APPENDIX H

RIPRAP DURABILITY

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ATTACHMENTS

H.1 INTRODUCTION

This appendix outlines the selection and evaluation of rock sources for erosion protection materials on the outside slopes and perimeter drainage areas of disposal cell. The sizing of these materials to meet U.S. Nuclear Regulatory Commission (NRC) long-term stability criteria is presented in Appendix D of this document. The specifications for receipt and placement of these materials on the disposal cell are outlined in the Technical Specifications (Reclamation Plan Attachment A). This appendix reflects responses to the NRC in 2006 and 2007 on testing and placement of erosion protection materials. Attachment H-1 of this appendix is a riprap suitability study submitted to the NRC by Sequoyah Fuels Corporation (SFC) on September 13, 2007.

H.2 ROCK SOURCE EVALUATION

Two rock sources have been evaluated by SFC: (1) a limestone quarry (Souter quarry) near the SFC site, and (2) several gravel pits in the site area. The gravel pits in the site area contain rounded particles of chert and other durable materials, but are limited to particle sizes of up to six to eight-inch size. SFC selected the Souter Quarry as the primary source of erosion protection rock for the potential to produce larger-sized rock and for uniformity in rock quality.

H.3 ROCK TESTING

Various limestone samples from the Souter Quarry have been tested under the direction of SFC from 2002 through 2007. These test results are presented below and compared with the NRC durability criteria in Table D-1 of NUREG-1623 (Johnson, 2002).

H.3.1 Initial Stage of Testing

A sample of limestone from the Souter Quarry was tested in 2002 for screening of the rock for durability according to the guidelines in Appendix D of NUREG-1623. The test results and rock quality designation scoring are presented in Table H.1 below.

The rock quality designation at the bottom of each table is a weighted durability percentage, from guidelines in NUREG-1623. A rock quality designation of 60 percent indicates unsuitable durability. A rock quality designation above 80 percent indicates suitable durability. A rock quality designation between 60 and 80 percent indicates suitable durability, but with oversizing (an increase in rock particle diameter) required to accommodate long-term particle weathering.

Table H.1 Test Results From 2002 Sample

Test	Result	Score[a]	Weighting Factor	Weighted Test Score[b]	Weighted Max. Score[c]
Specific gravity	2.64	7.8	12	93.6	120
Absorbtion (%)	0.4	8.5	13	110.5	130
Sodium sulfate soundness (%)	0.2	10.0	4	40.0	40
Freeze-thaw (%)	0.2	9.0	7	63.0	70
LA abrasion (%)	35.6/5[d]	6.5	1	6.5	10
Weighted test score total	-----	-----	-----	313.6	370
Rock quality designation (%)	-----	-----	-----	**85**	-----

[a]Based on a scale of 1 to 10, from NUREG-1623.
[b]Product of score and weighting factor.
[c]Product of weighting factor and score of 10.
[d]Result adjusted for 100 revolutions.

In 2006, a Souter Quarry limestone sample was collected for durability testing from an area of the quarry that would be used for riprap production. Durability tests were focused on analyses that better characterize the durability of limestone (from NUREG-1623). The petrographic analysis was included upon suggestion from NRC. The test results are summarized in Table H.2.

Table H.2 Test Results From 2006 Sample

Test	Result	Score[a]	Weighting Factor	Weighted Test Score[b]	Weighted Max. Score[c]
Specific gravity	2.65	8.0	12	96.0	120
Absorbtion (%)	0.4	8.5	13	110.5	130
Petrographic analysis	6.5	6.5	10	65.0	100
Weighted test score total	-----	-----	-----	271.5	350
Rock quality designation (%)	-----	-----	-----	**78**	-----

[a]Based on a scale of 1 to 10, from NUREG-1623.
[b]Product of score and weighting factor.
[c]Product of weighting factor and score of 10.

The results from the 2002 testing indicate that the limestone is of acceptable durability, based on a rock quality designation of 85 percent. The results from the 2006 testing (more specific to limestone) indicate that the limestone is of acceptable durability, but would require oversizing. The amount of oversizing would be two percent, based on the difference between the measured rock quality designation (78 percent) and the acceptable designation value (80 percent).

H.3.2 Second Stage of Testing

Additional testing of Souter Quarry limestone was conducted under the direction of SFC in 2007, using samples from the area of the quarry planned for riprap production. These results are compiled in Attachment H-1 of this appendix.

The test results from the 2007 testing are listed in Table H-3, and the rock quality designation calculations are summarized in Table H-4.

Table H.3 Test Results From 2007 Samples

Sample Description	Specific Gravity	Absorbtion (%)	Sodium Sulfate Soundness (%)	LA Abrasion (%)	Comments
Crushed limestone	2.600	1.10	0.4	10	For 500 revolutions
Dark gray stone #1	2.736	0.60	-----	-----	
Dark gray stone #1	2.661	0.57	-----	-----	
North wall stockpile (E)	2.646	0.74	-----	-----	
North wall stockpile (W)	2.659	0.70	-----	-----	
Pink stone	2.662	0.53	-----	-----	
Values used in scoring	2.661	0.71	0.4	2	For 100 revolutions[a]

[a]Result from LA abrasion test adjusted for 100 revolutions.

Table H.4 Summary of Test Results From 2007 Samples

Test	Result	Score[a]	Weighting Factor	Weighted Test Score[b]	Weighted Max. Score[c]
Specific gravity	2.66	8.1	12	97.2	120
Absorbtion (%)	0.71	6.7	13	87.1	130
Sodium sulfate soundness (%)	0.4	10.0	4	40.0	40
LA abrasion (%)	2[d]	9.5	1	9.5	10
Petrographic analysis	7.5	7.5	10	75.0	100
Weighted test score total	-----	-----	-----	308.8	400
Rock quality designation (%)	-----	-----	-----	77	-----

[a]Based on a scale of 1 to 10, from NUREG-1623.
[b]Product of score and weighting factor.
[c]Product of weighting factor and score of 10.
[d]Result adjusted for 100 revolutions.

The results in Table H.4 are similar to the previous test results. The rock quality designation indicated some oversizing is required (three percent). The Technical Specifications (Reclamation Plan Attachment A) specify rock sizes for all of the erosion protection material with a ten percent oversizing, and outline the frequency and testing for confirmation of durability and size of the actual limestone to be delivered to SFC.

H.4 REFERENCES

Johnson, T.L., 2002. "Design of Erosion Protection for Long-Term Stabilization," *NUREG-1623*, U.S. Nuclear Regulatory Commission, September.

ATTACHMENT H.1

RIPRAP SUITABILITY STUDY

SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

COPY

RE: 0740-N

September 13, 2007

FedEx – Tracking # 7924 1787 3770

U.S. Nuclear Regulatory Commission
ATTN: Mr. Myron Fliegel, Senior Project Manager
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
And Safeguards, NMSS
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

Subject: Sequoyah Fuels Corporation, Docket – 40-8027
Response to OIs on the Final Safety Evaluation Report –
Reclamation Plan (TAC L52511)

Dear Mike,

Please find enclosed with this letter 4 copies of the final Rip Rap Suitability Study performed on the Souter Quarry, and the Rock Production Strategy Report. These reports respond to the final issue raised by your staff on the Reclamation Plan.

If you have any questions, don't hesitate to call me at (918) 489-5511, ext. 14.

Sincerely,

John H. Ellis

John H. Ellis
President

Enclosures

XC: Alvin Gutterman, MLB
Rita Ware, EPA
Jeanine Hale, CN
Trevor Hammons, OAG

HIGHWAY 10 & I-40 PO BOX 610, GORE, OKLAHOMA 74435 (918) 489-5511 FAX: (918) 489-2291

ENCLOSURE 1

RIP RAP SUITABILITY STUDY

REPORT
FOR
SEQUOYAH FUELS CORPORATION
DISPOSAL CELL PROJECT

SOUTER QUARRY
RIP RAP SUITABILITY STUDY

PREPARED BY
KENNETH SCHLAG, P.G.
CONSULTING GEOLOGIST
September 12, 2007

INTRODUCTION

This report has been prepared based on findings from the quarry study conducted on February 10, 2007 at the Souter Quarry for the Sequoyah Fuels Corporation (SFC) Disposal Cell Project. The Souter Construction Company Quarry is located northeast of Gore, OK. in Sequoyah County. Mr. Scott Munson of SFC accompanied me during this study. A memorandum of a proposed work plan was prepared and submitted on February 3, 2007 based on discussions during a conference call held on February 1, with the NRC. The proposed work plan was followed for the purpose of this study and has been included as Appendix A of this report.

GEOLOGY BACKGROUND

The rock from the Souter Quarry is part of the Pennsylvanian aged, Morrowan Series, which is comprised of two formations, the Hale, below, and the Bloyd, above. A report titled, <u>Carbonate platform facies of the Morrowan Series (Lower Pennsylvanian), northeastern Oklahoma and northwestern Arkansas</u>, by Sutherland and Manger, 1988, has correlated the traditional sequence of the Morrowan Series in Arkansas with the quarry area in Oklahoma. The Sutherland and Manger report goes into great detail of the geological deposition of the different units and their correlation with the surrounding formations. That report identified two well developed limestones, the Brentwood and Kessler Limestone members of the Bloyd Formation. These two members are largely identified by macrofossils that were not investigated as part of this study. Therefore, for the purpose of this report, the subject rock quarry is considered to be the Bloyd Formation.

The Bloyd Formation is best described as a sequence of alternating shales and limestones. The lithology of the limestone is variable, ranging from blue gray to black, from fine to coarse crystalline in texture, and from massive to thin bedded. The interbedding of the limestone, shale and sandstones has led to difficulty in mapping these units in this area.

The Souter Quarry site currently has two working faces comprised of an approximately 40 foot highwall of limestone with an irregular floor and approximately 10 foot of overburden. Portions of the west wall is thin layered and changes within short horizontal distances to thicker layers with small lenses of chert scattered throughout. The north wall is layered toward the west but becomes more massive blocky units to the east with staining from overlying minerals of copper and iron. Currently, the majority of material is mined from the west wall based upon the suitability of the rock for the size and use of the material the quarry is currently supplying. The material along the eastern half of the north wall tends to have thicker layers and has a more blocky characteristic. This area is actually utilized by the quarry for stone more suitable for larger stone products such as Rip Rap.

PREVIOUS LITERATURE EVALUATION

The complete Corps of Engineers (COE) report, dated October 2004, was acquired and reviewed for relevant information (see Appendix B). In particular, petrographic analysis of the COE report was reviewed. The mineralogy of the stone analyzed by the COE was indicative of the stone observed in the quarry in the area of interest. The quarry stone "is principally calcite with minor dolomite present." The report also documents the lack of clay minerals in the stone that was analyzed using X-Ray Diffraction. It was not specified in the report precisely where, within the quarry, the COE sample was collected from. However, according to the superintendent of the quarry, it is believed to be from a previously mined area due south of where SFC's preferred rip rap stone is located in the northeast corner. This is consistent with the fact that quarry management has recognized for several years that this eastern most area, along a north south axis, is more suitable for rip rap production. The stone in the northeast corner of the quarry appears visually to have the same composition as the stone analyzed by the COE. Based on the field reconnaissance in the quarry, the quarry walls contain more impurities as you move further west. Therefore, the COE analysis appears to be directly applicable to the proposed rip rap to be taken from the north east area.

QUARRY WALL EVALUATION

A fresh shot along the north quarry wall was performed a few days prior to this study which provided a cleaner wall of stone to work with. Several photos of the north wall have been included as Figure C-1 and C-2 in Appendix C. The cleaner wall improved the surface visibility and aided in identifying bedding planes, stylolites, vugs, and dolomitic lenses. Very few visible stylolites were present along this section of the north wall rock face that was accessible near the base of the highwall. Furthermore, there were no dolomitic lenses or large vugs that had been filled with clays or other impurities near the base of the highwall. The few irregular bedding planes present had no pattern and were mostly found near the top surface of the highwall. The only significant visible feature found along the northeast portion of the quarry face was the abundance of vugs located in one, ten foot by ten foot, area of the face. The vugs were approximately 10 to 25mm in size and the majority appeared to be clean, i.e., very little to no calcite crystals or clay buildup within the vugs. The vugs were spaced irregularly, ten to twenty-four inches apart. A section diagram has been prepared on a photo taken from the northeast corner wall and is included as Figure C-3. This diagram shows the location of the vuggy area and the irregular bedding planes near the top surface. Figures C-4, C-5, C-6 and C-7 show details and close ups of the vug area. The remainder of the north wall to the west, as well as the west wall itself, was also inspected for stylolites. It was evident from this inspection that very thin striations and discolored bands (possibly stylolites), less than 9.5mm thick became more visible along the west wall and appeared to be clustered in areas making it very difficult to measure any type of spacing. Since this area of the quarry is not intended to be used for the riprap on the SFC project, the measurement of stylolite spacing was not attempted along this wall.

SHOT ROCK EVALUATION

An inspection was conducted of the rock shot from the north wall of the northeast corner face with the intention of identifying stone to measure stylolite spacing. Several hundred feet of fresh shot-rock was on the ground along the northeast corner area. It was very difficult to find any stone with regular surface features that resembled stylolites. There were several stones that contained thin discolored bands that blend into the surrounding stone surface which may be stylolites. Occasionally, a stone was found with a tint of dolomitic clay-like material or very thin stylolite staining on a stone surface. However, without cutting the stones, I could not determine for certain that these discolorations were actually stylolites. The absence of discernable stylolites prevented the recording of any spacing measurements. Very few vugs were found in the shot rock at the base of the wall. The vugs that were identified in the shot rock were less than 25mm and lined with a thin veneer of calcite crystals with little or no dolomitic clay present. Appendix D has several photos of individual stones found along this area. Again, the absence of visible stylolites, bedding planes and dolomitic clay impurities prevented meaningful recording of these features. Several representative stones were collected from the shot rock in the area of interest for petrographic examination, and fro absorption, specific gravity, sodium sulfate soundness, and abrasion analyses. The results of these analyses have been included as Appendix E.

CRUSHED STONE STOCKPILE EVALUATION

The final step of the work plan was to inspect a stockpile that had been mechanically crushed to the approximate size (<4") that will be utilized as filter rock on the SFC project. The stockpile material was made from rock along the west wall, not the proposed north wall. Thus, this stone would represent a "worst case scenario" as far as impurities that have survived the mechanical crushing operations. A front-end loader was used to extract approximately 4 tons of stone from two ends of the stockpile. This stone was then spread into a thin layer by the loader with the intent to quantify the amount of visible stylolites that were still intact after mechanical crushing. Several photos have been included as Appendix F. The two piles were spread to a ten foot by twenty foot area of stone and each were approximately four inches thick. Based on this area measurement, the weight of this stone was estimated to be over 18,000 pounds. As the individual rock was inspected from each pile, it became apparent there were very few discernable stylolites. Numerous visual passes across the spread piles revealed impurities such as small calcite crystal filled vugs, very thin layers of mineral stains as well as several stylolites. These rocks were collected and weighed. Less than 70 pounds of stone were collected and identified as containing visible stylolite impurities. Short of inspecting each individual stone, I made a broad assumption that there was more stone that was not identified or collected as containing stylolite features within these spread areas. Using 180 pounds of rock containing impurities instead of 70 pounds that was actually collected, still indicates only 1% of the stone contain stylolite impurities after mechanical crushing operations. This result is based on the "worst case scenario", west wall.

DURABILTIY TEST RESULTS

The following table summarizes durability test results from material collected in the Souter Quarry. These analyses are from stone that has been collected by different entities over several years at various times and may have been performed under different procedures. Realizing that not all the data in this table represents rock intended for this project, the results do show that while individual tests may vary (i.e. number of cycles, different procedures, etc.), test results from the rock within this quarry remains within a consistent acceptable range. Therefore, the table is intended to show the variability of individual test data collected by the Oklahoma Department of Transportation (ODOT), the Corps of Engineers (COE), Terracon Consultants/John C. Webb and from recent analyses from rock collected within the last several months by SFC.

TEST	ODOT	COE	Terracon/Webb	SFC
Specific Gravity (SSD)	2.64	2.65	2.66	2.68
Absorption (%)	0.5	0.5	0.4	0.7
Petrography (Pass/Fail)		Pass	Pass	Pass
L.A. Abrasion (%)	37	37		10
Sulfate Soundness (%)		0.0		0.4
Freeze-Thaw (%)	0.7	2.6		

The Oklahoma Department of Transportation (ODOT) has collected samples from this quarry for use on ODOT projects since 1991. Although ODOT has not required a petrographic analysis of the stone, they have performed other rigorous testing over the years such as LA Abrasion (AASHTO T-96), Freeze Thaw Durability (AASHTO T-161), Freeze-Thaw Soundness (ASTM D-53), Durability Index (AASHTO T-210), Absorption and Specific Gravity Tests(ASTM D-6473). The numbers in the table represent an average of the last ten results. Satisfactory results from these tests have allowed the Souter Quarry to be placed on the ODOT Qualified Product List.

The Corp of Engineers (COE) analyzed rock from the Souter Quarry in 2004 for a nearby project. The sample collected is believed to be from the same area that SFC intends to use. The analyses from this rock provided the COE with favorable results and concluded that "Slope protection material from this quarry appears to be good sound rock and should be satisfactory for use as riprap, armor stone, derrick stones, etc.".

In 2006, a sample was collected by SFC for petrographic analysis as well as several durability tests. The material was selected randomly, without regard for the desirable characteristics. The analysis performed by John C Webb, in October 2006, on a stone most likely taken from a less desirable section of the quarry, was assigned a number of 6.5 for the "estimated suitability for riprap use", indicating an above average material when compared to a Granite (10) that is not available in Eastern Oklahoma.

In February 2007, several representative stones were collected from the shot rock in the area of interest for petrographic examination. Additional samples were collected from the same area several months later for absorption, specific gravity, sodium sulfate soundness and abrasion analyses. The results from these tests confirm that the rock collected along the north eastern portion of the north wall of the quarry exhibits desirable characteristics for the SFC application of this material. The absorption analysis was inconsistent with the majority of test results on previously analyzed rock. Therefore, five additional samples were collected and analyzed for specific gravity and absorption. The SFC results in the table represent the average of the six samples collected by SFC between July and September.

The test results from the SFC samples were scored according to the guidance in NUREG 1623. The resultant rock quality score of 78% is similar to what SFC has calculated in the past. Since the score is below 80%, the rock requires an oversizing of 2%. SFC oversized the rock 10% in the latest revision to the technical specifications, so no changes are required to the Reclamation Plan as a result of this score. The averaging and rock quality calculations are included as Appendix G.

SUMMARY AND CONCLUSION

In summary, the stylolites identified in this quarry are very small, discontinuous and mainly appear as discolored spots or bands less than 12.5mm wide and several inches long that may or may not actually be stylolites. The stylolites in this quarry are very difficult to discern with the naked eye and only under a microscope or thin section can they positively be identified. There was also very little dolomitic clay present in the quarry. A few stones were identified with broken faces of olive green dolomitic clay less than 0.1mm in thickness. However, no widespread areas, veins, bedding planes, or boulder sized dolomitic clay were found on any of the quarry wall faces. Bedding planes were relatively nonexistent in the northeast portion of the quarry except near the top surface. Even there, the bedding planes were very irregular. One area containing very small vugs was identified on the north wall, but very few of the vugs contained calcite crystal impurities and the majority of the vugs will most likely not survive the mechanical crushing operations.

Realizing the microscopic analyses of limestone from this quarry magnifies potential permeable pathways, the fact that the rock absorbs <1.0% moisture, indicates that this is a very tight crystalline rock, in spite of any stylolite features that may be present. The proposed riprap from the north wall of the northeast corner of the Souter Quarry should supply SFC with 100% broken faces, without flat and elongated features associated with bedding planes and should be relatively free from degrading properties.

According to the superintendent, the company is currently permitted to mine another 100 feet to the north. Using the measurements taken on the February visit, there is well over 100,000 tons of material in what is considered to be the north east section of the north wall. This amount is more than triple the estimated quantity of stone required for the disposal cell project.

If you have any other questions, or need clarification on this subject matter, feel free to contact me.

Respectfully Submitted,

Kenny Schlag, P.G.
Consulting Geologist

APPENDIX A

MEMORANDUM

Project 12-06-011

TO: Craig Harlin, Sequoyah Fuels Corporation

FROM: Kenny Schlag, P.G.

DATE: February 3, 2007

SUBJECT: Proposed Workplan

This memorandum represents a proposed work plan to help delineate the issues discussed during the conference call on February 1st. I propose to utilize the following steps to provide more detail to justify the suitability of Rip Rap Stone from the Souter Quarry for the SFC Disposal Cell Project.

The Corps of Engineers report, dated October 2004, shall be acquired and reviewed for specific information. If any information can be directly correlated with the existing quarry section, this information shall be presented. Any other useful information found in this report shall also be presented and discussed.

The use of the northeast corner of the quarry for the proposed stone to be utilized in the disposal cell construction was discussed. In order to describe this area of the quarry in more detail, a clean face from a fresh shot would be ideal. At this point, the face can be measured and photographed. Using the photographs, a section diagram shall be prepared which shall detail and quantify the description of bedding planes, vugs and any stylolite spacing. A similar section diagram from another part of the quarry shall be prepared if necessary.

Utilizing the rock shot from this face, a representative quantity of stone will be set aside and each stone will be inspected. The stylolite spacing will be measured and quantified from these stones. Additionally, any vugs or other features that may potentially influence weathering of the stone shall be recorded. A representative sample of this stone shall be sent off for a petrographic analysis.

The final step shall be inspecting a stockpile that has been mechanically crushed. The stone shall be inspected for visual stylolites and vugs. This can be accomplished by taking two to three loader buckets full of material. These buckets will be mixed and back dragged. The back dragged pile can then be measured and quantified. The back dragged pile will then be quartered and 25 to 50 pounds of stone will be collected from each quarter. The stone will be individually inspected and the number of stylolites present in this sized material shall be quantified. The percentage of stylolites shall then be interpolated. Stone containing stylolites from this pile will also be collected and submitted to a laboratory for a sodium sulfate soundness test for what would be considered a "worst case scenario".

This information shall then be summarized and presented. If you have any other questions, or need clarification on this subject matter, feel free to contact me.

Respectively Submitted,

Kenny Schlag

Kenny Schlag, P.G.
Consulting Geologist

APPENDIX B

Geotechnical and Structures Laboratory

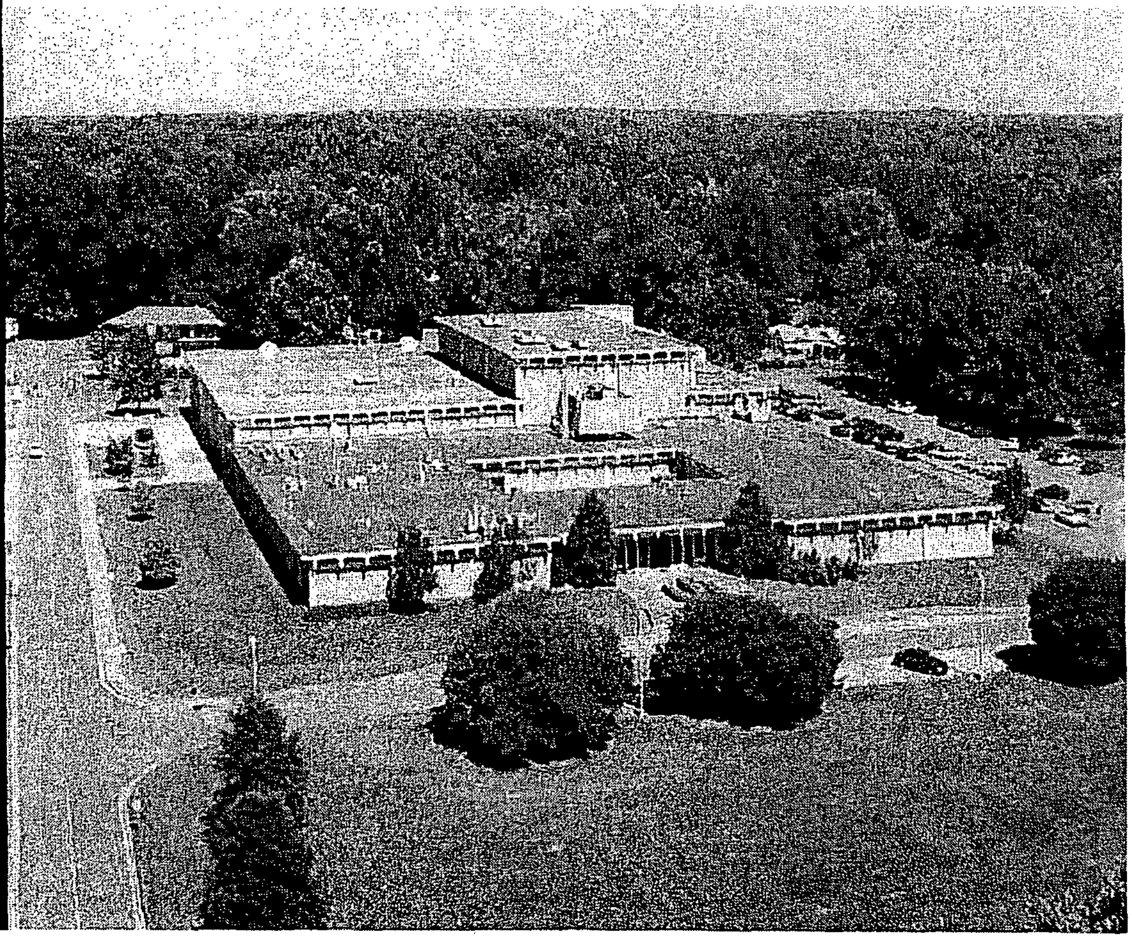
US Army Corps
of Engineers®
Engineer Research and
Development Center

Concrete and Materials Branch
Testing and Evaluation Program

CMB Report 05-001: Results of Slope Protection Material Investigation of Souter Construction Company, Souter Quarry, Gore, OK, for the US Army Engineer District, Tulsa

Joe G. Tom and Charles A. Weiss, Jr.

October 2004



Concrete and Materials Branch
Testing and Evaluation Program

October 2004

CMB Report 05-001:
Results of Slope Protection Material Investigation of Souter Construction Company, Souter Quarry, Gore, OK, for the US Army Engineer District, Tulsa

Prepared For

US Army Engineer District, Tulsa

By Joe G. Tom and Charles A. Weiss, Jr.
US Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Contents

Preface

The US Army Engineer District, Tulsa, authorized the investigation described in this report. The investigation was performed under Customer Order Number W44XGQ42197380, dated 24 Aug 04, managed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS. Mr. Joe G. Tom, ERDC, Geotechnical and Structures Laboratory (GSL), was the Principal Investigator. Mr. Tom and Dr. Charles A. Weiss, Jr., are the principal authors of this report.

Dr. William P. Grogan, Chief, Concrete and Materials Branch, monitored the work at ERDC, GSL, under the general supervision of Dr. Albert J. Bush, Chief, Engineering Systems and Materials Division, and Dr. David W. Pittman, Acting Director, GSL.

1 Introduction

Background

The US Army Engineer Research and Development Center (ERDC) has the responsibility of quality assurance for construction materials on US Army Corps of Engineers projects. That responsibility includes the assurance that all construction materials meet the minimum requirements of the project specifications. The ERDC performs this function for the Districts through its Laboratories. The quality assurance responsibility also includes preliminary investigations of construction materials in preparation of the Materials Design Memorandum for the Districts. Construction materials include portland-cement concretes, asphalt concrete, soils, stones, joint materials, steel reinforcements, and other materials as requested.

Authorization

This work is authorized through Customer Order Number W44XGQ42197380, dated 24 Aug 04, from the US Army Engineer District, Tulsa.

Objective

The objective of this report is to provide specific results of tests and evaluations performed on samples of slope protection material from the Souter Construction Company, Souter Quarry, in Gore, OK. Mr. Frank Oler, District Geologist, Tulsa District, made the initial contact for the materials investigation. The US Army Engineer District, Tulsa, is considering using the stone on Phase II of the Tenkiller Dam project and proposed the Souter Quarry have the material tested and evaluated at ERDC-WES.

Samples

Two stones, approximately 150-lb each, from Souter Construction Company, Souter Quarry, owned by Brazil Creek Minerals, Inc., Gore, OK, were received by the Concrete and Materials Branch (CMB) of the Geotechnical and Structures Laboratory, ERDC, on 10 Aug 04. The sample was assigned CMB serial number 040324.

Tests

The stones were evaluated with the current versions of the following ASTM and US Army Corps of Engineers CRD test methods:

a. ASTM C 88, "Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate."

b. ASTM C 127, "Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate."

c. ASTM C 295, "Standard Guide for Petrographic Examination of Aggregates for Concrete."

d. ASTM C 535, "Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine."

e. CRD-C 144, "Standard Test Method for Resistance of Rock to Freezing and Thawing."

2 Evaluation

Slope Protection Material

The stones were briefly examined by a CMB Geologist to identify the bedding planes within the stones. Cutting lines were marked on each stone to identify the location of each slab for the freezing and thawing test.

Test slabs were saw cut from each stone using the 5-ft diameter diamond studded saw. Each slab was cleaned of excess material. Photographs of each slab were taken to record the pre-test features and later to record post-test features of the freezing and thawing test specimens.

The sulfate soundness test, ASTM C 88, was conducted to determine the soundness of the rock to withstand deterioration from weathering conditions. Samples were sawn from the slabs to comprise the test sample. The magnesium sulfate solution was used during the evaluation. Five cycles of immersion and drying were conducted as required. Calculations were made to determine the percentage of loss material from the slabs.

The relative density (specific gravity) and absorption determinations, ASTM C 127, were conducted on the stone. Samples were immersed in water, mass determined in air and under water, dried to a constant mass, and then calculated for relative density and absorption. Calculations were also made to determine the dry density of the material.

The petrographic examination, ASTM C 295, was conducted to determine the physical and chemical characteristics of the stone; to describe and classify the constituents of the stone; to determine relative amounts of constituents that have a bearing on the performance of the stone as a slope protection material; and to compare this sample with results of previously examined samples and sources.

The Los Angeles abrasion test, ASTM C 535, was conducted to determine the degradation of the rock from abrasion, attrition, impact, and grinding. Samples were sawn from the slabs to comprise the test sample. Twelve steel spheres were used during this test. A total of only 500 revolutions were conducted in accordance with the project specifications in lieu of the 1,000 revolutions as specified in ASTM C 535. The No. 12 sieve was used to determine the amount of degraded material loss from the test. Calculations were made to determine the percentage of degraded material loss.

The freezing and thawing test, CRD-C 144, was conducted to determine the durability of the stone exposed to freezing and thawing conditions. The slab was subjected to 20 cycles of freezing and thawing in a 0.5% alcohol solution as required. The results are based upon the total mass of the remaining fragments whose masses were greater than 25-percent of the initial dry mass of the test slabs.

3 Conclusions and Recommendations

Slope Protection Material

The physical properties tests and the petrographic examination indicate that the stones (040324) from the Souter Construction Company, Souter Quarry, in Gore, OK, should be suitable in performing as slope protection material based upon the requirements in US Army Corps of Engineers District, Tulsa, Stone Specification Section 02485. The results are provided on ENG Form 6012R in Appendix A. The test results are summarized in Table 1 below:

Table 1. Summary of Test Results

Test	Tulsa District Stone Specifications	Results
Relative Density, SSD	≥2.49	2.65
Density, SSD	≥155 lb/cu ft	165
Absorption	≤6 %	0.5
Petrography		OK
LA Abrasion	≤45 %	37.2
Sulfate Soundness	≤18 %	0.0
Freeze-Thaw	<15 %	2.6

The results of the relative density determination, ASTM C 127, indicated the stones from the Souter Quarry exhibited normal values with a relative density of 2.65, saturated surface dry. The calculated saturated surface dry density of the stone based on the relative density (SSD) determination was 165-pounds/cubic foot.

The results of the absorption determination indicated the stones from the quarry exhibited an absorption value of 0.5%.

The results of the petrographic examination, ASTM C 295, indicated the rock is a fine-grained gray fossiliferous limestone with a few vuggy holes partially filled with more coarse-grained crystals of calcite. The detailed petrographic examination is detailed in Appendix C.

The results of the Los Angeles abrasion resistance test, ASTM C 535, indicated the stone has adequate resistance to degradation due to abrasion and other factors with a loss of 37.2% after 500 revolutions.

The results of the magnesium sulfate soundness test, ASTM D 5240, indicated the stone exhibit minimal deterioration due to weathering action with only a 0.0% loss following five cycles of immersion and drying.

The results of the resistance to cycles of freezing and thawing test, CRD-C 144, indicated the stones exhibited a loss of only 2.6% following 20 cycles of freezing and thawing. Photographs of the pre-test condition and post-test condition of each test slab are enclosed in Appendix B.

Slope protection material from this quarry appears to be good sound rock and should be satisfactory for use as riprap, armor stone, derrick stones, etc.

Appendix A
Stone Test Report, ENG Form 6012-R

STATE: OK	INDEX NO.:	**RIPRAP**	TESTED BY: CEERD-GM-C
LAT.: 35	LONG.: 96	**DATA SHEET**	DATE: September 2004
LAB ID: 040324			MATERIAL: Limestone
LOCATION: Gore, OK, Sec 21, T13N, R21E, Sequoyah County, OK			
PRODUCER: Souter Construction Company, Conway, AR, owned by Brazil Creek Minerals, Inc.			
SAMPLED BY: Tulsa District			
TESTED FOR: Tenkiller Dam			
USED AT:			
PROCESSING BEFORE TESTING:			
GEOLOGICAL FORMATION AND AGE:			

TEST METHOD		**RESULTS**
RELATIVE DENSITY (BULK SPECIFIC GRAVITY), SSD, (ASTM C 127)		2.65
ABSORPTION, %, (ASTM C 127)		0.5
SSD DENSITY, LB/CU FT, (ASTM C 127)		165.0
LOS ANGELES ABRASION, % LOSS, (ASTM C 535)		37.2*
SULFATE SOUNDNESS, % LOSS, (ASTM D5240)		0.0
FREEZING & THAWING, % LOSS, (ASTM D 5312)		--
WETTING & DRYING, % LOSS, (ASTM D 5313)		--
FREEZING & THAWING, % LOSS, (CRD-C 144)		2.6
ETHYLENE GLYCOL, % LOSS, (CRD-C 148)		--
WETTING & DRYING, % LOSS, (CRD-C 169)		--

PETROGRAPHIC REPORT (ASTM C 295)

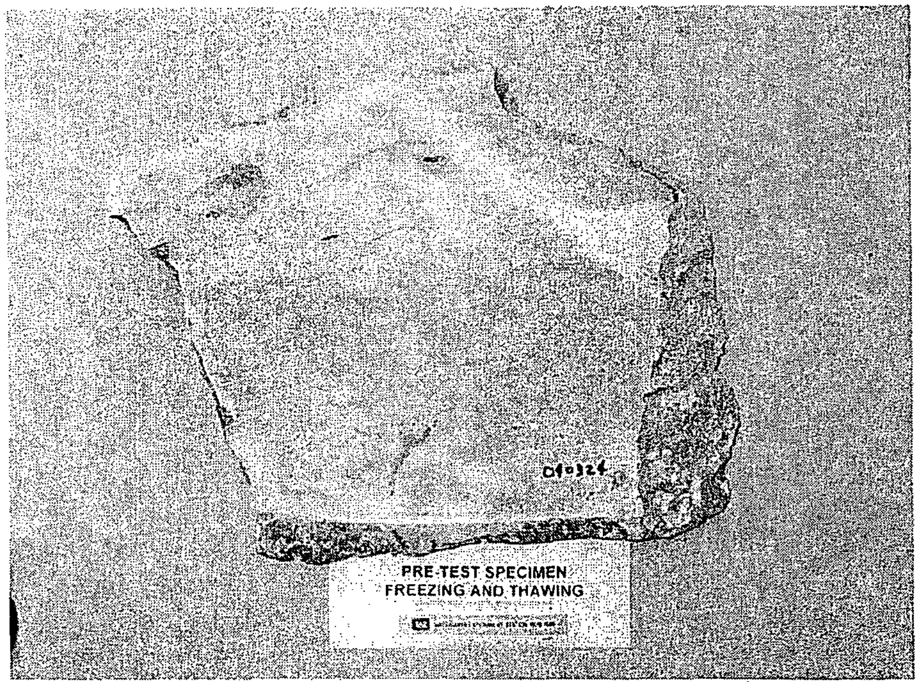
The rock appeared to be a fine-grained gray fossiliferous limestone with a few vuggy holes partially filled with coarse-grained crystals of calcite. The rock is principally calcite with minor amounts of dolomite present. The presence of clay minerals was not observed. The mineralogy of the rock as determined by XRD analysis does not indicate that here would be any phases present that would cause a problem if the rock was subjected to cycles of freezing and thawing.

REMARKS

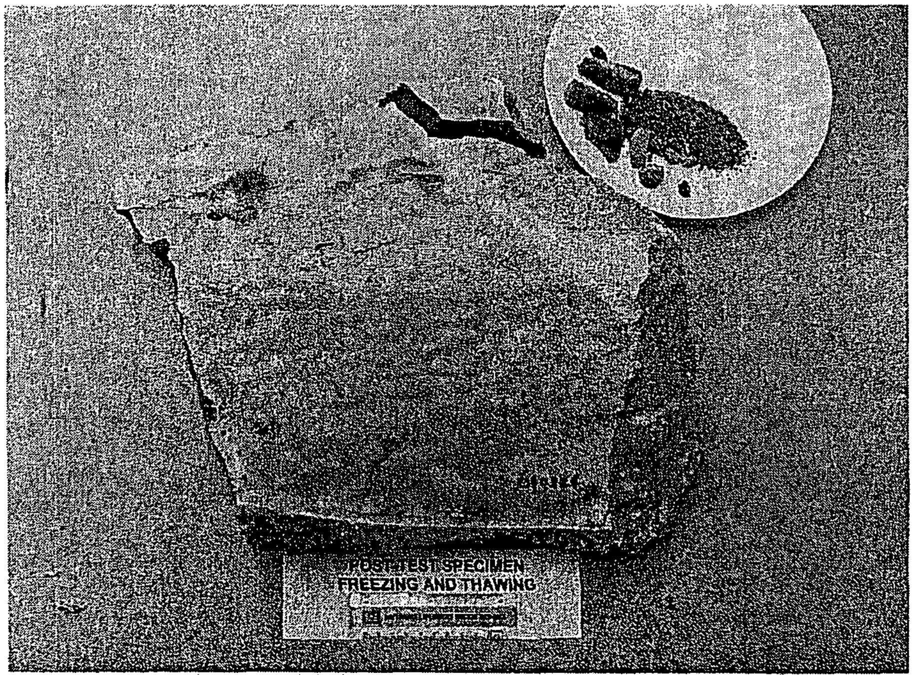
* The results are based upon 500 revolutions
The rock should perform satisfactorily as slope protection material.

ENG Form 6012-R

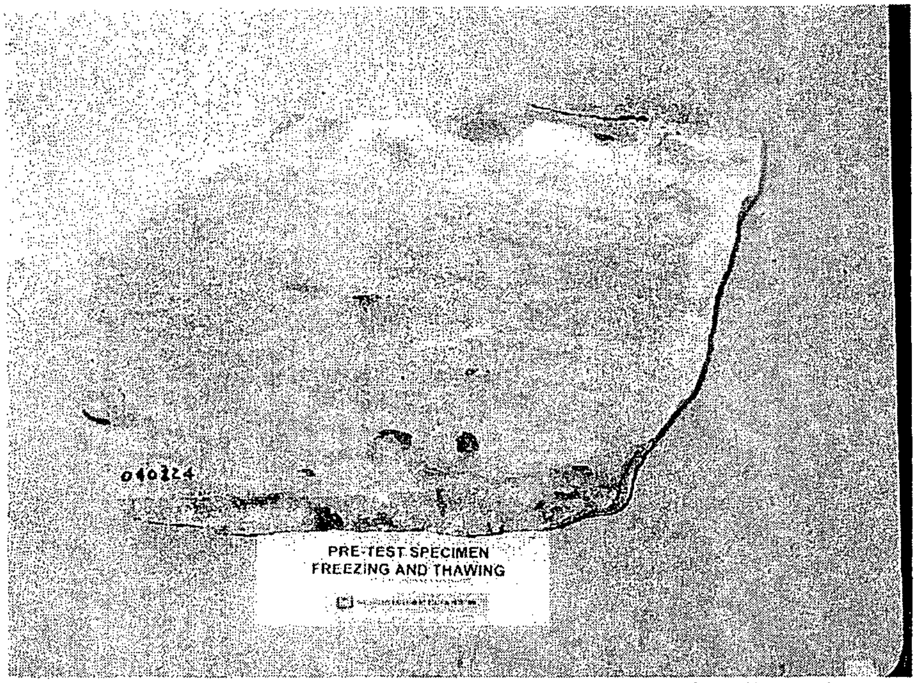
Appendix B
Photographs



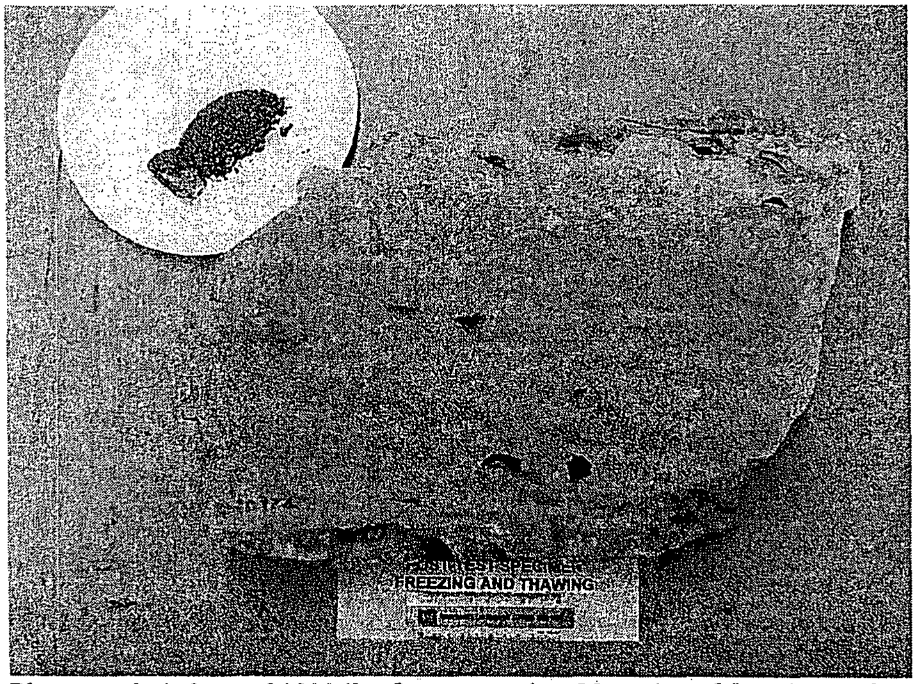
Photograph 1. Stone 040324a before subjected to 20 cycles of freezing and thawing.



Photograph 2. Stone 040324a after exposed to 20 cycles of freezing and thawing. Results are based upon largest remaining piece.



Photograph 3. Stone 040324b before subjected to 20 cycles of freezing and thawing.



Photograph 4. Stone 040324b after exposed to 20 cycles of freezing and thawing.

Appendix C
Petrographic Report

CEERD-GM-C 22 Sep 04

MEMORANDUM FOR RECORD

Subject: Petrographic Examination of 040324

1. Sample 040324 is a large boulder-sized gray rock (Figure 1). The rock appeared to be a fine-grained fossiliferous limestone with a few vuggy holes partially filled with more coarse-grained crystals of calcite.

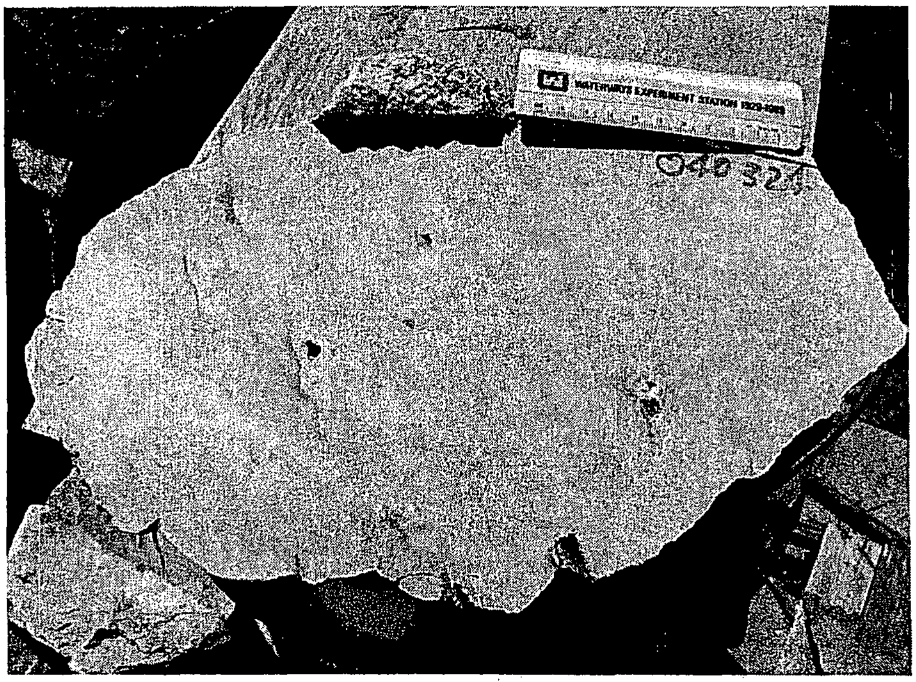


Figure 1. Photograph of rock sample CMB No. 040324

2. The samples were examined according to Standard Descriptive nomenclature for Constituents of Concrete Aggregates (ASTM C 294) and Standard Practices for Petrographic Examination of Aggregates for Concrete (ASTM C 295). The mineralogy of the sample was determined using X-ray diffraction (XRD) analysis. XRD patterns were run on each of the samples, and were run as randomly oriented packed powders. A Philips PW1800 Automated Powder Diffractometer system was used to collect the XRD patterns employing standard techniques for phase identification. The run conditions included Cu K_{α} radiation and scanning from 2 to 65 °2θ with collection of the diffraction patterns accomplished using the PC-based, Windows-based version of Datascan, and analysis of

the patterns using the Jade program from (both from Materials Data, Inc.). In preparation for XRD analysis, a portion of the sample was ground in a mortar and pestle to pass a 45-μm mesh sieve (No. 325). Bulk sample random powder mounts were analyzed using XRD to determine the mineral constituents present in each sample.

3. The XRD pattern of the sample is given in Figure 1. The sample is principally calcite with minor dolomite present. The presence of clay minerals was not observed.

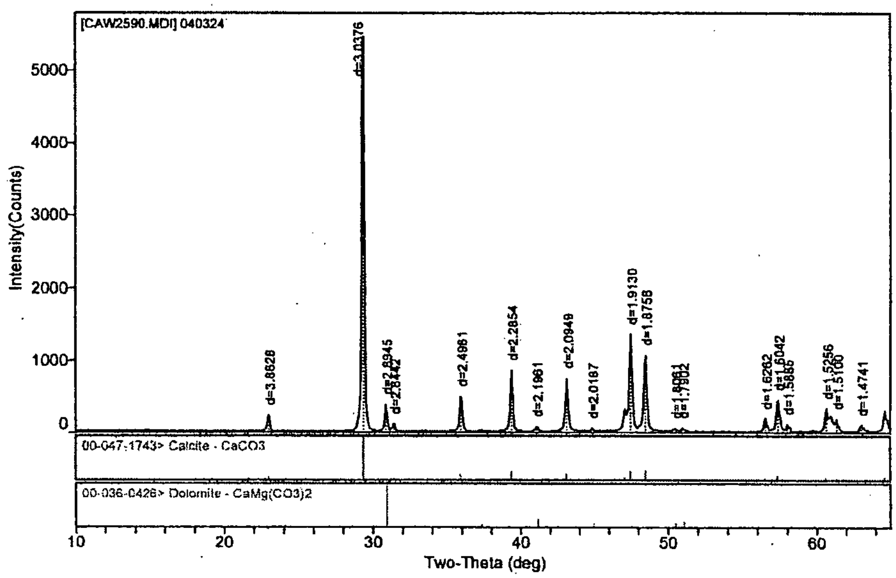


Figure 1. X-ray diffraction pattern of bulk sample of sample 040324.

4. The mineralogy of the sample as determined by XRD analysis does not indicate that there would be any phases present that would cause a problem if the rock was subjected to freezing and thawing conditions.

CHARLES A. WEISS, JR., PhD, RPG
Research Geologist
Concrete and Materials Branch
Engineering Systems and Materials Division

APPENDIX C

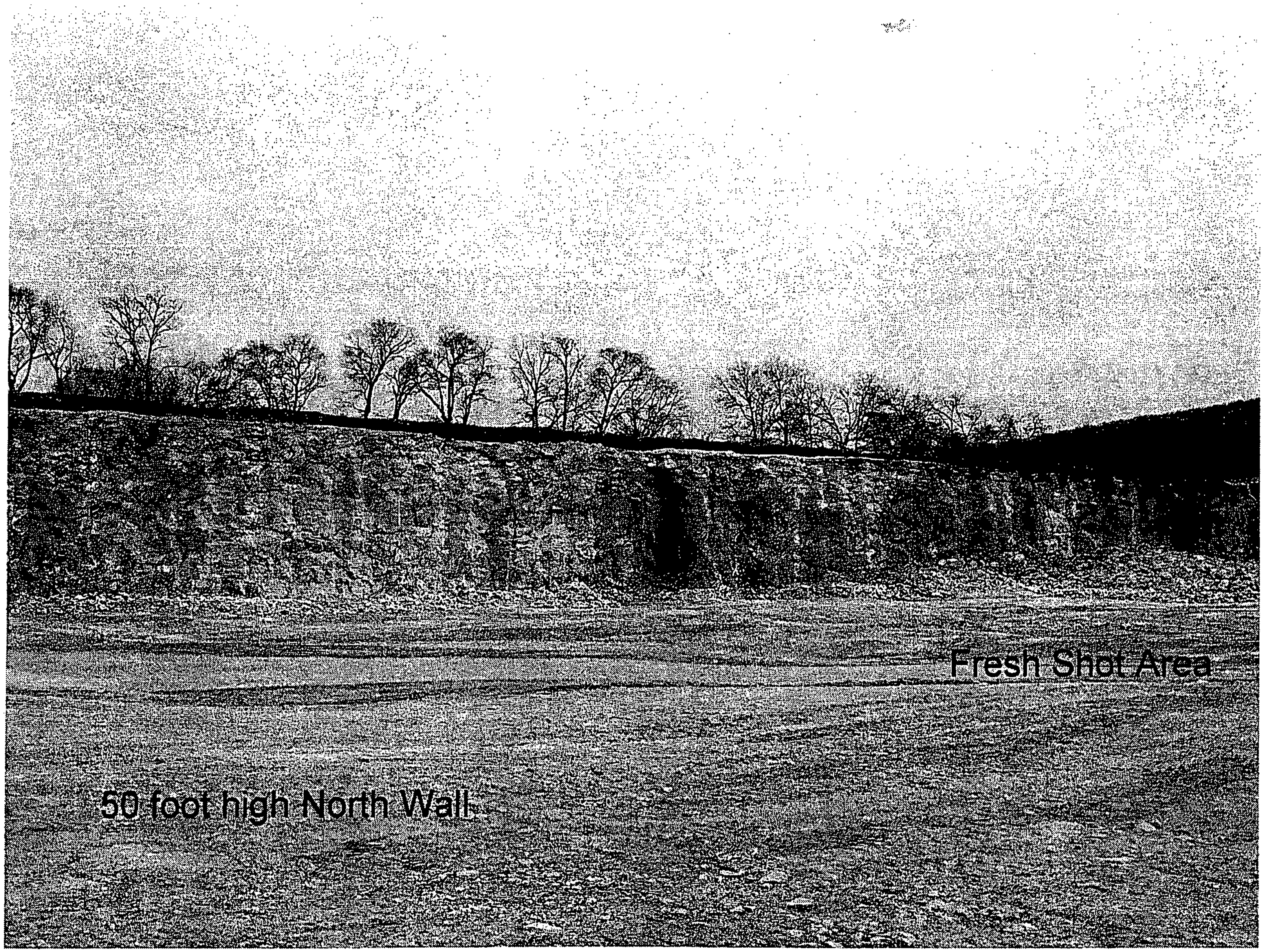


Figure C-1

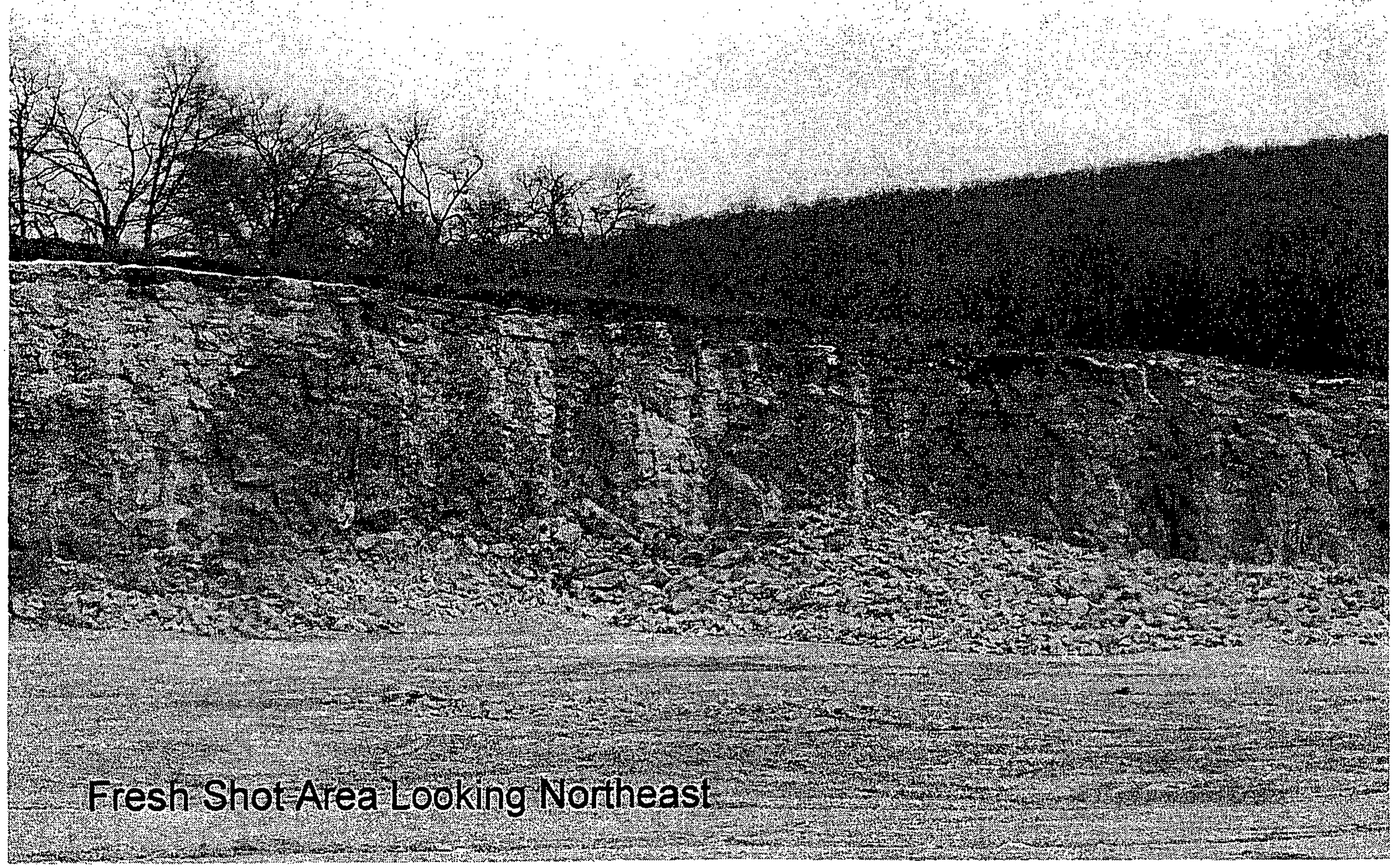


Figure C-2

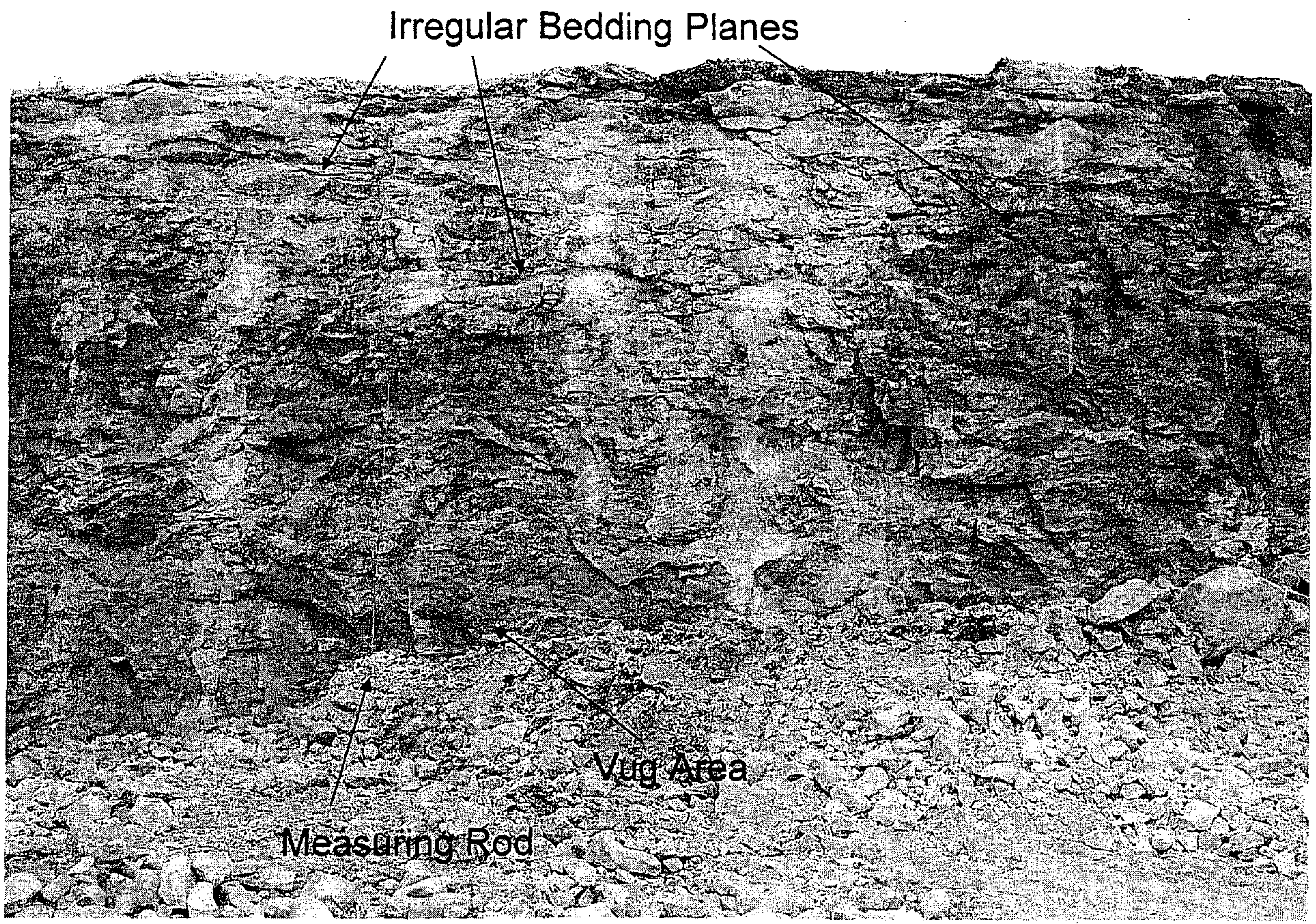


Figure C-3

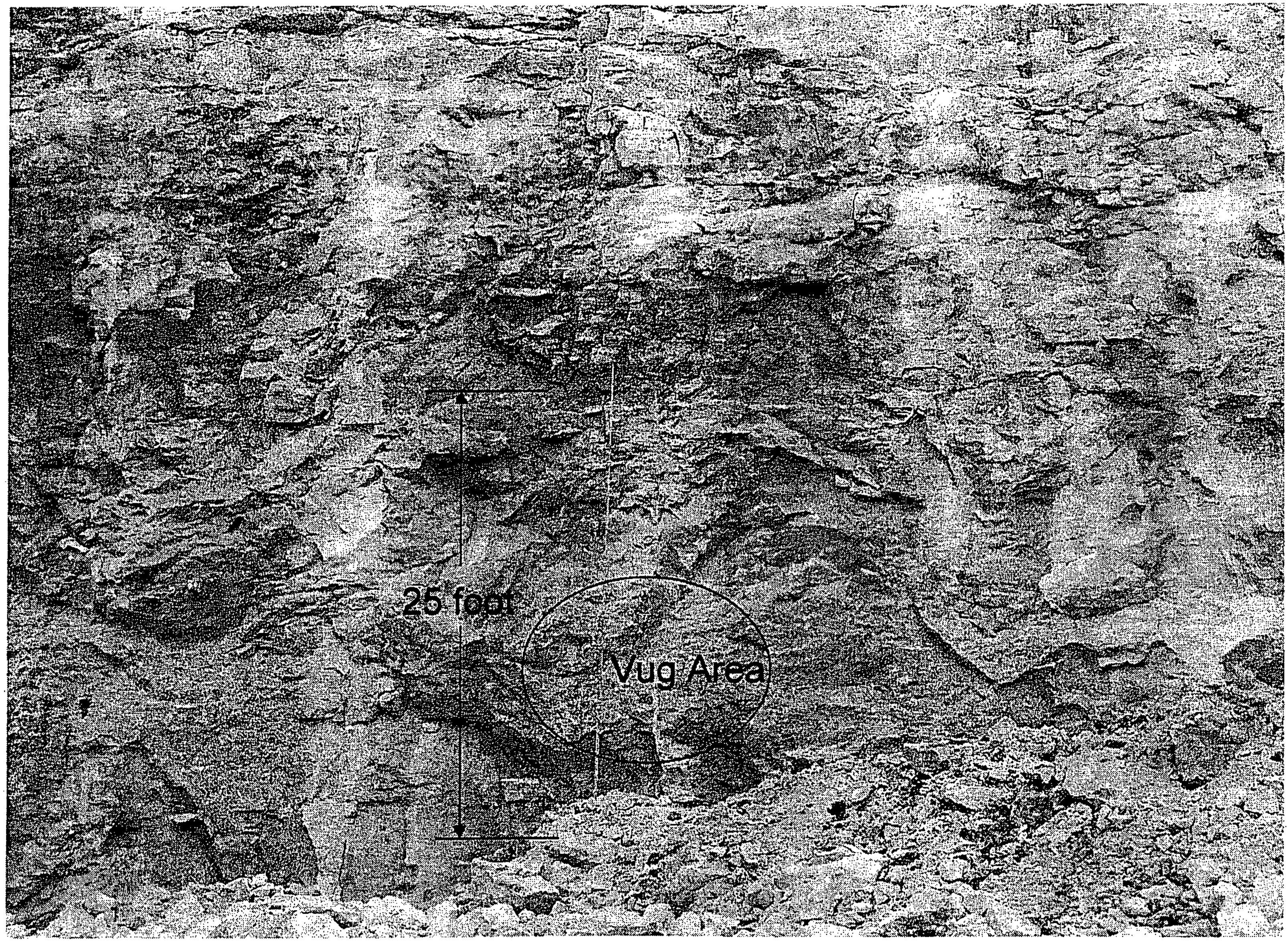


Figure C-4

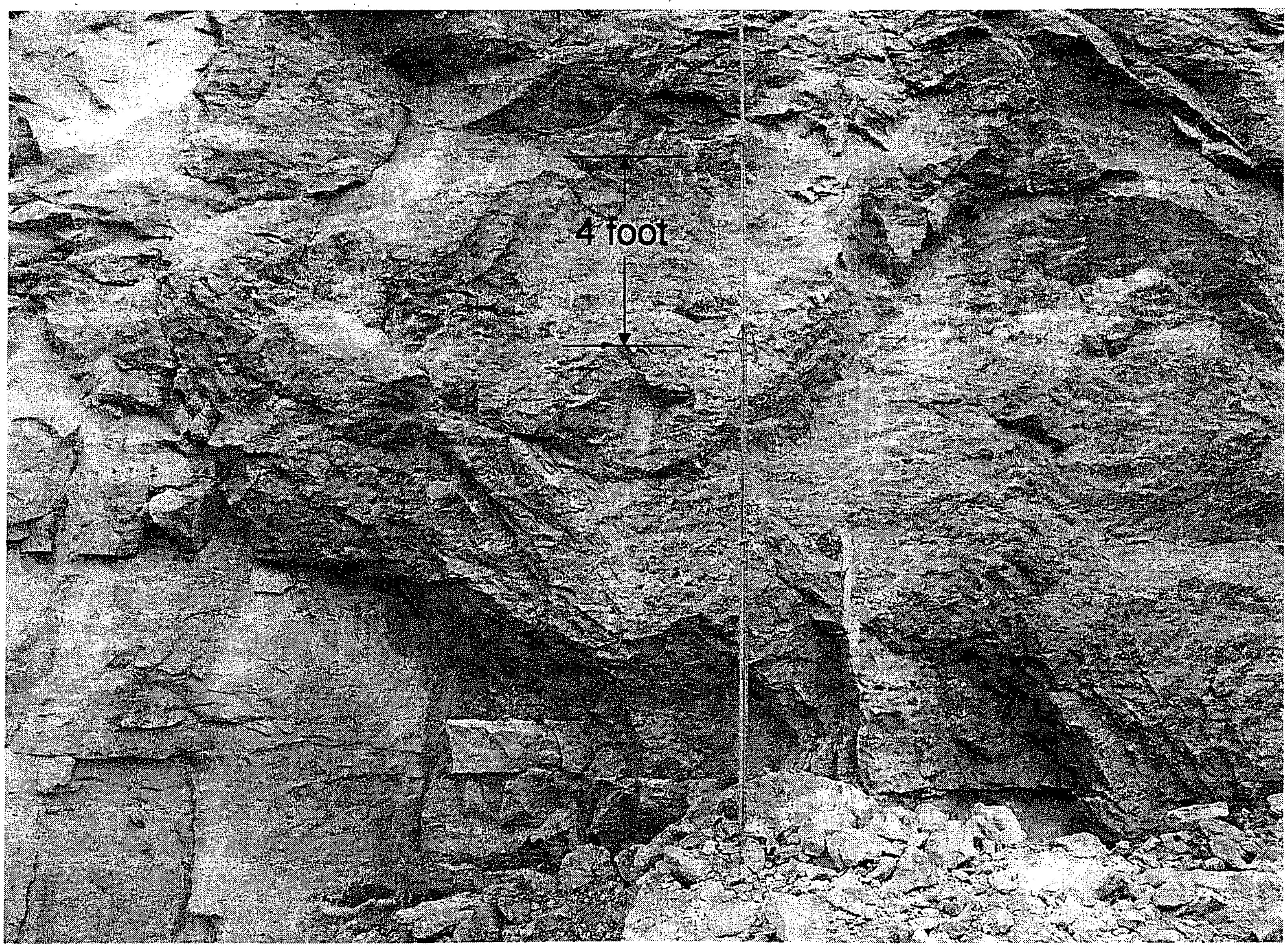


Figure C-5

Figure C-6

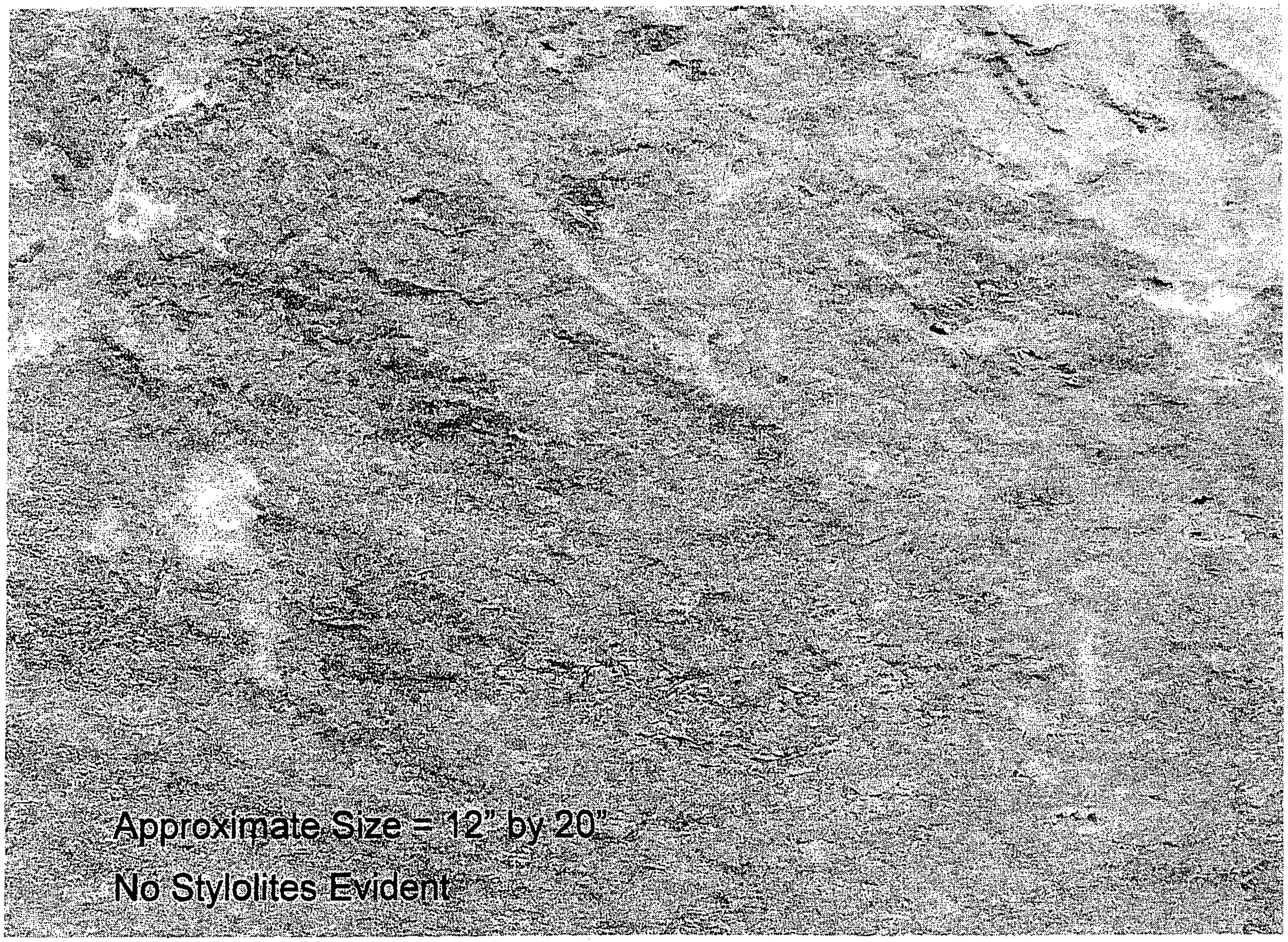


Figure C-7

APPENDIX D

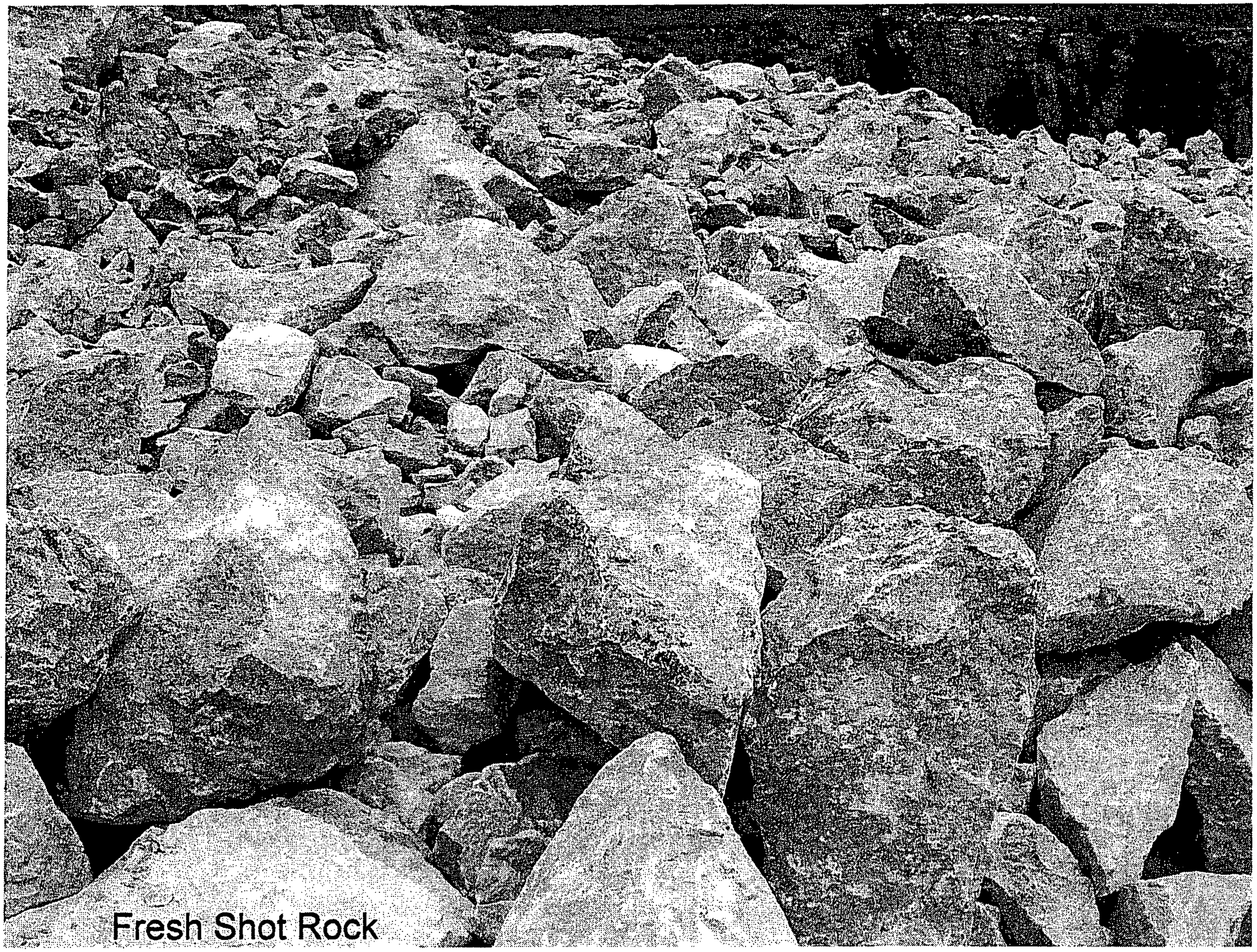


Figure D-1

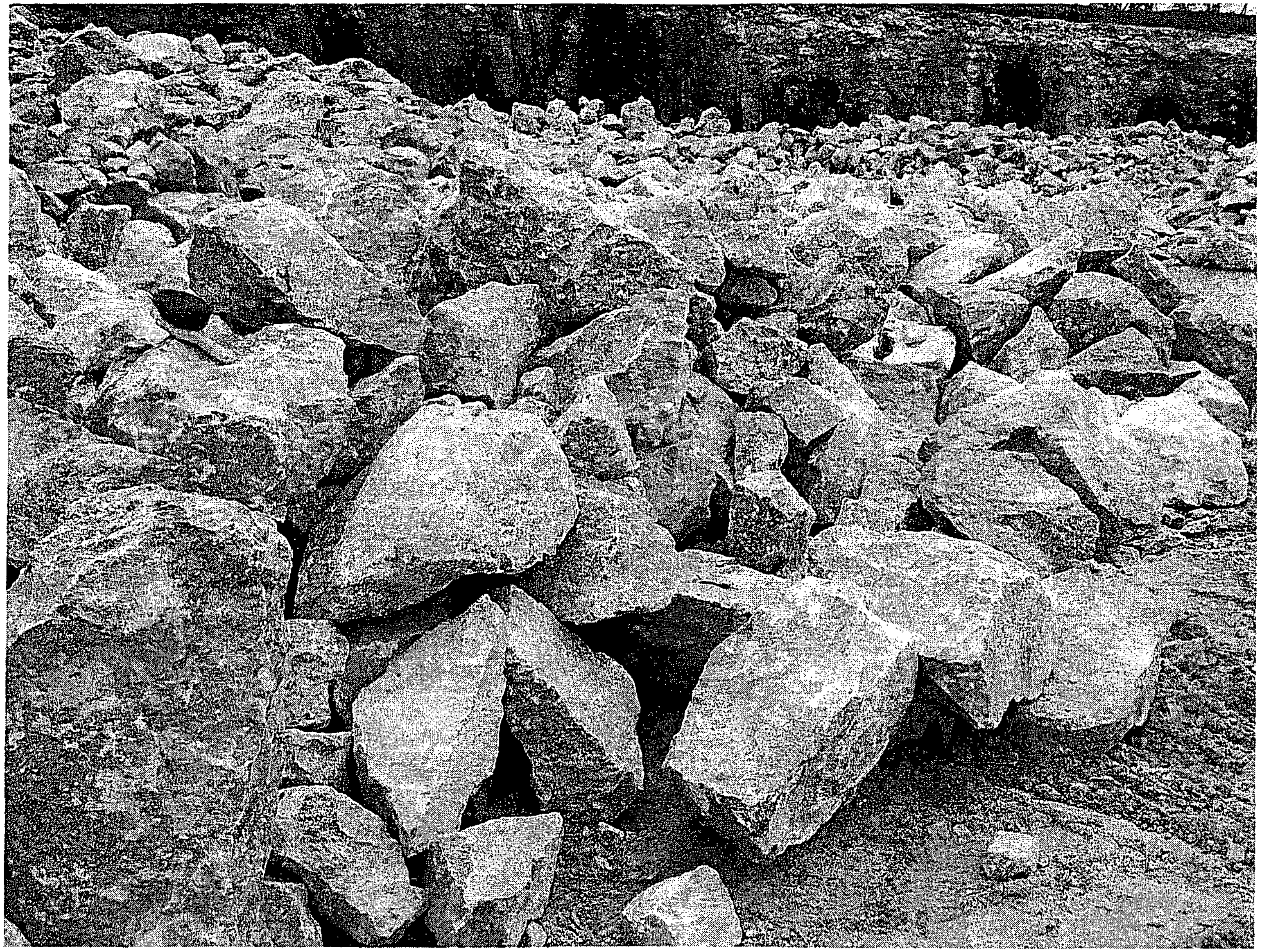


Figure D-2

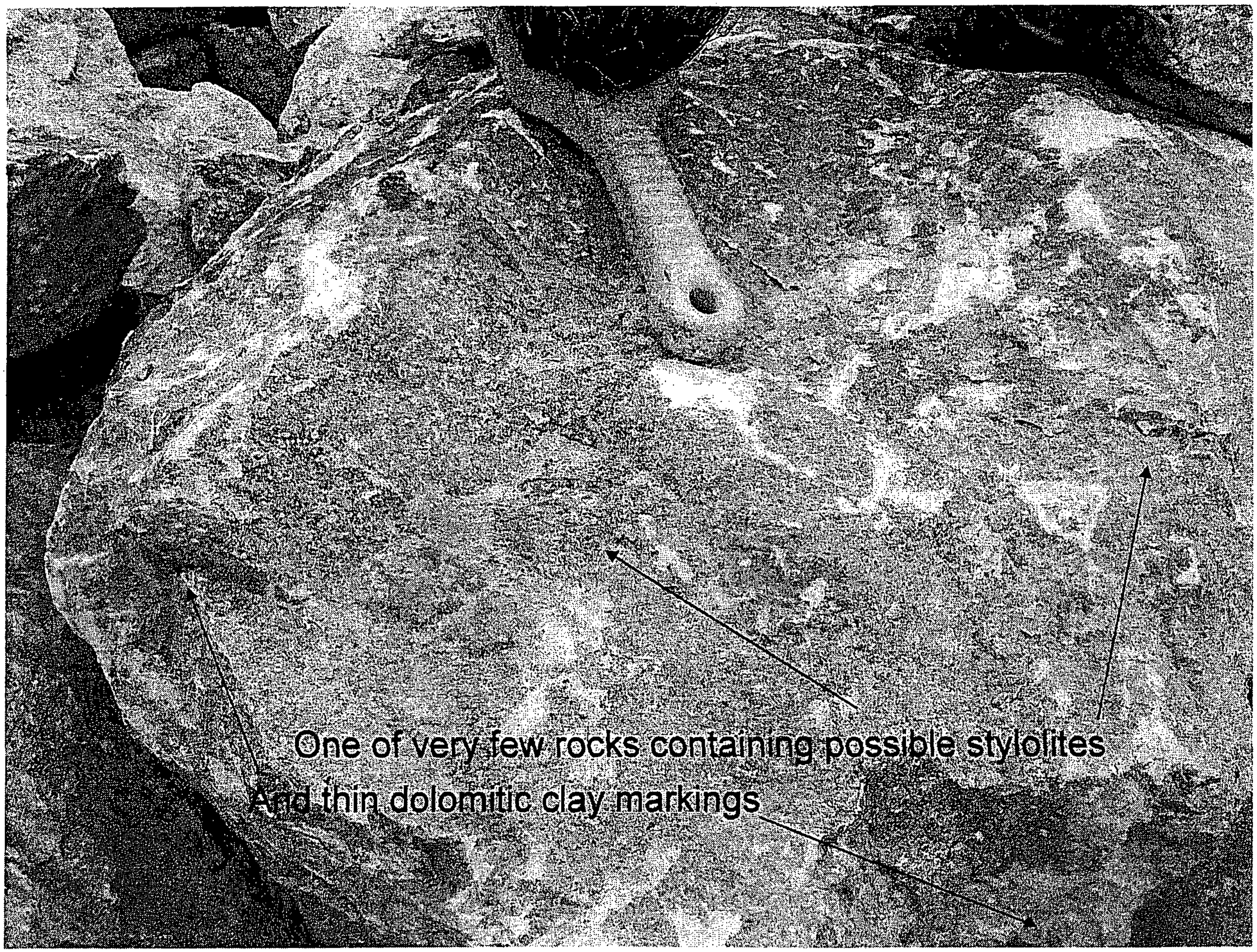

One of very few rocks containing possible stylolites
And thin dolomitic clay markings

Figure D-3

Overview of rock inspected for stylolites (Looking North)

Figure D-4

APPENDIX E

SEQUOYAH FUELS CORPORATION
Petrographic Examination of Limestone for Use as Riprap

Gore, Oklahoma

Final Report
24 April 2007
WJE No. 2007.1405

Prepared for:
Sequoyah Fuels Corporation

Prepared by:
Wiss, Janney, Elstner Associates, Inc.

WJE

SEQUOYAH FUELS CORPORATION
Petrographic Examination of Limestone for Use as Riprap

Gore, Oklahoma

Laura J. Powers
Consultant/Petrographer

Final Report
24 April 2007
WJE No. 2007.1405

Prepared for:
Sequoyah Fuels Corporation
I-40 and Hwy 10
P. O. Box 610
Gore, OK 74435

Prepared by:
Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax

WJE | ENGINEERS
ARCHITECTS
MATERIALS SCIENTISTS

SEQUOYAH FUELS CORPORATION
Petrographic Examination of Limestone for Use as Riprap

Gore, Oklahoma

INTRODUCTION

Contained in this report are the results of petrographic studies conducted on samples of limestone submitted by Mr. Kenny Schlag, Consulting Geologist. The rock fragments are reportedly representative of locally-mined rock that is being considered for use as erosion control riprap on the Sequoyah Fuels Disposal Cell Project. The studies were requested to evaluate the mineralogy, texture and fabric of the rock, and to identify any characteristics that might influence its long-term durability.

Three rock fragments were received for the studies; each fragment measured approximately 8 to 10 inches in the longest dimension, and weighed between 9 and 12 pounds. For ease in identification, we arbitrarily labeled the rock fragments A, B, and C. The fragments are shown in Figures 1, 2, and 3.

PETROGRAPHIC STUDIES

The petrographic studies were performed in accordance with standard geological petrographic practice, using the applicable procedures outlined in ASTM C 856, *Standard Practice for Petrographic Examination of Hardened Concrete* and in C 295, *Standard Guide for Petrographic Examination of Aggregates for Concrete*. The samples were examined visually. One sample was cut in two directions to expose bedding planes, if present. The saw-cut surfaces were lapped for stereomicroscope examination. A thin section was prepared from a rectangular block cut from a representative portion of the un-lapped pieces of the cut sample. The thin section was examined using a polarized-light (petrographic) microscope to identify the mineral constituents, describe their distribution, measure grain size, and evaluate microstructure. The samples are described below.

General Description

Samples A, B, and C are essentially identical (Figure 1, 2, and 3). The rock represented by the samples is a moderately hard, moderately dense, mottled pinkish-beige, white to light beige, and gray, limestone (Figure 4). No vugs, open fissures, large voids, or significant cavities are observed. No well-defined bedding planes or seams are detected; however, variations in color and grain size reveal non-planar bands (Figure 5) that broadly resemble bedding. Parallel, gray and grayish white bands and lenses occur sporadically. Dark gray layers up to 1 mm thick resemble poorly-formed stylolites; these features are rare. Calcite-filled, 'healed' fractures (Figure 6) up to 1 mm across intersect the bands at a steep angle, and are fairly frequent.

Fracture Characteristics

Fresh fractures passing through the pinkish-beige portions of the rock are hard and firm. Only the infrequent, narrow, dark gray bands constitute planes of weakness in the rock. Fracture surfaces through these regions are soft. The healed fractures are not planes of weakness.

Petrographic Description

The rock is a calcitic, fossiliferous limestone. The pinkish-beige portions of the stone (Figure 7) are mainly composed of interlocking crystals of medium to coarse-grained calcite (average crystal size of 1 to 3 mm). The white to pale-beige portions of the stone consist of fine-grained calcite. Pyrite is observed in trace amounts, less than 1 percent by volume, and occurs as small crystals and clumps of crystals scattered throughout the limestone (Figure 8). Hematite occurs in trace amounts as minute inclusions ('dust') within the calcite crystals in the pinkish-beige portions of the limestone (Figure 9). The gray portions of the limestone are softer and contain variable amounts of clay or clay-size siliceous minerals (Figures 10 and 11). Overall, the amount of soft, clay-size minerals is minor (estimated at less than 3 percent). Further analysis by X-ray diffraction (XRD) would be needed to identify these minerals.

SUMMARY AND DISCUSSION

The rock represented by the samples is a moderately hard, moderately dense, fine to coarse-grained calcitic, fossiliferous limestone. Bedding planes in the limestone are poorly-defined, but color banding and grain-size banding are prominent characteristics of the rock. The rock does not show a strong tendency to split parallel to the banding. The limestone contains trace amounts of interstitial pyrite. Calcite crystals are typically pinkish due to the presence of abundant small inclusions of hematite. Small, but variable, amounts of clay or clay-sized minerals are observed mostly in thin, dark gray layers that resemble poorly-formed stylolites. The rock has a tendency to break along these layers. However, little impact on the durability of the riprap produced from the limestone is expected because these layers are infrequent and would tend to occur on the outside surface of the mechanically crushed rock. The rock is free of cavities, vugs, and fissures. The porosity of the limestone is low. Old fractures that are now 'healed' with calcite are fairly common, but the limestone does not exhibit a tendency to break at these locations.

Overall, the limestone appears adequate for use as riprap provided that field examination of the limestone at the quarry can show that the frequency of the thin, dark gray layers is similar to that in the samples examined.

Storage: Thirty days after completion of our studies, the samples will be discarded unless the client submits a written request for their return. Shipping and handling fees will be assessed for any samples returned to the client. Any hazardous materials that may have been submitted for study will be returned to the client and shipping and handling fees will apply. The client may request that WJE retain samples in storage in our warehouse. In that case, a yearly storage fee will apply.

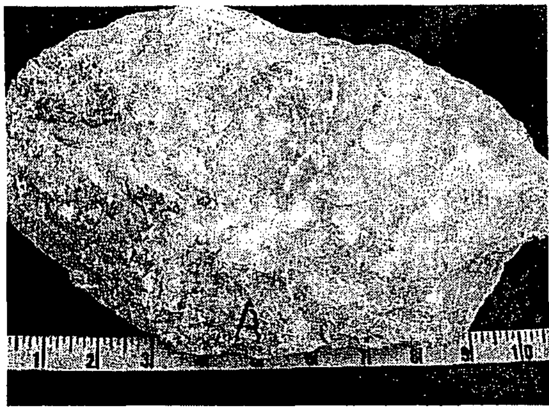


Figure 1. Rock Fragment A.

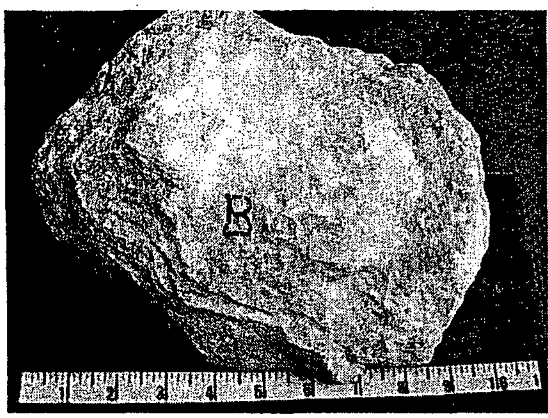


Figure 2. Rock Fragment B.

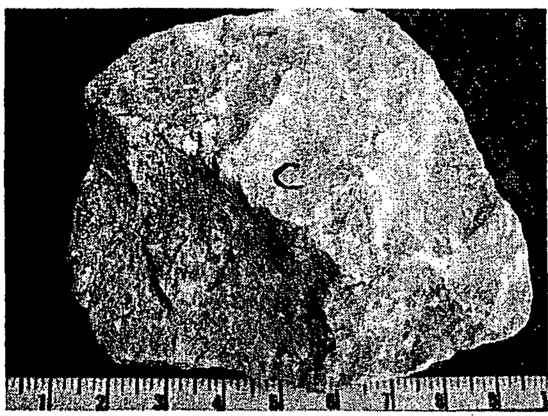


Figure 3. Rock Fragment C.

Figure 4. After washing, the Rock Fragment A is shown to be mottled pinkish-beige, gray and white.

Figure 5. Banding and color variation in the limestone. Arrows show layers that resemble poorly-formed stylolites. Millimeter scale.

Figure 6. Fine to coarse-grained whitish-beige to pinkish-beige bands of fossiliferous limestone. Arrows show a calcite-filled fracture. Millimeter scale.

Figure 7. The pinkish-beige portions consist of medium to coarse-grained calcite that contains inclusions of hematite 'dust.' Millimeter scale.

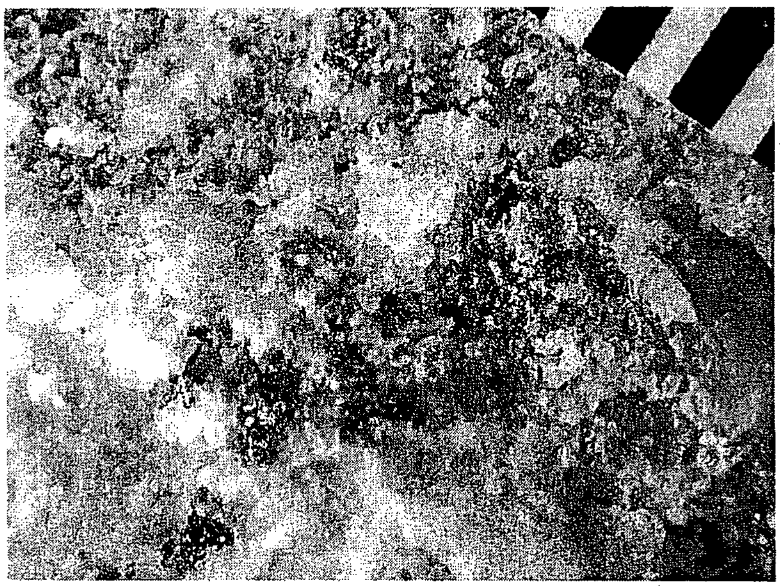


Figure 8. The limestone contains disseminated crystals of brassy pyrite. Millimeter scale.

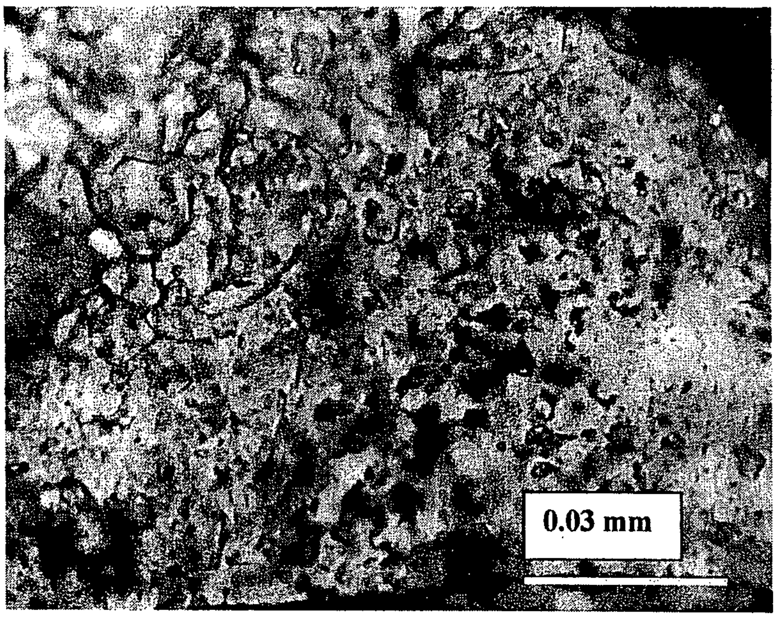


Figure 9. Cross-polarized light image showing small, red, hematite inclusions in calcite.

Figure 10. Gray portions of the limestone are soft clay or clay-size minerals. Millimeter scale.

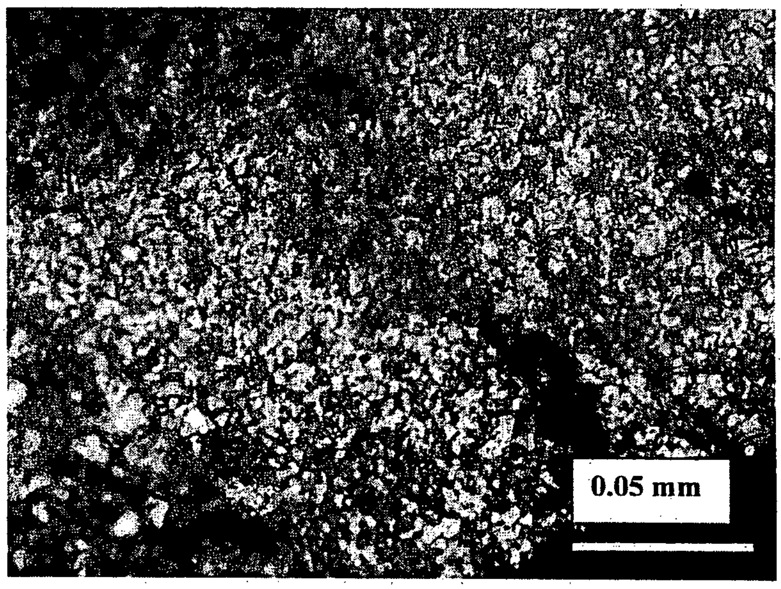


Figure 11. Cross-polarized light image of the soft, very fine-grained, clay-like siliceous material.

DATA TESTING INC

August 17, 2007

FOR: Sequoyah Fuels
P.O. Box 610
Gore, Oklahoma 74435

PROJECT: Souter Quarry – North Wall
Gore, Oklahoma

Date Sample Received: July 23, 2007
Date Test Performed: July 26, 2007

Material Source: Souter Quarry – Gore, OK

Type of Material: Crushed limestone.

ASTM C-137
Specific Gravity and Absorption Results

Bulk G_s = 2.600

Absorption = 1.1 %

Bulk G_{ssd} = 2.629

App. G_s = 2.676

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DATA TESTING INC

SODIUM SULFATE SOUNDNESS TEST
AASHTO T-104

FOR: Sequoyah Fuels
P.O. Box 610
Gore, Oklahoma 74435

August 17, 2007

Date Sample Received: July 23, 2007
Date Test Performed: August 1-6, 2007

Type of Material: Crushed limestone.

Source of Material: Souter Quarry - Gore, OK (North Wall)

Sieve	Grading of Orig. Sample % Retained	Wt. Of Test Fraction Before Test (g)	Wt. Passing Sieve After Test (g)	Percent Loss	Weighted Percent Loss
1 1/2" to 1"	n/a	1001.6	1508.9	0.2	0.1
1" to 3/4"	n/a	510.7			
3/4" to 1/2"	n/a	678.8	1002.8	0.7	0.3
1/2" to 3/8"	n/a	330.8			
Totals		2521.9	2511.7		**0.4**

Note: Samples were subjected to 5 cycles.

DATA TESTING INC

ASTM C131

Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

Sample Material: Limestone

Location: Souter Quarry
Gore, OK

Nominal Max Size: 25.0 mm (1 in.)

Date: 8/17/2007

Client: Sequoyah Fuels

Technician: SCO

Grading: A **Number of Spheres:** 12 **Weight of Charge:** 4986.4 (g)

Weight of Test Samples per Table1, (to nearest gram)

Passing:	Retained On:	Material (g)
37.5 mm (1 1/2 in.)	**25.0 mm** (1 in.)	1248.3
25.0 mm (1 in.)	**19.00 mm** (3/4 in.)	1251.1
19.00 mm (3/4 in.)	**12.5 mm** (1/2 in.)	1249.5
12.5 mm (1/2 in.)	**9.5 mm** (3/8 in.)	1250.4
9.5 mm (3/8 in.)	**6.3 mm** (1/4 in.)	
6.3 mm (1/4 in.)	**4.75 mm** (No.4)	
4.75 mm (No.4)	**2.36 mm** (No. 8)	

Original Total Weight (g): 4999.3

Weight of Oven Dried Material Coarser Than 1.70 mm (No. 12) (to nearest gram)

Final Weight (g): 4493.1

Percent Loss: 10 (nearest 1%)

Calculations: (Original Wt. - Final Wt.)/Original Wt. X 100

DATA TESTING INC

September 10, 2007

FOR: Sequoyah Fuels
P.O. Box 610
Gore, Oklahoma 74435

PROJECT: Souter Quarry
Gore, Oklahoma

Date Sample Received: September 6, 2007
Date Test Performed: September 6-10, 2007

Material Source: Souter Quarry – Gore, OK

Type of Material: Crushed limestone.

ASTM C-137
Specific Gravity and Absorption Results

Dark Gray Stone #1

Bulk G_s = 2.736 Absorption = 0.60 %

Bulk G_{ssd} = 2.752

App. G_s = 2.782

Dark Gray Stone #2

Bulk G_s = 2.661 Absorption = 0.57 %

Bulk G_{ssd} = 2.676

App. G_s = 2.702

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DATA TESTING INC

ASTM C-137
Specific Gravity and Absorption Results

North Wall Stockpile (East end)

Bulk G_s = 2.646 Absorption = 0.74 %

Bulk G_{ssd} = 2.666

App. G_s = 2.699

North Wall Stockpile (West end)

Bulk G_s = 2.659 Absorption = 0.70 %

Bulk G_{ssd} = 2.677

App. G_s = 2.709

Pink Stone

Bulk G_s = 2.662 Absorption = 0.53 %

Bulk G_{ssd} = 2.677

App. G_s = 2.701

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APPENDIX F

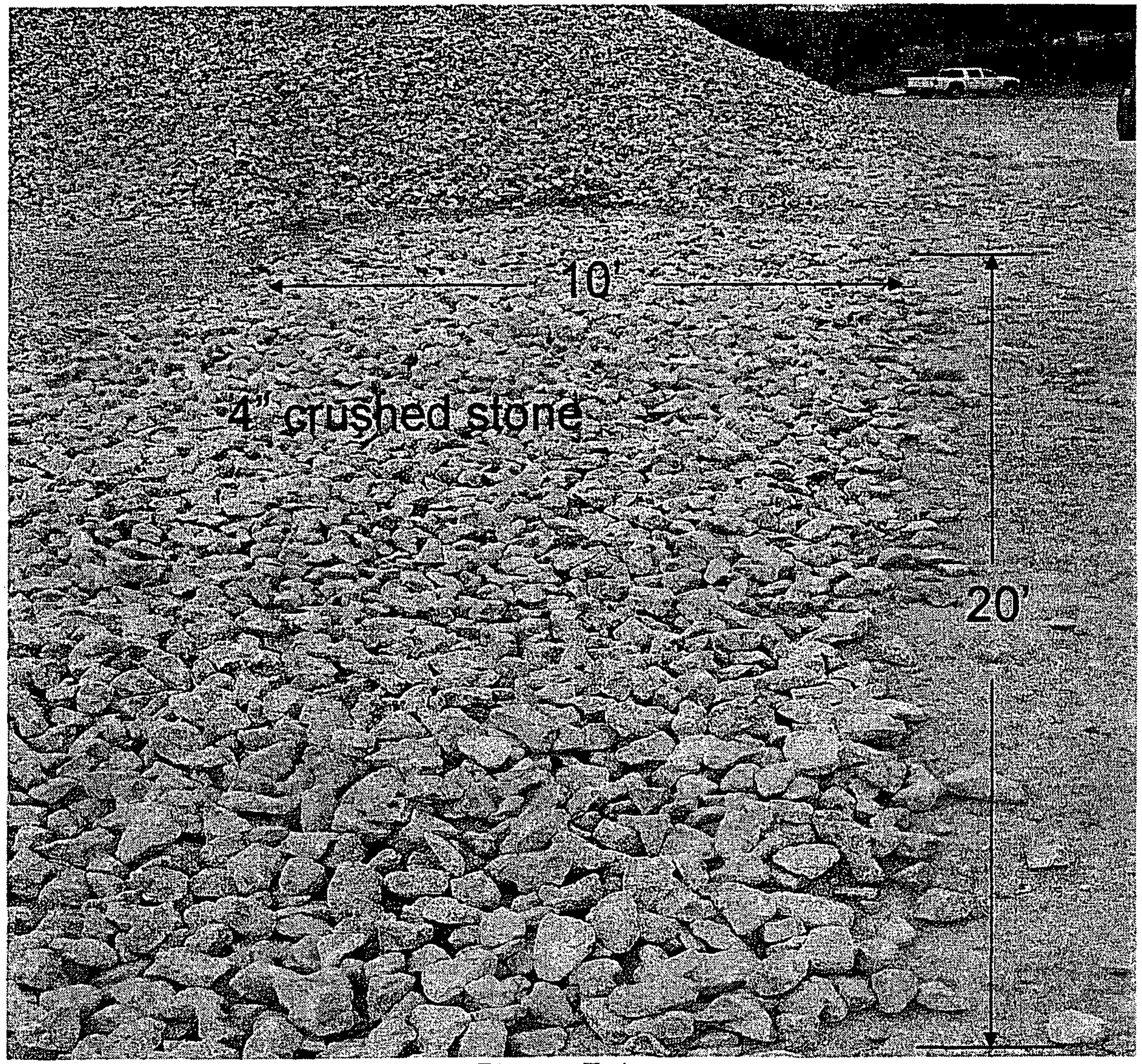

Figure F-1

Figure F-2

Figure F-3

Figure F-4

APPENDIX G

MWH

By CRB Date 11 Sep 07 Client SFC Sheet ___ of ___

Chkd. By ___ Description ___ Job No. ___

Samples from north wall of Souter quarry

Sample Description	Bulk Specific Gravity	Absorbtion (%)	Na_2SO_4 Soundness (%)	LA Abrasion (%)	
Crushed limestone	2.600	1.10	0.4	10	(500 revolutions)
Dark gray stone #1	2.736	0.60	-	-	
Dark gray stone #2	2.661	0.57	-	-	
North wall stockpile (E)	2.646	0.74	-	-	
North wall stockpile (W)	2.659	0.70	-	-	
Pink stone	2.662	0.53	-	-	
Values used in scoring calculation	2.661	0.71	0.4	2	(for 100 revolutions)

Test	Result	Score (1-10)	Weighting (limestone)	Weighted Score	Total Score
Specific gravity	2.661	8.1	12	97.2	120
Absorbtion	0.71	6.7	13	87.1	130
Na_2SO_4 Soundness	0.4	10.0	4	40.0	40
LA Abrasion	2	9.5	1	9.5	10
				233.8	300

233.8/300 = 78%

78% indicates rock is acceptable, but needs oversizing of 2%.
We have included an oversizing factor of 10% in our technical specifications

ENCLOSURE 2

ROCK PRODUCTION STRATEGY REPORT

REPORT
FOR
SEQUOYAH FUELS CORPORATION
DISPOSAL CELL PROJECT

SOUTER QUARRY
ROCK PRODUCTION STRATEGY REPORT

PREPARED BY
KENNETH SCHLAG, P.G.
CONSULTING GEOLOGIST
August 26, 2007

INTODUCTION

This report has been prepared for the rock selection procedure to be conducted at the Souter Quarry for the Sequoyah Fuels Corporation (SFC) Disposal Cell Project. The Souter Construction Company Quarry has been selected as the source of rip rap and rock drainage layer material. The quarry is located approximately 10 miles northeast of Gore, OK. in Sequoyah County. Based on discussions during a recent quarry visit with Ted Johnson and Robert Johnson and on behalf of SFC, this rock selection procedure will ensure the rock used on this project will meet the specified durability requirements.

PERSONNEL INVOLVED IN ROCK SELECTION

The selection and testing of the rock shall be performed by a geologist, or designee specifically trained by the geologist for this project. The geologist or designee shall be responsible for inspecting the quarry face prior to blasting, communicating with the quarry operator in the selection and/or processing of the shot rock and ensuring removal of rock that does not meet the criteria of the rip rap and drainage rock required for this project.

ROCK SELECTION PROCEDURE

The north wall section of the quarry has been determined to have sufficient quantities of rock that meets the criteria for the SFC project. A fresh shot along the selected north quarry wall shall be inspected immediately before and after the blast. The subsequent blast faces shall also be inspected, and any areas on the quarry wall that has material that has undesirable characteristics shall be avoided where possible. As long as the north wall appears to be consistent, the entire quantity of material shall be produced by moving along this section.

Undesirable characteristics of the rock include, but are not limited to large vugs, large concentrations of vugs (regardless of filling), large stylolites, broken fragments of weathered shale and dolomitic clay, or obvious unexpressed planes of weakness such as joints and seams.

SELECTION OF THE MATERIAL

The shot rock shall be stockpiled at the quarry near the blast area. An initial inspection shall take place and any rock that does not meet the specifications required shall be removed as necessary. If possible, a sample of rock with undesirable characteristics shall be created from this rejected rock to guide the operator in separating the undesirable material. The geologist, or designee, shall work with the quarry operator to select and generate smaller stockpiles of acceptable rock consisting of the desired size and characteristics. This shall be accomplished having the operator produce low-height stockpiles over a large area and not adding more height between inspections. Additionally, the stockpiled rock shall again be monitored as the material is being loaded for shipment to SFC.

The geologist, or designee, shall be onsite for at least the first two days of work for every operator used, to ensure that the operator is able to recognize and select the desired material. The geologist shall be onsite at least once per week thereafter to inspect the material that has been stockpiled. The interval between inspections shall be adjusted so that all the rock selected can be adequately assessed.

The selection process is designed to preclude shipment of rock with undesirable characteristics. If necessary, the inspected stockpiled material shall be separated from material stockpiled since the geologist's previous inspection, in order to ensure the rock to be shipped meets the selection criteria.

If you have any other questions, or need clarification on this subject matter, feel free to contact me.

Respectfully Submitted,

Kenny Schlag

Kenny Schlag, P.G.
Consulting Geologist