



Full wwPDB X-ray Structure Validation Report ⓘ

Oct 6, 2025 – 02:10 PM JST

PDB ID : 9JUX / pdb_00009jux
Title : Crystal structure of hyperthermostable carboxylesterase from Anoxybacillus
geothermalis D9
Authors : Rahman, N.F.Y.A.; Johan, U.U.M.; Rahman, R.N.Z.R.A.; Noor, N.D.M.;
Shariff, F.M.; Ali, M.S.M.
Deposited on : 2024-10-08
Resolution : 1.67 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
Xtriage (Phenix) : 2.0
EDS : 3.0
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)
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) : 2.46

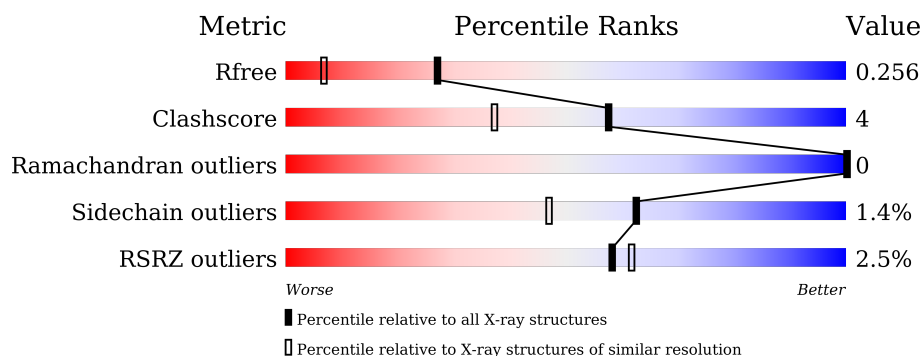
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.67 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}	164625	8422 (1.70-1.66)
Clashscore	180529	1005 (1.68-1.68)
Ramachandran outliers	177936	9065 (1.70-1.66)
Sidechain outliers	177891	9064 (1.70-1.66)
RSRZ outliers	164620	8421 (1.70-1.66)

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	242	 2% 91% 9%
1	B	242	 3% 88% 10% ..
1	C	242	 2% 87% 11% .

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6048 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 Carboxylesterase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	242	Total	C	N	O	S	0	0	0
			1947	1253	321	363	10			
1	B	242	Total	C	N	O	S	0	0	0
			1947	1253	321	363	10			
1	C	242	Total	C	N	O	S	0	0	0
			1947	1253	321	363	10			

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	70	Total	O	0	0
			70	70		
2	B	74	Total	O	0	0
			74	74		
2	C	63	Total	O	0	0
			63	63		

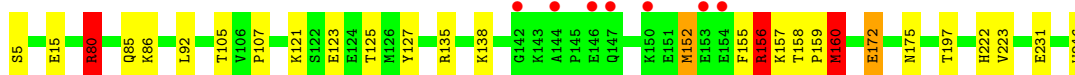
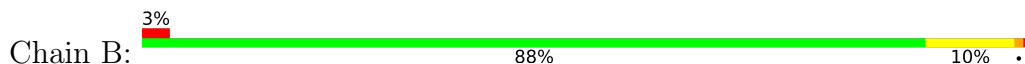
3 Residue-property plots [i](#)

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.

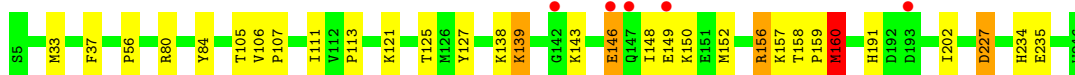
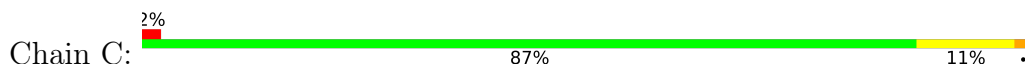
- Molecule 1: Carboxylesterase



- Molecule 1: Carboxylesterase



- Molecule 1: Carboxylesterase



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	58.97Å 111.63Å 114.89Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.48 – 1.67 47.48 – 1.67	Depositor EDS
% Data completeness (in resolution range)	99.7 (47.48-1.67) 99.7 (47.48-1.67)	Depositor EDS
R_{merge}	0.02	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.36 (at 1.67Å)	Xtriage
Refinement program	REFMAC 5.8.0430 (refmacat 0.4.100)	Depositor
R, R_{free}	0.168 , 0.225 0.212 , 0.256	Depositor DCC
R_{free} test set	4472 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å ²)	28.4	Xtriage
Anisotropy	0.153	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 29.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.014 for -h,l,k	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	6048	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.02% 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

5.1 Standard geometry

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	0.87	1/1997 (0.1%)	1.39	12/2703 (0.4%)
1	B	0.95	3/1997 (0.2%)	1.42	14/2703 (0.5%)
1	C	0.84	1/1997 (0.1%)	1.30	13/2703 (0.5%)
All	All	0.89	5/5991 (0.1%)	1.37	39/8109 (0.5%)

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	B	0	2
1	C	0	1
All	All	0	3

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	172	GLU	CD-OE2	7.50	1.39	1.25
1	A	222	HIS	CD2-NE2	5.62	1.44	1.37
1	B	222	HIS	CE1-NE2	5.42	1.38	1.32
1	C	235	GLU	CD-OE2	5.41	1.35	1.25
1	B	246	TRP	C-O	5.14	1.33	1.23

All (39) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	231	GLU	CB-CG-CD	8.34	126.77	112.60
1	B	156	ARG	CB-CG-CD	7.80	129.24	111.30
1	B	172	GLU	CB-CG-CD	7.78	125.83	112.60
1	B	123	GLU	CB-CG-CD	7.70	125.69	112.60
1	B	15	GLU	CB-CG-CD	7.49	125.33	112.60
1	B	231	GLU	CB-CG-CD	7.22	124.87	112.60

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	156	ARG	CG-CD-NE	-7.18	96.20	112.00
1	C	121	LYS	CB-CG-CD	6.92	127.21	111.30
1	A	193	ASP	CB-CA-C	6.89	121.60	110.09
1	B	105	THR	CA-CB-OG1	-6.88	99.28	109.60
1	A	101	LYS	CG-CD-CE	-6.48	96.40	111.30
1	B	125	THR	CA-CB-OG1	-6.42	99.97	109.60
1	C	125	THR	CA-CB-OG1	-6.42	99.97	109.60
1	A	73	MET	CG-SD-CE	6.38	114.92	100.90
1	B	175	ASN	CA-CB-CG	-6.21	106.39	112.60
1	C	160	MET	CG-SD-CE	-6.21	87.25	100.90
1	B	156	ARG	CD-NE-CZ	6.00	132.80	124.40
1	A	126	MET	CG-SD-CE	-5.88	87.96	100.90
1	C	235	GLU	CB-CG-CD	5.88	122.59	112.60
1	A	99	SER	CA-CB-OG	-5.75	99.60	111.10
1	C	149	GLU	CB-CA-C	-5.73	101.89	110.88
1	C	56	PRO	CB-CA-C	5.56	117.70	110.92
1	A	222	HIS	CA-C-N	-5.55	116.43	121.65
1	A	222	HIS	C-N-CA	-5.55	116.43	121.65
1	C	191	HIS	CA-CB-CG	-5.54	108.25	113.80
1	B	172	GLU	CG-CD-OE1	-5.49	105.78	118.40
1	B	172	GLU	CG-CD-OE2	5.45	130.94	118.40
1	B	197	THR	CA-CB-OG1	-5.42	101.46	109.60
1	A	6	PRO	CB-CA-C	-5.30	104.45	111.23
1	C	105	THR	CA-CB-OG1	-5.28	101.69	109.60
1	A	135	ARG	CB-CA-C	-5.27	101.90	110.85
1	C	227	ASP	CA-CB-CG	5.25	117.85	112.60
1	C	156	ARG	NE-CZ-NH2	5.17	123.86	119.20
1	A	190	ARG	CB-CG-CD	5.10	123.03	111.30
1	C	156	ARG	CB-CG-CD	5.10	123.03	111.30
1	A	191	HIS	CA-CB-CG	-5.08	108.72	113.80
1	C	146	GLU	CB-CA-C	5.06	118.82	110.88
1	C	139	LYS	CB-CA-C	5.05	119.17	110.79
1	B	160	MET	CG-SD-CE	-5.04	89.80	100.90

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	156	ARG	Sidechain
1	B	80	ARG	Sidechain
1	C	156	ARG	Sidechain

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	1947	0	1917	8	0
1	B	1947	0	1917	17	0
1	C	1947	0	1917	27	0
2	A	70	0	0	0	0
2	B	74	0	0	0	0
2	C	63	0	0	2	0
All	All	6048	0	5751	51	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 (51) 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:C:152:MET:HA	1:C:152:MET:HE2	1.26	1.09
1:B:152:MET:HE2	1:B:152:MET:HA	1.36	1.06
1:C:138:LYS:HB3	1:C:148:ILE:HD12	1.44	1.00
1:C:138:LYS:HE3	1:C:152:MET:CE	1.90	1.00
1:B:152:MET:HA	1:B:152:MET:CE	1.93	0.97
1:C:138:LYS:HE3	1:C:152:MET:HE3	1.50	0.92
1:C:127:TYR:CE1	1:C:160:MET:HE1	2.05	0.91
1:C:138:LYS:HE3	1:C:152:MET:HE1	1.62	0.81
1:C:143:LYS:HB2	1:C:148:ILE:HD11	1.63	0.80
1:B:152:MET:HE2	1:B:155:PHE:HB3	1.64	0.78
1:C:143:LYS:HB2	1:C:148:ILE:CD1	2.13	0.77
1:C:152:MET:HE2	1:C:152:MET:CA	2.10	0.77
1:C:152:MET:HA	1:C:152:MET:CE	2.11	0.76
1:B:107:PRO:HG3	1:C:202:ILE:HD11	1.76	0.67
1:A:80:ARG:HH21	1:A:85:GLN:HE22	1.41	0.66
1:C:138:LYS:CE	1:C:152:MET:HE3	2.27	0.65
1:C:127:TYR:CD1	1:C:160:MET:HE1	2.35	0.61
1:B:127:TYR:CE1	1:B:160:MET:HE1	2.37	0.59
1:B:152:MET:CE	1:B:155:PHE:HB3	2.31	0.59
1:B:80:ARG:NH1	1:B:85:GLN:HE22	2.05	0.55
1:A:55:VAL:HB	1:A:56:PRO:HD2	1.91	0.52

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:158:THR:N	1:B:159:PRO:CD	2.75	0.50
1:B:152:MET:CE	1:B:155:PHE:CB	2.90	0.50
1:A:73:MET:HE1	1:A:106:VAL:HG11	1.93	0.49
1:B:135:ARG:HH12	1:B:156:ARG:HH22	1.61	0.47
1:C:150:LYS:HB2	1:C:150:LYS:HE2	1.65	0.46
1:C:111:ILE:HG22	1:C:113:PRO:HD3	1.96	0.46
1:B:160:MET:N	1:B:160:MET:HE2	2.32	0.45
1:A:111:ILE:HG22	1:A:113:PRO:HD3	1.98	0.44
1:A:80:ARG:HH21	1:A:85:GLN:NE2	2.13	0.44
1:B:80:ARG:HH21	1:B:107:PRO:HG2	1.81	0.44
1:A:183:PRO:HA	1:A:211:ILE:O	2.18	0.44
1:C:158:THR:N	1:C:159:PRO:CD	2.81	0.43
1:C:138:LYS:HB3	1:C:148:ILE:CD1	2.30	0.43
1:A:103:GLY:HA3	1:A:111:ILE:HD11	2.00	0.43
1:C:80:ARG:HD2	1:C:84:TYR:O	2.18	0.43
1:A:150:LYS:HE2	1:A:150:LYS:HB3	1.89	0.43
1:B:138:LYS:HE3	1:B:152:MET:HE3	2.00	0.42
1:C:143:LYS:HB2	1:C:148:ILE:HD13	2.00	0.42
1:C:157:LYS:HA	1:C:160:MET:HE3	2.00	0.42
1:C:227:ASP:HB3	2:C:317:HOH:O	2.19	0.42
1:B:86:LYS:HA	1:B:86:LYS:HD3	1.88	0.42
1:C:33:MET:HE2	2:C:304:HOH:O	2.20	0.41
1:B:92:LEU:HD21	1:B:223:VAL:HG13	2.02	0.41
1:B:157:LYS:HA	1:B:160:MET:HE3	2.03	0.41
1:C:106:VAL:HB	1:C:107:PRO:HD2	2.03	0.41
1:C:106:VAL:HB	1:C:107:PRO:CD	2.51	0.41
1:C:37:PHE:CD2	1:C:234:HIS:HB3	2.56	0.41
1:C:138:LYS:CD	1:C:152:MET:HE3	2.50	0.41
1:C:139:LYS:HE2	1:C:139:LYS:HB3	1.89	0.40
1:B:152:MET:O	1:B:156:ARG:HG3	2.21	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	240/242 (99%)	237 (99%)	3 (1%)	0	100	100
1	B	240/242 (99%)	233 (97%)	7 (3%)	0	100	100
1	C	240/242 (99%)	233 (97%)	7 (3%)	0	100	100
All	All	720/726 (99%)	703 (98%)	17 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	209/209 (100%)	208 (100%)	1 (0%)	86	81
1	B	209/209 (100%)	203 (97%)	6 (3%)	37	18
1	C	209/209 (100%)	207 (99%)	2 (1%)	73	62
All	All	627/627 (100%)	618 (99%)	9 (1%)	62	47

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	73	MET
1	B	5	SER
1	B	80	ARG
1	B	121	LYS
1	B	152	MET
1	B	160	MET
1	B	172	GLU
1	C	146	GLU
1	C	160	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	85	GLN
1	A	191	HIS
1	A	201	ASN
1	A	205	ASN
1	B	70	GLN
1	B	85	GLN
1	B	167	GLN
1	B	205	ASN
1	C	167	GLN
1	C	201	ASN
1	C	205	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 [i](#)

There are no ligands in this entry.

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	242/242 (100%)	0.11	6 (2%) 58 62	15, 18, 25, 36	0
1	B	242/242 (100%)	0.14	7 (2%) 54 57	13, 18, 26, 37	0
1	C	242/242 (100%)	0.05	5 (2%) 63 67	14, 19, 28, 36	0
All	All	726/726 (100%)	0.10	18 (2%) 58 62	13, 18, 27, 37	0

All (18) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	144	ALA	4.8
1	B	142	GLY	4.4
1	A	142	GLY	4.3
1	B	150	LYS	4.1
1	A	146	GLU	3.3
1	A	144	ALA	3.1
1	B	147	GLN	2.6
1	B	146	GLU	2.3
1	B	153	GLU	2.3
1	C	146	GLU	2.3
1	A	153	GLU	2.2
1	B	154	GLU	2.2
1	A	112	VAL	2.2
1	A	148	ILE	2.1
1	C	142	GLY	2.1
1	C	149	GLU	2.1
1	C	147	GLN	2.1
1	C	193	ASP	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.