



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 24, 2026 – 09:29 PM EDT

PDB ID : 1CAO / pdb_00001cao
Title : CRYSTALLOGRAPHIC STUDIES OF THE BINDING OF PROTONATED AND UNPROTONATED INHIBITORS TO CARBONIC ANHYDRASE USING HYDROGEN SULPHIDE AND NITRATE ANIONS
Authors : Mangani, S.; Hakansson, K.
Deposited on : 1992-07-02
Resolution : 1.90 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

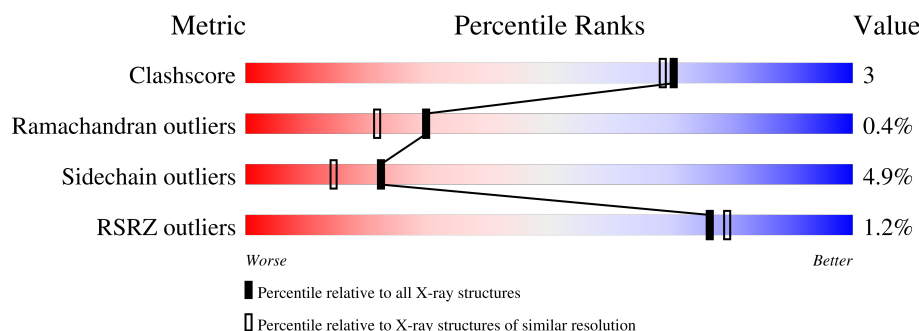
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.90 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	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)
RSRZ outliers	180081	7790 (1.90-1.90)

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	260	77% 20% .

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 2306 atoms, of which 1 is hydrogen 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.

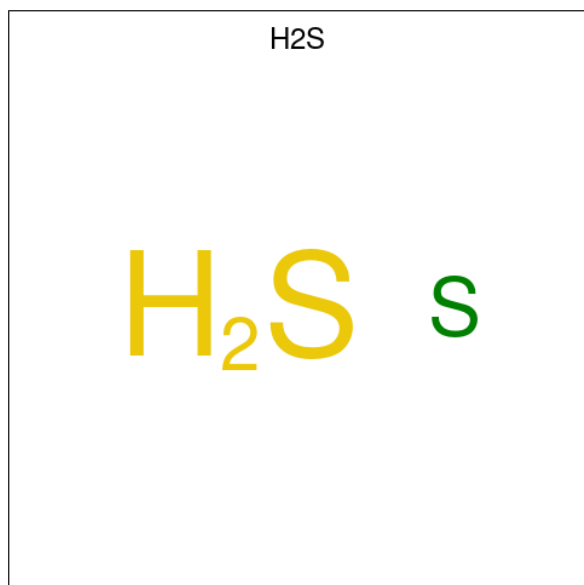
- Molecule 1 is a protein called CARBONIC ANHYDRASE II.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	260	Total	C	H	N	O	S	0	1	1
			2074	1330	1	358	383	2			

- Molecule 2 is ZINC ION (CCD ID: ZN) (formula: Zn).

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

- Molecule 3 is HYDROSULFURIC ACID (CCD ID: H2S) (formula: H₂S).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	S	0	0
			1	1		

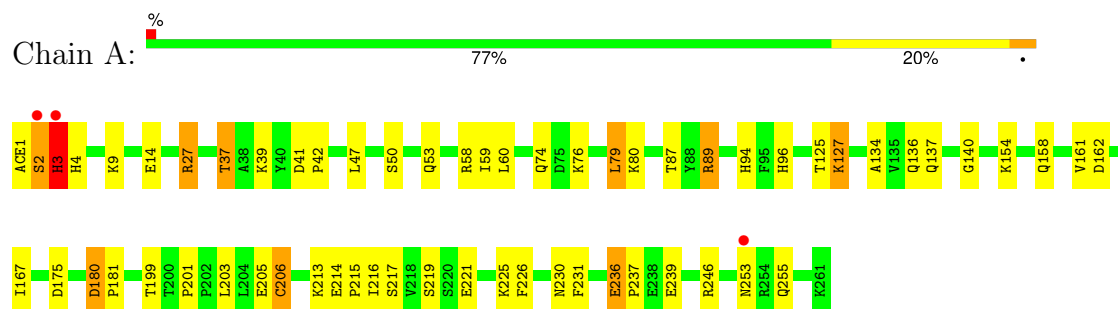
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	230	Total 230	O 230	0	0

3 Residue-property plots

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 II



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	42.70Å 41.70Å 73.00Å 90.00° 104.60° 90.00°	Depositor
Resolution (Å)	(Not available) – 1.90 70.64 – 1.90	Depositor EDS
% Data completeness (in resolution range)	(Not available) ((Not available)-1.90) 94.4 (70.64-1.90)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.72 (at 1.84Å)	Xtriage
Refinement program	PROFFT	Depositor
R, R_{free}	0.146 , (Not available) 0.143 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	12.7	Xtriage
Anisotropy	0.104	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 70.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.044 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	2306	wwPDB-VP
Average B, all atoms (Å ²)	15.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.06% 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

Bond lengths and bond angles in the following residue types are not validated in this section: H2S, ZN, ACE

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	1.10	0/2138	1.90	45/2900 (1.6%)

There are no bond length outliers.

All (45) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	2	SER	CA-C-N	12.37	145.17	121.54
1	A	2	SER	C-N-CA	12.37	145.17	121.54
1	A	14	GLU	CB-CG-CD	10.04	129.66	112.60
1	A	4	HIS	CA-CB-CG	9.31	123.11	113.80
1	A	230	ASN	CA-CB-CG	9.18	121.78	112.60
1	A	3	HIS	N-CA-C	-8.06	93.63	110.80
1	A	27	ARG	CA-CB-CG	8.05	130.20	114.10
1	A	58	ARG	N-CA-CB	-7.77	99.51	111.56
1	A	158	GLN	OE1-CD-NE2	-7.51	115.09	122.60
1	A	221	GLU	CG-CD-OE1	7.51	135.66	118.40
1	A	3	HIS	CA-C-O	-7.05	110.43	120.51
1	A	219	SER	CA-C-O	6.72	129.65	121.72
1	A	226	PHE	CA-CB-CG	6.46	120.27	113.80
1	A	236	GLU	N-CA-C	-6.45	101.95	110.40
1	A	87	THR	CA-CB-OG1	-6.36	100.07	109.60
1	A	96	HIS	CA-CB-CG	-6.21	107.59	113.80
1	A	236	GLU	CG-CD-OE1	6.18	132.61	118.40
1	A	89	ARG	NE-CZ-NH2	-6.12	113.69	119.20
1	A	53	GLN	OE1-CD-NE2	6.06	128.66	122.60
1	A	37	THR	CB-CA-C	5.95	120.01	109.65
1	A	216	ILE	CA-C-N	-5.95	113.29	122.87
1	A	216	ILE	C-N-CA	-5.95	113.29	122.87
1	A	137	GLN	O-C-N	5.91	127.30	121.57
1	A	231	PHE	CA-CB-CG	5.90	119.70	113.80

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	221	GLU	O-C-N	5.60	128.54	122.15
1	A	180	ASP	CB-CA-C	5.59	116.37	110.17
1	A	206	CYS	N-CA-CB	-5.56	102.04	111.27
1	A	154	LYS	CA-C-O	5.51	124.66	119.59
1	A	80	LYS	CA-C-O	-5.49	115.43	121.31
1	A	246	ARG	CA-C-O	5.48	125.29	120.19
1	A	180	ASP	CA-CB-CG	5.47	118.07	112.60
1	A	217	SER	CA-CB-OG	-5.43	100.25	111.10
1	A	136	GLN	OE1-CD-NE2	-5.40	117.20	122.60
1	A	37	THR	CA-CB-CG2	5.36	119.61	110.50
1	A	74	GLN	OE1-CD-NE2	5.31	127.91	122.60
1	A	94	HIS	CA-CB-CG	-5.30	108.50	113.80
1	A	53	GLN	CG-CD-NE2	-5.25	108.53	116.40
1	A	199	THR	CA-CB-CG2	5.20	119.34	110.50
1	A	53	GLN	CB-CG-CD	-5.19	103.78	112.60
1	A	180	ASP	CA-C-O	5.18	124.36	119.59
1	A	37	THR	N-CA-CB	-5.18	102.82	110.53
1	A	175	ASP	CB-CG-OD1	5.15	130.25	118.40
1	A	27	ARG	NH1-CZ-NH2	-5.15	112.61	119.30
1	A	50	SER	CA-CB-OG	-5.12	100.86	111.10
1	A	127	LYS	CA-CB-CG	5.02	124.13	114.10

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	2073	1	2017	14	2
2	A	1	0	0	0	0
3	A	1	0	0	0	0
4	A	230	0	0	1	2
All	All	2305	1	2017	14	2

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 3.

All (14) 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:27:ARG:HG3	1:A:205:GLU:HB3	1.90	0.53
1:A:59:ILE:HG12	1:A:167:ILE:HD13	1.93	0.51
1:A:161:VAL:CG1	1:A:225:LYS:HD2	2.42	0.49
1:A:206:CYS:HB3	4:A:498:HOH:O	2.13	0.49
1:A:134:ALA:O	1:A:140:GLY:HA3	2.13	0.48
1:A:201:PRO:HA	1:A:203:LEU:HG	1.94	0.48
1:A:236:GLU:HB3	1:A:237:PRO:CD	2.44	0.47
1:A:236:GLU:HB3	1:A:237:PRO:HD2	1.98	0.45
1:A:180:ASP:HA	1:A:181:PRO:HD2	1.92	0.43
1:A:41:ASP:HA	1:A:42:PRO:HD2	1.86	0.43
1:A:214:GLU:HA	1:A:215:PRO:HD3	1.87	0.43
1:A:47:LEU:HD22	1:A:79:LEU:HD21	2.00	0.43
1:A:89:ARG:HG3	1:A:125:THR:CG2	2.50	0.41
1:A:2:SER:OG	1:A:3:HIS:O	2.39	0.40

All (2) 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:1:ACE:C	4:A:426:HOH:O[1_655]	1.40	0.80
1:A:162:ASP:OD2	4:A:373:HOH:O[2_445]	2.14	0.06

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	258/260 (99%)	248 (96%)	9 (4%)	1 (0%)	30 22

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	3	HIS

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	225/224 (100%)	214 (95%)	11 (5%)	22 14

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	9	LYS
1	A	37	THR
1	A	39	LYS
1	A	60	LEU
1	A	76	LYS
1	A	79	LEU
1	A	127	LYS
1	A	213	LYS
1	A	239	GLU
1	A	253	ASN
1	A	255	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	67	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](#)

Of 2 ligands modelled in this entry, 1 is monoatomic and 1 is modelled with single atom - 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	1:ACE	C	2:SER	N	2.46

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	259/260 (99%)	-0.66	3 (1%) 76 79	3, 12, 26, 35	3 (1%)

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	2	SER	4.3
1	A	3	HIS	3.6
1	A	253	ASN	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(Å ²)	Q<0.9
3	H2S	A	263	1/1	0.97	0.15	25,25,25,25	0
2	ZN	A	262	1/1	0.98	0.03	9,9,9,9	0

6.5 Other polymers [i](#)

There are no such residues in this entry.