Mechanical Properties of Sea Ice – Statistical Data Analysis

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ABSTRACT

Mechanical Properties of Sea Ice (MPSI) is a joint industry-government program to investigate the crystal structure and mechanical properties of multi-year pressure ridges of sea ice. Over 200 uniaxial compression tests were conducted on samples collected from near Beaufort Sea. This report presents a statistical analysis of these test results. Effect of location variables and physical properties on mechanical properties and crystal structure were statistically analyzed.

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by

P. Sengupta

INTRODUCTION

Mechanical Properties of Sea Ice (MPSI) is a joint industry-government program, administered by Shell, to investigate the structure and mechanical properties of multi-year pressure ridges of sea ice. In Phase 1 of this study, ice samples were collected from ten ridges northwest of Reindeer Island in the Beaufort Sea. Tests were then conducted by U. S. Army Cold Region Research and Engineering Laboratory (CRREL) under contract to Shell Development Company. Tests were primarily uniaxial compression, with some uniaxial tension and conventional triaxial.

This report presents the statistical analysis done at Shell Development's Systems Development Department of 222 uniaxial compression constant strain rate tests. Mechanical properties (e.g., peak stress/strain), physical properties (e.g., porosity), and location parameters (e.g., ridge) were available for each test. The objective of this analysis was to correlate these properties and parameters statistically.

1. TEST TYPES AND VARIABLES

One of the principal purposes of Phase 1 was to determine if ice samples from different locations have different mechanical properties. Therefore, ten different multi-year ridges were sampled. To determine variations within a ridge, samples were collected at two different sites (14 to 46 meters apart) within each ridge. To get necessary replications, two cores were obtained close to each other (less than 100 cm apart) from the same site. The four cores within a ridge will be referred to as A,B (one site), and C,D (the other site). Yet another important variable to be examined is whether a sample is from above or below the sea level, and its depth from the surface.

The significant independent variables to be investigated were strain rate and temperature. To this end, tests were conducted at two different strain rates (10^{-3}/sec, 10^{-5}/sec) and temperatures (-5°C, -20°C). These

values approximately cover the range of strain rate and temperature that is of practical importance. The number of tests done at different strain rates ($\dot{\varepsilon}$) and temperature (T) is summarized below:

Strain Rate	Temperature -5°C	Temperature -20°C
10^{-3}/sec	69	41
10^{-5}/sec	71	41

The following table gives a breakdown of the above by different ridges.

Ridge No.	Strain Rate and Temperature 10^{-3}/sec -5°C	10^{-3}/sec -20°C	10^{-5}/sec -5°C	10^{-5}/sec -20°C	Total
1	5	6	6	6	23
2	12	6	6		24
3	5		11	6	22
4	11	6	5		22
5	5		13	6	24
6	3	3	3	3	12
7	12	6	5		23
8	6		12	6	24
9	6	8	4	6	24
10	4	6	6	8	24
Total	69	41	71	41	222

We also give below the detailed breakdown of types of tests done for samples from any one ridge. For illustrative purposes, we select ridge 1. Others are similar, though not identical (see Appendix 1 for full details).

Ridge 1

Site	Sea Level Above	Sea Level Below
AB	2 (10^{-3}/sec, -5°C) 2 (10^{-5}/sec, -5°C)	3 (10^{-3}/sec, -5°C) 4 (10^{-5}/sec, -5°C)
CD	2 (10^{-3}/sec, -20°C) 2 (10^{-5}/sec, -20°C)	4 (10^{-3}/sec, -20°C) 4 (10^{-5}/sec, -20°C)

The tests were done on a closed-loop electrohydraulic machine. Test temperature and strain rates were controlled during the test. Measurements on

various strains and loads were taken on a continuous basis. Later, from force-displacement curves, different modulus values were calculated. In addition, physical properties of the sample, like salinity, porosity, etc., were also measured. On a limited number of tests, crystallographic analyses were done. Finally, from photographs taken during the tests, the failure mechanisms were determined.

A list of measured properties (mechanical and physical) is given below:

Variable	Description
σ_m(psi)	Peak stress, or strength
ε_m(FS)(%)	Strain at σ_m determined by the extensometer over the full sample length of 10 in.
t_m(s)	Time to peak stress
σ_e(psi)	Stress at end of test
ε_e(FS)(%)	Full sample strain at end of test
t_e(s)	Time to end of test
E_i(GL)(10^6 psi)	Initial tangent modulus determined using strains found over the gauge length
E_0(FS)(10^6 psi)	Secant modulus determined using full sample strains
S_i(^{o}/oo)	Sample salinity at test temperature
ρ(lb/ft^3)	Sample weight density at test temperature
V_b(^{o}/oo)	Brine volume at test temperature
V_a(^{o}/oo)	Air volume at test temperature
n(^{o}/oo)	Porosity at test temperature
ν_0	Initial Poisson's ratio; circumferential and gauge length strain measurements used
FAIL	Failure Mechanism; Primary, Secondary
CRYS	Crystal structure

A commercial statistical software, SAS (Ref. 3) was extensively used for the statistical analysis.

2. EFFECT OF LOCATION ON ICE PROPERTIES

The location of a test is characterized by a number of parameters. These are ridge, site, core, above/below sea level, depth. For our analysis,

we do not differentiate between cores within a site. Also, after looking at the data and making some preliminary plots, it was decided that depth does not have any statistically significant effect on ice properties. Therefore, we concentrated on ridge, site, and above/below sea level in further analysis. We dealt with only the major measured variables.

2.1 Effect of Sea Level

Disregarding the effects of ridges and site, the average of σ_m (psi) at different $(T, \dot{\varepsilon})$ levels for above and below sea levels were calculated. These are given below:

	Strain Rate = 10^{-3}/sec		Strain Rate = 10^{-5}/sec	
	Temperature		Temperature	
Sea Level	-5°C	-20°C	-5°C	-20°C
Above	836	1429	335	414
Below	902	1377	342	389

A more detailed summary (segregated by ridges) is given in Appendix 2.

From the above table, there does not seem to be large difference in σ_m based strictly on whether the sample is from above or below sea level. To get more specific statistical information, t-tests were performed at each of the $(T, \dot{\varepsilon})$ levels. There were no statistically significant differences in mean σ_m between above and below sea level samples. To account for differences among ridges, similar t-tests were done for one single ridge, again at all $(T, \dot{\varepsilon})$ levels. The results again indicated no significant differences. Complete details are given in Appendix 3.

Similar t-tests were done on porosity. Significant variations were found here. Above sea level samples had higher porosity than below sea level samples. This was true for all the tests (i.e., grouping all ridges together), as well as for many of the individual ridges. Details are in Appendix 4. The average porosity values for above and below sea level samples are given below:

	Average Porosity (0/00)
Above sea level	55.5
Below sea level	36.1

2.2 Effect of Ridge

Determining variation of ice properties over different ridges is one of the primary objectives of Phase 1. This impacts the sampling of subsequent phases in a major way. For instance, no significant ridge effect would allow us to collect ice only from one or two ridges in Phase 2/3.

Figures 2.1 and 2.2 display the averages and standard deviations of σ_m over the ridges for all four $(T,\dot{\varepsilon})$ levels. There is obviously a large amount of scatter in the data, as can be seen from high standard deviations for some of the ridges in Figure 2.2. Another important point is the wide variation in standard deviation from ridge to ridge. A visual inspection of Figure 2.1 shows some patterns. There is some increase in average σ_m from ridge 9 to ridge 10 for all $(T,\dot{\varepsilon})$ levels, decrease from ridge 1 to ridge 2, increase from ridge 4 to ridge 5, and so on. Whether these are statistically significant or not will be tested later.

Figure 2.3 is a similar plot, and it displays minimum observed σ_m by ridges (minimum σ_m is important for design purposes). The plot for temperature = -5°C and strain rate = 10^{-3} looks different from others in that it displays wider variations in minimum observed σ_m from ridge to ridge. From Figure 2.2, the same thing is true for standard deviations of σ_m. The primary reason is that there are some samples with extremely low σ_m values in ridges 2, 7, and 8. These are:

Sample	σ_m
R2A-110/135	408
R7B-072/098	487
R8A/033-058	346

To illustrate the wide variation in σ_m in seemingly similar ice samples, we give below the details of two test results from ridge 8.

Ridge	Site	Depth	Sea Level	Density	Porosity	σ_m
R8	AB	033/059	Above	53	75	346
R8	AB	011/037	Above	52	84	811

Complete details of averages, standard deviation, maximum/minimum, etc., of σ_m by ridges are given in Appendix 5.

To better quantify effect of ridge on σ_m, it was decided to analyze the data using formal General Linear Models. Since sea level was found not to have significant effect on σ_m, the two remaining location variables are ridge and site.

Model: Dependent variable = σ_m
Independent variables = ridge, site (nested within ridge)

The significance level of the effects of the two variables for different $(T, \dot{\varepsilon})$ combinations are given below:

Strain Rate	Temperature	R^2 Value	Probability > F Ridge	Site (Ridge)
10^{-3}	-5	0.31	0.06	0.43
10^{-3}	-20	0.41	0.05	0.13
10^{-5}	-5	0.20	0.28	0.89
10^{-5}	-20	0.21	0.42	0.84

Details are given in Appenxix 6.

Since site does not seem to have a significant effect on σ_m, we next model σ_m as a linear function of ridge only. The results are similar to above and are given below (details in Appendix 7).

Strain Rate	Temperature	R^2 Value	Probability of Ridge
10^{-3}	-5	0.23	0.06
10^{-3}	-20	0.29	0.05
10^{-5}	-5	0.17	0.22
10^{-5}	-20	0.18	0.29

The table points to a few conflicting results:

(i) A simplistic conclusion will be that there is significant ridge-to-ridge variation at strain rate of 10^{-3}/sec, but not at 10^{-5}/sec.

(ii) However, there are some statistical assumptions behind using General Linear Models that are not strictly satisfied for our data. Leaving aside the normal distribution assumption, there is an assumption of homogeneous variance of σ_m (for all the ridges). Referring back to Figure 2.2, we can see that variances from ridge to ridge are widely different.

(iii) The very low R^2 values indicate either large random scatter within a ridge or 'incomplete' model, or both (more likely). Therefore, any conclusion drawn will be suspect.

Doing t-tests on individual pairs of ridges with unequal variances built in the t-test allows us to circumvent the first difficulty to a large extent. Therefore some pair-wise t-tests were carried out for the samples at 10^{-3}/sec strain rate and -5°C temperature. These results are given below:

Ridge	No. of Tests	Average σ_m	S.D. of σ_m	Prob > |T| Equal Variance	Prob > |T| Unequal Variance
5	5	1018	180	0.01	0.03
9	6	756	92		
3	5	927	44	0.01	0.001
4	11	785	94		

Thus the t-test shows that for the above pairs, average σ_m of one ridge is significantly different from that of the other ridge.

The final analysis we did to analyze effect of ridge on σ_m was by working with ranks rather than values of σ_m. This was to see if different ridges had similar rankings (i.e., ridge 1 samples had higher/lower average σ_m than ridge 5) across different $(T,\dot{\varepsilon})$ levels. This was done in two different ways:

(A) For strain rate of 10^{-3}/sec and temperature of -5°C (we refer to it later as type 1), all 10 ridges were ranked 1 to 10 based on average σ_m of their samples (1 - lowest, 10 - highest). Similarly for strain rate of 10^{-5}/sec and temperature of -20°C (type 2). The other two $(T,\dot{\varepsilon})$ levels were not included because those did not contain test data from all 10 ridges. The resultant ranks are:

Type	Ridge 1	2	3	4	5	6	7	8	9	10
1	10	4	8	2	9	3	6	5	1	7
2	10	6	4	3	9	1	5	8	2	7

We can visually see some patterns. Ridge 10 had 7th lowest average σ_m in both test types. Ridge 4 had very close ranks (2nd, 3rd) for the two types, and so on.

(B) All 4 $(T,\dot{\varepsilon})$ levels and 4 ridges (1, 6, 9, 10) were ranked and analyzed in same way. Again, all ridges were not included as tests for the other ridges were not conducted for all $(T,\dot{\varepsilon})$ levels. The resultant ranks are given below:

Type	Ridge 1	6	9	10
1	4	2	1	3
2	4	1	2	3
3	3	2	1	4
4	4	1	2	3

An ANOVA (Friedman Test) showed consistent rankings of ridges across the 4 $(T,\dot{\varepsilon})$ levels at high statistical significance (α level = .006).

Similar tests were done on standard deviations of σ_m within ridges. Results again showed consistency.

See Appendices 8 and 9 for details.

In conclusion, variations of σ_m values within a ridge dominate variations between ridges. Nevertheless, we cannot say that in Phase 2 or 3, if we sample ice from one or two ridges, we can be sure that the behavior of ice is truly representative of all ice (over all ridges). The only way to resolve this problem is to characterize ice by its underlying physical properties like salinity, porosity, crystal structure, etc. Then we can determine differences among ridges, if any, and account for such in final analysis. After more crystallographic data become available, further analysis will be done in this area.

3. EFFECT OF PHYSICAL PROPERTIES ON COMPRESSIVE STRENGTH

3.1 Effect of Porosity

Figures 3.1-3.4 show the plot of σ_m vs. air volume, brine volume, density, and salinity, all for temperature = -20°C, and strain rate = 10^{-3}/sec. Figures 3.5-3.8 show the plots of σ_m vs. porosity at all 4 $(T,\dot{\varepsilon})$ levels. Even though there are some general trends, as would be expected, the plots also show large scatter, making it difficult to draw any definitive conclusions. In order to quantify some relationship of σ_m with physical properties of ice, we tried various linear models, taking different combinations of air and brine volume, porosity (which is air + brine volume), density, and salinity. Only

at one $(T, \dot{\varepsilon})$ level we found any reasonable fit. At temperature = -20°C and strain rate = 10^{-3}/sec, the following model

$$\sigma_m = -0.51\ (\text{porosity})^2 + 0.48\ (\text{air volume})^2$$

gave an R^2 value of 0.45.

3.2 Effect of Crystal Structure

Crystal structure of ice was found to be one of the most important variable for predicting ice behavior. Unfortunately, information is available for only 34 tests. CRREL (Ref. 1) came up with a classification scheme. The major classes were granular ice (Type I), columnar ice (Type II, with further subclasses), and mixed ice (Type III, with further subclasses). Their complete scheme is given below.

Ice Type	Code	Structural Characteristics
Granular	I	Isotropic, equiaxed crystals
Columnar	II	Elongated, columnar grains
	IIA	Columnar sea ice with c-axes normal to growth direction. Axes may not be aligned.
	IIB	Columnar sea ice having random c-axis orientation (transition ice).
	IIC	Columnar freshwater ice, may be either anisotropic or isotropic.
Mixed	III	Combination of Types I and II
	IIIA	Largely Type II with granular veins
	IIIB	Largely Type I with inclusion of Type I or II ice (brecciated ice).

We give below the crystal structures, σ_m, and porosity for the 34 tests for which data were available.

Temperature = -5°C, Strain Rate = 10^{-3}/sec

Crystal Structure	Porosity	σ_m	Average σ_m
1	86.9	408	408
2A	20.3	1580	
2A	24.2	1297	
2A	21.1	1270	
2A	22.3	1270	1323
2A	32.0	1540	
2A	25.6	1440	
2A	16.3	915	
2A	16.2	1270	
2C	23.3	557	557
3	21.0	925	
3	15.1	587	
3	23.5	970	775
3	56.2	910	
3	53.4	487	
3A	53.0	910	628
3A	75.2	346	
3B	31.4	971	971

Temperature = -5°C, Strain Rate = 10^{-5}/sec

Crystal Structure	Porosity	σ_m	Average σ_m
1	56.1	368	
1	10.1	388	372
1	69.5	361	
2A	25.3	1090	
2A	16.9	619	
2A	23.7	696	675
2A	24.5	657	
2A	72.3	774	
2A	19.4	214	
2B	23.8	348	348
2C	24.4	607	607
3	38.9	214	221
3	77.8	229	
3A	153.9	68	68
3B	15.3	394	282
3B	143.0	171	

Clearly, some patterns emerge:

(i) Ice having 2A crystal structure is the strongest type at both strain rates. Others have low to intermediate strengths.

(ii) Within a particular crystal structure, there is still large (though much lower) scatter. Some of it may be explainable by other variables like porosity. In general, higher porosity gives rise to lower σ_m. But significant scatter will still remain. For example, at strain rate = 10^{-3}/sec, two samples having identical structure (Type 3) and porosity (56.2 and 53.4) had widely different σ_m (910 and 487 psi).

4. EFFECT OF STRAIN RATE AND TEMPERATURE

So far, we have been doing most of analysis on the assumption that temperature and strain rate have significant effect on peak stress. This is, of course, well known; and is supported by our test data.

The average values of σ_m for different (T, ε) levels are given below:

Strain Rate	Temperature -5°C	Temperature -20°C
10^{-3}/sec	879	1396
10^{-5}/sec	340	399

As expected, σ_m increases as strain rate increases and as temperature decreases.

A straightforward ANOVA-type analysis showed both effects to be statistically significant (see Appendix 10).

To get some idea about the distribution of σ_m for each test condition, frequency histograms were drawn. These are given in Figure 4.1-4.4. The data at temperature = -5°C, strain rate = 10^{-5}/sec look definitely skewed to the right. So do the data at temperature = -5°C, strain rate = 10^{-3}/sec, though to a lesser extent. The calculated skewness numbers are given below:

Strain Rate	Temperature -5°C	Temperature -20°C
10^{-3}/sec	0.72	0.19
10^{-5}/sec	2.37	-0.02

Tests were also conducted for normality. For temperature = -5°C, Kolomogorov D-Statistic was used. Data at both strain rates indicated non-normality. For temperature = -20°C, a special small sample statistic, Shapiro-Wilk's W statistic, was used. Here normality was indicated very strongly for both the strain rates.

Details are given in Appendix 11.

5. FAILURE MODE ANALYSIS

5.1 Failed vs. Nonfailed (Before 5% Strain)

All the tests were programmed to continue up to 5% strain. However, some tests were terminated before this point by failure. We wanted to deter-

mine if we can distinguish between these two groups of samples (i.e., those which failed and those which did not fail before 5% strain) by some of their physical or mechanical properties.

At strain rate of 10^{-5}/sec, close to 90% of the samples continued to 5% strain without failure. Among the rest, many tests were terminated early, not because of failure, but because of experimental problems; but we do not have records to distinguish these. Therefore, we did not analyze these tests.

At strain rate of 10^{-3}/sec, a much higher number of samples failed before 5% strain. This differential in behavior at different strain rates obviously needs to be investigated further (i.e., ice acting in more of a brittle manner at higher strain rate). The number of samples that failed is given below:

	No. of Samples	No. of Samples That Failed	Percentage of Failed Samples
Strain rate = 10^{-3}/sec Temperature = -5°C	68	42	62
Strain rate = 10^{-3}/sec Temperature = -20°C	39	18	46

We did a discriminant analysis on failed/non-failed samples. A number of models were tried. The final model adopted was a quadratic discriminant model with E_o(FS) and E_i(GL) as independent variables, see Appendix 12. From the plots given in Appendix 12 one can visually associate increase in E_o(FS) with increasing chance of non-failure of a sample.

5.2 Failure Type

From the photographs taken during testing, three different failure modes were identified (Ref. 2). These are:

Shear failure (Type 1)
Longitudinal splitting (Type 2)
Crushing failure (Type 3)
None (Type 0)

Some test samples failed in a combination of modes. An attempt was made to identify both the primary and the secondary modes. However, very high reliance cannot be placed on such distinctions. Also, potential failure modes

were assigned to samples that did not fail. These were determined by the condition of the sample at the time the tests were terminated.

A summary of the number of samples for different failure modes is given below:

	Failure Modes (Primary & Secondary)								
	10	12	13	20	21	23	30	31	32
$T = -5°C$, $\varepsilon = 10^{-3}$/sec	5	2	8	10	1	10	17	9	5
$T = -20°C$, $\varepsilon = 10^{-3}$/sec	2	5	2	7	1	5	7	9	2
$T = -5°C$, $\varepsilon = 10^{-5}$/sec	9	1	10				32	15	3
$T = -20°C$, $\varepsilon = 10^{-5}$/sec	2	3	12				10	7	1

Similar information is given below, only taking the dominant mode into account:

	Primary Failure Mode		
	1	2	3
$T = -5°C$, $\varepsilon = 10^{-3}$/sec	15 (22%)	21 (31%)	31 (47%)
$T = -20°C$, $\varepsilon = 10^{-3}$/sec	9 (23%)	12 (32%)	18 (45%)
$T = -5°C$, $\varepsilon = 10^{-5}$/sec	20 (29%)		50 (71%)
$T = -20°C$, $\varepsilon = 10^{-5}$/sec	17 (49%)		18 (51%)

Clearly, as strain rate goes down, Type 2 (longitudinal splitting) failures decrease markedly. Out of 105 tests at strain rate = 10^{-5}/sec, no samples failed with Type 2 as the primary mode, and only 8 samples had Type 2 as either primary or secondary mode. The corresponding numbers for strain rate = 10^{-3}/sec were 106, 33, and 47.

At strain rate = 10^{-5}/sec, percentage of failures primarily through mode 3 (crushing failure) increased from 51% to 71% as temperature went up from -20°C to -5°C. This pattern was not repeated for tests at strain rate = 10^{-3}/sec. In fact, there is remarkable consistency in percent failed by each primary mode for the two temperature levels at strain rate = 10^{-3}/sec.

Another analysis we carried out was to determine if any correlation exists between whether a test sample failed or not before 5% strain and the failure modes. Only tests at strain rate = 10^{-3}/sec were considered, as sufficient accurate data were not available for the lower strain rate tests. Different ways of grouping the different failure modes were tried. One pattern emerged clearly. For the samples that actually failed, Type 2 (longitudinal splitting) was present either as primary or secondary mode in the majority of cases. For the samples that did not fail before 5% strain, exactly the opposite was true. That is, mode 2 was present either as primary or secondary mode only in very few cases. The details are given below:

	Mode 2 Was Primary or Secondary Mode		Mode 2 Was Not Primary or Secondary Mode	
	Temp = -5°C	Temp = -20°C	Temp = -5°C	Temp = -20°C
Sample failed before 5% strain	23	19	3	3
Sample did not fail before 5% strain	5	1	36	17

6. RESIDUAL COMPRESSIVE STRENGTH ANALYSIS

Residual compressive strength is defined as stress at end of test, σ_e, for the samples that continued to 5% strain. A summary by temperature and strain rates is given below:

Temperature and Strain Rate	Average σ_e (psi)	Average σ_e/σ_m
-5°C, 10^{-3}/sec	167	0.20
-20°C, 10^{-3}/sec	222	0.16
-5°C, 10^{-5}/sec	211	0.69
-20°C, 10^{-5}/sec	254	0.65

Clearly, at higher strain rate, the ratio of σ_e/σ_m is substantially lower than at lower strain rate. The temperature effect is quite low, and is found to be not significant statistically (see Appendix 13).

A plot of porosity vs. (σ_e/σ_m) ratio (Figures 6.1-6.4) revealed an interesting pattern. As porosity increases, the general tendency of the (σ_e/σ_m) ratio is to decrease for strain rate = 10^{-3}/sec, and increase at strain rate = 10^{-5}/sec. An approximate analysis to confirm this was done by a regression of (σ_e/σ_m) on porosity at different $(T,\dot{\varepsilon})$ levels. The regression coefficients for porosity were negative for $\dot{\varepsilon} = 10^{-3}$/sec and positive for $\dot{\varepsilon} = 10^{-5}$/sec. The models were significant at all $(T,\dot{\varepsilon})$ levels except at $T = -5°C$, $\dot{\varepsilon} = 10^{-3}$/sec. However, due to large scatter in data and lack of enough samples at high porosity levels, definitive conclusion cannot be drawn.

7. INITIAL TANGENT MODULUS ANALYSIS

Initial tangent modulus, E_i, were obtained by CRREL from initial slope of force-displacement curve. The average values are given below:

	Strain Rate	
Temperature	10^{-3}/sec	10^{-5}/sec
-5°C	1.02	0.74
-20°C	1.10	0.89

As expected, E_i increases with increasing strain rate and decreases with increasing temperature. An ANOVA analysis showed both effects to be highly significant. Large scatter in the data resulted in poor (though statistically significant) fit (see Appendix 14).

The plots of E_i vs. porosity are given in Figure 7.1-7.4. At 10^{-3}/sec strain rate, E_i decreases with increasing porosity. This conclusion is confirmed by results from a regression of E_i on porosity. At 10^{-5}/sec, there does not seem to be any definite correlation. Again, this was confirmed by regression analysis.

We now give below the average E_i values by crystal structure, for those tests where crystal structure information is present. Number of samples is given within parenthesis.

	1	2A	2B	2C	3	3A	3B
Strain rate = 10^{-3}/sec Temperature = -5°C	0.87 (1)	1.25 (8)		0.88 (1)	1.26 (5)	0.89 (2)	1.05 (1)
Strain rate = 10^{-5}/sec Temperature = -5°C	0.80 (3)	1.14 (6)	0.59 (1)	0191 (1)	0.62 (2)	0.43 (1)	0.68 (2)

As in the case of σ_m, Type 2A crystals seem to have the highest initial tangent modulus values for both strain rates. Again, there was quite a bit of scatter in E_i values even within a particular crystal structure (see Appendix 15).

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GLOSSARY

N	Number of samples.
SIGM	σ_m (PSI)
Level A (B)	Above (Below) Sea Level
Prob > |T|	Probability of a greater |T| value under the null hypothesis of equal means. (Low value suggests strongly that means are not equal.)
POR	Porosity (%.)
Pr > F	Probability of a higher F value under the null hypothesis of equal means.
DF	Degrees of freedom
AVG_SIGM/ SD_SIGM	Calculated mean/standard deviation of σ_m (PSI)
RSIGM/ RSDSIGM	Calculated rank based on AVG_SIGM/SD_SIGM
R^2	Ratio of regression sum of squares to total sum of squares. Values close to 1.0 indicate good regression fit.

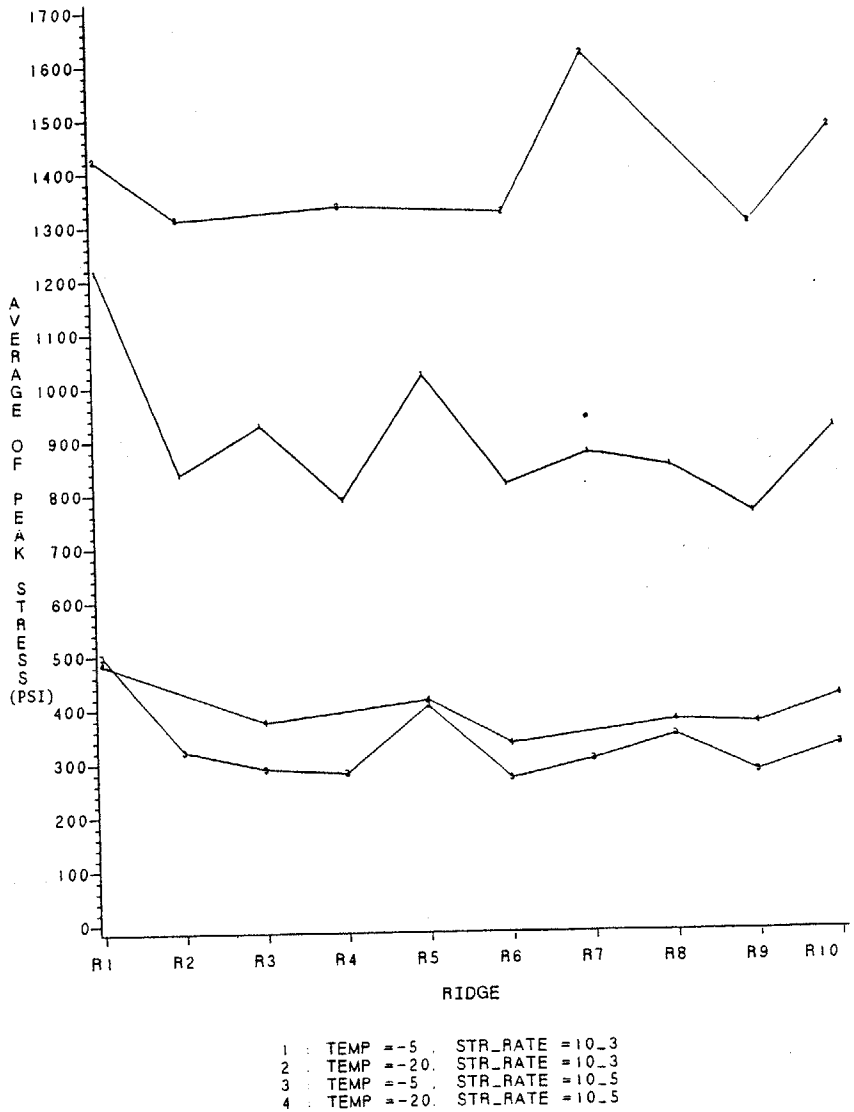


Figure 2.1. Average Peak Stress by Ridge

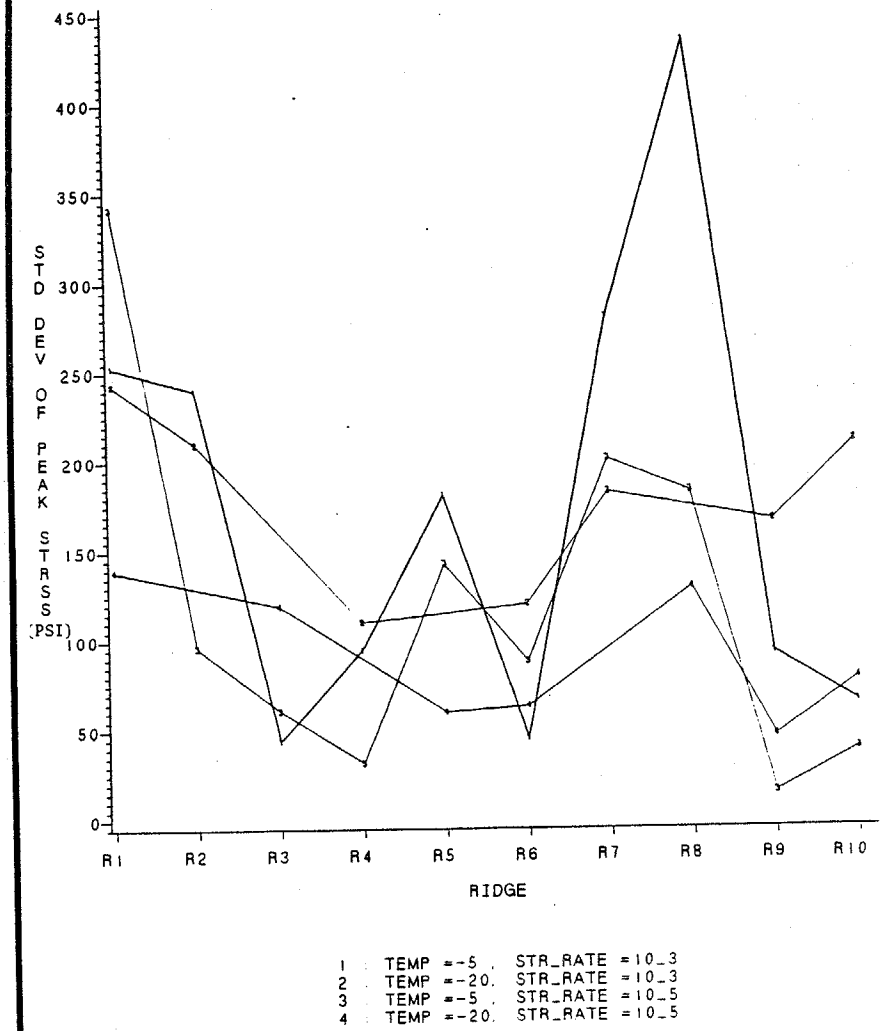


Figure 2.2. Standard Deviation of Peak Stress by Ridge

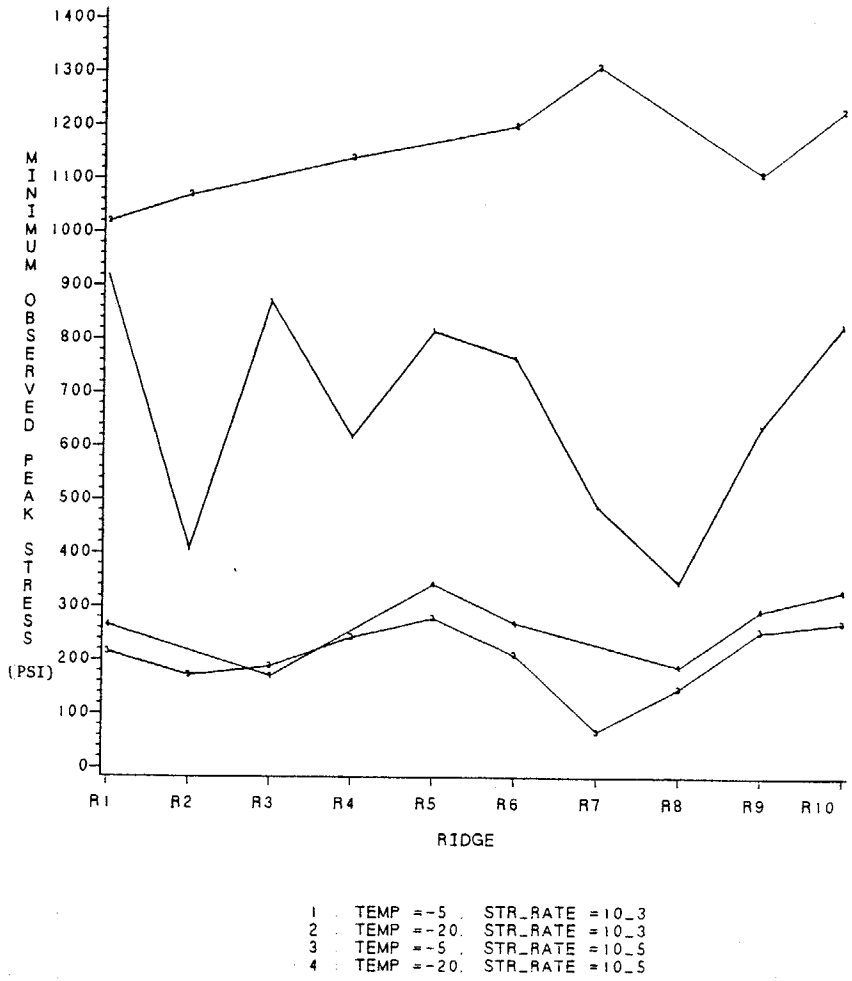


Figure 2.3. Minimum Peak Stress by Ridge

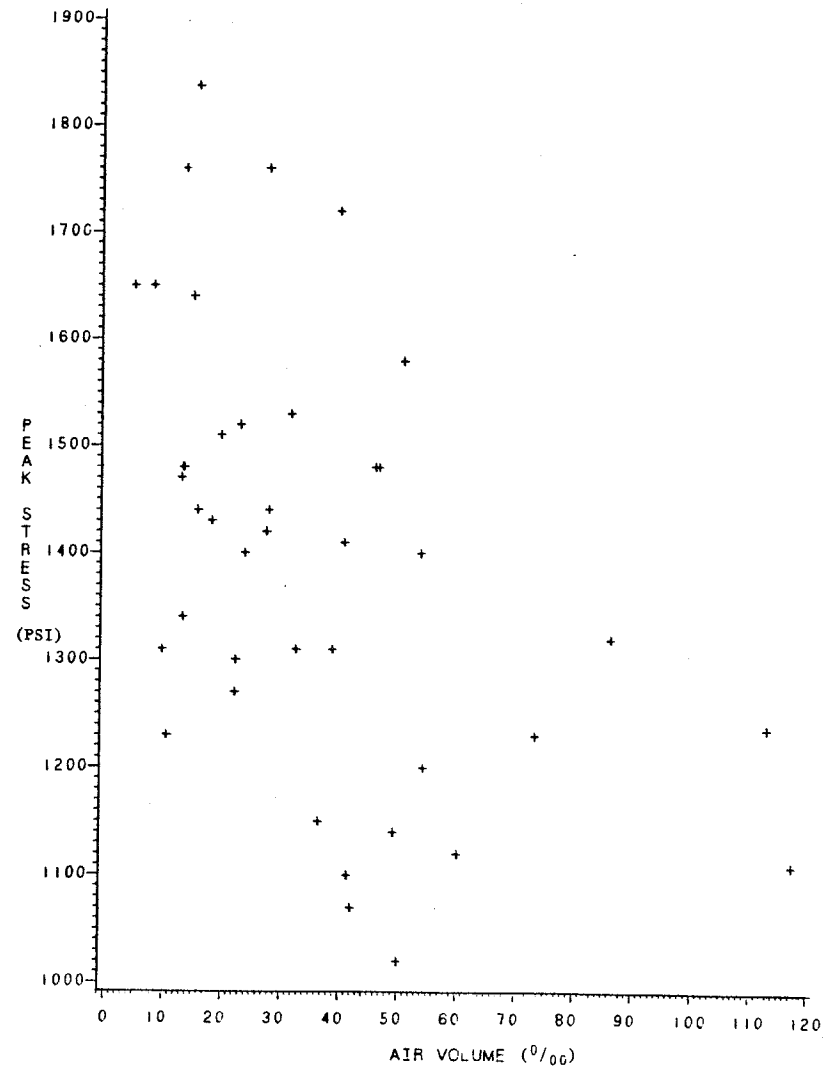


Figure 3.1 Peak Stess vs. Air Volume
Temp = -20°C, Stress Rate = 10^{-3}/sec

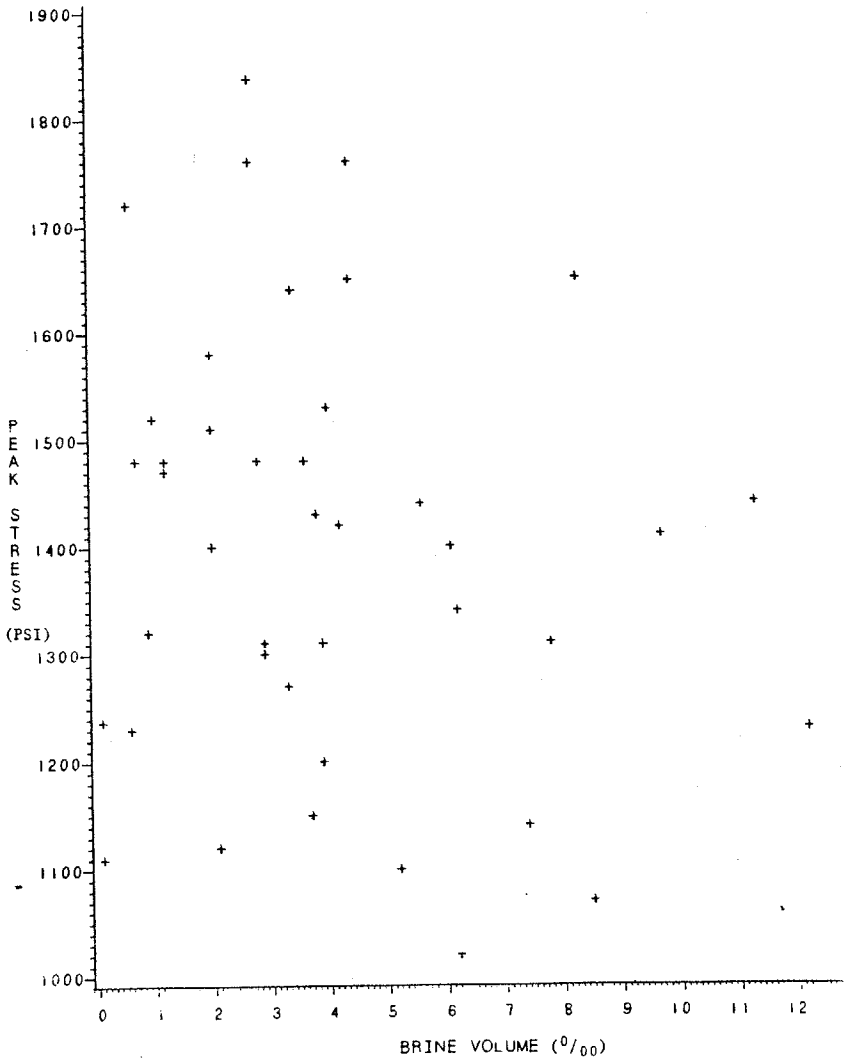


Figure 3.2 Peak Stress vs. Brine Volume
Temp = -20°C, Stress Rate = 10^{-3}/sec

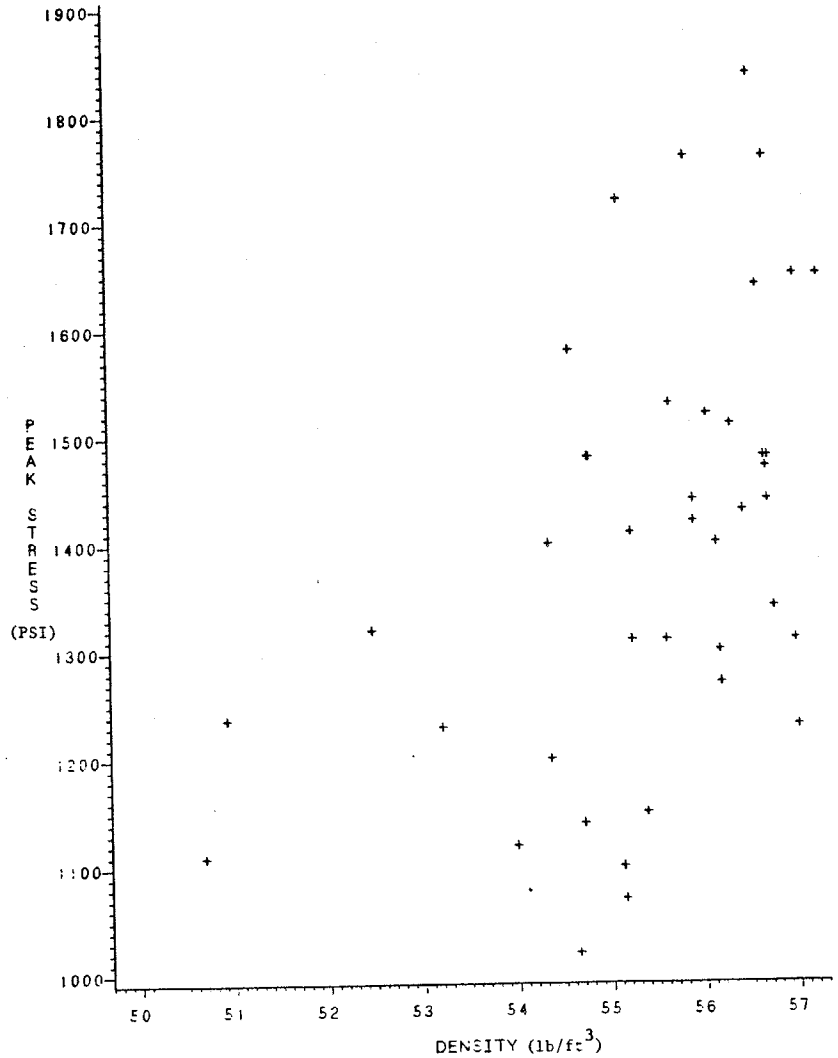


Figure 3.3 Peak Stress vs. Density
Temp = -20°C, Stress Rate = 10^{-3}/sec

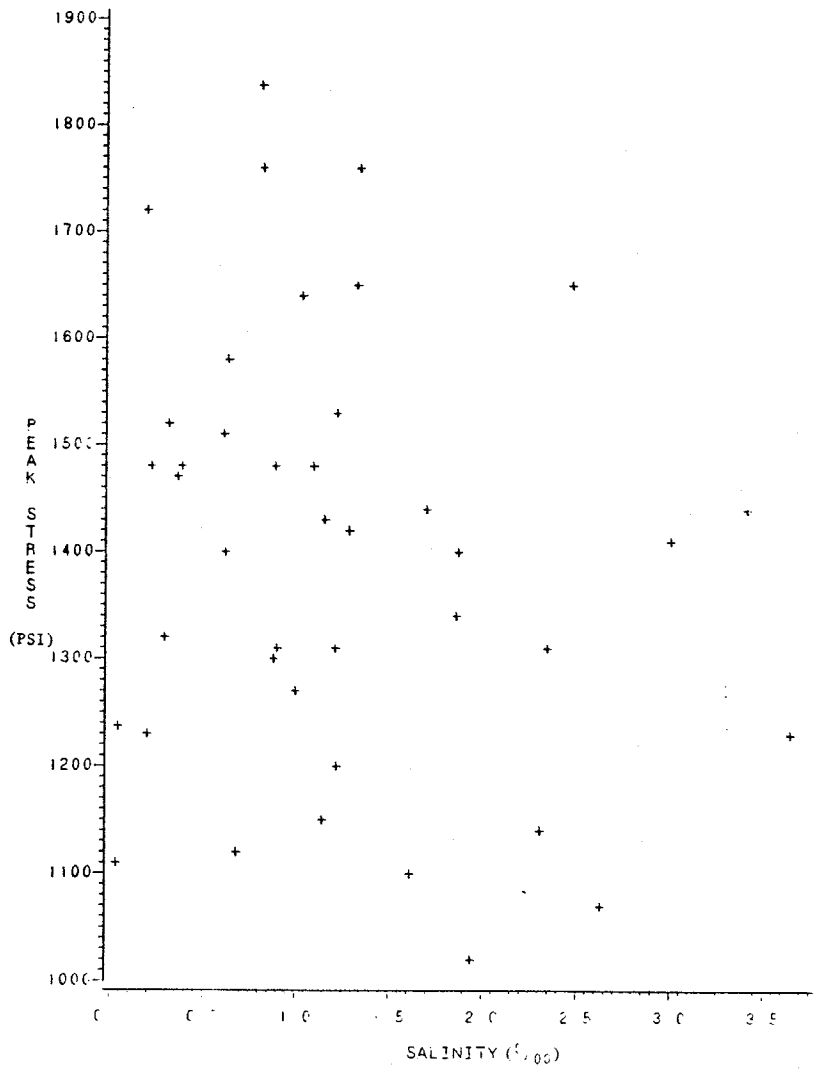


Figure 3.4 Peak Stress vs. Salinity
Temp = -20°C, Stress Rate = 10^{-3}/sec

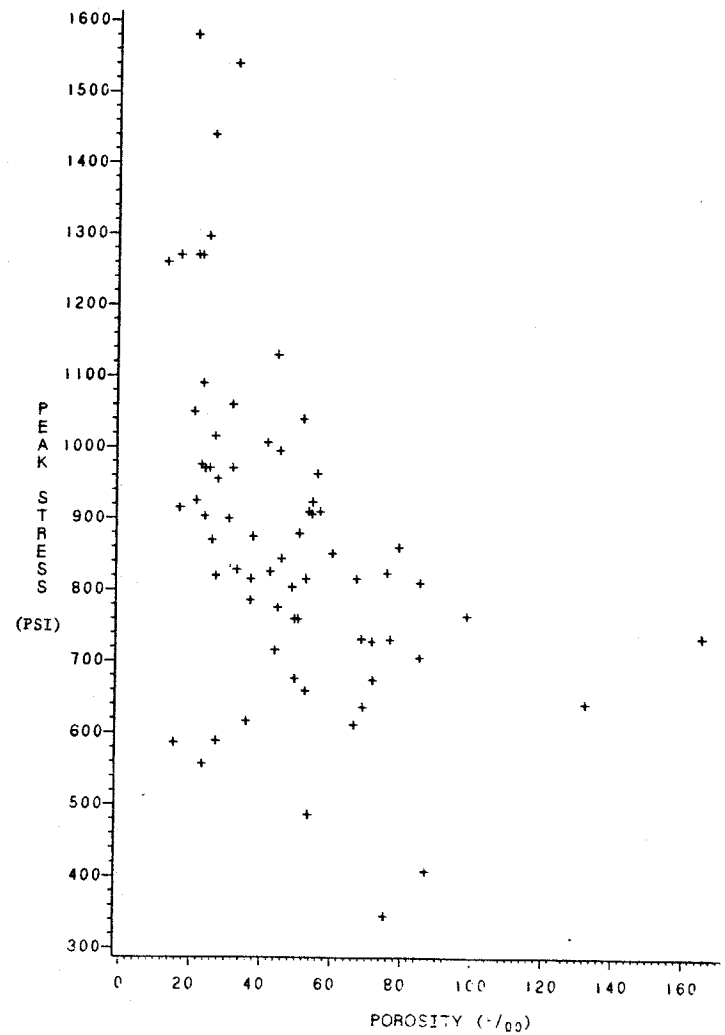


Figure 3.5 Peak Stress vs. Porosity
Stress Rate = 10^{-3}/sec, Temp = -5°C

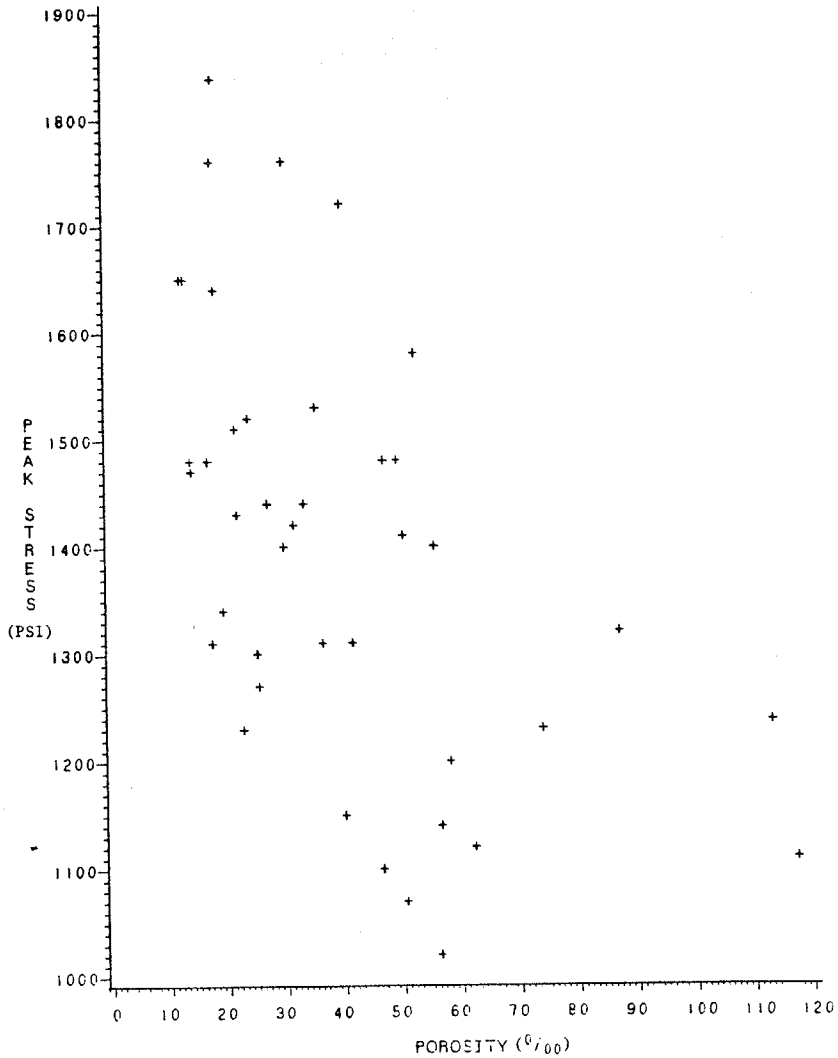


Figure 3.6 Peak Stress vs. Porosity
Stress Rate = 10^{-3}/sec, Temp = -20° C

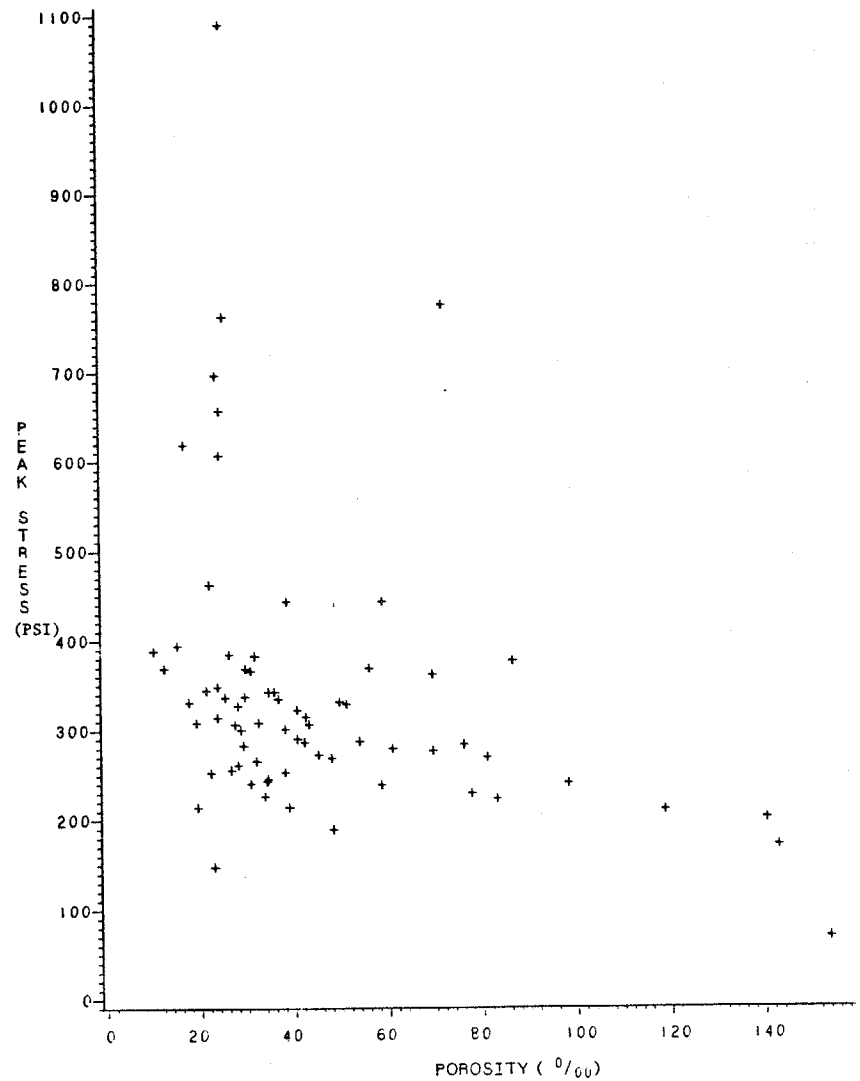


Figure 3.7 Peak Stress vs. Porosity
Stress Rate = 10^{-5}/sec, Temp = -5° C

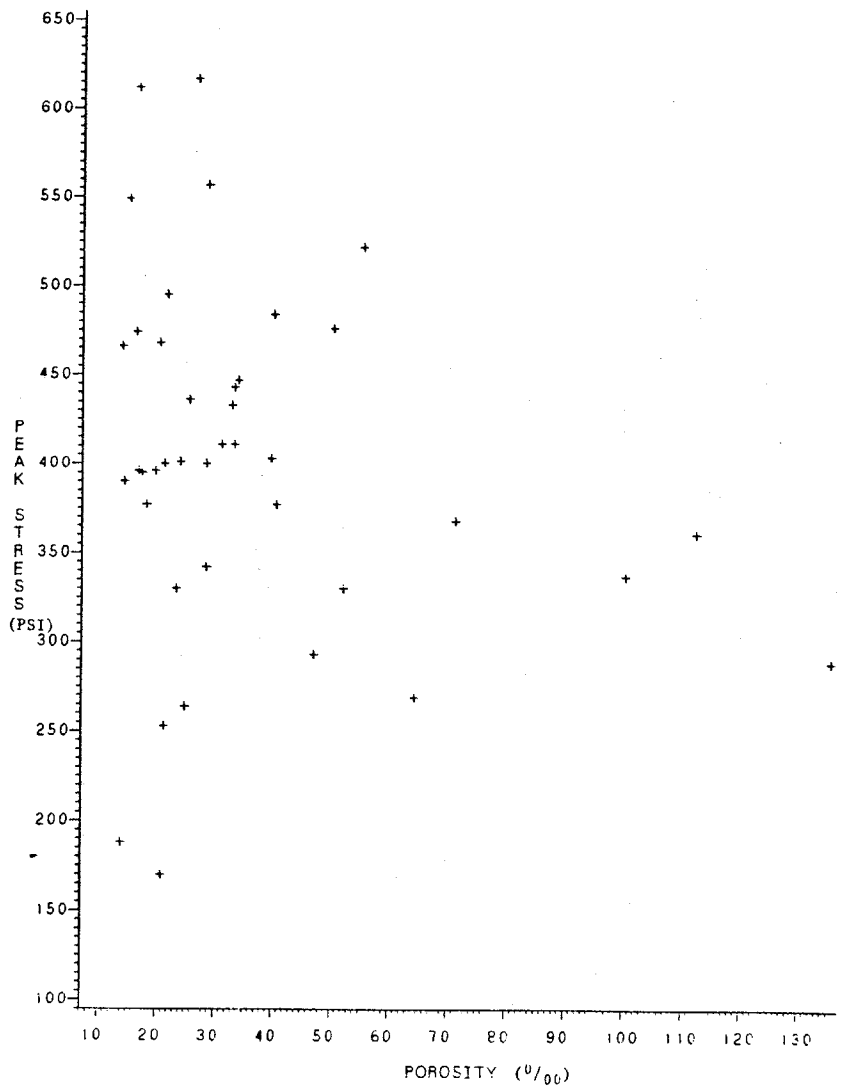


Figure 3.8. Peak Stress vs. Posority
Stress Rate = 10^{-5}/sec, Temp = -20° C

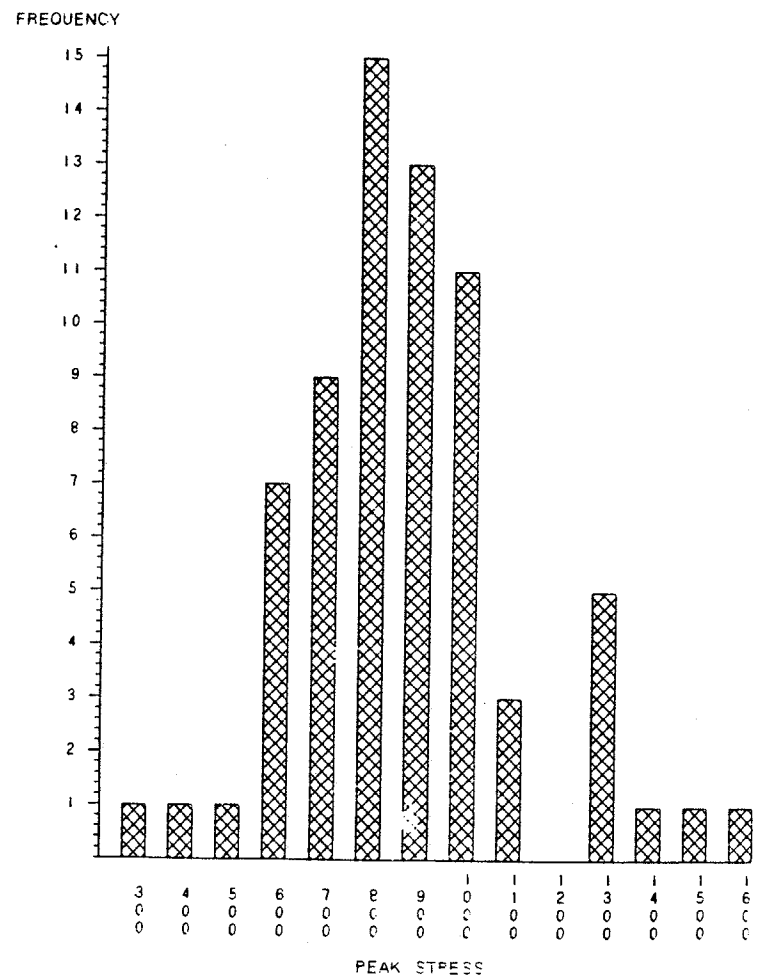


Figure 4.1. Peak Stress Histogram
Stress Rate = 10^{-3}/sec, Temp = -5°C

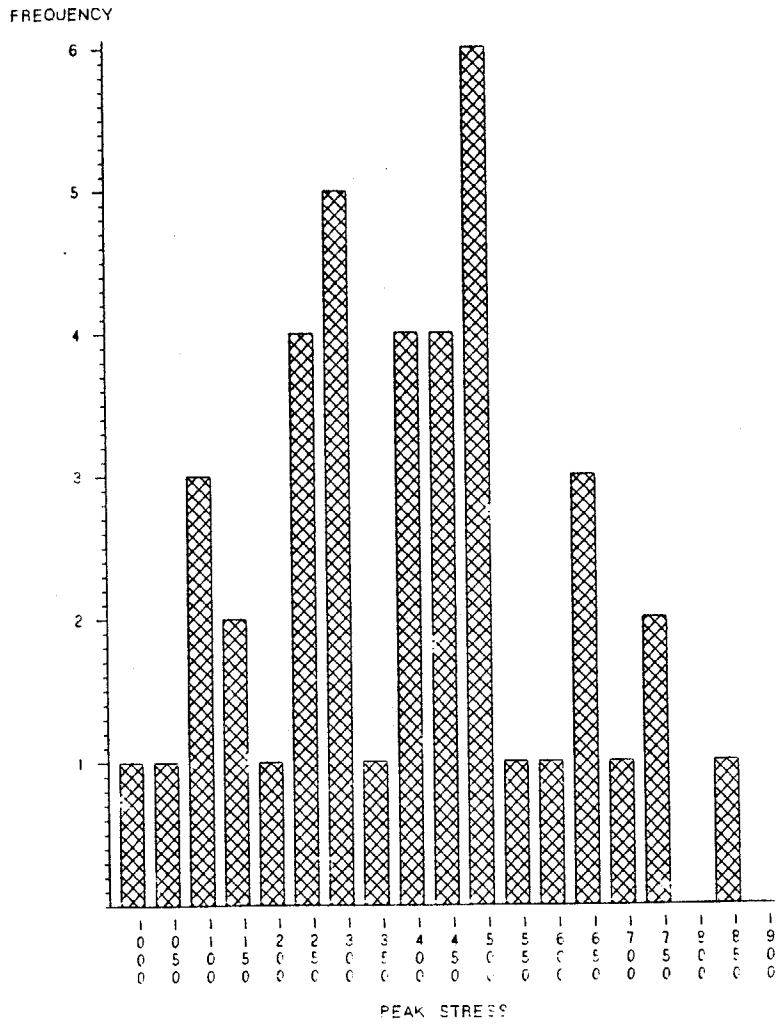


Figure 4.2. Peak Stress Histogram
Stress Rate = 10^{-3}/sec, Temp = -20°C

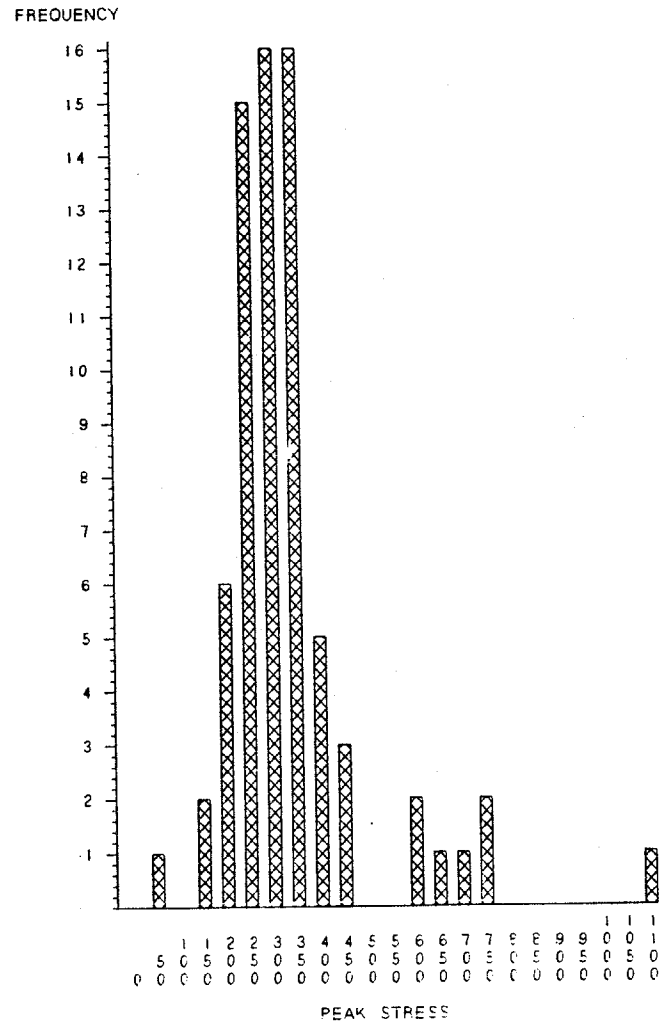


Figure 4.3. Peak Stress Histogram
Stress Rate - 10^{-5}/sec, Temp = -5°C

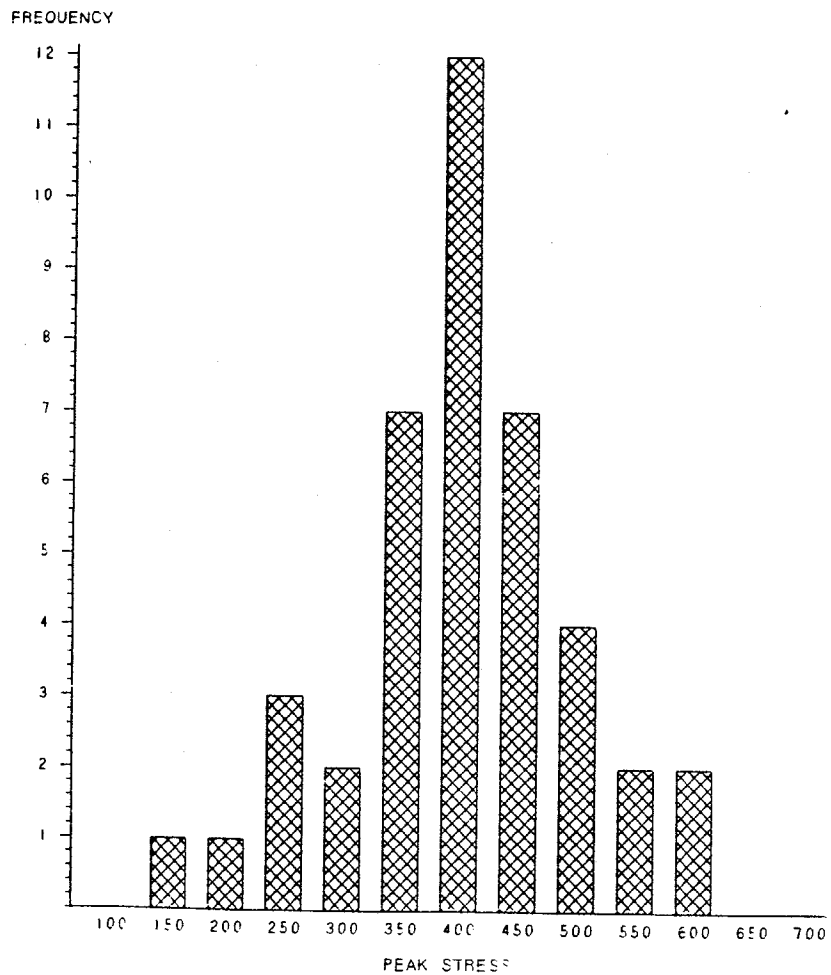


Figure 4.4 Peak Stress Histogram
Stress Rate = 10^{-5}/sec, Temp = - 20°C

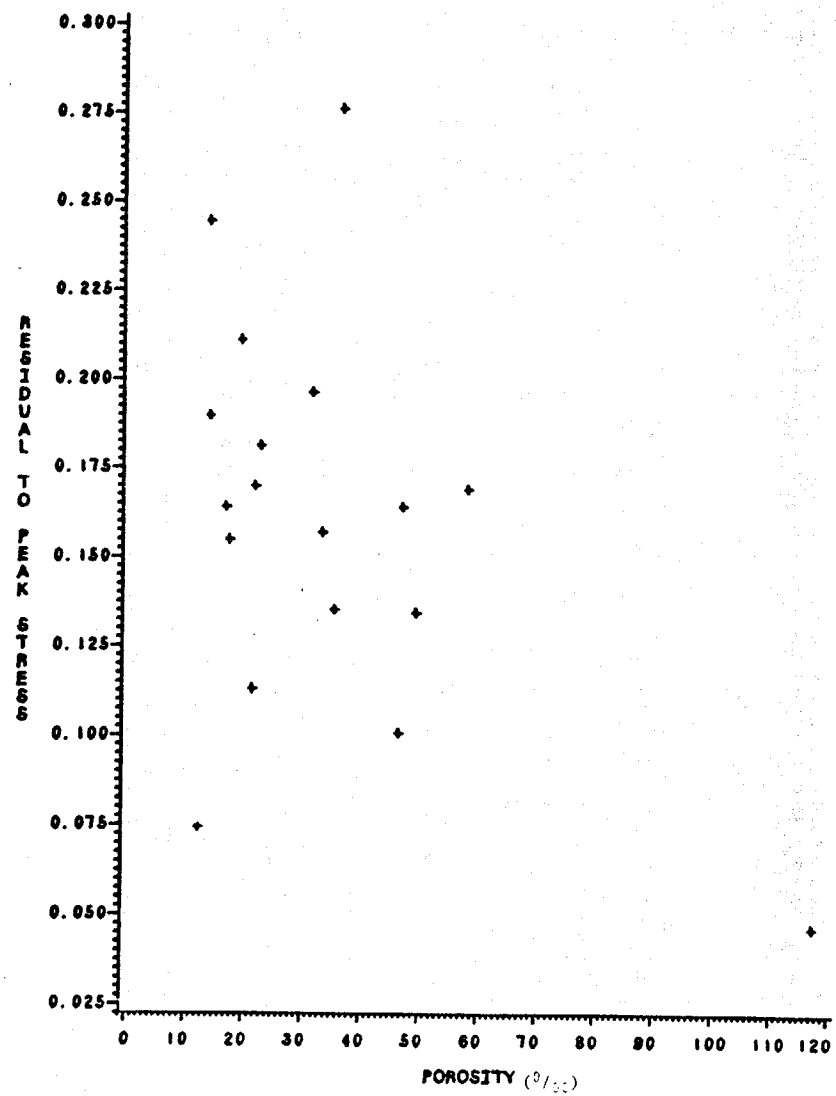


Figure 6.1. Ratio of Residual to Peak Stress vs. Porosity
Stress Rate = 10^{-3}/sec, Temp = −20°C

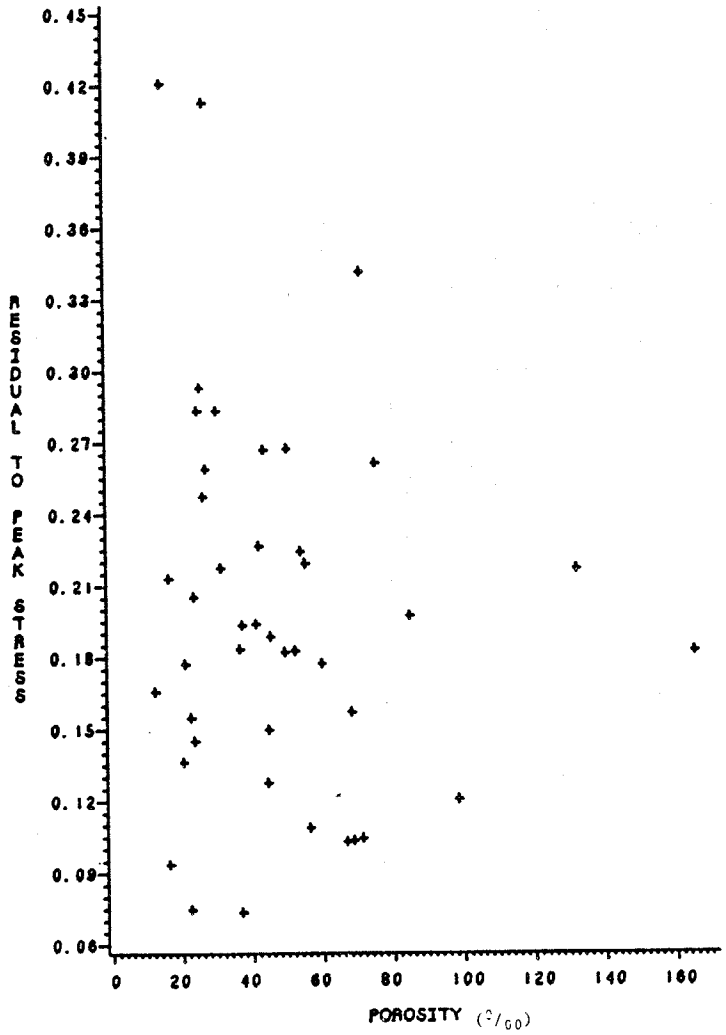


Figure 6.2. Ratio of Residual to Peak Stress vs. Porosity
Stress Rate = 10^{-3}/sec, Temp = −5°C

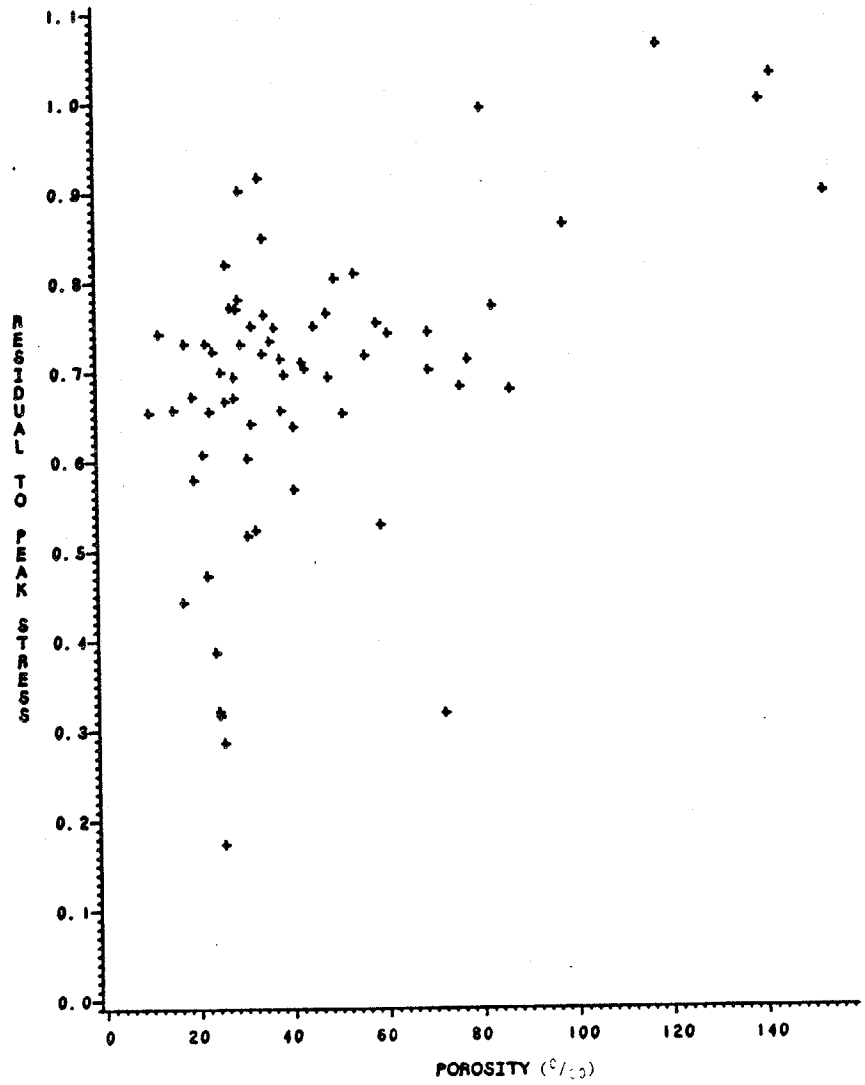


Figure 6.3. Ratio of Residual to Peak Stress vs. Porosity
Stress Rate = 10^{-5}/sec, Temp = −5°C

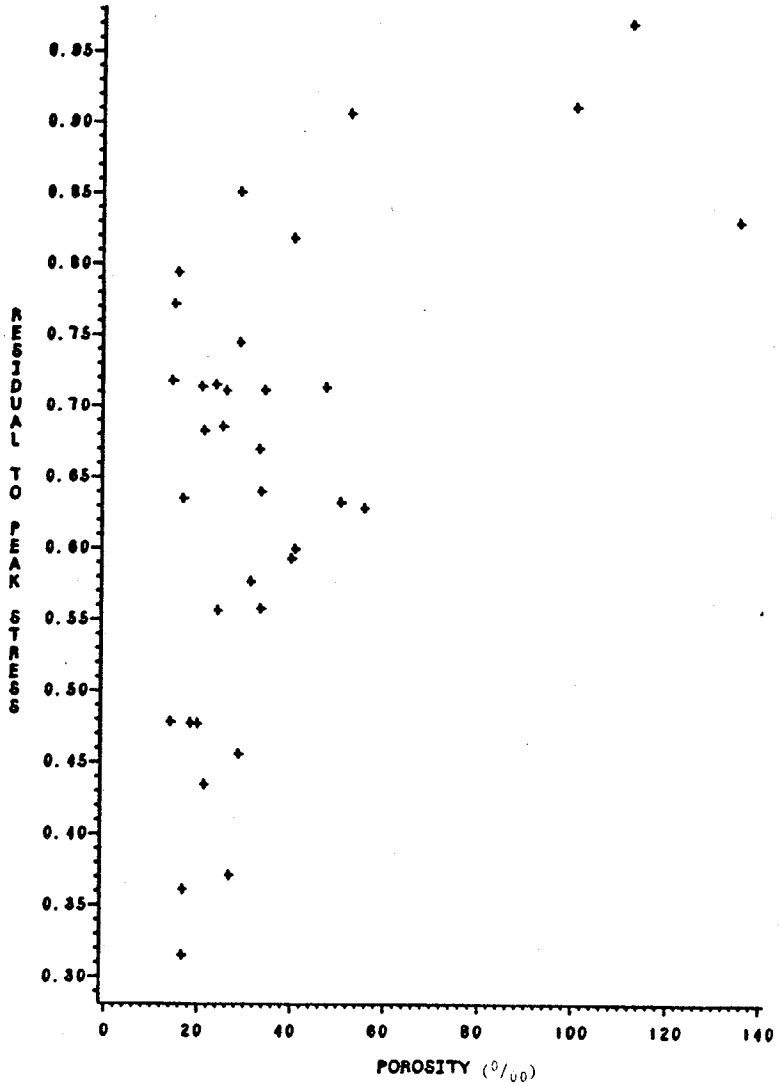


Figure 6.4. Ratio of Residual to Peak Stress vs. Porosity
Stress Rate = 10^{-5}/sec, Temp = −20°C

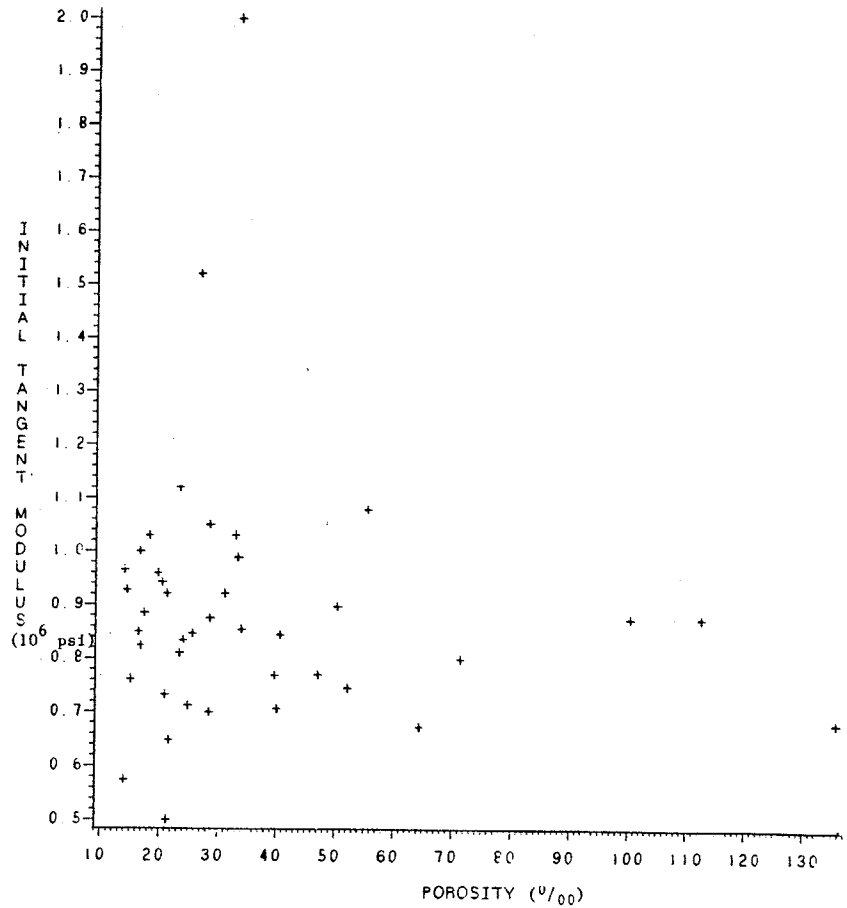


Figure 7.1 Initial Tangent Modulus vs. Porosity
Stress Rate = 10^{-5}/sec, Temp = -20°C

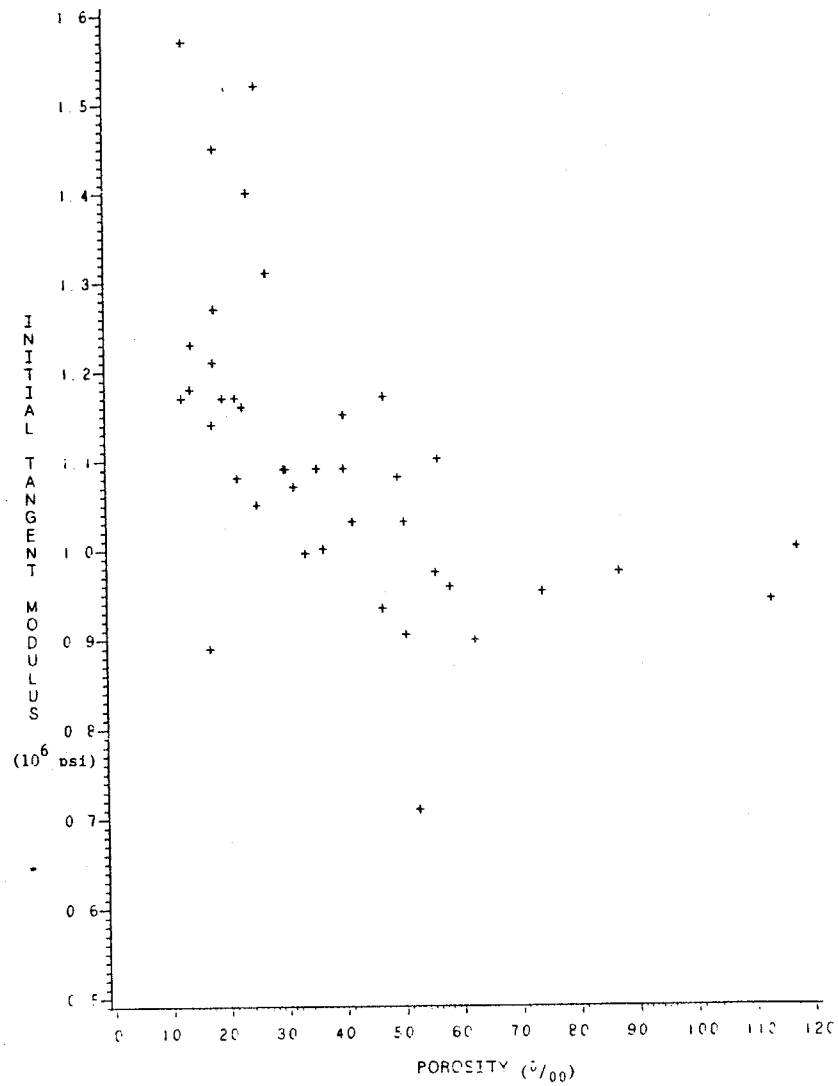


Figure 7.2 Initial Tangent Modulus vs. Porosity
Stress Rate = 10^{-3}/sec, Temp = -20°C

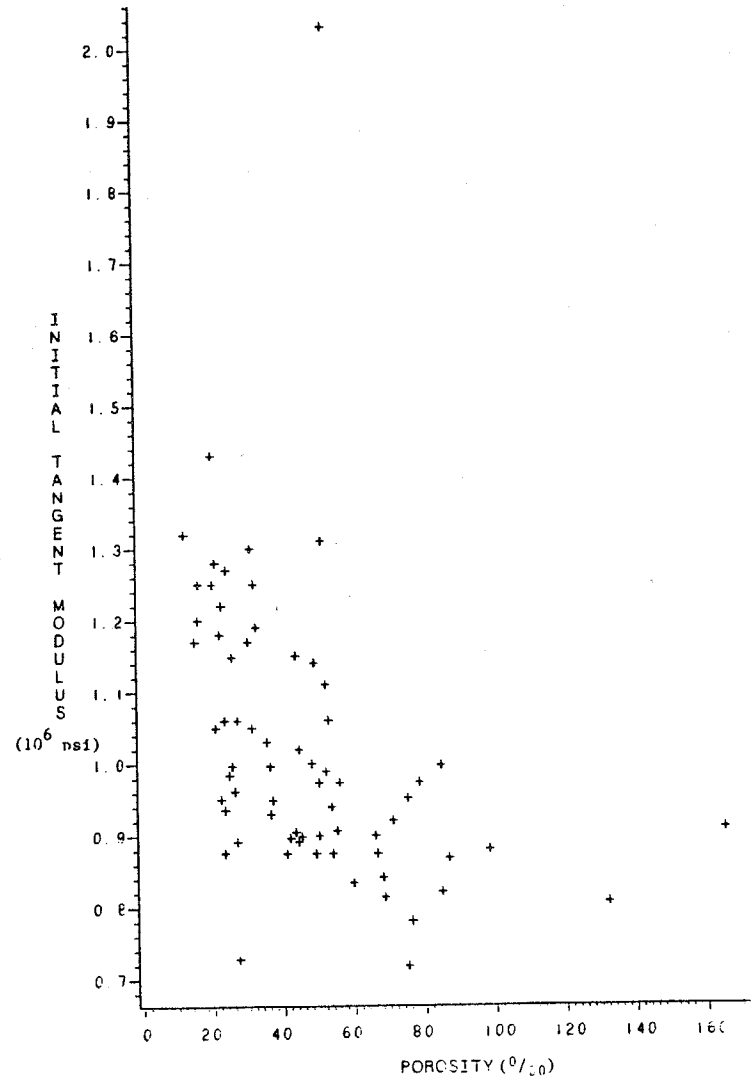


Figure 7.3. Initial Tangent Modulus vs. Porosity
Stress Rate - 10^{-3}/sec, Temp = -5°C

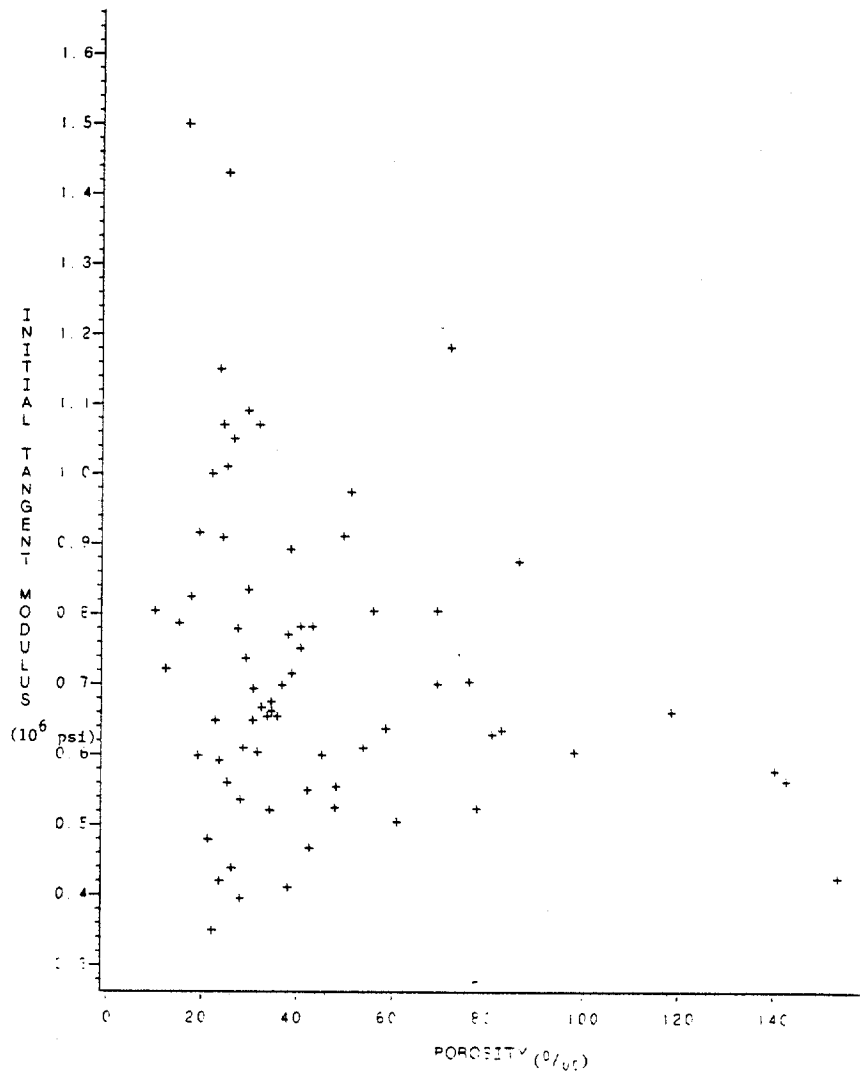


Figure 7.4. Initial Tangent Modulus vs. Porosity
Stress Rate = 10^{-5}/sec, Temp = -5°C

APPENDIX 1

RAW TEST DATA

Variable	Description	Column
Ridge	Ridge Number	1- 3
Core	Core Number	4
Depth (cm)	Depth from Sea Level	6-12
σ_m(psi)	Peak stress, or strength	17-20
ε_m(FS)(%)	Strain at σ_m determined by the extensometer over the full sample length of 10 in.	21-24
t_m(s)	Time to peak stress	25-30
σ_e(psi)	Stress at end of test	31-34
ε_e(FS)(%)	Full sample strain at end of test	35-38
t_e(s)	Time to end of test	39-45
E_0(FS)(10^6psi)	Secant modulus determined using full sample strains	46-50
S_i(^{o}/oo)	Sample salinity at test temperature	51-54
ρ (lb/ft^3)	Sample weight desity at test temperature	55-59
V_b(^{o}/oo)	Brine volume at test temperature	60-63
V_a(^{o}/oo)	Air volume at test temperature	64-68
n(^{o}/oo)	Porosity at test temperature	69-73
ν_o	Initial Poisson's ratio; circumferential and gauge length strain measurements used	74-77
FAIL	Failure Mechanism; Primary, Secondary	78-81
CRYS	Crystal structure	83-85
E_i (GL)(10^6psi)	Initial tangent modulus determined using strains found over the gauge length	86-90

Note 1: Crystal structure code is given below.

	Code	Structural Characteristics
Granular	I	Isotropic, equiaxed crystals
Columnar	II	Elongated, columnar grains
	IIA	Columnar sea ice with c-axes normal to growth direction. Axes may not be aligned.
	IIB	Columnar sea ice having random c-axis orientation (transition ice).
	IIC	Columnar freshwater ice, may be either anisotropic or isotropic.
Mixed	III	Combination of Types I and II
	IIIA	Largely Type II with granular veins
	IIIB	Largely Type I with inclusion of Type I or II ice (brecciated ice).

Note 2: The Failure mode is coded as follows: the two nonblank characters (Col. 80 & 81) represent primary and secondary failure mode respectively. The modes are:

0 - None
1 - Shear Failure
2 - Longitudinal Splitting
3 - Crushing Failure

ABOVE SEA LEVEL, 10_3/SEC, -20 DEG F

R1C-127/154	15200.17	1.66152C	0.2	1.66C.8940.3156.08	1.0	22.8	23.80.00	.	1.400
R1D-153/178	12700.08	0.84127C	C.1	C.841.59C1.0C56.20	3.3	22.1	25.40.00	23	1.52C
R2C-129/156	15300.23	2.45158C	0.2	2.45C.6870.6354.62	2.0	5C.5	52.50.41	23	C.709
R2D-C95/122	12300.14	1.54123C	0.1	1.540.8790.2C53.22	0.6	73.3	73.9C.32	21	0.951
R4D-198/225	11400.13	1.3C114C	0.1	1.30C.8772.3154.72	7.4	49.2	56.50.17	20	.
R6A-531/558	12CC0.18	1.75 203	5.C	5C.00C.6671.2254.37	3.9	54.2	58.10.31	30	0.957
R6C-134/161	13200.17	1.741320	0.2	1.74C.7770.2952.48	0.9	86.2	87.10.31	12	0.973
R7C-092/119	176C0.28	2.6C 589	1.6	16.50C.6290.8255.89	2.7	27.4	30.10.29	23	1.090
R7D-C36/C63	172C0.24	2.45172C	0.2	2.45C.7170.1955.16	0.6	39.5	40.10.28	23	1.090
R9A-C71/C98	12370.23	2.35 231	2.6	2.64C.5380.0450.93	0.1	113.0	113.10.31	12	0.941
R9B-076/103	11100.25	2.45 52	5.C	5C.00C.4440.0350.68	0.1	117.4	117.40.18	13	1.000
R9C-C49/076	14800.27	2.76 243	5.C	5C.00C.5480.3854.81	1.2	45.8	47.00.27	31	1.170
R9D-150/177	15300.24	2.55 207	5.C	50.00C.6381.2255.68	4.0	31.4	35.40.19	31	1.090
R10A-238/265	18380.34	3.331739	0.4	4.35C.5410.8156.58	2.7	15.4	18.00.26	23	1.270
R10B-084/111	15100.21	2.28 171	5.C	50.000.7190.6156.33	2.0	19.5	21.50.20	31	1.170

ABOVE SEA LEVEL, 10_3/SEC, -5 DEG F

R1A-175/201	12700.15	1.45	119	5.0	50.00	8470.70	56.81	6.9	9.4	16.20	0.00	.	2A	21.200
R1B-131/157	12600.24	2.35	209	5.0	50.00	5250.37	56.82	3.6	8.7	12.30	0.00	31		1.320
R2A-110/135	4080.04	0.44	408	0.0	0.44	1.020	0.20	52.43	1.8	85.0	86.90	0.00	20	1 0.868
R2B-135/161	8200.10	1.00	820	0.1	1.00	0.820	0.10	55.81	1.0	25.8	26.30	0.00	23	0.892
R3A-188/213	9700.16	1.64	199	5.0	50.00	0.606	1.40	56.85	13.7	9.8	23.50	0.00	31	3 1.060
R3B-130/155	9000.15	1.50	255	5.0	50.00	0.600	1.13	56.28	11.0	19.3	30.30	0.00	30	1.170
R4A-283/309	8600.10	1.00	860	0.1	1.00	0.860	1.30	53.58	12.0	66.7	78.70	0.00	23	0.973
R4B-299/325	9100.15	1.50	99	5.0	50.00	0.607	1.30	54.89	12.3	43.9	56.20	0.00	30	3 0.973
R5A-135/161	10900.09	0.35	109	0.1	0.85	1.210	0.20	56.10	1.9	20.9	22.90	0.00	23	1.220
R5B-141/167	12700.13	1.30	127	0.1	1.30	0.977	0.20	56.20	1.9	19.2	21.10	0.00	23	2A 01.280
R7A-C05/C31	7310.11	1.08	731	0.1	1.08	0.665	0.02	52.92	0.2	76.2	76.40	0.00	23	0.781
R7B-C72/C98	4870.14	1.40	487	0.1	1.40	0.348	0.49	54.53	4.5	48.9	53.40	0.00	23	3 2.030
R8A-C33/C59	3460.11	1.15	346	0.1	1.15	0.315	0.30	53.16	2.8	72.5	75.20	0.00	23	3A 0.718
R8B-C11/C37	8110.08	0.80	811	0.1	0.80	1.010	0.10	52.48	0.9	84.0	84.90	0.00	20	0.997
R2C-C49/C76	6420.15	1.15	139	5.0	50.00	0.428	0.17	49.93	1.51	30.6	132.10	0.04	31	0.806
R2D-134/161	7060.16	1.70	139	5.0	50.00	0.441	0.37	52.64	3.4	81.5	84.30	0.14	31	0.821
R4C-244/271	7600.11	1.08	760	0.1	1.08	0.691	2.58	36.13	25.0	24.3	49.20	0.05	20	1.140
R4D-309/336	8260.21	2.17	187	5.0	50.00	0.393	0.38	55.43	8.4	33.7	42.10	0.12	30	0.897
R4D-228/255	6590.09	0.95	659	0.1	0.95	0.732	2.51	55.90	24.2	28.1	52.30	0.12	20	1.110
R7C-C07/C34	9070.11	1.12	907	0.1	1.12	0.825	0.10	54.27	0.9	52.9	53.80	0.78	23	0.940
R6A-398/425	7640.15	1.45	92	5.0	50.00	0.509	0.88	52.18	7.9	90.4	98.30	0.27	32	0.880
R6A-504/531	8240.21	2.03	215	5.0	50.00	0.392	0.81	53.47	7.5	67.9	75.30	0.00	30	0.952
R7D-088/114	10070.17	1.69	195	5.0	50.00	0.592	0.64	55.33	6.1	35.1	41.20	0.25	30	0.875
R9C-080/107	8790.19	1.87	235	5.0	50.00	0.463	0.46	54.67	4.3	46.1	50.40	0.25	31	0.973
R9D-032/109	8160.17	1.69	84	5.0	50.00	0.480	0.41	53.72	3.8	62.9	66.70	0.26	10	0.875

ABOVE SEA LEVEL, 10_S/SEC, -5 DEG F

R1A-C62/C89	4430.	34344.0C	234	5.C500C.00C.	13C1.8C	55.C5	17.1	41.9	59.00.00	31	1.660
R1B-C62/C89	3280.	37365.0C	214	5.C5C00.00C.	C890.3C	54.54	2.8	48.4	51.30.00	31	0.973
R2A-140/165	3880.	68683.0C	254	5.C5C0C.00C.	C570.1C	56.77	1.0	9.1	10.10.00	30 1	0.804
R2B-C94/121	1710.	16156.0C	176	5.C5C0C.00C.	1070.44	49.35	3.71	39.21	43.00.00	10 3B	0.563
R3A-106/131	3420.	86855.0C	251	5.C5C0C.00C.	04C0.6C	55.61	5.8	3C.1	35.90.00	30	0.654
R3B-161/187	3080.	36360.0C	207	5.C5C0C.00C.	C861.13	56.92	11.1	8.1	19.20.00	13	0.598
R4A-312/338	2830.	47465.0C	193	5.C5C0C.00C.	C6C1.6C	53.92	14.9	61.2	76.10.00	30	0.703
R4B-328/354	2530.	62615.0C	166	5.C5C0C.00C.	C411.57	56.11	15.2	22.9	38.10.00	31	0.411
R5A-165/191	6190.	22217.0C	274	5.C5C0C.00C.	2810.41	56.58	4.0	12.9	16.90.00	13 2A	01.500
R5B-C75/101	7740.	202C1.0C	246	5.C5C0C.00C.	3871.8C	54.26	16.9	55.5	72.30.00	30 2A	11.180
R7A-C59/C85	3610.	59588.0C	253	5.C5C0C.00C.	C611.7C	54.37	15.9	53.6	69.50.00	30 1	0.804
R7B-126/152	2400.	47468.0C	207	5.C5C0C.00C.	C510.4C	51.90	3.6	94.6	98.20.00	10	0.603
R8A-133/159	2450.	33333.0C	208	5.C5C0C.00C.	C741.0C	55.95	9.7	24.8	34.50.00	13	0.675
R8B-162/189	3360.	47473.0C	235	5.C5C0C.00C.	C710.82	56.36	8.0	17.4	25.40.00	30	0.560
R3C-C95/122	2680.	47472.0C	205	5.C5C0C.00C.	C570.54	54.87	5.1	42.9	48.00.17	30	0.524
R3D-159/186	2010.	72700.0C	201	5.C5C0C.00C.	C280.26	49.39	2.21	38.21	40.50.10	30	0.578
R5C-C39/C66	3760.	39416.0C	255	5.C5C0C.00C.	C961.27	53.10	11.6	75.0	86.60.14	30	0.875
R5D-159/186	3840.	67690.0C	256	5.C5C0C.00C.	C570.58	56.15	5.6	20.7	26.30.39	30	0.438
R6C-166/193	2100.	31300.0C	223	5.C5C00.00C.	06E0.45	50.74	3.91	14.81	18.80.19	10	0.661
R8C-048/C75	2390.	28278.0C	18C	5.C5000.00C.	C850.56	54.28	5.2	53.4	58.60.27	31	0.637
R8D-236/263	3310.	25248.0C	266	5.C5C0C.00C.	1320.5C	54.74	4.7	45.1	49.80.26	30	0.910
R10C-C63/C90	3060.	43444.0C	236	5.C5000.00C.	C710.84	56.25	8.2	19.4	27.50.00	30	0.778
R10D-126/153	3010.	45484.0C	215	5.C5000.00C.	6690.83	55.63	8.0	30.2	38.10.27	30	0.770

ABOVE SEA LEVEL, 10_5/SEC, -20 DEG F

R1C-065/092	6170.19192.00	229	5.05000.00	0.3250.27	55.94	0.9	25.9	26.80.00	.	1.520
R1D-071/098	6120.22219.00	193	5.05000.00	0.2780.61	56.61	2.0	14.6	16.60.00	10	1.000
R3C-128/155	4360.35341.00	310	5.05000.00	0.1250.74	56.13	2.4	23.1	25.60.14	31	0.847
R3D-129/156	2890.27269.00	240	5.05000.00	0.1070.14	49.65	0.4	135.4	135.80.24	31	0.682
R5C-097/124	3680.36373.00	280	3.83830.00	0.1020.28	53.38	0.9	70.6	71.40.30	.	0.800
R5D-121/148	3420.26240.00	291	5.05000.00	0.1320.53	55.91	1.7	26.7	28.50.23	13	1.050
R6A-461/488	3300.28278.00	299	5.05000.00	0.1181.05	54.67	3.4	48.8	52.20.00	31	0.745
R8C-165/192	5220.33334.00	328	5.05000.00	0.1580.88	54.44	2.8	52.7	55.50.00	13	1.080
R8D-192/219	4760.25253.00	301	5.05000.00	0.1900.83	54.72	2.7	47.7	50.40.10	13	0.898
R9A-125/152	3610.45449.00	350	5.05000.00	0.0800.04	50.96	0.1	112.5	112.60.16	13	0.875
R9B-043/070	3370.44447.00	307	5.05000.00	0.0770.02	51.65	0.1	100.4	100.50.02	31	0.875
R10A-195/222	3300.26264.00	236	5.05000.00	0.1270.53	56.20	1.7	21.7	23.40.28	30	0.810
R10A-195/222	3300.26264.00	236	5.05000.00	0.1270.53	56.20	1.7	21.7	23.40.28	13	1.120
R10C-032/059	4840.69696.00	396	5.05000.00	0.0700.36	55.20	1.2	38.9	40.10.16	13	0.707
R10D-157/184	3900.47468.00	301	5.05000.00	0.0830.69	56.76	2.3	12.1	14.40.21	30	0.928

BELOW SEA LEVEL, 10_3/SEC, -5 DEG F

R1A-300/326	15800.14	1.38	1580	0.1	1.38	1.13	01.0	056.77	9.8	10.5	20.30.00	20	2A	01.430
R1B-216/241	9150.17	1.70	195	5.0	50.00	0.53	81.2	057.14	11.8	4.4	16.30.00	13	2A	21.250
R1B-243/268	10500.14	1.40	143	5.0	50.00	0.75	01.5	657.14	15.4	5.0	20.40.00	32		1.250
R2A-285/310	12700.22	2.20	95	5.0	50.00	0.57	70.7	056.46	6.8	15.5	22.30.00	32	2A	11.180
R2A-383/408	10600.11	1.10	1060	0.1	1.10	0.96	42.0	056.81	19.6	11.5	31.10.00	20		1.300
R2B-351/377	11300.13	1.26	1130	0.1	1.26	0.86	92.4	656.37	23.9	19.8	43.80.00	12		1.150
R2B-438/464	9950.18	1.80	149	5.0	50.00	0.55	32.7	056.48	26.3	18.3	44.60.00	30		1.020
R3A-401/427	9250.15	1.52	164	5.0	50.00	0.61	71.4	557.03	14.3	6.8	21.00.00	13	3	1.050
R3B-239/265	8700.16	1.60	255	5.0	50.00	0.54	42.0	057.13	19.7	5.9	25.60.00	30		0.997
R3B-331/357	9710.18	1.75	211	5.0	50.00	0.53	92.0	056.79	19.6	11.8	31.40.00	32	3B	1.050
R4A-398/423	7860.21	2.10	144	5.0	50.00	0.37	41.3	056.03	12.6	23.2	36.50.00	30		0.997
R4B-358/384	7760.17	1.68	99	5.0	50.00	0.45	61.9	656.00	18.9	25.5	44.40.00	32		0.892
R4B-420/446	9100.19	1.85	910	0.2	1.85	0.47	93.3	056.39	32.2	20.8	53.00.00	10	3A	1.060
R5A-473/499	8750.17	1.68	169	5.0	50.00	0.51	50.9	155.75	8.8	28.3	37.10.00	13		0.949
R5B-287/313	10400.10	1.05	1040	0.1	1.05	1.04	04.0	056.96	39.4	12.1	51.40.00	20		1.310
R5B-370/396	8160.14	1.40	149	5.0	50.00	0.58	31.2	655.0	912.0	40.4	52.30.00	31		0.989
R7A-232/258	7360.18	1.83	134	5.0	50.00	0.40	93.4	049.76	29.2	136.1	165.30.00	30		0.908
R7A-295/321	6120.21	2.08	607	0.2	2.33	0.29	10.9	554.09	8.9	57.3	66.10.00	20		0.900
R7B-175/201	5570.04	0.43	557	0.0	0.43	1.39	00.1	356.03	1.3	22.0	23.30.00	10	2C	20.876
R7B-440/466	15400.23	2.30	1540	0.2	2.30	0.67	02.4	857.08	24.4	7.6	32.00.00	23	2A	11.250
R8A-305/331	5890.11	1.05	243	5.0	50.00	0.53	51.5	056.70	14.7	12.6	27.20.00	30		0.728
R8A-384/410	12970.17	1.69	1297	0.2	1.69	0.76	31.7	057.01	16.7	7.5	24.20.00	10	2A	01.270
R8B-300/326	5870.29	2.93	247	5.0	50.00	0.20	20.3	056.61	2.9	12.2	15.10.00	30	3	1.170
R8B-483/509	14400.38	3.78	1440	0.4	3.78	0.37	92.1	057.20	20.7	4.9	25.60.00	23	2A	11.148
R2C-196/223	8440.14	1.40	159	5.0	50.00	0.60	31.0	455.35	9.9	35.4	45.30.09	31		0.899
R2C-278/305	6740.19	1.93	230	5.0	50.00	0.35	52.3	354.65	22.0	49.5	71.50.11	31		.
R2C-220/247	7600.14	1.49	760	0.1	1.49	0.54	30.3	754.65	3.5	46.7	50.10.08	12		0.900
R2D-334/371	7320.16	1.70	115	5.0	50.00	0.45	81.9	054.58	17.9	50.3	68.10.13	13		0.842
R4C-414/441	7160.16	1.62	191	5.0	50.00	0.44	83.0	356.76	29.7	14.1	43.70.18	30		0.905
R4C-512/539	8160.15	1.54	60	5.0	50.00	0.54	41.0	355.85	9.9	26.6	36.60.23	10		0.930
R4D-495/522	6170.16	1.57	119	0.3	33.60	0.38	62.9	257.16	28.8	6.9	35.70.07	20		1.030
R6C-476/503	8520.19	1.87	151	5.0	50.00	0.44	80.9	354.44	8.7	51.2	59.90.30	13		0.834
R7C-143/170	10150.23	2.23	251	5.0	50.00	0.44	10.7	756.27	7.5	18.9	26.40.23	30		0.962
R7C-541/568	9750.16	1.55	151	5.0	50.00	0.60	91.1	556.75	11.3	11.2	22.50.22	30		0.951
R7D-223/250	9230.24	2.41	207	5.0	50.00	0.38	52.0	455.49	19.5	34.5	54.00.19	30		0.875
R7D-312/339	9630.18	1.76	211	5.0	50.00	0.53	51.1	254.82	10.6	44.7	55.30.29	30		0.907
R9A-445/482	6370.19	1.85	66	5.0	50.00	0.33	51.0	554.01	9.8	58.8	68.60.28	13		0.814
R9B-329/356	8040.10	1.06	804	0.1	1.06	0.80	40.7	855.00	7.4	41.0	48.40.07	20		1.000
R9C-332/359	6760.21	2.06	123	5.0	50.00	0.32	20.8	354.98	7.9	41.5	49.30.28	30		0.875
R9D-249/276	7280.18	1.82	76	5.0	50.00	0.40	40.9	653.81	8.9	62.2	71.10.22	13		0.921
R10A-269/296	9710.18	1.84	275	5.0	50.00	0.53	90.8	156.39	7.9	16.9	24.80.25	13		0.984
R10B-274/301	9550.18	1.81	247	5.0	50.00	0.53	11.0	956.44	10.6	16.5	27.10.26	.		1.060
R10C-445/472	8280.13	1.30	828	0.1	1.30	0.63	71.9	956.71	19.5	13.2	32.70.30	21		1.190
R10D-231/258	9030.18	1.77	131	5.0	50.00	0.50	21.0	356.61	10.1	13.4	23.50.00	31		0.936

BELOW SEA LEVEL, 10_3/SEC, -20 DEG F

R1C-349/375	14400.18	1.80	1440	0.2	1.80	0.80	3.42	56.71	11.3	15.6	27.00	.00	20	1.310
R1C-384/410	10200.10	1.02	1020	0.1	1.02	1.02	1.94	54.65	6.2	50.0	56.20	.00	20	1.100
R1D-179/206	16400.18	1.84	1640	0.2	1.84	0.91	11.03	56.63	3.4	14.7	18.10	.00	20	1.450
R1D-285/312	1650 .	.	1650	.	.	.	2.48	57.29	8.3	4.6	12.90	.00	20	1.570
R2C-226/253	14800.26	2.64	199	5.0	50.00	0.56	90.89	54.80	2.8	46.4	49.30	.14	13	1.080
R2C-310/337	10700.33	3.36	466	1.7	17.60	0.32	42.63	55.15	8.5	42.0	50.50	.32	32	0.904
R2D-265/292	14100.23	2.28	1410	0.2	2.28	0.61	33.01	55.25	9.7	40.6	50.30	.30	10	1.030
R2D-406/433	11000.26	2.72	111	5.0	50.00	0.42	31.61	55.13	5.2	41.4	46.50	.31	31	0.933
R4C-482/509	14200.24	2.40	279	5.0	50.00	0.59	21.28	55.92	4.2	27.3	31.50	.24	30	1.070
R4C-543/570	14000.28	2.84	179	4.2	42.20	0.50	11.87	56.16	6.1	23.7	29.80	.23	31	1.090
R4D-382/409	14300.29	2.92	243	5.0	50.00	0.49	31.15	56.45	3.8	18.0	21.80	.23	31	1.080
R4D-414/441	13100.15	1.48	1310	0.2	1.48	0.87	30.90	55.25	2.9	38.6	41.50	.23	12	1.030
R4D-525/552	13000.27	2.70	1300	0.3	2.70	0.48	20.88	56.19	2.9	22.2	25.10	.29	10	1.050
R6C-559/586	14400.26	2.60	226	5.0	50.00	0.55	41.70	55.92	5.6	27.7	33.30	.30	30	0.995
R7C-457/484	16500.32	3.17	123	5.0	50.00	0.51	61.32	57.04	4.4	7.9	12.30	.26	31	1.170
R7C-572/599	17600.29	2.85	1760	0.3	2.85	0.60	71.33	56.73	4.4	13.3	17.70	.00	20	1.210
R7D-254/281	13100.32	3.14	362	5.0	50.00	0.40	91.21	55.62	3.9	32.5	36.40	.23	31	1.000
R7D-546/573	14800.26	2.70	243	5.0	50.00	0.56	91.09	56.72	3.6	13.2	16.80	.29	32	0.889
R9A-424/451	11200.17	1.68	1120	0.2	1.68	0.65	90.68	54.00	2.1	60.1	62.30	.34	12	0.898
R9B-417/444	14000.26	2.70	1400	0.3	2.70	0.53	90.62	54.37	2.0	53.6	55.60	.22	12	0.973
R9C-507/534	13400.21	2.16	283	5.0	50.00	0.63	81.86	56.77	6.2	13.1	19.30	.24	30	1.170
R9D-348/375	11500.15	1.52	1150	0.2	1.52	0.76	71.14	55.39	3.7	36.4	40.10	.29	20	1.150
R10A-407/434	14800.28	2.87	362	5.0	50.00	0.52	90.22	56.68	0.7	13.0	13.80	.19	30	1.180
R10B-449/476	14700.25	2.53	279	5.0	50.00	0.58	80.36	56.70	1.2	12.8	14.00	.19	30	1.230
R10C-506/533	12300.25	2.53	223	5.0	50.00	0.49	23.65	57.02	12.2	10.5	22.70	.18	31	1.160
R10D-508/535	13100.22	2.26	203	5.0	50.00	0.59	62.35	57.00	7.8	9.6	17.40	.29	30	1.140

BELOW SEA LEVEL, 10_5/SEC, -5 DEG F

R1A-226/252	2140.17173.00	124	5.C5000.000.1261.2657.C012.4	7.0	19.40.00	31		2A	20.916
R1A-399/425	2140.25248.00	149	5.C5000.00C.C862.4056.6223.4	15.4	38.90.00	13	3		0.715
R1B-320/346	1C900.25253.0C	189	5.C5000.00C.0441.9C57.C818.7	6.6	25.30.00	32		2A	01.C10
R1B-429/455	6960.29285.0C	269	5.C5000.00C.24C1.8C57.1117.7	5.9	23.70.00	31		2A	11.150
R2A-205/230	4430.49489.0C	243	3.C2975.00C.C9C0.3855.32 3.6	35.0	38.60.00	.			0.892
R2A-314/339	3080.28278.0C	161	5.C5000.00C.11C2.1C56.7920.6	12.0	32.50.00	12			0.667
R2B-408/434	3420.6C597.0C	261	5.C5000.00C.C570.8C55.82 7.7	26.9	34.60.00	13			0.662
R2B-468/494	2650.39390.0C	199	5.C5000.00C.0680.7C55.91 6.8	25.2	32.00.00	31			1.070
R3A-220/245	2530.39387.0C	185	5.C5000.00C.0651.6157.C615.8	6.5	22.30.00	31			0.350
R3A-430/456	3060.53525.0C	215	5.C5000.00C.0582.1856.2121.1	22.2	43.30.00	31			0.782
R3B-363/389	3940.51507.0C	259	5.C5000.00C.0770.8956.99 8.7	6.5	15.30.00	30	3B		0.787
R4A-426/452	3220.33330.0C	183	5.C5000.00C.C981.3C55.7912.5	28.2	40.80.00	32			0.782
R4B-391/417	2900.31308.0C	185	5.C5000.00C.0932.2756.4222.1	18.7	40.80.00	31			0.751
R4B-449/475	2430.37368.0C	175	5.C5000.00C.C661.8356.5117.8	16.4	34.20.00	13			0.521
R5A-397/423	3140.56558.0C	227	5.C5000.00C.C560.8C56.44 7.8	16.0	23.80.00	10			0.420
R5A-442/468	4620.28279.0C	218	5.C5000.000.1651.0556.7310.7	11.4	22.10.00	30			1.000
R5A-504/530	3270.56555.0C	227	5.C5000.00C.C581.2356.4712.0	16.1	28.10.00	30			0.395
R5B-341/367	3680.61608.0C	264	5.C5000.00C.06C0.7954.57 7.4	48.7	56.10.00	31	1		0.804
R5B-398/423	3000.53525.0C	231	5.C5000.000.0571.1356.3711.0	17.7	28.70.00	13			0.609
R7A-263/289	680.10 96.0C	61	5.C5000.000.C683.0350.2226.31	27.6	153.90.00	31		3A	20.425
R7A-342/368	6070.26255.0C	195	5.C5000.000.2331.0556.5710.2	14.1	24.40.00	32		2C	00.908
R7B-241/267	2290.47465.0C	163	5.C5000.000.C491.3C53.6312.0	65.8	77.80.00	30	3		0.523
R8A-164/190	2610.29285.0C	175	5.C5000.00C.C9C1.2C56.4511.7	16.4	28.10.00	10			0.536
R8A-432/458	6570.16156.0C	208	5.C500C.00C.4111.8C57.C617.7	6.8	24.50.00	13		2A	11.070
R8B-333/359	3440.25248.0C	209	5.C5000.00C.1381.5C57.C414.8	6.7	21.40.00	30			0.479
R8B-515/541	348 . .	.	5.C5000.00 . 1.8C57.1017.7	6.1	23.80.00	30	2B		0.592
R3C-296/323	2860.64650.0C	271	1.21250.000.4471.6255.9115.6	26.5	42.20.10	30			0.549
R3C-380/407	1890.19188.0C	131	5.C5000.000.C991.2855.3312.2	36.1	48.30.19	10			0.554
R3D-219/246	2690.38380.0C	267	5.C5000.00C.C711.2853.4311.8	69.3	81.10.23	30			0.628
R3D-287/314	3340.68710.0C	250	5.C5000.000.C491.3656.0513.1	23.7	36.80.25	30			0.698
R5C-219/246	3140.56550.0C	223	5.C5000.000.C561.2955.6712.4	30.2	42.60.73	30			0.467
R5C-282/309	2790.50520.0C	207	5.C5000.00C.C563.6456.1435.3	25.8	61.00.36	31			0.504
R5D-225/252	3820.50480.0C	245	5.C5000.000.C761.3756.3513.3	18.5	31.80.33	30			0.603
R5D-294/321	3370.52548.0C	304	5.C5000.00C.C651.7356.7216.9	12.7	29.60.23	31			1.090
R6A-562/589	2230.54538.0C	172	5.C5000.00C.0412.3854.0122.2	60.9	83.10.19	30			0.634
R6C-529/556	3680.82777.0C	269	5.C5000.00C.C450.8656.14 8.3	21.3	29.70.20	30			0.834
R8C-378/405	7620.24245.0C	218	5.C5000.000.3181.4456.7714.1	11.3	25.40.18	13			1.430
R8C-476/503	1480.25257.0C	97	5.C5000.00C.C591.8657.2018.4	4.5	22.90.24	10			0.648
R8D-446/473	2260.21237.0C	207	5.C5000.00C.1081.9556.6219.0	14.7	33.80.25	10			0.654
R8D-534/561	2400.21210.0C	124	5.C5000.00C.1141.9656.8019.2	11.6	30.80.23	30			0.648
R9A-341/368	2760.48488.0C	205	5.C5000.00C.C570.6553.71 6.0	63.5	69.50.31	30			0.700
R9B-385/412	2870.72704.0C	232	5.C500C.00C.C4C0.7254.65 6.8	47.2	54.00.17	30			0.609
R9C-426/453	2830.47459.0C	221	5.C500C.00C.C6C1.0856.3110.5	18.7	29.20.24	30			0.737
R9D-181/208	2550.29291.0C	209	5.C5000.00C.C881.3956.6713.6	13.0	26.60.30	13			1.050
R10A-351/378	3690.72721.0C	274	5.C500C.00C.C510.2756.75 2.6	9.8	12.40.31	30			0.722
R10B-351/378	3310.43439.0C	242	5.C500C.00C.C770.8956.85 8.7	9.0	17.80.17	10			0.824
R10C-316/343	2720.30309.0C	204	5.C5000.000.C912.8956.5828.2	17.0	45.20.19	30			0.599
R10D-325/352	3650.33340.00	22C	5.C5000.00C.1111.6156.5615.7	15.2	30.90.29	31			0.693

BELOW SEA LEVEL, 10_5/SEC, -20 DEG F

R1C-210/236	4030.28282.0C	239	5.C500C.00C.1441.1C55.40	3.6	36.1	39.70.00	13	0.769
R1C-240/266	4430.25246.0C	247	5.C500C.00C.1771.5555.88	5.1	28.2	33.30.00	.	C.989
R1D-209/236	5570.28282.0C	254	5.C500C.00C.1990.9956.01	3.2	25.4	28.60.00	12	0.876
R1D-315/342	2640.29285.0C	181	5.C5CCC.00C.C912.2156.53	7.3	17.6	24.90.00	31	0.712
R3C-329/359	4330.45466.0C	29C	5.C5CCC.00C.C961.6955.94	5.5	27.4	32.90.06	10	1.030
R3C-411/438	17CC.25250.0C	116	5.C500C.00C.C681.3656.55	4.5	16.4	20.90.22	13	0.732
R3D-250/277	4470.34350.0C	318	5.C500C.00C.1321.5955.85	5.2	28.8	34.00.11	30	0.854
R3D-318/345	4680.55547.0C	334	5.C500C.00C.C851.4556.60	4.8	15.6	20.40.24	30	0.942
R5C-250/277	4950.40395.0C	286	1.91870.00C.1241.5556.55	5.1	16.6	21.70.69	32	0.648
R5C-328/355	4010.30340.0C	223	5.C5000.00C.1343.8857.0012.9		11.1	24.00.36	.	0.834
R5D-255/282	4000.47490.0C	298	5.C5000.00C.C851.6956.22	5.5	22.5	28.50.29	.	0.700
R5D-325/352	4740.41440.0C	301	5.C5000.00C.1161.4456.83	4.8	11.6	16.40.28	.	0.850
R6A-661/688	2690.26263.0C	207	1.51475.00C.1042.8354.39	9.0	55.4	64.40.21	13	0.673
R6C-589/616	3950.28288.0C	255	2.22220.00C.1411.6356.52	5.4	12.0	17.40.13	30	0.886
R8C-444/471	4000.29290.0C	202	2.7270C.00C.1381.4856.56	4.9	16.4	21.30.14	12	0.921
R8C-508/535	2530.2C2C2.0C	11C	5.C500C.00C.1272.6156.84	8.7	12.6	21.30.31	31	0.500
R8D-477/504	1880.40367.0C	135	5.C500C.00C.0471.9557.10	6.5	7.4	14.00.21	12	0.574
R8D-565/592	3960.24254.0C	143	5.C500C.00C.1651.4556.81	4.8	12.0	16.80.15	30	0.824
R9A-523/550	4110.16161.0C	237	5.C500C.00C.2570.8155.83	2.6	28.4	31.10.32	13	0.921
R9B-449/476	2930.3C3C8.0C	209	5.C5000.00C.0981.5755.C9	5.1	42.0	47.10.34	31	0.770
R9C-395/422	4110.37363.0C	263	5.C5000.00C.1111.0955.77	3.6	29.7	33.30.43	30	2.000
R9D-317/344	3770.40394.0C	226	5.C5000.00C.0941.1155.35	3.6	37.1	40.60.00	30	0.844
R10A-320/347	4660.23259.0C	223	5.C5000.00C.2031.2356.92	4.1	9.9	14.00.23	13	0.966
R10B-418/445	5490.69682.0C	436	5.C5000.00C.C8C0.2856.62	0.9	14.1	15.10.50	30	0.761
R10C-347/374	3960.28286.0C	189	5.C5000.00C.1412.6556.94	8.8	10.9	19.70.15	13	0.959
R10D-356/383	3770.26268.0C	180	5.C5000.000.1451.6556.78	5.5	12.7	18.20.22	30	1.030

APPENDIX 2

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_3 1

LEVEL=A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	25	836.9200000	236.2623753	346.0000000	1270.000000	47.2524751
LEVEL=3						
SIGM	44	902.6363636	239.7985677	557.0000000	1580.000000	36.1509943

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_3 2

RIDGE=R1 LEVEL=A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	2	1265.000000	7.07106781	1260.000000	1270.000000	5.00000000
RIDGE=R1 LEVEL=B						
SIGM	3	1181.666667	351.5086533	915.0000000	1580.000000	202.943616
RIDGE=R10 LEVEL=B						
SIGM	4	914.2500000	64.41208479	828.0000000	971.0000000	32.2060424
RIDGE=R2 LEVEL=A						
SIGM	4	644.0000000	173.7047303	408.0000000	820.0000000	36.8523652
RIDGE=R2 LEVEL=B						
SIGM	8	933.1250000	213.0334900	674.0000000	1270.000000	75.3187127
RIDGE=R3 LEVEL=A						
SIGM	2	935.0000000	49.49747468	900.0000000	970.0000000	35.0000000
RIDGE=R3 LEVEL=B						
SIGM	3	922.0000000	50.56678752	870.0000000	971.0000000	29.1947484
RIDGE=R4 LEVEL=A						
SIGM	5	803.0000000	97.22653959	659.0000000	910.0000000	43.4810303
RIDGE=R4 LEVEL=B						
SIGM	6	770.1666667	98.31869948	617.0000000	910.0000000	40.1384410
RIDGE=R5 LEVEL=A						
SIGM	2	1180.000000	127.2792206	1090.000000	1270.000000	90.0000000
RIDGE=R5 LEVEL=B						
SIGM	3	910.3333333	116.1048377	816.0000000	1040.000000	67.0331593
RIDGE=R6 LEVEL=A						
SIGM	2	794.0000000	42.42640687	764.0000000	824.0000000	30.0000000
RIDGE=R6 LEVEL=B						
SIGM	1	852.0000000		852.0000000	852.0000000	
RIDGE=R7 LEVEL=A						
SIGM	4	783.0000000	227.9415130	487.0000000	1007.000000	113.970756

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_3 3

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
RIDGE=R7 LEVEL=B						
SIGM	8	915.1250000	306.7355480	557.0000000	1540.000000	108.447393
RIDGE=R8 LEVEL=A						
SIGM	2	578.5000000	328.8046533	346.0000000	811.0000000	232.500000
RIDGE=R8 LEVEL=B						
SIGM	4	978.2500000	454.3885085	587.0000000	1440.000000	227.194254
RIDGE=R9 LEVEL=A						
SIGM	2	847.5000000	44.54772721	816.0000000	879.0000000	31.5000000
RIDGE=R9 LEVEL=B						
SIGM	4	711.2500000	72.20053093	637.0000000	804.0000000	36.1002655

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_5 4

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
LEVEL=A						
SIGM	23	335.0869565	134.1952150	171.0000000	774.0000000	27.9816366
LEVEL=B						
SIGM	48	342.9166667	169.9288754	68.00000000	1090.000000	24.5271205

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_5 5

RIDGE=R1 LEVEL=A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	2	385.5000000	81.31727934	328.0000000	443.0000000	57.5000000
RIDGE=R1 LEVEL=B						
SIGM	4	553.5000000	423.7369467	214.0000000	1090.000000	211.868473
RIDGE=R10 LEVEL=A						
SIGM	2	303.5000000	3.53553391	301.0000000	306.0000000	2.50000000
RIDGE=R10 LEVEL=B						
SIGM	4	334.2500000	44.86553986	272.0000000	369.0000000	22.4327699
RIDGE=R2 LEVEL=A						
SIGM	2	279.5000000	153.4421715	171.0000000	388.0000000	108.500000
RIDGE=R2 LEVEL=B						
SIGM	4	339.5000000	75.85292787	265.0000000	443.0000000	37.9264639
RIDGE=R3 LEVEL=A						
SIGM	4	279.7500000	60.58809014	201.0000000	342.0000000	30.2940451
RIDGE=R3 LEVEL=B						
SIGM	7	290.1428571	64.59470714	189.0000000	394.0000000	24.4145044
RIDGE=R4 LEVEL=A						
SIGM	2	268.0000000	21.21320344	253.0000000	283.0000000	15.0000000
RIDGE=R4 LEVEL=B						
SIGM	3	285.0000000	39.73663297	243.0000000	322.0000000	22.9419557
RIDGE=R5 LEVEL=A						
SIGM	4	538.2500000	193.4052309	376.0000000	774.0000000	96.7026154
RIDGE=R5 LEVEL=B						
SIGM	9	342.5555556	55.02751837	279.0000000	462.0000000	18.3425061
RIDGE=R6 LEVEL=A						
SIGM	1	210.0000000		210.0000000	210.0000000	
RIDGE=R6 LEVEL=B						
SIGM	2	295.5000000	102.5304833	223.0000000	368.0000000	72.5000000

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_5 6

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
			RIDGE=R7 LEVEL=A			
SIGM	2	300.5000000	85.55992052	240.0000000	361.0000000	60.5000000
			RIDGE=R7 LEVEL=B			
SIGM	3	301.3333333	276.6845376	68.00000000	607.0000000	159.743892
			RIDGE=R8 LEVEL=A			
SIGM	4	287.7500000	52.92368720	239.0000000	336.0000000	26.4618436
			RIDGE=R8 LEVEL=B			
SIGM	8	373.2500000	219.0595157	148.0000000	762.0000000	77.4492345
			RIDGE=R9 LEVEL=B			
SIGM	4	275.2500000	14.24483212	255.0000000	287.0000000	7.12244106

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_3 7

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
			LEVEL=A			
SIGM	15	1429.666667	233.4999745	1110.000000	1838.000000	60.2894342
			LEVEL=B			
SIGM	26	1377.307692	187.4578927	1020.000000	1760.000000	36.7635174

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_3 8

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
			RIDGE=R1 LEVEL=A			
SIGM	2	1395.000000	176.7766953	1270.000000	1520.000000	125.000000
			RIDGE=R1 LEVEL=B			
SIGM	4	1437.500000	294.6608220	1020.000000	1650.000000	147.330411
			RIDGE=R10 LEVEL=A			
SIGM	2	1674.000000	231.9310242	1510.000000	1838.000000	164.000000
			RIDGE=R10 LEVEL=B			
SIGM	4	1372.500000	122.8481447	1230.000000	1480.000000	61.4240724
			RIDGE=R2 LEVEL=A			
SIGM	2	1405.000000	247.4873734	1230.000000	1580.000000	175.000000
			RIDGE=R2 LEVEL=B			
SIGM	4	1265.000000	210.1586702	1070.000000	1480.000000	105.079335
			RIDGE=R4 LEVEL=A			
SIGM	1	1140.000000		1140.000000	1140.000000	
			RIDGE=R4 LEVEL=B			
SIGM	5	1372.000000	62.20932406	1300.000000	1430.000000	27.8208555
			RIDGE=R6 LEVEL=A			
SIGM	2	1260.000000	84.85281374	1200.000000	1320.000000	60.0000000
			RIDGE=R6 LEVEL=B			
SIGM	1	1440.000000		1440.000000	1440.000000	
			RIDGE=R7 LEVEL=A			
SIGM	2	1740.000000	28.28427125	1720.000000	1760.000000	20.0000000
			RIDGE=R7 LEVEL=B			
SIGM	4	1550.000000	197.1463078	1310.000000	1760.000000	98.5731539
			RIDGE=R9 LEVEL=A			
SIGM	4	1339.250000	199.3378623	1110.000000	1530.000000	99.6689311
			RIDGE=R9 LEVEL=B			
SIGM	4	1252.500000	138.4135313	1120.000000	1400.000000	69.2068157

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_5 9

LEVEL=A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	15	414.9333333	105.1186178	289.0000000	617.0000000	27.1415104
LEVEL=B						
SIGM	26	389.8461538	98.12713888	170.0000000	557.0000000	19.2443152

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_5 10

RIDGE=R1 LEVEL=A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	2	614.5000000	3.53553391	612.0000000	617.0000000	2.50000000
RIDGE=R1 LEVEL=B						
SIGM	4	416.7500000	120.9417904	264.0000000	557.0000000	60.4708952
RIDGE=R10 LEVEL=A						
SIGM	4	383.5000000	72.72551134	330.0000000	484.0000000	36.3627557
RIDGE=R10 LEVEL=B						
SIGM	4	447.0000000	78.02990880	377.0000000	549.0000000	39.0149544
RIDGE=R3 LEVEL=A						
SIGM	2	362.5000000	103.9446968	289.0000000	436.0000000	73.5000000
RIDGE=R3 LEVEL=B						
SIGM	4	379.5000000	140.4053655	170.0000000	468.0000000	70.2026828
RIDGE=R5 LEVEL=A						
SIGM	2	355.0000000	18.38477631	342.0000000	368.0000000	13.0000000
RIDGE=R5 LEVEL=B						
SIGM	4	442.5000000	49.25105752	400.0000000	495.0000000	24.6255288
RIDGE=R6 LEVEL=A						
SIGM	1	330.0000000		330.0000000	330.0000000	
RIDGE=R6 LEVEL=B						
SIGM	2	332.0000000	89.09545443	269.0000000	395.0000000	63.0000000
RIDGE=R8 LEVEL=A						
SIGM	2	499.0000000	32.52691193	476.0000000	522.0000000	23.0000000
RIDGE=R8 LEVEL=B						
SIGM	4	309.2500000	105.8721714	188.0000000	400.0000000	52.9360857
RIDGE=R9 LEVEL=A						
SIGM	2	349.0000000	16.97056275	337.0000000	361.0000000	12.0000000
RIDGE=R9 LEVEL=B						
SIGM	4	373.0000000	55.68961603	293.0000000	411.0000000	27.8448080

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_3 1

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	25	836.9200000	236.2623753	47.25247507	346.0000000	1270.000000
B	44	902.6363636	239.7985677	36.15099429	557.0000000	1580.000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	-1.1046	50.6	0.2746
EQUAL	-1.1000	67.0	0.2753

FOR HO: VARIANCES ARE EQUAL, F'= 1.03 WITH 43 AND 24 DF PROB > F'= 0.9621

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_3 2
RIDGE=R4

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	5	803.0000000	97.22653959	43.48103035	659.0000000	910.0000000
B	6	770.1666667	98.31869948	40.13844098	617.0000000	910.0000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.5549	8.7	0.5930
EQUAL	0.5542	9.0	0.5929

FOR HO: VARIANCES ARE EQUAL, F'= 1.02 WITH 5 AND 4 DF PROB > F'= 1.0000

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_5 3

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	23	335.0869565	134.1952150	27.98163663	171.0000000	774.000000
B	48	342.9166667	169.9238754	24.52712049	68.0000000	1090.000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	-0.2104	53.9	0.8341
EQUAL	-0.1937	69.0	0.8470

FOR HO: VARIANCES ARE EQUAL, F'= 1.60 WITH 47 AND 22 DF PROB > F'= 0.2308

EFFECT OF SEA LEVEL : TEMP -5, STRAIN RATE 10_5 4
RIDGE=R3

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	4	279.7500000	60.58809014	30.29404507	201.0000000	342.0000000
B	7	290.1428571	64.59470714	24.41450444	189.0000000	394.0000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	-0.2671	6.7	0.7974
EQUAL	-0.2620	9.0	0.7992

FOR HO: VARIANCES ARE EQUAL, F'= 1.14 WITH 6 AND 3 DF PROB > F'= 0.9950

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_3 5

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	15	1429.666667	233.4999745	60.28943417	1110.000000	1830.000000
B	26	1377.307692	187.4578927	36.76351742	1020.000000	1760.000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.7415	24.5	0.4655
EQUAL	0.7870	39.0	0.4360

FOR HO: VARIANCES ARE EQUAL, F'= 1.55 WITH 14 AND 25 DF PROB > F'= 0.3278

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_3 6
RIDGE=R9

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	4	1339.250000	199.3378623	99.66893113	1110.000000	1530.000000
B	4	1252.500000	138.4136313	69.20681566	1120.000000	1400.000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.7149	5.3	0.5049
EQUAL	0.7149	6.0	0.5015

FOR HO: VARIANCES ARE EQUAL, F'= 2.07 WITH 3 AND 3 DF PROB > F'= 0.5644

APPENDIX 3

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_5 7

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	15	414.9333333	105.1186178	27.14151041	289.0000000	617.0000000
B	26	389.8461538	98.1271389	19.24431523	170.0000000	557.0000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.7540	27.7	0.4572
EQUAL	0.7684	39.0	0.4469

FOR HO: VARIANCES ARE EQUAL, F'= 1.15 WITH 14 AND 25 DF PROB > F'= 0.7382

EFFECT OF SEA LEVEL : TEMP -20, STRAIN RATE 10_5 8
RIDGE=R10

TTEST PROCEDURE

VARIABLE: SIGM

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	4	383.5000000	72.72551134	36.36275567	330.0000000	484.0000000
B	4	447.0000000	78.02990880	39.01495440	377.0000000	549.0000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	-1.1906	6.0	0.2790
EQUAL	-1.1906	6.0	0.2788

FOR HO: VARIANCES ARE EQUAL, F'= 1.15 WITH 3 AND 3 DF PROB > F'= 0.9106

APPENDIX 4

EFFECT OF SEA LEVEL : ALL DATA

TTEST PROCEDURE

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	78	55.53589744	33.56579108	3.80057744	10.10000000	143.0000000
B	144	36.15138889	21.64179777	1.80348315	12.30000000	165.3000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	4.6079	112.5	0.0001
EQUAL	5.2160	220.0	0.0001

FOR HO: VARIANCES ARE EQUAL, F'= 2.41 WITH 77 AND 143 DF
PROB > F'= 0.0001

EFFECT OF SEA LEVEL : ALL DATA 2
RIDGE=R1

TTEST PROCEDURE

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	28.92500000	17.06531570	6.03350023	12.30000000	59.00000000
B	15	27.00000000	11.19534342	2.89062524	12.90000000	56.20000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.2877	10.3	0.7793
EQUAL	0.3272	21.0	0.7468

FOR HO: VARIANCES ARE EQUAL, F'= 2.32 WITH 7 AND 14 DF PROB > F'= 0.1700

---------- RIDGE=R2 ----------

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	76.26250000	46.52498369	16.44906573	10.10000000	143.0000000
B	16	44.44375000	12.96291987	3.24072997	22.30000000	71.5000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	1.8979	7.5	0.0966
EQUAL	2.5926	22.0	0.0166

FOR HO: VARIANCES ARE EQUAL, F'= 12.38 WITH 7 AND 15 DF PROB > F'= 0.0001

---------- RIDGE=R3 ----------

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	57.35000000	50.64845224	17.90693202	19.20000000	140.5000000
B	14	33.96428571	16.81375843	4.49366596	15.30000000	81.1000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	1.2667	7.9	0.2414
EQUAL	1.6044	20.0	0.1243

FOR HO: VARIANCES ARE EQUAL, F'= 9.07 WITH 7 AND 13 DF PROB > F'= 0.0003

EFFECT OF SEA LEVEL : ALL DATA 3
RIDGE=R4

TTEST PROCEDURE

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	56.15000000	14.60410901	5.16333226	38.10000000	78.70000000
B	14	36.81428571	8.17584220	2.18508574	21.80000000	53.00000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	3.4487	9.6	0.0067
EQUAL	4.0146	20.0	0.0007

FOR HO: VARIANCES ARE EQUAL, F'= 3.19 WITH 7 AND 13 DF PROB > F'= 0.0677

---------- RIDGE=R5 ----------

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	43.25000000	28.33342297	10.01737776	16.90000000	86.60000000
B	16	34.70000000	13.79574814	3.44893703	16.40000000	61.00000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.8070	8.7	0.4412
EQUAL	1.0061	22.0	0.3253

FOR HO: VARIANCES ARE EQUAL, F'= 4.22 WITH 7 AND 15 DF PROB > F'= 0.0185

---------- RIDGE=R6 ----------

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	6	81.63333333	25.09690552	10.24576877	52.20000000	118.8000000
B	6	47.96666667	25.01964561	10.21422755	17.40000000	83.1000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	2.3271	10.0	0.0423
EQUAL	2.3271	10.0	0.0423

FOR HO: VARIANCES ARE EQUAL, F'= 1.01 WITH 5 AND 5 DF PROB > F'= 0.9948

EFFECT OF SEA LEVEL : ALL DATA 4
RIDGE=R7

TTEST PROCEDURE

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	57.83750000	22.38142964	7.91303034	30.10000000	98.2000000
B	15	52.28000000	47.69299439	12.31427820	12.30000000	165.3000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	0.3797	20.8	0.7080
EQUAL	0.3094	21.0	0.7601

FOR HO: VARIANCES ARE EQUAL, F'= 4.54 WITH 14 AND 7 DF PROB > F'= 0.0517

---------- RIDGE=R8 ----------

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	54.28750000	19.47822502	6.88659250	25.40000000	84.90000000
B	16	23.51250000	5.31649947	1.32912487	14.00000000	33.30000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	4.3879	7.5	0.0027
EQUAL	6.0069	22.0	0.0001

FOR HO: VARIANCES ARE EQUAL, F'= 13.42 WITH 7 AND 15 DF PROB > F'= 0.0001

---------- RIDGE=R9 ----------

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	80.38750000	34.03231395	12.03223999	35.40000000	117.4000000
B	16	46.63125000	16.21750983	4.05437746	19.30000000	71.1000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	2.6586	8.6	0.0271
EQUAL	3.3306	22.0	0.0031

FOR HO: VARIANCES ARE EQUAL, F'= 4.40 WITH 7 AND 15 DF PROB > F'= 0.0154

EFFECT OF SEA LEVEL : ALL DATA 5
RIDGE=R10

TTEST PROCEDURE

VARIABLE: POR

LEVEL	N	MEAN	STD DEV	STD ERROR	MINIMUM	MAXIMUM
A	8	25.80000000	9.09850851	3.21680853	14.40000000	40.10000000
B	16	21.83125000	8.80005445	2.20001361	12.40000000	45.20000000

VARIANCES	T	DF	PROB > |T|
UNEQUAL	1.0134	13.7	0.3262
EQUAL	1.0303	22.0	0.3141

FOR HO: VARIANCES ARE EQUAL, F'= 1.07 WITH 7 AND 15 DF PROB > F'= 0.8568

APPENDIX 5

STR_RATE=10_3 TEMP=- 5

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	69	878.8260870	238.9058981	346.0000000	1580.000000	28.7608903

---------- STR_RATE=10_3 TEMP=-20 ----------

SIGM	41	1396.463415	204.1996691	1020.000000	1838.000000	31.8906305

---------- STR_RATE=10_5 TEMP=- 5 ----------

SIGM	71	340.3802817	158.3080511	68.00000000	1090.000000	18.7877091

---------- STR_RATE=10_5 TEMP=-20 ----------

SIGM	41	399.0243902	100.1759671	170.0000000	617.0000000	15.6448576

STR_RATE=10_3 TEMP=- 5 RIDGE=R1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	5	1215.000000	252.7350391	915.0000000	1580.000000	113.026546
STR_RATE=10_3 TEMP=- 5 RIDGE=R2						
SIGM	12	836.7500000	239.5295104	408.0000000	1270.000000	69.1462137
STR_RATE=10_3 TEMP=- 5 RIDGE=R3						
SIGM	5	927.2000000	44.06472512	870.0000000	971.0000000	19.7063442
STR_RATE=10_3 TEMP=- 5 RIDGE=R4						
SIGM	11	785.0909091	94.38480232	617.0000000	910.0000000	28.4580887
STR_RATE=10_3 TEMP=- 5 RIDGE=R5						
SIGM	5	1018.200000	180.5718693	816.0000000	1270.000000	80.7541949
STR_RATE=10_3 TEMP=- 5 RIDGE=R6						
SIGM	3	813.3333333	44.95924080	764.0000000	852.0000000	25.9572298
STR_RATE=10_3 TEMP=- 5 RIDGE=R7						
SIGM	12	871.0833333	279.7776579	487.0000000	1540.000000	80.7648531
STR_RATE=10_3 TEMP=- 5 RIDGE=R8						
SIGM	6	845.0000000	433.7247975	346.0000000	1440.000000	177.067407
STR_RATE=10_3 TEMP=- 5 RIDGE=R9						
SIGM	6	756.6666667	92.06012528	637.0000000	879.0000000	37.5833888
STR_RATE=10_3 TEMP=- 5 RIDGE=R10						
SIGM	4	914.2500000	64.41208479	828.0000000	971.0000000	32.2060424
STR_RATE=10_3 TEMP=-20 RIDGE=R1						
SIGM	6	1423.333333	242.5420926	1020.000000	1650.000000	99.0173947
STR_RATE=10_3 TEMP=-20 RIDGE=R2						
SIGM	6	1311.666667	209.7061436	1070.000000	1580.000000	85.6121746

STR_RATE=10_3 TEMP=-20 RIDGE=R4

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	6	1333.333333	109.8483804	1140.000000	1430.000000	44.8454135
STR_RATE=10_3 TEMP=-20 RIDGE=R6						
SIGM	3	1320.000000	120.0000000	1200.000000	1440.000000	69.2820323
STR_RATE=10_3 TEMP=-20 RIDGE=R7						
SIGM	6	1613.333333	181.9523747	1310.000000	1760.000000	74.2817459
STR_RATE=10_3 TEMP=-20 RIDGE=R9						
SIGM	8	1295.875000	165.5004855	1110.000000	1530.000000	58.5132578
STR_RATE=10_3 TEMP=-20 RIDGE=R10						
SIGM	6	1473.000000	209.8904476	1230.000000	1838.000000	35.6874164
STR_RATE=10_5 TEMP=- 5 RIDGE=R1						
SIGM	6	497.5000000	341.4391600	214.0000000	1090.000000	139.391953
STR_RATE=10_5 TEMP=- 5 RIDGE=R2						
SIGM	6	319.5000000	95.50445016	171.0000000	443.0000000	38.9895285
STR_RATE=10_5 TEMP=- 5 RIDGE=R3						
SIGM	11	286.3636364	60.26818850	189.0000000	394.0000000	18.1715426
STR_RATE=10_5 TEMP=- 5 RIDGE=R4						
SIGM	5	278.2000000	31.44360030	243.0000000	322.0000000	14.0620055
STR_RATE=10_5 TEMP=- 5 RIDGE=R5						
SIGM	13	402.7692308	142.1537629	279.0000000	774.0000000	39.4263601
STR_RATE=10_5 TEMP=- 5 RIDGE=R6						
SIGM	3	267.0000000	87.70974860	210.0000000	368.0000000	50.6392470
STR_RATE=10_5 TEMP=- 5 RIDGE=R7						
SIGM	5	301.0000000	200.2685697	68.00000000	607.0000000	89.5628271

STR_RATE=10_5 TEMP=- 5 RIDGE=R8

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIGM	12	344.7500000	181.8606484	148.0000000	762.0000000	52.4986472

---------- STR_RATE=10_5 TEMP=- 5 RIDGE=R9 ----------

SIGM	4	275.2500000	14.24488212	255.0000000	287.0000000	7.12244106

---------- STR_RATE=10_5 TEMP=- 5 RIDGE=R10 ----------

SIGM	6	324.0000000	38.24133889	272.0000000	369.0000000	15.6119612

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R1 ----------

SIGM	6	482.6666667	138.5881188	264.0000000	617.0000000	56.5783626

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R3 ----------

SIGM	6	373.8333333	118.6008713	170.0000000	468.0000000	48.4186029

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R5 ----------

SIGM	6	413.3333333	59.70482951	342.0000000	495.0000000	24.3743946

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R6 ----------

SIGM	3	331.3333333	63.01058112	269.0000000	395.0000000	36.3791760

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R8 ----------

SIGM	6	372.5000000	128.6013219	188.0000000	522.0000000	52.5012698

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R9 ----------

SIGM	6	365.0000000	45.51922671	293.0000000	411.0000000	18.5831465

---------- STR_RATE=10_5 TEMP=-20 RIDGE=R10 ----------

SIGM	8	415.2500000	77.64157575	330.0000000	549.0000000	27.4504424

APPENDIX 6

VARIATION OF SIGM AMONG RIDGES 2
STR_RATE=10_3 TEMP=- 5

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	15	1211353.02971014	80756.86864734	1.60
ERROR	53	2669816.88333334	50373.90345912	PR > F
CORRECTED TOTAL	68	3881169.91304348		0.1043

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.312110	25.5388	224.44131406	878.82608696

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	9	906793.48728590	2.00	0.0573
SITE(RIDGE)	6	304559.54242424	1.01	0.4303

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	9	892902.87402945	1.97	0.0614
SITE(RIDGE)	6	304559.54242424	1.01	0.4303

VARIATION OF SIGM AMONG RIDGES 4
STR_RATE=10_3 TEMP=-20

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	9	682527.11178862	75836.34575429	2.39
ERROR	31	985373.08333334	31786.22849462	PR > F
CORRECTED TOTAL	40	1667900.19512196		0.0349

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.409213	12.7670	178.28692744	1396.46341463

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	6	487213.98678862	2.55	0.0397
SITE(RIDGE)	3	195313.12500000	2.05	0.1275

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	6	464760.32222222	2.44	0.0479
SITE(RIDGE)	3	195313.12500000	2.05	0.1275

VARIATION OF SIGM AMONG RIDGES 6
STR_RATE=10_5 TEMP=- 5

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	15	353072.89906103	23538.19327074	0.92
ERROR	55	1401227.83333333	25476.86969697	PR > F
CORRECTED TOTAL	70	1754300.73239437		0.5442

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.201261	46.8931	159.61475401	340.38028169

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	9	295479.07924751	1.29	0.2637
SITE(RIDGE)	6	57593.81981352	0.38	0.8907

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	9	286981.22959922	1.25	0.2837
SITE(RIDGE)	6	57593.81981352	0.38	0.8907

VARIATION OF SIGM AMONG RIDGES 8
STR_RATE=10_5 TEMP=-20

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	9	82732.97560976	9192.55284553	0.89
ERROR	31	318676.00000000	10279.87096774	PR > F
CORRECTED TOTAL	40	401408.97560976		0.5416

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.206106	25.4094	101.38959853	399.02439024

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	6	74031.80894309	1.20	0.3323
SITE(RIDGE)	3	8701.16666667	0.28	0.8379

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	6	63911.98888889	1.04	0.4211
SITE(RIDGE)	3	8701.16666667	0.28	0.8379

APPENDIX 7

VARIATION OF SIGM AMONG RIDGES 2
STR_RATE=10_3 TEMP=- 5

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	9	906793.48728590	100754.83192066	2.00
ERROR	59	2974376.42575758	50413.15975860	PR > F
CORRECTED TOTAL	68	3881169.91304348		0.0552

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.233639	25.5487	224.52875041	878.82608696

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	9	906793.48728590	2.00	0.0552

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	9	906793.48728590	2.00	0.0552

VARIATION OF SIGM AMONG RIDGES 4
STR_RATE=10_3 TEMP=-20

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	6	487213.98678862	81202.33113144	2.34
ERROR	34	1180686.20833334	34726.06495098	PR > F
CORRECTED TOTAL	40	1667900.19512196		0.0535

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.292112	13.3444	186.34930896	1396.46341463

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	6	487213.98678862	2.34	0.0535

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	6	487213.98678862	2.34	0.0535

VARIATION OF SIGM AMONG RIDGES 6
STR_RATE=10_5 TEMP=- 5

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	9	295479.07924751	32831.00880528	1.37
ERROR	61	1458821.65314685	23915.10906798	PR > F
CORRECTED TOTAL	70	1754300.73239437		0.2198

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.168431	45.4330	154.64510683	340.38028169

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	9	295479.07924751	1.37	0.2198

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	9	295479.07924751	1.37	0.2198

VARIATION OF SIGM AMONG RIDGES 8
STR_RATE=10_5 TEMP=-20

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	6	74031.80894309	12338.63482385	1.28
ERROR	34	327377.16666667	9628.74019608	PR > F
CORRECTED TOTAL	40	401408.97560976		0.2919

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.184430	24.5915	98.12614430	399.02439024

SOURCE	DF	TYPE I SS	F VALUE	PR > F
RIDGE	6	74031.80894309	1.28	0.2919

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
RIDGE	6	74031.80894309	1.28	0.2919

APPENDIX 8

FRIEDMAN RANK SUM TEST ON RSIGM

Type	Ridge 1	6	9	10
1	4	2	1	3
2	4	1	2	3
3	3	2	1	4
4	4	1	2	3

Test statistic S is calculated to be 9.9.

If $S \geq s(\alpha, 4, 4) =>$ Reject Null hypothesis of no ridge effect.

Calculated $\alpha = 0.006$.

APPENDIX 9

FRIEDMAN RANK SUM TEST ON RSDSIGM

Type	Ridge 1	6	9	10
1	4	1	3	2
2	4	3	1	2
3	4	1	2	3
4	4	2	1	3

Test statistic S is calculated to be 8.1.

If $S \geq d\ (\alpha,\ 4,\ 4)$ = > Reject null hypothesis of no Ridge effect.

Calculated α = .033.

APPENDIX 10

VARIATION OF PEAK STRESS BY TEMP AND STRAIN RATE 1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
STR_RATE=10_3 TEMP=- 5						
SIGM	69	878.8260870	238.9058981	346.0000000	1580.000000	28.7608903
STR_RATE=10_3 TEMP=-20						
SIGM	41	1396.463415	204.1996691	1020.000000	1838.000000	31.8906305
STR_RATE=10_5 TEMP=- 5						
SIGM	71	340.3802817	158.3080511	68.00000000	1090.000000	18.7877091
STR_RATE=10_5 TEMP=-20						
SIGM	41	399.0243902	100.1759671	170.0000000	617.0000000	15.6448576

VARIATION OF PEAK STRESS BY TEMP AND STRAIN RATE 3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SIGM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	2	32225764.11380559	16112882.05690279	338.38
ERROR	219	10428162.79159983	47617.18169680	PR > F
CORRECTED TOTAL	221	42653926.90540541		0.0001

R-SQUARE	C.V.	STD DEV	SIGM MEAN
0.755517	30.5789	218.21361483	713.60810811

SOURCE	DF	TYPE I SS	F VALUE	PR > F
STR_RATE	1	27968614.63121711	587.36	0.0001
TEMP	1	4257149.48258848	89.40	0.0001

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
STR_RATE	1	27817016.57320855	584.18	0.0001
TEMP	1	4257149.48258848	89.40	0.0001

APPENDIX 11

PEAK STRESS (PSI) 1

STR_RATE=10_3 TEMP=- 5

UNIVARIATE

VARIABLE=SIGM PEAK STRESS

MOMENTS

N	69	SUM WGTS	69	100% MAX	1580	99%	1580
MEAN	878.826	SUM	60639	75% Q3	973	95%	1368.5
STD DEV	238.906	VARIANCE	57076	50% MED	852	90%	1270
SKEWNESS	0.720087	KURTOSIS	1.14544	25% Q1	731.5	10%	612
USS	57172305	CSS	3881170	0% MIN	346	5%	522
CV	27.1847	STD MEAN	28.7609			1%	346
T:MEAN=0	30.5563	PROB>|T|	0.0001	RANGE	1234		
SGN RANK	1207.5	PROB>|S|	0.0001	Q3-Q1	241.5		
NUM ^= 0	69			MODE	816		
D:NORMAL	0.111752	PROB>D	0.031				

QUANTILES(DEF=4)

EXTREMES

LOWEST	HIGHEST
346	1270
408	1297
487	1440
557	1540
587	1580

PEAK STRESS (PSI) 2

STR_RATE=10_3 TEMP=-20

UNIVARIATE

VARIABLE=SIGM PEAK STRESS

MOMENTS

N	41	SUM WGTS	41	100% MAX	1838	99%	1838
MEAN	1396.46	SUM	57255	75% Q3	1515	95%	1760
STD DEV	204.2	VARIANCE	41697.5	50% MED	1410	90%	1706
SKEWNESS	0.187988	KURTOSIS	-0.53646	25% Q1	1233.5	10%	1112
USS	81622413	CSS	1667900	0% MIN	1020	5%	1073
CV	14.6226	STD MEAN	31.8906			1%	1020
T:MEAN=0	43.7891	PROB>|T|	0.0001	RANGE	818		
SGN RANK	430.5	PROB>|S|	0.0001	Q3-Q1	281.5		
NUM ^= 0	41			MODE	1480		
W:NORMAL	0.972608	PROB<W	0.518				

QUANTILES(DEF=4)

EXTREMES

LOWEST	HIGHEST
1020	1650
1070	1720
1100	1760
1110	1760
1120	1838

PEAK STRESS (PSI) 3

STR_RATE=10_5 TEMP=- 5

UNIVARIATE

VARIABLE=SIGM PEAK STRESS

MOMENTS

N	71	SUM WGTS	71	100% MAX	1090	99%	1090
MEAN	340.38	SUM	24167	75% Q3	368	95%	722.4
STD DEV	158.308	VARIANCE	25061.4	50% MED	308	90%	577.998
SKEWNESS	2.37114	KURTOSIS	7.55033	25% Q1	253	10%	214
USS	9980271	CSS	1754301	0% MIN	68	5%	181.8
CV	46.5092	STD MEAN	18.7877			1%	68
T:MEAN=0	18.1172	PROB>|T|	0.0001	RANGE	1022		
SGN RANK	1278	PROB>|S|	0.0001	Q3-Q1	115		
NUM ^= 0	71			MODE	214		
D:NORMAL	0.22685	PROB>D	<0.01				

QUANTILES(DEF=4)

EXTREMES

LOWEST	HIGHEST
68	657
148	696
171	762
189	774
201	1090

PEAK STRESS (PSI) 4

STR_RATE=10_5 TEMP=-20

UNIVARIATE

VARIABLE=SIGM PEAK STRESS

MOMENTS

N	41	SUM WGTS	41	100% MAX	617	99%	617
MEAN	399.024	SUM	16360	75% Q3	467	95%	606.5
STD DEV	100.176	VARIANCE	10035.2	50% MED	400	90%	543.6
SKEWNESS	-0.0193428	KURTOSIS	0.253725	25% Q1	333.5	10%	265
USS	6929448	CSS	401409	0% MIN	170	5%	194.5
CV	25.1052	STD MEAN	15.6449			1%	170
T:MEAN=0	25.5051	PROB>|T|	0.0001	RANGE	447		
SGN RANK	430.5	PROB>|S|	0.0001	Q3-Q1	133.5		
NUM ^= 0	41			MODE	330		
W:NORMAL	0.980108	PROB<W	0.749				

QUANTILES(DEF=4)

EXTREMES

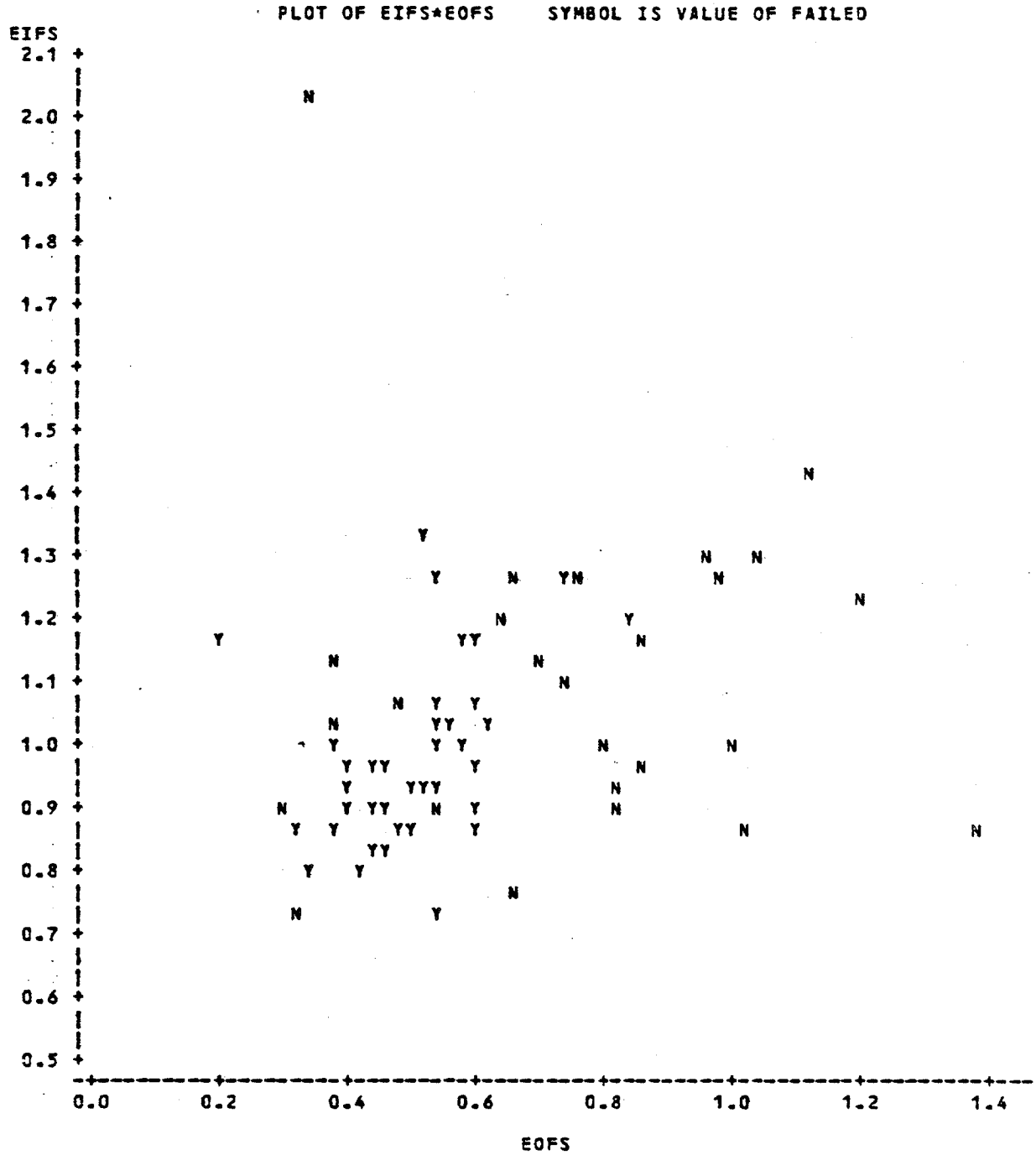
LOWEST	HIGHEST
170	522
188	549
253	557
264	612
269	617

APPENDIX 12

SAS 1

STR_RATE=10_3 TEMP=- 5

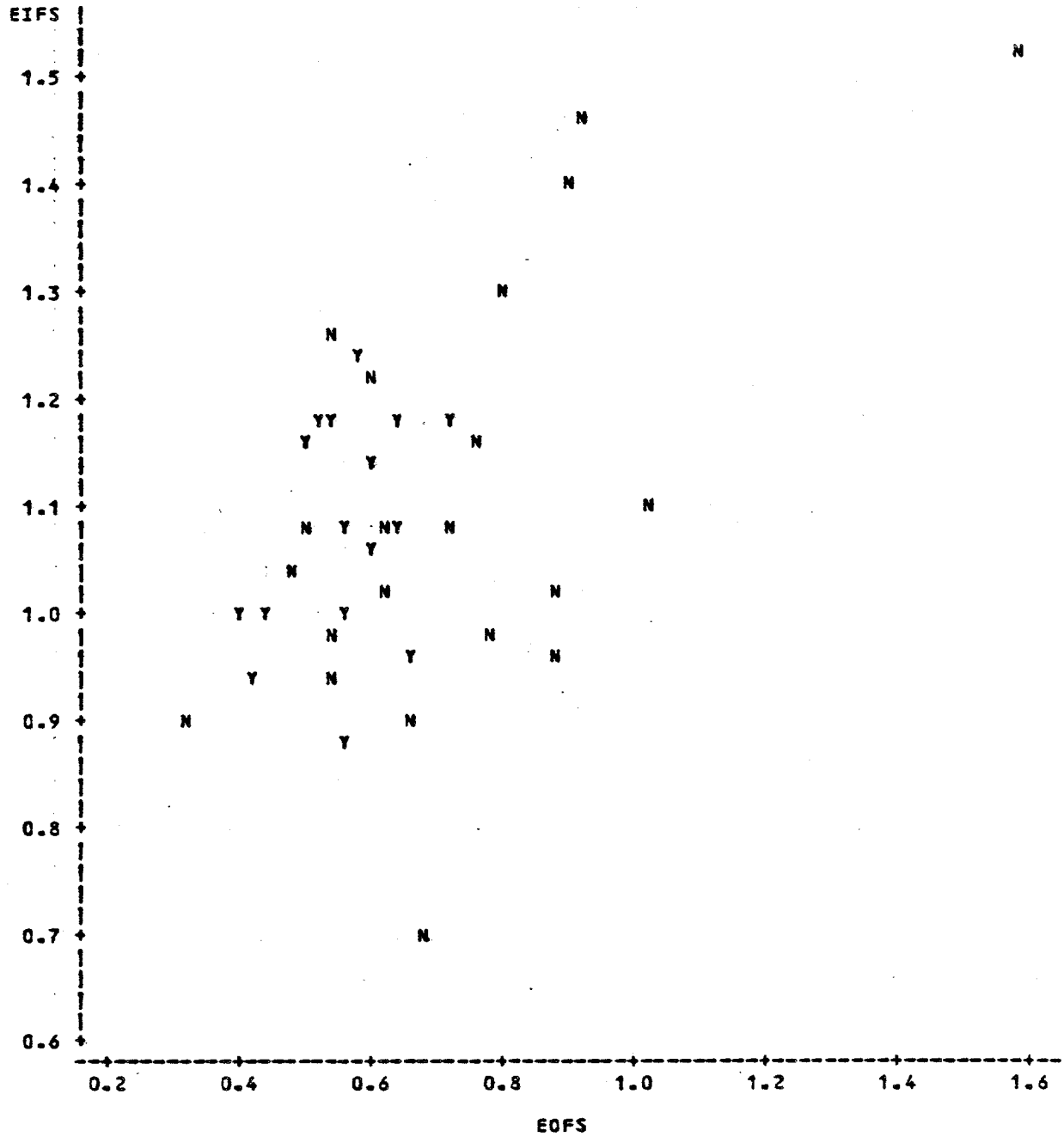
PLOT OF EIFS*EOFS SYMBOL IS VALUE OF FAILED



NOTE: 1 OBS HAD MISSING VALUES 5 OBS HIDDEN

SAS
STR_RATE=10_3 TEMP=-20

PLOT OF EIFS*EOFS SYMBOL IS VALUE OF FAILED



NOTE: 2 OBS HAD MISSING VALUES 2 OBS HIDDEN

SAS 3
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS

FAILED	FREQUENCY	PRIOR PROBABILITY
NO	26	0.50000000
YES	42	0.50000000
TOTAL	68	1.00000000

WARNING: 1 OF THE 69 OBSERVATIONS WILL NOT BE INCLUDED IN THE ANALYSIS DUE TO MISSING VALUES.

SAS 4
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS SIMPLE STATISTICS

FAILED = NO

VARIABLE	N	SUM	MEAN	VARIANCE	STANDARD DEVIATION
EOFS	26	19.81800000	0.76223077	0.08406570	0.28994086
EIFS	26	28.76300000	1.10626923	0.06853876	0.26179909

FAILED = YES

EOFS	42	21.17900000	0.50426190	0.01288420	0.11350858
EIFS	42	40.92700000	0.97445238	0.01792479	0.13388350

SAS 5
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS WITHIN COVARIANCE MATRIX INFORMATION

FAILED	COVARIANCE MATRIX RANK	NATURAL LOG OF DETERMINANT OF THE COVARIANCE MATRIX
NO	2	-5.15651263
YES	2	-8.55934634
POOLED	2	-6.52714692

SAS
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS TEST OF HOMOGENEITY OF WITHIN COVARIANCE MATRICES

NOTATION: K = NUMBER OF GROUPS

P = NUMBER OF VARIABLES

N = TOTAL NUMBER OF OBSERVATIONS

N(I) = NUMBER OF OBSERVATIONS IN THE I'TH GROUP

$$V = \frac{\prod |\text{WITHIN SS MATRIX}(I)|^{N(I)/2}}{|\text{POOLED SS MATRIX}|^{N/2}}$$

$$\text{RHO} = 1.0 - \left[\text{SUM} \frac{1}{N(I)-1} - \frac{1}{N-K} \right] \frac{2P^2 + 3P - 1}{6(P+1)(K-1)}$$

$$DF = .5(K-1)P(P+1)$$

UNDER NULL HYPOTHESIS: $-2 \text{ RHO LN} \left[\frac{N^{PN/2} \quad V}{\prod N(I)^{PN(I)/2}} \right]$

IS DISTRIBUTED APPROXIMATELY AS CHI-SQUARE(DF)

TEST CHI-SQUARE VALUE = 47.95146046
WITH 3 DF PROB > CHI-SQ = 0.0001

SINCE THE CHI-SQUARE VALUE IS SIGNIFICANT AT THE 0.2000 LEVEL,
THE WITHIN COVARIANCE MATRICES WILL BE USED IN
THE DISCRIMINANT FUNCTION.

REFERENCE: KENDALL,M.G. AND A.STUART
THE ADVANCED THEORY OF STATISTICS VOL.3 P266 & 282.

SAS 7
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS PAIRWISE SQUARED GENERALIZED DISTANCES BETWEEN GROUPS

$$D^2(I|J) = (\bar{X}_I - \bar{X}_J)' \, COV_J^{-1} \, (\bar{X}_I - \bar{X}_J) + LN \, |COV_J|$$

GENERALIZED SQUARED DISTANCE TO FAILED

FROM FAILED	NO	YES
NO	-5.15651263	-3.39146448
YES	-4.11092646	-8.55934634

SAS
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS CLASSIFICATION RESULTS FOR CALIBRATION DATA: WORK.TEMP

GENERALIZED SQUARED DISTANCE FUNCTION:

$$D_J^2(X) = (X-\bar{X}_J)' \, COV_J^{-1} \, (X-\bar{X}_J) + LN \, |COV_J|$$

POSTERIOR PROBABILITY OF MEMBERSHIP IN EACH FAILED:

$$PR(J|X) = EXP(-.5 \, D_J^2(X)) \, / \, SUM_K \, EXP(-.5 \, D_K^2(X))$$

POSTERIOR PROBABILITY OF MEMBERSHIP IN FAILED:

OBS	FROM FAILED	CLASSIFIED INTO FAILED		NO	YES
1	NO	NO		1.0000	0.0000
2	NO	NO		0.9982	0.0018
3	NO	NO		0.9671	0.0329
4	NO	YES	*	0.1361	0.8639
5	NO	NO		0.9999	0.0001
7	NO	NO		1.0000	0.0000
8	NO	NO		0.6085	0.3915
9	NO	NO		0.8415	0.1585
10	NO	YES	*	0.4670	0.5330
11	NO	YES	*	0.1248	0.8752
12	NO	YES	*	0.1660	0.8340
13	NO	NO		0.8982	0.1018
14	NO	YES	*	0.4024	0.5976
15	NO	NO		1.0000	0.0000
16	NO	NO		0.9754	0.0246
17	NO	NO		0.9828	0.0172
18	NO	NO		1.0000	0.0000
19	NO	NO		0.9987	0.0013
20	NO	NO		0.7212	0.2788
21	NO	NO		1.0000	0.0000
22	NO	YES	*	0.1554	0.8446
23	NO	NO		0.9999	0.0001
24	NO	YES	*	0.4505	0.5495
25	NO	NO		0.5809	0.4191
26	NO	NO		0.9638	0.0362
27	YES	NO	*	0.5373	0.4627
28	YES	NO	*	0.7874	0.2126
29	YES	YES		0.3172	0.6828
30	YES	YES		0.1292	0.8708
31	YES	YES		0.2071	0.7929
32	YES	YES		0.1181	0.8819
33	YES	YES		0.1349	0.8651
34	YES	YES		0.1444	0.8556
35	YES	YES		0.0842	0.9158
36	YES	YES		0.0989	0.9011
37	YES	YES		0.1501	0.8499
38	YES	YES		0.0859	0.9141

SAS 9
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS CLASSIFICATION RESULTS FOR CALIBRATION DATA: WORK.TEMP

POSTERIOR PROBABILITY OF MEMBERSHIP IN FAILED:

OBS	FROM FAILED	CLASSIFIED INTO FAILED		NO	YES
39	YES	YES		0.3272	0.6728
40	YES	NO	*	0.9799	0.0201
41	YES	YES		0.2183	0.7817
43	YES	YES		0.0934	0.9066
44	YES	YES		0.0830	0.9170
45	YES	YES		0.1178	0.8822
46	YES	YES		0.0930	0.9070
47	YES	YES		0.0911	0.9089
48	YES	YES		0.1969	0.8031
49	YES	YES		0.0888	0.9112
50	YES	YES		0.1157	0.8843
51	YES	YES		0.1097	0.8903
52	YES	YES		0.1244	0.8756
53	YES	YES		0.0891	0.9109
54	YES	YES		0.1132	0.8868
55	YES	YES		0.1382	0.8618
56	YES	YES		0.0937	0.9063
57	YES	NO	*	0.9462	0.0538
58	YES	NO	*	0.8067	0.1933
59	YES	YES		0.1952	0.8048
60	YES	YES		0.3131	0.6869
61	YES	YES		0.1860	0.8140
62	YES	YES		0.0981	0.9019
63	YES	YES		0.0955	0.9045
64	YES	YES		0.0884	0.9116
65	YES	YES		0.1051	0.8949
66	YES	YES		0.1028	0.8972
67	YES	YES		0.2163	0.7837
68	YES	YES		0.0923	0.9077
69	YES	YES		0.0924	0.9076

* MISCLASSIFIED OBSERVATION

SAS 1(
STR_RATE=10_3 TEMP=- 5

DISCRIMINANT ANALYSIS CLASSIFICATION SUMMARY FOR CALIBRATION DATA: WORK.TEMF

GENERALIZED SQUARED DISTANCE FUNCTION:

$$D_J^2(X) = (X-\bar{X}_J)' \, COV_J^{-1} \, (X-\bar{X}_J) + LN \, |COV_J|$$

POSTERIOR PROBABILITY OF MEMBERSHIP IN EACH FAILED:

$$PR(J|X) = EXP(-.5 \, D_J^2(X)) \, / \, SUM_K \, EXP(-.5 \, D_K^2(X))$$

NUMBER OF OBSERVATIONS AND PERCENTS CLASSIFIED INTO FAILED:

FROM FAILED	NO	YES	TOTAL
NO	18	8	26
	69.23	30.77	100.00
YES	5	37	42
	11.90	88.10	100.00
TOTAL	23	45	68
PERCENT	33.82	66.18	100.00
PRIORS	0.5000	0.5000	

SAS 11
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS

FAILED	FREQUENCY	PRIOR PROBABILITY
NO	21	0.50000000
YES	18	0.50000000
TOTAL	39	1.00000000

WARNING: 2 OF THE 41 OBSERVATIONS WILL NOT BE INCLUDED IN THE ANALYSIS DUE TO MISSING VALUES.

SAS 12
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS SIMPLE STATISTICS

FAILED = NO

VARIABLE	N	SUM	MEAN	VARIANCE	STANDARD DEVIATION
EOFS	21	15.34700000	0.73080952	0.06844276	0.26161568
EIFS	21	23.13900000	1.10185714	0.04004343	0.20010854

FAILED = YES

EOFS	18	9.98400000	0.55466667	0.00699224	0.08361959
EIFS	18	19.48400000	1.08244444	0.00989626	0.09947995

SAS 13
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS WITHIN COVARIANCE MATRIX INFORMATION

FAILED	COVARIANCE MATRIX RANK	NATURAL LOG OF DETERMINANT OF THE COVARIANCE MATRIX
NO	2	-6.29110096
YES	2	-9.67059254
POOLED	2	-7.18759546

SAS 14
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS TEST OF HOMOGENEITY OF WITHIN COVARIANCE MATRICES

NOTATION: K = NUMBER OF GROUPS

P = NUMBER OF VARIABLES

N = TOTAL NUMBER OF OBSERVATIONS

N(I) = NUMBER OF OBSERVATIONS IN THE I'TH GROUP

$$V = \frac{\prod |\text{WITHIN SS MATRIX}(I)|^{N(I)/2}}{|\text{POOLED SS MATRIX}|^{N/2}}$$

$$RHO = 1.0 - \left[\text{SUM} \frac{1}{N(I)-1} - \frac{1}{N-K} \right] \frac{2P^2 + 3P - 1}{6(P+1)(K-1)}$$

$$DF = .5(K-1)P(P+1)$$

UNDER NULL HYPOTHESIS: $-2\ RHO\ LN \left[\frac{N^{PN/2}\ V}{\prod N(I)^{PN(I)/2}} \right]$

IS DISTRIBUTED APPROXIMATELY AS CHI-SQUARE(DF)

TEST CHI-SQUARE VALUE = 24.34006875
WITH 3 DF PROB > CHI-SQ = 0.0001

SINCE THE CHI-SQUARE VALUE IS SIGNIFICANT AT THE 0.2000 LEVEL,
THE WITHIN COVARIANCE MATRICES WILL BE USED IN
THE DISCRIMINANT FUNCTION.

REFERENCE: KENDALL,M.G. AND A.STUART
THE ADVANCED THEORY OF STATISTICS VOL.3 P266 & 282.

SAS 15
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS PAIRWISE SQUARED GENERALIZED DISTANCES BETWEEN GROUPS

$$D^2(I|J) = (\bar{X}_I - \bar{X}_J)' \, COV_J^{-1} \, (\bar{X}_I - \bar{X}_J) + LN\ |COV_J|$$

GENERALIZED SQUARED DISTANCE TO FAILED

FROM FAILED	NO	YES
NO	-6.29110096	-5.03109148
YES	-5.71659155	-9.67059254

SAS 1(

STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS CLASSIFICATION RESULTS FOR CALIBRATION DATA: WORK.TEMI

GENERALIZED SQUARED DISTANCE FUNCTION:

$$D_J^2(X) = (X-\bar{X}_J)' \, COV_J^{-1} \, (X-\bar{X}_J) + LN \, |COV_J|$$

POSTERIOR PROBABILITY OF MEMBERSHIP IN EACH FAILED:

$$PR(J|X) = EXP(-.5 \, D_J^2(X)) \, / \, SUM_K \, EXP(-.5 \, D_K^2(X))$$

POSTERIOR PROBABILITY OF MEMBERSHIP IN FAILED:

OBS	FROM FAILED	CLASSIFIED INTO FAILED		NO	YES
1	NO	NO		0.9567	0.0433
2	NO	NO		1.0000	0.0000
3	NO	NO		0.9999	0.0001
5	NO	NO		0.8053	0.1947
6	NO	YES	*	0.2209	0.7791
7	NO	YES	*	0.1223	0.8777
8	NO	NO		0.9986	0.0014
9	NO	YES	*	0.1393	0.8607
10	NO	YES	*	0.1928	0.8072
11	NO	NO		0.7707	0.2293
12	NO	YES	*	0.2009	0.7991
13	NO	NO		0.8188	0.1812
14	NO	NO		0.9995	0.0005
15	NO	NO		1.0000	0.0000
16	NO	NO		0.9988	0.0012
17	NO	NO		0.9997	0.0003
19	NO	NO		0.9669	0.0331
20	NO	YES	*	0.2025	0.7975
21	NO	NO		0.5816	0.4184
22	NO	YES	*	0.2626	0.7374
23	NO	YES	*	0.2590	0.7410
24	YES	YES		0.1293	0.8707
25	YES	YES		0.3596	0.6404
26	YES	YES		0.1532	0.8468
27	YES	YES		0.1264	0.8736
28	YES	YES		0.1805	0.8195
29	YES	YES		0.1376	0.8624
30	YES	YES		0.2885	0.7115
31	YES	YES		0.4855	0.5145
32	YES	YES		0.2165	0.7835
33	YES	YES		0.1395	0.8605
34	YES	YES		0.1967	0.8033
35	YES	YES		0.1467	0.8533
36	YES	YES		0.1454	0.8546
37	YES	NO	*	0.6081	0.3919
38	YES	YES		0.2108	0.7892
39	YES	YES		0.1317	0.8683
40	YES	YES		0.2236	0.7764

SAS 17
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS CLASSIFICATION RESULTS FOR CALIBRATION DATA: WORK.TEMP

POSTERIOR PROBABILITY OF MEMBERSHIP IN FAILED:

OBS	FROM FAILED	CLASSIFIED INTO FAILED		NO	YES
41	YES	NO	*	0.5473	0.4527

* MISCLASSIFIED OBSERVATION

SAS 18
STR_RATE=10_3 TEMP=-20

DISCRIMINANT ANALYSIS CLASSIFICATION SUMMARY FOR CALIBRATION DATA: WORK.TEMP

GENERALIZED SQUARED DISTANCE FUNCTION:

$$D_J^2(X) = (X-\bar{X}_J)' \, COV_J^{-1} \, (X-\bar{X}_J) + LN \, |COV_J|$$

POSTERIOR PROBABILITY OF MEMBERSHIP IN EACH FAILED:

$$PR(J|X) = EXP(-.5 \, D_J^2(X)) \, / \, SUM_K \, EXP(-.5 \, D_K^2(X))$$

NUMBER OF OBSERVATIONS AND PERCENTS CLASSIFIED INTO FAILED:

FROM FAILED	NO	YES	TOTAL
NO	13	8	21
	61.90	38.10	100.00
YES	2	16	18
	11.11	88.89	100.00
TOTAL	15	24	39
PERCENT	38.46	61.54	100.00
PRIORS	0.5000	0.5000	

APPENDIX 13

RATIO OF RESIDUAL TO PEAK STRESS BY TEMP AND STRAIN RATE 2

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: RATIO

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	9.19887052	3.06629017	157.12
ERROR	161	3.14192094	0.01951504	PR > F
CORRECTED TOTAL	164	12.34079147		0.0001

R-SQUARE	C.V.	STD DEV	RATIO MEAN
0.745404	28.2442	0.13969623	0.49460184

SOURCE	DF	TYPE I SS	F VALUE	PR > F
STR_RATE	1	9.14786325	468.76	0.0001
TEMP	1	0.05099883	2.61	0.1079
STR_RATE*TEMP	1	0.00000843	0.00	0.9834

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
STR_RATE	1	7.91404413	405.54	0.0001
TEMP	1	0.04679985	2.40	0.1234
STR_RATE*TEMP	1	0.00000843	0.00	0.9834

1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
---------- STR_RATE=10_3 TEMP=- 5 ----------						
EIFS	68	1.02485294	0.20176159	0.71800000	2.03000000	0.02446719
---------- STR_RATE=10_3 TEMP=-20 ----------						
EIFS	40	1.10482500	0.17502335	0.70900000	1.57000000	0.02767362
---------- STR_RATE=10_5 TEMP=- 5 ----------						
EIFS	71	0.74014085	0.25364228	0.35000000	1.66000000	0.03010180
---------- STR_RATE=10_5 TEMP=-20 ----------						
EIFS	41	0.89029268	0.24721956	0.50000000	2.00000000	0.03860921

3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: EIFS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	2	4.38269888	2.19134944	43.49
ERROR	217	10.93321910	0.05038350	PR > F
CORRECTED TOTAL	219	15.31591798		0.0001

R-SQUARE	C.V.	STD DEV	EIFS MEAN
0.286153	24.3338	0.22446269	0.92243182

SOURCE	DF	TYPE I SS	F VALUE	PR > F
STR_RATE	1	3.69864035	73.41	0.0001
TEMP	1	0.68405853	13.58	0.0003

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
STR_RATE	1	3.68440540	73.13	0.0001
TEMP	1	0.68405853	13.58	0.0003

EFFECT OF CRYSTAL STRUCTURE ON INITIAL TANGENT MODULIS 1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
STR_RATE=10_3 CRYSTL=1						
EIFS	1	0.86800000	.	0.86800000	0.86800000	.
STR_RATE=10_3 CRYSTL=2A						
EIFS	8	1.25100000	0.08577046	1.14800000	1.43000000	0.03032444
STR_RATE=10_3 CRYSTL=2C						
EIFS	1	0.87600000	.	0.87600000	0.87600000	.
STR_RATE=10_3 CRYSTL=3						
EIFS	5	1.25660000	0.43801005	0.97300000	2.03000000	0.19588405
STR_RATE=10_3 CRYSTL=3A						
EIFS	2	0.88900000	0.24183052	0.71800000	1.06000000	0.17100000
STR_RATE=10_3 CRYSTL=3B						
EIFS	1	1.05000000	.	1.05000000	1.05000000	.
STR_RATE=10_5 CRYSTL=1						
EIFS	3	0.80400000	0	0.80400000	0.80400000	0
STR_RATE=10_5 CRYSTL=2A						
EIFS	6	1.13766667	0.20161514	0.91600000	1.50000000	0.08230904
STR_RATE=10_5 CRYSTL=2B						
EIFS	1	0.59200000	.	0.59200000	0.59200000	.
STR_RATE=10_5 CRYSTL=2C						
EIFS	1	0.90800000	.	0.90800000	0.90800000	.
STR_RATE=10_5 CRYSTL=3						
EIFS	2	0.61900000	0.13576450	0.52300000	0.71500000	0.09600000
STR_RATE=10_5 CRYSTL=3A						
EIFS	1	0.42500000	.	0.42500000	0.42500000	.
STR_RATE=10_5 CRYSTL=3B						
EIFS	2	0.67500000	0.15839192	0.56300000	0.78700000	0.11200000

APPENDIX 14

EFFECT OF CRYSTAL STRUCTURE ON INITIAL TANGENT MODULIS 1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
STR_RATE=10_3 CRYSTL=1						
EIFS	1	0.86800000	.	0.86800000	0.86800000	.
STR_RATE=10_3 CRYSTL=2A						
EIFS	8	1.25100000	0.08577046	1.14800000	1.43000000	0.03032444
STR_RATE=10_3 CRYSTL=2C						
EIFS	1	0.87600000	.	0.87600000	0.87600000	.
STR_RATE=10_3 CRYSTL=3						
EIFS	5	1.25660000	0.43801005	0.97300000	2.03000000	0.19588405
STR_RATE=10_3 CRYSTL=3A						
EIFS	2	0.88900000	0.24183052	0.71800000	1.06000000	0.17100000
STR_RATE=10_3 CRYSTL=3B						
EIFS	1	1.05000000	.	1.05000000	1.05000000	.
STR_RATE=10_5 CRYSTL=1						
EIFS	3	0.80400000	0	0.80400000	0.80400000	0
STR_RATE=10_5 CRYSTL=2A						
EIFS	6	1.13766667	0.20161514	0.91600000	1.50000000	0.08230904
STR_RATE=10_5 CRYSTL=2B						
EIFS	1	0.59200000	.	0.59200000	0.59200000	.
STR_RATE=10_5 CRYSTL=2C						
EIFS	1	0.90800000	.	0.90800000	0.90800000	.
STR_RATE=10_5 CRYSTL=3						
EIFS	2	0.61900000	0.13576450	0.52300000	0.71500000	0.09600000
STR_RATE=10_5 CRYSTL=3A						
EIFS	1	0.42500000	.	0.42500000	0.42500000	.
STR_RATE=10_5 CRYSTL=3B						
EIFS	2	0.67500000	0.15839192	0.56300000	0.78700000	0.11200000

APPENDIX 15

EFFECT OF CRYSTAL STRUCTURE ON INITIAL TANGENT MODULIS 2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
STR_RATE=10_3						
EIFS	18	1.15905556	0.27814310	0.71800000	2.03000000	0.0655589
STR_RATE=10_5						
EIFS	16	0.85943750	0.27889352	0.42500000	1.50000000	0.0697233

EFFECT OF CRYSTAL STRUCTURE ON INITIAL TANGENT MODULIS 2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
STR_RATE=10_3						
EIFS	18	1.15905556	0.27814310	0.71800000	2.03000000	0.0655589
STR_RATE=10_5						
EIFS	16	0.85943750	0.27889352	0.42500000	1.50000000	0.0697233