



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 14, 2026 – 09:56 AM UTC

PDB ID : 3D51 / pdb_00003d51
Title : GOLGI MANNOSIDASE II complex with gluco-hydroxyiminolactam
Authors : Kuntz, D.A.; Tarling, C.A.; Withers, S.G.; Rose, D.R.
Deposited on : 2008-05-15
Resolution : 1.43 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 : 2022.3.0, CSD as543be (2022)
Xtriage (Phenix) : 2.0
EDS : 3.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
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) : 2.49

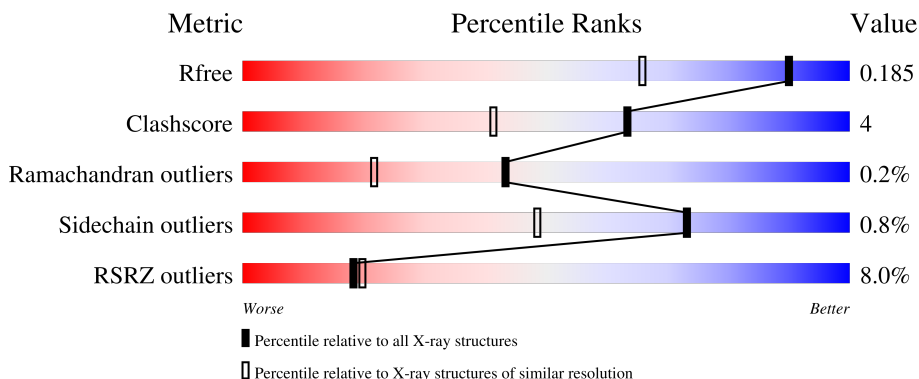
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.43 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	3234 (1.46-1.42)
Clashscore	190562	3289 (1.46-1.42)
Ramachandran outliers	187476	3248 (1.46-1.42)
Sidechain outliers	187428	3248 (1.46-1.42)
RSRZ outliers	180081	3234 (1.46-1.42)

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 $\leq 5\%$. 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	1045	

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 9408 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 Alpha-mannosidase 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	1016	Total	C	N	O	S	6	12	0
			8259	5257	1443	1517	42			

There are 13 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	ARG	-	expression tag	UNP Q24451
A	2	SER	-	expression tag	UNP Q24451
A	3	SER	-	expression tag	UNP Q24451
A	4	HIS	-	expression tag	UNP Q24451
A	5	HIS	-	expression tag	UNP Q24451
A	6	HIS	-	expression tag	UNP Q24451
A	7	HIS	-	expression tag	UNP Q24451
A	8	HIS	-	expression tag	UNP Q24451
A	9	HIS	-	expression tag	UNP Q24451
A	10	GLY	-	expression tag	UNP Q24451
A	11	GLU	-	expression tag	UNP Q24451
A	12	PHE	-	expression tag	UNP Q24451
A	907	LYS	GLU	SEE REMARK 999	UNP Q24451

- Molecule 2 is ZINC ION (CCD ID: ZN) (formula: Zn).

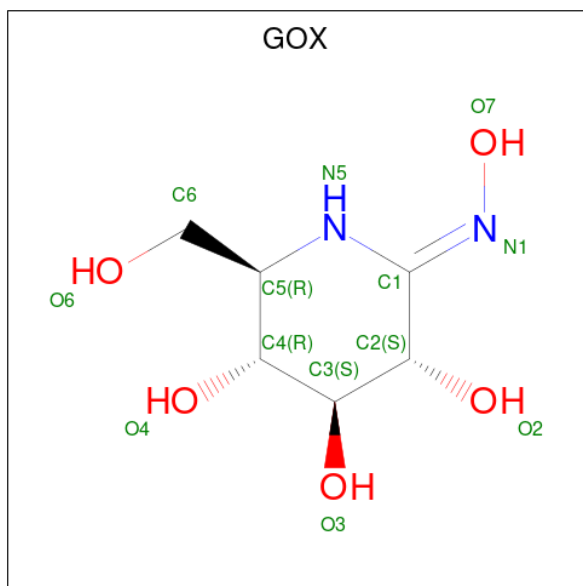
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Zn	0	0
			1	1		

- Molecule 3 is (4R)-2-METHYLPENTANE-2,4-DIOL (CCD ID: MRD) (formula: C₆H₁₄O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			8	6	2		

- Molecule 4 is (2S,3S,4R,5R)-6-(HYDROXYAMINO)-2-(HYDROXYMETHYL)-2,3,4,5-TETRAHYDROPYRIDINE-3,4,5-TRIOL (CCD ID: GOX) (formula: $C_6H_{12}N_2O_5$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	N	O	0	0
			13	6	2	5		

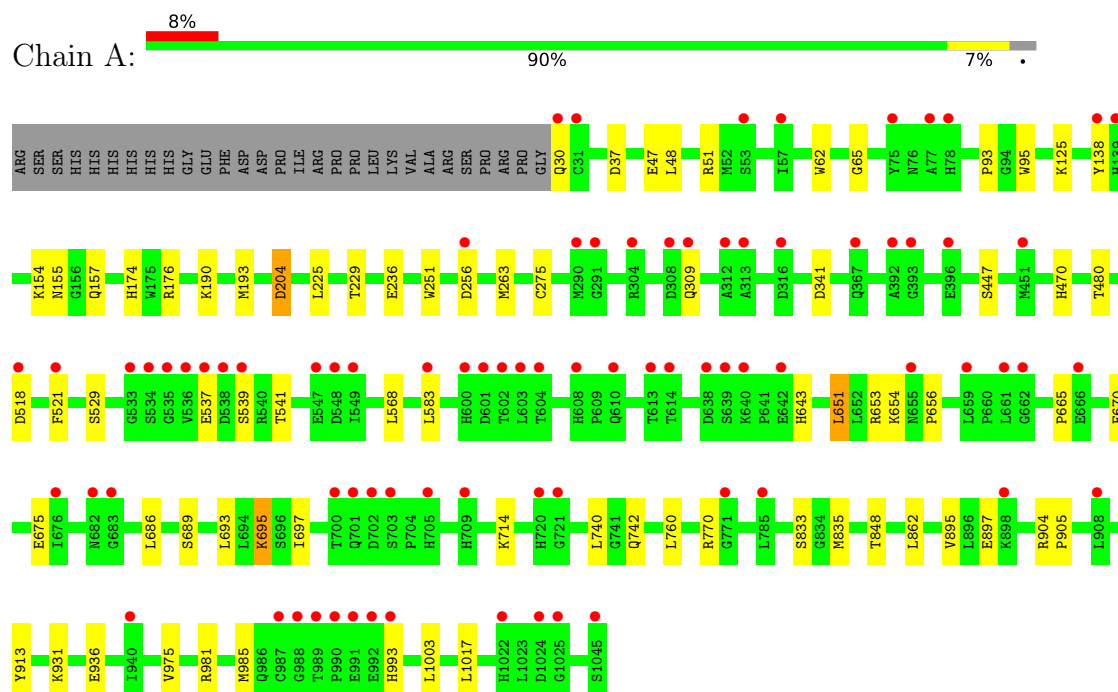
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	1124	Total 1127	O 1127	0	3

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: Alpha-mannosidase 2



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	68.74Å 109.12Å 137.69Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	40.00 – 1.43 40.00 – 1.43	Depositor EDS
% Data completeness (in resolution range)	96.4 (40.00-1.43) 96.4 (40.00-1.43)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.82 (at 1.43Å)	Xtriage
Refinement program	REFMAC, CNS	Depositor
R, R_{free}	0.187 , 0.201 0.181 , 0.185	Depositor DCC
R_{free} test set	2773 reflections (1.45%)	wwPDB-VP
Wilson B-factor (Å ²)	14.3	Xtriage
Anisotropy	0.060	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.40 , 47.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	9408	wwPDB-VP
Average B, all atoms (Å ²)	16.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.61% 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, 0.333 respectively for untwinned datasets, and 0.375, 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: ZN, GOX, MRD

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	0.76	0/8518	0.89	1/11563 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
1	A	665	PRO	N-CA-C	5.03	120.22	114.03

There are no chirality outliers.

There are no planarity outliers.

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	8259	0	8084	62	0
2	A	1	0	0	0	0
3	A	8	0	14	3	0
4	A	13	0	11	2	0
5	A	1127	0	0	16	0
All	All	9408	0	8109	65	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 (65) 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:695[B]:LYS:HZ3	1:A:695[B]:LYS:HB3	1.15	1.05
1:A:695[B]:LYS:HB3	1:A:695[B]:LYS:NZ	1.69	1.01
1:A:47:GLU:OE2	1:A:51:ARG:HD3	1.63	0.95
1:A:309:GLN:HG3	5:A:1526:HOH:O	1.65	0.95
1:A:695[B]:LYS:NZ	1:A:695[B]:LYS:CB	2.38	0.87
1:A:654:LYS:HG3	1:A:742:GLN:OE1	1.76	0.85
3:A:1047:MRD:H1C1	5:A:1506:HOH:O	1.81	0.80
3:A:1047:MRD:H1C3	5:A:1177:HOH:O	1.87	0.74
1:A:309:GLN:CG	5:A:1526:HOH:O	2.27	0.71
1:A:47:GLU:OE1	1:A:51:ARG:NH1	2.29	0.65
1:A:904:ARG:HG2	1:A:985[A]:MET:SD	2.39	0.63
1:A:154:LYS:HE2	5:A:1988:HOH:O	2.00	0.62
1:A:37:ASP:HB2	5:A:1391:HOH:O	2.00	0.61
1:A:256:ASP:HB2	5:A:1455:HOH:O	1.99	0.61
1:A:689:SER:HA	1:A:695[B]:LYS:HE2	1.83	0.60
1:A:656:PRO:CB	5:A:2067:HOH:O	2.49	0.59
1:A:975:VAL:HG21	1:A:1003:LEU:CD1	2.32	0.59
1:A:689:SER:CA	1:A:695[B]:LYS:HE2	2.33	0.58
1:A:643:HIS:HE1	5:A:2137:HOH:O	1.86	0.58
1:A:693:LEU:HD13	5:A:1076:HOH:O	2.04	0.58
1:A:204:ASP:OD2	4:A:1048:GOX:HC2	2.04	0.57
1:A:904:ARG:HG2	1:A:985[B]:MET:SD	2.46	0.56
1:A:174:HIS:CE1	1:A:176:ARG:HD3	2.41	0.55
1:A:47:GLU:OE2	1:A:51:ARG:CD	2.46	0.55
1:A:993:HIS:CG	1:A:993:HIS:O	2.61	0.52
1:A:740:LEU:HD22	1:A:760:LEU:HD22	1.91	0.52
1:A:656:PRO:HB2	5:A:2067:HOH:O	2.09	0.52
1:A:521[A]:PHE:HZ	1:A:936:GLU:OE2	1.92	0.52
1:A:47:GLU:CD	1:A:51:ARG:HH11	2.18	0.51
3:A:1047:MRD:H5C3	3:A:1047:MRD:HMC1	1.92	0.51
1:A:48:LEU:HD11	1:A:236:GLU:HG2	1.94	0.50
1:A:568:LEU:HD12	1:A:770:ARG:HD3	1.94	0.49
1:A:341:ASP:OD2	4:A:1048:GOX:N1	2.45	0.49
1:A:62:TRP:CD2	1:A:65:GLY:HA3	2.47	0.49
1:A:695[B]:LYS:CB	1:A:695[B]:LYS:HZ2	2.22	0.49
1:A:651:LEU:HD11	1:A:653:ARG:HD2	1.95	0.48
1:A:904:ARG:HA	1:A:985[B]:MET:HE1	1.95	0.48
1:A:643:HIS:CE1	5:A:2137:HOH:O	2.66	0.48
1:A:190:LYS:HD3	1:A:1017:LEU:HD22	1.96	0.47
1:A:835:MET:HE2	1:A:862:LEU:HD22	1.96	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:686:LEU:HD22	1:A:697:ILE:HG12	1.95	0.47
1:A:913:TYR:HB2	1:A:985[B]:MET:HE3	1.96	0.47
1:A:833:SER:C	1:A:848[B]:THR:HG22	2.39	0.47
1:A:714:LYS:HD2	5:A:1261:HOH:O	2.13	0.47
1:A:895:VAL:HG12	1:A:897:GLU:HG3	1.96	0.46
1:A:537:GLU:HG2	1:A:539:SER:HB3	1.96	0.46
1:A:981:ARG:NE	5:A:1754:HOH:O	2.48	0.45
1:A:975:VAL:HG21	1:A:1003:LEU:HD12	1.97	0.45
1:A:670:PHE:CE1	5:A:2067:HOH:O	2.67	0.45
1:A:93:PRO:HD2	1:A:470:HIS:CE1	2.52	0.44
1:A:229:THR:HG21	1:A:263:MET:HE2	1.99	0.44
1:A:518:ASP:HB3	1:A:521[B]:PHE:CG	2.52	0.44
1:A:529:SER:OG	1:A:931:LYS:NZ	2.47	0.44
1:A:251:TRP:CD1	1:A:251:TRP:C	2.95	0.44
1:A:993:HIS:O	1:A:993:HIS:ND1	2.51	0.44
1:A:675:GLU:OE2	1:A:695[B]:LYS:HE3	2.17	0.43
1:A:155:ASN:C	1:A:155:ASN:OD1	2.61	0.43
1:A:125:LYS:HD3	1:A:157:GLN:HA	2.00	0.43
1:A:651:LEU:CD1	1:A:653:ARG:HD2	2.49	0.43
1:A:47:GLU:CD	1:A:51:ARG:HD3	2.41	0.42
1:A:695[B]:LYS:HZ2	1:A:695[B]:LYS:HB2	1.84	0.42
1:A:225:LEU:C	1:A:225:LEU:HD23	2.45	0.41
1:A:480:THR:HG23	5:A:1663:HOH:O	2.20	0.41
1:A:138:TYR:CE1	1:A:193[A]:MET:CE	3.03	0.41
1:A:905:PRO:HD3	1:A:985[B]:MET:HE1	2.03	0.40

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	1026/1045 (98%)	1005 (98%)	19 (2%)	2 (0%)	43 22

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	95	TRP
1	A	204	ASP

5.3.2 Protein sidechains ⓘ

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	915/929 (98%)	907 (99%)	8 (1%)	70	44

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	30	GLN
1	A	275	CYS
1	A	447	SER
1	A	541	THR
1	A	583	LEU
1	A	651	LEU
1	A	695[A]	LYS
1	A	695[B]	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	91	ASN
1	A	249	GLN
1	A	347	ASN
1	A	371	ASN
1	A	778	ASN
1	A	812	GLN
1	A	866	GLN

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 oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 3 ligands modelled in this entry, 1 is 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	$\# Z > 2$
3	MRD	A	1047	-	7,7,7	0.38	0	9,10,10	0.58	0
4	GOX	A	1048	2	12,13,13	0.75	0	14,18,18	1.37	2 (14%)

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
3	MRD	A	1047	-	-	2/5/5/5	-
4	GOX	A	1048	2	-	0/3/24/24	0/1/1/1

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
4	A	1048	GOX	O2-C2-C1	2.13	113.77	109.31
4	A	1048	GOX	O3-C3-C2	-2.00	105.68	109.64

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	1047	MRD	C2-C3-C4-O4
3	A	1047	MRD	C2-C3-C4-C5

There are no ring outliers.

2 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	1047	MRD	3	0
4	A	1048	GOX	2	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, 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	A	1016/1045 (97%)	0.34	81 (7%) 18 20	6, 13, 27, 46	12 (1%)

All (81) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	603	LEU	6.5
1	A	655	ASN	6.0
1	A	534	SER	5.9
1	A	993	HIS	5.7
1	A	536	VAL	5.6
1	A	720	HIS	5.1
1	A	721	GLY	4.7
1	A	57	ILE	4.4
1	A	991	GLU	4.4
1	A	602	THR	4.2
1	A	702	ASP	4.1
1	A	535	GLY	3.9
1	A	682	ASN	3.9
1	A	703	SER	3.8
1	A	583	LEU	3.6
1	A	987	CYS	3.5
1	A	538	ASP	3.5
1	A	990	PRO	3.5
1	A	256	ASP	3.4
1	A	537	GLU	3.4
1	A	75	TYR	3.3
1	A	701	GLN	3.2
1	A	659	LEU	3.2
1	A	291	GLY	3.2
1	A	989	THR	3.2
1	A	548	ASP	3.1
1	A	613	THR	3.1

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Mol	Chain	Res	Type	RSRZ
1	A	139	HIS	3.1
1	A	1045	SER	3.1
1	A	539	SER	3.1
1	A	304	ARG	3.1
1	A	600	HIS	3.0
1	A	604	THR	3.0
1	A	771	GLY	2.9
1	A	78	HIS	2.9
1	A	992	GLU	2.9
1	A	642	GLU	2.9
1	A	638	ASP	2.8
1	A	30	GLN	2.8
1	A	640	LYS	2.7
1	A	290	MET	2.7
1	A	521[A]	PHE	2.7
1	A	676	ILE	2.6
1	A	614	THR	2.6
1	A	1024	ASP	2.6
1	A	1022	HIS	2.6
1	A	608	HIS	2.6
1	A	308	ASP	2.6
1	A	312	ALA	2.5
1	A	533	GLY	2.5
1	A	313	ALA	2.5
1	A	309	GLN	2.5
1	A	601	ASP	2.5
1	A	393	GLY	2.5
1	A	683	GLY	2.5
1	A	610	GLN	2.4
1	A	549	ILE	2.4
1	A	705	HIS	2.4
1	A	700	THR	2.4
1	A	908	LEU	2.4
1	A	392	ALA	2.3
1	A	31	CYS	2.3
1	A	547	GLU	2.3
1	A	661	LEU	2.3
1	A	53[A]	SER	2.3
1	A	396	GLU	2.3
1	A	451	MET	2.2
1	A	785	LEU	2.2
1	A	898	LYS	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	662	GLY	2.1
1	A	138	TYR	2.1
1	A	709	HIS	2.1
1	A	639	SER	2.1
1	A	988	GLY	2.1
1	A	316	ASP	2.1
1	A	1025	GLY	2.1
1	A	367	GLN	2.0
1	A	940	ILE	2.0
1	A	518	ASP	2.0
1	A	666	GLU	2.0
1	A	77	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 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, 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($\text{\AA}^2$)	Q<0.9
3	MRD	A	1047	8/8	0.90	0.12	14,20,24,25	0
4	GOX	A	1048	13/13	0.96	0.06	9,12,16,22	0
2	ZN	A	1046	1/1	1.00	0.01	9,9,9,9	0

6.5 Other polymers [i](#)

There are no such residues in this entry.