

## FURTHER NOTES ON CRYSTAL DRAWING

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## 1. GEOMETRICAL BASIS OF GOLDSCHMIDT'S METHOD

The orthogonal projection or plan of a crystal is a projection upon the gnomonic projection-plane from an eye-point considered as at an infinite distance, vertically above the crystal. Now a crystal edge, regarded as the axis of a zone, appears in gnomonic projection as the *central* of the zone (see p. 73), which is a line perpendicular to the zone line thru the center of the projection. Such a line, however, will be unchanged in direction if viewed from the stated direction; hence the rule: The direction of the edge between two faces in orthogonal projection is normal to the zone line containing the poles of the faces in gnomonic projection.

The orthogonal projection on the base brings out most clearly the relations and symmetry of the terminal faces of the crystal. But since the prism faces are projected as lines much of the relief of the solid is lost. It is therefore customary to make a perspective drawing which may be regarded as an orthogonal projection of the crystal upon a plane inclined at some chosen angle to the horizontal plane of the gnomonic projection. Experience and custom have established the rule that this chosen plane (we will call it the figure-plane) shall be normal to a line of sight, which is raised about ten degrees above the horizontal and deviates to the right of the front and back direction of the crystal about twenty degrees. It is to be noted, however, that this is an arbitrary position and in what follows nothing precludes the placing of the figure-plane in any position whatever. Its position is fixed by drawing in the gnomonic projection a straight line representing the trace or line of intersection of the chosen figure-plane with the gnomonic projection plane. The figure-plane is assumed to pass thru the center of the sphere of projection; its trace is called the guide-line, the standard position of which is shown in the figures illustrating the preceding article.

Goldschmidt's method of drawing solves the following problem: To find from the gnomonic projection of two face-poles the direction of their edge after being projected orthogonally upon the figure-plane and then transferred into the plane of the drawing. The proof and figures here given follow Boeke (*Gnom. Proj.*, p. 43.)

In the perspective Fig. 22 let  $F'$  and  $G'$  be two face-poles,  $Z'$  the zone which they define, and  $F$ ,  $G$ , and  $Z$  the gnomonic projection of the same;  $L'$  is the figure-plane with the trace  $LL$  in the gnomonic projection. The line  $SS'M$  is the line of inter-

section of the planes  $Z'$  and  $L'$ . The actual direction of the edge  $FG$  is shown by the line  $P'M$ , the zone axis of  $Z'$ , drawn thru  $M$  perpendicular to  $Z'$ .  $P'M$  is projected orthogonally on  $L'$  in the line  $MQ'$  by making  $P'Q'$  normal to  $L'$ . Then line  $SS'M$  is perpendicular to  $MQ'$  for  $S'M$  is perpendicular to  $P'M$  and also to  $P'Q'$  and therefore to  $MQ'$ .

We wish to find the direction of  $MQ'$  when transferred to the plane of the drawing. This we do by letting  $L'$ , the figure-plane, rotate about its trace  $LL$  as axis until it reaches the horizontal plane.  $S$ , the point of intersection of  $Z$  and  $L$  is the gnomonic projection of  $S'$  and is not shifted by this rotation of  $L'$ ;  $M$ , the center of the sphere, wanders to  $W$ , the angle-point of line  $LL$

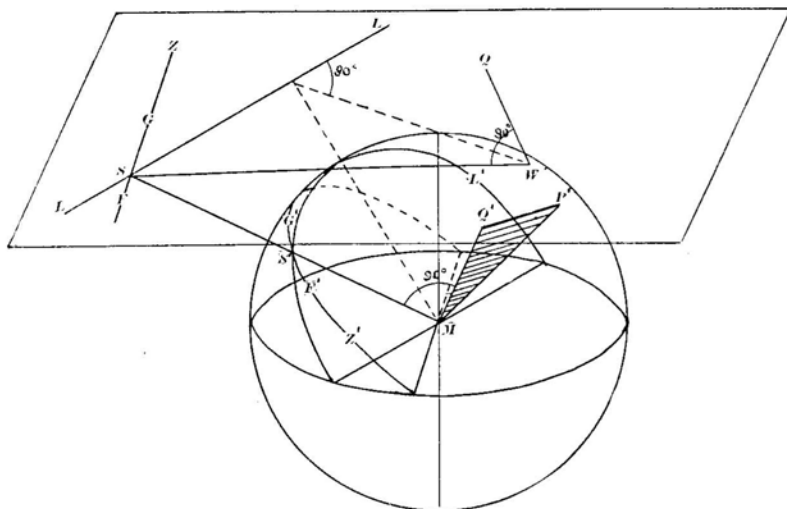


FIG. 22.

(p. 73). Therefore if we connect  $S$  and  $W$  we have the direction of  $SS'M$  when transferred to the horizontal plane.  $MQ'$  will still be perpendicular to this direction  $SW$  since  $MQ'$  lies in the plane  $L'$  which is rotated.  $WQ'$ , perpendicular to  $SW$ , will therefore be the desired direction of the edge  $FG$ .

For the prism zone  $S$  lies at infinity;  $SW$  is therefore parallel to the guide-line and the desired direction of the prism edge is normal to the guide-line.

Hence the rule: to find the direction of an edge between two faces in a parallel-perspective drawing, given the guide-line and its angle-point; find the intersection of the zone-line containing the two face-poles with the guide-line; connect it with the angle-point by a straight line; a perpendicular to this line will be the desired direction of the edge.

## 2. RELATION BETWEEN THE ORTHOGONAL AND THE PERSPECTIVE PROJECTIONS

In Fig. 23 let the solid  $abcdef$  be a prism with inclined base the edges of which are perpendicular to the plane  $P$ . Let  $a'b'c'$  be the orthogonal projection on  $P$ ; and let  $a''b''c''d''e''f''$  be the orthogonal projection on a plane  $Q$  inclined to  $P$ . The plane  $a''aa'$  contains the projection  $a''d''$  and is perpendicular to the line of intersection of the two planes,  $AB$ .  $P$  may be regarded as the plane of gnomonic projection,  $Q$  as the figure-plane,  $AB$  as the guide-line of the preceding figure. If we rotate  $Q$  about  $AB$  into the plane  $P$ ,  $a''d''$  will come to lie upon a normal from  $a'$  to the guide-line. Since the same will be true for each edge of the solid we have the rule: Each point of the orthogonal

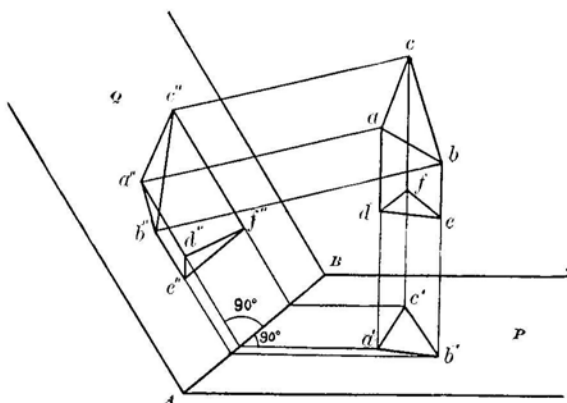


FIG. 23.

drawing corresponds to a point of the perspective drawing along a line normal to the guide-line. The use of this relation has been fully illustrated in the preceding paper.

### 3. DRAWING IN POSITIONS OTHER THAN NORMAL

In the preceding paper are given instructions for drawing parallel perspective figures in the normal position and for slight adjustments of this position to increase the clearness of the resulting figure. These rules may be applied directly to positions widely departing from the normal providing the appropriate change is first made in the position of the guide-line and its angle-point. For instance in Miss Porter's figure of vesuvianite on page 90, the orthogonal projection having been drawn, a projection normal to the plane (100) (the face numbered 3) will be obtained if the line thru  $O$  perpendicular to  $AB$  is taken as guide-line, in which case the point  $B$  will be the angle-point. Similarly a projection normal to (010) would have as guide-line

AB, whose angle-point is the extremity of the diameter perpendicular to AB. Each of these two figures will be related to the orthogonal projection on the base in the same way as shown in the drawing for the parallel-perspective figure.

## AN AMERICAN OCCURRENCE OF SARCOPSIDE

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In 1868 M. Websky published a description of a new mineral, which he named sarcopside.<sup>1</sup> It occurred under a thin covering of vivianite in a pegmatite dike intruding a gneiss formation, near Michelsdorf in the Eulengebirge, Silesia, associated with hureaulite. This has been regarded, however, by Dana and others as closely related to, if not an impure variety of, triplite, and specific rank has not been assigned to it.

A recent examination of a mineral found in Deering, N.H., in 1916, led the author to believe it to be sarcopside, with which it agreed closely in blowpipe and physical properties. A quantitative analysis of this mineral was therefore made, which not only confirmed this belief, but also indicated that it actually represents an independent species.

This first American occurrence (the second known for the mineral) is in a small pegmatite dike, cutting a gray schist composed of sillimanite, muscovite and garnet. This dike has been prospected for mica, and it was on the dump that two small specimens of sarcopside (approximately 3 x 3 x 2 cm. and 2 x 2 x 1 cm.) were found. The pegmatite was composed largely of orthoclase and quartz, with opaque apple-green beryl, black tourmaline, large plates of muscovite and flakes of biotite, and rather large opaque red garnets. No other phosphates than sarcopside were noted, altho no exhaustive search was made.

Sarcopside is a mineral of fibrous appearance, occurring in irregular slab-like masses. It has a distinct cleavage approximately perpendicular to the fibers, and another less distinct, parallel to the fibers. The fibers extended continuously across the specimens at hand. The fracture is splintery to fibrous.  $H. = 4$ . Sp. Gr. = 3.64, (average of five determinations on the Jolly balance; Websky gives sp. gr. = 3.69-3.73). Luster silky and glistening. Color, when unaltered, flesh-red to lavender; altering on exposure to blue, green, or brown. Translucent in thin splinters. Streak light straw yellow. Alters quite easily on surface to a material resembling and perhaps identical with "blue vivianite."

The optical properties of sarcopside have not been previously recorded, and it was thought essential, to confirm its specific

<sup>1</sup> *Z. Deutsche Geol. Ges.*, 20, 245, 1868.