inorganic compounds

Disilver(I) trinickel(II) hydrogenphosphate bis(phosphate), Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$

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The title compound, Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$, has been synthesized by the hydrothermal method. Its structure is formed by two types of chains running along the b axis. The first chain results from a linear and continuous succession of NiO$_6$ octahedra linked to PO$_4$ tetrahedra by a common vertex. The second chain is built up from two adjacent edge-sharing octahedra (dimers) whose ends are linked to two PO$_4$ tetrahedra by a common edge. Those two types of chains are linked together by the phosphate groups to form polyhedral sheets parallel to the (001) plane. The three-dimensional framework delimits two types of hexagonal tunnels parallel to the a-axis direction, at (x, 1/2, 0) and (x, 0, 1/2), where the Ag atoms are located. Each silver cation is surrounded by eight O atoms. The same Ag$^+$ coordination is found in other phosphates with the alluaudite structure, for example, AgMn$_3$(PO$_4$)(HPO$_4$)$_2$. Moreover, O—H⋯O hydrogen bonds link three PO$_4$ tetrahedra so as to build a three-dimensional network.

Related literature

For related applications, see: Viter & Nagornyi (2009); Gao & Gao (2005); Clearfield (1988); Trad *et al.* (2010). For compounds with the same structure, see: Assani *et al.* (2010, 2011); Leroux *et al.* (1995); Ben Smail & Jouini (2002).

Experimental

Crystal data

Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$	a = 12.9233 (3) Å
M_r = 677.79	b = 6.5678 (2) Å
Orthorhombic, $Ima2$	c = 10.6629 (3) Å

V = 905.04 (4) Å^3	μ = 10.98 mm^{-1}
Z = 4	T = 296 K
Mo $K\alpha$ radiation	0.25 × 0.13 × 0.08 mm

Data collection

Bruker X8 APEXII CCD area-detector diffractometer	3762 measured reflections
Absorption correction: multi-scan (*MULABS*; Blessing, 1995)	1125 independent reflections
T_{min} = 0.382, T_{max} = 0.471	1103 reflections with $I > 2\sigma(I)$
	R_{int} = 0.017

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.024	H-atom parameters constrained
$wR(F^2)$ = 0.060	$\Delta\rho_{max}$ = 1.81 e Å^{-3}
S = 1.06	$\Delta\rho_{min}$ = −1.12 e Å^{-3}
1125 reflections	Absolute structure: Flack (1983), 467 Friedel pairs
99 parameters	Flack parameter: 0.55 (3)
1 restraint	

Table 1
Hydrogen-bond geometry (Å, °).

D—H⋯A	D—H	H⋯A	D⋯A	D—H⋯A
O7—H7⋯O6^i	0.86	2.06	2.847 (6)	151

Symmetry code: (i) $-x + \frac{1}{2}, -y + \frac{1}{2}, z + \frac{1}{2}$.

Data collection: *APEX2* (Bruker, 2005); cell refinement: *SAINT*; data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *ORTEP-3 for Windows* (Farrugia, 1997) and *DIAMOND* (Brandenburg, 2006); software used to prepare material for publication: *WinGX* (Farrugia, 1999).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: RU2005).

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supporting information

Disilver(I) trinickel(II) hydrogenphosphate bis(phosphate), Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$

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S1. Comment

As the improvement has arisen in the synthesis of a variety of interesting porous materials and open-framework structures, extensive studies are devoted to the metal phosphates which exhibit a rich structural diversity and have been widely studied as catalysts (Viter & Nagornyi, 2009; Gao & Gao, 2005), ion-exchangers (Clearfield, 1988) and as positive electrode in the lithium and sodium batteries (Trad *et al.* (2010)).

Within this family of compounds, the resulting anionic frameworks, generally constructed from the alternation of PO$_4$ tetrahedra connected to metal cations in different coordinate geometry MO$_n$ (with n=4, 5 and 6), generate pores and channels offering suitable environment to accommodate different other cations. In our search for new phosphates with microporous framework, our most attention has been paid to the hydrothermal investigation of the A$_2$O—MO—P$_2$O$_5$ systems, with A = monovalent cations and M = divalent cations. Accordingly, we have succeed, for instance, to isolate new form of silver zinc phosphate (γ-AgZnPO$_4$) related to the ABW zeolite structure (Assani *et al.* 2010) while the silver magnesium phosphate, namely AgMg$_3$(PO$_4$)(HPO$_4$)$_2$, represent a new member of the well known alluaudite-like structure family (Assani *et al.* 2011). The present paper aims to develop the hydrothermal synthesis and the structural characterization of a new silver nickel phosphate, namely, Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$.

The structure of this compound is formed by two types of chains running along the *b* axis. The first chain (Ni2P2HO$_9$)∞ is built up from Ni2 and P2 atoms in special Wyckoff position 4 b (*m*) of the space group Ima2. This chain results from linear and continuous succession of octahedron (Ni2O$_6$) and P2O$_3$OH tetrahedron which share a vertex. The second chain (Ni$_2$P$_2$O$_{14}$)n is built up from two adjacent edge sharing octahedra ((Ni1)$_2$O$_{10}$ dimmers) whose ends are linked to two P1O$_4$ tetrahedra by a common edge (Fig.1). Those chains are linked together by the phosphate groups to form polyhedral sheets parallel to the (0 0 1) plane as shown in Fig.2.

The three dimensional framework delimits two types of hexagonal tunnels running along the a direction, at *x* 1/2 0 and *x* 0 1/2 (Fig.3). The Ag2 atom is located at centre of tunnels, this explains the high value of its anisotropic displacement U$_{11}$, whereas Ag1 is slightly shifted from this center (Wyckoff positions: Ag2 at 2a: 0, 0, *z* and Ag1 at 2 b: 1/4, *y*, *z*). However, each Ag$^+$ ion is surrounded by 8 O atoms with different Ag–O distances. Indeed, the first coordination environment of Ag2$^+$ is almost square planar with four short Ag2—O distances between 2.373 (4) and 2.421 (4) Å and the other four larger distances are in the range of 2.869 (4) to 3.133 (4) Å. A similar coordination surrounding Ag1$^+$ is observed with Ag1—O bond lengths in the range of 2.537 (4)–2.616 (4) Å and the longest bonds are situated between 2.661 (4) and 2.963 (4) Å. The same coordination for this cation is found in other phosphate with alluaudite structure like AgMn$_3$(PO$_4$)(HPO$_4$)$_2$ (Leroux *et al.* (1995)) and AgNi$_3$(PO$_4$)(HPO$_4$)$_2$ (Ben Smail & Jouini (2002)).

Moreover, O—H⋯O hydrogen bondings link two adjacent P2O$_4$ tetrahedra *via* a strong hydrogen bond O7–H7⋯O6 to two P1O$_4$ tetrahedra through weak bonds O7–H7⋯O4 in the way to build an infinite three-dimensional network as shown in Table 1.

S2. Experimental

By means of hydrothermal synthesis, we have isolate a new silver nickel phosphate from the reaction mixture of silver nitrate ($AgNO_3$; 0.1699 g), metallic nickel (Ni; 0.0881 g), 85%wt phosphoric acid (H_3PO_4; 0,10 ml) and water (12 ml). The hydrothermal treatment was conducted in a 23 ml Teflon-lined autoclave under autogeneous pressure at 468 K for two days. After being filtered off, washed with deionized water and air dried, the reaction product consists of a monophasic green powder and some green parallelepipedic crystals corresponding to the title compound.

S3. Refinement

The structure is solved by direct method technique and refined by full-matrix least-squares using *SHELXS97* and *SHELXL97* program packages. The structure refinement in the centrosymmetric space group was unsuccessful. Infact the crystal is a racemic twinned with a refined ratio of 0.479 (26), which explains the ambiguity in the Flack parameter. The space group is not centro symmetric and the polar axis restraint is generated automatically by *SHELXL* program. Friedel opposites reflections are not merged. The O-bound H atom is initially located unambiguously in a difference map and refined with O—H distance restraints of 0.86 (1). In a the last cycle ther is refined in the riding model approximation with U_{iso}(H) set to $1.2U_{eq}$(O). The highest and deepest hole residual peak in the final difference Fourier map are located at 0.72 Å and 0.62 Å, from Ag1.
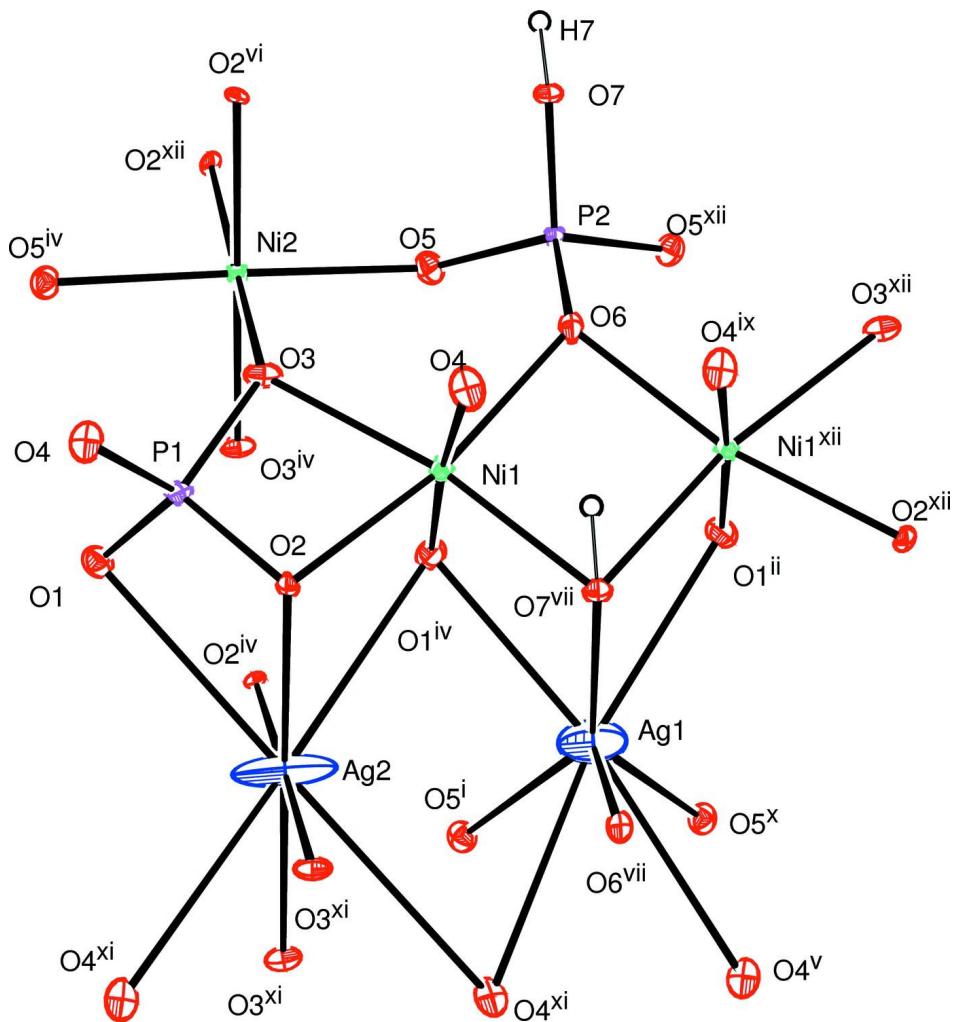
Figure 1

Partial plot of Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$ crystal structure. Displacement ellipsoids are drawn at the 50% probability level. Symmetry codes: (i) -x, -y + 1, z; (ii) x + 1/2, -y + 1, z; (iii) x, -y + 3/2, z - 1/2; (iv) -x + 1/2, -y + 3/2, z - 1/2; (v) -x + 1/2, -y + 1/2, z - 1/2; (vi) -x, y + 1/2, z - 1/2; (vii) x + 1/2, y + 1/2, z - 1/2; (viii) x, -y + 1/2, z - 1/2; (ix) -x, -y, z; (x) -x, y + 1/2, z + 1/2; (xi) x, -y + 1/2, z + 1/2; (xii) -x + 1/2, y, z.
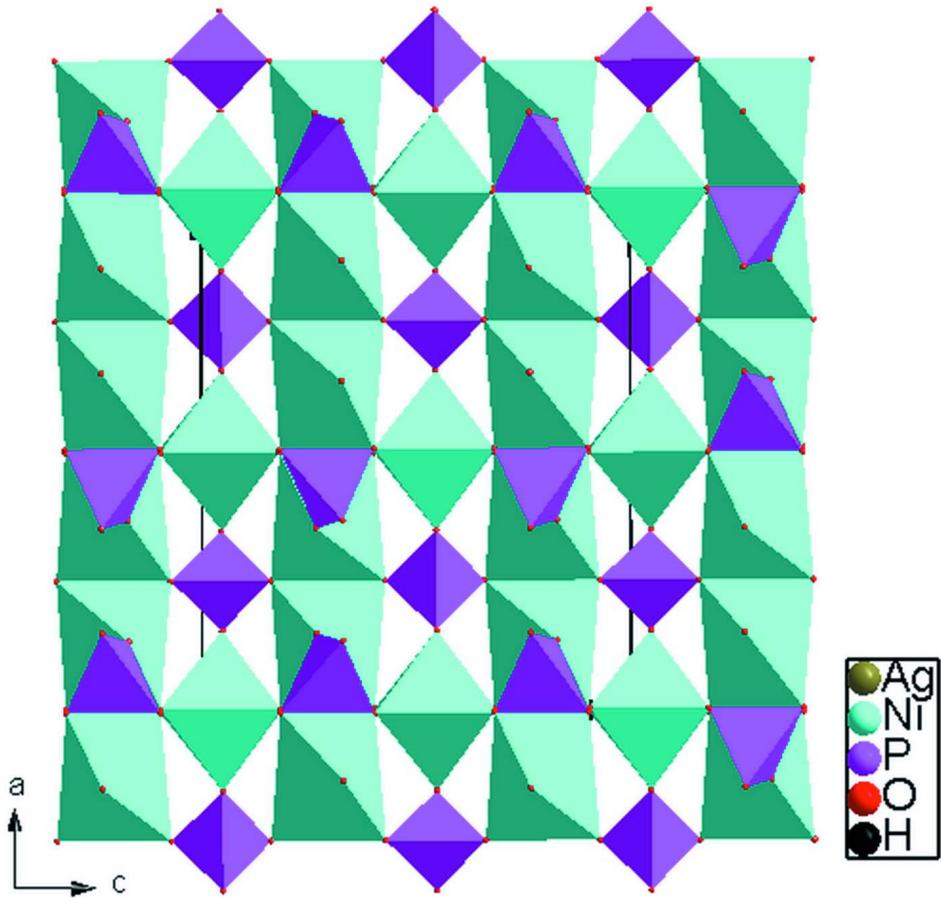
Figure 2
View along the *b* axis of polyhedral sheets parallel to the (0 0 1) plane.
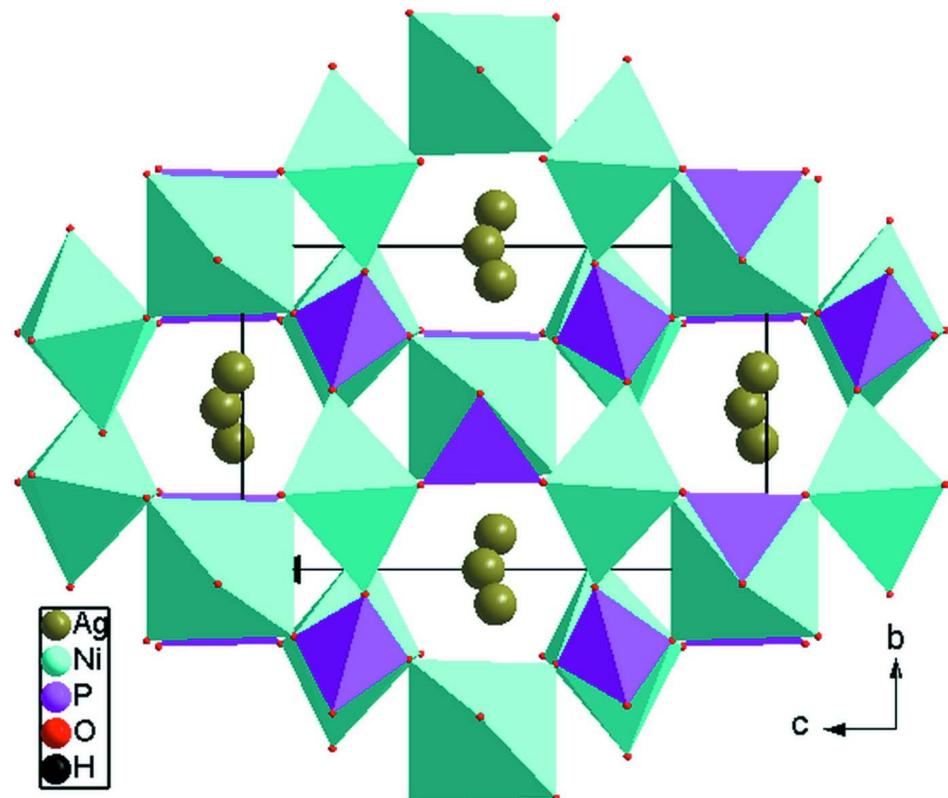
Figure 3

A three-dimensional polyhedral view of the crystal structure of the Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$, showing tunnels running along the a direction, at x, 1/2, 0 and x, 0, 1/2.

Disilver(I) trinickel(II) hydrogenphosphate bis(phosphate)

Crystal data

Ag$_2$Ni$_3$(HPO$_4$)(PO$_4$)$_2$	$F(000) = 1280$
$M_r = 677.79$	$D_x = 4.974$ Mg m^{-3}
Orthorhombic, *Ima*2	Mo *Kα* radiation, $\lambda = 0.71073$ Å
Hall symbol: I 2 -2a	Cell parameters from 1125 reflections
$a = 12.9233$ (3) Å	$\theta = 3.2–29.0°$
$b = 6.5678$ (2) Å	$\mu = 10.98$ mm^{-1}
$c = 10.6629$ (3) Å	$T = 296$ K
$V = 905.04$ (4) Å^3	Prism, green
$Z = 4$	$0.25 \times 0.13 \times 0.08$ mm

Data collection

Bruker X8 APEXII CCD area-detector diffractometer	3762 measured reflections
	1125 independent reflections
Radiation source: fine-focus sealed tube	1103 reflections with $I > 2\sigma(I)$
Graphite monochromator	$R_{int} = 0.017$
φ and ω scans	$\theta_{max} = 29.0°$, $\theta_{min} = 3.2°$
Absorption correction: multi-scan (*MULABS*; Blessing, 1995)	$h = -13 \rightarrow 14$
	$k = -16 \rightarrow 17$
$T_{min} = 0.382$, $T_{max} = 0.471$	$l = -8 \rightarrow 8$

Refinement

Refinement on F^2	Hydrogen site location: inferred from neighbouring sites
Least-squares matrix: full	
$R[F^2 > 2\sigma(F^2)] = 0.024$	H-atom parameters constrained
$wR(F^2) = 0.060$	$w = 1/[\sigma^2(F_o^2) + (0.0356P)^2 + 1.7344P]$ where $P = (F_o^2 + 2F_c^2)/3$
$S = 1.06$	
1125 reflections	$(\Delta/\sigma)_{max} < 0.001$
99 parameters	$\Delta\rho_{max} = 1.81$ e Å^{-3}
1 restraint	$\Delta\rho_{min} = -1.12$ e Å^{-3}
Primary atom site location: structure-invariant direct methods	Absolute structure: Flack (1983), 467 Friedel pairs
Secondary atom site location: difference Fourier map	Absolute structure parameter: 0.55 (3)

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R-factor wR and goodness of fit S are based on F^2, conventional R-factors R are based on F, with F set to zero for negative F^2. The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R-factors(gt) *etc*. and is not relevant to the choice of reflections for refinement. R-factors based on F^2 are statistically about twice as large as those based on F, and R- factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2)

	x	y	z	U_{iso}*/U_{eq}
Ag1	0.2500	0.60793 (8)	−0.01513 (7)	0.02914 (18)
Ag2	0.0000	0.5000	−0.03769 (5)	0.0443 (2)
Ni1	0.13623 (4)	0.24801 (10)	0.20871 (7)	0.00699 (13)
Ni2	0.0000	0.5000	0.45735 (7)	0.00462 (15)
P1	−0.07279 (7)	0.25722 (19)	0.20677 (13)	0.00587 (19)
P2	0.2500	0.4102 (2)	0.45653 (15)	0.0042 (3)
O1	−0.1343 (3)	0.4456 (5)	0.1739 (3)	0.0091 (7)
O2	0.0044 (3)	0.2070 (6)	0.1000 (3)	0.0056 (6)
O3	0.0036 (3)	0.2785 (5)	0.3204 (3)	0.0072 (8)
O4	−0.1494 (3)	0.0786 (5)	0.2360 (3)	0.0096 (9)
O5	0.1543 (2)	0.5443 (4)	0.4552 (3)	0.0085 (5)
O6	0.2500	0.2617 (8)	0.3420 (5)	0.0090 (12)
O7	0.2500	0.2692 (7)	0.5756 (5)	0.0064 (12)
H7	0.2500	0.3065	0.6529	0.008*

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Ag1	0.0491 (4)	0.0158 (3)	0.0225 (3)	0.000	0.000	0.0048 (3)
Ag2	0.1145 (7)	0.0083 (2)	0.0101 (3)	−0.0020 (3)	0.000	0.000
Ni1	0.0058 (2)	0.0092 (3)	0.0060 (3)	0.0005 (2)	0.0005 (3)	−0.00135 (19)
Ni2	0.0052 (3)	0.0049 (3)	0.0037 (3)	0.0006 (2)	0.000	0.000
P1	0.0064 (4)	0.0064 (5)	0.0047 (4)	−0.0001 (5)	0.0008 (6)	0.0004 (4)

P2	0.0043 (6)	0.0054 (6)	0.0030 (7)	0.000	0.000	−0.0012 (6)
O1	0.0086 (16)	0.0100 (18)	0.0088 (15)	0.0003 (14)	−0.0017 (10)	−0.0010 (12)
O2	0.0044 (18)	0.0088 (15)	0.0035 (15)	−0.0002 (15)	−0.0010 (12)	−0.0029 (13)
O3	0.012 (2)	0.0044 (17)	0.0049 (15)	0.0009 (15)	−0.0005 (12)	−0.0010 (12)
O4	0.010 (2)	0.0023 (18)	0.016 (2)	−0.0011 (13)	0.0015 (11)	0.0017 (11)
O5	0.0077 (12)	0.0082 (12)	0.0096 (15)	0.0014 (10)	−0.0008 (13)	−0.0003 (12)
O6	0.005 (3)	0.013 (3)	0.009 (2)	0.000	0.000	−0.0007 (16)
O7	0.007 (3)	0.007 (3)	0.005 (2)	0.000	0.000	0.0023 (16)

Geometric parameters (Å, º)

Ag1—O1^i	2.534 (3)	Ni2—O2^{xi}	2.041 (3)
Ag1—O1^{ii}	2.535 (3)	Ni2—O3^i	2.062 (4)
Ag1—O5^{iii}	2.617 (3)	Ni2—O3	2.062 (4)
Ag1—O5^{iv}	2.617 (3)	P1—O1	1.511 (4)
Ag1—O7^v	2.659 (5)	P1—O2	1.549 (4)
Ag1—O6^v	2.866 (5)	P1—O4	1.566 (4)
Ag1—O4^{vi}	2.962 (3)	P1—O3	1.569 (4)
Ag1—O4^{vii}	2.962 (3)	P2—O5	1.518 (3)
Ag1—Ag2	3.3164 (2)	P2—O5^{xii}	1.518 (3)
Ag2—O3^{vi}	2.375 (4)	P2—O6	1.563 (6)
Ag2—O3^{viii}	2.375 (4)	P2—O7	1.572 (5)
Ag2—O2	2.421 (4)	O1—Ni1^i	2.046 (4)
Ag2—O2^i	2.421 (4)	O1—O4	2.507 (5)
Ag2—O1	2.869 (4)	O1—Ag1^i	2.534 (3)
Ag2—O1^i	2.869 (4)	O2—Ni2^{xiii}	2.041 (3)
Ag2—O4^{viii}	3.133 (4)	O3—Ag2^{xiv}	2.375 (4)
Ag2—O4^{vi}	3.133 (4)	O4—Ni1^{ix}	2.172 (4)
Ni1—O1^i	2.046 (4)	O4—Ag1^{xv}	2.962 (3)
Ni1—O7^v	2.047 (3)	O4—Ag2^{xiv}	3.133 (4)
Ni1—O6	2.047 (4)	O5—Ag1^{xvi}	2.617 (3)
Ni1—O2	2.079 (4)	O6—Ni1^{xii}	2.047 (4)
Ni1—O3	2.097 (4)	O6—Ag1^{xvii}	2.866 (5)
Ni1—O4^{ix}	2.172 (4)	O7—Ni1^{xi}	2.047 (3)
Ni2—O5^i	2.015 (3)	O7—Ni1^{xvii}	2.047 (3)
Ni2—O5	2.015 (3)	O7—Ag1^{xvii}	2.659 (5)
Ni2—O2^x	2.041 (3)	O7—H7	0.8600
O1^i—Ag1—O1^{ii}	72.33 (16)	O3^{viii}—Ag2—O4^{vi}	67.92 (11)
O1^i—Ag1—O5^{iii}	86.46 (10)	O2—Ag2—O4^{vi}	125.71 (11)
O1^{ii}—Ag1—O5^{iii}	119.74 (11)	O2^i—Ag2—O4^{vi}	110.51 (11)
O1^i—Ag1—O5^{iv}	119.74 (11)	O1—Ag2—O4^{vi}	177.43 (10)
O1^{ii}—Ag1—O5^{iv}	86.46 (10)	O1^i—Ag2—O4^{vi}	102.27 (8)
O5^{iii}—Ag1—O5^{iv}	56.41 (12)	O4^{viii}—Ag2—O4^{vi}	79.25 (12)
O1^i—Ag1—O7^v	65.26 (11)	Ag1^i—Ag2—Ag1	171.68 (3)
O1^{ii}—Ag1—O7^v	65.26 (11)	O1^i—Ni1—O7^v	86.42 (17)
O5^{iii}—Ag1—O7^v	148.99 (7)	O1^i—Ni1—O6	95.26 (18)
O5^{iv}—Ag1—O7^v	148.99 (7)	O7^v—Ni1—O6	88.15 (12)

O1ⁱ—Ag1—O6ᵛ	107.78 (12)	O1ⁱ—Ni1—O2	90.92 (15)
O1ⁱⁱ—Ag1—O6ᵛ	107.78 (12)	O7ᵛ—Ni1—O2	101.25 (13)
O5ⁱⁱⁱ—Ag1—O6ᵛ	132.46 (11)	O6—Ni1—O2	169.08 (15)
O5ⁱᵛ—Ag1—O6ᵛ	132.46 (11)	O1ⁱ—Ni1—O3	89.93 (14)
O7ᵛ—Ag1—O6ᵛ	53.46 (12)	O7ᵛ—Ni1—O3	170.53 (14)
O1ⁱ—Ag1—O4ᵛⁱ	116.39 (11)	O6—Ni1—O3	100.89 (14)
O1ⁱⁱ—Ag1—O4ᵛⁱ	164.32 (10)	O2—Ni1—O3	70.05 (11)
O5ⁱⁱⁱ—Ag1—O4ᵛⁱ	74.98 (10)	O1ⁱ—Ni1—O4ⁱˣ	175.34 (13)
O5ⁱᵛ—Ag1—O4ᵛⁱ	98.97 (10)	O7ᵛ—Ni1—O4ⁱˣ	88.97 (17)
O7ᵛ—Ag1—O4ᵛⁱ	105.40 (12)	O6—Ni1—O4ⁱˣ	83.92 (17)
O6ᵛ—Ag1—O4ᵛⁱ	57.90 (11)	O2—Ni1—O4ⁱˣ	90.62 (14)
O1ⁱ—Ag1—O4ᵛⁱⁱ	164.32 (10)	O3—Ni1—O4ⁱˣ	94.73 (14)
O1ⁱⁱ—Ag1—O4ᵛⁱⁱ	116.39 (11)	O5ⁱ—Ni2—O5	178.70 (19)
O5ⁱⁱⁱ—Ag1—O4ᵛⁱⁱ	98.97 (10)	O5ⁱ—Ni2—O2ˣ	94.43 (14)
O5ⁱᵛ—Ag1—O4ᵛⁱⁱ	74.98 (10)	O5—Ni2—O2ˣ	86.54 (14)
O7ᵛ—Ag1—O4ᵛⁱⁱ	105.40 (12)	O5ⁱ—Ni2—O2ˣⁱ	86.55 (14)
O6ᵛ—Ag1—O4ᵛⁱⁱ	57.90 (11)	O5—Ni2—O2ˣⁱ	94.42 (14)
O4ᵛⁱ—Ag1—O4ᵛⁱⁱ	52.10 (14)	O2ˣ—Ni2—O2ˣⁱ	83.6 (2)
O3ᵛⁱ—Ag2—O3ᵛⁱⁱⁱ	100.81 (18)	O5ⁱ—Ni2—O3ⁱ	94.10 (14)
O3ᵛⁱ—Ag2—O2	177.72 (14)	O5—Ni2—O3ⁱ	84.97 (15)
O3ᵛⁱⁱⁱ—Ag2—O2	76.92 (10)	O2ˣ—Ni2—O3ⁱ	93.29 (11)
O3ᵛⁱ—Ag2—O2ⁱ	76.92 (10)	O2ˣⁱ—Ni2—O3ⁱ	176.91 (18)
O3ᵛⁱⁱⁱ—Ag2—O2ⁱ	177.72 (14)	O5ⁱ—Ni2—O3	84.97 (15)
O2—Ag2—O2ⁱ	105.35 (15)	O5—Ni2—O3	94.10 (14)
O3ᵛⁱ—Ag2—O1	125.84 (12)	O2ˣ—Ni2—O3	176.91 (18)
O3ᵛⁱⁱⁱ—Ag2—O1	114.65 (11)	O2ˣⁱ—Ni2—O3	93.29 (11)
O2—Ag2—O1	55.82 (11)	O3ⁱ—Ni2—O3	89.8 (2)
O2ⁱ—Ag2—O1	66.92 (11)	O1—P1—O2	110.0 (2)
O3ᵛⁱ—Ag2—O1ⁱ	114.65 (11)	O1—P1—O4	109.1 (2)
O3ᵛⁱⁱⁱ—Ag2—O1ⁱ	125.84 (12)	O2—P1—O4	113.2 (2)
O2—Ag2—O1ⁱ	66.92 (11)	O1—P1—O3	115.89 (19)
O2ⁱ—Ag2—O1ⁱ	55.82 (11)	O2—P1—O3	100.46 (15)
O1—Ag2—O1ⁱ	76.28 (13)	O4—P1—O3	108.1 (2)
O3ᵛⁱ—Ag2—O4ᵛⁱⁱⁱ	67.92 (11)	O5—P2—O5ˣⁱⁱ	109.1 (2)
O3ᵛⁱⁱⁱ—Ag2—O4ᵛⁱⁱⁱ	52.70 (12)	O5—P2—O6	110.77 (16)
O2—Ag2—O4ᵛⁱⁱⁱ	110.51 (11)	O5ˣⁱⁱ—P2—O6	110.77 (16)
O2ⁱ—Ag2—O4ᵛⁱⁱⁱ	125.71 (11)	O5—P2—O7	110.44 (16)
O1—Ag2—O4ᵛⁱⁱⁱ	102.27 (8)	O5ˣⁱⁱ—P2—O7	110.44 (16)
O1ⁱ—Ag2—O4ᵛⁱⁱⁱ	177.43 (10)	O6—P2—O7	105.3 (2)
O3ᵛⁱ—Ag2—O4ᵛⁱ	52.70 (12)	P2—O7—H7	127.4

Symmetry codes: (i) −*x*, −*y*+1, *z*; (ii) *x*+1/2, −*y*+1, *z*; (iii) *x*, −*y*+3/2, *z*−1/2; (iv) −*x*+1/2, −*y*+3/2, *z*−1/2; (v) −*x*+1/2, −*y*+1/2, *z*−1/2; (vi) −*x*, *y*+1/2, *z*−1/2; (vii) *x*+1/2, *y*+1/2, *z*−1/2; (viii) *x*, −*y*+1/2, *z*−1/2; (ix) −*x*, −*y*, *z*; (x) −*x*, *y*+1/2, *z*+1/2; (xi) *x*, −*y*+1/2, *z*+1/2; (xii) −*x*+1/2, *y*, *z*; (xiii) −*x*, *y*−1/2, *z*−1/2; (xiv) −*x*, *y*−1/2, *z*+1/2; (xv) *x*−1/2, *y*−1/2, *z*+1/2; (xvi) −*x*+1/2, −*y*+3/2, *z*+1/2; (xvii) −*x*+1/2, −*y*+1/2, *z*+1/2.

Hydrogen-bond geometry (Å, °)

D—H⋯*A*	*D*—H	H⋯*A*	*D*⋯*A*	*D*—H⋯*A*

O7—H7···O6[xvii]	0.86	2.06	2.847 (6)	151

Symmetry code: (xvii) $-x+1/2$, $-y+1/2$, $z+1/2$.