WORLDWIDE wwPDB PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report (i)

Nov 16, 2023 – 02:38 AM JST

PDB ID	:	6KH0
Title	:	Design and crystal structure of protein MOFs with ferritin nanocages as linkers and nickel clusters as nodes
Authors	:	Gu, C.; Zhang, T.; Zhao, G.
Deposited on	:	2019-07-12
Resolution	:	2.00 Å(reported)

The following versions of software and data (see references (i)) were used in the production of this report:

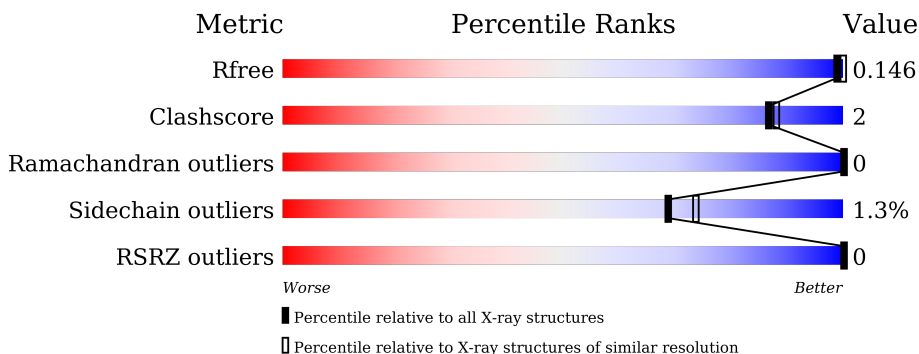|		
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation 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 2.00 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	Percentile Ranks	Value
Rfree		0.146
Clashscore		2
Ramachandran outliers		0
Sidechain outliers		1.3%
RSRZ outliers		0

Worse   Better

▮ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	8085 (2.00-2.00)
Clashscore	141614	9178 (2.00-2.00)
Ramachandran outliers	138981	9054 (2.00-2.00)
Sidechain outliers	138945	9053 (2.00-2.00)
RSRZ outliers	127900	7900 (2.00-2.00)

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 <=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	170	96% ·
1	B	170	94% 6%
1	C	170	94% 6%
1	D	170	93% 6% ·
1	E	170	96% ·
1	F	170	93% 6% ·

2 Entry composition ⓘ

There are 3 unique types of molecules in this entry. The entry contains 18402 atoms, of which 8174 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 Ferritin.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	170	Total 2759	C 879	H 1355	N 235	O 283	S 7	0	9	0
1	B	170	Total 2812	C 893	H 1382	N 244	O 286	S 7	0	14	0
1	C	170	Total 2797	C 890	H 1377	N 240	O 283	S 7	0	11	0
1	D	170	Total 2727	C 870	H 1341	N 234	O 275	S 7	0	4	0
1	E	170	Total 2767	C 881	H 1360	N 237	O 282	S 7	0	9	0
1	F	170	Total 2760	C 880	H 1359	N 235	O 279	S 7	0	7	0

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	159	HIS	-	insertion	UNP T2B7E1
A	160	HIS	THR	engineered mutation	UNP T2B7E1
B	159	HIS	-	insertion	UNP T2B7E1
B	160	HIS	THR	engineered mutation	UNP T2B7E1
C	159	HIS	-	insertion	UNP T2B7E1
C	160	HIS	THR	engineered mutation	UNP T2B7E1
D	159	HIS	-	insertion	UNP T2B7E1
D	160	HIS	THR	engineered mutation	UNP T2B7E1
E	159	HIS	-	insertion	UNP T2B7E1
E	160	HIS	THR	engineered mutation	UNP T2B7E1
F	159	HIS	-	insertion	UNP T2B7E1
F	160	HIS	THR	engineered mutation	UNP T2B7E1

- Molecule 2 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total 1	Fe 1	0	0
2	B	1	Total 1	Fe 1	0	0
2	C	1	Total 1	Fe 1	0	0
2	D	1	Total 1	Fe 1	0	0
2	E	1	Total 1	Fe 1	0	0
2	F	1	Total 1	Fe 1	0	0

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	304	Total 304	O 304	0	0
3	B	274	Total 274	O 274	0	0
3	C	308	Total 308	O 308	0	0
3	D	291	Total 291	O 291	0	0
3	E	312	Total 312	O 312	0	0
3	F	285	Total 285	O 285	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.
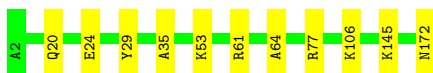
- Molecule 1: Ferritin

Chain A:

- Molecule 1: Ferritin

Chain B:

- Molecule 1: Ferritin

Chain C:

- Molecule 1: Ferritin

Chain D:

- Molecule 1: Ferritin

Chain E:

- Molecule 1: Ferritin

Chain F:

A2 Q20 E24 Y29 A35 Y36 K53 R61 S111 L115 H116 S117 N172

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	I 4	Depositor
Cell constants a, b, c, α, β, γ	125.30Å 125.30Å 175.66Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.95 – 2.00 29.95 – 2.00	Depositor EDS
% Data completeness (in resolution range)	99.9 (29.95-2.00) 99.9 (29.95-2.00)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	930.23 (at 2.00Å)	Xtriage
Refinement program	PHENIX 1.14_3260	Depositor
R, R_{free}	0.101 , 0.141 0.105 , 0.146	Depositor DCC
R_{free} test set	2009 reflections (2.21%)	wwPDB-VP
Wilson B-factor (Å^2)	21.4	Xtriage
Anisotropy	0.117	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.40 , 46.1	EDS
L-test for twinning[2]	$< |L| > = 0.41, < L^2 > = 0.24$	Xtriage
Estimated twinning fraction	0.068 for -1/2*h+1/2*k-1/2*l,1/2*h-1/2*k-1/2*l,-h-k 0.065 for -1/2*h+1/2*k+1/2*l,1/2*h-1/2*k+1/2*l,h+k 0.059 for -1/2*h-1/2*k+1/2*l,-1/2*h-1/2*k-1/2*l,h-k 0.064 for -1/2*h-1/2*k-1/2*l,-1/2*h-1/2*k+1/2*l,-h+k 0.209 for -h,k,-l	Xtriage
Reported twinning fraction	0.230 for -h,k,-l	Depositor
Outliers	0 of 90893 reflections	Xtriage
F_o,F_c correlation	0.98	EDS
Total number of atoms	18402	wwPDB-VP
Average B, all atoms (Å^2)	24.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.05% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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: FE

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	0.40	0/1457	0.51	0/1958
1	B	0.35	0/1494	0.49	0/2007
1	C	0.41	0/1478	0.59	2/1986 (0.1%)
1	D	0.36	0/1424	0.51	1/1913 (0.1%)
1	E	0.39	0/1461	0.52	0/1964
1	F	0.56	3/1447 (0.2%)	0.60	3/1945 (0.2%)
All	All	0.42	3/8761 (0.0%)	0.54	6/11773 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	F	0	2

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	F	117[A]	SER	CA-C	6.61	1.70	1.52
1	F	117[B]	SER	CA-C	6.61	1.70	1.52
1	F	24	GLU	CD-OE2	-5.70	1.19	1.25

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(º)	Ideal(º)
1	C	62[A]	GLU	CA-CB-CG	-7.03	97.93	113.40
1	C	62[B]	GLU	CA-CB-CG	-7.03	97.93	113.40
1	F	36	TYR	CB-CA-C	5.30	121.00	110.40
1	D	61	ARG	NE-CZ-NH1	-5.08	117.76	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	F	117[A]	SER	CB-CA-C	-5.06	100.49	110.10

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	F	117[A]	SER	Mainchain
1	F	117[B]	SER	Mainchain

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	1404	1355	1339	5	1
1	B	1430	1382	1349	8	0
1	C	1420	1377	1353	4	0
1	D	1386	1341	1341	9	0
1	E	1407	1360	1342	4	0
1	F	1401	1359	1353	5	1
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
2	E	1	0	0	0	0
2	F	1	0	0	0	0
3	A	304	0	0	5	9
3	B	274	0	0	2	4
3	C	308	0	0	0	1
3	D	291	0	0	6	10
3	E	312	0	0	1	9
3	F	285	0	0	3	5
All	All	10228	8174	8077	34	22

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 2.

The worst 5 of 34 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:F:172:ASN:ND2	3:F:301:HOH:O	2.07	0.85
1:D:11:GLU:OE1	3:D:301:HOH:O	2.10	0.69
1:D:61:ARG:HD2	3:D:438:HOH:O	1.96	0.66
1:D:169:LYS:NZ	3:D:306:HOH:O	2.31	0.63
1:A:11[B]:GLU:OE2	3:A:301:HOH:O	2.15	0.63

The worst 5 of 22 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)
3:A:351:HOH:O	3:E:527:HOH:O[7_545]	1.98	0.22
3:C:410:HOH:O	3:D:548:HOH:O[3_555]	1.98	0.22
1:A:69:LYS:NZ	1:F:36:TYR:CE1[4_555]	2.04	0.16
3:D:322:HOH:O	3:E:338:HOH:O[4_555]	2.06	0.14
3:B:502:HOH:O	3:B:502:HOH:O[2_655]	2.07	0.13

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	177/170 (104%)	174 (98%)	3 (2%)	0	100	100
1	B	181/170 (106%)	177 (98%)	4 (2%)	0	100	100
1	C	178/170 (105%)	174 (98%)	4 (2%)	0	100	100
1	D	172/170 (101%)	169 (98%)	3 (2%)	0	100	100
1	E	177/170 (104%)	174 (98%)	3 (2%)	0	100	100
1	F	175/170 (103%)	171 (98%)	4 (2%)	0	100	100
All	All	1060/1020 (104%)	1039 (98%)	21 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	154/146 (106%)	153 (99%)	1 (1%)	86	90
1	B	157/146 (108%)	155 (99%)	2 (1%)	69	74
1	C	156/146 (107%)	153 (98%)	3 (2%)	57	61
1	D	150/146 (103%)	148 (99%)	2 (1%)	69	74
1	E	154/146 (106%)	153 (99%)	1 (1%)	86	90
1	F	152/146 (104%)	150 (99%)	2 (1%)	69	74
All	All	923/876 (105%)	912 (99%)	11 (1%)	69	76

5 of 11 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	172	ASN
1	E	29	TYR
1	F	115	LEU
1	F	29	TYR
1	C	115	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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 monosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 6 ligands modelled in this entry, 6 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 ⓘ

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(Å²)	Q<0.9
1	A	170/170 (100%)	-0.38	0	100	100	14, 19, 32, 41	0
1	B	170/170 (100%)	-0.46	0	100	100	14, 19, 32, 40	0
1	C	170/170 (100%)	-0.45	0	100	100	14, 19, 31, 42	0
1	D	170/170 (100%)	-0.43	0	100	100	14, 18, 31, 43	0
1	E	170/170 (100%)	-0.45	0	100	100	13, 19, 30, 38	1 (0%)
1	F	170/170 (100%)	-0.44	0	100	100	15, 19, 31, 41	0
All	All	1020/1020 (100%)	-0.43	0	100	100	13, 19, 31, 43	1 (0%)

There are no RSRZ outliers to report.

6.2   Non-standard residues in protein, DNA, RNA chains   ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3   Carbohydrates   ⓘ

There are no monosaccharides in this entry.

6.4   Ligands   ⓘ

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(Å²)	Q<0.9
2	FE	E	201	1/1	0.95	0.07	34,34,34,34	1

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	FE	D	201	1/1	0.96	0.07	38,38,38,38	1
2	FE	B	201	1/1	0.98	0.09	31,31,31,31	1
2	FE	C	201	1/1	0.98	0.10	32,32,32,32	1
2	FE	F	201	1/1	0.98	0.09	26,26,26,26	1
2	FE	A	201	1/1	0.99	0.05	31,31,31,31	1

6.5 Other polymers ⓘ

There are no such residues in this entry.