



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 03:47 PM UTC

PDB ID : 5OT1 / pdb_00005ot1
Title : The type III pullulan hydrolase from *Thermococcus kodakarensis*
Authors : Guo, J.; Coker, A.R.; Wood, S.P.; Cooper, J.B.; Keegan, R.; Ahmad, N.;
Muhammad, M.A.; Rashid, N.; Akhtar, M.
Deposited on : 2017-08-18
Resolution : 2.80 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	:	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

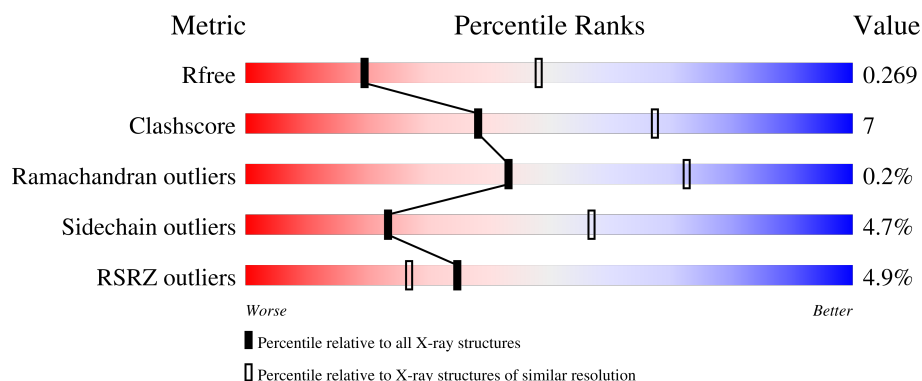
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.80 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	3866 (2.80-2.80)
Clashscore	190562	4276 (2.80-2.80)
Ramachandran outliers	187476	4196 (2.80-2.80)
Sidechain outliers	187428	4198 (2.80-2.80)
RSRZ outliers	180081	3869 (2.80-2.80)

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	765	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 4672 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 Pullulanase type II, GH13 family.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	572	Total	C	N	O	S	0	0	0
			4610	2977	770	850	13			

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Ca	0	0
			1	1		

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	61	Total	O	0	0
			61	61		

- Molecule 1: Pullulanase type II, GH13 family



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	192.65Å 63.89Å 56.12Å 90.00° 93.80° 90.00°	Depositor
Resolution (Å)	96.11 – 2.80 96.11 – 2.80	Depositor EDS
% Data completeness (in resolution range)	99.8 (96.11-2.80) 99.8 (96.11-2.80)	Depositor EDS
R_{merge}	0.17	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.48 (at 2.82Å)	Xtriage
Refinement program	PHENIX (1.11rc3_2553: ???)	Depositor
R, R_{free}	0.241 , 0.279 (Not available) , 0.269	Depositor DCC
R_{free} test set	909 reflections (4.67%)	wwPDB-VP
Wilson B-factor (Å ²)	47.9	Xtriage
Anisotropy	0.509	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 42.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	4672	wwPDB-VP
Average B, all atoms (Å ²)	47.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.77% 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](#)

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

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	0.19	0/4747	0.38	0/6454

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 [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	4610	0	4437	62	0
2	A	1	0	0	0	0
3	A	61	0	0	1	0
All	All	4672	0	4437	62	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 7.

All (62) 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:257:SER:HB2	1:A:263:PHE:HE1	1.52	0.73

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:321:ASN:ND2	1:A:323:VAL:O	2.23	0.71
1:A:293:THR:HG1	1:A:639:THR:HG1	1.38	0.70
1:A:338:THR:HG23	1:A:340:LEU:H	1.61	0.65
1:A:187:GLU:HB3	1:A:208:GLU:HB3	1.81	0.62
1:A:321:ASN:HD21	1:A:457:GLY:HA3	1.63	0.62
1:A:338:THR:HG22	1:A:345:GLN:OE1	2.00	0.61
1:A:658:ASP:OD1	1:A:660:GLN:NE2	2.26	0.60
1:A:696:ARG:O	1:A:708:PHE:N	2.33	0.60
1:A:379:SER:OG	1:A:384:ASP:OD2	2.12	0.59
1:A:735:TRP:O	1:A:748:LEU:N	2.35	0.59
1:A:206:ARG:NH2	1:A:582:TYR:O	2.32	0.59
1:A:228:MET:HG2	1:A:242:ALA:HB2	1.85	0.58
1:A:231:GLN:HA	1:A:696:ARG:HG3	1.86	0.56
1:A:343:CYS:HB3	1:A:381:HIS:CD2	2.40	0.56
1:A:360:TYR:O	1:A:363:SER:OG	2.23	0.54
1:A:297:PHE:N	1:A:644:GLN:OE1	2.39	0.53
1:A:232:VAL:HB	1:A:579:GLY:HA2	1.90	0.52
1:A:479:GLN:NE2	1:A:483:GLU:HG2	2.25	0.52
1:A:317:GLU:HB3	1:A:344:HIS:HE1	1.75	0.51
1:A:185:TYR:OH	1:A:208:GLU:OE1	2.24	0.51
1:A:296:ILE:HG21	1:A:354:ILE:HG21	1.93	0.50
1:A:210:LYS:HD3	1:A:213:THR:HG21	1.93	0.50
1:A:580:ARG:HD2	3:A:913:HOH:O	2.11	0.49
1:A:300:ARG:O	1:A:663:PRO:HA	2.12	0.49
1:A:417:PHE:CE1	1:A:500:ILE:HG12	2.46	0.49
1:A:482:ARG:O	1:A:486:ILE:HG12	2.13	0.49
1:A:479:GLN:HE21	1:A:483:GLU:HG2	1.77	0.49
1:A:609:LEU:HD13	1:A:625:ARG:HB2	1.94	0.48
1:A:375:PHE:O	1:A:392:ASP:HB2	2.13	0.47
1:A:482:ARG:HG3	1:A:514:PHE:CD1	2.49	0.47
1:A:364:LEU:HD23	1:A:678:ARG:HG3	1.95	0.47
1:A:713:ASP:O	1:A:764:ARG:NH2	2.39	0.47
1:A:206:ARG:NH2	1:A:583:ALA:HA	2.29	0.47
1:A:638:GLY:O	1:A:684:ARG:NH2	2.48	0.47
1:A:230:LEU:HD13	1:A:233:TRP:HZ3	1.80	0.46
1:A:339:PRO:HA	1:A:657:TYR:CD1	2.51	0.46
1:A:211:ARG:HA	1:A:238:GLU:HG3	1.98	0.46
1:A:620:ASN:O	1:A:624:GLN:HG2	2.16	0.45
1:A:694:ALA:O	1:A:709:ARG:NH1	2.49	0.45
1:A:277:ASP:HB3	1:A:279:VAL:HG12	1.99	0.45
1:A:392:ASP:CG	1:A:394:LYS:HE2	2.42	0.45

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:317:GLU:HB3	1:A:344:HIS:CE1	2.52	0.45
1:A:482:ARG:HG3	1:A:514:PHE:HD1	1.82	0.44
1:A:695:MET:HB2	1:A:695:MET:HE2	1.84	0.44
1:A:379:SER:O	1:A:394:LYS:NZ	2.49	0.44
1:A:232:VAL:HG11	1:A:582:TYR:HB2	1.99	0.44
1:A:433:ASP:O	1:A:437:LYS:HB2	2.18	0.44
1:A:321:ASN:ND2	1:A:457:GLY:HA3	2.32	0.43
1:A:559:ASP:O	1:A:563:ASN:ND2	2.52	0.42
1:A:573:SER:O	1:A:577:MET:HG3	2.18	0.42
1:A:587:GLU:HG2	1:A:693:SER:HB2	2.00	0.42
1:A:293:THR:HB	1:A:641:VAL:HG22	2.00	0.42
1:A:735:TRP:HB3	1:A:762:LEU:HB3	2.02	0.42
1:A:313:LEU:HG	1:A:328:PRO:HG2	2.03	0.41
1:A:446:TRP:CD2	1:A:481:VAL:HG22	2.56	0.41
1:A:230:LEU:HD13	1:A:233:TRP:CZ3	2.56	0.41
1:A:217:ALA:HB3	1:A:228:MET:HB2	2.04	0.40
1:A:719:ALA:HB2	1:A:759:ILE:HD13	2.02	0.40
1:A:231:GLN:OE1	1:A:241:ARG:HD2	2.22	0.40
1:A:535:ILE:HB	1:A:551:LEU:HD22	2.02	0.40
1:A:591:ALA:HB2	1:A:693:SER:HB3	2.04	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	568/765 (74%)	534 (94%)	33 (6%)	1 (0%)	43 72

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	349	GLY

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	487/652 (75%)	464 (95%)	23 (5%)	23 57

All (23) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	230	LEU
1	A	235	ASP
1	A	259	ASP
1	A	280	GLU
1	A	321	ASN
1	A	330	LEU
1	A	343	CYS
1	A	354	ILE
1	A	384	ASP
1	A	391	LEU
1	A	410	ARG
1	A	440	GLU
1	A	445	ASP
1	A	470	SER
1	A	507	GLU
1	A	517	GLU
1	A	525	LYS
1	A	532	VAL
1	A	537	THR
1	A	560	ILE
1	A	648	ARG
1	A	727	LEU
1	A	749	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	321	ASN
1	A	428	ASN

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	439	ASN
1	A	670	ASN

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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 1 ligands modelled in this entry, 1 is 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 ⓘ

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	572/765 (74%)	0.69	28 (4%) 35 27	30, 45, 65, 105	0

All (28) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	763	GLU	3.7
1	A	223	HIS	3.5
1	A	748	LEU	3.4
1	A	729	GLU	3.2
1	A	236	PHE	3.1
1	A	733	GLY	3.0
1	A	272	PRO	3.0
1	A	264	ALA	3.0
1	A	758	GLY	2.9
1	A	632	LEU	2.9
1	A	270	GLU	2.7
1	A	220	VAL	2.7
1	A	737	VAL	2.5
1	A	738	ILE	2.5
1	A	268	THR	2.5
1	A	354	ILE	2.4
1	A	620	ASN	2.3
1	A	722	TRP	2.3
1	A	760	ILE	2.3
1	A	221	THR	2.3
1	A	750	GLY	2.2
1	A	719	ALA	2.2
1	A	277	ASP	2.2
1	A	662	TYR	2.2
1	A	517	GLU	2.1
1	A	412	GLY	2.1
1	A	559	ASP	2.1

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	338	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](#)

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, 95th 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	CA	A	801	1/1	0.99	0.02	38,38,38,38	0

6.5 Other polymers [i](#)

There are no such residues in this entry.