# THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Vol. 52 MAY–JUNE, 1967 Nos. 5 and 6


## PENDLETONITE, A NEW HYDROCARBON MINERAL FROM CALIFORNIA


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ABSTRACT

Pendletonite, a new crystallized hydrocarbon, is described from a small mercury deposit near the New Idria Mine, San Benito County, California. It has been shown to be identical with the aromatic hydrocarbon compound *coronene* ($C_{24}H_{12}$) by microchemical analysis, melting point, ultraviolet absorption curve, X-ray powder pattern and unit-cell dimensions.

Pendletonite occurs intimately associated with cinnabar and quartz in seams and fissures. Grains are bladed to acicular in habit, rarely in well-formed crystals. Color, pale yellow; luster, vitreous (brilliant on fresh cleavages); hardness, less than one; flexible, almost plastic, but splinters very readily into fine fibers along three good cleavages; specific gravity, 1.35; melting point, 450°C.

Measurable crystals are monoclinic, elongated parallel to $b$, with (001) and (100) dominant, ($\bar{2}01$) less common (cleavage directions); rare terminal faces are (110) and (210).

Optically, biaxial positive dispersion extreme $v>r$; $2V_z$ 96° to 115°; $X=b$; $Z\wedge c=21°$; indices of refraction: $\gamma$ much above 1.85, $\beta$ 1.78, $\alpha$ 1.76.

X-ray data: unit cell, $a=16.25$, $b=4.638$, $c=10.42$ Å; $\beta=111°10'$. Strong powder lines and spacings: 9.44–10, 7.34–10, 3.96–4, 3.46–6, 3.03–4. Space Group $C_{2h}^4$, $P2/c$.


### INTRODUCTION

As early as 1912, specimens of a yellow prismatic mineral from the Picachos mercury mine south of New Idria in San Benito County, California, were submitted to A. F. Rogers of Stanford University for identification. He stated the mineral was valentinite, probably pseudomorphous after stibnite. Recently, collectors in this mine and in nearby prospects found similar crystals, which were submitted to the writer with a query as to their identity, as no antimony minerals have been found in this vicinity. Examination showed them to be a hydrocarbon compound, and more extensive investigation has shown that the material is a new mineral, identical with the known aromatic hydrocarbon "coronene", $C_{24}H_{12}$.

Identity of the two is proven by chemical analysis, ultraviolet absorp-

tion curves, X-ray data and crystal form. Mr. Forrest Cureton, who sent in the specimens, has asked that the mineral, if it turned out to be new, be named after Mr. Norman H. Pendleton, of Santa Cruz, California, who was apparently the first to suspect that the crystals were not valentinite. Accordingly the name "pendletonite" has been proposed, and has been approved by the Commission of New Minerals of the International Mineralogical Association.[1]

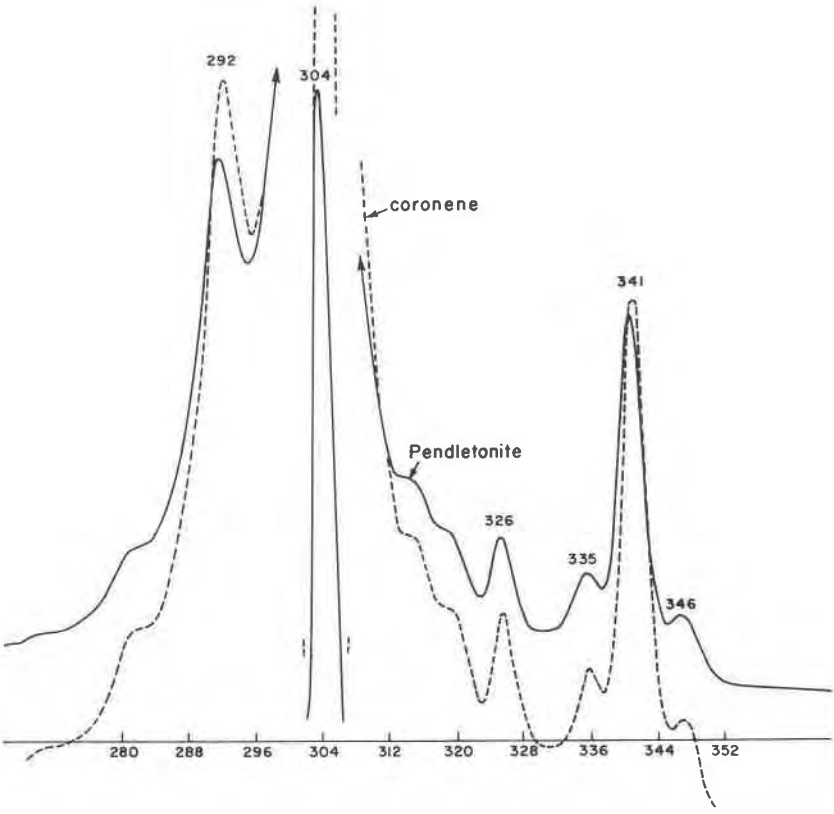


FIG. 1. Ultraviolet spectra, wavelength in nanometers.

The recent find was first made in a prospect trench just above the old Picachos and Fourth of July "mines", from both of which additional specimens have been collected. The exact locality is: E 1/2 of SE 1/4 of NW 1/4 of NE 1/4 S. 19, T. 18 S, R. 12 E, Mount Diablo B & M.

[1] A type specimen has been deposited with the U. S. National Museum, and the original collection is at the University of California, Los Angeles.

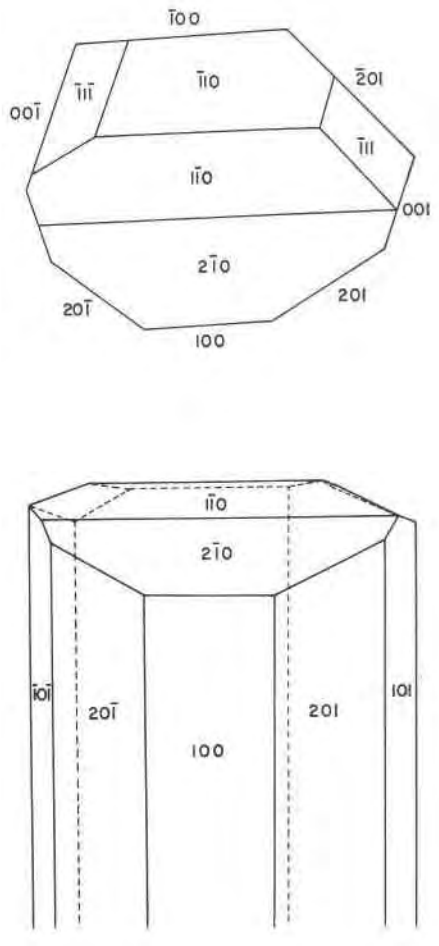


FIG. 2. Left termination typical crystal.

Pendletonite occurs sparingly as bladed aggregates, occasionally as single or clustered crystals, intimately associated with quartz and cinnabar, in veins in a silicified matrix. Single individuals may be as large as $10\times1\times1$ mm, but most are considerably smaller. It is essentially contemporaneous with quartz and cinnabar and has apparently been formed under identical conditions, so that it is presumably a low temperature hydrothermal mineral.

## PHYSICAL AND OPTICAL PROPERTIES

Pendletonite is pale yellow in color when fresh, but turns yellowish brown on the surface when exposed to the weather. Luster is vitreous,

brilliant on fresh cleavage surfaces. Hardness is under 1; flexible, almost plastic, so that undistorted crystals are difficult to obtain. Specific gravity, 1.35 determined by floating in Clerici solution (1.29, calculated from the unit cell, with $Z=2$). Cleavage is very perfect in three directions, (100), (001), ($\bar{2}$01), causing a finely splintery fracture on crushing. One cleavage, (001), is parallel to the dominantly broad surface and the other two, (100) and ($\bar{2}$01), are roughly symmetrical to an optic direction.

Optically, pendletonite is biaxial positive, with $\alpha$ 1.76, $\beta$ 1.78, and $\gamma$ well above 1.85. $2V_y = 96$–$115°$; dispersion extreme $v > r$; $X = b$; $Z \wedge c = 21°$.

## Chemistry

Pendletonite is completely and easily volatile, subliming to fine needles. It burns readily; is insoluble in acids but soluble in organic solvents. Microchemical analysis is as follows:

| | C | H | Melting point |
|---|---|---|---|
| Pendletonite | 96.04[1] | 4.04 | 450°C |
| $C_{24}H_{12}$ (Coronene) | 95.97 | 4.03 | 434–436°C |

[1] T. Stewart, analyst, Chemistry Department, University of California, Los Angeles.

The ultraviolet absorption spectra of pendletonite and coronene are shown to be identical (Fig. 1).

## Crystallography

Several crystals with good enough faces (Fig. 2) to give accurate readings were measured on the reflecting goniometer with the following results:

Monoclinic, prismatic parallel to $b$, with the crystals usually thin tabular parallel to (001). In the orthodome zone, (001) is dominant, (100) next in importance, and ($\bar{2}$01) often fair sized. Other forms, (201), ($\bar{3}$01), ($\bar{1}$01), are occasionally present as narrow faces, with still others as line faces, not always qualified for definite indexing. The terminal faces present, in the orientation chosen by Robertson and White, and followed by the writer, are: (110) and (210) common, with ($\bar{1}$11) occasional, and ($\bar{4}$11) rare. Observed angles agree very closely with calculated values, which are shown in the accompanying angle table (Table 1).

## X-Ray Study

Powder photographs match those of coronene very closely, and Table 2 shows their spacings and intensities. The spacings have been satis-

TABLE 1.—ANGLE TABLE

| Form | $\phi$ | $\rho$ | $\phi_2$ | $\rho_2$=B | A | C |
|---|---|---|---|---|---|---|
| 001 | 90° 00′ | 21° 10′ | 68° 50′ | 90° 00′ | 68° 50′ | 0° 0′ |
| 100 | 90 00 | 90 00 | 0 00 | 90 00 | 0 00 | 69 50 |
| 110 | 17 01½ | 90 00 | 0 00 | 17 01½ | 72 58½ | 83 56 |
| 210 | 31 28½ | 90 00 | 0 00 | 31 28½ | 58 31½ | 79 08 |
| 101[1] | 90 00 | 46 32½ | 43 27½ | 90 00 | 43 27½ | 25 22½ |
| 302[1] | 90 00 | 54 15½ | 35 44½ | 90 00 | 35 44½ | 33 05½ |
| 201 | 90 00 | 59 44 | 30 16 | 90 00 | 30 16 | 38 34 |
| $\bar{2}03$[1] | 90 00 | − 3 20 | 93 20 | 90 00 | 93 20 | 24 30 |
| $\bar{1}01$ | 90 00 | −16 42 | 106 42 | 90 00 | 106 42 | 37 52 |
| $\bar{5}03$[1] | 90 00 | −38 20 | 128 20 | 90 00 | 128 20 | 59 30 |
| $\bar{2}01$ | 90 00 | −43 30 | 133 30 | 90 00 | 133 30 | 64 40 |
| 301 | 90 00 | −58 16 | 148 16 | 90 00 | 148 16 | 79 26 |
| 221 | 21 33 | 77 58½ | 30 07 | 26 32 | 68 57 | 71 06 |
| $\bar{1}11$ | − 7 20½ | 65 33½ | 105 42 | 25 27½ | 96 48½ | 69 54 |
| $\bar{2}21$[1] | −12 16 | 77 23 | 133 30 | 17 32 | 101 58 | 82 36 |
| $\bar{4}11$ | −46 19 | 72 26½ | 156 22 | 48 49 | 133 35 | 88 09 |

($\bar{5}01$), ($\bar{6}01$), ($\bar{7}01$) and ($\bar{2}21$) also found as small faces in doubtful position.

Monoclinic prismatic $a:b:c=3.5028:1:2.1825$ $\beta$ 111° 10′ $\mu=68°$ 50′ $p_o:q_o:r_o=0.6231:2.035:1$ $r_2:p_2:q_2=0.4913:0.3061:1$ $p_o'=0.6681$ $q_o'=2.1825$ $e_o'=0.3872$.

[1] Always narrow.

factorily indexed down to 1.245 Å. Single crystal values, from rotation and layer line photographs, agree with morphological measurements, and show pendletonite to be monoclinic prismatic; space group $C_2h^4$, $P2/c$. Cell dimensions are in essential agreement with other determinations on coronene.

| | $a$ | $b$ | $c$ | $\beta$ |
|---|---|---|---|---|
| Murdoch | 16.246 | 4.638 | 10.12 | 111°10′ |
| Robertson & White | 16.10 | 4.695 | 10.15 | 110°48′ |
| Ruston & Rüdorff | 16.10 | 4.685 | 10.06[1] | 111°12′ |

[1] Faint lines suggest doubling of $c$.

ACKNOWLEDGEMENTS

The writers are greatly obligated to their colleague at the University of California, Los Angles; Dr. John Christie, for determination of the optic orientation and of the values for the optic axial angle in monochromatic light, and Miss Heather King, who was responsible for superintending the microanalysis.

TABLE 2. X-RAY POWDER DATA CuK$\alpha$ RADIATION, Ni FILTER, $\lambda = 1.5418$ Å

| obs. | calc. | $I$ | $hkl$ | obs. | calc. | $I$ | $hkl$ |
|---|---|---|---|---|---|---|---|
| 9.50 | 9.44 | 10 | 001 | 2.425 | 2.437 | ½ | 404 |
| 7.43 | 7.57 | 10 | 200 | 2.273 | 2.283 | ½ | $\bar{1}15$ |
| | 7.342 | | 201 | | | | |
| | | | | 2.165 | 2.165 | ½ | 316 |
| 5.09 | 5.080 | 1 | $\bar{2}01$ | | | | |
| | | | | 2.055 | 2.053 | ½ | $\bar{2}04$ |
| 4.84 | 4.873 | 1 | 202 | | | | |
| | | | | 1.989 | 1.997 | 1 | $\bar{2}15$ |
| 4.41 | 4.435 | ½ | 110 | | 1.981 | | 317 |
| 3.96 | 3.956 | 4 | 210 | 1.945 | 1.952 | 1 | $\bar{6}02$ |
| | 3.921 | | 112 | | 1.930 | | $\bar{2}22$ |
| 3.76 | 3.788 | ½ | 400 | 1.895 | 1.897 | ½ | $\bar{3}14$ |
| | 3.763 | | $\bar{1}04$ | | 1.894 | | 800 |
| 3.64 | 3.671 | ½ | 402 | 1.806 | 1.810 | ½ | 318 |
| | | | | | 1.807 | | $\bar{3}21$ |
| 3.49 | 3.497 | 6 | 311 | | | | |
| | | | | 1.635 | 1.640 | ½ | $\bar{3}23$ |
| 3.38 | 3.383 | ½ | 310 | | | | |
| | | | | 1.603 | 1.609 | ½ | $\bar{4}21$ |
| 3.20 | 3.158 | ½ | 213 | | | | |
| | | | | 1.533 | 1.538 | ½ | 130 |
| 3.03 | 3.074 | 4 | $\bar{1}12$ | | | | |
| | 3.001 | | 403 | 1.507 | 1.509 | ½ | $\bar{1}31$ |
| 2.79 | 2.784 | ½ | $\bar{2}12$ | 1.370 | 1.370 | ½ | $\bar{2}33$ |
| 2.68 | 2.690 | ½ | 115 | 1.289 | 1.293 | ½ | 034 |
| 2.49 | 2.493 | ½ | $\bar{2}13$ | 1.245 | 1.246 | ½ | $\bar{4}26$ |

## REFERENCES

ROGERS, A. F. (1912) Notes on rare minerals from California. *Columbia Sch. Mines Quart.* **33,** 373–381.

ROBERTSON, J. M. AND J. G. WHITE, (1945) The crystal structure of coronene, a quantitative X-ray investigation. *J. Chem. Soc. London* **1945,** 607–617.

RUSTON, W. R. AND W. RÜDORFF, (1947) Sur la structure crystallographique du coronène. *Soc. Chem. Belgique, Bull.* **56,** 97–105.

*Manuscript received, July 5, 1966; accepted for publication, November 5, 1966.*