



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 08:18 AM UTC

PDB ID : 4HPV / pdb_00004hpv
Title : Crystal structure of S-Adenosylmethionine synthetase from *Sulfolobus solfataricus*
Authors : Wang, F.; Hurley, K.A.; Helmich, K.E.; Singh, S.; Bingman, C.A.; Thorson, J.S.; Phillips Jr., G.N.; Enzyme Discovery for Natural Product Biosynthesis (NatPro)
Deposited on : 2012-10-24
Resolution : 2.21 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 ⓘ 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 ⓘ](#)) 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

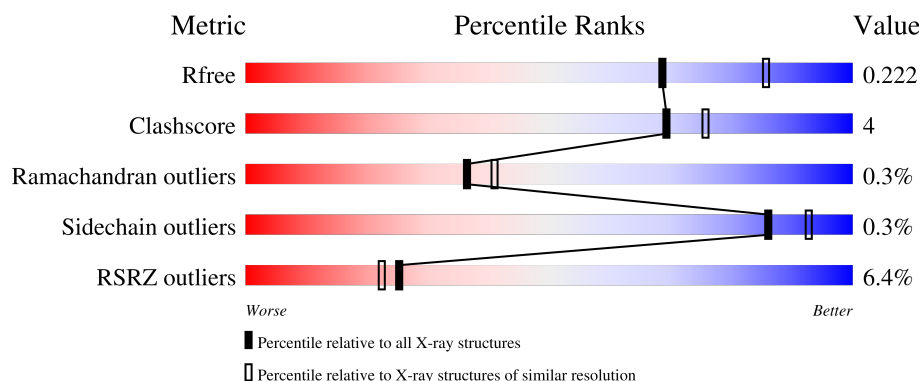
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.21 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	7682 (2.24-2.20)
Clashscore	190562	8402 (2.24-2.20)
Ramachandran outliers	187476	8303 (2.24-2.20)
Sidechain outliers	187428	8304 (2.24-2.20)
RSRZ outliers	180081	7683 (2.24-2.20)

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 $\leq 5\%$. 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	407	5% 90% 8%
1	B	407	7% 86% 12%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6605 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 S-adenosylmethionine synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	398	Total	C	N	O	Se	0	7	0
			3167	2004	552	604	7			
1	B	397	Total	C	N	O	Se	0	5	0
			3134	1985	542	601	6			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	expression tag	UNP Q980S9
A	-1	SER	-	expression tag	UNP Q980S9
A	0	HIS	-	expression tag	UNP Q980S9
B	-2	GLY	-	expression tag	UNP Q980S9
B	-1	SER	-	expression tag	UNP Q980S9
B	0	HIS	-	expression tag	UNP Q980S9

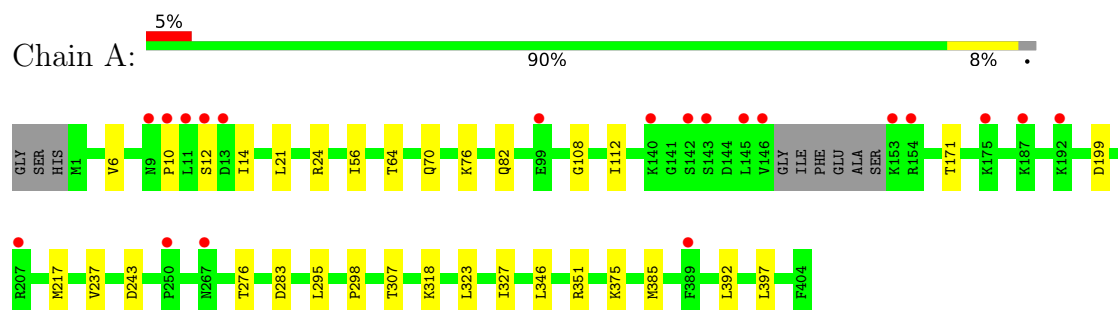
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	149	Total	O	0	0
			149	149		
2	B	155	Total	O	0	0
			155	155		

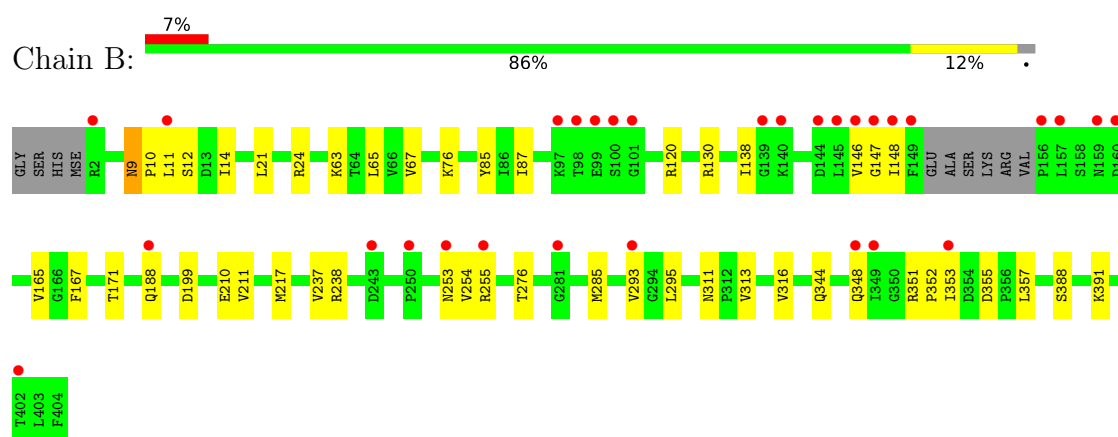
3 Residue-property plots [i](#)

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: S-adenosylmethionine synthase



• Molecule 1: S-adenosylmethionine synthase



4 Data and refinement statistics

Property	Value	Source
Space group	P 65 2 2	Depositor
Cell constants a, b, c, α , β , γ	151.30Å 151.30Å 221.15Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	49.53 – 2.21 49.53 – 2.21	Depositor EDS
% Data completeness (in resolution range)	99.5 (49.53-2.21) 92.5 (49.53-2.21)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.01 (at 2.22Å)	Xtriage
Refinement program	PHENIX 1.8_1069	Depositor
R, R_{free}	0.199 , 0.220 0.202 , 0.222	Depositor DCC
R_{free} test set	3732 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	39.0	Xtriage
Anisotropy	0.242	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 38.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	6605	wwPDB-VP
Average B, all atoms (Å ²)	38.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.52% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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](#)

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	0.27	0/3206	0.71	1/4321 (0.0%)
1	B	0.27	0/3173	0.72	3/4280 (0.1%)
All	All	0.27	0/6379	0.72	4/8601 (0.0%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	9	ASN	CA-C-N	6.35	126.56	119.32
1	B	9	ASN	C-N-CA	6.35	126.56	119.32
1	B	12	SER	N-CA-C	-5.91	105.93	113.02
1	A	12	SER	N-CA-C	-5.66	106.03	113.17

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	3167	0	3252	17	1
1	B	3134	0	3208	31	1
2	A	149	0	0	1	0
2	B	155	0	0	5	0
All	All	6605	0	6460	45	1

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 (45) 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:65:LEU:HD23	1:B:87[B]:ILE:HD11	1.70	0.72
1:B:238:ARG:NH1	2:B:548:HOH:O	2.23	0.71
1:B:188[B]:GLN:NE2	2:B:643:HOH:O	2.33	0.61
1:B:210:GLU:OE1	1:B:253[A]:ASN:ND2	2.32	0.60
1:B:199:ASP:HB2	1:B:276:THR:HA	1.89	0.55
1:A:217:MSE:SE	1:A:237:VAL:HG21	2.58	0.54
1:B:217:MSE:SE	1:B:237:VAL:HG21	2.58	0.53
1:A:199:ASP:HB2	1:A:276:THR:HA	1.91	0.52
1:A:351:ARG:NH1	2:A:587:HOH:O	2.46	0.49
1:B:165:VAL:HG12	1:B:344:GLN:HG2	1.94	0.48
1:B:65:LEU:HD13	1:B:285:MSE:HE3	1.95	0.48
1:A:14:ILE:HB	1:A:171:THR:HG21	1.96	0.48
1:A:323:LEU:HD11	1:A:385:MSE:HB3	1.95	0.48
1:B:316:VAL:HG22	1:B:353:ILE:HD12	1.96	0.47
1:B:211:VAL:HB	1:B:254:VAL:HG22	1.96	0.47
1:A:56:ILE:HD11	1:A:397:LEU:HD11	1.97	0.46
1:B:9:ASN:HA	1:B:10:PRO:HD2	1.76	0.46
1:B:138:ILE:O	2:B:647:HOH:O	2.20	0.45
1:A:24:ARG:HB2	1:A:295:LEU:HD23	1.99	0.45
1:A:307:THR:O	1:A:318:LYS:HE3	2.17	0.45
1:B:255[A]:ARG:HD2	2:B:548:HOH:O	2.16	0.45
1:B:348:GLN:HB2	1:B:357:LEU:HB2	1.98	0.45
1:B:67:VAL:HB	1:B:85:TYR:HB3	1.98	0.45
1:A:108:GLY:O	1:A:112:ILE:HG12	2.17	0.44
1:B:316:VAL:HG13	1:B:353:ILE:HG23	1.98	0.44
1:A:64:THR:C	1:B:285:MSE:HE1	2.42	0.44
1:A:327:ILE:HG12	1:A:385:MSE:HG3	2.01	0.43
1:A:346:LEU:HD22	1:B:21:LEU:HD21	2.00	0.43
1:B:14:ILE:HB	1:B:171:THR:HG21	2.00	0.43
1:A:70:GLN:HB3	1:A:82:GLN:HB3	2.01	0.43
1:A:76:LYS:HD3	1:A:76:LYS:HA	1.89	0.42
1:B:352:PRO:HG2	1:B:355:ASP:HB3	2.00	0.42
1:A:21:LEU:O	1:A:298:PRO:HD2	2.19	0.42
1:B:130:ARG:NH1	2:B:573:HOH:O	2.42	0.42
1:B:11:LEU:HD23	1:B:11:LEU:HA	1.86	0.41
1:B:388:SER:HB3	1:B:391:LYS:HD2	2.02	0.41
1:B:76:LYS:HD3	1:B:76:LYS:HA	1.87	0.41
1:B:348:GLN:HB3	1:B:351:ARG:CD	2.51	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:167:PHE:CZ	1:B:293:VAL:HG11	2.56	0.41
1:A:283:ASP:HB2	1:B:63:LYS:HG3	2.03	0.40
1:B:24:ARG:HB2	1:B:295:LEU:HD23	2.02	0.40
1:B:65:LEU:HB3	1:B:87[B]:ILE:HG13	2.03	0.40
1:A:6:VAL:HB	1:A:375:LYS:HG3	2.02	0.40
1:B:311:ASN:OD1	1:B:313:VAL:HG22	2.22	0.40
1:B:146:VAL:O	1:B:148:ILE:N	2.54	0.40

All (1) 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)
1:A:243:ASP:OD1	1:B:255[A]:ARG:NH1[5_555]	2.18	0.02

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	401/407 (98%)	394 (98%)	6 (2%)	1 (0%)	43	50
1	B	398/407 (98%)	394 (99%)	3 (1%)	1 (0%)	36	41
All	All	799/814 (98%)	788 (99%)	9 (1%)	2 (0%)	36	41

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	10	PRO
1	B	147	GLY

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	350/342 (102%)	349 (100%)	1 (0%)	86	93
1	B	346/342 (101%)	345 (100%)	1 (0%)	86	93
All	All	696/684 (102%)	694 (100%)	2 (0%)	86	93

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	392	LEU
1	B	120	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	209	ASN
1	A	232	ASN
1	B	82	GLN
1	B	321	ASN
1	B	344	GLN
1	B	360	ASN

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 oligosaccharides in this entry.

5.6 Ligand geometry

There are no ligands in this entry.

5.7 Other polymers

There are no such residues in this entry.

5.8 Polymer linkage issues

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, 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	391/407 (96%)	0.11	20 (5%) 33 30	14, 34, 62, 93	7 (1%)
1	B	391/407 (96%)	0.26	30 (7%) 19 17	13, 36, 67, 102	5 (1%)
All	All	782/814 (96%)	0.18	50 (6%) 25 22	13, 35, 65, 102	12 (1%)

All (50) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	149	PHE	9.3
1	A	11	LEU	7.8
1	A	12	SER	7.2
1	A	146	VAL	6.9
1	B	148	ILE	6.7
1	A	10	PRO	6.1
1	B	11	LEU	5.5
1	B	139	GLY	4.8
1	B	349	ILE	4.7
1	A	145	LEU	4.6
1	B	293	VAL	4.1
1	B	147	GLY	3.9
1	B	156	PRO	3.6
1	A	143	SER	3.6
1	B	159	ASN	3.5
1	A	389[A]	PHE	3.3
1	A	140	LYS	3.2
1	B	188[A]	GLN	3.2
1	B	146	VAL	3.1
1	B	145	LEU	3.1
1	A	9	ASN	3.0
1	B	160	ASP	2.9
1	B	157	LEU	2.9
1	A	153	LYS	2.8

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Mol	Chain	Res	Type	RSRZ
1	A	250	PRO	2.8
1	A	207[A]	ARG	2.8
1	B	253[A]	ASN	2.7
1	A	154	ARG	2.7
1	A	142	SER	2.6
1	A	13	ASP	2.6
1	B	144	ASP	2.4
1	B	101	GLY	2.4
1	B	140	LYS	2.4
1	B	98	THR	2.4
1	B	353	ILE	2.3
1	B	99	GLU	2.3
1	A	175[A]	LYS	2.3
1	A	192	LYS	2.3
1	B	2	ARG	2.3
1	B	97	LYS	2.2
1	B	100	SER	2.2
1	A	267	ASN	2.1
1	A	99	GLU	2.1
1	B	255[A]	ARG	2.1
1	B	243	ASP	2.1
1	B	250	PRO	2.1
1	B	281	GLY	2.1
1	A	187	LYS	2.1
1	B	348	GLN	2.1
1	B	402	THR	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 oligosaccharides in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.