



Fig. 3. Geometrical relations showing position of a grain with respect to rock slice necessary for reflection conditions to exist and the possible positions of the a-axis of the grain. See text for further explanation.

others, is designated as ϕ^3 and is found in the table of strong reflections of figure 2. The relations between the poles to any two planes in a crystal structure are easily determined by simple trigonometry if the cell dimensions are known.⁴

Since the planes contributing to the strong intensity of the 211 peak must lie parallel to the sample surface (i.e. rock slice surface) we conclude that the a-axes whose orientations are related to the strong 211 reflection must lie at an angle of $24^\circ 45'$ to both the normal to 211 and the normal to the rock section. However, these 211 planes cannot be restricted to any one position about their own normals so that all we know so far is that this group of a-axes lies on a cone about the normal to 211. These relations are illustrated in figure 3 for one particular olivine grain of the appropriate orientation. When this cone (of half-angle $\phi = 24^\circ 45'$) intersects the lower hemisphere of the spherical projection in an orientation fixed by the attitude of the rock section with respect to the primitive circle (= section A) it creates a small-circle. This small-circle is projected from the lower hemisphere to the plane of the stereographic projection as a true circle. The small-circle of ϕ -angle $24^\circ 45'$ is labeled 2 (fig. 2C).

The diffraction pattern for rock slice F was examined, and it was found that three peaks were very strong relative to the powder peaks and all had ³ ϕ is here defined as the angle between normals to crystallographic planes and crystallographic axes.

⁴ Except for the cubic system where only the indices are needed to determine ϕ .

ϕ -angles of similar magnitude. For example 133 is 3.2 times as strong as that of the powder pattern. The same geometrical relations apply here as for the case above except that the rock slice F has a different orientation. The resulting small-circle (10, fig. 2C) intersects the 211 small-circle in two places.

Similar construction of small-circles corresponding to strong reflections from planes lying parallel to rock slices A and G yield the remaining arcs of figure 2C. It is immediately apparent that there is a zone of intersections in the lower right-hand quadrant of the figure. When *all* of the strong reflections are used from the patterns obtained from the seven rock sections of figure 2A the restriction of intersections to this zone is even more remarkable. Of the fifteen recorded reflections that have an intensity of 2 times the powder value, or higher, only one lies outside of the region shown by the dashed line of figure 2C.

It is apparent from the x-ray (and optical) data that the dunite contains an a-axis point maximum. Yet a routine procedure such as that outlined above would be impractical from two standpoints: (1) the time-consuming nature of the constructions, and (2) the difficulty in describing the complete fabric anisotropy except for cases of point maxima.

Accordingly in order to generalize the technique it is necessary to standardize the number and orientation of the rock slices from the sample, and one such arrangement is that of figure 2A. Furthermore, for any one mineral the ϕ -angles are constant, and there are usually a sufficient number of crystallographic planes in the structure to obtain ϕ -angles from 15° to 90° . From this a net can be constructed composed of small-circles of varying ϕ -angle concentric about each of the four sections inclined 45° to A (fig. 2A). The resulting "small-circle net" is seen in figure 4 (in this example one for *calcite*). Note the four zones of concentric circles centered about the poles to the four inclined rock sections. It should also be pointed out that, because of the symmetry of this net, the intersections at the periphery of the net cannot be used. The width of this peripheral zone for a 20 cm diameter net would be approximately 1 cm. Therefore, in diagram D, plate 1; diagram D, plate 2; and diagram D, plate 3, the contours of the diagram have been extrapolated outward to the periphery.

In order to establish the position of any point on the stereographic projection that might correspond to a maximum, one is required to use intersections of three or more small-circles. In this respect the method is similar to the "three drill core" problem of structural geology. Thus the practical aspects of deriving a petrofabric diagram based on x-ray data consist of (1) assigning intensity values⁵ to the small-circles, (2) summing these values up at intersections of three or more small-circles, taking the averages, and plotting the values at the intersections, and (3) contouring over the entire net the values obtained.

The technique cannot be considered rigorous for the reason that false maxima can occur wherever small circles intersect at more than one place on the net. This situation is more readily visualized, and probably becomes more critical, when the orientation of grain becomes very perfect (i.e., when the grain aggregate approximates a single crystal).

⁵ Ratios of rock-section intensity to powder intensity for every reflection used.