Cheyenne Canyon near St. Peter's Dome, El Paso County, Colo., and he finds that the unit cell measurements of the two correspond.

REFERENCES

GLASS, J. J., AND ADAMS, J. W. (1953), Genthelvite crystal from El Paso County, Colorado: *Am. Mineral.*, **38,** 858–860.

STEVEN, T. A. (1949), Geology and fluorspar deposits of the St. Peter's Dome district, Colorado: *Colo. Sci. Soc. Proc.*, **15,** no. 6, 259–284.

THE CRYSTALLOGRAPHY OF CERITE

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In a recent note (Glass, Evans, Carron and Rose, 1956) the crystallography of the rare earth silicate, cerite, from the Mountain Pass district of California has been described as monoclinic with cell dimensions $a=17.81$, $b=10.85$, $c=14.10$ Å, $\beta=109°\ 10'$, and space group $I2/n$ or In. During the course of investigations of some rare earth silicates, the present author has examined a number of cerite specimens from the Mountain Pass and other localities. It has been found that all specimens are trigonal with slightly variable cell dimensions $a\sim10.8$, $c\sim37.7$ Å and probable space group $P312$, $P31m$ or $P\bar{3}1m$, etc. There is, however, a marked pseudocell in which the c-axis length is halved, giving a pseudo-space group $R32$, $R3m$ or $R\bar{3}m$; the true primitive cell is denoted by weak reflexions midway between the strong 19 Å layer lines on c-axis oscillation photographs.

It is of interest to see how these conflicting observations may be reconciled. Obviously the monoclinic b-axis is identical with the trigonal a-axis (i.e., $b_M=a_T$). If the trigonal description is correct it requires that in the (010) section of the monoclinic reciprocal net (Fig. 1) there shall exist two perpendicular row lines, along one of which the repeat distance is a_T^* and along the other the repeat is c_T^*; this latter direction must be a triad symmetry axis. The angle $201_M \wedge \bar{1}01_M$ is exactly 90° and the dimensions are such that the 201_M face normal is the direction of a_T^* and the $\bar{1}01_M$ face normal is the direction of c_T^* (Fig. 1). The trigonal character of the $\bar{1}01_M$ direction may be confirmed by suitable x-ray photographs. Although the body-centered monoclinic description of the cerite lattice may be reconciled with a trigonal cell of the correct dimensions, it implies that the true lattice is not primitive but rhombohedral. In the present work, no detailed examination of the Mountain Pass cerite was

made; the poor quality single crystals obtained were used only to confirm the general features of the diffraction pattern known from the examination of cerites from other localities. The primitive character of the trigonal lattice was demonstrated by indexing oscillation photo-

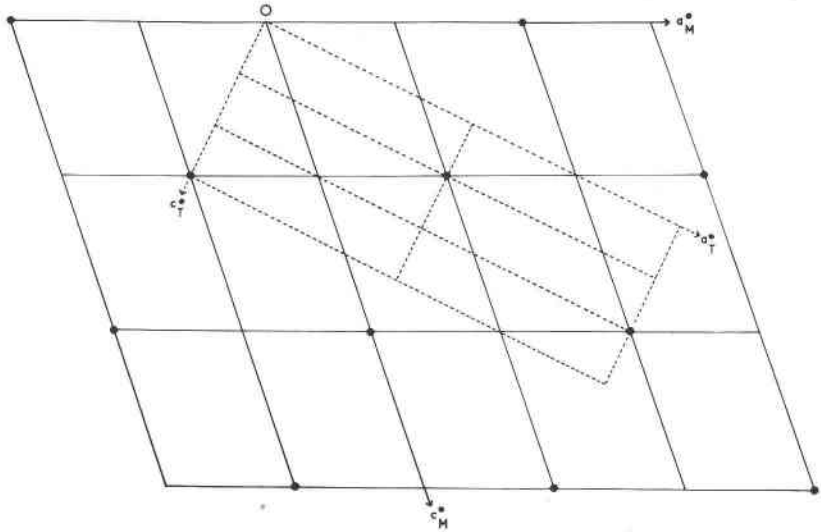

FIG. 1. (010) section of the monoclinic reciprocal net. Full lines denote the monoclinic lattice, dotted lines the trigonal lattice.

graphs of Swedish specimens. Nevertheless, it seems probable that the moving film methods employed by Glass *et al.* allowed the observation of only some of the weak true cell reflexions, whilst those denoting the primitive cell of the Mountain Pass specimen were undetected. The "octahedral" habit of the Mountain Pass cerite was ascribed by Glass *et al.* to the combination of the forms $\{100\}_M$, $\{011\}_M$ and $\{\bar{1}01\}_M$. These forms are plotted for holosymmetric monoclinic symmetry on the stereogram in Fig. 2. If this stereogram is rotated into the conventional trigonal orientation (i.e., with $\bar{1}01_M$ at the center of the projection), it can be seen that this "octahedral" habit is due to the relative development of the $\{0001\}$ pinacoid and the $\{\bar{1}012\}$ rhombohedron.

In the present work, cerite has always appeared optically uniaxial; it seems likely that the slight biaxial character recorded by Glass *et al.* must be regarded as anomalous. A new chemical analysis upon a cerite from Bastnäs, Sweden, has been carried out. This suggests a formula $(Ca, Ln)_3\ Si_2\ (O, OH, F)_9$, where Ln = lanthanon rare earths, with 20 or

21 formula units in the cell. The large cell dimensions prevent the unambiguous determination of Z.

Goddard and Glass (1940) suggested the existence of a series of cerites with variable lime contents. Some evidence in support of this suggestion

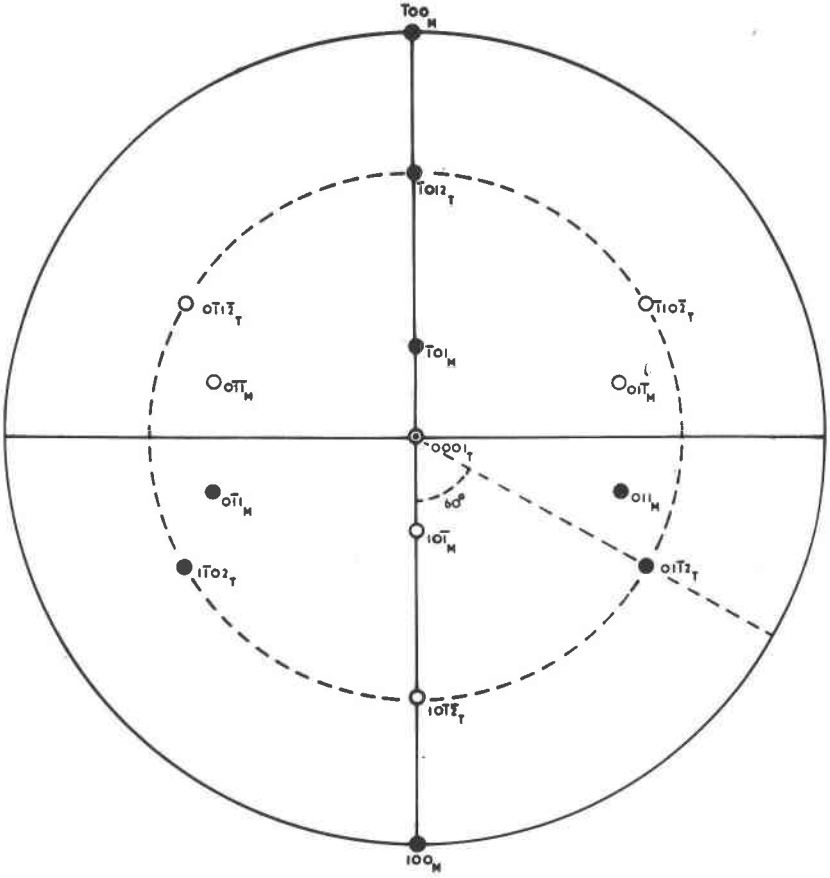

FIG. 2. Stereogram showing forms comprising the "octahedral" cerite crystals from Mountain Pass, California. Faces with subscript M denote position of monoclinic forms; faces with subscript T denote the positions of these poles after rotation of $\bar{1}01_M$ to the centre of the projection.

has been obtained. Apart from small cell dimension changes, the diffraction patterns from specimens from Bastnäs, Sweden, and Jamestown, Colorado, U. S. are similar except that the weak true cell reflexions are about twice as strong for the latter; chemically, the Colorado specimen

contains approximately twice as much CaO as the Bastnäs material. Thus, it might be expected that the hypothetical CaO-free cerite would have a rhombohedral lattice with $c\sim18$–19 Å; the doubled c-axis of the primitive cell becomes more clearly developed as the lime content of the cerite increases. The effect of this lime content may be further studied by examination of the minerals lessingite and beckelite, which can be regarded chemically as lime-rich members of the cerite series. It is found that these two minerals have a structure different from that of cerite. Their diffraction patterns are very similar to each other and to that of the phosphorus-bearing mineral britholite, and indicate a structure dimensionally comparable with apatite. For a hexagonal cell, the dimensions are $a\sim9.7$ Å, $c\sim7.1$ Å, with probable space group $P6_3$ or $P6_3/m$. An idealized formula $(Ca, Ln \cdots)_2$ (Si, Al, P) $(O, OH, F)_5$ is proposed for this series. Marked biaxial properties observed in some specimens suggest that the structure may be truly orthorhombic, with only a very close dimensional approximation to a hexagonal cell.

A full account of the work on these minerals, together with data for stillwellite, an unrelated silicate of the rare earths with boron, will be given in a paper to be published elsewhere.

The specimen of cerite from Mountain Pass, California, was kindly provided by Miss Jewell J. Glass (U. S. Geological Survey).

References

Glass, Jewell J., Evans, Howard T., Carron, M. K., and Rose, Harry (1956). Cerite from Mountain Pass, San Bernardino County, California: *Am. Mineral.*, **41**, 665.

Goddard, Edwin N., and Glass, Jewell J. (1940), Deposits of radio-active cerite near Jamestown, Colorado: *Am. Mineral.*, **25**, 381–404.

LINEATION PROTRACTOR*

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A practical transparent protractor that is simple and easy to use has been designed to show relationships between lineation and the containing s-plane. The instrument consists of a standard 180° protractor to which has been added s-plane dip curves and a movable plunge indicator arm. The values for plotting the s-plane dip curves were derived from the formulas given in a paper by Ingerson and Tuttle (1943).

The protractor makes possible a quick solution of any one of the 4 variables when 3 are known. For example, in practice the strike and dip

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