wwPDB X-ray Structure Validation Summary Report (i)

May 18, 2020 – 10:31 am BST

PDB ID	:	2XH2
Title	:	Engineering the enolase active site pocket: Crystal structure of the S39N D321A mutant of yeast enolase 1
Authors	:	Schreier, B.; Hocker, B.
Deposited on	:	2010-06-08
Resolution	:	1.80 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
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

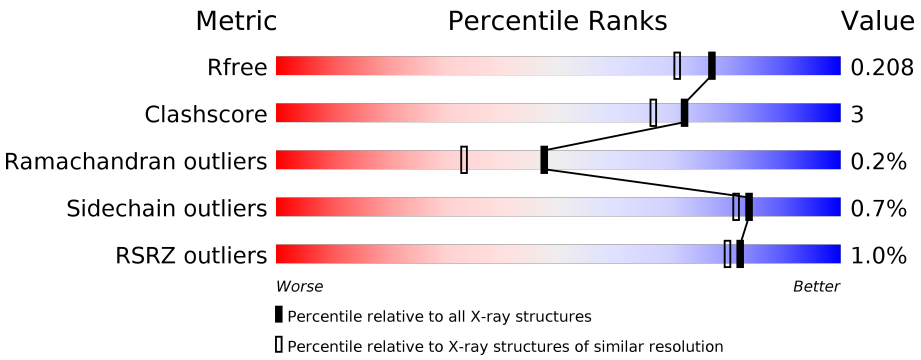
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA,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

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	5950 (1.80-1.80)
Clashscore	141614	6793 (1.80-1.80)
Ramachandran outliers	138981	6697 (1.80-1.80)
Sidechain outliers	138945	6696 (1.80-1.80)
RSRZ outliers	127900	5850 (1.80-1.80)

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 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 <=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	443	92% 7% •
1	B	443	% 93% 6% •
1	C	443	% 94% 5% •
1	D	443	% 91% 7% •

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 15921 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 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	438	3342	2117	575	644	6	0	12	1
1	B	438	3326	2105	571	643	7	0	12	1
1	C	438	3299	2087	568	638	6	0	6	1
1	D	438	3339	2114	572	647	6	0	13	1

There are 40 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	437	LEU	-	expression tag	UNP P00924
A	438	HIS	-	expression tag	UNP P00924
A	439	HIS	-	expression tag	UNP P00924
A	440	HIS	-	expression tag	UNP P00924
A	441	HIS	-	expression tag	UNP P00924
A	442	HIS	-	expression tag	UNP P00924
A	443	HIS	-	expression tag	UNP P00924
A	39	ASN	SER	engineered mutation	UNP P00924
A	241	ILE	VAL	SEE REMARK 999	UNP P00924
A	321	ALA	ASP	engineered mutation	UNP P00924
B	437	LEU	-	expression tag	UNP P00924
B	438	HIS	-	expression tag	UNP P00924
B	439	HIS	-	expression tag	UNP P00924
B	440	HIS	-	expression tag	UNP P00924
B	441	HIS	-	expression tag	UNP P00924
B	442	HIS	-	expression tag	UNP P00924
B	443	HIS	-	expression tag	UNP P00924
B	39	ASN	SER	engineered mutation	UNP P00924
B	241	ILE	VAL	SEE REMARK 999	UNP P00924
B	321	ALA	ASP	engineered mutation	UNP P00924
C	437	LEU	-	expression tag	UNP P00924

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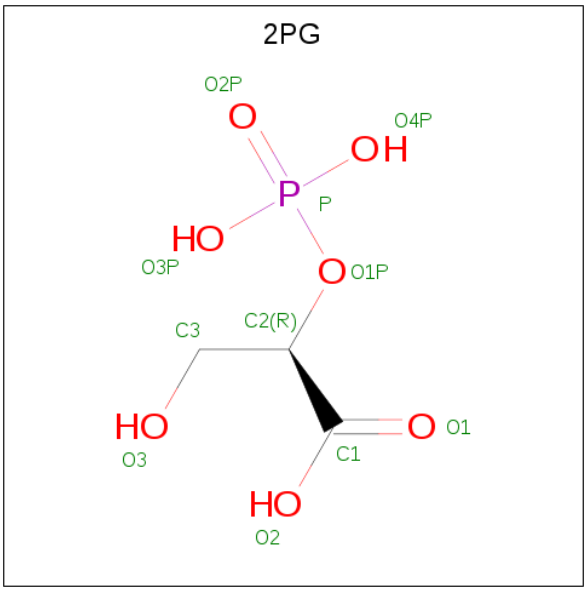
Chain	Residue	Modelled	Actual	Comment	Reference
C	438	HIS	-	expression tag	UNP P00924
C	439	HIS	-	expression tag	UNP P00924
C	440	HIS	-	expression tag	UNP P00924
C	441	HIS	-	expression tag	UNP P00924
C	442	HIS	-	expression tag	UNP P00924
C	443	HIS	-	expression tag	UNP P00924
C	39	ASN	SER	engineered mutation	UNP P00924
C	241	ILE	VAL	SEE REMARK 999	UNP P00924
C	321	ALA	ASP	engineered mutation	UNP P00924
D	437	LEU	-	expression tag	UNP P00924
D	438	HIS	-	expression tag	UNP P00924
D	439	HIS	-	expression tag	UNP P00924
D	440	HIS	-	expression tag	UNP P00924
D	441	HIS	-	expression tag	UNP P00924
D	442	HIS	-	expression tag	UNP P00924
D	443	HIS	-	expression tag	UNP P00924
D	39	ASN	SER	engineered mutation	UNP P00924
D	241	ILE	VAL	SEE REMARK 999	UNP P00924
D	321	ALA	ASP	engineered mutation	UNP P00924

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

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

- Molecule 3 is 2-PHOSPHOGLYCERIC ACID (three-letter code: 2PG) (formula: $C_3H_7O_7P$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	O	P		
3	A	1	11	3	7	1	0	0
			Total	C	O	P		
3	B	1	11	3	7	1	0	0
			Total	C	O	P		
3	C	1	11	3	7	1	0	0
			Total	C	O	P		
3	D	1	11	3	7	1	0	0

- Molecule 4 is water.

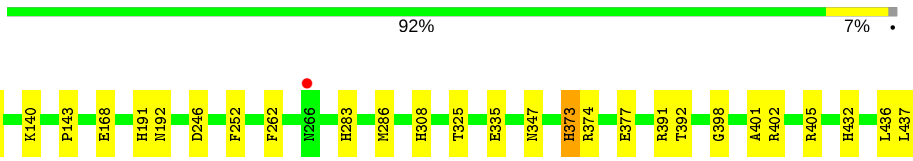
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	691	691	691	0	0
			Total	O		
4	B	625	625	625	0	0
			Total	O		
4	C	624	624	624	0	0
			Total	O		
4	D	627	627	627	0	0

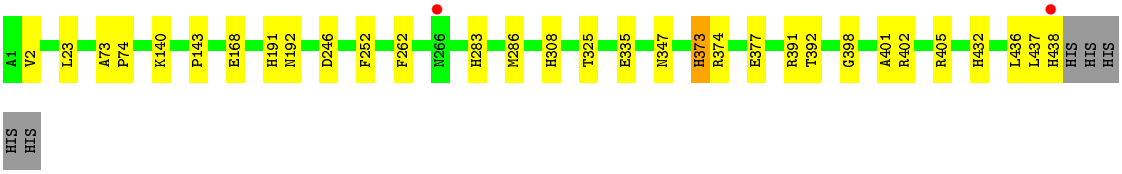
3 Residue-property plots (i)

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: ENOLASE 1

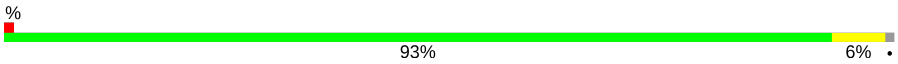
Chain A:

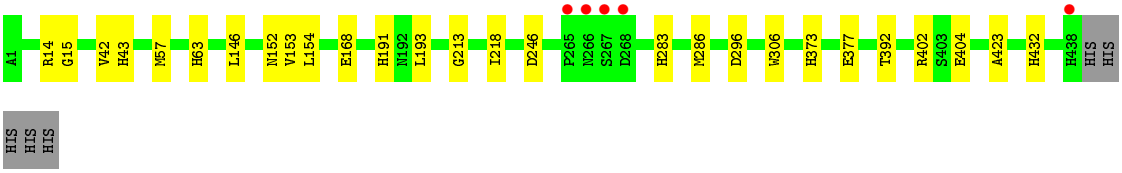




- Molecule 1: ENOLASE 1

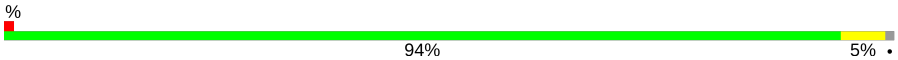
Chain B:

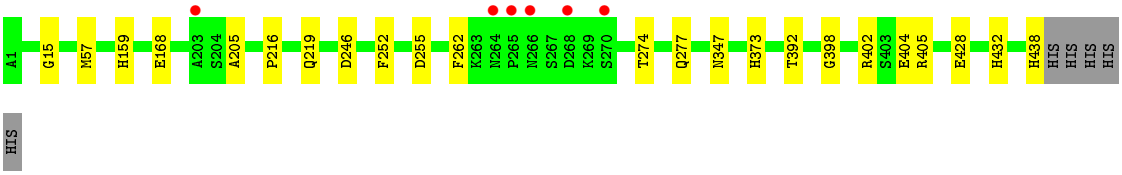




- Molecule 1: ENOLASE 1

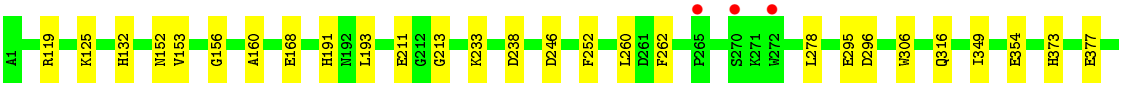
Chain C:

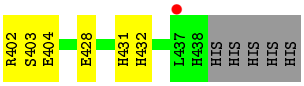




- Molecule 1: ENOLASE 1

Chain D:




R402
S403
E404
E428
H431
H432
L437
H438
HIS
HIS
HIS
HIS
HIS

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α, β, γ	64.72Å 82.54Å 95.61Å 89.41° 71.31° 84.80°	Depositor
Resolution (Å)	35.65 – 1.80 35.64 – 1.80	Depositor EDS
% Data completeness (in resolution range)	93.5 (35.65-1.80) 73.7 (35.64-1.80)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.28 (at 1.79Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.166 , 0.209 0.166 , 0.208	Depositor DCC
R_{free} test set	6426 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å^2)	15.3	Xtriage
Anisotropy	0.044	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 65.6	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.000 for -h,-k,-h+l	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	15921	wwPDB-VP
Average B, all atoms (Å^2)	18.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 87.90 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 5.8832e-08. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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, 2PG

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	0.52	0/3438	0.59	0/4654
1	B	0.52	0/3422	0.57	0/4636
1	C	0.52	0/3377	0.59	0/4577
1	D	0.51	0/3438	0.59	0/4658
All	All	0.52	0/13675	0.58	0/18525

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	3342	0	3366	22	0
1	B	3326	0	3325	17	0
1	C	3299	0	3293	15	0
1	D	3339	0	3346	42	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	A	11	0	4	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	11	0	4	0	0
3	C	11	0	4	0	0
3	D	11	0	4	0	0
4	A	691	0	0	9	0
4	B	625	0	0	4	2
4	C	624	0	0	5	2
4	D	627	0	0	23	0
All	All	15921	0	13346	91	2

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.

The worst 5 of 91 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:D:119[A]:ARG:NH1	4:D:2290:HOH:O	1.60	1.25
1:D:233[A]:LYS:HG3	4:D:2424:HOH:O	1.09	1.24
1:D:238[A]:ASP:OD2	4:D:2440:HOH:O	1.54	1.20
4:A:2433:HOH:O	1:B:57[A]:MET:HE2	1.54	1.05
1:D:233[B]:LYS:HE2	4:D:2427:HOH:O	1.56	1.04

All (2) 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)
4:B:2591:HOH:O	4:C:2427:HOH:O[1_546]	2.08	0.12
4:B:2423:HOH:O	4:C:2598:HOH:O[1_545]	2.13	0.07

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	448/443 (101%)	441 (98%)	7 (2%)	0	100	100
1	B	448/443 (101%)	437 (98%)	10 (2%)	1 (0%)	47	33
1	C	442/443 (100%)	434 (98%)	6 (1%)	2 (0%)	29	15
1	D	449/443 (101%)	441 (98%)	7 (2%)	1 (0%)	47	33
All	All	1787/1772 (101%)	1753 (98%)	30 (2%)	4 (0%)	47	33

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	402	ARG
1	C	255	ASP
1	C	402	ARG
1	D	402	ARG

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	351/350 (100%)	348 (99%)	3 (1%)	78	75
1	B	347/350 (99%)	345 (99%)	2 (1%)	86	84
1	C	343/350 (98%)	339 (99%)	4 (1%)	71	65
1	D	350/350 (100%)	349 (100%)	1 (0%)	92	91
All	All	1391/1400 (99%)	1381 (99%)	10 (1%)	84	81

5 of 10 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	392	THR
1	C	159	HIS
1	C	373	HIS
1	B	373	HIS
1	C	347	ASN

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 19 such

sidechains are listed below:

Mol	Chain	Res	Type
1	B	191	HIS
1	B	394	GLN
1	D	132	HIS
1	B	63	HIS
1	D	316	GLN

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 carbohydrates in this entry.

5.6 Ligand geometry (i)

Of 8 ligands modelled in this entry, 4 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	$\#\|Z\| > 2$
3	2PG	D	1440	-	7,10,10	0.83	0	8,14,14	0.94	0
3	2PG	C	1440	2	7,10,10	0.87	0	8,14,14	1.20	0
3	2PG	B	1440	-	7,10,10	1.14	1 (14%)	8,14,14	0.81	0
3	2PG	A	1440	2	7,10,10	1.02	0	8,14,14	0.79	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	2PG	D	1440	-	-	0/7/11/11	-
3	2PG	C	1440	2	-	1/7/11/11	-
3	2PG	B	1440	-	-	0/7/11/11	-
3	2PG	A	1440	2	-	0/7/11/11	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	1440	2PG	O1P-C2	-2.63	1.42	1.45

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	C	1440	2PG	C1-C2-C3-O3

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 (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	438/443 (98%)	-0.81	2 (0%)	91	89	8, 14, 25, 42	0
1	B	438/443 (98%)	-0.75	5 (1%)	80	78	9, 15, 32, 49	0
1	C	438/443 (98%)	-0.72	6 (1%)	75	72	8, 16, 30, 47	0
1	D	438/443 (98%)	-0.78	4 (0%)	84	82	8, 15, 32, 46	0
All	All	1752/1772 (98%)	-0.77	17 (0%)	82	80	8, 15, 30, 49	0

The worst 5 of 17 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	438	HIS	4.9
1	B	265	PRO	4.4
1	B	438	HIS	3.7
1	C	268	ASP	3.1
1	C	266	ASN	3.0

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, 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
2	MG	A	1439	1/1	0.98	0.12	2,2,2,2	0
2	MG	C	1439	1/1	0.98	0.09	5,5,5,5	0
3	2PG	A	1440	11/11	0.98	0.07	11,13,14,15	0
3	2PG	C	1440	11/11	0.98	0.07	13,15,18,18	0
2	MG	B	1439	1/1	0.98	0.10	2,2,2,2	0
2	MG	D	1439	1/1	0.98	0.12	2,2,2,2	0
3	2PG	D	1440	11/11	0.99	0.05	13,16,18,18	0
3	2PG	B	1440	11/11	0.99	0.05	14,16,18,20	0

6.5 Other polymers (i)

There are no such residues in this entry.