



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 21, 2020 – 03:02 am BST

PDB ID : 3U9I  
Title : The crystal structure of Mandelate racemase/muconate lactonizing enzyme from *Roseiflexus* sp.  
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Deposited on : 2011-10-19  
Resolution : 2.90 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](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.

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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
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

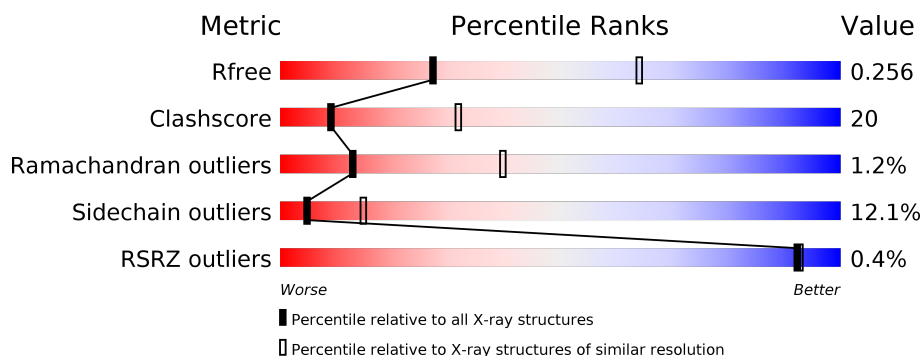
# 1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.90 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	1957 (2.90-2.90)
Clashscore	141614	2172 (2.90-2.90)
Ramachandran outliers	138981	2115 (2.90-2.90)
Sidechain outliers	138945	2117 (2.90-2.90)
RSRZ outliers	127900	1906 (2.90-2.90)

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  $\geq 3$ , 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	393	 50% 34% •• 12%
1	B	393	 55% 30% 5% 10%

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 5208 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 Mandelate racemase/muconate lactonizing enzyme, C-terminal domain protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	346	Total	C	N	O	S	0	0	0
			2546	1605	458	470	13			
1	B	354	Total	C	N	O	S	0	1	0
			2585	1628	460	483	14			

There are 44 discrepancies between the modelled and reference sequences:

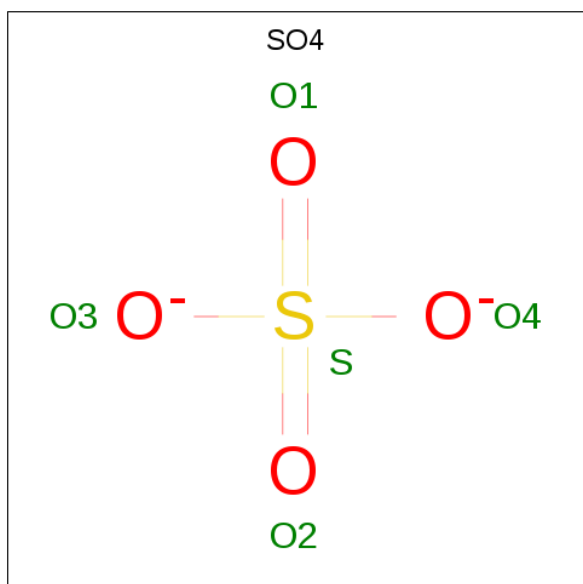
Chain	Residue	Modelled	Actual	Comment	Reference
A	-19	MET	-	EXPRESSION TAG	UNP A5UXJ3
A	-18	HIS	-	EXPRESSION TAG	UNP A5UXJ3
A	-17	HIS	-	EXPRESSION TAG	UNP A5UXJ3
A	-16	HIS	-	EXPRESSION TAG	UNP A5UXJ3
A	-15	HIS	-	EXPRESSION TAG	UNP A5UXJ3
A	-14	HIS	-	EXPRESSION TAG	UNP A5UXJ3
A	-13	HIS	-	EXPRESSION TAG	UNP A5UXJ3
A	-12	SER	-	EXPRESSION TAG	UNP A5UXJ3
A	-11	SER	-	EXPRESSION TAG	UNP A5UXJ3
A	-10	GLY	-	EXPRESSION TAG	UNP A5UXJ3
A	-9	VAL	-	EXPRESSION TAG	UNP A5UXJ3
A	-8	ASP	-	EXPRESSION TAG	UNP A5UXJ3
A	-7	LEU	-	EXPRESSION TAG	UNP A5UXJ3
A	-6	GLY	-	EXPRESSION TAG	UNP A5UXJ3
A	-5	THR	-	EXPRESSION TAG	UNP A5UXJ3
A	-4	GLU	-	EXPRESSION TAG	UNP A5UXJ3
A	-3	ASN	-	EXPRESSION TAG	UNP A5UXJ3
A	-2	LEU	-	EXPRESSION TAG	UNP A5UXJ3
A	-1	TYR	-	EXPRESSION TAG	UNP A5UXJ3
A	0	PHE	-	EXPRESSION TAG	UNP A5UXJ3
A	1	GLN	-	EXPRESSION TAG	UNP A5UXJ3
A	2	SER	-	EXPRESSION TAG	UNP A5UXJ3
B	-19	MET	-	EXPRESSION TAG	UNP A5UXJ3
B	-18	HIS	-	EXPRESSION TAG	UNP A5UXJ3

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Chain	Residue	Modelled	Actual	Comment	Reference
B	-17	HIS	-	EXPRESSION TAG	UNP A5UXJ3
B	-16	HIS	-	EXPRESSION TAG	UNP A5UXJ3
B	-15	HIS	-	EXPRESSION TAG	UNP A5UXJ3
B	-14	HIS	-	EXPRESSION TAG	UNP A5UXJ3
B	-13	HIS	-	EXPRESSION TAG	UNP A5UXJ3
B	-12	SER	-	EXPRESSION TAG	UNP A5UXJ3
B	-11	SER	-	EXPRESSION TAG	UNP A5UXJ3
B	-10	GLY	-	EXPRESSION TAG	UNP A5UXJ3
B	-9	VAL	-	EXPRESSION TAG	UNP A5UXJ3
B	-8	ASP	-	EXPRESSION TAG	UNP A5UXJ3
B	-7	LEU	-	EXPRESSION TAG	UNP A5UXJ3
B	-6	GLY	-	EXPRESSION TAG	UNP A5UXJ3
B	-5	THR	-	EXPRESSION TAG	UNP A5UXJ3
B	-4	GLU	-	EXPRESSION TAG	UNP A5UXJ3
B	-3	ASN	-	EXPRESSION TAG	UNP A5UXJ3
B	-2	LEU	-	EXPRESSION TAG	UNP A5UXJ3
B	-1	TYR	-	EXPRESSION TAG	UNP A5UXJ3
B	0	PHE	-	EXPRESSION TAG	UNP A5UXJ3
B	1	GLN	-	EXPRESSION TAG	UNP A5UXJ3
B	2	SER	-	EXPRESSION TAG	UNP A5UXJ3

- Molecule 2 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).



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

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

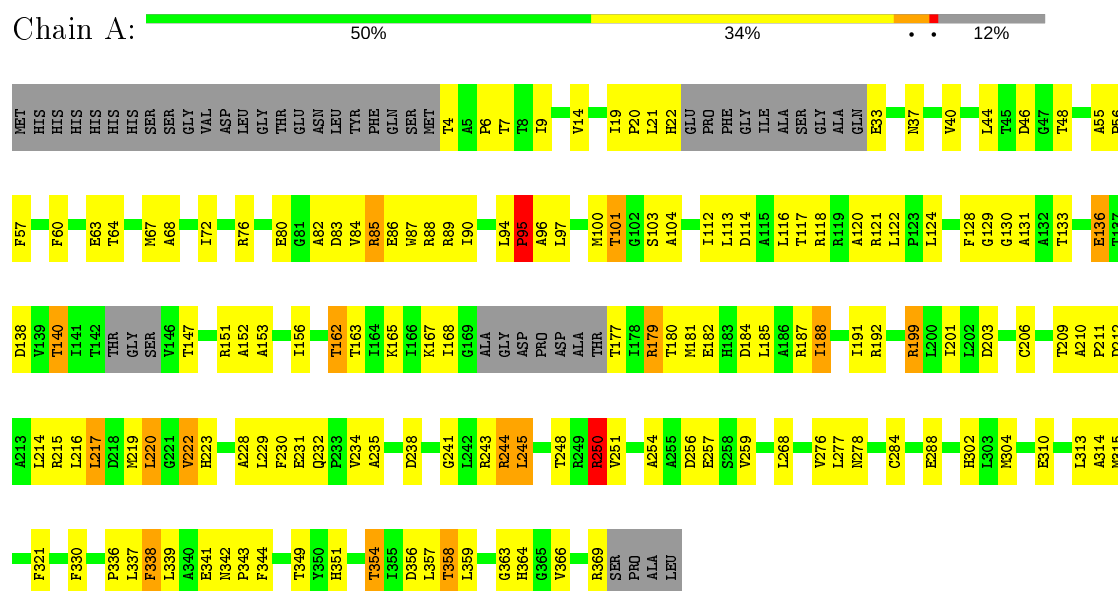
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	29	Total	O	0	0
			29	29		
3	B	38	Total	O	0	0
			38	38		

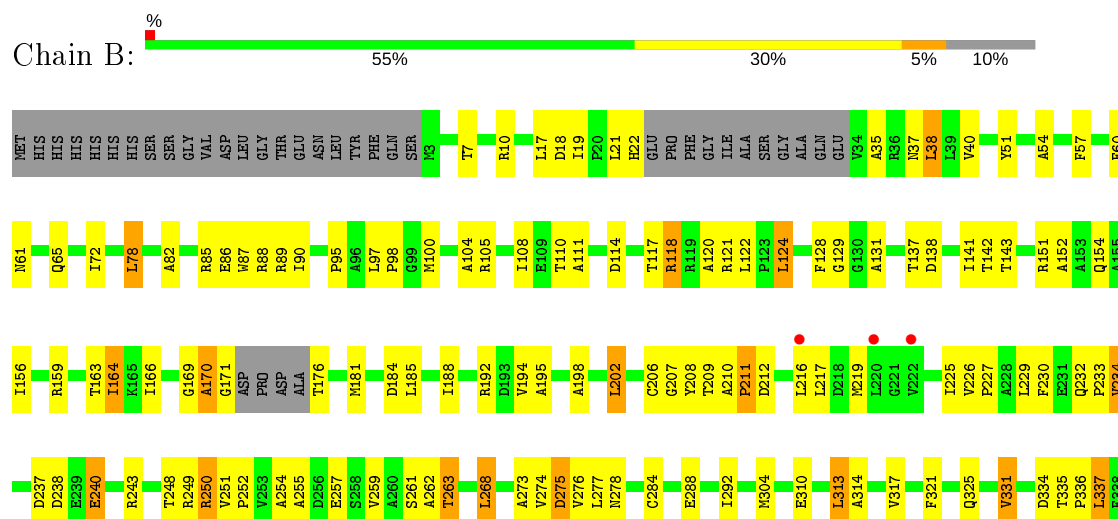
### 3 Residue-property plots

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: Mandelate racemase/muconate lactonizing enzyme, C-terminal domain protein



- Molecule 1: Mandelate racemase/muconate lactonizing enzyme, C-terminal domain protein



L339	A340	E341	N342	D345	T349	G353	D356	L357	G363	R369	S370	P371	ALA	LEU
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## 4 Data and refinement statistics

Property	Value	Source
Space group	H 3 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	209.89 Å   209.89 Å   116.60 Å 90.00°   90.00°   120.00°	Depositor
Resolution (Å)	49.07 – 2.90 49.07 – 2.70	Depositor EDS
% Data completeness (in resolution range)	95.8 (49.07-2.90) 99.7 (49.07-2.70)	Depositor EDS
$R_{merge}$	0.15	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.80 (at 2.69 Å)	Xtriage
Refinement program	PHENIX (phenix.refine)	Depositor
R, $R_{free}$	0.199   ,   0.255 0.202   ,   0.256	Depositor DCC
$R_{free}$ test set	1352 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	50.1	Xtriage
Anisotropy	0.507	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 30.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	5208	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	49.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.21% 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: SO4

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	0.34	0/2582	0.51	1/3513 (0.0%)
1	B	0.29	0/2626	0.50	0/3578
All	All	0.31	0/5208	0.51	1/7091 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	359	LEU	CA-CB-CG	5.91	128.89	115.30

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	2546	0	2611	127	0
1	B	2585	0	2642	90	0
2	A	5	0	0	1	0
2	B	5	0	0	0	0
3	A	29	0	0	2	0
3	B	38	0	0	0	0
All	All	5208	0	5253	209	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 20.

The worst 5 of 209 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:100:MET:HE3	1:A:101:THR:H	1.30	0.95
1:A:222:VAL:HG13	1:A:223:HIS:HD2	1.32	0.94
1:B:369:ARG:O	1:B:370:SER:HB3	1.71	0.89
1:A:188:ILE:HD11	1:A:220:LEU:HD11	1.57	0.87
1:B:248:THR:O	1:B:250:ARG:HG2	1.73	0.86

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	338/393 (86%)	312 (92%)	24 (7%)	2 (1%)	25	58
1	B	349/393 (89%)	322 (92%)	21 (6%)	6 (2%)	9	31
All	All	687/786 (87%)	634 (92%)	45 (7%)	8 (1%)	13	40

5 of 8 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	170	ALA
1	B	249	ARG
1	A	250	ARG
1	A	95	PRO
1	B	370	SER

### 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	254/292 (87%)	218 (86%)	36 (14%)	3	10
1	B	259/292 (89%)	232 (90%)	27 (10%)	7	21
All	All	513/584 (88%)	450 (88%)	63 (12%)	5	14

5 of 63 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	268	LEU
1	A	358	THR
1	B	313	LEU
1	A	277	LEU
1	A	338	PHE

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	271	ASN
1	B	342	ASN
1	A	342	ASN
1	A	205	ASN
1	B	69	HIS

### 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 [i](#)

There are no carbohydrates 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	$\# Z  > 2$
2	SO4	A	374	-	4,4,4	0.14	0	6,6,6	0.16	0
2	SO4	B	374	-	4,4,4	0.16	0	6,6,6	0.14	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.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	374	SO4	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, 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	346/393 (88%)	-0.26	0	100   100	32, 48, 76, 95	0
1	B	354/393 (90%)	-0.31	3 (0%)	86   86	30, 42, 77, 84	0
All	All	700/786 (89%)	-0.28	3 (0%)	92   93	30, 45, 76, 95	0

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	222	VAL	2.8
1	B	216	LEU	2.7
1	B	220	LEU	2.6

### 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, 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	SO4	B	374	5/5	0.97	0.11	52,62,68,70	0
2	SO4	A	374	5/5	0.98	0.10	56,58,66,67	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.