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Redetermination of Sr_2PdO_3 from single-crystal X-ray data

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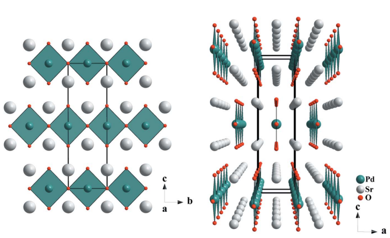
The crystal structure redetermination of Sr_2PdO_3 (distrontium palladium trioxide) was carried out using high-quality single-crystal X-ray data. The Sr_2PdO_3 structure has been described previously in at least three reports [Wasel-Nielen & Hoppe (1970). *Z. Anorg. Allg. Chem*. **375**, 209–213; Muller & Roy (1971). *Adv. Chem. Ser*. **98**, 28–38; Nagata *et al.* (2002). *J. Alloys Compd.* **346**, 50–56], all based on powder X-ray diffraction data. The current structure refinement of Sr_2PdO_3, as compared to previous powder data refinements, leads to more precise cell parameters and fractional coordinates, together with anisotropic displacement parameters for all sites. The compound is confirmed to have the orthorhombic Sr_2CuO_3 structure type (space group *Immm*) as reported previously. The structure consists of infinite chains of corner-sharing PdO_4 plaquettes interspersed by Sr^{II} atoms. A brief comparison of Sr_2PdO_3 with the related K_2NiF_4 structure type is given.



1. Chemical context

Low-dimensional transition-metal oxides with chain structures have received attention since they can enable interesting physical phenomena such as spin 1/2 antiferromagnetic Heisenberg coupling (Motoyama *et al.*, 1996; Takigawa *et al.*, 1996), superconductivity (Hiroi *et al.*, 1993), ultrafast non-linear optical response (Ogasawara *et al.*, 2000) or even glucose sensing (El-Ads *et al.*, 2016). The particularly relevant sub-family based on square-planar MO_4 (M = divalent metal) primary building units is dominated by oxidocuprates(II), while the chemistry of respective palladates(II), showing the same preference for a square-planar coordination by oxygen, is much less explored.

Here we address Sr_2PdO_3, which has previously been obtained as a microcrystalline material (Wasel-Nielen & Hoppe, 1970; Muller & Roy, 1971; Nagata *et al.*, 2002). Based on evaluations of powder X-ray diffractograms, Sr_2PdO_3 was identified as being isostructural with Sr_2CuO_3 (Teske & Müller-Buschbaum, 1969; Weller & Lines, 1989) and Sr_2FeO_3 (Tassel *et al.*, 2013). However, structural details derived from the given atomic parameters have only been reported with large uncertainties (Muller & Roy, 1971; Nagata *et al.*, 2002). Therefore, a redetermination of Sr_2PdO_3 based on single crystal X-ray data seemed appropriate.

2. Structural commentary

The crystal structure of Sr_2PdO_3 is essentially the same as determined previously (Wasel-Nielen & Hoppe, 1970; Muller

Table 1
Comparison of lattice parameters and bond lengths (Å) in Sr_2PdO_3 determined in different studies.

	1970 work[a]	1971 work[b]	2002 work[c]	This work
a	3.977	3.97	3.985	3.5342 (2)
b	3.53	3.544	3.539	3.9822 (3)
c	12.82	12.84	12.847	12.8414 (8)
Pd—O1 (×2)	2.08	2.045	2.068	2.052 (2)
Pd—O2 (×2)	1.99	1.985	1.993	1.9911 (1)
Sr—O1	2.45	2.504	2.467	2.474 (2)
Sr—O1 (×4)	2.67	2.668	2.671	2.6668 (2)
Sr—O2 (×2)	2.58	2.57	2.588	2.5906 (3)

References: (*a*) Wasel-Nielen & Hoppe (1970); (*b*) Muller & Roy (1971); (*c*) Nagata *et al.* (2002).

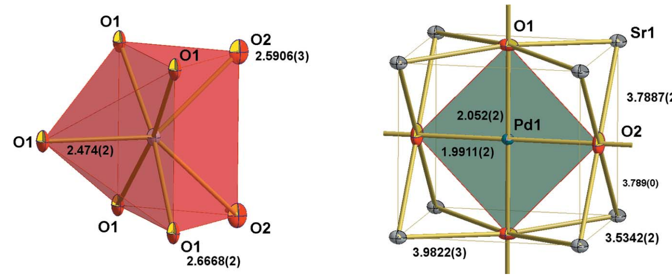


Figure 2
Coordination around the Sr^{II} (left) and Pd^{II} atoms (right). All atoms are drawn with displacement ellipsoids at the 80% probability level. Distances are in Å.

& Roy, 1971; Nagata *et al.*, 2002). The lattice parameters (Table 1) are almost identical to those in the previous reports but with higher precision. The Pd^{II} atom occupies the 2*d* crystallographic sites with *mmm* site symmetry. We would like to point out that we chose a different cell setting as compared to all the previous reports, where the Pd^{II} atom was chosen to be located at the cell origin (site 2*a*; 0, 0, 0; hence the different site designations). The Pd^{II} atom forms distorted PdO_4 square planes, which are linked by sharing oxygen atoms in the *trans*-position to form infinite chains extending along the *b*-axis direction as shown in Fig. 1. Corresponding to this connectivity pattern, the Pd—O bond lengths are longer for the shared oxygen atoms, 2.052 (2) Å, and shorter for the terminal ones, 1.9911 (2) Å. The Sr atom is situated at the 4*j* Wyckoff site having *mm*2 site symmetry. It is seven-coordinate in a monocapped trigonal–prismatic fashion by oxygen with three different bond lengths (Table 1, Fig. 2). In addition to the square-planar first coordination of Pd^{II} with oxygen, the second consists of eight Sr^{II} atoms present at the corner of a cuboid with dimension 3.5342 (2) × 3.7887 (2) × 3.9822 (3) $Å^3$ (Fig. 2). Of the two kinds of oxygen atoms, both surrounded by six metal ions that form distorted octahedra, O1 is coordinated by one Pd^{II} atom [2.052 (2) Å] and five Sr^{II} atoms with one short [2.474 (2) Å] and four long distances [2.6668 (2) Å] (Fig. 3). O2 is connected to four equidistant Sr^{II} [2.5906 (3) Å] and two Pd^{II} atoms [1.9911 (2) Å] (Fig. 3). In our current structure determination, much more precise values of the cell parameters along with the *z* parameters of Sr and O1 have been determined, consequently, yielding very precise values for the bond lengths (see Table 1). The quality of the current refinement is also clearly reflected by better reliability factors (see Table 2) as compared to the previous refinements. The atomic arrangement described here is same as provided by Wasel-Nielen & Hoppe (1970).

The structural features discussed above are closely related to those of the K_2NiF_4 type of structure, which is regarded as the prototype structure for all the high T_c cuprates. K_2NiF_4 consists of layers of corner-shared NiF_6 octahedra extending in the *ab* plane. One can derive the Sr_2PdO_3 structure from the K_2NiF_4 structure by systematically removing the bridging F atoms from the NiF_6 octahedra lying in the *a*-axis direction (Fig. 4). This would reduce the dimensionality of the layer, resulting in linear chains of square planes connected by edges along only one direction.

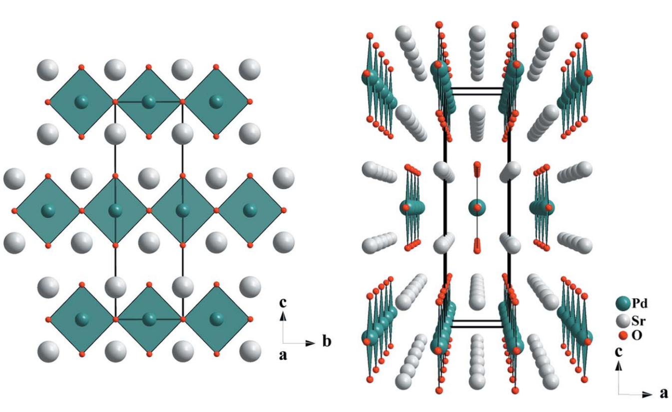


Figure 1
Crystal structure of Sr_2PdO_3 viewed along the *a* axis (left) and along the *b* axis (right).

3. Synthesis and crystallization

Millimeter-sized block-shaped crystals of dark-yellow colour with composition Sr_2PdO_3 as confirmed by SEM–EDS, were obtained from a mixture of different phases while attempting to synthesize $SrPd_3O_4$ using a KOH flux (Smallwood *et al.*, 2000). $SrCO_3$ and Pd metal powder were mixed in the molar ratio of 2:3, placed in an alumina crucible, and 15 grams of KOH pellets were added on top. The crucible was heated in a muffle furnace to 1023 K in 24 h with a 6 h dwell time. The

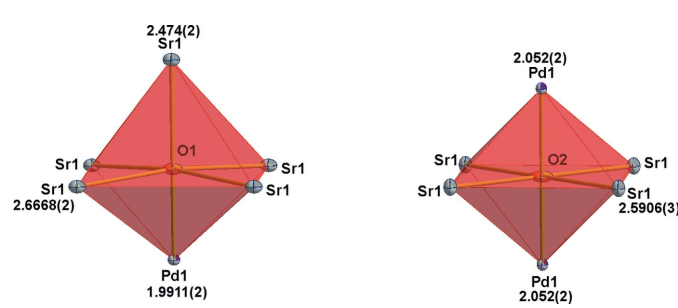


Figure 3
Coordination polyhedra of two types of oxygen atoms, O1 (left) and O2 (right). All atoms are drawn with displacement ellipsoids at the 80% probability level. Distances are in Å.

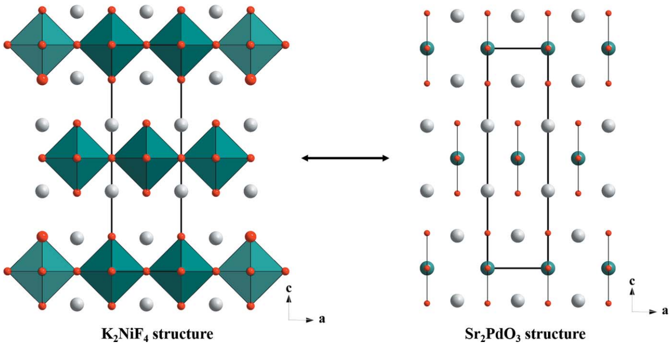


Figure 4
Interconversion of the Sr_2PdO_3 and K_2NiF_4 structures.

furnace was then cooled slowly to 873 K over 125 h after which it was switched off and allowed to cool naturally. The product was washed several times with water to remove the solidified flux and subsequently rinsed with ethanol.

4. Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2.

Table 2
Experimental details.

Crystal data	
Chemical formula	Sr_2PdO_3
M_r	329.64
Crystal system, space group	Orthorhombic, *Immm*
Temperature (K)	296
a, b, c (Å)	3.5342 (2), 3.9822 (3), 12.8414 (8)
V (Å^3)	180.73 (2)
Z	2
Radiation type	Mo $K\alpha$
μ (mm^{-1})	34.15
Crystal size (mm)	0.18 × 0.16 × 0.12
Data collection	
Diffractometer	Bruker APEXII CCD
Absorption correction	Multi-scan (*SADABS*; Bruker, 2009)
T_{min}, T_{max}	0.062, 0.102
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	8304, 178, 176
R_{int}	0.035
$(\sin \theta/\lambda)_{max}$ (Å^{-1})	0.702
Refinement	
$R[F^2 > 2\sigma(F^2)]$, $wR(F^2)$, S	0.009, 0.021, 1.27
No. of reflections	178
No. of parameters	16
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.43, −0.51

Computer programs: *APEX2* and, *SAINT* (Bruker, 2009), *SHELXS97* and *SHELXTL* (Sheldrick, 2008), *SHELXL2014/7* (Sheldrick, 2015), *DIAMOND* (Brandenburg, 2006).

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supporting information

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Computing details

Data collection: *APEX2* (Bruker, 2009); cell refinement: *SAINT* (Bruker, 2009); data reduction: *SAINT* (Bruker, 2009); program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL2014/7* (Sheldrick, 2015); molecular graphics: *DIAMOND* (Brandenburg, 2006); software used to prepare material for publication: *SHELXTL* (Sheldrick, 2008).

Distrontium palladium trioxide

Crystal data

Sr_2PdO_3
M_r = 329.64
Orthorhombic, *Immm*
a = 3.5342 (2) Å
b = 3.9822 (3) Å
c = 12.8414 (8) Å
V = 180.73 (2) Å^3
Z = 2
F(000) = 292
D_x = 6.057 Mg m^{-3}
Mo $K\alpha$ radiation, λ = 0.71073 Å
Cell parameters from 1490 reflections
θ = 3.2–29.9°
μ = 34.15 mm^{-1}
T = 296 K
Block, yellow-brown
0.18 × 0.16 × 0.12 mm

Data collection

Bruker APEXII CCD diffractometer
φ and ω scans
Absorption correction: multi-scan (*SADABS*; Bruker, 2009)
T_{min} = 0.062, T_{max} = 0.102
8304 measured reflections
178 independent reflections
176 reflections with $I > 2\sigma(I)$
R_{int} = 0.035
θ_{max} = 29.9°, θ_{min} = 3.2°
$h = -4 \rightarrow 4$
$k = -5 \rightarrow 5$
$l = -18 \rightarrow 18$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.009
$wR(F^2)$ = 0.021
S = 1.27
178 reflections
16 parameters
0 restraints
$w = 1/[\sigma^2(F_o^2) + (0.0092P)^2 + 0.2817P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ < 0.001
$\Delta\rho_{max}$ = 0.43 e Å^{-3}
$\Delta\rho_{min}$ = −0.51 e Å^{-3}
Extinction correction: SHELXL-2014/7 (Sheldrick, 2015), $Fc^* = kFc[1+0.001xFc^2\lambda^3/\sin(2\theta)]^{-1/4}$
Extinction coefficient: 0.0059 (5)

Special details

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

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	x	*y*	*z*	U_{iso}*/U_{eq}
Pd1	0.5000	0.0000	0.5000	0.00493 (11)
Sr1	0.5000	0.0000	0.14752 (2)	0.00656 (11)
O1	0.5000	0.0000	0.34021 (18)	0.0085 (5)
O2	0.5000	0.5000	0.5000	0.0128 (8)

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Pd1	0.00765 (19)	0.00396 (17)	0.00320 (18)	0.000	0.000	0.000
Sr1	0.00752 (17)	0.00760 (16)	0.00456 (17)	0.000	0.000	0.000
O1	0.0117 (13)	0.0101 (12)	0.0037 (11)	0.000	0.000	0.000
O2	0.021 (2)	0.0035 (15)	0.0134 (18)	0.000	0.000	0.000

Geometric parameters (Å, º)

Pd1—O2^{i}	1.9911 (1)	Sr1—O1^{ix}	2.6668 (2)
Pd1—O2	1.9911 (1)	Sr1—O1^{vii}	2.6668 (2)
Pd1—O1	2.052 (2)	Sr1—Pd1^{xi}	3.2674 (2)
Pd1—O1^{ii}	2.052 (2)	Sr1—Pd1^{xii}	3.2674 (2)
Pd1—Sr1^{iii}	3.2674 (2)	Sr1—Pd1^{xiii}	3.2674 (2)
Pd1—Sr1^{iv}	3.2674 (2)	Sr1—Pd1^{xiv}	3.2674 (2)
Pd1—Sr1^{v}	3.2674 (2)	Sr1—Sr1^{xv}	3.5342 (2)
Pd1—Sr1^{vi}	3.2674 (2)	O1—Sr1^{viii}	2.6668 (2)
Pd1—Sr1^{vii}	3.2674 (2)	O1—Sr1^{iii}	2.6668 (2)
Pd1—Sr1^{viii}	3.2674 (2)	O1—Sr1^{vii}	2.6668 (2)
Pd1—Sr1^{ix}	3.2674 (2)	O1—Sr1^{ix}	2.6668 (2)
Pd1—Sr1^{x}	3.2674 (2)	O2—Pd1^{xvi}	1.9911 (1)
Sr1—O1	2.474 (2)	O2—Sr1^{ix}	2.5906 (3)
Sr1—O2^{xi}	2.5906 (3)	O2—Sr1^{iv}	2.5906 (3)
Sr1—O2^{xii}	2.5906 (3)	O2—Sr1^{viii}	2.5906 (3)
Sr1—O1^{viii}	2.6668 (2)	O2—Sr1^{vi}	2.5906 (3)
Sr1—O1^{iii}	2.6668 (2)		
O2^{i}—Pd1—O2	180.0	O1—Sr1—O1^{vii}	86.61 (5)
O2^{i}—Pd1—O1	90.0	O2^{xi}—Sr1—O1^{vii}	119.68 (4)
O2—Pd1—O1	90.0	O2^{xii}—Sr1—O1^{vii}	65.87 (4)
O2^{i}—Pd1—O1^{ii}	90.0	O1^{viii}—Sr1—O1^{vii}	96.597 (9)
O2—Pd1—O1^{ii}	90.0	O1^{iii}—Sr1—O1^{vii}	83.000 (8)
O1—Pd1—O1^{ii}	180.0	O1^{ix}—Sr1—O1^{vii}	173.22 (10)

O2^{i}—Pd1—Sr1^{iii}	52.455 (3)	O1—Sr1—Pd1^{xi}	125.435 (5)
O2—Pd1—Sr1^{iii}	127.545 (3)	O2^{xi}—Sr1—Pd1^{xi}	37.546 (3)
O1—Pd1—Sr1^{iii}	54.565 (5)	O2^{xii}—Sr1—Pd1^{xi}	86.845 (8)
O1^{ii}—Pd1—Sr1^{iii}	125.435 (5)	O1^{viii}—Sr1—Pd1^{xi}	147.95 (5)
O2^{i}—Pd1—Sr1^{iv}	127.545 (3)	O1^{iii}—Sr1—Pd1^{xi}	38.82 (5)
O2—Pd1—Sr1^{iv}	52.455 (3)	O1^{ix}—Sr1—Pd1^{xi}	97.52 (3)
O1—Pd1—Sr1^{iv}	125.435 (5)	O1^{vii}—Sr1—Pd1^{xi}	86.43 (3)
O1^{ii}—Pd1—Sr1^{iv}	54.565 (5)	O1—Sr1—Pd1^{xii}	125.435 (5)
Sr1^{iii}—Pd1—Sr1^{iv}	180.0	O2^{xi}—Sr1—Pd1^{xii}	86.845 (8)
O2^{i}—Pd1—Sr1^{v}	52.455 (4)	O2^{xii}—Sr1—Pd1^{xii}	37.546 (3)
O2—Pd1—Sr1^{v}	127.545 (3)	O1^{viii}—Sr1—Pd1^{xii}	97.52 (3)
O1—Pd1—Sr1^{v}	125.435 (5)	O1^{iii}—Sr1—Pd1^{xii}	86.43 (3)
O1^{ii}—Pd1—Sr1^{v}	54.565 (5)	O1^{ix}—Sr1—Pd1^{xii}	147.95 (5)
Sr1^{iii}—Pd1—Sr1^{v}	70.871 (10)	O1^{vii}—Sr1—Pd1^{xii}	38.82 (5)
Sr1^{iv}—Pd1—Sr1^{v}	109.129 (10)	Pd1^{xi}—Sr1—Pd1^{xii}	65.481 (6)
O2^{i}—Pd1—Sr1^{vi}	127.545 (3)	O1—Sr1—Pd1^{xiii}	125.435 (5)
O2—Pd1—Sr1^{vi}	52.455 (4)	O2^{xi}—Sr1—Pd1^{xiii}	86.845 (9)
O1—Pd1—Sr1^{vi}	125.435 (5)	O2^{xii}—Sr1—Pd1^{xiii}	37.546 (3)
O1^{ii}—Pd1—Sr1^{vi}	54.565 (5)	O1^{viii}—Sr1—Pd1^{xiii}	38.82 (5)
Sr1^{iii}—Pd1—Sr1^{vi}	114.520 (6)	O1^{iii}—Sr1—Pd1^{xiii}	147.95 (5)
Sr1^{iv}—Pd1—Sr1^{vi}	65.480 (6)	O1^{ix}—Sr1—Pd1^{xiii}	86.43 (3)
Sr1^{v}—Pd1—Sr1^{vi}	75.090 (7)	O1^{vii}—Sr1—Pd1^{xiii}	97.52 (3)
O2^{i}—Pd1—Sr1^{vii}	52.455 (3)	Pd1^{xi}—Sr1—Pd1^{xiii}	109.130 (10)
O2—Pd1—Sr1^{vii}	127.545 (3)	Pd1^{xii}—Sr1—Pd1^{xiii}	75.091 (7)
O1—Pd1—Sr1^{vii}	54.565 (5)	O1—Sr1—Pd1^{xiv}	125.435 (5)
O1^{ii}—Pd1—Sr1^{vii}	125.435 (5)	O2^{xi}—Sr1—Pd1^{xiv}	37.546 (3)
Sr1^{iii}—Pd1—Sr1^{vii}	65.480 (5)	O2^{xii}—Sr1—Pd1^{xiv}	86.845 (8)
Sr1^{iv}—Pd1—Sr1^{vii}	114.520 (6)	O1^{viii}—Sr1—Pd1^{xiv}	86.43 (3)
Sr1^{v}—Pd1—Sr1^{vii}	104.910 (7)	O1^{iii}—Sr1—Pd1^{xiv}	97.52 (3)
Sr1^{vi}—Pd1—Sr1^{vii}	180.0	O1^{ix}—Sr1—Pd1^{xiv}	38.82 (5)
O2^{i}—Pd1—Sr1^{viii}	127.545 (3)	O1^{vii}—Sr1—Pd1^{xiv}	147.95 (5)
O2—Pd1—Sr1^{viii}	52.455 (3)	Pd1^{xi}—Sr1—Pd1^{xiv}	75.091 (7)
O1—Pd1—Sr1^{viii}	54.565 (5)	Pd1^{xii}—Sr1—Pd1^{xiv}	109.130 (10)
O1^{ii}—Pd1—Sr1^{viii}	125.435 (5)	Pd1^{xiii}—Sr1—Pd1^{xiv}	65.481 (6)
Sr1^{iii}—Pd1—Sr1^{viii}	109.129 (10)	O1—Sr1—Sr1^{xv}	90.0
Sr1^{iv}—Pd1—Sr1^{viii}	70.871 (10)	O2^{xi}—Sr1—Sr1^{xv}	133.011 (5)
Sr1^{v}—Pd1—Sr1^{viii}	180.0	O2^{xii}—Sr1—Sr1^{xv}	46.991 (5)
Sr1^{vi}—Pd1—Sr1^{viii}	104.910 (7)	O1^{viii}—Sr1—Sr1^{xv}	48.500 (3)
Sr1^{vii}—Pd1—Sr1^{viii}	75.090 (7)	O1^{iii}—Sr1—Sr1^{xv}	131.500 (4)
O2^{i}—Pd1—Sr1^{ix}	127.545 (4)	O1^{ix}—Sr1—Sr1^{xv}	131.500 (4)
O2—Pd1—Sr1^{ix}	52.455 (3)	O1^{vii}—Sr1—Sr1^{xv}	48.500 (4)
O1—Pd1—Sr1^{ix}	54.565 (5)	Pd1^{xi}—Sr1—Sr1^{xv}	122.741 (3)
O1^{ii}—Pd1—Sr1^{ix}	125.435 (5)	Pd1^{xii}—Sr1—Sr1^{xv}	57.260 (3)
Sr1^{iii}—Pd1—Sr1^{ix}	75.090 (7)	Pd1^{xiii}—Sr1—Sr1^{xv}	57.260 (3)
Sr1^{iv}—Pd1—Sr1^{ix}	104.910 (7)	Pd1^{xiv}—Sr1—Sr1^{xv}	122.741 (3)
Sr1^{v}—Pd1—Sr1^{ix}	114.520 (6)	Pd1—O1—Sr1	180.0
Sr1^{vi}—Pd1—Sr1^{ix}	70.871 (10)	Pd1—O1—Sr1^{viii}	86.61 (5)
Sr1^{vii}—Pd1—Sr1^{ix}	109.129 (10)	Sr1—O1—Sr1^{viii}	93.39 (5)

$Sr1^{viii}$—Pd1—$Sr1^{ix}$	65.480 (6)	Pd1—O1—$Sr1^{iii}$	86.61 (5)
$O2^{i}$—Pd1—$Sr1^{x}$	52.455 (3)	Sr1—O1—$Sr1^{iii}$	93.39 (5)
O2—Pd1—$Sr1^{x}$	127.545 (3)	$Sr1^{viii}$—O1—$Sr1^{iii}$	173.23 (10)
O1—Pd1—$Sr1^{x}$	125.435 (5)	Pd1—O1—$Sr1^{vii}$	86.61 (5)
$O1^{ii}$—Pd1—$Sr1^{x}$	54.565 (5)	Sr1—O1—$Sr1^{vii}$	93.39 (5)
$Sr1^{iii}$—Pd1—$Sr1^{x}$	104.910 (7)	$Sr1^{viii}$—O1—$Sr1^{vii}$	96.597 (9)
$Sr1^{iv}$—Pd1—$Sr1^{x}$	75.090 (7)	$Sr1^{iii}$—O1—$Sr1^{vii}$	83.001 (8)
$Sr1^{v}$—Pd1—$Sr1^{x}$	65.480 (5)	Pd1—O1—$Sr1^{ix}$	86.61 (5)
$Sr1^{vi}$—Pd1—$Sr1^{x}$	109.129 (10)	Sr1—O1—$Sr1^{ix}$	93.39 (5)
$Sr1^{vii}$—Pd1—$Sr1^{x}$	70.871 (10)	$Sr1^{viii}$—O1—$Sr1^{ix}$	83.001 (8)
$Sr1^{viii}$—Pd1—$Sr1^{x}$	114.520 (6)	$Sr1^{iii}$—O1—$Sr1^{ix}$	96.597 (9)
$Sr1^{ix}$—Pd1—$Sr1^{x}$	180.0	$Sr1^{vii}$—O1—$Sr1^{ix}$	173.23 (10)
O1—Sr1—$O2^{xi}$	136.990 (5)	$Pd1^{xvi}$—O2—Pd1	180.0
O1—Sr1—$O2^{xii}$	136.990 (5)	$Pd1^{xvi}$—O2—$Sr1^{ix}$	90.0
$O2^{xi}$—Sr1—$O2^{xii}$	86.020 (11)	Pd1—O2—$Sr1^{ix}$	90.0
O1—Sr1—$O1^{viii}$	86.61 (5)	$Pd1^{xvi}$—O2—$Sr1^{iv}$	90.0
$O2^{xi}$—Sr1—$O1^{viii}$	119.68 (4)	Pd1—O2—$Sr1^{iv}$	90.0
$O2^{xii}$—Sr1—$O1^{viii}$	65.87 (4)	$Sr1^{ix}$—O2—$Sr1^{iv}$	180.0
O1—Sr1—$O1^{iii}$	86.61 (5)	$Pd1^{xvi}$—O2—$Sr1^{viii}$	90.0
$O2^{xi}$—Sr1—$O1^{iii}$	65.87 (4)	Pd1—O2—$Sr1^{viii}$	90.0
$O2^{xii}$—Sr1—$O1^{iii}$	119.68 (4)	$Sr1^{ix}$—O2—$Sr1^{viii}$	86.018 (11)
$O1^{viii}$—Sr1—$O1^{iii}$	173.22 (10)	$Sr1^{iv}$—O2—$Sr1^{viii}$	93.982 (11)
O1—Sr1—$O1^{ix}$	86.61 (5)	$Pd1^{xvi}$—O2—$Sr1^{vi}$	90.0
$O2^{xi}$—Sr1—$O1^{ix}$	65.87 (4)	Pd1—O2—$Sr1^{vi}$	90.0
$O2^{xii}$—Sr1—$O1^{ix}$	119.68 (4)	$Sr1^{ix}$—O2—$Sr1^{vi}$	93.982 (11)
$O1^{viii}$—Sr1—$O1^{ix}$	83.000 (8)	$Sr1^{iv}$—O2—$Sr1^{vi}$	86.018 (11)
$O1^{iii}$—Sr1—$O1^{ix}$	96.597 (9)	$Sr1^{viii}$—O2—$Sr1^{vi}$	180.0

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