Full wwPDB X-ray Structure Validation Report ⓘ

Aug 23, 2026 – 08:31 am BST

PDB ID	:	8RTK / pdb_00008rtk
Title	:	X-ray structure of lysozyme obtained upon reaction with [VIVO(8-HQ)2] in sodium formate
Authors	:	Paolillo, M.; Ferraro, G.; Merlino, A.
Deposited on	:	2024-01-26
Resolution	:	1.21 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at *validation@mail.wwpdb.org*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

The following versions of software and data (see references ⓘ) were used in the production of this report:

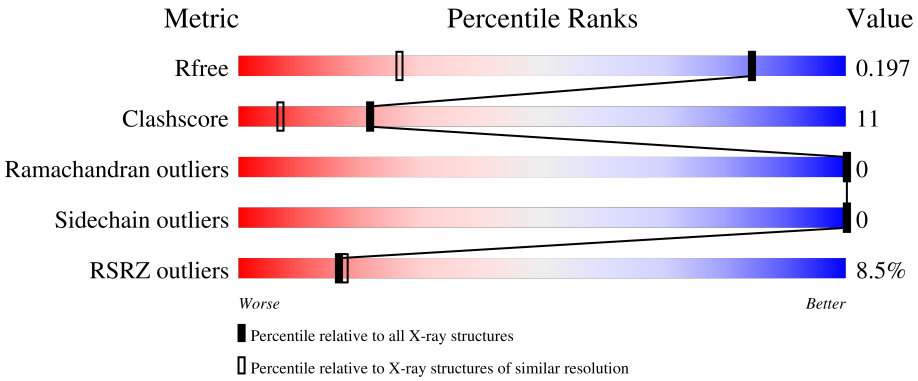
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.015 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.50

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.21 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	2002 (1.24-1.20)
Clashscore	190562	2061 (1.24-1.20)
Ramachandran outliers	187476	2009 (1.24-1.20)
Sidechain outliers	187428	2008 (1.24-1.20)
RSRZ outliers	180081	2000 (1.24-1.20)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	AAA	129	9% 88% 12%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	EPE	AAA	201[B]	-	-	X	-

2 Entry composition

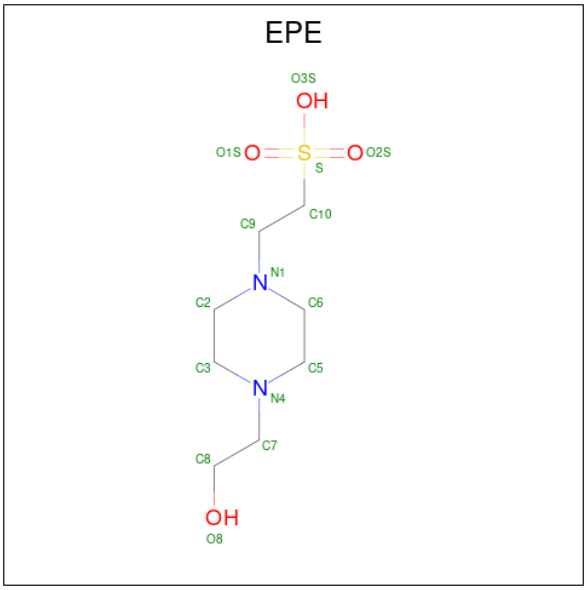
There are 6 unique types of molecules in this entry. The entry contains 1284 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Lysozyme C.

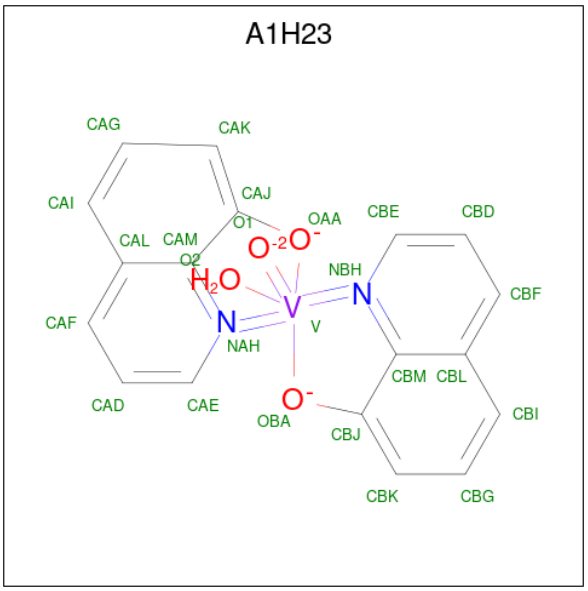
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	AAA	129	1073	654	209	200	10	0	11	0

- Molecule 2 is 4-(2-HYDROXYETHYL)-1-PIPERAZINE ETHANESULFONIC ACID (CCD ID: EPE) (formula: $C_8H_{18}N_2O_4S$).



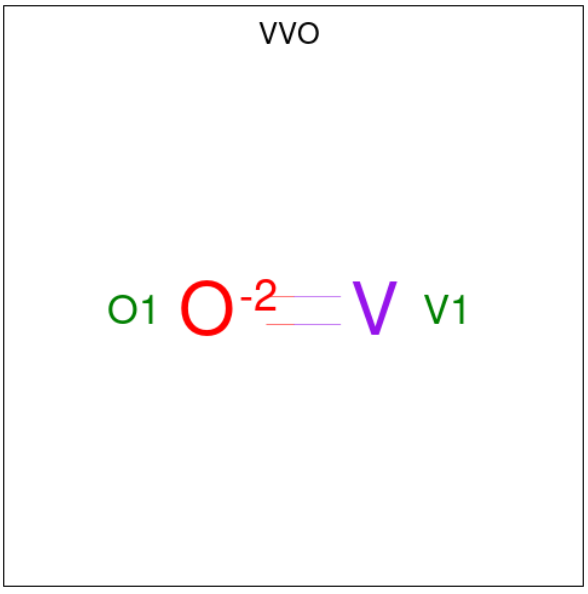
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	S		
2	AAA	1	30	16	4	8	2	0	1

- Molecule 3 is 2-$l^{3}-oxidanyl-2,2'-spirobi[3-oxa-1$l^{5}-aza-2$l^{9}-vanadatricyclo[6.3.1.0^{4,12}]dodeca-1,1(12),4,6,8,10-hexaene] 2-oxide (CCD ID: A1H23) (formula: $C_{18}H_{14}N_2O_4V$) (labeled as "Ligand of Interest" by depositor).



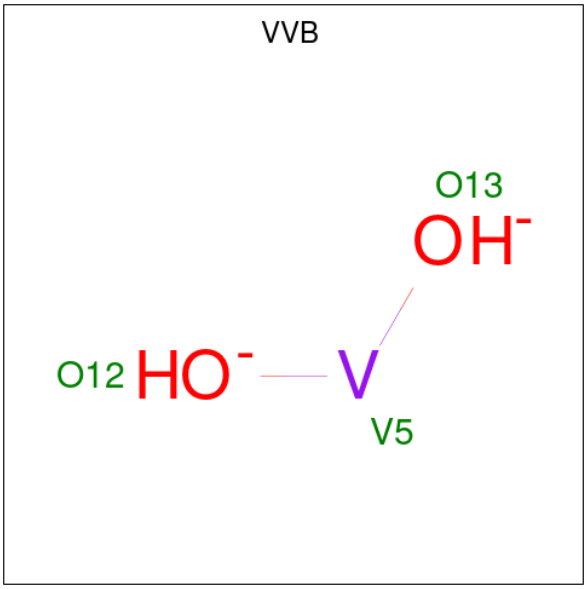
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	AAA	1	Total	C	N	O	V	0	0
			25	18	2	4	1		

- Molecule 4 is oxovanadium(2+) (CCD ID: VVO) (formula: OV) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	AAA	1	Total	O	V		0	1
			2	1	1			
4	AAA	1	Total	O	V		0	0
			2	1	1			

- Molecule 5 is bis(oxidanyl)vanadium (CCD ID: VVB) (formula: H_2O_2V) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	AAA	1	Total O V 3 2 1	0	1

- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	AAA	148	Total O 149 149	0	9

3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density (RSRZ > 2). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: Lysozyme C

Chain AAA:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, α, β, γ	77.08Å 77.08Å 37.53Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	38.54 – 1.21 38.54 – 1.21	Depositor EDS
% Data completeness (in resolution range)	100.0 (38.54-1.21) 100.0 (38.54-1.21)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.35 (at 1.21Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.173 , 0.192 0.179 , 0.197	Depositor DCC
R_{free} test set	1734 reflections (4.95%)	wwPDB-VP
Wilson B-factor (Å^2)	16.4	Xtriage
Anisotropy	0.011	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 35.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	1284	wwPDB-VP
Average B, all atoms (Å^2)	21.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.54% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: VVB, EPE, VVO, A1H23

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\#\|Z\| > 5$	RMSZ	$\#\|Z\| > 5$
1	AAA	1.11	0/1107	1.11	0/1495

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	AAA	1073	0	1023	20	1
2	AAA	30	0	36	7	0
3	AAA	25	0	0	1	0
4	AAA	4	0	0	1	0
5	AAA	3	0	0	0	0
6	AAA	149	0	0	6	0
All	All	1284	0	1059	24	1

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 11.

All (24) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:AAA:201[B]:EPE:H32	6:AAA:382[B]:HOH:O	1.01	1.17
1:AAA:78:ILE:HD12	1:AAA:83[B]:LEU:HD11	1.52	0.91
1:AAA:14[B]:ARG:NH2	6:AAA:301:HOH:O	2.17	0.76
1:AAA:78:ILE:CD1	1:AAA:83[B]:LEU:HD11	2.19	0.70
1:AAA:83[B]:LEU:HD12	1:AAA:83[B]:LEU:N	2.11	0.66
1:AAA:59[B]:ASN:HD21	1:AAA:61:ARG:HB3	1.62	0.64
1:AAA:78:ILE:HD12	1:AAA:83[B]:LEU:CD1	2.27	0.62
4:AAA:203[B]:VVO:V1	4:AAA:203[B]:VVO:O1	1.56	0.62
1:AAA:83[B]:LEU:N	1:AAA:83[B]:LEU:CD1	2.62	0.61
1:AAA:109[B]:VAL:HG11	2:AAA:201[B]:EPE:H91	1.83	0.59
3:AAA:202:A1H23:CBE	6:AAA:341:HOH:O	2.50	0.59
1:AAA:15:HIS:HB3	1:AAA:92:VAL:HG11	1.86	0.58
1:AAA:59[B]:ASN:ND2	1:AAA:61:ARG:H	2.00	0.57
1:AAA:109[B]:VAL:HG12	2:AAA:201[B]:EPE:H22	1.88	0.56
1:AAA:58:ILE:HB	1:AAA:83[B]:LEU:HD23	1.93	0.51
1:AAA:46:ASN:OD1	1:AAA:59[A]:ASN:ND2	2.48	0.47
1:AAA:57:GLN:O	2:AAA:201[B]:EPE:H81	2.17	0.45
1:AAA:57:GLN:O	2:AAA:201[B]:EPE:C8	2.66	0.44
1:AAA:59[B]:ASN:HB2	2:AAA:201[B]:EPE:H72	2.00	0.43
1:AAA:60:SER:O	6:AAA:302:HOH:O	2.21	0.43
2:AAA:201[B]:EPE:C3	6:AAA:382[B]:HOH:O	1.89	0.42
1:AAA:59[B]:ASN:HD21	1:AAA:61:ARG:CB	2.29	0.41
1:AAA:119:ASP:OD2	1:AAA:125:ARG:NH2	2.54	0.41
1:AAA:97:LYS:NZ	6:AAA:308:HOH:O	2.43	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:AAA:129:LEU:O	1:AAA:129:LEU:O[8_554]	1.42	0.78

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	AAA	137/129 (106%)	135 (98%)	2 (2%)	0	100 100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	AAA	116/105 (110%)	116 (100%)	0	100 100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA (i)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates (i)

There are no oligosaccharides in this entry.

5.6 Ligand geometry (i)

6 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond

length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
5	VVB	AAA	204[A]	6	0,2,2	-	-	-		
4	VVO	AAA	205	1	0,1,1	-	-	-		
3	A1H23	AAA	202	-	19,30,30	1.86	4 (21%)	16,53,53	2.33	2 (12%)
4	VVO	AAA	203[B]	6	0,1,1	-	-	-		
2	EPE	AAA	201[A]	-	15,15,15	0.98	1 (6%)	18,20,20	1.18	3 (16%)
2	EPE	AAA	201[B]	-	15,15,15	0.71	1 (6%)	18,20,20	0.63	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	EPE	AAA	201[A]	-	-	5/9/19/19	0/1/1/1
3	A1H23	AAA	202	-	-	-	0/6/6/6
2	EPE	AAA	201[B]	-	-	3/9/19/19	0/1/1/1

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	AAA	202	A1H23	OAA-V	-4.22	1.75	1.98
3	AAA	202	A1H23	OBA-V	-4.12	1.76	1.98
2	AAA	201[A]	EPE	O3S-S	3.69	1.60	1.47
3	AAA	202	A1H23	CAK-CAJ	-2.52	1.36	1.41
3	AAA	202	A1H23	CBK-CBJ	-2.42	1.37	1.41
2	AAA	201[B]	EPE	O3S-S	2.33	1.55	1.47

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	AAA	202	A1H23	CAD-CAF-CAL	6.08	126.69	119.49
3	AAA	202	A1H23	CBL-CBF-CBD	6.00	126.60	119.49
2	AAA	201[A]	EPE	O3S-S-C10	-3.00	100.92	105.77
2	AAA	201[A]	EPE	O3S-S-O1S	-2.55	105.04	111.27
2	AAA	201[A]	EPE	O2S-S-O1S	2.22	121.62	113.95

There are no chirality outliers.

All (8) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	AAA	201[A]	EPE	C9-C10-S-O1S
2	AAA	201[B]	EPE	C9-C10-S-O1S
2	AAA	201[B]	EPE	C9-C10-S-O3S
2	AAA	201[A]	EPE	C9-C10-S-O3S
2	AAA	201[A]	EPE	C10-C9-N1-C6
2	AAA	201[A]	EPE	C9-C10-S-O2S
2	AAA	201[B]	EPE	C9-C10-S-O2S
2	AAA	201[A]	EPE	C10-C9-N1-C2

There are no ring outliers.

3 monomers are involved in 9 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	AAA	202	A1H23	1	0
4	AAA	203[B]	VVO	1	0
2	AAA	201[B]	EPE	7	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

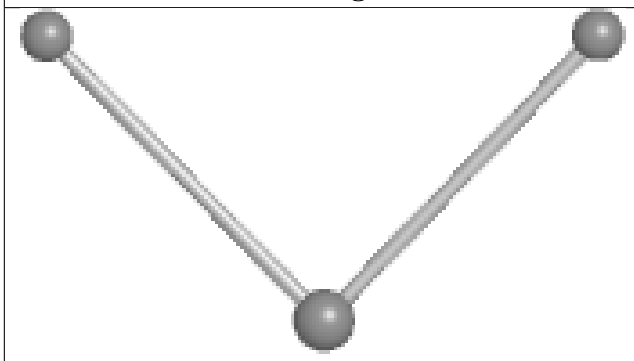
Ligand VVB AAA 204 (A)



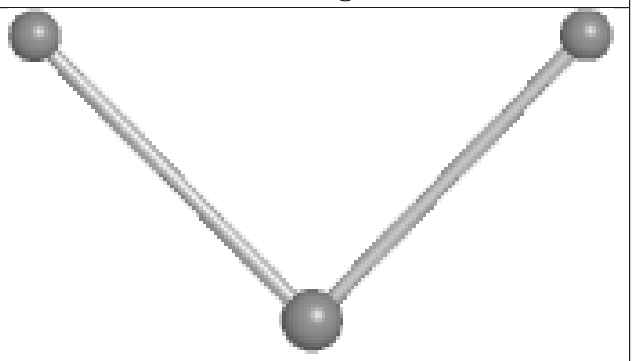
Bond lengths



Bond angles



Torsions



Rings

Ligand VVO AAA 205



Bond lengths



Bond angles

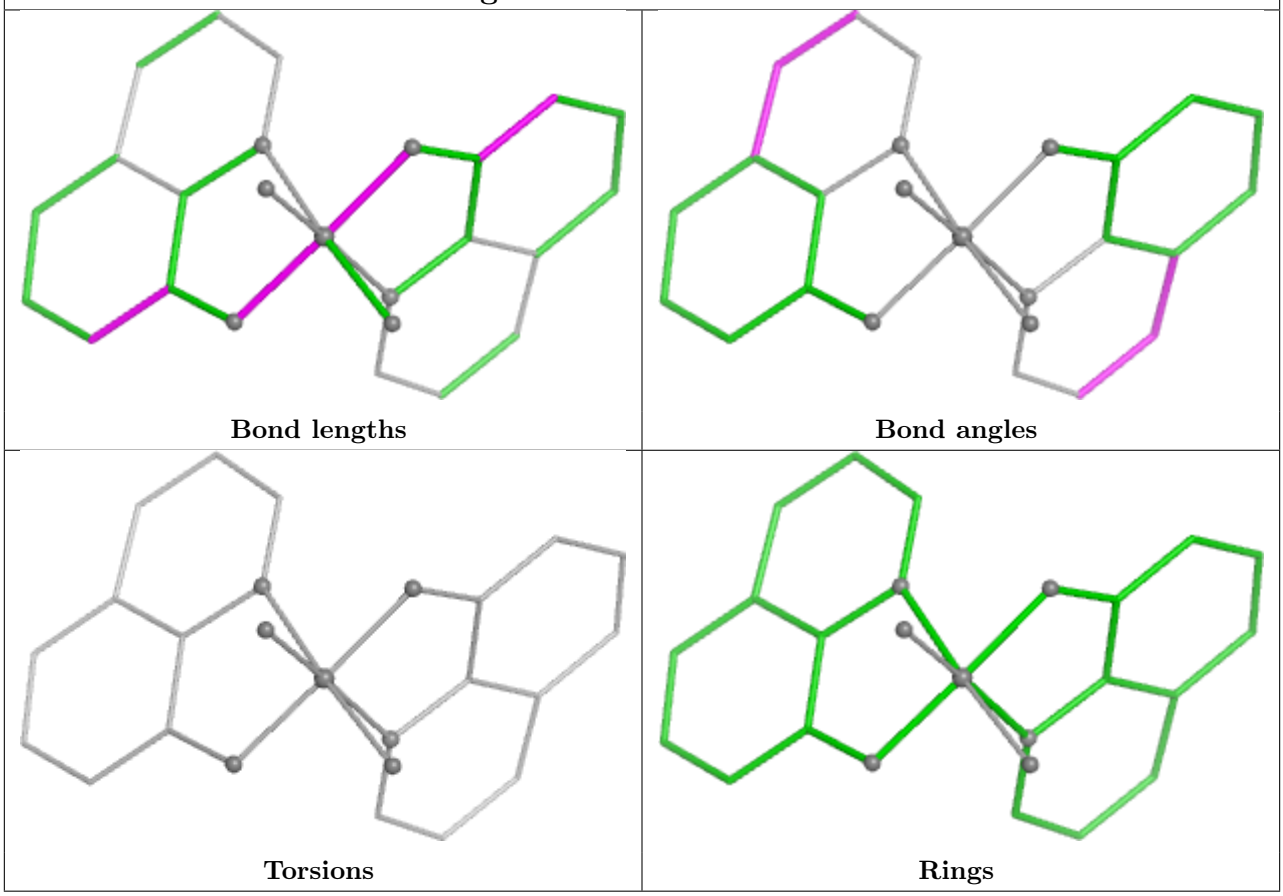


Torsions

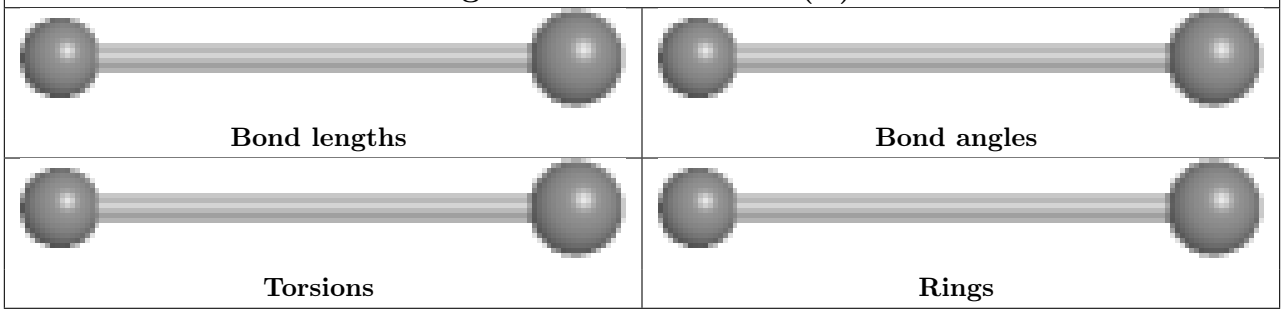


Rings

Ligand A1H23 AAA 202



Ligand VVO AAA 203 (B)



5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å^2)	Q<0.9
1	AAA	129/129 (100%)	0.56	11 (8%) 16 17	8, 17, 31, 40	11 (8%)

All (11) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	AAA	129	LEU	3.0
1	AAA	71	GLY	2.9
1	AAA	61	ARG	2.9
1	AAA	101	ASP	2.9
1	AAA	125	ARG	2.5
1	AAA	62	TRP	2.3
1	AAA	121	GLN	2.3
1	AAA	72	SER	2.2
1	AAA	102	GLY	2.2
1	AAA	14[A]	ARG	2.1
1	AAA	70	PRO	2.1

6.2 Non-standard residues in protein, DNA, RNA chains

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates

There are no oligosaccharides in this entry.

6.4 Ligands

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum,

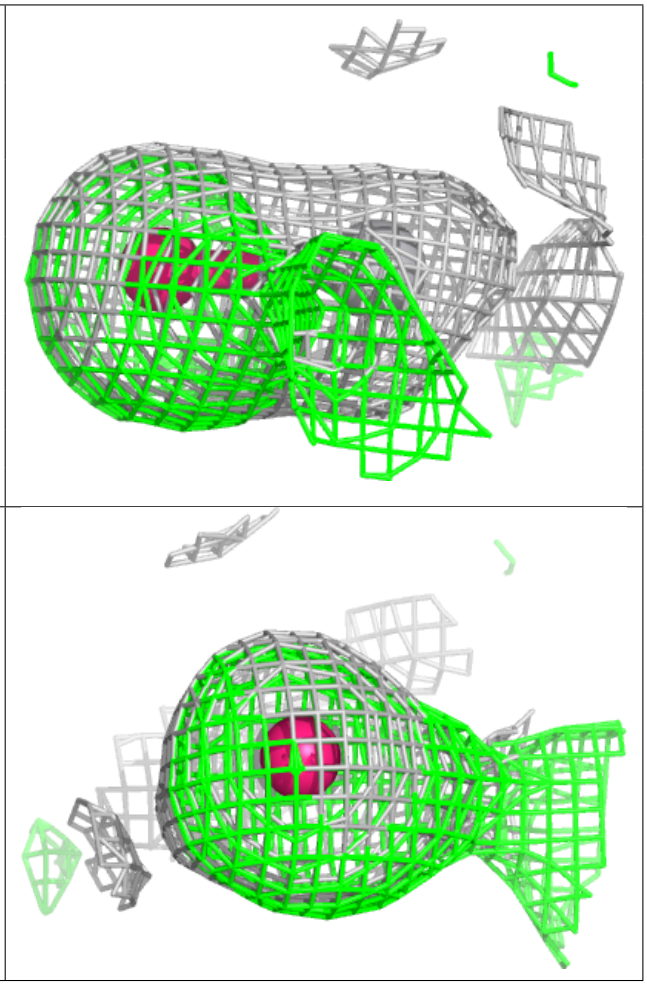
median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

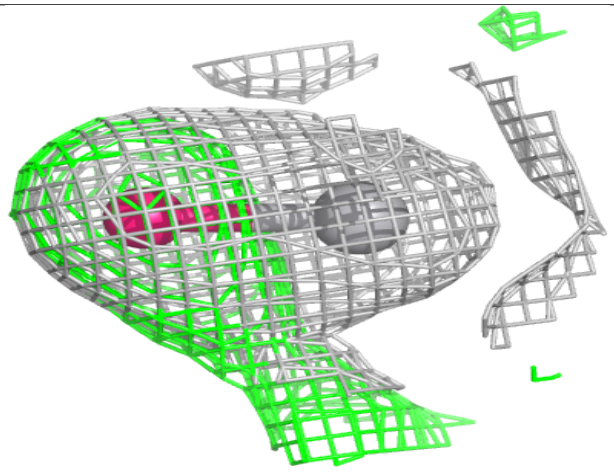
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
4	VVO	AAA	203[B]	2/2	0.53	0.24	13,13,13,24	2
5	VVB	AAA	204[A]	3/3	0.70	0.27	14,14,20,22	3
3	A1H23	AAA	202	25/25	0.75	0.23	33,36,38,39	25
4	VVO	AAA	205	2/2	0.77	0.30	23,23,23,33	2
2	EPE	AAA	201[A]	15/15	0.81	0.16	13,21,24,29	15
2	EPE	AAA	201[B]	15/15	0.81	0.16	25,48,53,54	15

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around VVO AAA 203 (B):

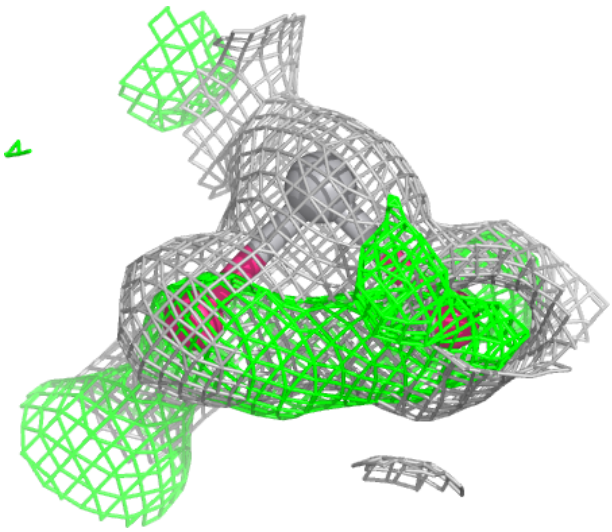
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

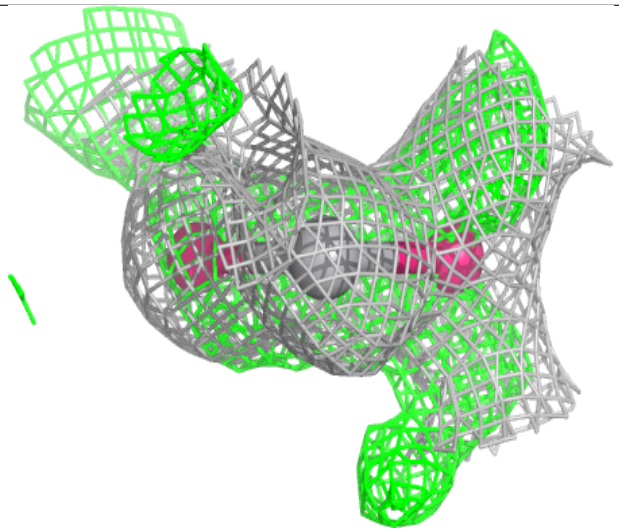


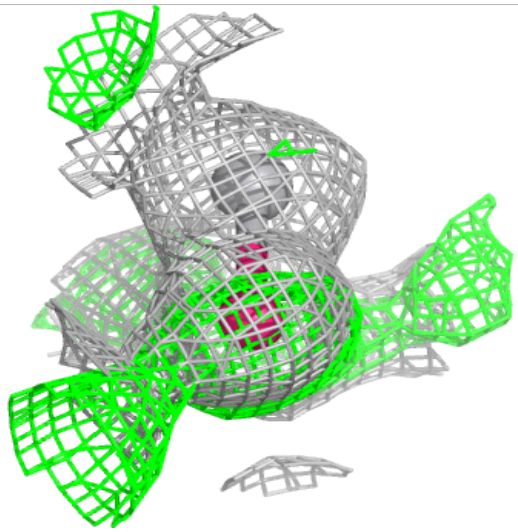


Electron density around VVB AAA 204 (A):

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

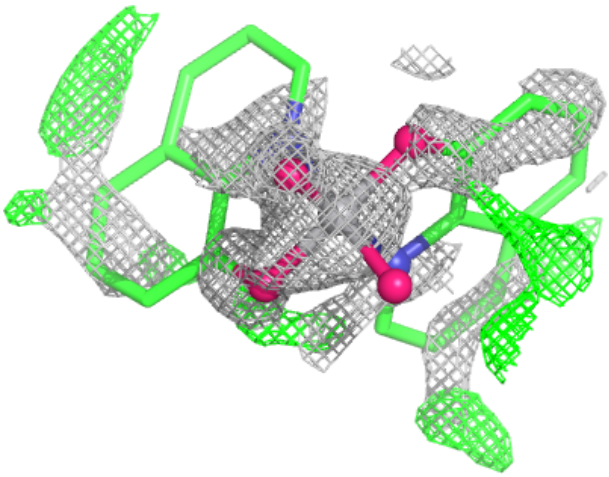


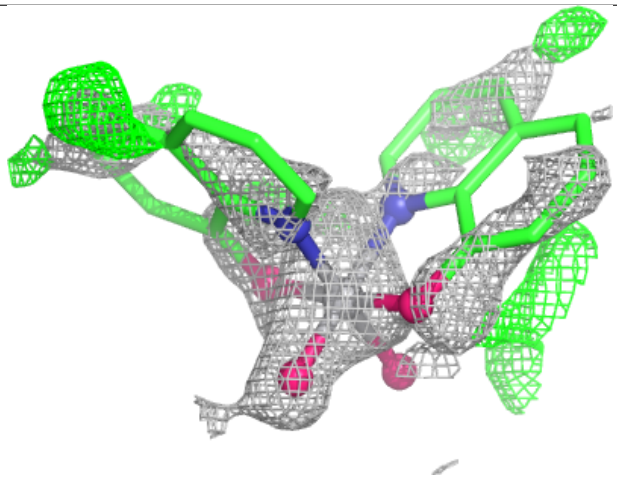


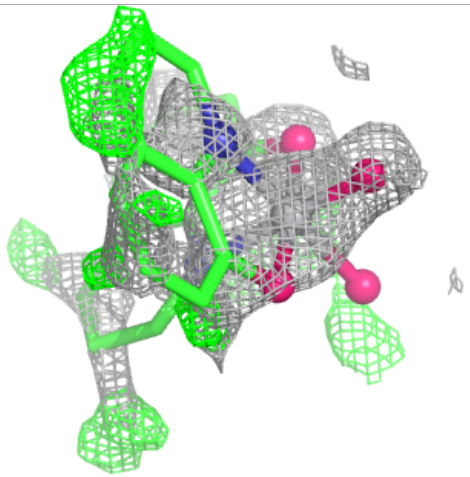


Electron density around A1H23 AAA 202:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

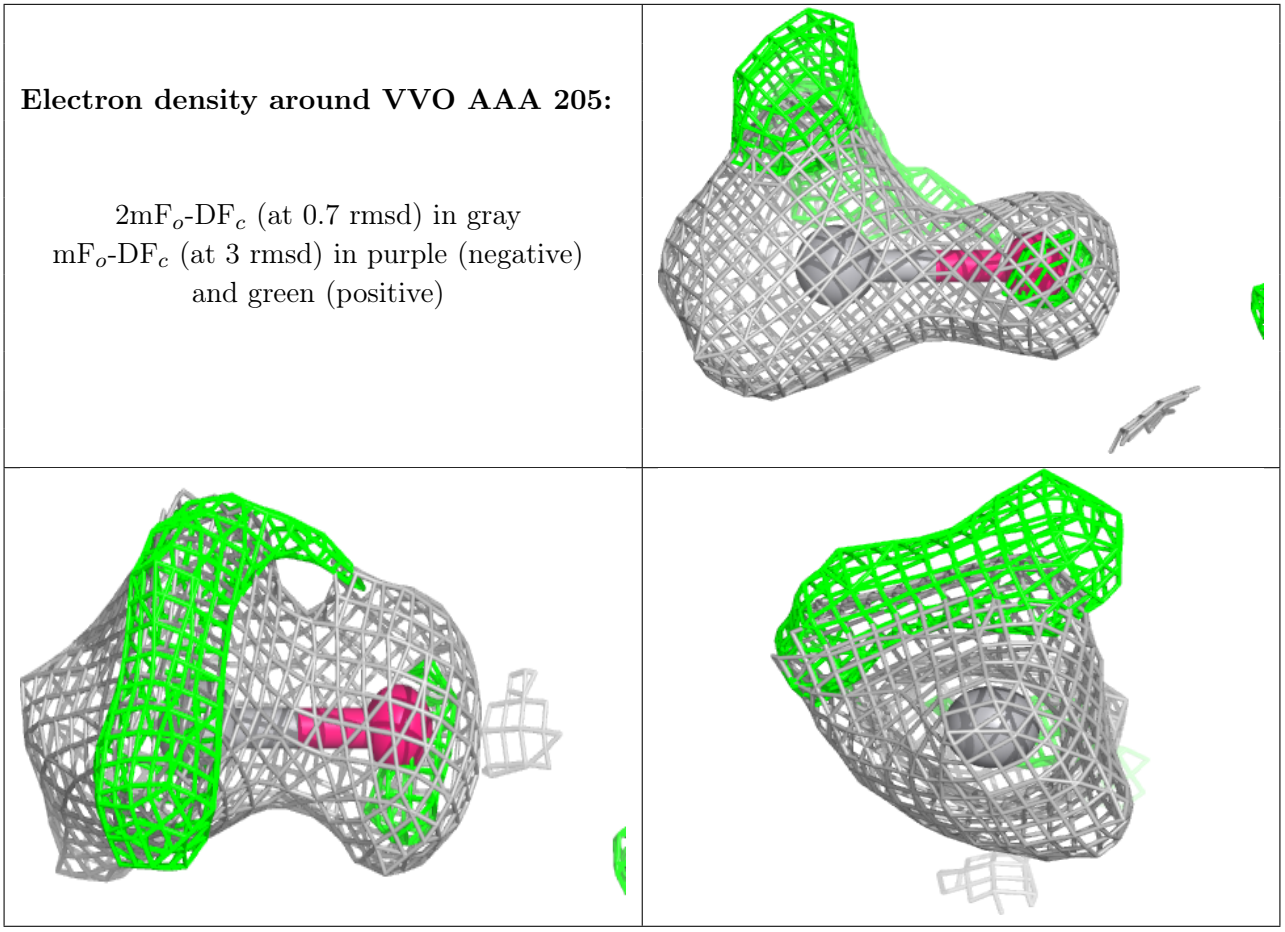






Electron density around VVO AAA 205:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)



6.5 Other polymers

There are no such residues in this entry.