# SHORTER COMMUNICATIONS

## COMPLEX SILVER ORES FROM MOREY, NEVADA: A CORRECTION


SIDNEY A. WILLIAMS AND FRANK B. MILLETT, JR.

*Western Exploration Office, Phelps Dodge Corporation, Douglas, Arizona*


Recomputation of the angle table for diaphorite in a recent paper by Williams (1968) in this journal has disclosed a large number of errors. The data referred to are in Table 1 of the paper "Complex Silver Ores from Morey, Nevada". No errors were found in Tables 2 and 3. A corrected version of the table is presented below.

TABLE 1. CRYSTALLOGRAPHIC DATA FOR DIAPHORITE

$a{:}b{:}c = 2.6900{:}1{:}3.0172$ $\beta = 116°27'$ $p_0{:}q_0{:}r_0{:}1.1216{:}2.7012{:}1$
$r_2{:}p_2{:}q_2 = 0.3702{:}0.4152{:}1$ $\mu = 63°33'$ $p'_0 = 1.2529$
$q'_0 = 3.0172$ $x'_0 = 0.4977$ Monoclinic $2/m$

| | old | new | $\phi$ | $\rho$ | $\phi_2$ | $B$ | $C$ | $A$ |
|---|---|---|---|---|---|---|---|---|
| *b* | 010 | 001 | 90°00′ | 26°27′ | 63°33′ | 90°00′ | 0°00′ | 63°33′ |
| *c* | 001 | 010 | 0 00 | 90 00 | — | 0 00 | 90 00 | 90 00 |
| *m* | 110 | 100 | 90 00 | 90 00 | 0 00 | 90 00 | 63 33 | 0 00 |
| *y* | 221 | 210 | 39 42 | 90 00 | 0 00 | 39 42 | 73 28 | 50 18 |
| *w* | 081 | 014 | 33 24 | 42 6 | 63 33 | 55 58 | 34 2 | 68 20 |
| $\pi$ | 130 | 101 | 90 00 | 60 16 | 29 44 | 90 00 | 33 49 | 29 44 |
| $\pi$ | $\bar{1}30$ | $\bar{1}02$ | −90 00 | 7 21 | 97 21 | 90 00 | 33 48 | 97 21 |
| *m* | $\bar{1}10$ | $\bar{1}01$ | −90 00 | 37 4 | 127 4 | 90 00 | 63 31 | 127 4 |
| *a* | $\bar{1}00$ | $\bar{2}01$ | −90 00 | 63 32 | 153 32 | 90 00 | 89 59 | 153 32 |
| | 531 | $51\bar{1}$ | 62 23 | 98 44 | −9 50 | 62 44 | 75 17 | 28 52 |
| *y* | $\bar{2}21$ | $\bar{2}12$ | −26 36 | 59 21 | 127 4 | 39 43 | 73 27 | 112 39 |
| | $\bar{4}01$ | $\bar{4}12$ | −53 5 | 68 17 | 153 32 | 56 5 | 89 59 | 137 58 |

The unusually large number of errors arose from failure to transform one of the gnomonic elements (Zepharovich to Hellner). Not all of the errors were thus systematic, however. A few were typographical and some were ordinary careless errors.

Computation of angle tables is a laborious task and it is dismayingly easy to make mistakes during the process. Interfacial angles are particularly susceptible to error since they are normally computed from angles of the first setting.

The angle table is a useful tool for the morphological crystallographer. Unusual settings can be quickly identified by their aid, or indexing can be accomplished without resetting the crystal. Nothing is learned by computing these angles, however, and an easier method would be welcome indeed.

A new approach to producing monoclinic angle tables has been devised. The method has two great advantages. All six angles normally given in the angle table are treated as independent variables—mistakes in computation of first setting angles do not carry over into interfacial angles. Another advantage is that angles may be readily calculated from every form, regardless of the signs of $h$, $k$, and $l$.

Figure 1 shows the monoclinic system of crystal axes; a plane $(hkl)$

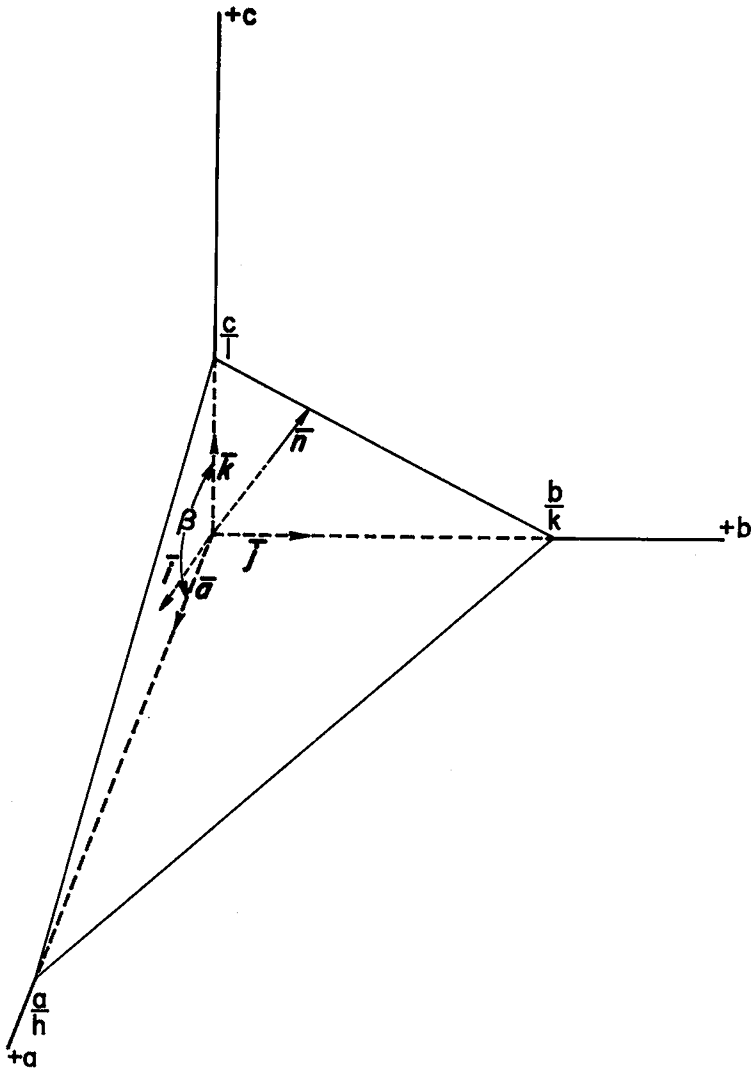


FIG. 1. Monoclinic axial system showing vector notation employed.

cutting axes $a,b,c$ at $a/h$, $b/k$, $c/l$ respectively; unit orthogonal vectors $\mathbf{i,j,k}$; a unit vector ($\mathbf{a}$) along the $a$-axis; and a unit vector ($\mathbf{n}$) normal to the plane.

Vector $\mathbf{a}$ is defined, in terms of orthogonal vectors $\mathbf{i}$ and $\mathbf{k}$, as

$$\mathbf{a} = \text{Sin}\,\beta\mathbf{i} + \text{Cos}\,\beta\mathbf{k}$$

and the unit normal $\mathbf{n}$ may be written as

$$\mathbf{n} = \frac{[hcb - lab\,\text{Cos}\,\beta]\mathbf{i} + [kac\,\text{Sin}\,\beta]\mathbf{j} + [lab\,\text{Sin}\,\beta]\mathbf{k}}{\sqrt{[hcb - lab\,\text{Cos}\,\beta]^2 + [kac\,\text{Sin}\,\beta]^2 + [lab\,\text{Sin}\,\beta]^2}}$$

Using the definition of the scalar product the angle $\theta$ between two vectors may be determined from

$$\text{Cos}\,\theta = \mathbf{n}_1 \cdot \mathbf{n}_2$$

where $\mathbf{n}_1$, and $\mathbf{n}_2$ are the unit vectors normal to the planes in question.

The cosine functions for the monoclinic system, shown in Table 2, were obtained from the above equations. The sine functions were calculated from a trigometric identity.

TABLE 2. EQUATIONS FOR FUNCTIONS OF ANGLES

| Angle | Functions | |
|---|---|---|
| $\phi$ | $\text{Cos}\,\phi = \dfrac{kac\,\text{Sin}\,\beta}{D_1}$ | $\text{Sin}\,\phi = \dfrac{hcb - lab\,\text{Cos}\,\beta}{D_1}$ |
| $\rho$ | $\text{Cos}\,\rho = \dfrac{lab\,\text{Sin}\,\beta}{R}$ | $\text{Sin}\,\rho = \dfrac{D_1}{R}$ |
| $\phi_2$ | $\text{Cos}\,\phi_2 = \dfrac{hcb - lab\,\text{Cos}\,\beta}{D_2}$ | $\text{Sin}\,\phi_2 = \dfrac{lab\,\text{Sin}\,\beta}{D_2}$ |
| $B$ | $\text{Cos}\,B = \dfrac{kac\,\text{Sin}\,\beta}{R}$ | $\text{Sin}\,B = \dfrac{D_2}{R}$ |
| $C$ | $\text{Cos}\,C = \dfrac{lab - hcb\,\text{Cos}\,\beta}{R}$ | $\text{Sin}\,C = \dfrac{c\,\text{Sin}\,\beta\sqrt{h^2b^2 + k^2a^2}}{R}$ |
| $A$ | $\text{Cos}\,A = \dfrac{hcb - lab\,\text{Cos}\,\beta}{R}$ | $\text{Sin}\,A = \dfrac{a\,\text{Sin}\,\beta\sqrt{k^2c^2 + l^2b^2}}{R}$ |

where $(D_1)^2 = [hcb - lab\,\text{Cos}\,\beta]^2 + [kac\,\text{Sin}\,\beta]^2$;
$(D_2)^2 = [hcb - lab\,\text{Cos}\,\beta]^2 + [lab\,\text{Sin}\,\beta]^2$;
$(R)^2 = [hcb - lab\,\text{Cos}\,\beta]^2 + [kac\,\text{Sin}\,\beta]^2 + [lab\,\text{Sin}\,\beta]^2$

We are grateful to William K. Meloy, Jr. for preparing the line drawing.

## REFERENCES

WILLIAMS, S. A. (1968): Complex Silver Ores from Morey, Nevada. *Can. Mineral.* **9**, 478.

*Manuscript submitted June 23, 1969*