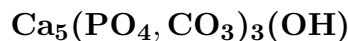


## Carbonate-hydroxylapatite



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**Crystal Data:** Hexagonal. *Point Group:* 6/*m*. Cryptocrystalline; as fibrous or laminated botryoidal crusts.

**Physical Properties:** *Cleavage:* Poor on {0001} and {10 $\bar{1}$ 0}. *Tenacity:* Brittle. Hardness = 5 D(meas.) = 2.9–3.2 D(calc.) = 2.87 (synthetic).

**Optical Properties:** Transparent to translucent. *Color:* Colorless, white, yellow, brown. *Luster:* Vitreous, earthy. *Optical Class:* Uniaxial (–).  $\omega = 1.603$   $\epsilon = 1.598$

**Cell Data:** *Space Group:*  $P6_3/m$  (synthetic).  $a = 9.309$   $c = 6.927$   $Z = 2$

**X-ray Powder Pattern:** Synthetic  $\text{Ca}_5(\text{PO}_4)_{1.5}\text{CO}_3)_{1.5}(\text{OH})$ . (ICDD 19-272). 2.78 (100), 2.68 (40), 3.46 (25), 2.231 (16), 1.929 (16), 1.838 (16), 3.04 (10)

### Chemistry:

|                                |       |
|--------------------------------|-------|
|                                | (1)   |
| SO <sub>3</sub>                | 0.45  |
| P <sub>2</sub> O <sub>5</sub>  | 38.7  |
| CO <sub>2</sub>                | 0.87  |
| SiO <sub>2</sub>               | 1.13  |
| La <sub>2</sub> O <sub>3</sub> | 0.14  |
| Ce <sub>2</sub> O <sub>3</sub> | 0.37  |
| CaO                            | 54.8  |
| SrO                            | 0.32  |
| F                              | 0.93  |
| Cl                             | 0.20  |
| OH                             | 2.42  |
| –O = (F, Cl, OH) <sub>2</sub>  | 1.57  |
| Total                          | 98.76 |

(1) The Kaiserstuhl, Germany; by electron microprobe and coulometric analysis, average of six analyses, (OH)<sup>1–</sup> calculated for stoichiometry; corresponding to  $(\text{Ca}_{4.97}\text{Sr}_{0.02}\text{Ce}_{0.01})_{\Sigma=5.00}[(\text{PO}_4)_{2.77}(\text{CO}_3)_{0.10}(\text{SiO}_2)_{0.10}(\text{SO}_3)_{0.03}]_{\Sigma=3.00}[(\text{OH})_{0.72}\text{F}_{0.25}\text{Cl}_{0.03}]_{\Sigma=1.00}$ .

**Mineral Group:** Apatite group.

**Occurrence:** As cement in phosphatic soils and bioclastic limestones. An accessory mineral in carbonatites and alkaline igneous rocks.

**Association:** Calcite.

**Distribution:** Carbonatian hydroxylapatite has been analyzed from many localities, although the species is not well-characterized, as the mechanism whereby carbonate is incorporated is controversial. At the Ødegården apatite mines, Bamble, Norway. From the Kaiserstuhl, Baden-Württemberg, Germany. Found on Tuvalu (Ellice Islands), central Pacific. At Phalaborwa, Transvaal, South Africa. From Magnet Cove, Hot Spring Co., Arkansas, USA.

**Name:** For a *carbonate-rich hydroxylapatite*.

**Type Material:** n.d.

**References:** (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 879–889. (2) Chang, L.L.Y., R.A. Howie, and J. Zussman (1996) Rock-forming minerals, (2nd edition), v. 5B, non-silicates, 297–334. (3) Sommerauer, J. and K. Katz-Lehnert (1985) A new partial substitution mechanism of  $\text{CO}_3^{2-}/\text{CO}_3\text{OH}^{3-}$  and  $\text{SiO}_4^4$  for the  $\text{PO}_4^{3-}$  group in hydroxyapatite from the Kaiserstuhl alkaline complex (SW-Germany). Contr. Mineral. Petrol., 91, 360–368.

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