



# Full wwPDB X-ray Structure Validation Report ⓘ

Nov 25, 2024 – 02:59 PM EST

PDB ID : 1HLB  
Title : Structural analysis of monomeric hemichrome and dimeric cyanomet hemoglobins from *Caudina arenicola*  
Authors : Hackert, M.L.; Mitchell, D.T.  
Deposited on : 1994-03-22  
Resolution : 2.50 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  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtriage (Phenix) : 1.21  
EDS : 3.0  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
CCP4 : 9.0.004 (Gargrove)  
Density-Fitness : 1.0.11  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.40

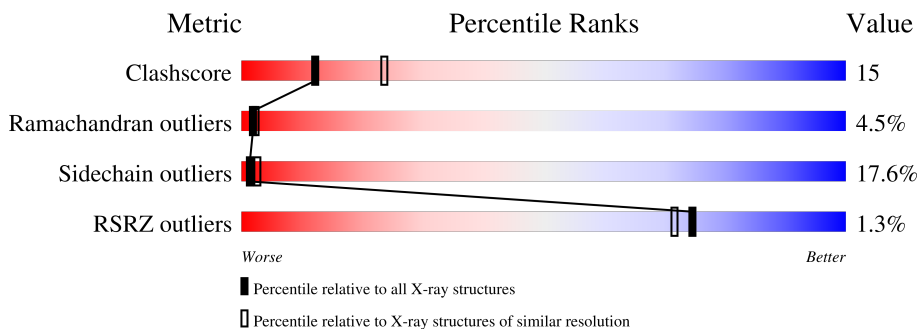
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.50 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	180529	6282 (2.50-2.50)
Ramachandran outliers	177936	6191 (2.50-2.50)
Sidechain outliers	177891	6193 (2.50-2.50)
RSRZ outliers	164620	5504 (2.50-2.50)

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  $\leq 5\%$ .

Mol	Chain	Length	Quality of chain
1	A	158	

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 1901 atoms, of which 511 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 HEMOGLOBIN (DEOXY).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace	
			Total	C	H	N	O				S
1	A	158	1525	781	289	219	230	6	0	0	0

- Molecule 2 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula:  $C_{34}H_{32}FeN_4O_4$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	
			Total	C	Fe	N			O
2	A	1	43	34	1	4	4	0	0

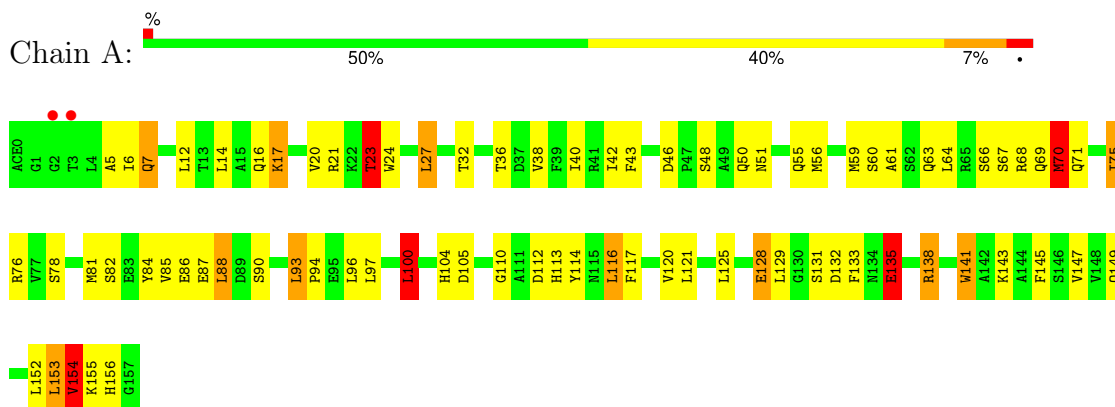
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf	
			Total	H			O
3	A	111	333	222	111	0	0

### 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. 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. 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: HEMOGLOBIN (DEOXY)



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	45.74Å 45.23Å 40.92Å 90.00° 104.40° 90.00°	Depositor
Resolution (Å)	5.00 – 2.50 5.00 – 2.50	Depositor EDS
% Data completeness (in resolution range)	(Not available) (5.00-2.50) 85.7 (5.00-2.50)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.78 (at 2.51Å)	Xtrriage
Refinement program	X-PLOR	Depositor
R, $R_{free}$	0.150 , (Not available) 0.246 , (Not available)	Depositor DCC
$R_{free}$ test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	38.8	Xtrriage
Anisotropy	0.098	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.08 , 31.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.91	EDS
Total number of atoms	1901	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	31.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 12.18% 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 [i](#)

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

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

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	0.82	0/1255	1.77	26/1692 (1.5%)

There are no bond length outliers.

All (26) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	154	VAL	CA-C-N	-12.70	89.26	117.20
1	A	76	ARG	NE-CZ-NH1	11.59	126.09	120.30
1	A	84	TYR	CB-CG-CD2	-10.08	114.95	121.00
1	A	154	VAL	CA-CB-CG2	-10.01	95.89	110.90
1	A	76	ARG	NE-CZ-NH2	-9.91	115.35	120.30
1	A	24	TRP	CD1-CG-CD2	9.06	113.55	106.30
1	A	153	LEU	CA-C-N	-8.58	98.33	117.20
1	A	141	TRP	CD1-CG-CD2	8.57	113.15	106.30
1	A	153	LEU	N-CA-C	8.39	133.65	111.00
1	A	154	VAL	N-CA-C	8.33	133.49	111.00
1	A	24	TRP	CE2-CD2-CG	-8.02	100.88	107.30
1	A	141	TRP	CE2-CD2-CG	-7.95	100.94	107.30
1	A	154	VAL	CA-CB-CG1	7.61	122.32	110.90
1	A	100	LEU	CA-CB-CG	7.10	131.63	115.30
1	A	154	VAL	O-C-N	6.83	133.63	122.70
1	A	56	MET	CA-CB-CG	6.44	124.25	113.30
1	A	155	LYS	N-CA-C	-6.20	94.27	111.00
1	A	154	VAL	CA-C-O	6.14	132.99	120.10
1	A	27	LEU	N-CA-CB	-5.83	98.74	110.40
1	A	70	MET	CA-CB-CG	5.71	123.02	113.30
1	A	96	LEU	CA-CB-CG	5.67	128.34	115.30
1	A	23	THR	N-CA-CB	-5.56	99.74	110.30
1	A	135	GLU	N-CA-C	5.51	125.89	111.00
1	A	24	TRP	CG-CD1-NE1	-5.49	104.61	110.10

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	141	TRP	CB-CG-CD1	-5.39	119.99	127.00
1	A	138	ARG	NE-CZ-NH2	-5.06	117.77	120.30

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	1236	289	1248	37	0
2	A	43	0	30	2	0
3	A	111	222	0	4	0
All	All	1390	511	1278	39	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 15.

All (39) 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:42:ILE:HG23	1:A:116:LEU:HD22	1.70	0.74
1:A:154:VAL:HG22	1:A:156:HIS:HB2	1.70	0.74
1:A:67:SER:HB3	1:A:70:MET:HB2	1.74	0.69
1:A:23:THR:HG21	1:A:141:TRP:HE1	1.59	0.67
1:A:125:LEU:HD23	3:A:231:HOH:O	1.94	0.66
1:A:104:HIS:HD1	1:A:114:TYR:HH	1.49	0.60
1:A:23:THR:CG2	1:A:141:TRP:HE1	2.16	0.59
1:A:82:SER:O	1:A:86:GLU:HG3	2.02	0.58
1:A:97:LEU:HD13	1:A:152:LEU:HD21	1.88	0.55
1:A:90:SER:O	1:A:93:LEU:HB2	2.08	0.54
1:A:97:LEU:HA	1:A:100:LEU:HD13	1.90	0.54
1:A:36:THR:O	1:A:40:ILE:HG12	2.08	0.53
1:A:143:LYS:O	1:A:147:VAL:HG23	2.10	0.51
1:A:145:PHE:O	1:A:149:GLN:HB2	2.10	0.51
1:A:16:GLN:O	1:A:20:VAL:HG12	2.10	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:129:LEU:HD12	1:A:133:PHE:HD1	1.77	0.50
1:A:132:ASP:HB2	3:A:171:HOH:O	2.12	0.49
1:A:27:LEU:HD13	1:A:128:GLU:HG3	1.93	0.49
1:A:40:ILE:HG23	1:A:64:LEU:HD23	1.94	0.48
1:A:21:ARG:HA	1:A:85:VAL:HG13	1.96	0.48
1:A:66:SER:HB2	3:A:243:HOH:O	2.12	0.48
1:A:154:VAL:CG2	1:A:156:HIS:HB2	2.43	0.47
1:A:48:SER:HA	1:A:51:ASN:OD1	2.14	0.47
1:A:38:VAL:HG13	1:A:120:VAL:HG12	1.98	0.45
1:A:43:PHE:HB3	1:A:50:GLN:HG2	1.99	0.45
1:A:12:LEU:H	1:A:17:LYS:HZ1	1.63	0.45
1:A:60:SER:HB3	3:A:253:HOH:O	2.17	0.44
1:A:59:MET:HB3	1:A:63:GLN:HG3	2.01	0.43
1:A:105:ASP:CG	1:A:154:VAL:HG21	2.40	0.43
1:A:12:LEU:HD23	1:A:16:GLN:HB3	2.02	0.42
1:A:46:ASP:HB2	1:A:116:LEU:HD11	2.01	0.42
2:A:158:HEM:HMC2	2:A:158:HEM:HBC2	2.01	0.42
1:A:71:GLN:O	1:A:75:ILE:HG13	2.20	0.42
1:A:117:PHE:CE2	1:A:121:LEU:HD12	2.56	0.41
1:A:42:ILE:HD13	1:A:42:ILE:HG21	1.90	0.41
1:A:85:VAL:HA	1:A:88:LEU:HD23	2.03	0.41
1:A:110:GLY:H	1:A:113:HIS:CD2	2.39	0.41
2:A:158:HEM:HBB2	2:A:158:HEM:HMB2	2.02	0.40
1:A:43:PHE:CG	1:A:50:GLN:HG2	2.57	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	156/158 (99%)	137 (88%)	12 (8%)	7 (4%)	<b>2</b> <b>2</b>



All (7) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	135	GLU
1	A	153	LEU
1	A	5	ALA
1	A	61	ALA
1	A	154	VAL
1	A	7	GLN
1	A	14	LEU

### 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	131/131 (100%)	108 (82%)	23 (18%)	<b>1</b> <b>2</b>

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

Mol	Chain	Res	Type
1	A	6	ILE
1	A	7	GLN
1	A	17	LYS
1	A	23	THR
1	A	32	THR
1	A	55	GLN
1	A	68	ARG
1	A	69	GLN
1	A	70	MET
1	A	75	ILE
1	A	78	SER
1	A	81	MET
1	A	87	GLU
1	A	88	LEU
1	A	93	LEU
1	A	94	PRO
1	A	100	LEU
1	A	112	ASP

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Mol	Chain	Res	Type
1	A	116	LEU
1	A	128	GLU
1	A	131	SER
1	A	135	GLU
1	A	138	ARG

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	134	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](#)

1 ligand is modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
2	HEM	A	158	1	42,50,50	1.89	15 (35%)	46,82,82	2.08	12 (26%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	HEM	A	158	1	-	5/12/54/54	-

All (15) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	158	HEM	C3B-C4B	-3.53	1.38	1.44
2	A	158	HEM	C1B-NB	-3.45	1.34	1.40
2	A	158	HEM	CBB-CAB	3.13	1.45	1.30
2	A	158	HEM	C3C-CAC	-3.02	1.40	1.47
2	A	158	HEM	C1D-C2D	-2.97	1.38	1.44
2	A	158	HEM	CHB-C1B	2.85	1.41	1.34
2	A	158	HEM	C4D-ND	-2.65	1.35	1.40
2	A	158	HEM	C4D-C3D	-2.64	1.40	1.45
2	A	158	HEM	CBC-CAC	2.63	1.45	1.29
2	A	158	HEM	CAB-C3B	-2.58	1.40	1.47
2	A	158	HEM	CHA-C4D	2.57	1.40	1.34
2	A	158	HEM	C1B-C2B	-2.52	1.39	1.44
2	A	158	HEM	C4B-NB	-2.30	1.34	1.38
2	A	158	HEM	C1D-ND	-2.23	1.34	1.38
2	A	158	HEM	O2D-CGD	-2.13	1.23	1.30

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	158	HEM	C4C-CHD-C1D	6.62	131.29	122.56
2	A	158	HEM	CAD-C3D-C4D	4.92	133.27	124.70
2	A	158	HEM	C4B-CHC-C1C	4.60	128.62	122.56
2	A	158	HEM	CBD-CAD-C3D	3.93	123.39	112.53
2	A	158	HEM	CBA-CAA-C2A	3.90	119.09	112.54
2	A	158	HEM	CMC-C2C-C3C	3.46	131.60	124.68
2	A	158	HEM	CAD-C3D-C2D	-3.18	121.91	127.87
2	A	158	HEM	C4A-C3A-C2A	-2.75	105.08	107.00
2	A	158	HEM	C3B-C4B-NB	2.68	111.39	109.47
2	A	158	HEM	C3B-C2B-C1B	-2.08	104.85	106.41
2	A	158	HEM	O2A-CGA-CBA	2.02	120.39	114.00
2	A	158	HEM	CHA-C4D-ND	-2.01	121.89	124.37

There are no chirality outliers.

All (5) torsion outliers are listed below:

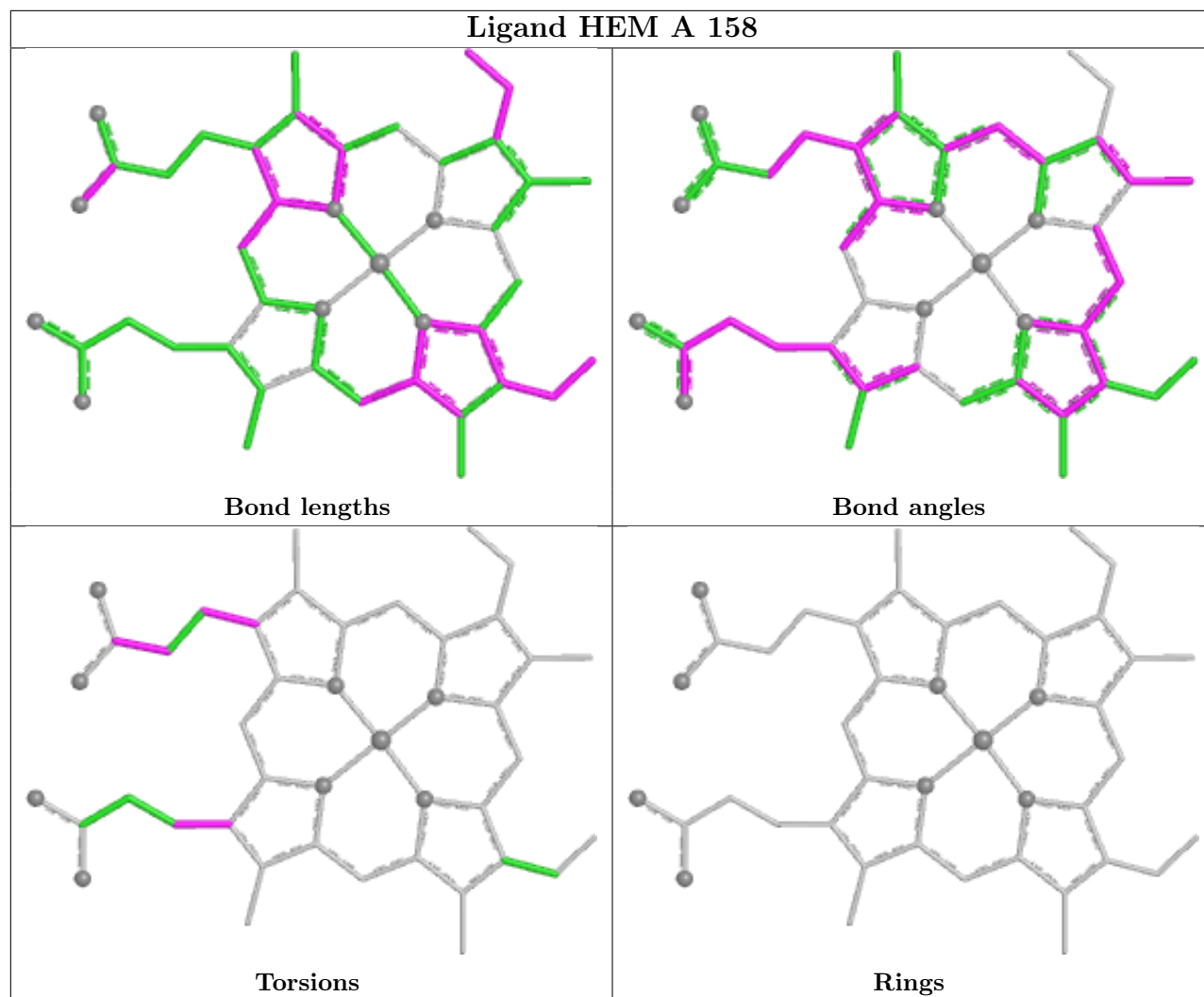
Mol	Chain	Res	Type	Atoms
2	A	158	HEM	C2D-C3D-CAD-CBD
2	A	158	HEM	C4D-C3D-CAD-CBD
2	A	158	HEM	C1A-C2A-CAA-CBA
2	A	158	HEM	CAD-CBD-CGD-O1D
2	A	158	HEM	CAD-CBD-CGD-O2D

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	158	HEM	2	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



## 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](#)

**Warning:** The R factor obtained from EDS is 0.2437, which does not match the depositor's R factor of 0.15. Please interpret the results in this section carefully.

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	157/158 (99%)	-0.46	2 (1%) 74 71	13, 32, 66, 82	0

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	2	GLY	2.8
1	A	3	THR	2.2

### 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.

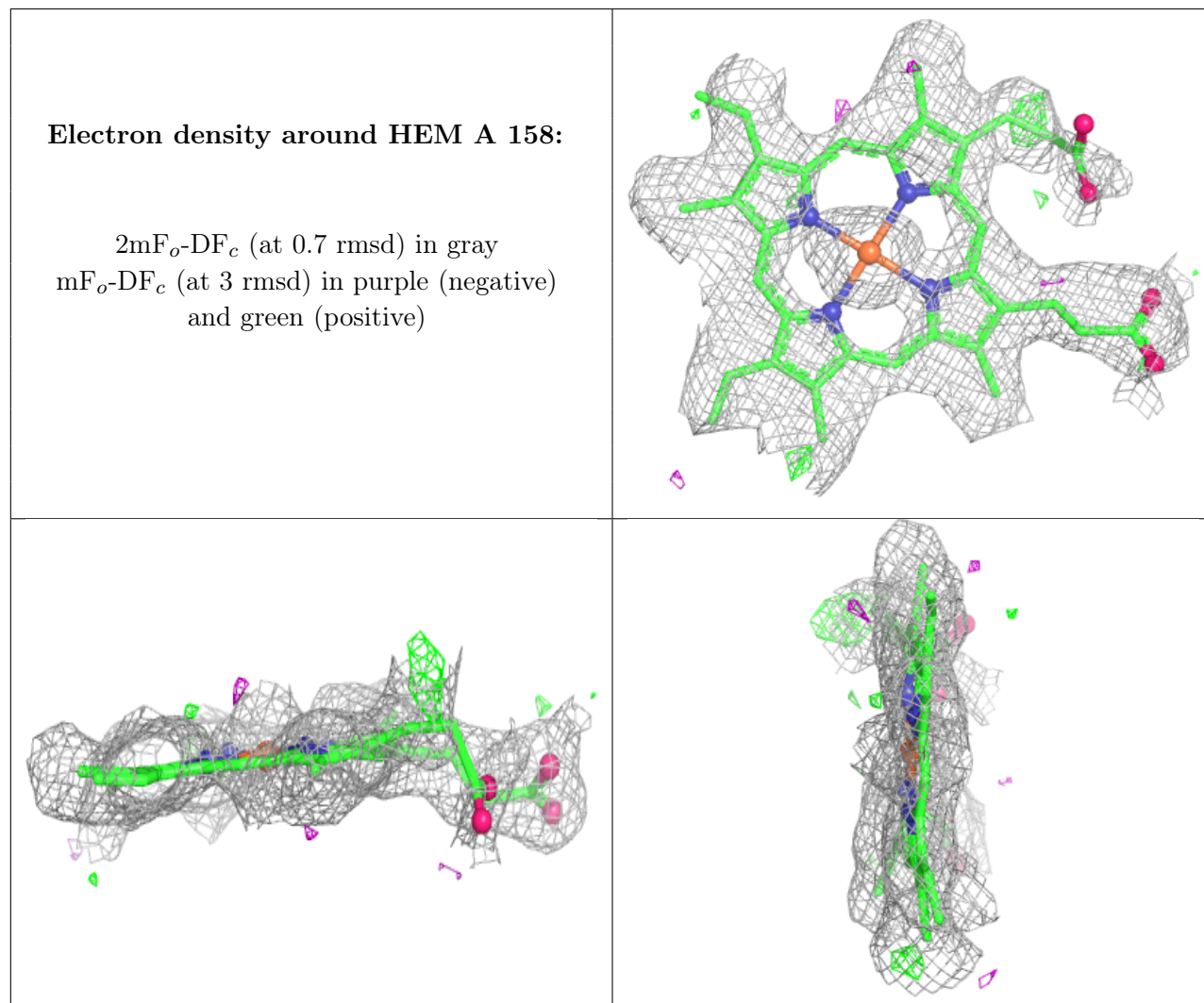
### 6.4 Ligands [i](#)

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	HEM	A	158	43/43	0.91	0.08	20,34,52,62	0

The following is a graphical depiction of the model fit to experimental electron density of all

instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.



## 6.5 Other polymers [i](#)

There are no such residues in this entry.