Full wwPDB X-ray Structure Validation Report (i)

Oct 27, 2026 – 03:07 pm GMT

PDB ID	:	31SS / pdb_000031ss
Title	:	Crystal structure of Cysteine Desulfurase domain of Molybdopterin-dependen t Ergothioneine Synthase
Authors	:	Bolotova, S.B.; Seebeck, F.P.
Deposited on	:	2026-06-22
Resolution	:	1.62 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 (i) 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 (i)) were used in the production of this report:

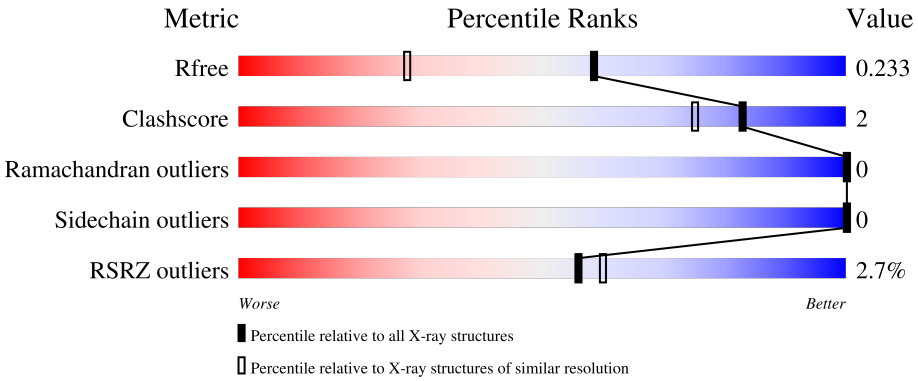
MolProbity	:	4-5-2 with Phenix2.2
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.2
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.015 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.51

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 1.62 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	6728 (1.64-1.60)
Clashscore	190562	7023 (1.64-1.60)
Ramachandran outliers	187476	6898 (1.64-1.60)
Sidechain outliers	187428	6896 (1.64-1.60)
RSRZ outliers	180081	6727 (1.64-1.60)

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 <=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	394	3% 93% 7%
1	B	394	2% 92% 6%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 6712 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 Metallopterin-dependent ergothioneine synthase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	393	Total	C	N	O	P	S	0	3	0
			3044	1910	552	565	1	16			
1	B	385	Total	C	N	O	P	S	0	3	0
			2996	1881	544	556	1	14			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	743	GLY	-	expression tag	UNP A0A7V4WV16
A	744	SER	-	expression tag	UNP A0A7V4WV16
A	745	GLY	-	expression tag	UNP A0A7V4WV16
A	746	MET	-	expression tag	UNP A0A7V4WV16
B	743	GLY	-	expression tag	UNP A0A7V4WV16
B	744	SER	-	expression tag	UNP A0A7V4WV16
B	745	GLY	-	expression tag	UNP A0A7V4WV16
B	746	MET	-	expression tag	UNP A0A7V4WV16

- Molecule 2 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	Cl	0	0
			2	2		
2	B	2	Total	Cl	0	0
			2	2		

- Molecule 3 is water.

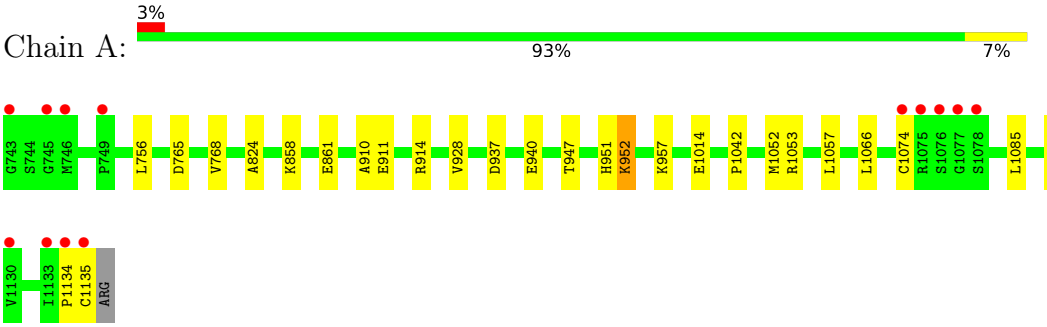
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	320	Total	O	0	0
			320	320		
3	B	348	Total	O	0	0
			348	348		

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.

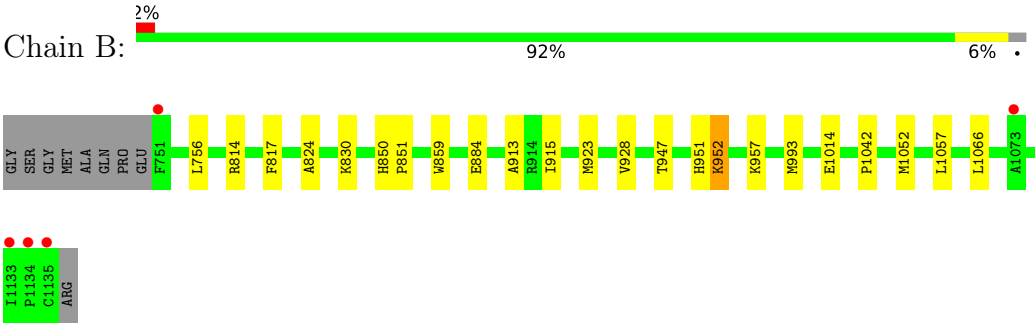
• Molecule 1: Metallopterin-dependent ergothioneine synthase

Chain A:



• Molecule 1: Metallopterin-dependent ergothioneine synthase

Chain B:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	95.18Å 83.72Å 98.41Å 90.00° 96.66° 90.00°	Depositor
Resolution (Å)	51.01 – 1.62 51.01 – 1.62	Depositor EDS
% Data completeness (in resolution range)	98.4 (51.01-1.62) 98.4 (51.01-1.62)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.39 (at 1.62Å)	Xtriage
Refinement program	PHENIX (1.21.2_5419: ???)	Depositor
R, R_{free}	0.185 , 0.231 0.185 , 0.233	Depositor DCC
R_{free} test set	2000 reflections (2.06%)	wwPDB-VP
Wilson B-factor (Å^2)	24.2	Xtriage
Anisotropy	0.736	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 34.5	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	6712	wwPDB-VP
Average B, all atoms (Å^2)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.76% of the height of the origin peak. No significant pseudotranslation is detected.*

[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

5.1 Standard geometry

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

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	0.30	0/3084	0.45	0/4171
1	B	0.30	0/3032	0.46	0/4102
All	All	0.30	0/6116	0.46	0/8273

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

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	3044	0	3092	16	0
1	B	2996	0	3043	13	0
2	A	2	0	0	0	0
2	B	2	0	0	0	0
3	A	320	0	0	1	0
3	B	348	0	0	0	0
All	All	6712	0	6135	29	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 2.

All (29) 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:1110:LYS:HD2	1:A:1110:LYS:H	1.21	1.00
1:B:1014:GLU:HB2	1:B:1042:PRO:HB3	1.71	0.72
1:A:1014:GLU:HB2	1:A:1042:PRO:HB3	1.82	0.62
1:A:1110:LYS:HD2	1:A:1110:LYS:N	2.06	0.54
1:A:756:LEU:HD12	1:A:1066:LEU:HD11	1.92	0.51
1:A:937:ASP:HB3	1:A:940:GLU:HB2	1.93	0.51
1:A:910:ALA:O	1:A:914:ARG:HG3	2.10	0.50
1:B:824:ALA:HB3	1:B:947:THR:HG23	1.93	0.50
1:A:765:ASP:HB3	1:A:768:VAL:HG23	1.93	0.50
1:A:1074:CYS:SG	1:A:1135:CYS:HB2	2.52	0.50
1:B:913:ALA:HB2	1:B:923:MET:HG2	1.94	0.49
1:B:928:VAL:CG1	1:B:952:LLP:HG2	2.43	0.48
1:B:884[A]:GLU:HG3	1:B:915:ILE:HD13	1.97	0.47
1:B:817:PHE:CD2	1:B:993:MET:HE2	2.49	0.47
1:A:928:VAL:CG1	1:A:952:LLP:HG2	2.45	0.45
1:A:911:GLU:HG3	3:A:1519:HOH:O	2.16	0.45
1:A:1053:ARG:HG3	1:A:1134:PRO:HB3	1.99	0.45
1:B:951:HIS:CE1	1:B:952:LLP:HE2	2.52	0.45
1:A:1052[A]:MET:HE3	1:A:1057:LEU:HD21	1.99	0.44
1:B:830:LYS:HE2	1:B:859:TRP:CE3	2.53	0.43
1:A:951:HIS:HB3	1:A:957:LYS:HA	1.99	0.43
1:A:858:LYS:HD3	1:A:861:GLU:OE2	2.20	0.42
1:B:756:LEU:HD12	1:B:1066:LEU:HD11	2.02	0.42
1:A:1085:LEU:O	1:A:1088:MET:HG2	2.20	0.41
1:B:951:HIS:HB3	1:B:957:LYS:HA	2.01	0.41
1:B:850:HIS:CG	1:B:851:PRO:HD2	2.55	0.41
1:B:814:ARG:HD3	1:B:814:ARG:HA	1.78	0.41
1:B:1052:MET:HB3	1:B:1057:LEU:HD11	2.03	0.41
1:A:824:ALA:HB3	1:A:947:THR:HG23	2.04	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	393/394 (100%)	387 (98%)	6 (2%)	0	100	100
1	B	385/394 (98%)	376 (98%)	9 (2%)	0	100	100
All	All	778/788 (99%)	763 (98%)	15 (2%)	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	325/323 (101%)	325 (100%)	0	100	100
1	B	320/323 (99%)	320 (100%)	0	100	100
All	All	645/646 (100%)	645 (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. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	881	HIS
1	B	809	ASN
1	B	881	HIS
1	B	919	HIS
1	B	1019	HIS

5.3.3 RNA (i)

There are no RNA molecules in this entry.

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

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	LLP	B	952	1	23,24,25	1.04	1 (4%)	25,32,34	1.33	3 (12%)
1	LLP	A	952	1	23,24,25	1.18	3 (13%)	25,32,34	1.45	5 (20%)

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	LLP	B	952	1	-	1/16/17/19	0/1/1/1
1	LLP	A	952	1	-	3/16/17/19	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	952	LLP	C4-C4'	2.61	1.51	1.46
1	A	952	LLP	C2-N1	2.58	1.38	1.33
1	B	952	LLP	C2-N1	2.16	1.37	1.33
1	A	952	LLP	C6-N1	2.04	1.38	1.34

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	952	LLP	CE-NZ-C4'	3.88	130.82	118.90
1	A	952	LLP	OP4-C5'-C5	2.74	114.57	109.35
1	A	952	LLP	CE-NZ-C4'	-2.74	110.50	118.90
1	A	952	LLP	C2'-C2-C3	-2.71	117.54	120.89
1	A	952	LLP	C4-C3-C2	2.62	121.81	120.19
1	A	952	LLP	C2'-C2-N1	2.14	121.84	117.67
1	B	952	LLP	OP4-P-OP1	2.10	112.36	106.47

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	952	LLP	C5-C6-N1	-2.01	120.47	123.82

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	952	LLP	C4-C4'-NZ-CE
1	B	952	LLP	C4-C4'-NZ-CE
1	A	952	LLP	CG-CD-CE-NZ
1	A	952	LLP	C4-C5-C5'-OP4

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	B	952	LLP	2	0
1	A	952	LLP	1	0

5.5 Carbohydrates (i)

There are no oligosaccharides in this entry.

5.6 Ligand geometry (i)

Of 4 ligands modelled in this entry, 4 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^{th} 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	392/394 (99%)	-0.07	13 (3%) 49 53	17, 30, 57, 112	3 (0%)
1	B	384/394 (97%)	-0.09	8 (2%) 63 68	15, 30, 48, 100	3 (0%)
All	All	776/788 (98%)	-0.08	21 (2%) 56 60	15, 30, 53, 112	6 (0%)

All (21) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1133	ILE	4.5
1	B	751	PHE	4.2
1	A	743	GLY	3.9
1	B	1135	CYS	3.5
1	A	1077	GLY	3.4
1	B	1133	ILE	3.3
1	A	745	GLY	3.3
1	B	1132	PHE	3.2
1	A	1135	CYS	3.2
1	B	1134	PRO	2.7
1	A	1134	PRO	2.6
1	B	1079	PRO	2.6
1	A	1076	SER	2.5
1	A	1074	CYS	2.4
1	A	746	MET	2.3
1	A	1078	SER	2.3
1	A	1075	ARG	2.2
1	B	1073	ALA	2.2
1	B	1078	SER	2.1
1	A	749	PRO	2.0
1	A	1130	VAL	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, 95^{th} 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	LLP	A	952	24/25	0.97	0.07	20,26,30,32	0
1	LLP	B	952	24/25	0.97	0.07	21,24,30,31	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^{th} 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	CL	B	1201	1/1	0.90	0.09	67,67,67,67	0
2	CL	B	1202	1/1	0.90	0.14	55,55,55,55	0
2	CL	A	1202	1/1	0.92	0.08	63,63,63,63	0
2	CL	A	1201	1/1	0.96	0.17	54,54,54,54	0

6.5 Other polymers (i)

There are no such residues in this entry.