CLAY MINERAL ANALYSIS OF WELL CHIPS AND HAND SAMPLES FROM THE PERMIAN YESO AND ABO FORMATIONS, ROSWELL BASIN AREA, SOUTHEASTERN NEW MEXICO

by

Joan R. Resnick

Submitted in Partial Fulfillment of
the Requirements for the Degree of
Master of Science in Hydrology

New Mexico Institute of Mining and Technology
Socorro, New Mexico

January, 1989

ACKNOWLEDGMENTS

I thank Drs. Gerardo W. Gross and John R. MacMillan for their assistance and guidance in preparation of this report. I also wish to thank Dr. George S. Austin, New Mexico Bureau of Mines and Mineral Resources, for his technical contributions regarding clay mineralogy.

I gratefully acknowledge the New Mexico Water Resources Research Institute for funding the project and Frank Kottlowski (Director), New Mexico Bureau of Mines and Mineral Resources for use of laboratory and support facilities. In addition, I wish to thank Robert Bieberman, Richard Chavez, and the staff at the Petroleum Records Library at the NMBM&MR for providing the well chip samples and support. I would also like to thank the entire staff of the NMBM&MR, who contributed in so many ways.

I am grateful to Tanya Brickell, James Harvey, and Julie Tupper for their help. I would especially like to thank my parents and family for their support. Also, I would like to thank Harlen Smith and Rich Watts of the Bureau of Land Management for their encouragement.

Finally, I would like to thank my editor and dearest companion, Paul W. Bauer, for his unending support throughout this work.

ABSTRACT

Clay mineral analysis, using x-ray diffractometry, was performed on well cuttings and outcrop samples of the Permian Yeso and Abo formations from the Roswell Basin and vicinity of southeastern New Mexico. The three wells sampled were previously studied by Childers and Gross (1985) in a hydrogeophysical investigation of 18 wells. They concluded that clay mineral analysis would aid in the intepretation of permeability and porosity. Potential aquifer and/or high-clay-bearing stratigraphic intervals were sampled to determine whether certain clay mineral assemblages are associated with a particular stratigraphic position, geographic relation to hydraulic gradient, or dominant lithology. Statistical analysis was performed in order to examine possible interrelationships. In addition, laboratory methods were investigated for clay mineral analysis of volumetrically small samples which may have been contaminated by drilling mud.

The relative proportions of clay mineral groups present in all samples were remarkably uniform, and consisted of an average assemblage, in parts per ten, of illite=4, smectite=0, chlorite=2, mixed-layer clays (excluding chlorite group minerals)=2, and kaolinite=1. The presence of a mixed-layered chlorite group mineral in some samples

indicates diagenesis. Similar assemblages of clay minerals have been well documented in evaporite sequences of various ages throughout the world.

TABLE OF CONTENTS

Acknowledgments i
Abstract ii
Table of Contents iv
List of Figures v
List of Tables vi
1. Introduction 1
   A. Purpose of Study 1
   B. Previous Work 2
   C. Physiographic and Geologic Characteristics of the Roswell Basin 3
   D. Stratigraphy and Hydrologic Characteristics ... 7
2. Methods 10
   A. Sample Selection 10
   B. Laboratory Methods 17
   C. Sample Preparation Problems 24
   D. Sample Analysis 25
   E. Analytical Method 29
3. Results 32
   A. Data Characterization 32
   B. Analytical Treatment 43
   C. Results 47
4. Discussion 53
5. Summary of Conclusions 58
6. Recommendation for Future Work 59
References 61
Appendix I. Hand Sample Descriptions 66
Appendix II. Fortran Program for Calculating Relative Proportions of Clay Minerals.................................... 74
Appendix IIIA. Sorts on Semi-Quantitative Database 77
Appendix IIIB. Sorts on Semi-Qualitative Database 85
Appendix IIIC. Sorts on Combined Database 93
Appendix IV. Sorts Using Multiple Criteria for the Combined Database 103

LIST OF FIGURES

Figure 1. Location of study area, wells and outcrops 4

Figure 2. Geologic cross section of Roswell Basin 5

Figure 3. Generalized stratigraphic column Roswell Basin 6

Figure 4. Generalized stratigraphic column of Yeso Fmn 8

Figure 5. Well logs for well no. 2 12

Figure 6. Well logs for well no. 6 13

Figure 7. Well logs for well no. 8 14

Figure 8. Cross section through wells 15

Figure 9. Representative diffractograms for semi-quantitative database 34

Figure 10. Representative diffractogram for "rectorite?" samples 39

Figure 11. Representative diffractograms for subsurface "corrensite?" samples 41

Figure 12. Representative diffractograms for surface "corrensite?" samples 42

LIST OF TABLES

Table 1. Measurements of pre- and post-leach sample weight 22

Table 2. Semi-quantitative database........ 33

Table 3. Records with zero parts per ten clay minerals 35

Table 4. Duplicate samples 37

Table 5. Semi-qualitative database 38

Table 6. Combined database 45

Table 7. Multiple criteria for sorting........ 48

Table 8. Percents insoluble residues and soluble materials 49

Table 9. Clay mineral assemblages of evaporite sequences in other studies 56

CHAPTER 1. INTRODUCTION

A. PURPOSE OF STUDY

This study follows from the investigations by Childers and Gross (1985) of geophysical logs of the Permian Yeso Formation in 18 wells located in the Roswell Artesian Basin of southeastern New Mexico. These workers identified several deep zones within the Yeso Formation as potential aquifers. Other zones containing high percentages of clay minerals were also reported. However, these studies concluded that the lack of details regarding clay mineralogy severely limited log interpretation of hydraulic properties, such as porosity, in clay-bearing rocks. This in turn inhibits the interpretation of potential aquifer zones. In addition, knowledge of clay mineralogy would improve the lithologic interpretation of radioactive zones. Therefore, the main purpose of this study was to investigate the relative proportions of clay minerals in well cuttings from the previously studied wells in order to achieve better lithologic and hydrologic control. Other important goals were to investigate whether or not certain clay mineral assemblages are associated with a particular dominant lithology, stratigraphic position, or geographic position. Because sample volumes were relatively small, this study will also discuss the validity of the analytical procedures used. Specifically of interest are the potential effects from drilling mud contamination, the use of distinct chips versus the fine powder fraction of a sample, and the inherent effect of rotary drilling on shales and sandstones with regard to potential bias in sampling.

B. PREVIOUS WORK

The Roswell Artesian Basin is a major regional source of groundwater, and it also provides baseflow to the Pecos River. Although the area has been studied since the 1940's, there are many unanswered questions regarding the recharge and hydrologic budget of the basin. As human influence and climatic changes proceed to impact the basin, the need for a model of the hydrologic characteristics of the basin becomes increasingly important (Childers and Gross, 1985). This study will contribute to the areas hydrologic data base.

A detailed description of previous work related to the geology and hydrology of the Roswell Basin can be found in Childers and Gross (1985). Classical studies of this area are those by Fiedler and Nye (1933), Lloyd (1949), and Pray (1961). A collection of studies on clay effects on geophysical logs was issued by SPWLA, 1982. Analytical investigations of clay mineralogy are numerous. This study draws on the classic works of Gibbs (1965, 1968), Grimm (1968), Carroll (1970), and Schultz (1968).

C. PHYSIOGRAPHIC AND GEOLOGIC CHARACTERISTICS OF THE ROSWELL BASIN

The Roswell Basin is located along the eastern flank of the north-trending Sacramento Mountains and is part of the Pecos Slope which grades to the Pecos River (Fig. 1). Vegetation ranges from aspens and pines in the mountains to spare desert flora in the broad basin. Annual precipitation averages 18 inches annually in Mayhill (elevation 6562 ft), and 12 inches in Roswell (elevation 3609 ft). The Principal Intake Area (PIA), or that area which receives the most recharge, is shown on Figure 1, along with the location of the wells sampled in this study and by Childers and Gross (1985).

Figure 2 is a generalized, geologic west-east cross section of the Roswell Basin area. Rocks range in age from Precambrian to Recent (see Fig. 3). Precambrian crystalline rocks are nonconformably overlain by Phanerozoic sedimentary rocks which thicken along the gentle dipslope eastward to the Pecos River. The area is cut by north- to northeast-trending faults and gentle folds.

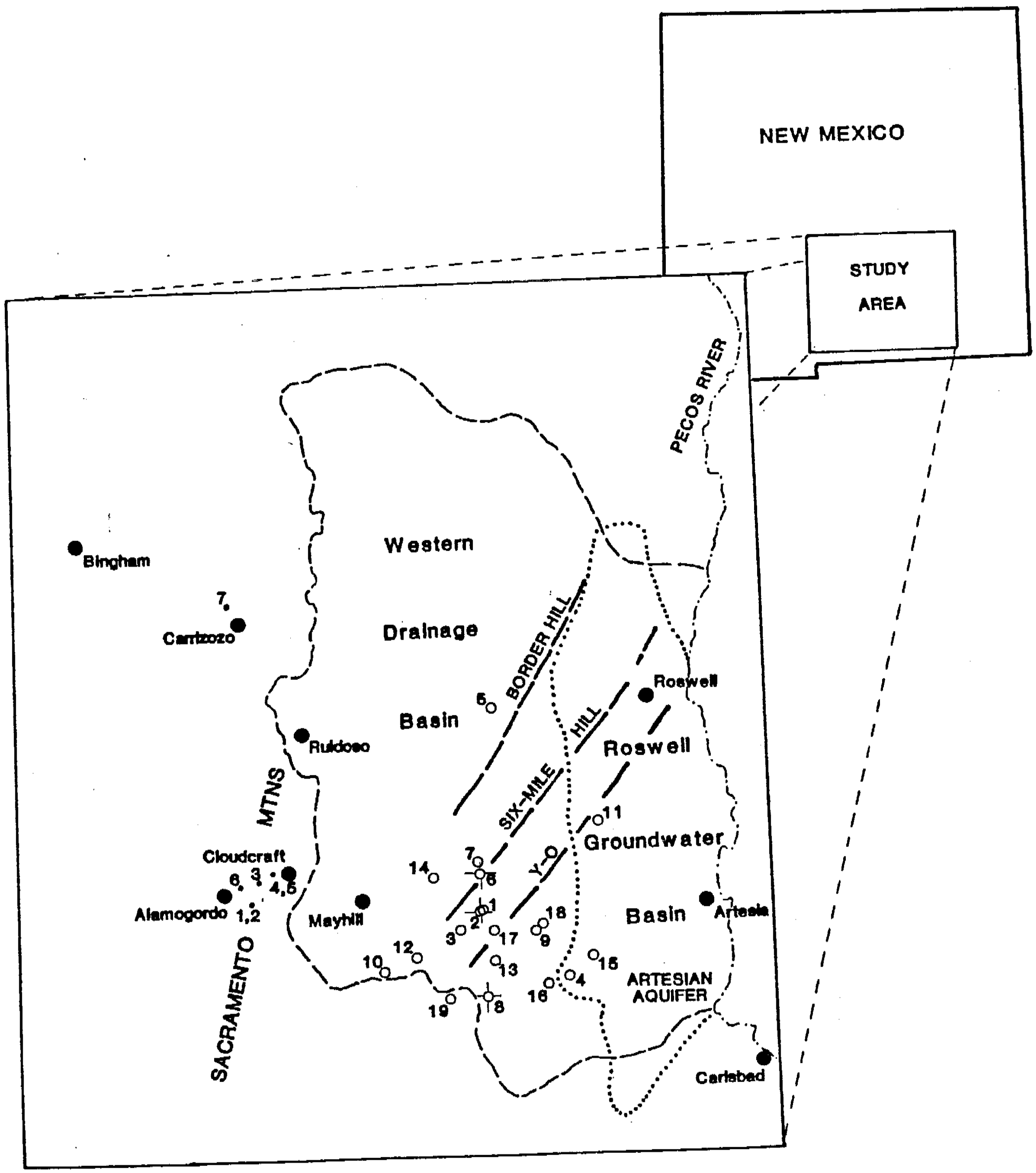

Figure 1. Location map of study area. Outcrop locations are shown by small numbered dots; wells studied by Childers and Gross (1985) are shown by circles; wells sampled in this study are shown by well symbols. Modified from Childers and Gross (1985).

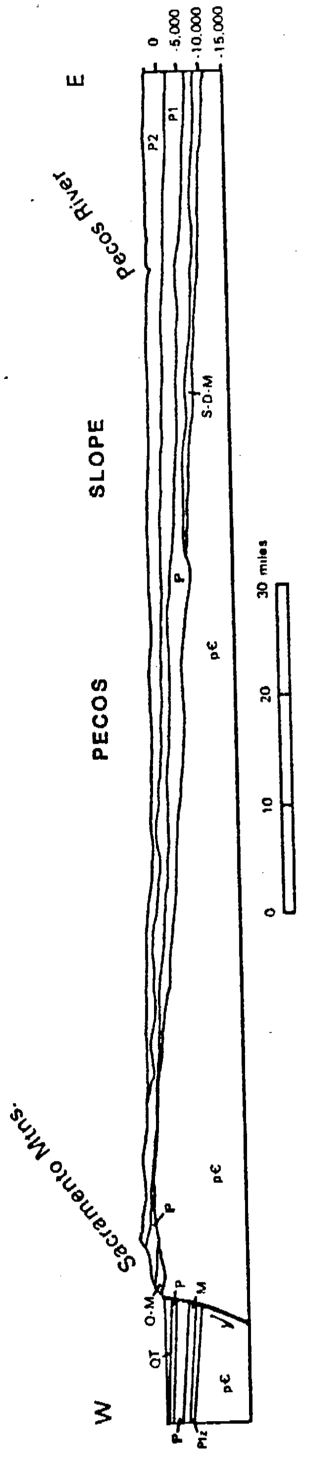

Figure 2. Generalized geologic cross section of the Roswell Basin area. Modified from New Mexico Highway Geologic Map, New Mexico Geological Society (1982). See Fig. 3 for explanation.

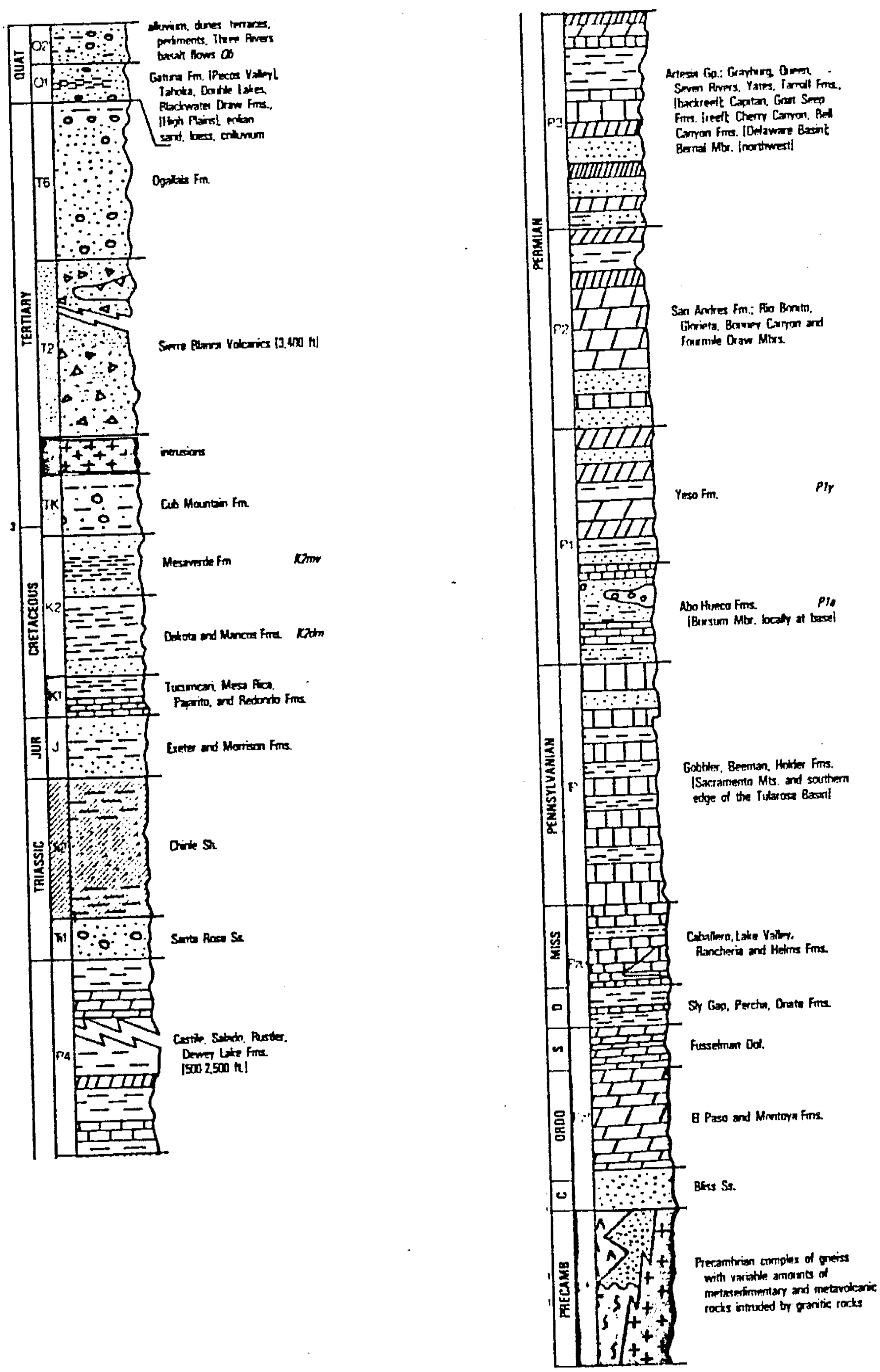

Figure 3. Generalized stratigraphic column for southeastern New Mexico corresponding to Figure 2. From the New Mexico Highway Geologic Map, New Mexico Geological Society (1982).

D. STRATIGRAPHY AND HYDROLOGIC CHARACTERISTICS

Yeso Formation (Permian)

This study is concerned with the Permian Yeso Formation which contains a great variety of sedimentary rock types. Up to 2000 ft (Childers and Gross, 1985) of thinly bedded limestone, sandstone, dolomite, shale, anhydrite (gypsum at the surface), and salt are somewhat uniformly interlayered throughout the formation. These beds were deposited in a saline epicontinental sea (Childers and Gross, 1985). Figure 4 is a schematic stratigraphic column for the Yeso Formation, taken from Childers and Gross (1985). There are several water-bearing zones within the Yeso Formation, of which the most pronounced is the Drinkard Sandstone (also known as the Tubb or Fullerton Sandstone), some 400 feet above the basal contact. However, common deposits of gypsum and salt impair the quality of water in these zones.

Abo Formation (Permian)

The Yeso Formation is underlain by the Permian Abo Formation, a thick unit (up to 3000 feet in the deepest part of the basin) which contains primarily dark red shale with sandstone, limestone, and dolomite. Childers and Gross (1985) used the dark red shales of the Abo Formation for a shale line on geophysical logs. The Abo Formation, which consists of continental sediments near the Pedernal Uplift,

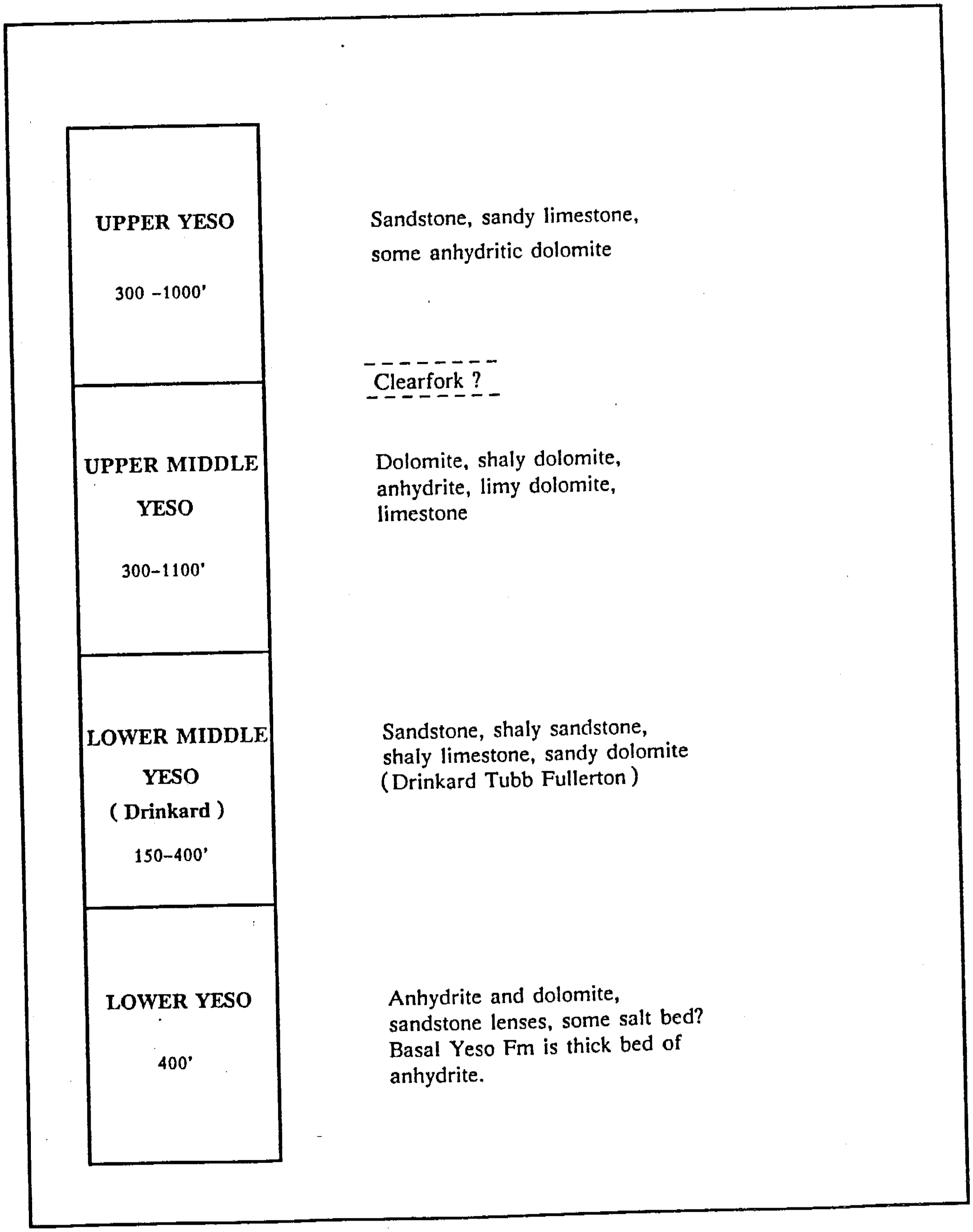

Figure 4. Generalized stratigraphic column of the Yeso Formation. Modified from Childers and Gross (1985).

grades into marine deposits toward the east.

San Andres Formation (Permian)

The Yeso Formation is conformably overlain by the Glorieta Sandstone of the Permian San Andres Formation. The San Andres dominantly consists of homogeneous limestone, dolomite, and anhydrite, and is considered the principal aquifer in the basin (Childers and Gross, 1985).

CHAPTER 2. METHODS

A. SAMPLE SELECTION

Samples consisted of both well cuttings from three wells that were studied by Childers and Gross (1985), and hand samples collected from selected outcrops in the Sacramento Mountain - Roswell Basin study area (Fig 1). Hand samples provided comparison with the subsurface samples and rendered a greater volume of material for analysis. Although samples from the Yeso Formation were of primary interest, also collected were several hand samples from the San Andres and Abo formations, and well cuttings from the Abo Formation. Well cuttings were obtained from the New Mexico Bureau of Mines and Mineral Resources Petroleum Records Library in Socorro. Because the analytical techniques used in this study are destructive, the cuttings were thoroughly described, and only half of each sample was removed and analyzed. One well, No. 2, had duplicate samples available from Yates Petroleum Corp., thereby allowing more volume for analysis. The criteria for selection of the three wells investigated included the extent of geophysical investigation by Childers and Gross (1985), the volume of available well cuttings, and the location of the well with respect to the hydraulic gradient in the area. Of the 18 wells studied by Childers and Gross

(1985), only five adequately satisfied the selection criteria. The greatest limiting factor was the relatively small volumes of desired samples available in the Petroleum Records Library.

During drilling, well cuttings that are to be collected are cleaned and placed into small envelopes. Typically each envelope represents a ten-foot interval of borehole depth, which in this case because strata are nearly horizontal, is also approximately stratigraphic thickness. For this study, sample interval selection was based on Childers and Gross's (1985) geophysical well log interpretations; they interpreted several aquifer zones within the Yeso Formation, and intervals potentially containing high percentages of clay materials were identified from gamma-ray logs. These zones were the prime candidates for study where sample volume was sufficient. The intervals chosen for sampling are shown for each well in Figures 5, 6, and 7. A stratigraphic cross-section containing the three wells is shown in Figure 8. Within each interval, chips were separated into rough "lithologies" according to visual appearance (color, texture, and luster), response to immersion in HCL, and physical characteristics (hardness). Drilling mud chips were identified by their bright white color, softness, and striation marks from the drill bit, and were separated from the rest of the chips. The purpose of this classification scheme was to attempt to relate a

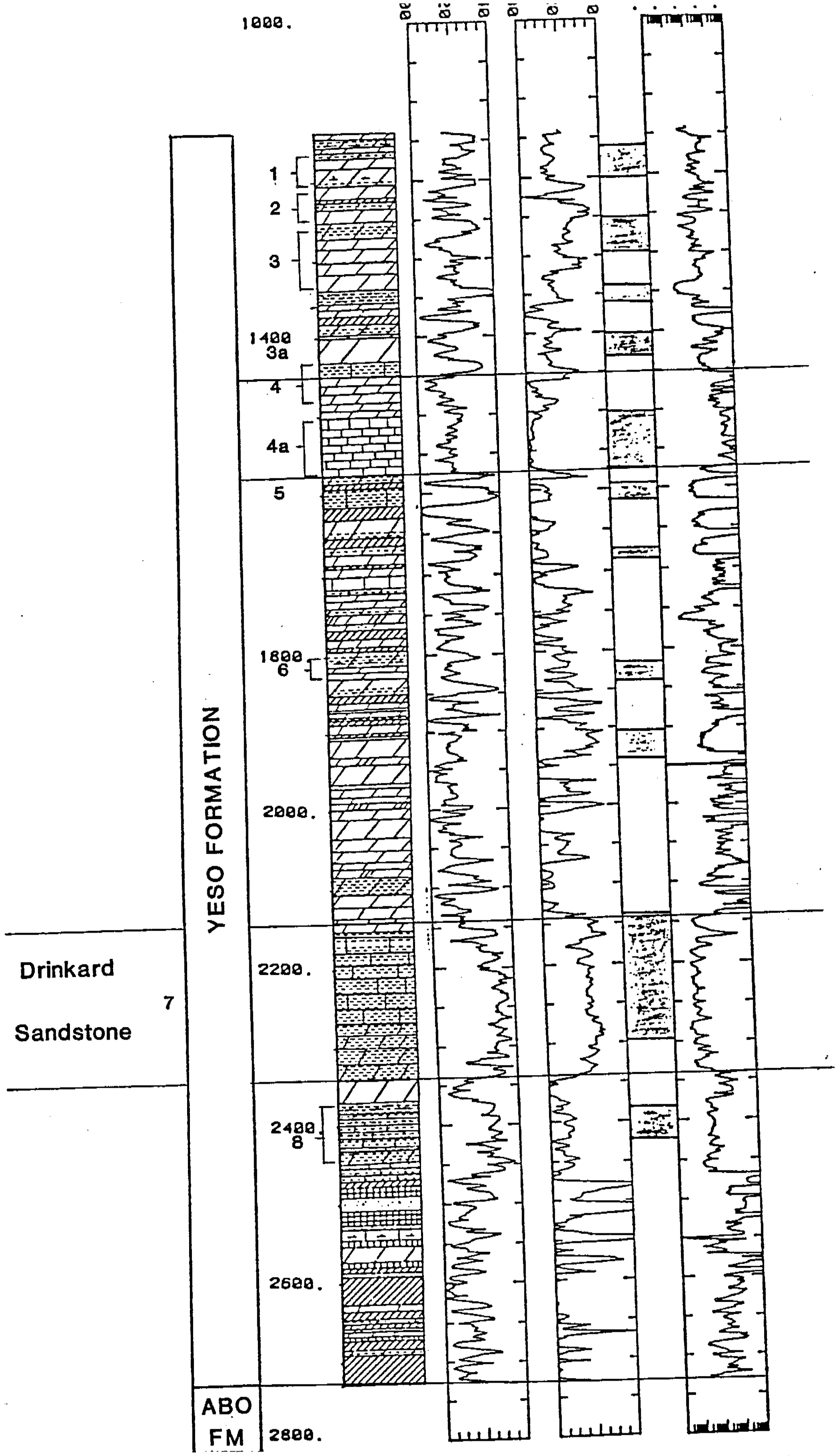

Figure 5. Well logs and stratigraphy for well no. 2, Dunken Dome Unit No. 2, 7-17S-18E, from Childers and Gross (1985). Bracketed sections in columns indicate sampling intervals chosen for this study.

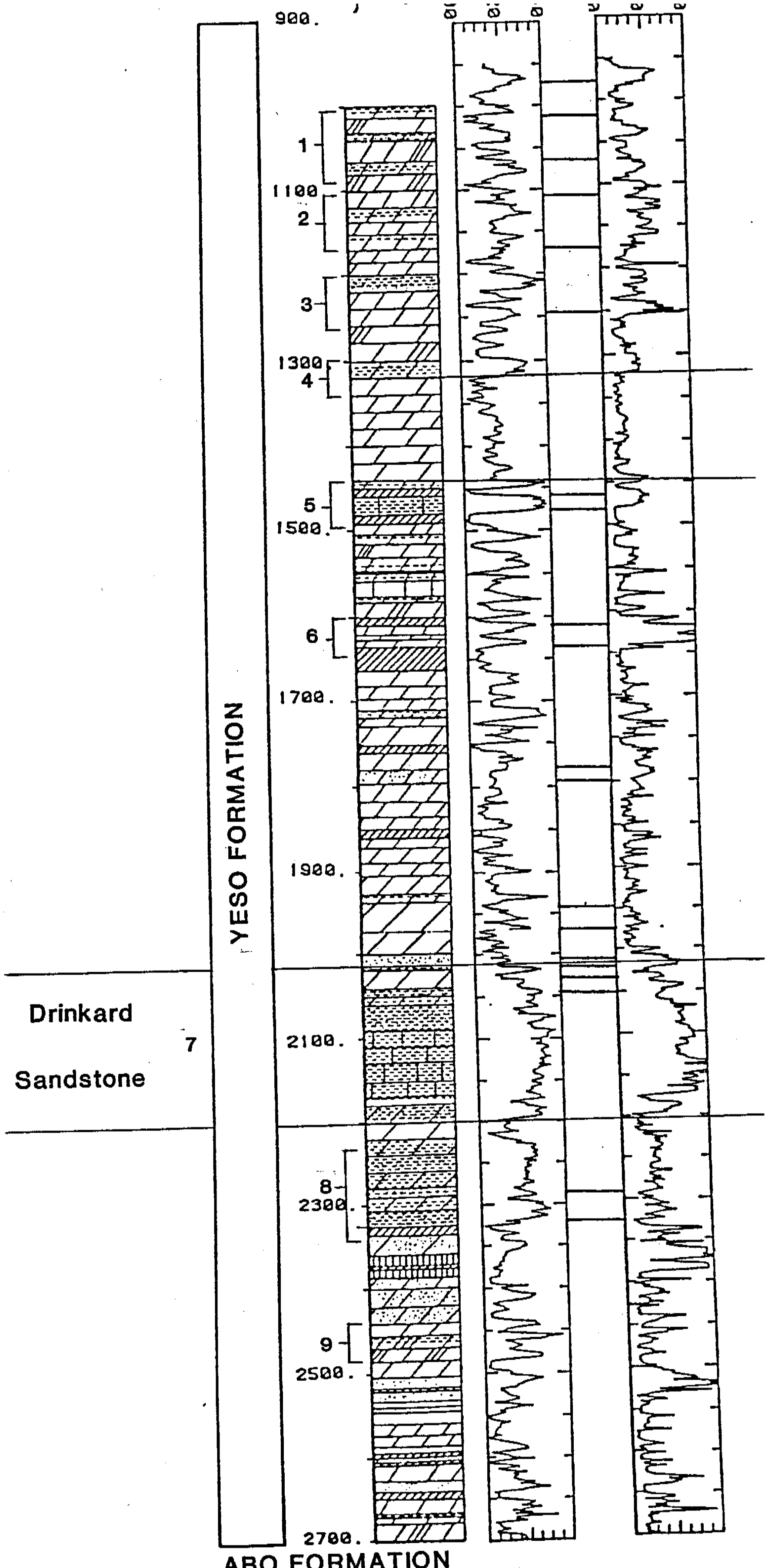

Figure 6. Well logs and stratigraphy for well no. 6, New Mexico State #1, 8-16S-18E, from Childers and Gross (1985). Bracketed sections in columns indicate sampling intervals chosen for this study.

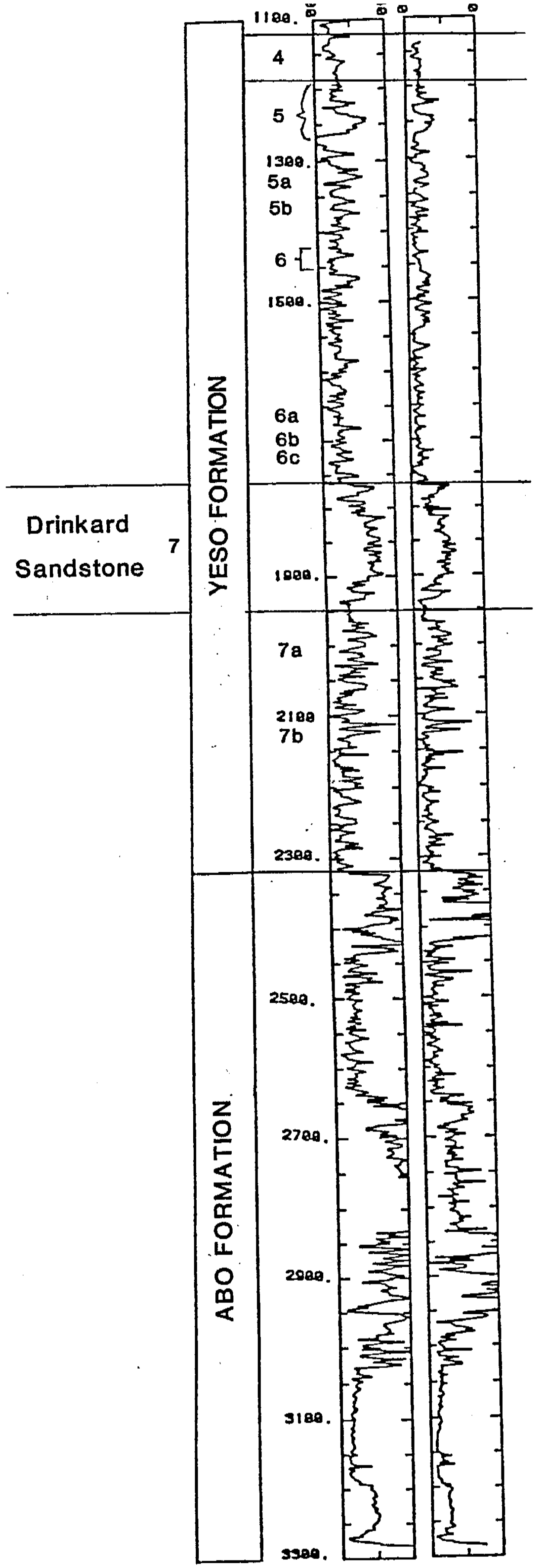

Figure 7. Well logs for well no. 8, Munson Federal No. 1, 19S-18E, from Childers and Gross (1985). Bracketed sections in columns indicate sampling intervals chosen for this study.

Repnik

Tolstol Fig. 8

particular dominant lithology to the relative proportions of clay mineral groups present. In order to produce a sufficiently large volume of samples, these "lithologies" were composited over several intervals. In general, sufficient sample volumes for inspection by powder mount x-ray diffractometry and for clay mineral analysis was not available from the most desirable stratigraphic zones. This was expected because lithologies from the zones of interest, (i.e. aquifers and/or high-percentage clay intervals) are less likely to be coherent and recovered as chips from the drilling process. For example, although there are high percentages of clays in shales, shales are easily broken by the drill bit and are therefore not generally recovered as distinct chips. For those intervals in which chips were insufficient in size and/or volume, the finest fractions in the envelopes, here called powders, were collected for analysis. Using the above mentioned criteria to produce a single sample, the samples were then named by well number, interval number or well depth, and physical characteristic. If the sample was composed of the powder fraction, then the word powder was added to the sample designation. Once samples were prepared for x-ray diffraction, the slide number was then added to the sample name. Thus (2Y) 1520-30 Powder #2 indicates that this sample is from well 2, the duplicate Yates Petroleum Corp. sample envelopes, the NMBM&MR library, a depth interval of 1520 to 1530 ft, consists of powders, and is the second slide for that "lithology".

The outcrop samples were collected from the area indicated in Figure 1. This area contains excellent exposures of easily accessible Abo, Yeso, and San Andres formations. These outcrop exposures provided large hand samples, which, upon treatment, would yield a larger volume of insoluble residues and clay minerals compared to the smaller volume chip or powder samples from the subsurface. These samples were catalogued according to stop number on the day of collection and to the order in which they were collected. Thus, (3-2) Rk -1, indicates that the sample was the second sample collected at stop 3, that it is a hand sample as opposed to well cutting, and that it was the first slide made. Appendix I contains descriptions of the hand samples. In outcrops and some of the hand samples, several sets of closely-spaced, continuous fractures and joints were observed in the Yeso Formation. These features were not evident during examination of the well cuttings.

B. LABORATORY METHODS

Although the effect of analytical technique on the precision of quantitative clay mineral analysis has been discussed (Gibbs, 1965, 1968; Pierce and Siegal, 1968), a single method for quantitative analysis of clay minerals has not yet been accepted internationally. More recent work has shown that a semi-quantitative approach may be more useful (Austin and Lenninger, 1976). With either a quantitative or semi-quantitative approach, a critical element is the consistency with which the analytical procedure is conducted.

Because the objective of this study was to evaluate the relative abundance of the clay minerals present in each bulk sample semi-quantitatively, the preparation techniques chosen for x-ray diffraction were the unoriented powder mount for bulk mineral analysis and the oriented slide of less than 2 micron-size particles for clay mineral analysis. The unoriented powder mount was used to observe the (hkl) reflections and is especially effective for fine-grained samples (Carroll, 1970). The oriented slide technique, also called the sedimented slide described by Schultz, (1960), produces a slide in which the clay minerals are mounted in an orientation perpendicular to their c-axis, thus enhancing the basal (001) reflection. Diffractometer patterns that show only the (001) series of basal reflections are very useful in clay mineral identification because each basal spacing is related to the type of layer structure and interlayer material involved (Brown and Brindley, 1980). Also used for producing the desired orientation was the filter-membrane peel technique (Drever, 1973) of rapid filtration via suction. Drever's method has the added advantage of concentrating the sediment onto a small portion of the glass slide. Because the samples were of such small quantities, this advantage was important and slides made this way were generally superior to the sedimented slides. However, many of the samples were not conducive to this treatment, perhaps due to the type of material or insignificant amount of clay minerals. Although the quality of the sedimented slides ranged from excellent to poor, even the poorest quality mounts yielded some useful data on clay mineralogy.

Because the entire slide preparation procedure is somewhat involved and poorly documented in the literature, it is given below in outline form:

1. If necessary, chips of a "lithology" from severaladjacent intervals were combined in order to produce a large enough volume for analysis. Then the sample was washed with distilled water to remove any remnant of drilling mud.

2. The sample was crushed and hand ground with a mortar and pestle, then passed through a 230 mesh screen.

3. The bulk mineralogy for each sample was obtained by x-ray diffractometry with a Phillips Norelco wide-range x-ray diffractometer at the New Mexico Bureau of Mines and Mineral

Resources x-ray laboratory, using monochromatic Cu radiation at 40 kV and 25 mA, with divergence, anti-scatter, and receiving slits set at 1^{o}, 4^{o}, and 1^{o}, respectively. The sample was scanned from 2 degrees to at least 35 degrees two-theta at a scan speed of 2 degrees per minute. The hand samples were commonly treated differently at this stage. Because their larger volumes exceeded the size of the Norelco sample holder, they were split with a micro-splitter to obtain a compositionally representative sample of a volume correct for analysis. Following x-ray diffraction of this subsample, it was recombined with the rest of that sample.

4. The sample was then weighed to four decimal places using an A & D electronic analytical balance (hand samples were weighed to two decimal places).

5. The diffraction traces were analyzed for bulk mineralogy. In all samples bulk mineral analysis revealed the presence of either sulfates, Ca-Mg carbonates, or salts, or a combination of these. Removal of these minerals before clay mineral analysis was necessary because the x-ray diffractogram traces of peaks for these minerals would mask the peaks of clay minerals. Therefore, the method of EDTA dissolution of gypsum, anhydrite, and Ca-Mg carbonates (Bodine and Fernalld, 1973) was applied to all samples.

6. Next, the sample was acid-leached in .25M EDTA solution buffered by 1 M NaOH to a pH of 10 - 12 for four hours. Alternatively, the more convenient form, Tetrasodium EDTA was used to eliminate the step of buffering with NaOH. Condensor jackets were used to prevent rapid evaporation of the solution.

7. After boiling, the sample was allowed to cool under a hood until it could be handled easily.

8. The sample was then centrifuged and washed three times for five minutes at maximum speed (approximately 4700 rpm) to remove the acid and clean the sample.

9. If there was enough material, then the sample was recovered into a pre-weighed beaker and dehydrated overnight in a 100°C oven. After dehydration, the sample was reweighed and beaker weight was subtracted. This measurement was considered the insoluble residue weight (See Table 1). Often, there was too little material to attempt this, in which case this step was omitted and the following step was begun immediately.

10. The material was placed in a 100 ml beaker, and distilled water was added to the 100 ml mark.

Table 1. MEASUREMENTS OF PRE-LEACH AND POST-LEACH ROCK SAMPLE WEIGHTS (in grams). "Beaker weight" was subtracted from "postleach sample plus beaker weight" to obtain "weight of insoluble residues". The remainder was recorded as "weight of soluble materials". Lack of data in any columns produced error or negative readings.

NAME	CHIP/ POWDER	(PERMIAN) FORMATION	SITE	DOMINANT LITHOLOGY	PRE-LEACH WEIGHT	BEAKER WEIGHT	INSOLUBLE RESIDUES WEIGHT	SOLUBLE MATERIALS
(3-0-1) #1 Rk		Yeso	ROCK	clay	21.0000	84.1700	104.1000	1.07
(3-1) #2 Rk		Yeso	ROCK	calcite	18.4100	106.7700	116.6500	8.53
(3-2-1) #1 Rk		Yeso	ROCK	dolomite	21.2300	105.5800	117.6100	9.20
(3-2-2) #3 Rk		Yeso	ROCK	mixed				
(3-2-3) #1 Rk		Yeso	ROCK	calcite				0.00
(3-3-3) Rk		Yeso	ROCK	quartz	20.1700	110.0900	122.9700	7.29
(3-4) #3 Rk		Yeso	ROCK	mixed	11.7400	105.6600	113.4600	3.94
(3-5) #2 Rk		Yeso	ROCK	calcite	22.6100	106.7300	117.2600	12.08
(3-7b) #2 Rk		Yeso	ROCK	calcite	19.7900	106.0900	110.7000	15.18
(5-1) #1 Rk		Yeso	ROCK	calcite	26.6900	79.2000	94.6800	11.21
(5-2) #2 Rk		Yeso	ROCK	dolomite	18.7200	111.3000	119.5600	10.46
(5-4) #1 Rk		Yeso	ROCK	quartz	19.2900	84.1800	101.1200	2.35
(5-5) #1 Rk		Yeso	ROCK	calcite	26.3800	84.1900	99.0500	11.52
(6-X)-2 Rk		Abo	ROCK	calcite	25.4300	106.6300	119.4000	12.66
(6-Pa1)-3Rk		Abo	ROCK	calcite	22.5000	106.8300	118.0300	11.30
(6-Pa2)-1Rk		Abo	ROCK	quartz	23.0000	107.8100	124.0000	6.81
(7-2a) #1 Rk		Yeso	ROCK	dolomite	33.5800	108.2200	141.8300	-0.03
(7-3a) #2 Rk		Yeso	ROCK	dolomite	23.8800	99.1600	164.3400	-41.30
(7-4a) #2 Rk		Yeso	ROCK	mixed	21.3200	84.0600	95.1500	10.23
(1-A) Rk		San Andres	Rock	calcite				
(1-C) Rk		San Andres	Rock	calcite				
(3-XC) Rk		Yeso	Rock	quartz				
(2Y) 1520-30 Powd #2	POWDER	Yeso	WELL 2	calcite				
(2Y) 1540-50 Powd #1	POWDER	Yeso	WELL 2	calcite				
(6-1) Red E3	CHIP	Yeso	WELL 6	gypsum				
(6-2) Red S#1	CHIP	Yeso	WELL 6	gypsum				
(6-2) Red Powd #3	POWDER	Yeso	WELL 6	mixed				
(6-3) Gray 5	CHIP	Yeso	WELL 6	mixed				
(8-5) Red 1	CHIP	Yeso	WELL 8	quartz				
(8-5) Black 2	CHIP	Yeso	WELL 8	dolomite				
(8-6) Red 1	CHIP	Yeso	WELL 8	quartz				
(8-7) Dk Gray	CHIP	Yeso	WELL 8	anhydrite				

Table 1a. MEASUREMENTS OF PRE-LEACH AND POST-LEACH WELL CUTTINGS SAMPLE WEIGHTS FOR SUBSURFACE SAMPLES (in grams). Very few post-leach weights were recovered. Results obtained as per Table 1.

SAMPLE NAME	SITE	LITHOL	PRE-LEACH	BEAKER	BEAKER PLUS	POST-LEACH	WT. SOL
(8-2) Mixed	WELL 8	MIXED	13.87	102.40	108.60	6.20	7.67
(8-3) Mixed	WELL 8	MIXED	13.59	104.43	111.43	7.00	6.59
(8-3) Black	WELL 8	DOLOMITE	00.73	100.74	100.85	0.11	0.62
(8-4) Black	WELL 8	DOLOMITE	1.12	109.96	110.09	0.13	0.99
(8-4) Gray	WELL 8	UNKNOWN	10.13	162.27	168.49	6.22	3.92

11. The sample was agitated by stirring to create a suspension of the particles. This suspension was left undisturbed for 5 minutes if flocculation did not occur.

12. If flocculation did occur, further treatment was necessary to obtain a state of dispersion of clay particles. This was achieved by a variety of methods depending on the extent of the flocculation. The first method attempted was to re-centrifuge the clear liquid portion of the material in the beaker for five minutes at maximum speed (approximately 4700 rpm). The sediment in the bottom of the tube was then recovered into a 100 ml beaker and mixed with distilled water. If this method was not successful in achieving the state of suspension, then the sediment in the beaker was hand-ground with a mortar and pestle with a small amount of water to produce a slurry. Finally, if wet grinding was not effective, a few drops of NH_4O_H was added to the mixture.

13. Once the clay was in a dispersed state, the beaker and its contents were left undisturbed for 10 minutes. At the end of 10 minutes, a pipette was touched to the surface of the suspension and enough material was withdrawn to cover a glass slide whether a sedimented slide or membrane peel was made. This procedure withdraws the < 2 micron size fraction of the suspension into the pipette. For a sedimented slide,

the pipetted material was placed on a glass slide and left to air-dry overnight at room temperature. For a membrane peel it was necessary to place a fine filter, 0.45um dia. pore size, onto a porous centered glass base attached to a vacuum filter apparatus; the pipetted material was drawn onto the filter. The sediment on the filter was then rolled out onto a glass slide using a centrifuge tube as a type of rolling pin.

This procedure produces a strongly oriented sample with the mineral's c-axis perpendicular to the surface of the slide which yields an intense basal x-ray reflection.

C. SAMPLE PREPARATION PROBLEMS

It should be re-emphasized here that due to the extremely small volume of sample available from the well cuttings, this procedure was often unsuccessful. In particular, the volume of material left after leaching was often too small to recover or insufficient for slide preparation. In addition, problems inherent in x-ray analysis of clays are magnified by small sample volume. For example, thin films prepared by sedimentation give the best orientation for x-ray diffractometry, but are often too thin and/or too inhomogeneous to provide relative intensities representative of the sample material (Brown and Brindley, 1980). The correct thickness of the mounted sample is required to give maximum intensity for diffraction from crystal lattice planes (Carroll, 1970). Therefore, the ideal preparation method chosen for diffractometry should result in a thick, homogeneous sample smear in which the maximum preferred orientation of basal planes lies parallel to the slide surface. Also, the imperfectly crystalline nature of many clay materials may in itself result in weak diffraction patterns relative to background (Brown and Brindley, 1980), thereby hindering interpretation.

D. SAMPLE ANALYSIS

Diffraction traces were made on the Rigaku Geigerflex D/Max IA 2θ/θ x-ray diffractometer at the New Mexico Bureau of Mines and Mineral Resources x-ray lab. Machine settings were 40 kv and 25 mA with Cu K-alpha radiation and divergence, scatter, receiving and monochromatic slits set at 1^{o}, 1^{o}, $.3^{o}$, and $.3^{o}$ respectively.

It is not possible to uniquely determine clay mineral groups based on basal reflections alone. Limitations are the result of the typically broad nature of reflections due to thin crystals and frequently disordered layer stacking (Brown and Brindley, 1980). These factors produce overlapping reflections and few observable reflections from less abundant components. (Brown and Brindley, 1980). Therefore it is typical in clay mineral studies to subject the samples to a variety of treatments that alter diffraction patterns of components. Comparisons are then made between diffraction patterns from samples before and after treatment. Standard treatments include saturation with a polar liquid, such as ethlyene-glycol, in order to identify swelling components (i.e. smectites), and subsequent heat treatments that collapse swelling minerals by dehydration of the interlayer material or destruction of the mineral.

For this study, the method presented by G. S. Austin (written commun., 1988) of the New Mexico Bureau of Mines and Mineral Resources was used. In this method, all samples were subjected to the following three runs:

1) The first run was an untreated, air-dried slide which was scanned from 35 to 2 degrees (2.5 to 44.17Å) at 2° 2θ/minute, and then slow scanned from 26° to 24° (3.7 to 3.4Å) at $.25^{\circ}$ 2θ/minute. The purpose of this run was to provide a background diffractogram to which other diffractograms from treated slides would be compared. The slow scan was used to separate chlorite and kaolinite because the (002) and (004) reflections of chlorite (d=approx. 7.1, 3.55Å) overlap the (001) and (002) reflections of kaolinite (d=approx. 7.15, 3.58Å).

2) The second run was the ethlyene-glycol-saturated slide (

i.e., a slide saturated in ethylene-glycol after at least 24 hours at room temperature or 30 minutes at elevated temperatures), which was scanned from 15 to 2 degrees (5.9 to 44.17Å) at a scan speed of 2° 2θ/minute.

3. The third run was the heated slide, (i.e. a slide heated for 30 minutes in a 375°C oven), scanned from 9.5 to 8° 2θ (9.3 to 11.1Å) at 2° 2θ/min and from 15 to 2° 2θ (5.9 to 44.17Å) at 2° 2θ/minute.

This treatment provides a method of comparing initial peaks representing clay minerals with peaks that may shift upon expansion or collapse. Identification of clay mineral groups was based on their (001)d spacing and the variation of their d spacing in response to glycolation and dehydration. Identification of the clay minerals depends on measuring this response under controlled conditions (Carroll, 1970).

The following discussion of the x-ray identification of individual clay minerals is largely based on the study by Carroll (1970).

Kaolinite - The presence of kaolinite group minerals (treated as kaolinite) was determined by basal reflections (peaks) at 7.2Å=d(001), or 12.4° 2θ, and at 3.57Å=d(002), or 24.9° 2θ on the untreated run. The (002) reflection was also identified by the slow-scan run of the air-dried slide.

Smectite - Smectite group minerals (treated as smectite) were identified by their characteristic d-spacing expansion upon glycolation. In glycol-treated slides, the (001) peak expands to 17Å, or 5.2° 2θ, from about 15Å, or 5.7° 2θ.

Illite - Discrete illite was best identified by a peak at 9.98Å=d(001), or 8.8° 2θ, on the glycol run. Whereas smectite will expand upon glycolation producing a change in d-spacing and consequent shift in peak position, the illite d-spacing will remain intact.

It is important to note that although illite and smectite were distinguished from each other as mineral end members on the basis of response to glycolation, they may also be present in the illite-smectite mixed layer series. Therefore, where illite is interlayered with smectite, some expansion will take place.

Chlorite - The chlorite group minerals (treated as chlorite) were identified by a peak at d(001)=14Å, or about 6.2° 2θ, especially on the heat-treated slide. Other reflections used in identification were on the untreated slide at d(003)=4.7Å, or 18.9° 2θ, and on the slow run at d(004)=3.5Å, or 25.1° 2θ. As with the illite group, mixed layering with expandable clay minerals was noted.

Mixed-layer clays - The identification of the mixed-layer clay minerals was based on comparison of the peaks for illite on the heated and glycol runs, and smectite on the glycol run, and their relationships. The technique employed only differentiated the mixed-layer clay minerals in a general manner. Carroll (1970) stated that regular interstratified clays can be identified by an integral sequence of (001) reflections that represent the sum of the layer thicknesses, whereas randomly interstratified clays are more difficult to recognize.

E. ANALYTICAL METHODS

A semi-quantitative method outlined by Austin (written commun., 1988) was used to determine the relative proportions of clay mineral groups with respect to the total amount of clay minerals present. In this method peak heights are used to represent the amount of mineral present, and calculations are based on peak height above background. Relative amounts are reported in integer values of parts per ten rather than as absolute abundances, because results are obtained by comparison of the untreated, glycolated, and heat-treated x-ray diffractograms as well as by measurement of peak heights as counts. The following equations were used to calculate the relative proportions of clay minerals in each sample:

$$\text{Illite} = I_{1G}/T \times 10$$

$$\text{Smectite} = M_1/4//T \times 10$$

$$\text{Mixed-layer clays} = I_{1H} - (I_{1G} + M_1/4)/T \times 10$$

$$\text{Kaolinite} = K_1/T \times 10$$

or, if chlorite is present

$$= K_2/2C_4 \times C_3/I_2 \quad \times I_{1G} \times 10$$

, where $T = I_{1H} + K_1$

or, if chlorite is present

$$= I_{1H} + (C_3)(I_{1G})/I_2 + (K_2)(C_3)(I^{)}/2C_4(I_2),$$

where T = Total counts (peak heights above background);

K^1 = 12.4° 2θ (7.16Å) counts on the untreated run;

I_2 = 17.8° 2θ (4.96Å) counts on the untreated run;

C_3 = 18.4° to 18.9° 2θ (4.7Å) counts on the untreated run;

K_2 = 24.9° 2θ (3.57Å) counts on the slow untreated run;

C_4 = 25.1° 2θ (3.54Å) counts on the slow untreated run;

I_{1G} = 8.8° 2θ (9.98Å) counts on the glycol run;

$M_1/4 = 5.2_o\ 2\Theta$ (17.0Å) counts on the glycol run;

and, $I_{1H} = 8.8^o\ 2\Theta$ (9.98Å) counts on the heated run, for illite, smectite, and mixed layer clay minerals.

A computer program written in Fortran was used to perform all calculations (see Appendix II). This calculation method is not sufficient to differentiate various mineral types within the smectite, mixed-layer clay, and chlorite, etc. groups. However, it is appropriate for approximation of proportions of illite, smectite, chlorite, kaolinite and mixed-layer clay mineral groups and is modified from other standard calculation methods.

CHAPTER 3. RESULTS

A. DATA CHARACTERIZATION

Based on an examination of all diffractograms for 54 samples, samples were assigned to one of two data sets. The first set, which comprised approximately two thirds of all the data, consisted of diffractograms that were compatible with the criteria for semi-quantitative analysis as described by Austin (written commun., 1988). This set, referred to as the "semi-quantitative database", is shown in Table 2 with results of relative proportions of clay mineral groups given as integer values of parts per ten. Samples from this data set all yielded very consistent diffractograms. Figure 9 shows a representative diffractogram for this group. Six additional samples either contained insufficient volume of clay minerals for analysis or were devoid of clay minerals. Consequently, a value of zero was assigned for each clay mineral in the parts per ten calculations for these samples. Records of these samples (see Table 3) were separated from the semi-quantitative data base because the zeros would produce a weighted effect in statistical analysis and would not be useful in comparing relative proportions of clay minerals in other samples. However, these six records may provide other pertinent information concerning the relative volume of clay minerals

Reynick

Folded Table 2

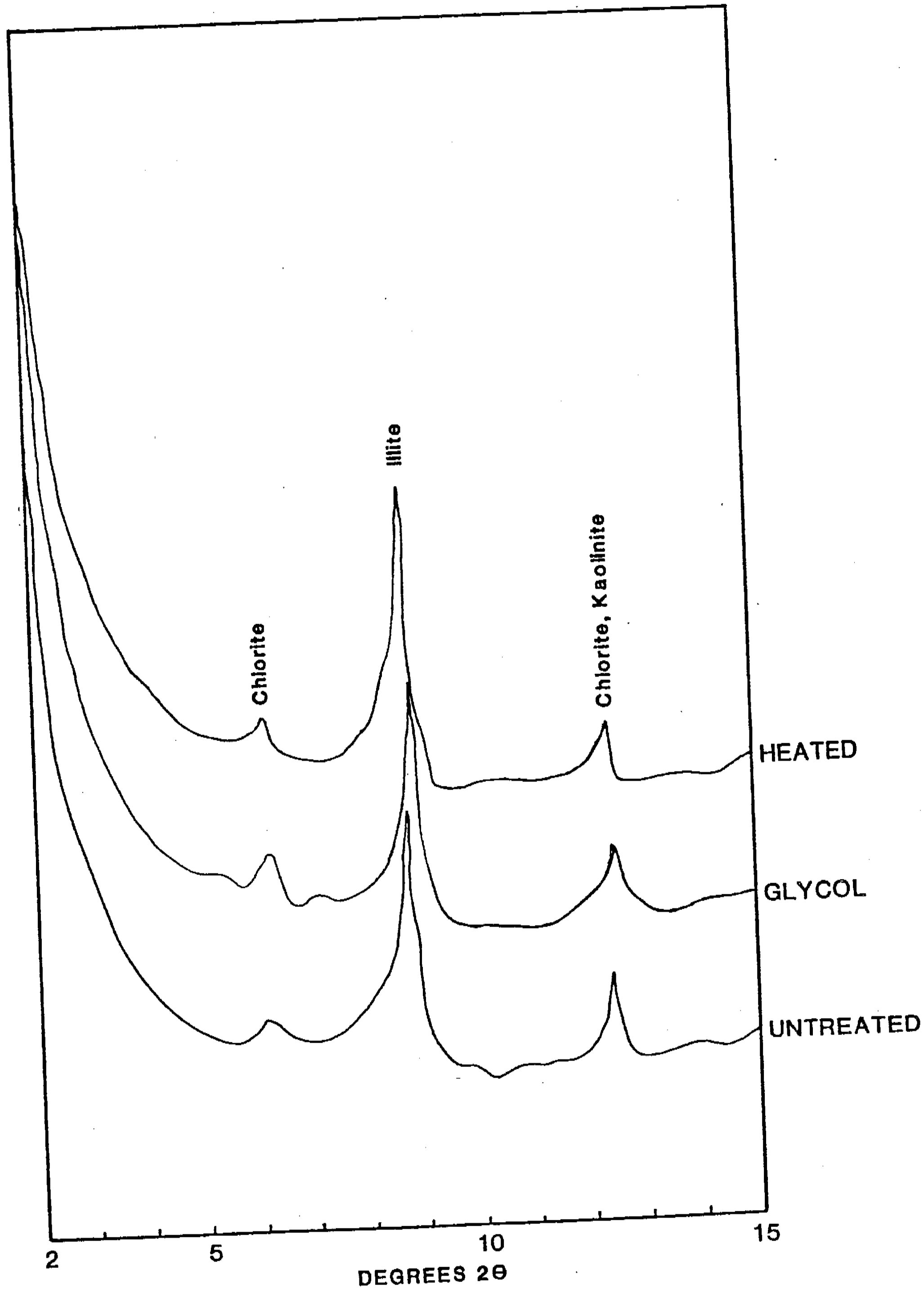

Figure 9. Representative diffractograms, from sample (2Y) Lt. Gray #1, for semi-quantitative data set. See text for details concerning untreated, glycol, and heated runs.

Table 3. SAMPLES CONTAINING ZERO PARTS PER TEN CLAY MINERALS. See text for description. Column headings from left to right are sample id, nature of sample (chip or powder), formation, site, depth of sampling, assigned zone of sampling, character of zone (porous and/or high clay content per Childers and Gross (1985)), dominant mineralogy.

NAME	CHIP/ POWDER	FORM	SITE	(DEPTH) INTERVAL	ZONE	FORM CHAR	DOMINANT LITHOLOGY	BULK MINERALOGY	IL	SM	CHL	MX	KAOL
(2-1) Lt. Tan	CHIP	Yeso	WELL 2	1400-1440	3a	p	dolomite	dol>>qtz	0	0	0	0	0
(2-1) Brown	CHIP	Yeso	WELL 2	1400-1440	3a	p	dolomite	dol>qtz,fspar	0	0	0	0	0
(2-1) Brown-Black	CHIP	Yeso	WELL 2	1400-1440	3a	p	dolomite	dol>>qtz>fspar	0	0	0	0	0
(2-1) Black	CHIP	Yeso	WELL 2	1400-1440	3a	p	dolomite	dol>>qtz,+/-gyp,+/-calc	0	0	0	0	0
(B-4) Clear #2	CHIP	Yeso	WELL B	1650-1700	6a	p	anhydrite	anhydrite	0	0	0	0	0
(6-X)-2 Rk		Abo	ROCK	---			calcite	calc,+/-qtz	0	0	0	0	0

in a rock sample. Also separated from the semi-quantitative data base were eight records for seven duplicate samples. The best record per duplicate sample was chosen for the semi-quantitative data base and the others were maintained separately for comparison. These results are given in Table 4.

The second set, which consisted of diffractograms for 13 samples, could not be evaluated semi-quantitatively due to the presence of additional peaks that were unaccountable using Austin's (written commun., 1988) equations. This set, referred to as the "semi-qualitative database" (Table 5), was further subdivided into either the "rectorite?" group or the "corrensite?" group depending on the location of additional peaks.

Diffractogram traces of the four "rectorite?" group samples, see Figure 10 for a representative example, showed sharp, symmetrical peaks at 6.4° and 11° 2θ, (13.8 and 8.0Å), which intensified with glycol treatment and were destroyed by heat treatment. These characteristics are suggestive of rectorite, a three layer (2:1) ordered mixed-layer clay mineral. Therefore, the label "rectorite?" was tentatively applied to represent this phase. However, unlike rectorite, the unknown phase is unstable at $375^{\circ}C$, (Brown and Brindley, 1980). Further identification of this phase was not possible due to the absence of a third peak, which, in combination with the other two peaks would be

Table 4. DUPLICATE SAMPLE RESULTS. See text for description. Results are given in parts per ten illite (il), smectite (sm), chlorite (chl), mixed-layer clays (mx), and kaolinite (kaol).

SAMPLE NAME	SITE	DOMINANT LITHOLOGY	IL	SM	CHL	MX	KAOL
(6-1) Red E2	WELL 6	gypsum	5	0	3	1	1
(6-1) Red E3	WELL 6	gypsum	4	0	0	2	4
(6-1) Red E4	WELL 6	gypsum	5	0	2	2	1
(6-2) Red Comp #1	WELL 6	gypsum	13	1	0	-3	0
(6-2) Red S #1	WELL 6	gypsum	4	0	3	1	1
(6-3) Gray #1	WELL 6	mixed	5	0	5	-1	2
(6-3) Gray #5	WELL 6	mixed	4	0	3	1	1
(6-3) Black Sty Comp#1	WELL 6	mixed	5	0	3	1	1
(6-3) Black Sty Comp#2	WELL 6	mixed	5	0	3	0	2
(6-4) Smooth Comp	WELL 6	dolomite	4	0	1	4	1
(6-4) S#3 Str Cent	WELL 6	dolomite	5	0	2	2	1
(8-3) Black #1	WELL 8	dolomite	4	0	2	3	1
(8-3) Black #2	WELL 8	dolomite	4	0	2	3	1
(7-4) #1 Rk	ROCK	mixed	6	0	0	4	0
(7-4) #2 Rk	ROCK	mixed	8	0	0	2	0

Reprint

Folded Table 5

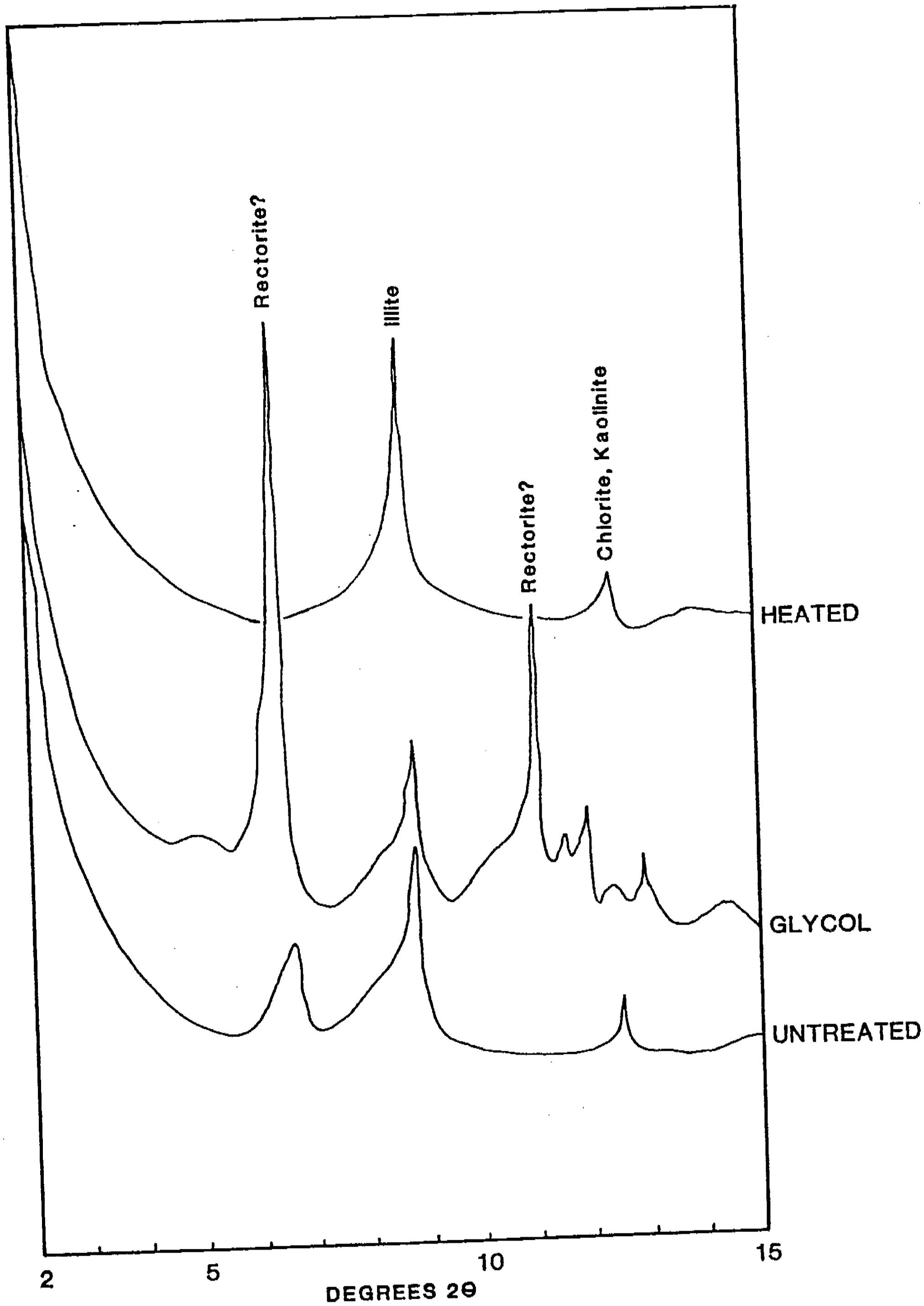

Figure 10. Representative diffractograms, from sample (2Y) 1520-30 Powder #2, for "rectorite?"-bearing samples . See text for details concerning untreated, glycol, and heated runs.

diagnostic of rectorite, within the scanning range used. The very sharp, symmetrical nature of the peaks, which indicates a high degree of crystallinity, suggests this phase may not be a clay mineral. One possibility for the presence of this phase is that it was generated during the process of Na_4-EDTA leaching. If so, it may be a precipitate of sodium carbonate.

The "corrensite?" group contained nine samples with diffractogram traces, see Figures 11 and 12 for representative samples, that showed peaks between 2.4 and 3^o 2θ (36.8 and 29.4Å), and a broad peak in the vicinity of smectite, between 5.2 and 6.0^o 2θ (16.9 and 14.7Å), on the air-dried run. With glycol treatment the lattice expands, so the latter peak shifts to about 5.6^o 2θ (15.8Å), and upon heat treatment partially collapses to about 6.1^o 2θ (14.5Å). The presence of the low-angle peak, which indicates a superlattice structure, combined with the swelling behavior is characteristic of the diagenetic mixed-layer chlorite/expanding 2:1 clay referred to as corrensite (Hower, 1981). Original usage of the name corrensite was applied to a regular-ordered 1:1 interstratification of chlorite and swelling chlorite by Lippmann (1954), where swelling chlorite refers to an imperfect type of chlorite structure that expands with glycolation to 18Å but does not collapse to 10Å upon heating to 500^oC. Restriction of the name to a regular 1:1 interstratification of trioctahedral

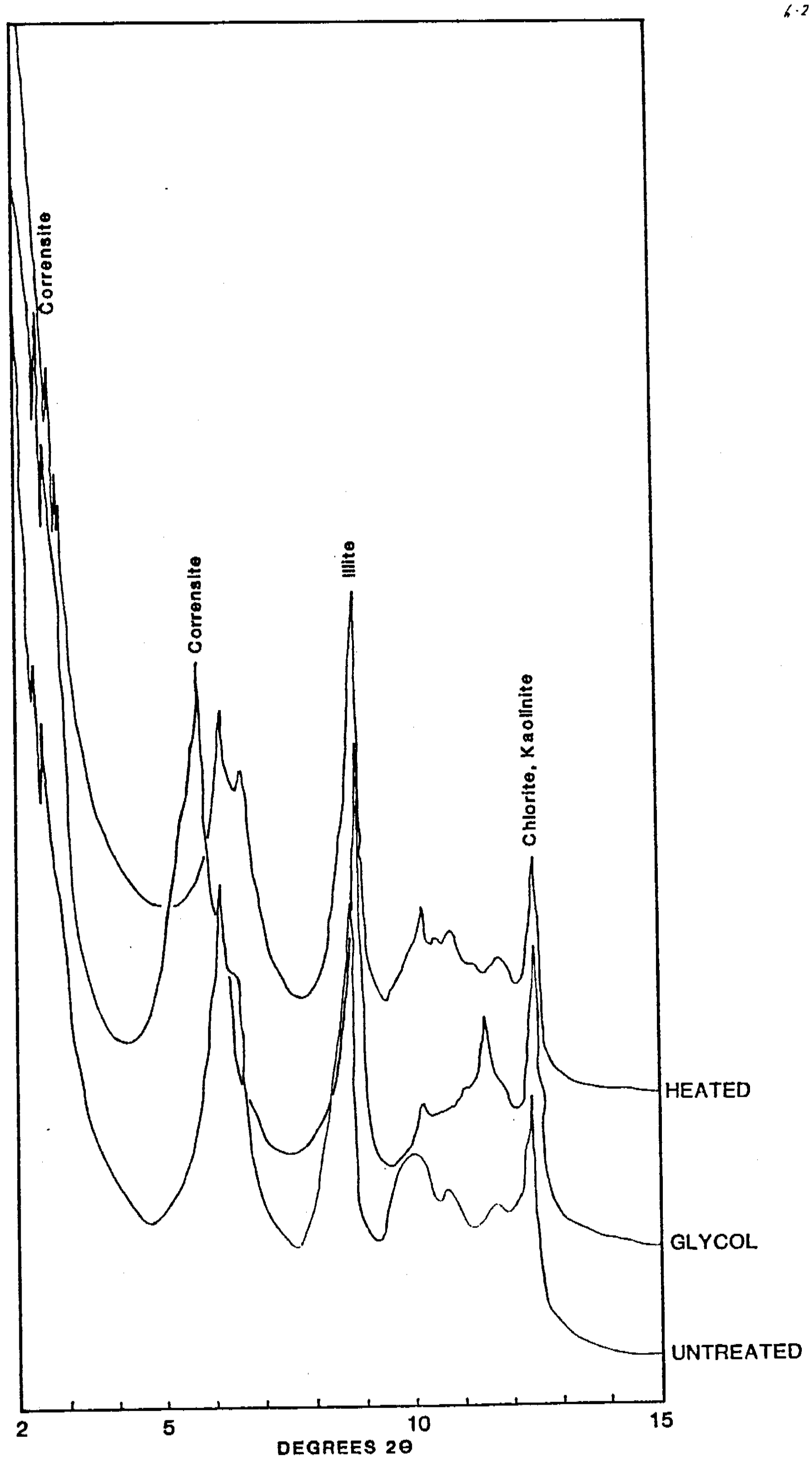

Figure 11. Representative diffractograms, from sample (6-2) Red Powder #3, for subsurface "corrensite?"-bearing samples. See text for details concerning untreated, glycol, and heated runs. Patterns between 10-12° 2Θ were from machine errors.

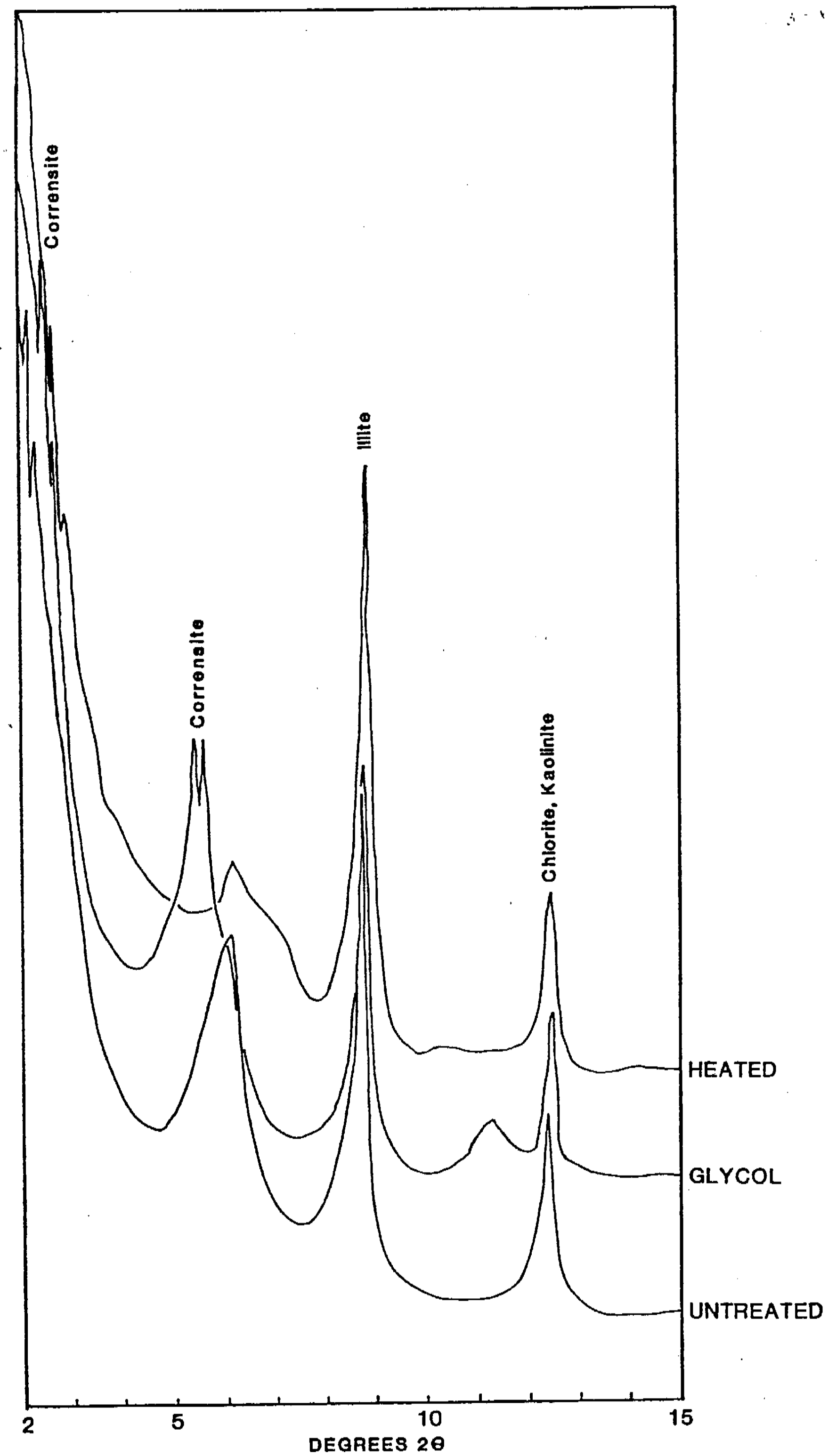

Figure 12. Representative diffractograms, from sample 3-XC Rock, for surface "corrensite?"-bearing samples. See text for details concerning untreated, glycol, and heated runs.

chlorite with trioctahedral smectite or vermiculite has been suggested for current usage (Newman and Brown, 1987). Distinction between corrensite, chlorite/smectite, and chlorite/vermiculite requires heating to 600°C (Bassett and Palmer, 1981), and was not possible in this study because samples were prepared using glass slides that would not withstand that temperature. However, comparisons of the peaks in these samples with diagnostic charts in Brown and Brindley (1980) and the study by Bassett and Palmer (1981) suggest that this phase is probably either corrensite (Lippman, 1954) or chlorite/smectite. Because positive identification of this phase was not made, the tentative label "corrensite?" was used to flag samples containing this phase in the semi-qualitative database.

B. ANALYTICAL TREATMENT

Initially, the two databases were analyzed separately. The semi-quantitative data were analyzed for relative proportions of clay mineral groups, expressed in parts per ten (Table 2). The semi-qualitative data were also analyzed for relative proportions of clay mineral groups, but with the understanding that this was not a strict application of the equations developed by Austin (written commun., 1988). Instead, values for this database were considered to be "assigned" rather than rigorously calculated, with the basis of assignment being peak heights and shifts in peak locations comparable to Austin's method. The reason for including these data was to determine whether or not the mixed-layered chlorite phase was present under distinctive conditions, such as with a particular dominant lithology, or in a particular stratigraphic zone, or with a particular assemblage of other clay minerals. The values obtained in this fashion are given for the semi-qualitative data in Table 5. Comparison of Table 5 with Table 2 indicates that the semi-qualitative data appear compatible with the semi-quantitative data, and so a third database was created which contained both data sets. This database, referred to as the "combined database", is given in Table 6.

All three databases were analyzed for several basic statistical parameters using the LOTUS 123 software package on an IBM personal computer. Results of clay mineral analyses from each database were evaluated for the mean, standard deviation, coefficient of variance, and minimum and maximum values for each clay mineral group in combination with desired parameters. These results are given in Appendixes IIIA, IIIB, and IIIC, for the "semi-quantitative", "semi-qualitative", and "combined" databases respectively. Database statistics were performed by Julie Tupper, (New Mexico Institute of Mining and Technology, Department of Geoscience) in LOTUS 123. Because the purpose of this study is to look for possible trends in the relative

Reyniil

Folded Table 6

proportions of clay mineral groups associated with various parameters (dominant mineralogies, porous zones, etc.), rather than absolute measurements, the application of statistics is viewed here as nonparametric statistics. Nonparametric statistics are used when the probability density distribution of a variable is not known and therefore few rigorous statistical tests are applicable. However, numerical values of the means, standard deviations, minima, maxima and number of data in sets of data, etc., are useful for comparison of data sets with each other. For example, each data set has a range defined by its mean plus and minus its standard deviation and if this range doesnot overlap another set's range, then, for the purposes of this study, there is a significant difference in the means between these two data sets.

Each data set was sorted, meaning that representative individual samples were compiled, by each of the following parameters in order to determine if a particular clay mineral group assemblage was directly related to any of the parameters or dependent on the presence or absence of any of the parameters: 1) by site (well #2, well #6, well #8, outcrop) which represents geographic or lateral position; 2) by dominant lithology/mineralogy (anhydrite, calcite, dolomite, gypsum, mixed -- the latter where minerals such as calcite and quartz occur subequally as they might in a sandy limestone or a calcite-cemented quartz sandstone); 3) by stratigraphic zone (see Figures 5, 6, and 7); 4) by character of the zone (porous, high clay content, or both (Childers and Gross, 1985); 5) by formation (Yeso or Abo); and 6) by the form of the sample (powder or chip). If there were insufficient records, (i.e. two or less), then a mean, standard deviation, coefficient of variance, maxima and minima were not computed.

These parameters were used to make comparisons between data sets. When it was determined that the semi-qualitative data were deemed quite similar to, that is lacking significant difference from, the semi-quantitative data, the two were combined and this third database was subjected to the final statistical analysis. At this stage, the data were sorted according to selected multiple criteria (Table 7) in order to define trends or consistencies in the relative proportions of clay mineral groups with respect to those criteria.

The percentage insoluble residue data were not pertinent to the sorting analysis and are therefore shown separately in Table 8.

C. RESULTS

Overall, the data indicate consistent relative proportions of clay mineral groups for all samples. Typically, illite is the most abundant clay mineral group,

Table 7. MULTIPLE CRITERIA FOR PERFORMING DATABASE SORTS.

	WELL 2	Well 6	Well 8	ROCK SAMP.	YESO	ABO	POROUS	HIGH CLAY	BOTH	CHIP	POWDER	ZONE 4,4A	ZONE 10
CALCITE	X			X	X		X				X	X	
DOLOMITE		X	X	X	X					X			
GYPSUM				X	X					X			
QUARTZ	X	X	X	X	X	X				X			X
MIXED		X		X	X				X		X		
YESO	X	X		X									
ABO	X	X											
POROUS	X		X		X					X			
CLAY	X	X	X		X					X			
BOTH		X			X					X			
CHIP	X	X			X								
POWDER	X	X			X								
ZONE 3,3A					X					X			
4,4A	X				X		X				X		
5			X		X				X	X			
6			X		X		X			X			
7			X		X					X			
10	X	X				X			X	X			

Table 8. WEIGHT PERCENTS INSOLUBLE RESIDUES AND SOLUBLE MATERIALS. See table 1 for additional data.

SURFACE SAMPLES

NAME	(PERMIAN) FORMATION	SITE	DOMINANT LITHOLOGY	% INSOLUB RESIDUES	SOLUBLE PERCENT
(3-0-1) #1 Rk	Yeso	ROCK	clay	-442	542
(3-1) #2 Rk	Yeso	ROCK	calcite	95	5
(3-2-1) #1 Rk	Yeso	ROCK	dolomite	54	46
(3-2-2) #3 Rk	Yeso	ROCK	mixed	57	43
(3-2-3) #1 Rk	Yeso	ROCK	calcite		
(3-3-3) Rk	Yeso	ROCK	quartz	ERR	ERR
(3-4) #3 Rk	Yeso	ROCK	mixed	64	36
(3-5) #2 Rk	Yeso	ROCK	calcite	66	34
(3-7b) #2 Rk	Yeso	ROCK	calcite	47	53
(5-1) #1 Rk	Yeso	ROCK	calcite	23	77
(5-2) #2 Rk	Yeso	ROCK	dolomite	58	42
(5-4) #1 Rk	Yeso	ROCK	quartz	44	56
(5-5) #1 Rk	Yeso	ROCK	calcite	88	12
(6-X)-2 Rk	Abo	ROCK	calcite	56	44
(6-Pa1)-3Rk	Abo	ROCK	calcite	50	50
(6-Pa2)-1Rk	Abo	ROCK	quartz	50	50
(7-2a) #1 Rk	Yeso	ROCK	dolomite	70	30
(7-3a) #2 Rk	Yeso	ROCK	dolomite	100	0
(7-4a) #2 Rk	Yeso	ROCK	mixed	273	-173

SUBSURFACE SAMPLES

SAMPLE NAME	SITE	LITHOL	%INSOL	% SOL
(8-2) Mixed	WELL 8	MIXED	45	55
(8-3) Mixed	WELL 8	MIXED	51	49
(8-3) Black	WELL 8	DOLOMITE	15	85
(8-4) Black	WELL 8	DOLOMITE	11	88
(8-4) Gray	WELL 8	UNKNOWN	62	38

with chlorite, mixed-layer clays, kaolinite and smectite occurring in decreasing order of relative abundance. The average clay mineral assemblage, in parts per ten, for all samples in the combined data base is as follows, with the corresponding standard deviation given in parenthesis: illite = 4 (+/- 1.51), smectite = 0 (+/- .93), chlorite = 2 (+/- 1.28), mixed-layer clays (excluding chlorite groups) = 2 (+/- 1.47), and kaolinite = 1 (+/-.96). These values and other values for maximum, minimum, and coefficient of variation are shown in Table 6.

The results of sorting the data according to the combinations of criteria shown for the combined database in Table 6 are given in Appendix IV. The results show no deviation from the average composition regardless of stratigraphic or geographic position, dominant lithology/mineralogy, character of zone, formation, or form of the sample. Of interest, however, is that the ten "corrensite?"-bearing samples are from all localities other than well 2.

Bowie and McLemore (1987) studied the clay mineralogy of Yeso sandy claystones and Abo claystones and fine-grained sandstones in outcrops from the Loma de las Canas and vicinity near San Antonio, New Mexico. They used a sample preparation procedure similar to that used in this study, as well as Austin's semi-quantitative method for reporting relative proportions of clay mineral groups. Consequently, a direct comparison of the relative proportions of clay mineral groups present can be made between the studies. The average clay mineralogy for the Yeso and Abo Formations reported in Bowie and McLemore (1987), given in parts per ten with standard deviations in paraenthesis, is as follows: 3 Yeso samples - illite = 4 (+/- 0.6), chlorite = 3 (+/- 0.6), kaolinite = 2 (+/- 1.0), smectite = 0 (+/- 0.6), and mixed-layered clay minerals = 0 (+/- 0.6); and 10 Abo samples - illite = 3 (+/- 0.6), chlorite = 3 (+/- 0.6), kaolinite = 3 (+/- 1.6), smectite = 0 (+/- 0.3), and mixed-layer clay minerals = 1 (+/- 0.8). These values fall within the range of values determined for the Yeso and Abo formations in the present study (see Appendix IIIA p.83).

The consistency of values for relative proportions of clay minerals in all samples in this study indicates that drilling mud contamination was not a problem. Drilling muds are typically from bentonites; a clay rock consisting essentially of smectite minerals (Patterson and Murray, 1983), used for their swelling properties. Most commonly used is a high-swelling sodium bentonite, called Wyoming bentonite. Hectorite, a high-swelling lithium-bearing variety with high-viscosity properties is also widely used (Larsen, 1955). Therefore, contamination of subsurface samples by drilling mud would have produced a high value for smectite minerals. Comparison of averages and standard deviations for samples from chip versus samples from powder and between surface and subsurface samples eliminates this concern (See Appendix IV) because of the low proportion of smectite.

Measurement of percentage insoluble residues was intended to provide information regarding the volume fraction of clay minerals, especially between lithologies. Recovery of post-leach weights was very poor for subsurface samples, with only five successful measurements. Post-leach weights for surface samples were more easily measured because of their greater sample volume. Samples yielding results were from clay-, calcite-, dolomite-, mixed-, and quartz-dominant lithologies. Values for weight percentage insoluble residues ranged from 95 percent in the single dominantly clay sample to 23 weight percent for a sample composed mostly of calcite.

CHAPTER 4. DISCUSSION

Given the wide variety of sampled lithologies, the relative proportions of clay minerals present in all samples is remarkably uniform. Therefore, it is necessary to evaluate the possible contributing factors in this study to determine if the uniformity could have been induced. Firstly, the inherent difficulties in attempting to quantify relative proportions of clay mineral groups in the less than two micron size fraction has been discussed in Chapter Two. In this study the greatest difficulty has been the lack of replication in methodology, owing to the destructive nature of sampling and processing. However, Schultz (1968), stated that of four variables (interpretation of measurement of peak size; machine variations; sample preparation; and sampling procedures) affecting the reproducibility of quantitative values from x-ray diffraction studies of clays, the inconsistency in interpretation of peak size seems to cause the largest variation in calculated values. Therefore, in this semi-quantitative study, interpretation of peak size was made as consistently as possible.

A second potential problem is that the summation of total parts per ten clay minerals sometimes adds up to less than or greater than ten parts per ten for many samples. However, this is acceptable in Austin's (written commun., 1988) semi-quantitative method. The equations used for mixed-layer clays may result in a negative value (see page 30), thus making it possible to obtain sums less than ten. Also, computed values are rounded off to the nearest whole number, which can produce sums less than or greater than ten. This type of variation is not uncommon in clay mineral studies (Pierce and Siegal, 1968).

A third factor that may enhance the appearance of uniformity is inherent in the application of statistics to semi-quantitative data when the population density distribution is unknown. In a Gaussian density distribution two thirds of all data would fall in a range of plus or minus one standard deviation about the mean, and the other one third data would fall equally into the extremes. Thus, for a deviation to be significant in a semi-closed system where all data add up to approximatlely ten, a deviation would have to be extreme. In addition, each time a sort is performed on selective data, the sample population decreases, thus adding a weighted effect to each observation. The number of observations is an important consideration in statistical analysis.

In addition, it is necessary to consider the effect of drilling on certain lithologies to determine if lithologies may have been selectively removed from sampling by not being recovered in the drilling process. This is probably a reasonable concern due to the fact that there are few clastic lithologies represented in the subsurface samples.

A combination of these factors may produce an enhanced appearance of uniformity.

Comparison of the results from this study with studies of clay minerals in evaporite sequences throughout the world (Table 9) shows agreement with respect to the types of clay minerals present. However, it is difficult to make quantitative comparisons between studies of the relative proportions of clay minerals present due to differences in sample preparation and analytical methodology (Pierce and Siegal, 1968). Therefore, comparisons should be made in general terms such as the dominance of a certain clay mineral group compared to the other clay mineral groups present. A common component of the clay mineral assemblages in all the cited studies is the abundance of chlorite, followed by the mix-layered chlorite group minerals. Palmer (1987), presented a detailed clay and brine chemical model that addressed the development of this characteristic assemblage. Most of the above-mentioned studies also indicate the presence of well-crystallized illite minerals, which are typically of detrital origin.

Corrensite is thought to have a diagenetic origin (Hower, 1981) and other studies cited in Table 9 tend to agree about a diagenetic origin for corrensite as well as the possible varieties of the "corrensite" of this study. The consistency of the relative proportions of clay mineral groups reported in this study could indicate a consistent

Table 9. Previous studies of clay assemblages in evaporite rocks.

Study	Rock age and location	Formation and lithology	Clay assemblage
Earley and others (1956)	Permian Southwest Texas	Yates Formation siltstone/dolomite	Chlorite/ smectite
Grim and others (1960)	Permian Southeast New Mexico	Salado Formation potash	Smectite/ chlorite, vermiculite/ chlorite
Harrison and Droste (1960)	Mississippian Indiana	St. Louis Formation gypsum/anhydrite	Chlorite, illite
Fournier (1961)	Permian Southeast New Mexico	Salado Formation potash	Chlorite/ vermiculite, chlorite
Lounsbury (1963)	Silurian Michigan	Salina Formation evaporites	Chlorite, illite
Braitsch (1971)	Permian Germany	Zechstein evaporites	Talc, chlorite, corrensite
Bodine and Standaert (1977)	Silurian Western New York	Vernon Formation halite	Chlorite illite
Bodine (1978)	Permian Southeast New Mexico	Salado Formation halite/anhydrite chaotic mudstone-halite	Chlorite/ saponite talc/saponite, talc, chlorite, saponite, illite
Holdoway (1978)	Permian Southwest Kansas	Flowerpot Shale chaotic mudstone-halite	Chlorite/ vermiculite, illite
Bodine and Rueger (1984)	Pennsylvanian Utah	Paradox Formation halite	Chlorite/ smectite, chlorite, illite

From Palmer (1987)

diagenetic pore fluid over an area as large as the study area (Fig. 1). If so, the lack of corrensite in well 2 could result from a local anomalous diagenetic fluid. This could require that well 2 lithologies be somehow physically isolated or separated from the pore fluids affecting the rest of the area, perhaps by topographic barriers.

CHAPTER 5. SUMMARY OF CONCLUSIONS

The relative proportions of clay mineral groups in samples used in this study are remarkably uniform without regard to dominant lithology/mineralogy, stratigraphic or geographic position, or physical nature of samples. Inherent properties of semi-quantitative and semi-qualitative clay mineral analysis and the application of basic statistical analysis to them in a semi-closed number system may produce an exaggerated sense of uniformity. Although sample preparation techniques removed drilling mud from subsurface samples, rotary drilling effects may have removed some lithologies from the sample population, further enhancing the consistency of the results. However, the overall types of clay minerals present in the Yeso are compatible with those in other evaporite sequences throughout the world. In particular, the occurrence of corrensite or chlorite/smectite in the samples is consistent with other studies and is indicative of diagenetic conditions.

CHAPTER 6. RECOMMENDATIONS FOR FUTURE WORK

As Childers and Gross (1985) concluded, the best way to address the questions concerning subsurface lithology would be to drill a well through the Yeso Formation and extract core and water samples. This is also a conclusion in this study. Core samples would increase sample volumeand include clastic lithologies, and therefore permit replicate analyses for more statistically reproducible results. Due to the prohibitive cost of coring a deep well, less expensive alternate means of sample augmentation could include collection of outcrop and/or core samples from the Yeso and Abo formations from nearby areas. At present, core samples from the Ozark-Mahoning HNM-8 well near Bingham, New Mexico, are being analyzed for relative proportions of clay mineral groups in the less than two micron size fraction by other workers at New Mexico Institute of Mining and Technology.

Future laboratory studies will be important, especially if they can discriminate between kaolinite and chlorite by using different slide materials and techniques. A high-temperature resistent material, probably ceramic, will be required to further investigate the "corrensite?" of this study. In addition, supplemental analysis for major ions by x-ray fluoresence would contribute to our understanding of pore-fluid chemistry and its effect on clay mineral diagenesis. Such data would provide geological, geophysical, and geochemical constraints in modelling the depositional and diagenetic environments of the Yeso and Abo formations in the Roswell Basin. X-ray fluorescence analysis might also answer the question of whether "rectorite?" exists in some samples.

More information might be obtained from the existing data by additional statistical analysis. Further investigation, using multi-variate distribution tests and additional nonparametric tests such as cluster ranking, might be helpful in delineating any deviations from the means that were not apparent using the methods employed in this study.

Most importantly, developing a method for improving recovery techniques for small weights of insoluble residues could greatly aid in defining the volume fraction of clay minerals, and its potential effect on geophysical logs. Clay mineral volume estimates of this nature would also be useful in predicting hydrologic characteristics and water quality for the basin. Fritz (1986), discussed the importance of clay membranes on hydraulic permeability and pressure and on solute transport. These hydrologic parameters are important for groundwater modelling. As continued population and industrial growth impose increasing demands for high quality water in the Roswell Basin area, water quality information will become critical.

REFERENCES

Austin, G. S., and Leininger, R. K., 1976, The effect of heat-treating sedimented mixed-layer illite-smectite as related to quantitative clay mineral determinations: Journal of Sedimentary Petrology, v. 46, pp. 206-215.

Bassett, R. L., and Palmer, D. P., 1981, Clay mineralogy of the Palo Duro Basin Evaporite Sequences, Randall County Core; <u>in</u> Geology and Geohydrology of the Palo Duro Basin, Texas Panhandle: Bureau of Economic Geology, Geological Circular 81-3, pp. 108-118.

Bodine, M. W., Jr., and Fernalld, T. H., 1973, EDTA dissolution of gypsum, anhydrite, and Ca-Mg carbonates: Journal of Sedimentary Petrology, v. 43, pp. 1152-1156.

Bowie, M. R., and McLemore, V.T., 1987, Clay mineralogy of selected sedimentary and volcanic rocks, Socorro County, New Mexico; <u>in</u> McLemore, V. T., and Bowie, M. R., (compilers): Guidebook to the Socorro area, New Mexico, Guidebook for the 36th annual Clay Minerals Conference, pp. 46-64.

Brown, G., and Brindley, G. W., 1980, X-ray diffraction procedures for clay mineral identification; <u>in</u>

Brindley, G. W., and Brown, G. (eds.): Crystal structures of clay minerals and their x-ray identification: Mineralogical Society, London, pp. 305-359.

Carroll, D., 1980 Clay minerals, a guide to their x-ray identification: Geological Society of America Special Paper 126, 80 pp.

Childers, A. and Gross, G. W., 1985, The Yeso Aquifer of the Middle Pecos Basin, Analysis and Interpretation: New Mexico Institute of Mining and Technology, Geophysical Research Center Report H-16, 162 pp.

Dott, R. H., 1964, Wacke, Graywacke and Matrix -- What Approach to Immature Sandstone Classification?: Journal of Sedimentary Petrology, v.34, pp. 625-632.

Drever, J. I., 1973, The preparation of oriented clay mineral specimens for XRD analysis by a filter-membrane peel technique: American Mineralogist, v. 58, pp. 553-554.

Dunham, R. J., 1962, Classification of carbonate rocks according to depositional texture: American Assoc. of Petroleum Geologists Memoir, no. 1, pp. 108-121.

Fiedler, A. G., and Nye, S. S., 1933, Geology and ground-water resources of the Roswell Artesian Basin, New Mexico: U. S. Geological Survey, Water Supply Paper 639, 372 pp.

Fritz, S. J., 1986, Ideality of clay membranes in osmotic processes: a review: Clays and Clay Minerals, v. 34, No. 2, pp. 214-223.

Gibbs, R. J., 1965, Error due to segregation in quantitative clay mineral x-ray diffraction mounting techniques: The American Mineralogist, v. 50, pp. 741-751.

______ 1968, Clay mineral mounting techniques for x-ray diffraction analysis, a discussion: Journal of Sedimentary Petrology, v. 38, pp. 242-244.

Grimm, R. E., 1968, Clay Mineralogy (2nd ed.): New York, McGraw-Hill, 596 pp.

Hower, J., 1981, Mixed-layer clay minerals; <u>in</u> Longstaffe, F. J. (ed.), Clays and the Resource Geologist: Mineralogical Association of Canada, Short Course Handbook, v. 7, pp. 52-59.

Larsen, D. H., 1955, Use of clay in drilling fluids; <u>in</u>

Pask, J. A., and Turner, M. D. (eds.): California Division of Mines Bulletin 169, pp. 269-281.

Lippmann, F., 1954, Uber einen Keuperton von Zaisersweiker bei Maulbroon: Heidel., Beitr. Min. Petr. 4, 130-134.

Lloyd, E. R., 1949, Pre-San Andres stratigraphy and oil producing zones in southeastern New Mexico: New Mexico Bureau of Mines and Mineral Resources Bull 29, 87 pp.

Newman, A. C. D., and Brown, G., 1987, The chemical constitution of clays; in Newman, A. C. D., (ed.), 1987, Chemistry of Clays and Clay Minerals: Mineralogical Society Monograph no. 6, New York, Wiley and Sons, pp. 104-125.

Palmer, D. P., 1987, A saponite and chlorite-rich clay assemblage in Permian evaporite and red-bed strata, Palo Duro Basin, Texas Panhandle: Austin, Texas, Bureau of Economic Geology, Geological Circular 87-3.

Patterson, S. H., and Murray, H. H., 1983, Clays; in LeFond, H., (ed.): Industrial Minerals and Rocks: American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, pp. 585-650.

Pettijohn, F. J., Potter, P. E., and Siever, R., 1972, Sand and Sandstones, Springer-Verlag, New York, 618 pp.

Pierce, J. W., and Siegal, F. R., 1968, Quantification in clay mineral studies of sediments and sedimentary rocks: Journal of Sedimentary Petrology, v. 39, pp. 187-193.

Pray, L. C., 1961, Geology of the Sacramento Mountains Escarpment, Otero County, New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 35, 133 pp.

Schultz, L. G., 1968, Quantitative interpretation of mineralogical composition from x-ray and chemical data for the Pierre shale: U. S. Geological Society Professional Paper 391-C, pp. C1-C31.

SPWLA Reprint Volume; Shaley Sand, 1982. Society of Professional Well Log Analysts.

APPENDIX I. HAND SAMPLE DESCRIPTIONS*

*Classifications based on Dunham (1962) for carbonates, Dott (1964), Pettijohn et. al (1972) for clastics. Described by James Harvey, NMIMT. Locations are shown on Figure 1.

Stop #1:

<u>1-A.</u> Lime-mudstone (micrite), (San Andres). Gray to brown on weathered surfaces, deep tan on fresh surface; calicci and soil on weathered surface; well indurated; cut face crossed by small viens of calcite; no visible grains; no bedding; may be recrystallized.

<u>1-B.</u> Wackestone (San Andres). Gray to tan on weathered surfaces with some calicci, gray to on fresh surfaces; calcite-filled cracks on cut face; well indurated; skelatal clasts and gragments compose >10% of rock; mud matrix approx. 40% of rock, matrix-supported; fragments up to 3mm long, elongated to subspherical, geranlly sub-to-well-rounded; reacts vigorously with 10% HCL.

<u>1-B-1.</u> Quartz Wacke. Tan on weathered and fresh surfaces; moderate to poorly indurated; fine grains visible at 10X;

very fine sand; 30-75% fine matrix; some fossils and gragments; gractures subparallel to bedding occur in irregular intervals; quartz, calcite; reacts vigorously with HCL.

<u>1-C.</u> Limestone? (San Andres). Gray on weathered and fresh surfaces; calicci on weathered surfaces; well indurated; highly fractured with calcite filling; reacts vigorously with HCL.

Stop #2:

<u>2-1.</u> Limestone (San Andres). Light gray on weathered surfaces, light tan to gray on fresh surface, well indurated, some small fractures (<2mm), filled with calcite and mostly connected. Worked skeletal particles compose approx. 30% of rock and are commonly elongate, up to 12mm X 15mm, subspherical; most fragments sub- to well- rounded; not grain supported; reacts vigorously with HCL on fresh surfaces.

<u>2-2.</u> Limestone (San Andres). Gray on weathered and freshly broken surfaces, light gray on cut surfaces; fractures are connected and commonly filled with calcite, fracture diamter approx <2mm; many highly elongate (recrystalized?) grains up

to 30 mm long.

Stop #3. (all in Yeso)

3-0. Quartz Wacke (Quartz rich siltstone/sandstone). Light tan; moderately indurated; calcareous cement; finely laminated; laminations are waxy and alternate in several colors on a fine scale; broken surfaces react violently with HCL; fractures of <1mm commonly paralell to laminations, some perpendicular; most partially filled with calcite; grainsize is fine to very fine; poorly sorted; angular to subangular; rock consists of >15% matrix.

3-0-1. Quartz Wacke. Gray to reddish tan on weathered surfaces, gray on fresh surfaces; well indurated, no bedding; quartz is dominant mineral; very angular to subangular grains, poorly sorted; fine grained to medium grained; no reaction to HCL on fresh surfaces; light brown mineral on freshly broken surfaces (dolomite?); fractures and solution cavities abundant.

3-1. Wackestone "breccia". Grayish white on weathered surfaces, tan to gray on fresh surfaces; well induarted with cavities up to > 1.5cm max diameter; reacts vigorously with HCL; most cavities not filed, some filled with bluish-white material that reacts less withy HCL than surrounding rock; no preferential alignment of cavities.; very angular, recrystalized (?) grains of calcite common up to 10 mm, compose approx. 30% of rock, not grain supported; (are cavities from dissolution of these grains?).

3-2a. Wackestone(?). Gray on weathered surfaces, darker gray on fresh surfaces; moderately indurated; exterior covered with light gray clay-like material, also fond on ibnterior; many irregulary shaped cavities, some elongate with a roughly parallel orientaiton. Fine gray clay-like material partially fills many cavities..; this clay(?) material reacts vigorously with hcl, creating new cavities; rock is recrystalized (?) Caco3; streaked with brown material (dolomite?).

3-2-1. Light gray, grainy, poorly-to well-indurated, well indurated portions are matrix supported with fine grains; fines react violently with HCL, expanding up to twice the volume before collapsing, reacting to completion. Appears to have some clastic grains.

3-2-2. Quartz Arenite

3-2-3. Quartz Arenite. Light to buff with light red on weathered surfaces, buff to gray on cut surfaces; moderately indurated, calcareously cemented; angular to subrounded grains; porrly sorted, v.f. sand; dominantly quartz; no distinct bedding; cut faces shows blotches of light and dark tan breccia.

3-3. Feldspathic Arenite. Orange-red on weathered and fresh surfaces; moderately- to well-indurated; calcerous cement; reacts moderately with HCL; very poorly sorted; grains mostly angular; mineralogy includes mica (?), feldspar (?), and quartz, plus crystaline grains of clacite; fine grained to very fine sand.

3-4. Quartz Arenite. Yellow buff to gray on weathered and fresh surfaces; poorly indurated; reacts vigorously with HCL; no bedding; grains subrounded to subangular, sorting moderate, distinct quartz grains; fine to very fine sand size particles.

3-5. Quartz Wacke. Tan to brownish gray on weathered surfaces, mostly gray on fresh surfaces; finely laminiated (<1mm thick), fractures easily along bedding; grains subangular to subrounded; moderatley sorted; calcareous cement; dominantly grainy calcite and quartz of fine sand to coarse silt size.

3-6. Dolostone. Brownish gray on weathered, gray on fresh surfaces; well indurated; no reaction with HCL; large crystalline and fibrous grains.

3-7. Dolomitic Limestone. Brownish gray on weathered, gray on fresh surfaces; reacts midly with HCL, no visible grains.

Stop #5:

5-1. Limestone (recrystalized?), (Yeso). Brown to orange on weathered surfaces, gray to orange on fresh surfaces; thin laminations up to .5 cm; very fine grained; massive; moderately indurated; small solution cavities elongated; strong reaction with HCL.

5-2. Brecciated Limestone (Yeso). Gray on weathered surfaces, gray to red on fresh surfaces; brecciated appearance on fresh surfacess with red viens surrounding gray, angular fragments of fine-grained calcite; very soft; reacts vigorously with 10% HCL.

5-3. Calcareous Mudstone (Yeso). Brown to tan on weathered and fresh surfaces; wet and friable; no visible grains at 40X; gritty feel indicates quartz; reacts vigorously with 10% HCL, calcareously cemented.

5-4. Calcareous Mudstone (Yeso). As above.

5-5. Carbonate Mudstone (Yeso). Brownish-tan on weathered surfaces, light tan to gray on fresh surfaces; well indurated; no visible grains; reacts strongly with 10% HCL.

Stop #6:

6-Pa-1. Quartz Mudstone (Abo). Maroon on weathered and fresh surfaces; friable; composed dominantly of matrix <62u, with some quartz grains up to sand size; grains are sub rounded to well rounded; poorly sorted; calcareously cemented; reacts strongly with 10% HCl.

6-Pa-2. Quartz Mudstone (Abo). As above.

6-Pa-3. Mudstone (Abo). Maroon on weathered and fresh surfaces; highly friable; dominantly matrix <62u with some large (fine sand size) well rounded grains; reacts vigorously with 10% HCL, calcareously cemented.

Stop #7:

7-1. Gypsum (Yeso). Brownish tan on weathered surfaces, white on fresh surfaces; matrix of small grains up to fine sand, with some larger crystals; very soft and poorly indurated; no reaction with 10%HCl; very permeable;

7-2. Dolomite (Yeso). Greenish-gray to mauve on weathered and fresh surfaces; finely laminated with interfingering of greenish-gray with maroon laminations; very fine grained; well indurated; minor fracfturing; slight reaction with 10% HCl.

7-3. Dolomite (Yeso). As above

7-4. ? (Yeso). Mauve to yellow on weathered and fresh surfaces; crumbly and very poorly indurated; subtle mottled lamination with possible rip up clasts of yellowish materials; vienlets of gypsum; reacts vigorously with 10% HCL; gritty feel indicates quartz.

APPENDIX II. FORTRAN PROGRAM FOR CALCULATING RELATIVE PROPORTIONS OF CLAY MINERAL GROUPS IN PARTS PER TEN

APPENDIX II. FORTRAN PROGRAM FOR CALCULATING RELATIVE PROPORTIONS OF CLAY MINERALS IN PARTS PER TEN.

```
c      This program calculates the relative proportions of clay
c     minerals based on xray diffraction peak heights.  This method
c     is George Austin's method for semi-quantitative analysis of
c     clay minerals. The following peak heights above background
c     are used:  on the initial (air-dried) run: 12.4(K1), 17.8(I2),
c     and 18.4 to 18.9(C3); on the slow run: 24.9(K2),and 25.1(C4);
c     on the glycol run: 5.2(M1),and 8.8(I1g); and on the heat
c     treated run: 8.8(I1h).  Austin's method of calculation
c     produces results in parts per ten, as follows:

      Integer chlor
      Character*50 sname

      open(1, file = 'results.dat', fileopt = 'eof',status = 'old')
      write (1,10)'SAMPLE','ILL','MONT','CHLOR','MIX','KAOL'
 10   format(a6,20x,a3,2x,a4,2x,a5,2x,a3,2x,a4)

 3    X=0
      Y=0
      K1=0
      I2=0
      C3=0
      K2=0
      C4=0
      M1=0
      I1G=0
      I1H=0
      T=0

      write(6,*) 'Enter the sample name.'
      read*, sname
      Print*,'Enter the counts for K1.'
      Read*,K1
      Print*,'Enter the counts for I2.'
      Read*,I2
      Print*,'Enter the counts for C3.'
      Read*,C3
      Print*,'Enter the counts for K2.'
      Read*,K2
      Print*,'Enter the value for C4.'
      Read*,C4
      Print*,'Enter the value for M1.'
      Read*,M1
      Print*,'Enter the value for I1G.'
      Read*,I1G
      Print*,'Enter the value for I1H.'
      Read*,I1H
      Print*,'If chlorite is present, type 1, if no chlorite, type 0.'
      Read*,X
      If (X.eq.0) goto 1

c     If chlorite is present, then use

      T = I1H + ((C3*I1G)/I2) + ((K2*C3*I1G)/(2.*C4*I2))
      Zka = (K2/(2.*C4))*(C3/I2)*(I1G/T)*10.
```

```
      Kaolin = NINT(Zka)
      goto 2
c     If no chlorite is present, then use
1     T = I1H + K1
      Zka = (K1/T)*10.
2     Zil = (I1G/T) *10.
      Zmo = (M1/4)/T * 10.
      Zch = (C3/I2)*(I1G/T)*10.
      Zmi=  (I1H-(I1G+(M1/4)))/T*10.
      Illite = NINT(Zil)
      Mont = NINT(Zmo)
      Chlor = NINT(Zch)
      Mixed = NINT(Zmi)
      Kaolin = NINT(Zka)

      Print *,'The sample name is: ',sname
      Print*,'Illite = ',Illite
      Print*,'Montmorillonite = ', Mont
      Print*,'Chlorite = ', Chlor
      Print*,'Mixed-layer clay minerals = ', Mixed
      Print*,'Kaolinite = ', Kaolin

      write(1,20)sname,Illite,Mont,Chlor,Mixed,Kaolin
20    format(a20,6x,i3,2x,i4,2x,i5,2x,i3,2x,i4)
      write(1,*)

      Print*,'Do you want to do more calculations?  Type 1'
      Print*,'for yes and 2 for no.'
      Read*,Y
      If(Y.eq.1) goto 3

      close(1)

      stop

      end
```

APPENDIX IIIA. RESULTS OF SEMI-QUANTITATIVE DATABASE SORTS

BY: SITE (WELL 8)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.599	0.000	1.344	0.471	0.471
COEFFICIENT OF VARIATION:	0.300	ERR	0.739	0.202	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	8	0	3	3	1
NUMBER OF OBSERVATIONS:	6				

BY: SITE (WELL 2)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	2	1
STANDARD DEVIATION:	0.990	0.728	0.833	1.050	0.350
COEFFICIENT OF VARIATION:	0.239	1.700	0.449	0.432	0.306
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	4	2
NUMBER OF OBSERVATIONS:	7				

BY: SITE (ROCK)

NAME	IL	SM	CHL	MX	KAOL
(3-0) #3 Rk	5	0	2	3	0
(3-0-1) #1 Rk	5	5	0	0	0
(3-1) #2 Rk	4	0	0	4	3
(3-2-1) #1 Rk	4	0	3	2	1
(3-2-3) #1 Rk	6	0	0	2	2
(3-2-2) #3 Rk	3	0	1	5	0
(3-3-3) Rk	6	0	0	1	3
(3-4) #3 Rk	5	0	2	2	1
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-2) #2 Rk	8	0	0	2	0
(5-4) #1 Rk	5	0	2	2	1
(5-5) #1 Rk	7	0	0	3	0
(6-Pa1)-3Rk	1	3	3	0	3
(6-Pa2)-1Rk	2	1	3	3	1
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
(7-4a) #2 Rk	6	0	0	4	0
AVERAGE:	5	0	1	3	1
STANDARD DEVIATION:	1.785	1.272	1.191	1.542	1.089
COEFFICIENT OF VARIATION:	0.369	2.685	1.131	0.553	1.293
MINIMUM:	1	0	0	0	0
MAXIMUM:	8	5	3	6	3
NUMBER OF OBSERVATIONS:	19				

BY: LITHOLOGY (DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(8-1) Brown #1	8	0	0	2	0
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(3-2-1) #1 Rk	4	0	3	2	1
(5-2) #2 Rk	8	0	0	2	0
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
AVERAGE:	6	0	2	2	1
STANDARD DEVIATION:	1.559	0.000	1.298	0.750	0.643
COEFFICIENT OF VARIATION:	0.281	ERR	0.793	0.330	1.010
MINIMUM:	4	0	0	1	0
MAXIMUM:	8	0	3	3	2
NUMBER OF OBSERVATIONS:	11				

BY: LITHOLOGY (CALCITE)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(3-1) #2 Rk	4	0	0	4	3
(3-2-3) #1 Rk	6	0	0	2	2
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-5) #1 Rk	7	0	0	3	0
(6-Pa1)-3Rk	1	3	3	0	3
AVERAGE:	4	0	1	3	1
STANDARD DEVIATION:	1.750	0.956	1.155	1.663	1.155
COEFFICIENT OF VARIATION:	0.414	2.151	1.155	0.535	0.866
MINIMUM:	1	0	0	0	0
MAXIMUM:	7	3	3	6	3
NUMBER OF OBSERVATIONS:	9				

BY: LITHOLOGY (ANHYDRITE)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2010-50 #1	3	1	2	2	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
AVERAGE:	4	2	2	2	1
STANDARD DEVIATION:	1.000	0.500	0.000	0.500	0.000
COEFFICIENT OF VARIATION:	0.250	0.333	0.000	0.333	0.000
MINIMUM:	3	1	2	1	1
MAXIMUM:	5	2	2	2	1
NUMBER OF OBSERVATIONS:	2				

BY: ZONE (3 OR 3A)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(2-1) Lt. Gray #1	4	0	3	1	1
AVERAGE:	5	0	3	1	1
STANDARD DEVIATION:	0.500	0.000	0.000	0.000	0.000
COEFFICIENT OF VARIATION:	0.111	ERR	0.000	0.000	0.000
MINIMUM:	4	0	3	1	1
MAXIMUM:	5	0	3	1	1
NUMBER OF OBSERVATIONS:	2				

BY: CHARACTER (POROUS)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.245	0.728	1.161	0.833	0.535
COEFFICIENT OF VARIATION:	0.256	1.700	0.677	0.389	0.535
MINIMUM:	3	0	0	1	0
MAXIMUM:	7	2	3	3	2
NUMBER OF OBSERVATIONS:	7				

BY: FORMATION (YESO)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
(3-0) #3 Rk	5	0	2	3	0
(3-0-1) #1 Rk	5	5	0	0	0
(3-1) #2 Rk	4	0	0	4	3
(3-2-1) #1 Rk	4	0	3	2	1
(3-2-2) #3 Rk	3	0	1	5	0
(3-2-3) #1 Rk	6	0	0	2	2
(3-3-3) Rk	6	0	0	1	3
(3-4) #3 Rk	5	0	2	2	1
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-2) #2 Rk	8	0	0	2	0
(5-4) #1 Rk	5	0	2	2	1
(5-5) #1 Rk	7	0	0	3	0
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
(7-4a) #2 Rk	6	0	0	4	0
AVERAGE:	5	0	1	2	1
STANDARD DEVIATION:	1.413	0.949	1.314	1.317	0.858
COEFFICIENT OF VARIATION:	0.279	3.678	0.926	0.530	1.064
MINIMUM:	3	0	0	0	0
MAXIMUM:	8	5	4	6	3
NUMBER OF OBSERVATIONS:	31				

BY: FORMATION (ABO)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(6-Pa1)-3Rk	1	3	3	0	3
(6-Pa2)-1Rk	2	1	3	3	1
AVERAGE:	3	1	2	2	2
STANDARD DEVIATION:	1.077	0.922	0.900	1.114	0.800
COEFFICIENT OF VARIATION:	0.337	1.844	0.391	0.464	0.500
MINIMUM:	1	0	0	0	1
MAXIMUM:	5	3	3	4	3
NUMBER OF OBSERVATIONS:	10				

BY: POWDER (CHIP)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3000-9200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-1) Lt. Gray #1	4	0	3	1	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.323	0.000	1.111	0.857	0.747
COEFFICIENT OF VARIATION:	0.294	ERR	0.523	0.361	0.703
MINIMUM:	3	0	0	1	0
MAXIMUM:	8	0	3	4	3
NUMBER OF OBSERVATIONS:	16				

APPENDIX IIIB. RESULTS OF SEMI-QUALITATIVE DATABASE SORTS.

SAMPLE NAME	IL	SM	CHL	MX	KAOL	NATURE OF PROBLEM
(1-A) Rk	3	0	0	7	0	rectorite
(1-C) Rk	2	1	3	4	0	rectorite
(3-XC) Rk	4	1	2	2	1	corrensite
(2Y) 1520-30 Powd #2	4	0	3	2	1	rectorite
(2Y) 1540-50 Powd #1	6	0	3	1	1	rectorite
(6-1) Red E3	3	2	3	1	2	corrensite
(6-2) Red S#1	4	1	3	1	1	corrensite
(6-2) Red Powd #3	6	2	2	0	1	corrensite
(6-3) Gray 5	4	2	3	-1	1	corrensite
(8-5) Red 1	4	1	2	2	1	corrensite
(8-5) Black 2	5	0	0	1	4	corrensite
(8-6) Red 1	4	0	0	2	3	corrensite
(8-7) Dk Gray	2	0	3	3	1	corrensite
AVERAGE:	4	1	2	2	1	
STANDARD DEVIATION:	1.21	0.80	1.21	1.90	1.07	
COEFFICIENT OF VARIATION:	0.31	1.04	0.58	0.99	0.82	
MINIMUM:	2	0	0	-1	0	
MAXIMUM:	6	2	3	7	4	
NUMBER OF OBSERVATIONS:	13					

BY: SITE (WELL 6)

NAME	IL	SM	CHL	MX	KAOL
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	2	3	0	1
STANDARD DEVIATION:	1.09	0.43	0.43	0.83	0.43
COEFFICIENT OF VARIATION:	0.256	0.247	0.157	3.317	0.346
MINIMUM:	3	1	2	-1	1
MAXIMUM:	6	2	3	1	2
NUMBER OF OBSERVATIONS:	4				

BY: SITE (WELL 8)

NAME	IL	SM	CHL	MX	KAOL
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	0	1	2	2
STANDARD DEVIATION:	1.09	0.43	1.30	0.71	1.30
COEFFICIENT OF VARIATION:	0.291	1.732	1.039	0.354	0.577
MINIMUM:	2	0	0	1	1
MAXIMUM:	5	1	3	3	4
NUMBER OF OBSERVATIONS:	4				

BY: SITE (WELL 2)

NAME	IL	SM	CHL	MX	KAOL
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	3	2	1
STANDARD DEVIATION:	1.00	0.00	0.00	0.50	0.00
COEFFICIENT OF VARIATION:	0.200	ERR	0.000	0.333	0.000
MINIMUM:	4	0	3	1	1
MAXIMUM:	6	0	3	2	1
NUMBER OF OBSERVATIONS:	2				

BY: SITE (ROCK)

NAME	IL	SM	CHL	MX	KAOL
(1-A) Rk	3	0	0	7	0
(1-C) Rk	2	1	3	4	0
(3-XC) Rk	4	1	2	2	1
AVERAGE:	3	1	2	4	0
STANDARD DEVIATION:	0.82	0.47	1.25	2.05	0.47
COEFFICIENT OF VARIATION:	0.272	0.707	0.748	0.474	1.414
MINIMUM:	2	0	0	2	0
MAXIMUM:	4	1	3	7	1
NUMBER OF OBSERVATIONS:	3				

BY: LITHOLOGY (MIXED)

NAME	IL	SM	CHL	MX	KAOL
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	5	2	3	-1	1
STANDARD DEVIATION:	1.00	0.00	0.50	0.50	0.00
COEFFICIENT OF VARIATION:	0.200	0.000	0.200	-1.000	0.000
MINIMUM:	4	2	2	-1	1
MAXIMUM:	6	2	3	0	1
NUMBER OF OBSERVATIONS:	2				

BY: LITHOLOGY (QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(3-XC) Rk	4	1	2	2	1
(8-5) Red 1	4	1	2	2	1
(8-6) Red 1	4	0	0	2	3
AVERAGE:	4	1	1	2	2
STANDARD DEVIATION:	0.00	0.47	0.94	0.00	0.94
COEFFICIENT OF VARIATION:	0.000	0.707	0.707	0.000	0.566
MINIMUM:	4	0	0	2	1
MAXIMUM:	4	1	2	2	3
NUMBER OF OBSERVATIONS:	3				

BY: LITHOLOGY (CALCITE)

NAME	IL	SM	CHL	MX	KAOL
(1-A) Rk	3	0	0	7	0
(1-C) Rk	2	1	3	4	0
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	4	0	2	4	1
STANDARD DEVIATION:	1.48	0.43	1.30	2.29	0.50
COEFFICIENT OF VARIATION:	0.394	1.732	0.577	0.655	1.000
MINIMUM:	2	0	0	1	0
MAXIMUM:	6	1	3	7	1
NUMBER OF OBSERVATIONS:	4				

BY: LITHOLOGY (GYPSUM)

NAME	IL	SM	CHL	MX	KAOL
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
AVERAGE:	4	2	3	1	2
STANDARD DEVIATION:	0.50	0.50	0.00	0.00	0.50
COEFFICIENT OF VARIATION:	0.143	0.333	0.000	0.000	0.333
MINIMUM:	3	1	3	1	1
MAXIMUM:	4	2	3	1	2
NUMBER OF OBSERVATIONS:	2				

BY: CHARACTER (CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	1	2	1	2
STANDARD DEVIATION:	1.33	0.75	1.10	1.02	1.20
COEFFICIENT OF VARIATION:	0.316	0.935	0.548	0.728	0.750
MINIMUM:	2	0	0	0	1
MAXIMUM:	6	2	3	3	4
NUMBER OF OBSERVATIONS:	5				

BY: CHARACTER (POROUS)

NAME	IL	SM	CHL	MX	KAOL
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	3	2	1
STANDARD DEVIATION:	1.00	0.00	0.00	0.50	0.00
COEFFICIENT OF VARIATION:	0.200	ERR	0.000	0.333	0.000
MINIMUM:	4	0	3	1	1
MAXIMUM:	6	0	3	2	1
NUMBER OF OBSERVATIONS:	2				

BY: CHARACTER (BOTH)

NAME	IL	SM	CHL	MX	KAOL
(6-1) Red E3	3	2	3	1	2
(6-3) Gray 5	4	2	3	-1	1
(8-6) Red 1	4	0	0	2	3
AVERAGE:	4	1	2	1	2
STANDARD DEVIATION:	0.47	0.94	1.41	1.25	0.82
COEFFICIENT OF VARIATION:	0.129	0.707	0.707	1.871	0.408
MINIMUM:	3	0	0	-1	1
MAXIMUM:	4	2	3	2	3
NUMBER OF OBSERVATIONS:	3				

BY: FORMATION (YESO)

NAME	IL	SM	CHL	MX	KAOL
(3-XC) Rk	4	1	2	2	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	1	2	1	2
STANDARD DEVIATION:	1.11	0.89	1.11	1.05	0.99
COEFFICIENT OF VARIATION:	0.266	1.018	0.510	0.827	0.639
MINIMUM:	2	0	0	-1	1
MAXIMUM:	6	2	3	3	4
NUMBER OF OBSERVATIONS:	11				

BY: FORMATION (SAN ANDRES)

NAME	IL	SM	CHL	MX	KAOL
(1-A) Rk	3	0	0	7	0
(1-C) Rk	2	1	3	4	0
AVERAGE:	3	1	2	6	0
STANDARD DEVIATION:	0.50	0.50	1.50	1.50	0.00
COEFFICIENT OF VARIATION:	0.200	1.000	1.000	0.273	ERR
MINIMUM:	2	0	0	4	0
MAXIMUM:	3	1	3	7	0
NUMBER OF OBSERVATIONS:	2				

BY: POWDER (POWDER)

NAME	IL	SM	CHL	MX	KAOL
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
AVERAGE:	5	1	3	1	1
STANDARD DEVIATION:	0.94	0.94	0.47	0.82	0.00
COEFFICIENT OF VARIATION:	0.177	1.414	0.177	0.816	0.000
MINIMUM:	4	0	2	0	1
MAXIMUM:	6	2	3	2	1
NUMBER OF OBSERVATIONS:	3				

BY: POWDER (CHIP)

NAME	IL	SM	CHL	MX	KAOL
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	1	2	1	2
STANDARD DEVIATION:	0.88	0.83	1.31	1.16	1.12
COEFFICIENT OF VARIATION:	0.237	0.972	0.655	0.903	0.606
MINIMUM:	2	0	0	-1	1
MAXIMUM:	5	2	3	3	4
NUMBER OF OBSERVATIONS:	7				

BY: PROBLEM (CORRENSITE)

NAME	IL	SM	CHL	MX	KAOL
(3-XC) Rk	4	1	2	2	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	1	2	1	2
STANDARD DEVIATION:	1.05	0.82	1.15	1.13	1.05
COEFFICIENT OF VARIATION:	0.264	0.816	0.577	0.927	0.632
MINIMUM:	2	0	0	-1	1
MAXIMUM:	6	2	3	3	4
NUMBER OF OBSERVATIONS:	9				

BY: PROBLEM (CORRENSITE)

NAME	IL	SM	CHL	MX	KAOL
(3-XC) Rk	4	1	2	2	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	1	2	1	2
STANDARD DEVIATION:	1.05	0.82	1.15	1.13	1.05
COEFFICIENT OF VARIATION:	0.264	0.816	0.577	0.927	0.632
MINIMUM:	2	0	0	-1	1
MAXIMUM:	6	2	3	3	4
NUMBER OF OBSERVATIONS:	9				

BY: PROBLEM (RECTORITE)

NAME	IL	SM	CHL	MX	KAOL
(1-A) Rk	3	0	0	7	0
(1-C) Rk	2	1	3	4	0
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	4	0	2	4	1
STANDARD DEVIATION:	1.48	0.43	1.30	2.29	0.50
COEFFICIENT OF VARIATION:	0.394	1.732	0.577	0.655	1.000
MINIMUM:	2	0	0	1	0
MAXIMUM:	6	1	3	7	1
NUMBER OF OBSERVATIONS:	4				

APPENDIX IIIC. RESULTS OF COMBINED DATABASE SORTS.

BY: SITE (WELL 2 AND WELL 6 AND WELL 8)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(6-3) Black Sty Comp#1	5	0	3	1	1	
(6-4) S#3 Str Cent	5	0	2	3	0	
(6-7) Red Powder #3	5	0	3	1	1	
(6-8) Red Powder #1	3	0	4	1	2	
(6-Pa) Powd 2810-50 #1	3	1	2	2	1	
(6-Pa) Black 3000-3200 #1	3	0	3	2	2	
(6-Pa) Red 3000-3200 #1	5	0	0	3	3	
(6-Pa) Black 3200-3300 #2	4	0	3	1	2	
(6-Pa) Red 3200-3300 #1	3	0	3	3	1	
(2-1) Lt. Gray #1	4	0	3	1	1	
(2y-2) Powder 1500-10 #1	6	0	0	2	2	
(2y-2) Powder 1530-40 #2	3	1	2	3	1	
(2y-2) Powder 1560-70 #2	5	2	2	1	1	
(2-Pa) Red 2800-2890 #5	4	0	2	3	1	
(2-Pa) Black 2900-3000 #1	4	0	2	3	1	
(2-Pa) Red 2900-3000 #2	3	0	2	4	1	
(8-1) Brown #1	8	0	0	2	0	
(8-1) Lt. Gray #3b	4	0	3	2	1	
(8-1) White #1	4	0	3	2	1	
(8-3) Black #1	4	0	2	3	1	
(8-4) Black #1	5	0	3	2	1	
(8-4) Mx #2	7	0	0	3	0	
(2Y) 1520-30 Powd #2	4	0	3	2	1	rectorite
(2Y) 1540-50 Powd #1	6	0	3	1	1	rectorite
(6-1) Red E3	3	2	3	1	2	corrensite
(6-2) Red S#1	4	1	3	1	1	corrensite
(6-2) Red Powd #3	6	2	2	0	1	corrensite
(6-3) Gray 5	4	2	3	-1	1	corrensite
(8-5) Red 1	4	1	2	2	1	corrensite
(8-5) Black 2	5	0	0	1	4	corrensite
(8-6) Red 1	4	0	0	2	3	corrensite
(8-7) Dk Gray	2	0	3	3	1	corrensite
AVERAGE:	4	ERR ?	2	2	1	
STANDARD DEVIATION:	1.265	0.696	1.149	1.053	0.838	
COEFFICIENT OF VARIATION:	0.291	ERR	0.533	0.562	0.654	
MINIMUM:	2	0	0	-1	0	
MAXIMUM:	8	2	4	4	4	
NUMBER OF OBSERVATIONS:	32					

BY: SITE (ROCK)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(3-0) #3 Rk	5	0	2	3	0	
(3-0-1) #1 Rk	5	5	0	0	0	
(3-1) #2 Rk	4	0	0	4	3	
(3-2-1) #1 Rk	4	0	3	2	1	
(3-2-2) #3 Rk	3	0	1	5	0	
(3-2-3) #1 Rk	6	0	0	2	2	
(3-3-3) Rk	6	0	0	1	3	
(3-4) #3 Rk	5	0	2	2	1	
(3-5) #2 Rk	3	0	2	5	0	
(3-7b) #2 Rk	4	0	0	6	0	
(5-1) #1 Rk	4	0	2	3	1	
(5-2) #2 Rk	8	0	0	2	0	
(5-4) #1 Rk	5	0	2	2	1	
(5-5) #1 Rk	7	0	0	3	0	
(6-Pa1)-3Rk	1	3	3	0	3	
(6-Pa2)-1Rk	2	1	3	3	1	
(7-2a) #1 Rk	7	0	0	3	0	
(7-3a) #2 Rk	7	0	0	3	0	
(7-4a) #2 Rk	6	0	0	4	0	
(1-A) Rk	3	0	0	7	0	rectorite
(1-C) Rk	2	1	3	4	0	rectorite
(3-XC) Rk	4	1	2	2	1	corrensite
AVERAGE:	5	1	1	3	1	
STANDARD DEVIATION:	1.800	1.197	1.217	1.706	1.041	
COEFFICIENT OF VARIATION:	0.392	2.393	1.071	0.569	1.348	
MINIMUM:	1	0	0	0	0	
MAXIMUM:	8	5	3	7	3	
NUMBER OF OBSERVATIONS:	22					

BY: SITE (WELL 8)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(8-1) Brown #1	8	0	0	2	0	
(8-1) Lt. Gray #3b	4	0	3	2	1	
(8-1) White #1	4	0	3	2	1	
(8-3) Black #1	4	0	2	3	1	
(8-4) Black #1	5	0	3	2	1	
(8-4) Mx #2	7	0	0	3	0	
(8-5) Red 1	4	1	2	2	1	corrensite
(8-5) Black 2	5	0	0	1	4	corrensite
(8-6) Red 1	4	0	0	2	3	corrensite
(8-7) Dk Gray	2	0	3	3	1	corrensite
AVERAGE:	5	0	2	2	1	
STANDARD DEVIATION:	1.616	0.300	1.356	0.600	1.187	
COEFFICIENT OF VARIATION:	0.344	3.000	0.848	0.273	0.913	
MINIMUM:	2	0	0	1	0	
MAXIMUM:	8	1	3	3	4	
NUMBER OF OBSERVATIONS:	10					

BY: SITE (WELL 2)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(2-1) Lt. Gray #1	4	0	3	1	1	
(2y-2) Powder 1500-10 #1	6	0	0	2	2	
(2y-2) Powder 1530-40 #2	3	1	2	3	1	
(2y-2) Powder 1560-70 #2	5	2	2	1	1	
(2-Pa) Red 2800-2890 #5	4	0	2	3	1	
(2-Pa) Black 2900-3000 #1	4	0	2	3	1	
(2-Pa) Red 2900-3000 #2	3	0	2	4	1	
(2Y) 1520-30 Powd #2	4	0	3	2	1	rectorite
(2Y) 1540-50 Powd #1	6	0	3	1	1	rectorite
AVERAGE:	4	0	2	2	1	
STANDARD DEVIATION:	1.054	0.667	0.875	1.030	0.314	
COEFFICIENT OF VARIATION:	0.243	2.000	0.414	0.464	0.283	
MINIMUM:	3	0	0	1	1	
MAXIMUM:	6	2	3	4	2	
NUMBER OF OBSERVATIONS:	9					

BY: LITHOLOGY (DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(6-3) Black Sty Comp#1	5	0	3	1	1	
(6-4) S#3 Str Cent	5	0	2	3	0	
(6-Pa) Black 3200-3300 #2	4	0	3	1	2	
(2-Pa) Black 2900-3000 #1	4	0	2	3	1	
(8-1) Brown #1	8	0	0	2	0	
(8-3) Black #1	4	0	2	3	1	
(8-4) Black #1	5	0	3	2	1	
(3-2-1) #1 Rk	4	0	3	2	1	
(5-2) #2 Rk	8	0	0	2	0	
(7-2a) #1 Rk	7	0	0	3	0	
(7-3a) #2 Rk	7	0	0	3	0	
(8-5) Black 2	5	0	0	1	4	corrensite
AVERAGE:	6	0	2	2	1	
STANDARD DEVIATION:	1.500	0.000	1.323	0.799	1.115	
COEFFICIENT OF VARIATION:	0.273	ERR	0.882	0.369	1.216	
MINIMUM:	4	0	0	1	0	
MAXIMUM:	8	0	3	3	4	
NUMBER OF OBSERVATIONS:	12					

BY: LITHOLOGY (CALCITE)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(2y-2) Powder 1500-10 #1	6	0	0	2	2	
(2y-2) Powder 1530-40 #2	3	1	2	3	1	
(3-1) #2 Rk	4	0	0	4	3	
(3-2-3) #1 Rk	6	0	0	2	2	
(3-5) #2 Rk	3	0	2	5	0	
(3-7b) #2 Rk	4	0	0	6	0	
(5-1) #1 Rk	4	0	2	3	1	
(5-5) #1 Rk	7	0	0	3	0	
(6-Pa1)-3Rk	1	3	3	0	3	
(1-A) Rk	3	0	0	7	0	rectorite
(1-C) Rk	2	1	3	4	0	rectorite
(2Y) 1520-30 Powd #2	4	0	3	2	1	rectorite
(2Y) 1540-50 Powd #1	6	0	3	1	1	rectorite
AVERAGE:	4	0	1	3	1	
STANDARD DEVIATION:	1.685	0.836	1.332	1.887	1.071	
COEFFICIENT OF VARIATION:	0.413	2.173	0.962	0.584	0.995	
MINIMUM:	1	0	0	0	0	
MAXIMUM:	7	3	3	7	3	
NUMBER OF OBSERVATIONS:	13					

BY: LITHOLOGY (ANHYDRITE)

NAME	IL	SM	CHL	MX	KAOL	PROBLEM
(6-Pa) Powd 2810-50 #1	3	1	2	2	1	
(2y-2) Powder 1560-70 #2	5	2	2	1	1	
(8-7) Dk Gray	2	0	3	3	1	corrensite
AVERAGE:	3	1	2	2	1	
STANDARD DEVIATION:	1.247	0.816	0.471	0.816	0.000	
COEFFICIENT OF VARIATION:	0.374	0.816	0.202	0.408	0.000	
MINIMUM:	2	0	2	1	1	
MAXIMUM:	5	2	3	3	1	
NUMBER OF OBSERVATIONS:	3					

BY: ZONE (3 OR 3A)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(2-1) Lt. Gray #1	4	0	3	1	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	0	1
STANDARD DEVIATION:	0.471	0.943	0.000	0.943	0.000
COEFFICIENT OF VARIATION:	0.109	1.414	0.000	2.828	0.000
MINIMUM:	4	0	3	-1	1
MAXIMUM:	5	2	3	1	1
NUMBER OF OBSERVATIONS:	3				

BY: ZONE (5)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.886	0.000	1.414	0.000	0.471
COEFFICIENT OF VARIATION:	0.354	ERR	0.707	0.000	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	8	0	3	2	1
NUMBER OF OBSERVATIONS:	3				

BY: ZONE (6 OR 6A)

NAME	IL	SM	CHL	MX	KAOL
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	3	1
STANDARD DEVIATION:	1.247	0.000	1.247	0.471	0.471
COEFFICIENT OF VARIATION:	0.234	ERR	0.748	0.177	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	7	0	3	3	1
NUMBER OF OBSERVATIONS:	3				

BY: ZONE (7 OR 7B)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	0	2	2	2
STANDARD DEVIATION:	1.095	0.400	1.356	0.748	1.265
COEFFICIENT OF VARIATION:	0.274	2.000	0.848	0.416	0.632
MINIMUM:	2	0	0	1	1
MAXIMUM:	5	1	3	3	4
NUMBER OF OBSERVATIONS:	5				

BY: CHARACTER (POROUS)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.197	0.667	1.155	0.816	0.471
COEFFICIENT OF VARIATION:	0.245	2.000	0.577	0.408	0.471
MINIMUM:	3	0	0	1	0
MAXIMUM:	7	2	3	3	2
NUMBER OF OBSERVATIONS:	9				

BY: FORMATION (YESO)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	3	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
(3-0) #3 Rk	5	0	2	3	0
(3-0-1) #1 Rk	5	5	0	0	0
(3-1) #2 Rk	4	0	0	4	3
(3-2-1) #1 Rk	4	0	3	2	1
(3-2-2) #3 Rk	3	0	1	5	0
(3-2-3) #1 Rk	6	0	0	2	2
(3-3-3) Rk	6	0	0	1	3
(3-4) #3 Rk	5	0	2	2	1
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-2) #2 Rk	8	0	0	2	0
(5-4) #1 Rk	5	0	2	2	1
(5-5) #1 Rk	7	0	0	3	0
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
(7-4a) #2 Rk	6	0	0	4	0
(3-XC) Rk	4	1	2	2	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1

	IL	SM	CHL	MX	KAOL
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.396	0.953	1.308	1.361	0.951
COEFFICIENT OF VARIATION:	0.289	2.354	0.808	0.628	0.951
MINIMUM:	2	0	0	-1	0
MAXIMUM:	8	5	4	6	4
NUMBER OF OBSERVATIONS:	42				

BY: POWDER (CHIP)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-1) Lt. Gray #1	4	0	3	1	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1

	IL	SM	CHL	MX	KAOL
AVERAGE:	4	0	2	2	1
STANDARD DEVIATION:	1.259	0.606	1.176	1.083	0.953
COEFFICIENT OF VARIATION:	0.295	2.321	0.564	0.530	0.730
MINIMUM:	2	0	0	-1	0
MAXIMUM:	8	2	3	4	4
NUMBER OF OBSERVATIONS:	23				

APPENDIX IV. RESULTS OF MULTIPLE CRITERIA SORTS FOR COMBINED DATABASE.

BY: SITE & CHARACTER (WELL 2 & PERM)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1.11	0.76	1.07	0.75	0.37
COEFFICIENT OF VARIATION:	0.237	1.528	0.493	0.447	0.319
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	6				

BY: SITE & CHARACTER (WELL 2 & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	1
STANDARD DEVIATION:	0.47	0.00	0.00	0.47	0.00
COEFFICIENT OF VARIATION:	0.129	ERR	0.000	0.141	0.000
MINIMUM:	3	0	2	3	1
MAXIMUM:	4	0	2	4	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & ZONE (WELL 2 & 4*)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1.17	0.80	1.10	0.75	0.40
OEFFICIENT OF VARIATION:	0.243	1.333	0.548	0.416	0.333
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	5				

BY: SITE & ZONE (WELL 2 AND 10)

NAME	IL	SM	CHL	MX	KAOL
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	1
STANDARD DEVIATION:	0.47	0.00	0.00	0.47	0.00
COEFFICIENT OF VARIATION:	0.129	ERR	0.000	0.141	0.000
MINIMUM:	3	0	2	3	1
MAXIMUM:	4	0	2	4	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & CHIP/POWDER (WELL 2 AND POWDER)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1.17	0.80	1.10	0.75	0.40
COEFFICIENT OF VARIATION:	0.243	1.333	0.548	0.416	0.333
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	5				

BY: SITE & CHIP/POWDER (WELL 2 AND CHIP)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	1
STANDARD DEVIATION:	0.43	0.00	0.43	1.09	0.00
COEFFICIENT OF VARIATION:	0.115	ERR	0.192	0.396	0.000
MINIMUM:	3	0	2	1	1
MAXIMUM:	4	0	3	4	1
NUMBER OF OBSERVATIONS:	4				

BY: SITE & CHARACTER (WELL 8 & PERM)

NAME	IL	SM	CHL	MX	KAOL
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	3	1
STANDARD DEVIATION:	1.25	0.00	1.25	0.47	0.47
COEFFICIENT OF VARIATION:	0.234	ERR	0.748	0.177	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	7	0	3	3	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & CHARACTER (WELL 8 & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.80	0.37	1.34	0.58	1.25
COEFFICIENT OF VARIATION:	0.401	2.236	0.733	0.289	0.935
MINIMUM:	2	0	0	1	0
MAXIMUM:	8	1	3	3	4
NUMBER OF OBSERVATIONS:	6				

BY: SITE & LITHOLOGY (WELL 2 & CALCITE)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.30	0.43	1.22	0.71	0.43
COEFFICIENT OF VARIATION:	0.273	1.732	0.612	0.354	0.346
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	1	3	3	2
NUMBER OF OBSERVATIONS:	4				

BY: SITE & LITHOLOGY (WELL 2 & QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	1
STANDARD DEVIATION:	0.47	0.00	0.47	1.25	0.00
COEFFICIENT OF VARIATION:	0.129	ERR	0.202	0.468	0.000
MINIMUM:	3	0	2	1	1
MAXIMUM:	4	0	3	4	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & FORMATION (WELL 2 & YESO)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1.11	0.76	1.07	0.75	0.37
COEFFICIENT OF VARIATION:	0.237	1.528	0.493	0.447	0.319
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	6				

BY: SITE & FORMATION (WELL 2 & ABO)

NAME	IL	SM	CHL	MX	KAOL
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	1
STANDARD DEVIATION:	0.47	0.00	0.00	0.47	0.00
COEFFICIENT OF VARIATION:	0.129	ERR	0.000	0.141	0.000
MINIMUM:	3	0	2	3	1
MAXIMUM:	4	0	2	4	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE AND CHARACTER (WELL 6 & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
AVERAGE:	4	1	2	2	1
STANDARD DEVIATION:	1.05	0.71	0.97	1.05	0.86
COEFFICIENT OF VARIATION:	0.255	1.414	0.430	0.562	0.623
MINIMUM:	3	0	0	0	0
MAXIMUM:	6	2	3	3	3
NUMBER OF OBSERVATIONS:	8				

BY: SITE AND CHARACTER (WELL 6 & BOTH)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-1) Red E3	3	2	3	1	2
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	1	1
STANDARD DEVIATION:	0.89	0.98	0.97	0.80	0.49
COEFFICIENT OF VARIATION:	0.224	1.225	0.303	1.333	0.350
MINIMUM:	3	0	3	-1	1
MAXIMUM:	5	2	4	1	2
NUMBER OF OBSERVATIONS:	5				

BY: SITE & LITHOLOGY (WELL 6 & DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
AVERAGE:	5	0	3	2	1
STANDARD DEVIATION:	0.47	0.00	0.47	0.94	0.82
COEFFICIENT OF VARIATION:	0.101	ERR	0.177	0.566	0.816
MINIMUM:	4	0	2	1	0
MAXIMUM:	5	0	3	3	2
NUMBER OF OBSERVATIONS:	3				

BY: SITE & LITHOLOGY (WELL 6 & MIXED)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	5	1	3	0	1
STANDARD DEVIATION:	1.12	1.00	0.71	0.83	0.43
COEFFICIENT OF VARIATION:	0.248	1.000	0.236	3.317	0.346
MINIMUM:	3	0	2	-1	1
MAXIMUM:	6	2	4	1	2
NUMBER OF OBSERVATIONS:	4				

BY: SITE & LITHOLOGY (WELL 6 & QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	0.94	0.00	1.41	0.47	0.82
COEFFICIENT OF VARIATION:	0.257	ERR	0.707	0.177	0.408
MINIMUM:	3	0	0	2	1
MAXIMUM:	5	0	3	3	3
NUMBER OF OBSERVATIONS:	3				

BY: SITE & ZONE (WELL 6 & ZONE 10)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
AVERAGE:	4	0	2	2	2
STANDARD DEVIATION:	0.80	0.40	1.17	0.75	0.75
COEFFICIENT OF VARIATION:	0.222	2.000	0.530	0.340	0.416
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	1	3	3	3
NUMBER OF OBSERVATIONS:	5				

BY: SITE & FORMATION (WELL 6 & YESO)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	1	1
STANDARD DEVIATION:	0.99	0.93	0.60	1.05	0.60
COEFFICIENT OF VARIATION:	0.227	1.059	0.209	1.204	0.533
MINIMUM:	3	0	2	-1	0
MAXIMUM:	6	2	4	3	2
NUMBER OF OBSERVATIONS:	8				

BY: SITE & FORMATION (WELL 6 & ABO)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
AVERAGE:	4	1	3	1	1
STANDARD DEVIATION:	1.00	0.84	0.92	1.15	0.74
COEFFICIENT OF VARIATION:	0.245	1.358	0.353	0.828	0.533
MINIMUM:	3	0	0	-1	0
MAXIMUM:	6	2	4	3	3
NUMBER OF OBSERVATIONS:	13				

BY: SITE & POWDER (WELL 6 & POWDER)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-2) Red Powd #3	6	2	2	0	1
AVERAGE:	4	1	3	1	1
STANDARD DEVIATION:	1.30	0.83	0.83	0.71	0.43
'ICIENT OF VARIATION:	0.306	1.106	0.302	0.707	0.346
MINIMUM:	3	0	2	0	1
MAXIMUM:	6	2	4	2	2
ER OF OBSERVATIONS:	4				

BY: SITE & POWDER (WELL 6 & CHIP)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	2	1
STANDARD DEVIATION:	0.82	0.83	0.96	1.26	0.83
COEFFICIENT OF VARIATION:	0.204	1.497	0.374	0.808	0.576
MINIMUM:	3	0	0	-1	0
MAXIMUM:	5	2	3	3	3
NUMBER OF OBSERVATIONS:	9				

BY: SITE & LITHOLOGY (ROCK & MIXED)

NAME	IL	SM	CHL	MX	KAOL
(3-2-2) #3 Rk	3	0	1	5	0
(3-4) #3 Rk	5	0	2	2	1
(7-4a) #2 Rk	6	0	0	4	0
AVERAGE:	5	0	1	4	0
STANDARD DEVIATION:	1.25	0.00	0.82	1.25	0.47
COEFFICIENT OF VARIATION:	0.267	ERR	0.816	0.340	1.414
MINIMUM:	3	0	0	2	0
MAXIMUM:	6	0	2	5	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & LITHOLOGY (ROCK & DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL
(3-2-1) #1 Rk	4	0	3	2	1
(5-2) #2 Rk	8	0	0	2	0
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
AVERAGE:	7	0	1	3	0
STANDARD DEVIATION:	1.50	0.00	1.30	0.50	0.43
COEFFICIENT OF VARIATION:	0.231	ERR	1.732	0.200	1.732
MINIMUM:	4	0	0	2	0
MAXIMUM:	8	0	3	3	1
NUMBER OF OBSERVATIONS:	4				

BY: SITE & LITHOLOGY (ROCK & QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(3-0) #3 Rk	5	0	2	3	0
(3-3-3) Rk	6	0	0	1	3
(5-4) #1 Rk	5	0	2	2	1
(6-Pa2)-1Rk	2	1	3	3	1
(3-XC) Rk	4	1	2	2	1
AVERAGE:	4	0	2	2	1
STANDARD DEVIATION:	1.36	0.49	0.98	0.75	0.98
COEFFICIENT OF VARIATION:	0.308	1.225	0.544	0.340	0.816
MINIMUM:	2	0	0	1	0
MAXIMUM:	6	1	3	3	3
NUMBER OF OBSERVATIONS:	5				

BY: SITE & LITHOLOGY (WELL 8 & QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-5) Red 1	4	1	2	2	1
(8-6) Red 1	4	0	0	2	3
AVERAGE:	4	0	2	2	2
STANDARD DEVIATION:	0.00	0.47	1.25	0.00	0.94
COEFFICIENT OF VARIATION:	0.000	1.414	0.748	0.000	0.566
MINIMUM:	4	0	0	2	1
MAXIMUM:	4	1	3	2	3
NUMBER OF OBSERVATIONS:	3				

BY: SITE & FORMATION (ROCK & YESO)

NAME	IL	SM	CHL	MX	KAOL
(3-0) #3 Rk	5	0	2	3	0
(3-0-1) #1 Rk	5	5	0	0	0
(3-1) #2 Rk	4	0	0	4	3
(3-2-1) #1 Rk	4	0	3	2	1
(3-2-2) #3 Rk	3	0	1	5	0
(3-2-3) #1 Rk	6	0	0	2	2
(3-3-3) Rk	6	0	0	1	3
(3-4) #3 Rk	5	0	2	2	1
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-2) #2 Rk	8	0	0	2	0
(5-4) #1 Rk	5	0	2	2	1
(5-5) #1 Rk	7	0	0	3	0
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
(7-4a) #2 Rk	6	0	0	4	0
(3-XC) Rk	4	1	2	2	1
AVERAGE:	5	0	1	3	1
STANDARD DEVIATION:	1.42	1.15	1.05	1.45	0.99
COEFFICIENT OF VARIATION:	0.276	3.464	1.179	0.501	1.370
MINIMUM:	3	0	0	0	0
MAXIMUM:	8	5	3	6	3
NUMBER OF OBSERVATIONS:	18				

BY: SITE & LITHOLOGY (ROCK & CALCITE)

NAME	IL	SM	CHL	MX	KAOL
(3-1) #2 Rk	4	0	0	4	3
(3-2-3) #1 Rk	6	0	0	2	2
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-5) #1 Rk	7	0	0	3	0
(6-Pa1)-3Rk	1	3	3	0	3
(1-A) Rk	3	0	0	7	0
(1-C) Rk	2	1	3	4	0
AVERAGE:	4	0	1	4	1
STANDARD DEVIATION:	1.75	0.96	1.29	1.99	1.25
COEFFICIENT OF VARIATION:	0.463	2.151	1.158	0.526	1.247
MINIMUM:	1	0	0	0	0
MAXIMUM:	7	3	3	7	3
NUMBER OF OBSERVATIONS:	9				

BY: SITE & ZONE (WELL 8 & ZONE 5)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.89	0.00	1.41	0.00	0.47
COEFFICIENT OF VARIATION:	0.354	ERR	0.707	0.000	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	8	0	3	2	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & ZONE (WELL 8 & ZONE 6)

NAME	IL	SM	CHL	MX	KAOL
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	3	1
STANDARD DEVIATION:	1.25	0.00	1.25	0.47	0.47
COEFFICIENT OF VARIATION:	0.234	ERR	0.748	0.177	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	7	0	3	3	1
NUMBER OF OBSERVATIONS:	3				

BY: SITE & ZONE (WELL 8 AND ZONE 7)

NAME	IL	SM	CHL	MX	KAOL
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	0	1	2	2
STANDARD DEVIATION:	1.09	0.43	1.30	0.71	1.30
COEFFICIENT OF VARIATION:	0.291	1.732	1.039	0.354	0.577
MINIMUM:	2	0	0	1	1
MAXIMUM:	5	1	3	3	4
NUMBER OF OBSERVATIONS:	4				

BY: SITE & LITHOLOGY (WELL 8 & DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-5) Black 2	5	0	0	1	4
AVERAGE:	6	0	1	2	2
STANDARD DEVIATION:	1.50	0.00	1.30	0.71	1.50
COEFFICIENT OF VARIATION:	0.273	ERR	1.039	0.354	1.000
MINIMUM:	4	0	0	1	0
MAXIMUM:	8	0	3	3	4
NUMBER OF OBSERVATIONS:	4				

BY: FORMATION & LITHOLOGY (YESO & DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(8-1) Brown #1	8	0	0	2	0
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(3-2-1) #1 Rk	4	0	3	2	1
(5-2) #2 Rk	3	0	0	2	0
(7-2a) #1 Rk	7	0	0	3	0
(7-3a) #2 Rk	7	0	0	3	0
(8-5) Black 2	5	0	0	1	4
AVERAGE:	6	0	1	2	1
STANDARD DEVIATION:	1.47	0.00	1.35	0.75	1.17
COEFFICIENT OF VARIATION:	0.253	ERR	1.035	0.340	1.453
MINIMUM:	4	0	0	1	0
MAXIMUM:	8	0	3	3	4
NUMBER OF OBSERVATIONS:	10				

BY: FORMATION & LITHOLOGY (YESO & QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(6-1) Lt. Gray #3b	4	0	3	2	1
(3-0) #3 Rk	5	0	2	3	0
(3-3-3) Rk	6	0	0	1	3
(5-4) #1 Rk.c	5	0	2	2	1
(3-XC) Rk calcite	4	1	2	2	1
(8-5) Red 1-/-dol	4	1	2	2	1
(8-6) Red 1-/-dol	4	0	0	2	3
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	0.71	0.43	1.09	0.60	0.99
COEFFICIENT OF VARIATION:	0.157	1.732	0.623	0.320	0.722
MINIMUM:	4	0	0	1	0
MAXIMUM:	6	1	3	3	3
NUMBER OF OBSERVATIONS:	8				

BY: FORMATION & LITHOLOGY (YESO & CALCITE)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(3-1) #2 Rk	4	0	0	4	3
(3-2-3) #1 Rk	6	0	0	2	2
(3-5) #2 Rk	3	0	2	5	0
(3-7b) #2 Rk	4	0	0	6	0
(5-1) #1 Rk	4	0	2	3	1
(5-5) #1 Rk	7	0	0	3	0
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	1	3	1
STANDARD DEVIATION:	1.35	0.30	1.25	1.45	0.94
COEFFICIENT OF VARIATION:	0.296	3.000	1.041	0.466	0.858
MINIMUM:	3	0	0	1	0
MAXIMUM:	7	1	3	6	3
NUMBER OF OBSERVATIONS:	10				

BY: FORMATION & LITHOLOGY (YESO & MIXED)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(8-4) Mx #2	7	0	0	3	0
(3-2-2) #3 Rk	3	0	1	5	0
(3-4) #3 Rk	5	0	2	2	1
(7-4a) #2 Rk	6	0	0	4	0
(6-2) Red Powd #3	6	2	2	0	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1.36	0.87	1.36	1.90	0.66
COEFFICIENT OF VARIATION:	0.280	1.732	0.727	1.013	0.882
MINIMUM:	3	0	0	-1	0
MAXIMUM:	7	2	4	5	2
NUMBER OF OBSERVATIONS:	8				

BY: FORMATION & LITHOLOGY (YESO & GYPSUM)

NAME	IL	SM	CHL	MX	KAOL
(8-1) White #1	4	0	3	2	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
AVERAGE:	4	1	3	1	1
STANDARD DEVIATION:	0.47	0.82	0.00	0.47	0.47
COEFFICIENT OF VARIATION:	0.129	0.816	0.000	0.354	0.354
MINIMUM:	3	0	3	1	1
MAXIMUM:	4	2	3	2	2
NUMBER OF OBSERVATIONS:	3				

BY: FORMATION & CHARACTER (YESO & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-4) S#3 Str Cent	5	0	2	3	0
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(6-2) Red S#1	4	1	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.56	0.68	1.15	0.92	1.10
COEFFICIENT OF VARIATION:	0.335	1.541	0.577	0.515	0.990
MINIMUM:	2	0	0	0	0
MAXIMUM:	8	2	3	3	4
NUMBER OF OBSERVATIONS:	9				

BY: FORMATION & CHARACTER (YESO & PERMEABLE)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.20	0.67	1.15	0.82	0.47
COEFFICIENT OF VARIATION:	0.245	2.000	0.577	0.408	0.471
MINIMUM:	3	0	0	1	0
MAXIMUM:	7	2	3	3	2
NUMBER OF OBSERVATIONS:	9				

BY: FORMATION & CHARACTER (YESO & BOTH)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-1) Red E3	3	2	3	1	2
(6-3) Gray 5	4	2	3	-1	1
(8-6) Red 1	4	0	0	2	3
AVERAGE:	4	1	3	1	2
STANDARD DEVIATION:	0.82	0.94	1.25	0.90	0.75
COEFFICIENT OF VARIATION:	0.204	1.414	0.468	1.077	0.447
MINIMUM:	3	0	0	-1	1
MAXIMUM:	5	2	4	2	3
NUMBER OF OBSERVATIONS:	6				

BY: FORMATION & ZONE (YESO & ZONE 3*)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(2-1) Lt. Gray #1	4	0	3	1	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	0	1
STANDARD DEVIATION:	0.47	0.94	0.00	0.94	0.00
COEFFICIENT OF VARIATION:	0.109	1.414	0.000	2.828	0.000
MINIMUM:	4	0	3	-1	1
MAXIMUM:	5	2	3	1	1
NUMBER OF OBSERVATIONS:	3				

BY: FORMATION & POWDER (YESO)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
(6-2) Red Powd #3	6	2	2	0	1
AVERAGE:	ERR	ERR	ERR	ERR	ERR
STANDARD DEVIATION:	ERR	ERR	ERR	ERR	ERR
COEFFICIENT OF VARIATION:	ERR	ERR	ERR	ERR	ERR
MINIMUM:	ERR	ERR	ERR	ERR	ERR
MAXIMUM:	ERR	ERR	ERR	ERR	ERR
NUMBER OF OBSERVATIONS:	0				

BY: FORMATION & CHIP (YESO)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(2-1) Lt. Gray #1	4	0	3	1	1
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
(6-3) Gray 5	4	2	3	-1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.37	0.70	1.25	1.03	1.01
COEFFICIENT OF VARIATION:	0.304	1.856	0.605	0.589	0.854
MINIMUM:	2	0	0	-1	0
MAXIMUM:	8	2	3	3	4
NUMBER OF OBSERVATIONS:	16				

BY: FORMATION & LITHOLOGY (ABO & QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2900-2990 #5	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(6-Pa2)-1Rk	2	1	3	3	1
AVERAGE:	3	0	2	3	2
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.283	2.236	0.493	0.192	0.509
MINIMUM:	2	0	0	2	1
MAXIMUM:	5	1	3	4	3
NUMBER OF OBSERVATIONS:	6				

BY: FORMATION & CHIP (ABO)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.188	ERR	0.462	0.324	0.464
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	0	3	4	3
NUMBER OF OBSERVATIONS:	7				

BY: FORMATION & CHARACTER (ABO & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.192	2.646	0.436	0.326	0.471
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	1	3	4	3
NUMBER OF OBSERVATIONS:	8				

BY: FORMATION & ZONE (ABO & ZONE 10)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.192	2.646	0.436	0.326	0.471
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	1	3	4	3
NUMBER OF OBSERVATIONS:	8				

BY: LITHOLOGY & ZONE (CALCITE & ZONE 4*)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1	0	1	1	0
COEFFICIENT OF VARIATION:	0.273	1.732	0.612	0.354	0.346
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	1	3	3	2
NUMBER OF OBSERVATIONS:	4				

BY: LITHOLOGY & ZONE (QUARTZ & ZONE 10)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.222	ERR	0.548	0.211	0.500
MINIMUM:	3	0	0	2	1
MAXIMUM:	5	0	3	4	3
NUMBER OF OBSERVATIONS:	5				

BY: LITHOLOGY & CHARACTER (CALCITE & PERMEABLE)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1	0	1	1	0
COEFFICIENT OF VARIATION:	0.273	1.732	0.612	0.354	0.346
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	1	3	3	2
NUMBER OF OBSERVATIONS:	4				

BY: LITHOLOGY & CHARACTER (DOLOMITE & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(8-1) Brown #1	8	0	0	2	0
(8-5) Black 2	5	0	0	1	4
AVERAGE:	5	0	1	2	1
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.283	ERR	0.857	0.447	1.069
MINIMUM:	4	0	0	1	0
MAXIMUM:	8	0	3	3	4
NUMBER OF OBSERVATIONS:	5				

BY: LITHOLOGY & CHARACTER (QUARTZ & CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-5) Red 1	4	1	2	2	1
AVERAGE:	4	0	2	3	1
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.188	2.449	0.462	0.258	0.510
MINIMUM:	3	0	0	2	1
MAXIMUM:	5	1	3	4	3
NUMBER OF OBSERVATIONS:	7				

BY: LITHOLOGY & CHARACTER (MIXED & BOTH)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	0	1
STANDARD DEVIATION:	1	1	0	1	0
COEFFICIENT OF VARIATION:	0.204	1.414	0.141	2.828	0.354
MINIMUM:	3	0	3	-1	1
MAXIMUM:	5	2	4	1	2
NUMBER OF OBSERVATIONS:	3				

BY: CHARACTER & ZONE (PERMEABLE & ZONE 4*)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1	1	1	1	0
COEFFICIENT OF VARIATION:	0.243	1.333	0.548	0.416	0.333
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	5				

BY: CHARACTER & ZONE (PERMEABLE & ZONE 6*)

NAME	IL	SM	CHL	MX	KAOL
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	3	1
STANDARD DEVIATION:	1	0	1	0	0
COEFFICIENT OF VARIATION:	0.234	ERR	0.748	0.177	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	7	0	3	3	1
NUMBER OF OBSERVATIONS:	3				

BY: CHARACTER & ZONE (CLAY & ZONE 10)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Powd 2810-50 #1	3	1	2	2	1
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	1	0	1	1	1
COEFFICIENT OF VARIATION:	0.192	2.646	0.436	0.326	0.471
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	1	3	4	3
NUMBER OF OBSERVATIONS:	8				

BY: CHARACTER & ZONE (CLAY & ZONE 5)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #35	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	2	0	1	0	0
COEFFICIENT OF VARIATION:	0.354	ERR	0.707	0.000	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	8	0	3	2	1
NUMBER OF OBSERVATIONS:	3				

BY: CHIP & LITHOLOGY (DOLOMITE)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(8-1) Brown #1	8	0	0	2	0
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-5) Black 2	5	0	0	1	4
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.22	0.00	1.17	0.87	1.20
COEFFICIENT OF VARIATION:	0.245	ERR	0.622	0.433	0.959
MINIMUM:	4	0	0	1	0
MAXIMUM:	8	0	3	3	4
NUMBER OF OBSERVATIONS:	8				

BY: CHIP & LITHOLOGY (QUARTZ)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-1) Lt. Gray #1	4	0	3	1	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-5) Red 1	4	1	2	2	1
(8-6) Red 1	4	0	0	2	3
AVERAGE:	4	0	2	2	2
STANDARD DEVIATION:	0.63	0.31	1.15	0.83	0.83
COEFFICIENT OF VARIATION:	0.166	2.828	0.577	0.340	0.535
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	1	3	4	3
NUMBER OF OBSERVATIONS:	9				

BY: CHIP & LITHOLOGY (GYPSUM)

NAME	IL	SM	CHL	MX	KAOL
(8-1) White #1	4	0	3	2	1
(6-1) Red E3	3	2	3	1	2
(6-2) Red S#1	4	1	3	1	1
AVERAGE:	4	1	3	1	1
STANDARD DEVIATION:	0.47	0.82	0.00	0.47	0.47
COEFFICIENT OF VARIATION:	0.129	0.816	0.000	0.354	0.354
MINIMUM:	3	0	3	1	1
MAXIMUM:	4	2	3	2	2
NUMBER OF OBSERVATIONS:	3				

BY: CHIP & CHARACTER (CLAY)

NAME	IL	SM	CHL	MX	KAOL
(6-4) S#3 Str Cent	5	0	2	3	0
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
(6-2) Red S#1	4	1	3	1	1
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	0	2	2	1
STANDARD DEVIATION:	1.31	0.34	1.12	0.87	1.01
COEFFICIENT OF VARIATION:	0.317	2.550	0.544	0.373	0.758
MINIMUM:	2	0	0	1	0
MAXIMUM:	8	1	3	4	4
NUMBER OF OBSERVATIONS:	15				

BY: CHIP & CHARACTER (PERMEABLE)

NAME	IL	SM	CHL	MX	KAOL
(2-1) Lt. Gray #1	4	0	3	1	1
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4)_Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.22	0.00	1.22	0.83	0.43
COEFFICIENT OF VARIATION:	0.245	ERR	0.612	0.369	0.577
MINIMUM:	4	0	0	1	0
MAXIMUM:	7	0	3	3	1
NUMBER OF OBSERVATIONS:	4				

BY: CHIP & CHARACTER (BOTH)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(6-1) Red E3	3	2	3	1	2
(6-3) Gray 5	4	2	3	-1	1
(8-6) Red 1	4	0	0	2	3
	4	1	2	1	2
STANDARD DEVIATION:	0.71	1.00	1.30	1.09	0.83
COEFFICIENT OF VARIATION:	0.177	1.000	0.577	1.453	0.474
MINIMUM:	3	0	0	-1	1
MAXIMUM:	5	2	3	2	3
NUMBER OF OBSERVATIONS:	4				

BY: CHIP & ZONE (ZONE 3*)

NAME	IL	SM	CHL	MX	KAOL
(6-3) Black Sty Comp#1	5	0	3	1	1
(2-1) Lt. Gray #1	4	0	3	1	1
(6-3) Gray 5	4	2	3	-1	1
AVERAGE:	4	1	3	0	1
STANDARD DEVIATION:	0.47	0.94	0.00	0.94	0.00
COEFFICIENT OF VARIATION:	0.109	1.414	0.000	2.829	0.000
MINIMUM:	4	0	3	-1	1
MAXIMUM:	5	2	3	1	1
NUMBER OF OBSERVATIONS:	3				

BY: CHIP & ZONE (ZONE 5)

NAME	IL	SM	CHL	MX	KAOL
(8-1) Brown #1	8	0	0	2	0
(8-1) Lt. Gray #3b	4	0	3	2	1
(8-1) White #1	4	0	3	2	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1.89	0.00	1.41	0.00	0.47
COEFFICIENT OF VARIATION:	0.354	ERR	0.707	0.000	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	8	0	3	2	1
NUMBER OF OBSERVATIONS:	3				

BY: CHIP & ZONE (ZONE 6*)

NAME	IL	SM	CHL	MX	KAOL
(8-3) Black #1	4	0	2	3	1
(8-4) Black #1	5	0	3	2	1
(8-4) Mx #2	7	0	0	3	0
AVERAGE:	5	0	2	3	1
STANDARD DEVIATION:	1.25	0.00	1.25	0.47	0.47
COEFFICIENT OF VARIATION:	0.234	ERR	0.748	0.177	0.707
MINIMUM:	4	0	0	2	0
MAXIMUM:	7	0	3	3	1
NUMBER OF OBSERVATIONS:	3				

BY: CHIP & ZONE (ZONE 7*)

NAME	IL	SM	CHL	MX	KAOL
(8-5) Red 1	4	1	2	2	1
(8-5) Black 2	5	0	0	1	4
(8-6) Red 1	4	0	0	2	3
(8-7) Dk Gray	2	0	3	3	1
AVERAGE:	4	0	1	2	2
STANDARD DEVIATION:	1.09	0.43	1.30	0.71	1.30
COEFFICIENT OF VARIATION:	0.291	1.732	1.039	0.354	0.577
MINIMUM:	2	0	0	1	1
MAXIMUM:	5	1	3	3	4
NUMBER OF OBSERVATIONS:	4				

BY: CHIP & ZONE (ZONE 10)

NAME	IL	SM	CHL	MX	KAOL
(6-Pa) Black 3000-3200 #1	3	0	3	2	2
(6-Pa) Red 3000-3200 #1	5	0	0	3	3
(6-Pa) Black 3200-3300 #2	4	0	3	1	2
(6-Pa) Red 3200-3300 #1	3	0	3	3	1
(2-Pa) Red 2800-2890 #5	4	0	2	3	1
(2-Pa) Black 2900-3000 #1	4	0	2	3	1
(2-Pa) Red 2900-3000 #2	3	0	2	4	1
AVERAGE:	4	0	2	3	2
STANDARD DEVIATION:	0.70	0.00	0.99	0.88	0.73
COEFFICIENT OF VARIATION:	0.188	ERR	0.462	0.324	0.464
MINIMUM:	3	0	0	1	1
MAXIMUM:	5	0	3	4	3
NUMBER OF OBSERVATIONS:	7				

BY: POWDER & LITHOLOGY (MIXED)

NAME	IL	SM	CHL	MX	KAOL
(6-7) Red Powder #3	5	0	3	1	1
(6-8) Red Powder #1	3	0	4	1	2
(6-2) Red Powd #3	6	2	2	0	1
AVERAGE:	5	1	3	1	1
STANDARD DEVIATION:	1	1	1	0	0
COEFFICIENT OF VARIATION:	0.267	1.414	0.272	0.707	0.354
MINIMUM:	3	0	2	0	1
MAXIMUM:	6	2	4	1	2
NUMBER OF OBSERVATIONS:	3				

BY: POWDER & LITHOLOGY (CALCITE)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	0	2	2	1
STANDARD DEVIATION:	1	0	1	1	0
COEFFICIENT OF VARIATION:	0.273	1.732	0.612	0.354	0.346
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	1	3	3	2
NUMBER OF OBSERVATIONS:	4				

BY: POWDER & CHARACTER (PERMEABLE)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1	1	1	1	0
COEFFICIENT OF VARIATION:	0.243	1.333	0.548	0.416	0.333
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	5				

3Y: POWDER & ZONE (ZONE 4*)

NAME	IL	SM	CHL	MX	KAOL
(2y-2) Powder 1500-10 #1	6	0	0	2	2
(2y-2) Powder 1530-40 #2	3	1	2	3	1
(2y-2) Powder 1560-70 #2	5	2	2	1	1
(2Y) 1520-30 Powd #2	4	0	3	2	1
(2Y) 1540-50 Powd #1	6	0	3	1	1
AVERAGE:	5	1	2	2	1
STANDARD DEVIATION:	1	1	1	1	0
COEFFICIENT OF VARIATION:	0.243	1.333	0.548	0.416	0.333
MINIMUM:	3	0	0	1	1
MAXIMUM:	6	2	3	3	2
NUMBER OF OBSERVATIONS:	5				