❖ Statistical rock fabric characterization

Rock fabric is the term used to describe the innumerable small discontinuities which dissect the rock mass. This may include joints, bedding joints, foliation, small scale faults, etc (Figure M1). Because of the large number of small features, rock fabric should be dealt with statistically. This implies that the collection of the data representing the rock fabric must be done in a statistically rigorous fashion.

Rock fabric data can be collected from outcrop mapping, wall mapping (surface or underground), and oriented core, with data collection techniques being relatively simple. However, **<u>if the sampling procedure is not well thought out, the data collected may be at best misleading and at worst, worthless</u>**. As stated before, sampling must be done using statistically correct methods. Biases are inherent in two dimensional collection of three dimensional data. These can invalidate much of the collection effort. In addition, sample locations must be chosen so as to render a valid sample. For example, if silicified zones in a limestone unit are the resistant units forming outcrop, the data collected from these would be biased. These would be the strongest units, and not representative for design purposes.

The object with fabric data reduction is to distill a large number of observations regarding individual rock joints into its essence. In other words, the parameters which succinctly describe the critical discontinuity spatial characteristics for design must be found and described.

Rock fabric data is difficult to reduce. We are attempting to describe the results of a three dimensional fracture process that varies as a function of the generating stresses, lithology, nearby major geologic structures, etc. Each fabric set has a different history of generation, including outside influences. These outside influences include nearby joints in the rock mass generated at some earlier stage in time. Even the shape of the discontinuities is not known for certain. At times they are polyhedrons, at times circular or elliptical, at times combinations of both. We then complicate the entire estimation process by only sampling traces of these fractures in two-dimensional space.

While fabric data can be reduced to such a point that it can be utilized for rock mechanics designs - and in doing so provide reasonable results - it will never provide an exact reproduction of what is occurring in the rock mass. Simply too many variables exist.

➢ Discontinuity spatial characteristics

Rock fabric data is reduced in such a fashion as to describe distributions for what are called "discontinuity spatial characteristics". This is a rather fancy way of saying that statistical distributions of each joint set's geometric properties are required to generate a model of joints in three-dimensions. The "spatial characteristics" of tradition are:

- Orientation;
- Length, and;
- Spacing

These will be further complimented here by three additional parameters:

- Trace center density;
- Center density, and;
- Joint shape

Orientation models

Structures in a specific orientation have been created, at some point in time, by a specific stress field. These structures, in a similar lithology, hopefully exhibiting similar strengths throughout, will have similar spatial characteristics. In other words, a set or family of structures will be created which have similar length, spacing, and joint center densities. As the features are orientation dependent, it seems reasonable to segregate the field mapping data based on orientation characteristics. The methodology utilized by Ursa Engineering to segregate and describe discontinuity sets is given as Figure M2.

Reduced fabric data

The completed fabric data reduction process is generally depicted in a diagram similar to that given as Figure M3. Note that the statistics given provide information on orientation parameters, center density, continuity, roughness (both large and small scale), etc. Any value that can be of import to a design in the specific rock mass may be included. For example, if the design was fabric infill critical, then statistics representing the mineralogical infill would be presented by discontinuity family as well.

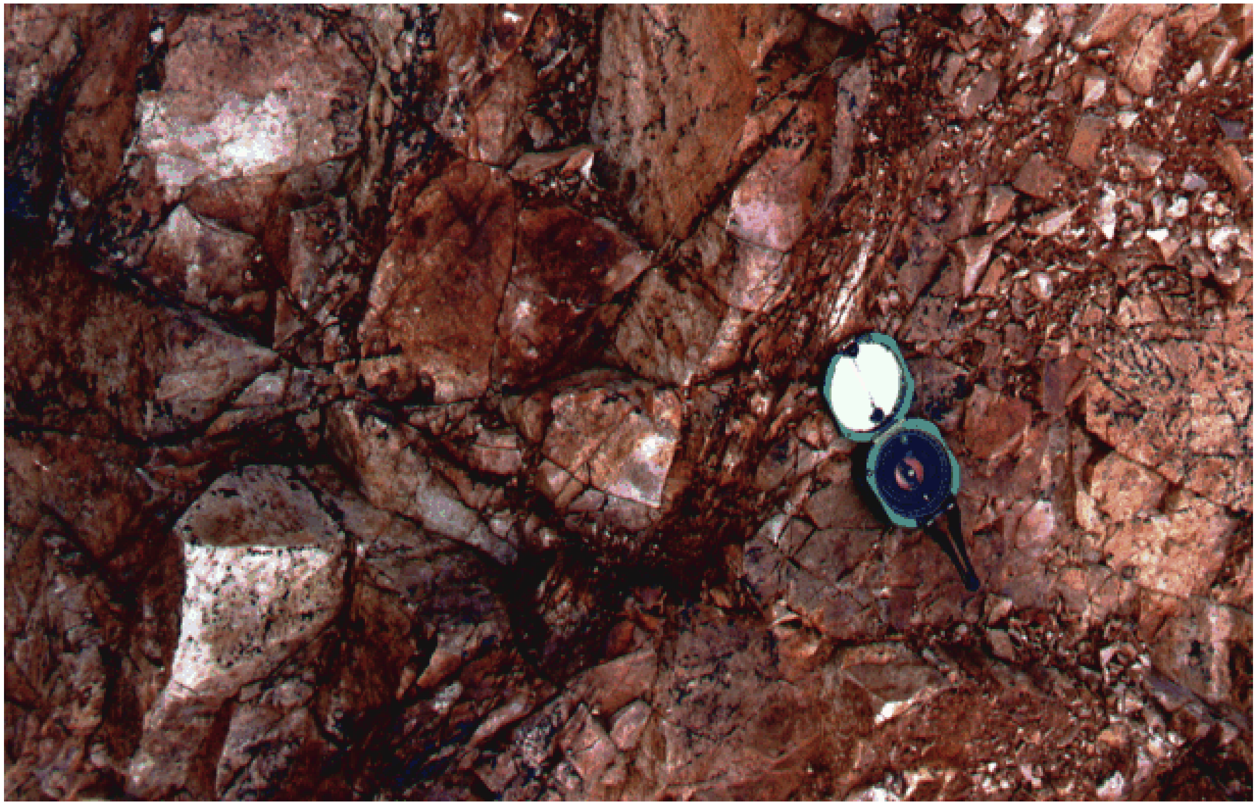
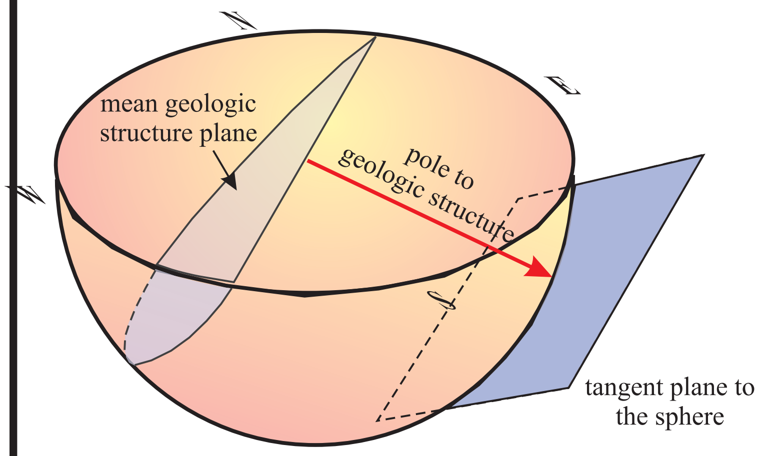
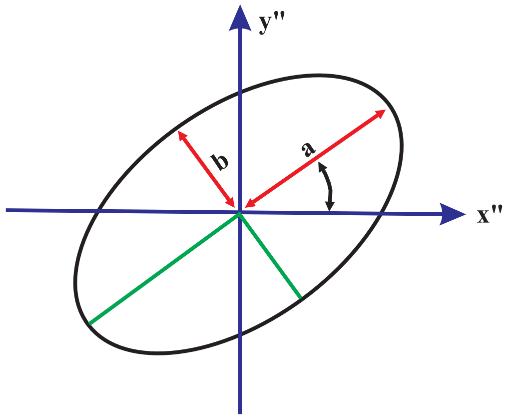


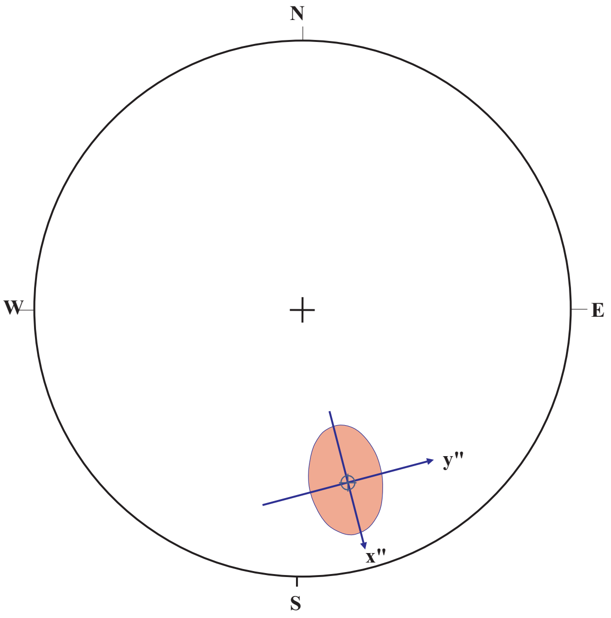
FIGURE M1



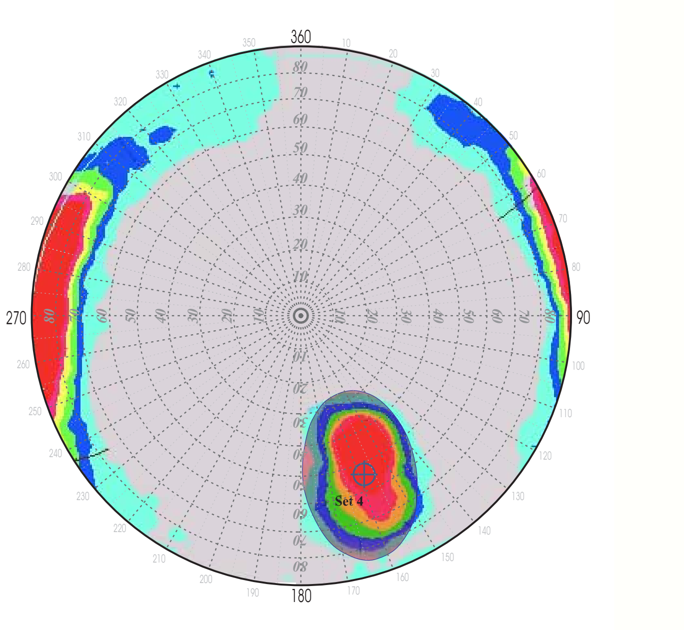
Schematic view of Schmidt lower hemisphere and the tangent plane to the sphere



Coordinate convention on the tangent plane to the sphere. Note the rotation angle



Bivariate normal distribution confidence interval on the tangent plane to the sphere, as tranformed to planar stereonet view.

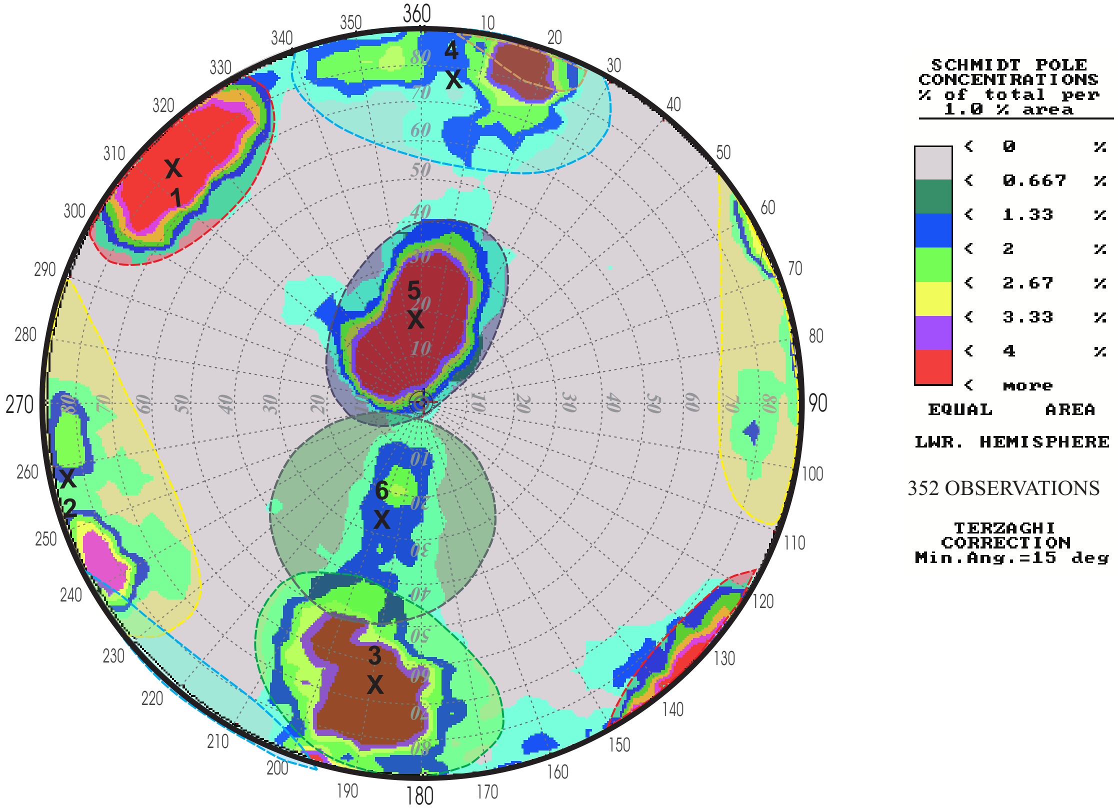


Approximate confidence interval as seen for design

FIGURE M2

JOINT SET STATISTICS

							Joint length		Joint center density		Joint Spacing		NGI
Set No.	Dip Direction	Dip	No.	Sigma Max	Sigma Min	Omega	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean
1	134	81	38	1.45E-01	1.42E-01	54.727	4.3	2.3	0.021	0.015	0.57	0.60	9.8
2	79	85	28	2.78E-01	1.68E-01	124	5.2	4.1	0.011	0.066	0.95	1.10	11.1
3	9	65	49	1.94E-01	1.32E-01	41.298	5.1	2.5	0.150	0.210	0.67	1.60	15.2
4	186	78	24	2.18E-01	1.69E-01	63.695	1.3	0.5	0.270	0.210	1.70	1.10	7.1
5	174	19	109	6.03E-02	3.82E-02	141.817	4.2	2.3	0.100	0.110	0.40	0.19	4.2



This lower hemisphere stereonet has been created for the purpose of illustrating the data reduction process for bench face design..

FIGURE M3

URSA ENGINEERING

(888) 412-5901