



# Full wwPDB X-ray Structure Validation Report ⓘ

May 24, 2020 – 04:41 pm BST

PDB ID : 3QTG  
Title : Crystal structure of pyruvate kinase from *Pyrobaculum aerophilum*  
Authors : Davies, C.; Solomons, J.T.G.  
Deposited on : 2011-02-22  
Resolution : 2.20 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](mailto: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.

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

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.11  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.11

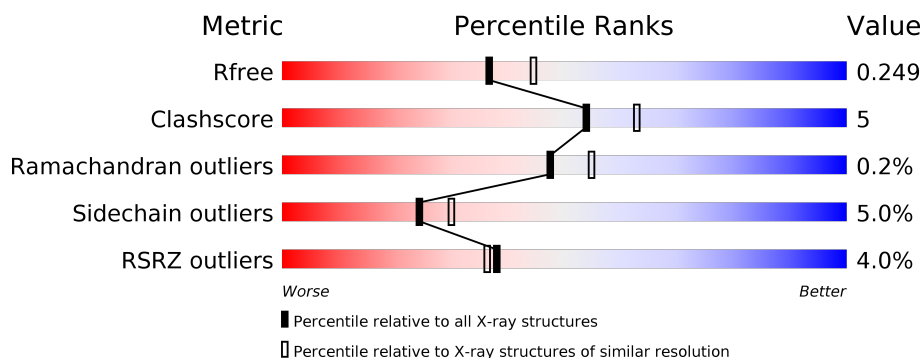
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*



The reported resolution of this entry is 2.20 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))
$R_{free}$	130704	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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 on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 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  $\leq 5\%$ . 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	461	 82% 13% • •
1	B	461	 7% 78% 12% • 9%

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	SO4	B	500	-	-	X	-
2	SO4	B	501	-	-	X	-

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6889 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 Pyruvate kinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	450	Total	C	N	O	S	0	2	0
			3473	2204	602	660	7			
1	B	419	Total	C	N	O	S	0	3	0
			3261	2077	566	611	7			

- Molecule 2 is SULFATE ION (three-letter code: SO<sub>4</sub>) (formula: O<sub>4</sub>S).



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

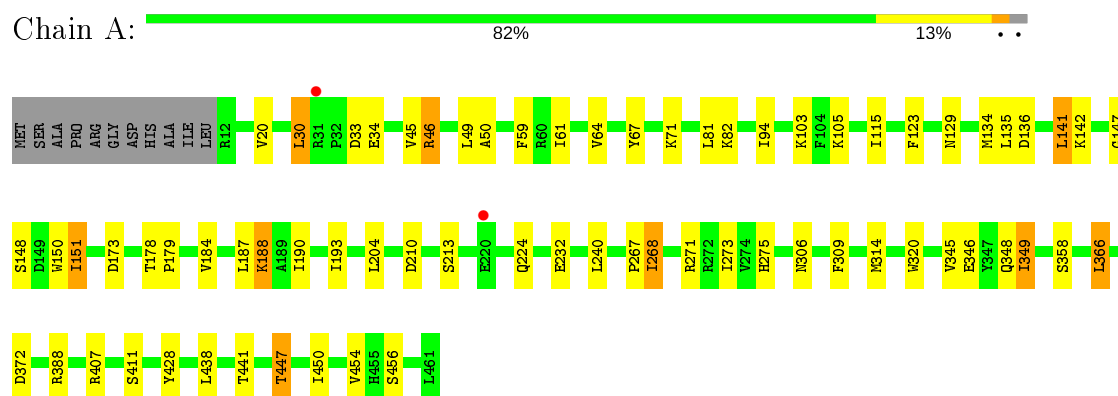
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	70	Total 70	O 70	0	0
3	B	70	Total 70	O 70	0	0

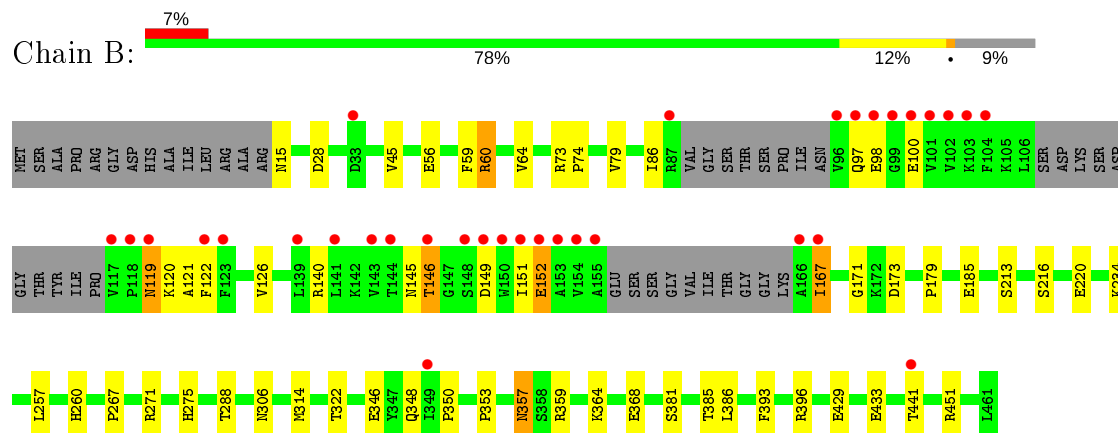
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: Pyruvate kinase



#### • Molecule 1: Pyruvate kinase



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	116.30Å 107.40Å 105.00Å 90.00° 110.50° 90.00°	Depositor
Resolution (Å)	39.00 – 2.20 39.03 – 2.20	Depositor EDS
% Data completeness (in resolution range)	99.4 (39.00-2.20) 99.2 (39.03-2.20)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.46 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.206 , 0.247 0.204 , 0.249	Depositor DCC
$R_{free}$ test set	3110 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	44.6	Xtriage
Anisotropy	0.157	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 36.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	6889	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	47.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.74% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  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: SO4

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	0.57	0/3534	0.68	3/4798 (0.1%)
1	B	0.61	1/3320 (0.0%)	0.67	2/4503 (0.0%)
All	All	0.59	1/6854 (0.0%)	0.68	5/9301 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	146	THR	CB-OG1	-6.04	1.31	1.43

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	141	LEU	CA-CB-CG	7.91	133.49	115.30
1	A	46	ARG	NE-CZ-NH1	7.36	123.98	120.30
1	A	46	ARG	NE-CZ-NH2	-6.11	117.25	120.30
1	B	257	LEU	CA-CB-CG	5.46	127.86	115.30
1	B	60	ARG	NE-CZ-NH1	5.03	122.82	120.30

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	A	3473	0	3579	39	0
1	B	3261	0	3370	35	0
2	A	5	0	0	0	0
2	B	10	0	0	8	0
3	A	70	0	0	1	0
3	B	70	0	0	3	0
All	All	6889	0	6949	73	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 5.

All (73) 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:A:103:LYS:HE2	1:A:105:LYS:HE2	1.46	0.94
2:B:501:SO4:O4	3:B:518:HOH:O	1.88	0.92
2:B:500:SO4:O3	3:B:517:HOH:O	1.92	0.86
1:B:97:GLN:HG3	1:B:100:GLU:HB2	1.56	0.84
1:A:50:ALA:HB2	1:A:82:LYS:HD3	1.60	0.84
1:B:350:PRO:HD3	1:B:396[B]:ARG:NH2	1.99	0.78
1:B:56:GLU:O	1:B:60:ARG:HG3	1.84	0.77
1:B:381:SER:OG	2:B:500:SO4:O2	2.00	0.77
2:B:500:SO4:O4	3:B:467:HOH:O	2.05	0.74
1:A:94:ILE:HD13	1:A:115:ILE:CD1	2.20	0.71
1:A:94:ILE:HD13	1:A:115:ILE:HD13	1.73	0.71
1:B:350:PRO:HD3	1:B:396[B]:ARG:HH21	1.59	0.66
1:A:123:PHE:CD1	1:A:151:ILE:HD12	2.34	0.61
1:A:447:THR:HG22	1:A:456:SER:O	2.01	0.60
1:B:359:ARG:HD3	2:B:501:SO4:O2	2.04	0.58
1:B:179:PRO:HD3	1:B:213:SER:HB3	1.85	0.58
1:A:271:ARG:HA	1:A:314:MET:HE1	1.86	0.58
1:B:288:THR:HG22	1:B:322:THR:HG21	1.86	0.57
1:A:366:LEU:HD21	1:A:447:THR:HG21	1.85	0.57
1:A:346:GLU:HG3	1:B:271:ARG:NH2	2.21	0.56
1:A:50:ALA:CB	1:A:82:LYS:HD3	2.33	0.55
1:A:306:ASN:ND2	1:B:267:PRO:HG3	2.22	0.55
1:B:28:ASP:OD1	1:B:60:ARG:HD3	2.08	0.54
1:A:178:THR:HB	1:A:179:PRO:HA	1.90	0.52
1:A:267:PRO:HG3	1:B:306:ASN:ND2	2.24	0.52
1:A:184:VAL:O	1:A:188:LYS:HG2	2.10	0.52
1:A:49:LEU:HD12	1:A:81:LEU:HD23	1.92	0.52
1:B:171:GLY:H	1:B:260:HIS:HD2	1.57	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:240:LEU:HD21	1:A:273:ILE:HA	1.93	0.50
1:B:86:ILE:HG22	1:B:167:ILE:HG12	1.94	0.50
1:B:451:ARG:HA	2:B:501:SO4:O2	2.11	0.50
1:A:30:LEU:HG	1:A:34[B]:GLU:HB3	1.93	0.50
1:B:119:ASN:HD22	1:B:121:ALA:H	1.60	0.49
1:A:179:PRO:HD3	1:A:213:SER:HB3	1.94	0.49
1:A:268:ILE:HD11	1:B:346:GLU:HB2	1.95	0.48
1:A:366:LEU:HD21	1:A:447:THR:CG2	2.44	0.48
1:A:103:LYS:CE	1:A:105:LYS:HE2	2.32	0.48
1:B:216:SER:O	1:B:220:GLU:HG3	2.14	0.48
1:A:204:LEU:N	1:A:232:GLU:OE2	2.38	0.48
1:A:147:GLY:HA3	1:A:150:TRP:CE2	2.49	0.47
1:B:271:ARG:HA	1:B:314:MET:HE1	1.95	0.47
1:B:120:LYS:HE3	1:B:120:LYS:HB2	1.74	0.47
1:A:45:VAL:HG21	1:A:64:VAL:HG21	1.97	0.46
1:B:429:GLU:O	1:B:433:GLU:HG3	2.15	0.46
1:A:46:ARG:NH2	3:A:506:HOH:O	2.46	0.46
1:B:122:PHE:O	1:B:126:VAL:HG23	2.16	0.46
1:B:73:ARG:HA	1:B:74:PRO:HD3	1.70	0.46
1:A:428:TYR:OH	1:A:450:ILE:HG23	2.16	0.46
1:A:268:ILE:HA	1:A:268:ILE:HD13	1.68	0.45
1:B:364:LYS:O	1:B:368:GLU:HG3	2.17	0.45
1:B:86:ILE:HD13	1:B:122:PHE:HB2	1.98	0.45
1:B:45:VAL:HG21	1:B:64:VAL:HG21	1.99	0.45
1:B:385:THR:HB	2:B:500:SO4:O1	2.17	0.45
1:B:353:PRO:HG2	1:B:393:PHE:CE1	2.52	0.45
1:A:20:VAL:HB	1:A:320:TRP:CD1	2.52	0.44
1:A:224:GLN:HB2	1:A:407:ARG:NH2	2.32	0.44
1:B:171:GLY:HA2	1:B:234:LYS:HD2	1.99	0.44
1:B:145:ASN:HB2	1:B:152:GLU:HG2	1.99	0.44
1:A:388:ARG:NH2	1:A:411:SER:OG	2.51	0.43
1:A:61:ILE:HD12	1:A:193:ILE:HD12	2.00	0.43
1:A:123:PHE:HD1	1:A:151:ILE:HD12	1.79	0.42
1:A:309:PHE:CE1	1:A:345:VAL:HA	2.54	0.42
1:B:28:ASP:OD2	1:B:60:ARG:NH1	2.51	0.42
1:B:350:PRO:CD	1:B:396[B]:ARG:HH21	2.30	0.42
1:A:67:TYR:CE1	1:A:71:LYS:HG3	2.55	0.42
1:A:94:ILE:HD13	1:A:115:ILE:HD12	2.00	0.42
1:A:178:THR:OG1	1:A:210:ASP:OD1	2.36	0.41
1:B:386:LEU:N	2:B:500:SO4:O1	2.53	0.41
1:A:129:ASN:O	1:A:142:LYS:HE2	2.20	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:348:GLN:O	1:A:349:ILE:C	2.59	0.41
1:A:428:TYR:OH	1:A:450:ILE:CG2	2.69	0.41
1:B:357:ASN:HD22	1:B:359:ARG:H	1.68	0.41

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	450/461 (98%)	435 (97%)	13 (3%)	2 (0%)	34	37
1	B	414/461 (90%)	402 (97%)	12 (3%)	0	100	100
All	All	864/922 (94%)	837 (97%)	25 (3%)	2 (0%)	47	55

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	148	SER
1	A	349	ILE

### 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	385/391 (98%)	364 (94%)	21 (6%)	21	26

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	B	361/391 (92%)	345 (96%)	16 (4%)	28	35
All	All	746/782 (95%)	709 (95%)	37 (5%)	24	30

All (37) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	30	LEU
1	A	33	ASP
1	A	59	PHE
1	A	134	MET
1	A	135	LEU
1	A	136	ASP
1	A	141	LEU
1	A	151	ILE
1	A	173	ASP
1	A	187	LEU
1	A	188	LYS
1	A	190	ILE
1	A	268	ILE
1	A	275	HIS
1	A	358	SER
1	A	366	LEU
1	A	372	ASP
1	A	438	LEU
1	A	441	THR
1	A	447	THR
1	A	454	VAL
1	B	15	ASN
1	B	59	PHE
1	B	79	VAL
1	B	98	GLU
1	B	119	ASN
1	B	140	ARG
1	B	146	THR
1	B	149	ASP
1	B	151	ILE
1	B	152	GLU
1	B	167	ILE
1	B	173	ASP
1	B	185	GLU
1	B	275	HIS
1	B	357	ASN

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Mol	Chain	Res	Type
1	B	441	THR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	15	ASN
1	A	306	ASN
1	B	55	ASN
1	B	119	ASN
1	B	129	ASN
1	B	260	HIS
1	B	306	ASN
1	B	357	ASN

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

## 5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

3 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	$\# Z  > 2$
2	SO4	B	501	-	4,4,4	0.24	0	6,6,6	0.52	0
2	SO4	B	500	-	4,4,4	0.39	0	6,6,6	0.48	0
2	SO4	A	500	-	4,4,4	0.18	0	6,6,6	0.32	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.

2 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	501	SO4	3	0
2	B	500	SO4	5	0

## 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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	450/461 (97%)	-0.07	2 (0%) 92 91	31, 46, 62, 76	0
1	B	419/461 (90%)	0.31	33 (7%) 12 11	28, 43, 93, 103	0
All	All	869/922 (94%)	0.11	35 (4%) 38 36	28, 45, 83, 103	0

All (35) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	144	THR	7.2
1	B	102	VAL	6.6
1	B	146	THR	5.9
1	B	154	VAL	5.7
1	B	149	ASP	5.2
1	B	101	VAL	4.8
1	B	87	ARG	4.4
1	B	118	PRO	4.4
1	B	104	PHE	4.3
1	B	97	GLN	4.2
1	B	150	TRP	4.1
1	B	153	ALA	3.7
1	B	117	VAL	3.6
1	B	103	LYS	3.4
1	B	96	VAL	3.2
1	B	167	ILE	2.9
1	B	100	GLU	2.8
1	B	155	ALA	2.8
1	B	99	GLY	2.8
1	B	139	LEU	2.7
1	A	31	ARG	2.7
1	B	151	ILE	2.7
1	B	122	PHE	2.6
1	B	152	GLU	2.5

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Mol	Chain	Res	Type	RSRZ
1	B	119	ASN	2.5
1	B	143	VAL	2.5
1	B	123	PHE	2.4
1	B	98	GLU	2.3
1	B	141	LEU	2.3
1	B	148	SER	2.3
1	B	349	ILE	2.3
1	B	441	THR	2.2
1	A	220	GLU	2.2
1	B	33	ASP	2.1
1	B	166	ALA	2.0

## 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

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

## 6.3 Carbohydrates [i](#)

There are no carbohydrates 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<sup>th</sup> 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( $\text{\AA}^2$ )	Q<0.9
2	SO4	B	501	5/5	0.94	0.26	44,45,48,48	5
2	SO4	B	500	5/5	0.99	0.21	21,29,31,31	5
2	SO4	A	500	5/5	0.99	0.10	39,41,42,45	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.