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$SrZnSi_3O_8$, a synthetic member of the feldspar group

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Strontium *tecto*-zincotrisilicate, $SrZnSi_3O_8$, is a synthetic member of the feldspar group with monoclinic symmetry (space group $P2_1/n$, $Z = 4$). In comparison with the alkali feldspars, the aluminium-richest tetrahedral site in these minerals is completely substituted by Zn, and the alkali metal M site by strontium. The crystal structure is fully ordered, *i.e.* there is no mutual co-occupation of the tetrahedral sites or positional disorder of the M site. Although the tetrahedral site substituted by Zn exhibits significantly longer bond lengths [$\overline{d}$(Zn—O) = 1.973 Å] due to the incorporation of the larger cation, there is no noticeable distortion of the SiO_4 tetrahedra compared to the aluminium-bearing feldspars. The coordination number of Sr^{2+} is [6 + 2], with six short distances to oxygen sites in a narrow range [$\overline{d}$ = 2.560 Å] and two significantly longer distances > 3.10 Å.

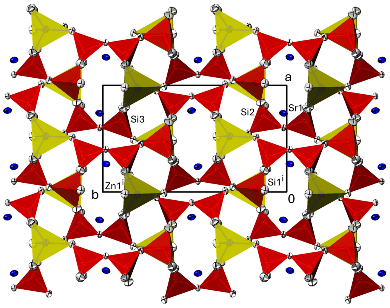
1. Chemical context

Strontium silicate, Sr_2SiO_4, is a well-known host material for luminescence applications. When lanthanides, especially Eu, are used as dopants, efficient white light-emitting diodes can be produced (Park *et al.*, 2003; Gupta *et al.*, 2015).

In this context, it was investigated how the luminescence properties change when the Eu-doped host material is modified by incorporating divalent cations (M = Ca, Ba, Mg, Zn) to form a possible solid solution $(Sr_{1.9}M_{0.1})SiO_4$ (Wieser, 2006). In one of these experiments for the intended preparation of $(Sr_{1.9}Zn_{0.1})SiO_4$:Eu^{3+}, $SrZnSi_3O_8$ has been obtained serendipitously instead. Its feldspar-type crystal structure is presented and discussed in the present article.

2. Structural commentary

The probable existence of $SrZnSi_3O_8$ was predicted some time ago (Fehr & Huber, 2001), and this phase was actually obtained during investigations of solid solutions $(Ba_{1-x}Sr_x)ZnSi_3O_8$ investigated for microwave dielectric properties (Song *et al.*, 2019). Another phase in the system $SrO/Al_2O_3/SiO_2$ has been identified to date, *viz*. synthetic Sr-hardysonite, $Sr_2ZnSi_2O_7$ (Ardit *et al.*, 2010). The putative crystal structure of $SrZnSi_3O_8$ was derived from laboratory powder X-ray diffraction data and reported as triclinic with space group $P\overline{1}$ (Song *et al.*, 2019). Although the corresponding article states: 'The lattice parameters of [$\cdots$] $SrZnSi_3O_8$ were extracted from XRD data using the least-squares method. All the peaks are indexed accordingly, and the crystal structure information is given in the supplemental file', no such data are available. Therefore, no direct comparison can be made with the results of the current single crystal X-ray diffraction data. In any case, the latter data clearly revealed that the symmetry is mono-



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clinic rather than triclinic as previously reported. The crystal structure shows a feldspar-type arrangement of the tetrahedral framework and the metal position.

Table 1
Selected bond lengths (Å).

Sr1—O3^{i}	2.510 (2)	Si1—O1^{iii}	1.597 (2)
Sr1—O7^{ii}	2.523 (2)	Si1—O4^{vii}	1.610 (2)
Sr1—O1^{iii}	2.533 (2)	Si1—O6	1.613 (2)
Sr1—O2^{ii}	2.583 (2)	Si1—O8	1.614 (2)
Sr1—O5^{iv}	2.593 (2)	Si2—O3	1.580 (2)
Sr1—O1^{v}	2.617 (2)	Si2—O6^{ix}	1.621 (2)
Sr1—O8	3.115 (3)	Si2—O8^{x}	1.624 (2)
Sr1—O4^{vi}	3.294 (3)	Si2—O2	1.638 (2)
Zn1—O5	1.903 (2)	Si3—O7^{x}	1.587 (2)
Zn1—O7	1.920 (2)	Si3—O5^{iv}	1.601 (2)
Zn1—O3^{vii}	1.969 (2)	Si3—O4	1.630 (3)
Zn1—O1^{viii}	2.010 (2)	Si3—O2^{ii}	1.665 (2)

Symmetry codes: (i) $-x+1, -y+1, -z$; (ii) $x, y+1, z$; (iii) $-x, -y+1, -z+1$; (iv) $-x+\frac{1}{2}, y+\frac{1}{2}, -z+\frac{1}{2}$; (v) $x, y+1, z-1$; (vi) $-x+1, -y+2, -z$; (vii) $x-1, y, z$; (viii) $x, y, z-1$; (ix) $-x+\frac{1}{2}, y-\frac{1}{2}, -z+\frac{1}{2}$; (x) $-x+1, -y+1, -z+1$.

Feldspars define a large group of aluminium silicate minerals (class of tectosilicates; Liebau, 1985) and are considered the most important rock-forming minerals in the Earth's crust, accounting for almost 60% of its composition. The frequently occurring alkali (*M*) feldspars can be described with the formula $M[\mathrm{Al(Al,Si)_3O_8}]$, or more generally $M[T_4\mathrm{O}_8]$ (where *T* is a tetrahedrally coordinated site), and crystallize either in the triclinic or monoclinic crystal system with unit cell parameter of $a \simeq 8.4$, $b \simeq 13.0$, $c \simeq 7.2$ Å, $\alpha \simeq 90$, $\beta \simeq 116$, $c \simeq 90°$ (Smith, 1974). It is precisely this dimension of the unit cell that is also found in the crystal structure of $\mathrm{SrZnSi_3O_8}$. This is a case of diadochy, and the tetrahedral position $\mathrm{T_1}(0)$ (for atomic designations in feldspars, see: Smith, 1974) is completely occupied by Zn, and Zn also does not co-occupy the other tetrahedral sites (Fig. 1). In feldspars, the $\mathrm{T_1}(0)$ position of the tetrahedral framework is usually occupied by the majority of $\mathrm{Al^{3+}}$ present in the structure, i.e. the cation with a lower charge than $\mathrm{Si^{4+}}$. In simplified terms, this trend continues in $\mathrm{SrZnSi_3O_8}$ with the even lower charged $\mathrm{Zn^{2+}}$, and electron neutrality in the overall structure is ensured by the doubly charged alkaline earth metal $\mathrm{Sr^{2+}}$, which occupies the *M* site. This substitution at the $\mathrm{T_1}(0)$ site with a considerably larger cation (0.60 Å for $\mathrm{Zn^{2+}}$ *versus* 0.39 Å for $\mathrm{Al^{3+}}$, Shannon, 1976) results in longer $\mathrm{T_1}(0)$—O bonds (average 1.973 Å, Table 1). Compared with the alkaline earth homologues $\mathrm{CaZnSi_3O_8}$ (Heuer *et al.*, 1998) and $\mathrm{BaZnSi_3O_8}$ (Zou *et al.*, 2021), which also exhibit feldspar-like crystal structures, the Zn—O distances are similar. $\mathrm{CaZnSi_3O_8}$: 1.916 (3), 1.941 (3), 1.943 (3), 2.047 (3) Å [$P\overline{1}$, a = 8.121 (1), b = 12.927 (1), c = 7.206 (1) Å, α = 93.76 (5), β = 116.120 (7), γ = 84.368 (7)°, Z = 2, single crystal X-ray data, distances calculated from the deposited crystallographic information file (CIF), entry 409286 in the Inorganic Crystal Structure Database (ICSD; Zagorac *et al.*, 2019)]; $\mathrm{BaZnSi_3O_8}$: 1.875 (12), 1.923 (9), 1.972 (11), 1.980 (10) Å [$P2_1/a$, a = 8.725 (10), b = 13.072 (20), c = 7.307 (10) Å, β = 115.85 (2)°, Z = 4, powder synchrotron X-ray data, distances taken from the publication: note that in this publication and the corresponding deposited CIF, entry 113904 in the ICSD, the fractional coordinates of the Zn site are incorrect, with x = 0.012 most likely the correct value].

The three $\mathrm{SiO_4}$ tetrahedra in the remaining framework of $\mathrm{SrZnSi_3O_8}$ are not significantly distorted and show the usual Si—O bond lengths distributions (Table 1; averaged values: Si1 1.609, Si2 1.616, Si3 1.621 Å), in very good agreement with

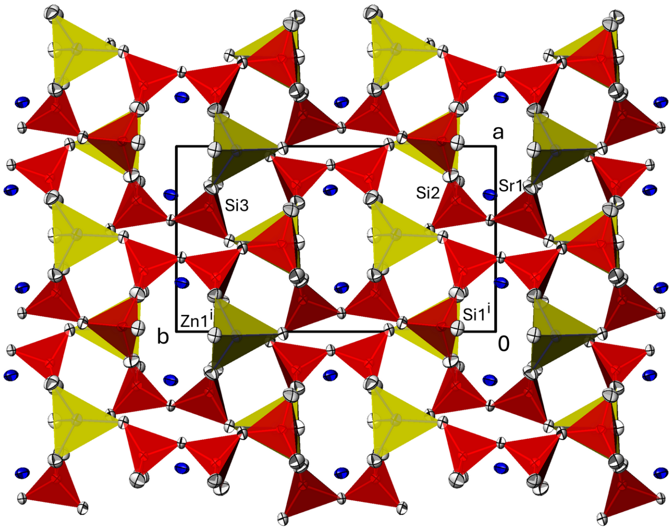

Figure 1
The crystal structure of $\mathrm{SrZnSi_3O_8}$ in a projection along $[00\overline{1}]$. Displacement ellipsoids are drawn at the 90% probability level; the tetrahedral framework atoms are shown in polyhedral representation (Zn yellow, Si red). [Symmetry code: (i) $-x, 1-y, z$.]

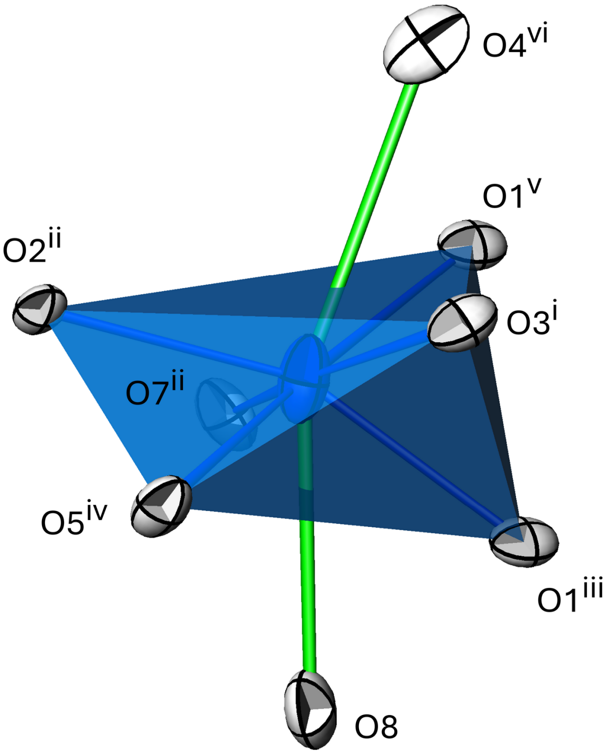

Figure 2
Coordination environment of the Sr1 site. Displacement ellipsoids are drawn at the 90% probability level; symmetry codes refer to Table 1. The polyhedron includes the six short Sr—O bonds, and the two O atoms capping the polyhedron are shown with green bonds.

Table 2
Bond-valence-sum calculations (in valence units) for $SrZnSi_3O_8$.

	Sr1	Zn1	Si1	Si2	Si3	Σ
O1	0.30, 0.25	0.43	1.07			2.05
O2	0.27			0.96	0.90	2.13
O3	0.32	0.47		1.12		1.91
O4	0.06		1.04		0.99	2.09
O5	0.27	0.56			1.06	1.89
O6			1.03	1.01		2.04
O7	0.31	0.54			1.10	1.95
O8	0.09		1.03	1.00		2.12
Σ	1.87	2.00	4.17	4.09	4.05	

Table 3
Experimental details.

Crystal data	
Chemical formula	$SrZnSi_3O_8$
M_r	365.26
Crystal system, space group	Monoclinic, $P2_1/n$
Temperature (K)	293
a, b, c (Å)	8.3060 (8), 13.0111 (13), 7.2454 (7)
β (°)	114.822 (2)
V (Å^3)	710.67 (12)
Z	4
Radiation type	Mo $K\alpha$
μ (mm^{-1})	11.40
Crystal size (mm)	0.06 × 0.04 × 0.03
Data collection	
Diffractometer	Bruker SMART APEXII CCD
Absorption correction	Multi-scan (*SADABS*; Krause *et al.*, 2015)
T_{min}, T_{max}	0.548, 0.764
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	7658, 2057, 1745
R_{int}	0.035
$(\sin \theta/\lambda)_{max}$ (Å^{-1})	0.703
Refinement	
$R[F^2 > 2\sigma(F^2)]$, $wR(F^2)$, S	0.029, 0.069, 1.03
No. of reflections	2057
No. of parameters	118
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.88, −0.67

Computer programs: *APEX2* and *SAINT* (Bruker, 2005), *SHELXS* (Sheldrick, 2008), *SHELXL* (Sheldrick, 2015), *ATOMS* (Dowty, 2006) and *publCIF* (Westrip, 2010).

the mean bond length of 1.62 Å for an SiO_4 tetrahedron (Liebau, 1985).

The coordination number (CN) of Sr can be described as [6 + 2], with six closer distances in a narrow range (average 2.560 Å) and two considerably longer Sr—O distances > 3.10 Å (Table 1). The closest matching polyhedron for CN = 6 was calculated with the *Polynator* program (Link & Niewa, 2023) and is a twisted trigonal prism (idealized point group 32, deviation from idealized values δ = 13.690), and the two O atoms at longer distances cap opposite faces (Fig. 2).

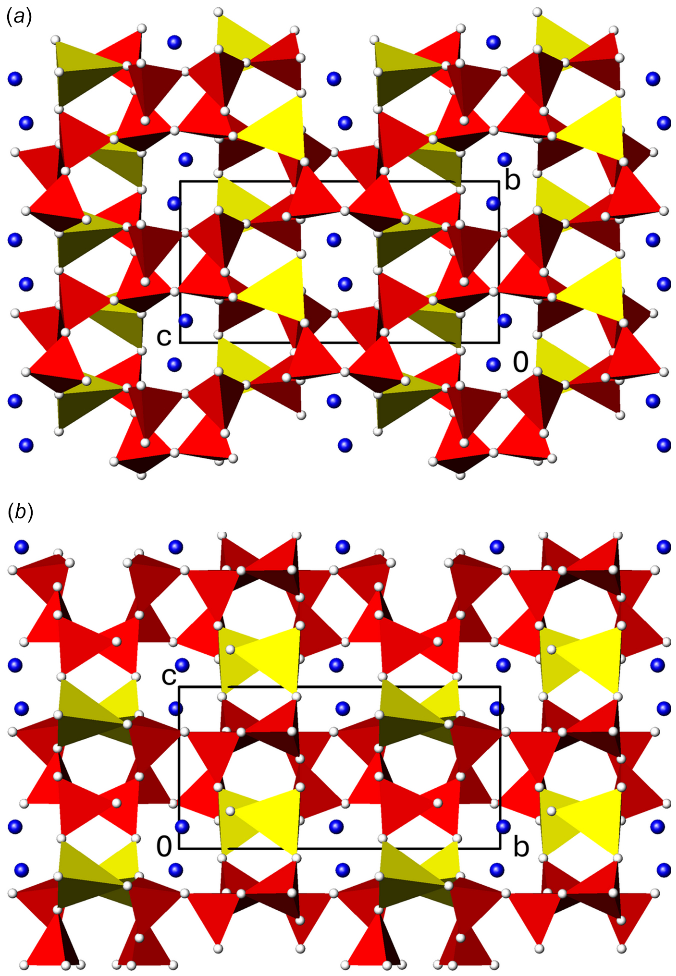

Figure 3
Comparison of the crystal structures of $SrZnSi_3O_8$ (*a*), projection along [$\overline{1}$00]) and $BaZnSi_3O_8$ (*b*), projection along [100]). Alkaline earth cations are shown as blue spheres, ZnO_4 tetrahedra are yellow and SiO_4 tetrahedra are red.

The plausibility of the $SrZnSi_3O_8$ structure model was verified and confirmed using bond-valence-sum calculations (Brown, 2002) performed with the *ECoN21* program (Ilinca, 2022). The calculated bond-valence sums (Table 2) are close to the expected values, and the global instability index (GII) of 0.10 valence units indicates a stable and not particularly strained crystal structure (Salinas-Sanchez *et al.*, 1992; Brown, 2009).

The same formula type, the same space group type and similar lattice parameters might suggest that $SrZnSi_3O_8$ and $BaZnSi_3O_8$ are isotypic to one another. However, a closer look at the crystal structures (under consideration of the corrected *x* parameter for Zn1 in the $BaZnSi_3O_8$ structure, see above) reveals that the two crystalline phases are isopointal (Lima-de-Faria *et al.*, 1990). As shown in Fig. 3, the crystal structures are clearly distinct from one another, with a different arrangement of the alkaline earth metal sites and the positions of ZnO_4 tetrahedra within the tetrahedral framework.

3. Synthesis and crystallization

SiO_2 (Fluka, purum), $SrCO_3$ (Merck, pure) and ZnO were weighted according to a composition of $Sr_{1.9}Zn_{0.1}SiO_4$ (total 2 g). During intensive mixing of the powders in an achate mortar, small amounts of EuF_3 (Aldrich, 99+; approx. 10 mg) were added as a dopant. The mixture was then compressed to a pellet that was heated in a corundum crucible at 1543 K for one day. After the reaction, the slightly yellowish sample appeared glassy in some places. A small colourless single crystal of the title compound was extracted from this matrix.

4. Refinement

Crystal data, data collection and structure refinement details are summarized in Table 3. The non-reduced setting of the unit cell was used to emphasize the relationship to the crystal structures of other feldspar group minerals (e.g. microcline, low-albite, high-albite, reedmergernite) listed by Smith (1974). Similarly, the atomic labelling [Zn1 = $T_1(0)$, Si1 = $T_1(m)$, Si2 = $T_2(0)$, Si3 = $T_2(m)$, O1 = $O_A(1)$, O2 = $O_A(2)$, O3 = $O_B(0)$, O4 = $O_B(m)$, O5 = $O_C(0)$, O6 = $O_C(m)$, O7 = $O_D(0)$, O8 = $O_D(m)$] and atomic coordinates were also adjusted to the atomic parameters listed there. In order to check for any possible co-occupation of Zn and Si (and *vice versa*), the site occupation factor (s.o.f.) of each Zn1, Si1, Si2 and Si3 site was freely refined (constraining all other sites to be fully occupied). In all cases, the free refinement converged at s.o.f. values very close to 1.0, showing no co-occupation.

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Computing details

Strontium *tecto*-zincotrisilicate

Crystal data

$SrZnSi_3O_8$
$M_r = 365.26$
Monoclinic, $P2_1/n$
$a = 8.3060$ (8) Å
$b = 13.0111$ (13) Å
$c = 7.2454$ (7) Å
$\beta = 114.822$ (2)°
$V = 710.67$ (12) Å^3
$Z = 4$
$F(000) = 696$
$D_x = 3.414$ Mg m^{-3}
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 2419 reflections
$\theta = 3.1$–30.0°
$\mu = 11.40$ mm^{-1}
$T = 293$ K
Fragment, colourless
0.06 × 0.04 × 0.03 mm

Data collection

Bruker SMART APEXII CCD diffractometer
Radiation source: fine-focus sealed tube
Graphite monochromator
ω–scans
Absorption correction: multi-scan (SADABS; Krause *et al.*, 2015)
$T_{min} = 0.548$, $T_{max} = 0.764$
7658 measured reflections
2057 independent reflections
1745 reflections with $I > 2\sigma(I)$
$R_{int} = 0.035$
$\theta_{max} = 30.0°$, $\theta_{min} = 3.1°$
$h = -11 \rightarrow 11$
$k = -18 \rightarrow 18$
$l = -10 \rightarrow 9$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.029$
$wR(F^2) = 0.069$
$S = 1.03$
2057 reflections
118 parameters
0 restraints
$w = 1/[\sigma^2(F_o^2) + (0.0377P)^2 + 0.2907P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} = 0.001$
$\Delta\rho_{max} = 0.88$ e Å^{-3}
$\Delta\rho_{min} = -0.67$ e Å^{-3}

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 (Å^2)

	x	y	z	U_{iso}*/U_{eq}
Sr1	0.26316 (4)	0.98248 (2)	0.13696 (5)	0.01620 (10)
Zn1	0.02329 (5)	0.18835 (3)	0.20052 (6)	0.01043 (10)
Si1	−0.02817 (11)	0.83033 (6)	0.24716 (13)	0.00802 (17)
Si2	0.70774 (11)	0.12373 (7)	0.32678 (13)	0.00844 (17)
Si3	0.67150 (11)	0.89689 (7)	0.38177 (13)	0.00864 (17)
O1	0.0187 (3)	0.11994 (18)	0.9496 (3)	0.0128 (5)
O2	0.6002 (3)	0.01681 (16)	0.3169 (3)	0.0103 (4)
O3	0.8042 (3)	0.12069 (18)	0.1797 (4)	0.0147 (5)
O4	0.8007 (3)	0.87771 (19)	0.2669 (4)	0.0191 (5)
O5	0.0104 (3)	0.33381 (17)	0.2183 (4)	0.0132 (5)
O6	−0.0480 (3)	0.70691 (17)	0.2380 (4)	0.0137 (5)
O7	0.2234 (3)	0.10919 (19)	0.3782 (3)	0.0163 (5)
O8	0.1561 (3)	0.85914 (19)	0.4367 (4)	0.0175 (5)

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Sr1	0.00884 (14)	0.01500 (16)	0.02113 (18)	0.00124 (11)	0.00275 (12)	−0.00635 (12)
Zn1	0.01131 (18)	0.00930 (18)	0.01112 (19)	0.00110 (13)	0.00514 (14)	−0.00009 (13)
Si1	0.0077 (4)	0.0086 (4)	0.0086 (4)	−0.0006 (3)	0.0042 (3)	−0.0005 (3)
Si2	0.0078 (4)	0.0080 (4)	0.0093 (4)	−0.0005 (3)	0.0034 (3)	0.0001 (3)
Si3	0.0076 (4)	0.0074 (4)	0.0112 (4)	0.0010 (3)	0.0042 (3)	0.0002 (3)
O1	0.0173 (11)	0.0135 (11)	0.0105 (11)	−0.0011 (9)	0.0088 (9)	0.0003 (8)
O2	0.0093 (10)	0.0062 (10)	0.0142 (11)	−0.0005 (8)	0.0039 (9)	0.0019 (8)
O3	0.0148 (11)	0.0156 (11)	0.0177 (12)	−0.0021 (9)	0.0107 (10)	−0.0003 (9)
O4	0.0181 (12)	0.0172 (12)	0.0294 (14)	0.0011 (10)	0.0172 (11)	−0.0038 (10)
O5	0.0118 (10)	0.0082 (10)	0.0191 (12)	0.0012 (8)	0.0061 (9)	0.0002 (9)
O6	0.0123 (11)	0.0083 (10)	0.0218 (12)	−0.0014 (8)	0.0085 (10)	−0.0011 (9)
O7	0.0157 (11)	0.0167 (12)	0.0124 (12)	0.0046 (9)	0.0019 (10)	0.0025 (9)
O8	0.0155 (11)	0.0176 (12)	0.0128 (12)	−0.0026 (9)	−0.0006 (10)	−0.0031 (9)

Geometric parameters (Å, º)

Sr1—O3^{i}	2.510 (2)	Si1—O1^{iii}	1.597 (2)
Sr1—O7^{ii}	2.523 (2)	Si1—O4^{vii}	1.610 (2)
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Sr1—O5^{iv}	2.593 (2)	Si2—O3	1.580 (2)
Sr1—O1^{v}	2.617 (2)	Si2—O6^{ix}	1.621 (2)
Sr1—O8	3.115 (3)	Si2—O8^{x}	1.624 (2)
Sr1—O4^{vi}	3.294 (3)	Si2—O2	1.638 (2)
Zn1—O5	1.903 (2)	Si3—O7^{x}	1.587 (2)
Zn1—O7	1.920 (2)	Si3—O5^{iv}	1.601 (2)
Zn1—O3^{vii}	1.969 (2)	Si3—O4	1.630 (3)
Zn1—O1^{viii}	2.010 (2)	Si3—O2^{ii}	1.665 (2)

O3^{i}—Sr1—O7^{ii}	159.85 (8)
O3^{i}—Sr1—O1^{iii}	70.38 (7)
O7^{ii}—Sr1—O1^{iii}	98.00 (8)
O3^{i}—Sr1—O2^{ii}	109.40 (7)
O7^{ii}—Sr1—O2^{ii}	88.09 (7)
O1^{iii}—Sr1—O2^{ii}	155.38 (7)
O3^{i}—Sr1—O5^{iv}	79.41 (8)
O7^{ii}—Sr1—O5^{iv}	119.40 (7)
O1^{iii}—Sr1—O5^{iv}	98.38 (7)
O2^{ii}—Sr1—O5^{iv}	58.43 (7)
O3^{i}—Sr1—O1^{v}	93.71 (7)
O7^{ii}—Sr1—O1^{v}	67.31 (7)
O1^{iii}—Sr1—O1^{v}	78.22 (8)
O2^{ii}—Sr1—O1^{v}	125.74 (7)
O5^{iv}—Sr1—O1^{v}	173.05 (7)
O3^{i}—Sr1—O8	110.02 (7)
O7^{ii}—Sr1—O8	72.24 (7)
O1^{iii}—Sr1—O8	52.92 (6)
O2^{ii}—Sr1—O8	107.66 (7)
O5^{iv}—Sr1—O8	72.81 (7)
O1^{v}—Sr1—O8	109.11 (7)
O3^{i}—Sr1—O4^{vi}	65.95 (7)
O7^{ii}—Sr1—O4^{vi}	103.62 (7)
O1^{iii}—Sr1—O4^{vi}	106.45 (7)
O2^{ii}—Sr1—O4^{vi}	95.10 (7)
O5^{iv}—Sr1—O4^{vi}	126.17 (7)
O1^{v}—Sr1—O4^{vi}	50.31 (6)
O8—Sr1—O4^{vi}	156.53 (6)
O5—Zn1—O7	123.07 (10)
O5—Zn1—O3^{vii}	111.92 (10)
O7—Zn1—O3^{vii}	108.89 (10)
O5—Zn1—O1^{viii}	121.42 (10)
O7—Zn1—O1^{viii}	92.94 (10)
O3^{vii}—Zn1—O1^{viii}	93.82 (10)
O1^{iii}—Si1—O4^{vii}	107.47 (13)
O1^{iii}—Si1—O6	114.14 (13)
O4^{vii}—Si1—O6	107.82 (13)
O1^{iii}—Si1—O8	106.32 (13)
O4^{vii}—Si1—O8	113.13 (14)
O6—Si1—O8	108.09 (13)
O3—Si2—O6^{ix}	113.99 (13)
O3—Si2—O8^{x}	112.93 (13)
O6^{ix}—Si2—O8^{x}	109.65 (14)
O3—Si2—O2	111.75 (13)
O6^{ix}—Si2—O2	100.91 (12)
O8^{x}—Si2—O2	106.74 (13)
O7^{x}—Si3—O5^{iv}	116.82 (14)
O7^{x}—Si3—O4	112.02 (14)
O5^{iv}—Si3—O4	112.87 (13)
O7^{x}—Si3—O2^{ii}	108.85 (13)
O5^{iv}—Si3—O2^{ii}	101.33 (12)
O4—Si3—O2^{ii}	103.38 (13)
Si1^{iii}—O1—Zn1^{xi}	129.67 (14)
Si1^{iii}—O1—Sr1^{iii}	112.26 (11)
Zn1^{xi}—O1—Sr1^{iii}	96.98 (9)
Si1^{iii}—O1—Sr1^{xii}	114.94 (12)
Zn1^{xi}—O1—Sr1^{xii}	96.74 (8)
Sr1^{iii}—O1—Sr1^{xii}	101.78 (8)
Si2—O2—Si3^{xiii}	131.35 (14)
Si2—O2—Sr1^{xiii}	128.63 (11)
Si3^{xiii}—O2—Sr1^{xiii}	99.33 (10)
Si2—O3—Zn1^{xiv}	130.61 (14)
Si2—O3—Sr1^{i}	130.42 (13)
Zn1^{xiv}—O3—Sr1^{i}	98.83 (9)
Si1^{xiv}—O4—Si3	154.04 (19)
Si1^{xiv}—O4—Sr1^{vi}	87.21 (11)
Si3—O4—Sr1^{vi}	118.31 (12)
Si3^{ix}—O5—Zn1	123.27 (13)
Si3^{ix}—O5—Sr1^{ix}	100.79 (10)
Zn1—O5—Sr1^{ix}	135.84 (11)
Si1—O6—Si2^{iv}	137.20 (16)
Si3^{x}—O7—Zn1	133.22 (15)
Si3^{x}—O7—Sr1^{xiii}	123.71 (13)
Zn1—O7—Sr1^{xiii}	102.37 (10)
Si1—O8—Si2^{x}	157.11 (19)
Si1—O8—Sr1	88.43 (10)
Si2^{x}—O8—Sr1	112.89 (12)

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