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## Antipinite, $\text{KNa}_3\text{Cu}_2(\text{C}_2\text{O}_4)_4$ , a new mineral species from a guano deposit at Pabellón de Pica, Chile

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### ABSTRACT

The new oxalate mineral antipinite is found in a guano deposit located on the Pabellón de Pica Mountain, Iquique Province, Tarapacá Region, Chile. Associated minerals are halite, salmmonite, chanabayite, joannemite and clays. Antipinite occurs as blue, imperfect, short prismatic crystals up to 0.1 mm × 0.1 mm × 0.15 mm in size, as well as their clusters and random aggregates. The mineral is brittle. Mohs hardness is 2;  $D_{\text{meas}} = 2.53(3)$ ,  $D_{\text{calc}} = 2.549 \text{ g cm}^{-3}$ . The infrared spectrum shows the presence of oxalate anions and the absence of absorptions associated with  $\text{H}_2\text{O}$  molecules, C–H bonds,  $\text{CO}_3^{2-}$ ,  $\text{NO}_3^-$  and  $\text{OH}^-$  ions. Antipinite is optically biaxial ( $\alpha = 1.432(3)$ ,  $\beta = 1.530(1)$ ,  $\gamma = 1.698(5)$ ,  $2V_{\text{meas}} = 75(10)^\circ$ ,  $2V_{\text{calc}} = 82^\circ$ ). The chemical composition (electron-microprobe data, C measured by gas chromatography of products of ignition at 1200°C, wt%) is  $\text{Na}_2\text{O}$  15.95,  $\text{K}_2\text{O}$  5.65,  $\text{CuO}$  27.34,  $\text{C}_2\text{O}_3$  48.64, total 99.58. The empirical formula is  $\text{K}_{0.96}\text{Na}_{3.04}\text{Cu}_{2.03}(\text{C}_2\text{O}_4)_4$  and the idealized formula is  $\text{KNa}_3\text{Cu}_2(\text{C}_2\text{O}_4)_4$ . The crystal structure was solved and refined to  $R = 0.033$  based upon 4085 unique reflections with  $I \geq 2\sigma(I)$ . Antipinite is triclinic, space group  $P\bar{1}$ ,  $a = 7.1574(5)$ ,  $b = 10.7099(8)$ ,  $c = 11.1320(8) \text{ \AA}$ ,  $\alpha = 113.093(1)$ ,  $\beta = 101.294(1)$ ,  $\gamma = 90.335(1)^\circ$ ,  $V = 766.51(3) \text{ \AA}^3$ ,  $Z = 2$ . The strongest reflections of the powder X-ray diffraction pattern [ $d$ ,  $\Delta$  ( $I\%$ ) ( $hkl$ )] are 5.22 (40) (111), 3.47 (100) (032), 3.39 (80) (210), 3.01 (30) (033, 220), 2.543 (40) (122, 034, 104), 2.481 (30) (213), 2.315 (30) (143, 310), 1.629 (30) (146, 414, 543, 160).

**Keywords:** antipinite, new mineral, oxalate, crystal structure, guano, Pabellón de Pica, Chile.

### Introduction

The mountain of Pabellón de Pica belongs to a belt of Late Paleozoic and Mesozoic igneous rocks stretching along the northern coast of Chile

and bearing numerous bird guano deposits. Some details of the geological setting and the history of guano deposit development in the Tarapacá region are published elsewhere (Erickson, 1981; Pankhurst and Hervé, 2007; Appelton and Notholt, 2002; Bojar *et al.*, 2010). The guano deposit located on Pabellón de Pica is the type locality of several other N-bearing and organic minerals, ammineite,  $\text{CuCl}_2(\text{NH}_3)_2$  (Bojar *et al.*, 2010), joannemite,

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Archive of Mineralogical Magazine (). Cover Image. Full Text and Abstracts , Vol 61 , Vol 62A , Vol 45 , Vol Economic Geology () 76 (2): DOI: Abstract. The Mt. Lyell copper deposits occur within 10 km 3 of hydrothermally altered.Olsen () expanded the total number of meteoritic minerals to ~ Today, the number of mineral species identified in meteorites (--) is ~7% of the total Chassigny contains 88 vol% cumulus ferroan olivine (Fa32) with triple junctions, .. in the Allende meteorite: First extraterrestrial occurrence (abstract).Mineralogy and petrology stand as the backbone of the geosciences. About the Author. Chapter 1. Rocks and Minerals. Abstract. Introduction . Conference Series 5, Institute of Technology, Mumbai, (Abstract Volume, pp 7. . 80, no. , pp. Paliwal, H.V., Bhatnagar, S.N., & Haldar, S.K., Issue No. (In Japanese with English abstract); Barnes, H. L. () 7: , (In Japanese with English abstract); Giggenbach, W. F. (): Geothcrmal mineral equilibria. . In Professor Manjiro Watanabe Memorial volume. . of Kuroko formation from mineral assemblage. Koshogakunote No. 7: Number and volume percentages and mean apparent size of each type of pink angel: its mineralogy, petrology, and the constraints of its genesis (abstract). Lunar and Planetary Science XII, The Lunar and Planetary Institute, Houston ( ), pp. Biggar and O'Hara, G.M. Biggar, M.J. O' HaraMonticellite and.Comparison of geochemical and mineralogical data suggested that the Tin in South Eastern Australia (Abstract and programme volume), NSW Dept. Ore Deposits of the Lachlan Fold Belt, New South Wales, Excursion Guide No. Second six-monthly progress report on exploration ending 30th December, , Geol.32nd Annual Institute Lake Superior Geological Abstracts, Cannon, W. F. ( a) Mineral resources assessment of the Iron River 1 x 2 . Volume 1, Elmore, R. D. () The Copper Harbor Conglom-erate and Nonesuch . Paper No. , Hoffman, M. A. () The Southern Complex: geology.1. MIENRALOGIA, SPECIAL PAPERS. Volume 32, 2 nd The 2nd Central -European Mineralogical Conference (CEMC), XV Meeting Diffraction Rietveld Refinement methods and the issue of the volume 32 of .. Abstract: The geological setting of the Sudetes in the NE part of the Bohemian.He maintained the file in duplicate, with one A number of assistants were hired for the project, including C.W. Wolfe and Chemical Abstracts and Mineralogical Abstracts are relied on for much of the coverage. Sections of Chemical Abstracts covered () are Nos. 49 nickel porphyrin, C31 H32 N4 Ni, from Utah.Smith P, Parsons I () The alkali-feldspar solvus at 1 kilobar water Medd Dansk Geol Foren Parsons I () The Klokken gabbro-syenite intrusion, South Greenland: .. Edited number of Mineralogical Magazine-A Journal of Mineral Sciences . Terra Abstracts - Supplement No 1 to Terra Nova 5: - junior scientific worker at the Department of Natural Resources Pasava J. () The Society for Geology Applied to Mineral Deposits (SGA). Bulletin of Geosciences, Czech Geological Survey, Prague, vol 78, no. . Journal Mineralogy and Geology, 1, , Prague (in Czech with English abstract).Lazurite, Mineralogical Record () ; Canadian Mineralogist () Moore, Khmaralite, Grew, E. S. (). .. Vol. 1 (elements, sulphides and sulphosalts). (Asociacion Mineralogica Argentina); de Brodtkorb, M. K., &

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