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AUGUST 25, 1993

TARGET RESERVOIR ANALYSIS

REPORT ON
UNIVERSAL RESOURCES CORPORATION
BLAND NO. 1-33
FOR BOB POWELL

Sec. 33, T. 21 N., R. 9 W.
Major Co., Oklahoma

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SUMMARY

A conventional core, core analysis results, and logs from the Universal Resources Corporation Bland No. 1-33 well (Section 33, T21N, R9W, Major County, Oklahoma) were submitted for analysis. The core is 5.7 feet long from 9189.0 to 9194.7 feet. Gray granite clasts dominate the core. At three levels within the core fine-grained matrix is present. The matrix consists of two distinct rock types: a sandstone that may be porous and a dense, nonporous, dolomitic mudstone. Because of the presence of shelter pores beneath the granite clasts and grading within the matrix material, the matrix is interpreted to have infiltrated into the porosity between the granite clasts after the clasts were deposited. The three levels of matrix material imply at least three depositional episodes are represented in this core. Three x-ray diffraction preparations were performed. Two of these show no expandable clays and one preparation shows a pure smectite which is interpreted as drilling mud.

Dissolution porosity is present within the granite clasts and within individual mineral grains in the sandstone matrix. Partial dissolution of perthite and mica grains is well documented in the report. There are also molds of grains that have been completely dissolved. Larger pores in the core appear to be present between granite clasts and are up to two centimeters across. These pores are generally lined by dolomite, abundant pyrite, and traces of bitumen. These large pores are probably the most important porosity class controlling production. The cored interval is interpreted as a granitic breccia ultimately produced by the impact or explosive force of a meteor.

The granite breccia is recorded by high gamma ray levels on the logs. Porosity logs have a sandstone profile and suggest a systematic improvement downward through the breccia. Spikes on the laterologs are interpreted as granite clasts that encircle the hole. A 100% water level is indicated below 9,270 feet and the lowest level recommended for testing is 9,200 to 9,212 feet.

INTRODUCTION

A conventional core, core analysis results, and logs from the Universal Resources Corporation Bland No. 1-33 well (Section 33, T21N, R9W, Major County, Oklahoma) were submitted for analysis. Thin section, scanning electron microscopy (SEM) with energy dispersive x-ray spectrometry (EDS), and x-ray diffraction analyses (XRD) described below were performed on selected samples. The petrographic work was undertaken in order to: determine reservoir quality, determine the effect of the mineralogy on log responses for proper log evaluation, and to estimate various petrophysical characteristics of the sampled intervals. The sample analysis scheme is:

DEPTH	THIN SECTION	SEM	XRD
9189.1A	X		
9189.1 B	X		
9191.0	X		
9191.4A	X	X	
9191.4B	X		
9191.5			X
9193.7	X		X
9194.6			X

Thin section petrography provides the best overall characterization of the rock samples. The thin sections are prepared by a contractor. The rock is first impregnated with a low viscosity, blue epoxy and then the thin sections are made. Most mineral and amorphous phases can be identified and visual estimates of all porosity types are possible from the thin sections. Grain size, sorting, and grain textures can be accurately estimated as well. Observations are documented in photomicrographs and summarized in the "Sample Data Sheets".

The scanning electron microscope (SEM) provides a three-dimensional view of the grain surfaces and pores. Freshly fractured surfaces of each sample are used for SEM analysis. The samples are sputter coated with gold-palladium and photographs document the observations. Measurements of pore sizes and estimates of pore tortuosity can be made. The high magnifications coupled with energy dispersive x-ray spectrometry (EDS) allow for the identification of even clay-size materials. Data from thin section and SEM petrography is used in the interpretation of depositional and diagenetic history.

X-ray diffraction analysis (XRD) provides excellent qualitative mineral identification and semiquantitative compositions by weight of the crystalline components of the rock samples. A complete procedure requires separate analysis of the "bulk" sample and a "clay" fraction. Only clay analyses were performed for this report. Graphs of the XRD scans are presented in the report. This information is used in the preparation of the sample description pages also.

Analysis of the clay fraction begins by crushing the samples then disaggregating the fine grained material in water and clay dispersant with ultrasonication. The suspended material is centrifuged to separate the particles by size. Particles less than 5 µm in size are then filtered out of suspension and saturated with magnesium ions. The filtered clays are then transferred to a glass slide and scanned from 2 to 40° 2-theta by step scanning as above and the data collected by computer. To test for the presence of swelling clays the samples are x-rayed a second time after they are saturated with ethylene glycol. The two resulting scans are presented together.

DESCRIPTION OF THE CORE

The core submitted is 5.7 feet long and is marked from 9189.0 to 9194.7 feet. The two-thirds portion of the slabbed core was examined for this report. The core is in fair condition. Pieces of the core are apparently missing from the 9190.8 to 9191.5, 9193.1 to 9193.5, and below 9194.2 foot intervals. This is however, the most complete core of the granite breccia material from the Ames field that we know of. Comparison of the core gamma ray log to the open hole logs suggest that core depth minus one foot equals log depth.

Gray granite clasts dominate the core. Small variations in the ratio of plagioclase to perthite within the clasts produces small variations in color in the granite. The perthite is lighter in color due to the difference in mineralogy and since the perthite is often partially dissolved and replaced by clay. At three levels within the core abundant matrix material is preserved. This is discussed in more detail below. Because of the presence of shelter pores beneath the granite clasts and grading within the matrix material it is interpreted to have infiltrated into the porosity between the granite clasts after the clasts were deposited. The three levels of matrix material imply at least three depositional or infiltration episodes are represented in this core.

Apparently missing core pieces may be interpreted as lost core, or may actually represent large interclastic pores. Support for the large pore hypothesis is that the log porosity is much higher than the porosity measured by whole core analysis and the high production rates attained in this unit imply good permeability.

X-RAY DIFFRACTION RESULTS

Clay preparations were made from samples from three depths in the core. The samples were rinsed with water but were not sonicated to clean them before they were crushed. The sample from 9191.5 feet is from matrix material. The sample from 9193.7 feet is from matrix material that has large vugs. The sample from 9194.6 feet is from a granite clast. A variety of scans are presented. In each case the scan after treatment with ethylene glycol is plotted over the untreated sample. Ethylene glycol attaches to the expandable clay layers and enlarges them. This shifts peaks of expandable clays to the left on these plots, toward smaller 2-theta values or toward larger D-spacings.

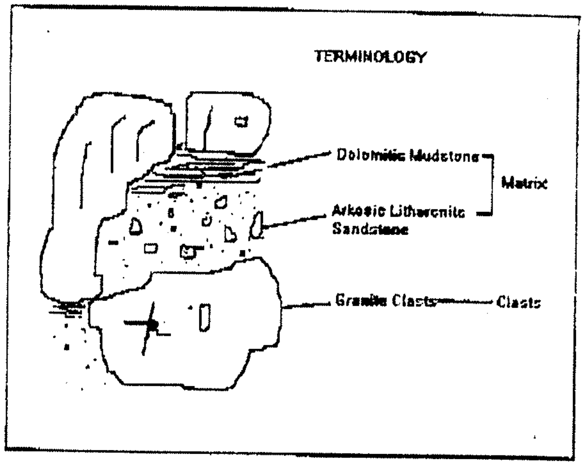
The upper and lower samples show no shifting in any of the peaks after treatment with ethylene glycol. This indicates that no expandable clays are present in these two samples. The peaks do indicate the presence of illite and chlorite mineralogies. Many other peaks representing other minerals besides clays are present in the scans. These are present because much sonication was required to obtain enough clay size material for analysis and the sonication liberated or broke up and released very small pieces of these other minerals.

The middle sample (9193.7 feet) does contain expandable clays. Note how the tallest peak has moved to the left about 1.3 degrees 2-theta. The expandable clay is smectite and is not interlayered with other clays. There are two criteria for determining the lack of interlayering. The first is that the D-spacings in the glycolated mineral are "rational". The expected "rational" D-spacings for the 002 and 003 peaks are determined by the formula d=d(001) / l. In this case d(001) is 16.9086 so the expected 002 spacing is 16.9085 / 2 = 8.4543Å. The observed value is 8.4630. The expected 003 spacing is 16.9085 / 2 = 5.6617 Å and the observed value is 5.6181. The close correspondence of these numbers suggests there is no random interstratification of other clay minerals in the expandable clays. A second criteria is that there is a regular increase in the difference between the 002 and 003 peaks as the percentage of illite in ethylene glycol saturated, illite/smectite increases. With 10% illite in the smectite, the difference should be 5.49 degrees 2-theta. With 90% illite, the difference is 8.38 degrees 2-theta. The difference observed in this sample is 15.761 - 10.444 = 5.317 degrees 2-theta. This again indicates that there is none or very little illite interstratified with the smectite.

The smectite observed in the sample from 9193.7 feet is interpreted to be drilling mud. The reasons for this are that 1) it is not present in every sample, 2) it is present in the samples with larger pores, 3) it is very unlikely that smectite could survive with no alteration to illite/smectite in rock of this age and at these depths and temperatures, 4) no smectite was observed in SEM examination of the rocks, and 5) smectite was used in the drilling mud.

PETROGRAPHIC DESCRIPTION

Petrographic work on this Granite Breccia core was undertaken to characterize the clasts and the matrix materials. The diagram below illustrates the terminology used in discussing the lithologies encountered in this core. The photographs that accompany the sample descriptions illustrate the features discussed below. The main lithologic distinctions made are between the clasts and the matrix material. Clasts are defined as granite fragments larger than four centimeters across. The matrix consists of two distinct rock types: a sandstone that may be porous and a dense, nonporous, dolomitic mudstone.



The clasts are gray granite. Most of the breccia in the core is clast supported. Individual clasts of granite are coarsely crystalline (3 to 10 mm) and are predominantly composed of perthite (K-feldspar with elongate plagioclase inclusions), plagioclase, and quartz, with minor amounts of altered mica. Most of the clasts are subangular. This suggests some transport of the granite clasts. Only one pebble size clast of dolomite was observed. The Arbuckle dolomite is well represented in the matrix material but is lacking in the coarser clasts in this core. The granites are altered. Many of the clasts are fractured and perthites and micas are partially dissolved. Within the dissolution pores, pore-bridging illite is usually found. Pyrite and bitumen are also commonly present in the dissolution pores and in the fractures. Porosity is present in the granite clasts, but the pores are relatively isolated and are probably not well enough connected to contribute much to production.

Most of the matrix is classified as sandstone. Individual grains in the sandstone range from about ten micrometers to four centimeters and are poorly sorted. The dominant detrital grains are fragments of dolomite. Quartz, perthite, plagioclase, granitic rock fragments, mica, and some molds after unidentified dissolved grains are also present. The matrix sandstone is classified as an arkosic litharenite. The composition is the result of mixing of fragments of basement granite and Arbuckle Dolomite.

Clast support in the breccia has apparently allowed the infiltration of matrix material. At several levels within the core, sandstone matrix is overlain by bedded dolomitic mudstone. This implies that the infiltration of clastic material was periodic and decreased in intensity. Infiltration also allowed localized patches of intergranular or interclastic porosity to be preserved. These pores can be quite large and were sheltered from infiltration by large overlying clasts.

Diagenesis has moderately altered the sandstones. Cementation involves the precipitation of ferroan dolomite and compaction and local solution and reprecipitation of the silt-size detrital dolomite. The amount of intergranular porosity appears to be directly related to the amount of dolomitic mudstone within the core. Where silt-size dolomite material is abundant in the matrix, intergranular porosity is low. Portions of the core that did not receive the fine-grained dolomitic material contain pore-lining diagenetic ferroan dolomite cements. Euhedral, ferroan dolomite crystals line intergranular pores, shelter pores, and fractures. Diagenetic dolomite is sometimes overlain by individual crystals or crusts of pyrite and bitumen.

Dissolution porosity is present within the granite clasts and within individual mineral grains in the sandstone matrix. Partial dissolution of perthite and mica grains is well documented in the report. There are also molds of grains that have been completely dissolved. The original composition of these grains cannot be determined. They are now filled by microporous clays, dolomite, and pyrite. One example of these removed grain shows a rim or chalcedony (chert) around part of the grain margin. Dissolution pores after mica often contain chlorite, titanium oxide minerals, and pyrite. Dissolution pores in perthite are bordered by microporous remnants of the feldspar grain and often contain pore bridging illite. Larger pores in the core appear to be present between granite clasts and are up to two centimeters across. These pores are generally lined by dolomite, abundant pyrite, and traces of bitumen. These large pores are probably the most important porosity class controlling production.

The paragenetic sequence determined from petrography is summarized in the table below.

PARAGENESIS

Infiltration and induration of matrix
Fracturing of clasts and matrix
Dissolution of unknown grains, perthites, and micas
Illite and Chlorite cements
Ferroan dolomite cements
Pyrite cements
Emplacement and degradation of hydrocarbons
Emplacement of additional hydrocarbons

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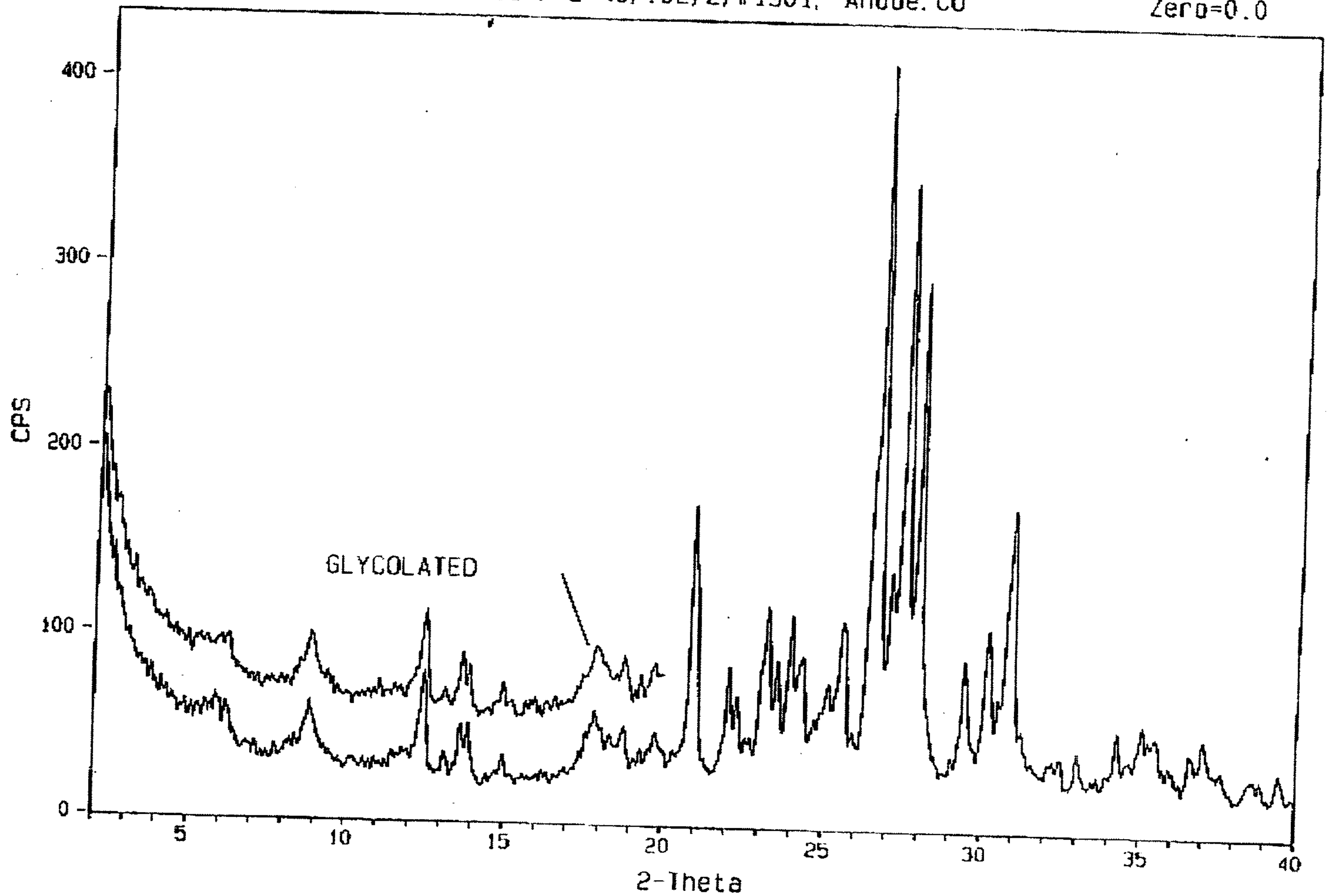

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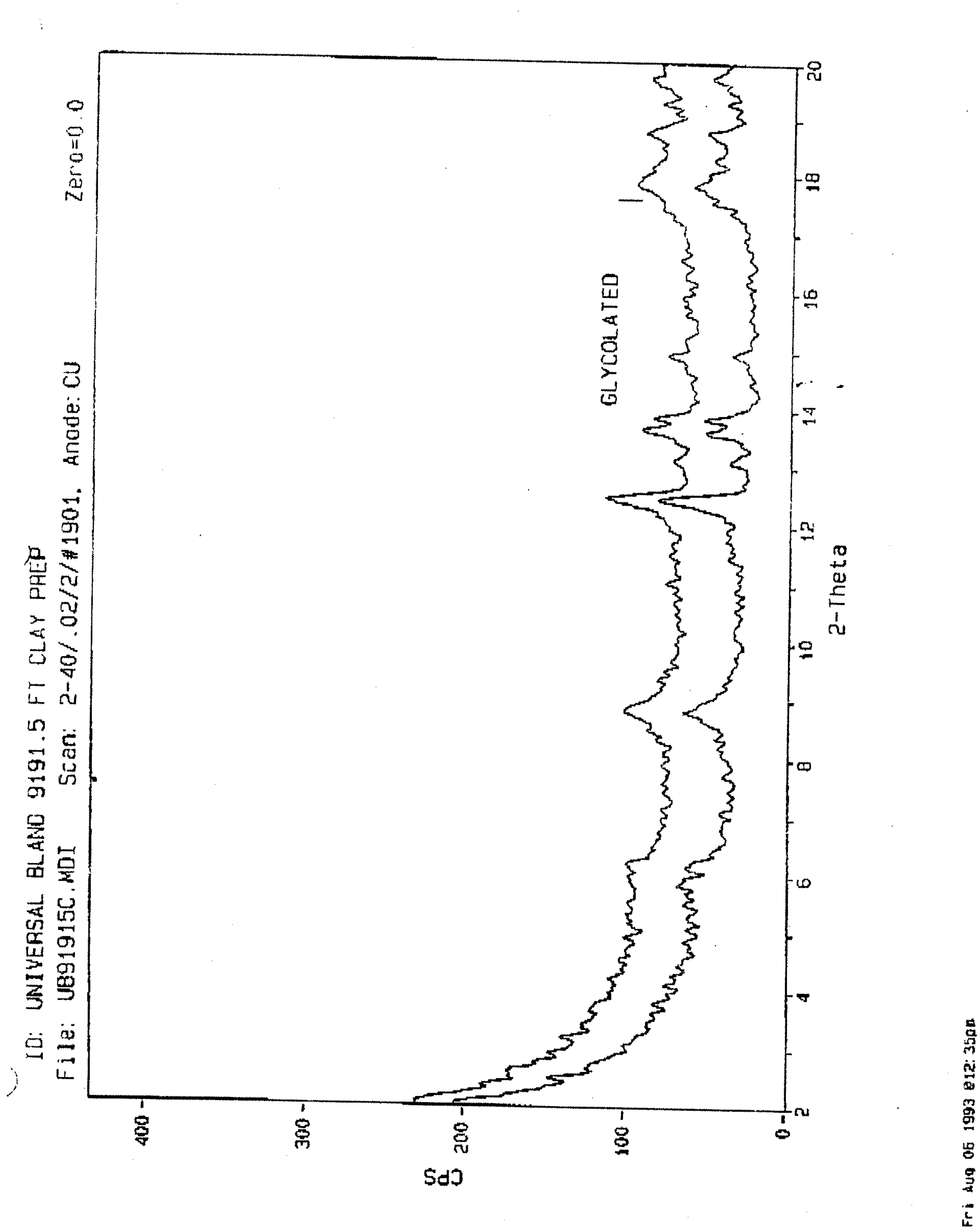
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GLYCOLATED
CPS
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300
200
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0
2
4
6
8
10
12
14
16
18
20
2-Theta
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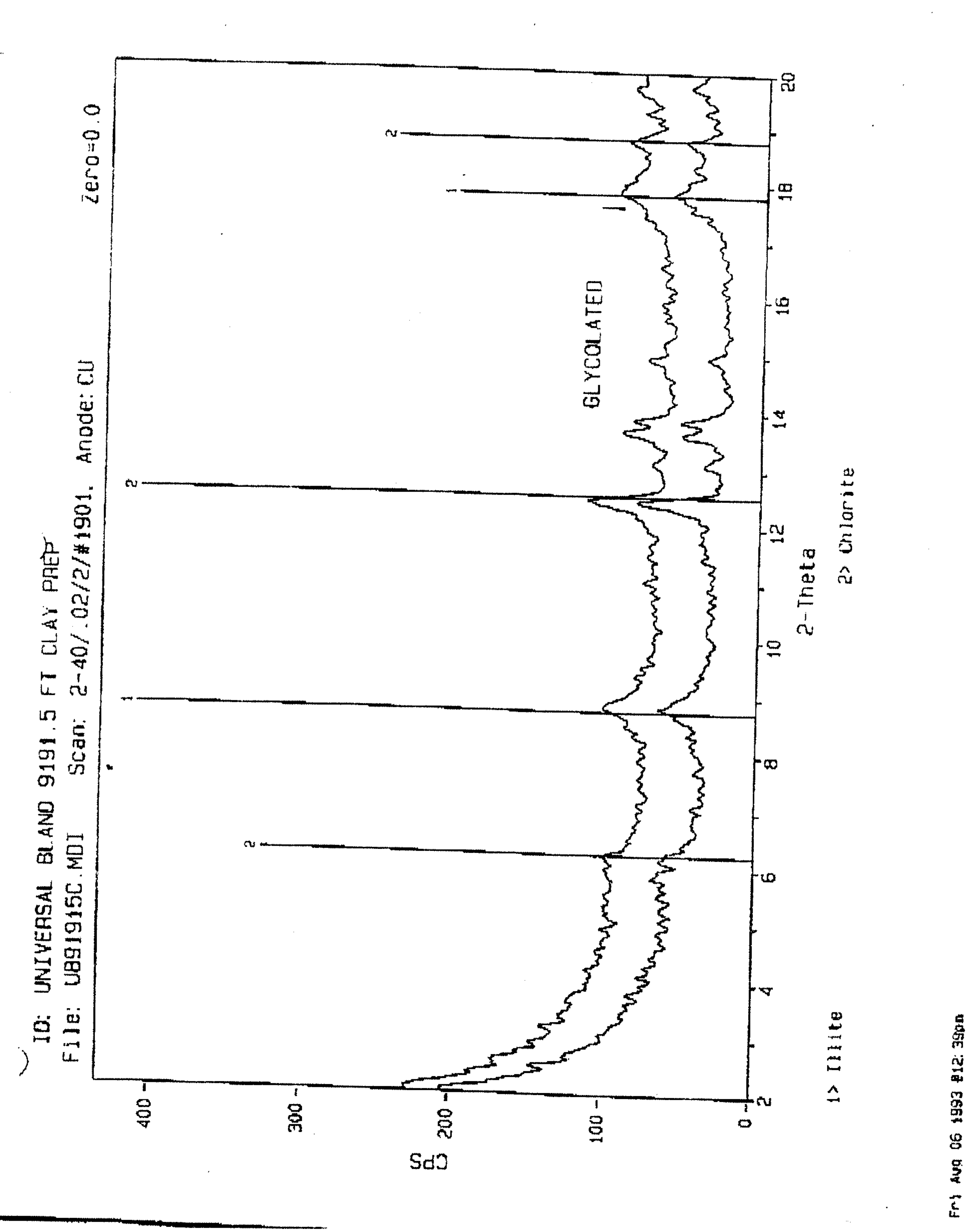

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GLYCOLATED
CPS
0
100
200
300
400
2
4
6
8
10
12
14
16
18
20
2-Theta
1> Illite
2> Chlorite
1
2
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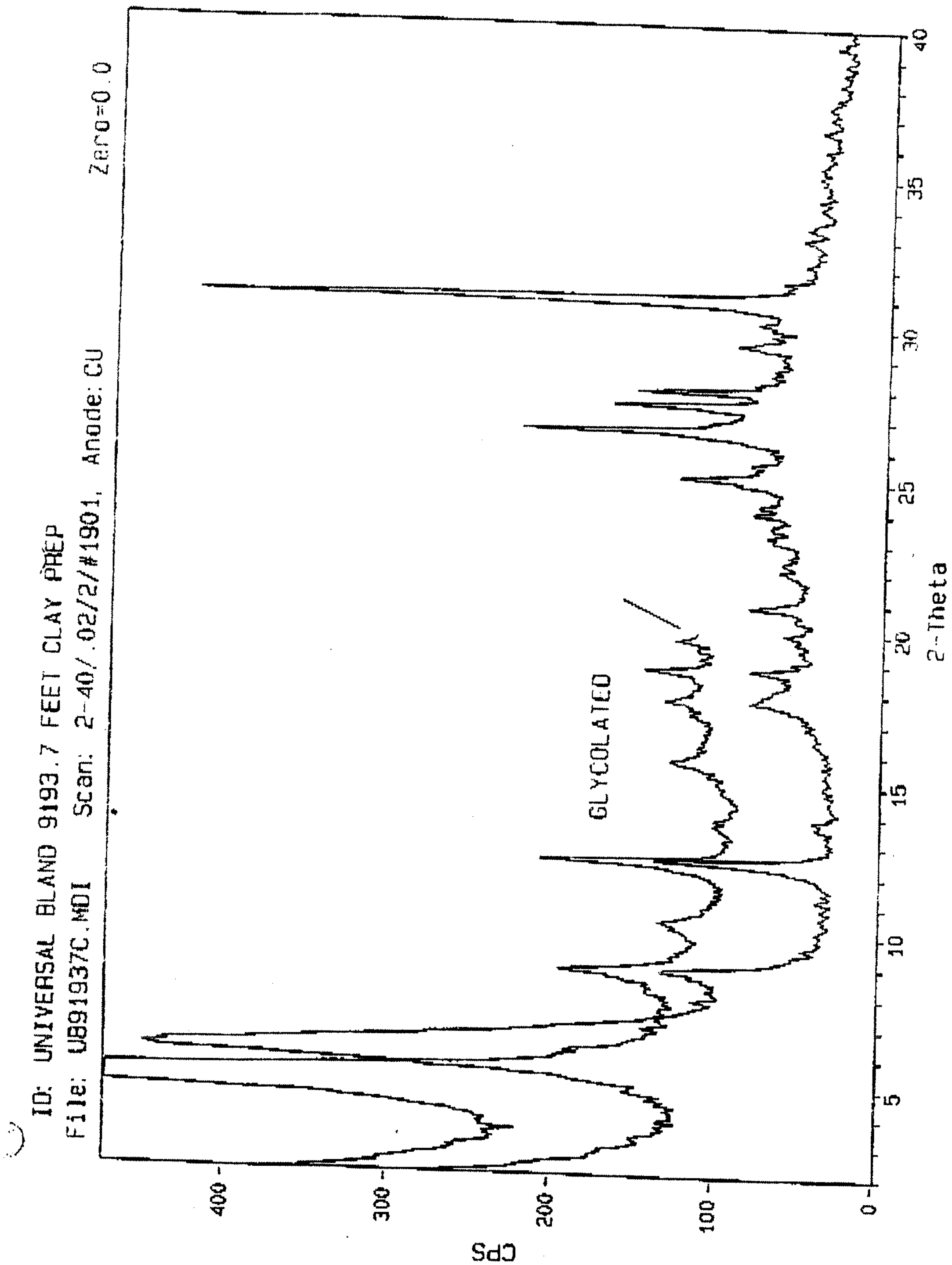

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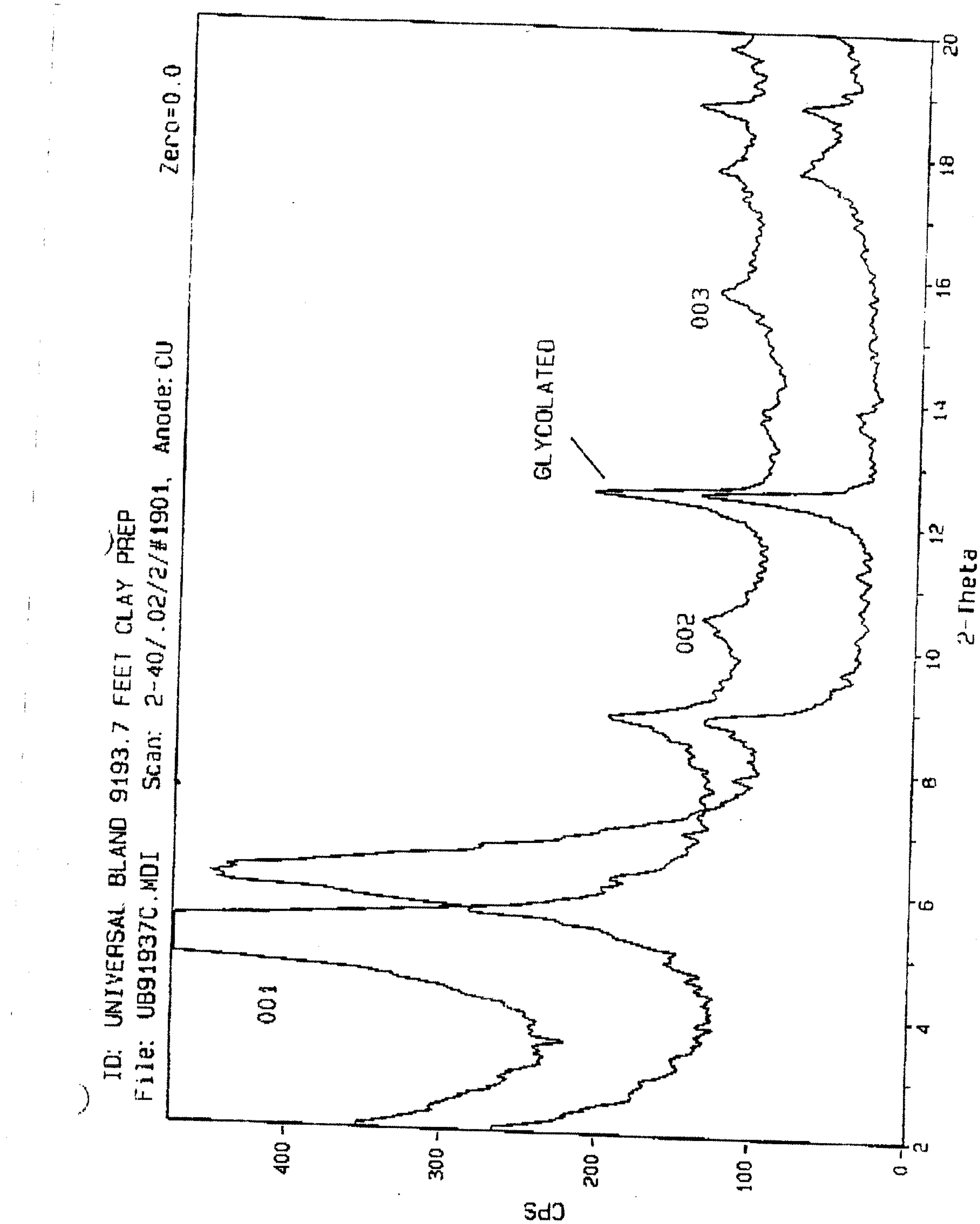

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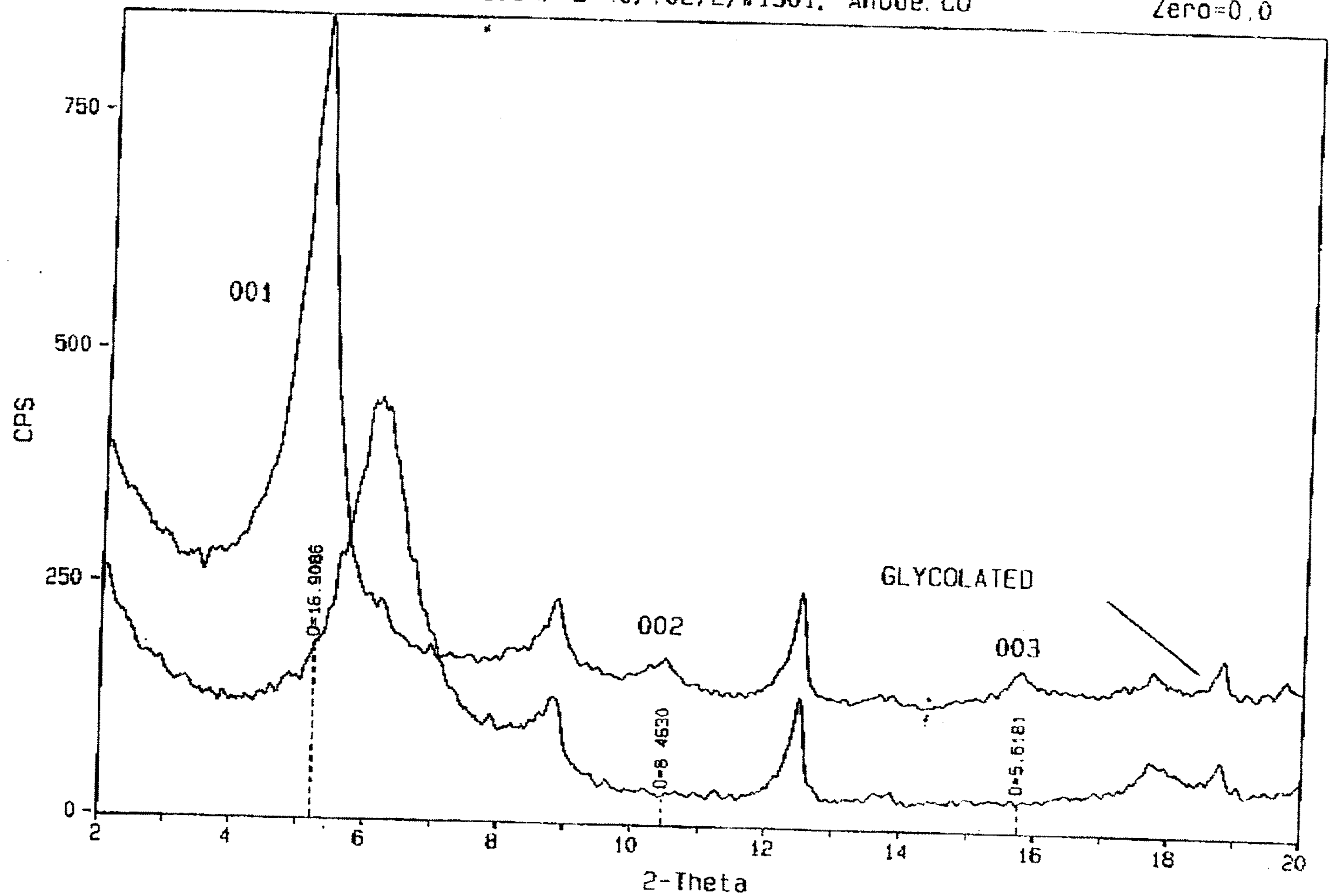

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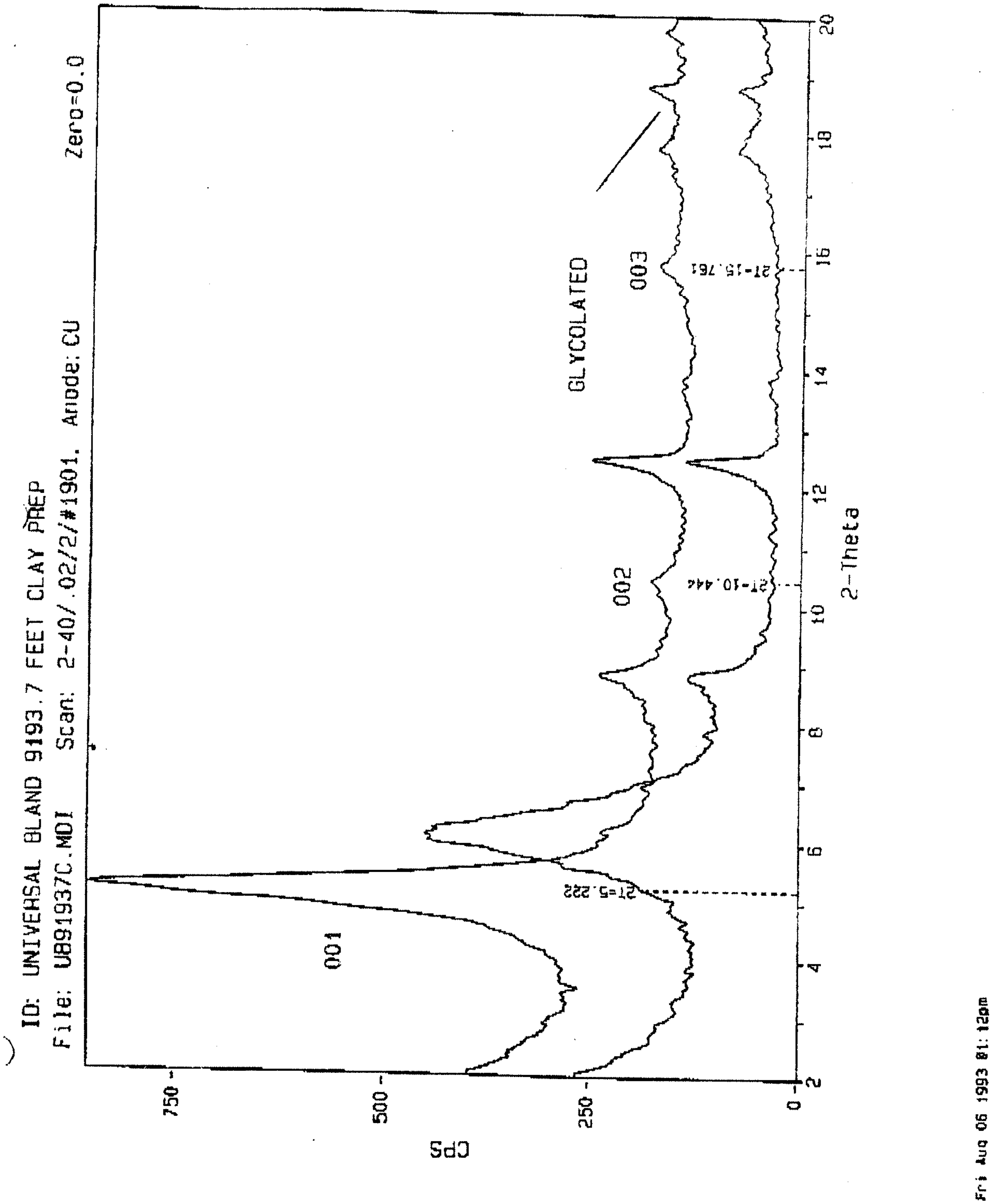
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001
002
003
GLYCOLATED
2T=5.222
2T=10.444
2T=15.761
CPS
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500
250
0
2
4
6
8
10
12
14
16
18
20
2-Theta
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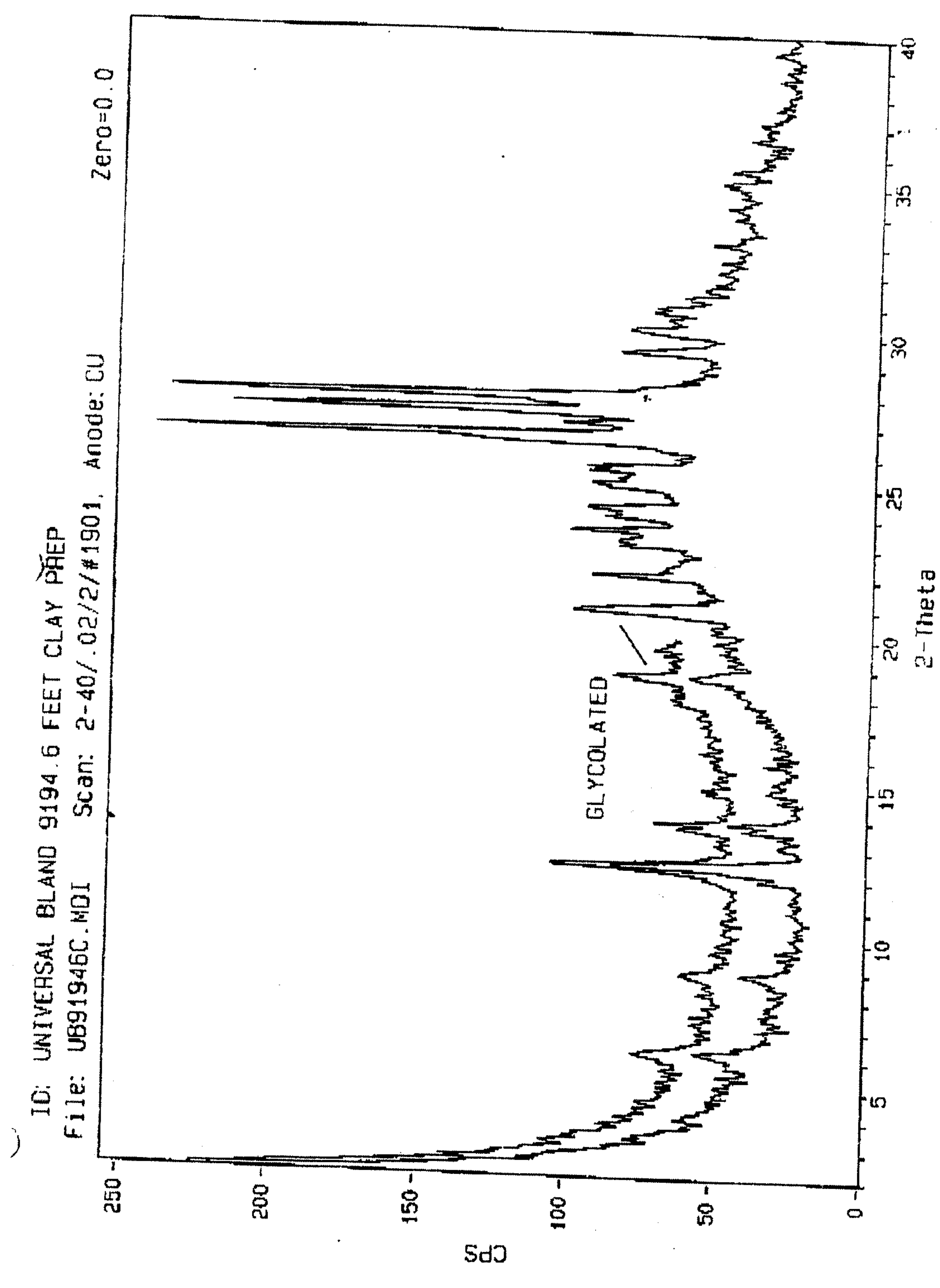

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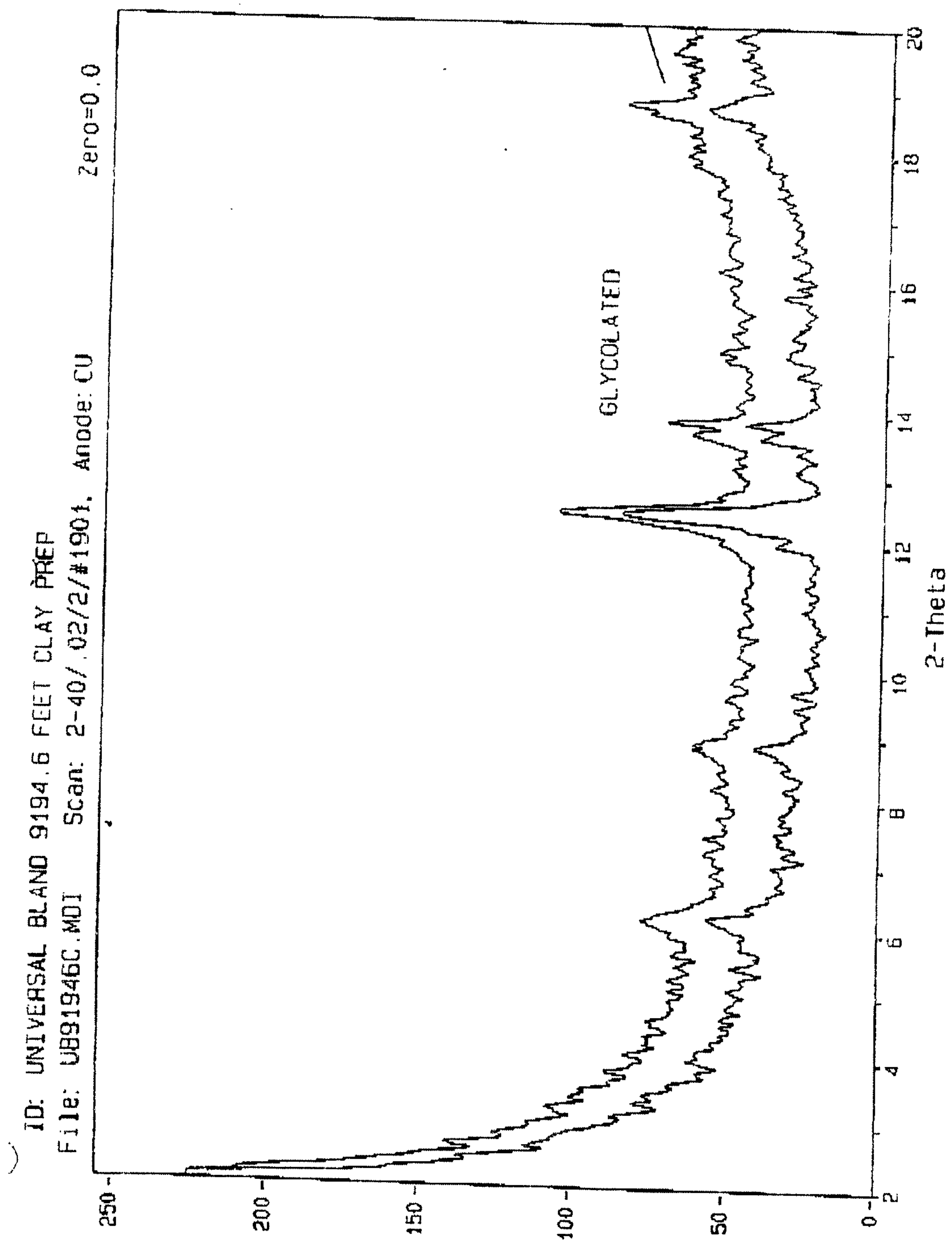

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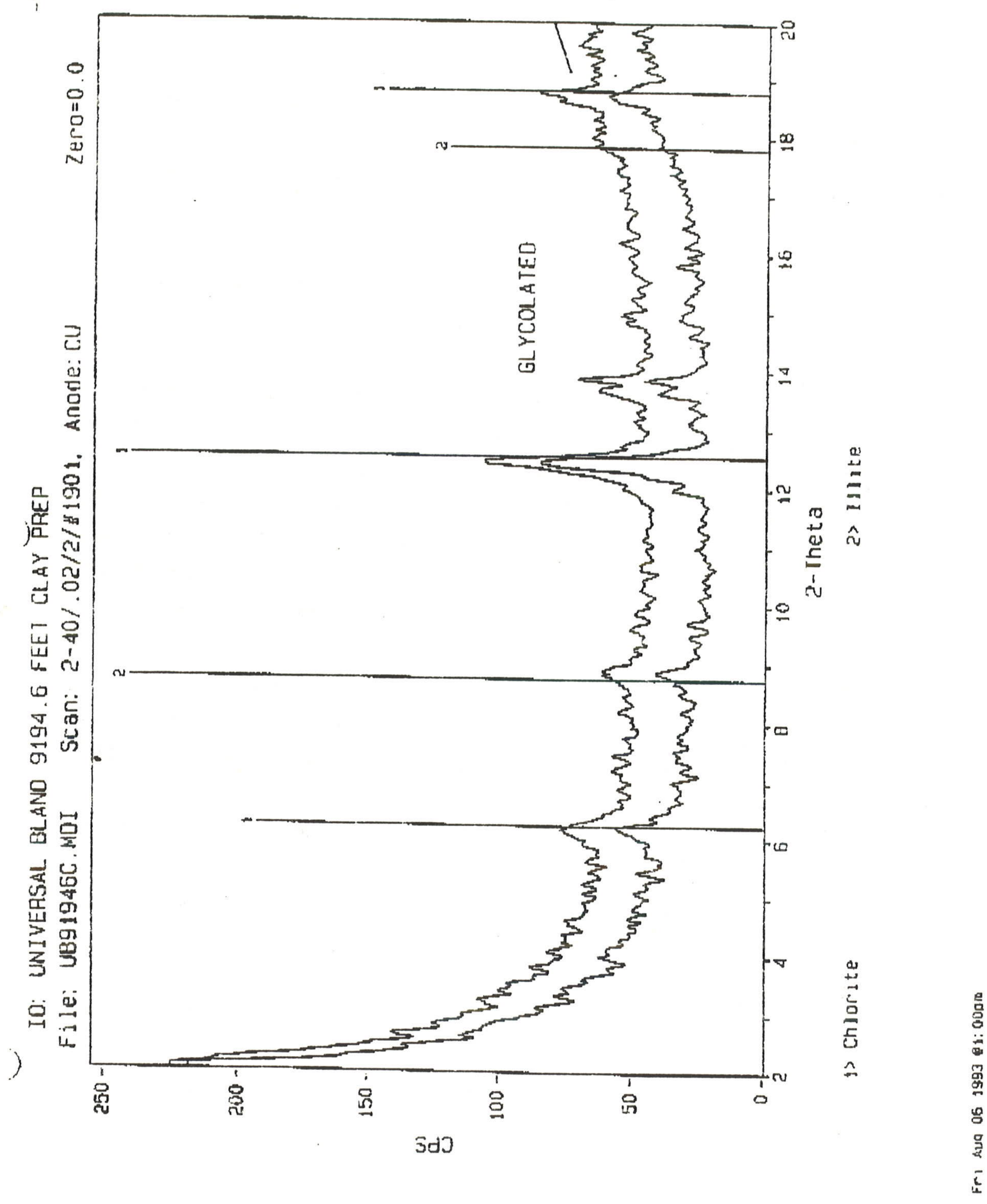

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GLYCOLATED
CPS
250
200
150
100
50
0
2
4
6
8
10
12
14
16
18
20
2-Theta
1
2
1> Chlorite
2> Illite
Fri Aug 06 1993 @1:00pm