Full wwPDB X-ray Structure Validation Report ⓘ

Nov 13, 2025 – 03:51 pm GMT

PDB ID	:	9RC3 / pdb_00009rc3
Title	:	Laccase (multicopper oxidase) from Pediococcus pentosaceus 4618 co-crystallized with Silver Nitrate
Authors	:	Paredes, F.; Casino, P.
Deposited on	:	2025-05-27
Resolution	:	2.70 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:

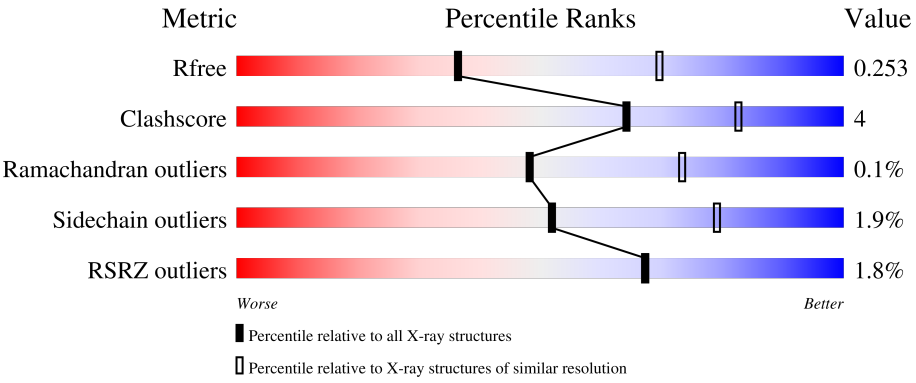
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.46

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 2.70 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}	164625	3333 (2.70-2.70)
Clashscore	180529	3684 (2.70-2.70)
Ramachandran outliers	177936	3633 (2.70-2.70)
Sidechain outliers	177891	3633 (2.70-2.70)
RSRZ outliers	164620	3333 (2.70-2.70)

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	A	532	2% 78% 7% • 14%
1	B	532	% 79% 7% • 13%

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	CU	B	604	-	-	X	-

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 7347 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 Multicopper oxidase, type 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	460	Total	C	N	O	S	0	0	0
			3645	2327	622	682	14			
1	B	462	Total	C	N	O	S	0	1	0
			3663	2337	626	686	14			

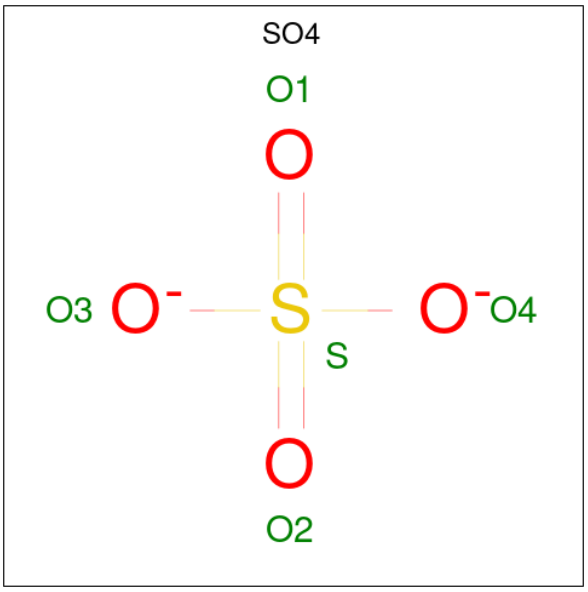
- Molecule 2 is COPPER (II) ION (CCD ID: CU) (formula: Cu).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	4	Total	Cu	0	0
			4	4		
2	B	4	Total	Cu	0	0
			4	4		

- Molecule 3 is SILVER ION (CCD ID: AG) (formula: Ag).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Ag	0	0
			1	1		
3	B	1	Total	Ag	0	0
			1	1		

- Molecule 4 is SULFATE ION (CCD ID: SO4) (formula: O_4S).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total O S 5 4 1	0	0
4	B	1	Total O S 5 4 1	0	0

- Molecule 5 is water.

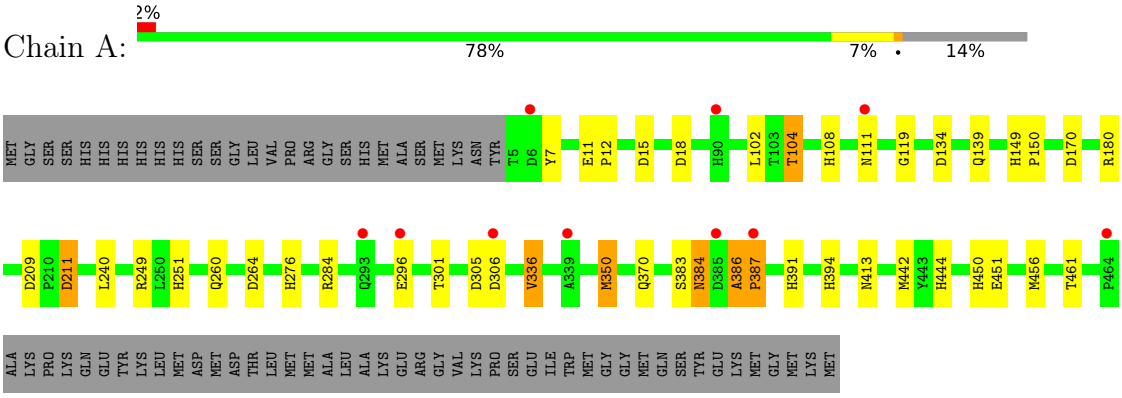
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	12	Total O 12 12	0	0
5	B	7	Total O 7 7	0	0

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.

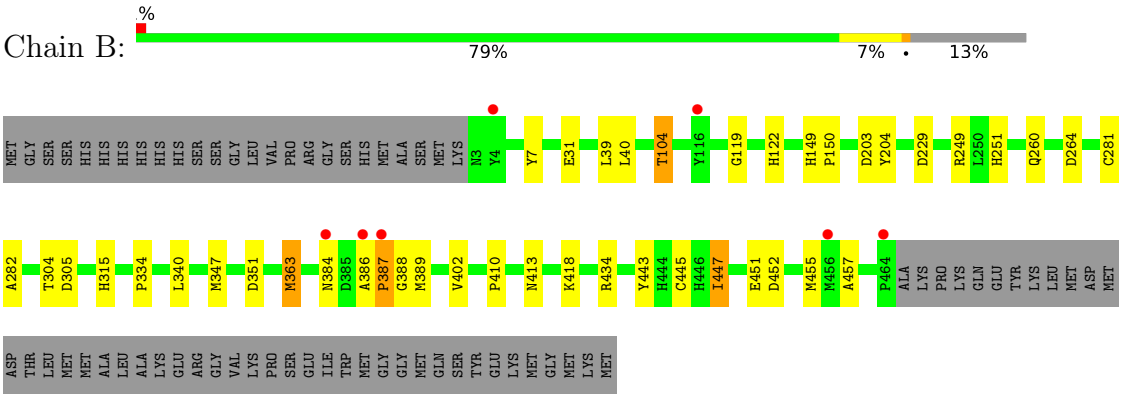
• Molecule 1: Multicopper oxidase, type 2

Chain A:



• Molecule 1: Multicopper oxidase, type 2

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, α, β, γ	121.12Å 121.12Å 174.56Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	104.89 – 2.70 104.89 – 2.70	Depositor EDS
% Data completeness (in resolution range)	99.9 (104.89-2.70) 99.9 (104.89-2.70)	Depositor EDS
R_{merge}	0.18	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.04 (at 2.69Å)	Xtriage
Refinement program	REFMAC 5.8.0425	Depositor
R, R_{free}	0.202 , 0.249 0.208 , 0.253	Depositor DCC
R_{free} test set	2004 reflections (4.85%)	wwPDB-VP
Wilson B-factor (Å^2)	56.8	Xtriage
Anisotropy	0.067	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.37 , 43.4	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.021 for -h,-k,l	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	7347	wwPDB-VP
Average B, all atoms (Å^2)	57.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.95% 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: CU, SO4, AG

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	A	0.52	0/3760	0.95	9/5142 (0.2%)
1	B	0.55	0/3781	0.98	4/5171 (0.1%)
All	All	0.54	0/7541	0.97	13/10313 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand.A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1

There are no bond length outliers.

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	447	ILE	N-CA-C	-9.70	94.18	108.54
1	B	387	PRO	N-CA-C	-6.47	99.15	112.47
1	A	387	PRO	N-CA-C	-6.14	99.82	112.47
1	A	18	ASP	CA-CB-CG	5.73	118.33	112.60
1	A	301	THR	CA-CB-OG1	-5.53	101.31	109.60
1	A	15	ASP	CA-CB-CG	5.49	118.09	112.60
1	B	31	GLU	CB-CA-C	5.47	119.00	109.65
1	A	264	ASP	CA-CB-CG	5.41	118.00	112.60
1	B	452	ASP	CA-CB-CG	5.32	117.92	112.60
1	A	336	VAL	N-CA-CB	5.30	119.04	110.13
1	A	209	ASP	CB-CA-C	5.11	116.29	109.65
1	A	306	ASP	CA-CB-CG	5.05	117.65	112.60
1	A	296	GLU	CB-CG-CD	5.02	121.14	112.60

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	180	ARG	Sidechain

5.2 Too-close contacts (i)

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	A	3645	0	3475	29	0
1	B	3663	0	3490	25	0
2	A	4	0	0	0	0
2	B	4	0	0	2	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	5	0	0	0	0
4	B	5	0	0	0	0
5	A	12	0	0	0	0
5	B	7	0	0	0	0
All	All	7347	0	6965	54	0

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 4.

All (54) 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)
1:B:445:CYS:SG	2:B:604:CU:CU	1.62	0.88
1:B:445:CYS:HG	2:B:604:CU:CU	0.57	0.86
1:A:260:GLN:HE22	1:A:413:ASN:HD22	1.33	0.76
1:A:104:THR:CG2	1:A:119:GLY:O	2.34	0.75
1:A:384:ASN:HD21	1:A:391:HIS:HE2	1.35	0.72
1:A:104:THR:HG23	1:A:119:GLY:O	1.89	0.72
1:B:104:THR:HG23	1:B:119:GLY:O	1.91	0.70
1:B:347:MET:HB3	1:B:455:MET:HE3	1.75	0.68
1:B:104:THR:CG2	1:B:119:GLY:O	2.43	0.66
1:A:350:MET:HE1	1:A:387:PRO:HB2	1.77	0.64

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:386:ALA:CB	1:A:387:PRO:HD3	2.28	0.63
1:A:386:ALA:HB3	1:A:387:PRO:HD3	1.80	0.63
1:A:451:GLU:CG	1:A:456:MET:HE3	2.32	0.59
1:A:386:ALA:HB3	1:A:387:PRO:CD	2.35	0.57
1:B:384:ASN:ND2	1:B:389:MET:H	2.04	0.55
1:B:251:HIS:HE1	1:B:305:ASP:O	1.90	0.53
1:B:334:PRO:HB3	1:B:434:ARG:NH2	2.24	0.53
1:A:451:GLU:HG3	1:A:456:MET:HE3	1.90	0.53
1:A:451:GLU:HG2	1:A:456:MET:HE3	1.93	0.51
1:A:386:ALA:CB	1:A:387:PRO:CD	2.89	0.51
1:B:347:MET:HB3	1:B:455:MET:CE	2.40	0.51
1:B:384:ASN:HD21	1:B:389:MET:H	1.57	0.50
1:B:386:ALA:HB3	1:B:387:PRO:CD	2.43	0.49
1:B:264:ASP:HB2	1:B:418:LYS:HA	1.94	0.49
1:A:211:ASP:HA	1:A:450:HIS:HE2	1.76	0.49
1:A:451:GLU:CG	1:A:456:MET:CE	2.90	0.49
1:A:108:HIS:CE1	1:A:394:HIS:CE1	3.01	0.48
1:B:229:ASP:OD1	1:B:315:HIS:HE1	1.96	0.48
1:A:251:HIS:HE1	1:A:305:ASP:O	1.96	0.48
1:A:451:GLU:HG2	1:A:456:MET:CE	2.44	0.48
1:A:170:ASP:OD1	1:A:170:ASP:C	2.58	0.47
1:A:444:HIS:CD2	1:A:456:MET:HE2	2.49	0.47
1:B:386:ALA:O	1:B:388:GLY:N	2.48	0.47
1:A:7:TYR:CE1	1:A:276:HIS:HB3	2.48	0.46
1:B:7:TYR:CZ	1:B:249:ARG:HB3	2.50	0.46
1:A:102:LEU:C	1:A:102:LEU:HD12	2.41	0.46
1:A:240:LEU:HD13	1:A:284:ARG:HD2	1.96	0.45
1:B:281:CYS:O	1:B:282:ALA:HB3	2.16	0.45
1:B:260:GLN:HE22	1:B:413:ASN:HD22	1.63	0.45
1:A:11:GLU:N	1:A:12:PRO:CD	2.79	0.45
1:A:260:GLN:NE2	1:A:413:ASN:HD22	2.10	0.45
1:A:384:ASN:ND2	1:A:391:HIS:HE2	2.10	0.44
1:B:149:HIS:N	1:B:150:PRO:CD	2.81	0.44
1:B:122:HIS:CE1	1:B:363:MET:HE2	2.54	0.43
1:B:389:MET:HE2	1:B:447:ILE:HD13	2.00	0.43
1:B:402:VAL:HG12	1:B:410:PRO:HB3	2.01	0.42
1:A:370:GLN:O	1:A:461:THR:HA	2.20	0.41
1:A:149:HIS:N	1:A:150:PRO:CD	2.83	0.41
1:B:249:ARG:O	1:B:304:THR:HA	2.20	0.41
1:B:251:HIS:CE1	1:B:305:ASP:O	2.72	0.41
1:A:111:ASN:H	1:A:139:GLN:HE22	1.69	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:443:TYR:CZ	1:B:457:ALA:HB3	2.55	0.41
1:A:7:TYR:CZ	1:A:249:ARG:HB3	2.56	0.40
1:B:203:ASP:O	1:B:204:TYR:C	2.65	0.40

There are no symmetry-related clashes.

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	A	458/532 (86%)	437 (95%)	20 (4%)	1 (0%)	44 68
1	B	461/532 (87%)	438 (95%)	23 (5%)	0	100 100
All	All	919/1064 (86%)	875 (95%)	43 (5%)	1 (0%)	48 73

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	386	ALA

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	A	393/454 (87%)	385 (98%)	8 (2%)	50 78
1	B	395/454 (87%)	388 (98%)	7 (2%)	54 80

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
All	All	788/908 (87%)	773 (98%)	15 (2%)	52 79

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	104	THR
1	A	134	ASP
1	A	211	ASP
1	A	336	VAL
1	A	350	MET
1	A	383	SER
1	A	384	ASN
1	A	442	MET
1	B	39	LEU
1	B	40	LEU
1	B	104	THR
1	B	340	LEU
1	B	351	ASP
1	B	363	MET
1	B	451	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (22) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	81	GLN
1	A	89	GLN
1	A	139	GLN
1	A	160	HIS
1	A	251	HIS
1	A	260	GLN
1	A	276	HIS
1	A	315	HIS
1	A	321	GLN
1	A	348	GLN
1	A	370	GLN
1	A	384	ASN
1	A	458	GLN
1	B	122	HIS
1	B	160	HIS
1	B	251	HIS
1	B	260	GLN

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Mol	Chain	Res	Type
1	B	315	HIS
1	B	321	GLN
1	B	348	GLN
1	B	370	GLN
1	B	458	GLN

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)

Of 12 ligands modelled in this entry, 10 are monoatomic - leaving 2 for Mogul analysis.

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	$\#\|Z\| > 2$
4	SO4	A	606	-	4,4,4	0.35	0	6,6,6	0.07	0
4	SO4	B	606	-	4,4,4	0.43	0	6,6,6	0.06	0

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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, 95^{th} 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	A	460/532 (86%)	-0.12	10 (2%)	62	61	40, 53, 77, 95	0
1	B	462/532 (86%)	-0.10	7 (1%)	71	71	31, 55, 79, 109	1 (0%)
All	All	922/1064 (86%)	-0.11	17 (1%)	67	67	31, 54, 78, 109	1 (0%)

All (17) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	387	PRO	4.1
1	B	116	TYR	3.7
1	A	293	GLN	3.5
1	A	90	HIS	3.5
1	B	384	ASN	3.3
1	B	386	ALA	3.1
1	B	4	TYR	2.8
1	A	387	PRO	2.7
1	A	339	ALA	2.6
1	A	296	GLU	2.6
1	B	464	PRO	2.4
1	A	306	ASP	2.4
1	A	6	ASP	2.2
1	A	385	ASP	2.2
1	A	464	PRO	2.1
1	B	456	MET	2.0
1	A	111	ASN	2.0

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 (i)

There are no oligosaccharides in this entry.

6.4 Ligands (i)

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, 95^{th} 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	SO4	B	606	5/5	0.77	0.09	99,100,109,116	0
4	SO4	A	606	5/5	0.79	0.08	92,104,107,109	0
3	AG	B	605	1/1	0.90	0.21	128,128,128,128	1
3	AG	A	605	1/1	0.91	0.25	134,134,134,134	1
2	CU	B	604	1/1	0.93	0.10	60,60,60,60	0
2	CU	B	602	1/1	0.98	0.05	57,57,57,57	0
2	CU	A	604	1/1	0.99	0.04	57,57,57,57	0
2	CU	A	601	1/1	0.99	0.03	44,44,44,44	0
2	CU	B	603	1/1	0.99	0.06	45,45,45,45	0
2	CU	A	602	1/1	0.99	0.03	50,50,50,50	0
2	CU	B	601	1/1	1.00	0.07	33,33,33,33	0
2	CU	A	603	1/1	1.00	0.07	33,33,33,33	0

6.5 Other polymers (i)

There are no such residues in this entry.