



# Full wwPDB X-ray Structure Validation Report ⓘ

Apr 5, 2026 – 11:52 AM UTC

PDB ID : 3DIP / pdb\_00003dip  
Title : Crystal structure of an enolase protein from the environmental genome shotgun sequencing of the Sargasso Sea  
Authors : Bonanno, J.B.; Freeman, J.; Bain, K.T.; Zhang, F.; Ozyurt, S.; Smith, D.; Wasserman, S.; Sauder, J.M.; Burley, S.K.; Almo, S.C.; New York SGX Research Center for Structural Genomics (NYSGXRC)  
Deposited on : 2008-06-20  
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](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	:	4-5-2 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

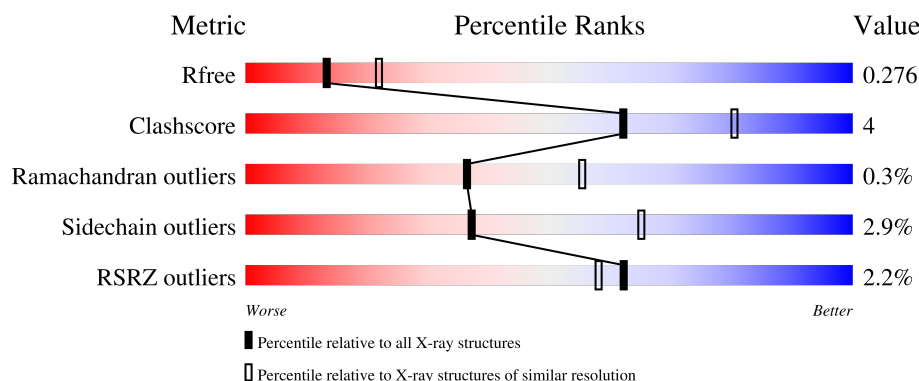
# 1 Overall quality at a glance

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  $\geq 3$ , 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	410	
1	B	410	

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
2	SO4	A	411	-	-	X	-

## 2 Entry composition [i](#)

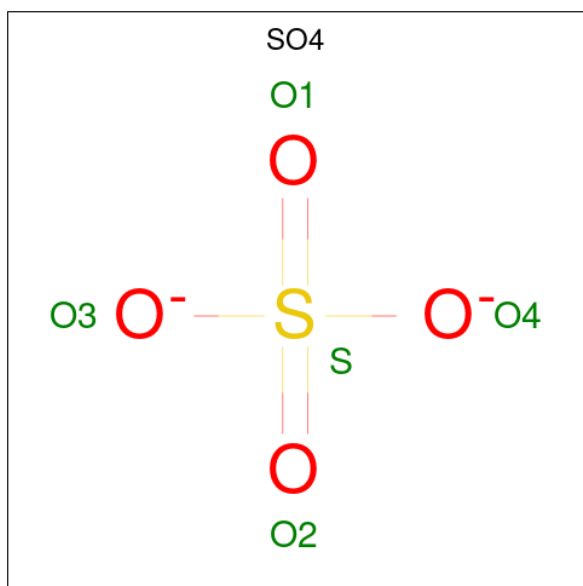
There are 3 unique types of molecules in this entry. The entry contains 5817 atoms, of which 0 are hydrogens and 0 are deuteriums.

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
1	A	372	Total	C	N	O	S	0	0	0
			2803	1777	503	510	13			
1	B	366	Total	C	N	O	S	0	0	0
			2763	1751	499	500	13			

- Molecule 2 is SULFATE ION (CCD ID: SO4) (formula: O<sub>4</sub>S).



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

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	121	Total 121	O 121	0	0
3	B	110	Total 110	O 110	0	0



- Molecule 1: enolase



## 4 Data and refinement statistics

Property	Value	Source
Space group	F 4 3 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	282.29Å 282.29Å 282.29Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 2.50 20.00 – 2.50	Depositor EDS
% Data completeness (in resolution range)	100.0 (20.00-2.50) 99.7 (20.00-2.50)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	0.10	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	12.28 (at 2.51Å)	Xtriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.215 , 0.275 0.216 , 0.276	Depositor DCC
$R_{free}$ test set	1729 reflections (5.11%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	29.5	Xtriage
Anisotropy	0.000	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 36.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.54$ , $\langle L^2 \rangle = 0.39$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	5817	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	30.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.03% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, SIC

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	0.75	0/2851	0.91	2/3887 (0.1%)
1	B	0.72	0/2809	0.91	0/3827
All	All	0.73	0/5660	0.91	2/7714 (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	A	0	1
1	B	0	1
All	All	0	2

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	71	ASN	CA-C-N	-5.95	114.14	120.03
1	A	71	ASN	C-N-CA	-5.95	114.14	120.03

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	321	SIC	Mainchain
1	B	321	SIC	Mainchain

## 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	A	2803	0	2802	23	0
1	B	2763	0	2762	26	0
2	A	10	0	0	3	0
2	B	10	0	0	0	0
3	A	121	0	0	0	0
3	B	110	0	0	0	0
All	All	5817	0	5564	46	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 (46) 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:30:THR:HG22	1:A:401:ARG:NH2	1.79	0.96
1:A:123:CYS:HG	1:A:321:SIC:HSG	0.89	0.87
1:B:294:LEU:HD11	1:B:334:LEU:HD22	1.64	0.77
1:B:347:VAL:HG11	1:B:350:SER:HB2	1.69	0.75
1:B:1:LEU:CB	1:B:2:PRO:CD	2.68	0.71
1:A:30:THR:HG22	1:A:401:ARG:HH21	1.59	0.68
1:A:30:THR:HG22	1:A:401:ARG:HH22	1.62	0.63
1:B:1:LEU:CB	1:B:2:PRO:HD2	2.29	0.63
1:B:168:GLU:OE2	1:B:348:ARG:NH2	2.33	0.62
1:B:30:THR:HG22	1:B:401:ARG:HH12	1.64	0.61
1:A:248:LYS:HE2	1:B:71:ASN:OD1	2.04	0.57
1:B:120:TYR:CG	1:B:215:MET:HE1	2.41	0.56
1:B:354:TRP:CZ3	1:B:358:LEU:HD11	2.42	0.55
1:B:67:SER:O	1:B:71:ASN:HB2	2.07	0.54
1:A:7:LEU:HD12	1:A:54:ILE:HD11	1.90	0.53
1:B:175:ILE:HG13	1:B:177:PRO:HD3	1.91	0.53
1:A:122:THR:CG2	1:A:176:TRP:HZ3	2.23	0.50
1:A:80:SER:HB3	1:B:80:SER:HB3	1.93	0.50
1:A:176:TRP:HB3	1:A:217:GLU:HB3	1.93	0.50
1:B:354:TRP:HZ3	1:B:358:LEU:HD11	1.78	0.48
1:A:17:LYS:HE2	2:A:411:SO4:O4	2.13	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:62:ILE:HD11	1:A:97:ALA:HB2	1.97	0.47
1:A:78:SER:HB2	1:B:78:SER:HB2	1.97	0.47
1:B:289:PHE:CD1	1:B:316:PRO:HG2	2.50	0.47
1:B:122:THR:HG23	1:B:176:TRP:HZ3	1.80	0.47
1:A:34:GLU:HB3	1:A:326:VAL:HB	1.97	0.46
1:A:354:TRP:HZ3	1:A:358:LEU:HD12	1.81	0.46
1:B:178:PHE:CE2	1:B:197:GLY:HA3	2.52	0.45
1:A:122:THR:CG2	1:A:176:TRP:CZ3	3.00	0.44
1:A:123:CYS:SG	1:A:321:SIC:SG	2.82	0.44
1:B:62:ILE:HG12	1:B:93:LEU:HB3	2.00	0.43
1:B:30:THR:HG22	1:B:401:ARG:NH1	2.31	0.43
1:A:320:HIS:CD2	1:A:345:GLU:OE1	2.71	0.43
1:B:247:ALA:HA	1:B:248:LYS:HA	1.82	0.42
1:A:198:LEU:HD11	1:A:233:ALA:HB1	2.00	0.42
1:A:36:PHE:CD2	1:A:37:ARG:HG3	2.55	0.41
1:B:122:THR:HG23	1:B:176:TRP:CZ3	2.56	0.41
1:B:215:MET:HG2	1:B:241:TRP:CE2	2.55	0.41
1:B:98:GLY:HA3	1:B:377:GLY:HA2	2.03	0.41
1:B:383:LEU:O	1:B:386:VAL:HG23	2.20	0.41
1:A:57:ARG:HA	2:A:410:SO4:O3	2.21	0.41
1:A:319:PRO:HG2	1:A:335:ALA:HB2	2.03	0.41
1:A:17:LYS:HG2	2:A:411:SO4:O3	2.22	0.40
1:B:328:LEU:HD11	1:B:346:VAL:HG12	2.03	0.40
1:A:18:LEU:CD1	1:A:354:TRP:HH2	2.35	0.40
1:B:291:MET:HE2	1:B:291:MET:HB2	1.95	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	367/410 (90%)	360 (98%)	6 (2%)	1 (0%)	36 55

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	359/410 (88%)	352 (98%)	6 (2%)	1 (0%)	36	55
All	All	726/820 (88%)	712 (98%)	12 (2%)	2 (0%)	36	55

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	37	ARG
1	B	156	ARG

### 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	280/313 (90%)	274 (98%)	6 (2%)	47	74
1	B	276/313 (88%)	266 (96%)	10 (4%)	31	58
All	All	556/626 (89%)	540 (97%)	16 (3%)	37	65

All (16) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	30	THR
1	A	78	SER
1	A	122	THR
1	A	225	HIS
1	A	351	LEU
1	A	366	GLN
1	B	5	THR
1	B	14	GLU
1	B	30	THR
1	B	49	GLN
1	B	71	ASN
1	B	164	SER
1	B	192	THR
1	B	225	HIS

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Mol	Chain	Res	Type
1	B	365	ILE
1	B	380	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	49	GLN
1	A	313	HIS
1	B	261	GLN
1	B	313	HIS
1	B	385	HIS

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

2 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	SIC	A	321	1	11,13,14	1.45	2 (18%)	13,18,20	2.72	6 (46%)
1	SIC	B	321	1	11,13,14	1.34	2 (18%)	13,18,20	2.52	5 (38%)

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	SIC	A	321	1	-	0/4/24/26	0/1/1/1

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
1	SIC	B	321	1	-	1/4/24/26	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	321	SIC	C5-N1	-3.47	1.33	1.39
1	B	321	SIC	C5-N1	-3.24	1.33	1.39
1	A	321	SIC	C2-N1	-3.08	1.34	1.39
1	B	321	SIC	C2-N1	-2.76	1.34	1.39

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	321	SIC	C3-CB-SG	-6.43	106.91	114.16
1	A	321	SIC	C4-C5-N1	4.79	111.41	107.59
1	B	321	SIC	C4-C5-N1	4.73	111.36	107.59
1	B	321	SIC	C3-CB-SG	-3.94	109.72	114.16
1	B	321	SIC	O5-C5-C4	-3.42	122.27	127.28
1	B	321	SIC	CA-C2-N1	3.41	111.01	107.45
1	B	321	SIC	O2-C2-CA	-2.92	122.03	126.65
1	A	321	SIC	O5-C5-C4	-2.87	123.08	127.28
1	A	321	SIC	CA-C4-C5	-2.56	101.75	104.82
1	A	321	SIC	O2-C2-CA	-2.50	122.70	126.65
1	A	321	SIC	CA-C2-N1	2.46	110.02	107.45

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	B	321	SIC	CB-C3-N1-C2

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	A	321	SIC	2	0

## 5.5 Carbohydrates

There are no oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

4 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	$\# Z  > 2$
2	SO4	B	410	-	4,4,4	0.30	0	6,6,6	0.46	0
2	SO4	A	410	-	4,4,4	0.24	0	6,6,6	0.23	0
2	SO4	B	411	-	4,4,4	0.30	0	6,6,6	0.29	0
2	SO4	A	411	-	4,4,4	0.28	0	6,6,6	0.20	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.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	410	SO4	1	0
2	A	411	SO4	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 [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, 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	371/410 (90%)	-0.20	5 (1%) 75 71	16, 27, 45, 63	0
1	B	365/410 (89%)	-0.07	11 (3%) 52 48	20, 29, 47, 69	0
All	All	736/820 (89%)	-0.14	16 (2%) 62 58	16, 28, 46, 69	0

All (16) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	154	PHE	4.5
1	A	127	ASP	4.1
1	B	350	SER	4.1
1	B	347	VAL	3.9
1	A	1	LEU	3.9
1	B	349	ALA	3.6
1	B	156	ARG	3.4
1	A	128	PHE	3.0
1	B	122	THR	2.9
1	B	155	MET	2.8
1	B	1	LEU	2.6
1	B	354	TRP	2.5
1	A	124	ALA	2.5
1	A	126	TYR	2.5
1	B	121	ALA	2.4
1	B	14	GLU	2.4

### 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, 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( $\text{\AA}^2$ )	Q<0.9
1	SIC	B	321	13/14	0.79	0.12	35,39,41,49	0
1	SIC	A	321	13/14	0.83	0.11	30,34,36,45	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, 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( $\text{\AA}^2$ )	Q<0.9
2	SO4	B	410	5/5	0.73	0.19	72,73,73,73	0
2	SO4	A	411	5/5	0.80	0.25	81,82,82,83	0
2	SO4	B	411	5/5	0.82	0.20	77,77,77,77	0
2	SO4	A	410	5/5	0.93	0.09	59,59,60,60	0

### 6.5 Other polymers [i](#)

There are no such residues in this entry.