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Soil
Conservation
Service

Northeast NTC
160 East 7th Street
Chester, PA 19013
215-499-3960

Subject: Ground-penetrating radar (GPR) Archaeological Investigations; Poverty Point State Commemorative Area, Epps, Louisiana; October 28 & 29, 1988

Date: November 4, 1988

To: Arville B. Touchet
State Soil Scientist
Soil Conservation Service
3737 Government Street
Alexandria, Louisiana 71302

File code: 430-13

Purpose:
To provide ground-penetrating radar field assistance to archaeological investigations at Poverty Point State Commemorative Area (SCA), Epps, Louisiana

Participants:
Thurmon Allen, Soil Scientist, SCS, Monroe, LA
Paul Baker, Anthropology Department, USL, Lafayette, LA
Jim Doolittle, Soil Specialist, SCS, Chester, PA
Doug Gillette, Soil Scientist, LA Dept. Ag. and Forestry, Monroe, LA
Dan Lee, GIS Specialist, NASA, ERL/STL, MS
Fred Mayer, Anthropology Department, USL,Lafayette, LA
Frank Miller, Director, MS Rem. Sensing Ctr., MSU, Mississippi State, MS
Tom Sever, Rem. Sensing Arch., NASA, ERL/STL, MS

Activities:
The GPR unit arrived at Poverty Point SCA on the afternoon of 27 October. Multiple transects were completed along established lines on 28 October. The data was reviewed and the unit began its return to Chester, PA, on 29 October.

GPR Equipment:
The GPR unit is the SIR System-8 manufactured by Geophysical Survey Systems, Inc. The unit consists of a power distribution unit, the model 4800 control unit, the ADTEK model DT-6000 graphic recorder, and the ADTEK model SR 8004H tape recorder. The system was powered by a 12 volt vehicular battery.

The 120 and 500 MHz antennas were used in this study. Antenna frequency affects the resolution and the profiling depth of the GPR. A general rule is that as the antenna frequency is decreased, the minimum and maximum profiling depths increase and the resolution is decreased. The long pulse (5 nanoseconds in air) width of the 120 MHz antenna made attempts to resolve features within the upper 35 cm of the Memphis soil profile impracticable. The signals from the 500 MHz antenna (pulse width

The 120 MHz antenna was towed behind a 4WD vehicle at speeds of 1-3 km/h. Soil borings were made at several site to scale the radar imagery and to confirm interpretations.

Discussion:
The depth of effective radar penetration was limited by the relatively high clay content (18 to 34 %) of Memphis (fine-silty, mixed, thermic Typic Hapludalfs) soils. In areas of undisturbed Memphis soils, imagery was restricted to the soil profile above the argillic horizon (35 to 60 cm). In all profiles, large "white-out" areas are evident below the image of the upper boundary of the argillic horizon. White-out areas represents zones of no or weak signal returns, and often signify the complete attenuation of the radar signal. High levels of unwanted background noise (identified by multiple, parallel lines) were present in the lower part of profiles at higher gain settings.

While imagery was restricted to depths of less than 60 cm, many artifacts buried within this shallow depth interval were indiscernible because of their small size and low reflection coefficients. The small size of most buried artifacts (such as projectile points and small stone tools) require higher antenna frequencies for resolution. Unfortunately, signals from the higher frequency 500 MHz antenna were attenuated within depths of less than 15 cm. In addition, most features occurring within the upper 15 cm of the soil profile were masked by the strong reflections from the soil surface. The 300 MHz antenna may provide a better balance of probing depth and resolution than either the 120 or 500 Mhz antennas.

Conclusions:
The performance of the GPR was poor at Poverty Point. Ground-penetrating radar techniques are highly site-specific and interpreter dependent. This techniques, while effective in many areas for archaeological investigation, is neither the most efficient nor economical method which can be applied at Poverty Point.

The GPR did distinguished areas of disturbed from undisturbed soils. However, this information is readily available from black and white and color IR images of the area. The radar failed to detect buried artifacts (other than a pipeline and a (my) buried metallic reflector). Though interpretations and detection of buried artifacts improve with familiarity and time spent in an area, because of the small and dispersed nature of the artifacts and their low reflection coefficients, it is doubtful that additional time spent with the radar at Poverty Point would result in any significant find.

James A. Doolittle
Soil Specialist (GPR)

cc:
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January 20, 1989

James A. Doolittle
Soil Specialist (GPR)
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160 East 7th Street
Chester, PA 19013

Dear Dr. Doolittle:

Hope you will accept my belated thank you for helping out with the Poverty Point investigations. Sorry I couldn't be there to make your acquaintance and see the radar work. Although I think I detected some general disappointment in results from yall, I am quite pleased, delighted is actually more appropriate. The imagery did detect a buried clay-lined fire pit (beneath your buried hubcap), showed the artificial loading in the ridges, and (although we have not yet truthed the anomolies) I believe also revealed patches of made-dirt in the plaza. This is precisely what I hoped it would show. I think it performed admirably. Good stuff. We plan to check out some of the presumed plaza fill spots this summer. How about coming back.

My work permit for these investigations requires that I submit a comprehensive report to the Louisiana Division of Archaeology and this is my second reason for writing. Fred Mayer, one of my students who worked with you, has written up the radar survey but the major part of his report is your report, and I'd like to have your permission to use your info in this manner, or preferably have you do revised version for inclusion in our to-be-published report. Please advise. The report submission date is 1 May 1989.

Again thanks,

Jon Gibson, Ph.D.
Professor of Anthropology

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P.S. Enclosed is transcript of tapes made during work.

GROUND PENETRATING RADAR TEST AT POVERTY POINT, 1988

Frederick J. Mayer, Department of Anthropology, University of Southwestern Louisiana, Lafayette, LA 70504

The following is a transcription of field notes from the Ground Penetrating Test at Poverty Point.

I. Interpreting Graphic Recorder Printouts

Jim Doolittle, soil specialist with the USDA SCS, demonstrated the Ground-Penetrating Radar's (GPR) ability to detect subsurface features by burying a metal hubcap below the surface and then driving over the hole with the GPR unit. After the test run was complete, the graphic recorder's printout was interpreted by Doolittle.

DOOLITTLE: So what I did was, they're expanse scales on there (the graphic recorder), I expanded this particular scale, and ran over it (the hole) again, and you see the imagery right here, here it is again. Frank (Miller) was a little slow on the mark.

You see the hyperbolic patterns here, the question is, I think it's going to be right about here, the first hyperbolic pattern. this is a draw down of surface material above it. there is a hole that has been cut, and then you have a reverberation of the signal, so we look at slightly above that line and probably right here. We'll say that's eight inches. And the scale therefore is, what I often do is put it from the top of that, the surface pulse line, which should be right here, here is the antenna pulse line again, the antenna background noise. I measured down using the ten scale on the engineer's ruler, and we see it comes in around about fourteen. So, eight divided by fourteen, and we'll store this factor, and then if I went fourteen times the factor we get eight inches. So, what we're looking at here is a depth to the Argillic horizon, we can go off to a side and look here and we see it's about seventeen, it's about 9.7 inches to the Argillic in this particular instance. So if the Argillic is deeper, which you know it is, then we should be able to get a signal from above that. I'm going to use the same scaling value, which is probably close, but not totally correct.

You can make a lot of different interpretations, depending on what you are looking for. This at first can be very confusing. remember if I go under a tree we want to look for these broad arches, because it picks up this signal as well. You get these dark blips and what happens if we don't get good signals, we start to stretch our interpretations, we say well, this is kind of uniform here, but what happened right about here. Well, the fact could be that I could be turning my truck around, I could have picked up some metal. Right in here we have a strong reflector here, very angular, up and down, there might be something here, what causes that? So you start

to look at the signal and try to make some inferences. We look across at the Argillic horizon, other than the fact that we buried an object at this point, but we see that it's eroded away here for some reason, we don't have an Argillic horizon signal there. It seems to bow-down here and here and then it's almost vertical cuts. That would be my inclination that something that's been cut away, a buried pit, if I had to make an interpretation. If this was scalped away, these signals should come upward, and you lose them as the Argillic horizon blends into the surface pulse. the radar hits the surface, it's a silty clay loam material, and it's silty clay loam all the way down, so it doesn't sense it anymore. but to have a scalped area the signal should come up, but when you have something going down like that with abrupt, very abrupt vertical breaks, that would be one indication of man's activity, because the soil has a natural continuum across the landscape. you usually don't find in natural situations, a very sharp break like that; so that's one of the things that we're going to be looking at. the other thing is note that the strongest reflector we have, or the only reflector we have here is the Bt, or Argillic horizon. We do have the option, once it's taped (the particular run) of expanding the scale to bring it out like that. The other thing is that the radar displays more imagery, more data than we can interpret, we only look at the big things, but you start braking this down and you're looking at it on a micro scale. All that information was recorded before, we just weren't (looking at it), what do all these breaks mean? To somebody that might be significant.

MAYER: How far back can you go back and expand your scale?

DOOLITTLE: Once it's taped I can do the whole thing. And when we run this, it's going to be on tape. So we can play it back at different speeds, I can play it back and adjust the range, I can expand any particular (area).

I think if that Argillic horizon is deeper, that Argillic horizon is real dense and it's just taking the whole signal out. We aren't getting any signal return below that point. And then if there's middens or things on there we will get a signal.

II.Northwest Ridges 3 & 4

After the north/south (N/S) transect run was complete the radar was pulled over northwest ridges three and four along the same line. Thurman Allen, soil scientist with the SCS, punched a core on each ridge so that a correlation with the graphic recorder's printouts could be made. The following is the discussion that took place in the field.

Northwest Ridge Three (NW3)

ALLEN: From what I see here, looks like most of this horizon is pretty much buried.

This looks like a pretty normal Argillic. You got your silt coats in it, your good 7½YR5/6 mottel or matrix color. Right about six or eight inches of surface. Then you've got some darkness down another six or eight inches. Almost like an Albic horizon right above the Argillic. Looks like twenty-seven inches of fill material here. Does this one (printout) show?

DOOLITTLE: Yeah, this one shows an abrupt boundary.

ALLEN: At twenty-seven inches, or there about?

DOOLITTLE: Well, I'm readjusting the scale on this one.

ALLEN: Looks like good normal Argillic, what's expected, I don't know.

DOOLITTLE: What did you have on the other one between twenty and about twenty-five?

ALLEN: It's quite similar to an Albic horizon, you got a reduced clay content.

DOOLITTLE: How about that gray layer, where did that come in?

ALLEN: Probably twenty-five inches or so, this is twenty-seven, twenty-eight.

BAKER: Would that be indicative of any water sitting on that anywhere, that clay?

ALLEN: No, I think this is brought in, and I think these clays, from what I've seen over here, look like some of these basin clays, at the base of the loess. I'm talking about twelve, fifteen...(feet?) Around these gullies and all they have these gray clays, gray and red clays, right at the base of the loess.

Northwest Ridge Four (NW4)

DOOLITTLE: The gray scale at NW3 showed a gray transitional boundary, and if we use the scale that we fabricated in the field, it would occur at a depth of twenty-five inches. It's a transitional boundary by the gray scale. At this site, which is NW4, we have a very abrupt boundary occurring at about twenty-eight inches.

So, there is a correlation, when we look at these profiles, if we use a scale at one place and we say we just made it up in the field, the scale holds on, relatively speaking. We do have an abrupt boundary and a more transitional one at the other one. More fill. The two pedons, or the two profiles do look dissimilar. So the radar is showing some differences, I'm not quite sure yet that this can be used, and how significant it is. Then, on the next ridge, we picked up a tree root, we thought it was a point object. A tree root which crosses perpendicularly to its long axis will appear as a point object. So, the purpose of this exercise is for us to see if we were to see any of the differences in the gray scale, expressions of the horizons, and we are, but it's tough interpretations.

III.North/South Transect Core Descriptions

Core samples were taken by Thurman Allen, soil scientist with the SCS, at random spots along the north/south (N/S) transect to correlate with the data from the GPR. The following is the descriptions of these cores, by Allen, recorded in the field.

ALLEN: This is Thurman Allen, October 21, 1988. This is on the N/S transect, the west side of the GPR. This soil we've got one probe here, one probe deep, down to 120 centimeters(cm) deep. We have about 95cm of kitchen midden over an Argillic of a Memphis type soil. This site is probed in a slight depressed, or drained area. Kitchen midden has basically four horizons. A surface horizon 0 to 20cm. Next horizon is 20 to 48cm. Forty-eight to fifty-nine centimeters is an Albic, a lighter colored horizon. Fifty-eight to ninety-five centimeters is a lower part of the kitchen midden. The bottom horizon is from 95 to 120cm. It's about a 7½YR5/6, probably a silt loam with many dark clay films. There are just a few small to medium sized Poverty Point objects located in the lower part of the kitchen midden material. End of stop twenty.

BAKER: We're 50 meters(m) north of Monument 1 (JECA 1) on the transect (N/S) between one (monument) and two.

ALLEN: This looks like a fairly normal soil with about 30, 35cm of dark surface, may qualify for a midden, it's questionable there's a few P.P.O.'s in it. Zero to thirty-five centimeters would be the surface horizon. Thirty-five to fifty centimeters is kind of a transition between the surface and the underlying horizon. This horizon doesn't seem to be too much altered, there's little evidence of basket-loading in it. If there is basket-loading in this horizon it goes to 75cm. Below

there I think is a normal soil. The Argillic horizon starts at about 75cm. It's a 7½YR5/6 silty clay loam. There's many silt coatings on the peds. And this Argillic horizon carries on to about 120cm.

SEVER: Soon as you look at these, compare the two, this to this, what do you see?

ALLEN: Compare the twenty meter site (N4859.86/E4999.86) on the printout, you have some dark bands here, where on the fifty meter (N4889.86/E4999.86) is a speckled, speckled globs of darkness I guess is a good terminology. I don't really understand it, this looked like at the 50m station... it has a pretty good Argillic in it, but it doesn't really show it on the printout.

SEVER: I'm almost reversing the way I was interpreting this. I thought these were the occupational and these were the sterile, unoccupied, and now it looks to me like it's the opposite.

BAKER: The thing though, remember he was only reading about twenty-five to thirty inches down to here. Now that's only to about half-way down this core. And the Argillic occurs...?

ALLEN: The Argillic occurs at seventy-five centimeters... about thirty inches. Do you think his reading was good down to about thirty inches?

BAKER: Well, that's when he (Doolittle) was over there in the woods, on N/W (ridge).

ALLEN: Well, at the twenty meter station (N4859.86/E4999.86) you did have thirty, thirty-five inches of kitchen midden, where here you have no real kitchen midden, it's real light material. Just a few objects (P.P.O.'s) in it. Very small. Both stops had an Argillic horizon in it.

I'm going to back up to station twenty (N4859.86/4999.86) and give the depths and textures, I believe I forgot to a while ago. The surface horizon is 0-20cm, silt loam. The next horizon is 20-45cm, it's a silt loam. The horizon I referred to is kind of an Albic-like. It's not a probably true Albic horizon, but it is lighter in color. It's a silt loam. It's from 45 to 55cm. From 55 to about 92cm it's probably a silt loam or a silty clay loam, the texture, or clay content is picking up in this horizon. From 92 to 120 is the Argillic horizon, it's a silty clay loam. End of stop twenty (N4859.86/E4999.86).

I'm going to give the depths and textures of stop

fifty, at the 50m station (N4889.86/E4999.86). The depth is zero to thirty-five centimeters, it was silt loam, probably a 10YR4/2 color. Thirty-five to fifty centimeters is kind of a transition from the surface to the underlying material. It's also a silt loam. Fifty to eighty centimeters is a silt loam. There is a little bit of evidence of some loading or mixing in this zone, so I think this is probably some altered or brought in material. Eighty centimeters you get into your Argillic and this Argillic horizon goes from 80 to 120cm. Color is about a 7½YR5/6. You got many silt coatings in the upper part of the Argillic. This is something like a 10YR7/1 color.

This is the stop at the sixty meter station (N4899.86/E4999.86) The graph indicated that it's about the same kind of soil, or Argillic horizon came in at 80cm, like stop fifty (N4889.86/E4999.86) did. Depths and textures... the surface is from zero to twenty-five centimeters. It's a silt loam, 10YR4/2. From 25 to 60cm, still a silt loam, but much darker, 10YR3/2 or 2½...10YR2.5Y. Let me back up, 2½Y, maybe one or two chroma. You got some fairly common culture features or P.P.O.'s. From 60 to 80cm is a silt loam, it's a light colored 10YR5/4, 6/3 colors, you should have a few small P.P.O.'s in it. You don't see any evidence of basket loading in here, but it may be or probably is. From 80 to 120cm is your Argillic horizon, its a 7½YR5/6 with a few silt coatings, not nearly as many as we had in stop, or station fifty (N4889.86/E4999.86). Clay films are quite common in this horizon and the horizon seems to be fairly sterile with any cultural features. End of station sixty (N4899.86/E4999.86).

This is station 110 (N4949.86/E4999.86), you have the basket-loading down to about 210cm. Your horizons are from zero to thirty centimeters is the surface horizon, about a 10YR4/2. The next horizon appears to be a basket-loaded horizon, it's basically a 10YR5/6, silty clay loam, we have some silt coatings in here, you have some P.P.O.'s, this horizon goes from 30 to 78cm. From 78cm to one meter it looks like a buried A, it's a fairly dark horizon, but it's chewed up with silt coats, or light silty materials in it. There's some gray silt loams embedded in here, it's been brought in from somewhere else, there's some P.P.O.'s, almost orange-looking. There's also some small or fine bits of charcoal in this horizon. The next horizon is from one meter to 160cm, it is basket-loaded, and you have gray, brown, probably a mixture of silt loams and silty clay loams. No cultural features that I can point out. The 160 to 175cm is kind of a buried A horizon, it's basket-loaded, you got a lot of charcoal in here, but also there's a thin layer gray, almost silty clay loam.

From 175 to 188cm it's a brown, yellowish brown, it's probably silt coats and quite a bit of charcoal, fine charcoal bits in it. From 188 to 196cm it's a zone of dark horizon, some charcoal. From 196 to 210cm it's probably the top part of the Argillic, looks like some black stains or charcoal in here, quite a few silt coatings. Color of this horizon is 7½YR5/6. From 210 to 228cm it's silty clay loam, Argillic, 7½YR5/6, Argillic horizon of a Memphis-like soil. That ends stop 110 (N4949.86/E4999.86).

This is stop 180 (N5019.86/E4999.86) on the N/S, GPR transect. This soil looks like a pretty good Grenada, if not it's a transition between a Grenada and a Calloway soil. The depths and textures are zero to twenty-five centimeters is a surface (horizon), 10YR4/2, silt loam. The next horizon is probably the Cambic horizon of a Grenada. It's 25 to 62cm, it's a 10YR5/4 with some dark colors in the upper part of this horizon, part of the old A. If this ever was a kind of a midden it was part of the organic matter left over. Texture is silt loam. From 20 to 62cm to 95cm is an Albic horizon. Color is about a 10YR6/3 or 6/4. Right below the Albic horizon is probably a Fragipan, if not it's some kind of dense Argillic horizon. It's a silty clay loam. Stacked right on top of the Argillic , or Fragipan, is almost a 10YR7/1. It's an Albic horizon. I don't see any kind of objects or cultural features in here except right near the surface. End of stop 180 (N5019.86/E4999.86).

This is stop 290 (N5129.86/E5000.00), it's a real subtle, but I think it's basket-loaded or mixed material down to 120cm. Breaks we are having in here are from zero to 25cm is the surface horizon, silt loam. Twenty-five to seventy-five centimeters is a silt loam. Pretty much a yellowish brown, silt loam, real subtle if it is loaded, it's subtle, but I think it is probably been altered or a loaded material. Seventy-five to 105cm is something like a transition between an Albic and a loaded, it's a lot of silt coatings in this horizon, it's pretty much chewed up with silt coatings. Color is about a 10YR5/4 with a lot of gray materials in here or gray mottles. There are some cultural features, some kind of yellowish brown, baked-clay, or an orange-looking, baked clay. The last horizon is a gray and brown, pretty well loaded horizon with some bright orange features in here. This the end of stop 290 (N5129.86/E5000.00) we're going to back up to 274 (N5113.86/E5000.00) to a different, darker layer, looks like a normal soil on the graph.

This is stop 274 (N5113.86/E5000.00). It appears to be a Grenada-like soil and is quite similar to stop 180 (N5019.86/E4999.86) so, we won't describe it any farther than that.

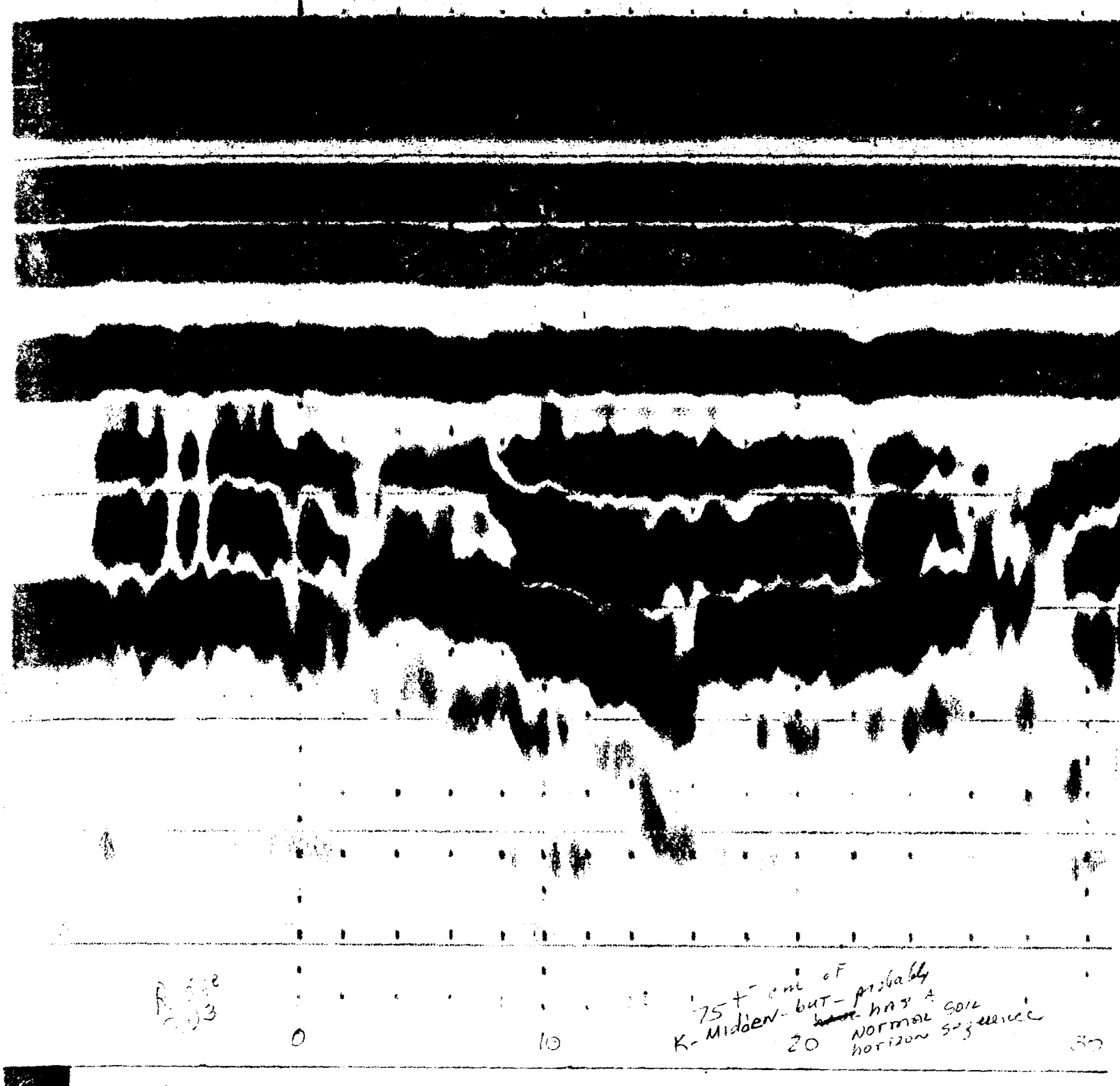
This is stop 524 (N5363.86/E5000.00). This soil has evidence of being kind of normal soil, but it tends to lean toward some basket-loading. It doesn't really show the basket-loading but, throughout the subsoil there's clay films around all the peds in here. This is not normal soil that we have on the Macon ridge. I think I would lean more toward the loaded material. Our depths are, the surface is zero to thirty centimeters, it's a silt loam, a 10YR4/2. We have a small clay ball at the base of this surface horizon. Thirty to seventy centimeters is a type of Argillic, it's a silty clay loam. Probably about a 10YR5/6, it's got all kind of colors, it's got a lot of mottles of 10YR6/3 or 6/4. You got iron manganese concretions. I see no cultural features in here. But again, this horizon is just loaded down with clay films around all the peds. The next horizon is from 70 to 90cm, it's a silty clay loam, basically the same colors, but you have quite a few silt coats around the peds plus your clay films. In both of these two subsoil horizons you have some iron manganese concretions, that are quite common. Even some black stains, or manganese stains within some of these peds. The bottom horizon, from 90 to 120cm is a silt loam, 10YR5/6, probably about a 6/3 mottles or 6/3 material between the peds. There's some clay films, but there not nearly as thick and prominent as in the two upper subsoil horizons. Again, in case I've forgot my textures, we have a silt loam in the surface, silty clay loam in the upper subsoil, from 30 to 70cm. From 70 to 90cm is silty clay loam, and the last horizon is a silt loam. That ends stop 524 (N5363.86/E5000.00).

ALLEN: The main reason I lean toward an artificial soil, or a built soil, brought in soil, is because of all the clay films, and I think if they brought in, say homogeneous materials from Argillic, or Memphis, or Grenada soil, possibly the pits could have been hard and dry. I think what you get is kind of a coarse, or coarse dry peds of Argillic being brought in. So, even though it's silty clay loam textures, I think as your clay is stripped out from the surface horizon, and moved through this horizon, you've got clay coating these peds, and this will give you a quick clay coat on these peds surface in this area. And I think maybe this may have something to do with why you have so many clay films in these two subsurface horizons. I did see a few iron manganese concretions, but probably you have more manganese stains than you do concretions. Another thing too, there are quite a few roots moving down through here. These roots seem to be pretty flat and look like they're just moving around the peds instead of just going right through them. And if you try to break these peds, they're pretty dense and pretty hard. And if this would have naturally occurring soil when your loess was put in

here, and as the soil develops, you would probably have larger bodies, or larger peds developed, where here you seem to have a lot of small B peds, or B, Argillic peds in here.

We're at station 540 (N5379.86/E5000.00) and to back track a little bit, station 525 (N5364.86/E5000.00) on the graph, we had a kind of a break up of the normal pattern, which is kind of splotchy, or more lighter colored area in here. Down at 540 (N5379.86/E5000.00) you have your darker bands, like a normal soil. The soil that we have here is something that's similar to a Grenada soil, it's not the best Grenada soil in the world, but it's probably a whole lot more a normal soil than the one we had at 524 (N5363.86/E5000.00). I'll give you a quick description. From zero to 32cm is about a 10YR4/2, silt loam, surface layer. Thirty-two to 65cm is an Argillic or Cambic, probably enough clay pick up to call it an Argillic horizon. You have a few clay films, but they're not nearly as pronounced in this stop as they were in 524 (N5363/E5000.00). It's a 10YR5/6 matrix with some 6/4 mottles. It's possible that this upper part may have been basket-loaded, but it's really hard to tell. From 65 to 75cm it's bridged between an Albic or an E primed horizon. It may be just some B bodies with some thick silt coatings around the B material in here. I think if you break open these peds, even though the horizon is laying on a tray, looks to be pretty much to be white, or Albic-looking if you break them up. Most of this horizon is probably some Argillic material. Probably about a 10YR5/6. The texture on this horizon is probably silt loam. Back up to the 32 to 65cm is a heavy silt loam, maybe a silty clay loam. The bottom horizon is a 10YR5/6 silt loam. It's close to being a Fragipan, it's probably not a good fragipan, but I think it's a natural soil, it's pretty friable. Your peds are fairly coarse. Quite different from the above horizons. So for sure, from 75cm this should be some sterile, pretty much sterile soil. From 32cm down there's probably some sterile soil, but it has some evidence that it could be basket-loaded, because you do have some clay films in here. I think, gut feeling, I'd say that this is probably close to a normal soil. End of stop 540 (N5379.86/E5000.00).

N4839.86
E4999.86



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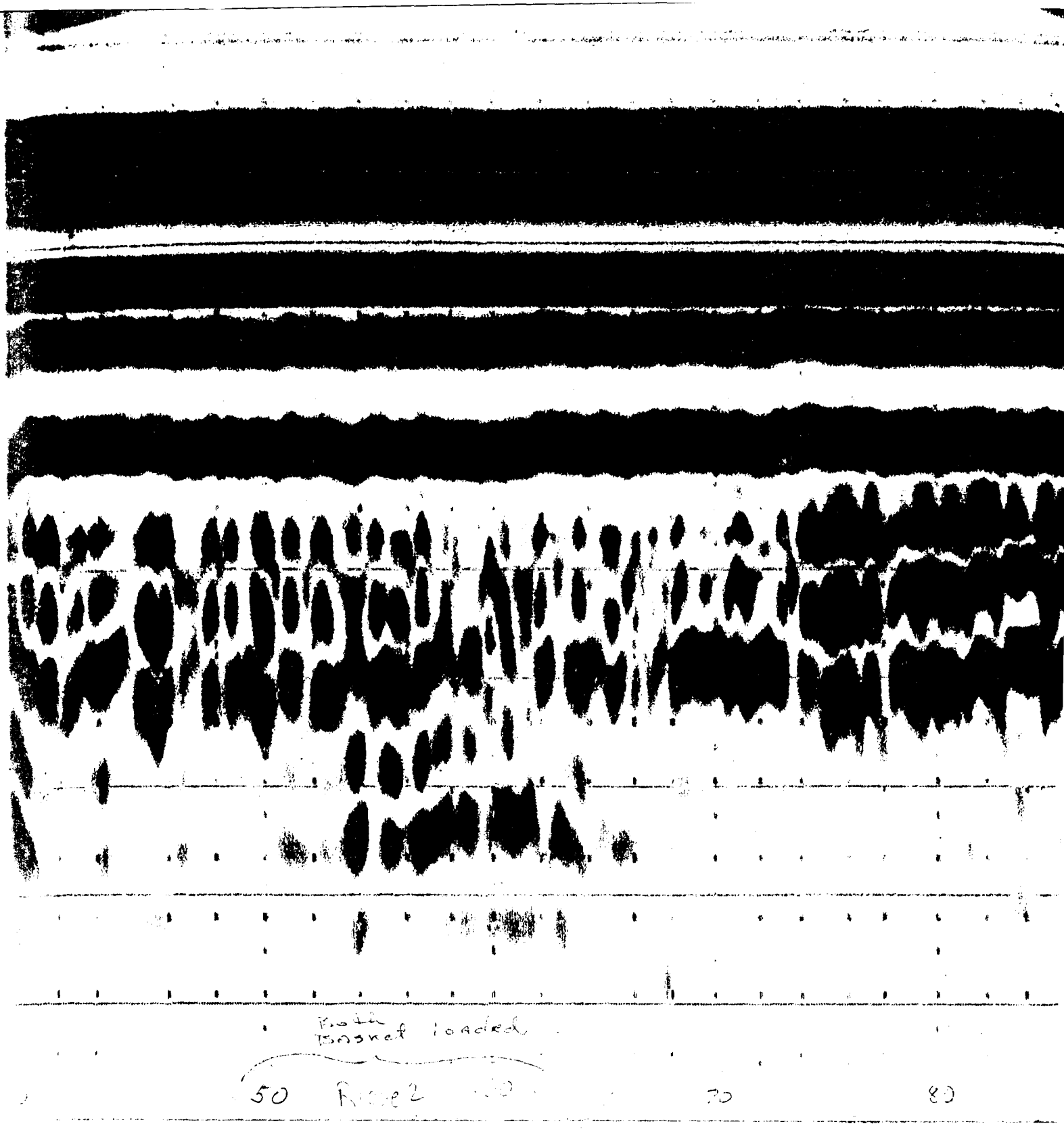

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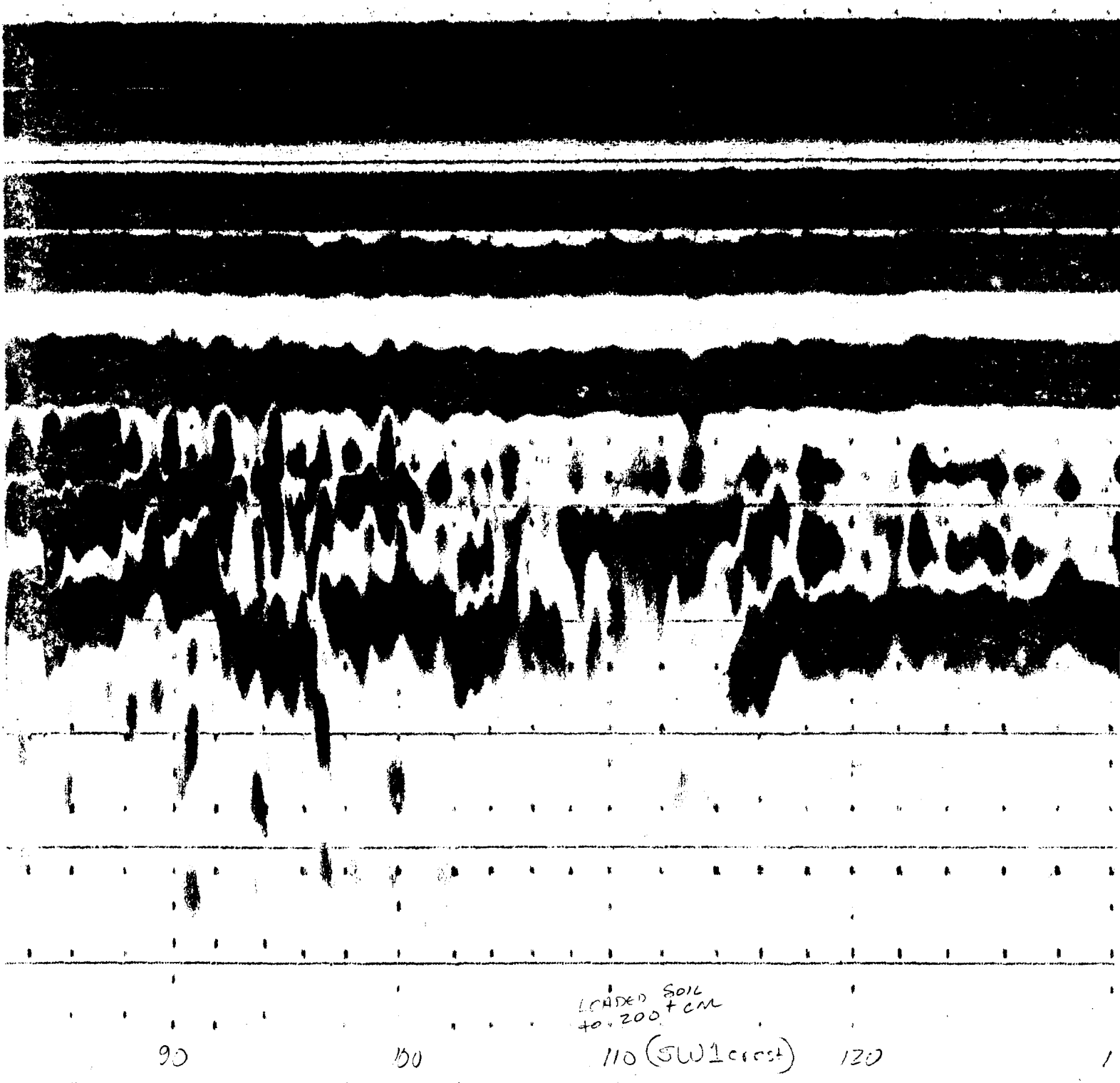

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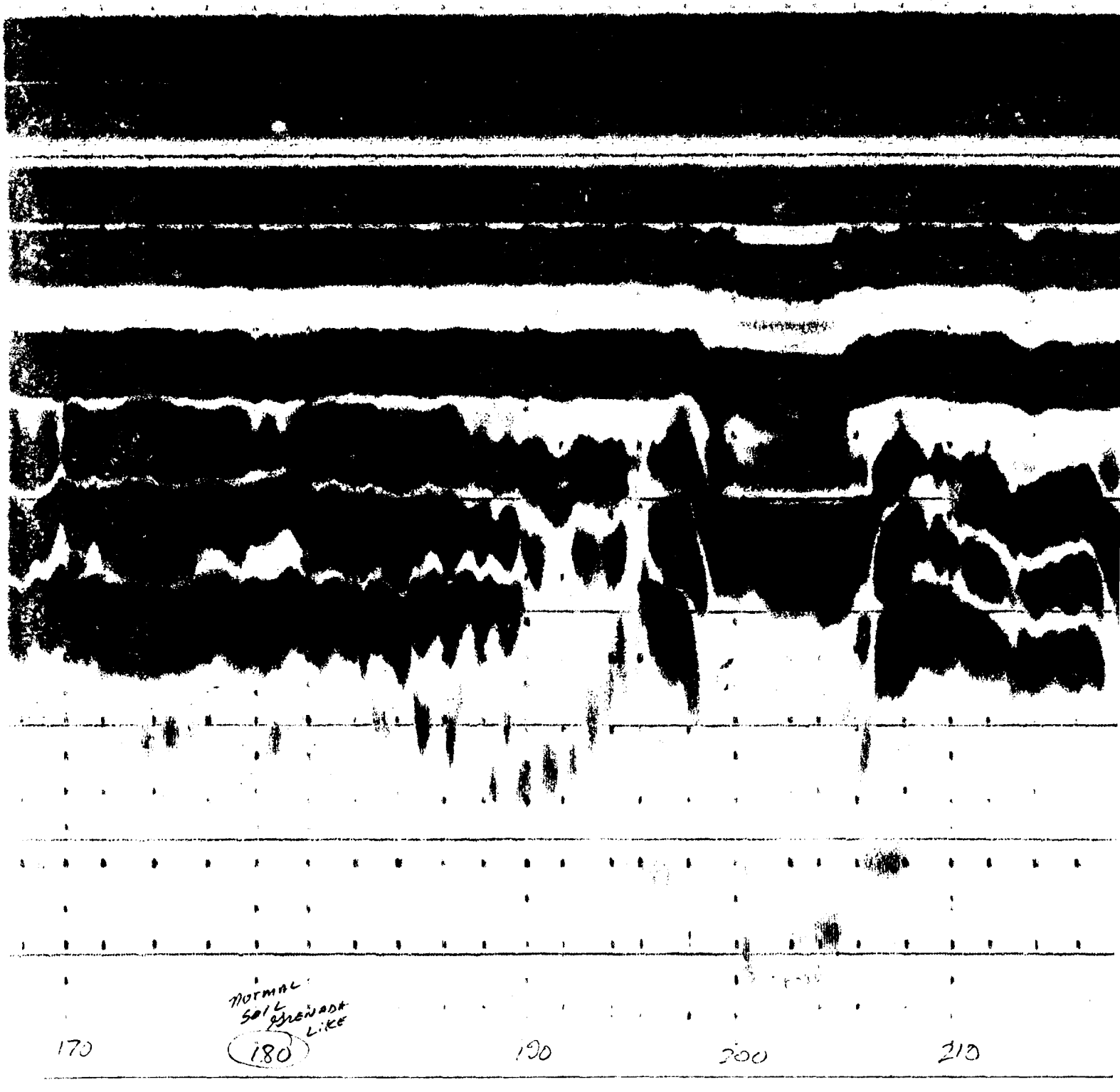

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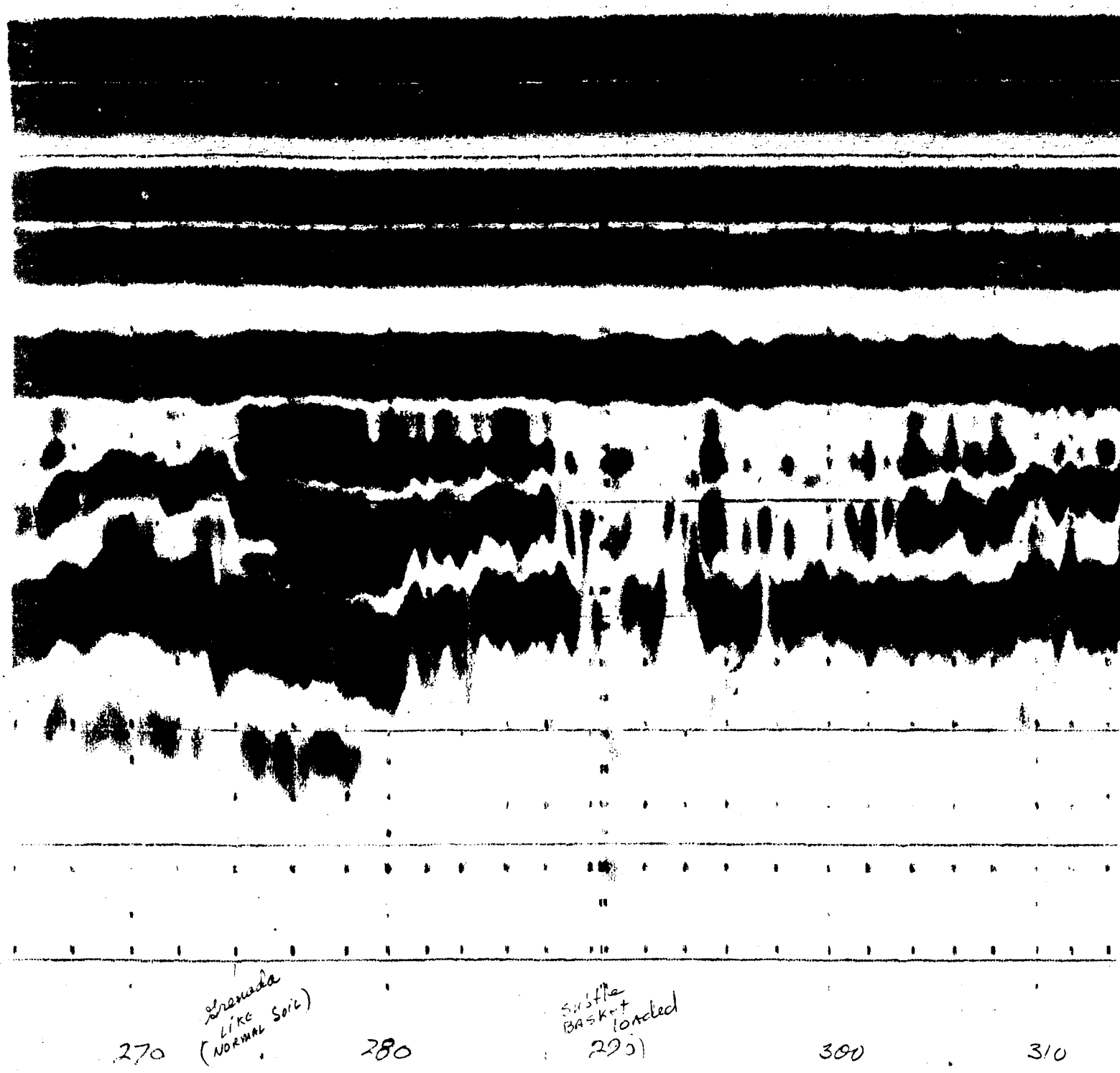

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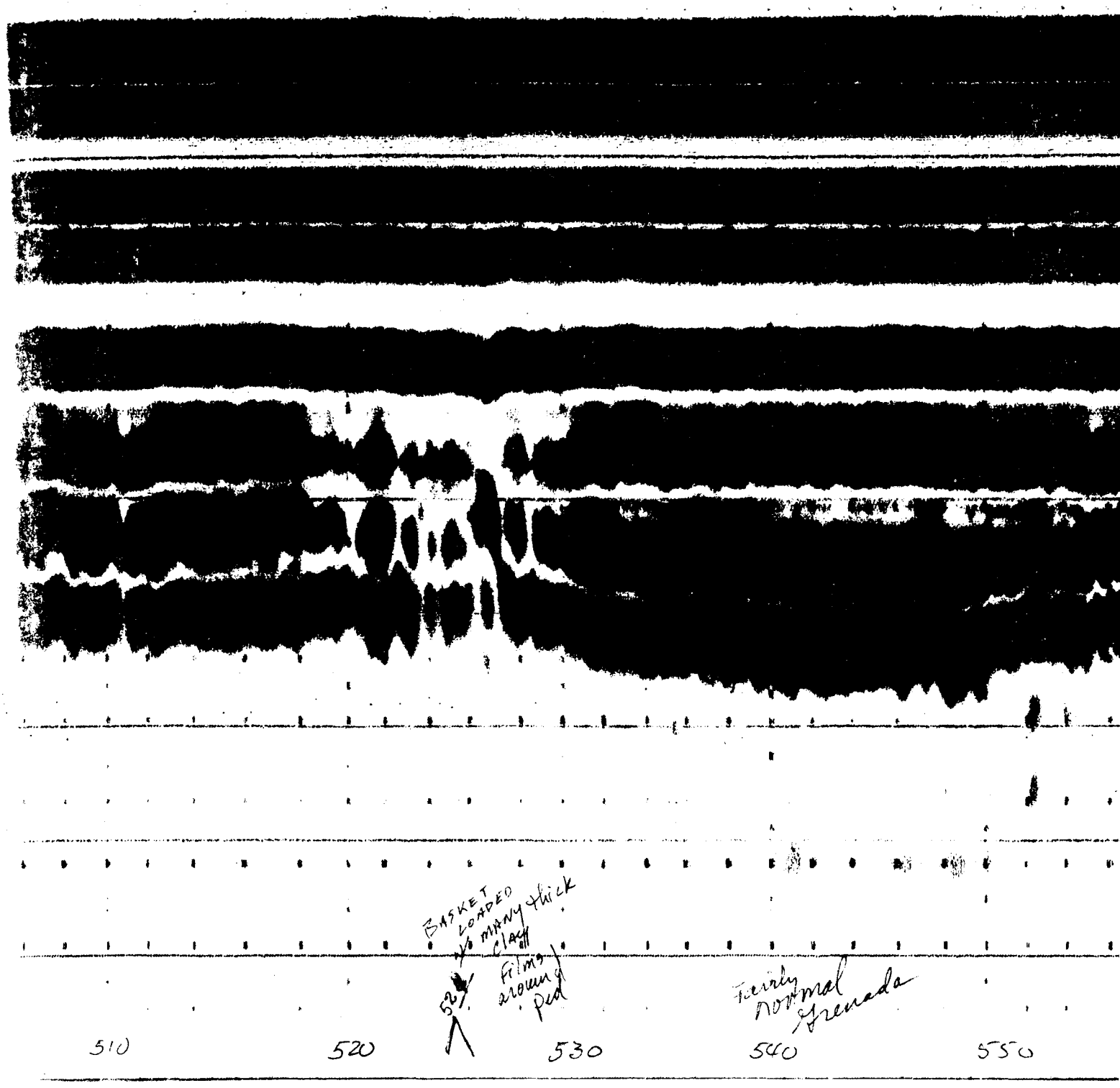

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