[AMERICAN JOURNAL OF SCIENCE, VOL. 250, AUGUST 1952, PP. 586-593]

A GRAPHIC TESTING PROCEDURE FOR POINT DIAGRAMS

INGEMAR LARSSON

ABSTRACT. A graphic test is described as a means of showing the change in distribution of petrofabric or other data plotted on the Schmidt net with increasing number of measurements.

CHAYES (1949) gives in *Structural Petrology of Deformed Rocks* (Fairbairn, 1949) a discussion of the collection and statistical treatment of the analysis of three-dimensional fabric diagrams. He shows in several tests the possibility of getting a statistical significance for theories built on petrofabric data. Also Pincus (1951) discusses statistical analysis of the data of point diagrams. By using the methods discussed by these authors, it is possible to get a mathematical estimation of the amount of security in conclusions collected from petrofabric data.

For practical geological work the present author has tried a graphic method of control for petrofabric work. The amount of security is here only visually controlled by the changeability of curves representing different numbers of measurements. The author is conscious of the fact that by this graphic method the security cannot be exactly estimated, but for many problems the exactitude reached by this graphic method is sufficient.

The method is being employed on petrofabric work in a coastal gneiss in Blekinge, southern Sweden. Thin sections are made perpendicular to B-axis, and biotite diagrams are plotted on the Schmidt net after Sander (1930, 1948 and 1950). The idea

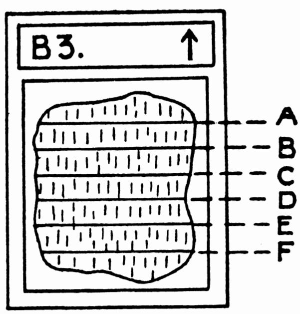

Fig. 1. Biotite poles in the rock-fabric are measured along parallel lines perpendicular to anisotropy. For each line a part-diagram is plotted.

of the method is to see if the distribution of the position of crystals plotted on the diagram changes with increasing number of measurements.

The poles of the biotite crystals (perpendiculars to (001)) are measured in the fabric along lines, each representing a zone visible in the microscope (fig. 1). The poles measured along each line are plotted in one diagram. The measuring lines are all parallel, equally spaced, and perpendicular to possible anisotropy.

Now the problem rises if the distribution of the position of poles in the first part-diagram A is the same as in the first and the second together, A+B, or as in A+B+C and so on. To investigate that, the distribution of the position of poles by this graphic method is represented by curves. One curve for part-diagram A = the distribution of 59 biotite poles, one for part-diagrams A+B = 112 poles, one for A+B+C = 165 poles and so on. The investigation runs as follows.

After plotting the biotite poles on the diagram it is divided into 18 sectors, 20 degrees in each (fig. 2). The poles in each sector are counted. The numbers are put into a table where the

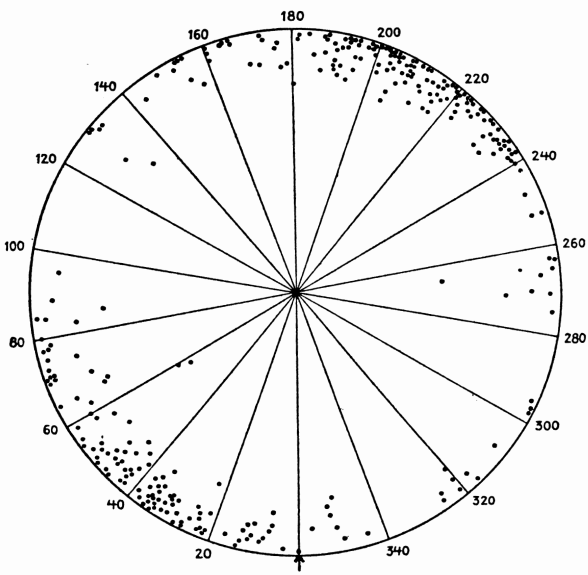

Fig. 2. Poles of biotite plotted on the Schmidt net. The diagram is divided into 20° sectors and is the sum of part-diagrams. It is an illustration and is only principally to be applied to table 1.

"ordinate" represents the 20° sectors and the "abscissa" part-diagrams A, B, C and so on. The number of poles in each part-diagram is given below the "abscissa" (table 1).

TABLE 1

Distribution of poles divided in part-diagrams and 20° sectors. From a gneiss in Blekinge, Sweden.

Sector	Number of poles					
340-360°	1	1	2	2	..	..
320-340	2	..	..	..	..	..
300-320	2	..	..	2	1	1
280-300	2	1	..	..	..	..
260-280	4	1	..	2	..	1
240-260	..	6	..	1	1	..
220-240	8	7	4	5	6	3
200-220	10	7	11	13	7	10
180-200	7	6	6	8	6	5
160-180	1	0	2	2	2	6
140-160	1	2	3	2	..	3
120-140	..	1	..	..	3	2
100-120	..	..	..	2	..	..
80-100	1	..	2	..	2	1
60-80	3	1	6	7	3	1
40-60	5	8	5	3	8	7
20-40	8	9	8	6	5	5
0-20	4	3	4	4	..	..
Part-diagram	A	B	C	D	E	F
Total	59	53	53	59	44	45 = 313.

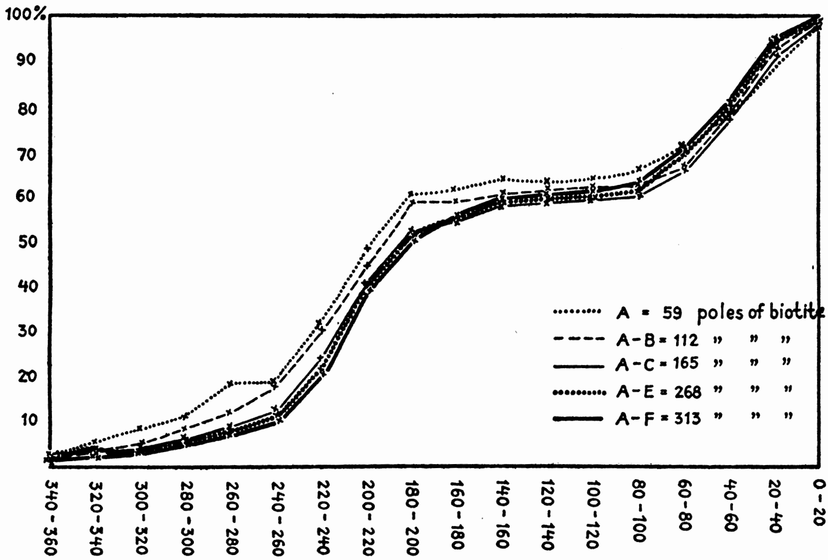

Fig. 8. Cumulative curves drawn from table 3, showing the change of the distribution of poles by increasing number.

Table 2 shows in the same manner the distribution in part-diagram A (59 poles), A+B (112 poles), A+B+C (165 poles), A+B+C+D+E (268 poles) and A+B+C+D+E +F (313 poles).

TABLE 2

Sector	Number of poles				
340-360°	1	2	4	6	6
320-340	2	2	2	2	2
300-320	2	2	2	5	6
280-300	2	3	3	3	3
260-280	4	5	5	7	8
240-260	..	6	6	8	8
220-240	8	15	19	30	33
200-220	10	17	28	48	58
180-200	7	13	19	33	38
160-180	1	1	8	7	18
140-160	1	3	6	8	11
120-140	..	1	1	4	6
100-120	..	..	..	2	2
80-100	1	1	3	5	6
60-80	3	4	10	20	21
40-60	5	13	18	29	36
20-40	8	17	25	36	41
0-20	4	7	11	15	15
Part-diagram	A	A-B	A-C	A-E	A-F
Total	59	112	165	268	313

TABLE 3

The same distribution as in table 2, but in per cent

Sector	Number of poles in per cent				
340-360°	2	2	2	2	2
320-340	3	2	1	1	1
300-320	3	2	1	2	2
280-300	3	3	2	1	1
260-280	7	4	3	3	2
240-260	..	5	4	3	2
220-240	14	13	12	11	11
200-220	17	15	17	18	19
180-200	12	12	12	12	12
160-180	2	1	2	3	4
140-160	2	3	4	3	4
120-140	..	1	1	1	2
100-120	..	..	..	1	1
80-100	2	1	2	2	2
60-80	5	4	6	7	7
40-60	8	12	11	11	12
20-40	14	15	15	13	13
0-20	7	6	7	6	5
Part-diagram	A	A-B	A-C	A-E	A-F
Total	101	101	102	100	102*
Number of poles	59	112	165	268	313

* The deviation from 100% results from the reduction of the decimal fractions to whole numbers.

In order to be able to compare the distributions with increasing number of poles, table 2 is recalculated in per cent (table 3).

From the distribution of poles in table 3, cumulative curves are drawn in figure 3. The curve A represents the distribution of biotite poles after the measurement of 59 biotite poles. A-B gives the distribution of 112 poles and so on. It is natural that the curves A (59 poles) and A-B (112 poles) are more erratic than the others. It is also easy to see that all curves from A-C (165 poles) to A-F (313 poles) are practically identical. The conclusion will be that in this case it is enough to measure 165 poles of biotite. Further measurements will not change the distribution.

The present author has found it practical to draw such curves besides making the microscopical observations.

In this case the poles of the diagram are of peripheral distribution. If the poles are spread over the whole Schmidt net it may perhaps be practical to divide the net into two parts by one or more concentric circles. This makes it possible to control any change appearing in the distribution in the direction from periphery to center.

This method of control is also available for other geological work, for instance, for structural analysis and tectonical work.

It has always been a problem how many measurements are needed to get a significant picture of all joints and other fracture planes which appear in a quarry. The graphic test can be useful for such an investigation and can be made coincident with the measurements.

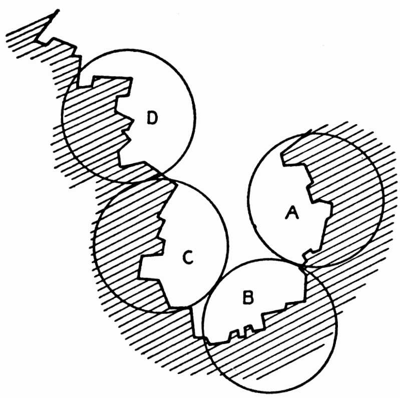

Fig. 4. A quarry in coastal gneiss in Blekinge, Sweden, divided into four parts. For each a part-diagram of the fracture planes is plotted.

It is convenient to divide the measurements of the fracture planes in a quarry into some parts, in this case 4 (fig. 4), and plot their poles on as many part-diagrams. In table 4, the fracture planes of a quarry in a coastal gneiss in Blekinge, Sweden, are described.

TABLE 4

The poles of the fracture planes in figure 4. The table is made in the same way as tables 1, 2 and 3

Sector	Number of poles								Number of poles in per cent			
340-360°	1	3	2	..	1	4	6	6	3	6	6	5
320-340	1	10	5	7	1	11	16	23	3	17	17	18
300-320	1	3	3	5	1	4	7	12	3	6	7	9
280-300	4	5	6	7	4	9	15	22	13	14	16	17
260-280	2	1	2	1	2	3	5	6	6	5	5	5
240-260	1	2	2	..	1	3	5	5	3	5	5	4
220-240	1	2	3	2	1	3	6	8	3	5	6	6
200-220	7	1	2	4	7	8	10	14	22	13	10	11
180-200	1	3	2	2	1	4	6	8	3	6	6	6
160-180	4	..	3	..	4	4	7	7	13	6	7	5
140-160	2	..	1	..	2	2	3	3	6	3	3	2
120-140	4	..	..	..	4	4	4	4	13	6	4	3
100-120	..	..	..	1	..	..	..	1	..	..	..	1
80-100	2	..	..	..	2	2	2	2	6	3	2	2
60-80	1	1	1	..	1	2	3	3	3	3	3	2
40-60	..	..	..	1	..	..	..	1	..	..	..	1
20-40	..	1	..	4	..	1	1	5	..	2	1	4
0-20	..	..	..	..	..	..	..	..	..	..	..	..
Part-diagram	A	B	C	D	A	A-B	A-C	A-D	A	A-B	A-C	A-D
Total	32	32	32	34	32	64	96	130	100	100	98	101*

* The deviation from 100% results from the reduction of the decimal fractions to whole numbers.

From the distribution of poles in per cent cumulative curves are drawn in figure 5. The four curves represent 32, 64, 96 and 130 poles of fracture planes. The curve containing 32 measurements shows a very divergent course. Probably the distribution here is determined by chance. But after 64, or better after 96 measurements, the chance seems to be eliminated. No greater change in the distribution of poles will appear with further measurements.

Figure 6 shows another quarry in the same rock. After 105 poles the curves are practically identical.

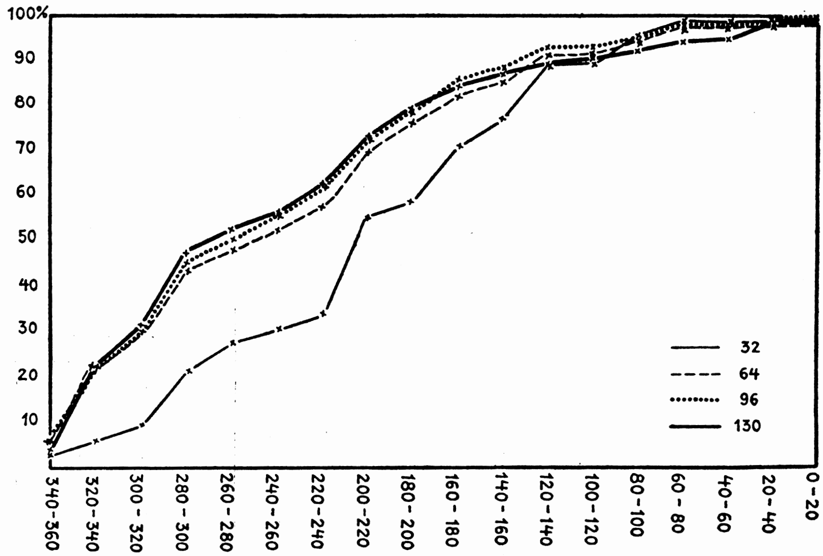

Fig. 5. Cumulative curves drawn from table 4, showing the change in the distribution of fracture planes by increasing number of measurments.

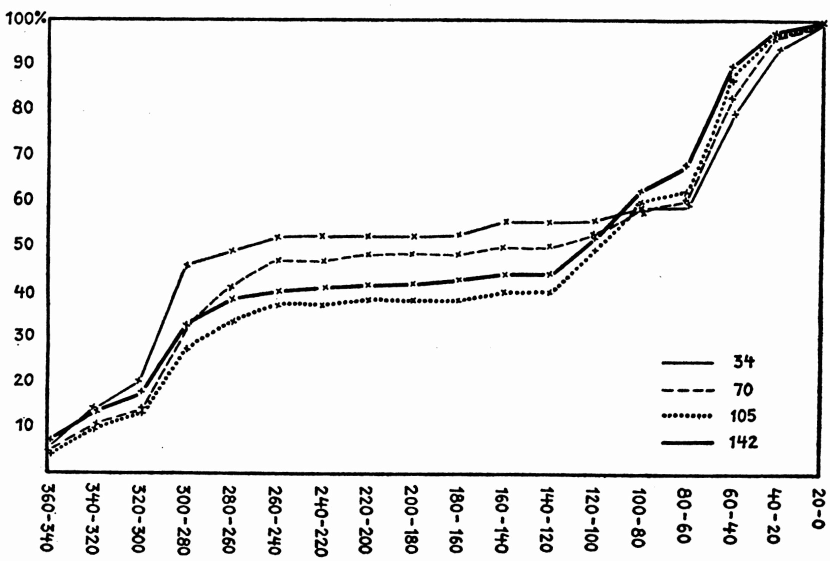

Fig. 6. Curves of the same type as in figure 5. From another quarry in the same rock.

Some critical remarks must be made. The present author has already in the introduction announced that the graphic test cannot give an exact mathematical knowledge of the amount of measurements needed for full significance at a certain security. If such criterion is needed, the papers of Chayes (1949) and Pincus (1951) may be referred to. The graphic test gives only a visual idea of the same thing. The curves are only tests of the distribution and except for that not specially practical for common geological work.

In conclusion the author may remark, in order not to be misunderstood, that in explaining his graphic method he never enters the discussion whether a single thin-section is representative of a whole rock or not. That seems to him quite another problem. The author is only dealing with the problem if the measurements in one rock-fabric are significant or not.

References

Chayes, F., 1949. *In* Fairbairn, H. W., Structural petrology of deformed rocks, Addison-Wesley Press, Inc., Cambridge, Mass.

Pincus, H. J., 1951. Statistical methods applied to the study of rock fractures: Geol. Soc. America Bull., vol. 62, pp. 81-130.

Sander, Bruno, 1930. Gefügekunde der Gesteine, Springer, Vienna.

———, 1948. Einführung in die Gefügekunde der geologischen Körper, I, Springer, Vienna and Innsbruck.

———, 1950. Einführung in die Gefügekunde der geologischen Körper, II, Springer, Vienna and Innsbruck.

Geographical Institute
Lund, Sweden