



wwPDB X-ray Structure Validation Summary Report ⓘ

Jan 31, 2016 – 06:56 PM GMT

PDB ID : 1D9D
Title : CRYSTALL STRUCTURE OF THE COMPLEX OF DNA POLYMERASE I KLENOW FRAGMENT WITH SHORT DNA FRAGMENT CARRYING 2'-O-AMINOPROPYL-RNA MODIFICATIONS 5'-D(TCG)-AP(AUC)-3'
Authors : Teplova, M.; Wallace, S.T.; Tereshko, V.; Minasov, G.; Simons, A.M.; Cook, P.D.; Manoharan, M.; Egli, M.
Deposited on : 1999-10-27
Resolution : 2.18 Å(reported)

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

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<http://wwpdb.org/validation/2016/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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

MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

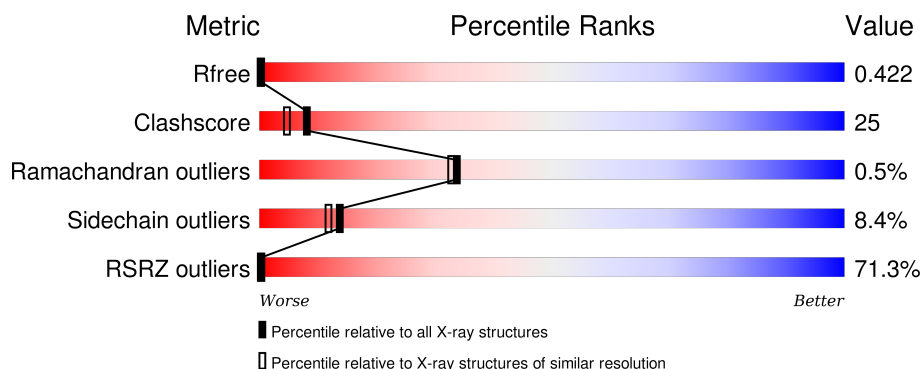
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.18 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}	91344	5130 (2.20-2.16)
Clashscore	102246	5965 (2.20-2.16)
Ramachandran outliers	100387	5863 (2.20-2.16)
Sidechain outliers	100360	5864 (2.20-2.16)
RSRZ outliers	91569	5142 (2.20-2.16)

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 ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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	B	6	
2	A	605	

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
1	U31	B	1005[A]	-	-	X	-
1	U31	B	1005[B]	-	-	X	-
1	C31	B	1006[B]	-	-	X	-
4	MG	A	321	-	-	-	X
5	SO4	A	32	-	-	X	-
5	SO4	A	38	-	-	X	X

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 5149 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 DNA/RNA hybrid called 5'-D(*TP*CP*GP)-R(AP*(U31)P*(C31))-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	B	3	Total	C	N	O	P	0	3	0
			106	55	18	30	3			

- Molecule 2 is a protein called DNA POLYMERASE I.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	A	601	Total	C	N	O	S	0	0	0
			4753	3008	830	899	16			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	324	MET	VAL	ENGINEERED	UNP P00582

- Molecule 3 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	4	Total	Zn	0	0
			4	4		

- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total	Mg	0	0
			1	1		

- Molecule 5 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



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

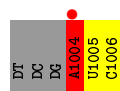
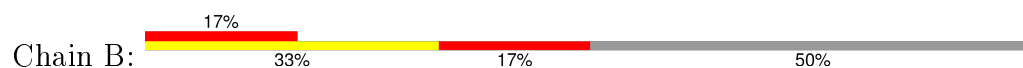
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	255	Total	O	0	0
			255	255		
6	B	10	Total	O	0	0
			10	10		

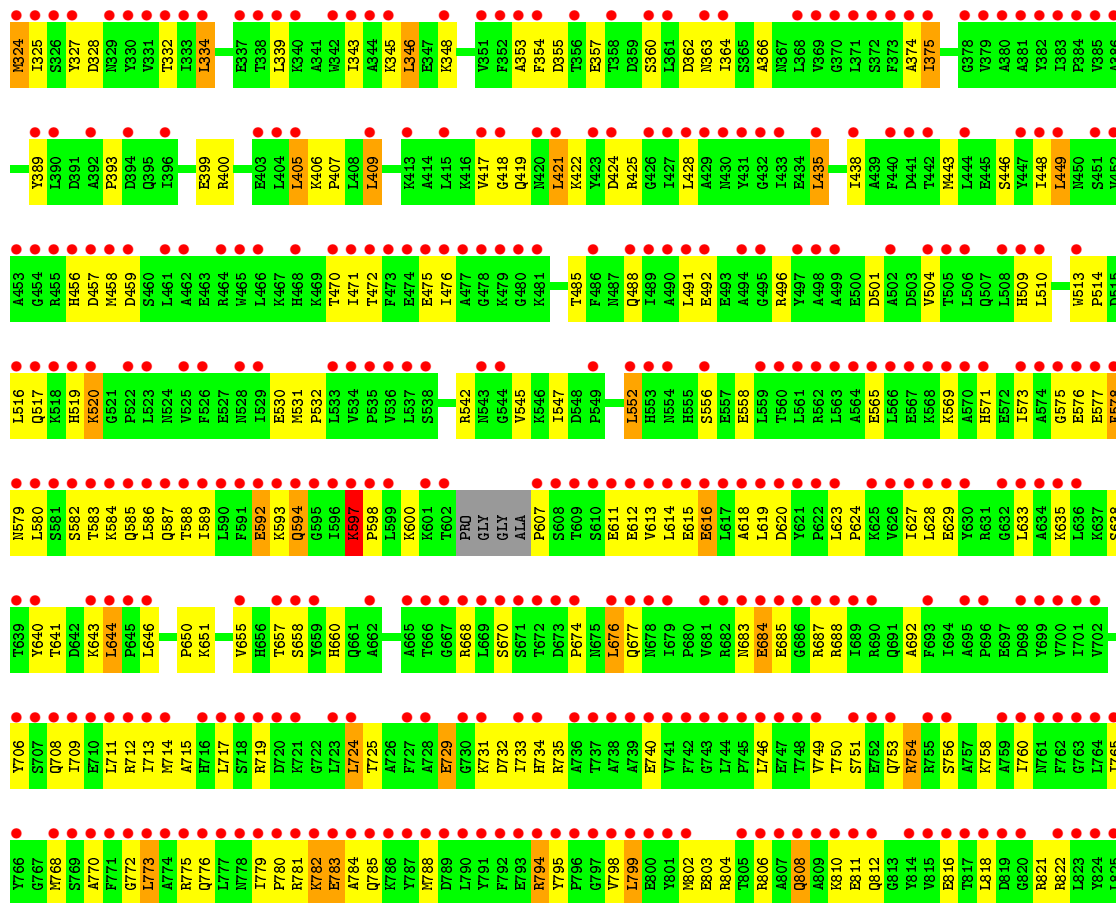
3 Residue-property plots

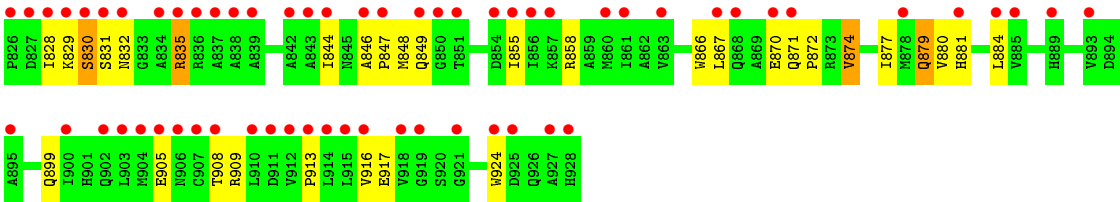
These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according 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: 5'-D(*TP*CP*GP)-R(AP*(U31)P*(C31))-3'



- Molecule 2: DNA POLYMERASE I





4 Data and refinement statistics

Property	Value	Source
Space group	P 43	Depositor
Cell constants a, b, c, α , β , γ	102.55Å 102.55Å 86.28Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 2.18 34.18 – 2.11	Depositor EDS
% Data completeness (in resolution range)	84.5 (20.00-2.18) 91.3 (34.18-2.11)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.56 (at 2.12Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.215 , 0.238 0.409 , 0.422	Depositor DCC
R_{free} test set	4023 reflections (8.56%)	DCC
Wilson B-factor (Å ²)	26.1	Xtriage
Anisotropy	0.146	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.40 , 76.0	EDS
Estimated twinning fraction	0.032 for h,-k,-l	Xtriage
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Outliers	1 of 46985 reflections (0.002%)	Xtriage
F_o, F_c correlation	0.74	EDS
Total number of atoms	5149	wwPDB-VP
Average B, all atoms (Å ²)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.13% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.375 respectively for untwinned datasets, and 0.333, 0.2 for perfectly twinned datasets.

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: MG, C31, ZN, U31, 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	B	1.96	1/20 (5.0%)	2.55	0/29
2	A	0.33	0/4839	0.66	3/6547 (0.0%)
All	All	0.36	1/4859 (0.0%)	0.68	3/6576 (0.0%)

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	B	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	1004[A]	DA	C6-N1	-5.56	1.31	1.35

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	835	ARG	NE-CZ-NH1	7.13	123.86	120.30
2	A	607	PRO	N-CA-CB	5.57	109.99	103.30
2	A	597	LYS	N-CA-C	5.51	125.86	111.00

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	1004[A]	DA	Sidechain

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	B	106	0	73	65	0
2	A	4753	0	4752	202	13
3	A	4	0	0	0	0
4	A	1	0	0	0	0
5	A	20	0	0	6	0
6	A	255	0	0	12	11
6	B	10	0	0	10	0
All	All	5149	0	4825	239	16

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 25.

The worst 5 of 239 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:1005[A]:U31:H5	2:A:458:MET:CE	1.75	1.16
1:B:1005[A]:U31:H3'	1:B:1005[A]:U31:HB'1	1.23	1.14
1:B:1005[B]:U31:O5'	6:B:189:HOH:O	1.64	1.13
1:B:1005[A]:U31:HB'1	1:B:1005[A]:U31:C3'	1.86	1.05
1:B:1005[A]:U31:ND'	6:B:364:HOH:O	1.90	1.05

The worst 5 of 16 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)
2:A:517:GLN:OE1	6:A:973:HOH:O[2_764]	1.67	0.53
2:A:565:GLU:OE2	6:A:1027:HOH:O[2_765]	1.87	0.33
2:A:751:SER:CA	6:A:1056:HOH:O[2_765]	1.95	0.25
6:A:1010:HOH:O	6:A:1026:HOH:O[3_654]	1.97	0.23
2:A:476:ILE:O	6:A:1128:HOH:O[3_654]	2.01	0.19

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	
2	A	597/605 (99%)	563 (94%)	31 (5%)	3 (0%)	34	33

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	A	830	SER
2	A	594	GLN
2	A	597	LYS

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	
2	A	500/510 (98%)	458 (92%)	42 (8%)	14	12

5 of 42 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	A	616	GLU
2	A	676	LEU
2	A	871	GLN
2	A	620	ASP
2	A	644	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
2	A	543	ASN
2	A	571	HIS
2	A	845	ASN
2	A	528	ASN
2	A	879	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

4 non-standard protein/DNA/RNA residues 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	$\# Z > 2$
1	U31	B	1005[A]	1	15,25,26	1.46	3 (20%)	21,34,37	3.82	12 (57%)
1	U31	B	1005[B]	1	12,17,26	1.20	1 (8%)	17,24,37	3.50	2 (11%)
1	C31	B	1006[A]	1,3	16,25,26	1.44	2 (12%)	22,34,37	2.56	5 (22%)
1	C31	B	1006[B]	1	16,25,26	1.30	1 (6%)	22,34,37	2.37	4 (18%)

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
1	U31	B	1005[A]	1	-	1/8/30/31	0/2/2/2
1	U31	B	1005[B]	1	-	0/2/18/31	0/2/2/2
1	C31	B	1006[A]	1,3	-	0/8/30/31	0/2/2/2
1	C31	B	1006[B]	1	-	0/8/30/31	0/2/2/2

The worst 5 of 7 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	1006[B]	C31	C4-N4	-3.96	1.23	1.35
1	B	1006[A]	C31	C4-N4	-3.82	1.24	1.35
1	B	1005[A]	U31	C6-N1	-2.34	1.32	1.35
1	B	1005[A]	U31	CB'-CC	-2.00	1.41	1.51
1	B	1006[A]	C31	C6-N1	2.04	1.38	1.35

The worst 5 of 23 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	1006[B]	C31	C5-C4-N3	-6.16	114.03	121.80
1	B	1006[A]	C31	C5-C4-N3	-5.85	114.42	121.80
1	B	1005[A]	U31	C5-C4-N3	-4.07	112.67	123.12
1	B	1005[B]	U31	C5-C4-N3	-3.38	114.44	123.12
1	B	1005[A]	U31	O3'-C3'-C4'	-2.93	102.26	111.05

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	B	1005[A]	U31	C2'-O2'-CA'-CB'

There are no ring outliers.

4 monomers are involved in 55 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	B	1005[A]	U31	22	0
1	B	1005[B]	U31	18	0
1	B	1006[A]	C31	7	0
1	B	1006[B]	C31	17	0

5.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

5.6 Ligand geometry [i](#)

Of 9 ligands modelled in this entry, 5 are monoatomic - leaving 4 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	$\# Z > 2$
5	SO4	A	32	-	4,4,4	0.70	0	6,6,6	0.14	0
5	SO4	A	38	-	4,4,4	0.53	0	6,6,6	0.12	0
5	SO4	A	40	-	4,4,4	0.65	0	6,6,6	0.09	0
5	SO4	A	94	-	4,4,4	0.62	0	6,6,6	0.15	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
5	SO4	A	32	-	-	0/0/0/0	0/0/0/0
5	SO4	A	38	-	-	0/0/0/0	0/0/0/0
5	SO4	A	40	-	-	0/0/0/0	0/0/0/0
5	SO4	A	94	-	-	0/0/0/0	0/0/0/0

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.

3 monomers are involved in 6 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	32	SO4	2	0
5	A	38	SO4	3	0
5	A	94	SO4	1	0

5.7 Other polymers

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	B	1/6 (16%)	3.72	1 (100%) 0 0	52, 52, 52, 52	1 (100%)
2	A	601/605 (99%)	3.09	428 (71%) 0 0	13, 30, 60, 60	0
All	All	602/611 (98%)	3.09	429 (71%) 0 0	13, 30, 60, 60	1 (0%)

The worst 5 of 429 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	A	582	SER	20.3
2	A	608	SER	14.0
2	A	602	THR	13.9
2	A	586	LEU	13.2
2	A	583	THR	12.6

6.2 Non-standard residues in protein, DNA, RNA chains [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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å ²)	Q<0.9
1	U31	B	1005[A]	24/25	0.59	0.47	-	39,41,48,50	24
1	U31	B	1005[B]	16/25	0.59	0.47	-	48,50,52,53	16
1	C31	B	1006[B]	24/25	0.64	0.55	-	40,45,47,49	24
1	C31	B	1006[A]	24/25	0.64	0.55	-	28,34,37,40	24

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å ²)	Q<0.9
4	MG	A	321	1/1	0.42	1.10	12.60	50,50,50,50	0
5	SO4	A	38	5/5	0.59	0.47	2.24	32,33,35,35	5
5	SO4	A	32	5/5	0.62	0.31	-0.08	29,32,33,34	5
3	ZN	A	322	1/1	0.36	0.18	-1.15	42,42,42,42	1
3	ZN	A	1	1/1	0.89	0.11	-15.01	24,24,24,24	0
3	ZN	A	3	1/1	0.89	0.14	-	44,44,44,44	0
5	SO4	A	94	5/5	0.81	0.34	-	32,34,35,35	5
3	ZN	A	320	1/1	0.71	0.31	-	59,59,59,59	1
5	SO4	A	40	5/5	0.78	0.35	-	31,33,34,37	5

6.5 Other polymers [i](#)

There are no such residues in this entry.