



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 17, 2024 – 11:44 PM EST

PDB ID : 4CAC  
Title : REFINED STRUCTURE OF HUMAN CARBONIC ANHYDRASE II AT 2.0  
ANGSTROMS RESOLUTION  
Authors : Lindahl, M.; Habash, D.; Harrop, S.; Helliwell, D.R.; Liljas, A.  
Deposited on : 1991-09-05  
Resolution : 2.20 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.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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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 : 2.36  
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) : 2.36

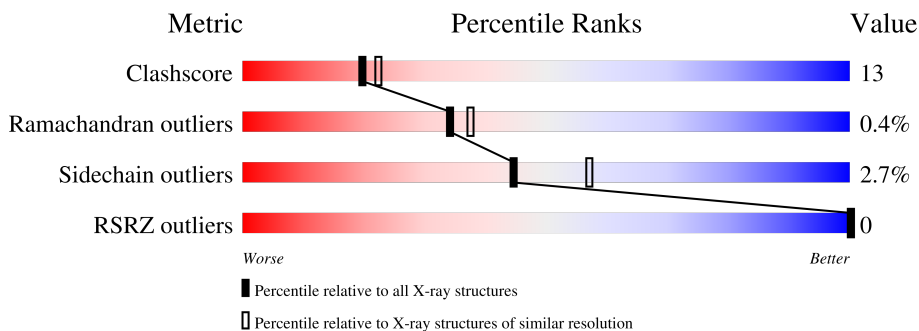
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*


The reported resolution of this entry is 2.20 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))
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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  $\geq 3$ , 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	259	

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2200 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 CARBONIC ANHYDRASE FORM C.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	256	2039	1309	350	378	2	0	0	0

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

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

- Molecule 3 is water.

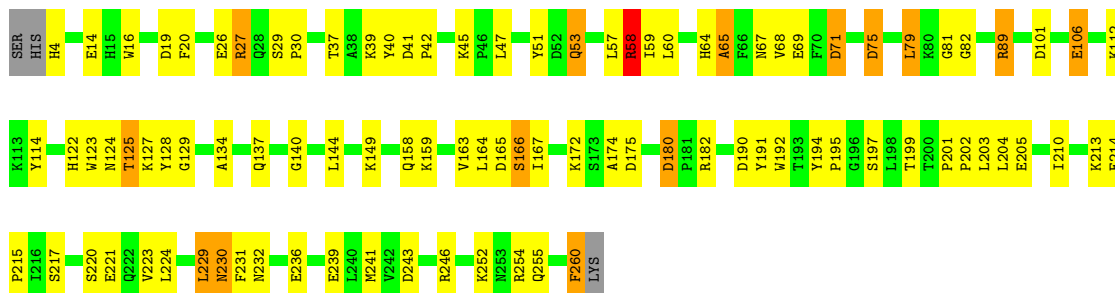
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	160	Total	O	0	0
			160	160		

### 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: CARBONIC ANHYDRASE FORM C

Chain A: 



## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	42.70Å 41.70Å 73.00Å 90.00° 104.60° 90.00°	Depositor
Resolution (Å)	(Not available) – 2.20 13.73 – 2.20	Depositor EDS
% Data completeness (in resolution range)	(Not available) ((Not available)-2.20) 59.7 (13.73-2.20)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	8.99 (at 2.20Å)	Xtrriage
Refinement program	PROLSQ	Depositor
R, $R_{free}$	0.187 , (Not available) 0.169 , (Not available)	Depositor DCC
$R_{free}$ test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	10.8	Xtrriage
Anisotropy	0.216	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.47 , 85.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.30$	Xtrriage
Estimated twinning fraction	0.079 for h,-k,-h-l	Xtrriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	2200	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	13.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 23.57 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 4.5414e-03.*

<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 [i](#)

### 5.1 Standard geometry [i](#)

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

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	1.59	12/2099 (0.6%)	1.83	36/2848 (1.3%)

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	129	GLY	C-O	6.71	1.34	1.23
1	A	166	SER	CA-CB	6.28	1.62	1.52
1	A	166	SER	CB-OG	-6.02	1.34	1.42
1	A	129	GLY	N-CA	-5.92	1.37	1.46
1	A	221	GLU	CD-OE2	-5.74	1.19	1.25
1	A	260	PHE	C-O	5.71	1.34	1.23
1	A	16	TRP	NE1-CE2	5.49	1.44	1.37
1	A	20	PHE	CG-CD2	5.39	1.46	1.38
1	A	236	GLU	CG-CD	-5.19	1.44	1.51
1	A	81	GLY	N-CA	5.06	1.53	1.46
1	A	254	ARG	NE-CZ	-5.06	1.26	1.33
1	A	158	GLN	C-O	5.05	1.32	1.23

All (36) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	58	ARG	NE-CZ-NH1	22.11	131.36	120.30
1	A	58	ARG	NE-CZ-NH2	-16.45	112.08	120.30
1	A	175	ASP	CB-CG-OD1	10.12	127.41	118.30
1	A	19	ASP	CB-CG-OD2	-9.10	110.11	118.30
1	A	175	ASP	CB-CG-OD2	-7.71	111.36	118.30
1	A	89	ARG	NE-CZ-NH2	-6.99	116.81	120.30
1	A	75	ASP	CB-CG-OD1	6.90	124.51	118.30
1	A	192	TRP	N-CA-CB	6.51	122.32	110.60
1	A	125	THR	CA-C-O	6.50	133.75	120.10

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	180	ASP	CB-CG-OD2	6.41	124.07	118.30
1	A	101	ASP	CB-CG-OD1	6.35	124.02	118.30
1	A	58	ARG	CD-NE-CZ	6.28	132.40	123.60
1	A	26	GLU	CB-CA-C	-6.25	97.89	110.40
1	A	106	GLU	CG-CD-OE1	6.15	130.61	118.30
1	A	236	GLU	OE1-CD-OE2	-6.07	116.01	123.30
1	A	194	TYR	CB-CG-CD1	-5.97	117.42	121.00
1	A	197	SER	N-CA-CB	-5.92	101.61	110.50
1	A	53	GLN	CA-CB-CG	-5.77	100.71	113.40
1	A	68	VAL	N-CA-C	-5.74	95.50	111.00
1	A	166	SER	CB-CA-C	-5.60	99.46	110.10
1	A	236	GLU	CG-CD-OE1	5.58	129.47	118.30
1	A	4	HIS	CA-CB-CG	5.57	123.07	113.60
1	A	27	ARG	NE-CZ-NH2	5.50	123.05	120.30
1	A	101	ASP	CA-CB-CG	5.48	125.46	113.40
1	A	27	ARG	CD-NE-CZ	-5.38	116.07	123.60
1	A	71	ASP	CB-CG-OD1	5.38	123.14	118.30
1	A	37	THR	CA-CB-CG2	5.24	119.73	112.40
1	A	243	ASP	CB-CG-OD2	5.23	123.01	118.30
1	A	230	ASN	CA-CB-CG	5.22	124.89	113.40
1	A	14	GLU	CB-CG-CD	5.19	128.21	114.20
1	A	89	ARG	CD-NE-CZ	-5.14	116.40	123.60
1	A	190	ASP	CB-CG-OD2	5.14	122.92	118.30
1	A	221	GLU	CG-CD-OE1	-5.13	108.03	118.30
1	A	166	SER	N-CA-C	5.11	124.80	111.00
1	A	246	ARG	CB-CA-C	-5.06	100.27	110.40
1	A	199	THR	O-C-N	5.04	130.77	122.70

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	2039	0	1988	51	0
2	A	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	160	0	0	6	0
All	All	2200	0	1988	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 13.

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:A:58:ARG:HD2	1:A:69:GLU:OE1	1.57	1.01
1:A:125:THR:C	1:A:127:LYS:N	2.18	0.96
1:A:213:LYS:HD3	1:A:260:PHE:CZ	2.01	0.94
1:A:163:VAL:O	1:A:166:SER:HB2	1.83	0.77
1:A:125:THR:C	1:A:127:LYS:CA	2.54	0.76
1:A:137:GLN:OE1	3:A:394:HOH:O	2.06	0.71
1:A:89:ARG:HG3	1:A:125:THR:CG2	2.21	0.71
1:A:231:PHE:CE1	1:A:241:MET:HG3	2.34	0.63
1:A:75:ASP:OD1	1:A:89:ARG:NE	2.23	0.61
1:A:128:TYR:CE1	1:A:137:GLN:HG3	2.36	0.60
1:A:27:ARG:HG3	1:A:205:GLU:HB3	1.85	0.59
1:A:112:LYS:HE3	1:A:114:TYR:CZ	2.40	0.57
1:A:134:ALA:O	1:A:140:GLY:HA3	2.05	0.56
1:A:27:ARG:HD3	3:A:293:HOH:O	2.05	0.56
1:A:82:GLY:HA2	1:A:191:TYR:OH	2.06	0.55
1:A:195:PRO:HG3	3:A:282:HOH:O	2.05	0.55
1:A:164:LEU:HB3	1:A:229:LEU:HD11	1.88	0.55
1:A:40:TYR:HE2	1:A:42:PRO:HB3	1.70	0.55
1:A:89:ARG:HG3	1:A:125:THR:HG22	1.88	0.54
1:A:159:LYS:CE	3:A:420:HOH:O	2.56	0.53
1:A:144:LEU:HD23	1:A:210:ILE:HB	1.90	0.52
1:A:30:PRO:HG3	1:A:106:GLU:HB3	1.91	0.51
1:A:149:LYS:O	1:A:217:SER:HA	2.10	0.51
1:A:125:THR:C	1:A:127:LYS:HA	2.32	0.50
1:A:40:TYR:CE2	1:A:42:PRO:HB3	2.47	0.49
1:A:64:HIS:O	1:A:65:ALA:HB2	2.15	0.47
1:A:167:ILE:O	1:A:167:ILE:HG13	2.13	0.47
1:A:231:PHE:HD2	1:A:239:GLU:HG2	1.79	0.47
1:A:202:PRO:HG2	1:A:204:LEU:HG	1.97	0.46
1:A:201:PRO:HA	1:A:203:LEU:HG	1.97	0.46
1:A:213:LYS:HD3	1:A:260:PHE:CE1	2.49	0.45
1:A:180:ASP:OD2	1:A:182:ARG:NH2	2.48	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:41:ASP:C	1:A:41:ASP:OD1	2.54	0.45
1:A:124:ASN:OD1	1:A:127:LYS:N	2.49	0.45
1:A:213:LYS:CD	1:A:260:PHE:CZ	2.88	0.45
1:A:123:TRP:CZ3	1:A:125:THR:HA	2.52	0.44
1:A:165:ASP:HB2	3:A:414:HOH:O	2.17	0.44
1:A:230:ASN:HB3	1:A:232:ASN:OD1	2.17	0.44
1:A:59:ILE:HA	1:A:67:ASN:O	2.18	0.43
1:A:60:LEU:HD12	1:A:172:LYS:O	2.20	0.42
1:A:51:TYR:OH	1:A:122:HIS:NE2	2.45	0.42
1:A:252:LYS:NZ	3:A:361:HOH:O	2.52	0.42
1:A:57:LEU:HD11	1:A:71:ASP:HB2	2.02	0.42
1:A:29:SER:HB3	1:A:30:PRO:HA	2.02	0.41
1:A:47:LEU:HD22	1:A:79:LEU:HD21	2.01	0.41
1:A:220:SER:O	1:A:224:LEU:HG	2.21	0.41
1:A:214:GLU:HA	1:A:215:PRO:HD3	1.87	0.41
1:A:47:LEU:HD11	1:A:210:ILE:HG21	2.02	0.41
1:A:45:LYS:O	1:A:82:GLY:HA2	2.21	0.40
1:A:58:ARG:HB2	1:A:174:ALA:O	2.21	0.40
1:A:223:VAL:O	1:A:223:VAL:HG12	2.21	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	252/259 (97%)	244 (97%)	7 (3%)	1 (0%)	34 37

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	65	ALA

### 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	221/224 (99%)	215 (97%)	6 (3%)	44 57

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	39	LYS
1	A	53	GLN
1	A	58	ARG
1	A	79	LEU
1	A	229	LEU
1	A	255	GLN

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	53	GLN
1	A	67	ASN
1	A	74	GLN
1	A	136	GLN
1	A	137	GLN

### 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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

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 [i](#)

There are no such residues in this entry.

## 5.8 Polymer linkage issues [i](#)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	A	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	125:THR	C	127:LYS	N	2.18

## 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, 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	256/259 (98%)	-0.71	0 <b>100</b> <b>100</b>	3, 13, 24, 28	0

There are no RSRZ outliers to report.

### 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 monosaccharides 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(Å <sup>2</sup> )	Q<0.9
2	ZN	A	262	1/1	1.00	0.02	8,8,8,8	0

### 6.5 Other polymers [i](#)

There are no such residues in this entry.