CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
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Arizona Department of Mines and Mineral Resources Mining Collection

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PRINTED: 04/17/2002

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: NELSON QUARRY

ALTERNATE NAMES:
FLINTKOTE COMPANY
CHEMICAL LIME COMPANY
CHEMSTAR

YAVAPAI COUNTY MILS NUMBER: 78

LOCATION: TOWNSHIP 25 N RANGE 10 W SECTION 25 QUARTER W2
LATITUDE: N 35DEG 31MIN 00SEC LONGITUDE: W 113DEG 18MIN 57SEC
TOPO MAP NAME: NELSON - 7.5 MIN

CURRENT STATUS: PRODUCER

COMMODITY:
CALCIUM LIMESTONE
STONE LIMESTONE
MILL LIME PLANT

BIBLIOGRAPHY:
ADMMR NELSON QUARRY FILE
ADMMR DIRECTORY OF ACTIVE MINES IN AZ 1980
OPERATION EXTENDS INTO SECS 26, 35, 36
ELEVATORSKI,E.A.1978,AZ INDUSTRIAL MINERALS
ADMMR MINERAL RPT. NO. 2, P. 61.

NELSON QUARRY

~~YAVAPAI COUNTY~~

Yavapai Prescott Peach Springs

S26, 25N, 10W (AML 10/1969) Yavapai county !!

ABM Bull. 129 p. 97

ABM Bull. 180, p. 390, 397

Skillings Mng. Rev. 6/16/73, p. 19

Contractor & Engineer 6/73, p. 32

Mining Congress Journal 7/73, p. 9

Skillings Mining Review, March 9, 1974, p. 27
" " " October 26, 1974, p. 17 (personnel)
" " " July 3, 1976, p. 25 (expansion)

April 21, 1958

Grand Canyon Lime and Cement Company
Quarry and Plant

Jim Curless, Supt.
Box 197 Peach Springs, Ariz.

The quarry and plant (1 kiln) are located adjacent to the railroad at Nelson, Yavapai Co. Ariz. 13 men are employed. Finished products are shipped to Arizona smelters and other small markets.

Lee Hammons, Field Engineer

April 21, 1958

Grand Canyon Lime and Cement Company
Quarry and Plant

Jim Curless, Supt.
Box 197 Peach Springs, Ariz.

The quarry and plant (1 kiln) are located adjacer
to the railroad at Nelson, Yavapai Co. Ariz. 13 men are employed.
Finished products are shipped to Arizona smelters and
other small markets.

Lee Hammons, Field Engineer

5-73

96% Lime in Az
for Metallurgical Use

	Lime	Cement
1970	309,000	
71	296,000	
72	346,000	

Nelso Quarry File
Yavapai County

Historical Facility:

The Nelson facility is located adjacent to the Hualapai Nation Reservation in Nelson, Arizona, approximately 60 miles from the nearest "full-service" town of Kingman, making it the most remote operation within the Chemical Lime organization.

The Nelson name came from Fred Nelson, the conductor of the construction train that arrived in late 1882. A construction train continued on reaching Peach Springs in 1883, and eventually the AT&SF reached Los Angeles.

According to Colorado Rail Annual No. 23, by Forrest, Cooley, and Albi the mine was started by William Carey, who filed a gold claim in 1893. Finding little gold, Carey built the first lime kiln. The town of Nelson was a complete mining community, and had its own post office by 1904. J.S. Schirm bought an interest in Carey's claim in 1904 and they increased production.

According to some past employees, the products of the Grand Canyon Lime and Cement Company helped rebuild San Francisco after the 1906 earthquake and fire. The reconstruction of San Francisco and the growth in the west spurred the plant to go from six (6) to nine (9) shaft kilns. Many employees came from the reservation, as did some wood fuel. Years later, oil was brought in by rail, also for fuel.

The Colorado Rail Annual No. 23 reports that in 1906, the AT&SF was fined by the US District Court in Los Angeles for delivering cars that did not have their reported weights of 800 pounds from the Nelson plant, and the investigation was prompted by Teddy Roosevelt. The fine was later exonerated when the full story came out that customers were not being over charged due to erroneous load weights, because the difference was being rebated.

In its infancy, the plant was producing about 20 tons per week. After several years a patent on the land was finally issued February 7, 1912. The Arizona statehood followed on February 14, 1912. In the 1918 an influenza epidemic resulted in over 20 million deaths in the United States. A large number of infant deaths occurred around that time in the small town of Nelson, as evident in the memorial cemetery.

The Nelson area, built around the plant, also had its own school, store, and many of the past and current employees grew up there. The town was mostly railroad and mine families. The Colorado Rail Annual No. 23 states, "The population in 1940 was one hundred and sixteen." The rail depot in Nelson was a flagged stop, and before World Wart II the company was shipping 250 loaded cars of lime a week, or about 100 tons. Most scheduled stops ceased sometime after WWII, and mining became the primary source of work for the town.

Ownership changed to US Lime some time after World War II, who in turn sold to Flintkote in 1956. The depot was finally closed in the 1960's and the mine was the primary employer in the area. The need for change became eminent. Production demands increased, as did the need for new technology in order to

meet those demands. Employees and their families vacated the small company owned town by the 1970's at the company's request. The move was to accommodate the expansion efforts that would occur later in 1974, when a newer plant was constructed about a mile northeast. The new kiln was the first KVS polygonal preheater design and displays the serial number one (1).

The old plant is used for storage; the school and store structures are no longer standing, and the cemetery has been moved to the other side of the road near the entrance to the plant. Flintkote installed the two KVS preheater kilns on-site today, with designed capacity for an additional third kiln. By 1980, Flintkote sold the facility to Genstar, who became a member of the Chemical Lime Group in 1986 as "Chemstar." Eventually the name would change to the Chemical Lime Company, a Lhoist Group Company.

Nelson now sits on more than 3600 acres of land. It has two computer controlled, coal, coke and fuel oil fired rotary preheater kilns with a combined (guaranteed) capacity of 1800 TPD. The plant was documented in the past as one of the largest lime producers in the U.S. The facility is permitted and has achieved 2025 TPD, which is one of the highest plant production rates in Chemical Lime Company.

Geology of the Nelson Quarry -The Redwall Limestone:

The limestone ore, which is mined at Nelson, is from the Mississippian Redwall Formation. The Formation is sub-divided into four members, in ascending order the Whitmore Wash, the Thunder Springs, the Mooney Falls and the Horseshoe Mesa.

Mining is limited to the Horseshoe Mesa and Mooney Falls members. Total thickness of the Quarry section is approximately 275 feet, the Horseshoe Mesa being divided by the Mooney Falls member by a 15-25 foot thick "medial' chert zone. The Mooney Falls member is considered the main ore zone and represents approximately 80% of the total section. The Thunder Springs dolomite member is considered the economic basement of the ore body, whereas bedded chert within the Horseshoe Mesa is the economic upper limit. The Horseshoe Mesa is truncated by an erosion contact of the Supai Formation.

The Supai Formation is considered the source of the red staining of Redwall Formation, hence the name.

The limestone of the Mooney Falls is typically light brownish gray in color, medium to coarsely crystalline, thick to very thickly bedded, fossiliferous, locally oolitic, and contains solution zones with reddish clay and silt washed down from the now absent Supai Formation.

Intense fracturing of the formation due to folding and faulting and subsequent cave has created many pathways for clay and groundwater movement and thus much of the rock now mined is contaminated to a large degree with red clay, fault gouge, erosion debris, and secondary mineralization. Successful mining of the deposit relies largely on the benefaction of these deleterious materials through the crushing and screening process, along with minor in-pit wasting when clay and

other deleterious materials are excessive.

Date Printed: 12/17/93

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

VERBAL INFORMATION SUMMARY

Information from: **David Flemming, District Sales Manager**

Company: Chemstar Lime

Address: 7272 East Indian School Road, Suite 350
City, State ZIP: Scottsdale, Arizona 85251
Phone: 602-941-1291

MINE: **Nelson Quarry**

ADMMR Mine File: Nelson Quarry
County: **Yavapai**
AzMILS Number: **78**

SUMMARY

Specification data on a number of Arizona mined products was obtained for Gerd A. Zimmermann of Scottsdale, the U.S. contact for Hebel GmbH of Germany. They (Hebel GmbH) are interested in building a wall panel plant in the southwestern United States.

David Fleming, District Sale Manager, Chemstar Lime, provided typical analysis on their quicklime from their Nelson Quarry and lime plant. Copies of the data provided by Mr. Fleming has been made for the Nelson Quarry mine file.

Ken A. Phillips, Chief Engineer Date: December 13, 1993

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1992 Yavapai

CHEMSTAR LIME

2800 N. 44th St., Suite 400, Phoenix, AZ 85008 - Phone 955-5711.
President Dave Reilly
Vice President, Manufacturing & Engineering Larry Warney
Vice President, Marketing Bob Derks
Vice President, Industrial Sales Bob Plains
District Sales Manager John Reaney
Chief Engineer Bill McCandlish
Manager, Technical Services Starr Curtis
HiCal Operations Manager Ed Barry
Materials Manager Mike Pinnau
Distribution Manager John Mc Mullan
Transportation Manager Chris Bruskes

Nelson Quarries & Plant T25N R10W Sec. 25
P.O. Box 370, Peach Springs, AZ 86434 - Phone 769-2271 - Employees: 74 - Limestone quarry - Lime plant with two rotary kilns rated at 1800 tons of lime per day.
Plant Manager Mike S. Eliason
Production Superintendent Bill Schoof
Maintenance Superintendent Mark Phillips
Quarry Superintendent Pat Terbilcox
Plant Buyer Danny Roberts
Shipping/Transportation Coordinator Joe Fuentes

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1991

CHEMSTAR LIME

2800 N. 44th St., Suite 400, Phoenix, AZ 85008 - Phone 955-5711.
President ..... Dave Reilly
Vice President, Sales ..... Bob Plains
Vice President, Manufacturing ..... William E. Dodge
Vice President, Engineering ..... Bill McCandlish
Purchasing Manager ..... Mike Pinnau

Nelson Quarries & Plant T25N R10W Sec. 25
P.O. Box 370, Peach Springs, AZ 86434 - Phone 769-2271 - Employees: 74 - Limestone quarry - Lime plant rated at 1800 tons of lime per day.
Plant Manager ..... Ed C. Barry
Production Superintendent ..... Jerry Young
Maintenance Superintendent ..... Ed Banfield
Quarry Superintendent ..... Pat Terbilcox Plant
Buyer ..... Danny Roberts
Shipping/Transportation Coordinator ..... Joe Fuentes

Douglas Quarry & Plant T24S R26E Sec. 7
Route 1, Box 110, Douglas, AZ 85607 - Phone 364-2429 - Employees: 60 - Quarry and plant located at Paul Spur - 3 lime kilns, plant capacity rated at 1000 tons of lime per day.
Plant Manager ..... Mike S. Eliason
Production & Maintenance Superintendent ..... Richard Anderson
Quarry Superintendent ..... R. Dean Vaughn
Production Services Superintendent ..... Don Williams

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1990

CHEMSTAR LIME

2800 N. 44th St., Suite 400, Phoenix, AZ 85008 - Phone 955-5711.
President ..... Dave Reilly
Vice President, Sales..... Bob Plains
Vice President, Manufacturing ..... William E. Dodge
Vice President, Engineering ..... Bill McCandlish
Purchasing Manager ..... Mike Pinnau
Nelson Quarries & Plant T25N R10W Sec. 25
P.O. Box 370, Peach Springs, AZ 86434 - Phone 769-2271 - Employees: 74 - Limestone quarry - Lime plant rated at 1800 tons of lime per day.
Plant Manager .....Ed C. Barry
Production Superintendent ..... Jerry Young
Maintenance Superintendent ..... Ed Banfield
Quarry Superintendent ..... Pat Terbilcox Plant
Buyer ..... Danny Roberts
Shipping/Transportation Coordinator ..... Joe Fuentes

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1989

CHEMSTAR INC.

2800 N. 44th St., Suite 400, Phoenix 85008 - Phone 955-5711.

President ..... John Crawley
Vice President, Sales ..... Charles Cook
Vice President, Manufacturing ..... William E. Dodge
Vice President, Engineering ..... Bill McCandlish
Vice President, Finance ..... Mark T. White
Purchasing Manager ..... Mike Pinnau

Nelson Quarries & Plant T25N R10W Sec. 25

P.O. Box 370, Peach Springs 86434 - Phone 769-2271 - Employees 73 - Limestone quarry - Lime plant rated at 1800 tons of lime per day.

Plant Manager .....Ed C. Barry
Production Superintendent ..... Jerry Young
Maintenance Superintendent ..... Jim Olander

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1988

CHEMSTAR INC.

2800 N. 44th St., Suite 400, Phoenix 85008 - Phone 955-5711.

President ..... John Crawley
Vice President, Sales ..... Charles Cook
Vice President, Manufacturing ..... Dave Johnson
Vice President, Engineering ..... Bill McCandlish
Purchasing Manager ..... Mike Pinnau

Nelson Quarries & Plant T25N R10W Sec. 25
P.O. Box 197, Peach Springs 86434 - Phone 769-2271 - Employees 58 -
Limestone quarry - Lime plant rated at 1800 tons of lime per day.

Plant Manager .....Ed C. Barry
Production Superintendent ..... Jerry Young
Maintenance Superintendent ..... Jim Olander

NELSON QUARRY YAVAPAI COUNTY

KAP WR 3/23/84: Norman Burns, Sales Representative, Genstar Cement and Lime Company, 1777 W. Camelback Road, Suite D-107, Phoenix, (Sales Office) Arizona 85015, Ph: 263-9562 was provided information on the status of the State's mineral processing industry. Genstar operates the Flintkote lime plant at Nelson. He explained that the shut down of Kaiser's steel mill at Fontana California and the slump in copper ore processing have hurt business. Fortunately construction related sales have been good enough to keep the Nelson operation going.

RRB WR 1/31/86: A man in Needles, California called trying to find someone producing dolomite. He intends to use it for agricultural purposes. I suggested that he contact Genstar at Peach Spings.

NJN WR 11/27/87: GenStar Mine is now Chem Star Inc (card). They are the operators at the Nelson Quarry - file, Yavapai County. Production continues at an 1800 ton of lime per day. Ed Barry is now the plant manager. They report that they believe they are the oldest continuous mining operation in the State. Their current period of operation is 102 years.

NELSON QUARRY YAVAPAI

Mr. Benson, sales manager for Flintkote, came in for a copy of the Active Mines list and to discuss the activities at their Nelson plant. The new plant manager is Tom Roberts. 12/12/77 a.p. GW, WR.

RRB WR 10/30/81: Visited the Nelson Quarries and Plant of Genstar Cement and Lime (formerly FlintKote). Talked to Dave Brooks, Manager and was given a tour of the property by Tony Tawril. Plant was down for repairs and modification.

CJH WR 9/3/82: Visitor: Clare Benson, District Sales Manager, Genstar Building Materials (lime products), 1777 W. Camelback Rd., Suite D-107, Phoenix, AZ 85015, Tel: 263-9562. Just came in to say hello. I had met Mr. Benson in Phoenix some years ago. Genstar produces 1800-2000 t/day of quicklime from its Nelson, AZ mined limestone. Most of it goes to the copper industry for use in flotation circuits. They also have mines in Sloan, Nevada and Dolomite, Utah.

NELSON QUARRY YAVAPAI

Went on to Nelson where Mr. Bravo of Flintkote Co. said the new "monster" would be in operation in about 6 weeks. The old plant was down temporarily for repairs. GW WR 8/28/74

Jim Rowan, salesman for U.S. Lime Co., Nelson plant stopped by to discuss lime sales, new deposits of copper ores, limestone deposits in southern Arizona and lime sales in New Mexico. His company is trucking lime from Nelson, Arizona, to the Pinto Valley Project near Miami. VBD WR 11/13/74

NELSON QUARRY YAVAPAI COUNTY

Dir. of Mining - August 1971 - 12 employees.

The U. S. Lime Products plant at Peach Springs operated at capacity during the period. GW QR 9/71

Went to the Flintkote lime plant at Nelson where there was no activity. GW WR 2/3/72

The U.S. Lime plant at Nelson was down the first of the year. GW QR 2/72

Went to Nelson but the Flintkote lime plant was still closed and one of the local workman said it had been for several months. He said Mr. Osborn, Supt., was in Henderson, Nevada but should return soon. GW WR 4/7/72

Went to Nelson and found the Flintkote Company lime plant in operation but Mr. Osborn was not in camp. GW WR 6/8/72

Stopped at the Flintkote Lime plant at Nelson but Mr. Osborn was in Henderson, Nevada. However, an Indian in charge said the platn handled 170 tons per day of 1" limestone and produced 85 tons of lime. It is shipped unstaked in bulk. GW WR 9/7/72

Active Mine List - October 1972 Empl. 12

Stopped at the Nelson Lime plant of the Flintkote Company where Mr. Osborn confirmed the rumor that they were to build a new 800 tpd plant immediately east of the present 100 tpd one. GW WR 5-3-73

Went to the Flintkote lime plant at Nelson where Mr. Osborn said they were "wheeling & dealing" to capacity. The contractor is working on the new plant about ¼ mile east of the present one. GW WR 10/4/73

Clare Benson, Dist. Sales Manager of Flintkote, U.S. Lime Div., came into the office. They will have a lot of lime to sell from their new Nelson Plant, which will be equipped to burn coal. They reported that Paul Spur Lime was for sale. James Rougher will be moved to somewhere near Phoenix. They would be interested in a state mining organization. GWI WR 11/13/73

Stopped at the Flintkote U.S. Lime Co. plant at Nelson where Messrs. Cronin, Straum and Bravo were met. Messrs. Cronin and Straum are from the LA office and explained Kennedy Van Saun, Davnille Pa. would have the 800 tpd plant ready by October. It will be the largest single kiln lime plant in the US. The Kiln is 15' by 150'. A new quarry east of the plant will supply the 1600tpd of stone necessary. Mr. Cronin also said that about ½ the daily production will be used in Arizona by mining and power companies. For the public utilities, US Lime has researched a rotating tubular piece of equipment containing chains dangling from the inside which prevents the quicklime from becoming lumpy as the effluent gases pass thru. GW WR 5-2-74

NELSON QUARRY YAVAPAI COUNTY

Visited Flintkote Lime Plant near Nelson. 13 employees including Mr. Curless, Supt. and his wife. Mining contracted to Wells Cargo. Plant processes about 90 tpd. FTJ WR 9-10-65

Visited U.S. Lime Plant & Quarry at Nelson - operating as usual. FTJ WR 5-14-66

Visited Nelson Quarry and Plant of United States Lime Products, James Osborn is the new manager replacing James Curless, who was transferred to their Richmond, California operation. FTJ WR 9-16-66

The Nelson Quarry and Lime Plant operated at their regular rate. FTJ QR 4-1967

Active Mine List Feb. 1962, Oct. 1962 - 12 men working

Active Mine List Oct. 1963 - 12 men
Active Mine List Oct. 1966 - 12 men

Interview with James Osborn, U.S. Lime Products Plant at Nelson. Operations normal. They were mining and stockpiling, besides full plant operation. FTJ WR 9-8-67

Active Mine List Nov. 1967 - 12 men
Active Mine List April 1968 - 12 men

Visited Nelson Lime Plant. Operation at regular rate. FTJ WR 5-10-68

Nelson Quarry operated at near capacity. FTJ QR 7-1-68

Active Mine List Oct. 1968 - 12 men
Active Mine List April 1969 - 12 men - James Osborn, Supt., Box 197, Peach Springs

To the Lime Plant at Nelson - operating as usual. FPK WR 9-5-69

Active Mine List Oct. 1969 - 12 men - James Osborn, Supt.

Visited U.S. Lime Plant at Nelson - no changes. FPK WR 5-8-70

Active Mine List May 1970 - 12 men - James Osborn, Supt.

Mine visit - visit James Osborn who said they were phasing out present plant and a new and larger modern plant about ½ mile east of present plant. Capacity to be about 400 tpd at cost of $2.5 million, completion date set for 1972. FTJ WR 9-4-70

Active Mine List Oct. 1970 - 12 men - James Osborn, Supt.

MEMO

GRAND CANYON QUARRY AND PLANT
(U.S. Lime Products Corp.) file

Sept. 22, 1961
TRAVIS P. LANE

Visited the quarry and plant on Sept. 22, 1961. The plant was operating at 80 tpd which is a near-normal rate. The principal product is pebble quick lime most of which is shipped to steel plants in California. Kaiser is the largest buyer, with substantial amounts going to Bethlehem at Vernon and Columbia at Torrance. Johns-Manville takes some powdered quick for blast furnace flux at Watson, California. In Arizona Bagdad take pebble quick, and Iron King and Cypress take hydrated lime.

Jim Curless is Supt., 14 men are employed in the plant and one in the office. The quarrying and crushing to plant feed (-1 5/8") is done by contractor working and stockpiling at intervals (usually about 2 months work provides plant feed for 1½ to 2 years).

MEMO

June 23, 1960

GRAND CANYON LIME CO. +

Travis P. Lane

Visited the Nelson Lime plant of the U.S. Lime Products Division of the Flintkote Company. This was formerly the Grand Canyon Lime & Cement Co.

James Curless is Supt., P.O. Box 197, Peach Springs, Arizona. The plant makes 3 products; ground lime, lime hydrate and ground sized limestone and was operating normally at an average output of about 80 TPD. The average crew numbers 12 men. Quarrying is contracted and is intermittent, and aims at maintaining always a large stockpile of quarried material on hand.

UNITED STATES LIME PRODUCTS CORP.

YAVAPAI COUNTY
NELSON DIST.

The quarry and plant (1 kiln) are located adjacent to the RR at Nelson, Ariz. 13 men are employed. Finished products are shipped to Ariz. smelters and other small markets.

Lee Hammons - 4-22-58

FLINTKOTE LIMESTONE QUARRY

Flintkote limestone quarry and furnace at Nelson operating normally with about 20 men employed on average.

TPL - WR - 2-23-60

This property active 9-1960 - 12 men working.

CHEMSTAR LIME

TYPICAL ANALYSIS

NELSON PLANT QUICKLIME

CHEMICAL ANALYSIS

AVAILABLE CaO	92.0% +
CaO	95.0%
MgO	0.5%
INSOLUBLE	1.5%
R2O3	0.7%
CO2	1.3%

PHYSICAL ANALYSIS
Percent Passing

SIZE	KILN RUN	1/2"X2"	-1/2"	1/8"X3/8"	1/8"
3/4	58.0	89.3	----	----	----
1/2	39.0	75.3	99.0	100.0	
1/4	8.0	53.1	60.2	64.7	
1/8		22.2	39.8	25.5	
12 Mesh			28.8	7.2	93.8
20 Mesh				4.7	79.7
30 Mesh					64.0
40 Mesh					56.7
50 Mesh					46.0
100 Mesh					36.0
200 Mesh					21.8
325 Mesh					15.8
#/Ft3	64.2	64.2	67.5	60	62.0

The above are averages from many samples. Normal variations can be expected in daily shipments.

CHEMSTAR LIME

CHEMSTAR LIME
2800 North 44th Street
Suite 400
Phoenix, AZ 85008-1557
Office 602-955-5711
FAX 602-468-0488

Nelson Quarry File
Yavapai

September 27, 1991

Mr. Ken Phillips
Chief Engineer
Arizona Dept. of Mines & Mineral Resources
1502 W. Washington
Phoenix, AZ 85007-3210

Dear Mr. Phillips:

Regarding your recent conversation with Mr. Brad Moss, we want to help you squelch any rumors about shutting down our Douglas Limestone mining and lime manufacturing facility.

The Douglas lime plant is a very important segment of Chemstar's lime production capacity. It furnishes lime to all of the copper concentration operations of Phelps Dodge Corporation, Cyprus Sierrita Corporation, Asarco, Inc. and Magma Copper Company. Chemstar intends to continue to operate the Douglas plant in the foreseeable future.

We also operate the largest lime manufacturing plant west of the Mississippi River at Nelson, Arizona. Total lime capacity of both operations is in excess of 2,600 tons of high calcium quicklime per day.

We are continuing to explore limestone deposits in the western United States and have plans to increase production at selected new sites in the future. We are presently building a new 600 ton capacity lime operation at Soda Springs, Idaho with another plant in engineering for our property near Winnemucca, Nevada.

We are enclosing brochures of Chemstar Lime Company and the Chemical Lime Group, for your interest.

If I can be of any further assistance to you, please call on me at any time.

Sincerely,

John Reaney
District Sales Manager

JMR/dd

Enclosure

cc: Bob Plains
Bob Derks
Dave Reilly

NELSON QUARRY (A) K 9

COMPLETE AND

STATE MINE INSPECTOR
1616 WEST ADAMS, SUITE 411
PHOENIX, ARIZONA 85007-2627

STATE MINE INSPECTOR

MAY 04 1989

FOR OFFICE USE ONLY
START-UP NUMBER 91329127
STATE NUMBER 03/138
DEPUTY NUMBER HAMM
NEW ✓ MOVE

NOTICE TO ARIZONA STATE MINE INSPECTOR

In compliance with the Arizona Revised Statute, we are submitting this written notice to the Arizona State Mine Inspector of our intent to start X, stop ____, move ____ an operation.

Please check the appropiate boxes: Contractor [X], Owner [ ], Operator [ ], Open Pit Mine [ ], Underground Mine [ ], Mill [ ], Quarry [ ], Aggregate Plant [ ], Hot Plant [ ], Batch Plant [ ], Smelter [ ], Leach Plant [ ].
If this is a move, please show last location: ____
If you have not operated a previously in Arizona, please check here: ____ If you want the Education and Training Division to assist with your mine safety training, please check here: ____
If this operation will use Cyanide for leaching, please check here: ____

COMPANY NAME: LAYNE-WESTERN COMPANY, INC.

DIVISION: DRILLING SERVICES COMPANY

MINE OR PLANT NAME: CHEMSTAR -NELSON QUARRY TELEPHONE: 602-769-2271

CHIEF OFFICER: JERRY YOUNG

COMPANY ADDRESS: 12030 EAST RIGGS ROAD

CITY: CHANDLER STATE: ARIZONA ZIP CODE: 85249

MINE OR PLANT LOCATION: (Include county and nearest town, as well as directions for locating property by vehicle: Yavapai - Mojave County border, Peach Springs, Arizona.

Just south off of Route 66.

TYPE OF OPERATION: DRILLING PRINCIPAL PRODUCT: LIMESTONE

STARTING DATE: 04/15/89 CLOSING DATE: NOT DETERMINED

PERSON COMPLETING NOTICE: MARK J. MADISON TITLE: SALES ENGINEER

FORM 101-106 REV. 01/88

KGN.

Society of Mining Engineers of AIME

~~POST OFFICE BOX 6600 • 540 KNAPP'S DRIVE • SALT LAKE CITY, UTAH 84108~~
~~PHONE • (801) 582-2744~~

Date September 11, 1978

RECEIVED
SEP 13 1978
DEPT. MINERAL RESOURCES
PHOENIX, ARIZONA

78-H-338

.Hohn H. Jett, Director
.Arizona State Mineral Resources Dept.
.Mineral Building - Fairgroundg
.Pheonix, Ariz. 85021

Dear Mr. Jett:

Perhaps the most important service SME-AIME performs for its members is providing media for exchange of technical information. Of the various forms of publication used by the Society to meet this obligation, the Technical Papers accepted for publication in the annual bound Transactions volume are probably the most permanent and comprehensive record of the technical accomplishments of the membership. This imposes a responsibility on the SME Technical Papers Committee, which in turn relies upon the review system, to publish only those manuscripts which provide valuable information and are a credit to its membership. SME-AIME cannot professionally or economically afford to publish a manuscript just because it is not incorrect, or as an accommodation to authors.

Mr. Thomson, Publications Chairman (Principal Reviewer) of the Ind. Minerals Division has requested your confidential opinion of the attached manuscript entitled:

Geology and Mine Planning in Redwall Limestone Nelson, Arizona

A simple form for reporting your evaluation of the paper will be found on pages three and four of this Reviewer's Report. Pages two and three contain brief explanations of the SME-AIME Review process and definitions to assist you in your evaluation.

Please complete the Reviewer's Report in TRIPLICATE. Forward two (2) copies with the manuscript and illustrations to the undersigned within three weeks, and keep one for your record. You may annotate the manuscript if you wish.

Very truly yours,

Roz Hayward

Return Report and Manuscript to:

Name: Rozlyn Hayward

Society of Mining Engineers of AIME

Society of Mining Engineers of AIME
CALLER NO. D • LITTLETON, CO 80123 • PHONE (303) 773-3424

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B. SME-AIME policy discourages prior publication. Papers containing material previously published by other professional organizations or commercial journals are not considered acceptable for review.

C. It should be an original contribution with respect to technical content, such as:

Innovative practice or research
New application of existing technology
An improved and updated source of current reference material

D. It must represent competent work, be technically correct, and be presented in a professional manner so as to reflect credit to the author, to SME-AIME, and to the profession.

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B. The contributions of time made by those involved in the review system is greatly appreciated by the Technical Papers Committee, indeed it is essential to the publication procedure. However, reviewers must accept the responsibility to perform their task promptly so that the requirement of timely production is aided. Accordingly if the reviewer anticipates that other commitments will prevent his review and return of the manuscript within the time requested, he will best serve the Committee by declining the request for review and returning the manuscript so that it can be referred to an alternate reviewer.

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D. Specific criteria for the judgment of a paper are outlined briefly below:

Title	Brief, descriptive
Abstract	Clear indication of object, scope, and results.
Body of Paper	Logical organization, purpose, description of problem, means of solution, results, and conclusion.
Symbols	Standard SI—(1) all SI, (2) SI with dual notation of other metric units, (3) SI with dual notation of English units. If one of these three options is not used, author should be told to do so before paper is acceptable for publication.
Tables and Illustrations	Must be purposeful to prove a point or support a conclusion, must be limited to pertinent data, and must be readily understood. Tabular material should supplement not duplicate the text.
Length	Manuscripts must be as concise as possible. Material of questionable value should be eliminated. A maximum length of 5000 words (16-17 pages of double-spaced typing) is suggested.
Style	The paper should be well written, conform to recognized standards of literary style, and be readily understandable to engineers in the field of interest of the paper.

III. EXPLANATORY NOTES AND DEFINITIONS

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B. An acceptable Technical Paper for inclusion in the annual bound Transactions volume is one with very limited interest but of importance to the record. Such a paper has long-term reference value indicative of a significant engineering advance and is apt to be theoretical or experimental in nature.

C. A paper that is an original contribution to technical literature is one in which the author supplies information never before published in a form readily available to the public and adds a new concept or development to existing technical knowledge.

D. A review paper is one in which an author presents new views on old but important problems. A review paper can collect in one document material previously published only in fragmented segments or information not in the public domain. To be most useful, a review should relate itself through bibliographic references to pertinent technical literature.

E. A progress report paper, generally published as a Technical Note, is one that represents a report on work in progress, a continuation of previously published work, or new data that supplement a previously published work, not necessarily by the same author. It should make maximum use of references as an alternative to repetition of background information.

F. Prior publication refers to reproduction and distribution of the paper in a manner such that it has been available previously to the engineering profession and can be turned up in the normal process of a search of the literature on the subject. A more subtle form of prior publication is the inclusion in the current paper of material included previously in another paper. In such a case the paper should be considered for publication only as a Technical Note with maximum use of references as an alternate to repetition of background information.

G. Examples of unacceptable Technical Papers are those having an obvious sales approach to technical problems, those based upon fallacious or dubious engineering analysis, and those whose approach is too elementary or repetitively descriptive of widely accepted engineering practice.

GEOLOGY AND MINE PLANNING IN REDWALL LIMESTONE

NELSON, ARIZONA

by

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Abstract. Large reser[illegible]o high calcium limestone have been outl[illegible] in the Redwall formation at Nelson, Arizona. Geologic mapping, core drilling and shallow seismic refraction studies have outlined more than 100 million tons of high quality, chemical and metallurgical grade limestone in the Mooney Falls member of the Mississippian Redwall Limestone. Well developed Karst zones in the Redwall were delineated by field mapping, seismic profiling and core drilling.

Development of large reserves of high quality, thick beds of limestone near the present mine and rail facilities was the basis for the current mine and plant expansion. When completed in 1978 the planned 1800 Tpd production will represent the largest lime operation in the Western United States.

Introduction

The Nelson, Arizona mine and plant operations are located on the main line of the Santa Fe Railroad, three miles south of highway 66 near Peach Springs, Arizona between Ash Fork and Kingman.

In 1976 the Flintkote Company/U.S. Lime Division initiated a 26 million dollar expansion program at their Nelson operations. Initial expansion plans began with a detailed geologic investigation of large scale reserves to meet expected demand and for long range planning. A geologic field mapping program began in the summer of 1976 to include the more than 2500 acres of the U.S. Lime Divisions property adjoining the Hualapai Indian Reservation in the extreme northwest corner of Yavapai county. The geologic investigation included field mapping, surface outcrop sampling and core drilling.

The Nelson plant currently produces about 800 tpd (727 mtpd) of high purity chemical and metallurgical grade lime. Upon completion of the planned expansion, the mine will produce about 4500 to 5500 mtpd of 3/8 inch (95 cm) to 1 3/4 inch (4.4 cm) rock. With the additional kiln facilities the new plant will produce about 1800 tpd (1636 mtpd) of lime product.

Mine production comes from open pit mining operations in the Mooney Falls member of the Redwall Limestone, adjacent to the new plant.

Old Karst surfaces of pre-Supai deposition are common in the Redwall, requiring detailed geologic studies for mine planning and mine development.

Detailed geologic investigations were successful in identifying and delineating Karst zones, chert zones, and thick minable lithologic units in the Redwall limestone at Nelson, Arizona.

Geology

Regional

The Redwall Limestone of Mississippian age outcrops extensively in northwestern Arizona, and offers excellent potential as a major source of high quality chemical and metallurgical grade limestone. Not all of the lithologic units of the Redwall, however, contain high quality rock or the minable thicknesses of high grade limestone that are found at Nelson, Arizona. Some units are [illegible]itic, cherty and contain thin shaley units. Locating the right stratigraphic units outcropping at the surface is the key to successful development of large scale reserves of economic significance in the Redwall.

The Redwall is best exposed in the walls of the Grand Canyon where it is primarily a cliff forming unit and ranges in thickness from 500 feet (151.5 meters) at the eastern end to more than 700 feet (212.1 meters) at the western end, on the average, however, it is more often found to be less than 400 feet (121.2 meters) thick. Regional distribution of the Redwall in northwestern Arizona is shown in the generalized outcrop map in figure 1. Flintkote's U.S. Lime operations are located at Nelson, Arizona between Seligman and Peach Springs, some 5 miles to the west.

The Redwall is considered to be correlative with other well known Paleozoic limestone formations in the western states; i.e. the Escabrosa Limestone, the Madison Limestone, the Leadville formation and the Monte Cristo Limestone. In south-central Nevada at Goodsprings, four units of the Monte Cristo limestone are considered to be lithologically similar to and probable counterparts of the four Redwall members. Lithologically the Redwall is quite uniform and outcrops over wide areas in northern Arizona; i.e.,in the Chino Valley, Juniper Mountains, Mingus Mountains -- Jerome area, Mogollan Rim, Grand Wash and Peach Springs areas. A stratigraphic correlation diagram showing the lithologic thickness and outcrop exposures of the Redwall Members from Pakoon on the west to Seligman on the east is shown in figure 2.

The Redwall is commonly found to be cavernous and has developed a distinctive pre-Supai Karst topography. The Karst zones and other solution/erosional features are filled with reddish clay/shale, greenish bentonitic clay, limestone boulders and cobbles. Some open caves and cavities quite often contain small stalagtite-stalagmite cone or dripstone build up and crusts of sugary textured selenite. Very often the clay/shales found in the limestone solution features show well developed bedding.

The first attempt at subdividing the Redwall into distinctive lithologic units was Walcott in the early 1920's. However, the generally accepted lithologic units used by most geologists today are the ones proposed by McKee and Gutschick (1969) who divided the Redwall into four recognizable stratigraphic units:

(Redwall Limestone)	Horseshoe Mesa	-	Upper Member
	Mooney Falls	-	
	Thunder Springs	-	
	Whitmore Wash	-	Lower Member

Previous authors described these same units as lower, middle and upper or units A, B, C and D members of the Redwall.

McKee and Gutschick (1969) pointed out that at nearly all localities in the Grand Canyon area where the Redwall outcrops, it is underlain by a dolomite or dolomitic unit.

The Whitmore Wash member of the Redwall is recognizable in the field as a massive, thick bedded cliff forming unit. It is mostly dolomite in the southeastern Grand Canyon area and lime-

stone alternating with c[illegible]e, the western sections. The Whitmore Wash member does not appear to be exposed at the surface in the Nelson/Peach Springs area. The Thunder Springs member is conspicuously thin bedded limestone alternating with beds of cherty limestone and dolomite and contrasts in color with the uniform darker color of the underlying Whitmore Wash member. The Thunder Springs does outcrop in the Nelson/Peach Springs area and its thin bedded character is quite conspicuous. The Mooney Falls member is a massive, thick bedded unit, and represents the massive cliff forming units in the sequence. This unit appears to have the best potential for mine development because of its massive, thick bedded nature and its distinct lack of dolomite and very few cherty beds. It outcrops extensively throughout the Nelson area and this is the reason that Flintkote's operations are so successful at consistently producing high grade limestone at plus 95 percent $CaCO_3$.

The uppermost member, Horseshoe Mesa, is characteristically thin bedded limestone, and can be recognized in outcrop patterns due to its contrasting thin, step-like ledges compared to the underlying massive bedded, cliff forming Mooney Falls unit.

Local Geology

Thick successions of the Redwall Limestone outcrop throughout the Nelson/Peach Springs area and aside from a few Volcanic rocks nearby, the Redwall controls the topography. The most prominent unit of the Redwall exposed in the study area was found by field mapping to be the Mooney Falls member, with its massive bedded, cliff forming features dominating the canyon walls and rock outcrops. The thin bedded Horseshoe Mesa member is well-exposed in highway cuts near Peach Springs. The Thunder Springs member, with its dolomitic beds is best exposed in the Nelson Area along the base of the cliff faces on the south side of Yampai Canyon and further to the southwest in Nelson Canyon where down section rocks are more predominantly exposed. Only the lower most unit, the Whitmore Wash member, is not exposed at the surface in the Nelson/Peach Springs area.

Geologic descriptions of the outcropping rocks in the Nelson Area indicate that the Mooney Falls member has a thickness of from 275 feet (83.6 meters) to 290 feet (87.8 meters) This entire thickness consists of gray limestone with only localized and lenticular beds of cherty limestone present near the upper part. It also appears to be dolomitic near the base. The distribution of the dolomite and chert zones cannot, on the basis of presently available data be related to any discernable or specific pattern. However, field observations and drill data indicates that dolomitic beds do occur at the base of the Mooney Falls member, and are rarely, if ever, found in the upper part of the unit.

In the Nelson Area, the Mooney Falls is typically light brownish gray in color, medium to coarsely crystalline, thick to very thickly bedded, fossiliferous and locally oolitic near the top. It is characterized by solution cavities f[illegible]wi[illegible] reddish clay/shales, silty clays and greenish bentonitic clay. Two limestone beds containing chert nodules were mapped in the upper few feet of the Mooney Falls where it is exposed near the very tops of the hills, forming a resistant caprock. The cherty beds may in fact be in the Horseshoe Mesa member. In places the cherty beds can be used by geologists as marker beds for field mapping. It is important to delineate the cherty beds geologically for proper mine planning and mine development, as untrained observers often cannot or do not detect them during mine exploration or production. The chert is difficult to recognize because of its inconsistent pattern and similar dark gray to black color not in contrast to the color of the limestone. Fortunately the cherty beds occur at or near the tops of the hills in the Nelson area, requiring very little stripping before mining begins. The chert occurs as nodules and lenses varying in size from a fraction of an inch to six or eight inches. It does not occur as discreet beds but as discontinuous layers within a bed. Coarse, sandy textured limestone appears to be quite common around the cherty zones and may be genetically related to the formation of the chert.

Reddish stained "gossan like" features are also quite common on the surface of the ground throughout the Nelson/Peach Springs area. These features appear to be common to the Redwall as solution features filled with clay, probably from the formerly overlying reddish colored Supai formation. They do not appear to be merely the result of oxidation or deep weathering of limestone. Similar features encountered during mining operations show on close inspection to be fault gauge and clay filled or open caverns.

The carbonate rocks outcropping in the Nelson/Peach Springs area are relatively flat lying generally dipping from 5 degrees to 17 degrees indicating broad folds or faulted beds. Large normal faults form the major canyons. See the geologic cross section in figure 3.

Yampai Canyon forms the major east-west trending topographic feature in the area. It is considered, from field mapping evidence and core drilling, to be a large normal fault, down dropped on the north side. The upthrown side of the fault has exposed the Thunder Springs member on the south side of Yampai Canyon. The rocks generally dip to the north on the north side of Yampai Canyon and dip to the south on the south side of the canyon. Numerous other faults were mapped during field investigations and they all appear to be normal faults with less than 50 to 100 feet (15.1 to 100 feet (15.1 to 30.3 meters) of displacement. Many of the fault zones have proven to be zones of solution channel development in the Redwall and are now filled with reddish clay from the Supai as well as fault gauge.

Karst Features

Solution features in the form of open caves, holes, cavities and channel fill features are common throughout the Redwall Limestone. Evidence of these features is most common in the Mooney Falls member. They are common in the Nelson/

Peach Springs area. The magnitude of these solution features can be seen in the Grand Canyon Caverns (caves) some five miles (8.06 km) east of Nelson near highway 66 where there are solution caves over 200 feet (45.7 meters) deep. These caves are indicative of the large scale solution features that have been found in the Redwall.

Solution features shown in figure 4 are typical of those found in the Redwall in the Nelson/Peach Springs area. The red staining or "gassan like" features so common on the hillsides are believed to be the remnants of old solution, Karst zones now filled with red clay/shale from the Supai formation that overlies the Redwall, but in this location is now eroded away. The solution features are commonly of four types (1) open caves and tunnels partially filled with clay and contain growths and euhedral crystals of calcium carbonate, dripstone, etc. (2) former cavities filled with clay/shales and limestone boulders (3) pot holes, usually as open holes (4) interconnecting pot holes, small tunnels and solution channels, usually open.

Seismic Studies

Because of the affect these features might have on proper mine planning, mine development and accurate estimates of reserves geologic investigations must concentrate on ways to delineate them. Studies at Nelson proved the use of small scale shallow seismic refraction to be useful in locating and outlining the aerial extent of these suspected Karst zones. With the proper conditions, it was found possible to use shallow seismic refraction, fan or broadside profiling to locate the boundaries between the cavernous or clay zones and the limestone -- and plot the locations of the clayey zones. The seismic technique used a curve radius for the profiling based on the observed general outline of a reddish stained area on the surface of the ground, then two "fan" profiles were run with radii approximately at right angles to each other. Time leads were compared from the two "fan" shots and one can then block in the outline of the postulated clay area.

Exploration

The exploration program completed at Nelson to outline the large reserves of high quality limestone needed for planned expansion and long range planning consisted of field mapping on a 500 scale topographic base map and black and white aerial photographs, outcrop (channel) sampling, exploration core drilling, shallow seismic refraction studies, mine mapping and mine development drilling.

This study covered about 2500 acres (1010 hectares) owned in fee by the Flintkote Company/U.S. Lime Division. The study area is bounded on the north by the Hualapai Indian Reservation and dissected by the main line of the Santa Fe Railroad with minable reserves on both sides of the railroad. Limestone mining has actually been going at or near this location since the late 1880's.

Upon completion of this study three general areas of reserves were outlined and selected as future mine sites, containing reserves of well over 100 million tons (see figure 5). The sites were selected on the basis of proven reserves of plus 95 percent calcium carbonate rock, over 100 feet (30.3 meters) of continuous minable sections of rock, general overall economics of mine development and proximity to the present plant location.

Lithologic and minable units of the Redwall were outlined and mapped on a 100 scale in the present mine area, and drill locations selected for core drilling. Core drilling in the mine site areas selected, was done by Joy Manufacturing using a wire line rig and obtaining Nx size core for logging and sampling. The larger size core was selected for purposes of identifying or collecting any deleterious material such as dolomite, chert, clay, etc. that might otherwise not be found in small size core, or where core loss might jeopardize an accurate analysis of the material. All core was logged, sampled and split by a field geologist at the site. The samples were analyzed in Flintkotes laboratory at Henderson, Nevada for insols, MgO, CaO, and R_2O_3.

Core drilling proved to be very efficient with an average of 39 feet per ten hour shift. The entire drilling program was completed during fall and winter months, in less than 20 weeks. Core recovery proved to be excellent, at an average of 95.6 percent for the entire drilling program. Most holes were less than 300 feet deep requiring moving of the drill rig every five days, but still providing an efficient program.

The upper part of the Thunder Springs member was considered to be the target depth for all drill holes, as this unit generally represented dolomite and cherty limestone, not suitable for use in high quality lime.

Mine Planning

The current mining and wasting plan designed for the expansion at Nelson was based on detailed geologic mapping to better understand the lithology and structure of the Redwall in this location, on outcrop sampling for quality control, drill target location and on diamond drilling. The mapping and drilling outlined, in detail, areas of high quality, minable stone as well as delineated areas of probable waste. In the present quarry area (west mine site) diamond drilling was supplemented with shallow production drill holes on a close pattern in order to more clearly delineate the waste zones from the high quality rock.

Parameters upon which the mine plan was based include (1) a mineable thickness of 250 feet (75.7 meters) of high quality stone, in the Mooney Falls member of the Redwall, (2) Proven reserves in excess of 100 million metric tons amenable to open pit mining, (3) Close proximity of large reserves to present production facilities.

Mine planning and design also considered the topography of the mine site with essentially all production and reserves topographically above plant grade. The mine was designed with 30 foot (9.25 meter) level benches and with virtually all mine production haulage on a downhill grade.

One of the major considerations in the mine design was to be able to adequately develop level mine benches in moderately dipping (± 15 degrees) strata that contained a cherty limestone bed near the upper portion of the mine. The geometry of the mine design, with level benches and dipping chert bed created an exaggerated area of influence in the mine face for the cherty bed for wasting purposes. Because of the geometry of the waste zones in the mine area; i.e., Karst filled holes and a cherty bed, the mine plan had to provide for scheduling waste removal far ahead of mining.

Mining Operation

Historical records indicate that some type of limestone mining has been going on at Nelson since about 1883. The present operating quarry, however, was opened in 1974 during the first major expansion and addition of the new 800 tpd preheater rotary kiln. The new mine and plant lie about one kilometer east of the old quarry and kiln that operated at Nelson for many years. The new mine and plant are located adjacent to the main line of the Santa Fe Railroad where easy access to transporting facilities make an efficient and economic operation.

New mine development was engineered and designed to increase the present production from 3,200-3,600 mtpd to 9,000-10,000 mtpd by the middle of 1978 when mine expansion plans go into effect.

Flintkote's mining operations at Nelson consist of an open pit mine using rubber tired frontend loaders and 50 ton haulage trucks. The longest haul to the crusher facilities is generally less than one kilometer. Waste haulage from the mine may be ± 3/4 kilometer. All of the mining at Nelson produces rock from the Mooney Falls member where the rock units (beds) average about 8 feet (2.4 meters) in thickness. The total minable thickness in the present mine area (West Mine Site) is between 150 to 200 feet (45.7 to 60.6 meters) depending on the location on the property (see typical mine section - figure 6). The lower limit of mining in the pit area is considered to be at the base of the Mooney Falls. Below this the rock becomes quite dolomitic and cherty.

In the mine area the rocks dip about 15 degrees to the north, with mine benches kept level. Bedding is well defined and easily amenable to development of 30 foot (9.25 meter) benches. Mining operations are essentially removing the top of a hill above the crusher and plant facilities which is designed for an efficient and economical mining operation. When the mine level reaches the 5150 elevation, mine haulage will still be level or have only a slight grade up to the crusher plant level.

Mining is carried out on a single shift five day-per-week basis. Production drilling is done with either a 4 or 5 inch (10.1 or 12.7 cm) percussion or two 6 3/4 inch (17.1 cm) rotary drill. The 4 inch (10.1 cm) drill uses a 9 x 12 foot (2.7 x 3.9 meter) drilling pattern, the 5 inch (12.7 cm) drill uses a 14 x 18 foot (4.2 x 5.4 meter) pattern on the 6 3/4 inch (17.1 cm) drill uses a 15 x 24 foot (4.5 x 7.2 meter) pattern. All rock from blast holes is sampled prior to shooting for mine quality control purposes.

Mining equipment consists of two 10 yard rubber tired front end loaders and six 50 ton trucks. One loader works with two or three trucks at a time to produce stone for crusher feed, and the remaining loader and trucks are used on waste removal. This enables waste removal to stay well ahead of stone production.

Shot rock is hauled to the primary crusher which is equipped with a 100 ton capacity hopper. This in turn feeds a 60 inch x 20 foot (152.4 cm x 6.0 meter) vibratory grizzly. The primary crusher is a 48 x 60 inch (121.9 x 152.4cm) jaw crusher when the rock is reduced to minus 10 inch (25.4 cm) size.

Secondary crushing in a 1752 gyratory reduces the rock to minus 4 inches (10.1 cm) which is fed into twin 1752 tertiary gyratory crushers for final reduction to 1 3/4 x 3/8 inch (4.4 x .95 cm) kiln feed.

Lime Plant Operations

The first expansion at Nelson occurred in 1973-74 when a new plantsite was established about one-half mile east of the old lime kiln. The installation of an 800 tpd kiln (15 feet in diameter x 155 feet long) in 1974 was at that time the largest lime kiln in the Western states and represented about a 900 percent increase in capacity. The number one kiln (1954) uses a Rexnord double gravel bed filtering system for dust collection from the kiln and preheater and a polygon shaped, low silouhett pre-heater. These were considered to be a first in the industry in 1974. The kiln has a contact cooler for heat recovery. Coal is brought in by rail from Gallup New Mexico.

The more recent 1978 expansion of the Nelson lime operations (kiln #2) consists of the installation of a new 1000 tpd-kvs kiln (17 feet in diameter and 178 feet long) along side the existing 1954 kiln, providing a total production capacity of around 1800 tpd. In addition to the new kiln, expansion includes additional rail spur to hold a capacity of 30 cars, additional truck loading and weighing facilities. Additional storage capacity of 10,000 tons of product was added in 1978. Underground electrical facilities and foundation construction for a third kiln, expected in the near future, were completed during this phase of the expansion.

With the 1978 additional capacity at the Nelson plant, it will be the largest lime operation in the Western United States.

Summary

More than 100 million tons of high-calcium limestone with minable thickness in excess of 200 feet has been mapped and outlined in the Mooney Falls member of the Redwall Limestone at Nelson, Arizona.

Geologic studies have indicated that the Mooney Falls member represents the best potential source of chemical-metallurgical grade limestone in this part of the country. The Nelson location is unique because the Mooney Falls outcrops at the surface and in most places is not covered by other materials that require stripping.

Karst zones are common in the Redwall, and

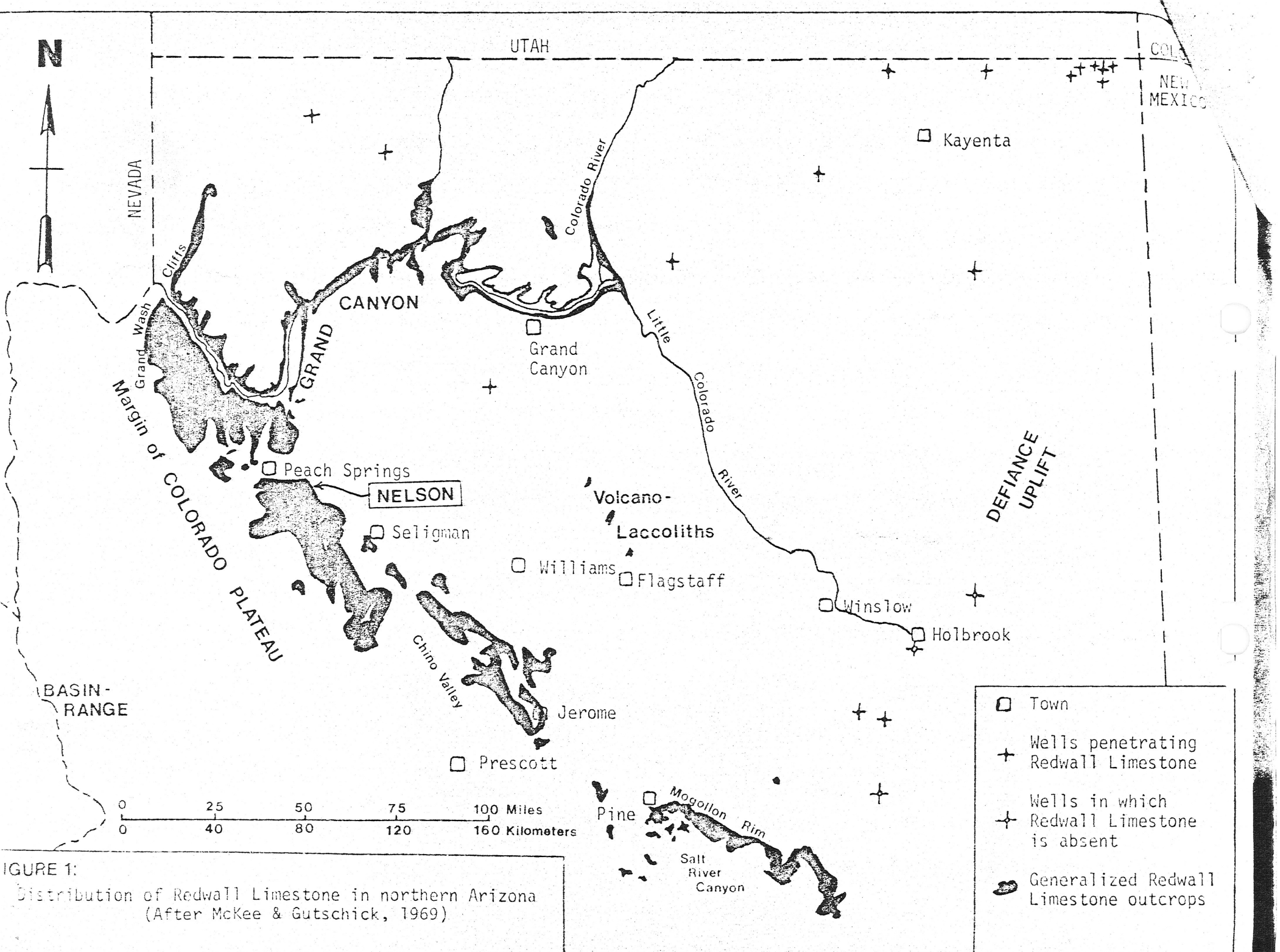
they must be carefully identified and delineated by geologic and geophysical methods for long range mine planning, mine development and accurate reserves estimates.

References

1. G.V. Henderson & Assoc.,(1977), "Investigation of Limestone Reserves at Nelson, Arizona", Unpublished Document.

2. McKee, E.D., and Gutschick, R.C. (1969), "History of the Redwall Limestone of Northern Arizona," GSA Memoir 114.

3. "Rock Products,"1975.



IGURE 1:
Distribution of Redwall Limestone in northern Arizona
(After McKee & Gutschick, 1969)

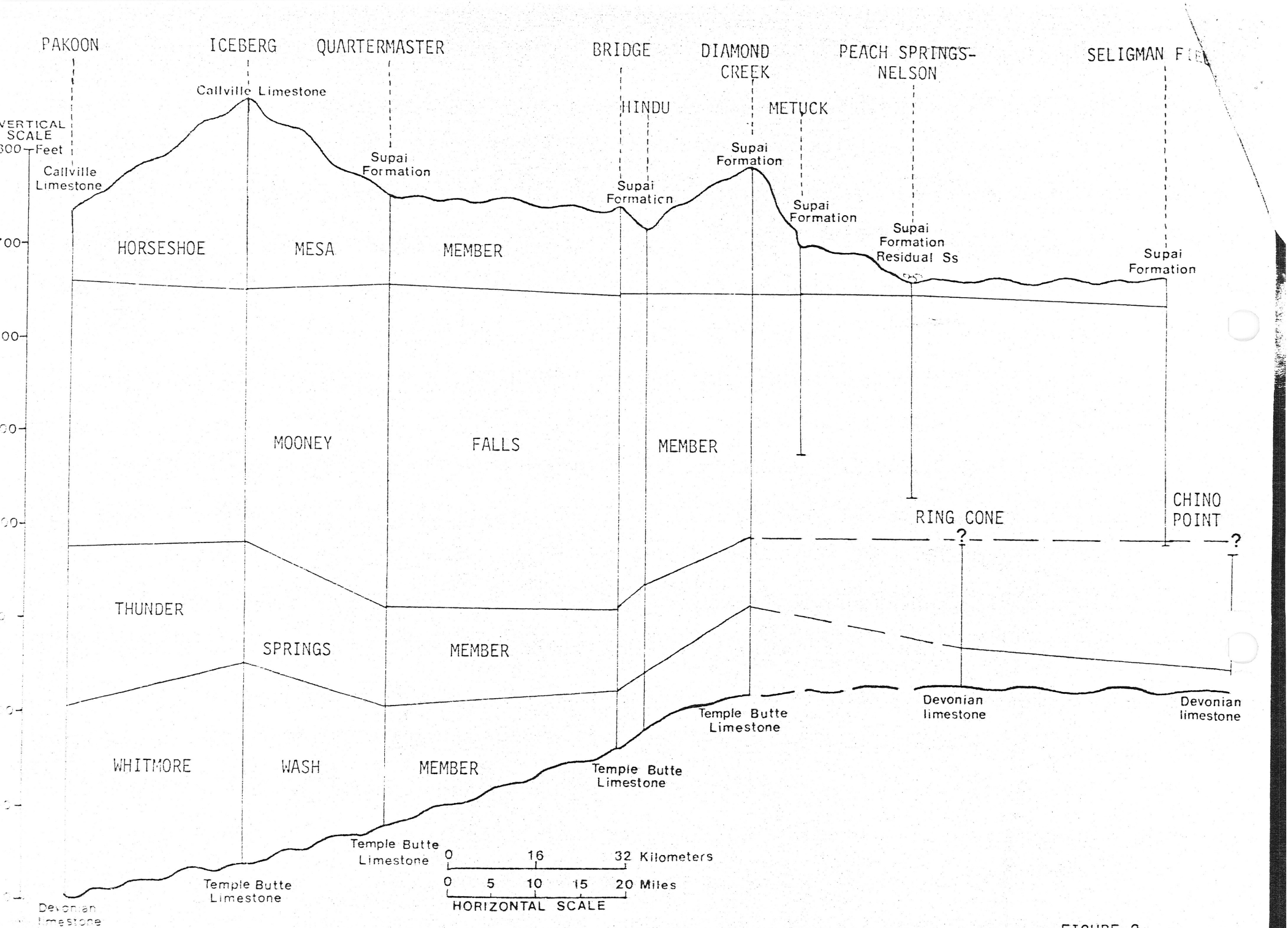
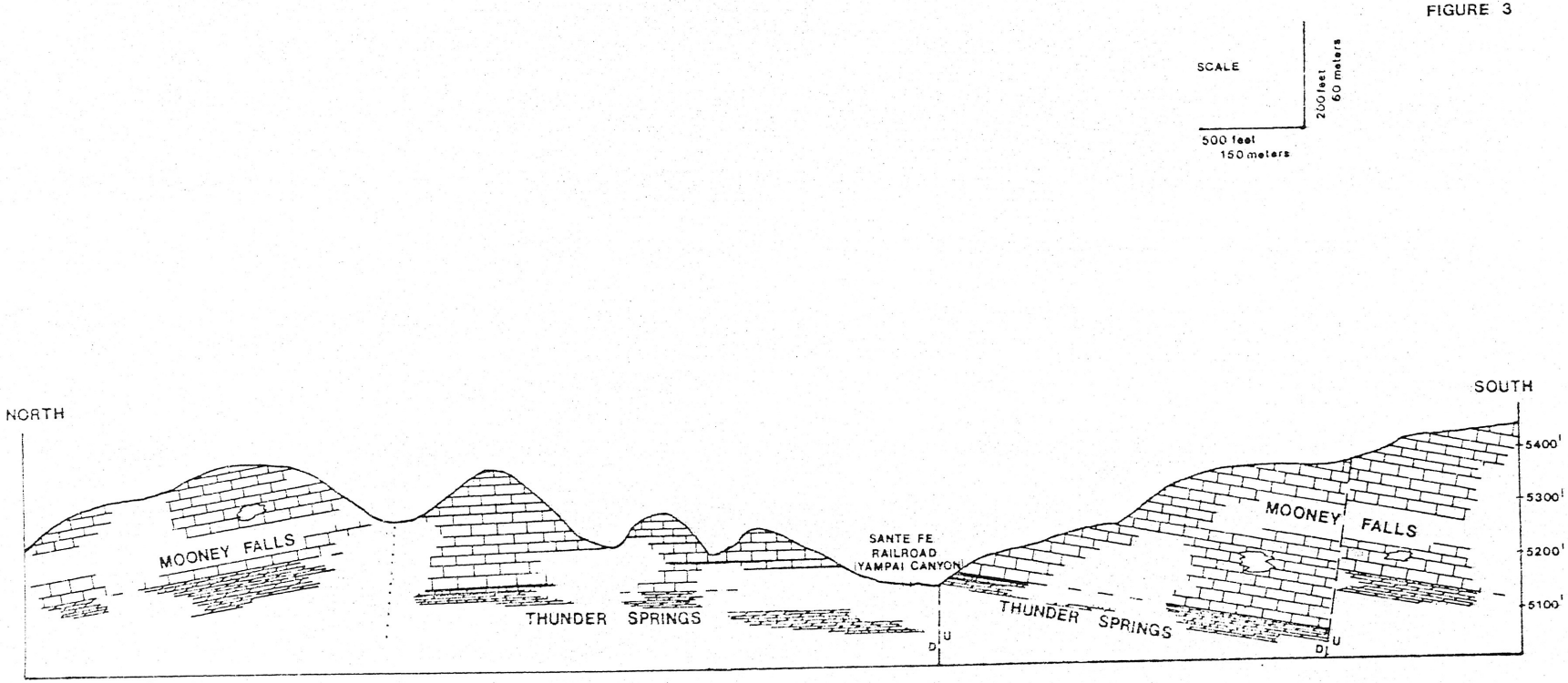
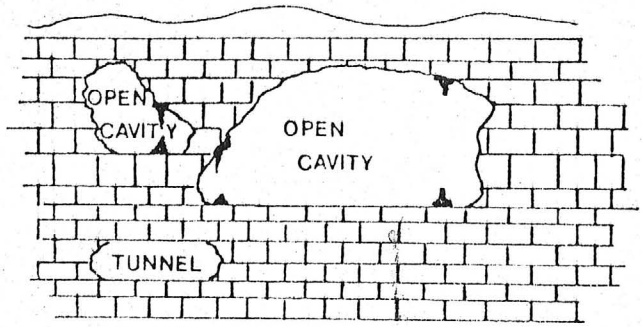


FIGURE 2:
Correlation of stratigraphic sections of the Redwall Limestone from west to south east (Pakoon to Chino Point).
(After McKee & Gutschick, 1969)

FIGURE 3

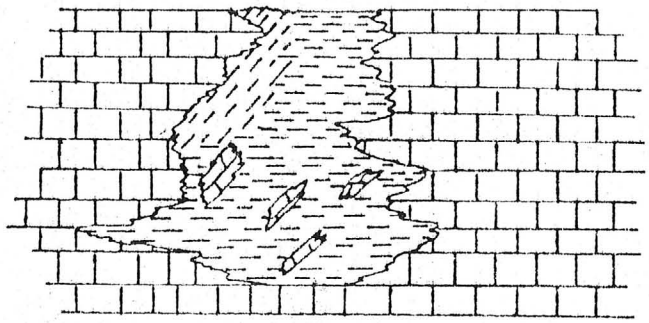


NORTH SOUTH
GEOLOGIC CROSS SECTION
AT
NELSON ARIZONA

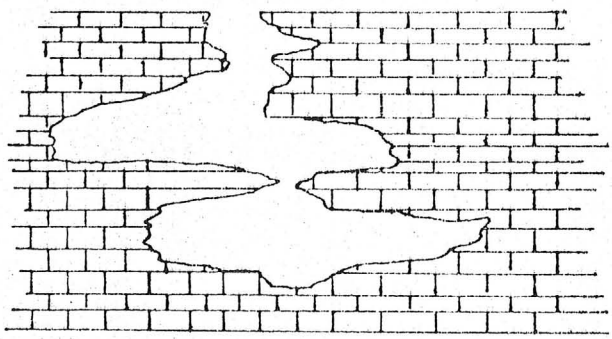


Open Cavity - (Cave Feature)

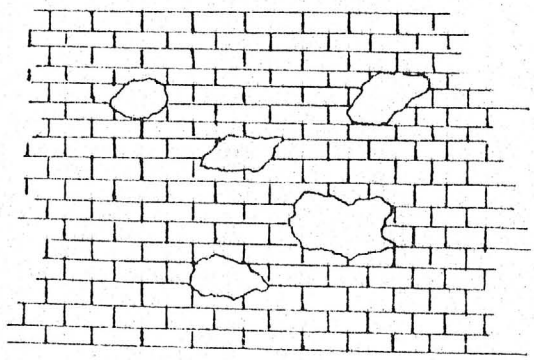
With calcium carbonate cones and growths in open cavities, sometimes animal bones.



Solution Cavity filled with clay/shale and limestone boulders.



Solution cavity (interconnected)
Usually Open



Solution Cavity
Small open holes

TYPICAL KARST FEATURES
IN REDWALL LIMESTONE
NELSON/PEACH SPRINGS AREA

FIGURE 4