



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 5, 2026 – 01:19 PM UTC

PDB ID : 2OWX / pdb_00002owx
Title : THERMUS THERMOPHILUS AMYLOMALTASE AT pH 5.6
Authors : Barends, T.R.M.; Kaper, T.; Bultema, J.J.; Dijkhuizen, L.; van der Maarel, J.E.C.; Dijkstra, B.W.
Deposited on : 2007-02-17
Resolution : 2.50 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

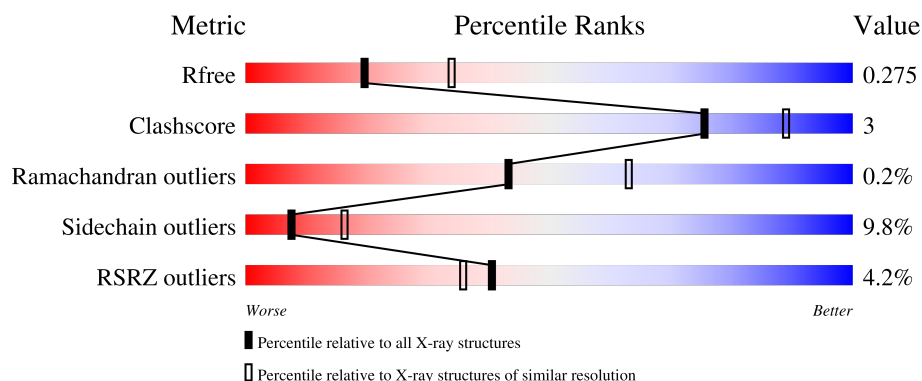
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.50 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	5829 (2.50-2.50)
Clashscore	190562	6492 (2.50-2.50)
Ramachandran outliers	187476	6378 (2.50-2.50)
Sidechain outliers	187428	6380 (2.50-2.50)
RSRZ outliers	180081	5833 (2.50-2.50)

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	502	4% 85% 13% ..

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 4176 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.

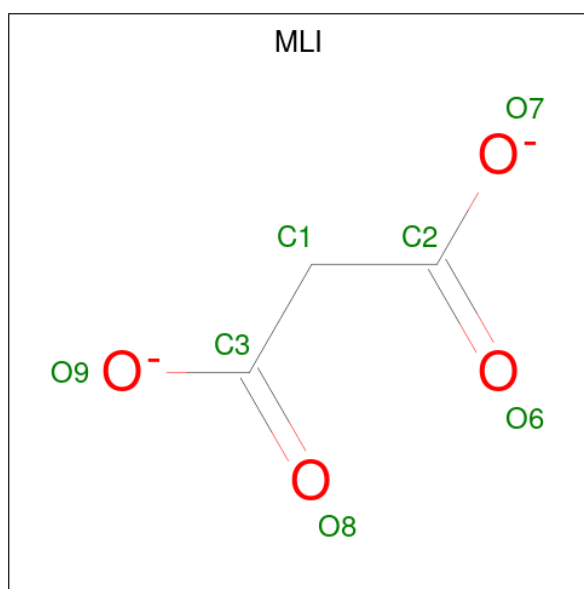
- Molecule 1 is a protein called 4-alpha-glucanotransferase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	499	4061	2641	703	706	11	0	0	0

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	cloning artifact	UNP Q72J82
A	-1	SER	-	cloning artifact	UNP Q72J82
A	0	HIS	-	cloning artifact	UNP Q72J82
A	370	SUI	ASP	modified residue	UNP Q72J82
A	370	SUI	GLY	modified residue	UNP Q72J82

- Molecule 2 is MALONATE ION (CCD ID: MLI) (formula: $C_3H_2O_4$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	7	3	4	0	0

- Molecule 3 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



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

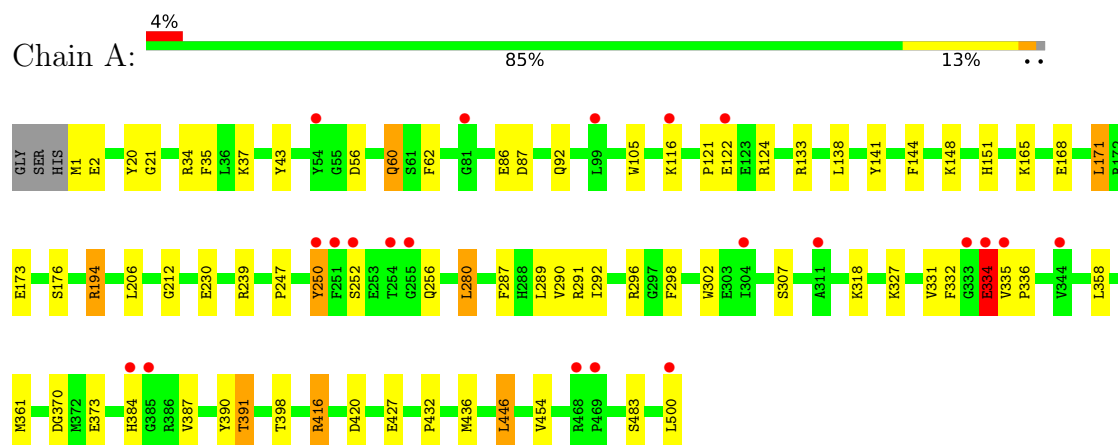
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	102	Total	O	0	0
			102	102		

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: 4-alpha-glucanotransferase



4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	93.80Å 93.80Å 154.77Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	34.92 – 2.50 34.92 – 2.50	Depositor EDS
% Data completeness (in resolution range)	90.4 (34.92-2.50) 90.4 (34.92-2.50)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.17 (at 2.51Å)	Xtriage
Refinement program	REFMAC 5.1.24	Depositor
R, R_{free}	0.220 , 0.276 0.219 , 0.275	Depositor DCC
R_{free} test set	1249 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å ²)	44.7	Xtriage
Anisotropy	0.500	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 31.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	0.012 for -h,-k,l	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	4176	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.02% 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: MLI, GOL, SUI

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	0.48	0/4190	0.95	8/5697 (0.1%)

There are no bond length outliers.

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	398	THR	N-CA-C	-7.08	101.19	110.53
1	A	21	GLY	N-CA-C	6.89	124.17	115.21
1	A	391	THR	N-CA-C	-6.61	103.34	111.40
1	A	20	TYR	N-CA-C	6.05	120.61	113.23
1	A	483	SER	N-CA-C	5.87	116.88	110.13
1	A	151	HIS	N-CA-C	5.78	117.83	110.61
1	A	250	TYR	N-CA-C	-5.31	105.40	111.14
1	A	138	LEU	N-CA-C	5.04	117.42	111.33

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	4061	0	3913	24	0
2	A	7	0	2	1	0
3	A	6	0	8	0	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	A	102	0	0	1	0
All	All	4176	0	3923	24	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 3.

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)
1:A:416:ARG:O	1:A:416:ARG:HD3	1.87	0.73
1:A:334:GLU:HG3	1:A:336:PRO:HD3	1.79	0.64
1:A:432:PRO:O	1:A:436:MET:HG3	2.00	0.61
1:A:416:ARG:HD3	1:A:416:ARG:C	2.30	0.57
1:A:62:PHE:CE2	1:A:148:LYS:HE3	2.40	0.57
1:A:37:LYS:HD3	1:A:206:LEU:O	2.05	0.56
1:A:121:PRO:HA	1:A:124:ARG:HD2	1.92	0.51
1:A:212:GLY:HA3	1:A:287:PHE:CD1	2.47	0.49
1:A:105:TRP:CD2	2:A:501:MLI:H12	2.48	0.49
1:A:292:ILE:HG21	1:A:298:PHE:HE1	1.78	0.48
1:A:171:LEU:HD12	1:A:171:LEU:HA	1.66	0.46
1:A:416:ARG:NH1	1:A:420:ASP:OD1	2.44	0.45
1:A:116:LYS:O	1:A:124:ARG:NH2	2.43	0.43
1:A:247:PRO:HB3	1:A:302:TRP:CE2	2.54	0.43
1:A:361:MET:HE3	1:A:390:TYR:CE1	2.54	0.42
1:A:35:PHE:CD2	1:A:35:PHE:C	2.97	0.42
1:A:327:LYS:HD3	1:A:327:LYS:HA	1.76	0.41
1:A:436:MET:HE1	1:A:454:VAL:HA	2.03	0.41
1:A:60:GLN:NE2	4:A:526:HOH:O	2.53	0.41
1:A:141:TYR:O	1:A:144:PHE:HB3	2.20	0.41
1:A:318:LYS:HA	1:A:318:LYS:HD3	1.91	0.41
1:A:43:TYR:CD1	1:A:446:LEU:HD21	2.56	0.41
1:A:280:LEU:HB3	1:A:332:PHE:CZ	2.56	0.41
1:A:194:ARG:HH11	1:A:194:ARG:HD3	1.77	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	496/502 (99%)	483 (97%)	12 (2%)	1 (0%)	43 63

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	334	GLU

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	400/402 (100%)	361 (90%)	39 (10%)	7 16

All (39) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	MET
1	A	2	GLU
1	A	34	ARG
1	A	56	ASP
1	A	60	GLN
1	A	86	GLU
1	A	87	ASP
1	A	92	GLN
1	A	122	GLU
1	A	133	ARG

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	165	LYS
1	A	168	GLU
1	A	171	LEU
1	A	173	GLU
1	A	176	SER
1	A	194	ARG
1	A	230	GLU
1	A	239	ARG
1	A	250	TYR
1	A	252	SER
1	A	256	GLN
1	A	280	LEU
1	A	289	LEU
1	A	290	VAL
1	A	291	ARG
1	A	296	ARG
1	A	307	SER
1	A	331	VAL
1	A	334	GLU
1	A	335	VAL
1	A	358	LEU
1	A	373	GLU
1	A	384	HIS
1	A	387	VAL
1	A	391	THR
1	A	416	ARG
1	A	427	GLU
1	A	446	LEU
1	A	500	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	151	HIS
1	A	228	HIS
1	A	233	HIS
1	A	464	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

1 non-standard protein/DNA/RNA residue is 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	SUI	A	370	1	10,11,12	3.64	4 (40%)	12,15,17	4.77	8 (66%)

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	SUI	A	370	1	-	1/2/19/20	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	370	SUI	C2A-N2	-10.27	1.28	1.47
1	A	370	SUI	C1-N2	-4.01	1.33	1.38
1	A	370	SUI	CG-N2	-2.14	1.35	1.38
1	A	370	SUI	O-C	-2.08	1.08	1.20

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	370	SUI	C2A-N2-C1	9.82	133.75	123.07
1	A	370	SUI	C-C2A-N2	9.08	133.09	112.43
1	A	370	SUI	O-C-C2A	-5.65	100.05	125.47
1	A	370	SUI	CB-CG-N2	5.01	111.22	108.07
1	A	370	SUI	OD-CG-CB	-3.11	122.72	127.28
1	A	370	SUI	CA-CB-CG	-2.99	101.24	104.82
1	A	370	SUI	O1-C1-N2	2.65	127.35	124.14
1	A	370	SUI	O1-C1-CA	-2.28	123.04	126.65

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	370	SUI	C-C2A-N2-CG

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

2 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	$\# Z > 2$
3	GOL	A	502	-	5,5,5	0.38	0	5,5,5	0.41	0
2	MLI	A	501	-	6,6,6	1.15	0	7,7,7	0.86	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
3	GOL	A	502	-	-	0/4/4/4	-
2	MLI	A	501	-	-	2/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	501	MLI	C2-C1-C3-O9
2	A	501	MLI	C2-C1-C3-O8

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	501	MLI	1	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 [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	A	498/502 (99%)	0.36	21 (4%) 40 36	27, 42, 68, 85	0

All (21) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	469	PRO	5.6
1	A	344	VAL	3.6
1	A	335	VAL	3.5
1	A	250	TYR	3.2
1	A	54	TYR	3.1
1	A	254	THR	3.0
1	A	252	SER	2.9
1	A	468	ARG	2.8
1	A	333	GLY	2.6
1	A	304	ILE	2.6
1	A	334	GLU	2.5
1	A	255	GLY	2.4
1	A	122	GLU	2.4
1	A	251	PHE	2.4
1	A	500	LEU	2.3
1	A	81	GLY	2.2
1	A	385	GLY	2.2
1	A	311	ALA	2.1
1	A	384	HIS	2.1
1	A	116	LYS	2.1
1	A	99	LEU	2.0

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. 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
1	SUI	A	370	11/12	0.87	0.10	31,33,35,36	0

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(Å ²)	Q<0.9
3	GOL	A	502	6/6	0.77	0.23	60,62,64,66	0
2	MLI	A	501	7/7	0.84	0.14	67,70,70,71	0

6.5 Other polymers [i](#)

There are no such residues in this entry.