



# Full wwPDB X-ray Structure Validation Report ⓘ

May 29, 2020 – 04:27 am BST

PDB ID : 4C3T  
Title : The Carbonic anhydrase from Thermovibrio ammonificans reveals an interesting intermolecular disulfide contributing to increasing thermal stability of this enzyme  
Authors : James, P.; Isupov, M.; Sayer, C.; Berg, S.; Lioliou, M.; Kotlar, H.; Littlechild, J.  
Deposited on : 2013-08-27  
Resolution : 1.69 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](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
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

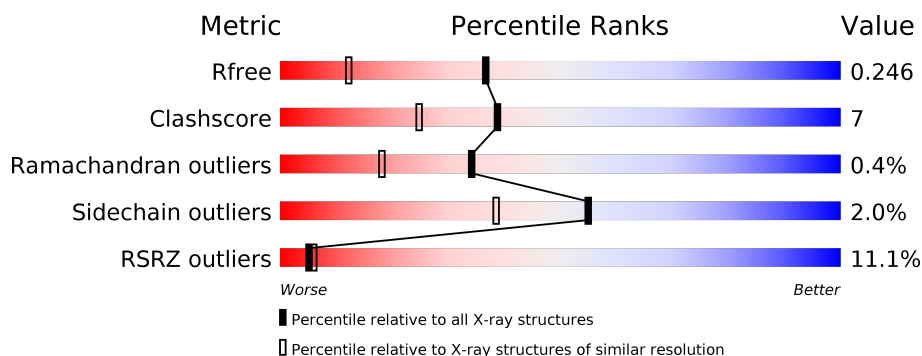
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.69 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	4298 (1.70-1.70)
Clashscore	141614	4695 (1.70-1.70)
Ramachandran outliers	138981	4610 (1.70-1.70)
Sidechain outliers	138945	4610 (1.70-1.70)
RSRZ outliers	127900	4222 (1.70-1.70)

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	247	 81% 11% 9%
1	B	247	 19% 78% 11% 9%

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 4198 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 CARBONATE DEHYDRATASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	225	Total	C	N	O	S	0	35	0
			2029	1313	353	349	14			
1	B	225	Total	C	N	O	S	0	11	0
			1874	1206	331	326	11			

- Molecule 2 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	B	1	Total	Zn	0	0
			1	1		
2	A	1	Total	Zn	0	0
			1	1		

- Molecule 3 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	B	1	Total	Cl	0	0
			1	1		
3	A	1	Total	Cl	0	0
			1	1		

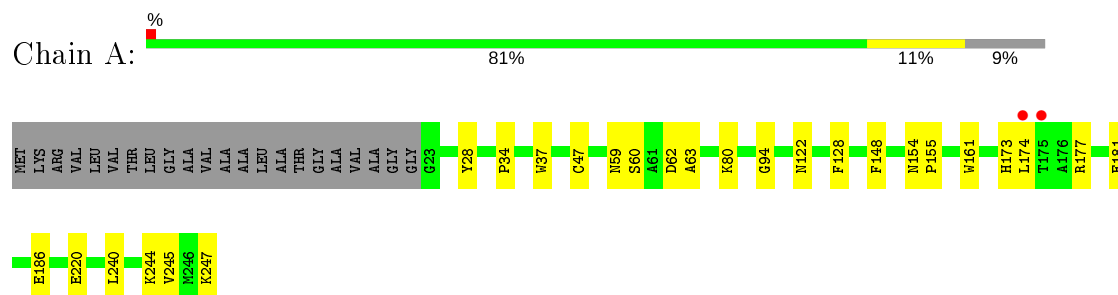
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	216	Total	O	0	0
			216	216		
4	B	75	Total	O	0	0
			75	75		

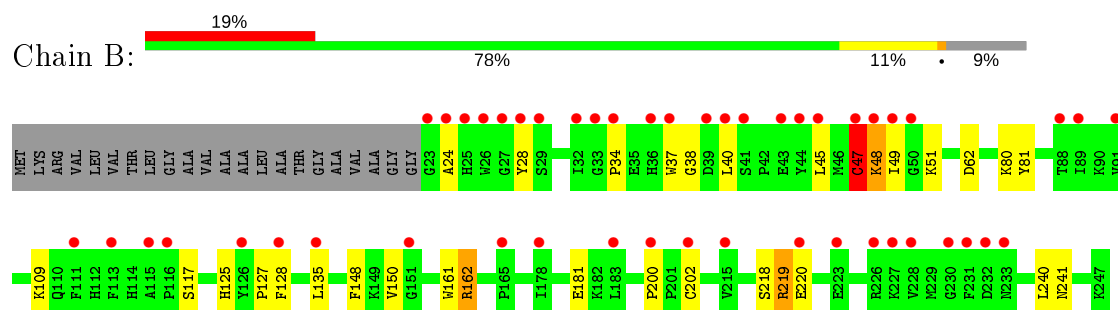
### 3 Residue-property plots [i](#)

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: CARBONATE DEHYDRATASE



#### • Molecule 1: CARBONATE DEHYDRATASE



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	80.93 Å 80.93 Å 154.62 Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	57.23 – 1.69 57.23 – 1.69	Depositor EDS
% Data completeness (in resolution range)	100.0 (57.23-1.69) 100.0 (57.23-1.69)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.64 (at 1.69 Å)	Xtriage
Refinement program	REFMAC 5.7.0032	Depositor
R, $R_{free}$	0.221 , 0.252 0.216 , 0.246	Depositor DCC
$R_{free}$ test set	2941 reflections (5.08%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	26.5	Xtriage
Anisotropy	0.402	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 48.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	4198	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	36.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.06% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: ZN, 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	0.47	0/2159	0.67	0/2907
1	B	0.35	0/1963	0.53	0/2651
All	All	0.42	0/4122	0.61	0/5558

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	2029	0	2090	27	0
1	B	1874	0	1876	32	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	216	0	0	9	0
4	B	75	0	0	2	0
All	All	4198	0	3966	59	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 (59) 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:220[B]:GLU:OE2	4:A:2190:HOH:O	1.60	1.19
1:A:181[B]:GLU:OE2	4:A:2161:HOH:O	1.58	1.17
1:A:186[A]:GLU:OE1	4:A:2166:HOH:O	1.61	1.13
1:A:177[B]:ARG:NH2	4:A:2074:HOH:O	1.89	1.04
1:A:244[A]:LYS:NZ	4:A:2055:HOH:O	1.76	0.94
1:A:177[B]:ARG:CZ	4:A:2074:HOH:O	2.16	0.91
1:B:220[B]:GLU:OE1	4:B:2067:HOH:O	1.90	0.90
1:A:80[A]:LYS:HE3	1:A:94:GLY:HA2	1.63	0.79
1:A:62[A]:ASP:HB2	1:A:240[A]:LEU:HD22	1.68	0.75
1:A:62[B]:ASP:O	4:A:2055:HOH:O	2.07	0.73
1:B:62:ASP:HB2	1:B:240:LEU:HD22	1.72	0.71
1:B:219[A]:ARG:CG	1:B:219[A]:ARG:HH11	2.06	0.68
1:B:162:ARG:HH11	1:B:162:ARG:HG2	1.58	0.68
1:A:62[A]:ASP:HB2	1:A:240[A]:LEU:CD2	2.24	0.67
1:B:80[B]:LYS:HB2	1:B:80[B]:LYS:NZ	2.13	0.62
1:B:162:ARG:NH1	1:B:162:ARG:HG2	2.14	0.62
1:A:177[B]:ARG:NE	4:A:2074:HOH:O	2.29	0.60
1:B:51:LYS:HB3	1:B:241:ASN:HD22	1.67	0.59
1:B:128:PHE:HB3	1:B:148:PHE:HB2	1.83	0.59
1:B:117:SER:O	1:B:125:HIS:HD2	1.86	0.58
1:A:173[B]:HIS:O	1:A:174[B]:LEU:HB2	2.05	0.57
1:B:109:LYS:HG3	1:B:135:LEU:HD13	1.89	0.54
1:A:37:TRP:HB2	1:A:47[B]:CYS:SG	2.48	0.53
1:A:62[A]:ASP:CB	1:A:240[A]:LEU:HD22	2.38	0.52
1:A:63[B]:ALA:HB3	1:A:247:LYS:HD3	1.90	0.52
1:B:62:ASP:CB	1:B:240:LEU:HD22	2.40	0.52
1:B:219[A]:ARG:HG3	1:B:219[A]:ARG:HH11	1.75	0.51
1:A:28:TYR:HA	1:A:34:PRO:HD3	1.92	0.51
1:B:219[A]:ARG:CG	1:B:219[A]:ARG:NH1	2.71	0.51
1:B:62:ASP:HB2	1:B:240:LEU:CD2	2.41	0.50
1:B:117:SER:O	1:B:125:HIS:CD2	2.67	0.48
1:B:219[A]:ARG:HG3	1:B:219[A]:ARG:NH1	2.29	0.48
1:B:220[B]:GLU:CD	4:B:2067:HOH:O	2.45	0.47
1:B:28:TYR:HA	1:B:34:PRO:HD3	1.97	0.46
1:B:80[B]:LYS:HB2	1:B:80[B]:LYS:HZ2	1.80	0.46
1:B:80[B]:LYS:NZ	1:B:80[B]:LYS:CB	2.79	0.46
1:B:37:TRP:HA	1:B:40:LEU:HD12	1.96	0.46
1:A:128:PHE:HB3	1:A:148:PHE:HB2	1.98	0.45
1:B:127:PRO:HD2	1:B:148:PHE:O	2.16	0.45
1:A:122:ASN:ND2	4:A:2050:HOH:O	2.49	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:186[A]:GLU:HA	1:A:186[A]:GLU:OE1	2.18	0.43
1:B:38:GLY:HA2	1:B:47[B]:CYS:HB3	2.00	0.43
1:B:48:LYS:HD3	1:B:49:ILE:N	2.32	0.43
1:B:150:VAL:HG21	1:B:219[B]:ARG:HH11	1.84	0.43
1:B:80[B]:LYS:HE3	1:B:81:TYR:CE2	2.55	0.42
1:B:45:LEU:O	1:B:48:LYS:HG3	2.18	0.42
1:B:219[A]:ARG:HH11	1:B:219[A]:ARG:HG2	1.82	0.42
1:A:154:ASN:HA	1:A:155:PRO:HD3	1.92	0.41
1:B:80[B]:LYS:HE3	1:B:81:TYR:HE2	1.84	0.41
1:A:63[A]:ALA:HA	1:A:245:VAL:O	2.21	0.41
1:A:59[B]:ASN:O	1:A:60[B]:SER:C	2.57	0.41
1:A:59[B]:ASN:O	1:A:62[B]:ASP:N	2.53	0.41
1:A:59[B]:ASN:HB3	1:A:62[B]:ASP:HB2	2.03	0.40
1:A:240[B]:LEU:HA	1:A:240[B]:LEU:HD23	1.92	0.40
1:A:34:PRO:HA	1:A:37:TRP:CD2	2.57	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	258/247 (104%)	249 (96%)	9 (4%)	0	100	100
1	B	234/247 (95%)	217 (93%)	14 (6%)	3 (1%)	12	2
All	All	492/494 (100%)	466 (95%)	23 (5%)	3 (1%)	34	11

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	24	ALA
1	B	47[A]	CYS
1	B	47[B]	CYS



### 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	229/208 (110%)	228 (100%)	1 (0%)	91	87
1	B	207/208 (100%)	198 (96%)	9 (4%)	29	11
All	All	436/416 (105%)	426 (98%)	10 (2%)	55	33

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	161	TRP
1	B	47[A]	CYS
1	B	47[B]	CYS
1	B	48	LYS
1	B	161	TRP
1	B	162	ARG
1	B	181	GLU
1	B	218	SER
1	B	219[A]	ARG
1	B	219[B]	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	122	ASN
1	B	125	HIS
1	B	241	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 [i](#)

There are no carbohydrates 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<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	225/247 (91%)	0.11	2 (0%) 84 87	14, 24, 43, 63	0
1	B	225/247 (91%)	1.27	48 (21%) 0 0	26, 45, 73, 106	0
All	All	450/494 (91%)	0.69	50 (11%) 5 6	14, 34, 67, 106	0

All (50) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	28	TYR	6.1
1	B	26	TRP	5.4
1	B	128	PHE	5.1
1	B	32	ILE	4.9
1	A	175	THR	4.8
1	B	45	LEU	4.4
1	B	43	GLU	4.4
1	B	44	TYR	4.2
1	B	231	PHE	3.9
1	B	27	GLY	3.8
1	B	88	THR	3.8
1	B	115	ALA	3.6
1	B	49	ILE	3.6
1	B	47[A]	CYS	3.5
1	B	113	PHE	3.4
1	B	36	HIS	3.4
1	B	91	VAL	3.3
1	B	48	LYS	3.3
1	B	25	HIS	3.2
1	B	33	GLY	3.2
1	B	89	ILE	3.2
1	B	23	GLY	3.2
1	B	223	GLU	3.1
1	B	41	SER	3.1

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Mol	Chain	Res	Type	RSRZ
1	B	37	TRP	3.1
1	B	183	LEU	3.0
1	B	200	PRO	3.0
1	B	227	LYS	2.9
1	B	34	PRO	2.9
1	B	24	ALA	2.9
1	B	230	GLY	2.7
1	B	39	ASP	2.7
1	B	228	VAL	2.6
1	B	215[A]	VAL	2.6
1	B	202[A]	CYS	2.5
1	B	233	ASN	2.5
1	B	151	GLY	2.4
1	B	226	ARG	2.4
1	B	29	SER	2.4
1	B	126	TYR	2.3
1	B	165	PRO	2.3
1	B	111	PHE	2.2
1	B	50	GLY	2.2
1	B	40	LEU	2.1
1	B	178	ILE	2.1
1	B	232	ASP	2.1
1	B	220[A]	GLU	2.1
1	B	116	PRO	2.0
1	A	174[A]	LEU	2.0
1	B	135	LEU	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 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( $\text{\AA}^2$ )	Q<0.9
2	ZN	B	300	1/1	0.91	0.07	32,32,32,32	1
3	CL	B	301	1/1	0.98	0.16	34,34,34,34	1
2	ZN	A	300	1/1	0.99	0.09	20,20,20,20	0
3	CL	A	301	1/1	1.00	0.07	27,27,27,27	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.