



# Full wwPDB X-ray Structure Validation Report ⓘ

Sep 18, 2023 – 12:25 AM EDT

PDB ID : 4YWS  
Title : Thermostable enolase from *Chloroflexus aurantiacus*  
Authors : Zadvornyy, O.A.; Peters, J.W.  
Deposited on : 2015-03-20  
Resolution : 2.45 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.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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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  
Xtriage (Phenix) : 1.13  
EDS : 2.35.1  
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) : 2.35.1

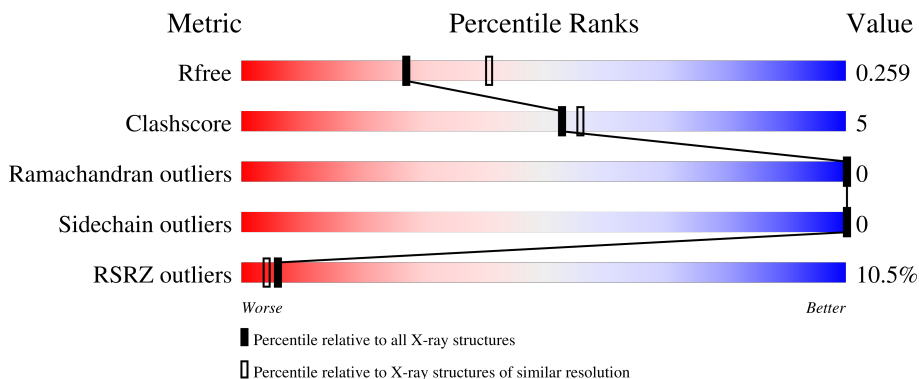
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.45 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	1544 (2.48-2.44)
Clashscore	141614	1613 (2.48-2.44)
Ramachandran outliers	138981	1598 (2.48-2.44)
Sidechain outliers	138945	1598 (2.48-2.44)
RSRZ outliers	127900	1523 (2.48-2.44)

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  $\geq 3$ , 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	426	
1	B	426	

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6154 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 Enolase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	405	3071	1935	537	591	8	0	0	0
1	B	393	2986	1884	521	573	8	0	0	0

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
2	A	1	1	1	0	0
2	B	1	1	1	0	0

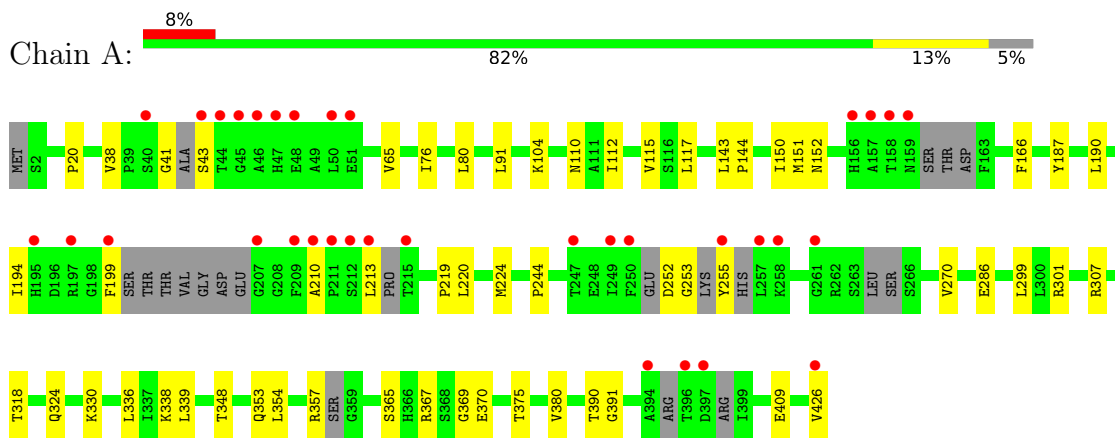
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	57	57	57	0	0
3	B	38	38	38	0	0

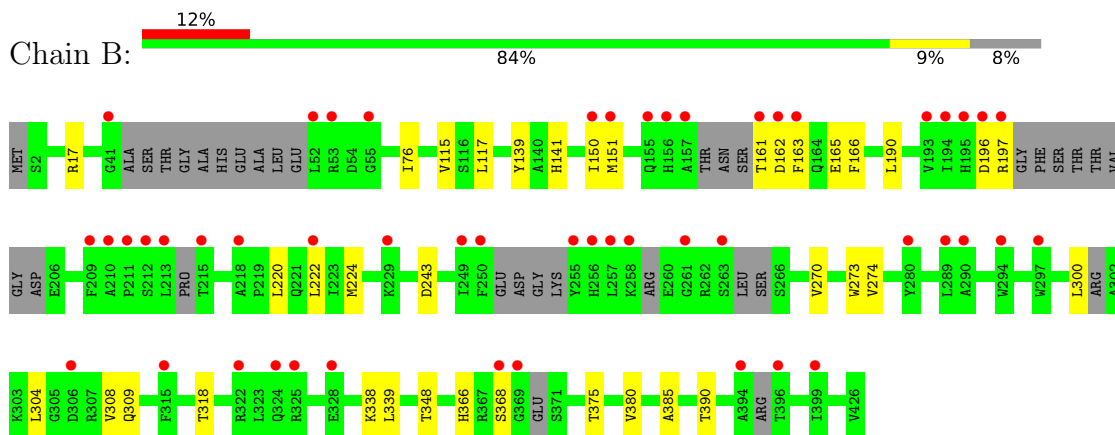
### 3 Residue-property plots [i](#)

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: Enolase



- Molecule 1: Enolase



## 4 Data and refinement statistics i

Property	Value	Source
Space group	I 4	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	146.32Å 146.32Å 102.99Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	37.76 – 2.45 37.76 – 2.45	Depositor EDS
% Data completeness (in resolution range)	99.7 (37.76-2.45) 99.7 (37.76-2.45)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.95 (at 2.45Å)	Xtrriage
Refinement program	BUSTER 2.10.1	Depositor
R, $R_{free}$	0.199 , 0.240 0.213 , 0.259	Depositor DCC
$R_{free}$ test set	2015 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	46.0	Xtrriage
Anisotropy	0.478	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 52.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.026 for -k,-h,-l	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	6154	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	64.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.93% 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 [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: MG

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	0.51	0/3109	0.68	0/4196
1	B	0.50	0/3024	0.67	0/4084
All	All	0.50	0/6133	0.67	0/8280

There are no bond length outliers.

There are no bond angle outliers.

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	3071	0	3066	37	0
1	B	2986	0	2990	28	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	57	0	0	0	0
3	B	38	0	0	0	0
All	All	6154	0	6056	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 5.

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:B:196:ASP:O	1:B:197:ARG:HG3	1.74	0.87
1:B:318:THR:HG21	1:B:338:LYS:H	1.40	0.87
1:A:80:LEU:HD13	1:A:91:LEU:HD11	1.57	0.86
1:A:318:THR:HG21	1:A:338:LYS:H	1.43	0.83
1:A:143:LEU:CD2	1:A:409:GLU:HB2	2.09	0.83
1:B:161:THR:HG23	1:B:162:ASP:N	2.03	0.72
1:B:163:PHE:CZ	1:B:273:TRP:CH2	2.78	0.71
1:B:163:PHE:CE2	1:B:273:TRP:HH2	2.09	0.70
1:A:253:GLY:O	1:A:255:TYR:N	2.25	0.69
1:A:143:LEU:HD22	1:A:409:GLU:HB2	1.72	0.69
1:A:143:LEU:HD21	1:A:409:GLU:HB2	1.74	0.69
1:B:163:PHE:CE2	1:B:273:TRP:CH2	2.80	0.69
1:B:161:THR:HG23	1:B:163:PHE:H	1.61	0.66
1:B:151:MET:HB3	1:B:166:PHE:HB2	1.78	0.65
1:A:318:THR:HG22	1:A:336:LEU:O	1.98	0.64
1:B:163:PHE:CZ	1:B:273:TRP:HH2	2.14	0.62
1:A:80:LEU:CD1	1:A:91:LEU:HD11	2.30	0.62
1:B:366:HIS:ND1	1:B:390:THR:HA	2.20	0.56
1:A:213:LEU:HD13	1:A:219:PRO:HG3	1.87	0.56
1:A:270:VAL:HG21	1:A:299:LEU:HD22	1.88	0.56
1:A:152:ASN:HB2	1:A:210:ALA:HB2	1.89	0.55
1:B:196:ASP:O	1:B:197:ARG:CG	2.51	0.54
1:A:80:LEU:HD13	1:A:91:LEU:CD1	2.33	0.54
1:B:165:GLU:HB2	1:B:243:ASP:HB3	1.88	0.54
1:A:301:ARG:HD3	1:A:330:LYS:HG2	1.91	0.53
1:B:380:VAL:HG23	1:B:385:ALA:HB3	1.89	0.53
1:B:139:TYR:O	1:B:141:HIS:CD2	2.61	0.53
1:A:318:THR:HG21	1:A:338:LYS:N	2.20	0.51
1:A:324:GLN:HG2	1:A:354:LEU:HD21	1.93	0.50
1:B:161:THR:HG23	1:B:162:ASP:H	1.76	0.50
1:A:244:PRO:HD2	1:A:286:GLU:O	2.11	0.50
1:A:336:LEU:HD21	1:A:365:SER:HB3	1.94	0.48
1:A:41:GLY:HA2	1:A:43:SER:HB3	1.94	0.48
1:B:339:LEU:HD12	1:B:348:THR:HG21	1.95	0.48
1:A:20:PRO:HB2	1:A:65:VAL:HG23	1.94	0.48
1:B:274:VAL:HA	1:B:304:LEU:HD11	1.94	0.48
1:B:117:LEU:HD22	1:B:375:THR:HG21	1.94	0.48
1:B:76:ILE:HG21	1:B:115:VAL:HG21	1.96	0.47
1:A:150:ILE:HD12	1:A:190:LEU:HD22	1.97	0.47
1:A:336:LEU:CD2	1:A:338:LYS:HG3	2.45	0.47
1:B:150:ILE:HD12	1:B:190:LEU:HD22	1.96	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:151:MET:HB3	1:A:166:PHE:HB2	1.96	0.46
1:A:367:ARG:HG3	1:A:369:GLY:H	1.81	0.46
1:A:76:ILE:HG21	1:A:115:VAL:HG21	1.97	0.45
1:A:353:GLN:O	1:A:357:ARG:HG2	2.17	0.45
1:A:144:PRO:HG3	1:A:380:VAL:HG11	1.98	0.44
1:A:367:ARG:H	1:A:370:GLU:HG2	1.82	0.44
1:A:252:ASP:O	1:A:252:ASP:OD1	2.35	0.44
1:A:38:VAL:HG11	1:A:110:ASN:HA	2.00	0.44
1:A:117:LEU:HD22	1:A:375:THR:HG21	2.00	0.44
1:A:220:LEU:O	1:A:224:MET:HG2	2.18	0.44
1:A:150:ILE:HG22	1:A:187:TYR:HD1	1.82	0.43
1:A:194:ILE:HG23	1:A:199:PHE:HB2	1.99	0.43
1:B:366:HIS:HD1	1:B:390:THR:HA	1.83	0.43
1:B:17:ARG:HD2	1:B:368:SER:HB3	2.00	0.43
1:A:307:ARG:HA	1:A:426:VAL:HG23	2.00	0.42
1:B:161:THR:CG2	1:B:162:ASP:N	2.72	0.42
1:A:339:LEU:CD1	1:A:348:THR:HG21	2.50	0.42
1:A:390:THR:HG22	1:A:391:GLY:H	1.84	0.42
1:B:339:LEU:CD1	1:B:348:THR:HG21	2.50	0.42
1:B:270:VAL:HG22	1:B:300:LEU:HB2	2.02	0.41
1:A:104:LYS:HB3	1:A:112:ILE:HD12	2.01	0.41
1:B:220:LEU:O	1:B:224:MET:HG2	2.21	0.41
1:B:308:VAL:CG1	1:B:309:GLN:N	2.82	0.41
1:B:197:ARG:HD2	1:B:222:LEU:HD21	2.03	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	382/426 (90%)	367 (96%)	15 (4%)	0	<a href="#">100</a> <a href="#">100</a>

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	371/426 (87%)	357 (96%)	14 (4%)	0	100	100
All	All	753/852 (88%)	724 (96%)	29 (4%)	0	100	100

There are no Ramachandran outliers to report.

### 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	313/332 (94%)	313 (100%)	0	100	100
1	B	306/332 (92%)	306 (100%)	0	100	100
All	All	619/664 (93%)	619 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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 monosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

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<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	405/426 (95%)	0.41	34 (8%) <b>11</b>   <b>8</b>	31, 51, 113, 139	0
1	B	393/426 (92%)	0.58	50 (12%) <b>3</b>   <b>2</b>	31, 59, 121, 139	0
All	All	798/852 (93%)	0.49	84 (10%) <b>6</b>   <b>4</b>	31, 55, 116, 139	0

All (84) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	45	GLY	12.6
1	A	46	ALA	11.1
1	A	47	HIS	9.1
1	B	213	LEU	7.2
1	B	209	PHE	6.5
1	A	158	THR	6.3
1	B	250	PHE	6.2
1	B	294	TRP	5.5
1	A	209	PHE	5.5
1	B	249	ILE	5.2
1	A	426	VAL	5.1
1	A	397	ASP	4.9
1	A	213	LEU	4.9
1	B	211	PRO	4.8
1	B	155	GLN	4.7
1	A	44	THR	4.7
1	A	212	SER	4.7
1	A	211	PRO	4.3
1	B	41	GLY	4.2
1	B	256	HIS	4.2
1	B	255	TYR	4.2
1	B	197	ARG	4.1
1	B	194	ILE	4.1
1	A	43	SER	4.1

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<b>Mol</b>	<b>Chain</b>	<b>Res</b>	<b>Type</b>	<b>RSRZ</b>
1	A	40	SER	4.1
1	A	199	PHE	4.1
1	B	163	PHE	4.0
1	B	322	ARG	3.8
1	B	156	HIS	3.8
1	A	210	ALA	3.7
1	A	396	THR	3.7
1	A	261	GLY	3.6
1	B	193	VAL	3.6
1	A	159	ASN	3.5
1	B	215	THR	3.5
1	B	161	THR	3.4
1	B	257	LEU	3.4
1	B	328	GLU	3.3
1	B	290	ALA	3.3
1	A	48	GLU	3.3
1	B	368	SER	3.2
1	B	222	LEU	3.2
1	A	250	PHE	3.2
1	B	218	ALA	3.1
1	B	212	SER	3.1
1	B	394	ALA	3.1
1	A	215	THR	3.0
1	B	324	GLN	3.0
1	A	51	GLU	3.0
1	A	157	ALA	2.9
1	B	280	TYR	2.9
1	A	255	TYR	2.9
1	B	53	ARG	2.9
1	A	50	LEU	2.8
1	A	258	LYS	2.8
1	B	195	HIS	2.7
1	B	150	ILE	2.7
1	B	258	LYS	2.6
1	A	195	HIS	2.6
1	B	289	LEU	2.6
1	B	297	TRP	2.5
1	B	151	MET	2.5
1	B	306	ASP	2.5
1	A	394	ALA	2.4
1	B	263	SER	2.4
1	B	315	PHE	2.4

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Mol	Chain	Res	Type	RSRZ
1	B	196	ASP	2.4
1	A	257	LEU	2.4
1	B	325	ARG	2.4
1	B	210	ALA	2.3
1	B	261	GLY	2.3
1	B	157	ALA	2.3
1	B	55	GLY	2.3
1	A	197	ARG	2.2
1	A	207	GLY	2.2
1	B	52	LEU	2.2
1	A	249	ILE	2.1
1	B	162	ASP	2.1
1	A	247	THR	2.1
1	B	399	ILE	2.1
1	B	369	GLY	2.1
1	B	229	LYS	2.1
1	B	396	THR	2.0
1	A	156	HIS	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 monosaccharides 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(Å <sup>2</sup> )	Q<0.9
2	MG	A	501	1/1	0.56	0.16	51,51,51,51	0
2	MG	B	501	1/1	0.79	0.19	71,71,71,71	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.