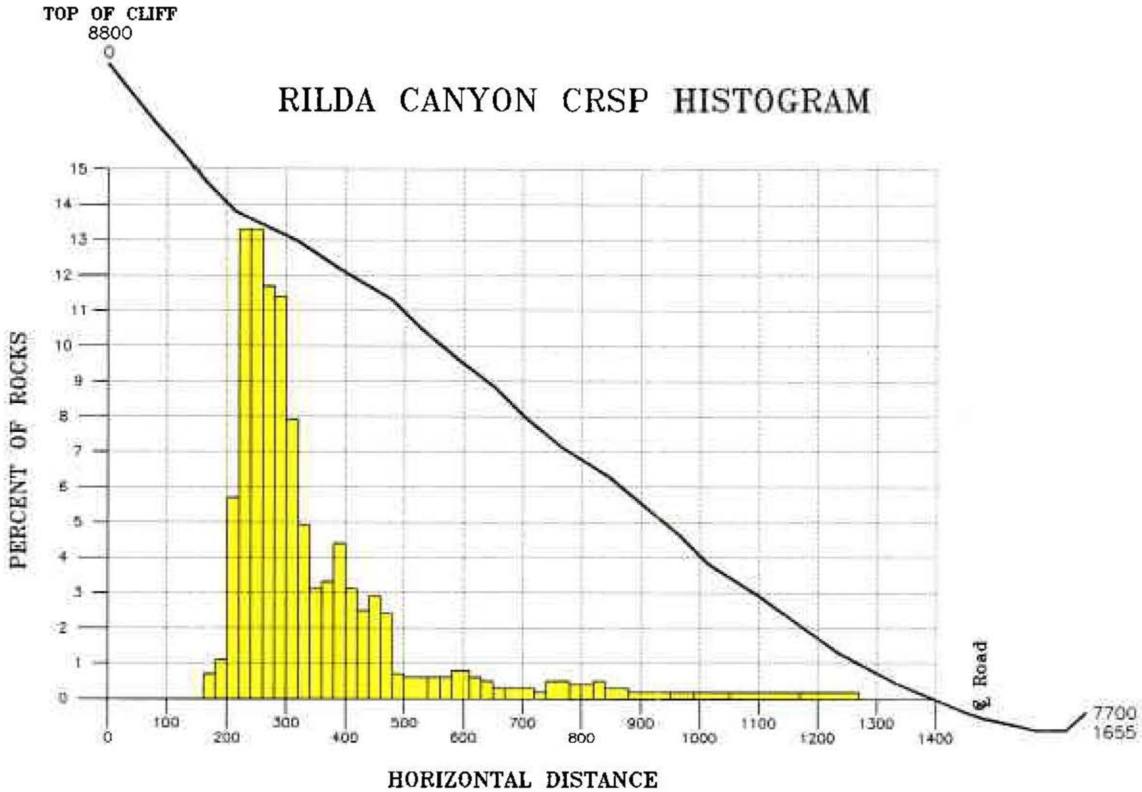
Energy West Mining Co.

Status Report

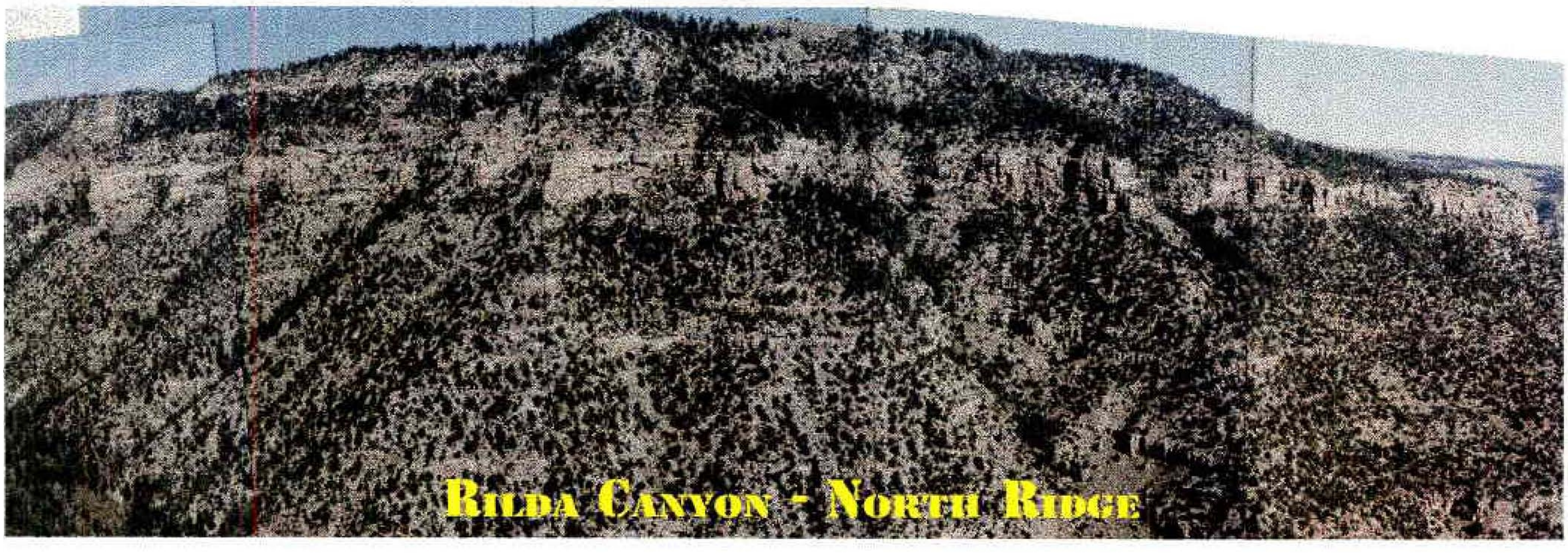
June 1998



Rilda Canyon Escarpment Study

☆ Development of Preliminary Modeling Procedures for Assessing Castlegate Escarpment Stability - Maleki Technologies

☆ Colorado Rockfall Simulation Program Data



ACT/015/018 #2 Copy Daron - Pam

LEGAL NOTICE
Manti-La Sal National Forest
29 April 1998

PacifiCorp (Energy West) has proposed to conduct longwall mining and subside the north slope of Rilda Canyon within their Deer Creek Mine permit area. The Federal Coal Leases involved included include: SL-051221, U-2810, and a portion of U-06039. The purpose is to recover remaining minable coal reserves in the area.

As proposed, underground mining and subsidence could cause failure at the Castlegate Sandstone outcrop. The Manti-La Sal National Forest and Bureau of Land Management are conducting an environmental assessment to evaluate the proposal for consent/approval respectively, of these changes to the Resource Recovery and Protection Plan, and the Mining and Reclamation Plan (Mine Plan Amendment). Existing Environmental Assessments for the leases have disclosed the potential impacts of underground mining and subsidence, but did not consider the effects of subsiding the Castlegate Sandstone outcrops on the north slope of Rilda Canyon due to lease stipulations that precluded subsidence of this escarpment area. Therefore, anticipated surface disturbance associated this subsidence must be evaluated.

This analysis considers impacts associated with escarpment failure on the north slope (south facing) of Rilda Canyon. The extraction of the southern-most longwall panels could cause failure of the Castlegate Sandstone outcroppings referenced above.

The Forest Service is inviting Federal, State, and local agencies; and other individuals or organizations interested in, or potentially affected by, the proposals to participate in the public participation process. Through this public involvement (scoping) efforts the agency seeks to provide information on the proposed actions and asks for your comment on them, to be addresses in analysis process. If requested, a copy of all comments provided in response to this notice will be made available to the public. This will include names, addresses, and any other personal information provided with the comments.

Please submit comments to the above address by May 15, 1998. Should you have questions or require additional information regarding these proposals, please contact Jeff DeFreest at (435)637-2817 or at the above address.

Published in the Sun Advocate May 5, 1998.

NOTICE OF BOARD MEETING

NOTICE IS HEREBY GIVEN THAT THE BOARD OF EDUCATION OF THE CARBON COUNTY SCHOOL DISTRICT WILL MEET AT THE SCHOOL DISTRICT OFFICE LOCATED AT 65 EAST 400 NORTH, PRICE, UTAH, ON WEDNESDAY, MAY 6, 1998 AT 5:00 PM.

AGENDA

5:00
1. Pledge of Allegiance
2. Blue ribbon comments
3. Public comments
4. Approve Minutes of April 15th meeting
5. G/T Travel request

Board Work Meeting

6. Development of format and ground rules

5:30
7. Reports:
   A. Mineral lease money
   B. Consultation period
   C. Form for action/information follow-up
8. Discussion Items:
   A. Review of Board goals
   B. School employee/volunteer of month ...

PUBLIC NO[T...]

Carbon Credit Union is accepting bids on the following

1993 MERCURY VILLAGER VAN VIN# 4

Please, call the Credit Union office between the hours ... 2443 for information.

Please, pick up your bid forms and sign the bid sheet or 675 East 100 North or mail to P.O. Box 719, Price, Uta[h]

All offers are subject to rejection. Bids will begin on April 18, 1998 at 5:00 p.m.

Published in the Sun Advocate May 5 and 7

PLEASE CHECK Y[...]

The SUN ADVOCATE makes every effort to a... ad the FIRST day it appears and immediately report any er... by calling 637-0732. We cannot be responsible for more tha... not call the error to our attention. Thank you.

NOTICE OF BOARD M[...] FOR HOUSING AUTHORITY OF CA[...]

The Housing Authority of Carbon County will b... 7, 1998, at 4:00 P.M., at 251 South 1600 East #2647, Pri...

Published in the Sun Advocate May 5, 1998.

INVITATION TO [...]

The Price River Water Improvement District w... equipment:

(1) 1998 Tracked Hydraulic Excavator.
(1) 1998 Three (3) Axle Tilt Deck Trailer

All bids must be received at the District's Servic... Road, Price, Utah, by 5:00 P.M., Tuesday, May 5, 1998.

All bids shall be sealed in an envelope marked "S... Trailer".

Bids received after 5:00 P.M. will be rejected.

Bids will be open at 7:00 P.M. at the District's reg... Tuesday, May 5, 1998.

Bidding specifications may be obtained at the D... (435) 637-6350 between the hours of 8:00 A.M. and 5:00 P.M...

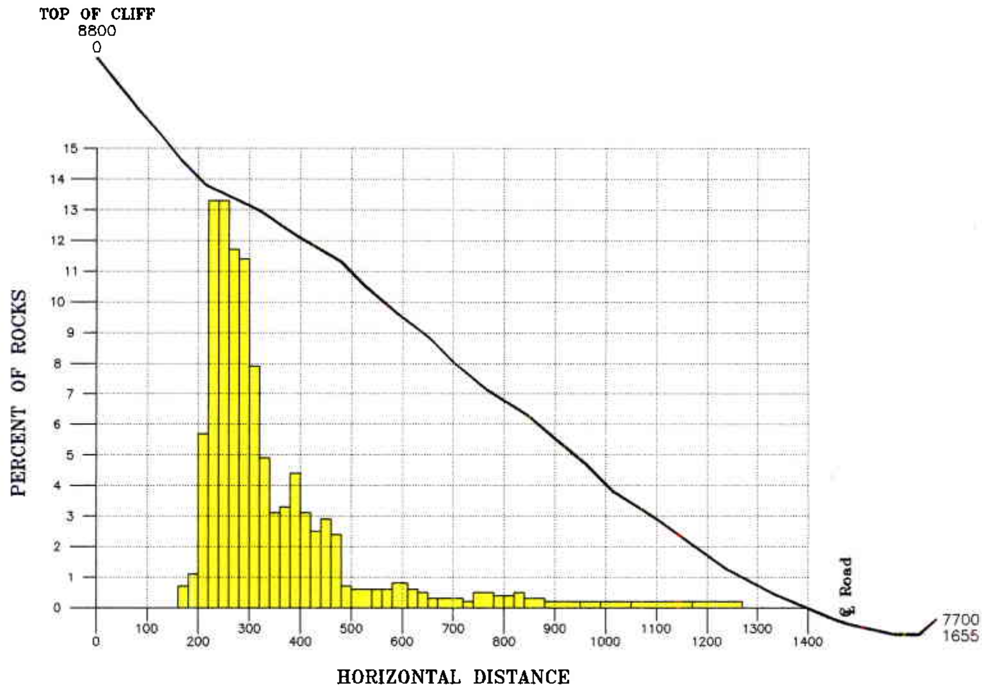
Published in the Sun Advocate April 28, 30 and ...

NOTICE OF MEETI[NG] FOR THE BOARD OF ADJU[...]

Energy West Mining Co.
A Subsidiary of Pacificorp

STATUS REPORT

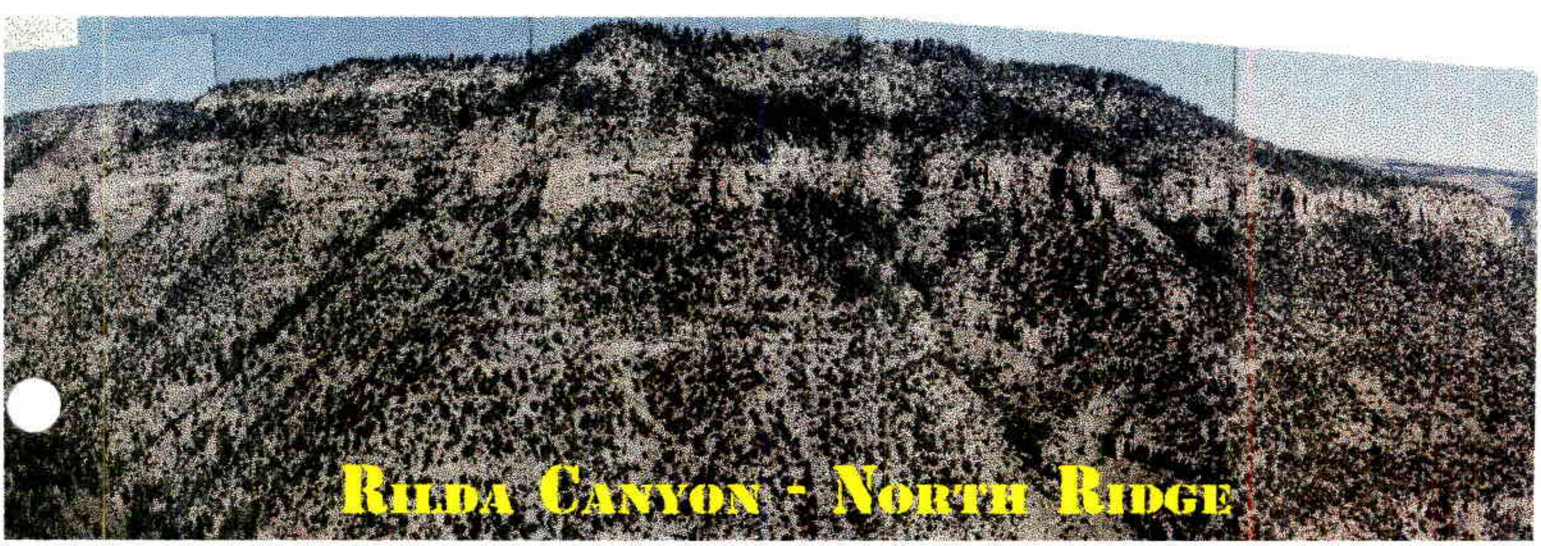
June 1998



RILDA CANYON CRSP HISTOGRAM

Rilda Canyon Escarpment Study

- Development of Preliminary Modeling Procedures for Assessing Castlegate Escarpment Stability - Maleki Technologies
- Colorado Rockfall Simulation Program Data

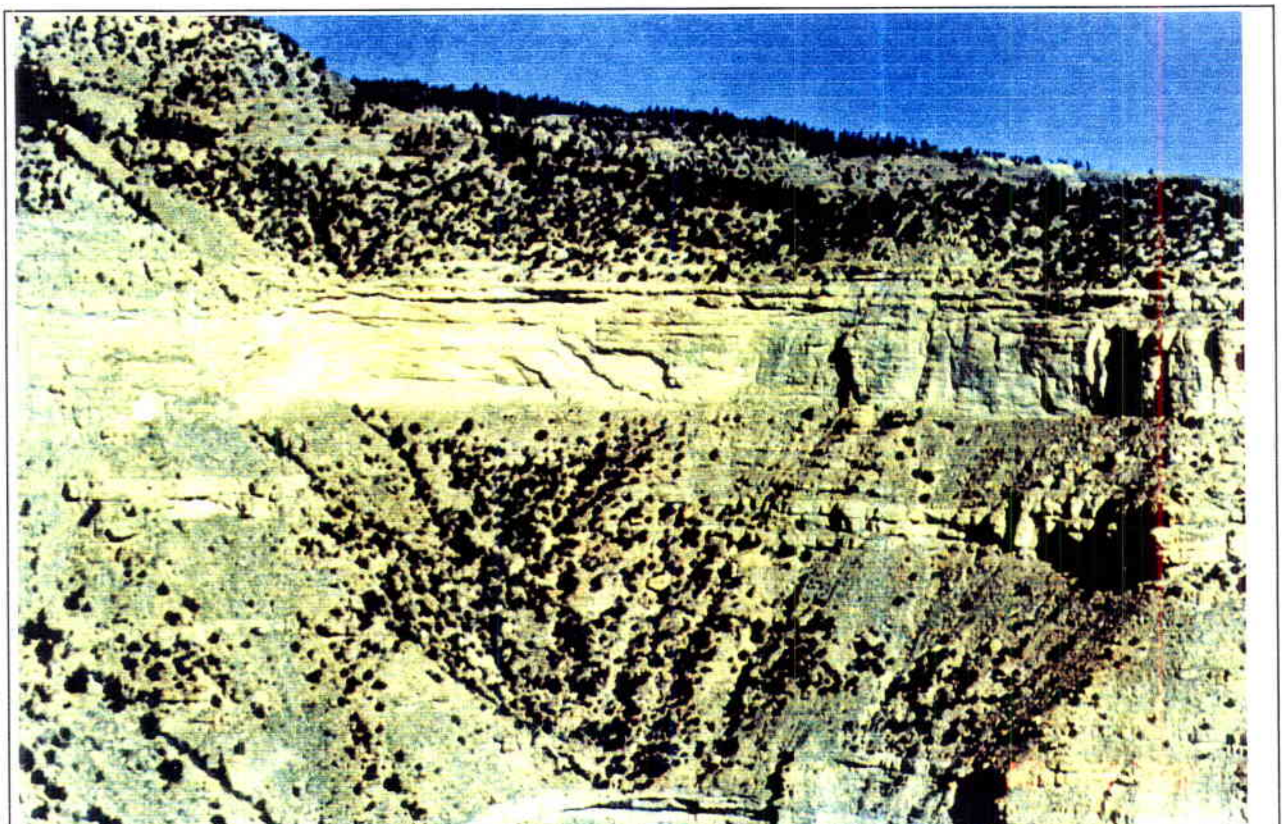


DEVELOPMENT OF PRELIMINARY MODELING PROCEDURES FOR ASSESSING CASTLEGATE ESCARPMENT STABILITY

PREPARED FOR

ENERGY WEST MINING

MAY 1998



MALEKI TECHNOLOGIES INC.

SOUTH 5608 MAGNOLIA
SPOKANE, WA 99223
(509) 448-7911

1 INTRODUCTION

This report with attachments presents progress being made in developing a predictive statistical model as a tool for assessing the stability of escarpments in the vicinity of Energy West's longwall operations near Huntington, Utah. Such models are ideal for probabilistic risk analysis so that the economic benefits of extracting coal reserves can be compared to the likelihood of escarpment instability.

The technical approach consists of a multiphase study in which data collected over many years on geology, mining, and escarpment stability in Newberry Canyon, Corncob Canyon, Miller Canyon, Rilda Canyon, Trail Mountain, and other areas are being gradually digitized for incorporation into a mathematical model (MTI 1997). This mathematical model will be used by mine personnel for routine assessment of escarpment stability in new mining areas. It will incorporate variability in geologic and mining conditions, including escarpment geometry, orientation of joints with respect to the escarpment, joint density, joint continuity, and excavation width-to-height ratios.

The first phase of the study was implemented during 1997 by a team of Energy West and MTI engineers and geologists. Energy West geologists initiated a comprehensive study to characterize geologic and mining factors in two study areas, one in Corncob Wash and one in Rilda Canyon. In Corncob Wash, the 3,000-ft-long study area provided the opportunity to observe surface effects and evaluate factors that contributed to escarpment instability after mining had been completed. In Rilda Canyon, premining conditions in the 11,000-ft-long study area have been characterized in detail, and postmining conditions will be observed in the near future as both the Blind Canyon and the Hiawatha seams are mined.

In response to a request by Energy West, MTI has used both preliminary models and comparative analysis techniques to address escarpment stability along the Rilda Canyon study area for permitting purposes. Energy West has the ultimate responsibility for analyzing any safety issues related to escarpment stability. MTI does not offer any expressed or implied warranty with regard to public safety for any option selected and implemented by Energy West for controlling ground movements.

Phase 1 consisted of (1) characterization of geologic, mining, and response variables in the two study areas, (2) comparison of statistical data from the two study areas, (3) analysis of patterns seen in the data and identification of important variables, (4) assessment of escarpment stability in Rilda Canyon, and (5) recommendations for enhancing the preliminary models for Energy West and developing regional models for the Utah resource area.

2 CHARACTERIZATION OF GEOLOGIC, MINING, AND RESPONSE VARIABLES

The first step in developing predictive statistical models was to create suitable numerical values that express geologic and mining conditions in the study areas (figure 1). The second step was to reduce the number of independent variables by combining some existing variables into new categories and identify highly correlated independent variables. Reducing the number of variables is needed when there are too many variables to relate to the number of data points. The presence of highly correlatable variables influences what procedures are selected for multiple regression analyses. The third step was to develop a multivariate regression model and identify significant factors that contribute to escarpment stability.

The study areas were partitioned into cells approximately 100 ft wide. This resulted in 29 cells for the Corncob Wash study area and 110 cells for the Rilda Canyon study area (figures 2 and 3). Energy West geologists estimated geologic, mining, and response variables for individual cells based on field mapping, examination of borehole logs, and aerial photographs obtained before and after mining (Energy West 1998). MTI personnel took part in designing the experiments, calculating mining variables, and developing new geologic and response variables as described below. Table 1 and attachment A present statistical information, including range, mean, standard deviation, and number of samples.

Most variables are self explanatory. Below is a brief description of some of the variables (identified in italics).

- *Joint sets 1 and 2* are the primary and secondary persistent joint sets mapped in each area. Note that the primary joint set in the Corncob Wash area is oriented approximately east-west, while in the Rilda Canyon study area, the primary joint set is oriented approximately north-south.

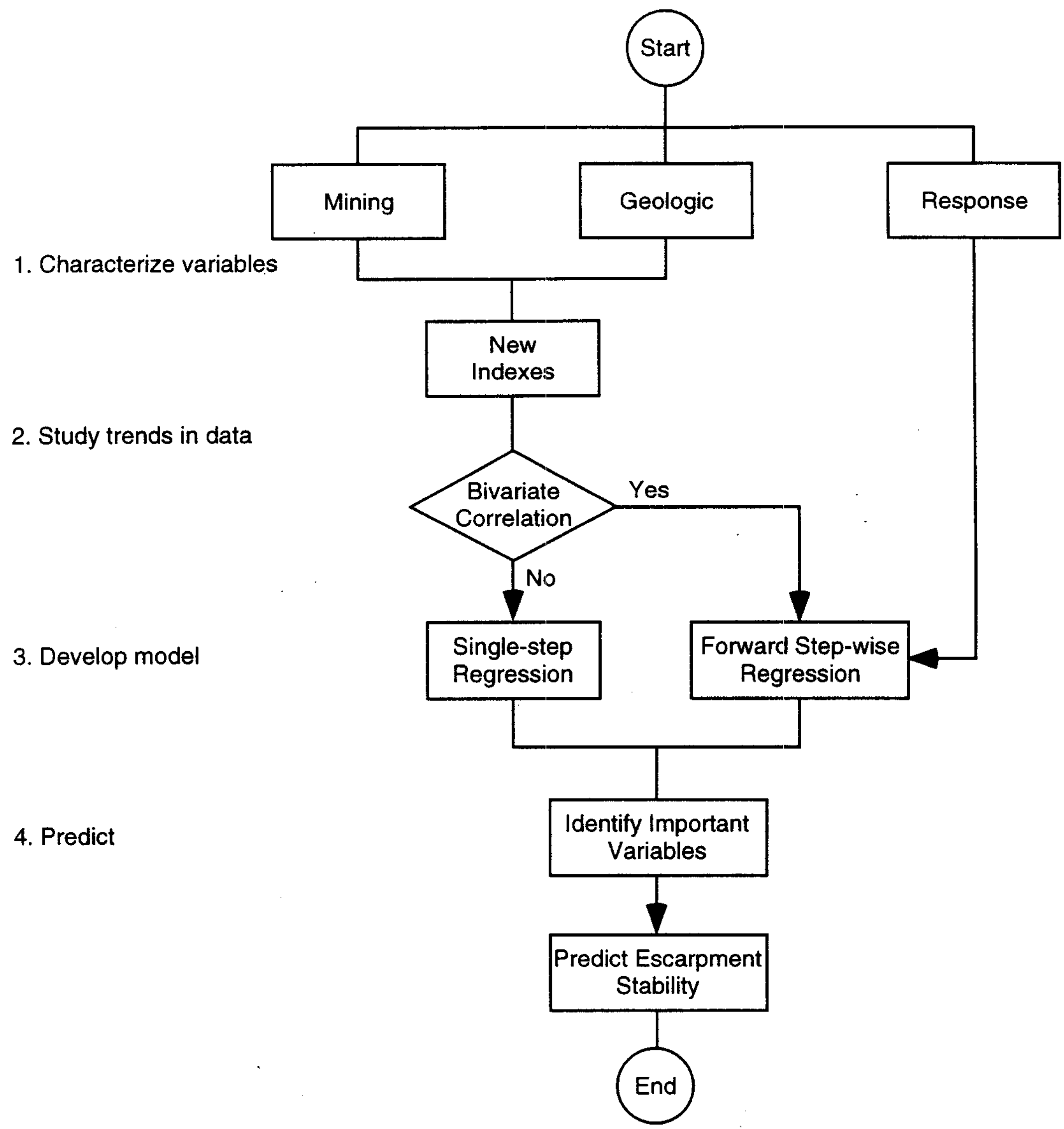
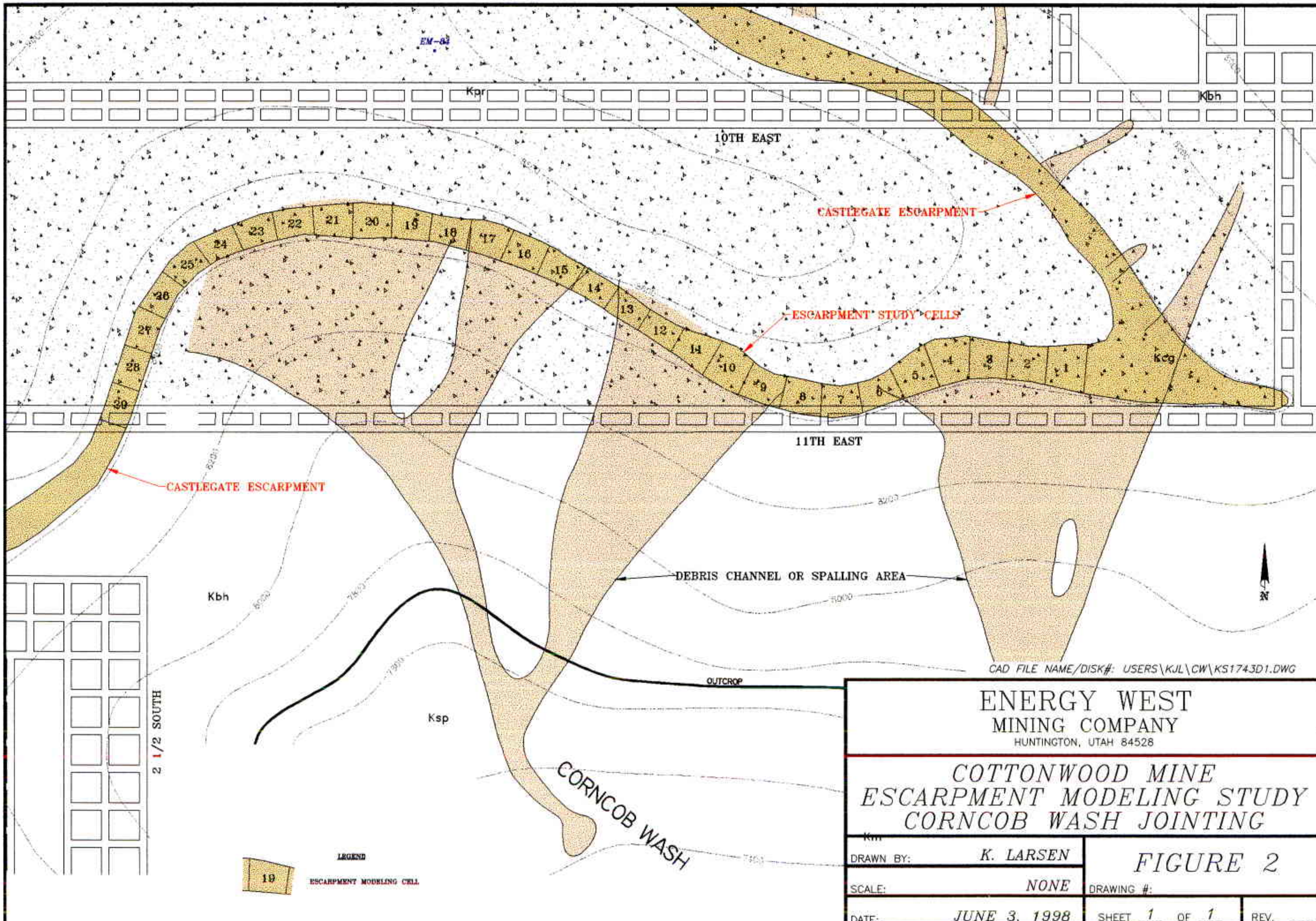


Figure 1 - Flow chart for statistical evaluations.



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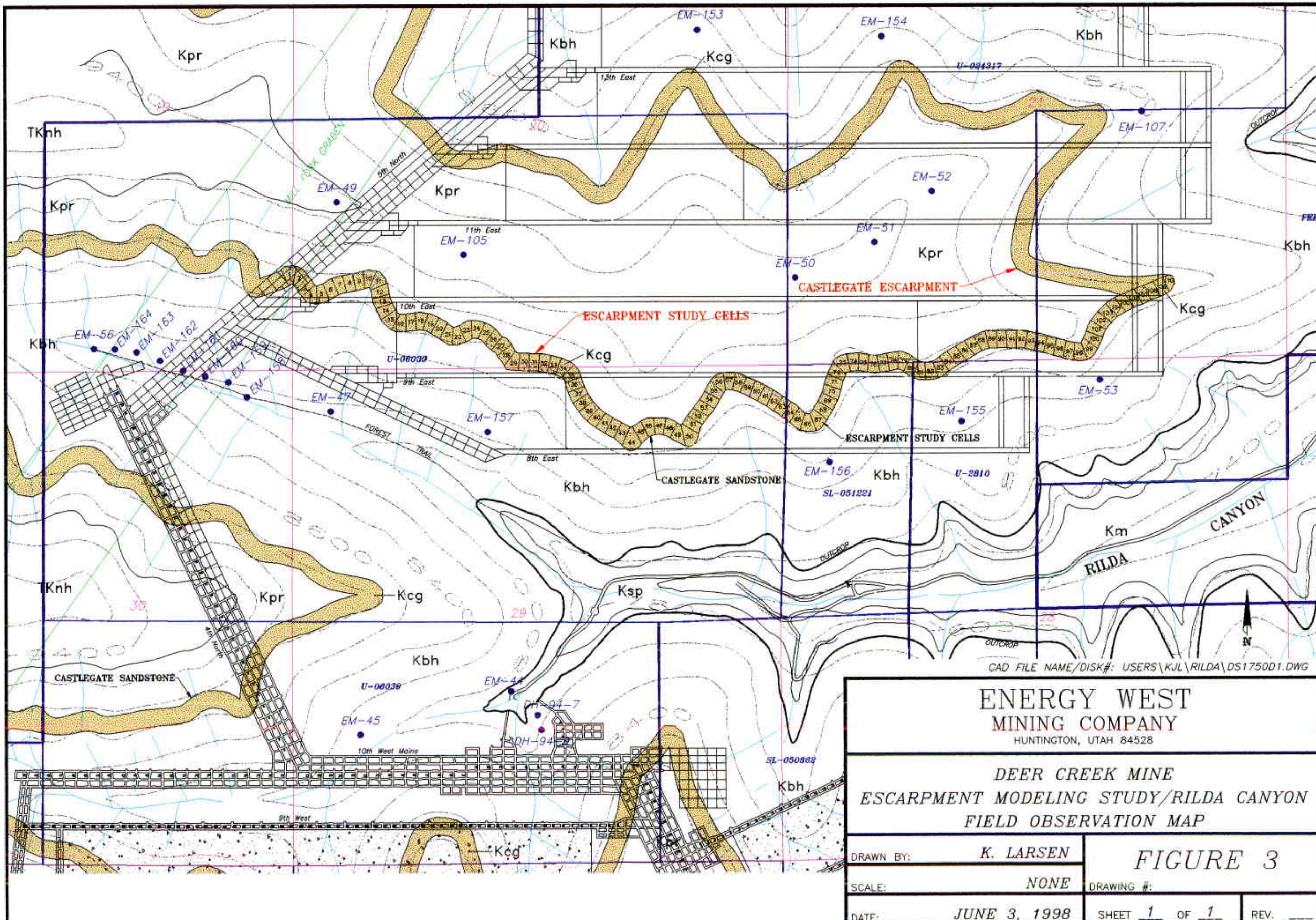
ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

COTTONWOOD MINE
ESCARPMENT MODELING STUDY
CORNCOB WASH JOINTING

DRAWN BY:	K. LARSEN	FIGURE 2	
SCALE:	NONE	DRAWING #:	
DATE:	JUNE 3, 1998	SHEET 1 OF 1	REV. ___



ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

DEER CREEK MINE
ESCARPMENT MODELING STUDY/RILDA CANYON
FIELD OBSERVATION MAP

DRAWN BY:	K. LARSEN	FIGURE 3	
SCALE:	NONE	DRAWING #:	
DATE:	JUNE 3, 1998	SHEET 1 OF 1	REV.

Table 1. Population means for the Corncob Wash and Rilda Canyon study areas

Variable	Corncob Wash	Rilda Canyon
A. Geologic:		
Angle between joint set 1* and escarpment, deg	27	52
Angle between joint set 1 and longwall face, deg	61	26
Angle between joint set 2* and escarpment, deg	57	37
Angle between joint set 2 and longwall face, deg	19	70
Joint set 1 spacing, ft	31	52
Joint set 2 spacing, ft	31	74
Horizontal continuity for joint set 1, ft	21	64
Horizontal continuity for joint set 2, ft	28	62
Vertical continuity for joint set 1, ft	13	64
Vertical continuity for joint set 2, ft	8	62
Joint set 1 and escarpment index	1.1	0.8
Joint set 1 and longwall index	1.2	2.7
Joint set 2 and escarpment index	0.2	0.4
Joint set 2 and longwall index	0.4	0.7
Joint set 1 index	3.9	5.6
Joint set 2 index	0.9	1.0
Erosion under escarpment index	0.1	0.26
Escarpment shape index	0.9	0.75
Canyon slope, percent	80	73
Escarpment slope, percent	218	143
Thickness of Castlegate Sandstone, ft	250	180
Seam-to-sandstone distance, ft	780	810
B. Mining:		
Influence angle, deg	71	71
Excavation width-to-depth ratio	2.5	3.8
C. Response:		
Failure index	1.4	NA

* Persistent joint sets have different orientations in the two study areas.

This change in orientation (roughly 90°) explains why the sum of the angles between joint set 1 (or 2) and the escarpment (or the longwall face) is approximately 90° when data from the Corncob Wash and Rilda Canyon study areas are compared (table 1)

- The *angle between joint sets and an escarpment* can possibly influence escarpment stability, a hypothesis based on observations of subsidence-related fracturing in the western United States (King 1980). Using this hypothesis, an escarpment may have a higher probability of failure where the angle between joints and the escarpment (or mining boundaries) is small (0° to 30°).
- The *excavation width-to-depth ratio* is similar to a subsidence engineering term (NCB 1975) that relates the total width of an excavation to the average depth of cover over the panel of interest. This ratio measures changes in subsidence mode as excavations are widened during mining of successive panels. As the ratio approaches 1.4, a supercritical subsidence stage is reached.
- Based on a review of mining maps and experience in Newberry Canyon (Jones 1994), *escarpment shape* (convex or concave) appears to influence escarpment stability and thus is included as a geologic variable. Observations in the Newberry Canyon by researchers from the University of Utah indicate that virtually all of the failures occurred in a concave portion of the escarpment. A possible explanation was that natural erosion of the escarpment took place at a faster rate at these locations as a result of higher premining structural density (Jones 1994).
- The *influence angle* is defined as the angle from a horizontal plane and a line from the mining limit to the base of the Castlegate escarpment (figure 4). This angle is 90° where the escarpment is directly above the mining limit and over 90° in areas outside the mining limit.

Several indexes were created to combine joint data from various data sets into a single variable

- The *joint set i and escarpment* index (or INJSiE, figure 5a) is—

  INJSiE = 4 if $\alpha = 0°$ to $\pm 30°$ or $\beta = 0°$ to $\pm 30°$,

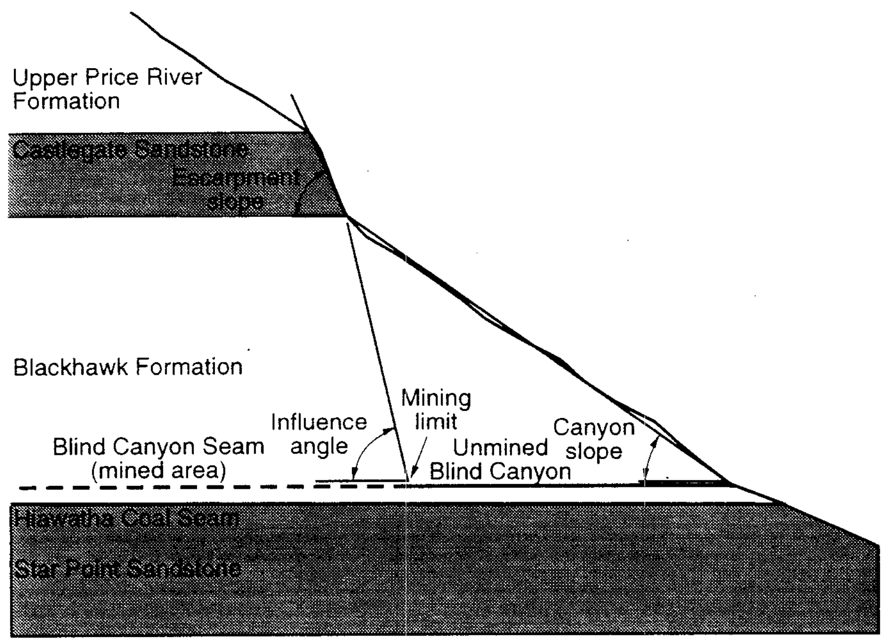


Figure 4 - Mining and escarpment geometry.

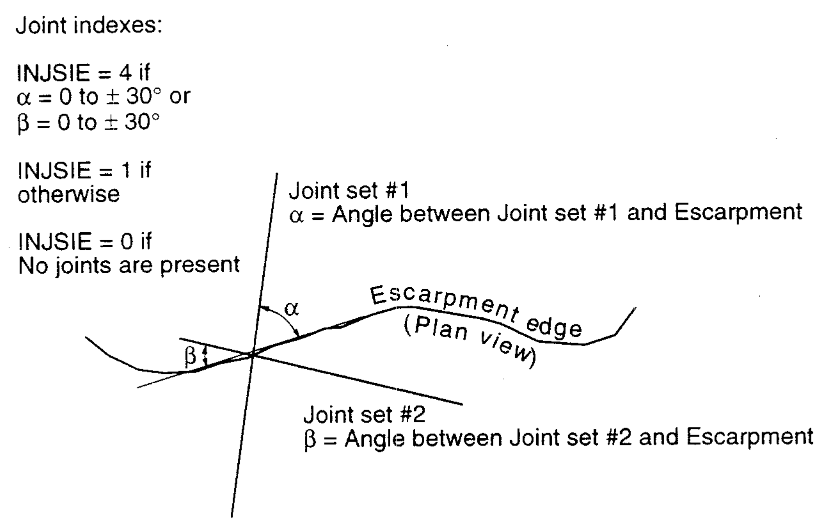


Figure 5a - Escarpment geometry and geological discontinuities.

INJSiE = 1 if otherwise,

or INJSiE = 0 if joints are not present,

where α = deviation angle between joint set 1 and the escarpment.

and β = deviation angle between joint set 2 and the escarpment.

- The *joint set i and face* index (or INJSiF, figure 5b) is—

  INJSiF = 4 if $\alpha = 0°$ to $\pm 30°$, $60° < \alpha < 120°$, or $\beta = 0°$ to $\pm 30°$, $60° < \beta < 120°$,

  INJSiF = 1 if otherwise,

or INJSiF = 0 if joints are not present,

where α = deviation angle between joint set 1 and longwall boundaries

and β = deviation angle between joint set 2 and longwall boundaries

when i = 1 or 2.

- The *joint set i* index is —

  INJSiE + INJSiF + horizontal continuity × vertical continuity ÷ spacing^2

where INJSiE = the joint set i and escarpment index

and INJSiF = the joint set i and face index

- The *erosion under escarpment* index equals values of 1 and 0, depending whether the area under the escarpment at the particular cell is eroded or not.
- The *escarpment shape* index equals values of 1 and 0 for concave and convex escarpment geometries.
- The *failure* index equals values of 0, 1, and 2, depending on the estimated volume of failed material within the cell of interest. The failure index was selected from among other response variables, including tensile cracking and vertical and horizontal movement on the surface,

because it best describes the stability of the escarpment and can be estimated for each cell. The failure index is used as a dependent variable in regression analyses.

3 DATA FROM STUDY AREAS

It is important to examine similarities and differences among geologic and mining conditions in the Corncob Wash and Rilda Canyon study areas if one wishes to predict escarpment stability. This can be achieved by examining the average values listed in table 1 or, more precisely, by testing the hypothesis that population means for individual variables are equal when data from the Corncob Wash study area and the Rilda Canyon study area are compared. Table 2 presents results of such a comparison for selected variables, and attachment B presents test statistics.

Table 2. Validity of hypotheses regarding equality of population means for the two study areas.

Variable	Hypothesis accepted
Geologic:	
Joint set 1 index	Yes
Joint set 2 index	Yes
Erosion under escarpment index	Maybe*
Escarpment shape index	Maybe*
Canyon slope, percent	No
Escarpment slope, percent	No
Thickness of Castlegate Sandstone, ft	No
Seam-to-sandstone distance, ft	No
Mining:	
Influence angle, deg	Yes
Excavation width-to-depth ratio	No

* Test result depends on assumptions regarding equality of population means

- Joints in the Rilda Canyon study area are more continuous both horizontally and vertically and are spaced wider apart than in the Corncob Wash study area. There is, however, no significant difference between the means of populations when comparing the indexes of joint set 1 and joint set 2. That is, the null hypothesis is accepted.

- Canyon slope, escarpment slope, thickness of the Castlegate Sandstone, and seam-to-sandstone distances are, however, significantly less in the Rilda Canyon study area than in the Corncob Wash study area. Thus, the null hypothesis regarding equality of means is not accepted. The first two variables benefit the stability of escarpments in Rilda Canyon, while seam-to-sandstone distances will not make a difference because in both areas, supercritical excavations are expected to form on completion of mining. Note that the excavation width-to-depth ratio is significantly larger in Rilda Canyon because the seam-to-sandstone distance is smaller, and there are a greater number of panels planned.
- Overall there are similarities between the two study areas (table 2). Applying the knowledge gained from mining in the Corncob Wash area to the Rilda Canyon area to predictions of escarpment stability is justified.

4 TRENDS IN DATA AND IMPORTANT VARIABLES

Because there are many variables that could influence the stability of the escarpment (table 1), it is important to study trends in the data and use prudent statistical procedures that take into account the interrelationships among independent variables. To study these relationships, a bivariate correlation matrix was constructed to measure the linear correlation among geologic, mining, and response variables using the data from Corncob Wash. The correlation matrix includes correlation coefficient, number of data points, and two-tailed significance tests. The matrix is described in attachment C. The correlation coeffiecient (r) indicates the strength of linear relationships between any pair of variables.

From a review of the correlation matrix, it is evident that bivariate correlation is fair between the failure index variable and several independent variables, as well as among some independent variables. For example, the correlation coefficients between the failure index variable and the escarpment shape and influence angle variable are 0.58 and -0.48, respectively. However, escarpment shape and influence angle happen to have fair correlation as well (correlation coefficient equals -0.48). Thus, there is an interrelationship among the independent variables that can be taken into account using step-wise inclusion of these independent variables while conducting multiple regression analyses (Maleki and others 1997; Nie 1975).

To identify important factors that contribute to escarpment stability, a multiple regression analysis was used. Escarpment stability was estimated using the failure index as a dependent variable. The multilinear regression procedure consisted of entering independent variables one at a time into the equation using a forward selection method (SPSS, 1995). In this method, a variable is entered into the equation using the largest correlation with the dependant variable. If a variable fails to meet entry requirements, it is not included in the equation. If the first variable meets the criteria, the second variable with the highest partial correlation is then selected and tested for entering into the equation. This procedure is very good when there are hidden relationships among the variables. The multiple correlation coefficient, R, which is a measure of goodness-of-fit, for the last step is 0.68 (attachment C).

Based on an examination of standardized regression coefficients (attachment C), the following variables best explain variations in the failure index.

- *Escarpment shape* index. The lower the escarpment shape index, the smaller the failure index. This is in agreement with experience in Corncob Wash and Newberry Canyon where convex areas have historically remained stable when undermined.
- *Joint set 2 and escarpment* index. This is the only geologic variable that contributes to goodness-of-fit in a mathematical sense. Because there are very few secondary joints mapped in the Corncob Wash study area (similar condition in Rilda Canyon), this index is judged to be not important.

5 EXPECTED ESCARPMENT STABILITY—RILDA CANYON

Based on the preliminary regression model, a comparative analysis, and a review of single-seam mine plans for the 11,000-ft-long study area in Rilda Canyon, we have made the following preliminary assessment of the impact of mining on escarpment stability.

The study area was divided into three cell zones depending on their expected stabilities. These zones are shown in an attached map located in a pocket (Deer Creek Escarpment Modeling Study/ Rilda Canyon: Projected Escarpment Stability Zones).

- Zone 1 consists of cells 1 through 11 and is regarded having the least potential for escarpment instability. This zone is located outside the mining limit as defined by an influence angle of 15°.
- Zone 2 consists of the following sets of cells: 14, 15, and 16; 21- 22; 28, 29, and 30; 43, 44, and 45; 49- 50; 65, 66, and 67; 80 through 83; and 97, 98, and 99. Zone 2 is expected to have little potential for escarpment instability. These cells have convex geometries, a factor known to enhance stability.
- Zone 3, which contains the remaining cells, has a high potential for becoming unstable.

6 RECOMMENDED FUTURE ACTIVITIES

This study has shown the potential for applying statistical methods to the wealth of data on mining and escarpment stability to assess the stability of the Castlegate escarpment. It is recommended that the accuracy of the preliminary models be enhanced by—

- Including cell data from the Rilda Canyon study area after mining has been completed. Detailed premining data from this area could be instrumental in developing enhanced models for two-seam mining situations.
- Including similar cell data from other operations so that other important variables and a more diverse range of information could be included in the model. This will generate a regional model.
- Expanding the data cells to include both stable and unstable locations in the Corncob Wash, Newberry, and Trail Mountain areas where escarpment stability has been observed after the completion of longwall mining. This will result in a site-specific model for Energy West operations.

Acknowledgments

This cooperative work was implemented in conjunction with the geology and mining staff of Energy West. The active participation of Mr. Ken Fleck, Chuck Semborski, Tom Lloyd, and Larry Lafrentz is greatly appreciated.

References

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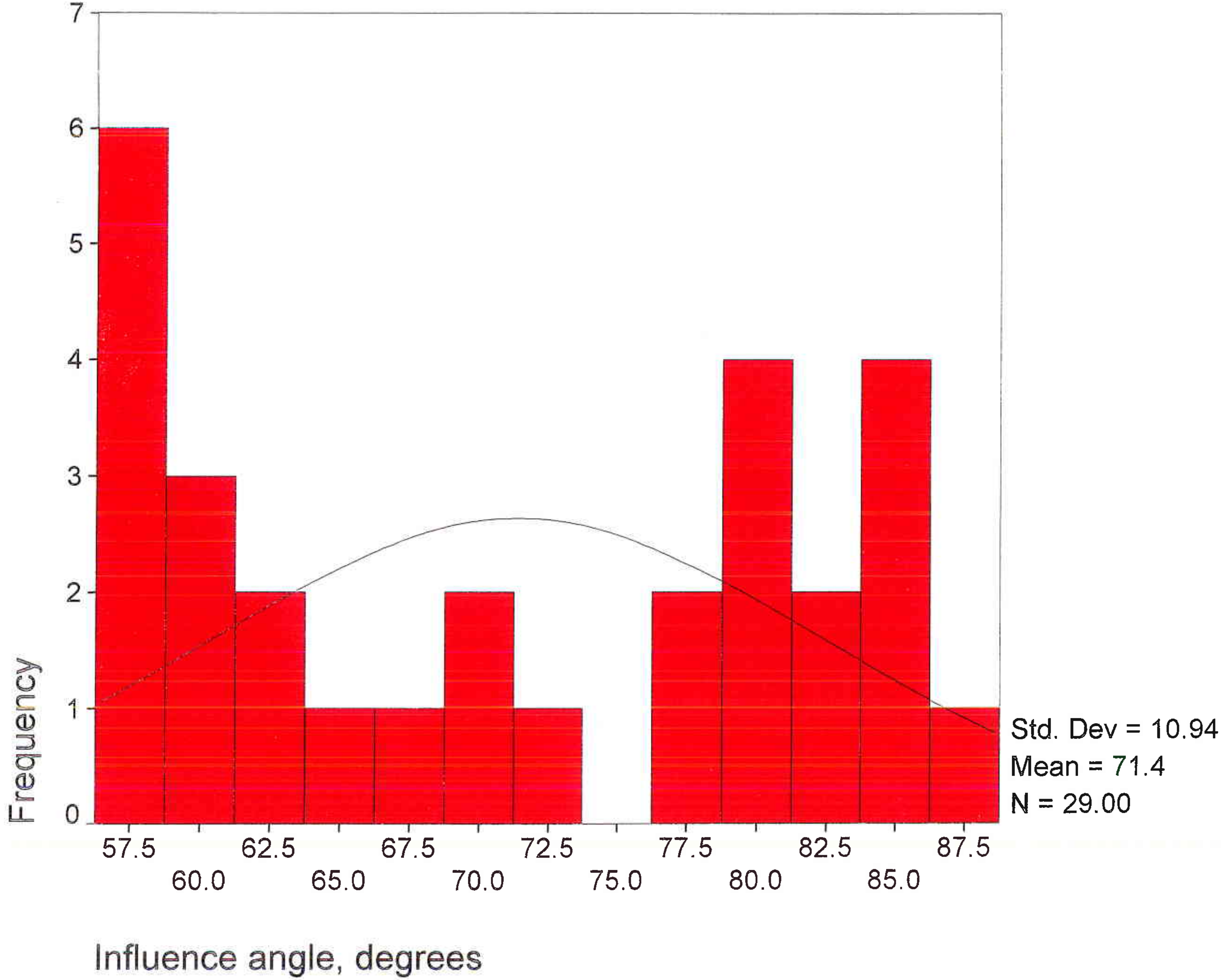
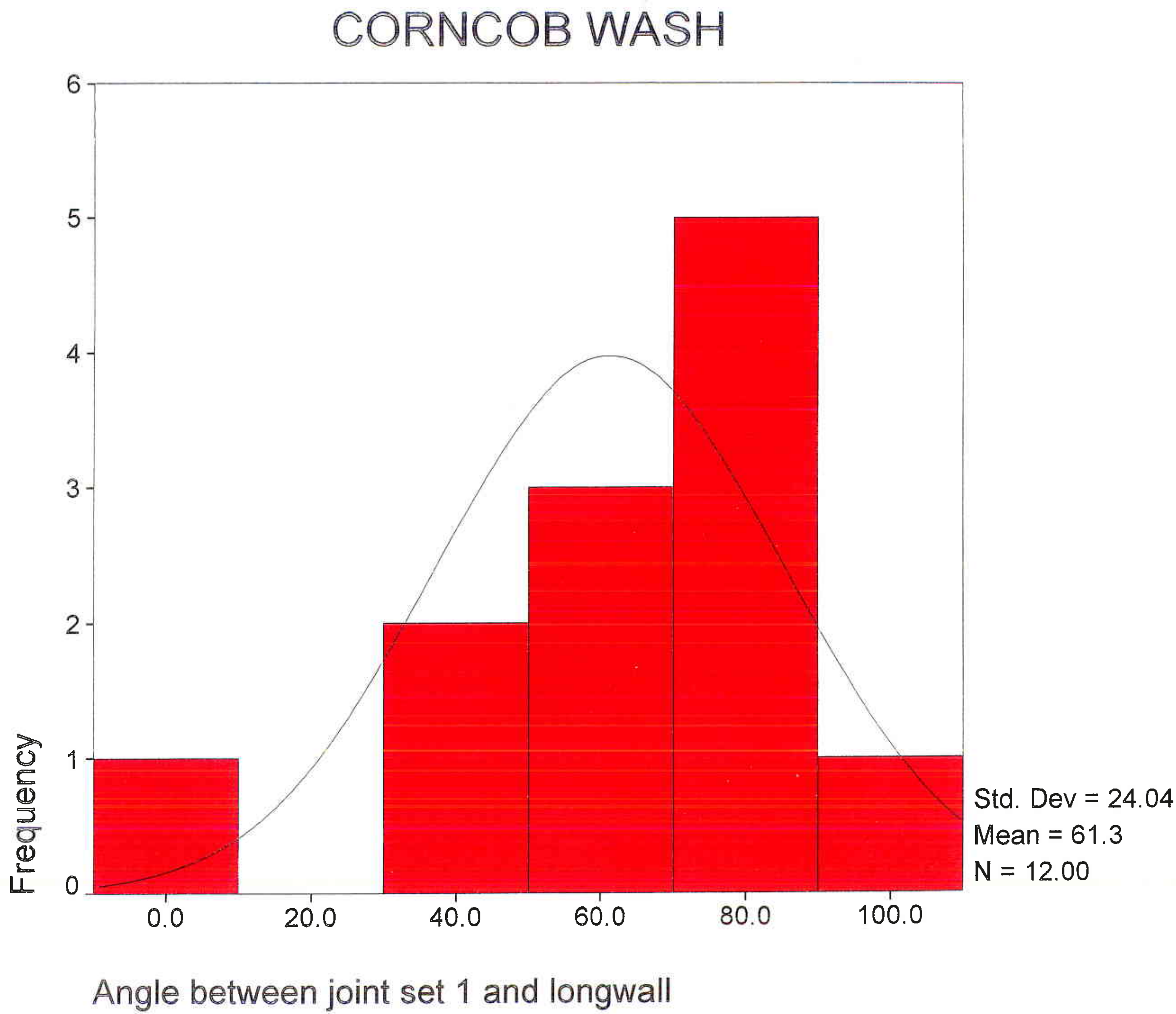
ATTACHMENT A

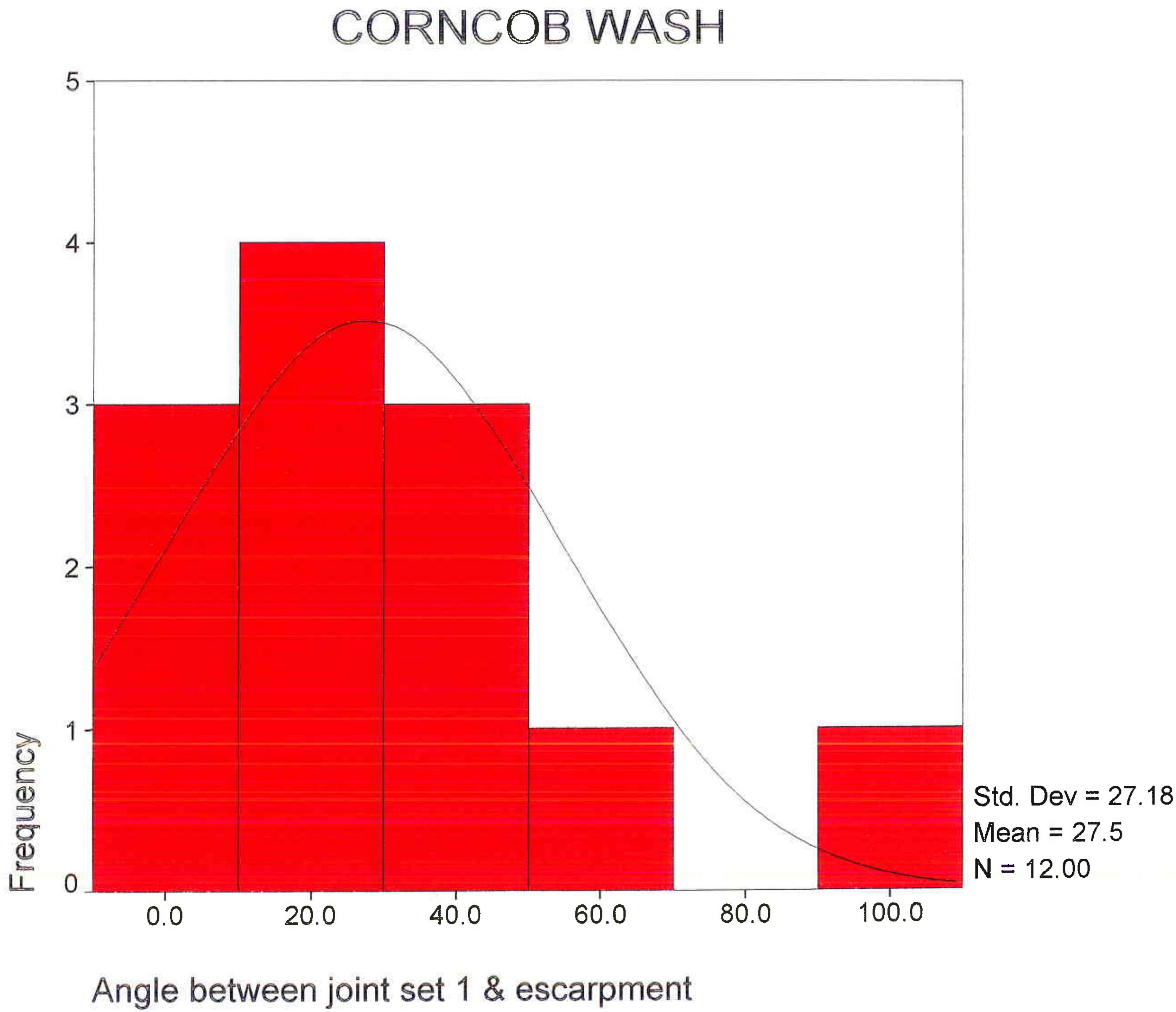
Histogram Frequency Diagrams for Geologic, Mining, and Response Variables

for the Corncob Wash and Rilda Canyon Study Areas

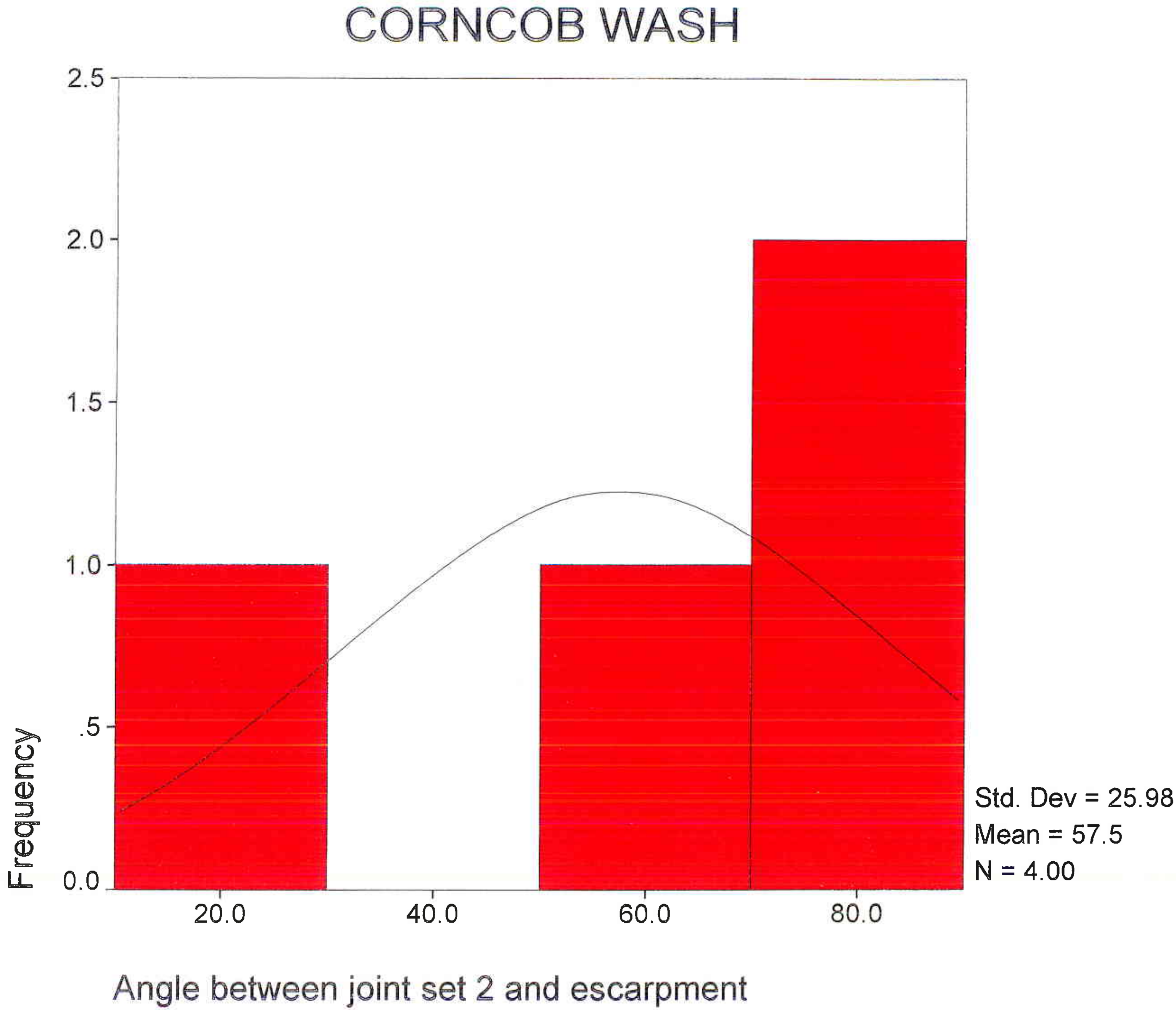
CORNCOB WASH

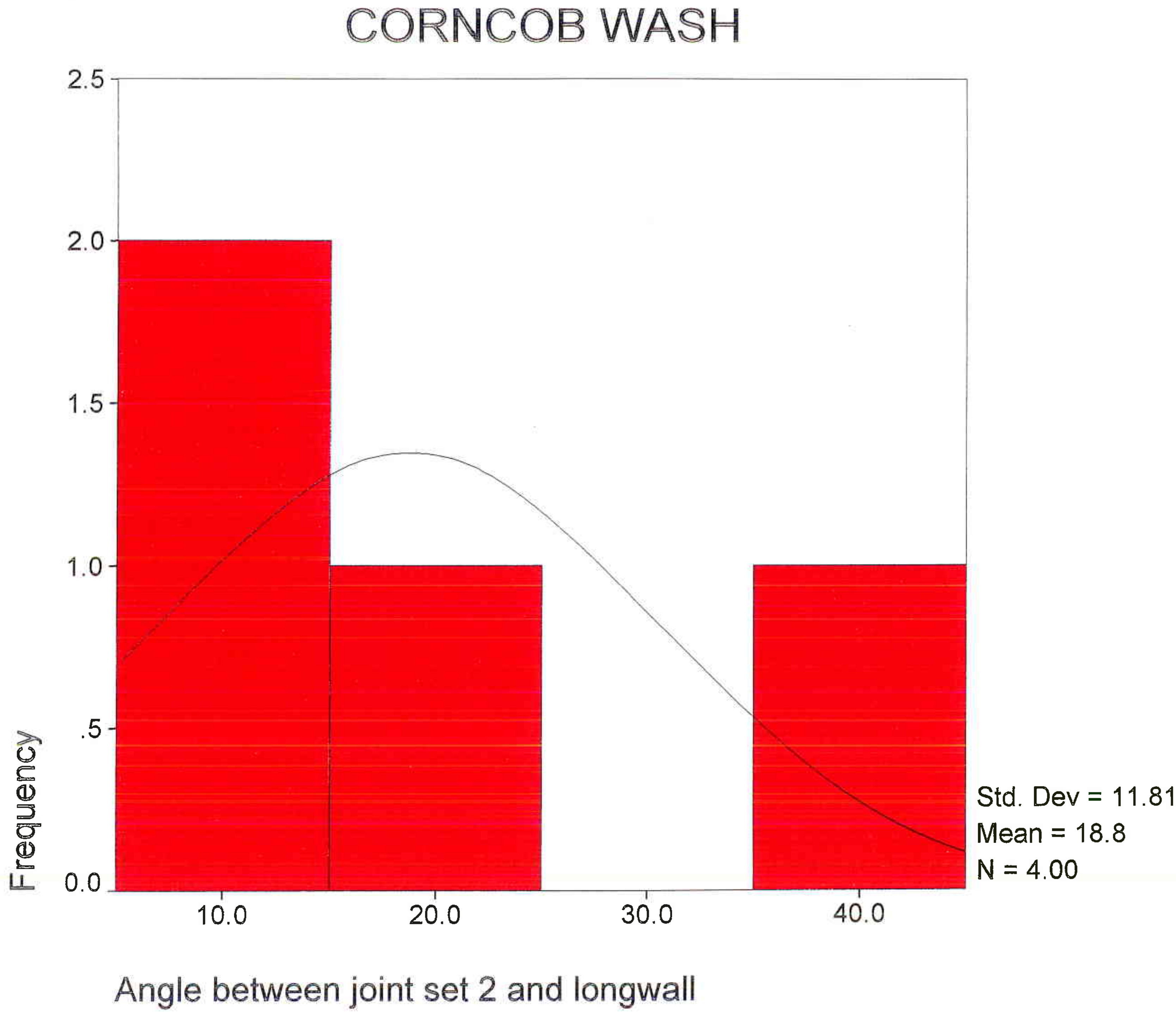



CORNCOB WASH
6
5
4
3
2
1
0
Frequency
0.0
20.0
40.0
60.0
80.0
100.0
Std. Dev = 24.04
Mean = 61.3
N = 12.00
Angle between joint set 1 and longwall



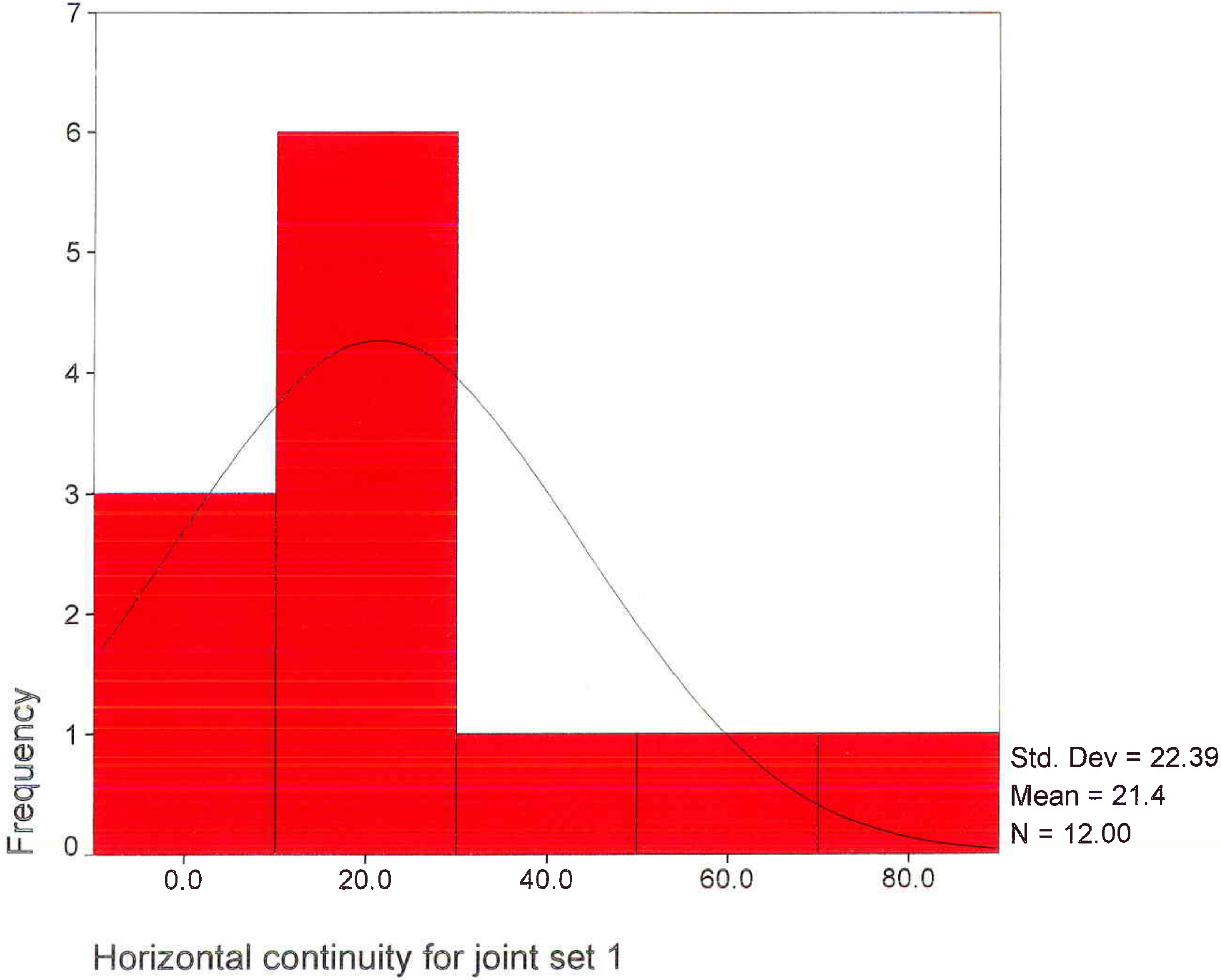
CORNCOB WASH
Frequency
0
1
2
3
4
5
0.0
20.0
40.0
60.0
80.0
100.0
Std. Dev = 27.18
Mean = 27.5
N = 12.00
Angle between joint set 1 & escarpment

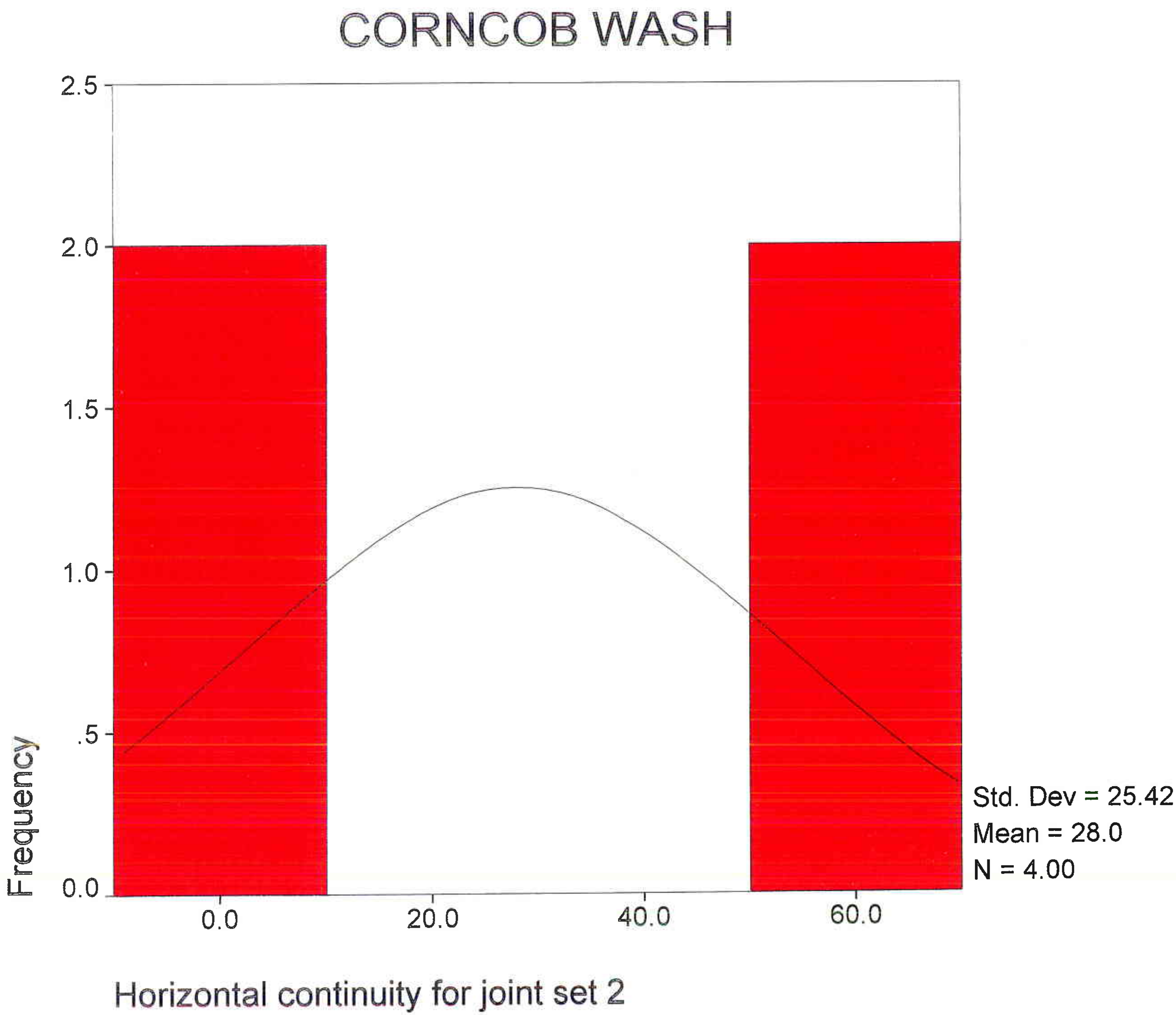

CORNCOB WASH
2.5
2.0
1.5
1.0
.5
0.0
Frequency
20.0
40.0
60.0
80.0
Angle between joint set 2 and escarpment
Std. Dev = 25.98
Mean = 57.5
N = 4.00

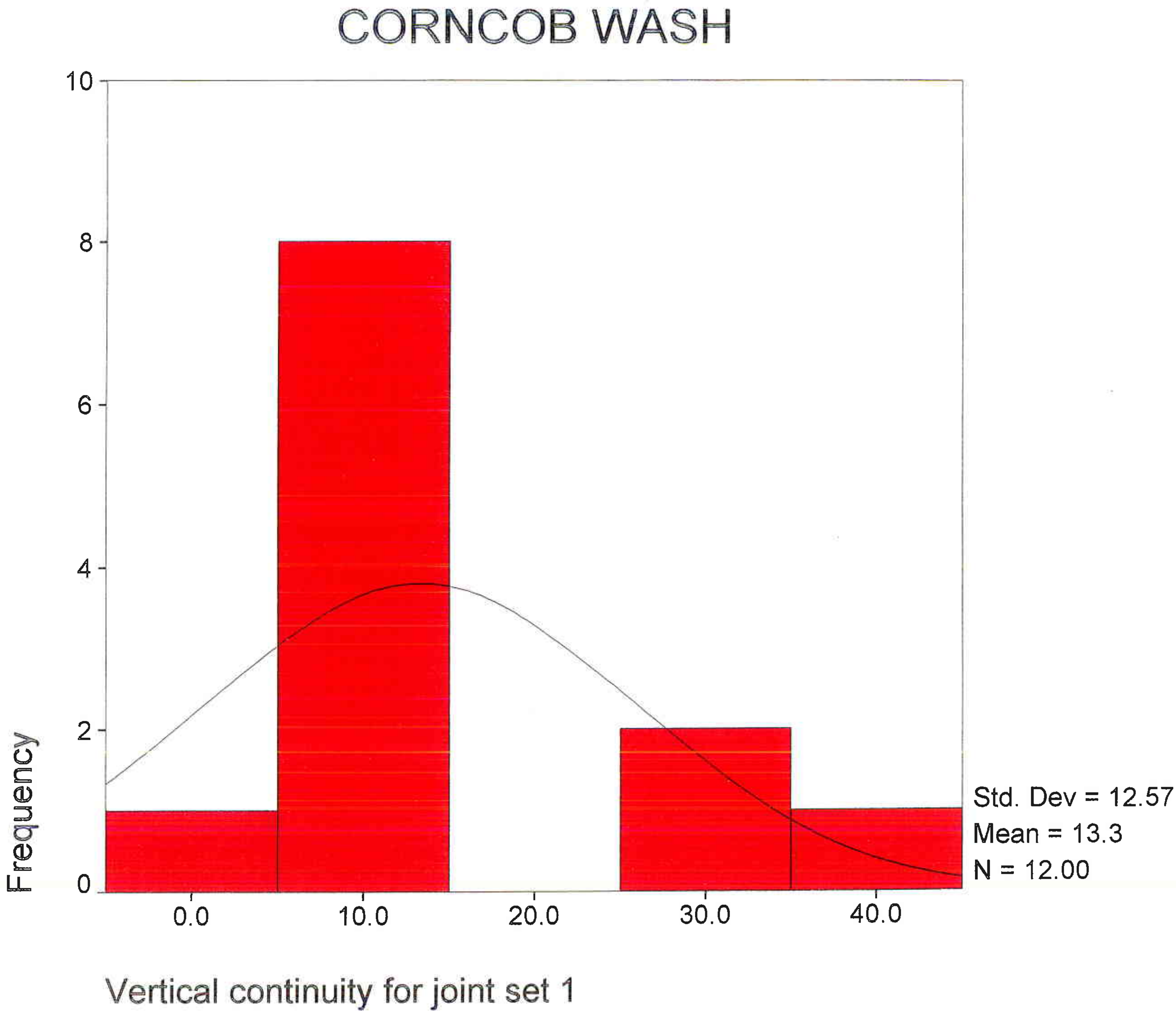


CORNCOB WASH
2.5
2.0
1.5
1.0
.5
0.0
Frequency
10.0
20.0
30.0
40.0
Std. Dev = 11.81
Mean = 18.8
N = 4.00
Angle between joint set 2 and longwall

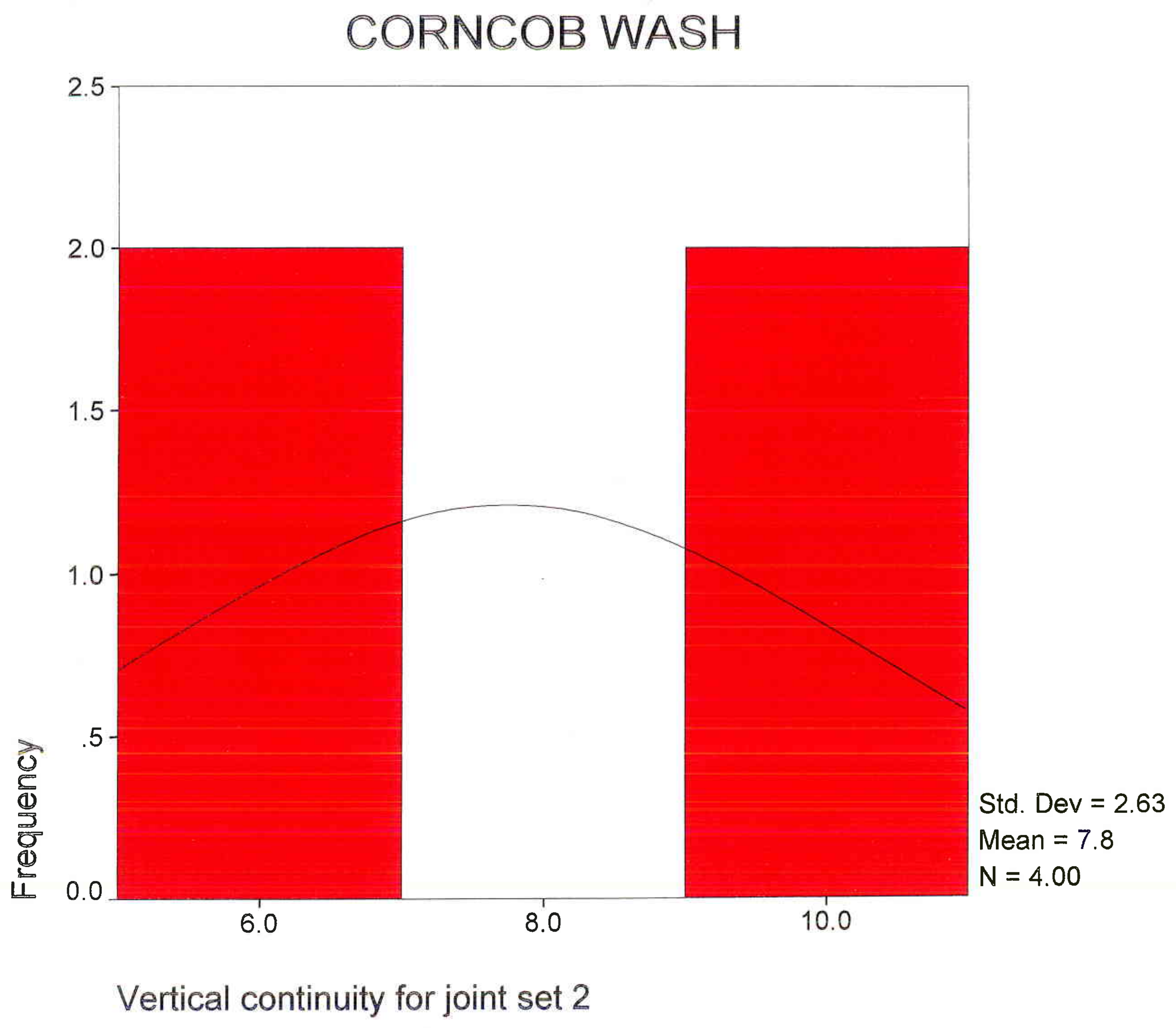
CORNCOB WASH



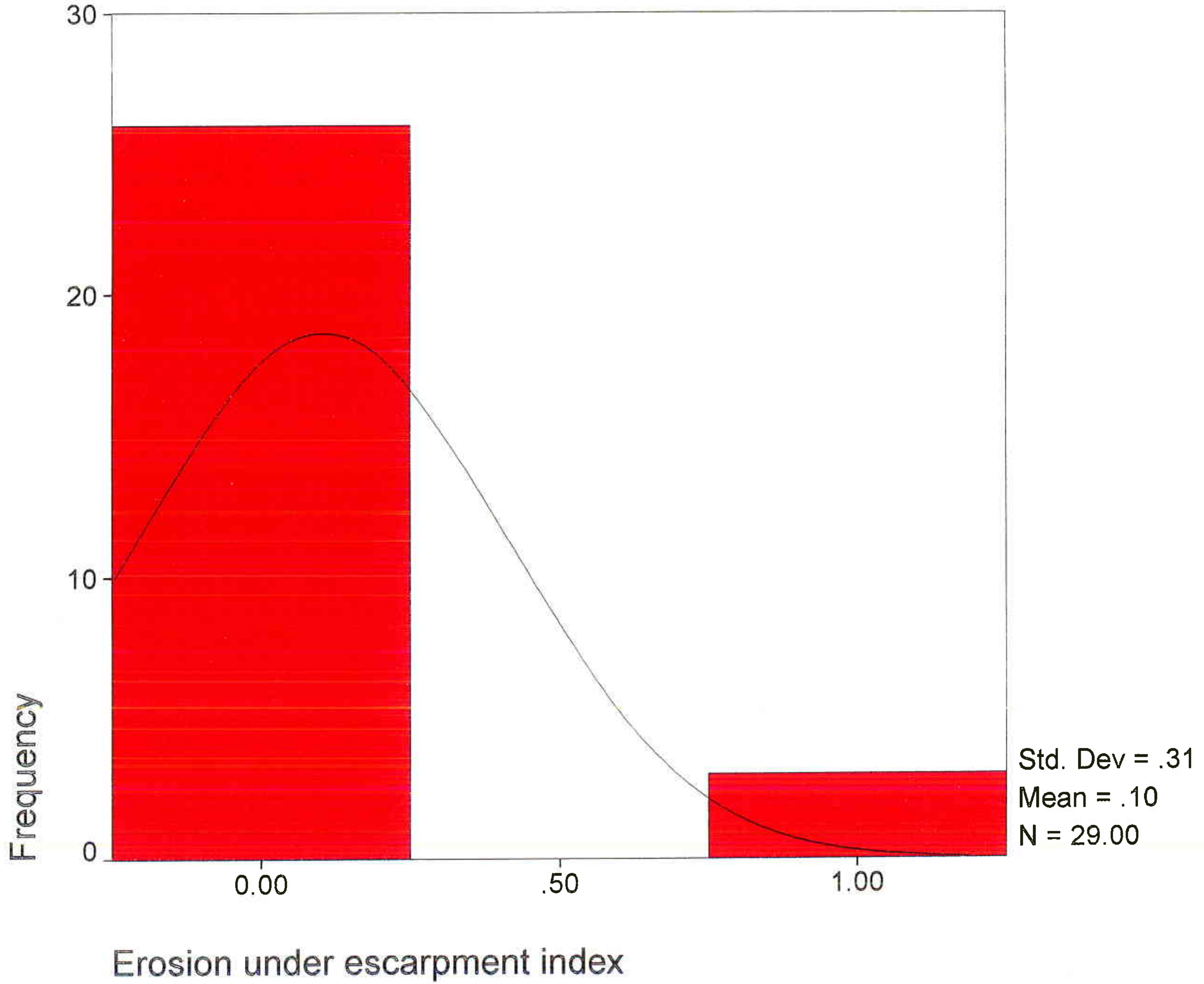

CORNCOB WASH
2.5
2.0
1.5
1.0
.5
0.0
Frequency
0.0
20.0
40.0
60.0
Std. Dev = 25.42
Mean = 28.0
N = 4.00
Horizontal continuity for joint set 2



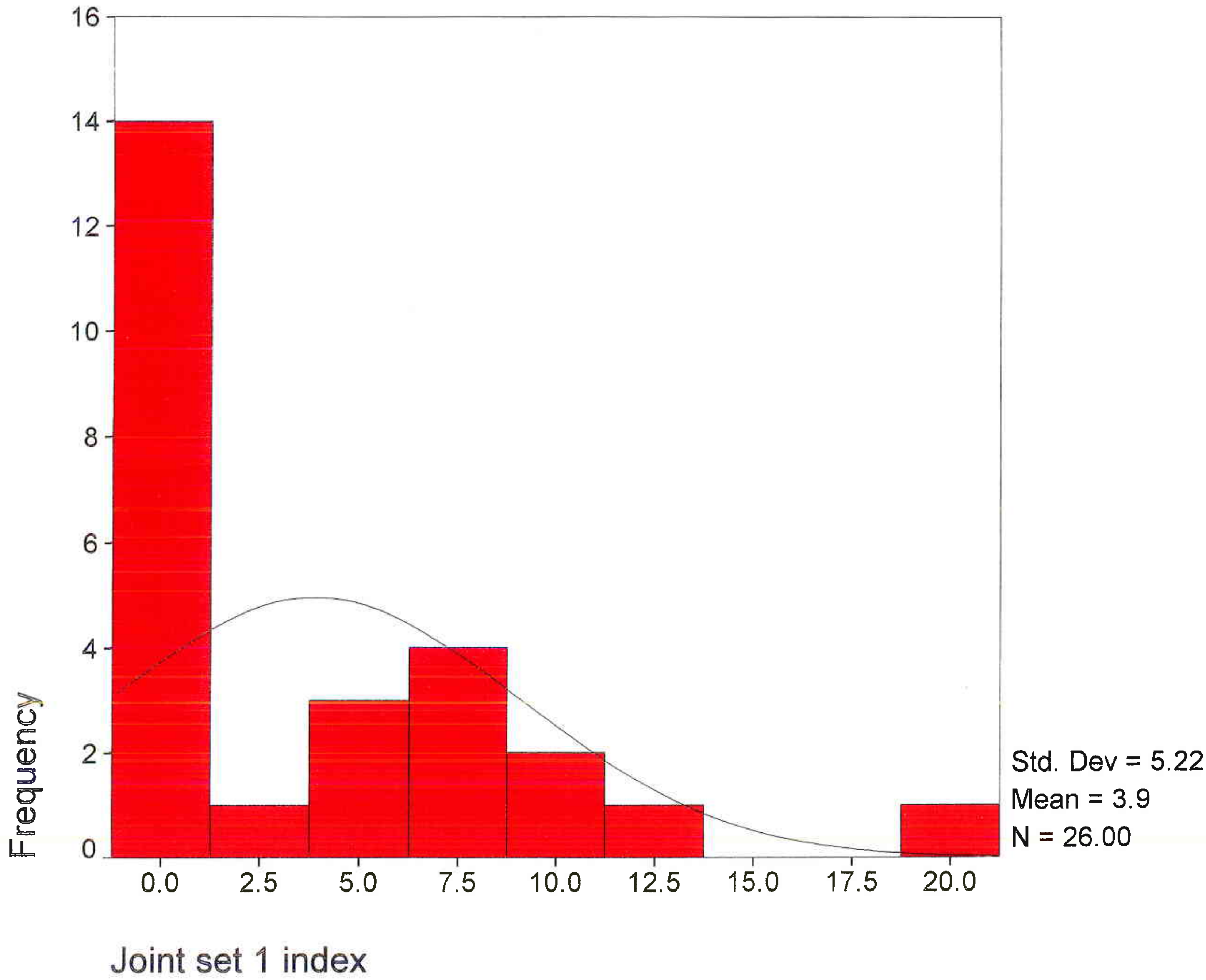
CORNCOB WASH
Frequency
10
8
6
4
2
0
0.0
10.0
20.0
30.0
40.0
Std. Dev = 12.57
Mean = 13.3
N = 12.00
Vertical continuity for joint set 1

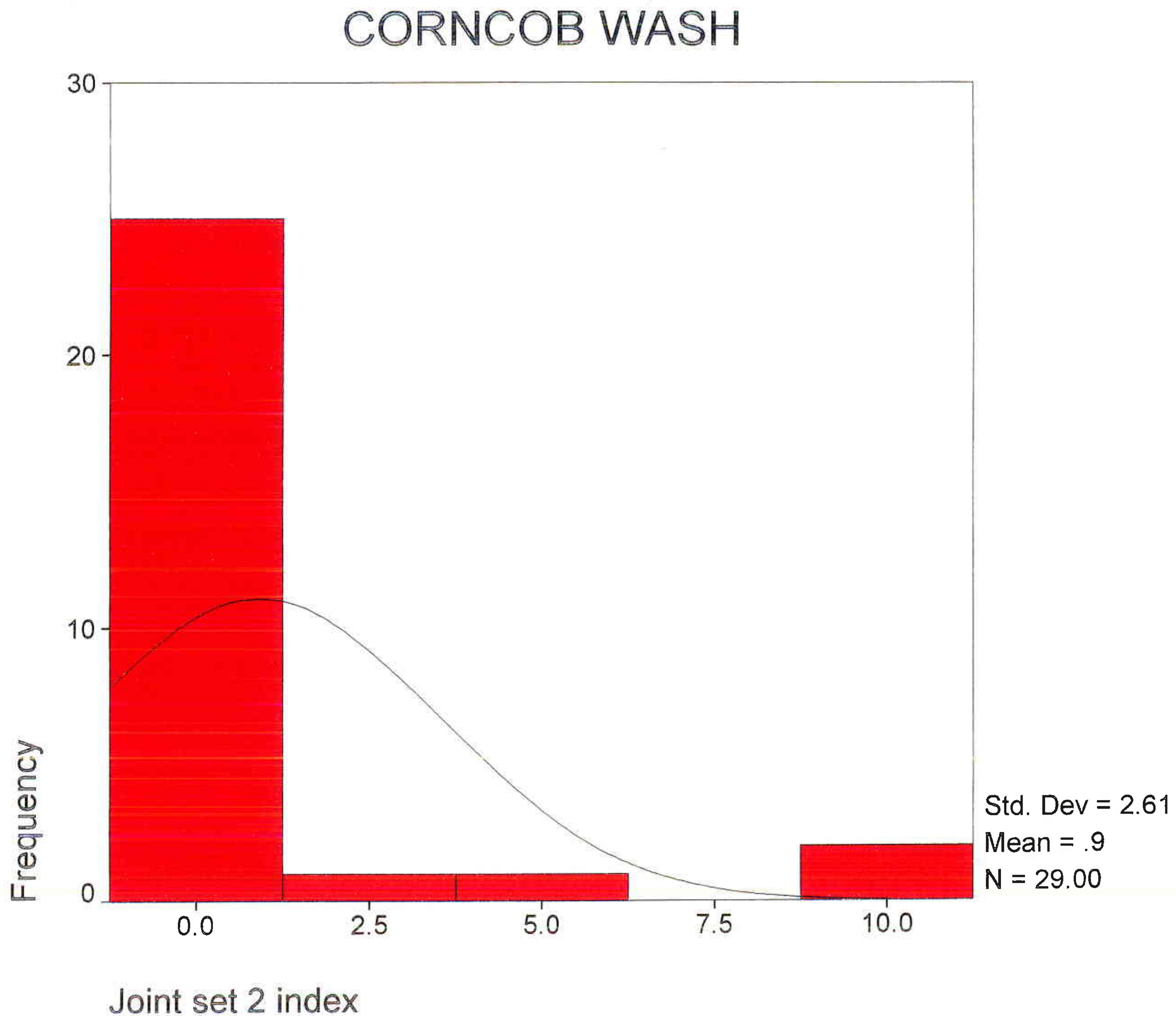

CORNCOB WASH
2.5
2.0
1.5
1.0
.5
0.0
Frequency
6.0
8.0
10.0
Std. Dev = 2.63
Mean = 7.8
N = 4.00
Vertical continuity for joint set 2

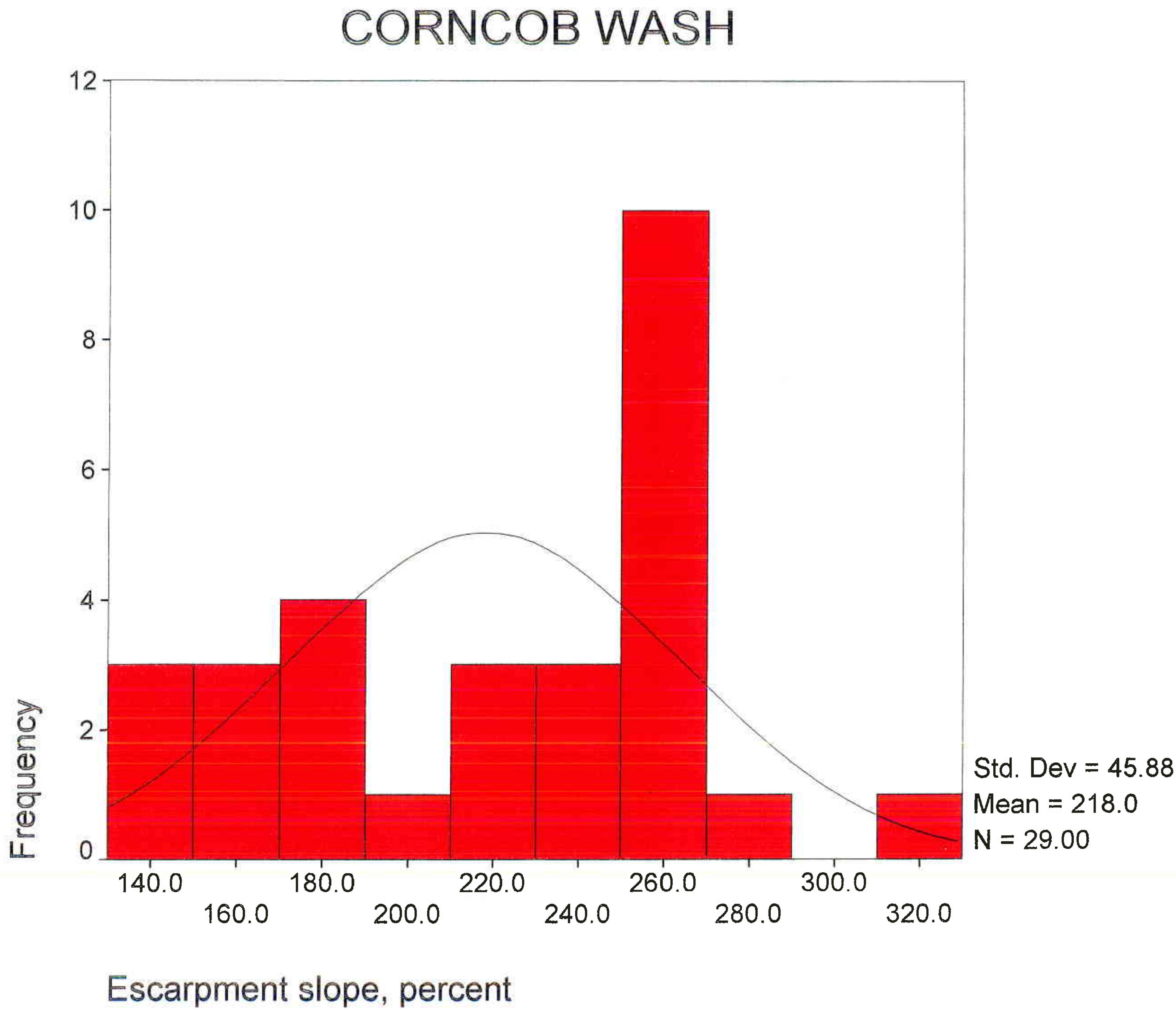
CORNCOB WASH

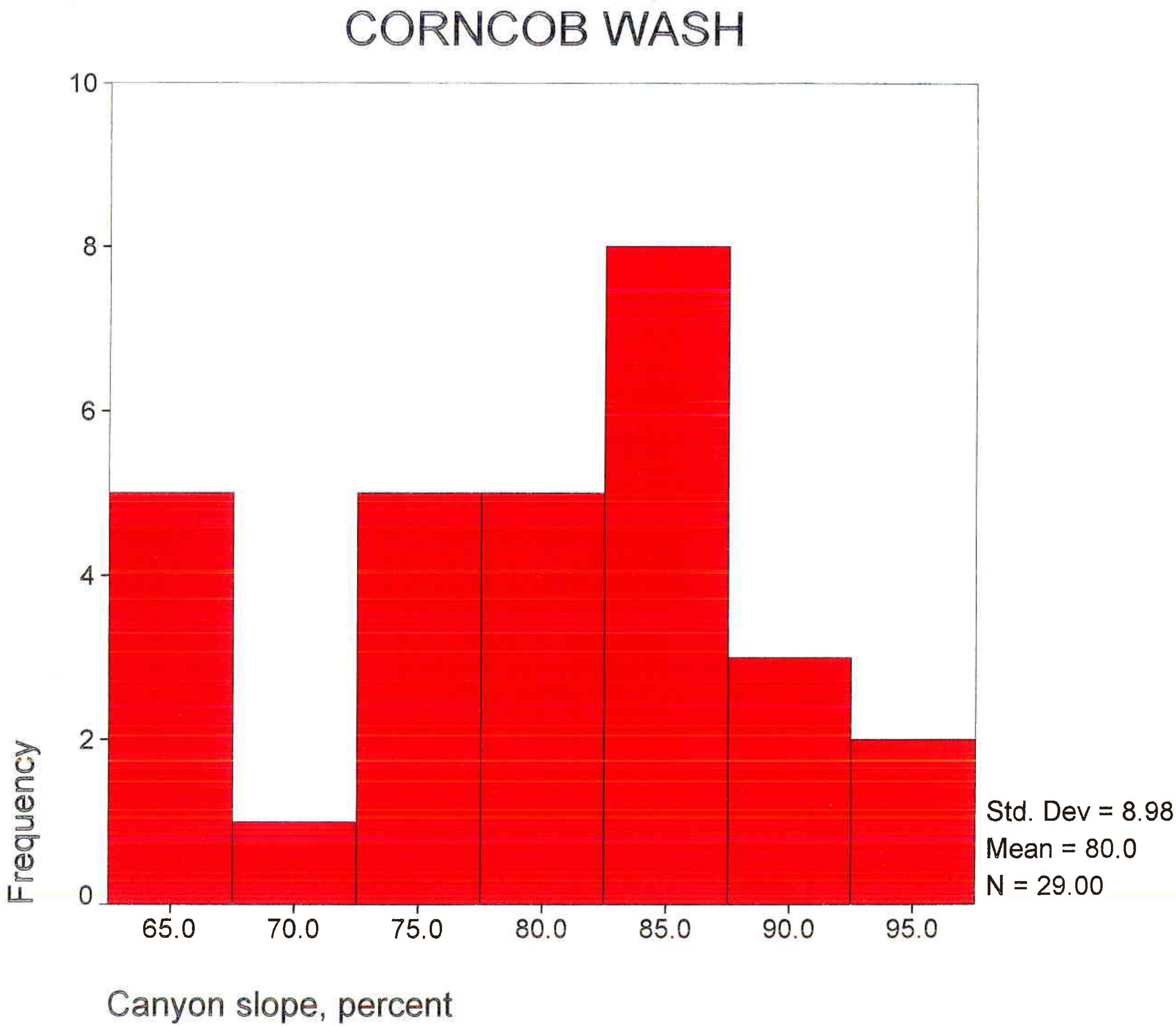


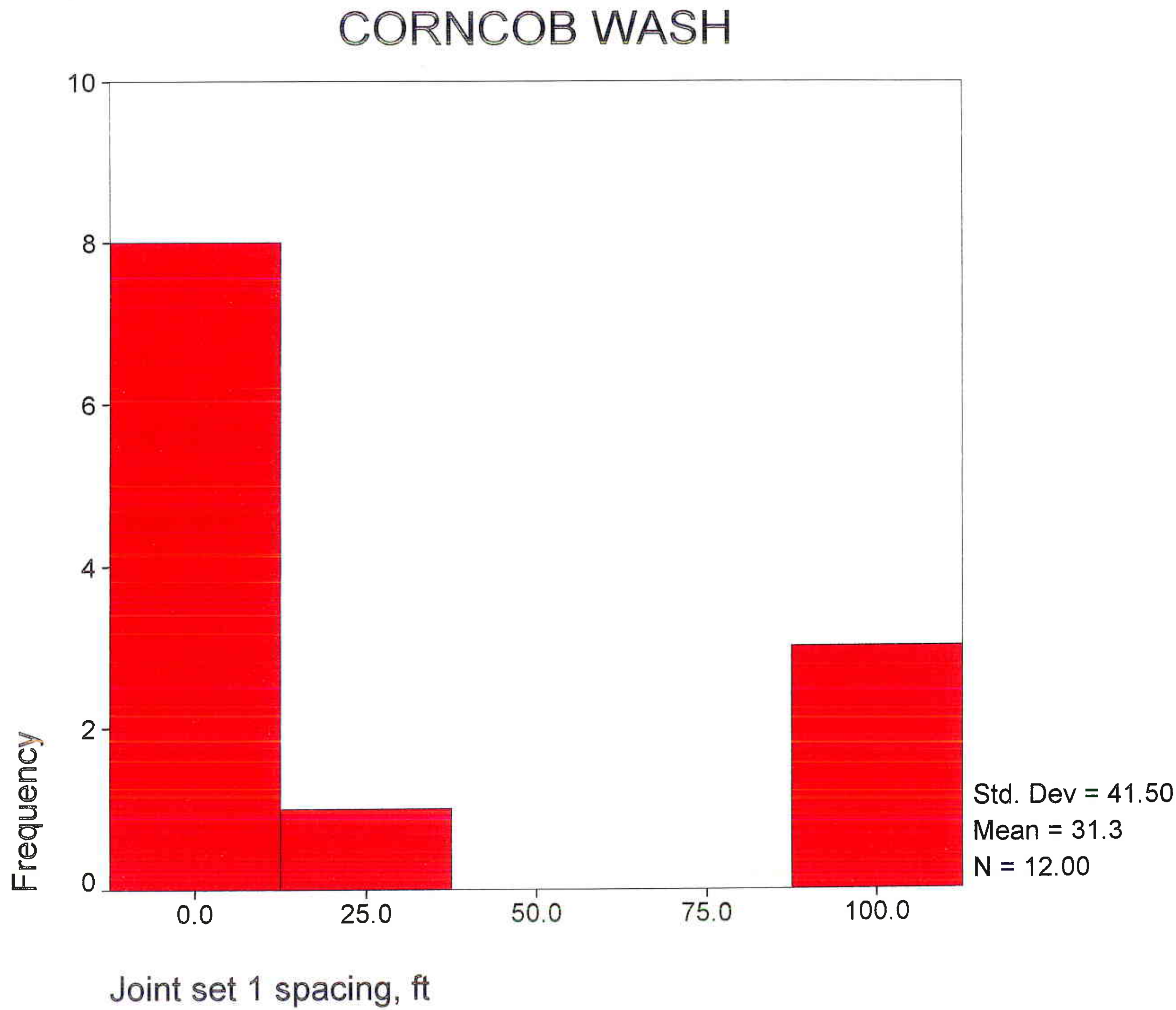
CORNCOB WASH

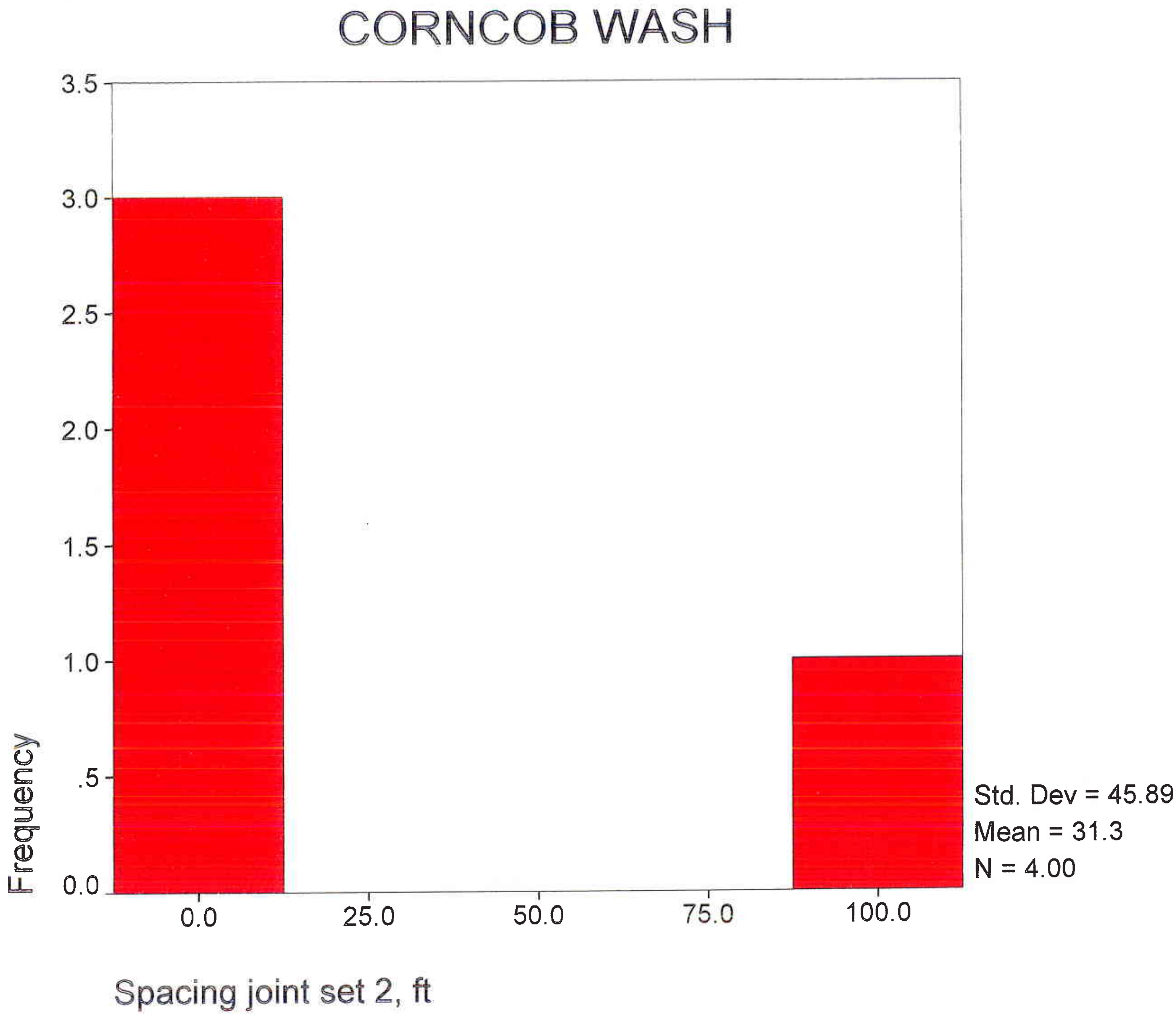


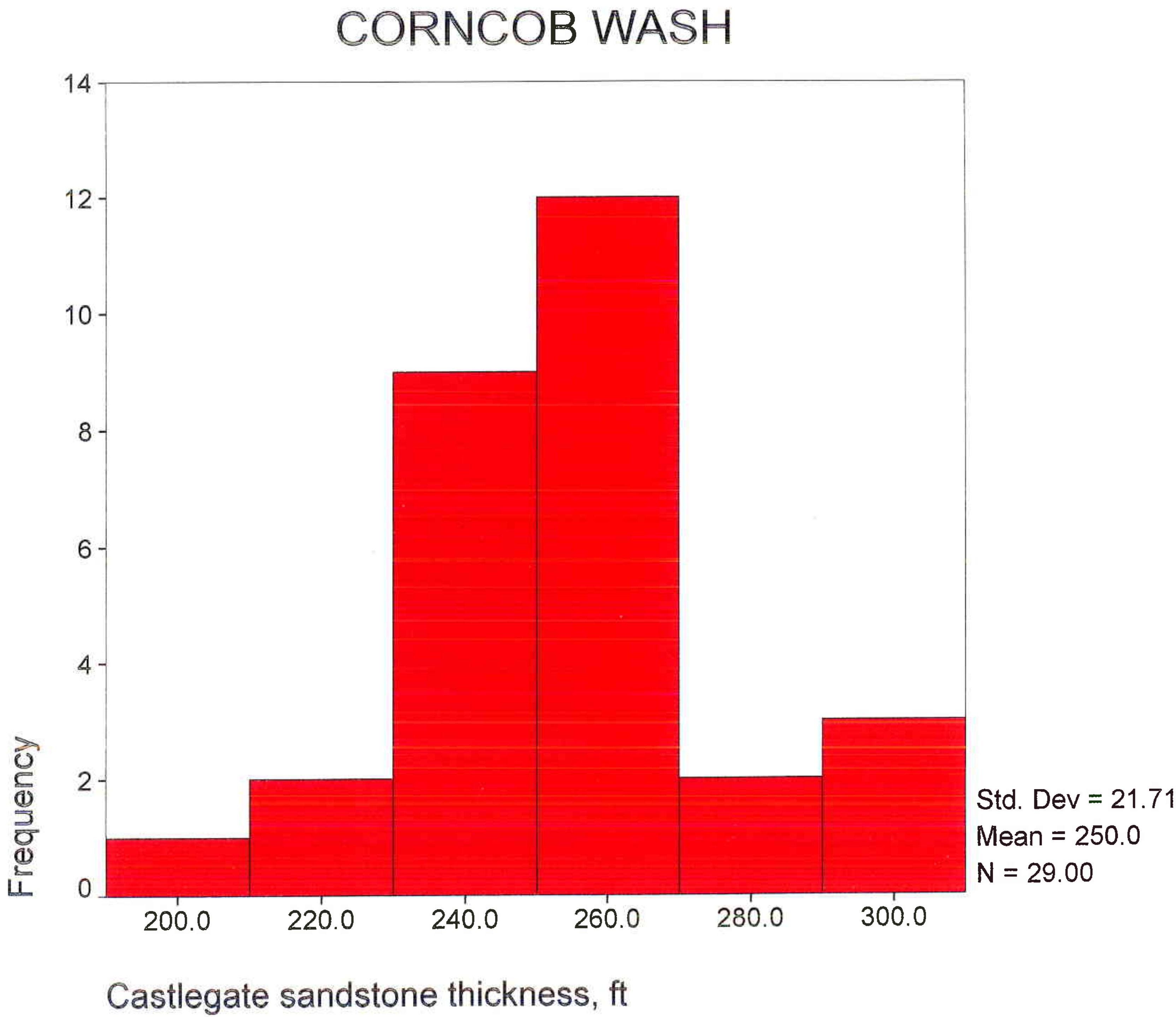

CORNCOB WASH
30
20
10
0
Frequency
0.0
2.5
5.0
7.5
10.0
Std. Dev = 2.61
Mean = .9
N = 29.00
Joint set 2 index


CORNCOB WASH
12
10
8
6
4
2
0
Frequency
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
Escarpment slope, percent
Std. Dev = 45.88
Mean = 218.0
N = 29.00


CORNCOB WASH
10
8
6
4
2
0
Frequency
65.0
70.0
75.0
80.0
85.0
90.0
95.0
Std. Dev = 8.98
Mean = 80.0
N = 29.00
Canyon slope, percent

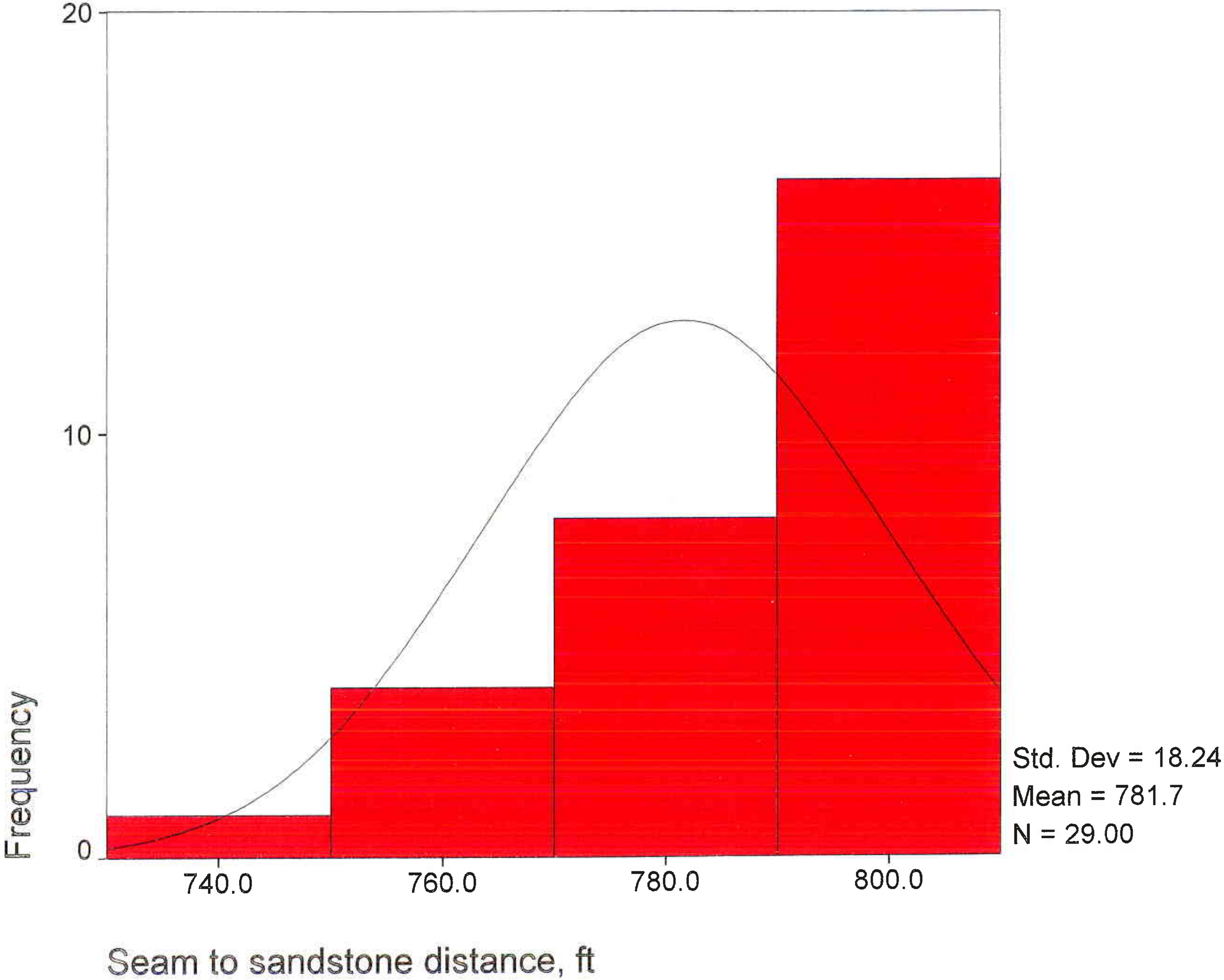

CORNCOB WASH
10
8
6
4
2
0
Frequency
0.0
25.0
50.0
75.0
100.0
Std. Dev = 41.50
Mean = 31.3
N = 12.00
Joint set 1 spacing, ft

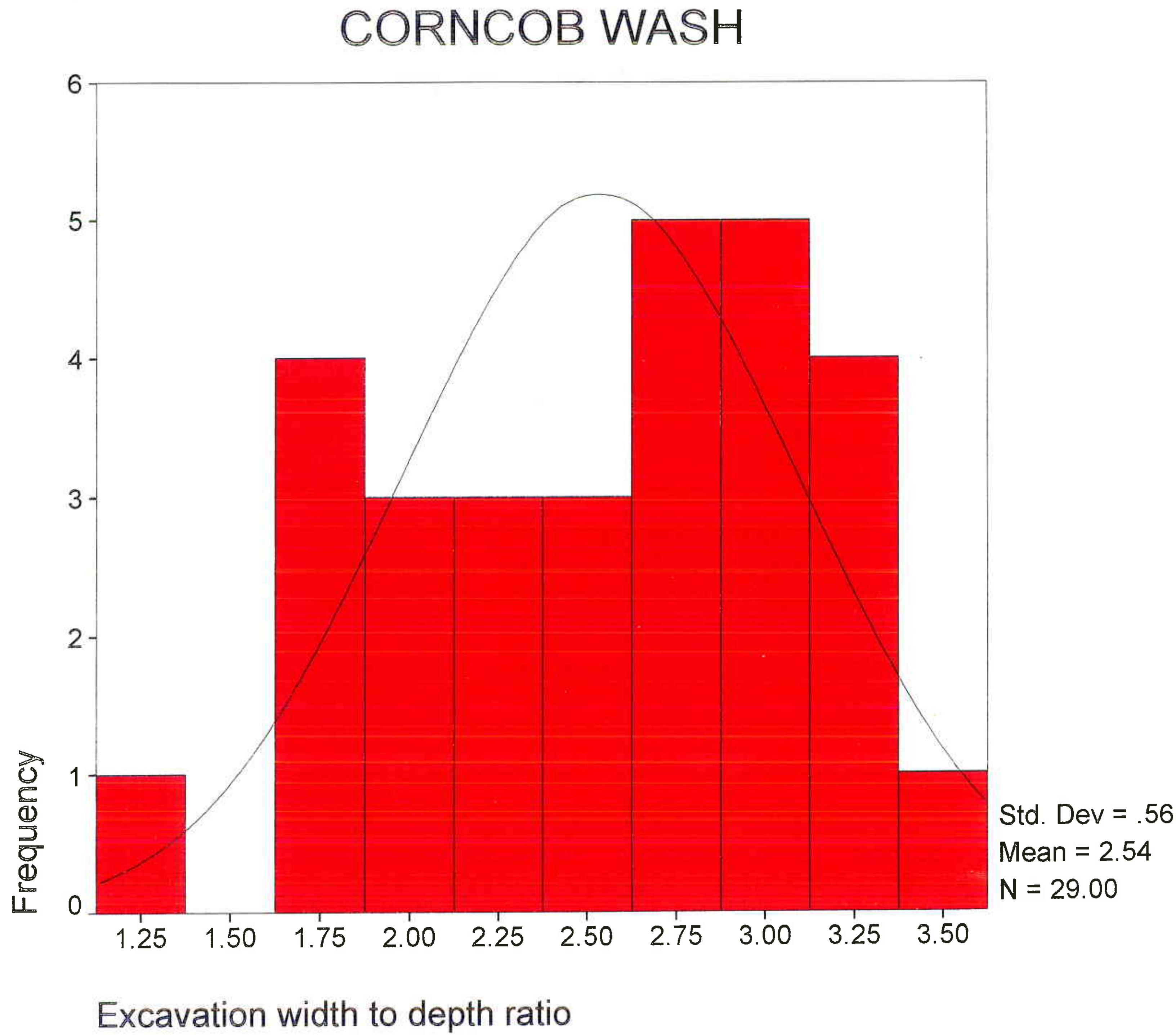

CORNCOB WASH
3.5
3.0
2.5
2.0
1.5
1.0
.5
0.0
Frequency
0.0
25.0
50.0
75.0
100.0
Std. Dev = 45.89
Mean = 31.3
N = 4.00
Spacing joint set 2, ft

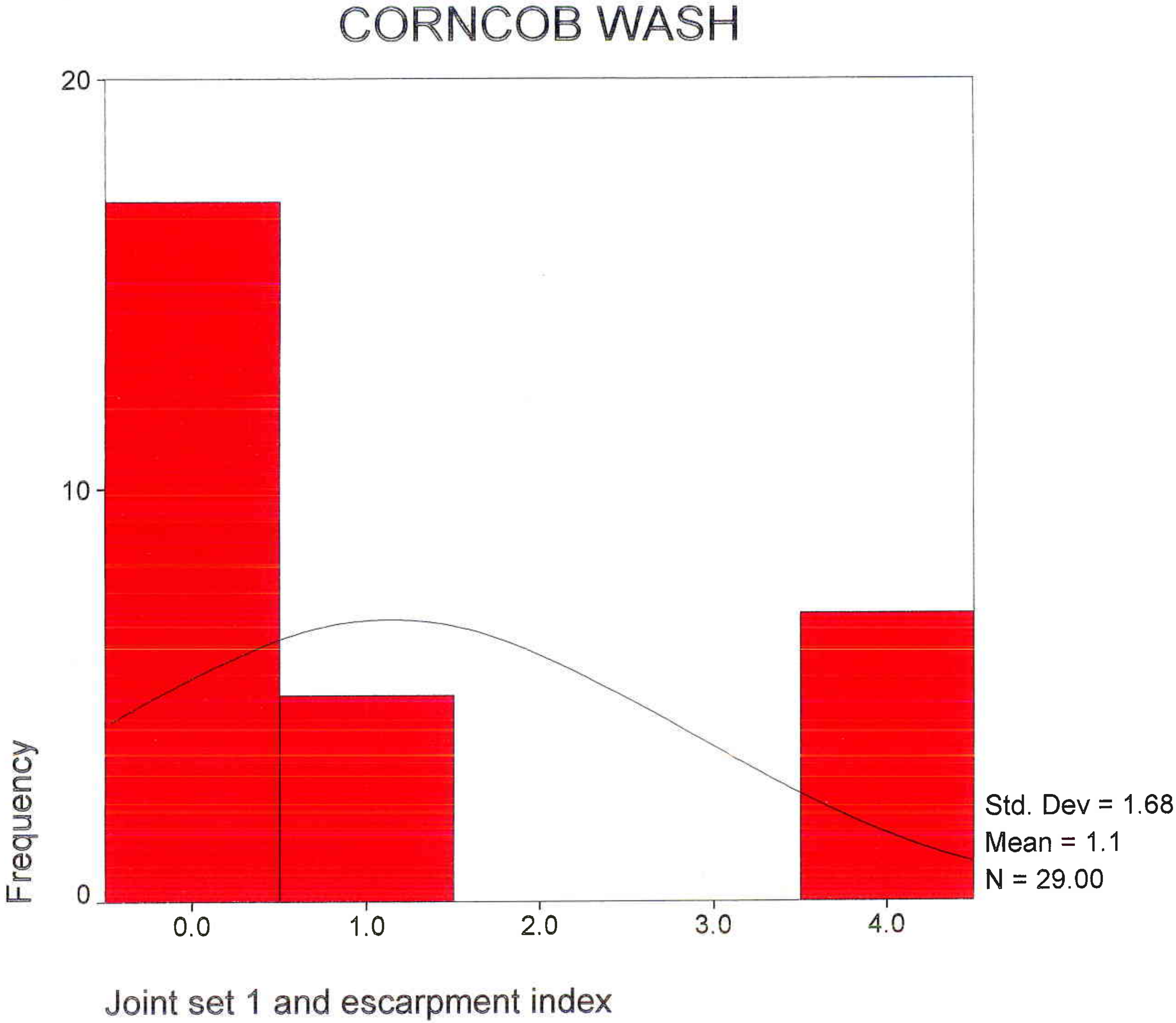


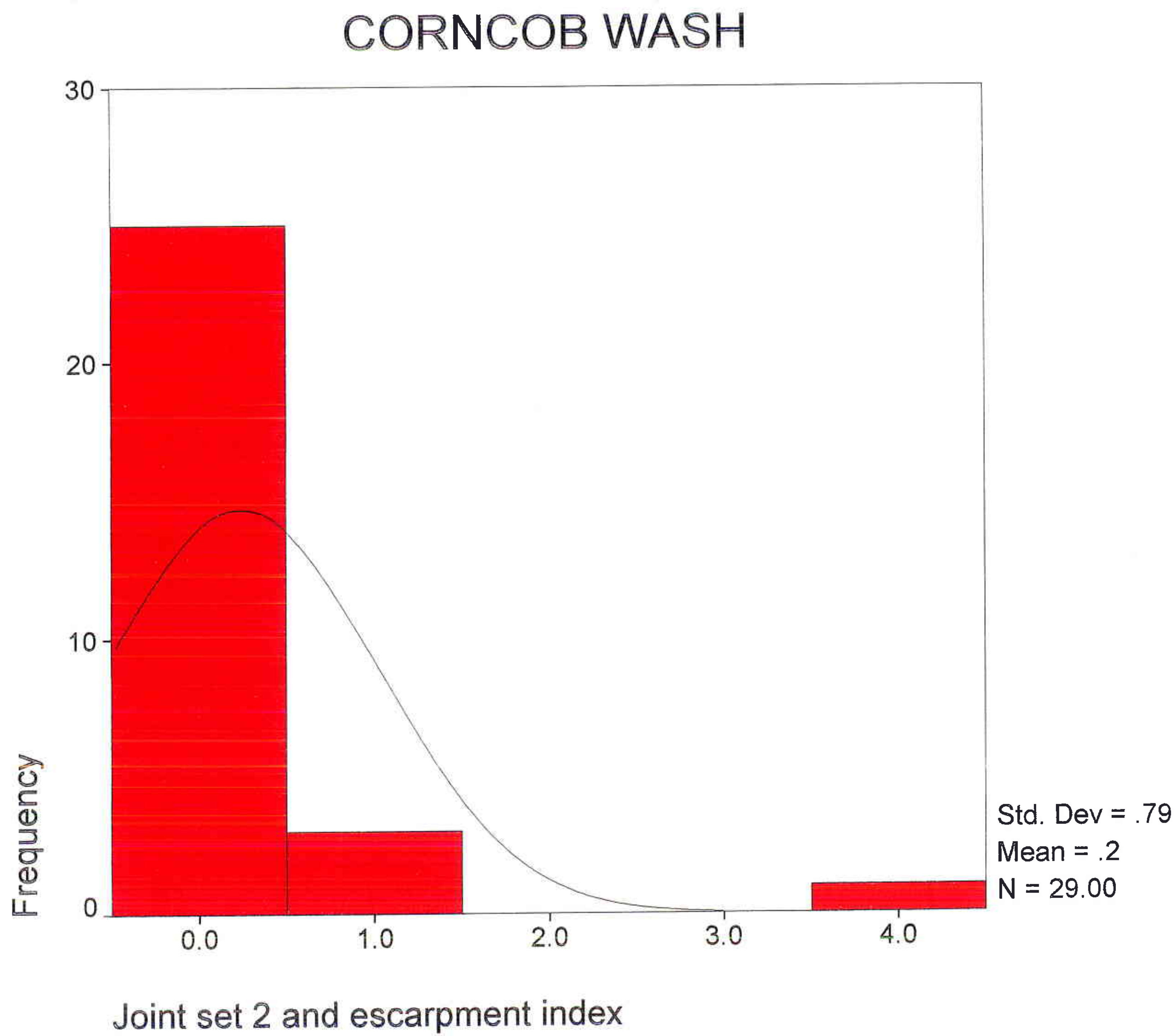
CORNCOB WASH
14
12
10
8
6
4
2
0
Frequency
200.0
220.0
240.0
260.0
280.0
300.0
Castlegate sandstone thickness, ft
Std. Dev = 21.71
Mean = 250.0
N = 29.00

CORNCOB WASH

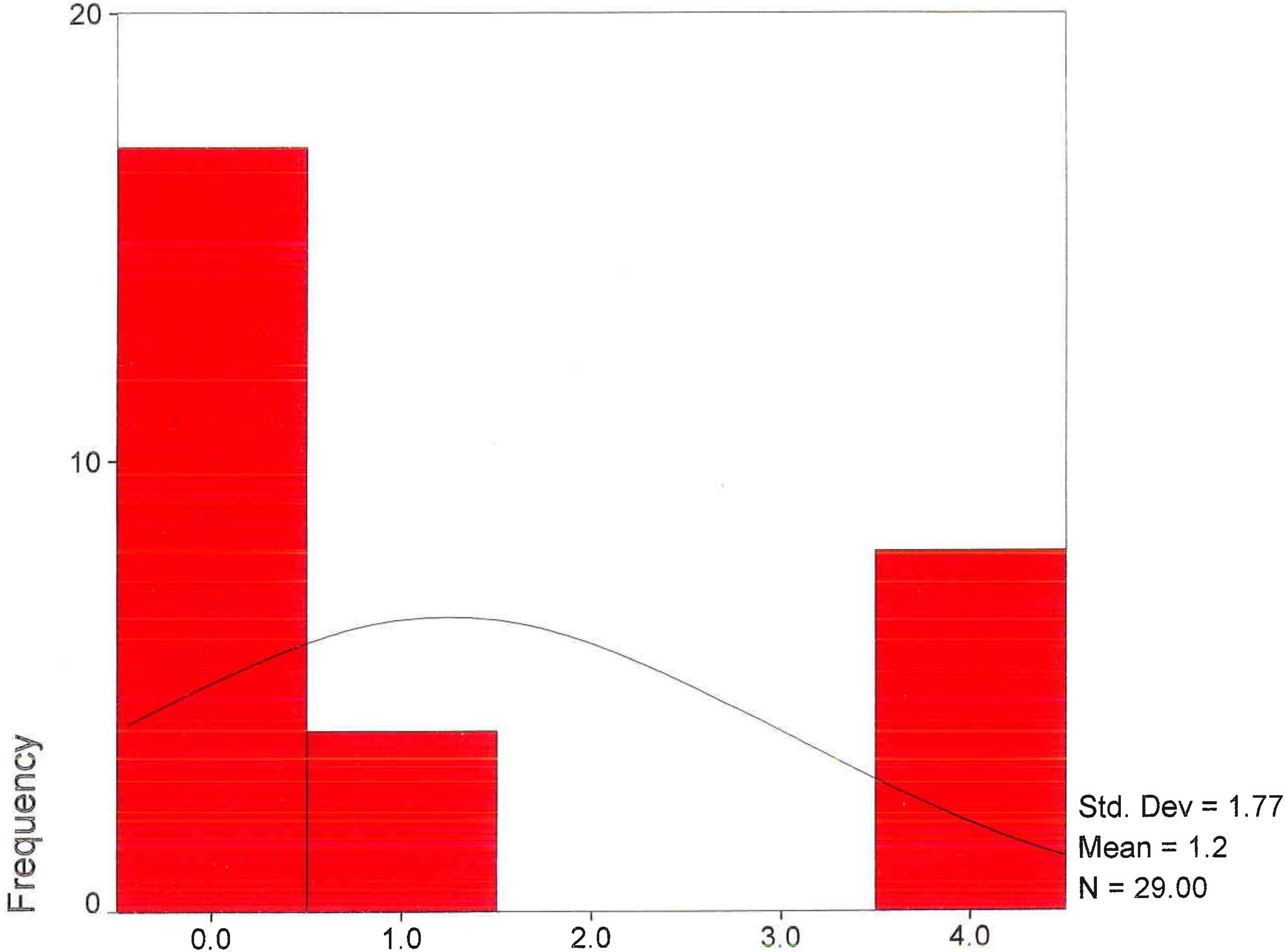



CORNCOB WASH
Frequency
6
5
4
3
2
1
0
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
Std. Dev = .56
Mean = 2.54
N = 29.00
Excavation width to depth ratio

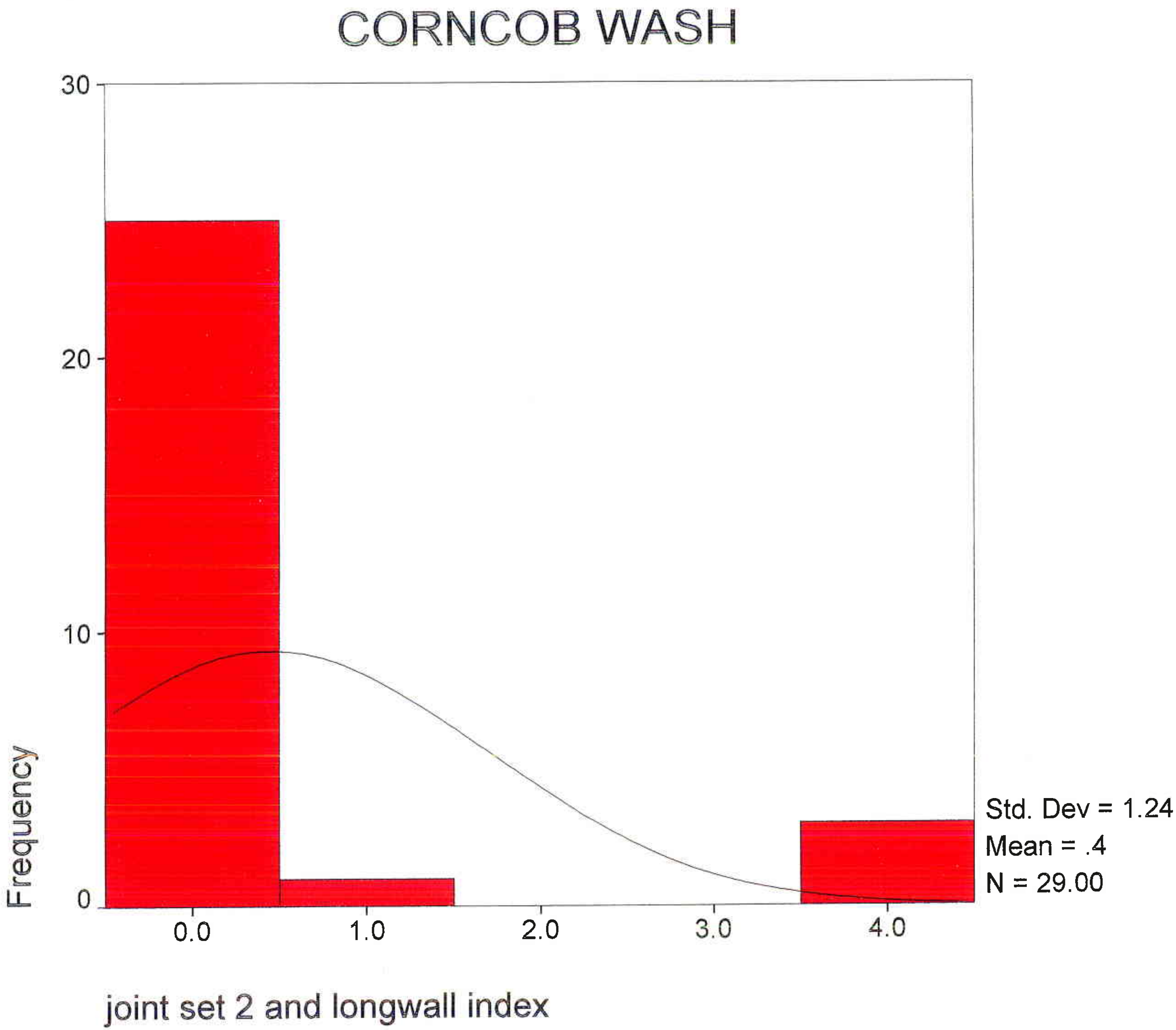

CORNCOB WASH
20
10
0
Frequency
0.0
1.0
2.0
3.0
4.0
Std. Dev = 1.68
Mean = 1.1
N = 29.00
Joint set 1 and escarpment index

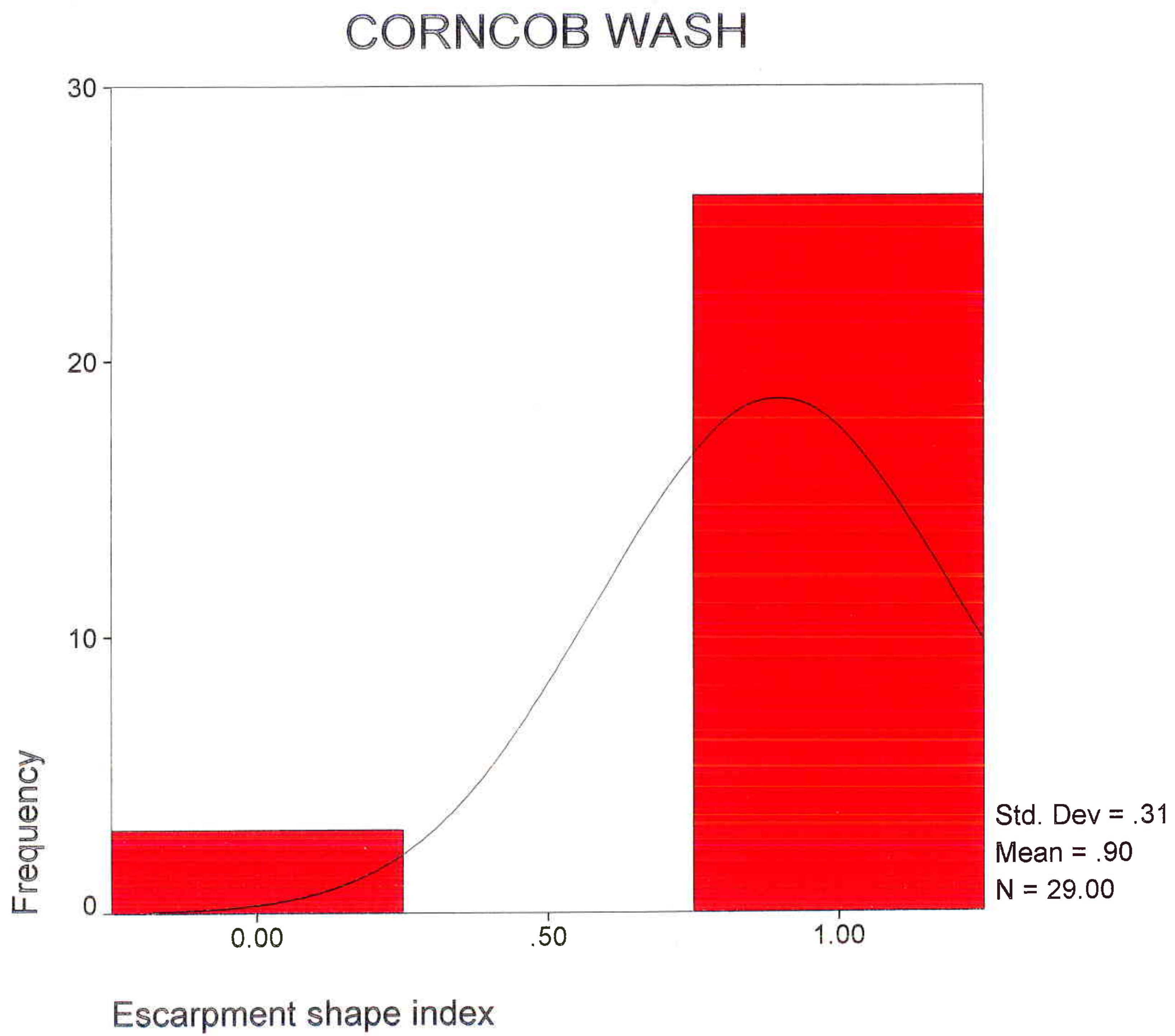

CORNCOB WASH
30
20
10
0
Frequency
0.0
1.0
2.0
3.0
4.0
Std. Dev = .79
Mean = .2
N = 29.00
Joint set 2 and escarpment index

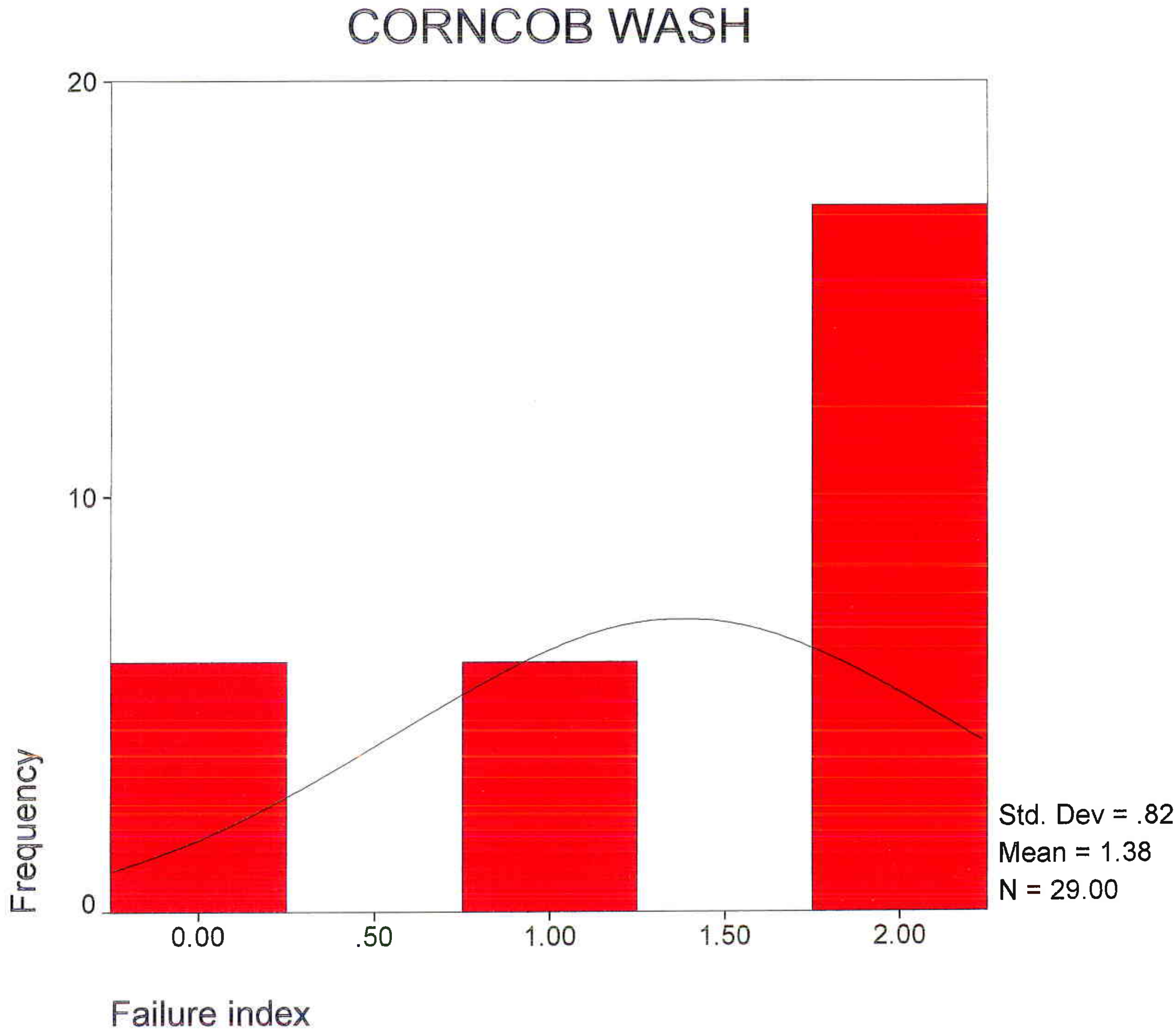
CORNCOB WASH

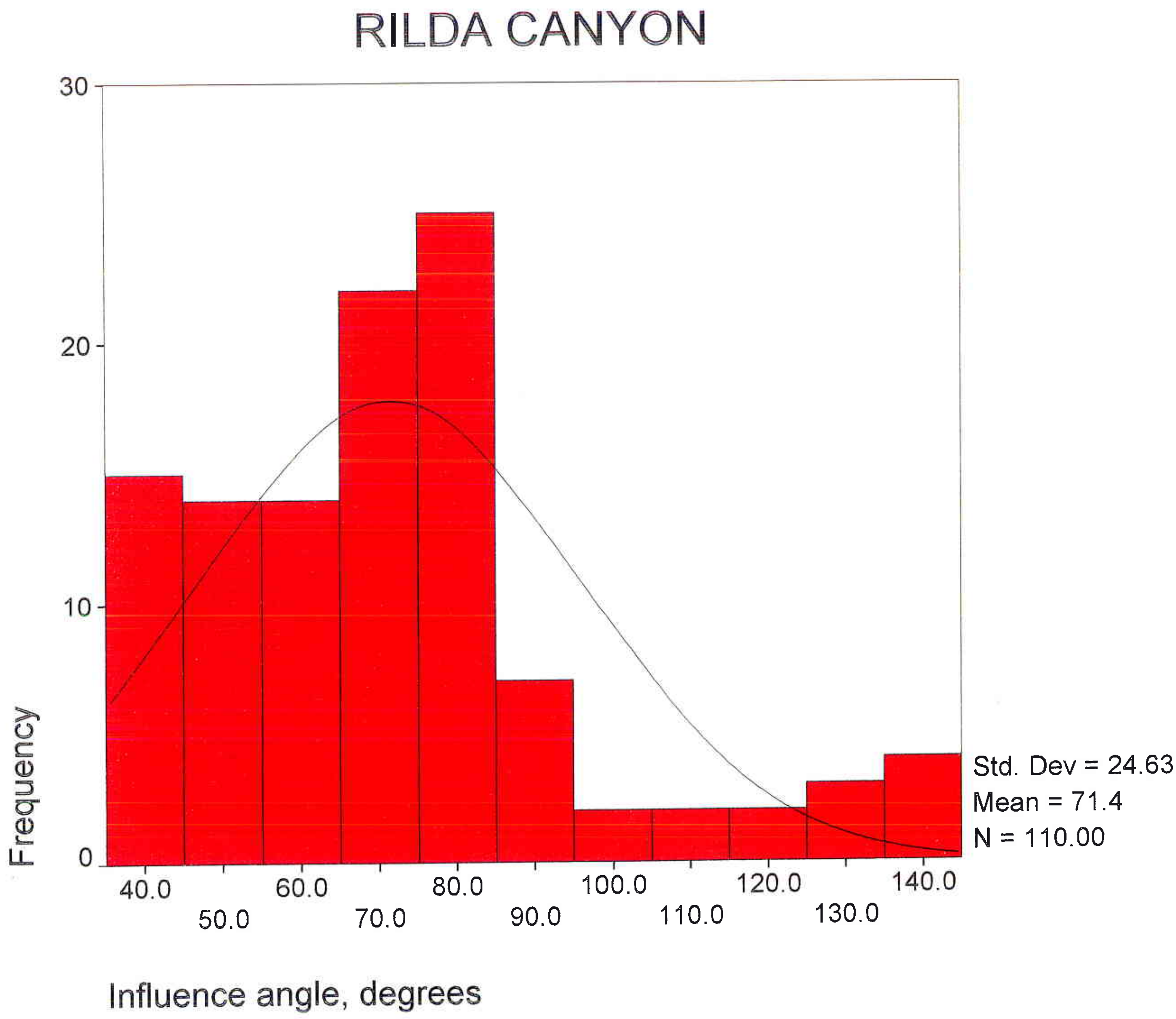


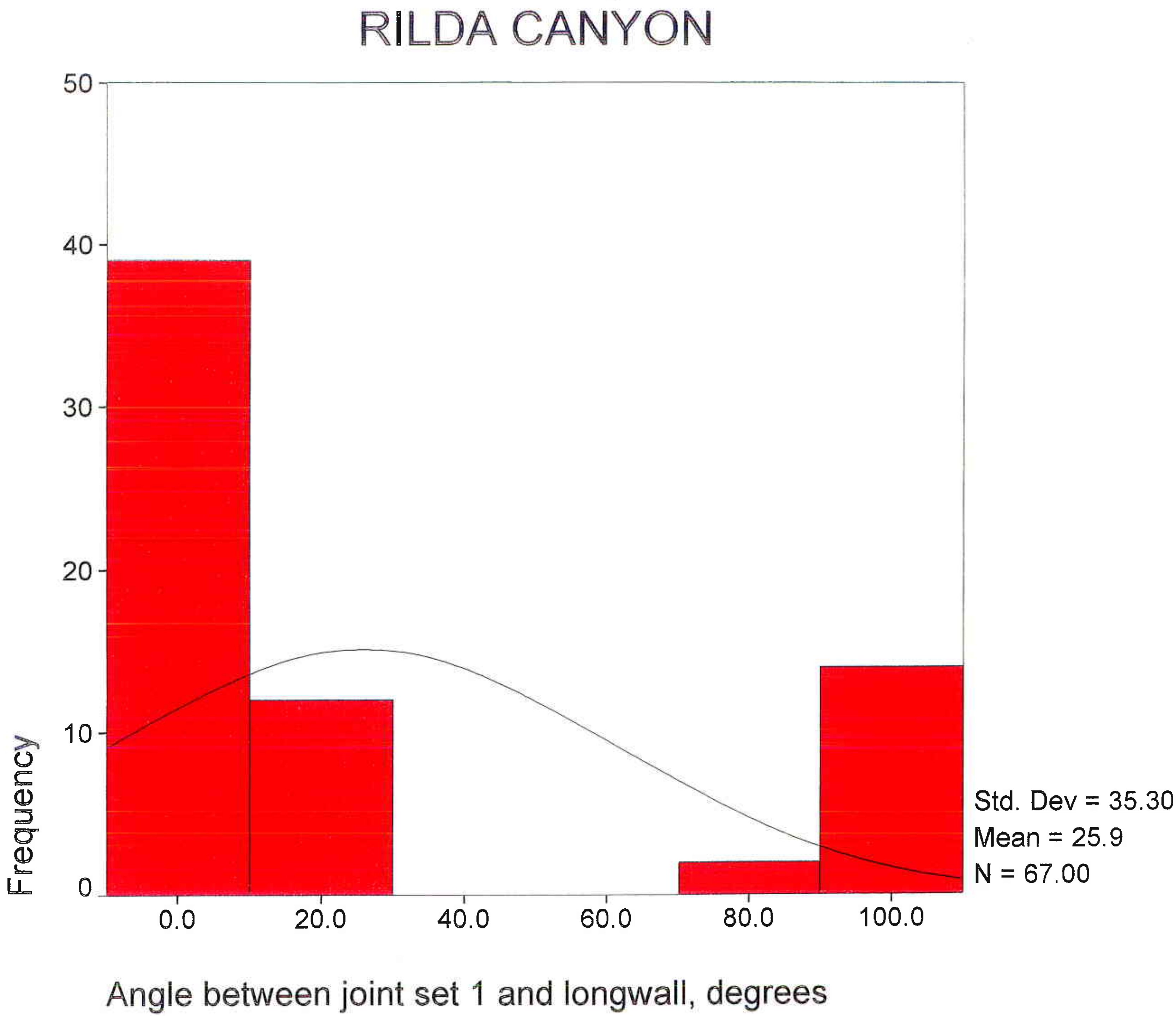
Joint set 1 and longwall index


CORNCOB WASH
30
20
10
0
Frequency
0.0
1.0
2.0
3.0
4.0
Std. Dev = 1.24
Mean = .4
N = 29.00
joint set 2 and longwall index

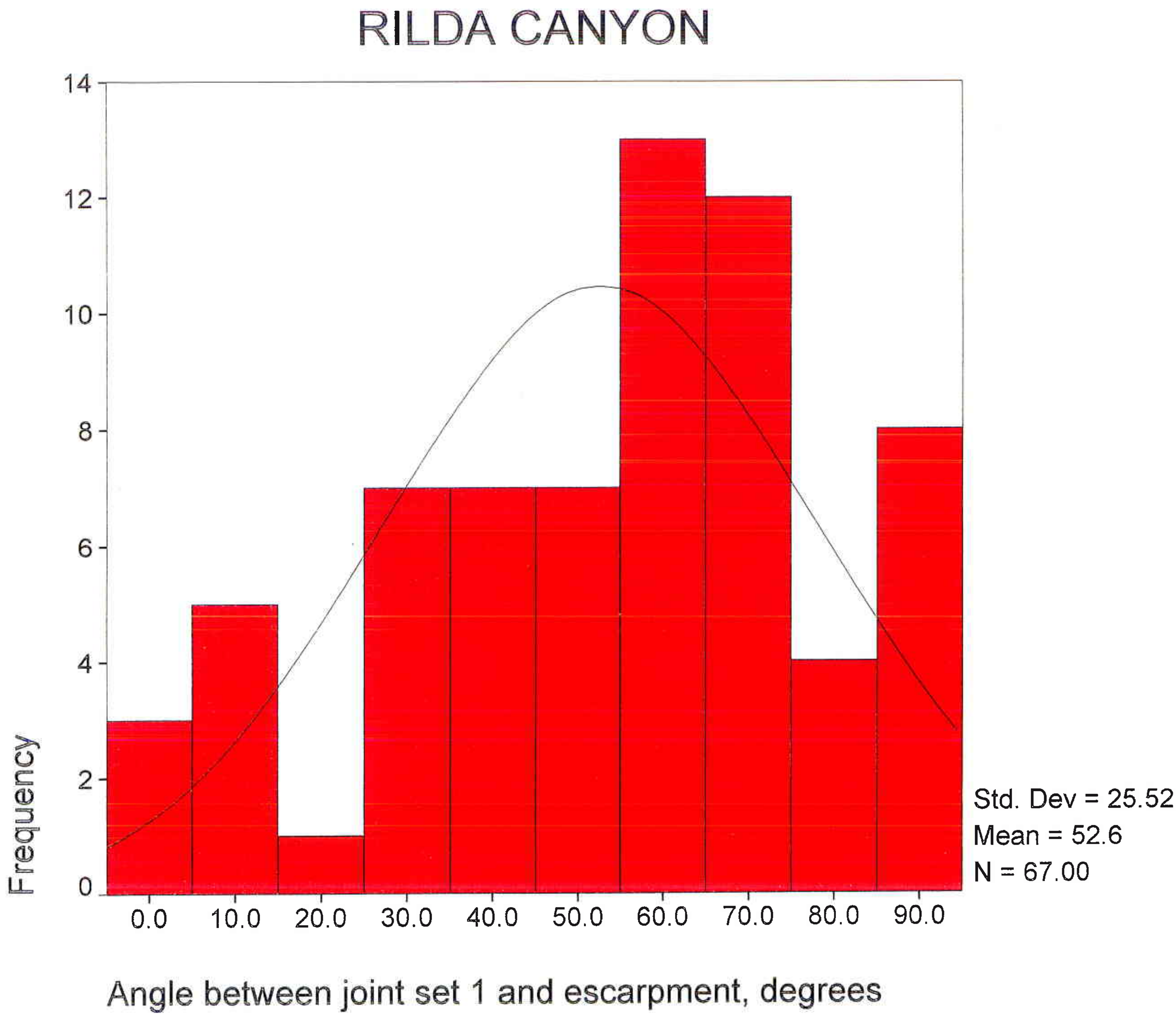

CORNCOB WASH
30
20
10
0
Frequency
0.00
.50
1.00
Escarpment shape index
Std. Dev = .31
Mean = .90
N = 29.00

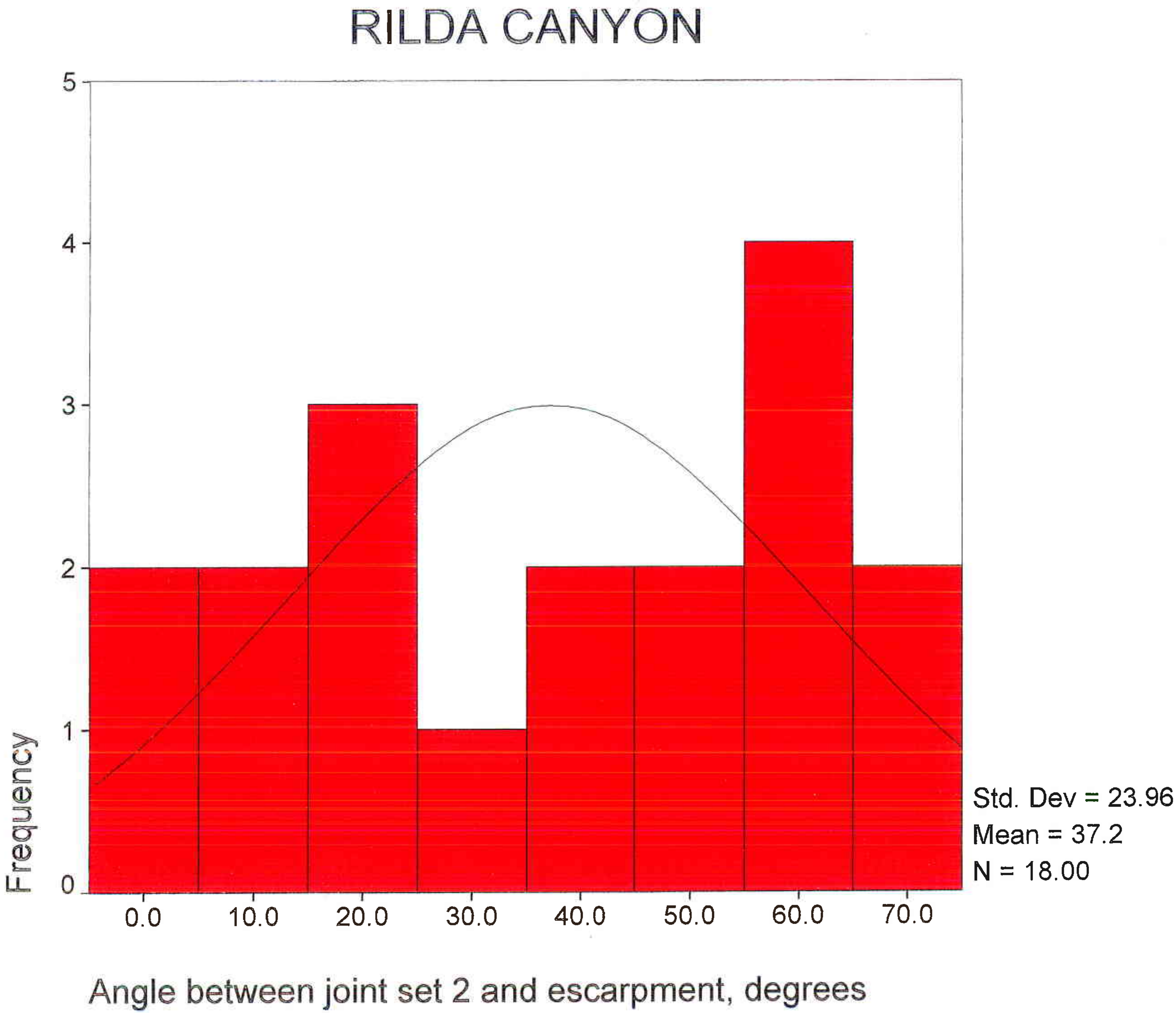

CORNCOB WASH
20
10
0
Frequency
0.00
.50
1.00
1.50
2.00
Failure index
Std. Dev = .82
Mean = 1.38
N = 29.00

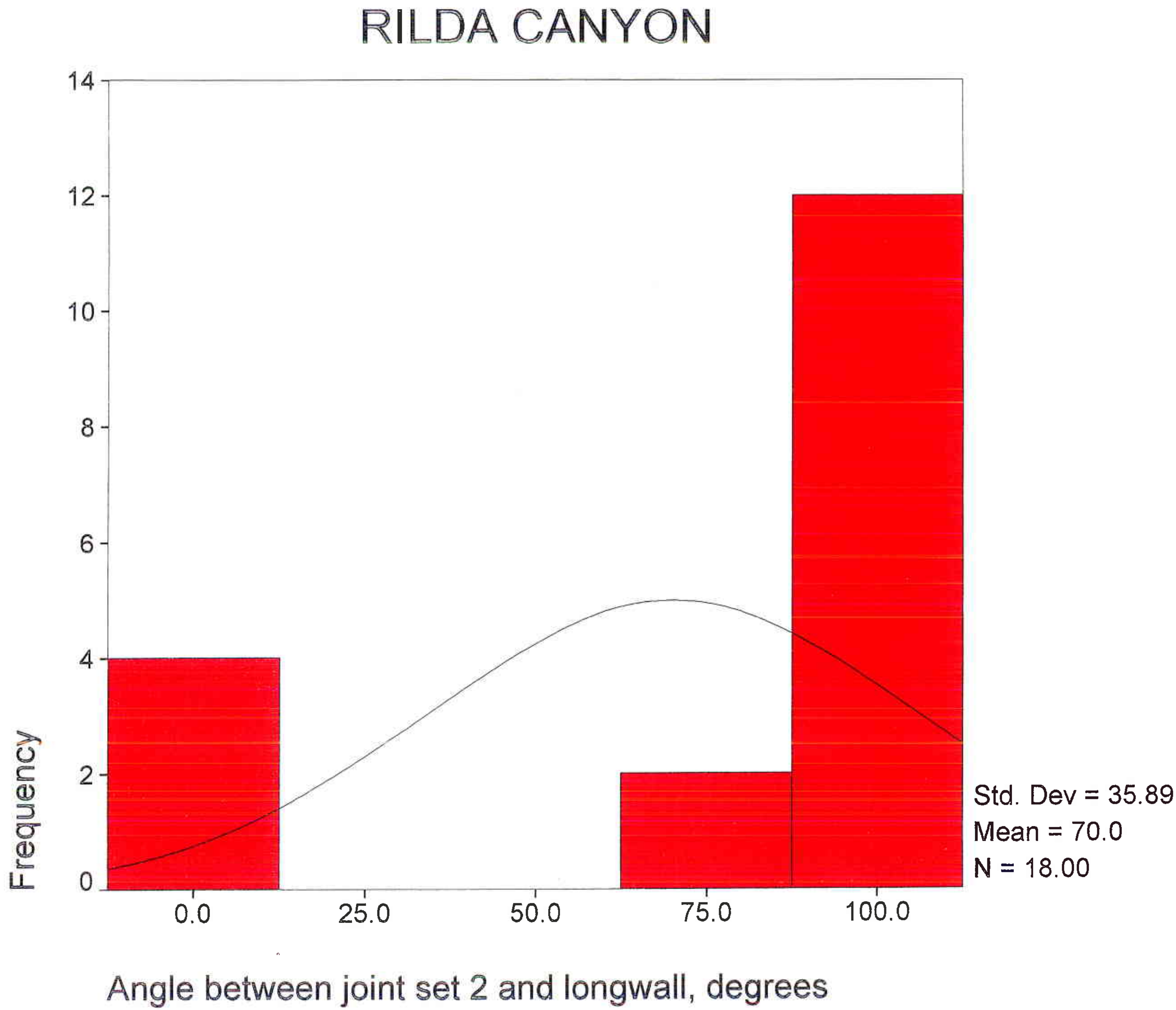

RILDA CANYON
30
20
10
0
Frequency
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0
140.0
Std. Dev = 24.63
Mean = 71.4
N = 110.00
Influence angle, degrees



RILDA CANYON
50
40
30
20
10
0
Frequency
0.0
20.0
40.0
60.0
80.0
100.0
Angle between joint set 1 and longwall, degrees
Std. Dev = 35.30
Mean = 25.9
N = 67.00

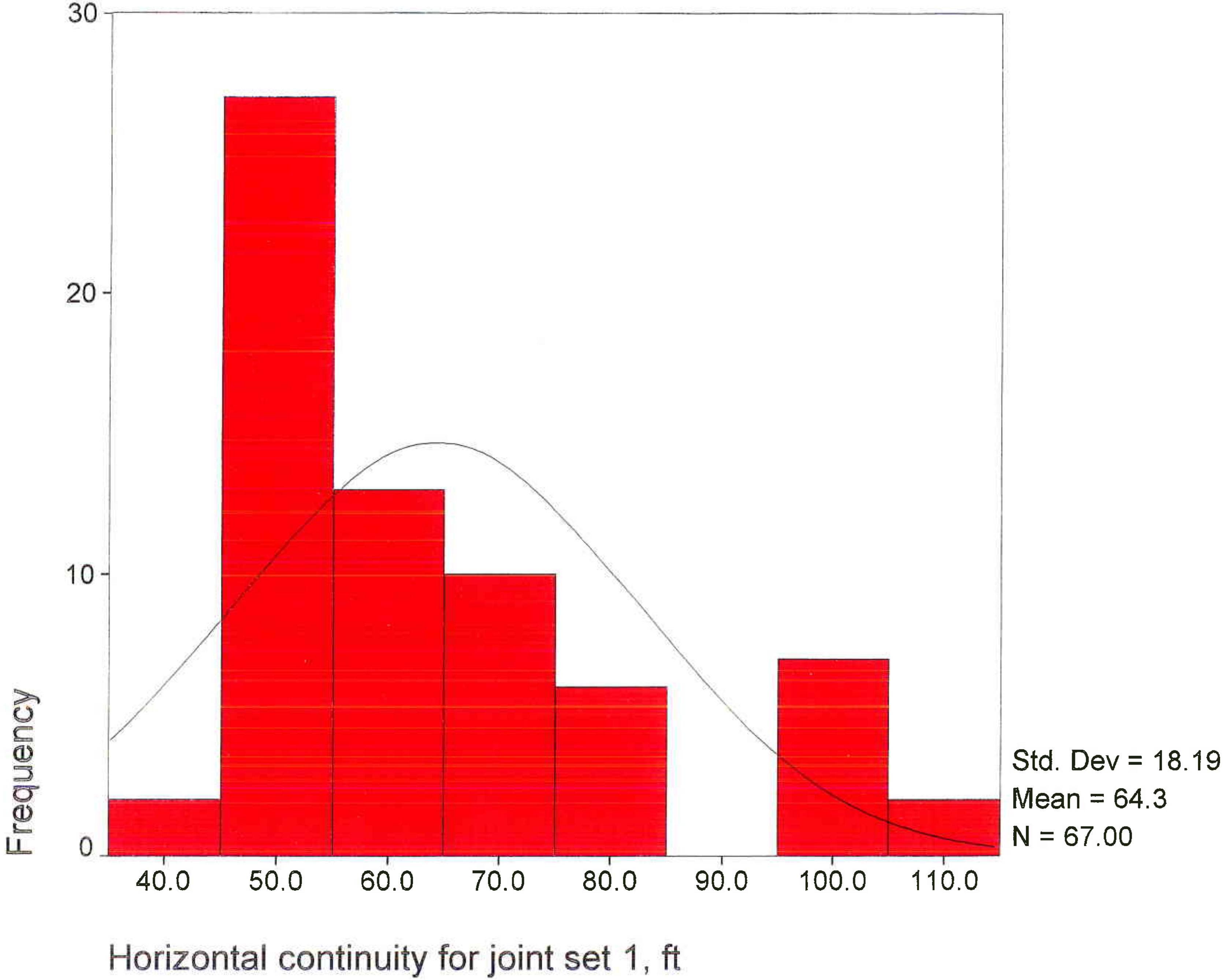

RILDA CANYON
14
12
10
8
6
4
2
0
Frequency
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Std. Dev = 25.52
Mean = 52.6
N = 67.00
Angle between joint set 1 and escarpment, degrees

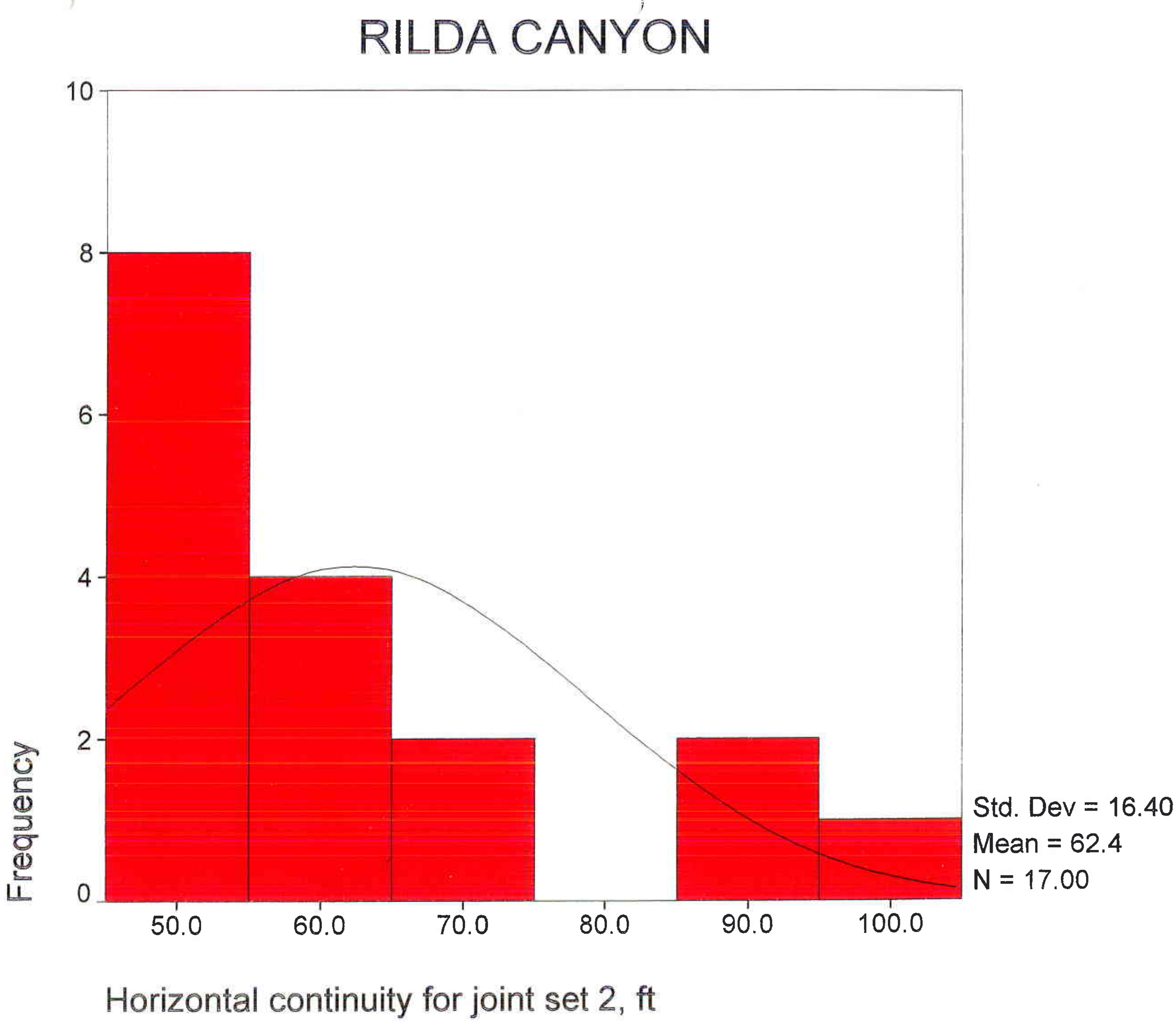

RILDA CANYON
Frequency
0
1
2
3
4
5
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Std. Dev = 23.96
Mean = 37.2
N = 18.00
Angle between joint set 2 and escarpment, degrees



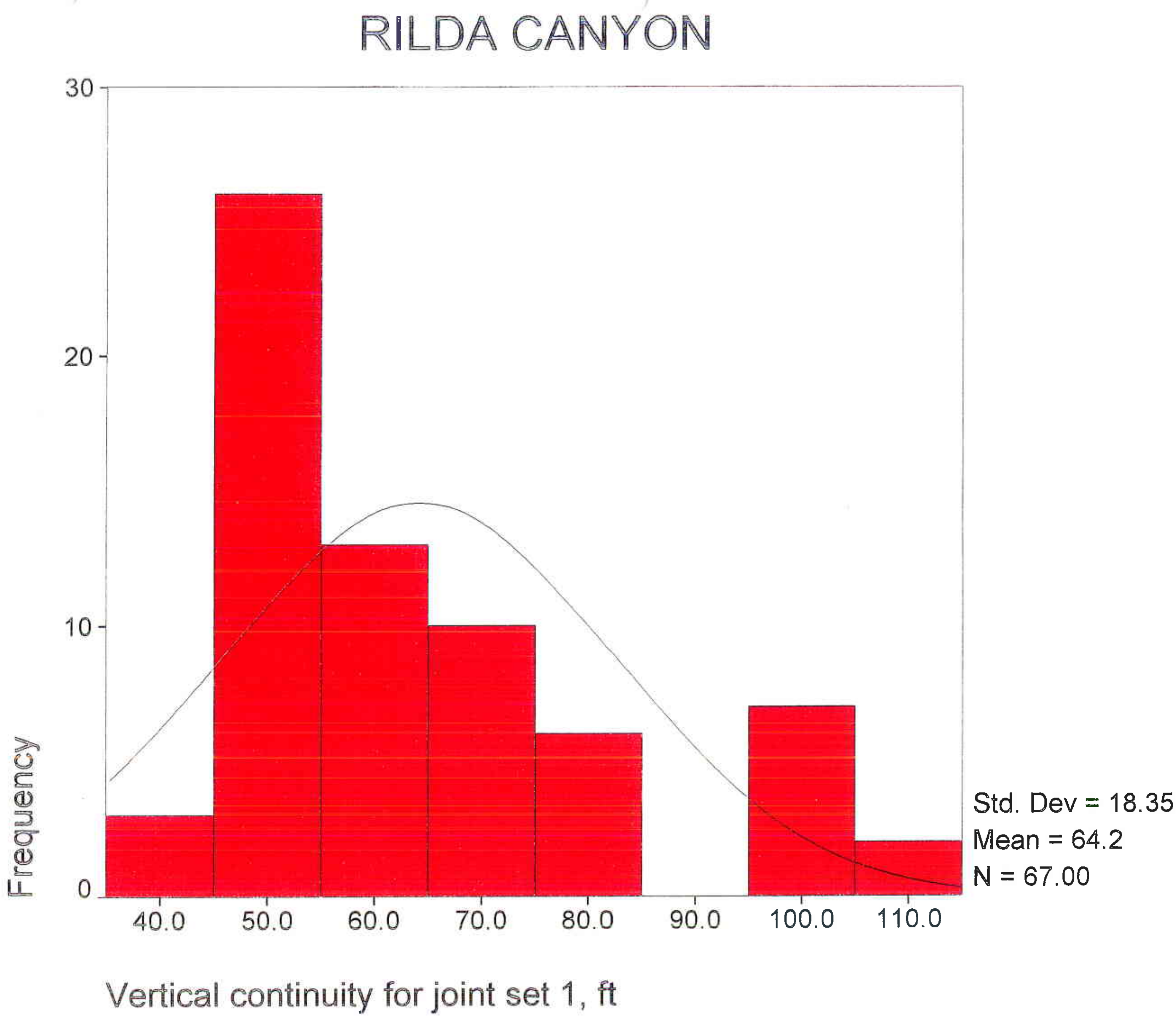
RILDA CANYON
Frequency
14
12
10
8
6
4
2
0
0.0
25.0
50.0
75.0
100.0
Std. Dev = 35.89
Mean = 70.0
N = 18.00
Angle between joint set 2 and longwall, degrees

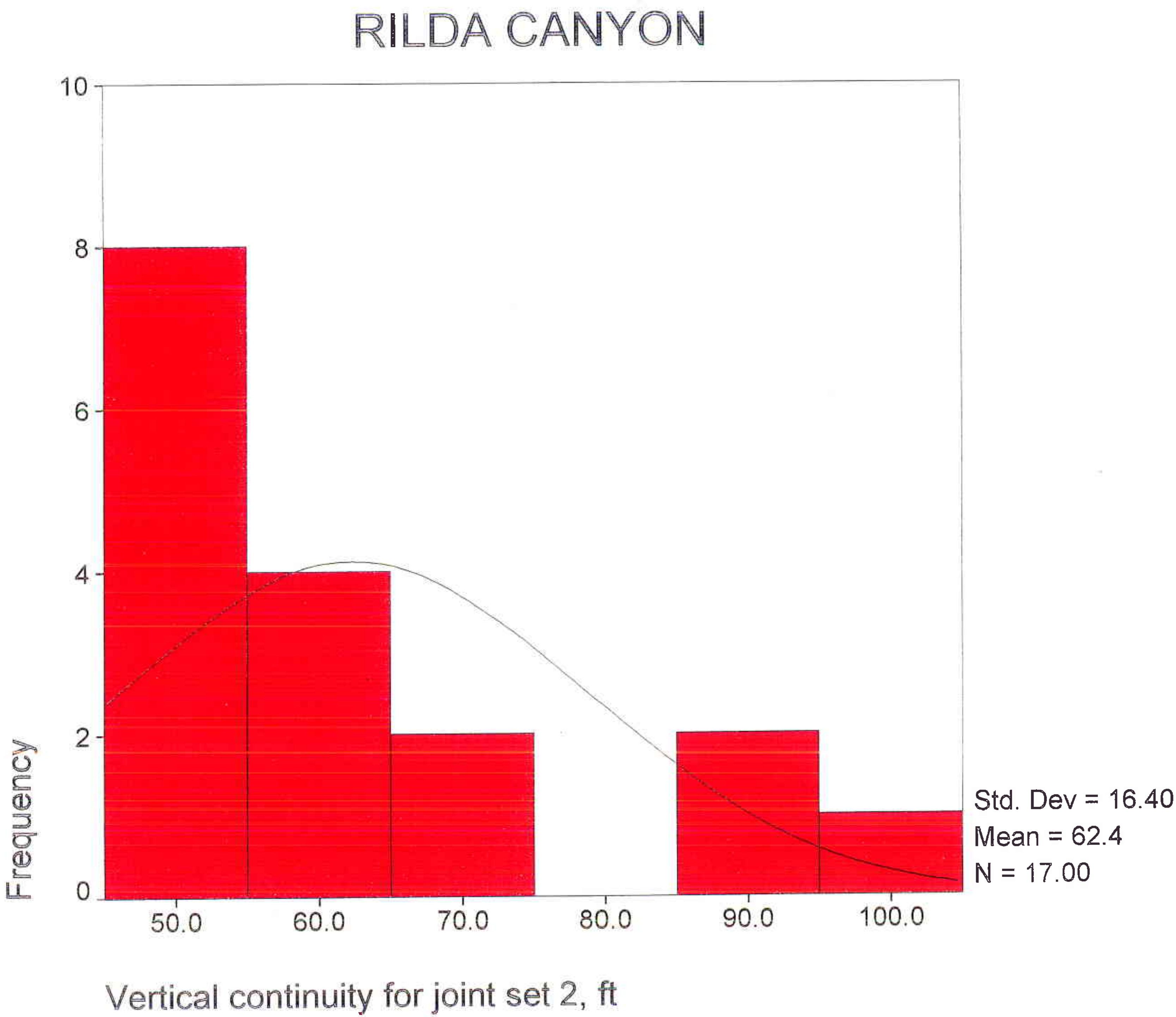
RILDA CANYON

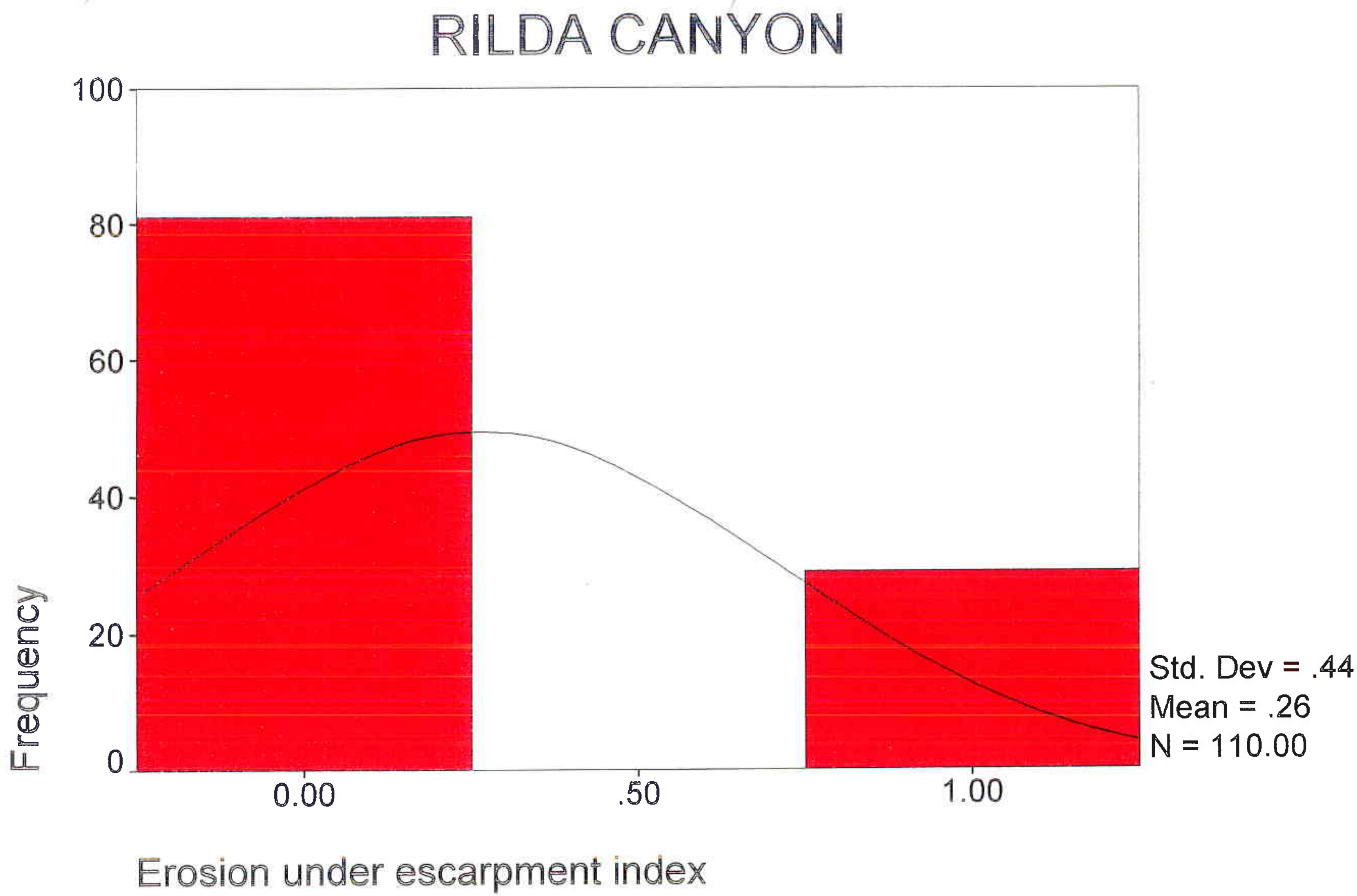




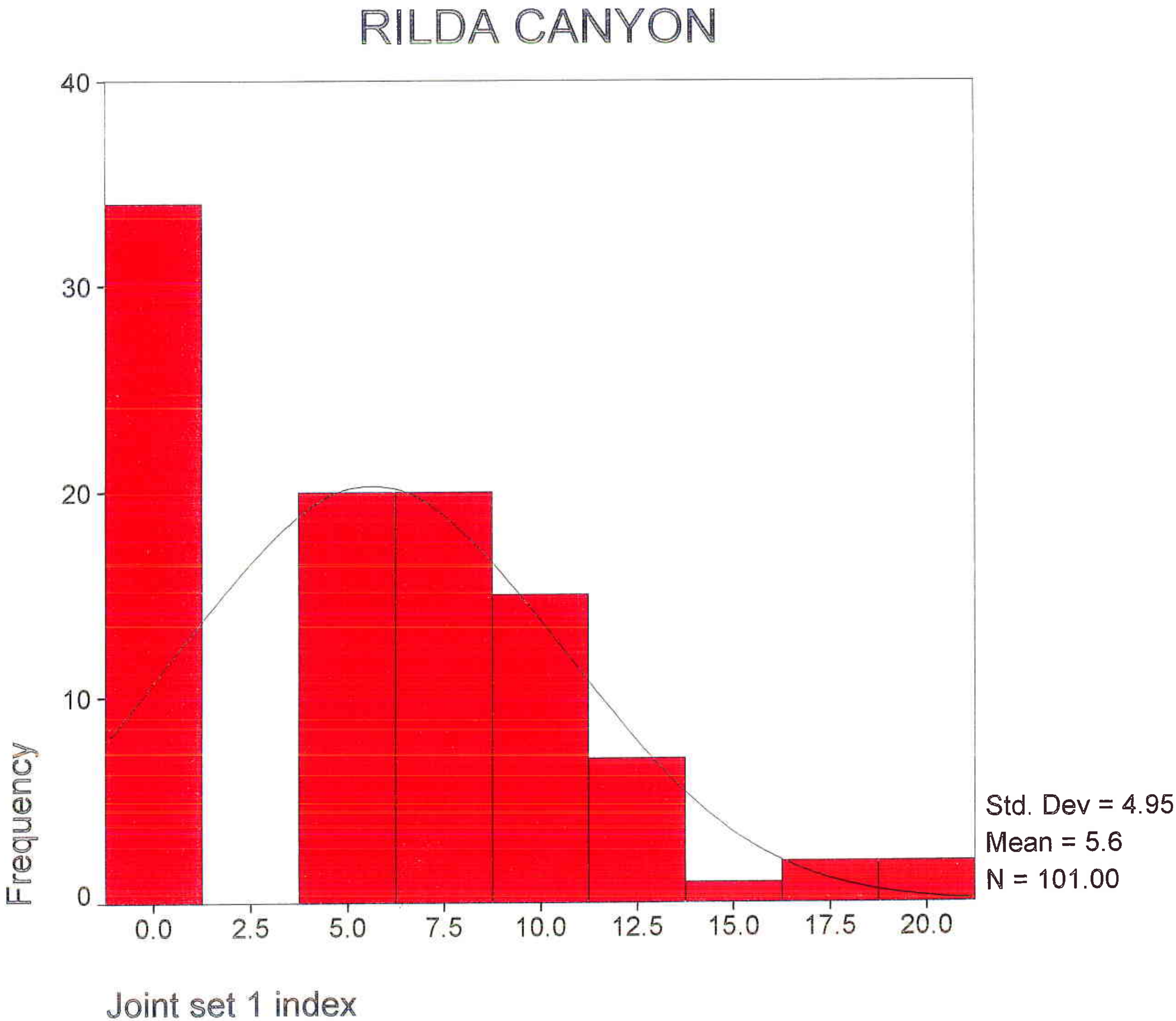
RILDA CANYON
10
8
6
4
2
0
Frequency
50.0
60.0
70.0
80.0
90.0
100.0
Horizontal continuity for joint set 2, ft
Std. Dev = 16.40
Mean = 62.4
N = 17.00

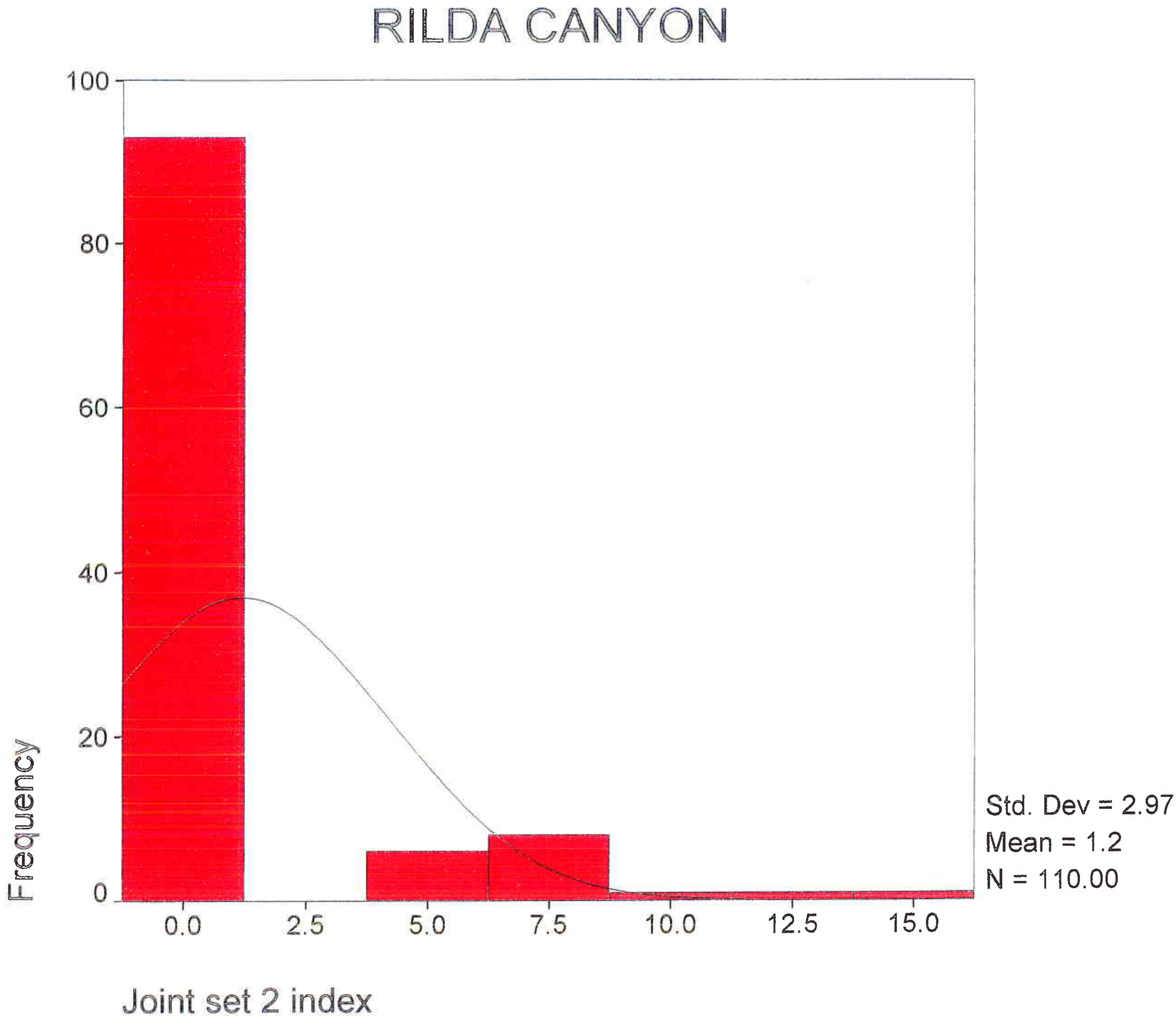

RILDA CANYON
30
20
10
0
Frequency
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
Std. Dev = 18.35
Mean = 64.2
N = 67.00
Vertical continuity for joint set 1, ft


RILDA CANYON
10
8
6
4
2
0
Frequency
50.0
60.0
70.0
80.0
90.0
100.0
Std. Dev = 16.40
Mean = 62.4
N = 17.00
Vertical continuity for joint set 2, ft

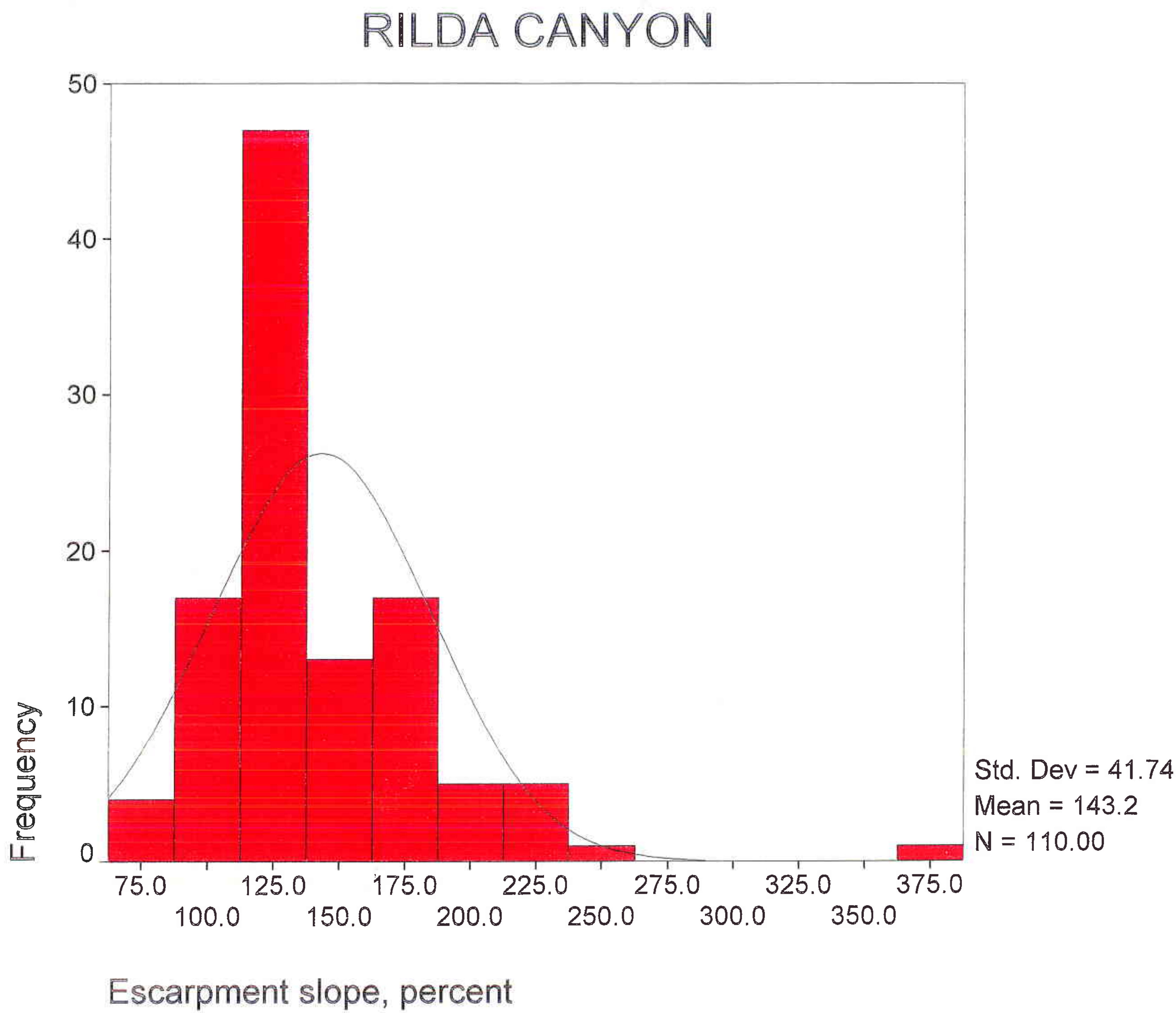


RILDA CANYON
100
80
60
40
20
0
Frequency
0.00
.50
1.00
Erosion under escarpment index
Std. Dev = .44
Mean = .26
N = 110.00

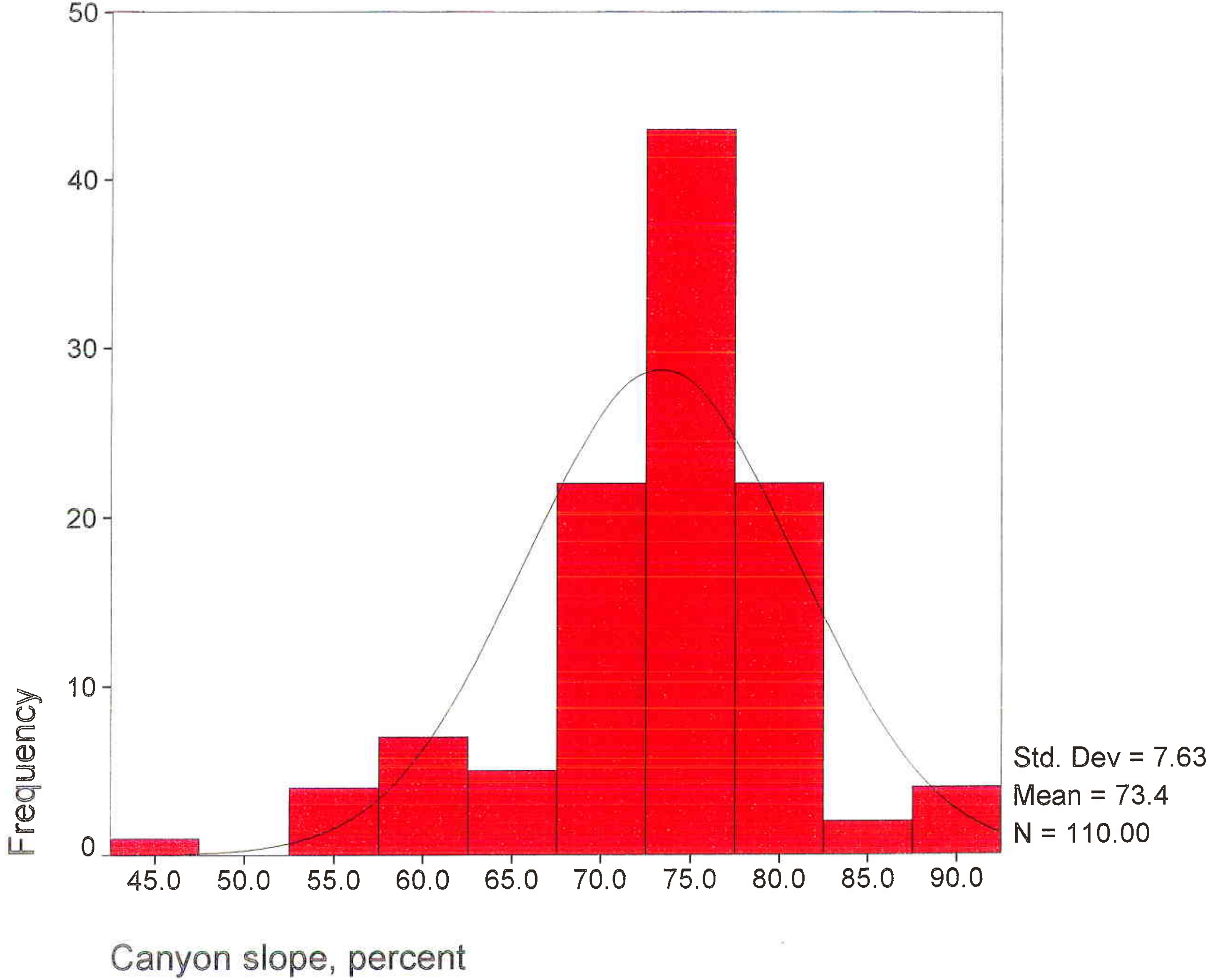

RILDA CANYON
40
30
20
10
0
Frequency
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Joint set 1 index
Std. Dev = 4.95
Mean = 5.6
N = 101.00

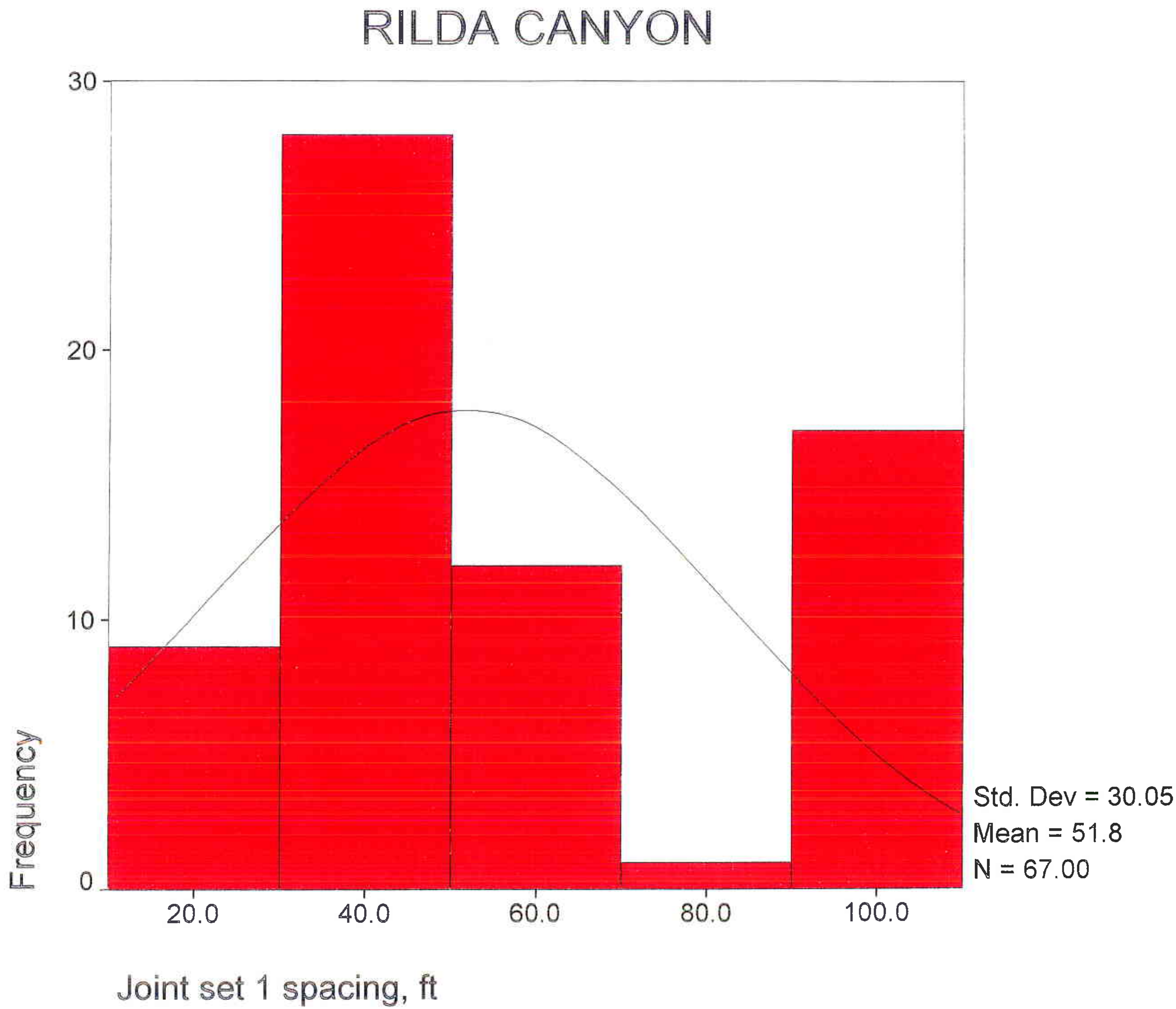


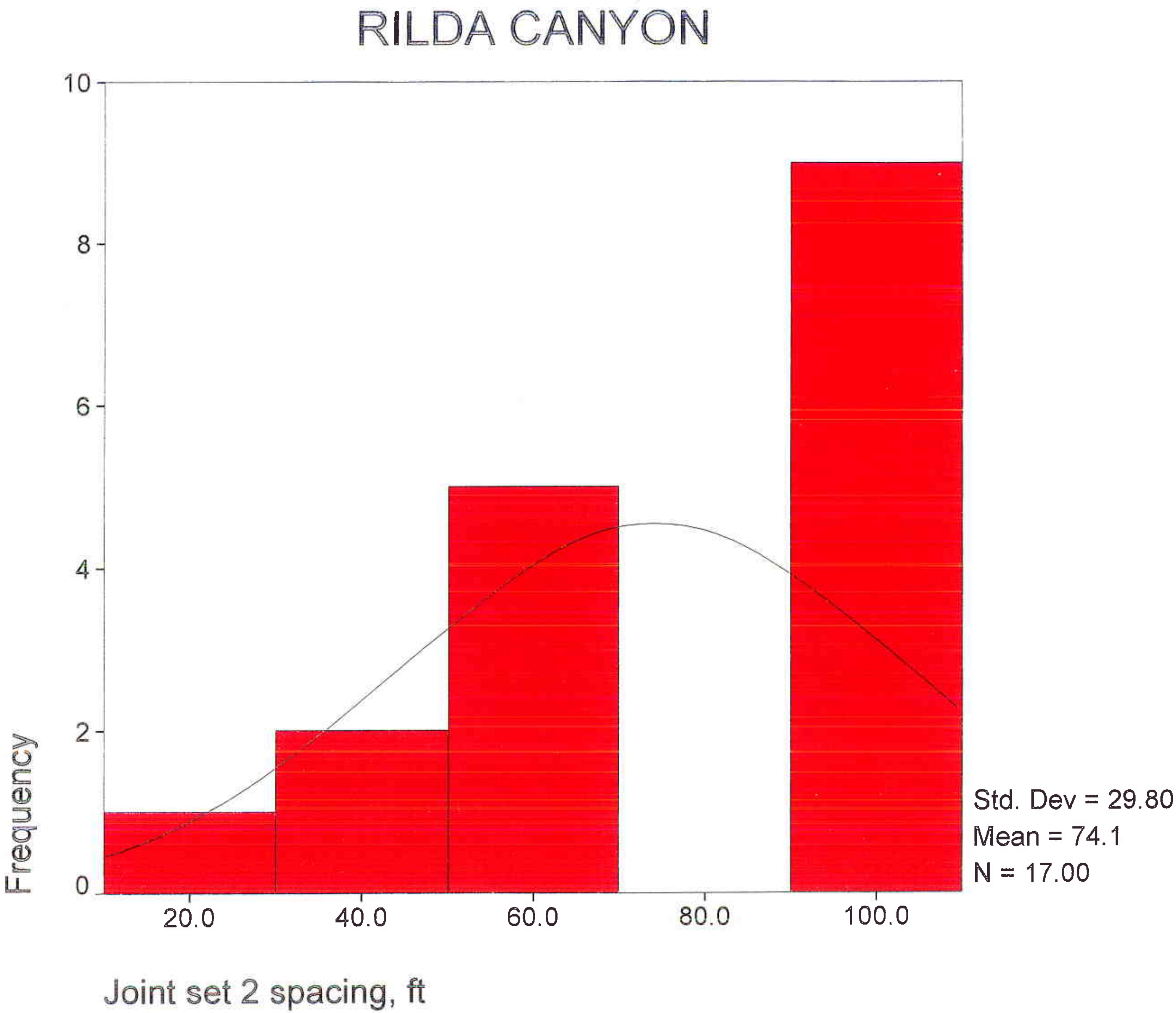
RILDA CANYON
100
80
60
40
20
0
Frequency
0.0
2.5
5.0
7.5
10.0
12.5
15.0
Std. Dev = 2.97
Mean = 1.2
N = 110.00
Joint set 2 index

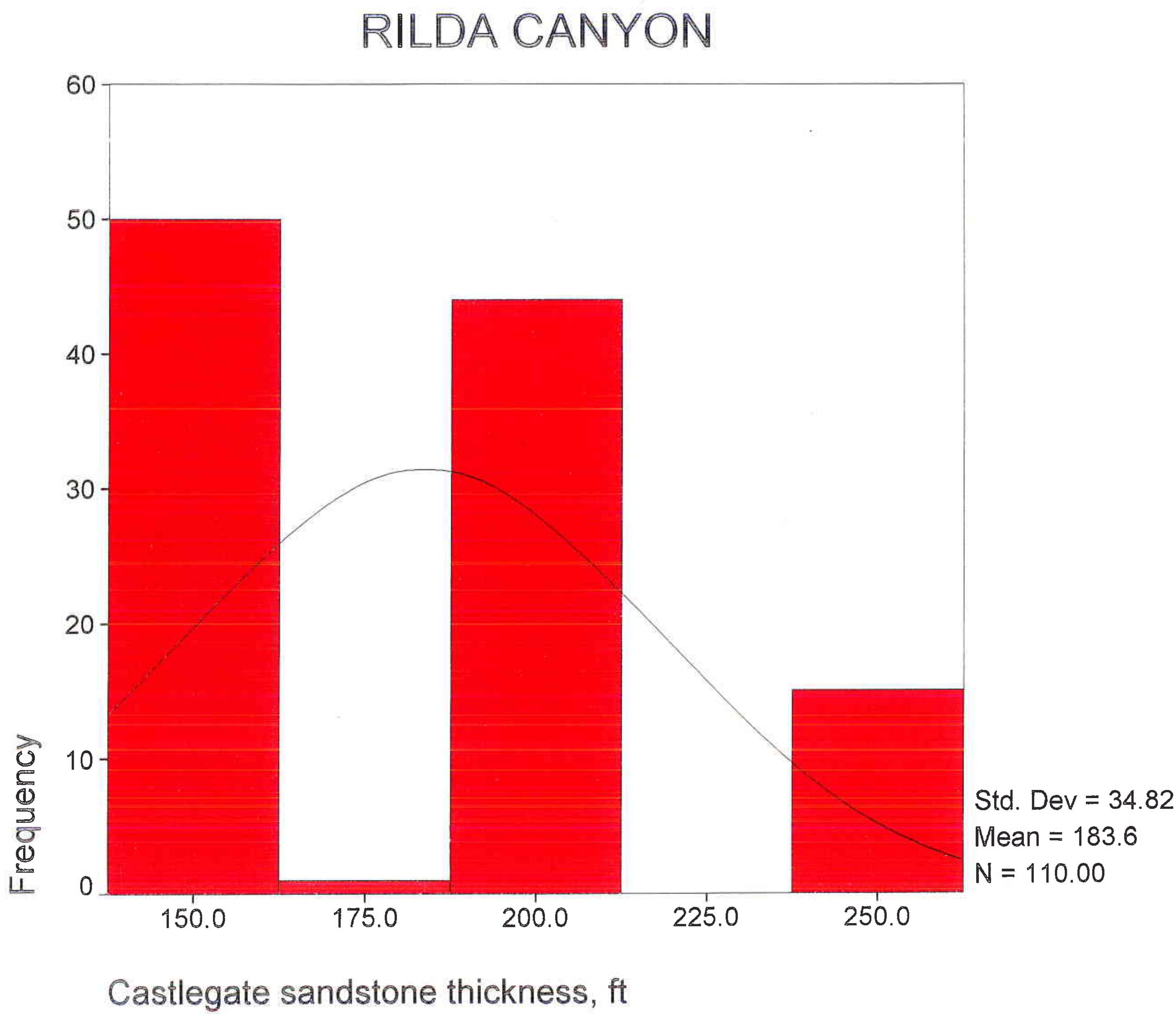

RILDA CANYON
50
40
30
20
10
0
Frequency
75.0
100.0
125.0
150.0
175.0
200.0
225.0
250.0
275.0
300.0
325.0
350.0
375.0
Escarpment slope, percent
Std. Dev = 41.74
Mean = 143.2
N = 110.00

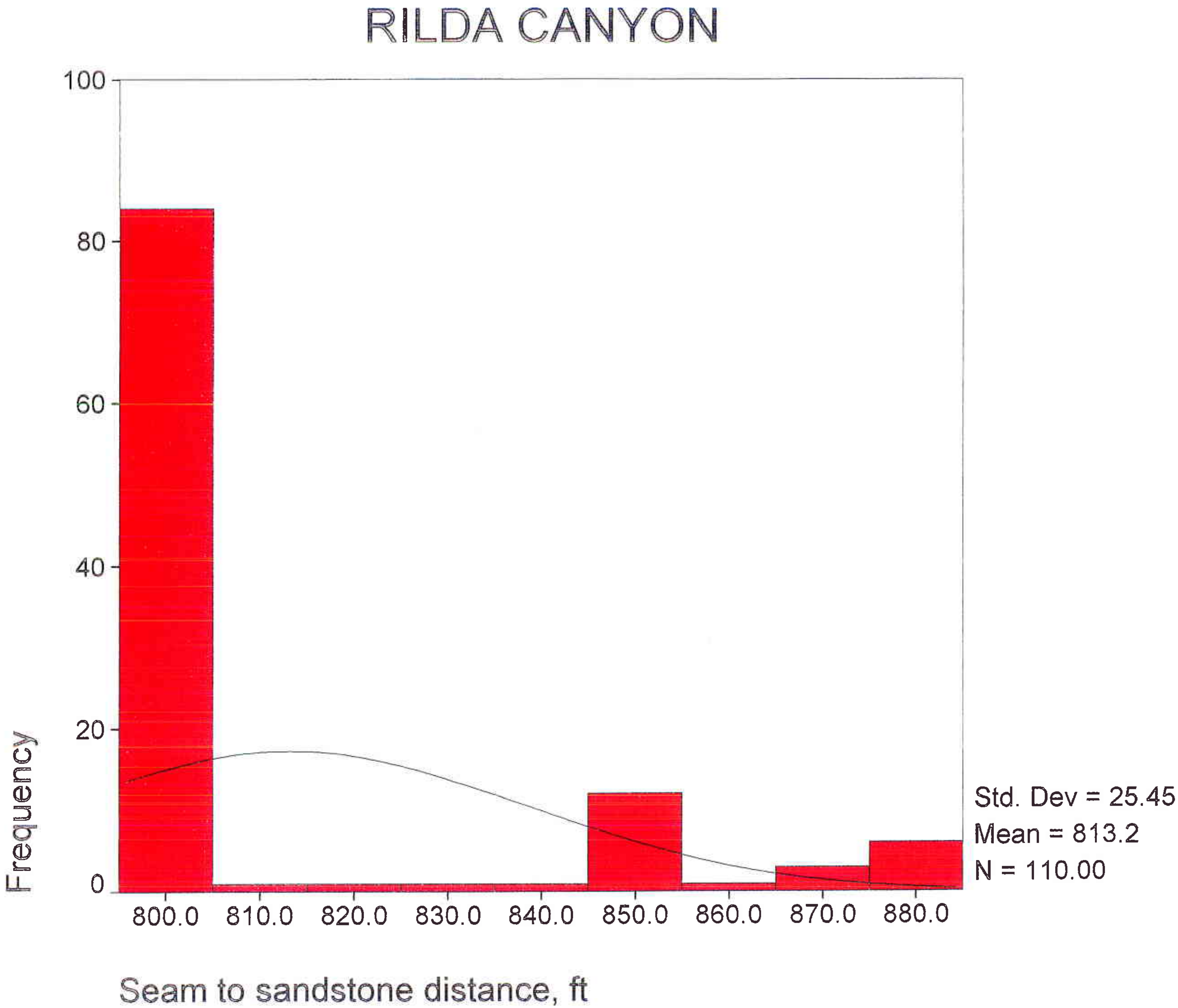
RILDA CANYON



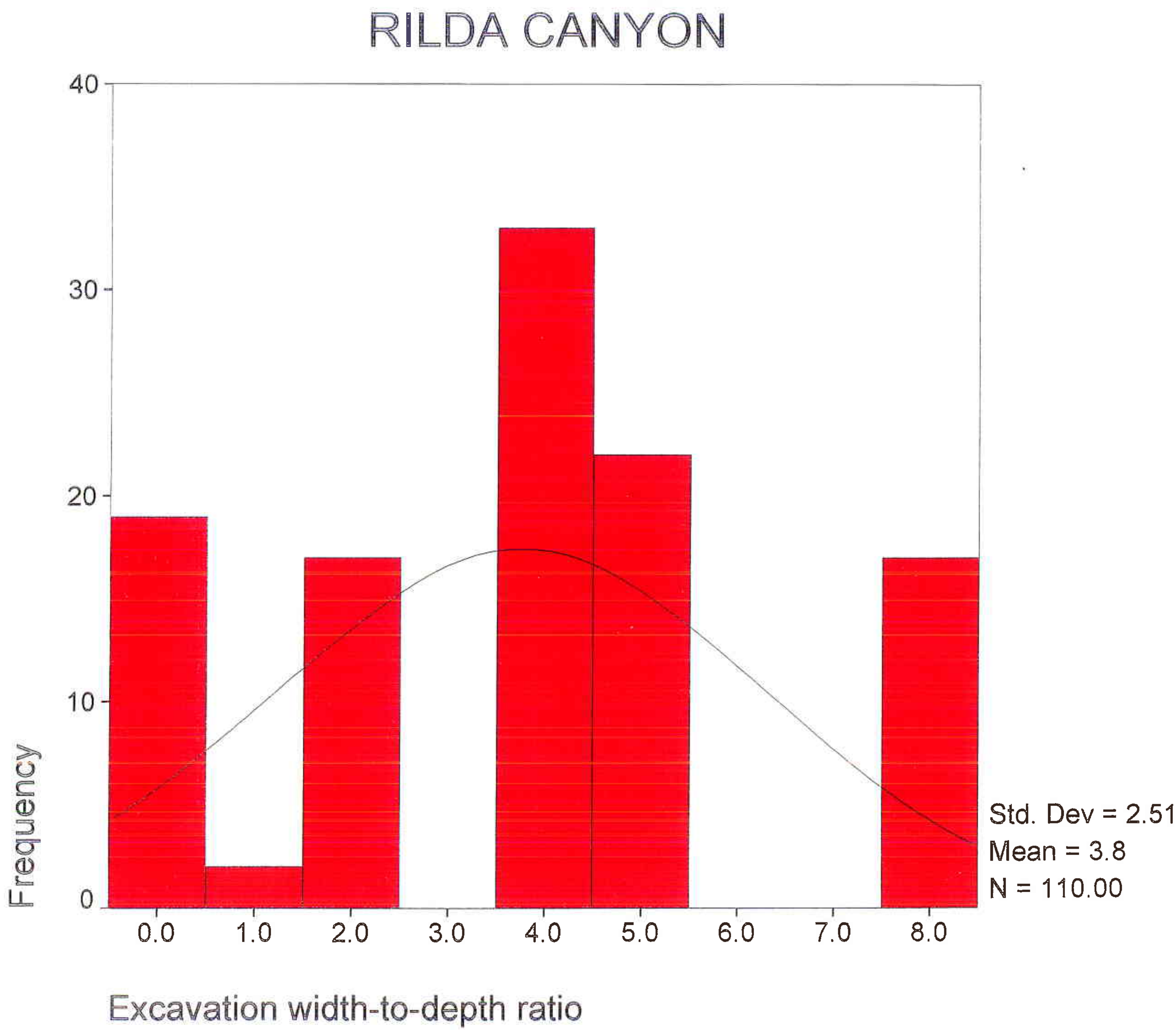

RILDA CANYON
30
20
10
0
Frequency
20.0
40.0
60.0
80.0
100.0
Joint set 1 spacing, ft
Std. Dev = 30.05
Mean = 51.8
N = 67.00

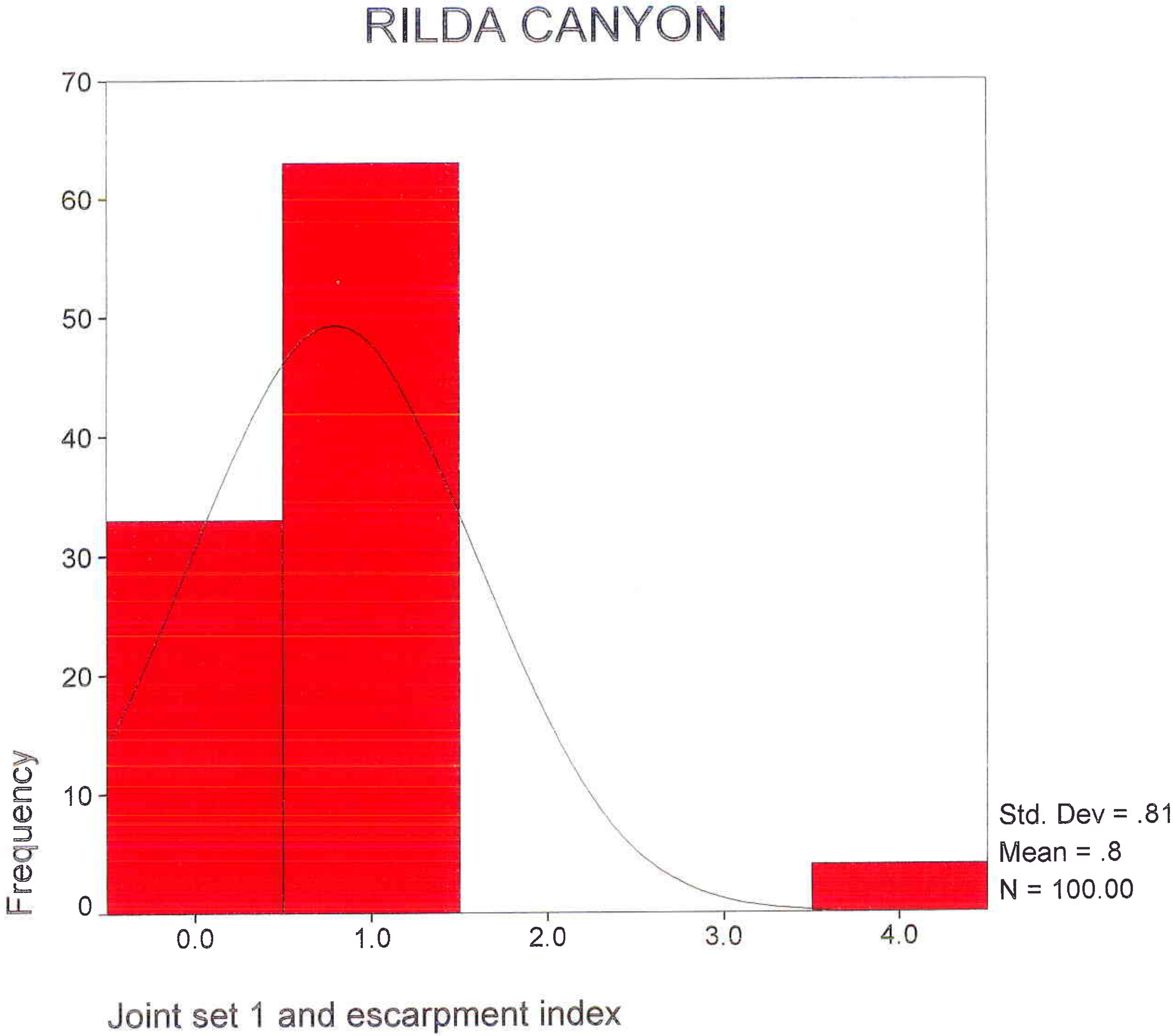

RILDA CANYON
10
8
6
4
2
0
Frequency
20.0
40.0
60.0
80.0
100.0
Joint set 2 spacing, ft
Std. Dev = 29.80
Mean = 74.1
N = 17.00

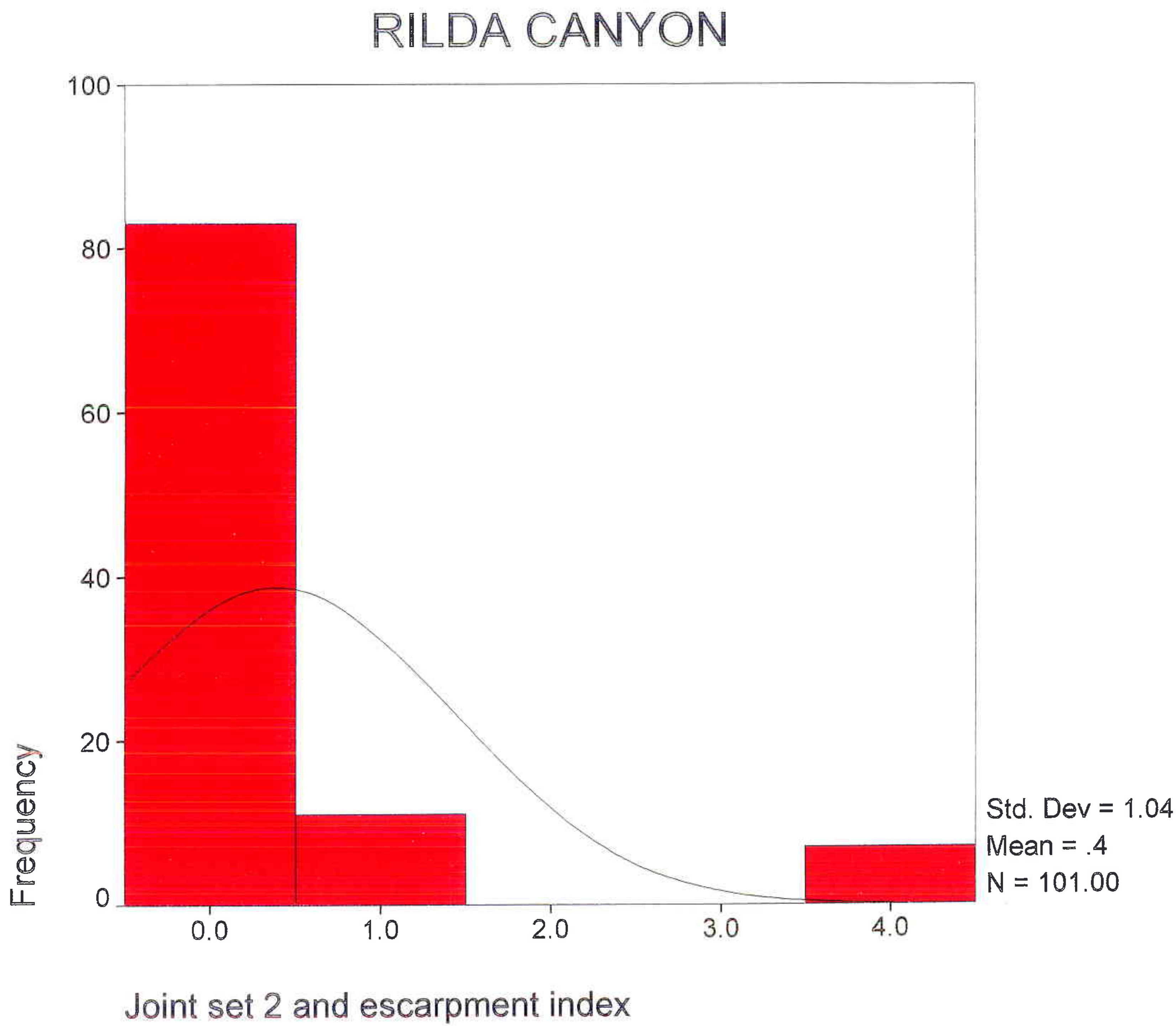

RILDA CANYON
60
50
40
30
20
10
0
Frequency
150.0
175.0
200.0
225.0
250.0
Castlegate sandstone thickness, ft
Std. Dev = 34.82
Mean = 183.6
N = 110.00

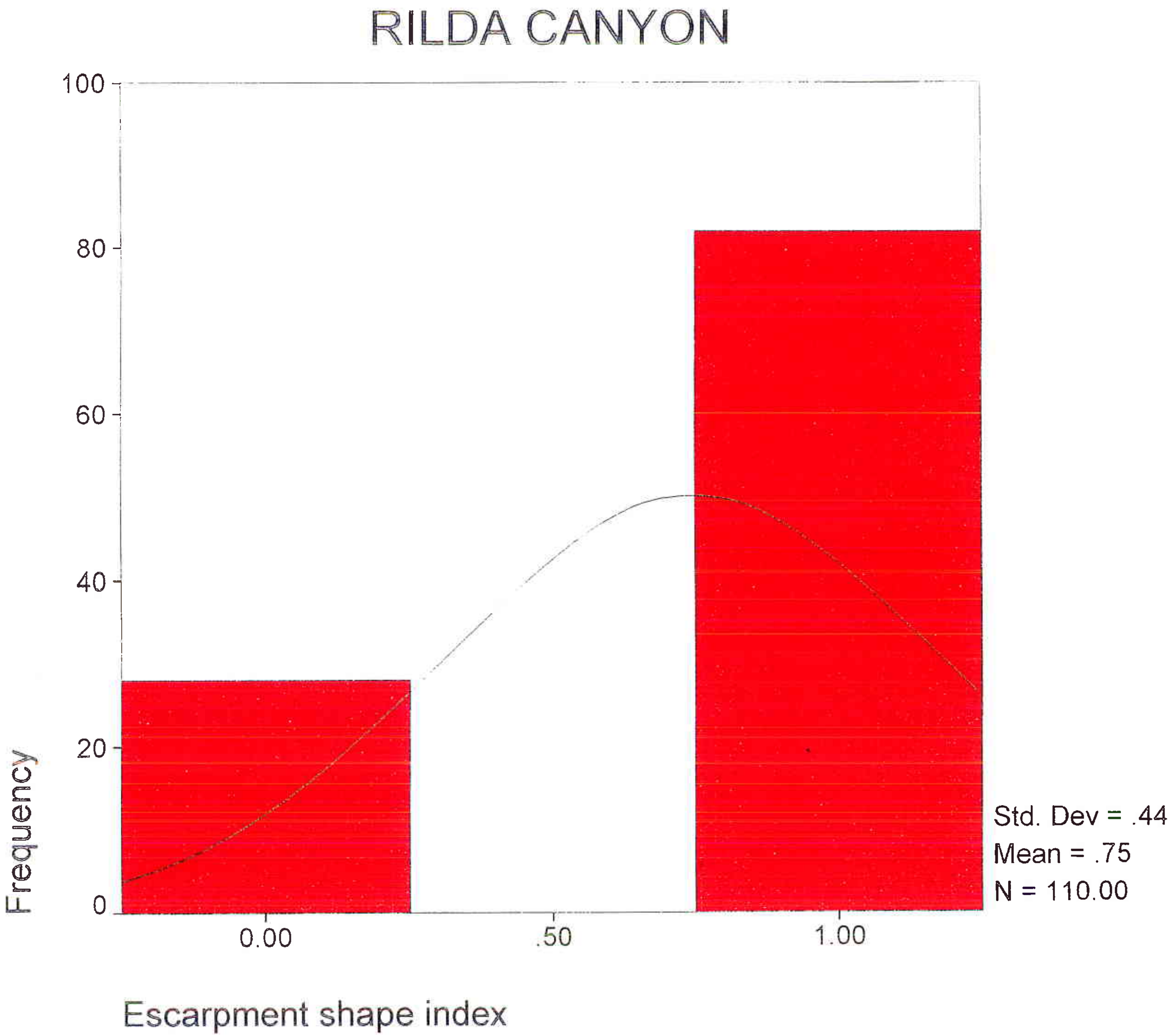


RILDA CANYON
100
80
60
40
20
0
Frequency
800.0
810.0
820.0
830.0
840.0
850.0
860.0
870.0
880.0
Seam to sandstone distance, ft
Std. Dev = 25.45
Mean = 813.2
N = 110.00


RILDA CANYON
40
30
20
10
0
Frequency
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Std. Dev = 2.51
Mean = 3.8
N = 110.00
Excavation width-to-depth ratio


RILDA CANYON
70
60
50
40
30
20
10
0
Frequency
0.0
1.0
2.0
3.0
4.0
Std. Dev = .81
Mean = .8
N = 100.00
Joint set 1 and escarpment index


RILDA CANYON
100
80
60
40
20
0
Frequency
0.0
1.0
2.0
3.0
4.0
Std. Dev = 1.04
Mean = .4
N = 101.00
Joint set 2 and escarpment index


RILDA CANYON
100
80
60
40
20
0
Frequency
0.00
.50
1.00
Escarpment shape index
Std. Dev = .44
Mean = .75
N = 110.00

ATTACHMENT B

Test Results Concerning Equality of Population Means

t-tests for Independent Samples of GROUP

Variable	Number of Cases	Mean	SD	SE of Mean
ANGLEINF				
GROUP corn	29	69.3793	13.297	2.469
GROUP rild	110	71.4091	24.631	2.348

Mean Difference = -2.0298

Levene's Test for Equality of Variances: F= 4.477 P= .036

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	-.43	137	.670	4.755	(-11.432, 7.372)
Unequal	-.60	83.93	.553	3.408	(-8.806, 4.747)

Variable	Number of Cases	Mean	SD	SE of Mean
EROSION				
GROUP corn	29	.1034	.310	.058
GROUP rild	110	.2636	.443	.042

Mean Difference = -.1602

Levene's Test for Equality of Variances: F= 19.999 P= .000

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	-1.83	137	.069	.087	(-.333, .013)
Unequal	-2.24	61.63	.028	.071	(-.303, -.018)

t-tests for Independent Samples of GROUP

Variable	Number of Cases	Mean	SD	SE of Mean
INDEXJS1				
GROUP corn	26	3.8735	5.218	1.023
GROUP rild	101	5.6320	4.951	.493

Mean Difference = -1.7585

Levene's Test for Equality of Variances: F= .341 P= .560

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	-1.60	125	.113	1.101	(-3.937, .420)
Unequal	-1.55	37.43	.130	1.136	(-4.059, .542)

Variable	Number of Cases	Mean	SD	SE of Mean
INDEXJS2				
GROUP corn	29	.9128	2.608	.484
GROUP rild	110	1.1887	2.967	.283

Mean Difference = -.2760

Levene's Test for Equality of Variances: F= .945 P= .333

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	-.46	137	.649	.605	(-1.472, .920)
Unequal	-.49	48.91	.625	.561	(-1.403, .851)

t-tests for Independent Samples of GROUP

Variable	Number of Cases	Mean	SD	SE of Mean
SHAPE				
GROUP corn	29	.8966	.310	.058
GROUP rild	110	.7455	.438	.042

Mean Difference = .1511

Levene's Test for Equality of Variances: F= 17.606 P= .000

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	1.75	137	.083	.087	(-.020, .322)
Unequal	2.13	60.85	.038	.071	(.009, .293)

Variable	Number of Cases	Mean	SD	SE of Mean
SLOPCAN				
GROUP corn	29	80.0000	8.984	1.668
GROUP rild	110	73.3545	7.633	.728

Mean Difference = 6.6455

Levene's Test for Equality of Variances: F= 2.727 P= .101

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	4.02	137	.000	1.655	(3.373, 9.918)
Unequal	3.65	39.31	.001	1.820	(2.965, 10.326)

t-tests for Independent Samples of GROUP

Variable	Number of Cases	Mean	SD	SE of Mean
SLOPESC				
GROUP corn	29	217.9655	45.882	8.520
GROUP rild	110	143.1727	41.737	3.979

Mean Difference = 74.7928

Levene's Test for Equality of Variances: F= 2.394 P= .124

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	8.41	137	.000	8.896	(57.201, 92.384)
Unequal	7.95	41.05	.000	9.404	(55.802, 93.783)

Variable	Number of Cases	Mean	SD	SE of Mean
THICKSS				
GROUP corn	29	250.0000	21.712	4.032
GROUP rild	110	183.6364	34.819	3.320

Mean Difference = 66.3636

Levene's Test for Equality of Variances: F= 24.180 P= .000

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	9.76	137	.000	6.799	(52.919, 79.808)
Unequal	12.71	70.51	.000	5.223	(55.948, 76.779)

t-tests for Independent Samples of GROUP

Variable	Number of Cases	Mean	SD	SE of Mean
TOEDIST				
GROUP corn	29	781.7241	18.238	3.387
GROUP rild	110	813.1818	25.448	2.426

Mean Difference = -31.4577

Levene's Test for Equality of Variances: F= 5.027 P= .027

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	-6.24	137	.000	5.041	(-41.426, -21.489)
Unequal	-7.55	60.05	.000	4.166	(-39.791, -23.124)

Variable	Number of Cases	Mean	SD	SE of Mean
WDEPTH				
GROUP corn	29	2.5352	.557	.103
GROUP rild	110	3.7565	2.514	.240

Mean Difference = -1.2213

Levene's Test for Equality of Variances: F= 28.902 P= .000

t-test for Equality of Means

Variances	t-value	df	2-Tail Sig	SE of Diff	95% CI for Diff
Equal	-2.59	137	.011	.471	(-2.153, -.290)
Unequal	-4.68	135.11	.000	.261	(-1.738, -.705)

ATTACHMENT C

Bivariate and Multiple Regression Results

- - Correlation Coefficients - -

	ANGLEINF	ANGLJS1E	ANGLJS1F	ANGLJS2E	ANGLJS2F	CONTHJS1
FAILV	-.4849	.0801	-.6002	.7071	.3455	.0300
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .008	P= .804	P= .039	P= .293	P= .654	P= .926
INDEXJS1	.0898	-.3623	.4693	-.3253	-.2467	.6754
	(26)	(12)	(12)	(4)	(4)	(12)
	P= .663	P= .247	P= .124	P= .675	P= .753	P= .016
INDEXJS2	.0971	.0800	.1028	-.8615	-.9820	-.1070
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .616	P= .805	P= .750	P= .139	P= .018	P= .741
INDJS1E	-.0961	-.8607	.4131	.4444	.3665	.4502
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .620	P= .000	P= .182	P= .556	P= .633	P= .142
INJS1LW	.0503	.0000	.4225	-.8889	-.8552	.0302
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .796	P=1.000	P= .171	P= .111	P= .145	P= .926
INJS2E	.1068	.2370	-.0122	-.8340	-.4937	-.2299
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .582	P= .458	P= .970	P= .166	P= .506	P= .472
INJS2LW	.1284	.1267	.0398	-.7057	-.9169	-.1354
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .507	P= .695	P= .902	P= .294	P= .083	P= .675
SHAPE	-.4612	.0000	-.4615	.	.	.1339
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .012	P=1.000	P= .131	P= .	P= .	P= .678
SLOPCAN	-.0821	-.4021	.3306	.9345	.7204	-.2084
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .672	P= .195	P= .294	P= .065	P= .280	P= .516
SLOPESC	-.6344	.0960	-.4393	-.4718	-.1266	-.2861
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .000	P= .767	P= .153	P= .528	P= .873	P= .367
SPACEJS1	-.6294	-.5961	.1650	.0214	-.4467	.1084
	(12)	(12)	(12)	(4)	(4)	(12)
	P= .028	P= .041	P= .608	P= .979	P= .553	P= .737

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	ANGLEINF	ANGLJS1E	ANGLJS1F	ANGLJS2E	ANGLJS2F	CONTHJS1
SPACEJS2	-.8341	-.2724	-.3072	.7373	.9260	-.4687
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .166	P= .728	P= .693	P= .263	P= .074	P= .531
THICKSS	-.5260	-.3189	-.1803	.5732	.7644	-.0836
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .003	P= .312	P= .575	P= .427	P= .236	P= .796
TOEDIST	-.5081	-.3289	.0325	.7964	.5030	.1967
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .005	P= .296	P= .920	P= .204	P= .497	P= .540
WDEPTH	-.8793	-.0410	-.2367	.4573	.4954	-.2109
	(29)	(12)	(12)	(4)	(4)	(12)
	P= .000	P= .899	P= .459	P= .543	P= .505	P= .510

(Coefficient / (Cases) / 2-tailed Significance)

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- - Correlation Coefficients - -

	CONTHJS2	CONTVJS1	CONTVJS2	EROSION	FAILINDE	FAILV
ANGLEINF	-.9199	.6171	-.8934	-.2652	-.4849	-.4849
	(4)	(12)	(4)	(29)	(29)	(29)
	P= .080	P= .033	P= .107	P= .164	P= .008	P= .008
ANGLJS1E	-.9143	.0984	-.9325	-.3187	.0801	.0801
	(4)	(12)	(4)	(12)	(12)	(12)
	P= .086	P= .761	P= .068	P= .313	P= .804	P= .804
ANGLJS1F	.5386	.1654	.4940	-.2784	-.6002	-.6002
	(4)	(12)	(4)	(12)	(12)	(12)
	P= .461	P= .607	P= .506	P= .381	P= .039	P= .039
ANGLJS2E	.4669	.5500	.5488	.	.7071	.7071
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .533	P= .450	P= .451	P= .	P= .293	P= .293
ANGLJS2F	.3774	.8639	.4157	.	.3455	.3455
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .623	P= .136	P= .584	P= .	P= .654	P= .654
CONTHJS1	.3892	-.1033	.4179	.4021	.0300	.0300
	(4)	(12)	(4)	(12)	(12)	(12)
	P= .611	P= .749	P= .582	P= .195	P= .926	P= .926
CONTHJS2	1.0000	.0000	.9924	.	.0321	.0321
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .	P=1.000	P= .008	P= .	P= .968	P= .968
CONTVJS1	.0000	1.0000	.0000	-.0835	-.2656	-.2656
	(4)	(12)	(4)	(12)	(12)	(12)
	P=1.000	P= .	P=1.000	P= .796	P= .404	P= .404
CONTVJS2	.9924	.0000	1.0000	.	.1552	.1552
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .008	P=1.000	P= .	P= .	P= .845	P= .845
EROSION	.	-.0835	.	1.0000	.2617	.2617
	(4)	(12)	(4)	(29)	(29)	(29)
	P= .	P= .796	P= .	P= .	P= .170	P= .170
FAILINDE	.0321	-.2656	.1552	.2617	1.0000	1.0000
	(4)	(12)	(4)	(29)	(29)	(29)
	P= .968	P= .404	P= .845	P= .170	P= .	P= .000

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	CONTHJS2	CONTVJS1	CONTVJS2	EROSION	FAILINDE	FAILV
SPACEJS2	.5987	.8006	.5972	.	.0445	.0445
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .401	P= .199	P= .403	P= .	P= .956	P= .956
THICKSS	.7630	-.2903	.7349	.4776	.1003	.1003
	(4)	(12)	(4)	(29)	(29)	(29)
	P= .237	P= .360	P= .265	P= .009	P= .605	P= .605
TOEDIST	.7829	-.5777	.8537	.0305	.3010	.3010
	(4)	(12)	(4)	(29)	(29)	(29)
	P= .217	P= .049	P= .146	P= .875	P= .113	P= .113
WDEPTH	.9637	-.7924	.9367	.0568	.3751	.3751
	(4)	(12)	(4)	(29)	(29)	(29)
	P= .036	P= .002	P= .063	P= .770	P= .045	P= .045

(Coefficient / (Cases) / 2-tailed Significance)

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- - Correlation Coefficients - -

	INDEXJS1	INDEXJS2	INDJS1E	INJS1LW	INJS2E	INJS2LW
ANGLEINF	.0898	.0971	-.0961	.0503	.1068	.1284
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .663	P= .616	P= .620	P= .796	P= .582	P= .507
ANGLJS1E	-.3623	.0800	-.8607	.0000	.2370	.1267
	(12)	(12)	(12)	(12)	(12)	(12)
	P= .247	P= .805	P= .000	P=1.000	P= .458	P= .695
ANGLJS1F	.4693	.1028	.4131	.4225	-.0122	.0398
	(12)	(12)	(12)	(12)	(12)	(12)
	P= .124	P= .750	P= .182	P= .171	P= .970	P= .902
ANGLJS2E	-.3253	-.8615	.4444	-.8889	-.8340	-.7057
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .675	P= .139	P= .556	P= .111	P= .166	P= .294
ANGLJS2F	-.2467	-.9820	.3665	-.8552	-.4937	-.9169
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .753	P= .018	P= .633	P= .145	P= .506	P= .083
CONTHJS1	.6754	-.1070	.4502	.0302	-.2299	-.1354
	(12)	(12)	(12)	(12)	(12)	(12)
	P= .016	P= .741	P= .142	P= .926	P= .472	P= .675
CONTHJS2	.6717	-.2016	.9995	-.0227	-.6033	-.5771
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .328	P= .798	P= .001	P= .977	P= .397	P= .423
CONTVJS1	.1283	-.3878	-.2855	-.1420	-.3188	-.3991
	(12)	(12)	(12)	(12)	(12)	(12)
	P= .691	P= .213	P= .368	P= .660	P= .313	P= .199
CONTVJS2	.5842	-.2491	.9879	-.1098	-.6971	-.5704
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .416	P= .751	P= .012	P= .890	P= .303	P= .430
EROSION	-.1546	-.1210	.0401	-.1778	-.1061	-.1248
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .451	P= .532	P= .836	P= .356	P= .584	P= .519
FAILINDE	-.2980	-.2275	-.1944	-.3615	-.3133	-.1730
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .139	P= .235	P= .312	P= .054	P= .098	P= .370

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	INDEXJS1	INDEXJS2	INDJS1E	INJS1LW	INJS2E	INJS2LW
FAILV	-.2980	-.2275	-.1944	-.3615	-.3133	-.1730
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .139	P= .235	P= .312	P= .054	P= .098	P= .370
INDEXJS1	1.0000	.2220	.8087	.8486	.1796	.1865
	(26)	(26)	(26)	(26)	(26)	(26)
	P= .	P= .276	P= .000	P= .000	P= .380	P= .362
INDEXJS2	.2220	1.0000	.2642	.3925	.8200	.9691
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .276	P= .	P= .166	P= .035	P= .000	P= .000
INDJS1E	.8087	.2642	1.0000	.7328	.1358	.2255
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .000	P= .166	P= .	P= .000	P= .483	P= .240
INJS1LW	.8486	.3925	.7328	1.0000	.3424	.3398
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .000	P= .035	P= .000	P= .	P= .069	P= .071
INJS2E	.1796	.8200	.1358	.3424	1.0000	.7997
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .380	P= .000	P= .483	P= .069	P= .	P= .000
INJS2LW	.1865	.9691	.2255	.3398	.7997	1.0000
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .362	P= .000	P= .240	P= .071	P= .000	P= .
SHAPE	-.2442	.1210	-.1085	-.2790	.1061	.1248
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .229	P= .532	P= .575	P= .143	P= .584	P= .519
SLOPCAN	.1414	-.0476	.3540	.1891	-.1871	-.0224
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .491	P= .806	P= .060	P= .326	P= .331	P= .908
SLOPESC	-.1690	-.0404	-.0295	-.1246	.0567	-.1144
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .409	P= .835	P= .879	P= .519	P= .770	P= .554
SPACEJS1	-.1756	-.3452	.4954	.0007	-.3227	-.3588
	(12)	(12)	(12)	(12)	(12)	(12)
	P= .585	P= .272	P= .101	P= .998	P= .306	P= .252

(Coefficient / (Cases) / 2-tailed Significance)

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- - Correlation Coefficients - -

	INDEXJS1	INDEXJS2	INDJS1E	INJS1LW	INJS2E	INJS2LW
SPACEJS2	.1281	-.8476	.5976	-.5976	-.3813	-.9987
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .872	P= .152	P= .402	P= .402	P= .619	P= .001
THICKSS	-.0368	.0935	.2637	-.1118	.1046	.0662
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .858	P= .629	P= .167	P= .564	P= .589	P= .733
TOEDIST	.0223	-.1465	.1605	-.0023	-.2791	-.1457
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .914	P= .448	P= .405	P= .991	P= .143	P= .451
WDEPTH	-.1589	-.0037	.0659	-.0151	-.0380	-.0350
	(26)	(29)	(29)	(29)	(29)	(29)
	P= .438	P= .985	P= .734	P= .938	P= .845	P= .857

(Coefficient / (Cases) / 2-tailed Significance)

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- - Correlation Coefficients - -

	SHAPE	SLOPCAN	SLOPESC	SPACEJS1	SPACEJS2	THICKSS
ANGLEINF	-.4612	-.0821	-.6344	-.6294	-.8341	-.5260
	(29)	(29)	(29)	(12)	(4)	(29)
	P= .012	P= .672	P= .000	P= .028	P= .166	P= .003
ANGLJS1E	.0000	-.4021	.0960	-.5961	-.2724	-.3189
	(12)	(12)	(12)	(12)	(4)	(12)
	P=1.000	P= .195	P= .767	P= .041	P= .728	P= .312
ANGLJS1F	-.4615	.3306	-.4393	.1650	-.3072	-.1803
	(12)	(12)	(12)	(12)	(4)	(12)
	P= .131	P= .294	P= .153	P= .608	P= .693	P= .575
ANGLJS2E	.	.9345	-.4718	.0214	.7373	.5732
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .	P= .065	P= .528	P= .979	P= .263	P= .427
ANGLJS2F	.	.7204	-.1266	-.4467	.9260	.7644
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .	P= .280	P= .873	P= .553	P= .074	P= .236
CONTHJS1	.1339	-.2084	-.2861	.1084	-.4687	-.0836
	(12)	(12)	(12)	(12)	(4)	(12)
	P= .678	P= .516	P= .367	P= .737	P= .531	P= .796
CONTHJS2	.	.6983	.2906	.2098	.5987	.7630
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .	P= .302	P= .709	P= .790	P= .401	P= .237
CONTVJS1	-.6192	-.2086	-.0144	-.2812	.8006	-.2903
	(12)	(12)	(12)	(12)	(4)	(12)
	P= .032	P= .515	P= .964	P= .376	P= .199	P= .360
CONTVJS2	.	.7746	.1709	.2746	.5972	.7349
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .	P= .225	P= .829	P= .725	P= .403	P= .265
EROSION	.1154	-.4489	.2841	.5214	.	.4776
	(29)	(29)	(29)	(12)	(4)	(29)
	P= .551	P= .015	P= .135	P= .082	P= .	P= .009
FAILINDE	.5815	-.0048	.2728	.3606	.0445	.1003
	(29)	(29)	(29)	(12)	(4)	(29)
	P= .001	P= .980	P= .152	P= .250	P= .956	P= .605

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	SHAPE	SLOPCAN	SLOPESC	SPACEJS1	SPACEJS2	THICKSS
FAILV	.5815 (29) P= .001	-.0048 (29) P= .980	.2728 (29) P= .152	.3606 (12) P= .250	.0445 (4) P= .956	.1003 (29) P= .605
INDEXJS1	-.2442 (26) P= .229	.1414 (26) P= .491	-.1690 (26) P= .409	-.1756 (12) P= .585	.1281 (4) P= .872	-.0368 (26) P= .858
INDEXJS2	.1210 (29) P= .532	-.0476 (29) P= .806	-.0404 (29) P= .835	-.3452 (12) P= .272	-.8476 (4) P= .152	.0935 (29) P= .629
INDJS1E	-.1085 (29) P= .575	.3540 (29) P= .060	-.0295 (29) P= .879	.4954 (12) P= .101	.5976 (4) P= .402	.2637 (29) P= .167
INJS1LW	-.2790 (29) P= .143	.1891 (29) P= .326	-.1246 (29) P= .519	.0007 (12) P= .998	-.5976 (4) P= .402	-.1118 (29) P= .564
INJS2E	.1061 (29) P= .584	-.1871 (29) P= .331	.0567 (29) P= .770	-.3227 (12) P= .306	-.3813 (4) P= .619	.1046 (29) P= .589
INJS2LW	.1248 (29) P= .519	-.0224 (29) P= .908	-.1144 (29) P= .554	-.3588 (12) P= .252	-.9987 (4) P= .001	.0662 (29) P= .733
SHAPE	1.0000 (29) P= .	-.1539 (29) P= .425	.5121 (29) P= .005	.2396 (12) P= .453	. (4) P= .	.1592 (29) P= .409
SLOPCAN	-.1539 (29) P= .425	1.0000 (29) P= .	-.3339 (29) P= .077	.3255 (12) P= .302	.6537 (4) P= .346	-.0641 (29) P= .741
SLOPESC	.5121 (29) P= .005	-.3339 (29) P= .077	1.0000 (29) P= .	.3723 (12) P= .233	.2254 (4) P= .775	.4689 (29) P= .010
SPACEJS1	.2396 (12) P= .453	.3255 (12) P= .302	.3723 (12) P= .233	1.0000 (12) P= .	-.5145 (4) P= .486	.3295 (12) P= .296

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	SHAPE	SLOPCAN	SLOPESC	SPACEJS1	SPACEJS2	THICKSS
SPACEJS2	.	.6537	.2254	-.5145	1.0000	.9493
	(4)	(4)	(4)	(4)	(4)	(4)
	P= .	P= .346	P= .775	P= .486	P= .	P= .051
THICKSS	.1592	-.0641	.4689	.3295	.9493	1.0000
	(29)	(29)	(29)	(12)	(4)	(29)
	P= .409	P= .741	P= .010	P= .296	P= .051	P= .
TOEDIST	.0327	.5035	-.1651	.4416	.4844	.2119
	(29)	(29)	(29)	(12)	(4)	(29)
	P= .866	P= .005	P= .392	P= .151	P= .516	P= .270
WDEPTH	.4567	.2553	.4503	.4843	.7443	.4182
	(29)	(29)	(29)	(12)	(4)	(29)
	P= .013	P= .181	P= .014	P= .111	P= .256	P= .024

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	TOEDIST	WDEPTH
ANGLEINF	-.5081	-.8793
	(29)	(29)
	P= .005	P= .000
ANGLJS1E	-.3289	-.0410
	(12)	(12)
	P= .296	P= .899
ANGLJS1F	.0325	-.2367
	(12)	(12)
	P= .920	P= .459
ANGLJS2E	.7964	.4573
	(4)	(4)
	P= .204	P= .543
ANGLJS2F	.5030	.4954
	(4)	(4)
	P= .497	P= .505
CONTHJS1	.1967	-.2109
	(12)	(12)
	P= .540	P= .510
CONTHJS2	.7829	.9637
	(4)	(4)
	P= .217	P= .036
CONTVJS1	-.5777	-.7924
	(12)	(12)
	P= .049	P= .002
CONTVJS2	.8537	.9367
	(4)	(4)
	P= .146	P= .063
EROSION	.0305	.0568
	(29)	(29)
	P= .875	P= .770
FAILINDE	.3010	.3751
	(29)	(29)
	P= .113	P= .045

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	TOEDIST	WDEPTH
FAILV	.3010	.3751
	(29)	(29)
	P= .113	P= .045
INDEXJS1	.0223	-.1589
	(26)	(26)
	P= .914	P= .438
INDEXJS2	-.1465	-.0037
	(29)	(29)
	P= .448	P= .985
INDJS1E	.1605	.0659
	(29)	(29)
	P= .405	P= .734
INJS1LW	-.0023	-.0151
	(29)	(29)
	P= .991	P= .938
INJS2E	-.2791	-.0380
	(29)	(29)
	P= .143	P= .845
INJS2LW	-.1457	-.0350
	(29)	(29)
	P= .451	P= .857
SHAPE	.0327	.4567
	(29)	(29)
	P= .866	P= .013
SLOPCAN	.5035	.2553
	(29)	(29)
	P= .005	P= .181
SLOPESC	-.1651	.4503
	(29)	(29)
	P= .392	P= .014
SPACEJS1	.4416	.4843
	(12)	(12)
	P= .151	P= .111

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	TOEDIST	WDEPTH
SPACEJS2	.4844	.7443
	(4)	(4)
	P= .516	P= .256
THICKSS	.2119	.4182
	(29)	(29)
	P= .270	P= .024
TOEDIST	1.0000	.6208
	(29)	(29)
	P= .	P= .000
WDEPTH	.6208	1.0000
	(29)	(29)
	P= .000	P= .

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

* * * - M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1   Dependent Variable..   FAILINDE   FAILINDEX

Variable(s) Entered on Step Number
2..   INJS2E

Multiple R	.68327
R Square	.46686
Adjusted R Square	.42050
Standard Error	.63761

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	8.18795	4.09397
Residual	23	9.35052	.40654

F =   10.07018   Signif F = .0007

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
INJS2E	-.376289	.155239	-.371722	-2.424	.0236
SHAPE	1.592784	.394237	.619582	4.040	.0005
(Constant)	-4.08344E-16	.368123		.000	1.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
ANGLEINF	-.150253	-.180871	.764901	-.863	.3977
EROSION	.185683	.249730	.964366	1.210	.2392
INDEXJS1	-.089172	-.115607	.896092	-.546	.5906
INDEXJS2	.044901	.035309	.329682	.166	.8699
INDJS1E	-.048112	-.065131	.969926	-.306	.7624
INJS1LW	-.043397	-.053195	.801070	-.250	.8050
INJS2LW	.171922	.141744	.362401	.672	.5088
SLOPCAN	.051638	.068665	.942695	.323	.7499
SLOPESC	-.080810	-.095597	.741232	-.450	.6568
THICKSS	.010930	.014701	.964502	.069	.9456
TOEDIST	.155036	.204910	.917972	.982	.3368
WDEPTH	.053267	.065113	.785241	.306	.7624

DEER CREEK MINE
NORTH RILDA
Colorado Rockfall Simulation Program Results

Introduction

To evaluate the potential public safety issues in Rilda Canyon related to Castlegate Sandstone escarpment failure, computer simulations of rockfalls in Rilda Canyon were conducted utilizing the Colorado Rockfall Simulation Program (CRSP). A total of ten (10) cross section profiles, representing likely rockfall paths, were generated along the escarpment in areas of projected full extraction mining under the North Rilda escarpment (refer map in Appendix 1: Deer Creek Mine, Escarpment Modeling Study/Rilda Canyon, CRSP Cross Section Locations Map, Drawing #DS1763D).

Based on these analyses, the conclusion is reached that it is very unlikely that any debris associated with escarpment failure will pose any danger to public health or safety. Further, it is concluded that the formation of a debris field or talus zone resulting from the failure of the Castlegate Sandstone escarpment will be concentrated within a zone approximately three hundred (300) feet below the escarpment. Prior to the full extraction mining in Rilda Canyon, perimeter signs [warning of potential rock fall hazards] will be posted below the affected escarpment areas along Emery County Road 306.

Colorado Rockfall Simulation

The Colorado Department of Transportation developed the Colorado Rockfall Simulation Program (CRSP) 3.0a with the help of the Colorado Geological Survey and the Colorado School of Mines . CRSP is based on field observations and data collected from studies of videotaped rockfalls. CRSP was initially designed as a tool for the location and design of rockfall mitigation structures. This program uses the slope profile, rebound and friction characteristics of the slope, and the rotational energy of the rocks to simulate rocks tumbling down a slope. Empirically derived functions for velocity, friction, and slope material properties are used to model the dynamic interaction of the rock and the slope. The statistical variation observed among rockfalls is modeled by randomly varying the angle at which the rock impacts the slope within limits set by rock diameter and slope roughness.

Rocks do not simply slide down a slope, but they travel down a slope with a combination of free fall, bouncing and rolling. This program models rockfalls during all of these modes of travel.

Slope inclination and length are the most important factors in determining the behavior of rockfalls because they define zones of acceleration. Slope inclination and length are input into CRSP by dividing the slope profile into straight line segments called cells. These cells are entered into the program using the beginning and ending coordinates of each line segment.

Second in importance to determining rockfall behavior are the surface irregularities on the slope. These irregularities alter the angle that a rock impacts the slope. CRSP models surface irregularities by randomly varying the slope angle between zero and a maximum value which is controlled by the rock size and the surface roughness. The maximum random angle is:

$$\theta_{max} = \tan^{-1}(S_{max}/R)$$

where:

θ_{max}= the maximum possible variation in the slope angle.

S_{max} = the perpendicular variation of the slope as measured along a slope distance equal to the radius of the rock.

R= radius of the rock.

Other variables that affect the behavior of a rock traveling down a slope are the material properties of the slope. These properties affect the behavior of a rock rebounding from the surface. CRSP uses two material properties to model rockfall behavior; the coefficient of restitution (R_n) and the tangential coefficient of frictional resistance (R_t). These coefficients measure the conservation of kinetic energy after a rock impacts the slope. R_n is a measure of the degree of elasticity in a collision normal to the slope, and R_t is a measure of the frictional resistance to movement parallel to the slope.

Some general assumptions used in development of the program are:

- This is a two dimensional analysis, therefore, the profile should follow the most probable rock path, as established by field investigation.
- Rock size and shape remain constant. Therefore, the rock does not break apart as it travels down the slope.

Based upon field data, rocks were observed to be more cylindrical than spherical in shape. Thus, modeling was performed using rocks that were cylinder - shaped. For the Rilda Canyon simulation 3 ft. x 3 ft. cylinder rock size was analyzed. The program assumes that all rocks remain intact as they travel down the slope.

General Discussion of Program Input

Input parameters are site-specific and depend on field observations of the chosen rockfall path from the Castlegate Sandstone escarpment to features of concern (roads and streams). The parameters that need to be determined are the rock size, the cell boundaries or slope profile, the surface roughness, the tangential coefficient, and the normal coefficient.

Rock sizes are usually determined by using the largest rocks found at the base of the rockfall path that can be identified as having fallen from the source area. The rock size or sizes can then be used later in determining the surface roughness.

Cell boundaries are selected where either a change in slope or a change in slope material occurs. In this case, changes in material resulted in changes in slope, therefore, distinct breaks in the slope inclination were used as cell boundaries.

The surface roughness (S) is the perpendicular variation of the slope as measured parallel to the dip of the slope along a distance equal to the radius of the rock. The surface roughness is not always the value for the largest bump on the slope, or an average variation in the slope, rather it is the value of the largest variation that occurs with some frequency. Surface roughness is also a function of rock size, such that different sized rocks may possess different surface roughness for the same slope profile. The tangential coefficient was determined from Table 1. The normal coefficient was determined from Table 2.

Table 1: Tangential Coefficient for Various Slope Conditions

Tangential	
.87-.92	Smooth hard surfaces such as pavement or smooth bedrock surfaces.
.83-.87	Most bedrock surfaces and talus with no vegetation.
.82-.85	Most talus slopes with some low vegetation.
.80-.83	Vegetated talus slopes and soil slopes with scarce vegetation.
.78-.82	Brush covered soil slope.

Table 2: Normal Coefficient for Various Slope Conditions

Normal Coefficient R_n	**Description of Slope**
.37-.42	Smooth hard surfaces and paving.
.33-.37	Most bedrock and boulder fields.
.30-.33	Talus and firm soil slopes.
.28-.30	Soft soil slopes.

Back Analysis of Escarpment Failure Utilizing CRSP 3.0a

PacifiCorp has conducted an actual escarpment failure back analysis of the Trail Mountain Mine Castlegate Sandstone escarpment test study area, utilizing field observations. Computer simulations of the slope failure were completed utilizing CRSP version 3.0a. Every effort was made to accurately represent the resultant conditions at Trail Mountain through technical engineering assumptions and data input files (refer to Status Report February 1998). Input variables for Rilda Canyon were determined based upon the back analysis of the Trail Mountain escarpment failure.

The results of the evaluation contained in this report discuss the simulation of mining induced surface effects on the Castlegate Sandstone escarpment above the proposed full extraction mining area in Rilda Canyon.

CRSP models rockfall behavior by dropping a specific number of rocks, all of the same size and shape, from a zone above the slope. For all modeled cross-sections, this zone was entered as the major area of failure, which was from an elevation of 8,800 ft. to 8,600 ft. This best accounts for the majority of Castlegate Sandstone escarpment failure.

Surface roughness for Rilda Canyon varied from 1.0 to 5.0 feet. The material makeup of the slope varied from very competent sandstone outcrops to moderately vegetated rocky soils. The tangential coefficient therefore varied from 0.87 to 0.82. The normal coefficient varied from 0.37 to 0.33.

As stated earlier, based upon field observations, rock shape was observed to be cylindrical rather than spherical in nature. Thus, modeling was carried on rocks that were block - shaped. For the Rilda Canyon simulation 3 ft. x 3 ft. cylinder rock size was analyzed. The program assumes that all rocks remain intact as they travel down the slope. The size determination of 3 ft. x 3ft. for Rilda Canyon was based on the physical characteristics of the Castlegate Sandstone outcrop; including weathering, jointing and field observations of historical rockfalls.

Based upon the back analysis from Trail Mountain the following variables were utilized for the Rilda Canyon simulation:

Table 3: Rilda Canyon CRSP Input Variables

RILDA CANYON CRSP INPUT VARIABLES		
Variable	**Escarpment Zone**	**Below Escarpment**
Surface Roughness for 3 ft. x 3 ft. Cylindrical Rock	1.0	5.0
Tangential Coefficient	0.87	0.82
Normal Coefficient	0.37	0.33

In the case of Trail Mountain, it was possible to produce results consistent with field observations by adjusting surface roughness factors for given rock sizes, but it should be noted that very large material in excess of 20 ft. x 15 ft. can be seen near the upper portion of the failure (Photo #2, refer to Status Report: February 1998). Surface roughness required to contain this material in close proximity to the failure and prevent it from rolling farther down the slope would be in excess of reasonable values.

Two explanations for the presence of such large boulders in the upper portion of the debris field may be:

- The mode of failure (foundation failure) did not lead to toppling of rock from higher elevations. Instead, the material may have slid downslope limiting the initial amount of potential energy available for the rock to begin rolling down the slope.

- The existence of small ledges just below the failure (see Photo #1, Status Report: February 1998) helped contain some of the failure material in the areas above those ledges. These ledges are not evident on the slope profile due to the fact that the slope profile was constructed from a topographic map that contained 80 ft. minimum contour intervals (best information available).

CRSP Program Results - Rilda Canyon

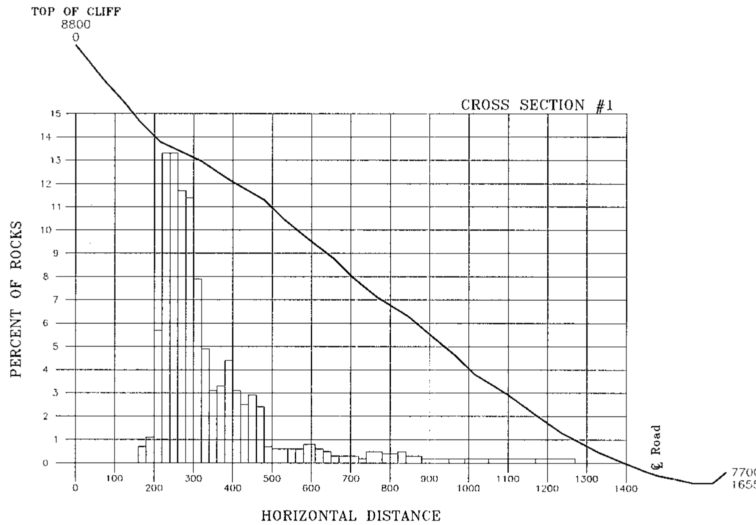
As stated earlier, a total of ten (10) cross section profiles were generated along the escarpment in areas of projected full extraction mining (refer map in Appendix A: Deer Creek Mine, Escarpment Modeling Study/Rilda Canyon, CRSP Cross Section Locations Map, Drawing #DS1763D). Selection of the cross sections were based on several factors: location of the road (minimum distance from the escarpment to the road), areas of escarpment instability from field inspections, and a mathematical model developed by Maleki Technologies Inc.. Each of the cross sections was divided into cells based on topographic varitions. The following table is a list of cross section input values:

Table 3: Rilda Canyon Cross Section Input Variables

Rilda Canyon Cross Section Input Variables							
Cross Section	# of Cells	Section Length (ft.)	Elevetion Difference (ft.)	Surface Roughness	Tangential Coefficient	Normal Coefficient	Number of Rocks
1	26	1655	1,100	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
2	27	1755	1,150	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
3	27	1865	1,150	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
4	27	1740	1,150	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
5	28	2330	1,150	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
6	29	2095	1,200	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
7	33	2150	1,300	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
8	31	2720	1,150	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
9	33	2490	1,250	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000
10	34	2530	1,350	1.00 - 5.00	0.87 - 0.82	0.37 - 0.33	1,000

Each cross section was analyzed by simulating 1,000 separate rockfalls (refer to CRSP Data in Appendix B). A histogram was generated for each cross section representing the percentage of rocks stopped vs. the horizontal distance along the cross section, see Figure 1 and CRSP Histogram Data in Appendix C.

Figure 1: CRSP Histogram Data - Cross Section #1



The CRSP data output shows that the majority of debris deposition occurs from 300 to 500 feet below the escarpment. Rocks do not reach the road in any of the cases. However, warning signs should be posted along the road during mining and until subsidence has stabilized (as was done at Trail Mountain). Due to the difficulty associated with subsidence survey data collection in steep terrain, the installation of survey prisms is recommended along the escarpment to document subsidence movement and stabilization.

** CRSP3 **

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

THIS PROGRAM HAS BEEN TESTED AND IS BELIEVED TO BE A RELABLE ENGINEERING TOOL NO RESPONSIBILITY IS ASSUMED BY THE AUTHOR(S) FOR ANY ERRORS, MISTAKES, OR MISREPRESENTATIONS THAT MAY OCCUR FROM ANY USE OF THIS PROGRAM

****

RILDXS1.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 26
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1655 ft
INITIAL Y ZONE 8650 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS1.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	40.0 ,8750.0
2	1.00	.87	.37	40.0 ,8750.0	80.0 ,8700.0
3	1.00	.87	.37	80.0 ,8700.0	125.0 ,8650.0
4	1.00	.87	.37	125.0 ,8650.0	165.0 ,8600.0
5	5.00	.82	.33	165.0 ,8600.0	215.0 ,8550.0
6	5.00	.82	.33	215.0 ,8550.0	320.0 ,8500.0
7	5.00	.82	.33	320.0 ,8500.0	395.0 ,8450.0
8	5.00	.82	.33	395.0 ,8450.0	480.0 ,8400.0
9	5.00	.82	.33	480.0 ,8400.0	530.0 ,8350.0
10	5.00	.82	.33	530.0 ,8350.0	590.0 ,8300.0
11	5.00	.82	.33	590.0 ,8300.0	655.0 ,8250.0
12	5.00	.82	.33	655.0 ,8250.0	705.0 ,8200.0
13	5.00	.82	.33	705.0 ,8200.0	765.0 ,8150.0
14	5.00	.82	.33	765.0 ,8150.0	845.0 ,8100.0
15	5.00	.82	.33	845.0 ,8100.0	905.0 ,8050.0
16	5.00	.82	.33	905.0 ,8050.0	965.0 ,8000.0
17	5.00	.82	.33	965.0 ,8000.0	1015.0 ,7950.0
18	5.00	.82	.33	1015.0 ,7950.0	1095.0 ,7900.0
19	5.00	.82	.33	1095.0 ,7900.0	1165.0 ,7850.0
20	5.00	.82	.33	1165.0 ,7850.0	1235.0 ,7800.0
21	5.00	.82	.33	1235.0 ,7800.0	1330.0 ,7750.0
22	5.00	.82	.33	1330.0 ,7750.0	1450.0 ,7700.0
23	5.00	.82	.33	1450.0 ,7700.0	1480.0 ,7690.0
24	5.00	.82	.33	1480.0 ,7690.0	1525.0 ,7670.0
25	5.00	.82	.33	1525.0 ,7670.0	1570.0 ,7670.0
26	5.00	.82	.33	1570.0 ,7670.0	1655.0 ,7700.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS1.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	47	26	9.12	2	10
2	68	36	13.27	4	18
3	77	42	15.28	5	21
4	93	58	12.74	9	30
5	104	52	18.70	8	32
6	78	32	15.23	4	18
7	80	35	15.57	4	25
8	80	31	18.02	3	13
9	91	40	19.11	8	35
10	81	40	19.43	5	21
11	93	41	21.02	5	22
12	110	49	23.03	8	20
13	76	41	21.30	5	20
14	87	36	21.90	5	17
15	85	40	24.37	6	20
16	86	36	27.92	5	17
17	91	48	28.29	6	11
18	48	32	0.00	4	9
19	21	20	0.00	1	2
20	10	10	0.00	3	3
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				

X INTERVAL	ROCKS STOPPED
160 ft TO 170 ft	4
170 ft TO 180 ft	3
180 ft TO 190 ft	4
190 ft TO 200 ft	7
200 ft TO 210 ft	6
210 ft TO 220 ft	51
220 ft TO 230 ft	69
230 ft TO 240 ft	64
240 ft TO 250 ft	71
250 ft TO 260 ft	62
260 ft TO 270 ft	60
270 ft TO 280 ft	57
280 ft TO 290 ft	53
290 ft TO 300 ft	61
300 ft TO 310 ft	41
310 ft TO 320 ft	38
320 ft TO 330 ft	28
330 ft TO 340 ft	21
340 ft TO 350 ft	14
350 ft TO 360 ft	17
360 ft TO 370 ft	14
370 ft TO 380 ft	19
380 ft TO 390 ft	21
390 ft TO 400 ft	23
400 ft TO 410 ft	15
410 ft TO 420 ft	16
420 ft TO 430 ft	11
430 ft TO 440 ft	14
440 ft TO 450 ft	13
450 ft TO 460 ft	16
460 ft TO 470 ft	13
470 ft TO 480 ft	11
480 ft TO 490 ft	3
490 ft TO 500 ft	4
500 ft TO 510 ft	4
530 ft TO 540 ft	2
540 ft TO 550 ft	5
550 ft TO 560 ft	1
560 ft TO 570 ft	2
570 ft TO 580 ft	4
590 ft TO 600 ft	2
600 ft TO 610 ft	6
610 ft TO 620 ft	4
620 ft TO 630 ft	2
630 ft TO 640 ft	2
640 ft TO 650 ft	3
650 ft TO 660 ft	2
660 ft TO 670 ft	1
690 ft TO 700 ft	1
710 ft TO 720 ft	2
720 ft TO 730 ft	1
730 ft TO 740 ft	1
760 ft TO 770 ft	1
770 ft TO 780 ft	4
780 ft TO 790 ft	2
790 ft TO 800 ft	2
800 ft TO 810 ft	1
810 ft TO 820 ft	3
820 ft TO 830 ft	3

830 ft	TO	840 ft		2
860 ft	TO	870 ft		2
870 ft	TO	880 ft		1
930 ft	TO	940 ft		1
940 ft	TO	950 ft		1
960 ft	TO	970 ft		1
980 ft	TO	990 ft		1
1030 ft	TO	1040 ft		1
1040 ft	TO	1050 ft		1
1060 ft	TO	1070 ft		1
1160 ft	TO	1170 ft		1
1170 ft	TO	1180 ft		1
1260 ft	TO	1270 ft		1

**CRSP3 **

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

THIS PROGRAM HAS BEEN TESTED AND IS BELIEVED TO BE A RELABLE ENGINEERING TOOL NO RESPONSIBILITY IS ASSUMED BY THE AUTHOR(S) FOR ANY ERRORS, MISTAKES, OR MISREPRESENTATIONS THAT MAY OCCUR FROM ANY USE OF THIS PROGRAM

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RILDXS2.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 27
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8650 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS2.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	10.0 ,8750.0
2	1.00	.87	.37	10.0 ,8750.0	40.0 ,8700.0
3	1.00	.87	.37	40.0 ,8700.0	65.0 ,8650.0
4	1.00	.87	.37	65.0 ,8650.0	98.0 ,8600.0
5	5.00	.82	.33	98.0 ,8600.0	160.0 ,8550.0
6	5.00	.82	.33	160.0 ,8550.0	220.0 ,8500.0
7	5.00	.82	.33	220.0 ,8500.0	285.0 ,8450.0
8	5.00	.82	.33	285.0 ,8450.0	355.0 ,8400.0
9	5.00	.82	.33	355.0 ,8400.0	420.0 ,8350.0
10	5.00	.82	.33	420.0 ,8350.0	490.0 ,8300.0
11	5.00	.82	.33	490.0 ,8300.0	540.0 ,8250.0
12	5.00	.82	.33	540.0 ,8250.0	580.0 ,8200.0
13	5.00	.82	.33	580.0 ,8200.0	655.0 ,8150.0
14	5.00	.82	.33	655.0 ,8150.0	745.0 ,8100.0
15	5.00	.82	.33	745.0 ,8100.0	845.0 ,8050.0
16	5.00	.82	.33	845.0 ,8050.0	915.0 ,8000.0
17	5.00	.82	.33	915.0 ,8000.0	1000.0 ,7950.0
18	5.00	.82	.33	1000.0 ,7950.0	1070.0 ,7900.0
19	5.00	.82	.33	1070.0 ,7900.0	1110.0 ,7850.0
20	5.00	.82	.33	1110.0 ,7850.0	1155.0 ,7800.0
21	5.00	.82	.33	1155.0 ,7800.0	1270.0 ,7750.0
22	5.00	.82	.33	1270.0 ,7750.0	1410.0 ,7700.0
23	5.00	.82	.33	1410.0 ,7700.0	1585.0 ,7663.0
24	5.00	.82	.33	1585.0 ,7663.0	1675.0 ,7650.0
25	5.00	.82	.33	1675.0 ,7650.0	1703.0 ,7640.0
26	5.00	.82	.33	1703.0 ,7640.0	1740.0 ,7640.0
27	5.00	.82	.33	1740.0 ,7640.0	1755.0 ,7650.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS2.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	53	27	10.74	9	26
2	71	38	13.77	5	25
3	85	47	17.27	9	39
4	101	60	13.02	10	42
5	91	44	16.39	6	28
6	93	43	18.18	6	27
7	97	40	19.06	5	25
8	92	39	18.34	4	22
9	101	37	19.56	5	31
10	95	37	19.61	5	35
11	105	44	20.48	7	30
12	117	51	21.93	11	49
13	76	36	17.71	4	18
14	69	34	18.42	4	18
15	59	34	15.72	4	9
16	51	39	12.02	5	11
17	43	30	0.00	4	9
18	38	30	0.00	4	8
19	57	37	0.00	17	30
20	90	50	0.00	6	12
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				

X INTERVAL	ROCKS STOPPED
90 ft TO 100 ft	10
100 ft TO 110 ft	36
110 ft TO 120 ft	25
120 ft TO 130 ft	18
130 ft TO 140 ft	16
140 ft TO 150 ft	9
150 ft TO 160 ft	22
160 ft TO 170 ft	14
170 ft TO 180 ft	18
180 ft TO 190 ft	28
190 ft TO 200 ft	16
200 ft TO 210 ft	27
210 ft TO 220 ft	24
220 ft TO 230 ft	21
230 ft TO 240 ft	26
240 ft TO 250 ft	25
250 ft TO 260 ft	18
260 ft TO 270 ft	26
270 ft TO 280 ft	17
280 ft TO 290 ft	25
290 ft TO 300 ft	33
300 ft TO 310 ft	28
310 ft TO 320 ft	24
320 ft TO 330 ft	29
330 ft TO 340 ft	24
340 ft TO 350 ft	17
350 ft TO 360 ft	23
360 ft TO 370 ft	11
370 ft TO 380 ft	12
380 ft TO 390 ft	10
390 ft TO 400 ft	21
400 ft TO 410 ft	11
410 ft TO 420 ft	25
420 ft TO 430 ft	18
430 ft TO 440 ft	15
440 ft TO 450 ft	17
450 ft TO 460 ft	14
460 ft TO 470 ft	11
470 ft TO 480 ft	12
480 ft TO 490 ft	17
490 ft TO 500 ft	4
500 ft TO 510 ft	3
510 ft TO 520 ft	5
520 ft TO 530 ft	6
530 ft TO 540 ft	2
560 ft TO 570 ft	2
570 ft TO 580 ft	1
580 ft TO 590 ft	18
590 ft TO 600 ft	10
600 ft TO 610 ft	12
610 ft TO 620 ft	8
620 ft TO 630 ft	4
630 ft TO 640 ft	6
640 ft TO 650 ft	9
650 ft TO 660 ft	14
660 ft TO 670 ft	6
670 ft TO 680 ft	6
680 ft TO 690 ft	13
690 ft TO 700 ft	14

700 ft	TO	710 ft		7
710 ft	TO	720 ft		5
720 ft	TO	730 ft		5
730 ft	TO	740 ft		6
740 ft	TO	750 ft		2
750 ft	TO	760 ft		4
760 ft	TO	770 ft		8
770 ft	TO	780 ft		5
780 ft	TO	790 ft		1
790 ft	TO	800 ft		2
800 ft	TO	810 ft		1
810 ft	TO	820 ft		3
820 ft	TO	830 ft		1
830 ft	TO	840 ft		1
840 ft	TO	850 ft		1
860 ft	TO	870 ft		1
870 ft	TO	880 ft		2
880 ft	TO	890 ft		2
890 ft	TO	900 ft		2
970 ft	TO	980 ft		1
1160 ft	TO	1170 ft		1
1180 ft	TO	1190 ft		1
1200 ft	TO	1210 ft		1
1210 ft	TO	1220 ft		1

***CRSP3 ***

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

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RILDXS3.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 27
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8650 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS3.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	50.0 ,8750.0
2	1.00	.87	.37	50.0 ,8750.0	70.0 ,8700.0
3	1.00	.87	.37	70.0 ,8700.0	115.0 ,8650.0
4	1.00	.87	.37	115.0 ,8650.0	155.0 ,8600.0
5	5.00	.82	.33	155.0 ,8600.0	210.0 ,8550.0
6	5.00	.82	.33	210.0 ,8550.0	265.0 ,8500.0
7	5.00	.82	.33	265.0 ,8500.0	340.0 ,8450.0
8	5.00	.82	.33	340.0 ,8450.0	445.0 ,8400.0
9	5.00	.82	.33	445.0 ,8400.0	525.0 ,8350.0
10	5.00	.82	.33	525.0 ,8350.0	590.0 ,8300.0
11	5.00	.82	.33	590.0 ,8300.0	640.0 ,8250.0
12	5.00	.82	.33	640.0 ,8250.0	685.0 ,8200.0
13	5.00	.82	.33	685.0 ,8200.0	765.0 ,8150.0
14	5.00	.82	.33	765.0 ,8150.0	855.0 ,8100.0
15	5.00	.82	.33	855.0 ,8100.0	955.0 ,8050.0
16	5.00	.82	.33	955.0 ,8050.0	1025.0 ,8000.0
17	5.00	.82	.33	1025.0 ,8000.0	1110.0 ,7950.0
18	5.00	.82	.33	1110.0 ,7950.0	1180.0 ,7900.0
19	5.00	.82	.33	1180.0 ,7900.0	1220.0 ,7850.0
20	5.00	.82	.33	1220.0 ,7850.0	1265.0 ,7800.0
21	5.00	.82	.33	1265.0 ,7800.0	1380.0 ,7750.0
22	5.00	.82	.33	1380.0 ,7750.0	1520.0 ,7700.0
23	5.00	.82	.33	1520.0 ,7700.0	1695.0 ,7663.0
24	5.00	.82	.33	1695.0 ,7663.0	1785.0 ,7650.0
25	5.00	.82	.33	1785.0 ,7650.0	1813.0 ,7640.0
26	5.00	.82	.33	1813.0 ,7640.0	1850.0 ,7640.0
27	5.00	.82	.33	1850.0 ,7640.0	1865.0 ,7650.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS3.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	46	25	9.03	2	10
2	71	39	14.60	10	41
3	90	41	14.65	4	19
4	84	57	11.40	8	29
5	95	48	17.97	7	28
6	99	46	19.37	7	31
7	90	37	17.46	5	31
8	82	33	16.79	4	17
9	83	35	18.35	4	18
10	85	38	18.11	4	20
11	99	43	20.90	8	36
12	93	53	18.55	11	45
13	59	32	15.82	4	17
14	55	34	13.71	4	11
15	27	18	0.00	6	12
16	27	27	0.00	5	5
17	16	16	0.00	5	5
18	17	17	0.00	2	2
19	9	9	0.00	3	3
20	28	28	0.00	6	6
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				

X INTERVAL						ROCKS STOPPED
150	ft	TO	160	ft		6
160	ft	TO	170	ft		8
170	ft	TO	180	ft		9
180	ft	TO	190	ft		9
190	ft	TO	200	ft		6
200	ft	TO	210	ft		11
210	ft	TO	220	ft		10
220	ft	TO	230	ft		8
230	ft	TO	240	ft		19
240	ft	TO	250	ft		20
250	ft	TO	260	ft		18
260	ft	TO	270	ft		28
270	ft	TO	280	ft		40
280	ft	TO	290	ft		40
290	ft	TO	300	ft		31
300	ft	TO	310	ft		37
310	ft	TO	320	ft		32
320	ft	TO	330	ft		38
330	ft	TO	340	ft		34
340	ft	TO	350	ft		53
350	ft	TO	360	ft		60
360	ft	TO	370	ft		65
370	ft	TO	380	ft		42
380	ft	TO	390	ft		44
390	ft	TO	400	ft		26
400	ft	TO	410	ft		46
410	ft	TO	420	ft		30
420	ft	TO	430	ft		29
430	ft	TO	440	ft		31
440	ft	TO	450	ft		16
450	ft	TO	460	ft		15
460	ft	TO	470	ft		10
470	ft	TO	480	ft		13
480	ft	TO	490	ft		8
490	ft	TO	500	ft		9
500	ft	TO	510	ft		3
510	ft	TO	520	ft		12
520	ft	TO	530	ft		4
530	ft	TO	540	ft		4
540	ft	TO	550	ft		3
550	ft	TO	560	ft		6
560	ft	TO	570	ft		4
570	ft	TO	580	ft		3
580	ft	TO	590	ft		3
600	ft	TO	610	ft		1
630	ft	TO	640	ft		2
640	ft	TO	650	ft		2
650	ft	TO	660	ft		1
680	ft	TO	690	ft		2
700	ft	TO	710	ft		2
710	ft	TO	720	ft		4
720	ft	TO	730	ft		3
730	ft	TO	740	ft		2
740	ft	TO	750	ft		2
750	ft	TO	760	ft		1
760	ft	TO	770	ft		4
770	ft	TO	780	ft		3
780	ft	TO	790	ft		6
790	ft	TO	800	ft		4

800	ft	TO	810	ft	1
810	ft	TO	820	ft	2
830	ft	TO	840	ft	1
840	ft	TO	850	ft	3
850	ft	TO	860	ft	2
860	ft	TO	870	ft	1
870	ft	TO	880	ft	2
890	ft	TO	900	ft	1
910	ft	TO	920	ft	1
920	ft	TO	930	ft	2
960	ft	TO	970	ft	1
1270	ft	TO	1280	ft	1

**CRSP3 **

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

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RILDXS4.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 27
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8650 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS4.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	10.0 ,8750.0
2	1.00	.87	.37	10.0 ,8750.0	20.0 ,8700.0
3	1.00	.87	.37	20.0 ,8700.0	65.0 ,8650.0
4	1.00	.87	.37	65.0 ,8650.0	100.0 ,8600.0
5	5.00	.82	.33	100.0 ,8600.0	150.0 ,8550.0
6	5.00	.82	.33	150.0 ,8550.0	230.0 ,8500.0
7	5.00	.82	.33	230.0 ,8500.0	285.0 ,8450.0
8	5.00	.82	.33	285.0 ,8450.0	350.0 ,8400.0
9	5.00	.82	.33	350.0 ,8400.0	420.0 ,8350.0
10	5.00	.82	.33	420.0 ,8350.0	485.0 ,8300.0
11	5.00	.82	.33	485.0 ,8300.0	520.0 ,8250.0
12	5.00	.82	.33	520.0 ,8250.0	570.0 ,8200.0
13	5.00	.82	.33	570.0 ,8200.0	645.0 ,8150.0
14	5.00	.82	.33	645.0 ,8150.0	730.0 ,8100.0
15	5.00	.82	.33	730.0 ,8100.0	830.0 ,8050.0
16	5.00	.82	.33	830.0 ,8050.0	900.0 ,8000.0
17	5.00	.82	.33	900.0 ,8000.0	985.0 ,7950.0
18	5.00	.82	.33	985.0 ,7950.0	1055.0 ,7900.0
19	5.00	.82	.33	1055.0 ,7900.0	1095.0 ,7850.0
20	5.00	.82	.33	1095.0 ,7850.0	1140.0 ,7800.0
21	5.00	.82	.33	1140.0 ,7800.0	1255.0 ,7750.0
22	5.00	.82	.33	1255.0 ,7750.0	1395.0 ,7700.0
23	5.00	.82	.33	1395.0 ,7700.0	1570.0 ,7663.0
24	5.00	.82	.33	1570.0 ,7663.0	1660.0 ,7650.0
25	5.00	.82	.33	1660.0 ,7650.0	1688.0 ,7640.0
26	5.00	.82	.33	1688.0 ,7640.0	1725.0 ,7640.0
27	5.00	.82	.33	1725.0 ,7640.0	1740.0 ,7650.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS4.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	54	27	10.76	8	27
2	78	39	15.79	13	58
3	74	40	13.30	4	20
4	90	58	11.69	10	39
5	93	49	17.43	9	32
6	82	37	16.90	4	21
7	95	43	19.82	7	35
8	103	39	18.78	5	26
9	98	36	17.89	4	25
10	92	37	19.69	5	28
11	107	52	20.72	12	43
12	111	49	21.21	8	36
13	76	38	18.25	4	20
14	65	32	15.82	4	13
15	61	38	15.08	6	18
16	77	41	17.43	5	10
17	61	42	12.47	4	11
18	64	41	23.42	5	11
19	54	41	8.67	6	19
20	70	51	23.21	9	27
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				

X INTERVAL			ROCKS STOPPED
100 ft	TO	110 ft	7
110 ft	TO	120 ft	6
120 ft	TO	130 ft	7
130 ft	TO	140 ft	5
140 ft	TO	150 ft	10
150 ft	TO	160 ft	48
160 ft	TO	170 ft	47
170 ft	TO	180 ft	40
180 ft	TO	190 ft	39
190 ft	TO	200 ft	49
200 ft	TO	210 ft	40
210 ft	TO	220 ft	42
220 ft	TO	230 ft	48
230 ft	TO	240 ft	16
240 ft	TO	250 ft	14
250 ft	TO	260 ft	11
260 ft	TO	270 ft	10
270 ft	TO	280 ft	12
280 ft	TO	290 ft	22
290 ft	TO	300 ft	14
300 ft	TO	310 ft	18
310 ft	TO	320 ft	21
320 ft	TO	330 ft	20
330 ft	TO	340 ft	8
340 ft	TO	350 ft	14
350 ft	TO	360 ft	19
360 ft	TO	370 ft	19
370 ft	TO	380 ft	23
380 ft	TO	390 ft	22
390 ft	TO	400 ft	19
400 ft	TO	410 ft	18
410 ft	TO	420 ft	24
420 ft	TO	430 ft	16
430 ft	TO	440 ft	14
440 ft	TO	450 ft	16
450 ft	TO	460 ft	10
460 ft	TO	470 ft	11
470 ft	TO	480 ft	13
480 ft	TO	490 ft	4
490 ft	TO	500 ft	1
500 ft	TO	510 ft	2
520 ft	TO	530 ft	6
530 ft	TO	540 ft	7
540 ft	TO	550 ft	6
550 ft	TO	560 ft	5
560 ft	TO	570 ft	3
570 ft	TO	580 ft	10
580 ft	TO	590 ft	5
590 ft	TO	600 ft	10
600 ft	TO	610 ft	5
610 ft	TO	620 ft	4
620 ft	TO	630 ft	6
630 ft	TO	640 ft	7
640 ft	TO	650 ft	10
650 ft	TO	660 ft	10
660 ft	TO	670 ft	3
670 ft	TO	680 ft	13
680 ft	TO	690 ft	6
690 ft	TO	700 ft	7

700 ft	TO	710 ft		12
710 ft	TO	720 ft		8
720 ft	TO	730 ft		5
730 ft	TO	740 ft		6
740 ft	TO	750 ft		4
750 ft	TO	760 ft		5
760 ft	TO	770 ft		9
770 ft	TO	780 ft		3
780 ft	TO	790 ft		2
790 ft	TO	800 ft		5
800 ft	TO	810 ft		4
810 ft	TO	820 ft		2
820 ft	TO	830 ft		2
860 ft	TO	870 ft		1
890 ft	TO	900 ft		1
900 ft	TO	910 ft		1
930 ft	TO	940 ft		1
940 ft	TO	950 ft		1
1010 ft	TO	1020 ft		1
1140 ft	TO	1150 ft		1
1160 ft	TO	1170 ft		2
1210 ft	TO	1220 ft		1
1230 ft	TO	1240 ft		1

CRSP3 *

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

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RILDXS5.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 28
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8600 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS5.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	25.0 ,8700.0
2	1.00	.87	.37	25.0 ,8700.0	50.0 ,8650.0
3	1.00	.87	.37	50.0 ,8650.0	70.0 ,8600.0
4	5.00	.82	.33	70.0 ,8600.0	135.0 ,8550.0
5	5.00	.82	.33	135.0 ,8550.0	235.0 ,8500.0
6	5.00	.82	.33	235.0 ,8500.0	330.0 ,8450.0
7	5.00	.82	.33	330.0 ,8450.0	450.0 ,8400.0
8	5.00	.82	.33	450.0 ,8400.0	530.0 ,8350.0
9	5.00	.82	.33	530.0 ,8350.0	610.0 ,8300.0
10	5.00	.82	.33	610.0 ,8300.0	695.0 ,8250.0
11	5.00	.82	.33	695.0 ,8250.0	780.0 ,8200.0
12	5.00	.82	.33	780.0 ,8200.0	875.0 ,8150.0
13	5.00	.82	.33	875.0 ,8150.0	1015.0 ,8100.0
14	5.00	.82	.33	1015.0 ,8100.0	1110.0 ,8050.0
15	5.00	.82	.33	1110.0 ,8050.0	1175.0 ,8000.0
16	5.00	.82	.33	1175.0 ,8000.0	1240.0 ,7950.0
17	5.00	.82	.33	1240.0 ,7950.0	1370.0 ,7900.0
18	5.00	.82	.33	1370.0 ,7900.0	1475.0 ,7850.0
19	5.00	.82	.33	1475.0 ,7850.0	1585.0 ,7800.0
20	5.00	.82	.33	1585.0 ,7800.0	1700.0 ,7750.0
21	5.00	.82	.33	1700.0 ,7750.0	1850.0 ,7700.0
22	5.00	.82	.33	1850.0 ,7700.0	2045.0 ,7650.0
23	5.00	.82	.33	2045.0 ,7650.0	2085.0 ,7640.0
24	5.00	.82	.33	2085.0 ,7640.0	2120.0 ,7630.0
25	5.00	.82	.33	2120.0 ,7630.0	2175.0 ,7620.0
26	5.00	.82	.33	2175.0 ,7620.0	2210.0 ,7615.0
27	5.00	.82	.33	2210.0 ,7615.0	2265.0 ,7600.0
28	5.00	.82	.33	2265.0 ,7600.0	2330.0 ,7600.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS5.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	68	38	13.55	11	47
2	89	47	17.25	10	42
3	107	55	20.72	15	54
4	75	37	15.60	5	19
5	66	30	14.34	3	19
6	88	32	16.78	3	11
7	43	25	11.37	3	6
8	46	39	0.00	3	5
9	50	32	0.00	5	8
10	43	43	0.00	2	2
11	NO ROCKS PASSED POINT				
12	NO ROCKS PASSED POINT				
13	NO ROCKS PASSED POINT				
14	NO ROCKS PASSED POINT				
15	NO ROCKS PASSED POINT				
16	NO ROCKS PASSED POINT				
17	NO ROCKS PASSED POINT				
18	NO ROCKS PASSED POINT				
19	NO ROCKS PASSED POINT				
20	NO ROCKS PASSED POINT				
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				
28	NO ROCKS PASSED POINT				

X INTERVAL	ROCKS STOPPED
0 ft TO 10 ft	2
70 ft TO 80 ft	128
80 ft TO 90 ft	67
90 ft TO 100 ft	40
100 ft TO 110 ft	34
110 ft TO 120 ft	36
120 ft TO 130 ft	40
130 ft TO 140 ft	49
140 ft TO 150 ft	79
150 ft TO 160 ft	63
160 ft TO 170 ft	60
170 ft TO 180 ft	40
180 ft TO 190 ft	42
190 ft TO 200 ft	40
200 ft TO 210 ft	34
210 ft TO 220 ft	26
220 ft TO 230 ft	33
230 ft TO 240 ft	23
240 ft TO 250 ft	15
250 ft TO 260 ft	26
260 ft TO 270 ft	17
270 ft TO 280 ft	19
280 ft TO 290 ft	10
290 ft TO 300 ft	4
300 ft TO 310 ft	9
310 ft TO 320 ft	7
320 ft TO 330 ft	13
330 ft TO 340 ft	7
340 ft TO 350 ft	7
350 ft TO 360 ft	3
360 ft TO 370 ft	4
370 ft TO 380 ft	3
380 ft TO 390 ft	4
390 ft TO 400 ft	2
400 ft TO 410 ft	2
410 ft TO 420 ft	3
430 ft TO 440 ft	2
440 ft TO 450 ft	1
470 ft TO 480 ft	1
480 ft TO 490 ft	1
530 ft TO 540 ft	1
610 ft TO 620 ft	1
680 ft TO 690 ft	1
720 ft TO 730 ft	1

***CRSP3 **

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

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RILDXS6.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 29
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8600 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS6.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	30.0 ,8750.0
2	1.00	.87	.37	30.0 ,8750.0	70.0 ,8700.0
3	1.00	.87	.37	70.0 ,8700.0	80.0 ,8650.0
4	1.00	.87	.37	80.0 ,8650.0	90.0 ,8600.0
5	5.00	.82	.33	90.0 ,8600.0	135.0 ,8550.0
6	5.00	.82	.33	135.0 ,8550.0	220.0 ,8500.0
7	5.00	.82	.33	220.0 ,8500.0	290.0 ,8450.0
8	5.00	.82	.33	290.0 ,8450.0	360.0 ,8400.0
9	5.00	.82	.33	360.0 ,8400.0	420.0 ,8350.0
10	5.00	.82	.33	420.0 ,8350.0	505.0 ,8300.0
11	5.00	.82	.33	505.0 ,8300.0	600.0 ,8250.0
12	5.00	.82	.33	600.0 ,8250.0	655.0 ,8200.0
13	5.00	.82	.33	655.0 ,8200.0	730.0 ,8150.0
14	5.00	.82	.33	730.0 ,8150.0	825.0 ,8100.0
15	5.00	.82	.33	825.0 ,8100.0	880.0 ,8050.0
16	5.00	.82	.33	880.0 ,8050.0	940.0 ,8000.0
17	5.00	.82	.33	940.0 ,8000.0	1005.0 ,7950.0
18	5.00	.82	.33	1005.0 ,7950.0	1135.0 ,7900.0
19	5.00	.82	.33	1135.0 ,7900.0	1240.0 ,7850.0
20	5.00	.82	.33	1240.0 ,7850.0	1350.0 ,7800.0
21	5.00	.82	.33	1350.0 ,7800.0	1465.0 ,7750.0
22	5.00	.82	.33	1465.0 ,7750.0	1615.0 ,7700.0
23	5.00	.82	.33	1615.0 ,7700.0	1810.0 ,7650.0
24	5.00	.82	.33	1810.0 ,7650.0	1850.0 ,7640.0
25	5.00	.82	.33	1850.0 ,7640.0	1885.0 ,7630.0
26	5.00	.82	.33	1885.0 ,7630.0	1940.0 ,7620.0
27	5.00	.82	.33	1940.0 ,7620.0	1975.0 ,7615.0
28	5.00	.82	.33	1975.0 ,7615.0	2030.0 ,7600.0
29	5.00	.82	.33	2030.0 ,7600.0	2095.0 ,7600.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS6.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

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CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	51	28	9.80	3	13
2	66	36	12.85	4	17
3	74	41	14.22	28	58
4	84	50	17.02	-27	97
5	118	52	28.63	12	88
6	68	31	14.00	3	15
7	75	33	15.24	4	20
8	71	32	15.90	4	17
9	81	37	17.31	6	36
10	59	30	15.40	3	14
11	51	34	17.44	3	12
12	73	42	22.00	6	25
13	54	37	11.90	6	12
14	50	50	0.00	6	6
15	45	45	0.00	14	14
16	52	52	0.00	2	2
17	34	34	0.00	15	15
18	NO ROCKS PASSED POINT				
19	NO ROCKS PASSED POINT				
20	NO ROCKS PASSED POINT				
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				
28	NO ROCKS PASSED POINT				
29	NO ROCKS PASSED POINT				

X INTERVAL	ROCKS STOPPED
0 ft TO 10 ft	3
90 ft TO 100 ft	90
100 ft TO 110 ft	25
110 ft TO 120 ft	23
120 ft TO 130 ft	18
130 ft TO 140 ft	54
140 ft TO 150 ft	75
150 ft TO 160 ft	93
160 ft TO 170 ft	73
170 ft TO 180 ft	53
180 ft TO 190 ft	45
190 ft TO 200 ft	37
200 ft TO 210 ft	43
210 ft TO 220 ft	33
220 ft TO 230 ft	24
230 ft TO 240 ft	17
240 ft TO 250 ft	15
250 ft TO 260 ft	28
260 ft TO 270 ft	27
270 ft TO 280 ft	19
280 ft TO 290 ft	16
290 ft TO 300 ft	8
300 ft TO 310 ft	18
310 ft TO 320 ft	13
320 ft TO 330 ft	10
330 ft TO 340 ft	6
340 ft TO 350 ft	10
350 ft TO 360 ft	6
360 ft TO 370 ft	6
370 ft TO 380 ft	8
380 ft TO 390 ft	5
390 ft TO 400 ft	7
400 ft TO 410 ft	4
410 ft TO 420 ft	2
420 ft TO 430 ft	9
430 ft TO 440 ft	7
440 ft TO 450 ft	14
450 ft TO 460 ft	7
460 ft TO 470 ft	4
470 ft TO 480 ft	4
480 ft TO 490 ft	2
490 ft TO 500 ft	4
500 ft TO 510 ft	8
510 ft TO 520 ft	5
520 ft TO 530 ft	6
530 ft TO 540 ft	1
540 ft TO 550 ft	2
550 ft TO 560 ft	1
570 ft TO 580 ft	1
580 ft TO 590 ft	1
640 ft TO 650 ft	1
660 ft TO 670 ft	2
680 ft TO 690 ft	2
750 ft TO 760 ft	2
780 ft TO 790 ft	1
800 ft TO 810 ft	1
1010 ft TO 1020 ft	1

***CRSP3 ***

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

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RILDXS7.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 33
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8600 ft TO 8800 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE
RILDXS7.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8800.0	25.0 ,8750.0
2	1.00	.87	.37	25.0 ,8750.0	55.0 ,8700.0
3	1.00	.87	.37	55.0 ,8700.0	100.0 ,8650.0
4	1.00	.87	.37	100.0 ,8650.0	130.0 ,8600.0
5	5.00	.82	.33	130.0 ,8600.0	170.0 ,8550.0
6	5.00	.82	.33	170.0 ,8550.0	255.0 ,8500.0
7	5.00	.82	.33	255.0 ,8500.0	335.0 ,8450.0
8	5.00	.82	.33	335.0 ,8450.0	400.0 ,8400.0
9	5.00	.82	.33	400.0 ,8400.0	470.0 ,8350.0
10	5.00	.82	.33	470.0 ,8350.0	550.0 ,8300.0
11	5.00	.82	.33	550.0 ,8300.0	640.0 ,8250.0
12	5.00	.82	.33	640.0 ,8250.0	725.0 ,8200.0
13	5.00	.82	.33	725.0 ,8200.0	795.0 ,8150.0
14	5.00	.82	.33	795.0 ,8150.0	865.0 ,8100.0
15	5.00	.82	.33	865.0 ,8100.0	935.0 ,8050.0
16	5.00	.82	.33	935.0 ,8050.0	1025.0 ,8000.0
17	5.00	.82	.33	1025.0 ,8000.0	1095.0 ,7950.0
18	5.00	.82	.33	1095.0 ,7950.0	1190.0 ,7900.0
19	5.00	.82	.33	1190.0 ,7900.0	1280.0 ,7850.0
20	5.00	.82	.33	1280.0 ,7850.0	1345.0 ,7800.0
21	5.00	.82	.33	1345.0 ,7800.0	1440.0 ,7750.0
22	5.00	.82	.33	1440.0 ,7750.0	1525.0 ,7700.0
23	5.00	.82	.33	1525.0 ,7700.0	1600.0 ,7650.0
24	5.00	.82	.33	1600.0 ,7650.0	1685.0 ,7600.0
25	5.00	.82	.33	1685.0 ,7600.0	1805.0 ,7550.0
26	5.00	.82	.33	1805.0 ,7550.0	1835.0 ,7540.0
27	5.00	.82	.33	1835.0 ,7540.0	1875.0 ,7530.0
28	5.00	.82	.33	1875.0 ,7530.0	1910.0 ,7520.0
29	5.00	.82	.33	1910.0 ,7520.0	1945.0 ,7510.0
30	5.00	.82	.33	1945.0 ,7520.0	2055.0 ,7500.0
31	5.00	.82	.33	2055.0 ,7500.0	2100.0 ,7490.0
32	5.00	.82	.33	2100.0 ,7490.0	2130.0 ,7490.0
33	5.00	.82	.33	2130.0 ,7490.0	2150.0 ,7500.0

CELL DATA OUTPUT

RILDXS7.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	52	29	11.00	4	17
2	74	38	13.74	6	26
3	84	43	14.98	5	21
4	93	53	19.21	11	43
5	106	51	21.75	10	50
6	79	34	15.99	4	23
7	81	33	16.58	4	15
8	88	37	17.61	4	20
9	74	36	15.32	4	27
10	75	33	15.44	4	16
11	58	30	14.81	3	17
12	79	40	24.43	5	11
13	55	35	16.28	6	19
14	52	30	0.00	5	12
15	48	45	0.00	4	5
16	58	58	0.00	6	6
17	NO ROCKS PASSED POINT				
18	NO ROCKS PASSED POINT				
19	NO ROCKS PASSED POINT				
20	NO ROCKS PASSED POINT				
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				
28	NO ROCKS PASSED POINT				
29	NO ROCKS PASSED POINT				
30	NO ROCKS PASSED POINT				
31	NO ROCKS PASSED POINT				
32	NO ROCKS PASSED POINT				
33	NO ROCKS PASSED POINT				

X INTERVAL	ROCKS STOPPED
0 ft TO 10 ft	3
130 ft TO 140 ft	4
140 ft TO 150 ft	5
150 ft TO 160 ft	2
160 ft TO 170 ft	3
170 ft TO 180 ft	86
180 ft TO 190 ft	66
190 ft TO 200 ft	65
200 ft TO 210 ft	69
210 ft TO 220 ft	57
220 ft TO 230 ft	56
230 ft TO 240 ft	62
240 ft TO 250 ft	32
250 ft TO 260 ft	33
260 ft TO 270 ft	36
270 ft TO 280 ft	27
280 ft TO 290 ft	29
290 ft TO 300 ft	22
300 ft TO 310 ft	34
310 ft TO 320 ft	33
320 ft TO 330 ft	21
330 ft TO 340 ft	17
340 ft TO 350 ft	11
350 ft TO 360 ft	9
360 ft TO 370 ft	16
370 ft TO 380 ft	7
380 ft TO 390 ft	8
390 ft TO 400 ft	8
400 ft TO 410 ft	9
410 ft TO 420 ft	14
420 ft TO 430 ft	10
430 ft TO 440 ft	7
440 ft TO 450 ft	5
450 ft TO 460 ft	8
460 ft TO 470 ft	9
470 ft TO 480 ft	12
480 ft TO 490 ft	4
490 ft TO 500 ft	3
500 ft TO 510 ft	8
510 ft TO 520 ft	8
520 ft TO 530 ft	11
530 ft TO 540 ft	6
540 ft TO 550 ft	8
550 ft TO 560 ft	5
560 ft TO 570 ft	3
570 ft TO 580 ft	5
580 ft TO 590 ft	4
590 ft TO 600 ft	2
600 ft TO 610 ft	4
610 ft TO 620 ft	5
620 ft TO 630 ft	3
630 ft TO 640 ft	1
640 ft TO 650 ft	3
650 ft TO 660 ft	2
660 ft TO 670 ft	2
670 ft TO 680 ft	3
680 ft TO 690 ft	1
690 ft TO 700 ft	5
720 ft TO 730 ft	1
750 ft TO 760 ft	1
760 ft TO 770 ft	1

770 ft	TO	780 ft	1
790 ft	TO	800 ft	1
860 ft	TO	870 ft	1
870 ft	TO	880 ft	1
930 ft	TO	940 ft	1
1070 ft	TO	1080 ft	1

**CRSP3 **

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

THIS PROGRAM HAS BEEN TESTED AND IS BELIEVED TO BE A RELABLE ENGINEERING TOOL NO RESPONSIBILITY IS ASSUMED BY THE AUTHOR(S) FOR ANY ERRORS, MISTAKES, OR MISREPRESENTATIONS THAT MAY OCCUR FROM ANY USE OF THIS PROGRAM

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RILDXS8A.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 31
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8500 ft TO 8600 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS8A.DAT

SURFACE CELL#	TANGENTIAL ROUGHNESS	NORM. COEF. COEFFICIENT	RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8600.0	50.0 ,8550.0
2	1.00	.87	.37	50.0 ,8550.0	90.0 ,8500.0
3	1.00	.87	.37	90.0 ,8500.0	175.0 ,8450.0
4	1.00	.87	.37	175.0 ,8450.0	285.0 ,8400.0
5	5.00	.82	.33	285.0 ,8400.0	375.0 ,8350.0
6	5.00	.82	.33	375.0 ,8350.0	450.0 ,8300.0
7	5.00	.82	.33	450.0 ,8300.0	575.0 ,8250.0
8	5.00	.82	.33	575.0 ,8250.0	675.0 ,8200.0
9	5.00	.82	.33	675.0 ,8200.0	745.0 ,8150.0
10	5.00	.82	.33	745.0 ,8150.0	830.0 ,8100.0
11	5.00	.82	.33	830.0 ,8100.0	910.0 ,8050.0
12	5.00	.82	.33	910.0 ,8050.0	1015.0 ,8000.0
13	5.00	.82	.33	1015.0 ,8000.0	1150.0 ,7950.0
14	5.00	.82	.33	1150.0 ,7950.0	1285.0 ,7900.0
15	5.00	.82	.33	1285.0 ,7900.0	1420.0 ,7850.0
16	5.00	.82	.33	1420.0 ,7850.0	1560.0 ,7800.0
17	5.00	.82	.33	1560.0 ,7800.0	1650.0 ,7750.0
18	5.00	.82	.33	1650.0 ,7750.0	1730.0 ,7700.0
19	5.00	.82	.33	1730.0 ,7700.0	1835.0 ,7650.0
20	5.00	.82	.33	1835.0 ,7650.0	1865.0 ,7600.0
21	5.00	.82	.33	1865.0 ,7600.0	2010.0 ,7550.0
22	5.00	.82	.33	2010.0 ,7550.0	2170.0 ,7500.0
23	5.00	.82	.33	2170.0 ,7500.0	2260.0 ,7490.0
24	5.00	.82	.33	2260.0 ,7490.0	2310.0 ,7480.0
25	5.00	.82	.33	2310.0 ,7480.0	2350.0 ,7470.0
26	5.00	.82	.33	2350.0 ,7470.0	2395.0 ,7460.0
27	5.00	.82	.33	2395.0 ,7460.0	2505.0 ,7450.0
28	5.00	.82	.33	2505.0 ,7450.0	2580.0 ,7445.0
29	5.00	.82	.33	2580.0 ,7445.0	2610.0 ,7440.0
30	5.00	.82	.33	2610.0 ,7440.0	2705.0 ,7440.0
31	5.00	.82	.33	2705.0 ,7440.0	2720.0 ,7450.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS8A.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	48	25	8.84	2	9
2	68	36	13.26	4	18
3	64	40	8.63	3	13
4	64	39	9.05	3	12
5	74	33	14.85	3	17
6	78	33	14.77	4	21
7	70	27	13.53	3	10
8	60	34	15.81	2	7
9	63	36	20.69	4	9
10	58	39	0.00	8	14
11	63	63	0.00	4	4
12	NO ROCKS PASSED POINT				
13	NO ROCKS PASSED POINT				
14	NO ROCKS PASSED POINT				
15	NO ROCKS PASSED POINT				
16	NO ROCKS PASSED POINT				
17	NO ROCKS PASSED POINT				
18	NO ROCKS PASSED POINT				
19	NO ROCKS PASSED POINT				
20	NO ROCKS PASSED POINT				
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				
28	NO ROCKS PASSED POINT				
29	NO ROCKS PASSED POINT				
30	NO ROCKS PASSED POINT				
31	NO ROCKS PASSED POINT				

X INTERVAL					ROCKS STOPPED
280	ft	TO	290	ft	4
290	ft	TO	300	ft	9
300	ft	TO	310	ft	31
310	ft	TO	320	ft	35
320	ft	TO	330	ft	63
330	ft	TO	340	ft	52
340	ft	TO	350	ft	42
350	ft	TO	360	ft	67
360	ft	TO	370	ft	64
370	ft	TO	380	ft	54
380	ft	TO	390	ft	41
390	ft	TO	400	ft	40
400	ft	TO	410	ft	36
410	ft	TO	420	ft	25
420	ft	TO	430	ft	37
430	ft	TO	440	ft	28
440	ft	TO	450	ft	18
450	ft	TO	460	ft	56
460	ft	TO	470	ft	53
470	ft	TO	480	ft	50
480	ft	TO	490	ft	30
490	ft	TO	500	ft	34
500	ft	TO	510	ft	35
510	ft	TO	520	ft	17
520	ft	TO	530	ft	18
530	ft	TO	540	ft	9
540	ft	TO	550	ft	9
550	ft	TO	560	ft	10
560	ft	TO	570	ft	6
570	ft	TO	580	ft	4
580	ft	TO	590	ft	2
590	ft	TO	600	ft	1
600	ft	TO	610	ft	1
610	ft	TO	620	ft	3
630	ft	TO	640	ft	3
640	ft	TO	650	ft	3
650	ft	TO	660	ft	3
660	ft	TO	670	ft	1
690	ft	TO	700	ft	1
750	ft	TO	760	ft	1
760	ft	TO	770	ft	1
810	ft	TO	820	ft	1
900	ft	TO	910	ft	1
950	ft	TO	960	ft	1

***CRSP3 ***

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

THIS PROGRAM HAS BEEN TESTED AND IS BELIEVED TO BE A RELABLE ENGINEERING TOOL NO RESPONSIBILITY IS ASSUMED BY THE AUTHOR(S) FOR ANY ERRORS, MISTAKES, OR MISREPRESENTATIONS THAT MAY OCCUR FROM ANY USE OF THIS PROGRAM

****

RILDXS9.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 33
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8550 ft TO 8700 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE

RILDXS9A.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8700.0	15.0 ,8650.0
2	1.00	.87	.37	15.0 ,8650.0	30.0 ,8600.0
3	1.00	.87	.37	30.0 ,8600.0	65.0 ,8550.0
4	1.00	.87	.37	65.0 ,8550.0	130.0 ,8500.0
5	5.00	.87	.33	130.0 ,8500.0	195.0 ,8450.0
6	5.00	.87	.33	195.0 ,8450.0	275.0 ,8400.0
7	5.00	.82	.33	275.0 ,8400.0	345.0 ,8350.0
8	5.00	.82	.33	345.0 ,8350.0	420.0 ,8300.0
9	5.00	.82	.33	420.0 ,8300.0	485.0 ,8250.0
10	5.00	.82	.33	485.0 ,8250.0	555.0 ,8200.0
11	5.00	.82	.33	555.0 ,8200.0	610.0 ,8150.0
12	5.00	.82	.33	610.0 ,8150.0	670.0 ,8100.0
13	5.00	.82	.33	670.0 ,8100.0	745.0 ,8050.0
14	5.00	.82	.33	745.0 ,8050.0	820.0 ,8000.0
15	5.00	.82	.33	820.0 ,8000.0	920.0 ,7950.0
16	5.00	.82	.33	920.0 ,7950.0	1055.0 ,7900.0
17	5.00	.82	.33	1055.0 ,7900.0	1190.0 ,7850.0
18	5.00	.82	.33	1190.0 ,7850.0	1330.0 ,7800.0
19	5.00	.82	.33	1330.0 ,7800.0	1420.0 ,7750.0
20	5.00	.82	.33	1420.0 ,7750.0	1500.0 ,7700.0
21	5.00	.82	.33	1500.0 ,7700.0	1605.0 ,7650.0
22	5.00	.82	.33	1605.0 ,7650.0	1635.0 ,7600.0
23	5.00	.82	.33	1635.0 ,7600.0	1780.0 ,7550.0
24	5.00	.82	.33	1780.0 ,7550.0	1940.0 ,7500.0
25	5.00	.82	.33	1940.0 ,7500.0	2030.0 ,7490.0
26	5.00	.82	.33	2030.0 ,7490.0	2080.0 ,7480.0
27	5.00	.82	.33	2080.0 ,7480.0	2120.0 ,7470.0
28	5.00	.82	.33	2120.0 ,7470.0	2165.0 ,7460.0
29	5.00	.82	.33	2165.0 ,7460.0	2275.0 ,7450.0
30	5.00	.82	.33	2275.0 ,7450.0	2350.0 ,7445.0
31	5.00	.82	.33	2350.0 ,7445.0	2380.0 ,7440.0
32	5.00	.82	.33	2380.0 ,7440.0	2475.0 ,7440.0
33	5.00	.82	.33	2475.0 ,7440.0	2490.0 ,7450.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS9.DAT

REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	51	28	9.78	5	23
2	73	38	13.62	12	44
3	87	43	15.18	6	25
4	76	49	10.73	5	21
5	90	46	17.80	6	25
6	85	37	17.13	4	21
7	91	38	18.84	5	31
8	86	36	17.87	4	21
9	85	38	19.38	4	38
10	104	37	18.92	4	18
11	90	41	19.71	6	34
12	97	42	20.92	5	25
13	75	36	17.56	5	26
14	75	31	16.44	4	13
15	69	53	0.00	3	6
16	NO ROCKS PASSED POINT				
17	NO ROCKS PASSED POINT				
18	NO ROCKS PASSED POINT				
19	NO ROCKS PASSED POINT				
20	NO ROCKS PASSED POINT				
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				
28	NO ROCKS PASSED POINT				
29	NO ROCKS PASSED POINT				
30	NO ROCKS PASSED POINT				
31	NO ROCKS PASSED POINT				
32	NO ROCKS PASSED POINT				
33	NO ROCKS PASSED POINT				

X INTERVAL	ROCKS STOPPED
130 ft TO 140 ft	1
140 ft TO 150 ft	3
150 ft TO 160 ft	12
160 ft TO 170 ft	9
170 ft TO 180 ft	21
180 ft TO 190 ft	23
190 ft TO 200 ft	29
200 ft TO 210 ft	43
210 ft TO 220 ft	34
220 ft TO 230 ft	43
230 ft TO 240 ft	53
240 ft TO 250 ft	36
250 ft TO 260 ft	40
260 ft TO 270 ft	40
270 ft TO 280 ft	26
280 ft TO 290 ft	33
290 ft TO 300 ft	28
300 ft TO 310 ft	19
310 ft TO 320 ft	24
320 ft TO 330 ft	27
330 ft TO 340 ft	22
340 ft TO 350 ft	31
350 ft TO 360 ft	37
360 ft TO 370 ft	20
370 ft TO 380 ft	21
380 ft TO 390 ft	17
390 ft TO 400 ft	24
400 ft TO 410 ft	19
410 ft TO 420 ft	23
420 ft TO 430 ft	10
430 ft TO 440 ft	8
440 ft TO 450 ft	12
450 ft TO 460 ft	12
460 ft TO 470 ft	8
470 ft TO 480 ft	10
480 ft TO 490 ft	5
490 ft TO 500 ft	7
500 ft TO 510 ft	13
510 ft TO 520 ft	12
520 ft TO 530 ft	5
530 ft TO 540 ft	7
540 ft TO 550 ft	9
550 ft TO 560 ft	3
560 ft TO 570 ft	4
570 ft TO 580 ft	6
580 ft TO 590 ft	7
590 ft TO 600 ft	4
600 ft TO 610 ft	1
610 ft TO 620 ft	3
620 ft TO 630 ft	2
630 ft TO 640 ft	4
640 ft TO 650 ft	1
650 ft TO 660 ft	1
660 ft TO 670 ft	3
670 ft TO 680 ft	6
680 ft TO 690 ft	4
690 ft TO 700 ft	4
700 ft TO 710 ft	6
710 ft TO 720 ft	6

720	ft	TO	730	ft	6
730	ft	TO	740	ft	4
740	ft	TO	750	ft	4
750	ft	TO	760	ft	2
760	ft	TO	770	ft	2
770	ft	TO	780	ft	1
780	ft	TO	790	ft	4
790	ft	TO	800	ft	7
800	ft	TO	810	ft	3
810	ft	TO	820	ft	3
820	ft	TO	830	ft	2
830	ft	TO	840	ft	1
840	ft	TO	850	ft	4
850	ft	TO	860	ft	2
860	ft	TO	870	ft	3
870	ft	TO	880	ft	1
890	ft	TO	900	ft	2
910	ft	TO	920	ft	5
1000	ft	TO	1010	ft	2
1010	ft	TO	1020	ft	1

**CRSP3 **

COLORADO ROCKFALL SIMULATION PROGRAM

MODELS THE TRAJECTORY OF ROCKS ON IRREGULAR SLOPES USING SLOPE PROFILE, SURFACE ROUGHNESS, SURFACE MATERIAL PROPERTIES ROCK SIZE, AND ROCK SHAPE TO PRODUCE A STATISTICAL ANALYSIS OF ROCKFALL BEHAVIOR ON THE SLOPE

THIS PROGRAM HAS BEEN TESTED AND IS BELIEVED TO BE A RELABLE ENGINEERING TOOL NO RESPONSIBILITY IS ASSUMED BY THE AUTHOR(S) FOR ANY ERRORS, MISTAKES, OR MISREPRESENTATIONS THAT MAY OCCUR FROM ANY USE OF THIS PROGRAM

****

RILDXS10.DAT

ROCK STATISTICS

3519 lbs CYLINDRICAL ROCK 3 ft BY 3 ft

NUMBER OF CELLS 34
NUMBER OF ROCKS 1000
ANALYSIS POSITION 1585 ft
INITIAL Y ZONE 8500 ft TO 8700 ft

INITIAL X VELOCITY 1 ft/sec
INITIAL Y VELOCITY -1 ft/sec

CELL DATA TABLE
RILDXS10.DAT

CELL#	SURFACE ROUGHNESS	TANGENTIAL COEFFICIENT	NORM. COEF. RESTITUTION	BEGINNING X,Y	ENDING X,Y
1	1.00	.87	.37	0.0 ,8700.0	30.0 ,8650.0
2	1.00	..87	.37	30.0 ,8650.0	75.0 ,8600.0
3	1.00	.87	.37	75.0 ,8600.0	115.0 ,8550.0
4	1.00	.87	.37	115.0 ,8550.0	150.0 ,8500.0
5	5.00	.87	.33	150.0 ,8500.0	205.0 ,8450.0
6	5.00	.87	.33	205.0 ,8450.0	255.0 ,8400.0
7	5.00	.82	.33	255.0 ,8400.0	315.0 ,8350.0
8	5.00	.82	.33	315.0 ,8350.0	405.0 ,8300.0
9	5.00	.82	.33	405.0 ,8300.0	475.0 ,8250.0
10	5.00	.82	.33	475.0 ,8250.0	545.0 ,8200.0
11	5.00	.82	.33	545.0 ,8200.0	620.0 ,8150.0
12	5.00	.82	.33	620.0 ,8150.0	695.0 ,8100.0
13	5.00	.82	.33	695.0 ,8100.0	765.0 ,8050.0
14	5.00	.82	.33	765.0 ,8050.0	855.0 ,8000.0
15	5.00	.82	.33	855.0 ,8000.0	925.0 ,7950.0
16	5.00	.82	.33	925.0 ,7950.0	995.0 ,7900.0
17	5.00	.82	.33	995.0 ,7900.0	1085.0 ,7850.0
18	5.00	.82	.33	1085.0 ,7850.0	1175.0 ,7800.0
19	5.00	.82	.33	1175.0 ,7800.0	1270.0 ,7750.0
20	5.00	.82	.33	1270.0 ,7750.0	1355.0 ,7700.0
21	5.00	.82	.33	1355.0 ,7700.0	1455.0 ,7650.0
22	5.00	.82	.33	1455.0 ,7650.0	1555.0 ,7600.0
23	5.00	.82	.33	1555.0 ,7600.0	1645.0 ,7550.0
24	5.00	.82	.33	1645.0 ,7550.0	1715.0 ,7500.0
25	5.00	.82	.33	1715.0 ,7500.0	1815.0 ,7450.0
26	5.00	.82	.33	1815.0 ,7450.0	1900.0 ,7400.0
27	5.00	.82	.33	1900.0 ,7400.0	2045.0 ,7390.0
28	5.00	.82	.33	2045.0 ,7390.0	2105.0 ,7380.0
29	5.00	.82	.33	2105.0 ,7380.0	2150.0 ,7370.0
30	5.00	.82	.33	2150.0 ,7370.0	2250.0 ,7360.0
31	5.00	.82	.33	2250.0 ,7360.0	2335.0 ,7350.0
32	5.00	.82	.33	2335.0 ,7345.0	2435.0 ,7340.0
33	5.00	.82	.33	2435.0 ,7340.0	2505.0 ,7340.0
34	5.00	.82	.33	2505.0 ,7340.0	2530.0 ,7350.0

NO ROCKS PAST ANALYSIS POINT

CELL DATA OUTPUT

RILDXS10.DAT

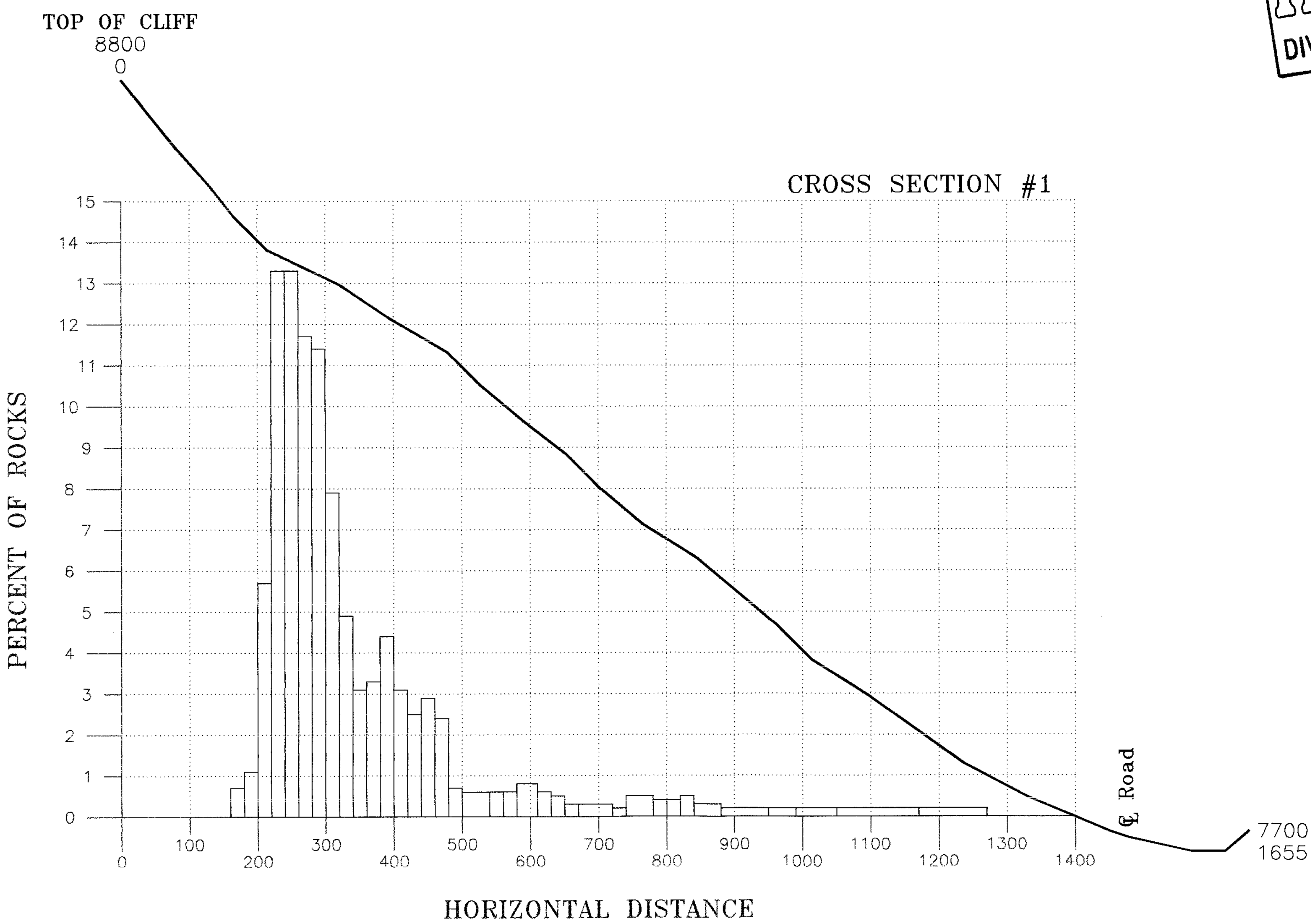
REMARKS:

DATA COLLECTED AT END OF EACH CELL

CELL #	MAXIMUM VELOCITY (ft/sec)	AVERAGE VELOCITY	STANDARD DEVIATION VELOCITY	AVERAGE BOUNCE HEIGHT (ft)	MAXIMUM BOUNCE HEIGHT (ft)
1	48	27	9.92	3	12
2	65	36	12.83	3	14
3	81	44	15.70	6	29
4	93	51	18.69	9	34
5	96	44	17.85	6	32
6	98	49	19.72	8	40
7	102	44	19.82	6	28
8	85	34	17.08	4	24
9	93	37	18.33	5	20
10	82	35	17.43	5	21
11	102	34	19.08	5	21
12	70	36	15.86	4	19
13	82	37	19.63	4	17
14	62	37	15.93	4	11
15	43	27	9.80	7	17
16	55	38	0.00	4	6
17	14	14	0.00	4	4
18	NO ROCKS PASSED POINT				
19	NO ROCKS PASSED POINT				
20	NO ROCKS PASSED POINT				
21	NO ROCKS PASSED POINT				
22	NO ROCKS PASSED POINT				
23	NO ROCKS PASSED POINT				
24	NO ROCKS PASSED POINT				
25	NO ROCKS PASSED POINT				
26	NO ROCKS PASSED POINT				
27	NO ROCKS PASSED POINT				
28	NO ROCKS PASSED POINT				
29	NO ROCKS PASSED POINT				
30	NO ROCKS PASSED POINT				
31	NO ROCKS PASSED POINT				
32	NO ROCKS PASSED POINT				
33	NO ROCKS PASSED POINT				
34	NO ROCKS PASSED POINT				

X INTERVAL			ROCKS STOPPED
0 ft	TO	10 ft	3
150 ft	TO	160 ft	29
160 ft	TO	170 ft	20
170 ft	TO	180 ft	16
180 ft	TO	190 ft	27
190 ft	TO	200 ft	19
200 ft	TO	210 ft	11
210 ft	TO	220 ft	14
220 ft	TO	230 ft	9
230 ft	TO	240 ft	12
240 ft	TO	250 ft	11
250 ft	TO	260 ft	17
260 ft	TO	270 ft	19
270 ft	TO	280 ft	18
280 ft	TO	290 ft	19
290 ft	TO	300 ft	21
300 ft	TO	310 ft	24
310 ft	TO	320 ft	38
320 ft	TO	330 ft	51
330 ft	TO	340 ft	57
340 ft	TO	350 ft	57
350 ft	TO	360 ft	40
360 ft	TO	370 ft	34
370 ft	TO	380 ft	39
380 ft	TO	390 ft	37
390 ft	TO	400 ft	29
400 ft	TO	410 ft	26
410 ft	TO	420 ft	22
420 ft	TO	430 ft	12
430 ft	TO	440 ft	20
440 ft	TO	450 ft	19
450 ft	TO	460 ft	7
460 ft	TO	470 ft	10
470 ft	TO	480 ft	13
480 ft	TO	490 ft	14
490 ft	TO	500 ft	13
500 ft	TO	510 ft	9
510 ft	TO	520 ft	5
520 ft	TO	530 ft	9
530 ft	TO	540 ft	7
540 ft	TO	550 ft	9
550 ft	TO	560 ft	10
560 ft	TO	570 ft	11
570 ft	TO	580 ft	8
580 ft	TO	590 ft	5
590 ft	TO	600 ft	7
600 ft	TO	610 ft	6
610 ft	TO	620 ft	6
620 ft	TO	630 ft	6
630 ft	TO	640 ft	6
640 ft	TO	650 ft	8
650 ft	TO	660 ft	3
660 ft	TO	670 ft	5
670 ft	TO	680 ft	2
680 ft	TO	690 ft	6
690 ft	TO	700 ft	2
700 ft	TO	710 ft	2
710 ft	TO	720 ft	5
730 ft	TO	740 ft	1
740 ft	TO	750 ft	2

750 ft	TO	760 ft	2
760 ft	TO	770 ft	1
770 ft	TO	780 ft	5
780 ft	TO	790 ft	2
790 ft	TO	800 ft	1
800 ft	TO	810 ft	1
810 ft	TO	820 ft	6
820 ft	TO	830 ft	3
840 ft	TO	850 ft	1
900 ft	TO	910 ft	1
910 ft	TO	920 ft	1
940 ft	TO	950 ft	1
960 ft	TO	970 ft	2
980 ft	TO	990 ft	2
1010 ft	TO	1020 ft	1
1040 ft	TO	1050 ft	1
1060 ft	TO	1070 ft	1
1130 ft	TO	1140 ft	1



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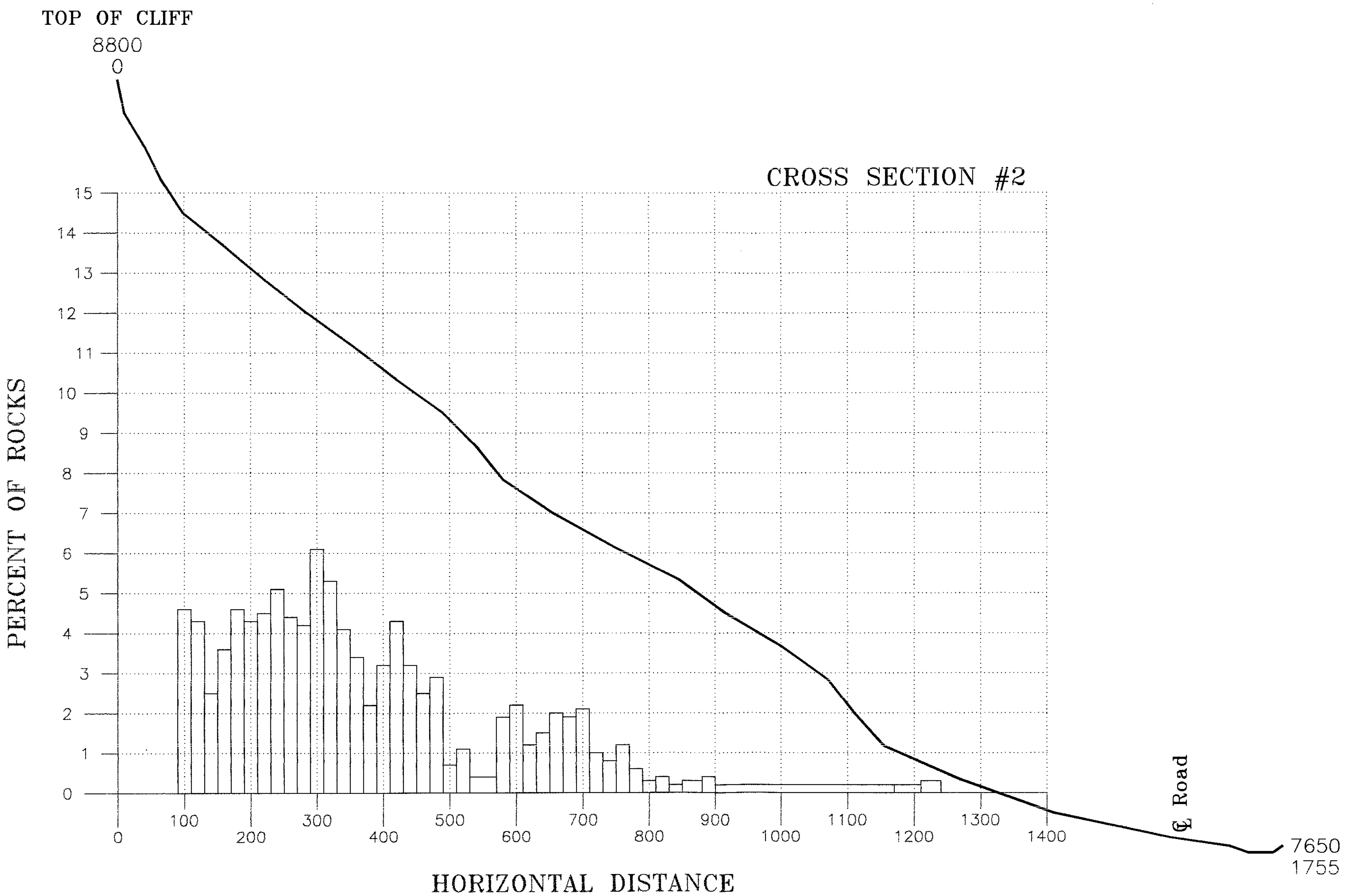
CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

NORTH RILDA RIDGE
CASTLEGATE SANDSTONE
ROCK ROLL PROJECTIONS

DRAWN BY: K. LARSEN	DS1762B	
SCALE: 1" =200'	DRAWING #:	
DATE: MAY 27, 1998	SHEET 1 OF 10	REV.

CROSS SECTION #2

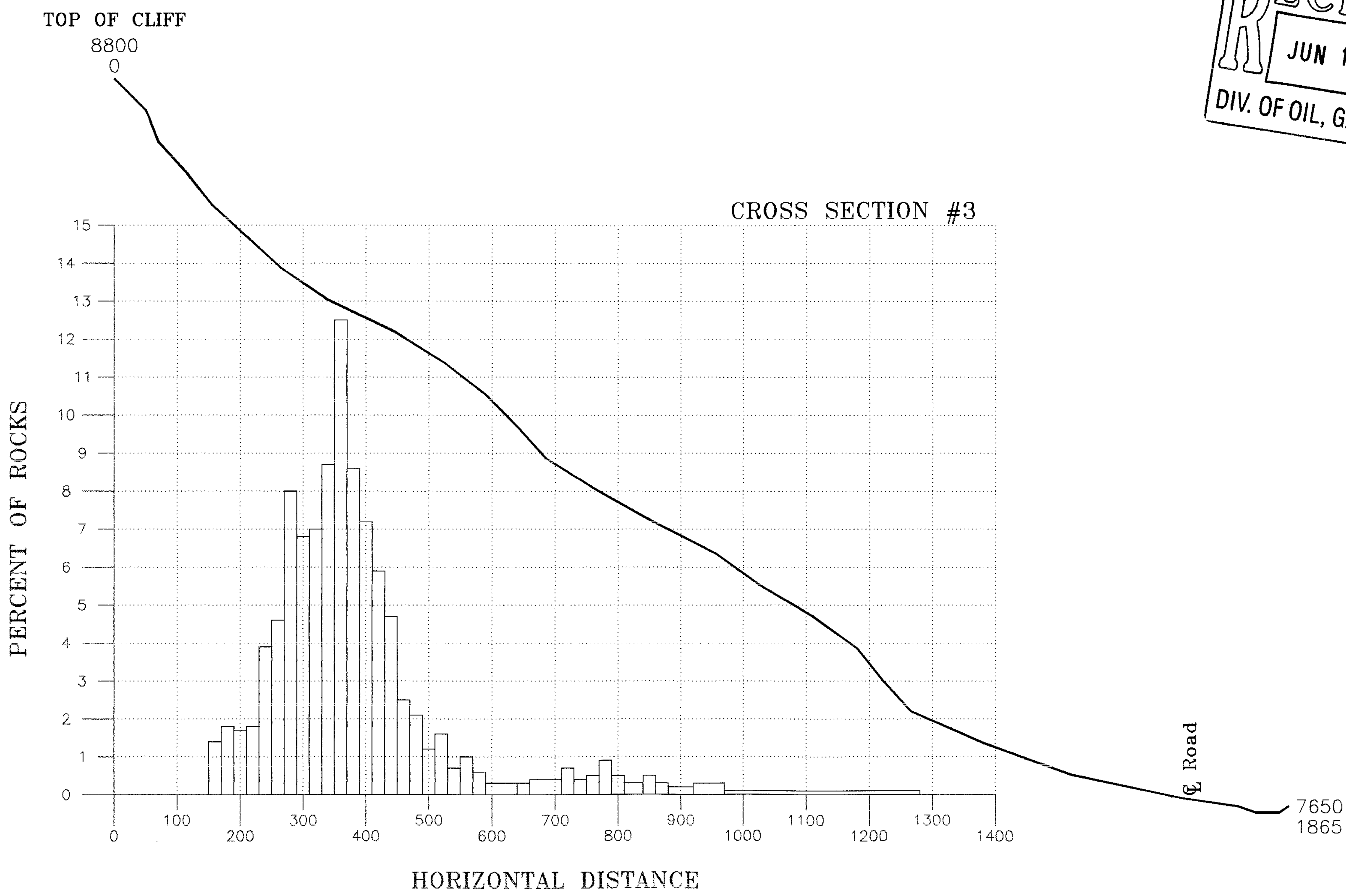


CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

NORTH RILDA RIDGE
CASTLEGATE SANDSTONE
ROCK ROLL PROJECTIONS

DRAWN BY: K. LARSEN		DS1762B	
SCALE: 1"=200'		DRAWING #:	
DATE: MAY 27, 1998		SHEET 2 OF 10	REV. ___



CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

NORTH RILDA RIDGE
CASTLEGATE SANDSTONE
ROCK ROLL PROJECTIONS

DRAWN BY:	*K. LARSEN*	*DS1762B*	
SCALE:	*1" =200'*	DRAWING #:	
DATE:	*MAY 27, 1998*	SHEET *3* OF *10*	REV.

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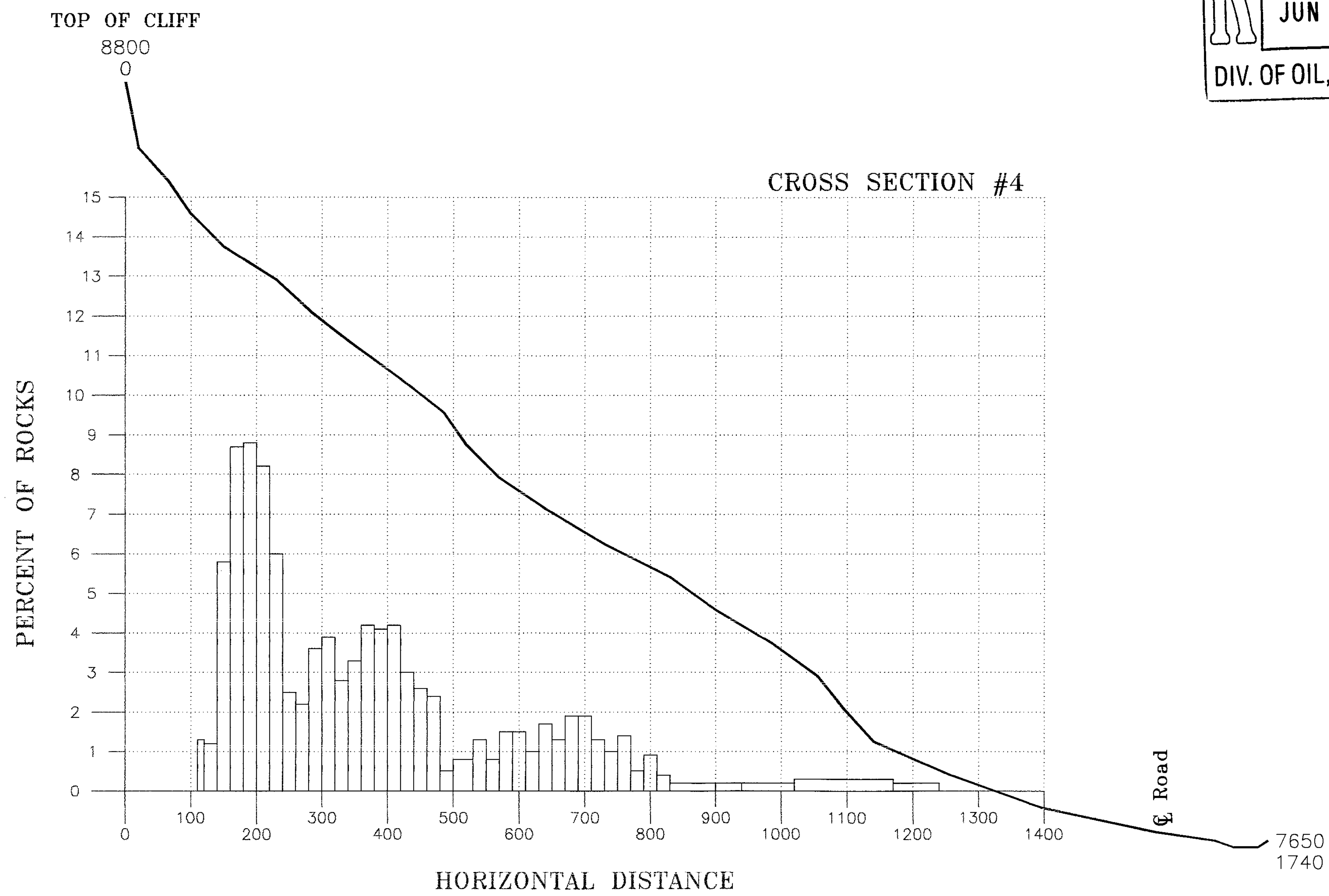
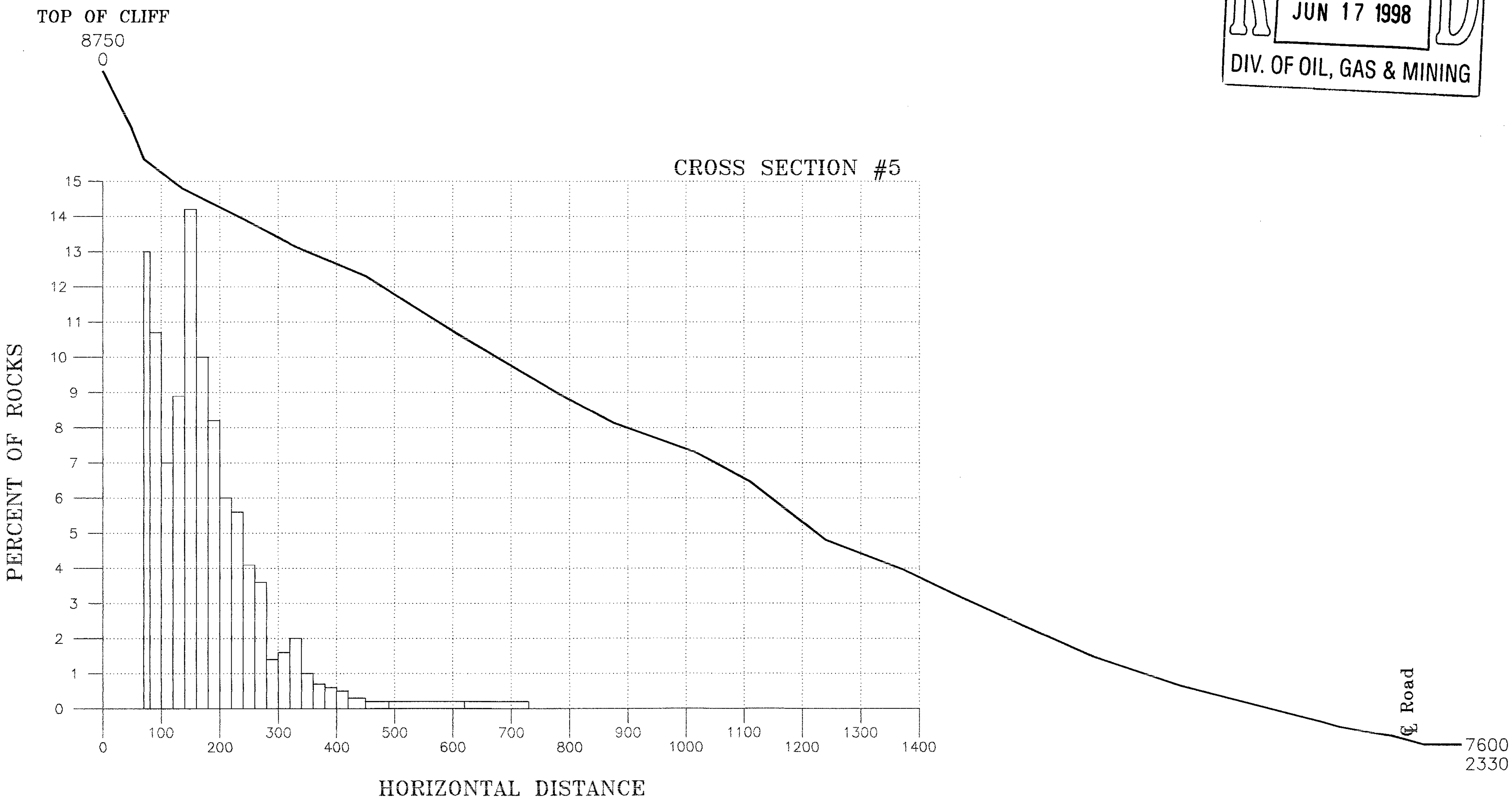


CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST MINING COMPANY HUNTINGTON, UTAH 84528	
NORTH RILDA RIDGE CASTLEGATE SANDSTONE ROCK ROLL PROJECTIONS	
DRAWN BY: *K. LARSEN*	*DS1762B*
SCALE: *1"=200'*	DRAWING #:
DATE: *MAY 27, 1998*	SHEET *4* OF *10* REV.



CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

NORTH RILDA RIDGE
CASTLEGATE SANDSTONE
ROCK ROLL PROJECTIONS

DRAWN BY: K. LARSEN	DS1762B
SCALE: 1"=200'	DRAWING #:
DATE: MAY 27, 1998	SHEET 5 OF 10 REV.

RECEIVED
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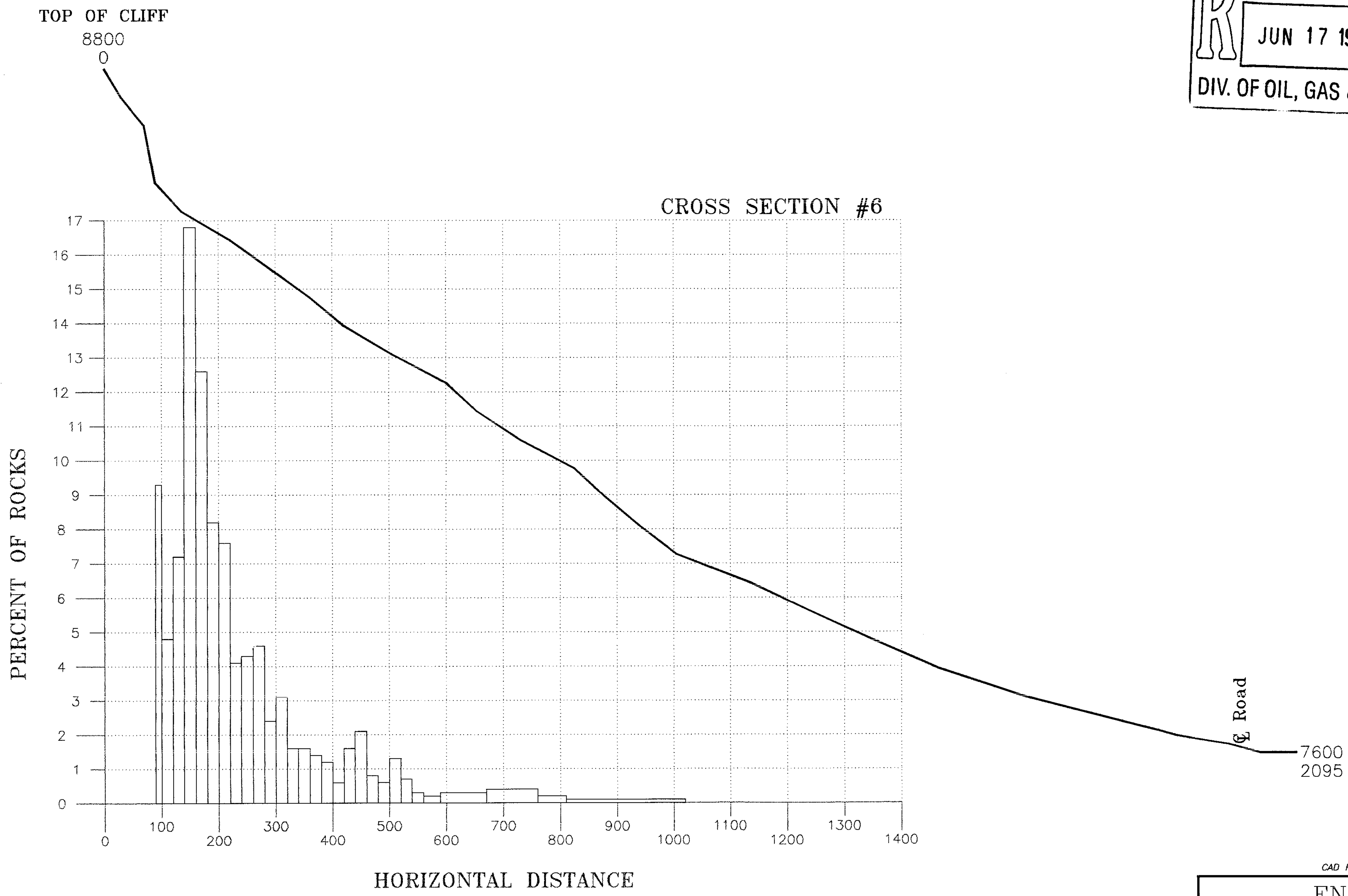
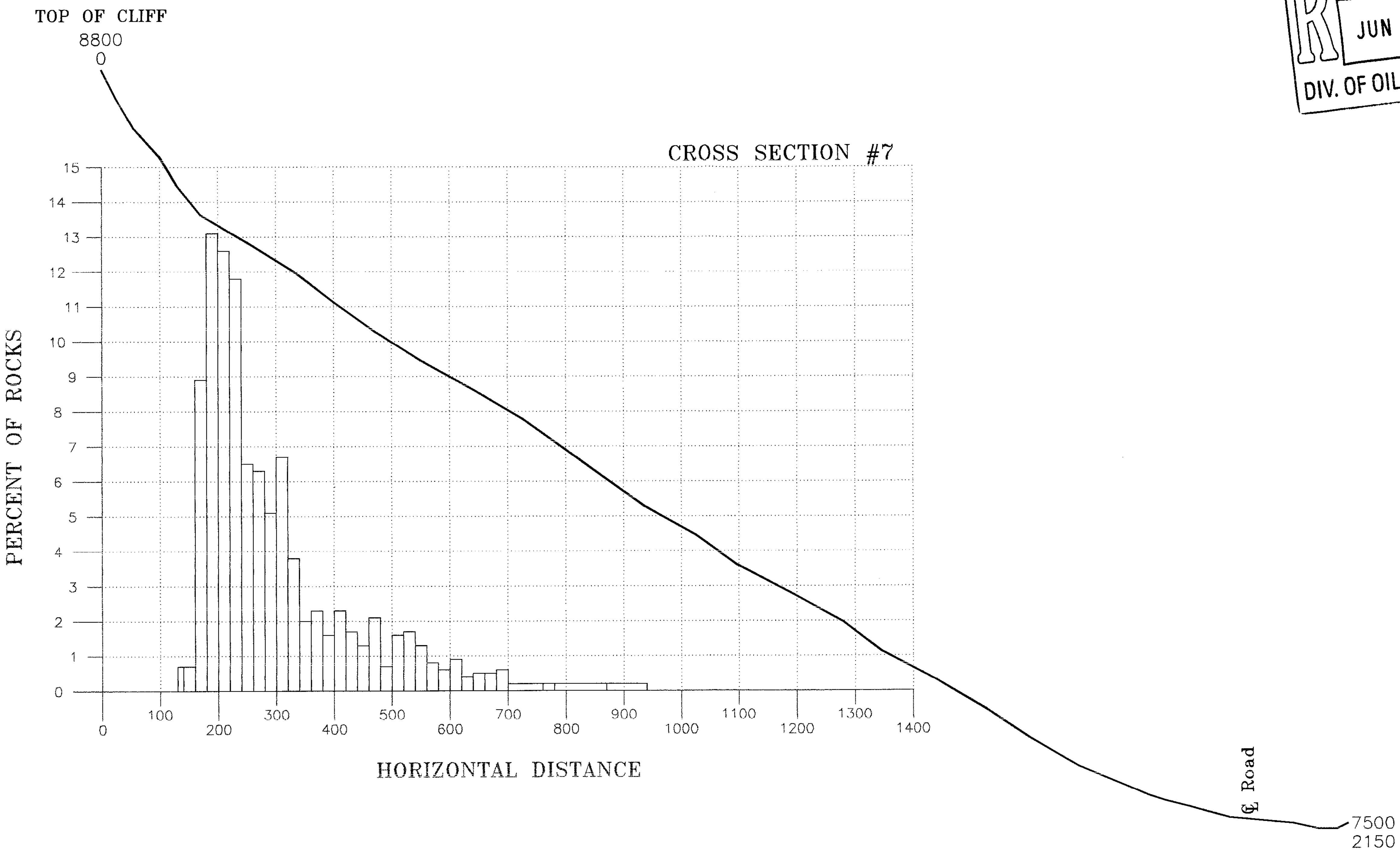
DIV. OF OIL, GAS & MINING



CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST MINING COMPANY HUNTINGTON, UTAH 84528	
NORTH RILDA RIDGE CASTLEGATE SANDSTONE ROCK ROLL PROJECTIONS	
DRAWN BY: *K. LARSEN*	*DS1762B*
SCALE: *1" =200'*	DRAWING #:
DATE: *MAY 27, 1998*	SHEET *6* OF *10* REV. ___



CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST MINING COMPANY HUNTINGTON, UTAH 84528	
NORTH RILDA RIDGE *CASTLEGATE SANDSTONE* *ROCK ROLL PROJECTIONS*	
DRAWN BY: *K. LARSEN*	*DS1762B*
SCALE: *1"=200'*	DRAWING #:
DATE: *MAY 27, 1998*	SHEET *7* OF *10* REV. ___

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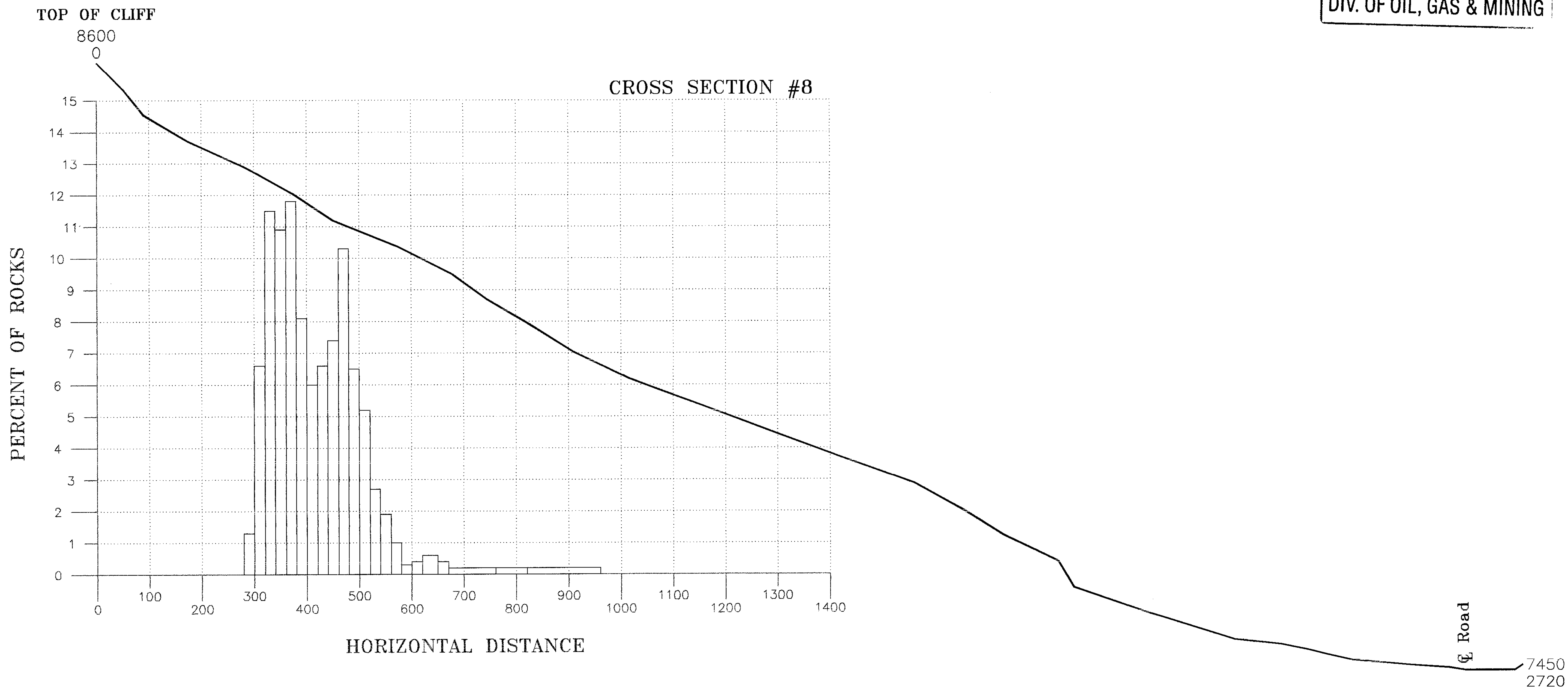

CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST MINING COMPANY HUNTINGTON, UTAH 84528	
NORTH RILDA RIDGE *CASTLEGATE SANDSTONE* *ROCK ROLL PROJECTIONS*	
DRAWN BY: *K. LARSEN*	*DS1762B*
SCALE: *1"=200'*	DRAWING #:
DATE: *MAY 27, 1998*	SHEET *8* OF *10* REV. ___

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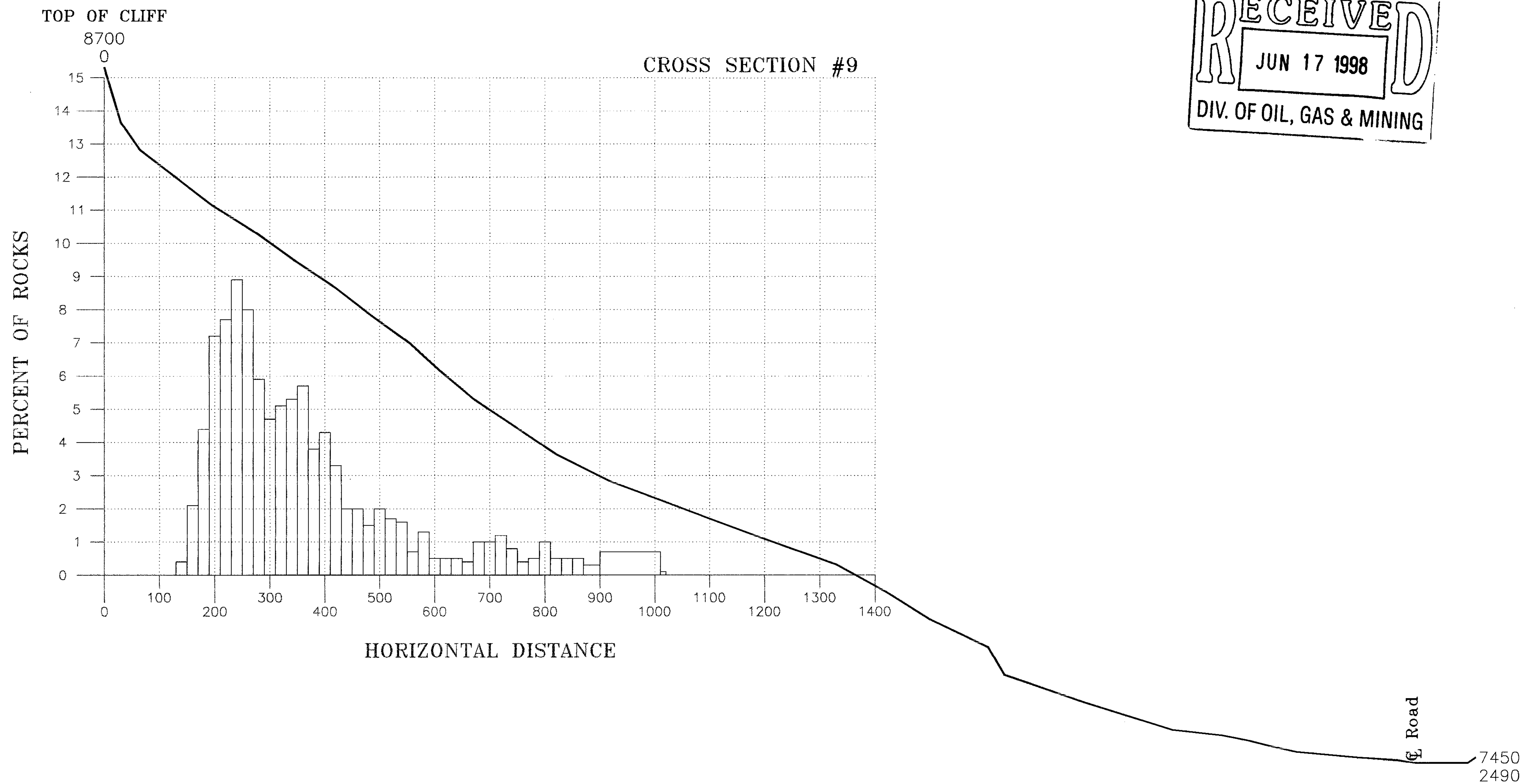
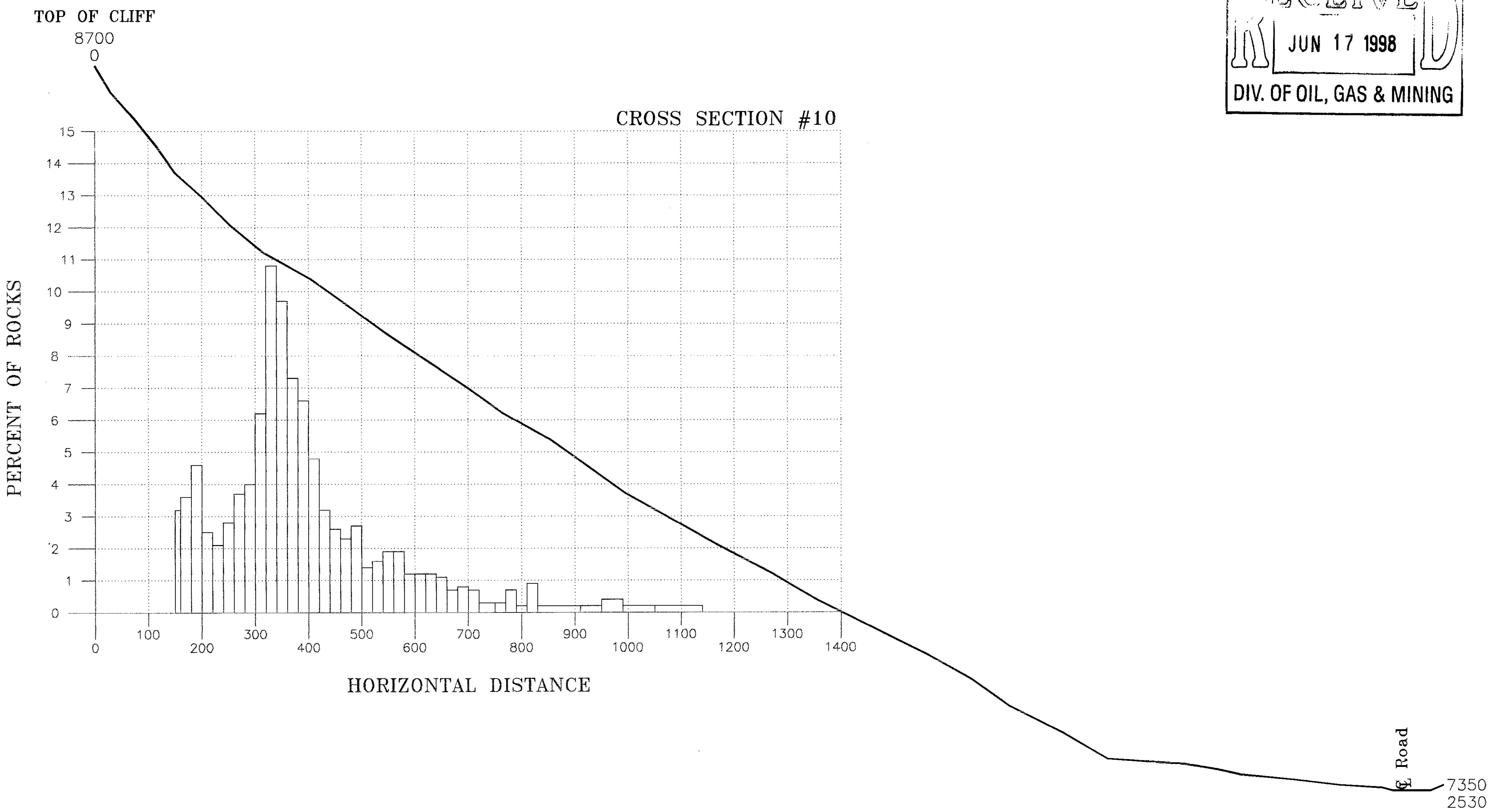


CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

NORTH RILDA RIDGE
CASTLEGATE SANDSTONE
ROCK ROLL PROJECTIONS

DRAWN BY: *K. LARSEN*	*DS1762B*
SCALE: *1"=200'*	DRAWING #:
DATE: *MAY 27, 1998*	SHEET *9* OF *10* REV. ___



CAD FILE NAME/DISK#: USERS\KJL\RILDA\ROCKROLL.DWG

ENERGY WEST MINING COMPANY HUNTINGTON, UTAH 84528	
NORTH RILDA RIDGE *CASTLEGATE SANDSTONE* *ROCK ROLL PROJECTIONS*	
DRAWN BY: *K. LARSEN*	*DS1762B*
SCALE: *1"=200'*	DRAWING #:
DATE: *MAY 27, 1998*	SHEET *10* OF *10* REV. ___