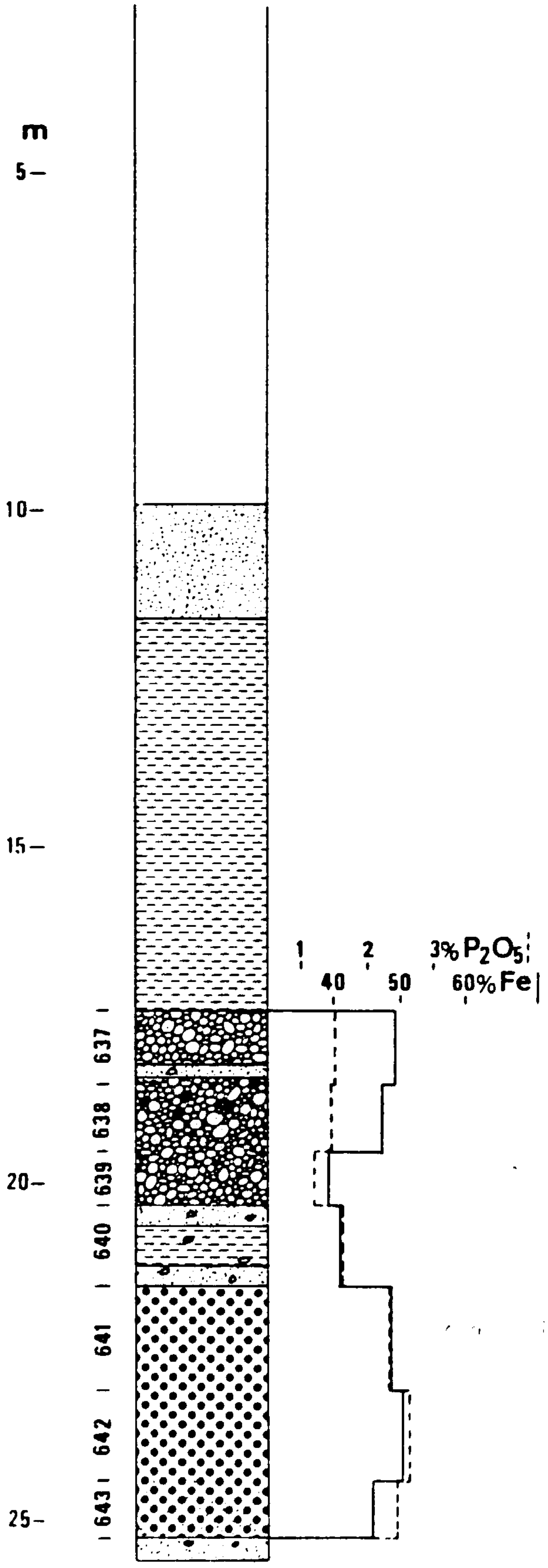
MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

STANDARD REFERENCE MATERIAL 1010a

(ANSI and ISO TEST CHART No. 2)

DK 70



not cored

Sandstone, fine grained, clayey, light brown

Clay, yellow-white

Iron oölite, consolidated, ca. 95 % oöliths, limonite matrix, dark red-brown

Sandstone, silty-clayey, oölitic, brown

Iron oölite, consolidated, pisolitic, clay-limonite matrix, dark red brown

increasing sand content up to 25 %

Sandstone, coarse grained, ca. 15 % oöliths, light brown

Clay, sandy, oölitic, brown

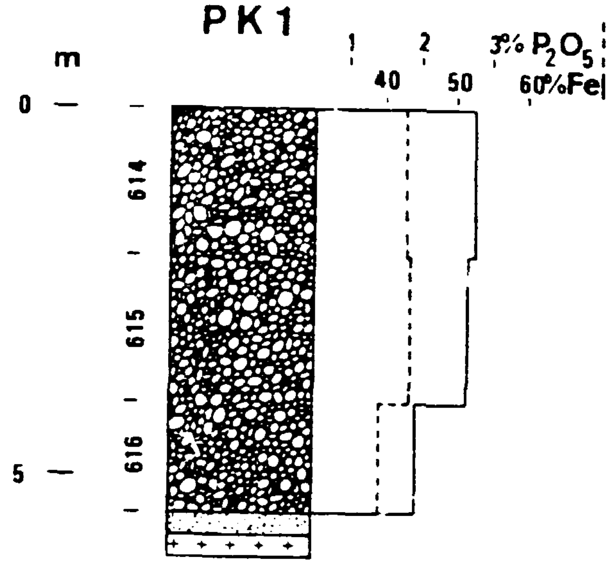
Sandstone medium to coarse grained, oölitic

Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content up to 15 %

Sandstone, fine to medium grained, white, isolated oöliths

PK 1



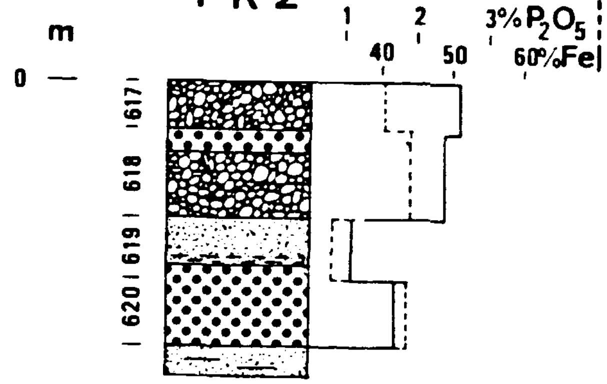
Iron oölite, consolidated, ca. 95 % oöliths, limonite matrix, dark red-brown

increasing sand content to the foot wall up to 10 %

Sandstone, fine grained, red-yellow

Sandstone, fine grained, kaolinitic clay matrix, white-grey

PK 2



Iron oölite, consolidated, ca. 95 % oöliths, limonite matrix, dark red-brown

Iron pisolite, consolidated, red-brown

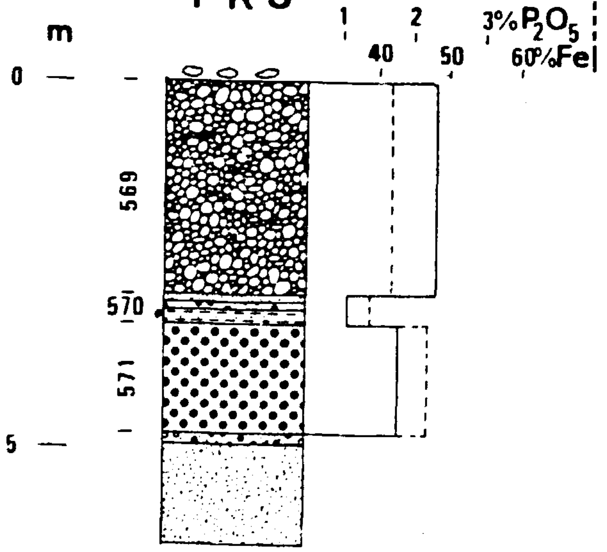
Iron oölite, consolidated, ca. 95 % oöliths, clay-limonite matrix, dark red-brown

Sandstone, clayey, strongly penetrated by iron crusts, brown

Iron oölite, pisolitic, unconsolidated, sandy, clay matrix, grey-brown

Sandstone, fine to medium grained, silty-clayey, brown to light brown

PK 3



Iron oölite, consolidated, ca. 90 % oöliths, isolated pisoliths, clay-limonite matrix, dark red-brown

Sandstone, clayey, yellow-brown

Iron oölite, clay matrix, grey-brown

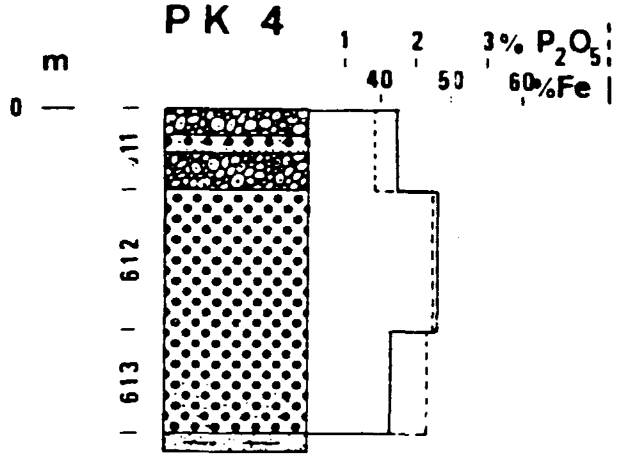
Clay, strongly sandy, iron crusts

Iron oölite, pisolitic, unconsolidated, sandy ca. 70 % oöliths and pisoliths, clay matrix, grey brown

Iron oölite, strongly sandy, clay matrix

Sandstone, fine to medium grained, clayey, red-yellow to white-yellow

PK 4



Iron oölite, consolidated, sandy, limonite matri

Iron pisolite, consolidated, sandy, red-brown

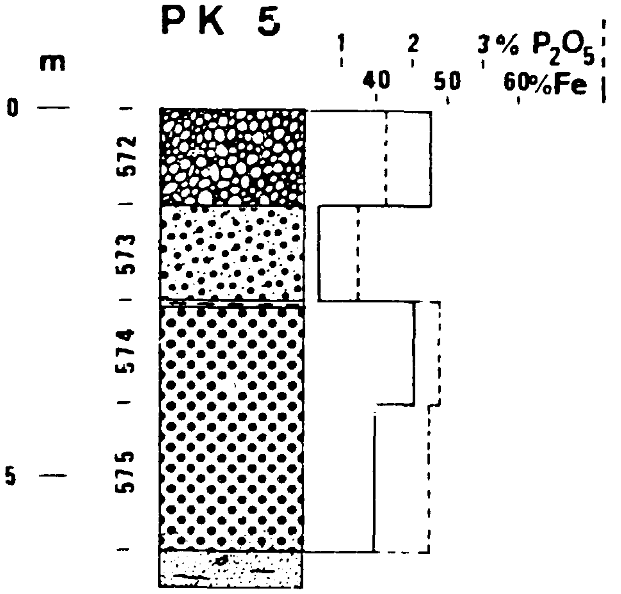
Iron oölite, consolidated, sandy, red-brown

Iron oölite, pisolitic, moderately consolidated, ca. 80-90 % oöliths and pisoliths, clay-silt matrix, grey-brown

increasing sand content to the foot wall up to 20-30 %

Sandstone, medium grained, clayey, red yellow

PK 5



Iron oölite, consolidated, ca. 90 % oöliths, clay-limonite matrix, dark red-brown

Iron oölite, ca. 15-20 % medium grained sand, clay matrix, grey-brown

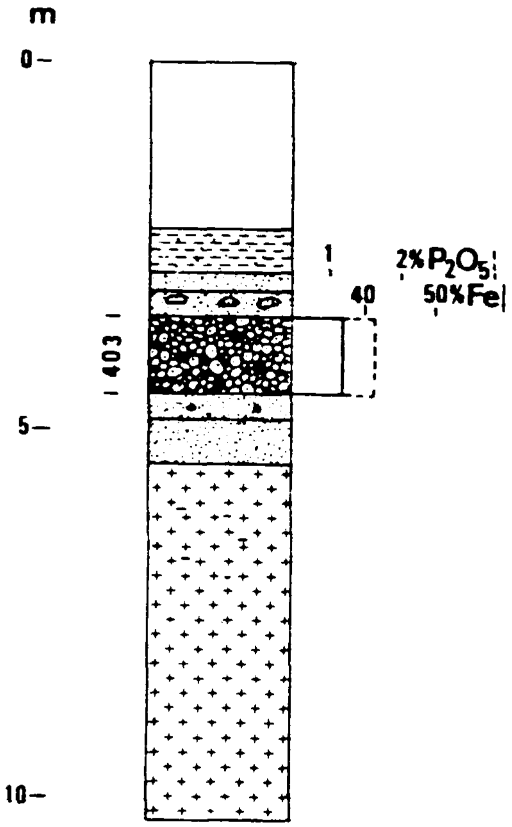
Clay and iron crusts, sand, brown

Iron oölite, pisolitic, slightly consolidated, sandy, clay-limonite matrix, dark red-brown

increasing sand content to the foot wall up to 10 %

Sandstone, fine grained, slightly oölitic, clayey, yellow-brown to white yellow

K 1



not cored

Clay, sandy-silty, grey to light brown

Sandstone, medium grained, grey to light brown

Sandstone, medium grained, conglomeratic

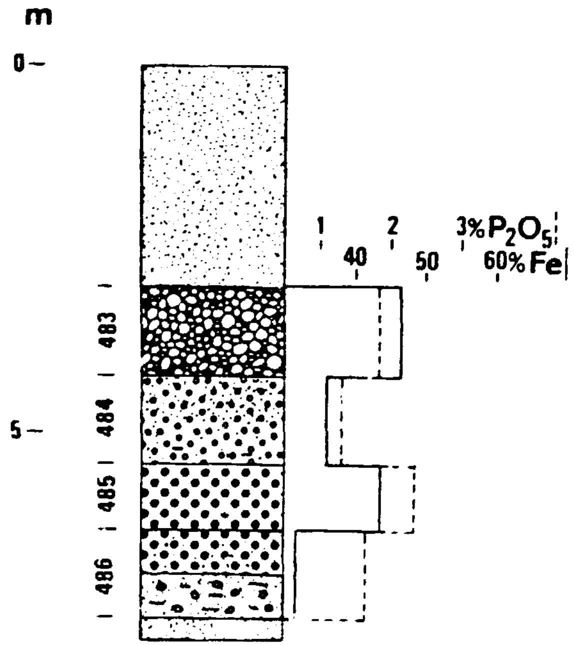
Iron oölite, sandy, pisolitic, moderately consolidated, brown

Sandstone, silty, ca. 10-20 % oöliths

Sandstone, fine grained, white-yellow

Kaolinitic clay, white, partly
limonite on joints,
altered basement

K 2



Sandstone, coarse grained, grey-red-brown

Iron oölite, consolidated, ca. 95 % oöliths, sandy, clay-limonite matrix, black-brown

Iron oölite, strongly sandy, slightly consolidated, clay-matrix, grey-brown

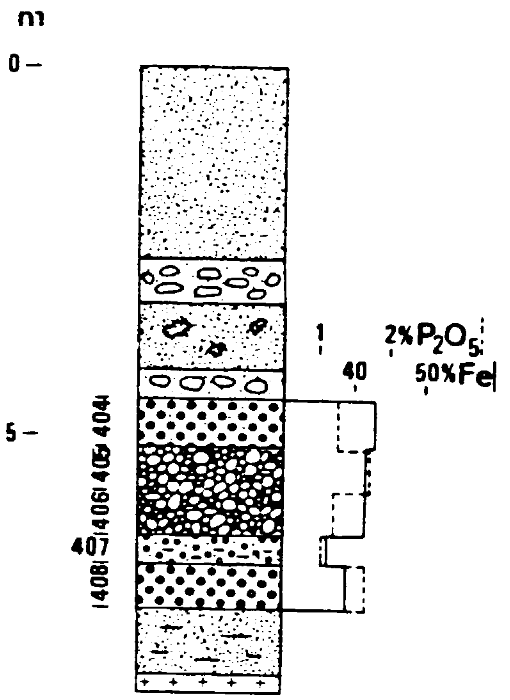
Iron oölite, pisolitic, slightly consolidated, clay matrix, grey-brown

strongly increasing sand content to the foot wall

Sandstone, medium grained, oölitic and pisolitic, clay matrix, red-grey

Sandstone, medium grained, light brown to white

K3



Eolian sand, fine grained,
light brown to light red

Gravel, moderately consolidated,
quartz and iron sandstone pebbles

Sandstone, coarse grained, brecciated
grey-red-brown

Gravel, moderately consolidated

Iron oolite, pisolitic, slightly consolidated,
clay-limonite matrix, grey-brown

Iron oölite, consolidated, well sorted,
ca. 70 % ooliths, sandy, clay matrix brown

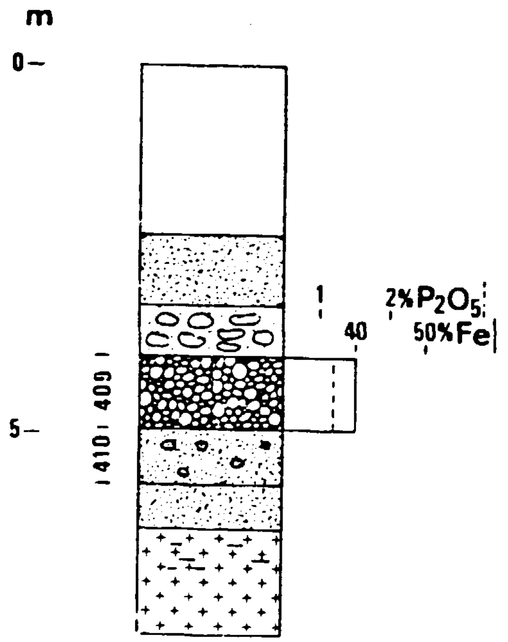
Iron oölite, sandy, clay matrix, grey-brown

Iron oölite, pisolitic, moderately consolidated

Sandstone, fine to medium grained,
clayey, light red-brown

Kaolinitic clay, white, altered basement

K4



not cored

Sand, medium grained,
grey

Terrace gravel, sandy, light grey-brown

Iron oölite, consolidated, ca. 85 %
oöliths, sandy, clay-limonite matrix,
dark red-brown

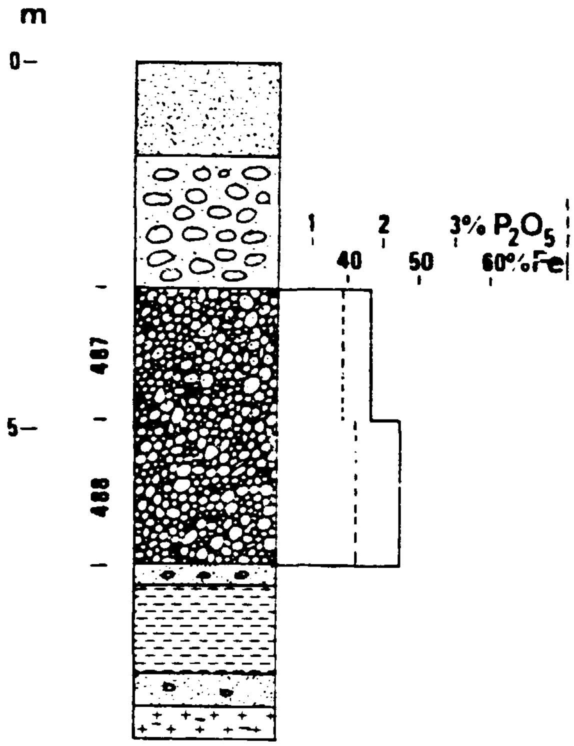
Sandstone, medium grained, ca. 30 %
oöliths, limonite matrix

Sandstone, medium grained, silty-
clayey, light brown

Kaolinitic clay, contaminated by limonite

Kaolinitic clay, white,
altered basement

K5



Sand, medium grained, silty-clayey, light brown

Conglomerate (Niger terrace), quartz and iron sandstone pebbles, sandy, light grey-brown

Iron oölite, consolidated, ca. 85 % oöliths, ca. 5 % sand, clay-limonite matrix, diameter of oöliths: ca. 0,5 to 1,0 mm, dark red-brown

no quartz grains

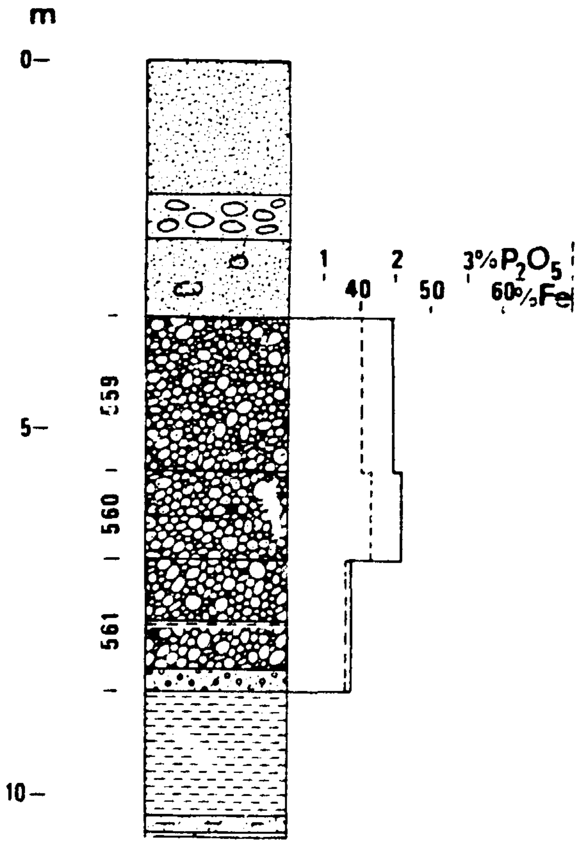
Sandstone, slightly oölitic, light brown

Clay, silty, light grey to brown

Sandstone, medium to coarse grained, isolated oöliths

Kaolinitic clay, slightly sandy, white, altered basement

K6



Eolian sand, medium grained, reddish-light brown

Terrace gravel, quartz and iron sandstone pebbles

Sand, medium to coarse grained, conglomeratic, slightly clayey, limonite matrix, red-brown

Iron oölite, consolidated, ca. 85 % oöliths, sandy, clay-limonite matrix, dark brown

isolated pisoliths

increasing sand content to the foot wall up to 10 %

Clay

Iron oölite, as above

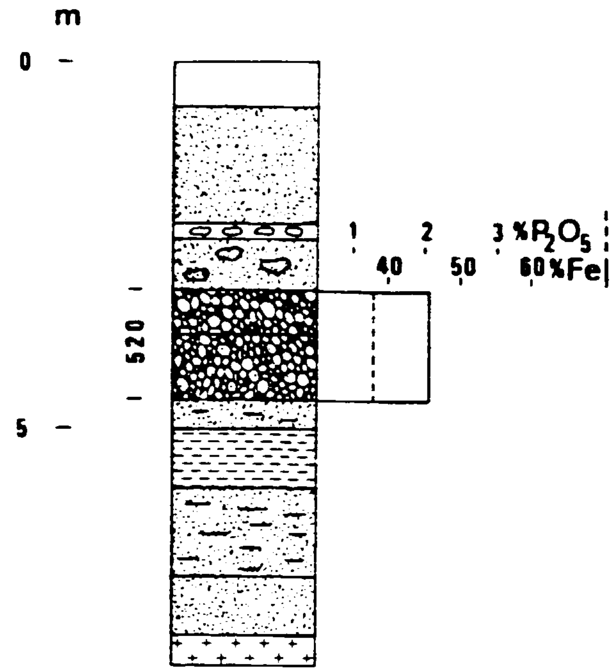
Iron oölite, sandy, clay-limonite matrix, red brown

Clay, slightly sandy, white-brown

Sandstone, medium grained, clayey, reddish

Kaolinitic clay, sandy, white altered basement

K 7



not cored

Sand, medium grained, slightly clayey, light brown to red

Conglomerate

Conglomerate, quartz and iron sandstone pebbles, sandy clay-limonite matrix

Iron oölite, consolidated, clay-matrix limonite matrix, red-brown

increasing sand content up to 10 %

Sandstone, medium grained, red to light-brown

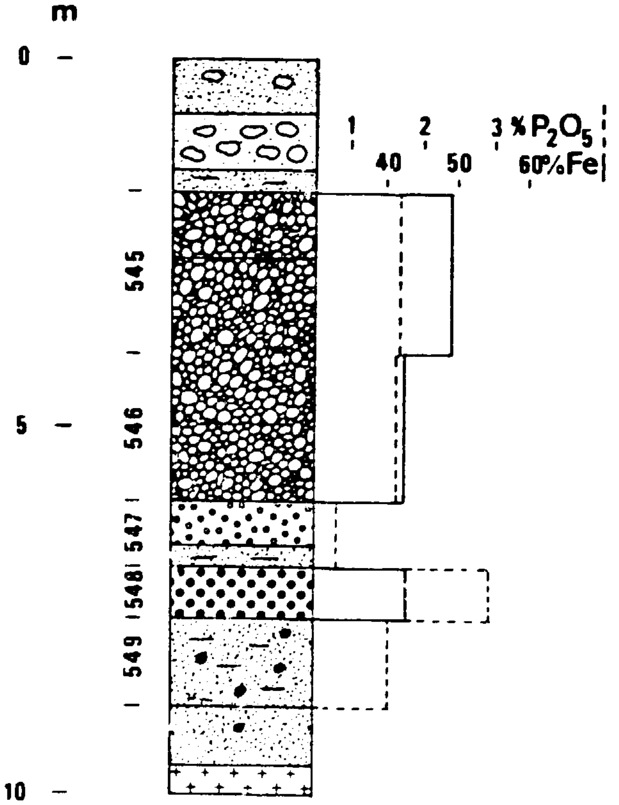
Clay, light brown to red

Sandstone, medium grained, strongly clayey, partly iron stained, red-brown to light grey

Sandstone, medium grained, light brown to white grey

Kaolinitic clay, sandy, white, altered basement

K 8



Sandstone, coarse grained, conglomeratic, light brown

Conglomerate, quartz and iron sandstone pebbles, limonite-silt matrix, red-brown

Iron sandstone, clay-limonite matrix

Iron oölite, consolidated, ca. 95 % oöliths, isolated pisoliths, clay-limonite matrix, dark red brown

increasing sand content to the foot wall up to 10 %

Iron oölite, strongly sandy up to 30-35 % light brown to red

Sandstone, fine-grained, silty-clayey

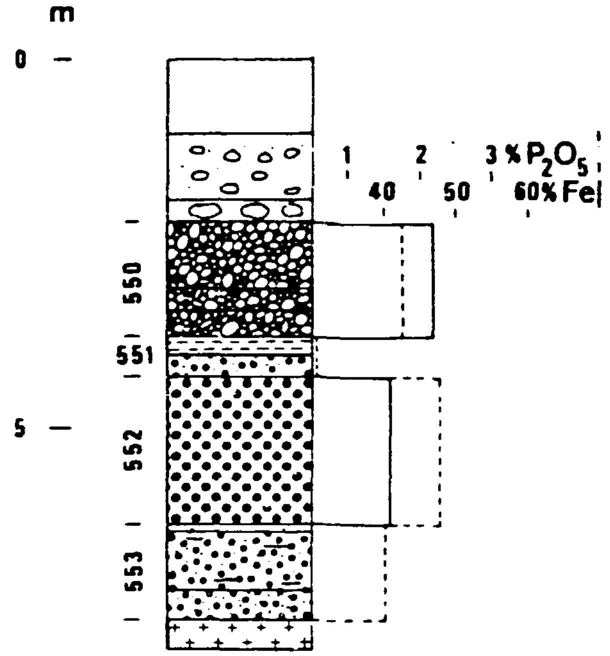
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

Sandstone, medium grained, oölitic and pisolitic, silty, clay matrix, light brown

Sandstone, medium grained, slightly oölitic and pisolitic, light brown

Kaolinitic clay, slightly contaminated by limonite, white, altered basement

K 9



not cored

Terrace gravel, medium to coarse sandy, clayey, light brown

Terrace gravel

Iron oölite, consolidated, ca. 95 % oöliths, clay-limonite matrix, red-brown

increasing sand content to the foot wall

Clay, sandy-silty, light grey-brown

Iron oölite, sandy, clay matrix, red brown

Iron oölite, pisolitic, unconsolidated, clay-matrix

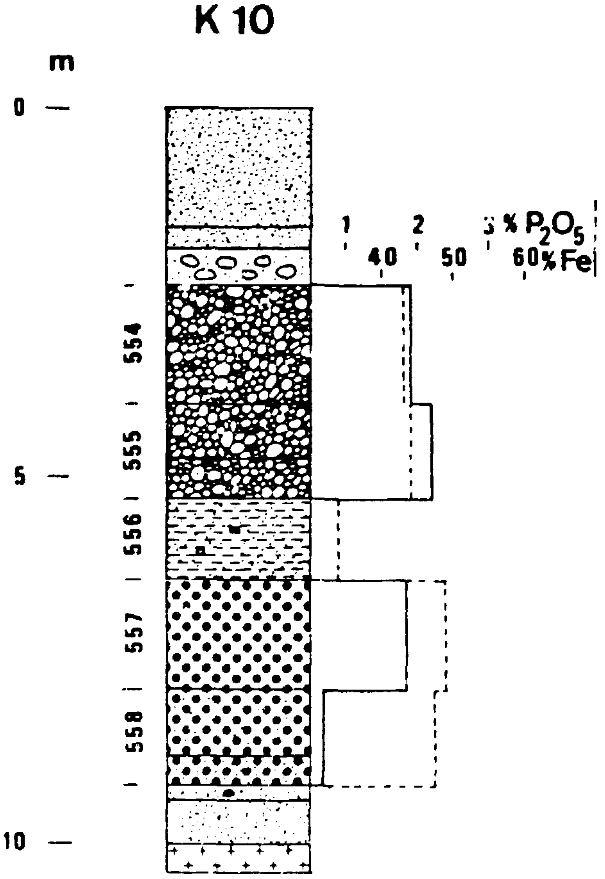
Siltstone, clayey, oölitic, light-brown

Iron oölite, strongly sandy, slightly consolidated, clay matrix, light grey-brown

increasing sand content to the foot wall

Kaolinitic clay, sandy, white, with limonite on joints, altered basement

K 10



Sand, fine to medium grained, silty-clayey, light brown

Sand, coarse grained, brown

Terrace gravel, quartz and iron sandstone pebbles

Iron oölite, consolidated, 80-90 % oöliths, isolated pisoliths, clay-limonite matrix, sandy, dark red-brown

slightly decreasing sand content

Clay, strongly sandy, slightly oölitic, brown

Iron oölite, pisolitic, unconsolidated, sandy, clay matrix, grey-brown

Increasing sand content to the foot wall up to ca. 15 %

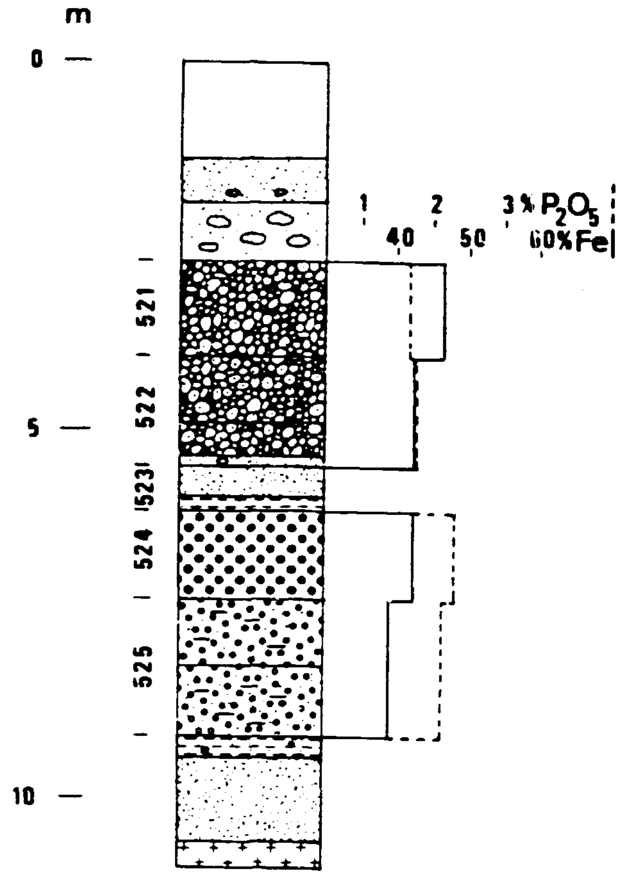
up to ca. 25 %

Sandstone, fine grained, oölitic

Sandstone, fine grained, clayey, light brown to white

Kaolinitic clay, slightly sandy, white, altered basement

K 11



not cored

Sand, medium to coarse grained,
slightly, conglomeratic, light grey-brown

Terrace gravel, predominantly iron
sandstone fragments, red-brown

Iron oŏlite, consolidated, ca. 90 %
oŏliths, sandy, clay-limonite matrix

Increasing sand content to the
foot wall up to 10 %

up to 20 %

Sandstone, medium grained, oŏlitic

Sandstone, medium grained, light brown

Clay, light brown to gray

Iron oŏlite, pisolitic, unconsolidated,
sandy, ca. 70 % oŏliths and pisoliths,
clay matrix, grey brown

Iron oŏlite, unconsolidated, ca. 10 %
sand, clay matrix, grey-brown

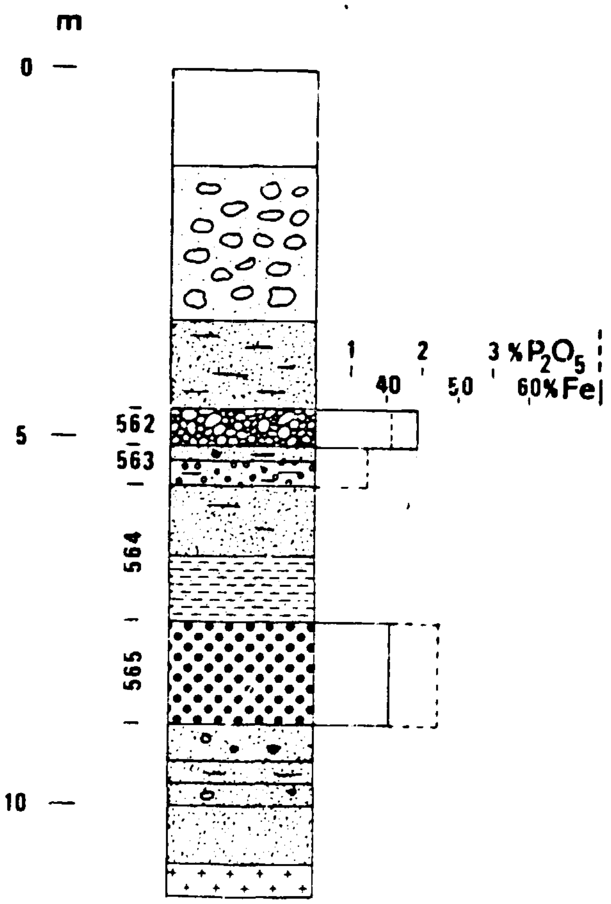
increasing sand content up to 20 %

Clay, strongly sandy, oŏlitic, grey-brown

Sandstone, moderately consolidated,
medium grained, light brown

Kaolinitic clay, slightly sandy,
white, altered basement

K 12



not cored

Lateritic conglomerate, iron sandstone and iron oŏlite fragments and
pebbles, limonite matrix

Siltstone, sandy clayey,
red to white-brown

Iron oŏlite, consolidated, sandy, dark brown

Sandstone, medium to coarse grained, oŏlitic

Iron oŏlite, strongly sandy, clay matrix

Sandstone, medium grained,
silty-clayey, light brown

Clay, sandy, white-brown

Iron oŏlite, pisolitic, slightly consolidated, ca. 70 % oŏliths and pisoliths,
clay-matrix, grey-brown

Sandstone, fine to medium grained, oŏlitic

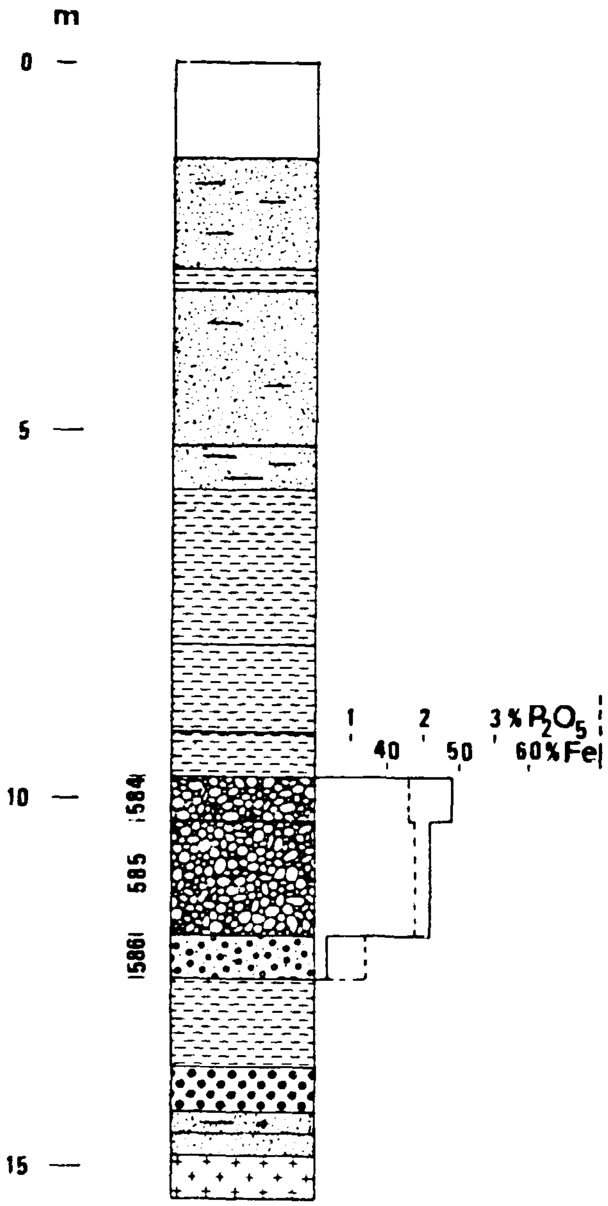
Sandstone, medium grained, clayey, red

Sandstone, slightly oŏlitic and pisolitic

Sandstone, medium grained, silty,
red-yellow

Kaolinitic clay, sandy, contaminated
by limonite, white, altered basement

K 13



not cored

Sandstone, fine grained, silty-clayey, red

Clay, white-grey

Siltstone
red-brown-yellow

Siltstone, clayey, light brown

Clay, silty, grey-red

partly limonitic

Clay, limonitic, silty, yellow-brown

Iron oölite, consolidated, ca. 95 % oöliths
limonite matrix, red-brown

increasing sand content up to 5 %

Iron oölite, ca. 20 % sand, clay-limonite matrix, grey-brown

Clay, silty, grey to light brown

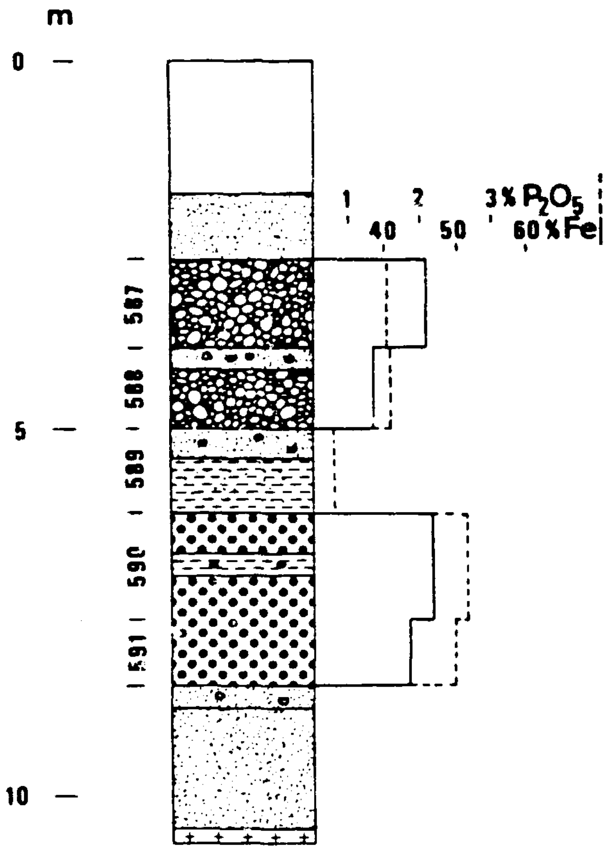
Iron oölite, pisolitic, slightly consolidated, strongly sandy, clay matrix

Sandstone, medium grained, oölitic

Sandstone, medium grained, light brown

Kaolinitic clay, slightly sandy, white, altered basement

K 14



not cored

Sand, fine to medium grained, silty, light brown

Iron oölite, consolidated, 70-80 % oöliths, ca. 5-10 % sand, clay-limonite matrix, red-brown

Sandstone, ca. 30 % oöliths, light brown

Iron oölite, consolidated, ca. 70 % oöliths, ca. 10 % sand, clay-limonite matrix, red-brown

Sandstone, oölitic, red-brown

Clay, sandy-silty, light-brown

Iron oölite, pisolitic, unconsolidated, clay-silt matrix, grey-brown

Clay, limonitic, oölitic

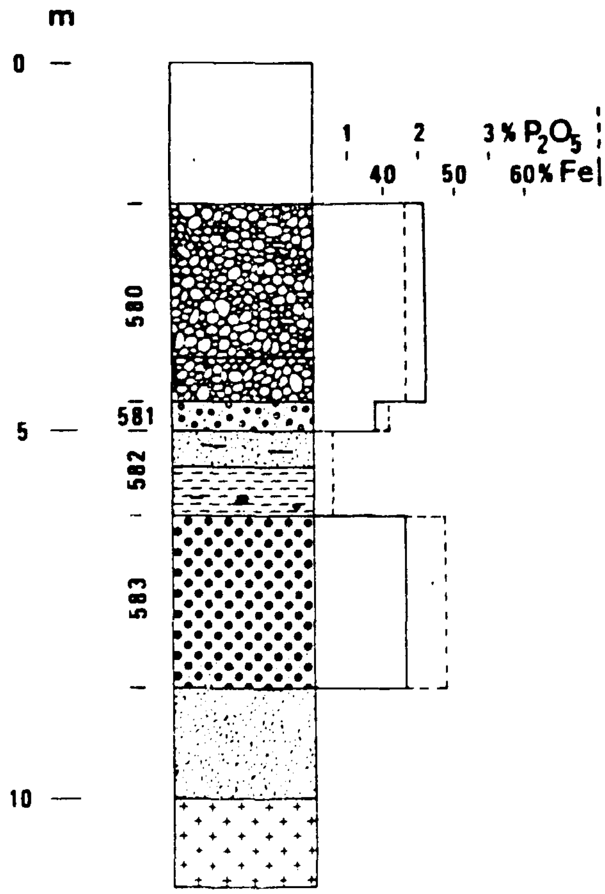
Iron oölite, pisolitic, unconsolidated, limonitic clay matrix, sandy, grey-brown

Sandstone, medium grained, oölitic, light brown

Sandstone, medium grained, light brown-red with white stripes

Kaolinitic clay, sandy, white, altered basement

K 15



not cored

Iron oölite, consolidated, ca. 80 % oöliths, sandy, clay-limonite matrix, dark red-brown

isolated pisoliths

Iron oölite, ca. 20-30 % sand, clay matrix

Sandstone, medium grained, clayey, light brown

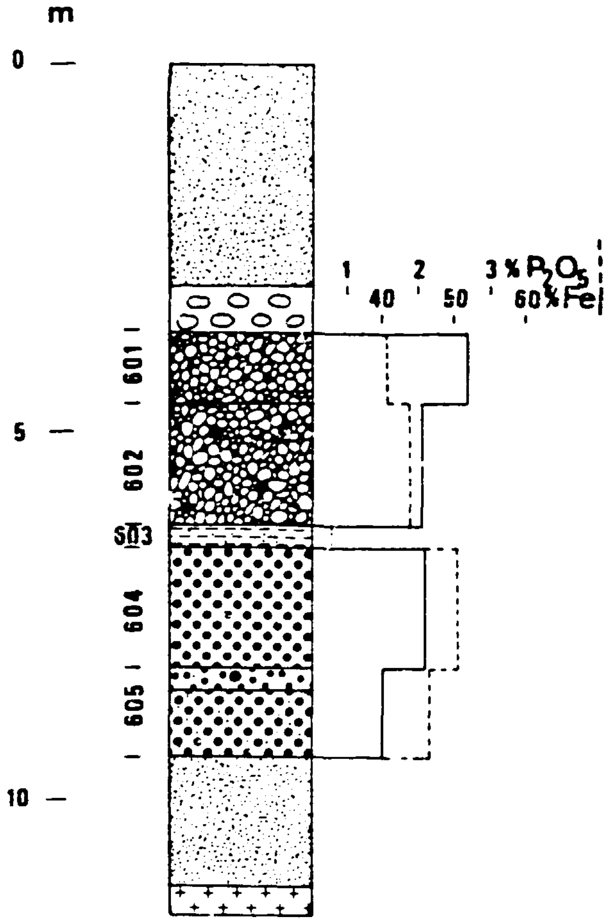
Clay, isolated oöliths, sandy, light brown

Iron oölite, pisolitic, unconsolidated sandy, clay matrix, grey-brown

Sandstone, fine to medium grained, light brown

Kaolinitic clay, sandy, white altered basement

K 16



Sand, fine to medium grained, silty-clayey, light red

Terrace gravel, sandy, silt-limonite matrix

Iron oölite, consolidated, ca. 95 % oöliths, limonite matrix, dark red-brown

Iron oölite, consolidated, pisolitic, sandy, clay-limonite matrix dark red-brown

Clay, sandy, light brown to yellow

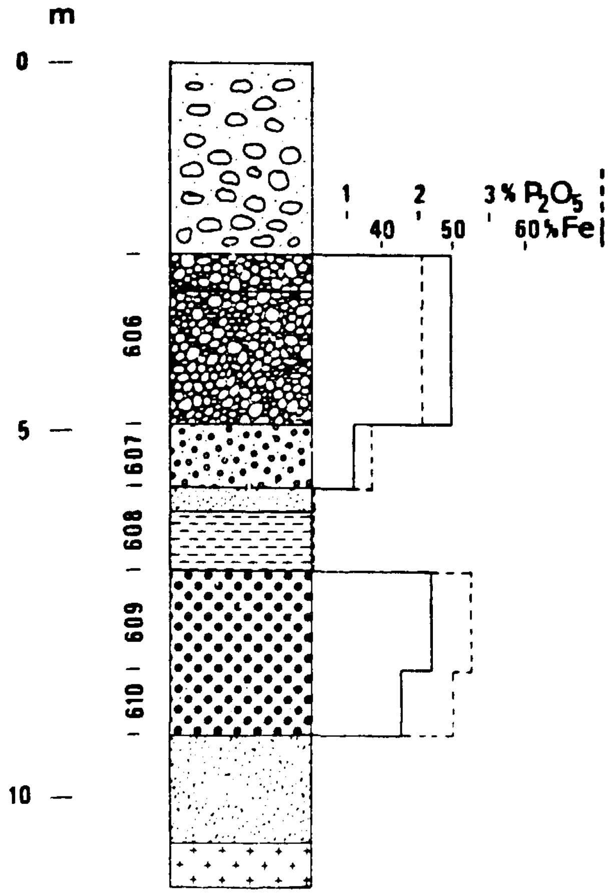
Iron oölite, pisolitic, unconsolidated, sandy, clay matrix, grey-brown

increasing sand content up to 15 %

Sandstone, fine to medium grained, silty, light brown

Kaolinitic clay, sandy, white, altered basement

K 17



Terrace gravel, sandy, quartz and iron sandstone pebbles, grey-brown

Iron oölite, moderately consolidated, ca. 95 % oöliths, clay-limonite matrix, dark brown

slightly increasing sand content to the foot wall

Iron oolite, moderately consolidated, ca. 65 % oöliths, ca. 10 % sand, clay matrix, brown

Sandstone, medium to coarse grained, light brown

Clay, light brown to white and red

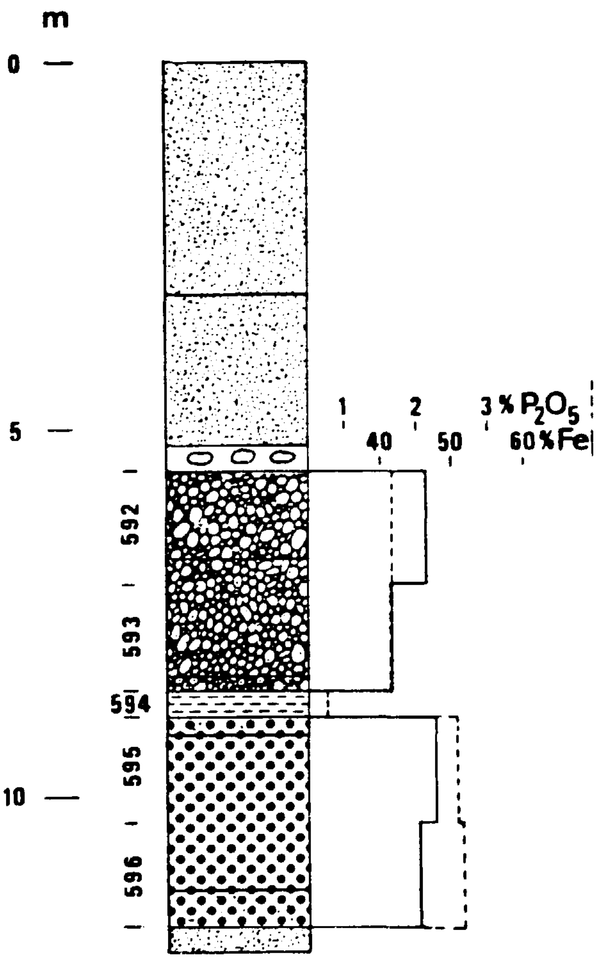
Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content up to 10 %

Sandstone, fine to medium grained, light grey-brown

Kaolinitic clay, sandy, white, altered basement

K 19



Sand, fine to medium grained,
light brown to grey

—

light brown to white

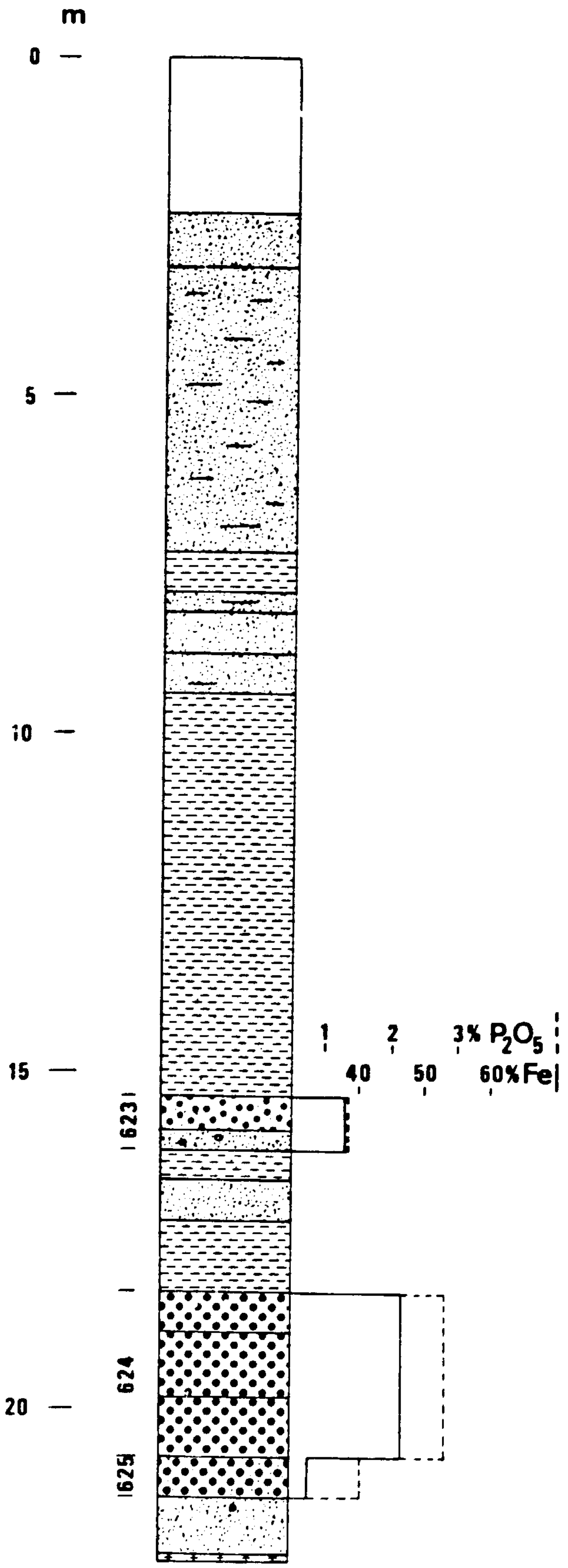
Terrace gravel, sandy, light brown to grey
Iron oölite, consolidated, ca. 85 % oöliths,
clay-limonite matrix, dark brown

—
increasing sand content to the foot wall
up to 10 %

— up to 20 %
Clay, light brown to grey
— Iron oölite, pisolitic, sandy, grey-brown
Iron oölite, pisolitic, unconsolidated,
clay matrix, grey-brown

—
increasing sand content up to 10 %
Sandstone, medium grained, white

K 20



not cored

Sandstone, medium grained,
red-yellow

Sandstone, fine grained, to Siltstone
clayey, red-brown to white-yellow

Clay, silty, red-yellow to light brown
Siltstone, clayey, light brown to red-white
Sandstone, fine grained, to Siltstone
Siltstone, light brown to white

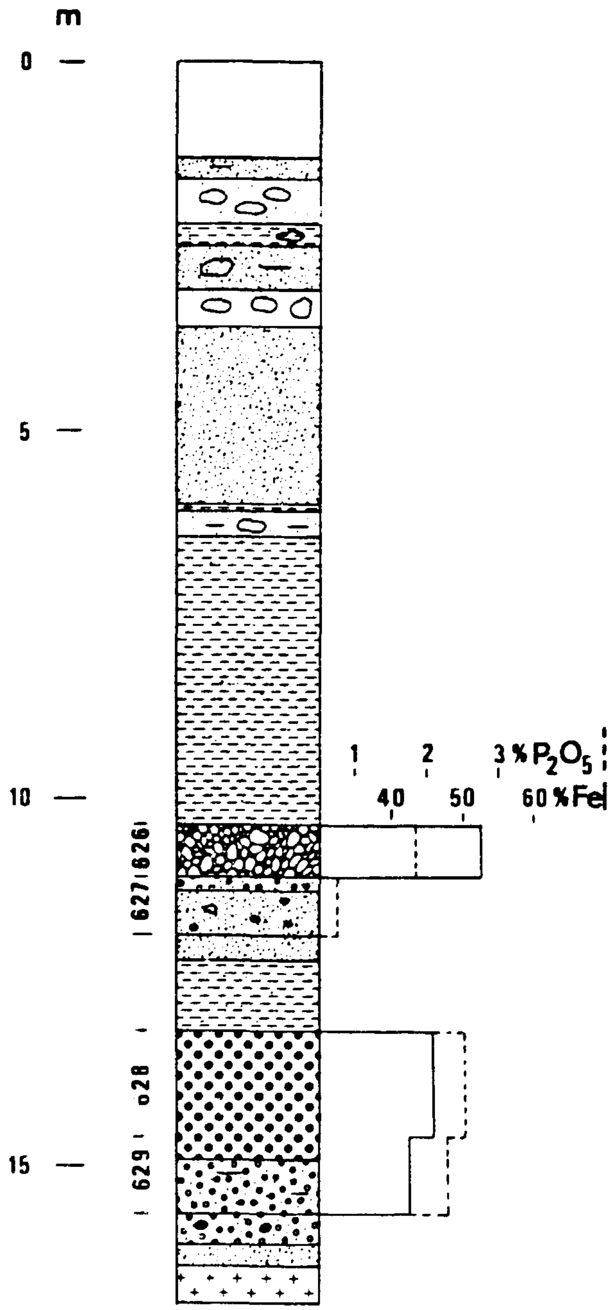
Clay, silty, light brown to white

Iron oölite, ca. 20-30 % sand, clay matrix
Sandstone, coarse grained, isolated oöliths
Clay, sandy-silty, white-grey
Sandstone, medium to coarse grained, light brown
Clay, light grey to reddish

Iron oölite, pisolitic, unconsolidated, slightly
sandy, clay matrix, grey-brown

increasing sand content up to 5 %
increasing sand content up to 30 %
Sandstone, medium grained, isolated ooliths,
silty, grey-brown-white
Kaolinitic clay, slightly sandy, white
altered basement

K 21



not cored

Sand, medium grained silty-clayey, red-brown

Terrace gravel, predominantly quartz pebbles

Clay, sandy-silty, isolated pebbles

Sand, clayey, quartz pebbles

Terrace gravel, predominantly quartz pebbles

Siltstone to Sandstone, fine grained
brown to red with white stripes

Clay, grey

Siltstone, sandy-clayey, isolated pebbles

Clay, silty, yellow-brown to white-grey

Iron oölite, consolidated, ca. 90 % oöliths,
clay-limonite matrix, dark brown

Iron oölite, 20-30 % sand

Sandstone, medium to coarse grained, ca.5-10 %
oöliths, clay-limonite matrix, brown

Sandstone, medium grained, red

Clay, silty-sandy, grey-brown

Iron oölite, pisolitic, unconsolidated,
sandy, clay matrix, grey-brown

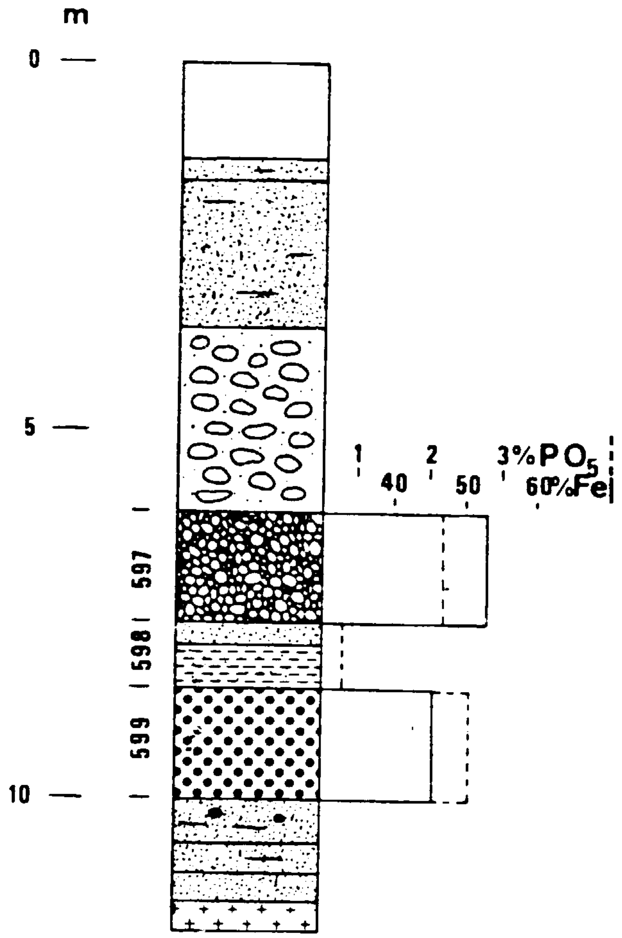
Iron oölite, ca. 5-10 % sand, clay matrix,
light grey-brown

Iron oölite, slightly pisolitic, ca. 30-40% sand

Sandstone, medium grained, grey

Kaolinitic clay, white,
altered basement

K 22



not cored

Sand, medium grained, light brown

Sand, fine to medium grained, silty-clayey, light brown to white

Terrace gravel, quartz and iron sandstone pebbles, sandy

Iron oölite, consolidated, ca. 95 % oölitns, clay-limonite matrix, dark red-brown

Sandstone, medium to coarse grained

Clay, sandy-silty, light brown

Iron oölite, pisolitic, moderately consolidated, sandy, clay matrix grey-brown

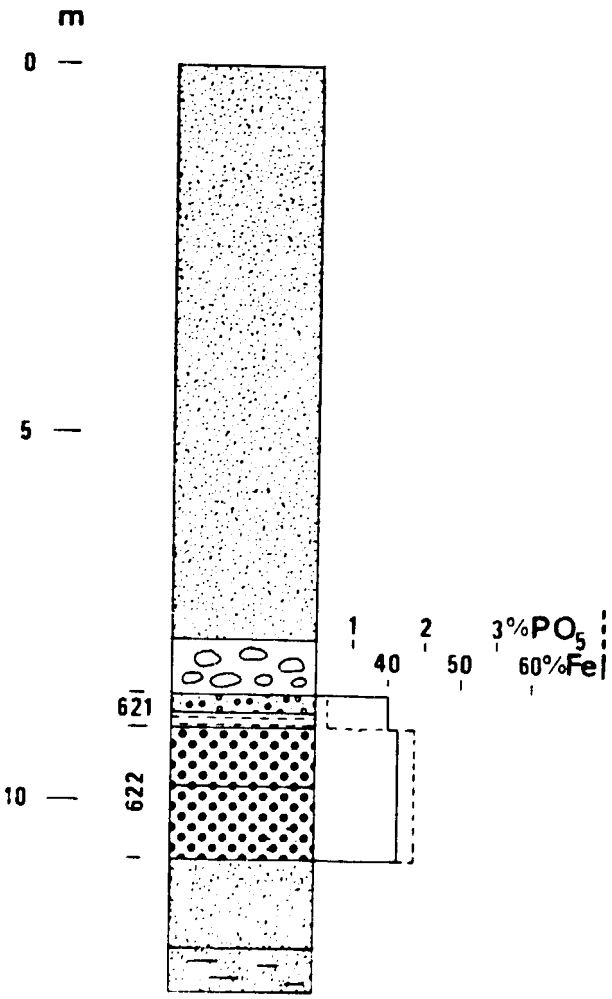
Sandstone, coarse grained, clayey, slightly oölitic and pisolitic, grey-brown

Sandstone, medium grained, clayey

Sandstone, medium to coarse grained, light brown

Kaolinitic clay, sandy, white, altered basement

K 23



Sand, medium grained, slightly clayey, red-yellow-brown

Terrace gravel, sandy

Iron oölite, sandy, isolated pebbles

Clay, sandy, red

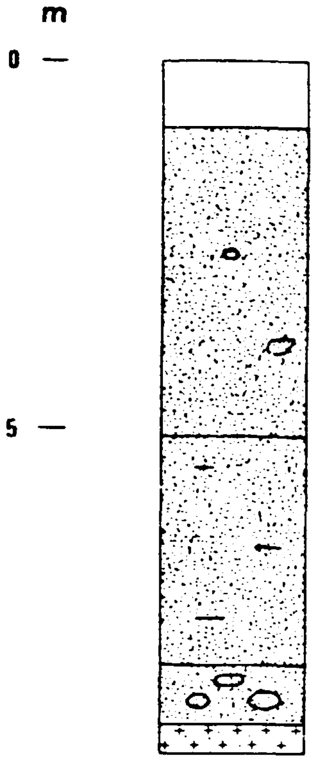
Iron oölite, pisolitic, unconsolidated, sandy, clay matrix, grey-brown

3 - 5 % sand

Sandstone, fine to medium grained, light brown to grey

Sandstone, fine to medium grained, kaolinitic clay matrix

K 24



not cored

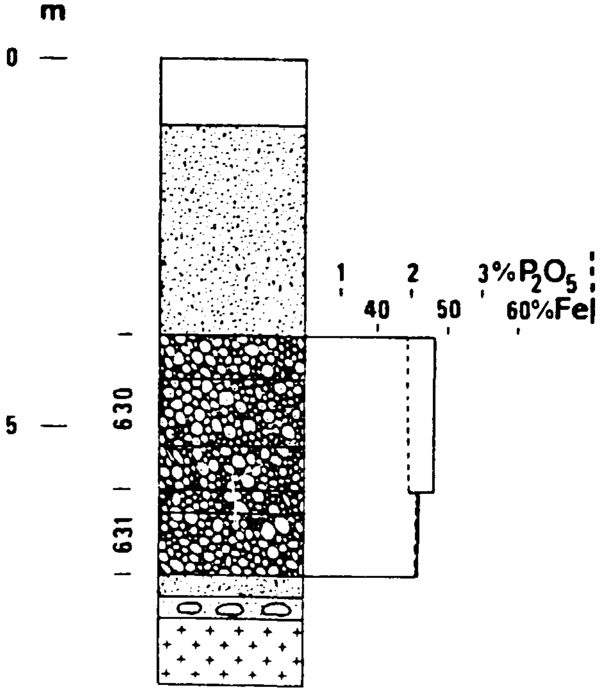
Sand, medium grained, isolated quartz and sandstone pebbles, red-yellow to red-grey

Sand, medium grained, silty-clayey, red-yellow to red-white

Sandstone, medium to coarse grained, quartz and iron sandstone pebbles

Kaolinitic clay, strongly sandy, contaminated by limonite on joints, altered basement

K 25



not cored

Sand, medium grained, red

Iron oölite, consolidated, ca. 3-5 % sand, clay-limonite matrix, dark red-brown

ca. 10-20 % sand

ca. 3- 5 % sand

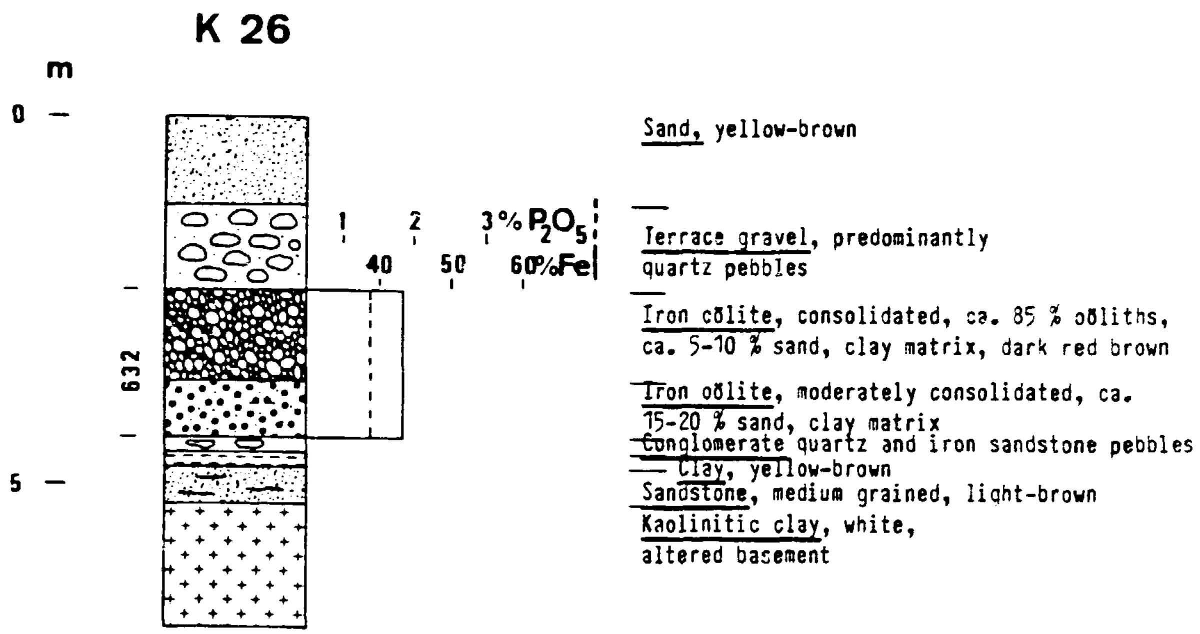
ca. 10 % sand

ca. 20 % sand

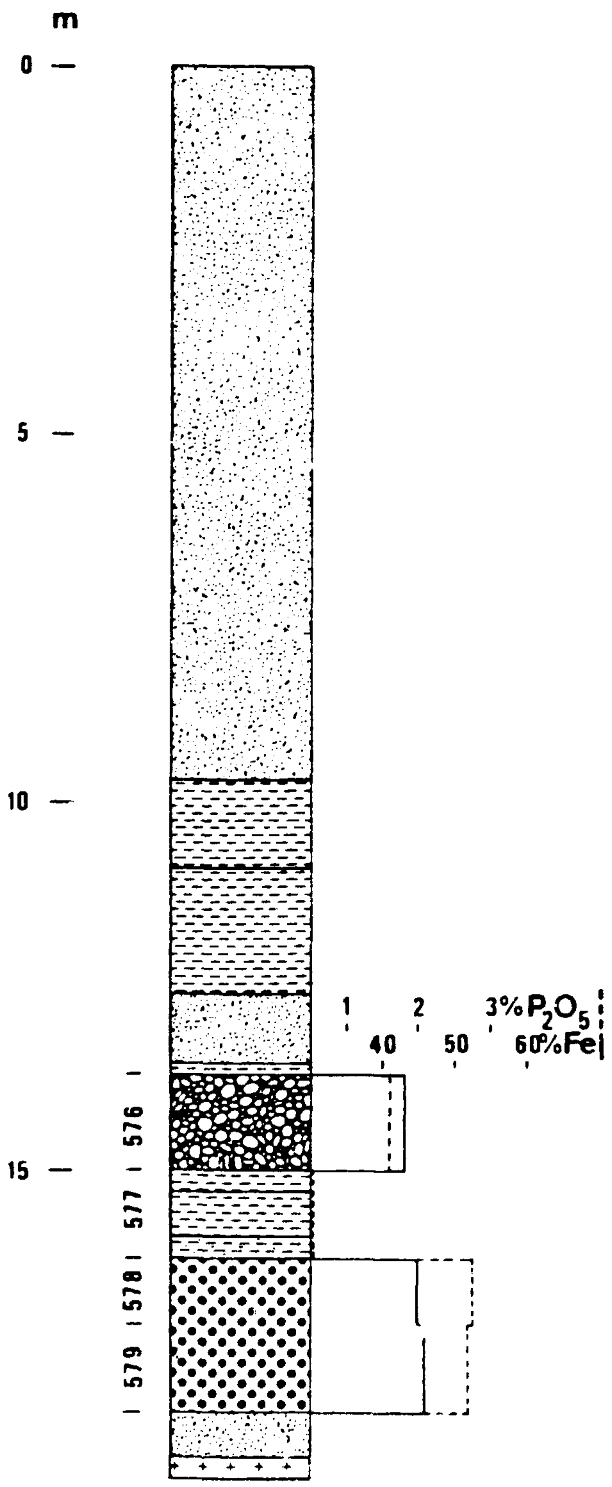
Sandstone, medium grained, brown

Conglomerate, iron pebbles, sandy

Kaolinitic clay, slightly sandy, altered basement


K 26
m
0
5
632
1
2
3 % P2O5
40
50
60 % Fe
Sand, yellow-brown
Terrace gravel, predominantly quartz pebbles
Iron oölite, consolidated, ca. 85 % oöliths, ca. 5-10 % sand, clay matrix, dark red brown
Iron oölite, moderately consolidated, ca. 15-20 % sand, clay matrix
Conglomerate quartz and iron sandstone pebbles
Clay, yellow-brown
Sandstone, medium grained, light-brown
Kaolinitic clay, white, altered basement

K 27



Eolian sand, fine to medium
grained, reddish-yellow

Clay, slightly silty,
grey-yellow

slightly increasing sand content

Sandstone, fine grained, limonite
matrix, brown

Clay, silty, grey to light brown

Iron oölite, consolidated, ca. 5-10 %
coarse sand, limonite-clay matrix,
red-brown

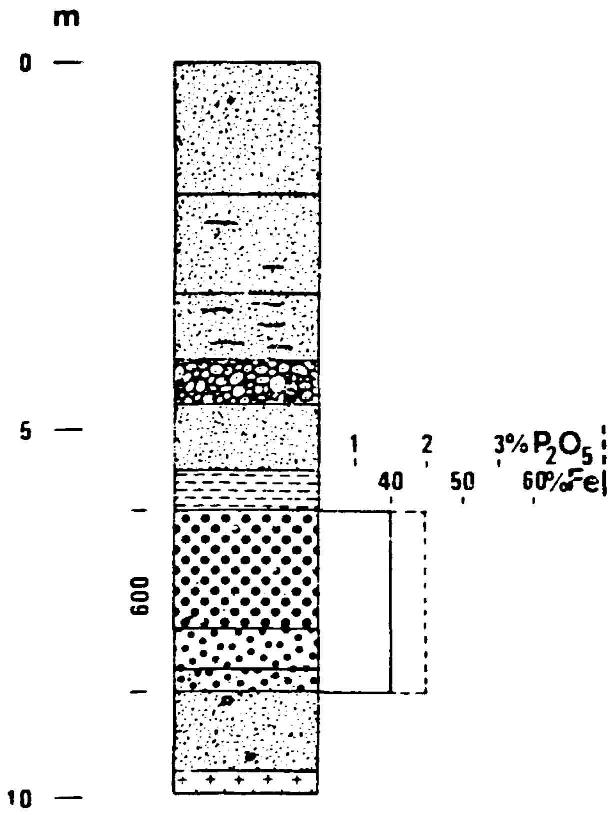
Clay ,sandy, isolated oöliths, brown
brown-yellow
strongly sandy,

Iron oolite, pisolitic, unconsolidated,
sandy, clay matrix, grey-brown

Sandstone, fine to medium grained,
light brown to white

Kaolinitic clay, white,
altered basement

K 28



Sand, medium grained, light brown to red

Sand, medium grained, silty-clayey, grey

strongly clayey

Iron oölite, consolidated, sandy, ca. 80 % oöliths, dark brown

Sandstone, medium to coarse grained, brown

Clay, sandy, light brown

Iron oölite, pisolitic, moderately consolidated, sandy, clay matrix, grey-brown

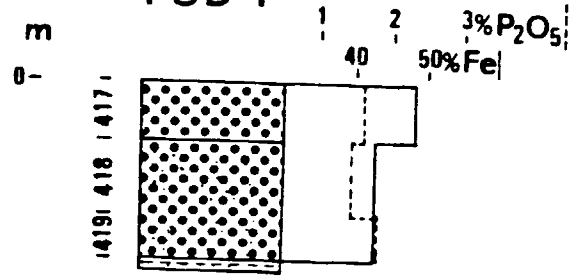
Iron oölite, sandy, clay matrix, grey

sandy up to 15 %

Sandstone, medium to coarse grained, oölitic and pisolitic, light brown

Kaolinitic clay, white, altered basement

PSD 1

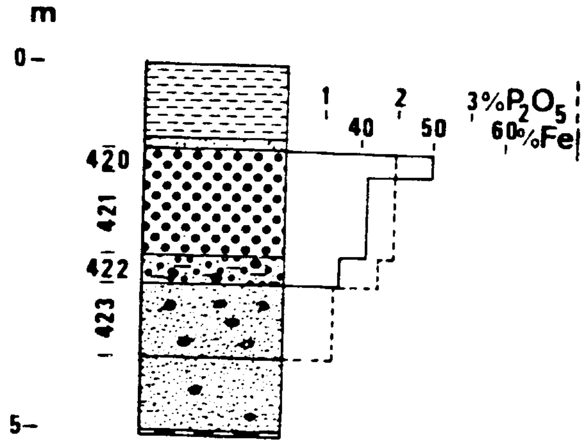


Iron oölite, pisolitic, unconsolidated, clay matrix, grey-brown

increasing sand content to the foot wall

Clay, sandy, light brown

PSD 2



Clay, sandy, white to light brown

Iron sandstone, consolidated, red

Iron oölite, pisolitic, unconsolidated, ca. 65 % oöliths, clay matrix, grey-brown

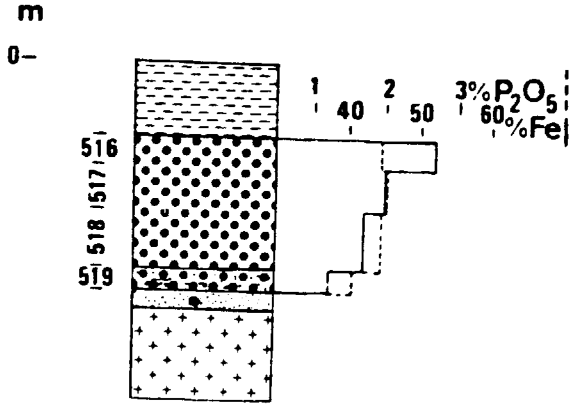
Iron oölite, sandy, slightly pisolitic, grey-brown

Sandstone, ca. 35 % oöliths and pisoliths, clayey, brown

Sandstone, isolated oöliths and pisoliths, light brown

Clay, light brown

PSD 3



Clay, light brown

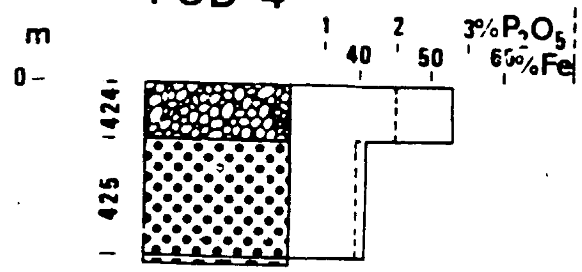
Iron oölite, pisolitic, moderately consolidated, clay-matrix, grey-brown increasing sand content to the foot wall

increasing sand content up to 30 %

Sandstone, medium to coarse grained isolated oöliths

Kaolinitic clay, sandy, white, altered basement

PSD 4

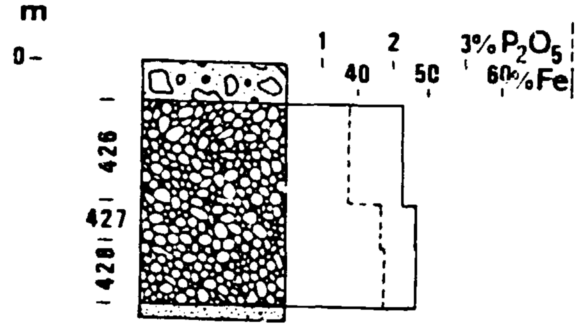


Iron oölite, consolidated, ca. 95 % oöliths, clay-limonite matrix, red-brown

Iron oölite, pisolitic, slightly consolidated, ca. 75 % oöliths and pisoliths, clay matrix, grey-brown

Clay, slightly clayey, light brown

PSD 5



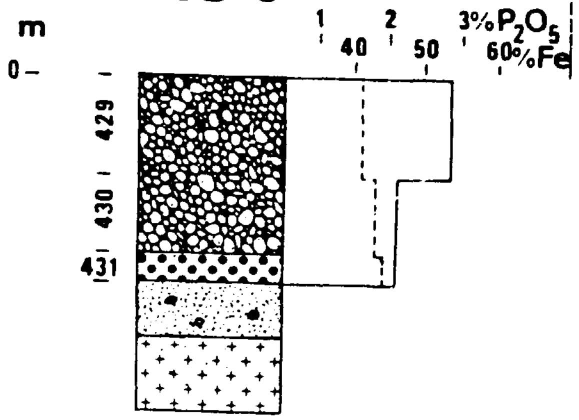
Laterite, quartz pebbles and fragments of iron sandstone, consolidated

Iron oölite, consolidated, slightly sandy, ca. 85 % oöliths, clay-limonite matrix, dark red-brown

ca. 90 - 95 % oöliths

Sandstone, clayey, red-brown

PSD 6



Iron oölite, consolidated, ca. 95 % oöliths, clay-limonite matrix, grey-brown

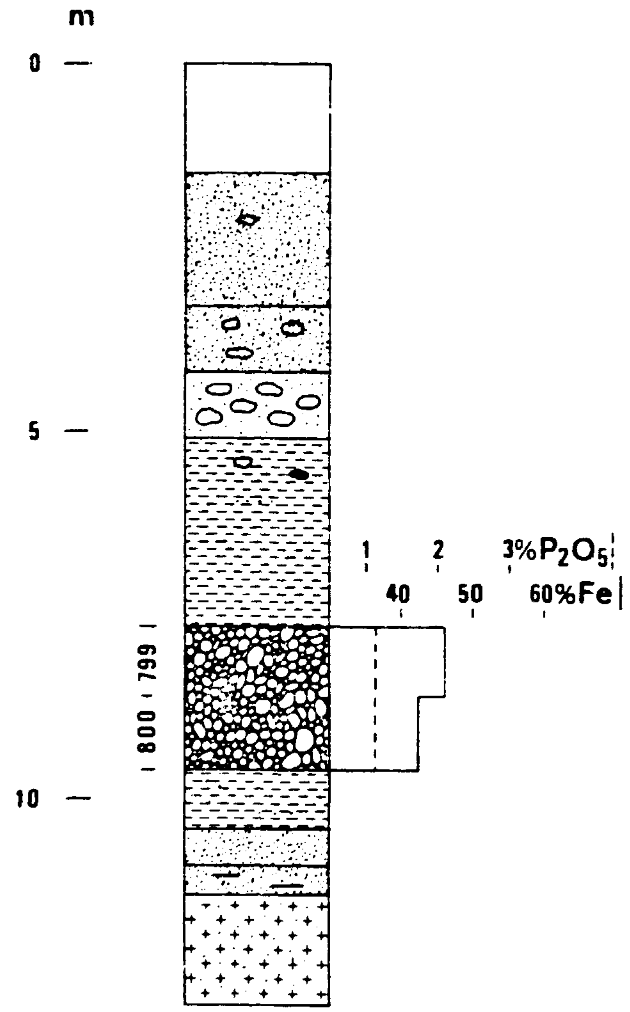
increasing sand content to the foot wall

Iron oölite, pisolitic, clay matrix, grey-brown

Sandstone, medium grained, oölitic and pisolitic, light grey-brown

Kaolinitic clay, slightly sandy, white, altered basement

D 1



not cored

Sandstone, fine to coarse grained, isolated quartz pebbles, iron stained, light red

Sandstone, medium to coarse grained, conglomeratic, light red

Quartz conglomerate, fine to medium sandy, light red

Clay, silty, light brown to reddish, isolated quartz pebbles in the upper part

Iron oölite, consolidated, 85-90 % oöliths, limonite matrix, dark red-brown

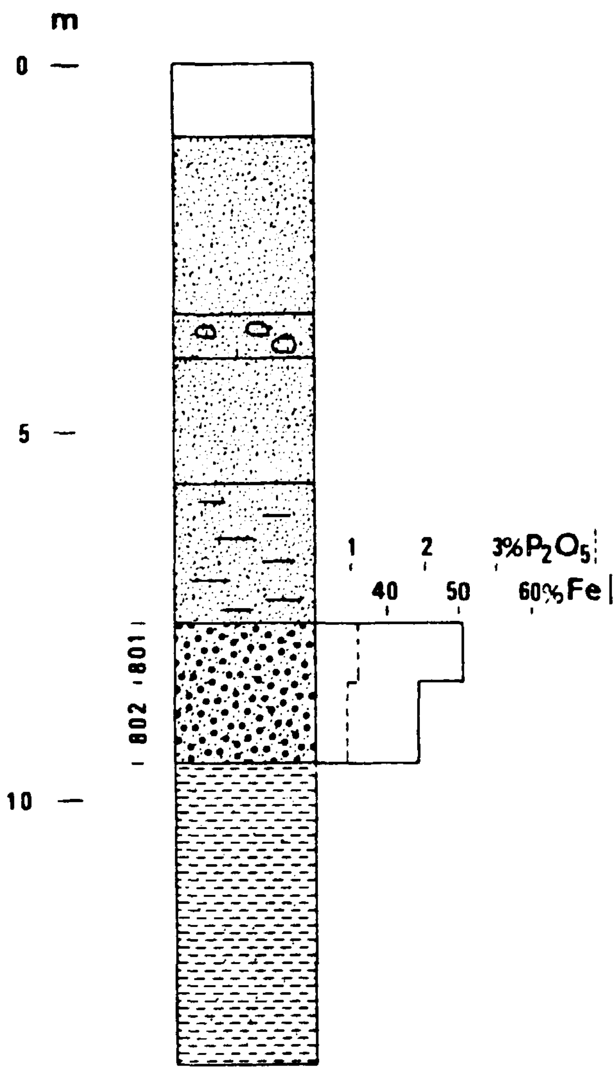
Clay, slightly silty, light brown with white stripes

Sandstone, medium to coarse grained, slightly kaolinitic, light red to white

Sandstone, fine grained, kaolinitic,

Kaolinitic clay, slightly sandy, white, altered basement

D 2



not cored

Sand, medium to coarse grained, light red to light brown

Sandstone, medium to coarse grained, conglomeratic, limonite matrix, brown-red

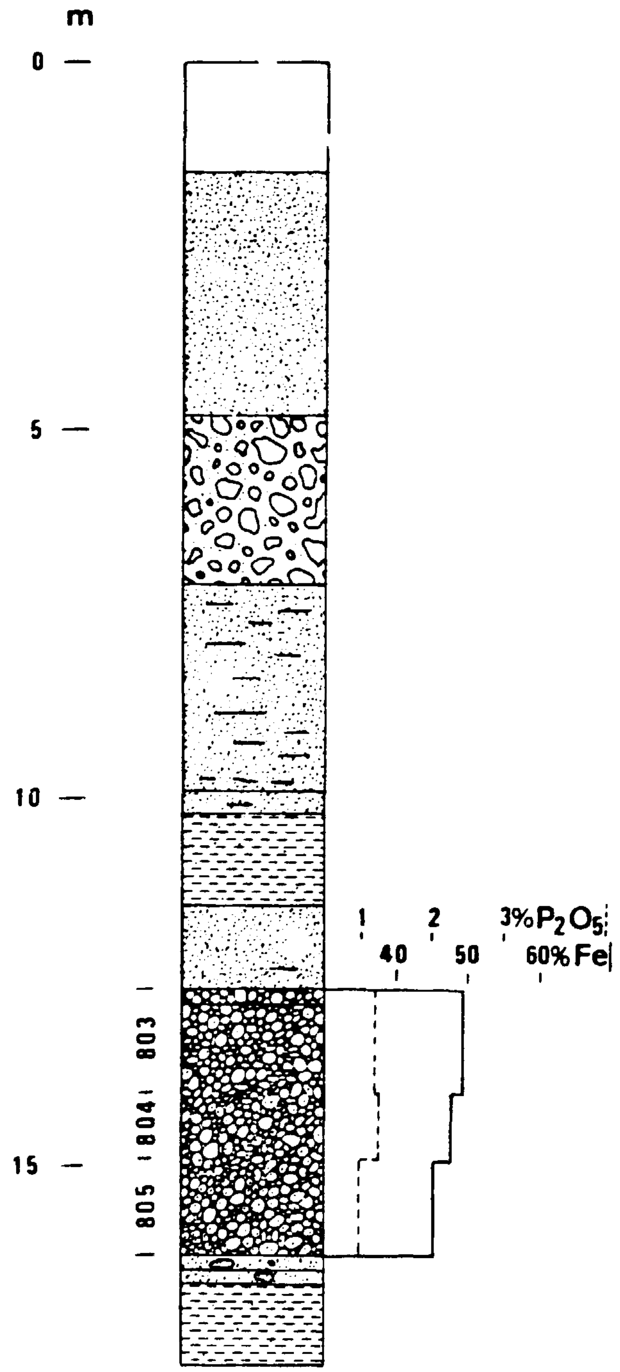
Sandstone, medium to coarse grained, light brown

Siltstone, clayey, brown to red-grey

Iron oölite, strongly sandy to oölitic sandstone, consolidated, limonite matrix, red-brown

Clay, slightly sandy, white to light brown

D 3



not cored

Sand, fine to medium grained,
red-brown

Laterite, sandy, quartz pebbles,
limonite matrix, red-brown

Siltstone, sandy-clayey,
red-white to light brown

Sandstone, fine grained, light brown

Clay, silty, light brown

Sandstone, medium to coarse grained,
clayey, light brown to red-white

Limonite hardground, isolated ooliths

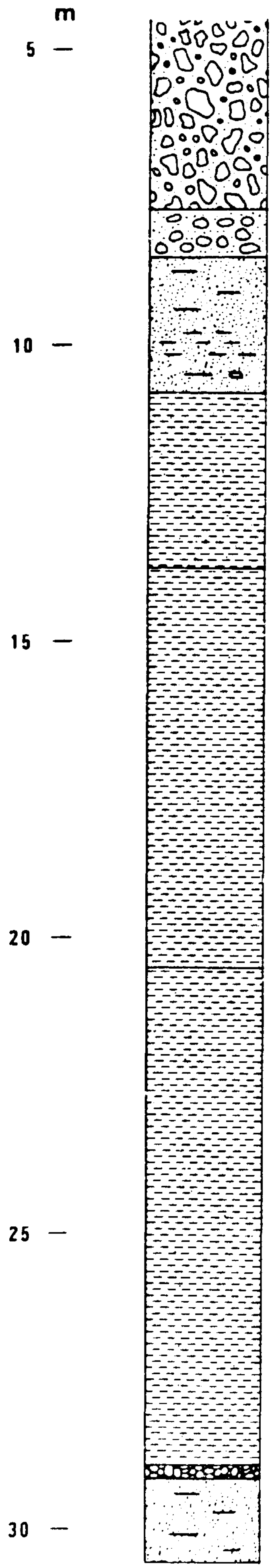
Iron oölite, strongly consolidated,
sandy, limonite matrix, dark
red-brown

Iron sandstone, conglomeratic

Sandstone, coarse grained, clayey

Kaolinitic clay, slightly sandy,
light brown to white,
altered basement

D 4



Laterite, iron sandstone, medium to coarse grained, brecciated, isolated quartz pebbles, red to red-brown

Conglomerate, sandy-clayey light grey-brown

Sandstone, coarse grained, clay matrix, isolated quartz pebbles, light brown

Clay, sandy, medium to coarse grained, light brown to red-white

Clay, silty, light brown to white

Clay, sandy, fine grained,

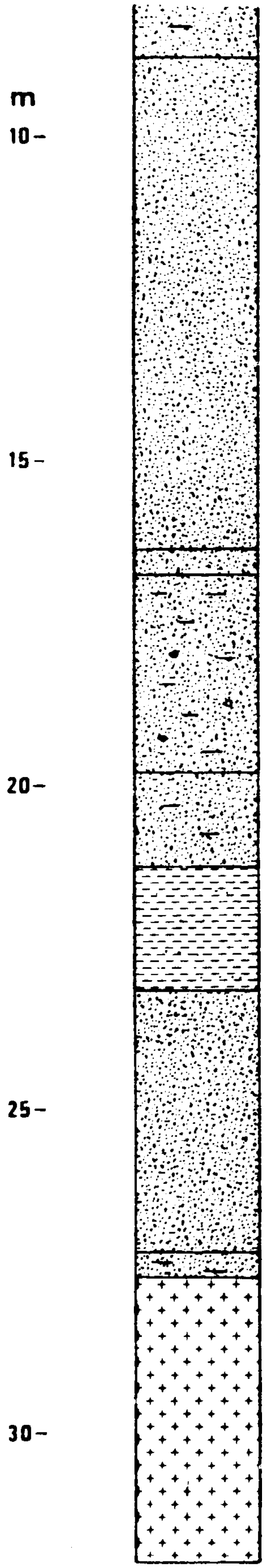
to

Siltstone, strongly clayey light brown to white red

Iron oölite, consolidated, sandy limonite matrix, dark red-brown

Siltstone, sandy-clayey, light brown to white

D 5



Sandstone, fine to medium grained, slightly clayey, white to light brown

Sandstone, fine to medium grained, red

Sandstone, fine grained, silty, reddish

Sandstone, medium to coarse grained, clayey, isolated oöliths, red

Sandstone, fine to medium grained, clayey, yellow to light brown

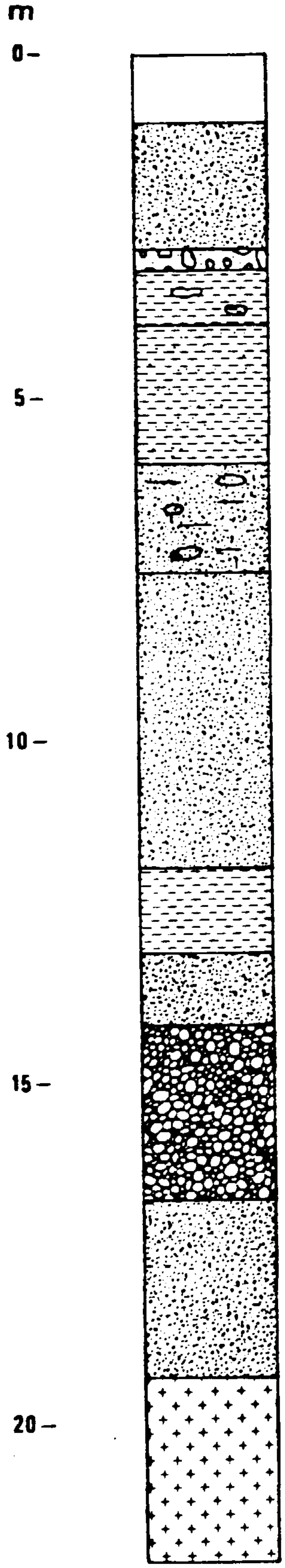
Clay, sandy, light brown with white stripes

Sandstone, fine grained, light brown to red

Sandstone, coarse grained, clayey

Schists, green to grey

D 6



not cored

Sandstone, medium to coarse grained, isolated ooliths, red

Laterite, quartz pebbles, sandy, red

Clay, isolated quartz pebbles, red yellow

Clay, strongly sand, red to light brown

Sandstone, clayey, quartz pebbles limonite matrix, dark red and yellow-brown

Sandstone, coarse grained, slightly clayey, red-yellow

Clay, slightly sandy, light brown

Sandstone, medium to coarse grained, light brown

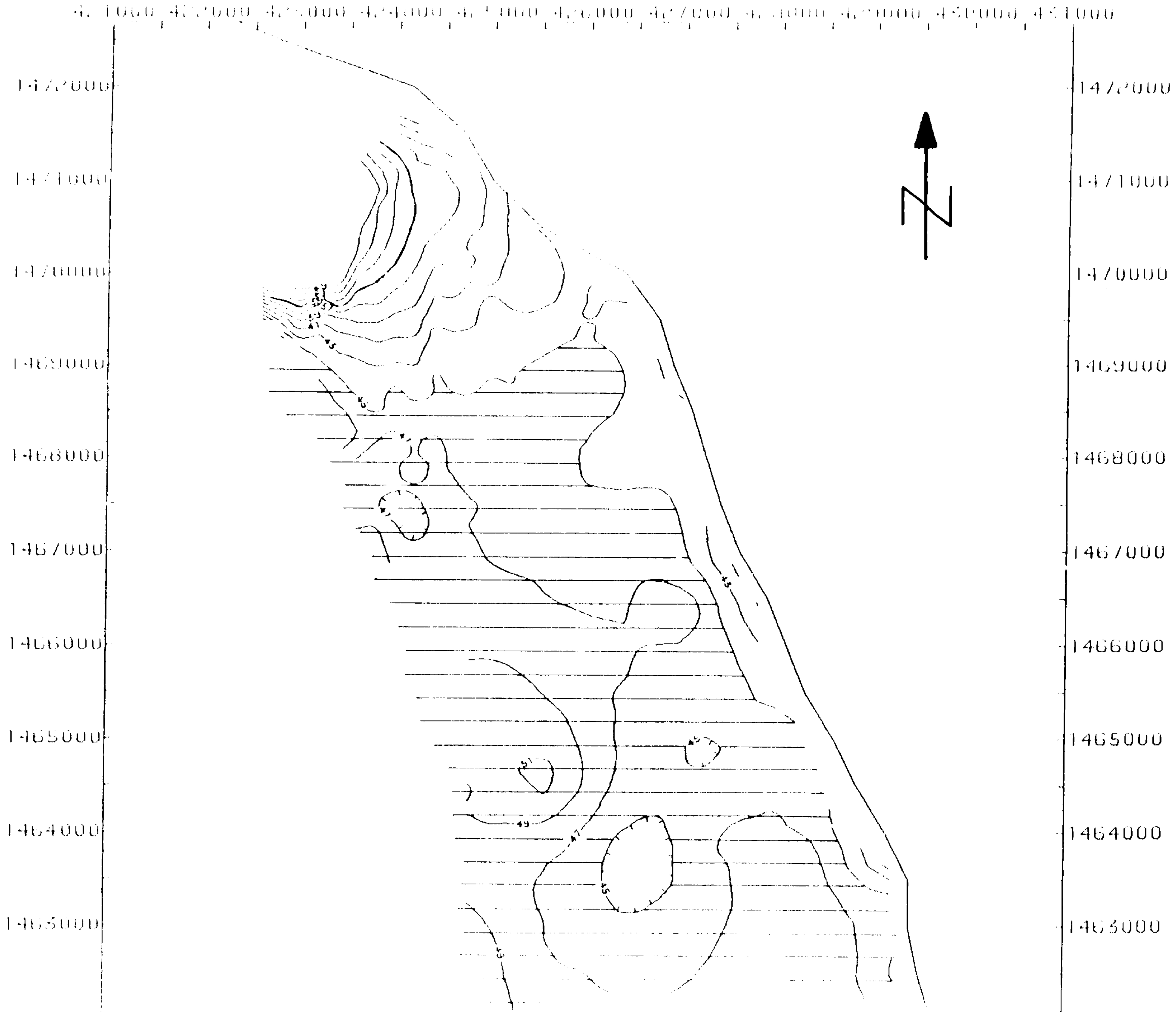
Iron oolite, consolidated, ca. 85 % ooliths, slightly sandy, limonite matrix, dark red brown

Sandstone, coarse grained, red to white

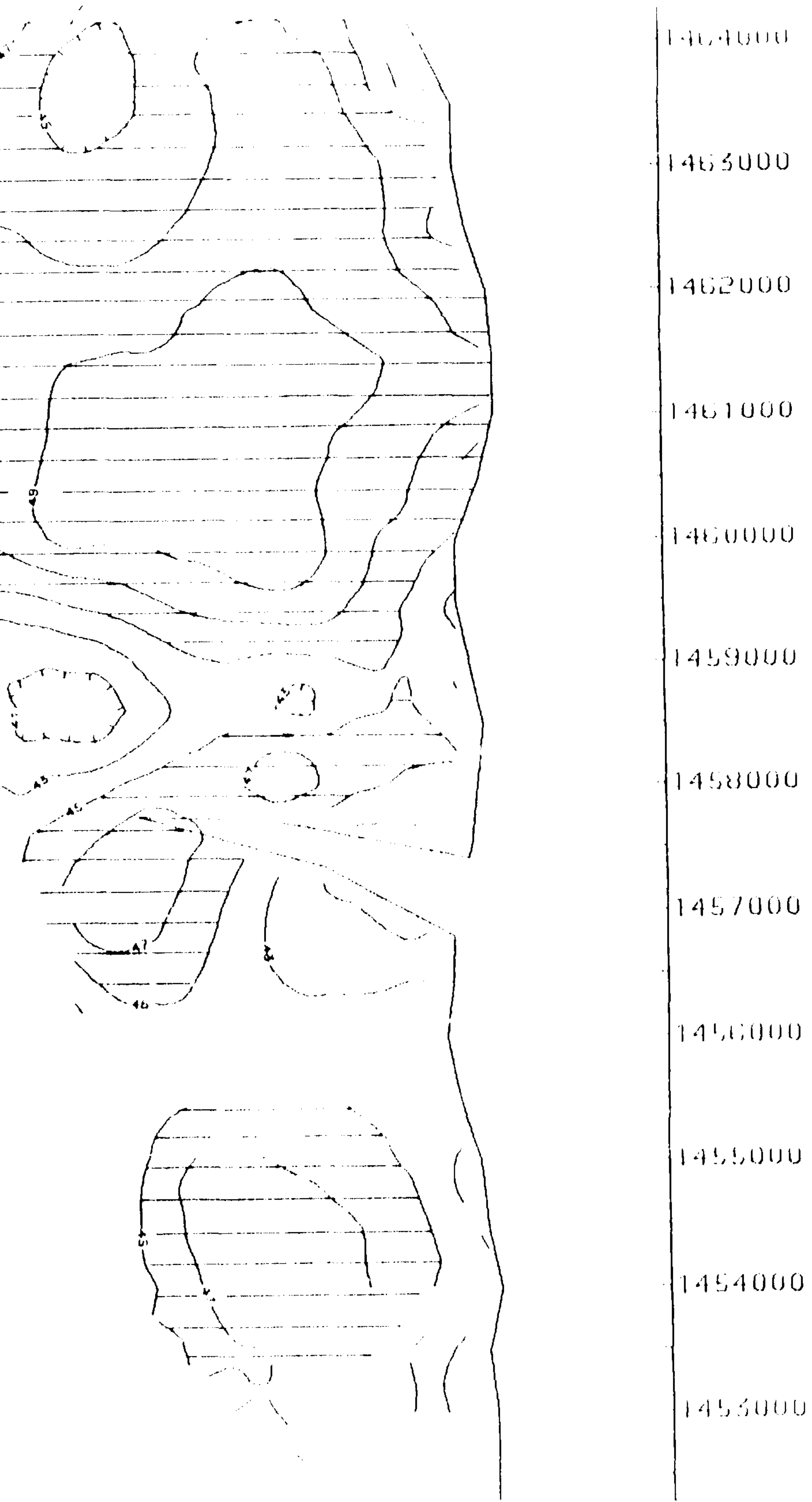
Granite

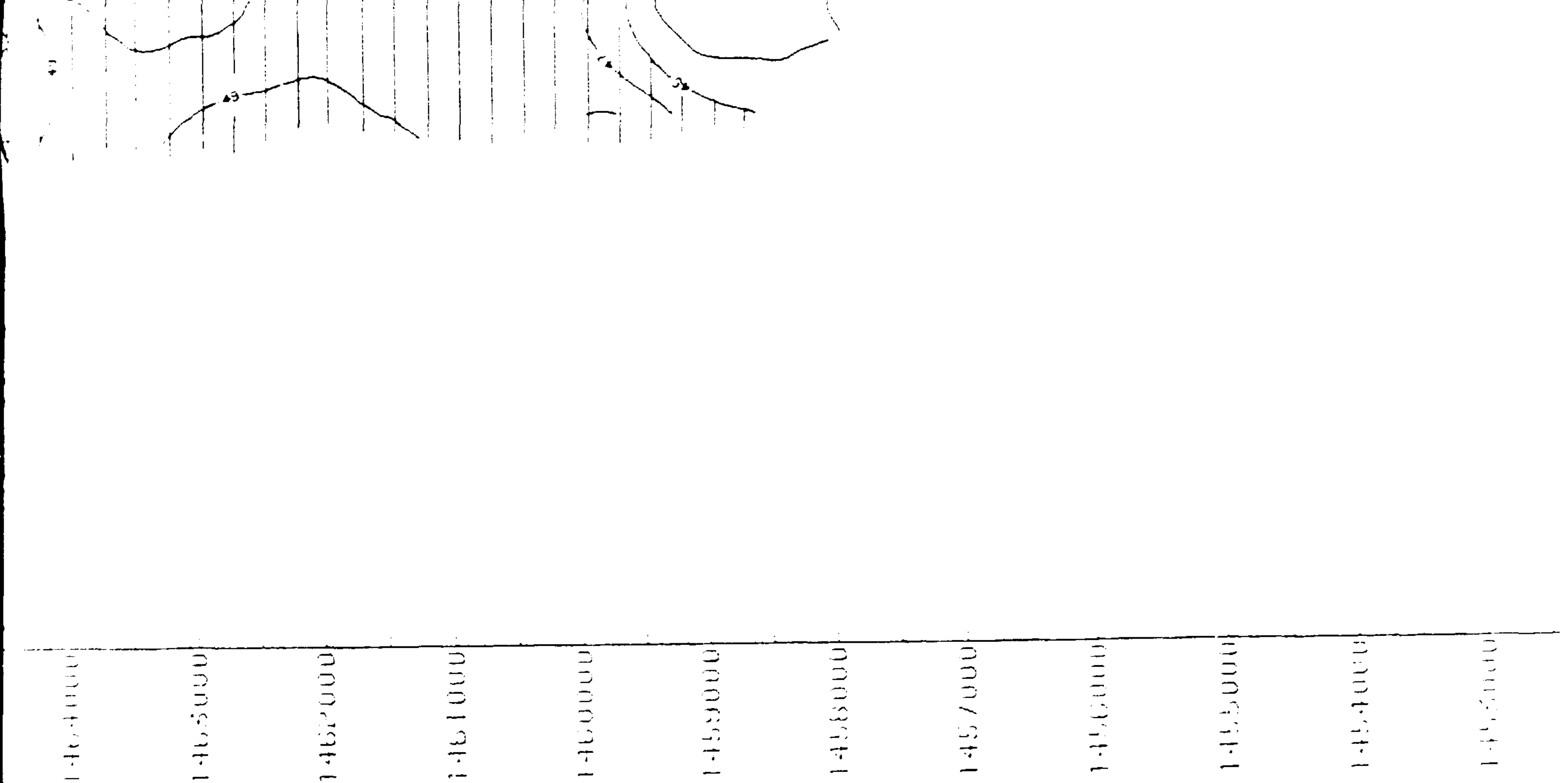
SOME FIGURES
OF THIS DOCUMENT
ARE TOO LARGE
FOR MICROFICHING
AND WILL NOT
BE PHOTOGRAPHED.

SECTION 1



421000
422000
423000
424000
425000
426000
427000
428000
429000
430000
431000
1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
N
43
45
47
49
51


1464000
1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
45
49
45
45
47
46
48
45
47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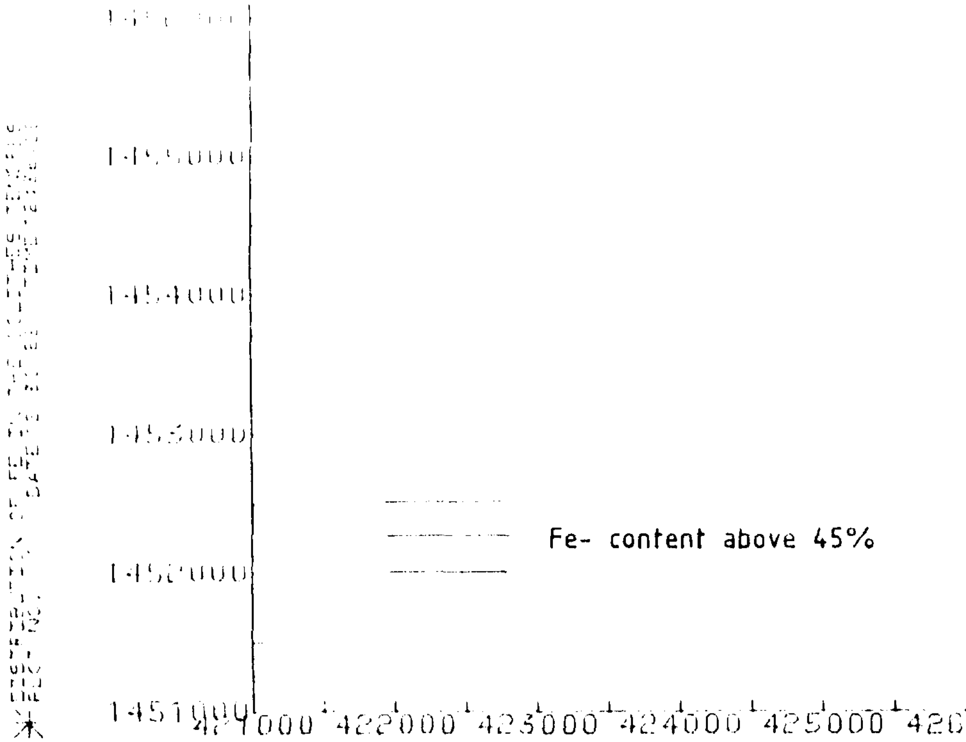
1454000
1453000
43
47
52

SECTION 2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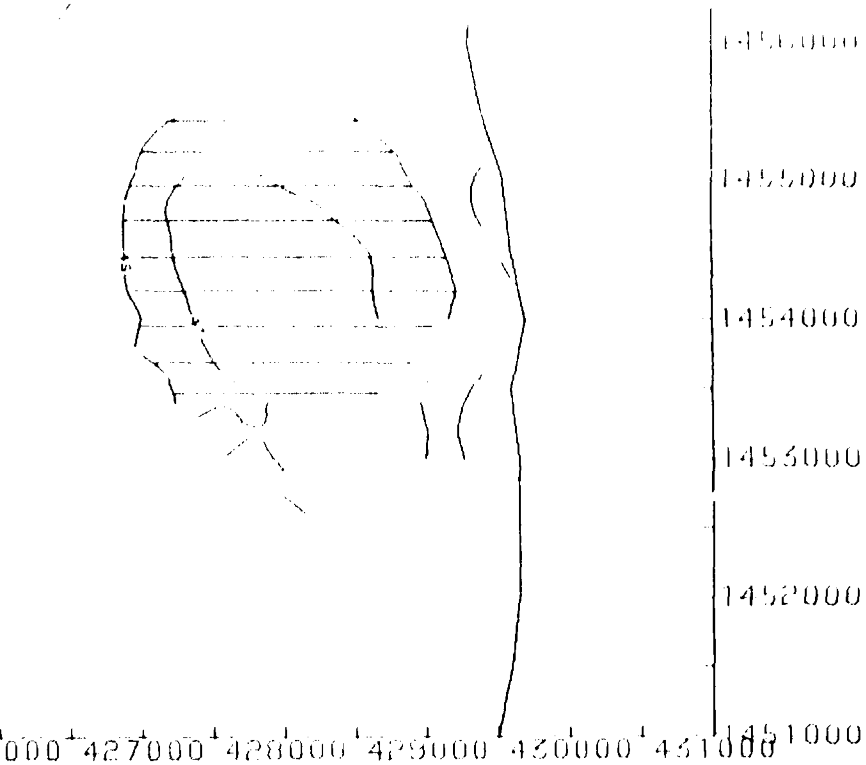
1451000
421000
422000
423000
424000
425000
Fe- content above 45%

SECTION 3



KHD HUMBOLDT WEDAG AG

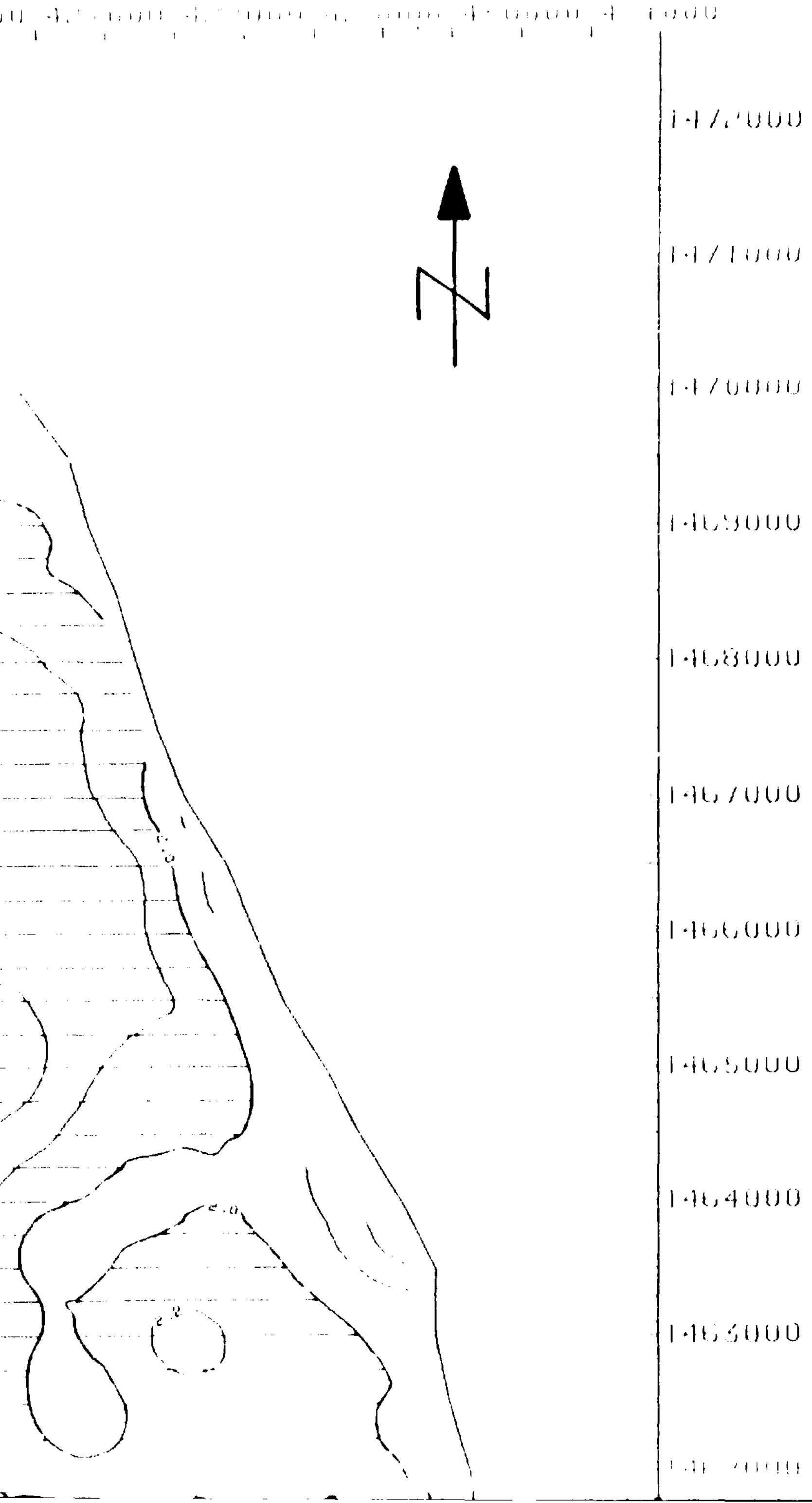
ANNEX NO.
B - 22

PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

Isolines of the Fe-distribution
in the Oolithes Tendres

GEOLOGIST: Sch.- E.	DATE: Feb 1984	SCALE: 1:50,000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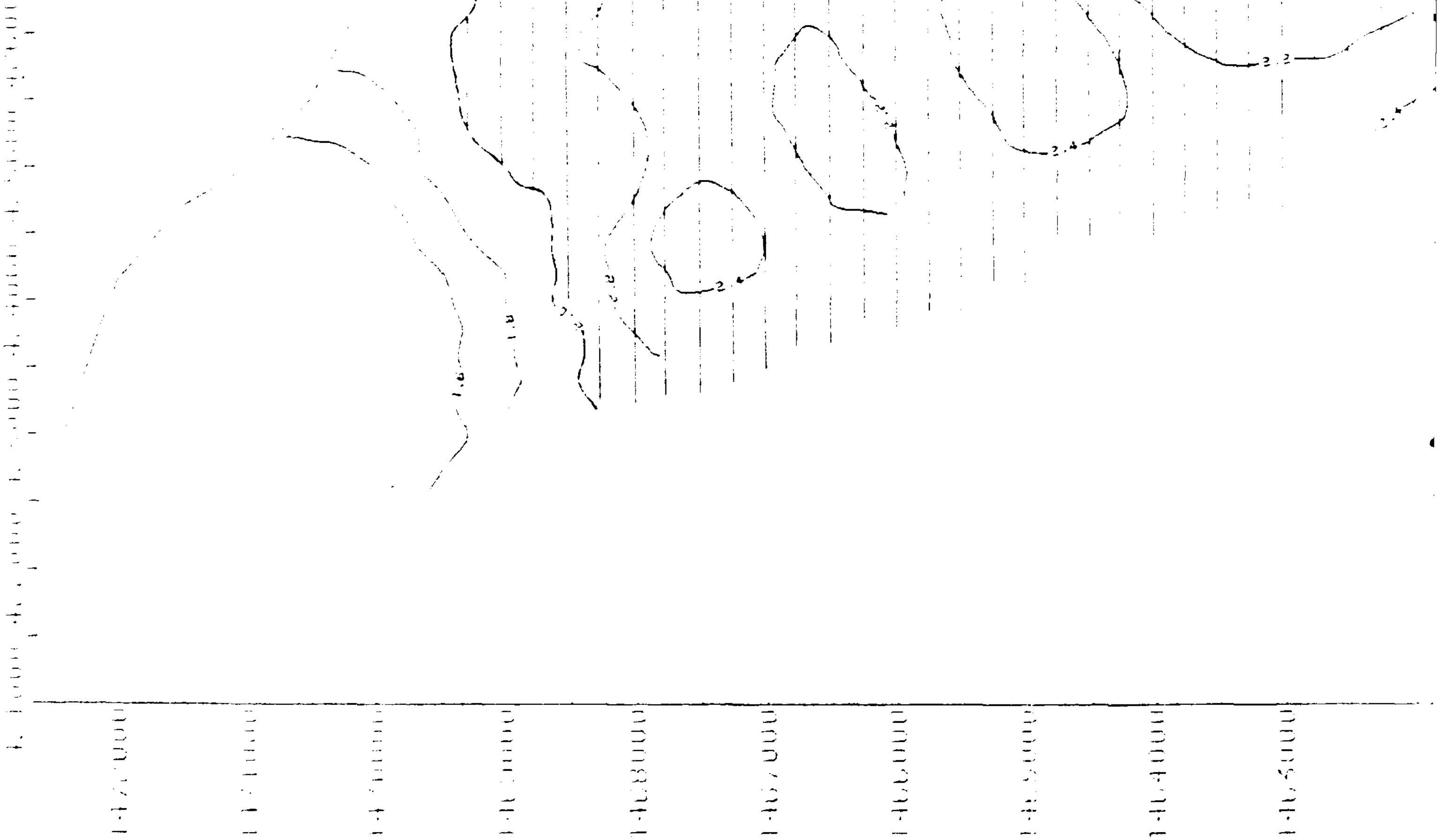
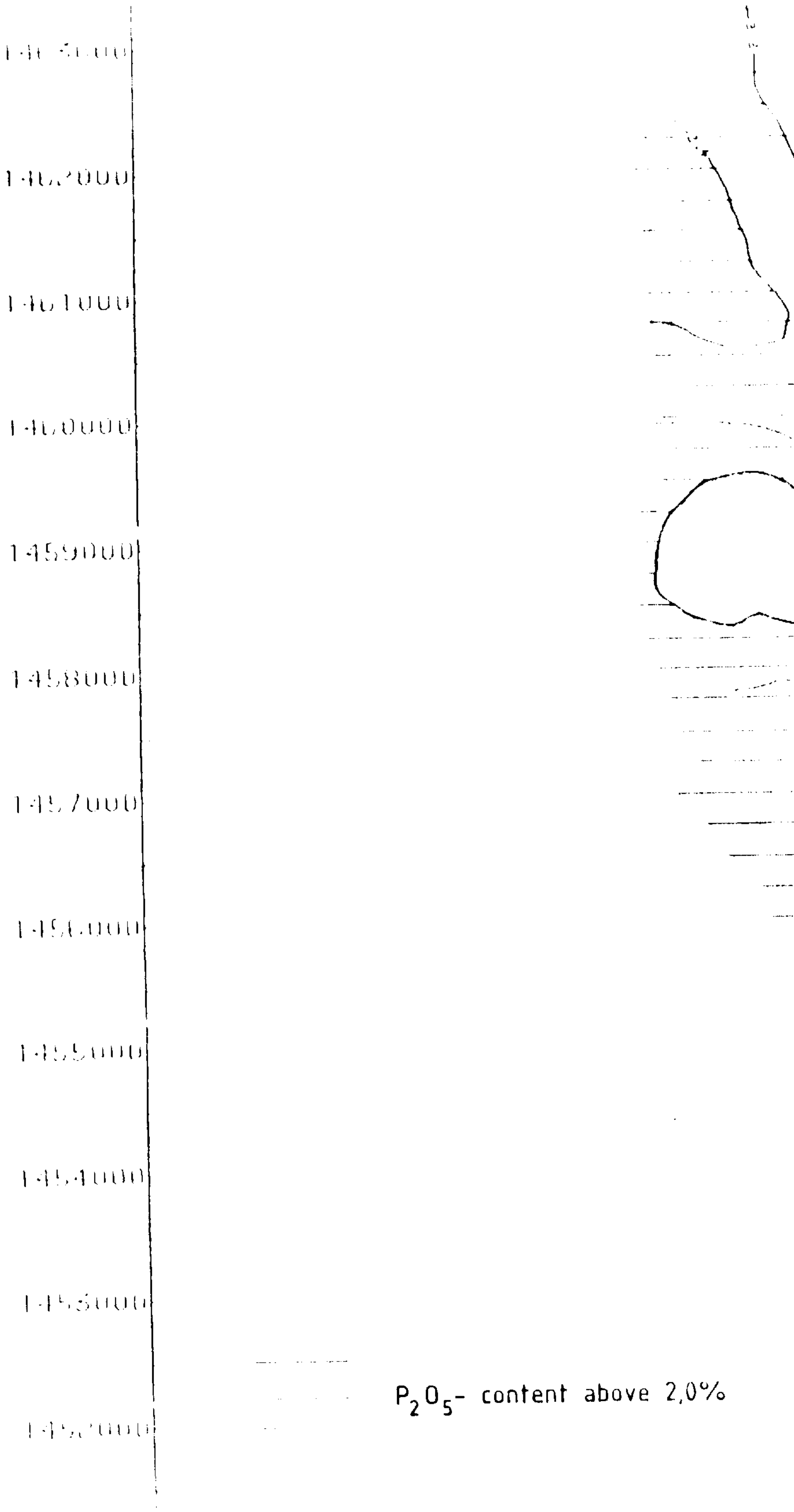
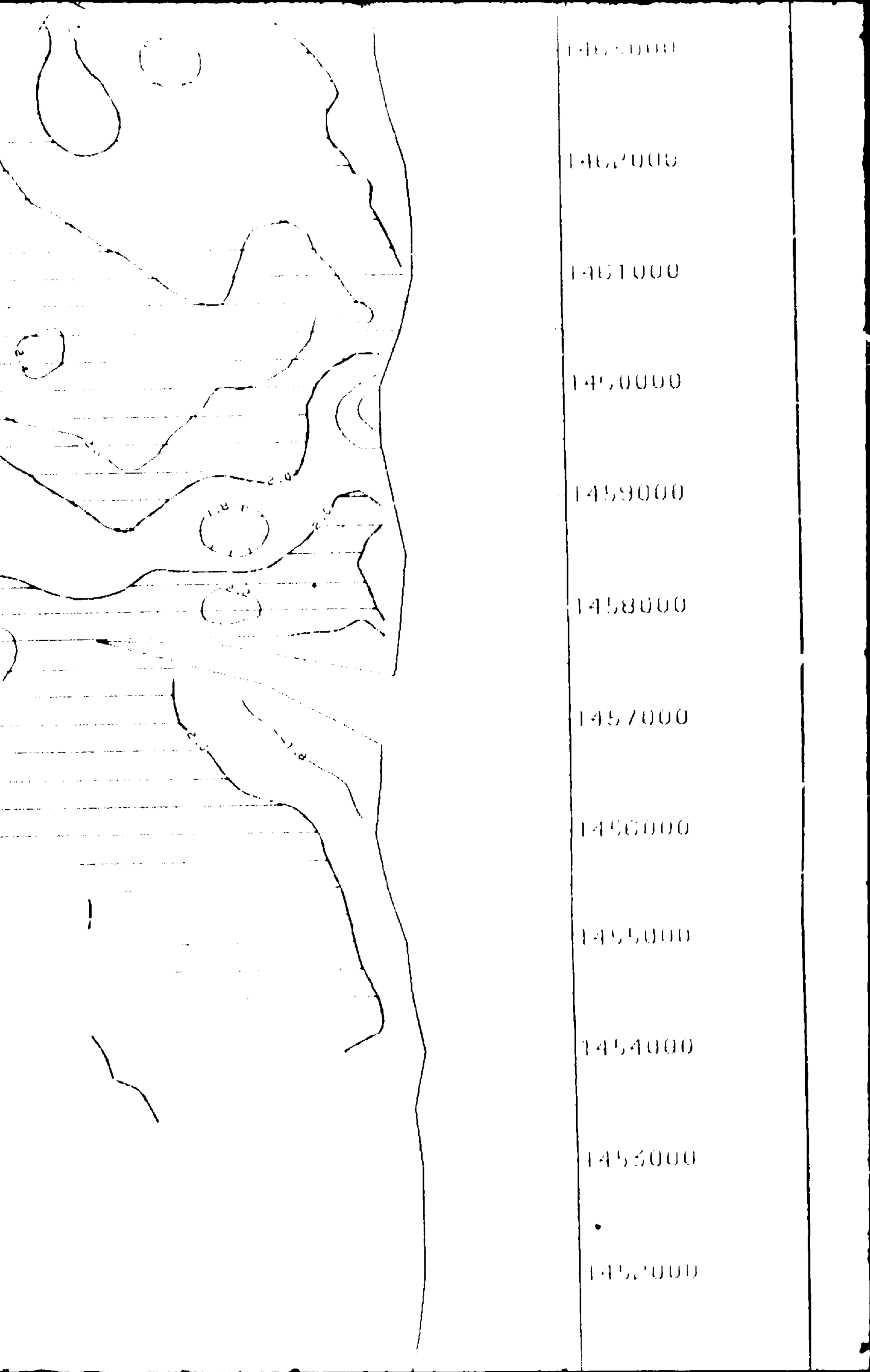
1466000
1465000
1464000
1463000
N



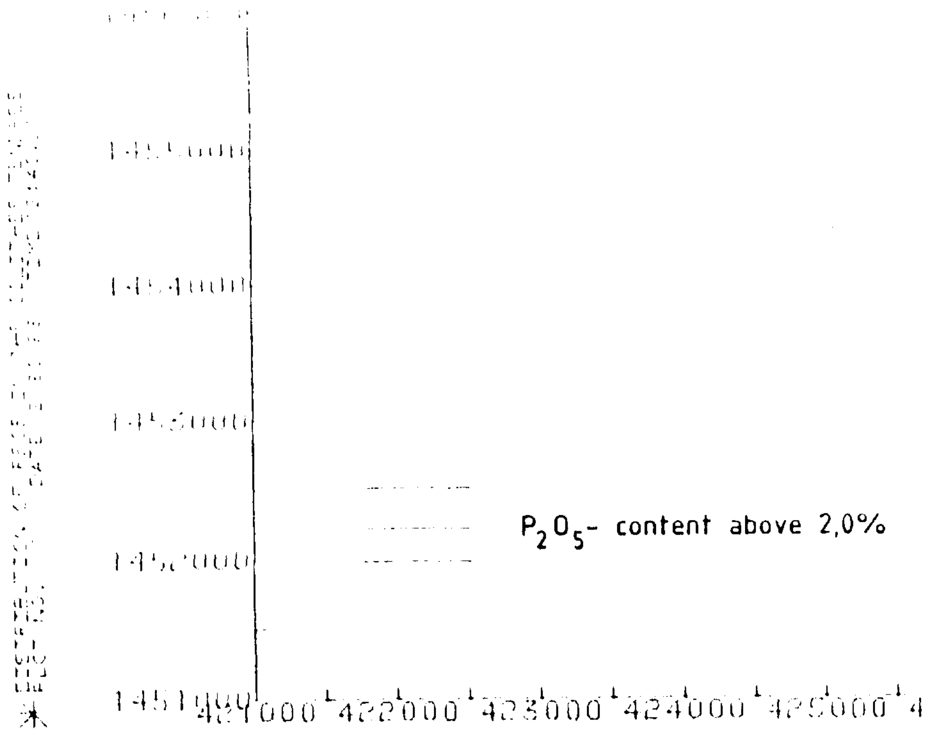
SECTION 1

SECTION 2

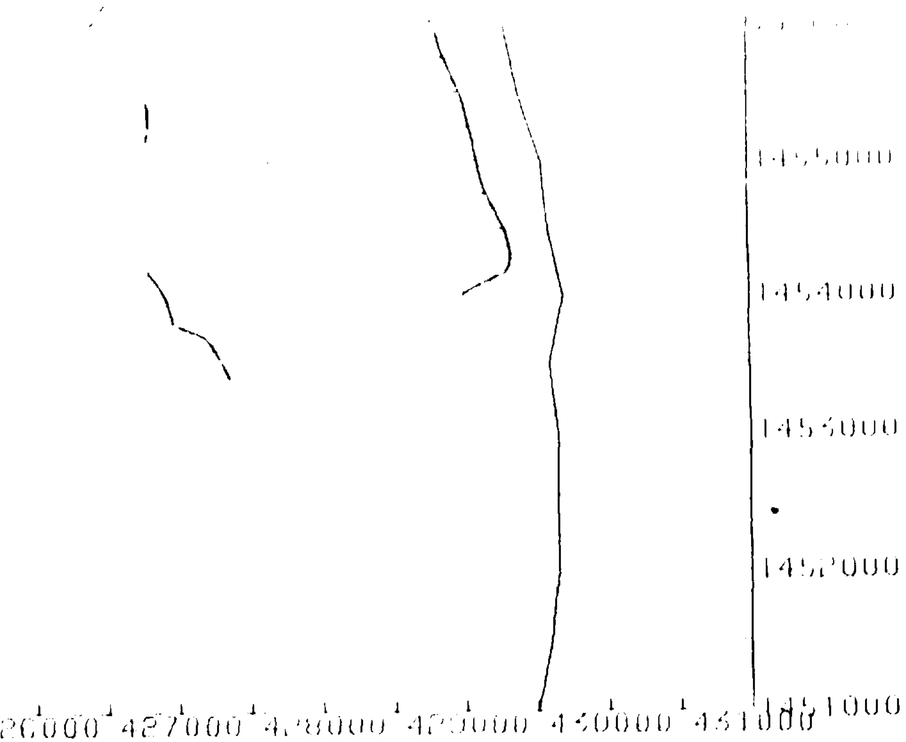

1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
1452000
P_2O_5- content above 2,0%



1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
1452000
2.0
1.8
2.5
2.0
1.8


1455000
1454000
1453000
1452000
1451000
421000
422000
423000
424000
425000
P_2O_5- content above 2,0%

SECTION 3



KHD HUMBOLDT WEDAG AG

ANNEX NO.

B - 23

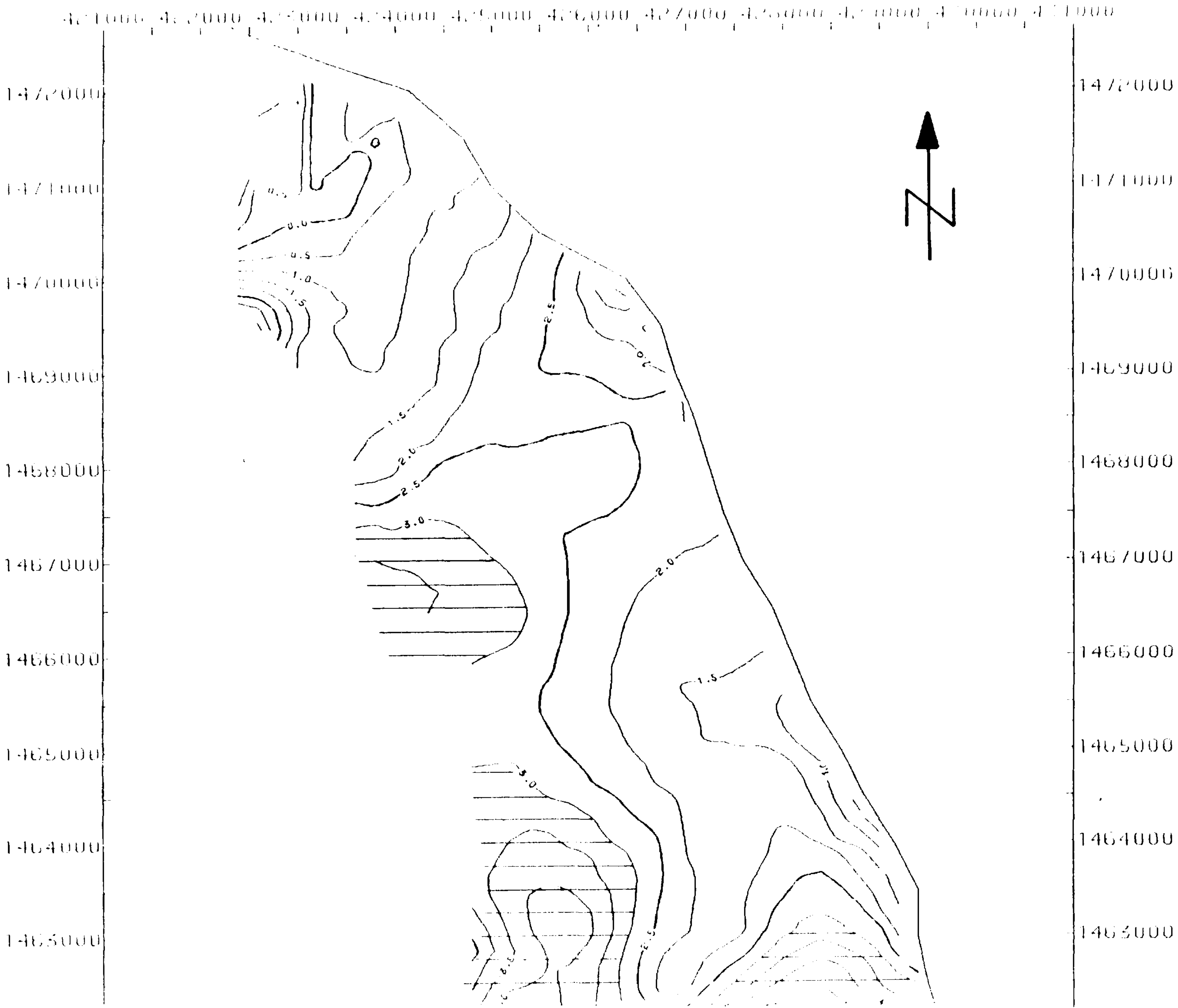
PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

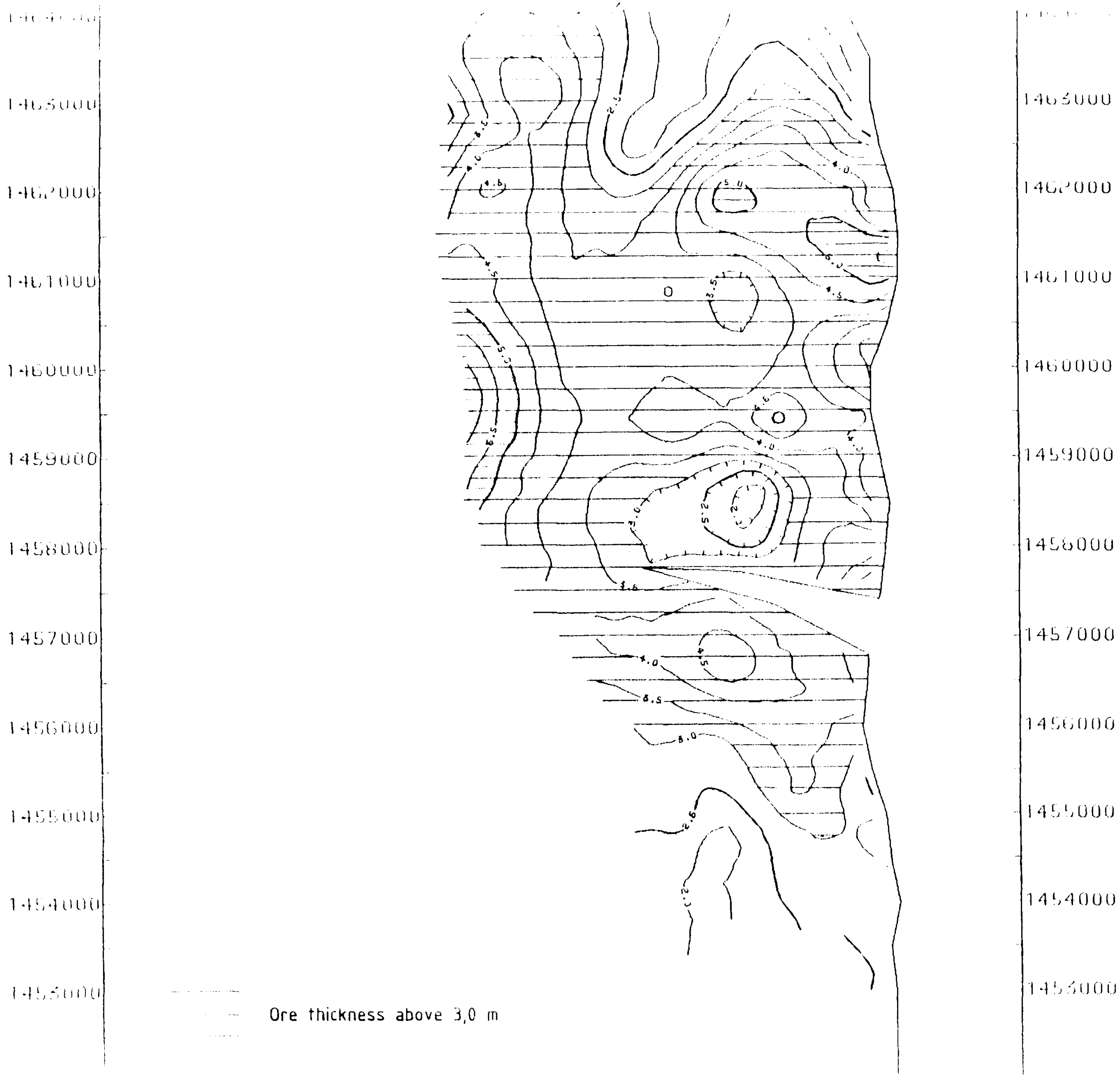
Isolines of the P_2O_5-distribution in the Oolithes Tendres

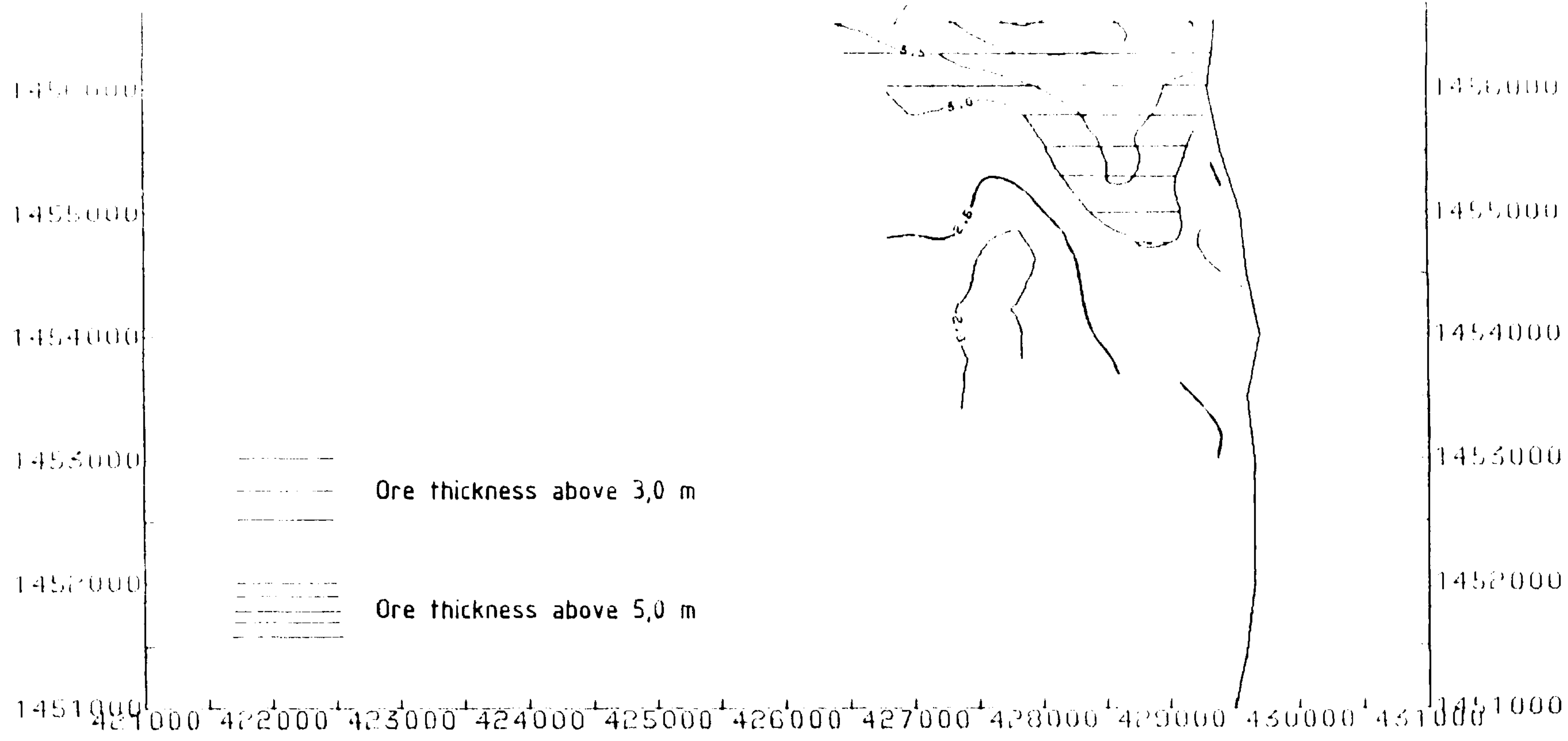
GEOLOGIST:	DATE:	SCALE:
Sch.-E.	Feb. 1984	1:50,000

SECTION 1


421000
422000
423000
424000
425000
426000
427000
428000
429000
430000
431000
1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
0
0.5
0.0
0.5
1.0
1.5
2.5
2.0
1.5
2.0
2.5
3.0
2.0
1.5
3.0
2.5
N

SECTION 2


1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
Ore thickness above 3,0 m
2.5
4.0
4.5
5.0
3.5
5.5
6.5
3.0
2.6
2.2



SECTION 3

KHD HU BOLDT WEDAG AG

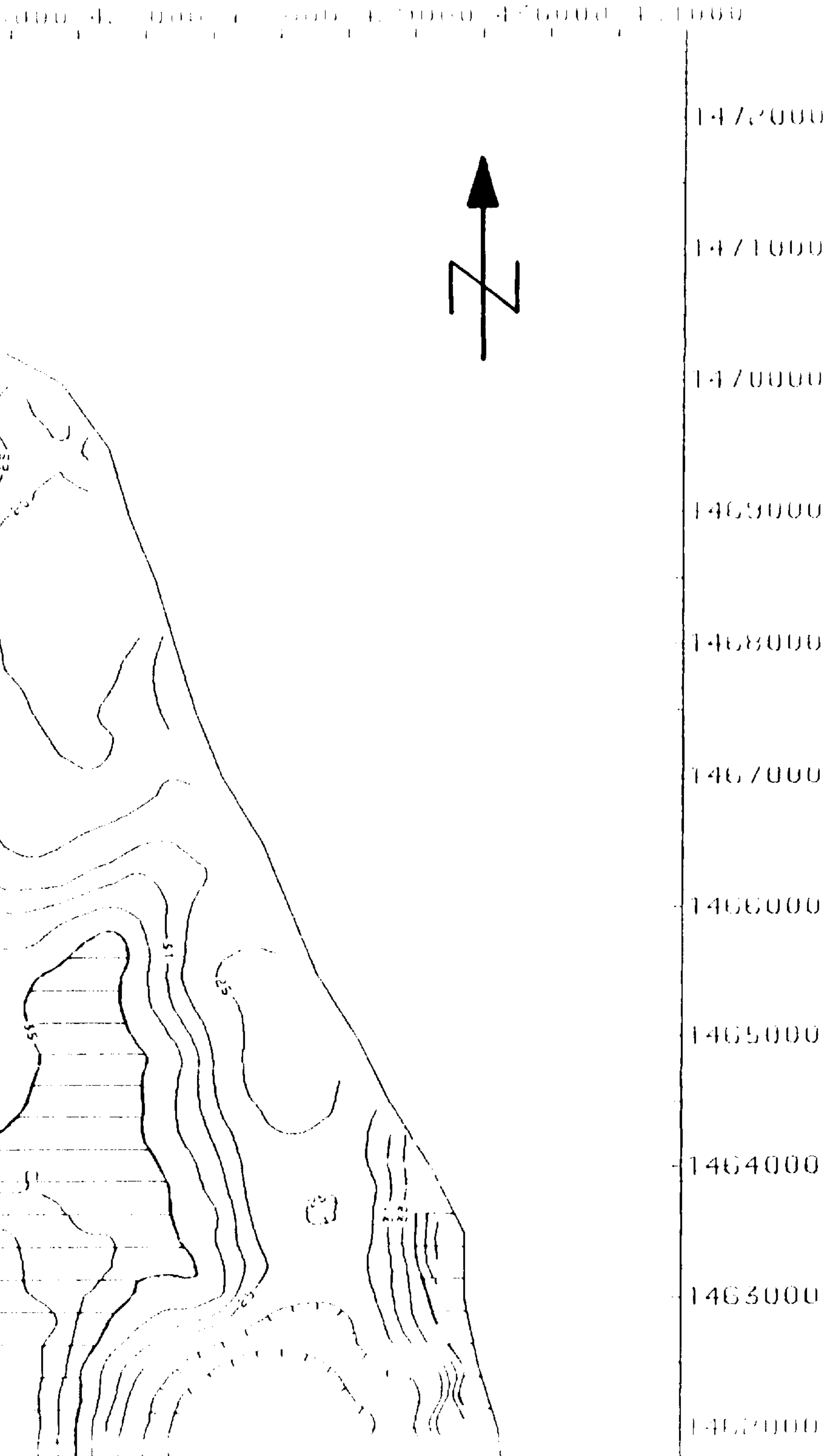
ANNEX NO.
B-24

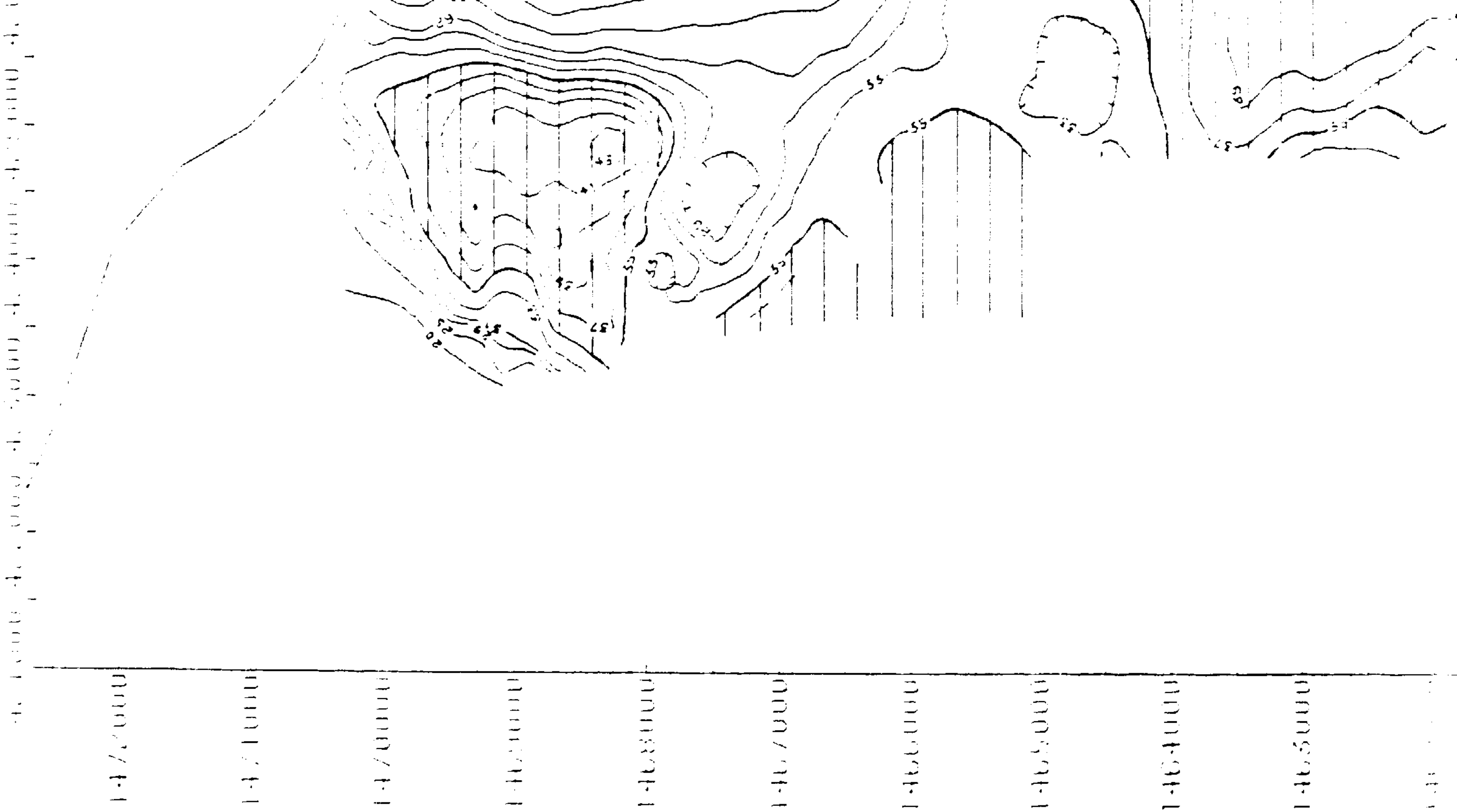
PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

Isolines of the Thickness of the Oolithes Tendres

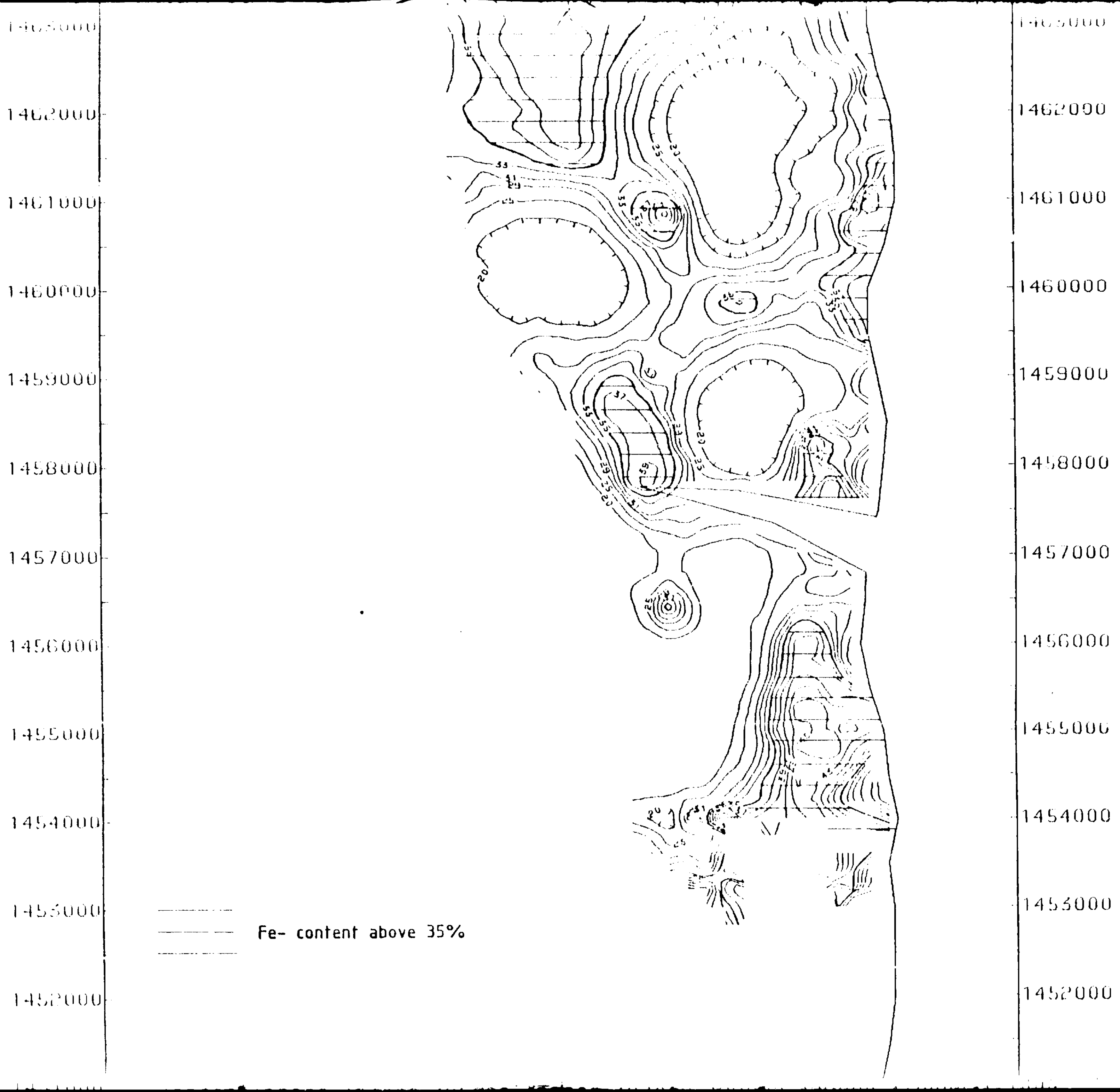
GEOLOGIST:	DATE:	SCALE:
Sch-E	Feb 1984	1:50,000


1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
1462000
N
15
25
35

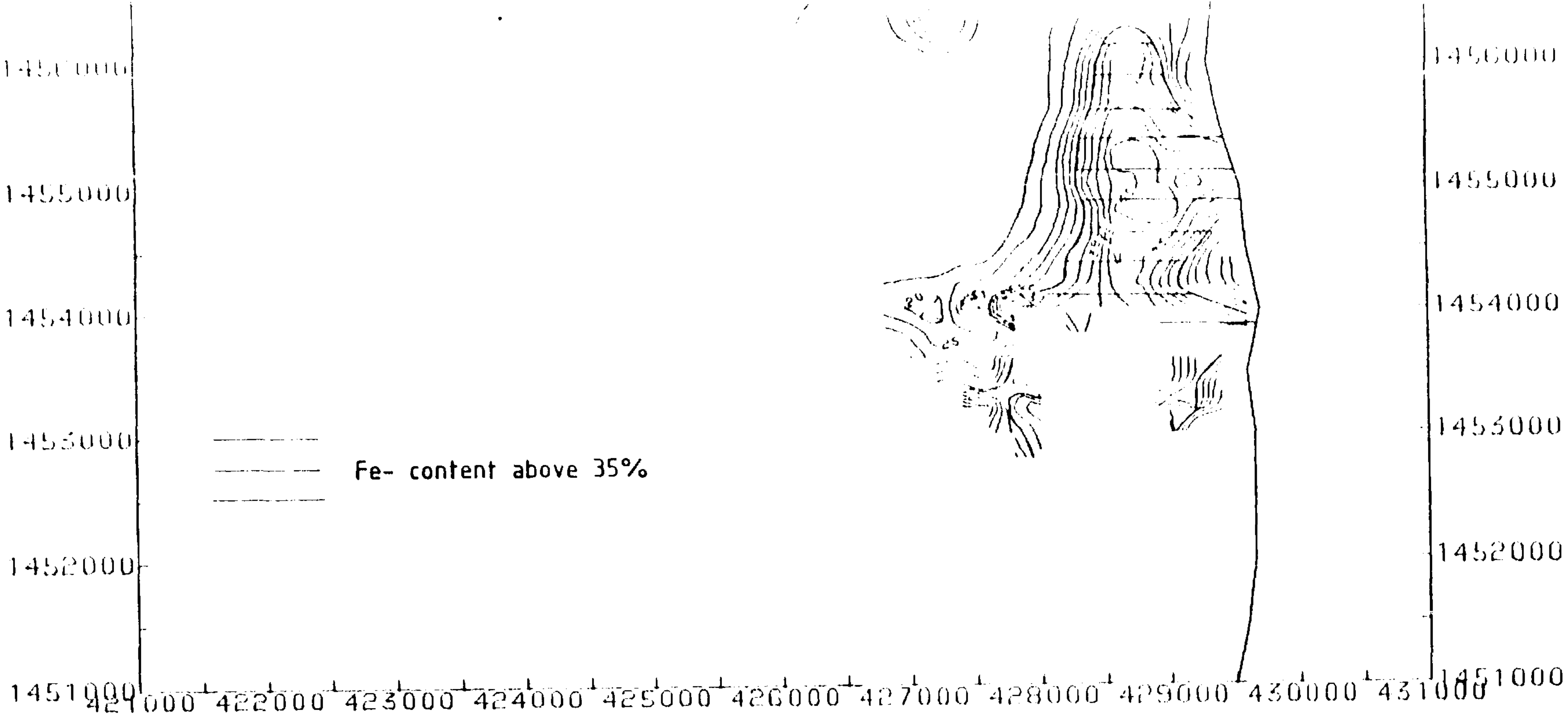

1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
55
37
69
20
23

SECTION 1

SECTION 2


1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
1452000
Fe- content above 35%
20
25
33
35
37
39

SECTION 3



KHD HUMBOLDT WEDAG AG

ANNEX NO.

B-25

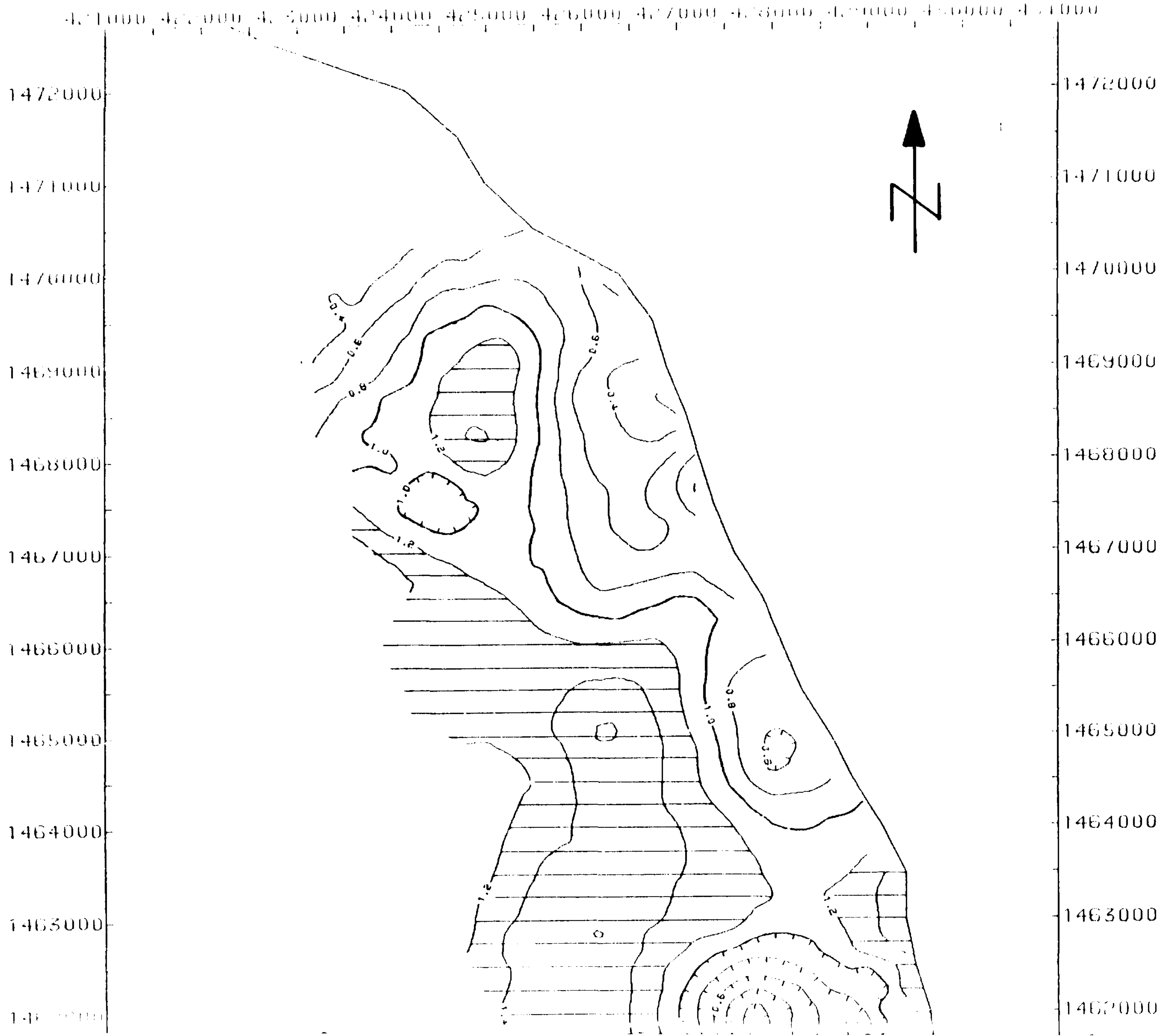
PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

Isolines of the Fe-distribution
in the Intercalation

GEOLOGIST:	DATE:	SCALE:
Sch. - E	Feb. 1984	1: 50,000

SECTION 1



421000
422000
423000
424000
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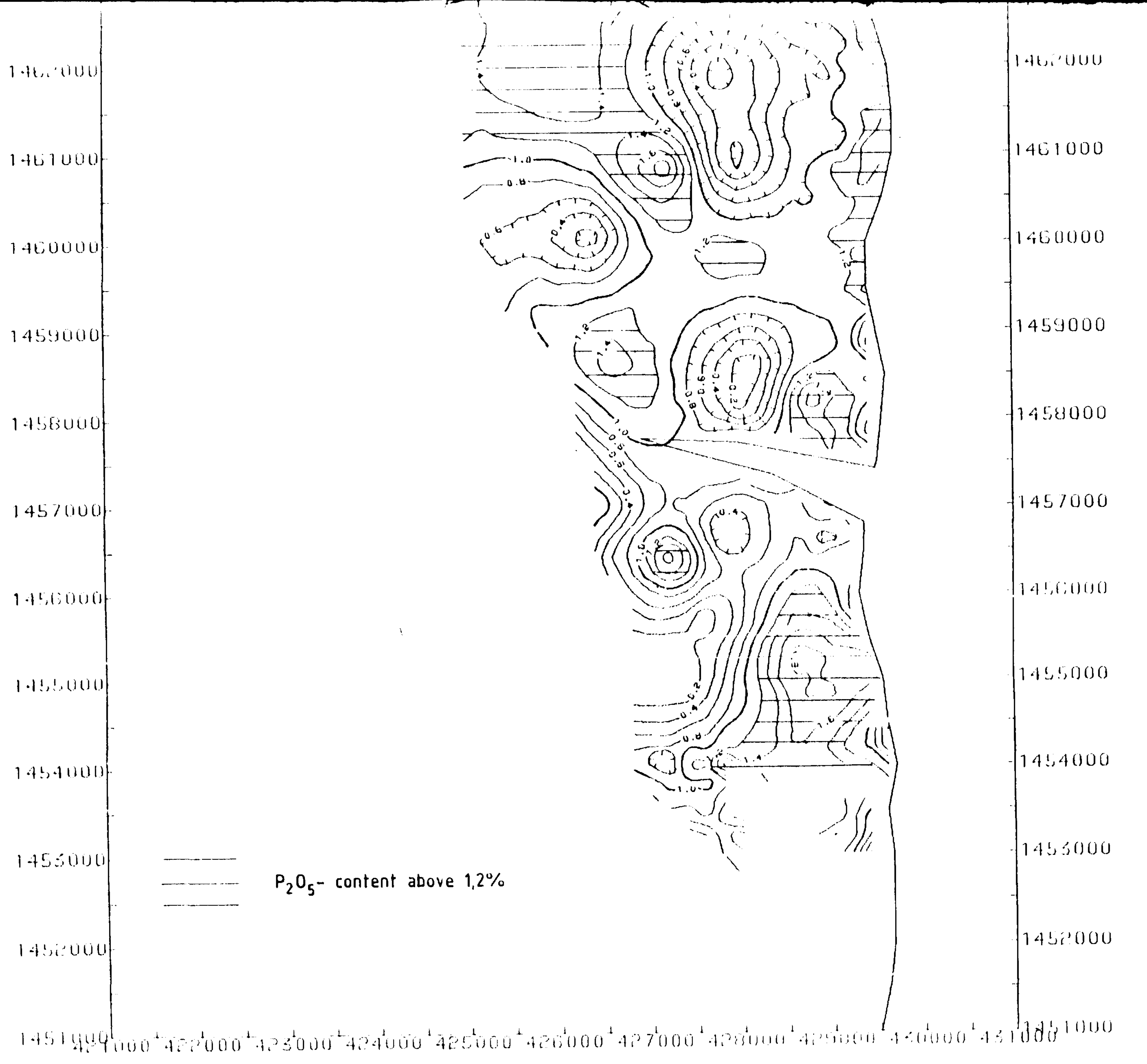
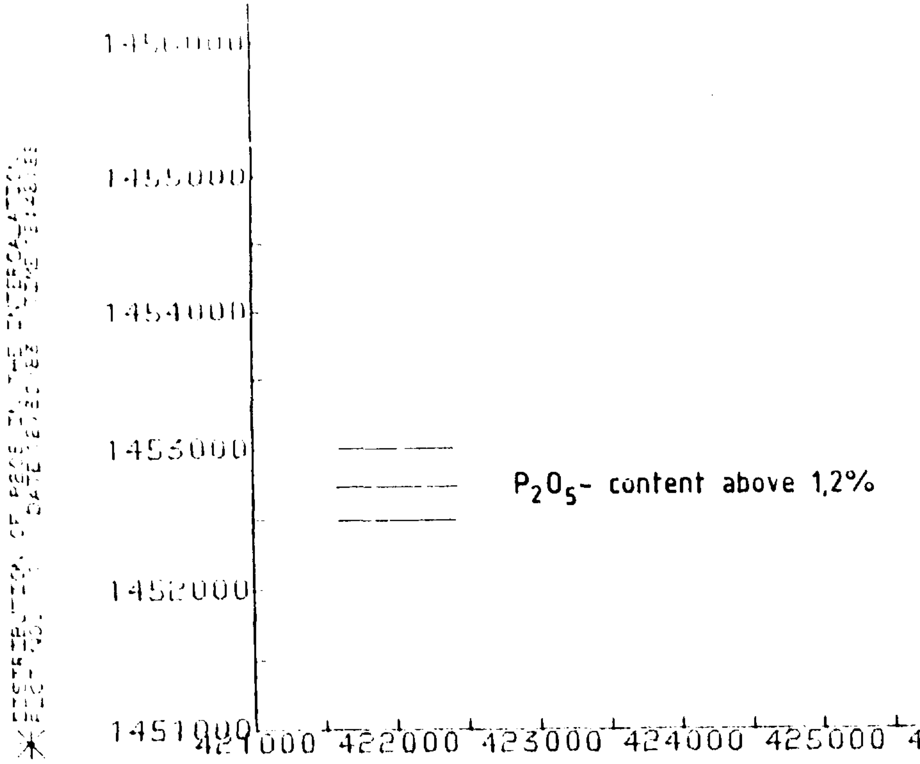
427000
428000
429000
430000
431000
1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
1462000
N
0.4
0.6
0.8
1.0
1.2
0.6
0.4
1.0
0.8
0.6
1.2
0
1.2
0.6

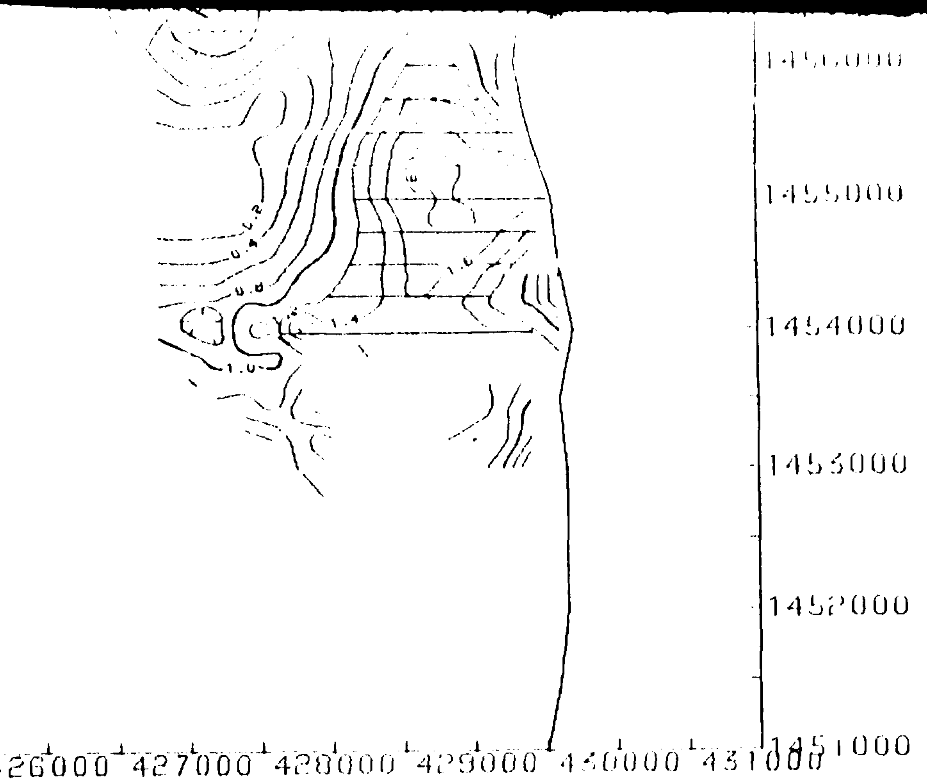
SECTION 2



P_2O_5- content above 1,2%
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
1452000
1451000
421000
422000
423000
424000
425000
426000
427000
428000
429000
430000
431000
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6


1456000
1455000
1454000
1453000
1452000
1451000
421000
422000
423000
424000
425000
P_2O_5- content above 1,2%

SECTION 3



KHD HUMBOLDT WEDAG AG

ANNEX NO.
B - 26

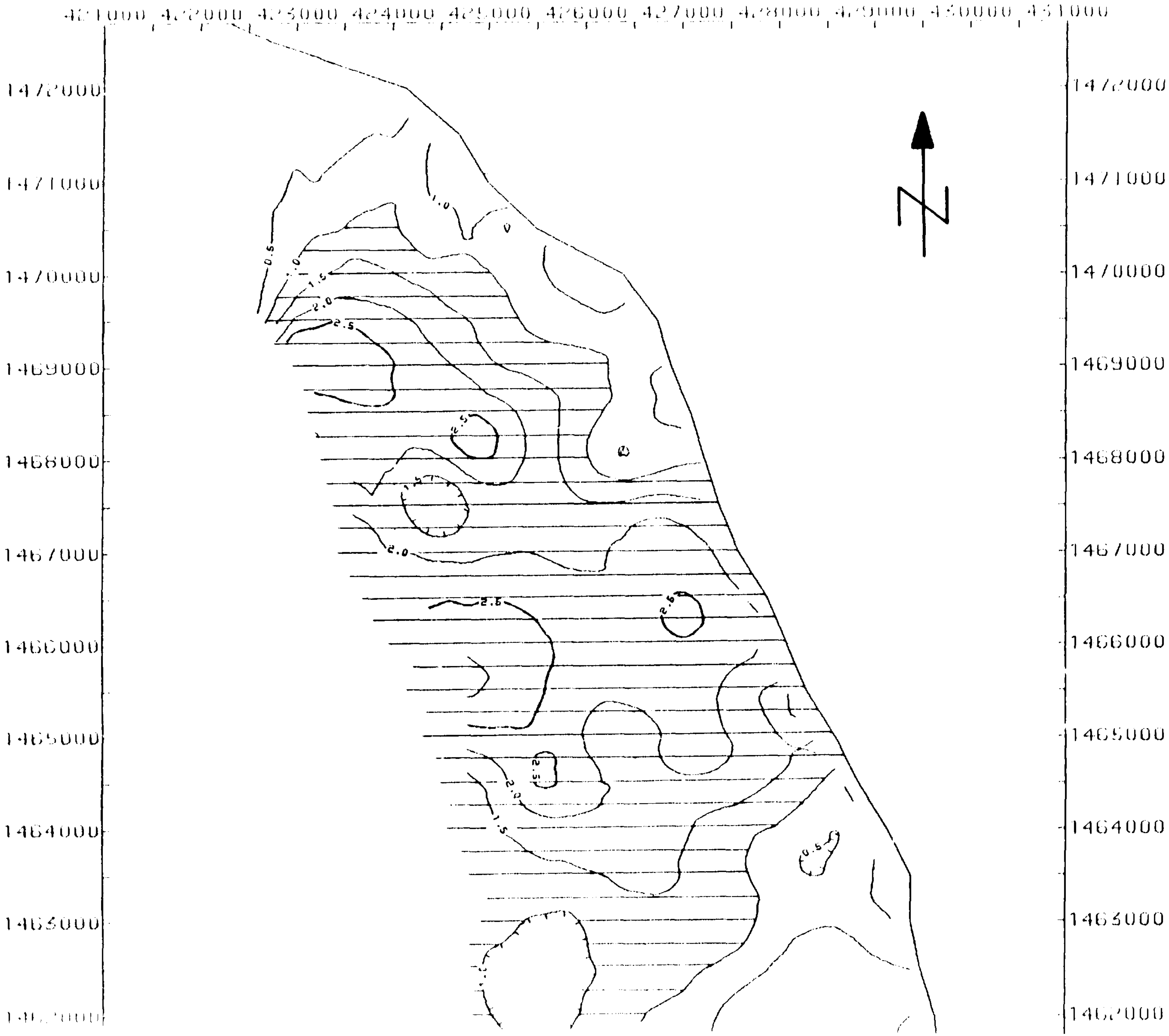
PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

Isolines of the P_2O_5-distribution
in the Intercalation

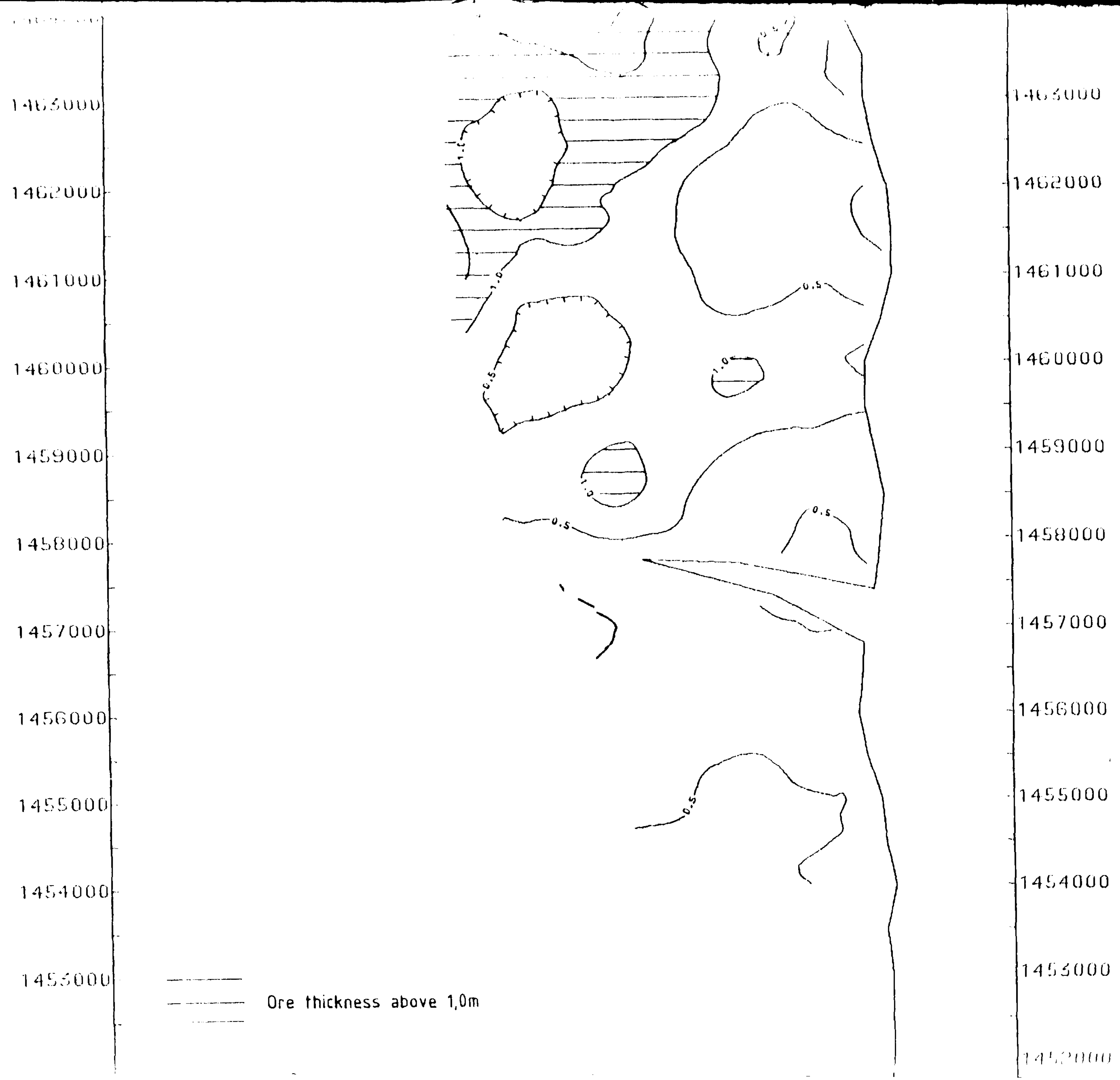
GEOLOGIST: Sch.-E.	DATE: Feb 1984	SCALE: 1:50,000

SECTION 1

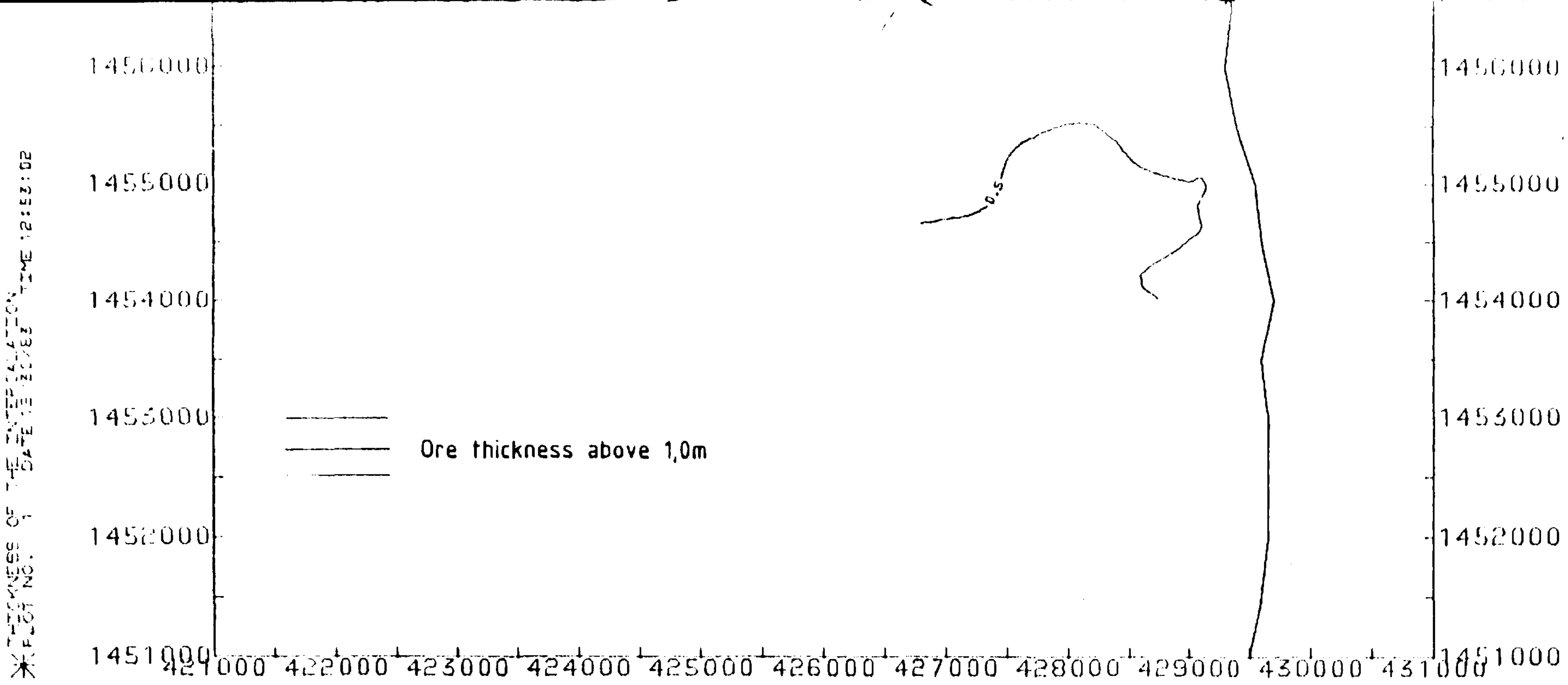


421000
422000
423000
424000
425000
426000
427000
428000
429000
430000
431000
1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
1462000
0
0.5
1.0
1.5
2.0
2.5

SECTION 2



1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
1452000
0.5
1.0
Ore thickness above 1,0m



SECTION 3

KHD HUMBOLDT WEDAG AG

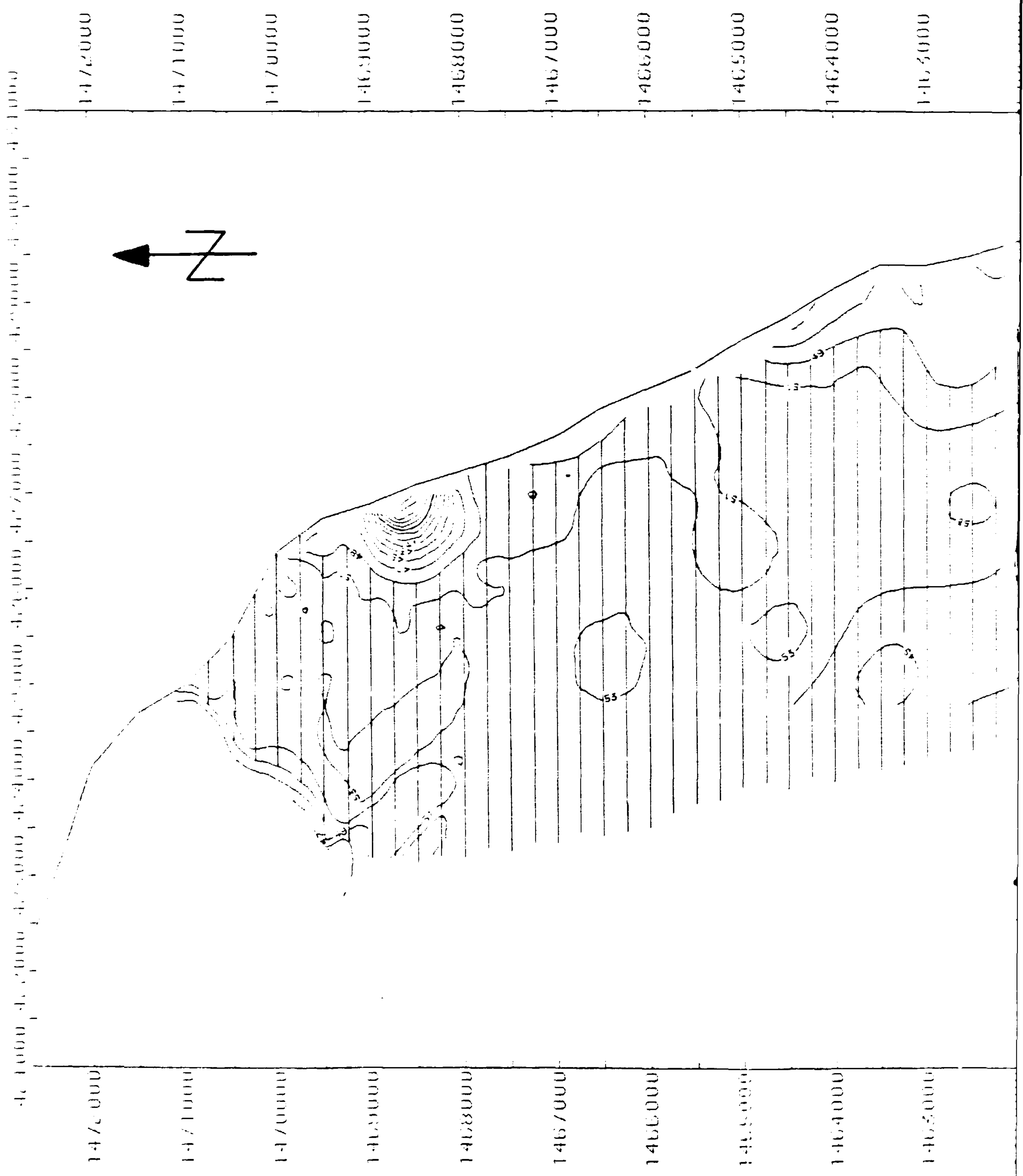
ANNEX NO.
B - 27

PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

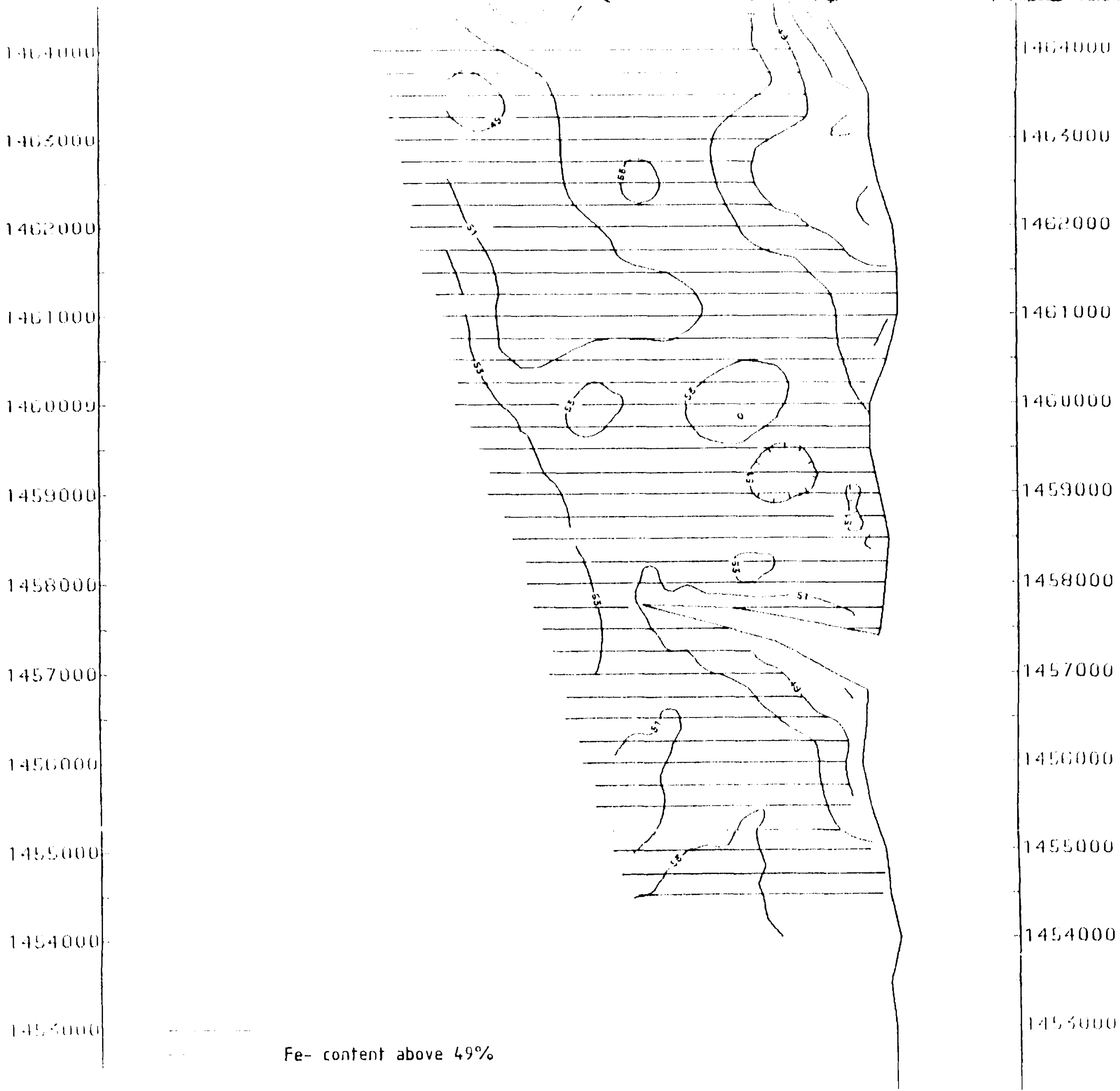
Isolines of the Thickness of the Intercalation

GEOLOGIST:	DATE:	SCALE:
Sch.-E.	Feb 1984	1:50,000

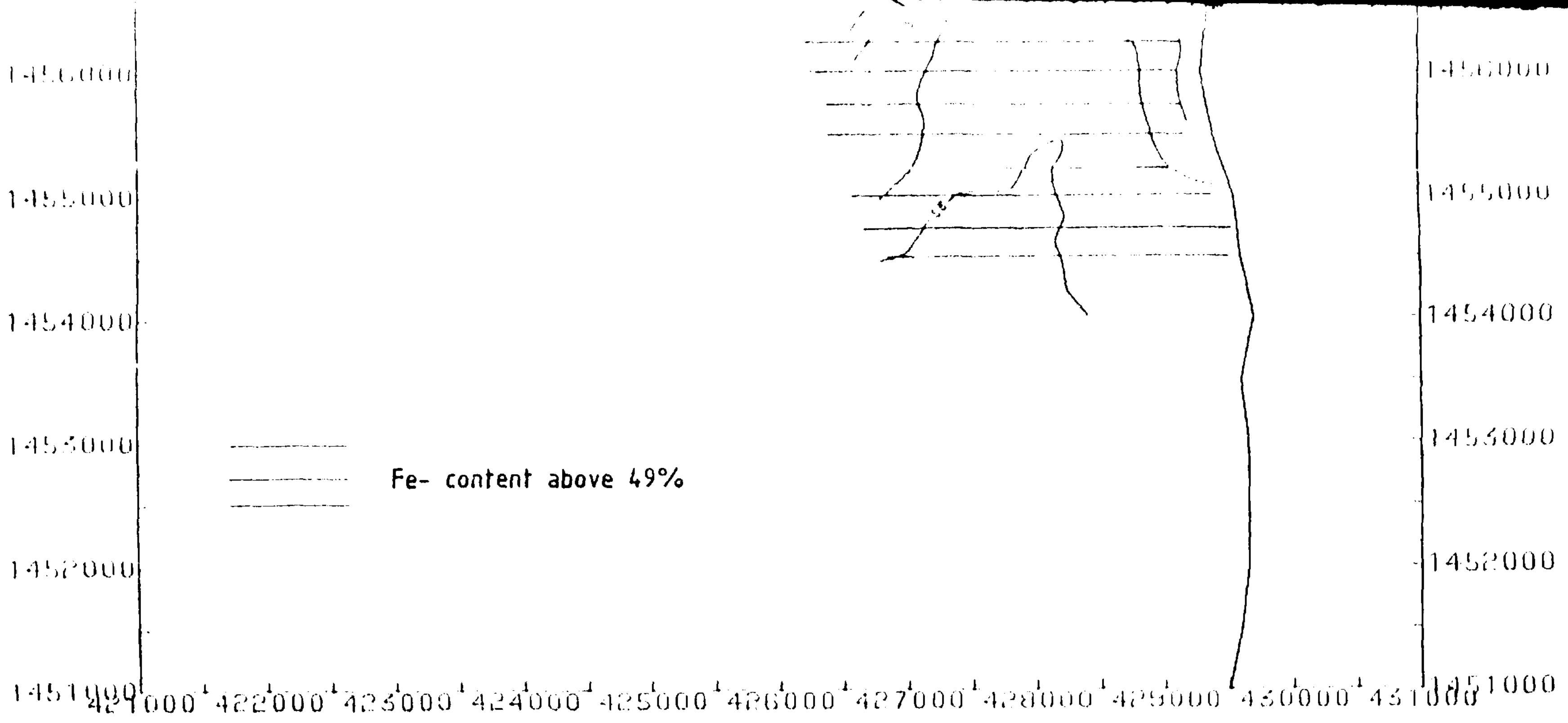

1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
N
53
55
45
47

SECTION 1

SECTION 2



Fe- content above 49%



SECTION 3

KHD HUMBOLDT WEDAG AG

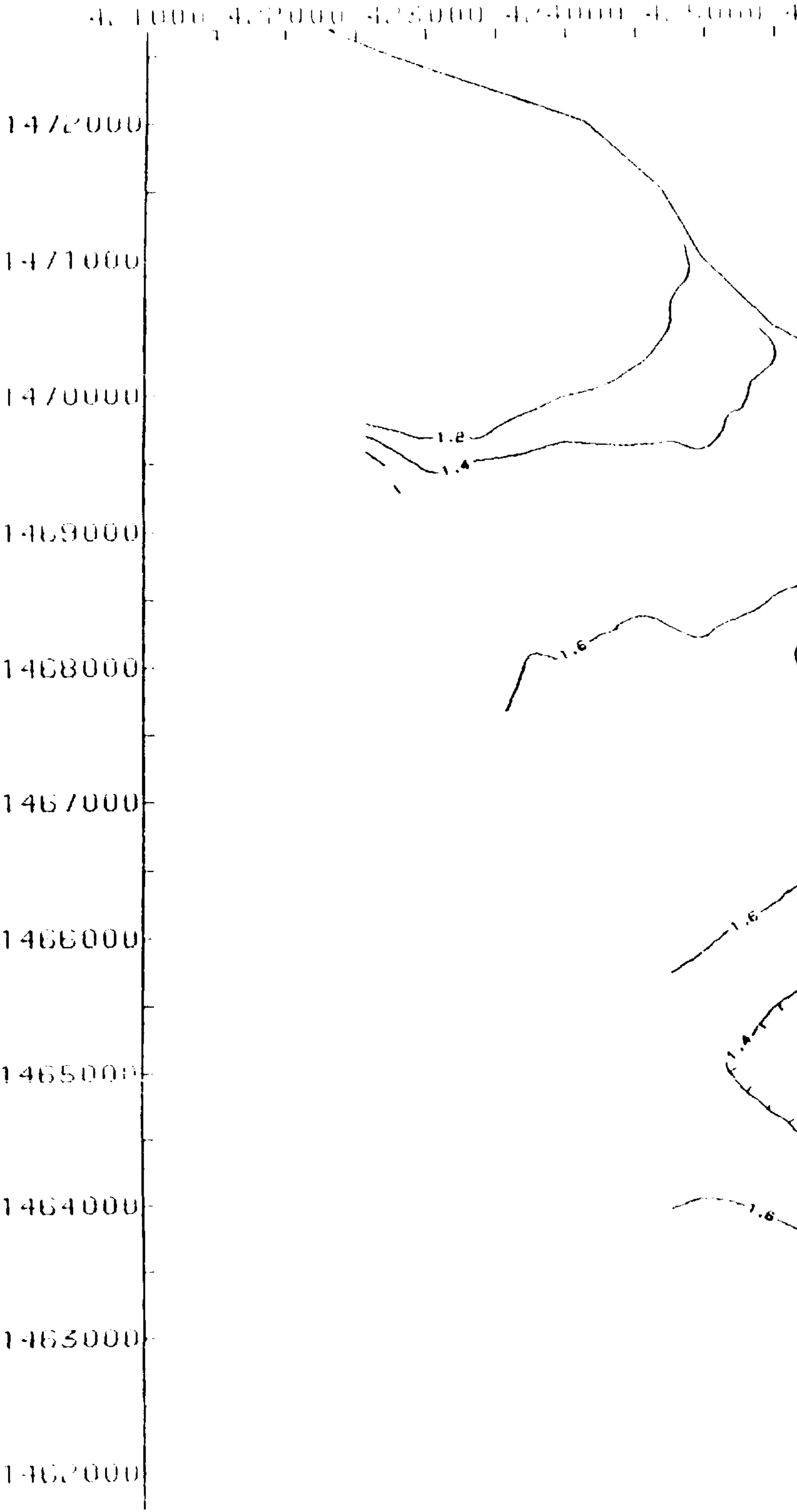
ANNEX NO.
B - 28

PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina OreBody
Isolines of the Fe-distribution
in the Oolithes Indurées

GEOLOGIST : Sch. - E.	DATE : Feb. 1984	SCALE : 1 : 50,000

SECTION 1


421000
422000
423000
424000
425000
1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
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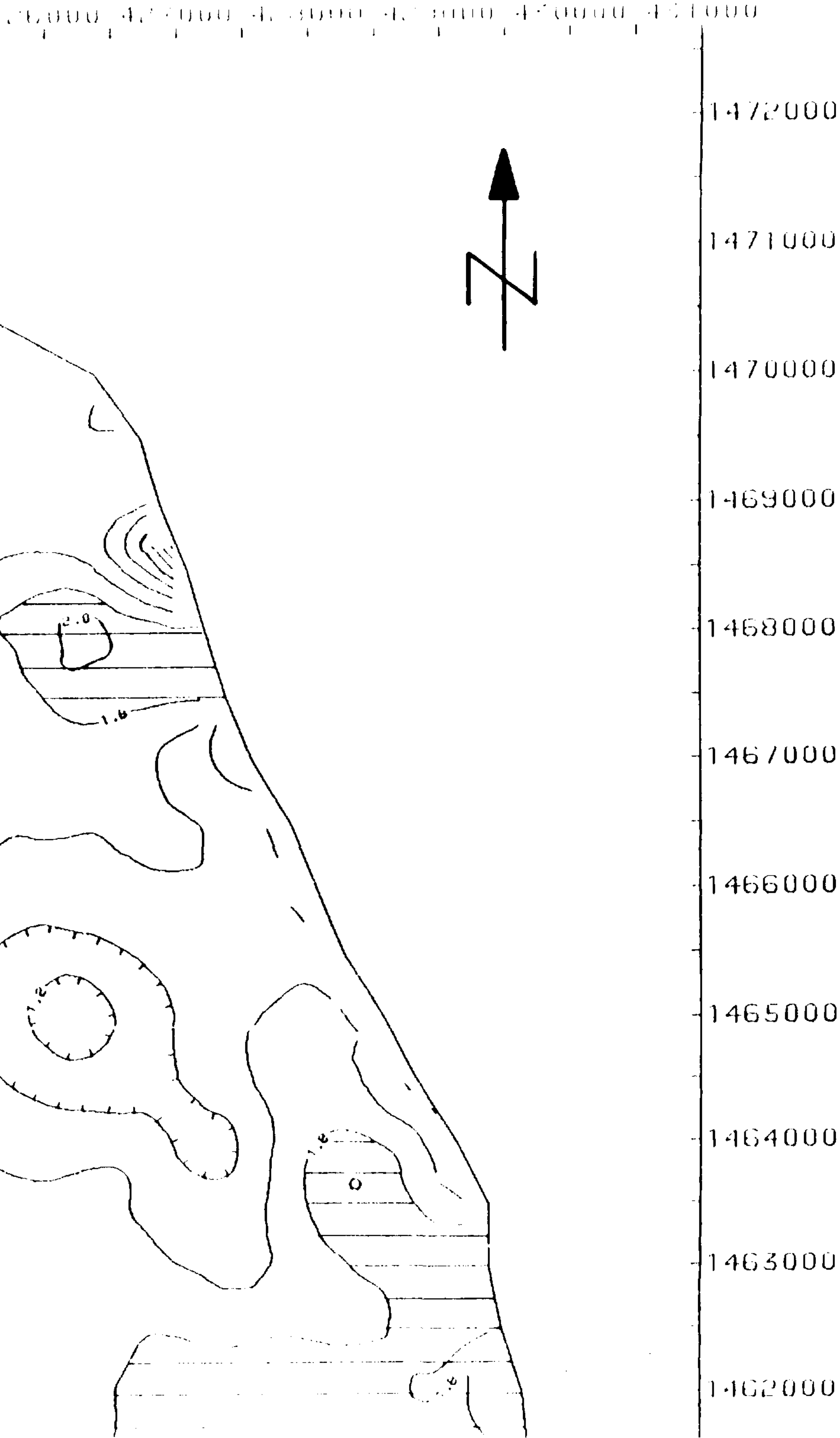
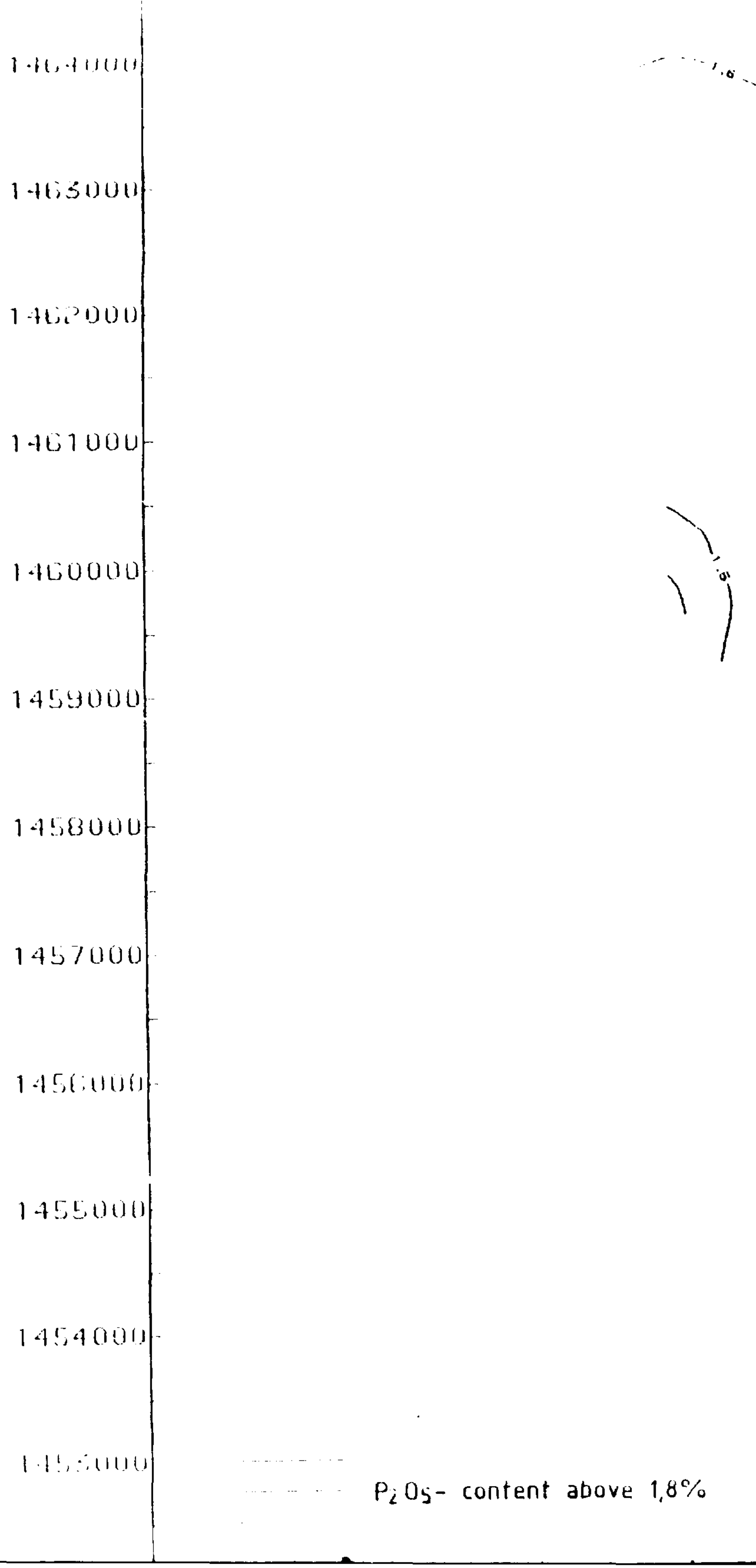
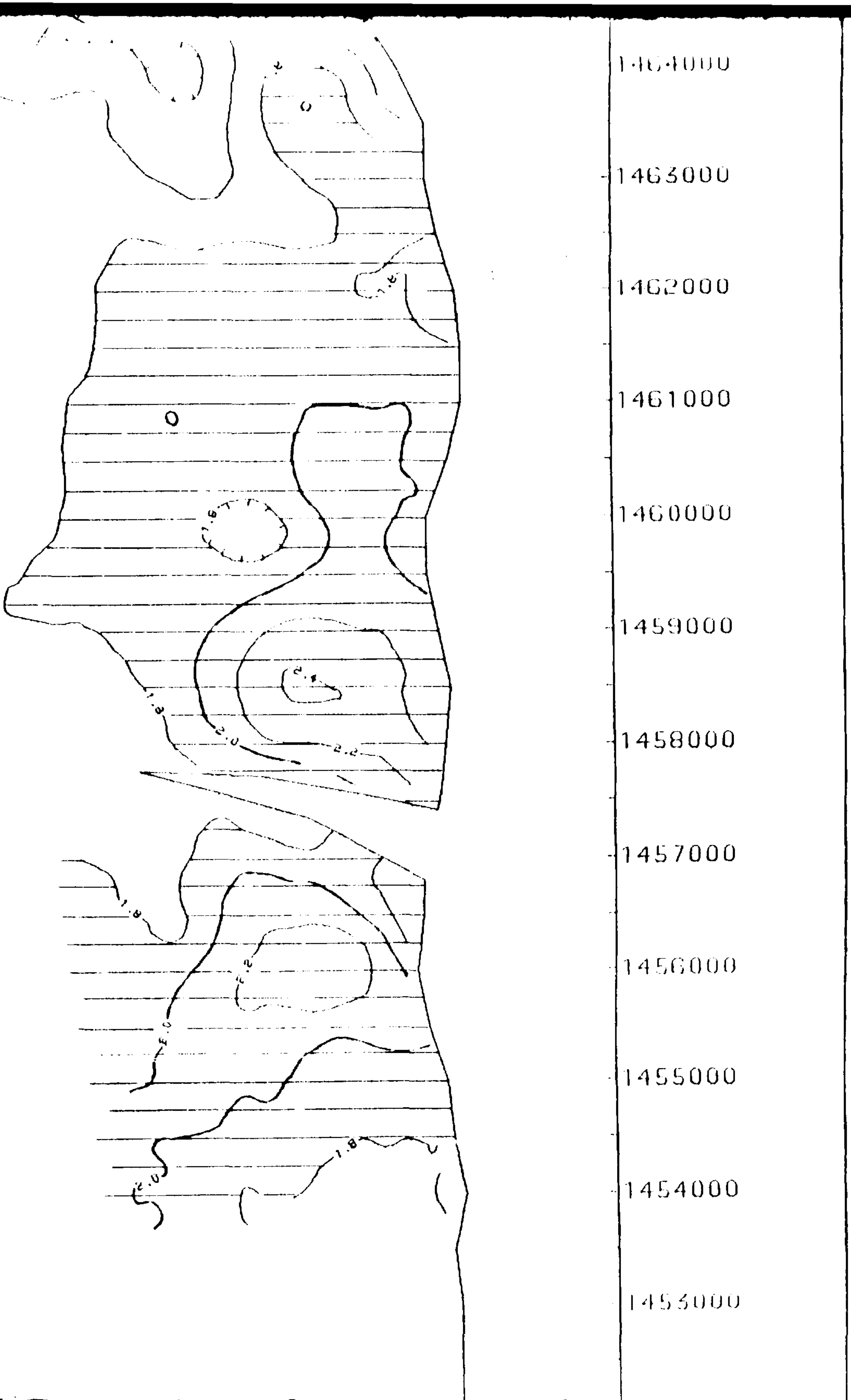
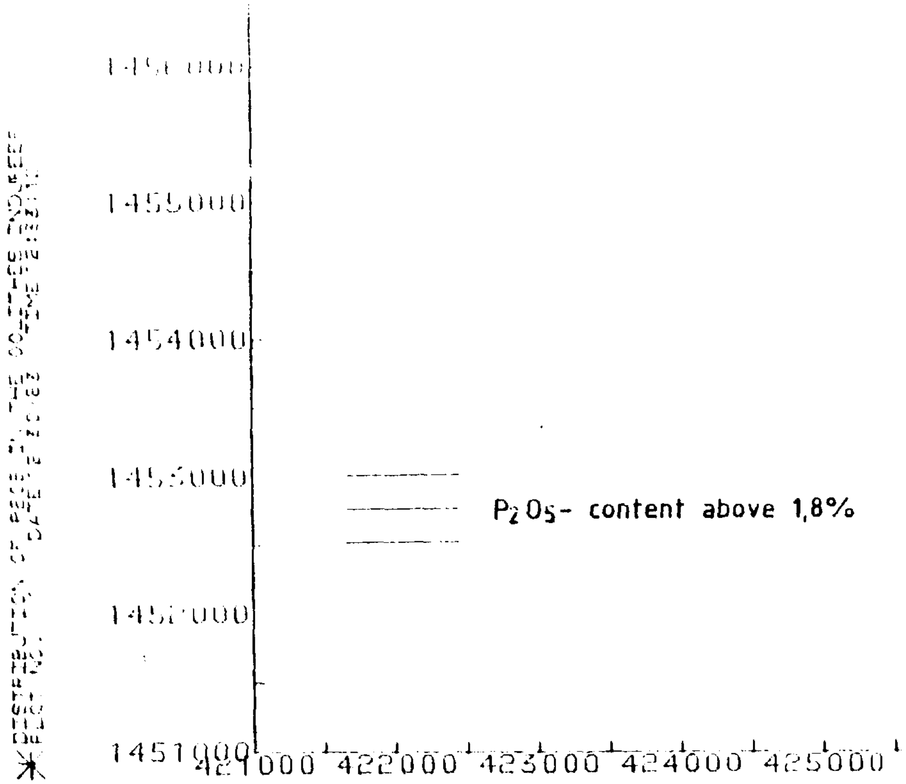
1.6
1.6
1.4
1.6


1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
1462000
2.0
1.8
1.2
1.8
0

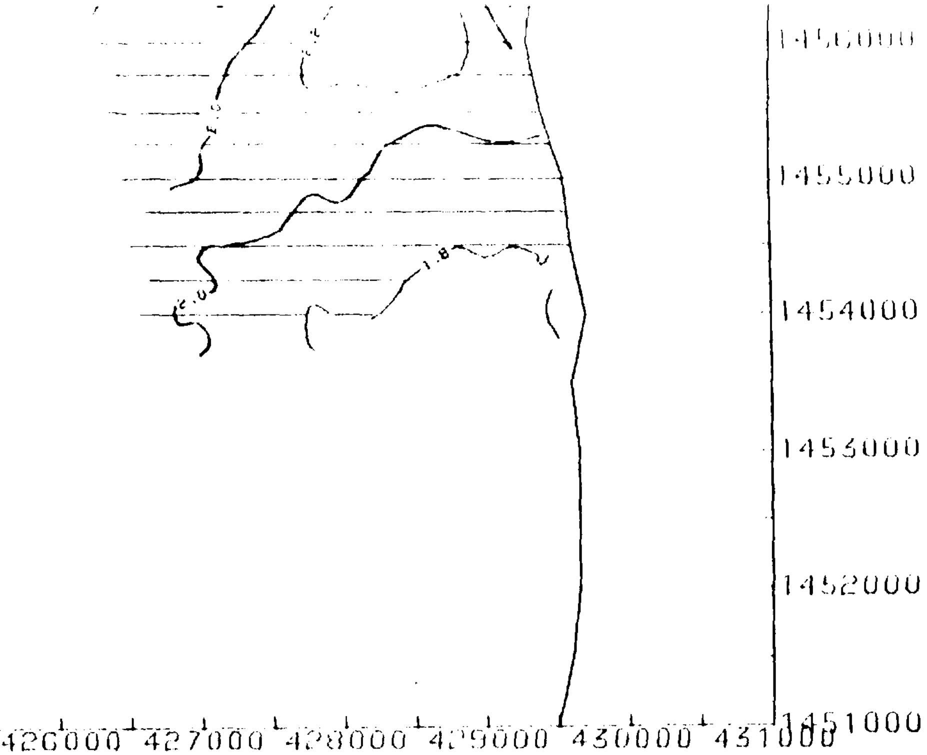
SECTION 2


1464000
1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
1,8
1,8
P₂O₅- content above 1,8%


1464000
0
1463000
1.8
1462000
1461000
0
1.6
1460000
1459000
2.4
1.8
2.0
2.2
1458000
1457000
1.8
2.2
1456000
2.0
1455000
1.8
2.0
1454000
1453000


1456000
1455000
1454000
1453000
1452000
1451000
421000
422000
423000
424000
425000
P$_2$O$_5$- content above 1,8%

SECTION 3



KHD HUMBOLDT WEDAG AG

ANNEX NO.

B - 29

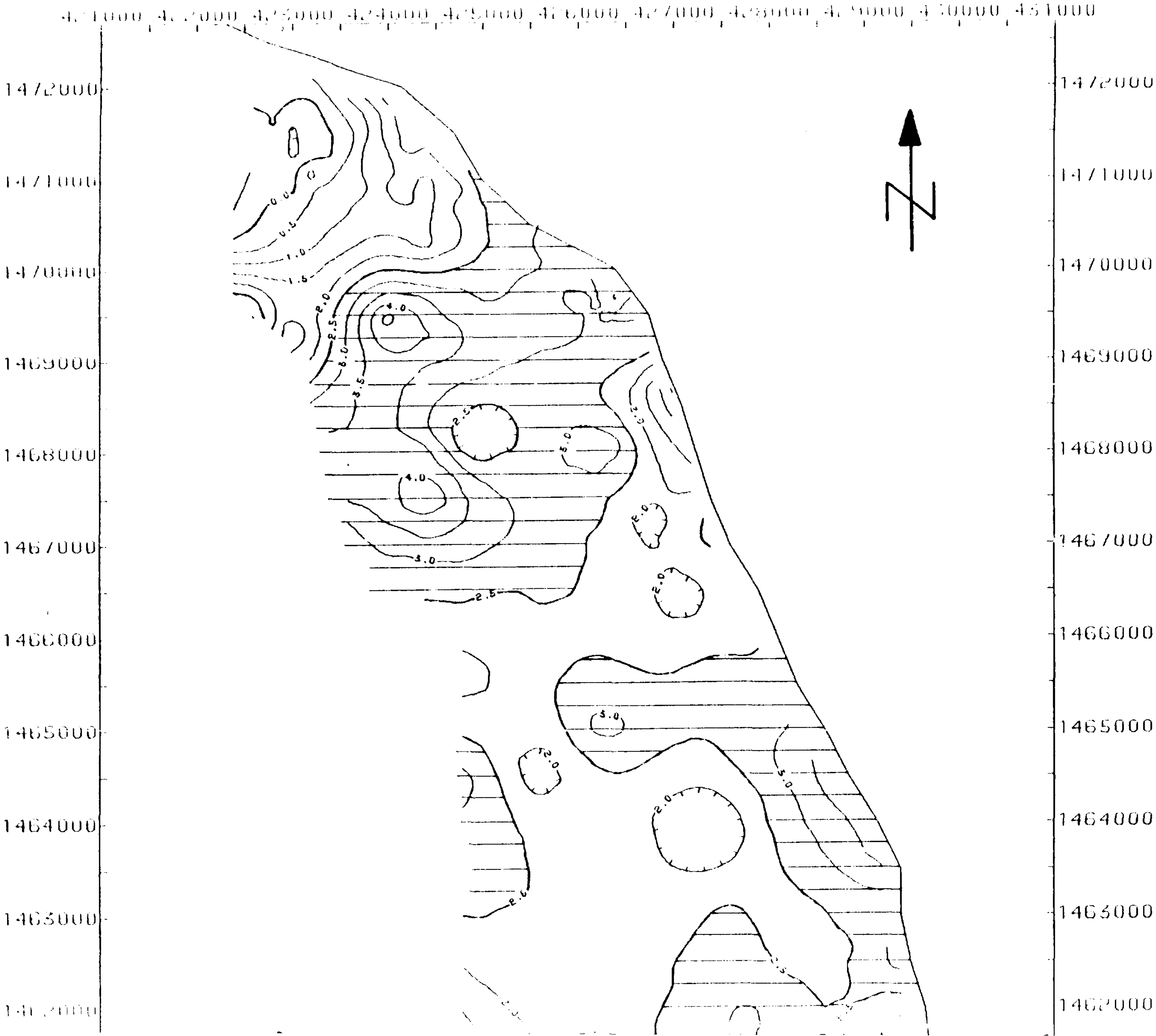
PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

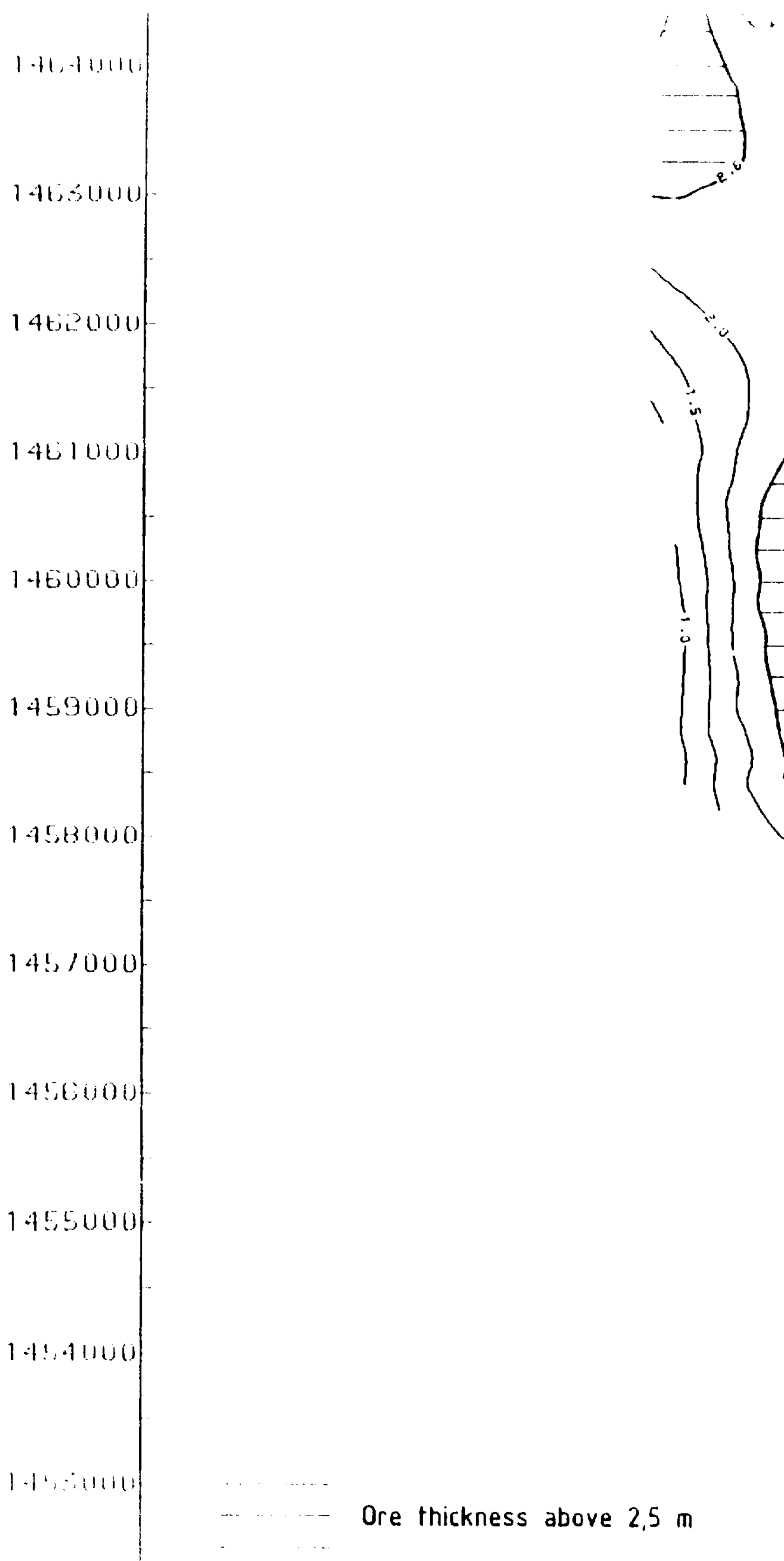
Isolines of the P_2O_5-distribution
in the Oolithes Indurées

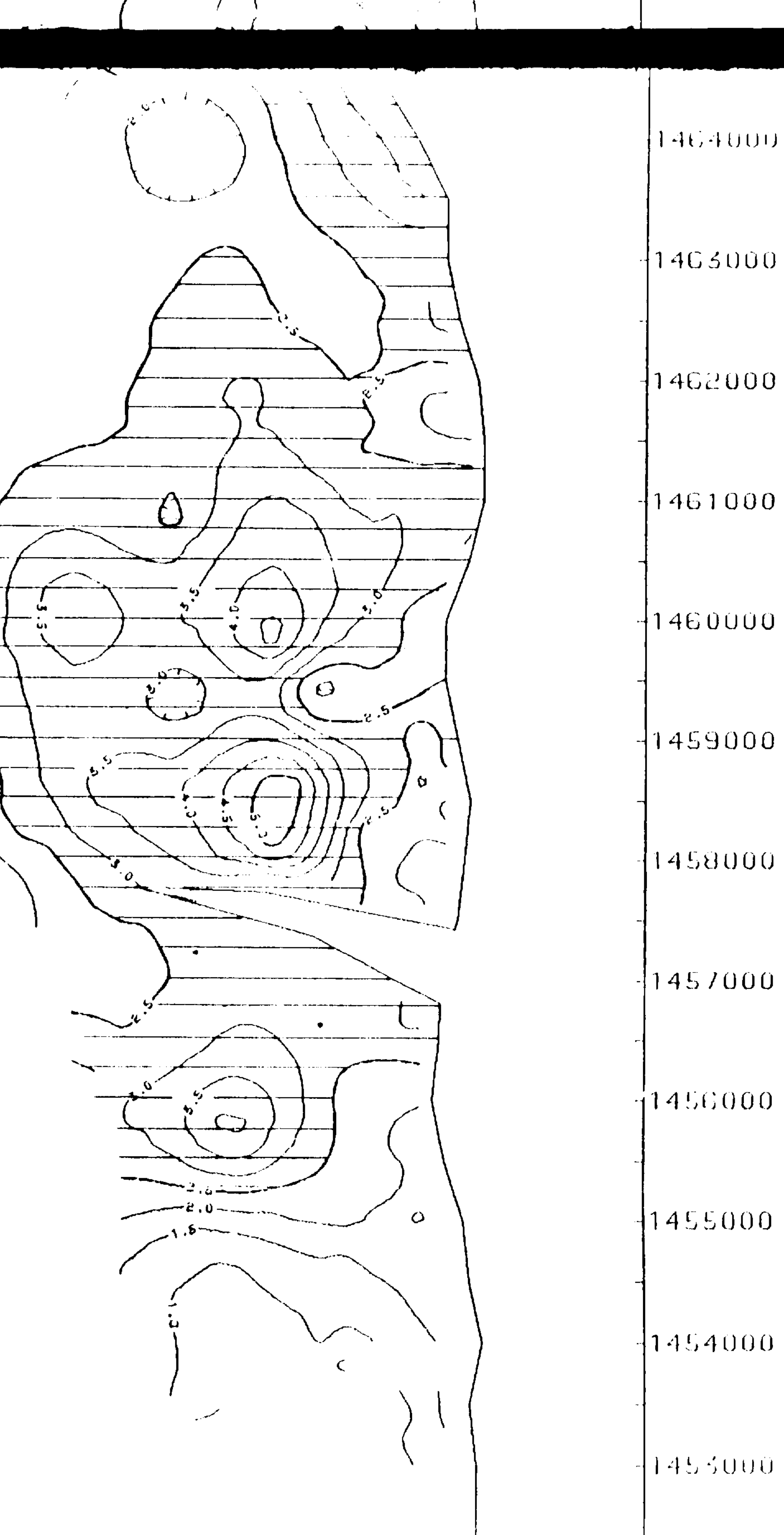
GEOLOGIST: Sch.-E.	DATE: Feb 1984	SCALE: 1:50,000

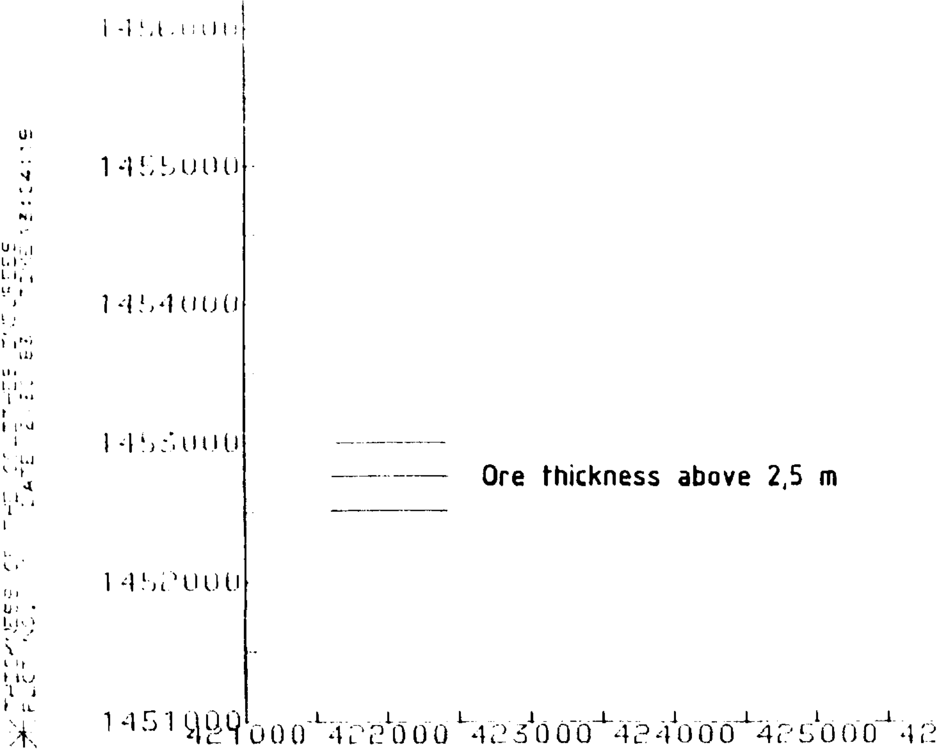
SECTION 1


421000
422000
423000
424000
425000
426000
427000
428000
429000
430000
431000
1472000
1471000
1470000
1469000
1468000
1467000
1466000
1465000
1464000
1463000
1462000
N
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
2.5
3.0
3.0
4.0
3.0
2.5
2.0
2.0
3.0
2.0
3.0
2.0
2.0

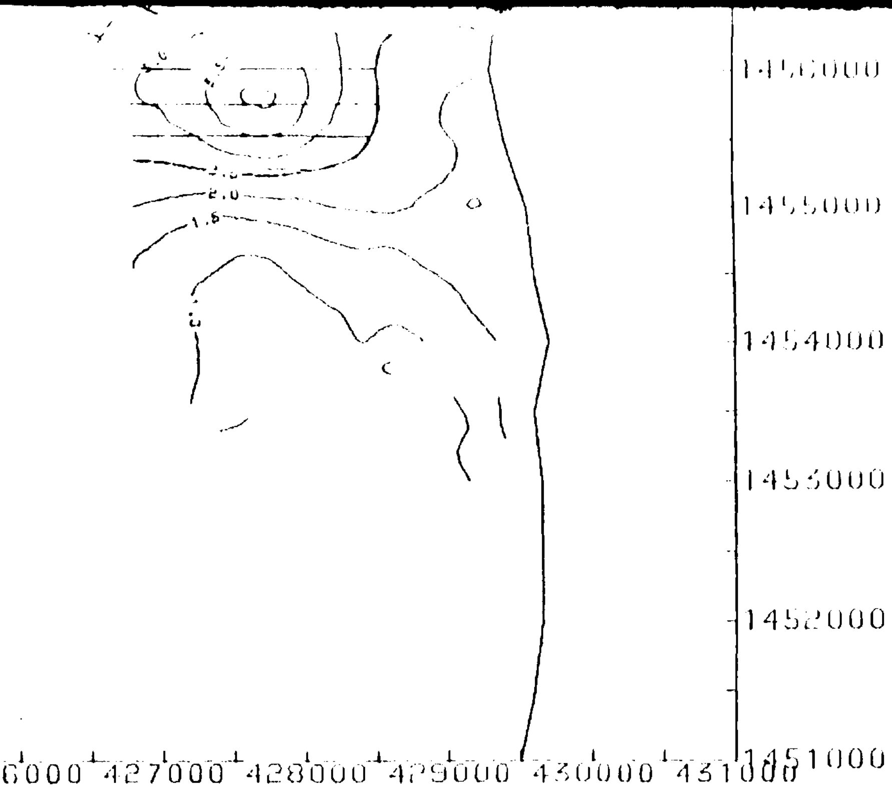
SECTION 2


1464000
1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
2.0
2.0
1.5
1.0
Ore thickness above 2,5 m


1464000
1463000
1462000
1461000
1460000
1459000
1458000
1457000
1456000
1455000
1454000
1453000
2.0
2.5
3.0
3.5
4.0
4.5
5.0
1.5
1.0


1456000
1455000
1454000
1453000
1452000
1451000
421000
422000
423000
424000
425000
42
Ore thickness above 2,5 m

SECTION 3



KHD HUMBOLDT WEDAG AG

ANNEX NO.
B - 30

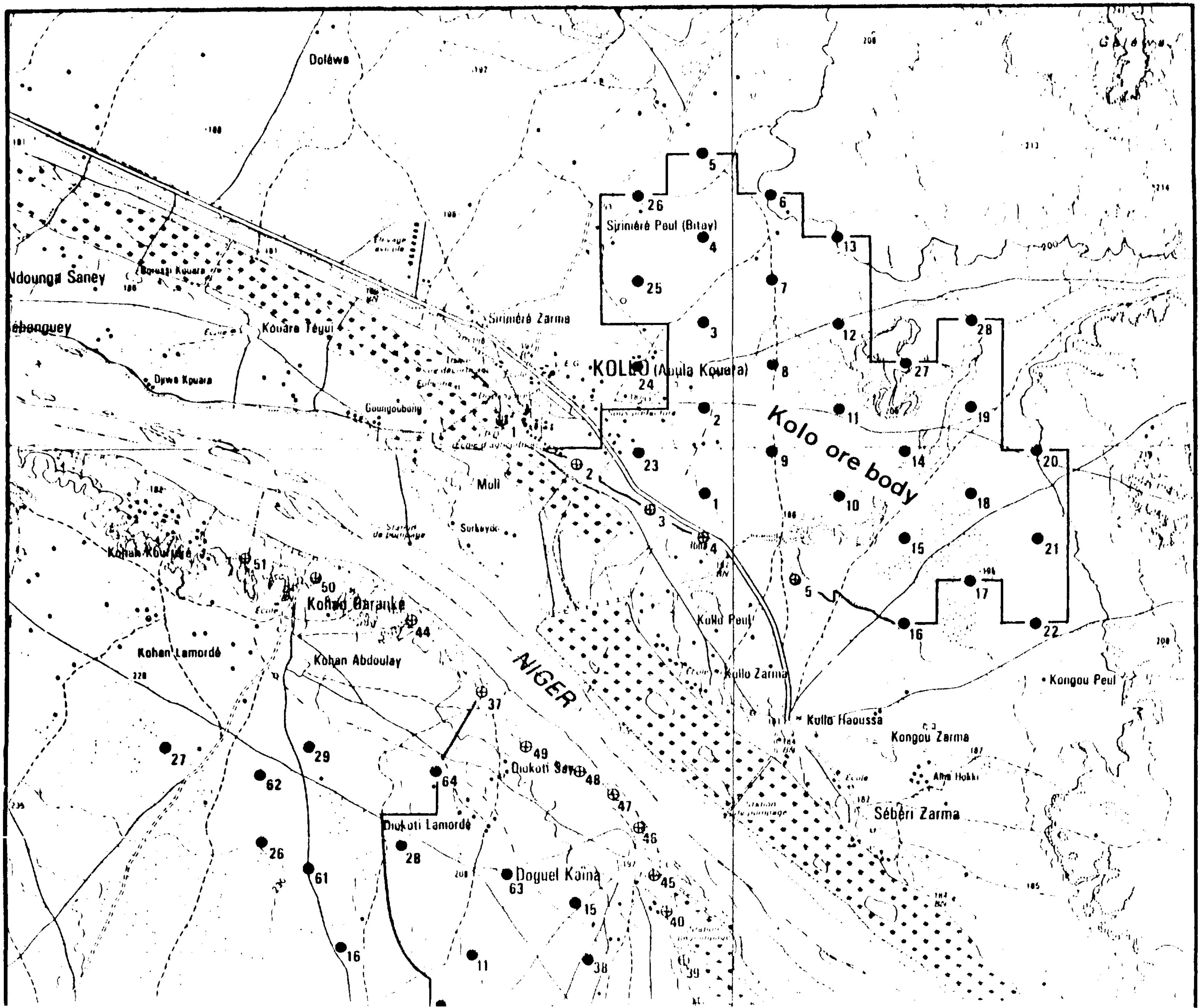
PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Doguel Kaina Ore Body

Isolines of the Thickness of the Oolithes Indurées

GEOLOGIST:	DATE:	SCALE:
Sch.-E.	Feb.1984	1 : 50,000

SECTION 1



Doléwa
Ndounga Saney
ébonguey
Djwa Kouara
Kouara Tégui
Goungoubou
Sirimèré Zarma
Sirimèré Peul (Bitay)
KOLLO (Abula Kouara)
Moli
Kolo ore body
NIGER
Kohan Kourtéyé
Kohan Baranké
Kohan Lamordé
Kohan Abdoulay
Kollo Peul
Kollo Zarma
Kollo Haoussa
Kongou Peul
Kongou Zarma
Alfa Hokki
Séberi Zarma
Diokoti Say
Diokoti Lamordé
Doguel Kaïna
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38
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44
45
46
47
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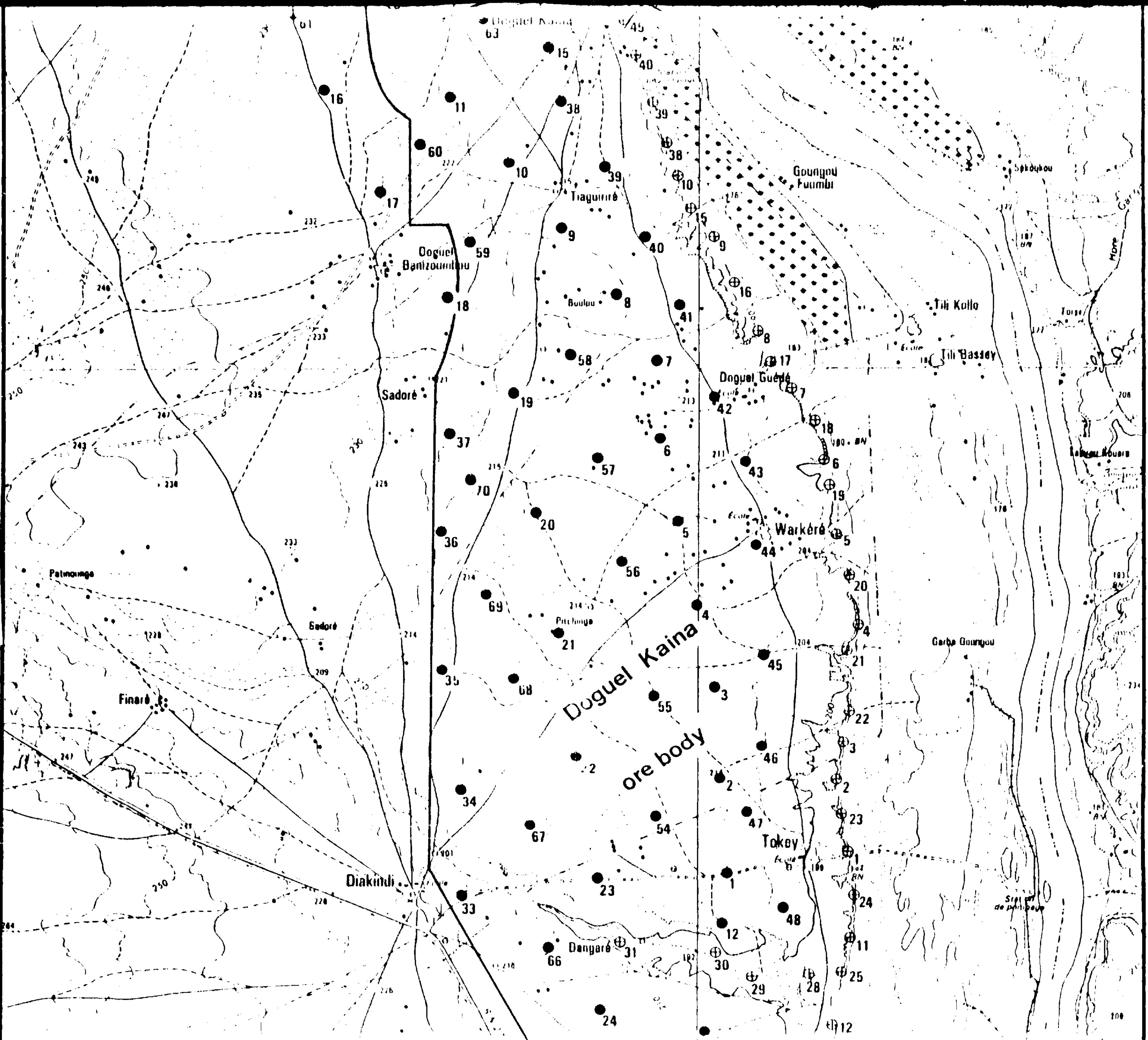
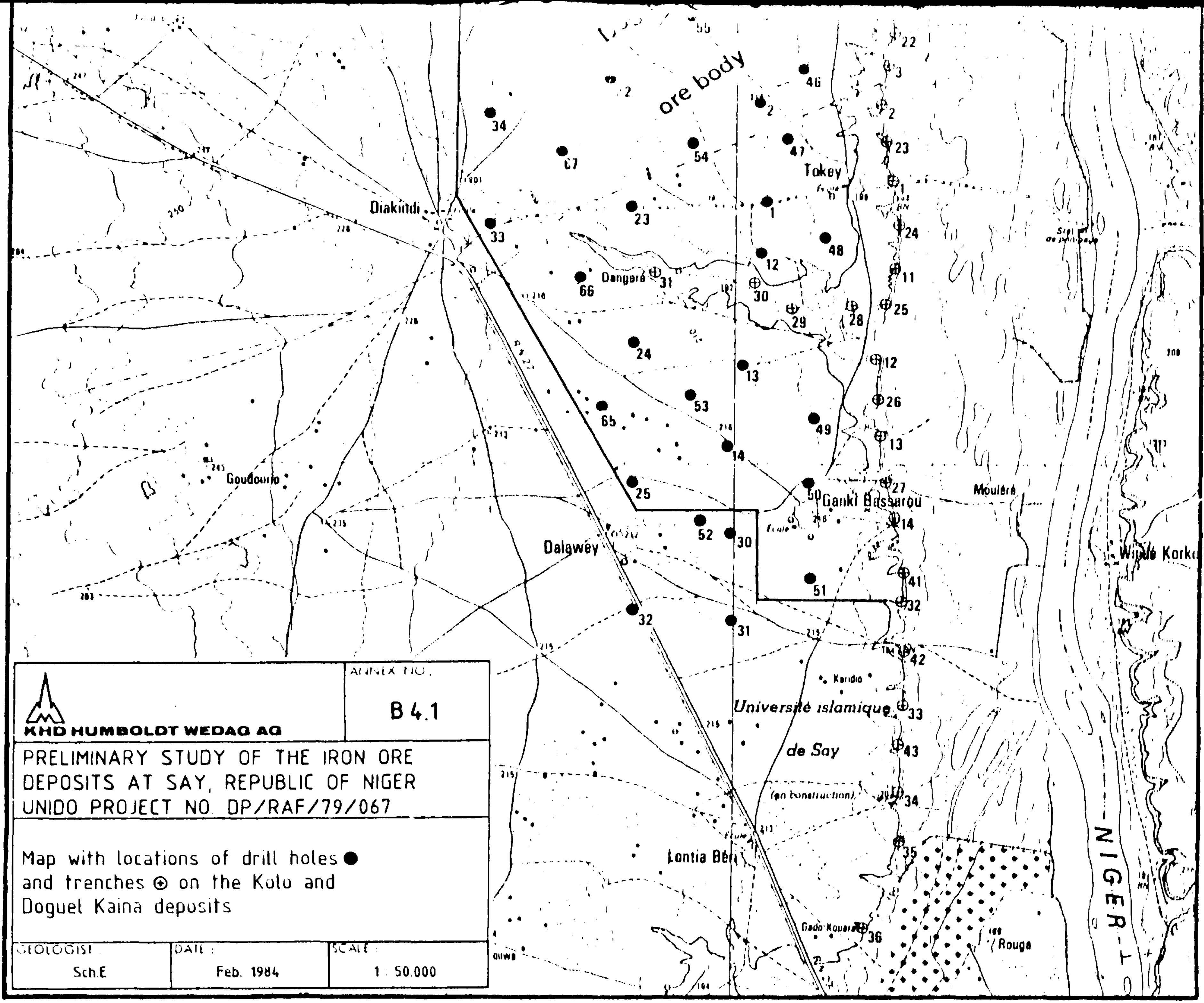
62
63
64

SECTION 2



Doguel Kaina
ore body
Doguel Kaina
Doguel Banizoumbou
Sadoré
Tiaguirré
Boulou
Goungou Foumbi
Sakoukou
Tili Kollo
Tili Bassey
Doguel Guédé
Warkéré
Pitchinga
Patinounga
Sadoré
Finaré
Garbe Goungou
Tokey
Diakindi
Dangaré
Ecole

SECTION 3



KHD HUMBOLDT WEDAG AG

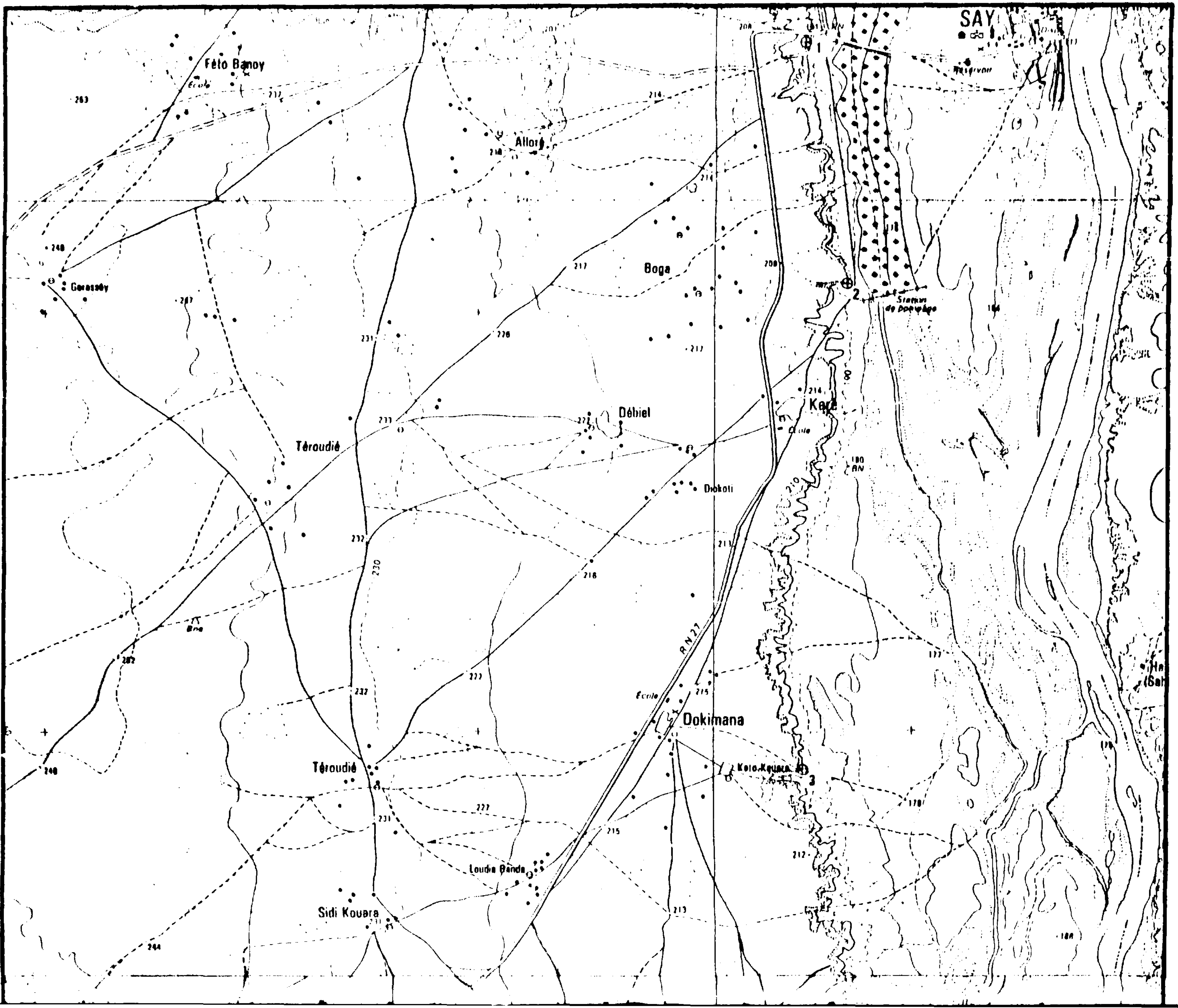
ANNEX NO.: B 4.1

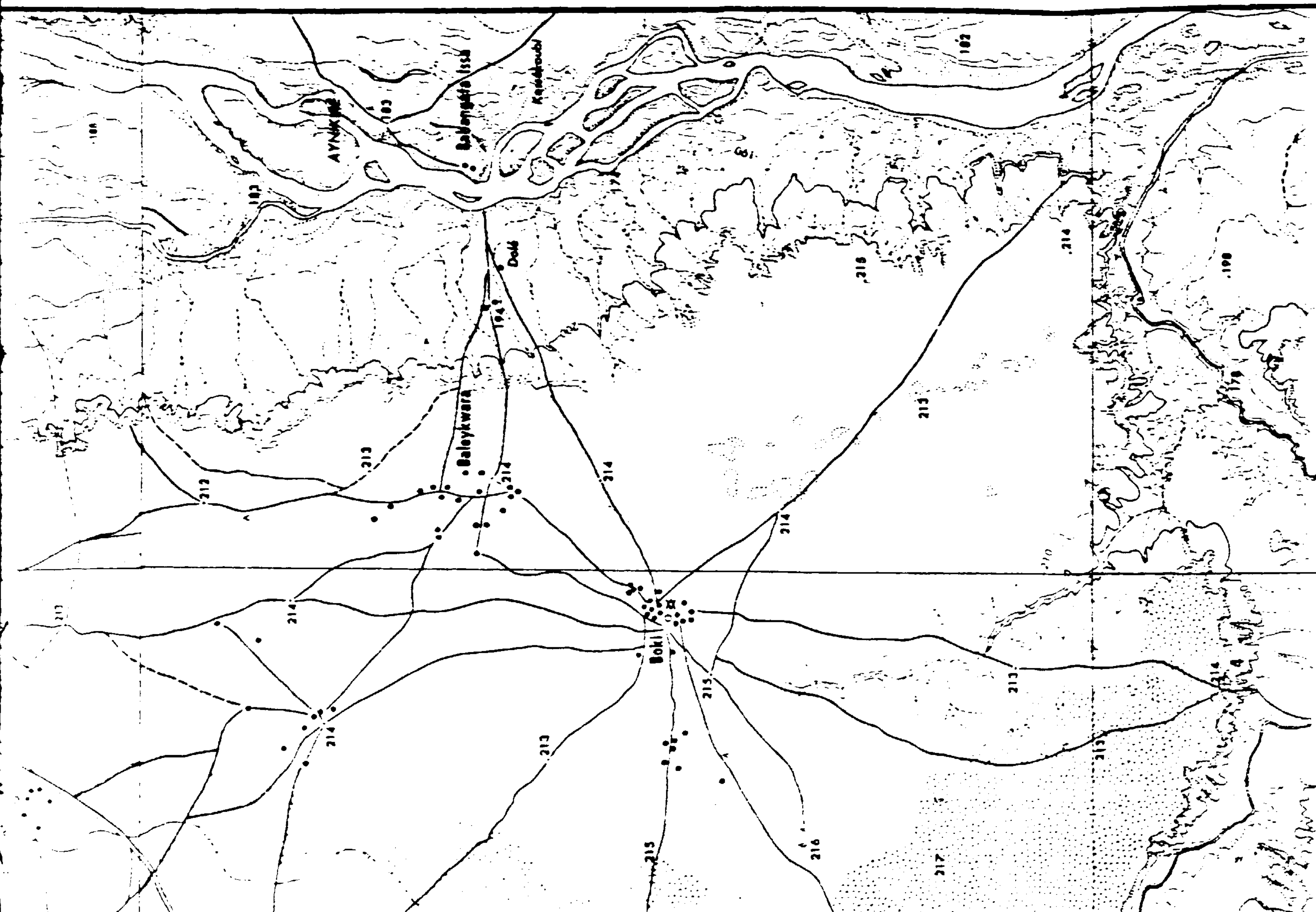
PRELIMINARY STUDY OF THE IRON ORE DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Map with locations of drill holes ● and trenches ⊕ on the Kolo and Doguel Kaina deposits

GEOLOGIST:	DATE:	SCALE:
Sch.E	Feb. 1984	1 : 50.000

SECTION 1


Féto Banoy
École
263
217
214
Allore
218
216
SAY
Réservoir
208
1
2
Station de pompage
Boga
217
208
Gorassay
240
227
226
231
217
184
Débiel
222
214
Karé
École
180 BN
Diokoti
233
Téroudié
232
230
213
218
RN 27
282
Bne
177
222
232
215
École
Dokimana
Koto Kouara
3
Téroudié
240
231
227
215
176
Loudia Banda
Sidi Kouara
212
213
244
186


Sidi Koura
Bayo
Boki
Baloykwara
Dolé
AYNAK
.235
.228
.225
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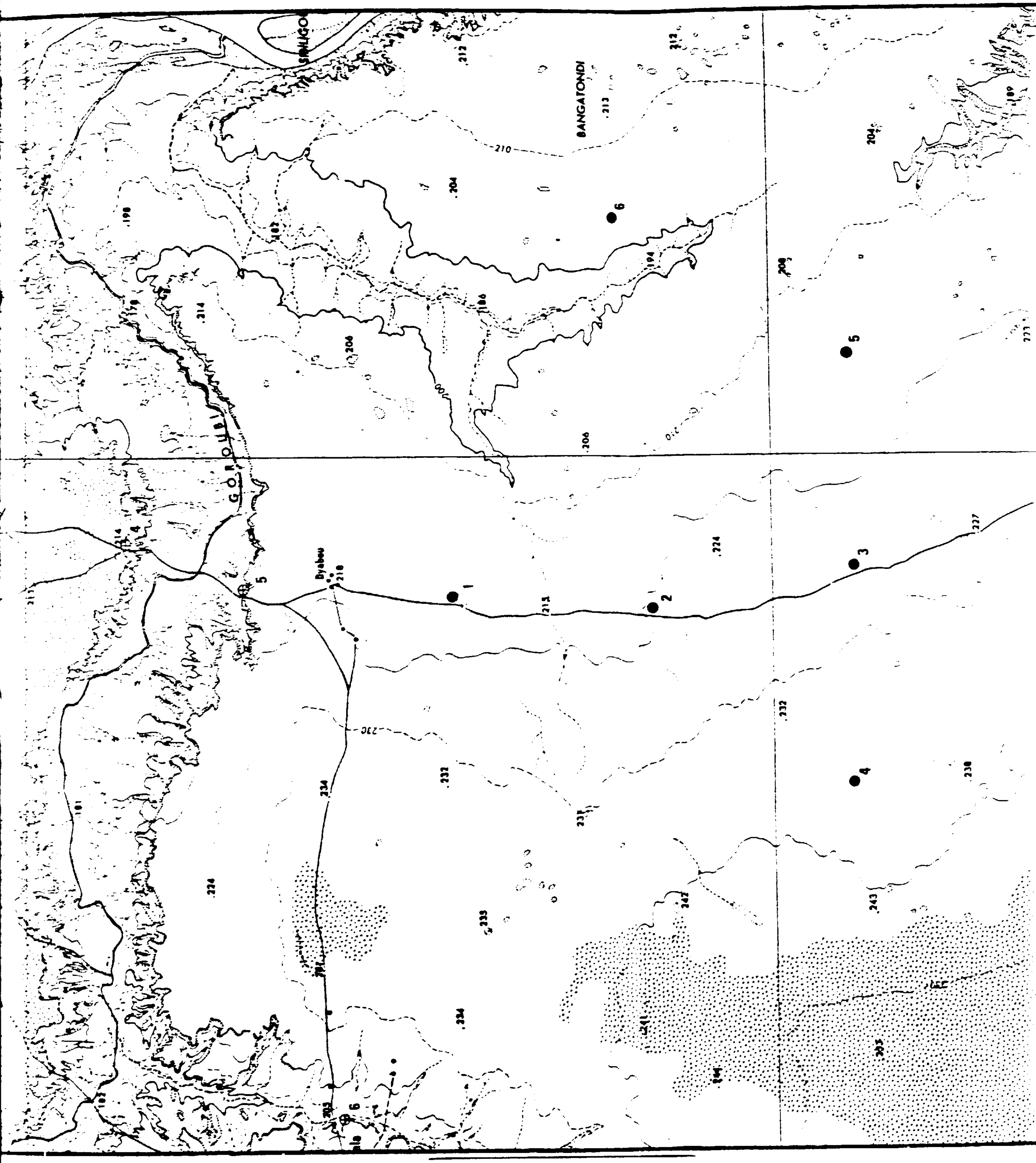
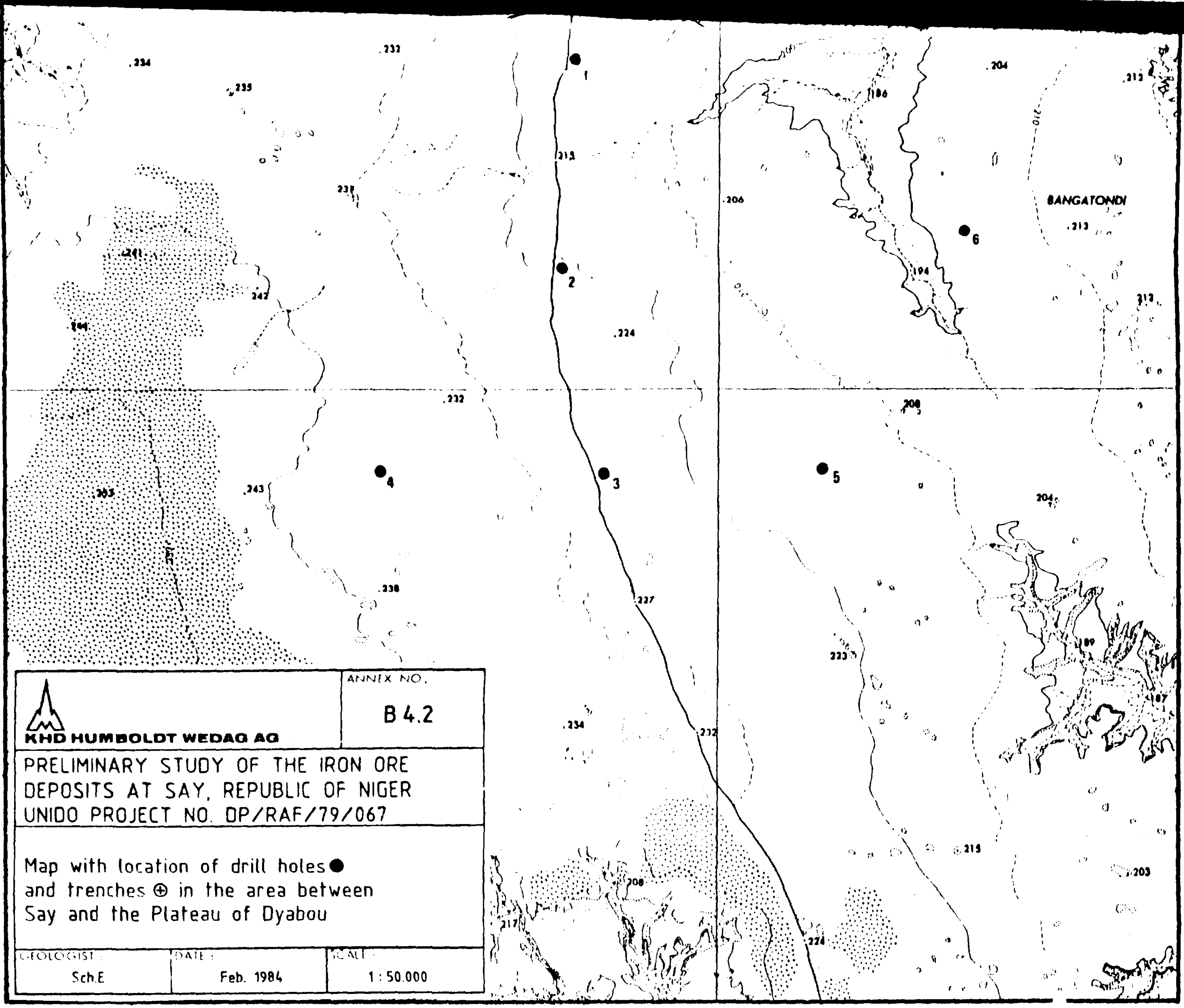
217
213
214
212
.218
.198
179
181
224
230
182
183
184
194

SECTION 2


SIRLIGO
BANGATONDI
.213
.212
.212
210
.204
6
.198
.182
.194
.186
204
5
208
.214
.206
206
210
GOROUBI
214
4
5
Dyabou
.218
1
.213
2
.224
3
.227
230
234
.232
.232
231
4
230
.224
.181
.233
242
243
202
234
241
203
244
6
202
183

SECTION 3

SECTION 4



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ANNEX NO.
B 4.2

PRELIMINARY STUDY OF THE IRON ORE
DEPOSITS AT SAY, REPUBLIC OF NIGER
UNIDO PROJECT NO. DP/RAF/79/067

Map with location of drill holes ●
and trenches ⊕ in the area between
Say and the Plateau of Dyabou

GEOLOGIST :	DATE :	SCALE :
Sch.E	Feb. 1984	1 : 50.000